

Analysis report examination with Cube

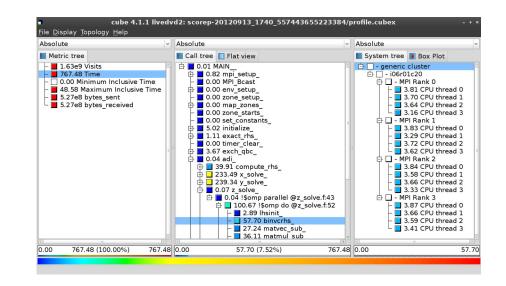
Anke Visser Jülich Supercomputing Centre





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 Qt4 \geq 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 v4.6 (April 2021)



Note:

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

Cube GUI (marenostrum)

mailto: scalasca@fz-juelich.de



- Run remote (often convenient)
 - start X server (e.g., Xming) locally
 - connect to marenostrum with X forwarding enabled
 - -Y may be faster but is insecure!
 - load cube module and start cube remotely

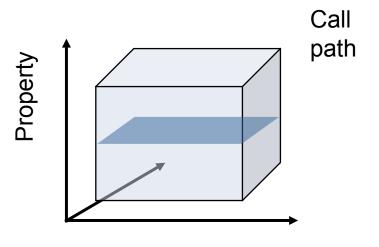
desk\$ ssh -X userid@mn2.bsc.es
mn2\$ PUBLIC=/gpfs/projects/nct00/nct00005/public
mn2\$ module use \$PUBLIC/software/modules
mn2\$ module load cubegui/4.6
mn2\$ cube ./scorep_sum/profile.cubex

- Install & run *local* (recommended)
 - 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@]mn2.bsc.es:[dir] \$HOME/mnt
desk\$ cd \$HOME/mnt
desk\$ cube ./scorep_sum/profile.cubex

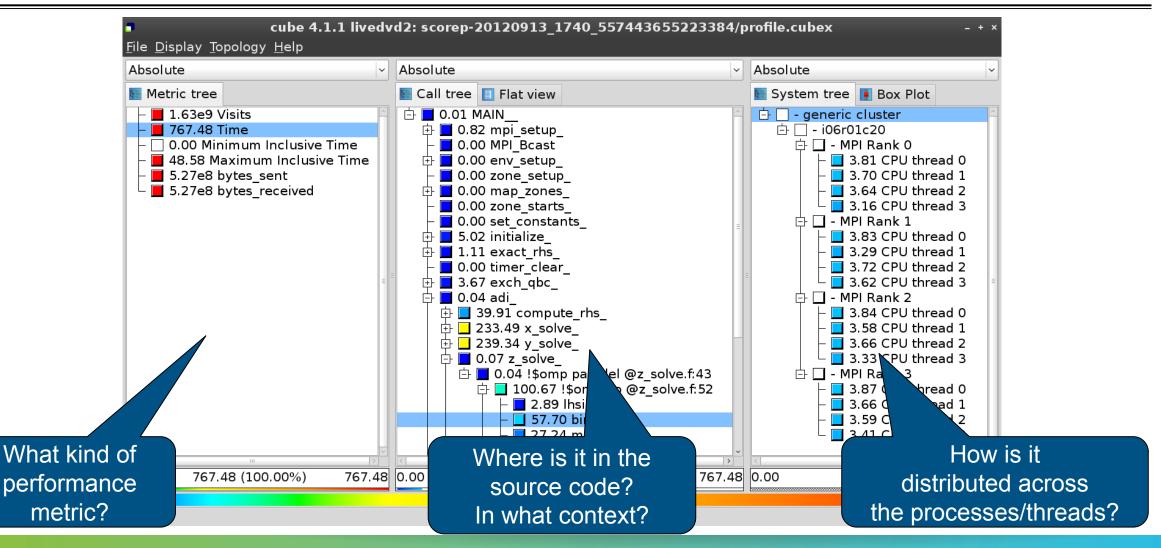
Analysis presentation and exploration

- 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





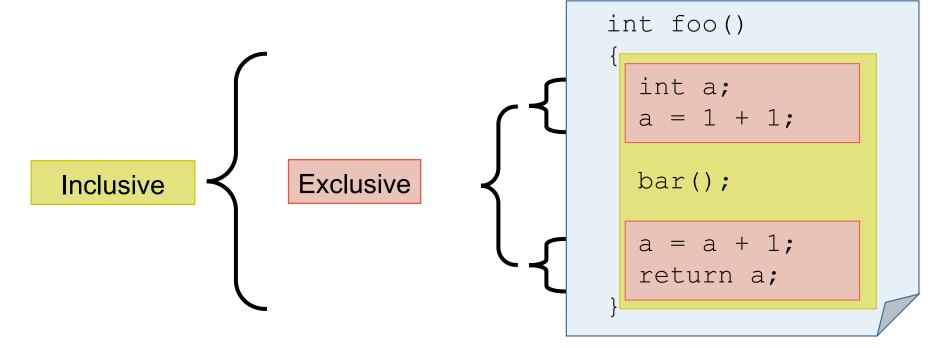
Analysis presentation



Inclusive vs. exclusive values



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



Score-P analysis report exploration (opening view)



