

# E4S: The Extreme-scale Scientific Software Stack Release 23.11



Release 23.11 notes

November 9, 2023

# E4S 23.11: What's New?

- E4S includes 120+ HPC packages on ARM, x86\_64, and ppc64le platforms, 110K+ binaries in E4S Spack Build Cache
- E4S includes new AI/ML packages: JAX, PyTorch, TensorFlow, Horovod, and LBANN. Updated Python tools including Jupyter notebook.
- E4S includes new applications: ExaGO and previously supported Xyce, Quantum Espresso, LAMMPS, WARPX, Dealii, and OpenFOAM
- E4S includes support for Intel oneAPI 2023.2.1 software (BaseKit and HPCToolkit) in containers on x86\_64 with support for HPC packages built with Intel compilers
- New solvers that support SYCL and Intel GPUs for the first time: PETSc, SUNDIALS, and SLATE.
- GPU support: ARM64 (aarch64) with H100 (90) with CUDA 12.1 and NVHPC 23.9
- E4S includes support for CUDA architectures
  - 80 (A100), and 90 (H100) under x86\_64
  - 70 under ppc64le (IBM Power 10)
  - 75, 80, and 90 (H100) under aarch64
- Updated E4S tools: Release 1.0 of e4s-alc (à la carte) customizes container images, e4s-cl (container launch) replaces MPI at runtime!
- New AWS E4S 23.11 image [ami-08c2daa0fb4864b90 in US-West-2 OR] with support for 50+ EDA tools with DCV and UPC++, CAF, and Chapel
- Adaptive Computing's ODDC platform for launching E4S images to AWS on multiple EFA enabled nodes using MVAPICH through a web browser
  - <https://youtu.be/kudLzNGE9sU>

# E4S: Extreme-scale Scientific Software Stack

- E4S is a community effort to provide open-source software packages for developing, deploying and running scientific applications on HPC platforms.
- E4S has built a comprehensive, coherent software stack that enables application developers to productively develop highly parallel applications that effectively target diverse exascale architectures.
- E4S provides a curated, Spack based software distribution of 120+ HPC, EDA (e.g., Xyce), and AI/ML packages (e.g., TensorFlow, PyTorch, JAX, Horovod, and LBANN).
- With E4S Spack binary build caches, E4S supports both bare-metal and containerized deployment for GPU based platforms.
  - X86\_64, ppc64le (IBM Power 10), aarch64 (ARM64) with support for GPUs from NVIDIA, AMD, and Intel
  - HPC and AI/ML packages are optimized for GPUs and CPUs.
- Container images on DockerHub and E4S website of pre-built binaries of ECP ST products.
- Base images and full featured containers (with GPU support) and DOE LLVM containers.
- Commercial support for E4S through ParaTools, Inc. for installation, maintaining an issue tracker, and ECP AD engagement.
  - <https://dashboard.e4s.io> [https://e4s.io/talks/E4S\\_Support\\_Oct23.pdf](https://e4s.io/talks/E4S_Support_Oct23.pdf)
- E4S for commercial cloud platforms: AWS image supports MPI implementations and containers with remote desktop (DCV).
  - Intel MPI, NVHPC, MVAPICH2, MPICH, MPC, OpenMPI
- e4s-cl container launch tool allows binary distribution of applications by substituting MPI in the containerized app with the system MPI.
- Quarterly releases: E4S 23.11 released on Nov 9, 2023: [https://e4s.io/talks/E4S\\_23.11.pdf](https://e4s.io/talks/E4S_23.11.pdf)

# Extreme-scale Scientific Software Stack (E4S)



- E4S: HPC Software Ecosystem – a curated software portfolio
- A **Spack-based** distribution of software tested for interoperability and portability to multiple architectures with support for GPUs from NVIDIA, AMD, and Intel in each release
- Available from **source, containers, cloud, binary caches**
- Leverages and enhances SDK interoperability thrust
- Not a commercial product – an open resource for all
- Oct 2018: E4S 0.1 - 24 full, 24 partial release products
- Jan 2019: E4S 0.2 - 37 full, 10 partial release products
- Nov 2019: E4S 1.0 - 50 full, 5 partial release products
- Feb 2020: E4S 1.1 - 61 full release products
- Nov 2020: E4S 1.2 (aka, 20.10) - 67 full release products
- Feb 2021: E4S 21.02 - 67 full release, 4 partial release
- May 2021: E4S 21.05 - 76 full release products
- Aug 2021: E4S 21.08 - 88 full release products
- Nov 2021: E4S 21.11 - 91 full release products
- Feb 2022: E4S 22.02 – 100 full release products
- May 2022: E4S 22.05 – 101 full release products
- August 2022: E4S 22.08 – 102 full release products
- November 2022: E4S 22.11 – 103 full release products
- February 2023: E4S 23.02 – 106 full release products
- May 2023: E4S 23.05 – 109 full release products
- Aug 2023: E4S 23.08 – 115 full release products
- Nov 2023: E4S 23.11 – 120 full release products

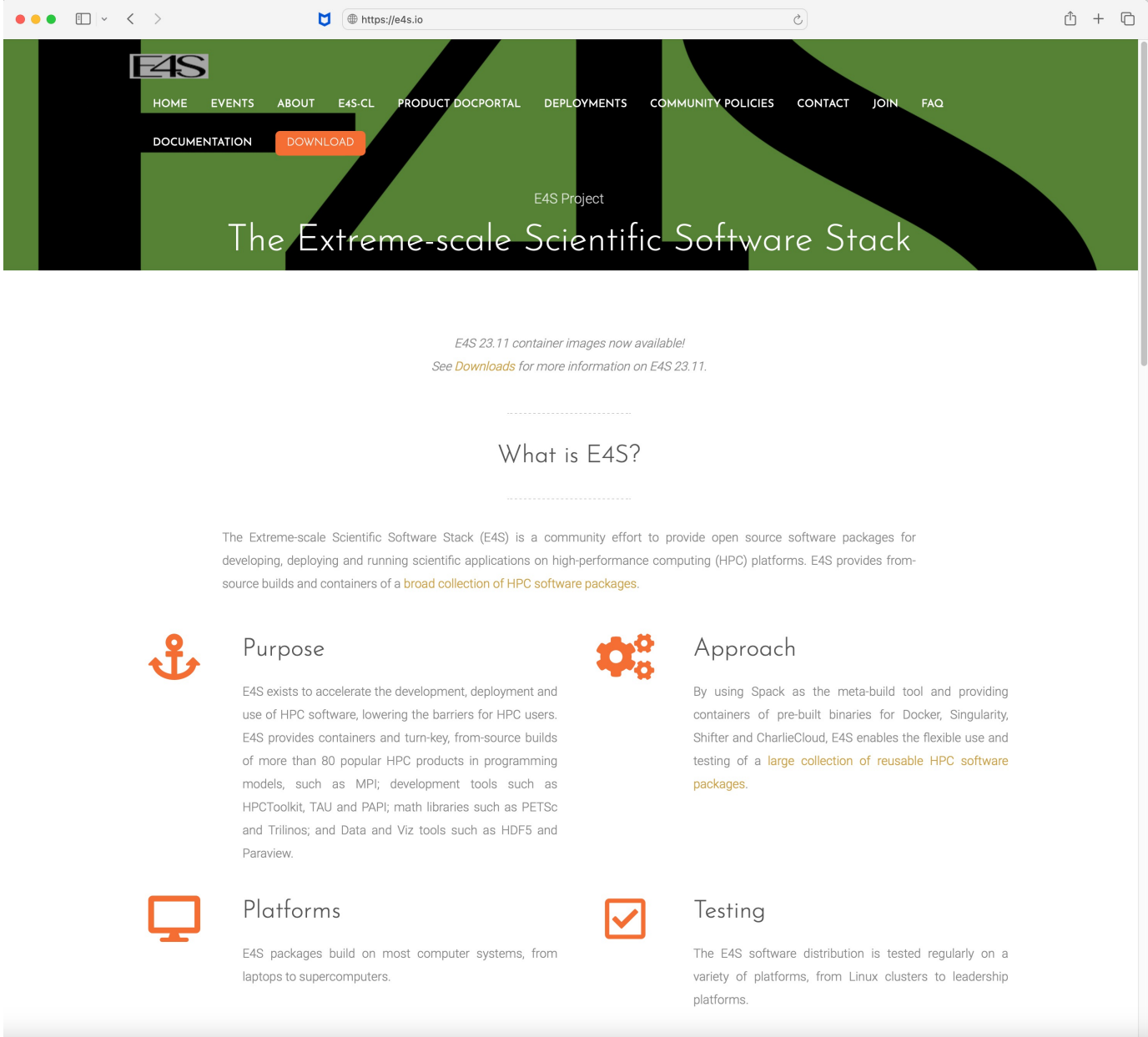


<https://e4s.io>

Lead: Sameer Shende  
(U Oregon)

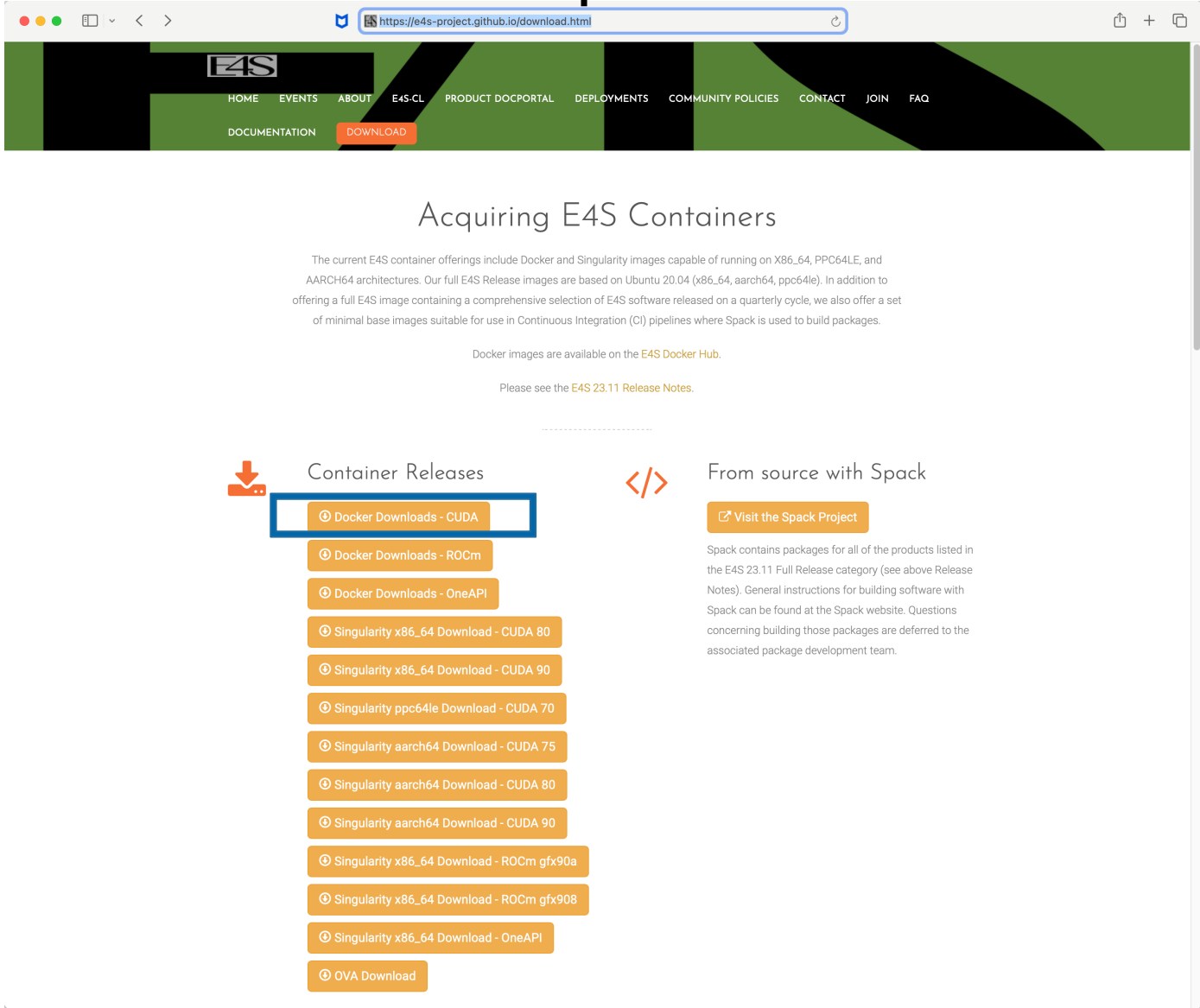
Also include other products .e.g.,  
AI: JAX, PyTorch, TensorFlow, Horovod, LBANN  
Co-Design: AMReX, Cabana, MFEM  
EDA: Xyce

# E4S Download from https://e4s.io



The screenshot shows the E4S website homepage. At the top, there is a navigation menu with links for HOME, EVENTS, ABOUT, E4S-CL, PRODUCT DOCPORTAL, DEPLOYMENTS, COMMUNITY POLICIES, CONTACT, JOIN, and FAQ. Below the navigation is a secondary menu with DOCUMENTATION and a prominent orange DOWNLOAD button. The main header features the E4S logo and the text "E4S Project" and "The Extreme-scale Scientific Software Stack". A central announcement states "E4S 23.11 container images now available!" with a link to "Downloads". Below this is a section titled "What is E4S?" which describes the project as a community effort to provide open source software packages for HPC. The page is divided into four columns, each with an icon and a title: Purpose (anchor icon), Approach (gears icon), Platforms (monitor icon), and Testing (checkmark icon). Each column contains a brief description of that aspect of the project.

# E4S Container Download from https://e4s.io



- Separate full featured Singularity images for 3 GPU architectures
- GPU full featured images for
  - x86\_64 (Intel, AMD, NVIDIA)
  - ppc64le (NVIDIA)
  - aarch64 (NVIDIA)
- Full featured images available on Dockerhub
- 120+ products on 3 architectures

# Download E4S 23.11 GPU Container Images: AMD, Intel, and NVIDIA

Note on Container Images

Container images contain binary versions of the Full Release packages listed above. Full-featured GPU-enabled container images are available from Dockerhub:

```
# docker pull ecpe4s/e4s-cuda:23.11
# docker pull ecpe4s/e4s-rocm:23.11
# docker pull ecpe4s/e4s-oneapi:23.11
```

## E4S Full GPU Images

These images contain a full Spack-based deployment of E4S, including GPU-enabled packages for NVIDIA, AMD, or Intel GPUs.

These images also contain TensorFlow, PyTorch, and TAU.

AMD ROCm (x86_64)	NVIDIA CUDA (X86_64, PPC64LE, AARCH64)	Intel OneAPI (x86_64)
ecpe4s/e4s-rocm:23.11	ecpe4s/e4s-cuda:23.11	ecpe4s/e4s-oneapi:23.11
e4s-rocm90a-x86_64-23.11.sif  mirror 1	e4s-cuda80-x86_64-23.11.sif  mirror 1	e4s-oneapi-x86_64-23.11.sif  mirror 1
e4s-rocm908-x86_64-23.11.sif  mirror 1	e4s-cuda90-x86_64-23.11.sif  mirror 1	
	e4s-cuda90-ppc64le-23.11.sif  mirror 1	
	e4s-cuda70-ppc64le-23.11.sif  mirror 1	
	e4s-cuda75-aarch64-23.11.sif  mirror 1	
	e4s-cuda80-aarch64-23.11.sif  mirror 1	
	e4s-cuda90-aarch64-23.11.sif  mirror 1	

# E4S base container images allow users to customize their containers

The screenshot shows a web browser window with the URL <https://e4s-project.github.io/download.html>. The page is titled "GPU Base Images" and contains the following content:

These images come with MPICH, CMake, and the relevant GPU SDK – either AMD ROCm, NVIDIA CUDA Toolkit and NVHPC, or Intel OneAPI.

