SEPTEMBER 23, 2025

Argonne NATIONAL LABORATORY | ALCF

HARDWARE OVERVIEW, BUILDING, AND RUNNING ON AURORA & POLARIS

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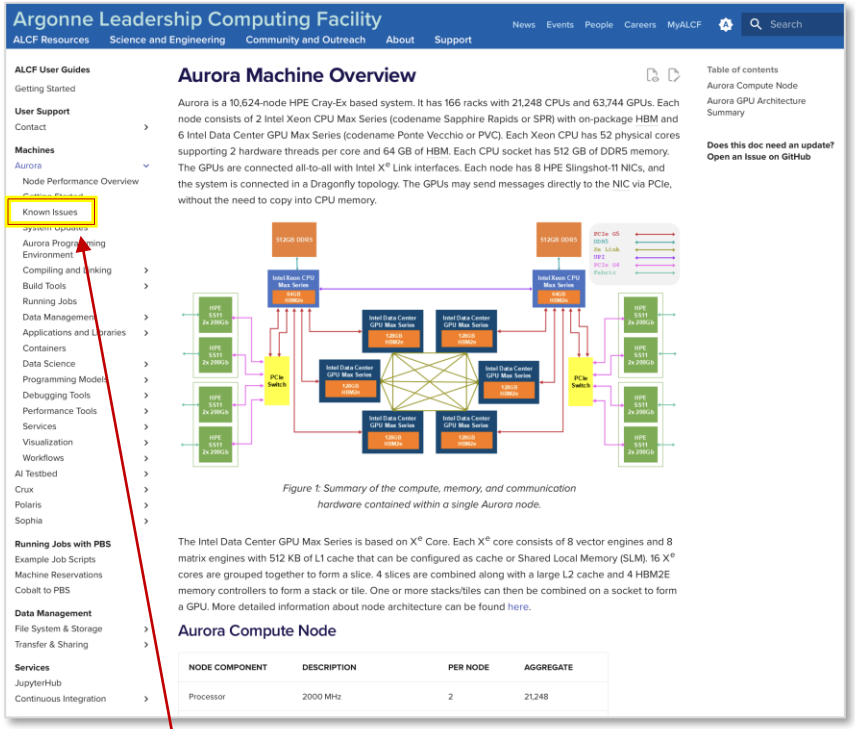
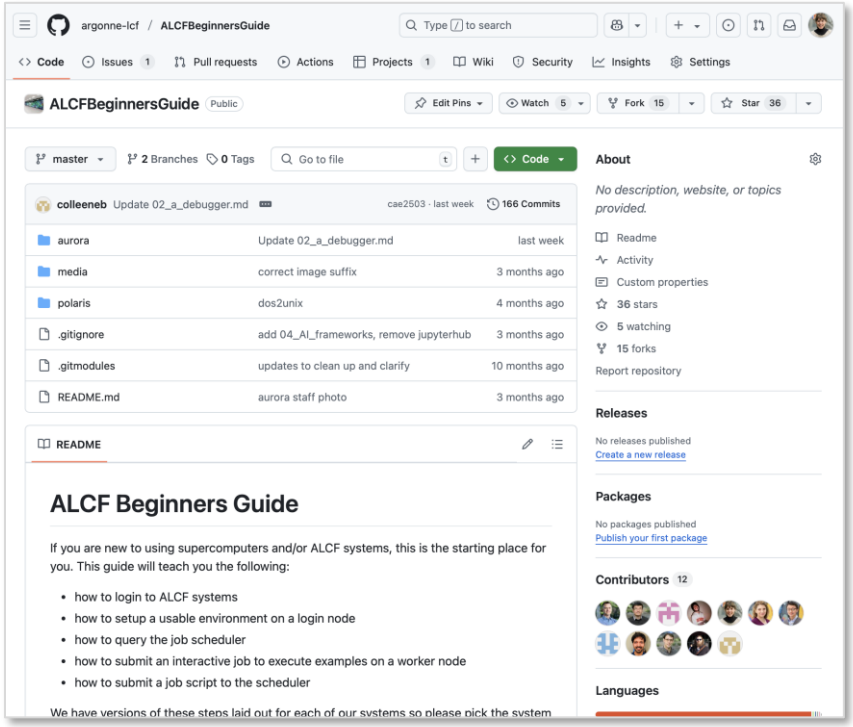
ALCF BEGINNERS GUIDE

https://docs.alcf.anl.gov/aurora/

https://github.com/argonne-lcf/ALCFBeginnersGuide





Known issues: https://docs.alcf.anl.gov/aurora/known-issues/

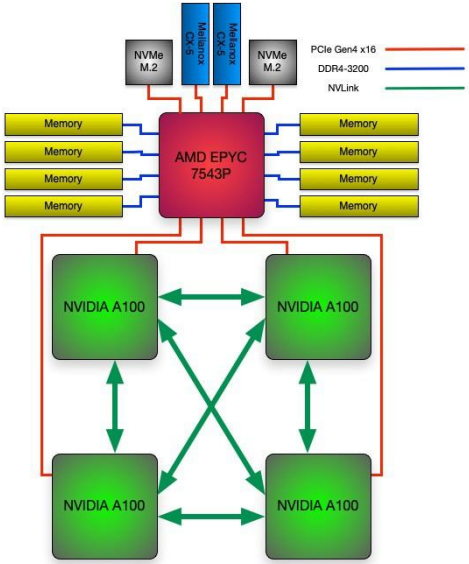
NOTE


Polaris
Argonne
ENERGY

POLARIS

# of AMD EPYC 7543P CPUs	1
# of NVIDIA A100 GPUs	4
Total HBM2 Memory	160 GB
HBM2 Memory BW per GPU	1.6 TB/s
Total DDR4 Memory	512 GB
DDR4 Memory BW	204.8 GB/s
# OF NVMe SSDs	2
Total NVMe SSD Capacity	3.2 TB
# of Cassini NICs	2
Total Injection BW (w/ Cassini)	50 GB/s
PCIe Gen4 BW	64 GB/s
NVLink BW	600 GB/s
Total GPU DP Tensor Core Flops	78 TF

Node Specs



# of River Compute racks	40
# of Apollo Gen10+ Chassis	280
# of Nodes	560
# of AMD EPYC 7543P CPUs	560
# of NVIDIA A100 GPUs	2240
Total GPU HBM2 Memory	87.5TB
Total CPU DDR4 Memory	280 TB
Total NVMe SSD Capacity	1.75 PB
Interconnect	HPE Slingshot
# of Cassini NICs	1120
# of Rosetta Switches	80
Total Injection BW (w/ Cassini)	28 TB/s
Total GPU DP Tensor Core Flops	44 PF
Total Power	1.8 MW

System Specs

Aurora

Argonne's exascale supercomputer leverages technological innovations to support machine learning and data science workloads alongside traditional modeling and simulation runs.

