FCC Software Status and Next Steps

on behalf of the software group

FCC Hadron Detector Meeting

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CERN - EP-SFT

# Where are we? Status of the Software

Get to a more steady pace development

- Tag FCCSW + externals for users
- Aiming to have a well-defined set of examples and tutorials in sync with this version

About to tag FCCSW "version 0.5":

- Simulation
  ‣ A proof of concept for Full and FastSim using Geant4
  ‣ Delphes without FCC EDM output
- FCC-hh detector status:
  ‣ DD4hep Test tracker developed by Julia
  ‣ (Untested) HCal design in DD4hep translated from Carlos' version
  ‣ B-field, beam-pipe and magnets by Clement
- Updated to ROOT 6 and newest versions of externals (Benedikt)
- General infrastructure:
  ‣ New guidelines for contributing code
  ‣ Doxygen documentation
    https://jlingema.web.cern.ch/jlingema/ (will be moved to a better place)

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Detector Envelopes

Test tracker
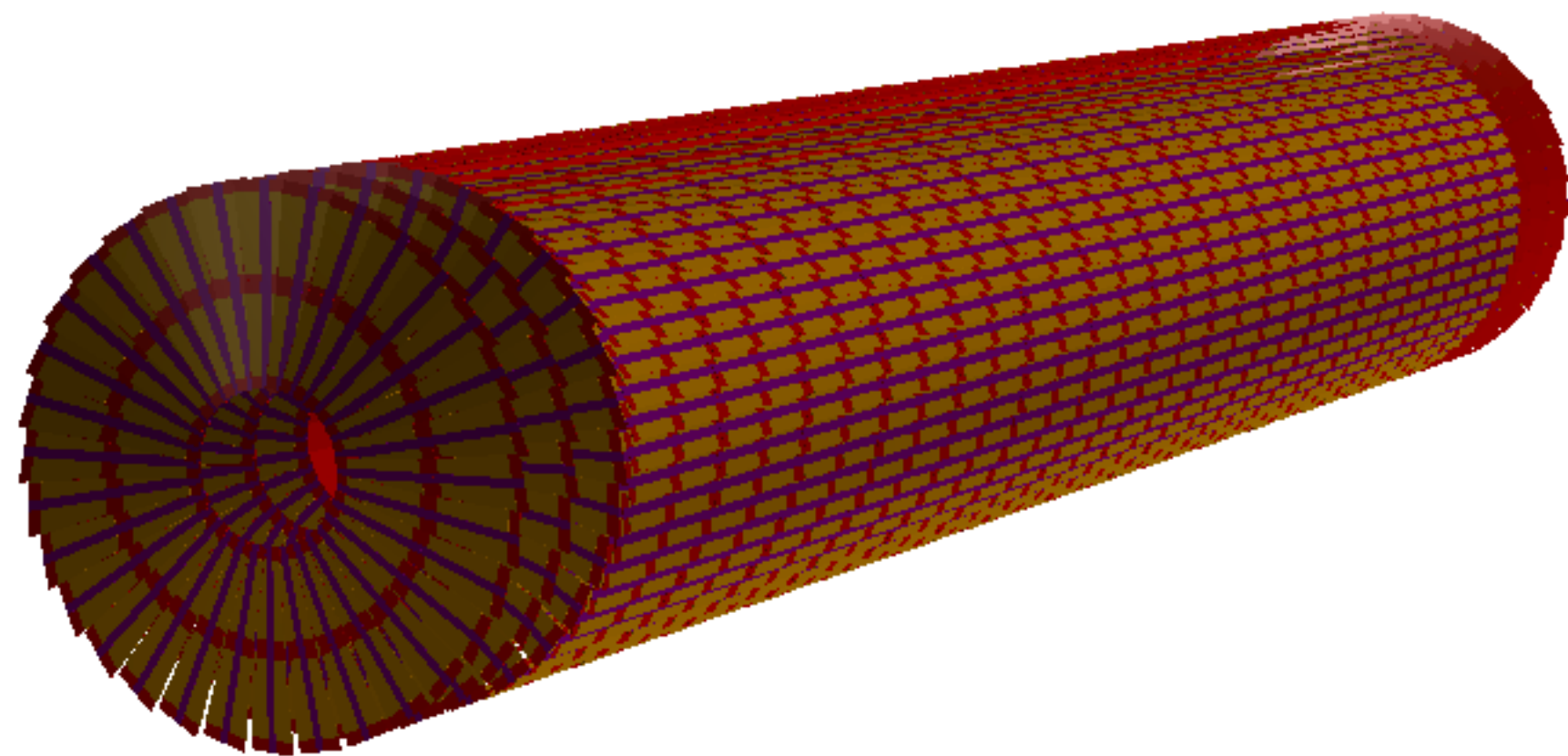
Magnets + HCal + beam-pipe
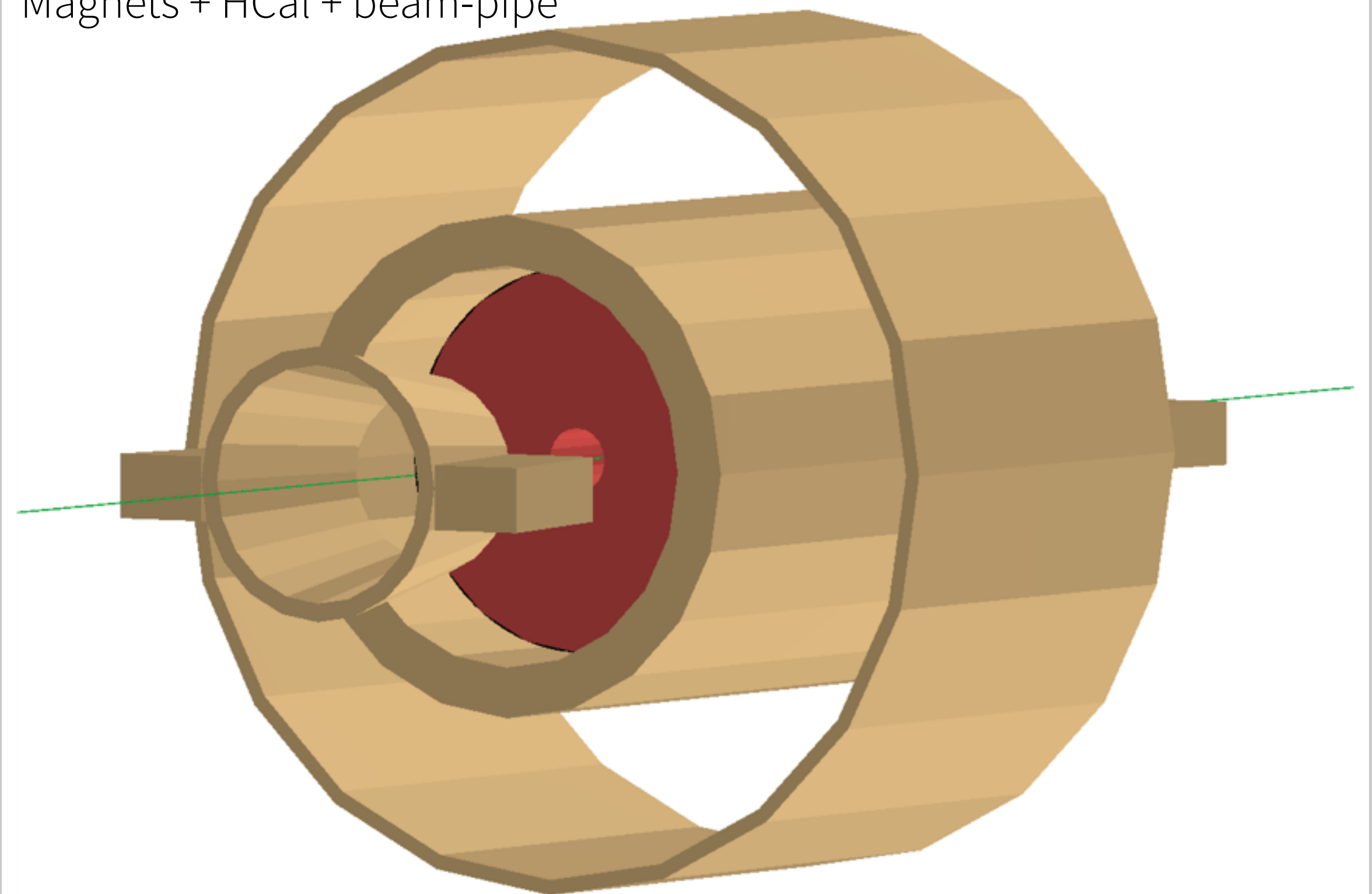
Overall picture: On-going activities

