Analysis report examination with Cube

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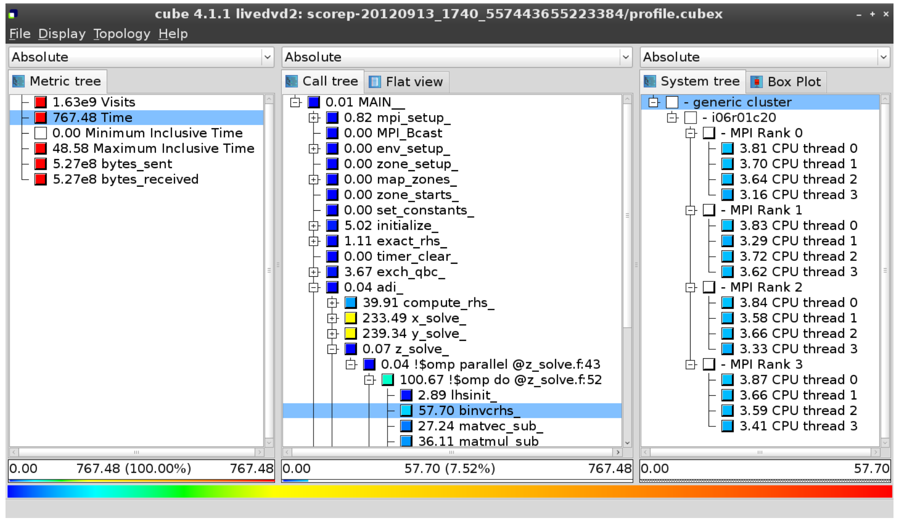
Cube

- Parallel program analysis report exploration tools
  - Libraries for XML+binary report reading & writing
  - Algebra utilities for report processing
  - GUI for interactive analysis exploration
    - Requires Qt4 ≥4.6 or Qt 5

- 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 v4.5 (May 2020)


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
```

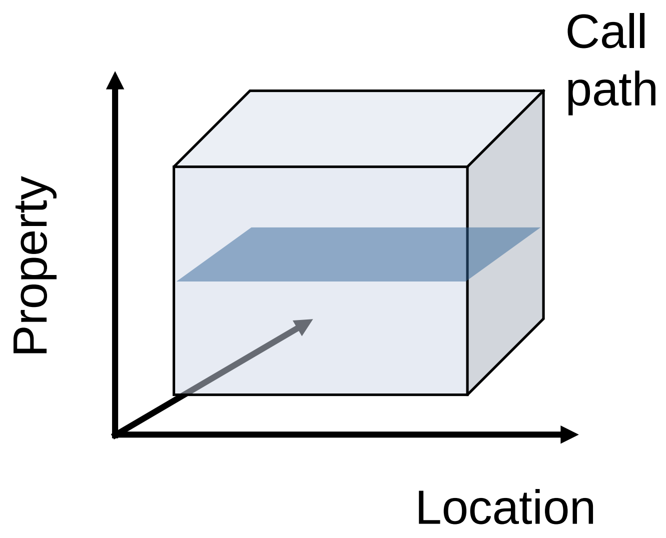
Note:
Binary packages provided for Windows & MacOS, from **www.scalasca.org** website in software/Cube-4x

Analysis presentation and exploration

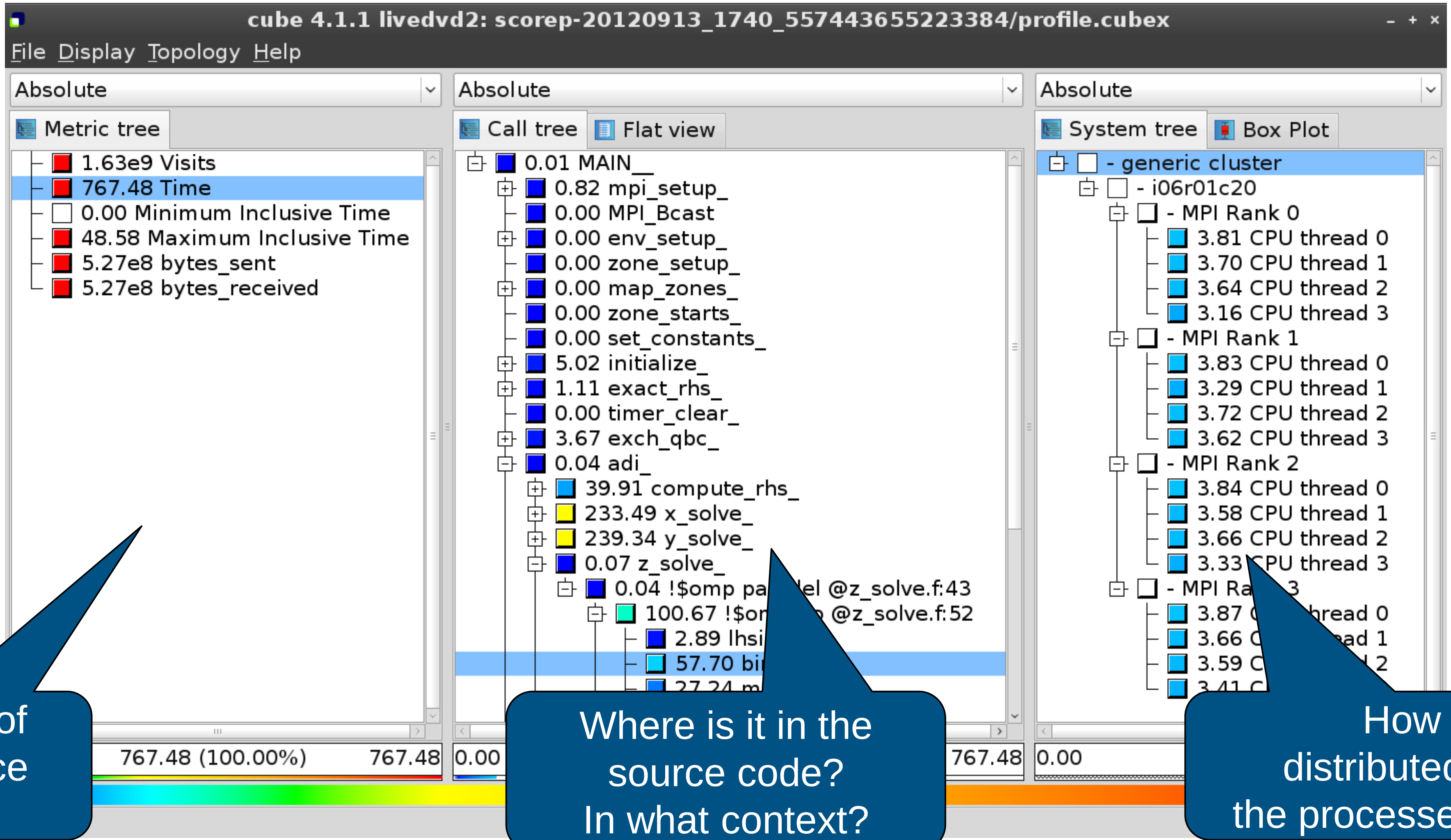
- Representation of values (severity matrix) on three hierarchical axes
  - Performance property (metric)
  - Call path (program location)
  - System location (process/thread)

- Three coupled tree browsers

- Cube displays severities
  - As value: for precise comparison
  - As color: 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
File  Display  Topology  Help

Absolute                          Absolute                              Absolute
Metric tree                       Call tree | Flat view                 System tree | Box Plot

1.63e9 Visits                     0.01 MAIN__                           - generic cluster
767.48 Time                         0.82 mpi_setup_                       - i06r01c20
0.00 Minimum Inclusive Time         0.00 MPI_Bcast                          - MPI Rank 0
48.58 Maximum Inclusive Time        0.00 env_setup_                           3.81 CPU thread 0
5.27e8 bytes_sent                   0.00 zone_setup_                          3.70 CPU thread 1
5.27e8 bytes_received               0.00 map_zones_                           3.64 CPU thread 2
                                    0.00 zone_starts_                         3.16 CPU thread 3
                                    0.00 set_constants_                     - MPI Rank 1
                                    5.02 initialize_                          3.83 CPU thread 0
                                    1.11 exact_rhs_                           3.29 CPU thread 1
                                    0.00 timer_clear_                         3.72 CPU thread 2
                                    3.67 exch_qbc_                            3.62 CPU thread 3
                                    0.04 adi_                               - MPI Rank 2
                                      39.91 compute_rhs_                      3.84 CPU thread 0
                                      233.49 x_solve_                         3.58 CPU thread 1
                                      239.34 y_solve_                         3.66 CPU thread 2
                                      0.07 z_solve_                           3.33 CPU thread 3
                                        0.04 !$omp pa   lel @z_solve.f:43   - MPI Ra   3
                                          100.67 !$or    @z_solve.f:52        3.87 C    hread 0
                                            2.89 lhsi                         3.66 C    ad 1
                                            57.70 bi                          3.59 C      2
                                            27.24 m                           3.41 C

767.48 (100.00%)       767.48     0.00                        767.48     0.00
```

