Analysis report examination with Cube

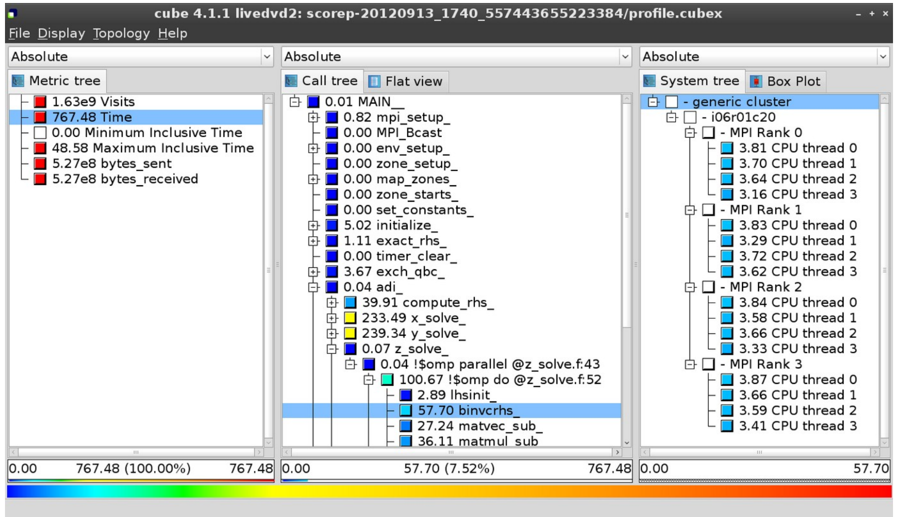
The Scalasca Team
Jülich Supercomputing Centre

Cube

- Parallel program analysis report exploration tools
  - Libraries for XML+binary report reading & writing
  - Algebra utilities for report processing
  - GUI for interactive analysis exploration
    - Requires Qt5 or Qt 6

- Originally developed as part of the Scalasca toolset

- Now available as a separate component
  - Can be installed independently of Score-P, e.g., on laptop or desktop
  - Latest release: Cube v4.7 (April 2022)


cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex
File Display Topology Help
Absolute
Absolute
Absolute
Metric tree
Call tree
Flat view
System tree
Box Plot

```
1.63e9 Visits
767.48 Time
0.00 Minimum Inclusive Time
48.58 Maximum Inclusive Time
5.27e8 bytes_sent
5.27e8 bytes_received
```

```
0.01 MAIN__
  0.82 mpi_setup_
  0.00 MPI_Bcast
  0.00 env_setup_
  0.00 zone_setup_
  0.00 map_zones_
  0.00 zone_starts_
  0.00 set_constants_
  5.02 initialize_
  1.11 exact_rhs_
  0.00 timer_clear_
  3.67 exch_qbc_
  0.04 adi_
    39.91 compute_rhs_
    233.49 x_solve_
    239.34 y_solve_
    0.07 z_solve_
      0.04 !$omp parallel @z_solve.f:43
        100.67 !$omp do @z_solve.f:52
          2.89 lhsinit_
          57.70 binvcrhs_
          27.24 matvec_sub_
          36.11 matmul_sub
```

```
- generic cluster
  - i06r01c20
    - MPI Rank 0
      3.81 CPU thread 0
      3.70 CPU thread 1
      3.64 CPU thread 2
      3.16 CPU thread 3
    - MPI Rank 1
      3.83 CPU thread 0
      3.29 CPU thread 1
      3.72 CPU thread 2
      3.62 CPU thread 3
    - MPI Rank 2
      3.84 CPU thread 0
      3.58 CPU thread 1
      3.66 CPU thread 2
      3.33 CPU thread 3
    - MPI Rank 3
      3.87 CPU thread 0
      3.66 CPU thread 1
      3.59 CPU thread 2
      3.41 CPU thread 3
```

```
0.00      767.48 (100.00%)      767.48
0.00      57.70 (7.52%)         767.48
0.00                            57.70
```

Note:
Binary packages provided for Windows & MacOS,
from **www.scalasca.org** website in software/Cube-4x

Cube GUI

mailto: **scalasca@fz-juelich.de**

- Run ***remote*** *(default)*
  - start X server (e.g., Xming) locally
  - connect to JUSUF with X forwarding enabled
  - load cube module and start cube remotely

```
desk$ ssh –X <yourid>@jusuf.fz-juelich.de
Welcome to …
jusuf$ module load CubeGUI
jusuf$ cube ./scorep_sum/profile.cubex
```

- Install & run ***local*** *(alternative)*
  - install Cube GUI locally on desktop
    - binary packages available for MacOS & Windows and externally provided by OpenHPC and various Linux distributions
    - source package available for Linux, requires Qt
      - configure/build/install manually or use your favourite framework (e.g. Spack or EasyBuild)
  - copy .cubex file (or entire scorep directory) to desktop from remote system
    OR locally mount remote filesystem
  - start cube locally

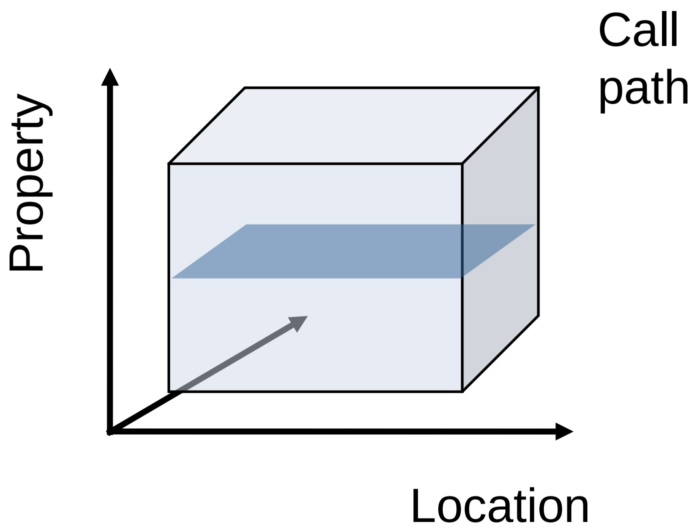
```
desk$ mkdir $HOME/mnt
desk$ sshfs [user@]remote.sys:[dir] $HOME/mnt
desk$ cd $HOME/mnt
desk$ cube ./scorep_sum/profile.cubex
```

Analysis presentation and exploration

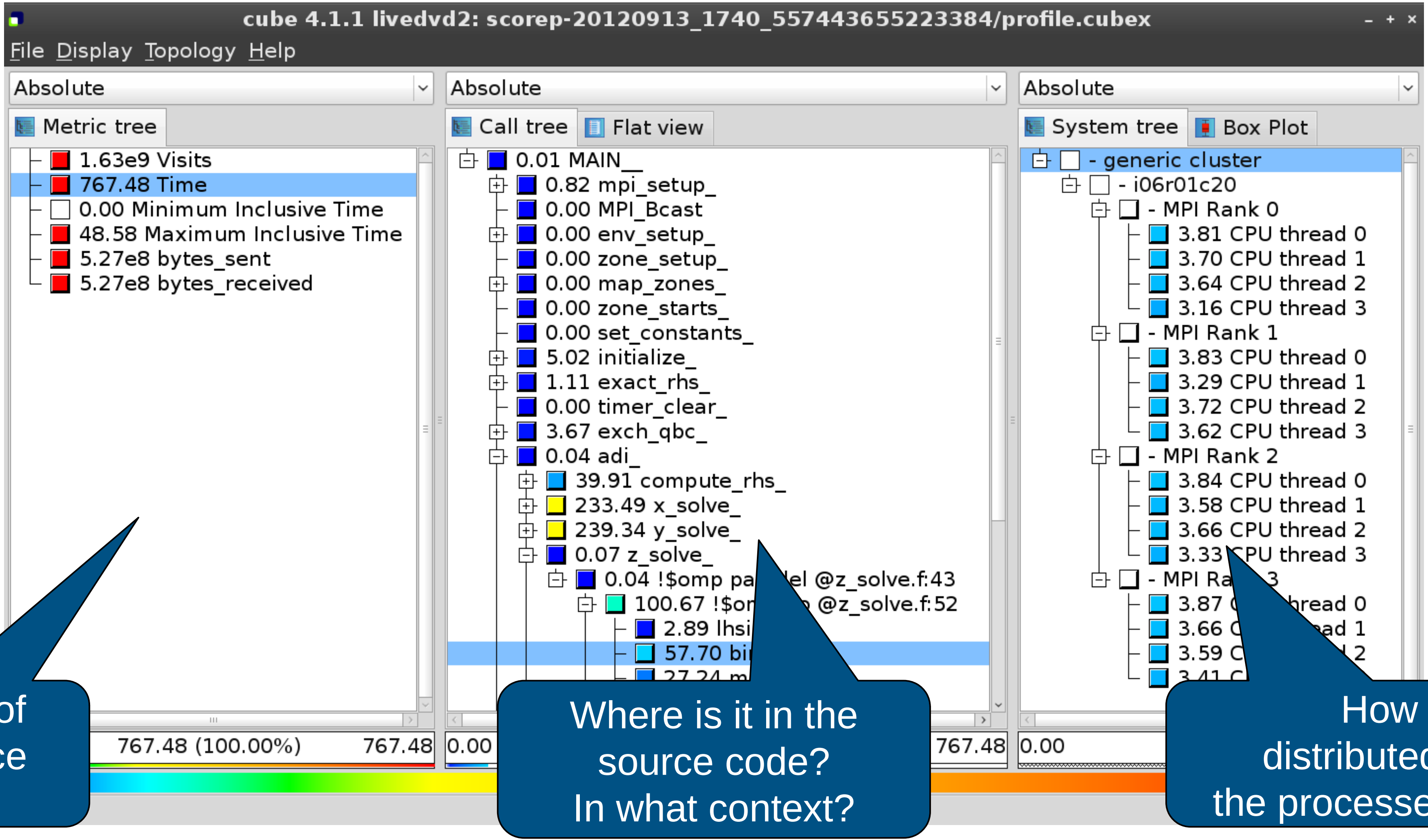
- Representation of values (severity matrix) on three hierarchical axes
  - Performance property (metric)
  - Call path (program location)
  - System location (process/thread)

- Three coupled tree browsers

- Cube displays severities
  - As *value*: for precise comparison
  - As *colour*: for easy identification of hotspots
  - *Inclusive* value when closed & *exclusive* value when expanded
  - Customizable via display modes



Analysis presentation



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

```
1.63e9 Visits
767.48 Time
0.00 Minimum Inclusive Time
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5.27e8 bytes_sent
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```

```
0.01 MAIN__
  0.82 mpi_setup_
  0.00 MPI_Bcast
  0.00 env_setup_
  0.00 zone_setup_
  0.00 map_zones_
  0.00 zone_starts_
  0.00 set_constants_
  5.02 initialize_
  1.11 exact_rhs_
  0.00 timer_clear_
  3.67 exch_qbc_
  0.04 adi_
    39.91 compute_rhs_
    233.49 x_solve_
    239.34 y_solve_
    0.07 z_solve_
      0.04 !$omp pa      lel @z_solve.f:43
        100.67 !$or      @z_solve.f:52
          2.89 lhsi
          57.70 bi
          27.24 m
```