SUSTAINED PERFORMANCE
1.012 Exaflops

Xe ARCHITECTURE-BASED GPU
Ponte Vecchio

INTEL XEON SCALABLE PROCESSOR
Sapphire Rapids

PLATFORM
HPE Cray EX

Compute Node
2 Intel® Xeon CPU Max Series processors: 64GB HBM on each, 512GB DDR5 each; 6 Intel Data Center GPU Max Series, 128GB on each, RAMBO cache on each; Unified Memory Architecture; 8 Slingshot 11 fabric endpoints

GPU Architecture
Xe arch-based "Ponte Vecchio" GPU
Tile-based chiplets, HBM stack,
Foveros 3D integration, 7nm

CPU-GPU Interconnect
CPU-GPU: PCIe; GPU-GPU: Xe Link

System Interconnect
HPE Slingshot 11, Dragonfly topology with adaptive routing, Peak Injection bandwidth 2.12 PB/s, Peak Bisection bandwidth 0.69 PB/s

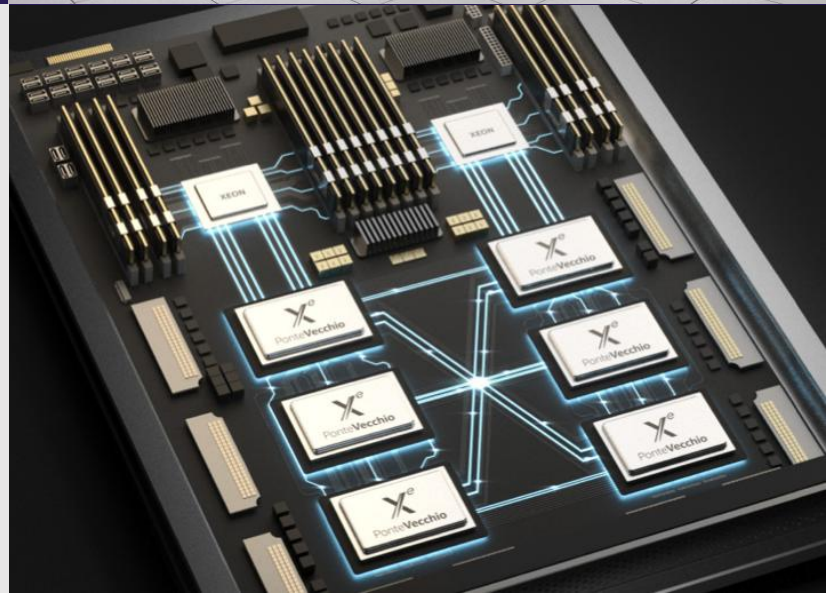
Network Switch
25.6 Tb/s per switch, from 64–200 Gbs
ports (25 GB/s per direction)

High-Performance Storage
230 PB, 31 TB/s, 1024 nodes (DAOS)

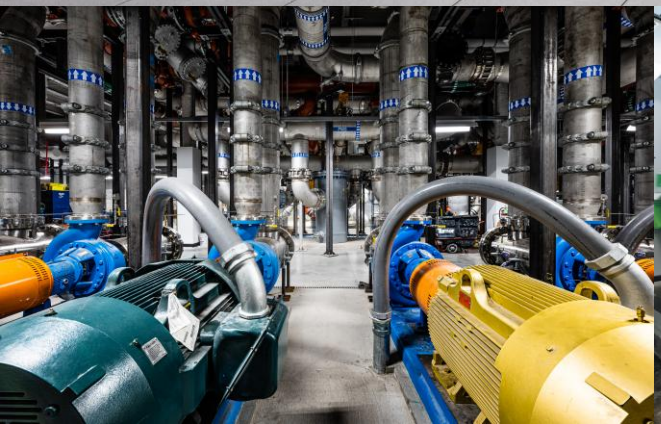
Programming Models
Intel oneAPI, MPI, OpenMP, C/C++, Fortran, SYCL/DPC++