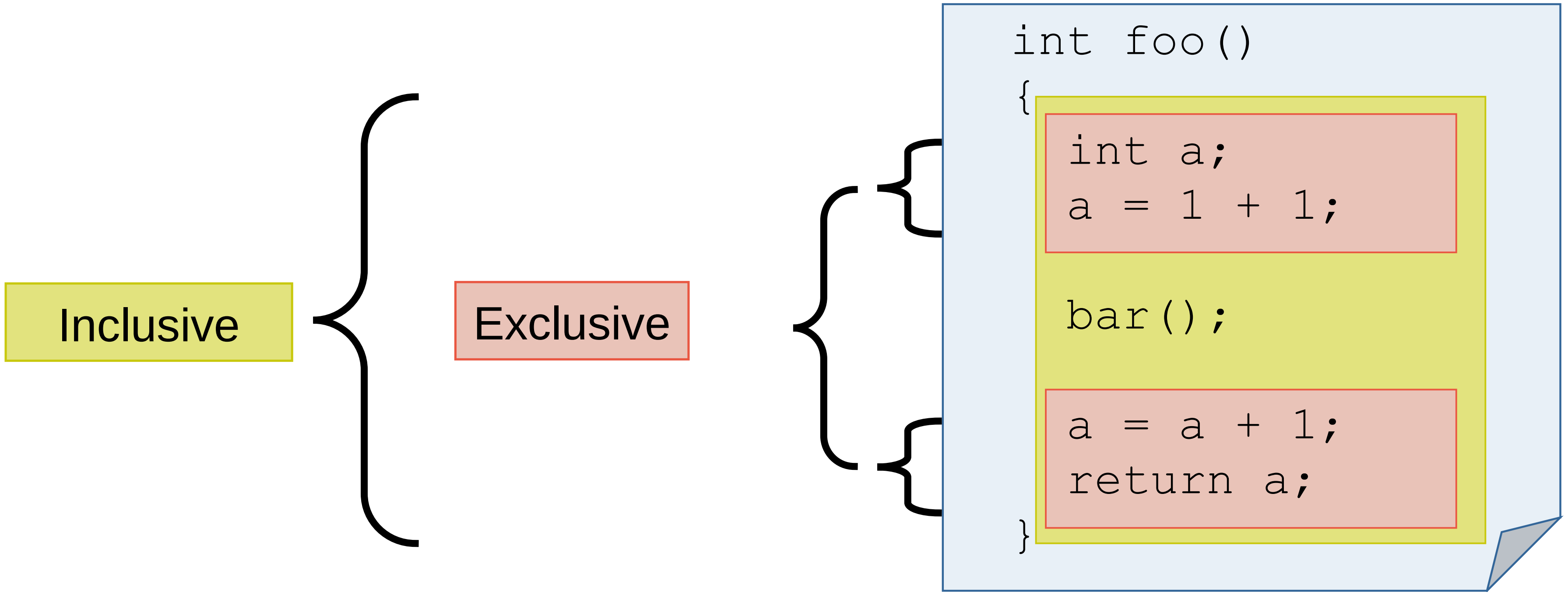
What kind of performance metric?

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

How is it distributed across the processes/threads?

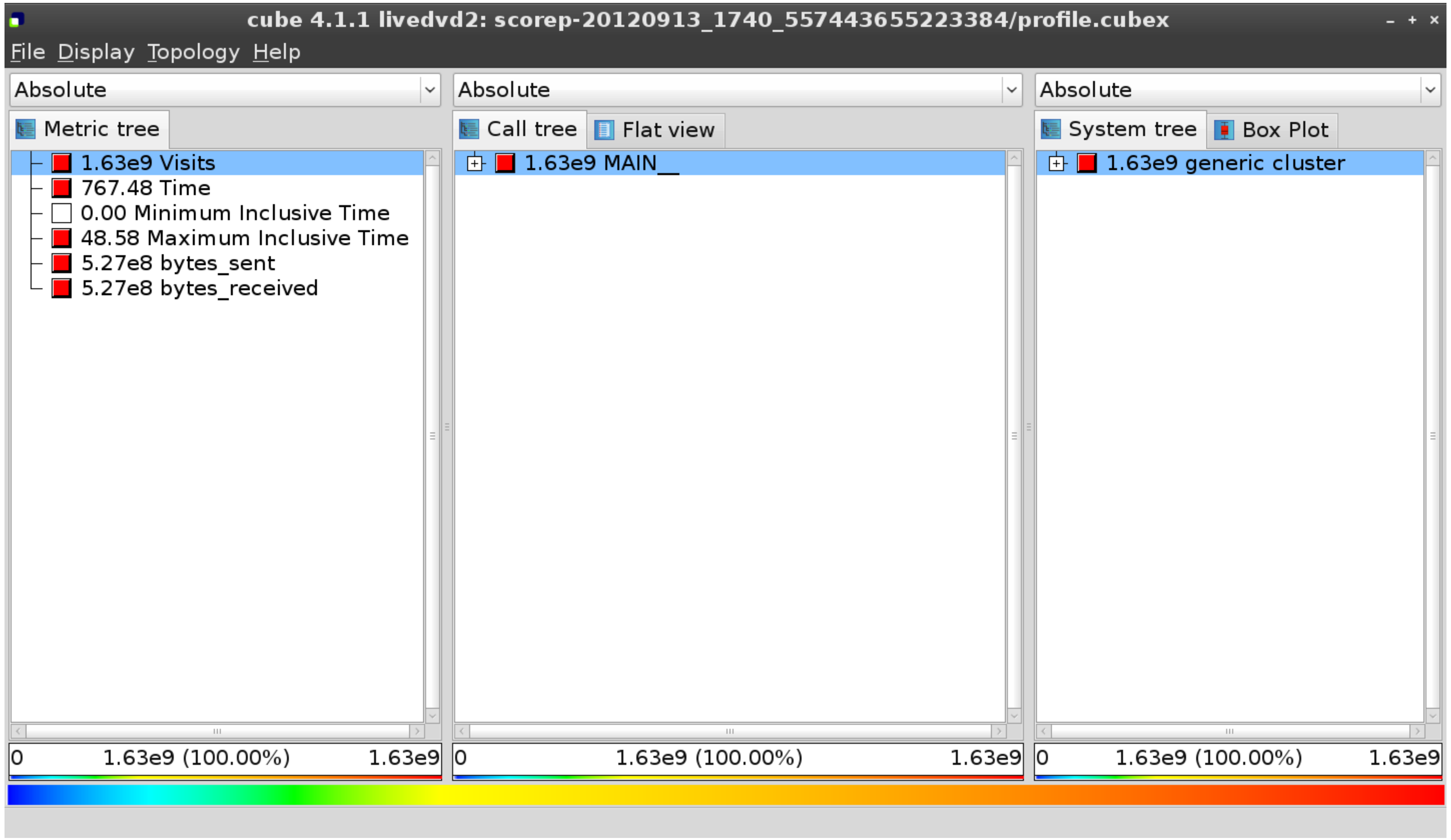
Inclusive vs. exclusive values

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



```
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

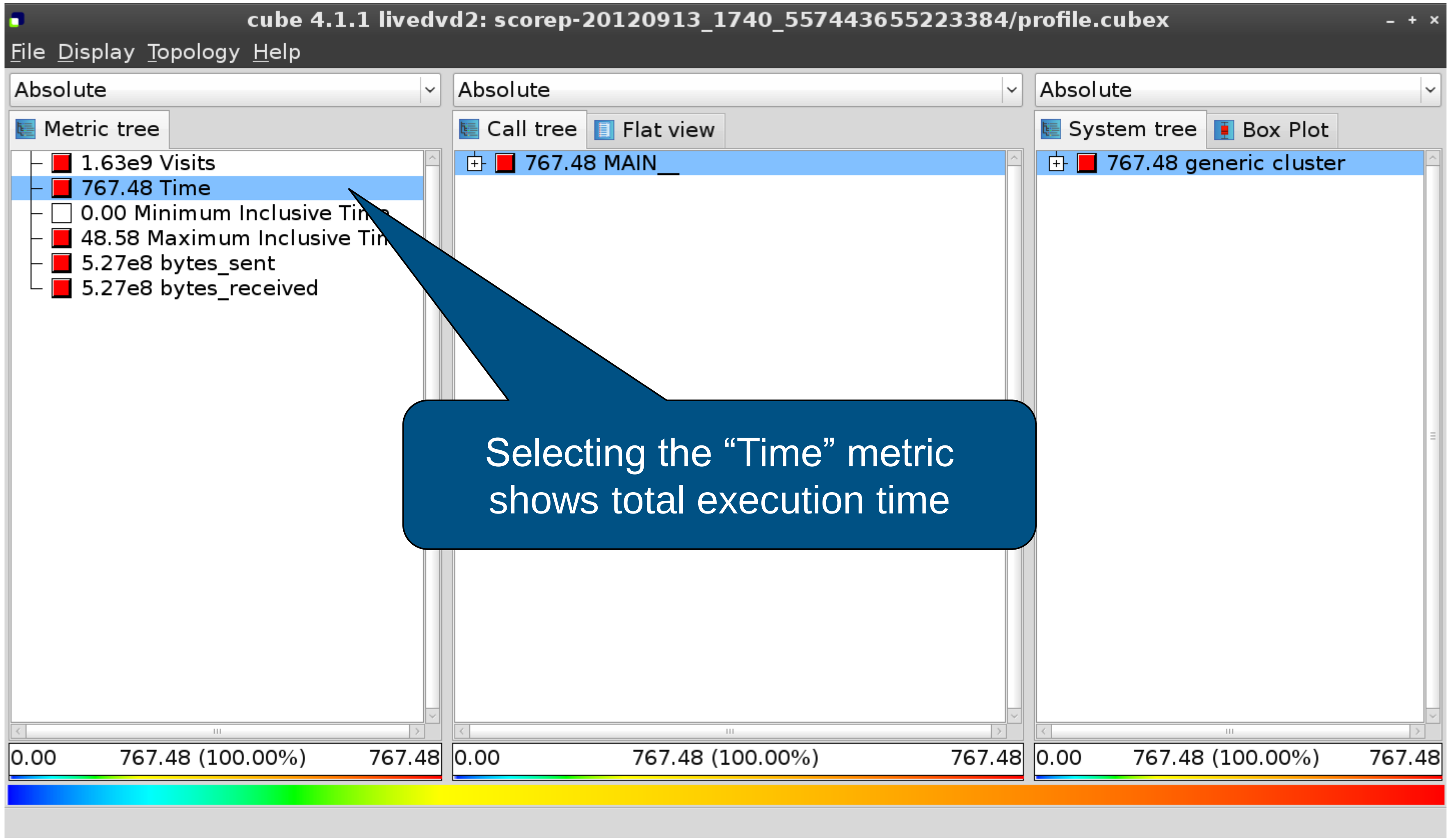
```
1.63e9 Visits
767.48 Time
0.00 Minimum Inclusive Time
48.58 Maximum Inclusive Time
5.27e8 bytes_sent
5.27e8 bytes_received
```

