

# Beam Background Challenges : Forward Ecal

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TIC Meeting

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Electron-Ion Collider



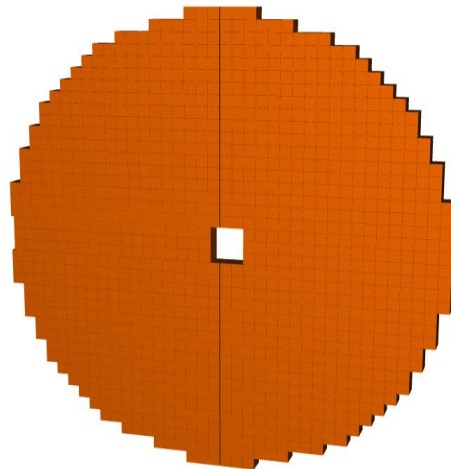
# Outline

- As of Feb 2026 simulation campaign, new forward Ecal geometry code is in place, matching current design with real segmentation
- Comparison of Feb 2026 simulation campaign (10 x 100) without and with Beam Background
- New Alex's radiation map
- <https://www.star.bnl.gov/~akio/epic/bg/index.html>

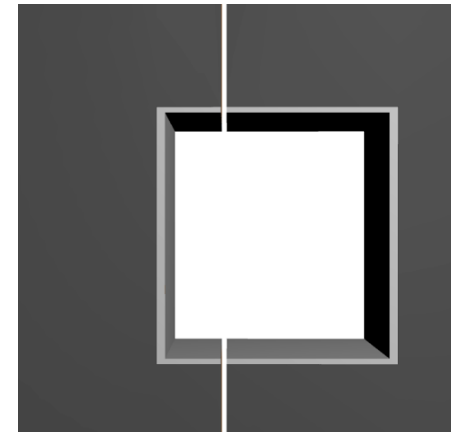
View with cover and back plate



View of 1145 Blocks  
(4x4 towers in a block)

