Warsaw University of Technology

ALICE

LPCC Fastsim

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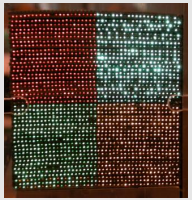
Fast simulation application / accuracy

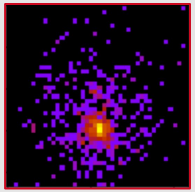
ALICE Run3:

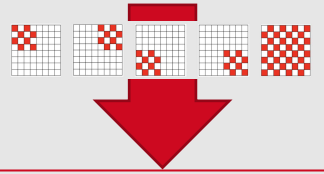
- in general, no ML fast sim used in production. In process of R&D
- no real outstanding sensitive detector **apart from ZDC** (zero degree calorimeter)
  - currently ZDC not used in all MC productions
- ZDC also appears to be ideal for ML, since it has 2D readout structure (n*m optical fibers collecting photons)
  - a response is a 2D image with pixels encoding photon count
  - the final output are 5 digits calculated from the image (5 channels)
  - Almost no material / other detectors in front of ZDC
  - Approach:
    - generate response directly from primary (no transport at all involved; main one followed up until now)
    - generate response from impinging track (transport involved)
- We target to replace detailed sim with fast sim for ZDC and use in all analysis (if possible)
- Training on actual data not done (possibly not easy; could be interesting idea)

120m

120m







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ALICE3: Fast simulation in Delphes spaces

ALICE 3 Upgrade studies

- **new fast-simulation framework developed on purpose (DelphesO2)**
  - based on Delphes
  - and on ALICE-O2 (simulation and reconstruction for Run3/4)
  - plus custom routines for simulation of signal of specific detectors
    - time-of-flight layers
    - RICH detectors
    - EMCal
    - muon identification layer
  - GRID enabled, extremely large data samples (billions of HI collisions)
- **produce analysis objects in the ALICE data format**
  - convert output of fast simulation into AOD data
  - can run same identical analysis code as normal simulation / reconstruction
  - GRID analysis of very large data samples
- **input to DelphesO2**
  - event generator output (pythia8, HepMC, …)
  - LUTs with tracking parameterisation (see later)
  - parameters for fast-simulation of signal of other (i.e. PID) detectors
    - time-of-flight layer(s): time resolution, location, …
    - RICH detector(s): refractive index, 1pe angular resolution, PDE, ...

Practical implementation: DelphesO2

Tracker design

This presentation

FAT

Full simulation (future)

AliRoot

O2

Expected covariance matrix

LUT entry

(p, η, r, dN/dη ..)

LUT File

Done only once

Generator

Pythia:
pp, Kr-Kr, Xe-Xe

Delphes

Tracking in magnetic filed

Smearing

Detector effects (efficiency, resolution)

Tracks

PID info

Prim. Vert.

Several of the analyses (not all!) shown in this workshop carried out from AODs via the O2

AODs

Write info to O2 compatible AOD

O2

Results

Later analysis: QA, secondary vertex reconstruction, ML ..

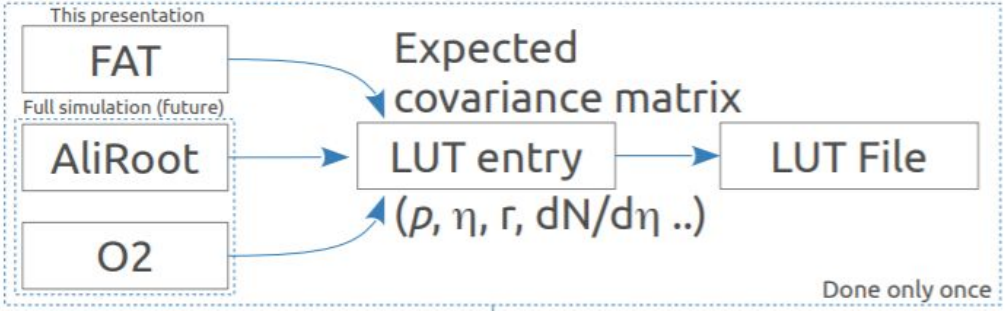
Attach PID signals to track (TOF, RICH, MuonID, FTOF, FRICH ..)

