Updates on resolutions from DIS and SR background

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RNC EIC Meeting
12/13/2022

Outline

- Resolutions from DIS events

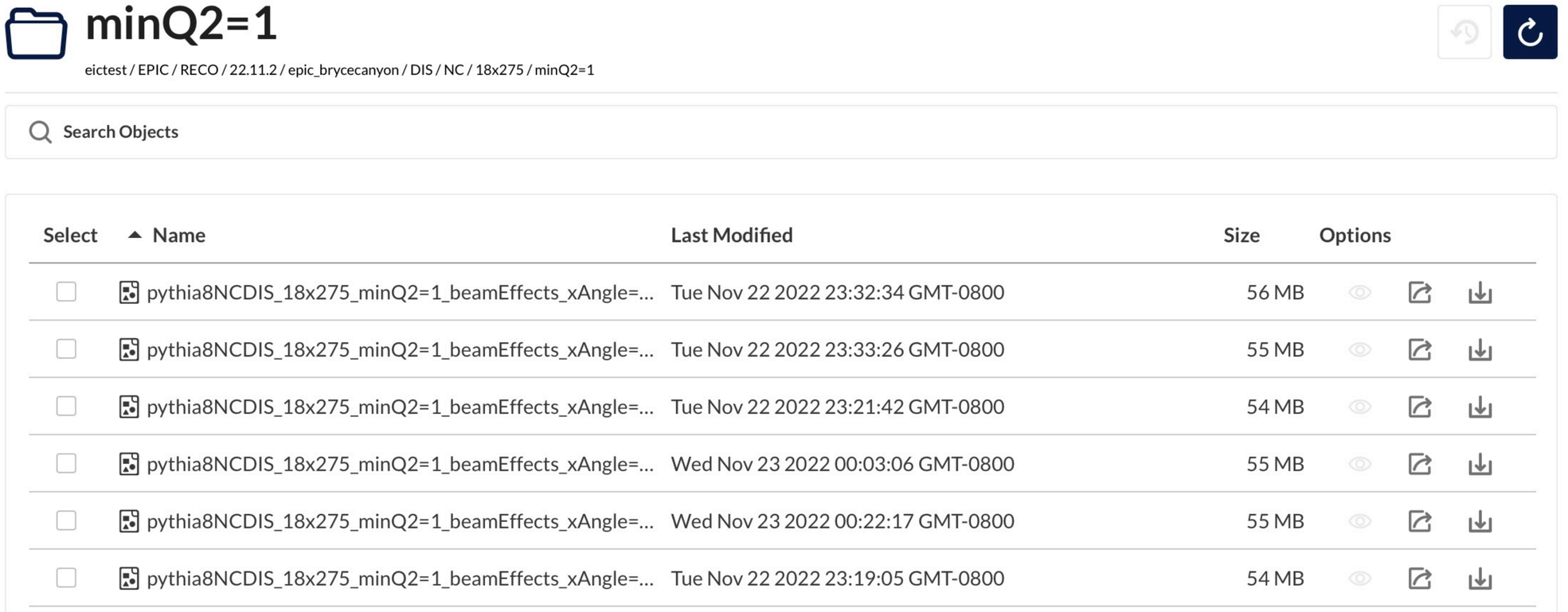
- SR background status

Objective

- Compare resolutions obtained from single-particle gun to those from DIS events as a cross-check

Data

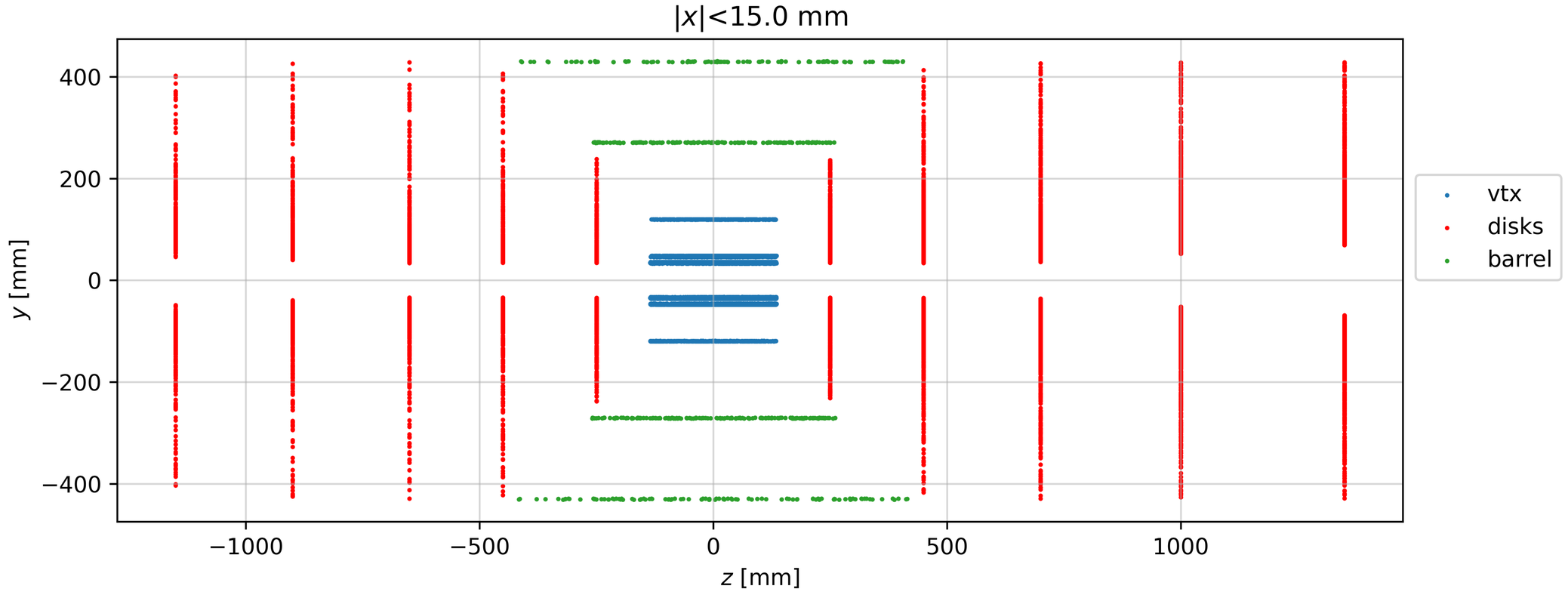
DIS events taken from here



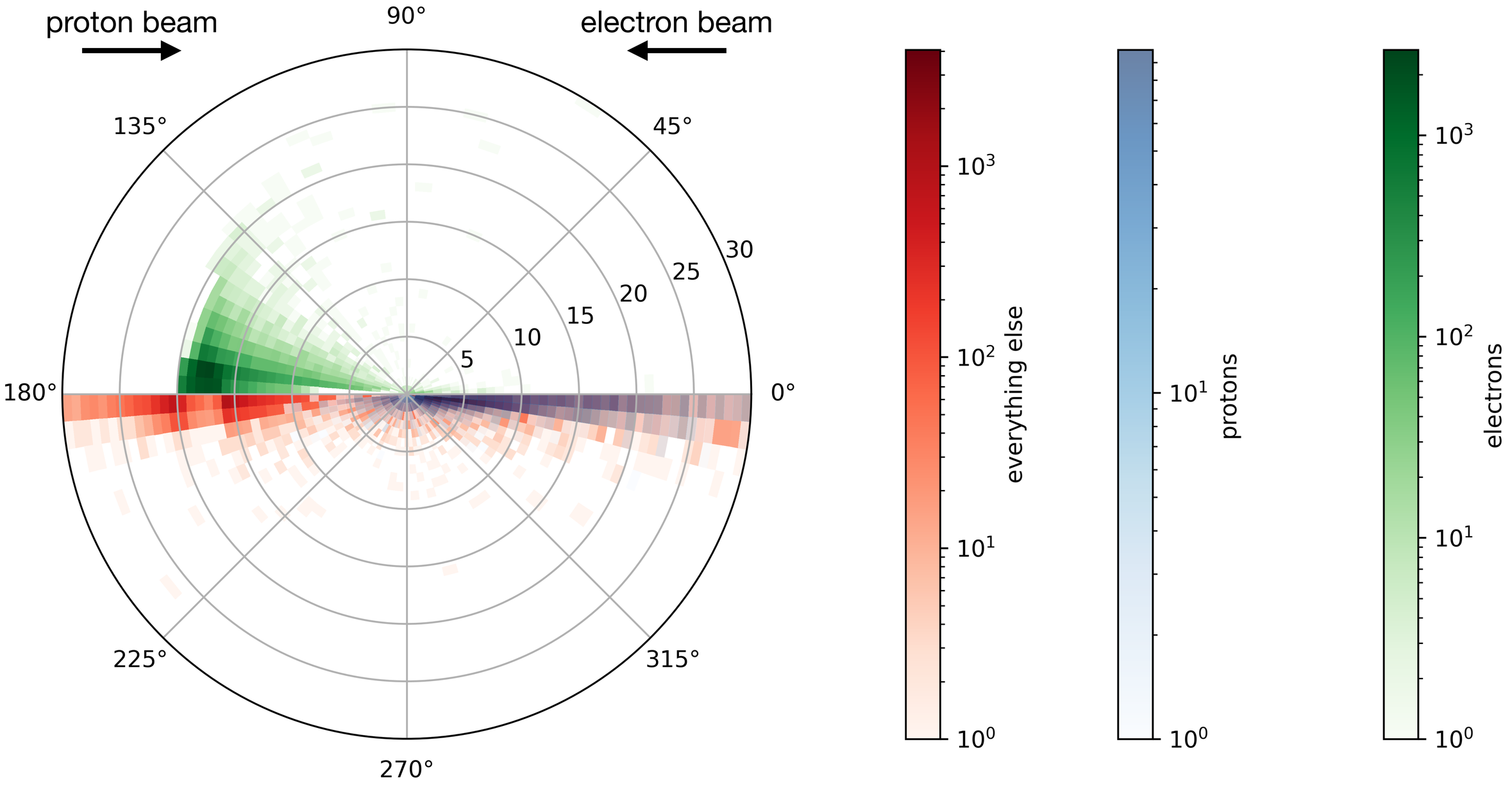
Content of these files changes with time

