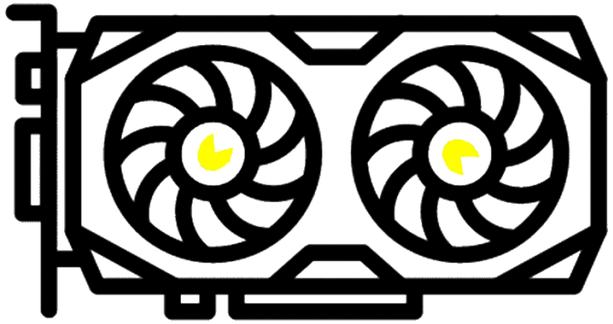
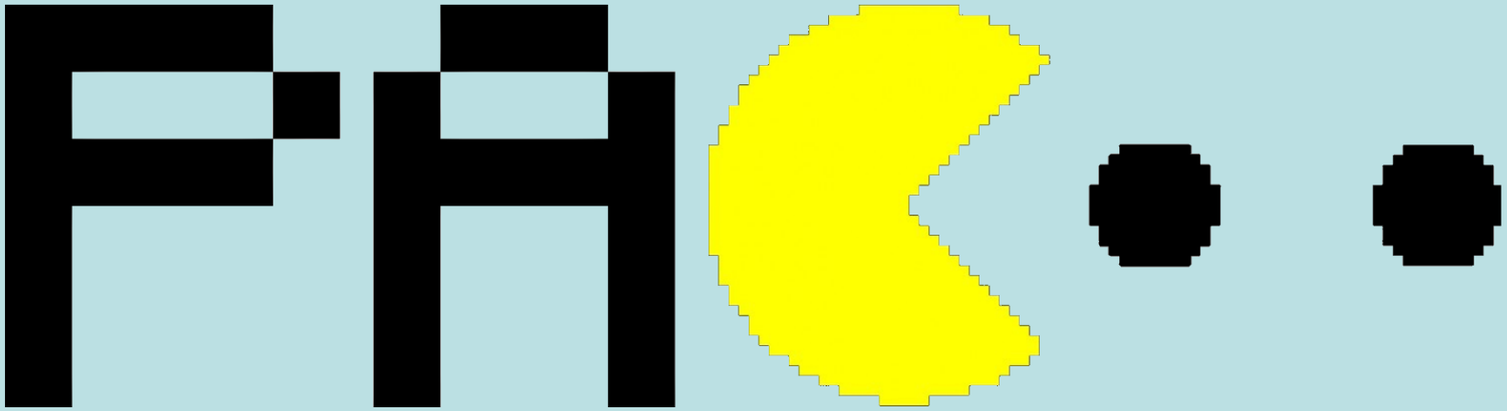
University of Applied Sciences and Arts Northwestern Switzerland
School of Engineering

