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Part 2: MPI Functions

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Part 2: MPI Functions

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Abstract

This report describes the second part of the performance analysis of `Talbot Suite` by means of TAU (Tuning and Analysis Utilities) tools. `Talbot Suite` is a parallel software collection developed by the authors for the numerical inversion of Laplace Transform on recent advanced architectures. `Talbot Suite` deals with both single and multi-point inversion problems and collects *Open MP* functions for shared memory machines and *MPI* functions for distributed memory one. It integrates a first version of a hybrid implementation too. This report presents only performance measurements of the MPI functions on a specific architecture: a Blade Server.

1 Introduction

`Talbot Suite` [1] is part of `Parallel Inverse Laplace Transform Package`[1], a set of sequential and parallel software based on different numerical methods for inverting Laplace Transform (LT) on high performance architectures. We note that at our knowledge, there are not parallel software for LT inversion (for more details, see [1]).
`Talbot Suite`'s algorithms are based on two versions of the Talbot's method in order to deal with single and multi-point inversion problems. The original version has been proposed by Talbot [4], and it produces approximations for $f(t)$ when numerical values of its Laplace Transform function:

$$F(s) = \int_0^\infty f(t)e^{-st}dt, \quad Re(s) > \sigma_0, \tag{1}$$

are available for all complex s. Generally, the numerical inversion of (1) consists in computing an approximation to $f(t)$ from a finite values of $F(s)$, starting from the Riemann's Inversion Formula on the Bromwich contour $B = \{s \in \mathbb{C} : Re(s) = \sigma \wedge Im(s) \in \Re\}$:

$$f(t) = \frac{1}{2\pi i}\int_B F(s)e^{st}ds. \tag{2}$$

[1] `PILTPack` is a work in progress project involving research studies and experiences of the authors. `PILTPack` collects different suites, each one is based on different method for the numerical inversion of Laplace Transform. In this report we discuss only about `Talbot Suite`.

In particular, Talbot's method belongs to the class of inversion methods based on the integration of (2) along a special contour. The underlying idea is to apply the composite trapezoidal rule in ordert to approximate (2) by a sum (of Chebyshev-Clenshaw kind) as follows:

$$f(t) \approx \widetilde{f(t)} = \lambda\, e^{\sigma t}\, \frac{1}{N} \left(\frac{\nu}{2} e^{\lambda t} F(\sigma + \lambda) + \sum_{j=1}^{N-1} (x_j \cos \phi_j - y_j \sin \phi_j) \right) = \lambda\, e^{\sigma t}\, \frac{T_N(t)}{N} \qquad (3)$$

where λ, σ, ν, are the Talbot's *geometrical parameters*, N is the number of nodes in the quadrature rule (the *accuracy parameter*), depending on t and on the singularities of $F(s)$, $\phi_j = \lambda t \nu \pi j / N$, x_j, y_j depend on j, on t, on geometrical parameters and on values of F along the contour. For more details on theoretical aspects we address to [4].
In `Talbot Suite` designing two version of Talbot's method have been employed as well as different parallel programming models have been used for the implementation. Tuning and performance analysis of `Talbot Suite`'s functions have been carried out with several tests to put in evidence (and then correct) performance problems (bottleneck, poor performance, load imbalance) on recent advanced architectures. Performance analysis has been performed using TAU[2]. Since TAU is able to track performance data of programs written in different (parallel) programming models in execution on several computing environments, it has been a suitable framework for examining our suite.
For the sake of brevity, in this report only the TAU results about MPI functions of `Talbot Suite` are shown. In [2] performance measurements about OMP functions are shown.

2 Talbot Suite

2.1 Parallel Algorithms

`Talbot Suite` deals with both single and multi-point inversion problems (that occurs in solution of partial or ordinary differential equation). For multi-point inversion a different version of the Talbot's method was implemented, the so-called *Modified* Talbot method. The *Modified* algorithm approximates the inverse LT function $f(t)$ at several values of t in the interval supplied using a fixed set of parameters, estimated at an optimal $t^\star$. In [6] the root mean square error is proved to be minimum provided that parameters are chosen for $t^\star$ equal to the midpoint of the interval enclosing the interval supplied.
The *Classical* and the *Modified* Talbot's method led respectively to two different strategies of parallelism:

- *Modified* Talbot: a coarse grain parallelism is realised by means of a distribution of the t values subsets (*data partitioning*) among the available processes;
- *Classical* Talbot: a fine grain parallelism is realised introducing the parallel Goertzel-Reinsh algorithm (as described in [7]) for evaluating a single Clenshaw sum (*task parallelism*).

[2]TAU (Tuning and Analysis Utilities) Performance System [8, 9, 10] is a robust, flexible, portable and integrated framework and toolkit for performance instrumentation, measurement, analysis and visualization of large-scale parallel computer system and application. TAU project is a product that gathers the researchers effort at University of Oregon, at the Research Centre Juelich and Los Alamos National Laboratory.

In this way, the functions of `Talbot Suite` are organised in two branches, one is based on the *Classical* algorithm and the second on the *Modified* one. A sketch of the two parallel algorithms is shown in **Algorithm 2** and **Algorithm 1** respectively. Since the two proposed parallel strategies may be combined together, we implemented in `Talbot Suite` a hybrid parallel algorithm depicted in **Algorithm 3**.

Algorithm 1: Coarse grain parallelism

Input: LT function $F(s)$, `NTval`=number of t values, $\mathbb{T} = \{t_1, \ldots, t_{\texttt{NTval}}\}$, error tolerance, singularities of F, midpoint $t^\star$ of $\mathbb{T}$, number of processes np

Output: $\widetilde{f(t)}, \quad \forall t \in \mathbb{T}$

1: compute λ, σ, ν, N for $t = t^\star$;
for *each process* i *:* $i = 0, 1, \ldots, np-1$ **do**
  2.1: compute $\texttt{NTval}_{\text{loc}}(i)$, the local number of t values;
  2.2: define $\mathbb{T}_i$, the local set of t values;
  2.3: **for** *each value* $t \in \mathbb{T}_i$ **do**
    compute $\widetilde{f(t)}$;
  end
end

Algorithm 2: Fine grain parallelism

Input: LT function $F(s)$, t, error tolerance, singularities of F, number of processes np

Output: $\widetilde{f(t)}$

1: compute λ, σ, ν, N;
2: compute $\widetilde{f(t)}$ in parallel.

`Talbot Suite` aims at recent advanced architectures, thus we provided versions of the two algorithms described above for both shared and distributed memory machines. We used *Open MP* [12] for the shared memory machines and *MPI* for the distributed memory one. Furthermore, the two levels hybrid parallel version uses MPI for the *coarse-grain parallelism* (data partitioning) and OMP for the *fine-grain parallelism* (parallel summation).
For more details see [1]. In this report we analyse only pure MPI functions.

Functions organisation of `Talbot Suite`, according to our conventions defined for `PILTPack`, is the following:

- `user_level:` one single driver function for inverting at one single or multi points;
- `skill_level:` two computational functions, the former for computation of the parameters method-based and the second for the numerical evaluation of the inverse LT.

We remark that each driver function includes the corresponding two skill-level functions. In this way, skill user can manage directly the two computational functions according to own goals.

Algorithm 3: Hybrid two-level parallelism

Input: LT function $F(s)$, `NTval`=number of t values, $\mathbb{T} = \{t_1, \ldots, t_{\texttt{NTval}}\}$, error tolerance, singularities of F, midpoint t^star of $\mathbb{T}$, number of processes np

Output: $\widetilde{f(t)}, \ \forall t \in \mathbb{T}$

1: compute λ, σ, ν, N for $t = t^\star$;

for *each process* i *:* $i = 0, 1, \ldots, np-1$ **do**

2.1: compute $\texttt{NTval}_{\text{loc}}(i)$, the local number of the t values;

2.2: define the local set of t values $\mathbb{T}_i$;

2.3: for *each value* $t \in \mathbb{T}_i$ **do**

compute $\widetilde{f(t)}$ in parallel;

end

end

2.2 Suite Organization and Conventions Assumed

To define a standard notation, we adopted a common name style for the `Talbot Suite`'s functions[3]. The driver functions have been named as follows:

`VERSION_Method strategy`

where:

- `VERSION` is one among `MPI` (pure MPI), `OMP` (pure OMP), `HYB` (hybrid);
- `Method` is `Talbot`;
- `strategy` is either `1` for **Algorithm 1** (for functions implementing the *coarse grain parallelism*) or `2` for **Algorithm 2** (for functions implementing the *fine grain parallelism*) or `3` for **Algorithm 3** (for functions implementing hybrid strategy).

For instance, `MPI_Talbot2` refers to the MPI parallel version (`MPI`) of the *Classical* Talbot's method with the *fine grain parallelism* (with the parallelism performed in the summation process).
A sketch of the organization of `Talbot Suite`'s functions is shown in Figure 1.
Driver functions prototypes have been defined so that arguments common to all versions and algorithms are listed first - input parameters, then output ones - followed by arguments related to the specific method and version. For instance, we have:

```
int VERSION_Talbot_strategy(double complex (*LTpt)(double complex s),
                  double sigma0,unsigned int NTval,double *Tval,double tol,
                  double *NUMft,int *IFAIL,unsigned int NSING,double complex *SING,
                  unsigned int *MULT,algorithm parameters,version parameters);
```

where:

- `LTpt (I)`: pointer to a Laplace Transform;

[3]This name style has been adopted also in the other suites of `PILTPack`.

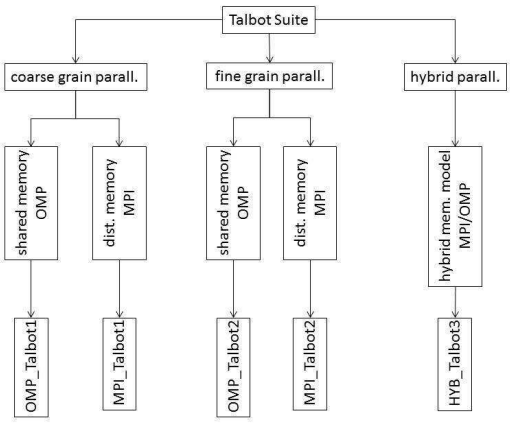


Figure 1: *Organization of* `Talbot Suite`*'s functions.*

- `sigma0 (I)`: abscissa of convergence;
- `NTval (I)`: number of points where inversion is required;
- `Tval (I)`: pointer to values where inversion is required;
- `tol (I)`: error threshold ;
- `NUMft (O)`: pointer to inverse Laplace Transform;
- `IFAIL (O)`: pointer to error flags;
- `NSINGS (I)`: number of singularities of function LTpt;
- `SING (I)`: pointer to singularities;
- `MULT (I)`: pointer to singularities multiplicities.

At skill level, the function evaluating Talbot's parameters is sequential and is used both **Algorithm 1** and **Algorithm 2**. It is named:

`TAPAR`

Whereas, we adopted a common name-style for the functions that evaluate the inverse Laplace transform as follows[4]:

[4]We are on going to define a common name-style like:

`Method_parameters`

for the functions that carry out parameters method-based. For instance, in `Talbot Suite` there will be `Talbot_parameters` instead of `TAPAR`.

`VERSION_TSUMxx`

where:

- `VERSION` is one among `MPI` (pure MPI), `OMP` (pure OMP), `HYB` (hybrid);
- `xx` is either `1` for **Algorithm 1** (for functions implementing the *coarse grain parallelism*) or `2` **Algorithm 2** (for functions implementing the *fine grain parallelism*) or `12` for the hybrid strategy.

For instance, `MPI_TSUM2` is the computational function for the parallel implementation of Goertzel-Reinsch algorithm using `MPI` and "2" denotes the *fine grain parallelism*.

3 Test Cases

Several LT $F(s)$, with known inverse functions $f(t)$, have been selected to test `Talbot Suite`. In this report we selected one test function [11]:

$$F_{24} = \frac{1}{(s^2+9)^2}, \quad f_{24} = tsin(3t)/6, \tag{4}$$

with complex singularities. In this case, the number of terms in the Clenshaw sum may becomes very large. The function name implementing F_{24} in (4) is `F24`. Two intervals in which t is sampled, have been chosen: $\mathtt{T_1} = [10, 50]$ and $\mathtt{T_2} = [1000, 3000]$; they refer to small and large values of t, in order to imply an increasing number of addends in the final sum. For both intervals $\mathtt{T_1}$ and $\mathtt{T_2}$, we analysed two problems: the first test requires the inversion of LT in a few values (`NTval=10`) and the second test in a greater number of t (`NTval=100`). In such a way we reproduced the following situations for a better comparison between the two parallel strategies:

- `NTval=10`, much less values of t than addends in summations;
- `NTval=100`, much more values of t than addends in summations.

All the experiments have been carried out on a HP Blade Server installed at Università di Napoli "Parthenope". It consists of 4 blades each one equipped with an Intel Quad-Core Xeon E5540 2.53 GHz processor and the Hyper-Threading Technology. Each blade has 6 GB of RAM and three levels of cache memory: 8 MB L3 cache memory shared among cores and 256KB L2 and 32KB L1 cache memory per core. Blades are connected via a 1 Gigabit Ethernet network. In Figure 2 a sketch of one of the blade is reported. Since on each blade of the system is equipped with four cores, each one with two PUs, different strategies for mapping MPI processes can be considered. We tested three mapping strategies: the first one (named *node mapping*) maps one process to each blade, so that a single core is activated on each processor. When the number of processes exceeds the the numbers of blade, two processes are assigned and so on. The second strategy (named *core mapping*) fills up each blade up to the core level, that is one blade is involved while the number of processes is lower of or equal to 4. The third strategy (named *PU mapping*) fills up each blade up to the PU level, so one blade is involved for a number of processes ranging from 1 to 8; in this case

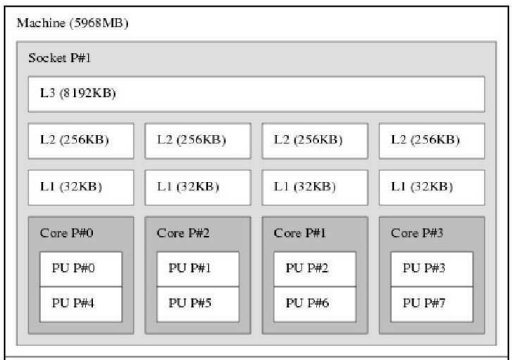


Figure 2: *Blade scheme*

hyper-threading is employed and the function `MPI_Init_Thread` is used with `MPI_THREAD_MULTIPLE` as desired level of thread support[5].

[5] `MPI_Init_Thread` initializes MPI environment in the same way that a call to `MPI_INIT` would. In addition, it initializes the thread environment. The argument required is used to specify the desired level of thread support. The possible values are listed in increasing order of thread support:

- `MPI_THREAD_SINGLE`, only one thread will execute.
- `MPI_THREAD_FUNNELED`, the process may be multi-threaded, but only the main thread will make MPI calls (all MPI calls are "funneled" to the main thread).
- `MPI_THREAD_SERIALIZED`, the process may be multi-threaded, and multiple threads may make MPI calls, but only one at a time: MPI calls are not made concurrently from two distinct threads (all MPI calls are "serialized").
- `MPI_THREAD_MULTIPLE`, multiple threads may call MPI, with no restrictions.

4 Performance Analysis with TAU Tools

In order to analyse performance behaviours of `Talbot Suite`'s functions by means of TAU tools, we had to insert additional instructions into the source code. This process is named *instrumentation*. We used the automatic instrumentation of the source code by means of PDT[6] framework as well as the *manual* instrumentation [8, 10] in order to customize the profiling (e.g. for deleting argument list in the profile tables). Furthermore, we enabled the *callpath* profile[7] setting the following TAU environmental variables:

- `TAU_CALLPATH = 1` (enabling callpath);

In the callpath profile, TAU displays for each test the following metrics:

- `%Time` - percentage of the "total" time spent in this function and its children;
- `Exclusive msec` - cumulative, exclusive time (milliseconds) summed over all the invocations of the functions. Exclusive time refers to the total time spent in the function minus any time spent in other profiled functions called from it;
- `Inclusive msec` - time spent from the entry point to the exit, summed over all the function invocations;
- `#Call` - number of function invocations;
- `#Subrs` - number of invocated functions (multiple invocations are accounted);
- `Inclusive usec/call` - inclusive time for call (microseconds);

Last column of the callpath profile is `Name` showing the analysed function name. Moreover, since we enabled the *callpath* in TAU profiling, the `Name` column displays also the symbol "a() => b()" describing the time spent (exclusive/inclusive) in routine "b()" when it is called by routine "a()".

4.1 Talbot Suite's MPI Functions

In this section we describe some profiling tests run on `Talbot Suite`'s MPI functions. Details on performance measurements carried out with TAU tools are described in subsection 4.1.1 for `MPI_Talbot1` and in subsection 4.1.2 for `MPI_Talbot2` respectively. We performed for both driver functions the following tests:

TEST 1 `MPI_Talbotx` with *Input Data*: Test Function n. 24, `NTval` = `10`, `T1` interval.

TEST 2 `MPI_Talbotx` with *Input Data*: Test Function n. 24, `NTval` = `100`, `T1` interval.

TEST 3 `MPI_Talbotx` with *Input Data*: Test Function n. 24, `NTval` = `10`, `T2` interval.

TEST 4 `MPI_Talbotx` with *Input Data*: Test Function n. 24, `NTval` = `100`, `T2` interval.

[6] Program Database Toolkit (PDT) is a framework for analysing source code included in TAU distribution.

[7] *Callpath profile* table tracks time spent in function paths rather than time spent in each function as shown in a table like *flat profile*. We point out that a flat profile can be constructed from a path profile, but not vice versa.

TEST 1 and **TEST 3** concern the multi-point inversion of LT on few values of t, (`NTval` = 10), and require a small or large number of addens in the Clenshaw summation respectively, whereas **TEST 2** and **TEST 4** concern the multi-point inversion of LT on a greater number of t (`NTval` = 100), and require small or large number of addens in Clenshaw summation respectively. In details for each test the total number of addens, $\mathbf{N} = \sum_i^{Ntval} N_i$ is shown in the following table:

	`MPI_Talbot1` **N**	`MPI_Talbot2` **N**
TEST 1	1480	1442
TEST 2	14800	14488
TEST 3	545997	2434700
TEST 4	18199900	23330900

The number of addens in **TEST 3** for `MPI_Talbot2` and in **TEST 4** for both driver functions leads to the *throttling*[8] of the function `F24` in TAU profiling. In order to avoid this, we set the TAU environmental variable, `TAU_THROTTLE_NUMCALLS`, in **TEST 3** to 2.500.000 and in **TEST 4** to 20.000.000 and 25.000.000 for `MPI_Talbot1` and `MPI_Talbot2` respectively.
For each test we analysed performances with the callpath profile tables and the graph of the inclusive execution time running the code with 1, 4 and 8 number of processes according to *node mapping*. Moreover, we compared *node mapping* against *core mapping*, and in this report we show the results by means of the graph of the inclusive execution time only for 8 processes. We note that *thread comparison window* of TAU[9] is displayed in the graph of the exclusive execution time, where we can observe a comparative analysis based on individual processes of execution. When the number of processes is greater than one, the *thread comparison window* shows the (inclusive) execution time for each process in each function and the time percentage with respect to process 0.

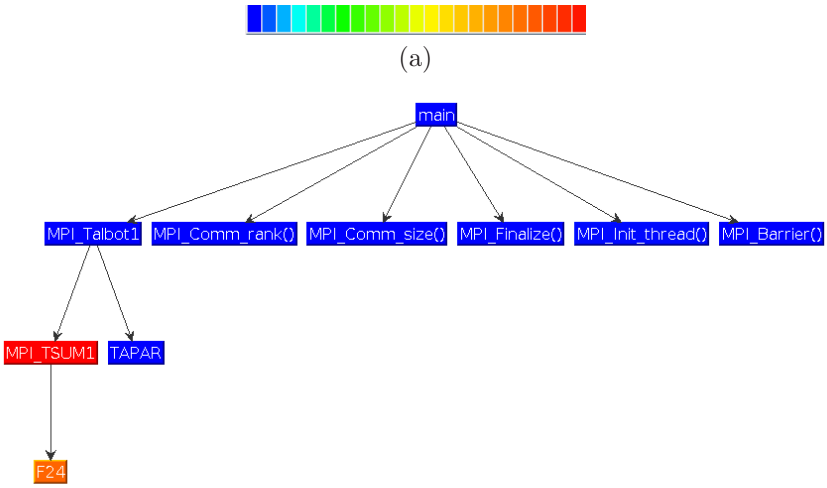
4.1.1 MPI_Talbot1

`MPI_Talbot1` driver function is the MPI implementation of **Algorithm 1**. It calls the two skill-level functions `TAPAR` and `MPI_TSUM1`. Figure 3 depicts a general case of the execution time distribution when running `MPI_Talbot1` on one process. So, we set `TAU_CALLPATH_DEPTH = 5` according to call tree depth of driver.

In the following, we reported the performance analysis of `MPI_Talbot1` in the four tests described above, by means callpath profile and the corresponding *thread comparison window*. We can summarize that `MPI_Talbot1` does not exhibit performance problems. In particular, **TEST 1** and **TEST 3** (concerning with `NTval` = 10 on `T1` and `T2` respectively) exhibit a balanced computational load among the processes as well as a reduction of the execution time with respect to number of processes (increasing speedup). Similar results can be observed on **TEST 2** and **TEST 4** (concerning

[8] In order to reduce profiling overhead, TAU does not profile (*throttles*) functions with short execution time and a large number of calls. Default values are less than 10 microseconds per call inclusive time, and 100000 per number of calls.

[9] The graphical analysis in TAU is supported by `ParaProf` (Parallel Analysis Profile) included in the TAU distribution.



(a)

(b)

Figure 3: *Call Graph of* `MPI_Talbot1` *(b), legend colour of increasing (exclusive) execution time (a).*

with `NTval` = 100 on `T1` and `T2` respectively). At last, we can observe in figures 6, 9, 12 an 15 that the execution tests don't show considerable differences about performance results of `MPI_Talbot1` on the two mapping used.

You can find the details about the results about `MPI_Talbot1` on a specific test searching the point list **TESTx - N. of Processes=y**, where **x**= 1, . . . , 4 and **y**=1,4,8.

TEST 1 `MPI_Talbot1` with *Input Data*: Test Function n. 24, `NTval` = 10, `T1` interval.

– **TEST 1 – N. of Processes =1** (see Figure 4)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.157            4           1           6       4366 main
 49.6            2            2           1           0       2165 MPI_Init_thread()
 49.6            2            2           1           0       2165 main => MPI_Init_thread()
 30.4        0.079            1           1           2       1329 MPI_Talbot1
 30.4        0.079            1           1           2       1329 main => MPI_Talbot1
 27.5        0.688            1           1        1480       1200 MPI_TSUM1
 27.5        0.688            1           1        1480       1200 main => MPI_Talbot1 => MPI_TSUM1
 14.6        0.637        0.637           1           0        637 MPI_Finalize()
 14.6        0.637        0.637           1           0        637 main => MPI_Finalize()
 11.7        0.512        0.512        1480           0          0 F24
```

```
 11.7        0.512        0.512        1480           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  1.1         0.05         0.05           1           0         50 TAPAR
  1.1         0.05         0.05           1           0         50 main => MPI_Talbot1 => TAPAR
  0.7        0.031        0.031           1           0         31 MPI_Barrier()
  0.7        0.031        0.031           1           0         31 main => MPI_Barrier()
  0.6        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.6        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.5        0.021        0.021           1           0         21 MPI_Comm_size()
  0.5        0.021        0.021           1           0         21 main => MPI_Comm_size()
```

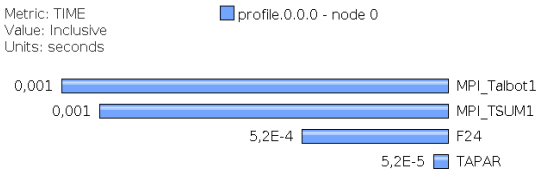


Figure 4: `MPI_Talbot1` on **TEST 1 - N. of Processes 1**: *Inclusive Time measured with TAU.*

– **TEST 1 – N. of Processes=4** (see Figure 5)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.223          105           1          15     105904 main
 96.6          102          102           1           0     102262 MPI_Init_thread()
 96.6          102          102           1           0     102262 main => MPI_Init_thread()
  1.5            1            1           1           0       1602 MPI_Barrier()
  1.5            1            1           1           0       1602 main => MPI_Barrier()
  0.8        0.839        0.839           1           0        839 MPI_Finalize()
  0.8        0.839        0.839           1           0        839 main => MPI_Finalize()
  0.6        0.086        0.594           1           2        594 MPI_Talbot1
  0.6        0.086        0.594           1           2        594 main => MPI_Talbot1
  0.4        0.259        0.456           1         444        456 MPI_TSUM1
  0.4        0.259        0.456           1         444        456 main => MPI_Talbot1 => MPI_TSUM1
  0.3        0.278        0.278           6           0         46 MPI_Recv()
  0.3        0.278        0.278           6           0         46 main => MPI_Recv()
  0.2        0.197        0.197         444           0          0 F24
  0.2        0.197        0.197         444           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.1        0.059        0.059           3           0         20 MPI_Send()
  0.1        0.059        0.059           3           0         20 main => MPI_Send()
  0.0        0.052        0.052           1           0         52 TAPAR
  0.0        0.052        0.052           1           0         52 main => MPI_Talbot1 => TAPAR
  0.0        0.024        0.024           1           0         24 MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 MPI_Comm_size()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
```

```
             msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.214            6           1           9       6877 main
 43.3            2            2           1           0       2977 MPI_Init_thread()
 43.3            2            2           1           0       2977 main => MPI_Init_thread()
 22.4            1            1           1           0       1539 MPI_Barrier()
 22.4            1            1           1           0       1539 main => MPI_Barrier()
 16.8            1            1           1           0       1153 MPI_Finalize()
 16.8            1            1           1           0       1153 main => MPI_Finalize()
  8.4        0.083        0.577           1           2        577 MPI_Talbot1
  8.4        0.083        0.577           1           2        577 main => MPI_Talbot1
  6.4        0.271        0.441           1         444        441 MPI_TSUM1
  6.4        0.271        0.441           1         444        441 main => MPI_Talbot1 => MPI_TSUM1
  3.3        0.227        0.227           2           0        114 MPI_Send()
  3.3        0.227        0.227           2           0        114 main => MPI_Send()
  2.5         0.17         0.17         444           0          0 F24
  2.5         0.17         0.17         444           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  2.1        0.142        0.142           1           0        142 MPI_Recv()
  2.1        0.142        0.142           1           0        142 main => MPI_Recv()
  0.8        0.053        0.053           1           0         53 TAPAR
  0.8        0.053        0.053           1           0         53 main => MPI_Talbot1 => TAPAR
  0.4        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.4        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.3        0.022        0.022           1           0         22 MPI_Comm_size()
  0.3        0.022        0.022           1           0         22 main => MPI_Comm_size()

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
             msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.225            6           1           9       6706 main
 43.9            2            2           1           0       2946 MPI_Init_thread()
 43.9            2            2           1           0       2946 main => MPI_Init_thread()
 23.5            1            1           1           0       1573 MPI_Barrier()
 23.5            1            1           1           0       1573 main => MPI_Barrier()
 20.0            1            1           1           0       1344 MPI_Finalize()
 20.0            1            1           1           0       1344 main => MPI_Finalize()
  7.0        0.086        0.471           1           2        471 MPI_Talbot1
  7.0        0.086        0.471           1           2        471 main => MPI_Talbot1
  4.9        0.206        0.331           1         296        331 MPI_TSUM1
  4.9        0.206        0.331           1         296        331 main => MPI_Talbot1 => MPI_TSUM1
  1.9        0.125        0.125         296           0          0 F24
  1.9        0.125        0.125         296           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.8        0.055        0.055           1           0         55 MPI_Recv()
  0.8        0.055        0.055           1           0         55 main => MPI_Recv()
  0.8        0.054        0.054           1           0         54 TAPAR
  0.8        0.054        0.054           1           0         54 main => MPI_Talbot1 => TAPAR
  0.7        0.044        0.044           2           0         22 MPI_Send()
  0.7        0.044        0.044           2           0         22 main => MPI_Send()
  0.4        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.4        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.3        0.023        0.023           1           0         23 MPI_Comm_size()
  0.3        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 3;CONTEXT 0;THREAD 0:
```

```
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.209          104           1           9     104940 main
 96.4         101          101           1           0     101179 MPI_Init_thread()
 96.4         101          101           1           0     101179 main => MPI_Init_thread()
  1.5           1            1           1           0       1604 MPI_Barrier()
  1.5           1            1           1           0       1604 main => MPI_Barrier()
  1.3           1            1           1           0       1335 MPI_Finalize()
  1.3           1            1           1           0       1335 main => MPI_Finalize()
  0.4       0.093        0.465           1           2        465 MPI_Talbot1
  0.4       0.093        0.465           1           2        465 main => MPI_Talbot1
  0.3       0.192        0.321           1         296        321 MPI_TSUM1
  0.3       0.192        0.321           1         296        321 main => MPI_Talbot1 => MPI_TSUM1
  0.1       0.129        0.129         296           0          0 F24
  0.1       0.129        0.129         296           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.0       0.051        0.051           1           0         51 MPI_Recv()
  0.0       0.051        0.051           1           0         51 TAPAR
  0.0       0.051        0.051           1           0         51 main => MPI_Recv()
  0.0       0.051        0.051           1           0         51 main => MPI_Talbot1 => TAPAR
  0.0        0.05         0.05           2           0         25 MPI_Send()
  0.0        0.05         0.05           2           0         25 main => MPI_Send()
  0.0       0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0       0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0       0.022        0.022           1           0         22 MPI_Comm_size()
  0.0       0.022        0.022           1           0         22 main => MPI_Comm_size()

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.871          224           4          42      56107 main
 93.3         209          209           4           0      52341 MPI_Init_thread()
 93.3         209          209           4           0      52341 main => MPI_Init_thread()
  2.8           6            6           4           0       1580 MPI_Barrier()
  2.8           6            6           4           0       1580 main => MPI_Barrier()
  2.1           4            4           4           0       1168 MPI_Finalize()
  2.1           4            4           4           0       1168 main => MPI_Finalize()
  0.9       0.348            2           4           8        527 MPI_Talbot1
  0.9       0.348            2           4           8        527 main => MPI_Talbot1
  0.7       0.928            1           4        1480        387 MPI_TSUM1
  0.7       0.928            1           4        1480        387 main => MPI_Talbot1 => MPI_TSUM1
  0.3       0.621        0.621        1480           0          0 F24
  0.3       0.621        0.621        1480           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.2       0.526        0.526           9           0         58 MPI_Recv()
  0.2       0.526        0.526           9           0         58 main => MPI_Recv()
  0.2        0.38         0.38           9           0         42 MPI_Send()
  0.2        0.38         0.38           9           0         42 main => MPI_Send()
  0.1        0.21         0.21           4           0         52 TAPAR
  0.1        0.21         0.21           4           0         52 main => MPI_Talbot1 => TAPAR
  0.0         0.1          0.1           4           0         25 MPI_Comm_rank()
  0.0         0.1          0.1           4           0         25 main => MPI_Comm_rank()
  0.0        0.09         0.09           4           0         22 MPI_Comm_size()
  0.0        0.09         0.09           4           0         22 main => MPI_Comm_size()
```

```
FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.218           56           1        10.5      56107 main
 93.3           52           52           1           0      52341 MPI_Init_thread()
 93.3           52           52           1           0      52341 main => MPI_Init_thread()
  2.8            1            1           1           0       1580 MPI_Barrier()
  2.8            1            1           1           0       1580 main => MPI_Barrier()
  2.1            1            1           1           0       1168 MPI_Finalize()
  2.1            1            1           1           0       1168 main => MPI_Finalize()
  0.9        0.087        0.527           1           2        527 MPI_Talbot1
  0.9        0.087        0.527           1           2        527 main => MPI_Talbot1
  0.7        0.232        0.387           1         370        387 MPI_TSUM1
  0.7        0.232        0.387           1         370        387 main => MPI_Talbot1 => MPI_TSUM1
  0.3        0.155        0.155         370           0          0 F24
  0.3        0.155        0.155         370           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.2        0.132        0.132        2.25           0         58 MPI_Recv()
  0.2        0.132        0.132        2.25           0         58 main => MPI_Recv()
  0.2        0.095        0.095        2.25           0         42 MPI_Send()
  0.2        0.095        0.095        2.25           0         42 main => MPI_Send()
  0.1       0.0525       0.0525           1           0         52 TAPAR
  0.1       0.0525       0.0525           1           0         52 main => MPI_Talbot1 => TAPAR
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0       0.0225       0.0225           1           0         22 MPI_Comm_size()
  0.0       0.0225       0.0225           1           0         22 main => MPI_Comm_size()
```

