

LUMI

A white wolf is the central focus, standing in a futuristic, blue-toned digital environment. The background is filled with vertical data streams, grid patterns, and glowing particles, creating a high-tech, cybernetic atmosphere. The wolf is looking slightly to the right of the viewer.

LUMI Software Stacks

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Software stack design considerations

L U M I

- Very leading edge and inhomogeneous machine (new interconnect, new GPU architecture with an immature software ecosystem, some NVIDIA GPUs for visualisation, a mix of zen2 and zen3)
 - Need to remain agile
- Users that come to LUMI from 11 different channels (not counting subchannels), with different expectations
- Small central support team considering the expected number of projects and users and the tasks the support team has
 - But contributions from local support teams
- Cray Programming Environment is a key part of our system
- Need for customised setups
 - Everybody wants a central stack as long as their software is in there but not much more
 - Look at the success of conda, Python virtual environments, containers, ...

The LUMI solution

LUMI

- Software organised in extensible software stacks based on a particular release of the PE
 - Many base libraries and some packages already pre-installed
 - Easy way to install additional packages in project space
- Modules managed by Lmod
 - More powerful than the (old) Modules Environment
 - Powerful features to search for modules
- EasyBuild is our primary tool for software installations
 - But uses HPE Cray specific toolchains
 - Offer a library of installation recipes
 - User installations integrate seamlessly with the central stack
 - We do have a Spack setup but don't do development in Spack ourselves

- Bring-your-own-license except for a selection of tools that are useful to a larger community
 - One downside of the distributed user management is that we do not even have the information needed to determine if a particular userid can use a particular software license
 - Even for software on the system, users remain responsible for checking the license!
- LUST tries to help with installations of recent software, but porting or bug fixing is not our work
 - Not all Linux or even supercomputer software will work on LUMI
 - We're too small a team to do all software installations, so don't count on us to do all the work
- Conda, (large) Python installations need to go in containers
 - We offer a container-based wrapper ([lumi-container-wrapper](#)) to do that

Organisation: Software stacks

L U M I

- **CrayEnv:** Cray environment with some additional tools pushed in through EasyBuild
- **LUMI** stacks, each one corresponding to a particular release of the PE
 - Work with the Cray PE modules, but accessed through a replacement for the PrgEnv-* modules
 - Tuned versions for the 3 ~~4~~ types of hardware: zen2 (login, large memory nodes), zen3 (LUMI-C compute nodes), ~~zen2 + NVIDIA GPU (visualisation partition)~~, zen3 + MI250X (LUMI-G GPU partition)
- **spack:** Install software with Spack using compilers from the PE
 - Offered as-is for users who know Spack, but we do not do development in Spack
- Far future: Stack based on common EB toolchains as-is for LUMI-C

Accessing the Cray PE on LUMI

3 different ways

- Very bare environment available directly after login
 - What you can expect on a typical Cray system
 - Few tools as only the base OS image is available
 - User fully responsible for managing the target modules
- **CrayEnv**
 - “Enriched” Cray PE environment
 - Takes care of managing the target modules: (re)loading CrayEnv will reload an optimal set for the node you’re on
 - Some additional tools, e.g., newer build tools (offered here and not in the bare environment as we need to avoid conflicts with other software stacks)
 - Otherwise used in the way discussed in this course

Accessing the Cray PE on LUMI

3 different ways

- **LUMI** software stack
 - Each stack based on a particular release of the HPE Cray PE
 - Other modules are accessible but hidden from the default view
 - Better not to use the PrgEnv modules but the EasyBuild LUMI toolchains

HPE Cray PE	LUMI toolchain	
PrgEnv-cray	cpeCray	Cray Compiling Environment
PrgEnv-gnu	cpeGNU	GNU C/C++ and Fortran
PrgEnv-aocc	cpeAOCC	AMD CPU compilers
PrgEnv-amd	cpeAMD	AMD ROCm GPU compilers (LUMI-G only)

- Environment in which we install most software (mostly with EasyBuild)

Accessing the Cray PE on LUMI

The LUMI software stack

LUMI

- The LUMI software stack uses two levels of modules
 - LUMI/22.08, LUMI/22.12, LUMI/23.03: Versions of the LUMI stack
 - partition/L, partition/C, partition/G (and ~~future partition/D~~): To select software optimised for the respective LUMI partition
 - partition/L is for both the login nodes and the large memory nodes (4TB)
 - Hidden partition/common for software that is available everywhere, but be careful using it for your own installs
 - When (re)loaded, the LUMI module will load the best matching partition module.
 - So be careful in job scripts: When your job starts, the environment will be that of the login nodes, but if you trigger a reload of the LUMI module it will be that of the compute node!

Installing software on HPC systems

- Software on an HPC system is rarely installed from RPM
 - Generic RPMs not optimised for the specific CPU
 - Generic RPMs may not work with the specific LUMI environment (SlingShot interconnect, kernel modules, resource manager)
 - Multi-user system so usually no “one version fits all”
 - Need a small system image as nodes are diskless
- Spack and EasyBuild are the two most popular HPC-specific software build and installation frameworks
 - Usually install from sources to adapt the software to the underlying hardware and OS
 - Installation instructions in a way that can be communicated and executed easily
 - Make software available via modules
 - Dependency handling compatible with modules

Extending the LUMI stack with EasyBuild

- Fully integrated in the LUMI software stack
 - Load the LUMI module and modules should appear in your module view
 - EasyBuild-user module to install packages in your user space
 - Will use existing modules for dependencies if those are already on the system or in your personal/project stack
- EasyBuild built-in easyconfigs do not work on LUMI, not even on LUMI-C
 - GNU-based toolchains: Would give problems with MPI
 - Intel-based toolchains: Intel compilers and AMD CPUs are a problematic cocktail
- Library of recipes that we made in the [LUMI-EasyBuild-contrib GitHub repository](#)
 - EasyBuild-user will find a copy on the system or in your install
 - List of recipes in lumi-supercomputer.github.io/LUMI-EasyBuild-docs

EasyBuild recipes - easyconfigs

- Build recipe for an individual package = module
 - Relies on either a generic or a specific installation process provided by an easyblock
- Steps
 - Downloading sources and patches
 - Typical configure – build – (test) – install process
 - Extensions mechanism for perl/python/R packages
 - Some simple checks
 - Creation of the module
- All have several parameters in the easyconfig file

The toolchain concept

- A set of compiler, MPI implementation and basic math libraries
 - Simplified concept on LUMI as there is no hierarchy as on some other EasyBuild systems
- These are the cpeCray, cpeGNU, cpeAOCC and cpeAMD modules mentioned before!

