AMD

Understanding GPU activity & checking jobs

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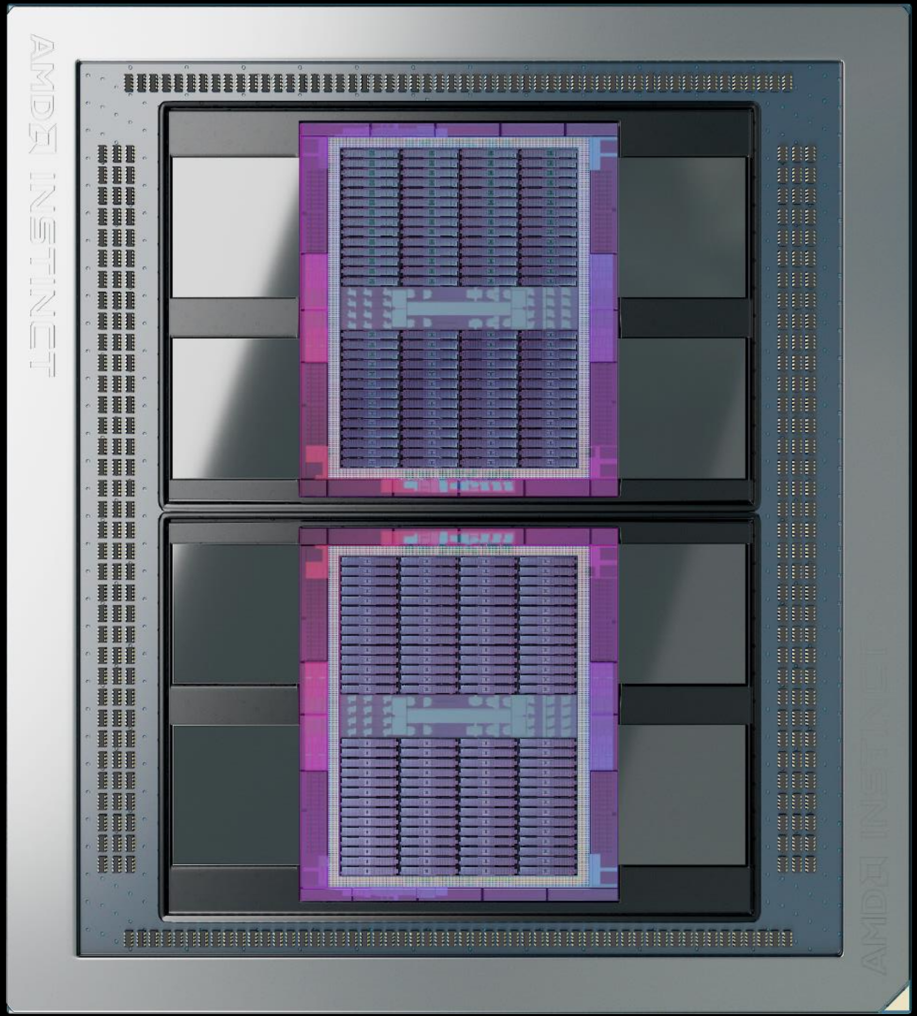
AMD Instinct™ GPUs



