



EIC TOF study

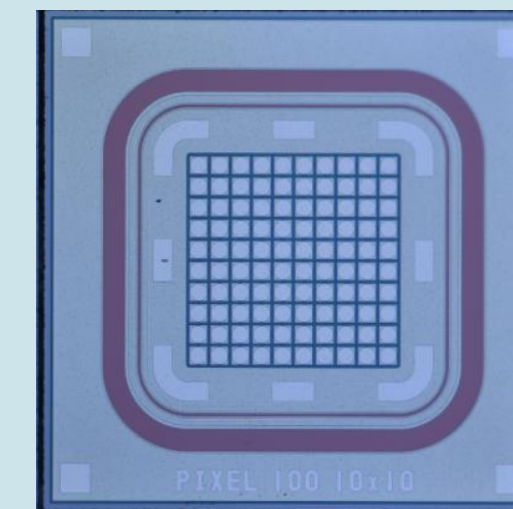
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EIC eRD112 meeting
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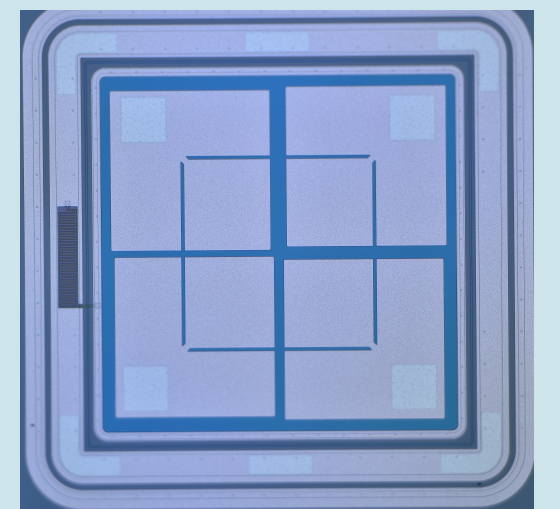
Motivation

- The performance required by the Barrel and Endcap TOF
 - Find the best AC-LGAD segment size
- AC-LGAD development status
 - Developed by BNL and KEK (with HPK) to use at HL-LHC ATLAS
 - Fine granularity and hard radiation tolerance (10^{15-16} n_{eq}/cm² @ 10^{35} cm²s⁻¹)
 - Pixel: 40x40 μm² on 1x1 mm² chip
 - Pad: 500x500 μm² on 3x3 mm² chip
 - Strip: 40x1000 μm² on 3x10 mm² chip
- Proposed TOF at EIC
 - Barrel type: R ~ 636 mm, $-1.4 < \eta < 1.4$
 - Endcap type: z ~ 1915 mm, 1925 mm, R_{min} ~ 66 mm, R_{max} ~ 665 mm
 - Expected required radiation hardness: 10^{10} n_{eq}/cm² @ 10^{34} cm²s⁻¹
 - Segmentation size: ? ← This presentation