Tracking

- Extract tracking software without pattern recognition from ATLAS (see Julia's talk)

Generation and Simulation

- Generation
  - ‣ General infrastructure to be taken from LHCb
  - ‣ Update Pile-Up handling to the needs we have
- Delphes
  - ‣ Need to finalise output in FCC EDM I/O
- Geant4
  - ‣ First proof of principle implementation of our design by Anna
  - ‣ See where we can synergise with LHCb migrating to Geant4 10 (multi-threaded)
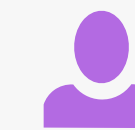
Datamodel:

- Make sure use-cases are covered (recently added namespace support)
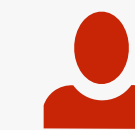
Extending examples

- Currently a small set of examples — could use some actual use-cases

Julia H. + Andi S.

Valentin V. + Joschka L. + Benedikt H.

Anna Z. + Joschka L. + Benedikt H.
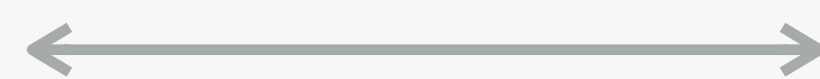
Zbynek D.

Benedikt H.

??

Fast and full simulation status

FULL SIMULATION ⟷ FAST SIMULATION

FULL SIMULATION

Full detector response

Produces:

