April 11th, 2023

Detector & MDI meeting

Key4HEP migration status

from ILCSoft framework

N. Bartosik [a, b]

for the **Muon Collider Physics and Detector Group**

[a] INFN Torino *(Italy)* [b] CERN *(Switzerland)*

Muon Colider software: general status

Steps for the gradual transition to Key4hep:

1. **Spack** ✓ **working Docker image prepared, using Spack package manager:** key4hep branch
   ↳ based on AlmaLinux 9 (EL9) distribution

2. **Gaudi** **converting reference Marlin configurations to Gaudi**
   ↳ will be placed in **mucoll-benchmarks** repository: baseline analysis reference

Alma Linux 9 machines already deployed at CERN for general use

`> ssh lxplus9.cern.ch` → in case of issues with permissions from macOS, see these instructions

We can start setting up installation of our software stack also on CVMFS
in the same way as done for Key4hep

Key4hep and Spack: few technicalities

Repositories involved in the new setup:

1. **MuonCollider-docker:** **build.sh + run.sh scripts for easy building and running of the image**
2. **mucoll-spack:** **Spack repository of packages specific to Muon Collider**
   ↳ used as a 2nd layer on top of the official Key4hep repository
   - **versioning done via realease tags** → to be created soon
   - **requires Spack version >= 19.0** (in progress of adoption by Key4hep)
     ↳ to define exact versions of all the dependencies
   - **currrently using versions identical to ILCSoft release 2.8**
     ↳ defined in the environment configuration: packages.yaml

Limited use of system tools as external packages in Spack: only build tools, e.g. cmake, openssl, etc.
Spack fails to properly identify certain headers → safer to let Spack install everything else by itself

Testing builds in Docker is quite slow now → it's much better to use a clean EL9 virtual machine
Should be significantly faster once we set up upstream installations on CVMFS mounted in Docker

Code rearrangements

Repositories under MuonColliderSoft need some restructuring

MuonCutil is becoming obsolete

- **SoftCheck/** configuration files for installation tests → **new repository: mucoll-test?**
- **confile/** reference sim-reco configuration files → **should move to mucoll-benchmarks**
- **macros/** example plotting macros → **should move to mucoll-benchmarks**
- **releases/** latest release configuration → **moved to mucoll-spack**

reference for tutorials

detector-simulation is becoming obsolete

- **geometries/** compact XML geometry definitions → **should go to lcgeo**
  ensures consistency between C++ and XML parts within a single package version
- **utils/** MARS15/FLUKA → LCIO scripts → **should go to mucoll-benchmarks**

Old repositories will remain on GitHub for a while for backward compatibility with ILCSoft

Geometries naming

Moving to lcgeo is a good moment to homogenise the naming of our geometries:

- `MuColl_v1` major version of the geometry, relevant for the outside world
  e.g. geometry designed for $\sqrt{s}$ = 1.5 TeV, frozen for Snowmass studies
- `MuColl_v1.1` minor version with backward-compatible changes: code imrovements, fixes
  ↳ no changes to sensitive-volume layout → no need to rerun BIB simulation
  newer versions can be gradually adopted by users
- `MuColl_v1.1.1` same as **v1.1**, but with some experimental change in the geometry
  e.g. increased thickness of passive material in VXD to account to cooling;
  e.g. alternative technology for ECAL detector

There are two alternative geometries in detector-simulation

- Crilin_ECAL/ in the ***master*** branch → `MuColl_v1.1.4`
- MPGD_Muons/ in the ***picosec*** branch → `MuColl_v1.1.5`
  + MuonProcessorPV Marlin processor → is it strictly coupled to the geometry?

Summer student proposal: for CERN

Project proposal for the 2023 CERN summer school → **ACCEPTED**

on behalf of the CERN software department

Integration of Muon Collider simulation code into Gaudi framework

Project description

Muon Collider is a promising candidate for a flagship post-LHC energy-frontier machine, which for the first time in history would collide high-energy beams of unstable muons. Its design study requires very high computational efficiency in order to accurately simulate effects from background radiation of unprecedented intensity.

This project will focus on implementation of the "background overlay" package that mixes into a single event detector signals from the primary collision and signals from background particles. The existing algorithm implemented in Marlin and struggles with ~10^8 particles/event present at Muon Collider. Therefore it has to be rewritten for an improved use of computing resources.

This project is part of the larger effort towards gradual transition of the present simulation code to Gaudi framework, adopting Key4hep software stack. In practice this work will include:

- adapting code to Gaudi-native EDM4hep format of input data;
- adopting Gaudi multithreading interface for intra-event parallelization;
- implementing user-configurable filters of input collections to reduce RAM usage;
- validation and profiling of code performance as part of the simulation chain.

The selected candidate will work closely with members of the *Muon Collider Detector and Physics* group, interacting regularly with Key4hep developers from the EP-SFT group. Once finished, this code will become part of the official Muon Collider software release and will be used in all future simulation studies performed by the collaboration.

Supervisors:

- **Nazar Bartosik** (Muon Collider)
- **Juan Miguel Carceller Lopez** (Key4hep)

Student assigned: ✓

- **Khrabatyn Yuriy**
  arriving on June 5th 2023