

# TAU Commander Basics

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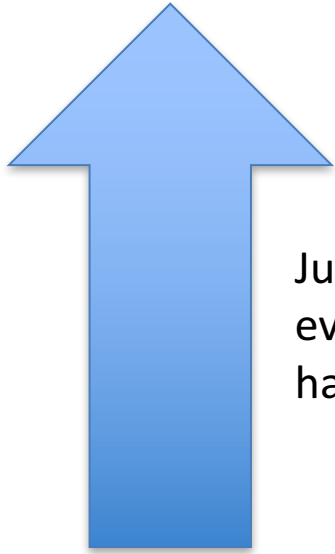
ParaTools, Inc.

28 September 2017

Webex from Baltimore, MD

# Getting Started with TAU Commander

1. **tau** initialize
2. **tau** g++ \*.cxx -o foo
3. **tau** srun -n 64 ./foo
4. **tau** show



Just put `**tau**` in front of everything and see what happens.

- This works on any supported system, even if TAU is not installed or has not been configured appropriately.
- TAU and all its dependencies will be downloaded and installed **if required**.

# Commands have subcommands

- tau [subcmd] [subsubcmd] [subsubsubcmd] ...
- Commands are tree-like and become more specific as you move to the right:

```
tau application edit dfft --new-name my_dfft
```

- Common commands:
  - tau initialize
  - tau dashboard
  - tau select [target] [application] [measurement]
  - tau target create <name> [options]
  - tau application edit <name> [options]
  - tau measurement copy <name> <new\_name> [options]
  - tau show [trial\_number]

# Command Line Hacks

- All commands and flags support abbreviation:
  - `tau initialize`
  - `tau initial`
  - `tau init`
- Boolean flags are flexible:
  - `tau init --mpi=True`
  - `tau init --mpi=yes`
  - `tau init --mpi=1`
  - `tau init --mpi`
- Use `--help` at any point to get help.



# Quick Help: tau --help

```
jlinford — ssh cori.nersc.gov — 80x47
jlinford@cori09 ~/workspace/openshmem17/applications/ISx $ tau --help
usage: tau [arguments] <subcommand> [options]

TAU Commander 1.0a [ www.taucommander.com ]

Positional Arguments:
  <subcommand>  See subcommand descriptions below.
  [options]     Options to be passed to <subcommand>.

Optional Arguments:
  -V, --version  Show program's version number and exit.
  -h, --help     Show this help message and exit.
  -q, --quiet    Suppress all output except error messages.
  -v, --verbose  Show debugging messages.

Configuration Subcommands:
  application  Create and manage application configurations.
  experiment   Create and manage experiments.
  measurement  Create and manage measurement configurations.
  project      Create and manage project configurations.
  target       Create and manage target configurations.
  trial        Create and manage experiment trials.

Subcommands:
  build        Instrument programs during compilation and/or linking.
  configure    Configure TAU Commander.
  dashboard    Show all project components.
  help         Show help for a command or suggest actions for a file.
  initialize   Initialize TAU Commander.
  select       Create a new experiment or select an existing experiment.

Shortcuts:
  tau <compiler>  Execute a compiler command
                  - Example: tau gcc *.c -o a.out
                  - Alias for 'tau build <compiler>'
  tau <program>   Gather data from a program
                  - Example: tau ./a.out
                  - Alias for 'tau trial create <program>'
  tau metrics     Show metrics available in the current experiment
                  - Alias for 'tau target metrics'
  tau select      Select configuration objects to create a new experiment
                  - Alias for 'tau experiment create'
  tau show        Show data from the most recent trial
                  - Alias for 'tau trial show'

See 'tau help <subcommand>' for more information on <subcommand>.
jlinford@cori09 ~/workspace/openshmem17/applications/ISx $
```

```
jlinford — ssh cori.nersc.gov — 80x35
jlinford@cori09 ~/workspace/openshmem17/applications/ISx $ tau app cre --help
usage: tau application create <application_name> [arguments]

Create application configurations.

Optional Arguments:
  -@ <level>      Create the application at the specified storage
                  level.
                  - <level>: project, user, system
                  - default: project
  -h, --help      Show this help message and exit.

Application Arguments:
  <application_name> Application configuration name.
  --cuda [T/F]      Application uses NVIDIA CUDA.
                  - default: False
  --linkage <linkage> Application linkage.
                  - <linkage>: static, dynamic
                  - default: static
  --mpc [T/F]        Application uses MPC.
                  - default: False
  --mpi [T/F]        Application uses MPI.
                  - default: False
  --opencl [T/F]     Application uses OpenCL.
                  - default: False
  --openmp [T/F]     Application uses OpenMP.
                  - default: False
  --pthreads [T/F]   Application uses pthreads.
                  - default: False
  --select-file path Specify selective instrumentation file.
  --shmem [T/F]      Application uses SHMEM.
                  - default: False
  --tbb [T/F]        Application uses Thread Building Blocks (TBB).
                  - default: False
jlinford@cori09 ~/workspace/openshmem17/applications/ISx $
```

# Online Manual: tau help <command line>

```
jlinford — jlinford@east03: ~ — ssh east03 — 90x63
jlinford@east03:~$ tau help application

== Usage: tau application =====

usage: tau application <subcommand> [arguments]

Create and manage application configurations.

Positional Arguments:
  <subcommand> See 'subcommands' below.
  [arguments]  Arguments to be passed to <subcommand>.

Optional Arguments:
  -h, --help  Show this help message and exit.

Subcommands:
  copy      Copy and modify application configurations.
  create    Create application configurations.
  delete    Delete application configurations.
  edit      Modify application configurations.
  list      Show application configuration data.

See 'tau application <subcommand> --help' for more information on <subcommand>.

== Help: tau application =====

TAU Commander Applications:

Creating new applications:
Enter: tau application create <new_application_name>

Copying a TAU Commander Application:
Enter: tau application copy <existing_application_name> <new_application_name>
The new application has the same properties as the original existing application.

Editing a TAU Commander Application:
Enter:
tau application edit <application_name> --<application_property> <property setting>

The following properties are set to True/False (T/F):
  cuda, mpc, mpi, opencl, openmp, pthreads, shmemp, tbb
  e.g. tau application edit <application_name> --mpi T
The property linkage is set to static/dynamic (default is dynamic) this is
changed by:
  tau application edit <application_name> --linkage static

The application name can be changed with --new-name as shown below:
tau application edit <application_name> <new_application_name>

A selective instrumentation file may be specified with --select-file and
its path.
e.g. tau application edit <application_name> --select_file <path>

Delete a TAU Commander Application:
Enter: tau application delete <application_name>

List TAU Commander Applications in a project:
Enter: tau application list
tau application list -l (long description)
tau application list -s (short description)
jlinford@east03:~$
```

Command line usage

Manual page with examples,  
common use cases, etc.

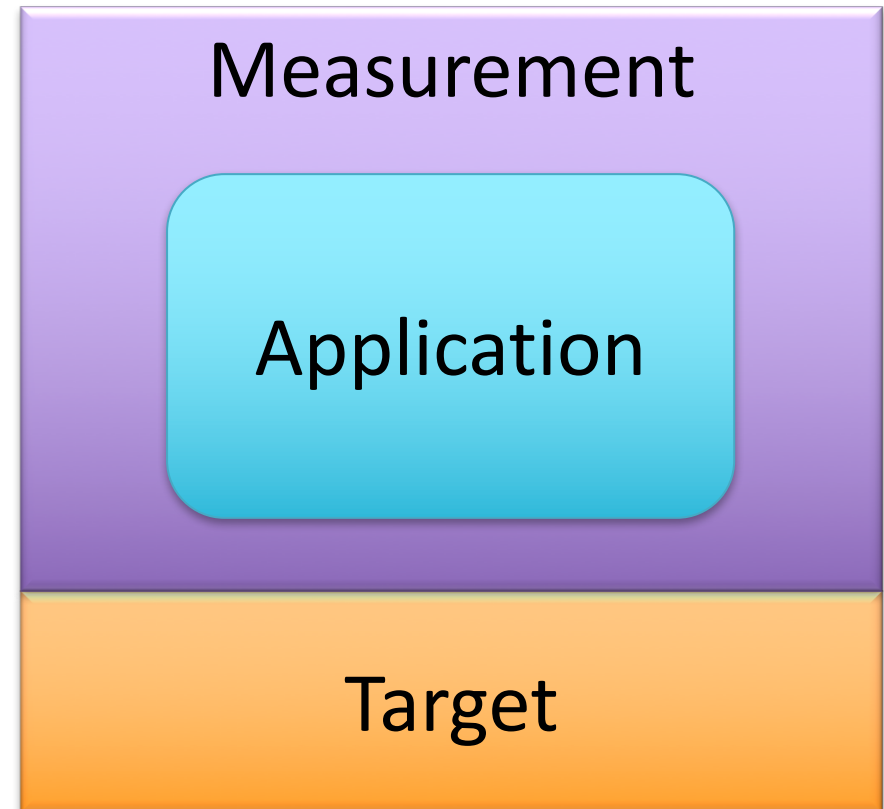
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# TAU COMMANDER PROJECTS

# T-A-M Model for Performance Engineering

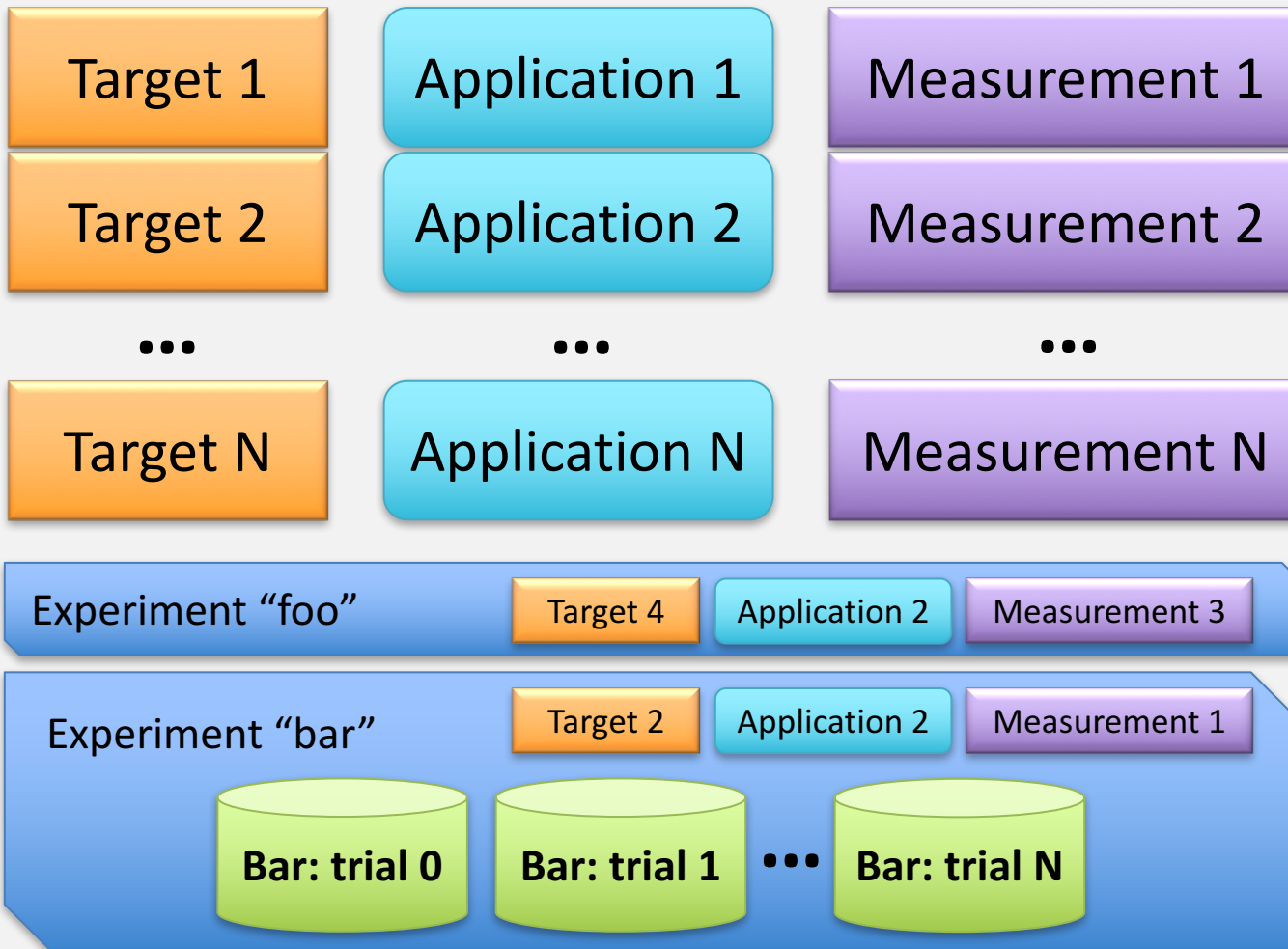
- Target
  - Installed software
  - Available compilers
  - Host architecture/OS
- Application
  - MPI, OpenMP, CUDA, OpenACC, etc.
- Measurement
  - Profile, trace, or both
  - Sample, source inst...



Experiment =  
(Target, Application, Measurement)

# TAU Commander Projects

## Project X



# TAU Commander Lexicon

- **Project:**
  - A container for TAM objects and data
- **Target:**
  - Description of hardware and software environment
- **Application:**
  - Description of a software application
- **Measurement:**
  - Description of desired performance data
- **Experiment:**
  - Exactly one target, application, and measurement with zero or more trials
- **Trial:**
  - Performance data and record of experiment environment

# T-A-M Objects Have Matching Commands

## Configuration Subcommands:

<code>application</code>	Create and manage application configurations.
<code>experiment</code>	Create and manage experiments.
<code>measurement</code>	Create and manage measurement configurations.
<code>project</code>	Create and manage project configurations.
<code>target</code>	Create and manage target configurations.
<code>trial</code>	Create and manage experiment trials.

```
$ tau application --help
usage: tau application <subcommand> [arguments]
```

Create and manage application configurations.

## Positional Arguments:

`<subcommand>` See 'subcommands' below.  
`[arguments]` Arguments to be passed to `<subcommand>`.

## Optional Arguments:

`-h, --help` Show this help message and exit.

## Subcommands:

<code>copy</code>	Copy and modify application configurations.
<code>create</code>	Create application configurations.
<code>delete</code>	Delete application configurations.
<code>edit</code>	Modify application configurations.
<code>list</code>	Show application configuration data.

See 'tau application <subcommand> --help' for more information on <subcommand>.

