Status of ECAL simulation

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ECAL physics requirements

- Prompt photons:

interested in p_T > 3-4 GeV, high background from π^0, η, etc.
Requirement: energy resolution at high (> 5 GeV) energies, π/γ separation

- Charmonia (χ_{c1}, χ_{c2}):

need to separate χ_{c1}, χ_{c2} from decay into J/ψ γ
Requirement: energy resolution at low (< 1 GeV) energies

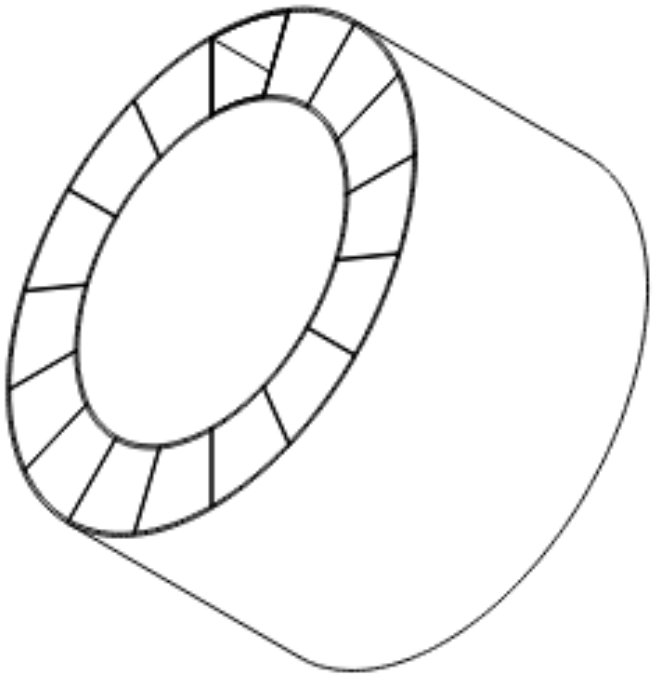
- Online polarizability measurement:

measure azimuthal asymmetry of π^0 production
Requirement: energy and position resolution, π/γ separation

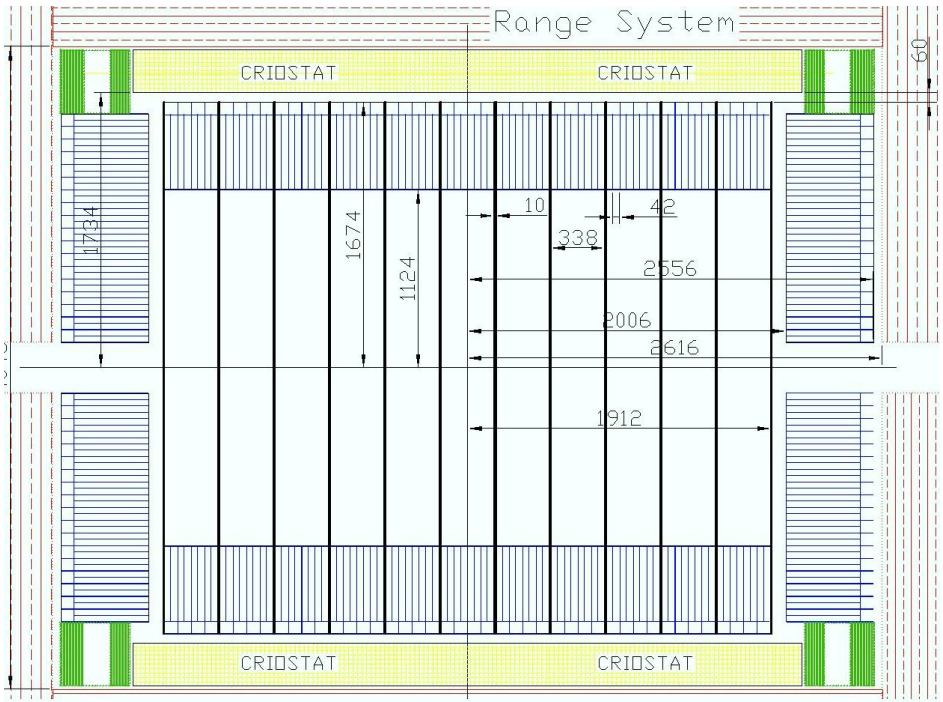
The two options for ECAL

- To support the weight of ECAL, supporting structures are needed
- How will the gaps influence physics measurements?
- Two different approaches:

