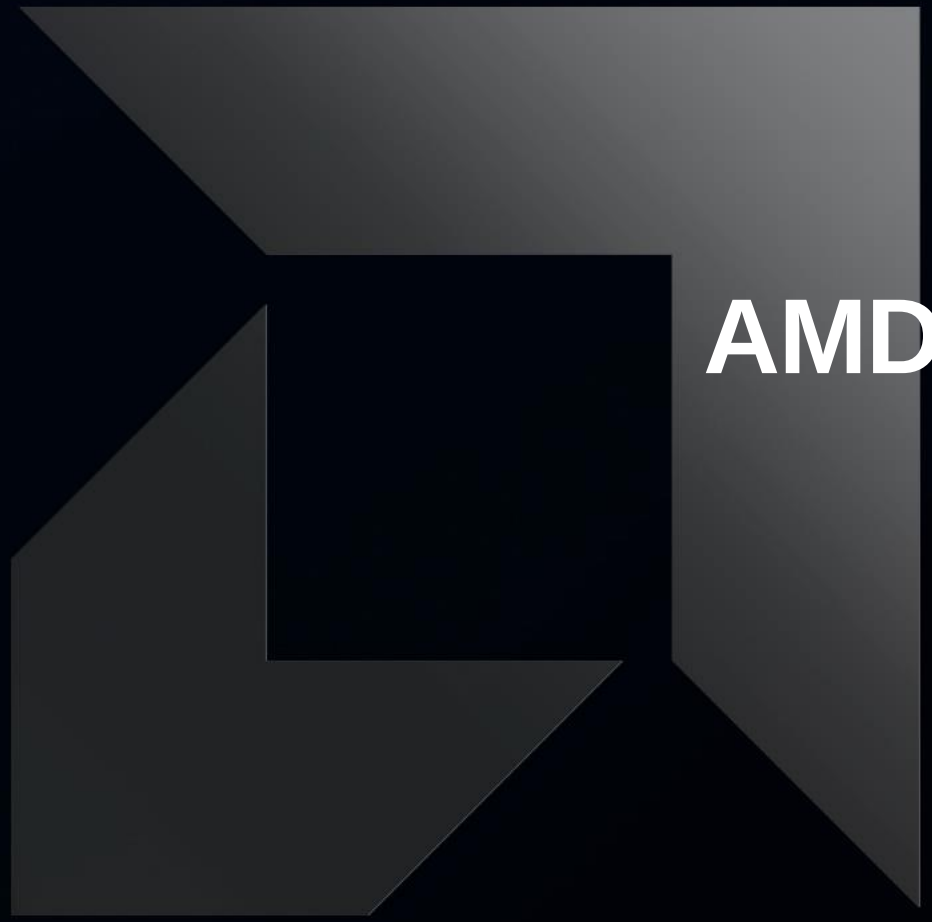

AMD Debugger: ROCgdb

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AMD
together we advance_

Rocgdb

- AMD ROCm ™ source-level debugger for Linux®
- based on the GNU Debugger (GDB)
  - tracks upstream GDB master
  - standard GDB commands for both CPU and GPU debugging
- considered a prototype
  - focus on source line debugging
  - no symbolic variable debugging yet

Simple saxpy kernel

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      hipMalloc(&d_x, size);
21      hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n, d_x, 1, d_y, 1);
26      hipDeviceSynchronize();
27  }
28
```

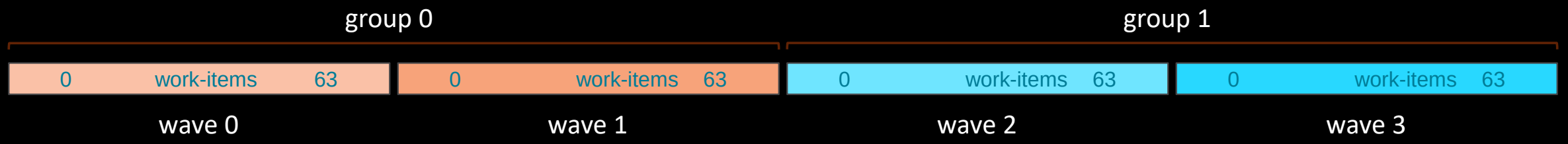
classic saxpy operation

one array index = one work-item

size of arrays = 256

two groups

each 128 work-items



Cause a page fault

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n, d_x, 1, d_y, 1);
26      hipDeviceSynchronize();
27  }
28
```

Break it by commenting out the allocations.
(better to initialize the pointers to nullptr)

It’s important to synchronize before exit.
Otherwise, the CPU thread may quit before the GPU gets a chance to report the error.

Compilation with hipcc

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n,
26      hipDeviceSynchronize();
27  }
28
```

Need be, set the target

- gfx906 – MI50, MI60, Radeon™ 7
- gfx908 – MI100
- gfx90a – MI200

```
saxpy$ hipcc --offload-arch=gfx90a -o saxpy saxpy.cpp
```

Execution

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n,
26      hipDeviceSynchronize();
27  }
28
```

```
saxpy$ hipcc --offload-arch=gfx90a -o saxpy saxpy.cpp
saxpy$ ./saxpy
```

- In this example we have already allocated a GPU with salloc

Get a page fault

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n, d
26      hipDeviceSynchronize();
27  }
28
```

```
saxpy$ hipcc --offload-arch=gfx90a -o saxpy saxpy.cpp
saxpy$ ./saxpy
Memory access fault by GPU node-2 (Agent handle: 0x2284d90) on address (nil). Reason: Unknown.
Aborted (core dumped)
saxpy$
```

Common gdb commands

Start GDB (GNU Debugger)

- **gdb <program> [core dump]**
- **gdb –args <program> <args>**
- **gdb -help**

Run commands

r[un] - Runs the program until a breakpoint or error
c[ontinue] - Continues running the program until the next breakpoint or error
q[uit] or kill - Quits gdb
fin[ish] - Runs until current function or loop is finished
n[ext] - Runs the next line of the program
n N - Runs the next N lines of the program
s[tep] - Runs the next line of the program, stepping into any called routines
until N - Runs until you get N lines after the current line

Breakpoint commands

b[reakpoint] <where> – set breakpoint
b main - Puts a breakpoint at the beginning of the program
b - Puts a breakpoint at the current line
b N - Puts a breakpoint at line N
b +N - Puts a breakpoint N lines down from the current line
b fn - Puts a breakpoint at the beginning of function "fn”
b/w <where> if <condition – conditional breakpoint or watch
i[nfo] b[reak] - list breakpoints
dis[able] N - disable breakpoint number N
en[able] N – enables breakpoint number N
d[elete] N – delete breakpoint number N
clear – clear all breakpoints

Print commands

[h]elp <command>
[p]rint var - Prints the current value of the variable "var”
[l]ist – list lines
bt (backtrace) - Prints a stack trace

Movement

up - Goes up a level in the stack
[do]wn - Goes down a level in the stack

Execution with rocgdb

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n, d_
26      hipDeviceSynchronize();
27  }
28
```

```
saxpy$ rocgdb saxpy
```

Get more information

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n,
26      hipDeviceSynchronize();
27  }
28
```

```
(gdb) run
Starting program: /home/gmarkoma/saxpy
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib64/libthread_db.so.1".
[New Thread 0x7fffed428700 (LWP 10456)]
Warning: precise memory violation signal reporting is not enabled, reported
location may not be accurate.  See "show amdgpu precise-memory".

Thread 3 "saxpy" received signal SIGSEGV, Segmentation fault.
[Switching to thread 3, lane 0 (AMDGPU Lane 1:2:1:1/0 (0,0,0)[0,0,0])]
0x00007ffff7ec1094 in saxpy(int, float const*, int, float*, int) () from file:///home/gmarkoma/s
axpy#offset=8192&size=13832
(gdb)
```

Reports segmentation fault in the saxpy kernel.

Compile with -ggdb

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n,
26      hipDeviceSynchronize();
27  }
28
```

```
saxpy$ hipcc -ggdb --offload-arch=gfx90a -o saxpy saxpy.cpp
```

Get more details

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n, d
26      hipDeviceSynchronize();
27  }
28
```

```
(gdb) run
Starting program: /home/gmarkoma/saxpy
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib64/libthread_db.so.1".
[New Thread 0x7fffed428700 (LWP 10637)]
Warning: precise memory violation signal reporting is not enabled, reported
location may not be accurate.  See "show amdgpu precise-memory".

