EPIC Far-Forward Working Group Updates

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9/13/2022

EPIC Simulation Trainings

https://indico.bnl.gov/category/443/

September 2022

- 30 Sep Tutorial: Writing physics benchmarks that run automatically and reproducibly NEW
- 29 Sep Tutorial: Writing physics benchmarks that run automatically and reproducibly NEW
- 23 Sep Tutorial: Reconstruction algorithms in JANA2: from geant4 to reconstructed quantities NEW
- 22 Sep Tutorial: Reconstruction algorithms in JANA2: from geant4 to reconstructed quantities NEW
- 16 Sep Tutorial: Simulation of single particles or physics events using geant4 and ddsim NEW
- 15 Sep Tutorial: Simulation of single particles or physics events using geant4 and ddsim NEW
- 09 Sep Tutorial: Geometry development using DD4hep: how to modify or add detector description NEW
- 08 Sep Tutorial: Geometry development using DD4hep: how to modify or add detector description NEW
- 02 Sep Tutorial: Setting up your environment for collaborative EPIC development NEW
- 01 Sep Tutorial: Setting up your environment for collaborative EPIC development NEW

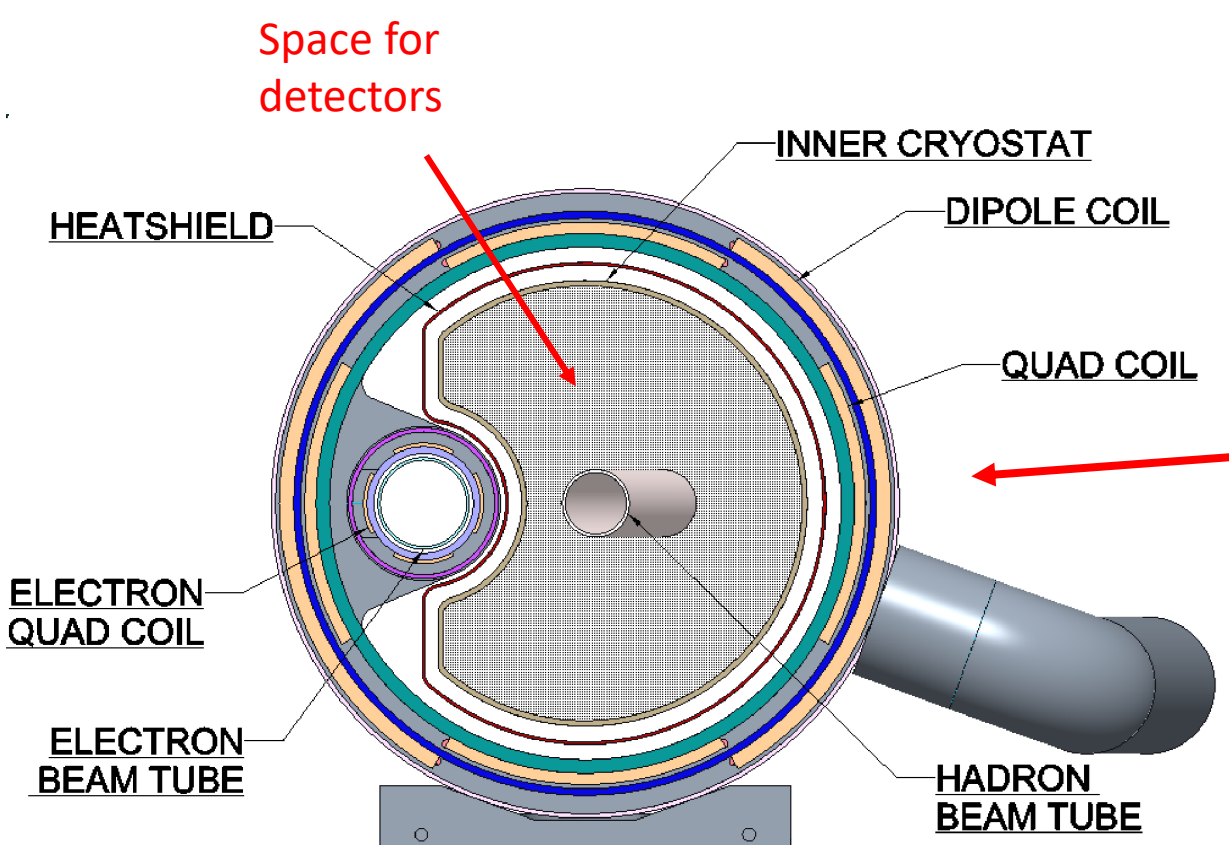
- If you want to participate in the simulations for the fall, it is VERY IMPORTANT to try and attend these tutorials.
  - Past tutorials can be found online with their recordings at the respective Indico pages.
- There are also office hours held regularly by the software group to help people troubleshoot their simulations.