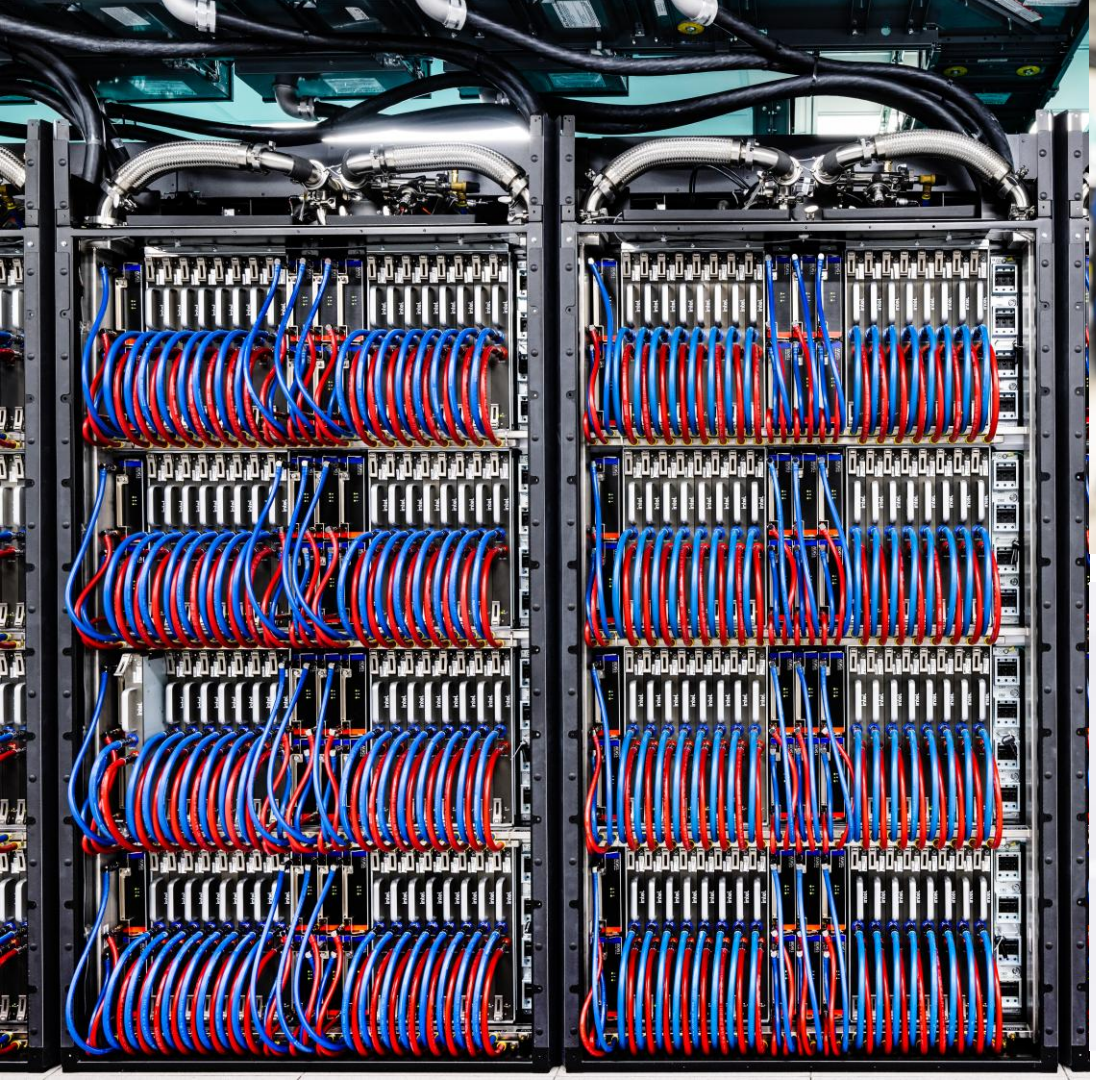
Node Performance
>130 TF

System Size
10,624 nodes, 166 compute racks
CPUs: 21,248
GPUs: 63,744




Aurora






intel.
intel.
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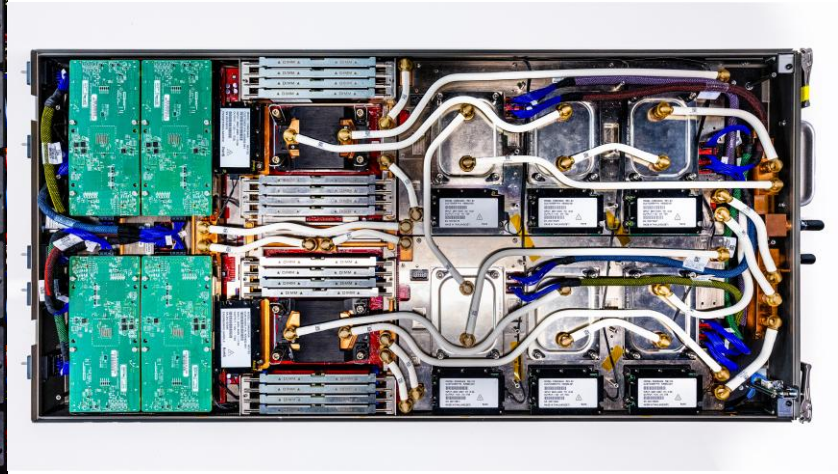
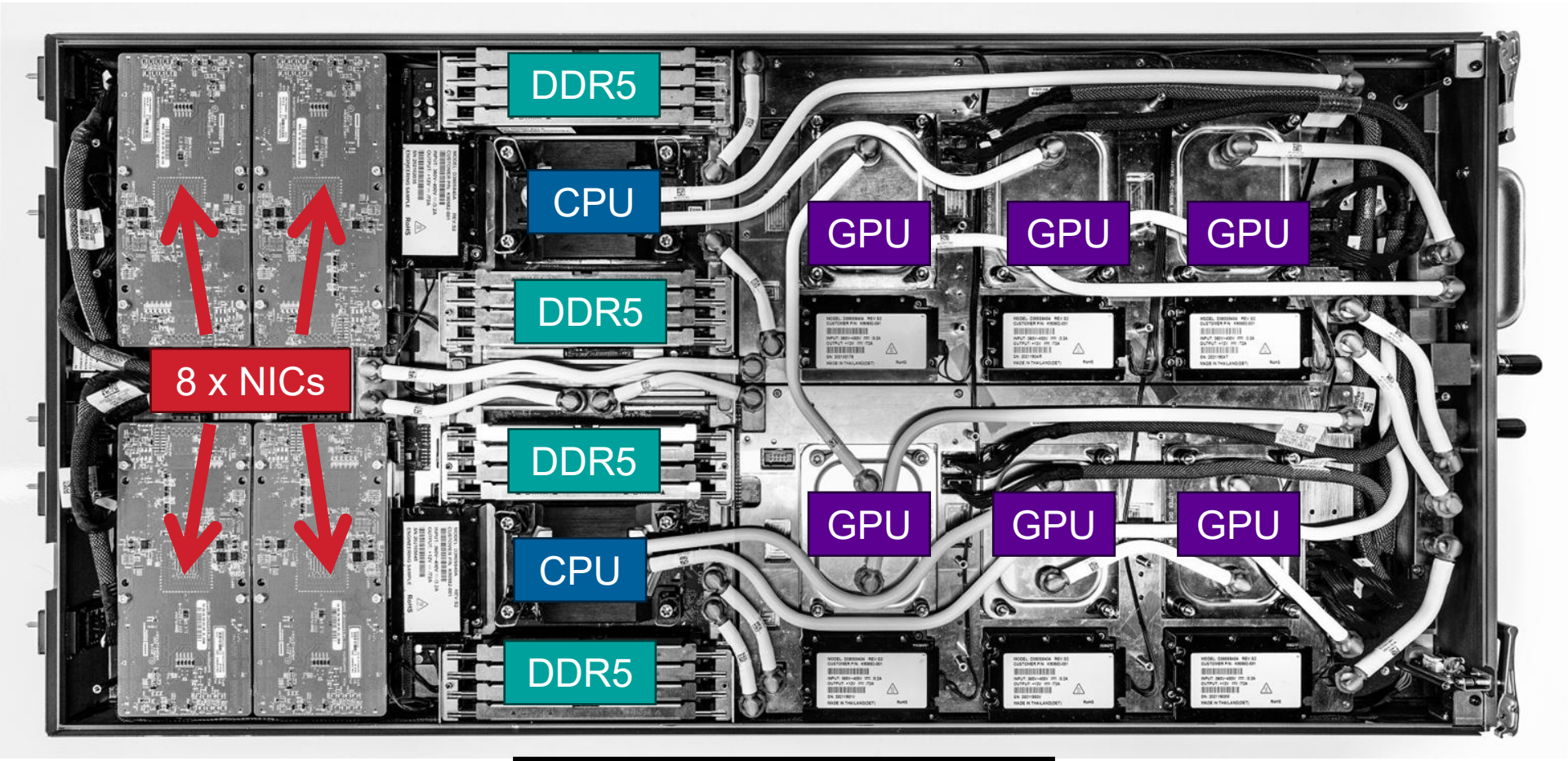
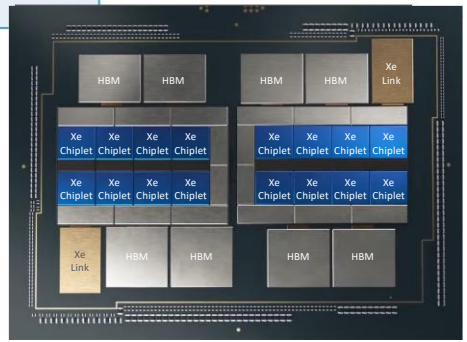




NODUS COMPUTANDI AURORAE
(Aurora Compute Node)