# `tau list` shows objects

View object attributes and show which command line option affects with attribute.

```
$ tau app list --long
== Application Configurations (/storage/users/jlinford/gpu_suite.1.1.0/.tau/project.json) =====

== gpu_suite.1.1.0 =====
```

Attribute	Value	Command Flag	Description
cuda	True	--cuda	Application uses NVIDIA CUDA.
linkage	dynamic	--linkage	Application linkage.
mpc	False	--mpc	Application uses MPC.
mpi	False	--mpi	Application uses MPI.
opencl	False	--opencl	Application uses OpenCL.
openmp	False	--openmp	Application uses OpenMP.
projects	gpu_suite.1.1.0	N/A	Projects using this application.
pthread	False	--pthread	Application uses pthreads.
shmem	False	--shmem	Application uses SHMEM.
tbb	False	--tbb	Application uses Thread Building Blocks (TBB).



# `tau dashboard` Shows Project Summary

```
jlinford — jlinford@godzilla:~/gpu_suite.1.1.0 — ssh talapas-ln1.uoregon.edu — 134x51
[jlinford@godzilla ~/gpu_suite.1.1.0 $ tau dashboard

== Project Configuration (/storage/users/jlinford/gpu_suite.1.1.0/.tau/project.json) =====

+-----+-----+-----+-----+-----+
| Name      | Targets | Applications | Measurements | # Experiments |
+-----+-----+-----+-----+-----+
| gpu_suite.1.1.0 | godzilla | gpu_suite.1.1.0 | sample, profile, trace | 1 |
+-----+-----+-----+-----+-----+

== Targets in project 'gpu_suite.1.1.0' =====

+-----+-----+-----+-----+-----+-----+
| Name | Host OS | Host Arch | Host Compilers | MPI Compilers | SHMEM Compilers |
+-----+-----+-----+-----+-----+-----+
| godzilla | Linux | x86_64 | GNU | System | OpenSHMEM |
+-----+-----+-----+-----+-----+-----+

== Applications in project 'gpu_suite.1.1.0' =====

+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Name | Linkage | OpenMP | Pthreads | TBB | MPI | CUDA | OpenCL | SHMEM | MPC |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| gpu_suite.1.1.0 | dynamic | No | No | No | No | Yes | No | No | No |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+

== Measurements in project 'gpu_suite.1.1.0' =====

+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Name | Profile | Trace | Sample | Source Inst. | Compiler Inst. | OpenMP | CUDA | I/O | MPI | SHMEM |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| sample | tau | none | Yes | never | never | ignore | Yes | No | No | No |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| profile | tau | none | No | automatic | never | ignore | Yes | No | No | No |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| trace | none | otf2 | No | automatic | never | ignore | Yes | No | No | No |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+

== Experiments in project 'gpu_suite.1.1.0' =====

+-----+-----+-----+-----+-----+-----+-----+
| Name | Trials | Data Size | Target | Application | Measurement | TAU Makefile |
+-----+-----+-----+-----+-----+-----+-----+
| godzilla-gpu_suite.1.1.0-sample | 1 | 23.9KiB | godzilla | gpu_suite.1.1.0 | sample | Makefile.tau-092e8e8f-cupti |
+-----+-----+-----+-----+-----+-----+-----+

Selected Experiment: godzilla-gpu_suite.1.1.0-sample
jlinford@godzilla ~/gpu_suite.1.1.0 $
```

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# **INSTRUMENTING CODE**

# Compiling with TAU Commander

- `tau <compiler> [options]`
  - `tau gcc *.c -o foo`
  - `tau ifort -c bar.f90`
  - `tau g++ baz.o -o baz`
- `tau <compiler>` is a shortcut:
  - Expands to `tau build <compiler>`
- Use `tau build --help` to show all known compilers.
- NOTE: Compilation isn't always necessary. Use sampling to gather data on uninstrumented executables.

# Makefiles

- Put “**tau**” in front of your compiler command
  - If necessary, automatically instruments source code, links with TAU libraries.
  - Handles special compiler flags needed for instrumentation.
  - Lazy: does nothing whenever possible.

## Makefile without taucmdr

```
CXX = mpicxx
F90 = mpif90
CXXFLAGS =
LIBS = -lm
OBJS = f1.o f2.o f3.o ... fn.o

app: $(OBJS)
    $(CXX) $(LDFLAGS) $(OBJS) -o $@
    $(LIBS)
.cpp.o:
    $(CXX) $(CXXFLAGS) -c $<
```

## Makefile with taucmdr

```
CXX = tau mpicxx
F90 = tau mpif90
CXXFLAGS =
LIBS = -lm
OBJS = f1.o f2.o f3.o ... fn.o

app: $(OBJS)
    $(CXX) $(LDFLAGS) $(OBJS) -o $@
    $(LIBS)
.cpp.o:
    $(CXX) $(CXXFLAGS) -c $<
```

Note: see advanced usage slides for CMake and Autotools

# Running with TAU Commander

- `tau <command>`
  - `tau srun -n 4 ./a.out`
  - `tau mpirun -np 4 ./a.out`
  - `tau ./a.out`
- `tau <command>` is just a shortcut:
  - Expands to `tau trial create <command>`

# Common Mistakes

- ~~mpirun -np 4 tau ./a.out~~

- “tau” always goes first

- Correct: **tau mpirun -np 4 ./a.out**

- ~~tau qsub myscript.batch~~

- You probably don’t want to profile “qsub”

- Correct: put “tau” in front of the command you want to profile inside myscript.batch, e.g. “tau ./a.out”

- ~~tau list application myapp~~

- On tau’s command line, the verb follows the object

- Correct: **tau application list myapp**

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# PROFILING WITH EVENT-BASED SAMPLING

# Step 1: Initialize TAU Project

```
$ cp -R /path/to/taucmdr-1.2.0/examples $HOME
$ cd $HOME/examples/mm
$ ls
Makefile  Makefile.intel  matmult.c
matmult_initialize.c  matmult_initialize.h  README.stampede
```

```
$ tau initialize
```

**WARNING: Don't execute tau initialize in \$HOME!**  
**(this bug is fixed in version 1.2.0.4)**



- Creates a new project configuration using defaults
- Project files exist in a directory named “.tau”
- Like git, all directories below the directory containing the “.tau” directory can access the project
  - E.g. `tau dashboard` works in miniapp1/baseline



# Serial examples/mm Dashboard

```
jlinf@east03: ~/examples/mm$ tau init
[TAU] System MPI C++ compiler '/opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpicxx' wraps
[TAU] '/usr/bin/g++'
[TAU] System MPI C compiler '/opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpicc' wraps
[TAU] '/usr/bin/gcc'
[TAU] System MPI Fortran compiler '/opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpif90' wraps
[TAU] '/usr/bin/gfortran'
[TAU] Created a new project named 'mm'.
[TAU] Added application 'mm' to project configuration 'mm'.
[TAU] Added target 'east03' to project configuration 'mm'.
[TAU] Added measurement 'sample' to project configuration 'mm'.
[TAU] Added measurement 'profile' to project configuration 'mm'.
[TAU] Added measurement 'trace' to project configuration 'mm'.
[TAU] Created a new experiment 'east03-mm-sample'
[TAU] Selected experiment 'east03-mm-sample'.

== Project Configuration (/home/jlinf@east03: ~/examples/mm/.tau/project.json) =====


| Name | Targets | Applications | Measurements           | # Experiments |
|------|---------|--------------|------------------------|---------------|
| mm   | east03  | mm           | sample, profile, trace | 1             |



== Targets in project 'mm' =====


| Name   | Host OS | Host Arch | Host Compilers | MPI Compilers | SHMEM Compilers |
|--------|---------|-----------|----------------|---------------|-----------------|
| east03 | Linux   | x86_64    | GNU            | System        | None            |



== Applications in project 'mm' =====


| Name | Linkage | OpenMP | Pthreads | TBB | MPI | CUDA | OpenCL | SHMEM | MPC |
|------|---------|--------|----------|-----|-----|------|--------|-------|-----|
| mm   | dynamic | No     | No       | No  | No  | No   | No     | No    | No  |



== Measurements in project 'mm' =====


| Name    | Profile | Trace | Sample | Source Inst. | Compiler Inst. | OpenMP | CUDA | I/O | MPI | SHMEM |
|---------|---------|-------|--------|--------------|----------------|--------|------|-----|-----|-------|
| sample  | tau     | none  | Yes    | never        | never          | ignore | No   | No  | No  | No    |
| profile | tau     | none  | No     | automatic    | never          | ignore | No   | No  | No  | No    |
| trace   | none    | otf2  | No     | automatic    | never          | ignore | No   | No  | No  | No    |



== Experiments in project 'mm' =====


| Name             | Trials | Data Size | Target | Application | Measurement | TAU Makefile          |
|------------------|--------|-----------|--------|-------------|-------------|-----------------------|
| east03-mm-sample | 0      | 0.0B      | east03 | mm          | sample      | Makefile.tau-beec6777 |



Selected Experiment: east03-mm-sample
jlinf@east03:~/examples/mm$
```

One target with GNU compilers

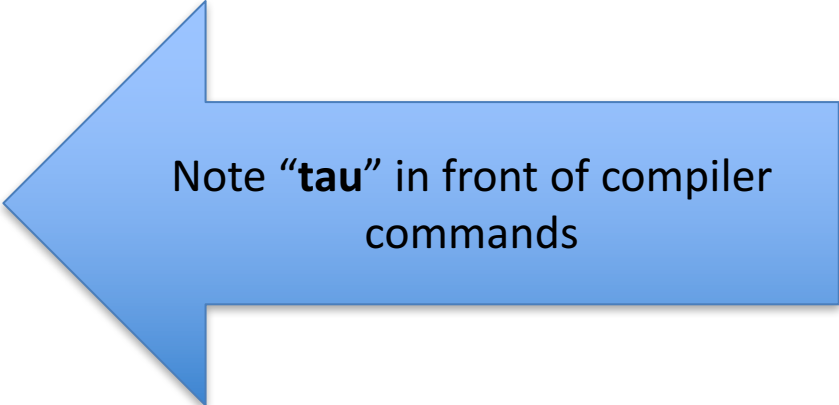
One application, all features = "no"

Three measurements

One experiment

# examples/mm/Makefile

```
6
7 ifdef MPI
8 CC = tau mpicc
9 MPI_CFLAGS = -DTAU_MPI
10 SUFFIX=.mpi
11 else
12 CC = tau gcc
13 MPI_CFLAGS =
14 SUFFIX=
15 endif
16
17 ifdef OPENMP
18 OMP_FLAGS = -fopenmp -DTAU_OPENMP
19 SUFFIX=.openmp
20 else
21 OMP_FLAGS =
22 endif
23
```