AMD INSTINCT™ MI250X

TWO COMPUTE CHIPLETS – 2 GCDs

58B
Transistors in 6nm

220
Compute Units

880
2nd Gen Matrix Cores

128
GB HBM2E @ 3.2 TB/s

https://www.amd.com/system/files/documents/amd-cdna2-white-paper.pdf

AMD Instinct™ GPUs

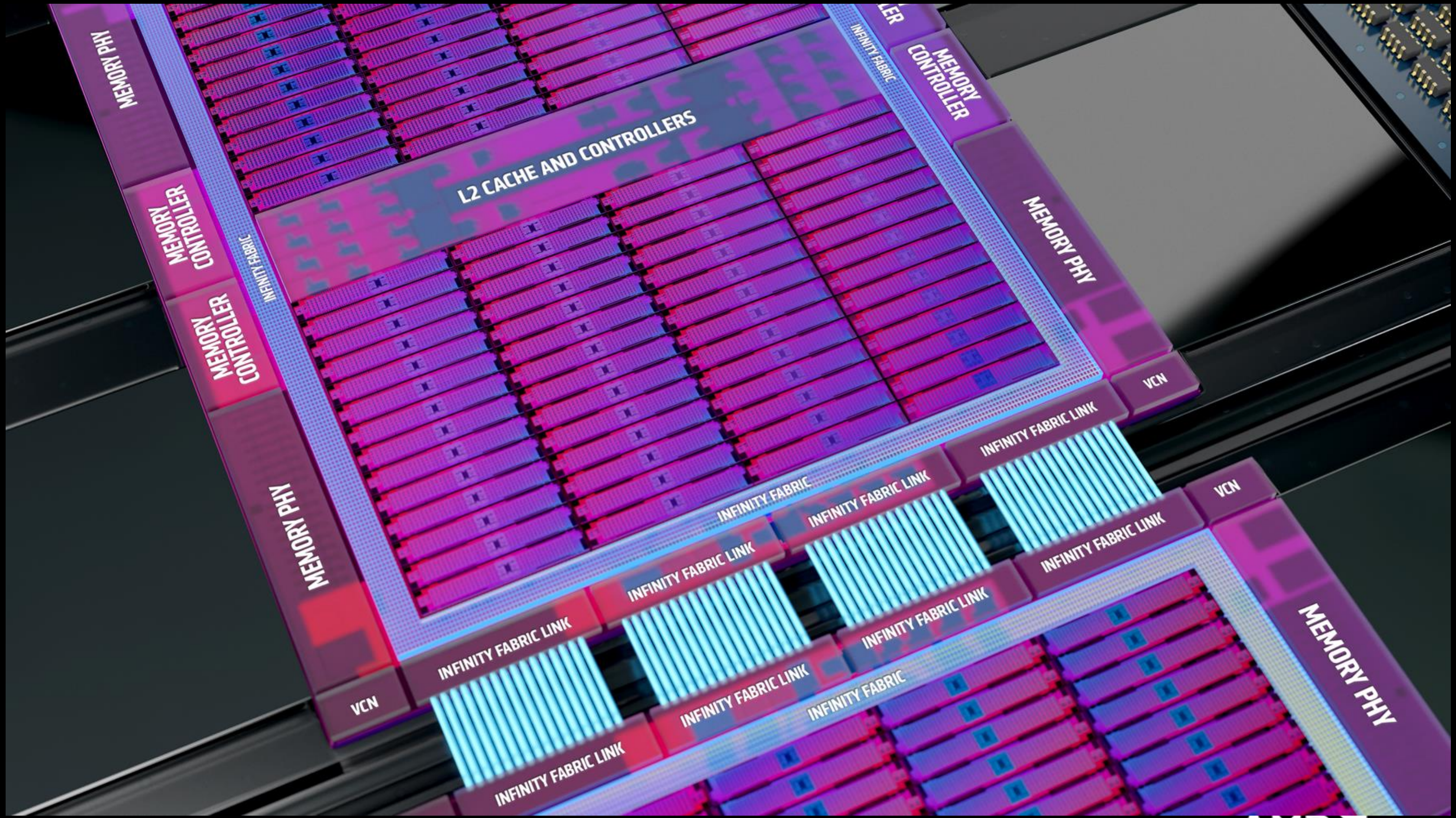
MULTI-CHIP DESIGN

TWO GPU DIES IN PACKAGE TO MAXIMIZE COMPUTE & DATA THROUGHPUT

INFINITY FABRIC FOR CROSS-DIE CONNECTIVITY

4 LINKS RUNNING AT 25GBPS

400GB/S OF BI-DIRECTIONALBANDWIDTH



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Multiple GCD design has implications on monitoring strategy!

- GPUs have a a given power budget for the two GCDs.
- What is happening in one GCD will limit power in the other.
- Drawn power is the best indicator of GPU activity:
  - A kernel waiting idle for data shows in the driver as 100% GPU utilization
  - Drawn power oscillating around 500W is good indication that compute capabilities in the full GPU are being leveraged
  - For single GCD, 300W should be a good indication.
- rocm-smi is que easiest way to peek at GPU utilization – but not the most accurate!

As reported by the driver – doesn't indicate how well the resource is used.

Average power consumption

```
======================= ROCm System Management Interface =======================
================================= Concise Info =================================
GPU  Temp   AvgPwr  SCLK     MCLK     Fan  Perf    PwrCap  VRAM%  GPU%
0    58.0c  324.0W  1650Mhz  1600Mhz  0%   manual  500.0W   98%   100%
1    49.0c  N/A     800Mhz   1600Mhz  0%   manual  0.0W      0%   0%
================================================================================
============================= End of ROCm SMI Log ==============================
```

Frequency will shift to observe GPU power/thermal budget.