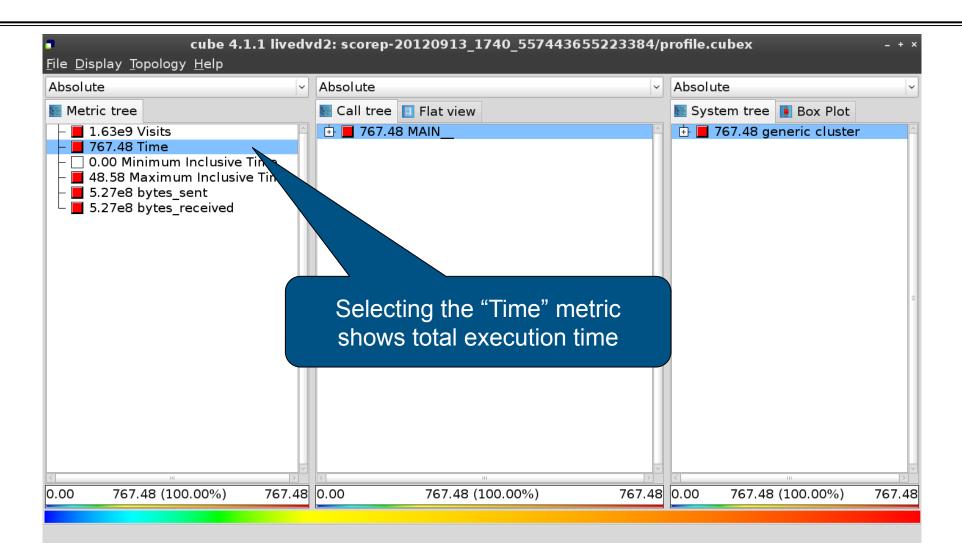
cube 4.1.1 livedvd2: scorep-20120913_1740_557443655223384/profile.cubex - + × File Display Topology Help								
Absolute	Absolute	~	Absolute					
💽 Metric tree	💽 Call tree 🔲 Flat view		🔄 System tree 頂 Box Plot					
 1.63e9 Visits 767.48 Time 0.00 Minimum Inclusive Time 48.58 Maximum Inclusive Time 5.27e8 bytes_sent 5.27e8 bytes_received 	■ 1.63e9 MAIN		■ 1.63e9 generic cluster					
		>						
0 1.63e9 (100.00%) 1.63e9	0 1.63e9 (100.00%) 1.63	3e9	0 1.63e9 (100.00%) 1.63e9					