```
- generic cluster
  - i06r01c20
    - MPI Rank 0
      3.81 CPU thread 0
      3.70 CPU thread 1
      3.64 CPU thread 2
      3.16 CPU thread 3
    - MPI Rank 1
      3.83 CPU thread 0
      3.29 CPU thread 1
      3.72 CPU thread 2
      3.62 CPU thread 3
    - MPI Rank 2
      3.84 CPU thread 0
      3.58 CPU thread 1
      3.66 CPU thread 2
      3.33 CPU thread 3
    - MPI Ra     3
      3.87 C      hread 0
      3.66 C      ead 1
      3.59 C        2
      3.41 C
```

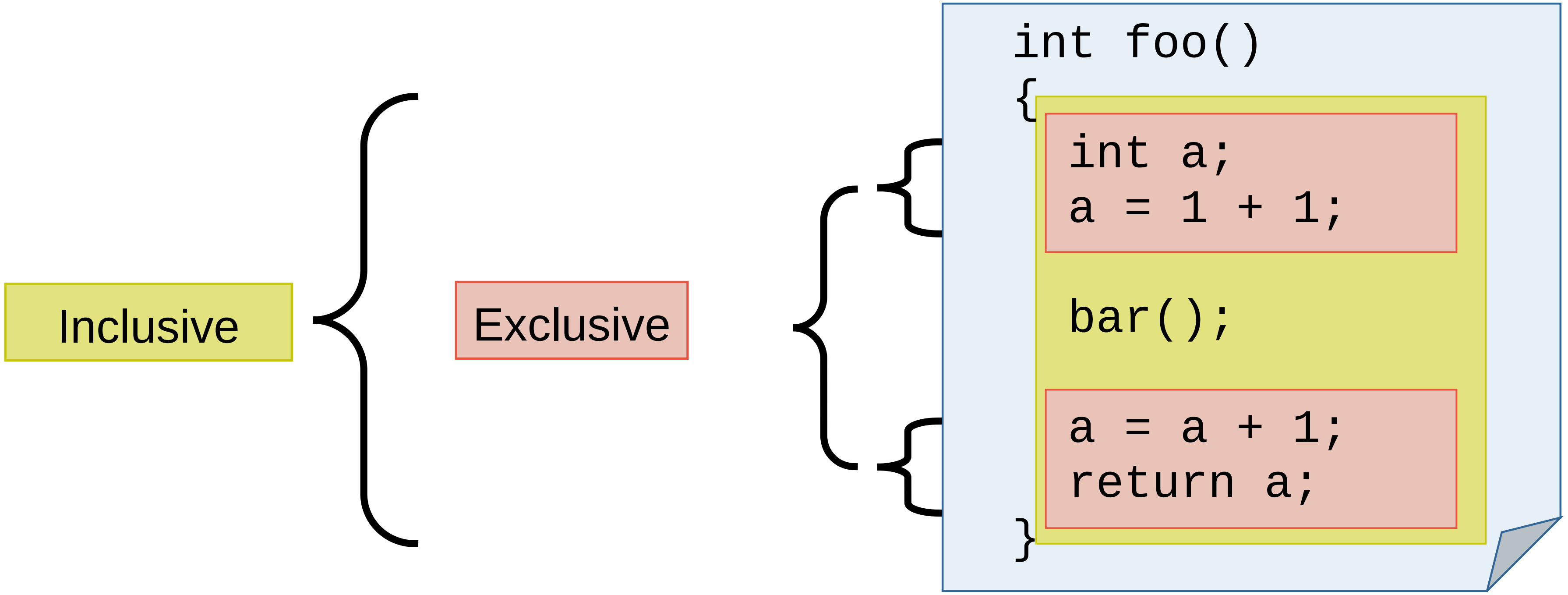
What kind of performance metric?

Where is it in the source code? In what context?

How is it distributed across the processes/threads?

Inclusive vs. exclusive values

- Inclusive
  - Information of all sub-elements aggregated into single value
- Exclusive
  - Information cannot be subdivided further

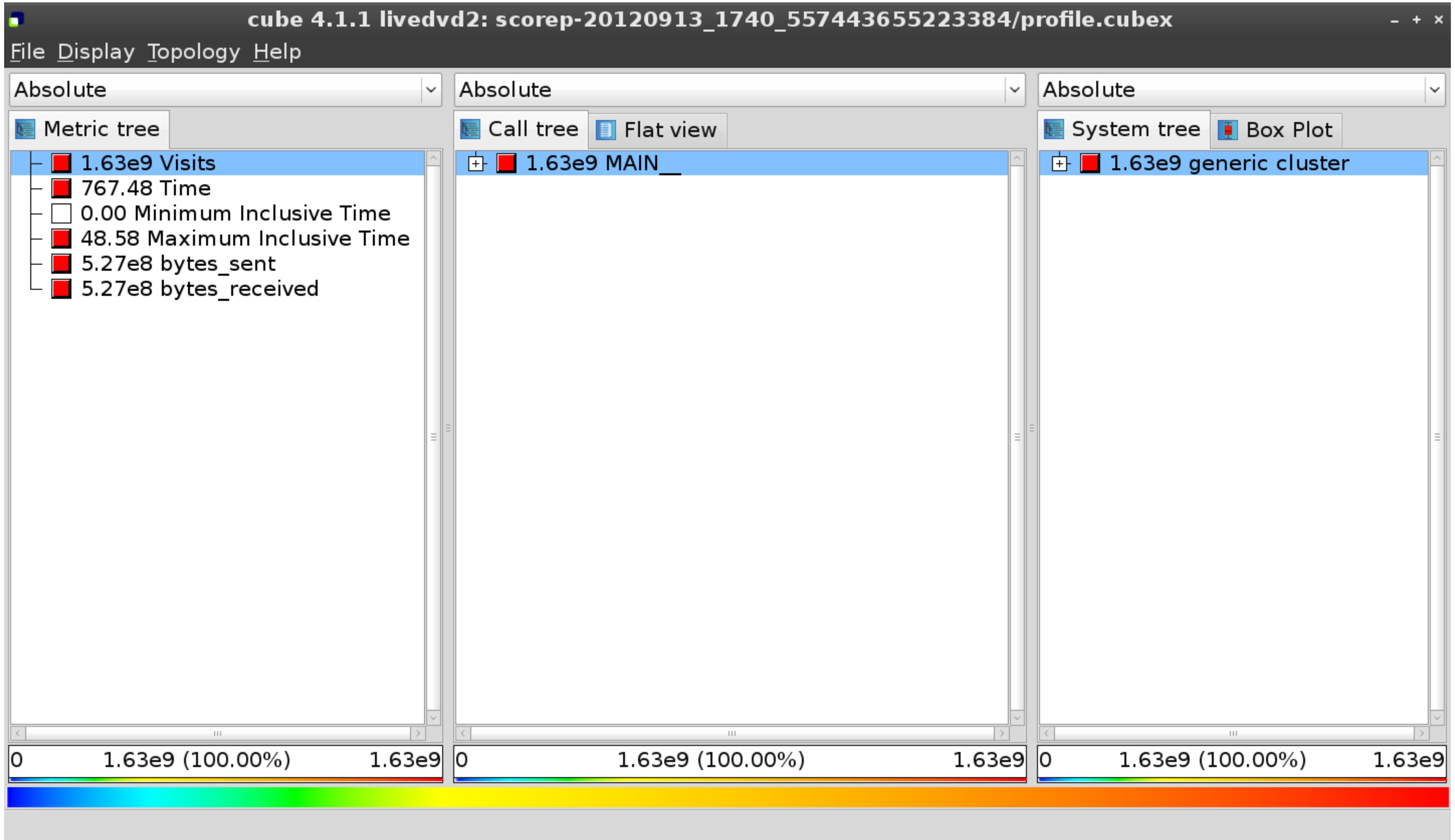


Inclusive

Exclusive

```
int foo()
{
  int a;
  a = 1 + 1;

  bar();

  a = a + 1;
  return a;
}
```

Score-P analysis report exploration (opening view)


cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex
File Display Topology Help
Absolute
Absolute
Absolute
Metric tree
Call tree
Flat view
System tree
Box Plot

Metric tree:
- 🟥 1.63e9 Visits
- 🟥 767.48 Time
- □ 0.00 Minimum Inclusive Time
- 🟥 48.58 Maximum Inclusive Time
- 🟥 5.27e8 bytes_sent
- 🟥 5.27e8 bytes_received

Call tree:
- 🟥 1.63e9 MAIN__

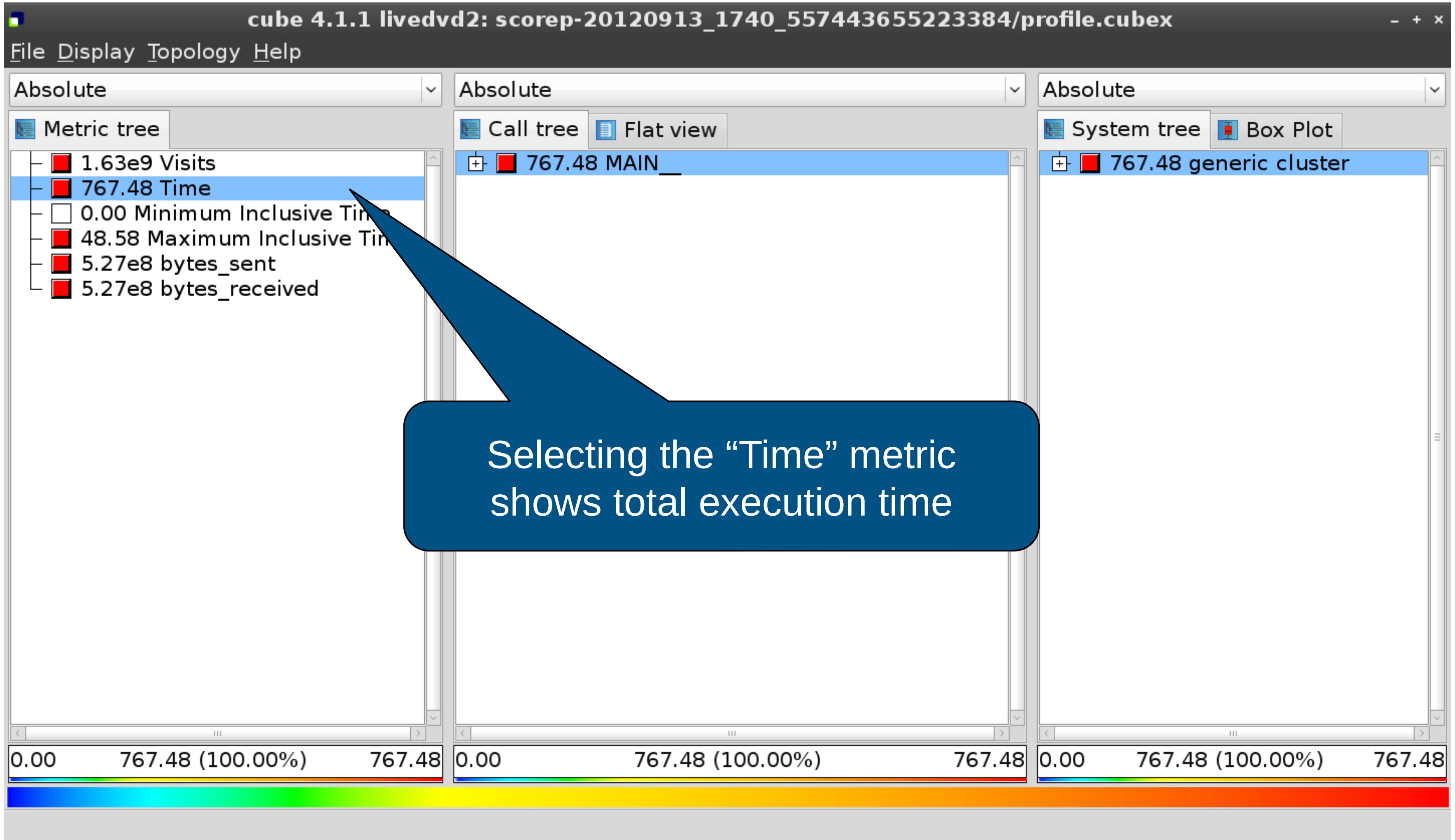
System tree:
- 🟥 1.63e9 generic cluster

0 1.63e9 (100.00%) 1.63e9

0 1.63e9 (100.00%) 1.63e9

0 1.63e9 (100.00%) 1.63e9

Metric selection



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

- 🟥 1.63e9 Visits
- 🟥 767.48 Time
- □ 0.00 Minimum Inclusive Time
- 🟥 48.58 Maximum Inclusive Time
- 🟥 5.27e8 bytes_sent
- 🟥 5.27e8 bytes_received

⊞ 🟥 767.48 MAIN__

⊞ 🟥 767.48 generic cluster

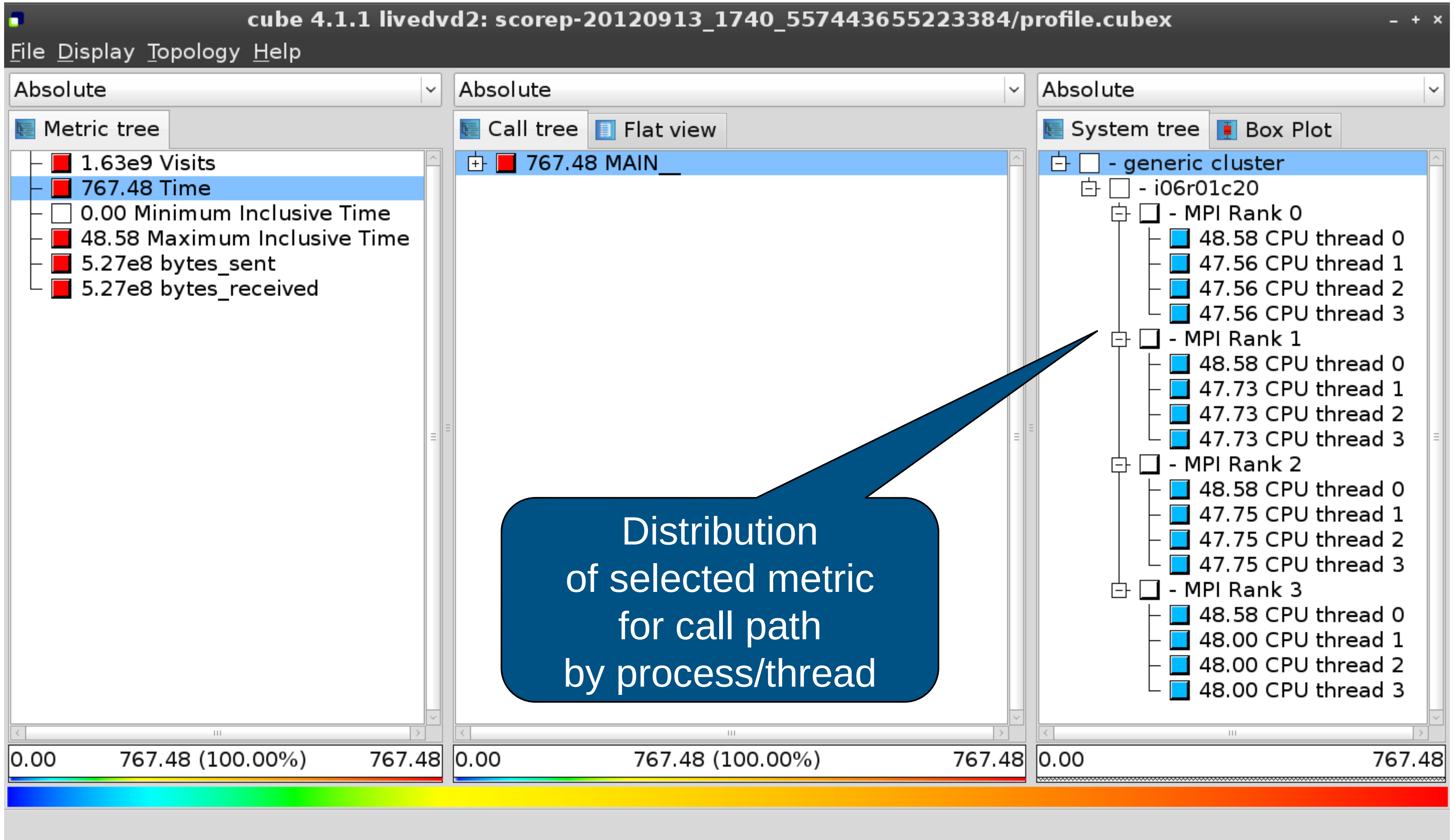
0.00 767.48 (100.00%) 767.48

0.00 767.48 (100.00%) 767.48

0.00 767.48 (100.00%) 767.48

Selecting the “Time” metric shows total execution time

Expanding the system tree



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

Absolute | Absolute | Absolute

Metric tree:

- 🟥 1.63e9 Visits
- 🟥 767.48 Time
- □ 0.00 Minimum Inclusive Time
- 🟥 48.58 Maximum Inclusive Time
- 🟥 5.27e8 bytes_sent
- 🟥 5.27e8 bytes_received

Call tree:

- 🟥 767.48 MAIN__

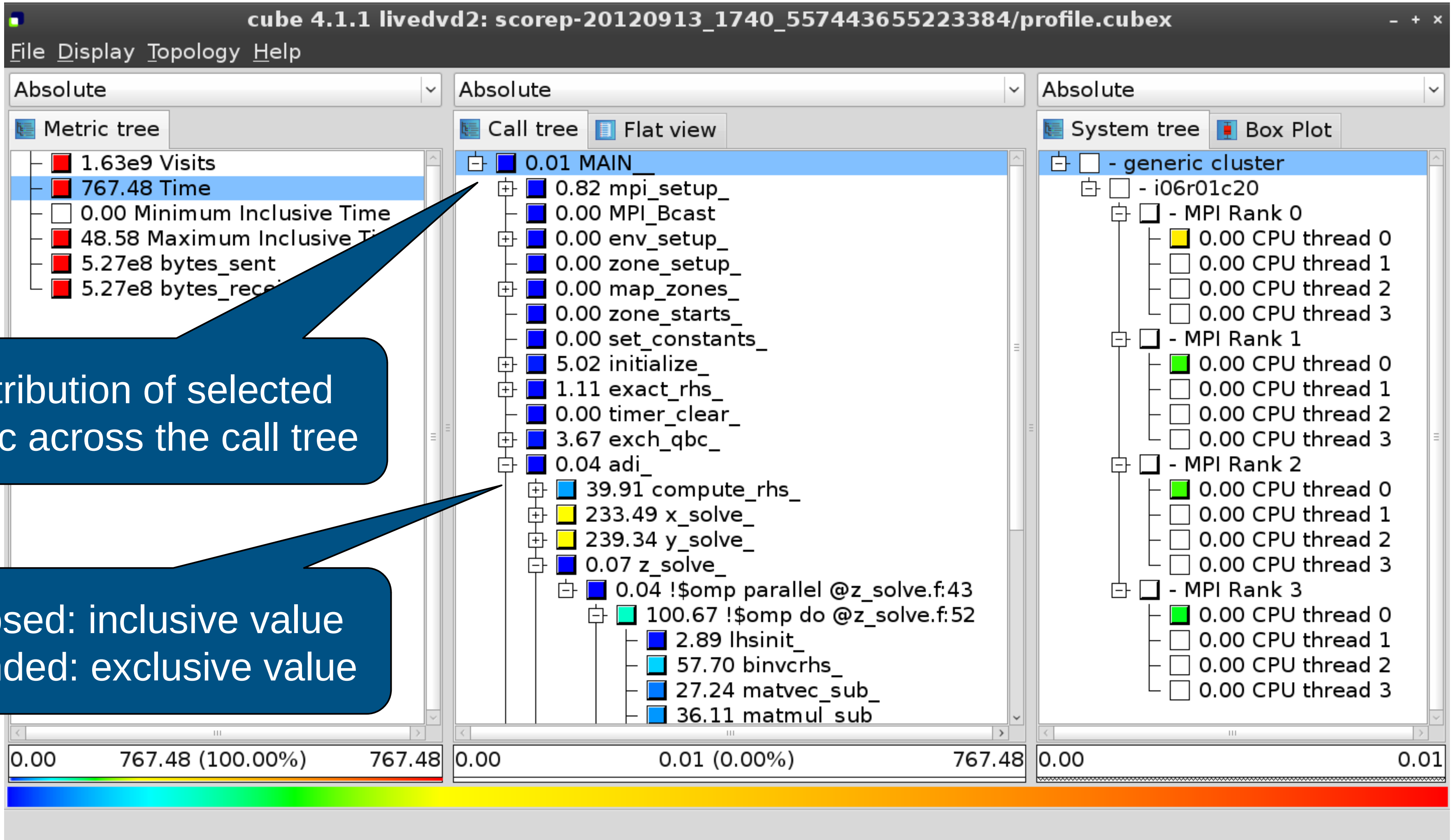
System tree:

- □ - generic cluster
  - □ - i06r01c20
    - □ - MPI Rank 0
      - 🟦 48.58 CPU thread 0
      - 🟦 47.56 CPU thread 1
      - 🟦 47.56 CPU thread 2
      - 🟦 47.56 CPU thread 3
    - □ - MPI Rank 1
      - 🟦 48.58 CPU thread 0
      - 🟦 47.73 CPU thread 1
      - 🟦 47.73 CPU thread 2
      - 🟦 47.73 CPU thread 3
    - □ - MPI Rank 2
      - 🟦 48.58 CPU thread 0
      - 🟦 47.75 CPU thread 1
      - 🟦 47.75 CPU thread 2
      - 🟦 47.75 CPU thread 3
    - □ - MPI Rank 3
      - 🟦 48.58 CPU thread 0
      - 🟦 48.00 CPU thread 1
      - 🟦 48.00 CPU thread 2
      - 🟦 48.00 CPU thread 3

0.00 767.48 (100.00%) 767.48 | 0.00 767.48 (100.00%) 767.48 | 0.00 767.48

Distribution
of selected metric
for call path
by process/thread

Expanding the call tree



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