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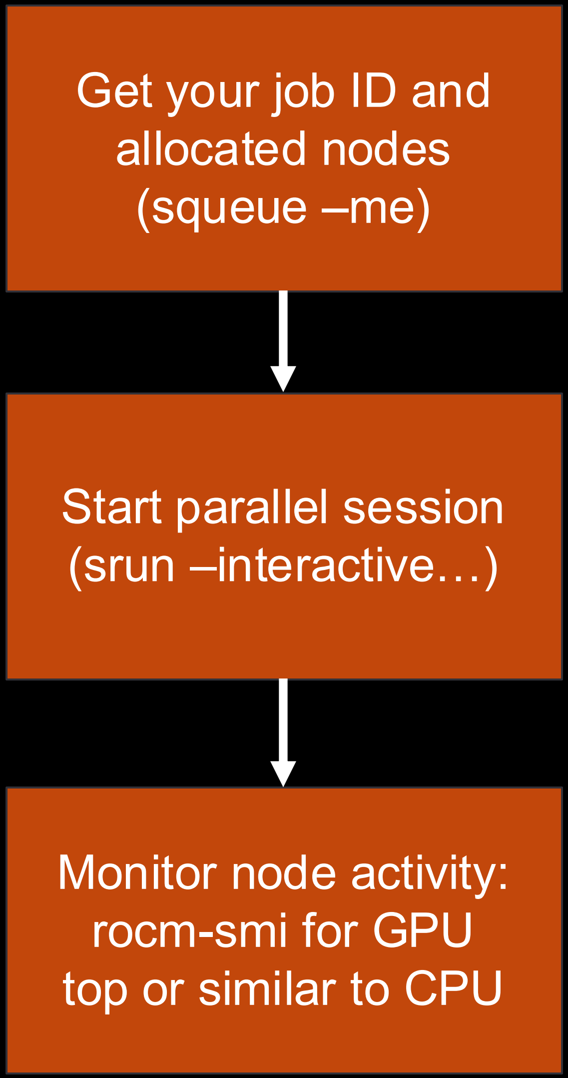
Starting a SLURM parallel session

- Staring session in specific nodes to monitor
  - For first node of allocation:

```
srun --interactive \
   --pty \
   /bin/bash
```

  - For other nodes nodes (GPU's won't be visible):

```
srun --pty \
   --jobid <jobid> \
   -w <target_node> \
   --overlap \
   /usr/bin/bash
```



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Logging from the environment

- HIP runtime and GPU dispatch information can be logged with AMD_LOG_LEVEL=4

```
:3:hip_module.cpp        :662 : 117659918626 us: 8088 : [tid:0x14b2015e9700]
   hipLaunchKernel ( 0x14b5ec183ed0, {32768,1,1}, {512,1,1}, 0x14b2015e71b0, 0, stream:<null> )
…
:3:rocvirtual.cpp        :786 : 117659918634 us: 8088 : [tid:0x14b2015e9700] Arg0:   = val:16777216
:3:rocvirtual.cpp        :786 : 117659918636 us: 8088 : [tid:0x14b2015e9700] Arg1:   = val:22689590804480

… ShaderName : _ZN2at6native6legacy18elementwise_kernelILi512ELi1EZNS0_15gpu_kernel_implIZZZNS0_23direct_copy_kernel

:3:hip_module.cpp        :663 : 117659918649 us: 8088 : [tid:0x14b2015e9700] hipLaunchKernel: Returned hipSuccess :
```

Number of blocks and threads of the dispatch

Arguments

Kernel mangled name

Return error.

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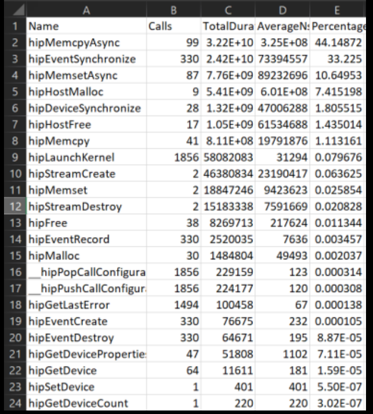
Background – AMD Profilers

ROC-profiler (rocprof)

Hardware Counters
- Raw collection of GPU counters and traces
- Counter collection with user input files
- Counter results printed to a CSV

Traces and timelines
- Trace collection support for
- CPU copy | HIP API | HSA API | GPU Kernels