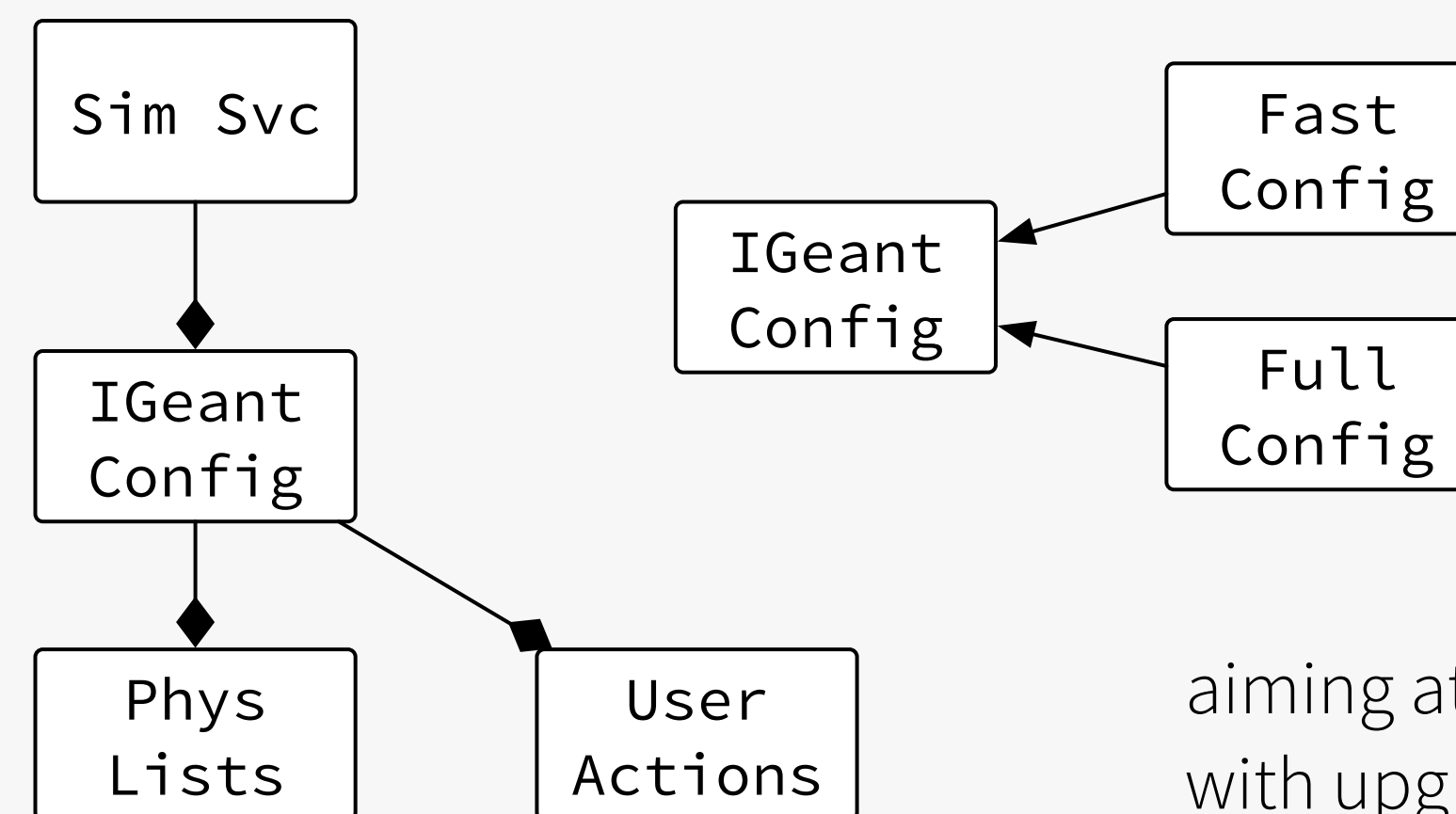- Tracker hits / clusters

- HCal energy deposits / clusters

FAST SIMULATION

Smearing

Produces:

- Reconstructed particles

a matter of configuring the
simulation service:
GeantConfig interface
to ease the configuration

```
Sim Svc
   |
   ◆
IGeant
Config
   |        \
   ◆         ◆
Phys      User
Lists     Actions
```

```
         Fast
         Config
          |
IGeant ◀──┘
Config ◀──┐
          |
         Full
         Config
```

aiming at a common implementation
with upgraded LHCb simulation

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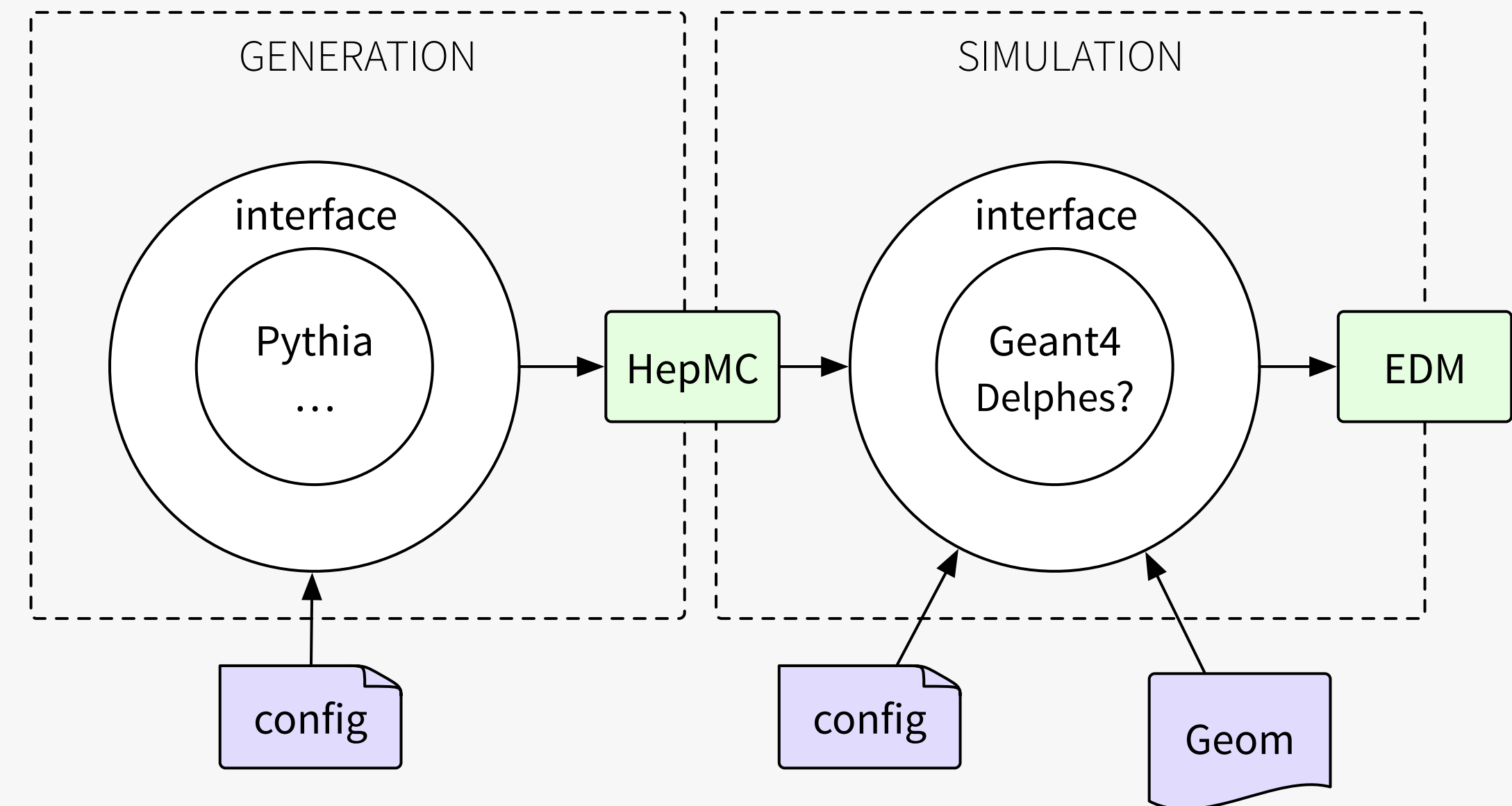
Extract and use LHCb's GenSim package Gauss