```
1.63e9 MAIN__
```

```
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
File Display Topology Help
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
```

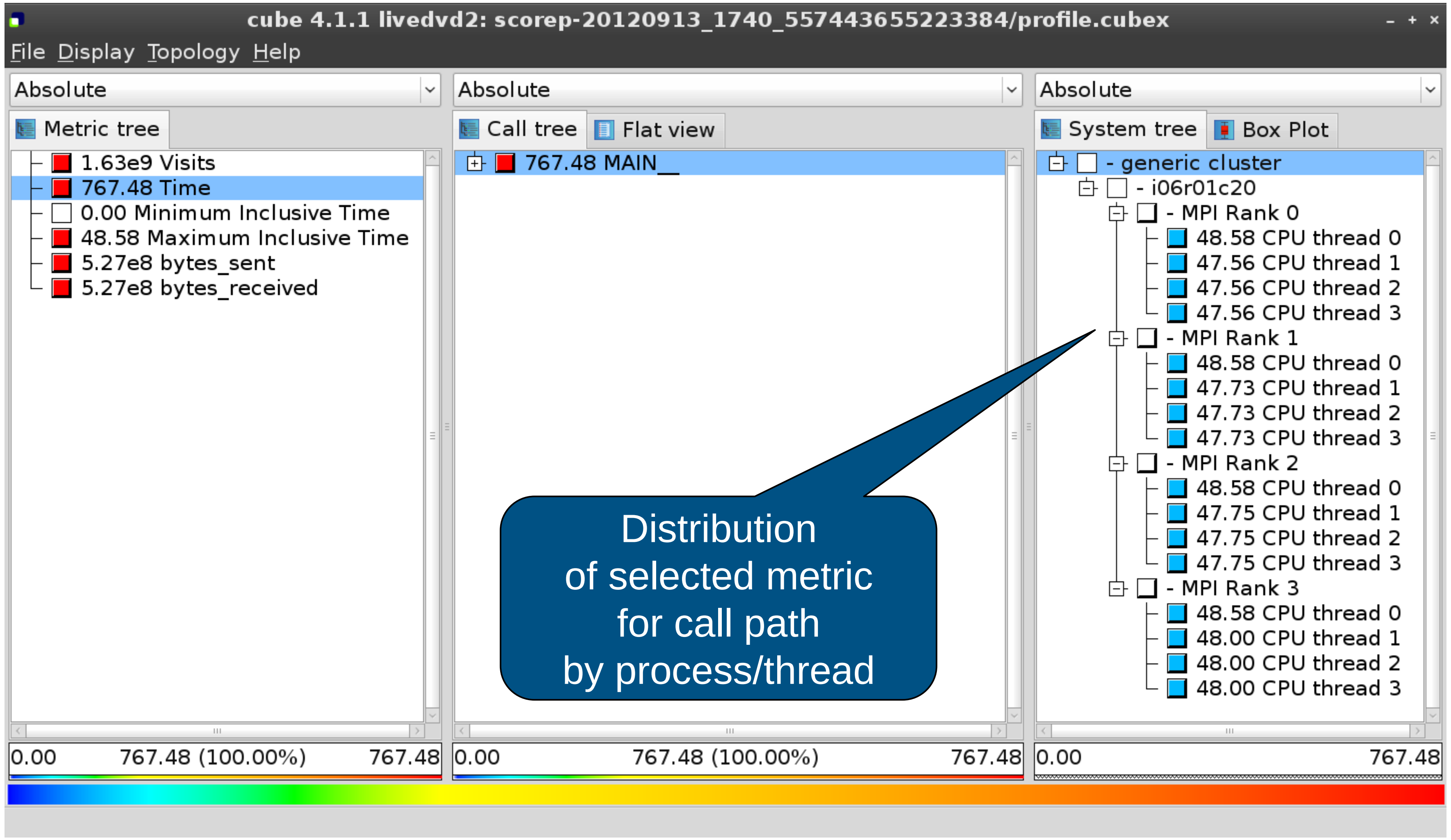
```
767.48 MAIN__
```

