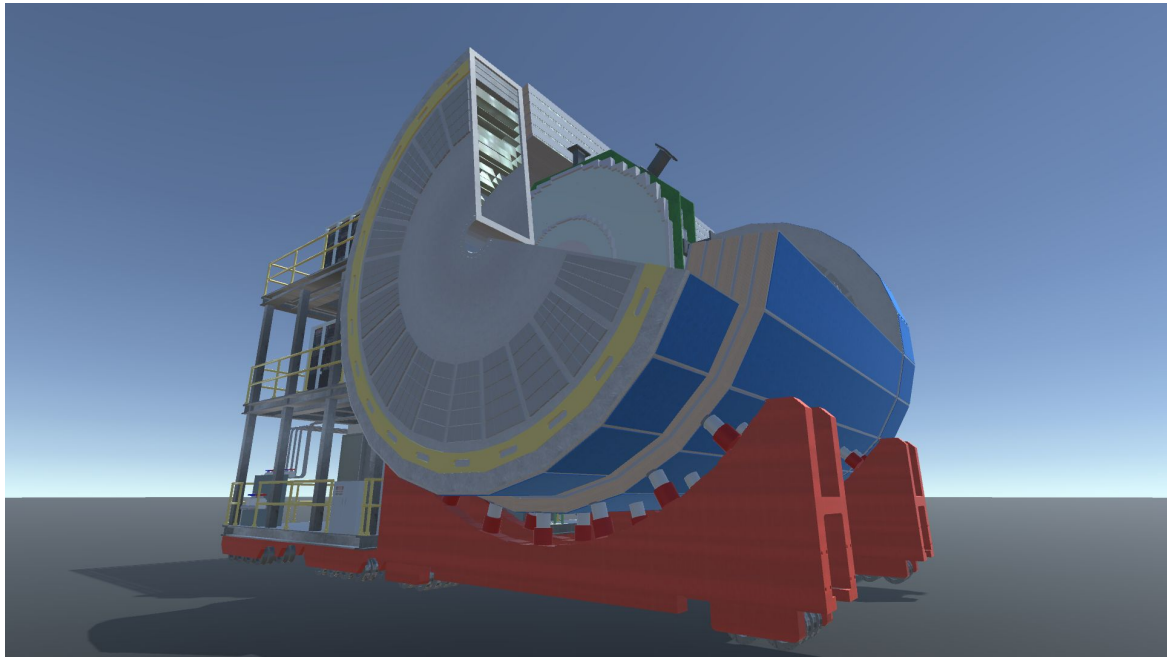
Jet/HF/EW/BSM update

ATHENA



Status

- Ongoing analyzes have so far used DD4Hep full sims (ECAL+HCAL reco only), Fun4All (tracking reco only), and/or fast simulations (Delphes).
- Most of work has focused on obtaining basic performance metrics such as jet energy resolution and bias, hadronic reconstruction resolutions, charm-jet tagging

Golden channels
(candidates)

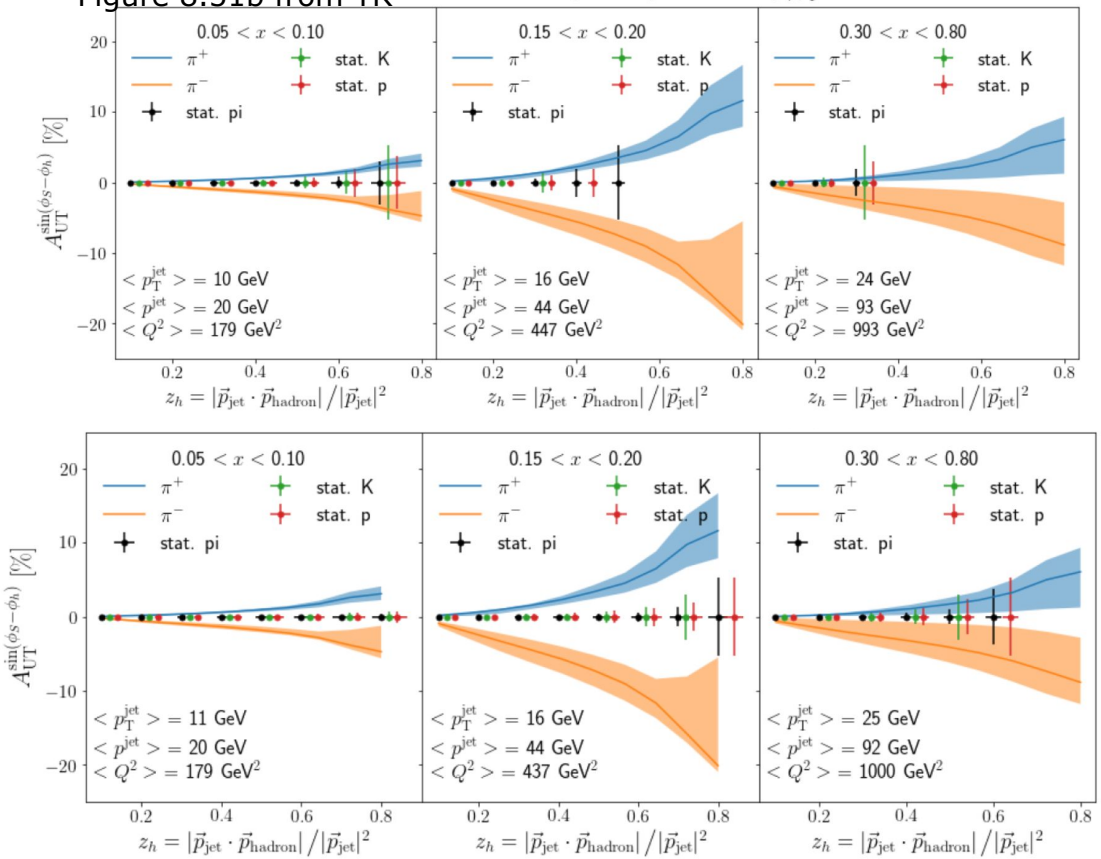
These represent four classes of measurements. So, we will pick representatives ones, aiming at emphasizing ATHENA unique features such as

- Bigger barrel
  (i.e superior PID, better calo, better energy-flow)
- Stronger field
  (i.e. better tracking, better energy-flow)

- **Heavy-flavour channels**
  - F_2^c
  - A_{LL} heavy quark
  - charm meson and charm-jet R_{eA}.
- **Lepton-jet and dijet correlations:**
  - quark-Sivers and gluon-Sivers [DIS]
  - low-x, Wigner function [diffractive DIS]
  - ΔG, photon structure [photo-production, DIS]
  - Cold-nuclear matter [(n)DIS]
- **Jet substructure and event-shapes**
  - Hadron-in-jet Collins [DIS].
  - Hadronization studies with angularities, correlation
- **Electroweak/BSM**
  - EW Structure functions [CC DIS].