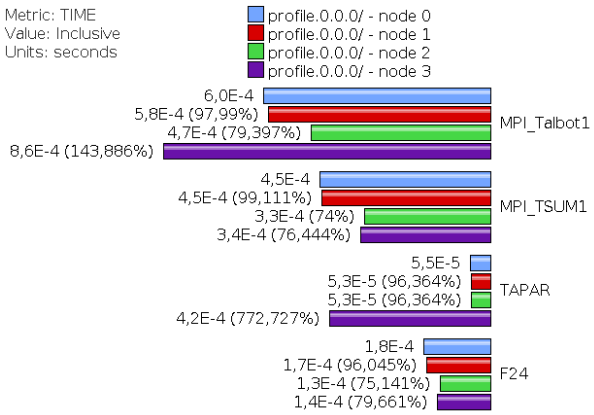


Figure 5: `MPI_Talbot1` on **TEST 1 - N. of Processes 4**: *Inclusive Time measured with TAU.*

– **TEST 1 – N. of Processes=8** (see Figure 6)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
```

```
             msec   total msec                          usec/call
-------------------------------------------------------------------------------
100.0        0.257          110           1          27     110545 main
 95.6          105          105           1           0     105656 MPI_Init_thread()
 95.6          105          105           1           0     105656 main => MPI_Init_thread()
  2.0            2            2           1           0       2242 MPI_Barrier()
  2.0            2            2           1           0       2242 main => MPI_Barrier()
  0.9            1            1           1           0       1019 MPI_Finalize()
  0.9            1            1           1           0       1019 main => MPI_Finalize()
  0.6        0.652        0.652           7           0         93 MPI_Send()
  0.6        0.652        0.652           7           0         93 main => MPI_Send()
  0.4        0.079        0.467           1           2        467 MPI_Talbot1
  0.4        0.079        0.467           1           2        467 main => MPI_Talbot1
  0.3        0.194        0.319           1         296        319 MPI_TSUM1
  0.3        0.194        0.319           1         296        319 main => MPI_Talbot1 => MPI_TSUM1
  0.2        0.202        0.202          14           0         14 MPI_Recv()
  0.2        0.202        0.202          14           0         14 main => MPI_Recv()
  0.1        0.125        0.125         296           0          0 F24
  0.1        0.125        0.125         296           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.1        0.069        0.069           1           0         69 TAPAR
  0.1        0.069        0.069           1           0         69 main => MPI_Talbot1 => TAPAR
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 MPI_Comm_size()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_size()

NODE 1;CONTEXT 0;THREAD 0:
-------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
             msec   total msec                          usec/call
-------------------------------------------------------------------------------
100.0        0.216            7           1           9       7615 main
 37.0            2            2           1           0       2815 MPI_Init_thread()
 37.0            2            2           1           0       2815 main => MPI_Init_thread()
 27.3            2            2           1           0       2078 MPI_Barrier()
 27.3            2            2           1           0       2078 main => MPI_Barrier()
 24.8            1            1           1           0       1886 MPI_Finalize()
 24.8            1            1           1           0       1886 main => MPI_Finalize()
  6.1        0.078        0.462           1           2        462 MPI_Talbot1
  6.1        0.078        0.462           1           2        462 main => MPI_Talbot1
  4.3          0.2         0.33           1         296        330 MPI_TSUM1
  4.3          0.2         0.33           1         296        330 main => MPI_Talbot1 => MPI_TSUM1
  1.7         0.13         0.13         296           0          0 F24
  1.7         0.13         0.13         296           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.8        0.063        0.063           1           0         63 MPI_Recv()
  0.8        0.063        0.063           1           0         63 main => MPI_Recv()
  0.7        0.054        0.054           1           0         54 TAPAR
  0.7        0.054        0.054           1           0         54 main => MPI_Talbot1 => TAPAR
  0.6        0.049        0.049           2           0         24 MPI_Send()
  0.6        0.049        0.049           2           0         24 main => MPI_Send()
  0.3        0.024        0.024           1           0         24 MPI_Comm_rank()
  0.3        0.024        0.024           1           0         24 main => MPI_Comm_rank()
  0.3        0.022        0.022           1           0         22 MPI_Comm_size()
  0.3        0.022        0.022           1           0         22 main => MPI_Comm_size()

NODE 2;CONTEXT 0;THREAD 0:
```

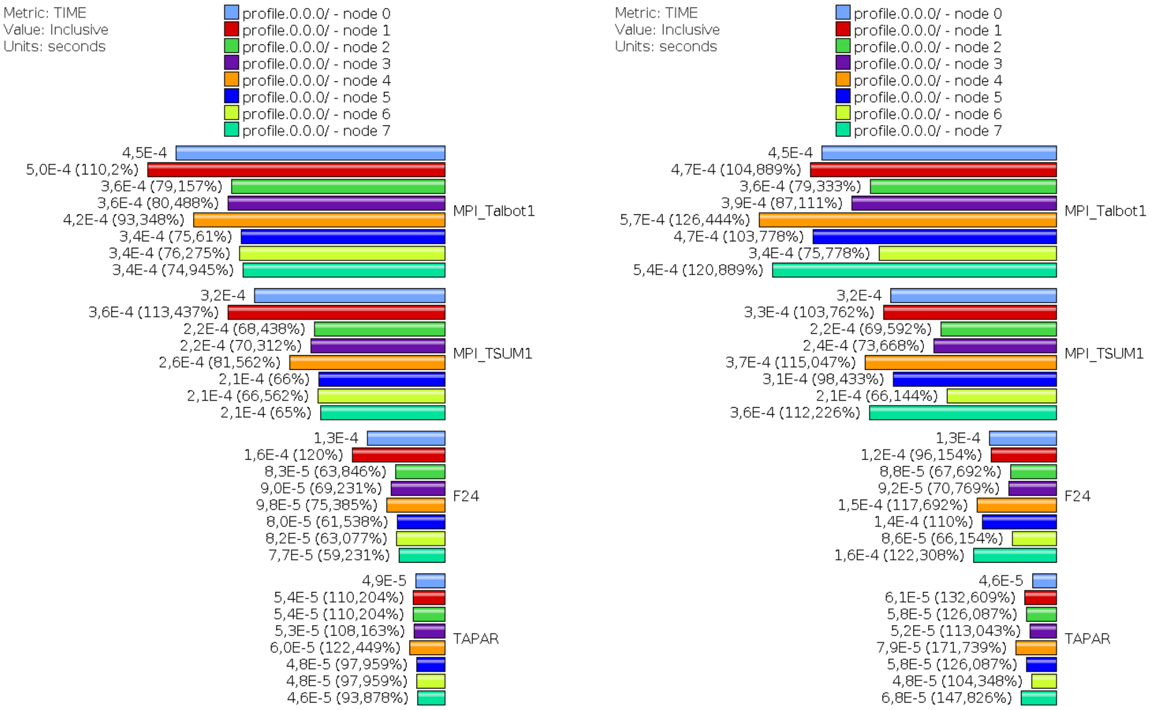
```
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.237          13           1           9     13426 main
 64.2            8           8           1           0      8623 MPI_Init_thread()
 64.2            8           8           1           0      8623 main => MPI_Init_thread()
 15.9            2           2           1           0      2136 MPI_Barrier()
 15.9            2           2           1           0      2136 main => MPI_Barrier()
 14.1            1           1           1           0      1896 MPI_Finalize()
 14.1            1           1           1           0      1896 main => MPI_Finalize()
  2.7        0.082       0.367           1           2       367 MPI_Talbot1
  2.7        0.082       0.367           1           2       367 main => MPI_Talbot1
  1.7        0.141       0.231           1         148       231 MPI_TSUM1
  1.7        0.141       0.231           1         148       231 main => MPI_Talbot1 => MPI_TSUM1
  0.7         0.09        0.09         148           0         1 F24
  0.7         0.09        0.09         148           0         1 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.6        0.081       0.081           1           0        81 MPI_Recv()
  0.6        0.081       0.081           1           0        81 main => MPI_Recv()
  0.4        0.054       0.054           1           0        54 TAPAR
  0.4        0.054       0.054           1           0        54 main => MPI_Talbot1 => TAPAR
  0.3        0.043       0.043           2           0        22 MPI_Send()
  0.3        0.043       0.043           2           0        22 main => MPI_Send()
  0.2        0.022       0.022           1           0        22 MPI_Comm_rank()
  0.2        0.022       0.022           1           0        22 main => MPI_Comm_rank()
  0.2        0.021       0.021           1           0        21 MPI_Comm_size()
  0.2        0.021       0.021           1           0        21 main => MPI_Comm_size()

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.286         109           1           9    109442 main
 95.6          104         104           1           0    104590 MPI_Init_thread()
 95.6          104         104           1           0    104590 main => MPI_Init_thread()
  2.0            2           2           1           0      2195 MPI_Barrier()
  2.0            2           2           1           0      2195 main => MPI_Barrier()
  1.5            1           1           1           0      1683 MPI_Finalize()
  1.5            1           1           1           0      1683 main => MPI_Finalize()
  0.3        0.084       0.373           1           2       373 MPI_Talbot1
  0.3        0.084       0.373           1           2       373 main => MPI_Talbot1
  0.2        0.144       0.231           1         148       231 MPI_TSUM1
  0.2        0.144       0.231           1         148       231 main => MPI_Talbot1 => MPI_TSUM1
  0.2        0.217       0.217           1           0       217 MPI_Recv()
  0.2        0.217       0.217           1           0       217 main => MPI_Recv()
  0.1        0.087       0.087         148           0         1 F24
  0.1        0.087       0.087         148           0         1 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.1        0.058       0.058           1           0        58 TAPAR
  0.1        0.058       0.058           1           0        58 main => MPI_Talbot1 => TAPAR
  0.0        0.051       0.051           2           0        26 MPI_Send()
  0.0        0.051       0.051           2           0        26 main => MPI_Send()
  0.0        0.025       0.025           1           0        25 MPI_Comm_rank()
  0.0        0.025       0.025           1           0        25 main => MPI_Comm_rank()
  0.0        0.022       0.022           1           0        22 MPI_Comm_size()
  0.0        0.022       0.022           1           0        22 main => MPI_Comm_size()
```

```
NODE 4;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.221           8           1           9       8848 main
 46.3            4           4           1           0       4099 MPI_Init_thread()
 46.3            4           4           1           0       4099 main => MPI_Init_thread()
 24.7            2           2           1           0       2183 MPI_Barrier()
 24.7            2           2           1           0       2183 main => MPI_Barrier()
 18.2            1           1           1           0       1610 MPI_Finalize()
 18.2            1           1           1           0       1610 main => MPI_Finalize()
  3.7        0.078        0.33           1           2        330 MPI_Talbot1
  3.7        0.078        0.33           1           2        330 main => MPI_Talbot1
  3.5        0.307       0.307           1           0        307 MPI_Recv()
  3.5        0.307       0.307           1           0        307 main => MPI_Recv()
  2.3        0.124       0.205           1         148        205 MPI_TSUM1
  2.3        0.124       0.205           1         148        205 main => MPI_Talbot1 => MPI_TSUM1
  0.9        0.081       0.081         148           0          1 F24
  0.9        0.081       0.081         148           0          1 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.5        0.048       0.048           2           0         24 MPI_Send()
  0.5        0.048       0.048           2           0         24 main => MPI_Send()
  0.5        0.047       0.047           1           0         47 TAPAR
  0.5        0.047       0.047           1           0         47 main => MPI_Talbot1 => TAPAR
  0.3        0.025       0.025           1           0         25 MPI_Comm_rank()
  0.3        0.025       0.025           1           0         25 MPI_Comm_size()
  0.3        0.025       0.025           1           0         25 main => MPI_Comm_rank()
  0.3        0.025       0.025           1           0         25 main => MPI_Comm_size()

NODE 5;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.221          14           1           9      14116 main
 65.8            9           9           1           0       9293 MPI_Init_thread()
 65.8            9           9           1           0       9293 main => MPI_Init_thread()
 14.8            2           2           1           0       2090 MPI_Barrier()
 14.8            2           2           1           0       2090 main => MPI_Barrier()
  9.7            1           1           1           0       1369 MPI_Finalize()
  9.7            1           1           1           0       1369 main => MPI_Finalize()
  5.0        0.711       0.711           1           0        711 MPI_Recv()
  5.0        0.711       0.711           1           0        711 main => MPI_Recv()
  2.4        0.078       0.336           1           2        336 MPI_Talbot1
  2.4        0.078       0.336           1           2        336 main => MPI_Talbot1
  1.5        0.134       0.209           1         148        209 MPI_TSUM1
  1.5        0.134       0.209           1         148        209 main => MPI_Talbot1 => MPI_TSUM1
  0.5        0.075       0.075         148           0          1 F24
  0.5        0.075       0.075         148           0          1 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.3        0.049       0.049           1           0         49 TAPAR
  0.3        0.049       0.049           1           0         49 main => MPI_Talbot1 => TAPAR
  0.3        0.047       0.047           2           0         24 MPI_Send()
  0.3        0.047       0.047           2           0         24 main => MPI_Send()
  0.2        0.025       0.025           1           0         25 MPI_Comm_rank()
  0.2        0.025       0.025           1           0         25 main => MPI_Comm_rank()
```

```
  0.2        0.024        0.024           1           0         24 MPI_Comm_size()
  0.2        0.024        0.024           1           0         24 main => MPI_Comm_size()

NODE 6;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.231           11           1           9     11805 main
 61.1            7            7           1           0      7215 MPI_Init_thread()
 61.1            7            7           1           0      7215 main => MPI_Init_thread()
 17.5            2            2           1           0      2060 MPI_Barrier()
 17.5            2            2           1           0      2060 main => MPI_Barrier()
 10.1            1            1           1           0      1191 MPI_Finalize()
 10.1            1            1           1           0      1191 main => MPI_Finalize()
  5.8        0.682        0.682           1           0       682 MPI_Recv()
  5.8        0.682        0.682           1           0       682 main => MPI_Recv()
  2.8         0.08        0.335           1           2       335 MPI_Talbot1
  2.8         0.08        0.335           1           2       335 main => MPI_Talbot1
  1.8        0.123        0.207           1         148       207 MPI_TSUM1
  1.8        0.123        0.207           1         148       207 main => MPI_Talbot1 => MPI_TSUM1
  0.7        0.084        0.084         148           0         1 F24
  0.7        0.084        0.084         148           0         1 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.4        0.048        0.048           1           0        48 TAPAR
  0.4        0.048        0.048           1           0        48 main => MPI_Talbot1 => TAPAR
  0.4        0.043        0.043           2           0        22 MPI_Send()
  0.4        0.043        0.043           2           0        22 main => MPI_Send()
  0.2        0.025        0.025           1           0        25 MPI_Comm_rank()
  0.2        0.025        0.025           1           0        25 main => MPI_Comm_rank()
  0.2        0.023        0.023           1           0        23 MPI_Comm_size()
  0.2        0.023        0.023           1           0        23 main => MPI_Comm_size()

NODE 7;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.219           10           1           9     10431 main
 53.9            5            5           1           0      5619 MPI_Init_thread()
 53.9            5            5           1           0      5619 main => MPI_Init_thread()
 20.8            2            2           1           0      2169 MPI_Barrier()
 20.8            2            2           1           0      2169 main => MPI_Barrier()
 12.7            1            1           1           0      1327 MPI_Finalize()
 12.7            1            1           1           0      1327 main => MPI_Finalize()
  6.4        0.672        0.672           1           0       672 MPI_Recv()
  6.4        0.672        0.672           1           0       672 main => MPI_Recv()
  3.2         0.08        0.335           1           2       335 MPI_Talbot1
  3.2         0.08        0.335           1           2       335 main => MPI_Talbot1
  2.0        0.132        0.207           1         148       207 MPI_TSUM1
  2.0        0.132        0.207           1         148       207 main => MPI_Talbot1 => MPI_TSUM1
  0.7        0.075        0.075         148           0         1 F24
  0.7        0.075        0.075         148           0         1 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.5        0.048        0.048           1           0        48 TAPAR
  0.5        0.048        0.048           1           0        48 main => MPI_Talbot1 => TAPAR
  0.4        0.042        0.042           2           0        21 MPI_Send()
  0.4        0.042        0.042           2           0        21 main => MPI_Send()
```

```
  0.2        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.2        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.2        0.022        0.022           1           0         22 MPI_Comm_size()
  0.2        0.022        0.022           1           0         22 main => MPI_Comm_size()

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0           1          286           8          90      35778 main
 86.6         247          247           8           0      30989 MPI_Init_thread()
 86.6         247          247           8           0      30989 main => MPI_Init_thread()
  6.0          17           17           8           0       2144 MPI_Barrier()
  6.0          17           17           8           0       2144 main => MPI_Barrier()
  4.2          11           11           8           0       1498 MPI_Finalize()
  4.2          11           11           8           0       1498 main => MPI_Finalize()
  1.0       0.639            3           8          16        376 MPI_Talbot1
  1.0       0.639            3           8          16        376 main => MPI_Talbot1
  1.0           2            2          21           0        140 MPI_Recv()
  1.0           2            2          21           0        140 main => MPI_Recv()
  0.7           1            1           8        1480        242 MPI_TSUM1
  0.7           1            1           8        1480        242 main => MPI_Talbot1 => MPI_TSUM1
  0.3       0.975        0.975          21           0         46 MPI_Send()
  0.3       0.975        0.975          21           0         46 main => MPI_Send()
  0.3       0.747        0.747        1480           0          1 F24
  0.3       0.747        0.747        1480           0          1 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.1       0.427        0.427           8           0         53 TAPAR
  0.1       0.427        0.427           8           0         53 main => MPI_Talbot1 => TAPAR
  0.1       0.197        0.197           8           0         25 MPI_Comm_rank()
  0.1       0.197        0.197           8           0         25 main => MPI_Comm_rank()
  0.1       0.184        0.184           8           0         23 MPI_Comm_size()
  0.1       0.184        0.184           8           0         23 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.236           35           1       11.25      35778 main
 86.6           30           30           1           0      30989 MPI_Init_thread()
 86.6           30           30           1           0      30989 main => MPI_Init_thread()
  6.0            2            2           1           0       2144 MPI_Barrier()
  6.0            2            2           1           0       2144 main => MPI_Barrier()
  4.2            1            1           1           0       1498 MPI_Finalize()
  4.2            1            1           1           0       1498 main => MPI_Finalize()
  1.0       0.0799        0.376           1           2        376 MPI_Talbot1
  1.0       0.0799        0.376           1           2        376 main => MPI_Talbot1
  1.0        0.367        0.367       2.625           0        140 MPI_Recv()
  1.0        0.367        0.367       2.625           0        140 main => MPI_Recv()
  0.7        0.149        0.242           1         185        242 MPI_TSUM1
  0.7        0.149        0.242           1         185        242 main => MPI_Talbot1 => MPI_TSUM1
  0.3        0.122        0.122       2.625           0         46 MPI_Send()
  0.3        0.122        0.122       2.625           0         46 main => MPI_Send()
  0.3       0.0934       0.0934         185           0          1 F24
  0.3       0.0934       0.0934         185           0          1 main => MPI_Talbot1 => MPI_TSUM1 => F24
```

0.1	0.0534	0.0534	1	0	53	TAPAR
0.1	0.0534	0.0534	1	0	53	main => MPI_Talbot1 => TAPAR
0.1	0.0246	0.0246	1	0	25	MPI_Comm_rank()
0.1	0.0246	0.0246	1	0	25	main => MPI_Comm_rank()
0.1	0.023	0.023	1	0	23	MPI_Comm_size()
0.1	0.023	0.023	1	0	23	main => MPI_Comm_size()



(a) (b)

Figure 6: `MPI_Talbot1` on **TEST 1 - N. of Processes 8**: *Inclusive Time measured by TAU on node mapping (a) VS core mapping (b).*

TEST 2 `MPI_Talbot1` with *Input Data*: Test Function n. 24, `NTval` = 100, `T1` interval.

- **TEST 2 – N. of Processes=1** (see Figure 7)

NODE 0;CONTEXT 0;THREAD 0:

%Time	Exclusive msec	Inclusive total msec	#Call	#Subrs	Inclusive usec/call	Name
100.0	0.174	14	1	6	14411	main
78.1	0.076	11	1	2	11262	MPI_Talbot1
78.1	0.076	11	1	2	11262	main => MPI_Talbot1
77.2	6	11	1	14800	11132	MPI_TSUM1

```
 77.2           6          11           1       14800      11132 main => MPI_Talbot1 => MPI_TSUM1
 32.7           4           4       14800           0          0 F24
 32.7           4           4       14800           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 15.7           2           2           1           0       2263 MPI_Init_thread()
 15.7           2           2           1           0       2263 main => MPI_Init_thread()
  4.4       0.639       0.639           1           0        639 MPI_Finalize()
  4.4       0.639       0.639           1           0        639 main => MPI_Finalize()
  0.4       0.054       0.054           1           0         54 TAPAR
  0.4       0.054       0.054           1           0         54 main => MPI_Talbot1 => TAPAR
  0.2       0.027       0.027           1           0         27 MPI_Barrier()
  0.2       0.027       0.027           1           0         27 main => MPI_Barrier()
  0.2       0.024       0.024           1           0         24 MPI_Comm_rank()
  0.2       0.024       0.024           1           0         24 main => MPI_Comm_rank()
  0.2       0.022       0.022           1           0         22 MPI_Comm_size()
  0.2       0.022       0.022           1           0         22 main => MPI_Comm_size()
```

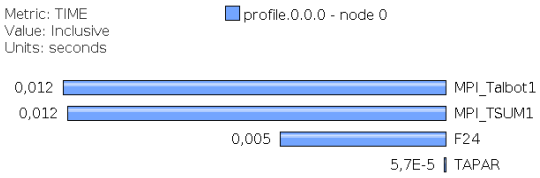


Figure 7: `MPI_Talbot1` on **TEST 2 - N. of Processes 1**: *Inclusive Time measured with TAU.*

– **TEST 2 – N. of Processes=4** (see Figure 8)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.222          103           1          15     103028 main
 93.9          96           96           1           0      96708 MPI_Init_thread()
 93.9          96           96           1           0      96708 main => MPI_Init_thread()
  2.9       0.077            2           1           2       2978 MPI_Talbot1
  2.9       0.077            2           1           2       2978 main => MPI_Talbot1
  2.8           1            2           1        3700       2843 MPI_TSUM1
  2.8           1            2           1        3700       2843 main => MPI_Talbot1 => MPI_TSUM1
  1.3           1            1           1           0       1377 MPI_Barrier()
  1.3           1            1           1           0       1377 main => MPI_Barrier()
  1.2           1            1        3700           0          0 F24
  1.2           1            1        3700           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.9       0.942        0.942           1           0        942 MPI_Finalize()
  0.9       0.942        0.942           1           0        942 main => MPI_Finalize()
  0.7       0.681        0.681           6           0        114 MPI_Recv()
  0.7       0.681        0.681           6           0        114 main => MPI_Recv()
  0.1       0.065        0.065           3           0         22 MPI_Send()
  0.1       0.065        0.065           3           0         22 main => MPI_Send()
  0.1       0.058        0.058           1           0         58 TAPAR
  0.1       0.058        0.058           1           0         58 main => MPI_Talbot1 => TAPAR
  0.0       0.033        0.033           1           0         33 MPI_Comm_rank()
```

```
  0.0        0.033        0.033           1           0         33 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 MPI_Comm_size()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.217            8           1           9       8898 main
 39.0        0.078            3           1           2       3466 MPI_Talbot1
 39.0        0.078            3           1           2       3466 main => MPI_Talbot1
 37.4            1            3           1        3700       3329 MPI_TSUM1
 37.4            1            3           1        3700       3329 main => MPI_Talbot1 => MPI_TSUM1
 28.9            2            2           1           0       2571 MPI_Init_thread()
 28.9            2            2           1           0       2571 main => MPI_Init_thread()
 16.5            1            1        3700           0          0 F24
 16.5            1            1        3700           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 15.4            1            1           1           0       1373 MPI_Barrier()
 15.4            1            1           1           0       1373 main => MPI_Barrier()
 12.1            1            1           1           0       1080 MPI_Finalize()
 12.1            1            1           1           0       1080 main => MPI_Finalize()
  1.0        0.086        0.086           1           0         86 MPI_Recv()
  1.0        0.086        0.086           1           0         86 main => MPI_Recv()
  0.7        0.059        0.059           1           0         59 TAPAR
  0.7        0.059        0.059           1           0         59 main => MPI_Talbot1 => TAPAR
  0.6        0.053        0.053           2           0         26 MPI_Send()
  0.6        0.053        0.053           2           0         26 main => MPI_Send()
  0.3        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.3        0.026        0.026           1           0         26 MPI_Comm_size()
  0.3        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.3        0.026        0.026           1           0         26 main => MPI_Comm_size()

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.22            8           1           9       8696 main
 36.9        0.083            3           1           2       3206 MPI_Talbot1
 36.9        0.083            3           1           2       3206 main => MPI_Talbot1
 35.3            1            3           1        3700       3068 MPI_TSUM1
 35.3            1            3           1        3700       3068 main => MPI_Talbot1 => MPI_TSUM1
 27.7            2            2           1           0       2407 MPI_Init_thread()
 27.7            2            2           1           0       2407 main => MPI_Init_thread()
 16.5            1            1        3700           0          0 F24
 16.5            1            1        3700           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 15.8            1            1           1           0       1371 MPI_Finalize()
 15.8            1            1           1           0       1371 main => MPI_Finalize()
 15.2            1            1           1           0       1318 MPI_Barrier()
 15.2            1            1           1           0       1318 main => MPI_Barrier()
  0.8        0.069        0.069           1           0         69 MPI_Recv()
  0.8        0.069        0.069           1           0         69 main => MPI_Recv()
  0.6        0.056        0.056           2           0         28 MPI_Send()
  0.6        0.056        0.056           2           0         28 main => MPI_Send()
  0.6        0.055        0.055           1           0         55 TAPAR
```

```
  0.6        0.055        0.055           1           0         55 main => MPI_Talbot1 => TAPAR
  0.3        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.3        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.3        0.023        0.023           1           0         23 MPI_Comm_size()
  0.3        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.217          102           1           9     102271 main
 93.7           95           95           1           0      95791 MPI_Init_thread()
 93.7           95           95           1           0      95791 main => MPI_Init_thread()
  2.9        0.074            2           1           2       2976 MPI_Talbot1
  2.9        0.074            2           1           2       2976 main => MPI_Talbot1
  2.8            1            2           1        3700       2850 MPI_TSUM1
  2.8            1            2           1        3700       2850 main => MPI_Talbot1 => MPI_TSUM1
  1.7            1            1           1           0       1786 MPI_Finalize()
  1.7            1            1           1           0       1786 main => MPI_Finalize()
  1.3            1            1           1           0       1348 MPI_Barrier()
  1.3            1            1           1           0       1348 main => MPI_Barrier()
  1.2            1            1        3700           0          0 F24
  1.2            1            1        3700           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.1        0.053        0.053           1           0         53 MPI_Recv()
  0.1        0.053        0.053           2           0         26 MPI_Send()
  0.1        0.053        0.053           1           0         53 main => MPI_Recv()
  0.1        0.053        0.053           2           0         26 main => MPI_Send()
  0.1        0.052        0.052           1           0         52 TAPAR
  0.1        0.052        0.052           1           0         52 main => MPI_Talbot1 => TAPAR
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 MPI_Comm_size()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.876          222           4          42      55723 main
 88.6          197          197           4           0      49369 MPI_Init_thread()
 88.6          197          197           4           0      49369 main => MPI_Init_thread()
  5.7        0.312           12           4           8       3156 MPI_Talbot1
  5.7        0.312           12           4           8       3156 main => MPI_Talbot1
  5.4            6           12           4       14800       3022 MPI_TSUM1
  5.4            6           12           4       14800       3022 main => MPI_Talbot1 => MPI_TSUM1
  2.4            5            5           4           0       1354 MPI_Barrier()
  2.4            5            5           4           0       1354 main => MPI_Barrier()
  2.4            5            5       14800           0          0 F24
  2.4            5            5       14800           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  2.3            5            5           4           0       1295 MPI_Finalize()
  2.3            5            5           4           0       1295 main => MPI_Finalize()
  0.4        0.889        0.889           9           0         99 MPI_Recv()
  0.4        0.889        0.889           9           0         99 main => MPI_Recv()
  0.1        0.227        0.227           9           0         25 MPI_Send()
```

```
  0.1        0.227        0.227          9          0         25 main => MPI_Send()
  0.1        0.224        0.224          4          0         56 TAPAR
  0.1        0.224        0.224          4          0         56 main => MPI_Talbot1 => TAPAR
  0.0         0.11         0.11          4          0         28 MPI_Comm_rank()
  0.0         0.11         0.11          4          0         28 main => MPI_Comm_rank()
  0.0        0.093        0.093          4          0         23 MPI_Comm_size()
  0.0        0.093        0.093          4          0         23 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.219           55           1        10.5      55723 main
 88.6           49           49           1           0      49369 MPI_Init_thread()
 88.6           49           49           1           0      49369 main => MPI_Init_thread()
  5.7        0.078            3           1           2       3156 MPI_Talbot1
  5.7        0.078            3           1           2       3156 main => MPI_Talbot1
  5.4            1            3           1        3700       3022 MPI_TSUM1
  5.4            1            3           1        3700       3022 main => MPI_Talbot1 => MPI_TSUM1
  2.4            1            1           1           0       1354 MPI_Barrier()
  2.4            1            1           1           0       1354 main => MPI_Barrier()
  2.4            1            1        3700           0          0 F24
  2.4            1            1        3700           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  2.3            1            1           1           0       1295 MPI_Finalize()
  2.3            1            1           1           0       1295 main => MPI_Finalize()
  0.4        0.222        0.222        2.25           0         99 MPI_Recv()
  0.4        0.222        0.222        2.25           0         99 main => MPI_Recv()
  0.1       0.0568       0.0568        2.25           0         25 MPI_Send()
  0.1       0.0568       0.0568        2.25           0         25 main => MPI_Send()
  0.1        0.056        0.056           1           0         56 TAPAR
  0.1        0.056        0.056           1           0         56 main => MPI_Talbot1 => TAPAR
  0.0       0.0275       0.0275           1           0         28 MPI_Comm_rank()
  0.0       0.0275       0.0275           1           0         28 main => MPI_Comm_rank()
  0.0       0.0232       0.0232           1           0         23 MPI_Comm_size()
  0.0       0.0232       0.0232           1           0         23 main => MPI_Comm_size()
```

