This project has received funding from the European Union's Horizon 2020
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Key4hep and DDDigi Status from CERN

André Sailer

CERN-EP-SFT

AIDAinnova Annual Meeting
April 24–27, 2023
Valencia

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1 Key4hep Status and Plans
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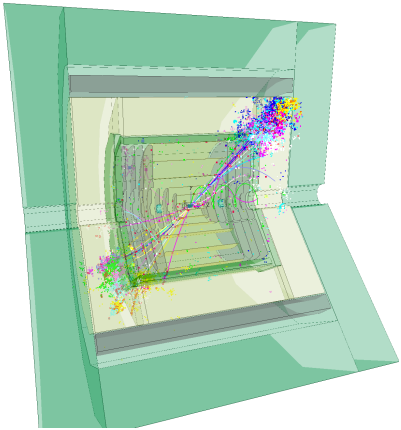
3 Conclusion



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Key4hep Status and Plans

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Key4hep Related Developments in the Last Year

- See also slides from Thomas

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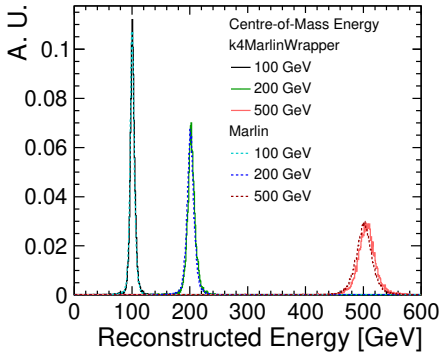
Infrastructure: Spack and Validation Framework

- Spack
  - Providing releases and nightly builds to CVMFS
  - Maintain and scale out the Key4hep builds (Juan Carceller)
  - Releases and nightly builds for different operating systems
- Implement validation framework to monitor changes (Juan Carceller)
  - Ensure we spot regressions immediately
  - Requires also building and testing multiple inter-dependent PRs together



Total Reconstructed Energy from Di-Quark events in CLIC_o3_v14 using k4MarlinWrapper or only Marlin.

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Gaudi and k4FWCore Developments

- New fellow starting to work on “Extend and develop support for heterogeneous resources in Gaudi” (funded by CERN EP RnD)
- Gaudi Data Service for podio::Frame (Benedikt Hegner)
- Improving Documentation of Gaudi or k4FWCore in view of algorithm migration

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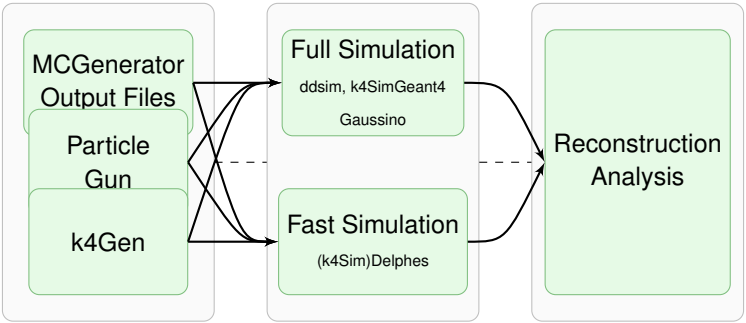
DD4hep Geometry and Simulations

- The simulations can be run in a stand-alone mode using the output from a Generator as input
- Work to integrate LHCb's Gaussino to replace framework integration on going (Graeme Stewart)
  - Ideally re-use existing components from DDG4, k4SimGeant4
- In all cases, the following step of (high level) reconstruction or analysis should be usable in the same way
- Moved lcgeo Github repository to key4hep/k4Geo, waiting for migration of FCCDetectors



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Reconstruction Developments

- Implement track fitting with ACTS, different fitting approaches (Gaussian Sum Filter), especially in view of electron reconstruction (Leonhard Reichenbach)
  - Apply for CLD tracking and detector optimisation studies
  - Integrate track reconstruction monitoring into validation framework
- Developments around Particle Flow Clustering and Pandora (Swathi Sasikumar)
  - Implement *DDGaudiPandora* interface between DD4hep Geometry and Pandora in the Gaudi framework, successor for *DDMarlinPandora*
  - Integrate Jet Energy Reconstruction monitoring into validation framework
  - Continue development to apply Pandora Clustering for LAr Calorimeter (IDEA-LAr, GranuLAr)
- Integration of k4CLUE (Erica Brondolin)

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Algorithm Migration to Gaudi

