

BO EMCAL Update

28 November 2023

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B0 design

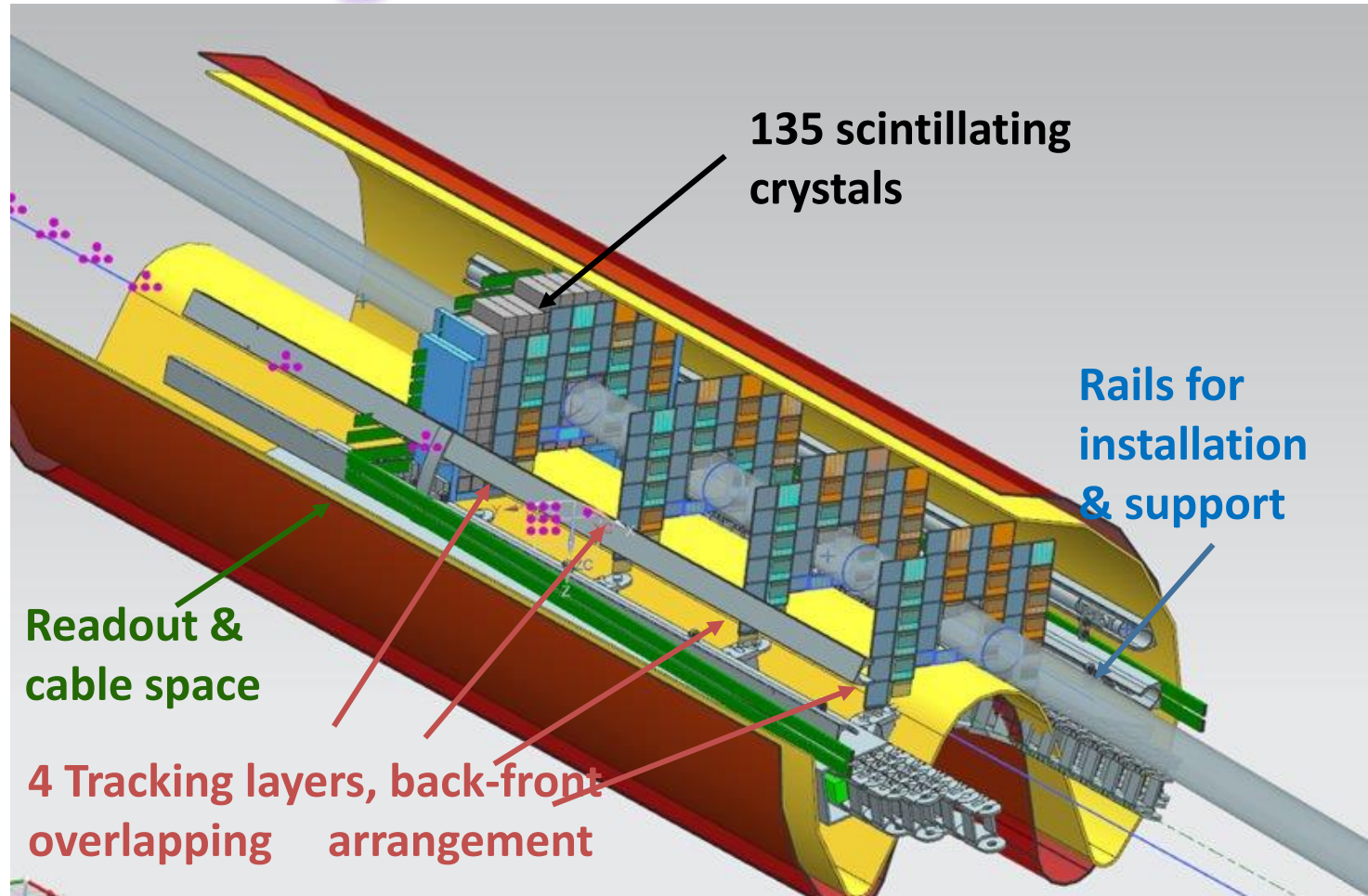
**since ePIC collaboration meeting*

Si Tracker:

- 4 Layers of **AC-LGAD**
- $dZ=8.1\text{cm} \rightarrow 27\text{cm}$ between planes
- Great timing capabilities
- Sufficient position resolution by utilizing charge sharing
- Technology overlap w/ Roman pots

EM Calorimeter:

- 135 $2 \times 2 \times 7 \text{ cm}^3$ LYSO crystals
- Sensitivity for sub-GeV photons
- Can work at room temperature, stable against temperature gradients
- Good timing and position resolution

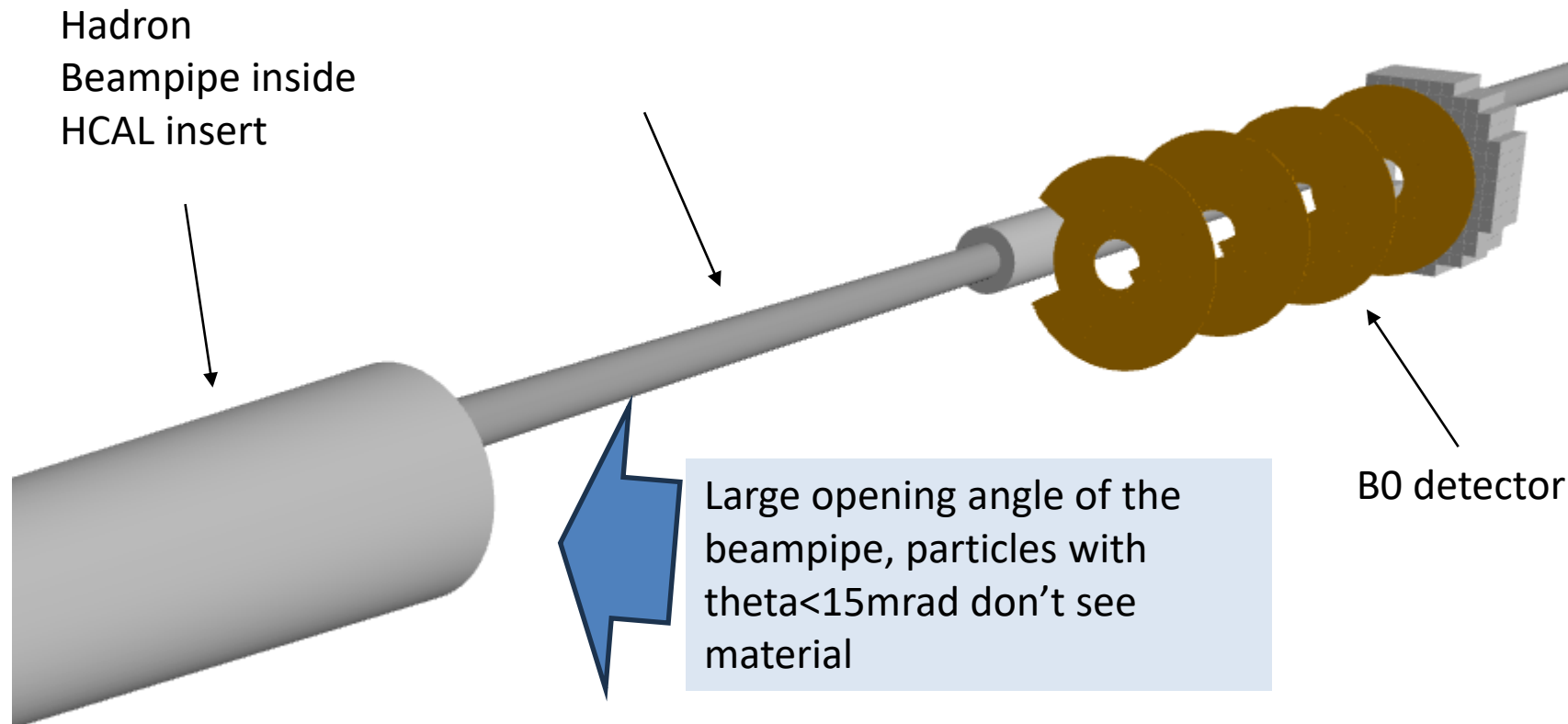


BOECAL Simulation status

Geometry

B0 Tracker: 4 AC-LGAD layers separated by 27 cm

~~10cm~~ 7cm long ~~PbWO4~~ LYSO crystals to form a B0 ECAL



BOECAL update

ECAL crystals

https://github.com/eic/epic/blob/main/compact/far_forward/B0_ECal.xml

- Crystal length form 10 cm to 7 cm:

```
<constant name="BOECal_IP_distance" value="683*cm"/>  
<constant name="BOECal_length" value="10*cm"/>
```



```
<constant name="BOECal_IP_distance" value="681.5*cm"/>  
<constant name="BOECal_length" value="7*cm"/>
```

<https://github.com/eic/epic/blob/main/compact/materials.xml>

```
<material name="LYSO"> <!-- given by the Taiwan Applied Crystals -->  
  <D type="density" unit="g/cm3" value="7.125"/>  
  <fraction n="0.71813" ref="Lu"/>  
  <fraction n="0.03613" ref="Y"/>  
  <fraction n="0.06338" ref="Si"/>  
  <fraction n="0.18046" ref="O"/>  
  <fraction n="0.00190" ref="Ce"/>  
</material>
```

- Crystal material PbWO4 -> LYSO

```
...  
<module  
  size="BOECal_CrystalModule_width"  
  size="BOECal_CrystalModule_width"  
  size="BOECal_CrystalModule_length"  
  vis="GreenVis"  
  material="PbWO4"/>  
...
```