Pixel type



Pad type



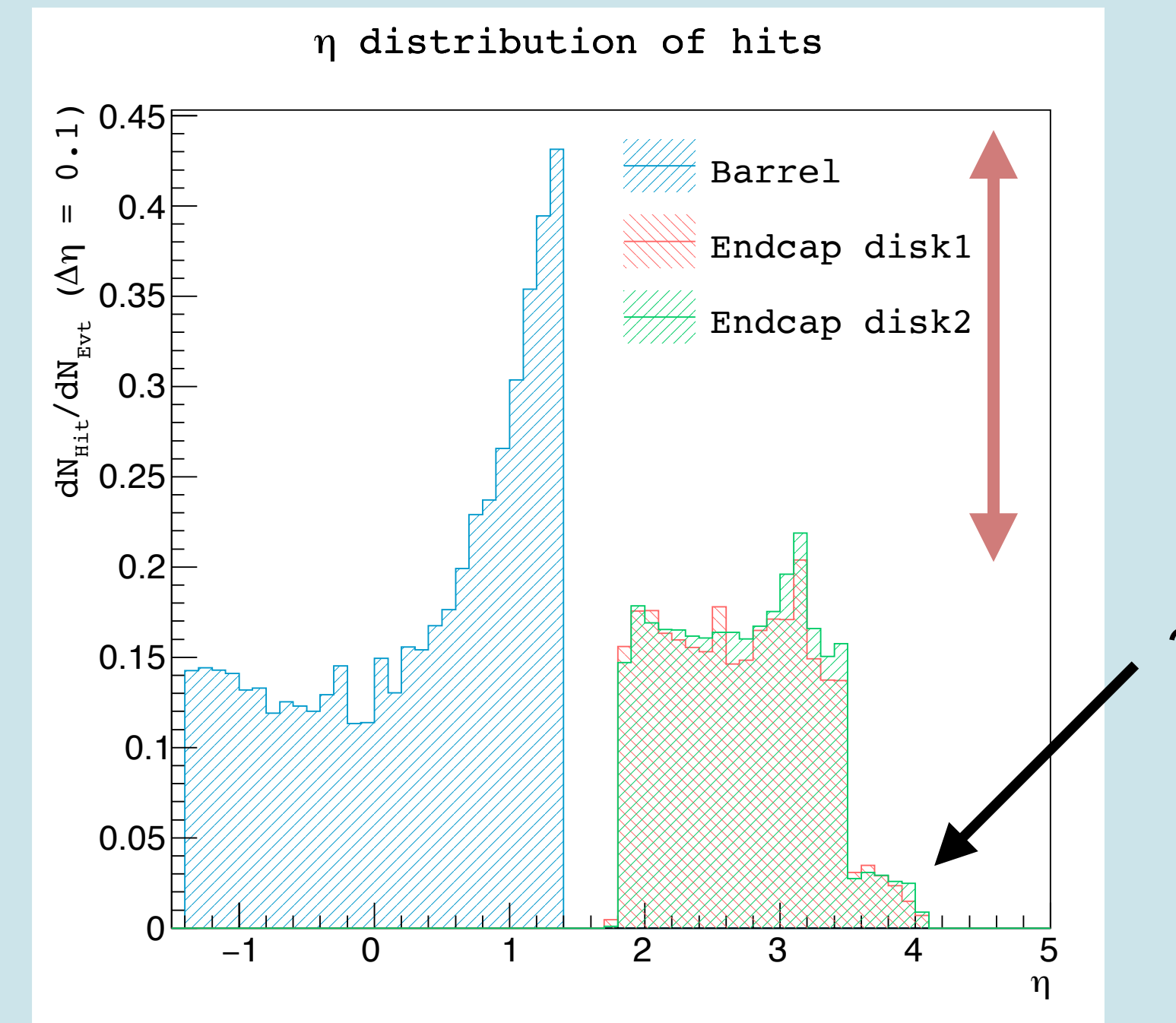
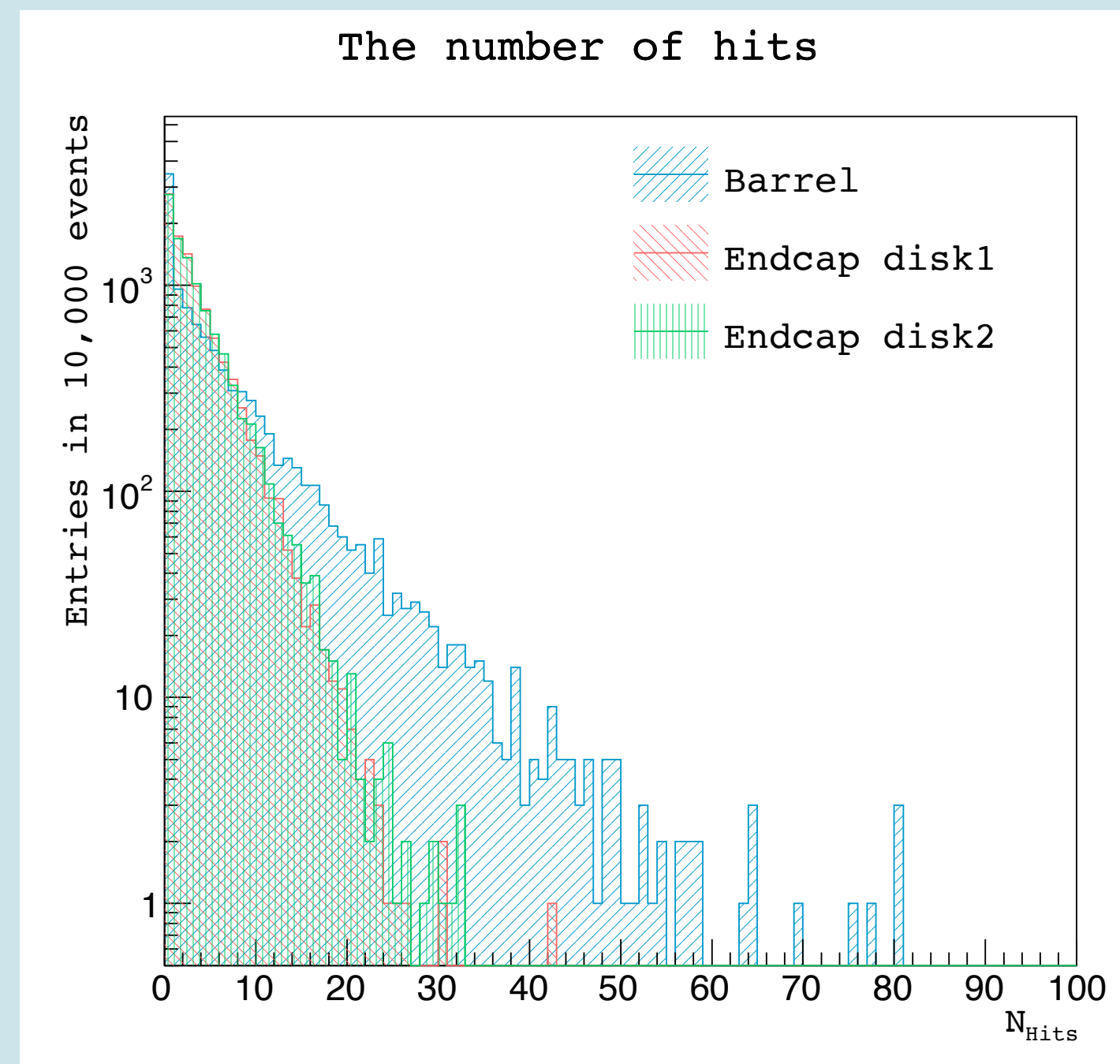
Strip type



