Debugging and Performance Tools

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Debugging via printf

- printf supported on devices of sm_20 and higher
- Requires inclusion of “stdio.h”

- Caution:
  - Fixed buffer size
  - Flushed under certain circumstances
    - E.g. next time a kernel is launched
  - Not flused by default at end of application
    - Forced eg. via cudaDeviceReset()

Debugging via cuda-gdb

- Compile with –g –G options
- Use –gencode option

  nvcc –g –G –gencode arch=compute_35,code=sm_35

- run via cuda-gdb myapp

- Determining focus:

  (cuda-gdb) cuda device sm warp lane block thread

- Breakpoint
- (cuda-gdb) break my_file.cu:185

Debugging via cuda-memcheck

- Useful in case of “unspecified launch failure”
  - Out-of-bound access, memory leaks
- Does not require recompilation

- More precise information if compiled with flags:

  -G -lineinfo –rdynamic

- racecheck to detect race conditions

  cuda-memcheck –tool racecheck myapp.x

Performance Analysis with Cmd-Line Profiler

- Basic trace of kernel launches and data transfers

  export CUDA_PROFILE=1

- Additional env variables for e.g visualization of parallel run in NVVP

  export COMPUTE_PROFILE_CSV=1

  export COMPUTE_PROFILE_LOG="profile_%p.csv"

  export COMPUTE_PROFILE_CONFIG=profile.cfg

- Signals to collect specified in configuration file "profile.cfg"

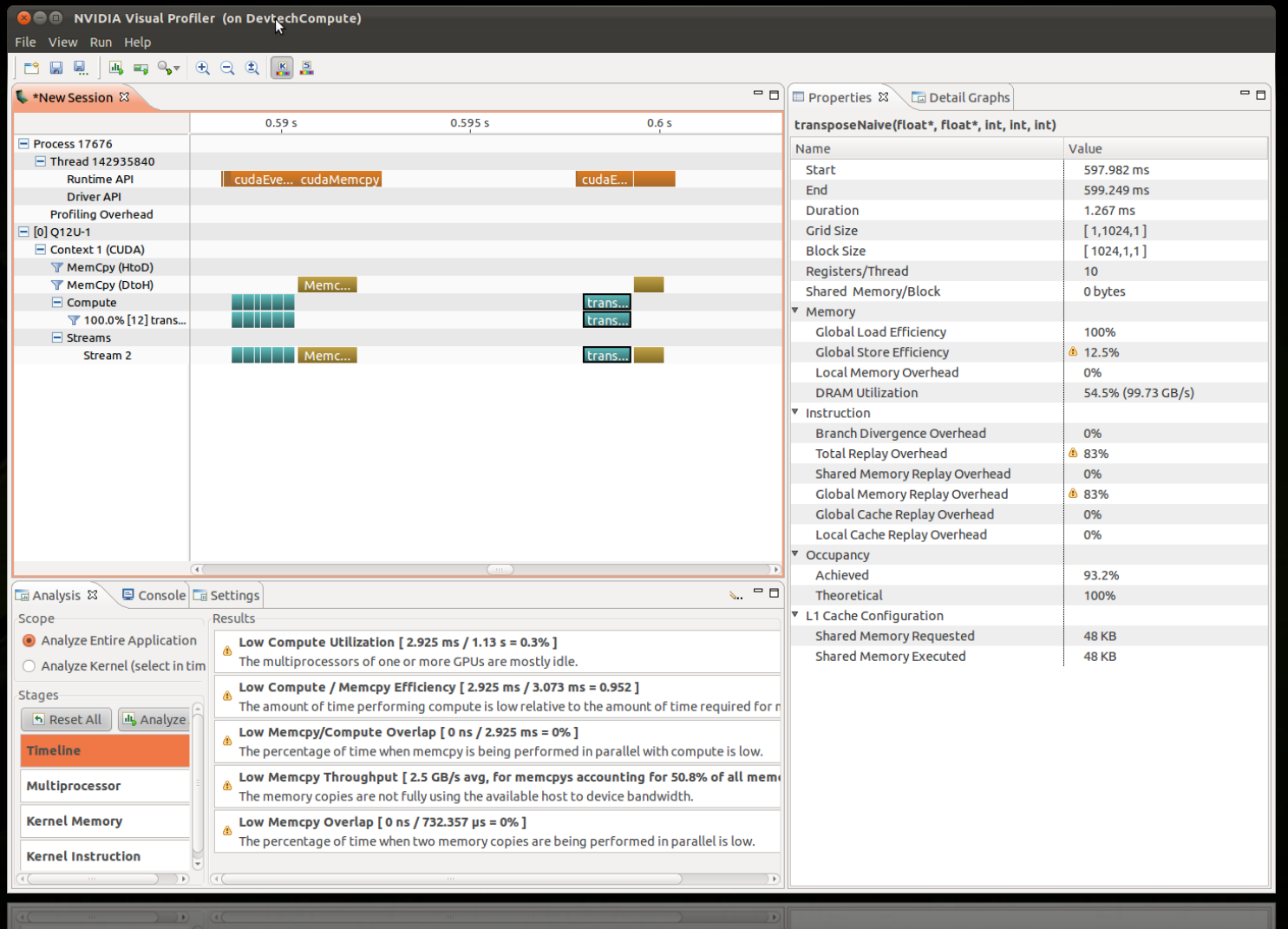
Performance Analysis with Cmd-Line Profiler