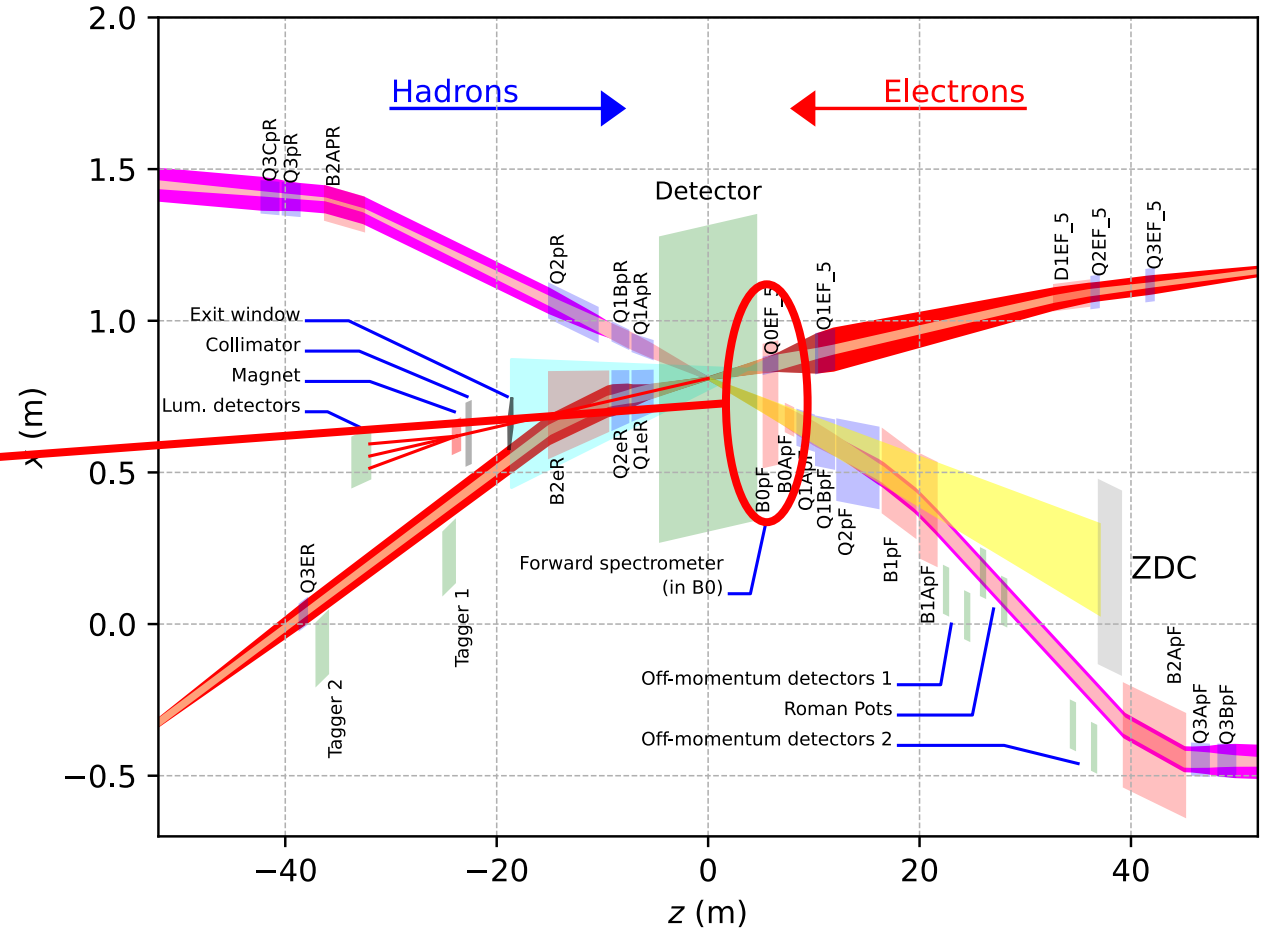
Engineering Progress

- Impedances from existence of Roman Pots a challenge.
  - First iteration complete – work in progress to reduce impact to machine.
- We have discussed beam backgrounds with the machine group so we can add some of the beam-related backgrounds into DD4HEP in the fall.
  - Conversation is ongoing.
- Work is progressing on engineering design of support structure and insertion tooling for the Roman Pots and OMD.
  - There will be lots of iteration as these designs are evaluated for their physics impact.
  - Once we settle-in with the EPIC framework, we will start looking at how we can include the CAD designs into the simulations to study the impact.

