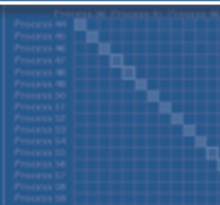


VI-HPS

SOFTWARE



```
0.00 <<time step loop>>
  0.00 updatedt
  6.62 updatex
 372.85 updateien
  0.00 gene
  0.00 <<iteration loop>>
 293.65 genbc
```

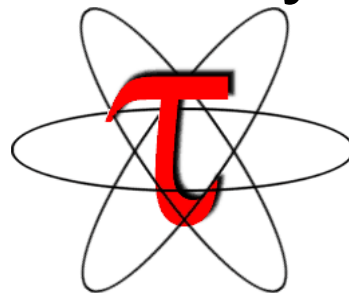


FAST SOLUTIONS

☒ PAPI\_L1\_DCM  
☒ PAPI\_L1\_JCM  
☐ PAPI\_L2\_DCM  
☒ PAPI\_L2\_JCM  
☒ PAPI\_L3\_TCM  
☐ PAPI\_L2\_TCM

PRODUCTIVITY

## Profile Analysis with ParaProf



Tuning and Analysis Utilities

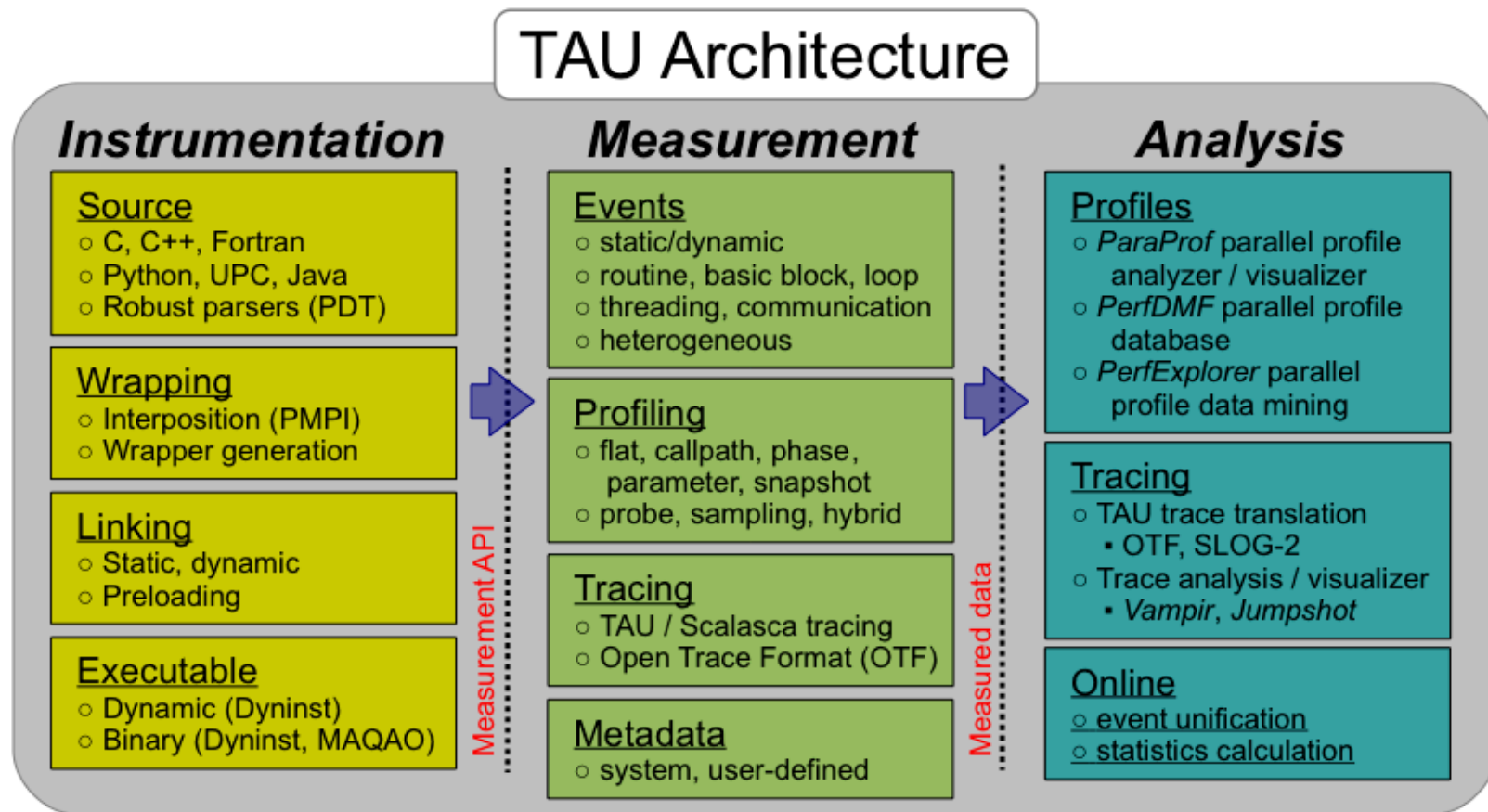
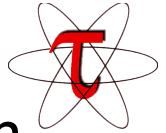


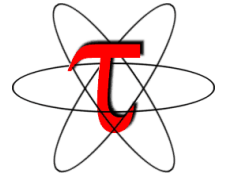
Sameer Shende

Performance Research Lab, University of Oregon

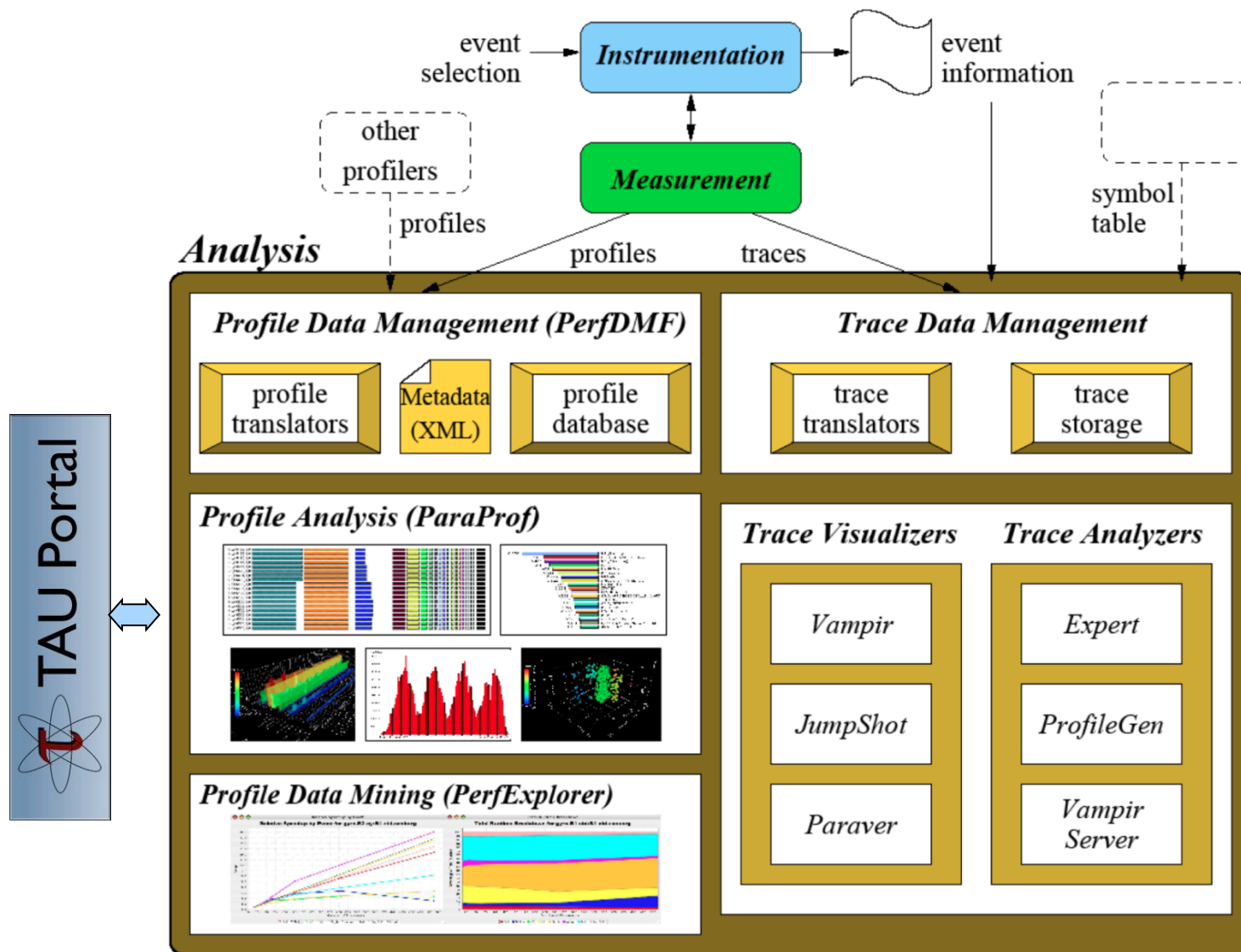
<http://TAU.uoregon.edu>

- Parallel performance framework and toolkit
  - Supports all HPC platforms, compilers, runtime system
  - Provides portable instrumentation, measurement, analysis