- Sample configuration file profile.cfg

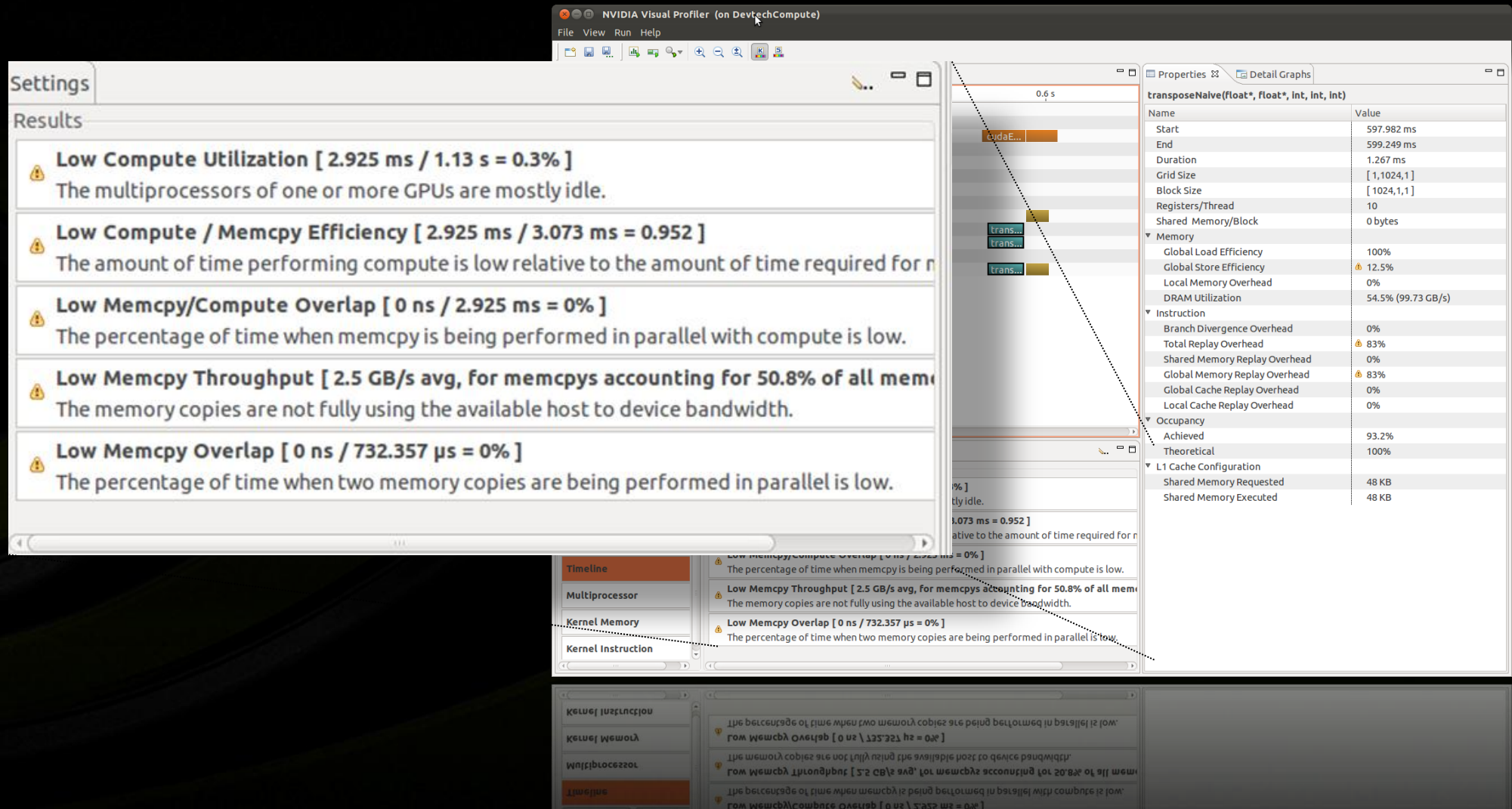
```
gpustarttimestamp
gridsize3d
threadblocksize
dynsmemperblock
stasmemperblock
regperthread
memtransfersize
memtransferdir
streamid
countermodeaggregate
active_warps
active_cycles
```

