

Ferramentas de Avaliação de Desempenho

Roteiro

1 Scalasca, Score-p, Cube

2 hpctoolkit

Scalasca

<https://www.scalasca.org>



Visualizando: CubeGUI

- O CubeGUI pode ser baixado e instalado para visualizar os resultados obtidos com o Scalasca
- <https://www.scalasca.org/scalasca/software/cube-4.x/download.html>
- Binários prontos em "Supplementary packages for download (Comfort zone)"
- Resultados previamente obtidos no SDumont estão no arquivo **profiling_scalasca_sequana.zip** do repositório no GitHub:

```
git clone https://github.com/robertopsouto/ESD2024.git  
ESD2024/sdbase/profiling_scalasca_sequana.zip
```

NPB: estudo de caso

```
$ cd profiling/NUMNODES-1/scorep_bt-mz_W_sum_MPI-1_OMP-1_JOBID-10407415  
$ cube summary.cubex
```

Estudo de caso

NPB: perfil de desempenho

```
scorep_bt-mz_S_sum_MPI-1_OMP-1_JOBID-437607/
profile.cubex
summary.cubex
scorep.score
scorep.cfg
scorep.log
slurm-437607.out
```

Estudo de caso

NPB: perfil de desempenho

```
scorep_bt-mz_S_sum_MPI-1_OMP-1_JOBID-437607/
profile.cubex    --> análise básica, a partir de dados coletados durante execução
summary.cubex   --> análise mais detalhada
scorep.score     --> relatório formato texto com a análise
scorep.cfg       --> configuração da coleta de dados
scorep.log        --> output da aplicação
slurm-437607.out --> output do SLURM
```

Estudo de caso

NPB: perfil de desempenho

```
scorep_bt-mz_S_sum_MPI-1_OMP-1_JOBID-437607/
profile.cubex
summary.cubex
scorep.score
scorep.cfg
scorep.log
slurm-437607.out
```

Estudo de caso

```
$ cat slurm-437607.out

Cluster configuration:
===
Partition: treinamento
Number of nodes: 1
Number of MPI processes: 1 ( 1 nodes)
Number of MPI processes per node: 1
Number of threads per MPI process: 1
NPB Benchmark: bt-mz
Bechmark class problem: S
scalasca 2.4 for GNU OpenMPI loaded
Compiled with openMPI 2.0.4.2 and GNU compilers Red Hat 4.8.5-36
S=C=A=N: Scalasca 2.4 runtime summarization
S=C=A=N: ./scorep_bt-mz_1x1_sum experiment archive
S=C=A=N: Tue Jan 28 14:17:02 2020: Collect start
/usr/bin/srun --resv-ports -n 1 /scratch/treinamento/professor/MC1-I/tools/scalasca/NPB3.3.1-MZ/NPB3.3.1-MZ-MPI
[1580231823.240921] [sdumont5000:73441:0]           mxm.c:196 MXM  WARN  The 'ulimit -s' on the sys
[1580231823.242634] [sdumont5000:73441:0]           mxm.c:196 MXM  WARN  The 'ulimit -s' on the sys

NAS Parallel Benchmarks (NPB3.3-MZ-MPI) - BT-MZ MPI+OpenMP Benchmark

Number of zones: 2 x 2
Iterations: 60 dt: 0.010000
Number of active processes: 1

Use the default load factors with threads
```

Estudo de caso (cont.)

Total number of threads: 1 (1.0 threads/process)

Calculated speedup = 1.00

Time step 1

Time step 20

Time step 40

Time step 60

Verification being performed for class S

accuracy setting for epsilon = 0.100000000000E-07

Comparison of RMS-norms of residual

1	0.1047687395830E+04	0.1047687395830E+04	0.1751386499571E-12
2	0.9419911314792E+02	0.9419911314792E+02	0.1478425555772E-13
3	0.2124737403068E+03	0.2124737403068E+03	0.9002435039286E-13
4	0.1422173591794E+03	0.1422173591794E+03	0.3089634277625E-12
5	0.1135441572375E+04	0.1135441572375E+04	0.3103895484466E-13

Comparison of RMS-norms of solution error

1	0.1775416062982E+03	0.1775416062982E+03	0.1922618237923E-12
2	0.1875540250835E+02	0.1875540250835E+02	0.1558955269742E-12
3	0.3863334844506E+02	0.3863334844506E+02	0.1105356386074E-12
4	0.2634713890362E+02	0.2634713890362E+02	0.3991337551951E-13
5	0.1965566269675E+03	0.1965566269675E+03	0.2336704854379E-12

Verification Successful

BT-MZ Benchmark Completed.

Class = S

Size = 24x 24x 6

Iterations = 60

Time in seconds = 0.35

Estudo de caso (cont.)

```
Total processes = 1
Total threads = 1
Mop/s total = 1093.41
Mop/s/thread = 1093.41
Operation type = floating point
Verification = SUCCESSFUL
Version = 3.3.1
Compile date = 21 Jan 2020
```

Compile options:

```
F77      = scalasca -instrument mpif77
FLINK    = $(F77)
F_LIB    = (none)
F_INC    = (none)
FFLAGS   = -O3 -fopenmp
FLINKFLAGS = $(FFLAGS)
RAND     = (none)
```

Please send all errors/feedbacks to:

NPB Development Team
npb@nas.nasa.gov

```
S=C=A=N: Tue Jan 28 14:17:03 2020: Collect done (status=0) 1s
S=C=A=N: ./scorep_bt-mz_1x1_sum complete.
INFO: Post-processing runtime summarization report...
/opt/bullxde/utils/scalasca/openmpi-gnu(scorep/bin(scorep-score -r ./scorep_bt-mz_S_sum_MPI-1_OMP-
INFO: Score report written to ./scorep_bt-mz_S_sum_MPI-1_OMP-1_JOBID-437607(scorep.score
```

Estudo de caso (cont.)

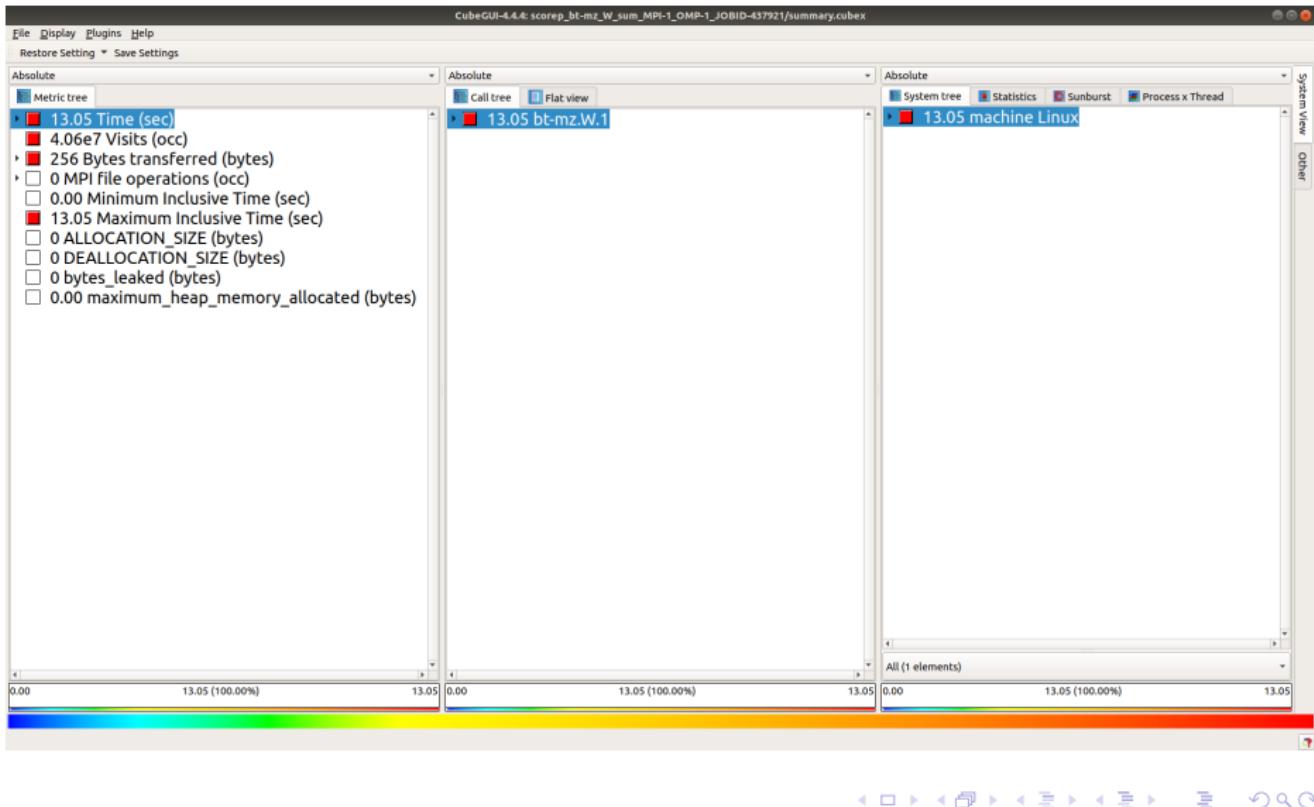
Estudo de caso

NPB: perfil de desempenho

```
scorep_bt-mz_W_sum_MPI-1_OMP-1_JOBID-437632/
profile.cubex
summary.cubex
scorep.score
scorep.cfg
scorep.log
slurm-437632.out
```

