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SHiP
Search for Hidden Particles

Introduction to FairShip

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International School "SHiP (Search for Hidden Particles) experiment"

Outline

- What is the simulation? Why do we need it?
- What do we want to simulate in SHiP?
  - How can we do it?
- Why does this presentation have such a weird title → What is FairShip?
- Let's make our hands dirty! Hands-on part on how to work with FairShip
- How to implement a new channel in FairShip → Kyrylo Bondarenko
- What should I learn from it? →

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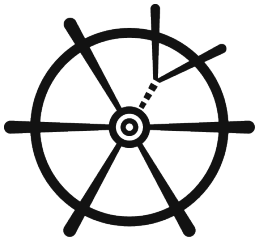
What is the simulation?



"**Simulation** is the imitation of the operation of a real-world process or system over time".

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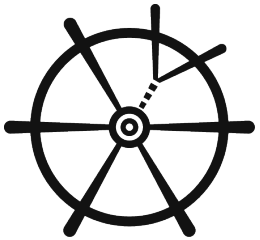
What is the simulation?



"**Simulation** is the imitation of the operation of a ~~real world~~ process or system over time".

Not only of the real world, of anything to what you can define rules to follow

©Wikipedia

Can we make a simulation of physics experiments?

We must have them! Simulations allow us to

- mimic our full experiment (designing the detectors);
- its respond;
- observe known and predicted physics behavior;
- test experiment software:

  In simulation we eager to produce MC data in the same output form as the real data from the experiment.

AND THAT'S WHAT WE ARE GOING TO TALK ABOUT IN THE NEXT HOUR

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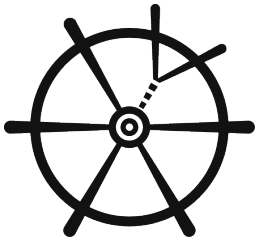
What do we want to simulate?



Environment conditions

Our mini-world:

which detectors do we have

what do they consist of

what material do we use

do we have any magnetic field

are we staying in the vacuum or is there an air around us

GEANT4

Physics Outcome

what would have happen after the collision

what will be the distribution of particles

how will they interact with material

what will we actually detect

what will be the distribution of new particles

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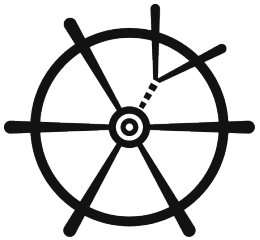
What do we want to simulate?



Primary proton interaction with Pythia8, followed by Geant4 simulation of target and hadron absorber + decays of prefabricated charm hadrons for muons

Geant4 for material interactions and particle decays

Prefabricated by Genie neutrino scattering events with different materials are used as input for the neutrino background simulation

Primary proton interaction with Pythia6, followed by Pythia6 simulations of secondary particles in the cascade for charm and beauty production; Pythia8 for new particles

+ multiples algorithms for detectors respond; track&particle reconstruction, particles identification etc...