For Example: **“Hadron in jet” Collins is representative of an entire class of jet substructure measurements (spin + PID)**

Figure 8.51b from YR



DIRC only 😞

DIRC + high-p device in barrel (aerogel RICH?) 😀

Only ATHENA could possibly have this and explore e… EIC phasespace, gaini… discovery potential 😎

What is in our fast simulations ?

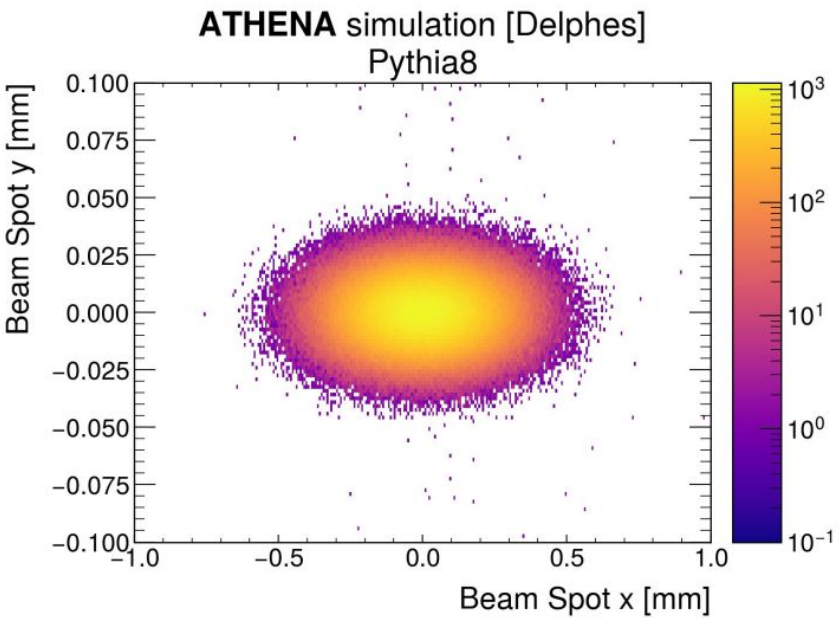
https://github.com/eic/delphes_EIC

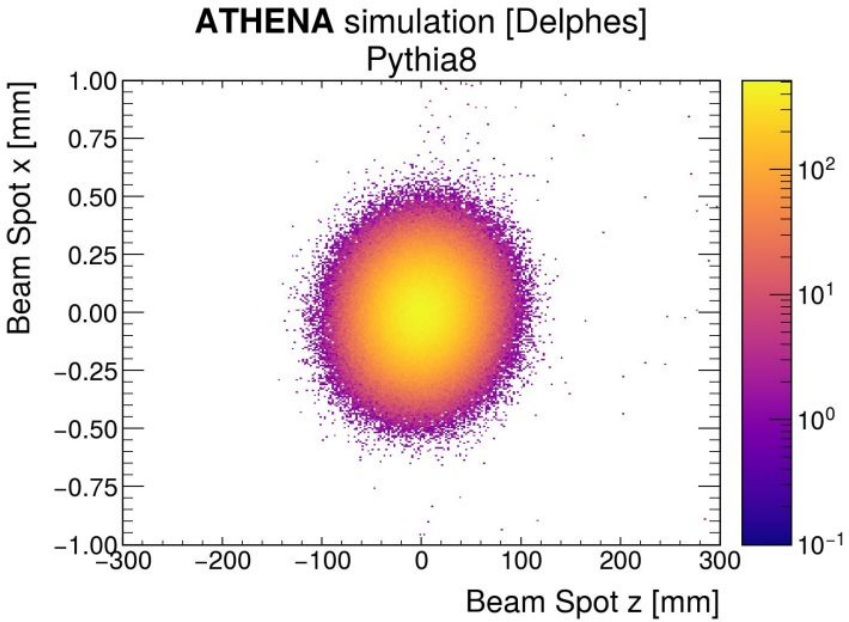
ATHENA Delphes model currently includes:

- All-silicon tracker parametrization, including for displaced tracks (from G4)
- PID matrix (mRICH, DIRC, and dRICH from G4)
- ECAL, HCAL from Yellow report parameters + simplified granularity
- Energy-flow algorithm
- Beam divergence, crossing angles, etc. (from Elke, Brian et al.)
- Propagation of charged-particles in magnetic field
- Charm-jet tagging algorithms

Beamspot, crossing angle already in Delphes model of ATHENA

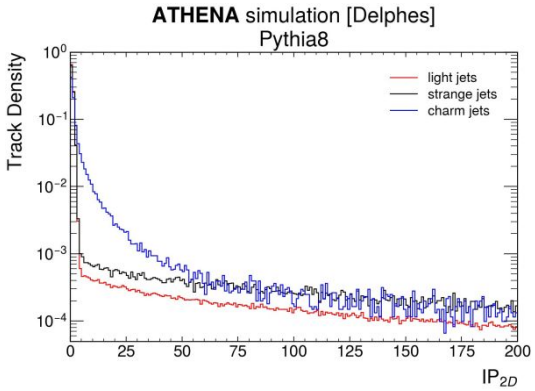
https://indico.bnl.gov/event/12339/
(S. Sekula's talk)