Gauss nicely divided into generation & simulation steps:

Generation:

- thin interface layer between various generators and Gaudi / LHCb software

Simulation:

- A bit more involved interface for Geant4
- Geometry interface via GDML

Event information is passed in HepMC format

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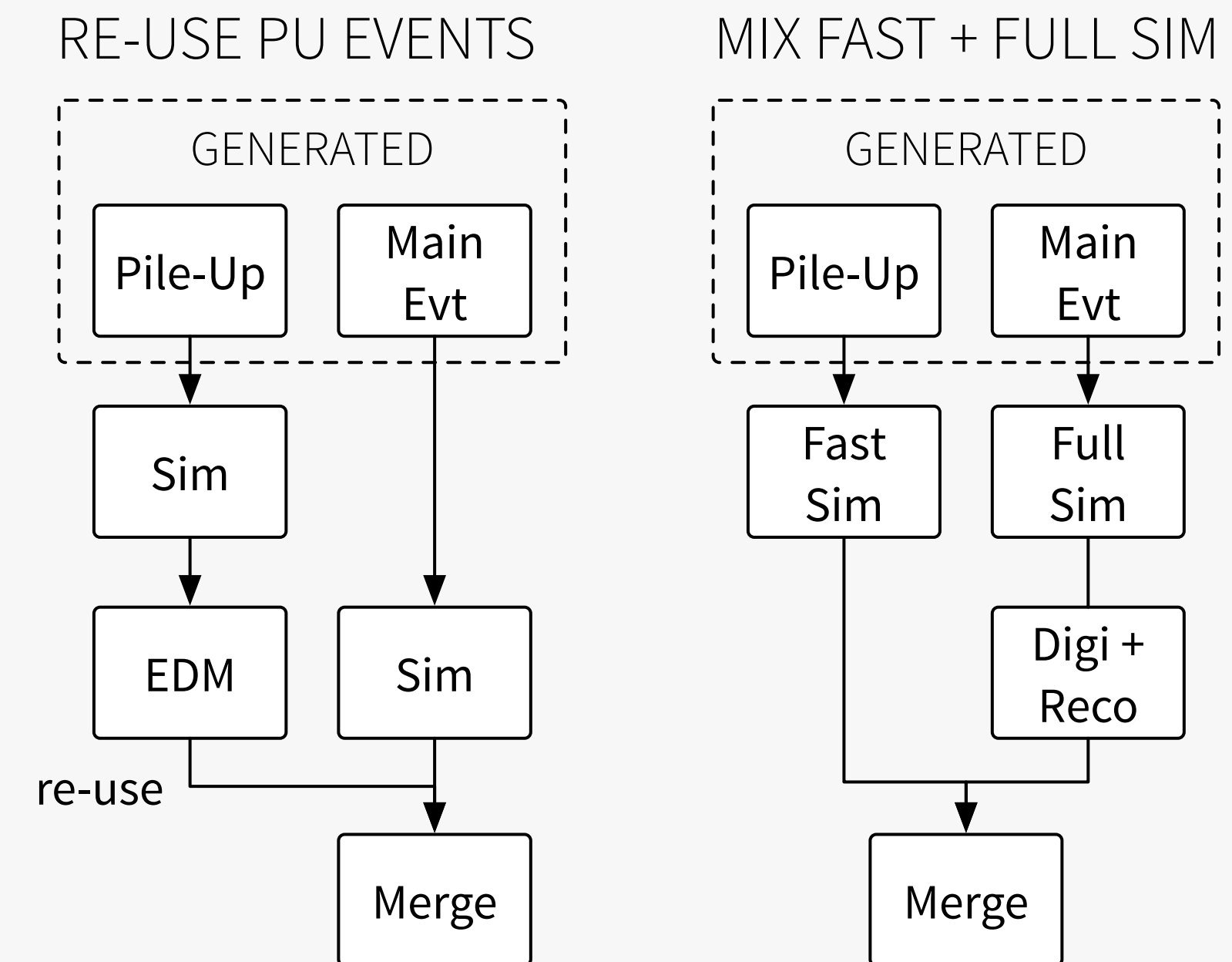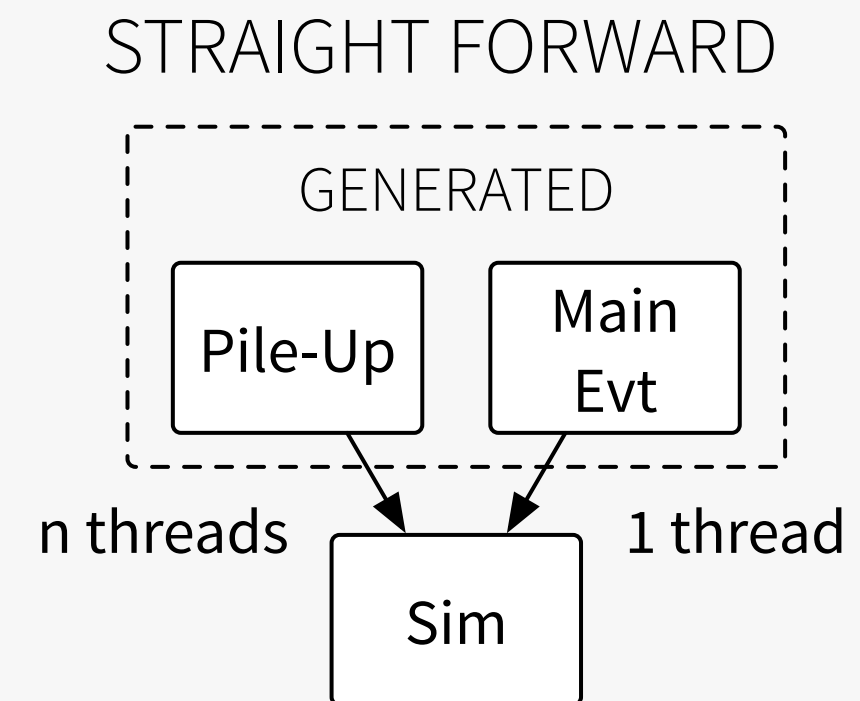
Pile-Up handling