Visualisation
- Traces visualized with Perfetto



	A	B	C	D	E
1	Name	Calls	TotalDura	AverageN:	Percentage
2	hipMemcpyAsync	99	3.22E+10	3.25E+08	44.14872
3	hipEventSynchronize	330	2.42E+10	73394557	33.225
4	hipMemsetAsync	87	7.76E+09	89232696	10.64953
5	hipHostMalloc	9	5.41E+09	6.01E+08	7.415198
6	hipDeviceSynchronize	28	1.32E+09	47006288	1.805515
7	hipHostFree	17	1.05E+09	61534688	1.435014
8	hipMemcpy	41	8.11E+08	19791876	1.113161
9	hipLaunchKernel	1856	58082083	31294	0.079676
10	hipStreamCreate	2	46380834	23190417	0.063625
11	hipMemset	2	18847246	9423623	0.025854
12	hipStreamDestroy	2	15183338	7591669	0.020828
13	hipFree	38	8269713	217624	0.011344
14	hipEventRecord	330	2520035	7636	0.003457
15	hipMalloc	30	1484804	49493	0.002037
16	__hipPopCallConfigura	1856	229159	123	0.000314
17	__hipPushCallConfigur	1856	224177	120	0.000308
18	hipGetLastError	1494	100458	67	0.000138
19	hipEventCreate	330	76675	232	0.000105
20	hipEventDestroy	330	64671	195	8.87E-05
21	hipGetDevicePropertie:	47	51808	1102	7.11E-05
22	hipGetDevice	64	11611	181	1.59E-05
23	hipSetDevice	1	401	401	5.50E-07
24	hipGetDeviceCount	1	220	220	3.02E-07

Omnitrace

Trace collection
- Comprehensive trace collection
- CPU | GPU

Supports
- CPU copy | HIP API | HSA API | GPU Kernels
- OpenMP® | MPI | Kokkos | p-threads | multi-GPU

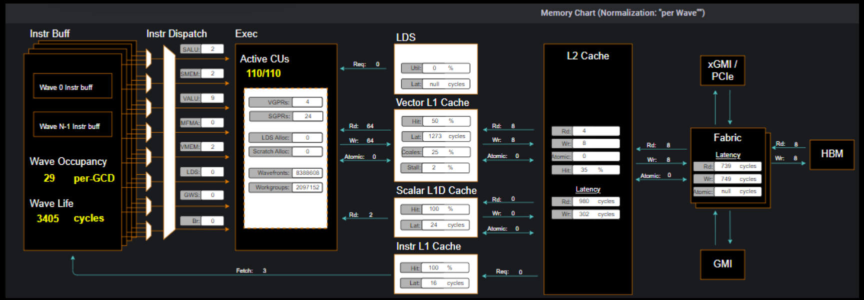
Visualisation
- Traces visualized with Perfetto

Omniperf
rocprofiler-compute

Performance Analysis
- Automated collection of hardware counters
- Analysis | Visualisation

Supports
- Speed of Light | Memory chart | Rooflines | Kernel comparison

Visualisation
- With Grafana or standalone GUI



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Profiling with Rocprof

- Rocprof profiler client is the easiest way to get started with GPU profiling.
- It is available as part of the ROCm stack and, therefore, available in the containers
- It is seldomly useful to profile every single process/rank of your app:
  - Profilling more than needed = more potential profiling overhead
  - Misleading conclusions

Pick representative process/rank → Profile → Interpret and identify what is actionable

```
pcmd=''
if [ $RANK -eq 2 ] ; then
  pcmd='rocprof --hip-trace'
fi
```