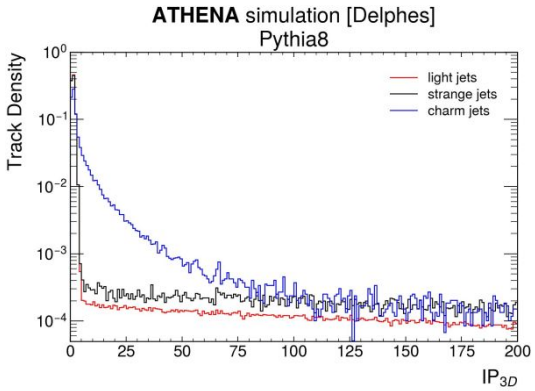




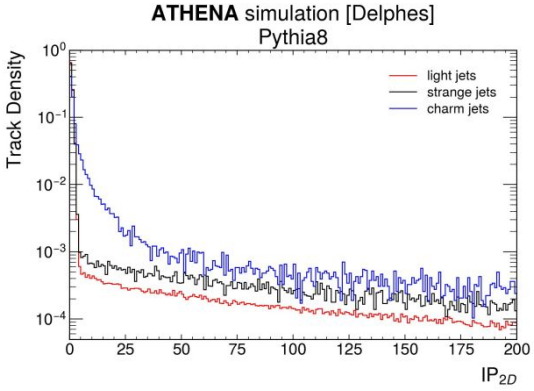
Beam effects impact on charm-jet tagging

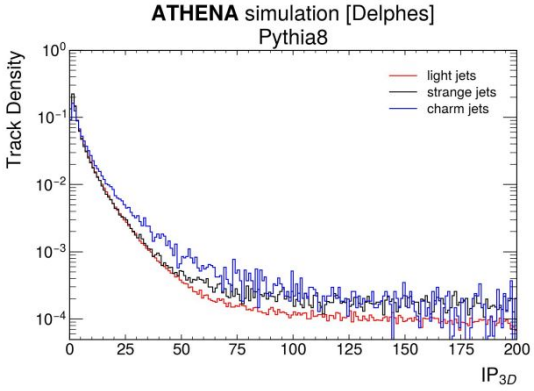
Transverse variable (IP 2D) is not much affected, but the one that includes longitudinal info gets obliterated





Use EIC Beam Simulation





https://indico.bnl.gov/event/12339/ (S. Sekula's talk)

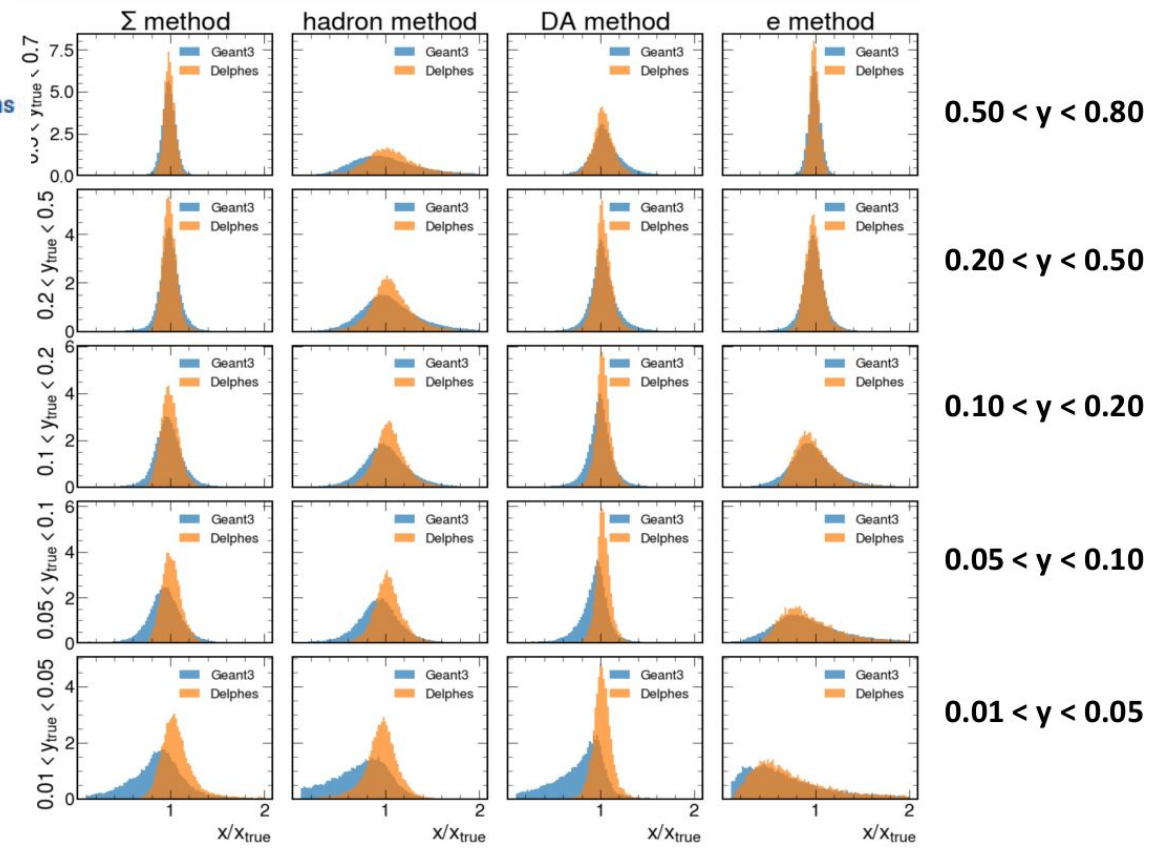
How far can we push fast sims for hadronic reco studies? What are the drivers for resolution?

00 **Hadronic reconstruction and tuning of fast simulations**

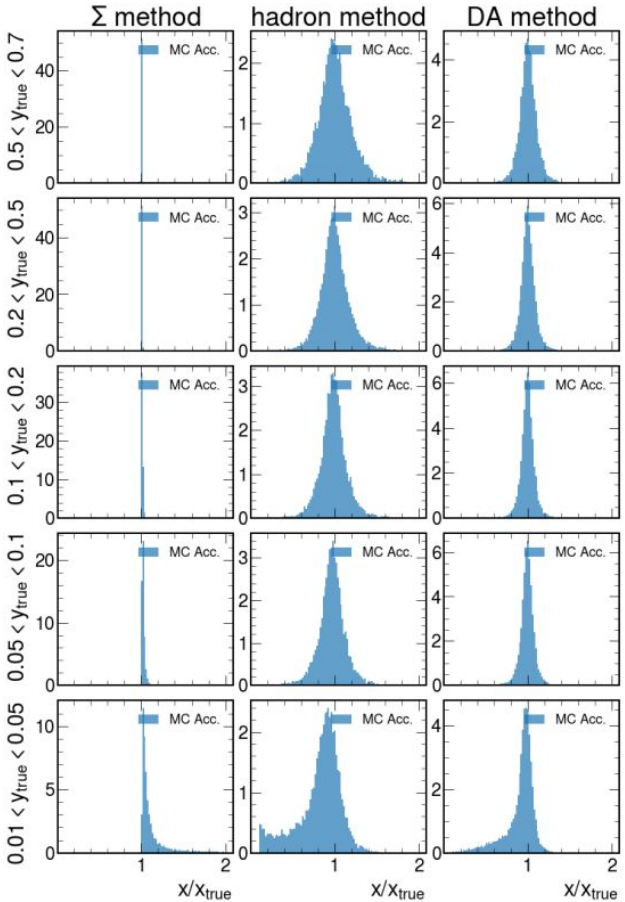
Speaker: Owen Long (UC Riverside)

had-reco-q2xy-2021...