Several approaches — Where do we merge?

Depends on the study you want to do

- Straight forward:
  - ‣ Hand over fully merged HepMC event to G4
  - ‣ Variant: Split simulation per interaction; directly merge
- Re-using pile-up events
  - ‣ Generate + Simulate a large pool of Minbias events
  - ‣ Merge the main event with read-in Pile-Up
- Mixing fast and full simulation:
  - ‣ Simulate pile-up with fast simulation; main event with full simulation
  - ‣ Merging at analysis level

Implementing distribution as described in recent FCC machine paper Optimizing integrated luminosity of future hadron colliders

STRAIGHT FORWARD

GENERATED
Pile-Up   Main Evt

n threads   1 thread

Sim

RE-USE PU EVENTS

GENERATED
Pile-Up   Main Evt

Sim

EDM   Sim

re-use

Merge

MIX FAST + FULL SIM

GENERATED
Pile-Up   Main Evt

Fast Sim   Full Sim

Digi + Reco

Merge

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Getting started with FCCSW simulation

The minimal infrastructure ingredients are there:

- ParticleGun

- Geometry service

- Geant4 full and fast simulation

Example:
ParticleGun cfg

```
config
```

```
Geo
Svc
```
```
Sim
Svc
```
```
Sim
Alg
```

What output?
(note that output will be
moved to tool in FCCSW 0.6)

Which detector?