Simulation condition

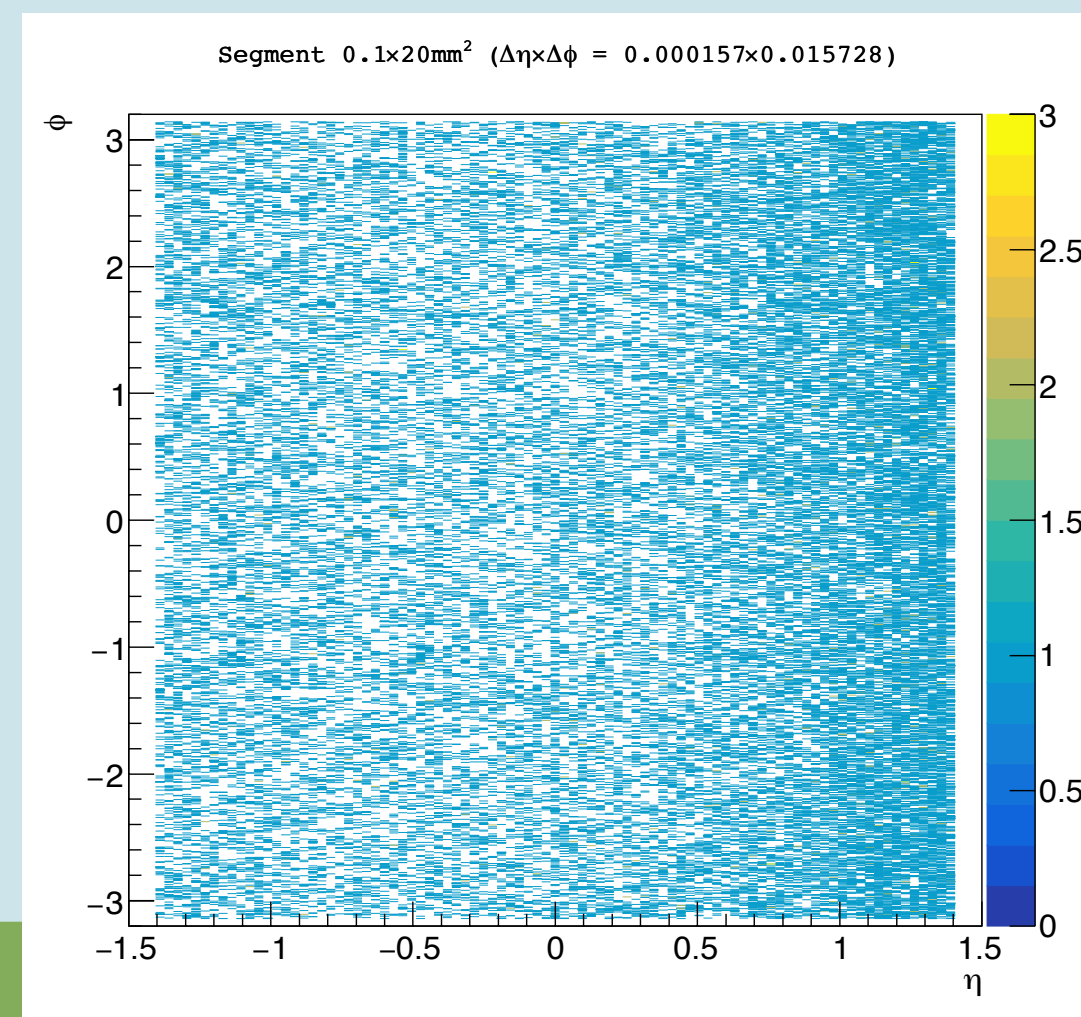
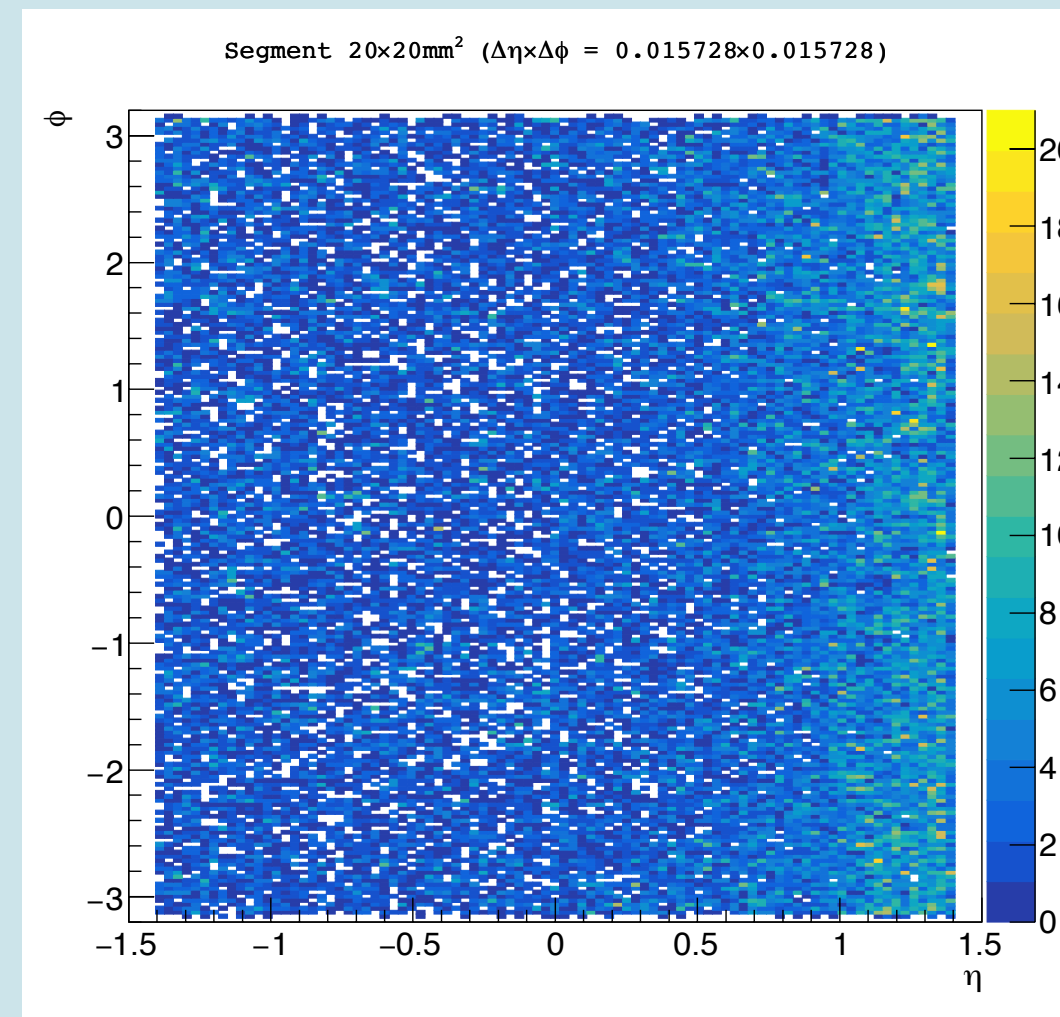
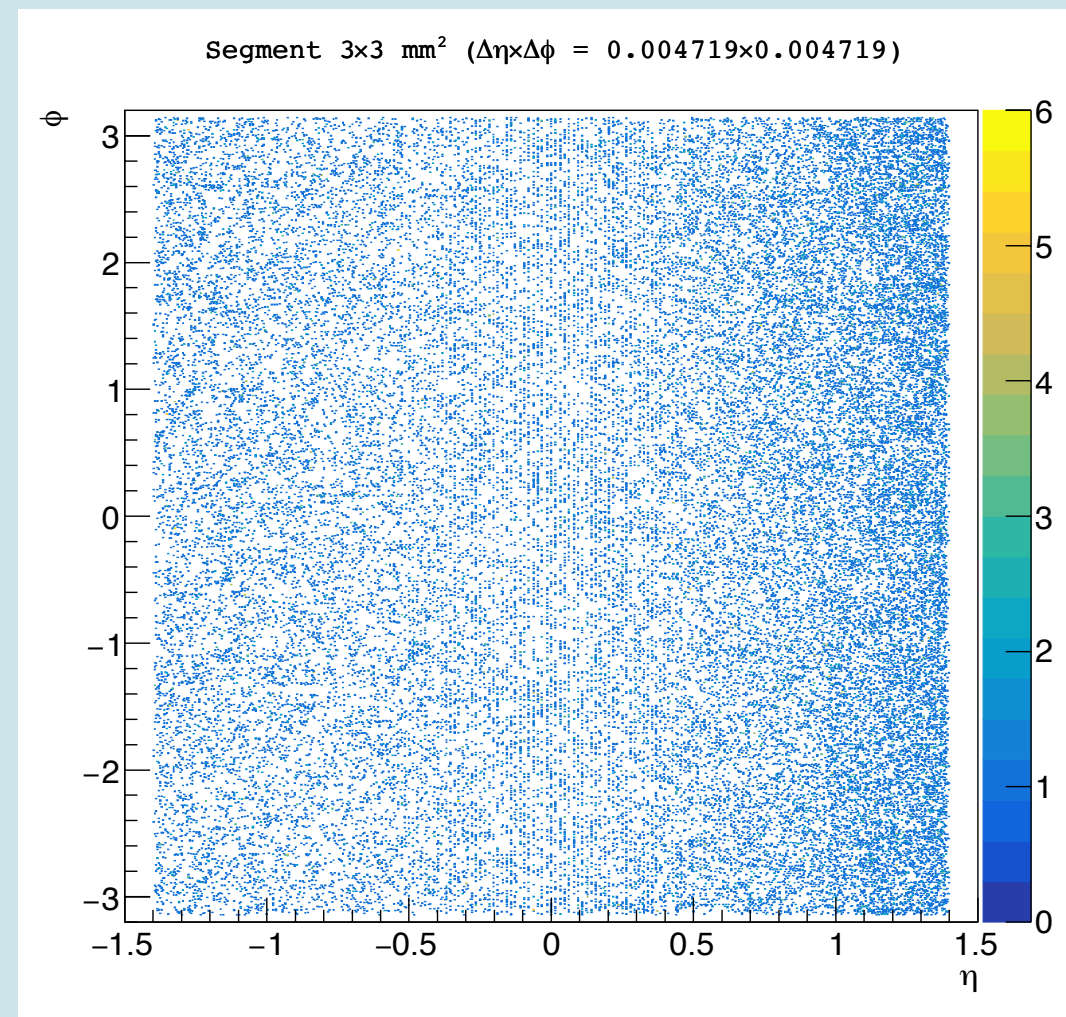
- Detector response simulation
 - EPIC detector (based on DD4Hep): <https://github.com/eic/epic>
- Data reconstruction
 - EICRecon: <https://github.com/eic/ElCrecon>
- Generated event
 - Pythia8 NC DIS $Q^2 > 1 \text{ GeV}^2$ in ep (18GeV electron + 275GeV proton beam) collisions x 10k events (HepMC data archived in S3)
- Installed detectors
 - All detectors except for the forward detectors and Barrel-HCal
 - The minimum hit decision granularity of TOF is 100um