Note “**tau**” in front of compiler  
commands

# Compiling examples/mm

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120×14
jlinford@east03:~/examples/mm$ make
tau gcc -c matmult.c -o matmult.o
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-beec6777
[TAU] TAU_OPTIONS=-optNoCompInst -optLinkOnly -optQuiet
[TAU] /usr/bin/gcc -g -c matmult.c -o matmult.o
tau gcc -c matmult_initialize.c -o matmult_initialize.o
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-beec6777
[TAU] TAU_OPTIONS=-optNoCompInst -optLinkOnly -optQuiet
[TAU] /usr/bin/gcc -g -c matmult_initialize.c -o matmult_initialize.o
tau gcc matmult.o matmult_initialize.o -o matmult.exe
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-beec6777
[TAU] TAU_OPTIONS=-optNoCompInst -optLinkOnly -optQuiet
[TAU] /usr/bin/gcc -g matmult.o matmult_initialize.o -o matmult.exe
jlinford@east03:~/examples/mm$
```

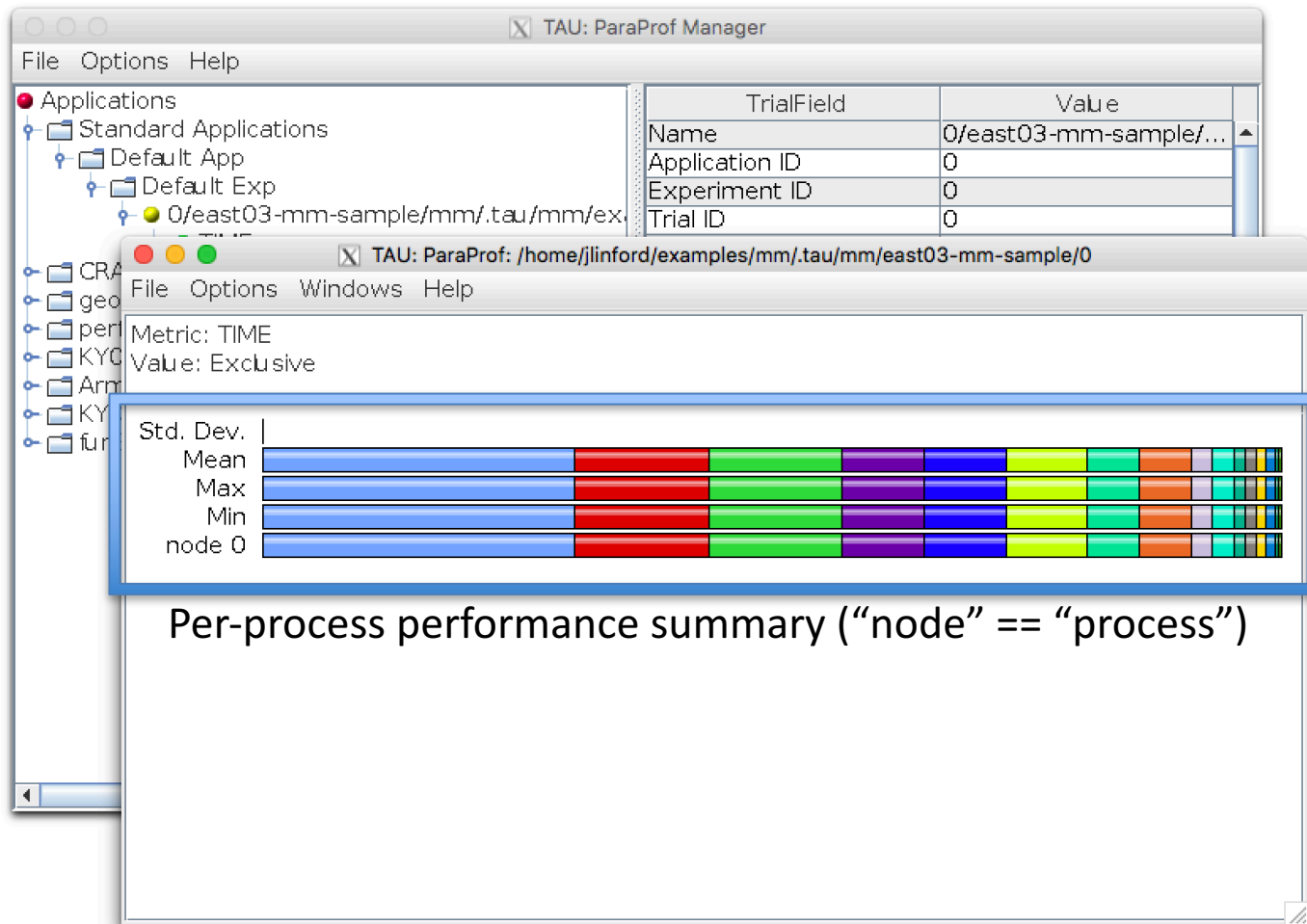
- **In general:** TAU Commander constructs a new compilation command line.
  - May replace compiler commands with TAU's compiler wrapper scripts.
  - May set environment variables, parse configuration files, etc.
  - If no changes are required then nothing is changed.
- **In this case:** No instrumentation required.
  - Selected experiment (east03-mm-sample) uses event-based sampling.
  - The "tau" command becomes a null-operation and passes through to the compiler.

# Running examples/mm in serial

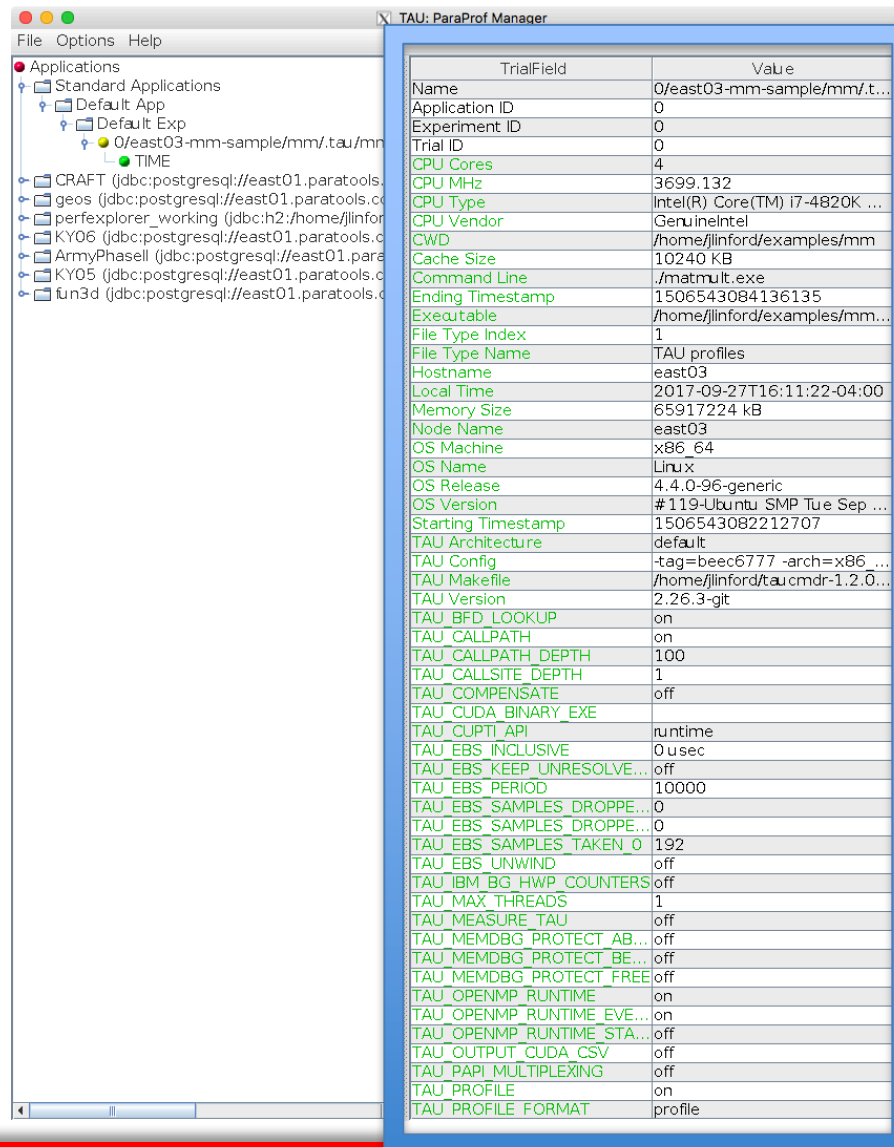
```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x35
[jlinford@east03:~/examples/mm$ ls
Makefile      matmult.c      matmult_initialize.c  matmult_initialize.o  README.stampede
Makefile.intel matmult.exe     matmult_initialize.h  matmult.o
[jlinford@east03:~/examples/mm$ tau ./matmult.exe
[TAU]
[TAU] == BEGIN Experiment at 2017-09-27 20:11:22.150137 =====
[TAU]
[TAU] PROFILEDIR=/home/jlinford/examples/mm/.tau/mm/east03-mm-sample/0
[TAU] SCOREP_ENABLE_TRACING=false
[TAU] TAU_CALLPATH=1
[TAU] TAU_CALLPATH_DEPTH=100
[TAU] TAU_CALLSITE=0
[TAU] TAU_COMM_MATRIX=0
[TAU] TAU_MERGE_METADATA=1
[TAU] TAU_METRICS=TIME,
[TAU] TAU_PROFILE=1
[TAU] TAU_SAMPLING=1
[TAU] TAU_THROTTLE=1
[TAU] TAU_THROTTLE_NUMCALLS=100000
[TAU] TAU_THROTTLE_PERCALL=10
[TAU] TAU_TRACE=0
[TAU] TAU_TRACK_HEAP=0
[TAU] TAU_VERBOSE=0
[TAU] TRACEDIR=/home/jlinford/examples/mm/.tau/mm/east03-mm-sample/0
[TAU]
Done
[TAU] Trial 0 produced 1 profile files.
[TAU]
[TAU] == END Experiment at 2017-09-27 20:11:24.149306 =====
[TAU]
[TAU] Experiment: east03-mm-sample
[TAU] Command: tau exec -T beec6777,serial -ebs ./matmult.exe
[TAU] Current working directory: /home/jlinford/examples/mm
[TAU] Data size: 7.9KiB bytes
jlinford@east03:~/examples/mm$
```

# show displays the most recent trial

\$ tau show



# ParaProf Manager Window



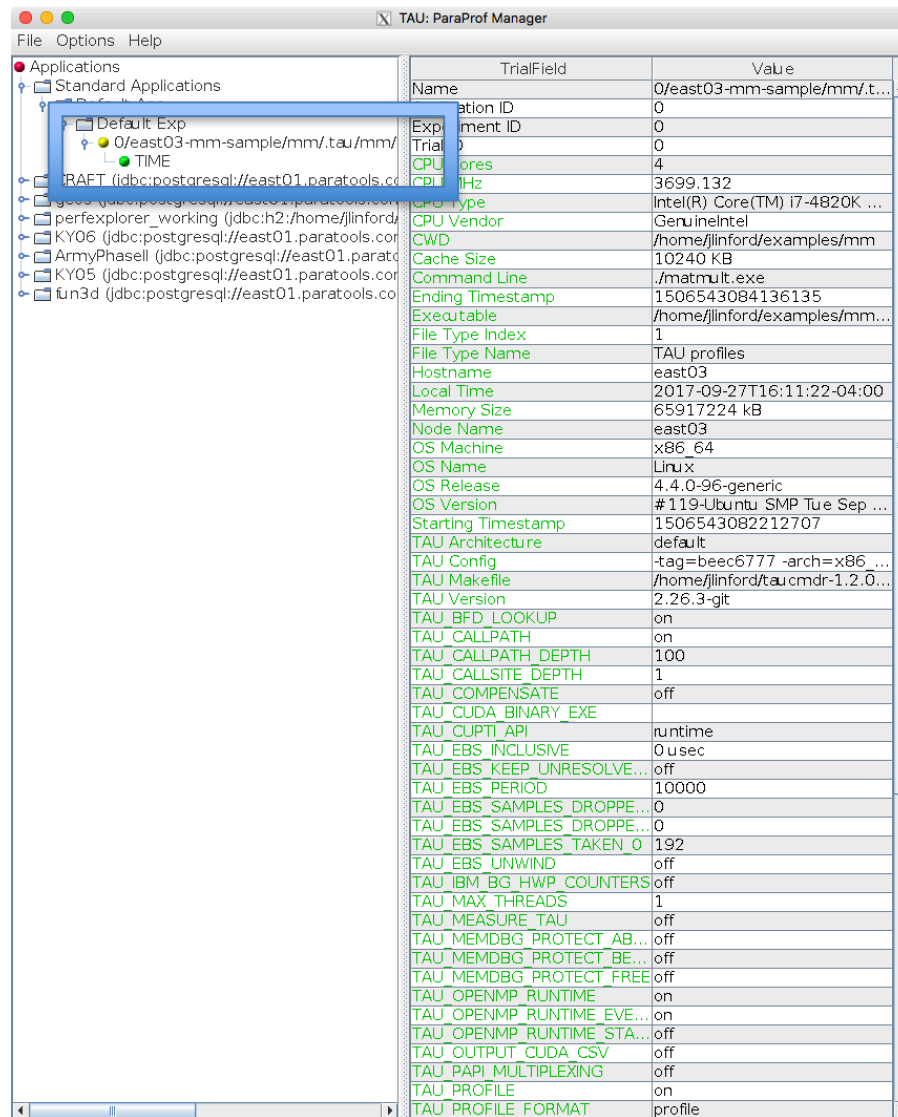
The screenshot shows the ParaProf Manager application window. On the left is a tree view under 'Applications' with a selected path: 'Standard Applications' > 'Default App' > 'Default Exp' > '0/east03-mm-sample/mm/tau/mm' > 'TIME'. On the right is a table titled 'TAU: ParaProf Manager' containing metadata for the selected trial.

TrialField	Value
Name	0/east03-mm-sample/mm/tau/mm
Application ID	0
Experiment ID	0
Trial ID	0
CPU Cores	4
CPU MHz	3699.132
CPU Type	Intel(R) Core(TM) i7-4820K ...
CPU Vendor	GenuineIntel
CWD	/home/jlinford/examples/mm
Cache Size	10240 KB
Command Line	./matmult.exe
Ending Timestamp	1506543084136135
Executable	/home/jlinford/examples/mm...
File Type Index	1
File Type Name	TAU profiles
Hostname	east03
Local Time	2017-09-27T16:11:22-04:00
Memory Size	65917224 kB
Node Name	east03
OS Machine	x86_64
OS Name	Linux
OS Release	4.4.0-96-generic
OS Version	#119-Ubuntu SMP Tue Sep ...
Starting Timestamp	1506543082212707
TAU Architecture	default
TAU Config	-tag=beec6777 -arch=x86 ...
TAU Makefile	/home/jlinford/taucmdr-1.2.0...
TAU Version	2.26.3-git
TAU_BFD_LOOKUP	on
TAU_CALLPATH	on
TAU_CALLPATH_DEPTH	100
TAU_CALLSITE_DEPTH	1
TAU_COMPENSATE	off
TAU_CUDA_BINARY_EXE	
TAU_CUPTI_API	runtime
TAU_EBS_INCLUSIVE	0 usec
TAU_EBS_KEEP_UNRESOLVE...	off
TAU_EBS_PERIOD	10000
TAU_EBS_SAMPLES_DROPPE...	0
TAU_EBS_SAMPLES_DROPPE...	0
TAU_EBS_SAMPLES_TAKEN_0	192
TAU_EBS_UNWIND	off
TAU IBM_BG_HWP_COUNTERS	off
TAU_MAX_THREADS	1
TAU_MEASURE_TAU	off
TAU_MEMDBG_PROTECT_AB...	off
TAU_MEMDBG_PROTECT_BE...	off
TAU_MEMDBG_PROTECT_FREE	off
TAU_OPENMP_RUNTIME	on
TAU_OPENMP_RUNTIME_EVE...	on
TAU_OPENMP_RUNTIME_STA...	off
TAU_OUTPUT_CUDA_CSV	off
TAU_PAPI_MULTIPLEXING	off
TAU_PROFILE	on
TAU_PROFILE_FORMAT	profile

## Metadata

# ParaProf Manager Window

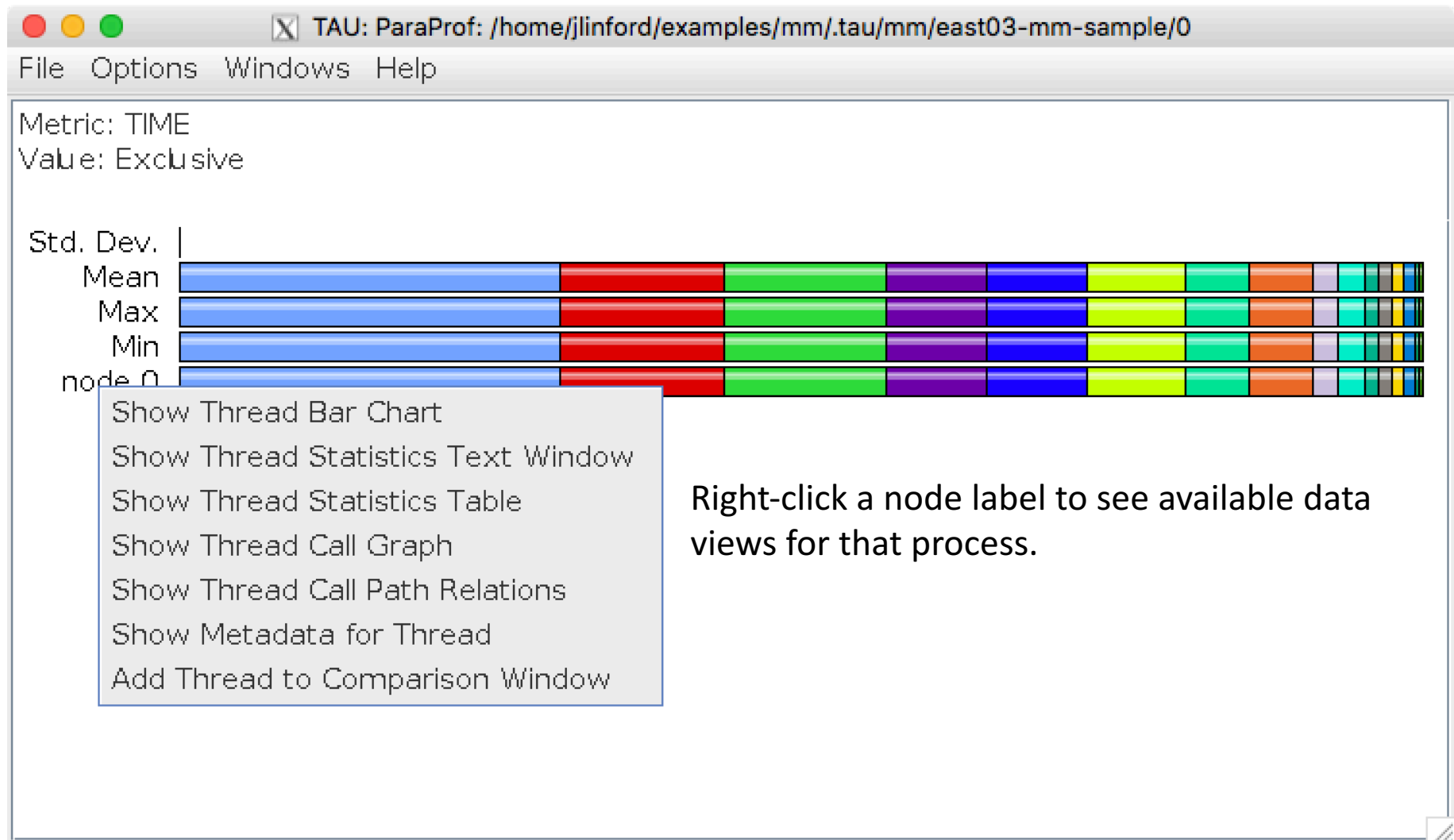
Metrics in this trial's  
dataset



TAU: ParaProf Manager

Applications	TrialField	Value
Standard Applications	Name	0/east03-mm-sample/mm/t...
