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# **Key4HEP, the common software framework for future experiments**

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**(Don't shoot me I'm only the piano player...)**

# Short Key4HEP history

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- Proposed a common software framework for all future HEP experiments at a workshop in Bologna on June 2019
  - Software experts from ILC, CLIC, FCC, CEPC, LHC, SCTF, HSF and more were present
  - Decided to use a common EDM for all experiments
    - Flexibility to add special sections tailored to specific needs of an experiment
  - Then decided to adopt a common software framework encompassing all the typical needs of HEP experiments
  - Key4HEP was chosen as name
- A second workshop was organised in Hong Kong on January 2020
  - The decision to move to Key4HEP was confirmed and strengthened
  - CEPC confirmed the willingness to act as "beta testers"

# The Key4HEP project

- Future detector studies critically rely on **well-maintained software stacks** to model detector concepts and to understand a detector's limitations and physics reach
- Aim at a low-maintenance common stack for **FCC, ILC/CLIC, CEPC** with ready to use “plug-ins” to develop detector concepts
- Reached consensus among all communities for future colliders to develop a **common turnkey software stack** at recent [Future Collider Software Workshop](#)
- Identified as an important project in the CERN [EP R&D initiative](#)
- Regular meetings
  - <https://indico.cern.ch/category/11461/>
- Docpages
  - <https://cern.ch/key4hep> (main documentation site)
  - <https://cern.ch/edm4hep> (doxygen code reference)

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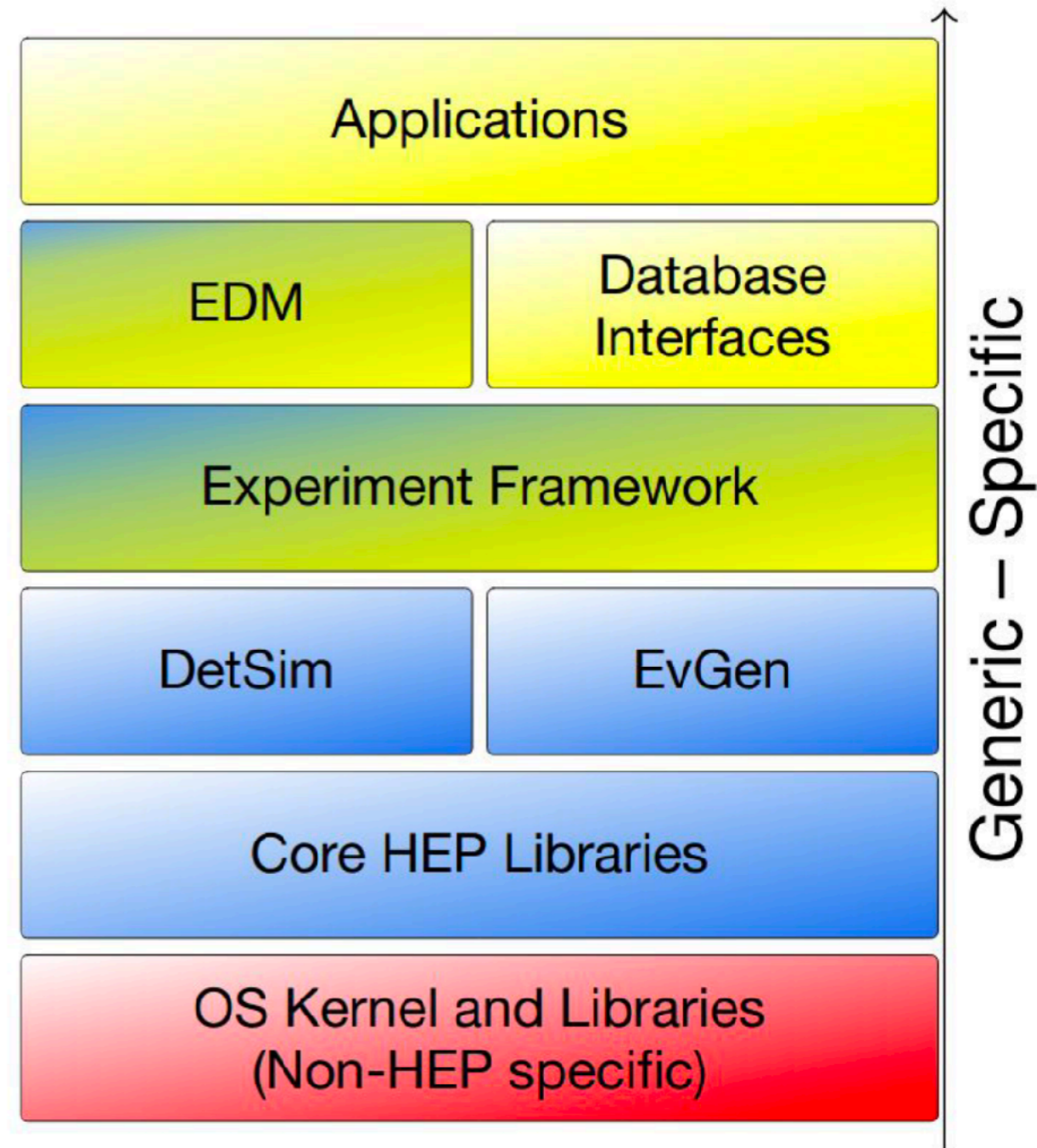
# Key4HEP software stack