VI-HPS

VIRTUAL INSTITUTE - HIGH PRODUCTIVITY SUPERCOMPUTING

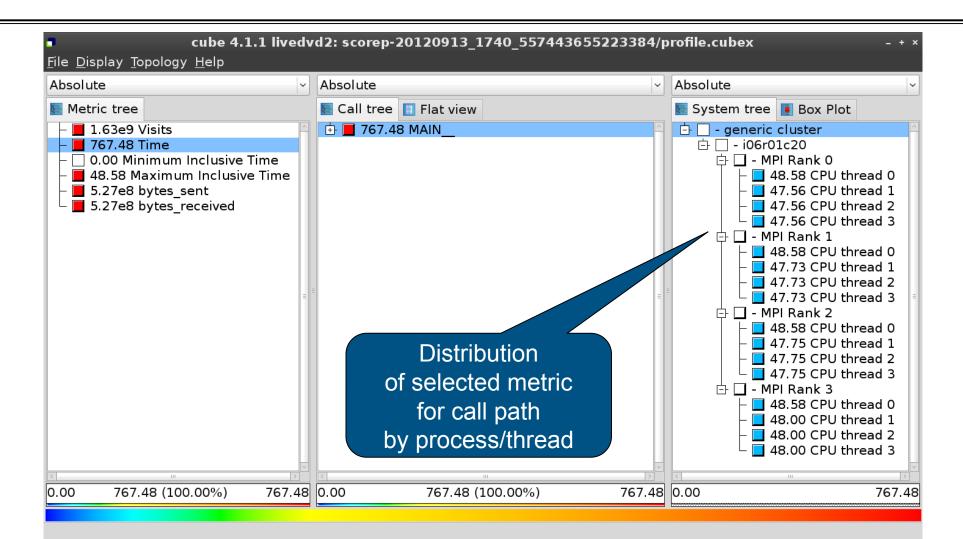
Metric selection





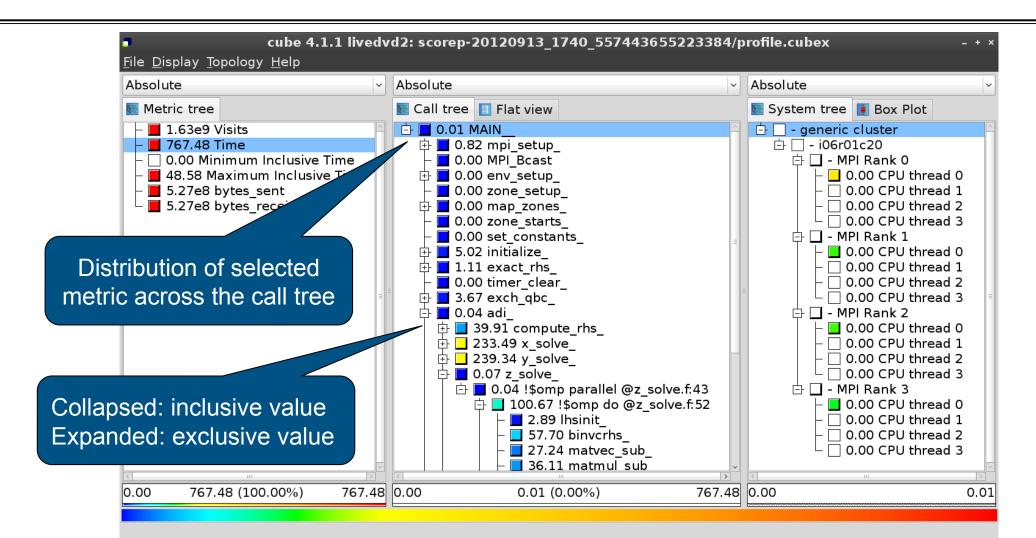
Expanding the system tree





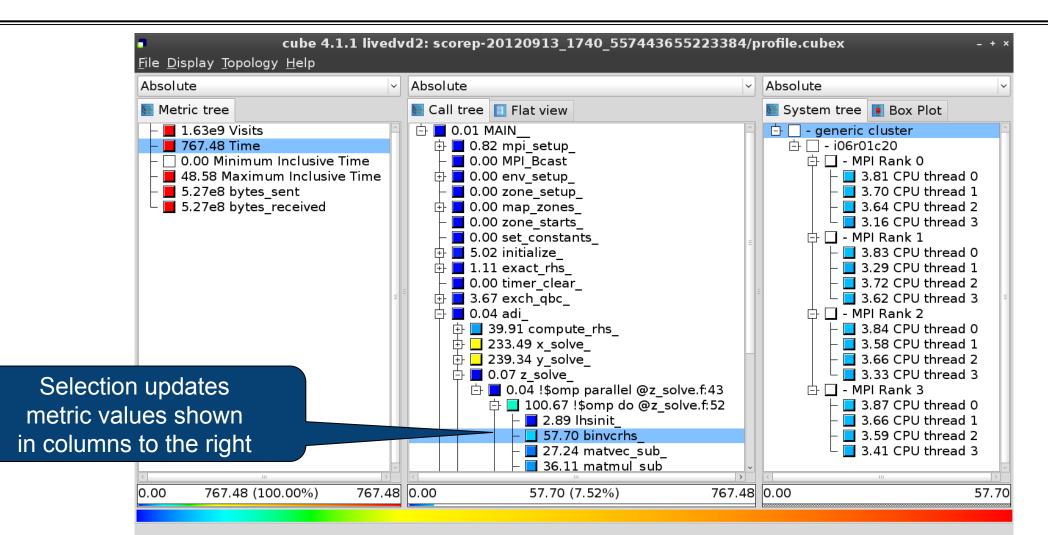
Expanding the call tree





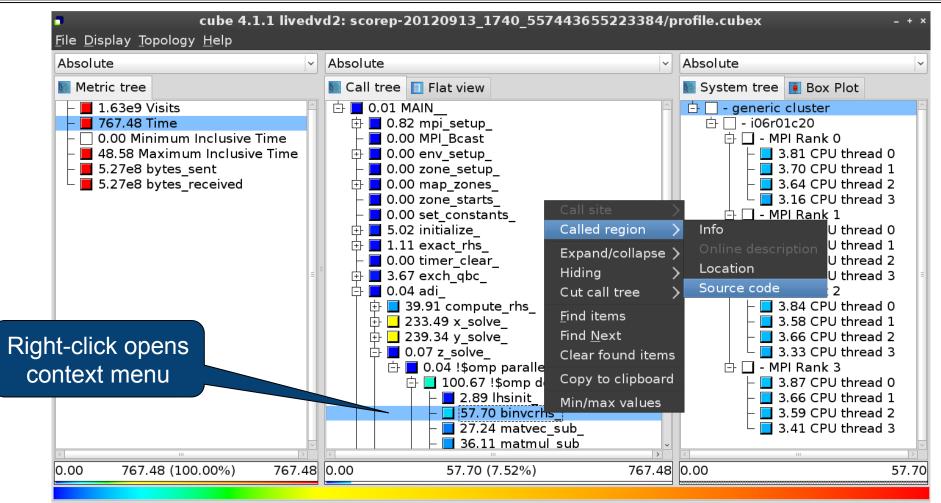
Selecting a call path





Source-code view via context menu





Shows the source code of the clicked item



Source-code view

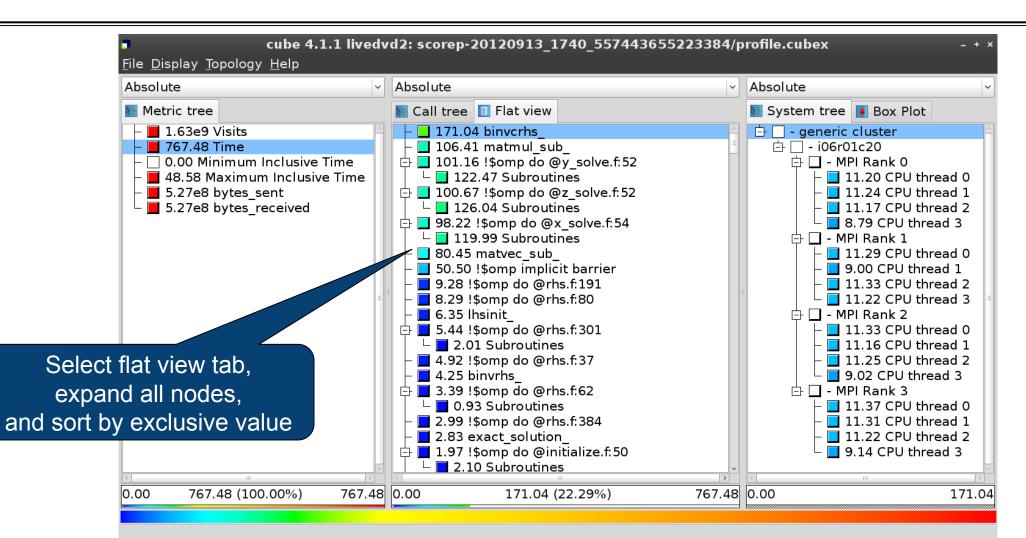


2	/home/geimer/Proje	ects/Tests/NPB3.3-MZ-MPI	/BT-MZ/solve_subs.f	×	
subroutine binvcrhs(c c implicit none double precision pivo dimension lhs(5,5) double precision c(5,	t, coeff, lhs	-			
c		-		Note:	a and line
pivot = $1.00d0/lhs(1, 2)$ lhs(1,2) = lhs(1,2)*pix lhs(1,3) = lhs(1,3)*pix lhs(1,4) = lhs(1,4)*pix lhs(1,5) = lhs(1,5)*pix c(1,1) = c(1,1)*pixot	vot vot		number in	re depends on fil formation provid ation, i.e., it may be available	ed by the
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	