B0 Detector

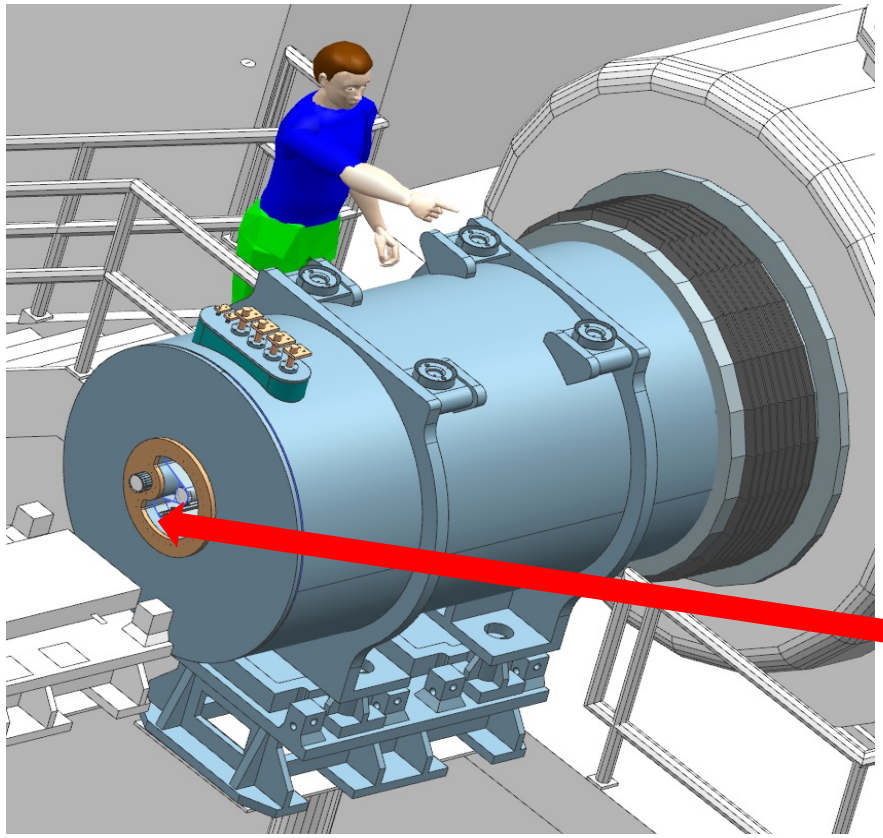
B0 Detectors



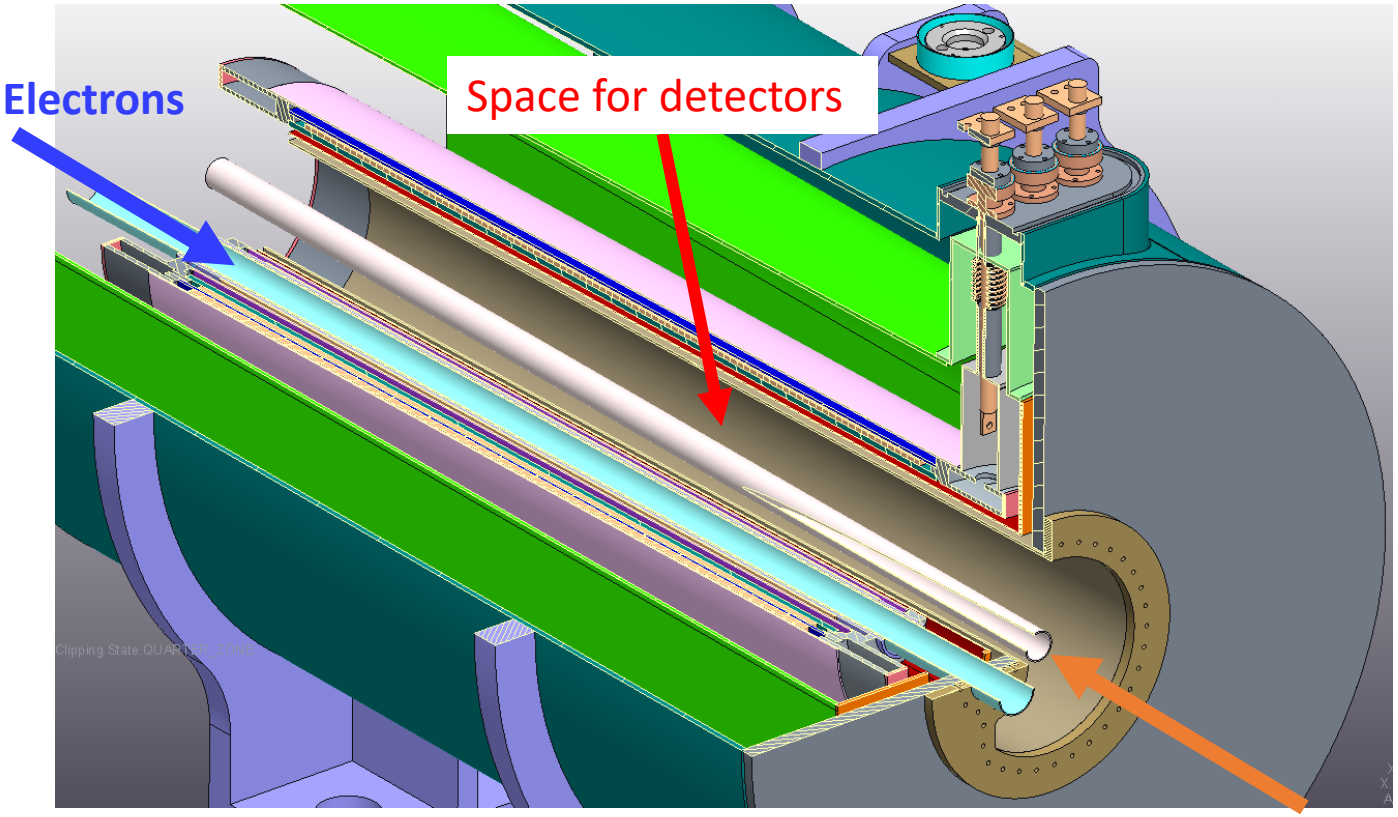


B0 Detectors

- Charged particle reconstruction and photon tagging.
  - Precise tracking (~10um spatial resolution).
  - Fast timing for background rejection and to remove crab smearing (~35ps).
  - Photon detection (tagging or full reco).