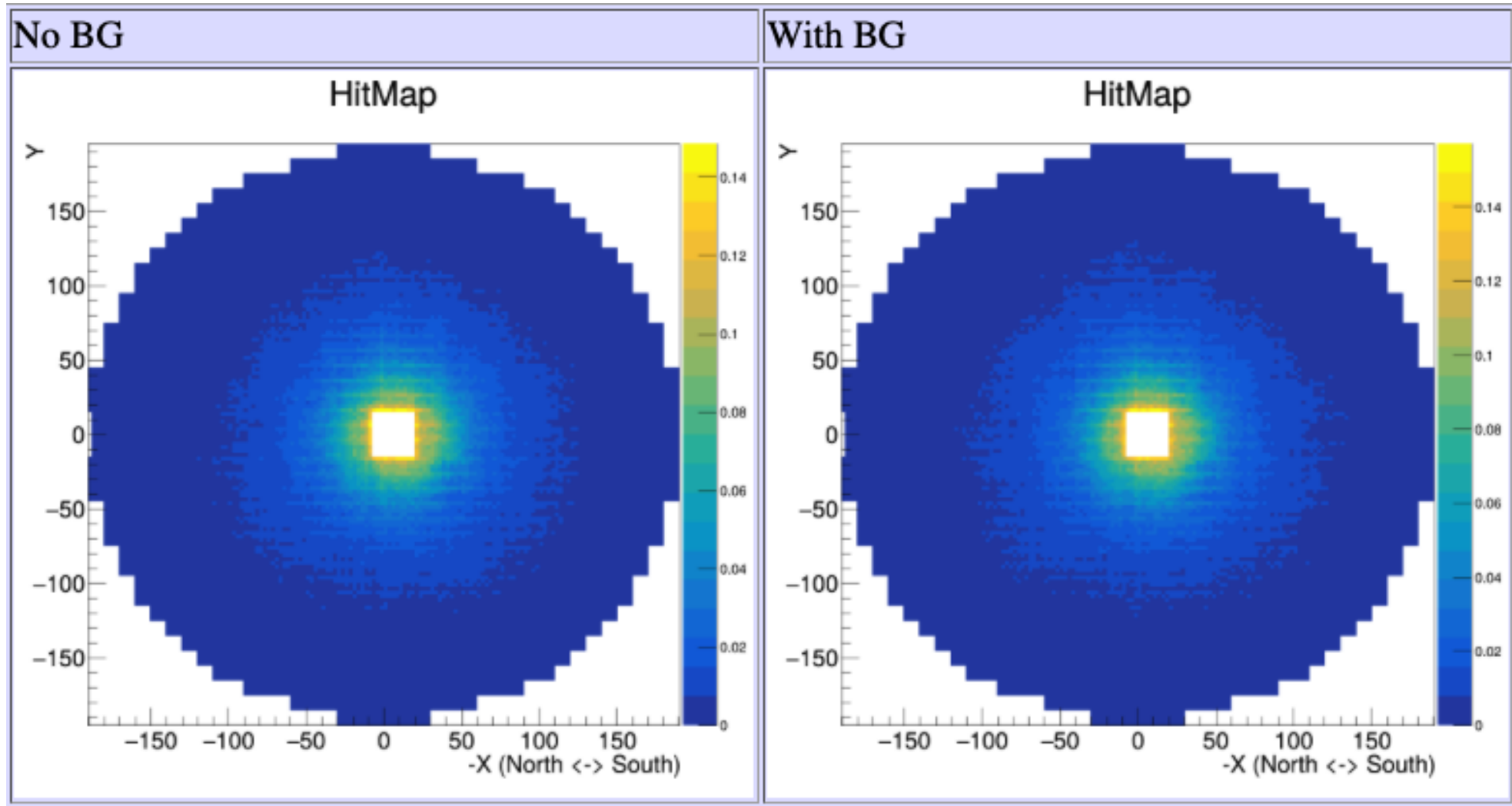


Steel Beampipe Protector



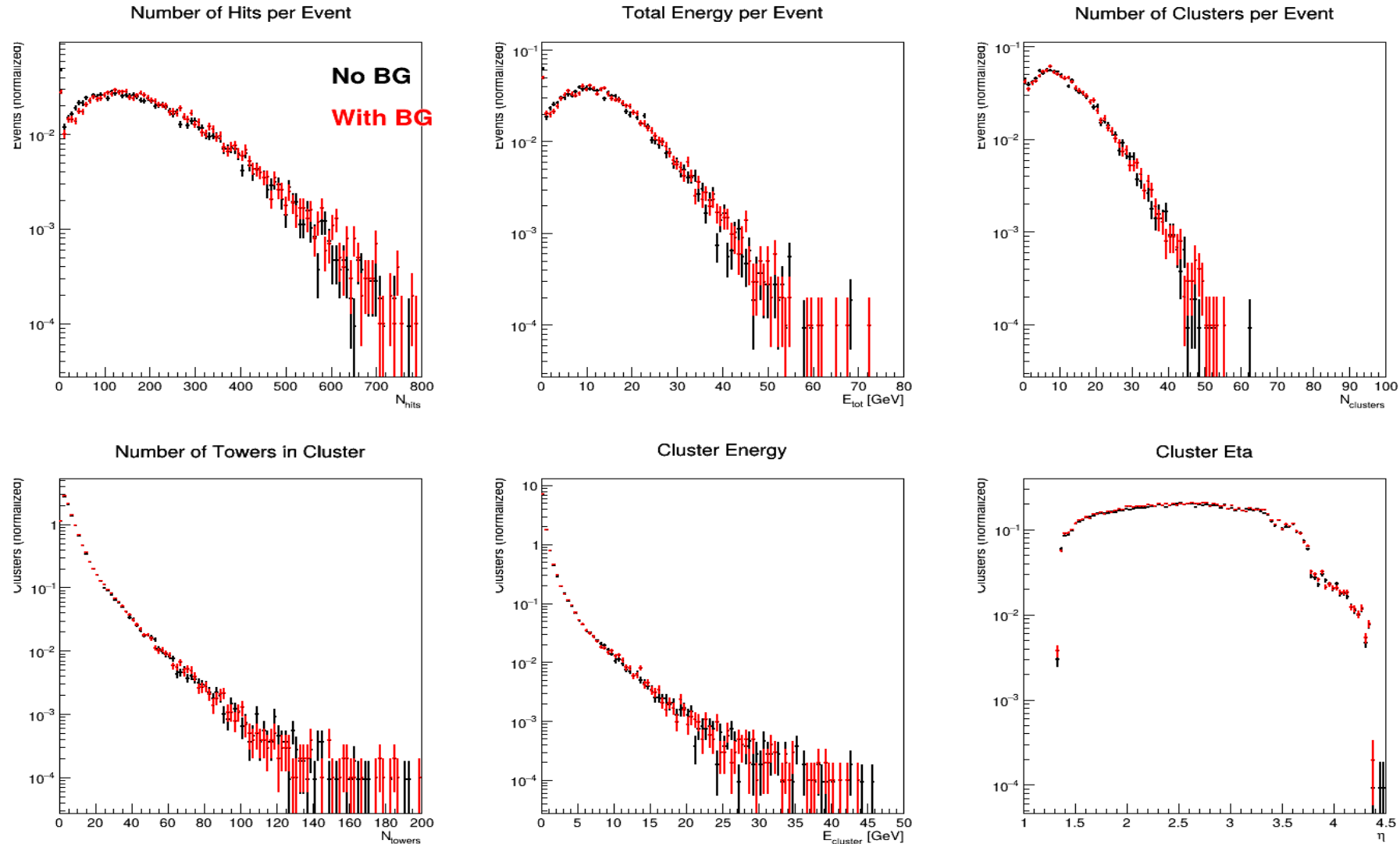
# With and Without Beam BG comparison : Hit Map