NVVP – NVIDIA Visual Profiler

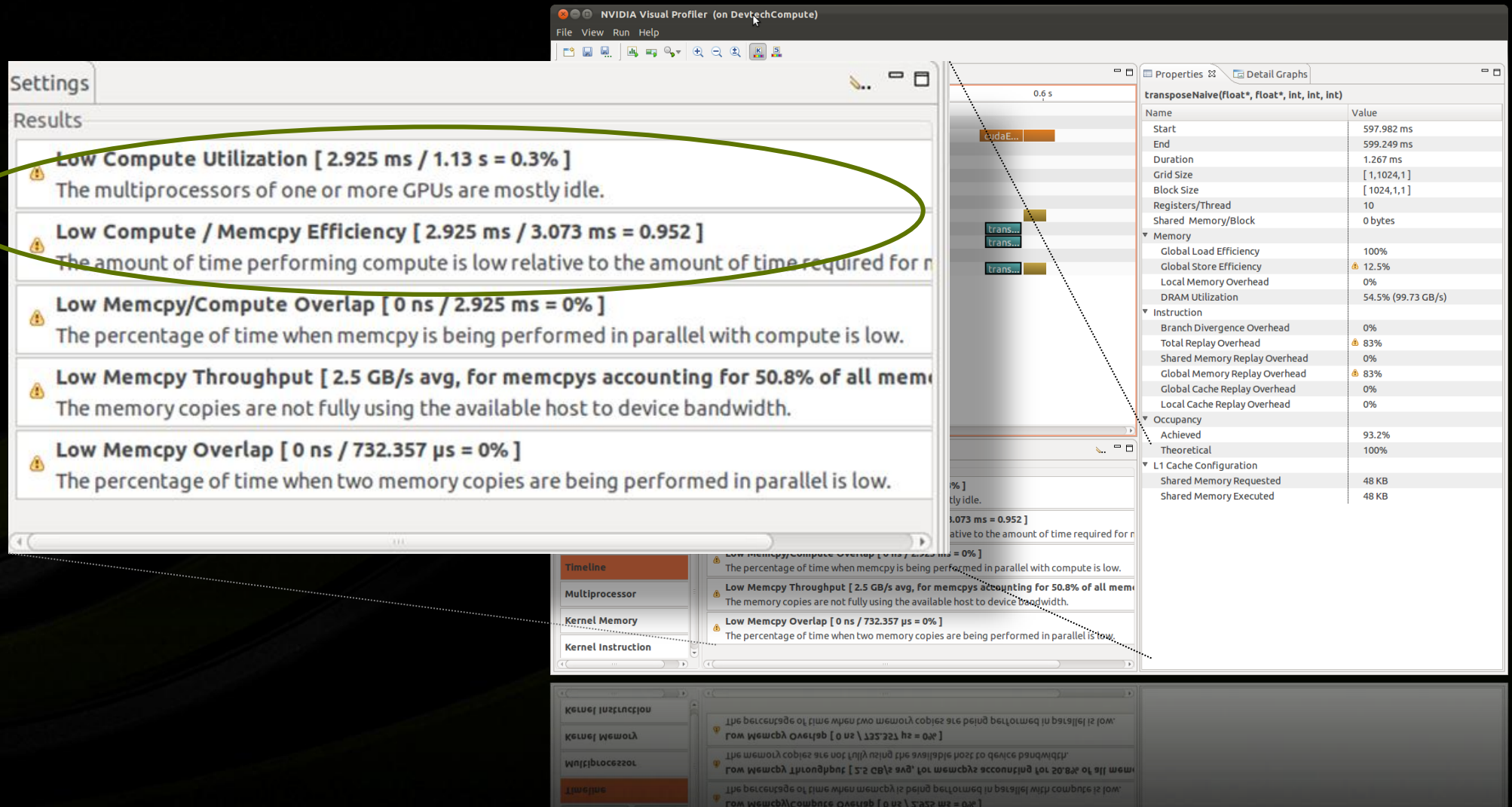
- Application analysis
- Kernel properties