**AMD ROCM (X86\_64)**

- ecpe4s/e4s-base-rocm:23.11
- e4s-base-rocm-23.11.sif mirror 1

**NVIDIA Multi-Arch (X86\_64, PPC64LE, AARCH64)**

- ecpe4s/e4s-base-cuda:23.11 (highlighted with a blue box)
- e4s-base-cuda-x86\_64-23.11.sif mirror 1
- e4s-base-cuda-aarch64-23.11.sif mirror 1
- e4s-base-cuda-ppc64le-23.11.sif mirror 1

**Intel OneAPI (X86\_64)**

- ecpe4s/e4s-base-oneapi:23.11
- e4s-base-oneapi-23.11.sif mirror 1

**Minimal Spack**

This image contains a minimal setup for using Spack 0.21.0 w/ GNU compilers

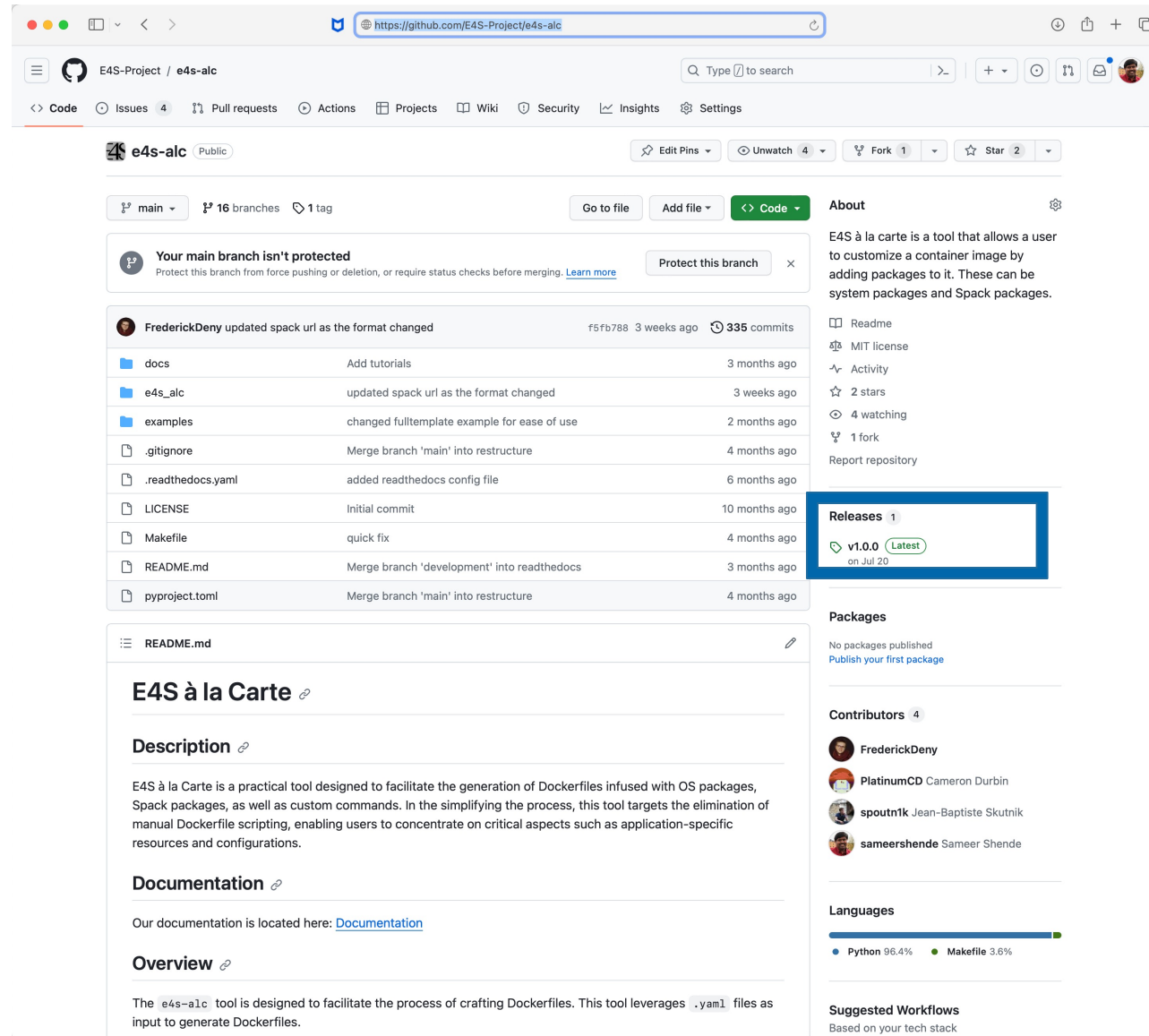
**X86\_64, PPC64LE, AARCH64**

- ecpe4s/ubuntu20.04
- ecpe4s-ubuntu20.04-x86\_64-23.11.sif mirror 1
- ecpe4s-ubuntu20.04-ppc64le-23.11.sif mirror 1
- ecpe4s-ubuntu20.04-aarch64-23.11.sif mirror 1

- Intel oneAPI
- AMD ROCm
- NVIDIA NVHPC and CUDA



# e4s-alc: a new tool to customize container images. Version 1.0



The screenshot displays the GitHub repository for E4S-Project/e4s-alc. The repository is public and has 16 branches and 1 tag. The main branch is not protected. The repository contains several files and folders, including docs, e4s\_alc, examples, .gitignore, .readthedocs.yaml, LICENSE, Makefile, README.md, and pyproject.toml. The README.md file is highlighted, showing the title "E4S à la Carte" and a description of the tool. The description states that E4S à la Carte is a practical tool designed to facilitate the generation of Dockerfiles infused with OS packages, Spack packages, as well as custom commands. In the simplifying the process, this tool targets the elimination of manual Dockerfile scripting, enabling users to concentrate on critical aspects such as application-specific resources and configurations. The documentation link is provided as [Documentation](#). The overview section states that the e4s-alc tool is designed to facilitate the process of crafting Dockerfiles. This tool leverages .yaml files as input to generate Dockerfiles. The right sidebar shows the repository's statistics, including 2 stars, 4 watchers, and 1 fork. The releases section is highlighted with a blue box, showing version v1.0.0 as the latest release on Jul 20. The packages section shows no packages published. The contributors section lists 4 contributors: FrederickDeny, PlatinumCD Cameron Durbin, spoutn1k Jean-Baptiste Skutnik, and sameershende Sameer Shende. The languages section shows Python at 96.4% and Makefile at 3.6%. The suggested workflows section is based on the user's tech stack.

Add to a base image:

- Spack packages
- OS packages
- Tarballs
- Can create a Dockerfile

# E4S DOE LLVM and CI images

**DOE LLVM E4S Image**

This multi-architecture image contains E4S products compiled with DOE LLVM 16 and Flang using Spack

**Multi-Arch (X86\_64, PPC64LE, AARCH64)**

- ecpe4s/e4s-doe-llvm:23.05
- e4s-doe-llvm-x86\_64-23.05.sif mirror 1
- e4s-doe-llvm-aarch64-23.05.sif mirror 1
- e4s-doe-llvm-ppc64le-23.05.sif mirror 1

**Continuous Integration Images**

These are barebones operating system images which contain only essential build tools and python packages needed by Spack.

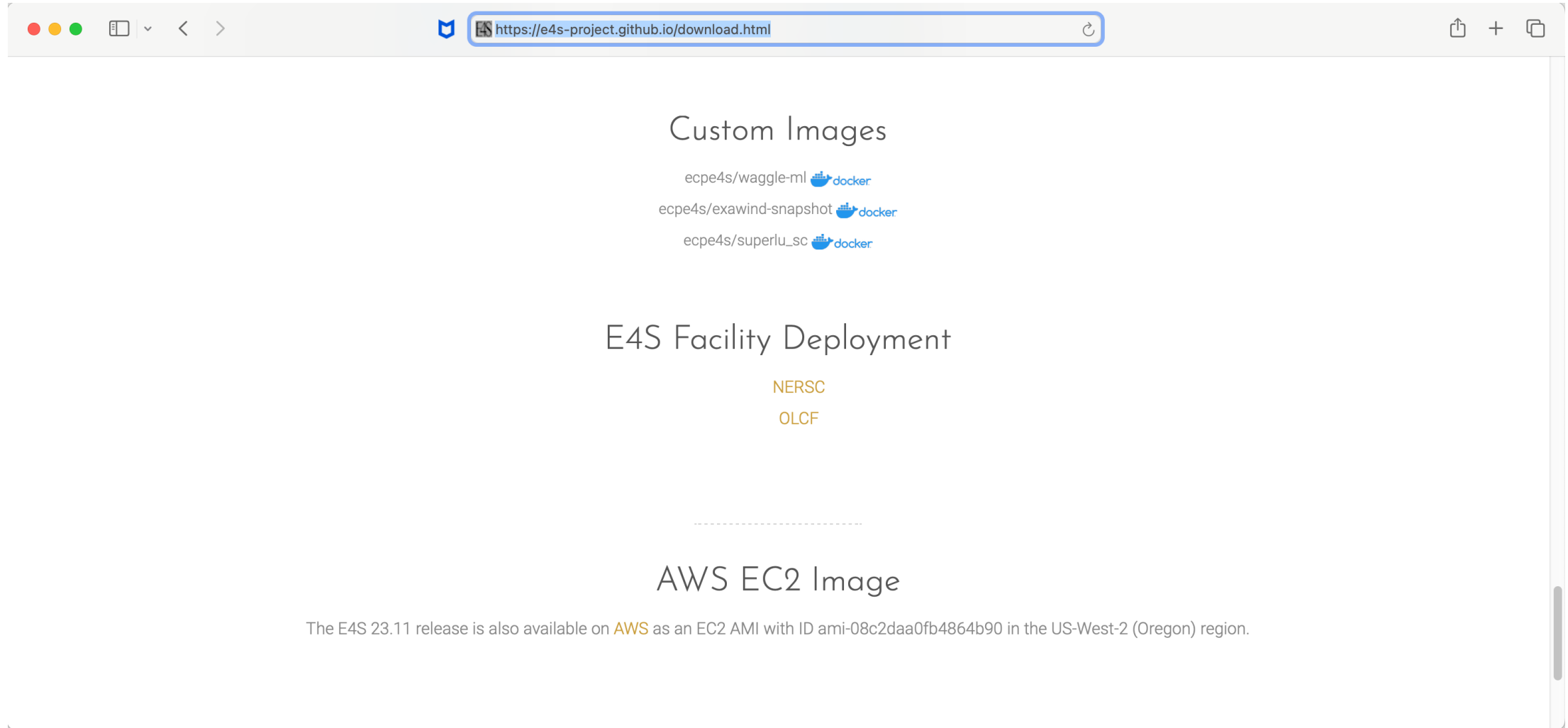
These images are intended to be used in continuous integration workflows where Spack is first cloned and then used to build and test software.

X86_64	PPC64LE	AARCH64
ecpe4s/ubuntu22.04-runner-x86_64 <a href="#">GitHub</a>	ecpe4s/ubuntu22.04-runner-ppc64le <a href="#">GitHub</a>	ecpe4s/ubuntu22.04-runner-aarch64 <a href="#">GitHub</a>
ecpe4s/ubuntu20.04-runner-x86_64 <a href="#">GitHub</a>	ecpe4s/ubuntu20.04-runner-ppc64le <a href="#">GitHub</a>	ecpe4s/ubuntu20.04-runner-aarch64 <a href="#">GitHub</a>
ecpe4s/ubuntu18.04-runner-x86_64 <a href="#">GitHub</a>	ecpe4s/ubuntu18.04-runner-ppc64le <a href="#">GitHub</a>	ecpe4s/rhel8-runner-aarch64 <a href="#">GitHub</a>
ecpe4s/rhel8-runner-x86_64 <a href="#">GitHub</a>	ecpe4s/rhel8-runner-ppc64le <a href="#">GitHub</a>	
ecpe4s/rhel7-runner-x86_64 <a href="#">GitHub</a>	ecpe4s/rhel7-runner-ppc64le <a href="#">GitHub</a>	

**Custom Images**




- ecpe4s/waggle-ml
- ecpe4s/exawind-snapshot
- ecpe4s/superlu\_sc

# E4S Facility Deployment and AWS EC2 Image



The screenshot shows a web browser window with the address bar containing <https://e4s-project.github.io/download.html>. The page content includes:

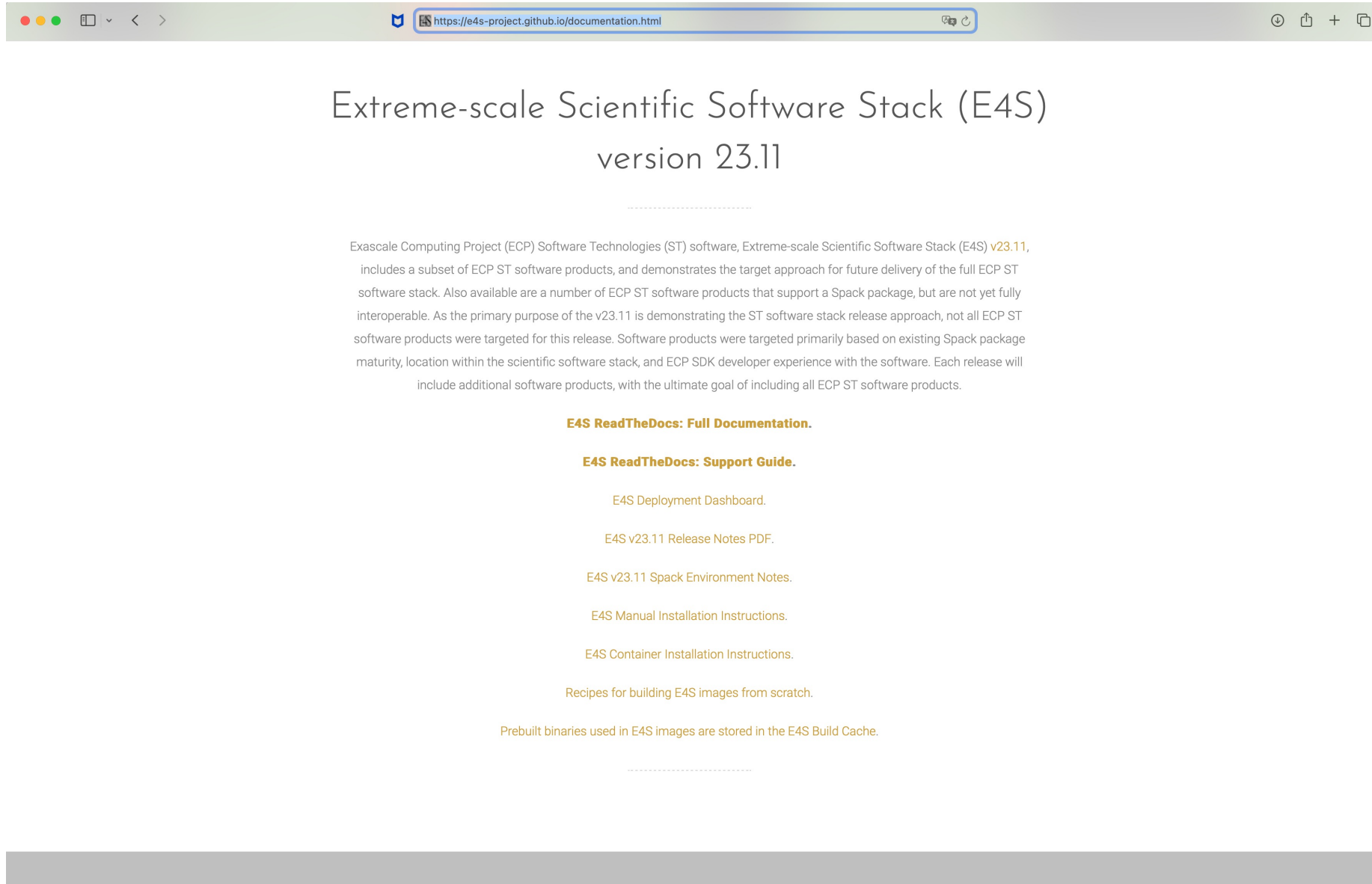
- ## Custom Images

  - ecpe4s/waggle-ml 
  - ecpe4s/exawind-snapshot 
  - ecpe4s/superlu\_sc 
- ## E4S Facility Deployment

  - NERSC
  - OLCF
- 
- ## AWS EC2 Image

The E4S 23.11 release is also available on [AWS](#) as an EC2 AMI with ID `ami-08c2daa0fb4864b90` in the US-West-2 (Oregon) region.