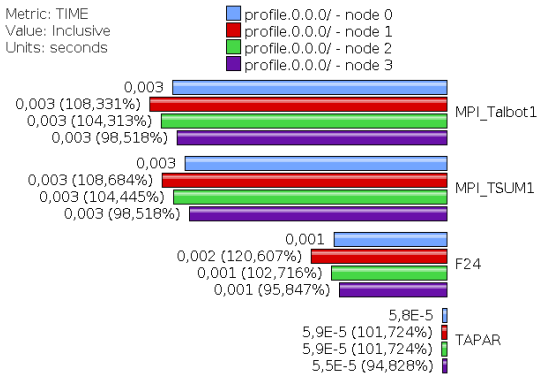


Figure 8: `MPI_Talbot1` on **TEST 2 - N. of Processes 4**: *Inclusive Time measured with TAU.*

– **TEST 2 – N. of Processes=8** (see Figure 9)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.25          109           1          27     109592 main
 92.4          101          101           1           0     101281 MPI_Init_thread()
 92.4          101          101           1           0     101281 main => MPI_Init_thread()
  2.5            2            2           7           0        385 MPI_Send()
  2.5            2            2           7           0        385 main => MPI_Send()
  1.9            2            2           1           0       2086 MPI_Barrier()
  1.9            2            2           1           0       2086 main => MPI_Barrier()
  1.6        0.077            1           1           2       1802 MPI_Talbot1
  1.6        0.077            1           1           2       1802 main => MPI_Talbot1
  1.5        0.866            1           1        1924       1675 MPI_TSUM1
  1.5        0.866            1           1        1924       1675 main => MPI_Talbot1 => MPI_TSUM1
  1.1            1            1           1           0       1232 MPI_Finalize()
  1.1            1            1           1           0       1232 main => MPI_Finalize()
  0.7        0.809        0.809        1924           0          0 F24
  0.7        0.809        0.809        1924           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.2        0.202        0.202          14           0         14 MPI_Recv()
  0.2        0.202        0.202          14           0         14 main => MPI_Recv()
  0.0         0.05         0.05           1           0         50 TAPAR
  0.0         0.05         0.05           1           0         50 main => MPI_Talbot1 => TAPAR
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 MPI_Comm_size()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.222           12           1           9      12007 main
 40.6            4            4           1           0       4876 MPI_Barrier()
 40.6            4            4           1           0       4876 main => MPI_Barrier()
 30.6            3            3           1           0       3680 MPI_Init_thread()
 30.6            3            3           1           0       3680 main => MPI_Init_thread()
 13.7        0.076            1           1           2       1648 MPI_Talbot1
 13.7        0.076            1           1           2       1648 main => MPI_Talbot1
 12.7         0.88            1           1        1924       1522 MPI_TSUM1
 12.7         0.88            1           1        1924       1522 main => MPI_Talbot1 => MPI_TSUM1
 12.1            1            1           1           0       1448 MPI_Finalize()
 12.1            1            1           1           0       1448 main => MPI_Finalize()
  5.3        0.642        0.642        1924           0          0 F24
  5.3        0.642        0.642        1924           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.4         0.05         0.05           1           0         50 TAPAR
  0.4         0.05         0.05           1           0         50 main => MPI_Talbot1 => TAPAR
  0.4        0.048        0.048           2           0         24 MPI_Send()
  0.4        0.048        0.048           2           0         24 main => MPI_Send()
  0.3        0.036        0.036           1           0         36 MPI_Recv()
  0.3        0.036        0.036           1           0         36 main => MPI_Recv()
  0.2        0.026        0.026           1           0         26 MPI_Comm_rank()
```

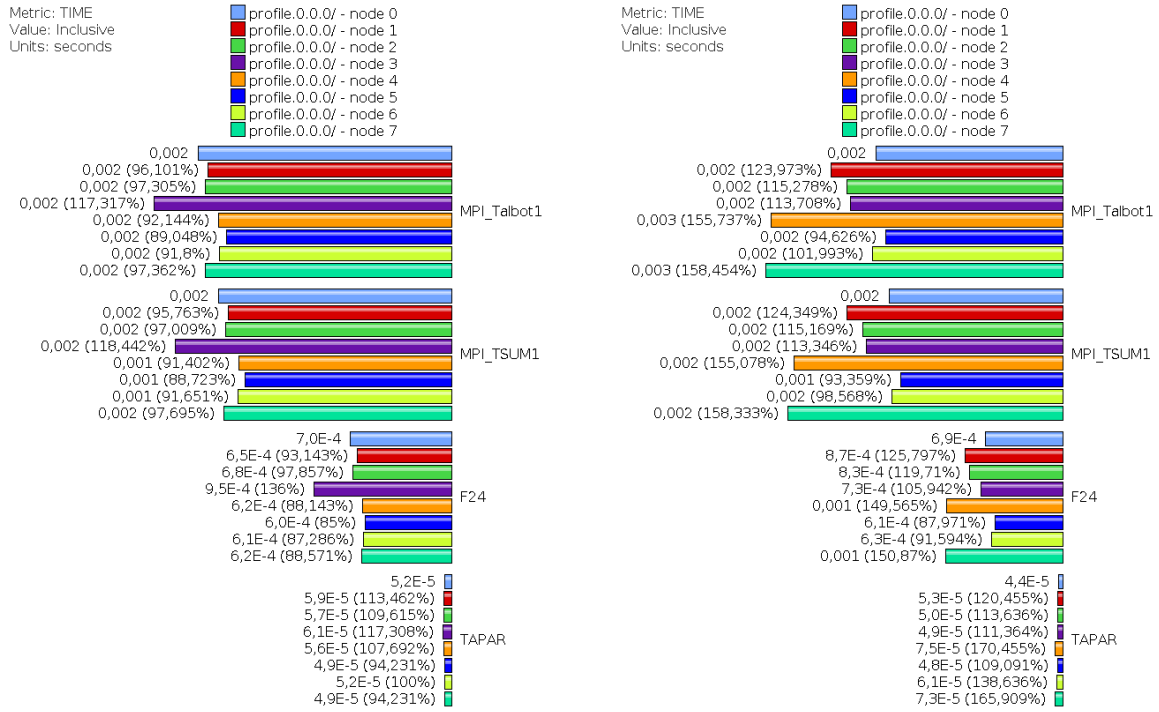
```
  0.2        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.2        0.023        0.023           1           0         23 MPI_Comm_size()
  0.2        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.339           14           1           9     14218 main
 41.7            5            5           1           0      5925 MPI_Init_thread()
 41.7            5            5           1           0      5925 main => MPI_Init_thread()
 28.5            4            4           1           0      4048 MPI_Finalize()
 28.5            4            4           1           0      4048 main => MPI_Finalize()
 12.9            1            1           1           0      1832 MPI_Barrier()
 12.9            1            1           1           0      1832 main => MPI_Barrier()
 12.5        0.083            1           1           2      1783 MPI_Talbot1
 12.5        0.083            1           1           2      1783 main => MPI_Talbot1
 11.6        0.903            1           1        1924      1644 MPI_TSUM1
 11.6        0.903            1           1        1924      1644 main => MPI_Talbot1 => MPI_TSUM1
  5.2        0.741        0.741        1924           0         0 F24
  5.2        0.741        0.741        1924           0         0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  1.3         0.19         0.19           1           0       190 MPI_Recv()
  1.3         0.19         0.19           1           0       190 main => MPI_Recv()
  0.4        0.056        0.056           1           0        56 TAPAR
  0.4        0.056        0.056           1           0        56 main => MPI_Talbot1 => TAPAR
  0.3        0.049        0.049           2           0        24 MPI_Send()
  0.3        0.049        0.049           2           0        24 main => MPI_Send()
  0.2        0.026        0.026           1           0        26 MPI_Comm_rank()
  0.2        0.026        0.026           1           0        26 MPI_Comm_size()
  0.2        0.026        0.026           1           0        26 main => MPI_Comm_rank()
  0.2        0.026        0.026           1           0        26 main => MPI_Comm_size()

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.26          109           1           9    109754 main
 92.3          101          101           1           0    101282 MPI_Init_thread()
 92.3          101          101           1           0    101282 main => MPI_Init_thread()
  3.3            3            3           1           0      3657 MPI_Finalize()
  3.3            3            3           1           0      3657 main => MPI_Finalize()
  1.8            1            1           1           0      1994 MPI_Barrier()
  1.8            1            1           1           0      1994 main => MPI_Barrier()
  1.8         0.09            1           1           2      1990 MPI_Talbot1
  1.8         0.09            1           1           2      1990 main => MPI_Talbot1
  1.7            1            1           1        1924      1820 MPI_TSUM1
  1.7            1            1           1        1924      1820 main => MPI_Talbot1 => MPI_TSUM1
  0.7        0.745        0.745        1924           0         0 F24
  0.7        0.745        0.745        1924           0         0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.4        0.468        0.468           1           0       468 MPI_Recv()
  0.4        0.468        0.468           1           0       468 main => MPI_Recv()
  0.1         0.08         0.08           1           0        80 TAPAR
  0.1         0.08         0.08           1           0        80 main => MPI_Talbot1 => TAPAR
  0.0        0.054        0.054           2           0        27 MPI_Send()
```

```
  0.0        0.054        0.054           2           0         27 main => MPI_Send()
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_size()

NODE 4;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.226           10           1           9      10649 main
 35.8            3            3           1           0       3810 MPI_Finalize()
 35.8            3            3           1           0       3810 main => MPI_Finalize()
 21.4            2            2           1           0       2284 MPI_Init_thread()
 21.4            2            2           1           0       2284 main => MPI_Init_thread()
 19.7            2            2           1           0       2098 MPI_Barrier()
 19.7            2            2           1           0       2098 main => MPI_Barrier()
 16.4         0.08            1           1           2       1744 MPI_Talbot1
 16.4         0.08            1           1           2       1744 main => MPI_Talbot1
 15.1            1            1           1        1776       1606 MPI_TSUM1
 15.1            1            1           1        1776       1606 main => MPI_Talbot1 => MPI_TSUM1
  5.6        0.594        0.594        1776           0          0 F24
  5.6        0.594        0.594        1776           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  3.7        0.389        0.389           1           0        389 MPI_Recv()
  3.7        0.389        0.389           1           0        389 main => MPI_Recv()
  0.5        0.058        0.058           1           0         58 TAPAR
  0.5        0.058        0.058           1           0         58 main => MPI_Talbot1 => TAPAR
  0.5         0.05         0.05           2           0         25 MPI_Send()
  0.5         0.05         0.05           2           0         25 main => MPI_Send()
  0.2        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.2        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.2        0.023        0.023           1           0         23 MPI_Comm_size()
  0.2        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 5;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.225           15           1           9      15519 main
 46.1            7            7           1           0       7162 MPI_Init_thread()
 46.1            7            7           1           0       7162 main => MPI_Init_thread()
 31.1            4            4           1           0       4822 MPI_Barrier()
 31.1            4            4           1           0       4822 main => MPI_Barrier()
 10.7            1            1           1           0       1657 MPI_Finalize()
 10.7            1            1           1           0       1657 main => MPI_Finalize()
  9.9        0.078            1           1           2       1533 MPI_Talbot1
  9.9        0.078            1           1           2       1533 main => MPI_Talbot1
  9.1        0.819            1           1        1776       1408 MPI_TSUM1
  9.1        0.819            1           1        1776       1408 main => MPI_Talbot1 => MPI_TSUM1
  3.8        0.589        0.589        1776           0          0 F24
  3.8        0.589        0.589        1776           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.3        0.047        0.047           1           0         47 TAPAR
  0.3        0.047        0.047           1           0         47 main => MPI_Talbot1 => TAPAR
  0.3        0.043        0.043           2           0         22 MPI_Send()
```

```
  0.3        0.043        0.043           2           0         22 main => MPI_Send()
  0.2         0.03         0.03           1           0         30 MPI_Recv()
  0.2         0.03         0.03           1           0         30 main => MPI_Recv()
  0.2        0.024        0.024           1           0         24 MPI_Comm_rank()
  0.2        0.024        0.024           1           0         24 main => MPI_Comm_rank()
  0.1        0.023        0.023           1           0         23 MPI_Comm_size()
  0.1        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 6;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.229           13           1           9      13911 main
 41.7            5            5           1           0       5802 MPI_Init_thread()
 41.7            5            5           1           0       5802 main => MPI_Init_thread()
 20.6            2            2           1           0       2871 MPI_Recv()
 20.6            2            2           1           0       2871 main => MPI_Recv()
 13.5            1            1           1           0       1879 MPI_Barrier()
 13.5            1            1           1           0       1879 main => MPI_Barrier()
 11.9        0.083            1           1           2       1657 MPI_Talbot1
 11.9        0.083            1           1           2       1657 main => MPI_Talbot1
 11.0        0.815            1           1        1776       1524 MPI_TSUM1
 11.0        0.815            1           1        1776       1524 main => MPI_Talbot1 => MPI_TSUM1
  9.9            1            1           1           0       1380 MPI_Finalize()
  9.9            1            1           1           0       1380 main => MPI_Finalize()
  5.1        0.709        0.709        1776           0          0 F24
  5.1        0.709        0.709        1776           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.4         0.05         0.05           1           0         50 TAPAR
  0.4         0.05         0.05           1           0         50 main => MPI_Talbot1 => TAPAR
  0.3        0.045        0.045           2           0         22 MPI_Send()
  0.3        0.045        0.045           2           0         22 main => MPI_Send()
  0.2        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.2        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.2        0.023        0.023           1           0         23 MPI_Comm_size()
  0.2        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 7;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.218           15           1           9      15378 main
 47.1            7            7           1           0       7237 MPI_Init_thread()
 47.1            7            7           1           0       7237 main => MPI_Init_thread()
 18.5            2            2           1           0       2843 MPI_Recv()
 18.5            2            2           1           0       2843 main => MPI_Recv()
 12.0            1            1           1           0       1848 MPI_Barrier()
 12.0            1            1           1           0       1848 main => MPI_Barrier()
 10.5            1            1           1           0       1610 MPI_Finalize()
 10.5            1            1           1           0       1610 main => MPI_Finalize()
  9.9        0.081            1           1           2       1525 MPI_Talbot1
  9.9        0.081            1           1           2       1525 main => MPI_Talbot1
  9.1        0.806            1           1        1776       1393 MPI_TSUM1
  9.1        0.806            1           1        1776       1393 main => MPI_Talbot1 => MPI_TSUM1
  3.8        0.587        0.587        1776           0          0 F24
```

```
  3.8        0.587        0.587        1776           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.3        0.051        0.051           1           0         51 TAPAR
  0.3        0.051        0.051           1           0         51 main => MPI_Talbot1 => TAPAR
  0.3        0.046        0.046           2           0         23 MPI_Send()
  0.3        0.046        0.046           2           0         23 main => MPI_Send()
  0.2        0.028        0.028           1           0         28 MPI_Comm_rank()
  0.2        0.028        0.028           1           0         28 main => MPI_Comm_rank()
  0.1        0.023        0.023           1           0         23 MPI_Comm_size()
  0.1        0.023        0.023           1           0         23 main => MPI_Comm_size()

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0           1          301           8          90      37628 main
 78.0         234          234           8           0      29332 MPI_Init_thread()
 78.0         234          234           8           0      29332 main => MPI_Init_thread()
  7.1          21           21           8           0       2679 MPI_Barrier()
  7.1          21           21           8           0       2679 main => MPI_Barrier()
  6.3          18           18           8           0       2355 MPI_Finalize()
  6.3          18           18           8           0       2355 main => MPI_Finalize()
  4.5       0.648           13           8          16       1710 MPI_Talbot1
  4.5       0.648           13           8          16       1710 main => MPI_Talbot1
  4.2           7           12           8       14800       1574 MPI_TSUM1
  4.2           7           12           8       14800       1574 main => MPI_Talbot1 => MPI_TSUM1
  2.3           7            7          21           0        335 MPI_Recv()
  2.3           7            7          21           0        335 main => MPI_Recv()
  1.8           5            5       14800           0          0 F24
  1.8           5            5       14800           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  1.0           3            3          21           0        144 MPI_Send()
  1.0           3            3          21           0        144 main => MPI_Send()
  0.1       0.442        0.442           8           0         55 TAPAR
  0.1       0.442        0.442           8           0         55 main => MPI_Talbot1 => TAPAR
  0.1       0.204        0.204           8           0         26 MPI_Comm_rank()
  0.1       0.204        0.204           8           0         26 main => MPI_Comm_rank()
  0.1       0.187        0.187           8           0         23 MPI_Comm_size()
  0.1       0.187        0.187           8           0         23 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.246           37           1       11.25      37628 main
 78.0          29           29           1           0      29332 MPI_Init_thread()
 78.0          29           29           1           0      29332 main => MPI_Init_thread()
  7.1           2            2           1           0       2679 MPI_Barrier()
  7.1           2            2           1           0       2679 main => MPI_Barrier()
  6.3           2            2           1           0       2355 MPI_Finalize()
  6.3           2            2           1           0       2355 main => MPI_Finalize()
  4.5       0.081            1           1           2       1710 MPI_Talbot1
  4.5       0.081            1           1           2       1710 main => MPI_Talbot1
  4.2       0.897            1           1        1850       1574 MPI_TSUM1
  4.2       0.897            1           1        1850       1574 main => MPI_Talbot1 => MPI_TSUM1
  2.3       0.879        0.879       2.625           0        335 MPI_Recv()
```

```
 2.3        0.879        0.879        2.625          0        335 main => MPI_Recv()
 1.8        0.677        0.677         1850          0          0 F24
 1.8        0.677        0.677         1850          0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 1.0        0.378        0.378        2.625          0        144 MPI_Send()
 1.0        0.378        0.378        2.625          0        144 main => MPI_Send()
 0.1       0.0553       0.0553            1          0         55 TAPAR
 0.1       0.0553       0.0553            1          0         55 main => MPI_Talbot1 => TAPAR
 0.1       0.0255       0.0255            1          0         26 MPI_Comm_rank()
 0.1       0.0255       0.0255            1          0         26 main => MPI_Comm_rank()
 0.1       0.0234       0.0234            1          0         23 MPI_Comm_size()
 0.1       0.0234       0.0234            1          0         23 main => MPI_Comm_size()
```



(a) (b)

Figure 9: `MPI_Talbot1` on **TEST 2 - N. of Processes 8**: *Inclusive Time measured by TAU on node mapping (a) VS core mapping (b).*

TEST 3 `MPI_Talbot1` with *Input Data*: Test Function n. 24, `NTval` = 10, `T2` interval.

– **TEST 3 – N. of Processes=1** (see Figure 10)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
```

```
---------------------------------------------------------------------------------------
100.0        0.157          828           1           6     828156 main
 99.7         0.08          825           1           2     825400 MPI_Talbot1
 99.7         0.08          825           1           2     825400 main => MPI_Talbot1
 99.7          460          825           1 1.81999E+06     825270 MPI_TSUM1
 99.7          460          825           1 1.81999E+06     825270 main => MPI_Talbot1 => MPI_TSUM1
 44.1          364          364 1.81999E+06           0          0 F24
 44.1          364          364 1.81999E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.2            1            1           1           0       1976 MPI_Init_thread()
  0.2            1            1           1           0       1976 main => MPI_Init_thread()
  0.1        0.544        0.544           1           0        544 MPI_Finalize()
  0.1        0.544        0.544           1           0        544 main => MPI_Finalize()
  0.0         0.05         0.05           1           0         50 TAPAR
  0.0         0.05         0.05           1           0         50 main => MPI_Talbot1 => TAPAR
  0.0        0.029        0.029           1           0         29 MPI_Barrier()
  0.0        0.029        0.029           1           0         29 main => MPI_Barrier()
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 MPI_Comm_size()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_size()
```

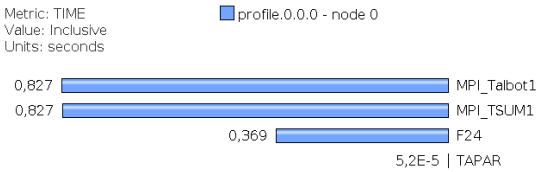


Figure 10: `MPI_Talbot1` on **TEST 3 - N. of Processes 1**: *Inclusive Time measured with TAU.*

– **TEST 3 – N. of Processes=4** (see Figure 11)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.197          422           1          15     422932 main
 76.0        0.085          321           1           2     321497 MPI_Talbot1
 76.0        0.085          321           1           2     321497 main => MPI_Talbot1
 76.0          179          321           1      545997     321360 MPI_TSUM1
 76.0          179          321           1      545997     321360 main => MPI_Talbot1 => MPI_TSUM1
 33.5          141          141      545997           0          0 F24
 33.5          141          141      545997           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 23.4           98           98           1           0      98902 MPI_Init_thread()
 23.4           98           98           1           0      98902 main => MPI_Init_thread()
  0.3            1            1           1           0       1389 MPI_Barrier()
  0.3            1            1           1           0       1389 main => MPI_Barrier()
  0.2        0.786        0.786           1           0        786 MPI_Finalize()
  0.2        0.786        0.786           1           0        786 main => MPI_Finalize()
  0.0        0.066        0.066           3           0         22 MPI_Send()
  0.0        0.066        0.066           3           0         22 main => MPI_Send()
  0.0        0.052        0.052           1           0         52 TAPAR
```

```
  0.0        0.052        0.052           1           0         52 main => MPI_Talbot1 => TAPAR
  0.0        0.048        0.048           6           0          8 MPI_Recv()
  0.0        0.048        0.048           6           0          8 main => MPI_Recv()
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 MPI_Comm_size()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.195          326           1           9     326320 main
 98.0        0.082          319           1           2     319903 MPI_Talbot1
 98.0        0.082          319           1           2     319903 main => MPI_Talbot1
 98.0          179          319           1      545997     319766 MPI_TSUM1
 98.0          179          319           1      545997     319766 main => MPI_Talbot1 => MPI_TSUM1
 43.0          140          140      545997           0          0 F24
 43.0          140          140      545997           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.7            2            2           1           0       2359 MPI_Init_thread()
  0.7            2            2           1           0       2359 main => MPI_Init_thread()
  0.7            2            2           1           0       2262 MPI_Finalize()
  0.7            2            2           1           0       2262 main => MPI_Finalize()
  0.5            1            1           1           0       1474 MPI_Barrier()
  0.5            1            1           1           0       1474 main => MPI_Barrier()
  0.0        0.055        0.055           1           0         55 TAPAR
  0.0        0.055        0.055           1           0         55 main => MPI_Talbot1 => TAPAR
  0.0        0.037        0.037           1           0         37 MPI_Recv()
  0.0        0.037        0.037           1           0         37 main => MPI_Recv()
  0.0        0.033        0.033           1           0         33 MPI_Comm_size()
  0.0        0.033        0.033           1           0         33 main => MPI_Comm_size()
  0.0        0.032        0.032           2           0         16 MPI_Send()
  0.0        0.032        0.032           2           0         16 main => MPI_Send()
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.197          326           1           9     326330 main
 78.2        0.086          255           1           2     255253 MPI_Talbot1
 78.2        0.086          255           1           2     255253 main => MPI_Talbot1
 78.2          142          255           1      363998     255115 MPI_TSUM1
 78.2          142          255           1      363998     255115 main => MPI_Talbot1 => MPI_TSUM1
 34.5          112          112      363998           0          0 F24
 34.5          112          112      363998           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 20.6           67           67           1           0      67114 MPI_Finalize()
 20.6           67           67           1           0      67114 main => MPI_Finalize()
  0.7            2            2           1           0       2232 MPI_Init_thread()
  0.7            2            2           1           0       2232 main => MPI_Init_thread()
  0.4            1            1           1           0       1394 MPI_Barrier()
  0.4            1            1           1           0       1394 main => MPI_Barrier()
  0.0        0.053        0.053           1           0         53 MPI_Recv()
```

```
  0.0        0.053        0.053           1           0         53 main => MPI_Recv()
  0.0        0.052        0.052           1           0         52 TAPAR
  0.0        0.052        0.052           1           0         52 main => MPI_Talbot1 => TAPAR
  0.0        0.032        0.032           1           0         32 MPI_Comm_rank()
  0.0        0.032        0.032           2           0         16 MPI_Send()
  0.0        0.032        0.032           1           0         32 main => MPI_Comm_rank()
  0.0        0.032        0.032           2           0         16 main => MPI_Send()
  0.0        0.023        0.023           1           0         23 MPI_Comm_size()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.186          422           1           9     422102 main
 58.5        0.081          246           1           2     246802 MPI_Talbot1
 58.5        0.081          246           1           2     246802 main => MPI_Talbot1
 58.4          138          246           1      363998     246673 MPI_TSUM1
 58.4          138          246           1      363998     246673 main => MPI_Talbot1 => MPI_TSUM1
 25.6          107          107      363998           0          0 F24
 25.6          107          107      363998           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 23.2           98           98           1           0      98074 MPI_Init_thread()
 23.2           98           98           1           0      98074 main => MPI_Init_thread()
 17.9           75           75           1           0      75487 MPI_Finalize()
 17.9           75           75           1           0      75487 main => MPI_Finalize()
  0.3            1            1           1           0       1405 MPI_Barrier()
  0.3            1            1           1           0       1405 main => MPI_Barrier()
  0.0        0.063        0.063           1           0         63 MPI_Recv()
  0.0        0.063        0.063           1           0         63 main => MPI_Recv()
  0.0        0.048        0.048           1           0         48 TAPAR
  0.0        0.048        0.048           1           0         48 main => MPI_Talbot1 => TAPAR
  0.0        0.035        0.035           2           0         18 MPI_Send()
  0.0        0.035        0.035           2           0         18 main => MPI_Send()
  0.0        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_size()

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.775        1,497           4          42     374421 main
 76.3        0.334        1,143           4           8     285864 MPI_Talbot1
 76.3        0.334        1,143           4           8     285864 main => MPI_Talbot1
 76.3          640        1,142           4 1.81999E+06     285728 MPI_TSUM1
 76.3          640        1,142           4 1.81999E+06     285728 main => MPI_Talbot1 => MPI_TSUM1
 33.6          502          502 1.81999E+06           0          0 F24
 33.6          502          502 1.81999E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 13.5          201          201           4           0      50392 MPI_Init_thread()
 13.5          201          201           4           0      50392 main => MPI_Init_thread()
  9.7          145          145           4           0      36412 MPI_Finalize()
  9.7          145          145           4           0      36412 main => MPI_Finalize()
  0.4            5            5           4           0       1416 MPI_Barrier()
```

```
  0.4           5           5           4           0       1416 main => MPI_Barrier()
  0.0       0.207       0.207           4           0         52 TAPAR
  0.0       0.207       0.207           4           0         52 main => MPI_Talbot1 => TAPAR
  0.0       0.201       0.201           9           0         22 MPI_Recv()
  0.0       0.201       0.201           9           0         22 main => MPI_Recv()
  0.0       0.165       0.165           9           0         18 MPI_Send()
  0.0       0.165       0.165           9           0         18 main => MPI_Send()
  0.0       0.108       0.108           4           0         27 MPI_Comm_rank()
  0.0       0.108       0.108           4           0         27 main => MPI_Comm_rank()
  0.0       0.102       0.102           4           0         26 MPI_Comm_size()
  0.0       0.102       0.102           4           0         26 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.194          374           1        10.5     374421 main
 76.3      0.0835          285           1           2     285864 MPI_Talbot1
 76.3      0.0835          285           1           2     285864 main => MPI_Talbot1
 76.3         160          285           1      454998     285728 MPI_TSUM1
 76.3         160          285           1      454998     285728 main => MPI_Talbot1 => MPI_TSUM1
 33.6         125          125      454998           0          0 F24
 33.6         125          125      454998           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 13.5          50           50           1           0      50392 MPI_Init_thread()
 13.5          50           50           1           0      50392 main => MPI_Init_thread()
  9.7          36           36           1           0      36412 MPI_Finalize()
  9.7          36           36           1           0      36412 main => MPI_Finalize()
  0.4           1            1           1           0       1416 MPI_Barrier()
  0.4           1            1           1           0       1416 main => MPI_Barrier()
  0.0      0.0517       0.0517           1           0         52 TAPAR
  0.0      0.0517       0.0517           1           0         52 main => MPI_Talbot1 => TAPAR
  0.0      0.0503       0.0503        2.25           0         22 MPI_Recv()
  0.0      0.0503       0.0503        2.25           0         22 main => MPI_Recv()
  0.0      0.0413       0.0413        2.25           0         18 MPI_Send()
  0.0      0.0413       0.0413        2.25           0         18 main => MPI_Send()
  0.0       0.027        0.027           1           0         27 MPI_Comm_rank()
  0.0       0.027        0.027           1           0         27 main => MPI_Comm_rank()
  0.0      0.0255       0.0255           1           0         26 MPI_Comm_size()
  0.0      0.0255       0.0255           1           0         26 main => MPI_Comm_size()
```

– **TEST 3 – N. of Processes=8** (see Figure 12)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.315          353           1          27     353051 main
 61.2       0.111          215           1           2     215897 MPI_Talbot1
 61.2       0.111          215           1           2     215897 main => MPI_Talbot1
 61.1         121          215           1      363998     215718 MPI_TSUM1
 61.1         121          215           1      363998     215718 main => MPI_Talbot1 => MPI_TSUM1
 37.6         132          132           1           0     132576 MPI_Init_thread()
 37.6         132          132           1           0     132576 main => MPI_Init_thread()
```

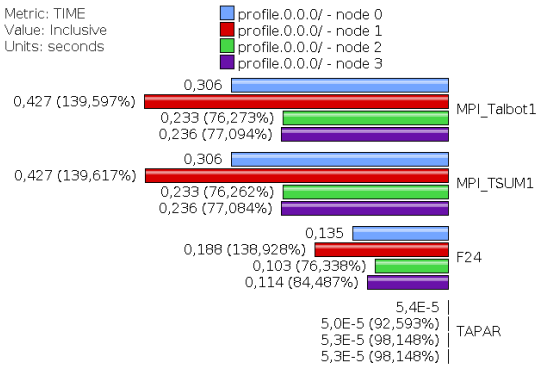


Figure 11: `MPI_Talbot1` on **TEST 3 - N. of Processes 4**: *Inclusive Time measured with TAU.*

```
 26.6          94          94      363998           0         0 F24
 26.6          94          94      363998           0         0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.7           2           2           1           0      2445 MPI_Barrier()
  0.7           2           2           1           0      2445 main => MPI_Barrier()
  0.2       0.824       0.824           1           0       824 MPI_Finalize()
  0.2       0.824       0.824           1           0       824 main => MPI_Finalize()
  0.2       0.803       0.803           7           0       115 MPI_Send()
  0.2       0.803       0.803           7           0       115 main => MPI_Send()
  0.0       0.124       0.124          14           0         9 MPI_Recv()
  0.0       0.124       0.124          14           0         9 main => MPI_Recv()
  0.0       0.068       0.068           1           0        68 TAPAR
  0.0       0.068       0.068           1           0        68 main => MPI_Talbot1 => TAPAR
  0.0       0.034       0.034           1           0        34 MPI_Comm_size()
  0.0       0.034       0.034           1           0        34 main => MPI_Comm_size()
  0.0       0.033       0.033           1           0        33 MPI_Comm_rank()
  0.0       0.033       0.033           1           0        33 main => MPI_Comm_rank()

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.21         262           1           9     262500 main
 82.1        0.084         215           1           2     215442 MPI_Talbot1
 82.1        0.084         215           1           2     215442 main => MPI_Talbot1
 82.0          119         215           1      363998     215306 MPI_TSUM1
 82.0          119         215           1      363998     215306 main => MPI_Talbot1 => MPI_TSUM1
 36.6           96          96      363998           0          0 F24
 36.6           96          96      363998           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 16.0           41          41           1           0      41967 MPI_Init_thread()
 16.0           41          41           1           0      41967 main => MPI_Init_thread()
  0.9            2           2           1           0       2435 MPI_Barrier()
  0.9            2           2           1           0       2435 main => MPI_Barrier()
  0.8            2           2           1           0       2197 MPI_Finalize()
  0.8            2           2           1           0       2197 main => MPI_Finalize()
  0.1        0.153       0.153           1           0        153 MPI_Recv()
  0.1        0.153       0.153           1           0        153 main => MPI_Recv()
```