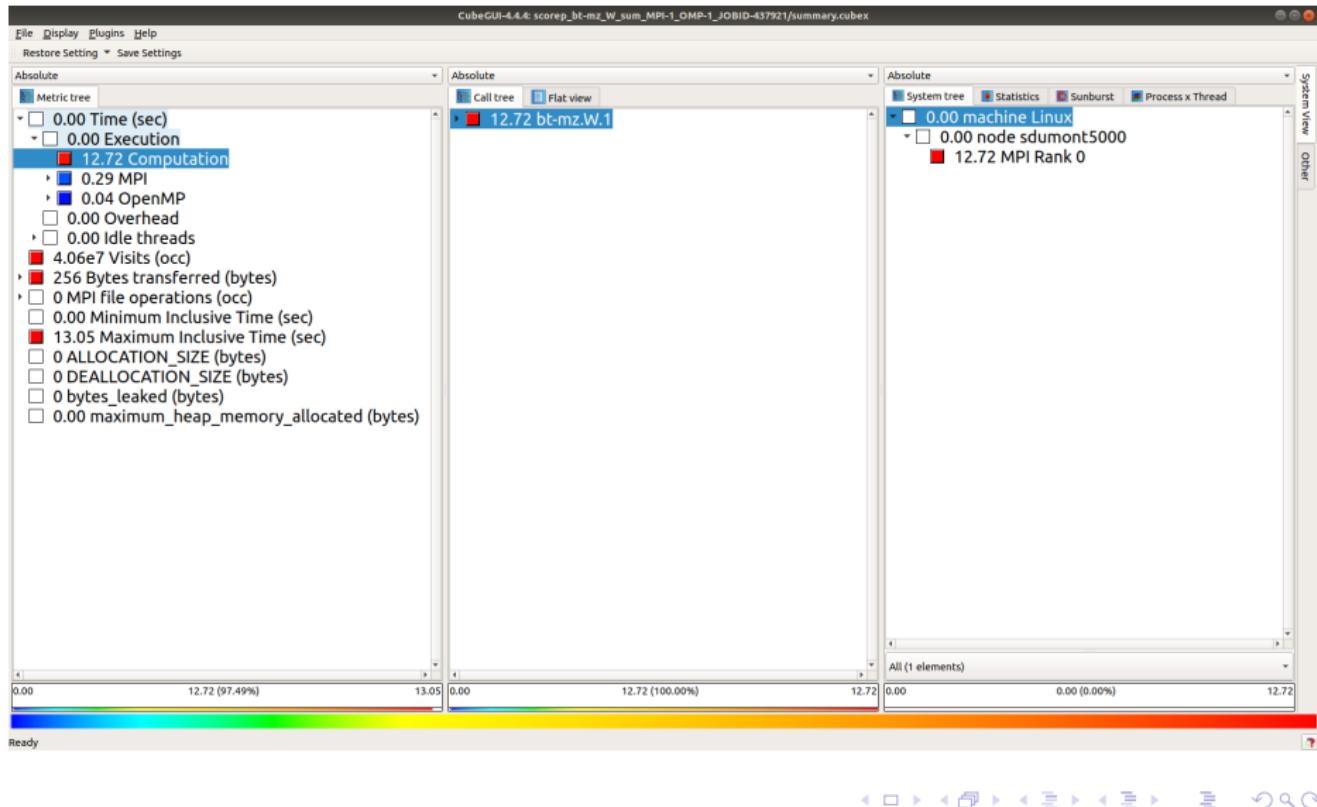
Visualizando: CubeGUI

-nodes=1 -ntasks=1



Visualizando: CubeGUI

-nodes=1 -ntasks=1



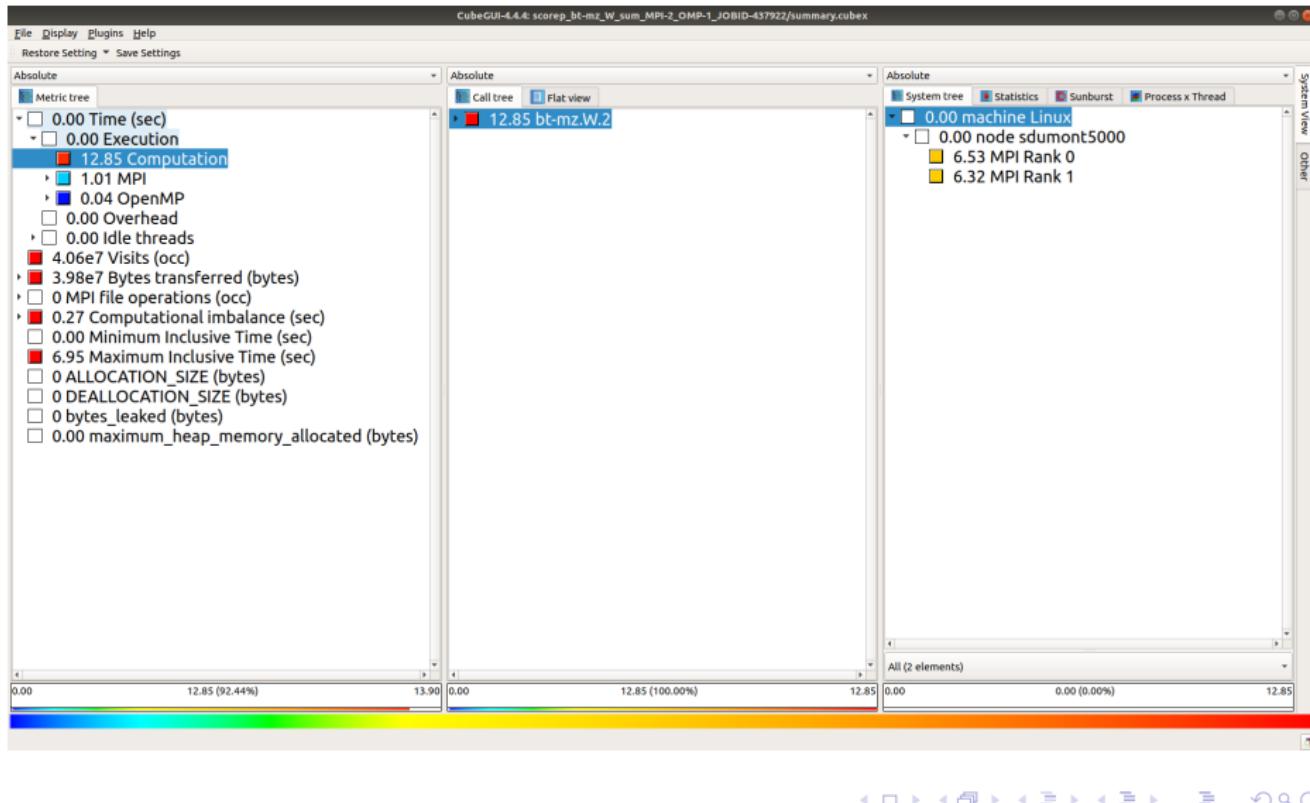
Visualizando: CubeGUI

divisão do tempo de processamento

- Tempo de computação: 12.72s
- Tempo de MPI: 0.29s
- Tempo de OpenMP: 0.04s

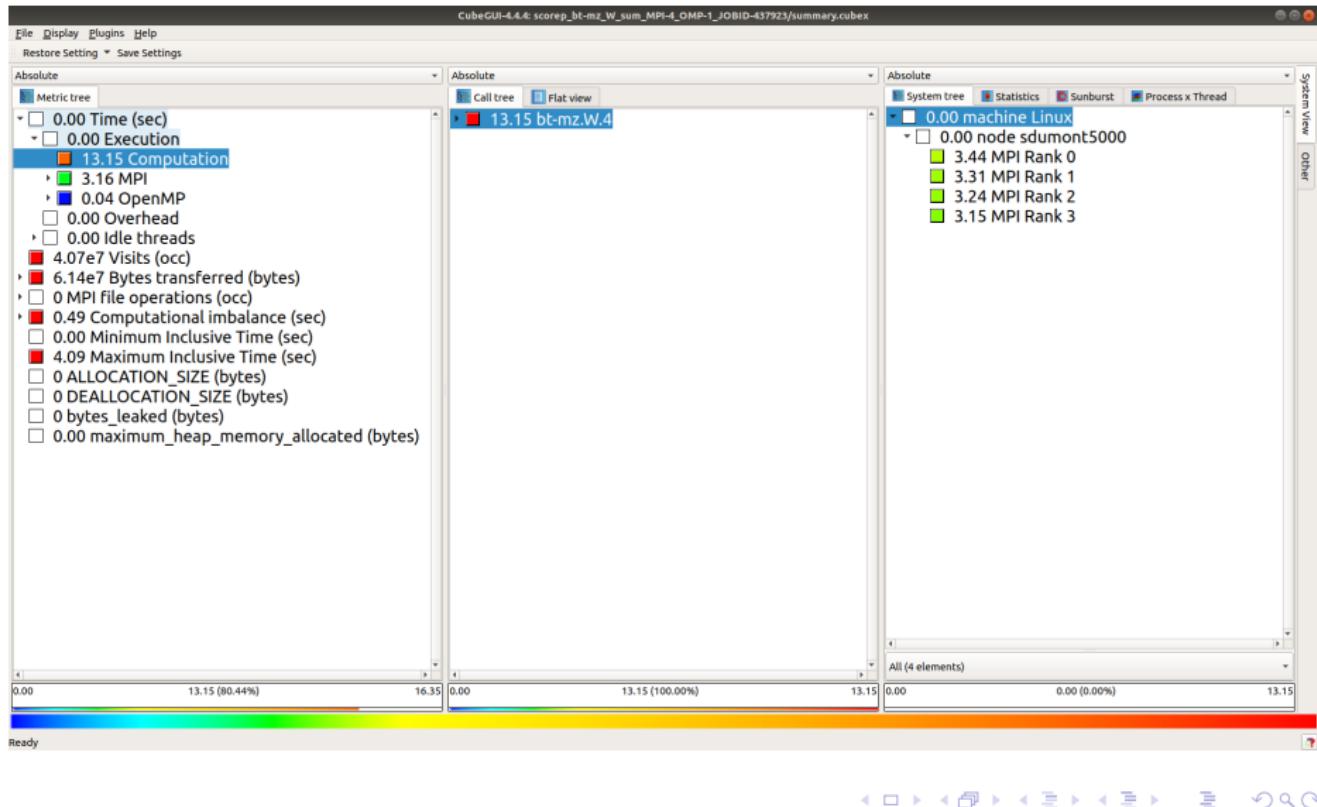
Visualizando: CubeGUI

-nodes=1 -ntasks=2



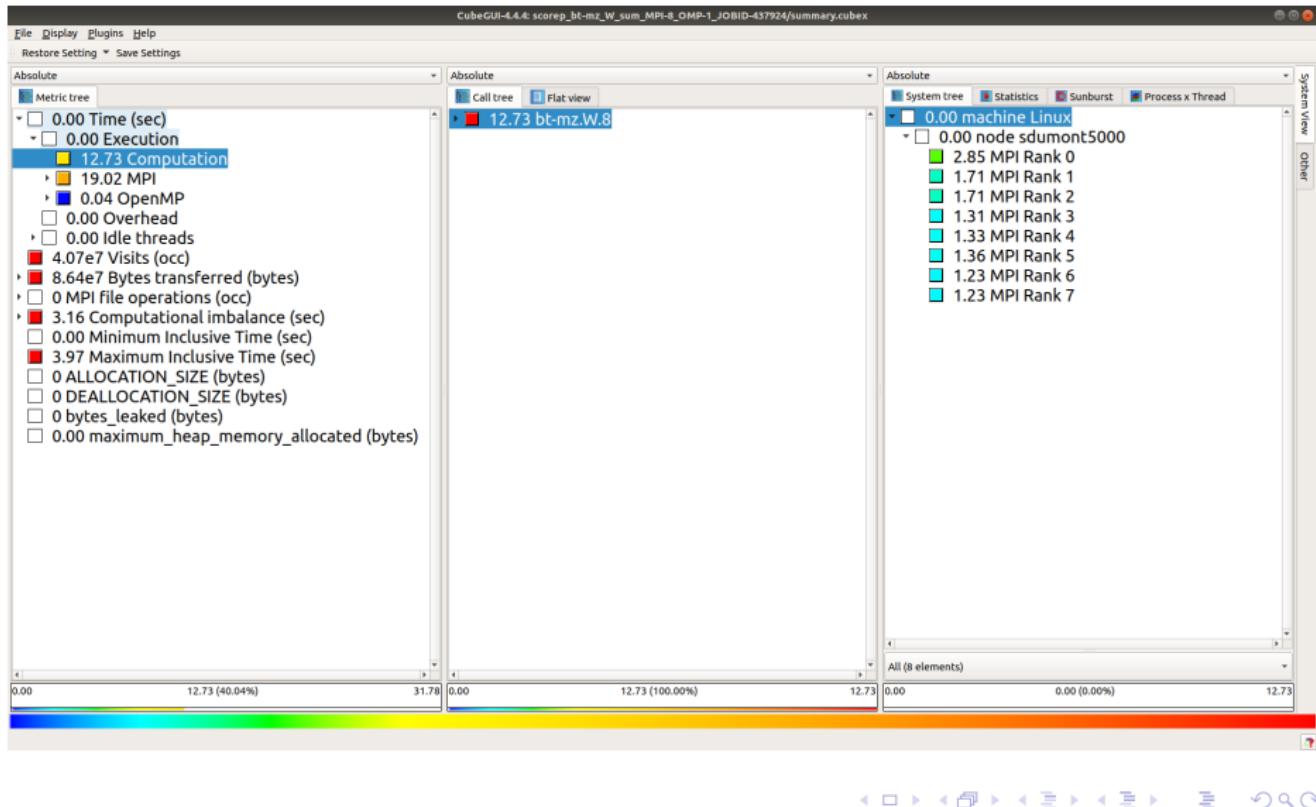
Visualizando: CubeGUI

-nodes=1 -ntasks=4



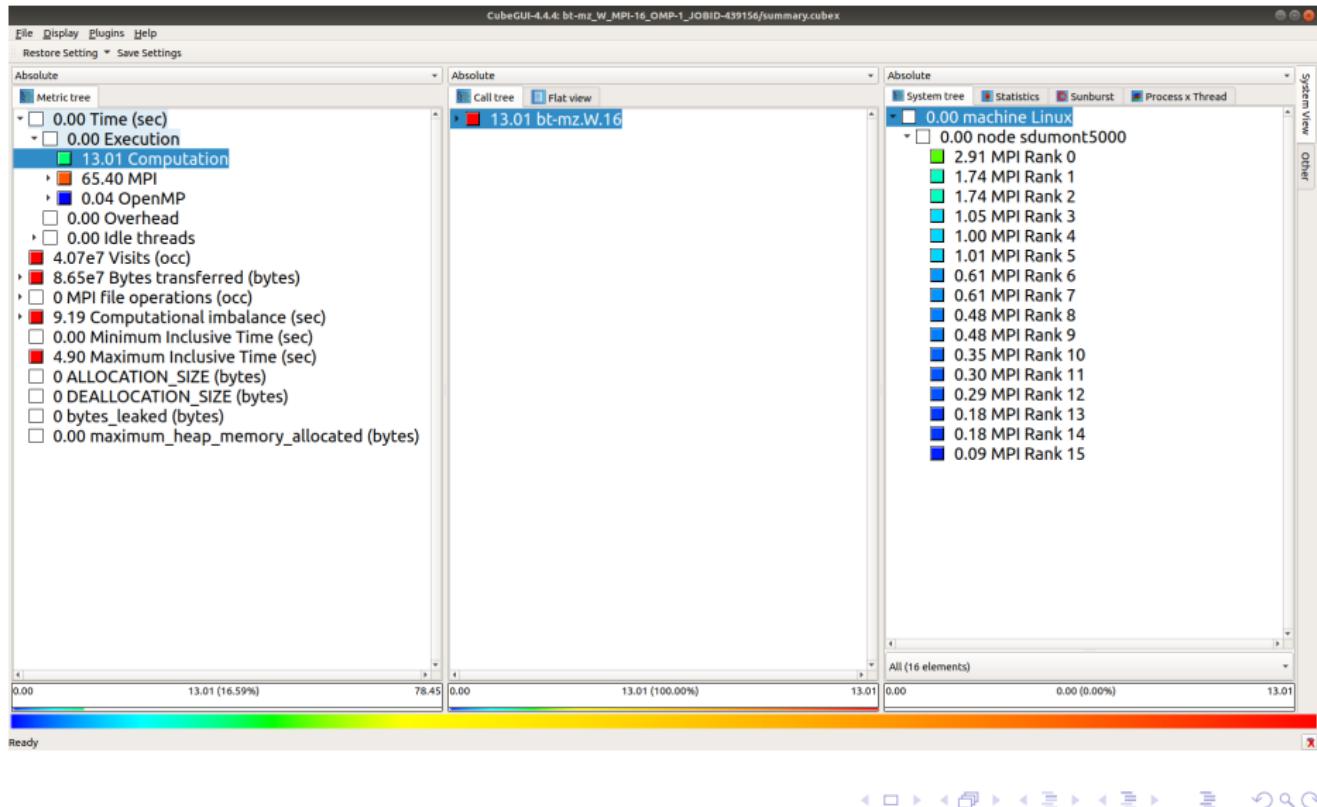
Visualizando: CubeGUI

-nodes=1 -ntasks=8



Visualizando: CubeGUI

-nodes=1 -ntasks=16



BT-MZ *benchmark*: divisão de domínio

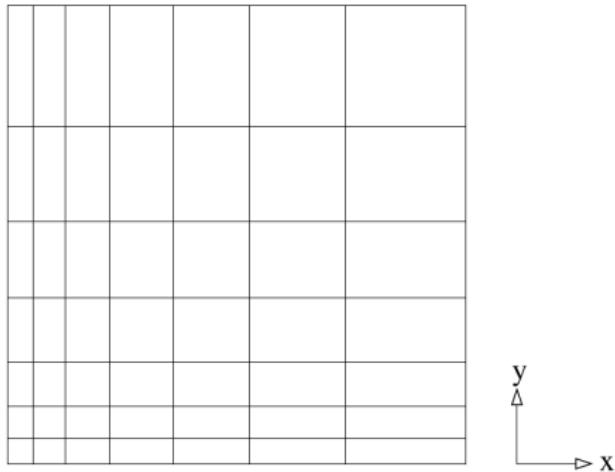


Figure 3: Example of uneven mesh tiling (horizontal cut through mesh system) for the BT-MZ benchmark.

Definição

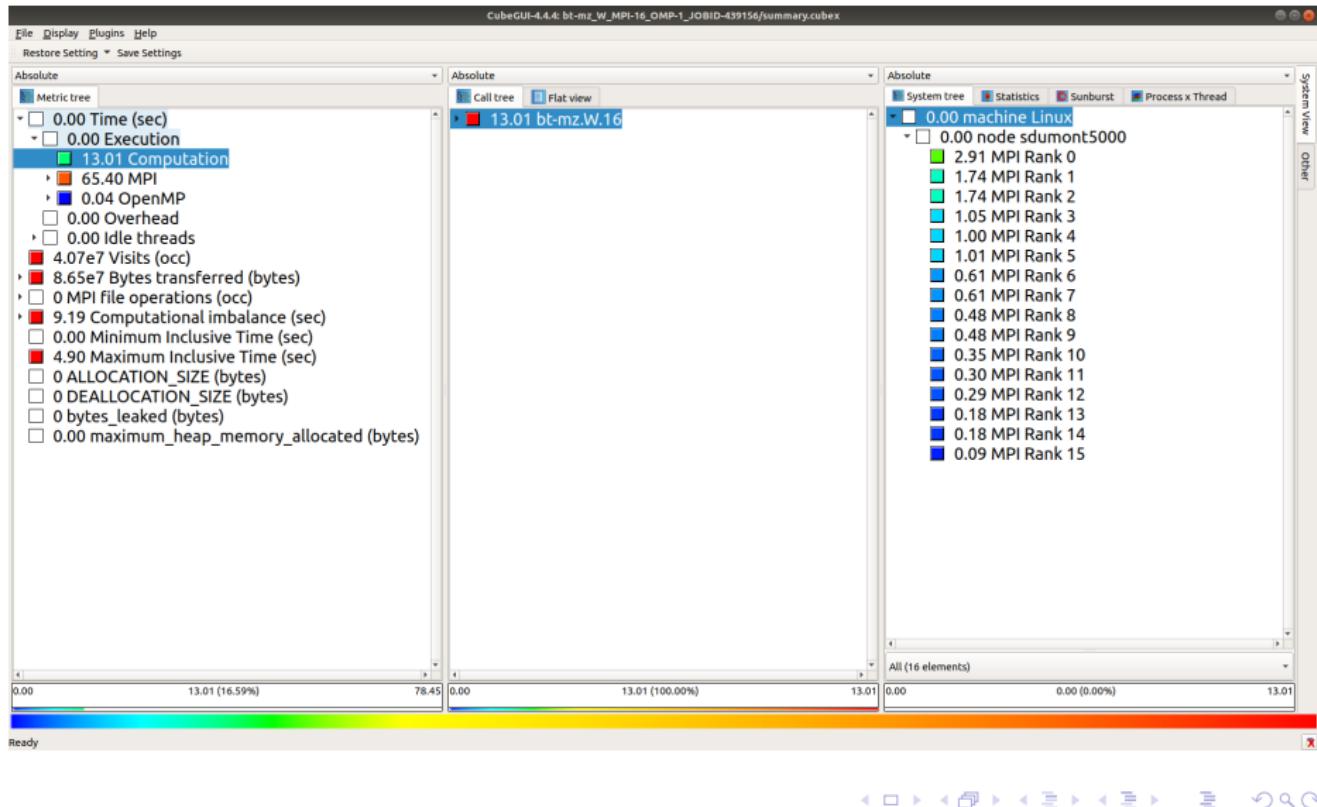
Balanço de carga de computação (LB):

