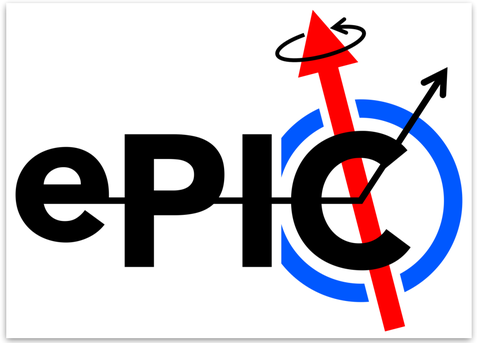


nHCal: lepton ID, a first look

Caroline Riedl, Vincent Andrieux
(UIUC)
June 28, 2024
ePIC nHCal DSC meeting

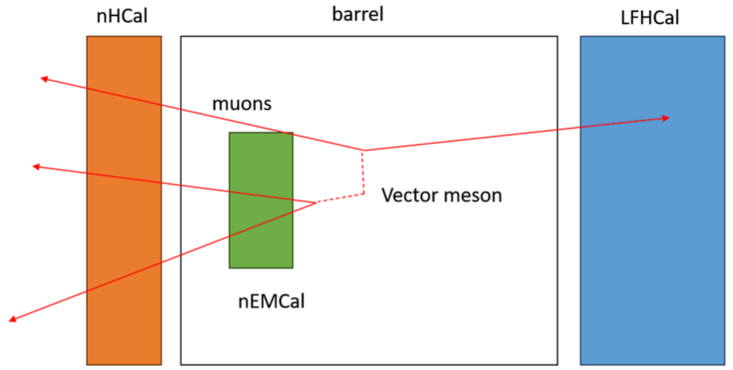
Muon ID

Crucial topics for TDR - needed help

4. Study muon ID efficiency and purity in DIS events with vector mesons produced. Look for MIP tracks with MIP energy deposits in EMcal and HCal. (No manpower here!) **CRUCIAL: In principle can be completed by 2024.11.1** **No manpower: 0.5 FTE for 1-3 months needed to start work**
5. The above steps should determine the optimal tile size. The tile performance will be tested at OSU with cosmic rays. Compare it to optical photon transport simulation. This will determine the technology choice.

- Reminder of Leszek's notes on this topic

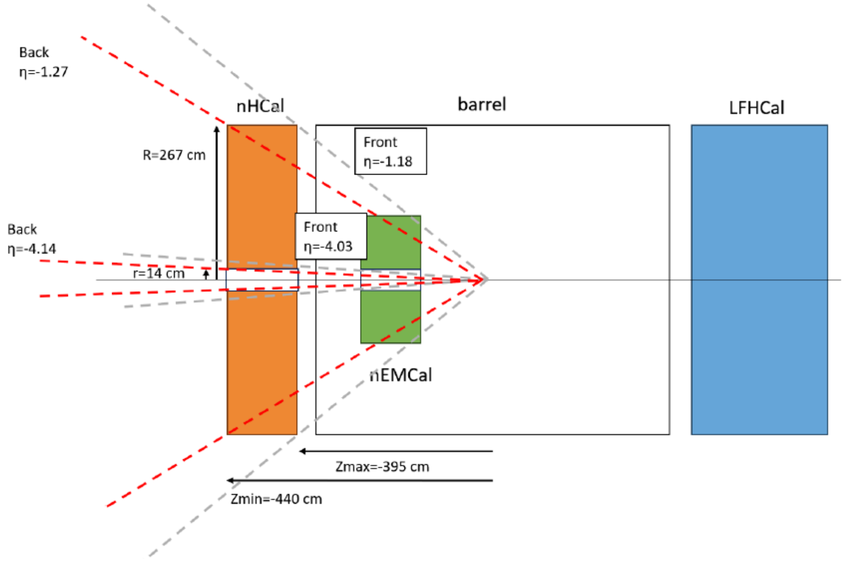
Vector meson studies



- Important for high y or low-p_T vector mesons - depends on type
- Increases acceptance
- Need projected MIP tracks and MIP signals in backward HCal and EMCal
  - μ/π distinction important, position resolution...
- Performance estimate required for TDR