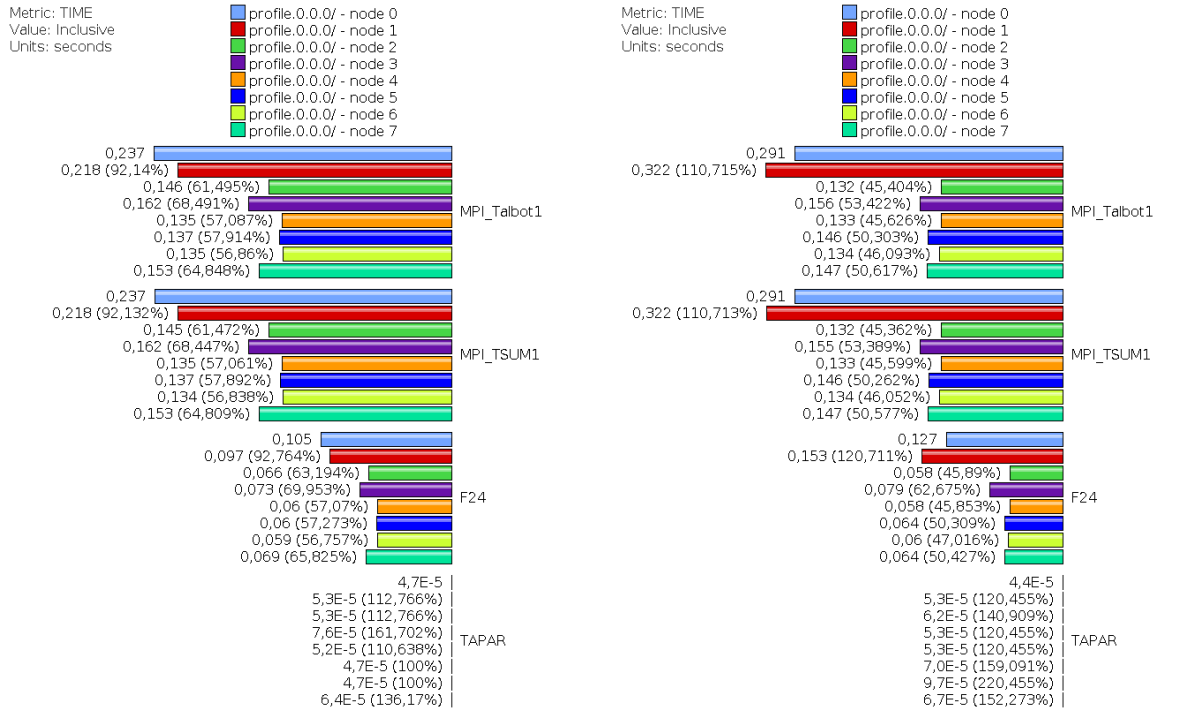
```
  0.0        0.052        0.052           1           0         52 TAPAR
  0.0        0.052        0.052           1           0         52 main => MPI_Talbot1 => TAPAR
  0.0        0.033        0.033           1           0         33 MPI_Comm_size()
  0.0        0.033        0.033           1           0         33 main => MPI_Comm_size()
  0.0        0.032        0.032           1           0         32 MPI_Comm_rank()
  0.0        0.032        0.032           1           0         32 main => MPI_Comm_rank()
  0.0        0.031        0.031           2           0         16 MPI_Send()
  0.0        0.031        0.031           2           0         16 main => MPI_Send()

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.268          254           1           9     254361 main
 53.6        0.082          136           1           2     136240 MPI_Talbot1
 53.6        0.082          136           1           2     136240 main => MPI_Talbot1
 53.5           75          136           1      181999     136106 MPI_TSUM1
 53.5           75          136           1      181999     136106 main => MPI_Talbot1 => MPI_TSUM1
 31.9           81           81           1           0      81210 MPI_Finalize()
 31.9           81           81           1           0      81210 main => MPI_Finalize()
 23.7           60           60      181999           0          0 F24
 23.7           60           60      181999           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 13.4           33           33           1           0      33967 MPI_Init_thread()
 13.4           33           33           1           0      33967 main => MPI_Init_thread()
  1.0            2            2           1           0       2483 MPI_Barrier()
  1.0            2            2           1           0       2483 main => MPI_Barrier()
  0.0        0.095        0.095           1           0         95 MPI_Recv()
  0.0        0.095        0.095           1           0         95 main => MPI_Recv()
  0.0        0.052        0.052           1           0         52 TAPAR
  0.0        0.052        0.052           1           0         52 main => MPI_Talbot1 => TAPAR
  0.0        0.048        0.048           2           0         24 MPI_Send()
  0.0        0.048        0.048           2           0         24 main => MPI_Send()
  0.0        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_size()

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.311          353           1           9     353135 main
 39.0        0.129          137           1           2     137562 MPI_Talbot1
 39.0        0.129          137           1           2     137562 main => MPI_Talbot1
 38.9           77          137           1      181999     137354 MPI_TSUM1
 38.9           77          137           1      181999     137354 main => MPI_Talbot1 => MPI_TSUM1
 37.5          132          132           1           0     132577 MPI_Init_thread()
 37.5          132          132           1           0     132577 main => MPI_Init_thread()
 22.6           79           79           1           0      79771 MPI_Finalize()
 22.6           79           79           1           0      79771 main => MPI_Finalize()
 16.8           59           59      181999           0          0 F24
 16.8           59           59      181999           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.7            2            2           1           0       2398 MPI_Barrier()
  0.7            2            2           1           0       2398 main => MPI_Barrier()
```

```
  0.1         0.41         0.41           1           0        410 MPI_Recv()
  0.1         0.41         0.41           1           0        410 main => MPI_Recv()
  0.0        0.079        0.079           1           0         79 TAPAR
  0.0        0.079        0.079           1           0         79 main => MPI_Talbot1 => TAPAR
  0.0        0.036        0.036           1           0         36 MPI_Comm_size()
  0.0        0.036        0.036           1           0         36 main => MPI_Comm_size()
  0.0        0.035        0.035           1           0         35 MPI_Comm_rank()
  0.0        0.035        0.035           2           0         18 MPI_Send()
  0.0        0.035        0.035           1           0         35 main => MPI_Comm_rank()
  0.0        0.035        0.035           2           0         18 main => MPI_Send()

NODE 4;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.213          253           1           9     253511 main
 53.5         0.11          135           1           2     135507 MPI_Talbot1
 53.5         0.11          135           1           2     135507 main => MPI_Talbot1
 53.4           74          135           1      181999     135330 MPI_TSUM1
 53.4           74          135           1      181999     135330 main => MPI_Talbot1 => MPI_TSUM1
 32.3           81           81           1           0      81770 MPI_Finalize()
 32.3           81           81           1           0      81770 main => MPI_Finalize()
 24.1           61           61      181999           0          0 F24
 24.1           61           61      181999           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 13.0           32           32           1           0      32997 MPI_Init_thread()
 13.0           32           32           1           0      32997 main => MPI_Init_thread()
  1.0            2            2           1           0       2467 MPI_Barrier()
  1.0            2            2           1           0       2467 main => MPI_Barrier()
  0.2        0.421        0.421           1           0        421 MPI_Recv()
  0.2        0.421        0.421           1           0        421 main => MPI_Recv()
  0.0        0.077        0.077           1           0         77 MPI_Comm_rank()
  0.0        0.077        0.077           1           0         77 main => MPI_Comm_rank()
  0.0        0.067        0.067           1           0         67 TAPAR
  0.0        0.067        0.067           1           0         67 main => MPI_Talbot1 => TAPAR
  0.0        0.033        0.033           2           0         16 MPI_Send()
  0.0        0.033        0.033           2           0         16 main => MPI_Send()
  0.0        0.026        0.026           1           0         26 MPI_Comm_size()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_size()

NODE 5;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.22          254           1           9     254468 main
 53.0         0.08          134           1           2     134811 MPI_Talbot1
 53.0         0.08          134           1           2     134811 main => MPI_Talbot1
 52.9           75          134           1      181999     134682 MPI_TSUM1
 52.9           75          134           1      181999     134682 main => MPI_Talbot1 => MPI_TSUM1
 32.2           82           82           1           0      82027 MPI_Finalize()
 32.2           82           82           1           0      82027 main => MPI_Finalize()
 23.3           59           59      181999           0          0 F24
 23.3           59           59      181999           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 13.4           33           33           1           0      33979 MPI_Init_thread()
 13.4           33           33           1           0      33979 main => MPI_Init_thread()
```

```
  0.9            2            2           1           0       2407 MPI_Barrier()
  0.9            2            2           1           0       2407 main => MPI_Barrier()
  0.4        0.916        0.916           1           0        916 MPI_Recv()
  0.4        0.916        0.916           1           0        916 main => MPI_Recv()
  0.0        0.049        0.049           1           0         49 TAPAR
  0.0        0.049        0.049           1           0         49 main => MPI_Talbot1 => TAPAR
  0.0        0.046        0.046           2           0         23 MPI_Send()
  0.0        0.046        0.046           2           0         23 main => MPI_Send()
  0.0        0.037        0.037           1           0         37 MPI_Comm_size()
  0.0        0.037        0.037           1           0         37 main => MPI_Comm_size()
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()

NODE 6;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.252          253           1           9     253630 main
 53.7        0.114          136           1           2     136105 MPI_Talbot1
 53.7        0.114          136           1           2     136105 main => MPI_Talbot1
 53.6           75          135           1      181999     135924 MPI_TSUM1
 53.6           75          135           1      181999     135924 main => MPI_Talbot1 => MPI_TSUM1
 31.8           80           80           1           0      80731 MPI_Finalize()
 31.8           80           80           1           0      80731 main => MPI_Finalize()
 24.0           60           60      181999           0          0 F24
 24.0           60           60      181999           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 13.1           33           33           1           0      33128 MPI_Init_thread()
 13.1           33           33           1           0      33128 main => MPI_Init_thread()
  1.0            2            2           1           0       2476 MPI_Barrier()
  1.0            2            2           1           0       2476 main => MPI_Barrier()
  0.3        0.845        0.845           1           0        845 MPI_Recv()
  0.3        0.845        0.845           1           0        845 main => MPI_Recv()
  0.0        0.067        0.067           1           0         67 TAPAR
  0.0        0.067        0.067           1           0         67 main => MPI_Talbot1 => TAPAR
  0.0        0.037        0.037           1           0         37 MPI_Comm_rank()
  0.0        0.037        0.037           1           0         37 main => MPI_Comm_rank()
  0.0        0.028        0.028           1           0         28 MPI_Comm_size()
  0.0        0.028        0.028           2           0         14 MPI_Send()
  0.0        0.028        0.028           1           0         28 main => MPI_Comm_size()
  0.0        0.028        0.028           2           0         14 main => MPI_Send()

NODE 7;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.219          223           1           9     223415 main
 60.0        0.079          134           1           2     134025 MPI_Talbot1
 60.0        0.079          134           1           2     134025 main => MPI_Talbot1
 59.9           75          133           1      181999     133897 MPI_TSUM1
 59.9           75          133           1      181999     133897 main => MPI_Talbot1 => MPI_TSUM1
 37.1           82           82           1           0      82781 MPI_Finalize()
 37.1           82           82           1           0      82781 main => MPI_Finalize()
 26.3           58           58      181999           0          0 F24
 26.3           58           58      181999           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
```

```
  1.3            2            2           1           0       2964 MPI_Init_thread()
  1.3            2            2           1           0       2964 main => MPI_Init_thread()
  1.1            2            2           1           0       2390 MPI_Barrier()
  1.1            2            2           1           0       2390 main => MPI_Barrier()
  0.4        0.931        0.931           1           0        931 MPI_Recv()
  0.4        0.931        0.931           1           0        931 main => MPI_Recv()
  0.0        0.049        0.049           1           0         49 TAPAR
  0.0        0.049        0.049           1           0         49 main => MPI_Talbot1 => TAPAR
  0.0        0.048        0.048           2           0         24 MPI_Send()
  0.0        0.048        0.048           2           0         24 main => MPI_Send()
  0.0        0.033        0.033           1           0         33 MPI_Comm_size()
  0.0        0.033        0.033           1           0         33 main => MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_rank()

FUNCTION SUMMARY (total):
-------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------
100.0            2        2,208           8          90     276009 main
 56.4        0.789        1,245           8          16     155699 MPI_Talbot1
 56.4        0.789        1,245           8          16     155699 main => MPI_Talbot1
 56.4          694        1,244           8 1.81999E+06     155540 MPI_TSUM1
 56.4          694        1,244           8 1.81999E+06     155540 main => MPI_Talbot1 => MPI_TSUM1
 24.9          550          550 1.81999E+06           0          0 F24
 24.9          550          550 1.81999E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 22.3          491          491           8           0      61414 MPI_Finalize()
 22.3          491          491           8           0      61414 main => MPI_Finalize()
 20.1          444          444           8           0      55519 MPI_Init_thread()
 20.1          444          444           8           0      55519 main => MPI_Init_thread()
  0.9           19           19           8           0       2438 MPI_Barrier()
  0.9           19           19           8           0       2438 main => MPI_Barrier()
  0.2            3            3          21           0        185 MPI_Recv()
  0.2            3            3          21           0        185 main => MPI_Recv()
  0.0            1            1          21           0         51 MPI_Send()
  0.0            1            1          21           0         51 main => MPI_Send()
  0.0        0.483        0.483           8           0         60 TAPAR
  0.0        0.483        0.483           8           0         60 main => MPI_Talbot1 => TAPAR
  0.0        0.289        0.289           8           0         36 MPI_Comm_rank()
  0.0        0.289        0.289           8           0         36 main => MPI_Comm_rank()
  0.0        0.251        0.251           8           0         31 MPI_Comm_size()
  0.0        0.251        0.251           8           0         31 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
-------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------
100.0        0.251          276           1       11.25     276009 main
 56.4       0.0986          155           1           2     155699 MPI_Talbot1
 56.4       0.0986          155           1           2     155699 main => MPI_Talbot1
 56.4           86          155           1      227499     155540 MPI_TSUM1
 56.4           86          155           1      227499     155540 main => MPI_Talbot1 => MPI_TSUM1
 24.9           68           68      227499           0          0 F24
 24.9           68           68      227499           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
```

22.3	61	61	1	0	61414 MPI_Finalize()
22.3	61	61	1	0	61414 main => MPI_Finalize()
20.1	55	55	1	0	55519 MPI_Init_thread()
20.1	55	55	1	0	55519 main => MPI_Init_thread()
0.9	2	2	1	0	2438 MPI_Barrier()
0.9	2	2	1	0	2438 main => MPI_Barrier()
0.2	0.487	0.487	2.625	0	185 MPI_Recv()
0.2	0.487	0.487	2.625	0	185 main => MPI_Recv()
0.0	0.134	0.134	2.625	0	51 MPI_Send()
0.0	0.134	0.134	2.625	0	51 main => MPI_Send()
0.0	0.0604	0.0604	1	0	60 TAPAR
0.0	0.0604	0.0604	1	0	60 main => MPI_Talbot1 => TAPAR
0.0	0.0361	0.0361	1	0	36 MPI_Comm_rank()
0.0	0.0361	0.0361	1	0	36 main => MPI_Comm_rank()
0.0	0.0314	0.0314	1	0	31 MPI_Comm_size()
0.0	0.0314	0.0314	1	0	31 main => MPI_Comm_size()



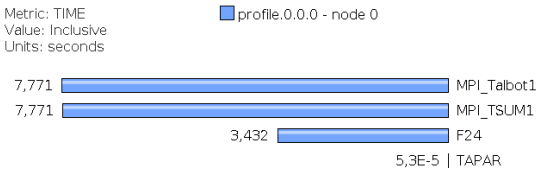
(a) (b)

Figure 12: `MP_Talbot1` on **TEST 3 - N. of Processes 8**: *Inclusive Time measured by TAU on node mapping (a) VS core mapping (b).*

TEST 4 `MPI_Talbot1` with *Input Data*: Test Function n. 24, `NTval` = `100`, `T2` interval.

– **TEST 4 – N. of Processes=1** (see Figure 13)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.164        7,738           1           6    7738939 main
100.0        0.079        7,735           1           2    7735976 MPI_Talbot1
100.0        0.079        7,735           1           2    7735976 main => MPI_Talbot1
100.0        4,326        7,735           1 1.81999E+07    7735844 MPI_TSUM1
100.0        4,326        7,735           1 1.81999E+07    7735844 main => MPI_Talbot1 => MPI_TSUM1
 44.1        3,409        3,409 1.81999E+07           0          0 F24
 44.1        3,409        3,409 1.81999E+07           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.0            2            2           1           0       2156 MPI_Init_thread()
  0.0            2            2           1           0       2156 main => MPI_Init_thread()
  0.0        0.567        0.567           1           0        567 MPI_Finalize()
  0.0        0.567        0.567           1           0        567 main => MPI_Finalize()
  0.0        0.053        0.053           1           0         53 TAPAR
  0.0        0.053        0.053           1           0         53 main => MPI_Talbot1 => TAPAR
  0.0        0.027        0.027           1           0         27 MPI_Barrier()
  0.0        0.027        0.027           1           0         27 main => MPI_Barrier()
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_size()
```



(b)

Figure 13: `MPI_Talbot1` on **TEST 4 - N. of Processes 1**: *Inclusive Time measured with TAU.*

– **TEST 4 – N. of Processes=4** (see Figure 14)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.23        2,157           1          15    2157147 main
 93.3        0.083        2,012           1           2    2012036 MPI_Talbot1
 93.3        0.083        2,012           1           2    2012036 main => MPI_Talbot1
 93.3        1,115        2,011           1 4.54998E+06    2011890 MPI_TSUM1
 93.3        1,115        2,011           1 4.54998E+06    2011890 main => MPI_Talbot1 => MPI_TSUM1
 41.6          896          896 4.54998E+06           0          0 F24
 41.6          896          896 4.54998E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  4.6           98           98           1           0      98943 MPI_Init_thread()
  4.6           98           98           1           0      98943 main => MPI_Init_thread()
  2.0           43           43           6           0       7237 MPI_Recv()
```

```
  2.0           43           43           6           0       7237 main => MPI_Recv()
  0.1            1            1           1           0       1673 MPI_Barrier()
  0.1            1            1           1           0       1673 main => MPI_Barrier()
  0.0         0.73         0.73           1           0        730 MPI_Finalize()
  0.0         0.73         0.73           1           0        730 main => MPI_Finalize()
  0.0        0.063        0.063           1           0         63 TAPAR
  0.0        0.063        0.063           1           0         63 main => MPI_Talbot1 => TAPAR
  0.0        0.059        0.059           3           0         20 MPI_Send()
  0.0        0.059        0.059           3           0         20 main => MPI_Send()
  0.0        0.032        0.032           1           0         32 MPI_Comm_rank()
  0.0        0.032        0.032           1           0         32 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 MPI_Comm_size()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.231        2,062           1           9    2062163 main
 99.7        0.096        2,055           1           2    2055291 MPI_Talbot1
 99.7        0.096        2,055           1           2    2055291 main => MPI_Talbot1
 99.7        1,143        2,055           1 4.54998E+06    2055131 MPI_TSUM1
 99.7        1,143        2,055           1 4.54998E+06    2055131 main => MPI_Talbot1 => MPI_TSUM1
 44.2          911          911 4.54998E+06           0          0 F24
 44.2          911          911 4.54998E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  0.2            3            3           1           0       3730 MPI_Init_thread()
  0.2            3            3           1           0       3730 main => MPI_Init_thread()
  0.1            1            1           1           0       1708 MPI_Barrier()
  0.1            1            1           1           0       1708 main => MPI_Barrier()
  0.1            1            1           1           0       1037 MPI_Finalize()
  0.1            1            1           1           0       1037 main => MPI_Finalize()
  0.0        0.071        0.071           1           0         71 MPI_Recv()
  0.0        0.071        0.071           1           0         71 main => MPI_Recv()
  0.0        0.064        0.064           1           0         64 TAPAR
  0.0        0.064        0.064           1           0         64 main => MPI_Talbot1 => TAPAR
  0.0        0.036        0.036           2           0         18 MPI_Send()
  0.0        0.036        0.036           2           0         18 main => MPI_Send()
  0.0        0.031        0.031           1           0         31 MPI_Comm_rank()
  0.0        0.031        0.031           1           0         31 main => MPI_Comm_rank()
  0.0        0.028        0.028           1           0         28 MPI_Comm_size()
  0.0        0.028        0.028           1           0         28 main => MPI_Comm_size()

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.207        2,060           1           9    2060851 main
 97.1        0.077        2,001           1           2    2001112 MPI_Talbot1
 97.1        0.077        2,001           1           2    2001112 main => MPI_Talbot1
 97.1        1,117        2,000           1 4.54998E+06    2000980 MPI_TSUM1
 97.1        1,117        2,000           1 4.54998E+06    2000980 main => MPI_Talbot1 => MPI_TSUM1
 42.9          883          883 4.54998E+06           0          0 F24
 42.9          883          883 4.54998E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  2.7           55           55           1           0      55151 MPI_Finalize()
```

```
  2.7           55           55           1           0      55151 main => MPI_Finalize()
  0.1            2            2           1           0       2600 MPI_Init_thread()
  0.1            2            2           1           0       2600 main => MPI_Init_thread()
  0.1            1            1           1           0       1526 MPI_Barrier()
  0.1            1            1           1           0       1526 main => MPI_Barrier()
  0.0        0.169        0.169           1           0        169 MPI_Recv()
  0.0        0.169        0.169           1           0        169 main => MPI_Recv()
  0.0        0.055        0.055           1           0         55 TAPAR
  0.0        0.055        0.055           1           0         55 main => MPI_Talbot1 => TAPAR
  0.0        0.036        0.036           2           0         18 MPI_Send()
  0.0        0.036        0.036           2           0         18 main => MPI_Send()
  0.0        0.027        0.027           1           0         27 MPI_Comm_rank()
  0.0        0.027        0.027           1           0         27 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 MPI_Comm_size()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.203        2,064           1           9    2064733 main
 96.2         0.08        1,986           1           2    1986242 MPI_Talbot1
 96.2         0.08        1,986           1           2    1986242 main => MPI_Talbot1
 96.2        1,108        1,986           1 4.54998E+06    1986108 MPI_TSUM1
 96.2        1,108        1,986           1 4.54998E+06    1986108 main => MPI_Talbot1 => MPI_TSUM1
 42.5          877          877 4.54998E+06           0          0 F24
 42.5          877          877 4.54998E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  3.4           70           70           1           0      70247 MPI_Finalize()
  3.4           70           70           1           0      70247 main => MPI_Finalize()
  0.3            6            6           1           0       6282 MPI_Init_thread()
  0.3            6            6           1           0       6282 main => MPI_Init_thread()
  0.1            1            1           1           0       1598 MPI_Barrier()
  0.1            1            1           1           0       1598 main => MPI_Barrier()
  0.0        0.077        0.077           1           0         77 MPI_Recv()
  0.0        0.077        0.077           1           0         77 main => MPI_Recv()
  0.0        0.054        0.054           1           0         54 TAPAR
  0.0        0.054        0.054           1           0         54 main => MPI_Talbot1 => TAPAR
  0.0        0.033        0.033           2           0         16 MPI_Send()
  0.0        0.033        0.033           2           0         16 main => MPI_Send()
  0.0        0.029        0.029           1           0         29 MPI_Comm_rank()
  0.0        0.029        0.029           1           0         29 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 MPI_Comm_size()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.871        8,344           4          42    2086224 main
 96.5        0.336        8,054           4           8    2013670 MPI_Talbot1
 96.5        0.336        8,054           4           8    2013670 main => MPI_Talbot1
 96.5        4,484        8,054           4 1.81999E+07    2013527 MPI_TSUM1
 96.5        4,484        8,054           4 1.81999E+07    2013527 main => MPI_Talbot1 => MPI_TSUM1
 42.8        3,569        3,569 1.81999E+07           0          0 F24
```

```
 42.8        3,569        3,569 1.81999E+07           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  1.5          127          127           4           0      31791 MPI_Finalize()
  1.5          127          127           4           0      31791 main => MPI_Finalize()
  1.3          111          111           4           0      27889 MPI_Init_thread()
  1.3          111          111           4           0      27889 main => MPI_Init_thread()
  0.5           43           43           9           0       4860 MPI_Recv()
  0.5           43           43           9           0       4860 main => MPI_Recv()
  0.1            6            6           4           0       1626 MPI_Barrier()
  0.1            6            6           4           0       1626 main => MPI_Barrier()
  0.0        0.236        0.236           4           0         59 TAPAR
  0.0        0.236        0.236           4           0         59 main => MPI_Talbot1 => TAPAR
  0.0        0.164        0.164           9           0         18 MPI_Send()
  0.0        0.164        0.164           9           0         18 main => MPI_Send()
  0.0        0.119        0.119           4           0         30 MPI_Comm_rank()
  0.0        0.119        0.119           4           0         30 main => MPI_Comm_rank()
  0.0        0.096        0.096           4           0         24 MPI_Comm_size()
  0.0        0.096        0.096           4           0         24 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.218        2,086           1        10.5    2086224 main
 96.5        0.084        2,013           1           2    2013670 MPI_Talbot1
 96.5        0.084        2,013           1           2    2013670 main => MPI_Talbot1
 96.5        1,121        2,013           1 4.54998E+06    2013527 MPI_TSUM1
 96.5        1,121        2,013           1 4.54998E+06    2013527 main => MPI_Talbot1 => MPI_TSUM1
 42.8          892          892 4.54998E+06           0          0 F24
 42.8          892          892 4.54998E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  1.5           31           31           1           0      31791 MPI_Finalize()
  1.5           31           31           1           0      31791 main => MPI_Finalize()
  1.3           27           27           1           0      27889 MPI_Init_thread()
  1.3           27           27           1           0      27889 main => MPI_Init_thread()
  0.5           10           10        2.25           0       4860 MPI_Recv()
  0.5           10           10        2.25           0       4860 main => MPI_Recv()
  0.1            1            1           1           0       1626 MPI_Barrier()
  0.1            1            1           1           0       1626 main => MPI_Barrier()
  0.0        0.059        0.059           1           0         59 TAPAR
  0.0        0.059        0.059           1           0         59 main => MPI_Talbot1 => TAPAR
  0.0        0.041        0.041        2.25           0         18 MPI_Send()
  0.0        0.041        0.041        2.25           0         18 main => MPI_Send()
  0.0       0.0297       0.0297           1           0         30 MPI_Comm_rank()
  0.0       0.0297       0.0297           1           0         30 main => MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_size()
```

– **TEST 4 – N. of Processes=8** (see Figure 15)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.23        1,298           1          27    1298873 main
```

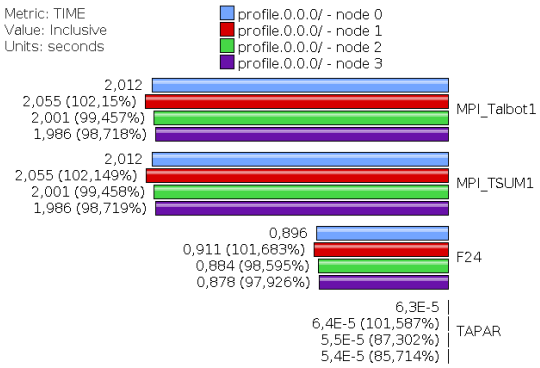


Figure 14: `MPI_Talbot1` on **TEST 4 - N. of Processes 4**: *Inclusive Time measured with TAU.*

```
 85.6        0.08        1,111           1           2    1111287 MPI_Talbot1
 85.6        0.08        1,111           1           2    1111287 main => MPI_Talbot1
 85.5         635        1,111           1 2.36599E+06    1111156 MPI_TSUM1
 85.5         635        1,111           1 2.36599E+06    1111156 main => MPI_Talbot1 => MPI_TSUM1
 36.7         476          476 2.36599E+06           0          0 F24
 36.7         476          476 2.36599E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  8.4         109          109           1           0     109452 MPI_Init_thread()
  8.4         109          109           1           0     109452 main => MPI_Init_thread()
  5.7          73           73          14           0       5257 MPI_Recv()
  5.7          73           73          14           0       5257 main => MPI_Recv()
  0.2           2            2           1           0       2656 MPI_Barrier()
  0.2           2            2           1           0       2656 main => MPI_Barrier()
  0.1       0.848        0.848           1           0        848 MPI_Finalize()
  0.1       0.848        0.848           1           0        848 main => MPI_Finalize()
  0.1       0.759        0.759           7           0        108 MPI_Send()
  0.1       0.759        0.759           7           0        108 main => MPI_Send()
  0.0       0.051        0.051           1           0         51 TAPAR
  0.0       0.051        0.051           1           0         51 main => MPI_Talbot1 => TAPAR
  0.0       0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0       0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0       0.021        0.021           1           0         21 MPI_Comm_size()
  0.0       0.021        0.021           1           0         21 main => MPI_Comm_size()

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.214        1,205           1           9    1205893 main
 94.4       0.081        1,138           1           2    1138453 MPI_Talbot1
 94.4       0.081        1,138           1           2    1138453 main => MPI_Talbot1
 94.4         633        1,138           1 2.36599E+06    1138318 MPI_TSUM1
 94.4         633        1,138           1 2.36599E+06    1138318 main => MPI_Talbot1 => MPI_TSUM1
 41.9         505          505 2.36599E+06           0          0 F24
 41.9         505          505 2.36599E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  4.0          47           47           1           0      47893 MPI_Finalize()
  4.0          47           47           1           0      47893 main => MPI_Finalize()
```

```
  1.4           16           16           1           0      16558 MPI_Init_thread()
  1.4           16           16           1           0      16558 main => MPI_Init_thread()
  0.2            2            2           1           0       2634 MPI_Barrier()
  0.2            2            2           1           0       2634 main => MPI_Barrier()
  0.0        0.056        0.056           1           0         56 MPI_Recv()
  0.0        0.056        0.056           1           0         56 main => MPI_Recv()
  0.0        0.054        0.054           1           0         54 TAPAR
  0.0        0.054        0.054           1           0         54 main => MPI_Talbot1 => TAPAR
  0.0        0.034        0.034           2           0         17 MPI_Send()
  0.0        0.034        0.034           2           0         17 main => MPI_Send()
  0.0        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 MPI_Comm_size()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_size()