- Feb 2026 simulation campaign (10 x 100) without and with Beam Background



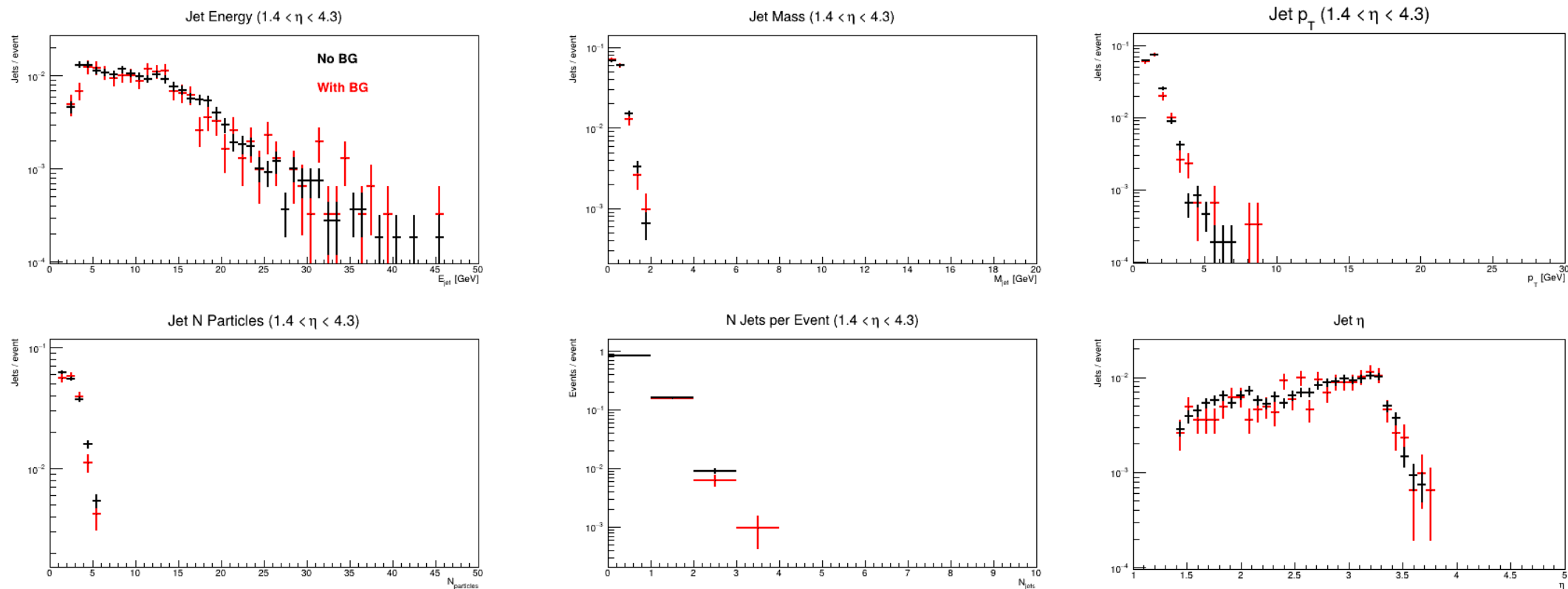
# With and Without Beam BG comparison : Hit and Clusters

- Feb 2026 simulation campaign (10 x 100) without and with Beam Background



# With and Without Beam BG comparison : Neutral Jets

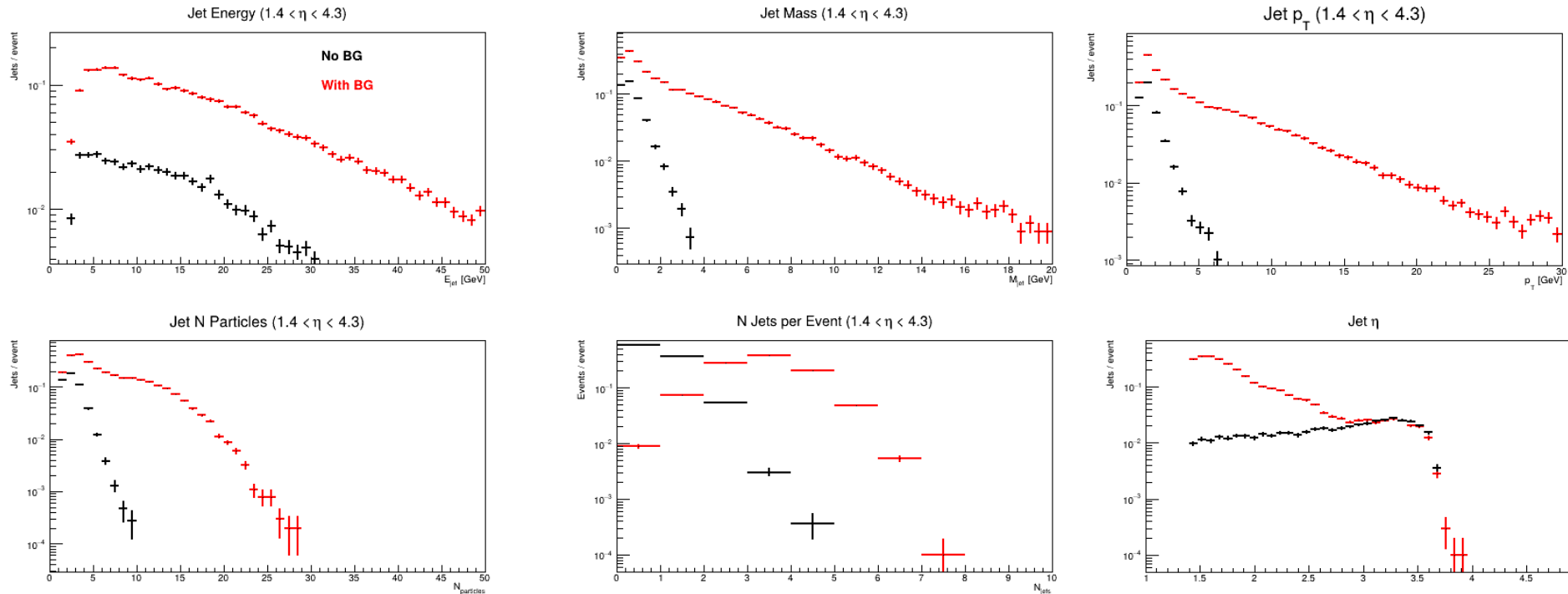
- Feb 2026 simulation campaign (10 x 100) without and with Beam Background



