FCC FAST SIMULATION

Anna Zaborowska

on behalf of the FCC Software Group

May 27, 2016
GeantV Fast Simulation mini-workshop

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for all FCC accelerators (FCC-ee, FCC-eh and FCC-hh)

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- Geant4 simulation (**fast** and **full** simulation):
  - sim service configures Geant4 (physics list, user actions...)
  - sim algorithm passes and retrieves `G4Event`
  - simulation is entirely in hands of Geant4, also **fast** simulation

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- others (**fast** simulation):
  - Delphes parametrised simulation
  - tracker fast simulation developed in ACTS (ATLAS Common Tracking Software)

Fast simulation in Geant 4

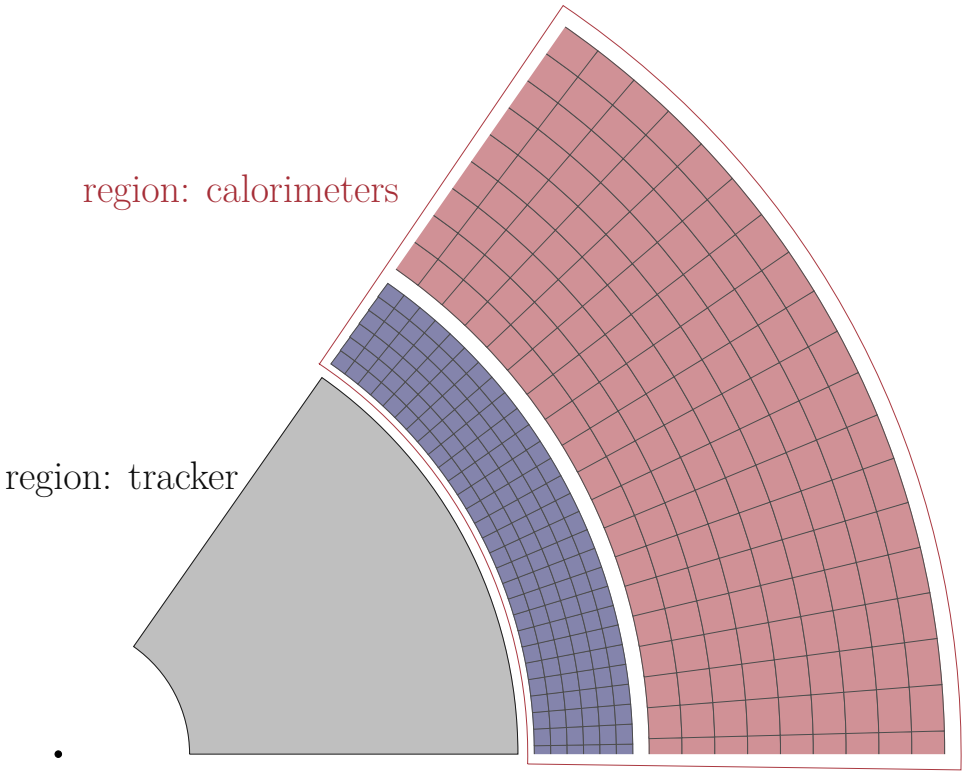
- parametrisation (`G4FastSimulationManagerProcess`)
  - another 'physics' process
  - can be added to specific particle types

- fast simulation models (`G4VFastSimulationModel`)
  - attached to region
    - volume
    - few volumes
    - defined in parallel geometry
  - triggered by chosen particles
    - based on `G4ParticleDefinition` (PDG data)
    - based on `G4FastTrack` (kinematics)
  - describe what happens to particle
    - `G4FastStep` allows to go back to `G4Track`
    - changes to momentum/position are made

Fast simulation in Geant 4 within FCCSW

- geometry described in DD4hep (envelope for tracker and sensitive detectors for calorimeters)

- fast simulation models
  - create tracks for tracker detectors
  - create energy deposits (showers) for calorimeters