```
Metric tree
├ 🟥 1.63e9 Visits
├ 🟥 767.48 Time
├ □ 0.00 Minimum Inclusive Time
├ 🟥 48.58 Maximum Inclusive Ti
├ 🟥 5.27e8 bytes_sent
└ 🟥 5.27e8 bytes_rece
```

```
Call tree
⊟ 🟦 0.01 MAIN__
  ⊞ 🟦 0.82 mpi_setup_
    🟦 0.00 MPI_Bcast
  ⊞ 🟦 0.00 env_setup_
    🟦 0.00 zone_setup_
  ⊞ 🟦 0.00 map_zones_
    🟦 0.00 zone_starts_
    🟦 0.00 set_constants_
  ⊞ 🟦 5.02 initialize_
  ⊞ 🟦 1.11 exact_rhs_
    🟦 0.00 timer_clear_
  ⊞ 🟦 3.67 exch_qbc_
  ⊟ 🟦 0.04 adi_
    ⊞ 🟦 39.91 compute_rhs_
    ⊞ 🟨 233.49 x_solve_
    ⊞ 🟨 239.34 y_solve_
    ⊟ 🟦 0.07 z_solve_
      ⊟ 🟦 0.04 !$omp parallel @z_solve.f:43
        ⊟ 🟦 100.67 !$omp do @z_solve.f:52
            🟦 2.89 lhsinit_
            🟦 57.70 binvcrhs_
            🟦 27.24 matvec_sub_
            🟦 36.11 matmul_sub_
```

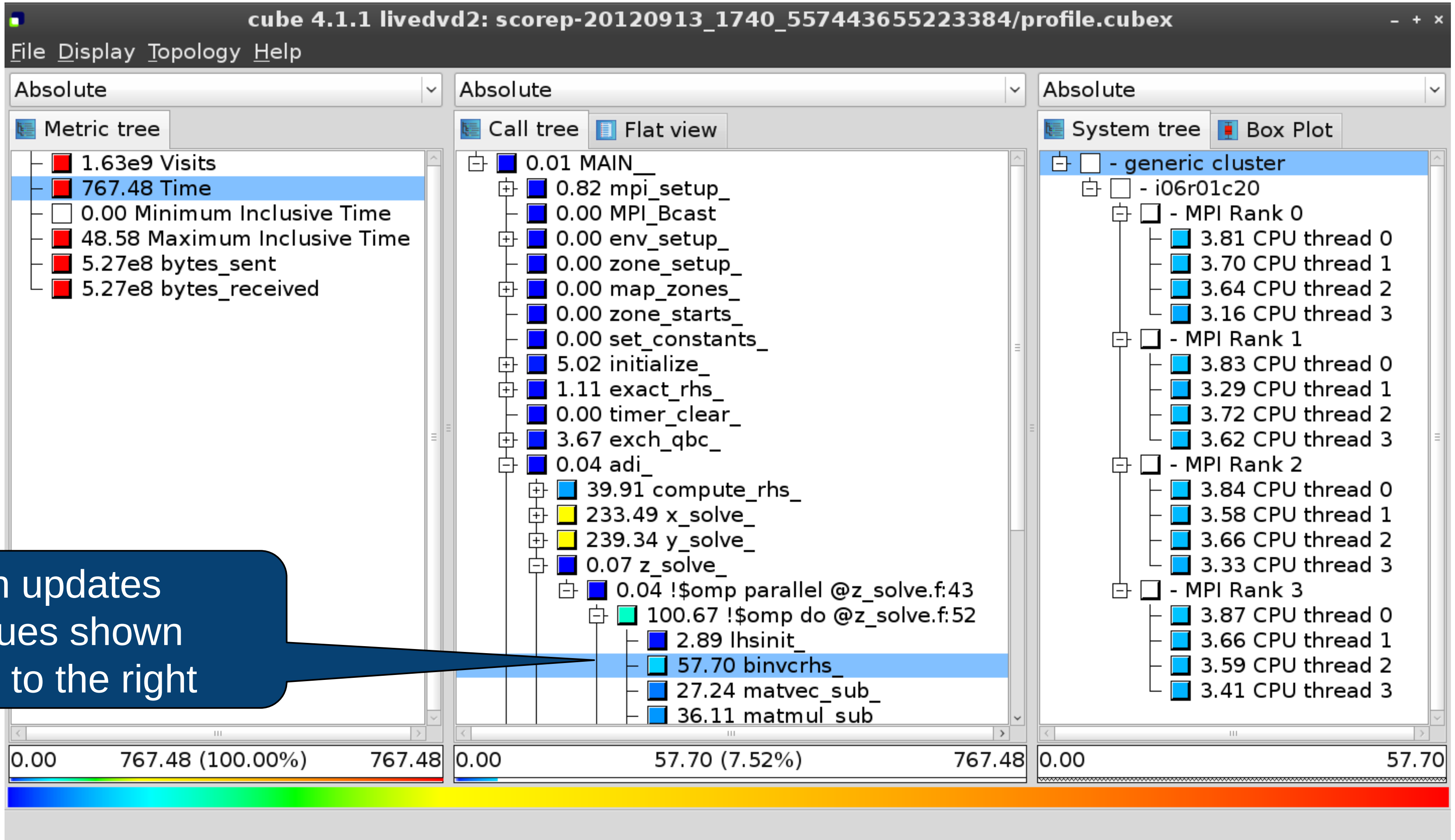
```
System tree
⊟ □ - generic cluster
  ⊟ □ - i06r01c20
    ⊟ □ - MPI Rank 0
      🟨 0.00 CPU thread 0
      □ 0.00 CPU thread 1
      □ 0.00 CPU thread 2
      □ 0.00 CPU thread 3
    ⊟ □ - MPI Rank 1
      🟩 0.00 CPU thread 0
      □ 0.00 CPU thread 1
      □ 0.00 CPU thread 2
      □ 0.00 CPU thread 3
    ⊟ □ - MPI Rank 2
      🟩 0.00 CPU thread 0
      □ 0.00 CPU thread 1
      □ 0.00 CPU thread 2
      □ 0.00 CPU thread 3
    ⊟ □ - MPI Rank 3
      🟩 0.00 CPU thread 0
      □ 0.00 CPU thread 1
      □ 0.00 CPU thread 2
      □ 0.00 CPU thread 3
```

0.00	767.48 (100.00%)	767.48
0.00	0.01 (0.00%)	767.48
0.00		0.01

Distribution of selected metric across the call tree

Collapsed: inclusive value
Expanded: exclusive value

Selecting a call path



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

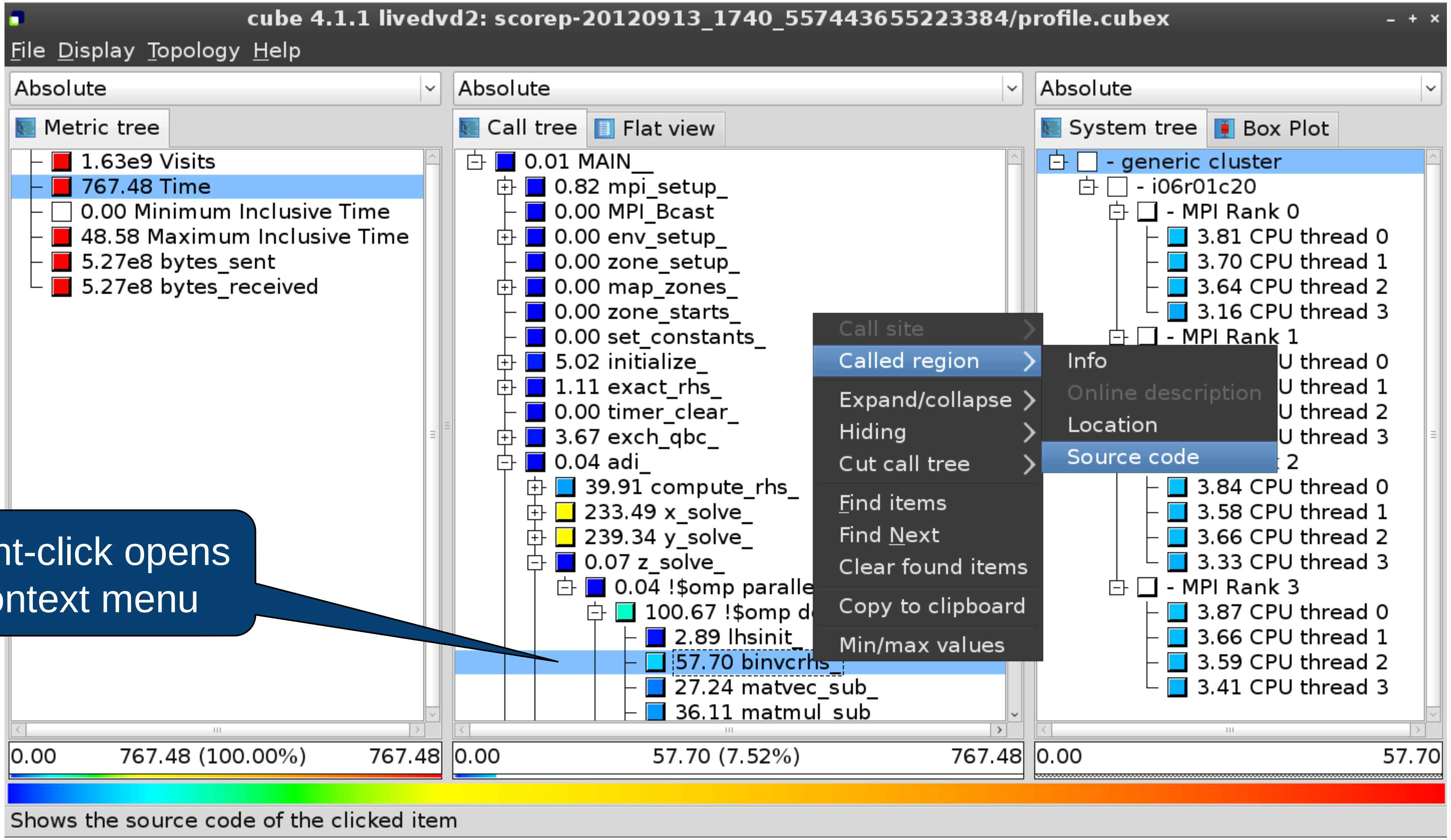
```
Metric tree
├ 1.63e9 Visits
├ 767.48 Time
├ 0.00 Minimum Inclusive Time
├ 48.58 Maximum Inclusive Time
├ 5.27e8 bytes_sent
└ 5.27e8 bytes_received