Parallel Computing



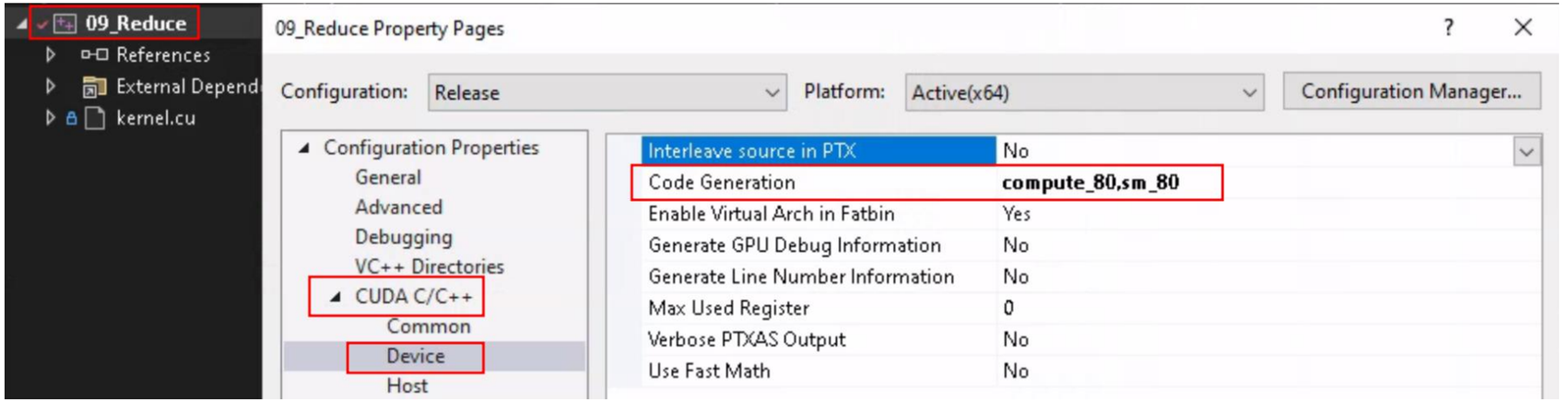
CUDA Tools



Simon Marcin, Filip Schramka

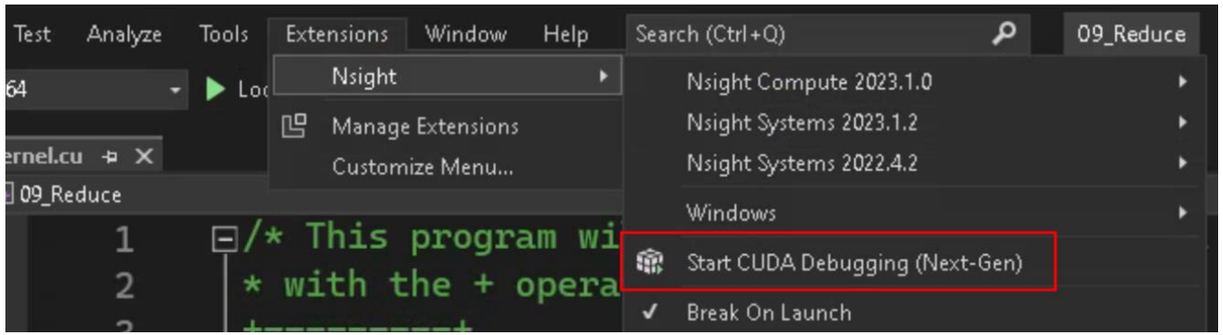
Visual Studio 2022

- Use for development with a local GPU
  - Nvidia Nsight integration (via VS extension)
  - CUDA Toolkit installation needed
  - Use your own GPU on Windows
- Change the code generation version to match your specific hardware



Visual Studio 2022

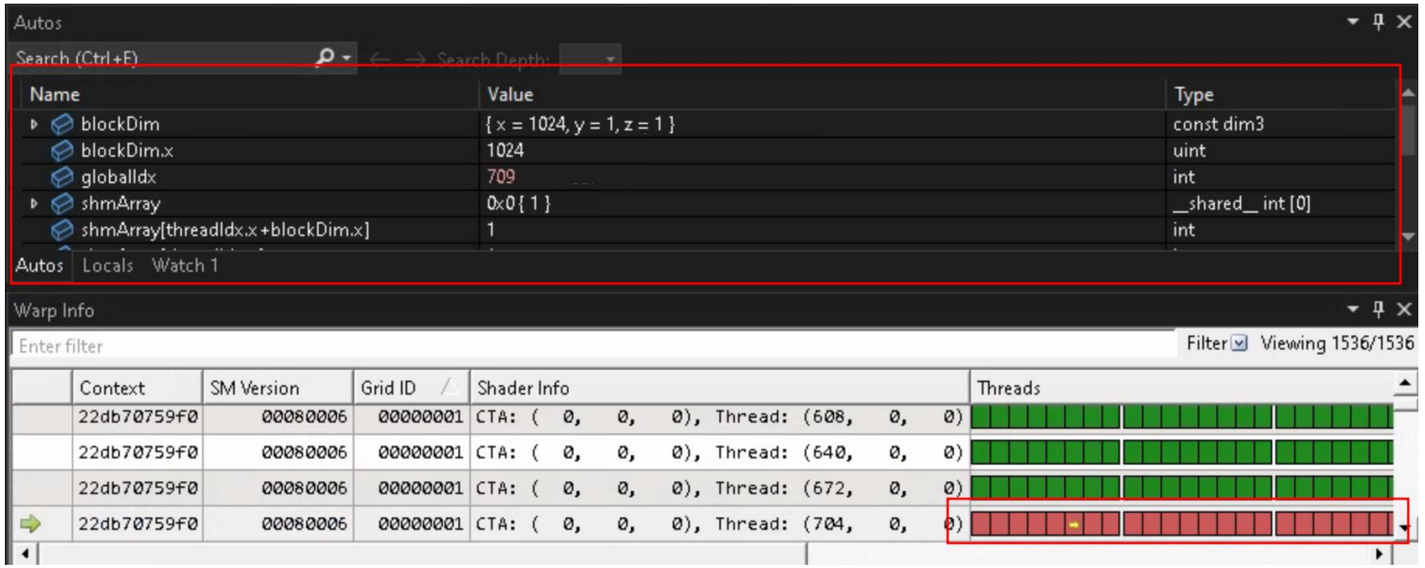
- Start debugging with the CUDA Debugger and not the regular CPU Debugger