HPE Cray PE	LUMI toolchain	
PrgEnv-cray	cpeCray	Cray Compiling Environment
PrgEnv-gnu	cpeGNU	GNU C/C++ and Fortran
PrgEnv-aocc	cpeAOCC	AMD CPU compilers
PrgEnv-amd	cpeAMD	AMD ROCm GPU compilers (LUMI-G only)

The toolchain concept (2)

- Special toolchain: SYSTEM to use the system compiler
 - Does not fully function in the same way as the other toolchains when it comes to dependency handling
 - Used on LUMI for CrayEnv and some packages with few dependencies
- It is not possible to load packages from different cpe toolchains at the same time
 - EasyBuild restriction, because mixing libraries compiled with different compilers does not always work
- Packages compiled with one cpe toolchain can be loaded together with packages compiled with the SYSTEM toolchain
 - But we do avoid mixing them when linking

easyconfig names and module names

GROMACS-2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU.eb



Name of the package



Version of the package



Toolchain name and version (missing for SYSTEM)



Additional information

Module: GROMACS/2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU

Installing

Step 1: Where to install

L U M I

- Default location is `$HOME/EasyBuild`
- But better is to install in your project directory for the whole project
 - `export EBU_USER_PREFIX=/project/project_465000000/EasyBuild`
 - Set this *before* loading the LUMI module
 - All users of the software tree have to set this environment variable to use the software tree

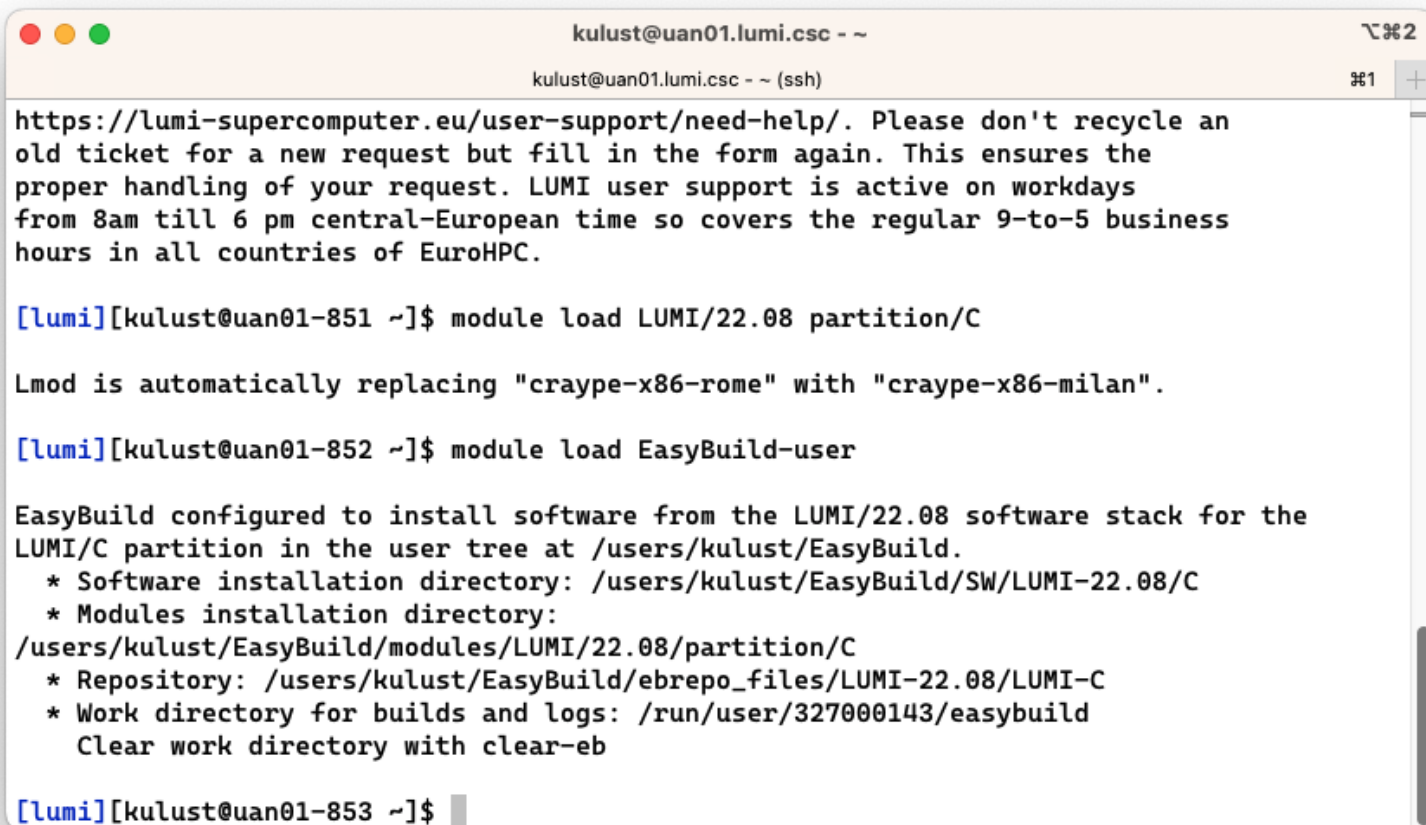
Installing

Step 2: Configure the environment

- Load the modules for the LUMI software stack and partition that you want to use. E.g.,
`module load LUMI/22.08 partition/C`
- Load the EasyBuild-user module to make EasyBuild available and to configure it for installing software in the chosen stack and partition:
`module load EasyBuild-user`
- In many cases, cross-compilation is possible by loading a different partition module than the one auto-loaded by LUMI
 - Though cross-compilation is currently problematic for GPU code


```
module load LUMI/22.08 partition/C
module load EasyBuild-user
```