```
767.48 generic cluster
```

```
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

File Display Topology Help

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 | Flat view

- 767.48 MAIN__

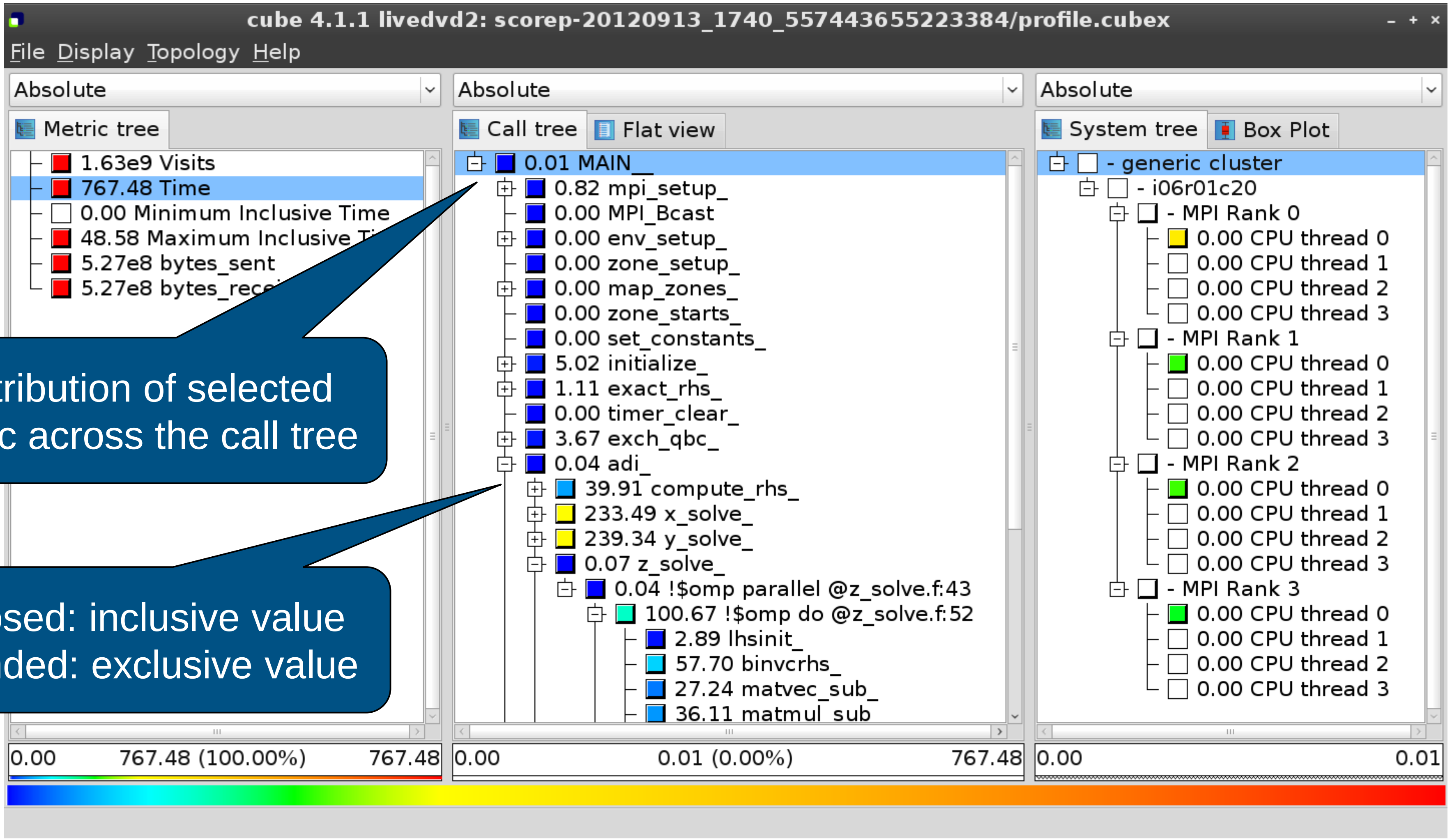
System tree | Box Plot

- - 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

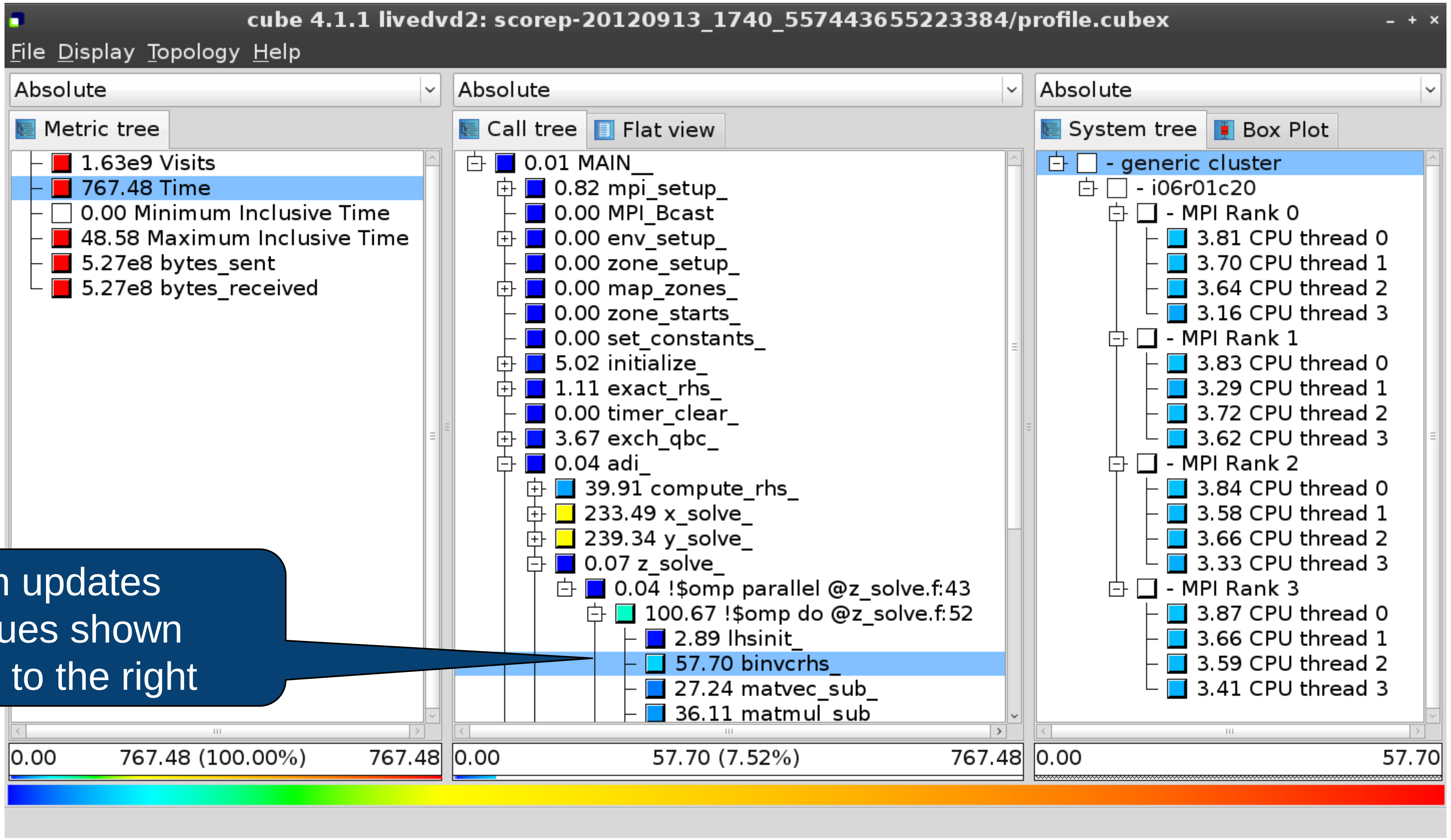

cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex
File Display Topology Help
Absolute
Metric tree
Call tree
Flat view
System tree
Box Plot

```
Metric tree:
1.63e9 Visits
767.48 Time
0.00 Minimum Inclusive Time
48.58 Maximum Inclusive 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

File Display Topology Help

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

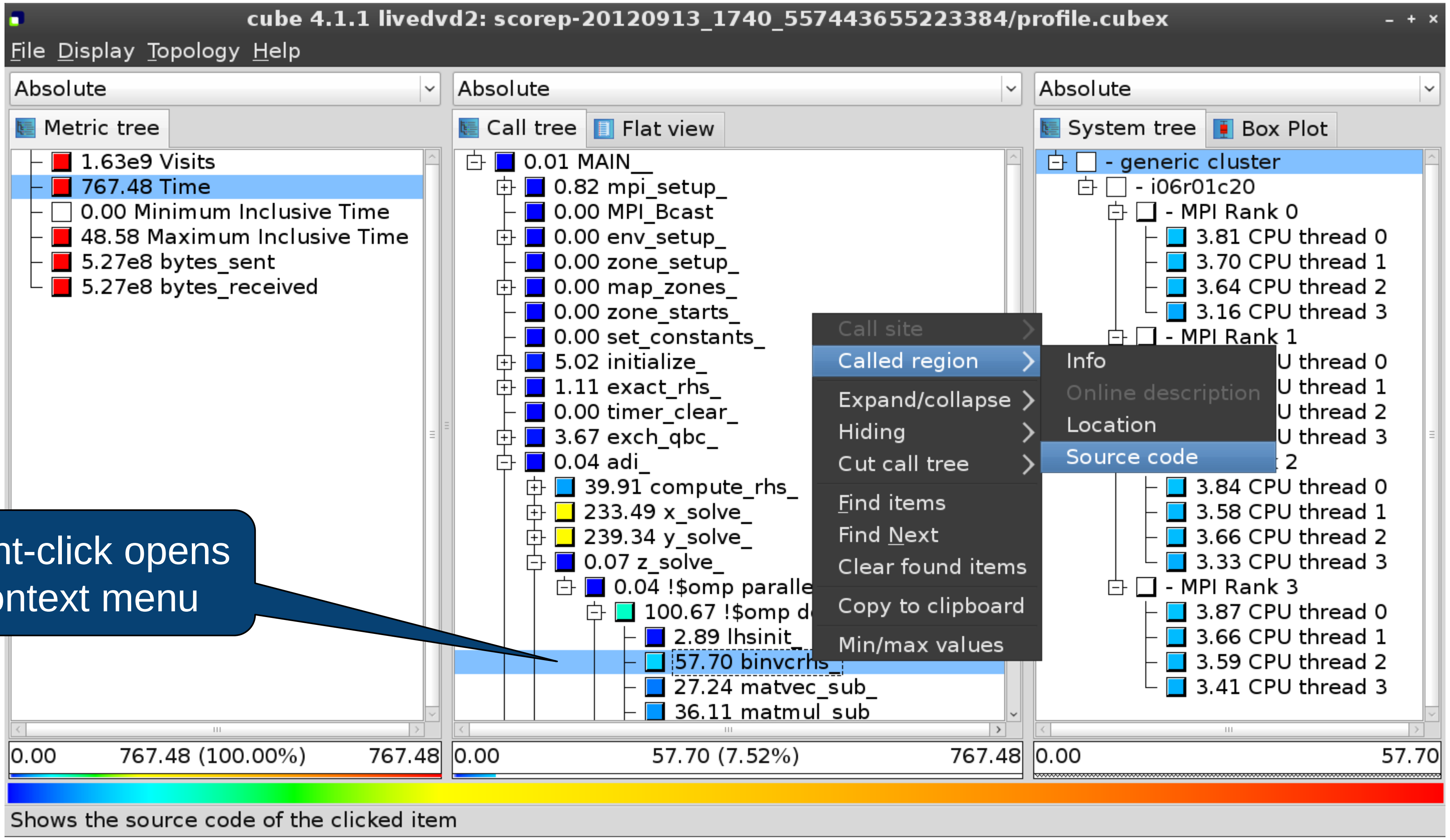
Call tree | Flat view
```
0.01 MAIN__
  0.82 mpi_setup_
  0.00 MPI_Bcast
  0.00 env_setup_
  0.00 zone_setup_
  0.00 map_zones_
  0.00 zone_starts_
  0.00 set_constants_
  5.02 initialize_
  1.11 exact_rhs_
  0.00 timer_clear_
  3.67 exch_qbc_
  0.04 adi_
    39.91 compute_rhs_
    233.49 x_solve_
    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 | Box Plot
```
- 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

Selection updates metric values shown in columns to the right

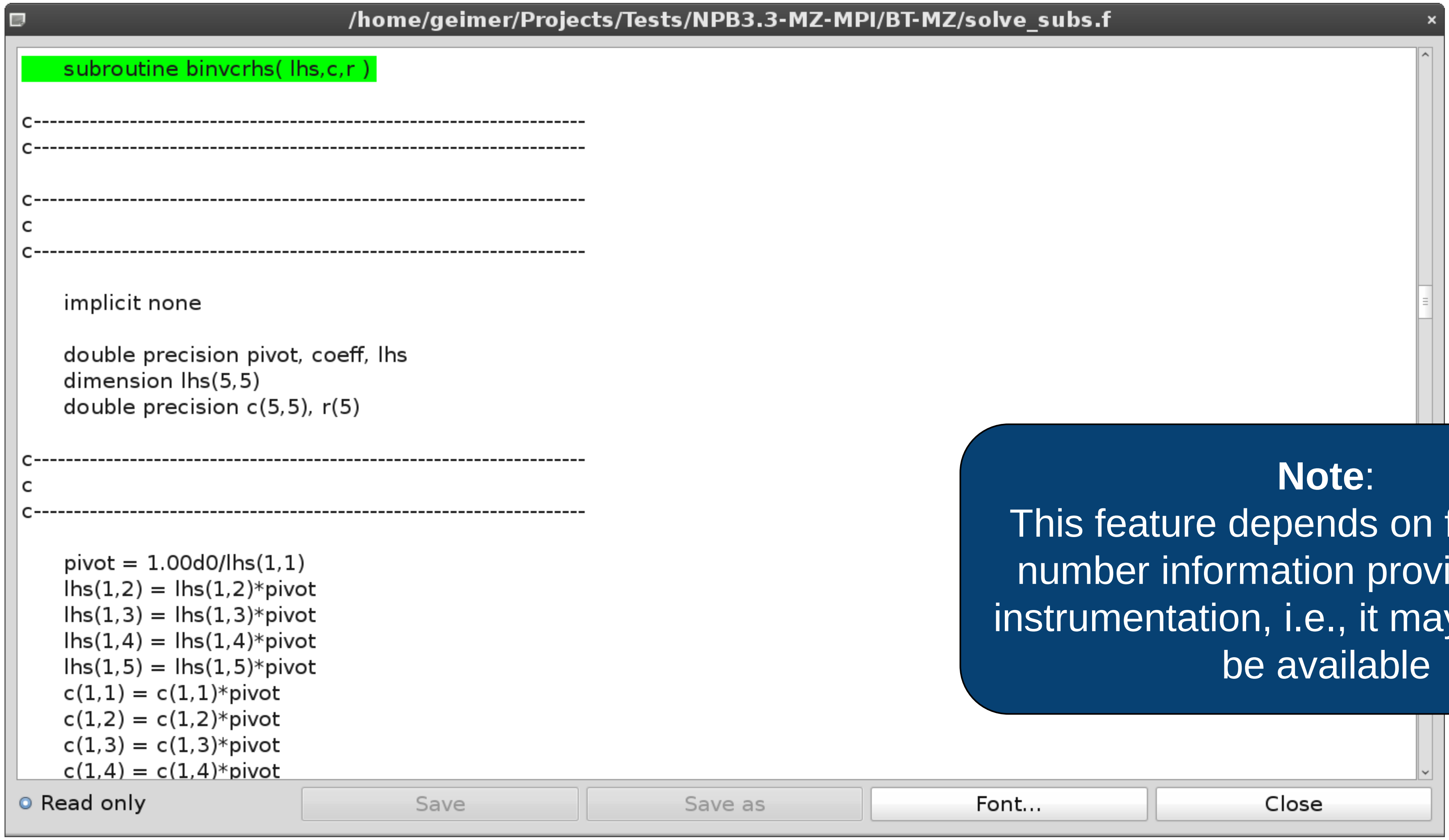
Source-code view via context menu



```
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                   0.01 MAIN__                           - generic cluster
767.48 Time                       0.82 mpi_setup_                       - i06r01c20
0.00 Minimum Inclusive Time       0.00 MPI_Bcast                          - MPI Rank 0
48.58 Maximum Inclusive Time      0.00 env_setup_                           3.81 CPU thread 0
5.27e8 bytes_sent                 0.00 zone_setup_                          3.70 CPU thread 1
5.27e8 bytes_received             0.00 map_zones_                           3.64 CPU thread 2
                                  0.00 zone_starts_                         3.16 CPU thread 3
                                  0.00 set_constants_                     - MPI Rank 1
                                  5.02 initialize_                          U thread 0
                                  1.11 exact_rhs_                           U thread 1
                                  0.00 timer_clear_                         U thread 2
                                  3.67 exch_qbc_                            U thread 3
                                  0.04 adi_                               2
                                    39.91 compute_rhs_                      3.84 CPU thread 0
                                    233.49 x_solve_                         3.58 CPU thread 1
                                    239.34 y_solve_                         3.66 CPU thread 2
                                    0.07 z_solve_                           3.33 CPU thread 3
                                      0.04 !$omp paralle                  - MPI Rank 3
                                        100.67 !$omp d                      3.87 CPU thread 0
                                          2.89 lhsinit_                     3.66 CPU thread 1
                                          57.70 binvcrhs_                   3.59 CPU thread 2
                                          27.24 matvec_sub_                 3.41 CPU thread 3
                                          36.11 matmul_sub