Sectors in ϕ



Slices in Z

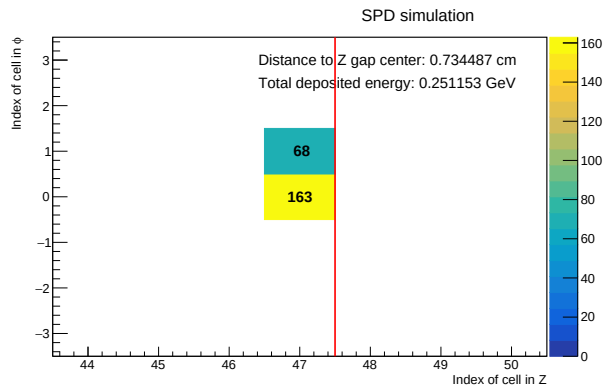


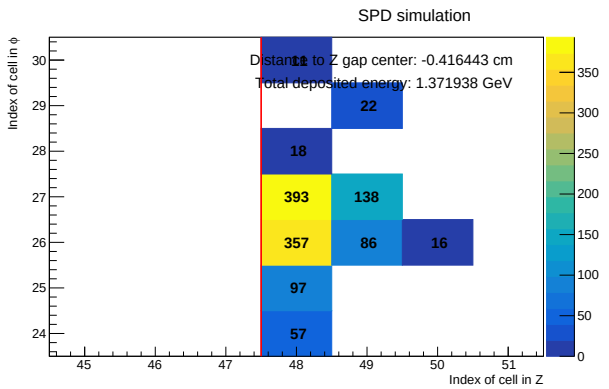
Precise parameters of ECAL for the simulation

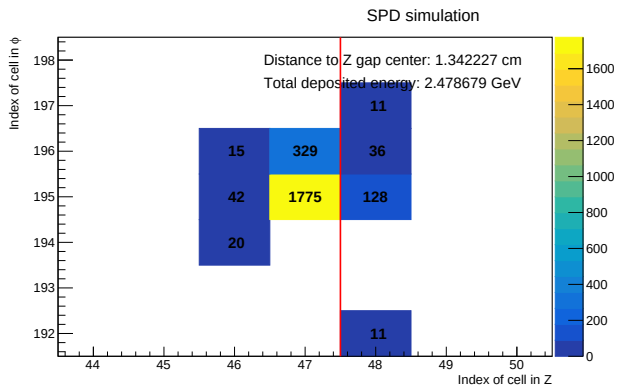
- barrel length (in Z): 372 cm
- barrel contains 11 rings in Z
- each of the ring in Z contains 8 cells in Z
- cell size in Z in simulation: 4.13977 cm (for 1 mm Z gaps) (chosen to pave the over barrel completely)
- cell size in ϕ dimension: 3.29115 cm (inner), 4.41381 cm (outer) (chosen to pave over the barrel completely)
- cell contains 190 layers, each layer is 0.5 mm of lead and 1.5 mm of scintillator
- barrel inner radius is 111.4 cm
- gaps in Z and ϕ sectors/slices: carbon with density of 1.75 g/cm^3

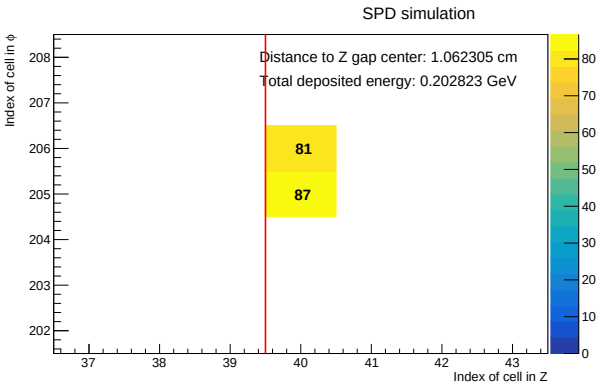
Some examples of events: slices in Z

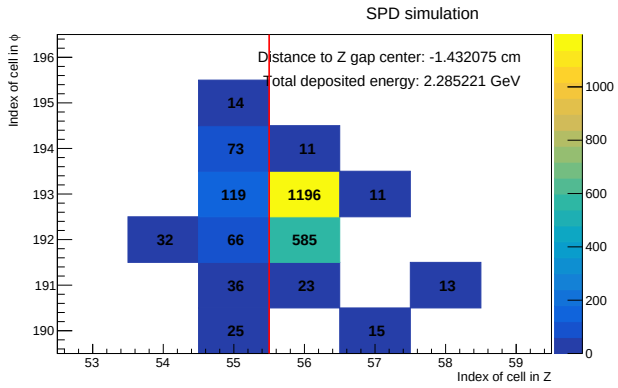
- 3 GeV photons, incidence angle perpendicular to beam axis
- Each bin of the histogram is a fired cell, number indicates energy deposition in MeV
- Vertical red line shows the 20 mm carbon gap: not to scale!