Thread 3 "saxpy" received signal SIGSEGV, Segmentation fault.
[Switching to thread 3, lane 0 (AMDGPU Lane 1:2:1:1/0 (0,0,0)[0,0,0])]
0x00007ffff7ec1094 in saxpy () at saxpy.cpp:10
10          y[i] += a*x[i];
(gdb)
```

more details
- what kernel
- what file:line

But where's my stack trace?

To get exceptions reported precisely: **`set amdgpu precise-memory on`**

List threads

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n,
26      hipDeviceSynchronize();
27  }
28
```

```
(gdb) i th
  Id   Target Id                                  Frame
  1    Thread 0x7ffff7fe6e80 (LWP 10633) "saxpy" 0x00007fffee0fc499 in rocr::core::InterruptSign
al::WaitRelaxed(hsa_signal_condition_t, long, unsigned long, hsa_wait_state_t) ()
   from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
  2    Thread 0x7fffed428700 (LWP 10637) "saxpy" 0x00007ffff5e1972b in ioctl ()
   from /lib64/libc.so.6
* 3    AMDGPU Wave 1:2:1:1 (0,0,0)/0 "saxpy"     0x00007ffff7ec1094 in saxpy () at saxpy.cpp:10
  4    AMDGPU Wave 1:2:1:2 (0,0,0)/1 "saxpy"     0x00007ffff7ec1094 in saxpy () at saxpy.cpp:10
  5    AMDGPU Wave 1:2:1:3 (1,0,0)/0 "saxpy"     0x00007ffff7ec1094 in saxpy () at saxpy.cpp:10
  6    AMDGPU Wave 1:2:1:4 (1,0,0)/1 "saxpy"     0x00007ffff7ec1094 in saxpy () at saxpy.cpp:10
(gdb)
```

What segfaulted is a GPU wave.
It does not have your CPU stack.
List threads to see what's going on.

Switch to the CPU thread

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n,
26      hipDeviceSynchronize();
27  }
28
```

t 1
(thread 1)
It's in the HSA runtime.

```
(gdb) t 1
[Switching to thread 1 (Thread 0x7ffff7fe6e80 (LWP 10633))]
#0  0x00007fffee0fc499 in rocr::core::InterruptSignal::WaitRelaxed(hsa_signal_condition_t, long,
 unsigned long, hsa_wait_state_t) () from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
(gdb)
```

But how did it get there?

See the stack trace of the CPU thread

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      // hipMalloc(&d_x, size);
21      // hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n, d_
26      hipDeviceSynchronize();
27  }
28
```

where

HSA runtime

HIP runtime

```
(gdb) where
#0  0x00007fffee0fc499 in rocr::core::InterruptSignal::WaitRelaxed(hsa_signal_condition_t, lo
ng, unsigned long, hsa_wait_state_t) () from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
#1  0x00007fffee0fc36a in rocr::core::InterruptSignal::WaitAcquire(hsa_signal_condition_t, long,
 unsigned long, hsa_wait_state_t) () from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
#2  0x00007fffee0f0869 in rocr::HSA::hsa_signal_wait_scacquire(hsa_signal_s, hsa_signal_conditio
n_t, long, unsigned long, hsa_wait_state_t) () from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
#3  0x00007ffff67bdd43 in bool roc::WaitForSignal<false>(hsa_signal_s, bool) ()
   from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#4  0x00007ffff67b5836 in roc::VirtualGPU::HwQueueTracker::CpuWaitForSignal(roc::ProfilingSignal
*) () from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#5  0x00007ffff67b77cf in roc::VirtualGPU::releaseGpuMemoryFence(bool) ()
   from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#6  0x00007ffff67b9523 in roc::VirtualGPU::flush(amd::Command*, bool) ()
   from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#7  0x00007ffff67b9db0 in roc::VirtualGPU::submitMarker(amd::Marker&) ()
   from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#8  0x00007ffff678ec2e in amd::Command::enqueue() () from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#9  0x00007ffff678f1e0 in amd::Event::notifyCmdQueue(bool) ()
   from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#10 0x00007ffff678f28c in amd::Event::awaitCompletion() ()
   from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#11 0x00007ffff6791fdc in amd::HostQueue::finish() () from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#12 0x00007ffff65c25f9 in hipDeviceSynchronize () from /opt/rocm-5.2.0/lib/libamdhip64.so.5
#13 0x0000000000020d615 in main () at saxpy.cpp:25
(gdb)
```

Quick tip

- Frontier and LUMI CPUs have 64 cores / 128 threads.
- If you’re debugging an app with OpenMP® threading and OMP_NUM_THREADS is not set you will see 128 CPU threads in rocgdb.
- Set OMP_NUM_THREADS=1 when debugging GPU codes.

Breakpoint

We try to put a breakpoint in line 22 but it is declared as line 24.

```
--Type <RET> for more, q to quit, c to continue without paging--For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from saxpy...
(gdb) b saxpy.cpp:22
Breakpoint 1 at 0x20d57f: file saxpy.cpp, line 24.
(gdb)
```

Simple saxpy kernel

```
1   #include <hip/hip_runtime.h>
2
3   __constant__ float a = 1.0f;
4
5   __global__
6   void saxpy(int n, float const* x, int incx, float* y, int incy)
7   {
8       int i = blockDim.x*blockIdx.x + threadIdx.x;
9       if (i < n)
10          y[i] += a*x[i];
11  }
12
13  int main()
14  {
15      int n = 256;
16      std::size_t size = sizeof(float)*n;
17
18      float* d_x;
19      float* d_y;
20      hipMalloc(&d_x, size);
21      hipMalloc(&d_y, size);
22
23      int num_groups = 2;
24      int group_size = 128;
25      saxpy<<<num_groups, group_size>>>(n, d_x, 1, d_y, 1);
26      hipDeviceSynchronize();
27  }
28
```

Breakpoint

We try to put a breakpoint in line 22 but it is declared as line 24.

```
--Type <RET> for more, q to quit, c to continue without paging--For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from saxpy...
(gdb) b saxpy.cpp:22
Breakpoint 1 at 0x20d57f: file saxpy.cpp, line 24.
(gdb)
```

Default compiler optimization for hipcc is –O3, compile with –O0

```
saxpy$  hipcc -ggdb -O0 --offload-arch=gfx90a -o saxpy saxpy.cpp
```

Creating a breakpoint again and it is declared in the correct line

```
--Type <RET> for more, q to quit, c to continue without paging--For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from saxpy...
(gdb) b saxpy.cpp:22
Breakpoint 1 at 0x219dec: file saxpy.cpp, line 22.
(gdb)
```

Running and architecture

Running with the keystroke ***r*** and stops at the breakpoint

```
--Type <RET> for more, q to quit, c to continue without paging--For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from saxpy...
(gdb) b saxpy.cpp:22
Breakpoint 1 at 0x219dec: file saxpy.cpp, line 22.
(gdb) r
Starting program: /home/gmarkoma/saxpy
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib64/libthread_db.so.1".
[New Thread 0x7fffed428700 (LWP 16916)]

Thread 1 "saxpy" hit Breakpoint 1, main () at saxpy.cpp:22
(gdb)
```

More information about the thread with the command ***i th***

```
(gdb) i th
  Id   Target Id                                  Frame
* 1    Thread 0x7ffff7fe6e80 (LWP 16912) "saxpy" main () at saxpy.cpp:22
  2    Thread 0x7fffed428700 (LWP 16916) "saxpy" 0x00007ffff5e1972b in ioctl () from /lib64/libc.so.6
(gdb)
```

We can see on what device is the thread with the ***show architecture*** command

```
(gdb) show architecture
The target architecture is set to "auto" (currently "i386:x86-64").
(gdb)
```

Breakpoint kernel and architecture

Breakpoint on the kernel called saxpy with the command ***b saxpy***

```
(gdb) b saxpy
Function "saxpy" not defined.
Make breakpoint pending on future shared library load? (y or [n]) yBreakpoint 2 (saxpy) pending.
(gdb)
```