Detector configuration

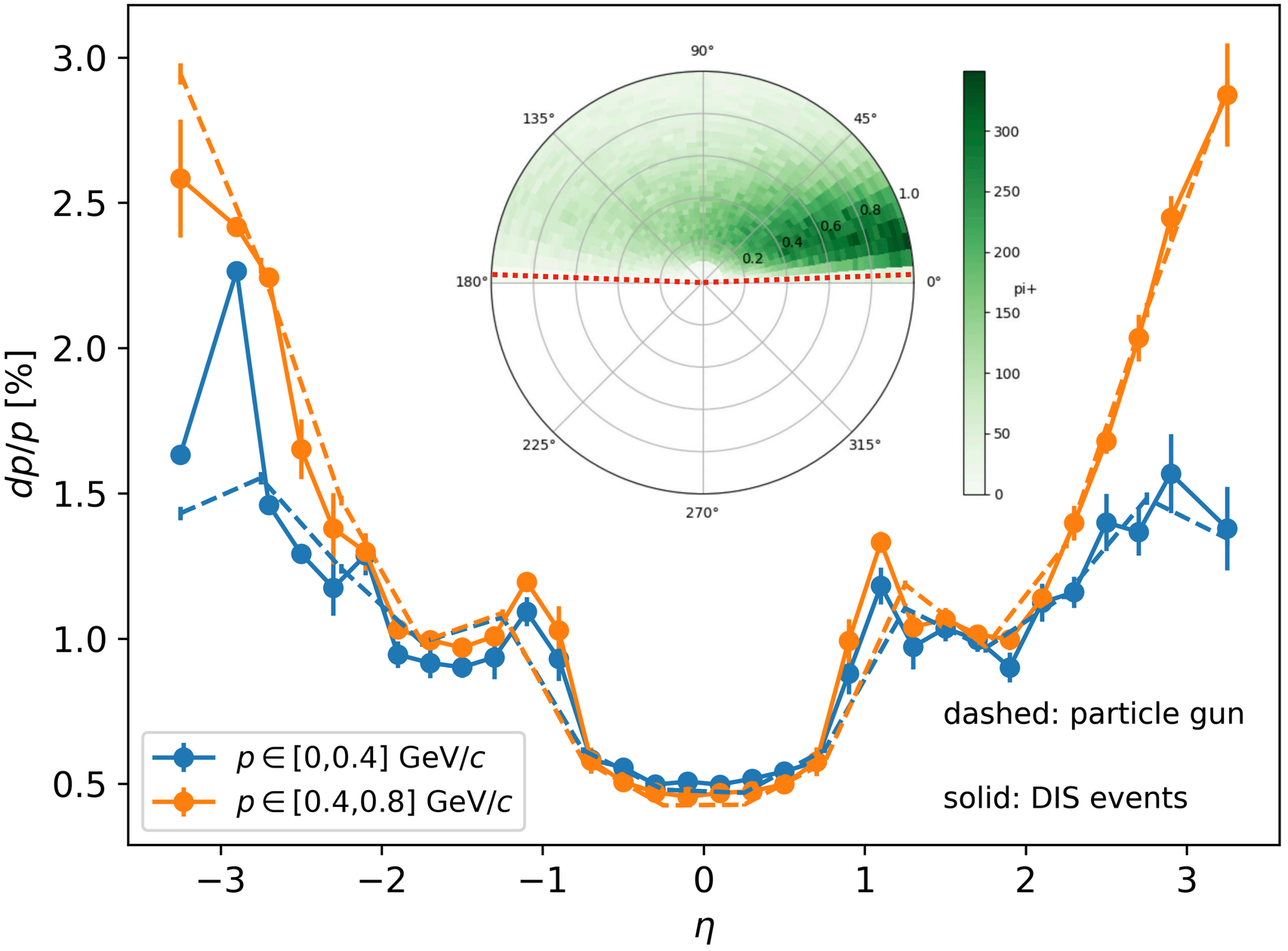
- Geometry tag: Brycecanyon
  - 5 Barrel silicon: spatial resolution 10μm/sqrt(12), r = 3.6, 4.8, 12, 27, 42cm
  - 1 Barrel MPGD: spatial resolution 150μm, r = 55cm
  - 1 Barrel TOF: spatial resolution 30x3000μm, r = 64.6cm
  - 10 Endcap silicon: spatial resolution 10μm/sqrt(12), z = -115, -90, -65, -45, 25, 25, 45, 70, 100, 135cm



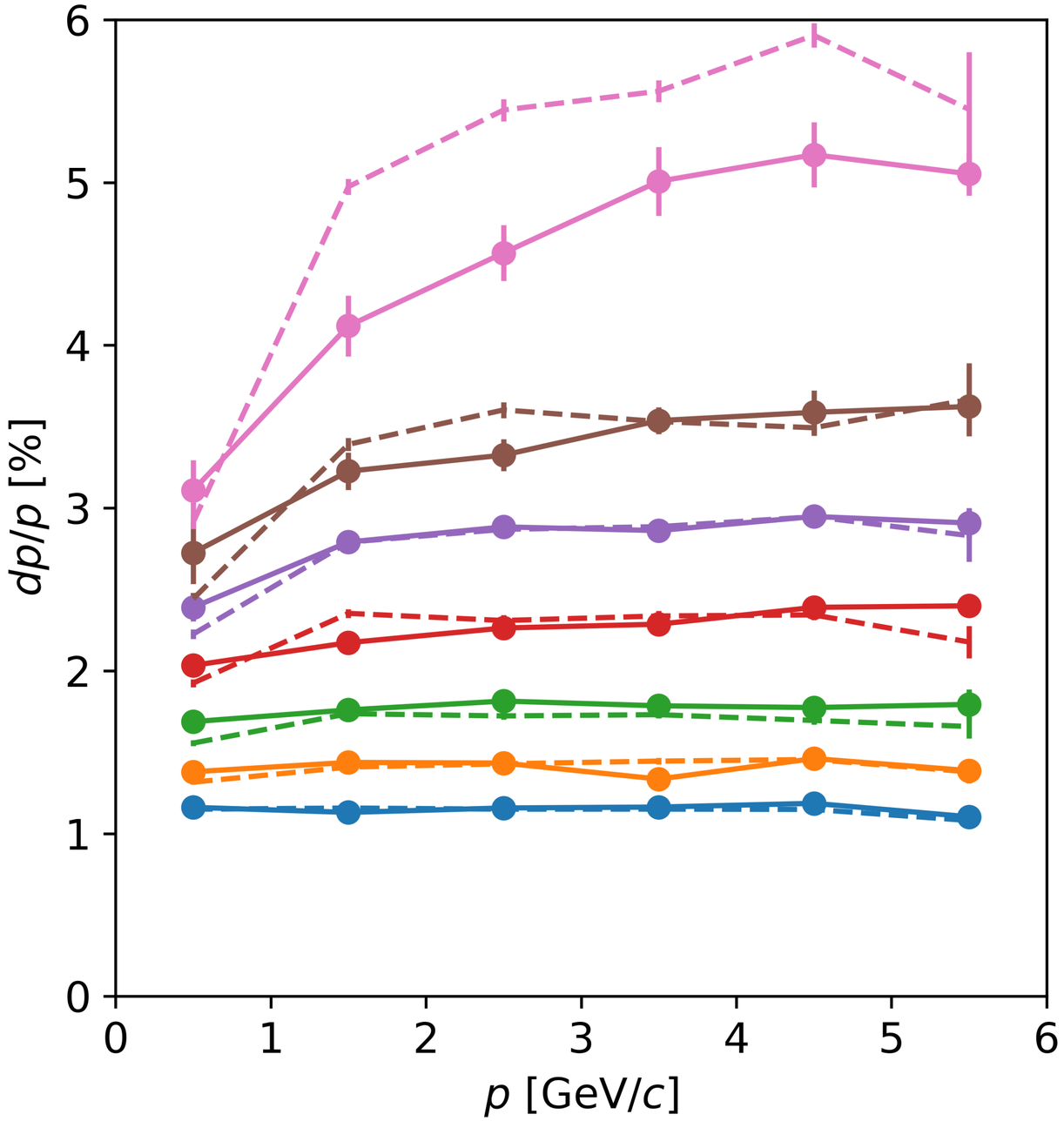
Reconstructed topology



Resulting resolutions

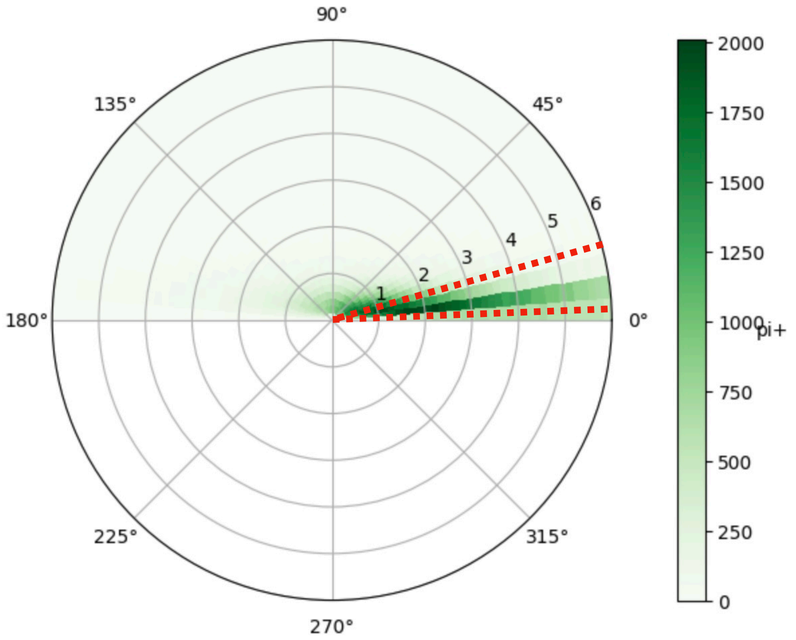


Comparison to Particle Gun Results



dashed: particle gun

solid: DIS events



Interim summary

- Centralized EPIC data bank seems to be changing with time without versioning.
- Carried out study to compare resolutions between particle-gun and DIS events.
- Results are overall consistent between the two samples.
- Small inconsistencies are found in more extreme kinematics. More data / finer binning should improve the agreement.

