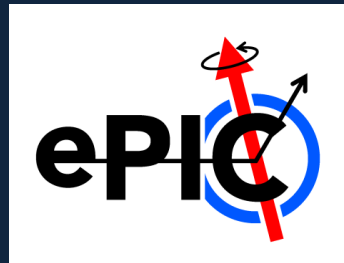


BO EMCAL Performance studies

10 January 2023

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Ben Gurion University of the Negev



אוניברסיטת בן-גוריון בנגב
جامعة بن غوريون في النقب
Ben-Gurion University of the Negev

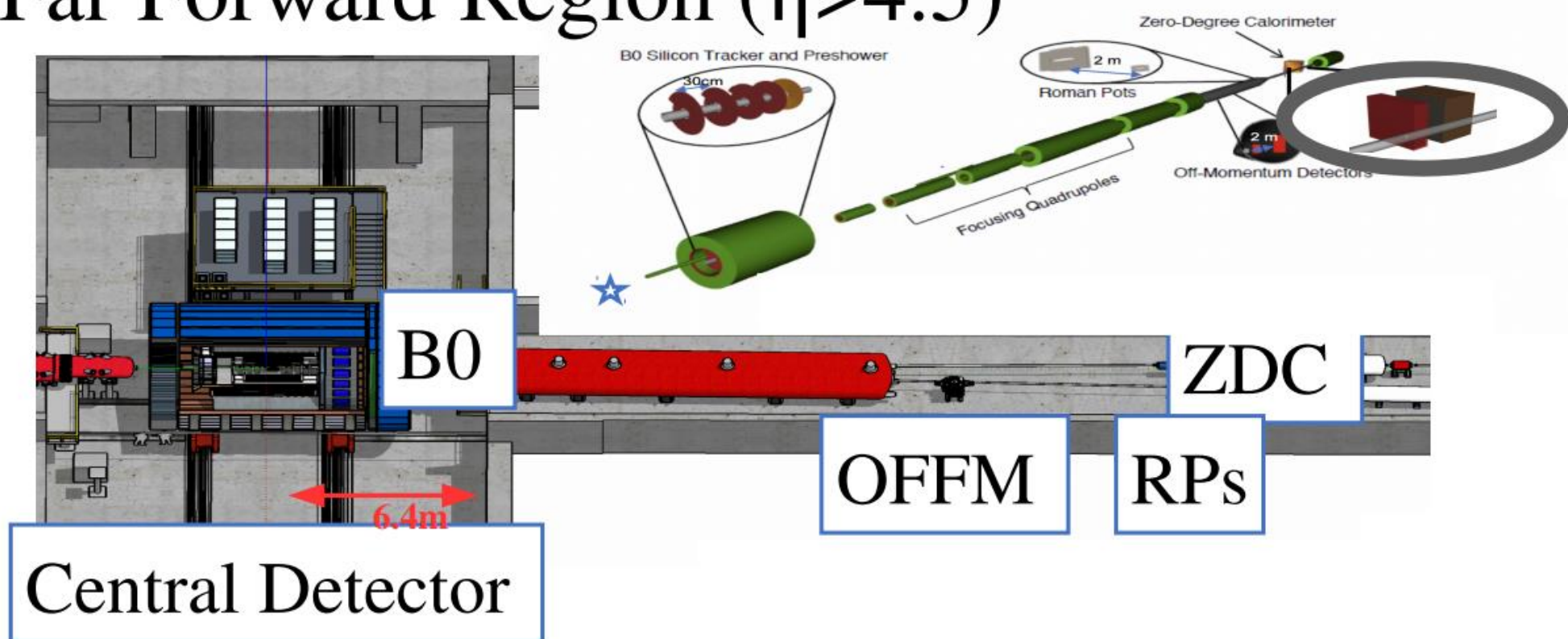


B0 detector at the EIC

The Goal

Performance studies of the B0 detector using EPIC simulation, and the impact on physics analysis

Far Forward Region ($\eta > 4.5$)

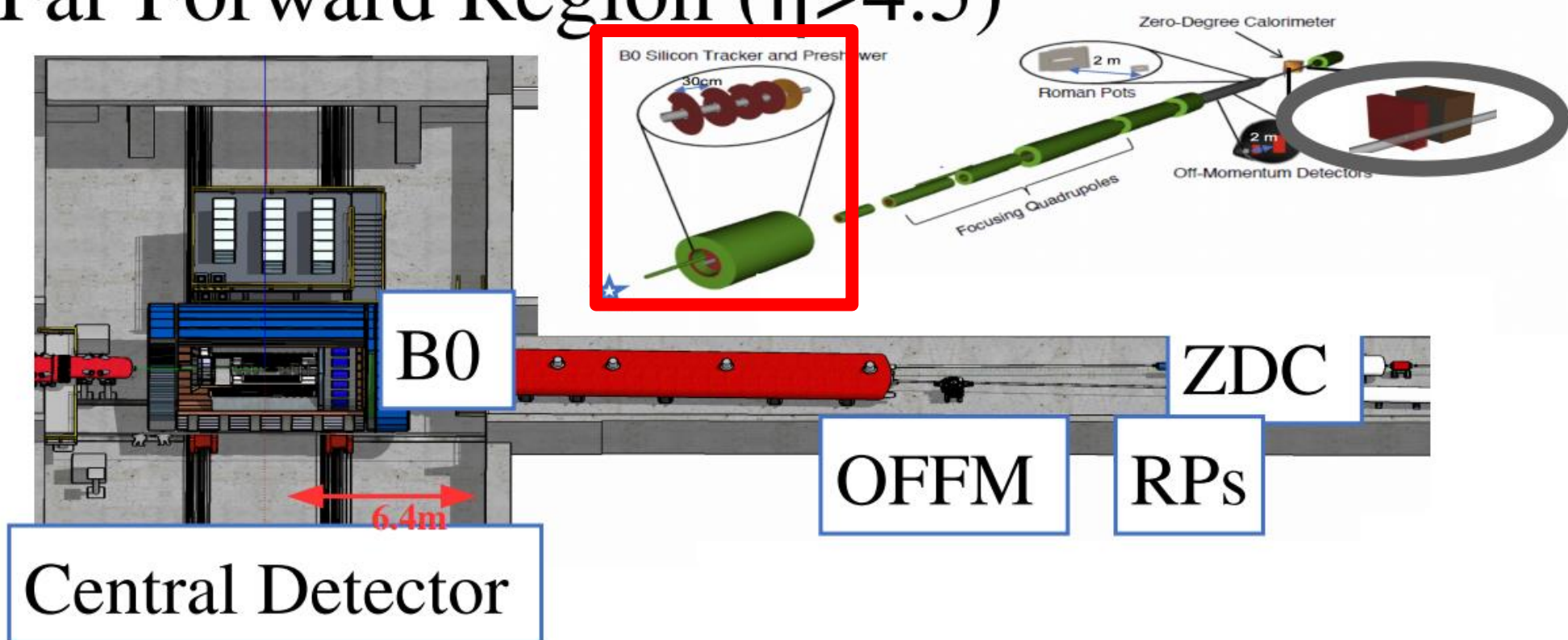


B0 detector at the EIC

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Simulation setup

Thanks to [Sakib Rahman](#) for integrating the B0 geometry into the ePIC simulation

Particle Gun using DDSIM

- Default simulation setup (275GeV mag. field)
- ddsim with particle gun: “gamma”

(*SIM.gun.particle = 'gamma'*)

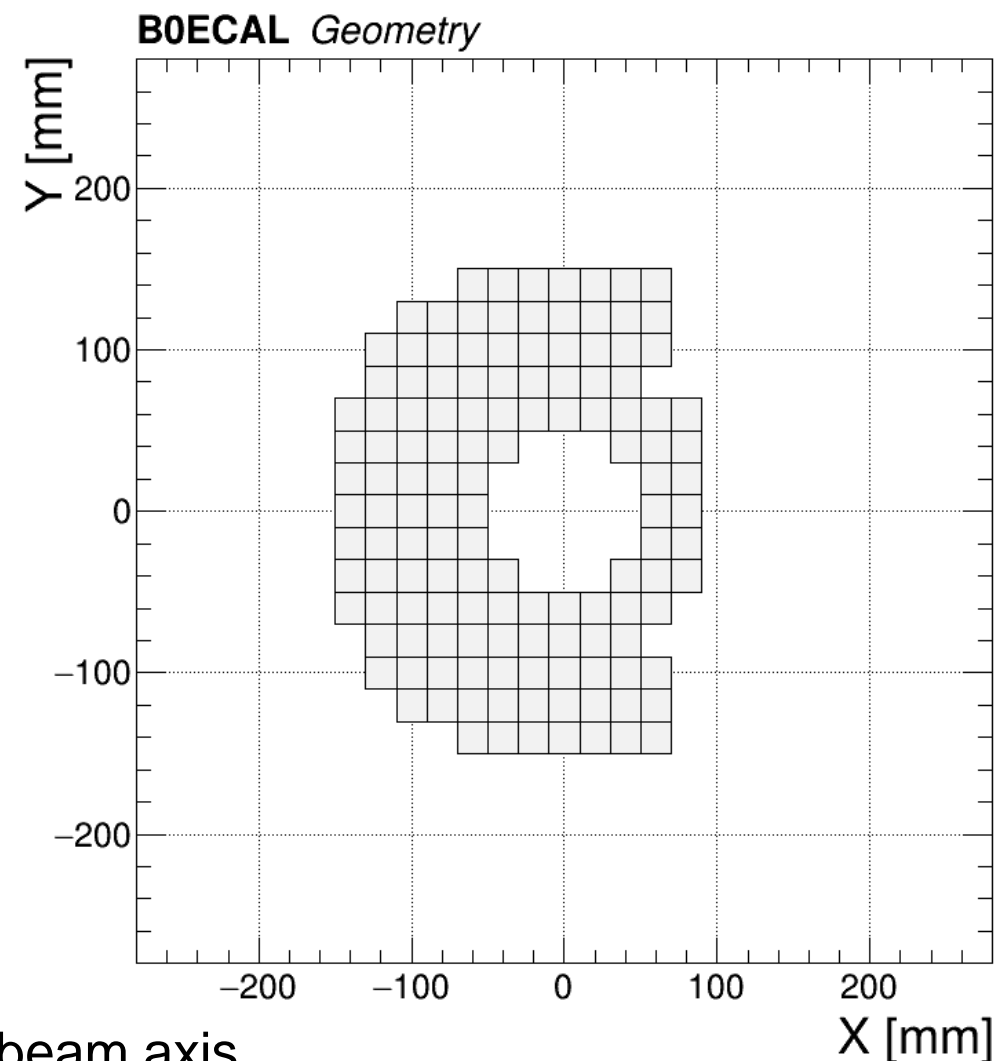
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- Coordinates (eta) defined with respect to the hadron beam axis