You can continue with he command ***c***

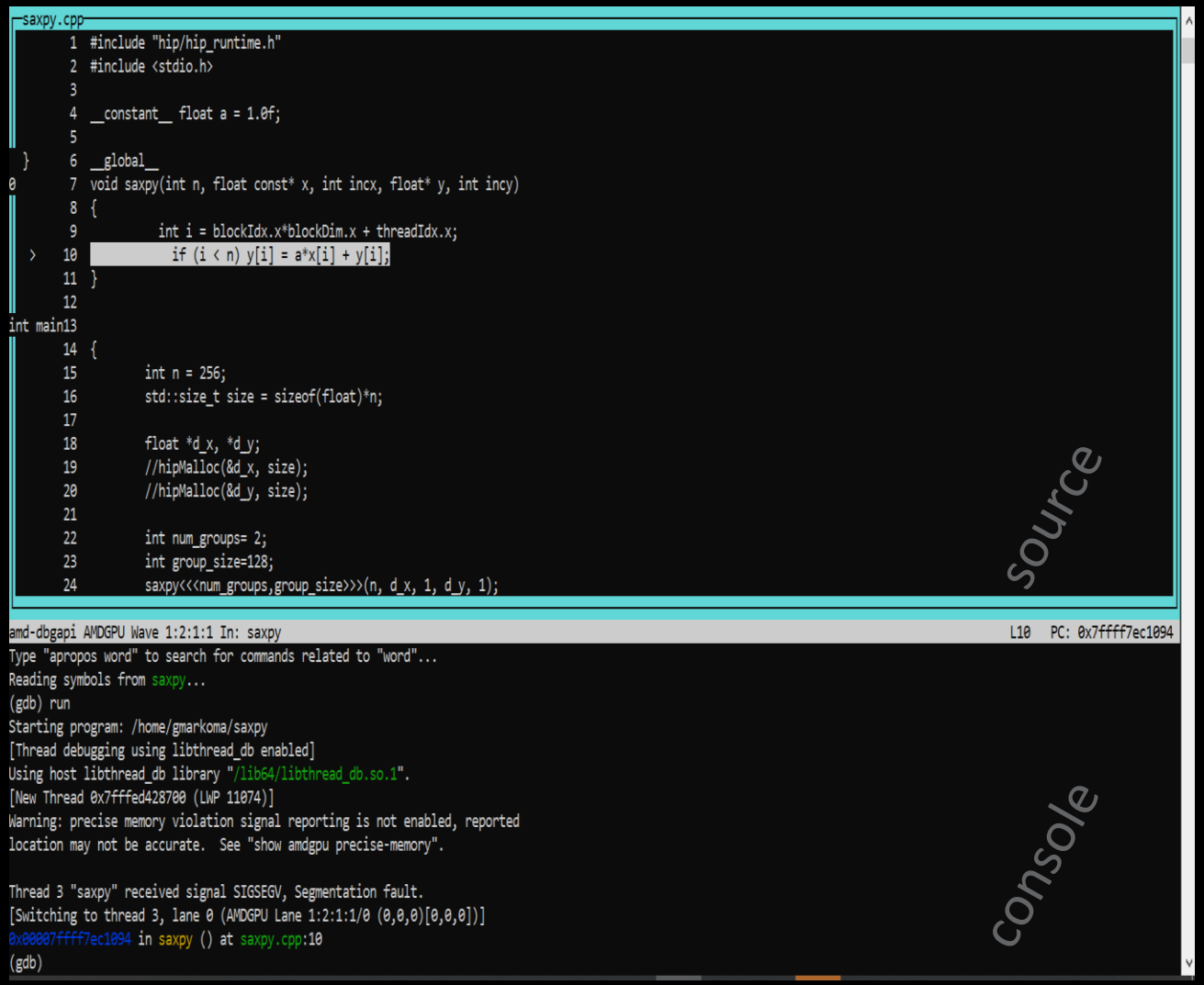
```
(gdb) c
Continuing.
[New Thread 0x7fffdefff700 (LWP 16937)]
[New Thread 0x7fffecaff700 (LWP 16938)]
[Thread 0x7fffdefff700 (LWP 16937) exited]
[Switching to thread 5, lane 0 (AMDGPU Lane 1:2:1:1/0 (0,0,0)[0,0,0])]

Thread 5 "saxpy" hit Breakpoint 2, with lanes [0-63], saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec701000, incy=1) at saxpy.cpp:9
```

We can see on what device is the thread with the command ***show architecture***

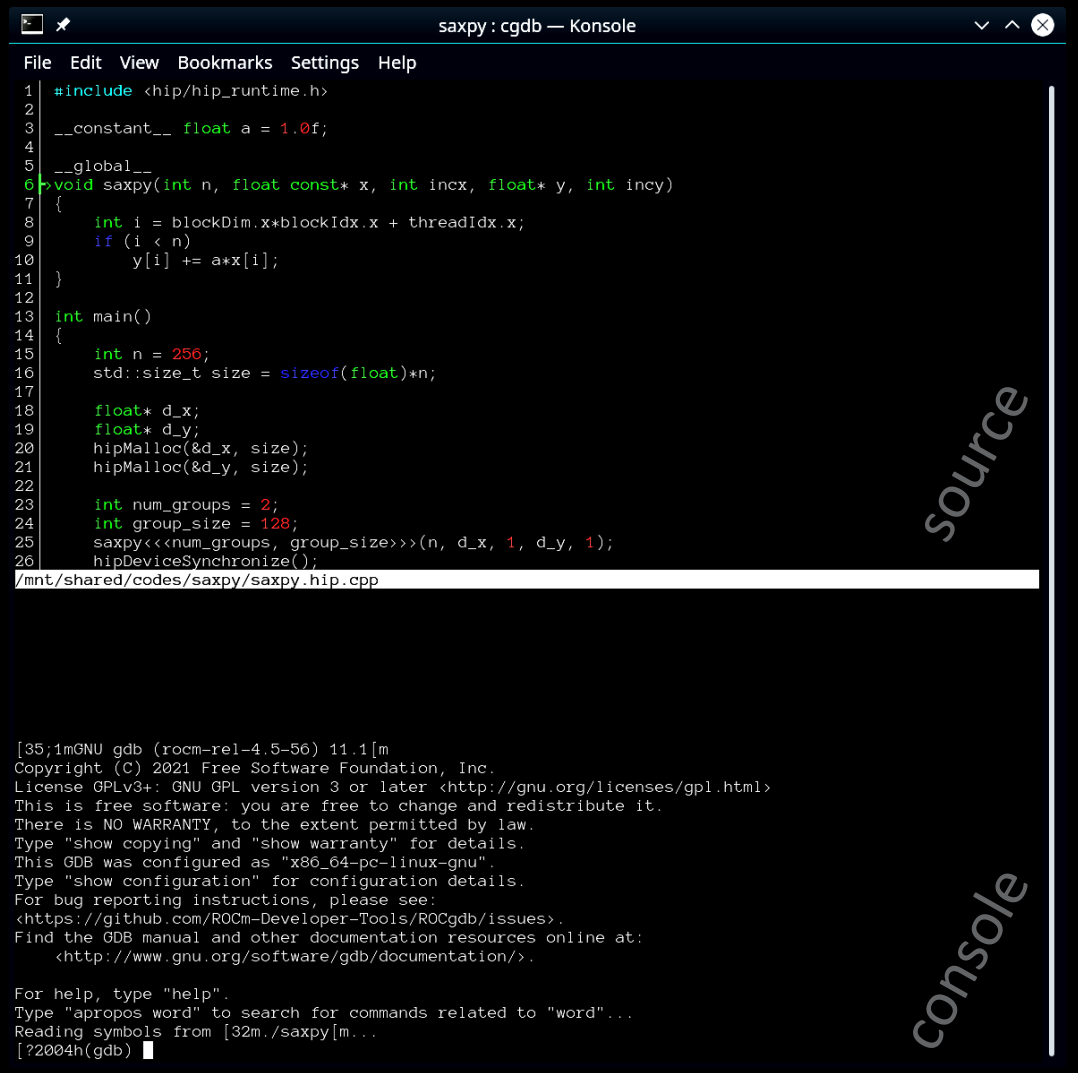
```
(gdb) show architecture
The target architecture is set to "auto" (currently "amdgcn:gfx90a").
```

“GUIs”

rocgdb -tui saxpy

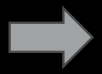


cgdb -d rocgdb saxpy



rocgdb + gdbgui

breakpoint in CPU code



Load Binary /mnt/shared/codes/saxpy/saxpy

show filesystem | fetch disassembly | reload file | jump to line | /mnt/shared/codes/saxpy/saxpy.hip.cpp:22 (27 lines total)

```
1  #include <hip/hip_runtime.h>
2
3  __constant__ float a = 1.0f;
4
5  __global__
6  void saxpy(int n, float const* x, float* y)
7  {
8      int i = blockDim.x*blockIdx.x + threadIdx.x;
9      if (i < n)
10         y[i] += a*x[i];
11 }
12
13 int main()
14 {
15     int n = 256;
16     std::size_t size = sizeof(float)*n;
17
18     float* d_x;
19     float* d_y;
20     hipMalloc(&d_x, size);
21     hipMalloc(&d_y, size);
22
23     int num_groups = 2;
24     int group_size = 128;
25     saxpy<<<num_groups, group_size>>>(n, d_x, d_y);
26 }
27
    (end of file)
```

source

```
running command: /opt/rocm/bin/rocgdb

GNU gdb (rocm-rel-4.5-56) 11.1
Copyright (C) 2021 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-pc-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<https://github.com/ROCm-Developer-Tools/ROCgdb/issues>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word".
New UI allocated
(gdb)
```