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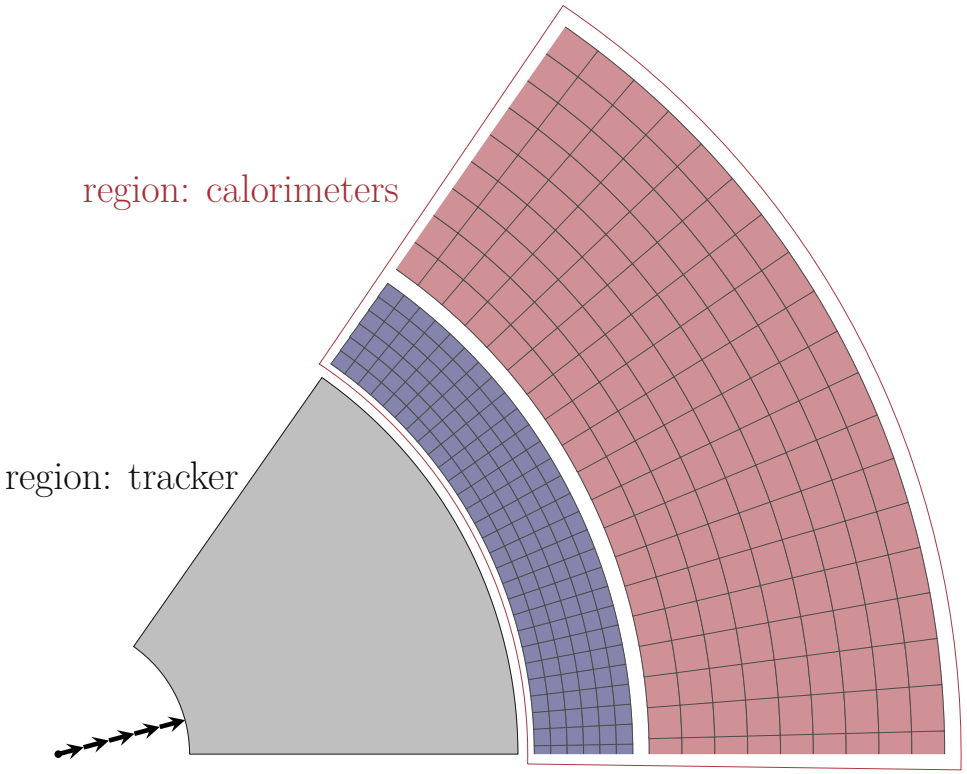

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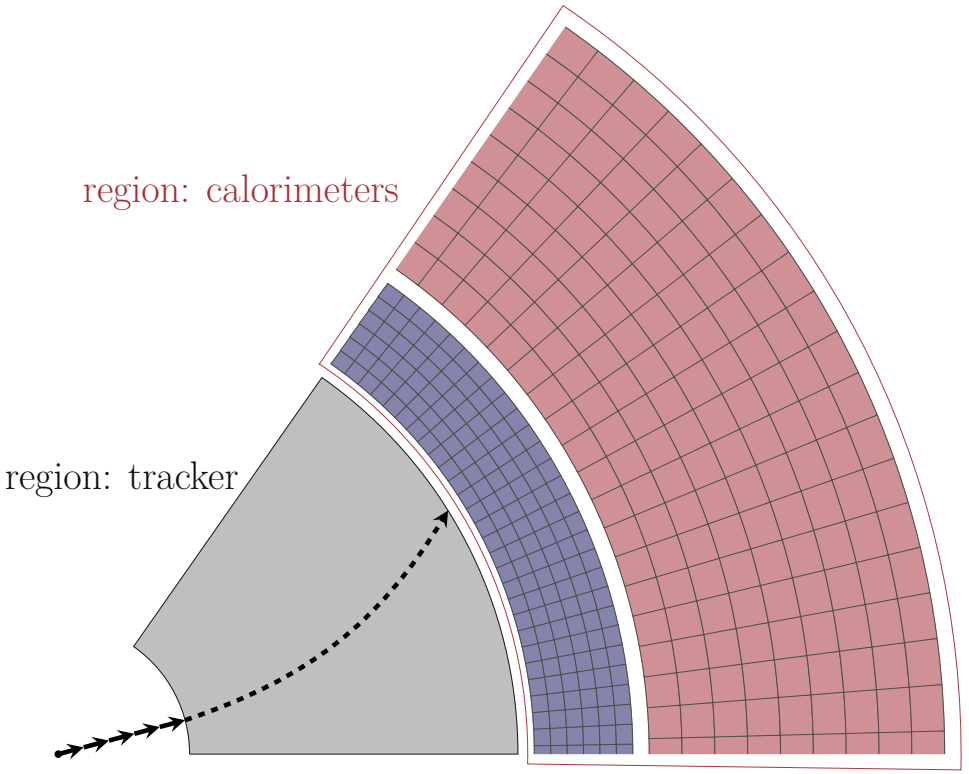
    - particle momentum can be changed (smeared)
    - tracks stored in Event Data Model