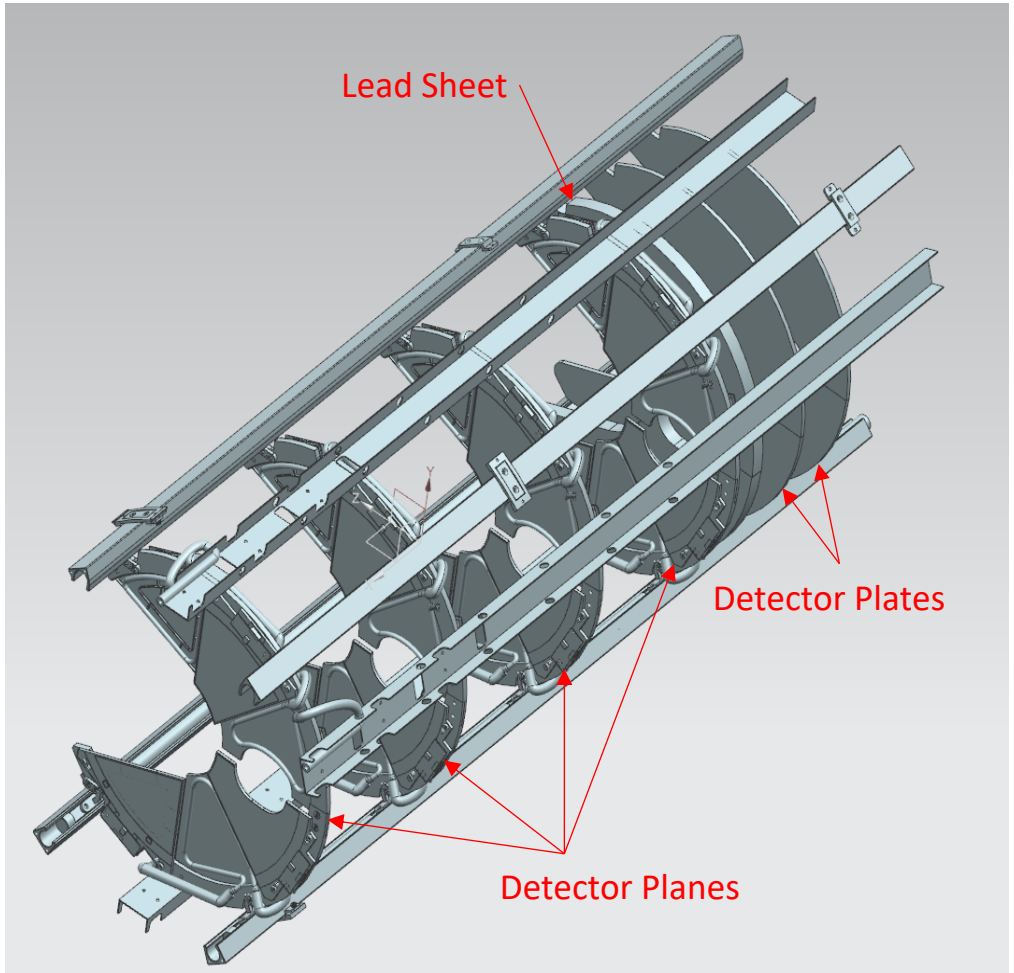


This is the opening where the detector planes will be inserted

