Occupancies and resolutions for projective vs perpendicular geometry of SPD ECAL

Andrei Maltsev

JINR, Dubna

SPD Physics & MC meeting

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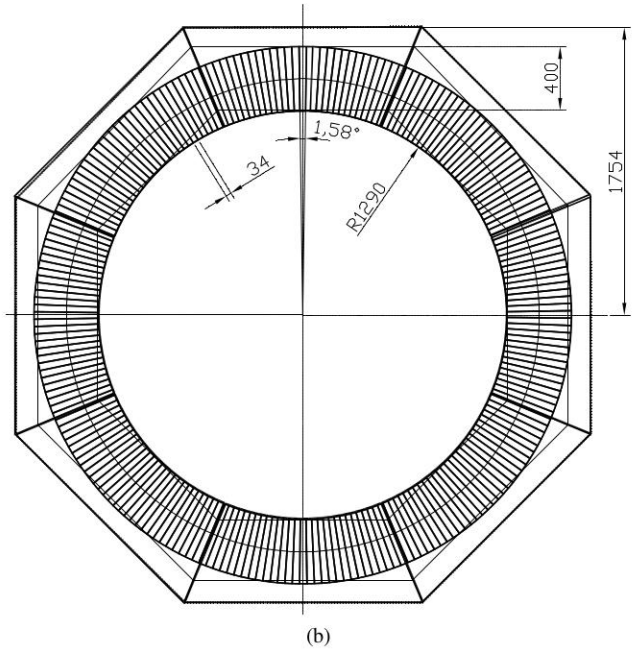
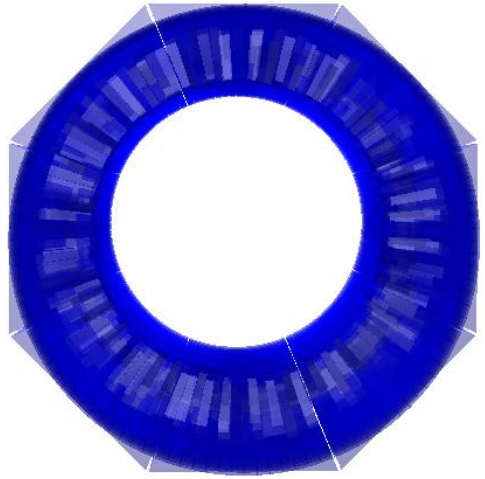
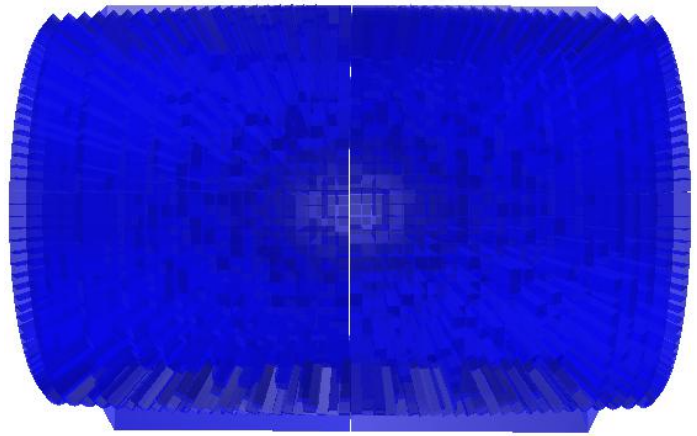
ECAL geometry