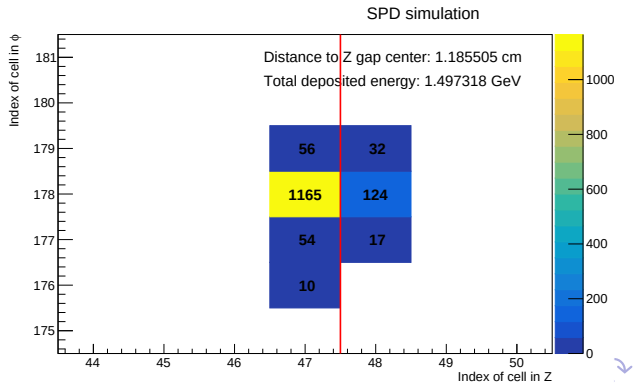






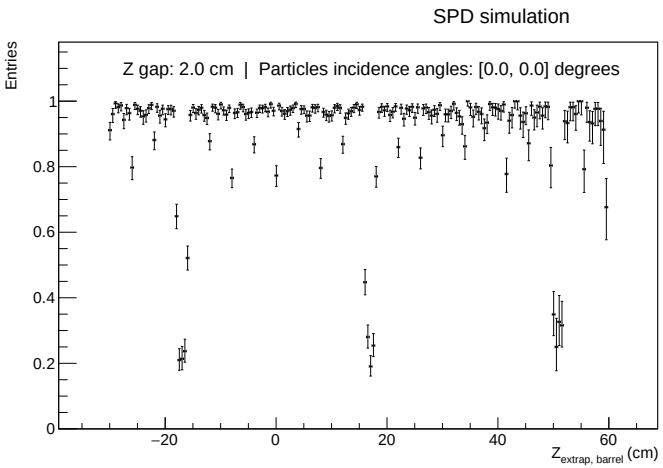


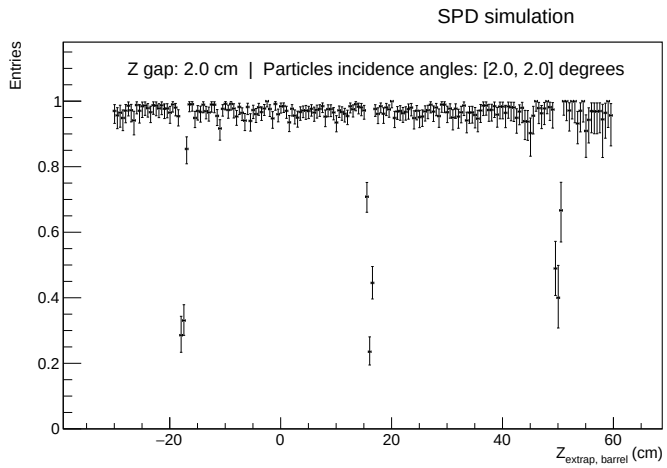


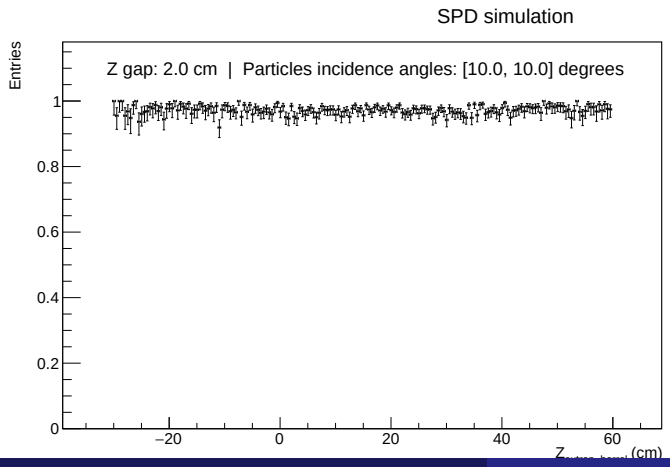


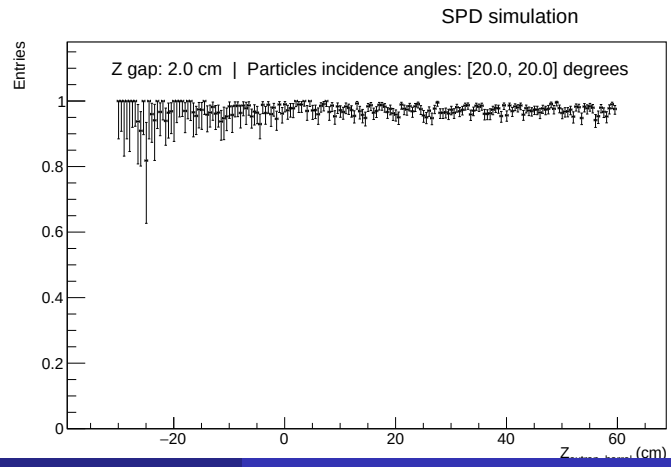
Efficiency of photon reconstruction vs Z (extrapolated to barrel) for different angles