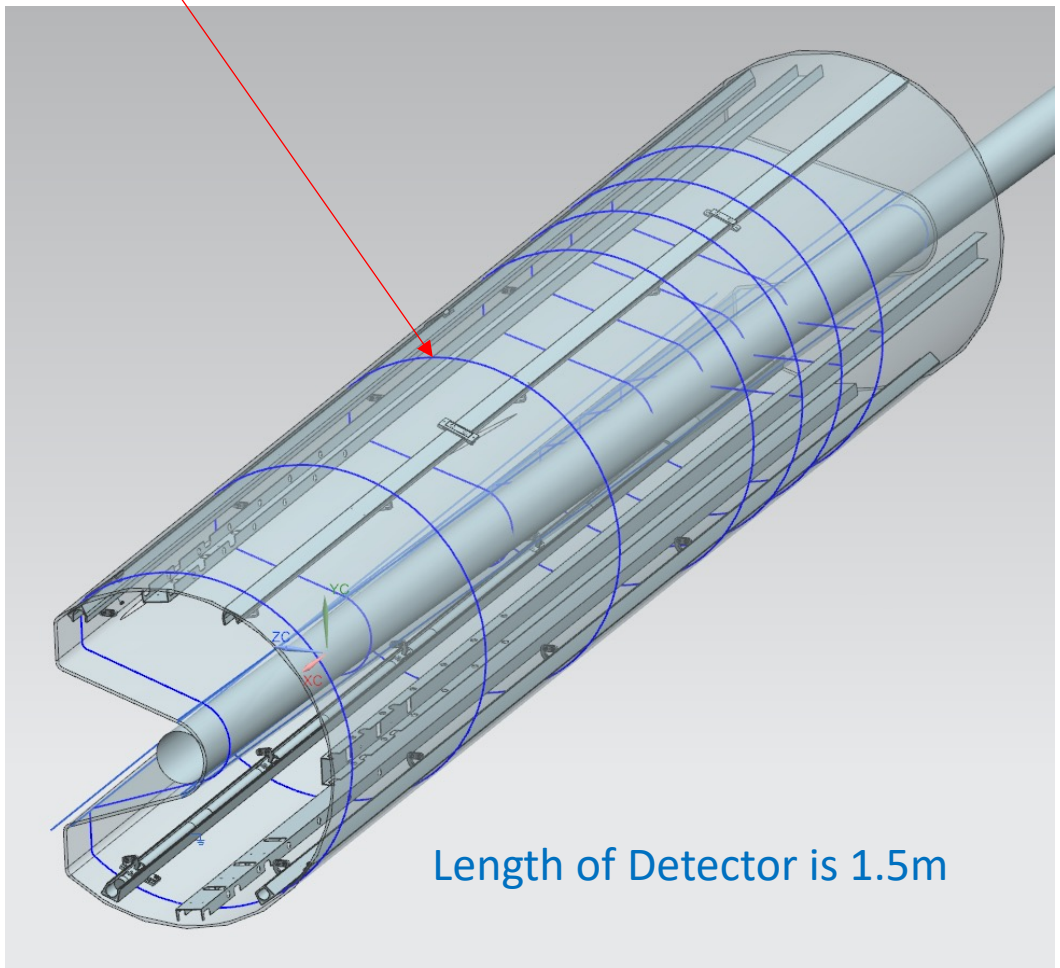


Preliminary Parameters:
229.5cm x 121.1cm x 195cm
(**Actual length will be shorter**)