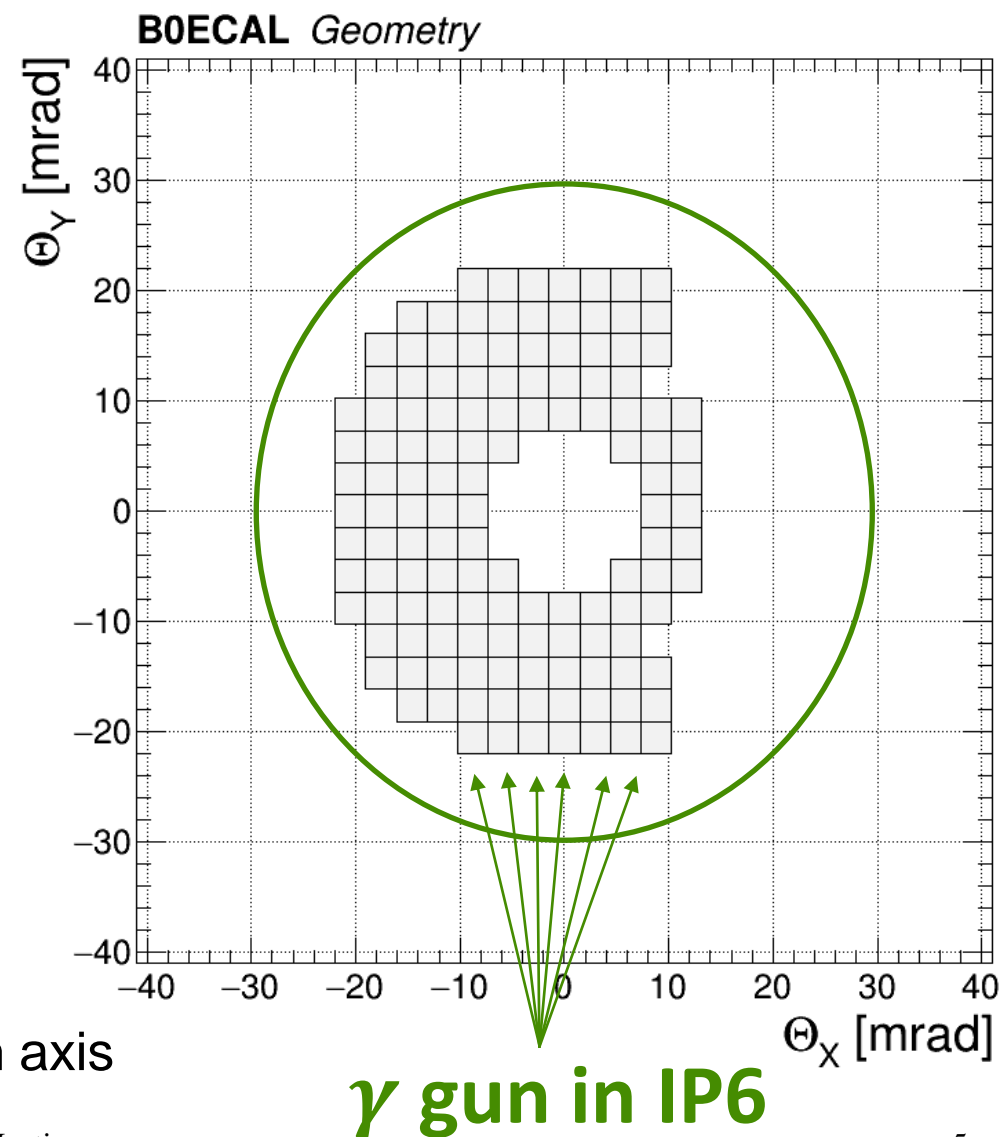


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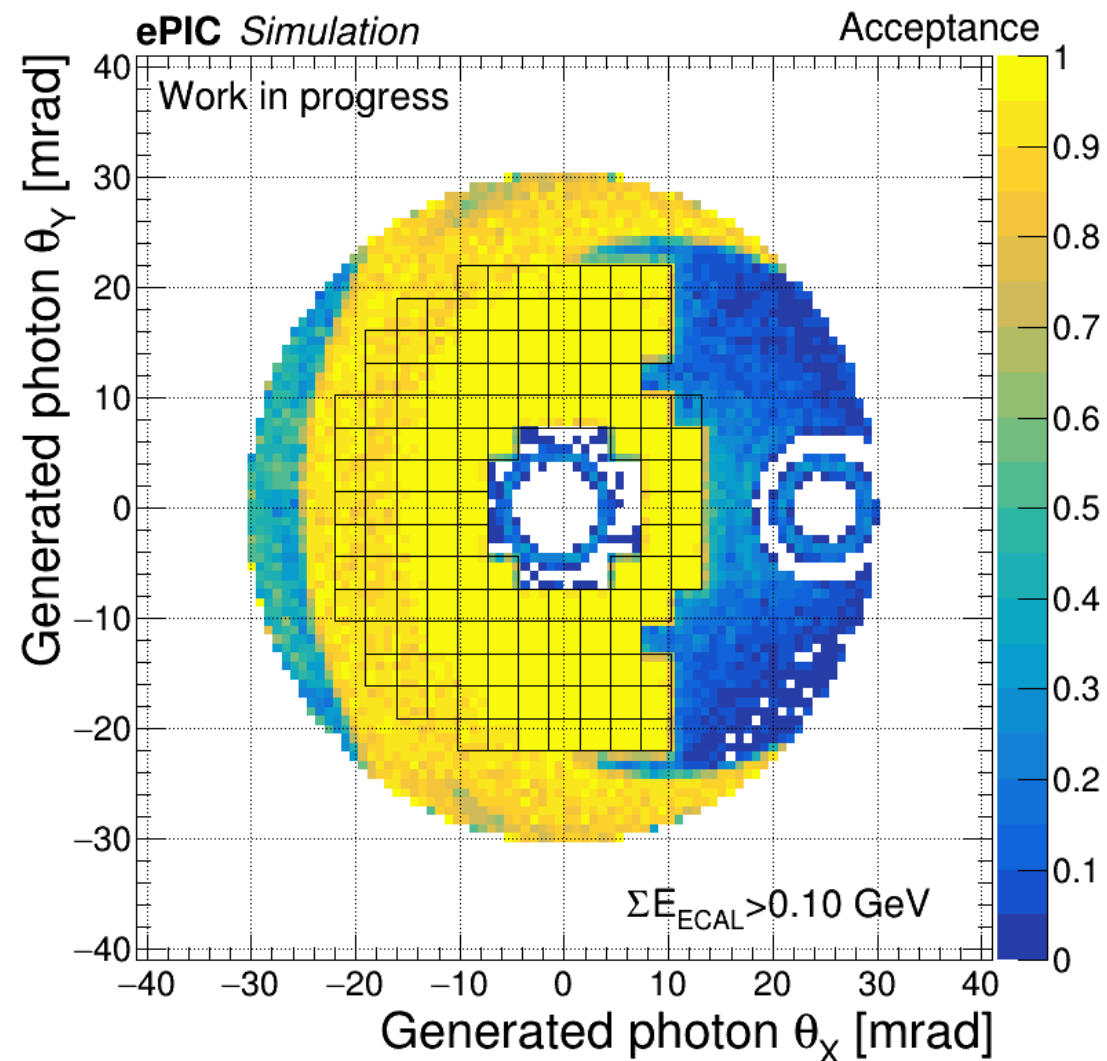
Photon Acceptance in B0EMCAL

Acceptance in X-Y plane

- Acceptance = $(\Sigma(\text{Hits in B0ECAL}) > 0.01 \text{ GeV}) / N_{\text{total}}$

Observations

- Photons out-of-fiducial region (outside B0EMCAL) deposit energy in B0EMCAL.