0.00        767.48 (100.00%)        767.48
```

```
Call tree
⊟ 0.01 MAIN__
  ⊞ 0.82 mpi_setup_
  ├ 0.00 MPI_Bcast
  ⊞ 0.00 env_setup_
  ├ 0.00 zone_setup_
  ⊞ 0.00 map_zones_
  ├ 0.00 zone_starts_
  ├ 0.00 set_constants_
  ⊞ 5.02 initialize_
  ⊞ 1.11 exact_rhs_
  ├ 0.00 timer_clear_
  ⊞ 3.67 exch_qbc_
  ⊟ 0.04 adi_
    ⊞ 39.91 compute_rhs_
    ⊞ 233.49 x_solve_
    ⊞ 239.34 y_solve_
    ⊟ 0.07 z_solve_
      ⊟ 0.04 !$omp parallel @z_solve.f:43
        ⊟ 100.67 !$omp do @z_solve.f:52
          ├ 2.89 lhsinit_
          ├ 57.70 binvcrhs_
          ├ 27.24 matvec_sub_
          ├ 36.11 matmul_sub_

0.00        57.70 (7.52%)        767.48
```

```
System tree
⊟ - generic cluster
  ⊟ - i06r01c20
    ⊟ - MPI Rank 0
      ├ 3.81 CPU thread 0
      ├ 3.70 CPU thread 1
      ├ 3.64 CPU thread 2
      └ 3.16 CPU thread 3
    ⊟ - MPI Rank 1
      ├ 3.83 CPU thread 0
      ├ 3.29 CPU thread 1
      ├ 3.72 CPU thread 2
      └ 3.62 CPU thread 3
    ⊟ - MPI Rank 2
      ├ 3.84 CPU thread 0
      ├ 3.58 CPU thread 1
      ├ 3.66 CPU thread 2
      └ 3.33 CPU thread 3
    ⊟ - MPI Rank 3
      ├ 3.87 CPU thread 0
      ├ 3.66 CPU thread 1
      ├ 3.59 CPU thread 2
      └ 3.41 CPU thread 3

0.00        57.70
```

Selection updates metric values shown in columns to the right

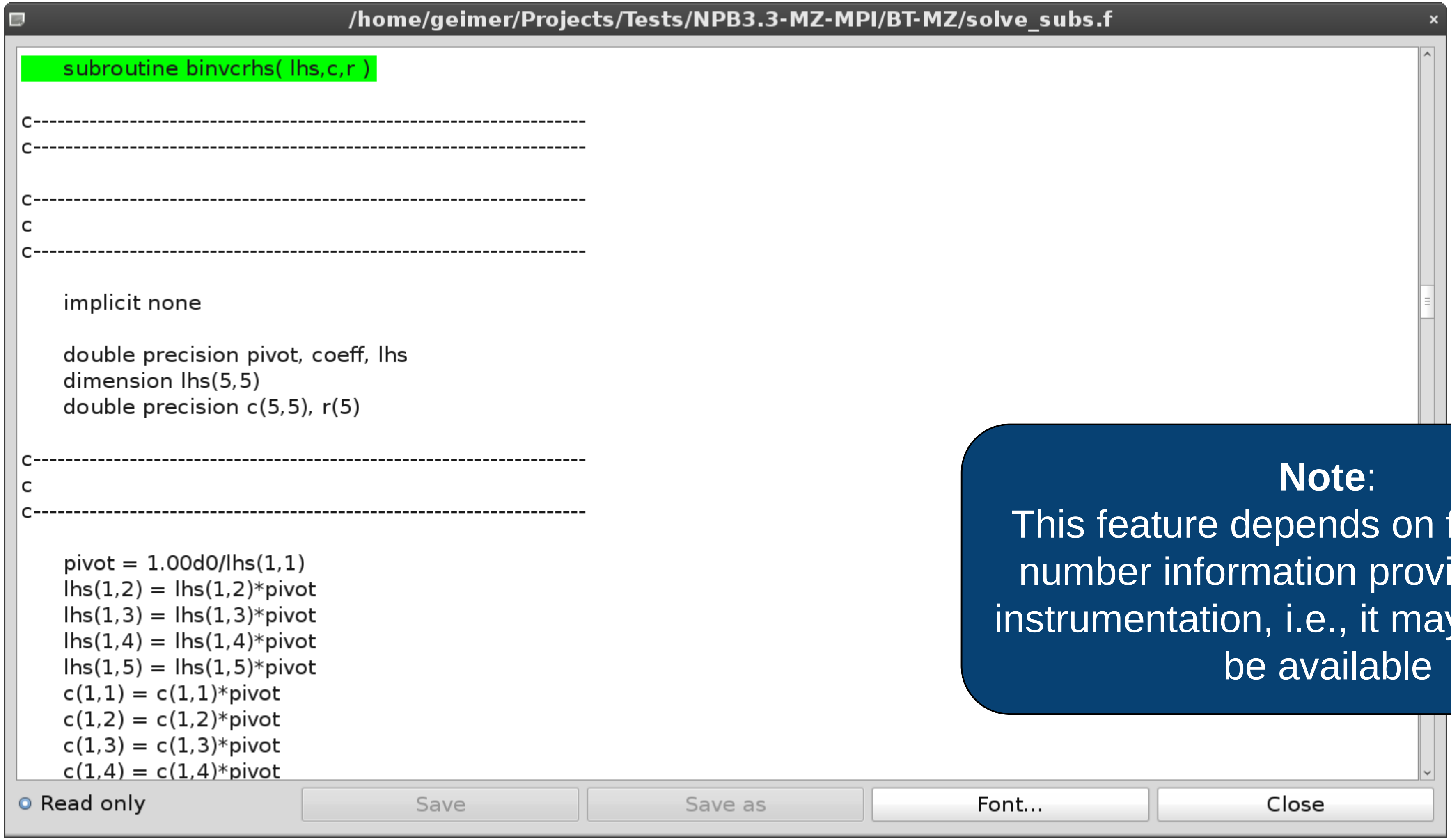
Source-code view via context menu



Shows the source code of the clicked item

Right-click opens context menu

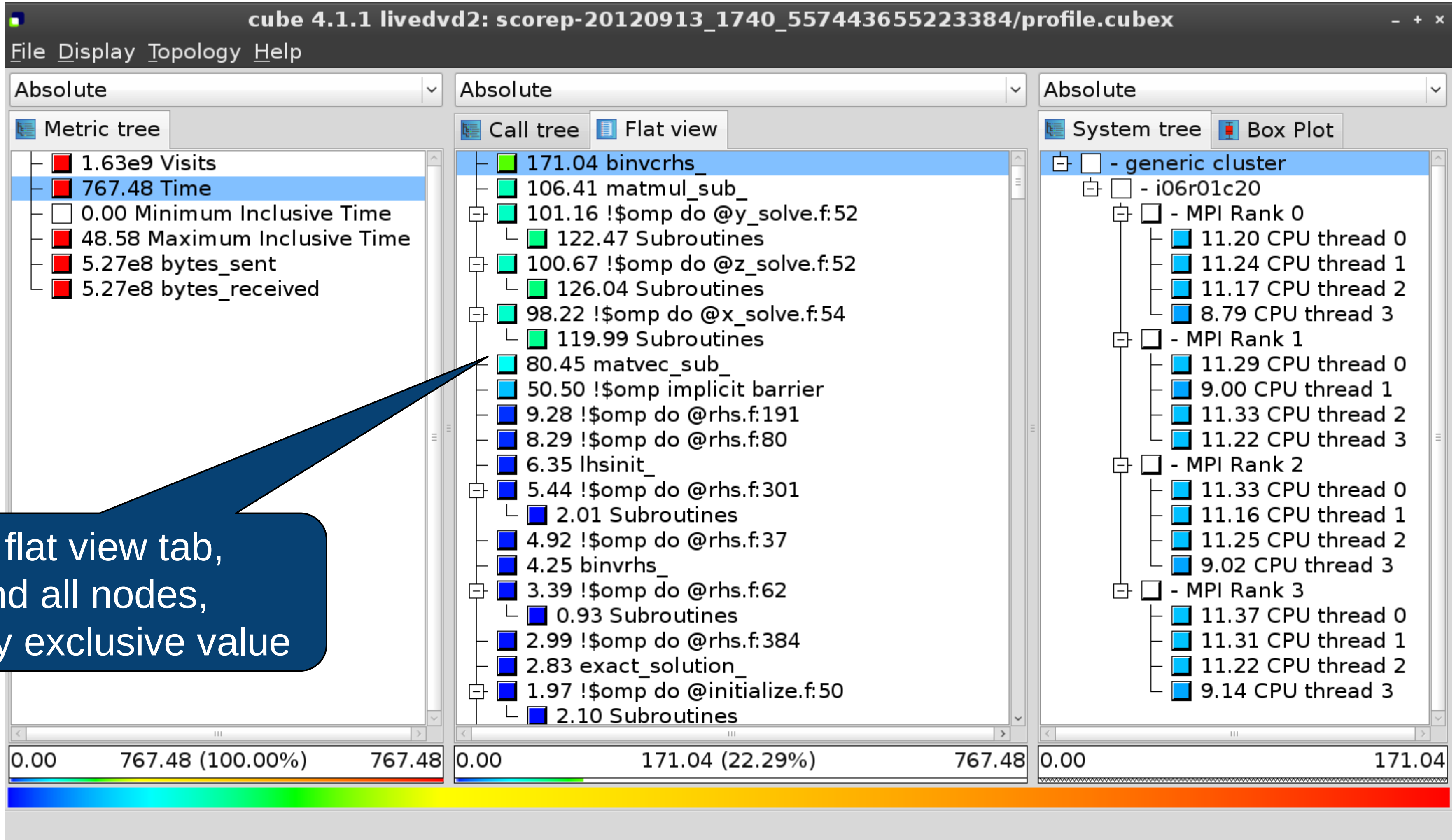
Source-code view


/home/geimer/Projects/Tests/NPB3.3-MZ-MPI/BT-MZ/solve_subs.f
○ Read only
Save
Save as
Font...
Close