# E4S 23.11 Detailed Documentation for Bare-metal Installation



# E4S 23.11 full featured container release on Dockerhub

The screenshot shows the Docker Hub page for the repository `ecpe4s/e4s-cuda`. The page includes a search bar, navigation links, and a 'Manage Repository' button. The repository description states it is the Extreme-scale Scientific Software Stack (E4S) and was updated 7 hours ago. The 'Tags' section is active, showing a table of tags with columns for TAG, DIGEST, OS/ARCH, LAST PULL, and COMPRESSED SIZE. Two tags are visible: `latest` and `23.11`, both pushed 7 hours ago. The `23.11` tag is highlighted as the current release.

TAG	DIGEST	OS/ARCH	LAST PULL	COMPRESSED SIZE
<a href="#">latest</a>	<a href="#">3c1883ecf2f3</a>	linux/amd64	3 hours ago	42.41 GB
	<a href="#">e1d8a1f2c2c9</a>	linux/arm64/v8	---	35.03 GB
	<a href="#">37d9dbd7dafc</a>	linux/ppc64le	---	36.19 GB
<a href="#">23.11</a>	<a href="#">3c1883ecf2f3</a>	linux/amd64	3 hours ago	42.41 GB
	<a href="#">e1d8a1f2c2c9</a>	linux/arm64/v8	---	35.03 GB
	<a href="#">37d9dbd7dafc</a>	linux/ppc64le	---	36.19 GB

## Architectures:

- x86\_64
- aarch64
- ppc64le

## Software:

- CUDA 12.1
- NVHPC 23.9
- ROCm 5.4.3
- oneAPI 2023.2.1

# E4S 23.11 base container release on Dockerhub

ecpe4s/ubuntu20.04 ☆

By [ecpe4s](#) • Updated 8 hours ago

Manage Repository

↓ Pulls 50K+

Overview **Tags**

Sort by Newest Filter Tags

TAG	DIGEST	OS/ARCH	LAST PULL	COMPRESSED SIZE
<a href="#">latest</a>				
Last pushed 8 hours ago by <a href="#">esw123</a>				
	<a href="#">0bad20ec8b73</a>	linux/amd64	42 minutes ago	934.68 MB
	<a href="#">cc0456ea5d27</a>	linux/arm64/v8	---	863.94 MB
	<a href="#">ce4c85ec19c5</a>	linux/ppc64le	---	814.89 MB

TAG	DIGEST	OS/ARCH	LAST PULL	COMPRESSED SIZE
<a href="#">23.11</a>				
Last pushed 8 hours ago by <a href="#">esw123</a>				
	<a href="#">0bad20ec8b73</a>	linux/amd64	42 minutes ago	934.68 MB
	<a href="#">cc0456ea5d27</a>	linux/arm64/v8	---	863.94 MB
	<a href="#">ce4c85ec19c5</a>	linux/ppc64le	---	814.89 MB

Architectures:

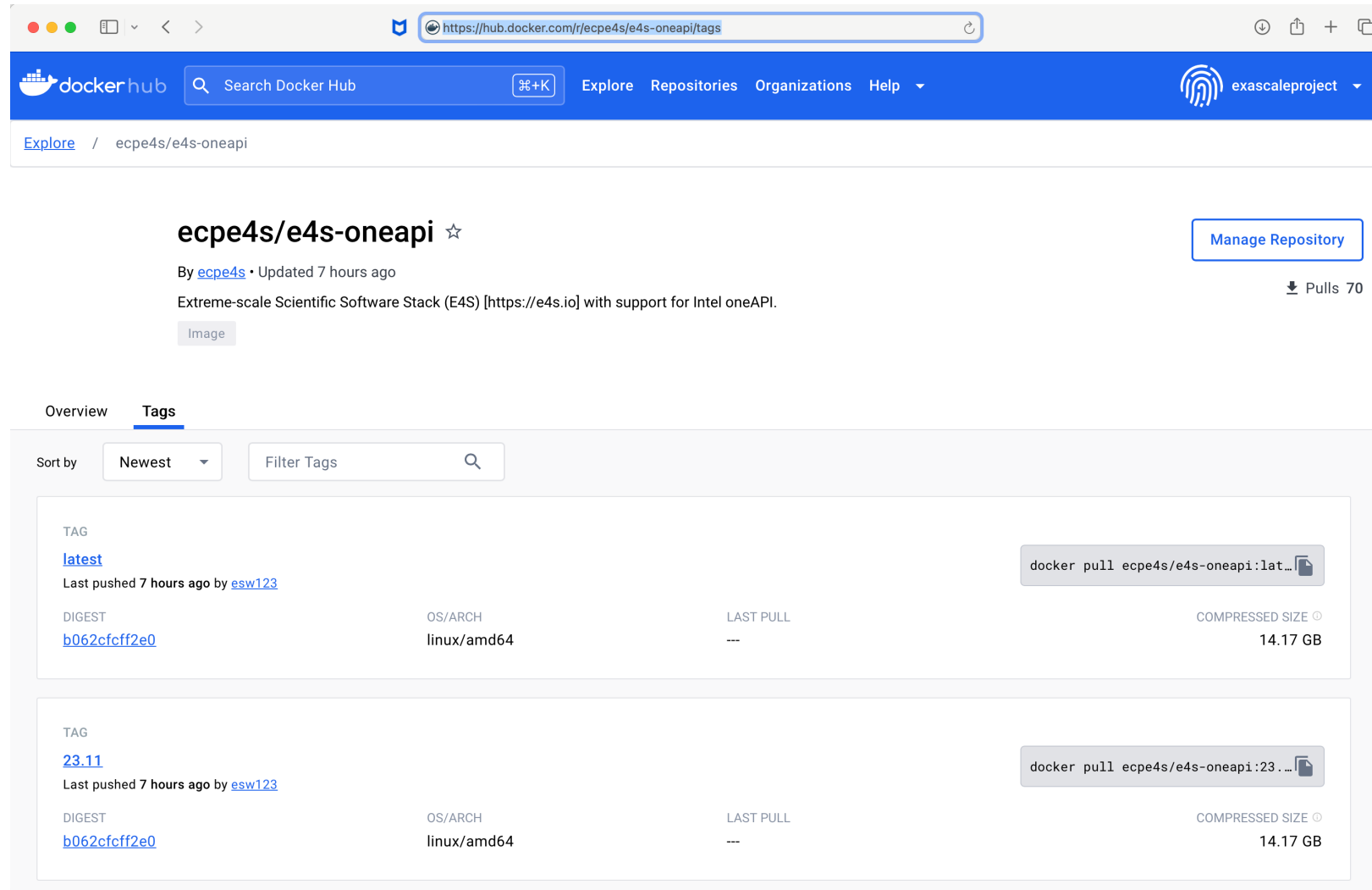
- x86\_64
- aarch64
- ppc64le

# E4S 23.11 ROCm release on Dockerhub

The screenshot shows the Docker Hub interface for the repository `ecpe4s/e4s-rocm`. The page is titled "ecpe4s/e4s-rocm" and is managed by `ecpe4s`. It shows two tags: `latest` and `23.11`. Both tags have a compressed size of 23.48 GB and were last pulled 2 hours ago. The `latest` tag was last pushed 7 hours ago by `esw123`. The `23.11` tag was also last pushed 7 hours ago by `esw123`. The page includes a search bar, navigation links, and a "Manage Repository" button.

TAG	DIGEST	OS/ARCH	LAST PULL	COMPRESSED SIZE
<a href="#">latest</a>	<a href="#">c5011760235a</a>	linux/amd64	2 hours ago	23.48 GB
<a href="#">23.11</a>	<a href="#">c5011760235a</a>	linux/amd64	2 hours ago	23.48 GB

# E4S 23.11 oneAPI release on Dockerhub



The screenshot shows the Docker Hub page for the repository `ecpe4s/e4s-oneapi`. The page is titled "ecpe4s/e4s-oneapi" and is updated 7 hours ago. It is described as "Extreme-scale Scientific Software Stack (E4S) [https://e4s.io] with support for Intel oneAPI." The repository has 70 pulls. The "Tags" tab is selected, showing two tags: "latest" and "23.11". Both tags have a compressed size of 14.17 GB and were last pushed 7 hours ago by user `esw123`. The OS/ARCH for both is `linux/amd64`. The digest for both is `b062cfcff2e0`. The "latest" tag has a "LAST PULL" of ---, while the "23.11" tag has a "LAST PULL" of ---.

TAG	DIGEST	OS/ARCH	LAST PULL	COMPRESSED SIZE
<a href="#">latest</a>	<a href="#">b062cfcff2e0</a>	linux/amd64	---	14.17 GB
<a href="#">23.11</a>	<a href="#">b062cfcff2e0</a>	linux/amd64	---	14.17 GB



# 23.11 Release: 120+ Official Products + dependencies (gcc, x86\_64)

1:	adios2	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/adios2-2.9.1-h3tqinydfwnmwed7n5o2uzqoakswh3f4
2:	alquimia	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/alquimia-1.1.0-onm5kxsvhlbblr6d3fsiegs2itkcdyk6
3:	aml	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/aml-0.2.1-delrfyzv4zumzjmtqdfydpkj2pk6iyye
4:	amrex	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/amrex-23.11-ynz45mrxpgtgcxnspefdaiu4reg2gdbf
5:	arborx	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/arborx-1.4.1-jayemxuy4wy4prvtvdyppjbjpyrsljr4
6:	argobots	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/argobots-1.1-33xjvt4kg6gzf7rvb3wvbegkmepr7of6
7:	ascent	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/ascent-0.9.1-nzcpmyjl4lvxcyom4y7s5rywddm5smh
8:	axom	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/axom-0.8.1-4t3dnemck5tejcklp3o4lozgbfnof55t
9:	bolt	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/bolt-2.0-gifklfyhev3qvjzdpilexsn2673plfg
10:	blaspp	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/blaspp-2023.08.25-nfokelfomg5gij2vnnwg3o3bodz75vhn
11:	bricks	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/bricks-2023.08.25-gkcb5rg3hndeo7xfzaolryvremrv3ajz
12:	butterflypack	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/butterflypack-2.4.0-f4ntve4pychsh37vg14742wqdm5letd
13:	cabana	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/cabana-0.6.0-t7p2le3r4yc7fnho5r2mp6hf7ggqdyem
14:	caliper	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/caliper-2.10.0-yrllzgojkh03xclwcmms3bvmiswofi5xt
15:	camp	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/camp-2022.10.1-incmpuinz7zco4msqjntjyirwvifcheiha
16:	chai	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/chai-2022.03.0-ed3kqfctkdr2ictc2jr7azlz7rrdppwm
17:	charliecloud	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/charliecloud-0.34-ajmjxvqswluur4kju6376qyv6fzosbd
18:	conduit	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/conduit-0.8.8-mdocwtkxzv46ruro32vacndjx4d5j6w6
19:	cusz	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/cusz-0.3.1-ntdhlqma2az44zpfidifycpi5r4isgz
20:	darshan-runtime	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/darshan-runtime-3.4.4-npeaexztv4quv34mwyttf5smcn7bsp7b
21:	datatransferkit	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/datatransferkit-3.1.1-olylqich3xnxh6awwdscs32s53ur7jd
22:	dealii	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/dealii-9.4.2-grhwhrhmjhjhpqvjpv7zbsxyueqbth44
23:	dyninst	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/dyninst-12.3.0-jpq4nsumxkdadyt5u7nzjum6dudrpic2
24:	ecp-data-vis-sdk	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/ecp-data-vis-sdk-1.0-cwsup4pwcyyvunjzlrmyng27onzwo2z
25:	exago	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/exago-1.6.0-o6t23yyyiteoboyfsh5g7eppzoamas4l
26:	exaworks	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/exaworks-0.1.0-jmluakqyvfsobcg24quhxii5w7iul7my
27:	faodel	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/faodel-1.2108.1-ouhu6kdibo76dvf6rahuebmvowajia6l
28:	flecsi	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/flecsi-2.2.1-dzlu665k7kyjz5f6bilrdwrlcwjyja3c
29:	flit	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/flit-2.1.0-e7rg7rydnglbgvdzka12iw74yxrmupvl
30:	flux-core	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/flux-core-0.55.0-hd6lzkme6z7yri7dbbp7bgbxg3fqo7q
31:	flux-sched	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/flux-sched-0.28.0-k55ozusl77ellybb6ag2hh6qidkxka3x5
32:	fortrilinos	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/fortrilinos-2.3.0-g660aatp465tj2sd6lfm45dna176mtp1
33:	gasnet	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/gasnet-2023.3.0-uipqxqhwzlwqpirm5rtakhmdd6tfjs57
34:	ginkgo	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/ginkgo-1.6.0-fpzzfp4a2jlfxmmm2my5qo36yeesunsl
35:	globalarrays	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/globalarrays-5.8.2-ykwomjrt6qqqmhf7fbxcflrzbz26ghetv
36:	gotcha	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/gotcha-1.0.4-z7rm5dm3rxaw3kn2g573b2zpfz5wgtml
37:	gptune	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/gptune-4.0.0-q72dvd1mmovb5z2zbimhtwoznaeokkih
38:	h5bench	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/h5bench-1.4-v3guh5cjqmeuecycyadxczke3yppbzaq
39:	hdf5	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/hdf5-1.14.3-e3o7l3maue5q7dlnqy5vzp3rustrvpr2
40:	hdf5-vol-async	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/hdf5-vol-async-1.7-xsnl4lew66itjrvdotgaxa6zv4wdrrq7i

## GPU runtimes

- AMD (ROCm)
  - 5.4.3
- NVIDIA (CUDA)
  - 12.1
- NVHPC
  - 23.9
- Intel oneAPI
  - 2023.2.1