Default Exp	Experiment ID	0
0/east03-mm-sample/mm/tau/mm/	Trial ID	0
TIME	CPU Cores	4
RAET (jdbc:postgresql://east01.paratools.co	CPU MHz	3699.132
RAET (jdbc:postgresql://east01.paratools.co	CPU Type	Intel(R) Core(TM) i7-4820K ...
perfeXplorer_working (jdbc:h2:/home/jlinford	CPU Vendor	GenuineIntel
KY06 (jdbc:postgresql://east01.paratools.co	CWD	/home/jlinford/examples/mm
ArmyPhasell (jdbc:postgresql://east01.parat	Cache Size	10240 KB
KY05 (jdbc:postgresql://east01.paratools.co	Command Line	./matmult.exe
fun3d (jdbc:postgresql://east01.paratools.co	Ending Timestamp	1506543084136135
	Executable	/home/jlinford/examples/mm...
	File Type Index	1
	File Type Name	TAU profiles
	Hostname	east03
	Local Time	2017-09-27T16:11:22-04:00
	Memory Size	65917224 kB
	Node Name	east03
	OS Machine	x86_64
	OS Name	Linux
	OS Release	4.4.0-96-generic
	OS Version	#119-Ubuntu SMP Tue Sep ...
	Starting Timestamp	1506543082212707
	TAU Architecture	default
	TAU Config	-tag=beec6777 -arch=x86 ...
	TAU Makefile	/home/jlinford/taucmdr-1.2.0...
	TAU Version	2.26.3-git
	TAU_BFD_LOOKUP	on
	TAU_CALLPATH	on
	TAU_CALLPATH_DEPTH	100
	TAU_CALLSITE_DEPTH	1
	TAU_COMPENSATE	off
	TAU_CUDA_BINARY_EXE	
	TAU_CUPTI_API	runtime
	TAU_EBS_INCLUSIVE	0 usec
	TAU_EBS_KEEP_UNRESOLVE...	off
	TAU_EBS_PERIOD	10000
	TAU_EBS_SAMPLES_DROPPE...	0
	TAU_EBS_SAMPLES_DROPPE...	0
	TAU_EBS_SAMPLES_TAKEN_0	192
	TAU_EBS_UNWIND	off
	TAU IBM_BG_HWP_COUNTERS	off
	TAU_MAX_THREADS	1
	TAU_MEASURE_TAU	off
	TAU_MEMDBG_PROTECT_AB...	off
	TAU_MEMDBG_PROTECT_BE...	off
	TAU_MEMDBG_PROTECT_FREE	off
	TAU_OPENMP_RUNTIME	on
	TAU_OPENMP_RUNTIME_EVE...	on
	TAU_OPENMP_RUNTIME_STA...	off
	TAU_OUTPUT_CUDA_CSV	off
	TAU_PAPI_MULTIPLEXING	off
	TAU_PROFILE	on
	TAU_PROFILE_FORMAT	profile

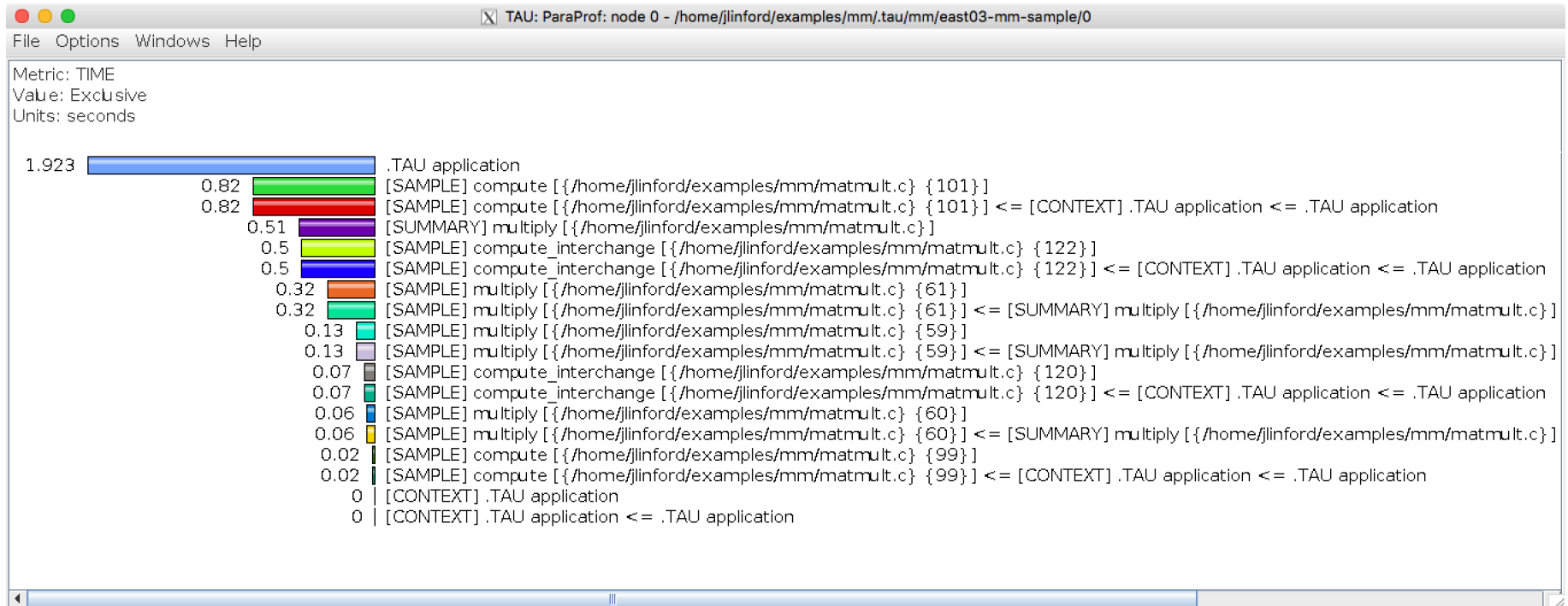
# ParaProf Summary Bar Chart





# Node 0 Inclusive Seconds (TIME metric)

Event-based sampling TIME data on process (a.k.a. “node”) 0



# Use the Group Legend to Filter Data

The screenshot shows the ParaTools application window titled "TAU: ParaProf: node 0 - /home/jlinford/examples/mm/tau/mm/east03-mm-sample/0". The "Windows" menu is open, and the "Group Legend" option is highlighted. A large blue arrow points from the "Group Legend" menu item to a separate window titled "TAU: ParaProf: Group Legend: 0/eas...". This window displays a list of TAU call paths with corresponding color-coded squares:

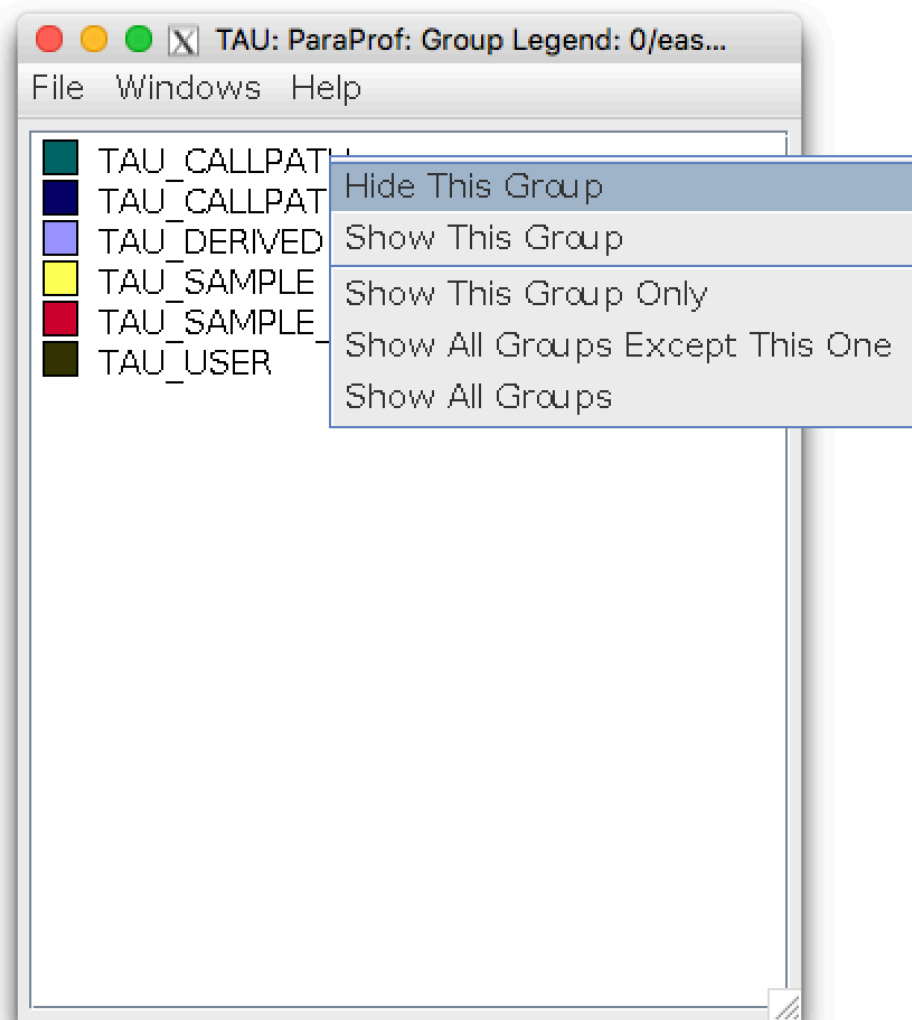
- TAU\_CALLPATH (dark blue)
- TAU\_CALLPATH\_DERIVED (light blue)
- TAU\_DERIVED (medium blue)
- TAU\_SAMPLE (yellow)
- TAU\_SAMPLE\_CONTEXT (red)
- TAU\_USER (dark blue)

Below the main menu, a list of TAU application events is visible, each preceded by a small colored square and a numerical value:

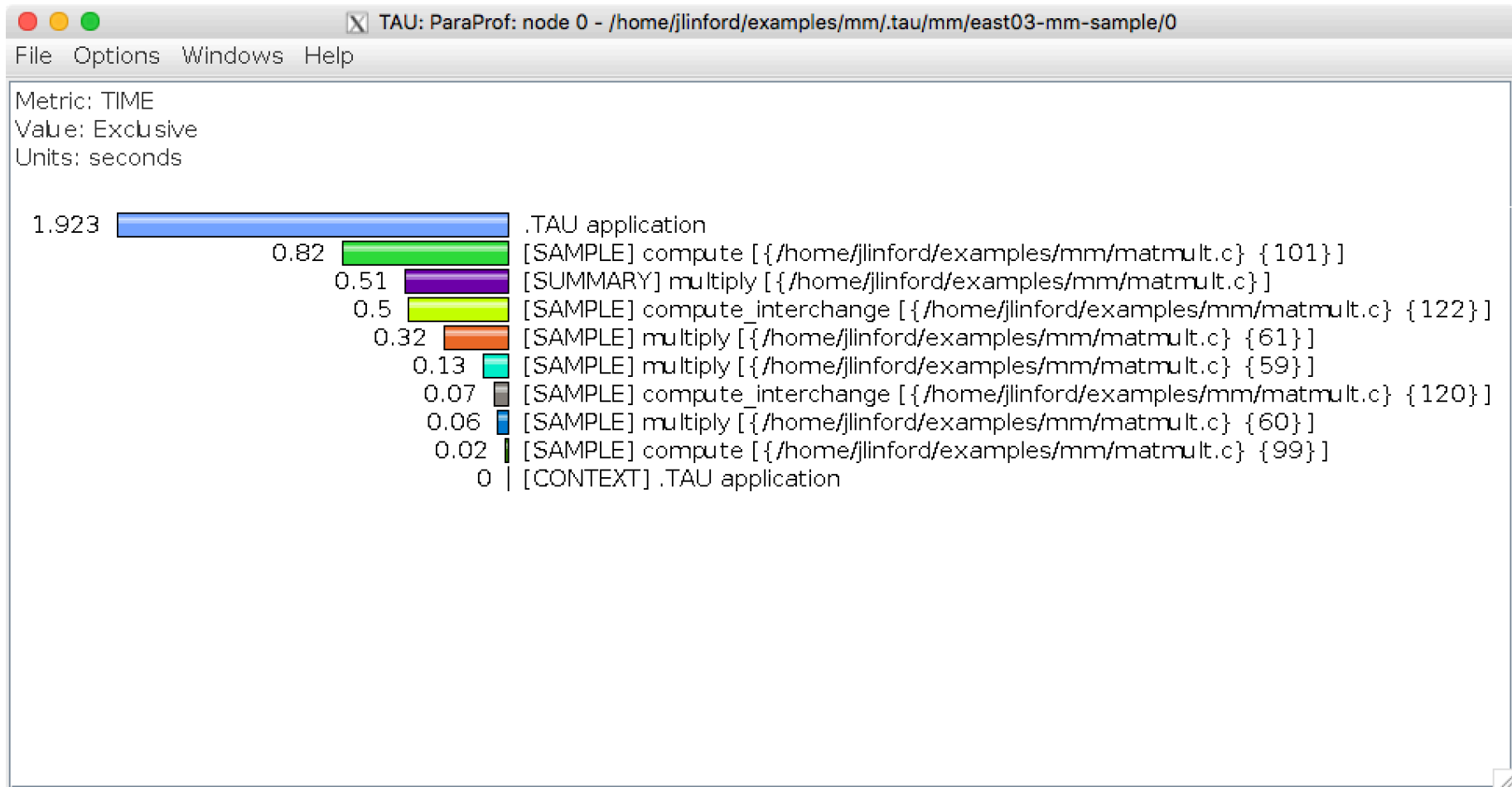
- 0.07 [SAMPLE] compute [ {/home/jlinford/examples/mm/matmult.c} {101} ]
- 0.07 [SAMPLE] compute\_interchange [ {/home/jlinford/examples/mm/matmult.c} {122} ]
- 0.06 [SAMPLE] multiply [ {/home/jlinford/examples/mm/matmult.c} {61} ]
- 0.06 [SAMPLE] multiply [ {/home/jlinford/examples/mm/matmult.c} {59} ]
- 0.02 [SAMPLE] compute\_interchange [ {/home/jlinford/examples/mm/matmult.c} {120} ]
- 0.02 [SAMPLE] multiply [ {/home/jlinford/examples/mm/matmult.c} {60} ]
- 0 [SAMPLE] compute [ {/home/jlinford/examples/mm/matmult.c} {99} ]
- 0 [CONTEXT] .TAU application
- 0 [CONTEXT] .TAU application

A blue arrow points from the text "Click here to open this" to the "Group Legend" menu item.

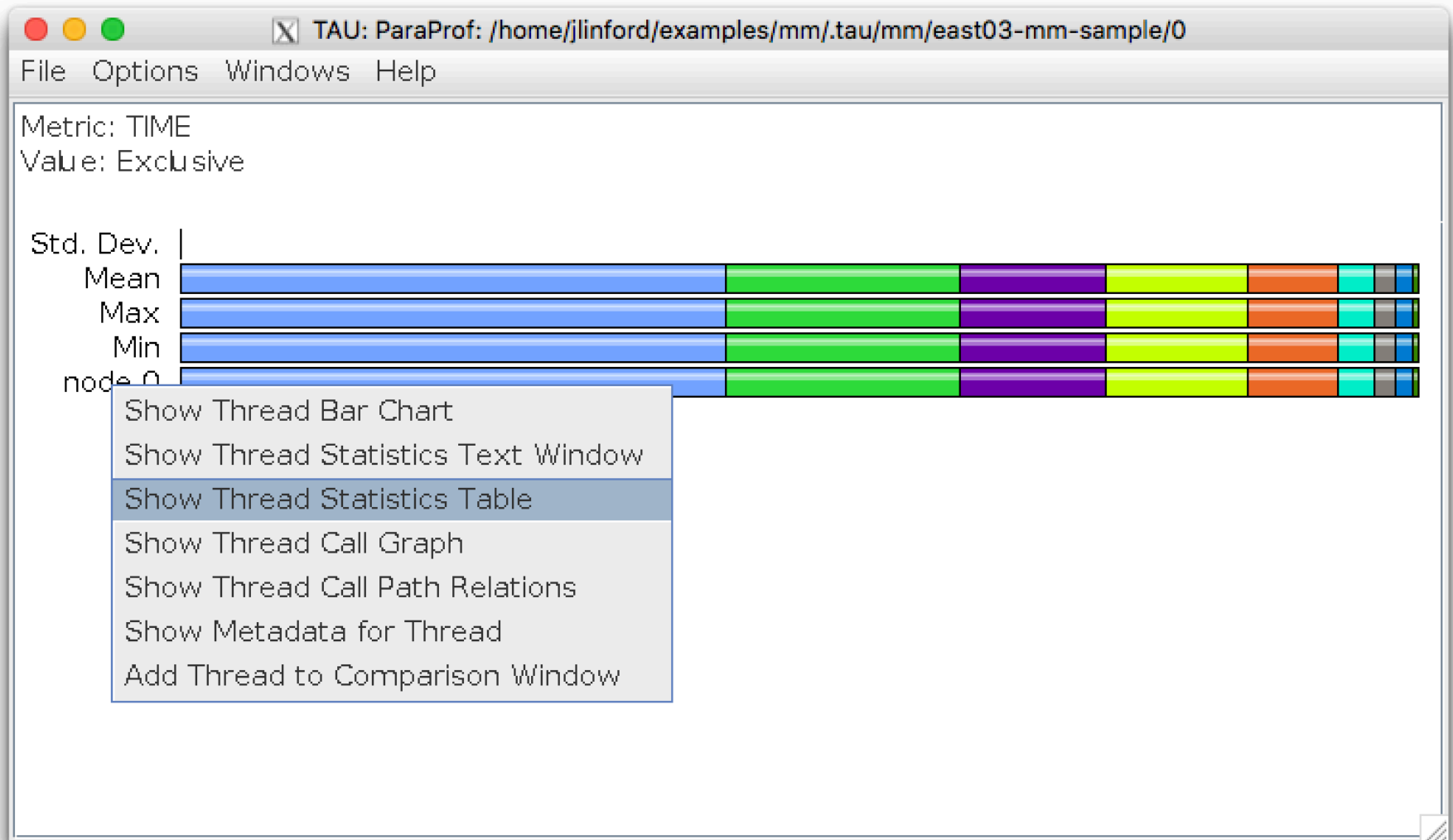
# Show or Hide Groups



# Node 0 Data With Callpath Data Hidden

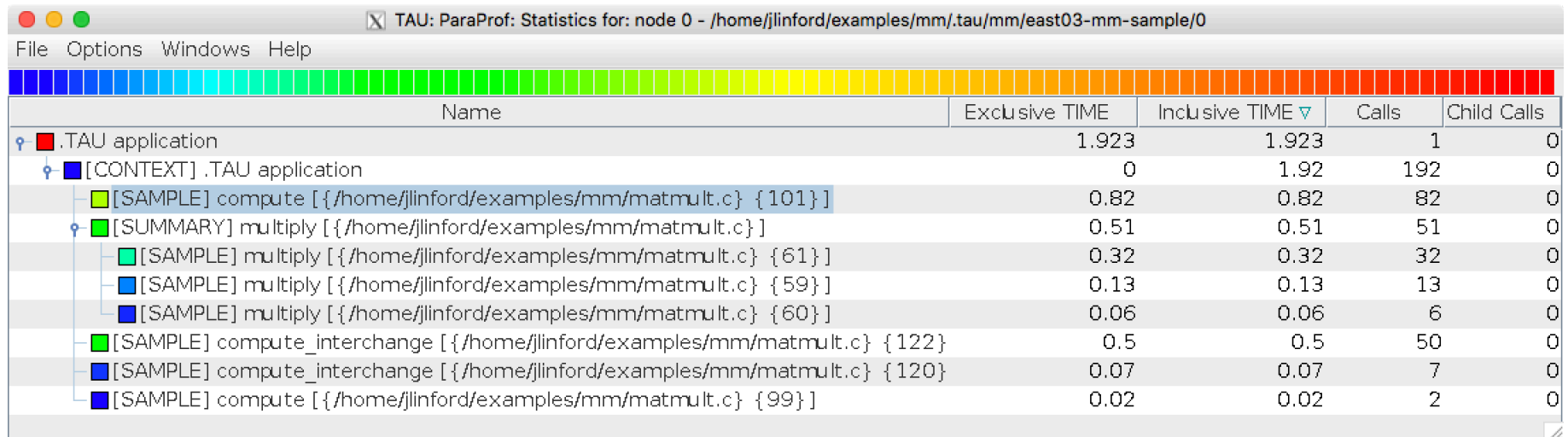


# View Sampling Data in the Statistics Table



# Node 0 Statistics Table

Sort by “Inclusive TIME” descending to put most expensive source code line on top.



Name	Exclusive TIME	Inclusive TIME ▾	Calls	Child Calls
.TAU application	1.923	1.923	1	0
[CONTEXT] .TAU application	0	1.92	192	0
[SAMPLE] compute [ {/home/jlinford/examples/mm/matmult.c} {101} ]	0.82	0.82	82	0
[SUMMARY] multiply [ {/home/jlinford/examples/mm/matmult.c} ]	0.51	0.51	51	0
[SAMPLE] multiply [ {/home/jlinford/examples/mm/matmult.c} {61} ]	0.32	0.32	32	0
[SAMPLE] multiply [ {/home/jlinford/examples/mm/matmult.c} {59} ]	0.13	0.13	13	0
[SAMPLE] multiply [ {/home/jlinford/examples/mm/matmult.c} {60} ]	0.06	0.06	6	0
[SAMPLE] compute_interchange [ {/home/jlinford/examples/mm/matmult.c} {122} ]	0.5	0.5	50	0
[SAMPLE] compute_interchange [ {/home/jlinford/examples/mm/matmult.c} {120} ]	0.07	0.07	7	0
[SAMPLE] compute [ {/home/jlinford/examples/mm/matmult.c} {99} ]	0.02	0.02	2	0

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---

# **PROFILING WITH SOURCE-BASED INSTRUMENTATION**

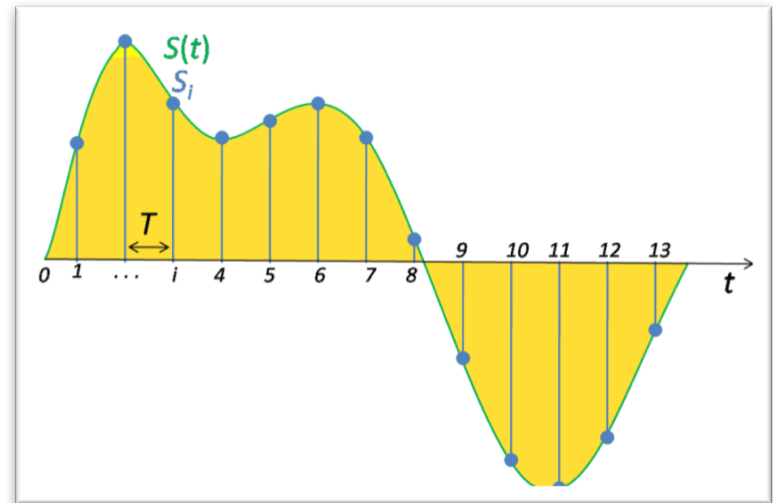
# Performance Data Measurement

## Direct via Probes