```
      subroutine binvcrhs( lhs,c,r )

c---------------------------------------------------------------------
c---------------------------------------------------------------------

c---------------------------------------------------------------------
c
c---------------------------------------------------------------------

      implicit none

      double precision pivot, coeff, lhs
      dimension lhs(5,5)
      double precision c(5,5), r(5)

c---------------------------------------------------------------------
c
c---------------------------------------------------------------------

      pivot = 1.00d0/lhs(1,1)
      lhs(1,2) = lhs(1,2)*pivot
      lhs(1,3) = lhs(1,3)*pivot
      lhs(1,4) = lhs(1,4)*pivot
      lhs(1,5) = lhs(1,5)*pivot
      c(1,1) = c(1,1)*pivot
      c(1,2) = c(1,2)*pivot
      c(1,3) = c(1,3)*pivot
      c(1,4) = c(1,4)*pivot
```

Note:
This feature depends on file and line number information provided by the instrumentation, i.e., it may not always be available

Flat profile view



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

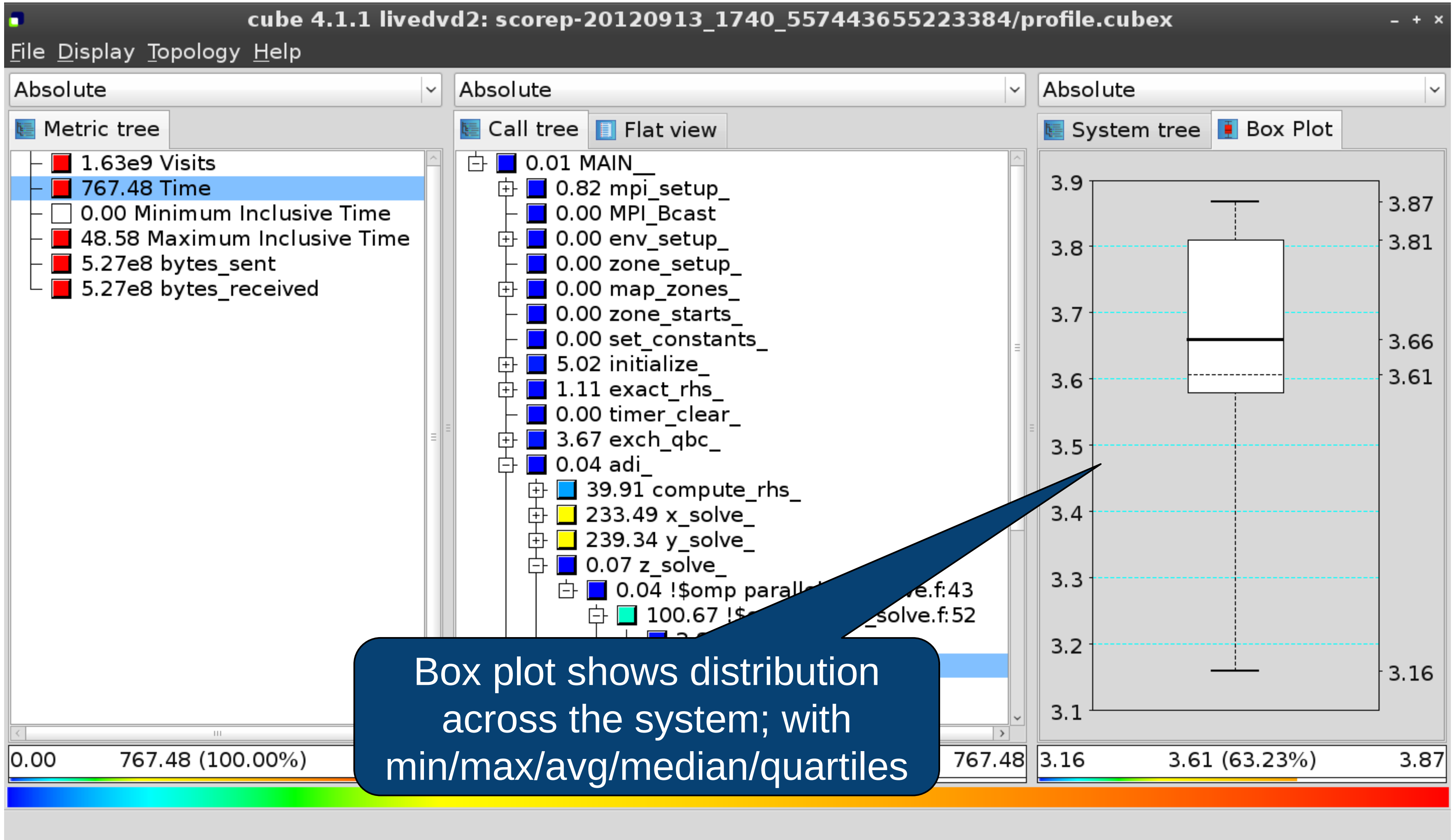
```
Metric tree
1.63e9 Visits
767.48 Time
0.00 Minimum Inclusive Time
48.58 Maximum Inclusive Time
5.27e8 bytes_sent
5.27e8 bytes_received

0.00        767.48 (100.00%)        767.48
```

```
Flat view
171.04 binvcrhs_
106.41 matmul_sub_
101.16 !$omp do @y_solve.f:52
   122.47 Subroutines
100.67 !$omp do @z_solve.f:52
   126.04 Subroutines
98.22 !$omp do @x_solve.f:54
   119.99 Subroutines
80.45 matvec_sub_
50.50 !$omp implicit barrier
9.28 !$omp do @rhs.f:191
8.29 !$omp do @rhs.f:80
6.35 lhsinit_
5.44 !$omp do @rhs.f:301
   2.01 Subroutines
4.92 !$omp do @rhs.f:37
4.25 binvrhs_
3.39 !$omp do @rhs.f:62
   0.93 Subroutines
2.99 !$omp do @rhs.f:384
2.83 exact_solution_
1.97 !$omp do @initialize.f:50
   2.10 Subroutines

0.00        171.04 (22.29%)        767.48
```

```
System tree
- generic cluster
  - i06r01c20
    - MPI Rank 0
        11.20 CPU thread 0
        11.24 CPU thread 1
        11.17 CPU thread 2
        8.79 CPU thread 3
    - MPI Rank 1
        11.29 CPU thread 0
        9.00 CPU thread 1
        11.33 CPU thread 2
        11.22 CPU thread 3
    - MPI Rank 2
        11.33 CPU thread 0
        11.16 CPU thread 1
        11.25 CPU thread 2
        9.02 CPU thread 3
    - MPI Rank 3
        11.37 CPU thread 0
        11.31 CPU thread 1
        11.22 CPU thread 2
        9.14 CPU thread 3

0.00                        171.04
```

Select flat view tab,
expand all nodes,
and sort by exclusive value

Box plot view



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

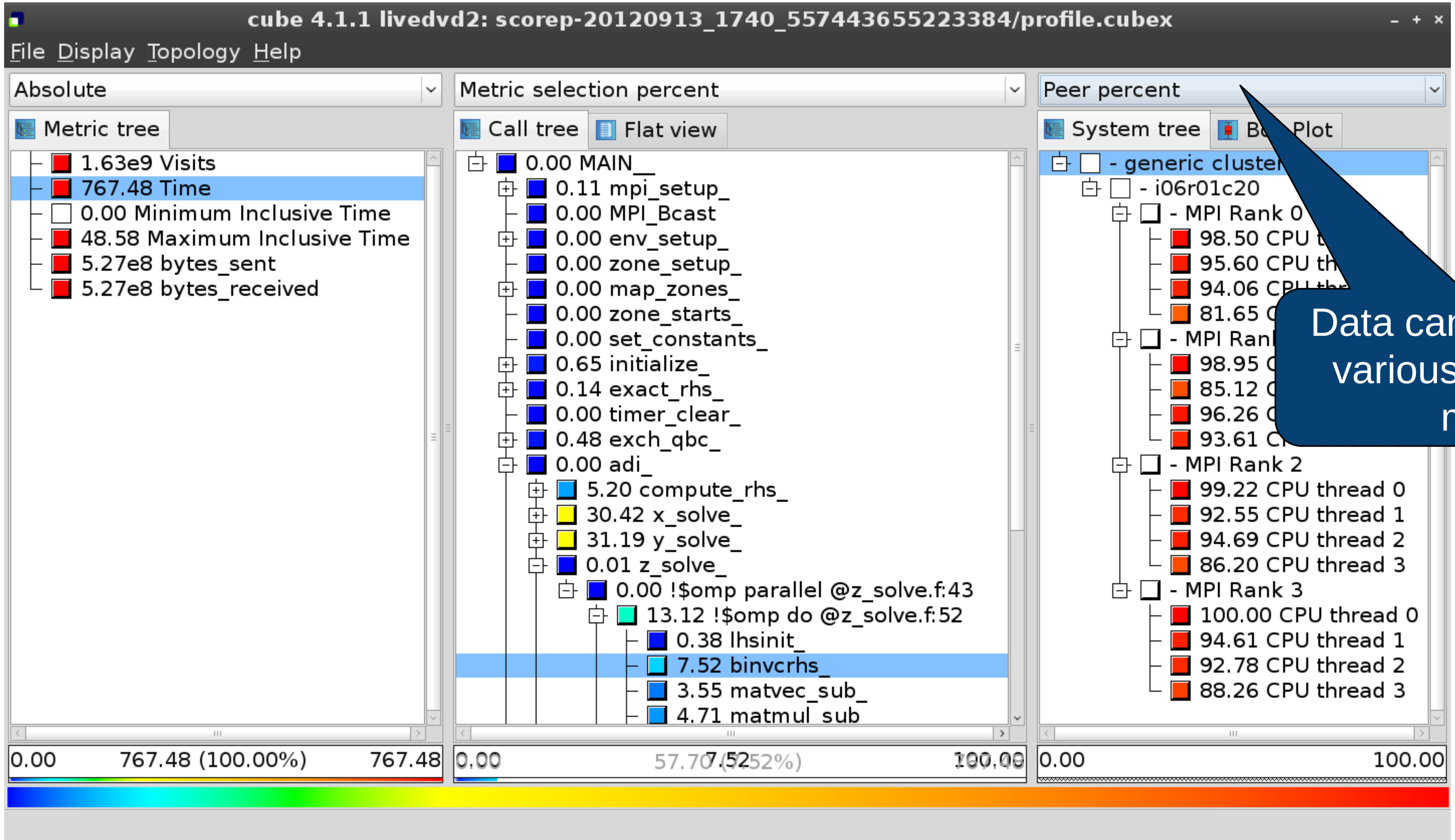
- 1.63e9 Visits
- 767.48 Time
- 0.00 Minimum Inclusive Time
- 48.58 Maximum Inclusive Time
- 5.27e8 bytes_sent
- 5.27e8 bytes_received

```
0.01 MAIN__
  0.82 mpi_setup_
  0.00 MPI_Bcast
  0.00 env_setup_
  0.00 zone_setup_
  0.00 map_zones_
  0.00 zone_starts_
  0.00 set_constants_
  5.02 initialize_
  1.11 exact_rhs_
  0.00 timer_clear_
  3.67 exch_qbc_
  0.04 adi_
    39.91 compute_rhs_
    233.49 x_solve_
    239.34 y_solve_
    0.07 z_solve_
      0.04 !$omp parall      e.f:43
        100.67 !$       solve.f:52
```

0.00	767.48 (100.00%)	767.48	3.16	3.61 (63.23%)	3.87

Box plot shows distribution across the system; with min/max/avg/median/quartiles

Alternative display modes



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

Absolute | Metric selection percent | Peer percent

```
1.63e9 Visits
767.48 Time
0.00 Minimum Inclusive Time
48.58 Maximum Inclusive Time
5.27e8 bytes_sent
5.27e8 bytes_received
```

0.00   767.48 (100.00%)   767.48

```
0.00 MAIN__
  0.11 mpi_setup_
  0.00 MPI_Bcast
  0.00 env_setup_
  0.00 zone_setup_
  0.00 map_zones_
  0.00 zone_starts_
  0.00 set_constants_
  0.65 initialize_
  0.14 exact_rhs_
  0.00 timer_clear_
  0.48 exch_qbc_
  0.00 adi_
    5.20 compute_rhs_
    30.42 x_solve_
    31.19 y_solve_
    0.01 z_solve_
      0.00 !$omp parallel @z_solve.f:43
        13.12 !$omp do @z_solve.f:52
          0.38 lhsinit_
          7.52 binvcrhs_
          3.55 matvec_sub_
          4.71 matmul_sub
```

0.00   57.70 (7.52%)   100.00