# 23.11 Release: 120+ Official Products + dependencies (gcc, x86\_64)

```
41: hdf5-vol-cache /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/hdf5-vol-cache-v1.1-o3ithsfbdflijikub2zdcskksdeuy5kkf
42: hdf5-vol-log /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/hdf5-vol-log-1.4.0-o2rafleuxj37eicnfo76vdm4y4mayqd
43: heffte /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/heffte-2.4.0-zotcawyumj6w7x7x6ct5kk7t23kekspa
44: hpctoolkit /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/hpctoolkit-2023.08.1-ucnmm7akxaa2xtqxocpo2mfy226yuv4
45: hpx /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/hpx-1.9.1-w6m4c5isyl5bhrckbz6vgjkhvhvdkcb
46: hypre /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/hypre-2.29.0-wptbvnsuwpwjwrazz4byh4lz23gzuw
47: kokkos /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/kokkos-4.1.00-s3ooieibw7drk2ilou7sk3c3ogknpsvk
48: kokkos-kernels /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/kokkos-kernels-4.0.00-gfjkpx65e5hcxoz7spmmcftm32l2lxxkq
49: lammmps /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/lammmps-20230802-cfhvdkn46vzhav5vsmfvykorynuas4aq6
50: lapackpp /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/lapackpp-2023.08.25-3ca5zqvkj5xt7oknexpwyz5y4yarlfj
51: lbann /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/lbann-0.102-agv4zilw6voj4qwwynsx3eamp5tbnvng
52: legion /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/legion-23.06.0-ucrcoi4asmrbzbieat5ecprkfuthnei5
53: libcatalyst /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/libcatalyst-2.0.0-rc4-22k754cwrbcvtvx6p74wj3sqgeygibim
54: libnrm /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/libnrm-0.1.0-womilym3lmofvrndp3m3iu6w2ejk4s
55: libpressio /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/libpressio-0.95.1-nxihpzujdvmqy3mh7ebc7jvbb16symr
56: libquo /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/libquo-1.3.1-fmjil6uktvm7yadvjhd7s6z5l63brd2l
57: loki /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/loki-0.1.7-k7aot6cukc7fmeesvrzc5loq7tnjve5i
58: magma /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/magma-2.7.2-tufynjoedccdmuigslyz17ulh44asxw2
59: mercury /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/mercury-2.3.1-pquyes2nsmqdd2dsrkcipvswvzvzhrs
60: metall /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/metall-0.25-5hmjjral2hw5jnrmlhcbonvc5ix4jno
61: mfem /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/mfem-4.6.0-utldtctkh4uvfsusz5bhvugdr3pygdwe
62: mgard /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/mgard-2023-03-31-mionudselpx77meu4nm5wru7bog72z6q
63: mpark-variant /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/mpark-variant-1.4.0-26er7ysumy4mc4kfmlopldgpqzw6fqv
64: mpich /usr/local/mpich/install/mpich
65: mpifileutils /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/mpifileutils-0.11.1-w33ilbeharizb3gfm7hkfv2q7imi7nje
66: nccmp /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/nccmp-1.9.1.0-3ilq5orjgpngkw3kl4crijy2mazqid6t
67: nco /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/nco-5.1.6-5zpx2ovgcrcahha3uzqemrhmdl33kpg
68: netlib-scalapack /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/netlib-scalapack-2.2.0-wk2wwukluwd7dpfiiu646l4i4bxdzwof
69: nrm /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/nrm-0.1.0-45g5mkvg4tpnxbtgksniz5fxf3mga5gn
70: omega-h /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/omega-h-9.34.13-lrulaqaxewfrbndrqbr6w2zeo03qi6hz
71: openfoam /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/openfoam-2306-5rka2iigdbmy2d4zakyqntbhffb6jd5v
72: openmpi /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/openmpi-4.1.6-md4en5vmcqaapt2z6iovgnfy3q33gu5f7
73: openpmd-api /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/openpmd-api-0.15.2-u44qz4uaxqsjndzzkvdryvldzfkrrxd64
74: papi /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/papi-6.0.0.1-72nk6zo54sjuosphlcmnwwwp5ttnlmbc
75: papyrus /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/papyrus-1.0.2-bd5qf5sfyluj56h3n7ejmjom2s6cmi6d
76: parallel-netcdf /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/parallel-netcdf-1.12.3-buziznjbtqmva5p4jfdauqpcexyylq
77: paraview /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/paraview-5.11.2-o4kqt5fg2o2g37tbwbelqjsrfjka3b27
78: parsec /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/parsec-3.0.2209-znyscwz6oa5vstw7x4ha7q3hjgayuwvy
79: pdt /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/pdt-3.25.1-ffhis4ch5zibi4vsgw7zygettdi5hkp3
80: petsc /spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/petsc-3.20.1-b3vxytygg4u6yll4bnfgv2bt7c5e4l76
```

# 23.11 Release: 120+ Official Products + dependencies (gcc, x86\_64)

81: phist	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/phist-1.12.0-d75fvxutgfrls4bafazdzyhbgkxioipj
82: plasma	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/plasma-23.8.2-mrkww4hbppmryla2hata33zbbkgcxd
83: plumed	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/plumed-2.9.0-ffjtdwfp3jk3vnt3wx7g4brubr3gles2
84: precice	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/precice-2.5.0-7x6rriuavukwbzbg2ugizyjhgsirx6ha
85: pruners-ninja	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/pruners-ninja-1.0.1-zaclredzria7t7md6rqr7ju5cqe3yoql
86: pumi	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/pumi-2.2.8-s7yku5wnpf34apqt7qzbh32po4apat57
87: py-cinemasci	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/py-cinemasci-1.3-4cfdtca3lv4eimmf43sncdgl4srfdwlx
88: py-jupyterhub	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/py-jupyterhub-1.4.1-fu7sfoxiivikdcvkniavkhs17iknl6d
89: py-libensemble	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/py-libensemble-1.0.0-7xl3reee lev54lw76xk7c2o5z7zy5dgh
90: py-parsl	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/py-parsl-2023.08.21-lrrwng4d6sl2wdi73k56rx6za7zhctin
91: py-radical-saga	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/py-radical-saga-1.20.0-opcx7gnnn2tkjw7sbpxnhbufjz2am3i
92: qthreads	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/qthreads-1.18-z7gy4texq5n7viuezuysl fvua47mrou
93: quantum-espresso	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/quantum-espresso-7.2-6rdjedntmcko2oxu7wakcdcrxh2zx3ie
94: raja	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/raja-2022.10.4-f62ixftvv lwygnuw7h3k3mle77l3pwqj
95: rempi	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/rempi-1.1.0-w3s4auqcmjuh4knezr24zppowhoxu6dv
96: scr	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/scr-3.0.1-ngtxi6tk5v6eswxthsgq54ilk26mg7bf
97: slate	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/slate-2023.08.25-v27dzgdzblfzrbgg7qux5u3odjdp2tq5
98: slepc	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/slepc-3.20.0-4u3mo7glxond4wsxod7iimlw77p2yys
99: stc	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/stc-0.9.0-tezaek7xix4c3fp4mwzpeebs27dfcpd3
100: strumpack	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/strumpack-7.2.0-vaaywamkyrq3ejic6bieored6yphy77
101: sundials	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/sundials-6.6.1-7pm7jket35co5lxcctqkksuamhd45n5g
102: superlu-dist	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/superlu-dist-8.1.2-b7owlntmfzxc7rhuzzzrw2o lng43idfh
103: swig	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/swig-4.1.1-aqoiv4uwzt77yyjnv14e36d5fqcbecag
104: sz3	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/sz3-3.1.7-we6faorx6wtdbij24boo3e6j4cgi4ixu
105: tasmanian	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/tasmanian-8.0-pdayiop7j3c2qcbqvchnhj6k2tnbzyyg7
106: tau	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/tau-2.33-su4wnkucus3amzrbsa35s5duaw52rkuvh
107: trilinos	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/trilinos-14.4.0-vlnbznuixhnf7wx5vf2rzhva6af5cnnw
108: turbine	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/turbine-1.3.0-fvdknaskt2weryvuzprcs3kxmn72cixm
109: umap	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/umap-2.1.0-j7nwwki6jddng6lkkvefw7d5remhp5hr
110: umpire	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/umpire-2022.10.0-izloaumfivkrpw22es2xijlk3jtozcd2
111: unifyfs	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/unifyfs-1.1-uovx3pyemkcfbohtndj6zoe77lkw44iu
112: upcxx	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/upcxx-2023.3.0-gjih3of4wpttybtbbpjkkmt2zqbq6r4
113: variorum	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/variorum-0.7.0-ch6jjcqiihsxv lmlghmazjkl6sievbz3
114: veloc	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/veloc-1.7-s26qya7dfrooqpcjgqs6v6jta6bqpk34
115: visit	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/visit-3.3.3-pbu6q4bs22pr3hhyh6l4dz5eqv5rc4hx
116: vtk-m	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/vtk-m-2.0.0-qphfufzsl i67k3qop4s5sbzdpzvnajco
117: wannier90	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/wannier90-3.1.0-nupc7qg4e2opiv7axj4octzfwk lcnxot
118: warpx	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/warpx-23.08-2a3phdnxo53nc4v3cgiazb4j7kaa7yvt
119: xyce	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/xyce-7.7.0-cs66kshjz4pwu43vkpor652jixasazoa
120: zfp	/spack/opt/spack/linux-ubuntu20.04-x86_64/gcc-11.4.0/zfp-1.0.0-6fg3luiw5e6sudjjsudczx2irdyl3teb

## Languages:

- Julia with support for MPI, and CUDA
- Python

## AI products with GPU support

- Tensorflow
- Pytorch
- JAX
- Horovod

## EDA Tools:

- Xyce

## 3D Visualization

- Paraview
- VisIt
- TAU's paraprof
- Jupyter notebook ...

# E4S Support for AI/ML frameworks with NVIDIA GPUs

```
$ singularity run --nv e4s-cuda90-x86_64-23.11.sif
Singularity> python
Python 3.8.10 (default, May 26 2023, 14:05:08)
[GCC 9.4.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import tensorflow
>>> tensorflow.__version__
'2.12.0'
>>> import torch
>>> torch.__version__
'2.0.0'
>>> import jax
>>> jax.__version__
'0.4.13'
>>> import horovod
>>> horovod.__version__
'0.28.1'
>>> torch.cuda.get_device_name(0)
'NVIDIA H100 PCIe'
>>> print(torch.cuda.get_arch_list())
['sm_35', 'sm_70', 'sm_75', 'sm_80', 'sm_90']
>>> █
```

E4S 23.11 supports NVIDIA H100 GPUs with TensorFlow 2.12.0 and PyTorch 2.0.0

# E4S 23.11 Support for GPUs: NVIDIA

```
Singularity> spack find +cuda
-- linux-ubuntu20.04-x86_64 / gcc@11.4.0 -----
adios2@2.9.1      dealii@9.4.2      hypre@2.29.0      nvcomp@2.2.0      strumpack@7.2.0
amrex@23.11      ecp-data-vis-sdk@1.0 kokkos@4.0.00     omega-h@9.34.13  sundials@6.6.1
arborx@1.4.1     exago@1.6.0       kokkos@4.1.00     papi@6.0.0.1     superlu-dist@8.1.2
blaspp@2023.08.25 flecsi@2.2.1      kokkos@4.1.00     paraview@5.11.2  tasmanian@8.0
bricks@2023.08.25 flux-core@0.55.0  kokkos-kernels@4.0.00 parsec@3.0.2209  tau@2.33
cabana@0.6.0     ginkgo@1.6.0      lammps@20230802   petsc@3.20.1     trilinos@14.4.0
caliper@2.10.0   gloo@2023-05-19   lapackpp@2023.08.25 petsc@3.20.1     umpire@6.0.0
camp@0.2.3       heffte@2.4.0      legion@23.06.0    py-torch@2.1.0   umpire@2022.10.0
camp@2022.10.1   hiop@1.0.0        libpressio@0.95.1 raja@0.14.0       upcxx@2023.3.0
camp@2022.10.1   hpctoolkit@2023.08.1 magma@2.7.2       raja@2022.10.4   vtk-m@2.0.0
chai@2022.03.0   hpx@1.9.1         mfem@4.6.0        slate@2023.08.25 zfp@0.5.5
cusz@0.3.1      hwloc@2.9.1       mgard@2023-03-31  slepc@3.20.0
==> 59 installed packages
```

# E4S 23.11 Support for GPUs: AMD

```
[Singularity> spack find +rocm
-- linux-ubuntu20.04-x86_64 / gcc@11.4.0 -----
amrex@23.11          exago@1.6.0        hipsolver@5.4.3    magma@2.7.2        sundials@6.6.1
arborx@1.4.1        gasnet@2023.3.0    hipsparse@5.4.3    mfem@4.6.0         superlu-dist@8.1.2
blaspp@2023.08.25   ginkgo@1.6.0       hpctoolkit@2023.08.1  paraview@5.11.2    tasmanian@8.0
cabana@0.6.0        heffte@2.4.0       hpx@1.9.1           petsc@3.20.1       tau@2.33
caliper@2.10.0      hiop@1.0.0         hypre@2.29.0        raja@0.14.0        trilinos@14.4.0
camp@0.2.3          hip@5.4.3          kokkos@3.7.01       raja@2022.10.4     umpire@6.0.0
camp@2022.10.1      hipblas@5.4.3      kokkos@4.1.00       slate@2023.08.25   umpire@2022.10.0
chai@2022.03.0      hipfft@5.4.3       lapackpp@2023.08.25  slepc@3.20.0       upcxx@2023.3.0
ecp-data-vis-sdk@1.0  hiprand@5.4.3     legion@23.06.0      strumpack@7.2.0    vtk-m@2.0.0
==> 45 installed packages
```

# E4S 23.11 Support for GPUs: Intel

```
[Singularity> H1=$(spack find --format /{hash} +level_zero)
[Singularity> H2=$(spack find --format /{hash} +sycl)
[Singularity> spack find $H1 $H2
-- linux-ubuntu22.04-x86_64 / oneapi@2023.2.1 -----
amrex@23.11   blaspp@2023.08.25  kokkos@4.0.00  kokkos@4.1.00      petsc@3.20.1    sundials@6.6.1
arborx@1.4.1  cabana@0.6.0    kokkos@4.0.00  lapackpp@2023.08.25  slate@2023.08.25  tau@2.33
==> 12 installed packages
Singularity> █
```

Use of Intel oneAPI BaseKit and HPCToolkit is subject to acceptance of Intel EULA by the user

# 23.11 Release: 120+ Official Products + dependencies (gcc, ppc64le)

1: adios2	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/adios2-2.9.1-ihpdzy4dsqrwh7jz7cv4nnht2woncjgd
2: alquimia	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/alquimia-1.1.0-fsdfwpg7gwg4r773eee5s6j5lpdjksfe
3: aml	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/aml-0.2.1-4uo5m3ex3zgt7osm5cd25syty43d6iaf
4: amrex	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/amrex-23.11-muif6apkte7iht2fa4qj2rkfntdrv2tw
5: arborx	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/arborx-1.4.1-3sk3esse5cgnblyprb7kaesyszy4azpn
6: argobots	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/argobots-1.1-ip5ldsfiwkffr6mfchrpai5kak2znaht
7: ascent	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/ascent-0.9.1-4rpesskqcm7kxvy6ejjehrny34lyrkb
8: axom	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/axom-0.8.1-3mchzrgofobr74n7adxlxdkdbfyfnwyek
9: blaspp	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/blaspp-2023.08.25-6xwxyrqpzbrwa5kqwo7vgui6kkdaf3
10: bolt	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/bolt-2.0-xq7q5476o6ffoixuudd2h7hsucba5vle
11: bricks	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/bricks-2023.08.25-5pil4ub5e3cw77n64shxbpn4r3fiu54h
12: butterflypack	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/butterflypack-2.4.0-ztlgxwffmbhkp3bl642mddwagtoinoum
13: cabana	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/cabana-0.6.0-etpdjbaqow3w74eh2tsxfhk4omjpm2qa
14: caliper	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/caliper-2.10.0-rp6dot6ed4qwrzor5pr7q2qdp2l7i47i
15: camp	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/camp-2022.10.1-nb6dssbn4lmdxjaqu5pvmzomrwhss7b
16: chai	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/chai-2022.03.0-25vuj3egmq5naj7hg7h2ki6cddwg43
17: charliecloud	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/charliecloud-0.34-fbooueqk7fwjiglm2ldwi4jkgua5ldsx
18: conduit	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/conduit-0.8.8-p4ajqe2l2bazvyiocer43c2ecetikmoj
19: darshan-runtime	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/darshan-runtime-3.4.4-is26455r2gn7vmqxlcoqopgd32pilqgh
20: datatransferkit	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/datatransferkit-3.1.1-4yehenigkjqmquai6qunxgjar5gurixt
21: dyninst	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/dyninst-12.3.0-gwhlxsuoxinwz2nv6qsieh3czg5iv75c
22: ecp-data-vis-sdk	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/ecp-data-vis-sdk-1.0-ezt6wvqjrllectlfx2suplxmoarxlfddb
23: exago	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/exago-1.6.0-fom5b762f3wpjx62nyv5ghsnlp6euvud
24: exaworks	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/exaworks-0.1.0-74fvnc4jvpcer2n5a3txwoxipafghehx
25: faodel	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/faodel-1.2108.1-jum3idkeyjgdcmpbtsbiwyfy62tchrxc
26: flecsi	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/flecsi-2.2.1-ll5al4sxjllp5wxmmtfgw5yac5uezfy
27: flit	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/flit-2.1.0-s6s4re6ouy7xjh526jz5vjdk3ye4yvdc
28: flux-core	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/flux-core-0.55.0-uacox6eqswawy73qdf23gnz2a4i2vy56
29: flux-sched	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/flux-sched-0.28.0-au2cj2blfeoudttsybp5lvlyryfklge7
30: fortrilinos	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/fortrilinos-2.3.0-77ggkxmajgcn5ohtsrfunonnm7g5c5i
31: gasnet	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/gasnet-2023.3.0-r2ixqqbifetxotbdrok4xmkeizsb3zy4
32: ginkgo	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/ginkgo-1.6.0-qvevqtav375scruxy53obmkfvt2ejinj
33: globalarrays	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/globalarrays-5.8.2-vmnny2lp7i2cyoew35bb37iz7qtahlp
34: gotcha	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/gotcha-1.0.4-lvpeg277suxpjvyparwa3vijksbe6iq4
35: gptune	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/gptune-4.0.0-woqutsjkz7dsd3gmki7vd7qp7ia543xl
36: h5bench	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/h5bench-1.4-yso2n36h6w73mijm2dqkxexy4o37ykke
37: hdf5	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/hdf5-1.14.3-ldmeyuivxhhu1rvcsxsbpjn5thcq3nlt
38: hdf5-vol-async	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/hdf5-vol-async-1.7-pztbuunl3kd3jozq64dvjtzkayfj6qik
39: hdf5-vol-cache	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/hdf5-vol-cache-v1.1-umtyv6b2mm2tjnkkyfzd56kmgffcbcem
40: hdf5-vol-log	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/hdf5-vol-log-1.4.0-qjvsniapxzd47i5fs2ewabvzpxpyxph