- bin width: 0.5 cm

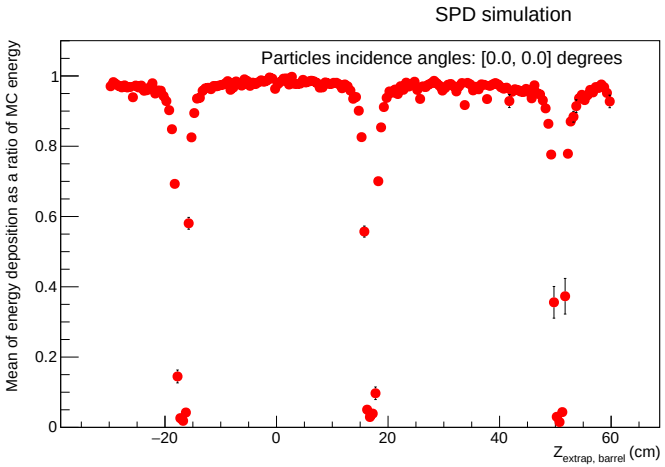


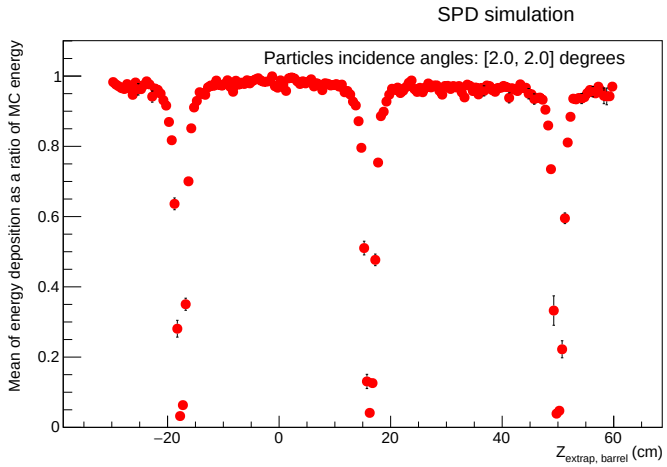


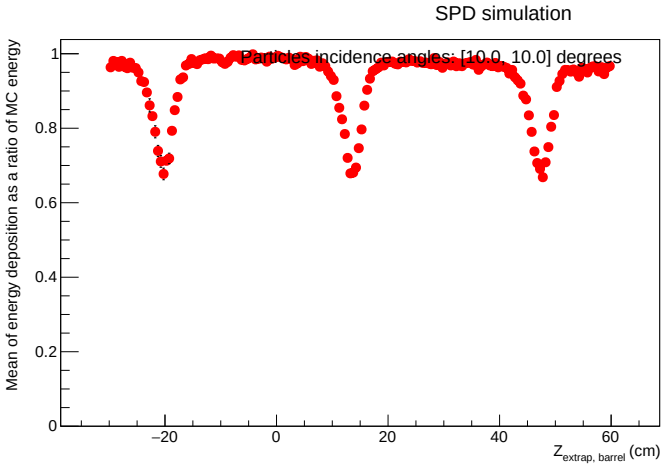


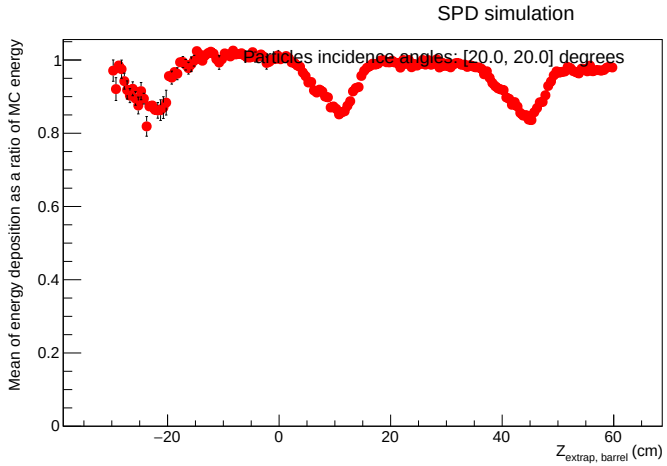


Portion of energy deposited in ECAL for different angles of incidence

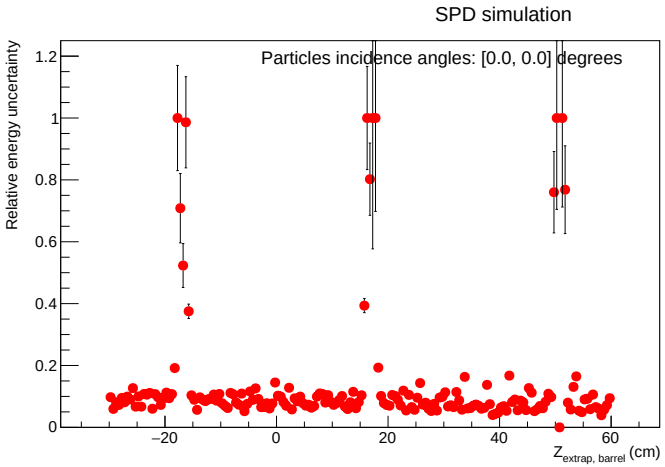


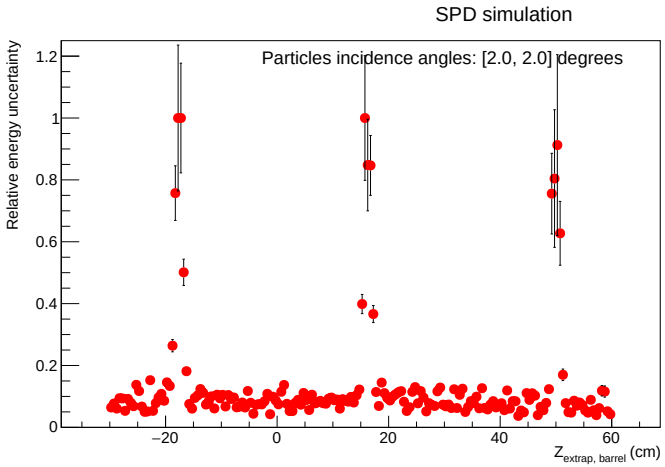


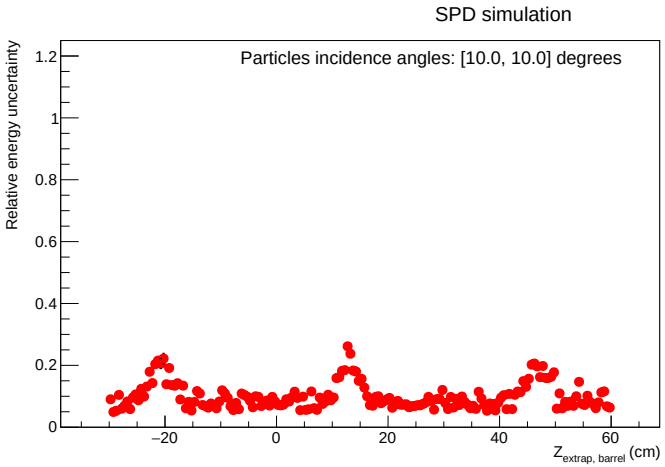