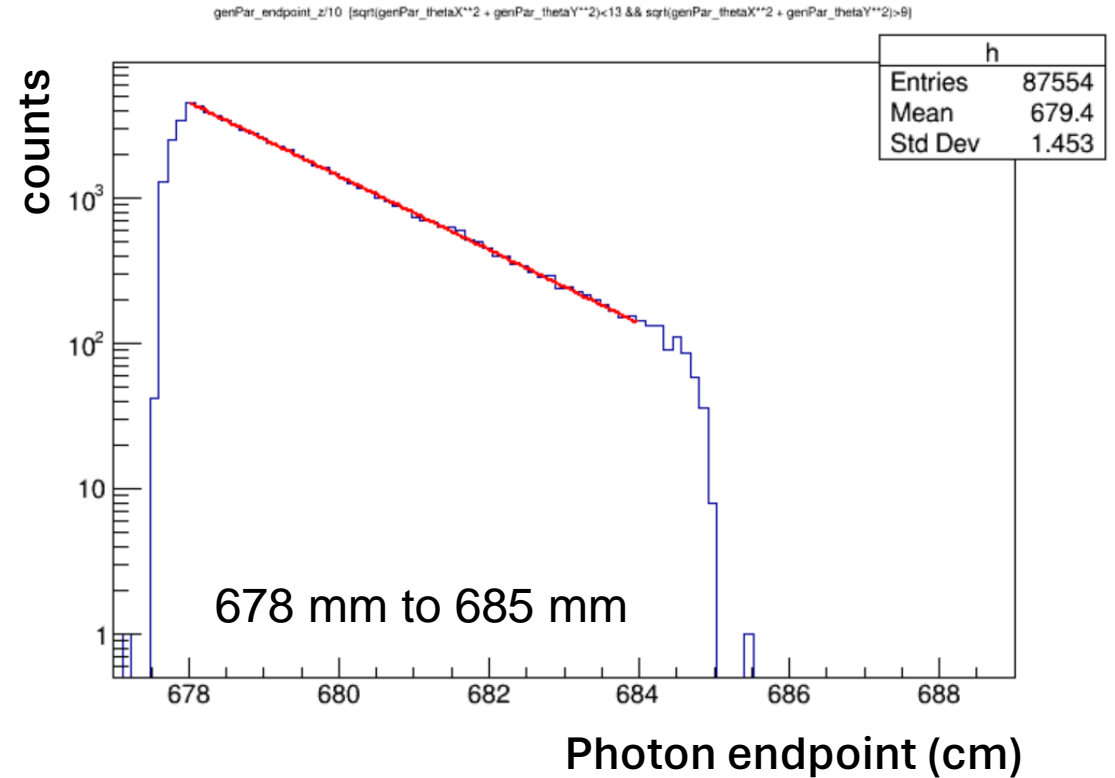
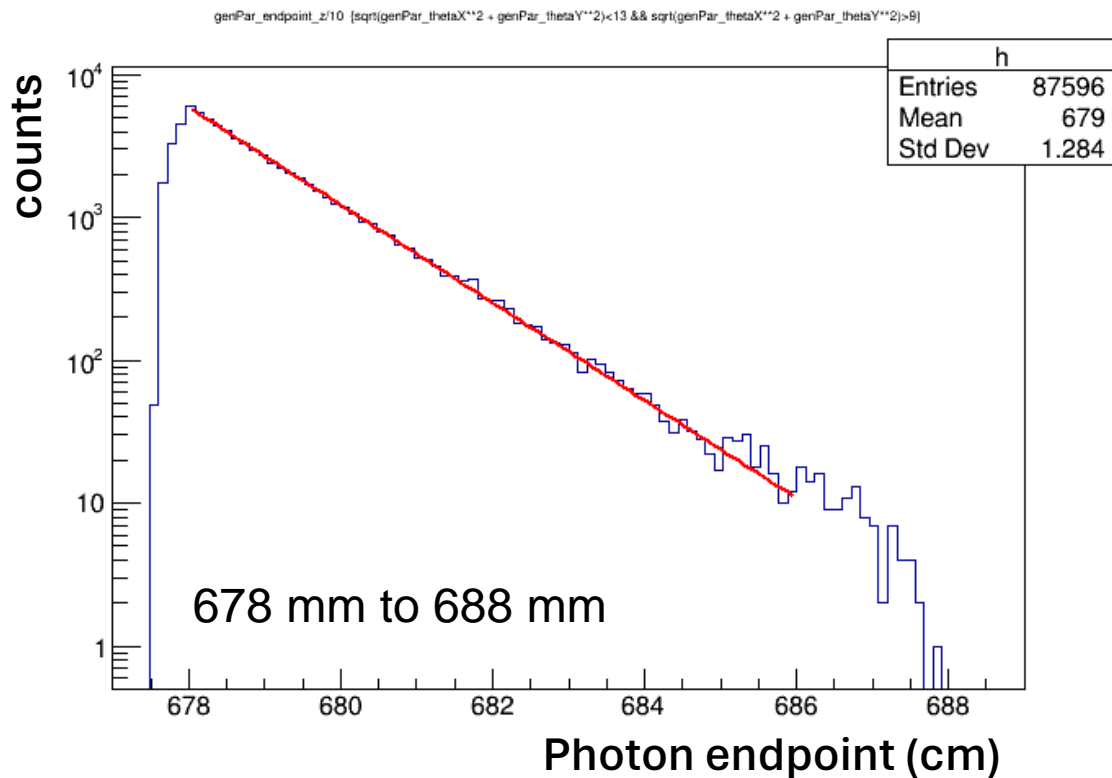


```
...  
<module  
  size="BOECal_CrystalModule_width"  
  size="BOECal_CrystalModule_width"  
  size="BOECal_CrystalModule_length"  
  vis="GreenVis"  
  material="LYSO"/>  
...
```

BOECAL update

ECAL crystals

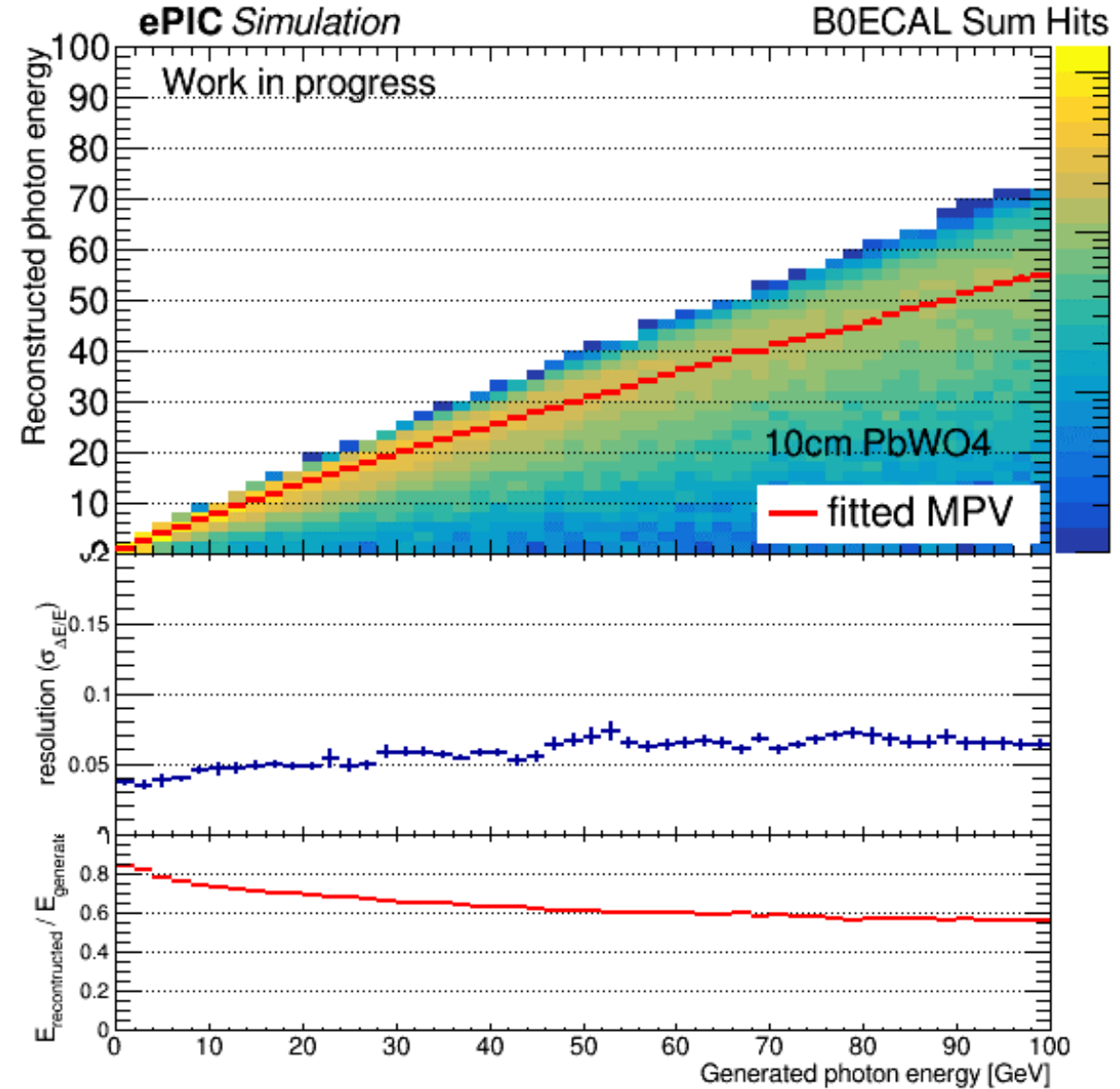
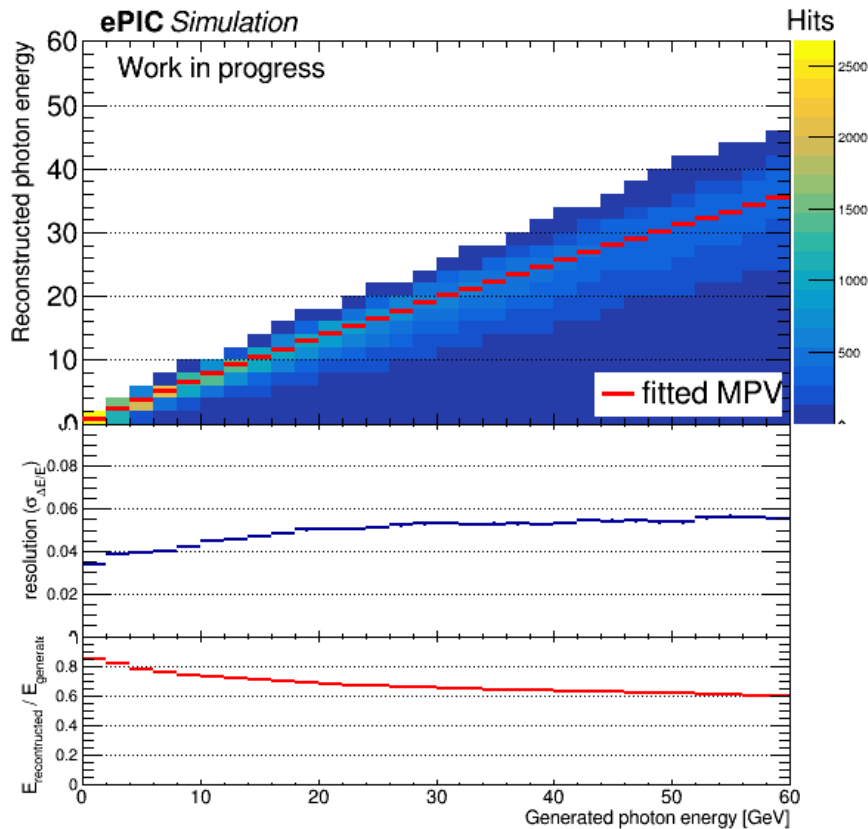
- X0 of PbWO4 is 0.92cm, of LYSO is 1.12.cm (20%)
- Density of PbWO4 is 8.3 g/cm³, LYSO is 7.125 g/cm³ (16%)
- Inspect the photon mean free path(end point along the Z axis), $\lambda=1.26\text{cm} \rightarrow \lambda=1.70\text{cm}$ (35%)