Physics Outcome

what would have happen after the collision

what will be the distribution of particles

how will they interact with material

what will we actually detect

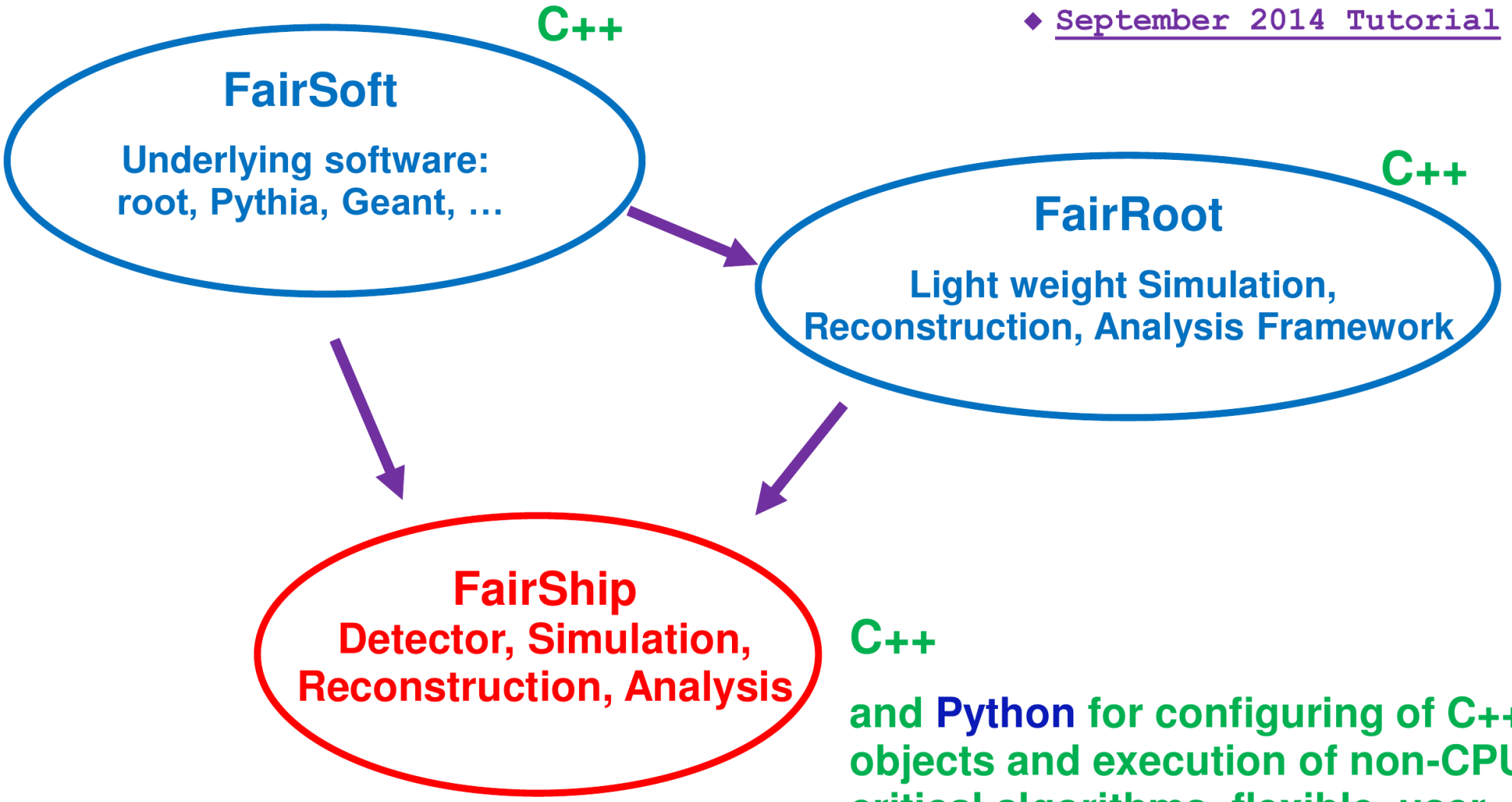
what will be the distribution of new particles

Everything is combined in

FairSHIP

Software overview

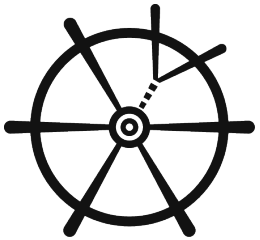
- https://fairroot.gsi.de/
- September 2014 Tutorial



C++

and Python for configuring of C++ objects and execution of non-CPU critical algorithms, flexible, user friendly!

Software overview



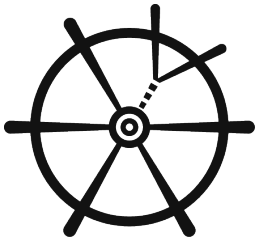
Geometry

- **Subdetector directories and passive materials**
  - /nutaudet, /veto, /strawtubes, /ecal, /hcal, /muon, /passive
- **Also contain**
  - Definition which volumes are sensitive
  - What information to store for MC particles entering the volume, momentum, entry/exit points

MC Generators

- **shipgen directory**
- **Implemented use cases:**
  - HNL signal from charm (beauty): HNLPythia8Generator
  - Muon background: MuonBackGenerator
  - Muon inelastic interactions: MuDISGenerator
  - Neutrino inelastic interactions: GenieGenerator, NuageGenerator
  - Cosmic background: CosmicsGenerator

Software overview



- **Configuration**
  - **python directory**
    - shipDet_conf.py, DecaySelection.conf
    - Also some other useful modules: shipunits.py, ShipStyle.py
  - **geometry directory**
    - Geometry parameters for ecal and hcal
    - List of materials, media.geo
- **Execution**
  - **macro directory**
  - **Scripts to run simulation, reconstruction, analysis and eventdisplay**
  - **Accept command line arguments for different use cases**
    - run_simScript.py simulation