B0 Detectors in CAD

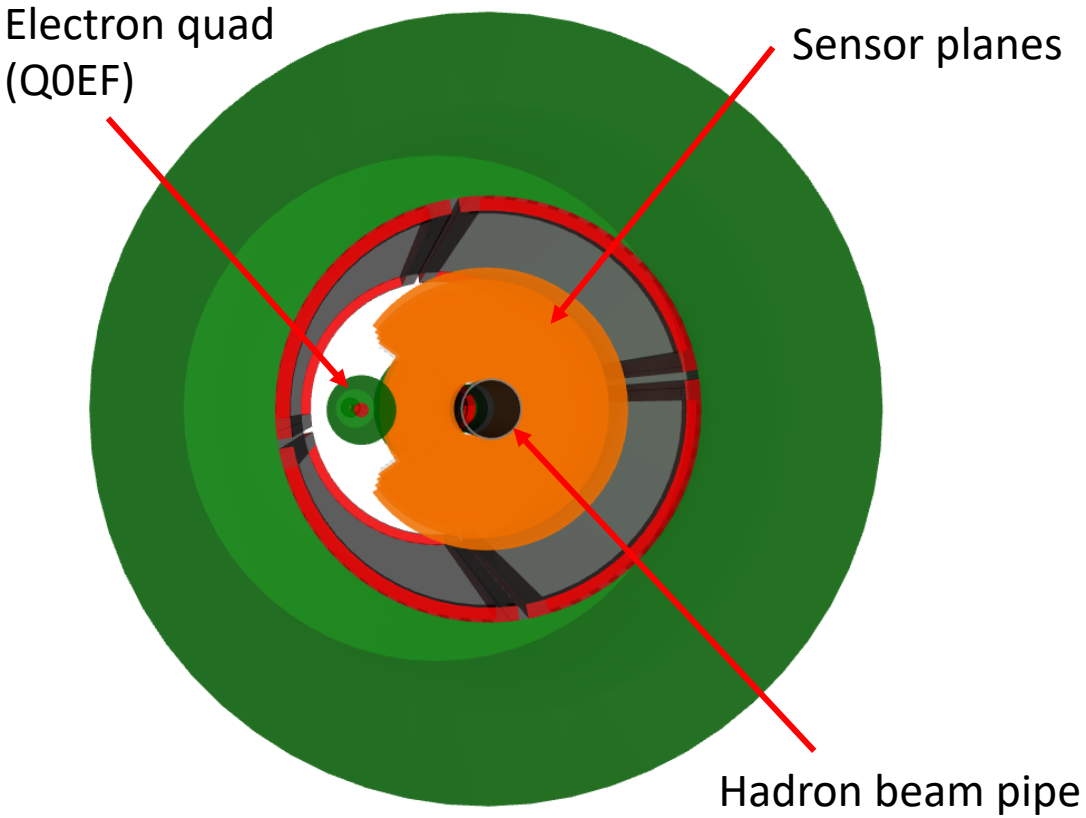


Blue lines represent where element locations are along beamline

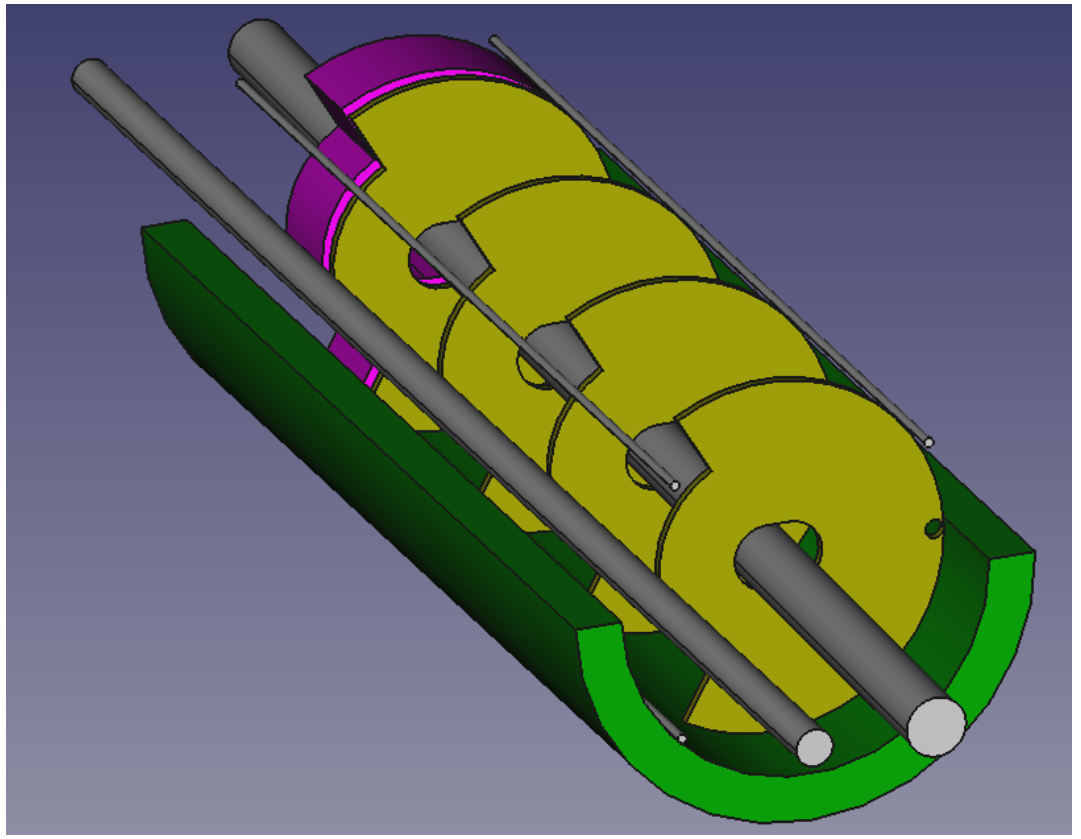


B0-detectors

(5.5 < $\boldsymbol{\theta}$ < 20.0 mrad)