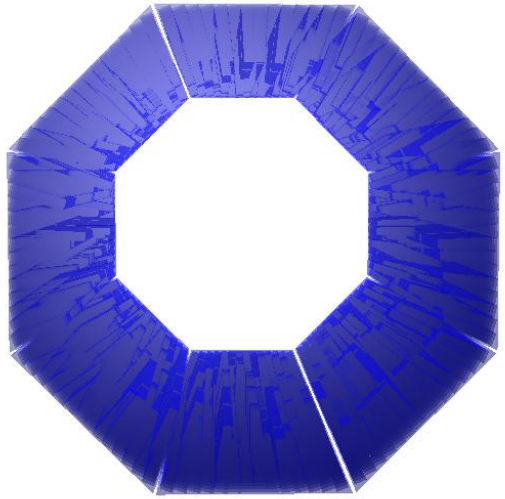
CDR ECAL barrel geometry

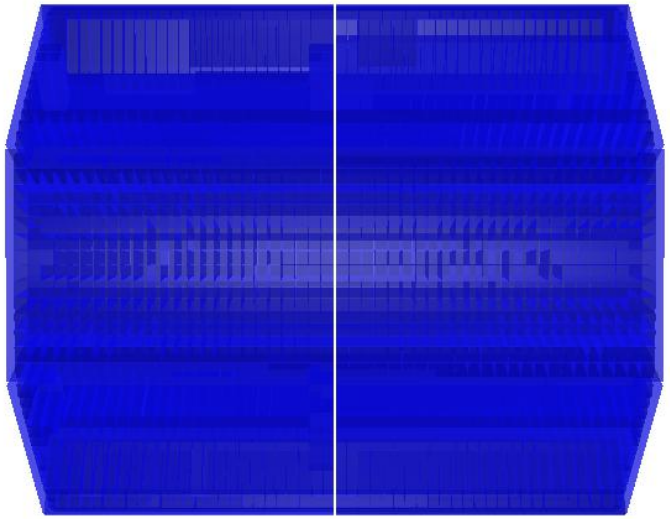
Option: **Projective**





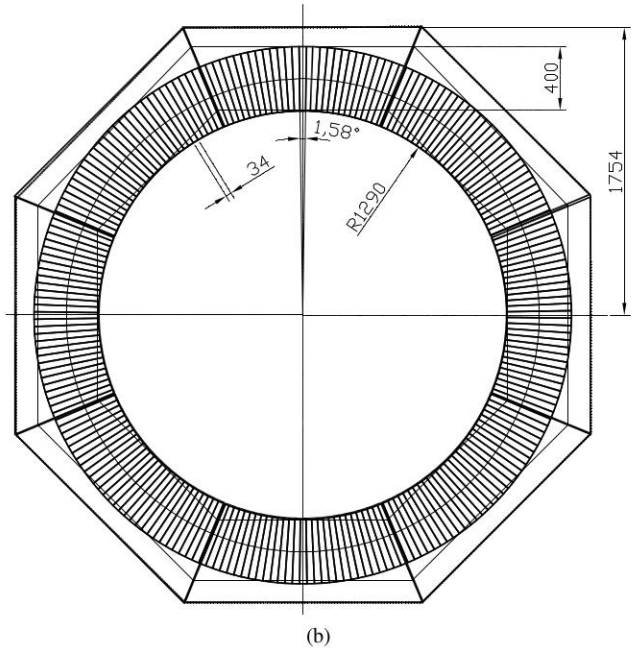
Option: **Perpendicular**





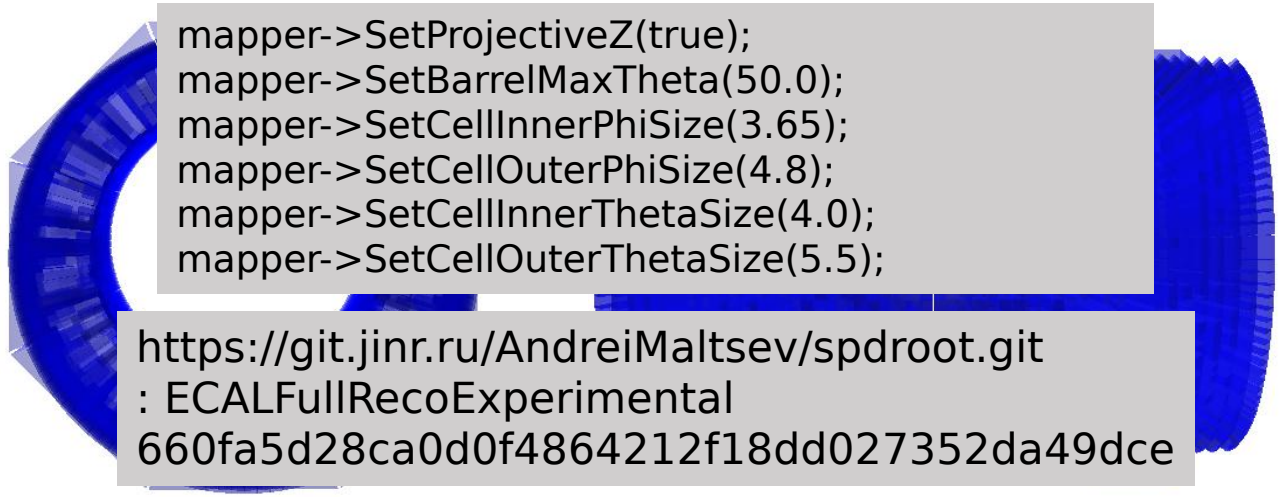
Cell sizes at inner sides are equal (~3.8 cm)

ECAL geometry



CDR ECAL barrel geometry

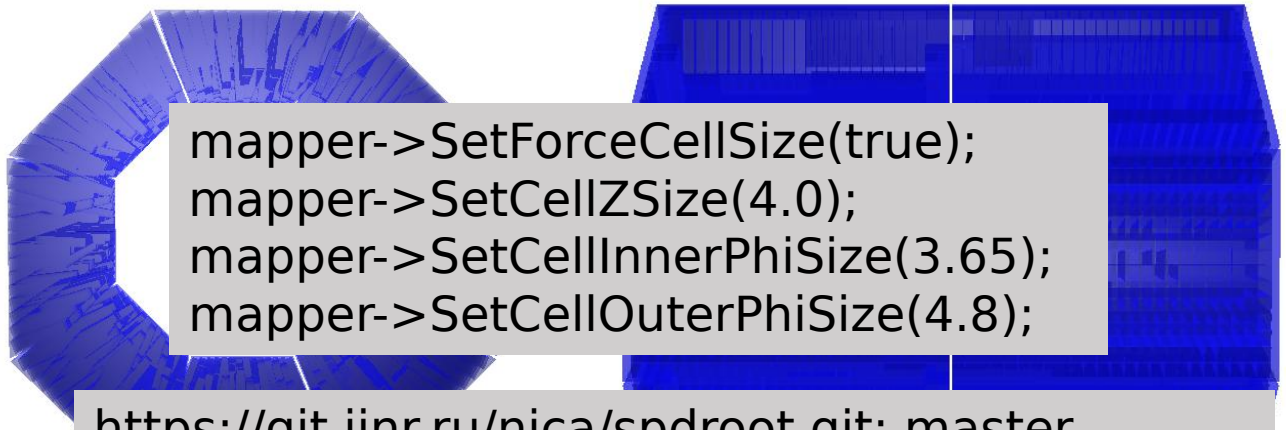
Option: **Projective**



```
mapper->SetProjectiveZ(true);
mapper->SetBarrelMaxTheta(50.0);
mapper->SetCellInnerPhiSize(3.65);
mapper->SetCellOuterPhiSize(4.8);
mapper->SetCellInnerThetaSize(4.0);
mapper->SetCellOuterThetaSize(5.5);
```

https://git.jinr.ru/AndreiMaltsev/spdroot.git
: ECALFullRecoExperimental
660fa5d28ca0d0f4864212f18dd027352da49dce