BOECAL update

ECAL crystals

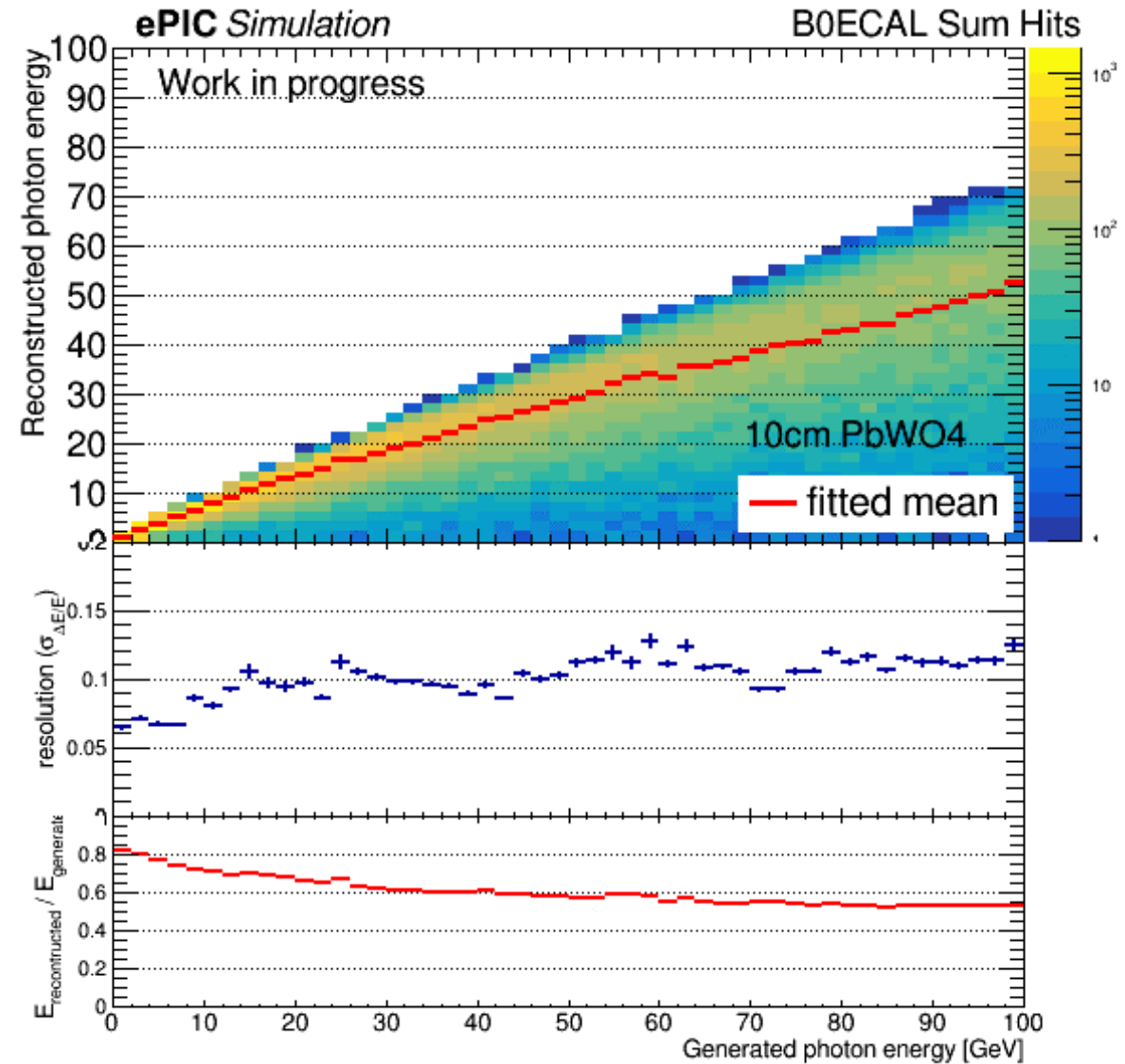
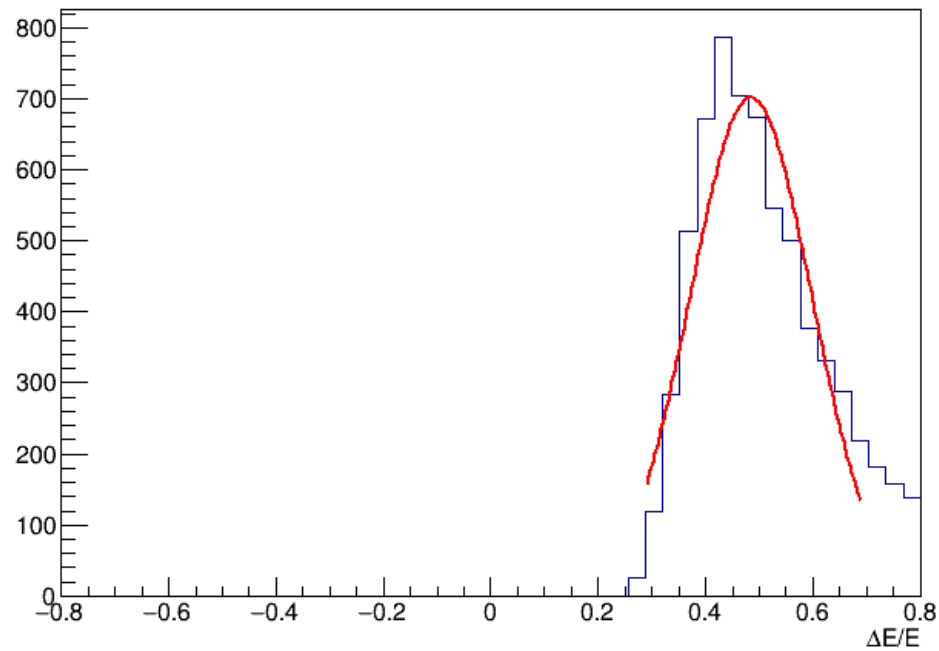
- Reproduce old results ([ePIC Cal. Jan 10 2023](#))



BOECAL update

ECAL crystals

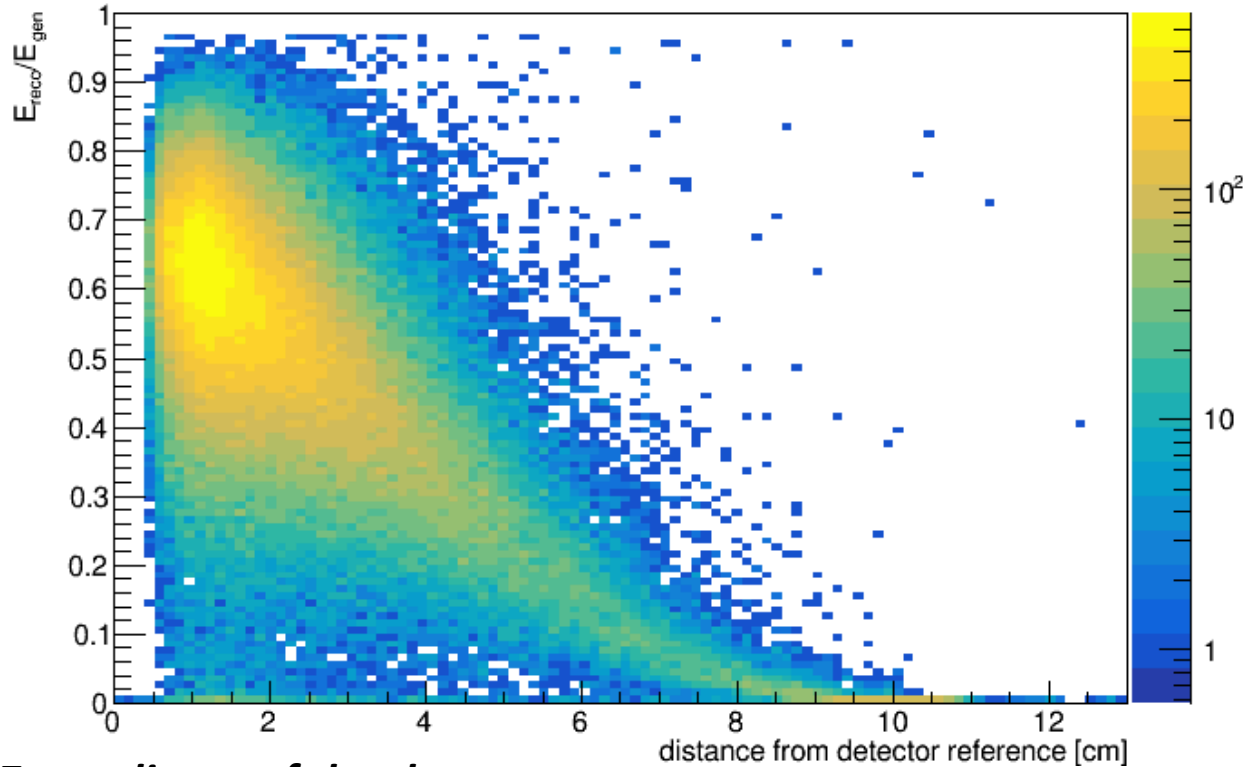
- Reproduce old results ([ePIC Cal. Jan 10 2023](#))
- Fit Gaussian (to obtain resolution)



