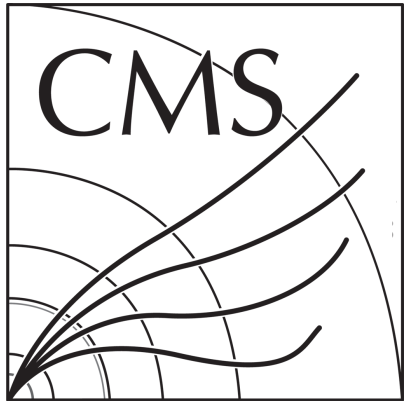
Offline Electron Reconstruction Validation

Caleb Fangmeier
Ilya Kravchenko, Greg Snow

University of Nebraska - Lincoln

July 21, 2017



Introduction

- Our goal is to study **seeding** for the **offline** Gsf tracking with the **new pixel detector**.
- Ongoing studies[1] in HLT examine the resolution of RecHits used in Gsf Tracking.
- In those studies, the resolution is computed by measuring the distance between the **RecHits** and the extrapolated paths from ECAL **super-clusters** (SCs).
- For **offline** reconstruction, we compute residuals by comparing the position of **RecHits** and associated **SimHits**.
- Knowing these resolutions is important in choosing the size of search windows in the hit matching algorithm used in electron reconstruction.

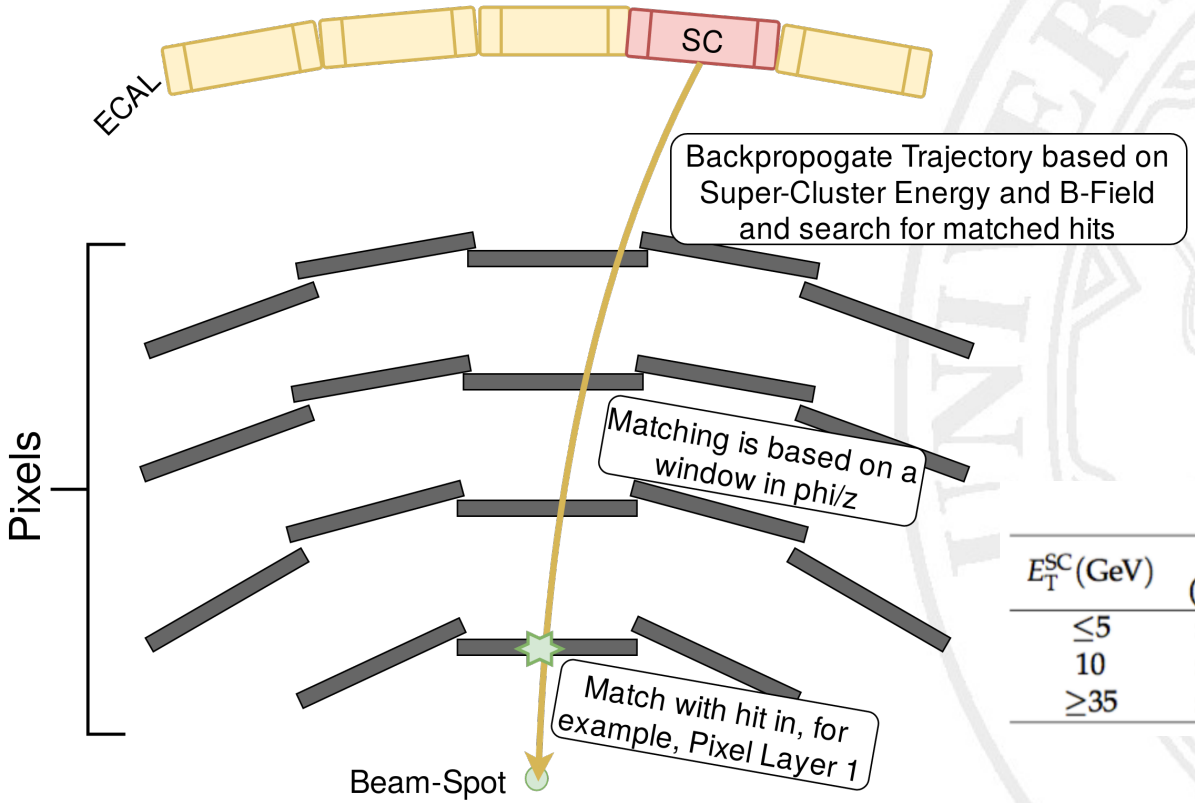
[1] `https://indico.cern.ch/event/613833/contributions/2646392/attachments/1486134/2307836/EGMHLT_PixelMatching_Jun30.pdf`

Introduction

- We use Rafael Lopes de Sa's analysis setup[2] that is derived from the standard offline tracking reconstruction tool `TrackingNtuple` from `Validation/RecoTrack`.
- Source dataset:
  `/DYJetsToLL_M-50_TuneCUETP8M1_13TeV-madgraphMLM-pythia8/PhaseIFall16DR-FlatPU28to62HcalNZSRAW_81X_upgrade2017_realistic_v26-v1/GEN-SIM-RAW`
- Using Release `CMSSW_8_1_0`
- Figures in this talk use 31790 events (could be re-run with more)

