Perspective from the FH Scientific Computing Platform

PU-FPF PoF V Preparation 19/20 Jun 2025

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HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

General Remark

MU vs MT

Computing topics often between **Matter & Universe** and **Matter & Technology**

A bit unclear where to draw the line

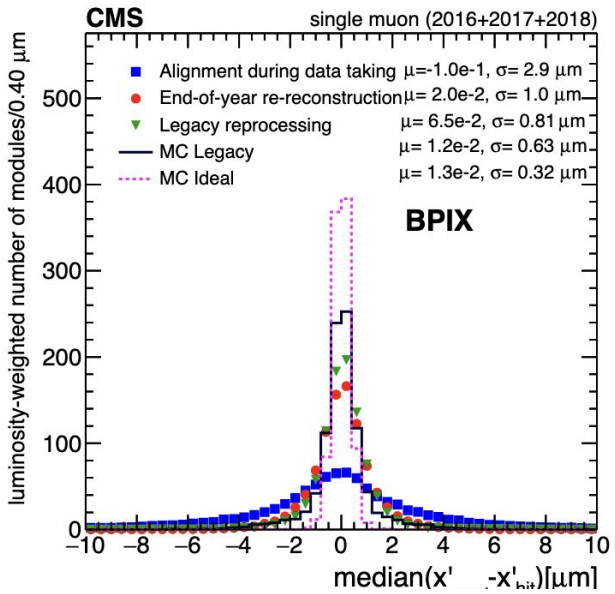
From a few discussions there seems to be a “natural” assignment

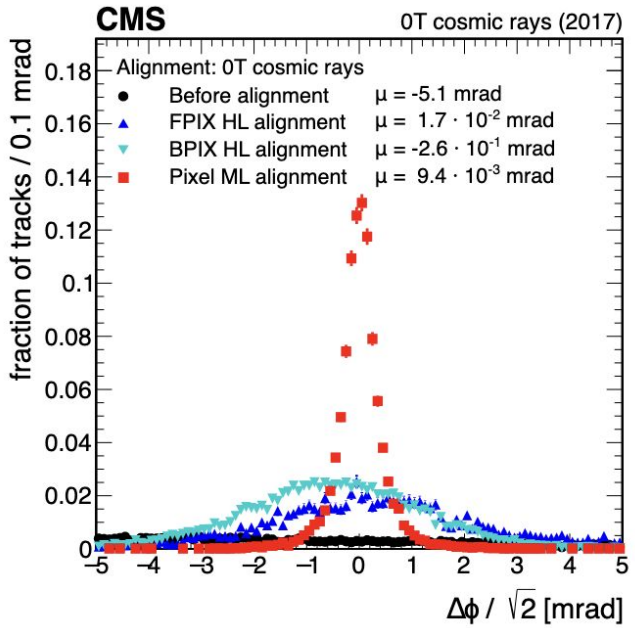
- **Applications** close to analysis or very **HEP domain specific** fit to MU
- More **engineering topics** or things applicable **across domains** fit into MT/DMA

In the following there are topics/applications that are considered relevant for MU (as discussed in the steering group of the FH SciComp platform) – not considered complete by any means!

Tracker Alignment

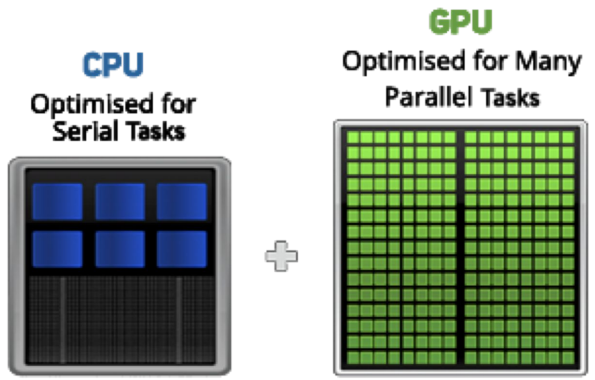
- LHC now more a precision machine (rather than a discovery one)
  - **Ultimate precision** requires advanced methods (usually software)
  - Alignment and calibration crucial for precision analysis
- DESY has major responsibilities in tracker alignment
  - Belle II and CMS
  - Long term commitment
  - Maintenance of **Millepede II**
- Possible related things going **potentially to DMA**
  - Rewrite (parts of) Millepede in more modern programming language
  - Port of Millepede to GPUs