VI-HPS

Flat profile view

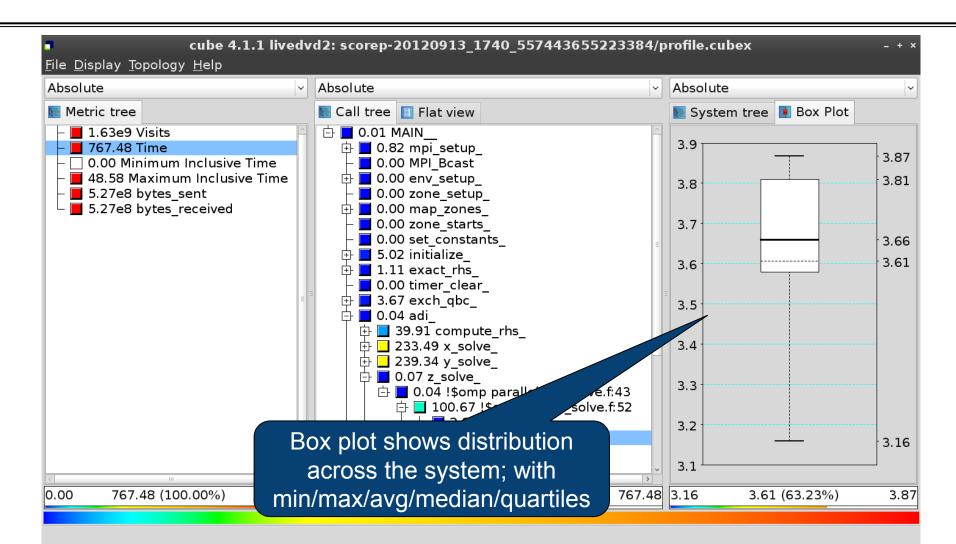




VI-HPS

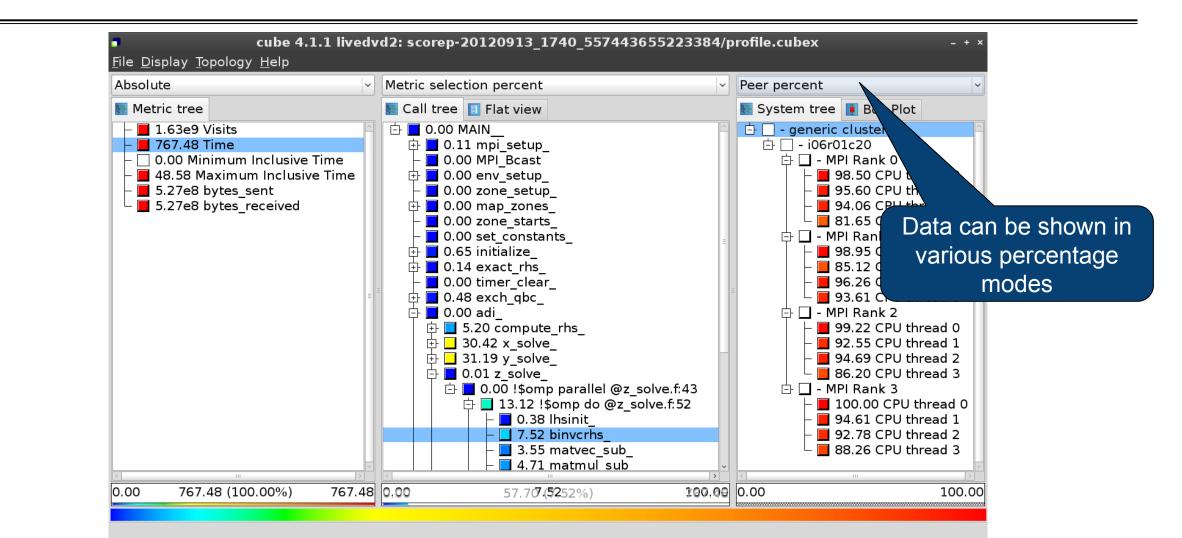
Box plot view





Alternative display modes





Important display modes



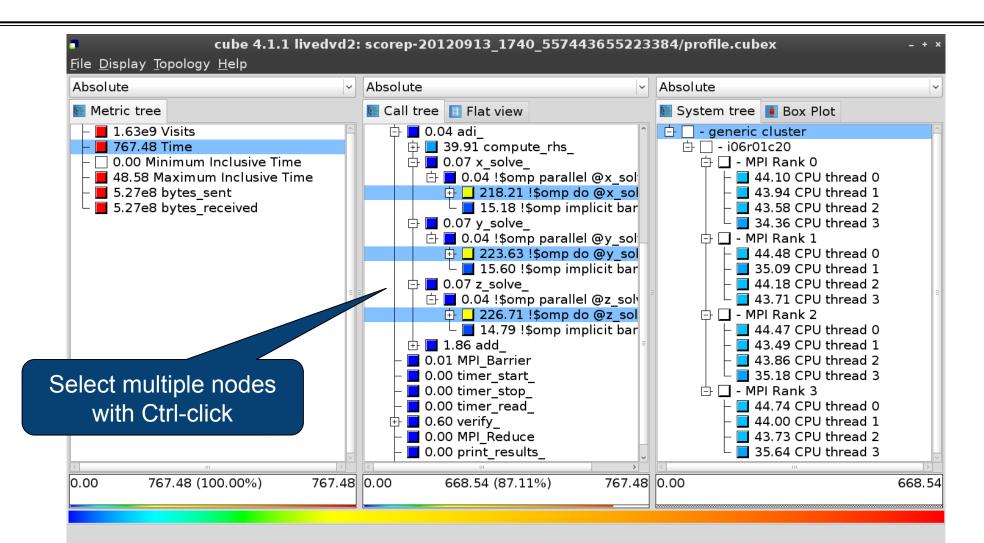
Absolute

- 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

VI-HPS

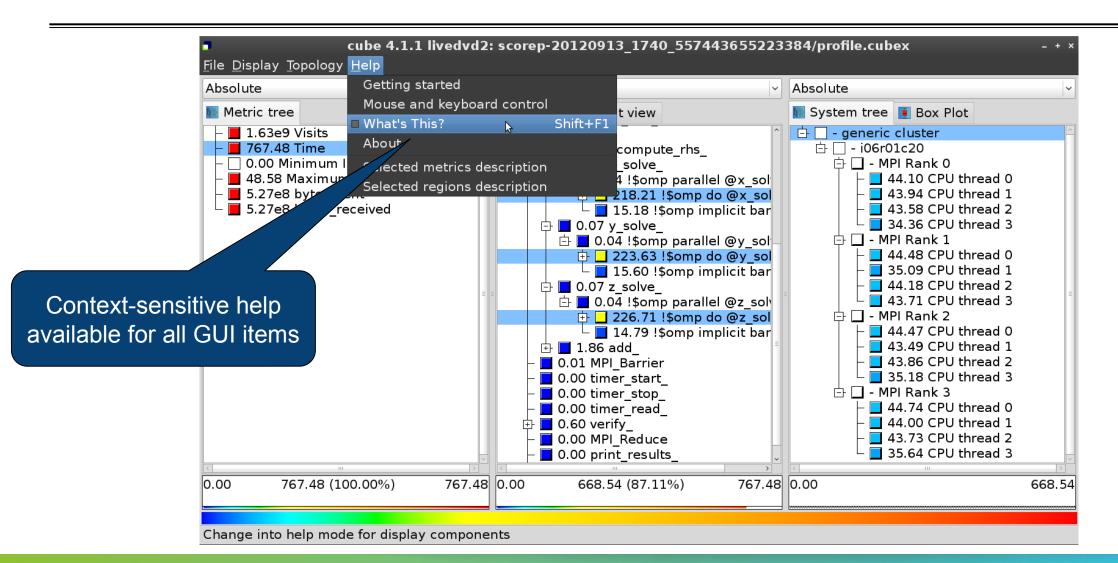
Multiple selection





Context-sensitive help





Derived metrics



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