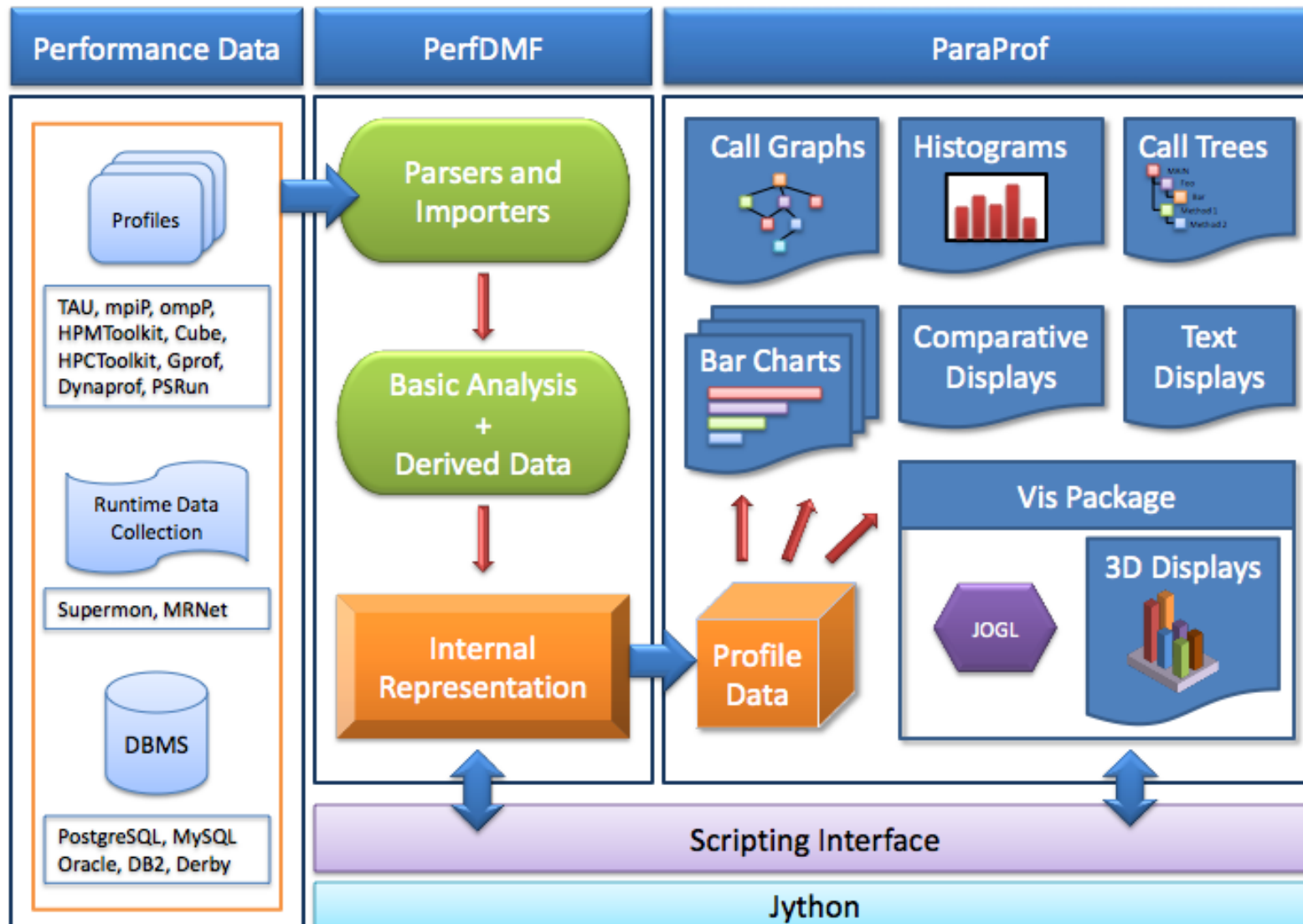




- Instrumentation
  - Fortran, C++, C, UPC, Java, Python, Chapel
  - Automatic instrumentation
- Measurement and analysis support
  - MPI, OpenSHMEM, ARMCI, PGAS, DMAPP
  - pthreads, OpenMP, hybrid, other thread models
  - GPU, CUDA, OpenCL, OpenACC
  - Parallel profiling and tracing
  - Use of Score-P for native OTF2 and CUBEX generation
  - Efficient callpath profiles and trace generation using Score-P
- Analysis
  - Parallel profile analysis (ParaProf), data mining (PerfExplorer)
  - Performance database technology (PerfDMF, TAUdb)
  - 3D profile browser

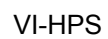


# ParaProf Profile Analysis Framework **VI-HPS**

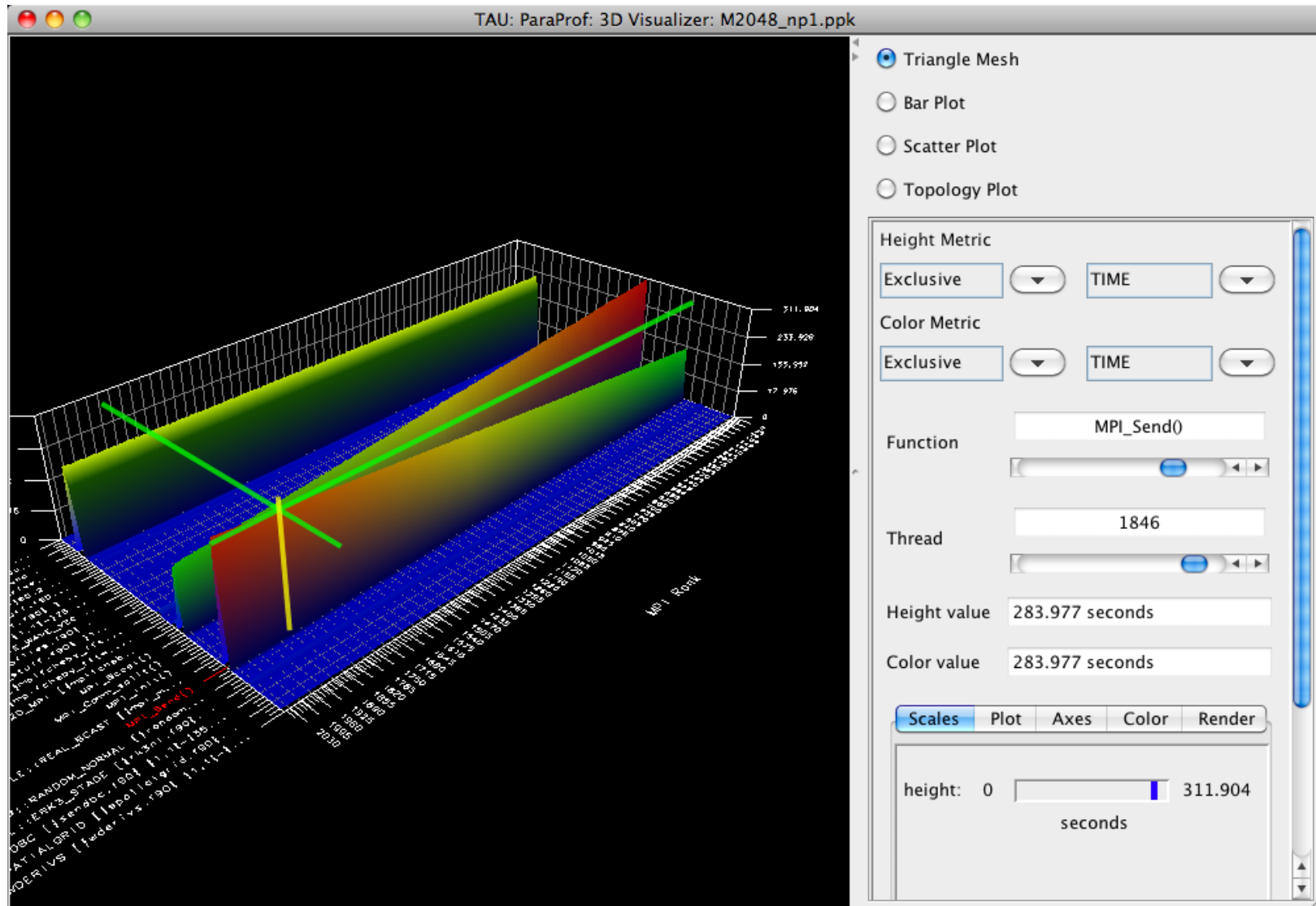




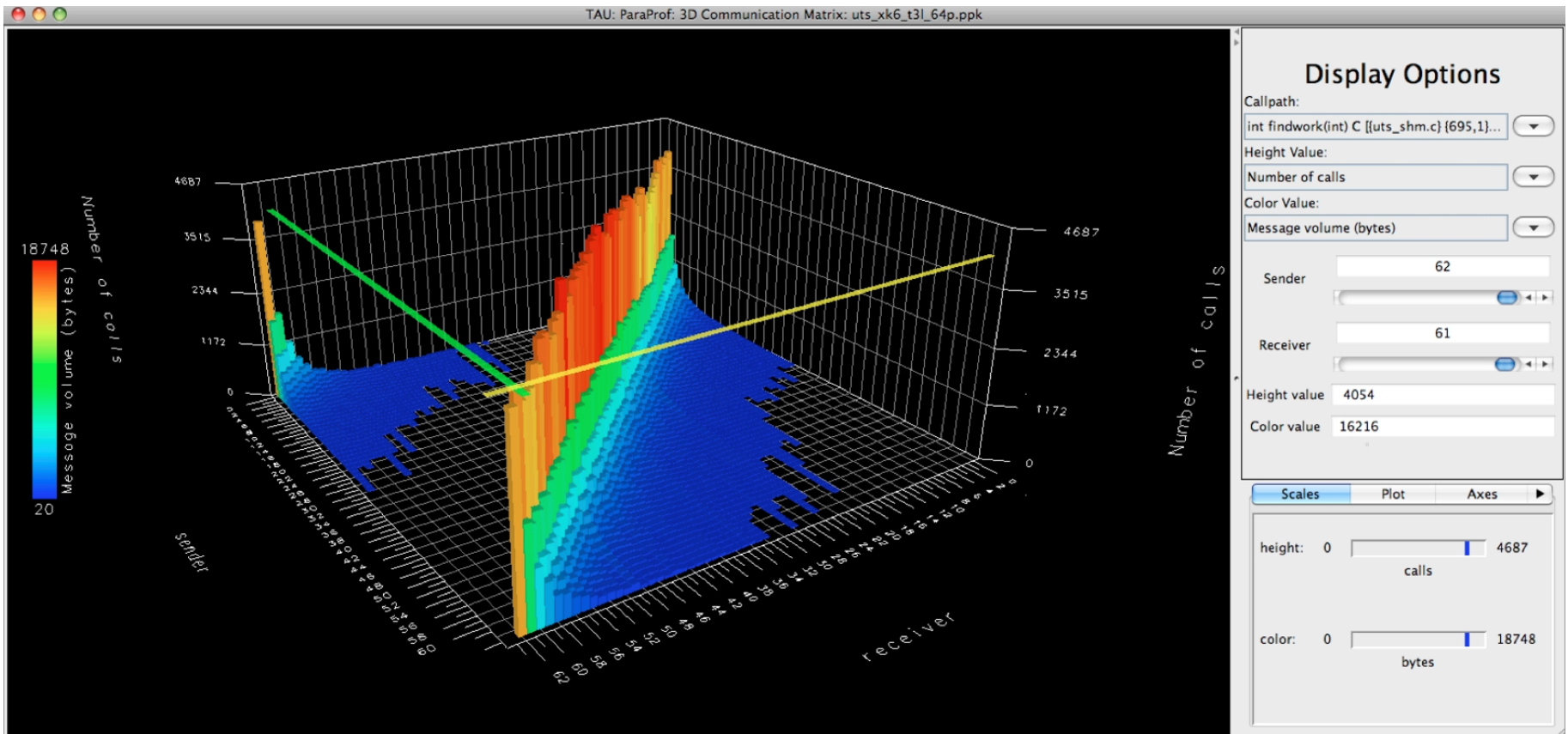
# VI-HPS



# Parallel Profile Visualization: ParaProf



## ParaProf: 3D Communication Matrix





- 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
README
run.out
scorep-20120913_1740_557443655223384
scorep_bt-mz_B_4x4_sum
scorep_bt-mz_B_4x4_sum+mets
scorep_bt-mz_B_4x4_trace
```

- Start TAU's paraprof GUI with default profile report