Comparison of
Full-Geant sim
And fast sim (Delphes)
For the H1 experiment



Acceptance alone has large impact on x resolutions



Generator-level MC HFS, |eta|<3.0

This is a cheat using all HFS status=1 MC particles.

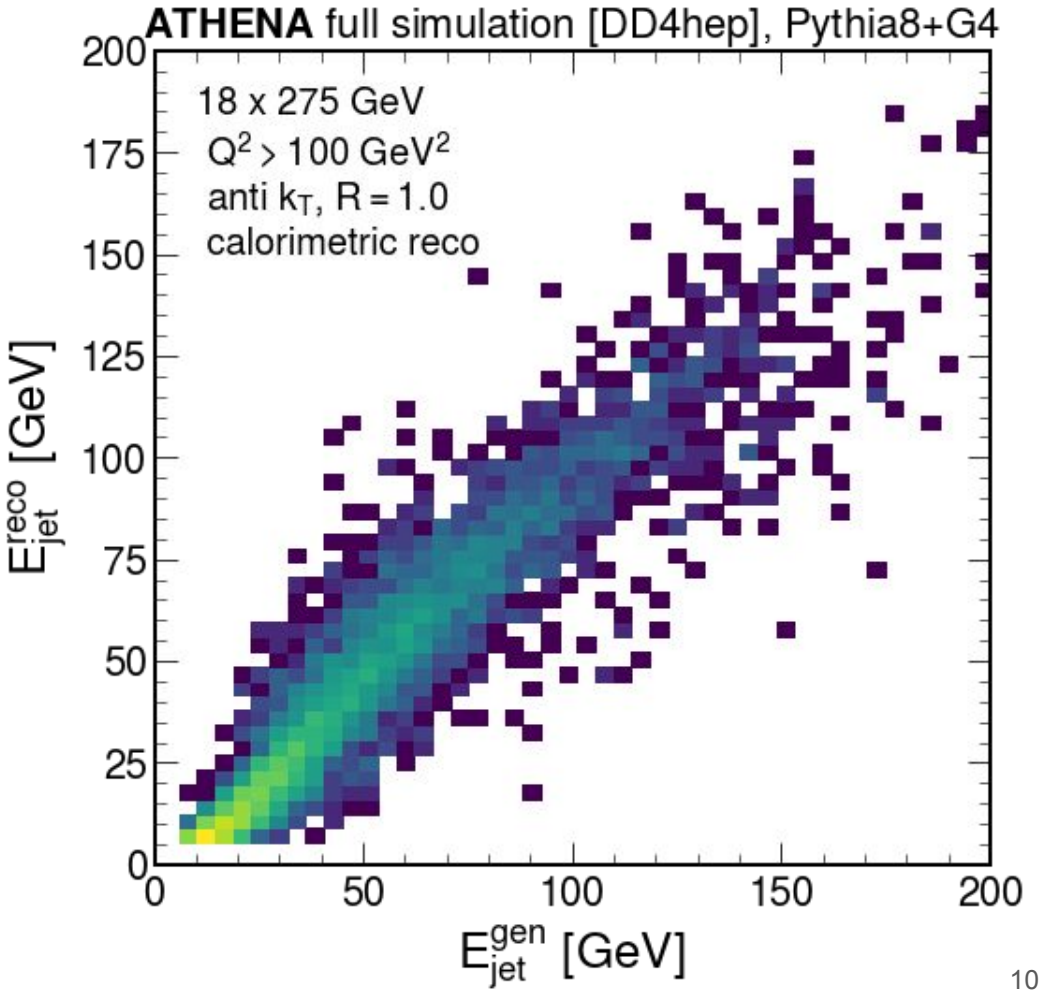
The only requirement is on the |eta| of the particles.

This models acceptance effects only with a perfect-response detecto

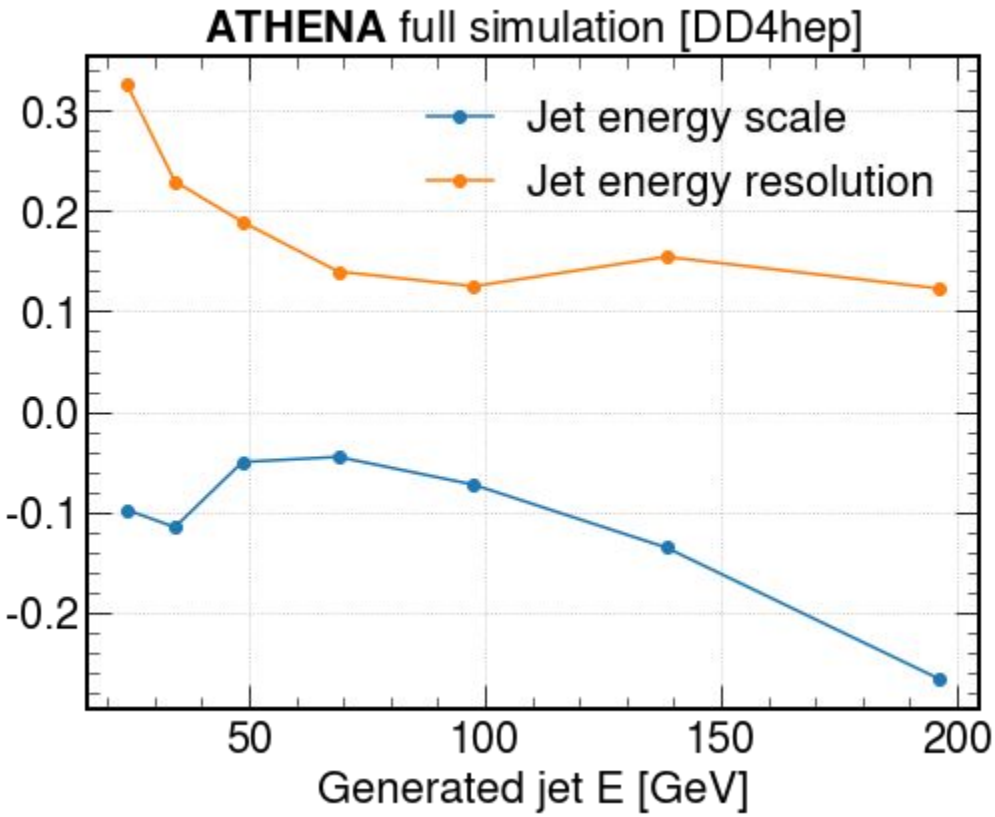
Bottom line: realistic fast sims need to account for “soft acceptance edges”