$$LB = \frac{avg(tcomp)}{max(tcomp)}$$

FONTE: <https://pop-coe.eu>

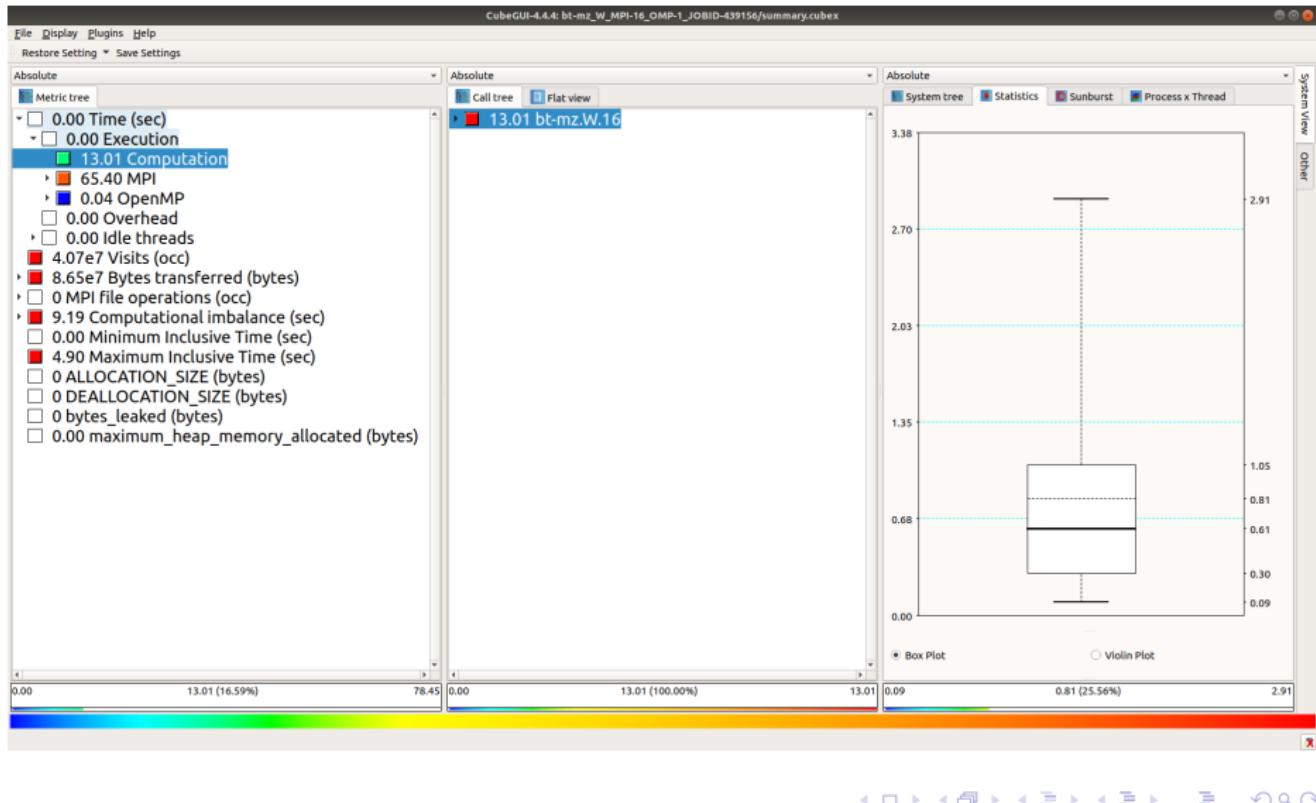
Visualizando: CubeGUI

-nodes=1 -ntasks=16



Visualizando: CubeGUI

-nodes=1 -ntasks=16



Cálculo

Balanço de carga de computação (LB)

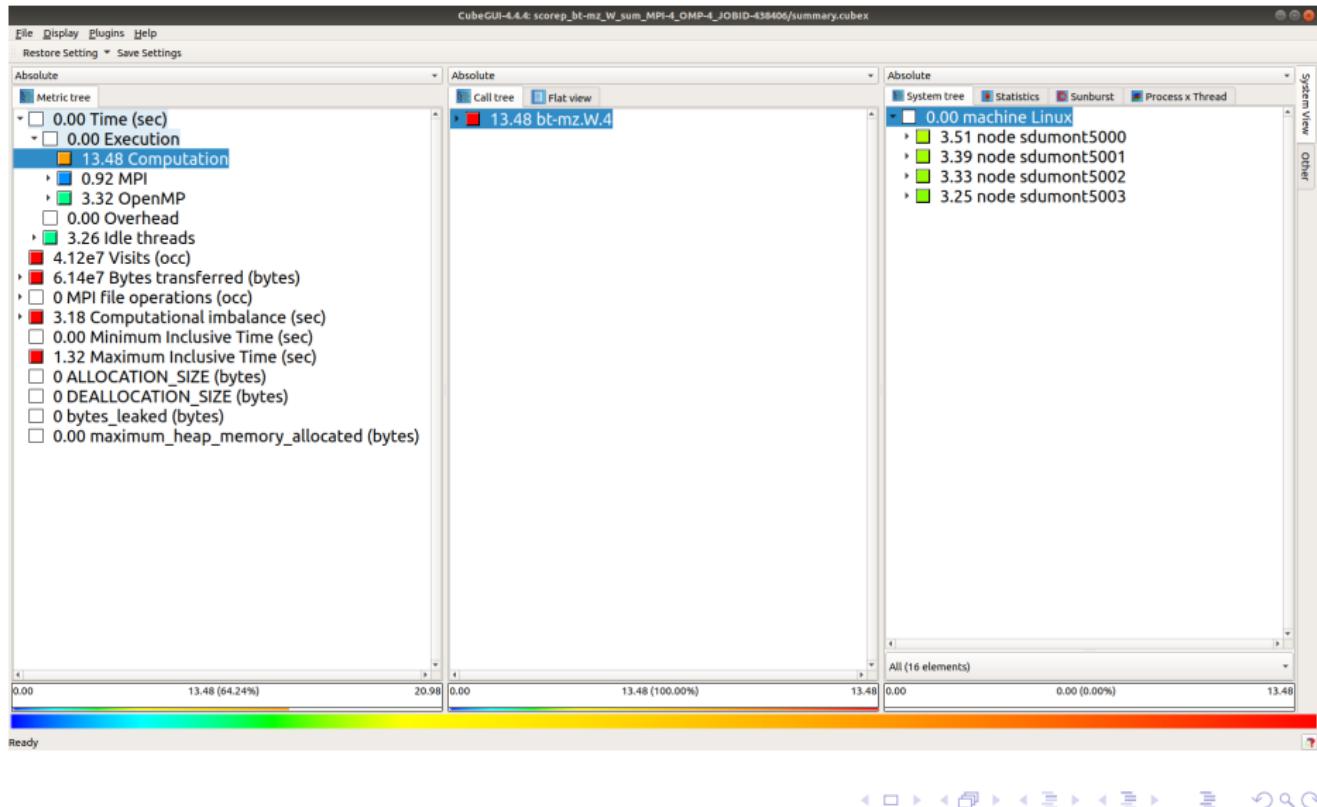
$$LB = \frac{avg(tcomp)}{max(tcomp)}$$

$$LB = \frac{0.81}{2.91}$$

$$LB = 0.28$$

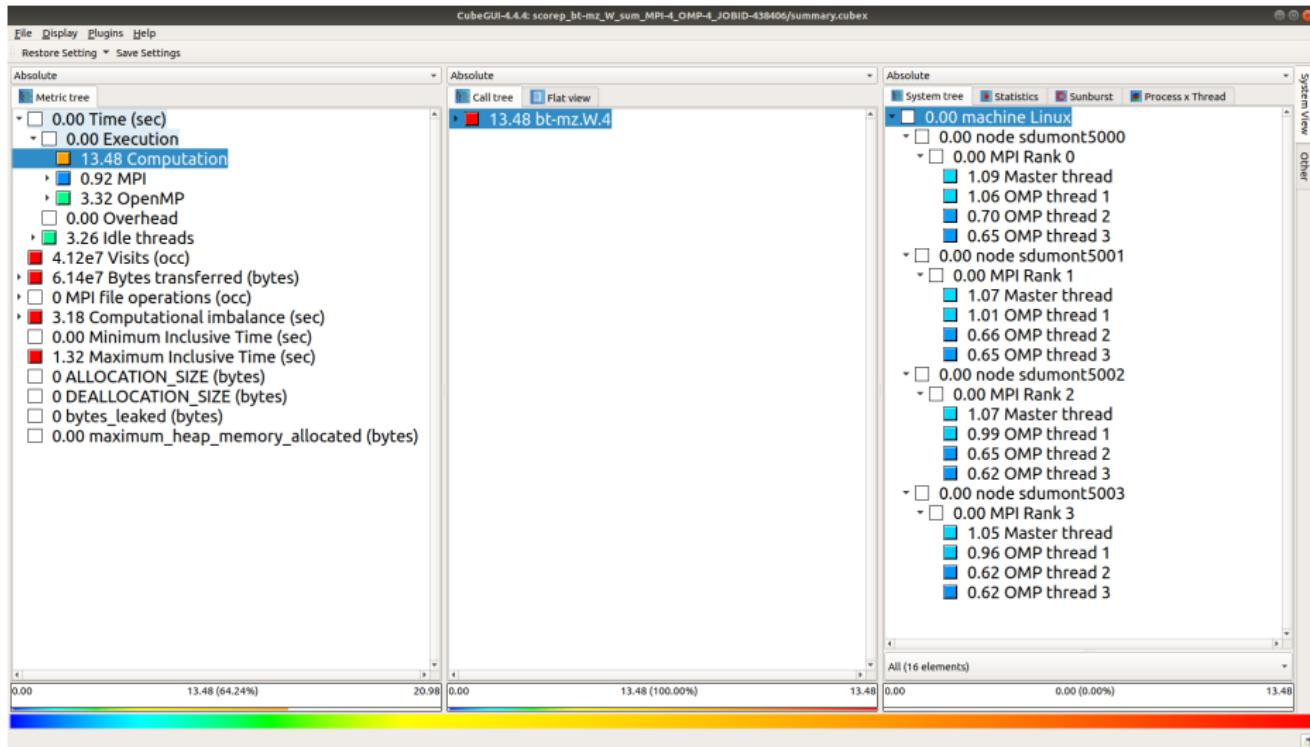
Visualizando: CubeGUI

-nodes=4 -ntasks=4 -cpus-per-task=4



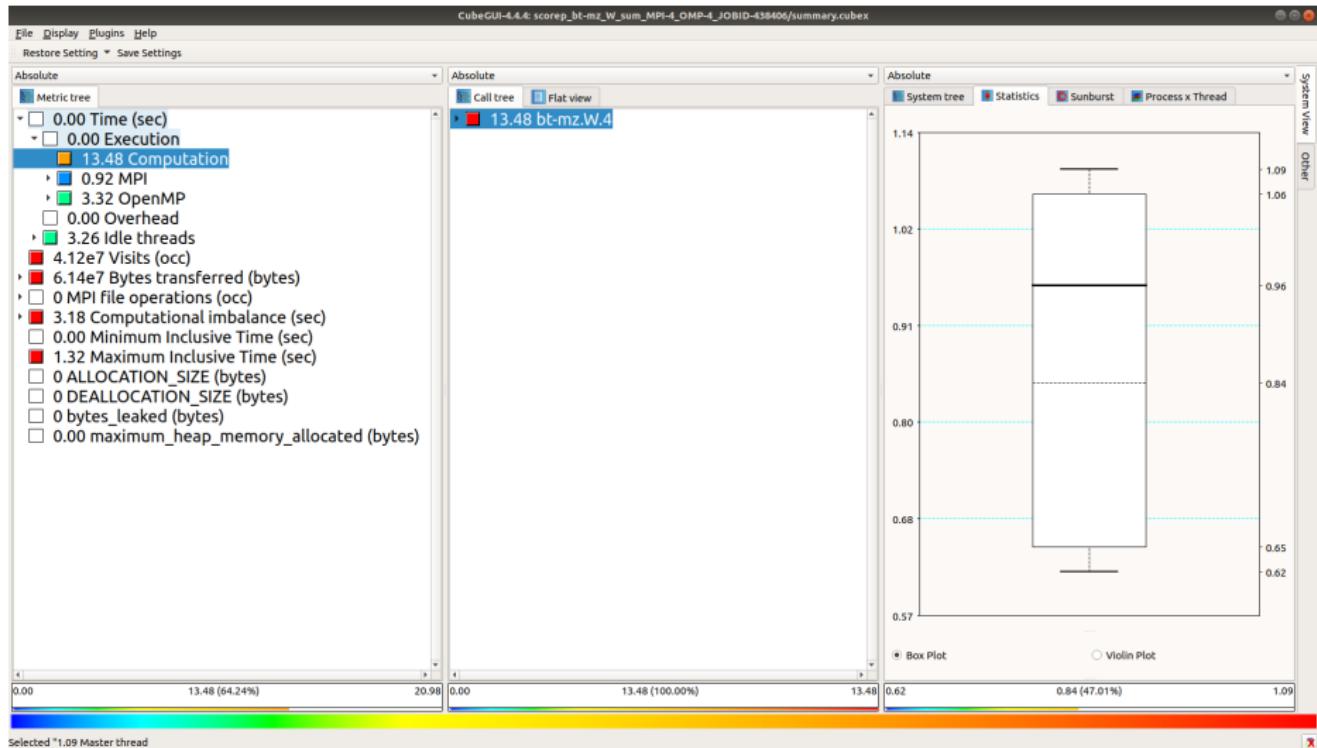
Visualizando: CubeGUI

-nodes=4 -ntasks=4 -cpus-per-task=4



Visualizando: CubeGUI

-nodes=4 -ntasks=4 -cpus-per-task=4



Cálculo

Balanço de carga de computação (LB)