12.1.2024 L. Kosarzewski OSU

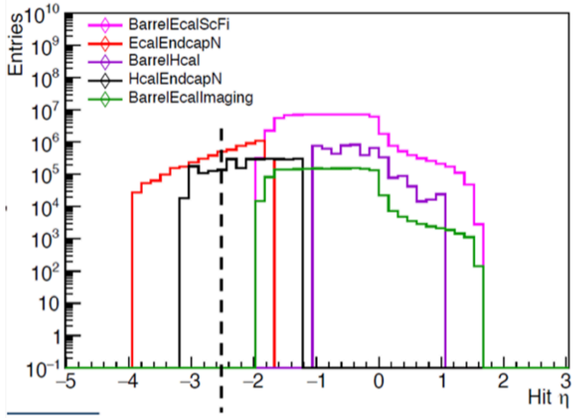
Acceptance check



- Front geometry limit: $-4.03 < \eta < -1.18$
- Back geometry limit: $-4.14 < \eta < -1.27$
- Clusters: $-3.95 < \eta < -1.25$

15.5.2024 L. Kosarzewski OSU

Hits overlap



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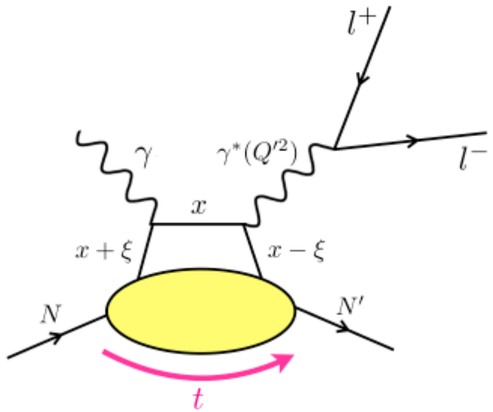
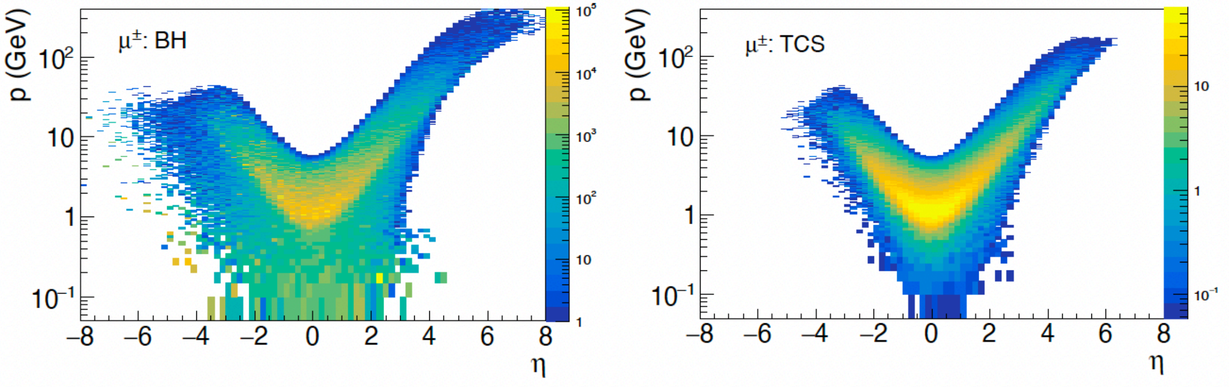
Vector mesons, muon & electron ID (1st look - not exhaustive)

[Simulations from EIC Yellow Report, (18x275)]

- Timelike Compton Scattering (TCS)





(~ similar for e^+e^- final state)

- Exclusive / diffractive VM production

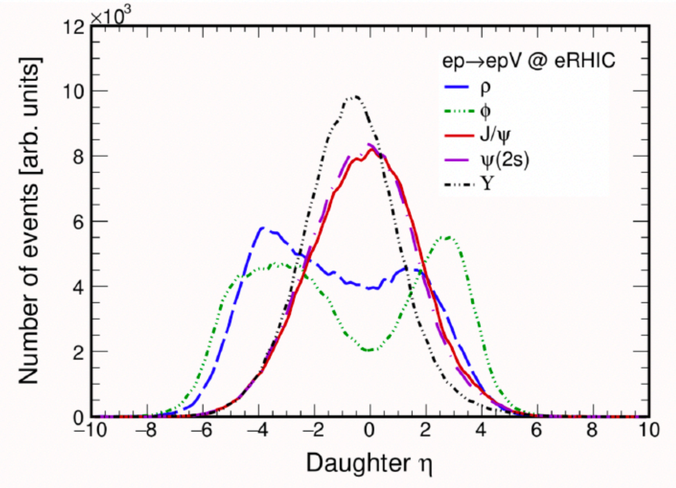
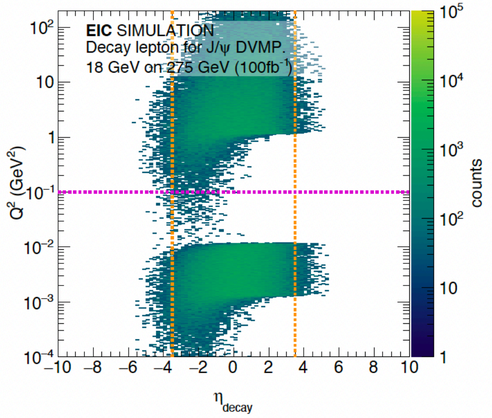