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

Shows the source code of the clicked item
```

Right-click opens context menu

Source-code view

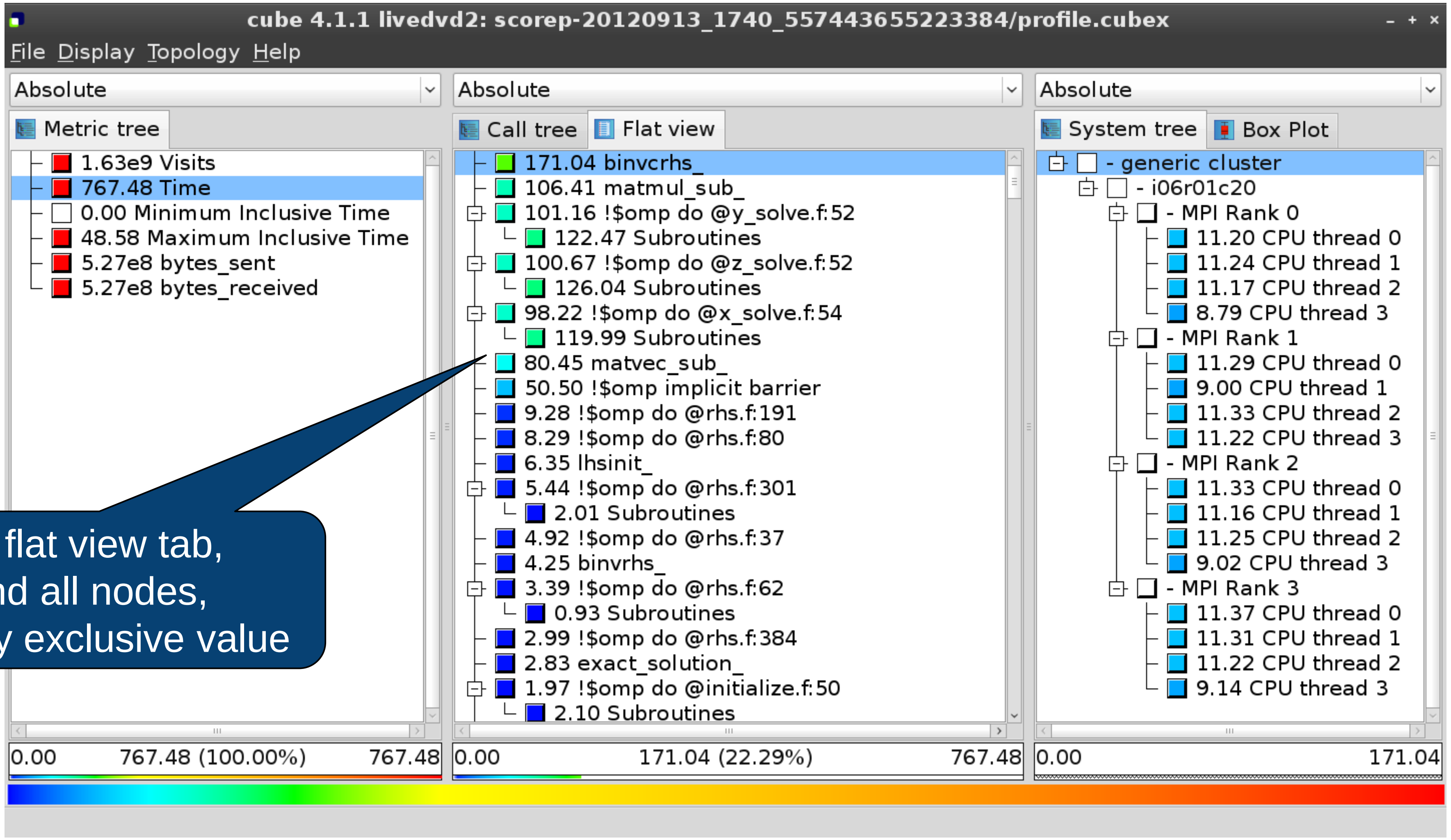

/home/geimer/Projects/Tests/NPB3.3-MZ-MPI/BT-MZ/solve_subs.f

```
      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
```

Read only
Save
Save as
Font...
Close

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

File Display Topology Help

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 | 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
```

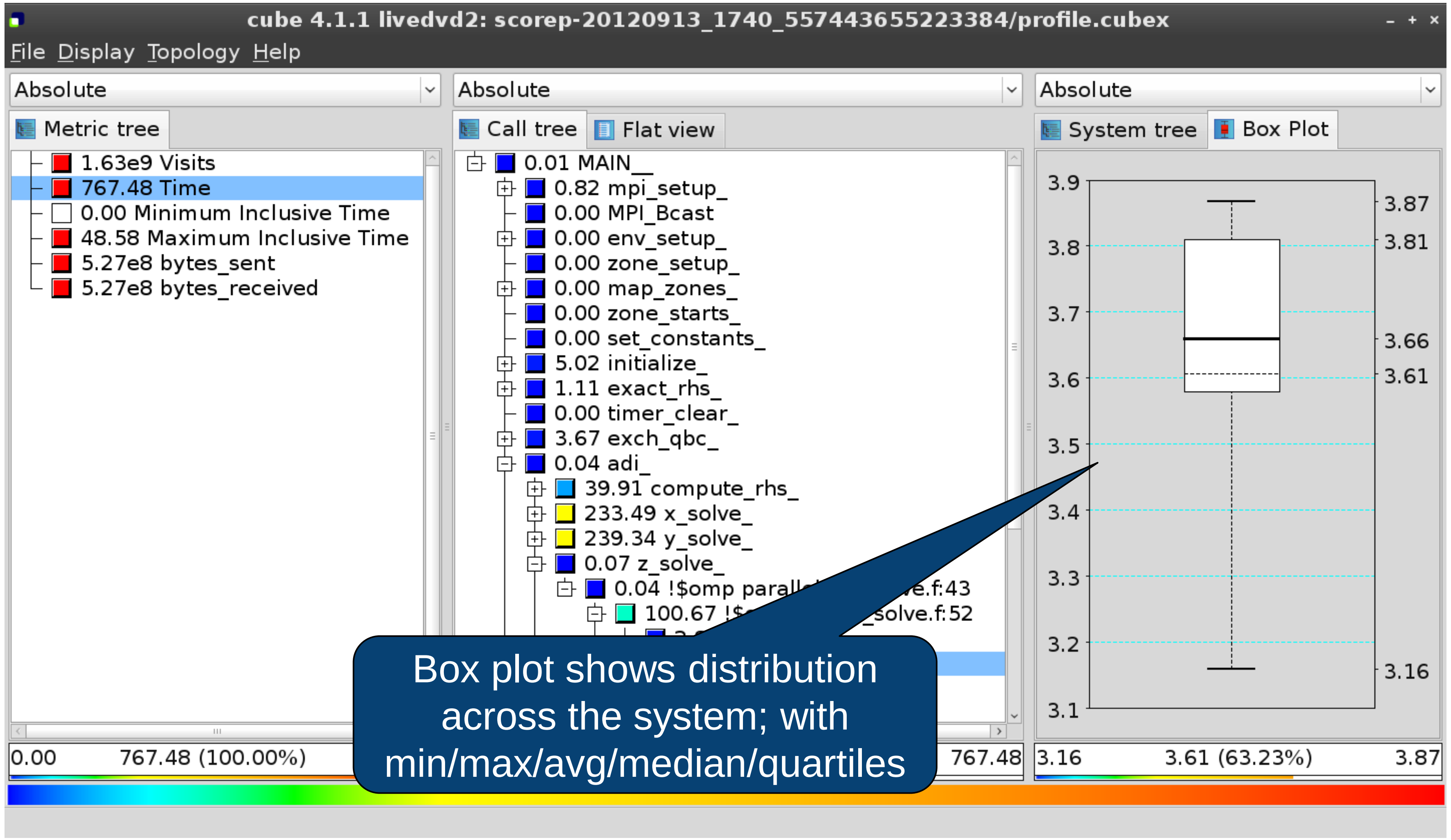
System tree | Box Plot

```
- 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   767.48 (100.00%)   767.48 | 0.00   171.04 (22.29%)   767.48 | 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

File Display Topology Help

Absolute | Absolute | Absolute

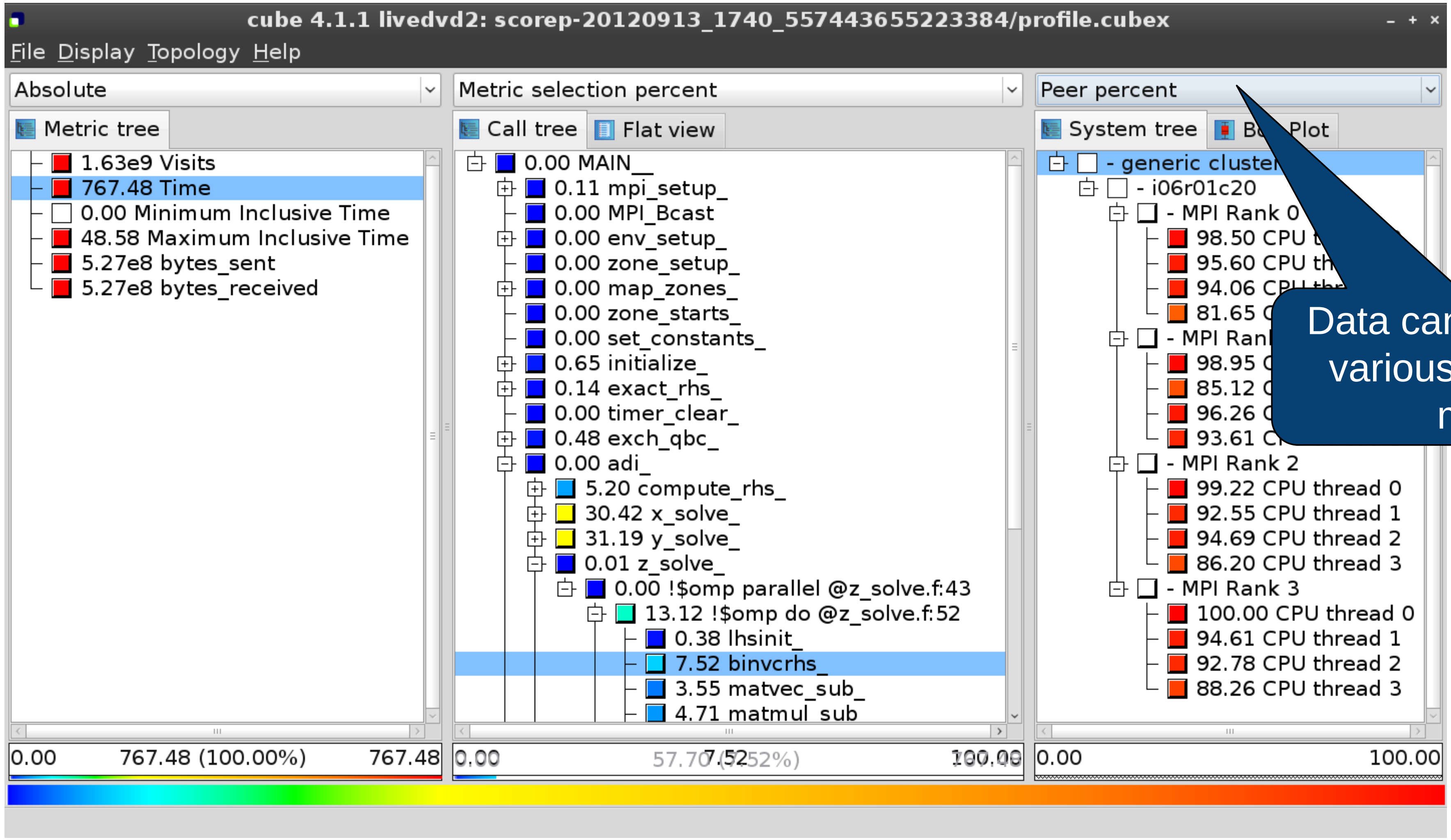
Metric tree:
- 1.63e9 Visits
- 767.48 Time
- 0.00 Minimum Inclusive Time
- 48.58 Maximum Inclusive Time
- 5.27e8 bytes_sent
- 5.27e8 bytes_received

Call tree:
```
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
File Display Topology Help
Absolute
Metric selection percent
Peer percent
Metric tree
Call tree
Flat view
System tree
Bo 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
```