```
- generic cluster
  - i06r01c20
    - MPI Rank 0
      98.50 CPU t
      95.60 CPU th
      94.06 CPU thr
      81.65 C
    - MPI Ran
      98.95 C
      85.12 C
      96.26 C
      93.61 C
    - MPI Rank 2
      99.22 CPU thread 0
      92.55 CPU thread 1
      94.69 CPU thread 2
      86.20 CPU thread 3
    - MPI Rank 3
      100.00 CPU thread 0
      94.61 CPU thread 1
      92.78 CPU thread 2
      88.26 CPU thread 3
```

0.00   100.00

Data can be shown in various percentage modes

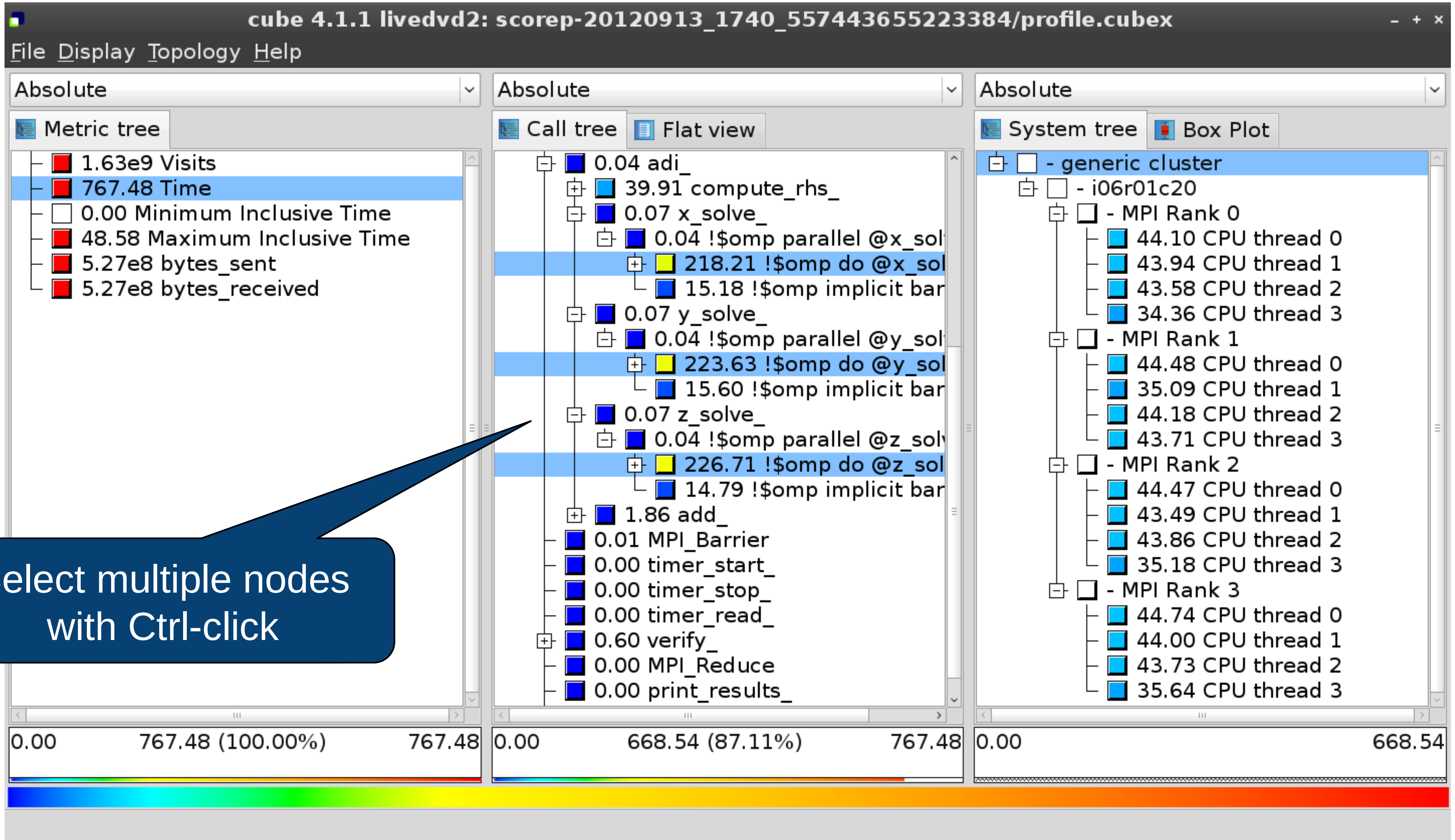
Important display modes

- Absolute
  - Absolute value shown in seconds/bytes/counts

- Selection percent
  - Value shown as percentage w.r.t. the selected node “on the left” (metric/call path)

- Peer percent (system tree only)
  - Value shown as percentage relative to the maximum peer value

Multiple selection



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex

Metric tree:

- 1.63e9 Visits
- 767.48 Time
- 0.00 Minimum Inclusive Time
- 48.58 Maximum Inclusive Time
- 5.27e8 bytes_sent
- 5.27e8 bytes_received

Call tree:

- 0.04 adi_
  - 39.91 compute_rhs_
  - 0.07 x_solve_
    - 0.04 !$omp parallel @x_sol
      - 218.21 !$omp do @x_sol
      - 15.18 !$omp implicit bar
  - 0.07 y_solve_
    - 0.04 !$omp parallel @y_sol
      - 223.63 !$omp do @y_sol
      - 15.60 !$omp implicit bar
  - 0.07 z_solve_
    - 0.04 !$omp parallel @z_solv
      - 226.71 !$omp do @z_sol
      - 14.79 !$omp implicit bar
  - 1.86 add_
- 0.01 MPI_Barrier
- 0.00 timer_start_
- 0.00 timer_stop_
- 0.00 timer_read_
- 0.60 verify_
- 0.00 MPI_Reduce
- 0.00 print_results_

System tree:

- generic cluster
  - i06r01c20
    - MPI Rank 0
      - 44.10 CPU thread 0
      - 43.94 CPU thread 1
      - 43.58 CPU thread 2
      - 34.36 CPU thread 3
    - MPI Rank 1
      - 44.48 CPU thread 0
      - 35.09 CPU thread 1
      - 44.18 CPU thread 2
      - 43.71 CPU thread 3
    - MPI Rank 2
      - 44.47 CPU thread 0
      - 43.49 CPU thread 1
      - 43.86 CPU thread 2
      - 35.18 CPU thread 3
    - MPI Rank 3
      - 44.74 CPU thread 0
      - 44.00 CPU thread 1
      - 43.73 CPU thread 2
      - 35.64 CPU thread 3

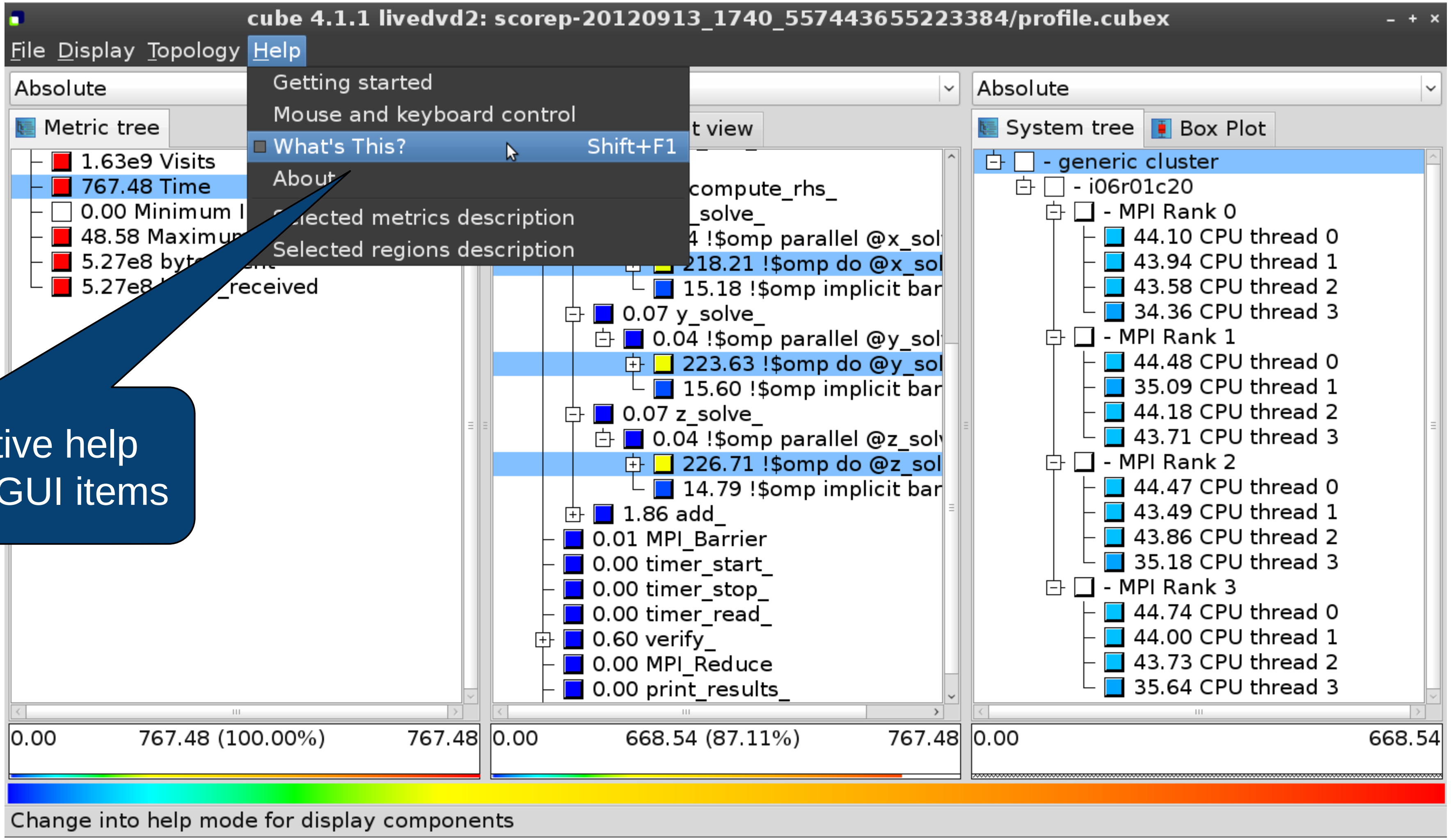
0.00 767.48 (100.00%) 767.48

0.00 668.54 (87.11%) 767.48

0.00 668.54

Select multiple nodes with Ctrl-click

Context-sensitive help



cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex
File
Display
Topology
Help
Getting started
Mouse and keyboard control
What's This? Shift+F1
About
Selected metrics description
Selected regions description
Absolute
Absolute
Metric tree
t view
System tree
Box Plot

```
1.63e9 Visits
767.48 Time
0.00 Minimum I
48.58 Maximum
5.27e8 byt
5.27e8        received
```

```
compute_rhs_
solve_
4 !$omp parallel @x_sol
  218.21 !$omp do @x_sol
  15.18 !$omp implicit bar
0.07 y_solve_
  0.04 !$omp parallel @y_sol
    223.63 !$omp do @y_sol
    15.60 !$omp implicit bar
0.07 z_solve_
  0.04 !$omp parallel @z_sol
    226.71 !$omp do @z_sol
    14.79 !$omp implicit bar
1.86 add_
0.01 MPI_Barrier
0.00 timer_start_
0.00 timer_stop_
0.00 timer_read_
0.60 verify_
0.00 MPI_Reduce
0.00 print_results_
```

```
- generic cluster
  - i06r01c20
    - MPI Rank 0
      44.10 CPU thread 0
      43.94 CPU thread 1
      43.58 CPU thread 2
      34.36 CPU thread 3
    - MPI Rank 1
      44.48 CPU thread 0
      35.09 CPU thread 1
      44.18 CPU thread 2
      43.71 CPU thread 3
    - MPI Rank 2
      44.47 CPU thread 0
      43.49 CPU thread 1
      43.86 CPU thread 2
      35.18 CPU thread 3
    - MPI Rank 3
      44.74 CPU thread 0
      44.00 CPU thread 1
      43.73 CPU thread 2
      35.64 CPU thread 3
```