Option: **Perpendicular**



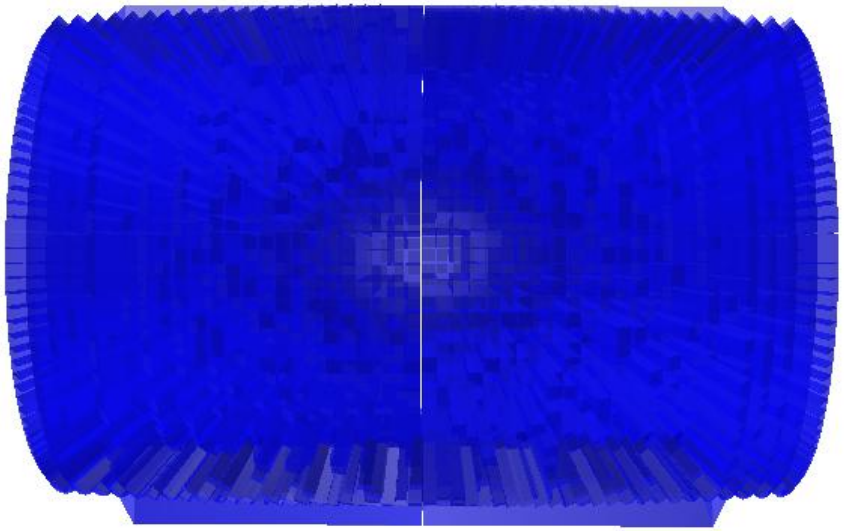
```
mapper->SetForceCellSize(true);
mapper->SetCellZSize(4.0);
mapper->SetCellInnerPhiSize(3.65);
mapper->SetCellOuterPhiSize(4.8);
```

https://git.jinr.ru/nica/spdroot.git: master
1458c31bbc4016b48fe1dfcd13962bd5a5003c6f

Cell sizes at inner sides are equal (~3.8 cm)

Reconstruction

- Sum all MC points in scintillator for each cell (“HitProducing”)
- Cell energy calibration
- Group neighboring cells above 20 MeV (“Clustering”)
- Reconstruct energy and position of the shower:
  modified center-of-gravity with **log.weighting**