Outline

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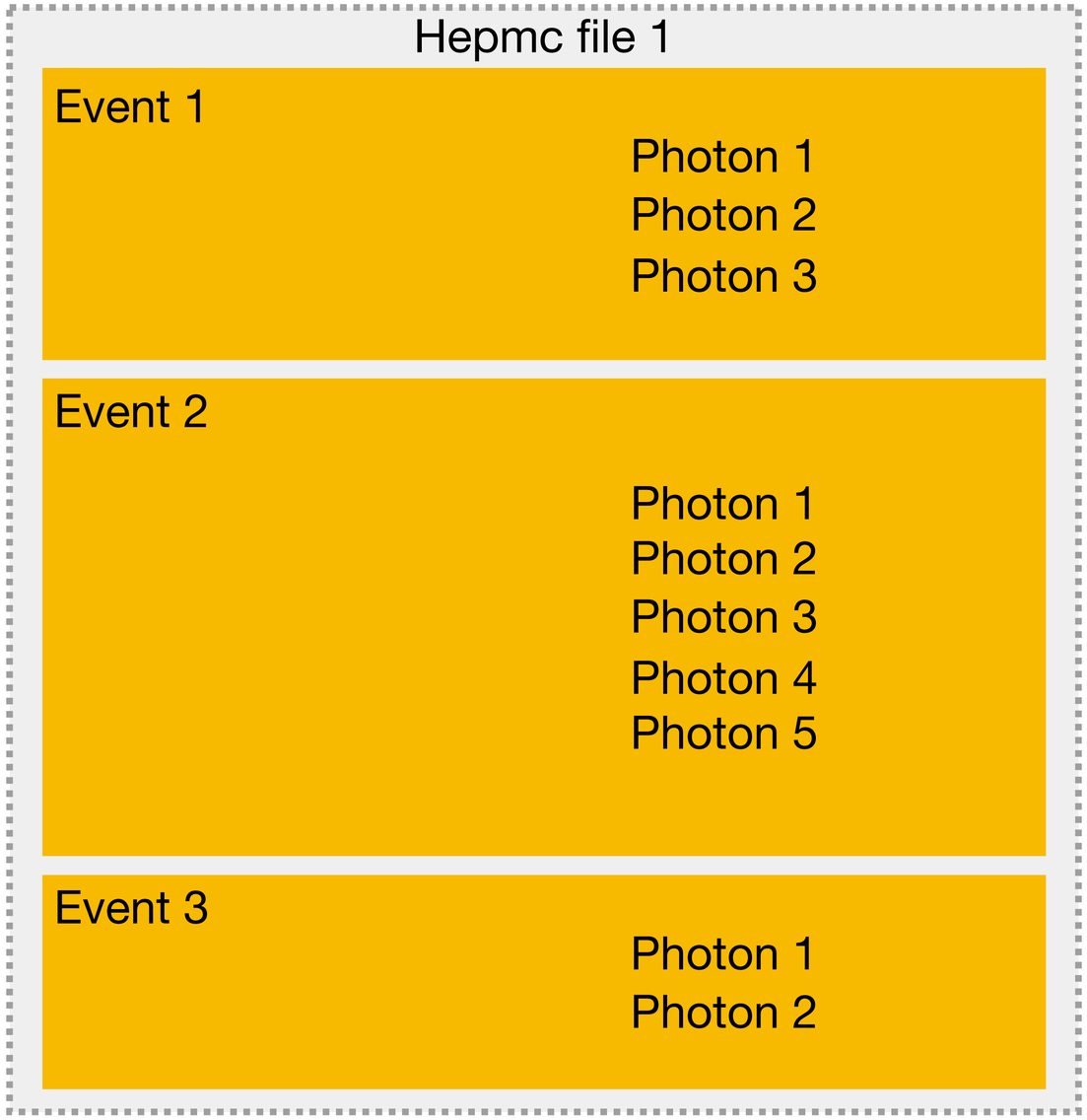
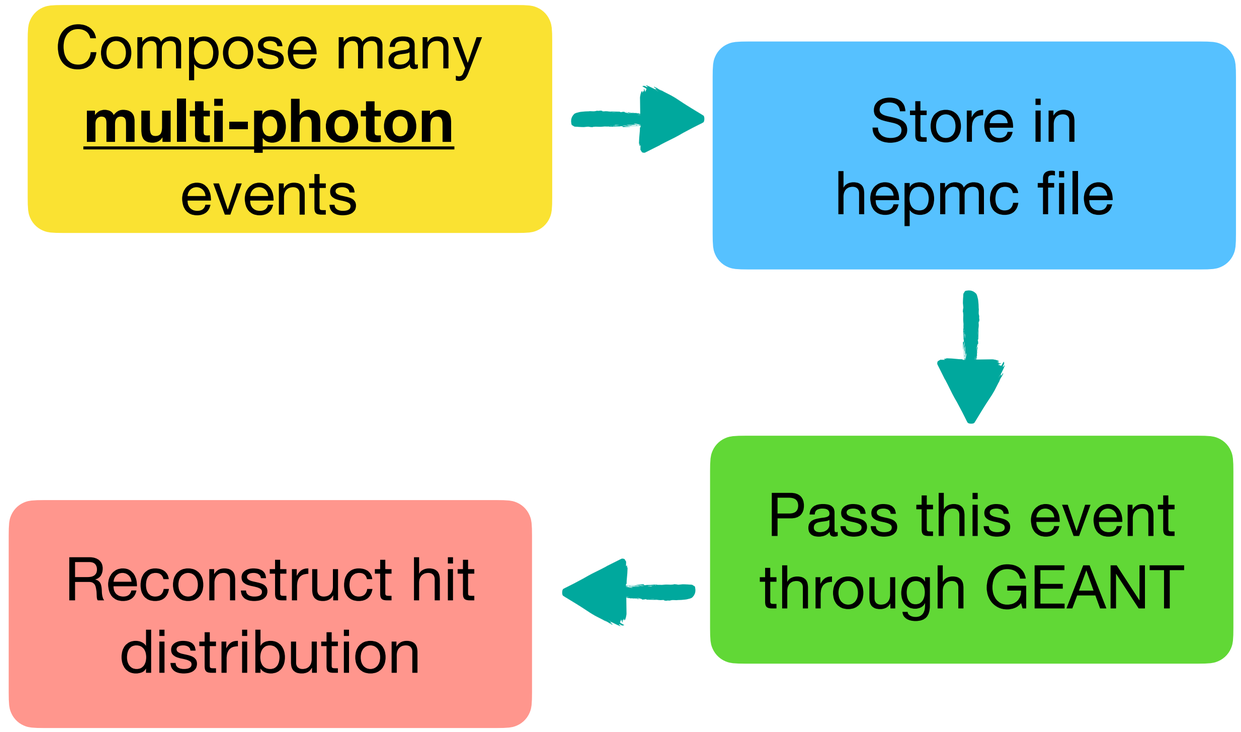
- SR background status

Geant propagation



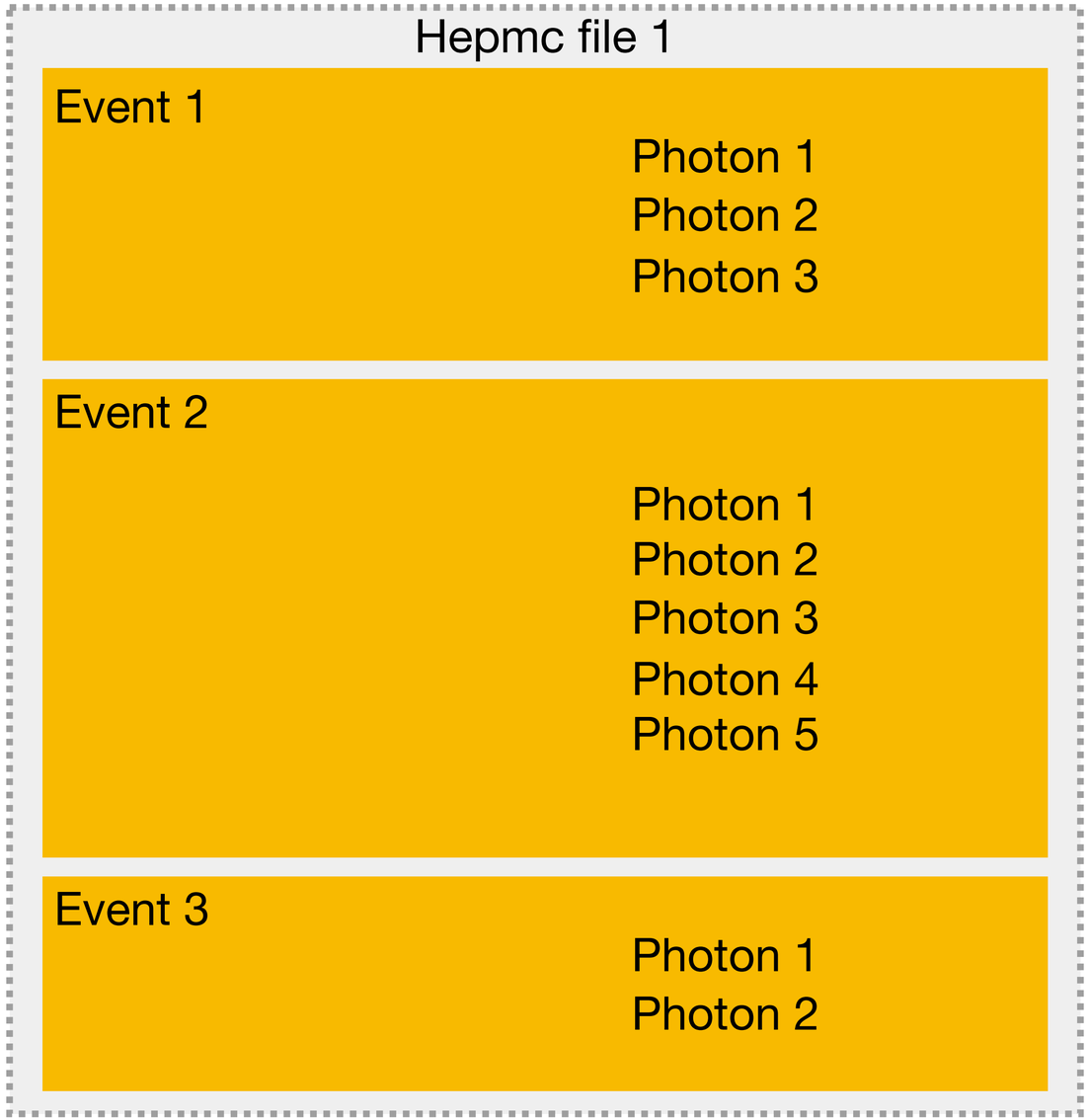


Issues:

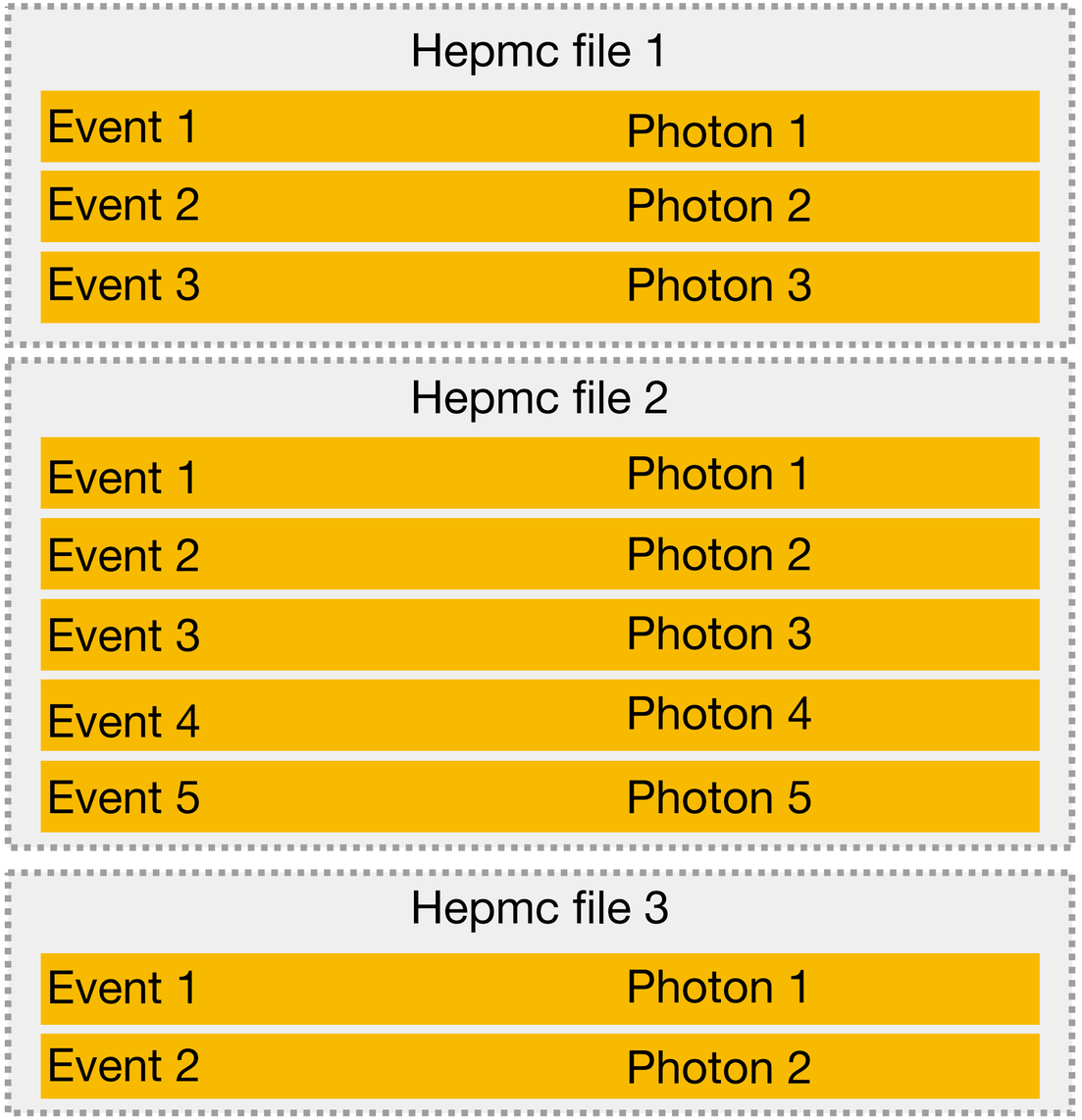
- DD4HEP hit distributions revealed that photon momentum vectors were detached from their respective vertices and launched from v = (0,0,0), which produces wrong topology

Workaround

Instead of:



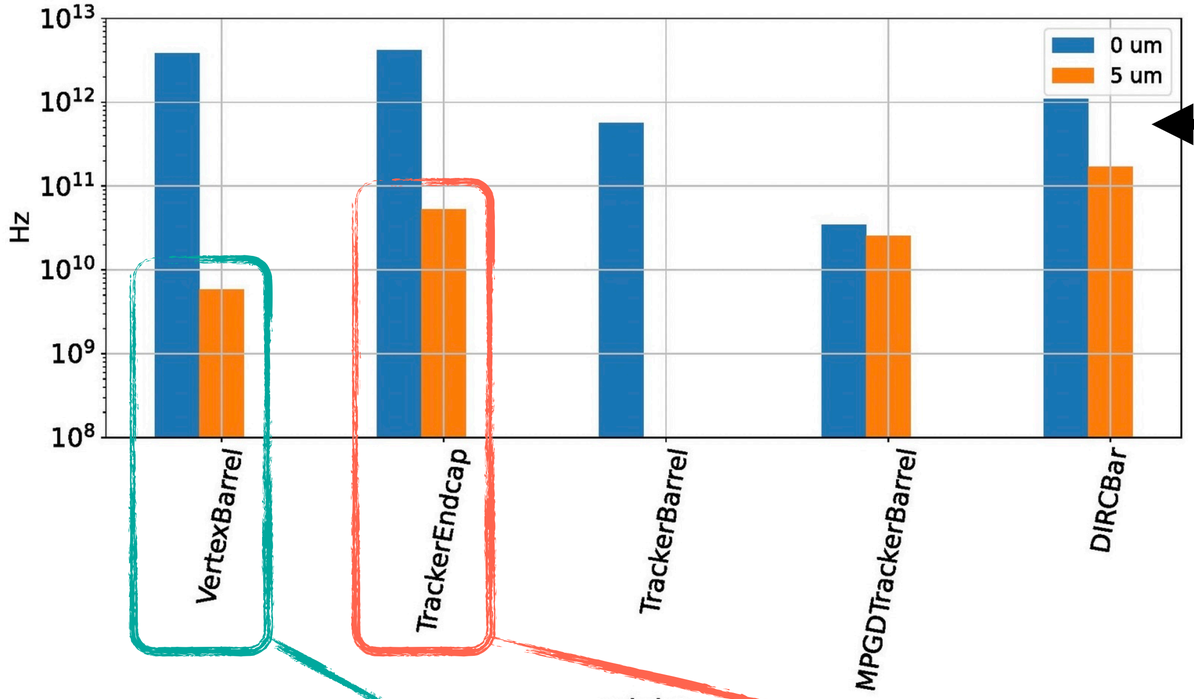
We use:



* Implemented by UC Berkeley undergrad B. Sterwerf

Comparison to previous results

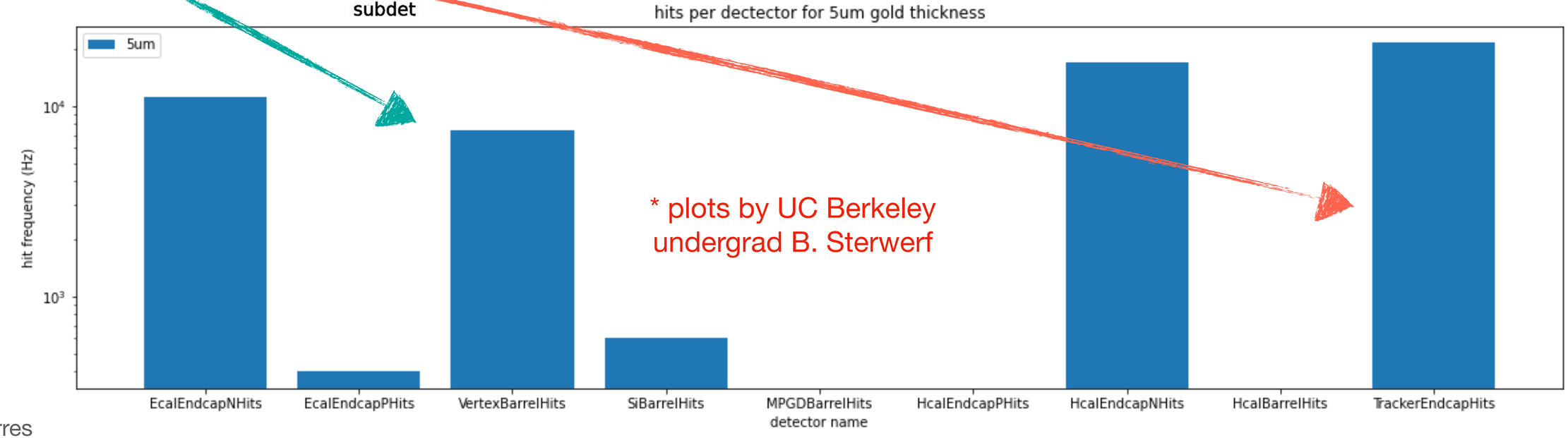
flux (for 2.5 mA electron beam of E = 10 GeV)



Old (biased) method in which we passed all photons through Geant only once and scaled the resulting contribution by the provided weight.