LUMI



```
kulust@uan01.lumi.csc - ~
kulust@uan01.lumi.csc - ~ (ssh)

https://lumi-supercomputer.eu/user-support/need-help/. Please don't recycle an
old ticket for a new request but fill in the form again. This ensures the
proper handling of your request. LUMI user support is active on workdays
from 8am till 6 pm central-European time so covers the regular 9-to-5 business
hours in all countries of EuroHPC.

[lumi][kulust@uan01-851 ~]$ module load LUMI/22.08 partition/C

Lmod is automatically replacing "craype-x86-rome" with "craype-x86-milan".

[lumi][kulust@uan01-852 ~]$ module load EasyBuild-user

EasyBuild configured to install software from the LUMI/22.08 software stack for the
LUMI/C partition in the user tree at /users/kulust/EasyBuild.
* Software installation directory: /users/kulust/EasyBuild/SW/LUMI-22.08/C
* Modules installation directory:
/users/kulust/EasyBuild/modules/LUMI/22.08/partition/C
* Repository: /users/kulust/EasyBuild/ebrepo_files/LUMI-22.08/LUMI-C
* Work directory for builds and logs: /run/user/327000143/easybuild
Clear work directory with clear-eb

[lumi][kulust@uan01-853 ~]$
```

Installing

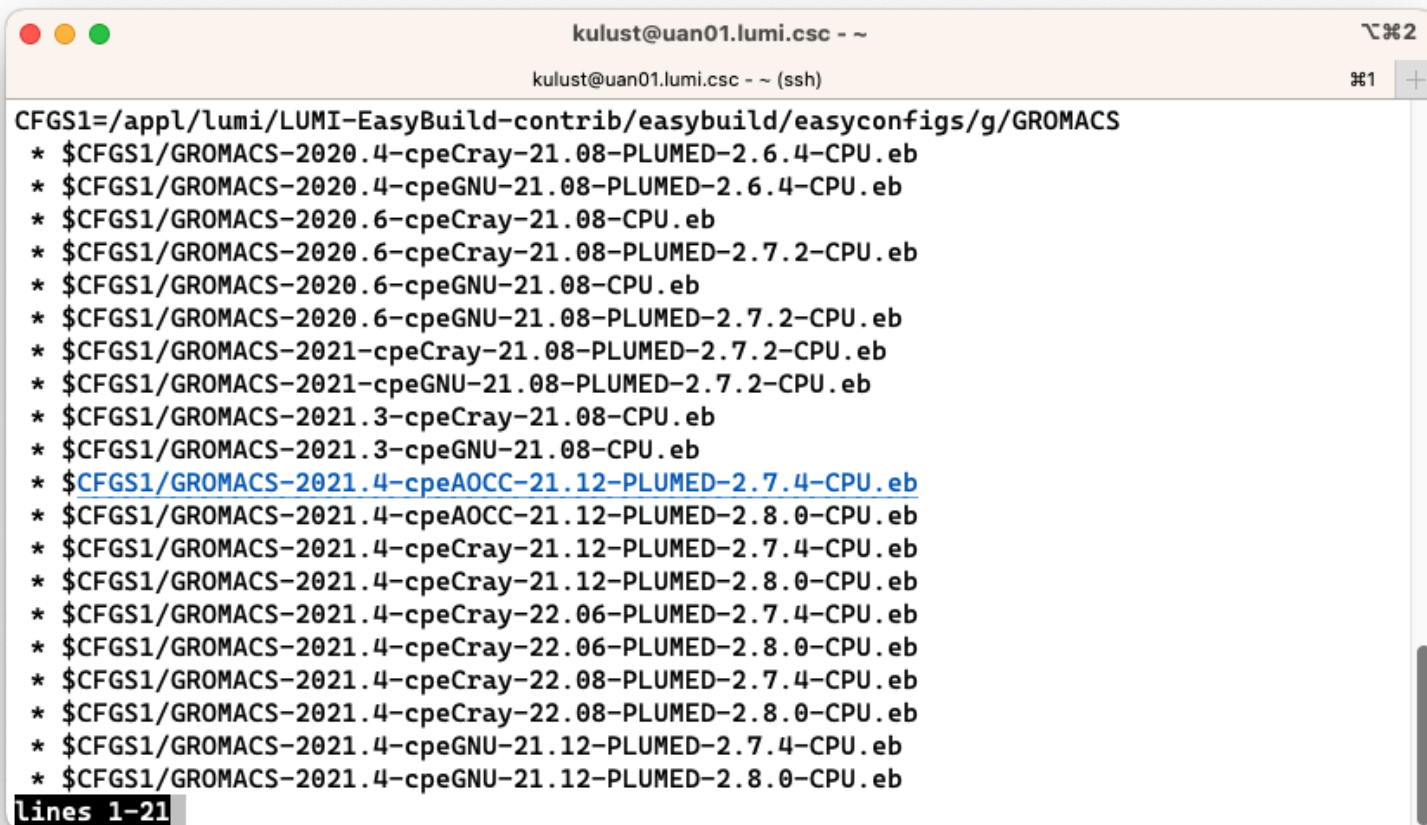
Step 3: Install the software

- Let's, e.g., install GROMACS
 - Search if GROMACS build recipes are available
 - `eb --search GROMACS`
 - `eb -S GROMACS`
 - But we now also have the [LUMI Software Library](#) that lists all available software through EasyBuild.
 - Let's take GROMACS-2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU.eb:
 - `eb GROMACS-2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU.eb -D`
 - `eb GROMACS-2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU.eb -r`
- Now the module should be available
 - `module avail GROMACS`