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

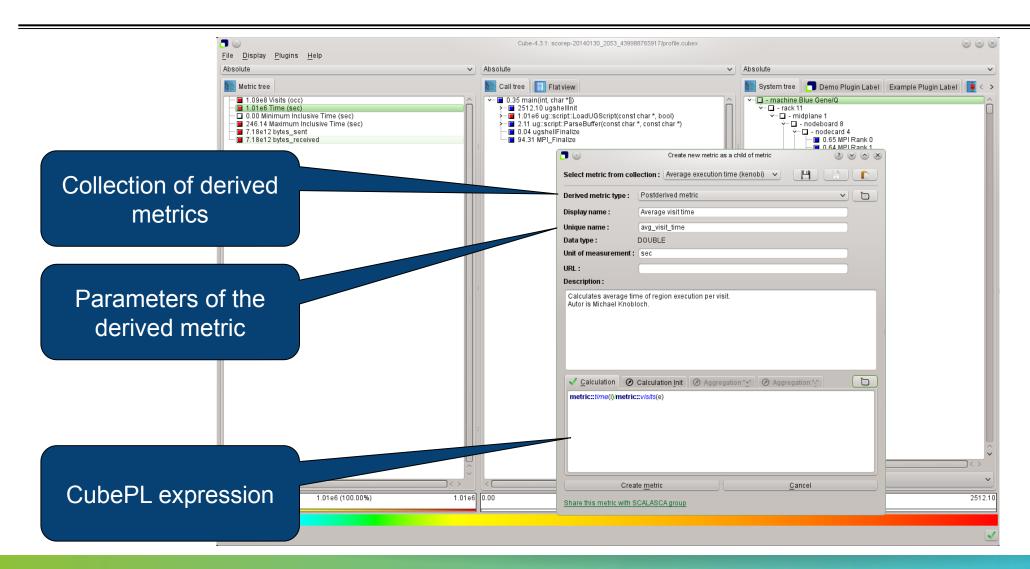
- Values of derived metrics are not stored, but calculated on-the-fly
- Types of derived metrics:
 - Prederived: evaluation of the CubePL expression is performed before aggregation
 - Postderived: evaluation of the CubePL expression is performed after aggregation
- Examples:
 - "Average execution time":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