- Show CUDA specific debug windows: Extensions -> Nsight -> Windows -> Choose one

Visual Studio 2022

- Use "Warp Info" to switch between threads/warps/thread blocks.
- Choose a specific thread to show its variables



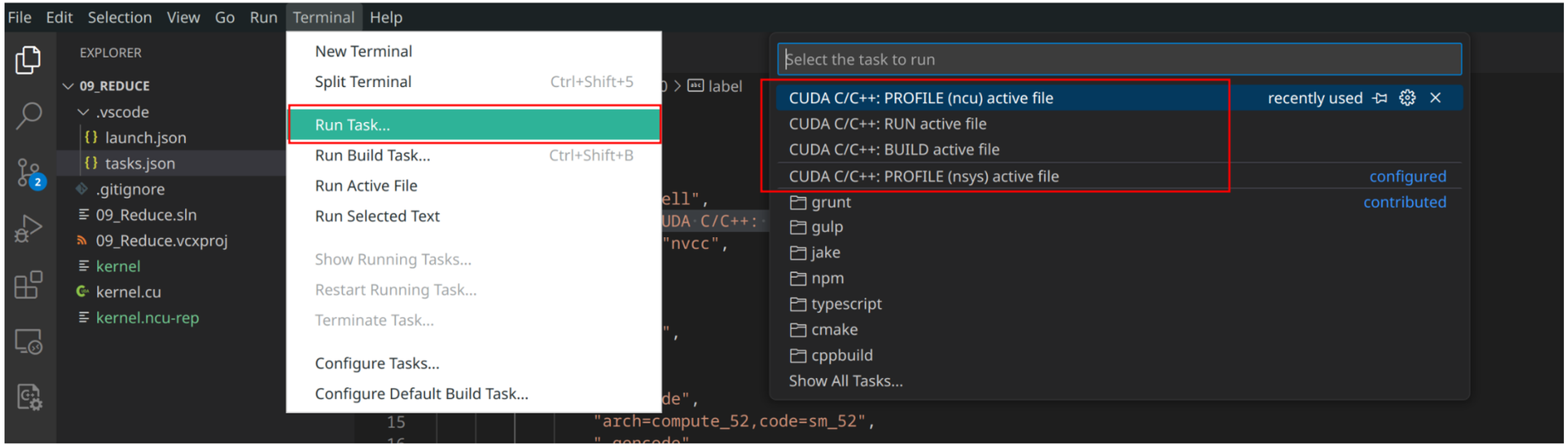
VS Code

- Use for development with a local or remote GPU
  - Use PAC Ubuntu VM on Paperspace or your own GPU (via WSL)
- Connect to the remote machine (using Remote SSH plugin)
  - ssh -i pac_key paperspace@publicIP (this will create a SSH config in VS code for you)
- Install (on the remote session) the Nsight and C++ extension
- Use the tasks.json and launch.json from PAC projects
  - Change tasks.json --> "CUDA C/C++: BUILD active file": Adapt to your hardware

- Intro video: https://www.youtube.com/watch?v=gN3XeFwZ4ng

VS Code

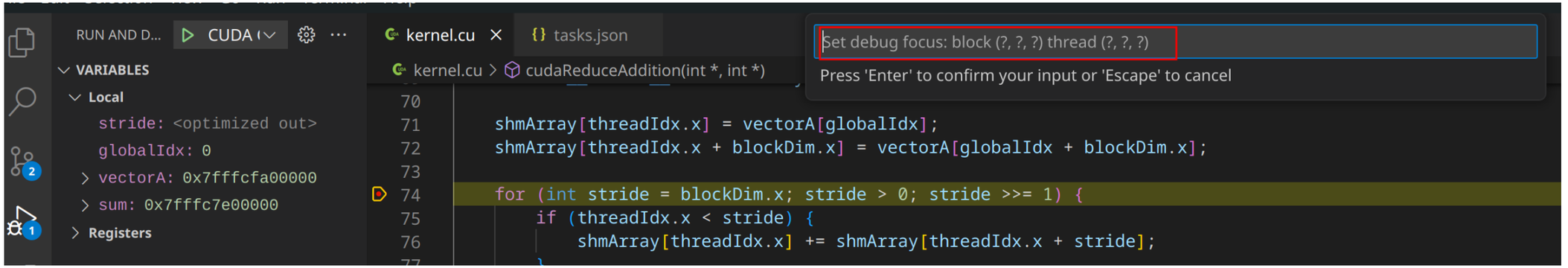
- Use PAC provided Tasks to build, execute or profile your code