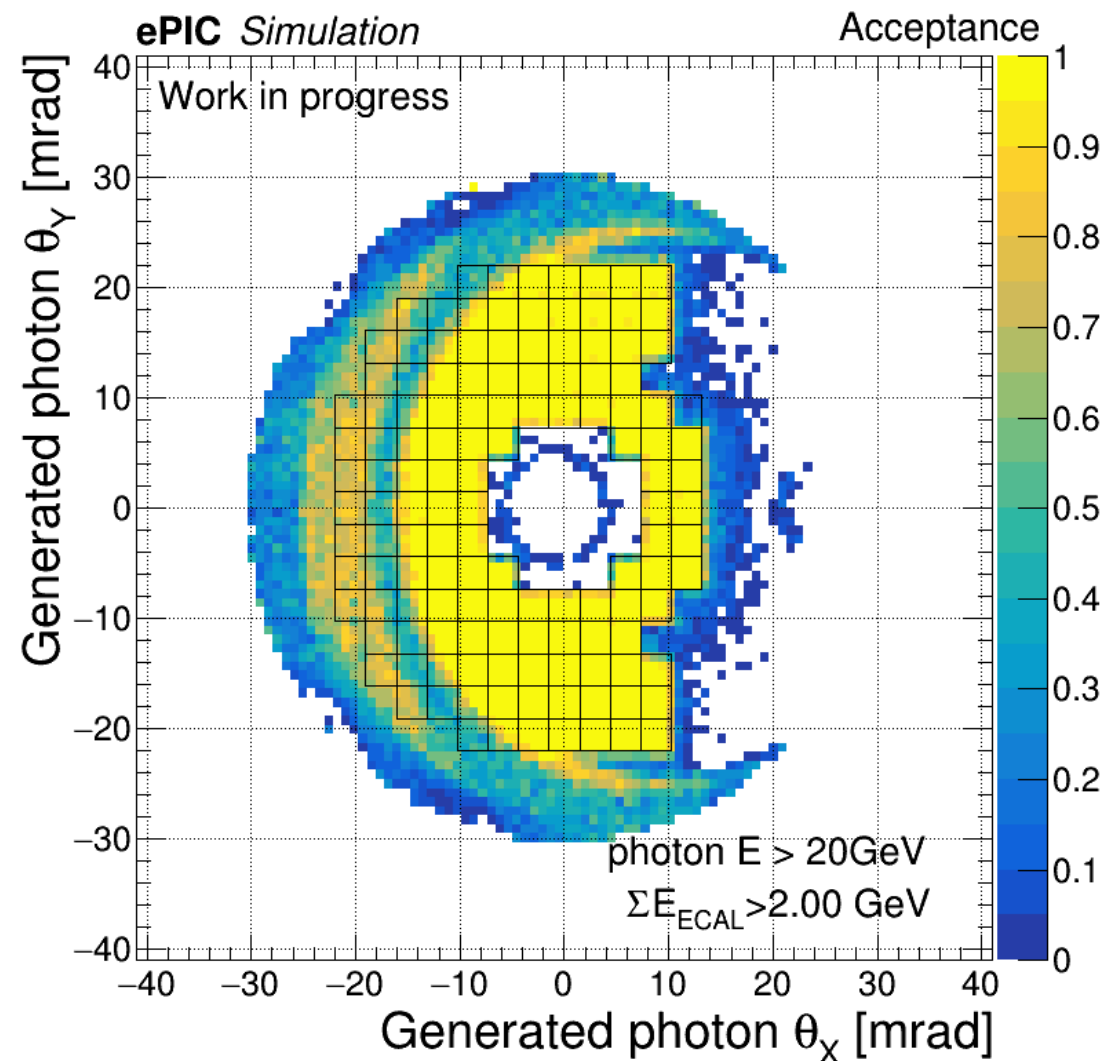
Photon Acceptance in B0EMCAL

Acceptance in X-Y plane

- Acceptance = $(\Sigma(\text{Hits in B0ECAL}) > 2.00 \text{ GeV}) / N_{\text{total}}$
- Photons with $E > 20 \text{ GeV}$

Observations

- Photons out-of-fiducial region (outside B0EMCAL) deposit energy in B0EMCAL.
- Acceptance drops with increased energy threshold within a circle around the detector active area



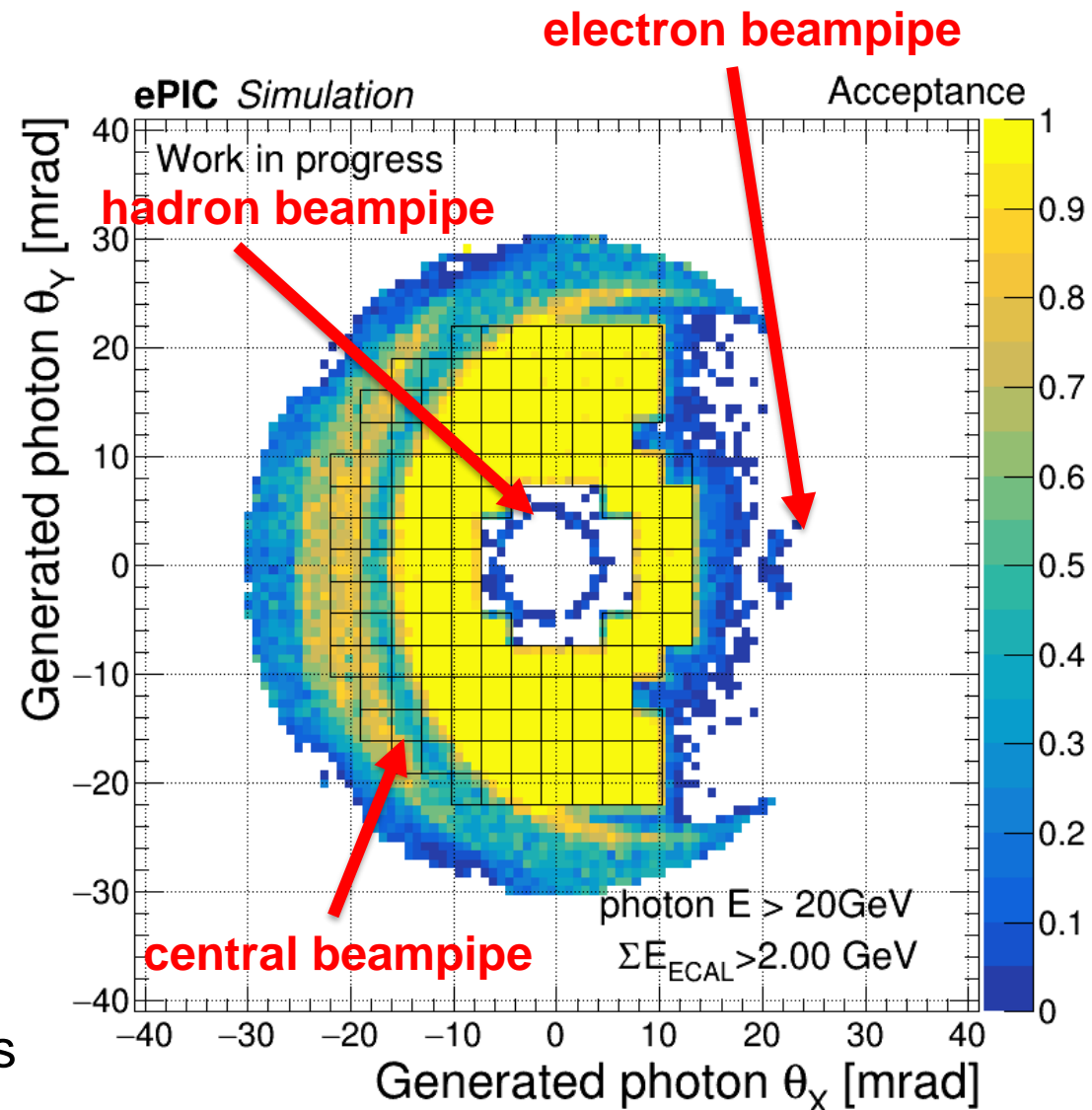
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- Photons with $E > 20 \text{ GeV}$

Observations

- Photons out-of-fiducial region (outside B0EMCAL) deposit energy in B0EMCAL.
- Acceptance drops with increased energy threshold within a circle around the detector active area
- Central beampipe overlaps with part of the detector area ([more in the backup](#)), photons create an ee pairs

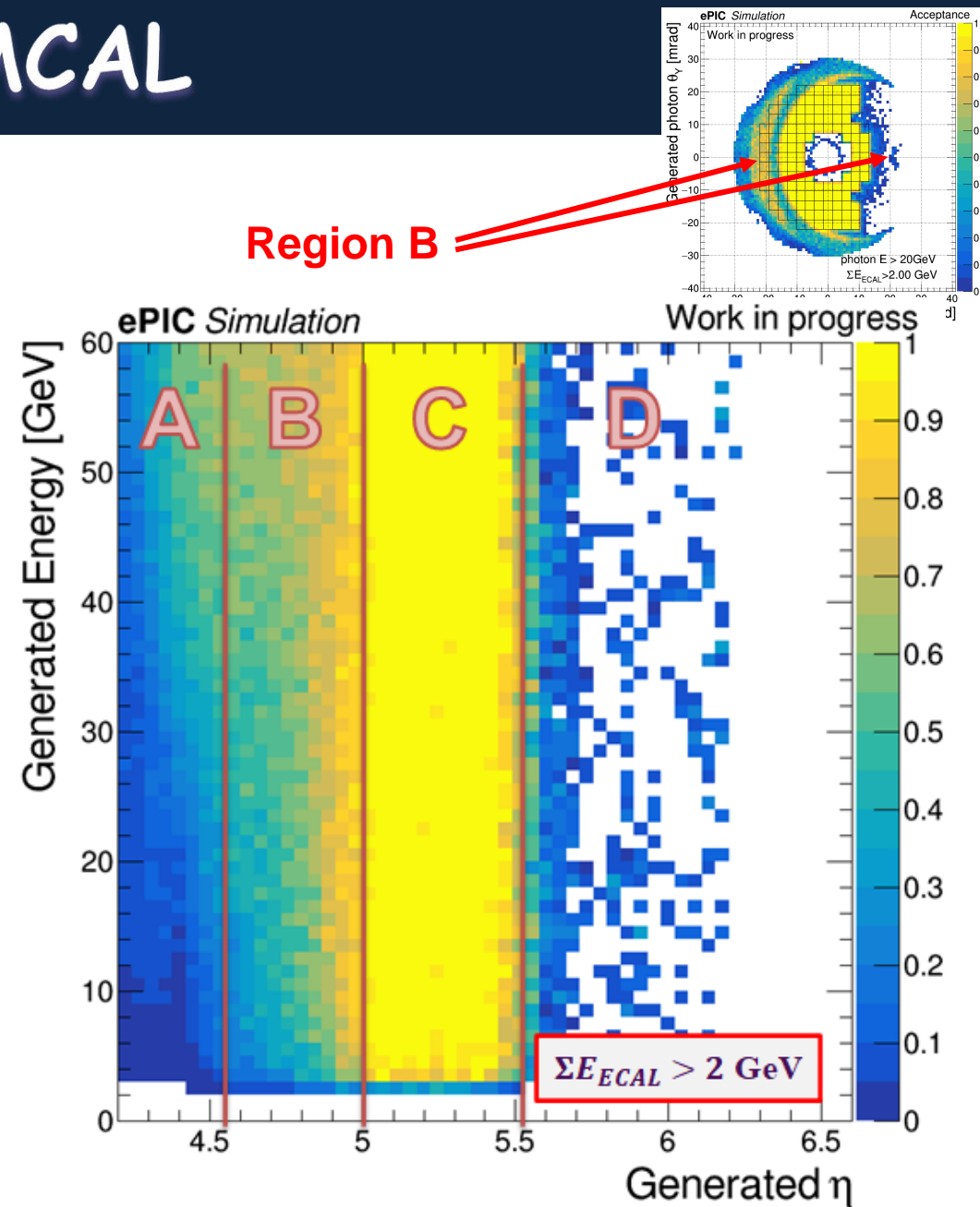


Photon Acceptance in B0EMCAL

Acceptance in eta

Photon acceptance can be divided into 4 regions:

- A. Outside B0EMCAL acceptance (low eta), overlaps with the dRICH acceptance
- B. Within B0EMCAL acceptance and crossing the central beampipe ($\theta_x < -15 \text{ mrad}$) or outside B0EMCAL acceptance ($\theta_x > 15 \text{ mrad}$)
- C. Within B0EMCAL acceptance, and within the central beampipe – photons interact with B0EMCAL
- D. Outside B0EMCAL acceptance (high eta), overlaps with ZDC acceptance

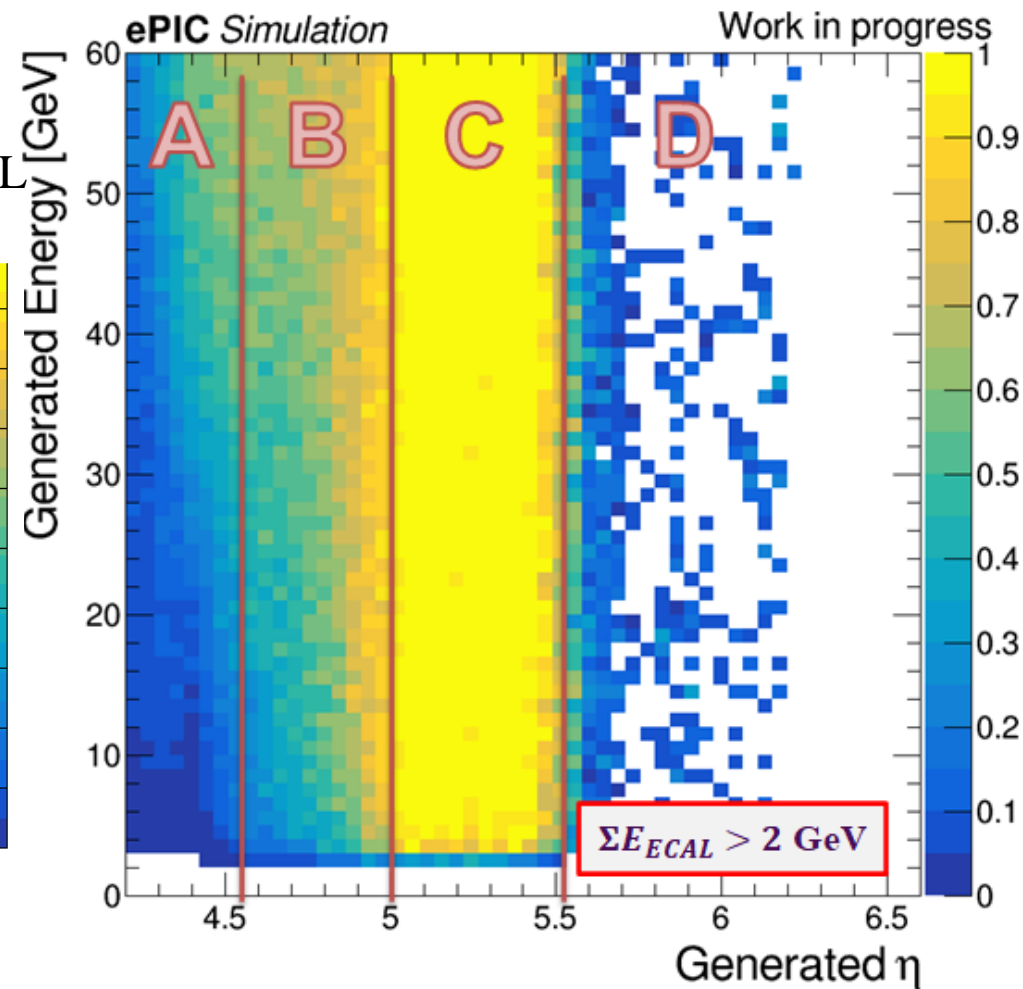
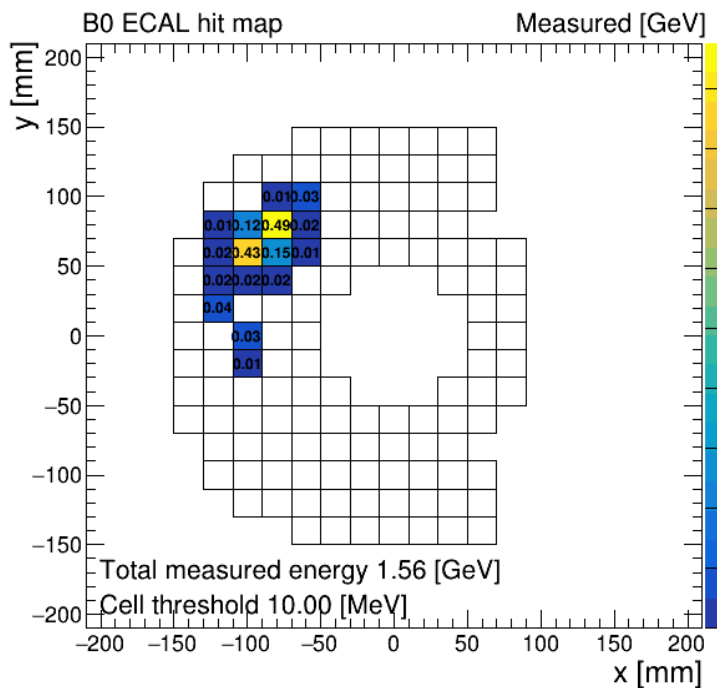
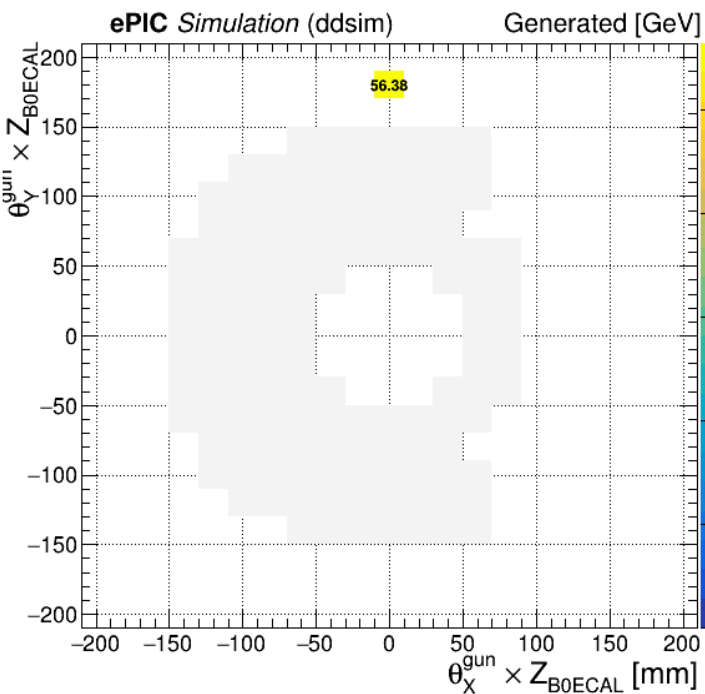


Photon Acceptance in BOEMCAL

Example (region A):

Photon detected:

Photon outside B0 ECAL fiducial volume, converted to ee pair when passing central beampipe. Resulting electrons can scatter to the BOEMCAL