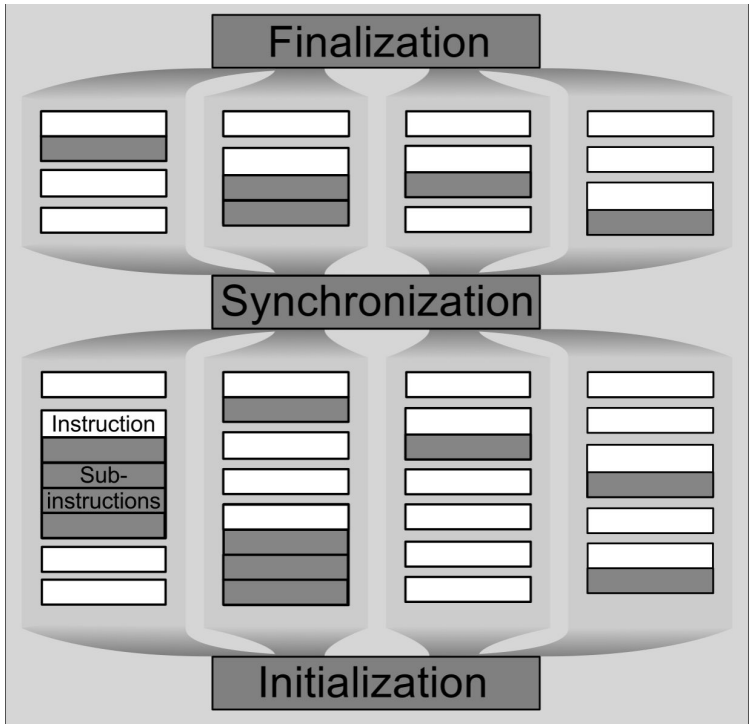




Generators

- Whizard major workhorse for *all* future colliders (FCCee, LCF, MuC)
- Beam simulations interfaces to generators: ee, μμ, AA colliders (cf. below)
- Infrastructure for photon beam simulations (application to LUXE and XCC)
- Need for MC support for experiments like ILD (or IDEA etc.)
- GPU off-leading implementation and benchmarking
- More research on parallelization strategies (SIMD etc.)
- Machine learning for phase space adaption: multi-leg processes
- ML infrastructure for gradient learning from matrix elements
- Physics part (cf. talk by G. Weiglein): towards NNLO EW automation