The number of hits of TOF



- The number of mean hits of Barrel-TOF per one event is 5.2 (51719 hits/10k evts)
- The number of mean hits of Endcap-TOF disk1@1915mm (disk2@1925) per one event is 2.8 (3.0)
- 35% and 28% of events have no hits on Barrel-TOF and Endcap-TOF, respectively
- The maximum hit achieves around 80 on Barrel-TOF

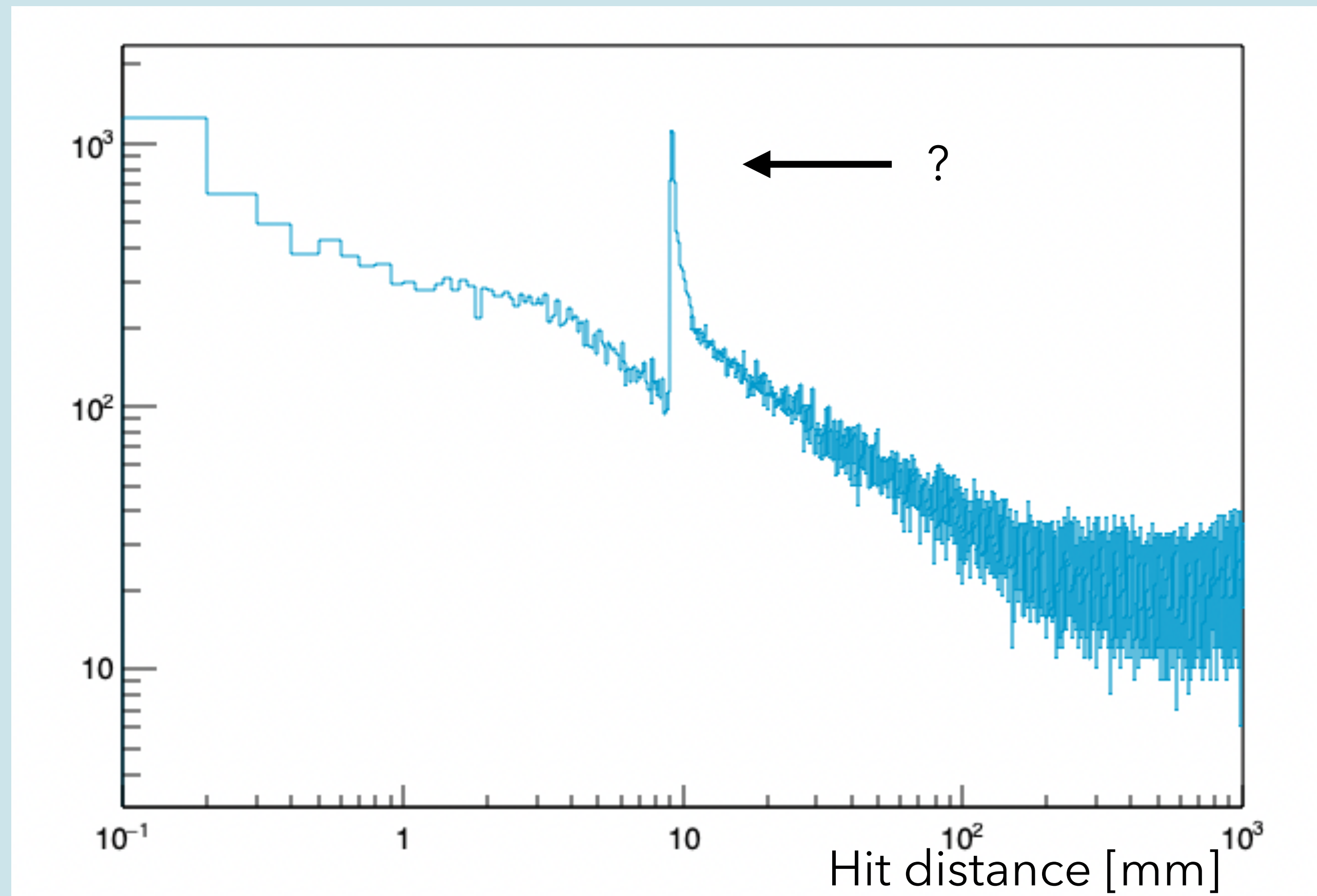
Barrel-TOF occupancy



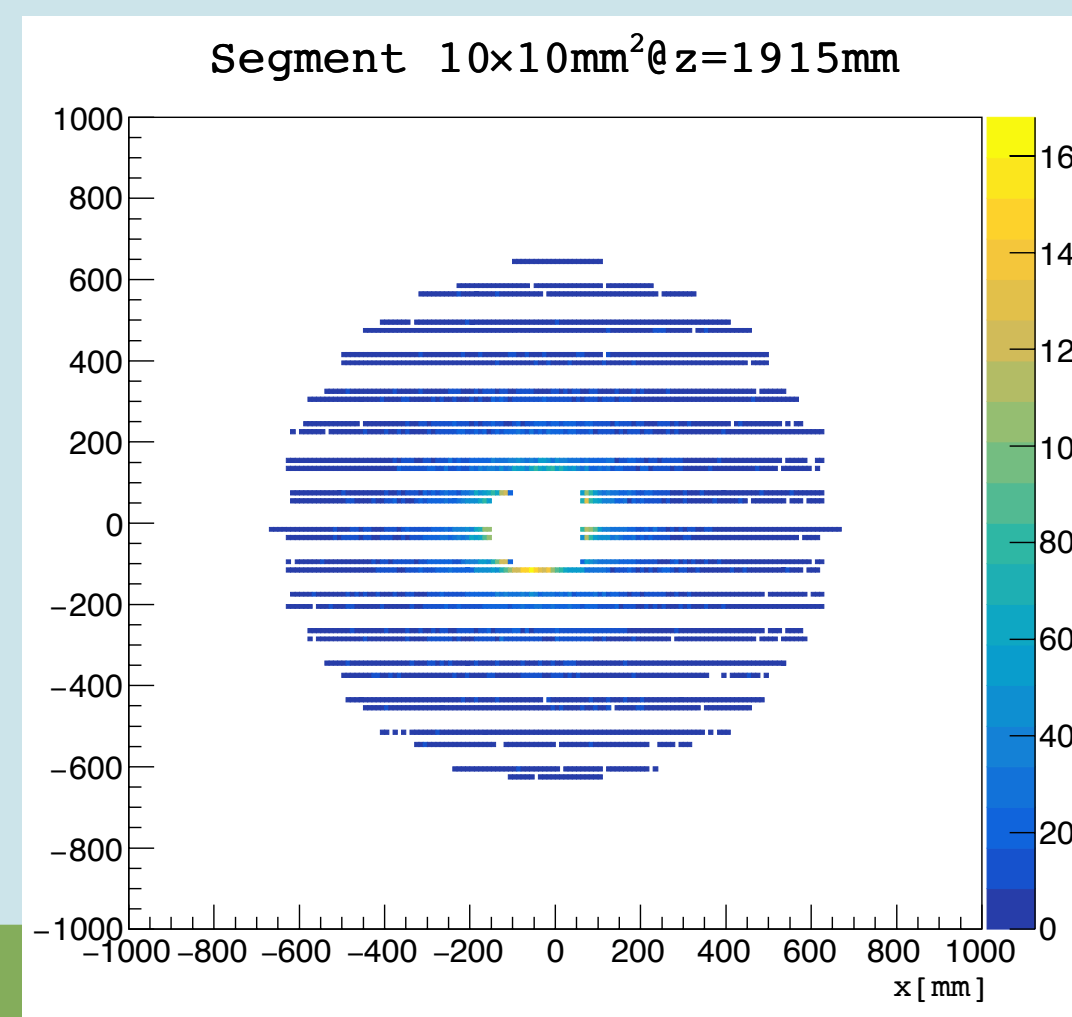
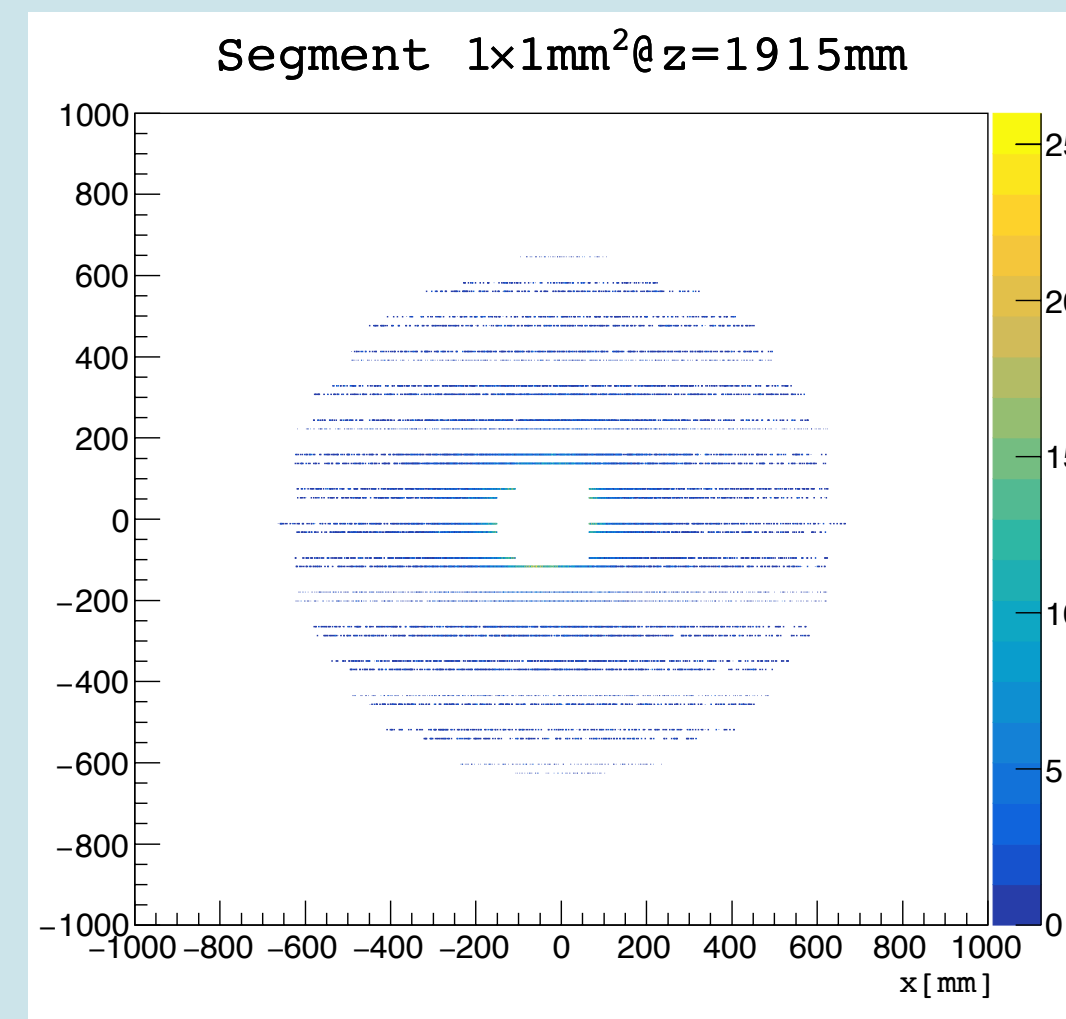