```
% paraprof scorep-20120913_1740_557443655223384/profile.cubex
OR
% paraprof scorep_bt-mz_B_4x4_trace/scout.cubex
```

## ParaProf: Manager Window: scout.cubex

TAU: ParaProf Manager

File Options Help

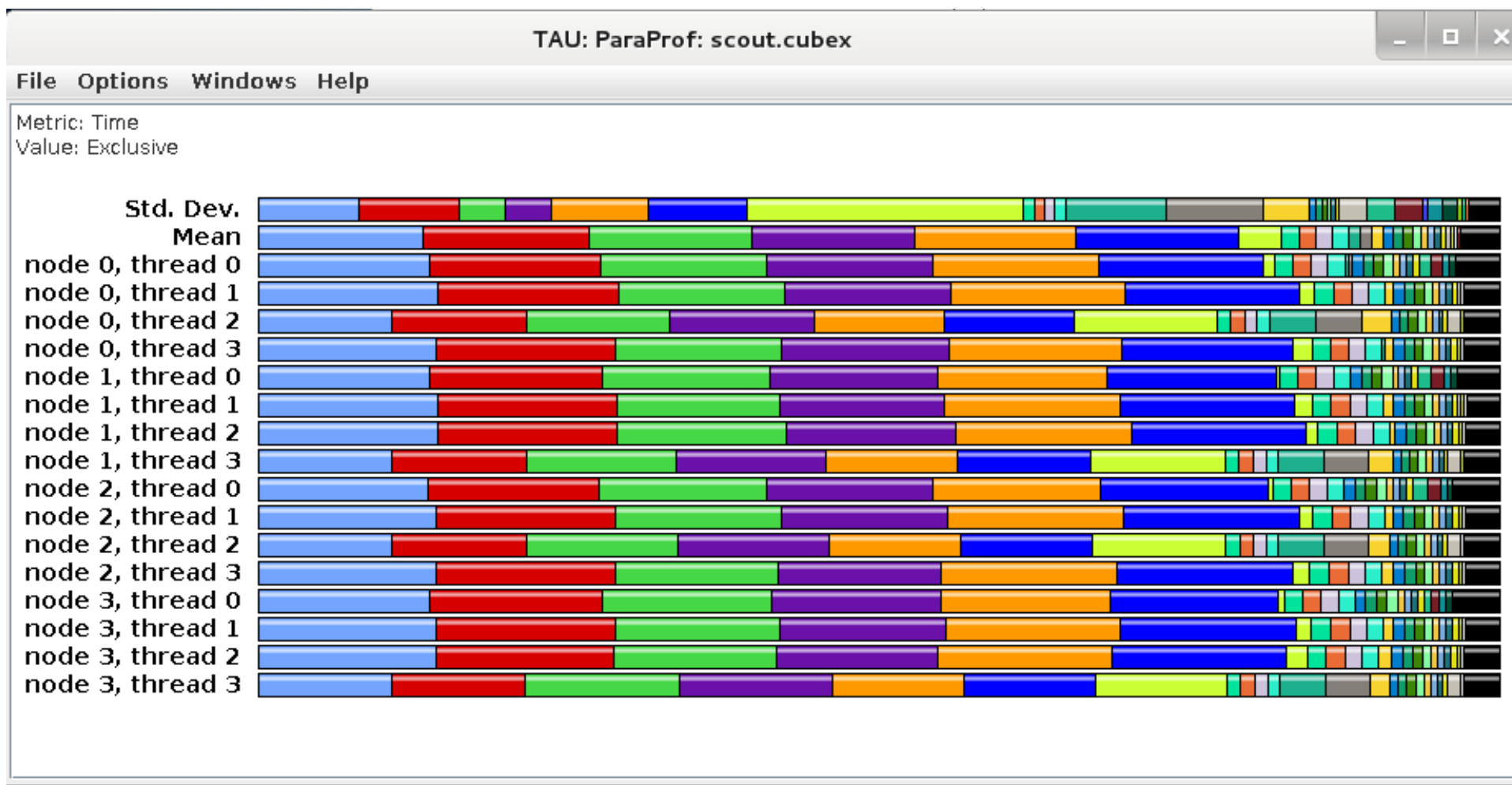
- Applications
  - Standard Applications
    - Default App
      - Default Exp
        - scout.cubex
          - Time
          - Wait at Barrier
          - Barrier Completion
          - Late Sender
          - Late Sender => Messages in Wrong Order
          - Late Sender => Messages in Wrong Order => Messages from different sources
          - Late Sender => Messages in Wrong Order => Messages from same source
          - Late Receiver
          - Early Reduce
          - Early Scan
          - Late Broadcast
          - Wait at N x N
          - N x N Completion
          - Management
          - Management => Fork
          - P2P send synchronizations
          - P2P send synchronizations => Late Receivers
          - P2P recv synchronizations
          - P2P recv synchronizations => Late Senders
          - P2P recv synchronizations => Late Senders => Messages in Wrong Order
          - Collective synchronizations
          - P2P send communications
          - P2P send communications => Late Receivers
          - P2P recv communications
          - P2P recv communications => Late Senders
          - P2P recv communications => Late Senders => Messages in Wrong Order
          - Collective exchange communications
          - Collective communications as source
          - Collective communications as destination
          - P2P bytes sent
          - P2P bytes received
          - Collective bytes outgoing
          - Collective bytes incoming
          - RMA bytes received
          - RMA bytes put

TrialField	Value
