FULL AND FAST SIMULATION FRAMEWORK FOR FUTURE CIRCULAR COLLIDER STUDIES

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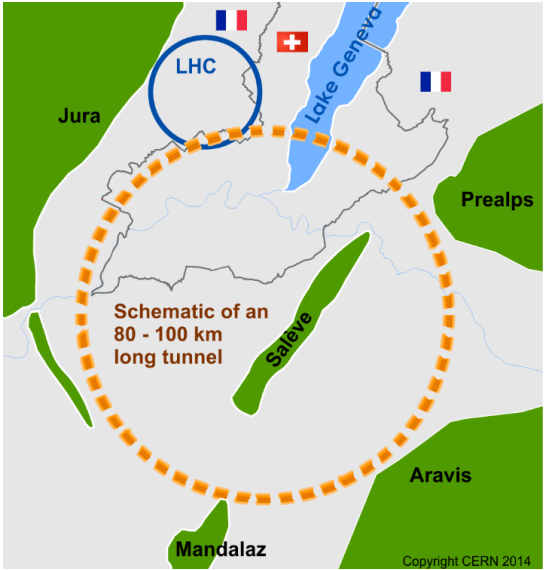
Future Circular Collider

- 80-100 km circumference
- studied collider options:
  - hadron-hadron (FCC-hh)
  - lepton-lepton (FCC-ee)
  - hadron-lepton (FCC-he)

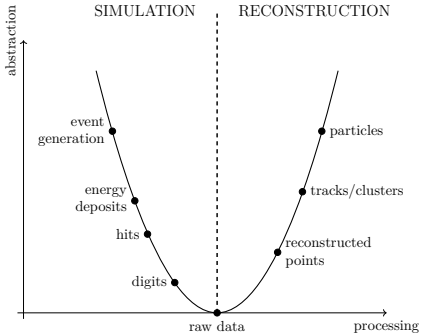
- goal 100 TeV for FCC-pp
  - more particles produced (×1.5 more than 14 TeV)
  - large detector (∼20 m x 50 m)
  - more pile-up events (∼1000 events)



http://fcc.web.cern.ch

Providing a flexible infrastructure

- different collider options
- several detector designs
- different accuracy, level of detail for
  - physics analyses
  - detector studies



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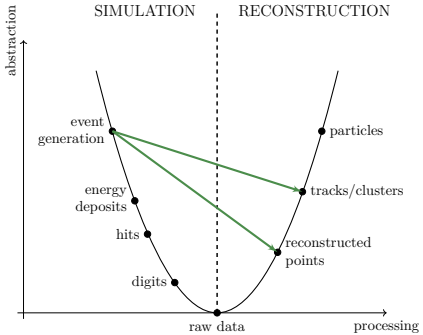

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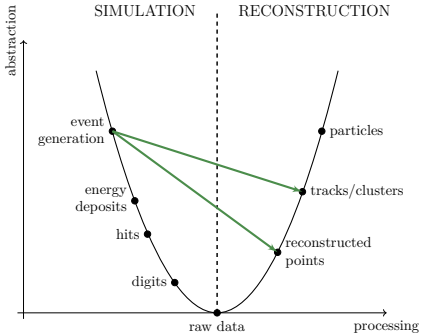
What can be used?

many specialised software solutions

or

one flexible framework



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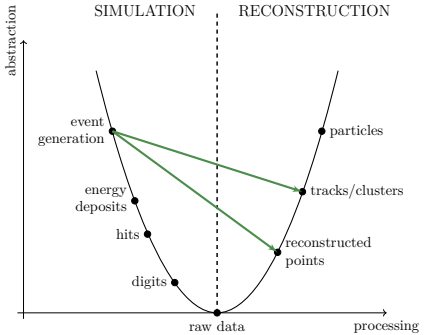
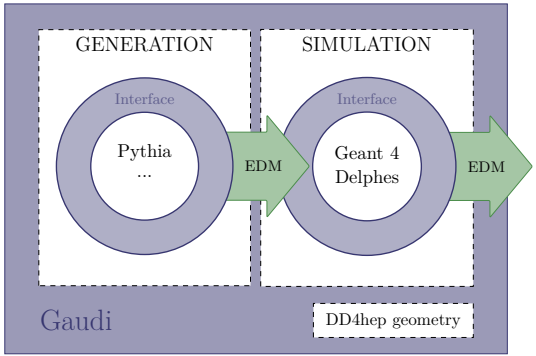


FCCSW - software common for all FCC collider options (hh, ee, eh) and experiments.

