



# Profile analysis with CUBE

David Böhme, Markus Geimer

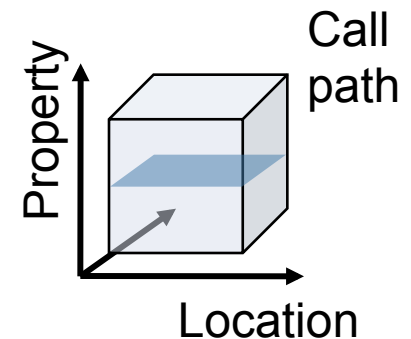
German Research School for Simulation Sciences

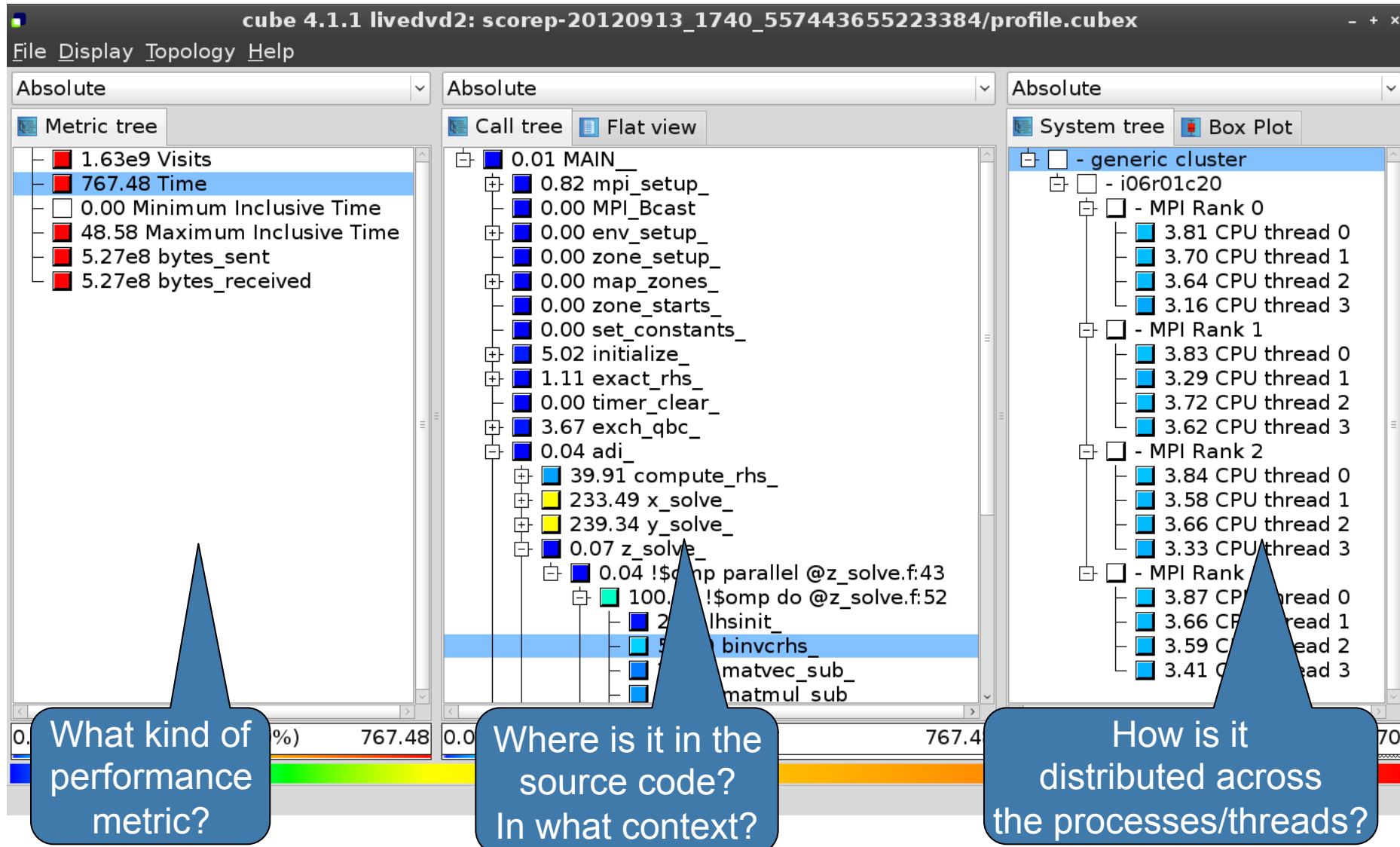
Jülich Supercomputing Centre



- Parallel program analysis report exploration tools
  - Libraries for XML report reading & writing
  - Algebra utilities for report processing
  - GUI for interactive analysis exploration
    - requires Qt4
- Originally developed as part of Scalasca toolset
- Now available as a separate component
  - Can be installed independently of Score-P, e.g., on laptop or desktop
  - Latest release: CUBE 4.1.2 (October 2012)

- Representation of values (severity matrix) on three hierarchical axes
  - Performance property (metric)
  - Call-tree 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 mode