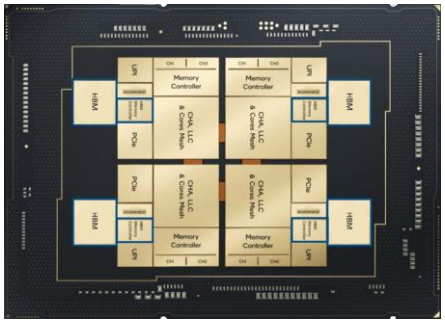
NODE CHARACTERISTICS

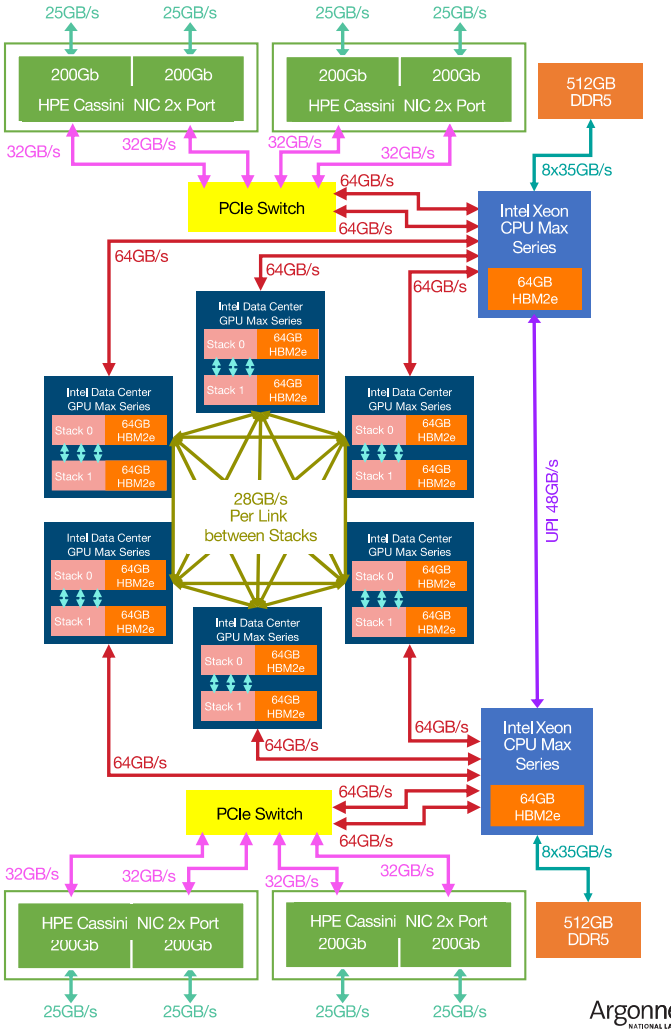
NODE CHARACTERISTICS	
6	GPU - Intel Data Center GPU Max Series (#)
2	CPU - Intel Xeon CPU Max Series (#)
768	GPU HBM Memory (GB)
19.66	Peak GPU HBM BW (TB/s)
128	CPU HBM Memory (GB)
2.87	Peak CPU HBM BW (TB/s)
1024	CPU DDR5 Memory (GB)
0.56	Peak CPU DDR5 BW (TB/s)
≧ 130	Peak Node DP FLOPS (TF)
200	Max Fabric Injection (GB/s)
8	NICs (#)



Intel® Data Center GPU Max

Intel® Xeon Max Series CPU with HBM





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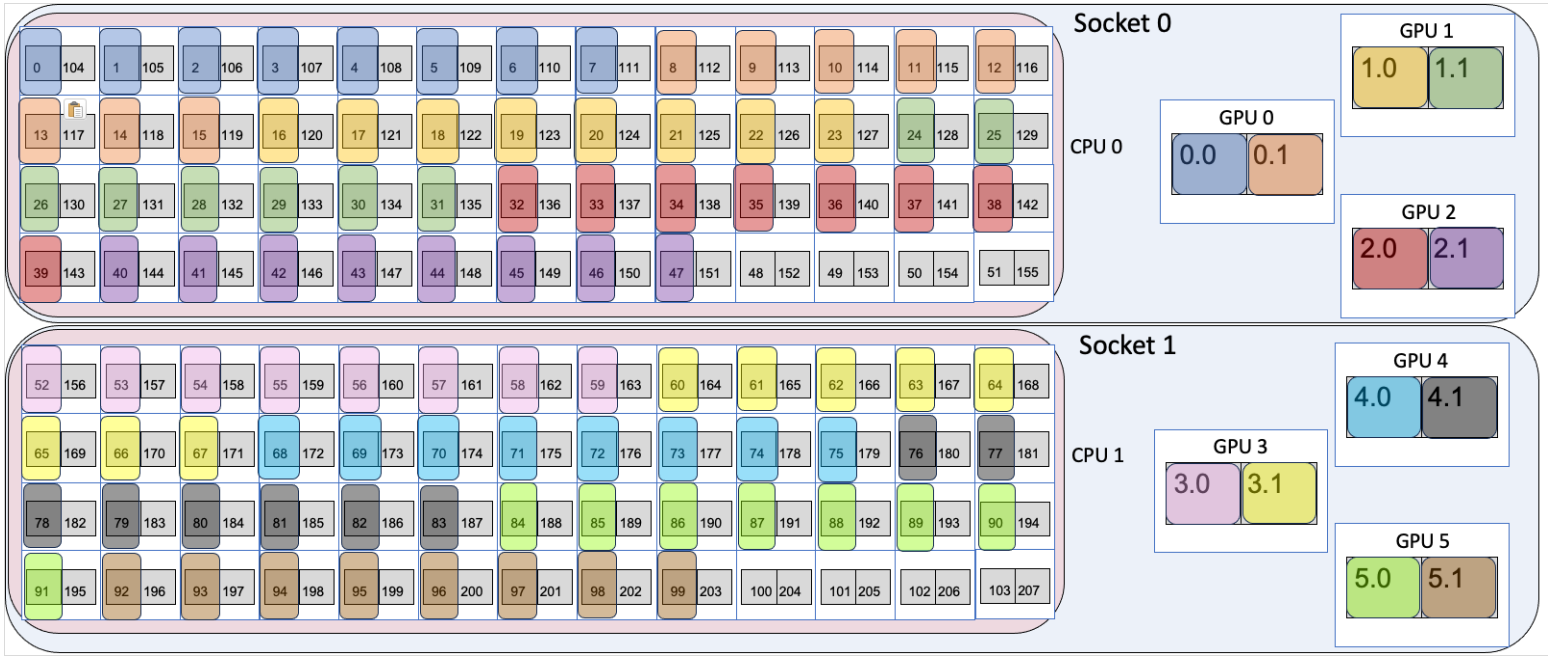
LOGICAL VIEW OF HARDWARE



A logical view of compute node hardware from an application perspective.
Though not quite correct, we can think of the compute blade as consisting of two sockets, each having a 52-core CPU and 3 GPUs. Each CPU core supports 2 hyperthreads. The GPUs physically consist of two tiles with a fast interconnect and many applications may be benefit by binding processes to individual tiles as indicated by the color assignments (one of many possibilities).

LOGGING IN

ssh <username>@aurora.alcf.anl.gov

You will be prompted for your password, which is a six digit code generated uniquely each time using the MobilePASS+ app or a physical token (if you have one).