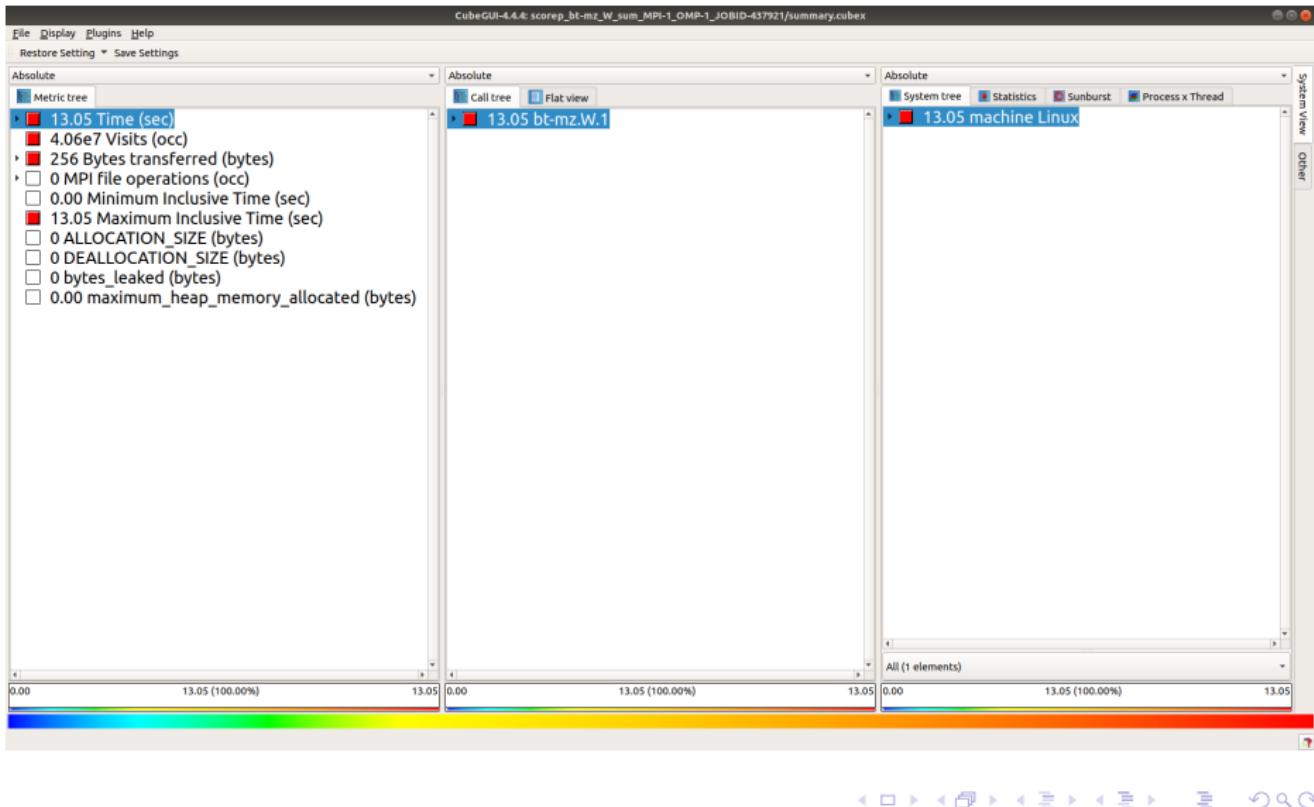
$$LB = \frac{avg(tcomp)}{max(tcomp)}$$

$$LB = \frac{0.84}{1.09}$$

$$LB = 0.77$$

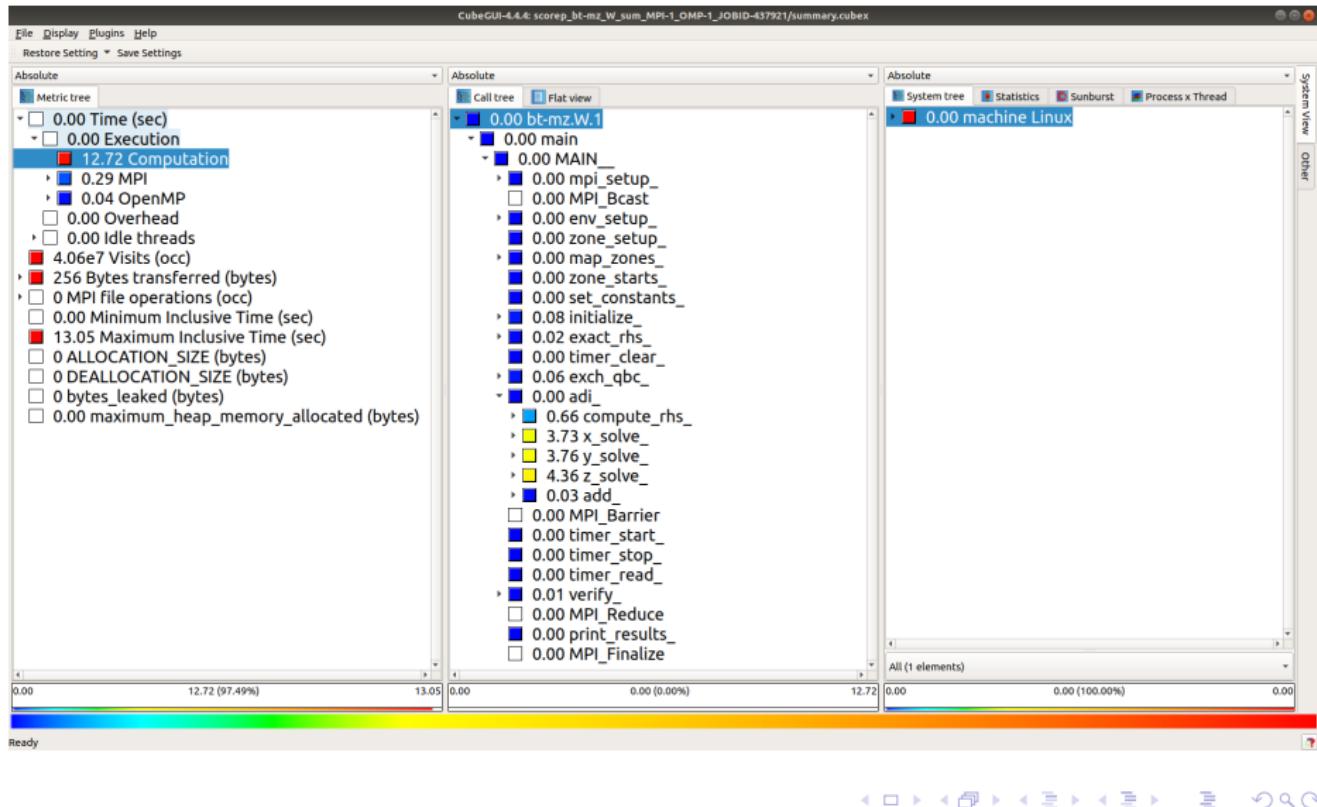
Visualizando: CubeGUI

-nodes=1 -ntasks=1 / Absolute



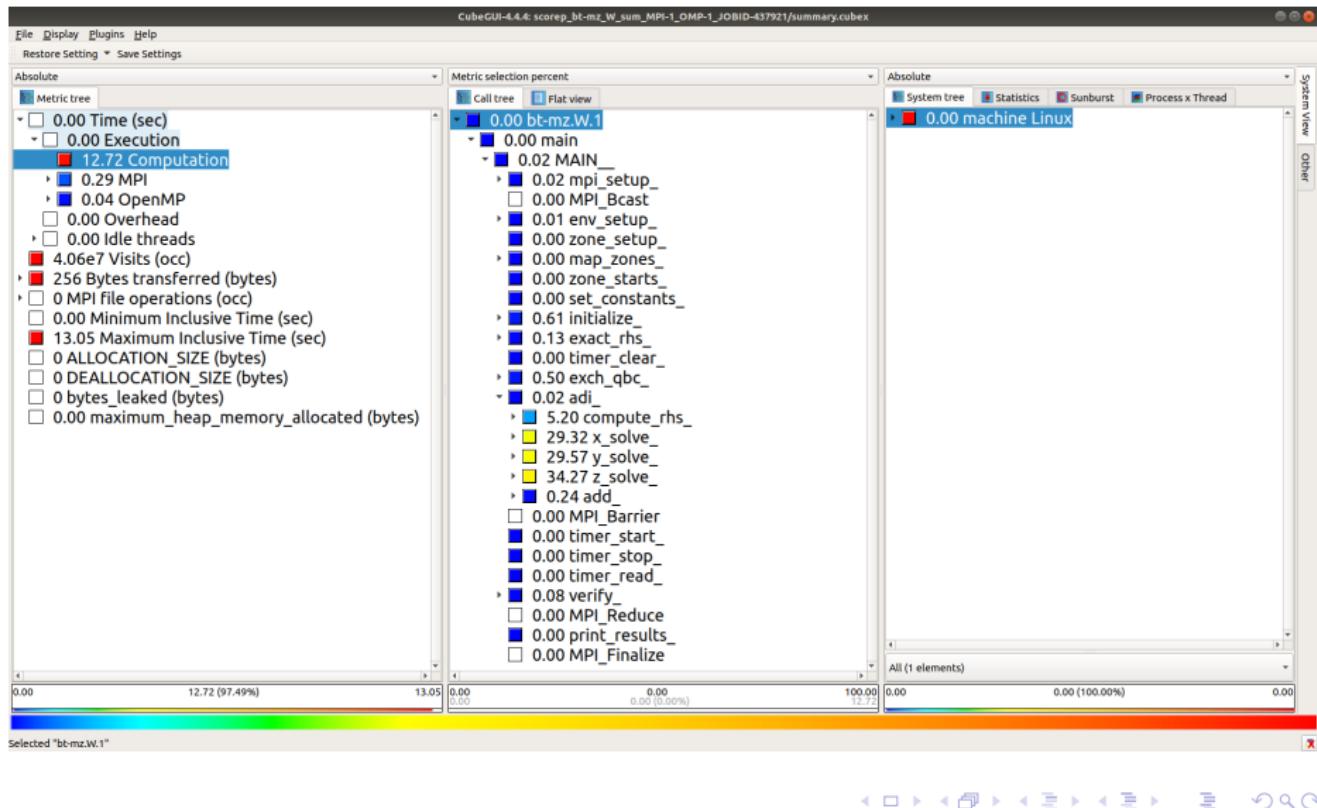
Visualizando: CubeGUI

-nodes=1 -ntasks=1 / Absolute



Visualizando: CubeGUI

-nodes=1 -ntasks=1 / Metric Own percent



Visualizando: CubeGUI

3 hotspots de computação

- **x_solve**: 3.73s (29.32%)
- **y_solve**: 3.76s (29.57%)
- **z_solve**: 4.36s (34.27%)

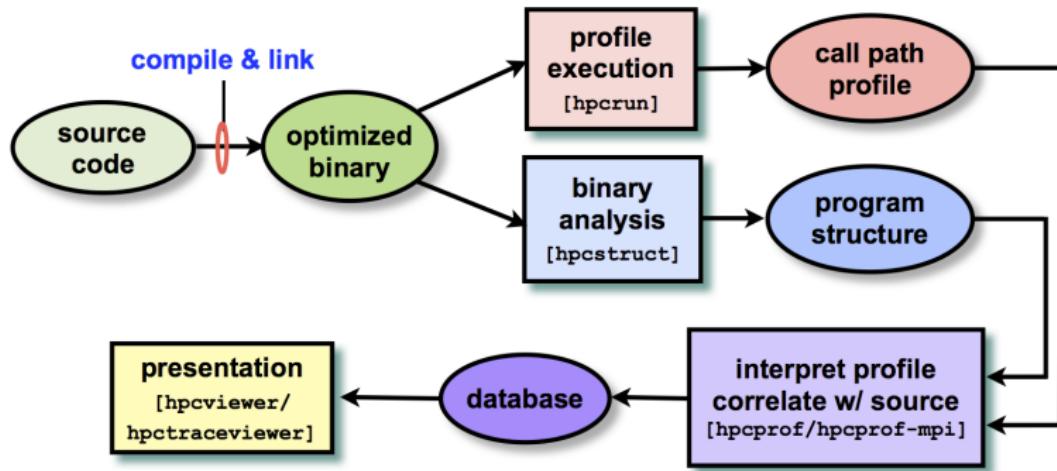
Roteiro

1 Scalasca, Score-p, Cube

2 hpctoolkit

HPCToolkit

<http://hpctoolkit.org>



Visualizando no **hpcviewer**

- O **hpcviewer** pode ser baixado e instalado para visualizar os resultados obtidos com o HPCToolkit
- <http://hpctoolkit.org/download.html>
- Binários prontos em "Binary Releases of HPCToolkit's hpcviewer Graphical User Interface"
- Resultados previamente obtidos no SDumont estão no arquivo **profiling_hpctoolkit_sdbase.zip** do repositório no GitHub:

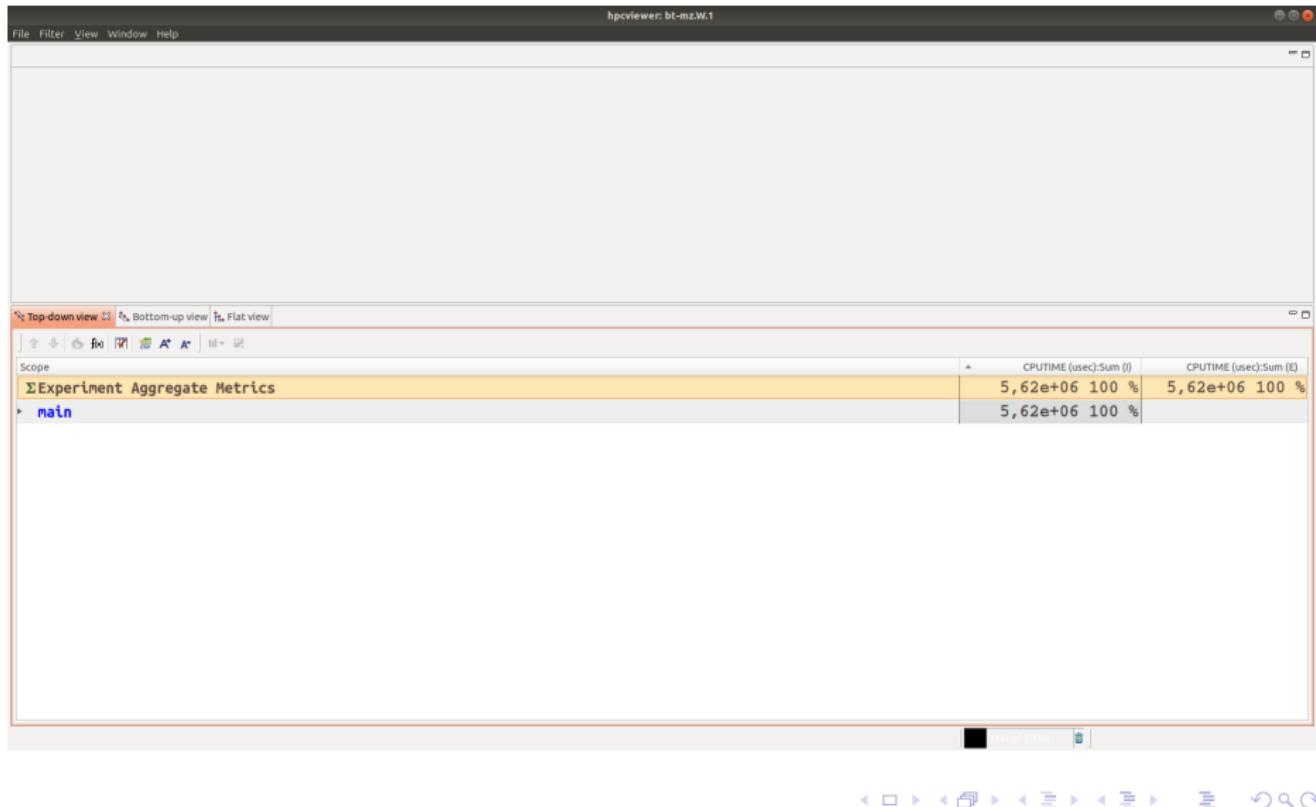
```
git clone https://github.com/robertopsouto/ESD2024.git  
ESD2024/sdbase/profiling_hpctoolkit_sequana.zip
```

NPB: estudo de caso

```
$ cd ESD2024/sdbase/profiling/hpctoolkit/NUMNODES-1/bt-mz_A_MPI-1_OMP-1_JC  
$ hpcviewer hpctoolkit-bt-mz.A.1-database-10756696
```

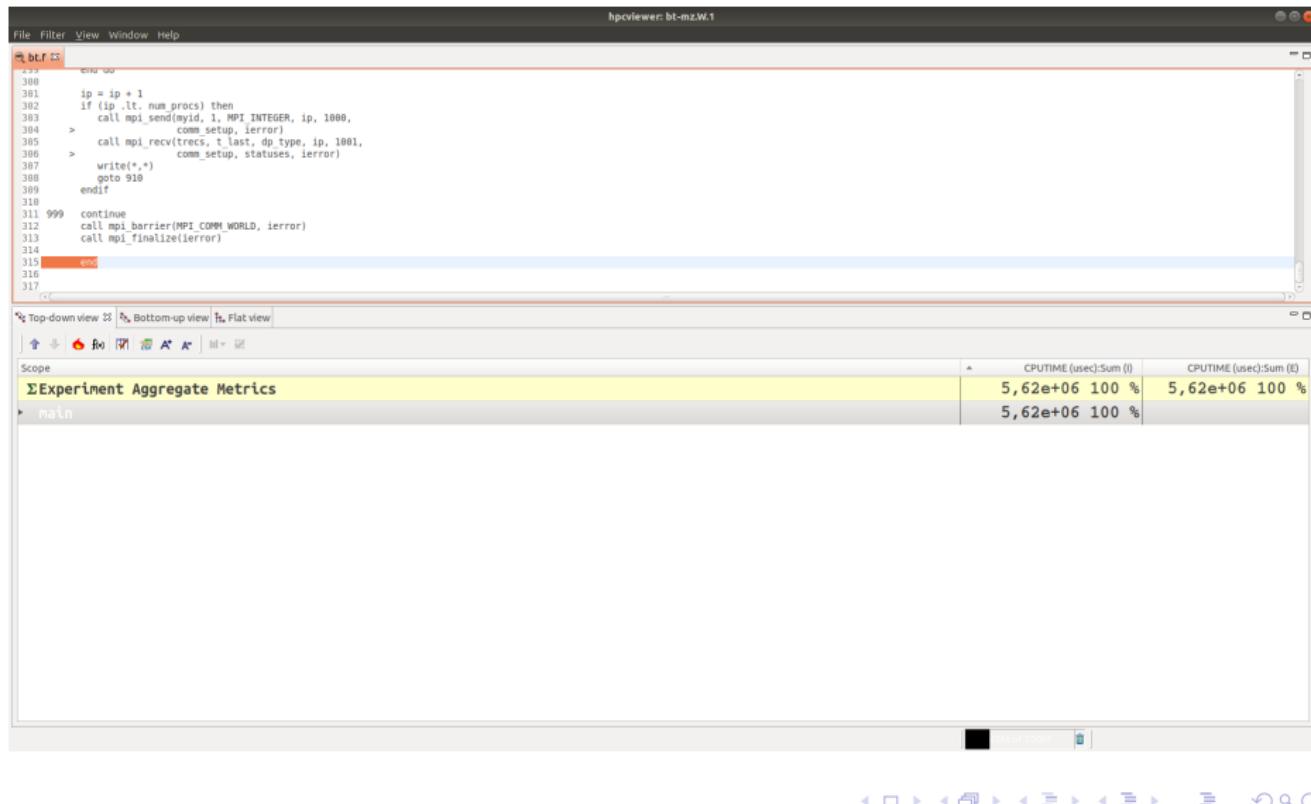
Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Top-down view



Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Top-down view



Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Top-down view

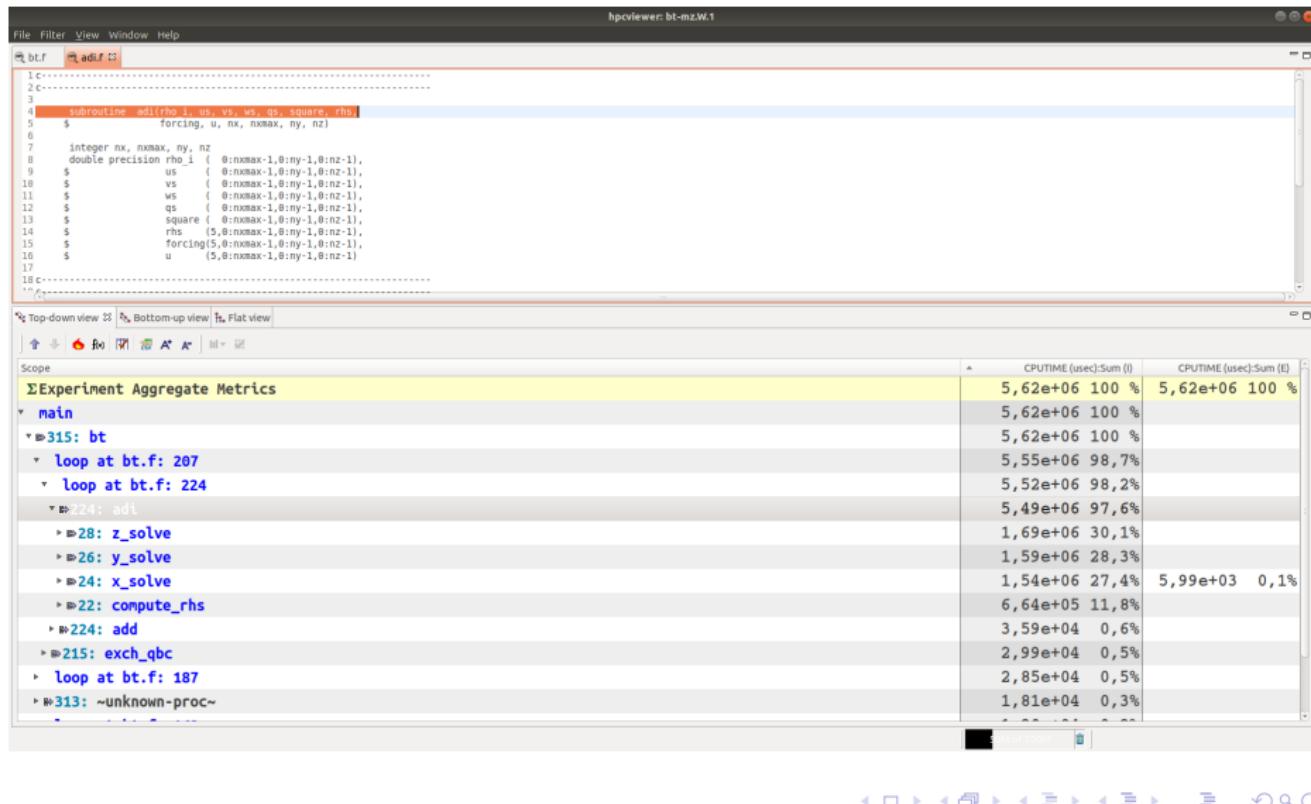
The screenshot shows the hpcviewer interface with the following details:

- Title Bar:** hpcviewer: bt-mzw.1
- File Menu:** File, Filter, View, Window, Help
- Code Editor:** Displays a C program named `bt.c` by H. Jin. The code includes headers like `header.h` and `mpi_stuff.h`, defines variables `num_zones`, `nx`, `ny`, and `nz`, and contains a `program BT` block.
- Performance Metrics:** A table titled "Experiment Aggregate Metrics" shows CPU time and percentage for three tasks:

Scope	CPUTIME (usec):Sum ()	CPUTIME (usec):Sum (%)
main	5,62e+06	100 %
bt	5,62e+06	100 %
i15: bt	5,62e+06	100 %
- Navigation:** Top-down view, Bottom-up view, Flat view, and various icons for zooming and filtering.
- Bottom Bar:** Navigation icons for file operations (New, Open, Save, Print, etc.) and search.

Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Top-down view



Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Top-down view

The screenshot shows the hpcviewer application window. At the top, there's a menu bar with File, Filter, View, Window, Help, and a tab bar with bt.f, adi.f, and z_solver.f. The main area displays a portion of a C code file:

```
49 c Compute the indices for storing the block-diagonal matrix;
50 c determine c (labeled f) and s Jacobians
51 c-----
52 #pragma DO
53 do j = 1, ny-2
54     do i = 1, nx-1
55         do k = 0, ksize
56
57             tmp1 = 1.0d / u(1,i,j,k)
58             tmp2 = tmp1 * tmp1
59             tmp3 = tmp1 * tmp2
60
61             fjac(1,1,k) = 0.0d
62             fjac(1,2,k) = 0.0d
63             fjac(1,3,k) = 0.0d
64             fjac(1,4,k) = 1.0d
65             fjac(1,5,k) = 0.0d
66
67             fjac(2,3,k) = - f_u(2,3,4,k) u(2,3,4,k) / u(1,3,4,k) - 1.
```

Below the code, there are three tabs: Top-down view, Bottom-up view, and Flat view. The Top-down view tab is selected. On the left, there's a tree view of the scope hierarchy:

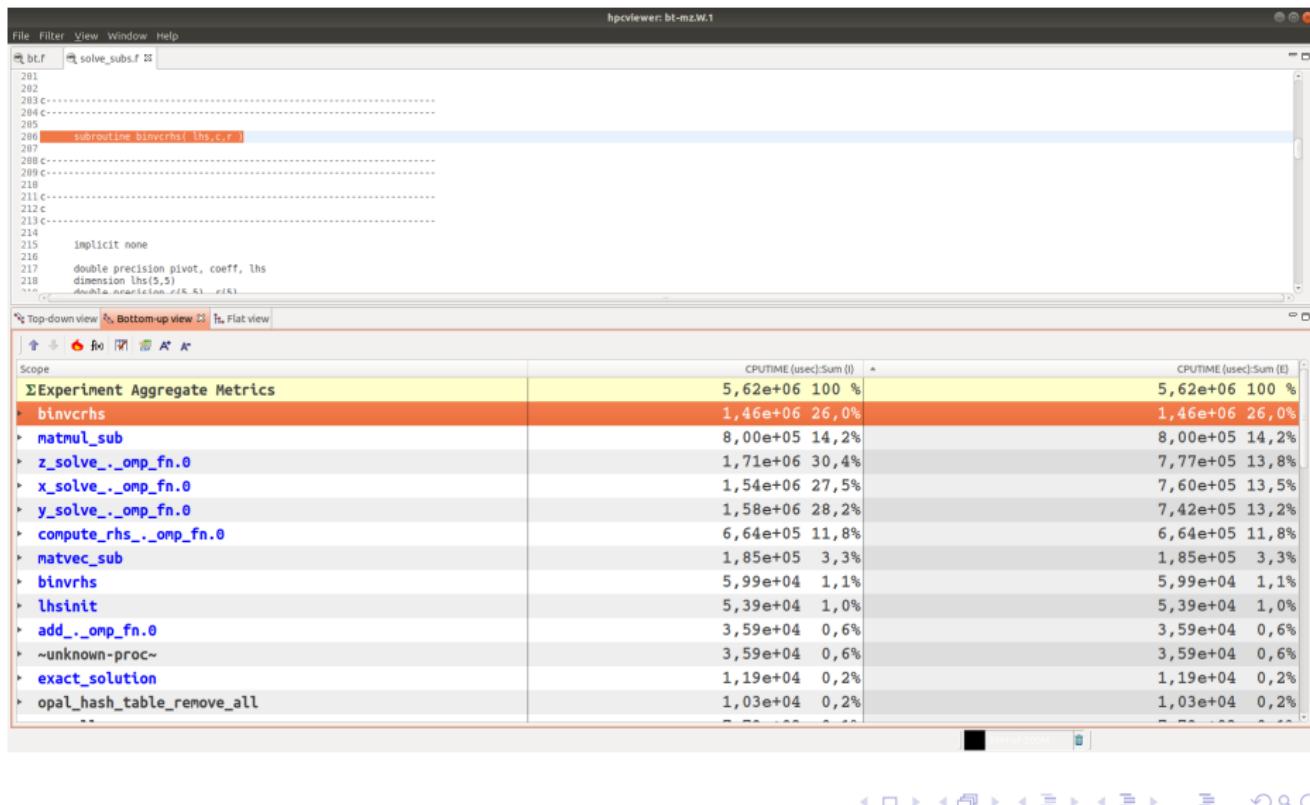
- Experiment Aggregate Metrics
- main
- bt (selected)
- loop at bt.f: 207
- loop at bt.f: 224
- adi
- z_solve
- [I] z_solve_
- [I] z_solve_.omp_fn.0
- loop at z_solve.f: 313
- loop at z_solve.f: 54
- loop at z_solve.f: 351
- loop at z_solve.f: 146

On the right, there's a table showing CPU TIME (usec):Sum (L) for each node. The table has two columns: CPUTIME (usec):Sum (L) and CPUTIME (usec):Sum (E). The data is as follows:

CPUTIME (usec):Sum (L)	CPUTIME (usec):Sum (E)
5,62e+06	100 %
5,62e+06	100 %
5,62e+06	100 %
5,55e+06	98,7%
5,52e+06	98,2%
5,49e+06	97,6%
1,69e+06	30,1%
7,84e+05	13,9%
4,91e+05	8,7%
4,91e+05	8,7%

Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Bottom-up view



Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Bottom-up view

File Filter View Window Help

hpcviewer: bt-mz.w1

bt.f solve_sub.f

```
281
282
283 C-----
284 C-----
285
286 subroutine binvcrhs (lhs,c,r)
287
288 C-----
289 C-----
290
291 C-----
292 C-----
293 C-----
294 C-----
295
296 implicit none
297
298 double precision pivot, coeff, lhs
299 dimension lhs(5,5)
300 dimension r(5,5)
301 dimension c(5,5)
302 dimension v(5,5)
```

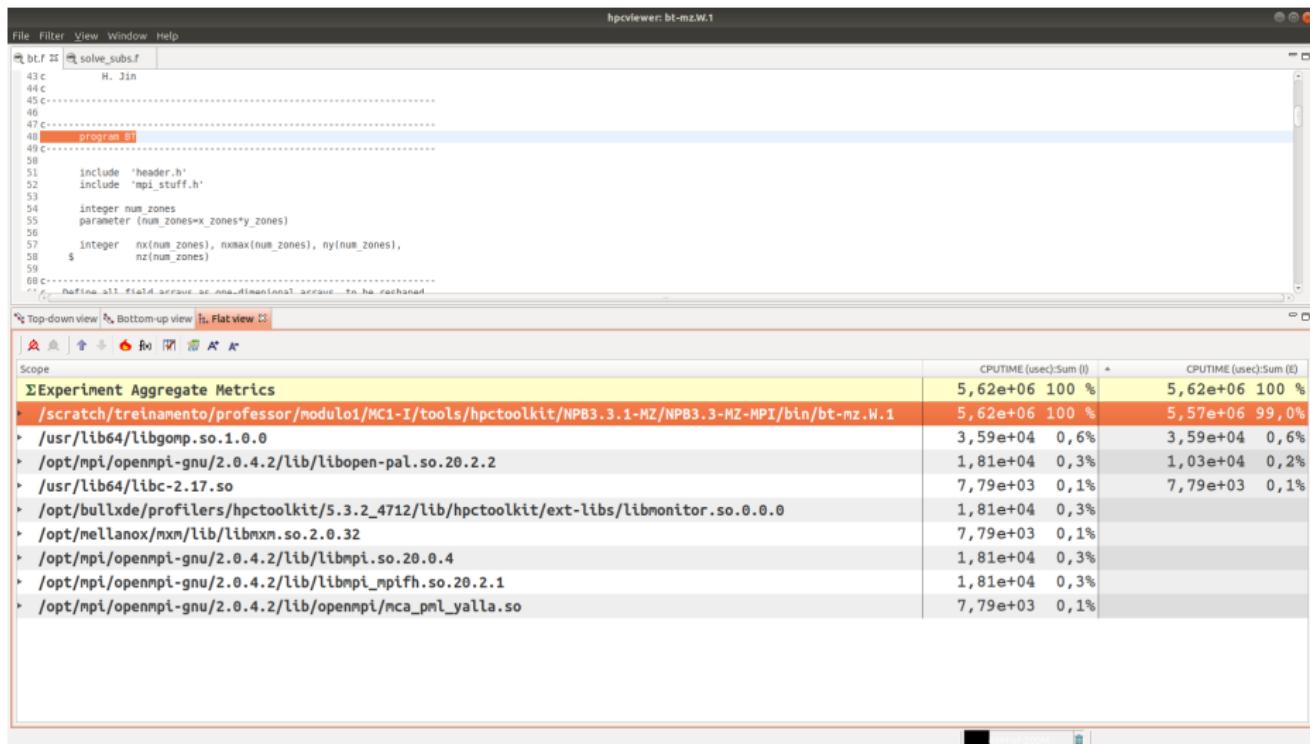
Top-down view Bottom-up view Flat view

Scope

	CPUTIME (usec):Sum (I)	CPUTIME (usec):Sum (I)
Experiment Aggregate Metrics	5,62e+06 100 %	5,62e+06 100 %
binvcrhs	1,46e+06 26,0%	1,46e+06 26,0%
#375: [I] z_solve_._omp_fn.0	5,32e+05 9,5%	5,32e+05 9,5%
#313: z_solve_._omp_fn.0	5,32e+05 9,5%	5,32e+05 9,5%
#45: [I] z_solve_	5,32e+05 9,5%	5,32e+05 9,5%
#45: z_solve	5,32e+05 9,5%	5,32e+05 9,5%
#28: adi	5,32e+05 9,5%	5,32e+05 9,5%
#187: bt	5,32e+05 9,5%	5,32e+05 9,5%
#315: main	5,32e+05 9,5%	5,32e+05 9,5%
#336: x_solve_._omp_fn.0	4,67e+05 8,3%	4,67e+05 8,3%
#331: y_solve_._omp_fn.0	4,61e+05 8,2%	4,61e+05 8,2%
matmul_sub	8,00e+05 14,2%	8,00e+05 14,2%
z_solve_._omp_fn.0	1,71e+06 30,4%	7,77e+05 13,8%
x_solve_._omp_fn.0	1,54e+06 27,5%	7,60e+05 13,5%

Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Flat view



Visualizando no hpcviewer

-nodes=1 -ntasks=1 / Flat view

hpcviewer: bt-mz.W.1

File Filter View Window Help

bt.f solve_subsf.f

281
282
283 C-----
284 C-----
285
286 subroutine binvcrhs(lhs,c,r)
287
288 C-----
289 C-----
290
291 C-----
292 C-----
293 C-----
294 C-----
295
296 implicit none
297
298 double precision pivot, coeff, lhs
299 dimension lhs(3,3)
300 dimension r(3,3), c(3,3)

Top-down view Bottom-up view Flat view

Scope

Experiment Aggregate Metrics

	CPUTIME (usec):Sum ()	CPUTIME (usec):Sum (%)
/scratch/treinamento/professor/modulo1/MC1-I/tools/hpctoolkit/NPB3.3.1-MZ/NPB3.3-MZ-MPI/bin/bt-mz.W.1	5,62e+06 100 %	5,62e+06 100 %
solve_subsf.f	5,62e+06 100 %	5,57e+06 99,0%
z_solve.f	2,51e+06 44,6%	2,51e+06 44,6%
x_solve.f	1,71e+06 30,4%	7,77e+05 13,8%
y_solve.f	1,55e+06 27,6%	7,66e+05 13,6%
rhs.f	1,59e+06 28,3%	7,42e+05 13,2%
initialize.f	6,70e+05 11,9%	6,64e+05 11,8%
add.f	7,19e+04 1,3%	5,99e+04 1,1%
exact_solution.f	3,59e+04 0,6%	3,59e+04 0,6%
exch_qbc.f	1,19e+04 0,2%	1,19e+04 0,2%
adi.f	2,99e+04 0,5%	5,99e+03 0,1%
bt.f	5,51e+06 98,1%	
verify.f	5,62e+06 100 %	
	5,99e+03 0,1%	

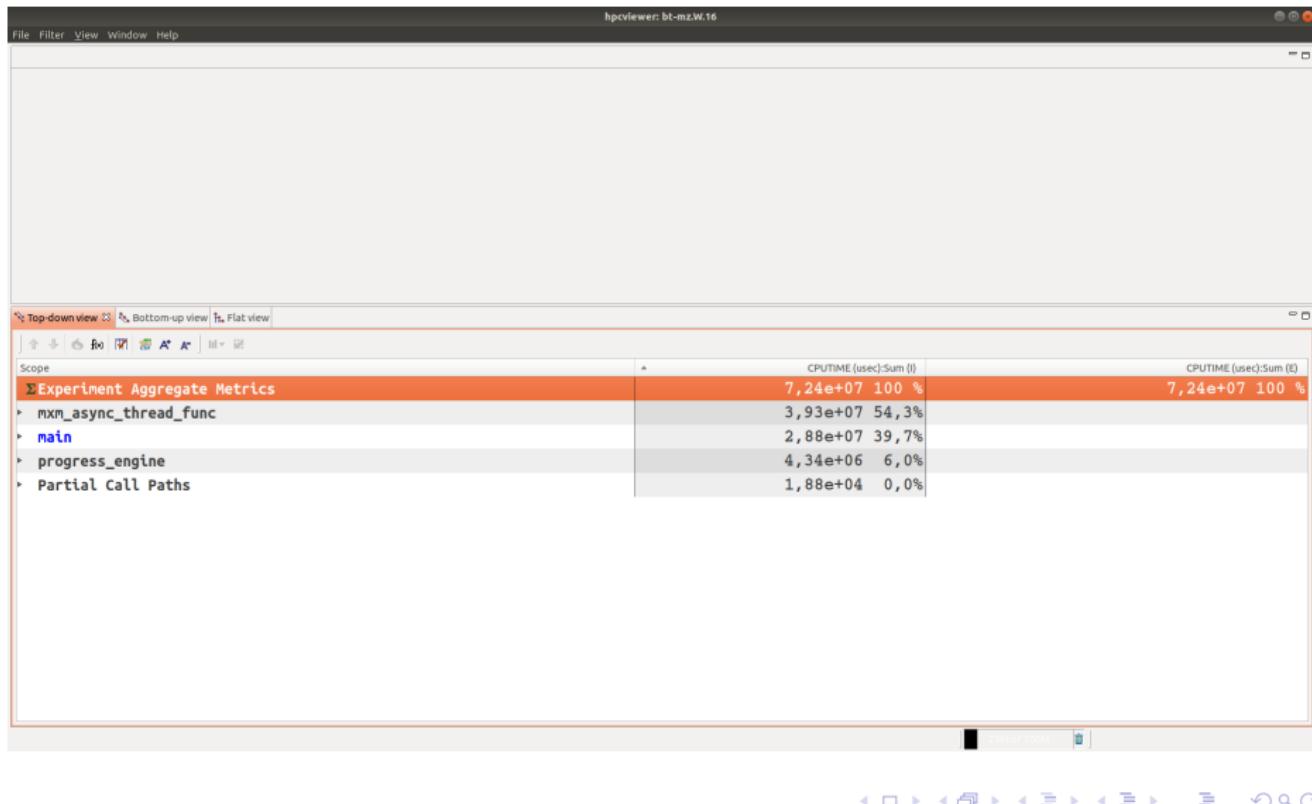
Visualizando no hpcviewer

NPB: estudo de caso

```
$ cd profiling/hpctoolkit/NUMNODES-1/bt-mz_W_MPI-16_OMP-1_JOBID-439032  
$ hpcviewer hpctoolkit-bt-mz.W.16-database-439032
```

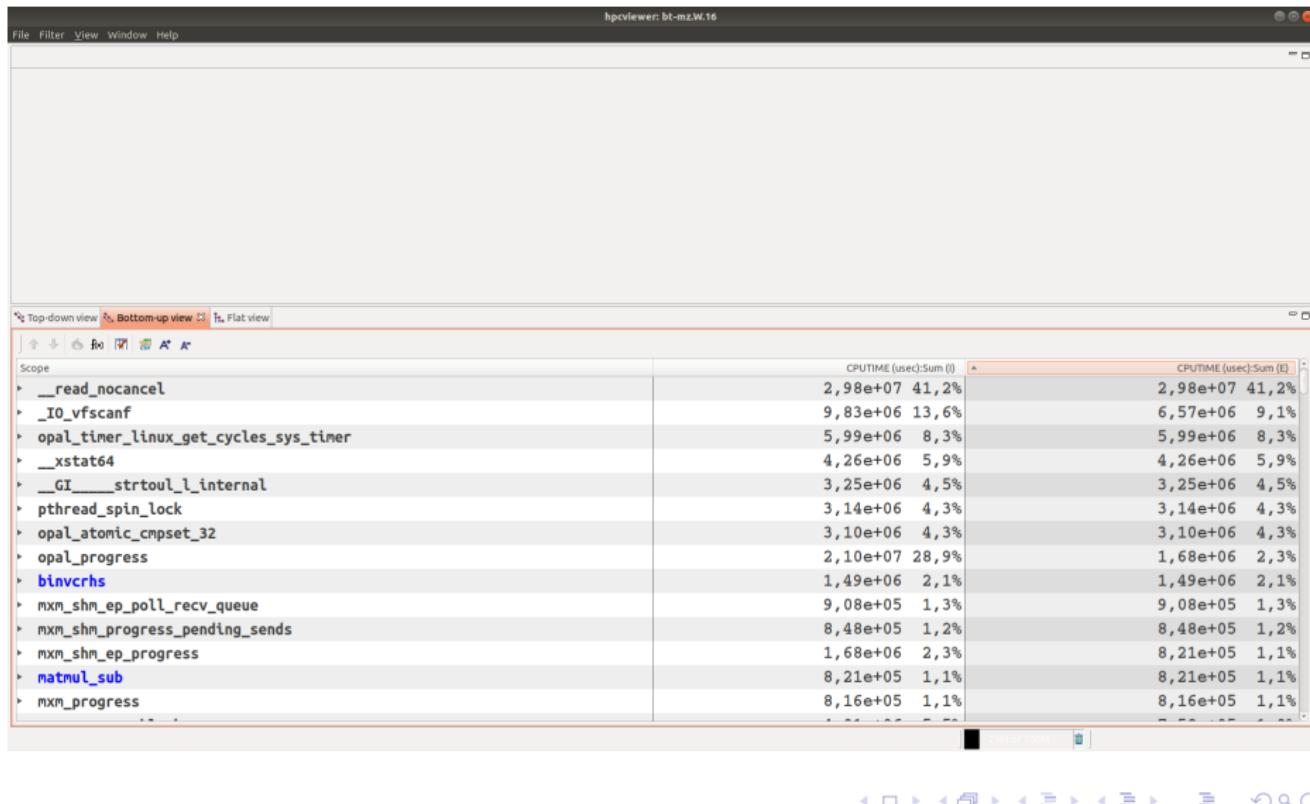
Visualizando no hpcviewer

-nodes=1 -ntasks=16 / Top-down view



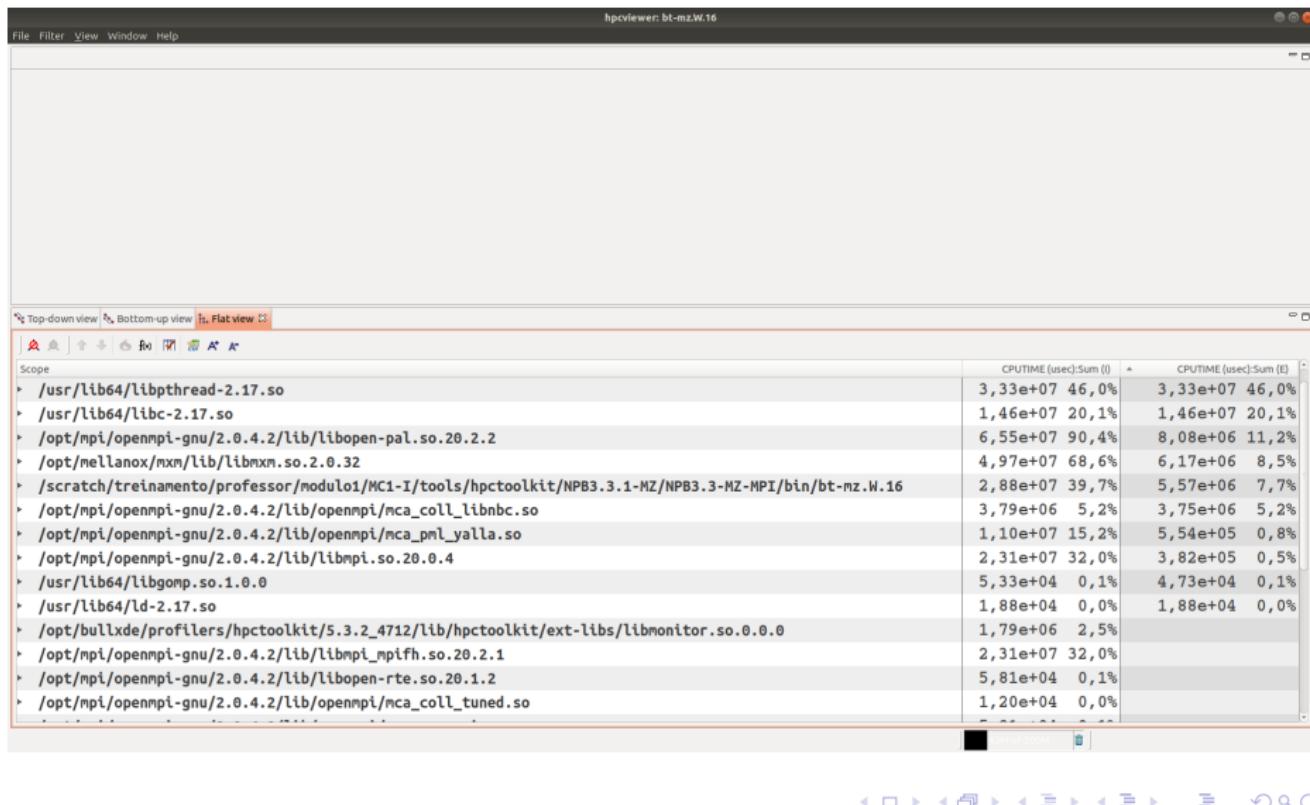
Visualizando no hpcviewer

-nodes=1 -ntasks=16 / Bottom-up view



Visualizando no hpcviewer

-nodes=1 -ntasks=16 / Flat view



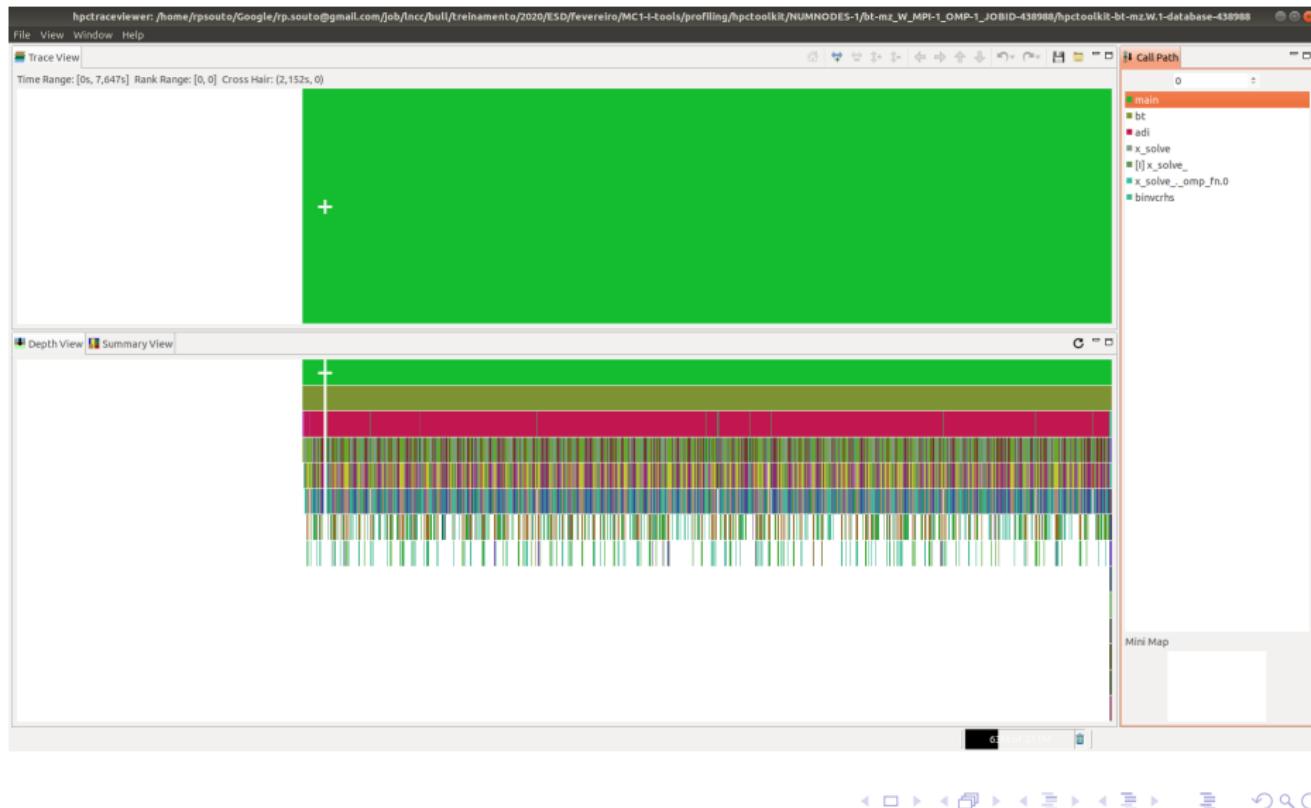
Visualizando no hpctraceview

NPB: estudo de caso

```
$ cd profiling/hpctoolkit/NUMNODES-1/bt-mz_W_MPI-1_OMP-1_JOBID-438988  
$ hpctraceview hpctoolkit-bt-mz.W.1-database-438988/
```