* Keep in mind the detector versions between these plots is different

Compare orange on top to blue on bottom plot



* plots by UC Berkeley undergrad B. Sterwerf

Comparison of the two methods

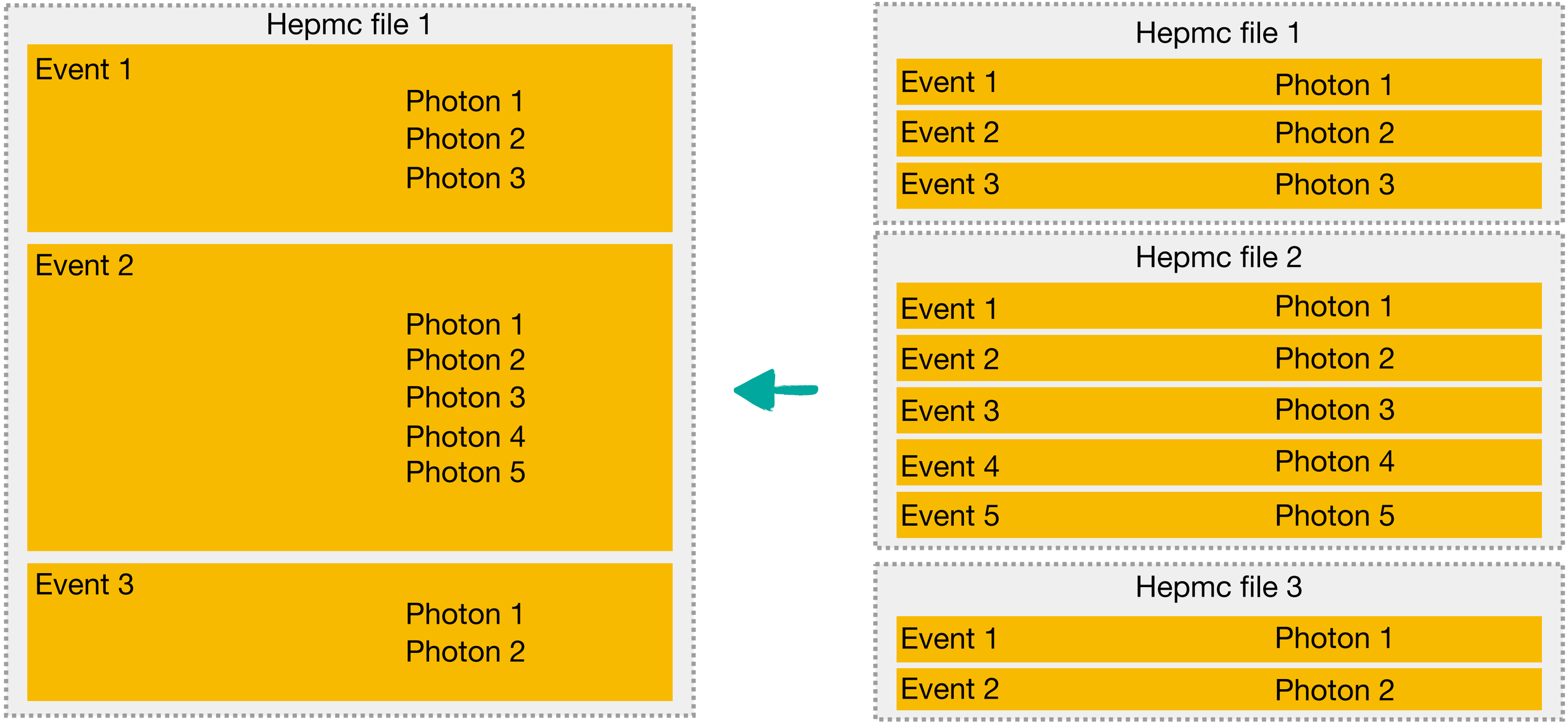
Initial method

- Simple
- Standalone
- Scalable
- Software-agnostic

Alternate method

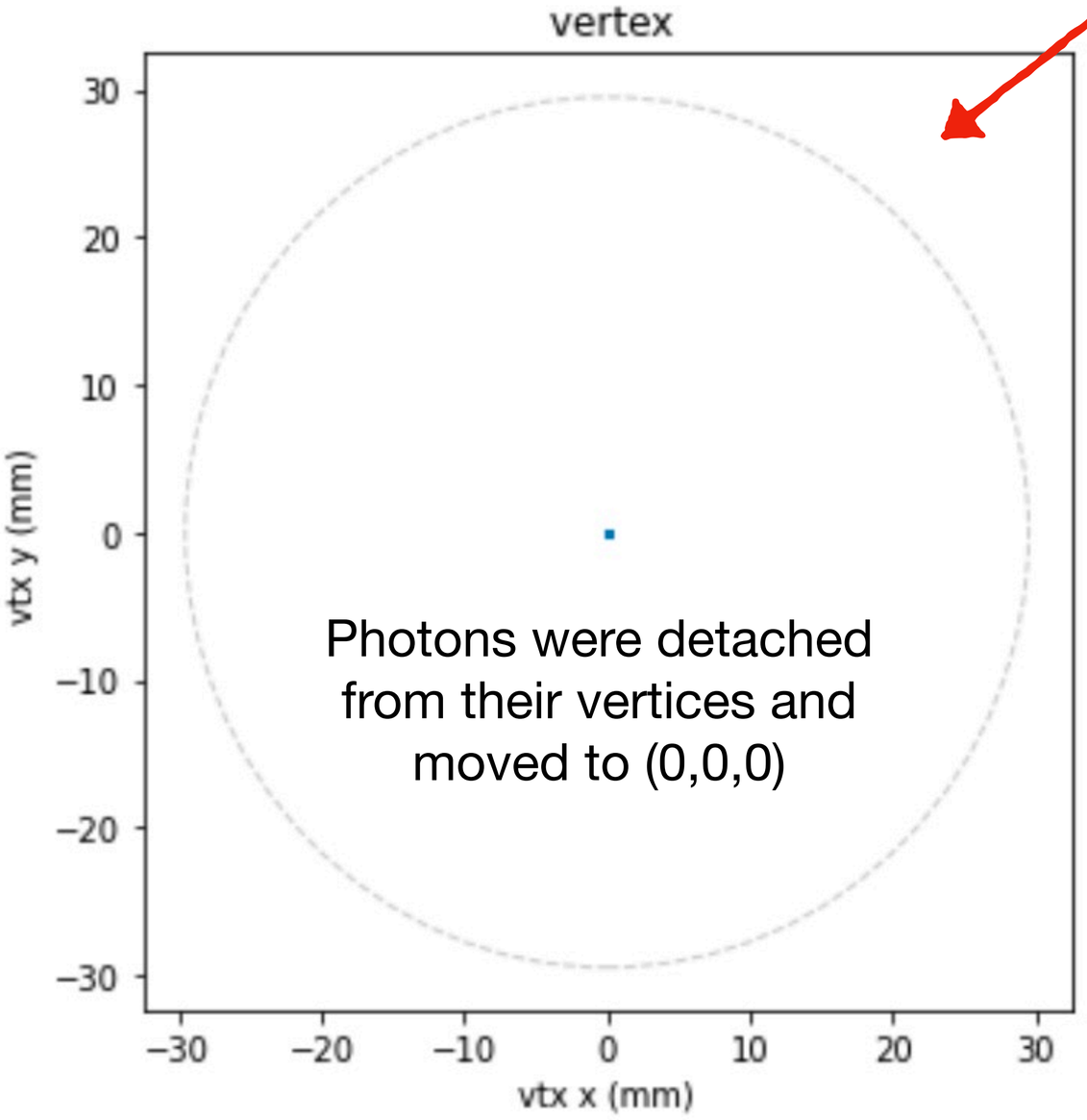
- Convoluted
- Significant processing of input photon files (bug prone)
- Not scalable
- DD4HEP specific
- Once hits are produced, cannot easily admix with signal and feed back for track reco

Can we go back now to the original method?

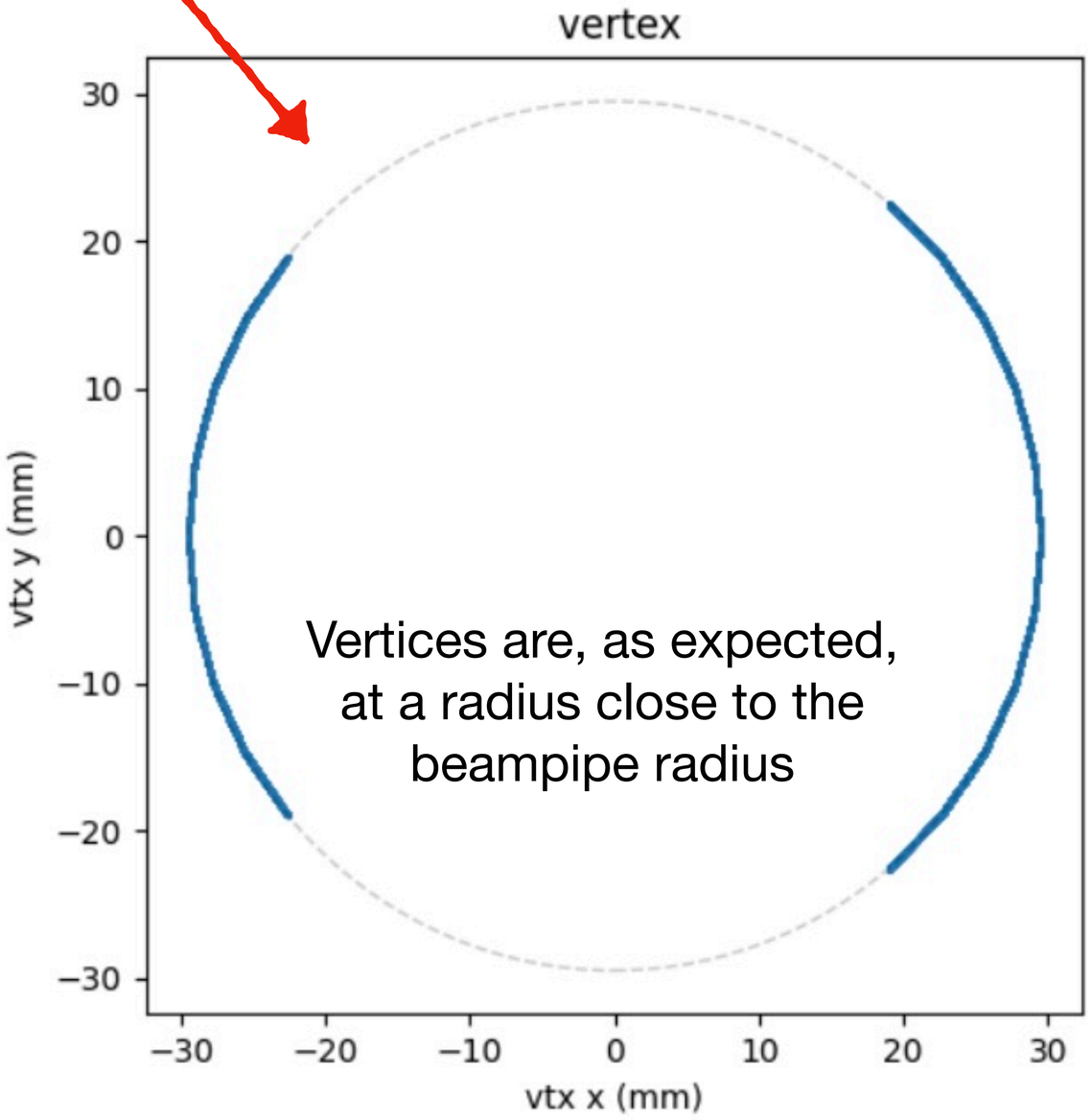


Is the vertex issue in DD4HEP fixed?