eb --search GROMACS | less

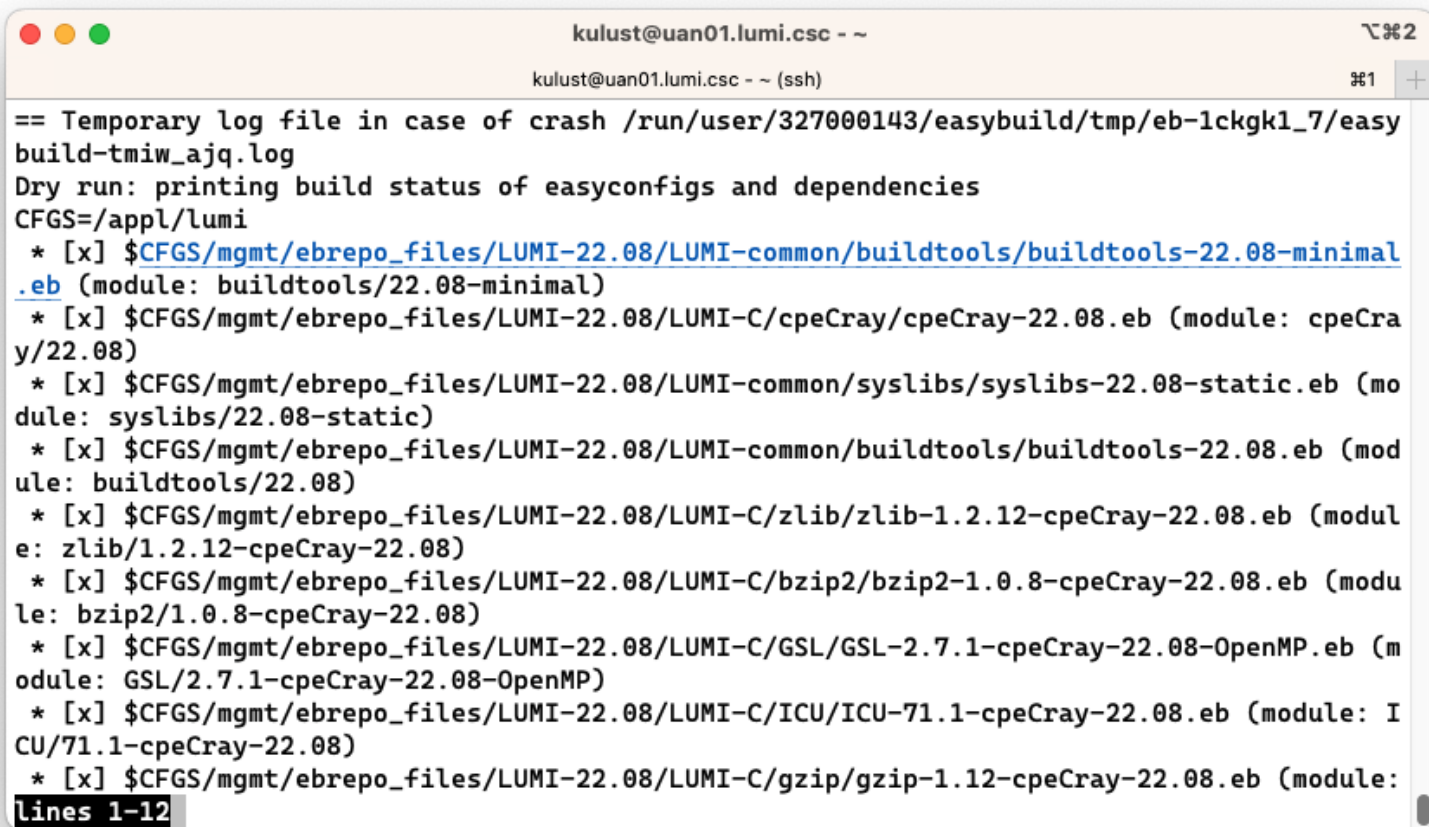
LUMI

```
kulust@uan01.lumi.csc - ~  
kulust@uan01.lumi.csc - ~ (ssh)  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2020.4-cpeCray-21.08-PLUMED-2.6.4-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2020.4-cpeGNU-21.08-PLUMED-2.6.4-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2020.6-cpeCray-21.08-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2020.6-cpeCray-21.08-PLUMED-2.7.2-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2020.6-cpeGNU-21.08-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2020.6-cpeGNU-21.08-PLUMED-2.7.2-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2021-cpeCray-21.08-PLUMED-2.7.2-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2021-cpeGNU-21.08-PLUMED-2.7.2-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2021.3-cpeCray-21.08-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2021.3-cpeGNU-21.08-CPU.eb  
* /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2021.4-cpeAO  
lines 1-11
```



A terminal window titled 'kulust@uan01.lumi.csc - ~' showing the output of the command 'eb -S GROMACS | less'. The terminal displays a list of 21 GROMACS configurations. The first line is 'CFGS1=/appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS'. The following lines are a list of configurations, each starting with an asterisk and a path. The 11th configuration, '\$CFGS1/GROMACS-2021.4-cpeAOCC-21.12-PLUMED-2.7.4-CPU.eb', is highlighted in blue. The terminal window has a title bar with three colored buttons (red, yellow, green) on the left and a search icon and a plus sign on the right. The bottom left corner of the terminal window shows 'lines 1-21'.

```
kulust@uan01.lumi.csc - ~  
kulust@uan01.lumi.csc - ~ (ssh)  
CFGS1=/appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS  
* $CFGS1/GROMACS-2020.4-cpeCray-21.08-PLUMED-2.6.4-CPU.eb  
* $CFGS1/GROMACS-2020.4-cpeGNU-21.08-PLUMED-2.6.4-CPU.eb  
* $CFGS1/GROMACS-2020.6-cpeCray-21.08-CPU.eb  
* $CFGS1/GROMACS-2020.6-cpeCray-21.08-PLUMED-2.7.2-CPU.eb  
* $CFGS1/GROMACS-2020.6-cpeGNU-21.08-CPU.eb  
* $CFGS1/GROMACS-2020.6-cpeGNU-21.08-PLUMED-2.7.2-CPU.eb  
* $CFGS1/GROMACS-2021-cpeCray-21.08-PLUMED-2.7.2-CPU.eb  
* $CFGS1/GROMACS-2021-cpeGNU-21.08-PLUMED-2.7.2-CPU.eb  
* $CFGS1/GROMACS-2021.3-cpeCray-21.08-CPU.eb  
* $CFGS1/GROMACS-2021.3-cpeGNU-21.08-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeAOCC-21.12-PLUMED-2.7.4-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeAOCC-21.12-PLUMED-2.8.0-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeCray-21.12-PLUMED-2.7.4-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeCray-21.12-PLUMED-2.8.0-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeCray-22.06-PLUMED-2.7.4-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeCray-22.06-PLUMED-2.8.0-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeCray-22.08-PLUMED-2.7.4-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeGNU-21.12-PLUMED-2.7.4-CPU.eb  
* $CFGS1/GROMACS-2021.4-cpeGNU-21.12-PLUMED-2.8.0-CPU.eb  
lines 1-21
```