```
0.00 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
```

```
- generic cluster
  - i06r01c20
    - MPI Rank 0
        98.50 CPU t
        95.60 CPU th
        94.06 CPU thr
        81.65 C
    - MPI Rank
        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
```

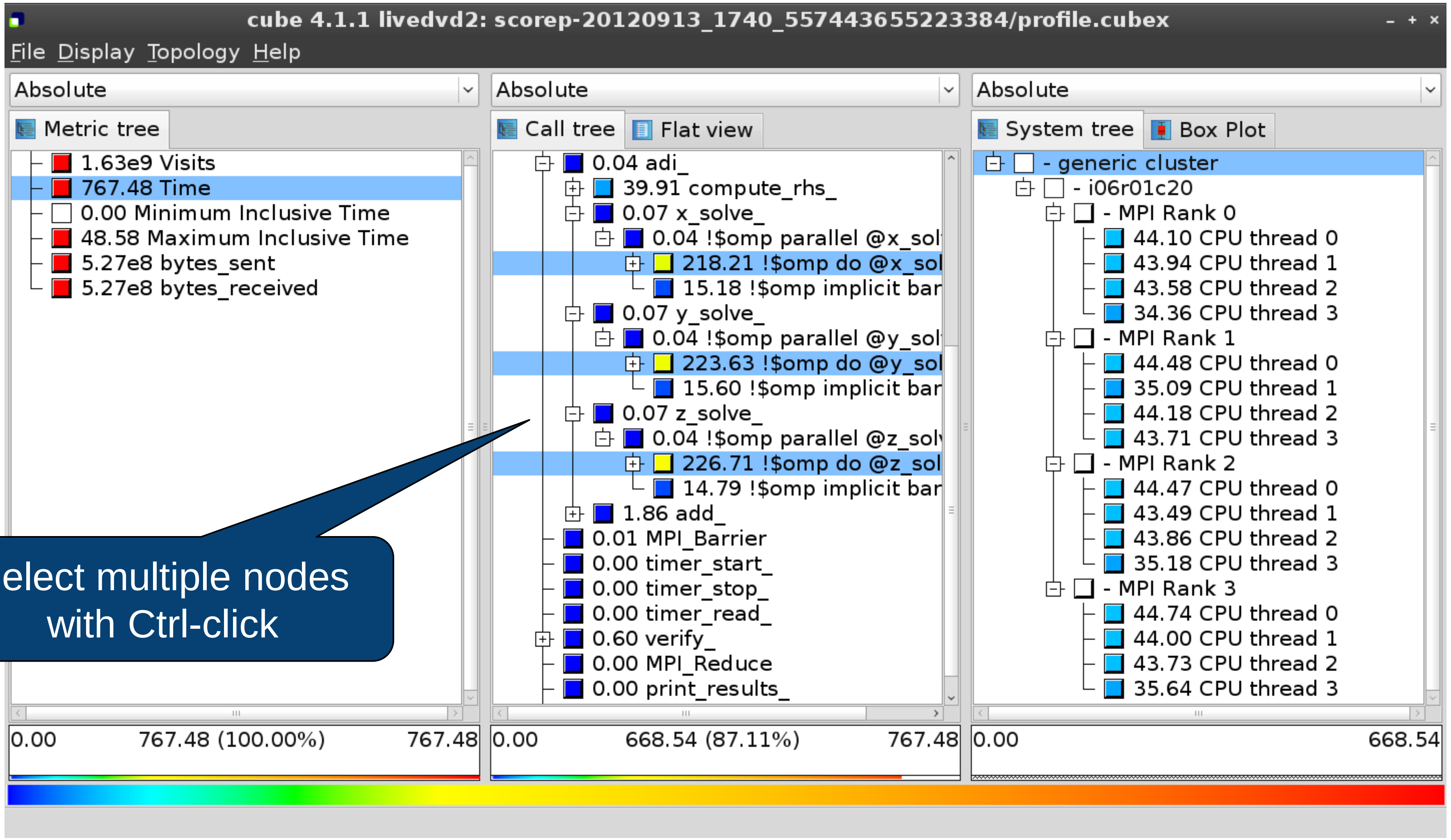
```
0.00   767.48 (100.00%)   767.48
0.00   7.52   57.70 (7.52%)   100.00
0.00   100.00
```

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

File Display Topology Help

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
```

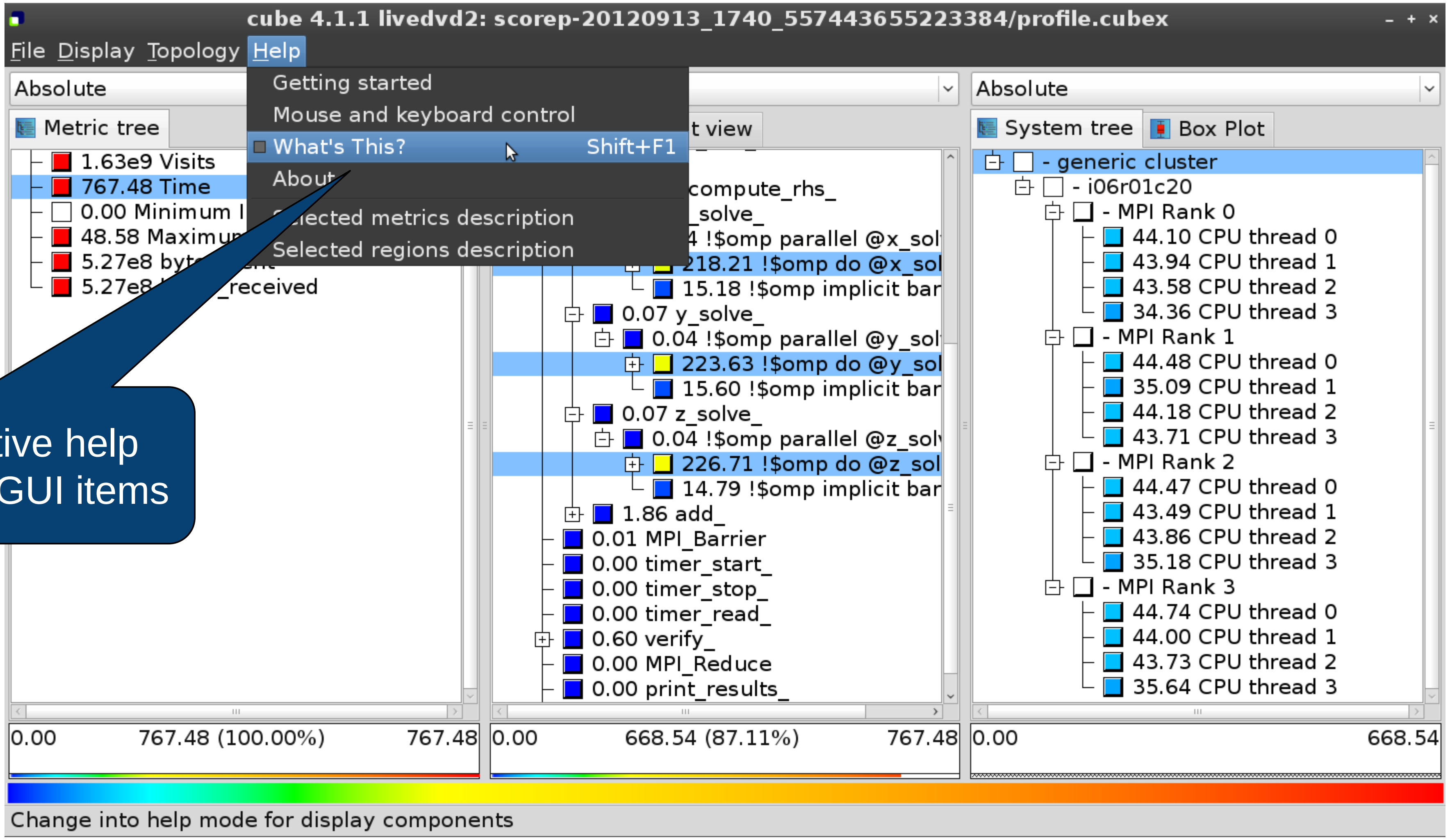
Call tree | Flat view:
```
0.04 adi_
  39.91 compute_rhs_
  0.07 x_solve_
    0.04 !$omp parallel @x_sol
      218.21 !$omp do @x_sol
      15.18 !$omp implicit bar
  0.07 y_solve_
    0.04 !$omp parallel @y_sol
      223.63 !$omp do @y_sol
      15.60 !$omp implicit bar
  0.07 z_solve_
    0.04 !$omp parallel @z_solv
      226.71 !$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 | Box Plot:
```
- 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
Metric tree
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