FAT: fast analytical tool
LUT: lookup table

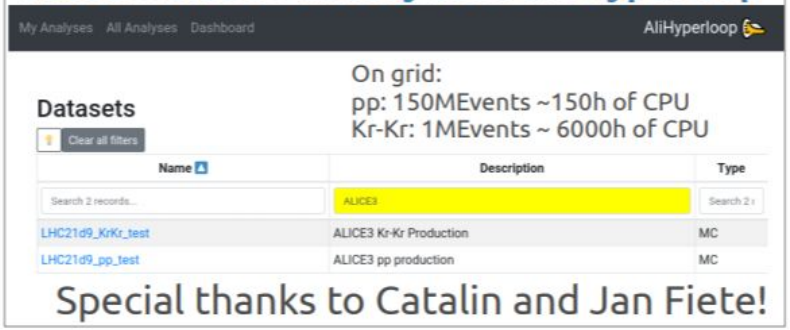
DelphesO2

Practical implementation: DelphesO2

Tracker design

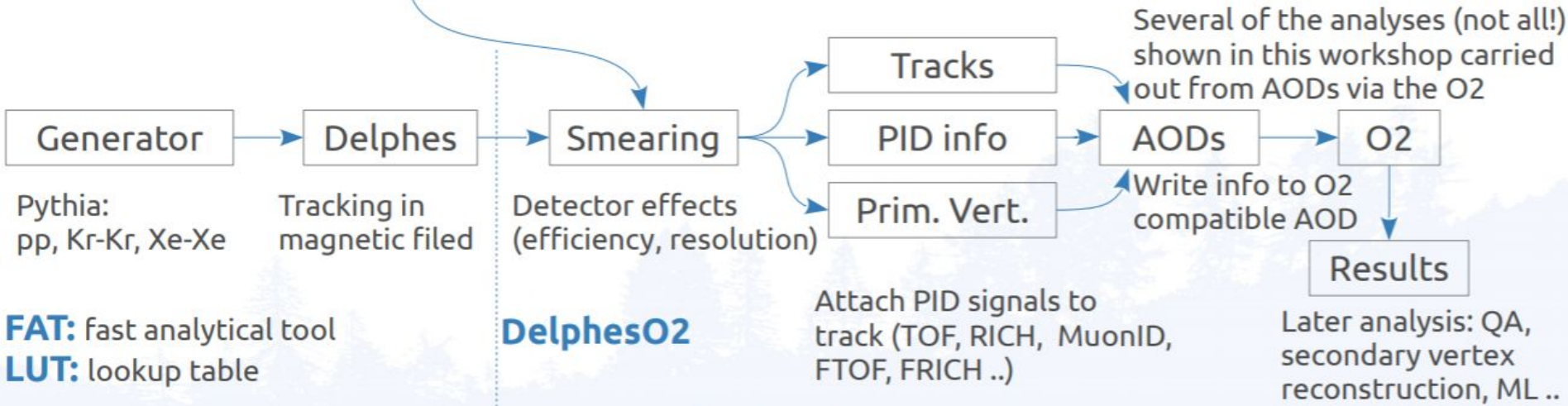


Fast simulation already took the hyperloop



On grid:
pp: 150MEvents ~150h of CPU
Kr-Kr: 1MEvents ~ 6000h of CPU

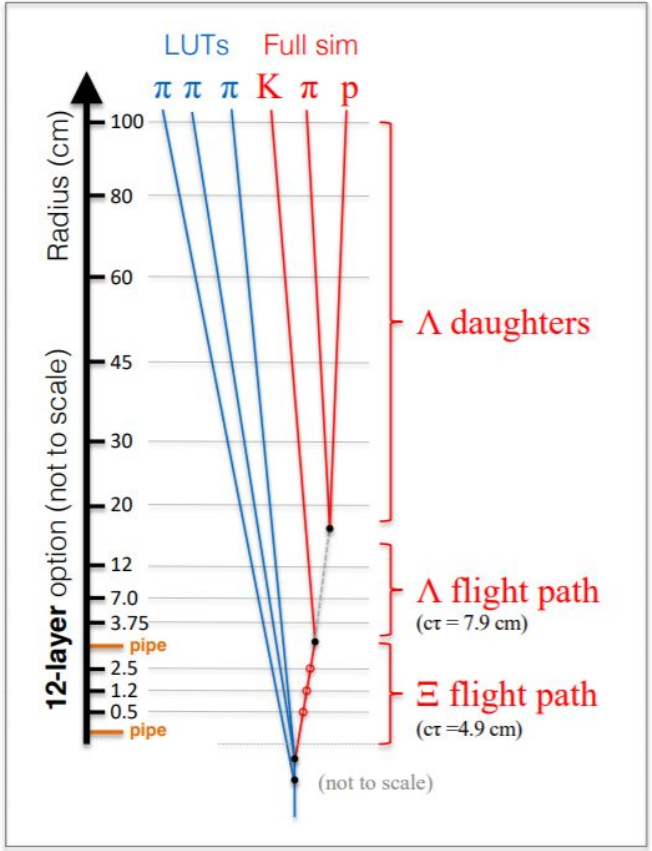
Special thanks to Catalin and Jan Fiete!