Example: FLOPS based on PAPI_FP_OPS and time



	Cub	e-4.3.1: scorep_8x4_sum/profile.cubex (on froggy1)	_ _ x				
	File Display Plugins Help I Restore Setting ▼ Save Settings						
Edit metric FLOPS (on froggy1)	Absolute	Absolute	Absolute				
	Netric tree	Call tree	🔚 System tree 🛛 Barplot 🔰 Heatmap 🔰 📑 Boy 4 🕨				
Select metric from collection : please select 🗵 📳 📋 💼	□ 1.17e7 Visits (occ)]	e – machine Linux				
Derived metric type : Postderived metric	■ 1148.49 Time (sec)	i ■ ■ 7.04e5 mpi setup	ende frog6				
	□ 0.00 Minimum Inclusive Time (sec)	■ 6.34e4 MPI Bcast	ia - MPI Rank 0				
Display name : FLOPS	■ 41.57 Maximum Inclusive Time (■ ■ 2.05e5 env setup	□ 1.17e9 Master thread				
Unique name : flops	□ 0 bytes_put (bytes)	■ 7.39e5 zone_setup_	-■ 9.43e8 OMP thread 1				
Data type : DOUBLE	0 bytes_get (bytes)	■ ■ 9.31e5 map_zones_	■ 9.47e8 OMP thread 2				
Unit of measurement :	■ 5.75e12 PAPI_TOT_INS (#)	■ 9.39e4 zone_starts_	■ 9.47e8 OMP thread 3				
URL :	■ 2.69e12 PAPI_TOT_CYC (#)	■ 6.16e5 set_constants_	⊨ □ - MPI Rank 1				
Description :	■ 2.12e12 PAPI_FP_OPS (#)	🗄 🖬 5.91e8 initialize_	■ 1.17e9 Master thread				
	3.12e9 bytes_sent (bytes)	🖶 🗆 0.00 exact_rhs_	■ 9.87e8 OMP thread 1				
	3.12e9 bytes_received (bytes)	🖻 🖬 145.62 !\$omp parallel @exac	■ 9.68e8 OMP thread 2				
	■ 1.84e9 FLOPS	■ 2.54e4 !\$omp do @exact_r	9.72e8 OMP thread 3				
		□ 9.65e8 !\$omp do @exact_r	📄 🗗 - MPI Rank 2				
		⊕ 🖬 9.62e8 !\$omp do @exact_r	■ 1.10e9 Master thread				
		🗉 🖬 8.14e8 !\$omp do @exact_r	■ 8.97e8 OMP thread 1				
✓ Calculation Ø Calculation Init Ø Aggregation "±" Ø Aggregation "±"		■ 1.21e5 !\$omp do @exact_r	■ 8.77e8 OMP thread 2				
<pre>metric::PAPI_FP_OPS()/metric::time()</pre>		□ 0.00 !\$omp implicit barrier	■ 8.76e8 OMP thread 3				
		■ ■ 6.23e4 exch_qbc_	🖻 🗆 - MPI Rank 3				
		🖻 🖻 1.94e9 adi_	🗖 🖬 1.09e9 Master thread				
		■ 2.19e5 MPI_Barrier	-■ 9.06e8 OMP thread 1				
		■ ■ 1.92e9 < <bt_iter>> (200 itera</bt_iter>	■ 9.04e8 OMP thread 2				
		🗉 🖬 1.98e8 verify_	9.02e8 OMP thread 3				
Edit <u>m</u> etric <u>C</u> ancel		I I.05e5 MPI_Reduce _					
Share this metric with SCALASCA group			All (32 elements)				
Share and meane that SCARSCA group	0.00 1.84e9 (100.00%) 1.84e	9 0.00 9.65e8 (-0.00%) -12858016489314434.00	0.00179769313486231570814527423731704356798070				
		<u> </u>					
	Selected "!\$omp do @exact rhs.f:46"		•				