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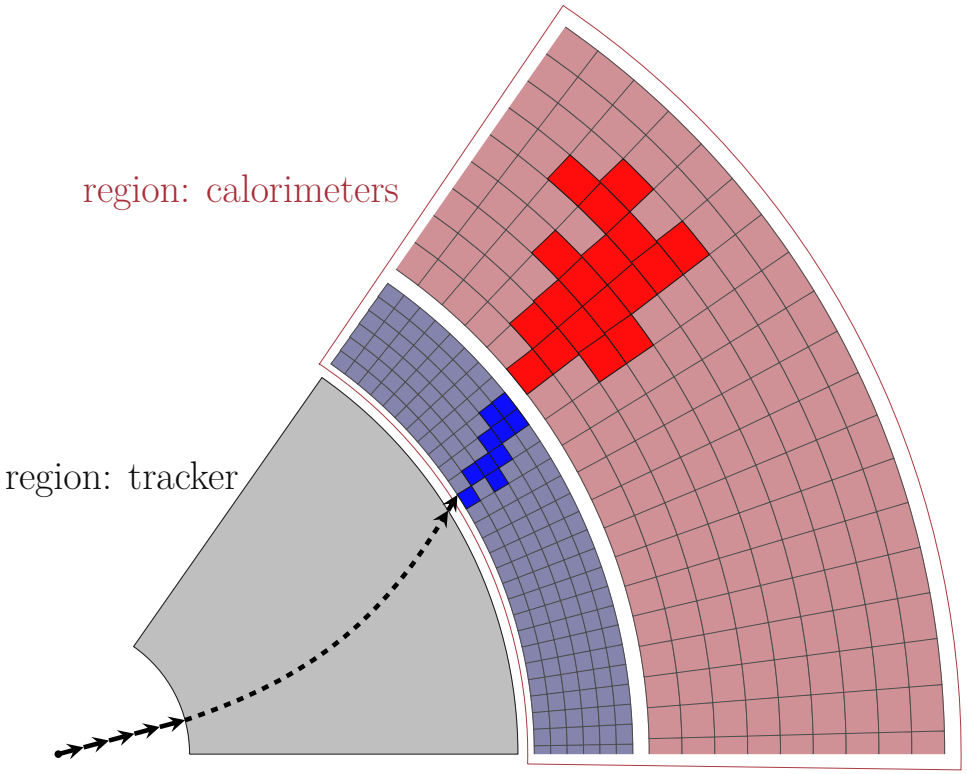
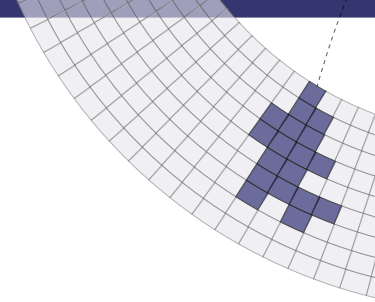
  - for calorimeter:
    - if particle is contained inside, hits are created
    - energy deposits stored in Event Data Model



Calorimeters



- hits in the calorimeter created instantly, based on the particle type and energy
- analytical parametrisation of the radial and longitudinal profiles
- implementation of shower parametrisation (for electrons) in Geant4: GFlash
- currently in validation