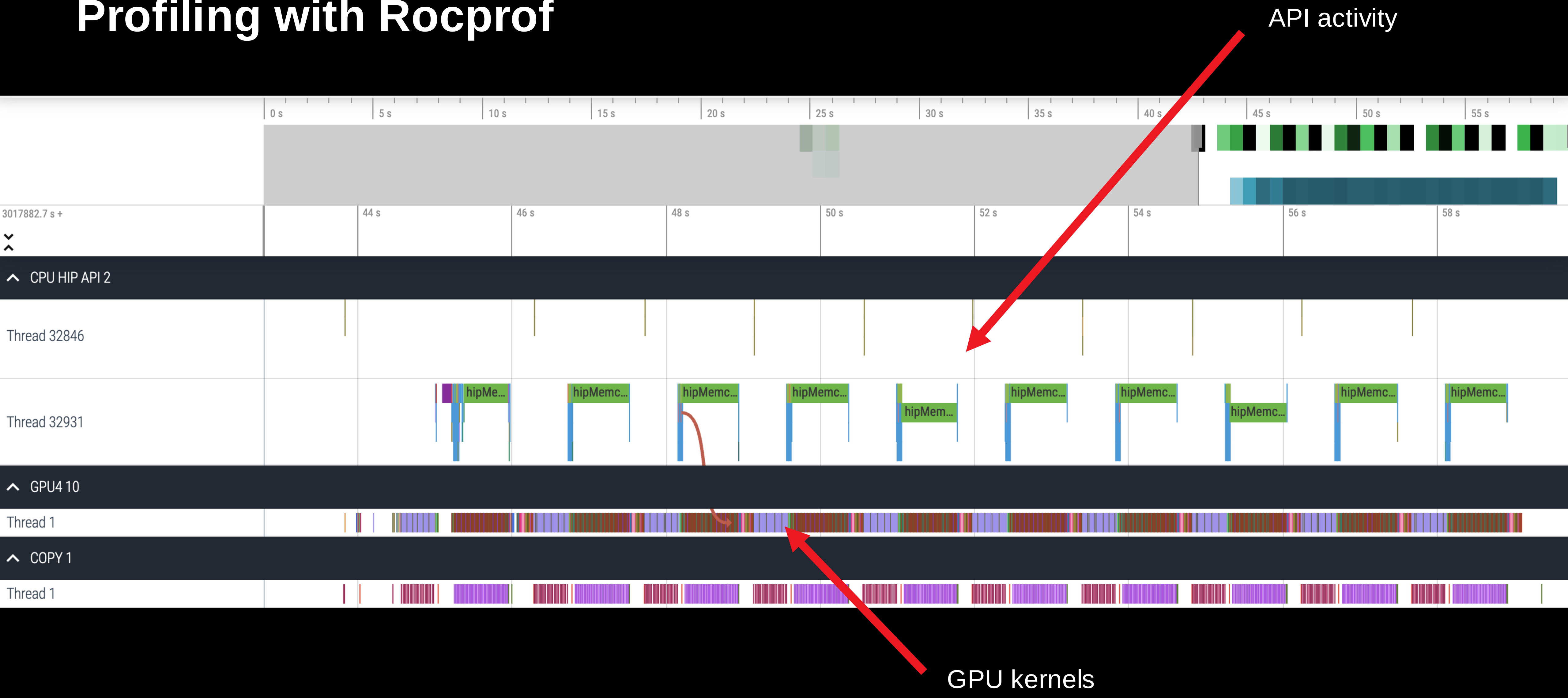
Command to prepend to my application instantiation

We want to profile only for one rank – in this case rank #2

Run command as before except to the prepended profiling command

```
$pcmd python -u myapp.py
```

Profiling with Rocprof



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Leveraging framework profiler infrastructure

- AI frameworks typically provide hooks for developers to gather profiling information
- An example with Pytorch:

```
from torch.profiler import profile, record_function, ProfilerActivity

for epoch in range(args.epochs):

    prof = None
    if epoch == 3:
        print("Starting profile...")
        prof = profile(activities=[ProfilerActivity.CPU, ProfilerActivity.CUDA])
        prof.start()

    for imgs, labels in dataloader:
        with torch.amp.autocast('cuda',enabled=args.amp):
            imgs, labels = imgs.cuda(), labels.cuda()
            outputs = model(imgs)
        loss = criterion(outputs, labels)
        loss = scaler.scale(loss)
        loss.backward()
        scaler.step(optimizer)
        scaler.update()

    if prof:
        prof.stop()
        prof.export_chrome_trace("trace.json")
```

Invoke the profiler

Enable profiling for epoch number 3

Training for an epoch

Finish profiling and generate trace

Trace file can be viewed in Perfetto UI tool

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Comment about visualizing Rocprof traces

- We came across some visualization issues in the latest versions of Perfetto UI https://ui.perfetto.dev/
- We suggest using a previous release https://ui.perfetto.dev/v46.0-35b3d9845/#/

- There is a service of an older version of Perfetto known to be better compatible running on the login nodes:

```
ssh <your username>@lumi-uan01.csc.fi -L 10000:localhost:10000
```

- Then connect to http://localhost:10000/ to access the service.

- This is based on this dockerHUB project in case you want to run it on your machine:
  - https://hub.docker.com/r/sfantao/perfetto4rocm

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