Iteration profiling



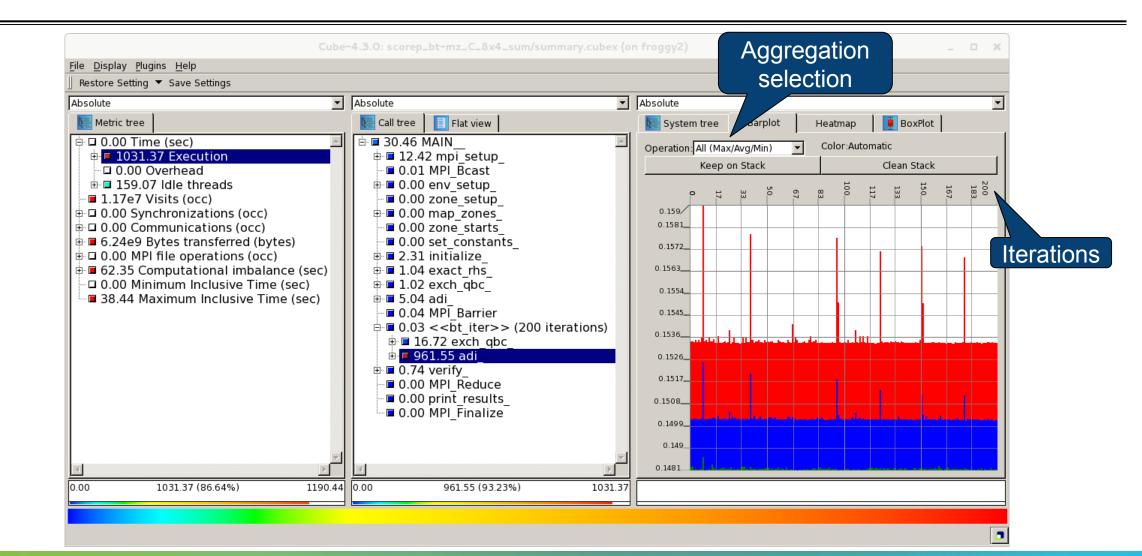
- Show time dependent behavior by "unrolling" iterations
- Preparations:
 - Mark loop body by using Score-P instrumentation API in your source cod

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

- 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

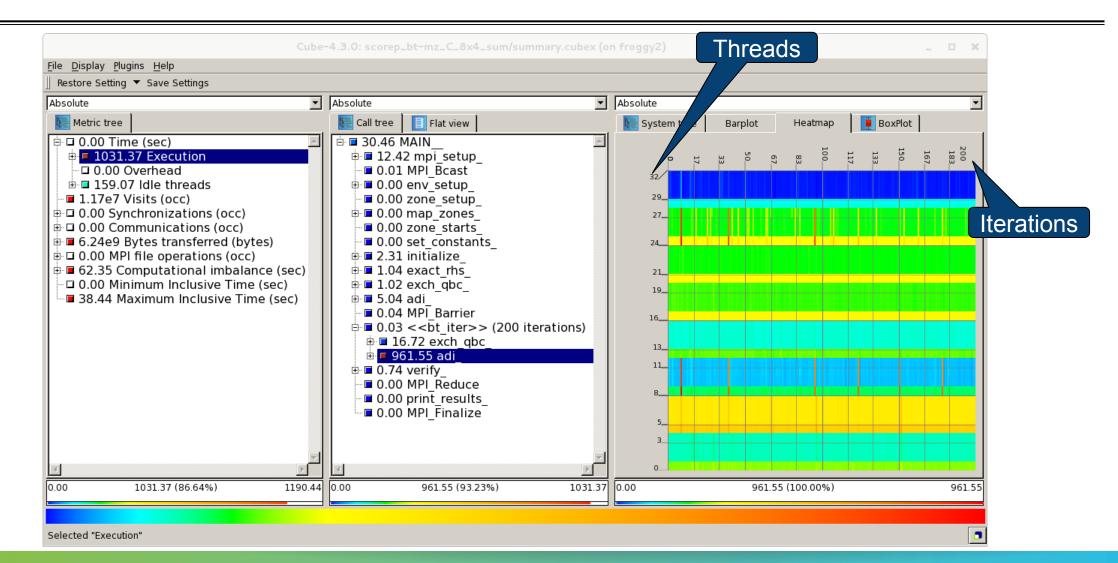
Iteration profiling: Barplot





Iteration profiling: Heatmap





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

