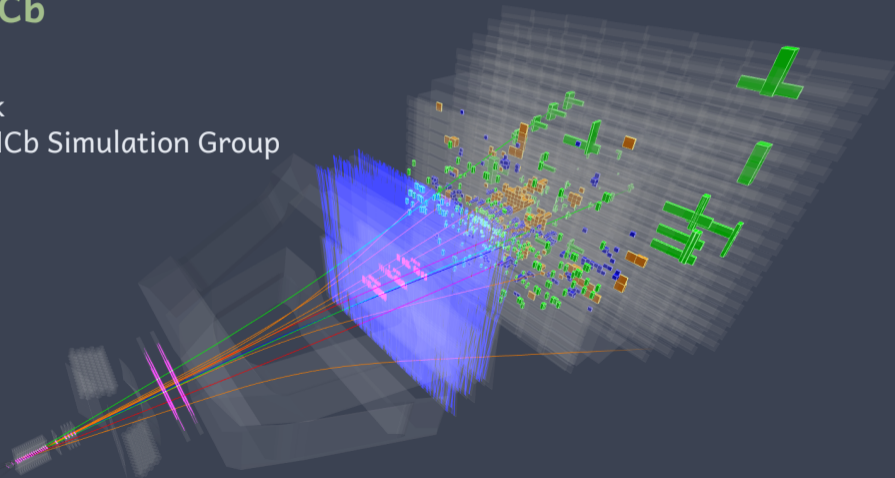# ML4Sim @ LHCb

by Michał Mazurek
on behalf of the LHCb Simulation Group

on April 22, 2021

» Fast Simulation @ LHCb (models under development)

Model	Generation	Decay	Propagation	Digitization	Trigger	Reconstruction
Lamarr	✗	✗	✓	✓	✓	✓
Point lib	✗	✗	✓	✗	✗	✗
GANs	✗	✗	✓	✗	✗	✗

* **Lamarr**   LHCB-FIGURE-2019-017
  Key features: <u>ML</u> & <u>in-house parametrization</u>
  Idea: Replace propagation, digitization and reconstruction with a fully-parametrized detector

* **Point library (calo)**   talk@ICHEP20
  Key features: <u>no ML</u> & <u>FastSim in G4</u>
  Idea: Extract points from a collection and then transform them based on properties of the incident particle

* **GANs (calo)**   LHCb-TALK-2019-403
  Key features: <u>ML</u> & <u>FastSim in G4</u>
  Idea: use GANs trained on the data produced by a detailed simulation to generate showers in the electromagnetic calorimeter
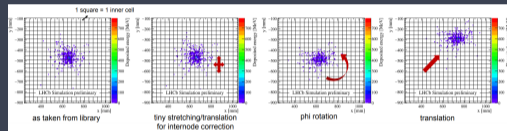

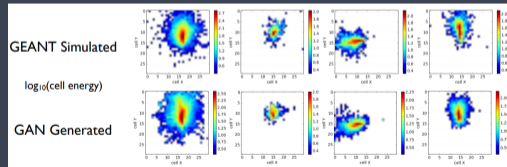Figure: Generation of the showers using point library.

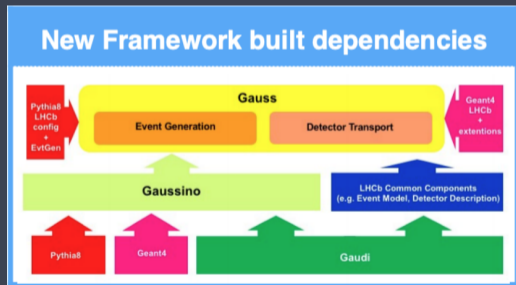Figure: Generation of the showers using GANs

Gauss (current) $\Rightarrow$ Gauss-on-Gaussino (upgrade)

Gaussino D. Muller, LHCb-TALK-2018-358

 * LHCb-independent core framework,
 * controls the multi-threaded event loop,
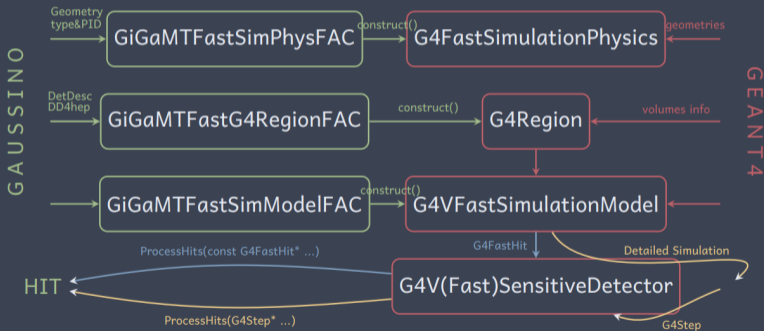 * ensures Geant4MT threads are separate from Gaudi (LHCb core software) software threads,
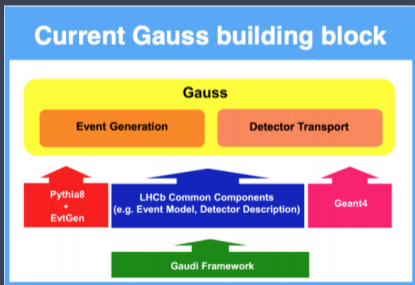
Fast Simulation Interface
* LHCb hook for Geant4 fast simulation,
* provides configuration and factories for all fast objects in Geant4,

» Currently work in progress

- ∗ geometry information needed in fast simulation $\Rightarrow$ tackling multiple geometries: DetDesc (Gaudi), DD4hep or parallel world,
- ∗ new classes for fast simulation in Geant4, $\Rightarrow$ migrating to Geant4 10.7,
- ∗ no central ML framework available yet $\Rightarrow$ investigating PyTorch C++ API,
- ∗ configuration of current Gauss to prepare a training dataset for GANs

Happy to collaborate and share further results!