Application Assessment with NVVP

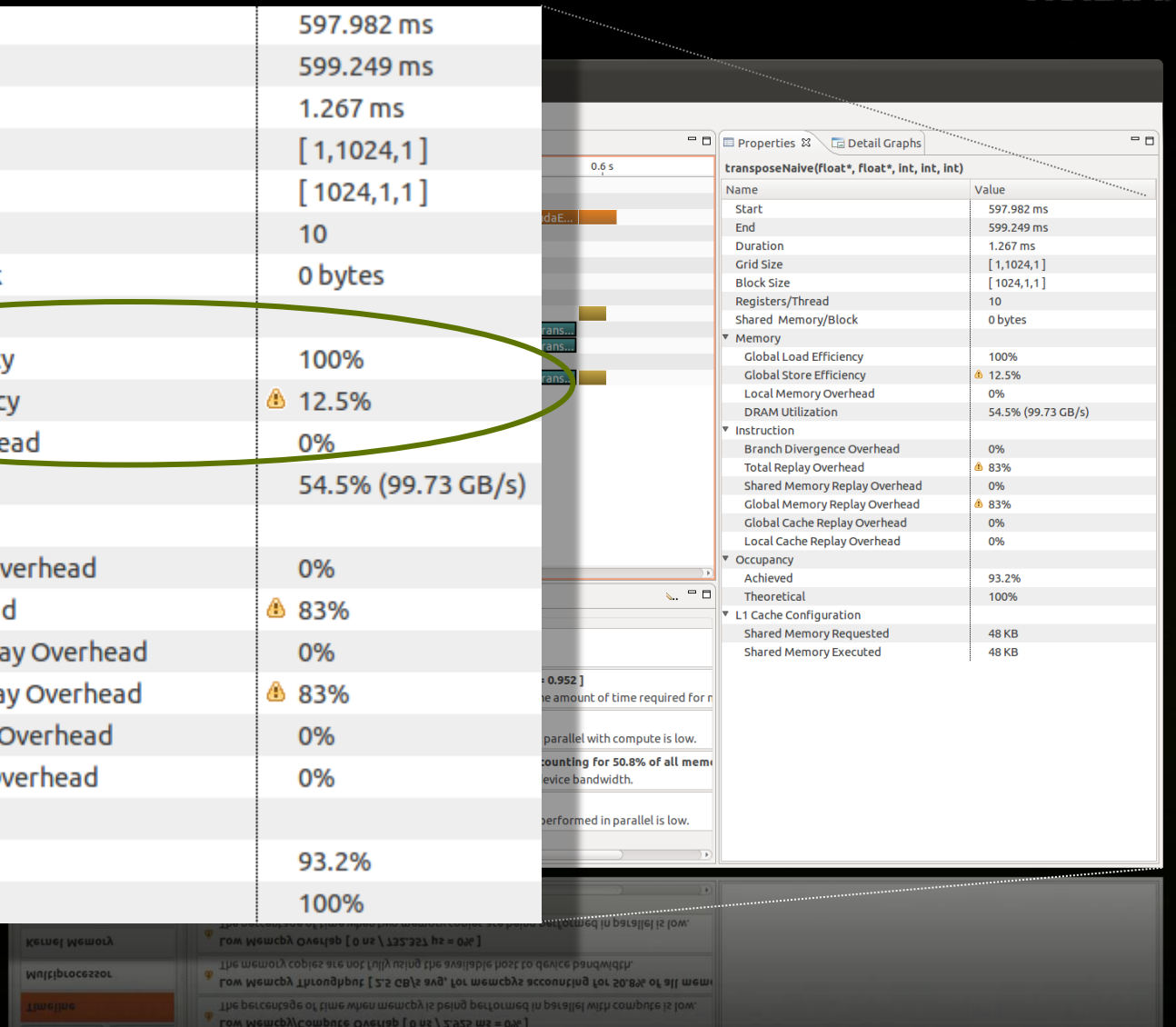


Application Assessment with NVVP

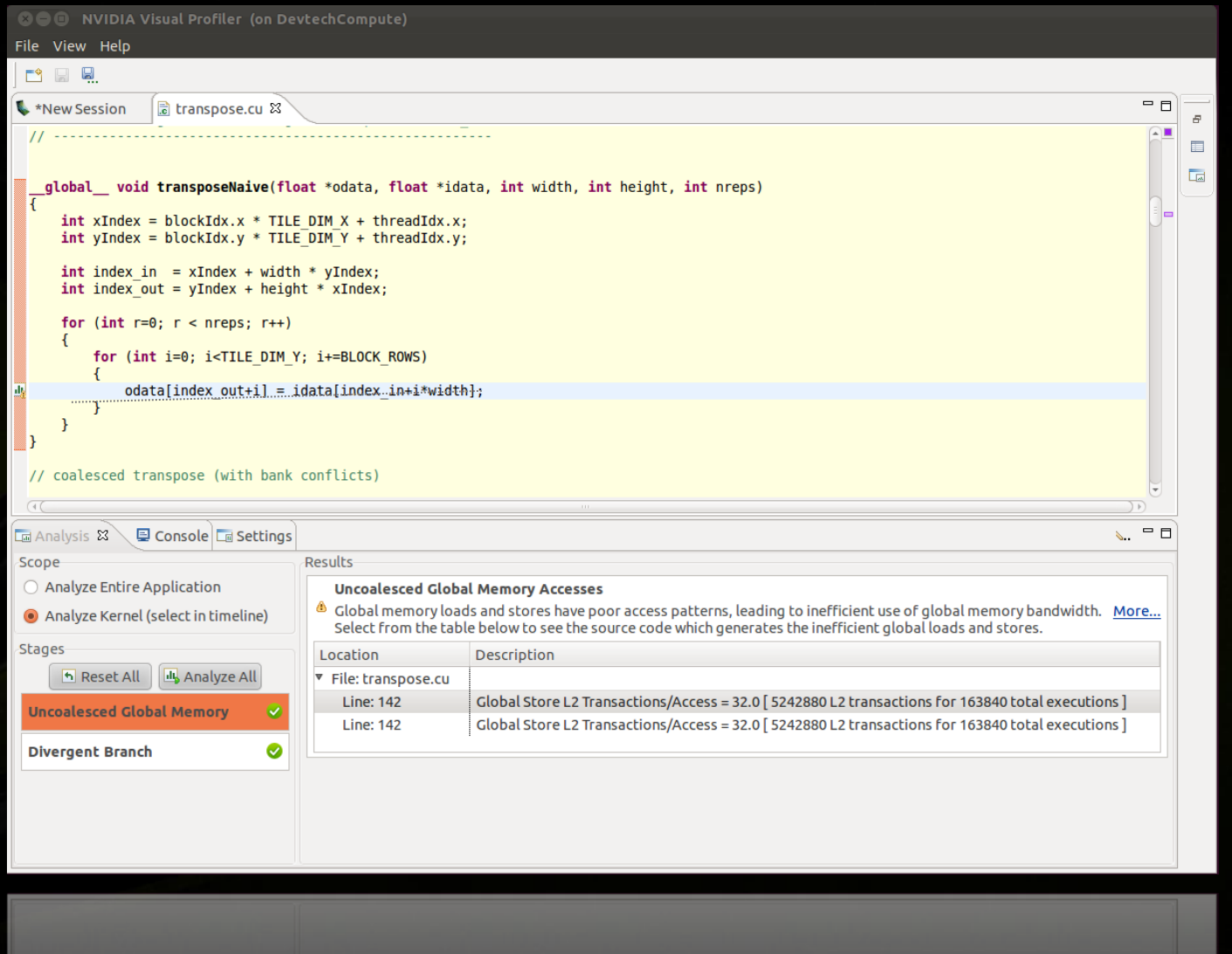


Application Assessment with NVVP

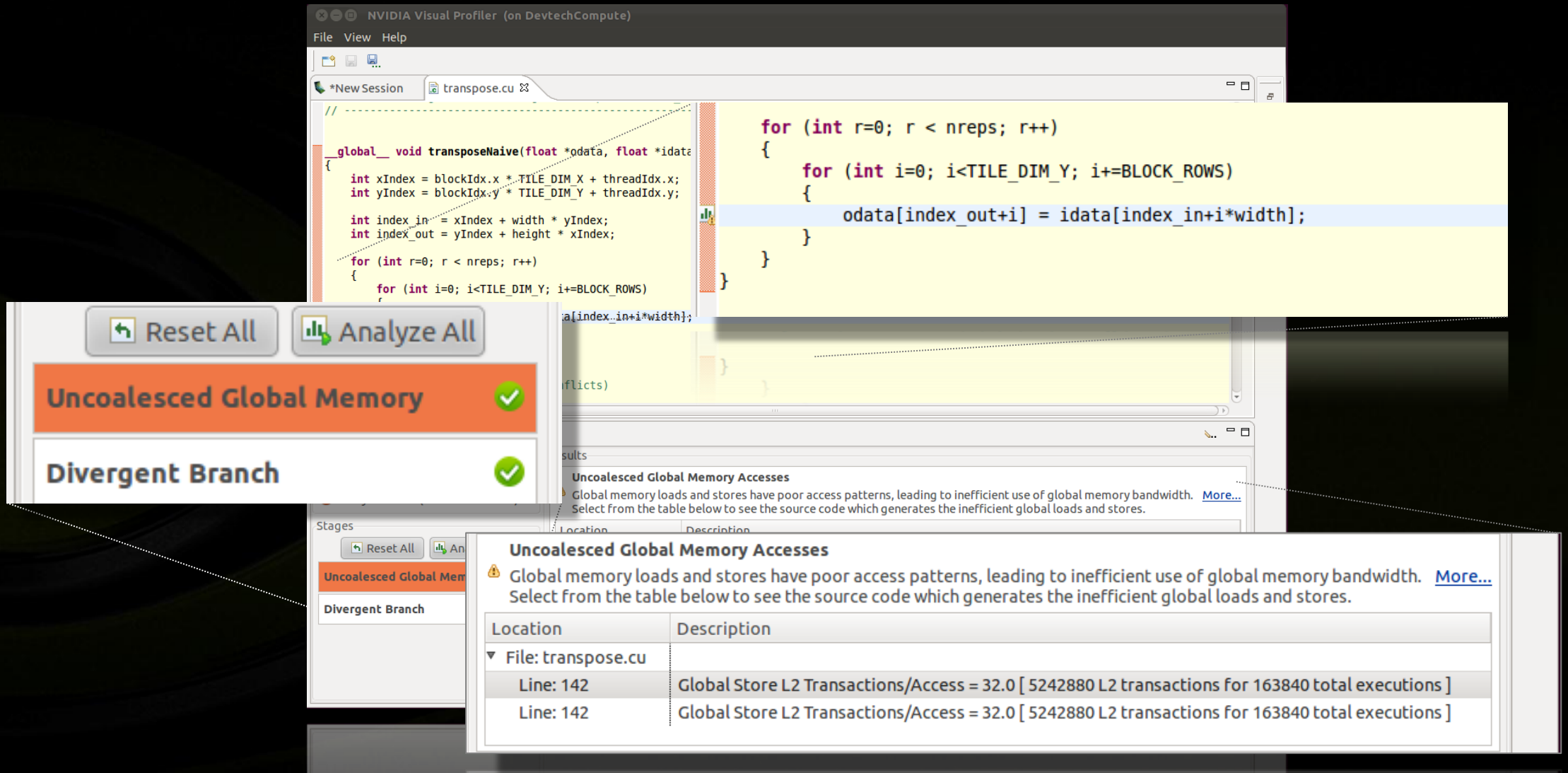
Start	597.982 ms
End	599.249 ms
Duration	1.267 ms
Grid Size	[1,1024,1]
Block Size	[1024,1,1]
Registers/Thread	10
Shared Memory/Block	0 bytes
Memory	
Global Load Efficiency	100%
Global Store Efficiency	⚠ 12.5%
Local Memory Overhead	0%
DRAM Utilization	54.5% (99.73 GB/s)
Instruction	
Branch Divergence Overhead	0%
Total Replay Overhead	⚠ 83%
Shared Memory Replay Overhead	0%
Global Memory Replay Overhead	⚠ 83%
Global Cache Replay Overhead	0%
Local Cache Replay Overhead	0%
Occupancy	
Achieved	93.2%
Theoretical	100%