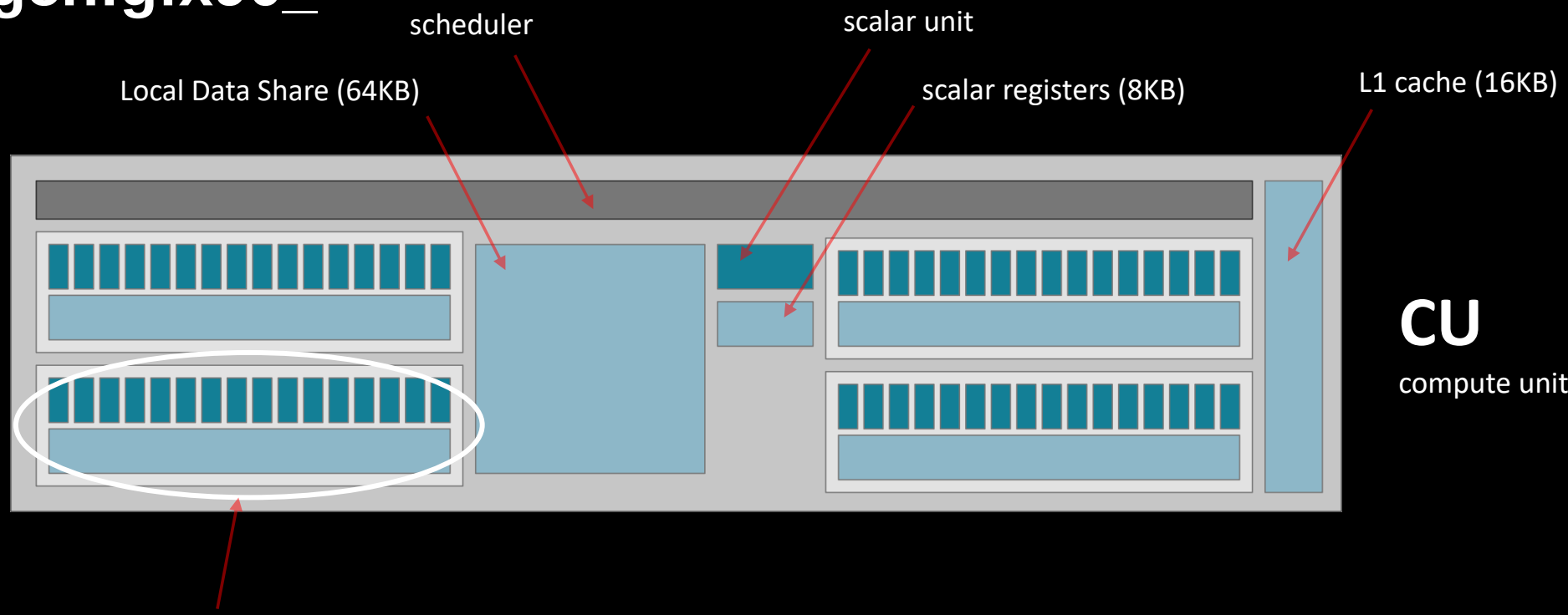
console

GDB Dashboard

- To show all the debugging information in one screen, you can also use GDB dashboard. Works with rocgdb.
- Shows:
  - Assembly
  - Breakpoints
  - Registers
  - Stack
  - Threads
  - Variables
  - … and more

- https://github.com/cyrus-and/gdb-dashboard

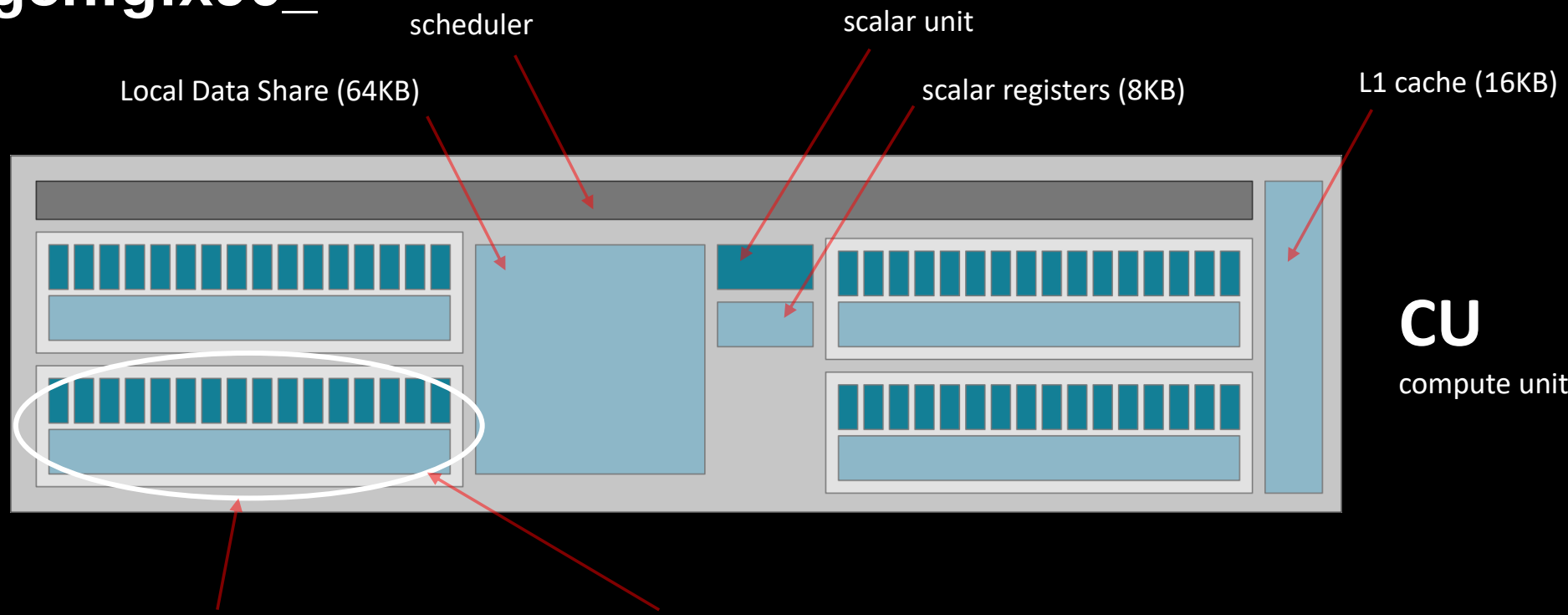
amdgcn:gfx90_



CU
compute unit

typically described as
- a 16-way SIMD unit
- with 64KB of registers

amdgcn:gfx90_



CU
compute unit

typically described as
- a 16-way SIMD unit
- with 64KB of registers

from the standpoint of rocGDB
- a **core**
- executing up to 10 **threads**
- with vector length of 64 **lanes**
- and containing 256 vector **registers**

List threads / waves

i th
(info threads)

some CPU threads

4 GPU “threads” (waves)

```
(gdb) i th
  Id   Target Id                                        Frame
  1    Thread 0x7ffff7fe6e80 (LWP 16912) "saxpy" 0x00007fffee0fc4c0 in rocr::core::InterruptSignal:
t) () from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
  2    Thread 0x7fffed428700 (LWP 16916) "saxpy" 0x00007ffff5e1972b in ioctl () from /lib64/libc.so
  4    Thread 0x7fffecaff700 (LWP 16938) "saxpy" 0x00007fffee0fc4af in rocr::core::InterruptSignal:
t) () from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
* 5    AMDGPU Wave 1:2:1:1 (0,0,0)/0 "saxpy"     saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec
  6    AMDGPU Wave 1:2:1:2 (0,0,0)/1 "saxpy"     saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec
  7    AMDGPU Wave 1:2:1:3 (1,0,0)/0 "saxpy"     saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec
  8    AMDGPU Wave 1:2:1:4 (1,0,0)/1 "saxpy"     saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec
```