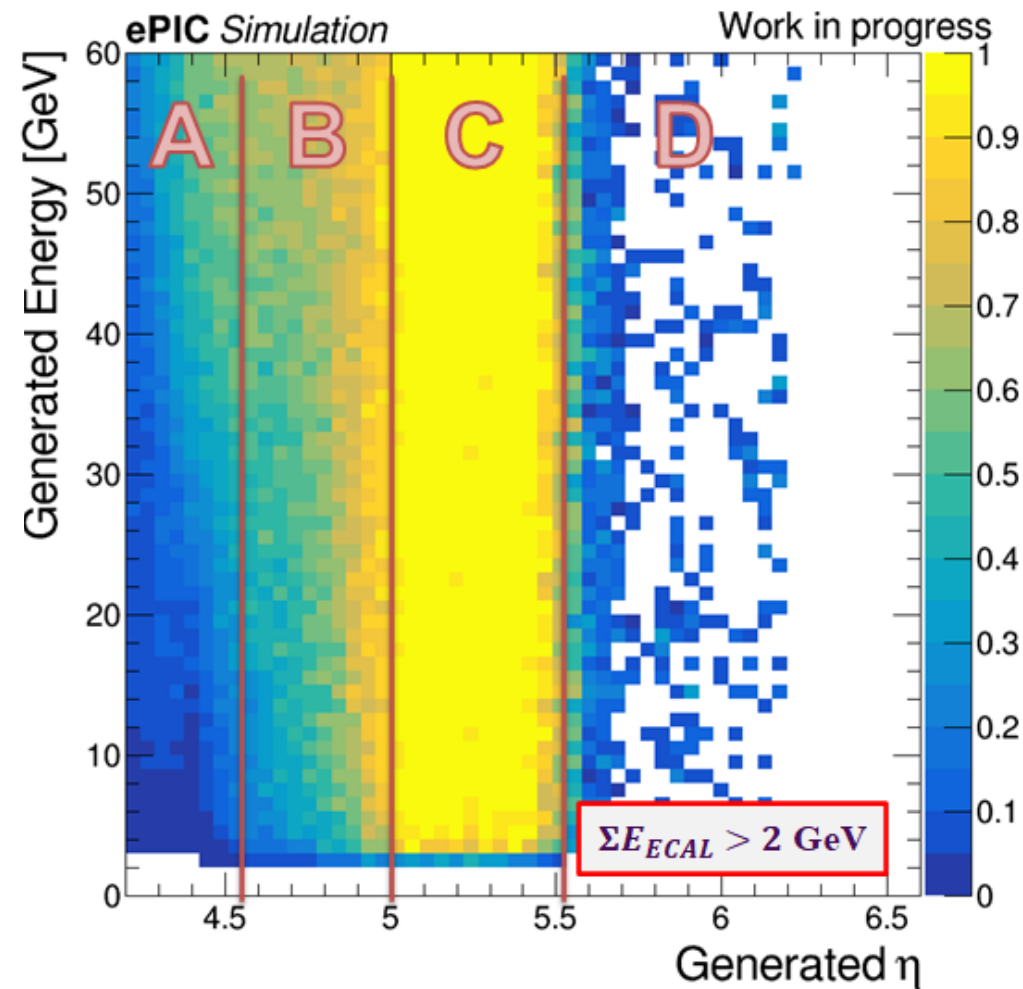
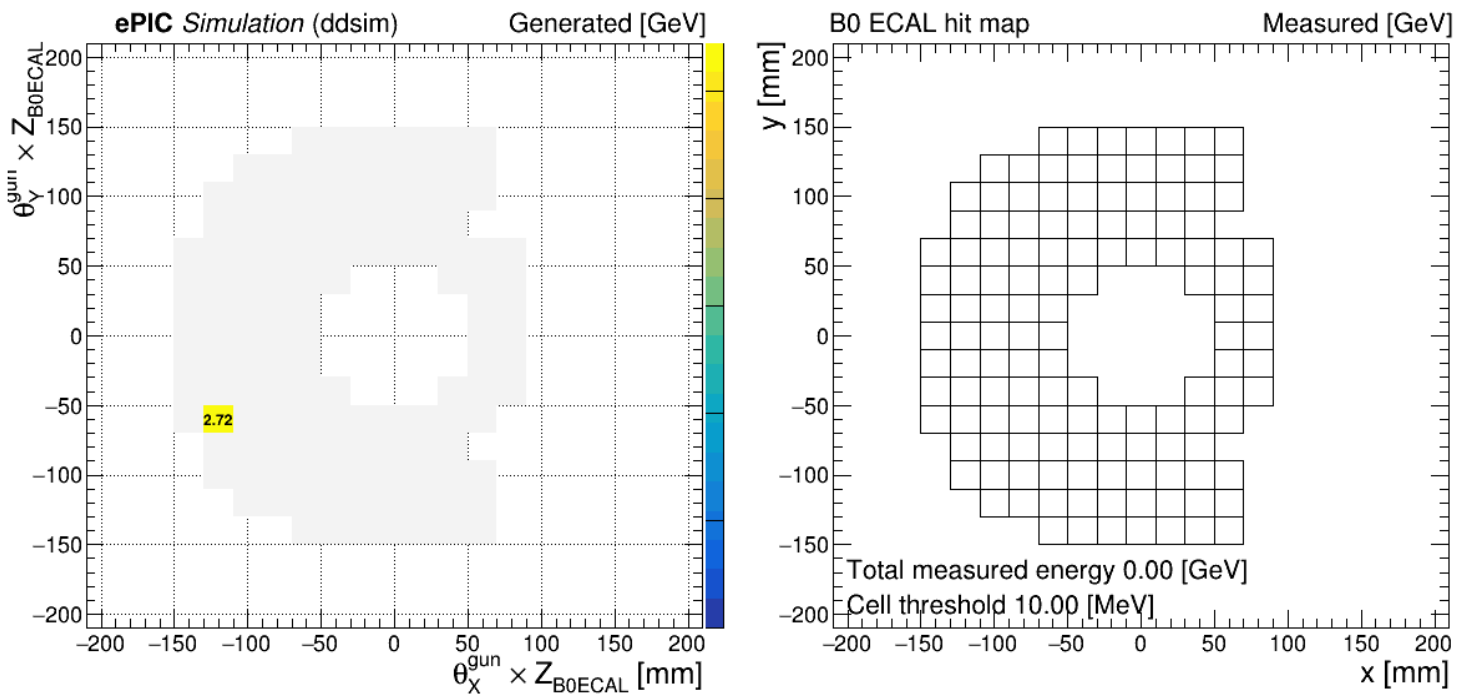


Photon Acceptance in BOEMCAL

Example (region B):

Photon undetected:

Photon within the B0EMCAL fiducial volume didn't reach the detector due to the intersection with the beampipe

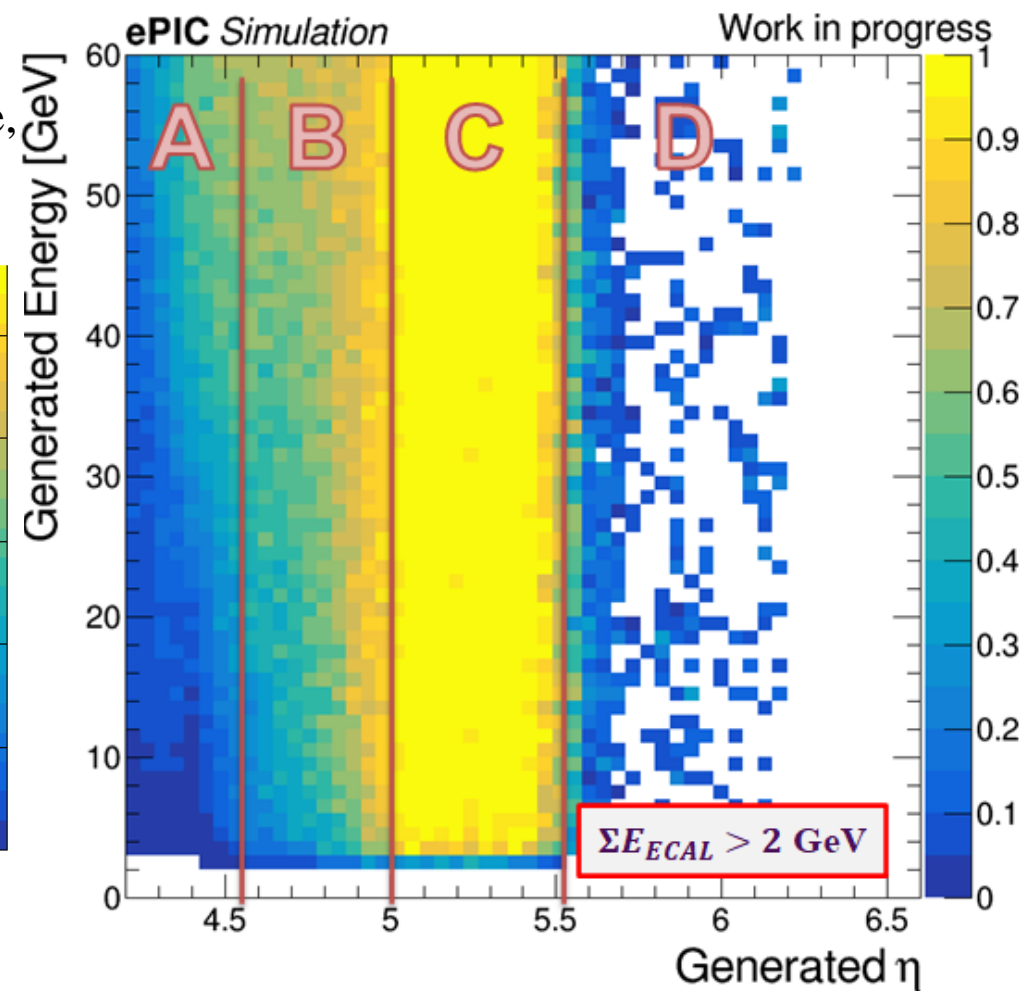
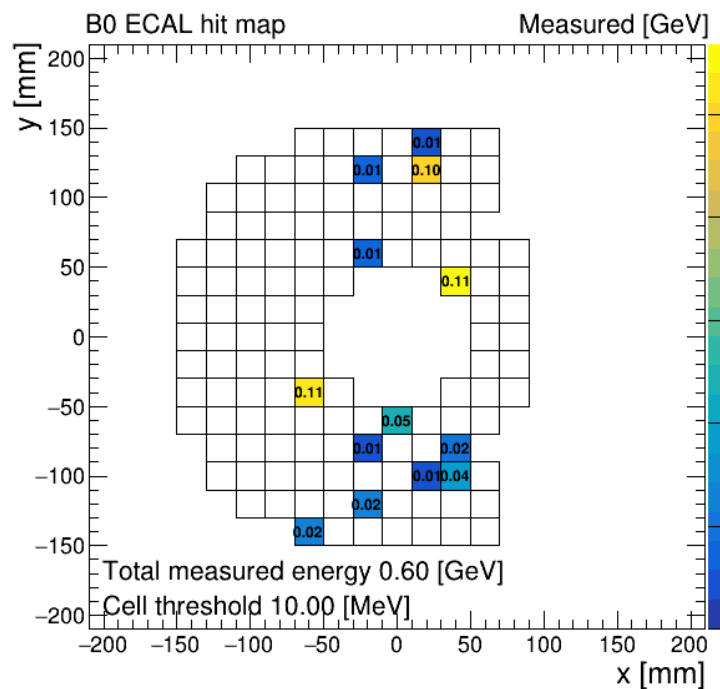
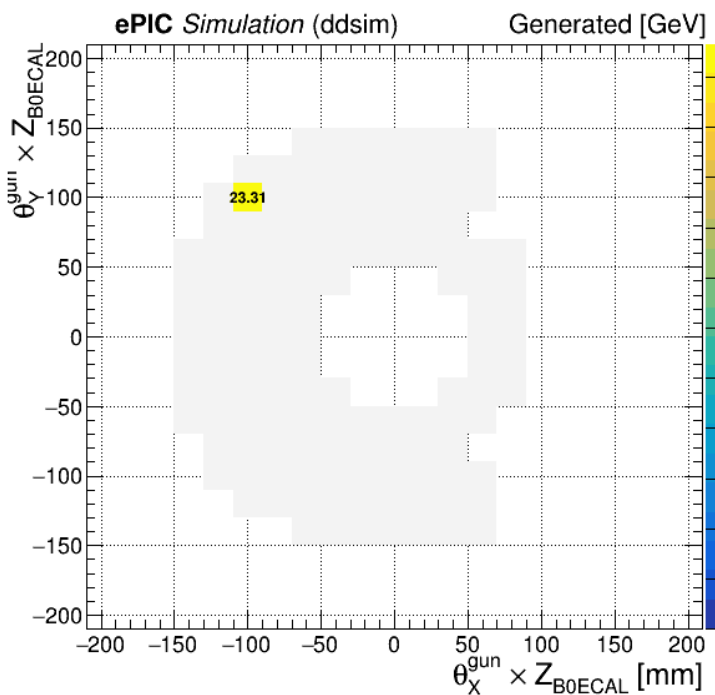