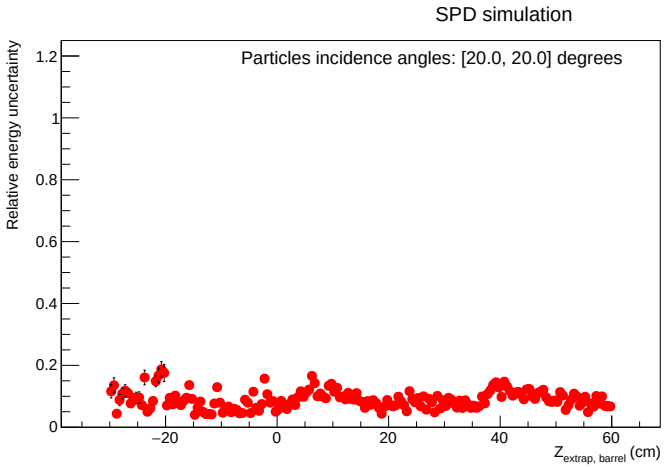


Relative energy resolution in ECAL for different angles of incidence



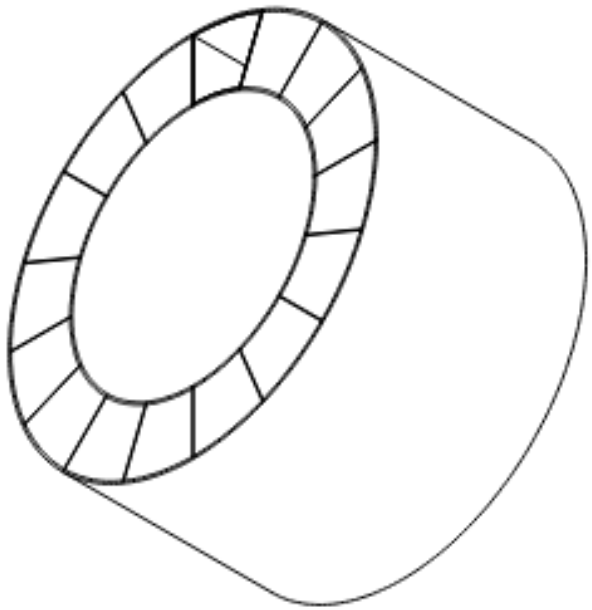






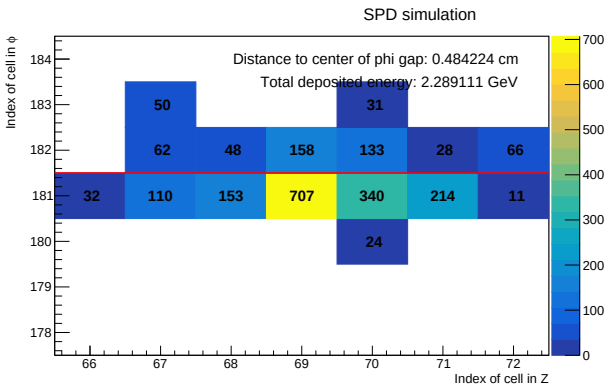
Second option: sectors in ϕ

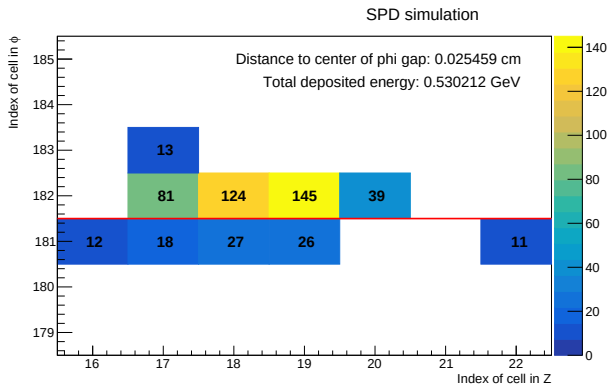
- Considering two options in terms of gap width: 10 mm or 24 mm of carbon;