[2] `https://github.com/rafaellopesdesa/cmssw/tree/ValidationGsfTracks81X`

GSF ELECTRON SEEDING I

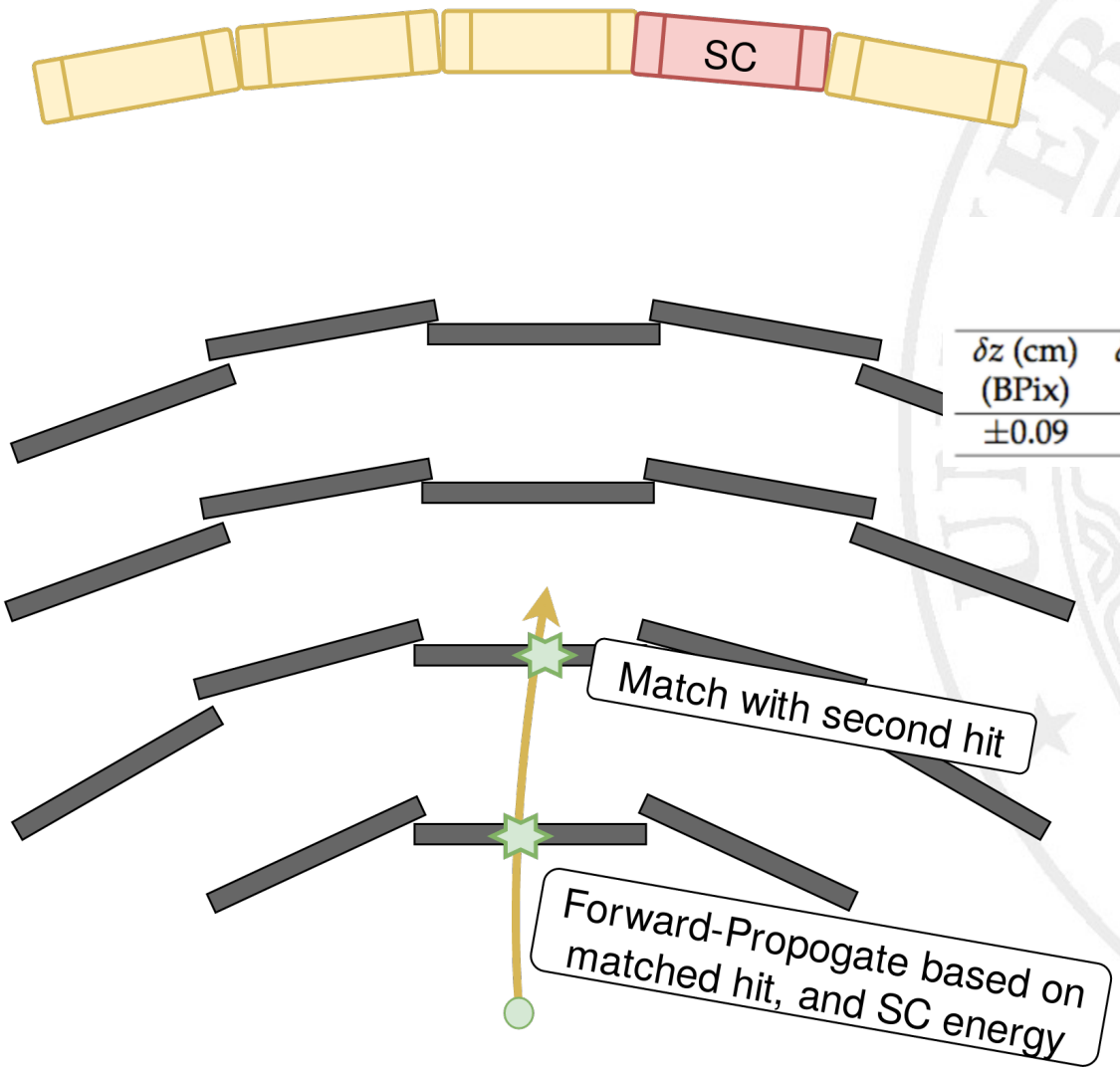


First window

E_T^{SC}(GeV)	δz (BPix)	δr (FPix or TEC)	$\delta\phi$ (rad) (positive charge)
≤ 5	$\pm 5\sigma_z$	$\pm 5\sigma_z$	$[-0.075; 0.155]$
10	$\pm 5\sigma_z$	$\pm 5\sigma_z$	$[-0.046; 0.096]$
≥ 35	$\pm 5\sigma_z$	$\pm 5\sigma_z$	$[-0.026; 0.054]$

Windows from `https://indico.cern.ch/event/611042/contributions/2464057/attachments/1406271/2148742/ElectronTracking30112016.pdf`