Figure 8.99: The pseudorapidity distribution for the daughter particles from the decay of different vector mesons at the EIC: $\rho \to \pi^+\pi^-$, $\phi \to K^+K^-$, $J/\psi \to e^+e^-$, $\psi' \to e^+e^-$ and $\Upsilon(1S) \to e^+e^-$. The lighter mesons have a broader pseudorapidity distribution because



Getting started

- We acquired ePIC computing accounts at SDCC / BNL and are getting familiar with ePIC software
- First topic: muon and electron ID with the goal of improvingVM reconstruction.
  a) Check how well muons can be discriminated from other particles i) without, ii) with the nHCal.
  b) What is the reconstruction efficiency?
  c) What is the nHCal's impact of the VM's performance? How does the acceptance change?
- Step 1: stand-alone pythia simulation.
  - Existing productions:

  - Lowest available Q^2, min Q^2=1; start with (18x275)

  - Which physics? DIS alone may not give the full answer; need exclusive, … (?) too
- We consider as step 2++: full simulation including GEANT4 / detector implementation promises more solid ground

```
jug_dev> criedl@eic0107:~/eic$ mc ls S3/eictest/EPIC
[2023-09-05 23:20:04 EDT]    38B STANDARD _condor_stderr
[2023-09-05 23:20:03 EDT] 607KiB STANDARD _condor_stdout
[2024-06-27 17:17:24 EDT]     0B Campaigns/
[2024-06-27 17:17:24 EDT]     0B EVGEN/
[2024-06-27 17:17:24 EDT]     0B FULL/
[2024-06-27 17:17:24 EDT]     0B LOG/
[2024-06-27 17:17:24 EDT]     0B RECO/
```

generated events → GEANT → reconstructed

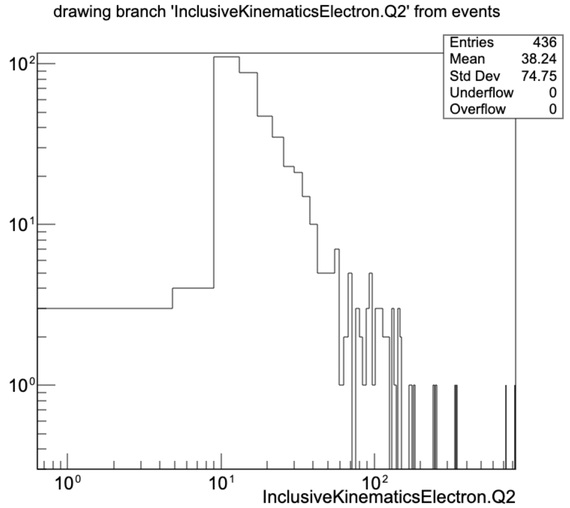
```
jug_dev> criedl@eic0107:~/eic$ mc ls S3/eictest/EPIC/EVGEN/DIS/NC/18x275/
[2024-06-27 17:22:05 EDT]     0B minQ2=1/
[2024-06-27 17:22:05 EDT]     0B minQ2=10/
[2024-06-27 17:22:05 EDT]     0B minQ2=100/
[2024-06-27 17:22:05 EDT]     0B minQ2=1000/
[2024-06-27 17:22:05 EDT]     0B noradcor/
[2024-06-27 17:22:05 EDT]     0B radcor/
```