<username>@aurora-uan-0012:~>

FILESYSTEM

/home/<username>

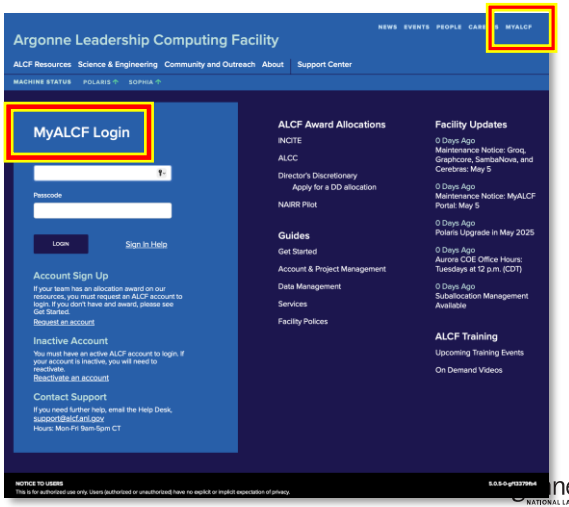
/lus/flare/projects/<project-name>

Users should use project spaces for large scale storage and software installations. Increases can be requested via support@alcf.anl.gov.

TIPS

myprojectquotas

MyALCF



GETTING TO KNOW THE ENVIRONMENT

ALCF uses Environment Modules to provide users with loadable software packages. This includes compilers, python installations, and other software. Here are some basic commands:

```
module list
```

```
module avail
```

By default, MODULEPATH only includes system libraries from Intel/HPE. One can include pre-built modules from ALCF staff by adding the path /soft/modulefiles to MODULEFILE using either of these commands:

```
export MODULEPATH=$MODULEPATH:/soft/modulefiles
# OR
module use /soft/modulefiles
```

Loading modules

```
module load cmake
```

Using Spack

Spack is an HPC oriented build management system. In this case of this quick introduction, Spack is simply used to offer additional pre-compiled software.
On Aurora, these additional spack packages are made available by default from the /soft/modulefiles area:

```
module use /soft/modulefiles
```

OUTPUT

```
mgarcia@x4516c2s0b0n0:~> module list

Currently Loaded Modules:
  1) gcc-runtime/13.3.0-ghotoln (H)   7) libiconv/1.17-jjpb4sl         (H)  13) cray-pals/1.4.0
  2) gmp/6.3.0-mtokfaw          (H)   8) libxml2/2.13.5                     14) cray-libpals/1.4.0
  3) mpfr/4.2.1-gkcdl5w         (H)   9) hwloc/2.11.3-mpich-level-zero      15) xpu-smi/1.2.39
  4) mpc/1.3.1-rdrlvsl          (H)  10) yaksa/0.3-7ks5f26            (H)  16) forge/24.1.2
  5) gcc/13.3.0                      11) mpich/opt/develop-git.6037a7a
  6) oneapi/release/2025.0.5         12) libfabric/1.22.0

  Where:
   H:  Hidden Module
```

```
mgarcia@x4516c2s0b0n0:~  module load cmake
mgarcia@x4516c2s0b0n0:~  module list

Currently Loaded Modules:
  1) gcc-runtime/13.3.0-ghotoln (H)   7) libiconv/1.17-jjpb4sl         (H)  13) cray-pals/1.4.0
  2) gmp/6.3.0-mtokfaw          (H)   8) libxml2/2.13.5                     14) cray-libpals/1.4.0
  3) mpfr/4.2.1-gkcdl5w         (H)   9) hwloc/2.11.3-mpich-level-zero      15) xpu-smi/1.2.39
  4) mpc/1.3.1-rdrlvsl          (H)  10) yaksa/0.3-7ks5f26            (H)  16) forge/24.1.2
  5) gcc/13.3.0                      11) mpich/opt/develop-git.6037a7a        17) gmake/4.4.1
  6) oneapi/release/2025.0.5         12) libfabric/1.22.0                     18) cmake/3.30.5

  Where:
   H:  Hidden Module
```

```
mgarcia@x4516c2s0b0n0:~> module avail

------------------------------------------ /soft/modulefiles ------------------------------------------
   alcf-reframe/alcf-reframe                      daos/base
   ascent/develop/2025-03-19-c1f63e7-openmp       daos_ops/base_old_pre_DAOS_15236_advice
   ascent/develop/2025-03-19-c1f63e7-sycl   (D)   daos_ops/base                          (D)
   bbfft/2022.12.30.003/eng-compiler/bbfft        daos_perf/base
   chipStar/1.2.1                                 daos_real_user/base
   chipStar/latest-math                           headers/cuda/12.0.0
   chipStar/latest-static                         jax/0.4.4
   chipStar/testing                               jax/0.4.25                             (D)
   codee/2024.4.5                                 libraries/libdrm-devel/2.4.104-1.12
   codee/2025.1                                   paraview/paraview-5.13.2
   codee/2025.1.2                                 tau/modulepath
   codee/2025.1.3                                 visit/visit-3.4.2
   codee/2025.2                             (D)

---- /opt/aurora/24.347.0/spack/unified/0.9.2/install/modulefiles/mpich/develop-git.6037a7a-sxnhr7p/oneapi/2025.0.5 ----
   adios/1.13.1                   hdf5-vol-async/1.7        parallel-netcdf/1.12.3
   adios2/2.10.2-cpu              hdf5/1.14.5               petsc/3.21.4-cpu
   adios2/2.10.2-sycl       (D)   heffte/2.4.1-cpu          pumi/2.2.9
   amrex/24.11-sycl               hypre/2.33.0-sycl         py-mpi4py/4.0.1
   boost/1.84.0                   launchmon/1.2.0           spindle/0.13
   cabana/0.7.0-omp-sycl          mpifileutils/0.11.1       stat/develop-git.5aa0d93
   copper/main                    netcdf-c/4.9.2            superlu-dist/9.1.0
   darshan-runtime/3.4.6          netcdf-cxx4/4.3.1         umpire/2024.07.0-omp
   fftw/3.3.10                    netcdf-fortran/4.6.1      valgrind/3.24.0
   geopm-runtime/3.1.0-omp        netlib-scalapack/2.2.0

--------------------- /opt/aurora/24.347.0/spack/unified/0.9.2/install/modulefiles/Core ----------------------
lines 1-29
```

USING THE AURORA JOB SCHEDULER: PBS

https://github.com/argonne-lcf/ALCFBeginnersGuide/blob/master/aurora/00_scheduler.md

Aurora uses the PBS scheduler similar to other ALCF systems, such as Polaris. PBS is a third-party product that comes with extensive documentation. This is an introduction, not an extensive tutorial so we will only cover some basics.