Source-Level Hot-spot Analysis in NVVP



Source-Level Hot-spot Analysis in NVVP



Additional Metrics

Start	588.755 ms
End	588.808 ms
Duration	53.344 µs
Grid Size	[64,64,1]
Block Size	[16,8,1]
Registers/Thread	21
Shared Memory/Block	1.062 KB
Memory	
Global Load Efficiency	100%
Global Store Efficiency	100%
Local Memory Overhead	0%
DRAM Utilization	92.7% (169.74 GB/s)
Instruction	
Branch Divergence Overhead	0%
Total Replay Overhead	17.6%
Shared Memory Replay Overhead	0%
Global Memory Replay Overhead	17.6%
Global Cache Replay Overhead	0%
Local Cache Replay Overhead	0%
Occupancy	
Achieved	91.3%
Theoretical	100%

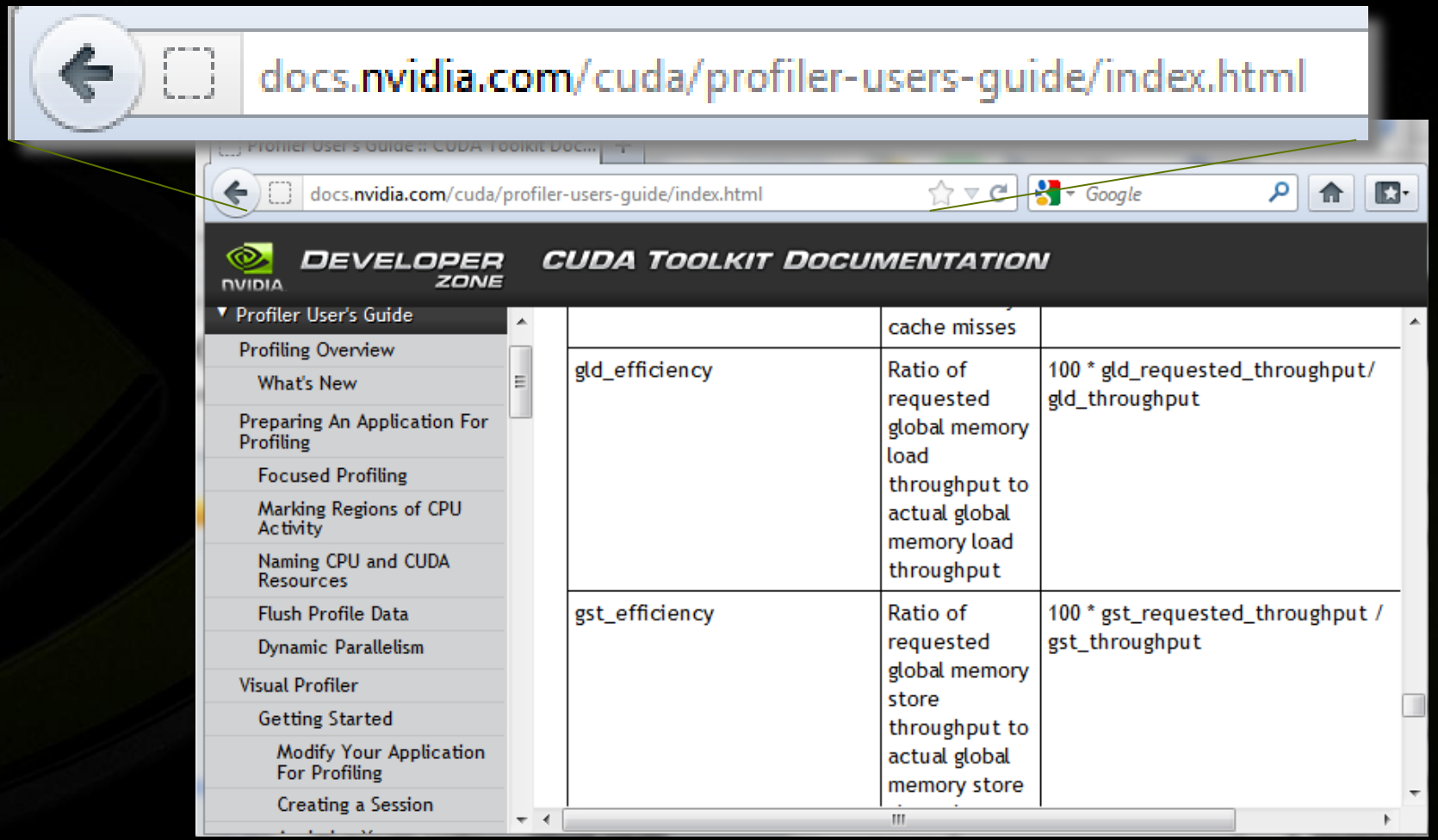
Alternatives to NVVP: nvprof

```
%nvprof  --print-gpu-trace ./transpose

Profiling result:
   Start  Duration Grid Size  Block Size  Regs*  Size    Throughput   Name
577.11ms  874.57us         -           -      -  4.19MB  4.80GB/s     [CUDA memcpy HtoD]
598.45ms    1.67ms   (1 1 1)   (1024 1 1)    22     -         -         transposeNaive(float*,
600.12ms    1.67ms   (1 1 1)   (1024 1 1)    22     -         -         transposeNaive(float*,
601.79ms    1.67ms   (1 1 1)   (1024 1 1)    22     -         -         transposeNaive(float*,
```

```
nvprof --print-gpu-trace  --aggregate-mode-off --events sm_cta_launched ./transpose

Profiling result:
Device            Event Name,      Kernel,                      Values
  0               sm_cta_launched, transposeNaive(float*, ..), 76 73 72 72 73 74 75 73 73 72 73 73 72 73
```

- Command-Line Profiler
- Access to hardware counters
- List of supported counters: --query-events

Alternatives to NVVP: nvprof



Alternatives to NVVP: Instrumentation

```
cudaEventRecord(start, 0);

transpose<<<grid, threads>>>(..);

cudaEventRecord(stop,0);

cudaEventSynchronize(stop);

cudaEventElapsedTime(&time, start, stop);
```