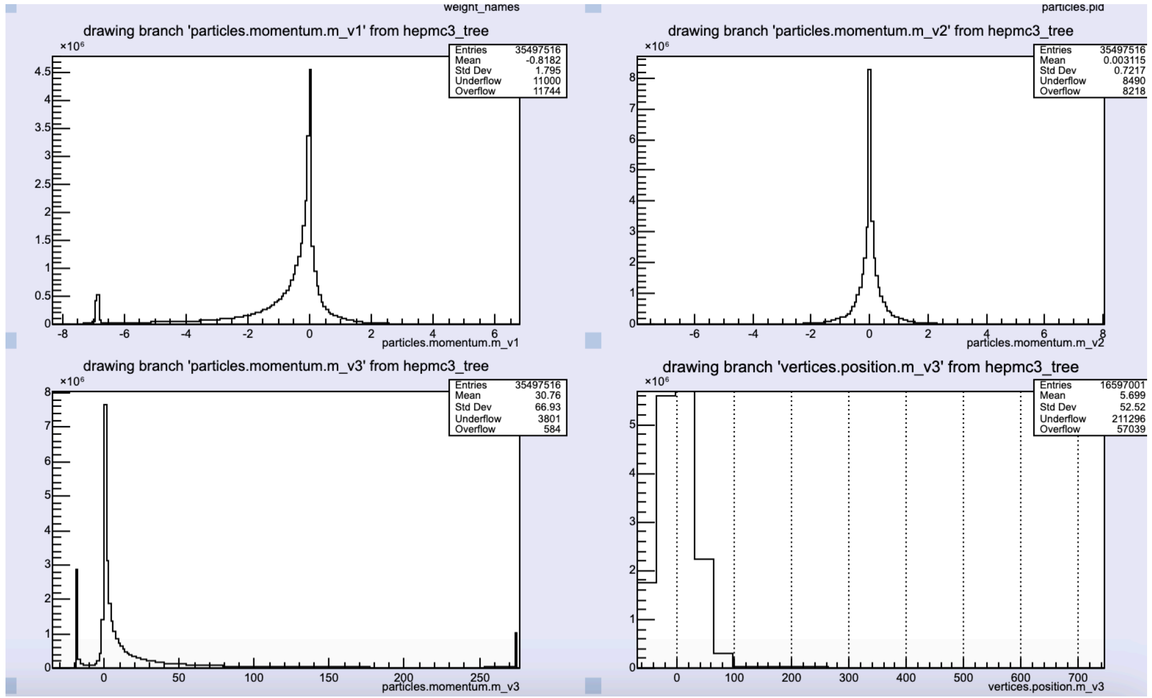
```
jug_dev> criedl@eic0107:~/eic$ mc ls S3/eictest/EPIC/EVGEN
[2023-08-28 16:01:51 EDT]     0B STANDARD .nfs000000000626edb600000001
[2023-05-30 01:57:17 EDT]   302B STANDARD sync.sh
[2023-06-05 13:28:14 EDT]     0B STANDARD sync.sh.tbritton.lock
[2023-06-05 13:28:14 EDT]     0B STANDARD sync.sh.wdconinc.lock
[2024-06-27 17:21:33 EDT]     0B BACKGROUNDS/
[2024-06-27 17:21:33 EDT]     0B CI/
[2024-06-27 17:21:33 EDT]     0B DIS/
[2024-06-27 17:21:33 EDT]     0B Djangoh/
[2024-06-27 17:21:33 EDT]     0B EXCLUSIVE/
[2024-06-27 17:21:33 EDT]     0B SIDIS/
[2024-06-27 17:21:33 EDT]     0B SINGLE/
```

Getting started - two approaches currently

fetch example simulation file to SDCC: xrdcp root://dtn-eic.jlab.org//work/eic2/EPIC/EVGEN/DIS/NC/18x275/minQ2=1/pythia8NCDIS_18x275_minQ2=1_beamEffects_xAngle=-0.025_hiDiv_vtxfix_5.hepmc3.tree.root ./
fetch to laptop: sftp -p criedl@sftp.sdcc.bnl.gov:/eic/u/criedl/eic/data/test/pythia8NCDIS_18x275_minQ2=1_beamEffects_xAngle=-0.025_hiDiv_vtxfix_5.hepmc3.tree.root .