Running interactively

qsub -I -l select=1 -l walltime=00:60:00 -l filesystems=home:flare -A **<your-project-name>** -q **<queue-name>**

module load xpu-smi

xpu-smi discovery

Some tests

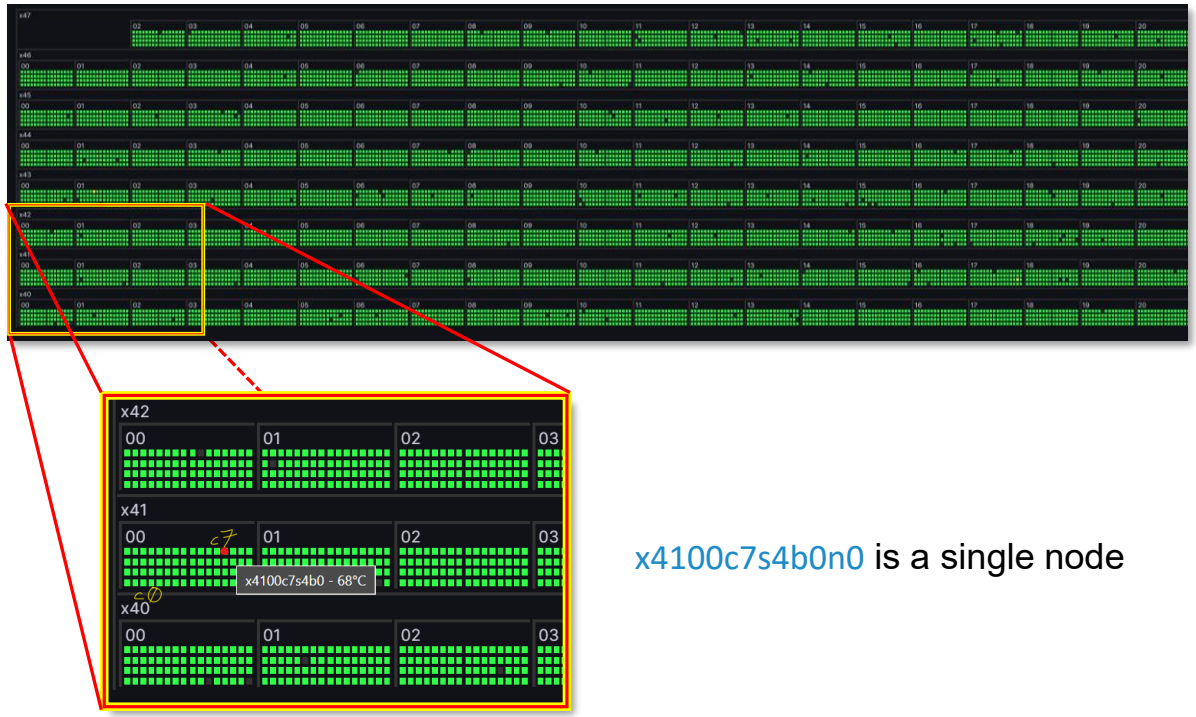
cd /lus/flare/projects/<your_project_name>/alcf_hands_on_workshop

git clone https://github.com/argonne-lcf/GettingStarted

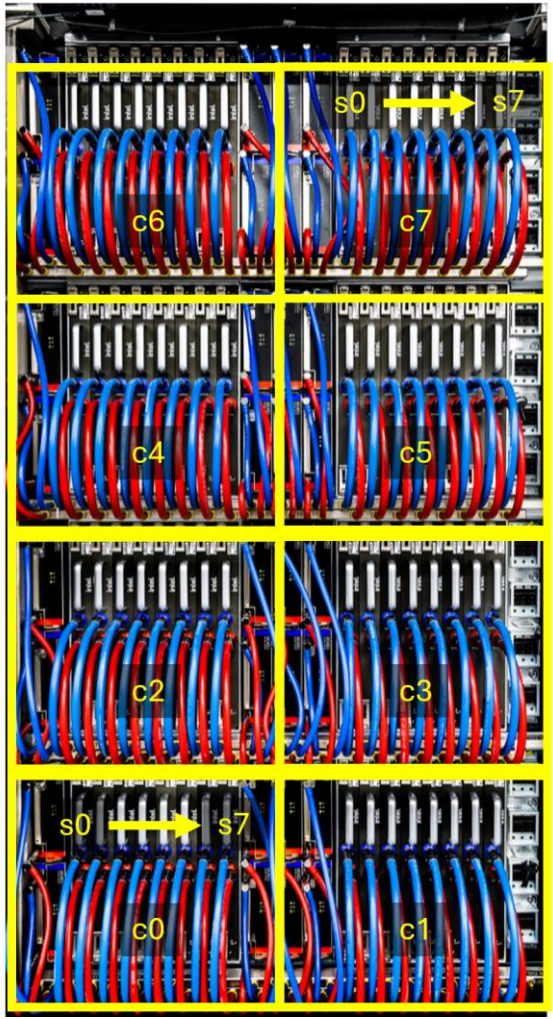
```
mgarcia@x4516c2s0b0n0:~> ls /lus/flare/projects/gpu_hack/alcf_training/examples/
00_hello_world.sh             01_example_openmp.sh         02_tools_example  HelperScripts
01_example.cpp                01_example_sycl_affinity.sh  04_AI_frameworks  logs
01_example_openmp_affinity.sh 01_example_sycl.cpp          copper_example
01_example_openmp.cpp         01_example_sycl.sh           daos_example
```

chmod u+x 00_hello_world.sh

AURORA NODES NAME CONVENTION



x4100c7s4b0n0 is a single node



x4100c7s4b0n0 == Rack x4100 Chassis c7 Slot s4 Board b0 Node n0

never changes on Aurora
(board 0, node 0)

USING THE AURORA JOB SCHEDULER: PBS

Submit your first job

The more standard method for running a job is to submit it to the scheduler via qsub with a script that will execute your job without you needing to login to the worker nodes. Let's walk through an example.

First we need to create a job script (example: examples/00_hello_world.sh):

```
#!/bin/bash -l
#PBS -l select=1
#PBS -l walltime=00:30:00
#PBS -q debug
#PBS -l filesystems=home:flare
#PBS -A <project-name>
#PBS -o logs/
#PBS -e logs/

GPUS_PER_NODE=6

mpiexec -n $GPUS_PER_NODE -ppn $GPUS_PER_NODE echo Hello World
```

NOTE

You'll notice we can use the #PBS line prefix at the top of our script to set qsub command line options. We can still use the command line to override the options in the script.

NOTE

*Here we used **-o logs/** and **-e logs/** which just redirects the STDOUT(**-o**) and the STDERR(**-e**) log files from the job into the **logs/** directory to keep things tidy. The **logs** directory must exist before the job is submitted.*

```
chmod u+x job_script.sh

qsub job_script.sh
```

USING THE AURORA JOB SCHEDULER: PBS

Monitor your job

```
qstat –u <username>
```

Without specifying the username we will get a full print out of every job queued and running. This can be overwhelming so using the username reduces the output to jobs for just that username. Adding alias qsme='qstat -u <username>' to your .bashrc is a nice shortcut.