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- Should cover Detector and Physics Studies
  - Generation, Simulation, Reconstruction ...
  - Includes most of the common libraries and projects: Geant4, ROOT, Delphes
- Where it will be used:
  - Locally
  - Batch farms
  - Grid
  - Opportunistic HPC
  - CI clouds (travis, github actions)
- Use CVMFS to deploy once and use as often as possible
- Containers currently used only to get a LCG-supported platform (currently [Centos7](#)) with CVMFS where not available
  - Especially the case on github / travis

# A typical software stack

- Interfaces to tracking and reconstruction libraries (PandoraPFA, ACTS ...)
- (More or less) experiment specific event datamodel libraries
- Experiment core orchestration layer, which controls everything else: Marlin, Gaudi, CMSSW, AliRoot
- Packages used by many experiments: DD4hep, Pythia, ...
- Usual core libraries: ROOT, Geant4, CLHEP ...
- Non-HEP libraries: Boost, Python, CMake...



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# Deployment strategy

- Key4HEP Software is built with **spack**
  - Reference deployment to **CVMFS**
    - Additionally buildcache can be used to install binaries on local machine (accessible via HTTP)
- Completely independent installation possible as well
- Not clear yet if experiments want to build common packages themselves or use Key4HEP CVMFS space

```
/cvmfs/sw.hsf.org/key4hep/
```

```
|-- releases / $LCG_version / $platform / $pkgname-$spackhash / (bin ... )  
|-- views / $K4_version / $platform / (bin include share ... init.sh)  
|-- setup.sh  
|-- contrib
```

```
/cvmfs/sw-nightlies.hsf.org/key4hep/
```

```
|-- nightlies / $timestamp / $platform / $pkgname-$spackhash / (bin ... )  
|-- views / $timestamp / $platform / (bin include share ... init.sh)  
|-- setup.sh  
|-- contrib
```

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# Spack for Key4HEP

- Spack is a package manager
  - Does not replace CMake, Autotools, ...
  - Comparable to apt, yum, homebrew, ...
    - But not tied to operating system
    - And no central repository for binaries!
- Originally written for/by HPC community
  - Emphasis on dealing with **multiple configurations** of the same packages
    - Different versions, compilers, external library versions ...
    - ... may coexist on the same system
  - Spec: Syntax to describe package version configuration and dependencies
- Repository added with Key4HEP package recipes

```
git clone https://github.com/spack/spack.git
git clone https://github.com/key4hep/k4-spack.git
alias spack='python $PWD/spack/bin/spack'
spack repo add k4-spack
# install the meta-package for the key4hep-stack
spack install key4hep-stack
```

# Key4HEP summary

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- Key4HEP Software is built with **spack**, and binaries are distributed on **CVMFS**
- Covers common experiment software for physics/detector studies on top of projects/LCG releases.
- Should run on batch / grid for production and laptops / CI for development
  - CVMFS /w LCG releases on Grid sites
  - Spack allows us to be fairly flexible
- Use of Containers:
  - No fixed decision yet, will do whatever is necessary or convenient



# Conclusions

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- Key4HEP is the best example of collaboration between different future projects! People from ILC, CLIC, FCC, CEPC, SCTF, etc., work together.
- Key4HEP accommodates both full and fast simulation
  - Delphes being ported to Key4HEP these days
- IHEP and CepC will be the first testers of Key4HEP
  - First implementation already available
  - Should have have a full implementation before the end of 2020
- IDEA simulation will use the same implementation for FCC-ee and CepC
- Event data model is ready to accept modifications and additions needed for the Dual Readout calorimeter
  - Key4HEP developers expressed their interest in helping to implement the DR needs
  - Implementing a crystal ECAL option will certainly be possible as well
- Key4HEP is part of the new CERN R&D program
- Key4HEP is the main task of the software WP of the AIDAInnova project

Backup