Thanks to Dmitry for neutral jet code: <https://github.com/eic/ElCrecon/tree/feature/neutral-jets-collection>

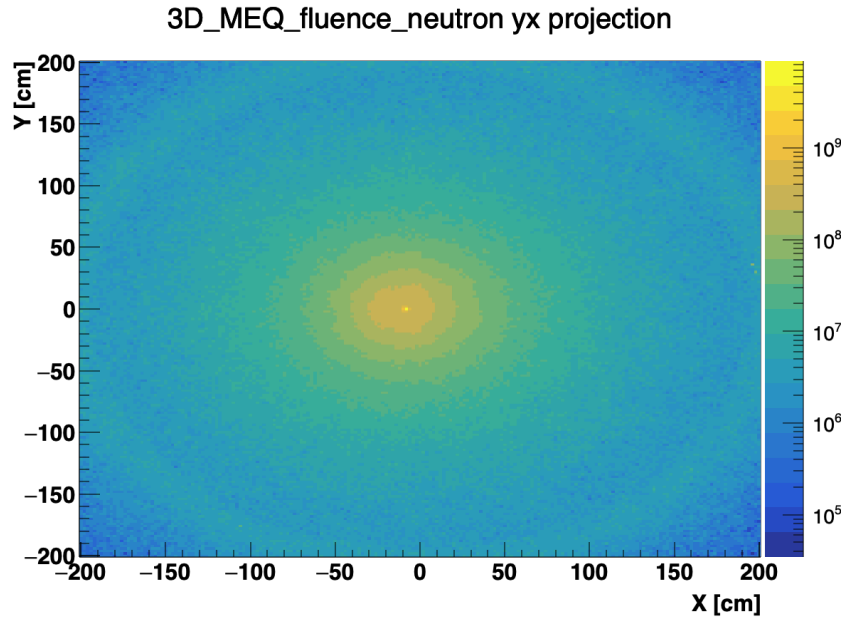
# With and Without Beam BG comparison : Tracking+Ecal Jets

- Feb 2026 simulation campaign (10 x 100) without and with Beam Background

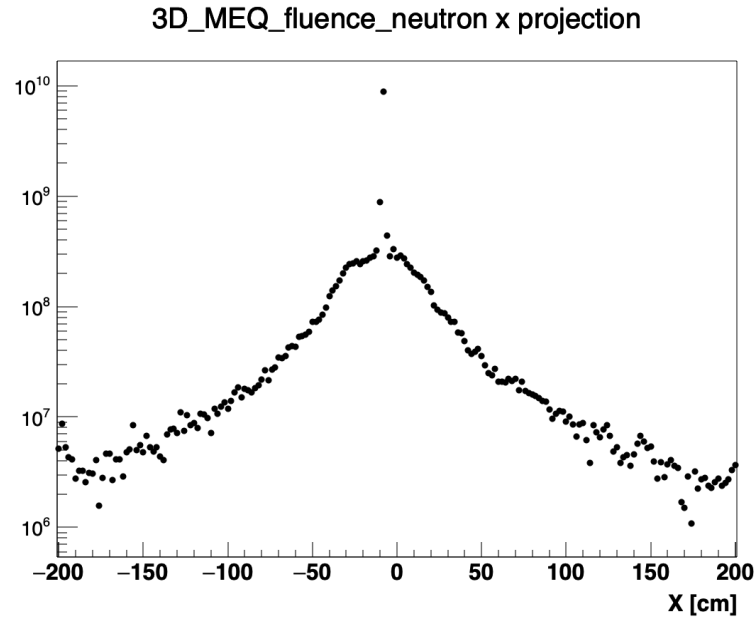


This is directly from RECO files of 2026Feb simulation campaign, not me running jet finder