```
call TAU_START('potential')  
// code  
call TAU_STOP('potential')
```

- Exact measurement
- Fine-grain control
- Calls inserted into code

## Indirect via Sampling



- No code modification
- Minimal effort
- Relies on debug symbols (**-g** option)



# Look for “automatic” in “Source Inst.”

The default “profile” measurement uses automatic source-based instrumentation.

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120×14
[jlinford@east03:~/examples/mm$ tau measurement list
== Measurement Configurations (/home/jlinford/examples/mm/.tau/project.json) =====
```

Name	Profile	Trace	Sample	Source Inst.	Compiler Inst.	OpenMP	CUDA	I/O	MPI	SHMEM
profile	tau	none	No	automatic	never	ignore	No	No	No	No
trace	none	ottr	No	automatic	never	ignore	No	No	No	No

```
jlinford@east03:~/examples/mm$
```

# `tau select` Creates a New Experiment

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x5
[jlinford@east03:~/examples/mm$ tau select profile
[TAU] Selected experiment 'east03-mm-profile'.
[TAU] Application rebuild required:
[TAU] - source_inst changed from 'never' to 'automatic'
jlinford@east03:~/examples/mm$
```

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x12
[jlinford@east03:~/examples/mm$ tau experiment list
== Experiment Configurations (/home/jlinford/examples/mm/.tau/project.json) ==
```

Name	Trials	Data Size	Target	Application	Measurement	TAU Makefile
east03-mm-sample	1	7.9KiB	east03	mm	sample	Makefile.tau-beec6777
east03-mm-profile	0	0.0B	east03	mm	profile	Makefile.tau-807d6138-pdt

```
jlinford@east03:~/examples/mm$
```

# Compiling examples/mm with source-inst

Note: compiler command has changed from “gcc” to “tau\_cc.sh”

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x32
[jlinford@east03:~/examples/mm$ make clean
/bin/rm -rf matmult.o matmult_initialize.o matmult.exe* profile.* *.trc *.edf *.z MULT* *.inst.* *.pdb Comp_gnu.o *.pom
p.* *.opari.inc pomregions.* *.output *.error *.cobaltlog
[jlinford@east03:~/examples/mm$ make
tau gcc -c matmult.c -o matmult.o
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-807d6138-pdt
[TAU] TAU_OPTIONS=-op Revert -optQuiet -optNoCompInst
[TAU] tau_cc.sh -DTAU_ENABLED=1 -c matmult.c -o matmult.o
In file included from /home/jlinford/taucmdr-1.2.0.4/system/tau/tau-2.26.3/include/Profile/Profiler.h:86:0,
from matmult.inst.c:1:
/home/jlinford/taucmdr-1.2.0.4/system/tau/tau-2.26.3/include/TAU.h:23:0: warning: "TAU_ENABLED" redefined
#define TAU_ENABLED
^
<command-line>:0:0: note: this is the location of the previous definition

tau gcc -c matmult_initialize.c -o matmult_initialize.o
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-807d6138-pdt
[TAU] TAU_OPTIONS=-op Revert -optQuiet -optNoCompInst
[TAU] tau_cc.sh -DTAU_ENABLED=1 -c matmult_initialize.c -o matmult_initialize.o
In file included from /home/jlinford/taucmdr-1.2.0.4/system/tau/tau-2.26.3/include/Profile/Profiler.h:86:0,
from matmult_initialize.inst.c:1:
/home/jlinford/taucmdr-1.2.0.4/system/tau/tau-2.26.3/include/TAU.h:23:0: warning: "TAU_ENABLED" redefined
#define TAU_ENABLED
^
<command-line>:0:0: note: this is the location of the previous definition

tau gcc matmult.o matmult_initialize.o -o matmult.exe
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-807d6138-pdt
[TAU] TAU_OPTIONS=-op Revert -optQuiet -optNoCompInst
[TAU] tau_cc.sh -DTAU_ENABLED=1 matmult.o matmult_initialize.o -o matmult.exe