Name	scout.cubex
Application ID	0
Experiment ID	0
Trial ID	0
File Type Index	9
File Type Name	Cube

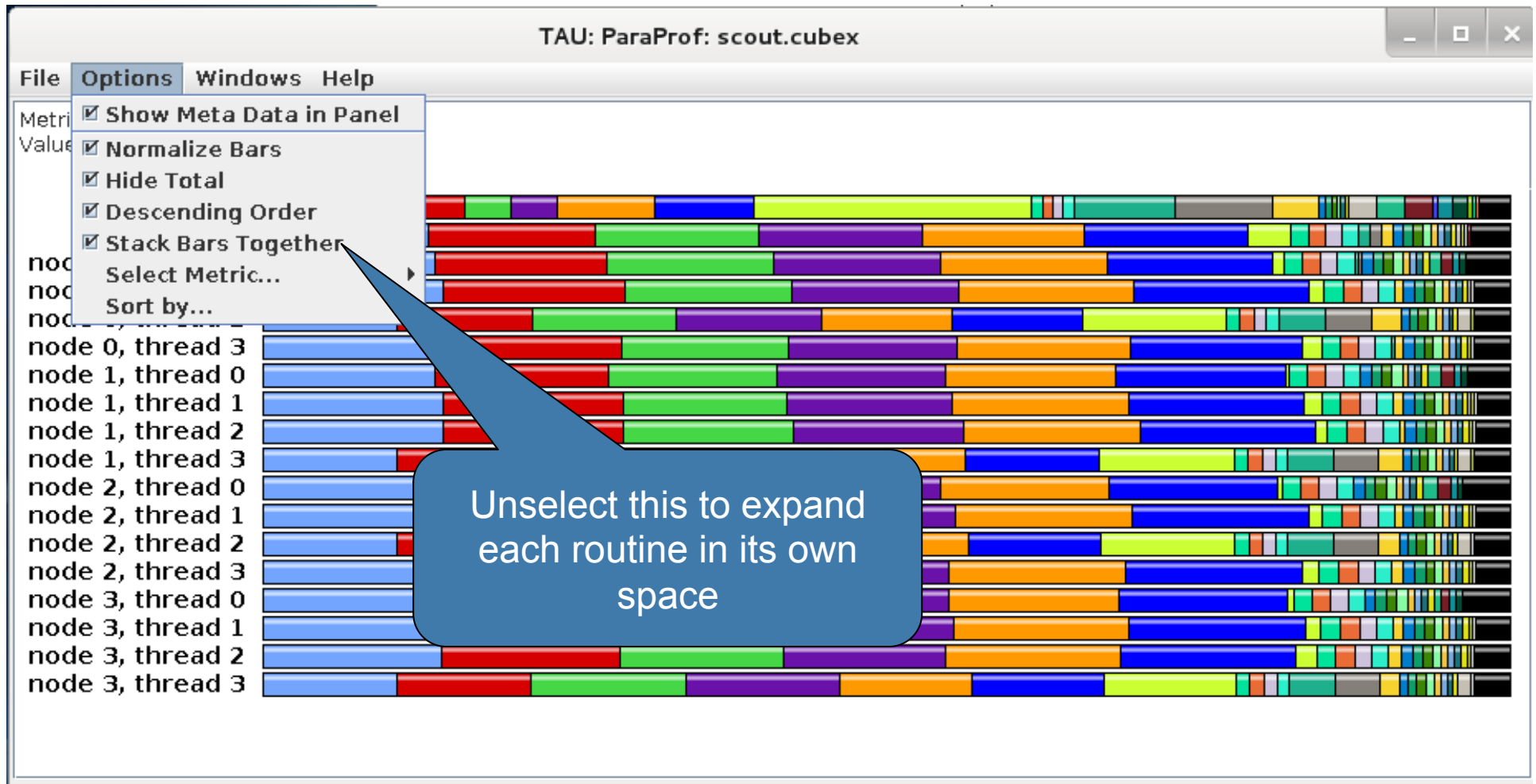
Metrics in the profile

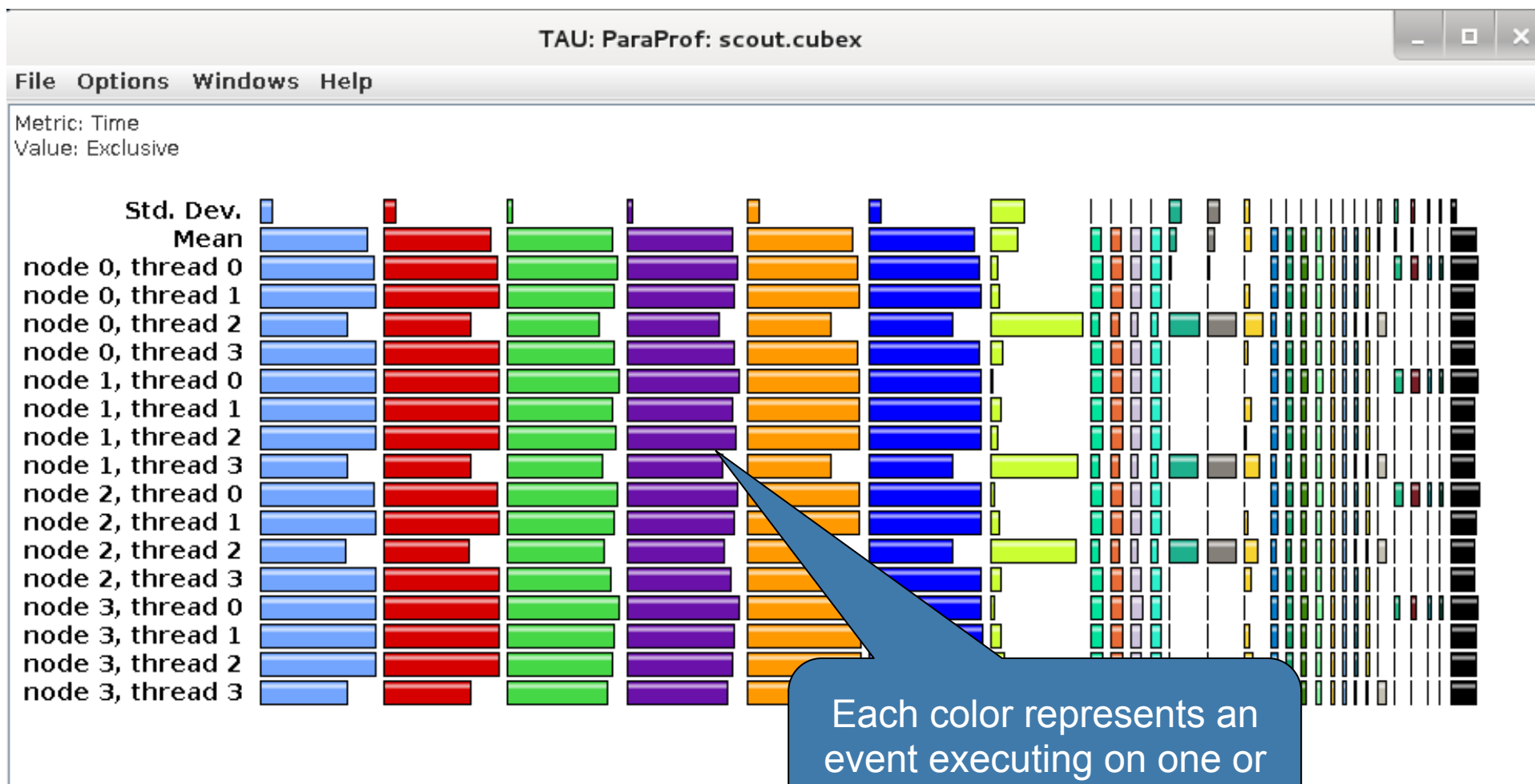
# ParaProf: Main window

# VI-HPS



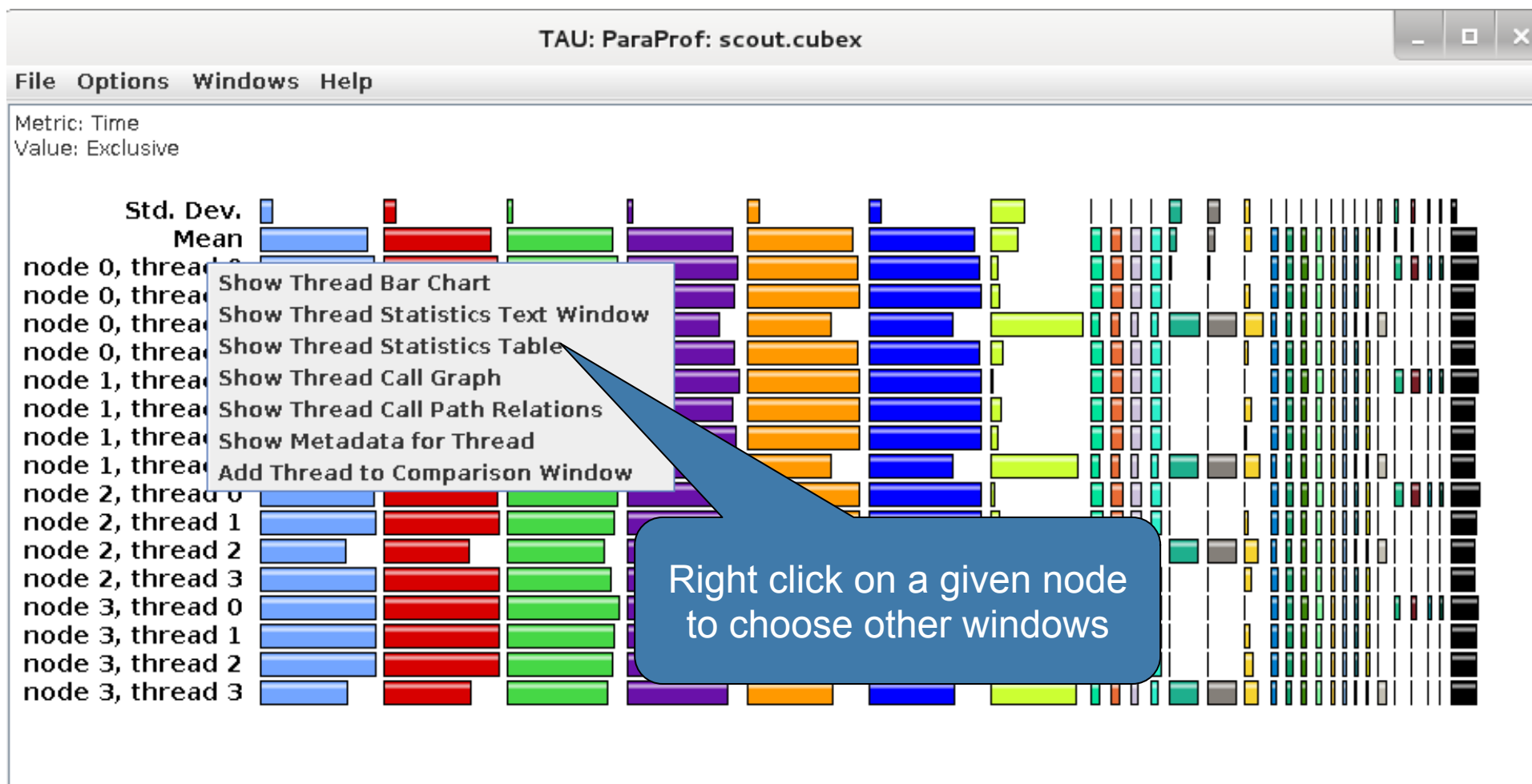
## ParaProf: Options







# ParaProf: Windows



## ParaProf: Thread Statistics Table

TAU: ParaProf: Statistics for: node 0, thread 0 - scout.cubex

File Options Windows Help

Time

Name	Exclusive Time ▾	Inclusive Time	Calls	Child Calls
!\$omp do @y_solve.f:52	5.817	5.817	3,216	0
!\$omp do @z_solve.f:52	5.657	5.657	3,216	0
!\$omp do @x_solve.f:54	5.609	5.609	3,216	0
!\$omp do @rhs.f:191	0.609	0.609	3,232	0
!\$omp do @rhs.f:80	0.583	0.583	3,232	0
MPI_Waitall	0.402	0.402	1	0
!\$omp implicit barrier	0.402	0.402	1	0
!\$omp do @rhs.f:301	0.36	0.36	1	0
!\$omp implicit barrier	0.026	0.026	1	0
!\$omp implicit barrier	0	0	1	0
!\$omp do @rhs.f:37	0.343	0.343	1	0
!\$omp do @rhs.f:62	0.225	0.228	3,232	3,232
!\$omp implicit barrier	0.004	0.004	3,216	0
!\$omp implicit barrier	0	0	16	0
MPI_Init_thread	0.218	0.218	1	0
!\$omp do @rhs.f:384	0.199	0.199	3,232	0
!\$omp parallel do @add.f:22	0.099	0.111	3,216	3,216
!\$omp do @rhs.f:428	0.069	0.069	3,232	0
MPI_Isend	0.043	0.043	603	0
!\$omp do @initialize.f:50	0.04	0.04	32	0
!\$omp parallel @rhs.f:28	0.03	2.536	3,232	51,712
!\$omp parallel do @exch_qbc.f:215	0.021	0.029	6,432	6,432
!\$omp parallel do @exch_qbc.f:255	0.02	0.033	6,432	6,432
!\$omp parallel @exch_qbc.f:255	0.02	0.053	6,432	6,432
!\$omp parallel @exch_qbc.f:244				

Click to sort by a given metric, drag and move to rearrange columns

FinderScreenSnapz003.png

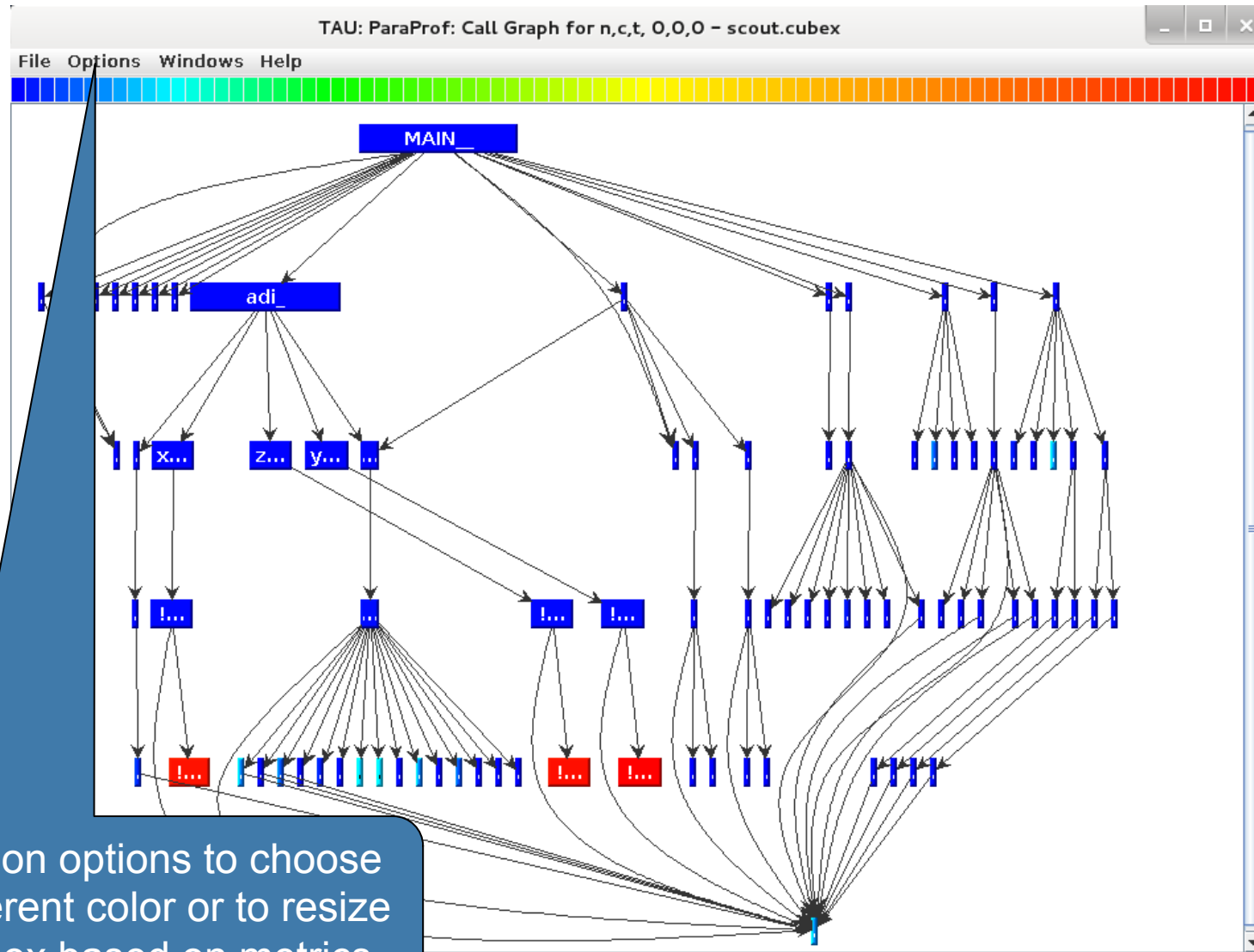
# Example: Score-P with TAU (LU NPB)



TAU: ParaProf: Statistics for: node 0, thread 0 - profile.cubex