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.238        1,191           1           9    1191874 main
 90.5        0.083        1,078           1           2    1078659 MPI_Talbot1
 90.5        0.083        1,078           1           2    1078659 main => MPI_Talbot1
 90.5          608        1,078           1 2.36599E+06    1078521 MPI_TSUM1
 90.5          608        1,078           1 2.36599E+06    1078521 main => MPI_Talbot1 => MPI_TSUM1
 39.5          470          470 2.36599E+06           0          0 F24
 39.5          470          470 2.36599E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  9.0          107          107           1           0     107669 MPI_Finalize()
  9.0          107          107           1           0     107669 main => MPI_Finalize()
  0.2            2            2           1           0       2689 MPI_Init_thread()
  0.2            2            2           1           0       2689 main => MPI_Init_thread()
  0.2            2            2           1           0       2357 MPI_Barrier()
  0.2            2            2           1           0       2357 main => MPI_Barrier()
  0.0        0.154        0.154           1           0        154 MPI_Recv()
  0.0        0.154        0.154           1           0        154 main => MPI_Recv()
  0.0        0.055        0.055           1           0         55 TAPAR
  0.0        0.055        0.055           1           0         55 main => MPI_Talbot1 => TAPAR
  0.0        0.038        0.038           1           0         38 MPI_Comm_size()
  0.0        0.038        0.038           1           0         38 main => MPI_Comm_size()
  0.0        0.037        0.037           1           0         37 MPI_Comm_rank()
  0.0        0.037        0.037           1           0         37 main => MPI_Comm_rank()
  0.0        0.033        0.033           2           0         16 MPI_Send()
  0.0        0.033        0.033           2           0         16 main => MPI_Send()

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.236        1,302           1           9    1302077 main
 91.0        0.096        1,185           1           2    1185286 MPI_Talbot1
 91.0        0.096        1,185           1           2    1185286 main => MPI_Talbot1
 91.0          653        1,185           1 2.36599E+06    1185136 MPI_TSUM1
 91.0          653        1,185           1 2.36599E+06    1185136 main => MPI_Talbot1 => MPI_TSUM1
 40.8          531          531 2.36599E+06           0          0 F24
 40.8          531          531 2.36599E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
```

```
  8.6          112          112           1           0     112583 MPI_Init_thread()
  8.6          112          112           1           0     112583 main => MPI_Init_thread()
  0.2            2            2           1           0       2680 MPI_Barrier()
  0.2            2            2           1           0       2680 main => MPI_Barrier()
  0.1            1            1           1           0       1011 MPI_Finalize()
  0.1            1            1           1           0       1011 main => MPI_Finalize()
  0.0        0.196        0.196           1           0        196 MPI_Recv()
  0.0        0.196        0.196           1           0        196 main => MPI_Recv()
  0.0        0.054        0.054           1           0         54 TAPAR
  0.0        0.054        0.054           1           0         54 main => MPI_Talbot1 => TAPAR
  0.0        0.037        0.037           2           0         18 MPI_Send()
  0.0        0.037        0.037           2           0         18 main => MPI_Send()
  0.0        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 MPI_Comm_size()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()

NODE 4;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.203        1,203           1           9    1203629 main
 93.4        0.076        1,124           1           2    1124263 MPI_Talbot1
 93.4        0.076        1,124           1           2    1124263 main => MPI_Talbot1
 93.4          622        1,124           1 2.18399E+06    1124136 MPI_TSUM1
 93.4          622        1,124           1 2.18399E+06    1124136 main => MPI_Talbot1 => MPI_TSUM1
 41.7          501          501 2.18399E+06           0          0 F24
 41.7          501          501 2.18399E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  5.1           61           61           1           0      61790 MPI_Finalize()
  5.1           61           61           1           0      61790 main => MPI_Finalize()
  1.2           14           14           1           0      14405 MPI_Init_thread()
  1.2           14           14           1           0      14405 main => MPI_Init_thread()
  0.2            2            2           1           0       2485 MPI_Barrier()
  0.2            2            2           1           0       2485 main => MPI_Barrier()
  0.0          0.4          0.4           1           0        400 MPI_Recv()
  0.0          0.4          0.4           1           0        400 main => MPI_Recv()
  0.0        0.051        0.051           1           0         51 TAPAR
  0.0        0.051        0.051           1           0         51 main => MPI_Talbot1 => TAPAR
  0.0        0.034        0.034           2           0         17 MPI_Send()
  0.0        0.034        0.034           2           0         17 main => MPI_Send()
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_size()

NODE 5;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.258        1,204           1           9    1204641 main
 86.3        0.115        1,039           1           2    1039212 MPI_Talbot1
 86.3        0.115        1,039           1           2    1039212 main => MPI_Talbot1
 86.3          582        1,039           1 2.18399E+06    1039027 MPI_TSUM1
 86.3          582        1,039           1 2.18399E+06    1039027 main => MPI_Talbot1 => MPI_TSUM1
```

```
 37.9          456          456 2.18399E+06           0          0 F24
 37.9          456          456 2.18399E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 12.2          146          146           1           0     146482 MPI_Finalize()
 12.2          146          146           1           0     146482 main => MPI_Finalize()
  1.3           15           15           1           0      15338 MPI_Init_thread()
  1.3           15           15           1           0      15338 main => MPI_Init_thread()
  0.2            2            2           1           0       2441 MPI_Barrier()
  0.2            2            2           1           0       2441 main => MPI_Barrier()
  0.1        0.804        0.804           1           0        804 MPI_Recv()
  0.1        0.804        0.804           1           0        804 main => MPI_Recv()
  0.0         0.07         0.07           1           0         70 TAPAR
  0.0         0.07         0.07           1           0         70 main => MPI_Talbot1 => TAPAR
  0.0        0.039        0.039           1           0         39 MPI_Comm_rank()
  0.0        0.039        0.039           1           0         39 main => MPI_Comm_rank()
  0.0        0.034        0.034           1           0         34 MPI_Comm_size()
  0.0        0.034        0.034           1           0         34 main => MPI_Comm_size()
  0.0        0.033        0.033           2           0         16 MPI_Send()
  0.0        0.033        0.033           2           0         16 main => MPI_Send()

NODE 6;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.218        1,203           1           9    1203711 main
 88.7        0.075        1,068           1           2    1068177 MPI_Talbot1
 88.7        0.075        1,068           1           2    1068177 main => MPI_Talbot1
 88.7          604        1,068           1 2.18399E+06    1068053 MPI_TSUM1
 88.7          604        1,068           1 2.18399E+06    1068053 main => MPI_Talbot1 => MPI_TSUM1
 38.5          463          463 2.18399E+06           0          0 F24
 38.5          463          463 2.18399E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  9.8          117          117           1           0     117500 MPI_Finalize()
  9.8          117          117           1           0     117500 main => MPI_Finalize()
  1.2           14           14           1           0      14455 MPI_Init_thread()
  1.2           14           14           1           0      14455 main => MPI_Init_thread()
  0.2            2            2           1           0       2433 MPI_Barrier()
  0.2            2            2           1           0       2433 main => MPI_Barrier()
  0.1        0.844        0.844           1           0        844 MPI_Recv()
  0.1        0.844        0.844           1           0        844 main => MPI_Recv()
  0.0        0.049        0.049           1           0         49 TAPAR
  0.0        0.049        0.049           1           0         49 main => MPI_Talbot1 => TAPAR
  0.0        0.035        0.035           2           0         18 MPI_Send()
  0.0        0.035        0.035           2           0         18 main => MPI_Send()
  0.0        0.025        0.025           1           0         25 MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.024        0.024           1           0         24 MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_size()

NODE 7;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.244        1,204           1           9    1204391 main
 84.1        0.114        1,012           1           2    1012497 MPI_Talbot1
 84.1        0.114        1,012           1           2    1012497 main => MPI_Talbot1
```

```
 84.1          567        1,012           1 2.18399E+06    1012313 MPI_TSUM1
 84.1          567        1,012           1 2.18399E+06    1012313 main => MPI_Talbot1 => MPI_TSUM1
 36.9          444          444 2.18399E+06           0          0 F24
 36.9          444          444 2.18399E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
 14.4          173          173           1           0     173293 MPI_Finalize()
 14.4          173          173           1           0     173293 main => MPI_Finalize()
  1.2           14           14           1           0      14976 MPI_Init_thread()
  1.2           14           14           1           0      14976 main => MPI_Init_thread()
  0.2            2            2           1           0       2571 MPI_Barrier()
  0.2            2            2           1           0       2571 main => MPI_Barrier()
  0.1        0.724        0.724           1           0        724 MPI_Recv()
  0.1        0.724        0.724           1           0        724 main => MPI_Recv()
  0.0         0.07         0.07           1           0         70 TAPAR
  0.0         0.07         0.07           1           0         70 main => MPI_Talbot1 => TAPAR
  0.0        0.035        0.035           2           0         18 MPI_Send()
  0.0        0.035        0.035           2           0         18 main => MPI_Send()
  0.0        0.026        0.026           1           0         26 MPI_Comm_rank()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 MPI_Comm_size()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_size()

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0           1        9,815           8          90    1226886 main
 89.2        0.72        8,757           8          16    1094729 MPI_Talbot1
 89.2        0.72        8,757           8          16    1094729 main => MPI_Talbot1
 89.2       4,907        8,756           8 1.81999E+07    1094582 MPI_TSUM1
 89.2       4,907        8,756           8 1.81999E+07    1094582 main => MPI_Talbot1 => MPI_TSUM1
 39.2       3,848        3,848 1.81999E+07           0          0 F24
 39.2       3,848        3,848 1.81999E+07           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  6.7         656          656           8           0      82061 MPI_Finalize()
  6.7         656          656           8           0      82061 main => MPI_Finalize()
  3.1         300          300           8           0      37557 MPI_Init_thread()
  3.1         300          300           8           0      37557 main => MPI_Init_thread()
  0.8          76           76          21           0       3656 MPI_Recv()
  0.8          76           76          21           0       3656 main => MPI_Recv()
  0.2          20           20           8           0       2532 MPI_Barrier()
  0.2          20           20           8           0       2532 main => MPI_Barrier()
  0.0           1            1          21           0         48 MPI_Send()
  0.0           1            1          21           0         48 main => MPI_Send()
  0.0       0.454        0.454           8           0         57 TAPAR
  0.0       0.454        0.454           8           0         57 main => MPI_Talbot1 => TAPAR
  0.0       0.229        0.229           8           0         29 MPI_Comm_rank()
  0.0       0.229        0.229           8           0         29 main => MPI_Comm_rank()
  0.0       0.213        0.213           8           0         27 MPI_Comm_size()
  0.0       0.213        0.213           8           0         27 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.23        1,226           1       11.25    1226886 main
```

```
 89.2        0.09        1,094           1           2    1094729 MPI_Talbot1
 89.2        0.09        1,094           1           2    1094729 main => MPI_Talbot1
 89.2         613        1,094           1 2.27499E+06    1094582 MPI_TSUM1
 89.2         613        1,094           1 2.27499E+06    1094582 main => MPI_Talbot1 => MPI_TSUM1
 39.2         481          481 2.27499E+06           0          0 F24
 39.2         481          481 2.27499E+06           0          0 main => MPI_Talbot1 => MPI_TSUM1 => F24
  6.7          82           82           1           0      82061 MPI_Finalize()
  6.7          82           82           1           0      82061 main => MPI_Finalize()
  3.1          37           37           1           0      37557 MPI_Init_thread()
  3.1          37           37           1           0      37557 main => MPI_Init_thread()
  0.8           9            9       2.625           0       3656 MPI_Recv()
  0.8           9            9       2.625           0       3656 main => MPI_Recv()
  0.2           2            2           1           0       2532 MPI_Barrier()
  0.2           2            2           1           0       2532 main => MPI_Barrier()
  0.0       0.125        0.125       2.625           0         48 MPI_Send()
  0.0       0.125        0.125       2.625           0         48 main => MPI_Send()
  0.0      0.0568       0.0568           1           0         57 TAPAR
  0.0      0.0568       0.0568           1           0         57 main => MPI_Talbot1 => TAPAR
  0.0      0.0286       0.0286           1           0         29 MPI_Comm_rank()
  0.0      0.0286       0.0286           1           0         29 main => MPI_Comm_rank()
  0.0      0.0266       0.0266           1           0         27 MPI_Comm_size()
  0.0      0.0266       0.0266           1           0         27 main => MPI_Comm_size()
```

4.1.2 MPI_ Talbot2

`MPI_Talbot2` driver function is the MPI implementation of **Algorithm 2**. It calls the two skill-level functions `TAPAR` and `MPI_TSUM2`. Figure 16 depicts a general case of the execution time distribution when running `MPI_Talbot2` on one process. So, we set `TAU_CALLPATH_DEPTH = 5` according to call tree depth of the function.

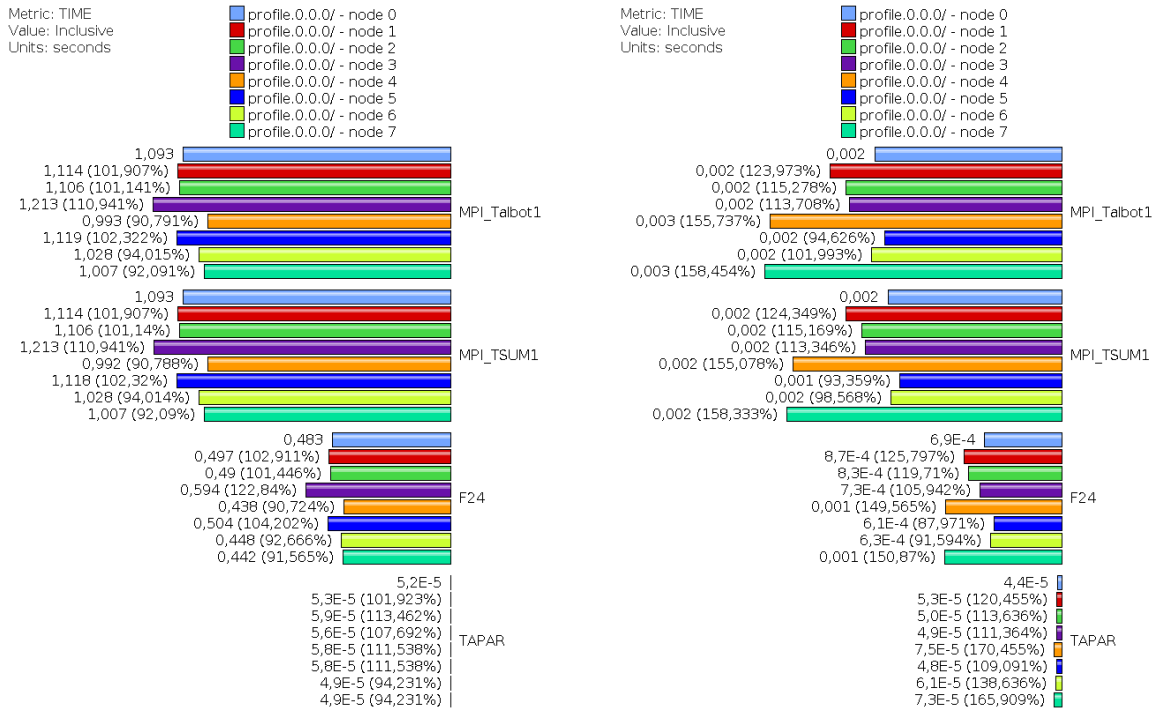
In the following, we reported the performance analysis of `MPI_Talbot2` in the four tests described above, by means callpath profile and the corresponding *thread comparison window*. We can summarize that `MPI_Talbot2` does not exhibit performance problems. In particular, **TEST 3** and **TEST 4** (concerning with `T2` interval with `NTval` = `10` and `NTval` = `100`) exhibit a balanced computational load among the processes as well as a reduction of the execution time with respect to number of processes (increasing speedup). Whereas we can observe in **TEST 1** and **TEST 2** (concerning with `T1` interval with `NTval` = `10` and `NTval` = `100`) a slight load imbalance produced by the very low computational cost of the tests with respect to execution time and to synchronization overhead of the `MPI_Reduce`. At last, we can observe in figures 19, 22, 25 an 28 that execuition tests don't show considerable differences about performance results of `MPI_Talbot2` on the two mapping used.

You can find the details about the results about `MPI_Talbot2` on a specific test searching the point list **TESTx - N. of Processes=y**, where **x**= $1, \ldots, 4$ and **y**=1,4,8.

TEST 1 `MPI_Talbot2` with *Input Data*: Test Function n. 24, `NTval` = `10`, `T1` interval.

– **TEST 1 – N. of Processes=1** (see Figure 17)

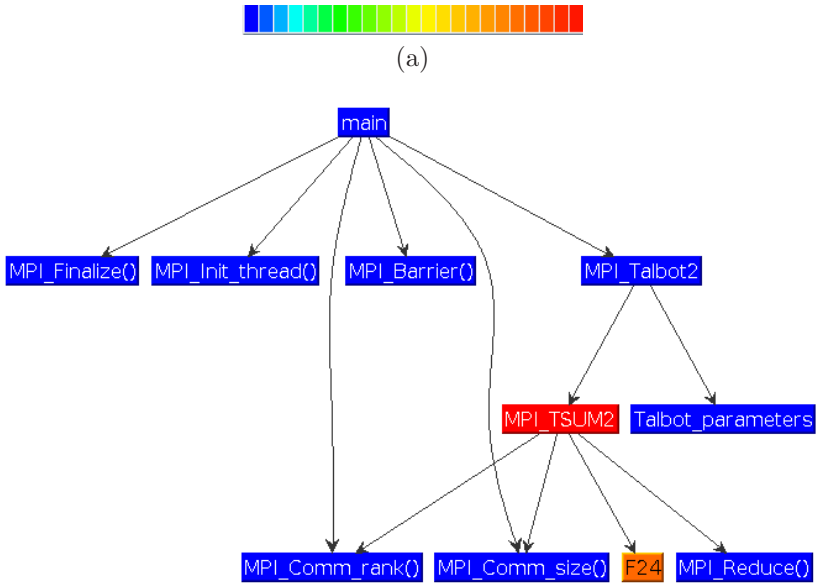
```
NODE 0;CONTEXT 0;THREAD 0:
```



(a) (b)

Figure 15: `MPI_Talbot1` on **TEST 4 - N. of Processes 8**: *Inclusive Time measured by TAU on node mapping (a)VS core mapping (b).*

```
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.158           4           1           6       4760 main
 47.1             2           2           1           0       2240 MPI_Init_thread()
 47.1             2           2           1           0       2240 main => MPI_Init_thread()
 34.3         0.083           1           1          20       1631 MPI_Talbot2
 34.3         0.083           1           1          20       1631 main => MPI_Talbot2
 31.1         0.778           1          10        1472        148 MPI_TSUM2
 31.1         0.778           1          10        1472        148 main => MPI_Talbot2 => MPI_TSUM2
 13.8         0.655       0.655           1           0        655 MPI_Finalize()
 13.8         0.655       0.655           1           0        655 main => MPI_Finalize()
 12.2          0.58        0.58        1442           0          0 F24
 12.2          0.58        0.58        1442           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  1.4         0.068       0.068          10           0          7 TAPAR
  1.4         0.068       0.068          10           0          7 main => MPI_Talbot2 => TAPAR
  1.4         0.066       0.066          10           0          7 MPI_Reduce()
  1.4         0.066       0.066          10           0          7 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.1         0.053       0.053          11           0          5 MPI_Comm_rank()
  1.1          0.05        0.05          11           0          5 MPI_Comm_size()
```



(a)

(b)

Figure 16: *Call Graph of* `MPI_TSUM2` *(b), legend colour of increasing (exclusive) execution time (a).*

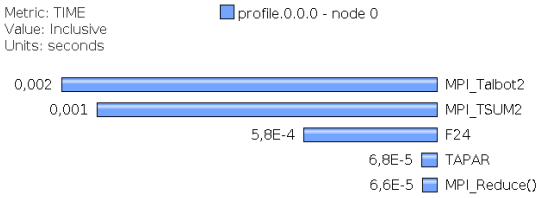


Figure 17: `MPI_Talbot2` on **TEST 1 - N. of Processes 1**: *Inclusive Time measured with TAU.*

```
 0.6        0.029        0.029          1          0         29 MPI_Barrier()
 0.6        0.029        0.029          1          0         29 main => MPI_Barrier()
 0.6        0.028        0.028         10          0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
 0.6        0.028        0.028         10          0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
 0.5        0.025        0.025          1          0         25 main => MPI_Comm_rank()
 0.5        0.022        0.022          1          0         22 main => MPI_Comm_size()
---------------------------------------------------------------------------------------
```

– **TEST 1 – N. of Processes=4**

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.169          114           1           6     114621 main
 86.4          98           98           1           0      98984 MPI_Init_thread()
 86.4          98           98           1           0      98984 main => MPI_Init_thread()
 11.1        0.09           12           1          20      12677 MPI_Talbot2
 11.1        0.09           12           1          20      12677 main => MPI_Talbot2
 10.9       0.303           12          10         396       1252 MPI_TSUM2
 10.9       0.303           12          10         396       1252 main => MPI_Talbot2 => MPI_TSUM2
 10.5          11           11          10           0       1199 MPI_Reduce()
 10.5          11           11          10           0       1199 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.4           1            1           1           0       1654 MPI_Barrier()
  1.4           1            1           1           0       1654 main => MPI_Barrier()
  0.9           1            1           1           0       1088 MPI_Finalize()
  0.9           1            1           1           0       1088 main => MPI_Finalize()
  0.1       0.165        0.165         366           0          0 F24
  0.1       0.165        0.165         366           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.1       0.071        0.071          10           0          7 TAPAR
  0.1       0.071        0.071          10           0          7 main => MPI_Talbot2 => TAPAR
  0.0       0.054        0.054          11           0          5 MPI_Comm_rank()
  0.0       0.049        0.049          11           0          4 MPI_Comm_size()
  0.0       0.028        0.028          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0       0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0       0.026        0.026          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0       0.023        0.023           1           0         23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.167           17           1           6      17934 main
 71.3          12           12           1           0      12790 MPI_Finalize()
 71.3          12           12           1           0      12790 main => MPI_Finalize()
 12.6           2            2           1           0       2263 MPI_Init_thread()
 12.6           2            2           1           0       2263 main => MPI_Init_thread()
  9.0           1            1           1           0       1614 MPI_Barrier()
  9.0           1            1           1           0       1614 main => MPI_Barrier()
  5.8         0.1            1           1          20       1049 MPI_Talbot2
  5.8         0.1            1           1          20       1049 main => MPI_Talbot2
  4.9       0.486         0.87          10         390         87 MPI_TSUM2
  4.9       0.486         0.87          10         390         87 main => MPI_Talbot2 => MPI_TSUM2
  1.0       0.178        0.178         360           0          0 F24
  1.0       0.178        0.178         360           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.8       0.142        0.142          10           0         14 MPI_Reduce()
  0.8       0.142        0.142          10           0         14 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.4       0.079        0.079          10           0          8 TAPAR
  0.4       0.079        0.079          10           0          8 main => MPI_Talbot2 => TAPAR
  0.3       0.062        0.062          11           0          6 MPI_Comm_rank()
  0.3       0.053        0.053          11           0          5 MPI_Comm_size()
  0.2       0.036        0.036          10           0          4 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.2       0.028        0.028          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
```

```
  0.1        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.1        0.025        0.025           1           0         25 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.182           21           1           6     21500 main
 58.7        0.089           12           1          20     12624 MPI_Talbot2
 58.7        0.089           12           1          20     12624 main => MPI_Talbot2
 57.9        0.286           12          10         389      1246 MPI_TSUM2
 57.9        0.286           12          10         389      1246 main => MPI_Talbot2 => MPI_TSUM2
 55.4           11           11          10           0      1191 MPI_Reduce()
 55.4           11           11          10           0      1191 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
 27.7            5            5           1           0      5953 MPI_Init_thread()
 27.7            5            5           1           0      5953 main => MPI_Init_thread()
  7.2            1            1           1           0      1548 MPI_Barrier()
  7.2            1            1           1           0      1548 main => MPI_Barrier()
  5.3            1            1           1           0      1144 MPI_Finalize()
  5.3            1            1           1           0      1144 main => MPI_Finalize()
  0.9        0.193        0.193         359           0         1 F24
  0.9        0.193        0.193         359           0         1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.4        0.078        0.078          10           0         8 TAPAR
  0.4        0.078        0.078          10           0         8 main => MPI_Talbot2 => TAPAR
  0.3        0.059        0.059          11           0         5 MPI_Comm_rank()
  0.3        0.054        0.054          11           0         5 MPI_Comm_size()
  0.1        0.032        0.032          10           0         3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.1        0.032        0.032          10           0         3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1        0.027        0.027           1           0        27 main => MPI_Comm_rank()
  0.1        0.022        0.022           1           0        22 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.165           20           1           6     20348 main
 64.3           13           13           1           0     13078 MPI_Finalize()
 64.3           13           13           1           0     13078 main => MPI_Finalize()
 22.9            4            4           1           0      4659 MPI_Init_thread()
 22.9            4            4           1           0      4659 main => MPI_Init_thread()
  7.9            1            1           1           0      1616 MPI_Barrier()
  7.9            1            1           1           0      1616 main => MPI_Barrier()
  3.8        0.094        0.778           1          20       778 MPI_Talbot2
  3.8        0.094        0.778           1          20       778 main => MPI_Talbot2
  3.0        0.277        0.611          10         387        61 MPI_TSUM2
  3.0        0.277        0.611          10         387        61 main => MPI_Talbot2 => MPI_TSUM2
  0.8        0.155        0.155         357           0         0 F24
  0.8        0.155        0.155         357           0         0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.6        0.123        0.123          10           0        12 MPI_Reduce()
  0.6        0.123        0.123          10           0        12 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.4        0.073        0.073          10           0         7 TAPAR
  0.4        0.073        0.073          10           0         7 main => MPI_Talbot2 => TAPAR
```

```
  0.3        0.058        0.058          11           0          5 MPI_Comm_rank()
  0.2         0.05         0.05          11           0          5 MPI_Comm_size()
  0.1        0.029        0.029           1           0         29 main => MPI_Comm_rank()
  0.1        0.029        0.029          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.1        0.027        0.027          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1        0.023        0.023           1           0         23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.683          174           4          24      43601 main
 64.1          111          111           4           0      27965 MPI_Init_thread()
 64.1          111          111           4           0      27965 main => MPI_Init_thread()
 16.1           28           28           4           0       7025 MPI_Finalize()
 16.1           28           28           4           0       7025 main => MPI_Finalize()
 15.6        0.373           27           4          80       6782 MPI_Talbot2
 15.6        0.373           27           4          80       6782 main => MPI_Talbot2
 15.2            1           26          40        1562        661 MPI_TSUM2
 15.2            1           26          40        1562        661 main => MPI_Talbot2 => MPI_TSUM2
 13.9           24           24          40           0        604 MPI_Reduce()
 13.9           24           24          40           0        604 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  3.7            6            6           4           0       1608 MPI_Barrier()
  3.7            6            6           4           0       1608 main => MPI_Barrier()
  0.4        0.691        0.691        1442           0          0 F24
  0.4        0.691        0.691        1442           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.2        0.301        0.301          40           0          8 TAPAR
  0.2        0.301        0.301          40           0          8 main => MPI_Talbot2 => TAPAR
  0.1        0.233        0.233          44           0          5 MPI_Comm_rank()
  0.1        0.206        0.206          44           0          5 MPI_Comm_size()
  0.1        0.125        0.125          40           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.1        0.113        0.113          40           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1        0.108        0.108           4           0         27 main => MPI_Comm_rank()
  0.1        0.093        0.093           4           0         23 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.171           43           1           6      43601 main
 64.1           27           27           1           0      27965 MPI_Init_thread()
 64.1           27           27           1           0      27965 main => MPI_Init_thread()
 16.1            7            7           1           0       7025 MPI_Finalize()
 16.1            7            7           1           0       7025 main => MPI_Finalize()
 15.6       0.0932            6           1          20       6782 MPI_Talbot2
 15.6       0.0932            6           1          20       6782 main => MPI_Talbot2
 15.2        0.338            6          10       390.5        661 MPI_TSUM2
 15.2        0.338            6          10       390.5        661 main => MPI_Talbot2 => MPI_TSUM2
 13.9            6            6          10           0        604 MPI_Reduce()
 13.9            6            6          10           0        604 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  3.7            1            1           1           0       1608 MPI_Barrier()
  3.7            1            1           1           0       1608 main => MPI_Barrier()
  0.4        0.173        0.173       360.5           0          0 F24
```

```
 0.4        0.173        0.173       360.5           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 0.2       0.0752       0.0752          10           0          8 TAPAR
 0.2       0.0752       0.0752          10           0          8 main => MPI_Talbot2 => TAPAR
 0.1       0.0583       0.0583          11           0          5 MPI_Comm_rank()
 0.1       0.0515       0.0515          11           0          5 MPI_Comm_size()
 0.1       0.0312       0.0312          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
 0.1       0.0283       0.0283          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
 0.1        0.027        0.027           1           0         27 main => MPI_Comm_rank()
 0.1       0.0232       0.0232           1           0         23 main => MPI_Comm_size()
```

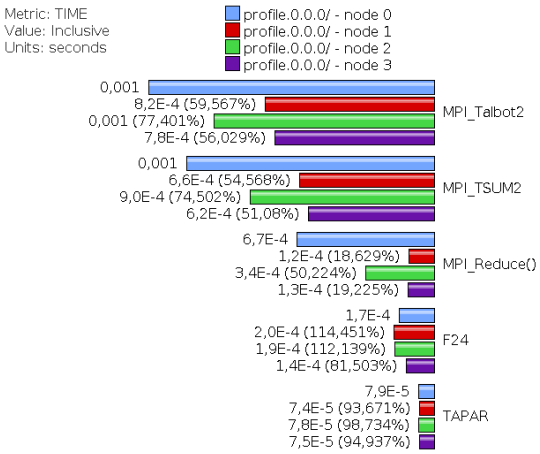


Figure 18: `MPI_Talbot2` on **TEST 1 - N. of Processes 4**: *Inclusive Time measured with TAU.*

– TEST 1 – N. of Processes=8

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.217          110           1           6     110997 main
 94.3         104          104           1           0     104680 MPI_Init_thread()
 94.3         104          104           1           0     104680 main => MPI_Init_thread()
  2.4       0.147            2           1          20       2633 MPI_Talbot2
  2.4       0.147            2           1          20       2633 main => MPI_Talbot2
  2.2       0.296            2          10         216        239 MPI_TSUM2
  2.2       0.296            2          10         216        239 main => MPI_Talbot2 => MPI_TSUM2
  1.8           1            1           1           0       1952 MPI_Barrier()
  1.8           1            1           1           0       1952 main => MPI_Barrier()
  1.7           1            1          10           0        184 MPI_Reduce()
  1.7           1            1          10           0        184 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.3           1            1           1           0       1447 MPI_Finalize()
  1.3           1            1           1           0       1447 main => MPI_Finalize()
  0.1       0.163        0.163         186           0          1 F24
  0.1       0.163        0.163         186           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.1       0.094        0.094          10           0          9 TAPAR
```