## GPU runtimes for IBM Power

- CUDA 12.2
- NVHPC 23.9

## Languages

- Julia with MPI and CUDA
- Python

## EDA Tools

- Xyce

## CFD Tools

- OpenFOAM

## AI packages for NVIDIA GPU

- TensorFlow
- PyTorch
- LBANN



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41: heffte	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/heffte-2.4.0-5yjaxnerbmwzyjycnka7dm6p5srqv2
42: hiop	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/hiop-1.0.0-gjxeaxnby4nj4gy6hkhmaipths6rm64
43: hpctoolkit	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/hpctoolkit-2023.08.1-5ya42md6zqawbftkh3sof3vvqrwebmlk
44: hpx	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/hpx-1.9.1-tmndtkm5kv7skzuog4oy6aea6v2cten3
45: hypre	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/hypre-2.29.0-xafpu6ka5poq2metwdeb3w357mqpcfb1
46: kokkos	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/kokkos-4.1.00-mdwjej16t5hmcoecaob3ll7e5on4hbwc
47: kokkos-kernels	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/kokkos-kernels-4.0.00-nfzxt7sjifsmn4kmy6uf37556j2557i
48: lammps	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/lammps-20230802-xjtlwkptlhlclcoqvaqbwyestatid6tkl
49: lapackpp	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/lapackpp-2023.08.25-d66jpyjk2rvmro4yffor5awnwdrd3ih5
50: lbann	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/lbann-0.102-4pgfuox3kwgntrfafys7zau6l7bjcq2k
51: legion	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/legion-23.06.0-v6kg226wal2bgaja1pzkdms5cjb7qsu7y
52: libnm	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/libnm-0.1.0-gczzg3dnazmhvtx2l7kr3yot5dzwpamu
53: libpressio	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/libpressio-0.95.1-zeq62cksskfbytrp6m5u6yxqzsmofhz
54: libquo	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/libquo-1.3.1-noue3szg7ljiv6oxsm1qgltw76mohbf
55: loki	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/loki-0.1.7-xjrdr7sdls5gkrosqhykqu74zk2lqxn
56: magma	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/magma-2.7.2-j5knwazdi6mseha3lhxtf3j4peipeqej
57: mercury	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/mercury-2.3.1-3n56a5fvm2yaks6cj7ntylezjiaeymg
58: mgard	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/mgard-2023-03-31-tkvarpjfwroxx5jklnj56rpf7efdjxu
59: metall	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/metall-0.25-ke2rr3b4rv5glcszbrbdyo4ywdrrz3gf
60: mfem	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/mfem-4.6.0-i4jpse2teo3ft25emlf2tpufzqtpdnlp
61: mpark-variant	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/mpark-variant-1.4.0-ririz5ovbtkiyusx6uervst45plz5h5g
62: mpich	/usr/local/mpich/install/mpich
63: mpifileutils	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/mpifileutils-0.11.1-e7ekl6oxoxaa6ggy3zrjure3kmzbe654
64: nccmp	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/nccmp-1.9.1.0-cd6sctvwy65hlg62ma3drqhzocpysm55
65: nco	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/nco-5.1.6-lgoymbimatw3lq6piar5wwddo3huuqpr
66: netcdf-c	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/netcdf-c-4.9.2-xkdm6sj7y3uwoxoemxtbxcyhllclmo3v
67: netlib-scalapack	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/netlib-scalapack-2.2.0-mgsenm33zlkofr6drz4gcapy2tjehnyf
68: nrm	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/nrm-0.1.0-jup6rr7vod334xqjaqtcspsvgtggbkfej
69: omega-h	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/omega-h-9.34.13-5tfq4tc62ngc56a65tn4vnnvvgbi3tgqz
70: openfoam	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/openfoam-2306-ob46pi75qvijibmstxvvpw2nibkn2aqvn
71: openmpi	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/openmpi-4.1.6-w43d6iisjgvncu7xnpkwuy76xsnmsdn
72: openpmd-api	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/openpmd-api-0.15.2-rbnixfbpyhlpc6t7h6juvuwg5gnygzxr
73: papi	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/papi-6.0.0.1-a5hh5jnbmc7bmsq3ywuqf7mlip5d5qxu
74: papyrus	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/papyrus-1.0.2-zo2oyva3xhdtnocmwyn7j25kfdcjrpd
75: parallel-netcdf	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/parallel-netcdf-1.12.3-3vrlabot5wa6b3r3v3gdqcp4abr7qlgj
76: paraview	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/paraview-5.11.2-lhidhoi3xdjealydgpemdnv76wcqa4ig
77: parsec	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/parsec-3.0.2209-dqdfjlgfv3jf6ntppqdxumrizrejt4c
78: pdt	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/pdt-3.25.1-ze6vpc16vajxvknibsdurnuttu25p7f5
79: petsc	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/petsc-3.20.1-irydrf4k4nzktzau2xr72m44kefpcrcv
80: plasma	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/plasma-23.8.2-5vfsp2ia57he7aflv4vviq5t2t3mrbac

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81:	plumed	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/plumed-2.9.0-jlleadfhqynhlhgrvg5gjecfkllygycx
82:	precice	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/precice-2.5.0-ed3pisb4lfr4aaweybqaoflx5u5t6u2p
83:	pruners-ninja	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/pruners-ninja-1.0.1-znaejqmsz5lo7oqxqwlwde2wy3ozd5h
84:	pumi	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/pumi-2.2.8-2claov3kfcx6w54o2oy3zmc2uuxopjns
85:	py-cinemasci	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/py-cinemasci-1.3-n7c3jkmm26fcesiyzhcgdwbu7knm7cq
86:	py-jupyterhub	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/py-jupyterhub-1.4.1-m45rfxh4yshbptjigx7ruw7vpf72suxv
87:	py-libensemble	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/py-libensemble-1.0.0-z73csgy7hvt6bwbgozbrhni7cvf225q6
88:	py-parsl	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/py-parsl-2023.08.21-uvudb3nharj6h43g55n4jxcpsxaqzv5d
89:	py-radical-pilot	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/py-radical-pilot-1.20.0-egv7er3kdbjrh7vbgoy2cdd23lpkgtyg
90:	py-radical-saga	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/py-radical-saga-1.20.0-6br2l2z6j5nvdice4h5fsoaguwc5adw2
91:	qthreads	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/qthreads-1.18-vq6ui6c2qiizdf5gl2z4jmqmpdntpxpb
92:	quantum-espresso	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/quantum-espresso-7.2-gzgv5uate7b75e75dzwpcdnfpawogjo
93:	raja	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/raja-2022.10.4-7ootusdyhsfgiva7fxqt rwd66uvc5xop
94:	rempi	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/rempi-1.1.0-d35pbskviiefhz7shn7k3evuvvw33cdb
95:	scr	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/scr-3.0.1-z7ngk3g7fiip7djhlm3vxdzncos6g
96:	slate	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/slate-2023.08.25-cxyt5nre5rjb3nptmwktomymjc7fqov
97:	slepc	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/slepc-3.20.0-dq6rxxwfrcooh53xfhh2kd53ybyq4prak
98:	stc	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/stc-0.9.0-q5h6ac5maywtljun7zimxkyvpxbdkaxg
99:	strumpack	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/strumpack-7.2.0-pqdhylnfut7wrw6yyp7wcy5thbkd6ci
100:	sundials	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/sundials-6.6.1-uxtnnmja77hrsno5vwm5suktyknzt
101:	superlu	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/superlu-5.3.0-rslxrp6xmbjtm6kvvc7dth64atu9y5mq
102:	superlu-dist	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/superlu-dist-8.1.2-3i5373lzamvgaw5us2a54vzvopo6dco
103:	swig	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/swig-4.1.1-qljcvrmgm3e5cbti2opgmzww4kuu7ixr
104:	sz	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/sz-2.1.12.5-6xehs lqqe6ub2o4h6o5y2flwxjhzxpo
105:	sz3	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/sz3-3.1.7-a7jrbvqxdehj7s3wp43azq5uxvc3j4su
106:	tasmanian	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/tasmanian-8.0-lgqssqwxckctz45wc6jb7hhnegzaccvx
107:	tau	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/tau-2.33-tqv5wr63b2xzxlc2kiumj23466igje3
108:	trilinos	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/trilinos-14.4.0-j7qmkitn4vkzsmvnns6n4y3v6f4atsxx
109:	turbine	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/turbine-1.3.0-j6syfz7ydatc5yngk5yar5fmi4aq7s
110:	umap	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/umap-2.1.0-ndekgmacnqysxbqiuaj7ajjmudt3aopv
111:	umpire	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/umpire-2022.10.0-4mkmdh2xegjoxpk736krbtplpgwwiyr
112:	unifyfs	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/unifyfs-1.1-c3h2bojb2mn6sdluujwvgoy2zdgdzqa
113:	upcxx	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/upcxx-2023.3.0-2b6f6lm33c6wyoobvsxzwy744iyfo2i2
114:	veloc	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/veloc-1.7-q7khqjblg3uy52xm5tol4tchrohvjrr5
115:	visit	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/visit-3.3.3-ld57dpvltpzua6btm5hcrmqi2vfrlunq
116:	vtk-m	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/vtk-m-2.0.0-tgnhx43yh6d3wqi4bdptdmomz63ziabe
117:	wannier90	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/wannier90-3.1.0-i7j4n7lkhwrvzqouj3ngss75i4ddc33
118:	warpx	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/warpx-23.08-xcmc2moe2hrtmkcel5jlp2mkwz3zomvc
119:	xyce	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/xyce-7.7.0-als6bbddavc2d2m6alyxsul2b7cd5toe
120:	zfp	/spack/opt/spack/linux-ubuntu20.04-ppc64le/gcc-9.4.0/zfp-1.0.0-qsgdtjjrij57atf3ns3elsd3uyj26ez4

Supports  
IBM Power10 and  
Power 9 processors

# E4S 23.11 Support for GPUs: NVIDIA CUDA

```
[Singularity> lscpu | grep "Model name"  
Model name: POWER10 (architected), altivec supported  
[Singularity> spack find +cuda  
-- linux-ubuntu20.04-ppc64le / gcc@9.4.0 -----  
adios2@2.9.1          ecp-data-vis-sdk@1.0  kokkos@4.0.00        paraview@5.11.2      tasmanian@8.0  
amrex@23.11           exago@1.6.0           kokkos@4.1.00        parsec@3.0.2209      tau@2.33  
arborx@1.4.1          flecsi@2.2.1          kokkos@4.1.00        petsc@3.20.1         trilinos@14.4.0  
blaspp@2023.08.25    flux-core@0.55.0      kokkos-kernels@4.0.00  petsc@3.20.1         umpire@6.0.0  
bricks@2023.08.25    ginkgo@1.6.0          lapackpp@2023.08.25   raja@0.14.0          umpire@2022.10.0  
cabana@0.6.0          heffte@2.4.0          magma@2.7.2           raja@2022.10.4       vtk-m@2.0.0  
caliper@2.10.0        hiop@1.0.0            mfem@4.6.0            slate@2023.08.25     zfp@0.5.5  
camp@0.2.3            hpctoolkit@2023.08.1  mgard@2023-03-31      slepc@3.20.0  
camp@2022.10.1        hpx@1.9.1             nvcomp@2.2.0          strumpack@7.2.0  
camp@2022.10.1        hwloc@2.9.1           omega-h@9.34.13       sundials@6.6.1  
chai@2022.03.0        hypre@2.29.0          papi@6.0.0.1         superlu-dist@8.1.2  
==> 51 installed packages  
Singularity> █
```