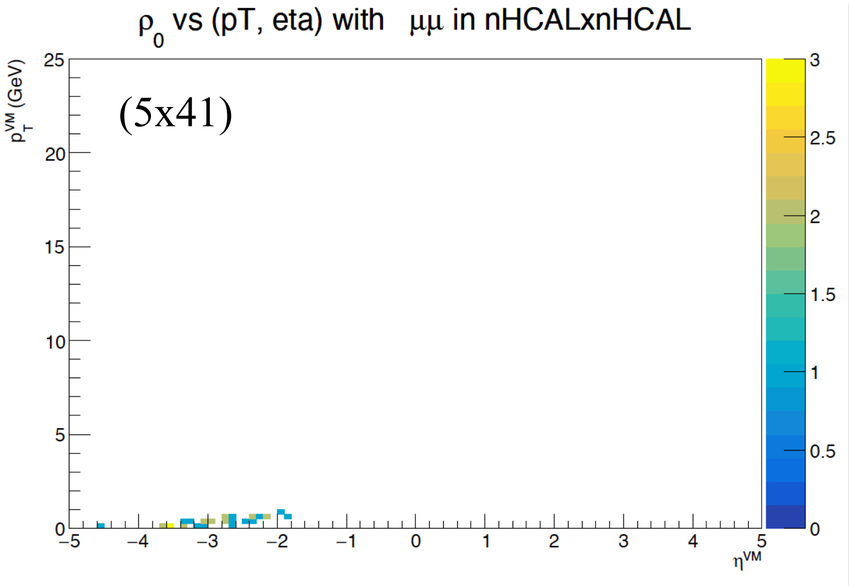
- Caroline
  - Need to understand content of generated Pythia files
  - Also looked into reconstructed file (from tutorial)