- options of 8 and 16 sectors are considered.

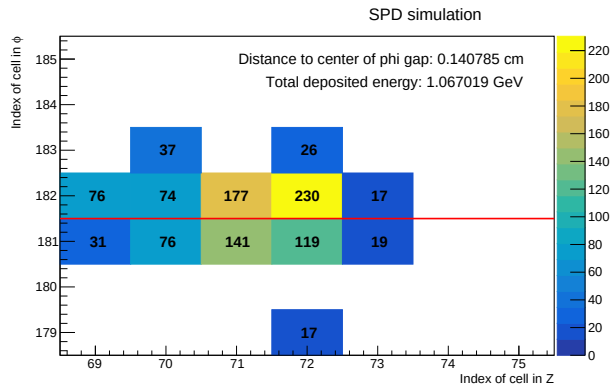


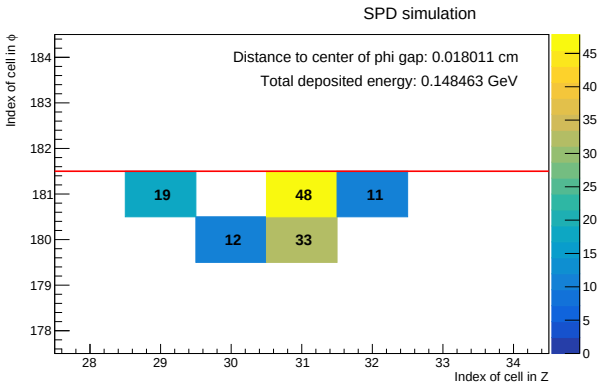
Some examples of events: sectors in ϕ

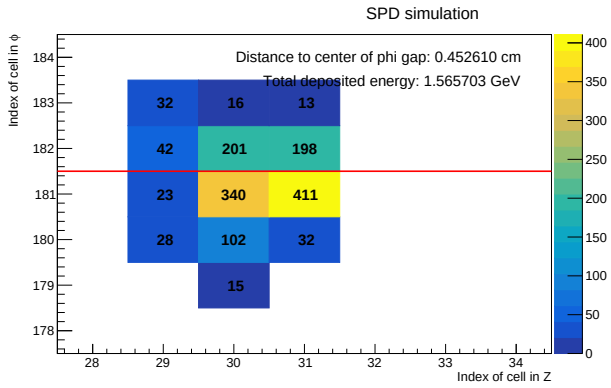
- 5 GeV photons, 24 mm gap
- Each bin of the histogram is a fired cell, number indicates energy deposition in MeV
- Horizontal red line shows the carbon gap: not to scale!