# 23.11 Release: 120+ Official Products + dependencies (gcc, aarch64)

1: adios2	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/adios2-2.9.1-uft22g2mrry7ga3uf6ef64qrgi524imh
2: alquimia	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/alquimia-1.1.0-2wtbogmb5utr7aobrs4aijy2utnp5dr3
3: aml	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/aml-0.2.1-w7viezgpmbzdttdjfneceskvam2llhd4h6
4: amrex	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/amrex-23.11-xrurplfkepihnygqubz5xwj3k76ej5eb
5: arborx	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/arborx-1.4.1-5uwjyf2axgvv4t25gpzgbvjb7blz3362
6: argobots	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/argobots-1.1-gr47krthtg5yafbughtbvfnisn53o6zt7
7: ascent	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/ascent-0.9.2-lhsneqzg7vthmcoy4ltmwnlp3ahqsid2
8: axom	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/axom-0.8.1-dqb2cku35wdlyifhdgc3doboih5iysny
9: blaspp	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/blaspp-2023.08.25-njb5lz7qcsinda7wnelql744jxsegxa6
10: bolt	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/bolt-2.0-eepeuib5dtu6tnwrkcb6kifv3w7kiqf
11: bricks	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/bricks-2023.08.25-4pgczi2ggeskz7gx3ijsk4nqkzndo42r
12: butterflypack	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/butterflypack-2.4.0-hifvtxgulqzkrinkadie2m3rlyqrefa
13: cabana	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/cabana-0.6.0-w7qg5cnaaejvjbpeyjopp2k6zkw4arwsb
14: caliper	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/caliper-2.10.0-jhmmthydhvt4femkmiedm7nyvwmwtwn5
15: camp	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/camp-2022.10.1-oop4gctvzf5rcvxpjglbxjfuzyghsiyz
16: chai	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/chai-2022.03.0-4xu2qmjt72vrplbjehwrzprmx5t7bld5
17: charliecloud	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/charliecloud-0.34-cagxu3tetwr3xkpln66r2ghzsmfbl3
18: conduit	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/conduit-0.8.8-lc56hbwnernfuiuzmrkb4ms6jm7lh4c4x
19: darshan-runtime	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/darshan-runtime-3.4.4-iwkj3a7xl4pnhwcjbczgcgskwxmqohfyo
20: datatransferkit	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/datatransferkit-3.1.1-xasaq5tdb6xbwjfugbivue3fdq2blwkw
21: dealii	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/dealii-9.4.2-ibonlcdumwguc54bqeoexpxpnwkemb2h
22: dyninst	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/dyninst-12.3.0-qdivrghrm4hn56hkuvzf7mefrlj6loid
23: ecp-data-vis-sdk	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/ecp-data-vis-sdk-1.0-agbw2rqivjmfzji74razmhn7cm6qgjh
24: exago	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/exago-1.6.0-k33qfrsqklgpzvci647zokzlo7hfprnn
25: exaworks	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/exaworks-0.1.0-mkgxnddmhxjes2v5ajvilrgh6jfnhcxx
26: faodel	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/faodel-1.2108.1-svalgqvueeyfvvjswiegrkmbom4zaih
27: flecsi	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/flecsi-2.2.1-4bxmrsca3z37qxyeyc6afv6cqz7qvnwo
28: flit	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/flit-2.1.0-tdnojm5tcfyh7rkb2nhztphqgvdqmdsz
29: flux-core	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/flux-core-0.55.0-ouxkxlx2ef3bj2aclxyjne4nccqyzkyy3
30: flux-sched	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/flux-sched-0.28.0-fxsxuwjwzwnwgqiekyniyuihgo7wgs7jl
31: fortrilinos	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/fortrilinos-2.3.0-m2i5xmdqxq6oft6bvj5o5mrdikzd4k4f
32: gasnet	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/gasnet-2023.3.0-wll3acsqgquumawdsbprb5cog7l4mkos
33: ginkgo	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/ginkgo-1.6.0-zww5mpt3axs5xmv2qgbcwroomp3skegg
34: globalarrays	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/globalarrays-5.8.2-hbum2e775x4odzjiqkcapht2u5sfww
35: gotcha	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/gotcha-1.0.4-mr2wu2wyzrnqlywugyeth23epm72htq7
36: gptune	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/gptune-4.0.0-354tew3jikrmdcs4xholtmr5p7tqj7nb
37: h5bench	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/h5bench-1.4-qbqzt6mkk7q3a4trolhb5kh3jl4jz52
38: hdf5	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/hdf5-1.14.3-nguuw5n5vi7vanfpjiyiffrbhzug6c3
39: hdf5-vol-async	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/hdf5-vol-async-1.7-f3s4vezg2c3ysz47oadlcaemwmsit3r6
40: hdf5-vol-cache	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/hdf5-vol-cache-v1.1-cvgyiu6sf5hzipmg7p3winnbahqou4xr

## GPU runtimes for aarch64

- CUDA 12.2
- NVHPC 23.9

## Languages

- Julia with MPI and CUDA
- Python

## EDA

- Xyce

## AI packages for NVIDIA GPU

- TensorFlow
- PyTorch
- JAX
- Horovod
- LBANN

# 23.11 Release: 120+ Official Products + dependencies (gcc, aarch64)

41: hdf5-vol-log	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/hdf5-vol-log-1.4.0-askwti2uhmlqciyotwmssu22nd7hfcpe
42: heffte	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/heffte-2.4.0-nlefprawl2amop2xn5yp76uducmdrgf7
43: hiop	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/hiop-1.0.0-c3pggtagjpkckfjytdyjiaaoliixjftf
44: hpctoolkit	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/hpctoolkit-2023.08.1-r7gu47hjez3dz63gg5kew7xe45r5kwx5
45: hpx	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/hpx-1.9.1-l2osvhyqf57w3zpqfksap5dcoxgucxegs
46: hypre	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/hypre-2.29.0-5yaiw5gbyngxmdlzeaoy66hzcqgkyu
47: kokkos	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/kokkos-4.1.00-kyfxs4ow7bcl4eftkxxukowvprs6oku
48: kokkos-kernels	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/kokkos-kernels-4.0.00-bdvue6m3nkkkq2x4g3jigmhhibs4mzaaf
49: lammmps	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/lammmps-20230802-zqaokelg4ucinzvltvfa5xubhukxsev
50: lapackpp	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/lapackpp-2023.08.25-nx5s7h3nofqg5qoqvbkfrp55ezv5piea
51: lbann	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/lbann-0.102-pvqyvg7f7j5jn6npdwr4o53qucfuwp3k
52: legion	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/legion-23.06.0-3xud3q7a4cmv25bq62ltc77yrlzulu5es
53: libnrm	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/libnrm-0.1.0-mc566yor3refvyrespcbg2xaewejaplw
54: libpressio	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/libpressio-0.95.1-dajhp3lomiflm2tlj5wo4e3lcxm26uqm
55: libquo	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/libquo-1.3.1-qdrq2fnjlyoeietws5hf66i2qm3d5sr7
56: loki	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/loki-0.1.7-c7vcttrw2dsxbf4lfpgeu3yg2wdra5h4
57: magma	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/magma-2.7.2-l4qpnzbrbh4q7a6bn6b2imt3iis7babn
58: mercury	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/mercury-2.3.1-7gi27gfvyfwav3feb6mrdhd6i2ejypa7
59: metall	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/metall-0.25-oihlh4zpwatnx5kj1ch4tupnphxrtnt
60: mfem	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/mfem-4.6.0-dzfpk6ksrqh6rqxchj7fty2r4rxzeph
61: mgard	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/mgard-2023-03-31-7wmscjugmga3sqfwdjstffyt6eeyccxg
62: mpark-variant	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/mpark-variant-1.4.0-sjcpjtlkzwjvlfwtc4upb74yp7cjwbcg
63: mpich	/usr/local/mpich/install/mpich
64: mpifileutils	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/mpifileutils-0.11.1-l2lodjtmwpu7uc147jsd4i6al523n7l5
65: nccmp	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/nccmp-1.9.1.0-krelczi3on2x75qekfvntq3wmnqolhyo
66: nco	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/nco-5.1.6-jmkhimcj3zn22exemhanqz3qgzom2qjq
67: netcdf-c	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/netcdf-c-4.9.2-sestahceq42gejet66jxfjyjt775lyd4
68: netlib-scalapack	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/netlib-scalapack-2.2.0-3jdyuvvzoa5hsxj6fxlx47pcrynf23g5
69: nrm	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/nrm-0.1.0-ze4bp63qs47yjwle5meg23bnxwm6wcjn
70: omega-h	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/omega-h-9.34.13-o3hrfhsxjuxmrazzyusevcwsdgobu3b
71: openfoam	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/openfoam-2306-svcidwoghv2d3upt6pyvqow5aytjqwny
72: openmpi	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/openmpi-4.1.6-tokf2wr56b5h7k6wfbwjbkc2detfjov
73: openpmd-api	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/openpmd-api-0.15.2-43zhb3zsjgx5rdkypc477uemxoloijsk
74: papi	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/papi-6.0.0.1-xl67muwm32gd7ihffvzhssrz3kmo77is
75: papyrus	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/papyrus-1.0.2-5seeb4y2ouo33pdlxrykllmacirzqlwv
76: parallel-netcdf	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/parallel-netcdf-1.12.3-hjrgtkmpfarivcjrqrjaaxt56er625e
77: paraview	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/paraview-5.11.2-mvx5wfwzxrxe4xv6ri7ylvfk3nvvzmxl
78: parsec	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/parsec-3.0.2209-qbpmkkrwxlwmkga2cvbk3qfh5cfsfpqc
79: pdt	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/pdt-3.25.1-ja6n6kerewjwq5heec2p7haznux3rta
80: petsc	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/petsc-3.20.1-mfome36qyemllxmz46fl7bpajhnyvcig

# 23.11 Release: 120+ Official Products + dependencies (gcc, aarch64)

81:	phist	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/phist-1.12.0-sqefaqj3bkvs72vg6y5invdhxzpvnkqj
82:	plasma	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/plasma-23.8.2-ksrdra6qy5vhl2b2mgyo2cahzmmtgouz
83:	plumed	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/plumed-2.9.0-edy6dyolgmvepjtegm46z5bviadiq4p
84:	precice	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/precice-2.5.0-kuyz5ezu2qilbqttqlvrarg73hasfq5l
85:	pruners-ninja	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/pruners-ninja-1.0.1-4tcd663wymmdiyijhyvolb4bj4nezzrm
86:	pumi	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/pumi-2.2.8-66yv6y63cnepeqlq76tucrhold7xdq2f
87:	py-cinemasci	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/py-cinemasci-1.3-254yajm7c2ehjphmuhhmpz5q5mrceuw
88:	py-jupyterhub	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/py-jupyterhub-1.4.1-tbuic7rvqnic4ahob7gbc32abzofhk5j
89:	py-libensemble	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/py-libensemble-1.0.0-xpgmddjq753ldshwq3xcoixvziegwvcd
90:	py-parsl	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/py-parsl-2023.08.21-33ccycqjtw6k25vdrehceg3xzbcnqnv
91:	py-radical-saga	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/py-radical-saga-1.20.0-3jfnfljb2jaxel6axgwiclols3an5ry7t
92:	qthreads	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/qthreads-1.18-whrpaz7mmgjxripbacnxwki4tl3mz2td
93:	quantum-espresso	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/quantum-espresso-7.2-uvm6s4d4zrljbrkb223lblopuzlzkv5o
94:	raja	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/raja-2022.10.4-t5wt2dllepntcgysiqiw7afjnyte5g7o
95:	rempi	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/rempi-1.1.0-7xeoova2qxwqjxkaweujgnfsfuiqpd
96:	scr	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/scr-3.0.1-ublrmcdmdyycgontq3gsthaieaptic
97:	slate	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/slate-2023.08.25-zm6apwfmfecft4boaua63bweohxosyva
98:	slepc	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/slepc-3.20.0-hi76rds7khmxyuiz6nrlqf2gomgt6m
99:	stc	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/stc-0.9.0-ami5ftjxjg6xfkbvx3ld6fdrd2met4qt
100:	strumpack	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/strumpack-7.2.0-y4jcz7od4sgmsnic7uea22r54kfo55d
101:	sundials	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/sundials-6.6.1-byxdyutgnn2e6zxut5iw2squaba4t42rz
102:	superlu-dist	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/superlu-dist-8.1.2-d6ygrw5kf7juhbj4psbpb5nmt6ndzjkk
103:	swig	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/swig-4.1.1-uxe5rqc6ckx2zskykft2jfcigtldo7
104:	sz	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/sz-2.1.12.5-xnlcrsdqfrc54yqhm3qec6kxz4j4vcvu
105:	sz3	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/sz3-3.1.7-ru6xv3yvmhrrmtwqi57dkwkp6jht45
106:	tasmanian	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/tasmanian-8.0-dzigpliqklwf3qifgyjbbodh44rj7bx
107:	tau	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/tau-2.33-iexs5h7d6fbqokbl4kxfkrj5b3l5wchs
108:	trilinos	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/trilinos-14.4.0-llnjmxf27uwjqac57tbxzxq3ogfr3wu
109:	turbine	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/turbine-1.3.0-lbxcndhw76uy6hf3tjlrxbmr5tisu7uj
110:	umap	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/umap-2.1.0-fv3b5twed65uguuwl2dslyilbnb7oop
111:	umpire	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/umpire-2022.10.0-j56z2ax27skkexmrfyxsfaazcl4ydmz
112:	unifyfs	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/unifyfs-1.1-exepusu7yo5cnukhq6ngevszobjbxismv
113:	upcxx	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/upcxx-2023.3.0-whffawlrdezubel6qiacindjmp7vktioa
114:	veloc	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/veloc-1.7-x6zhs lhptku6xqixa5c6qe4u6mqhaiw2
115:	visit	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/visit-3.3.3-ybdrxdnxgwaizyqzftkvd6mhgtjppq27w
116:	vtk-m	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/vtk-m-2.0.0-3p3w7nrimg6n6bo5qwbgc6pvbrueuyjfu
117:	wannier90	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/wannier90-3.1.0-bwhu37ygvhbu7x43au7qy3oevetk37su
118:	warpx	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/warpx-23.08-3jbeqgufv7bpik7qcbbv5tzbtdauwtk
119:	xyce	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/xyce-7.7.0-3qtj2llp6hmz4xohbjoaimhlg4m2uup
120:	zfp	/spack/opt/spack/linux-ubuntu20.04-aarch64/gcc-11.4.0/zfp-1.0.0-r5qrqfqpqgtmzvplmtwsnvgwoibe6rso

# E4S Support for GPUs: CUDA on aarch64

```
[Singularity> spack find +cuda
-- linux-ubuntu20.04-aarch64 / gcc@11.4.0 -----
adios2@2.9.1      dealii@9.4.2      kokkos@4.0.00     papi@6.0.0.1      tasmanian@8.0
amrex@23.11       ecp-data-vis-sdk@1.0 kokkos@4.1.00     paraview@5.11.2    tau@2.33
arborx@1.4.1      exago@1.6.0       kokkos@4.1.00     parsec@3.0.2209    trilinos@14.4.0
blaspp@2023.08.25 flecsi@2.2.1       kokkos-kernels@4.0.00 petsc@3.20.1      umpire@6.0.0
bricks@2023.08.25 flux-core@0.55.0   lammps@20230802   petsc@3.20.1      umpire@2022.10.0
cabana@0.6.0      ginkgo@1.6.0      lapackpp@2023.08.25 raja@0.14.0        upcxx@2023.3.0
caliper@2.10.0    heffte@2.4.0      legion@23.06.0    raja@2022.10.4    vtk-m@2.0.0
camp@0.2.3        hiop@1.0.0        magma@2.7.2       slate@2023.08.25   zfp@0.5.5
camp@2022.10.1    hpctoolkit@2023.08.1 mfem@4.6.0        slepc@3.20.0
camp@2022.10.1    hpx@1.9.1         mgard@2023-03-31 strumpack@7.2.0
chai@2022.03.0    hwloc@2.9.1       nvcomp@2.2.0     sundials@6.6.1
cusz@0.3.1        hypre@2.29.0      omega-h@9.34.13  superlu-dist@8.1.2
==> 56 installed packages
```