```
0.00   767.48 (100.00%)   767.48
0.00   668.54 (87.11%)    767.48
0.00                      668.54
```

Change into help mode for display components

Context-sensitive help available for all GUI items

Derived metrics

- Derived metrics are defined using CubePL expressions, e.g.:

  metric::time(i)/metric::visits(e)

- Values of derived metrics are not stored, but calculated on-the-fly
- Types of derived metrics:
  - Prederived: evaluation of the CubePL expression is performed before aggregation
  - Postderived: evaluation of the CubePL expression is performed after aggregation

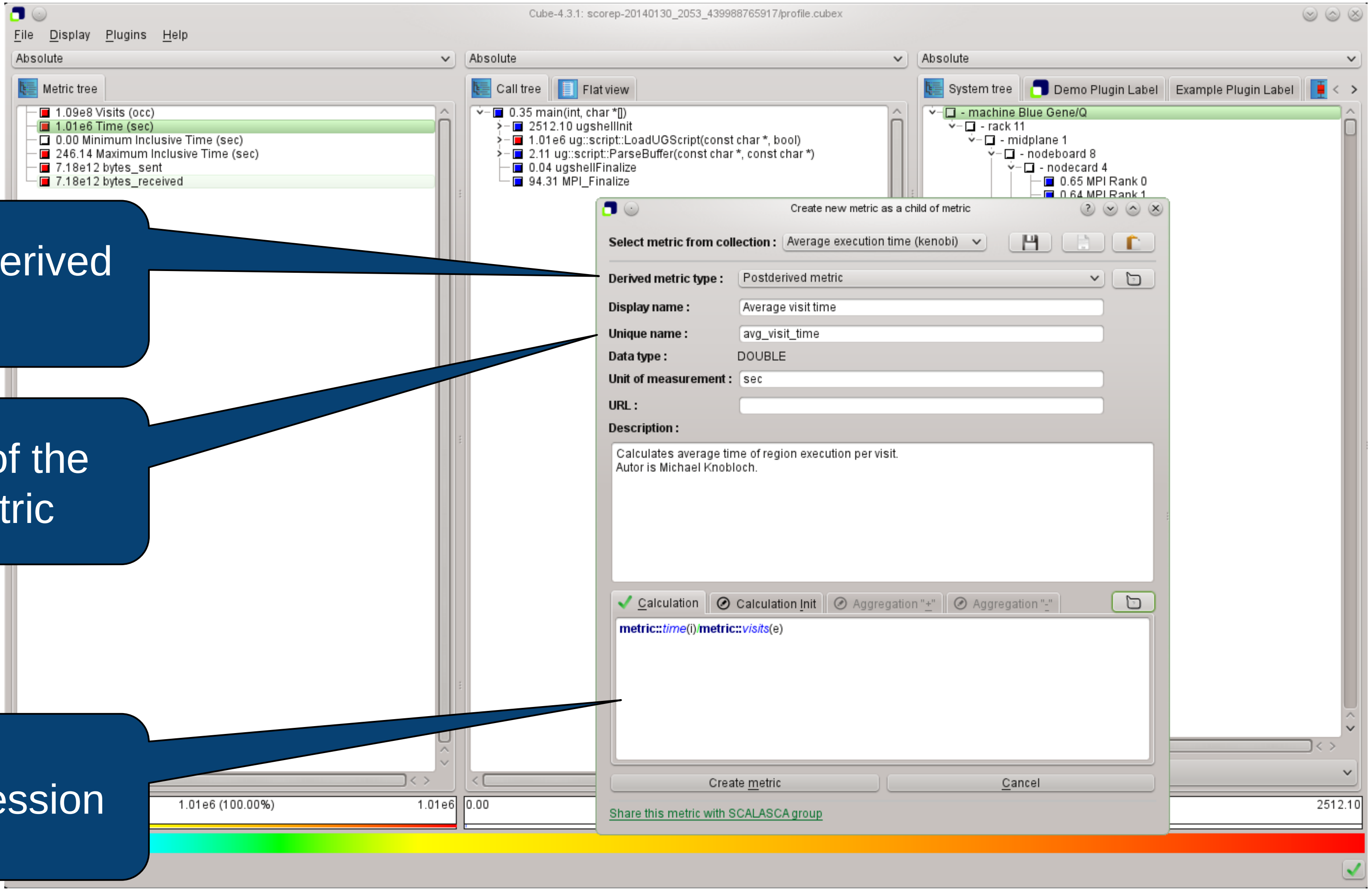
- Examples:
  - “Average execution time”: Postderived metric with expression

    metric::time(i)/metric::visits(e)

  - “Number of FLOP per second”: Postderived metric with expression

    metric::FLOP()/metric::time()

Derived metrics in Cube GUI



1.09e8 Visits (occ)
1.01e6 Time (sec)
0.00 Minimum Inclusive Time (sec)
246.14 Maximum Inclusive Time (sec)
7.18e12 bytes_sent
7.18e12 bytes_received

0.35 main(int, char *[])
2512.10 ugshellInit
1.01e6 ug::script::LoadUGScript(const char *, bool)
2.11 ug::script::ParseBuffer(const char *, const char *)
0.04 ugshellFinalize
94.31 MPI_Finalize

- machine Blue Gene/Q
- rack 11
- midplane 1
- nodeboard 8
- nodecard 4
0.65 MPI Rank 0
0.64 MPI Rank 1

1.01e6 (100.00%) 1.01e6 0.00 2512.10

Create new metric as a child of metric

Select metric from collection : Average execution time (kenobi)

Derived metric type : Postderived metric

Display name : Average visit time

Unique name : avg_visit_time

Data type : DOUBLE

Unit of measurement : sec

URL :

Description :

Calculates average time of region execution per visit.
Autor is Michael Knobloch.

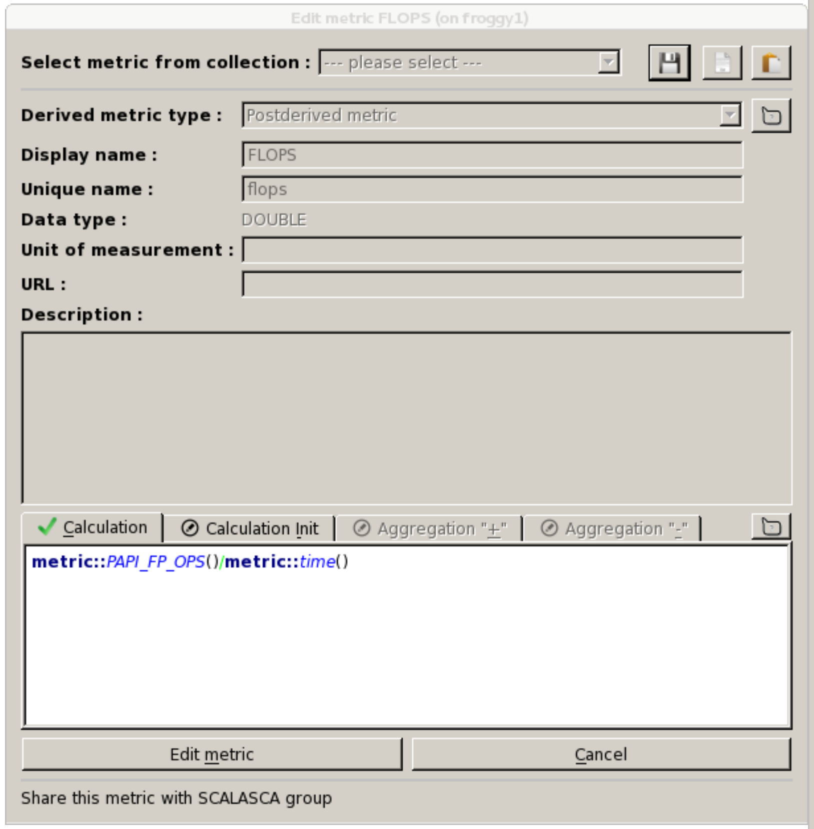
```
metric::time(i)/metric::visits(e)
```

Collection of derived metrics

Parameters of the derived metric

CubePL expression

Example: FLOPS based on PAPI_FP_OPS and time

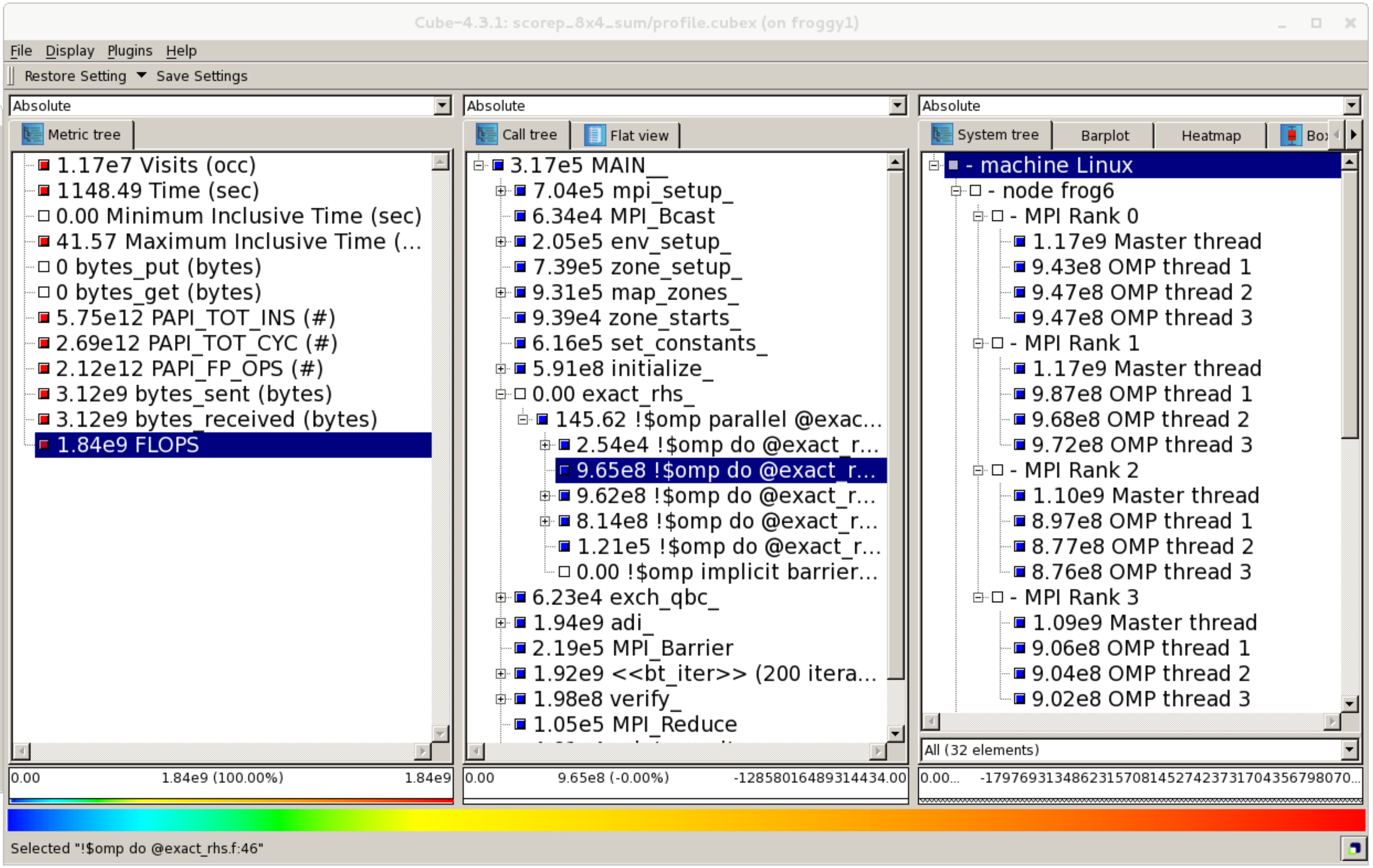


Edit metric FLOPS (on froggy1)

Select metric from collection :	--- please select ---
Derived metric type :	Postderived metric
Display name :	FLOPS
Unique name :	flops
Data type :	DOUBLE
Unit of measurement :	
URL :	
Description :	

```
metric::PAPI_FP_OPS()/metric::time()
```

Share this metric with SCALASCA group



Cube-4.3.1: scorep_8x4_sum/profile.cubex (on froggy1)

```
1.17e7 Visits (occ)
1148.49 Time (sec)
0.00 Minimum Inclusive Time (sec)
41.57 Maximum Inclusive Time (...
0 bytes_put (bytes)
0 bytes_get (bytes)
5.75e12 PAPI_TOT_INS (#)
2.69e12 PAPI_TOT_CYC (#)
2.12e12 PAPI_FP_OPS (#)
3.12e9 bytes_sent (bytes)
3.12e9 bytes_received (bytes)
1.84e9 FLOPS
```

```
3.17e5 MAIN__
  7.04e5 mpi_setup_
  6.34e4 MPI_Bcast
  2.05e5 env_setup_
  7.39e5 zone_setup_
  9.31e5 map_zones_
  9.39e4 zone_starts_
  6.16e5 set_constants_
  5.91e8 initialize_
  0.00 exact_rhs_
    145.62 !$omp parallel @exac...
      2.54e4 !$omp do @exact_r...
      9.65e8 !$omp do @exact_r...
      9.62e8 !$omp do @exact_r...
      8.14e8 !$omp do @exact_r...
      1.21e5 !$omp do @exact_r...
      0.00 !$omp implicit barrier...
  6.23e4 exch_qbc_
  1.94e9 adi_
  2.19e5 MPI_Barrier
  1.92e9 <<bt_iter>> (200 itera...
  1.98e8 verify_
  1.05e5 MPI_Reduce
```