- common toolkits for event generation, simulation, ...
- easy to mix fast and full simulation

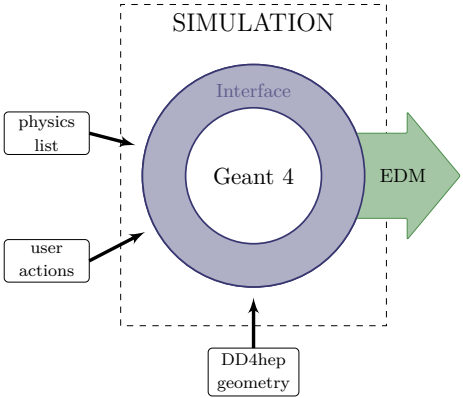
FCC software



- Gaudi - main framework
- Delphes - fast simulation
- Geant 4 - full & fast simulation
- DD4hep - detector description

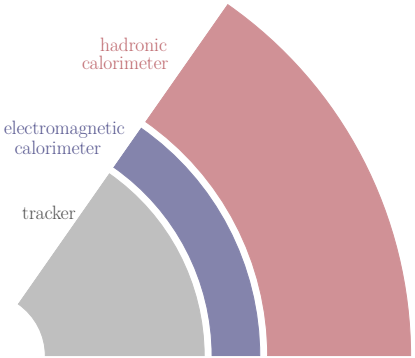
Non-FCC specific part is extracted to Gaudi+Geant4 simulation framework: Gaussino

Full simulation configuration



Full simulation

- detectors



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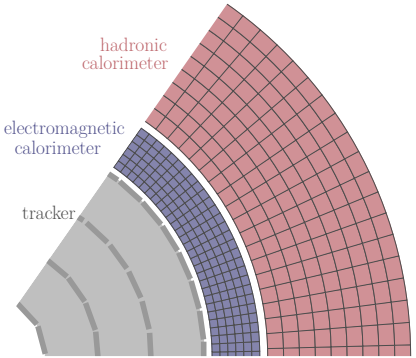

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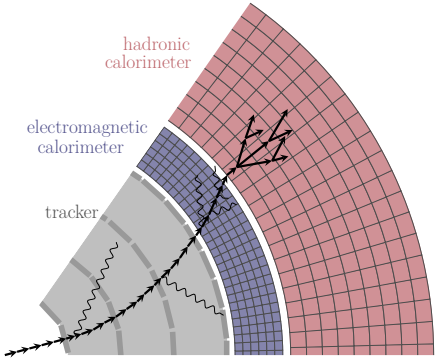

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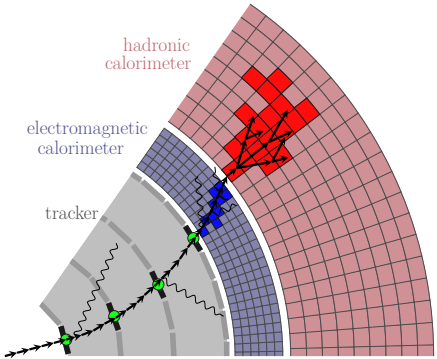