DD4HEP Simulation

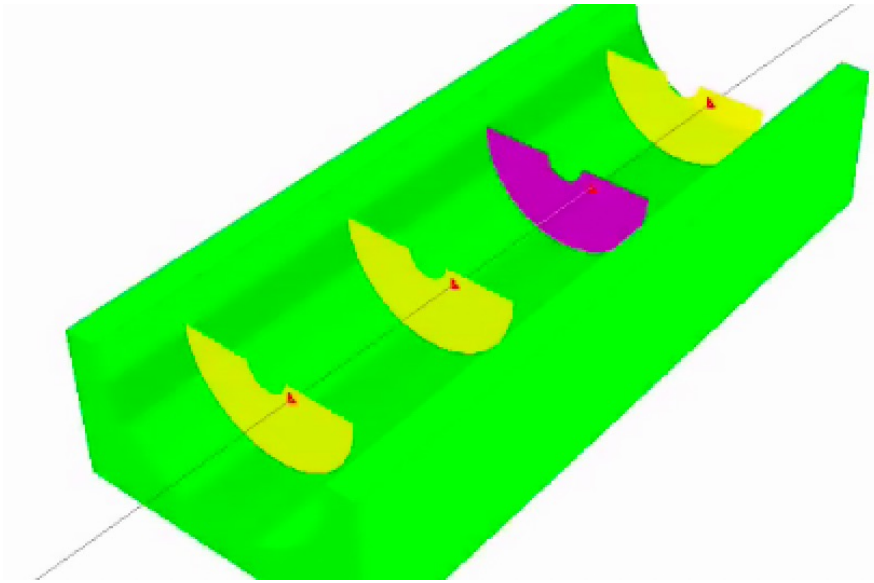


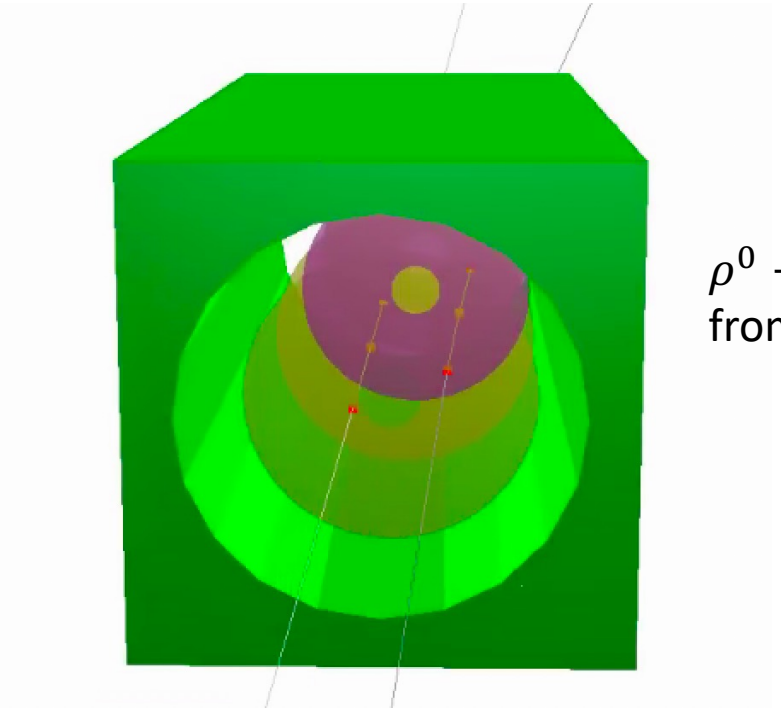
- Higher granularity silicon (e.g. MAPS) required.
- Tagging photons important in differentiating between coherent and incoherent heavy-nuclear scattering, and for reconstructing $\pi^0 \rightarrow \gamma\gamma$.
  - **Space is a major concern here – an EMCAL is highly preferred, but may only have space for a preshower.**

Why are the B0 detectors useful?

- Needed for measuring final states with θ > 5.5 mrad.
  - Especially important at medium and low hadron beam energies at the EIC.
- Important for incoherent vetoing in e+A (heavy nuclear) collisions.
  - Charged particles and photons.
- Calorimetry needed for backward u-channel DVCS measurements.