Wave details

`agent-id:queue-id:dispatch-num:wave-id (work-group-x,work-group-y,work-group-z)/work-group-thread-index`

```
(gdb) i th
  Id   Target Id                                        Frame
  1    Thread 0x7ffff7fe6e80 (LWP 16912) "saxpy" 0x00007fffee0fc4c0 in rocr::core::InterruptSignal:
t) () from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
  2    Thread 0x7fffed428700 (LWP 16916) "saxpy" 0x00007ffff5e1972b in ioctl () from /lib64/libc.so
  4    Thread 0x7fffecaff700 (LWP 16938) "saxpy" 0x00007fffee0fc4af in rocr::core::InterruptSignal:
t) () from /opt/rocm-5.2.0/lib/libhsa-runtime64.so.1
* 5    AMDGPU Wave 1:2:1:1 (0,0,0)/0 "saxpy"     saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec
  6    AMDGPU Wave 1:2:1:2 (0,0,0)/1 "saxpy"     saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec
  7    AMDGPU Wave 1:2:1:3 (1,0,0)/0 "saxpy"     saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec
  8    AMDGPU Wave 1:2:1:4 (1,0,0)/1 "saxpy"     saxpy (n=256, x=0x7fffec700000, incx=1, y=0x7fffec
```

agent (GPU) ID

(HSA) queue ID

dispatch number

wave ID

workgroup (x, y, z)

wave ID (within group)

Other things you can do

- inspect / modify registers
- inspect / modify memory
- inspect / modify LDS
- step through the assembly one instruction at a time

Inspect assembly

We can use tools like gdbgui to display source code and assembly next to each other

```
#include <hip/hip_runtime.h>

__constant__ float a = 1.0f;

__global__
void saxpy(int n, float const* x, float* y)
{
    int i = blockDim.x*blockIdx.x + threadIdx.x;
    if (i < n)

        y[i] += a*x[i];

}
```

```
0x7fffe8a01030 s_load_dwordx2 s[0:1], s[6:7], 0x
0x7fffe8a01038 s_load_dwordx2 s[2:3], s[6:7], 0x
0x7fffe8a01020 v_add_u32_e32 v0, s8, v0
0x7fffe8a01024 v_cmp_gt_i32_e32 vcc, s0, v0
0x7fffe8a01028 s_and_saveexec_b64 s[0:1], vcc
0x7fffe8a0102c s_cbranch_execz 29 # 0x7fffe8a010
0x7fffe8a01040 v_ashrrev_i32_e32 v1, 31, v0
0x7fffe8a01044 v_lshlrev_b64 v[0:1], 2, v[0:1]
0x7fffe8a0104c s_getpc_b64 s[4:5]
0x7fffe8a01050 s_add_u32 s4, s4, 0x1fb0
0x7fffe8a01058 s_addc_u32 s5, s5, 0
0x7fffe8a01060 s_waitcnt lgkmcnt(0)
0x7fffe8a01064 v_mov_b32_e32 v3, s1
0x7fffe8a01068 v_add_co_u32_e32 v2, vcc, s0, v0
0x7fffe8a0106c v_addc_co_u32_e32 v3, vcc, v3, v1
0x7fffe8a01070 global_load_dword v2, v[2:3], off
0x7fffe8a01078 v_mov_b32_e32 v3, s3
0x7fffe8a0107c v_add_co_u32_e32 v0, vcc, s2, v0
0x7fffe8a01080 v_addc_co_u32_e32 v1, vcc, v3, v1
0x7fffe8a01084 global_load_dword v3, v[0:1], off
0x7fffe8a0108c s_load_dword s4, s[4:5], 0x0
0x7fffe8a01094 s_waitcnt vmcnt(0) lgkmcnt(0)
0x7fffe8a01098 v_fmac_f32_e32 v3, s4, v2
0x7fffe8a0109c global_store_dword v[0:1], v3, of
0x7fffe8a010a4 s_endpgm
```

check the condition
create the exec mask
quit if exec mask is zero

Inspect assembly

```
#include <hip/hip_runtime.h>

__constant__ float a = 1.0f;

__global__
void saxpy(int n, float const* x, float* y)
{
    int i = blockDim.x*blockIdx.x + threadIdx.x;
    if (i < n)

        y[i] += a*x[i];

}
```

address arithmetic

```
0x7fffe8a01030 s_load_dwordx2 s[0:1], s[6:7], 0x
0x7fffe8a01038 s_load_dwordx2 s[2:3], s[6:7], 0x
0x7fffe8a01020 v_add_u32_e32 v0, s8, v0      _Z5
0x7fffe8a01024 v_cmp_gt_i32_e32 vcc, s0, v0  _Z5
0x7fffe8a01028 s_and_saveexec_b64 s[0:1], vcc _Z5
0x7fffe8a0102c s_cbranch_execz 29 # 0x7fffe8a010
0x7fffe8a01040 v_ashrrev_i32_e32 v1, 31, v0  _Z5
0x7fffe8a01044 v_lshlrev_b64 v[0:1], 2, v[0:1] _Z
0x7fffe8a0104c s_getpc_b64 s[4:5]            _Z5
0x7fffe8a01050 s_add_u32 s4, s4, 0x1fb0      _Z5
0x7fffe8a01058 s_addc_u32 s5, s5, 0          _Z5
0x7fffe8a01060 s_waitcnt lgkmcnt(0)          _Z5
0x7fffe8a01064 v_mov_b32_e32 v3, s1          _Z5
0x7fffe8a01068 v_add_co_u32_e32 v2, vcc, s0, v0
0x7fffe8a0106c v_addc_co_u32_e32 v3, vcc, v3, v1
0x7fffe8a01070 global_load_dword v2, v[2:3], off
0x7fffe8a01078 v_mov_b32_e32 v3, s3          _Z5
0x7fffe8a0107c v_add_co_u32_e32 v0, vcc, s2, v0
0x7fffe8a01080 v_addc_co_u32_e32 v1, vcc, v3, v1
0x7fffe8a01084 global_load_dword v3, v[0:1], off
0x7fffe8a0108c s_load_dword s4, s[4:5], 0x0  _Z5
0x7fffe8a01094 s_waitcnt vmcnt(0) lgkmcnt(0) _Z5
0x7fffe8a01098 v_fmac_f32_e32 v3, s4, v2     _Z5
0x7fffe8a0109c global_store_dword v[0:1], v3, of
0x7fffe8a010a4 s_endpgm                      _Z5
```

Inspect assembly

```
#include <hip/hip_runtime.h>

__constant__ float a = 1.0f;

__global__
void saxpy(int n, float const* x, float* y)
{
    int i = blockDim.x*blockIdx.x + threadIdx.x;
    if (i < n)

        y[i] += a*x[i];

}
```

```
0x7fffe8a01030 s_load_dwordx2 s[0:1], s[6:7], 0x
0x7fffe8a01038 s_load_dwordx2 s[2:3], s[6:7], 0x
0x7fffe8a01020 v_add_u32_e32 v0, s8, v0      _Z5
0x7fffe8a01024 v_cmp_gt_i32_e32 vcc, s0, v0  _Z5
0x7fffe8a01028 s_and_saveexec_b64 s[0:1], vcc _Z5
0x7fffe8a0102c s_cbranch_execz 29 # 0x7fffe8a010
0x7fffe8a01040 v_ashrrev_i32_e32 v1, 31, v0  _Z5
0x7fffe8a01044 v_lshlrev_b64 v[0:1], 2, v[0:1] _Z
0x7fffe8a0104c s_getpc_b64 s[4:5]            _Z5
0x7fffe8a01050 s_add_u32 s4, s4, 0x1fb0      _Z5
0x7fffe8a01058 s_addc_u32 s5, s5, 0          _Z5
0x7fffe8a01060 s_waitcnt lgkmcnt(0)          _Z5
0x7fffe8a01064 v_mov_b32_e32 v3, s1          _Z5
0x7fffe8a01068 v_add_co_u32_e32 v2, vcc, s0, v0
0x7fffe8a0106c v_addc_co_u32_e32 v3, vcc, v3, v1
0x7fffe8a01070 global_load_dword v2, v[2:3], off
0x7fffe8a01078 v_mov_b32_e32 v3, s3          _Z5
0x7fffe8a0107c v_add_co_u32_e32 v0, vcc, s2, v0
0x7fffe8a01080 v_addc_co_u32_e32 v1, vcc, v3, v1
0x7fffe8a01084 global_load_dword v3, v[0:1], off
0x7fffe8a0108c s_load_dword s4, s[4:5], 0x0  _Z5
0x7fffe8a01094 s_waitcnt vmcnt(0) lgkmcnt(0) _Z5
0x7fffe8a01098 v_fmac_f32_e32 v3, s4, v2     _Z5
0x7fffe8a0109c global_store_dword v[0:1], v3, of
0x7fffe8a010a4 s_endpgm                      _Z5
```