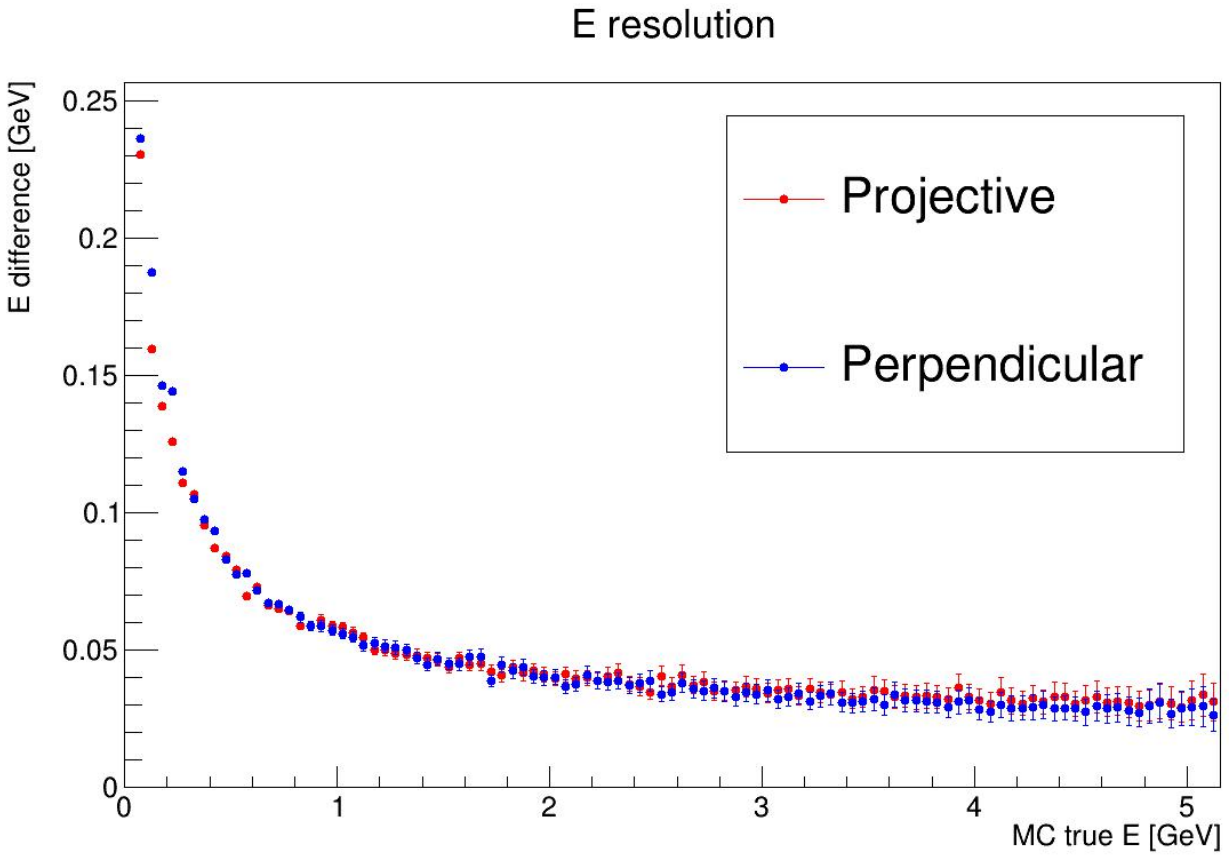


$$x_c = \frac{\Sigma_i W_i(E_i) x_i}{\Sigma_i W_i(E_i)} \qquad W_i^{(linear)}(E_i) = E_i,$$

$$W_i^{(log)}(E_i) = Max\{0, a_0 + ln(E_i) - ln(E_{total})\}.$$

http://spd.jinr.ru/wp-content/uploads/2020/05/2020-05-13_terkulov.pdf

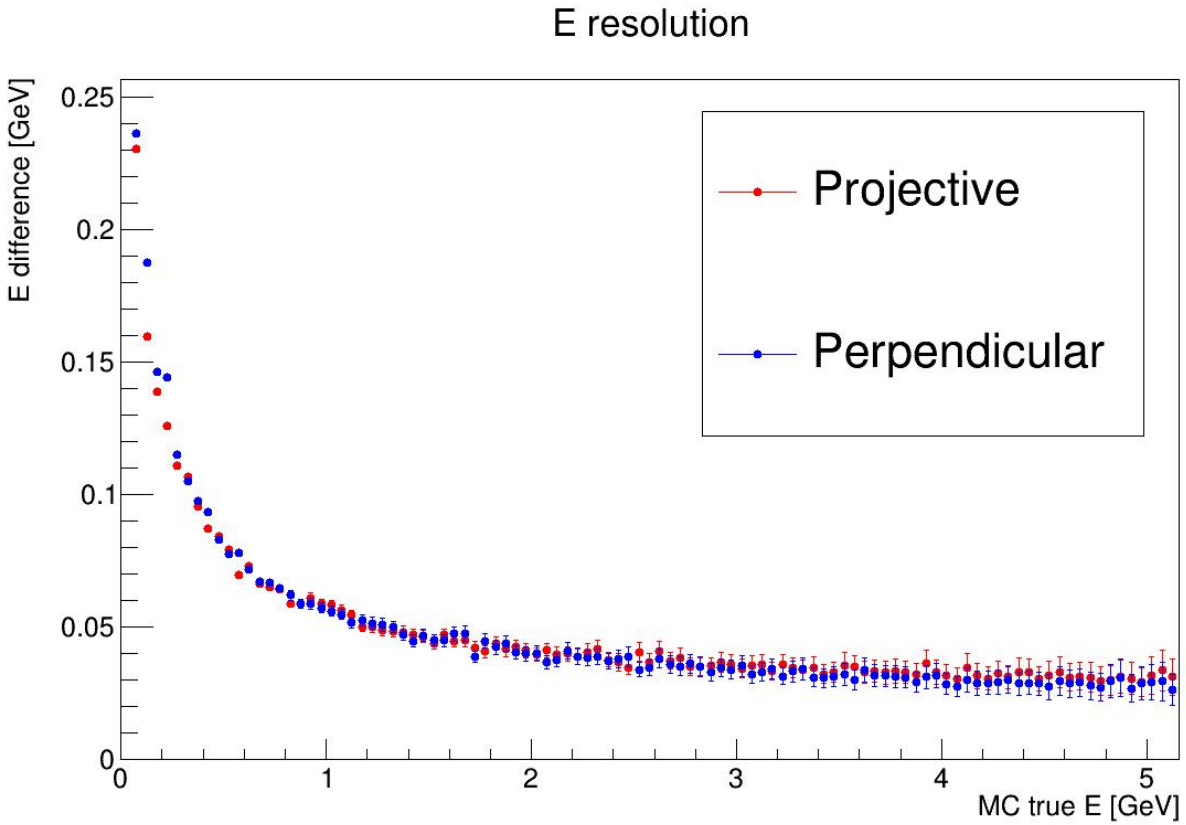
Energy resolution (photons)