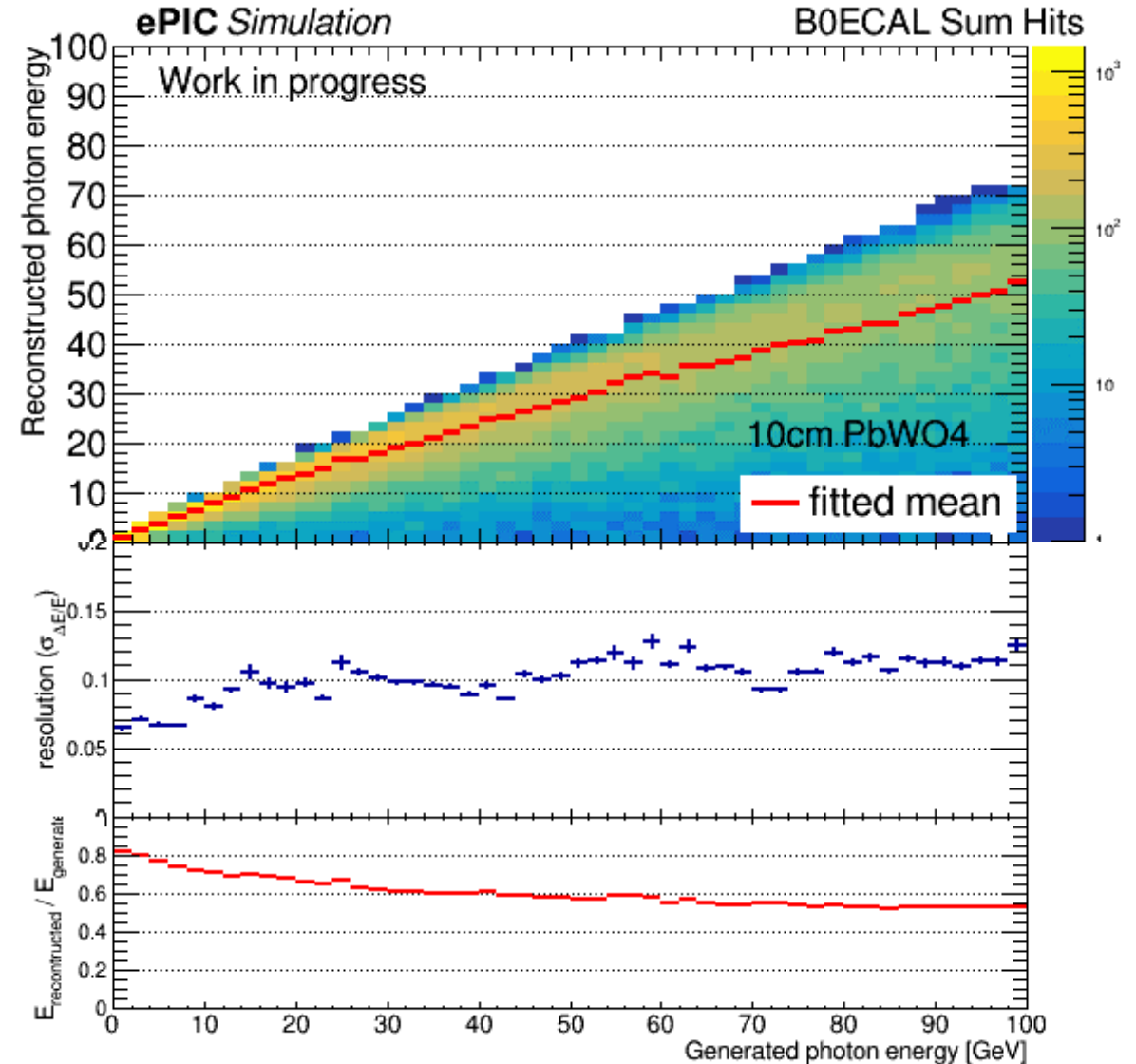
BOECAL update

ECAL crystals

- Reproduce old results ([ePIC Cal. Jan 10 2023](#))
- Fit Gaussian (to obtain resolution)



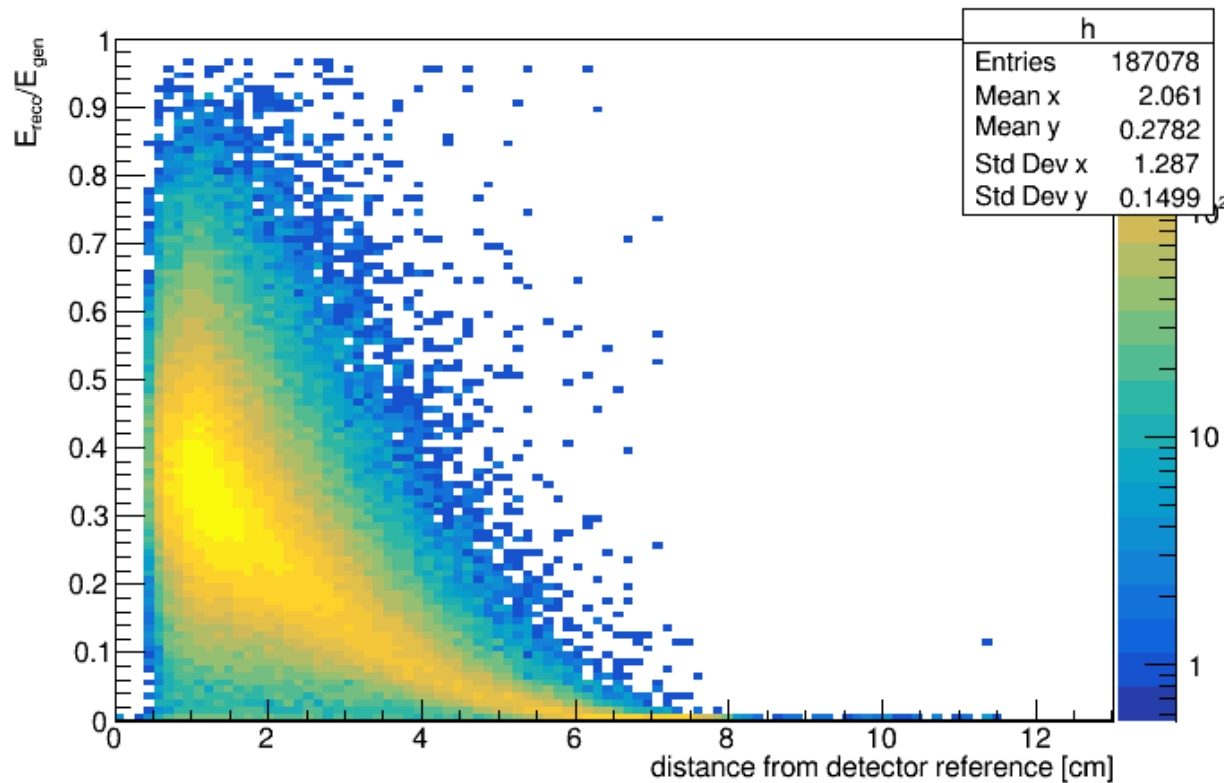
Z coordinate of the shower



BOECAL update

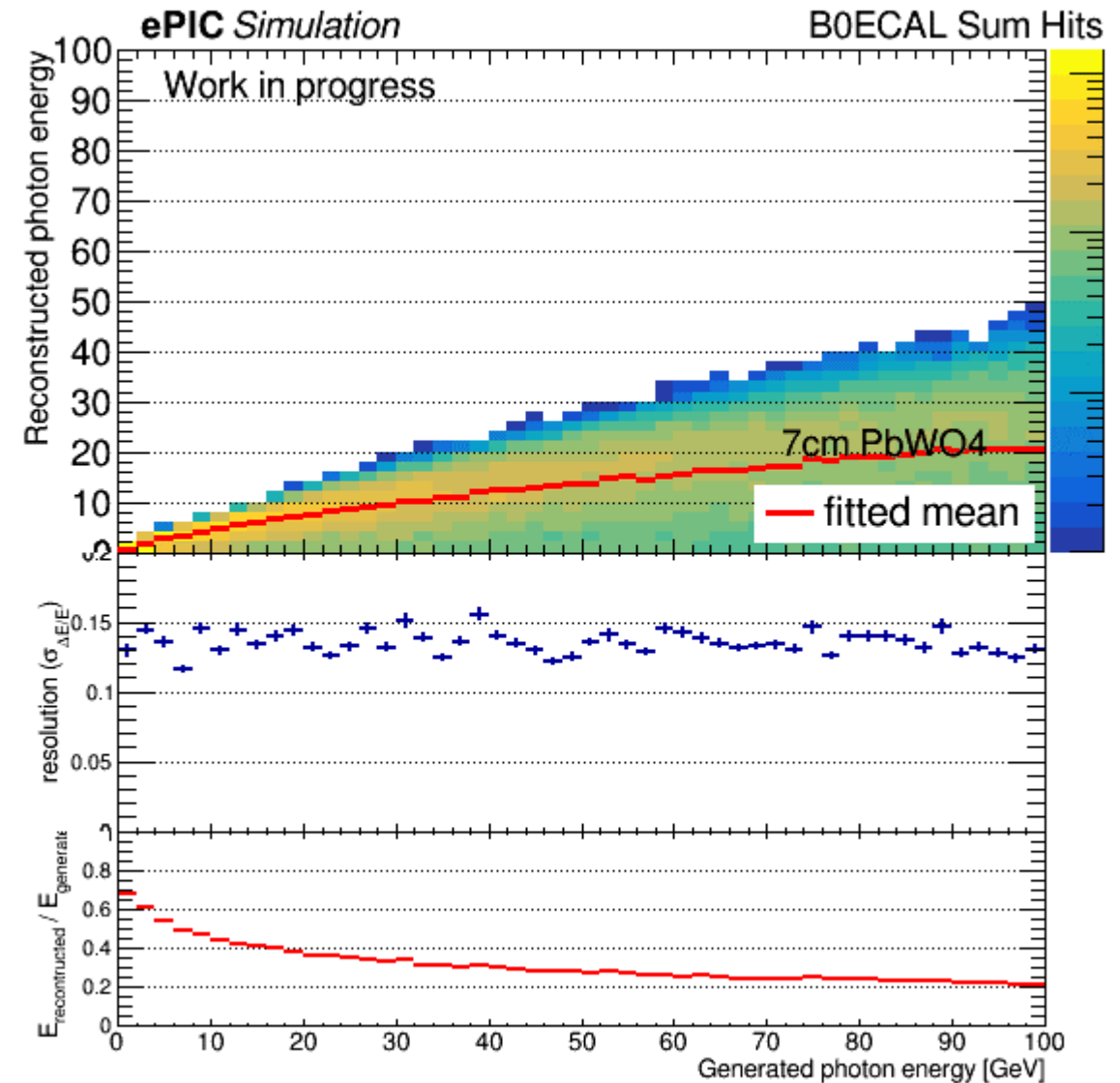
ECAL crystals

- Resolution calculated for PbWO4 crystals of 7cm
- Extracted for photons that hit B0 with $9 < \theta < 13 \text{ mrad}$