# E4S DOE LLVM Release: x86\_64, ppc64le, and aarch64

```
Singularity> spack find -x
```

```
-- linux-ubuntu20.04-x86_64 / clang@16.0.2 -----
```

```
adios@1.13.1 cabana@0.5.0 globalarrays@5.8.2 heffte@2.3.0 mfem@4.5.2 parsec@3.0.2209 sundials@6.5.1 umpire@2022.03.1  
aml@0.2.0 chai@2022.03.0 gmp@6.2.1 hypre@2.28.0 mpark-variant@1.4.0 pdt@3.25.1 superlu@5.3.0 upcxx@2023.3.0  
amrex@23.05 charliecloud@0.32 gotcha@1.0.4 legion@23.03.0 mpich@4.1.1 plumed@2.8.2 swig@4.0.2-fortran  
arborx@1.3 flit@2.1.0 h5bench@1.3 libnrm@0.1.0 nccmp@1.9.0.1 pumi@2.2.7 tasmanian@7.9  
argobots@1.1 flux-core@0.49.0 hdf5-vol-async@1.5 libquo@1.3.1 nco@5.1.5 qthreads@1.16 turbine@1.3.0  
bolt@2.0 gasnet@2023.3.0 hdf5-vol-log@1.4.0 libunwind@1.6.2 papyrus@1.0.2 stc@0.9.0 umap@2.1.0
```

```
-- linux-ubuntu20.04-x86_64 / gcc@11.1.0 -----
```

```
cmake@3.26.3 llvm-doe@16.0.2
```

```
Singularity> spack find -x
```

```
-- linux-ubuntu20.04-ppc64le / clang@16.0.2 -----
```

```
adios@1.13.1 cabana@0.5.0 globalarrays@5.8.2 heffte@2.3.0 mfem@4.5.2 parsec@3.0.2209 sundials@6.5.1 umpire@2022.03.1  
aml@0.2.0 chai@2022.03.0 gmp@6.2.1 hypre@2.28.0 mpark-variant@1.4.0 pdt@3.25.1 superlu@5.3.0 upcxx@2023.3.0  
amrex@23.05 charliecloud@0.32 gotcha@1.0.4 legion@23.03.0 mpich@4.1.1 plumed@2.8.2 swig@4.0.2-fortran  
arborx@1.3 flit@2.1.0 h5bench@1.3 libnrm@0.1.0 nccmp@1.9.0.1 pumi@2.2.7 tasmanian@7.9  
argobots@1.1 flux-core@0.49.0 hdf5-vol-async@1.5 libquo@1.3.1 nco@5.1.5 qthreads@1.16 turbine@1.3.0  
bolt@2.0 gasnet@2023.3.0 hdf5-vol-log@1.4.0 libunwind@1.6.2 papyrus@1.0.2 stc@0.9.0 umap@2.1.0
```

```
-- linux-ubuntu20.04-ppc64le / gcc@11.1.0 -----
```

```
cmake@3.26.3 llvm-doe@16.0.2
```

```
Singularity> spack find -x
```

```
-- linux-ubuntu20.04-aarch64 / clang@16.0.2 -----
```

```
adios@1.13.1 cabana@0.5.0 globalarrays@5.8.2 heffte@2.3.0 mfem@4.5.2 parsec@3.0.2209 sundials@6.5.1 umpire@2022.03.1  
aml@0.2.0 chai@2022.03.0 gmp@6.2.1 hypre@2.28.0 mpark-variant@1.4.0 pdt@3.25.1 superlu@5.3.0 upcxx@2023.3.0  
amrex@23.05 charliecloud@0.32 gotcha@1.0.4 legion@23.03.0 mpich@4.1.1 plumed@2.8.2 swig@4.0.2-fortran  
arborx@1.3 flit@2.1.0 h5bench@1.3 libnrm@0.1.0 nccmp@1.9.0.1 pumi@2.2.7 tasmanian@7.9  
argobots@1.1 flux-core@0.49.0 hdf5-vol-async@1.5 libquo@1.3.1 nco@5.1.5 qthreads@1.16 turbine@1.3.0  
bolt@2.0 gasnet@2023.3.0 hdf5-vol-log@1.4.0 libunwind@1.6.2 papyrus@1.0.2 stc@0.9.0 umap@2.1.0
```

```
-- linux-ubuntu20.04-aarch64 / gcc@11.1.0 -----
```

```
cmake@3.26.3 llvm-doe@16.0.2
```



# E4S Build Cache for Spack 0.21.0 hosted at U. Oregon

**E4S Build Cache for Spack 0.21.0**

To add this mirror to your Spack:

```
$> spack mirror add E4S https://cache.e4s.io
```

```
$> spack buildcache keys -it
```

**111,843 total packages**

Last updated 2023-11-09 15:48 PST

All Arch  PPC64LE  X86\_64  AARCH64

All OS  Centos 7  Centos 8  RHEL 7  RHEL 8  Ubuntu 18.04  Ubuntu 20.04

Search

[adiak@0.1.1](#) [adiak@0.2.1](#) [adiak@0.2.2](#) [adios2@2.5.0](#) [adios2@2.6.0](#) [adios2@2.7.0](#) [adios2@2.7.1](#) [adios2@2.8.0](#) [adios2@2.8.3](#) [adios@1.13.1](#) [adlbox@0.9.2](#) [adlbox@1.0.0](#)

[adol-c@2.7.2](#) [alquimia@1.0.10](#) [alquimia@1.0.9](#) [alsa-lib@1.2.3.2](#) [amg@1.2](#) [aml@0.1.0](#) [aml@0.2.0](#) [amr-wind@ascent](#) [amr-wind@main](#) [amrex@20.07](#) [amrex@20.09](#)

[amrex@20.10](#) [amrex@20.11](#) [amrex@20.12](#) [amrex@21.01](#) [amrex@21.02](#) [amrex@21.03](#) [amrex@21.04](#) [amrex@21.05](#) [amrex@21.06](#) [amrex@21.07](#) [amrex@21.08](#) [amrex@21.09](#)

[amrex@21.10](#) [amrex@21.11](#) [amrex@21.12](#) [amrex@22.01](#) [amrex@22.02](#) [amrex@22.03](#) [amrex@22.04](#) [amrex@22.05](#) [amrex@22.08](#) [amrex@22.11](#) [ant@1.10.0](#) [ant@1.10.7](#)

[antlr@2.7.7](#) [apcomp@0.0.4](#) [arborx@0.9-beta](#) [arborx@1.0](#) [arborx@1.1](#) [arborx@1.2](#) [arborx@1.3](#) [archer@2.0.0](#) [argobots@1.0](#) [argobots@1.0rc1](#) [argobots@1.0rc2](#) [argobots@1.1](#)

[argobots@main](#) [arpack-ng@3.7.0](#) [arpack-ng@3.8.0](#) [ascent@0.6.0](#) [ascent@0.7.0](#) [ascent@0.7.1](#) [ascent@0.8.0](#) [ascent@develop](#) [ascent@pantheon\\_ver](#) [asio@1.16.1](#) [asio@1.18.2](#)

[asio@1.20.0](#) [asio@1.21.0](#) [assimp@4.0.1](#) [assimp@5.0.1](#) [assimp@5.1.4](#) [assimp@5.2.2](#) [assimp@5.2.3](#) [assimp@5.2.4](#) [at-spi2-atk@2.38.0](#) [at-spi2-core@2.40.1](#) [atk@2.36.0](#)

[autoconf-archive@2019.01.06](#) [autoconf-archive@2022.02.11](#) [autoconf@2.69](#) [autoconf@2.70](#) [automake@1.15.1](#) [automake@1.16.1](#) [automake@1.16.2](#) [automake@1.16.3](#) [automake@1.16.5](#)

[axl@0.1.1](#) [axl@0.3.0](#) [axl@0.4.0](#) [axl@0.5.0](#) [axl@0.6.0](#) [axl@0.7.1](#) [axom@0.3.3](#) [axom@0.4.0](#) [axom@0.5.0](#) [axom@0.6.1](#) [axom@0.7.0](#) [bacio@2.4.1](#) [bash@5.0](#) [bats@0.4.0](#)

[bdftopcf@1.0.5](#) [berkeley-db@18.1.40](#) [berkeley-db@6.2.32](#) [binutils@2.31.1](#) [binutils@2.32](#) [binutils@2.33.1](#) [binutils@2.34](#) [binutils@2.36.1](#) [binutils@2.37](#) [binutils@2.38](#) [bison@3.4.2](#)

[bison@3.6.4](#) [bison@3.7.4](#) [bison@3.7.6](#) [bison@3.8.2](#) [bitgroomingz@2022-10-14](#) [blaspp@2020.10.02](#) [blaspp@2021.04.01](#) [blaspp@2022.05.00](#) [blaspp@2022.07.00](#) [blt@0.3.6](#)

[blt@0.3.6rocm](#) [blt@0.4.0](#) [blt@0.4.1](#) [blt@0.5.0](#) [blt@0.5.1](#) [blt@0.5.2](#) [blt@develop](#) [bmi@develop](#) [bmi@main](#) [bolt@1.0](#) [bolt@1.0rc2](#) [bolt@1.0rc3](#) [bolt@2.0](#) [boost@1.68.0](#)

[boost@1.70.0](#) [boost@1.72.0](#) [boost@1.73.0](#) [boost@1.74.0](#) [boost@1.75.0](#) [boost@1.76.0](#) [boost@1.77.0](#) [boost@1.78.0](#) [boost@1.79.0](#) [boost@1.80.0](#) [bricks@r0.1](#) [bufr@11.5.0](#)

- Over 110K binaries!
- No need to recompile from source code

# E4S 23.11 AWS image: ami-08c2daa0fb4864b90 in US-West-2 (OR)

The screenshot displays a Linux desktop environment with the following components:

- ParaView 5.9.0:** A 3D visualization of a pressure field on a surface, showing a color gradient from blue (0.0e+00) to red (1.2e-38).
- TAU ParaProf Statistics:** A table showing performance metrics for various components.
 

Name	Exclusive Time	Inclusive Time
.TAU application	8.784	218.852
Belos: Operation Op*x	0.629	0.706
Belos: PseudoBlockGmresSolMgr total solve time	0.615	65.591
Belos: ICGS[2]: Orthogonalization	0.22	18.854
Belos: Operation Op*x	1.672	2.32
Belos: Operation Prec*x	7.617	43.327
Ifpack2::Chebyshev::apply	4.76	25.865
Kokkos::parallel_for Kokkos::View::initialization [DualV	0.003	0.003
Kokkos::parallel_for Kokkos::View::initialization [MV::D	0.004	0.004
Kokkos::parallel_for Kokkos::View::initialization [export	0.002	0.002
Kokkos::parallel_for Kokkos::View::initialization [import	0.002	0.002
- Terminal:** Shows the output of the `singularity run` command, listing installed modules such as `adiak/0.2.1-4vc`, `amrex/21.11-roc6cm`, and `parmetis/4.0.3-vhi`.

## E4S AWS

- Intel oneAPI
- CUDA
- NVHPC
- ROCm
- AWS DCV
- Spack Build Cache
- ECP: Nalu-Wind
- Trinos
- OpenFOAM
- ParaView
- TAU
- Docker
- Shifter
- Charliecloud
- E4S Singularity...

# E4S for Commercial Cloud Platforms for EDA on AWS

- E4S: HPC Software Ecosystem – a curated software portfolio for Electronic Design Automation

The screenshot displays a Linux desktop environment with several windows open:

- Xschem - top.sch**: A schematic editor window showing a circuit diagram with components like PERP, VPP, CAP, RERAM, ES, VARACTORS, MIM, PFET, NFET, RES, DIODE, PNP, and NPN. It includes a 'Layers' menu and various simulation options.
- KLayout 0.28.5**: A layout editor window showing a 3D rendering of a golden sphere with a large black letter 'K' on its surface.
- Terminal**: A terminal window showing the installation and configuration of EDA tools. The commands and output are as follows:
 

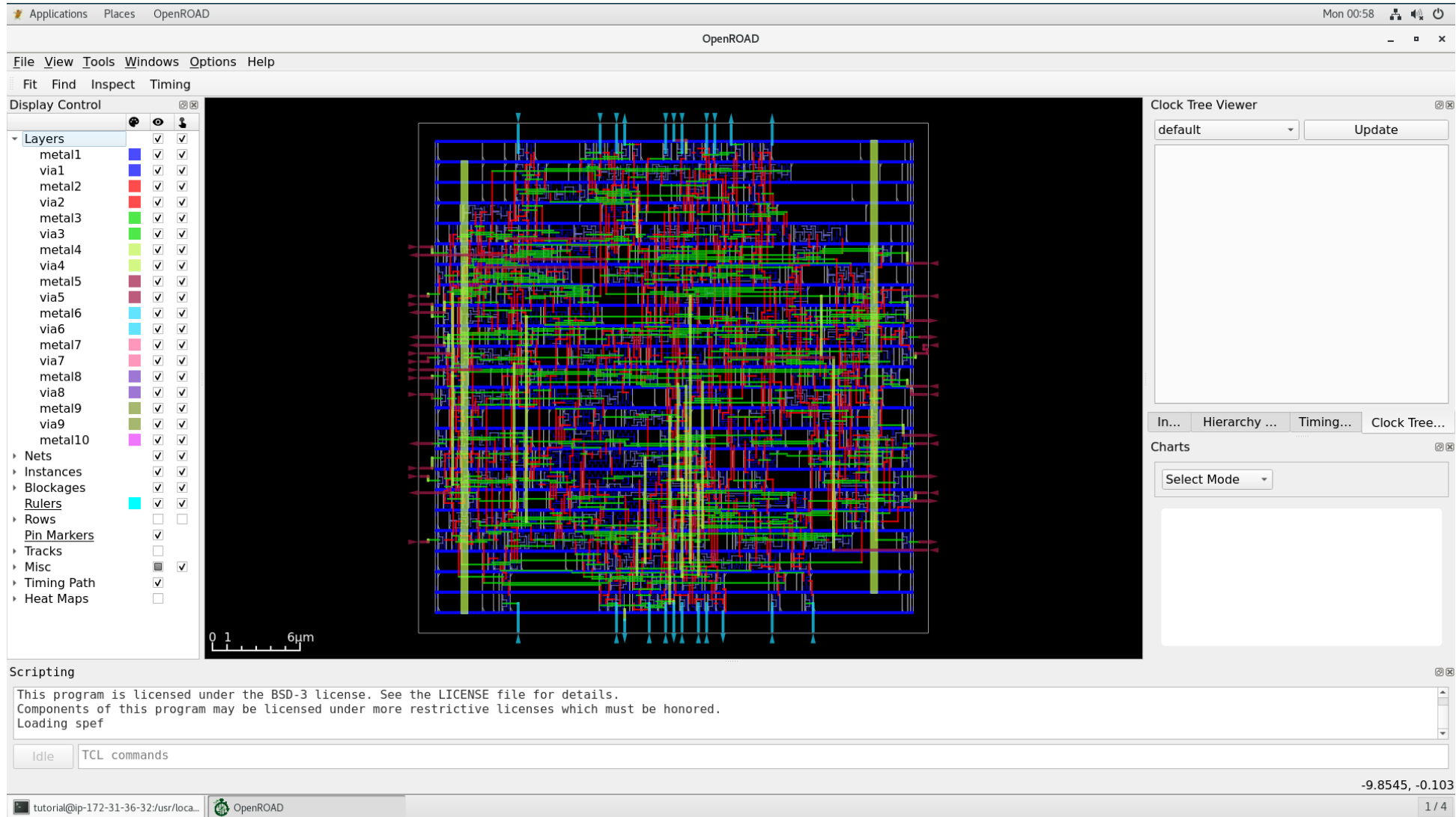
```
[tutorial@ip-172-31-43-167 eda]$ module load eda
[tutorial@ip-172-31-43-167 eda]$ pwd
/usr/local/packages/eda
[tutorial@ip-172-31-43-167 eda]$ ls
act-022223          netgen-1.5          qucs-s-0.0.23
adms-022223        ngspice-39          rggen-021423
boost-1.80.0       nvc-021423          riscv-gnu-toolchain-rv32ia-021423
fault-021423       open_pdks-1.0.393  SRC
gds3d-021423       openroad-021123    swift-5.7.3
ghdl-021423        opensta-021123     tar
graywolf-0.1.6     opentimer-021123   verilator-021423
gtkwave-gtk3-021423 or-tools-021123    xcircuit-3.10.30
irsim-9.7.116      padring-021423     xschem-021323
iverilog-021423    pcb-3.0.98         xscheme-gaw-021423
klayout-0.28.5     qflow-1.4          yosys-021123
magic-8.3          qrouter-1.4
[tutorial@ip-172-31-43-167 eda]$ python3
Python 3.7.16 (default, Dec 15 2022, 23:24:54)
[GCC 7.3.1 20180712 (Red Hat 7.3.1-15)] on linux
Type "help", "copyright", "credits" or "license()" for more information.
>>> import openram
>>> import cocotb
>>> import amaranth
>>> import edalize
>>> import gdsfactory
2023-02-23 02:21:35.822 | INFO | gdsfactory.config:<module>:51 - Load '/home/tutorial/.local/lib/python3.7/site-packages/gdsfactory' 6.38.0
2023-02-23 02:21:35.876 | INFO | gdsfactory.technology.layer_views: _init_
:780 - Importing LayerViews from KLayout layer properties file: /home/tutorial/.local/lib/python3.7/site-packages/gdsfactory/generic_tech/klayout/tech/layers.lyp.
mp>>> import gdspys
>>> import pyverilog
>>> import spyci
>>> import volare
>>> import siliconcompiler
>>>
[tutorial@ip-172-31-43-167 eda]$ ls /usr/local/packages/eda/SRC/OpenLane/
AUTHORS.md      designs         install         pdks             requirements.txt
configuration   docker          Jenkinsfile    README.md       run_designs.py
CONTRIBUTING.md docs            klayoutrc      regression_results scripts
default.cvcrc   env.py          LICENSE        requirements_dev.txt tests
dependencies    flow.tcl       Makefile       requirements_lint.txt venv
[tutorial@ip-172-31-43-167 eda]$ magic --version
8.3.365
[tutorial@ip-172-31-43-167 eda]$ conda activate openfasoc
(openfasoc) [tutorial@ip-172-31-43-167 eda]$ magic --version
8.3.303
(openfasoc) [tutorial@ip-172-31-43-167 eda]$
```
- Qflow Manager**: A window showing a checklist of tasks for project preparation, synthesis, placement, static timing analysis, routing, post-route STA, migration, DRC, LVS, and GDS.