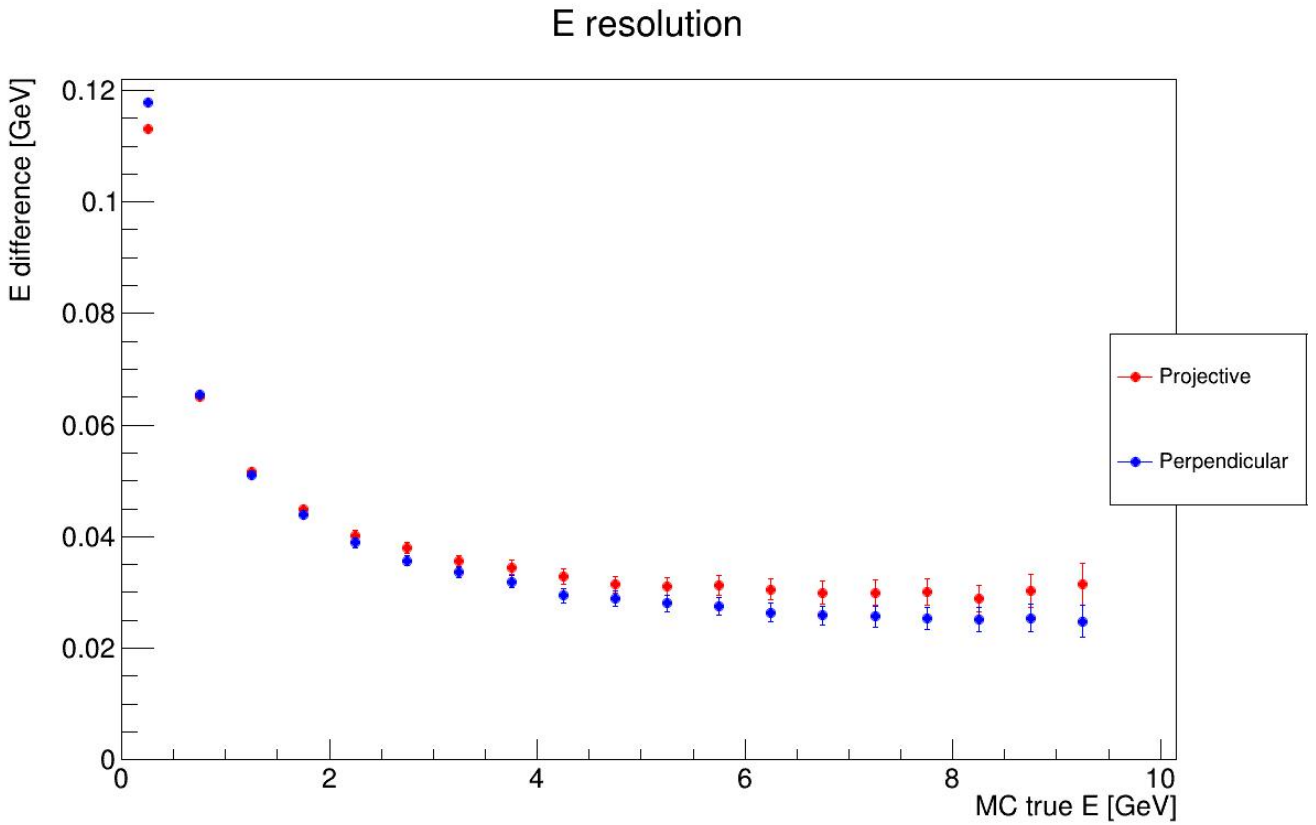


- Using modified “center-of-gravity” with logarithmic weighting
- Not using perpendicular-specific algorithms (might improve resolution)
- Included: sampling fluctuations, cell threshold effect (20 MeV threshold)
- Not included: photoelectron statistics, light attenuation

Significant differences only at low ($\lessapprox$ 200-300 MeV) and very high ($\gtrapprox$ 7-10 GeV) energies

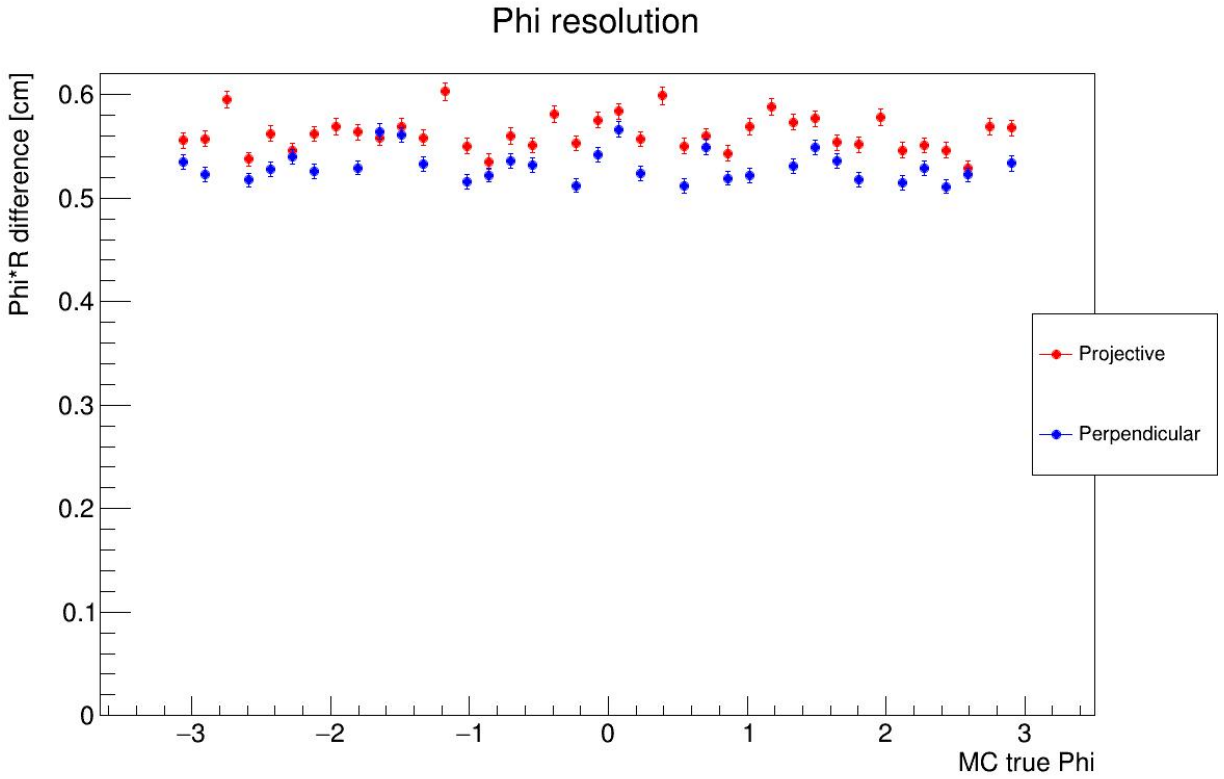
Energy resolution (photons)