**via IGeantConfig:
Fast? Full?**

```
EDM
Output
```
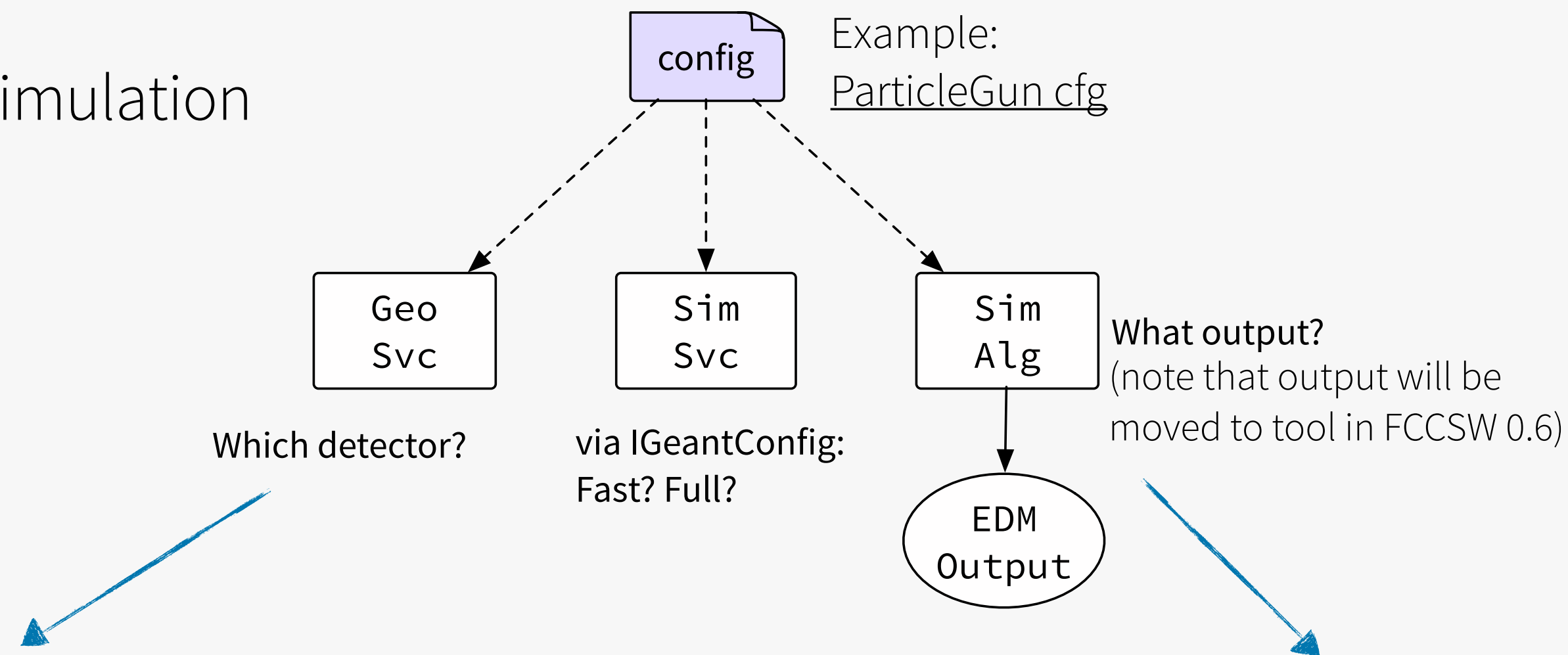
Adding a detector:
- Define the geometry and materials in DD4hep XML
  - Example: Solenoid XML
- Implement the DD4hep factory method
  - Example: Cylinder Factory

Adding readout / sensitive detectors:
- DD4hep has facilities to generate these for you
- You need to define the readout encoding
- Add functionality to read out the G4VHitsCollection
  - Example: FullSim Algorithm

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Rough Roadmap to Rome

FCCSW 0.5 + FCC-EDM 0.1 + Albers 0.1

- Current version

FCCSW 0.6 + FCC-EDM 0.2 + PODIO 0.1 — February

- Changes in EDM needed for Delphes output

- New feature encoding particle relations

- Full set of FCC-hh detector envelopes

- Tests for simulation package

- Gaussino Generation package (may slip to 0.7)