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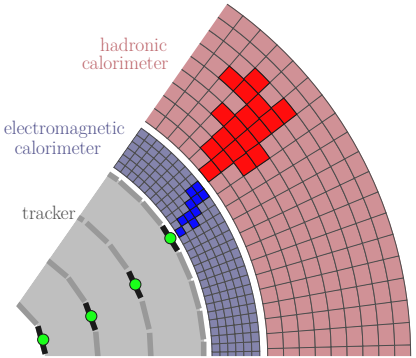
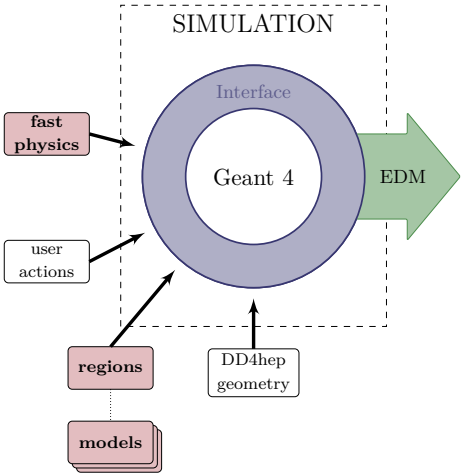
- saving energy deposits



Fast simulation configuration

Configuration of fast simulation:

- configuration of Geant 4
- add parametrisation process
- add models that govern the particle (its lifetime, properties, energy deposits).



Fast simulation

- regions
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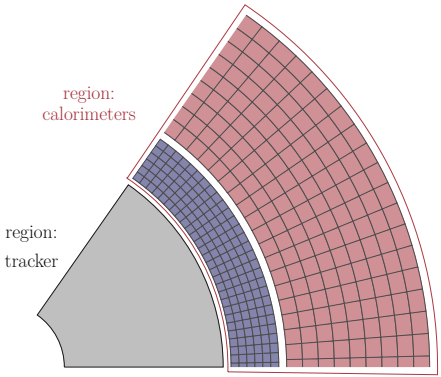
  - sensitive detectors for calorimeters



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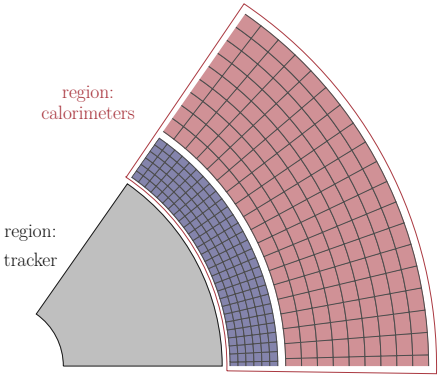

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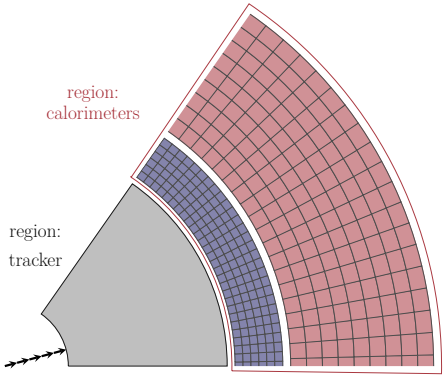

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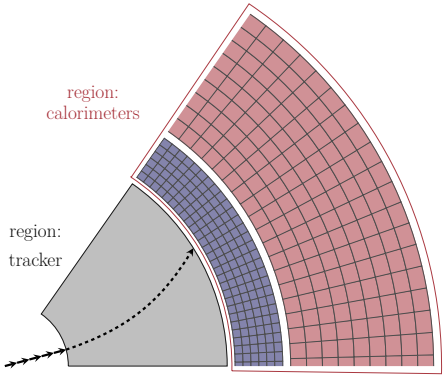

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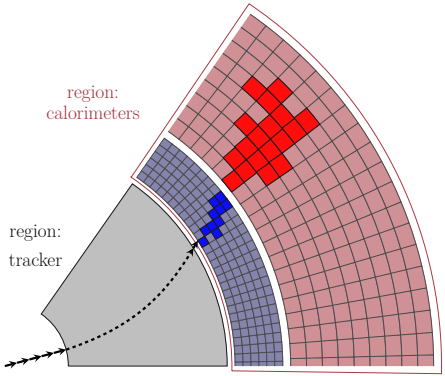
  - calorimeter:
    - hits created
    - energy deposits stored