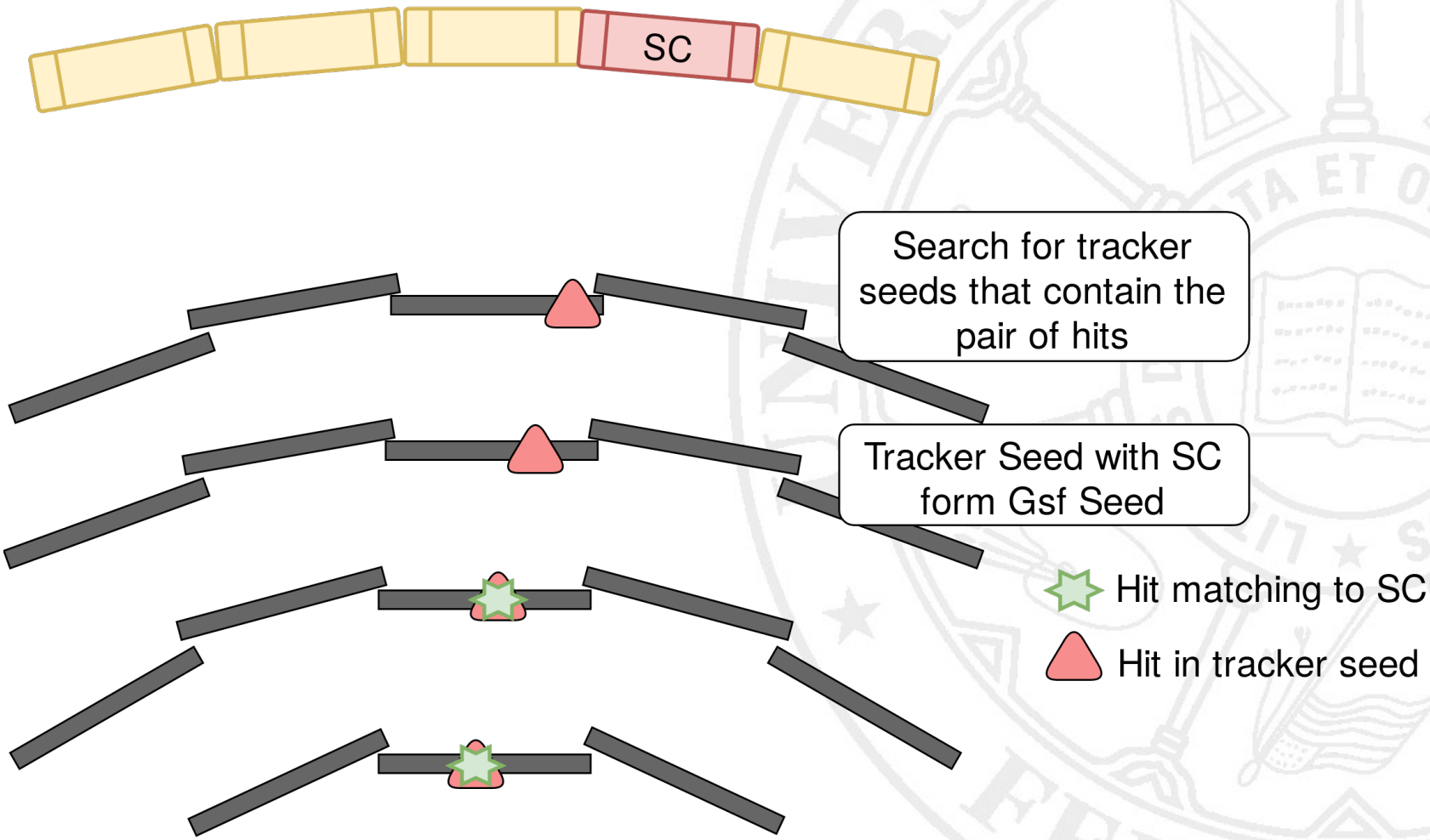
GSF ELECTRON SEEDING II



Second window

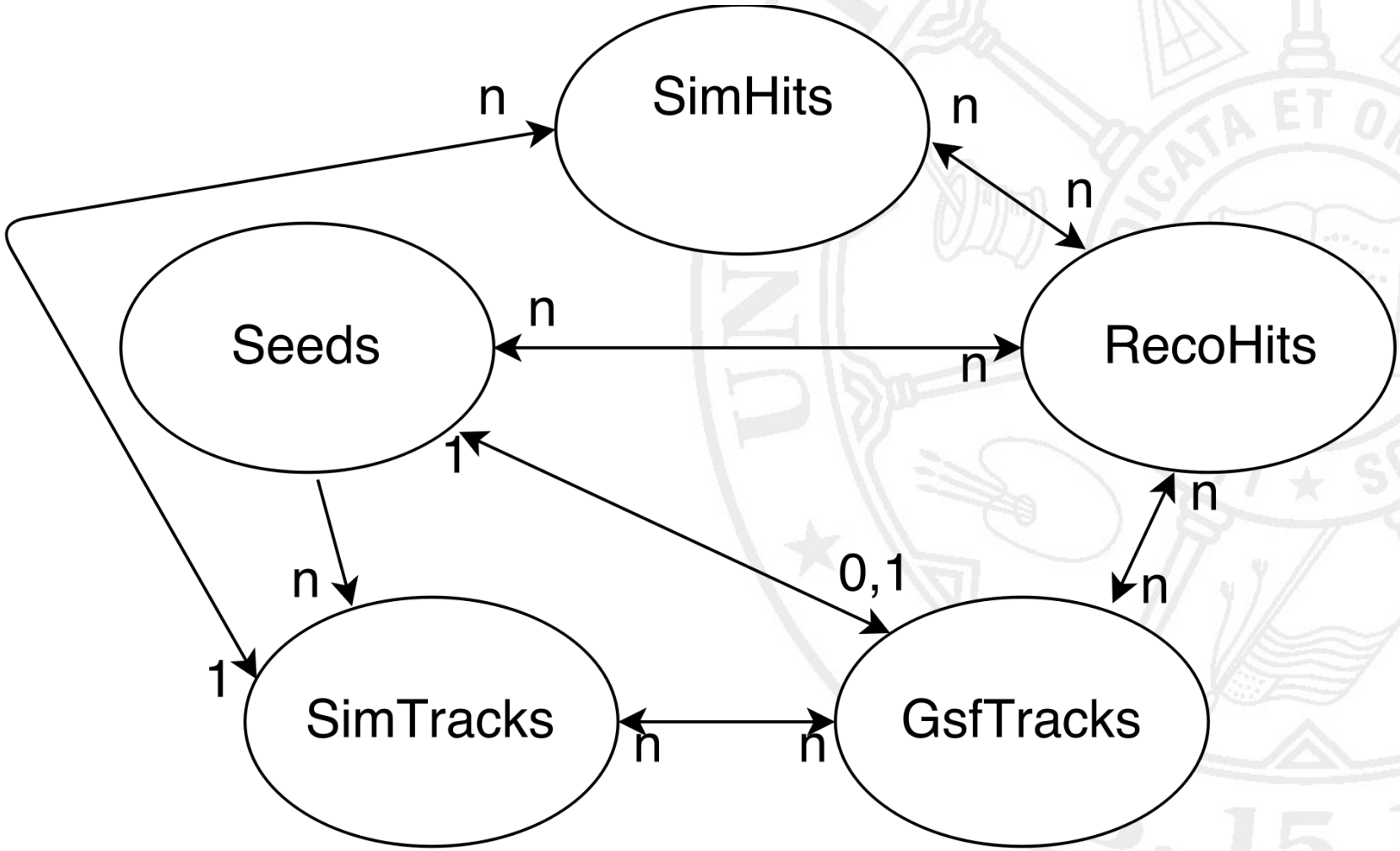
δz (cm) (BPix)	δr (cm) (FPix)	δr (cm) (TEC)	$\delta\phi$ (rad) (BPix)	$\delta\phi$ (rad) (FPix or TEC)
± 0.09	± 0.15	± 0.2	± 0.004	± 0.006

Gsf Electron Seeding III



TrackingNtuple

The `TrackingNtuple` format contains (among others) the below crosslinked collections