Photon Acceptance in BOEMCAL

Example (region B):

Photon detected:

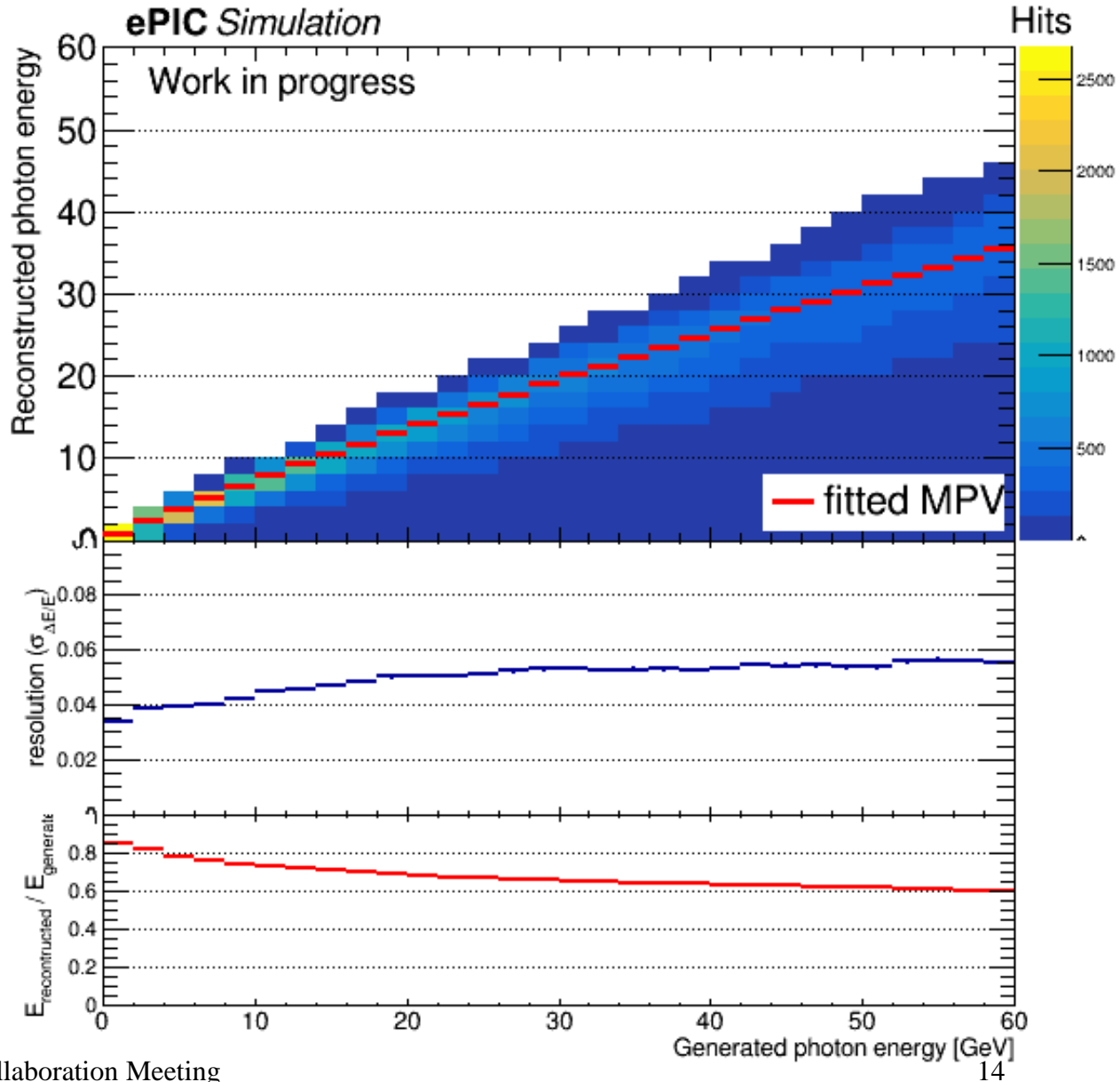
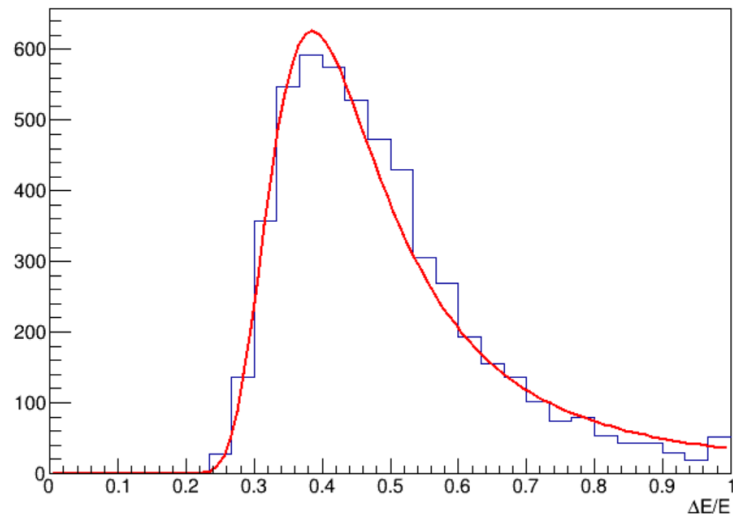
Photon within BOEMCAL fiducial volume, converted inside the beampipe, conversion products generates energy deposits in the BOEMCAL

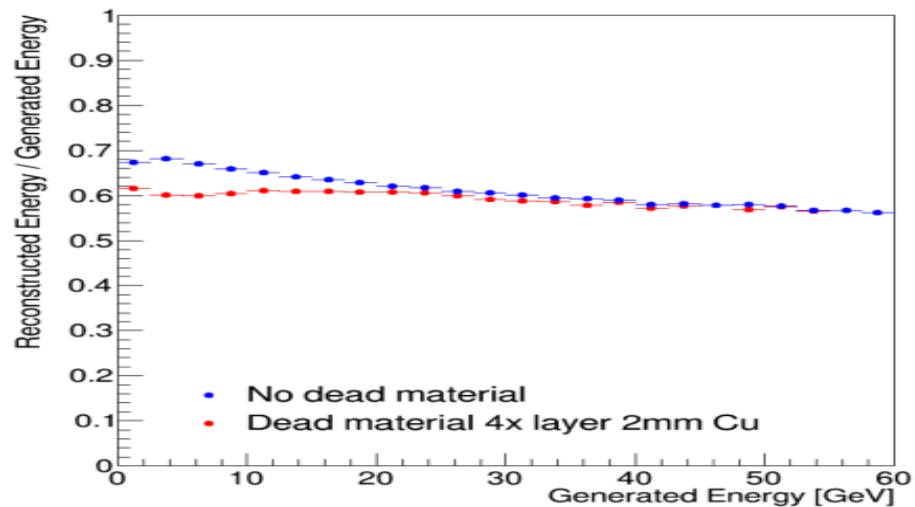
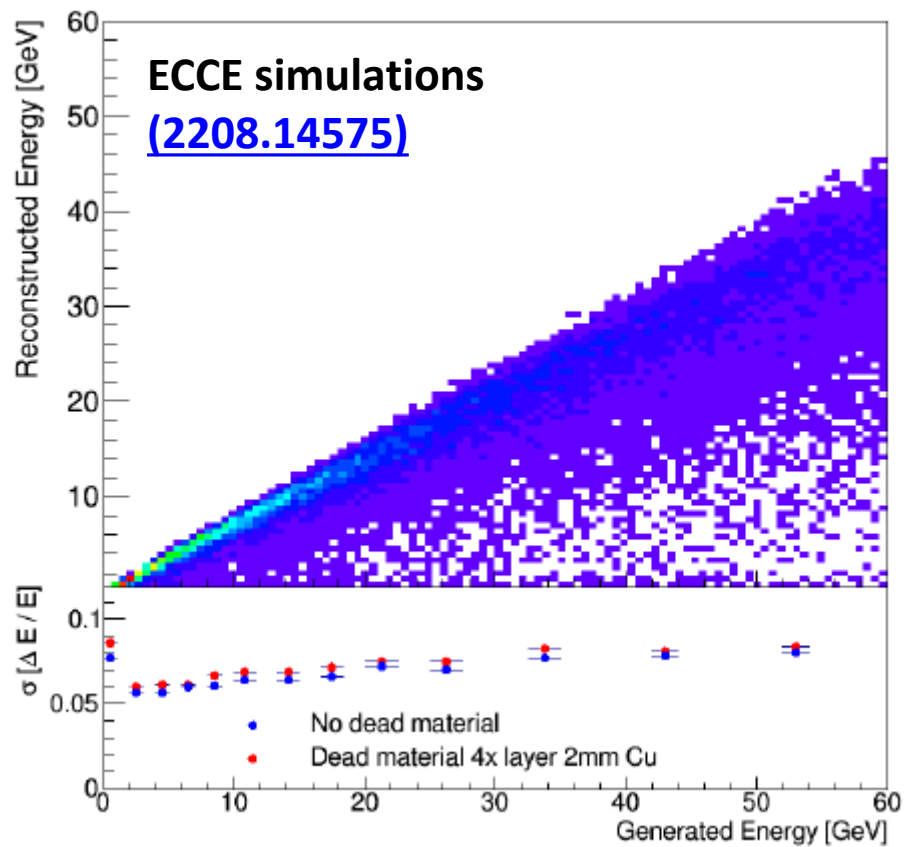