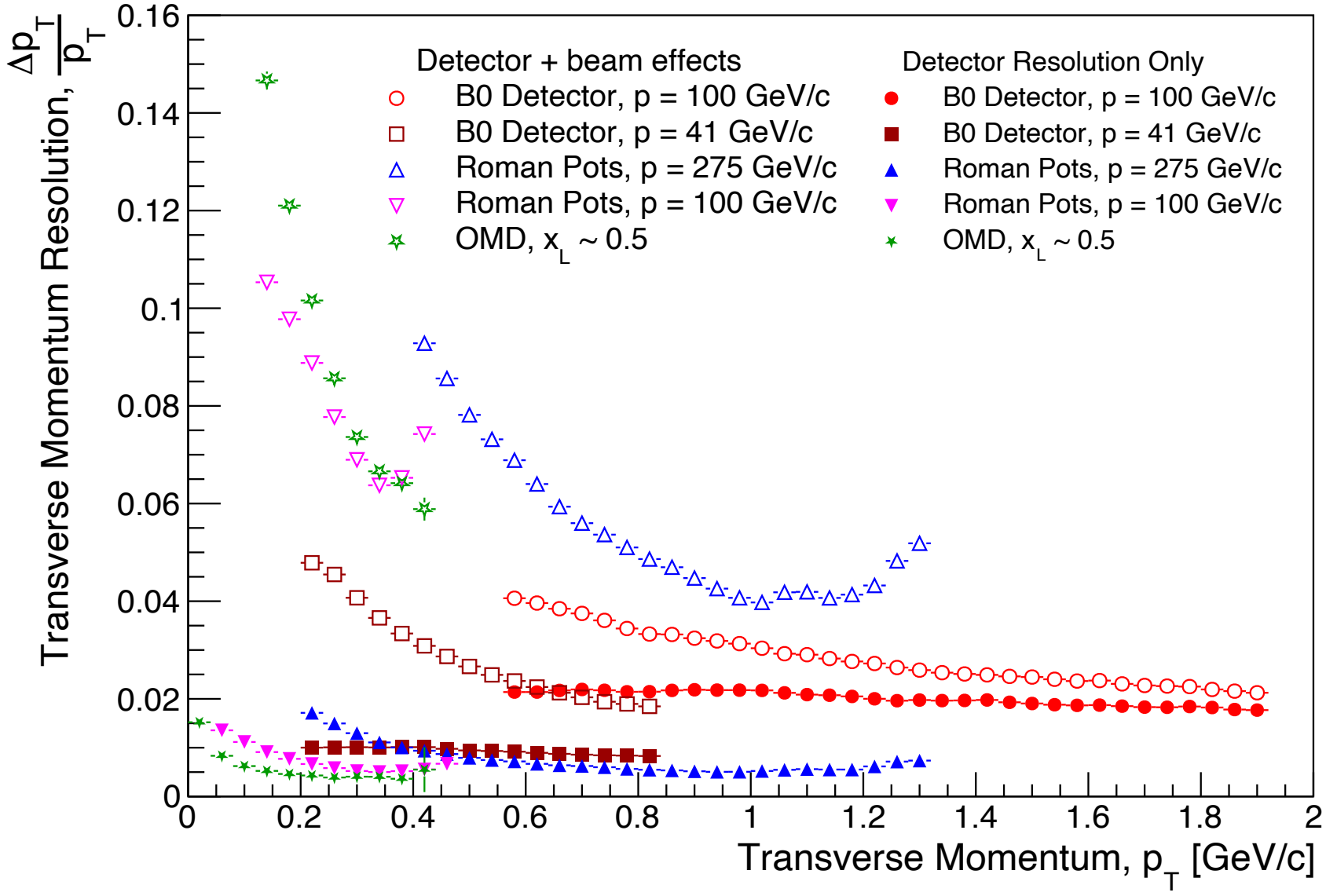
GEANT simulation: 100 GeV proton





$\rho^0 \rightarrow \pi^+\pi^-$ decay
from u-channel production

Summary of Detector Performance (Trackers)



- More study needed on material budget.
- All beam effects included!
  - Angular divergence.
  - Crossing angle.
  - Crab rotation/vertex smearing.

Beam effects the dominant source of momentum smearing!

So what is needed through the fall?

- B0 simulation work likely to be broken into three parts:
  - Tracking system – especially evaluation of engineering design w.r.t. material budget, and tracking resolution with updated field map (when available).
  - Preshower – the goal for this device was for photon tagging – in principle could be used to reconstruct photon kinematics from pair production in Pb layers. What kinds of optimization can be done? # layers? Thickness of absorber?
  - EMCAL – currently assuming PWO4. If we go this route, need detailed account of services, mounting system, etc. There is not much space in the magnet!
- It should be noted that the EMCAL is going to be very challenging, and possibly not possible with the updated B0pf magnet design (it was already going to be a stretch with the current design).
  - We should set our expectations to be realistically on the preshower, but our simulations should show **comparisons of specific physics channels** with the two options.
  - This has not been demonstrated and is needed.

So what is needed through the fall?

- There are many institutions interested in working on the B0 in some form or fashion.
  - The B0 task list will grow over the next few weeks along the lines of what was discussed above.
- We will plan to have dedicated meetings for the B0 development to solidify the decisions, starting in October (once people have some time to digest the simulation tutorials).
  - The interested parties from the physics working group (especially on the EMCAL) need to be involved, as their physics is what will be impacted.