GFlash

hep-ex/0001020

Summary

Main goal

- using Geant4 as the framework for both fast and full simulation
- configuration of the simulation on Gaudi side:
  - which models to use
  - what parametrisation to take
  - where to perform fast and where full sim
- extracting as much as possible to make it detector-independent Gaudi simulation package 'Gaussino'

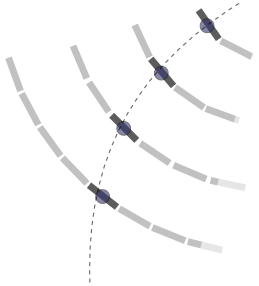
Current ideas for future

- fast simulation in tracker using resolutions obtained from full simulation
- extension of GFlash parametrisation
- frozen showers

I would be glad to hear your suggestions and hope for fruitful cooperation.

BACKUP SLIDES

Tracking detector

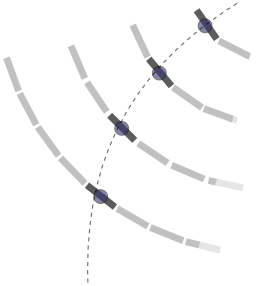


- fast simulation simulates the detector response:
  - physics processes
  - detector performance (resolution and efficiency)
  - reconstruction procedure

  by smearing the particle momentum (and exit position)

- smeared tracks can be treated as 'reconstructed'
- the three CPU expensive stages - detector simulation, digitisation, reconstruction, are replaced with a single, fast one

Tracking detector



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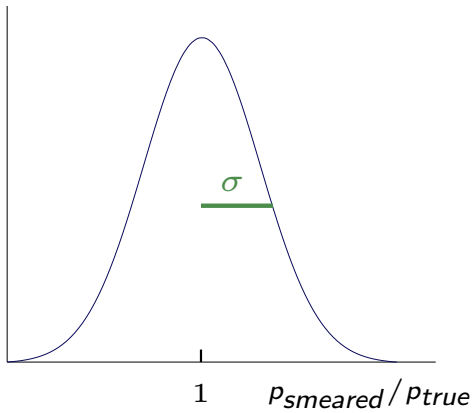
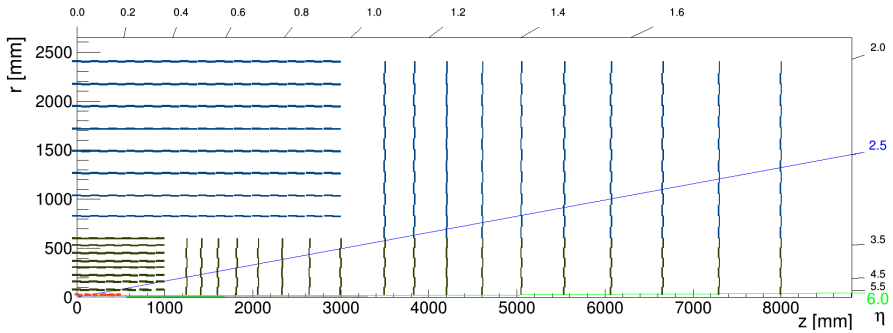
Smearing resolutions σ may be derived from:

1. momentum dependent formula (using existing measurements)
2. external packages, e.g. tkLayout
3. full sim performed in the same framework (in particular, using the same geometry description)



tkLayout

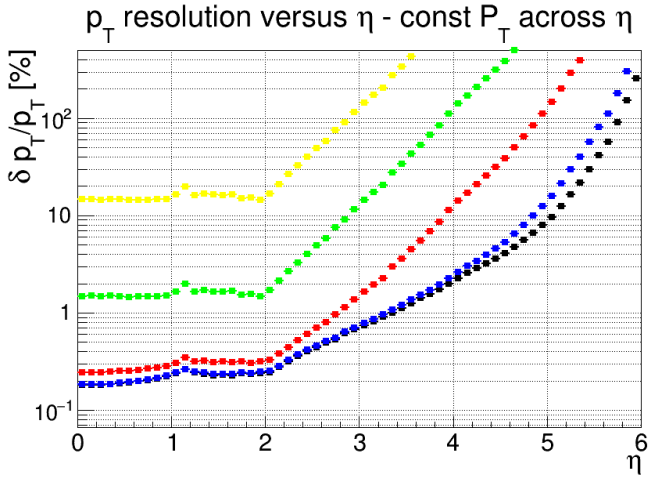


- tracker layout simulation toolkit
- developed and used for CMS Phase 2 Upgrade studies