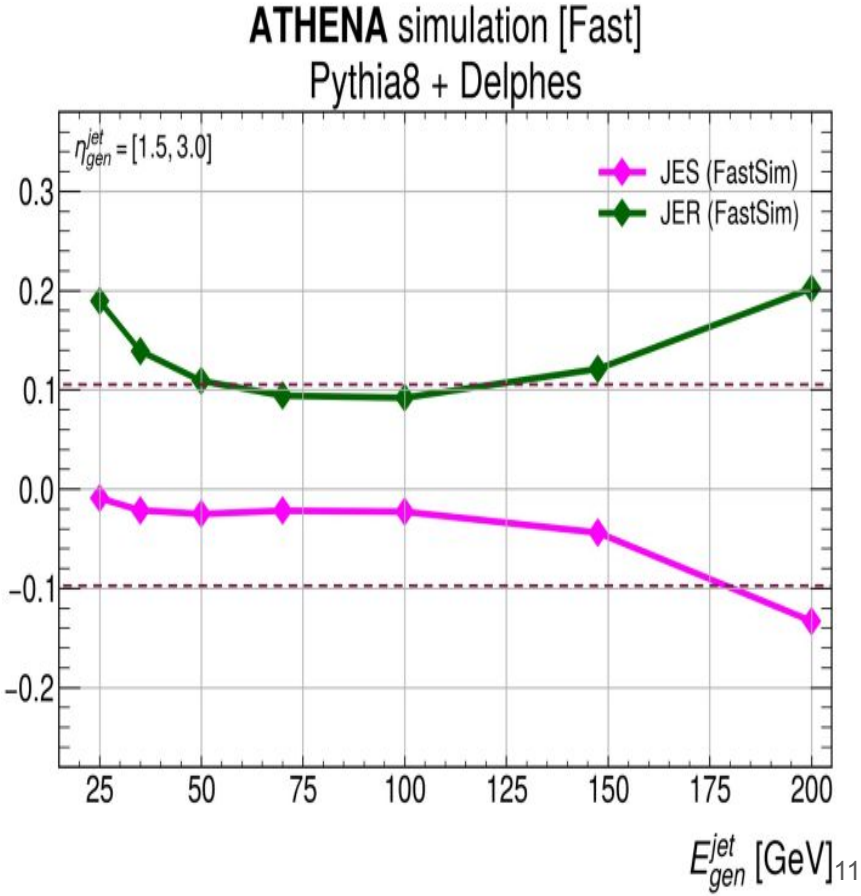
What is in our full sims (DD4Hep) ?

- Full Pythia8 DIS events
- Full calorimeter cluster reconstruction
- Full calorimetric jet reconstruction
- Beamspot, beam crossing effects
- Some version of material for every single subsystem