load x

load y

load a

Inspect assembly

```
#include <hip/hip_runtime.h>

__constant__ float a = 1.0f;

__global__
void saxpy(int n, float const* x, float* y)
{
    int i = blockDim.x*blockIdx.x + threadIdx.x;
    if (i < n)

        y[i] += a*x[i];

}
```

```
0x7fffe8a01030 s_load_dwordx2 s[0:1], s[6:7], 0x
0x7fffe8a01038 s_load_dwordx2 s[2:3], s[6:7], 0x
0x7fffe8a01020 v_add_u32_e32 v0, s8, v0      _Z5
0x7fffe8a01024 v_cmp_gt_i32_e32 vcc, s0, v0  _Z5
0x7fffe8a01028 s_and_saveexec_b64 s[0:1], vcc _Z5
0x7fffe8a0102c s_cbranch_execz 29 # 0x7fffe8a010
0x7fffe8a01040 v_ashrrev_i32_e32 v1, 31, v0  _Z5
0x7fffe8a01044 v_lshlrev_b64 v[0:1], 2, v[0:1] _Z
0x7fffe8a0104c s_getpc_b64 s[4:5]            _Z5
0x7fffe8a01050 s_add_u32 s4, s4, 0x1fb0      _Z5
0x7fffe8a01058 s_addc_u32 s5, s5, 0          _Z5
0x7fffe8a01060 s_waitcnt lgkmcnt(0)          _Z5
0x7fffe8a01064 v_mov_b32_e32 v3, s1          _Z5
0x7fffe8a01068 v_add_co_u32_e32 v2, vcc, s0, v0
0x7fffe8a0106c v_addc_co_u32_e32 v3, vcc, v3, v1
0x7fffe8a01070 global_load_dword v2, v[2:3], off
0x7fffe8a01078 v_mov_b32_e32 v3, s3          _Z5
0x7fffe8a0107c v_add_co_u32_e32 v0, vcc, s2, v0
0x7fffe8a01080 v_addc_co_u32_e32 v1, vcc, v3, v1
0x7fffe8a01084 global_load_dword v3, v[0:1], off
0x7fffe8a0108c s_load_dword s4, s[4:5], 0x0  _Z5
0x7fffe8a01094 s_waitcnt vmcnt(0) lgkmcnt(0) _Z5
0x7fffe8a01098 v_fmac_f32_e32 v3, s4, v2     _Z5
0x7fffe8a0109c global_store_dword v[0:1], v3, of
0x7fffe8a010a4 s_endpgm                      _Z5
```

FMA

Inspect assembly

```
#include <hip/hip_runtime.h>

__constant__ float a = 1.0f;

__global__
void saxpy(int n, float const* x, float* y)
{
    int i = blockDim.x*blockIdx.x + threadIdx.x;
    if (i < n)

        y[i] += a*x[i];

}
```

```
0x7fffe8a01030 s_load_dwordx2 s[0:1], s[6:7], 0x
0x7fffe8a01038 s_load_dwordx2 s[2:3], s[6:7], 0x
0x7fffe8a01020 v_add_u32_e32 v0, s8, v0      _Z5
0x7fffe8a01024 v_cmp_gt_i32_e32 vcc, s0, v0  _Z5
0x7fffe8a01028 s_and_saveexec_b64 s[0:1], vcc _Z5
0x7fffe8a0102c s_cbranch_execz 29 # 0x7fffe8a010
0x7fffe8a01040 v_ashrrev_i32_e32 v1, 31, v0  _Z5
0x7fffe8a01044 v_lshlrev_b64 v[0:1], 2, v[0:1] _Z
0x7fffe8a0104c s_getpc_b64 s[4:5]            _Z5
0x7fffe8a01050 s_add_u32 s4, s4, 0x1fb0      _Z5
0x7fffe8a01058 s_addc_u32 s5, s5, 0          _Z5
0x7fffe8a01060 s_waitcnt lgkmcnt(0)          _Z5
0x7fffe8a01064 v_mov_b32_e32 v3, s1          _Z5
0x7fffe8a01068 v_add_co_u32_e32 v2, vcc, s0, v0
0x7fffe8a0106c v_addc_co_u32_e32 v3, vcc, v3, v1
0x7fffe8a01070 global_load_dword v2, v[2:3], off
0x7fffe8a01078 v_mov_b32_e32 v3, s3          _Z5
0x7fffe8a0107c v_add_co_u32_e32 v0, vcc, s2, v0
0x7fffe8a01080 v_addc_co_u32_e32 v1, vcc, v3, v1
0x7fffe8a01084 global_load_dword v3, v[0:1], off
0x7fffe8a0108c s_load_dword s4, s[4:5], 0x0  _Z5
0x7fffe8a01094 s_waitcnt vmcnt(0) lgkmcnt(0) _Z5
0x7fffe8a01098 v_fmac_f32_e32 v3, s4, v2     _Z5
0x7fffe8a0109c global_store_dword v[0:1], v3, of
0x7fffe8a010a4 s_endpgm                      _Z5
```

store y

List agents

info agents
- shows devices + properties

```
(gdb) info agents
  Id State Target Id                    Architecture Device Name Cores Threads Location
* 1  A     AMDGPU Agent (GPUID 31957) gfx90a       aldebaran   440   3520    29:00.0
```

gfx90a
MI200 series

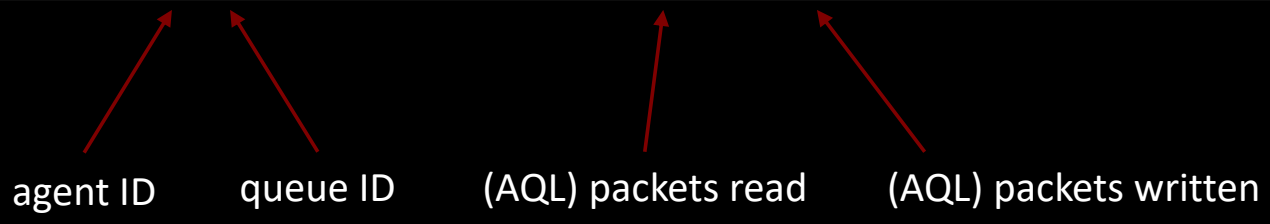
SIMDs
(CUs x 4)

max waves
(SIMDs x 8)

List queues

info queues
- shows HSA queues

```
(gdb) info queues
  Id   Target Id                    Type         Read   Write  Size     Address
  1    AMDGPU Queue 1:1 (QID 0) HSA (Multi)  4      4      4096     0x00007ffff7eb6000
* 2    AMDGPU Queue 1:2 (QID 1) HSA (Multi)  0      2      262144   0x00007ffff7e40000
(gdb)
```



Dispatch details

info dispatches

- shows kernel dispatches

```
(gdb) info dispatches
  Id   Target Id                          Grid      Workgroup Fence   Kernel Function
* 1    AMDGPU Dispatch 1:2:1 (PKID 0) [256,1,1] [128,1,1] B|Aa|Ra saxpy(int, float const*, int, float*, int)
```