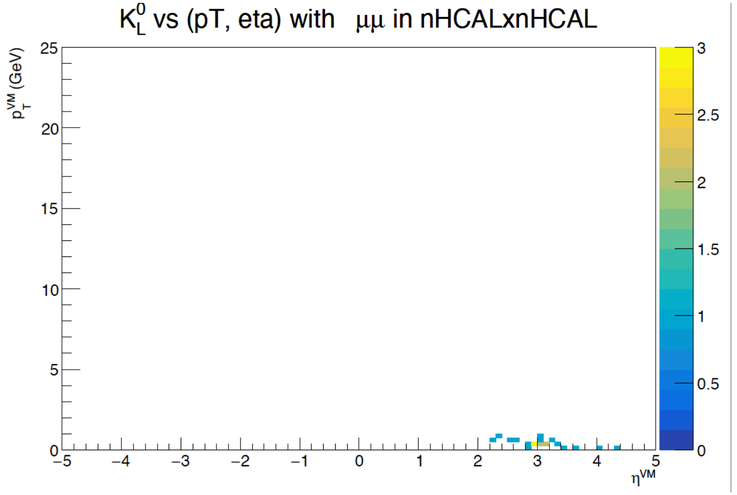


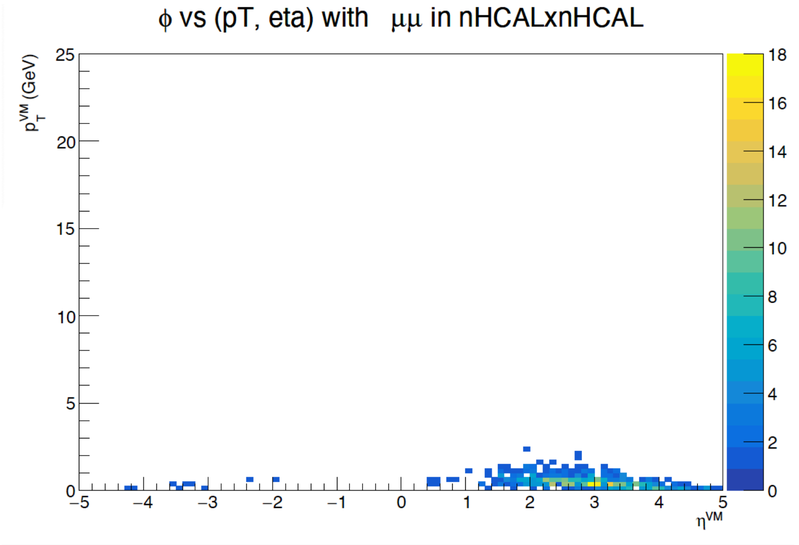


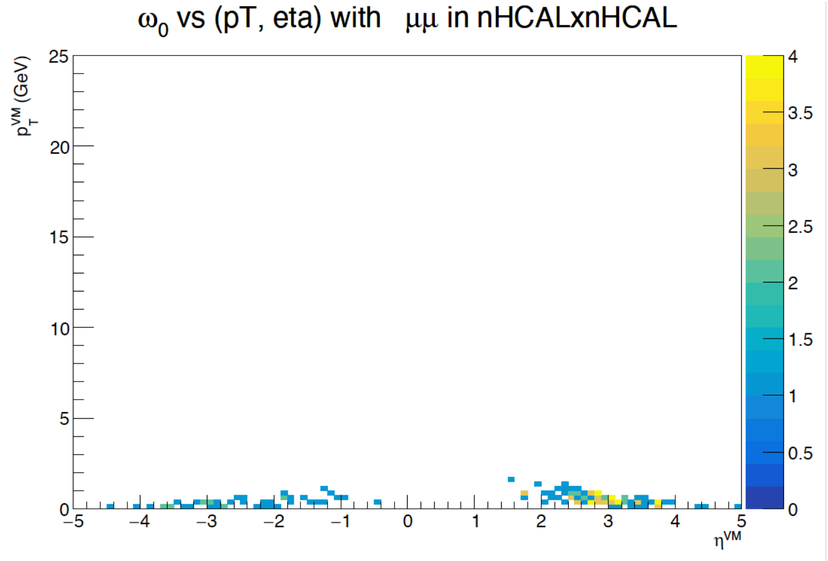
Getting started - two approaches currently

- Vincent
  - Running standalone Pythia8 on personal laptop - “à la HERA”, turn on diffractive processes and photo-production, (5x41) and (18x275), 15M events
  - Muon pairs from decay of vector mesons → rapidity distribution.
    (-4.14<eta)&&(eta<-1.18) for nHCal, ((-1.0<eta) && (eta<1.0)) for the barrel HCal and ((1.18<eta) && (eta<3.5)) for forward HCal

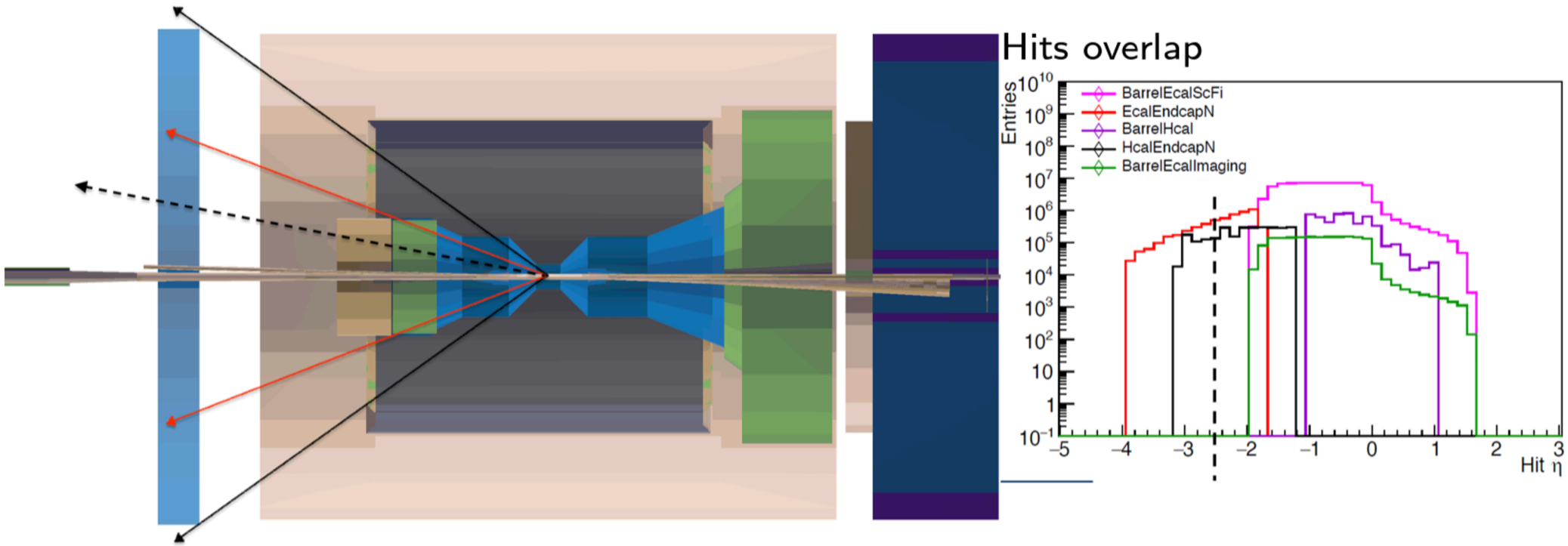








nHCal acceptance



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- Acceptance $-3.5 < \eta < -1.27$ - approximate values
- Overlaps with backward and barrel EMcals
- Scattering may be important in these overlap regions