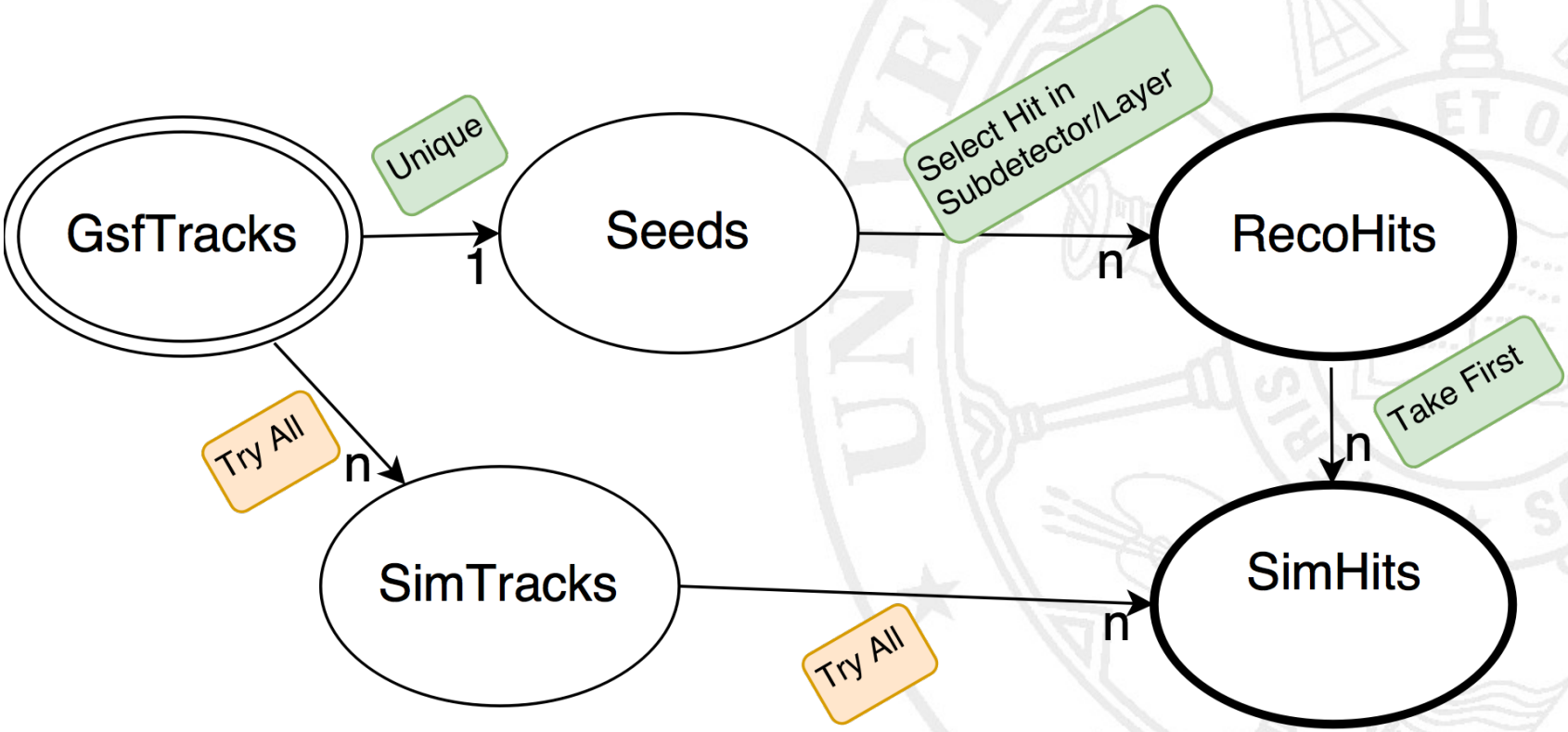


Finding SimHit/RecHit Pairs

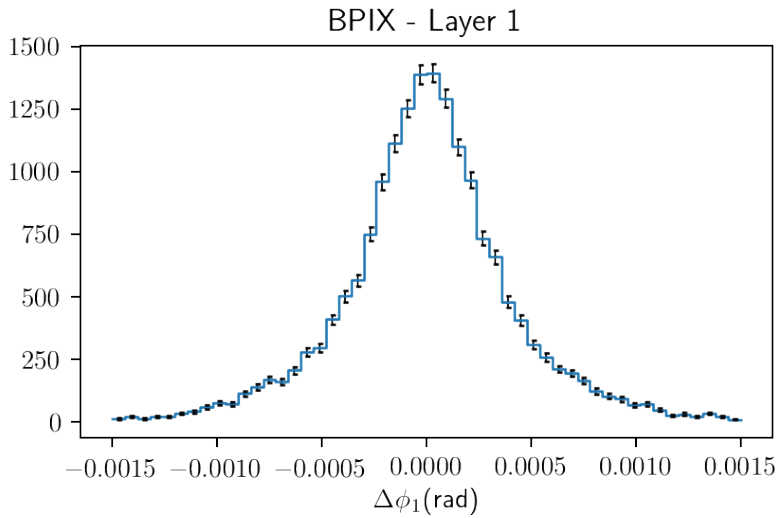
To find residuals for calculating resolutions, require a pair containing 1 `RecHit` and 1 `SimHit`. Procedure is as follows:

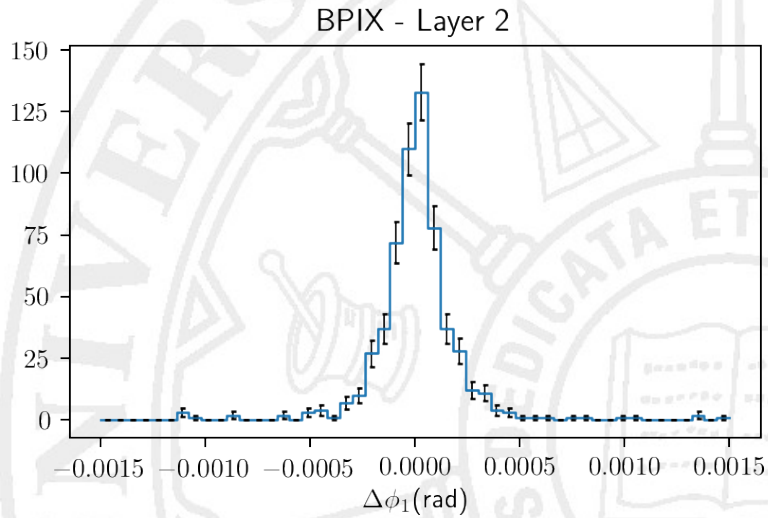
1. For each `Track`, get it's `Seed` (unique)
2. For each `RecHit` in the `Seed`, require
   - It is in the specified subdetector (e.g. BPIX Layer 1)
   - It is the 1st/2nd hit in the `Seed`.
   - It is matched to at least one `SimHit`.
3. For each `RecHit` (**B**) passing the above, take the first matched `SimHit` (**A**).
4. Now look through all `SimHits` associated with `SimTracks` associated with the original `Track`. If **A** exists in this set. Make a pair of `SimHit` **A** and `RecHit` **B**.