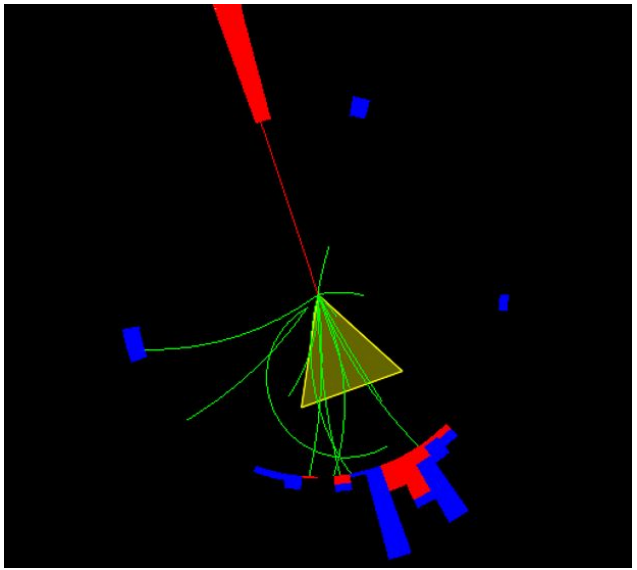


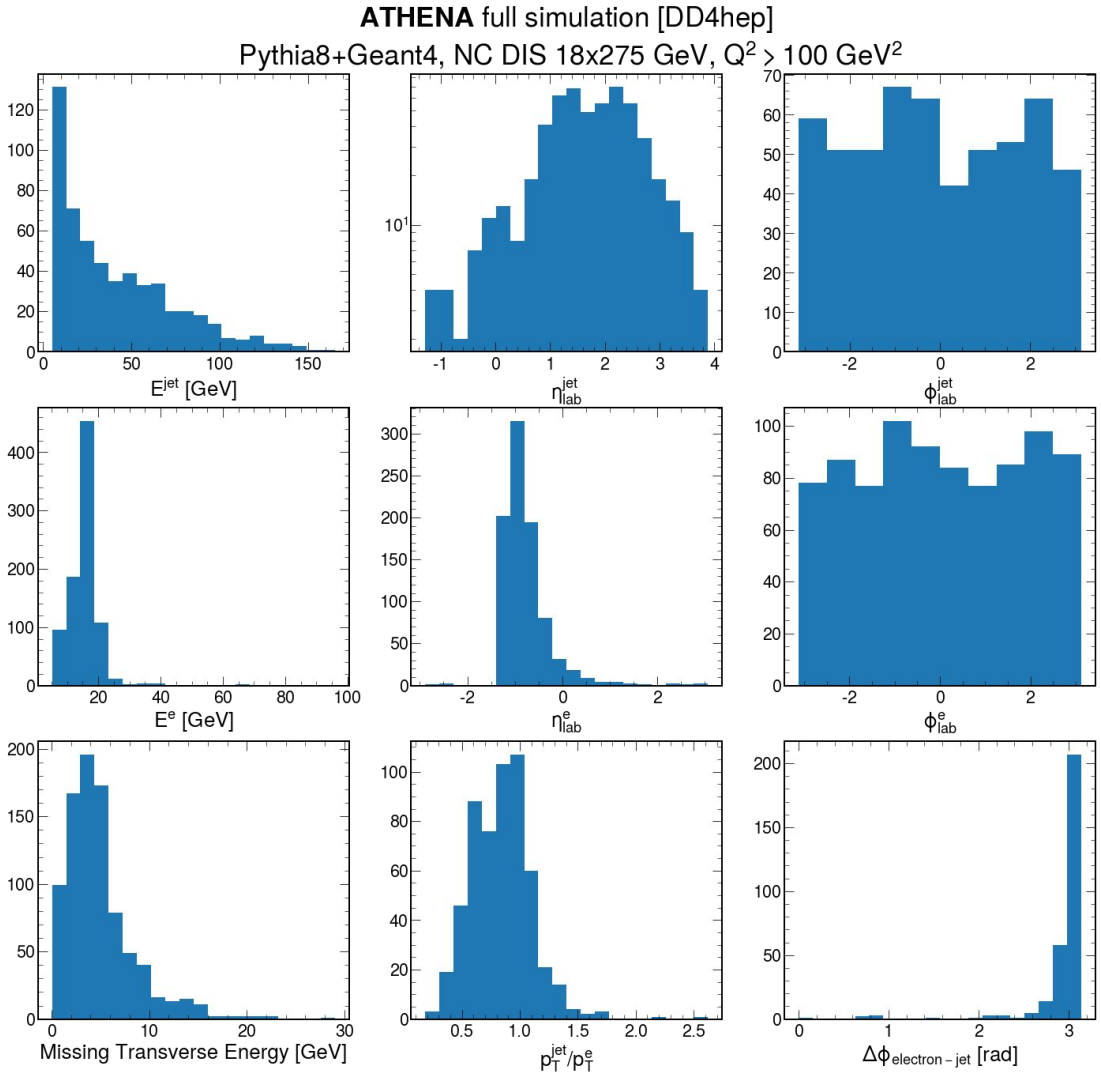
Full vs fast sim comparisons for jet performance





Golden channel candidate
Lepton-jet correlations (quark TMDs & e-A)

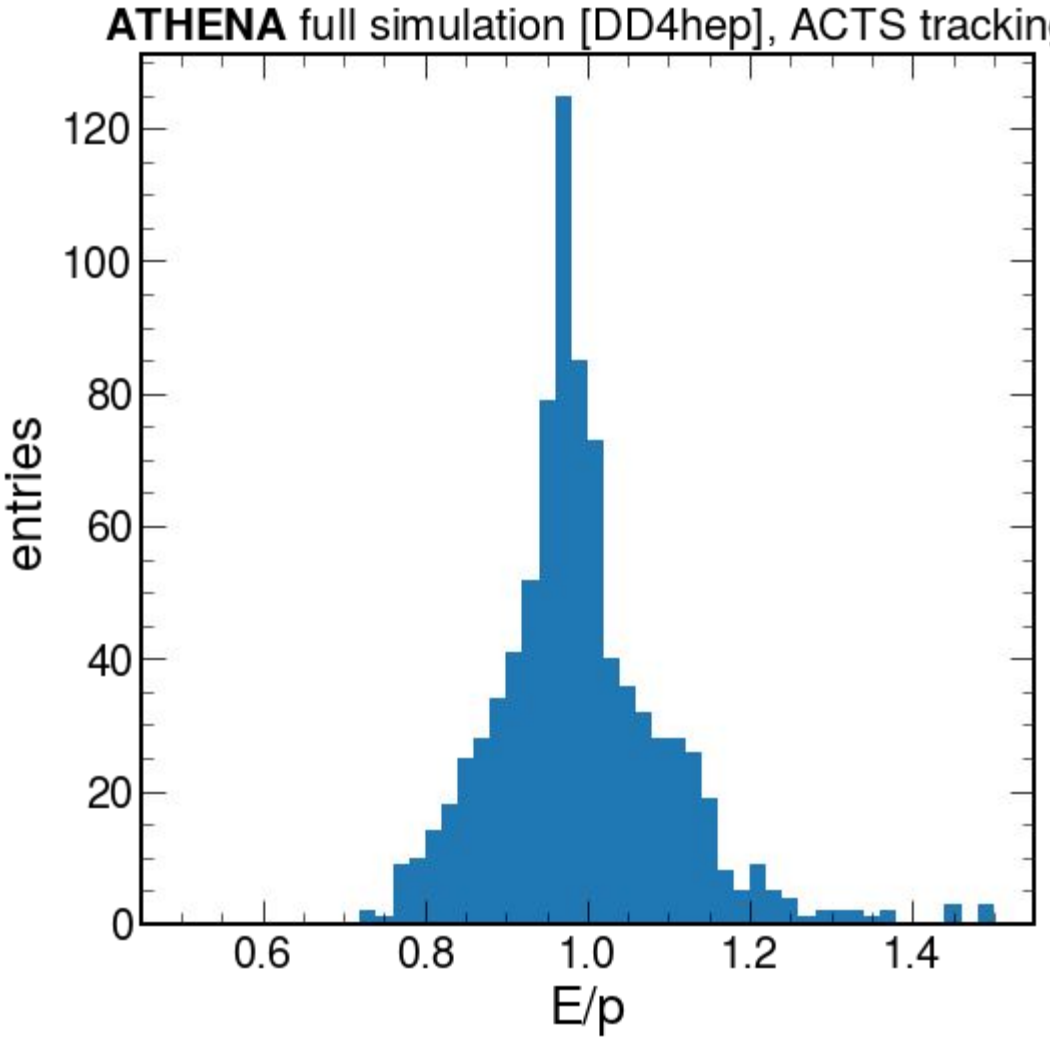




On the readiness

We have already started benchmarking some of our golden channels with full-detector simulations in DD4Hep since more than a month ago (with some version of geometry/materials for every single subsystem, and full reconstruction code for ECAL+HCAL, and beamspot and crossing angle).

Given recent progress on the ACTS front made by software team, there are reasons to be optimistic that we will get full tracking +calo soon, but we understand that careful benchmarking needs to be done, realistic geometry implemented, etc.