Vertex of photons **before** and **after** K. Kauder's fix

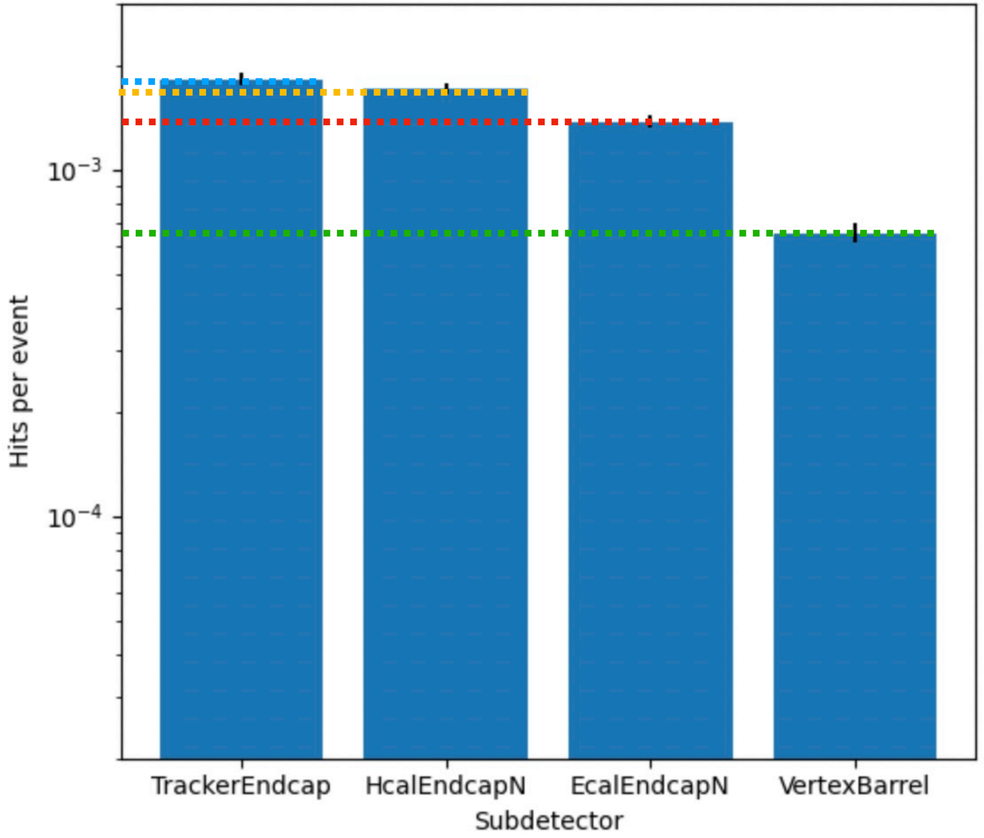


Photons were detached from their vertices and moved to (0,0,0)

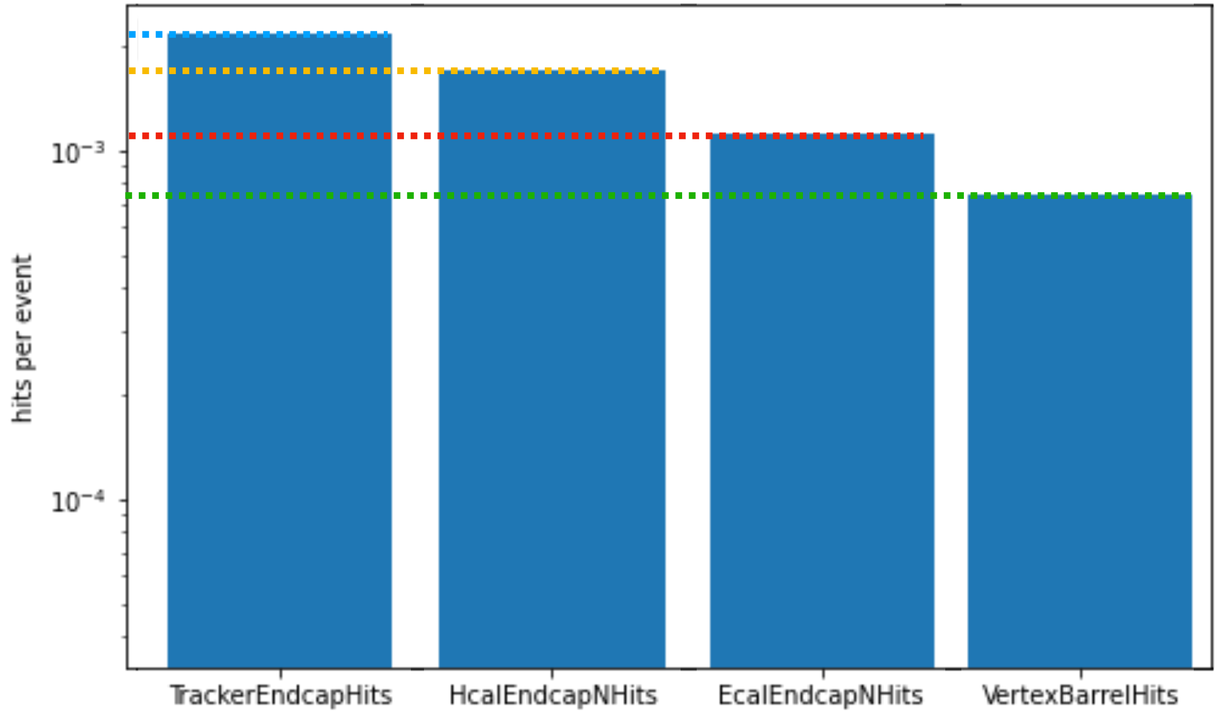


Vertices are, as expected, at a radius close to the beampipe radius

Comparison to Benjamen's results



* plots by UC Berkeley undergrad B. Sterwerf



flux (for 2.5 mA electron beam of E = 10 GeV)

100-ns-wide events

Old (better) method, new results

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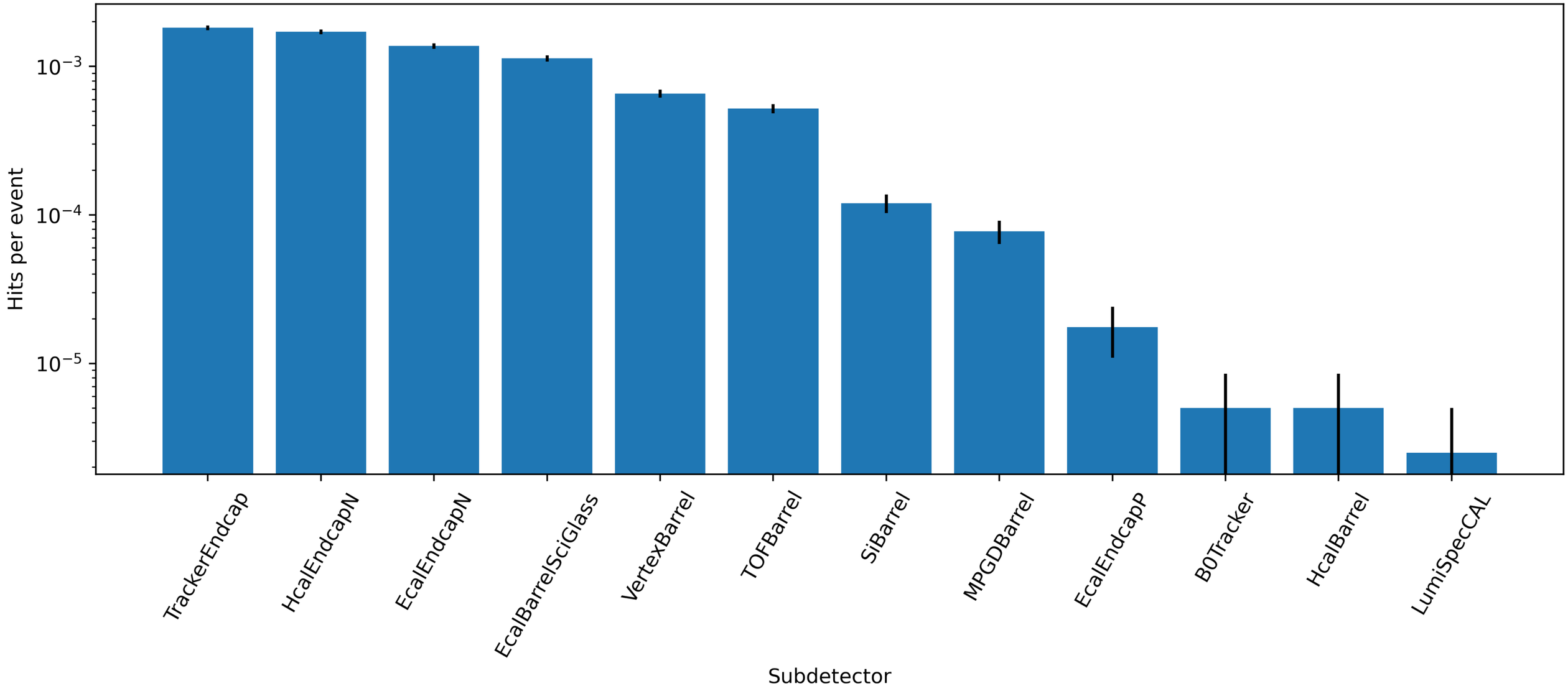