```
  0.1        0.094        0.094          10           0          9 main => MPI_Talbot2 => TAPAR
  0.1        0.081        0.081          11           0          7 MPI_Comm_rank()
  0.1        0.077        0.077          11           0          7 MPI_Comm_size()
  0.0        0.047        0.047          10           0          5 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.043        0.043          10           0          4 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.034        0.034           1           0         34 main => MPI_Comm_rank()
  0.0        0.034        0.034           1           0         34 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.17           18           1           6     18692 main
 66.7           12           12           1           0     12468 MPI_Init_thread()
 66.7           12           12           1           0     12468 main => MPI_Init_thread()
 17.6            3            3           1           0      3293 MPI_Finalize()
 17.6            3            3           1           0      3293 main => MPI_Finalize()
 11.0            2            2           1           0      2062 MPI_Barrier()
 11.0            2            2           1           0      2062 main => MPI_Barrier()
  3.5        0.094        0.647           1          20       647 MPI_Talbot2
  3.5        0.094        0.647           1          20       647 main => MPI_Talbot2
  2.6        0.193        0.479          10         213        48 MPI_TSUM2
  2.6        0.193        0.479          10         213        48 main => MPI_Talbot2 => MPI_TSUM2
  0.7        0.127        0.127          10           0        13 MPI_Reduce()
  0.7        0.127        0.127          10           0        13 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.5        0.098        0.098         183           0         1 F24
  0.5        0.098        0.098         183           0         1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.4        0.074        0.074          10           0         7 TAPAR
  0.4        0.074        0.074          10           0         7 main => MPI_Talbot2 => TAPAR
  0.3        0.058        0.058          11           0         5 MPI_Comm_size()
  0.3        0.055        0.055          11           0         5 MPI_Comm_rank()
  0.2        0.031        0.031          10           0         3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2         0.03         0.03          10           0         3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.1        0.027        0.027           1           0        27 main => MPI_Comm_size()
  0.1        0.025        0.025           1           0        25 main => MPI_Comm_rank()
---------------------------------------------------------------------------------------

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.167            8           1           6      8740 main
 31.8            2            2           1           0      2779 MPI_Barrier()
 31.8            2            2           1           0      2779 main => MPI_Barrier()
 29.1            2            2           1           0      2547 MPI_Init_thread()
 29.1            2            2           1           0      2547 main => MPI_Init_thread()
 18.4        0.087            1           1          20      1612 MPI_Talbot2
 18.4        0.087            1           1          20      1612 main => MPI_Talbot2
 18.2            1            1           1           0      1588 MPI_Finalize()
 18.2            1            1           1           0      1588 main => MPI_Finalize()
 16.7        0.196            1          10         213       146 MPI_TSUM2
 16.7        0.196            1          10         213       146 main => MPI_Talbot2 => MPI_TSUM2
 12.6            1            1          10           0       110 MPI_Reduce()
```

```
 12.6           1           1          10           0        110 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.1       0.098       0.098         183           0          1 F24
  1.1       0.098       0.098         183           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.8       0.067       0.067          10           0          7 TAPAR
  0.8       0.067       0.067          10           0          7 main => MPI_Talbot2 => TAPAR
  0.7       0.061       0.061          11           0          6 MPI_Comm_rank()
  0.6       0.052       0.052          11           0          5 MPI_Comm_size()
  0.4       0.037       0.037          10           0          4 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.3       0.029       0.029          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.3       0.024       0.024           1           0         24 main => MPI_Comm_rank()
  0.3       0.023       0.023           1           0         23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.176          21           1           6     21105 main
 70.6          14          14           1           0     14901 MPI_Init_thread()
 70.6          14          14           1           0     14901 main => MPI_Init_thread()
 15.2           3           3           1           0      3211 MPI_Finalize()
 15.2           3           3           1           0      3211 main => MPI_Finalize()
  9.6           2           2           1           0      2023 MPI_Barrier()
  9.6           2           2           1           0      2023 main => MPI_Barrier()
  3.5       0.104       0.741           1          20       741 MPI_Talbot2
  3.5       0.104       0.741           1          20       741 main => MPI_Talbot2
  2.7       0.237       0.561          10         211        56 MPI_TSUM2
  2.7       0.237       0.561          10         211        56 main => MPI_Talbot2 => MPI_TSUM2
  0.7       0.149       0.149          10           0        15 MPI_Reduce()
  0.7       0.149       0.149          10           0        15 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.5       0.112       0.112         181           0         1 F24
  0.5       0.112       0.112         181           0         1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.4       0.076       0.076          10           0         8 TAPAR
  0.4       0.076       0.076          10           0         8 main => MPI_Talbot2 => TAPAR
  0.3       0.059       0.059          11           0         5 MPI_Comm_rank()
  0.3       0.057       0.057          11           0         5 MPI_Comm_size()
  0.2       0.032       0.032          10           0         3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.1       0.031       0.031          10           0         3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1       0.027       0.027           1           0        27 main => MPI_Comm_rank()
  0.1       0.026       0.026           1           0        26 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 4;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.226         111           1           6    111037 main
 94.3         104         104           1           0    104666 MPI_Init_thread()
 94.3         104         104           1           0    104666 main => MPI_Init_thread()
  2.1       0.139           2           1          20      2370 MPI_Talbot2
  2.1       0.139           2           1          20      2370 main => MPI_Talbot2
  1.9       0.288           2          10         210       212 MPI_TSUM2
  1.9       0.288           2          10         210       212 main => MPI_Talbot2 => MPI_TSUM2
  1.8           1           1           1           0      1957 MPI_Barrier()
```

```
  1.8            1            1            1            0       1957 main => MPI_Barrier()
  1.6            1            1            1            0       1745 MPI_Finalize()
  1.6            1            1            1            0       1745 main => MPI_Finalize()
  1.4            1            1           10            0        159 MPI_Reduce()
  1.4            1            1           10            0        159 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.1        0.154        0.154          180            0          1 F24
  0.1        0.154        0.154          180            0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.1        0.108        0.108           10            0         11 TAPAR
  0.1        0.108        0.108           10            0         11 main => MPI_Talbot2 => TAPAR
  0.1        0.085        0.085           11            0          8 MPI_Comm_rank()
  0.1        0.083        0.083           11            0          8 MPI_Comm_size()
  0.0        0.048        0.048           10            0          5 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.047        0.047           10            0          5 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.037        0.037            1            0         37 main => MPI_Comm_rank()
  0.0        0.036        0.036            1            0         36 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 5;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.166           12            1           6      12429 main
 49.0            6            6            1           0       6089 MPI_Init_thread()
 49.0            6            6            1           0       6089 main => MPI_Init_thread()
 27.3            3            3            1           0       3390 MPI_Finalize()
 27.3            3            3            1           0       3390 main => MPI_Finalize()
 16.6            2            2            1           0       2065 MPI_Barrier()
 16.6            2            2            1           0       2065 main => MPI_Barrier()
  5.4        0.094        0.666            1          20        666 MPI_Talbot2
  5.4        0.094        0.666            1          20        666 main => MPI_Talbot2
  4.0        0.195        0.498           10         207         50 MPI_TSUM2
  4.0        0.195        0.498           10         207         50 main => MPI_Talbot2 => MPI_TSUM2
  1.0        0.125        0.125           10           0         12 MPI_Reduce()
  1.0        0.125        0.125           10           0         12 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.9        0.114        0.114          177           0          1 F24
  0.9        0.114        0.114          177           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.6        0.074        0.074           10           0          7 TAPAR
  0.6        0.074        0.074           10           0          7 main => MPI_Talbot2 => TAPAR
  0.5        0.063        0.063           11           0          6 MPI_Comm_rank()
  0.4        0.054        0.054           11           0          5 MPI_Comm_size()
  0.3        0.034        0.034           10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.2         0.03         0.03           10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2        0.029        0.029            1           0         29 main => MPI_Comm_rank()
  0.2        0.024        0.024            1           0         24 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 6;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.179            8            1           6       8910 main
 29.6            2            2            1           0       2639 MPI_Init_thread()
 29.6            2            2            1           0       2639 main => MPI_Init_thread()
 25.9            2            2            1           0       2307 MPI_Finalize()
```

```
 25.9           2           2           1           0       2307 main => MPI_Finalize()
 24.4           2           2           1           0       2173 MPI_Barrier()
 24.4           2           2           1           0       2173 main => MPI_Barrier()
 17.6       0.093           1           1          20       1564 MPI_Talbot2
 17.6       0.093           1           1          20       1564 main => MPI_Talbot2
 15.7       0.185           1          10         206        140 MPI_TSUM2
 15.7       0.185           1          10         206        140 main => MPI_Talbot2 => MPI_TSUM2
 11.9           1           1          10           0        106 MPI_Reduce()
 11.9           1           1          10           0        106 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.1       0.096       0.096         176           0          1 F24
  1.1       0.096       0.096         176           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.8       0.075       0.075          10           0          8 TAPAR
  0.8       0.075       0.075          10           0          8 main => MPI_Talbot2 => TAPAR
  0.6       0.056       0.056          11           0          5 MPI_Comm_rank()
  0.6       0.051       0.051          11           0          5 MPI_Comm_size()
  0.3        0.03        0.03          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.3       0.029       0.029          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.3       0.026       0.026           1           0         26 main => MPI_Comm_rank()
  0.2       0.022       0.022           1           0         22 main => MPI_Comm_size()
--------------------------------------------------------------------------------

NODE 7;CONTEXT 0;THREAD 0:
--------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
--------------------------------------------------------------------------------
100.0         0.17          13           1           6      13760 main
 55.0            7           7           1           0       7562 MPI_Init_thread()
 55.0            7           7           1           0       7562 main => MPI_Init_thread()
 24.6            3           3           1           0       3379 MPI_Finalize()
 24.6            3           3           1           0       3379 main => MPI_Finalize()
 14.0            1           1           1           0       1920 MPI_Barrier()
 14.0            1           1           1           0       1920 main => MPI_Barrier()
  4.9       0.092        0.68           1          20        680 MPI_Talbot2
  4.9       0.092        0.68           1          20        680 main => MPI_Talbot2
  3.7       0.215       0.515          10         206         52 MPI_TSUM2
  3.7       0.215       0.515          10         206         52 main => MPI_Talbot2 => MPI_TSUM2
  0.9        0.12        0.12          10           0         12 MPI_Reduce()
  0.9        0.12        0.12          10           0         12 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.7       0.101       0.101         176           0          1 F24
  0.7       0.101       0.101         176           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.5       0.073       0.073          10           0          7 TAPAR
  0.5       0.073       0.073          10           0          7 main => MPI_Talbot2 => TAPAR
  0.5       0.067       0.067          11           0          6 MPI_Comm_rank()
  0.4       0.061       0.061          11           0          6 MPI_Comm_size()
  0.3       0.041       0.041          10           0          4 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.3       0.038       0.038          10           0          4 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2       0.026       0.026           1           0         26 main => MPI_Comm_rank()
  0.2       0.023       0.023           1           0         23 main => MPI_Comm_size()
--------------------------------------------------------------------------------

FUNCTION SUMMARY (total):
--------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
--------------------------------------------------------------------------------
```

```
100.0           1          305           8          48      38209 main
 83.6         255          255           8           0      31944 MPI_Init_thread()
 83.6         255          255           8           0      31944 main => MPI_Init_thread()
  6.7          20           20           8           0       2545 MPI_Finalize()
  6.7          20           20           8           0       2545 main => MPI_Finalize()
  5.5          16           16           8           0       2116 MPI_Barrier()
  5.5          16           16           8           0       2116 main => MPI_Barrier()
  3.6        0.85           10           8         160       1364 MPI_Talbot2
  3.6        0.85           10           8         160       1364 main => MPI_Talbot2
  3.1           1            9          80        1682        118 MPI_TSUM2
  3.1           1            9          80        1682        118 main => MPI_Talbot2 => MPI_TSUM2
  2.0           6            6          80           0         76 MPI_Reduce()
  2.0           6            6          80           0         76 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.3       0.936        0.936        1442           0          1 F24
  0.3       0.936        0.936        1442           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.2       0.641        0.641          80           0          8 TAPAR
  0.2       0.641        0.641          80           0          8 main => MPI_Talbot2 => TAPAR
  0.2       0.527        0.527          88           0          6 MPI_Comm_rank()
  0.2       0.493        0.493          88           0          6 MPI_Comm_size()
  0.1       0.299        0.299          80           0          4 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.1       0.278        0.278          80           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1       0.228        0.228           8           0         28 main => MPI_Comm_rank()
  0.1       0.215        0.215           8           0         27 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
-------------------------------------------------------------------------------
%Time     Exclusive     Inclusive       #Call      #Subrs  Inclusive Name
               msec   total msec                          usec/call
-------------------------------------------------------------------------------
100.0        0.184            38           1           6      38209 main
 83.6           31            31           1           0      31944 MPI_Init_thread()
 83.6           31            31           1           0      31944 main => MPI_Init_thread()
  6.7            2             2           1           0       2545 MPI_Finalize()
  6.7            2             2           1           0       2545 main => MPI_Finalize()
  5.5            2             2           1           0       2116 MPI_Barrier()
  5.5            2             2           1           0       2116 main => MPI_Barrier()
  3.6        0.106             1           1          20       1364 MPI_Talbot2
  3.6        0.106             1           1          20       1364 main => MPI_Talbot2
  3.1        0.226             1          10      210.25        118 MPI_TSUM2
  3.1        0.226             1          10      210.25        118 main => MPI_Talbot2 => MPI_TSUM2
  2.0        0.763         0.763          10           0         76 MPI_Reduce()
  2.0        0.763         0.763          10           0         76 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.3        0.117         0.117      180.25           0          1 F24
  0.3        0.117         0.117      180.25           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.2       0.0801        0.0801          10           0          8 TAPAR
  0.2       0.0801        0.0801          10           0          8 main => MPI_Talbot2 => TAPAR
  0.2       0.0659        0.0659          11           0          6 MPI_Comm_rank()
  0.2       0.0616        0.0616          11           0          6 MPI_Comm_size()
  0.1       0.0374        0.0374          10           0          4 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.1       0.0348        0.0348          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1       0.0285        0.0285           1           0         28 main => MPI_Comm_rank()
  0.1       0.0269        0.0269           1           0         27 main => MPI_Comm_size()
```

TEST 2 `MPI_Talbot2` with *Input Data*: Test Function n. 24, `NTval` = 100, `T1` interval.

– **TEST 2 – N. of Processes=1** (see Figure 20)

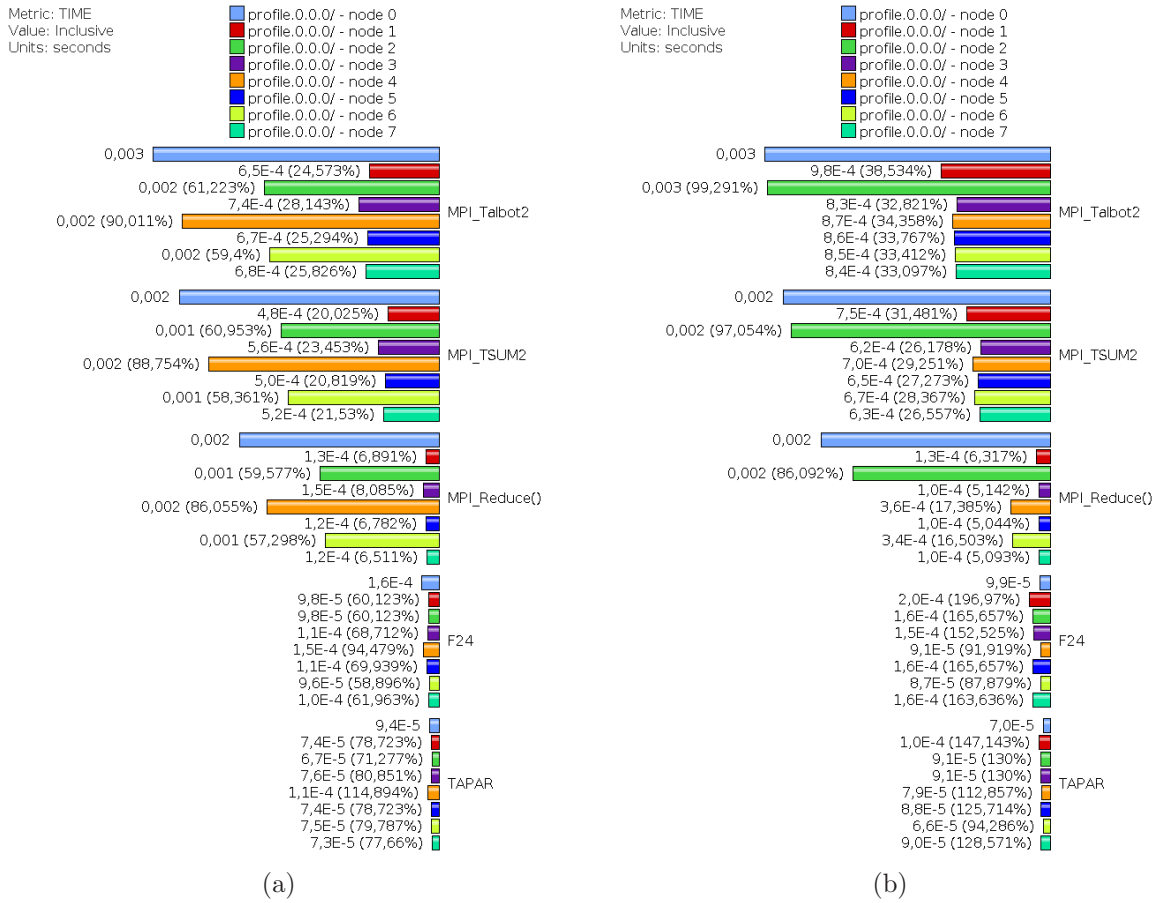


Figure 19: `MPI_Talbot2` on **TEST 1 - N. of Processes 8**: *Inclusive Time measured by TAU on node mapping (a) VS core mapping (b).*

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.164           15           1           6      15855 main
 81.9       0.131           12           1         200      12978 MPI_Talbot2
 81.9       0.131           12           1         200      12978 main => MPI_Talbot2
 79.8           6           12         100       14788        127 MPI_TSUM2
 79.8           6           12         100       14788        127 main => MPI_Talbot2 => MPI_TSUM2
 34.2           5            5       14488           0          0 F24
 34.2           5            5       14488           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 12.5           1            1           1           0       1989 MPI_Init_thread()
 12.5           1            1           1           0       1989 main => MPI_Init_thread()
  4.1        0.65         0.65           1           0        650 MPI_Finalize()
```

```
 4.1         0.65         0.65            1            0        650 main => MPI_Finalize()
 1.2        0.187        0.187          100            0          2 TAPAR
 1.2        0.187        0.187          100            0          2 main => MPI_Talbot2 => TAPAR
 1.1        0.169        0.169          100            0          2 MPI_Reduce()
 1.1        0.169        0.169          100            0          2 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
 0.6        0.093        0.093          101            0          1 MPI_Comm_size()
 0.5        0.086        0.086          101            0          1 MPI_Comm_rank()
 0.4        0.071        0.071          100            0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
 0.4        0.061        0.061          100            0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
 0.2        0.027        0.027            1            0         27 MPI_Barrier()
 0.2        0.027        0.027            1            0         27 main => MPI_Barrier()
 0.2        0.025        0.025            1            0         25 main => MPI_Comm_rank()
 0.1        0.022        0.022            1            0         22 main => MPI_Comm_size()
-------------------------------------------------------------------------------
```

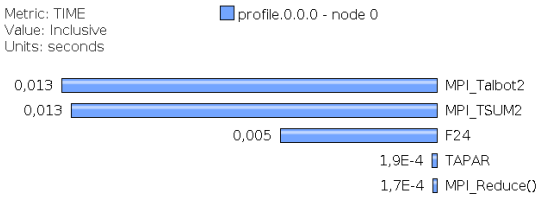


Figure 20: `MPI_Talbot2` on **TEST 2 - N. of Processes 1**: *Inclusive Time measured with TAU.*

– **TEST 2 – N. of Processes=4**(see Figure 21)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.18          103           1           6     103713 main
 92.0          95           95           1           0      95380 MPI_Init_thread()
 92.0          95           95           1           0      95380 main => MPI_Init_thread()
  5.5       0.132            5           1         200       5716 MPI_Talbot2
  5.5       0.132            5           1         200       5716 main => MPI_Talbot2
  5.2           2            5         100        3962         54 MPI_TSUM2
  5.2           2            5         100        3962         54 main => MPI_Talbot2 => MPI_TSUM2
  1.6           1            1         100           0         16 MPI_Reduce()
  1.6           1            1         100           0         16 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.4           1            1           1           0       1496 MPI_Barrier()
  1.4           1            1           1           0       1496 main => MPI_Barrier()
  1.4           1            1        3662           0          0 F24
  1.4           1            1        3662           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.9       0.892        0.892           1           0        892 MPI_Finalize()
  0.9       0.892        0.892           1           0        892 main => MPI_Finalize()
  0.2       0.193        0.193         100           0          2 TAPAR
  0.2       0.193        0.193         100           0          2 main => MPI_Talbot2 => TAPAR
  0.1       0.097        0.097         101           0          1 MPI_Comm_rank()
  0.1       0.094        0.094         101           0          1 MPI_Comm_size()
  0.1       0.071        0.071         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
```

```
  0.1        0.071        0.071         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.177           12           1           6      12089 main
 37.9        0.159            4           1         200       4580 MPI_Talbot2
 37.9        0.159            4           1         200       4580 main => MPI_Talbot2
 34.8            1            4         100        3934         42 MPI_TSUM2
 34.8            1            4         100        3934         42 main => MPI_Talbot2 => MPI_TSUM2
 31.2            3            3           1           0       3771 MPI_Init_thread()
 31.2            3            3           1           0       3771 main => MPI_Init_thread()
 16.0            1            1           1           0       1932 MPI_Finalize()
 16.0            1            1           1           0       1932 main => MPI_Finalize()
 13.1            1            1           1           0       1580 MPI_Barrier()
 13.1            1            1           1           0       1580 main => MPI_Barrier()
 12.4            1            1        3634           0          0 F24
 12.4            1            1        3634           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  5.6        0.671        0.671         100           0          7 MPI_Reduce()
  5.6        0.671        0.671         100           0          7 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.7        0.208        0.208         100           0          2 TAPAR
  1.7        0.208        0.208         100           0          2 main => MPI_Talbot2 => TAPAR
  0.8        0.102        0.102         101           0          1 MPI_Comm_rank()
  0.8        0.094        0.094         101           0          1 MPI_Comm_size()
  0.6        0.076        0.076         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.6        0.071        0.071         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.2        0.023        0.023           1           0         23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.182           14           1           6      14641 main
 43.2            6            6           1           0       6324 MPI_Init_thread()
 43.2            6            6           1           0       6324 main => MPI_Init_thread()
 38.3        0.167            5           1         200       5612 MPI_Talbot2
 38.3        0.167            5           1         200       5612 main => MPI_Talbot2
 35.4            2            5         100        3910         52 MPI_TSUM2
 35.4            2            5         100        3910         52 main => MPI_Talbot2 => MPI_TSUM2
 11.1            1            1         100           0         16 MPI_Reduce()
 11.1            1            1         100           0         16 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  9.4            1            1           1           0       1380 MPI_Barrier()
  9.4            1            1           1           0       1380 main => MPI_Barrier()
  9.2            1            1        3610           0          0 F24
  9.2            1            1        3610           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.5            1            1           1           0       1095 MPI_Finalize()
  7.5            1            1           1           0       1095 main => MPI_Finalize()
  1.8        0.266        0.266         100           0          3 TAPAR
```

```
  1.8        0.266        0.266         100           0          3 main => MPI_Talbot2 => TAPAR
  0.7        0.104        0.104         101           0          1 MPI_Comm_rank()
  0.6        0.089        0.089         101           0          1 MPI_Comm_size()
  0.5        0.078        0.078         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.5        0.067        0.067         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.2        0.022        0.022           1           0         22 main => MPI_Comm_size()
-------------------------------------------------------------------------------------------

NODE 3;CONTEXT 0;THREAD 0:
-------------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------------------
100.0        0.171           10           1           6      10810 main
 41.2        0.151            4           1         200       4454 MPI_Talbot2
 41.2        0.151            4           1         200       4454 main => MPI_Talbot2
 37.9            2            4         100        3882         41 MPI_TSUM2
 37.9            2            4         100        3882         41 main => MPI_Talbot2 => MPI_TSUM2
 22.9            2            2           1           0       2471 MPI_Init_thread()
 22.9            2            2           1           0       2471 main => MPI_Init_thread()
 19.8            2            2           1           0       2145 MPI_Finalize()
 19.8            2            2           1           0       2145 main => MPI_Finalize()
 14.1            1            1           1           0       1521 MPI_Barrier()
 14.1            1            1           1           0       1521 main => MPI_Barrier()
 11.7            1            1        3582           0          0 F24
 11.7            1            1        3582           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  6.1        0.664        0.664         100           0          7 MPI_Reduce()
  6.1        0.664        0.664         100           0          7 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  2.0        0.211        0.211         100           0          2 TAPAR
  2.0        0.211        0.211         100           0          2 main => MPI_Talbot2 => TAPAR
  0.9        0.096        0.096         101           0          1 MPI_Comm_rank()
  0.9        0.096        0.096         101           0          1 MPI_Comm_size()
  0.7        0.074        0.074         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.6         0.07         0.07         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.2        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.2        0.022        0.022           1           0         22 main => MPI_Comm_size()
-------------------------------------------------------------------------------------------

FUNCTION SUMMARY (total):
-------------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------------------
100.0         0.71          141           4          24      35313 main
 76.4          107          107           4           0      26986 MPI_Init_thread()
 76.4          107          107           4           0      26986 main => MPI_Init_thread()
 14.4        0.609           20           4         800       5090 MPI_Talbot2
 14.4        0.609           20           4         800       5090 main => MPI_Talbot2
 13.4            8           18         400       15688         47 MPI_TSUM2
 13.4            8           18         400       15688         47 main => MPI_Talbot2 => MPI_TSUM2
  4.3            6            6           4           0       1516 MPI_Finalize()
  4.3            6            6           4           0       1516 main => MPI_Finalize()
  4.2            5            5           4           0       1494 MPI_Barrier()
  4.2            5            5           4           0       1494 main => MPI_Barrier()
  4.0            5            5       14488           0          0 F24
```

```
  4.0            5            5       14488            0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  3.2            4            4         400            0         11 MPI_Reduce()
  3.2            4            4         400            0         11 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.6        0.878        0.878         400            0          2 TAPAR
  0.6        0.878        0.878         400            0          2 main => MPI_Talbot2 => TAPAR
  0.3        0.399        0.399         404            0          1 MPI_Comm_rank()
  0.3        0.373        0.373         404            0          1 MPI_Comm_size()
  0.2        0.295        0.295         400            0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.2        0.283        0.283         400            0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1        0.104        0.104           4            0         26 main => MPI_Comm_rank()
  0.1         0.09         0.09           4            0         22 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.177           35           1           6      35313 main
 76.4           26           26           1           0      26986 MPI_Init_thread()
 76.4           26           26           1           0      26986 main => MPI_Init_thread()
 14.4        0.152            5           1         200       5090 MPI_Talbot2
 14.4        0.152            5           1         200       5090 main => MPI_Talbot2
 13.4            2            4         100        3922         47 MPI_TSUM2
 13.4            2            4         100        3922         47 main => MPI_Talbot2 => MPI_TSUM2
  4.3            1            1           1           0       1516 MPI_Finalize()
  4.3            1            1           1           0       1516 main => MPI_Finalize()
  4.2            1            1           1           0       1494 MPI_Barrier()
  4.2            1            1           1           0       1494 main => MPI_Barrier()
  4.0            1            1        3622           0          0 F24
  4.0            1            1        3622           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  3.2            1            1         100           0         11 MPI_Reduce()
  3.2            1            1         100           0         11 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.6         0.22         0.22         100           0          2 TAPAR
  0.6         0.22         0.22         100           0          2 main => MPI_Talbot2 => TAPAR
  0.3       0.0998       0.0998         101           0          1 MPI_Comm_rank()
  0.3       0.0932       0.0932         101           0          1 MPI_Comm_size()
  0.2       0.0737       0.0737         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.2       0.0707       0.0707         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.1       0.0225       0.0225           1           0         22 main => MPI_Comm_size()
```

– **TEST 2 – N. of Processes=8** (see Figure 22)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.187          111           1           6     111907 main
 91.9          102          102           1           0     102834 MPI_Init_thread()
 91.9          102          102           1           0     102834 main => MPI_Init_thread()
  5.1        0.128            5           1         200       5676 MPI_Talbot2
  5.1        0.128            5           1         200       5676 main => MPI_Talbot2
  4.8            1            5         100        2154         53 MPI_TSUM2
  4.8            1            5         100        2154         53 main => MPI_Talbot2 => MPI_TSUM2
```