- configuration tool with a sample detector for FCC-hh has been prepared
- resolutions can be read in FCCSW and used for momentum smearing in tracker

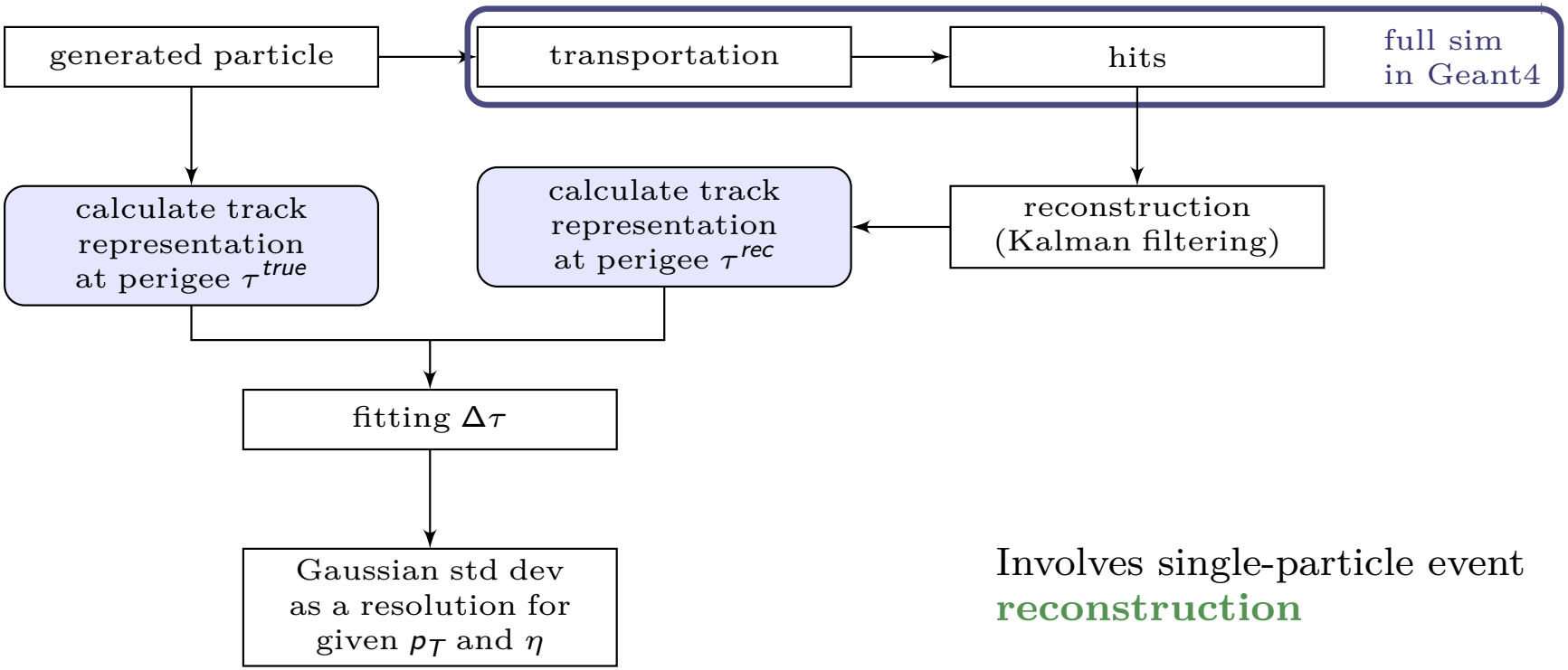
tkLayout for FCC

http://fcc-tklayout.web.cern.ch



p_T = **5 GeV**, **10 GeV**, **100 GeV**, **1 TeV**, **10 TeV**

Resolutions obtained from full simulation



Involves single-particle event **reconstruction**

To be introduced once reconstruction (ACTS) is integrated into FCCSW