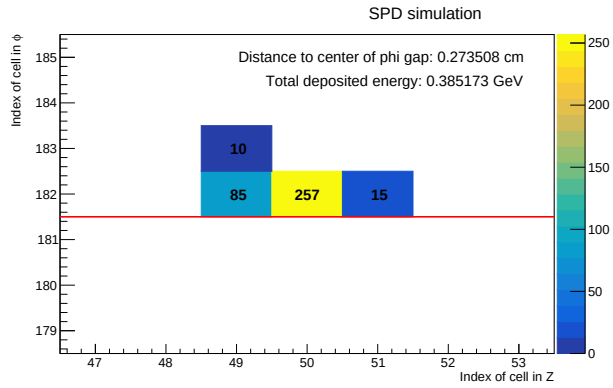






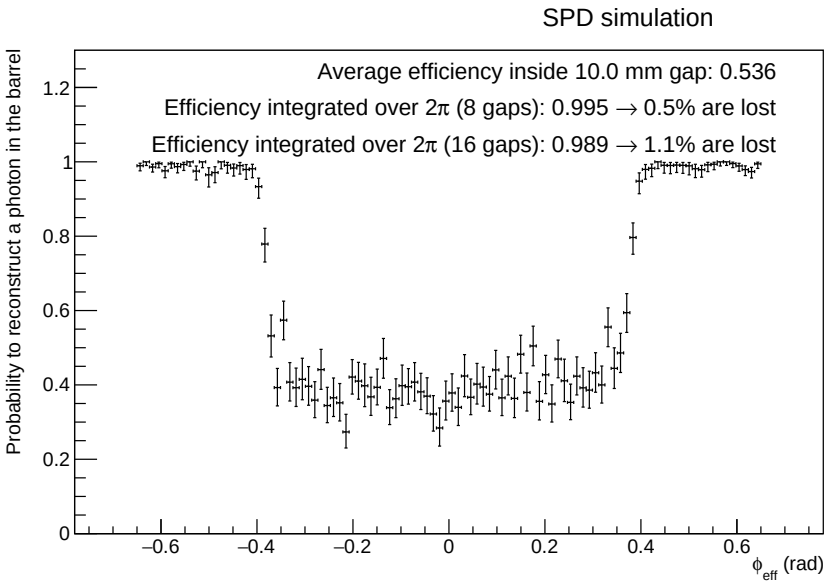




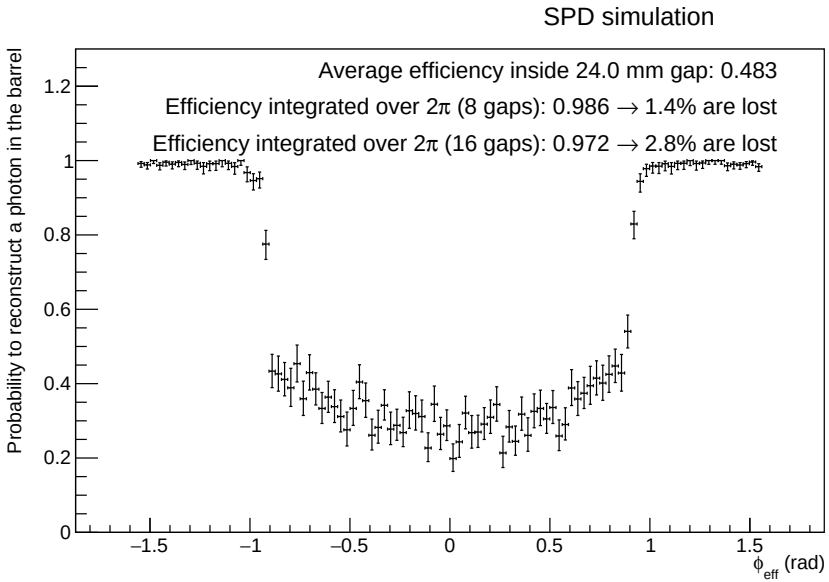


Efficiency of photon detection

10 mm gap, 5 GeV photons
53% efficiency for 5 GeV
49% efficiency for 2 GeV

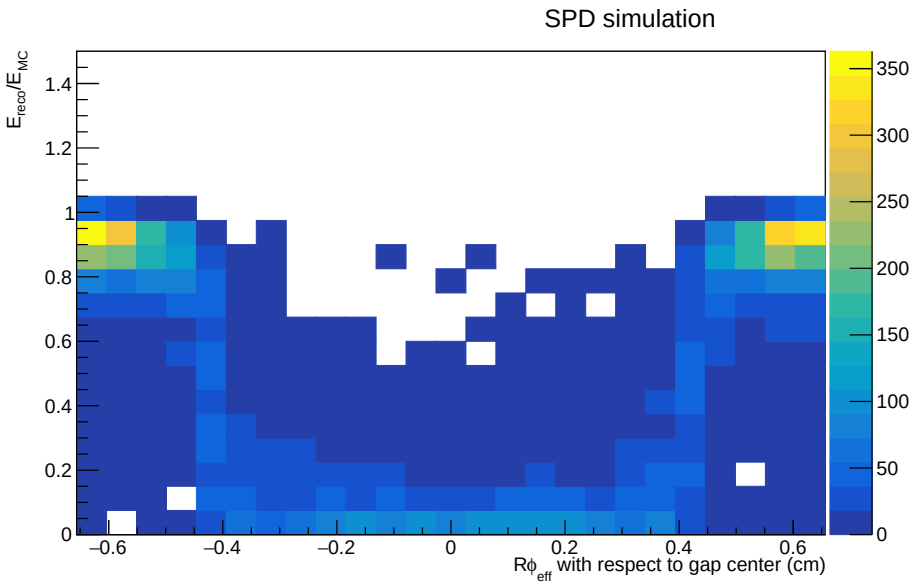