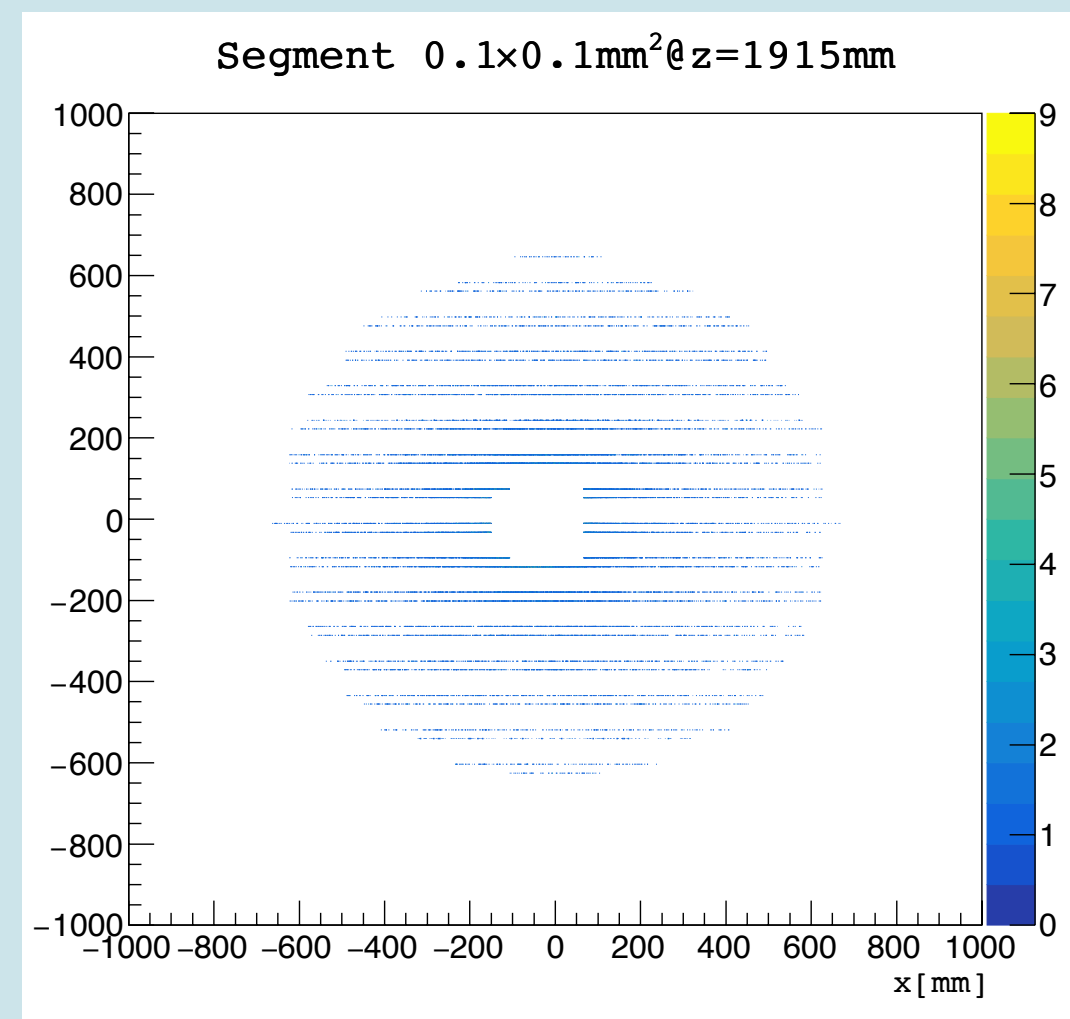
- The maximum multiple-hit segment
 - $3 \times 3 \text{ mm}^2$ (pad-type) : 5×10^{-4}
 - $20 \times 20 \text{ mm}^2$ (pad-type) : 2×10^{-3}
 - $0.1 \times 20 \text{ mm}^2$ (strip-type) : 3×10^{-4}