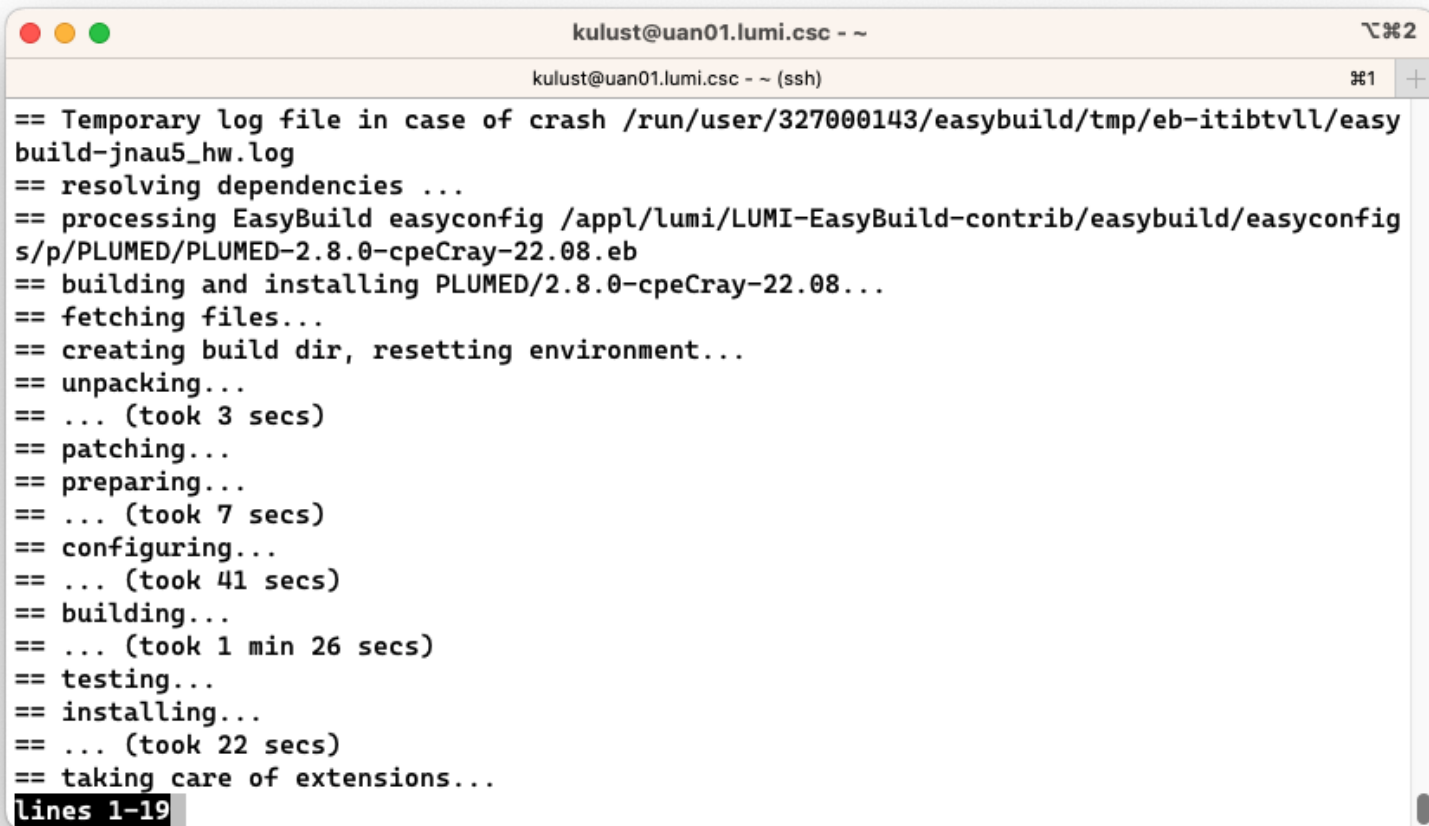
```
kulust@uan01.lumi.csc - ~
kulust@uan01.lumi.csc - ~ (ssh)

== Temporary log file in case of crash /run/user/327000143/easybuild/tmp/eb-1ckgk1_7/easy
build-tmiw_ajq.log
Dry run: printing build status of easyconfigs and dependencies
CFGS=/appl/lumi
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-common/buildtools/buildtools-22.08-minimal
.eb (module: buildtools/22.08-minimal)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/cpeCray/cpeCray-22.08.eb (module: cpeCra
y/22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-common/syslibs/syslibs-22.08-static.eb (mo
dule: syslibs/22.08-static)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-common/buildtools/buildtools-22.08.eb (mod
ule: buildtools/22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/zlib/zlib-1.2.12-cpeCray-22.08.eb (modul
e: zlib/1.2.12-cpeCray-22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/bzip2/bzip2-1.0.8-cpeCray-22.08.eb (modu
le: bzip2/1.0.8-cpeCray-22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/GSL/GSL-2.7.1-cpeCray-22.08-OpenMP.eb (m
odule: GSL/2.7.1-cpeCray-22.08-OpenMP)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/ICU/ICU-71.1-cpeCray-22.08.eb (module: I
CU/71.1-cpeCray-22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/gzip/gzip-1.12-cpeCray-22.08.eb (module:
lines 1-12
```

```
kulust@uan01.lumi.csc - ~
kulust@uan01.lumi.csc - ~ (ssh)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/gzip/gzip-1.12-cpeCray-22.08.eb (module:
gzip/1.12-cpeCray-22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/lz4/lz4-1.9.3-cpeCray-22.08.eb (module:
lz4/1.9.3-cpeCray-22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/ncurses/ncurses-6.2-cpeCray-22.08.eb (mo
dule: ncurses/6.2-cpeCray-22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/gettext/gettext-0.21-cpeCray-22.08-minim
al.eb (module: gettext/0.21-cpeCray-22.08-minimal)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/XZ/XZ-5.2.5-cpeCray-22.08.eb (module: XZ
/5.2.5-cpeCray-22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/zstd/zstd-1.5.2-cpeCray-22.08.eb (module
: zstd/1.5.2-cpeCray-22.08)
* [x] $CFGS/mgmt/ebrepo_files/LUMI-22.08/LUMI-C/Boost/Boost-1.79.0-cpeCray-22.08.eb (mod
ule: Boost/1.79.0-cpeCray-22.08)
* [ ] $CFGS/LUMI-EasyBuild-contrib/easybuild/easyconfigs/p/PLUMED/PLUMED-2.8.0-cpeCray-2
2.08.eb (module: PLUMED/2.8.0-cpeCray-22.08)
* [ ] $CFGS/LUMI-EasyBuild-contrib/easybuild/easyconfigs/g/GROMACS/GROMACS-2021.4-cpeCra
y-22.08-PLUMED-2.8.0-CPU.eb (module: GROMACS/2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU)
== Temporary log file(s) /run/user/327000143/easybuild/tmp/eb-1ckgk1_7/easybuild-tmiw_ajq
.log* have been removed.
== Temporary directory /run/user/327000143/easybuild/tmp/eb-1ckgk1_7 has been removed.
lines 12-22/22 (END)
```