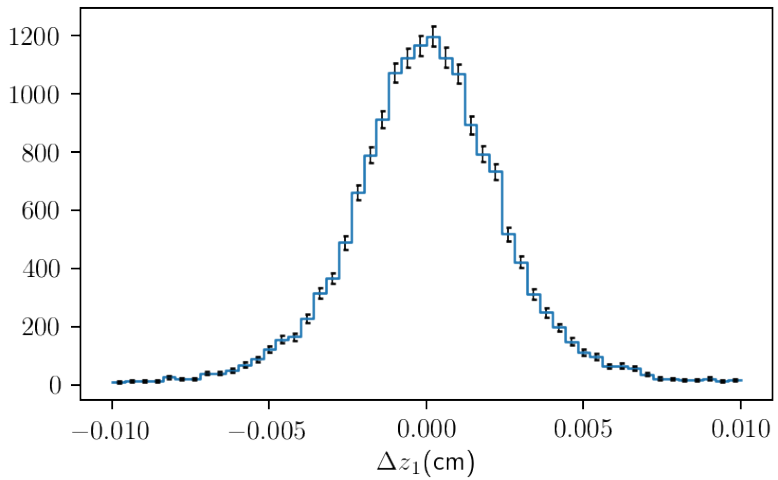
Finding SimHit/RecHit Pairs

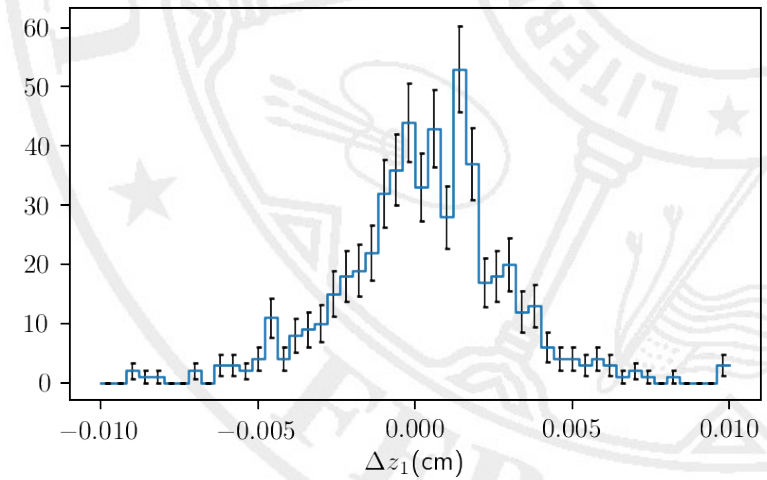


BPIX Hit 1 Resolution

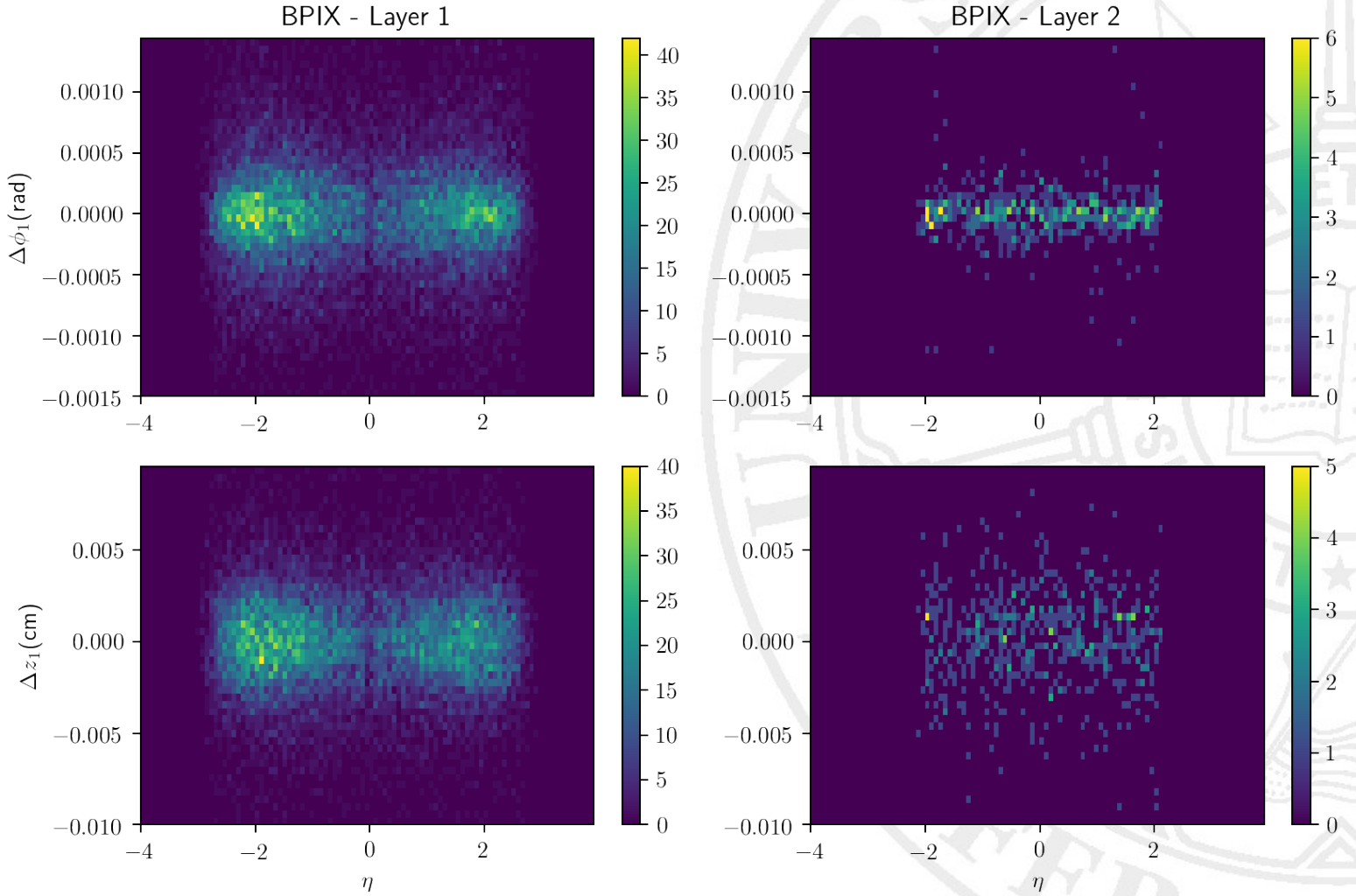




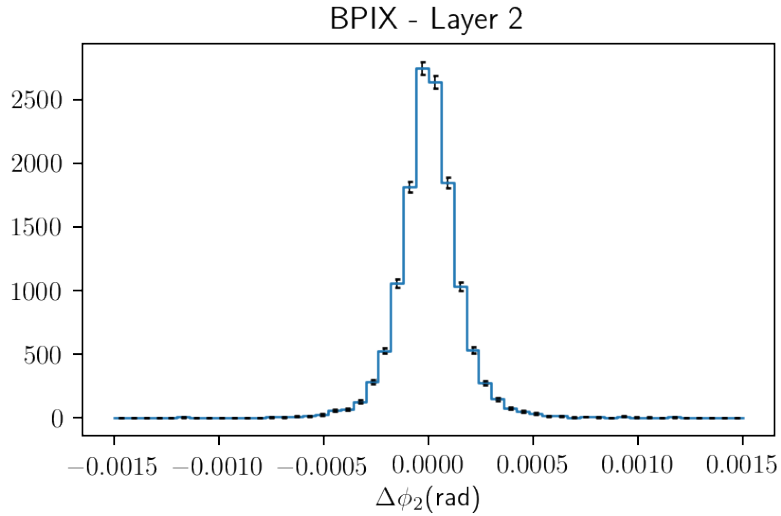


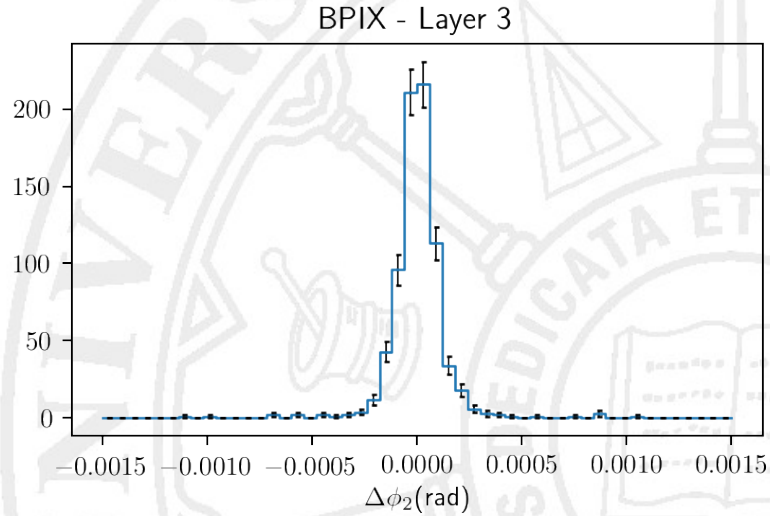


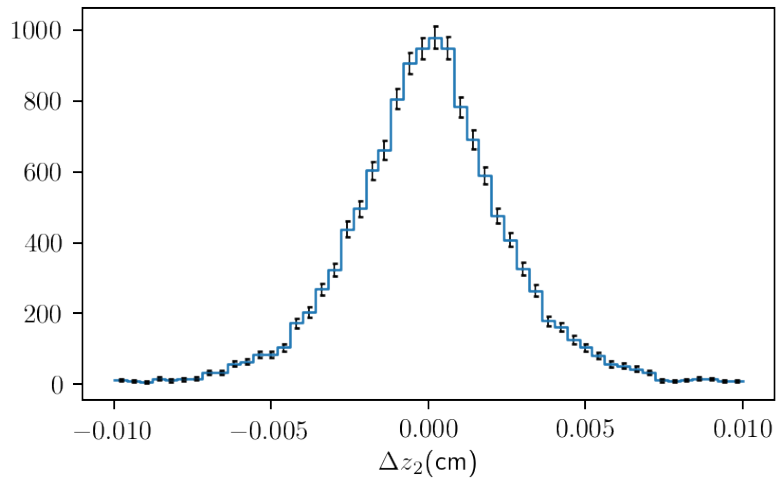
BPIX Hit 1 Resolution vs. η

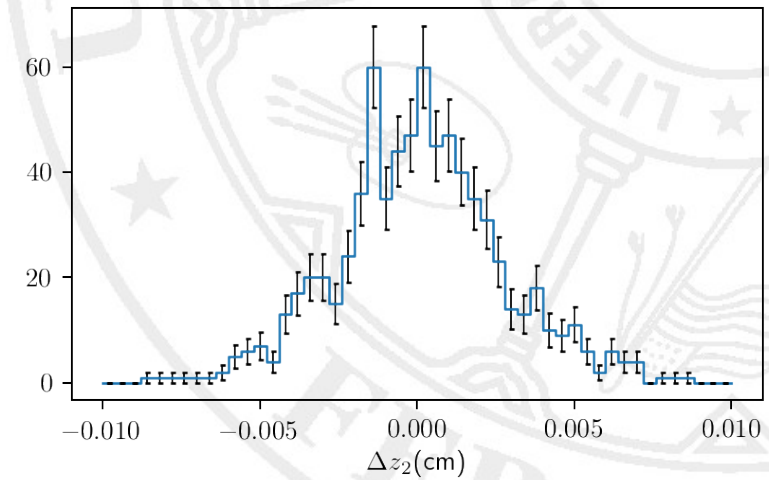