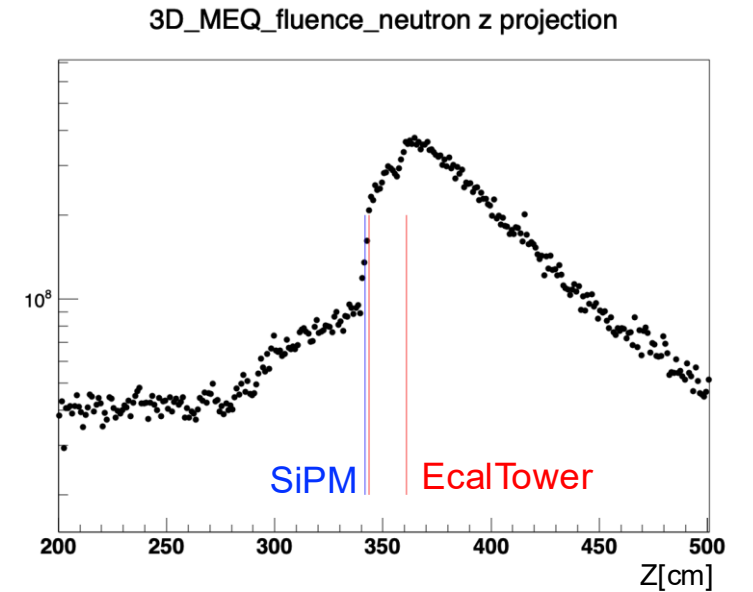
# Alex's New 3D Radiation Map : 1MEQ Neutron Equiv. Fluence per 1/fb



at Z=341.63cm (SiPM)



at Z=341.63cm(SiPM)  
Y= 0

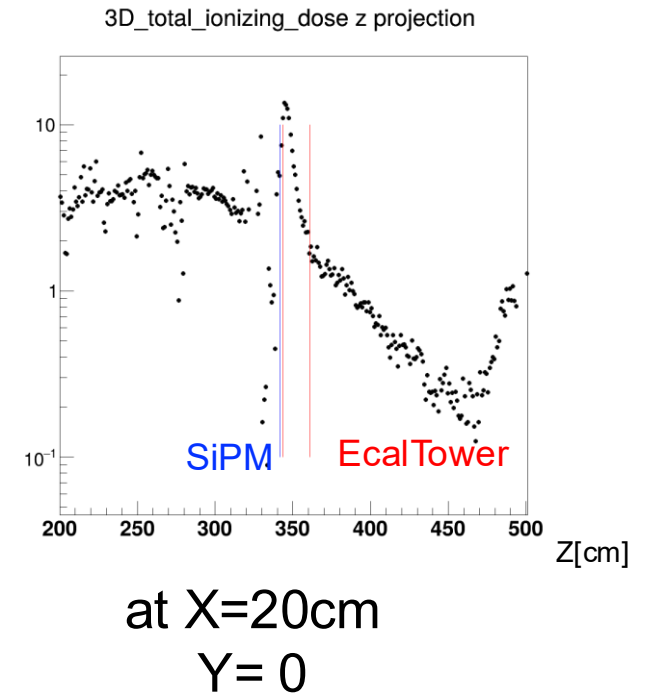
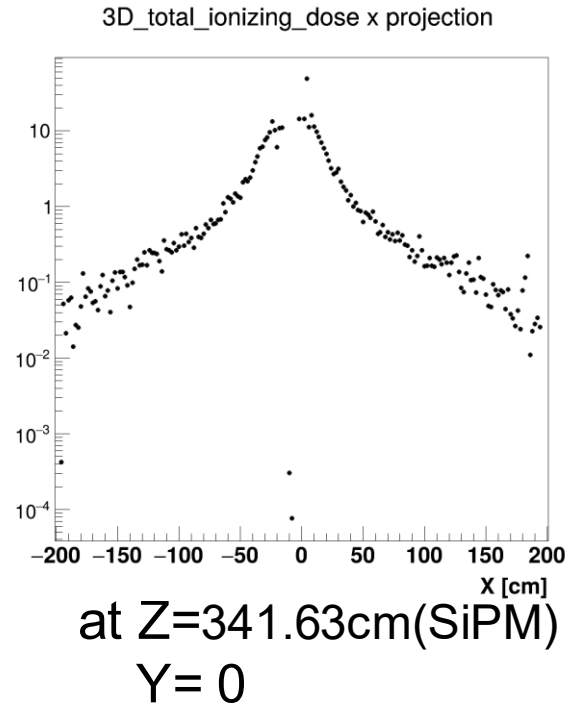
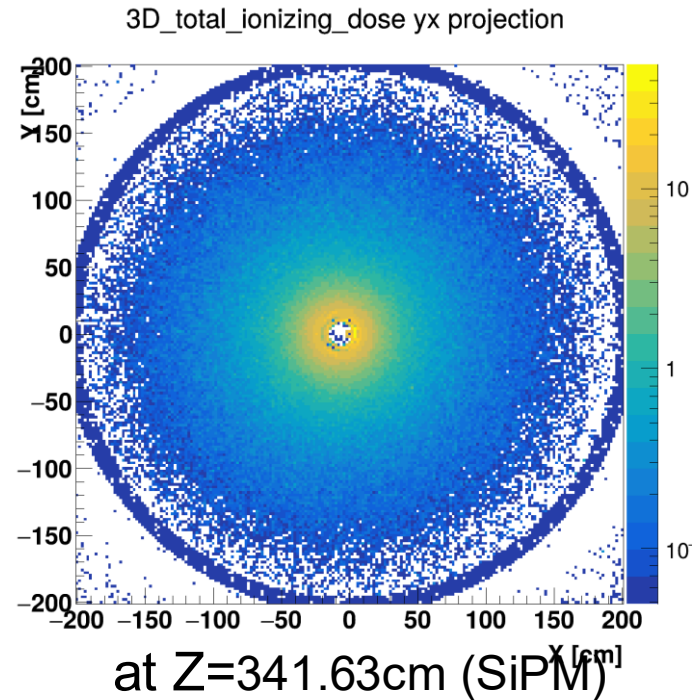