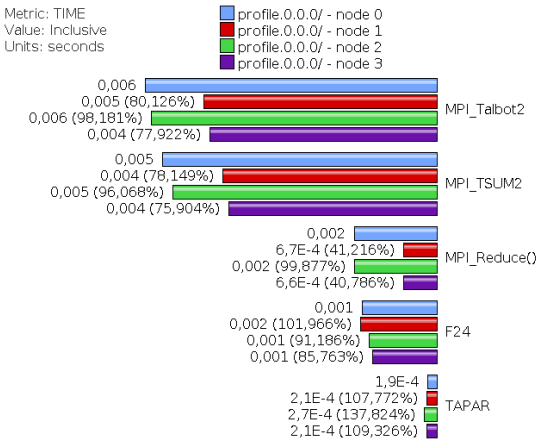


Figure 21: `MPI_Talbot2` on **TEST 2 - N. of Processes 4**: *Inclusive Time measured with TAU.*

```
 2.9          3          3        100          0         33 MPI_Reduce()
 2.9          3          3        100          0         33 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
 1.9          2          2          1          0       2137 MPI_Barrier()
 1.9          2          2          1          0       2137 main => MPI_Barrier()
 0.9          1          1          1          0       1023 MPI_Finalize()
 0.9          1          1          1          0       1023 main => MPI_Finalize()
 0.7      0.828      0.828       1854          0          0 F24
 0.7      0.828      0.828       1854          0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 0.2      0.227      0.227        100          0          2 TAPAR
 0.2      0.227      0.227        100          0          2 main => MPI_Talbot2 => TAPAR
 0.1       0.11       0.11        101          0          1 MPI_Comm_rank()
 0.1      0.088      0.088        101          0          1 MPI_Comm_size()
 0.1      0.082      0.082        100          0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
 0.1      0.066      0.066        100          0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
 0.0      0.028      0.028          1          0         28 main => MPI_Comm_rank()
 0.0      0.022      0.022          1          0         22 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.201          14           1           6      14516 main
 36.8           5           5           1           0       5338 MPI_Init_thread()
 36.8           5           5           1           0       5338 main => MPI_Init_thread()
 35.7       0.206           5           1         200       5183 MPI_Talbot2
 35.7       0.206           5           1         200       5183 main => MPI_Talbot2
 32.0           1           4         100        2143         46 MPI_TSUM2
 32.0           1           4         100        2143         46 main => MPI_Talbot2 => MPI_TSUM2
 14.7           2           2           1           0       2130 MPI_Barrier()
 14.7           2           2           1           0       2130 main => MPI_Barrier()
 11.1           1           1           1           0       1605 MPI_Finalize()
 11.1           1           1           1           0       1605 main => MPI_Finalize()
```

```
 10.0            1            1        1843           0          1 F24
 10.0            1            1        1843           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.4            1            1         100           0         11 MPI_Reduce()
  7.4            1            1         100           0         11 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  2.3        0.336        0.336         100           0          3 TAPAR
  2.3        0.336        0.336         100           0          3 main => MPI_Talbot2 => TAPAR
  1.1        0.156        0.156         101           0          2 MPI_Comm_rank()
  1.0        0.146        0.146         101           0          1 MPI_Comm_size()
  0.9        0.126        0.126         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.8        0.117        0.117         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2         0.03         0.03           1           0         30 main => MPI_Comm_rank()
  0.2        0.029        0.029           1           0         29 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.183           22           1           6     22520 main
 60.2           13           13           1           0     13554 MPI_Init_thread()
 60.2           13           13           1           0     13554 main => MPI_Init_thread()
 19.1        0.174            4           1         200      4310 MPI_Talbot2
 19.1        0.174            4           1         200      4310 main => MPI_Talbot2
 17.0            1            3         100        2129        38 MPI_TSUM2
 17.0            1            3         100        2129        38 main => MPI_Talbot2 => MPI_TSUM2
 10.3            2            2           1           0      2316 MPI_Finalize()
 10.3            2            2           1           0      2316 main => MPI_Finalize()
  9.4            2            2           1           0      2109 MPI_Barrier()
  9.4            2            2           1           0      2109 main => MPI_Barrier()
  6.7            1            1         100           0        15 MPI_Reduce()
  6.7            1            1         100           0        15 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  3.6        0.816        0.816        1829           0         0 F24
  3.6        0.816        0.816        1829           0         0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  1.4        0.312        0.312         100           0         3 TAPAR
  1.4        0.312        0.312         100           0         3 main => MPI_Talbot2 => TAPAR
  0.5        0.109        0.109         101           0         1 MPI_Comm_rank()
  0.4        0.091        0.091         101           0         1 MPI_Comm_size()
  0.4        0.084        0.084         100           0         1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.3        0.068        0.068         100           0         1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1        0.025        0.025           1           0        25 main => MPI_Comm_rank()
  0.1        0.023        0.023           1           0        23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.194           11           1           6     11717 main
 30.9            3            3           1           0      3623 MPI_Finalize()
 30.9            3            3           1           0      3623 main => MPI_Finalize()
 26.7        0.154            3           1         200      3125 MPI_Talbot2
 26.7        0.154            3           1         200      3125 main => MPI_Talbot2
 23.6            1            2         100        2116        28 MPI_TSUM2
 23.6            1            2         100        2116        28 main => MPI_Talbot2 => MPI_TSUM2
```

```
 21.9            2            2           1           0       2568 MPI_Init_thread()
 21.9            2            2           1           0       2568 main => MPI_Init_thread()
 18.4            2            2           1           0       2158 MPI_Barrier()
 18.4            2            2           1           0       2158 main => MPI_Barrier()
  7.0        0.824        0.824        1816           0          0 F24
  7.0        0.824        0.824        1816           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  5.5        0.644        0.644         100           0          6 MPI_Reduce()
  5.5        0.644        0.644         100           0          6 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.7          0.2          0.2         100           0          2 TAPAR
  1.7          0.2          0.2         100           0          2 main => MPI_Talbot2 => TAPAR
  0.8        0.098        0.098         101           0          1 MPI_Comm_rank()
  0.8        0.091        0.091         101           0          1 MPI_Comm_size()
  0.6        0.072        0.072         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.6        0.068        0.068         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.2        0.023        0.023           1           0         23 main => MPI_Comm_size()
--------------------------------------------------------------------------------

NODE 4;CONTEXT 0;THREAD 0:
--------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
--------------------------------------------------------------------------------
100.0        0.212          111           1           6     111908 main
 91.8          102          102           1           0     102750 MPI_Init_thread()
 91.8          102          102           1           0     102750 main => MPI_Init_thread()
  5.1        0.159            5           1         200       5660 MPI_Talbot2
  5.1        0.159            5           1         200       5660 main => MPI_Talbot2
  4.6            1            5         100        2108         52 MPI_TSUM2
  4.6            1            5         100        2108         52 main => MPI_Talbot2 => MPI_TSUM2
  2.6            2            2         100           0         29 MPI_Reduce()
  2.6            2            2         100           0         29 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.8            2            2           1           0       2065 MPI_Barrier()
  1.8            2            2           1           0       2065 main => MPI_Barrier()
  1.0            1            1           1           0       1175 MPI_Finalize()
  1.0            1            1           1           0       1175 main => MPI_Finalize()
  0.7        0.758        0.758        1808           0          0 F24
  0.7        0.758        0.758        1808           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.3        0.317        0.317         100           0          3 TAPAR
  0.3        0.317        0.317         100           0          3 main => MPI_Talbot2 => TAPAR
  0.1        0.112        0.112         101           0          1 MPI_Comm_rank()
  0.1        0.099        0.099         101           0          1 MPI_Comm_size()
  0.1        0.088        0.088         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.1        0.077        0.077         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.024        0.024           1           0         24 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()
--------------------------------------------------------------------------------

NODE 5;CONTEXT 0;THREAD 0:
--------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
--------------------------------------------------------------------------------
100.0         0.18           14           1           6      14607 main
 38.0        0.301            5           1         200       5552 MPI_Talbot2
 38.0        0.301            5           1         200       5552 main => MPI_Talbot2
```

```
 37.1            5            5           1           0       5424 MPI_Init_thread()
 37.1            5            5           1           0       5424 main => MPI_Init_thread()
 33.6            2            4         100        2091         49 MPI_TSUM2
 33.6            2            4         100        2091         49 main => MPI_Talbot2 => MPI_TSUM2
 14.2            2            2           1           0       2078 MPI_Barrier()
 14.2            2            2           1           0       2078 main => MPI_Barrier()
 10.4            1            1        1791           0          1 F24
 10.4            1            1        1791           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  9.0            1            1           1           0       1311 MPI_Finalize()
  9.0            1            1           1           0       1311 main => MPI_Finalize()
  7.2            1            1         100           0         11 MPI_Reduce()
  7.2            1            1         100           0         11 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  2.4        0.348        0.348         100           0          3 TAPAR
  2.4        0.348        0.348         100           0          3 main => MPI_Talbot2 => TAPAR
  1.2        0.174        0.174         101           0          2 MPI_Comm_rank()
  1.0        0.145        0.145         101           0          1 MPI_Comm_size()
  1.0        0.139        0.139         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.8        0.118        0.118         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2        0.035        0.035           1           0         35 main => MPI_Comm_rank()
  0.2        0.027        0.027           1           0         27 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 6;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.181           18           1           6      18937 main
 52.1            9            9           1           0       9868 MPI_Init_thread()
 52.1            9            9           1           0       9868 main => MPI_Init_thread()
 22.2        0.165            4           1         200       4209 MPI_Talbot2
 22.2        0.165            4           1         200       4209 main => MPI_Talbot2
 19.5            1            3         100        2081         37 MPI_TSUM2
 19.5            1            3         100        2081         37 main => MPI_Talbot2 => MPI_TSUM2
 13.4            2            2           1           0       2546 MPI_Finalize()
 13.4            2            2           1           0       2546 main => MPI_Finalize()
 11.0            2            2           1           0       2085 MPI_Barrier()
 11.0            2            2           1           0       2085 main => MPI_Barrier()
  7.8            1            1         100           0         15 MPI_Reduce()
  7.8            1            1         100           0         15 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  3.9        0.734        0.734        1781           0          0 F24
  3.9        0.734        0.734        1781           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  1.8        0.343        0.343         100           0          3 TAPAR
  1.8        0.343        0.343         100           0          3 main => MPI_Talbot2 => TAPAR
  0.6        0.116        0.116         101           0          1 MPI_Comm_rank()
  0.5        0.098        0.098         101           0          1 MPI_Comm_size()
  0.5        0.091        0.091         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.4        0.075        0.075         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.1        0.023        0.023           1           0         23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 7;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
```

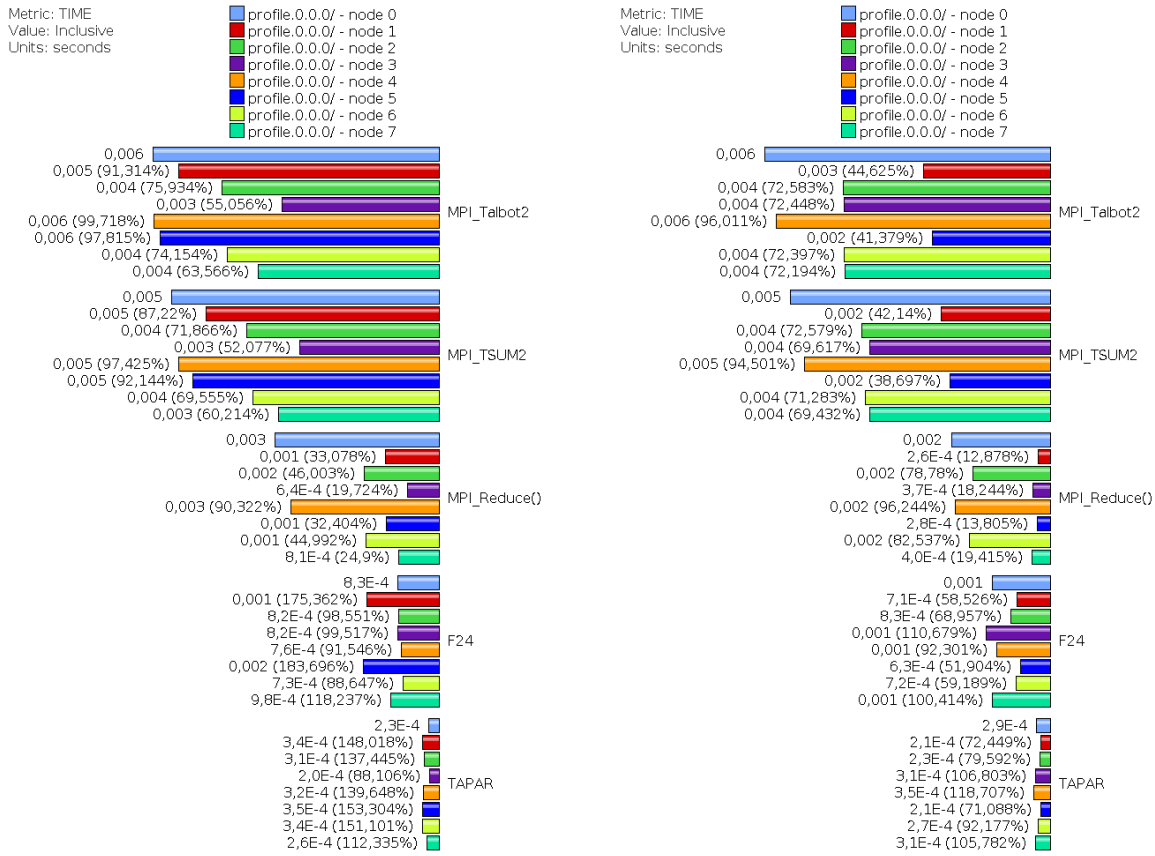
```
---------------------------------------------------------------------------------------
100.0        0.181           13           1           6      13095 main
 30.2            3            3           1           0       3950 MPI_Init_thread()
 30.2            3            3           1           0       3950 main => MPI_Init_thread()
 27.6        0.149            3           1         200       3608 MPI_Talbot2
 27.6        0.149            3           1         200       3608 main => MPI_Talbot2
 24.5            1            3         100        2066         32 MPI_TSUM2
 24.5            1            3         100        2066         32 main => MPI_Talbot2 => MPI_TSUM2
 24.3            3            3           1           0       3187 MPI_Finalize()
 24.3            3            3           1           0       3187 main => MPI_Finalize()
 16.2            2            2           1           0       2121 MPI_Barrier()
 16.2            2            2           1           0       2121 main => MPI_Barrier()
  7.5        0.979        0.979        1766           0          1 F24
  7.5        0.979        0.979        1766           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  6.2        0.813        0.813         100           0          8 MPI_Reduce()
  6.2        0.813        0.813         100           0          8 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  1.9        0.255        0.255         100           0          3 TAPAR
  1.9        0.255        0.255         100           0          3 main => MPI_Talbot2 => TAPAR
  0.9        0.124        0.124         101           0          1 MPI_Comm_rank()
  0.8         0.11         0.11         101           0          1 MPI_Comm_size()
  0.7        0.098        0.098         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.7        0.088        0.088         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.2        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.2        0.022        0.022           1           0         22 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0           1          319           8          48      39901 main
 77.2         246          246           8           0      30786 MPI_Init_thread()
 77.2         246          246           8           0      30786 main => MPI_Init_thread()
 11.7           1           37           8        1600       4665 MPI_Talbot2
 11.7           1           37           8        1600       4665 main => MPI_Talbot2
 10.5          11           33         800       16888         42 MPI_TSUM2
 10.5          11           33         800       16888         42 main => MPI_Talbot2 => MPI_TSUM2
  5.3          16           16           8           0       2110 MPI_Barrier()
  5.3          16           16           8           0       2110 main => MPI_Barrier()
  5.3          16           16           8           0       2098 MPI_Finalize()
  5.3          16           16           8           0       2098 main => MPI_Finalize()
  4.0          12           12         800           0         16 MPI_Reduce()
  4.0          12           12         800           0         16 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  2.5           7            7       14488           0          1 F24
  2.5           7            7       14488           0          1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.7           2            2         800           0          3 TAPAR
  0.7           2            2         800           0          3 main => MPI_Talbot2 => TAPAR
  0.3       0.999        0.999         808           0          1 MPI_Comm_rank()
  0.3       0.868        0.868         808           0          1 MPI_Comm_size()
  0.2        0.78         0.78         800           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.2       0.677        0.677         800           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1       0.219        0.219           8           0         27 main => MPI_Comm_rank()
  0.1       0.191        0.191           8           0         24 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
```

```
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.19           39           1           6     39901 main
 77.2           30           30           1           0     30786 MPI_Init_thread()
 77.2           30           30           1           0     30786 main => MPI_Init_thread()
 11.7        0.179            4           1         200      4665 MPI_Talbot2
 11.7        0.179            4           1         200      4665 main => MPI_Talbot2
 10.5            1            4         100        2111        42 MPI_TSUM2
 10.5            1            4         100        2111        42 main => MPI_Talbot2 => MPI_TSUM2
  5.3            2            2           1           0      2110 MPI_Barrier()
  5.3            2            2           1           0      2110 main => MPI_Barrier()
  5.3            2            2           1           0      2098 MPI_Finalize()
  5.3            2            2           1           0      2098 main => MPI_Finalize()
  4.0            1            1         100           0        16 MPI_Reduce()
  4.0            1            1         100           0        16 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  2.5        0.989        0.989        1811           0         1 F24
  2.5        0.989        0.989        1811           0         1 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.7        0.292        0.292         100           0         3 TAPAR
  0.7        0.292        0.292         100           0         3 main => MPI_Talbot2 => TAPAR
  0.3        0.125        0.125         101           0         1 MPI_Comm_rank()
  0.3        0.108        0.108         101           0         1 MPI_Comm_size()
  0.2       0.0975       0.0975         100           0         1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.2       0.0846       0.0846         100           0         1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.1       0.0274       0.0274           1           0        27 main => MPI_Comm_rank()
  0.1       0.0239       0.0239           1           0        24 main => MPI_Comm_size()
```

TEST 3 `MPI_Talbot2` with *Input Data*: Test Function n. 24, `NTval` = 10, `T2` interval.

– **TEST 3 – N. of Processes=1** (see Figure 23)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.161        1,090           1           6   1090339 main
 99.7        0.088        1,087           1          20   1087427 MPI_Talbot2
 99.7        0.088        1,087           1          20   1087427 main => MPI_Talbot2
 99.7          605        1,087          10 2.43473E+06    108728 MPI_TSUM2
 99.7          605        1,087          10 2.43473E+06    108728 main => MPI_Talbot2 => MPI_TSUM2
 44.2          481          481 2.4347E+06           0         0 F24
 44.2          481          481 2.4347E+06           0         0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.2            2            2           1           0      2113 MPI_Init_thread()
  0.2            2            2           1           0      2113 main => MPI_Init_thread()
  0.1        0.563        0.563           1           0       563 MPI_Finalize()
  0.1        0.563        0.563           1           0       563 main => MPI_Finalize()
  0.0        0.075        0.075          10           0         8 MPI_Reduce()
  0.0        0.075        0.075          10           0         8 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.064        0.064          10           0         6 TAPAR
  0.0        0.064        0.064          10           0         6 main => MPI_Talbot2 => TAPAR
  0.0        0.056        0.056          11           0         5 MPI_Comm_rank()
  0.0        0.046        0.046          11           0         4 MPI_Comm_size()
  0.0        0.031        0.031          10           0         3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
```



(a) (b)

Figure 22: `MPI_Talbot2` on **TEST 2 - N. of Processes 8**: *Inclusive Time measured by TAU on node mapping (a) VS core mapping (b).*

```
  0.0        0.028        0.028          1          0        28 MPI_Barrier()
  0.0        0.028        0.028          1          0        28 main => MPI_Barrier()
  0.0        0.025        0.025          1          0        25 main => MPI_Comm_rank()
  0.0        0.024        0.024         10          0         2 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.022        0.022          1          0        22 main => MPI_Comm_size()
---------------------------------------------------------------------------------------
```

– **TEST 3 – N. of Processes=4** (see Figure 24)

```
NODO 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
```

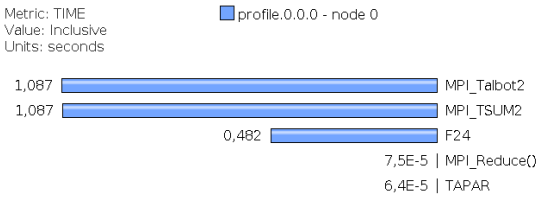


Figure 23: `MPI_Talbot2` on **TEST 3 - N. of Processes 1**: *Inclusive Time measured with TAU.*

```
---------------------------------------------------------------------------------------
100.0         0.17          469           1           6     469708 main
 78.3        0.086          367           1          20     367808 MPI_Talbot2
 78.3        0.086          367           1          20     367808 main => MPI_Talbot2
 78.3          201          367          10      608708      36765 MPI_TSUM2
 78.3          201          367          10      608708      36765 main => MPI_Talbot2 => MPI_TSUM2
 33.5          157          157      608678           0          0 F24
 33.5          157          157      608678           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 21.1           99           99           1           0      99259 MPI_Init_thread()
 21.1           99           99           1           0      99259 main => MPI_Init_thread()
  1.8            8            8          10           0        857 MPI_Reduce()
  1.8            8            8          10           0        857 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.4            1            1           1           0       1784 MPI_Barrier()
  0.4            1            1           1           0       1784 main => MPI_Barrier()
  0.1        0.638        0.638           1           0        638 MPI_Finalize()
  0.1        0.638        0.638           1           0        638 main => MPI_Finalize()
  0.0        0.076        0.076          10           0          8 TAPAR
  0.0        0.076        0.076          10           0          8 main => MPI_Talbot2 => TAPAR
  0.0        0.057        0.057          11           0          5 MPI_Comm_rank()
  0.0        0.053        0.053          11           0          5 MPI_Comm_size()
  0.0        0.031        0.031          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0         0.03         0.03          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.163          379           1           6     379204 main
 94.5        0.086          358           1          20     358425 MPI_Talbot2
 94.5        0.086          358           1          20     358425 main => MPI_Talbot2
 94.5          195          358          10      608705      35826 MPI_TSUM2
 94.5          195          358          10      608705      35826 main => MPI_Talbot2 => MPI_TSUM2
 42.9          162          162      608675           0          0 F24
 42.9          162          162      608675           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  2.8           10           10           1           0      10439 MPI_Finalize()
  2.8           10           10           1           0      10439 main => MPI_Finalize()
  2.2            8            8           1           0       8282 MPI_Init_thread()
  2.2            8            8           1           0       8282 main => MPI_Init_thread()
  0.5            1            1           1           0       1846 MPI_Barrier()
  0.5            1            1           1           0       1846 main => MPI_Barrier()
```

```
  0.0        0.167        0.167          10           0         17 MPI_Reduce()
  0.0        0.167        0.167          10           0         17 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.083        0.083          10           0          8 TAPAR
  0.0        0.083        0.083          10           0          8 main => MPI_Talbot2 => TAPAR
  0.0        0.054        0.054          11           0          5 MPI_Comm_rank()
  0.0        0.054        0.054          11           0          5 MPI_Comm_size()
  0.0        0.031        0.031          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.028        0.028          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()
-------------------------------------------------------------------------------------------

NODE 2;CONTEXT 0;THREAD 0:
-------------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------------------
100.0        0.168          372           1           6     372840 main
 93.3        0.091          347           1          20     347959 MPI_Talbot2
 93.3        0.091          347           1          20     347959 main => MPI_Talbot2
 93.3          182          347          10      608703      34778 MPI_TSUM2
 93.3          182          347          10      608703      34778 main => MPI_Talbot2 => MPI_TSUM2
 38.7          144          144      608673           0          0 F24
 38.7          144          144      608673           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  5.6           21           21          10           0       2105 MPI_Reduce()
  5.6           21           21          10           0       2105 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  5.5           20           20           1           0      20598 MPI_Finalize()
  5.5           20           20           1           0      20598 main => MPI_Finalize()
  0.6            2            2           1           0       2299 MPI_Init_thread()
  0.6            2            2           1           0       2299 main => MPI_Init_thread()
  0.5            1            1           1           0       1768 MPI_Barrier()
  0.5            1            1           1           0       1768 main => MPI_Barrier()
  0.0        0.083        0.083          10           0          8 TAPAR
  0.0        0.083        0.083          10           0          8 main => MPI_Talbot2 => TAPAR
  0.0        0.057        0.057          11           0          5 MPI_Comm_size()
  0.0        0.055        0.055          11           0          5 MPI_Comm_rank()
  0.0        0.034        0.034          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0         0.03         0.03          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()
-------------------------------------------------------------------------------------------

NODE 3;CONTEXT 0;THREAD 0:
-------------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------------------
100.0        0.158          381           1           6     381376 main
 91.2         0.09          347           1          20     347927 MPI_Talbot2
 91.2         0.09          347           1          20     347927 main => MPI_Talbot2
 91.2          202          347          10      608700      34776 MPI_TSUM2
 91.2          202          347          10      608700      34776 main => MPI_Talbot2 => MPI_TSUM2
 38.1          145          145      608670           0          0 F24
 38.1          145          145      608670           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  5.5           20           20           1           0      20883 MPI_Finalize()
  5.5           20           20           1           0      20883 main => MPI_Finalize()
```

```
  2.8           10           10           1           0      10624 MPI_Init_thread()
  2.8           10           10           1           0      10624 main => MPI_Init_thread()
  0.5            1            1           1           0       1732 MPI_Barrier()
  0.5            1            1           1           0       1732 main => MPI_Barrier()
  0.0        0.169        0.169          10           0         17 MPI_Reduce()
  0.0        0.169        0.169          10           0         17 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.077        0.077          10           0          8 TAPAR
  0.0        0.077        0.077          10           0          8 main => MPI_Talbot2 => TAPAR
  0.0        0.058        0.058          11           0          5 MPI_Comm_rank()
  0.0        0.054        0.054          11           0          5 MPI_Comm_size()
  0.0        0.032        0.032          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.028        0.028          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.659        1,603           4          24     400782 main
 88.7        0.353        1,422           4          80     355530 MPI_Talbot2
 88.7        0.353        1,422           4          80     355530 main => MPI_Talbot2
 88.7          781        1,421          40 2.43482E+06      35536 MPI_TSUM2
 88.7          781        1,421          40 2.43482E+06      35536 main => MPI_Talbot2 => MPI_TSUM2
 38.0          609          609  2.4347E+06           0          0 F24
 38.0          609          609  2.4347E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.5          120          120           4           0      30116 MPI_Init_thread()
  7.5          120          120           4           0      30116 main => MPI_Init_thread()
  3.3           52           52           4           0      13140 MPI_Finalize()
  3.3           52           52           4           0      13140 main => MPI_Finalize()
  1.9           29           29          40           0        749 MPI_Reduce()
  1.9           29           29          40           0        749 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.4            7            7           4           0       1782 MPI_Barrier()
  0.4            7            7           4           0       1782 main => MPI_Barrier()
  0.0        0.319        0.319          40           0          8 TAPAR
  0.0        0.319        0.319          40           0          8 main => MPI_Talbot2 => TAPAR
  0.0        0.224        0.224          44           0          5 MPI_Comm_rank()
  0.0        0.218        0.218          44           0          5 MPI_Comm_size()
  0.0        0.123        0.123          40           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.121        0.121          40           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.103        0.103           4           0         26 main => MPI_Comm_rank()
  0.0        0.095        0.095           4           0         24 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.165          400           1           6     400782 main
 88.7       0.0882          355           1          20     355530 MPI_Talbot2
 88.7       0.0882          355           1          20     355530 main => MPI_Talbot2
 88.7          195          355          10      608704      35536 MPI_TSUM2
 88.7          195          355          10      608704      35536 main => MPI_Talbot2 => MPI_TSUM2
 38.0          152          152      608674           0          0 F24
```

```
 38.0          152          152       608674           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.5           30           30            1           0      30116 MPI_Init_thread()
  7.5           30           30            1           0      30116 main => MPI_Init_thread()
  3.3           13           13            1           0      13140 MPI_Finalize()
  3.3           13           13            1           0      13140 main => MPI_Finalize()
  1.9            7            7           10           0        749 MPI_Reduce()
  1.9            7            7           10           0        749 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.4            1            1            1           0       1782 MPI_Barrier()
  0.4            1            1            1           0       1782 main => MPI_Barrier()
  0.0       0.0798       0.0798           10           0          8 TAPAR
  0.0       0.0798       0.0798           10           0          8 main => MPI_Talbot2 => TAPAR
  0.0        0.056        0.056           11           0          5 MPI_Comm_rank()
  0.0       0.0545       0.0545           11           0          5 MPI_Comm_size()
  0.0       0.0307       0.0307           10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0       0.0302       0.0302           10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0       0.0257       0.0257            1           0         26 main => MPI_Comm_rank()
  0.0       0.0238       0.0238            1           0         24 main => MPI_Comm_size()
```

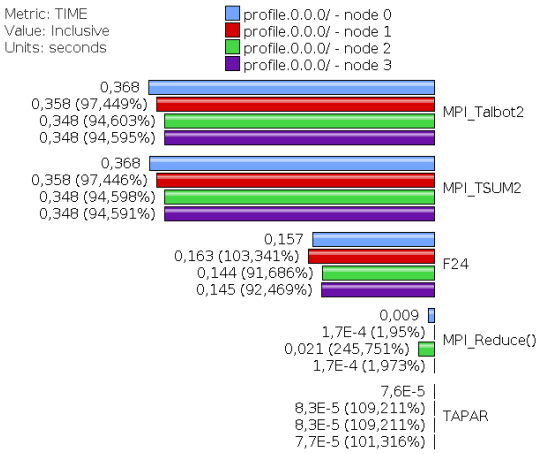


Figure 24: `MPI_Talbot2` on **TEST 3 - N. of Processes 4**: *Inclusive Time measured with TAU.*

– **TEST 3 – N. of Processes=8** (see Figure 25)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.169          342           1           6     342454 main
 70.4        0.096          241           1          20     241208 MPI_Talbot2
 70.4        0.096          241           1          20     241208 main => MPI_Talbot2
 70.4          116          241          10      304372      24103 MPI_TSUM2
 70.4          116          241          10      304372      24103 main => MPI_Talbot2 => MPI_TSUM2
 29.1           99           99      304342           0          0 F24
 29.1           99           99      304342           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 28.6           97           97           1           0      97823 MPI_Init_thread()
```

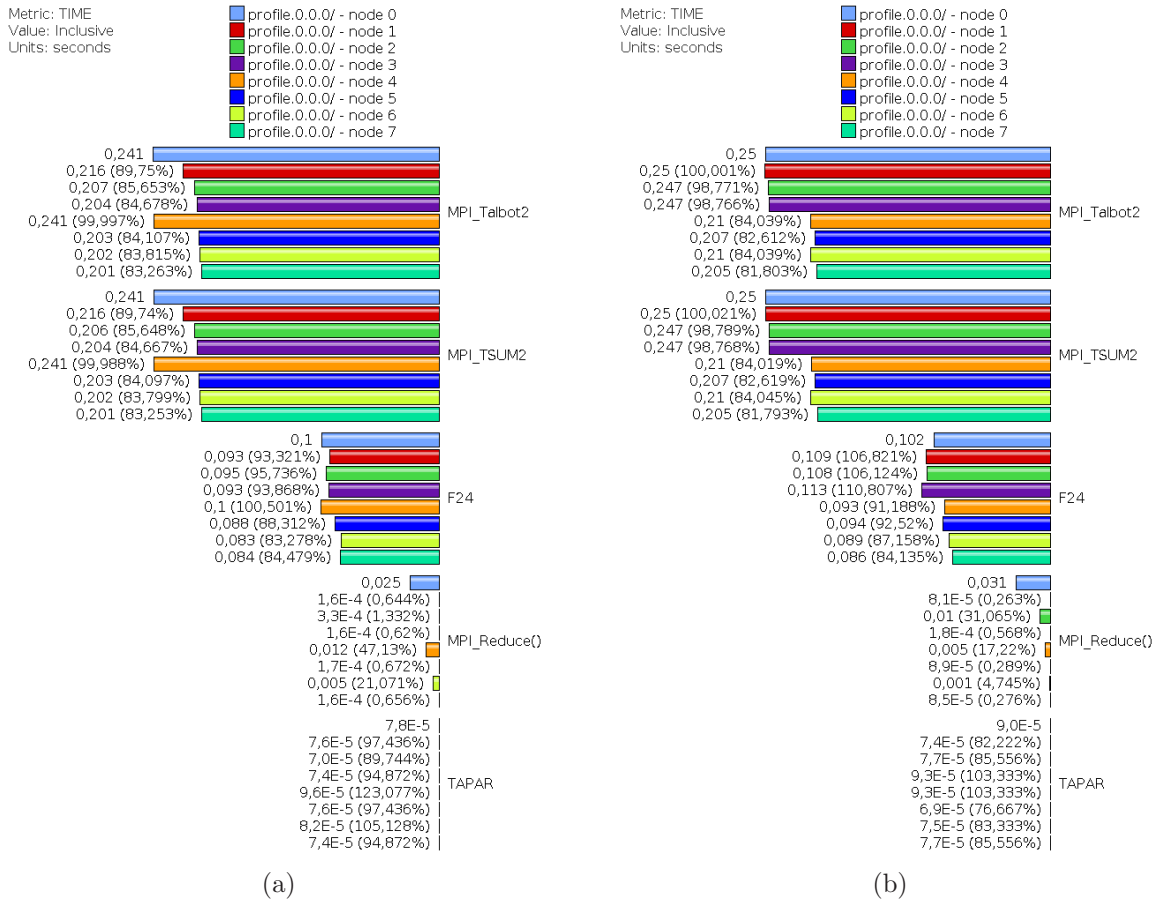
```
 28.6          97          97           1           0      97823 main => MPI_Init_thread()
  7.3          24          24          10           0       2500 MPI_Reduce()
  7.3          24          24          10           0       2500 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.6           1           1           1           0       1967 MPI_Barrier()
  0.6           1           1           1           0       1967 main => MPI_Barrier()
  0.4           1           1           1           0       1239 MPI_Finalize()
  0.4           1           1           1           0       1239 main => MPI_Finalize()
  0.0       0.078       0.078          10           0          8 TAPAR
  0.0       0.078       0.078          10           0          8 main => MPI_Talbot2 => TAPAR
  0.0       0.059       0.059          11           0          5 MPI_Comm_rank()
  0.0       0.055       0.055          11           0          5 MPI_Comm_size()
  0.0       0.034       0.034          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0       0.032       0.032          10           0          3 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0       0.025       0.025           1           0         25 main => MPI_Comm_rank()
  0.0       0.023       0.023           1           0         23 main => MPI_Comm_size()
-------------------------------------------------------------------------------------------
```

TEST 4 `MPI_Talbot2` with *Input Data*: Test Function n. 24, `NTval` = 100, `T2` interval.