- Profiling tasks will create new files which can be opened with Nsight Tools

VS Code

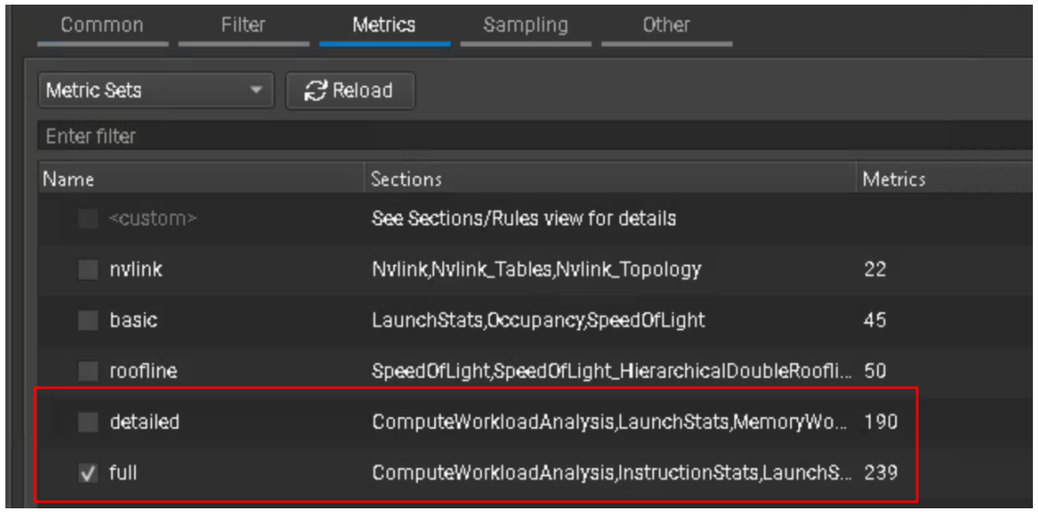
- Use "Run --> Start debugging (F5)" to debug CUDA code
- Change the focus (which CUDA thread is shown) by click on the bottom-right corner: CUDA: (0, 0, 0) (0, 0, 0)
- Jump to the CUDA thread of interest (e.g. block(16,0,0) thread(64,0,0))



- Use conditional break points to break at the right spot for the right CUDA thread/block

Nsight Compute

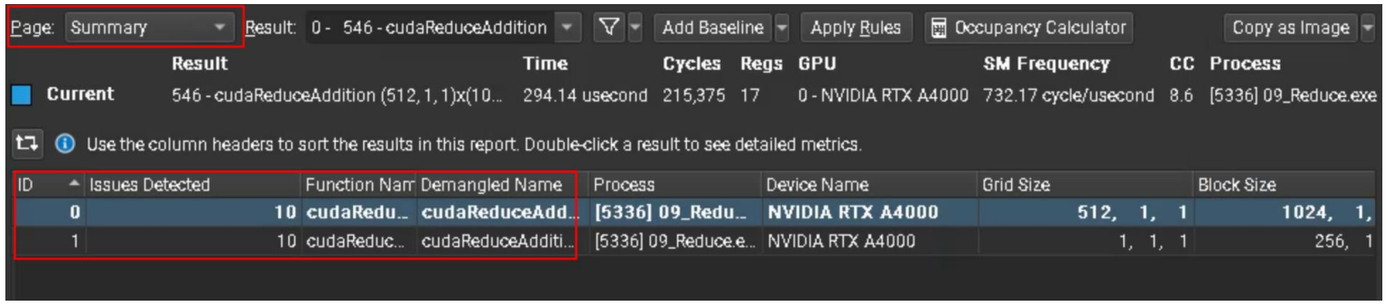
- Use to learn more about the performance of the CUDA kernel
- Choose the metrics you need / are interested



- Nvidia performance counters are need to be enabled for non-root users
- Intro: https://www.youtube.com/watch?v=04dJ-aePYpE