at X=20cm  
Y= 0

- Consistent with previous numbers used to estimate data rate (see Backup)
- Table of tower by tower radiation number available:

[https://www.star.bnl.gov/~akio/epic/bg/tower\\_with\\_meq.txt](https://www.star.bnl.gov/~akio/epic/bg/tower_with_meq.txt)

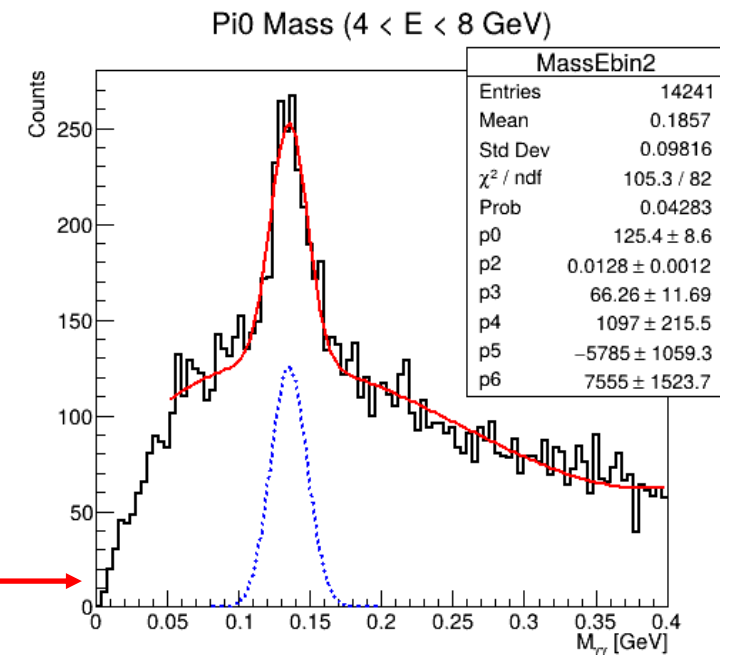
# Alex's New 3D Radiation Map : Total Ionizing Dose per 1/fb



- Table of tower by tower radiation number available:  
[https://www.star.bnl.gov/~akio/epic/bg/tower\\_with\\_meq.txt](https://www.star.bnl.gov/~akio/epic/bg/tower_with_meq.txt)

# Conclusions

- As of Feb 2026 simulation campaign, new forward Ecal geometry code is in place, matching current design with real segmentation
- Comparison of Feb 2026 simulation campaign (10 x 100) without and with Beam Background
  - We don't see any significant loss of performance due to beam background
    - # of hits, total energy, # of clusters, cluster energy, # of hits in cluster
    - Neutral jets : # of jet, jet energy, mass, rapidity, # of clusters
    - Tracking+Ecal jet : BG contribution at  $\eta < 3$  (???)
- New Alex's radiation map
  - Numbers are consistent with # used for studies of hit rates (see backup slides for previous rate studies)
- <https://www.star.bnl.gov/~akio/epic/bg/index.html>
- Working on pi0 reconstruction code for day1 calibration (with/without BG study is not yet done but coming...)



