Introducing fast simulation models in the MT simulation framework

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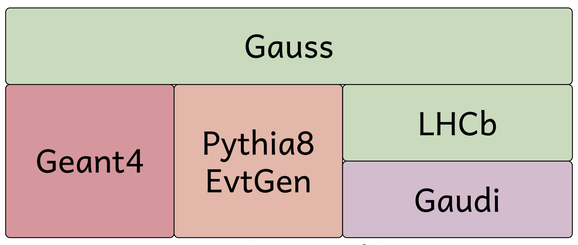
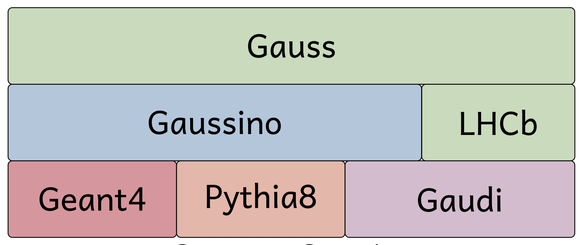
1. Gauss-on-Gaussino

- **Gaussino** [1, 2, 3] is a new experiment-independent core simulation framework that:
  - is based on Gaudi's inter-event-based parallelism of the event loop;
  - marries it with Geant4 multi-threading;
  - provides infrastructure for a 'plug-in' of HEP generators.
- **Gauss-on-Gaussino** is the newest version of the LHCb simulation framework, based on Gaussino.



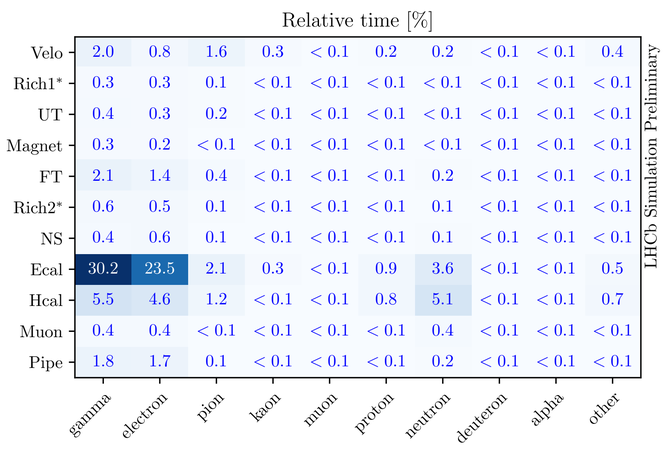
Gauss in Run 1 and Run 2



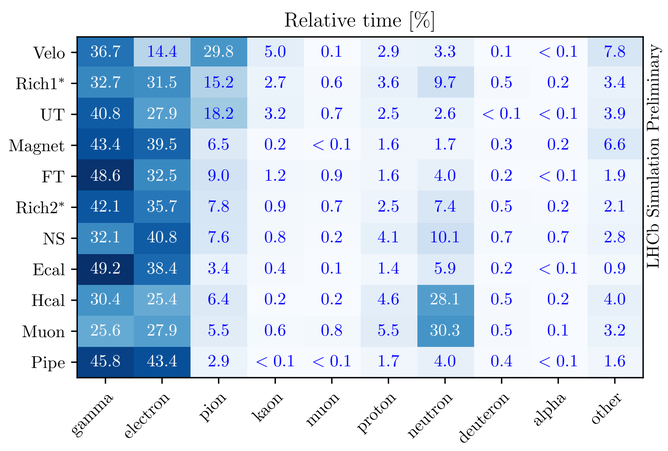
Gauss-on-Gaussino

2. Timing

- Around 80% [4] of the LHCb allocated CPU resources are used to produce Run 1 and Run 2 simulated samples.
- Particle showers in the electromagnetic calorimeter at LHCb dominate the time spent on simulation (RICH optical processes are turned off in the comparison).



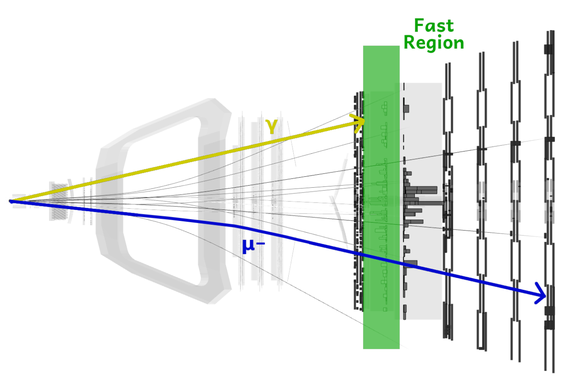
Relative time [5, 6] spent by given particles in a sub-detector with respect to the total time of the simulation