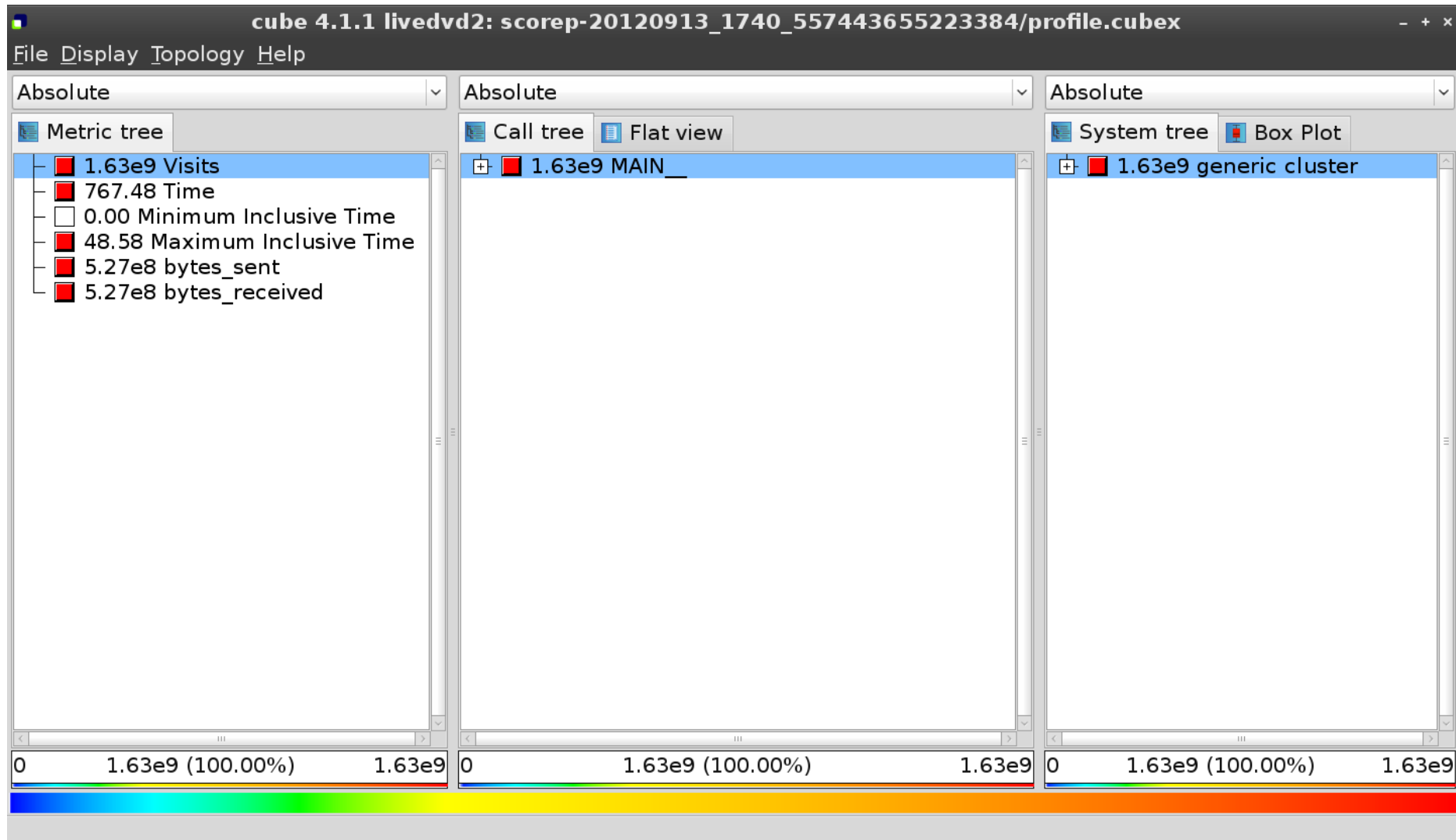
- The Live-DVD contains Score-P experiments of BT-MZ
  - class “B“, 4 processes with 4 OpenMP threads each
  - collected on a dedicated node of the SuperMUC HPC system at Leibniz Rechenzentrum (LRZ), Munich, Germany