Z coordinate of the shower

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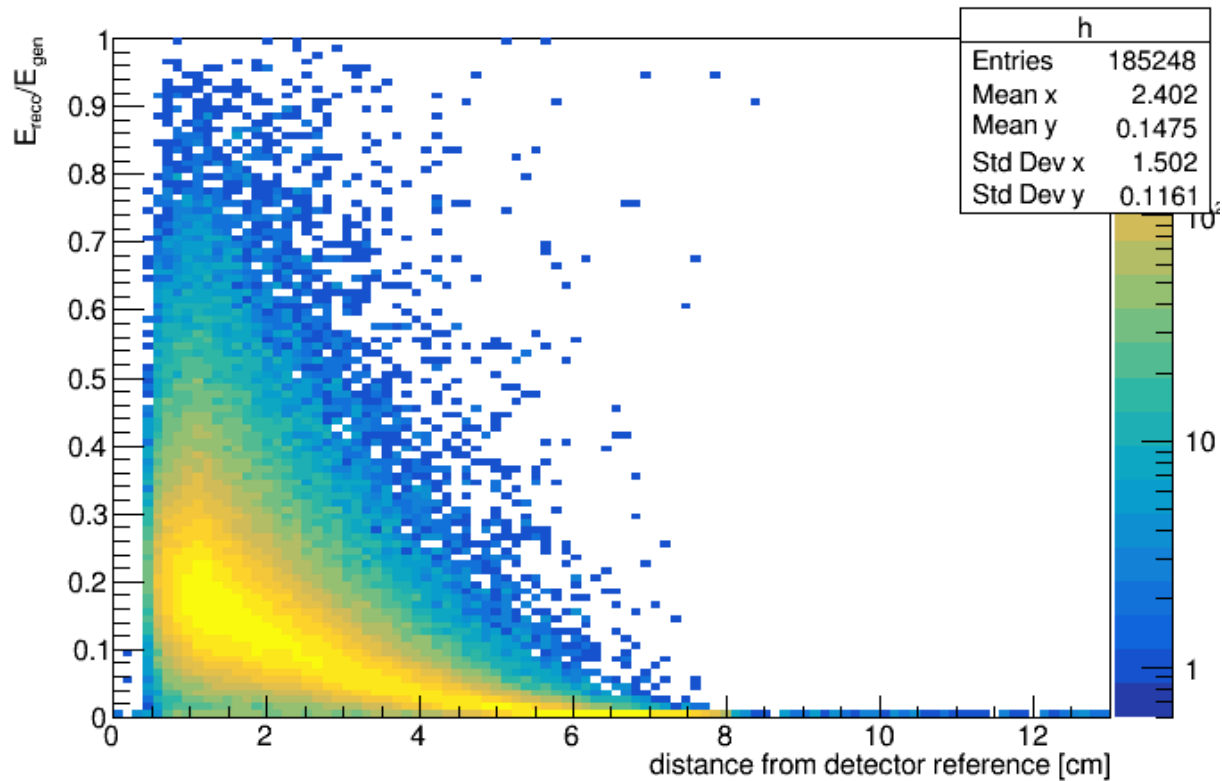


M. Pitt @ EPIC Far-Forward Weekly Meeting

BOECAL update

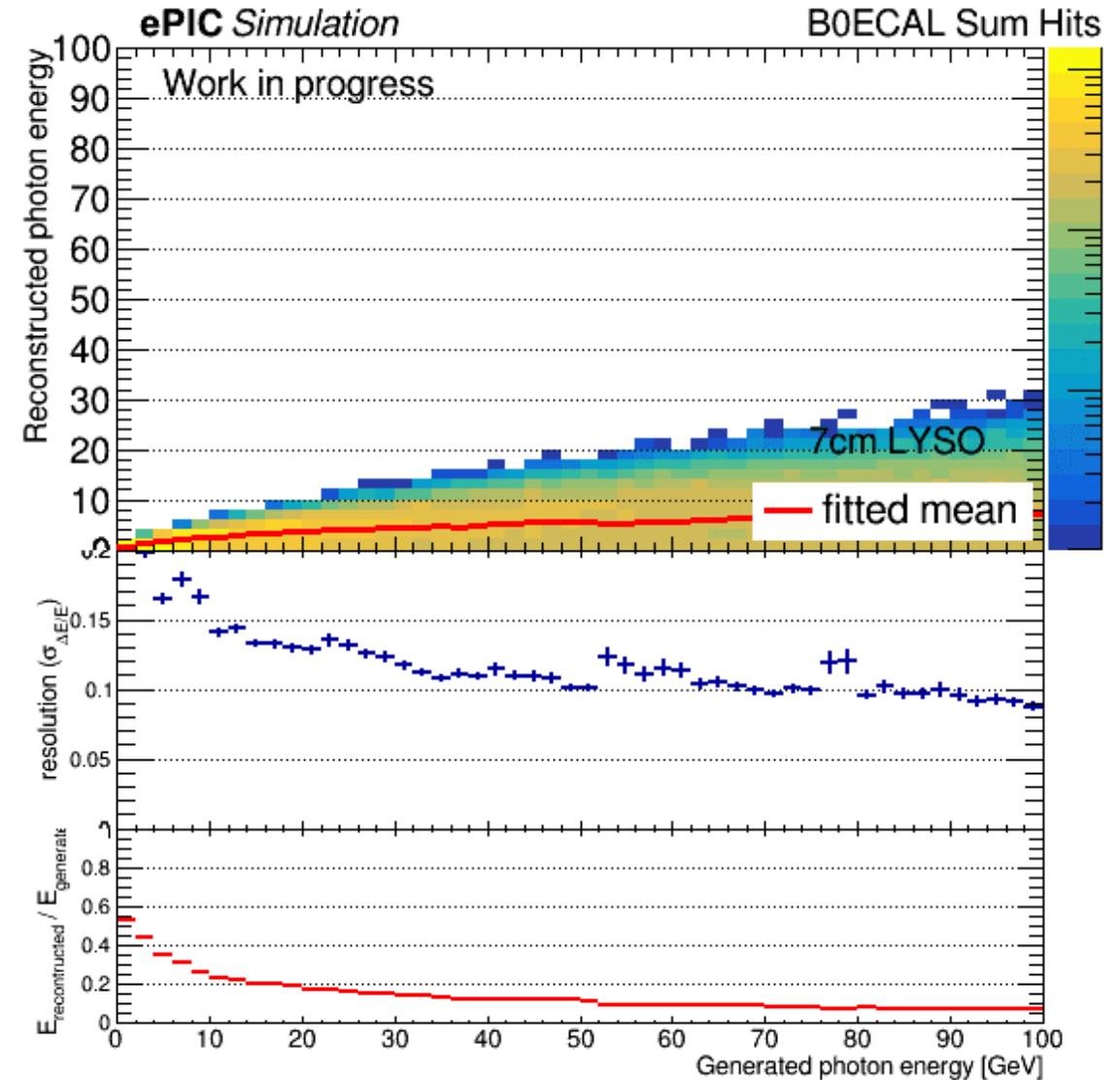
ECAL crystals

- Resolution calculated for LYSO crystals of 7cm
- Extracted for photons that hit B0 with $9 < \theta < 13 \text{ mrad}$