Name	Exclusive Time	Inclusive Time	Calls	Child Calls
APPLU [{lu.f} {46,7}-{162,9}]	0	8.035	1	19
SSOR [{ssor.f} {4,7}-{241,9}]	0.064	6.225	2	37,643
RHS [{rhs.f} {5,7}-{504,9}]	0.743	2.524	303	606
BLTS [{blts.f} {4,7}-{259,9}]	0.613	0.658	9,331	18,662
BUTS [{buts.f} {4,7}-{259,9}]	0.612	1.871	9,331	18,662
EXCHANGE_1 [{exchange_1.f} {5,7}-{177,9}]	0.024	1.259	18,662	18,662
MPI_Recv	1.235	1.235	18,662	0
MPI_Send	0	0	0	0
JACU [{jacu.f} {5,7}-{384,9}]	0.532	0.532	9,331	0
JACLD [{jacld.f} {5,7}-{384,9}]	0.522	0.522	9,331	0
MPI_Allreduce	0.018	0.018	2	0
L2NORM [{l2norm.f} {4,7}-{68,9}]	0	0.035	4	4
MPI_Barrier	0	0	2	0
TIMER_START [{timers.f} {23,7}-{37,9}]	0	0	2	0
TIMER_STOP [{timers.f} {43,7}-{59,9}]	0	0	2	0
TIMER_CLEAR [{timers.f} {4,7}-{17,9}]	0	0	2	0
TIMER_READ [{timers.f} {65,7}-{77,9}]	0	0	2	0
SETIV [{setiv.f} {4,7}-{67,9}]	0.043	0.111	2	95,232
PROC_GRID [{proc_grid.f} {5,7}-{34,9}]	0.011	0.011	1	0
ERHS [{erhs.f} {4,7}-{536,9}]	0.004	0.108	1	2
ERROR [{error.f} {4,7}-{81,9}]	0.004	0.009	1	7,937
SETBV [{setbv.f} {5,7}-{79,9}]	0.002	0.004	2	3,400
READ_INPUT [{read_input.f} {5,7}-{125,9}]	0	0.001	1	2
VERIFY [{verify.f} {5,9}-{403,11}]	0	0	1	0
PRINT_RESULTS [{print_results.f} {2,7}-{115,12}]	0	0	1	0
PINTGR [{pintgr.f} {5,7}-{288,9}]	0	0	1	6
INIT_COMM [{init_comm.f} {5,7}-{57,9}]	0	1.565	1	4
MPI_Finalize	0	0	1	0
SETHYPER [{sethyper.f} {5,7}-{94,9}]	0	0	1	0
NEIGHBORS [{neighbors.f} {5,7}-{48,9}]	0	0	1	0
SETCOEFF [{setcoeff.f} {5,7}-{157,9}]	0	0	1	0

## ParaProf: Thread Callgraph Window



## ParaProf: Callpath Thread Relations Window

TAU: ParaProf: Call Path Data n,c,t, 0,0,0 - scout.cubex

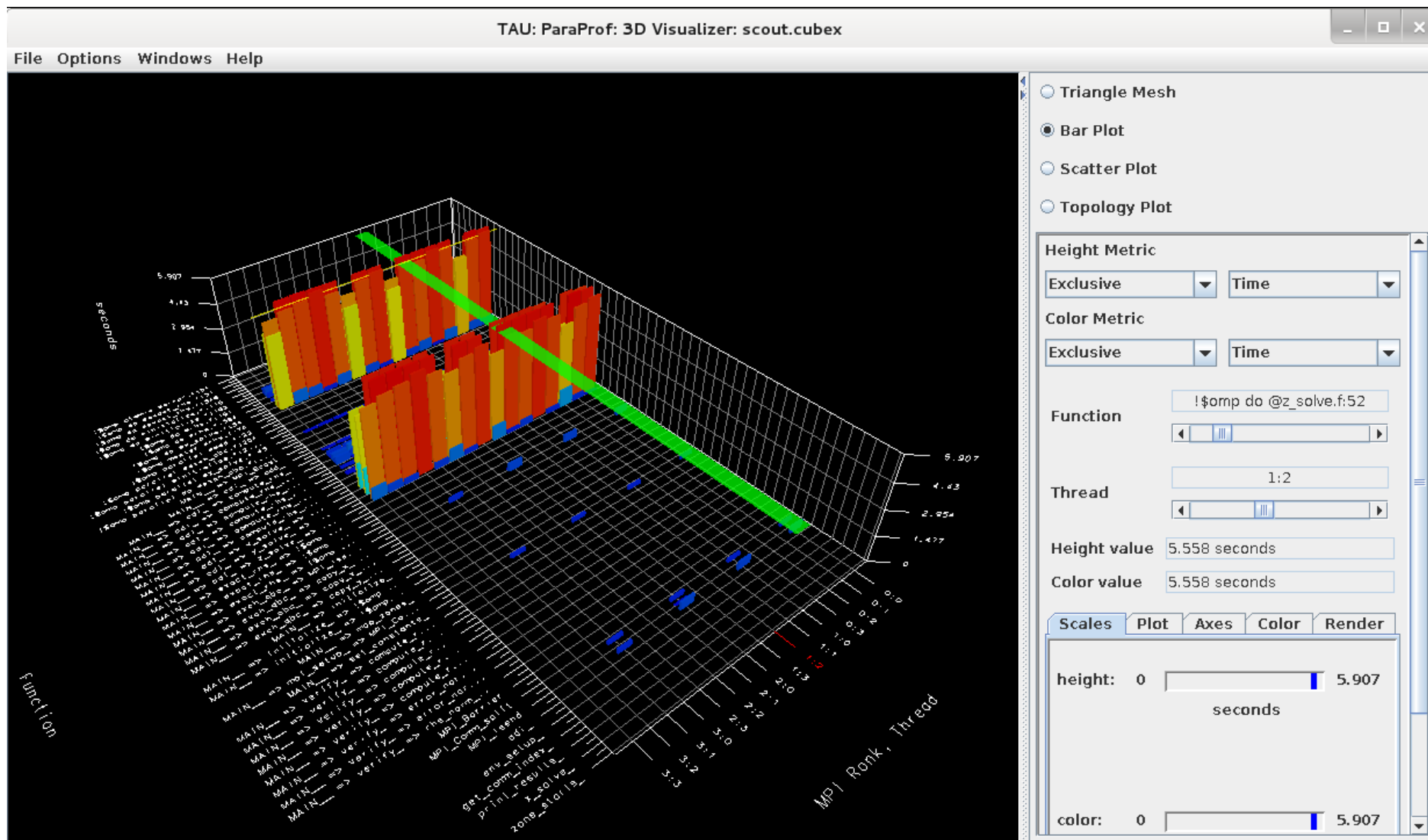
File Options Windows Help

Metric Name: Time  
Sorted By: Exclusive  
Units: seconds

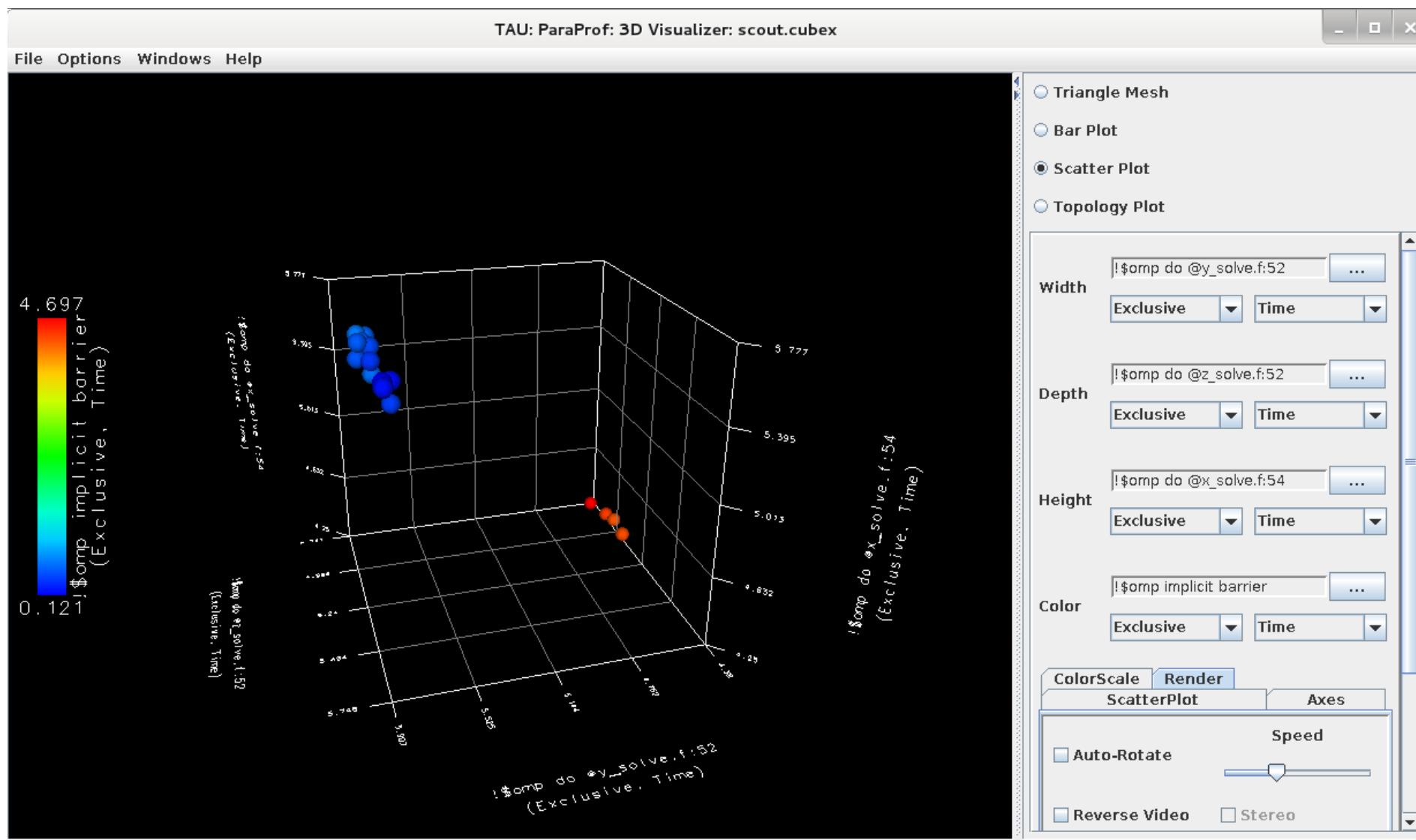