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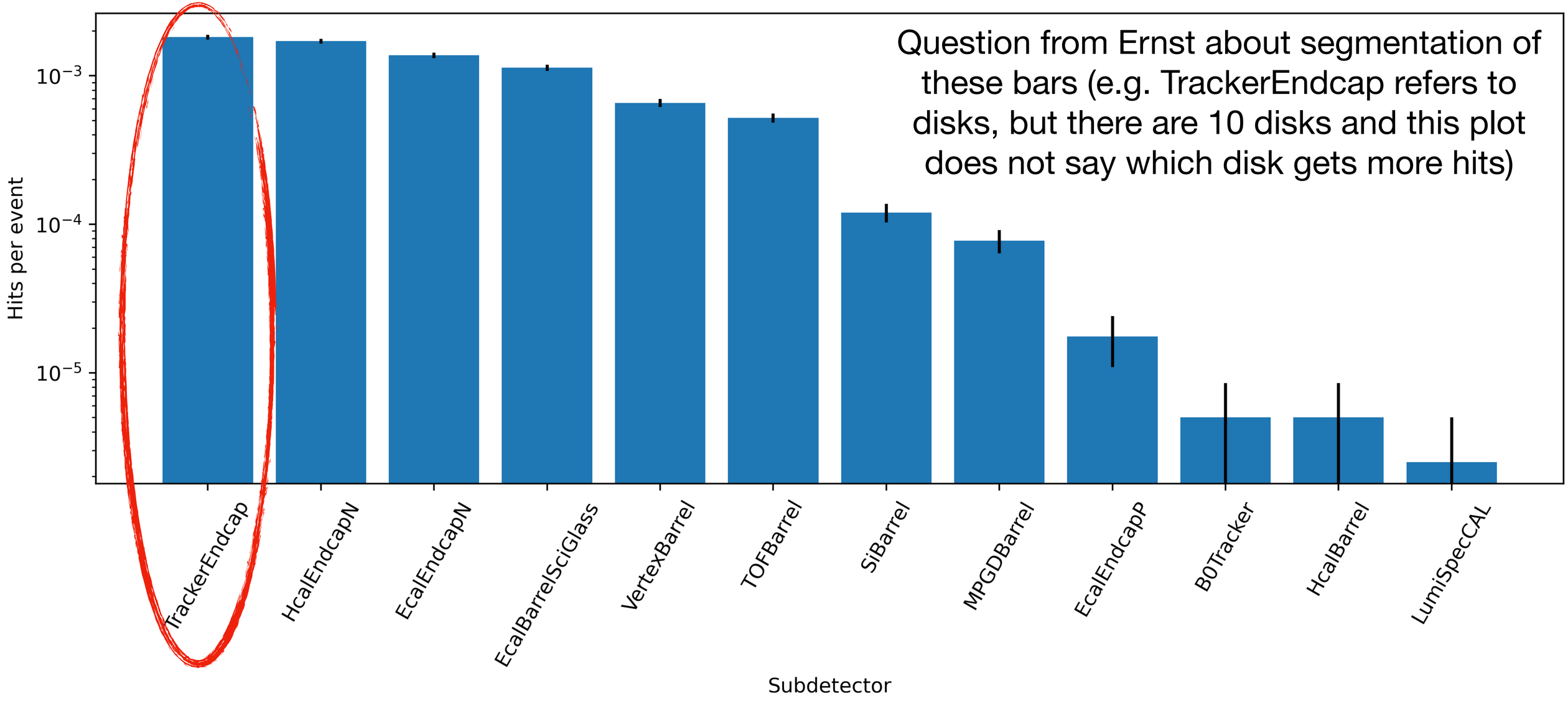
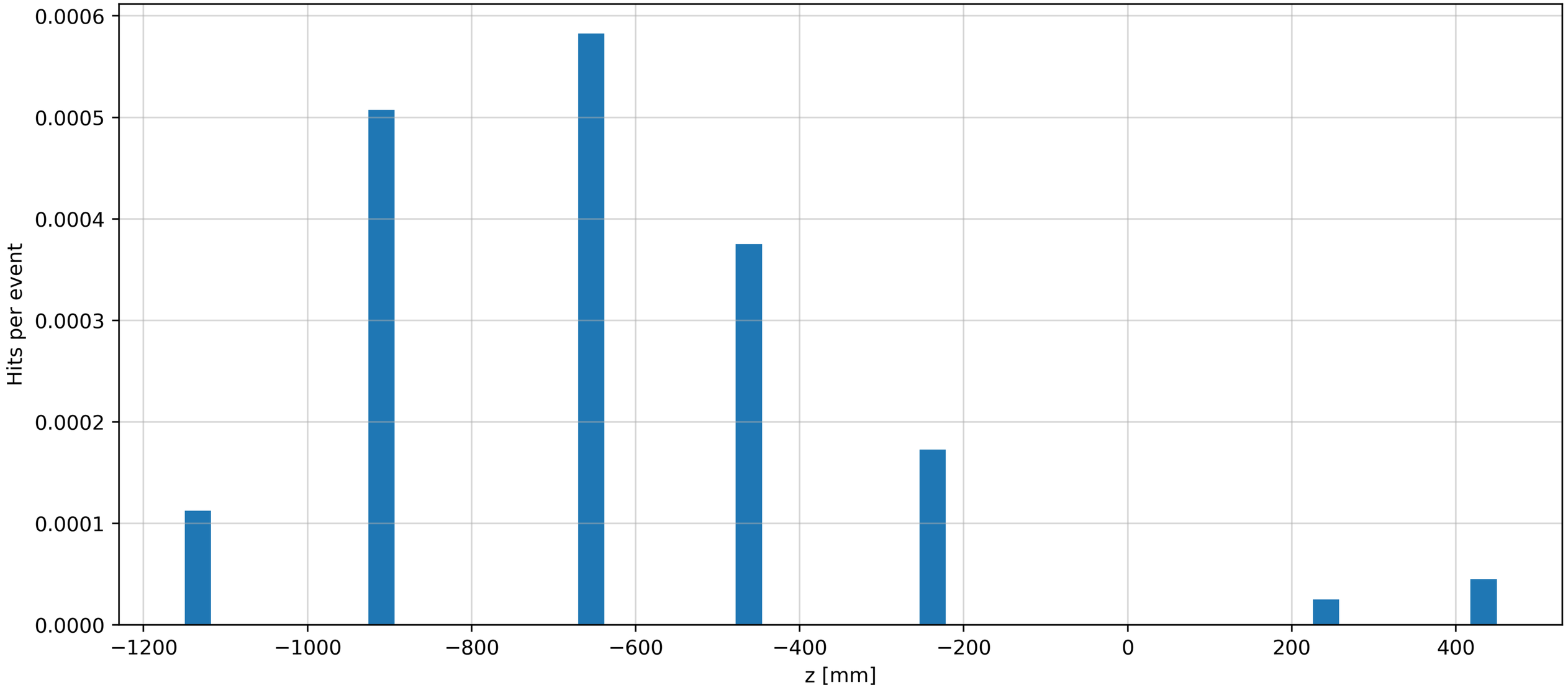


Hits in the tracker disks

flux (for 2.5 mA electron beam of E = 10 GeV)

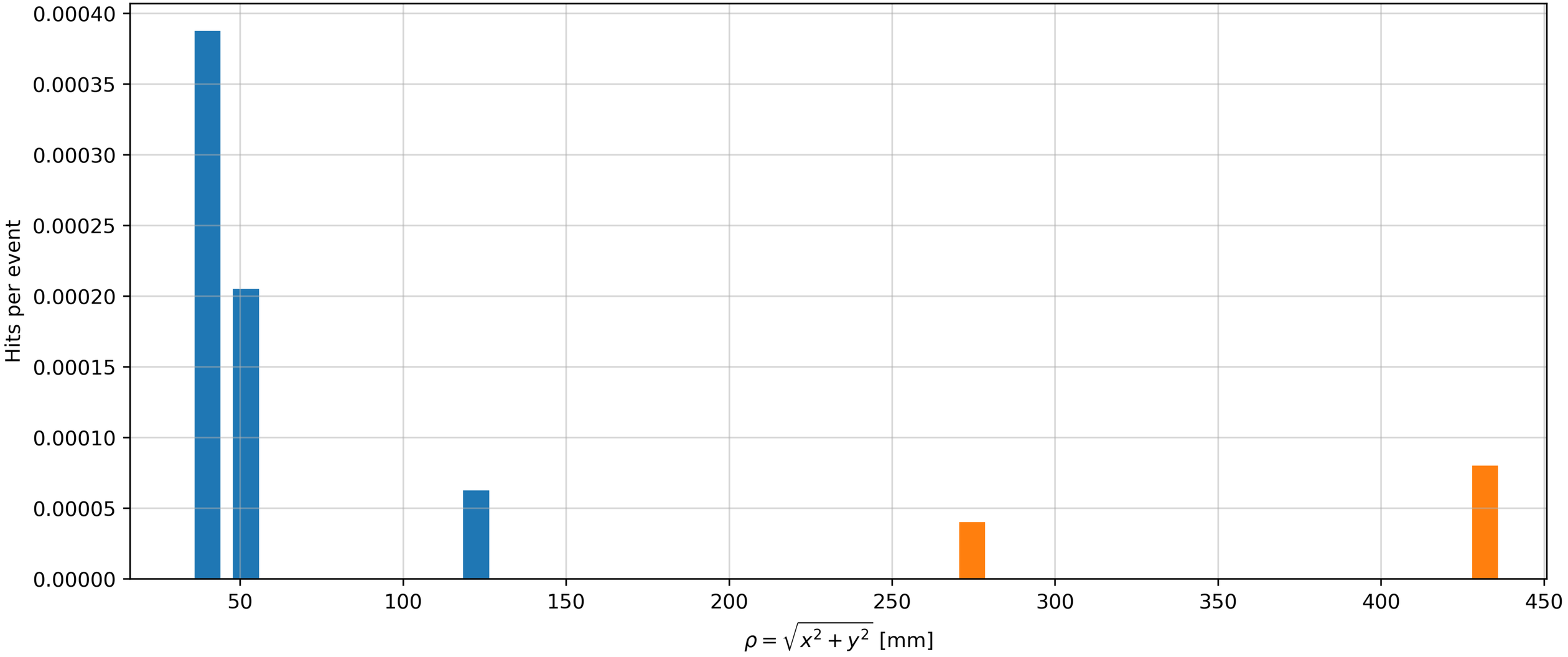
100-ns-wide events



Hits in the tracker barrel

flux (for 2.5 mA electron beam of E = 10 GeV)

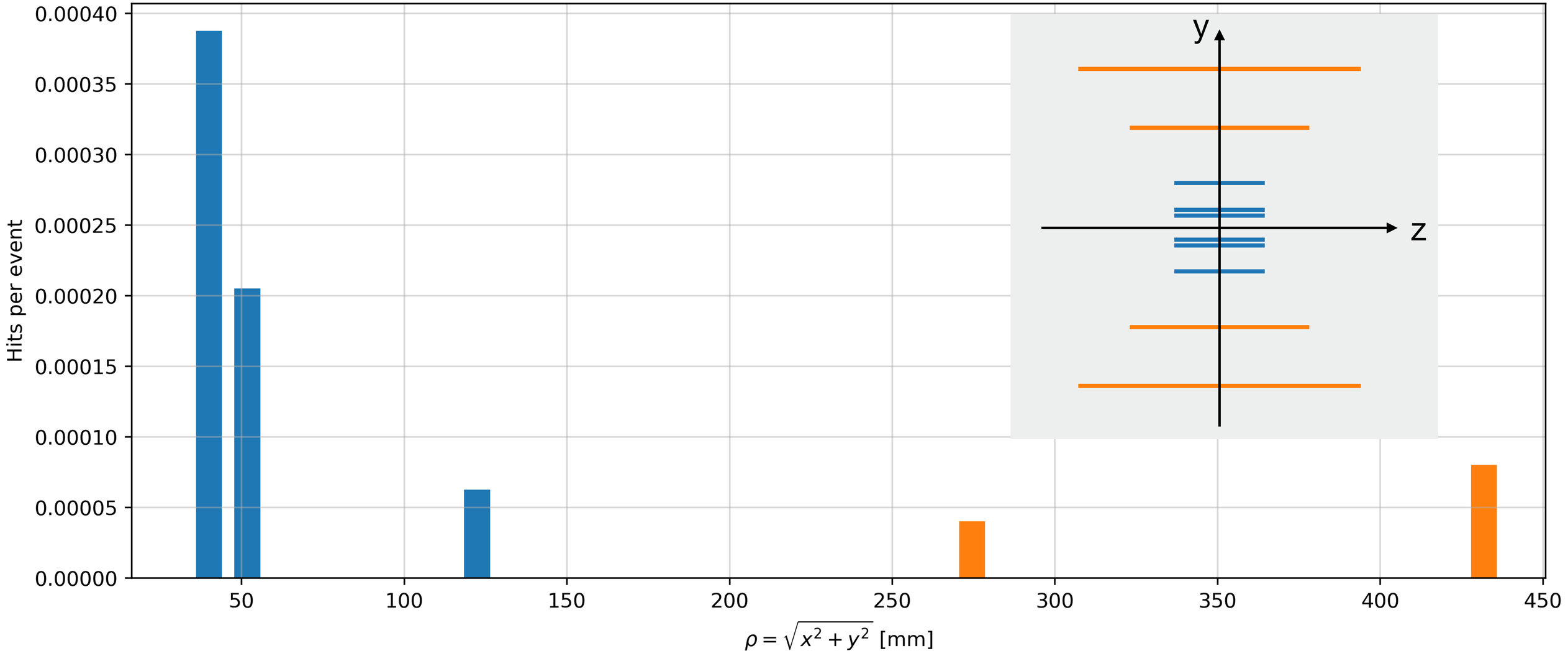
100-ns-wide events



Hits in the tracker barrel

flux (for 2.5 mA electron beam of E = 10 GeV)