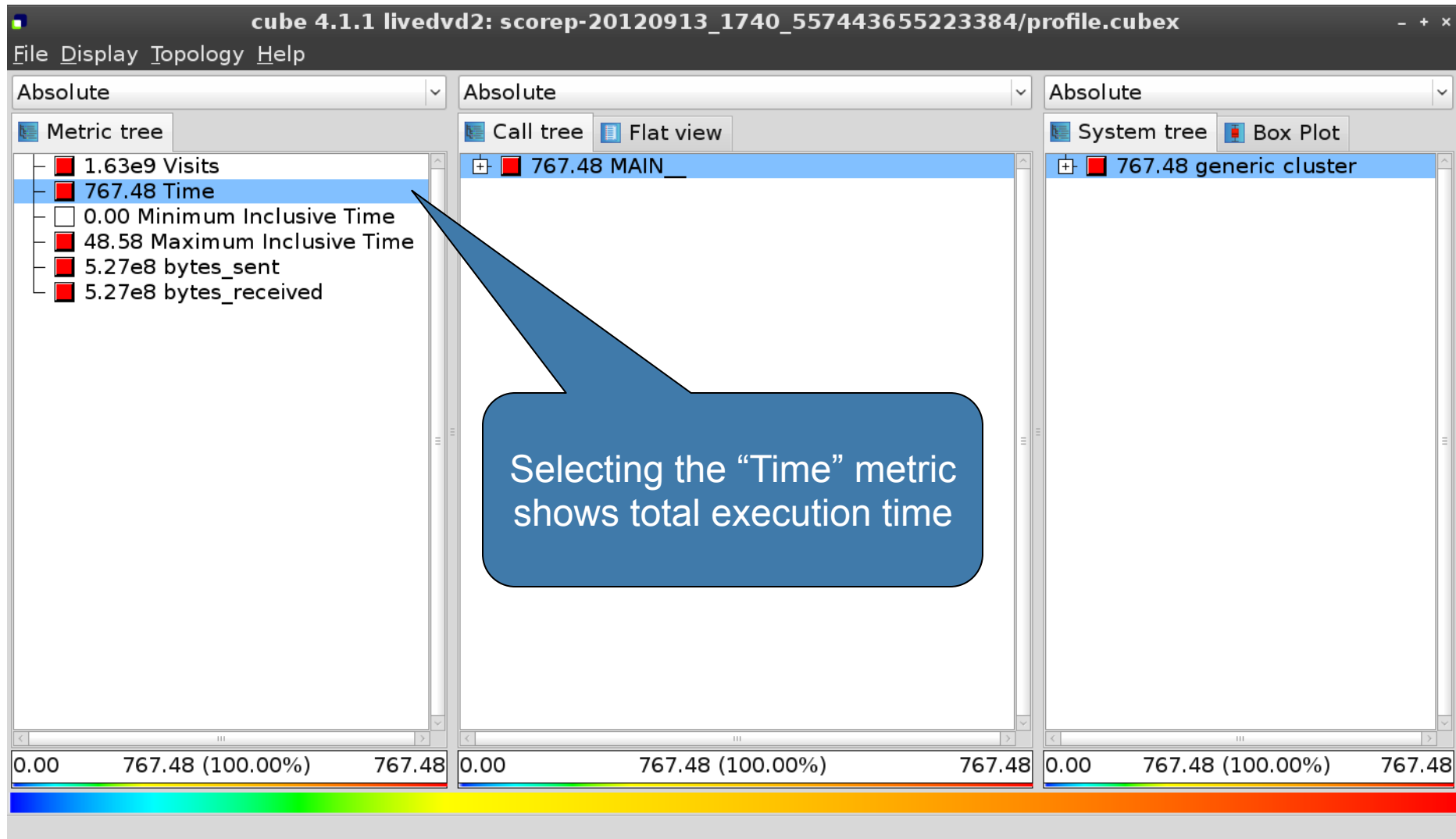
```
% cd
% cd workshop-vihps/supermuc_expts
% ls
periscope-1.5                scorep_bt-mz_B_4x4_sum
README                       scorep_bt-mz_B_4x4_sum+mets
run.out                      scorep_bt-mz_B_4x4_trace
scorep-20120913_1740_557443655223384
```