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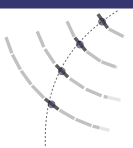

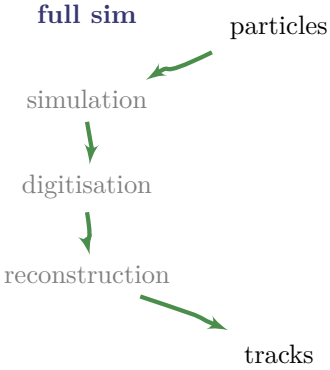

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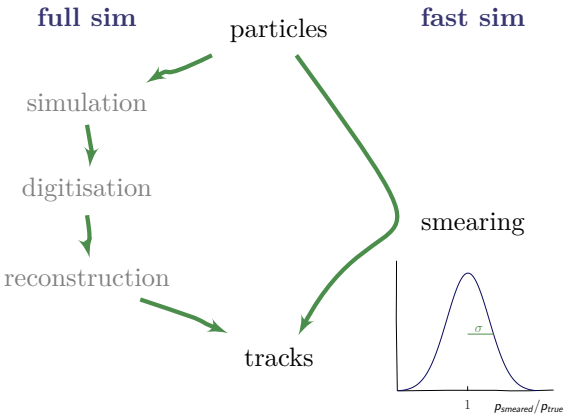

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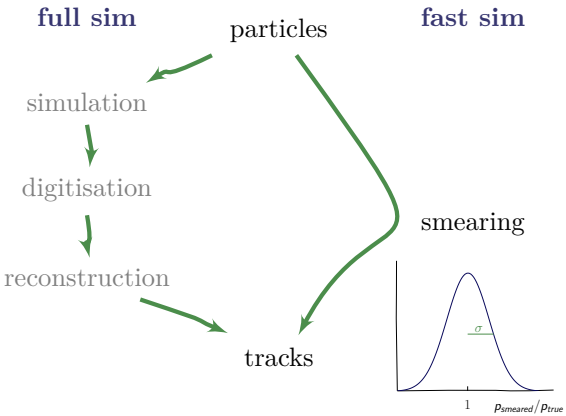

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tkLayout
fcc-tklayout.web.cern.ch

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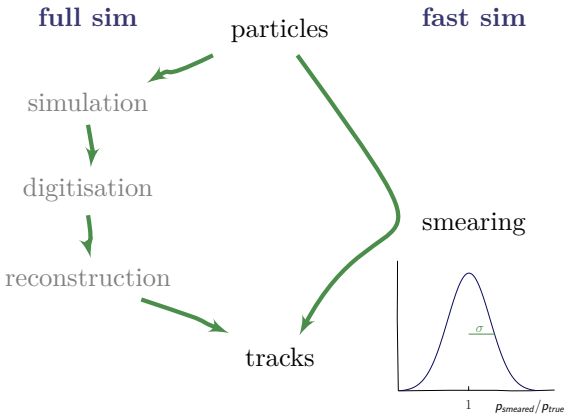

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  - FCC software, awaiting tracker reconstruction: ACTS

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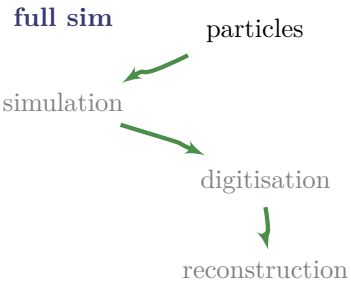
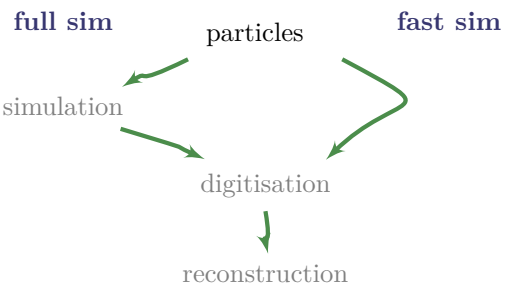
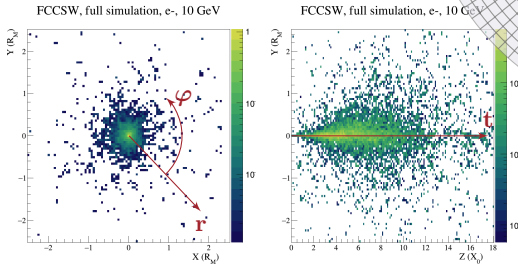
ACTS
CHEP 2016, Track 2: 12
Oct 2016, 11:30
acts.web.cern.ch