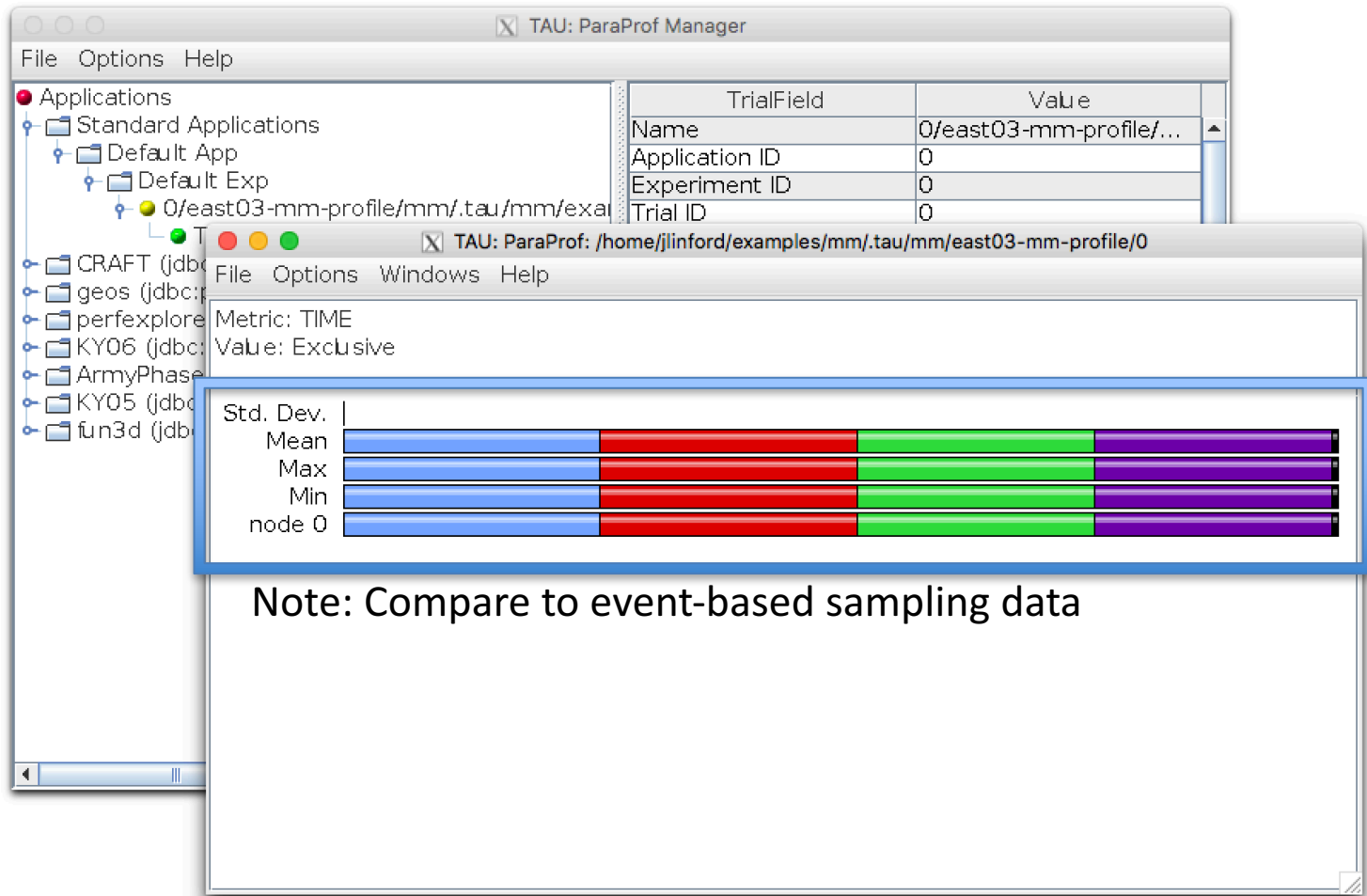
jlinford@east03:~/examples/mm$
```

# Execute exactly the same as before

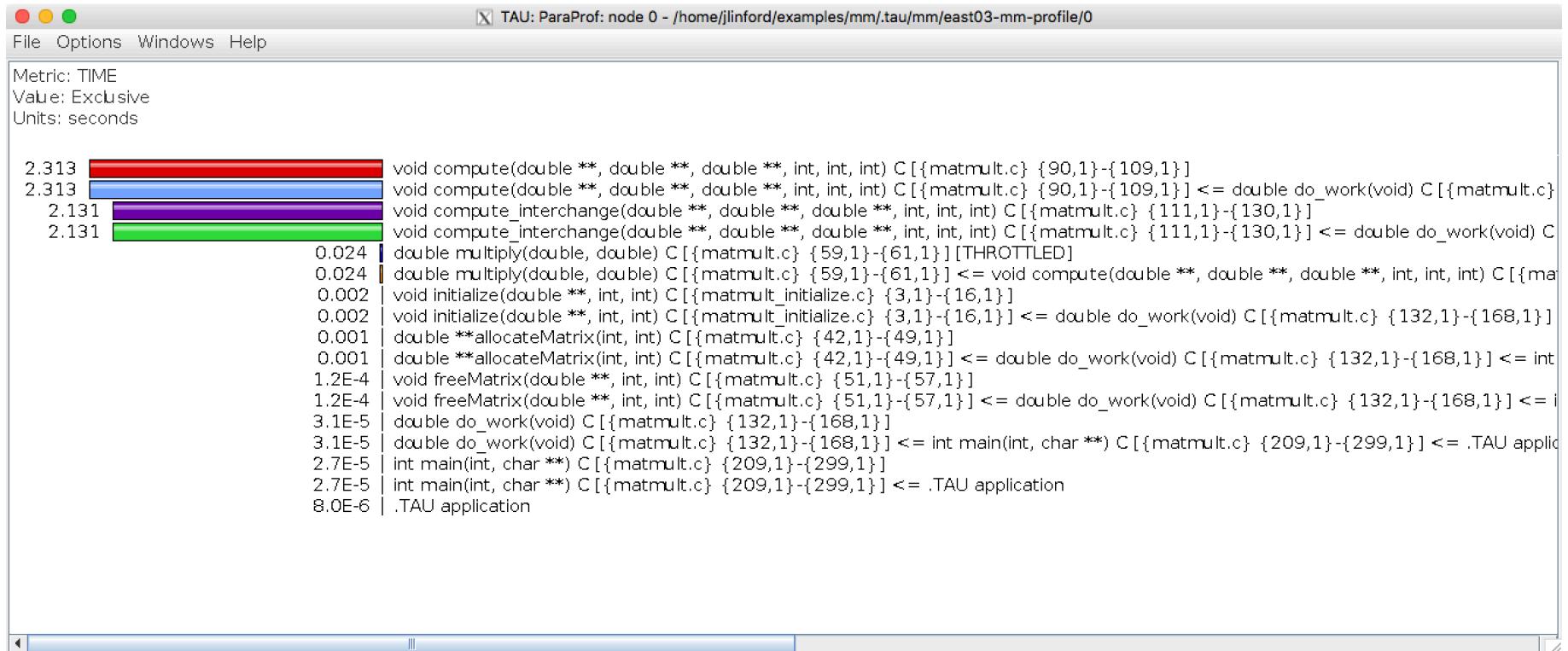
```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x35
[jlinford@east03:~/examples/mm$ ls
Makefile      matmult.c      matmult_initialize.c  matmult_initialize.o  README.stampede
Makefile.intel matmult.exe     matmult_initialize.h  matmult.o
[jlinford@east03:~/examples/mm$ tau ./matmult.exe
[TAU]
[TAU] == BEGIN Experiment at 2017-09-27 21:12:47.855738 =====
[TAU]
[TAU] PROFILEDIR=/home/jlinford/examples/mm/.tau/mm/east03-mm-profile/0
[TAU] SCOREP_ENABLE_TRACING=false
[TAU] TAU_CALLPATH=1
[TAU] TAU_CALLPATH_DEPTH=100
[TAU] TAU_CALLSITE=0
[TAU] TAU_COMM_MATRIX=0
[TAU] TAU_MERGE_METADATA=1
[TAU] TAU_METRICS=TIME,
[TAU] TAU_PROFILE=1
[TAU] TAU_SAMPLING=0
[TAU] TAU_THROTTLE=1
[TAU] TAU_THROTTLE_NUMCALLS=100000
[TAU] TAU_THROTTLE_PERCALL=10
[TAU] TAU_TRACE=0
[TAU] TAU_TRACK_HEAP=0
[TAU] TAU_VERBOSE=0
[TAU] TRACEDIR=/home/jlinford/examples/mm/.tau/mm/east03-mm-profile/0
[TAU] ./matmult.exe
Done.
[TAU] Trial 0 produced 1 profile files.
[TAU]
[TAU] == END Experiment at 2017-09-27 21:12:52.352675 =====
[TAU]
[TAU] Experiment: east03-mm-profile
[TAU] Command: ./matmult.exe
[TAU] Current working directory: /home/jlinford/examples/mm
[TAU] Data size: 8.2KiB bytes
jlinford@east03:~/examples/mm$
```

# `tau show` Displays the Most Recent Trial's Data

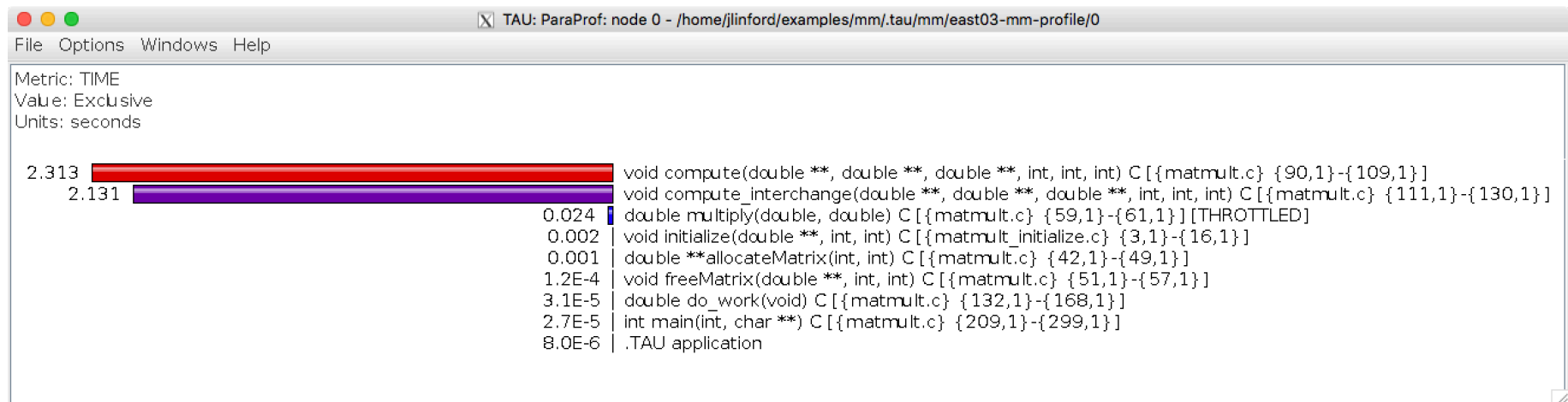
```
$ tau show
```



# Node 0 Source-Inst Data



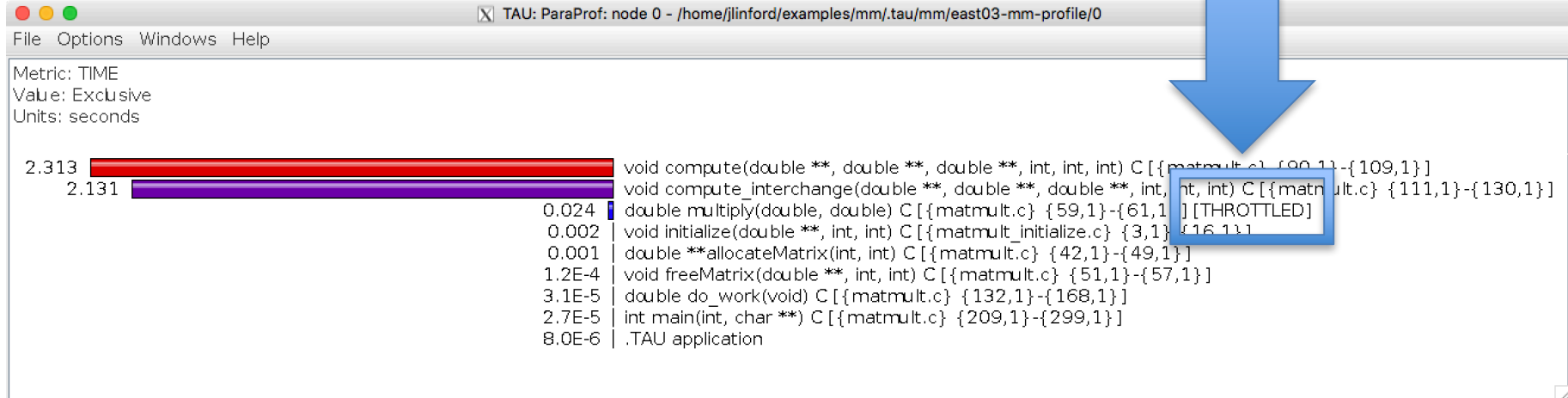
# Node 0 Source-Inst with Callpath Hidden



# THROTTLED and Selective Instrumentation

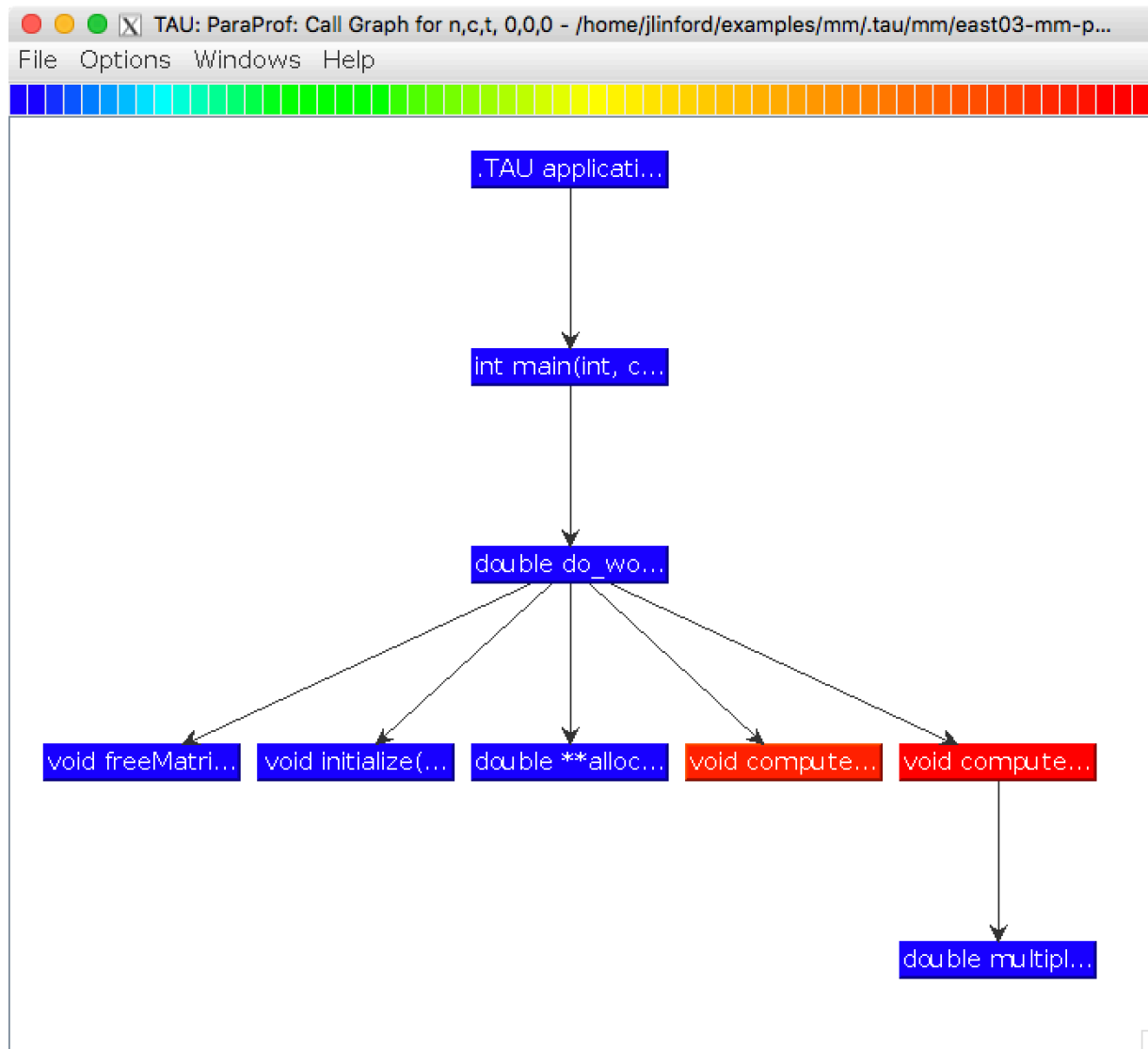
[**THROTTLED**] Indicates that instrumentation was automatically disabled in this code region.

- The cost of instrumentation was higher than the cost of the code region itself.
- Use **selective instrumentation** to statically disable.

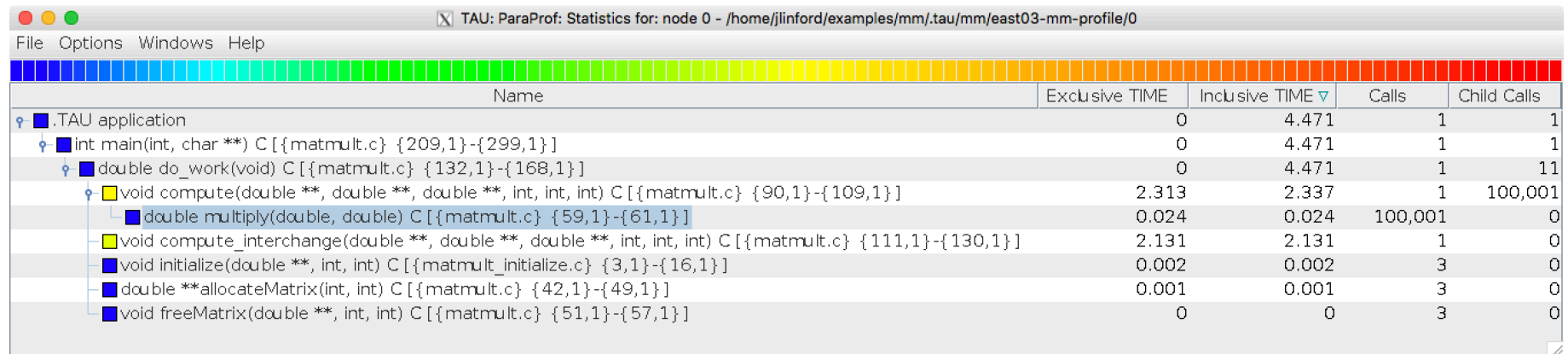




# Node 0 Call Graph Showing Time Hot-Spots



# Node 0 Statistics Table



Name	Exclusive TIME	Inclusive TIME	Calls	Child Calls
.TAU application	0	4.471	1	1
int main(int, char **) C [{matmult.c} {209,1}-{299,1}]	0	4.471	1	1
double do_work(void) C [{matmult.c} {132,1}-{168,1}]	0	4.471	1	11
void compute(double **, double **, double **, int, int, int) C [{matmult.c} {90,1}-{109,1}]	2.313	2.337	1	100,001
double multiply(double, double) C [{matmult.c} {59,1}-{61,1}]	0.024	0.024	100,001	0
void compute_interchange(double **, double **, double **, int, int, int) C [{matmult.c} {111,1}-{130,1}]	2.131	2.131	1	0
void initialize(double **, int, int) C [{matmult_initialize.c} {3,1}-{16,1}]	0.002	0.002	3	0
double **allocateMatrix(int, int) C [{matmult.c} {42,1}-{49,1}]	0.001	0.001	3	0
void freeMatrix(double **, int, int) C [{matmult.c} {51,1}-{57,1}]	0	0	3	0

- Compare to event-based sampling statistics table
  - Coarser granularity: code region, not source line.
  - Time and call metrics are much more accurate.

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# **PROFILING HARDWARE PERFORMANCE**

# `tau target metrics` Shows Available Metrics

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x10
[jlinford@east03:~/examples/mm$ tau target list
== Target Configurations (/home/jlinford/examples/mm/.tau/project.json) =====

+-----+-----+-----+-----+-----+-----+
| Name   | Host OS | Host Arch | Host Compilers | MPI Compilers | SHMEM Compilers |
+-----+-----+-----+-----+-----+-----+
| east03 | Linux   | x86_64    | GNU            | System        | None            |
+-----+-----+-----+-----+-----+-----+

jlinford@east03:~/examples/mm$
```