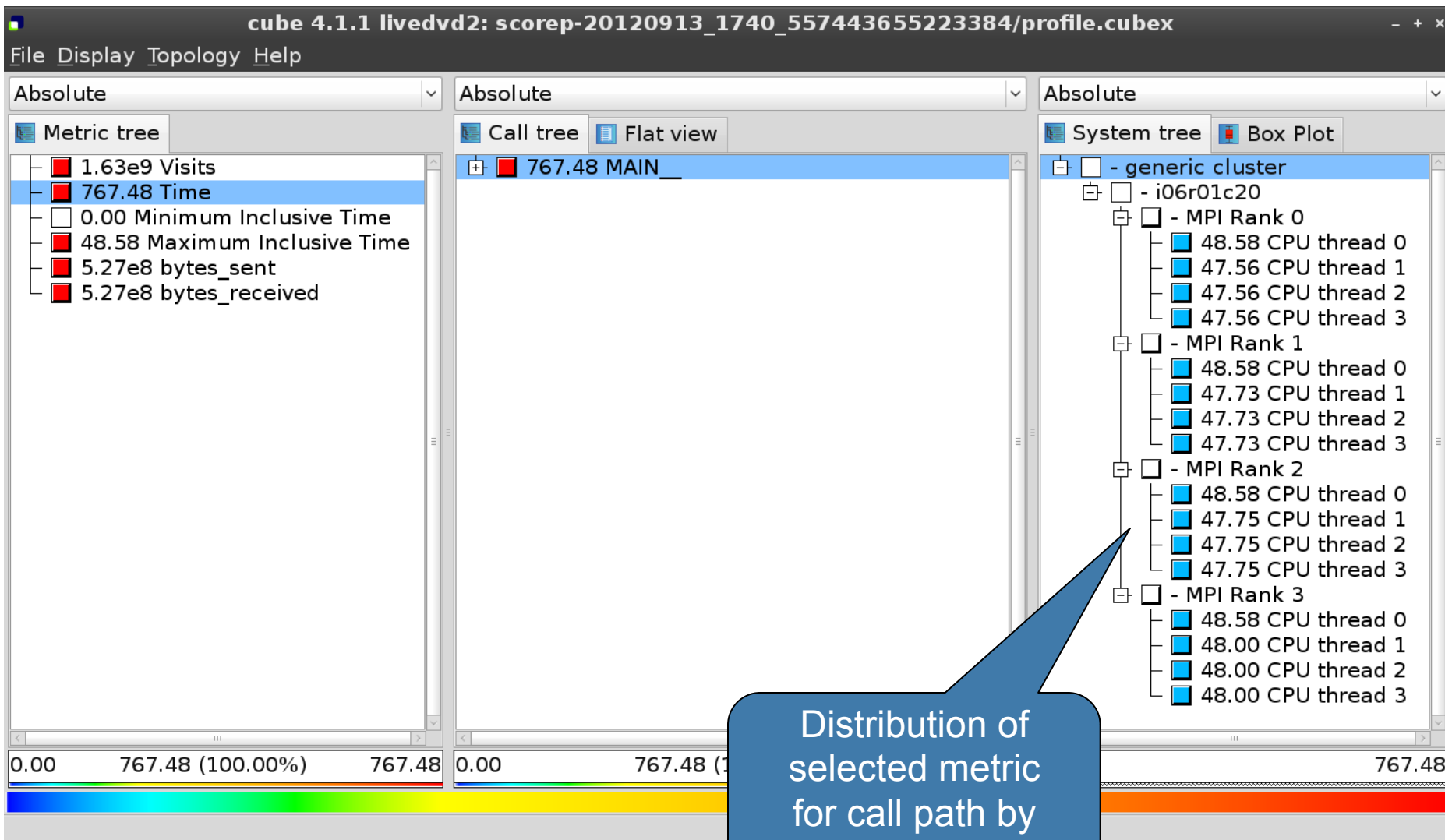
- Start CUBE GUI with default profile report

```
% cube scorep-20120913_1740_557