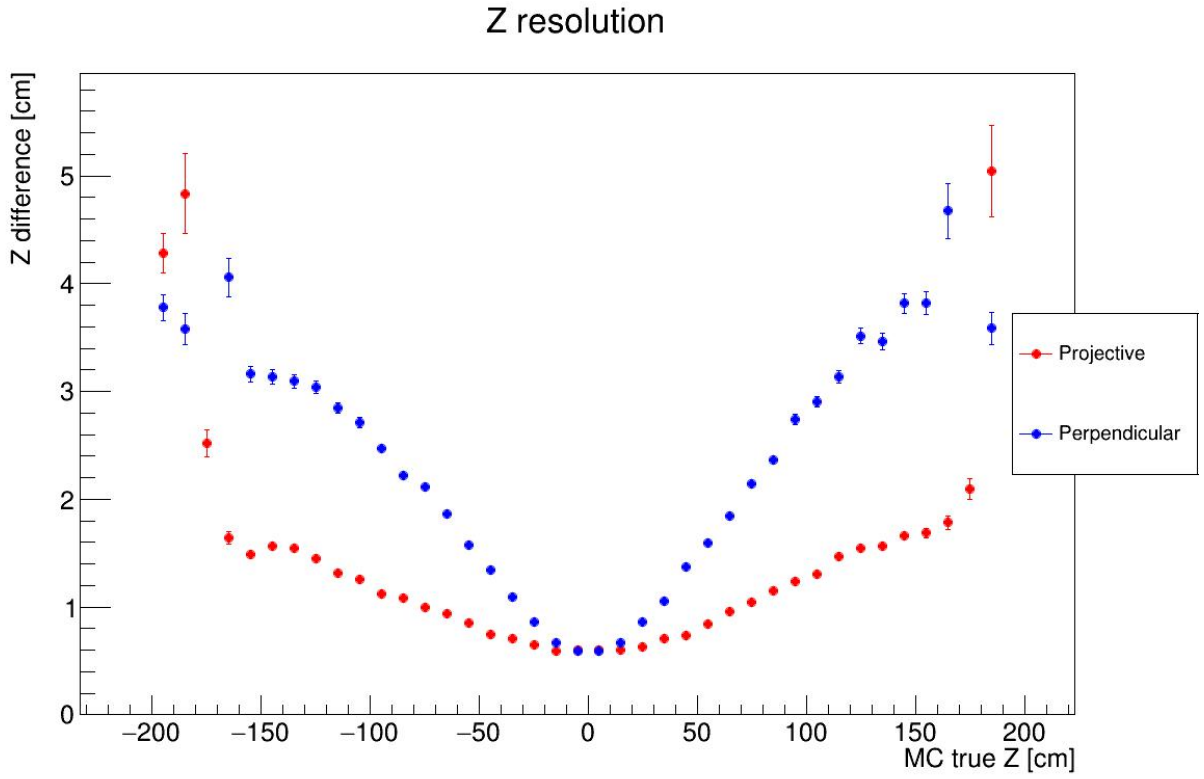




Significant differences only at low (≲ 200-300 MeV) and very high (≳ 5 GeV) energies

Position resolution (photons)