agent ID

queue ID

dispatch ID

grid dimensions

group dimensions

kernel

Registers

info registers
- shows registers in use

vector registers

scalar registers

program counter, exec mask, …

```
(gdb) info registers
v0             {0x0, 0x1, 0x2, 0x3, 0x4, 0x5, 0x6, 0x7, 0x8, 0x9, 0xa, 0xb, 0xc, 0xd, 0xe, 0xf, 0x10, 0x11, 0x12, 0x13,
0x14, 0x15, 0x16, 0x17, 0x18, 0x19, 0x1a, 0x1b, 0x1c, 0x1d, 0x1e, 0x1f, 0x20, 0x21, 0x22, 0x23, 0x24, 0x25, 0x26, 0x27,
0x28, 0x29, 0x2a, 0x2b, 0x2c, 0x2d, 0x2e, 0x2f, 0x30, 0x31, 0x32, 0x33, 0x34, 0x35, 0x36, 0x37, 0x38, 0x39, 0x3a, 0x3b,
0x3c, 0x3d, 0x3e, 0x3f}
v1             {0x19800, 0x19804, 0x19808, 0x1980c, 0x19810, 0x19814, 0x19818, 0x1981c, 0x19820, 0x19824, 0x19828, 0x198
2c, 0x19830, 0x19834, 0x19838, 0x1983c, 0x19840, 0x19844, 0x19848, 0x1984c, 0x19850, 0x19854, 0x19858, 0x1985c, 0x19860,
 0x19864, 0x19868, 0x1986c, 0x19870, 0x19874, 0x19878, 0x1987c, 0x19880, 0x19884, 0x19888, 0x1988c, 0x19890, 0x19894, 0x
19898, 0x1989c, 0x198a0, 0x198a4, 0x198a8, 0x198ac, 0x198b0, 0x198b4, 0x198b8, 0x198bc, 0x198c0, 0x198c4, 0x198c8, 0x198
cc, 0x198d0, 0x198d4, 0x198d8, 0x198dc, 0x198e0, 0x198e4, 0x198e8, 0x198ec, 0x198f0, 0x198f4, 0x198f8, 0x198fc}
v2             {0xf7e0e670, 0xf7e0e671, 0xf7e0e672, 0xf7e0e673, 0xf7e0e674, 0xf7e0e675, 0xf7e0e676, 0xf7e0e677, 0xf7e0e6
78, 0xf7e0e679, 0xf7e0e67a, 0xf7e0e67b, 0xf7e0e67c, 0xf7e0e67d, 0xf7e0e67e, 0xf7e0e67f, 0xf7e0e680, 0xf7e0e681, 0xf7e0e6
82, 0xf7e0e683, 0xf7e0e684, 0xf7e0e685, 0xf7e0e686, 0xf7e0e687, 0xf7e0e688, 0xf7e0e689, 0xf7e0e68a, 0xf7e0e68b, 0xf7e0e6
8c, 0xf7e0e68d, 0xf7e0e68e, 0xf7e0e68f, 0xf7e0e690, 0xf7e0e691, 0xf7e0e692, 0xf7e0e693, 0xf7e0e694, 0xf7e0e695, 0xf7e0e6
96, 0xf7e0e697, 0xf7e0e698, 0xf7e0e699, 0xf7e0e69a, 0xf7e0e69b, 0xf7e0e69c, 0xf7e0e69d, 0xf7e0e69e, 0xf7e0e69f, 0xf7e0e6
a0, 0xf7e0e6a1, 0xf7e0e6a2, 0xf7e0e6a3, 0xf7e0e6a4, 0xf7e0e6a5, 0xf7e0e6a6, 0xf7e0e6a7, 0xf7e0e6a8, 0xf7e0e6a9, 0xf7e0e6
aa, 0xf7e0e6ab, 0xf7e0e6ac, 0xf7e0e6ad, 0xf7e0e6ae, 0xf7e0e6af}
```

```
s0             0x10080             65664
s1             0x80000000          -2147483648
s2             0x0                 0
s3             0xea4fac            15355820
s4             0xf7e40000          -136052736
s5             0x7fff              32767
s6             0xec500000          -330301440
s7             0x7fff              32767
s8             0x0                 0
s9             0x0                 0
m0             0xffffffff          4294967295
pc             0x7ffff7ec1008      0x7ffff7ec1008 <saxpy(int, float const*, int, float*, int)+8>
exec           0xffffffffffffffff  18446744073709551615
vcc            0x7ffff7e90000      140737352630272
```

v0 = theadIdx.x

t 3
info reg v0
- values from 0 to 63

t 4
info reg v0
- values from 64 to 127

```
(gdb) t 3
[Switching to thread 3, lane 0 (AMDGPU Lane 1:2:1:1/0 (0,0,0)[0,0,0])]
#0  saxpy (n=<optimized out>, x=<optimized out>, incx=<optimized out>, y=<optimized out>, incy=<optimized out>) at saxpy.hi
6       void saxpy(int n, float const* x, float* y)
(gdb) info reg v0
v0             {0x0, 0x1, 0x2, 0x3, 0x4, 0x5, 0x6, 0x7, 0x8, 0x9, 0xa, 0xb, 0xc, 0xd, 0xe, 0xf, 0x10, 0x11, 0x12, 0x13, 0x1
x17, 0x18, 0x19, 0x1a, 0x1b, 0x1c, 0x1d, 0x1e, 0x1f, 0x20, 0x21, 0x22, 0x23, 0x24, 0x25, 0x26, 0x27, 0x28, 0x29, 0x2a, 0x2b
2e, 0x2f, 0x30, 0x31, 0x32, 0x33, 0x34, 0x35, 0x36, 0x37, 0x38, 0x39, 0x3a, 0x3b, 0x3c, 0x3d, 0x3e, 0x3f}
(gdb) t 4
[Switching to thread 4, lane 0 (AMDGPU Lane 1:2:1:2/0 (0,0,0)[64,0,0])]
#0  saxpy (n=<optimized out>, x=<optimized out>, incx=<optimized out>, y=<optimized out>, incy=<optimized out>) at saxpy.hi
6       void saxpy(int n, float const* x, float* y)
(gdb) info reg v0
v0             {0x40, 0x41, 0x42, 0x43, 0x44, 0x45, 0x46, 0x47, 0x48, 0x49, 0x4a, 0x4b, 0x4c, 0x4d, 0x4e, 0x4f, 0x50, 0x51,
4, 0x55, 0x56, 0x57, 0x58, 0x59, 0x5a, 0x5b, 0x5c, 0x5d, 0x5e, 0x5f, 0x60, 0x61, 0x62, 0x63, 0x64, 0x65, 0x66, 0x67, 0x68,
, 0x6c, 0x6d, 0x6e, 0x6f, 0x70, 0x71, 0x72, 0x73, 0x74, 0x75, 0x76, 0x77, 0x78, 0x79, 0x7a, 0x7b, 0x7c, 0x7d, 0x7e, 0x7f}
(gdb)
```

t 5
info reg v0
- values from 0 to 63

t 6
info reg v0
- values from 64 to 127

```
(gdb) t 5
[Switching to thread 5, lane 0 (AMDGPU Lane 1:2:1:3/0 (1,0,0)[0,0,0])]
#0  saxpy (n=<optimized out>, x=<optimized out>, incx=<optimized out>, y=<optimized out>, incy=<optimized out>) at saxpy.hi
6       void saxpy(int n, float const* x, float* y)
(gdb) info reg v0
v0             {0x0, 0x1, 0x2, 0x3, 0x4, 0x5, 0x6, 0x7, 0x8, 0x9, 0xa, 0xb, 0xc, 0xd, 0xe, 0xf, 0x10, 0x11, 0x12, 0x13, 0x1
x17, 0x18, 0x19, 0x1a, 0x1b, 0x1c, 0x1d, 0x1e, 0x1f, 0x20, 0x21, 0x22, 0x23, 0x24, 0x25, 0x26, 0x27, 0x28, 0x29, 0x2a, 0x2b
2e, 0x2f, 0x30, 0x31, 0x32, 0x33, 0x34, 0x35, 0x36, 0x37, 0x38, 0x39, 0x3a, 0x3b, 0x3c, 0x3d, 0x3e, 0x3f}
(gdb) t 6
[Switching to thread 6, lane 0 (AMDGPU Lane 1:2:1:4/0 (1,0,0)[64,0,0])]
#0  saxpy (n=<optimized out>, x=<optimized out>, incx=<optimized out>, y=<optimized out>, incy=<optimized out>) at saxpy.hi
6       void saxpy(int n, float const* x, float* y)
(gdb) info reg v0
v0             {0x40, 0x41, 0x42, 0x43, 0x44, 0x45, 0x46, 0x47, 0x48, 0x49, 0x4a, 0x4b, 0x4c, 0x4d, 0x4e, 0x4f, 0x50, 0x51,
4, 0x55, 0x56, 0x57, 0x58, 0x59, 0x5a, 0x5b, 0x5c, 0x5d, 0x5e, 0x5f, 0x60, 0x61, 0x62, 0x63, 0x64, 0x65, 0x66, 0x67, 0x68,
, 0x6c, 0x6d, 0x6e, 0x6f, 0x70, 0x71, 0x72, 0x73, 0x74, 0x75, 0x76, 0x77, 0x78, 0x79, 0x7a, 0x7b, 0x7c, 0x7d, 0x7e, 0x7f}
(gdb)
```

s8 = blockIdx.x

t 3/4
info reg s8
- blockIdx.x = 0

```
(gdb) t 3
[Switching to thread 3, lane 0 (AMDGPU Lane 1:2:1:1/0 (0,0,0)[0,0,0])]
#0  saxpy (n=<optimized out>, x=<optimized out>, incx=<optimized out>,
6       void saxpy(int n, float const* x, float* y)
(gdb) info reg s8
s8             0x0                 0
(gdb) t 4
[Switching to thread 4, lane 0 (AMDGPU Lane 1:2:1:2/0 (0,0,0)[64,0,0])]
#0  saxpy (n=<optimized out>, x=<optimized out>, incx=<optimized out>,
6       void saxpy(int n, float const* x, float* y)
(gdb) info reg s8
s8             0x0                 0
(gdb)
```

t 5/6
info reg s8
- blockIdx.x = 1

```
(gdb) t 5
[Switching to thread 5, lane 0 (AMDGPU Lane 1:2:1:3/0 (1,0,0)[0,0,0])]
#0  saxpy (n=<optimized out>, x=<optimized out>, incx=<optimized out>,
6       void saxpy(int n, float const* x, float* y)
(gdb) info reg s8
s8             0x1                 1
(gdb) t 6
[Switching to thread 6, lane 0 (AMDGPU Lane 1:2:1:4/0 (1,0,0)[64,0,0])]
#0  saxpy (n=<optimized out>, x=<optimized out>, incx=<optimized out>,
6       void saxpy(int n, float const* x, float* y)
(gdb) info reg s8
s8             0x1                 1
(gdb)
```