FCCSW 0.7 + FCC-EDM 0.3 + PODIO 0.2 — FCC Week Rome

- More involved restructuring of the repository

  ‣ Clean up things that aren't needed

- First version of tracking software from ATLAS

- Gaussino integration

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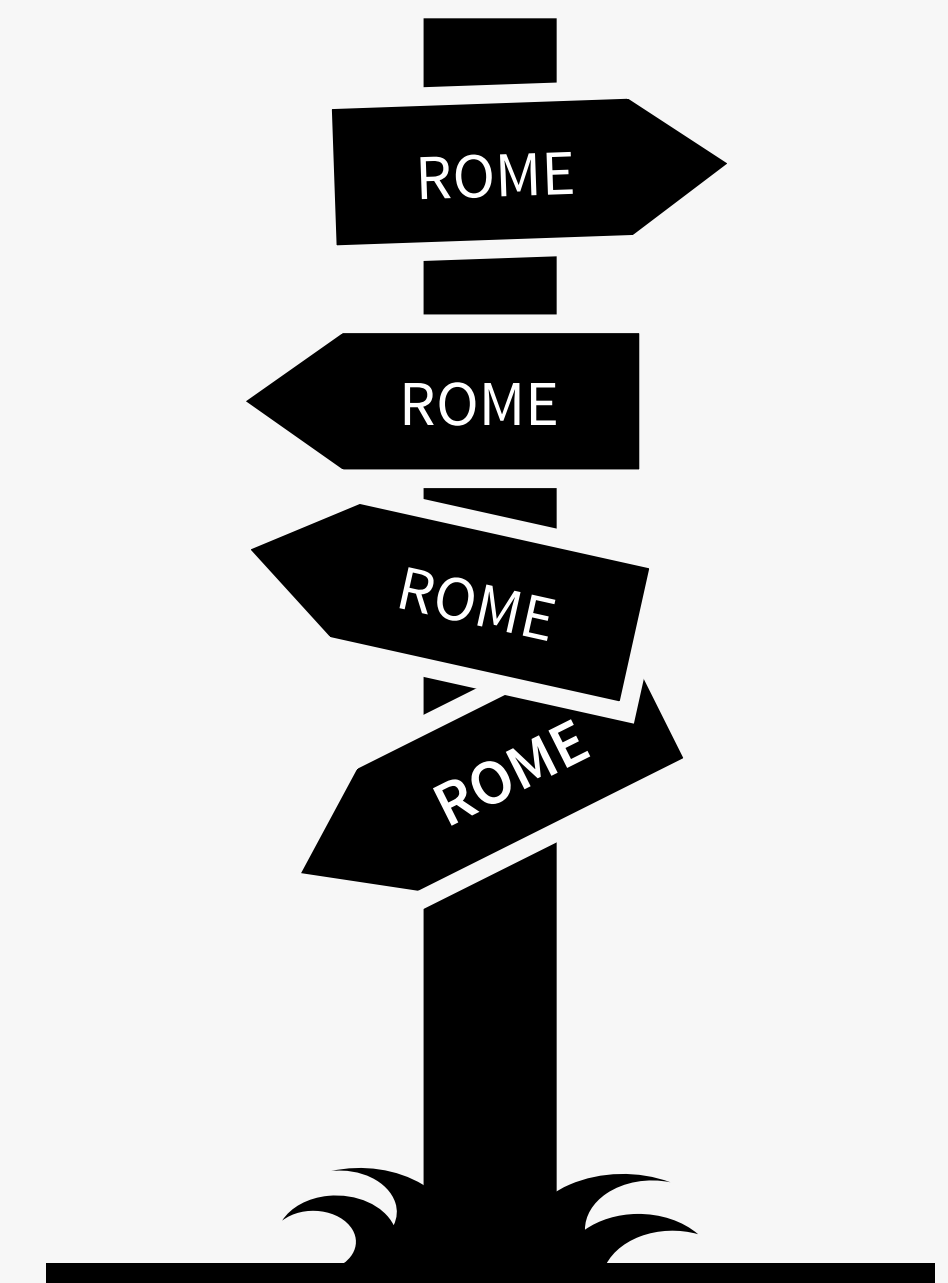
Conclusion

Several aspects are well covered

- Track reconstruction and tracker detector description

- Gen-Sim development on-going

  ‣ Expect to profit from LHCb migrating to Geant4 10

- EDM is in a good shape

Currently not covered

- HCAL and ECAL detector description and reconstruction software

  ‣ Expect new people starting soon to contribute

Not covered

- Event display — need to see what is out there and could be used

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