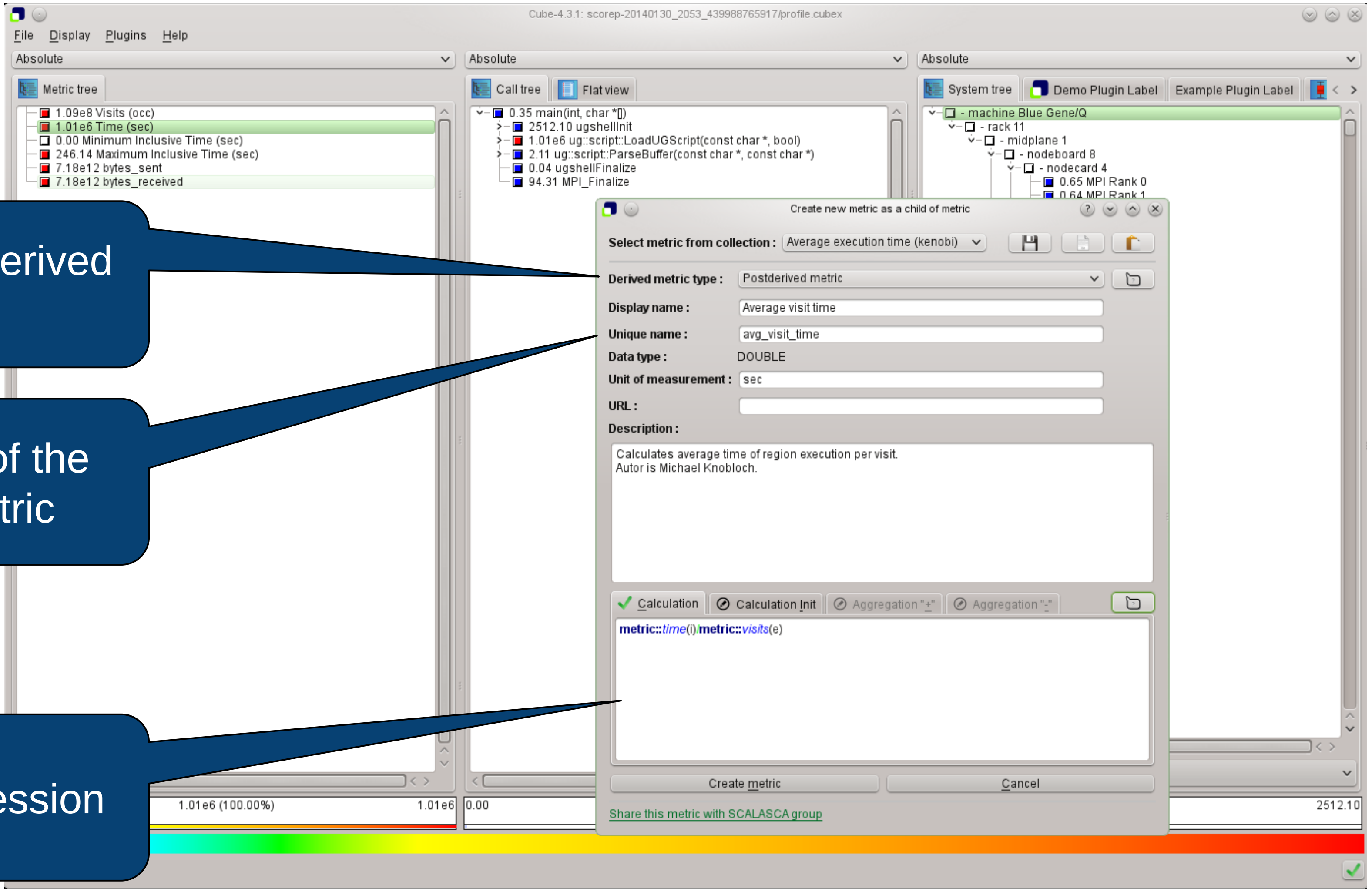
- Examples:
  - "Average execution time": Postderived metric with expression

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

  - "Number of FLOP per second": Postderived metric with expression

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

Derived metrics in Cube GUI


Cube-4.3.1: scorep-20140130_2053_439988765917/profile.cubex

File Display Plugins Help

Absolute | Absolute | Absolute

Metric tree
- 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

Call tree | Flat view
- 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

System tree | Demo Plugin Label | Example Plugin Label
- machine Blue Gene/Q
  - rack 11
    - midplane 1
      - nodeboard 8
        - nodecard 4
          - 0.65 MPI Rank 0
          - 0.64 MPI Rank 1

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.

Calculation | Calculation Init | Aggregation "+" | Aggregation "-"

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

Create metric | Cancel

Share this metric with SCALASCA group

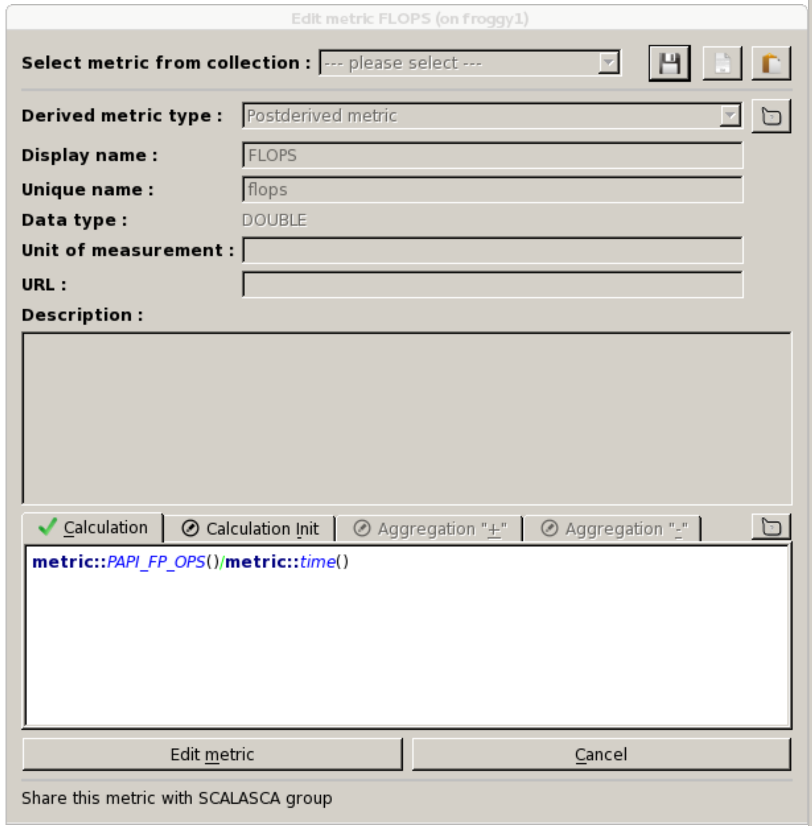
1.01e6 (100.00%) 1.01e6 | 0.00 | 2512.10

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 :

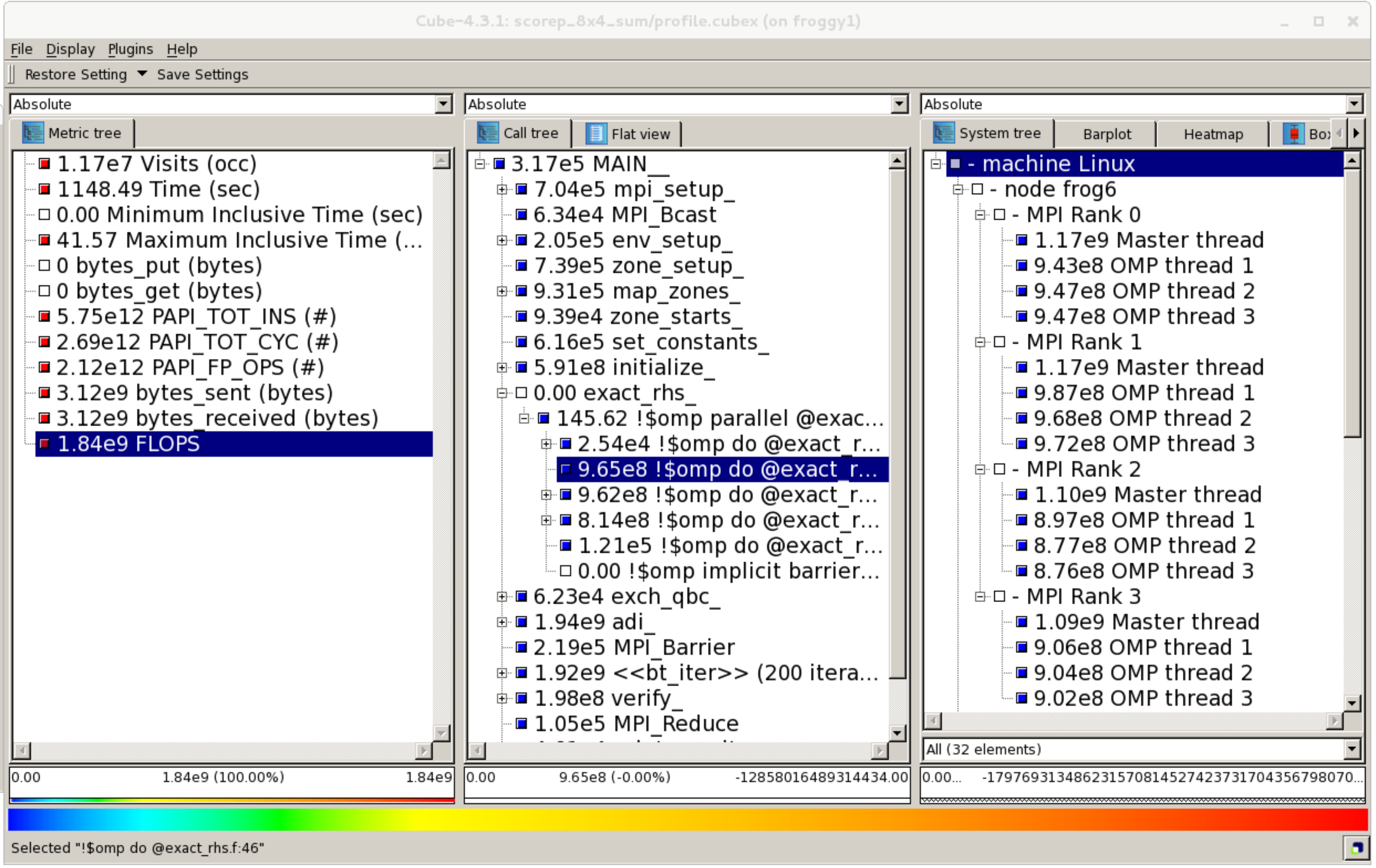
Description :