eb GROMACS-2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU.eb -r

LUMI



```
kulust@uan01.lumi.csc - ~  
kulust@uan01.lumi.csc - ~ (ssh)  
== Temporary log file in case of crash /run/user/327000143/easybuild/tmp/eb-itibtvll/easy  
build-jnau5_hw.log  
== resolving dependencies ...  
== processing EasyBuild easyconfig /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfig  
s/p/PLUMED/PLUMED-2.8.0-cpeCray-22.08.eb  
== building and installing PLUMED/2.8.0-cpeCray-22.08...  
== fetching files...  
== creating build dir, resetting environment...  
== unpacking...  
== ... (took 3 secs)  
== patching...  
== preparing...  
== ... (took 7 secs)  
== configuring...  
== ... (took 41 secs)  
== building...  
== ... (took 1 min 26 secs)  
== testing...  
== installing...  
== ... (took 22 secs)  
== taking care of extensions...  
lines 1-19
```

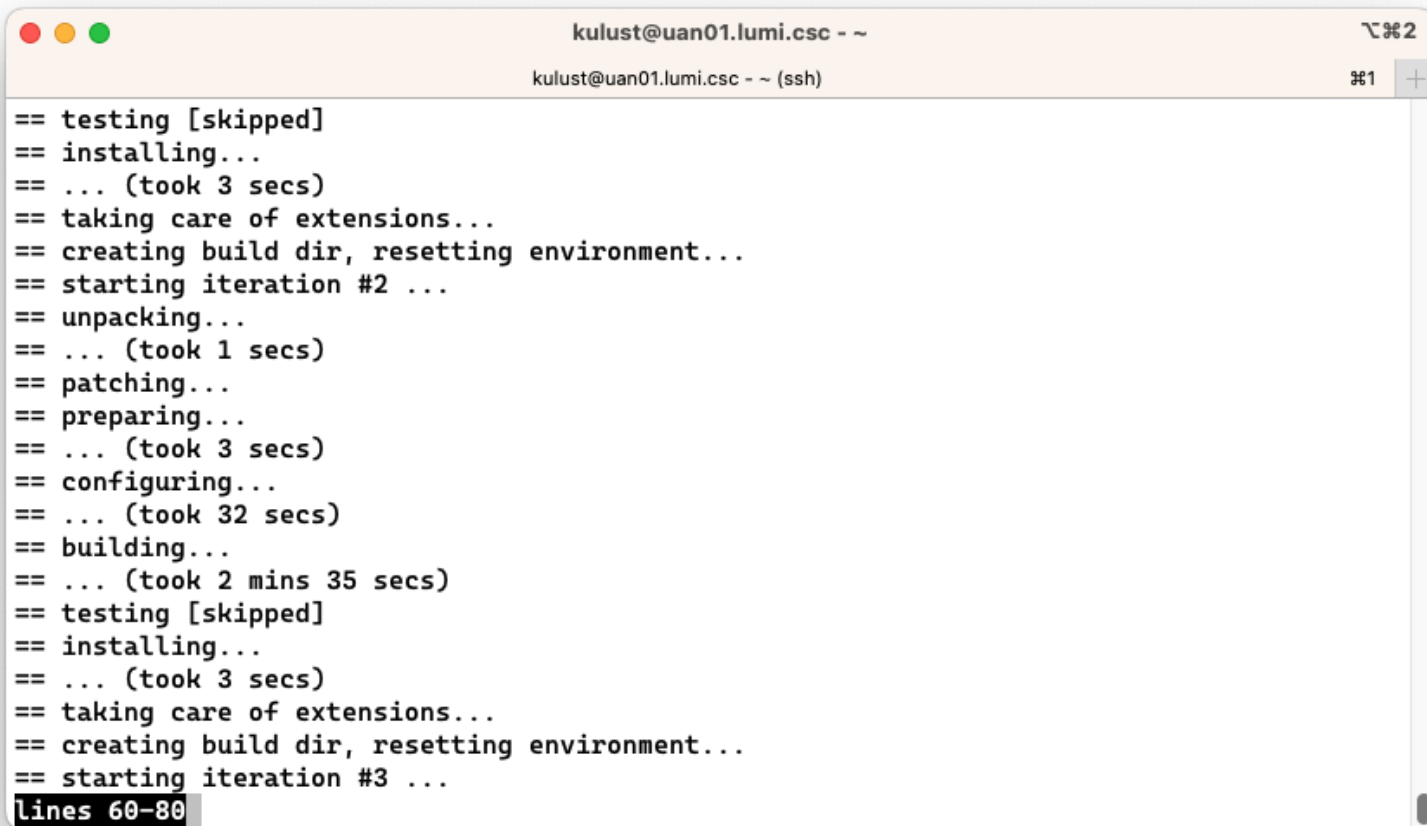


```
kulust@uan01.lumi.csc - ~
kulust@uan01.lumi.csc - ~ (ssh)

== restore after iterating...
== postprocessing...
== sanity checking...
== ... (took 3 secs)
== cleaning up...
== creating module...
== ... (took 2 secs)
== permissions...
== packaging...
== COMPLETED: Installation ended successfully (took 2 mins 49 secs)
== Results of the build can be found in the log file(s) /users/kulust/EasyBuild/SW/LUMI-2
2.08/C/PLUMED/2.8.0-cpeCray-22.08/easybuild/easybuild-PLUMED-2.8.0-20221117.190106.log
== processing EasyBuild easyconfig /appl/lumi/LUMI-EasyBuild-contrib/easybuild/easyconfig
s/g/GROMACS/GROMACS-2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU.eb
== building and installing GROMACS/2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU...
== fetching files...
== creating build dir, resetting environment...
== starting iteration #0 ...
== unpacking...
== ... (took 1 secs)
== patching...
lines 20-38
```



```
kulust@uan01.lumi.csc - ~
kulust@uan01.lumi.csc - ~ (ssh)
== preparing...
== ... (took 5 secs)
== configuring...
== ... (took 35 secs)
== building...
== ... (took 2 mins 37 secs)
== testing [skipped]
== installing...
== ... (took 5 secs)
== taking care of extensions...
== creating build dir, resetting environment...
== starting iteration #1 ...
== unpacking...