Is still very early, but we already have samples with full tracking, calo ready to be analyzed.
(although, of course, for tracking performance surely needs tuning)

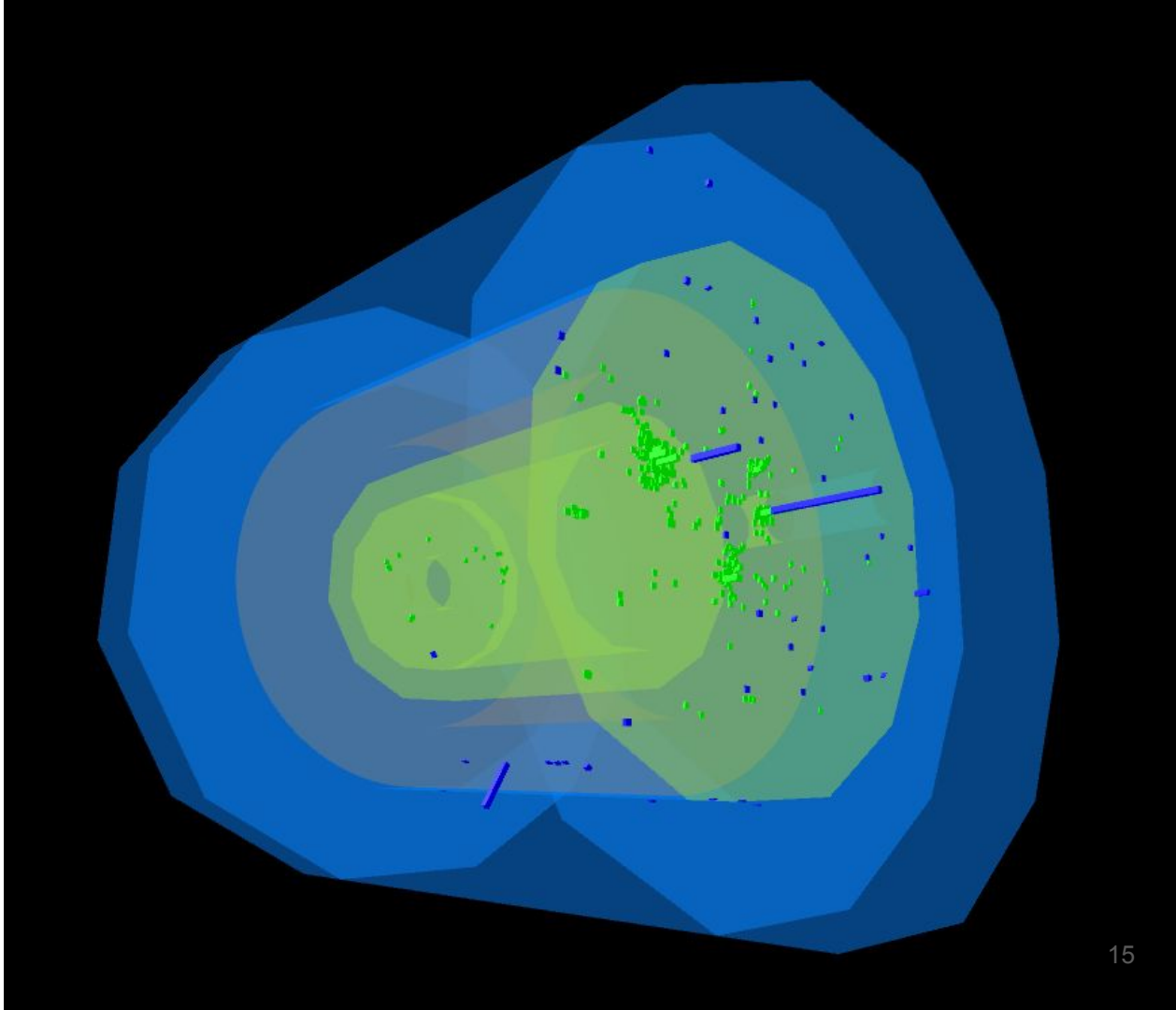
Developing of full analysis chain can start today

Summary

The state of our group is strong.

We look forward to start analysing track+calo DD4Hep samples

And to continue developing fast/full simulation synergy for proposal



Backup

The Proposals should include two parts:

1. A description of the science addressed and performance estimated through simulation including, but not limited to, e/γ, jets, π/K/p separation, vertex, and tracking, and how the simulated performance compares to the requirements detailed in the YR. The realization of the conceptual detector design given the technology choices, the R&D needs, risks, and, if applicable, adoption of emerging new technologies.

- We have identified some of the 'low-level' plots
, which seem required by proposal, that are relevant for our group

Performance plots relevant for this group (there is overlap with other groups)

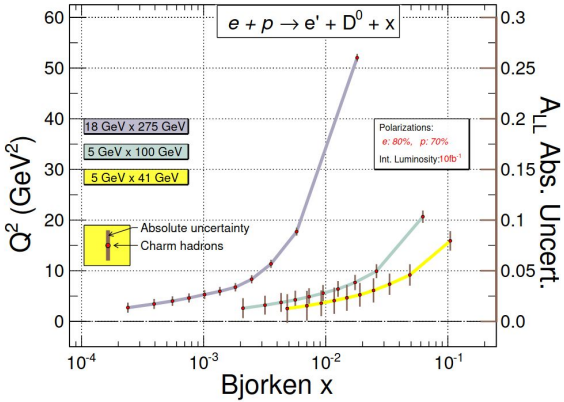
1 Secondary vertex performance (resolution)

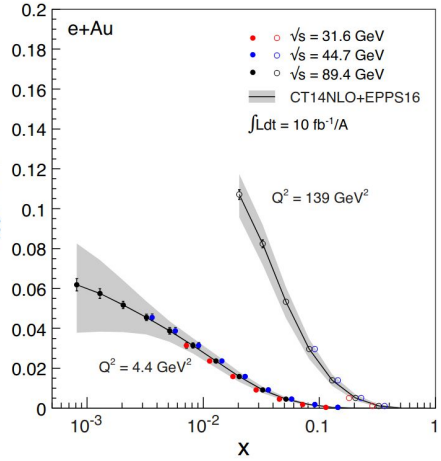
2 Hadronic-final-state reconstruction (energy-flow algorithm)

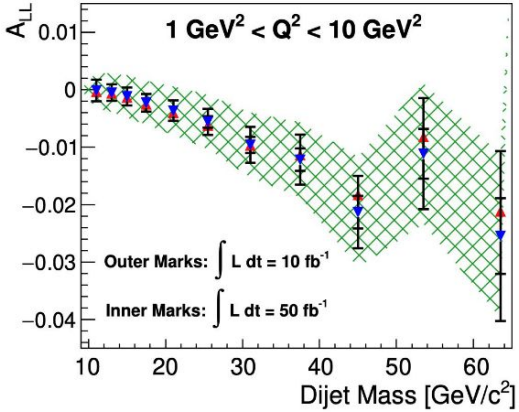
2 Jet performance (resolution and bias)
with energy-flow, calorimetric reco. PID for 4-vectors (?).