Visualizando no hpctraceview

-nodes=1 -ntasks=1



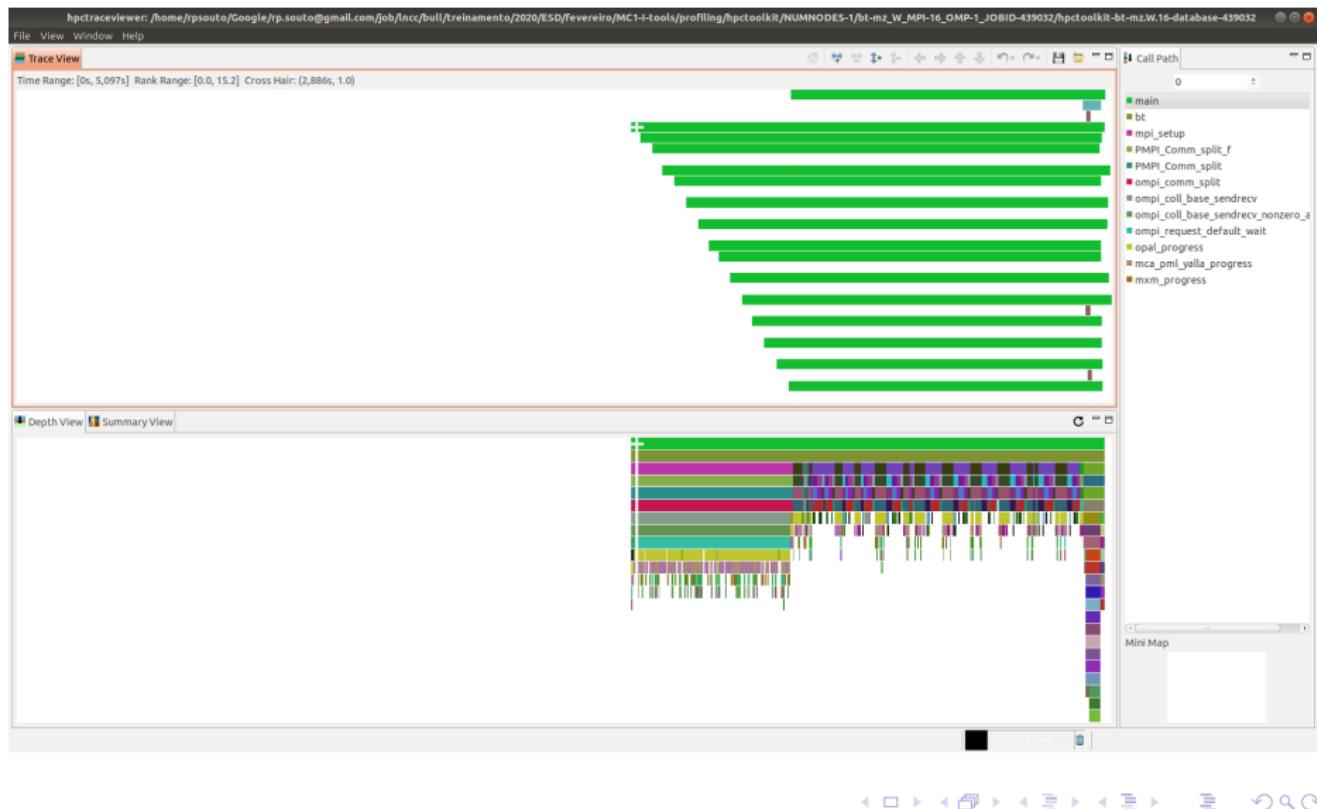
Visualizando no hpctraceview

NPB: estudo de caso

```
$ cd profiling/hpctoolkit/NUMNODES-1/bt-mz_W_MPI-16_OMP-1_JOBID-439032  
$ hpctraceview hpctoolkit-bt-mz.W.16-database-439032
```