Z coordinate of the shower

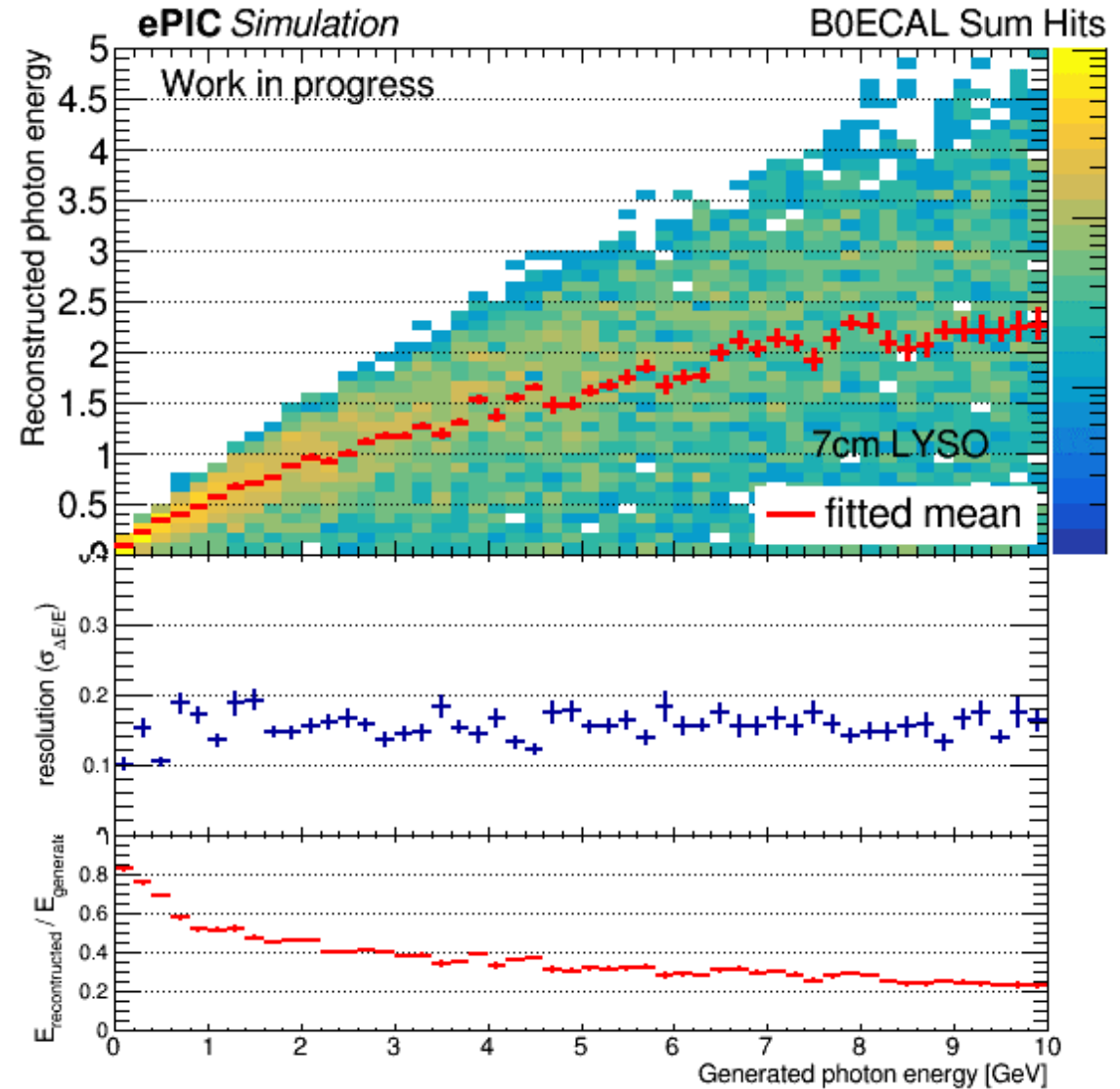
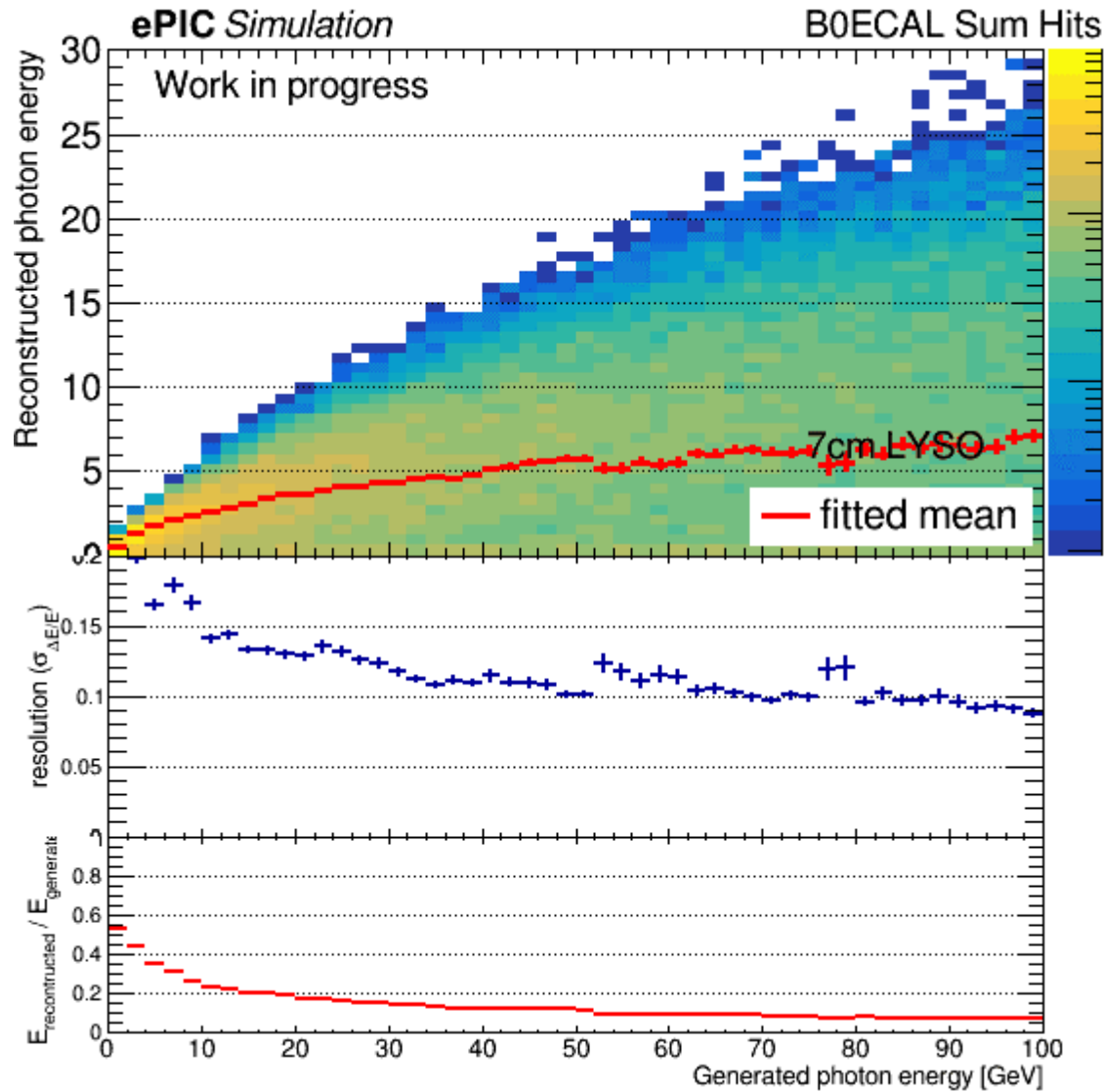
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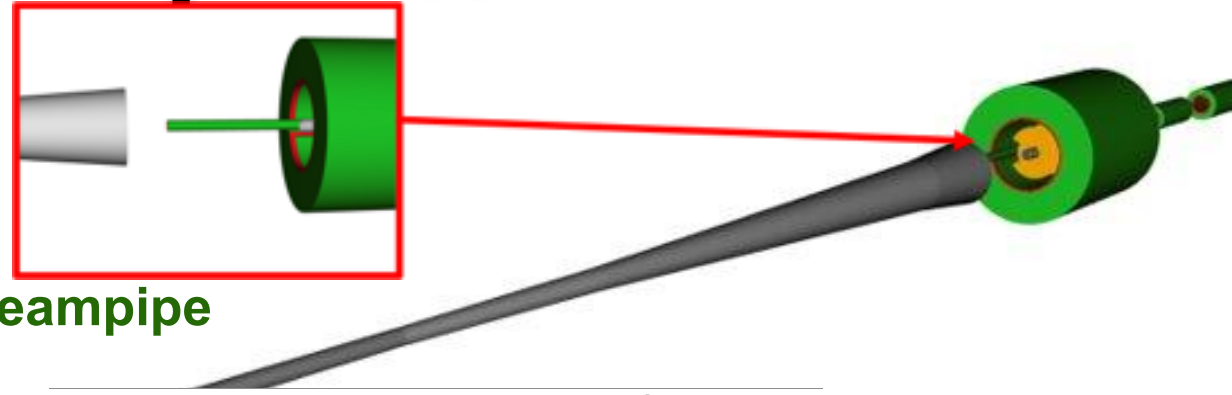
10

BOECAL update

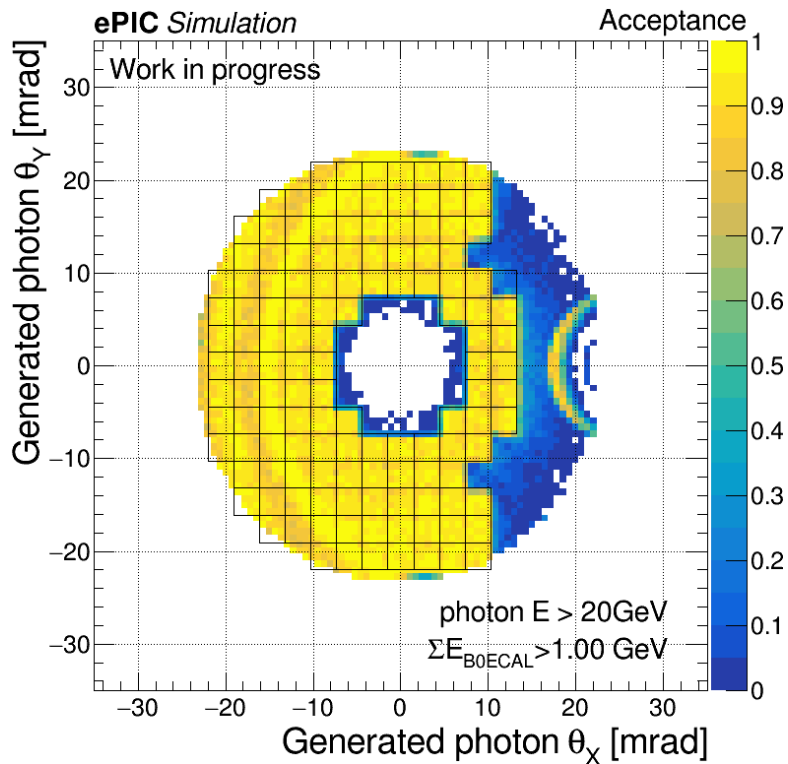


BOECAL acceptance

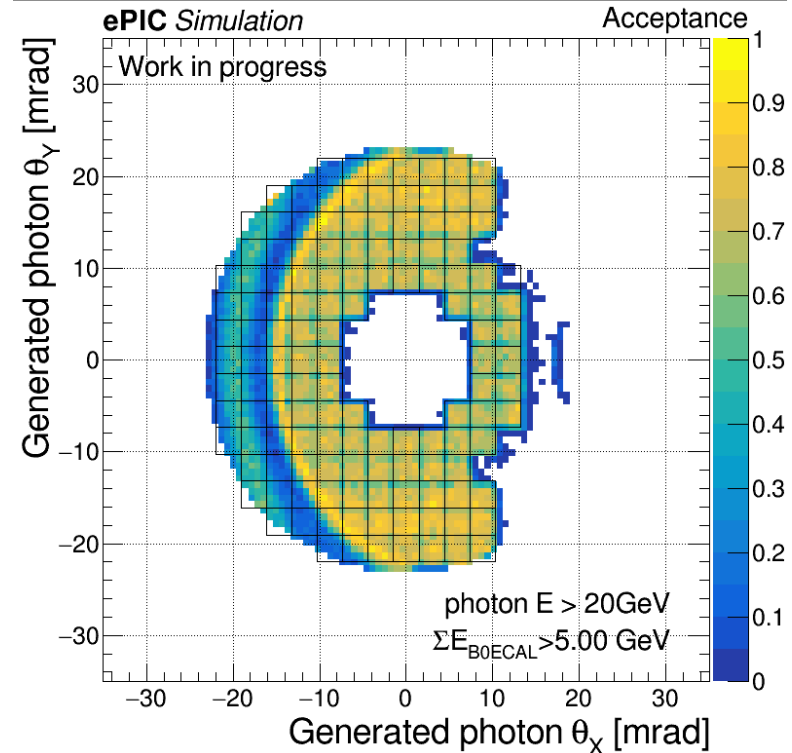
- Acceptance if $E > E_{th}$
- Very low material budget in $5 < \eta < 5.5$