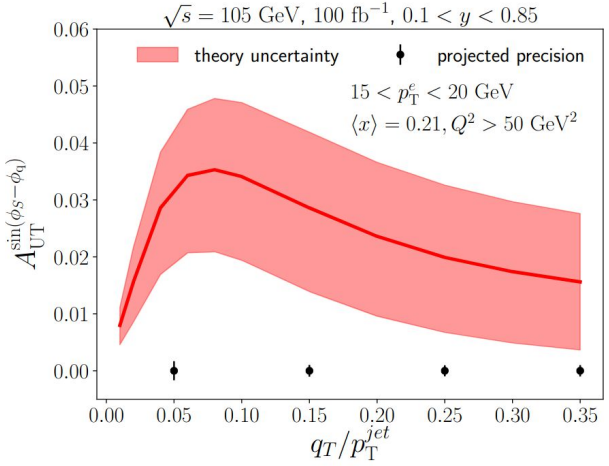
3 Charm-jet performance (tagging efficiency/mis-id)

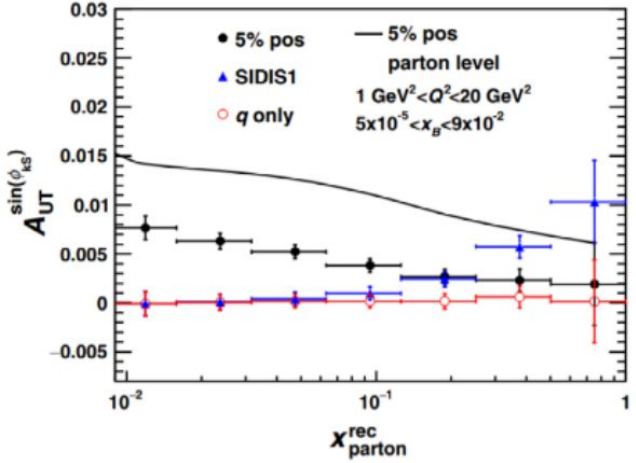
Summary (some of our golden channels)

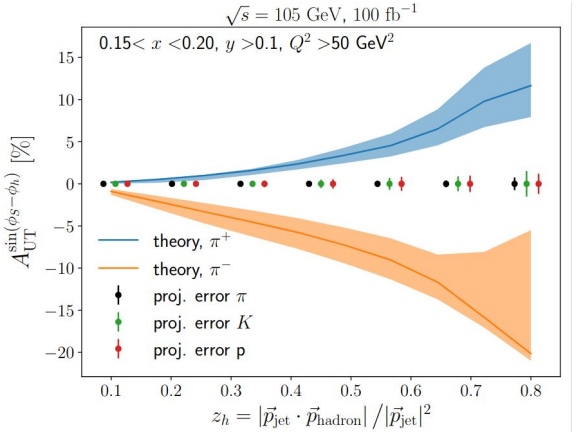




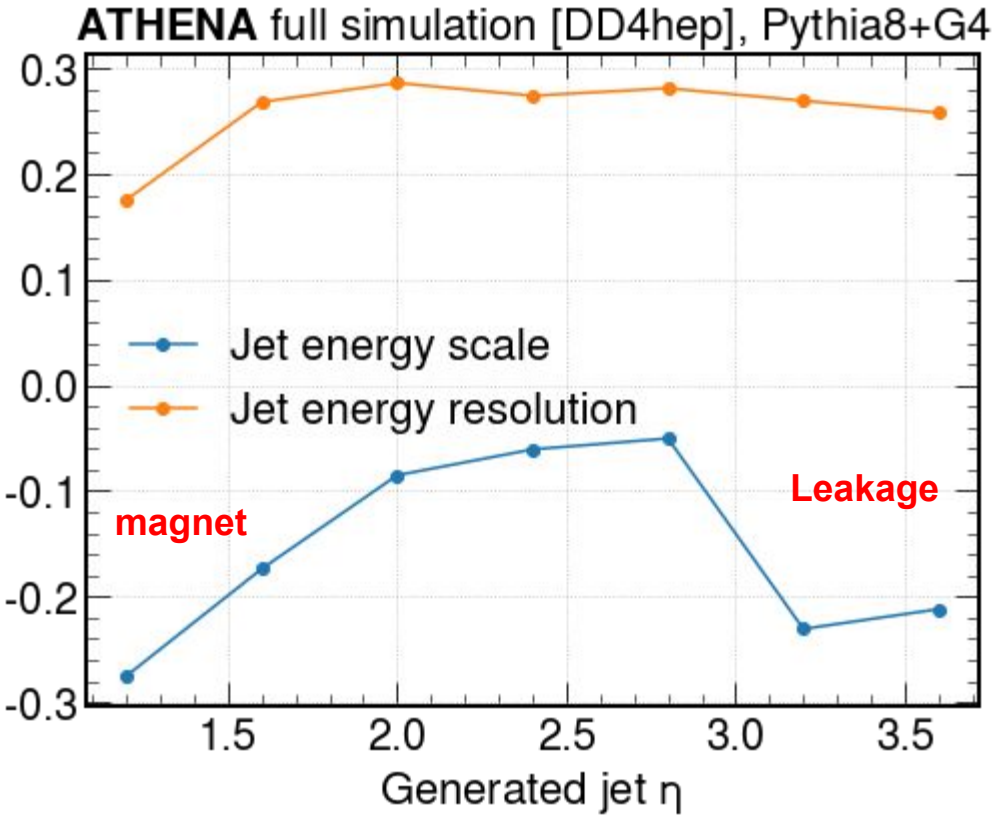








Impact of magnet in barrel, and leakages to beam-pipe in forward region



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