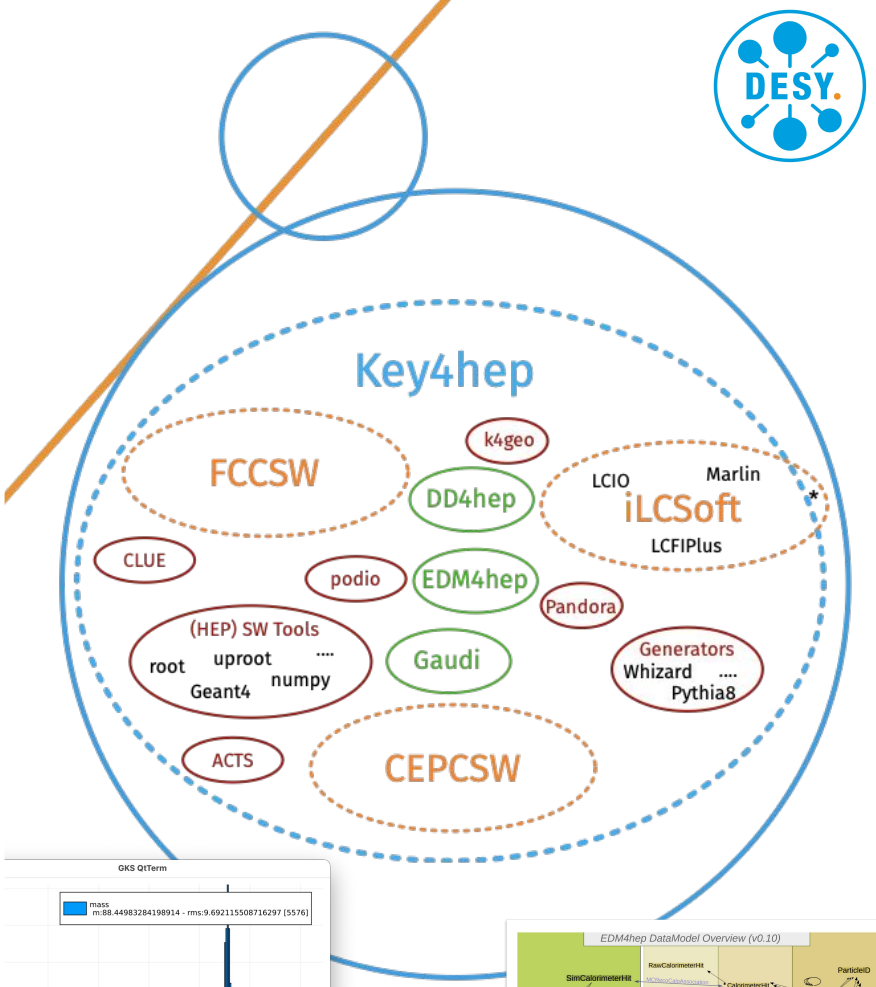


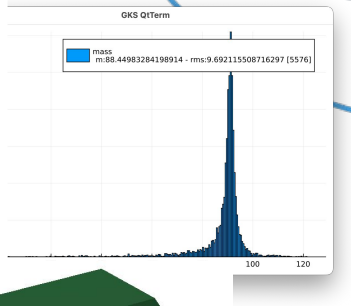


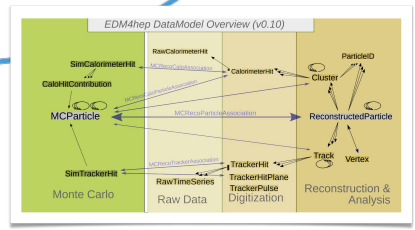
Topics with strong relation to DMA

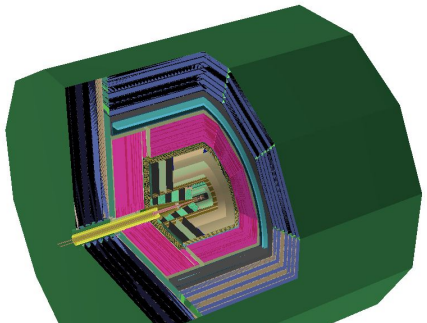
Key4HEP

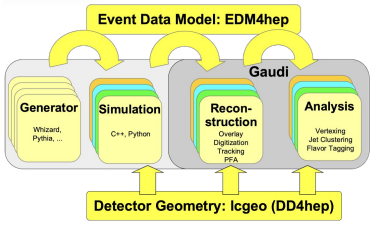
- Key4hep is **the software stack** that is used by all future collider projects:
  - CEPC, CLIC, FCC, ILC, Muon Collider, EIC, ….
- DESY has traditionally a **strong role** in developing core components like geometry (DD4hep) and event data model (LCIO/EDM4hep) as well as **tracking** algorithms and high level **reconstruction** (PID, flavor tagging, etc)
- important for the German community to provide and further develop this expertise at DESY for preparing the next future collider project
- core component development of Key4hep also proposed for MT-**DMA** in PoF-V -> algorithmic developments, detector optimisations and physics studies would fit well in **MU**

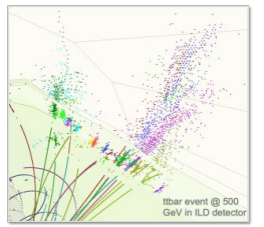












Machine Learning and AI

- Fast detector simulation: generative ML provides orders of magnitude speed up for simulation of calorimeters with high fidelity
  - further develop these methods for start-to-end simulation
- Reconstruction software: jet flavor tagging, PID, increasingly also track reconstruction and PFA
- Ongoing and expanding efforts in various fields
  - Triggers …
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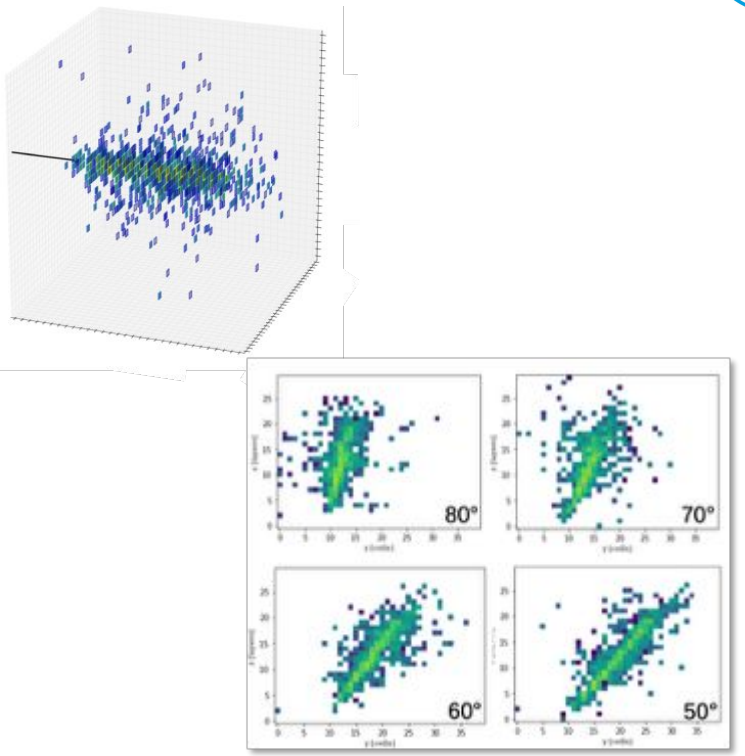
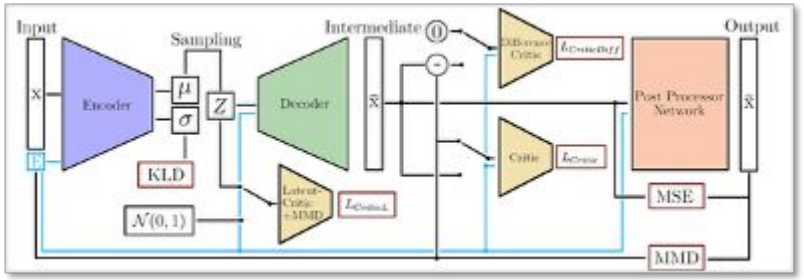
- ML for MC generators: phase-space sampling and event generation & inference learning from MEs





In general efforts should/need align to the (to be developed and shaped) DESY overall AI strategy