BPIX Hit 2 Resolution

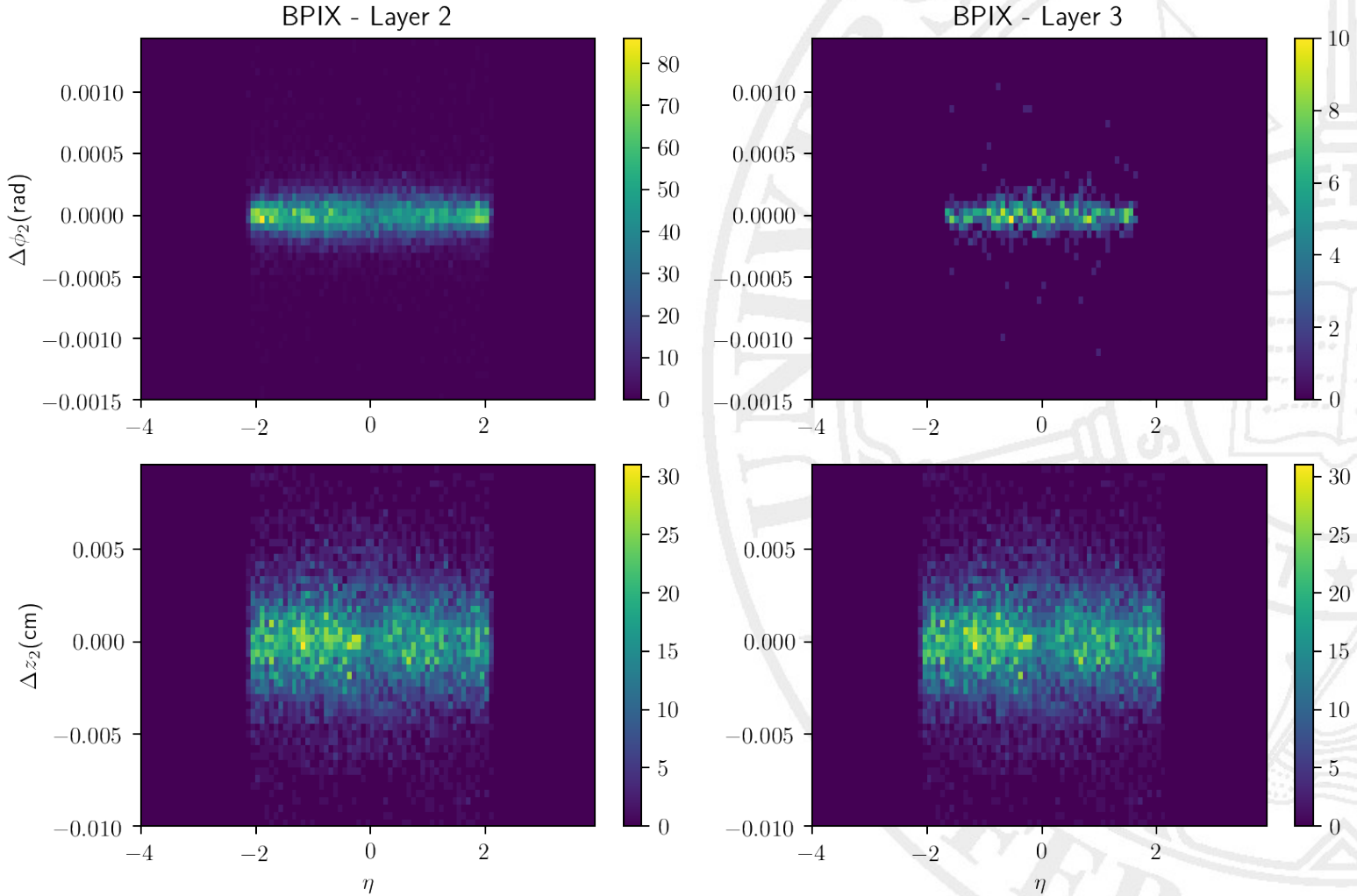




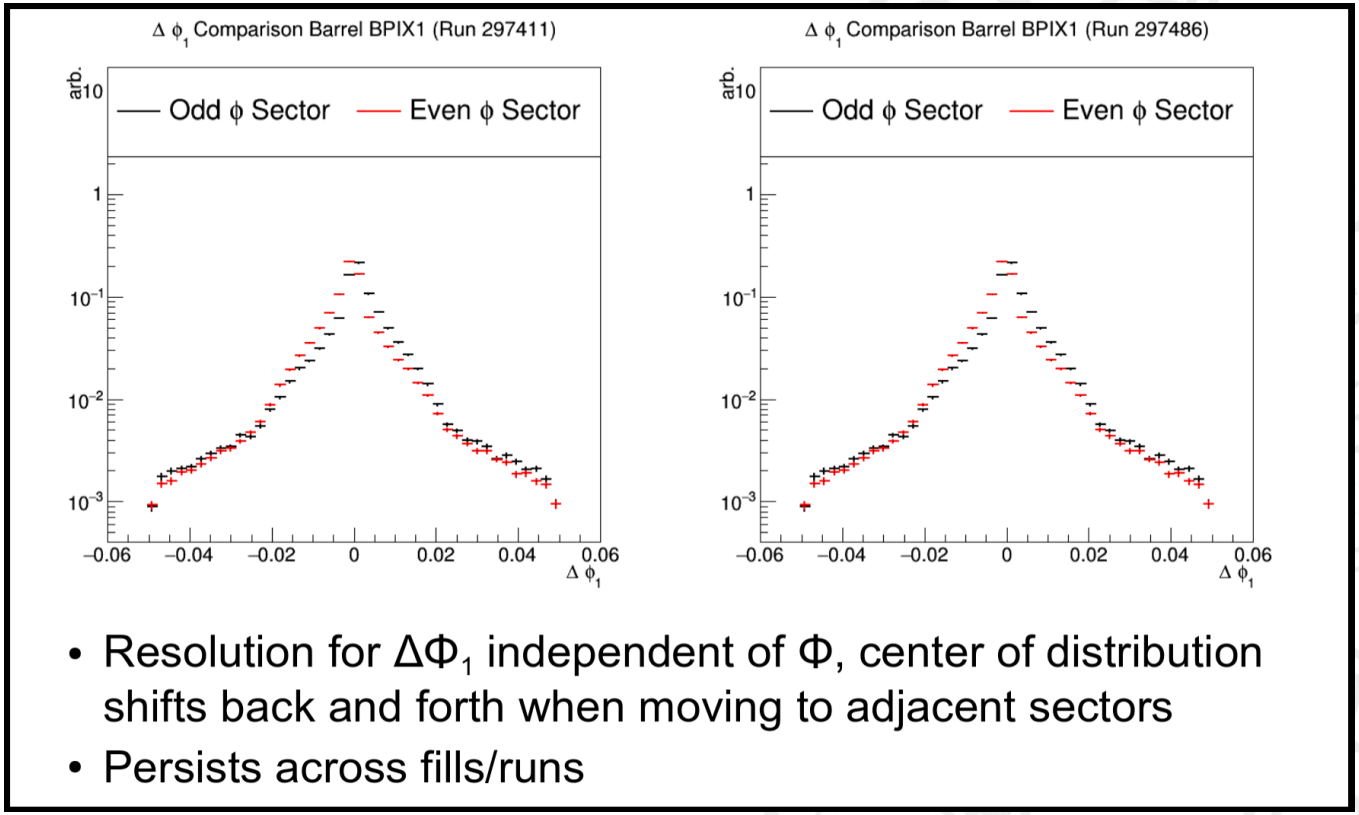




BPIX Hit 2 Resolution vs. η

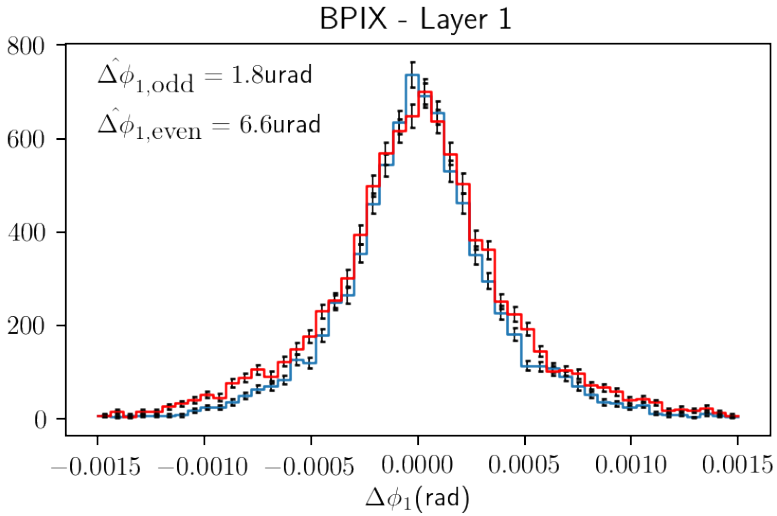


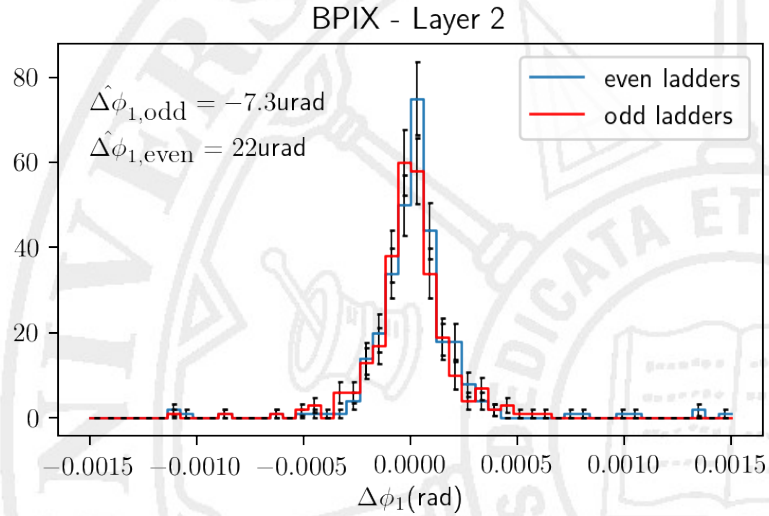
Resolution dependence on even/odd ladder number

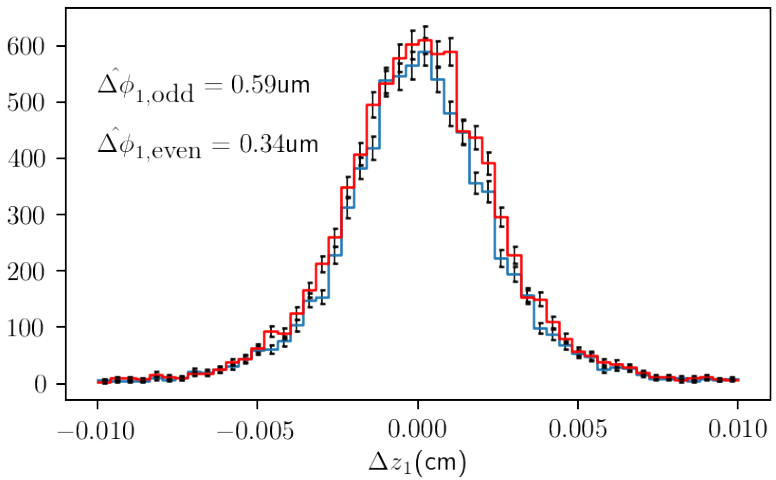


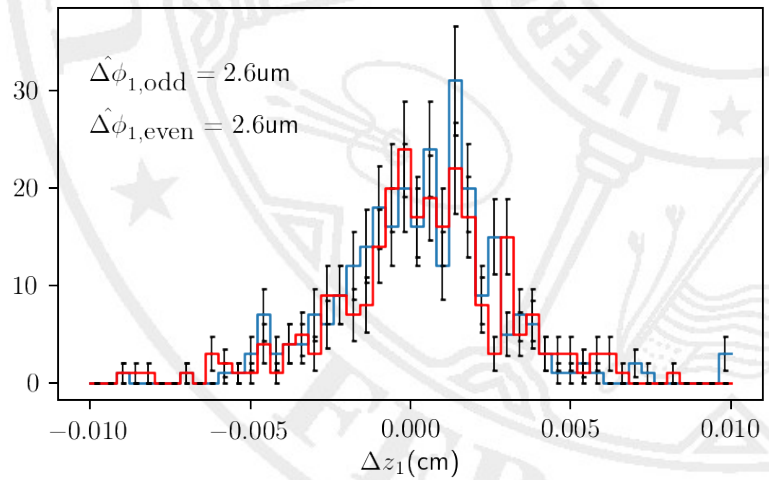
- Above From Dylan Rankin's June 30 Presentation. (See slide 1)
- We have slightly different definitions of $\Delta\phi_1$, but wanted to investigate ourselves.

Resolution dependence on even/odd ladder number









Conclusions

- Analysis machinery for offline electron RECO studies with MC truth is in place.
- Preliminary plots of $\Delta\phi_{1/2}$ and $\Delta z_{1/2}$ for BPIX Layers 1/2 are shown.
- Code for this analysis is here:

  `git.fangmeier.tech/caleb/EGamma_ElectronTrackingValidation`

- next to come
  - run on larger event samples (`trackingNtuples` are generated, just need to use)
  - include FPIX
  - investigate reasons for rec hit inefficiencies
  - introduce triplet-based pixel matching for the seeds and repeat the studies