Particles within $5.5 < \theta < 15$ mrad don't cross the beampipe

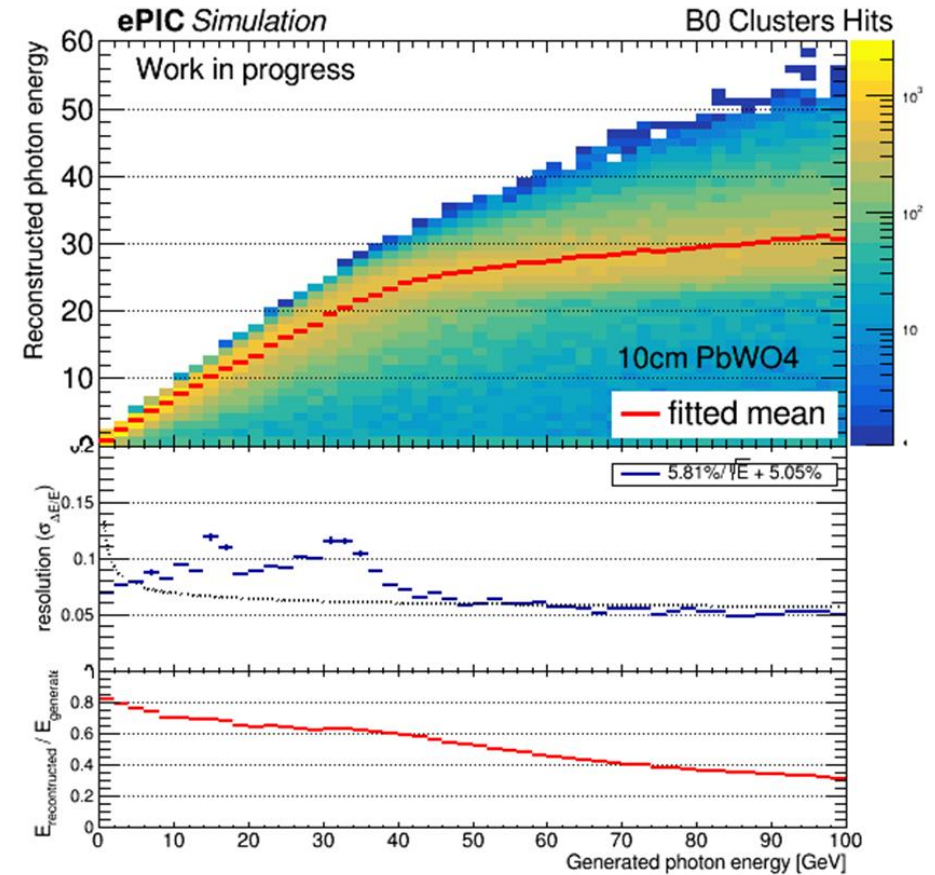
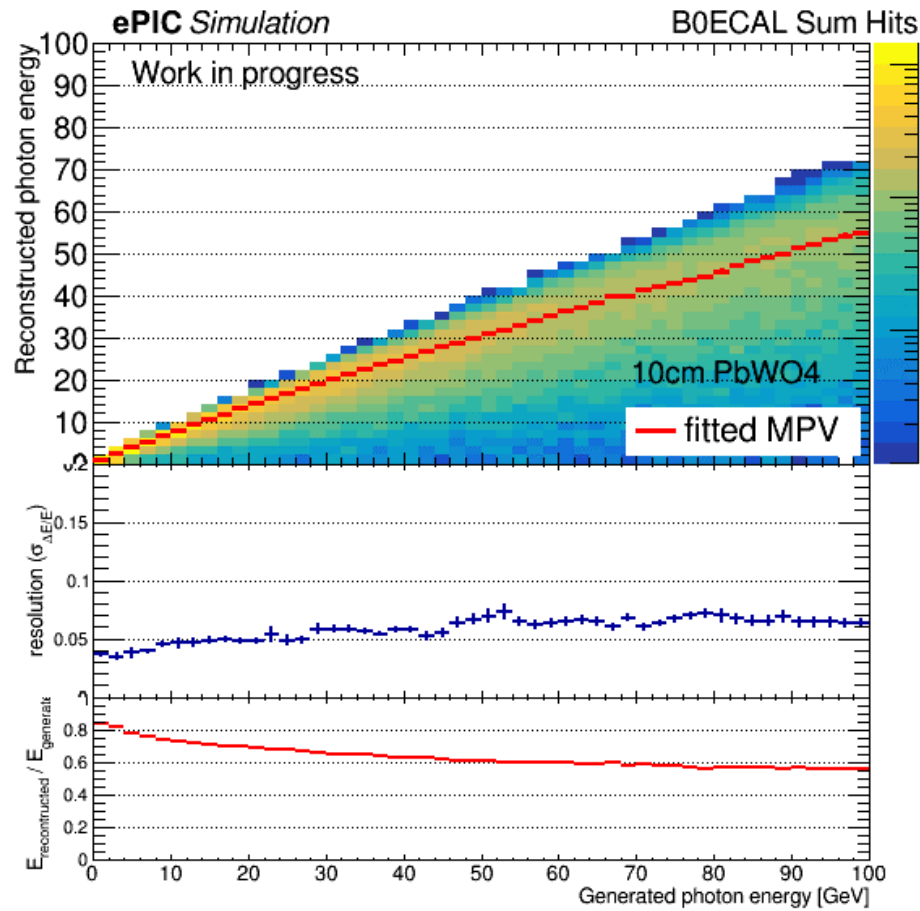


threshold



BOECAL reconstruction

- Sum cluster energy is used instead of Sum if hit energy



Summary and discussion

Summary:

- B0ECAL geometry change: 7 cm of LYSO
- Loss in resolution (x2) and shower is less contained in the crystals
- Pending issues
 - Energy saturation observed in the reconstruction algorithm
 - Photons with $15 < \theta < 23$ intersect central beampipe (not clear if it is expected)

Discussion:

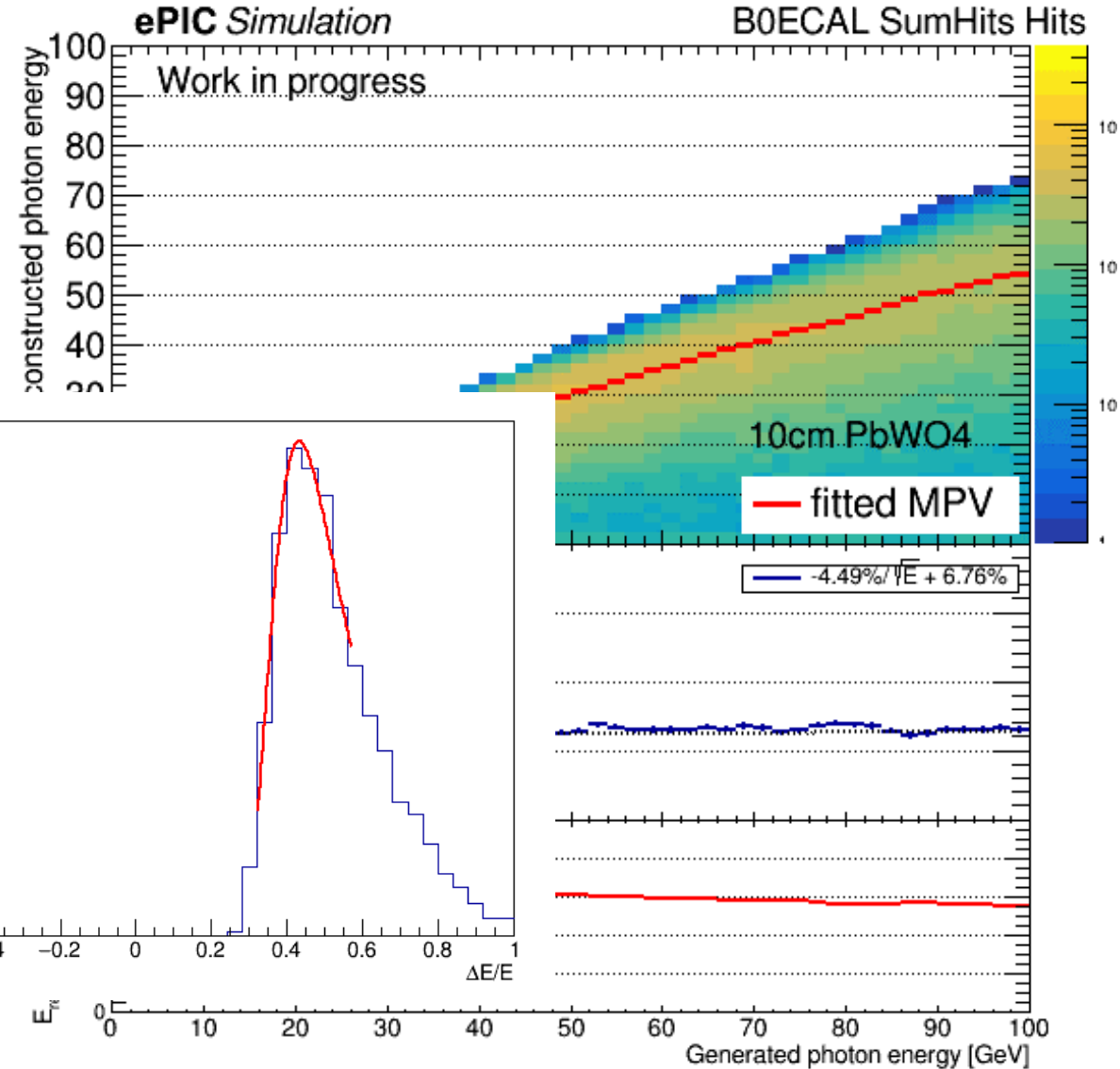
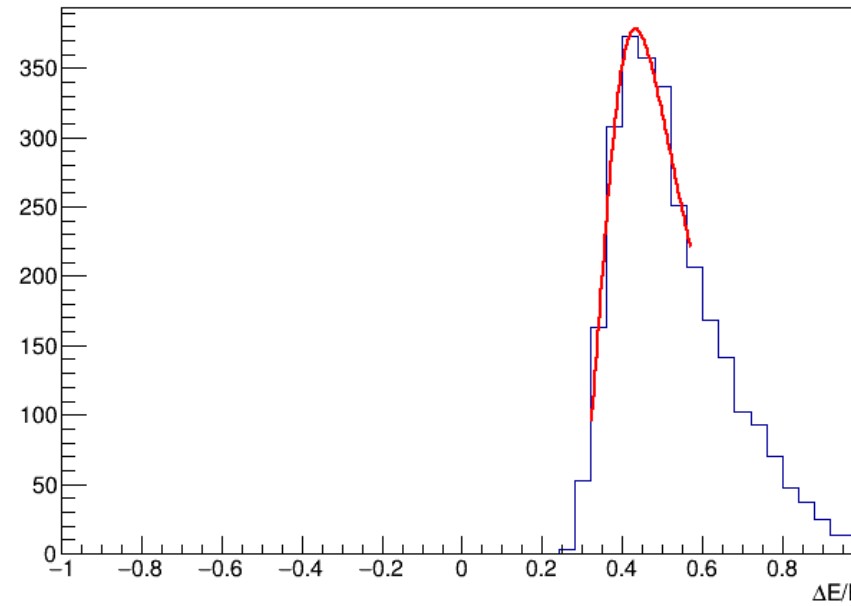
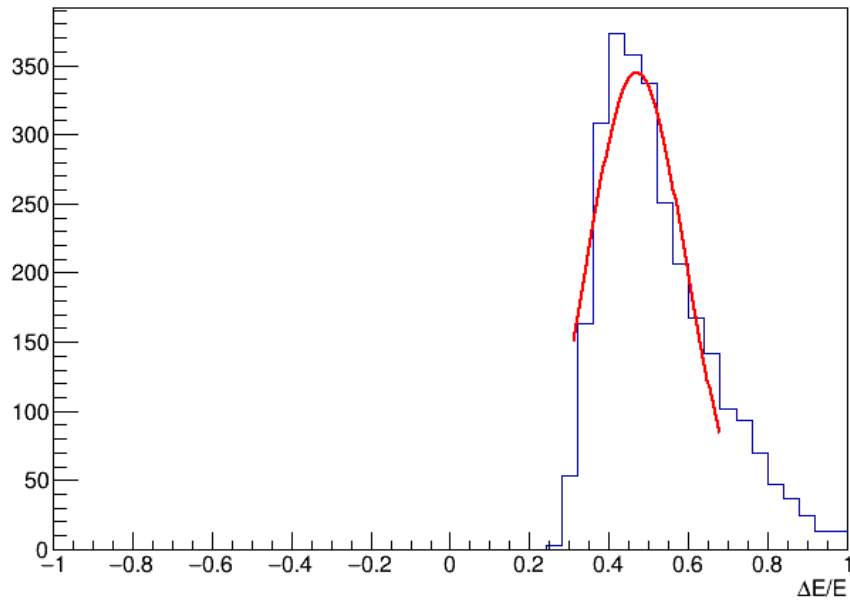
- Can we leave with 7cm LYSO > Can we increase crystal length?
 - We have space in the magnet
 - We can make a shorter distance between 3rd and 4th LGAD planes