## E4S EDA on AWS

- Magic
- ACT
- Klayout
- Qflow
- Xschem
- Xcircuit
- Yosys
- Volator
- OpenROAD
- OpenLane
- iVerilog
- Gtkwave
- Irsim
- Qrouter
- Fault
- GDS3D
- Rggen
- Python tools
  - Cocotb
  - Amaranth
  - Edalize
  - Gdsfactory
  - Gdspys
  - OpenRAM
  - Gdstk
  - Silicon compiler
  - Volare ...
- PDKs
  - GF
  - Skywater

# E4S for Commercial Cloud Platforms for EDA on AWS

- E4S: HPC Software Ecosystem – a curated software portfolio for Electronic Design Automation. Microwatt CPU (IBM) in OpenROAD.



## E4S EDA on AWS

- Magic
- ACT
- Klayout
- Qflow
- Xschem
- Xcircuit
- Yosys
- Volator
- OpenROAD
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- iVerilog
- Gtkwave
- Irsim
- Qrouter
- Fault
- GDS3D
- Rggen
- Python tools
  - Cocotb
  - Amaranth
  - Edalize
  - Gdsfactory
  - Gdspy
  - OpenRAM
  - Gdstk
  - Silicon compiler
  - Volare ...
- PDKs
  - GF
  - Skywater

# E4S for Commercial Cloud Platforms for EDA on AWS

- E4S: HPC Software Ecosystem – a curated software portfolio for Electronic Design Automation

#	Packages currently in E4S	URL	#	Packages currently in E4S	URL
1	Magic	<a href="http://opencircuitdesign.com/magic/">http://opencircuitdesign.com/magic/</a>	13	Yosys	<a href="https://github.com/YosysHQ/yosys">https://github.com/YosysHQ/yosys</a>
2	Xyce	<a href="https://xyce.sandia.gov">https://xyce.sandia.gov</a>	14	Xcircuit	<a href="http://opencircuitdesign.com/xcircuit/">http://opencircuitdesign.com/xcircuit/</a>
3	NGSPICE	<a href="https://ngspice.sourceforge.io">https://ngspice.sourceforge.io</a>	15	Graywolf	<a href="https://github.com/rubund/graywolf">https://github.com/rubund/graywolf</a>
4	KLayout	<a href="https://www.klayout.de">https://www.klayout.de</a>	16	OpenSTA	<a href="https://github.com/The-OpenROAD-Project/OpenSTA">https://github.com/The-OpenROAD-Project/OpenSTA</a>
5	Qflow	<a href="http://opencircuitdesign.com/qflow">http://opencircuitdesign.com/qflow</a>	17	OpenTimer	<a href="https://github.com/OpenTimer/OpenTimer">https://github.com/OpenTimer/OpenTimer</a>
6	OR-Tools	<a href="https://developers.google.com/optimization">https://developers.google.com/optimization</a>	18	Qrouter	<a href="http://opencircuitdesign.com/qrouter/">http://opencircuitdesign.com/qrouter/</a>
7	IRSIM	<a href="http://opencircuitdesign.com/irsim/">http://opencircuitdesign.com/irsim/</a>	19	Xschem	<a href="https://github.com/silicon-vlsi-org/eda-xschem">https://github.com/silicon-vlsi-org/eda-xschem</a>
8	OpenROAD	<a href="https://github.com/The-OpenROAD-Project/OpenROAD">https://github.com/The-OpenROAD-Project/OpenROAD</a>	20	RISC-V GNU Toolchain	<a href="https://github.com/riscv-collab/riscv-gnu-toolchain">https://github.com/riscv-collab/riscv-gnu-toolchain</a>
9	OpenLane	<a href="https://openlane.readthedocs.io/">https://openlane.readthedocs.io/</a>	21	Fault: Design for Test	<a href="https://github.com/AUCOHL/Fault">https://github.com/AUCOHL/Fault</a>
10	OpenFASOC	<a href="https://openfasoc.readthedocs.io/">https://openfasoc.readthedocs.io/</a>	22	NVC	<a href="https://github.com/nickg/nvc">https://github.com/nickg/nvc</a>
11	Open_PDKs	<a href="http://opencircuitdesign.com/open_pdks/">http://opencircuitdesign.com/open_pdks/</a>	23	Amaranth	<a href="https://github.com/amaranth-lang/amaranth">https://github.com/amaranth-lang/amaranth</a>
12	Netgen	<a href="http://opencircuitdesign.com/netgen/">http://opencircuitdesign.com/netgen/</a>	24	Cocotb	<a href="https://github.com/cocotb/cocotb">https://github.com/cocotb/cocotb</a>

# E4S for Commercial Cloud Platforms for EDA on AWS

- E4S: HPC Software Ecosystem – a curated software portfolio for Electronic Design Automation

#	Packages currently in E4S	URL	#	Packages currently in E4S	URL
25	Covered	<a href="https://github.com/hpretl/verilog-covered">https://github.com/hpretl/verilog-covered</a>	37	Padring	<a href="https://github.com/donn/padring">https://github.com/donn/padring</a>
26	Edalize	<a href="https://github.com/olofk/edalize">https://github.com/olofk/edalize</a>	38	Pyverilog	<a href="https://github.com/PyHDI/Pyverilog">https://github.com/PyHDI/Pyverilog</a>
27	Gaw3-xschem	<a href="https://github.com/StefanSchippers/xschem-gaw.git">https://github.com/StefanSchippers/xschem-gaw.git</a>	39	OpenRAM	<a href="https://github.com/VLSIDA/OpenRAM">https://github.com/VLSIDA/OpenRAM</a>
28	GDSFactory	<a href="https://github.com/gdsfactory/gdsfactory">https://github.com/gdsfactory/gdsfactory</a>	40	Rggen	<a href="https://github.com/rggen/rggen">https://github.com/rggen/rggen</a>
29	GDSPy	<a href="https://github.com/heitzmann/gdspy">https://github.com/heitzmann/gdspy</a>	41	Spyci	<a href="https://github.com/gmagno/spyci">https://github.com/gmagno/spyci</a>
30	GDS3D	<a href="https://github.com/trilomix/GDS3D">https://github.com/trilomix/GDS3D</a>	42	Volare	<a href="https://github.com/efabless/volare">https://github.com/efabless/volare</a>
31	Ghdl	<a href="https://github.com/ghdl/ghdl">https://github.com/ghdl/ghdl</a>	43	Siliconcompiler	<a href="https://github.com/siliconcompiler/siliconcompiler">https://github.com/siliconcompiler/siliconcompiler</a>
32	Gtkwave	<a href="https://github.com/gtkwave/gtkwave">https://github.com/gtkwave/gtkwave</a>	44	Verilator	<a href="https://github.com/verilator/verilator">https://github.com/verilator/verilator</a>
33	iic-osic	<a href="https://github.com/hpretl/iic-osic.git">https://github.com/hpretl/iic-osic.git</a>	45	Sky130	SkyWater Technologies 130nm CMOS PDK
34	Iverilog	<a href="https://github.com/steveicarus/iverilog.git">https://github.com/steveicarus/iverilog.git</a>	46	Actflow	<a href="https://github.com/asynclsi/actflow.git">https://github.com/asynclsi/actflow.git</a>
35	Netlistsvg	<a href="https://github.com/nturley/netlistsvg">https://github.com/nturley/netlistsvg</a>	47	Qucs-s	<a href="https://github.com/Qucs">https://github.com/Qucs</a>
36	Ngspyce	<a href="https://github.com/ignamv/ngspyce">https://github.com/ignamv/ngspyce</a>	48	ADMS	<a href="https://github.com/Qucs/ADMS.git">https://github.com/Qucs/ADMS.git</a>
			49	Gdstk	<a href="https://heitzmann.github.io/gdstk/">https://heitzmann.github.io/gdstk/</a>
			50	xcell	<a href="https://github.com/asynclsi/xcell.git">https://github.com/asynclsi/xcell.git</a>

# e4s-cl: A tool to simplify the launch of MPI jobs in E4S containers

- E4S containers support replacement of MPI libraries using MPICH ABI compatibility layer and Wi4MPI [CEA] for OpenMPI replacement.
- Applications binaries built using E4S can be launched with Singularity using MPI library substitution for efficient inter-node communications.
- e4s-cl is a new tool that simplifies the launch and MPI replacement.
  - e4s-cl init --backend [singularity|shifter|docker] --image <file> --source <startup\_cmds.sh>
  - e4s-cl mpirun -np <N> <command>

- Usage:

```
% e4s-cl init --backend singularity --image ~/images/e4s-gpu-x86.sif --source ~/source.sh
% cat ~/source.sh
  . /spack/share/spack/setup-env.sh
  spack load trilinos+cuda cuda_arch=80
% e4s-cl mpirun -np 4 ./a.out
```



# New release of e4s-cl on GitHub

The screenshot displays the GitHub repository page for `E4S-Project/e4s-cl`. The repository is public and has 11 stars and 1 fork. The main content area shows a list of files and folders with their commit history:

File/Folder	Commit Message	Time
<code>.github/workflows</code>	Updated python	10 months ago
<code>assets/images</code>	Proper image conversion	last year
<code>docs</code>	Sameer report sync	last month
<code>e4s_cl</code>	Allow non-existing paths to source scripts	last month
<code>scripts</code>	Merge branch 'makefile-cleanup' into init-update	last month
<code>tests</code>	Merge branch 'makefile-cleanup' into init-update	last month
<code>.coveragerc</code>	Introduced the coverage tool	last year
<code>.gitignore</code>	Replace setup.py with pyproject.toml	2 months ago
<code>.gitlab-ci.yml</code>	added .gitlab-ci.yml file in order to use gitlab's continuous inte...	8 months ago
<code>.readthedocs.yaml</code>	Adapt documentation build to PEP518	2 months ago
<code>CHANGELOG</code>	Update CHANGELOG	last month
<code>LICENSE</code>	Updated LICENSE	2 years ago

The right sidebar shows the repository's metadata, including the description "Container manager for E4S", the website `e4s-cl.readthedocs.io`, and tags for various container managers: `containers`, `mpi`, `singularity-container`, `shifter`, `podman`, `apptainer`, and `e4s`. The "Releases" section shows 9 releases, with the latest release, `E4S-CL release v1.0.2`, highlighted in a blue box. This release was published on Mar 31 and is marked as the "Latest" version.

<https://github.com/E4S-Project/e4s-cl>



# E4S: Open Source Development on GitHub

The screenshot shows the GitHub repository for E4S-Project/e4s. The left sidebar displays the file tree with the '23.11' directory selected. The main content area shows a commit by eugenewalker titled 'Update README.md' from 5 hours ago. Below the commit is a table of files and their commit messages:

Name	Last commit message	Last commit date
..		
cuda-aarch64	e4s 23.11 environments added	5 hours ago
cuda-ppc64le	e4s 23.11 environments added	5 hours ago
cuda-x86_64	e4s 23.11 environments added	5 hours ago
oneapi-x86_64	e4s 23.11 environments added	5 hours ago
rocm-x86_64	e4s 23.11 environments added	5 hours ago
README.md	Update README.md	5 hours ago

Below the table is the content of the README.md file, titled 'E4S Release 23.11'. It includes the text: 'November 2023 release of E4S' and a section 'Files' listing several Model Spack Environment files:

- `cuda-x86_64/spack.yaml` -- Model Spack Environment for systems w/ NVIDIA GPUs (x86\_64)
- `cuda-ppc64le/spack.yaml` -- Model Spack Environment for systems w/ NVIDIA GPUs (ppc64le)
- `cuda-aarch64/spack.yaml` -- Model Spack Environment for systems w/ NVIDIA GPUs (aarch64)
- `rocm-x86_64/spack.yaml` -- Model Spack Environment for systems w/ AMD GPUs (x86\_64)
- `oneapi-x86_64/spack.yaml` -- Model Spack Environment for systems w/ Intel GPUs (x86\_64)

The README also mentions `concretize.log` files and provides instructions on commenting out specs in the Model Spack Environments.

<https://github.com/E4S-Project>

# Release of custom E4S images: Waggle and SAGE projects

The screenshot shows the Docker Hub page for the repository `ecpe4s/waggle-ml`. The repository is owned by `ecpe4s` and was updated 13 days ago. It has 137 pulls. The 'Tags' section is active, showing a table of image tags. The 'latest' tag is highlighted with a blue border. The table lists the OS/ARCH, last pull date, and compressed size for each tag.

TAG	OS/ARCH	LAST PULL	COMPRESSED SIZE
latest	linux/amd64	3 days ago	9.15 GB
	linux/arm64	3 days ago	1.58 GB

`% docker pull ecpe4s/waggle-ml`

The screenshot shows the website for the SAGE project, hosted by Argonne National Laboratory. The page title is "SAGE: A Software-Defined Sensor Network". The text describes the project as building a national research infrastructure of new sensors that support programmable edge computers and machine learning within an interconnected cyberinfrastructure, spanning multiple major science instruments. The website features a navigation menu with links for CAREERS, NEWS, EVENTS, STAFF DIRECTORY, RESEARCH, WORK WITH US, COMMUNITY, and ABOUT US. A sidebar on the right contains a "MCS Division" menu with links for About MCS, Research, News, Events, and Publications. Social media sharing icons for Facebook, Twitter, LinkedIn, and Email are also present. The project status is listed as "Active".

## SAGE: A Software-Defined Sensor Network

SAGE will build a national research infrastructure of new sensors that support programmable edge computers and machine learning within an interconnected cyberinfrastructure, spanning multiple major science instruments

# SAGE

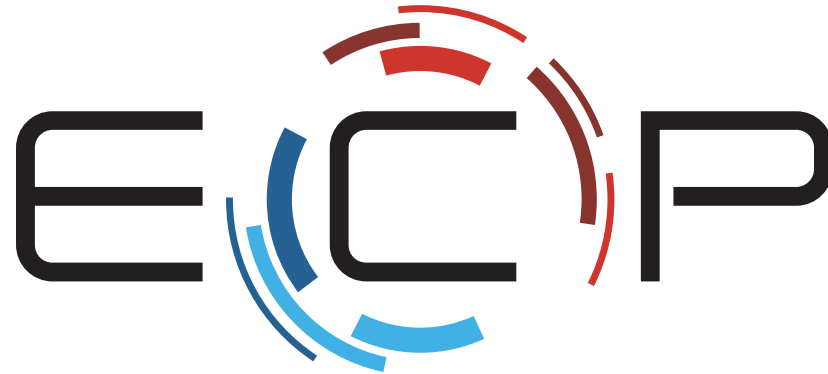
*A Software-Defined Sensor Network*  
**Cyberinfrastructure for AI at the Edge**

[www.sagecontinuum.org](http://www.sagecontinuum.org)

# Thank you

<https://www.exascaleproject.org>

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EXASCALE COMPUTING PROJECT

**Thank you** to all collaborators in the ECP and broader computational science communities. The work discussed in this presentation represents creative contributions of many people who are passionately working toward next-generation computational science.