-->	0.04	0.04	32/32	!\$omp parallel @initialize.f:28
	0.04	0.04	32	!\$omp do @initialize.f:50
-->	0.03	2.536	3232/3232	compute_rhs_
	0.03	2.536	3232	!\$omp parallel @rhs.f:28
	9.8E-4	9.8E-4	3232/3232	!\$omp master @rhs.f:424
	0.225	0.228	3232/3232	!\$omp do @rhs.f:62
	0.002	0.002	3232/3232	!\$omp master @rhs.f:74
	0.002	0.002	3232/3232	!\$omp master @rhs.f:293
	0.199	0.199	3232/3232	!\$omp do @rhs.f:384
	0.002	0.002	3232/3232	!\$omp master @rhs.f:183
	0.343	0.343	3232/3232	!\$omp do @rhs.f:37
	0.016	0.016	3232/3232	!\$omp do @rhs.f:372
	0.014	0.027	3232/3232	!\$omp do @rhs.f:413
	0.609	0.609	3232/3232	!\$omp do @rhs.f:191
	0.36	0.386	3232/3232	!\$omp do @rhs.f:301
	0.583	0.583	3232/3232	!\$omp do @rhs.f:80
	0.019	0.019	3232/3232	!\$omp do @rhs.f:400
	0.006	0.006	3232/51680	!\$omp implicit barrier
	0.069	0.069	3232/3232	!\$omp do @rhs.f:428
	0.015	0.015	3232/3232	!\$omp do @rhs.f:359
-->	0.021	0.029	6432/6432	!\$omp parallel @exch_qbc.f:215
	0.021	0.029	6432	!\$omp parallel do @exch_qbc.f:215
	0.007	0.007	6432/51680	!\$omp implicit barrier
-->	0.02	0.033	6432/6432	!\$omp parallel @exch_qbc.f:255
	0.02	0.033	6432	!\$omp parallel do @exch_qbc.f:255
	0.013	0.013	6432/51680	!\$omp implicit barrier



# V-HPS

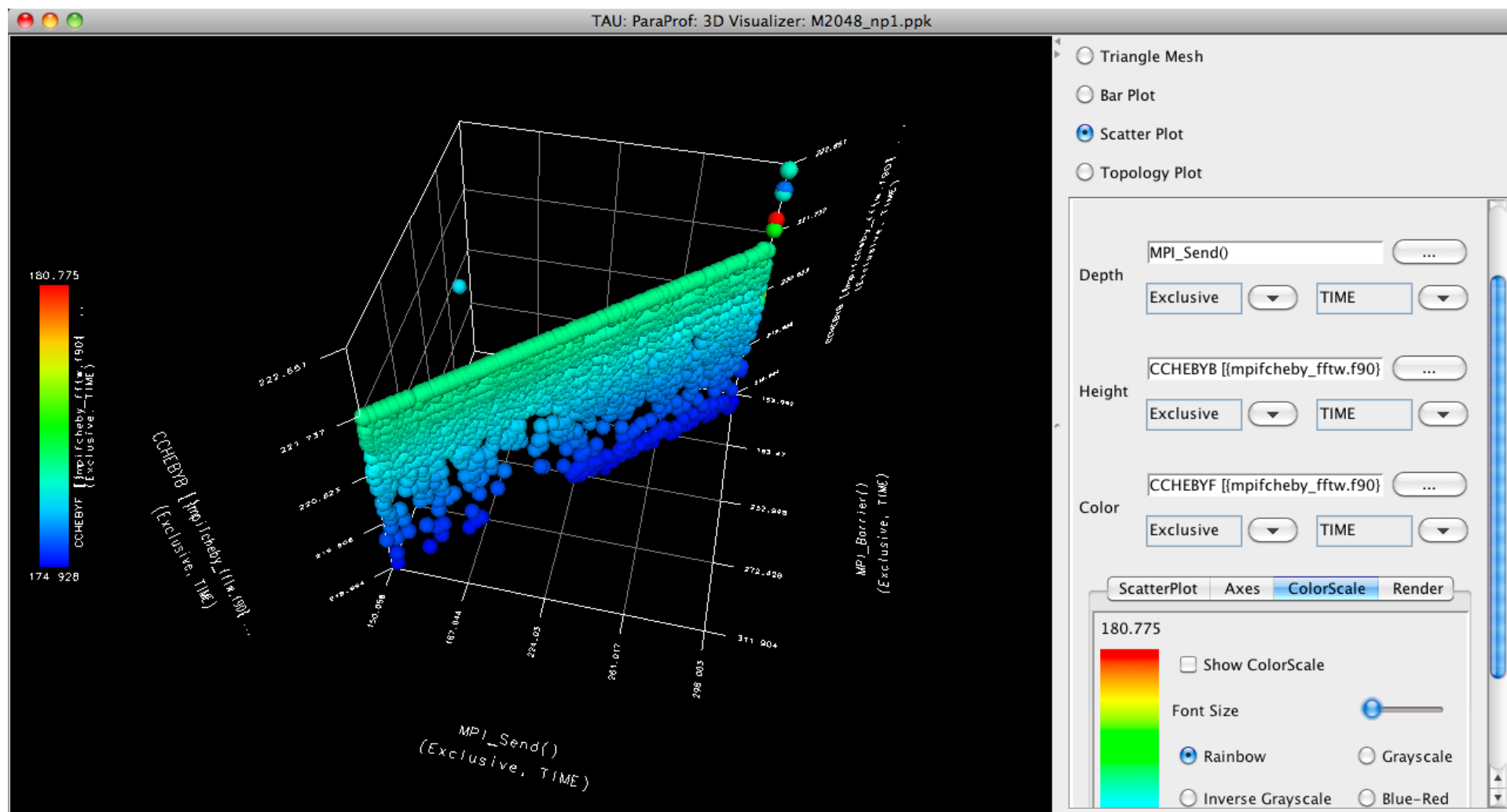


# ParaProf: 3D Scatter Plot

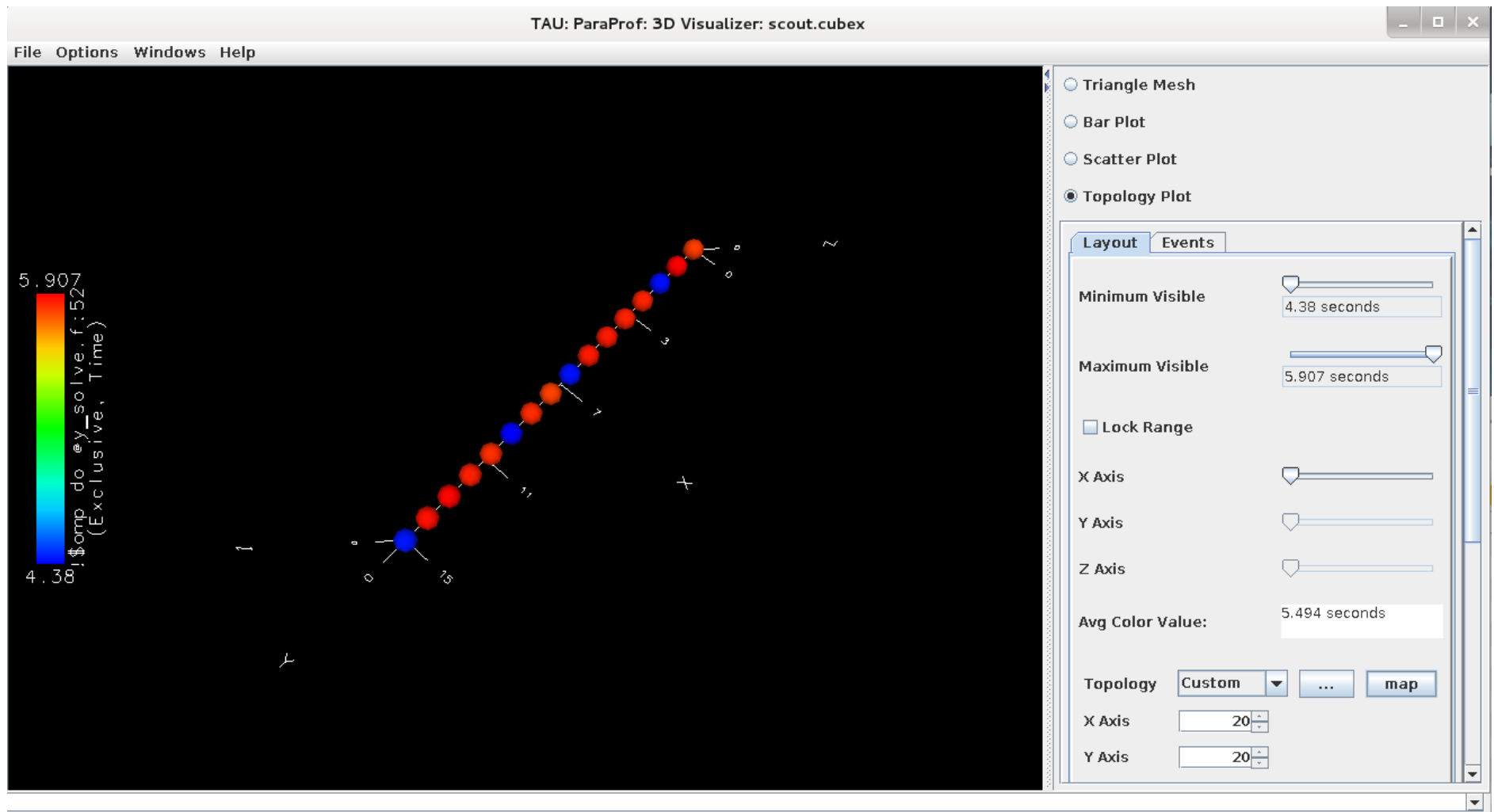


# ParaProf: Scatter Plot

# VI-HPS

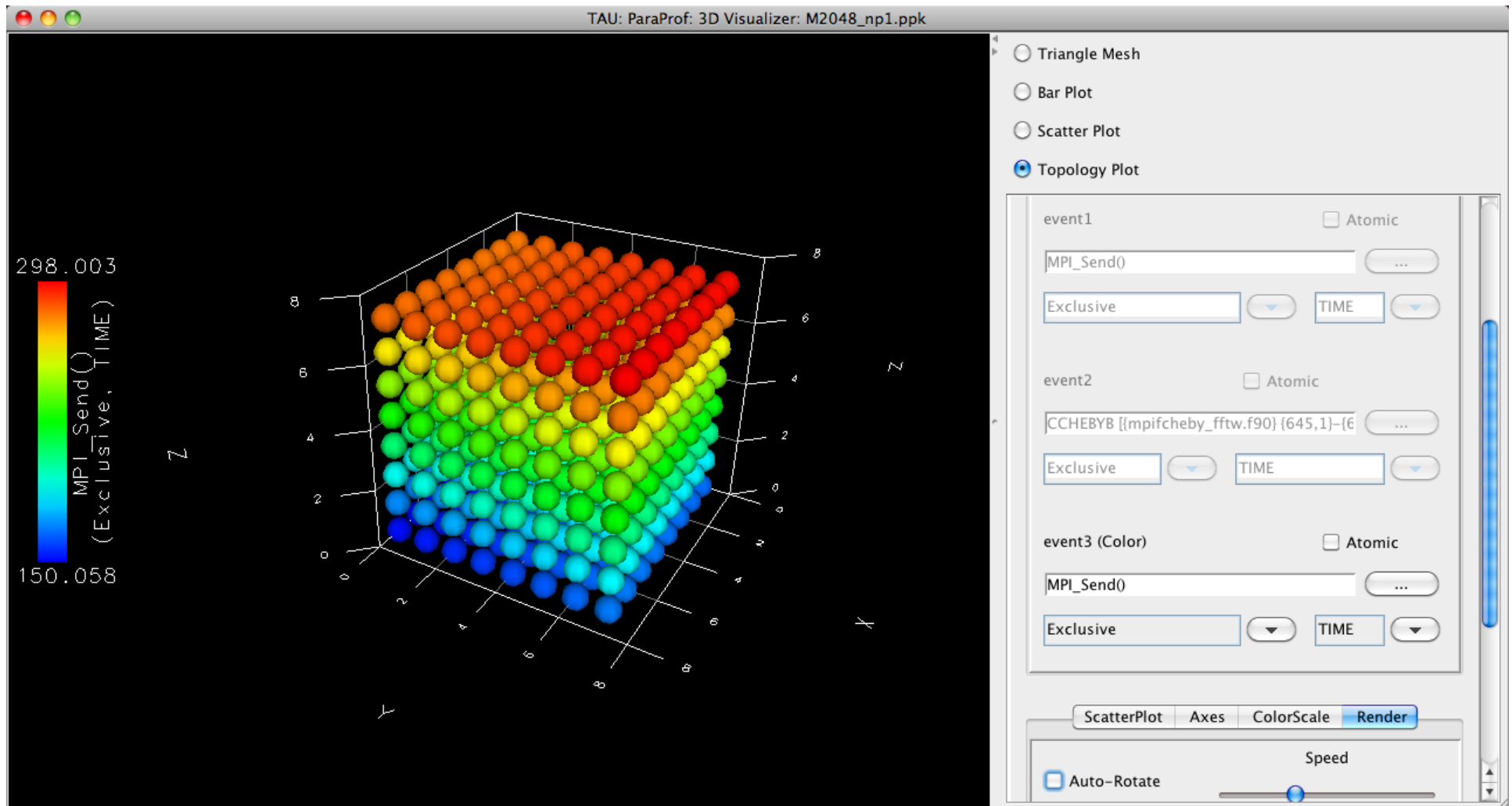


## ParaProf: 3D Topology View for a Routine



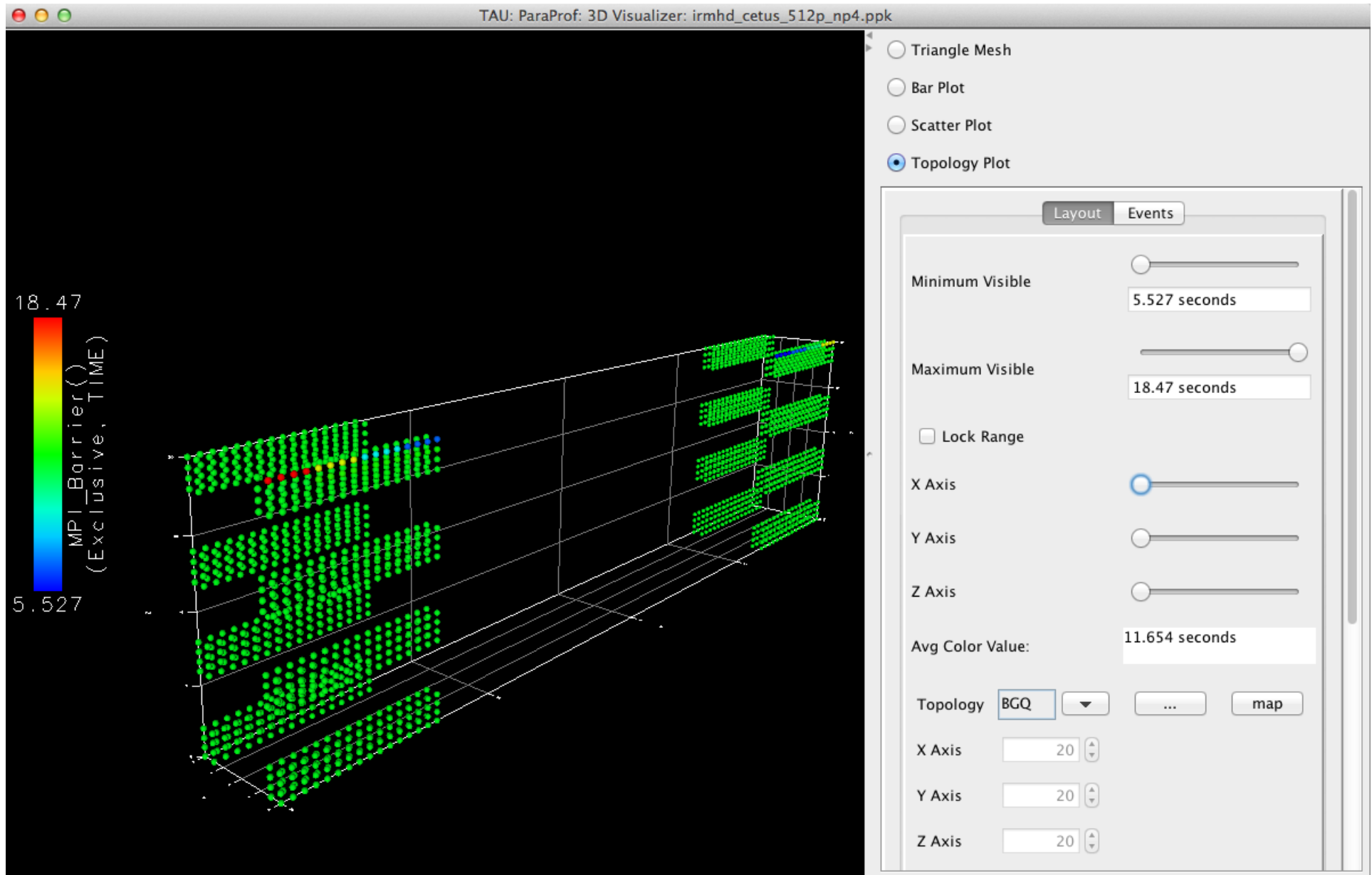
# ParaProf: Topology View 3D Torus (IBM BG/P)

VI-HPS

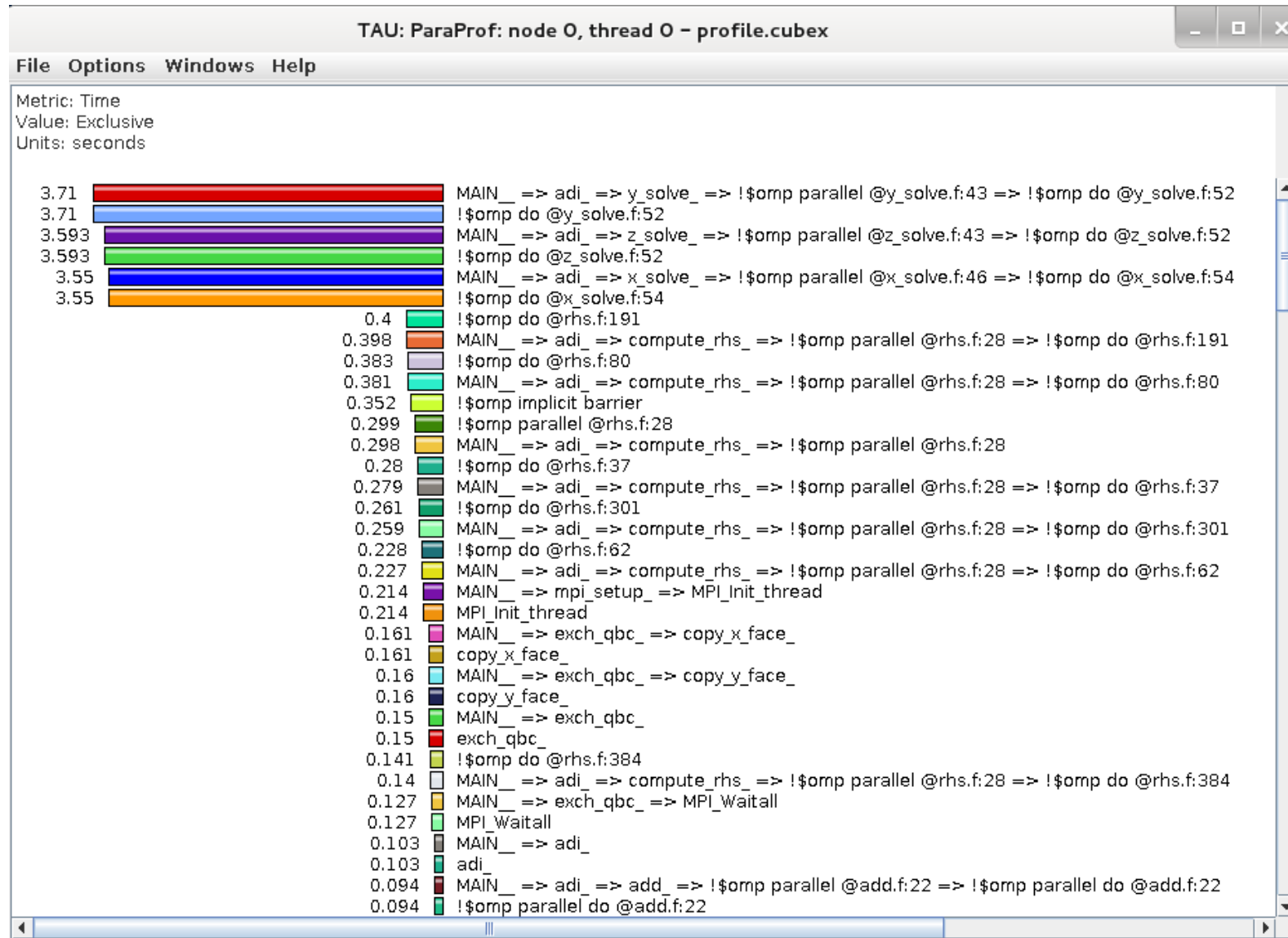




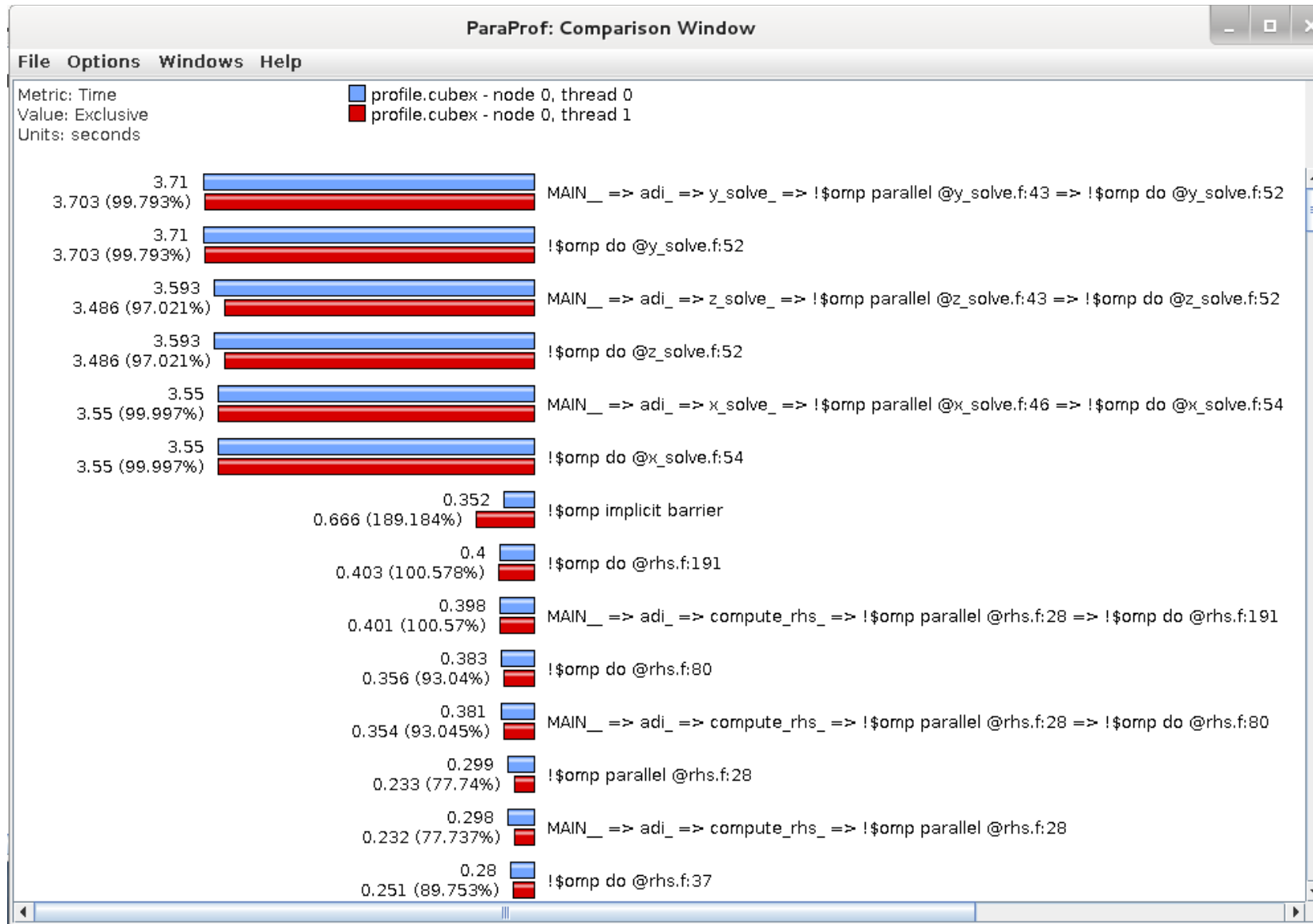
# ParaProf:Topology View (6D Torus Coordinates BG/Q) VI-HPS



## ParaProf: Node View



## ParaProf: Add Thread to Comparison Window



## ParaProf: Score-P Profile Files, Database

TAU: ParaProf Manager