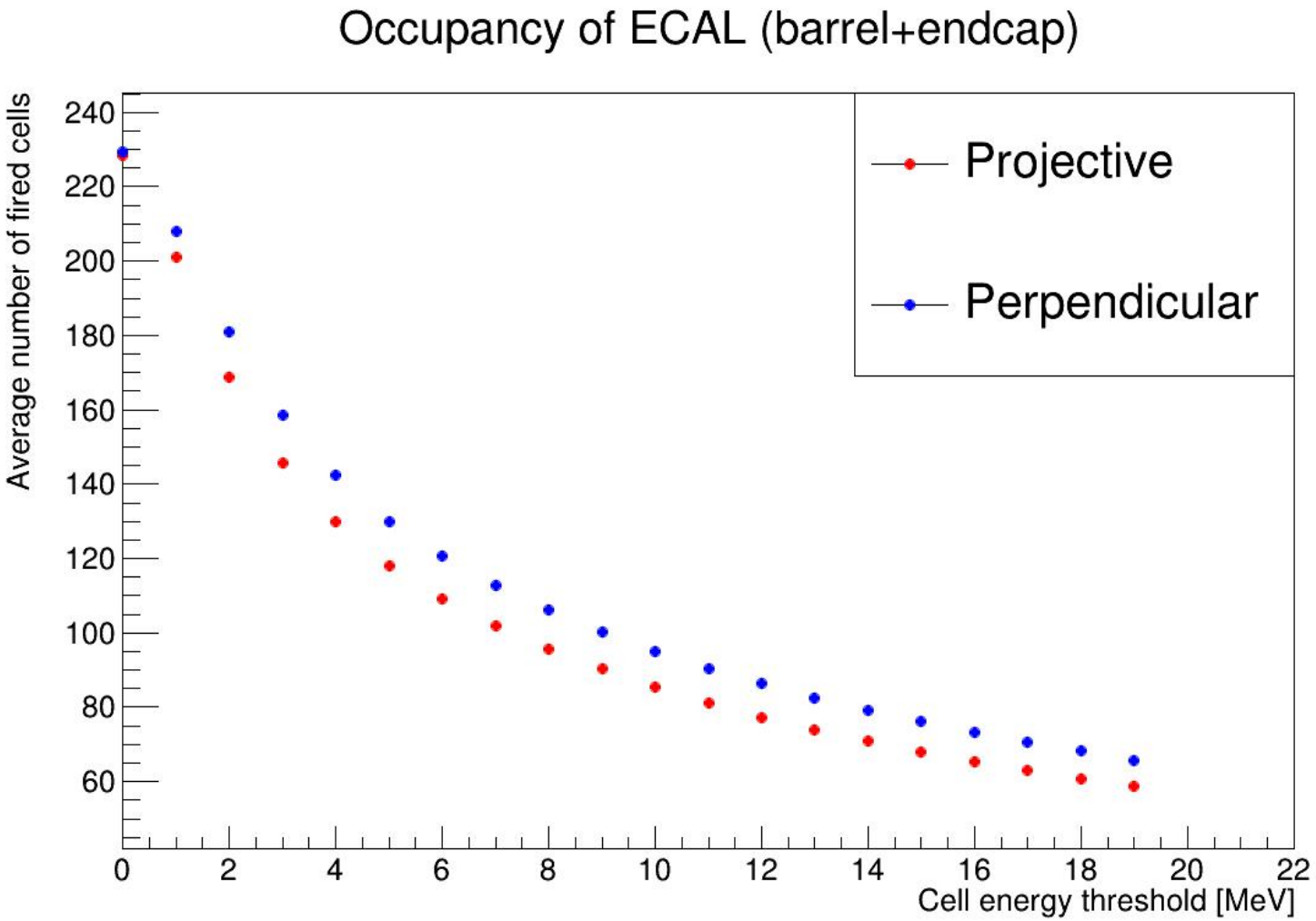




Small difference in φ resolution may occur due to differences in Z=const cross section (see slide 2)

Large |Z| effects due to absense of Endcap-Barrel “bridging”

Occupancies (minimum bias at sqrt(s) = 26 GeV)



~ 10% decrease in occupancy when using projective geometry

Conclusions

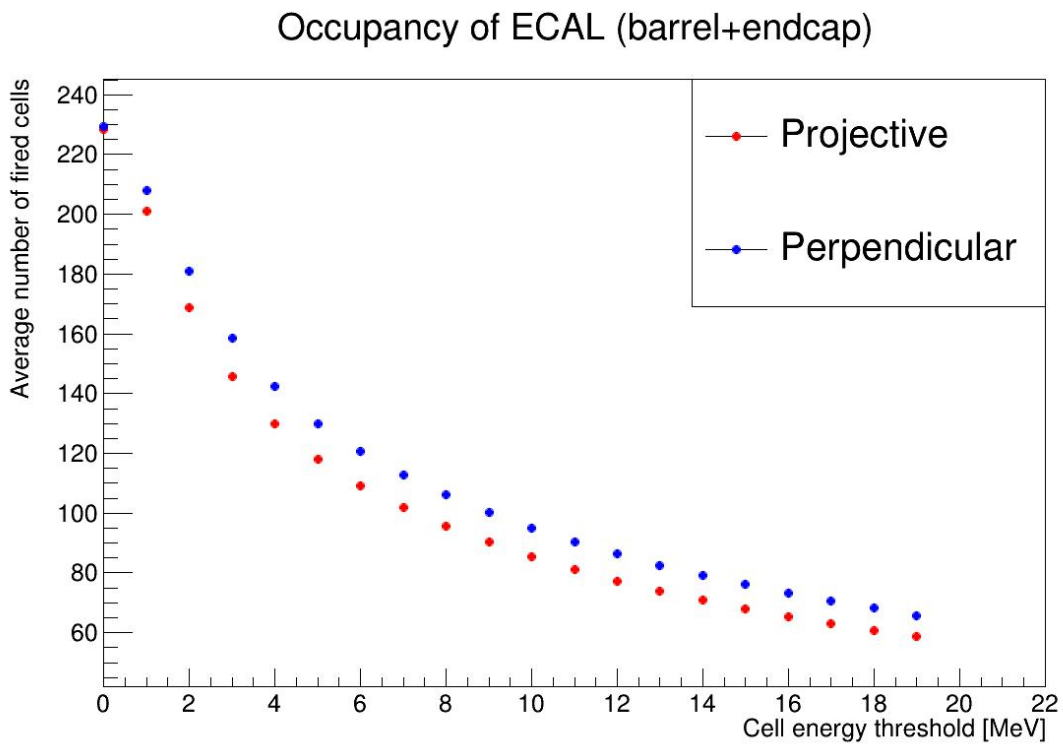
Projective geometry with respect to perpendicular:

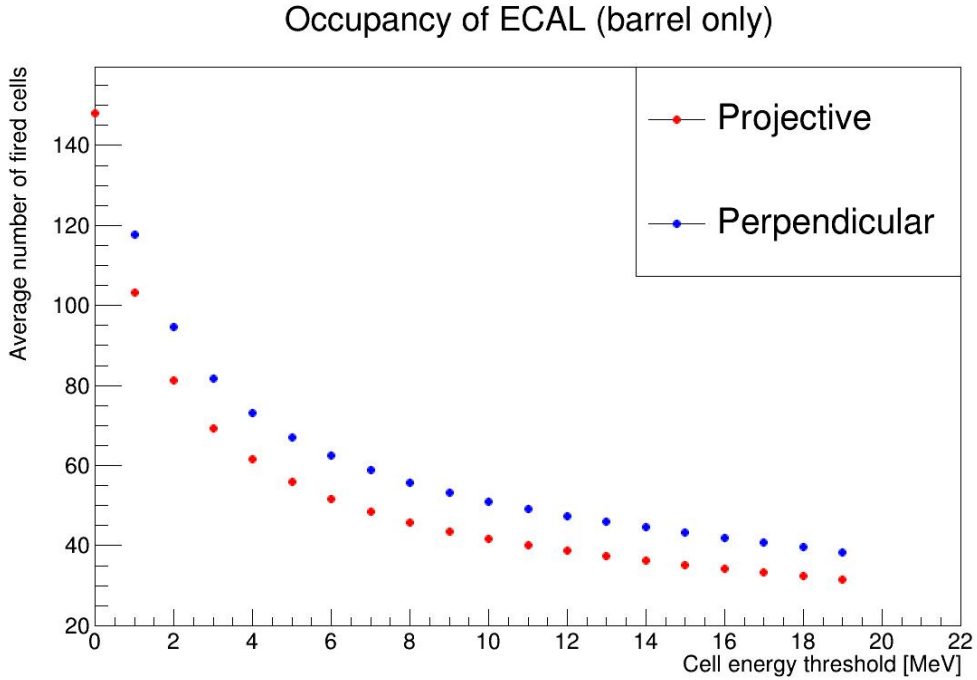
- improves the **energy resolution** at $\lessapprox$ 200 MeV
- worsens the **energy resolution** $\gtrapprox$ 5 GeV
- significantly improves **affects Z resolution (with default reconstruction)**
- reduces the **occupancy** in ECAL by ~10%
- requires less sofisticated reconstruction algorithms
- requires more work in terms of maintenance (alignment, construction, ...)

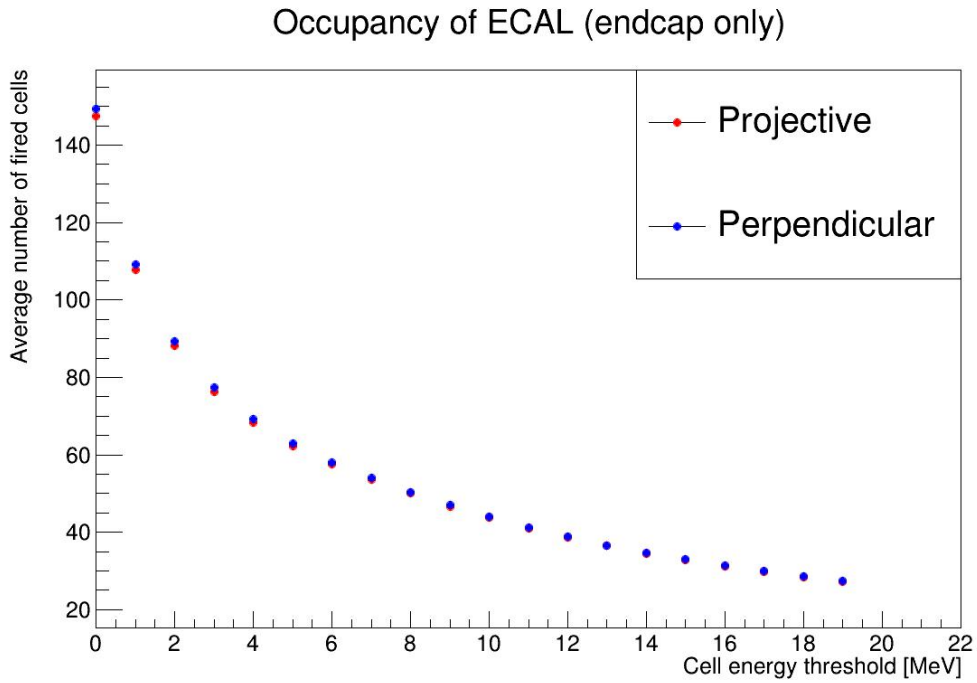
Possible effects not studies:

- 2-photon resolution

BACKUP


Occupancy of ECAL (barrel+endcap)
Average number of fired cells
Cell energy threshold [MeV]
Projective
Perpendicular


Occupancy of ECAL (barrel only)
Average number of fired cells
Cell energy threshold [MeV]
Projective
Perpendicular


Occupancy of ECAL (endcap only)
Average number of fired cells
Cell energy threshold [MeV]
Projective
Perpendicular