100-ns-wide events



SR event generator

https://github.com/reynier0611/SR_event_generator

1. Download csv file stored here. You can get this file following one of the two methods below:

```
wget -O combined_data.csv 'https://drive.google.com/uc?export=download&id=1XX78_qeuoMK8xhuOB5QgbU
```

or

```
curl -L 'https://drive.google.com/uc?export=download&id=1XX78_qeuoMK8xhuOB5QgbUyye7Lv_xPg&confirm
```

2. Create a yaml configuration file (e.g. `config.yaml`) with the following information:
   - `input_single_photons`: path to csv file downloaded in step 1.
   - `n_events`: number of events to be generated.
   - `integration_window`: time window that will define one event.
   - `seed`: random seed for reproducibility. Set to 0 to leave the seed unconstrained.
3. Run the generator as:

```
python3 sr_generator.py --configFile config.yaml
```

Path forward

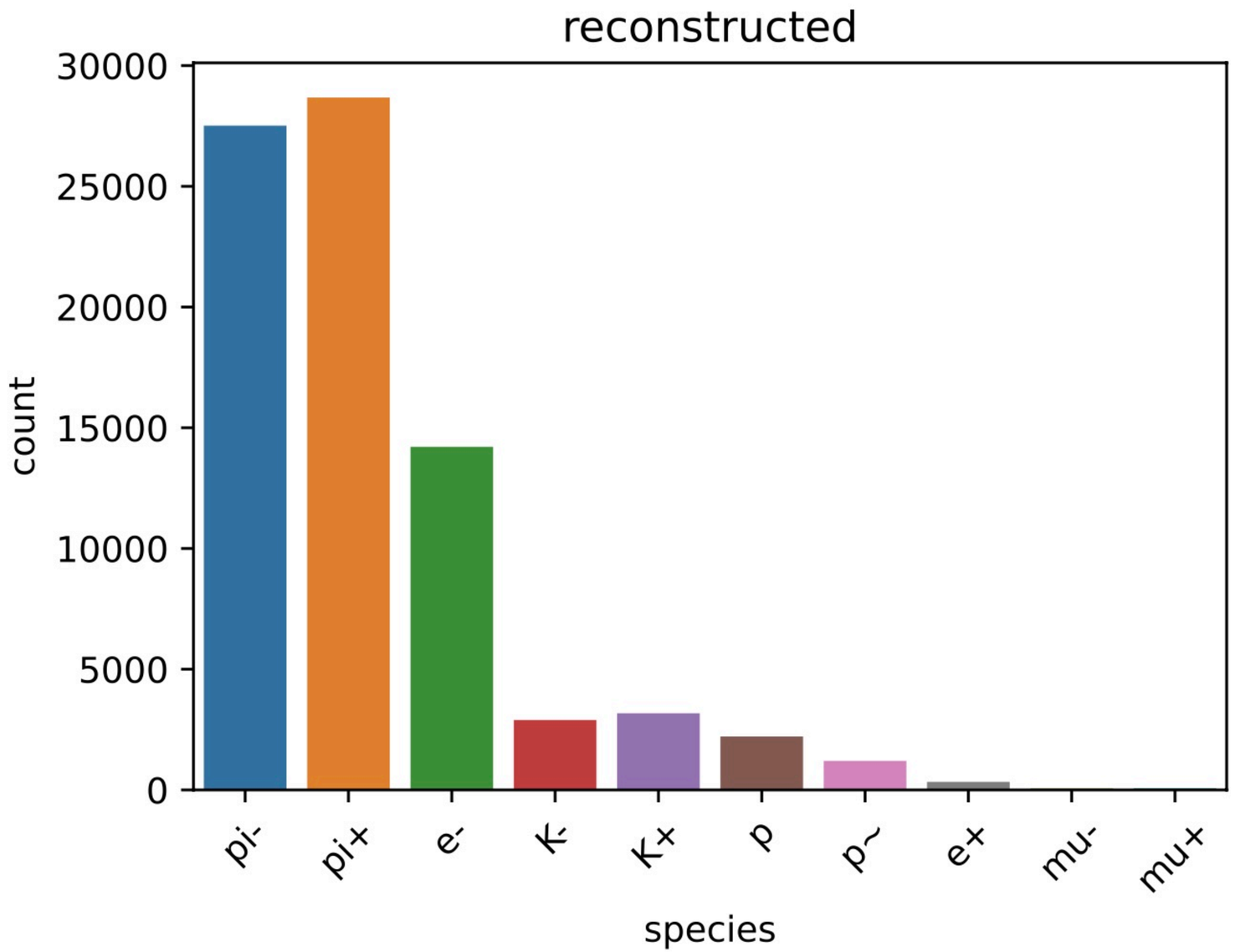
Now we can produce SR hit files that are in the right format for DD4HEP

Need to admix these with DIS events to then, e.g. run track reconstruction on the combined sample with and without SR hits to see effect

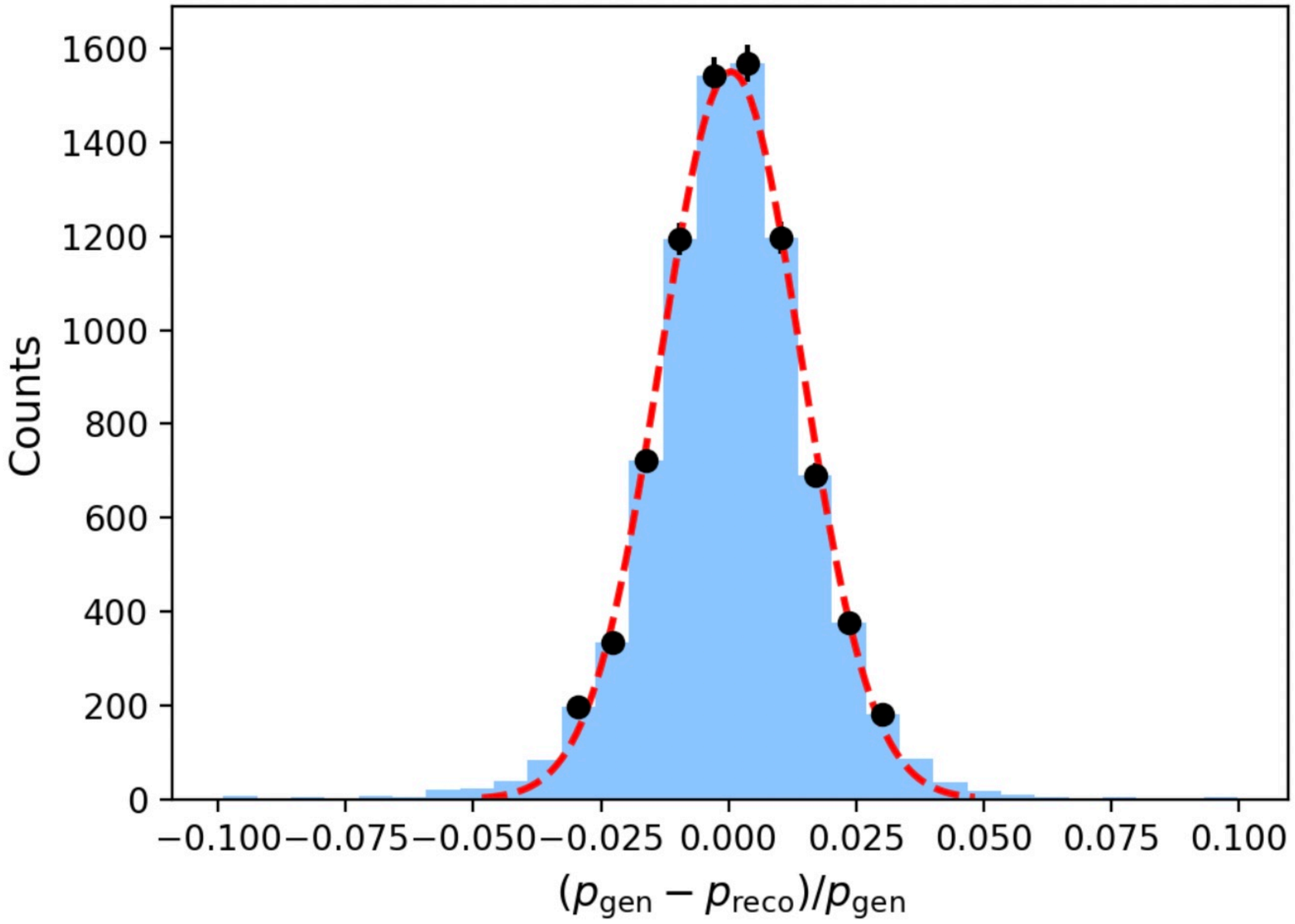
Kolja Kauder is actively working on implementing this capability in DD4HEP

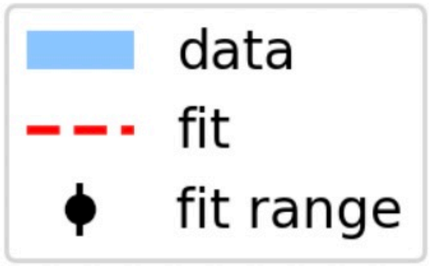
Backup

Reconstructed species



Fits within +/- 2 sigma





pi+

$2 < p < 3$ GeV/c

$2 < \eta < 2.5$

$\mu = 0.00051 \pm 0.00036$

$\sigma = 0.01381 \pm 0.00032$