- Some constraints in iLCSoft algorithms prevent reproducible multi-threading
  - static variables; random seeding
  - Need to migrate (some) algorithms to Gaudi
    - ⋆ Also to reduce memory consumption (requirement from Muon Collider studies)
- Implemented a random seed service for Gaudi: thread-safe, reproducible
- Migrated first algorithm from iLCSoft to Gaudi
  - Together with a summer student (Violeta Vicente Cantero) (**https://indico.cern.ch/event/1180962/**)
  - Need much better documentation, or this is expert task only
- This years summer student project for some processor, e.g. Overlay (Juan Carceller, Nazar Bartosik (Muon Collider))

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DDDigi

Material provided by Markus Frank

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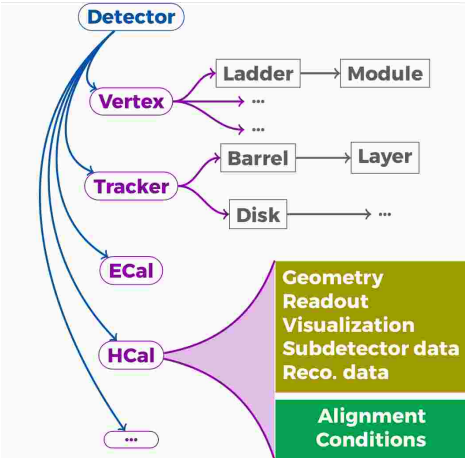
DDDigi: Definitions

- Transformation of energy deposits from simulation to "real-world" detector response
- Tree-like hierarchy of largely independent elements
  - Experiment
  - Subdetectors (Vertex, ECal,...)
  - Segmented entities ladder, barrel, endcap, layers, modules, etc.
- Benefit from independent segments → Invitation for parallelization
- Handle interaction overlays and spill-over
- Handle noise, dead channels



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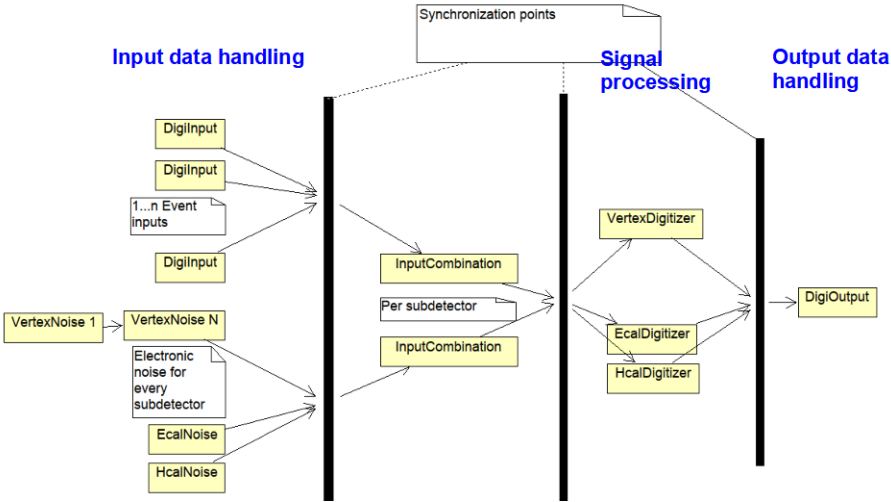
DDDigi: Schematic of Data Pipelines



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DDDigi: Achievements

- Generic multi-threaded framework to handle described data pipelines based on TBB
- Simulation input modules: DDG4 (native), EDM4hep
  - Allow to move IP per input source
  - Attenuate signal per collision & subdetector for spillover
- Digitization output modules: DDDigi (native), EDM4hep
- Modules to
  - Manage the handling of deposits from single subdetectors
  - Generic handling of deposit sub-sets according to detector segmentation: useful for subdetectors with high response
  - Combine deposits from interaction overlays and spill-over
  - Smear energy deposit in calorimeters
  - Smear the hit location/proper time in trackers
  - Zero suppression/threshold handling

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DDDigi: Implementation Issue

- DDDigi is a “turn key system”
  - Input: DD4hep detector description
  - Configuration of digitization from component pallette using python (like DDG4)
- The entire digitization itself is a module
  - Integrate to existing software buses (python, Gaudi)
  - Chained execution: DDG4 $\rightarrow$ DDDigi $\rightarrow$ Reco ...
  - Idealistic approach, but should technically feasible
- But: No users found so far
  - Missing drivers for required functionality

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Conclusions

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Conclusions/Main Goals for the Year

- Continuous Validation
- Simulation consolidation
- ACTS tracking
- Extending use of Pandora Particle Flow Clustering
- Gaudi implementation of algorithms
- Documentation improvements
- PS: I did not mention work done as part of FCC studies

Acknowledgements

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Thank you for your attention!