443655223384/profile.cubex
```

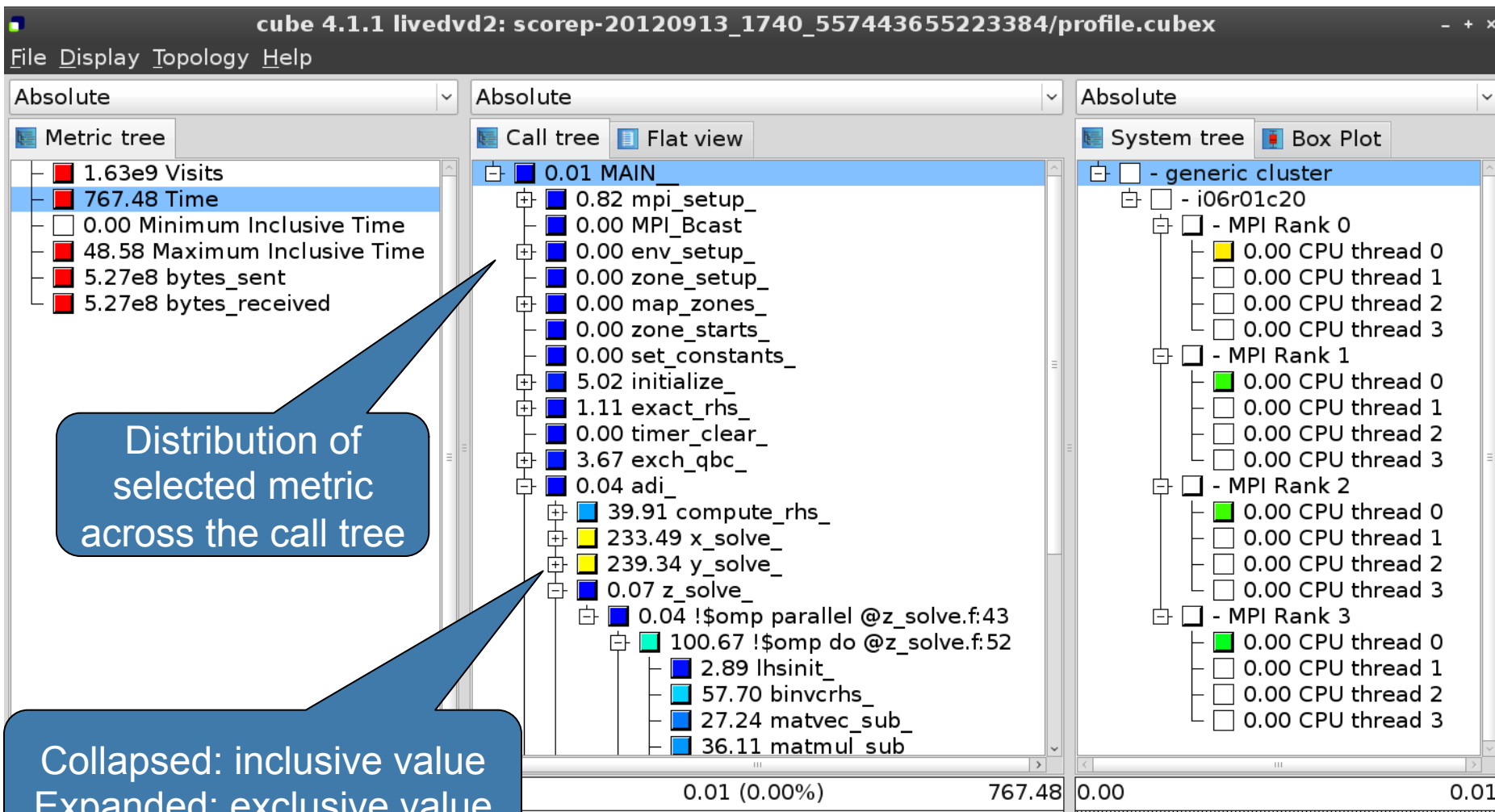
# Analysis report exploration (opening view)