BOEMCAL performance (sim)

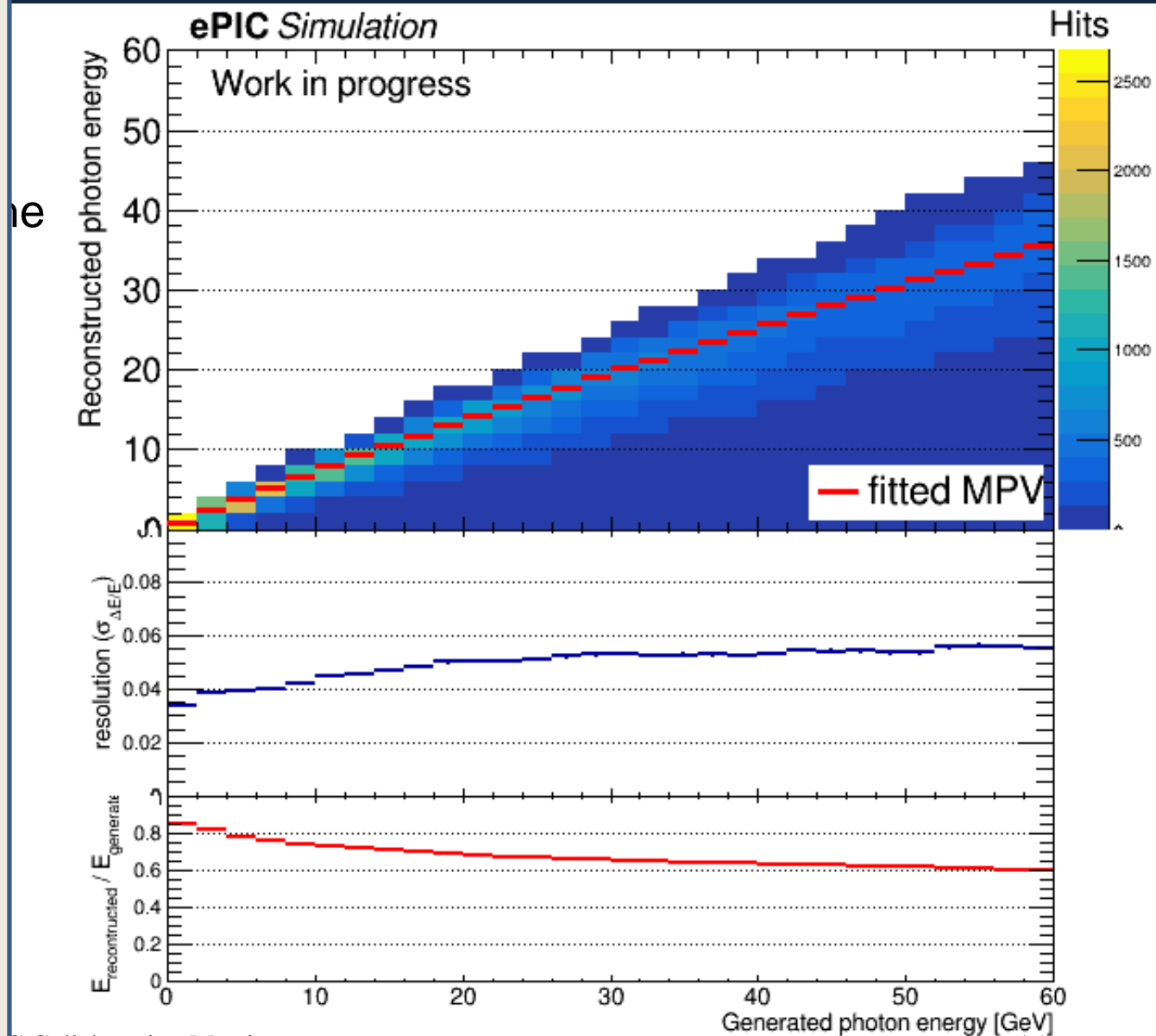
Energy response

- Consider only photons that interact directly in the BOEMCAL (converted photons were excluded).
- Fit landau to each slice in $E+\Delta E$ to extract response and resolution (example of last bin)





(sim)



Summary and discussion

Summary

- ECCE simulations were reproduced with ePIC (using DD4SIM)
- Addition of the beampipe in G4 simulation as an active material decreases detector acceptance
- Early photon conversion produces multiple showers in the B0 EMCAL – requires treatment at the reconstruction level (preliminary studies showed that track veto in B0 tracker could reject ~50% of converted photons)

Next steps

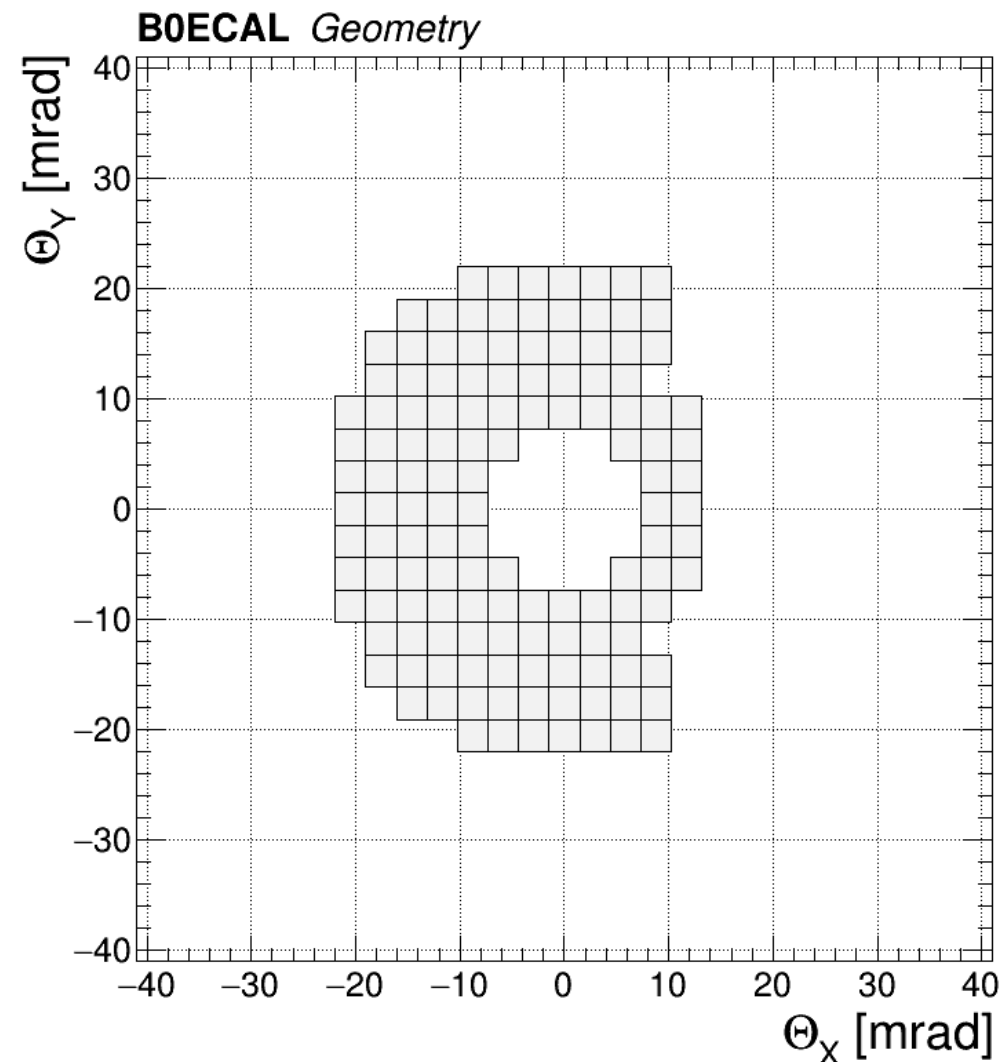
- Photon ID in full reconstruction chain (including tracks in B0 TRK)
- Impact of reconstructed objects in B0 detector on physics analysis