Nsight Compute

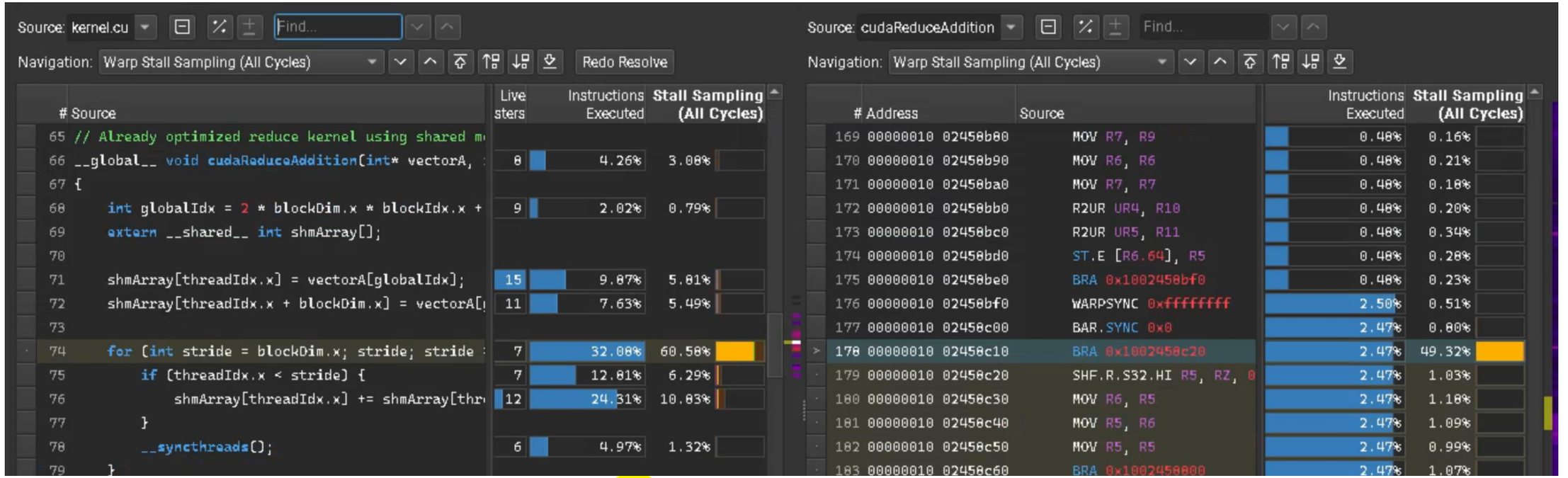
- Compare different kernels at once



- Check "Occupancy" to see if you hit a sweet spot
- Check "Memory Workload Analysis" to learn more about your data access patterns
  - Coalesced or not
  - Bank conflicts
  - Amount of data transferred
  - Cache misses

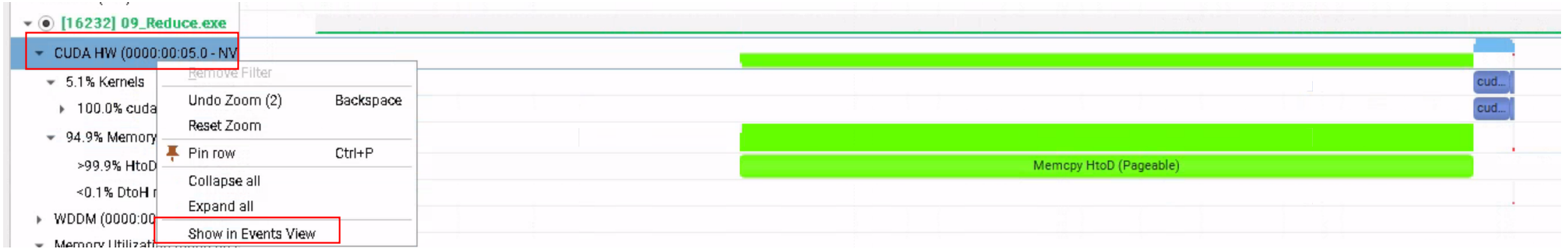
Nsight Compute

- Use SourceCounters to directly correlate your code with warp stalls and other performance problems
- The warnings often point to this section and provide shortcuts the interesting counters



Nsight Systems

- Collect information about the timings and duration of the CUDA API calls
- Can you use the memory engine and the kernel engine in parallel?
- Which CUDA stream is execution what and what is overlapping each other



- Select CUDA traces

Nsight Systems

- The "Event View" will show some basic information about the CUDA API calls and its performance

#	Name	Start	Duration	GPU	Context
1	Memcpy HtoD (Pageable)	0.748356s	2.864 ms	GPU 0	Stream 7
2	cudaReduceAddition(int *, int *)	0.751224s	142.400 µs	GPU 0	Stream 7
3	cudaReduceAddition(int *, int *)	0.751368s	11.200 µs	GPU 0	Stream 7
4	Memcpy DtoH (Pageable)	0.751381s	900 ns	GPU 0	Stream 7