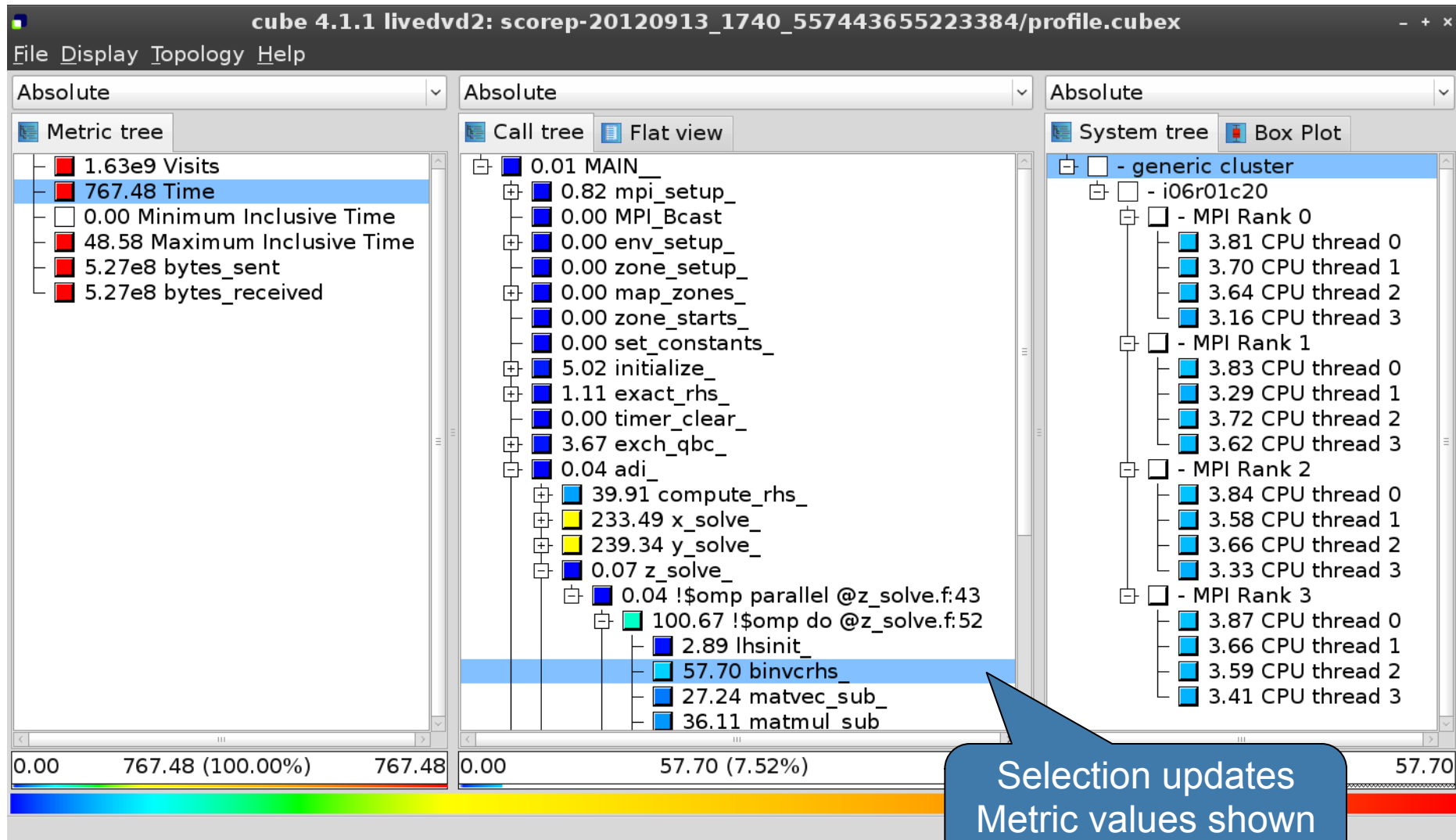








# Selecting a call path

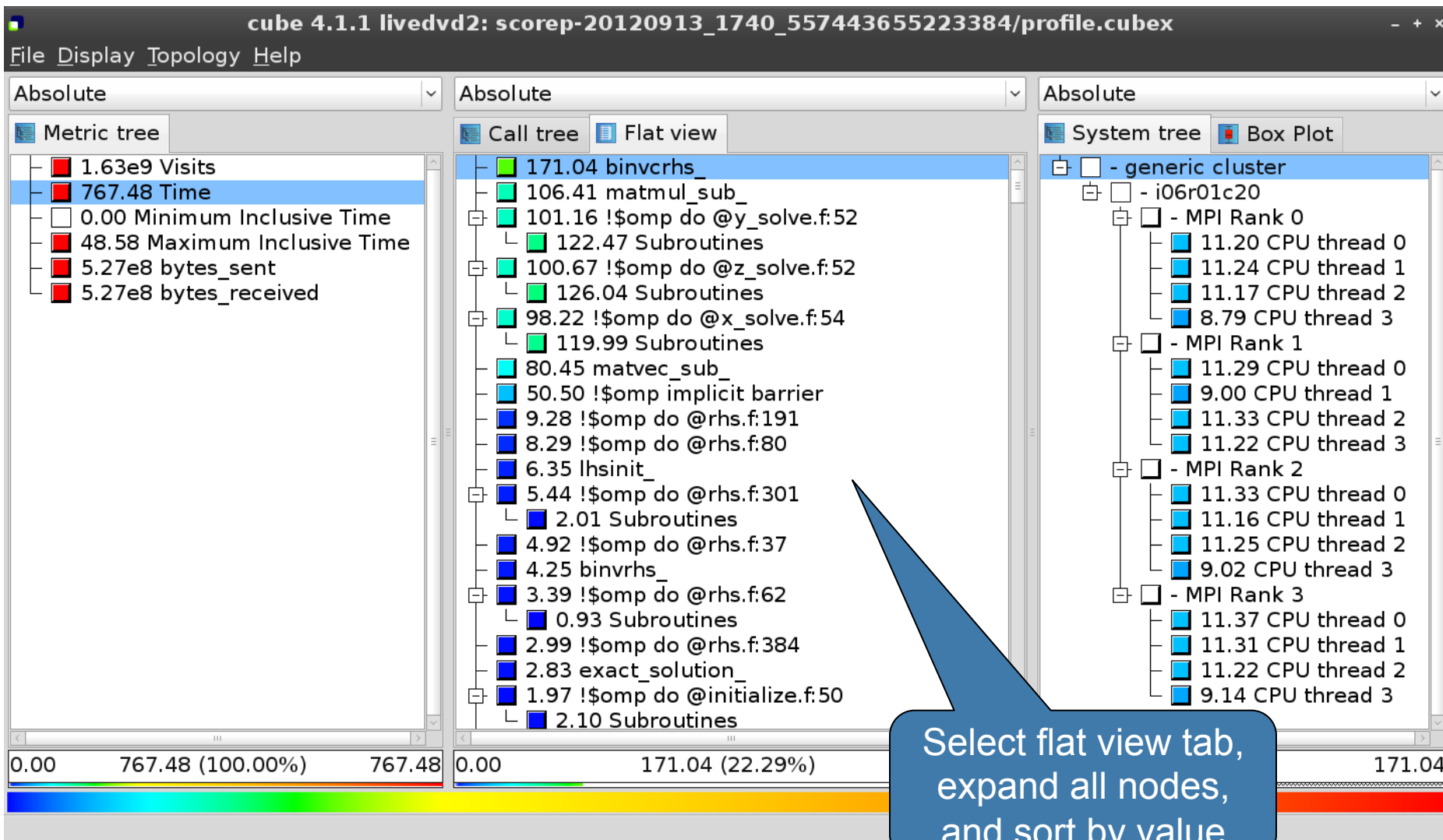