full sim
particles
simulation
digitisation
reconstruction





a. GFlash library: existing in Geant 4

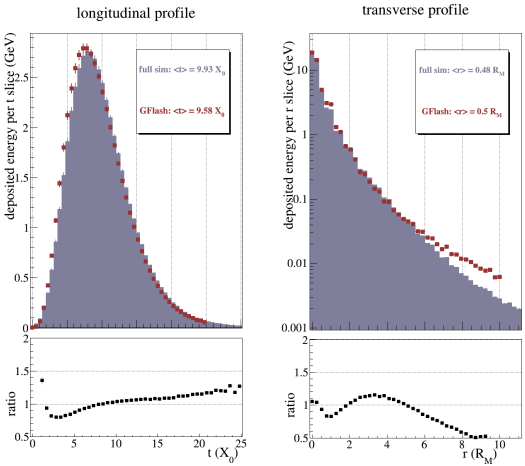
analytical parametrisation of shower profiles: longitudinal (t) and radial (r, uniform in ϕ)

b. frozen showers: library of presimulated showers

GFlash
arXiv:hep-ex/0001020

Parametrisation of the electromagnetic showers, using the original GFlash parameters

First tests with FCC-hh size calorimeters and single electron events...



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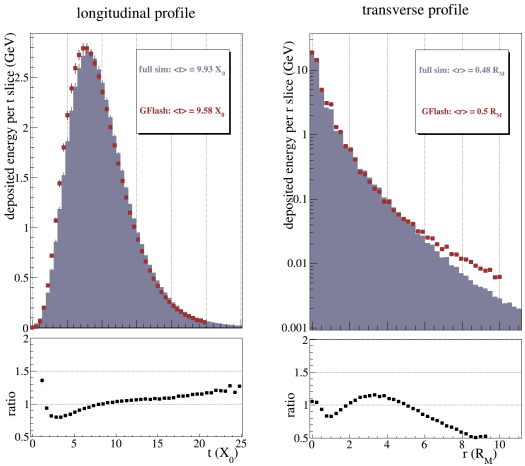

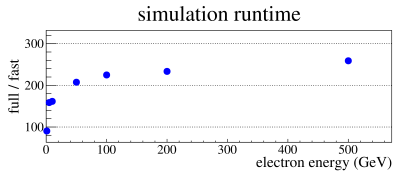

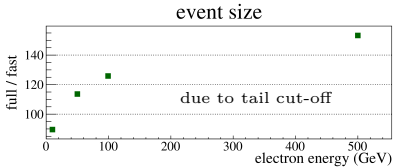

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Currently

- possible to mix fast and full simulation within the same event
- event simulation entirely in hands of one framework
- first parametrisation models provided:
  - for tracking detectors:
    - p-dependent smearing
    - resolutions from external tools, e.g. tkLayout
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Simulation in Geant 4

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What next

- tools for extracting the parameters from full simulation
  - for existing models
  - within FCC software (same geometry)
- new parametrisation models:
  - for calorimeters:
    - frozen showers

Summary

- FCC software is designed to be shared between accelerator options and all experiments
- Simulation important for both detector design studies and physics analyses

http://fccsw.web.cern.ch/fccsw/

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- Simulation important for both detector design studies and physics analyses
- Possibility to use in early studies Delphes ultra-fast parametrised simulation
- Integrated full and fast simulation within Geant 4

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