File Options Help

Applications

Standard Applications

Default App

Default Exp

profile.cubex

Time

Minimum Inclusive Time

Maximum Inclusive Time

PAPI\_TOT\_CYC

PAPI\_TOT\_INS

PAPI\_FP\_INS

ru\_utime

ru\_stime

ru\_maxrss

ru\_ixrss

ru\_idrss

ru\_isrss

ru\_minflt

ru\_majflt

ru\_nswap

ru\_inblock

ru\_oublock

ru\_msgsnd

ru\_msgrcv

ru\_nsignals

ru\_nvcsw

ru\_nivcsw

bytes\_sent

bytes\_received

Default (jdbc:h2:/home/livetau/.ParaProf/perfdmf;AUTO\_SERVER=TRUE)

perfexplorer\_working (jdbc:h2:/home/livetau/.ParaProf/perfexplorer\_wo

Add Application  
Add Experiment  
Add Trial

TrialField	Value
Name	profile.cubex
Application ID	0
Experiment ID	0
Trial ID	0
File Type Index	9
File Type Name	Cube

## ParaProf: File -> Preferences

ParaProf Preferences

File

Font

SansSerif

☐ Bold

Size

☐ Italic

0 10 20 30 40

n,c,t 0,0,0

n,c,t 0,0,1

n,c,t 0,0,2

Window defaults

Units

Seconds

☐ Show Values as Percent

Settings

☐ Show Path Title in Reverse

☐ Reverse Call Paths

☒ Interpret threads that do not call a given function as a 0 value for statistics computation

☐ Generate data for reverse calltree  
(requires lots of memory)  
(does not apply to currently loaded profiles)

☒ Show Source Locations

☒ Auto label node/context/threads

Restore Defaults

Apply

Cancel



## ParaProf: Group Changer Window

TAU: ParaProf: Group Changer: profile.cubex

Region	Current	Available
filter: <input type="text"/> <div>             !\$omp atomic @error.f:104              !\$omp atomic @error.f:51  <b>!\$omp do @error.f:33</b>              !\$omp do @error.f:91              !\$omp do @exact_rhs.f:147              !\$omp do @exact_rhs.f:247              !\$omp do @exact_rhs.f:31              !