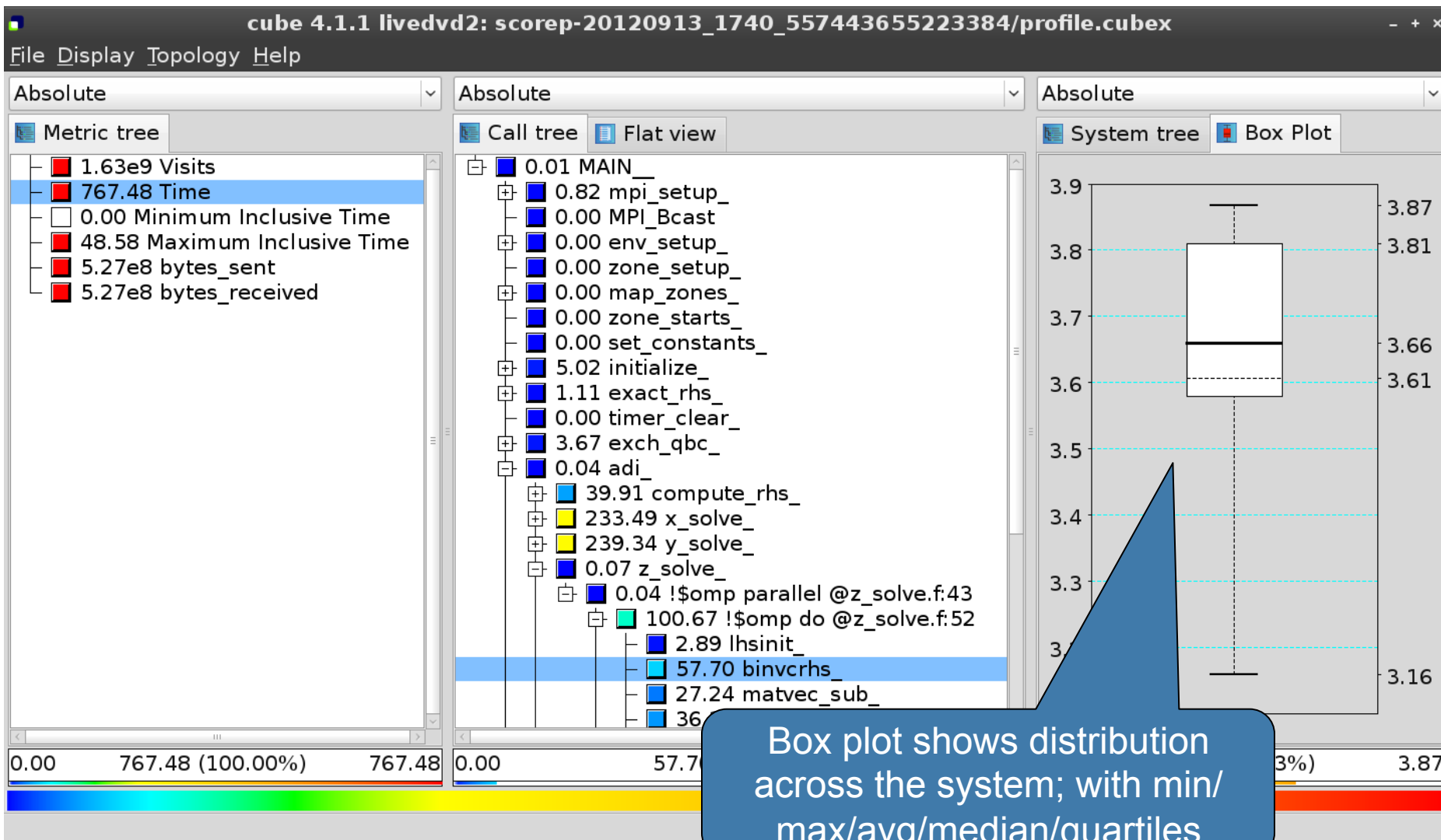
Selection updates Metric values shown in columns to right