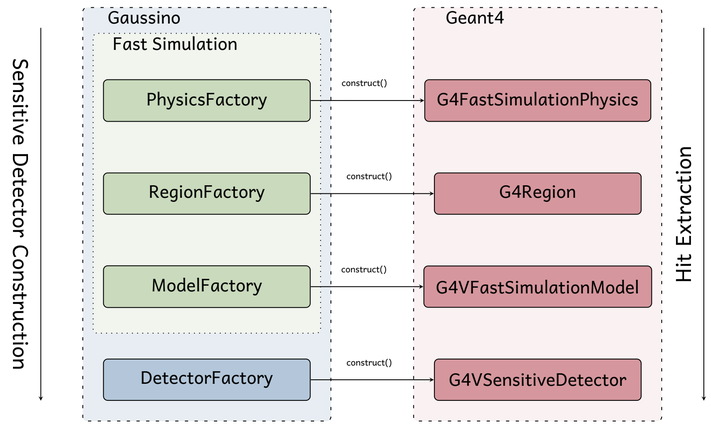
Relative time [5, 6] spent by given particles in a sub-detector with respect to the time spent in that sub-detector

3. Fast Simulation Interface

- The Geant4 [7] toolkit gives the possibility to replace its simulation of physics processes with a custom fast model.
- LHCb is introducing a palette of fast simulation models to complement the detailed simulation.



Fast Simulation in Geant4

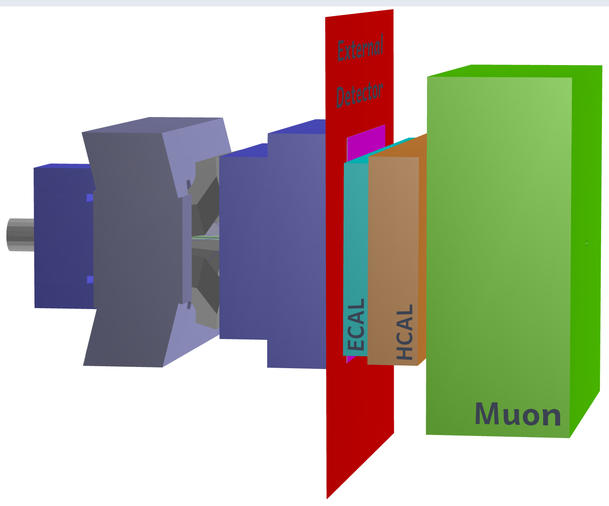


A simplified model [5, 6] of the FastSimulation interface in Gaussino

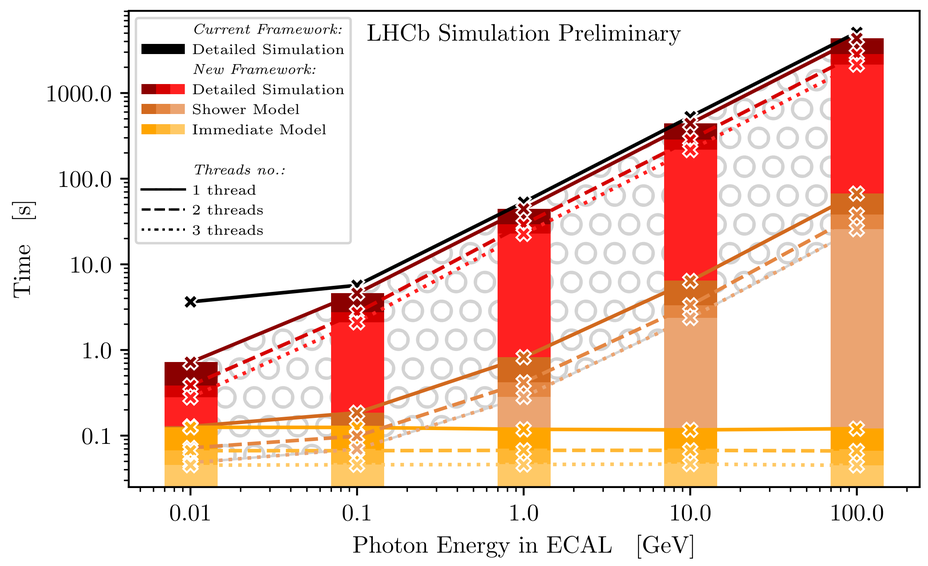
- **FastSimulation** interface provides a set of factories that configure the corresponding Geant4 objects at the right moment when running the application.
- Gaussino's implementation minimizes the work needed to implement fast simulation models and guarantees the integrity of the simulated data.