== ... (took 1 secs)
== patching...
== preparing...
== ... (took 3 secs)
== configuring...
== ... (took 33 secs)
== building...
== ... (took 2 mins 36 secs)
lines 39-59
```



```
kulust@uan01.lumi.csc - ~
kulust@uan01.lumi.csc - ~ (ssh)

== testing [skipped]
== installing...
== ... (took 3 secs)
== taking care of extensions...
== creating build dir, resetting environment...
== starting iteration #2 ...
== unpacking...
== ... (took 1 secs)
== patching...
== preparing...
== ... (took 3 secs)
== configuring...
== ... (took 32 secs)
== building...
== ... (took 2 mins 35 secs)
== testing [skipped]
== installing...
== ... (took 3 secs)
== taking care of extensions...
== creating build dir, resetting environment...
== starting iteration #3 ...

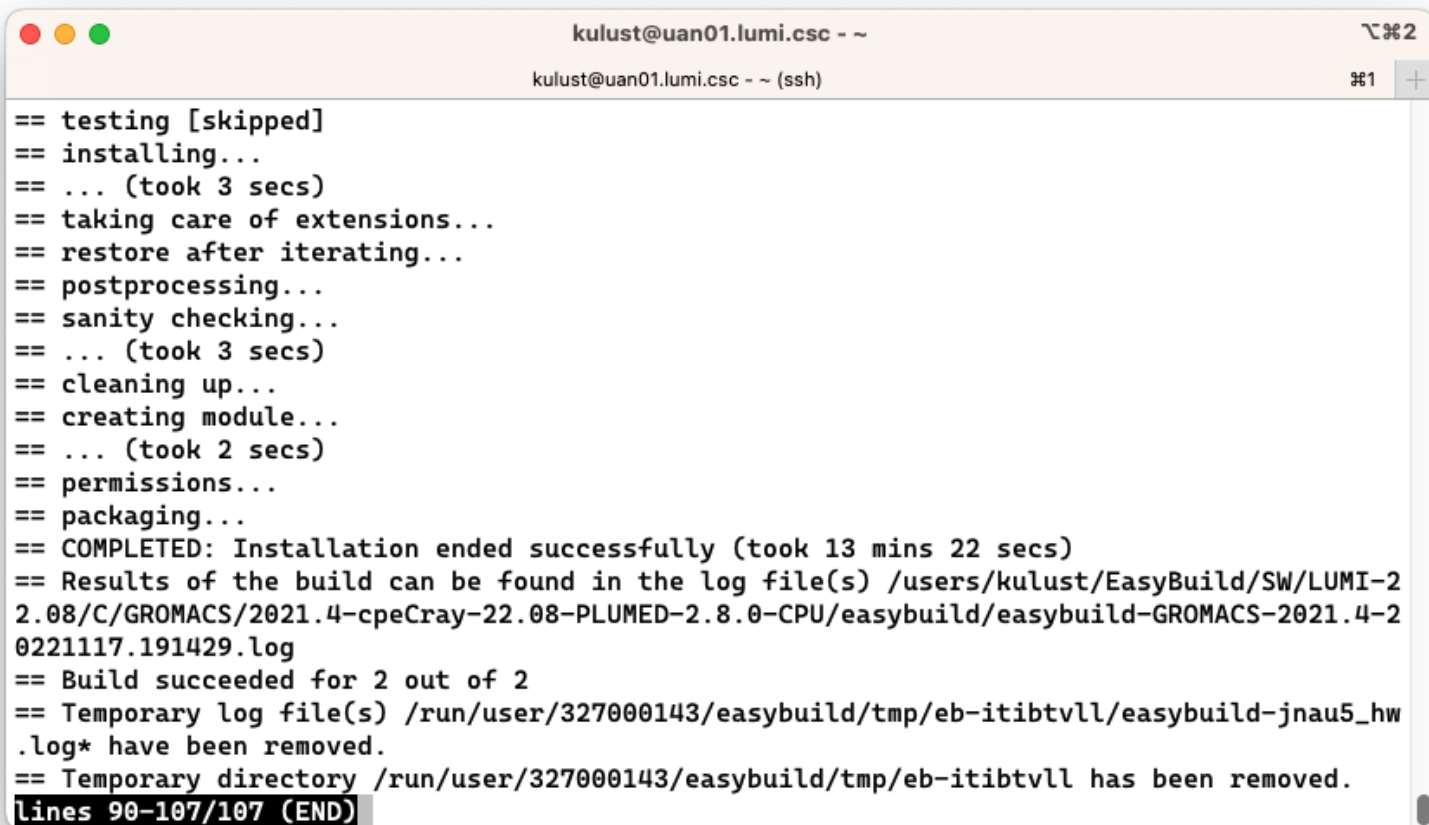
lines 60-80
```



```
kulust@uan01.lumi.csc - ~
kulust@uan01.lumi.csc - ~ (ssh)

== unpacking...
== ... (took 1 secs)
== patching...
== preparing...
== ... (took 3 secs)
== configuring...
== ... (took 33 secs)
== building...
== ... (took 2 mins 33 secs)
== testing [skipped]
== installing...
== ... (took 3 secs)
== taking care of extensions...
== restore after iterating...
== postprocessing...
== sanity checking...
== ... (took 3 secs)
== cleaning up...
== creating module...
== ... (took 2 secs)
== permissions...

lines 81-101
```



```
kulust@uan01.lumi.csc - ~
kulust@uan01.lumi.csc - ~ (ssh)

== testing [skipped]
== installing...
== ... (took 3 secs)
== taking care of extensions...
== restore after iterating...
== postprocessing...
== sanity checking...
== ... (took 3 secs)
== cleaning up...
== creating module...
== ... (took 2 secs)
== permissions...
== packaging...
== COMPLETED: Installation ended successfully (took 13 mins 22 secs)
== Results of the build can be found in the log file(s) /users/kulust/EasyBuild/SW/LUMI-2
2.08/C/GROMACS/2021.4-cpeCray-22.08-PLUMED-2.8.0-CPU/easybuild/easybuild-GROMACS-2021.4-2
0221117.191429.log
== Build succeeded for 2 out of 2
== Temporary log file(s) /run/user/327000143/easybuild/tmp/eb-itibtvll/easybuild-jnau5_hw
.log* have been removed.
== Temporary directory /run/user/327000143/easybuild/tmp/eb-itibtvll has been removed.
lines 90-107/107 (END)
```