Calculation | Calculation Init | Aggregation "+" | Aggregation "-"

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

Edit metric | Cancel

Share this metric with SCALASCA group


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

File Display Plugins Help

Restore Setting ▾ Save Settings

Absolute | Absolute | Absolute

Metric tree:

```
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
```

Call tree | Flat view:

```
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
```

System tree | Barplot | Heatmap | Box:

```
- 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"

CUBE algebra utilities

- Extracting solver sub-tree from analysis report

```
% cube_cut  -r '<<ITERATION>>'  scorep_bt-mz_C_32x4_sum/profile.cubex
Writing cut.cubex... done.
```

- Calculating difference of two reports

```
% cube_diff  scorep_bt-mz_C_32x4_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

Iteration profiling

- Show time dependent behavior by “unrolling” iterations

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

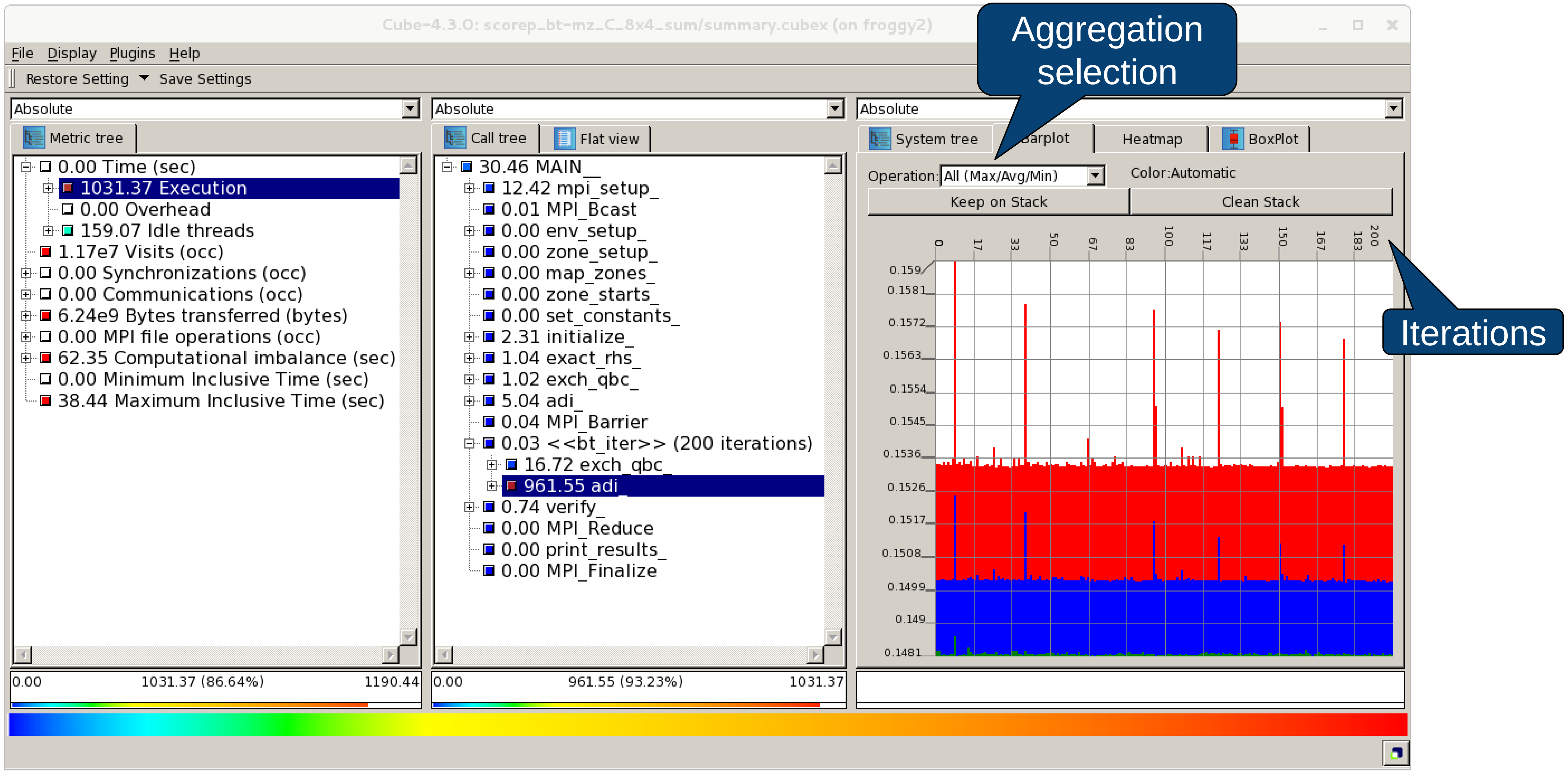
```
SCOREP_USER_REGION_DEFINE( scorep_bt_loop )
SCOREP_USER_REGION_BEGIN( scorep_bt_loop, "<<bt_iter>>", SCOREP_USER_REGION_TYPE_DYNAMIC )
SCOREP_USER_REGION_END( scorep_bt_loop )
```

- 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


Cube-4.3.0: scorep_bt-mz_C_8x4_sum/summary.cubex (on froggy2)
File Display Plugins Help
Restore Setting Save Settings
Absolute
Metric tree
Call tree
Flat view
System tree
Barplot
Heatmap
BoxPlot
Operation: All (Max/Avg/Min)
Color:Automatic
Keep on Stack
Clean Stack
Aggregation selection
Iterations

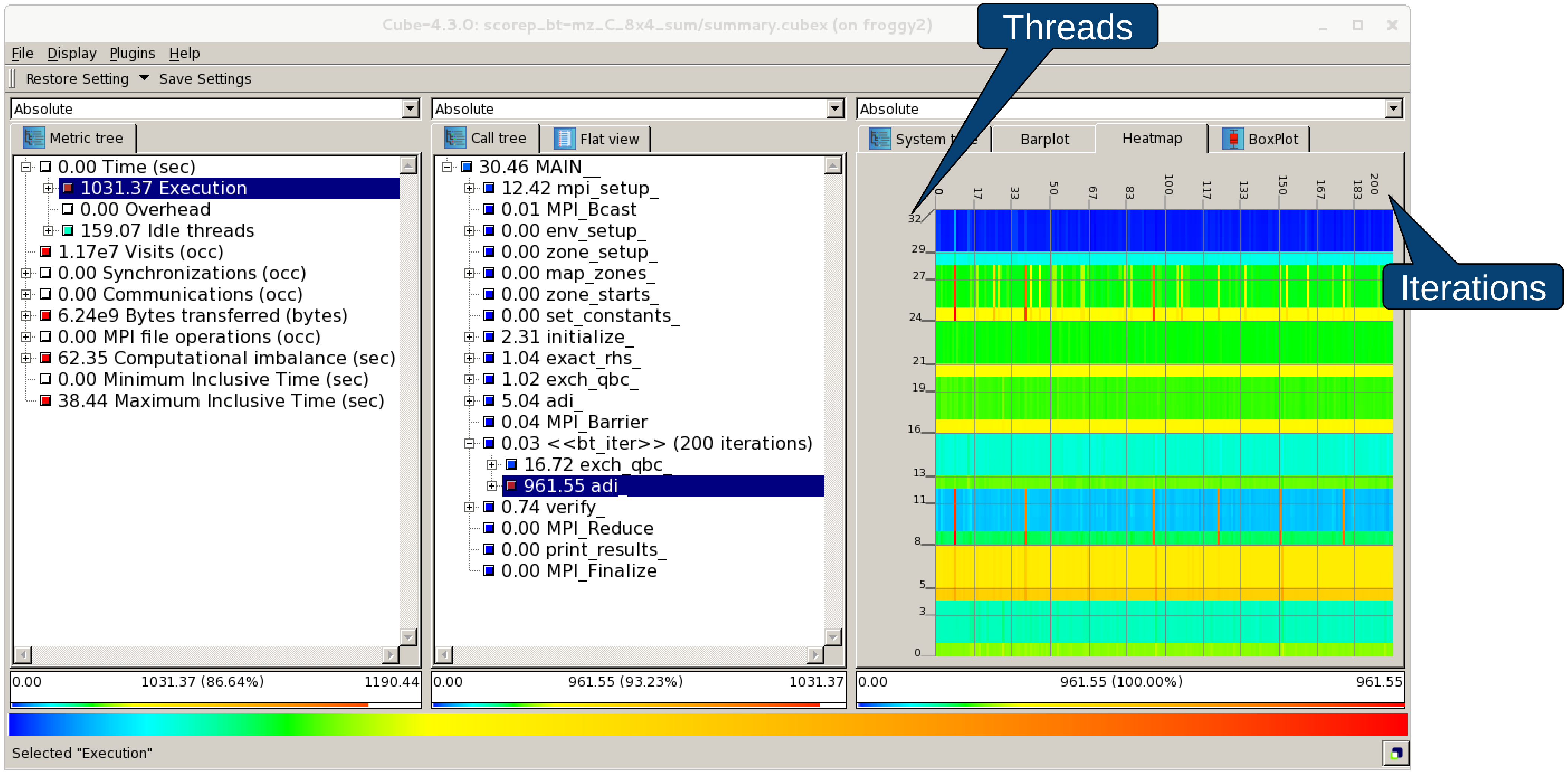
```
0.00 Time (sec)
  1031.37 Execution
  0.00 Overhead
  159.07 Idle threads
1.17e7 Visits (occ)
0.00 Synchronizations (occ)
0.00 Communications (occ)
6.24e9 Bytes transferred (bytes)
0.00 MPI file operations (occ)
62.35 Computational imbalance (sec)
0.00 Minimum Inclusive Time (sec)
38.44 Maximum Inclusive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

Iteration profiling: Heatmap



```
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: 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