4. External Geometry

- **ExternalDetector** is a new package in Gaussino that allows for abstract, sensitive volumes of any shape to be inserted.
- **ParallelGeometry** is another special package that takes care of potential overlaps caused by extra volumes.
- These features allow to save custom information from detailed simulation needed to train and validate new models.

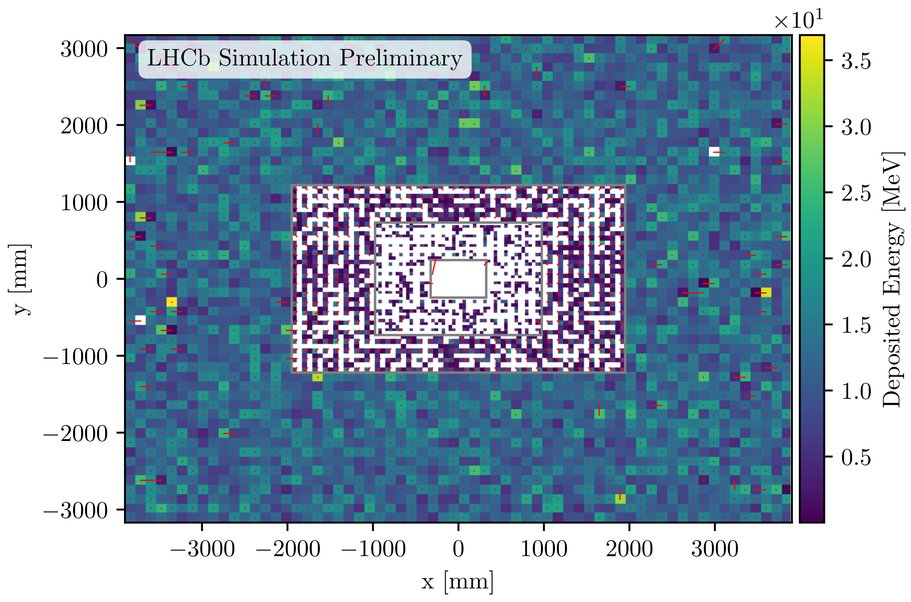


5. Performance of the interface

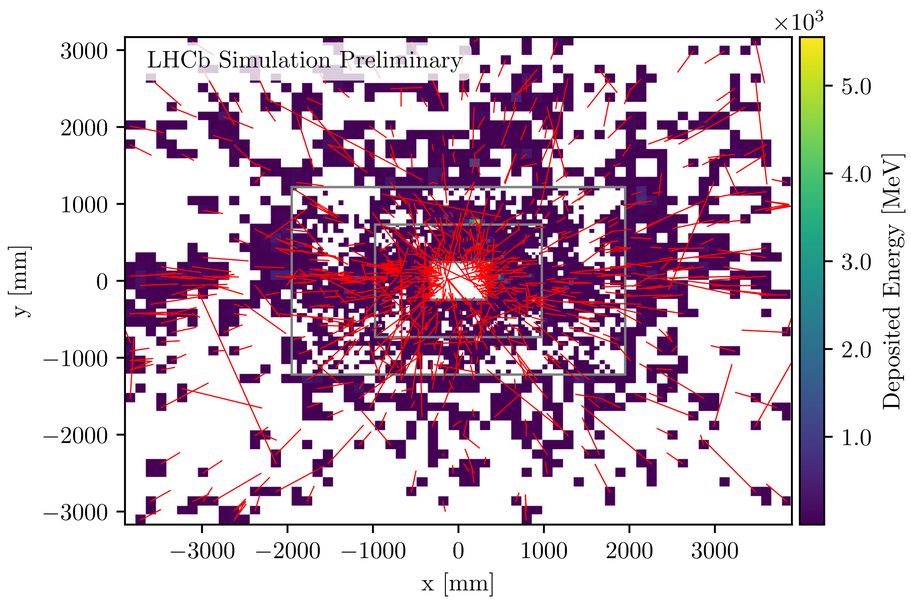


Comparison of the time [5, 6] spent by the infrastructure of the fast simulation interface and the detailed simulation with Geant4

6. Examples of training samples



Energy deposition [5, 6] in the LHCb ECAL from a training dataset produced with a grid of 3328 evenly-spaced 100 MeV photons



Energy deposition [5, 6] in the LHCb ECAL from a training dataset produced by a minimum bias event with the beam conditions as foreseen in the Run 3 data-taking period

7. References

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