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x22
[jlinford@east03:~/examples/mm$ tau target metrics --help
usage: tau target metrics <target_name> [arguments]

Show metrics available on this target.

Positional Arguments:
  <target_name>      Target name.

Optional Arguments:
  --all              Show all metrics and their modifiers.
                    - default: False
  --modifiers        Show metric modifiers.
                    - default: False
  --systems system [system ...]
                    List metrics from these measurement systems.
                    - system: TAU, PAPI_PRESET, PAPI_NATIVE, CUPTI
                    - default: TAU, PAPI_PRESET
  -@ <level>         Use the target at the specified storage level.
                    - <level>: project, user, system
                    - default: project
  -h, --help         Show this help message and exit.

jlinford@east03:~/examples/mm$
```

# Example Metrics

```
jlinford@east03:~/examples/mm$ tau target metrics east03
== PAPI Preset Metrics on Target 'east03' ==
```

Name	Description
PAPI_BR_CN	Conditional branch instructions.
PAPI_BR_INS	Branch instructions.
PAPI_BR_MSP	Conditional branch instructions mispredicted.
PAPI_BR_MTK	Conditional branch instructions not taken.
PAPI_BR_PRC	Conditional branch instructions correctly predicted.
PAPI_BR_TKN	Conditional branch instructions taken.
PAPI_BR_UCN	Unconditional branch instructions.
PAPI_DP_OPS	Floating point operations; optimized to count scaled double precision vector operations.
PAPI_FDV_INS	Floating point divide instructions.
PAPI_FP_INS	Floating point instructions.
PAPI_FP_OPS	Floating point operations.
PAPI_L1_DCM	Level 1 data cache misses.
PAPI_L1_ICM	Level 1 instruction cache misses.
PAPI_L1_LDM	Level 1 load misses.
PAPI_L1_STM	Level 1 store misses.
PAPI_L1_TCM	Level 1 cache misses.
PAPI_L2_DCA	Level 2 data cache accesses.
PAPI_L2_DCH	Level 2 data cache hits.
PAPI_L2_DCM	Level 2 data cache misses.
PAPI_L2_DCR	Level 2 data cache reads.
PAPI_L2_DCW	Level 2 data cache writes.
PAPI_L2_ICA	Level 2 instruction cache accesses.
PAPI_L2_ICh	Level 2 instruction cache hits.
PAPI_L2_ICM	Level 2 instruction cache misses.
PAPI_L2_ICR	Level 2 instruction cache reads.
PAPI_L2_STM	Level 2 store misses.
PAPI_L2_TCA	Level 2 total cache accesses.
PAPI_L2_TCM	Level 2 cache misses.
PAPI_L2_TCR	Level 2 total cache reads.
PAPI_L2_TCW	Level 2 total cache writes.
PAPI_L3_DCA	Level 3 data cache accesses.
PAPI_L3_DCR	Level 3 data cache reads.
PAPI_L3_DCW	Level 3 data cache writes.
PAPI_L3_ICA	Level 3 instruction cache accesses.
PAPI_L3_ICR	Level 3 instruction cache reads.
PAPI_L3_TCA	Level 3 total cache accesses.
PAPI_L3_TCM	Level 3 cache misses.
PAPI_L3_TCR	Level 3 total cache reads.
PAPI_L3_TCW	Level 3 total cache writes.
PAPI_LD_INS	Load instructions.
PAPI_REF_CYC	Reference clock cycles.
PAPI_SP_OPS	Floating point operations; optimized to count scaled single precision vector operations.
PAPI_SR_INS	Store instructions.
PAPI_STL_ICY	Cycles with no instruction issue.
PAPI_TLB_DM	Data translation lookaside buffer misses.
PAPI_TLB_IM	Instruction translation lookaside buffer misses.
PAPI_TOT_CYC	Total cycles.
PAPI_TOT_INS	Instructions completed.
PAPI_VEC_DP	Double precision vector/SIMD instructions.
PAPI_VEC_SP	Single precision vector/SIMD instructions.

```
== TAU Metrics on Target 'east03' ==
```

Name	Description
CLOCK_GET_TIME	Wall clock that calls clock_gettime.
CPU_TIME	CPU timer that calls getrusage.
GET_TIME_OF_DAY	Wall clock that calls gettimeofday.
LINUX_TIMERS	Linux high resolution wall clock.
LOGICAL_CLOCK	Logical clock that increments on each request.
MEMORY_DELTA	Instantaneous resident set size (RSS)
PAPI_TIME	Alias for P_WALL_CLOCK_TIME. Wall clock that calls PAPI_get_real_usec.
PAPI_VIRTUAL_TIME	Alias for P_VIRTUAL_TIME. PAPI virtual clock that calls PAPI_get_virt_usec.
P_VIRTUAL_TIME	PAPI virtual clock that calls PAPI_get_virt_usec.
P_WALL_CLOCK_TIME	Wall clock that calls PAPI_get_real_usec.
TAU_MPI_MESSAGE_SIZE	Running sum of all MPI message sizes.
TIME	Alias for GET_TIME_OF_DAY. Wall clock that calls gettimeofday.
USER_CLOCK	User-defined clock. Implement 'void metric_write_userClock(int tid, double value)' to set the clock value.

```
jlinford@east03:~/examples/mm$
```

PAPI Preset metrics show high-level hardware performance

- Cache hits/misses
- Floating point instructions executed
- Branch instructions predicted/missed
- CPU cycles
- Load/store instructions
- Vector/SIMD instructions

# Create a New Measurement

jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120×18

```
jlinford@east03:~/examples/mm$ tau measurement create --help
usage: tau measurement create <measurement_name> [arguments]
```

Create measurement configurations.

## Optional Arguments:

**-@ <level>** Create the measurement at the specified storage level.  
- <level>: project, user, system  
- default: project

**-h, --help** Show this help message and exit.

## Data Arguments:

**--callpath [depth]** Maximum depth for callpath recording.  
- default: 100

**--metrics <metric> [<metric> ...]** Performance metrics to gather, e.g. TIME, PAPI\_FP\_INS.  
- default: TIME

# Create and Select a New Measurement

```
$ tau measurement create sample.papi \  
    --metrics TIME PAPI_L2_DCA PAPI_L2_DCM
```

[TAU] Added measurement 'sample.papi' to project configuration 'mm'.

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120×22  
[jlinford@east03:~/examples/mm$ tau measurement list  
== Measurement Configurations (/home/jlinford/examples/mm/.tau/project.json) =====  
  
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+  
| Name   | Profile | Trace | Sample | Source Inst. | Compiler Inst. | OpenMP | CUDA | I/O | MPI | SHMEM |  
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+  
| sample | tau     | none  | Yes    | never        | never          | ignore | No   | No  | No  | No    |  
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+  
| profile | tau     | none  | No     | automatic    | never          | ignore | No   | No  | No  | No    |  
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+  
| trace  | none    | otf2   | No     | automatic    | never          | ignore | No   | No  | No  | No    |  
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+  
  
[jlinford@east03:~/examples/mm$ tau measurement create sample.papi --metrics TIME PAPI_L2_DCA PAPI_L2_DCM  
[TAU] Added measurement 'sample.papi' to project configuration 'mm'.  
[jlinford@east03:~/examples/mm$ tau select sample.papi  
[TAU] Created a new experiment 'east03-mm-sample.papi'  
[TAU] Selected experiment 'east03-mm-sample.papi'.  
[TAU] Application rebuild required:  
[TAU]   - source_inst changed from 'automatic' to 'never'  
[TAU]   - metrics changed from [TIME] to [TIME, PAPI_L2_DCA, PAPI_L2_DCM]  
jlinford@east03:~/examples/mm$
```

# Rebuild examples/mm as before

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x17
[jlinford@east03:~/examples/mm$ make clean
/bin/rm -rf matmult.o matmult_initialize.o matmult.exe* profile.* *.trc *.edf *.z MULT* *.inst.* *.pdb Comp_gnu.o *.pom
p.* *.opari.inc pompreregions.* *.output *.error *.cobaltlog
[jlinford@east03:~/examples/mm$ make
tau gcc -c matmult.c -o matmult.o
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-19cec192-papi
[TAU] TAU_OPTIONS=-optNoCompInst -optLinkOnly -optQuiet
[TAU] /usr/bin/gcc -g -c matmult.c -o matmult.o
tau gcc -c matmult_initialize.c -o matmult_initialize.o
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-19cec192-papi
[TAU] TAU_OPTIONS=-optNoCompInst -optLinkOnly -optQuiet
[TAU] /usr/bin/gcc -g -c matmult_initialize.c -o matmult_initialize.o
tau gcc matmult.o matmult_initialize.o -o matmult.exe
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau/./tau-2.26.3/x86_64/lib/Makefile.tau-19cec192-papi
[TAU] TAU_OPTIONS=-optNoCompInst -optLinkOnly -optQuiet
[TAU] /usr/bin/gcc -g matmult.o matmult_initialize.o -o matmult.exe
jlinford@east03:~/examples/mm$
```



# Run as before