# Backup

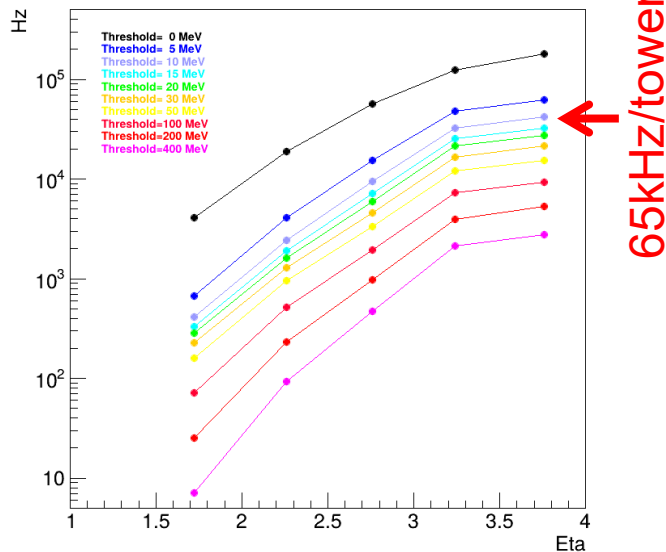
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# Dynamic range & Hit Rate from DIS and SiPM Noise

- 1.5 Pixel / MeV
- 14bit ADC & saturate at 100GeV → 6.1 MeV/count
- Digitizing at ~5MHz (~20nsec). Preamp shaping to ~80nsec → 12 time samples per pulse
- 12 time samples \* 14 bits ADC + 5 bits (32ch) + 19bit (time stamps) = 24 Byte per hit
- FEB limit is 50MB/s = 2MHz/FEB \* 24 Byte = 32ch \* 65kHz/tower \* 24 Byte → Avg 4 hits/event/FEB @  $L=1.0 \times 10^{34}$   
Avg 6 hits/event/FEB @  $L=6.5 \times 10^{33}$

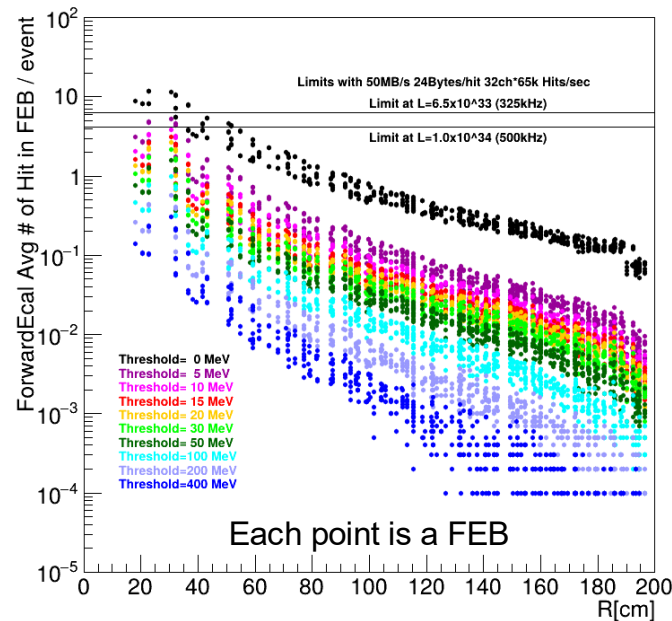
Tower Hit Rate at  $L=1 \times 10^{34}$

Hit Rate @ 500 kHz vs Eta



Per FEB Avg Hit Rate vs R

PYTHIA6 0<Q2<1 10GeVx275GeV DIS 1M events



Hit rates from backgrounds (dominated by electron beam gas and proton beam gas) are ~10% of DIS

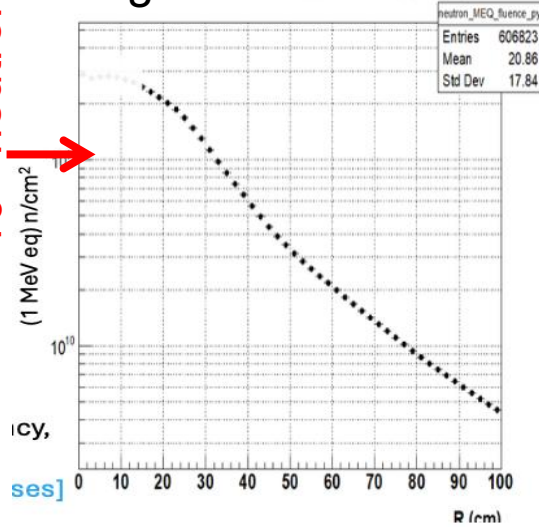
- For few FEBs near beam, we may need
- Higher threshold than nominal 15MeV
  - “Feature Extraction” (i.e peak finder) on FEB to compress data size / hit