AMD_LOG_LEVEL=3

```
:3:devprogram.cpp           :2978: 157529658660 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: _Z5saxpyiPKfiPfi
:3:hip_module.cpp           :365 : 157529658684 us: 224178: [tid:0x7f59c7439e80] ihipModuleLaunchKernel ( 0x0x12e9720, 256, 1, 1, 128, 1, 1, 0, stream:<null>, 0x7fff94e2e07
0, char array:<null>, event:0, event:0, 0, 0 )
:3:rocdevice.cpp            :2686: 157529658695 us: 224178: [tid:0x7f59c7439e80] number of allocated hardware queues with low priority: 0, with normal priority: 0, with hig
h priority: 0, maximum per priority is: 4
:3:rocdevice.cpp            :2757: 157529663975 us: 224178: [tid:0x7f59c7439e80] created hardware queue 0x7f59c72f4000 with size 4096 with priority 1, cooperative: 0
:3:devprogram.cpp           :2675: 157529852150 us: 224178: [tid:0x7f59c7439e80] Using Code Object V4.
:3:devprogram.cpp           :2978: 157529853058 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_fillImage
:3:devprogram.cpp           :2978: 157529853065 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_fillBufferAligned2D
:3:devprogram.cpp           :2978: 157529853070 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_fillBufferAligned
:3:devprogram.cpp           :2978: 157529853076 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_copyImage1DA
:3:devprogram.cpp           :2978: 157529853080 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_copyBufferAligned
:3:devprogram.cpp           :2978: 157529853084 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_streamOpsWait
:3:devprogram.cpp           :2978: 157529853087 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_copyBuffer
:3:devprogram.cpp           :2978: 157529853091 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_streamOpsWrite
:3:devprogram.cpp           :2978: 157529853094 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_copyBufferRectAligned
:3:devprogram.cpp           :2978: 157529853096 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_gwsInit
:3:devprogram.cpp           :2978: 157529853099 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_copyBufferRect
:3:devprogram.cpp           :2978: 157529853101 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_copyImageToBuffer
:3:devprogram.cpp           :2978: 157529853105 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_copyBufferToImage
:3:devprogram.cpp           :2978: 157529853108 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: __amd_rocclr_copyImage
:3:rocvirtual.cpp           :753 : 157529853195 us: 224178: [tid:0x7f59c7439e80] Arg0:   = val:256
:3:rocvirtual.cpp           :679 : 157529853200 us: 224178: [tid:0x7f59c7439e80] Arg1:   = ptr:0x7f59bbb00000 obj:[0x7f59bbb00000-0x7f59bbb00400]
:3:rocvirtual.cpp           :753 : 157529853205 us: 224178: [tid:0x7f59c7439e80] Arg2:   = val:1
:3:rocvirtual.cpp           :679 : 157529853209 us: 224178: [tid:0x7f59c7439e80] Arg3:   = ptr:0x7f59bbb01000 obj:[0x7f59bbb01000-0x7f59bbb01400]
:3:rocvirtual.cpp           :753 : 157529853213 us: 224178: [tid:0x7f59c7439e80] Arg4:   = val:1
:3:rocvirtual.cpp           :2723: 157529853216 us: 224178: [tid:0x7f59c7439e80] ShaderName : _Z5saxpyiPKfiPfi
:3:hip_platform.cpp         :676 : 157529853233 us: 224178: [tid:0x7f59c7439e80] ihipLaunchKernel: Returned hipSuccess :
:3:hip_module.cpp           :509 : 157529853237 us: 224178: [tid:0x7f59c7439e80] hipLaunchKernel: Returned hipSuccess :
:3:hip_device_runtime.cpp   :476 : 157529853243 us: 224178: [tid:0x7f59c7439e80] hipDeviceSynchronize (  )
:3:rocdevice.cpp            :2636: 157529853248 us: 224178: [tid:0x7f59c7439e80] No HW event
:3:rocvirtual.hpp           :62  : 157529853255 us: 224178: [tid:0x7f59c7439e80] Host active wait for Signal = (0x7f59c7442600) for -1 ns
:3:hip_device_runtime.cpp   :488 : 157529853267 us: 224178: [tid:0x7f59c7439e80] hipDeviceSynchronize: Returned hipSuccess :
:3:hip_memory.cpp           :536 : 157529853279 us: 224178: [tid:0x7f59c7439e80] hipFree ( 0x7f59bbb00000 )
:3:rocdevice.cpp            :2093: 157529853291 us: 224178: [tid:0x7f59c7439e80] device=0x12d34f0, freeMem_ = 0xfefffc00
:3:hip_memory.cpp           :538 : 157529853296 us: 224178: [tid:0x7f59c7439e80] hipFree: Returned hipSuccess :
:3:hip_memory.cpp           :536 : 157529853300 us: 224178: [tid:0x7f59c7439e80] hipFree ( 0x7f59bbb01000 )
:3:rocdevice.cpp            :2093: 157529853306 us: 224178: [tid:0x7f59c7439e80] device=0x12d34f0, freeMem_ = 0xff000000
:3:hip_memory.cpp           :538 : 157529853310 us: 224178: [tid:0x7f59c7439e80] hipFree: Returned hipSuccess :
:3:devprogram.cpp           :2978: 157529853333 us: 224178: [tid:0x7f59c7439e80] For Init/Fini: Kernel Name: _Z5saxpyiPKfiPfi
```

How to use rocgdb + gdbgui + Chrome

test if X forwarding works

```
ssh -X USERNAME@server
ssh -X login1._______.olcf.ornl.gov
srun -A VEN113 -N 1 -n 1 -c 64 --x11 --pty bash
xmessage -center hello!
```

install gdbgui

```
python3 -m pip install --user pipx
python3 -m userpath append ~/.local/bin
pipx install gdbgui
```

install Chrome

- Go to https://www.google.com/chrome/
- Click *Download Chrome*
- Click *64 bit .rpm (For Fedora/openSUSE)*
- Click *Accept and Install*

```
scp google-chrome-stable_current_x86_64.rpm USERNAME@home.ccs.ornl.gov:
ssh -X USERNAME@home.ccs.ornl.gov
mkdir ~/chrome
cd ~/chrome
rpm2cpio ../google-chrome-stable_current_x86_64.rpm | cpio -id
```

run rocgdb with gdbgui in Chrome

```
ssh -X USERNAME@home.ccs.ornl.gov
ssh -X login1._______.olcf.ornl.gov
srun -A VEN113 -N 1 -n 1 -c 64 --x11 --pty bash
gdbgui -g /opt/rocm/bin/rocgdb --no-browser &
~/chrome/opt/google/chrome/google-chrome 2>/dev/null &
```

- In Chrome, go to: http://127.0.0.1:5000
- Click *Load Binary* to load your binary (compiled with -ggdb)
- Step into a kernel
- Click *fetch disassembly*

```
show architecture
info threads
info queues
info dispatches
info registers
info reg vcc
info reg exec
s
si
n
ni
...
```

More resources for rocgdb

- /opt/rocm<-version>/share/doc/rocgdb/
  - rocgdb.pdf -- has additions for GPU commands
  - rocrefcard.pdf -- standard gdb reference card
- Presentations
  - https://www.olcf.ornl.gov/wp-content/uploads/2021/04/rocgdb_hipmath_ornl_2021_v2.pdf -- Justin Chang (AMD)
  - https://lpc.events/event/11/contributions/997/attachments/928/1828/LPC2021-rocgdbdemo.pdf – Andrew Stubbs (Siemens®) – See https://youtu.be/IGWFph4SlpU for 24 min video from presentation of debugging GCC offloading code (OpenACC and OpenMP®)

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