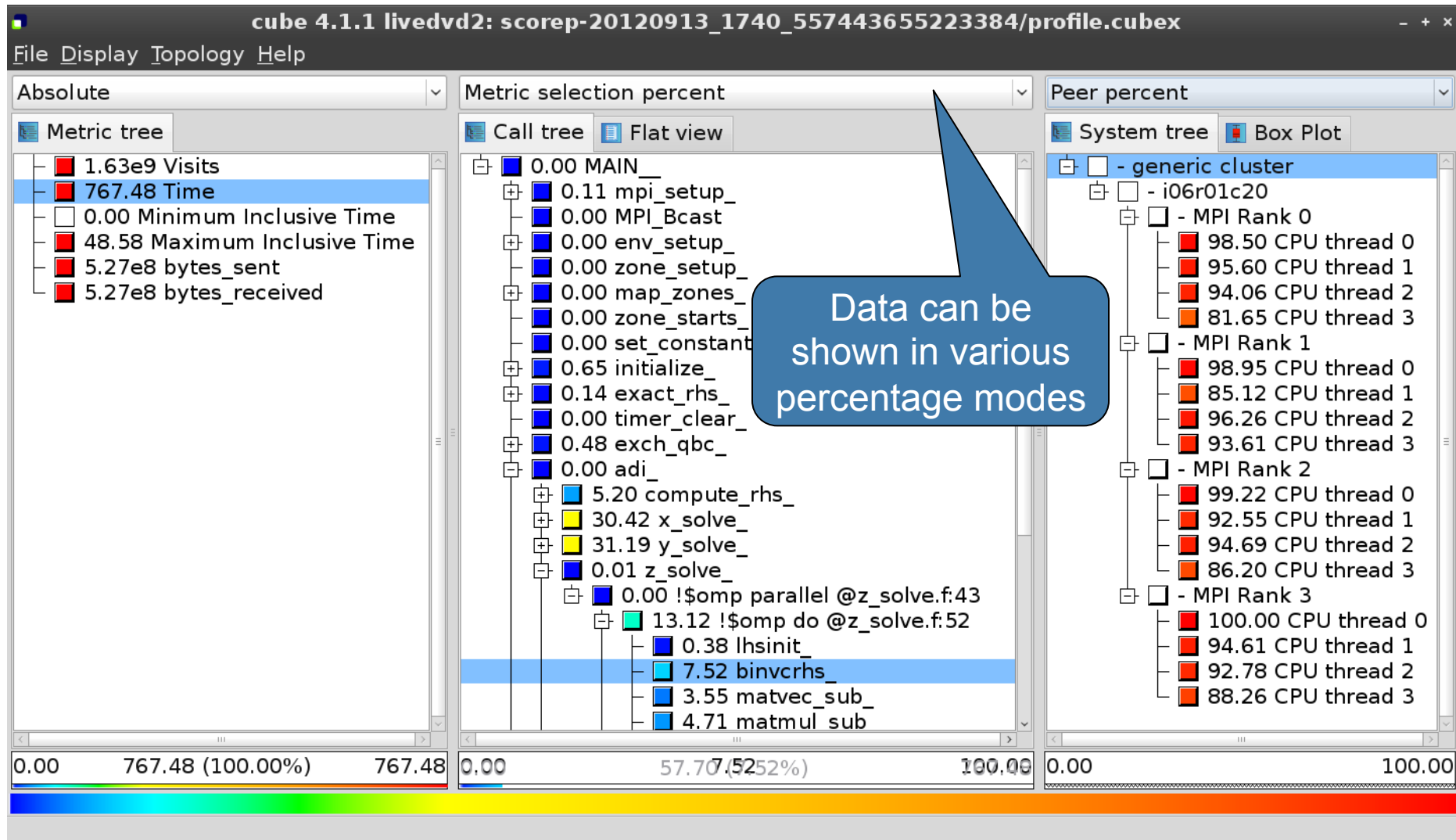


```
subroutine binvrhs( lhs,c,r )  
  
C-----  
C-----  
  
C-----  
C  
C-----  
  
implicit none  
  
double precision pivot, coeff, lhs  
dimension lhs(5,5)  
double precision c(5,5), r(5)  
  
C-----  
C  
C-----  
  
pivot = 1.00d0/lhs(1,1)  
lhs(1,2) = lhs(1,2)*pivot  
lhs(1,3) = lhs(1,3)*pivot  
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
```

# Flat profile view







- Absolute
  - Absolute value shown in seconds/bytes/occurrences
- Selection percent
  - Value shown as percentage of the value of 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

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

Absolute

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\_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

Absolute

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 48

0.00 668.54

Select multiple nodes with Ctrl-click

The screenshot shows the 'cube 4.1.1' application window with the 'Help' menu open. The 'What's This?' option is selected, and a callout box points to it with the text 'Context-sensitive help available for all GUI items'. The main window displays a 'Metric tree' on the left and a 'System tree' on the right. The 'Metric tree' shows a hierarchy of metrics, with '223.63 !\$omp do @y\_solve\_' selected. The 'System tree' shows a hierarchy of system components, with '44.10 CPU thread 0' selected. The bottom status bar shows 'Change into help mode for display components'.

cube 4.1.1 livedvd2: scorep-20120913\_1740\_557443655223384/profile.cubex

File Display Topology Help

Absolute

Metric tree

- 1.63e9 Visits
- 767.48 Time
- 0.00 Minimum I
- 48.58 Maximum
- 5.27e8 bytes\_s
- 5.27e8 bytes\_received

Getting started

Mouse and keyboard control

What's This? Shift+F1

About

Selected metrics description

Selected regions description

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\_solve\_

15.60 !\$omp implicit bar

0.07 z\_solve\_

0.04 !\$omp parallel @z\_solve\_

226.71 !\$omp do @z\_solve\_

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\_

Absolute

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

Change into help mode for display components

- Extracting solver sub-tree from analysis report

```
% cube_cut -r '<<SMG.Solve>>' scorep_smg2000/profile.cubex  
Writing cut.cubex... done.
```

- Calculating difference of two reports

```
% cube_diff scorep_smg2000/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

## CUBE

- Parallel program analysis report exploration tools
  - Libraries for XML report reading & writing
  - Algebra utilities for report processing
  - GUI for interactive analysis exploration
- Available under New BSD open-source license
- Documentation & Sources:
  - <http://www.score-p.org>
- User guide also part of installation:
  - ``cube-config --cube-dir`/share/doc/CubeGuide.pdf`
- Contact:
  - `mailto:scalasca@fz-juelich.de`