# SiPM Noise Simulation (by Gerard)

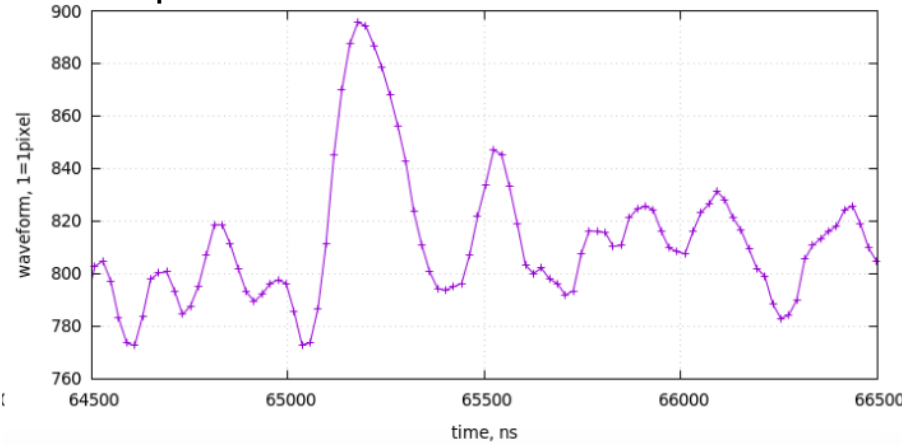
[https://indico.bnl.gov/event/29611/contributions/112908/attachments/64481/110719/rates\\_sim.pdf](https://indico.bnl.gov/event/29611/contributions/112908/attachments/64481/110719/rates_sim.pdf)

Integrated neutron fluence at  $100 \text{ fb}^{-1}$  after 1<sup>st</sup> 10 years → Tower DCR = **14GHz** @  $10^{11}$  neutron/cm<sup>2</sup>

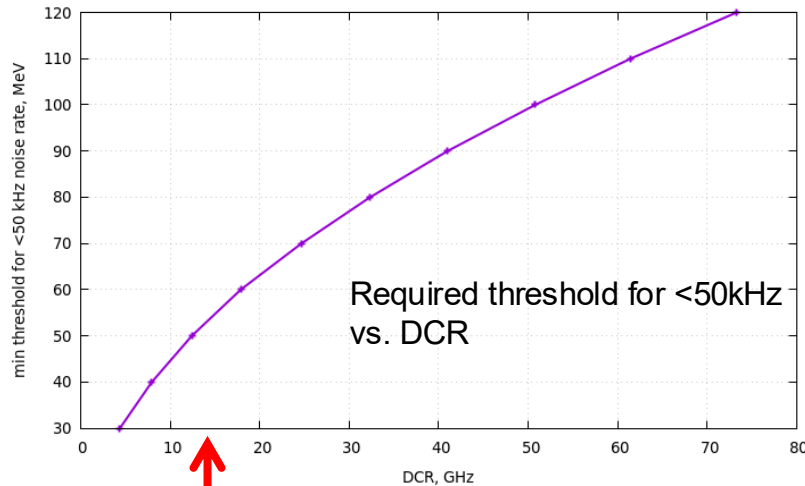
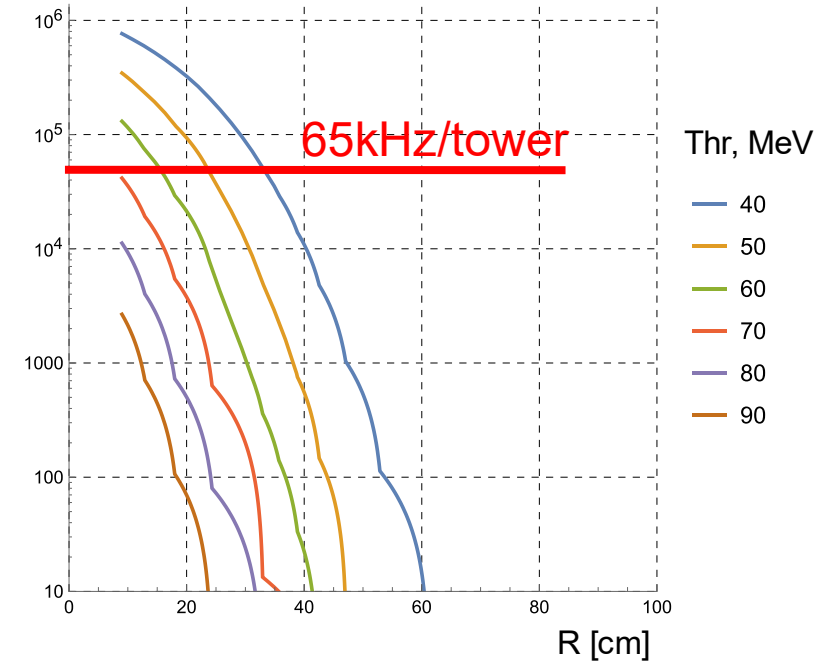
10<sup>11</sup> neutron/cm<sup>2</sup>



Example Simulated waveform for 10GHz DCR



Tower noise hit rate at  $100 \text{ fb}^{-1}$  vs R and threshold



**14GHz**

For FEBs within ~30cm of beam, we may need higher threshold than nominal 15MeV → ~100MeV when reaching  $100 \text{ fb}^{-1}$  after first 10 years of running