– **TEST 4 – N. of Processes=1** (see Figure 26)

```
NODE 0;CONTEXT 0;THREAD 0:
-------------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------------------
100.0       0.167       10,516           1           6   10516888 main
100.0       0.133       10,514           1         200   10514076 MPI_Talbot2
100.0       0.133       10,514           1         200   10514076 main => MPI_Talbot2
100.0       5,912       10,513         100 2.33312E+07     105138 MPI_TSUM2
100.0       5,912       10,513         100 2.33312E+07     105138 main => MPI_Talbot2 => MPI_TSUM2
 43.8       4,601        4,601 2.33309E+07           0          0 F24
 43.8       4,601        4,601 2.33309E+07           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.0           1            1           1           0       1991 MPI_Init_thread()
  0.0           1            1           1           0       1991 main => MPI_Init_thread()
  0.0       0.581        0.581           1           0        581 MPI_Finalize()
  0.0       0.581        0.581           1           0        581 main => MPI_Finalize()
  0.0       0.226        0.226         100           0          2 MPI_Reduce()
  0.0       0.226        0.226         100           0          2 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0       0.174        0.174         100           0          2 TAPAR
  0.0       0.174        0.174         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0       0.086        0.086         101           0          1 MPI_Comm_rank()
  0.0       0.073        0.073         101           0          1 MPI_Comm_size()
  0.0       0.061        0.061         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0       0.052        0.052         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0       0.027        0.027           1           0         27 MPI_Barrier()
  0.0       0.027        0.027           1           0         27 main => MPI_Barrier()
  0.0       0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0       0.021        0.021           1           0         21 main => MPI_Comm_size()
-------------------------------------------------------------------------------------------
```

– **TEST 4 – N. of Processes=4** (see Figure 27)



(a) (b)

Figure 25: `MPI_Talbot2` on **TEST 3 - N. of Processes 8**: *Inclusive Time measured by TAU on node mapping (a) VS core mapping (b).*

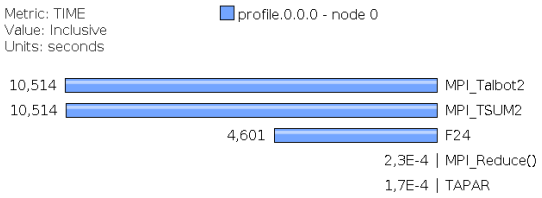


Figure 26: `MPI_Talbot2` on **TEST 4 - N. of Processes 1**: *Inclusive Time measured with TAU.*

```
NODO 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
```

```
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------------
100.0         0.17        2,895           1           6    2895872 main
 96.5        0.145        2,795           1         200    2795163 MPI_Talbot2
 96.5        0.145        2,795           1         200    2795163 main => MPI_Talbot2
 96.5        1,557        2,794         100 5.83307E+06      27948 MPI_TSUM2
 96.5        1,557        2,794         100 5.83307E+06      27948 main => MPI_Talbot2 => MPI_TSUM2
 42.7        1,236        1,236 5.83277E+06           0          0 F24
 42.7        1,236        1,236 5.83277E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  3.4           98           98           1           0      98211 MPI_Init_thread()
  3.4           98           98           1           0      98211 main => MPI_Init_thread()
  0.0            1            1           1           0       1317 MPI_Barrier()
  0.0            1            1           1           0       1317 main => MPI_Barrier()
  0.0            1            1         100           0         13 MPI_Reduce()
  0.0            1            1         100           0         13 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.959        0.959           1           0        959 MPI_Finalize()
  0.0        0.959        0.959           1           0        959 main => MPI_Finalize()
  0.0        0.184        0.184         100           0          2 TAPAR
  0.0        0.184        0.184         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0          0.1          0.1         101           0          1 MPI_Comm_rank()
  0.0        0.078        0.078         101           0          1 MPI_Comm_size()
  0.0         0.07         0.07         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.056        0.056         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0         0.03         0.03           1           0         30 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()
-------------------------------------------------------------------------------------

NODE 1;CONTEXT 0;THREAD 0:
-------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------------
100.0        0.161        2,803           1           6    2803775 main
 89.6        0.128        2,512           1         200    2512740 MPI_Talbot2
 89.6        0.128        2,512           1         200    2512740 main => MPI_Talbot2
 89.6        1,404        2,512         100 5.83304E+06      25124 MPI_TSUM2
 89.6        1,404        2,512         100 5.83304E+06      25124 main => MPI_Talbot2 => MPI_TSUM2
 39.5        1,107        1,107 5.83274E+06           0          0 F24
 39.5        1,107        1,107 5.83274E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 10.1          283          283           1           0     283188 MPI_Finalize()
 10.1          283          283           1           0     283188 main => MPI_Finalize()
  0.2            6            6           1           0       6183 MPI_Init_thread()
  0.2            6            6           1           0       6183 main => MPI_Init_thread()
  0.1            1            1           1           0       1454 MPI_Barrier()
  0.1            1            1           1           0       1454 main => MPI_Barrier()
  0.0        0.958        0.958         100           0         10 MPI_Reduce()
  0.0        0.958        0.958         100           0         10 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.223        0.223         100           0          2 TAPAR
  0.0        0.223        0.223         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0         0.09         0.09         101           0          1 MPI_Comm_rank()
  0.0        0.083        0.083         101           0          1 MPI_Comm_size()
  0.0        0.064        0.064         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0         0.06         0.06         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()
```

```
---------------------------------------------------------------------------------------

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0         0.17        2,800           1           6    2800956 main
 94.4         0.15        2,643           1         200    2643681 MPI_Talbot2
 94.4         0.15        2,643           1         200    2643681 main => MPI_Talbot2
 94.4        1,449        2,643         100 5.83302E+06      26433 MPI_TSUM2
 94.4        1,449        2,643         100 5.83302E+06      26433 main => MPI_Talbot2 => MPI_TSUM2
 41.3        1,156        1,156 5.83272E+06           0          0 F24
 41.3        1,156        1,156 5.83272E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  5.4          152          152           1           0     152455 MPI_Finalize()
  5.4          152          152           1           0     152455 main => MPI_Finalize()
  1.3           36           36         100           0        364 MPI_Reduce()
  1.3           36           36         100           0        364 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.1            3            3           1           0       3261 MPI_Init_thread()
  0.1            3            3           1           0       3261 main => MPI_Init_thread()
  0.0            1            1           1           0       1342 MPI_Barrier()
  0.0            1            1           1           0       1342 main => MPI_Barrier()
  0.0        0.249        0.249         100           0          2 TAPAR
  0.0        0.249        0.249         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0        0.107        0.107         101           0          1 MPI_Comm_rank()
  0.0        0.091        0.091         101           0          1 MPI_Comm_size()
  0.0        0.082        0.082         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.069        0.069         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.168        2,800           1           6    2800654 main
 94.4        0.144        2,643           1         200    2643430 MPI_Talbot2
 94.4        0.144        2,643           1         200    2643430 main => MPI_Talbot2
 94.4        1,539        2,643         100   5.833E+06      26431 MPI_TSUM2
 94.4        1,539        2,643         100   5.833E+06      26431 main => MPI_Talbot2 => MPI_TSUM2
 39.4        1,102        1,102  5.8327E+06           0          0 F24
 39.4        1,102        1,102  5.8327E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  5.4          152          152           1           0     152622 MPI_Finalize()
  5.4          152          152           1           0     152622 main => MPI_Finalize()
  0.1            2            2           1           0       2755 MPI_Init_thread()
  0.1            2            2           1           0       2755 main => MPI_Init_thread()
  0.1            1            1           1           0       1630 MPI_Barrier()
  0.1            1            1           1           0       1630 main => MPI_Barrier()
  0.0        0.768        0.768         100           0          8 MPI_Reduce()
  0.0        0.768        0.768         100           0          8 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.216        0.216         100           0          2 TAPAR
  0.0        0.216        0.216         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0        0.091        0.091         101           0          1 MPI_Comm_rank()
  0.0        0.084        0.084         101           0          1 MPI_Comm_size()
```

```
  0.0        0.065        0.065         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.061        0.061         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

FUNCTION SUMMARY (total):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
             msec   total msec                           usec/call
---------------------------------------------------------------------------------------
100.0        0.669       11,301           4          24    2825314 main
 93.8        0.567       10,595           4         800    2648754 MPI_Talbot2
 93.8        0.567       10,595           4         800    2648754 main => MPI_Talbot2
 93.7        5,950       10,593         400 2.33321E+07      26484 MPI_TSUM2
 93.7        5,950       10,593         400 2.33321E+07      26484 main => MPI_Talbot2 => MPI_TSUM2
 40.7        4,602        4,602 2.33309E+07           0          0 F24
 40.7        4,602        4,602 2.33309E+07           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  5.2          589          589           4           0     147306 MPI_Finalize()
  5.2          589          589           4           0     147306 main => MPI_Finalize()
  1.0          110          110           4           0      27602 MPI_Init_thread()
  1.0          110          110           4           0      27602 main => MPI_Init_thread()
  0.3           39           39         400           0         99 MPI_Reduce()
  0.3           39           39         400           0         99 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.1            5            5           4           0       1436 MPI_Barrier()
  0.1            5            5           4           0       1436 main => MPI_Barrier()
  0.0        0.872        0.872         400           0          2 TAPAR
  0.0        0.872        0.872         400           0          2 main => MPI_Talbot2 => TAPAR
  0.0        0.388        0.388         404           0          1 MPI_Comm_rank()
  0.0        0.336        0.336         404           0          1 MPI_Comm_size()
  0.0        0.281        0.281         400           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.246        0.246         400           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.107        0.107           4           0         27 main => MPI_Comm_rank()
  0.0         0.09         0.09           4           0         22 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
             msec   total msec                           usec/call
---------------------------------------------------------------------------------------
100.0        0.167        2,825           1           6    2825314 main
 93.8        0.142        2,648           1         200    2648754 MPI_Talbot2
 93.8        0.142        2,648           1         200    2648754 main => MPI_Talbot2
 93.7        1,487        2,648         100 5.83303E+06      26484 MPI_TSUM2
 93.7        1,487        2,648         100 5.83303E+06      26484 main => MPI_Talbot2 => MPI_TSUM2
 40.7        1,150        1,150 5.83273E+06           0          0 F24
 40.7        1,150        1,150 5.83273E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  5.2          147          147           1           0     147306 MPI_Finalize()
  5.2          147          147           1           0     147306 main => MPI_Finalize()
  1.0           27           27           1           0      27602 MPI_Init_thread()
  1.0           27           27           1           0      27602 main => MPI_Init_thread()
  0.3            9            9         100           0         99 MPI_Reduce()
  0.3            9            9         100           0         99 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.1            1            1           1           0       1436 MPI_Barrier()
  0.1            1            1           1           0       1436 main => MPI_Barrier()
  0.0        0.218        0.218         100           0          2 TAPAR
```

```
  0.0        0.218        0.218          100            0          2 main => MPI_Talbot2 => TAPAR
  0.0        0.097        0.097          101            0          1 MPI_Comm_rank()
  0.0        0.084        0.084          101            0          1 MPI_Comm_size()
  0.0       0.0703       0.0703          100            0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0       0.0615       0.0615          100            0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0       0.0267       0.0267            1            0         27 main => MPI_Comm_rank()
  0.0       0.0225       0.0225            1            0         22 main => MPI_Comm_size()
```

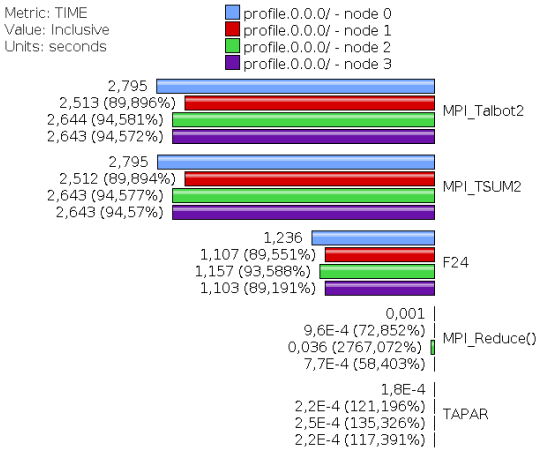


Figure 27: `MPI_Talbot2` on **TEST 4 - N. of Processes 4**: *Inclusive Time measured with TAU.*

– **TEST 4 – N. of Processes=8** (see Figure 28)

```
NODE 0;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.203        1,669           1           6    1669532 main
 91.9       0.157        1,534           1         200    1534965 MPI_Talbot2
 91.9       0.157        1,534           1         200    1534965 main => MPI_Talbot2
 91.9         816        1,534         100 2.91671E+06      15346 MPI_TSUM2
 91.9         816        1,534         100 2.91671E+06      15346 main => MPI_Talbot2 => MPI_TSUM2
 38.8         648          648 2.91641E+06           0          0 F24
 38.8         648          648 2.91641E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.9         131          131           1           0     131097 MPI_Init_thread()
  7.9         131          131           1           0     131097 main => MPI_Init_thread()
  4.2          69           69         100           0        699 MPI_Reduce()
  4.2          69           69         100           0        699 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.1           2            2           1           0       2156 MPI_Barrier()
  0.1           2            2           1           0       2156 main => MPI_Barrier()
  0.1           1            1           1           0       1069 MPI_Finalize()
  0.1           1            1           1           0       1069 main => MPI_Finalize()
  0.0       0.206        0.206         100           0          2 TAPAR
  0.0       0.206        0.206         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0       0.096        0.096         101           0          1 MPI_Comm_rank()
```

```
  0.0        0.074        0.074         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.072        0.072         101           0          1 MPI_Comm_size()
  0.0        0.052        0.052         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_rank()
  0.0         0.02         0.02           1           0         20 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 1;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.177        1,575           1           6    1575358 main
 81.2        0.142        1,279           1         200    1279387 MPI_Talbot2
 81.2        0.142        1,279           1         200    1279387 main => MPI_Talbot2
 81.2          688        1,279         100 2.91669E+06      12790 MPI_TSUM2
 81.2          688        1,279         100 2.91669E+06      12790 main => MPI_Talbot2 => MPI_TSUM2
 37.4          589          589 2.91639E+06           0          0 F24
 37.4          589          589 2.91639E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 16.3          256          256           1           0     256933 MPI_Finalize()
 16.3          256          256           1           0     256933 main => MPI_Finalize()
  2.3           36           36           1           0      36599 MPI_Init_thread()
  2.3           36           36           1           0      36599 main => MPI_Init_thread()
  0.1            2            2           1           0       2215 MPI_Barrier()
  0.1            2            2           1           0       2215 main => MPI_Barrier()
  0.0        0.734        0.734         100           0          7 MPI_Reduce()
  0.0        0.734        0.734         100           0          7 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.212        0.212         100           0          2 TAPAR
  0.0        0.212        0.212         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0        0.097        0.097         101           0          1 MPI_Comm_rank()
  0.0        0.088        0.088         101           0          1 MPI_Comm_size()
  0.0        0.072        0.072         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.066        0.066         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 2;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0        0.188        1,577           1           6    1577993 main
 89.7         0.19        1,416           1         200    1416052 MPI_Talbot2
 89.7         0.19        1,416           1         200    1416052 main => MPI_Talbot2
 89.7          770        1,415         100 2.91668E+06      14156 MPI_TSUM2
 89.7          770        1,415         100 2.91668E+06      14156 main => MPI_Talbot2 => MPI_TSUM2
 40.8          643          643 2.91638E+06           0          0 F24
 40.8          643          643 2.91638E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.6          119          119           1           0     119893 MPI_Finalize()
  7.6          119          119           1           0     119893 main => MPI_Finalize()
  2.5           39           39           1           0      39689 MPI_Init_thread()
  2.5           39           39           1           0      39689 main => MPI_Init_thread()
  0.1            2            2           1           0       2127 MPI_Barrier()
  0.1            2            2           1           0       2127 main => MPI_Barrier()
  0.1            1            1         100           0         16 MPI_Reduce()
```

```
  0.1           1           1         100           0         16 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0       0.285       0.285         100           0          3 TAPAR
  0.0       0.285       0.285         100           0          3 main => MPI_Talbot2 => TAPAR
  0.0       0.113       0.113         101           0          1 MPI_Comm_rank()
  0.0       0.103       0.103         101           0          1 MPI_Comm_size()
  0.0        0.09        0.09         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0       0.082       0.082         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0       0.023       0.023           1           0         23 main => MPI_Comm_rank()
  0.0       0.021       0.021           1           0         21 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 3;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.172       1,577           1           6    1577878 main
 83.0       0.135       1,309           1         200    1309953 MPI_Talbot2
 83.0       0.135       1,309           1         200    1309953 main => MPI_Talbot2
 83.0         733       1,309         100 2.91667E+06      13096 MPI_TSUM2
 83.0         733       1,309         100 2.91667E+06      13096 main => MPI_Talbot2 => MPI_TSUM2
 36.5         575         575 2.91637E+06           0          0 F24
 36.5         575         575 2.91637E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 14.3         225         225           1           0     225966 MPI_Finalize()
 14.3         225         225           1           0     225966 main => MPI_Finalize()
  2.5          39          39           1           0      39511 MPI_Init_thread()
  2.5          39          39           1           0      39511 main => MPI_Init_thread()
  0.1           2           2           1           0       2230 MPI_Barrier()
  0.1           2           2           1           0       2230 main => MPI_Barrier()
  0.0       0.625       0.625         100           0          6 MPI_Reduce()
  0.0       0.625       0.625         100           0          6 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0       0.192       0.192         100           0          2 TAPAR
  0.0       0.192       0.192         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0       0.085       0.085         101           0          1 MPI_Comm_rank()
  0.0       0.077       0.077         101           0          1 MPI_Comm_size()
  0.0       0.061       0.061         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0       0.055       0.055         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0       0.024       0.024           1           0         24 main => MPI_Comm_rank()
  0.0       0.022       0.022           1           0         22 main => MPI_Comm_size()
---------------------------------------------------------------------------------------

NODE 4;CONTEXT 0;THREAD 0:
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.227       1,669           1           6    1669506 main
 91.9       0.143       1,534           1         200    1534955 MPI_Talbot2
 91.9       0.143       1,534           1         200    1534955 main => MPI_Talbot2
 91.9         761       1,534         100 2.91666E+06      15345 MPI_TSUM2
 91.9         761       1,534         100 2.91666E+06      15345 main => MPI_Talbot2 => MPI_TSUM2
 38.4         640         640 2.91636E+06           0          0 F24
 38.4         640         640 2.91636E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.9         131         131         100           0       1316 MPI_Reduce()
  7.9         131         131         100           0       1316 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  7.9         131         131           1           0     131093 MPI_Init_thread()
```

```
  7.9          131          131           1           0     131093 main => MPI_Init_thread()
  0.1            2            2           1           0       2136 MPI_Barrier()
  0.1            2            2           1           0       2136 main => MPI_Barrier()
  0.1            1            1           1           0       1047 MPI_Finalize()
  0.1            1            1           1           0       1047 main => MPI_Finalize()
  0.0        0.286        0.286         100           0          3 TAPAR
  0.0        0.286        0.286         100           0          3 main => MPI_Talbot2 => TAPAR
  0.0        0.115        0.115         101           0          1 MPI_Comm_rank()
  0.0        0.089        0.089         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.079        0.079         101           0          1 MPI_Comm_size()
  0.0        0.057        0.057         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.026        0.026           1           0         26 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()
-------------------------------------------------------------------------------

NODE 5;CONTEXT 0;THREAD 0:
-------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------
100.0        0.185        1,571           1           6    1571833 main
 84.4        0.144        1,326           1         200    1326850 MPI_Talbot2
 84.4        0.144        1,326           1         200    1326850 main => MPI_Talbot2
 84.4          746        1,326         100 2.91664E+06      13265 MPI_TSUM2
 84.4          746        1,326         100 2.91664E+06      13265 main => MPI_Talbot2 => MPI_TSUM2
 36.8          579          579 2.91634E+06           0          0 F24
 36.8          579          579 2.91634E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
 13.3          209          209           1           0     209006 MPI_Finalize()
 13.3          209          209           1           0     209006 main => MPI_Finalize()
  2.1           33           33           1           0      33533 MPI_Init_thread()
  2.1           33           33           1           0      33533 main => MPI_Init_thread()
  0.1            2            2           1           0       2212 MPI_Barrier()
  0.1            2            2           1           0       2212 main => MPI_Barrier()
  0.0        0.701        0.701         100           0          7 MPI_Reduce()
  0.0        0.701        0.701         100           0          7 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.205        0.205         100           0          2 TAPAR
  0.0        0.205        0.205         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0        0.089        0.089         101           0          1 MPI_Comm_size()
  0.0        0.087        0.087         101           0          1 MPI_Comm_rank()
  0.0        0.067        0.067         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.062        0.062         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()
-------------------------------------------------------------------------------

NODE 6;CONTEXT 0;THREAD 0:
-------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-------------------------------------------------------------------------------
100.0        0.168        1,541           1           6    1541757 main
 99.5        0.188        1,534           1         200    1534766 MPI_Talbot2
 99.5        0.188        1,534           1         200    1534766 main => MPI_Talbot2
 99.5          783        1,534         100 2.91663E+06      15343 MPI_TSUM2
 99.5          783        1,534         100 2.91663E+06      15343 main => MPI_Talbot2 => MPI_TSUM2
 48.6          748          748 2.91633E+06           0          0 F24
```

```
 48.6          748          748 2.91633E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  0.2            3            3           1           0       3417 MPI_Init_thread()
  0.2            3            3           1           0       3417 main => MPI_Init_thread()
  0.1            2            2           1           0       2122 MPI_Barrier()
  0.1            2            2           1           0       2122 main => MPI_Barrier()
  0.1            1            1         100           0         15 MPI_Reduce()
  0.1            1            1         100           0         15 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.1            1            1           1           0       1237 MPI_Finalize()
  0.1            1            1           1           0       1237 main => MPI_Finalize()
  0.0        0.252        0.252         100           0          3 TAPAR
  0.0        0.252        0.252         100           0          3 main => MPI_Talbot2 => TAPAR
  0.0        0.116        0.116         101           0          1 MPI_Comm_rank()
  0.0        0.093        0.093         101           0          1 MPI_Comm_size()
  0.0        0.091        0.091         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.071        0.071         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.025        0.025           1           0         25 main => MPI_Comm_rank()
  0.0        0.022        0.022           1           0         22 main => MPI_Comm_size()
-----------------------------------------------------------------------------------------

NODE 7;CONTEXT 0;THREAD 0:
-----------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-----------------------------------------------------------------------------------------
100.0        0.164        1,573           1           6    1573933 main
 90.3        0.158        1,422           1         200    1422038 MPI_Talbot2
 90.3        0.158        1,422           1         200    1422038 main => MPI_Talbot2
 90.3          830        1,421         100 2.91662E+06      14217 MPI_TSUM2
 90.3          830        1,421         100 2.91662E+06      14217 main => MPI_Talbot2 => MPI_TSUM2
 37.5          589          589 2.91632E+06           0          0 F24
 37.5          589          589 2.91632E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.2          113          113           1           0     113905 MPI_Finalize()
  7.2          113          113           1           0     113905 main => MPI_Finalize()
  2.3           35           35           1           0      35798 MPI_Init_thread()
  2.3           35           35           1           0      35798 main => MPI_Init_thread()
  0.1            1            1           1           0       1982 MPI_Barrier()
  0.1            1            1           1           0       1982 main => MPI_Barrier()
  0.0        0.779        0.779         100           0          8 MPI_Reduce()
  0.0        0.779        0.779         100           0          8 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.0        0.205        0.205         100           0          2 TAPAR
  0.0        0.205        0.205         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0        0.113        0.113         101           0          1 MPI_Comm_rank()
  0.0        0.096        0.096         101           0          1 MPI_Comm_size()
  0.0         0.09         0.09         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0        0.073        0.073         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_rank()
  0.0        0.023        0.023           1           0         23 main => MPI_Comm_size()
-----------------------------------------------------------------------------------------

FUNCTION SUMMARY (total):
-----------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
-----------------------------------------------------------------------------------------
100.0            1       12,757           8          48    1594724 main
 89.0            1       11,358           8        1600    1419871 MPI_Talbot2
```

```
 89.0           1       11,358           8        1600    1419871 main => MPI_Talbot2
 89.0       6,132       11,355         800 2.33333E+07      14195 MPI_TSUM2
 89.0       6,132       11,355         800 2.33333E+07      14195 main => MPI_Talbot2 => MPI_TSUM2
 39.3       5,015        5,015 2.33309E+07           0          0 F24
 39.3       5,015        5,015 2.33309E+07           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.3         929          929           8           0     116132 MPI_Finalize()
  7.3         929          929           8           0     116132 main => MPI_Finalize()
  3.5         450          450           8           0      56342 MPI_Init_thread()
  3.5         450          450           8           0      56342 main => MPI_Init_thread()
  1.6         207          207         800           0        259 MPI_Reduce()
  1.6         207          207         800           0        259 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.1          17           17           8           0       2148 MPI_Barrier()
  0.1          17           17           8           0       2148 main => MPI_Barrier()
  0.0           1            1         800           0          2 TAPAR
  0.0           1            1         800           0          2 main => MPI_Talbot2 => TAPAR
  0.0       0.822        0.822         808           0          1 MPI_Comm_rank()
  0.0       0.697        0.697         808           0          1 MPI_Comm_size()
  0.0       0.629        0.629         800           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0       0.523        0.523         800           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0       0.193        0.193           8           0         24 main => MPI_Comm_rank()
  0.0       0.174        0.174           8           0         22 main => MPI_Comm_size()

FUNCTION SUMMARY (mean):
---------------------------------------------------------------------------------------
%Time    Exclusive    Inclusive       #Call      #Subrs  Inclusive Name
              msec   total msec                          usec/call
---------------------------------------------------------------------------------------
100.0       0.185        1,594           1           6    1594724 main
 89.0       0.157        1,419           1         200    1419871 MPI_Talbot2
 89.0       0.157        1,419           1         200    1419871 main => MPI_Talbot2
 89.0         766        1,419         100 2.91666E+06      14195 MPI_TSUM2
 89.0         766        1,419         100 2.91666E+06      14195 main => MPI_Talbot2 => MPI_TSUM2
 39.3         626          626 2.91636E+06           0          0 F24
 39.3         626          626 2.91636E+06           0          0 main => MPI_Talbot2 => MPI_TSUM2 => F24
  7.3         116          116           1           0     116132 MPI_Finalize()
  7.3         116          116           1           0     116132 main => MPI_Finalize()
  3.5          56           56           1           0      56342 MPI_Init_thread()
  3.5          56           56           1           0      56342 main => MPI_Init_thread()
  1.6          25           25         100           0        259 MPI_Reduce()
  1.6          25           25         100           0        259 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Reduce()
  0.1           2            2           1           0       2148 MPI_Barrier()
  0.1           2            2           1           0       2148 main => MPI_Barrier()
  0.0        0.23         0.23         100           0          2 TAPAR
  0.0        0.23         0.23         100           0          2 main => MPI_Talbot2 => TAPAR
  0.0       0.103        0.103         101           0          1 MPI_Comm_rank()
  0.0      0.0871       0.0871         101           0          1 MPI_Comm_size()
  0.0      0.0786       0.0786         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_rank()
  0.0      0.0654       0.0654         100           0          1 main => MPI_Talbot2 => MPI_TSUM2 => MPI_Comm_size()
  0.0      0.0241       0.0241           1           0         24 main => MPI_Comm_rank()
  0.0      0.0217       0.0217           1           0         22 main => MPI_Comm_size()
```

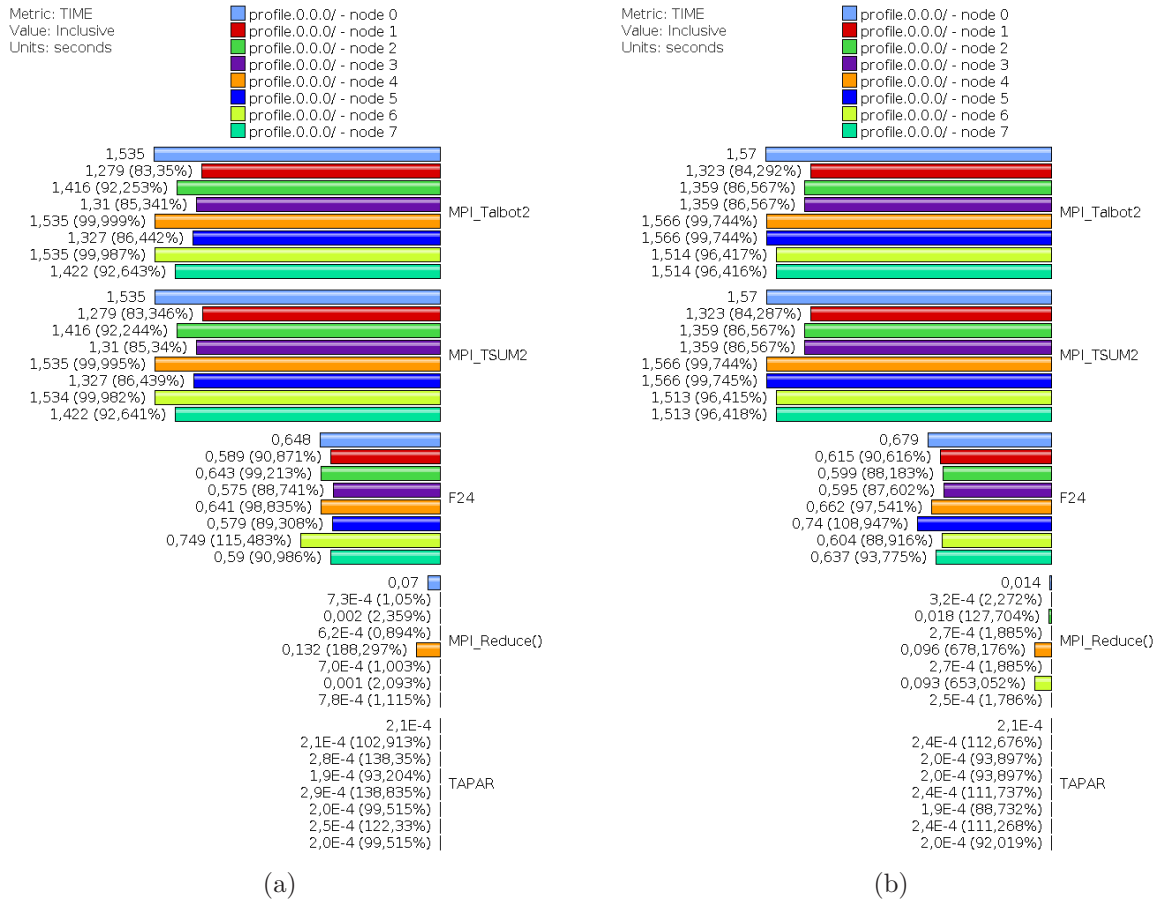


Figure 28: `MPI_Talbot2` on **TEST 4 - N. of Processes 8**: *Inclusive Time measured by TAU on node mapping (a) VS core mapping (b).*

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