```
jlinford — jlinford@east03: ~/examples/mm — ssh east03.paratools.com — 120x32
[jlinford@east03:~/examples/mm$ tau ./matmult.exe
[TAU]
[TAU] == BEGIN Experiment at 2017-09-27 21:46:29.228853 =====
[TAU]
[TAU] PROFILEDIR=/home/jlinford/examples/mm/.tau/mm/east03-mm-sample.papi/0
[TAU] SCOREP_ENABLE_TRACING=false
[TAU] TAU_CALLPATH=1
[TAU] TAU_CALLPATH_DEPTH=100
[TAU] TAU_CALLSITE=0
[TAU] TAU_COMM_MATRIX=0
[TAU] TAU_MERGE_METADATA=1
[TAU] TAU_METRICS=TIME,PAPI_L2_DCA,PAPI_L2_DCM,
[TAU] TAU_PROFILE=1
[TAU] TAU_SAMPLING=1
[TAU] TAU_THROTTLE=1
[TAU] TAU_THROTTLE_NUMCALLS=100000
[TAU] TAU_THROTTLE_PERCALL=10
[TAU] TAU_TRACE=0
[TAU] TAU_TRACK_HEAP=0
[TAU] TAU_VERBOSE=0
[TAU] TRACEDIR=/home/jlinford/examples/mm/.tau/mm/east03-mm-sample.papi/0
[TAU] tau_exec -T serial,19cec192,papi -ebs ./matmult.exe
Done.
[TAU] Trial 0 produced 3 profile files.
[TAU]
[TAU] == END Experiment at 2017-09-27 21:46:31.42 =====
[TAU]
[TAU] Experiment: east03-mm-sample.papi
[TAU] Command: tau_exec -T serial,19cec192,papi -ebs ./matmult.exe
[TAU] Current working directory: /home/jlinford/examples/mm
[TAU] Data size: 12.9KiB bytes
jlinford@east03:~/examples/mm$
```

One profile per metric, per thread

# `tau show` Displays the Most Recent Trial's Data

\$ tau show

- Metrics appear in the manager window.
- Double-click a metric to view it.

The screenshot shows the TAU: ParaProf Manager application. The left pane displays a tree view of applications and metrics. A blue box highlights the 'TIME' metric under the '0/east03-mm-sample.papi/0' application. The right pane shows a table of trial fields and values.

TrialField	Value
Name	0/east03-mm-sample....
Application ID	0
Experiment ID	0
Trial ID	0
CPU Cores	4
CPU MHz	3696.386
CPU Type	Intel(R) Core(TM) i7-4...
CPU Vendor	GenuineIntel

Below the table, a detailed view of the 'TIME' metric is shown. It includes the metric name, value, and a bar chart comparing the metric across different nodes.

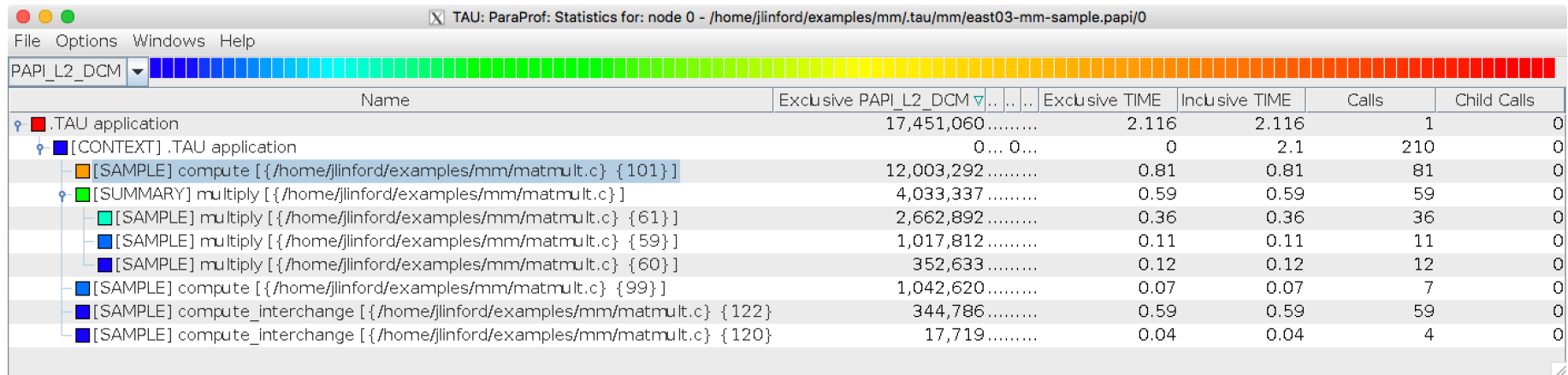
Metric: TIME  
Value: Exclusive

Std. Dev. |  
Mean |  
Max |  
Min |  
node 0 |

The bar chart displays the distribution of the 'TIME' metric across different nodes, with colors representing different metrics: blue, red, green, purple, blue, yellow, green, orange, and grey.

# View Sampling Data in the Statistics Table

Source code line with the most L2 data cache misses is highlighted.



Name	Exclusive PAPI_L2_DCM	Exclusive TIME	Inclusive TIME	Calls	Child Calls
.TAU application	17,451,060 .....	2.116	2.116	1	0
[CONTEXT] .TAU application	0 ... 0 ...	0	2.1	210	0
[SAMPLE] compute [{/home/jlinford/examples/mm/matmult.c} {101}]	12,003,292 .....	0.81	0.81	81	0
[SUMMARY] multiply [{/home/jlinford/examples/mm/matmult.c}]	4,033,337 .....	0.59	0.59	59	0
[SAMPLE] multiply [{/home/jlinford/examples/mm/matmult.c} {61}]	2,662,892 .....	0.36	0.36	36	0
[SAMPLE] multiply [{/home/jlinford/examples/mm/matmult.c} {59}]	1,017,812 .....	0.11	0.11	11	0
[SAMPLE] multiply [{/home/jlinford/examples/mm/matmult.c} {60}]	352,633 .....	0.12	0.12	12	0
[SAMPLE] compute [{/home/jlinford/examples/mm/matmult.c} {99}]	1,042,620 .....	0.07	0.07	7	0
[SAMPLE] compute_interchange [{/home/jlinford/examples/mm/matmult.c} {122}]	344,786 .....	0.59	0.59	59	0
[SAMPLE] compute_interchange [{/home/jlinford/examples/mm/matmult.c} {120}]	17,719 .....	0.04	0.04	4	0

# Derive L2 Miss Rate

TAU: ParaProf Manager

File Options Help

☒ Show Derived Metric Panel

Apply Expression File

Re-Apply Expression File

0/east03-mm-sample.papi/mm

- PAPI\_L2\_DCM
- PAPI\_L2\_DCA
- TIME

CRAFT (jdbc:postgresql://east01.paratools.com:5432/craft)

geos (jdbc:postgresql://east01.paratools.com:5432/geos)

perfexplorer\_working (jdbc:h2:/home/jlinford/.Paratools/perfexplorer\_working)

KY06 (jdbc:postgresql://east01.paratools.com:5432/kyl06)

ArmyPhasell (jdbc:postgresql://east01.paratools.com:5432/armyphasell)

KY05 (jdbc:postgresql://east01.paratools.com:5432/kyl05)

fun3d (jdbc:postgresql://east01.paratools.com:5432/fun3d)

MetricField	Value
Name	PAPI_L2_DCM
Value	0
Value	0
Value	0
Metric ID	0

Check "Show Derived Metric Panel" to show this panel.

Expression:

Clear

+ - \* / = ( ) Apply

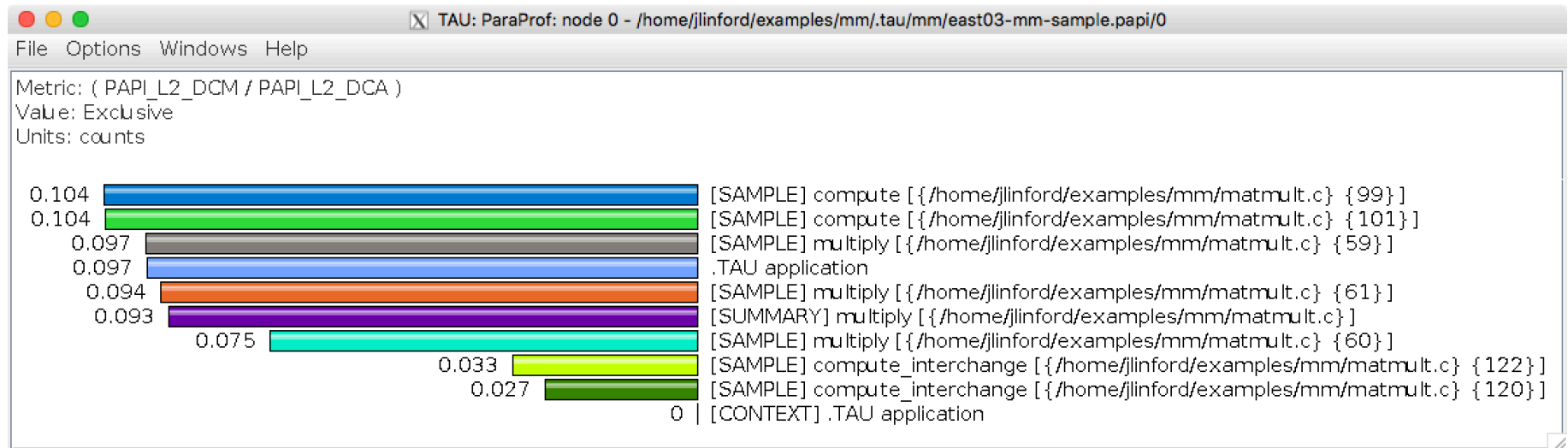
# Create a New Derived Metric

The screenshot shows the TAU: ParaProf Manager application window. The left pane displays a tree view of applications, with the path `0/east03-mm-sample.papi/mm/.tau/mm/` expanded. Under this path, several metrics are listed: `PAPI_L2_DCM`, `PAPI_L2_DCA`, `TIME`, and `( PAPI_L2_DCM / PAPI_L2_DCA )`. The last metric is selected. The right pane shows a table with two columns: `MetricField` and `Value`. The table contains the following data:

MetricField	Value
Name	( PAPI_L2_DCM / PAPI_L2_DCA )
Application ID	0
Experiment ID	0
Trial ID	0
Metric ID	0

At the bottom of the window, there is an `Expression:` field containing the text `"PAPI_L2_DCM"/"PAPI_L2_DCA"`. To the right of this field is a `Clear` button. Below the expression field is a row of buttons for mathematical operators: `+`, `-`, `*`, `/`, `=`, `(`, `)`, and an `Apply` button.

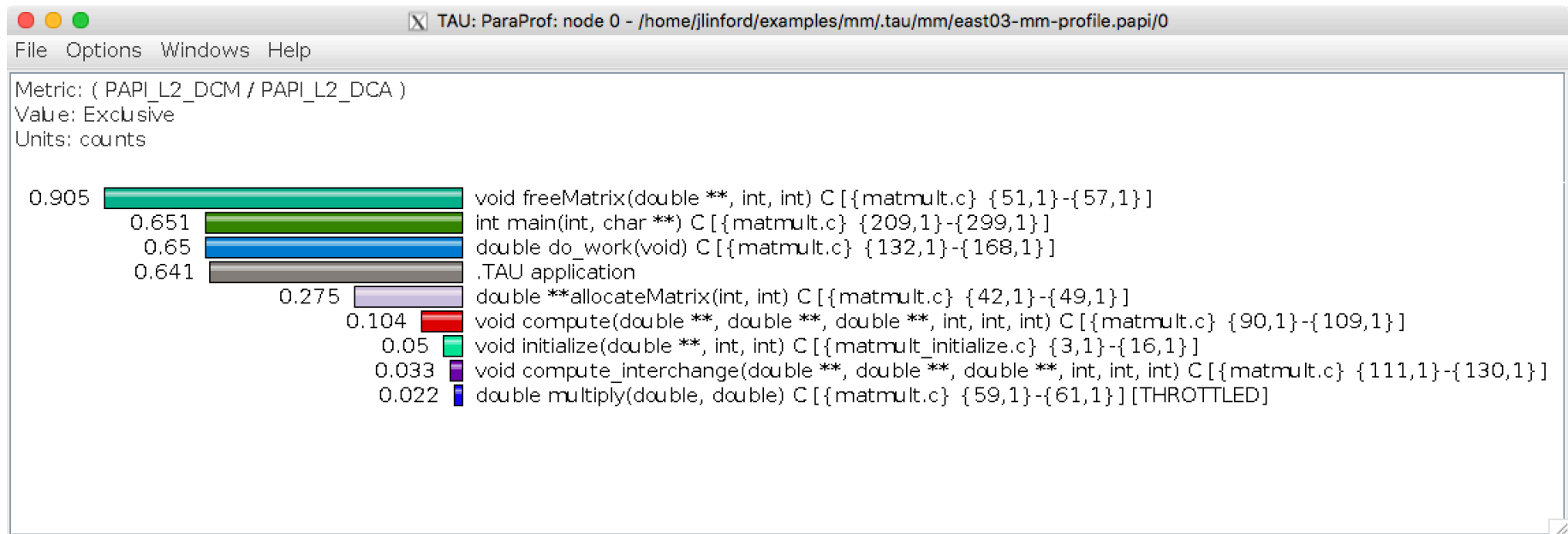
# Fraction of L2 Accesses that Miss



- 10.4% of L2 data cache accesses at matmult.c:99 miss.
- Only 3.3% of L2 data cache accesses miss at the equivalent line in compute\_interchange()

# Same Data When Using source-inst

```
tau measurement create profile.papi \  
  --metrics TIME PAPI_L2_DCA PAPI_L2_DCM \  
  --source-inst automatic --sample no
```



# Other Useful Measurements

## Fraction of CPU cycles with no instruction issue:

```
tau measurement create noissue \  
    --metrics TIME PAPI_STL_ICY PAPI_TOT_CYC
```

## Fraction of instructions that are SIMD instructions:

```
tau measurement create SIMD \  
    --metrics PAPI_TOT_INS PAPI_VEC_DP PAPI_VEC_SP
```

## Executed instruction breakdown:

```
tau measurement create ins_breakdown \  
    --metrics PAPI_BR_INS PAPI_FP_INS \  
              PAPI_LD_INS PAPI_SR_INS PAPI_TOT_INS
```

Note: available metrics depend on your CPU.

Use `tau target metrics` to see what's available.