      Philosophy: one script for many use cases, instead of many scripts each for one use case.
    - ShipReco.py reconstruction
    - ShipAna.py template for analysis
    - eventdisplay.py visualization of detector geometry and event data
  - **genfit directory**
    - External package for track fitting, extrapolation of track states through magnetic field and material

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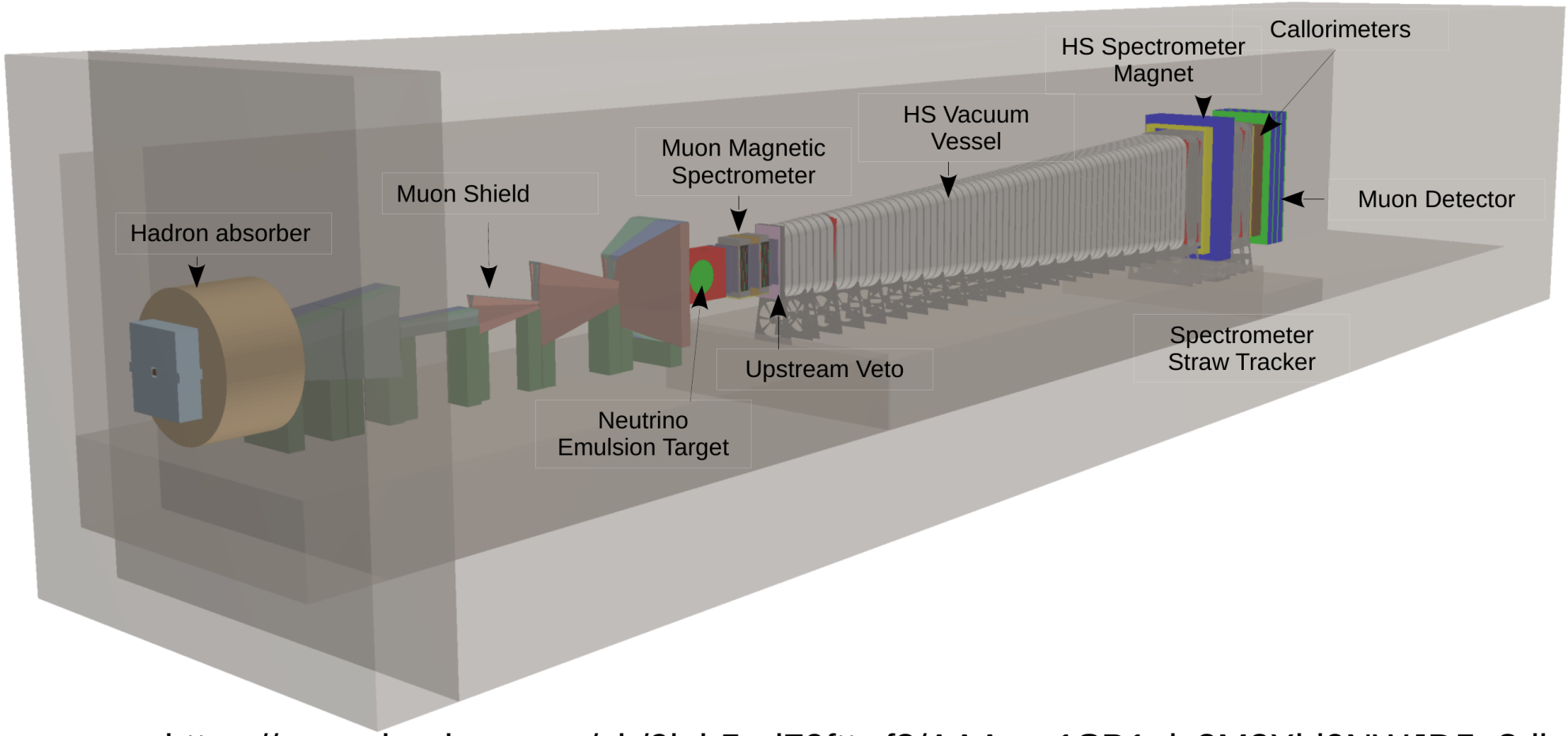
Hands-on part!

It's time to roll our sleeves up and open a Terminal!



https://www.dropbox.com/sh/9iuh5ad79fttwf8/AAAm_1SB1nlx2M2Xhi0NWJD5a?dl=0