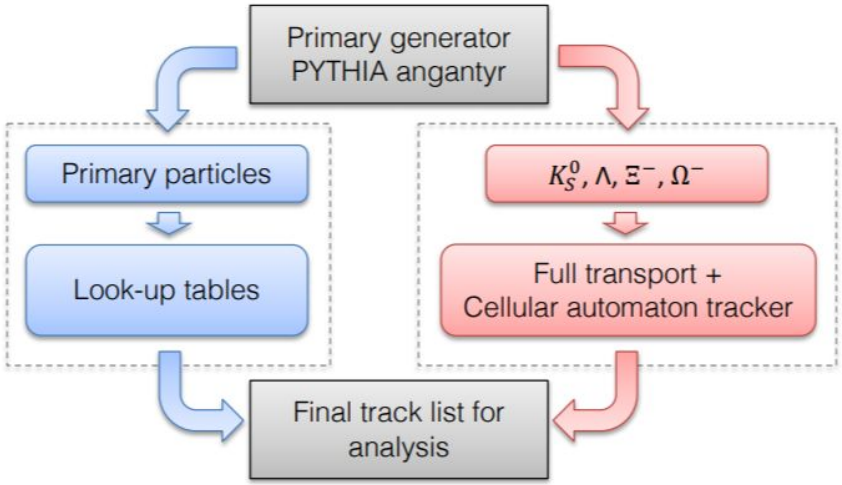


FAT: fast analytical tool
LUT: lookup table

DelphesO2

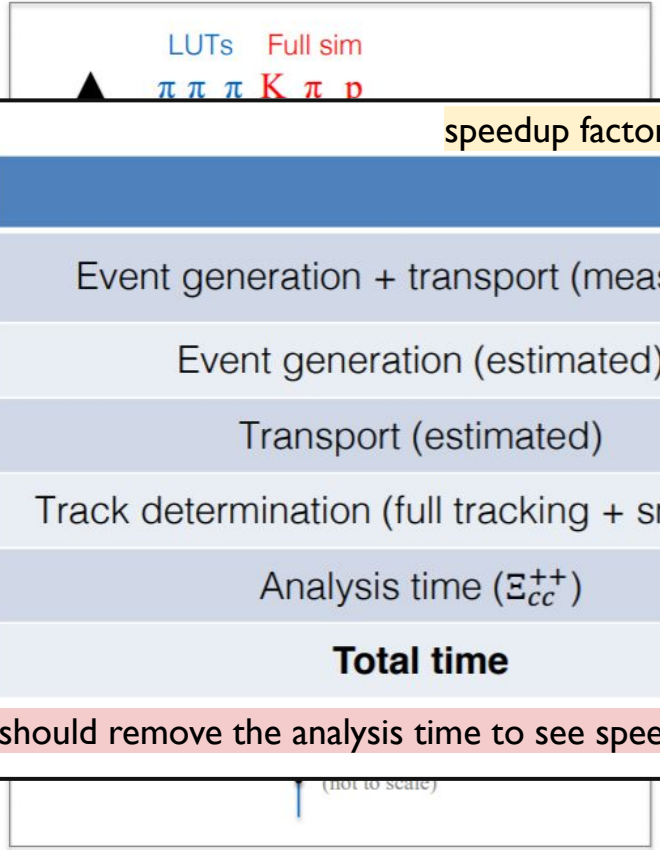
HYBRID technology





- LUTs: adequate for primary particles
- Full simulation: adequate for secondaries
- Combination yields high speed: reasonable objective is that time in tracking + smearing is less than analysis and event generation
- Full preservation of weak decay selections vs LUT approach!

HYBRID technology



speedup factors (numbers for 100 min.bias Pb-Pb events)

	Full sim	Fraction	Hybrid sim	Fraction
Event generation + transport (measured)	15 minutes	14%	3 minutes	26.5%
Event generation (estimated)	~2.5 minutes	2.3%	~2.5 minutes	22.1%
Transport (estimated)	~12.5 minutes	5.8%	~30 seconds	4.4%
Track determination (full tracking + smearing)	85 minutes	78.7%	20 seconds	2.9%
Analysis time (Ξ_{cc}^{++})	~8 minutes	7.4%	~8 minutes	70.8%
Total time	**108 minutes**	**100%**	**11.3 minutes**	**100%**
should remove the analysis time to see speedup	100 minutes		3.3 minutes	30x faster

generation

- Full preservation of weak decay selections vs LUT approach!