Delete your job

```
qdel <jobID>
```

Job output

Any job STDOUT or STDERR output will go into two different files that by default are named:

```
<script_name>.o<pbs-job-id>
<script_name>.e<pbs-job-id>
```

In our example submit script, we specify -o logs/ and -e logs/ so that the files go into the logs/ directory. In that case, the output files are named differently:

```
logs/${PBS_JOBID}.ER
logs/${PBS_JOBID}.OU
```

OUTPUT

```
mgarcia@x4516c2s0b0n0:~> xpu-smi discovery
+-----------+--------------------------------------------------------------------------------------+
| Device ID | Device Information                                                                   |
+-----------+--------------------------------------------------------------------------------------+
| 0         | Device Name: Intel(R) Data Center GPU Max 1550                                       |
|           | Vendor Name: Intel(R) Corporation                                                    |
|           | SOC UUID: 00000000-0000-0000-e1c3-1c0d8a8e9392                                       |
|           | PCI BDF Address: 0000:18:00.0                                                        |
|           | DRM Device: /dev/dri/card0                                                           |
|           | Function Type: physical                                                              |
+-----------+--------------------------------------------------------------------------------------+
| 1         | Device Name: Intel(R) Data Center GPU Max 1550                                       |
|           | Vendor Name: Intel(R) Corporation                                                    |
|           | SOC UUID: 00000000-0000-0000-46e0-d0969a8e940e                                       |
|           | PCI BDF Address: 0000:42:00.0                                                        |
|           | DRM Device: /dev/dri/card1                                                           |
|           | Function Type: physical                                                              |
+-----------+--------------------------------------------------------------------------------------+
| 2         | Device Name: Intel(R) Data Center GPU Max 1550                                       |
|           | Vendor Name: Intel(R) Corporation                                                    |
|           | SOC UUID: 00000000-0000-0000-df0a-686d0813f2f8                                       |
|           | PCI BDF Address: 0000:6c:00.0                                                        |
|           | DRM Device: /dev/dri/card2                                                           |
|           | Function Type: physical                                                              |
+-----------+--------------------------------------------------------------------------------------+
| 3         | Device Name: Intel(R) Data Center GPU Max 1550                                       |
|           | Vendor Name: Intel(R) Corporation                                                    |
|           | SOC UUID: 00000000-0000-0000-60b5-7aa827b18071                                       |
|           | PCI BDF Address: 0001:18:00.0                                                        |
|           | DRM Device: /dev/dri/card3                                                           |
|           | Function Type: physical                                                              |
+-----------+--------------------------------------------------------------------------------------+
| 4         | Device Name: Intel(R) Data Center GPU Max 1550                                       |
|           | Vendor Name: Intel(R) Corporation                                                    |
|           | SOC UUID: 00000000-0000-0000-b684-572f3c35f00f                                       |
|           | PCI BDF Address: 0001:42:00.0                                                        |
|           | DRM Device: /dev/dri/card4                                                           |
|           | Function Type: physical                                                              |
+-----------+--------------------------------------------------------------------------------------+
| 5         | Device Name: Intel(R) Data Center GPU Max 1550                                       |
|           | Vendor Name: Intel(R) Corporation                                                    |
|           | SOC UUID: 00000000-0000-0000-3695-0a03c5be4597                                       |
|           | PCI BDF Address: 0001:6c:00.0                                                        |
|           | DRM Device: /dev/dri/card5                                                           |
|           | Function Type: physical                                                              |
+-----------+--------------------------------------------------------------------------------------+
```

Submit a job

```
mgarcia@x4516c2s0b0n0:~/gpu_hack/My_Tests> qsub -A gpu_hack -q gpu_hack_prio job_script.sh
4673810.aurora-pbs-0001.hostmgmt.cm.aurora.alcf.anl.gov
mgarcia@x4516c2s0b0n0:~/gpu_hack/My_Tests> qstat -u mgarcia

aurora-pbs-0001.hostmgmt.cm.aurora.alcf.anl.gov:

                                                                  Req'd  Req'd   Elap
Job ID                  Username Queue    Jobname    SessID NDS TSK Memory Time  S Time
----------------------- -------- -------- ---------- ------ --- --- ------ ----- - -----
4673776.aurora-pbs-* mgarcia  gpu_hac* STDIN      137497   1 208    --  01:00 R 00:26
4673810.aurora-pbs-* mgarcia  gpu_hac* job_scrip*    --    1 208    --  00:05 Q   --
```

Remember to create the directory logs

```
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests/logs> ls -ltr
total 4
-rw-r--r-- 1 mgarcia users  0 May  6 09:34 4673810.aurora-pbs-0001.hostmgmt.cm.aurora.alcf.anl.gov.ER
-rw-r--r-- 1 mgarcia users 72 May  6 09:34 4673810.aurora-pbs-0001.hostmgmt.cm.aurora.alcf.anl.gov.OU
```

```
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests/logs> more 4673810.aurora-pbs-0001.hostmgmt.cm.aurora.alcf.anl.gov.OU
Hello World
Hello World
Hello World
Hello World
Hello World
Hello World
```

PBS CHEATSHEET

User Commands

Command	Description
`qsub`	Submit a job
`qsub -I`	Submit an interactive job
`qstat <jobid>`	Job status
`qstat -Q`	Print Queue information
`qstat -B`	Cluster status
`qstat -x`	Job History
`qstat -f <jobid>`	Job status with all information
`qstat -ans`	Job status with comments and vnode info
`qhold <jobid>`	Hold a job
`qrls <jobid>`	Release a job
`pbsnodes -a`	Print node information
`pbsnodes -l`	Print nodes that are offline or down
`qdel <jobid>`	kill a job
`qdel -W force <jobid>`	Force kill a job
`qmove`	Moves PBS batch job between queues
`qalter`	Alters a PBS job
`pbs_rstat`	Shows status of PBS advance or standing reservations

QSUB Options

Option	Description
`-P project_name`	Specifying a project name
`-q destination`	Specifying queue and/or server
`-r value`	Marking a job as rerunnable or not
`-W depend = list`	Specifying job dependencies
`-W stagein=list stageout=list`	Input/output file staging
`-W sandbox=<value>`	Staging and execution directory: user's home vs. job-specific
`-a date_time`	Deferring execution
`-c interval`	Specifying job checkpoint interval
`-e path`	Specifying path for output and error files
`-h`	Holding a job (delaying execution)
`-J X-Y[:Z}`	Defining job array
`-j join`	Merging output and error files
`-k keep`	Retaining output and error files on execution host
`-l resource_list`	Requesting job resources
`-M user_list`	Setting email recipient list
`-m MailOptions`	Specifying email notification
`-N name`	Specifying a job name
`-o path`	Specifying path for output and error files

PBS CHEATSHEET

Environment Variables

Your job will have access to these environment variables

Option	Description
`PBS_JOBID`	Job identifier given by PBS when the job is submitted. Created upon execution
`PBS_JOBNAME`	Job name given by user. Created upon execution
`PBS_NODEFILE`	The filename containing a list of vnodes assigned to the job.
`PBS_O_WORKDIR`	Absolute path to directory where qsub is run. Value taken from user's submission environment.
`TMPDIR`	Pathname of job's scratch directory
`NCPUS`	Number of threads, defaulting to number of CPUs, on the vnode
`PBS_ARRAY_ID`	Identifier for job arrays. Consists of sequence number.
`PBS_ARRAY_INDEX`	Index number of subjob in job array.
`PBS_JOBDIR`	Pathname of job's staging and execution directory on the primary execution host.