```
- machine Linux
  - node frog6
    - MPI Rank 0
      1.17e9 Master thread
      9.43e8 OMP thread 1
      9.47e8 OMP thread 2
      9.47e8 OMP thread 3
    - MPI Rank 1
      1.17e9 Master thread
      9.87e8 OMP thread 1
      9.68e8 OMP thread 2
      9.72e8 OMP thread 3
    - MPI Rank 2
      1.10e9 Master thread
      8.97e8 OMP thread 1
      8.77e8 OMP thread 2
      8.76e8 OMP thread 3
    - MPI Rank 3
      1.09e9 Master thread
      9.06e8 OMP thread 1
      9.04e8 OMP thread 2
      9.02e8 OMP thread 3
```

All (32 elements)

```
0.00   1.84e9 (100.00%)   1.84e9
0.00   9.65e8 (-0.00%)   -12858016489314434.00
0.00...   -179769313486231570814527423731704356798070...
```

Selected "!$omp do @exact_rhs.f:46"

Iteration profiling

- Show time dependent behavior by “unrolling” iterations

- Preparations:
  - Mark loop body by using Score-P instrumentation API in your source code

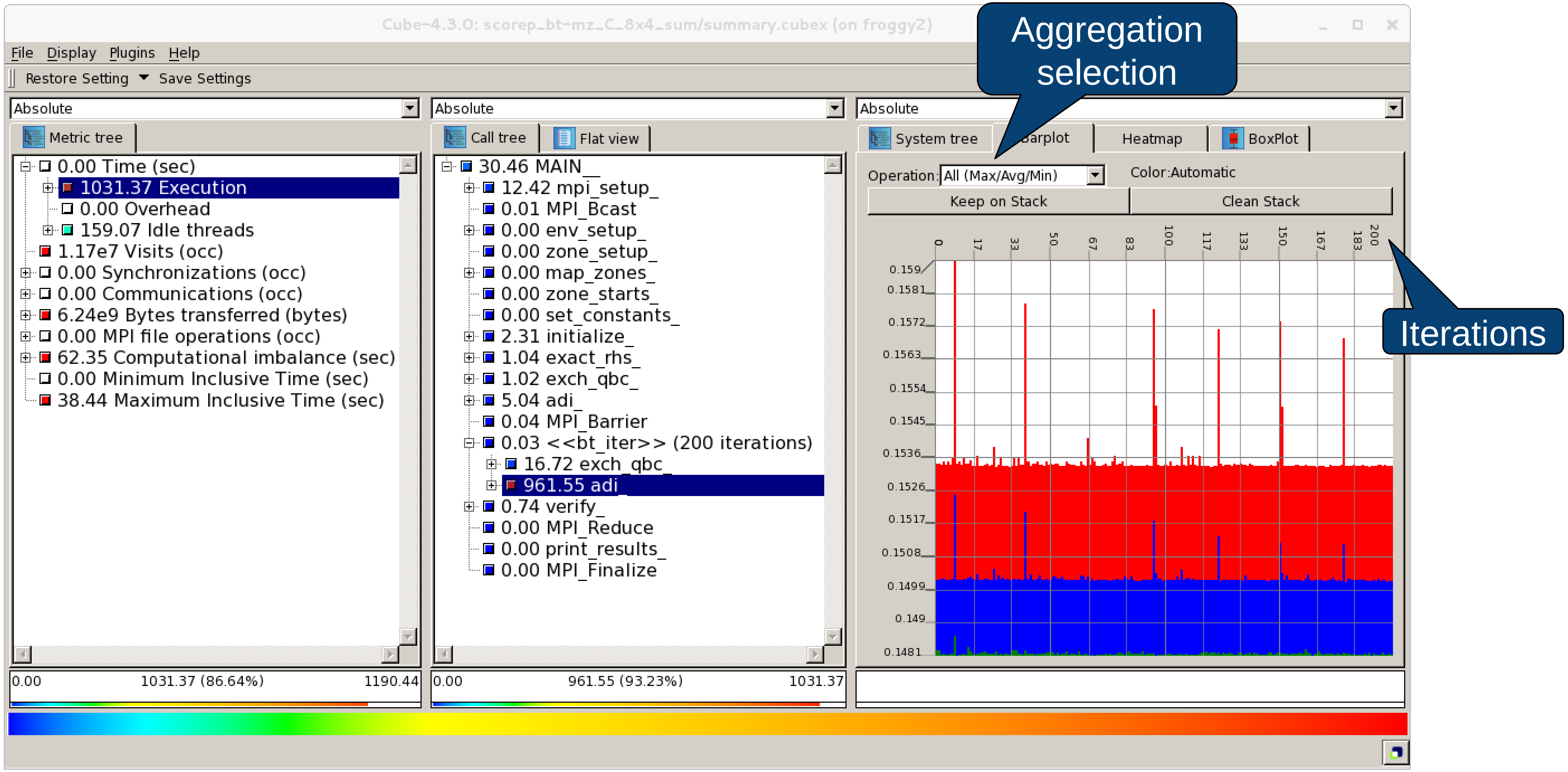
```
SCOREP_USER_REGION_DEFINE( scorep_bt_loop )
SCOREP_USER_REGION_BEGIN( scorep_bt_loop, "<<bt_iter>>", SCOREP_USER_REGION_TYPE_DYNAMIC )
SCOREP_USER_REGION_END( scorep_bt_loop )
```

- Result in the Cube profile:
  - Iterations shown as separate call trees
  - ➢ Useful for checking results for specific iterations

or

  - Select your user-instrumented region and mark it as loop
  - Choose “Hide iterations”
  - ➢ View the Barplot statistics or the (thread x iterations) Heatmap

Iteration profiling: Barplot



- 0.00 Time (sec)
  - 1031.37 Execution
  - 0.00 Overhead
  - 159.07 Idle threads
- 1.17e7 Visits (occ)
- 0.00 Synchronizations (occ)
- 0.00 Communications (occ)
- 6.24e9 Bytes transferred (bytes)
- 0.00 MPI file operations (occ)
- 62.35 Computational imbalance (sec)
- 0.00 Minimum Inclusive Time (sec)
- 38.44 Maximum Inclusive Time (sec)

- 30.46 MAIN__
  - 12.42 mpi_setup_
  - 0.01 MPI_Bcast
  - 0.00 env_setup_
  - 0.00 zone_setup_
  - 0.00 map_zones_
  - 0.00 zone_starts_
  - 0.00 set_constants_
  - 2.31 initialize_
  - 1.04 exact_rhs_
  - 1.02 exch_qbc_
  - 5.04 adi_
  - 0.04 MPI_Barrier
  - 0.03 <<bt_iter>> (200 iterations)
    - 16.72 exch_qbc_
    - 961.55 adi_
  - 0.74 verify_
  - 0.00 MPI_Reduce
  - 0.00 print_results_
  - 0.00 MPI_Finalize

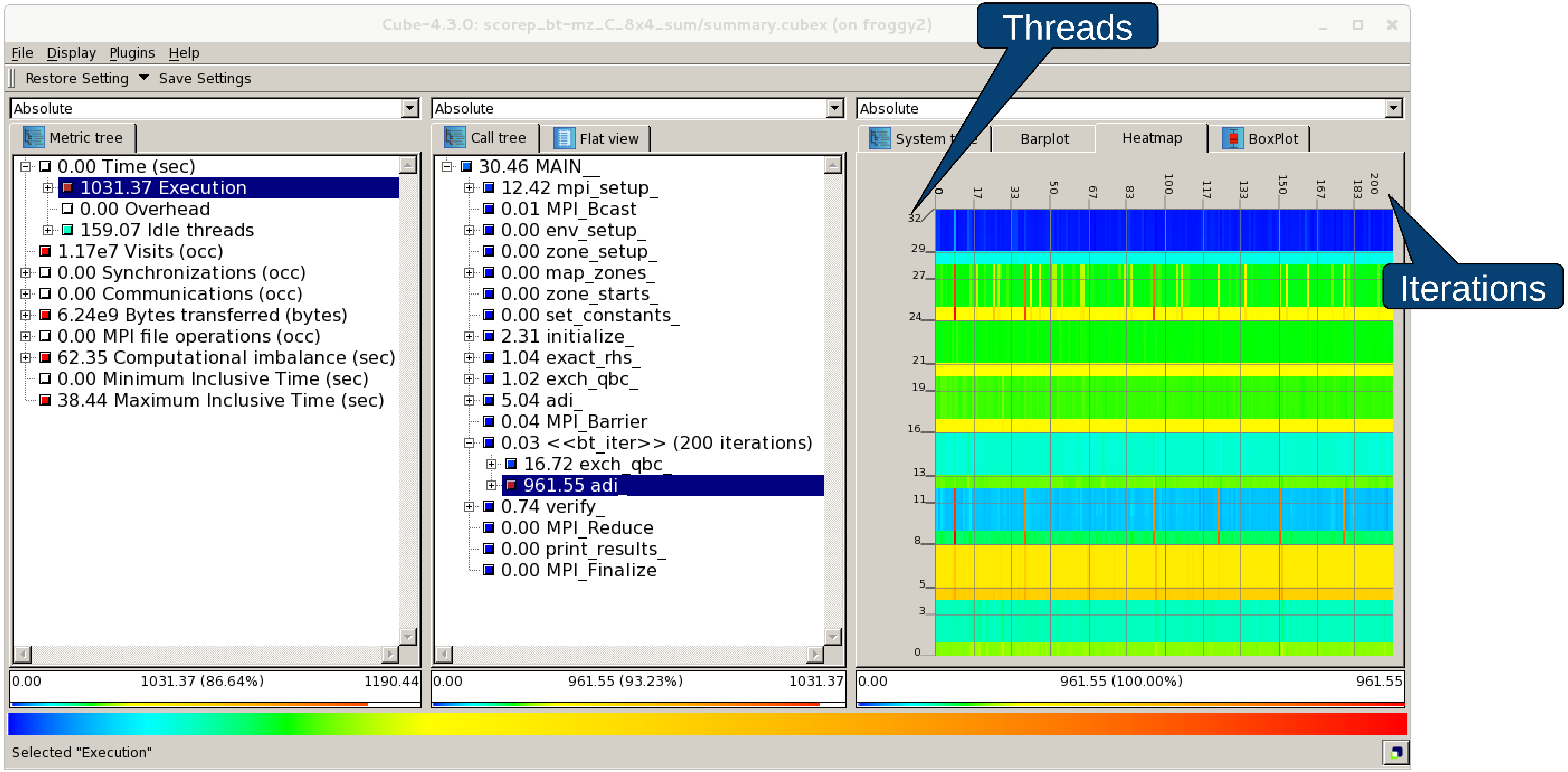
0.00 1031.37 (86.64%) 1190.44

0.00 961.55 (93.23%) 1031.37

Aggregation selection

Iterations

Iteration profiling: Heatmap



Cube-4.3.0: scorep_bt-mz_C_8x4_sum/summary.cubex (on froggy2)

```
0.00 Time (sec)
  1031.37 Execution
    0.00 Overhead
  159.07 Idle threads
1.17e7 Visits (occ)
0.00 Synchronizations (occ)
0.00 Communications (occ)
6.24e9 Bytes transferred (bytes)
0.00 MPI file operations (occ)
62.35 Computational imbalance (sec)
0.00 Minimum Inclusive Time (sec)
38.44 Maximum Inclusive Time (sec)
```

```
30.46 MAIN__
  12.42 mpi_setup_
  0.01 MPI_Bcast
  0.00 env_setup_
  0.00 zone_setup_
  0.00 map_zones_
  0.00 zone_starts_
  0.00 set_constants_
  2.31 initialize_
  1.04 exact_rhs_
  1.02 exch_qbc_
  5.04 adi_
  0.04 MPI_Barrier
  0.03 <<bt_iter>> (200 iterations)
    16.72 exch_qbc_
    961.55 adi_
  0.74 verify_
  0.00 MPI_Reduce
  0.00 print_results_
  0.00 MPI_Finalize
```

0.00	1031.37 (86.64%)	1190.44
0.00	961.55 (93.23%)	1031.37
0.00	961.55 (100.00%)	961.55

Selected "Execution"

CUBE algebra utilities

- Extracting solver sub-tree from analysis report

```
% cube_cut  -r '<<ITERATION>>'  scorep_bt-mz_C_16x8_sum/profile.cubex
Writing cut.cubex... done.
```

- Calculating difference of two reports

```
% cube_diff  scorep_bt-mz_C_16x8_sum/profile.cubex  cut.cubex
Writing diff.cubex... done.
```

- Additional utilities for merging, calculating mean, etc.
- Default output of cube_*utility* is a new report *utility*.cubex
- Further utilities for report scoring & statistics
- Run utility with `-h’ (or no arguments) for brief usage info

Square sneak preview

- Scalasca provides ***square*** to facilitate analysis report exploration
  - square = scalasca –examine [OPTIONS] (./scorep_expt_sum | ./profile.cubex)
- Processes intermediate .cubex files produced by Score-P and Scout
  - profile.cubex -> summary.cubex
  - scout.cubex -> trace.cubex
- and (optionally) starts CUBE GUI with the post-processed file
  - containing additional derived metrics and metric hierarchies

Cube: Further information

- Parallel program analysis report exploration tools
  - Libraries for Cube report reading & writing
  - Algebra utilities for report processing
  - GUI for interactive analysis exploration
- Available under 3-clause BSD open-source license
- Documentation & sources:
  - http://www.scalasca.org
- User guide also part of installation:
  - <prefix>/share/doc/CubeGuide.pdf
- Contact:
  - mailto: scalasca@fz-juelich.de