\$omp do @exact_rhs.f:346              !\$omp do @exact_rhs.f:46              !\$omp do @initialize.f:100              !\$omp do @initialize.f:119              !\$omp do @initialize.f:137              !\$omp do @initialize.f:156              !\$omp do @initialize.f:174              !\$omp do @initialize.f:192              !\$omp do @initialize.f:31           </div>	CUBE_DEFAULT <div>^--</div> <div>--v</div>	<input type="text"/> <input type="button" value="new group"/> CUBE_CALLPATH

## ParaProf: Options -> Derived Metric Panel

TAU: ParaProf Manager

File Options Help

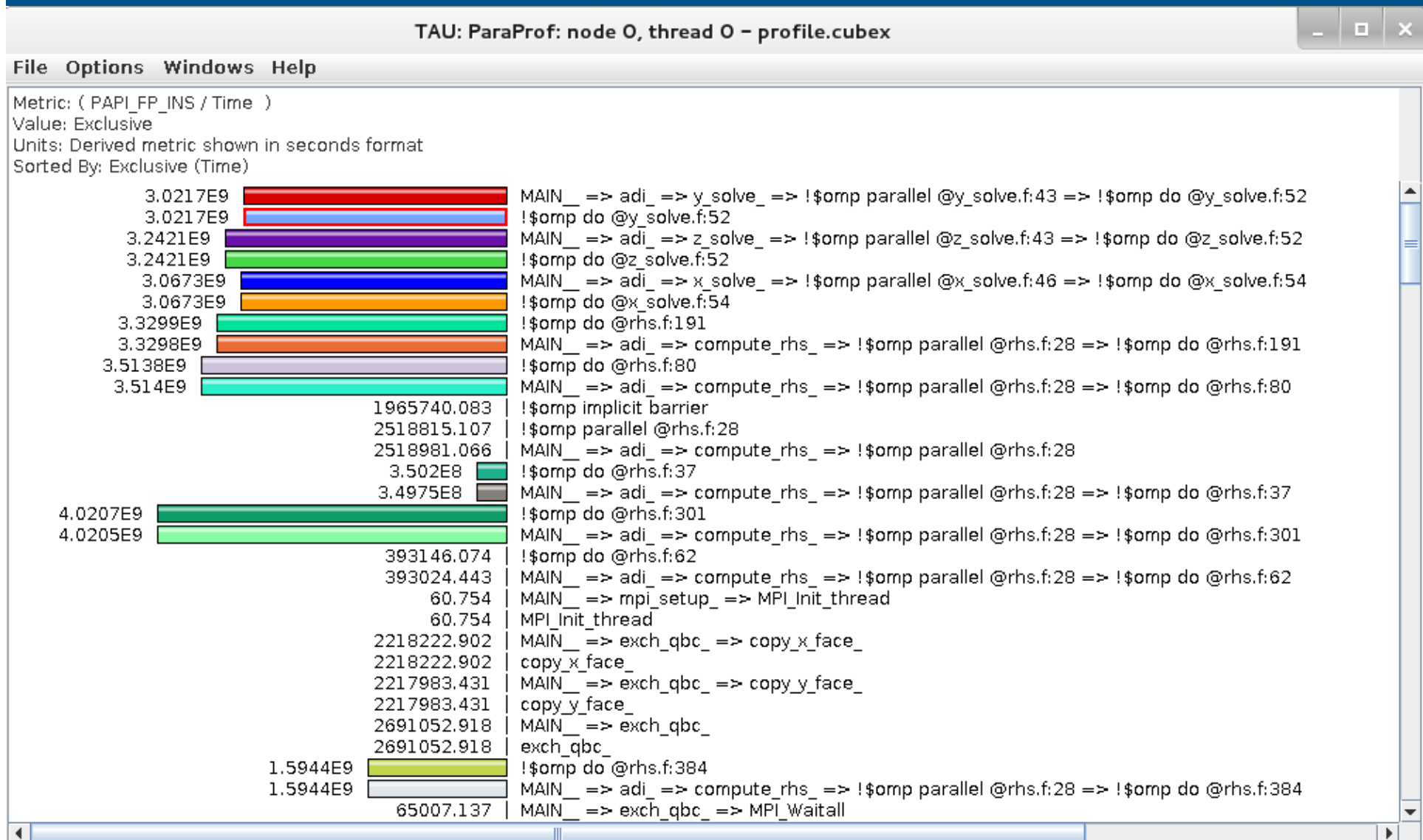
Applications

- Standard Applications
  - Default App
    - Default Exp
      - profile.cubex
        - Time
        - Minimum Inclusive Time
        - Maximum Inclusive Time
        - PAPI\_TOT\_CYC
        - PAPI\_TOT\_INS
        - PAPI\_FP\_INS
        - ru\_utime
        - ru\_stime
        - ru\_maxrss
        - ru\_ixrss
        - ru\_idrss
        - ru\_isrss
        - ru\_minflt
        - ru\_majflt
        - ru\_nswap
        - ru\_inblock
        - ru\_oublock
        - ru\_msgsnd
        - ru\_msgrcv
        - ru\_nsignals
        - ru\_nvcsw

MetricField	Value
Name	Time
Application ID	0
Experiment ID	0
Trial ID	0
Metric ID	0

Expression: "PAPI\_FP\_INS"/"Time"

## Sorting Derived Flops Metric by Exclusive Time



# Support Acknowledgments

# VI-HPS

- US Department of Energy (DOE)
  - Office of Science contracts
  - SciDAC, LBL contracts
  - LLNL-LANL-SNL ASC/NNSA contract
  - Battelle, PNNL contract
  - ANL, ORNL contract
- Department of Defense (DoD)
  - PETTT, HPCMP
- National Science Foundation (NSF)
  - Glassbox, SI-2
- University of Tennessee, Knoxville
- T.U. Dresden, GWT
- Juelich Supercomputing Center



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