Backup

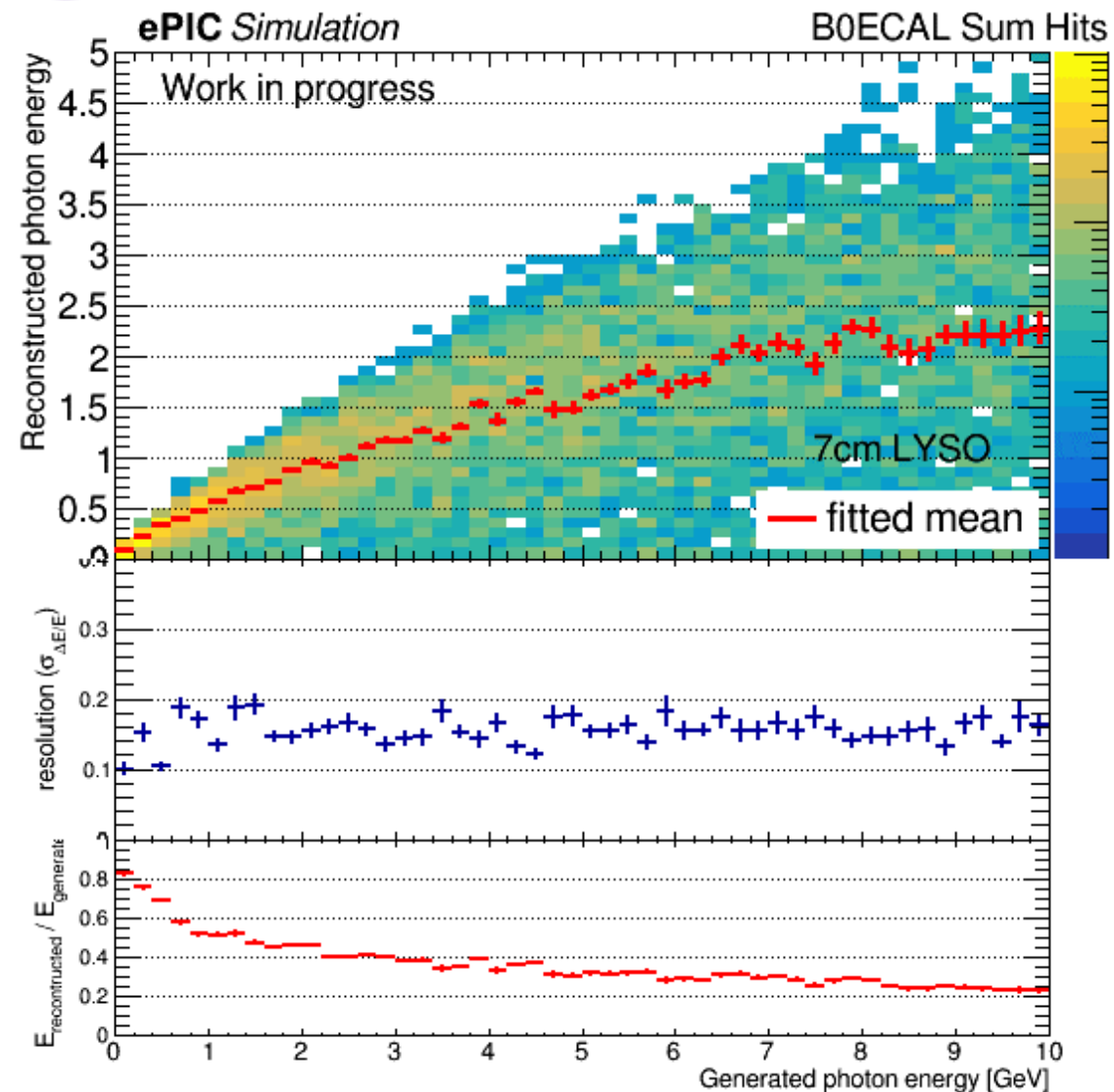
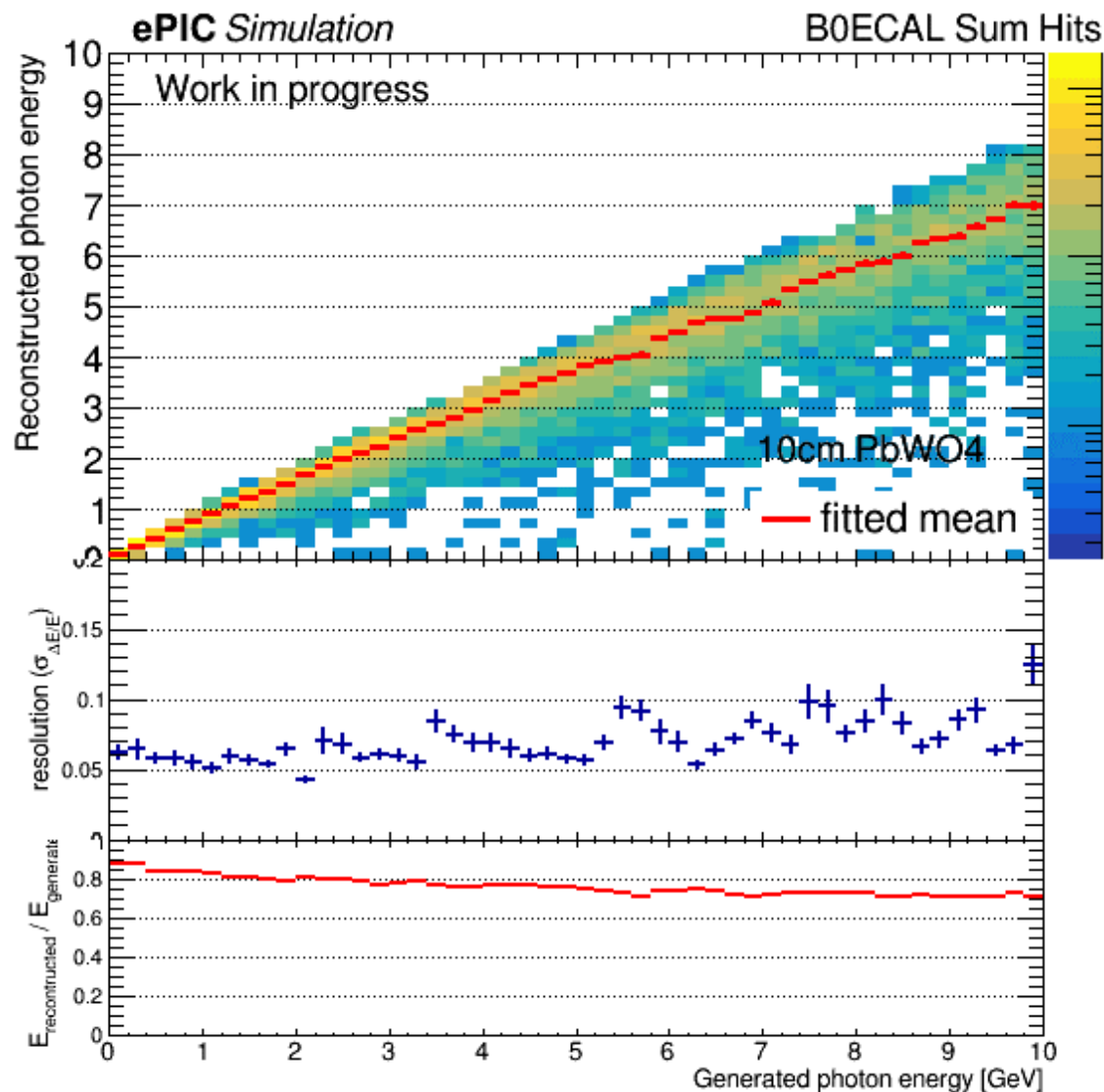
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ECAL crystals

- Fitted Gauss / MPV



BOECAL update



BOECAL update