Backup

Simulation setup

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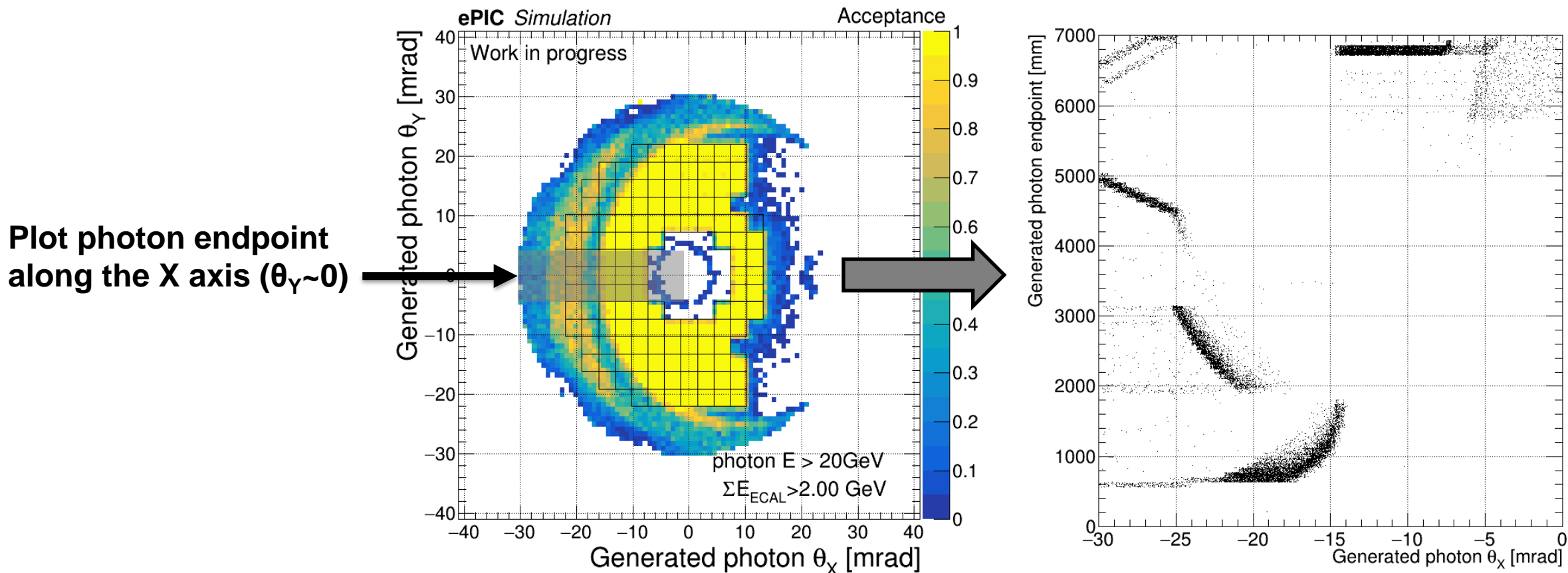


Photon Acceptance in BOECAL

[Back to slide 7](#)

Acceptance in X-Y plane

- G4 simulations provides information of the proton endpoint ($\gamma \rightarrow ee$)



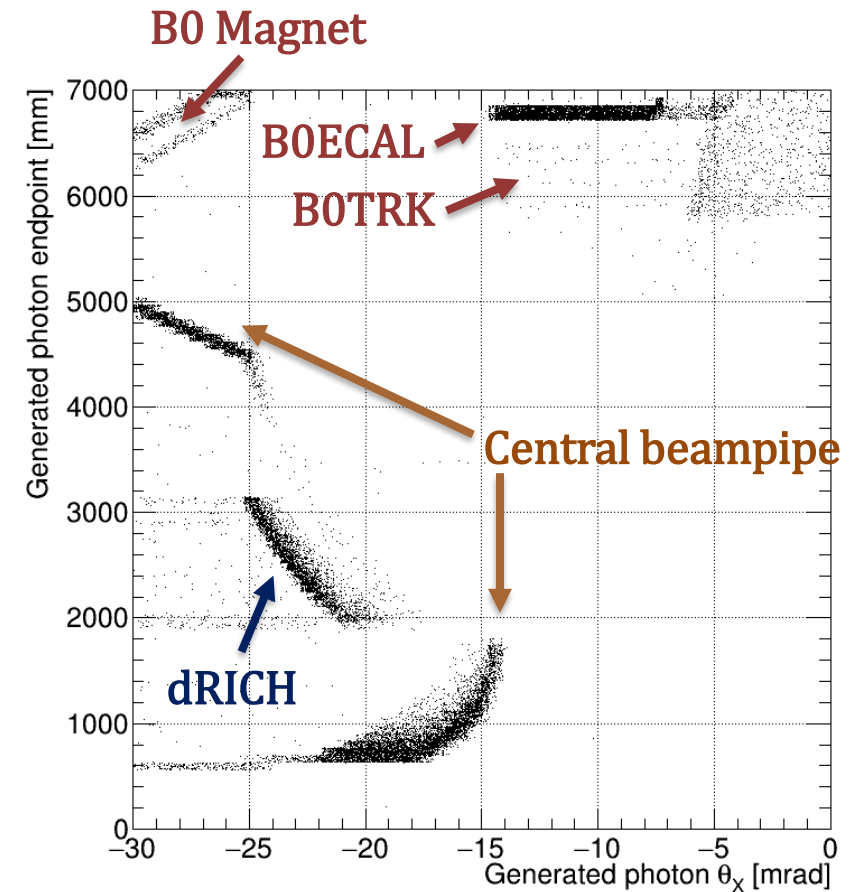
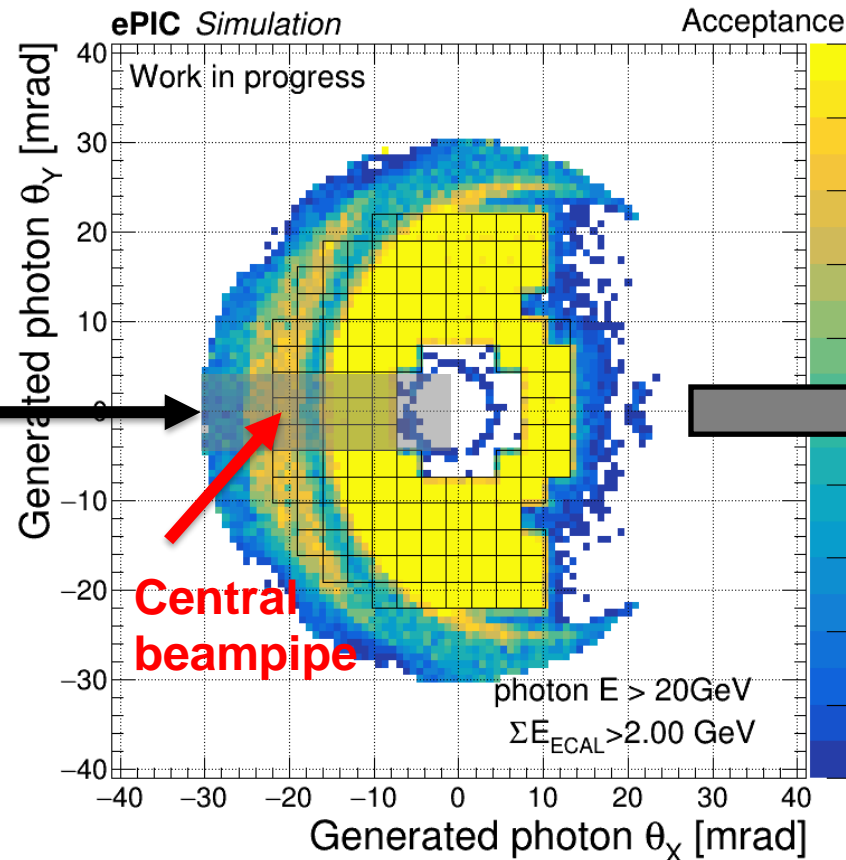
Photon Acceptance in BOEMCAL

[Back to slide 7](#)

Acceptance in X-Y plane

- G4 simulations provides information of the proton endpoint ($\gamma \rightarrow ee$)

Plot photon endpoint
along the X axis ($\theta_Y \sim 0$)



Photon Acceptance in BOEMCAL

Performance:

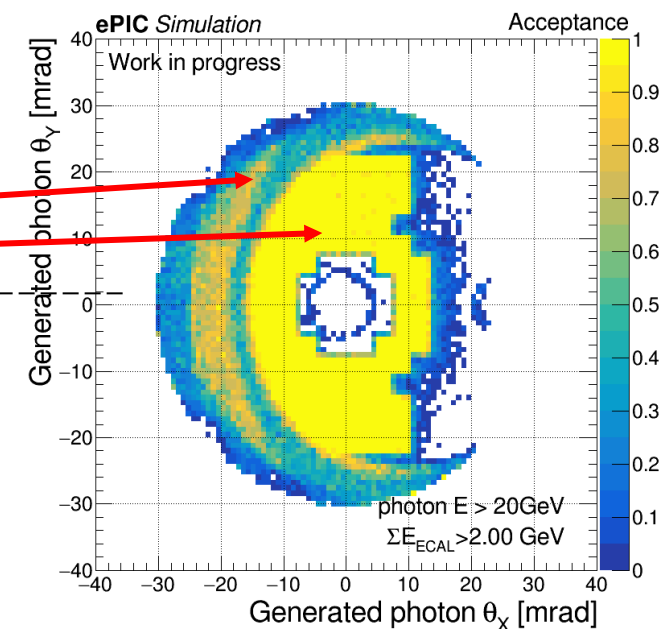
- We generate photons at different directions and study the response (acceptance) of the B0 EMCAL



Interaction Region
(Central detector)

Central
beampipe

γ



Photon Acceptance in BOEMCAL

Performance:

- We generate photons at different directions and study the response (acceptance) of the B0 EMCAL



Interaction Region
(Central detector)

No central
beampipe

γ