Barrel-TOF

Distance between hits



Endcap TOF occupancy



- The maximum multiple-hit segment
 - $0.1 \times 0.1 \text{ mm}^2$ (pad-type) : 9×10^{-4}
 - $1 \times 1 \text{ mm}^2$ (pad-type) : 2.5×10^{-3}
 - $10 \times 10 \text{ mm}^2$ (pad-type) : 1.7×10^{-2}



Summary



- I have started to check Barrel and Endcap TOF performance
- In NC DIS $Q^2 > 1 \text{ GeV}^2$ in ep collisions
 - The number of hits on Barrel (Endcap) TOF per event is ~ 5 (~ 3)
 - 35% (28%) of events have no hit on Barrel TOF (Endcap TOF)
 - The number of maximum hits is ~ 80 (~ 30) on Barrel TOF (Endcap TOF each disk)
- Occupancy of Barrel TOF
 - $3 \times 3 \text{ mm}^2$: $\sim 5 \times 10^{-4}$
 - $20 \times 20 \text{ mm}^2$: $\sim 2 \times 10^{-3}$
 - $0.1 \times 20 \text{ mm}^2$: $\sim 5 \times 10^{-4}$
- Occupancy of Endcap TOF
 - $0.1 \times 0.1 \text{ mm}^2$: $\sim 9 \times 10^{-4}$
 - $1 \times 1 \text{ mm}^2$: $\sim 2.5 \times 10^{-3}$
 - $10 \times 10 \text{ mm}^2$: $\sim 1.6 \times 10^{-2}$