COMPILERS ON AURORA

https://github.com/argonne-lcf/ALCFBeginnersGuide/blob/master/aurora/01_compilers.md

This section describes how to compile C/C++ code standalone, with SYCL and OpenMP, and with MPI.

Specifically, it introduces the Intel software environment for compiling system compatible codes. The same flags apply to Fortran applications as well.

User is assumed to know:

- how to compile and run code
- basic familiarity with MPI
- basic familiarity with SYCL and/or OpenMP

Learning Goals:

- MPI compiler wrappers for oneAPI C/C++/FORTRAN compilers
- How to compile a C++ code
- How to compile a C++ code with SYCL and MPI
- How to compile a C++ code with OpenMP and MPI
- How to control CPU and GPU affinities in job scripts

COMPILING C/C++/FORTRAN CODE

When you first login to Aurora, there will be a default list of loaded modules (see them with module list). This includes the oneAPI suite of compilers, libraries, and tools and MPICH. It is recommended to use the MPI compiler wrappers for building applications:

- mpicc - C compiler (use it like oneAPI icx or GNU gcc)
- mpicxx - C++ compiler (use it like oneAPI icpx or GNU g++)
- mpif90 - Fortran compiler (use it like oneAPI ifx or GNU gfortran)

Polaris uses Cray MPI compiler wrappers which follow a different naming convection

Next an example C++ code is compiled.

Example code: 01_example.cpp

```
#include <iostream>

int main(void){

   std::cout << "Hello World!\n";
   return 0;
}
```

Build and run on an Aurora login node or worker node

```
mpicxx 01_example.cpp -o 01_example

./01_example
```

NOTE

This example only uses the CPU. A GPU programming model, such as SYCL, OpenMP, or OpenCL (or HIP) is required to use the GPU.

COMPILING C/C++ WITH OPENMP

Users have the choice when compiling GPU-enabled applications to compile the GPU kernels at link-time or at runtime.

Compiling the kernels while linking the application is referred to **Ahead-Of-Time (AOT)** compilation.
Delaying the compilation of GPU kernels to runtime is referred to as **Just-In-Time (JIT)** compilation.

AOT
- Compile: -fiopenmp -fopenmp-targets=spir64_gen
- Link: -fiopenmp -fopenmp-targets=spir64_gen -Xopenmp-target-backend "-device pvc".

JIT
- Compile: -fiopenmp -fopenmp-targets=spir64
- Link: -fiopenmp -fopenmp-targets=spir64

Both options are available to users, though we recommend using AOT to reduce overhead of starting the application.
The examples that follow use AOT compilation.

Example code: 01_example_openmp.cpp

```
mpicxx -fiopenmp -fopenmp-targets=spir64_gen -c 01_example_openmp.cpp

mpicxx -o 01_example_openmp -fiopenmp -fopenmp-targets=spir64_gen -Xopenmp-target-backend "-device pvc"
01_example_openmp.o
```

```
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests> mpicxx -fiopenmp -fopenmp-targets=spir64_gen -c 01_example_openmp.cpp

mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests>
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests> mpicxx -o 01_example_openmp -fiopenmp -fopenmp-targets=spir64_gen -Xopenmp-target-backend "-device pvc" 01_example_openmp.o
Compilation from IR - skipping loading of FCL
Build succeeded.
```

COMPILING C/C++ WITH OPENMP

Running the code: 01_example_openmp.cpp

```
mgarcia@aurora-uan-0009:~> which icpx
/opt/aurora/24.347.0/oneapi/compiler/latest/bin/icpx
```

```
mgarcia@aurora-uan-0009:~> icpx --version
Intel(R) oneAPI DPC++/C++ Compiler 2025.0.4 (2025.0.4.20241205)
Target: x86_64-unknown-linux-gnu
Thread model: posix
InstalledDir: /opt/aurora/24.347.0/oneapi/compiler/2025.0/bin/compiler
Configuration file: /opt/aurora/24.347.0/oneapi/compiler/2025.0/bin/compiler/../icpx.cfg
```

```
#!/bin/bash -l
#PBS -l select=1
#PBS -l walltime=00:10:00
#PBS -q debug
#PBS -A <project-name>
#PBS -l filesystems=home:flare
#PBS -o logs/
#PBS -e logs/

cd ${PBS_O_WORKDIR}

mpiexec -n 1 --ppn 1 ./01_example_openmp
```

Submit your job: qsub -A <project-name> -q <queue-name> 01_example_openmp.sh

```
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests> qsub -A gpu_hack -q gpu_hack_prio 01_example_openmp.sh
4673830.aurora-pbs-0001.hostmgmt.cm.aurora.alcf.anl.gov
```

The output should look like this in the logs/<jobID>.<hostname>.OU file:

```
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests> more logs/4673830.aurora-pbs-0001.hostmgmt.cm.aurora.alcf.anl.gov.OU
# of devices= 6
Rank 0 on host 6 running on GPU 0!
Using double-precision

Result is CORRECT!! :)
```

COMPILING C/C++ WITH SYCL

Now you can compile your C/C++ with SYCL code. Users again have the choice of JIT or AOT compilation.

AOT
- Compile: --intel -fsycl -fsycl-targets=spir64_gen
- Link: --intel -fsycl -fsycl-targets=spir64_gen -Xsycl-target-backend "-device pvc"

JIT
- Compile: --intel -fsycl -fsycl-targets=spir64
- Link: --intel -fsycl -fsycl-targets=spir64

```
mpicxx --intel -fsycl  -fsycl-targets=spir64_gen -c 01_example_sycl.cpp

mpicxx -o 01_example_sycl --intel -fsycl  -fsycl-targets=spir64_gen -Xsycl-target-backend "-device pvc" 01_example_sycl.o
```

Running the code: 01_example_sycl.cpp

Submit your job: qsub -A <project-name> -q <queue-name> 01_example_sycl.sh

```
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests> mpicxx --intel -fsycl  -fsycl-targets=spir64_gen -c 01_example_sycl.cpp
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests> mpicxx -o 01_example_sycl --intel -fsycl  -fsycl-targets=spir64_gen -Xsycl-target-backend "-device pvc" 01_example_sycl.o
Compilation from IR - skipping loading of FCL
Build succeeded.
mgarcia@aurora-uan-0009:~/gpu_hack/My_Tests> qsub -A gpu_hack -q gpu_hack_prio 01_example_sycl.sh
4673854.aurora-pbs-0001.hostmgmt.cm.aurora.alcf.anl.gov
```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