Installing

Step 3: Install the software - Note

- Note: Sometimes the module does not show up immediately. This is because Lmod keeps a cache and fails to detect that the cache is outdated.
 - Remove `$HOME/.lmod.d/.cache`
`rm -rf $HOME/.lmod.d/.cache`
 - We've seen rare cases where internal Lmod data structures were corrupt and logging out and in again was needed
- Installing this way is 100% equivalent to an installation in the central software tree. The application is compiled in exactly the same way as we would do and served from the same file systems.

More advanced work

- You can also install some EasyBuild recipes that you got from support and are in the current directory (preferably one without subdirectories):
`eb my_recipe.eb -r .`
 - Note the dot after the `-r` to tell EasyBuild to also look for dependencies in the current directory (and its subdirectories)
- In some cases you will have to download the sources by hand, e.g., for VASP, which is then at the same time a way for us to ensure that you have a license for VASP. E.g.,
 - `eb --search VASP`
 - Then from the directory with the VASP sources:
`eb VASP-6.3.2-cpeGNU-22.08.eb -r .`

More advanced work (2): Repositories

- It is possible to have your own clone of the LUMI-EasyBuild-contrib repo in your `$EBU_USER_PREFIX` subdirectory if you want the latest and greatest before it is in the centrally maintained repository
 - `cd $EBU_USER_PREFIX`
`git clone https://github.com/Lumi-supercomputer/LUMI-EasyBuild-contrib.git`
- It is also possible to maintain your own repo
 - The directory should be `$EBU_USER_PREFIX/UserRepo` (but of course on GitHub the repository can have a different name)
 - Structure should be compatible with EasyBuild: easyconfig files go in `$EBU_USER_PREFIX/easybuild/easyconfigs`

More advanced work (3): Reproducibility

- EasyBuild will keep a copy of the sources in `$EBU_USER_PREFIX/sources`
- EasyBuild also keeps copies of all installed easyconfig files in two locations:
 - In `$EBU_USER_PREFIX/ebrepo_files`
 - And note that EasyBuild will use this version if you try to reinstall and did not delete this version first!
 - This ensures that the information that EasyBuild has about the installed application is compatible with what's in the module files
 - With the installed software (in `$EBU_USER_PREFIX/SW`) in a subdirectory called `easybuild`

This is meant to have all information about how EasyBuild installed the application and to help in reproducing

EasyBuild tips&tricks

- Updating version: Often some trivial changes in the EasyConfig (.eb) file
 - Checksums may be annoying: Use `--ignore-checksums` with the `eb` command
- Updating to a new toolchain:
 - Be careful, it is more than changing one number
 - Versions of preinstalled dependencies should be changed and EasyConfig files of other dependencies also checked
- [LUMI Software Library](https://lumi-software.github.io/LUMI-EasyBuild-docs) at lumi-supercomputer.github.io/LUMI-EasyBuild-docs
 - For most packages, pointers to the license
 - User documentation gives info about the use of the package, or restrictions
 - Technical documentation aimed at users who want more information about how we build the package

EasyBuild training for advanced users and developers

L U M I

- EasyBuild web site: easybuild.io
- Generic EasyBuild training materials on easybuilders.github.io/easybuild-tutorial.
- Training for CSC and local support organisations: Most up-to-date version of the training materials on lumi-supercomputer.github.io/easybuild-tutorial.