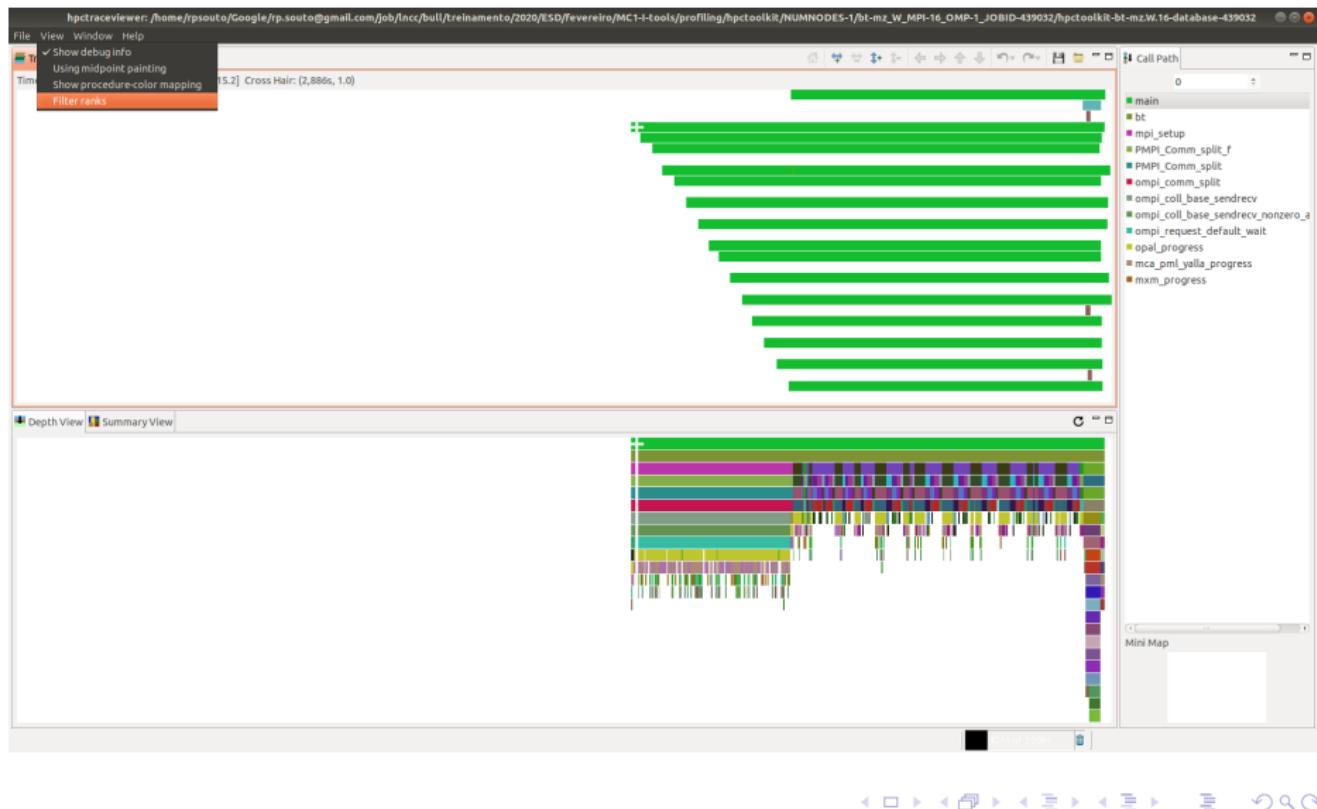
Visualizando no hpctraceview

-nodes=1 -ntasks=16



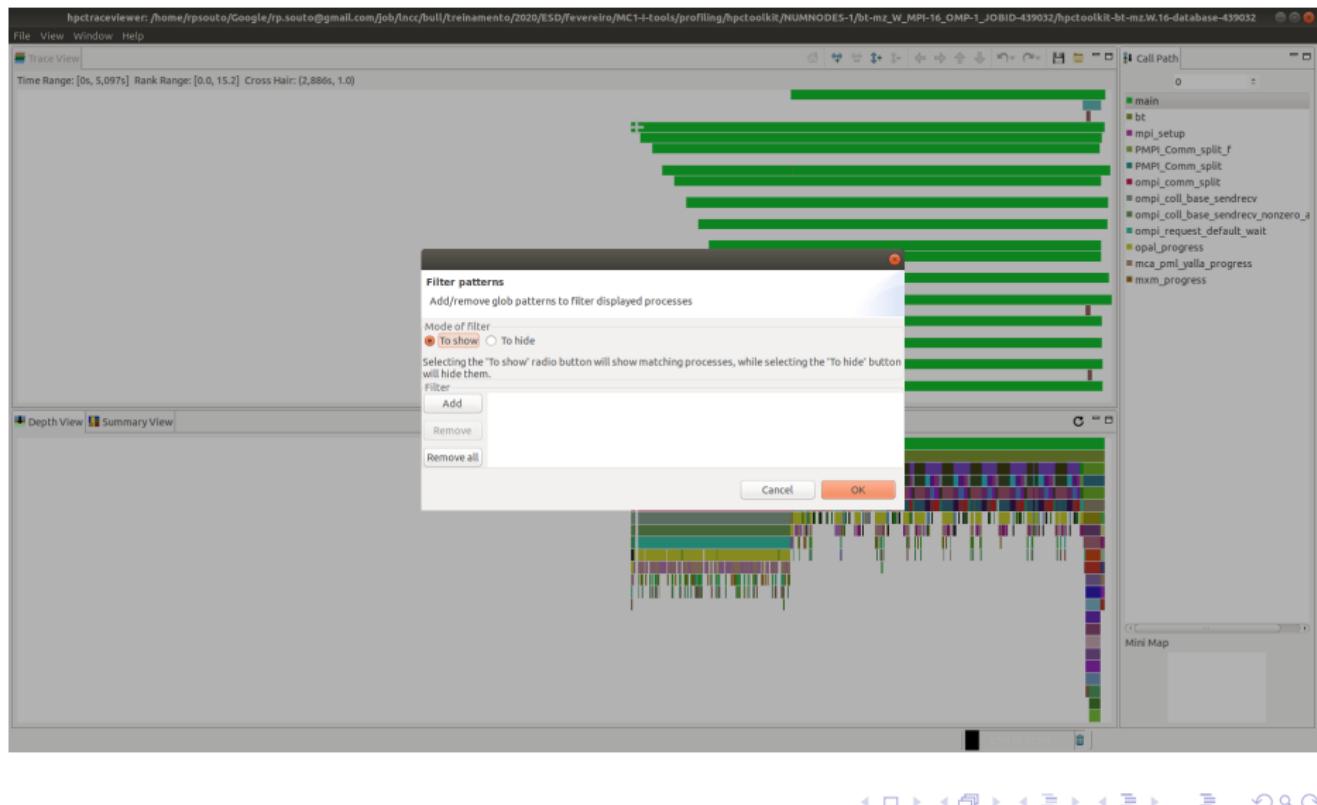
Visualizando no hpctraceview

-nodes=1 -ntasks=16



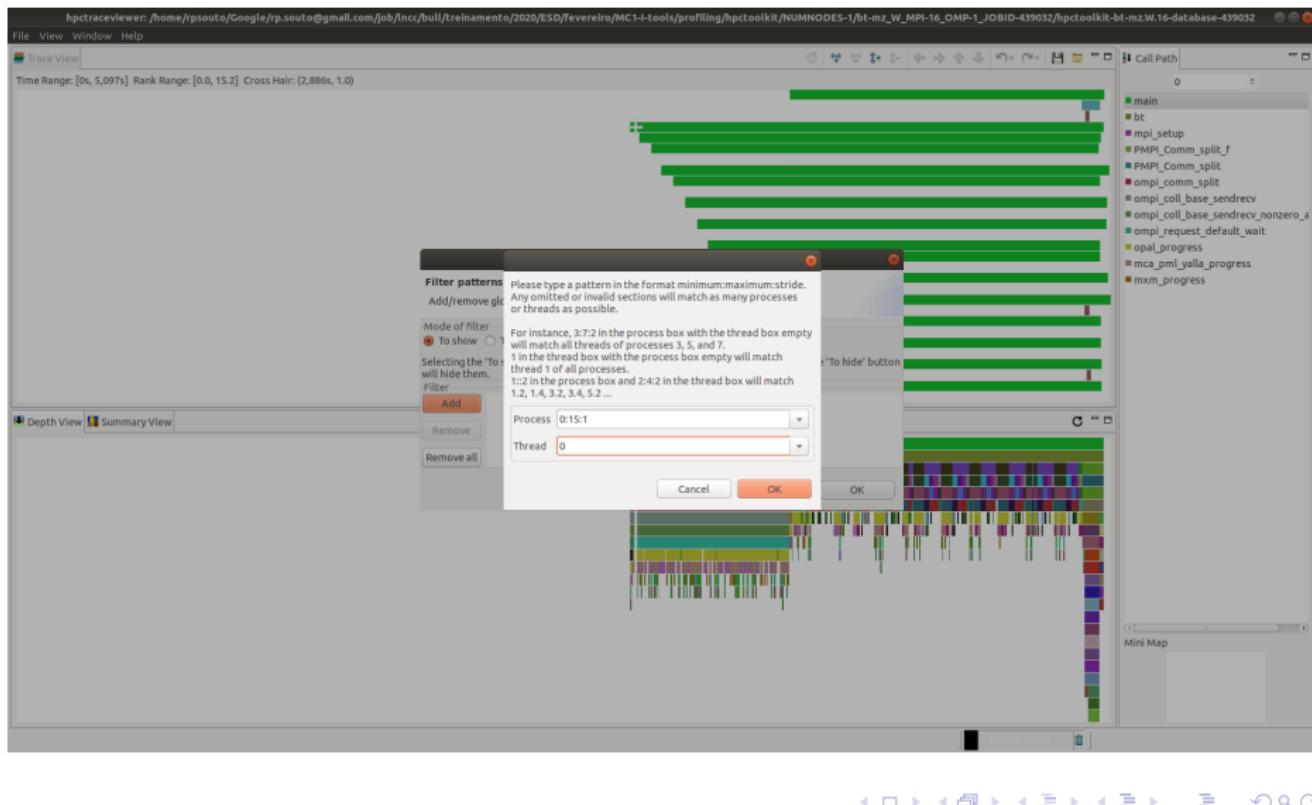
Visualizando no hpctraceview

-nodes=1 -ntasks=16



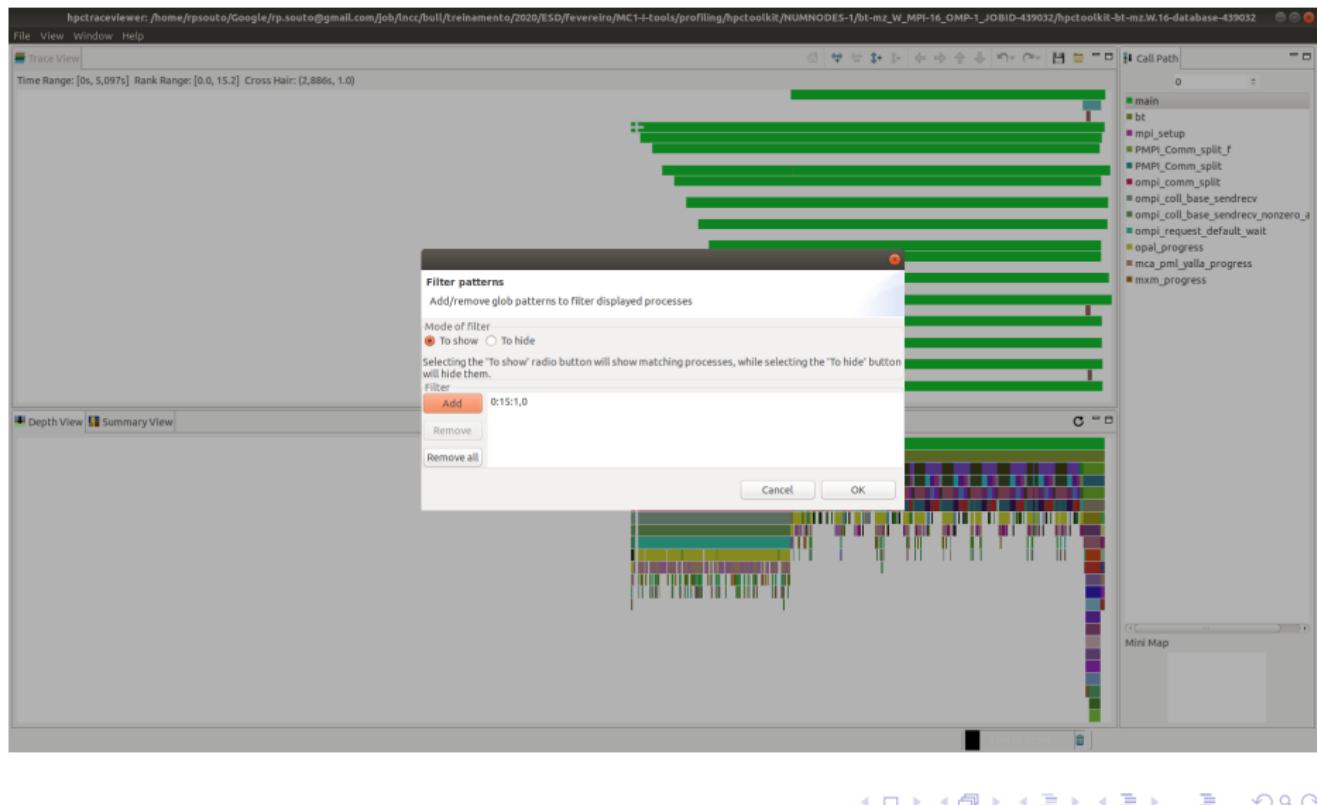
Visualizando no hpctraceview

-nodes=1 -ntasks=16



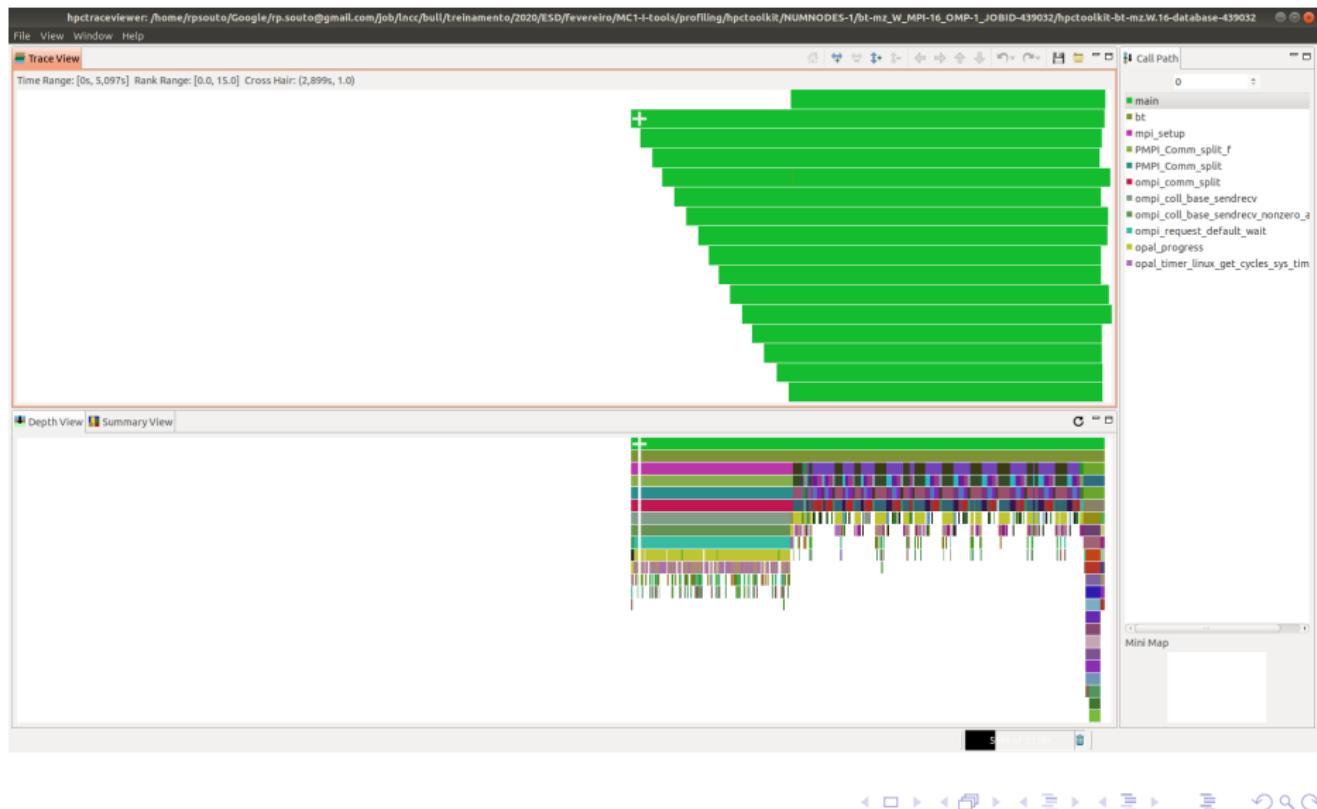
Visualizando no hpctraceview

-nodes=1 -ntasks=16



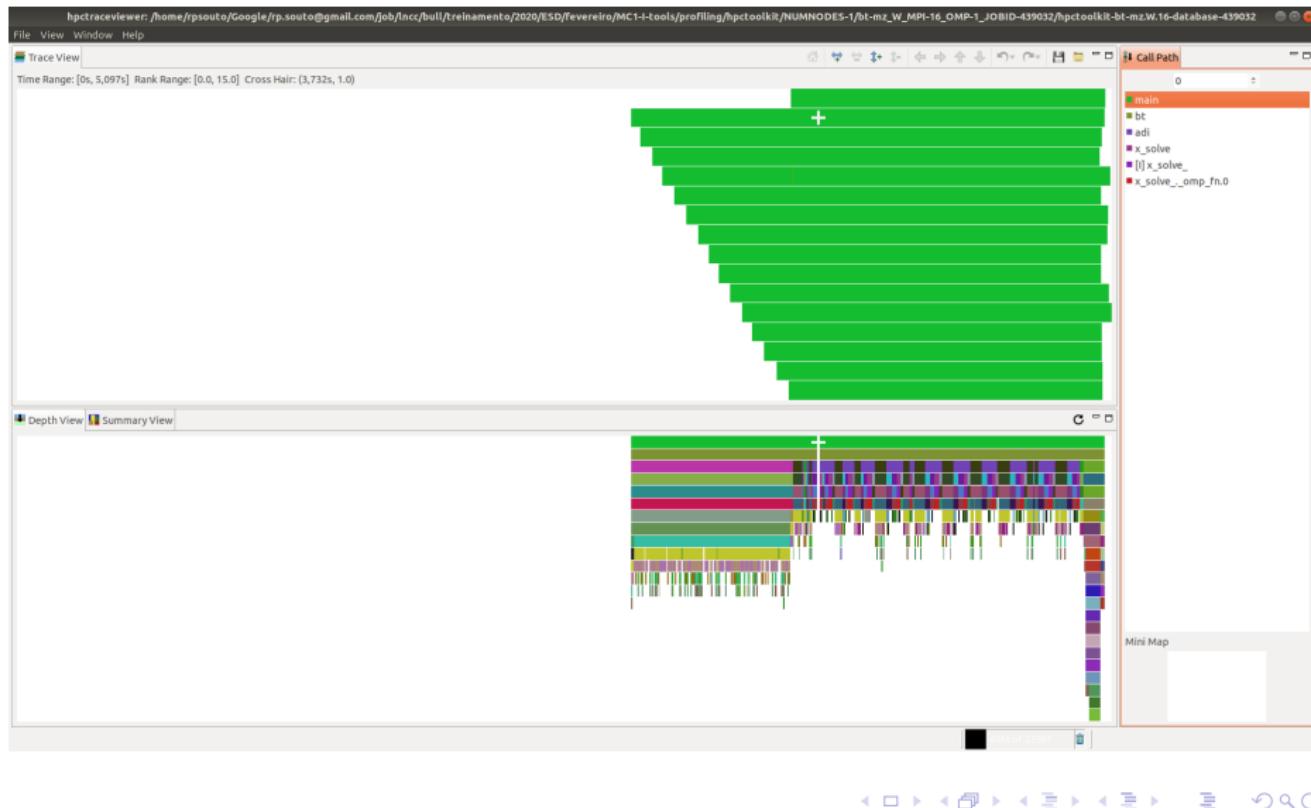
Visualizando no hpctraceview

-nodes=1 -ntasks=16



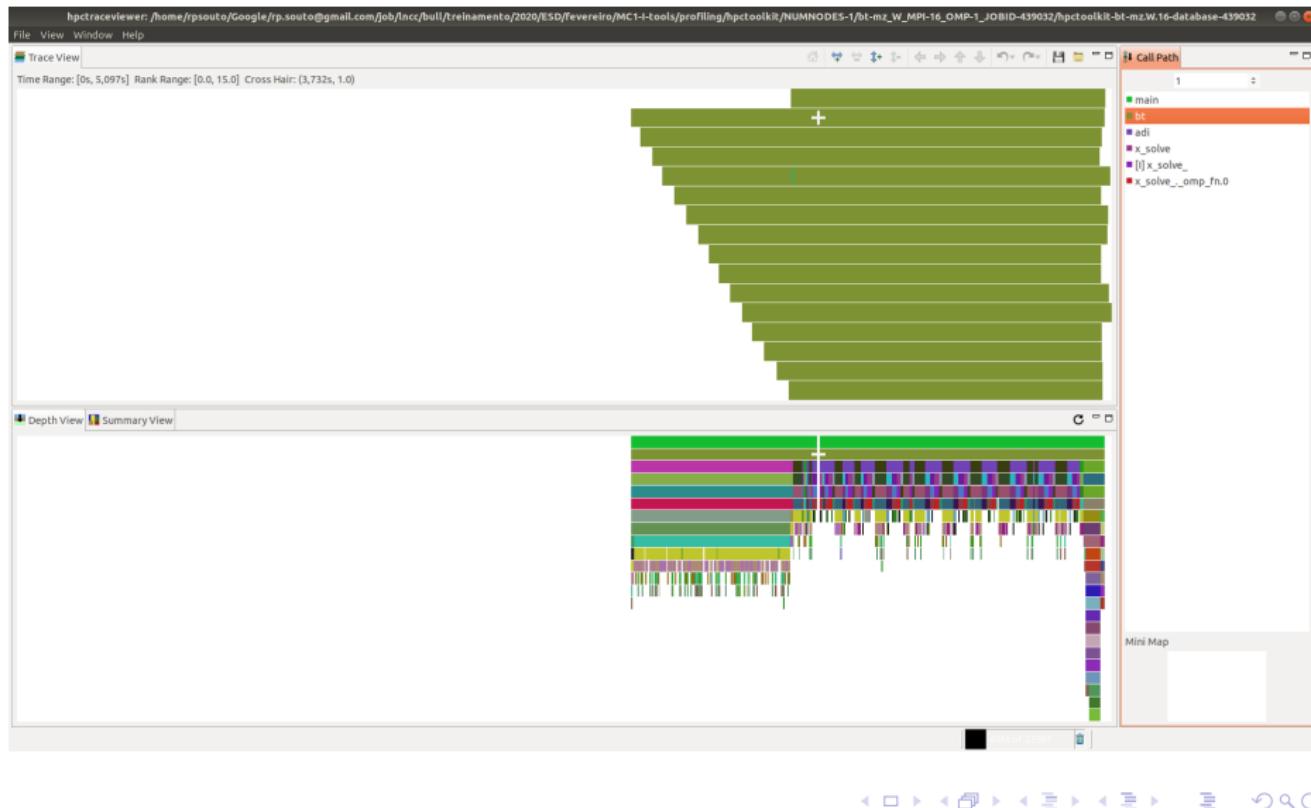
Visualizando no hpctraceview

-nodes=1 -ntasks=16 – função **main**



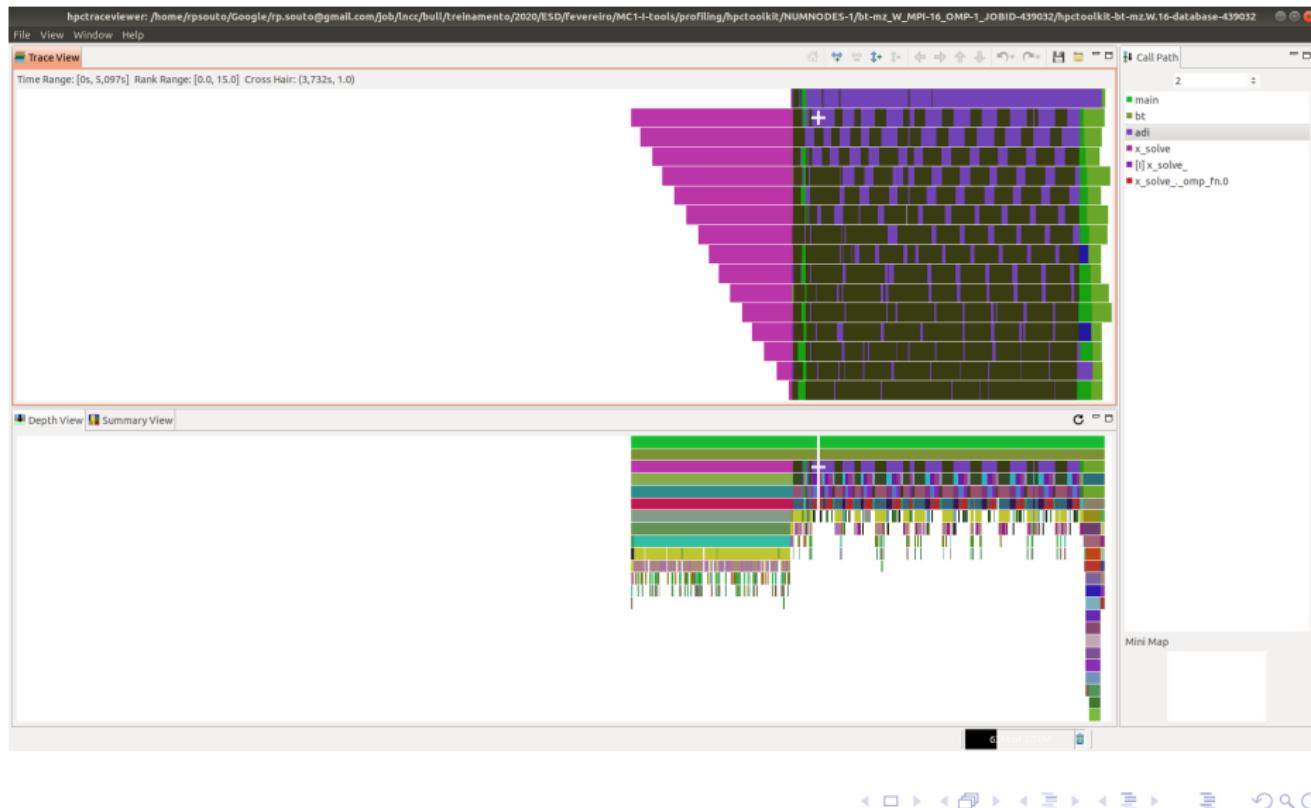
Visualizando no hpctraceview

-nodes=1 -ntasks=16 - função bt



Visualizando no hpctraceview

-nodes=1 -ntasks=16 – função adi



Visualizando no hpctraceview

-nodes=1 -ntasks=16 – função **xsolve**