24 mm gap, 5 GeV photons

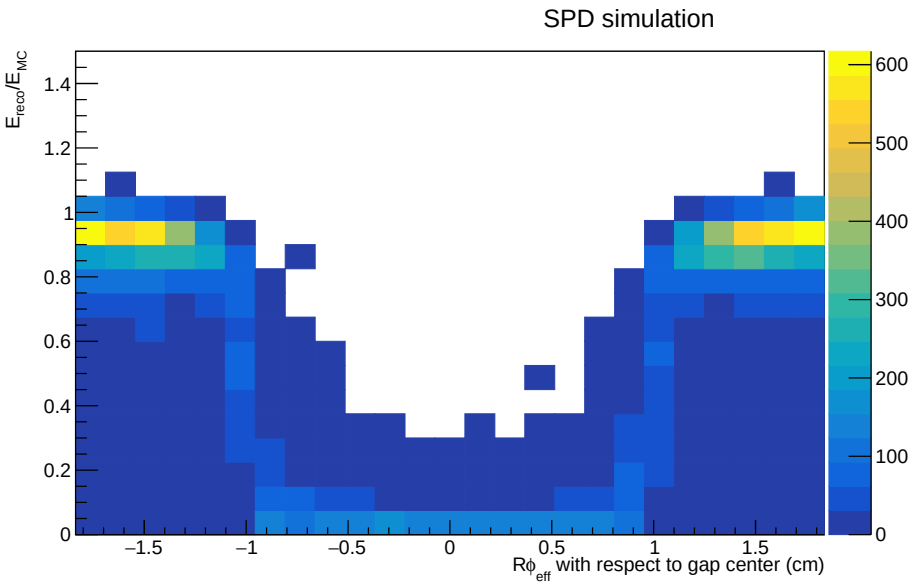


Ratio of reconstructed to simulated energies

5 GeV photons
10 mm gap

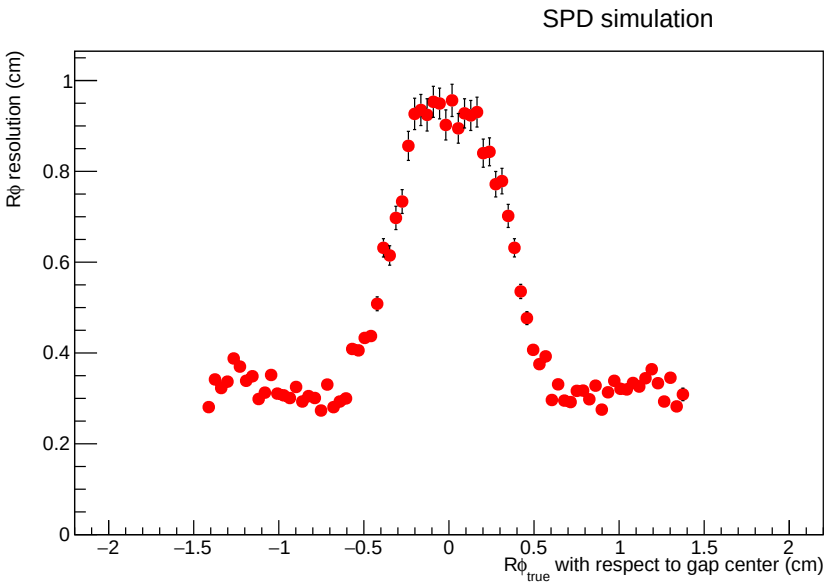


24 mm gap

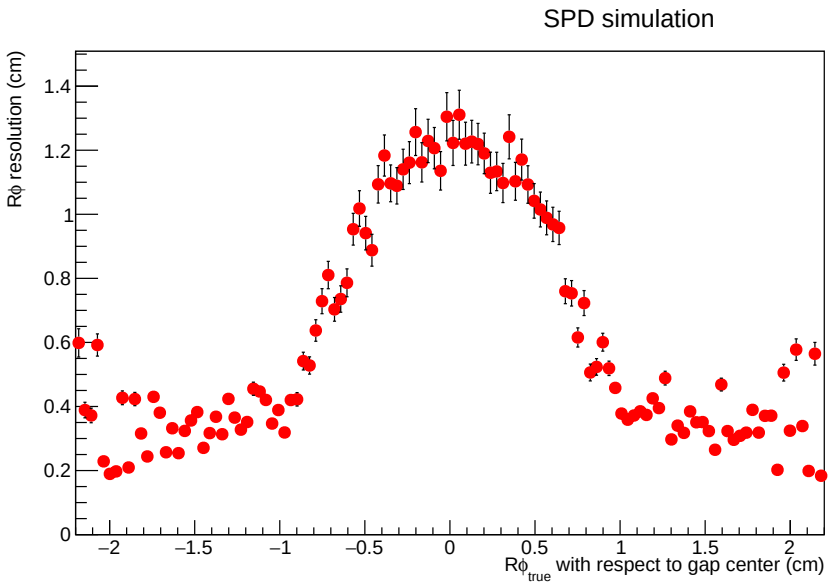


ϕ position resolution

5 GeV photons
10 mm gap



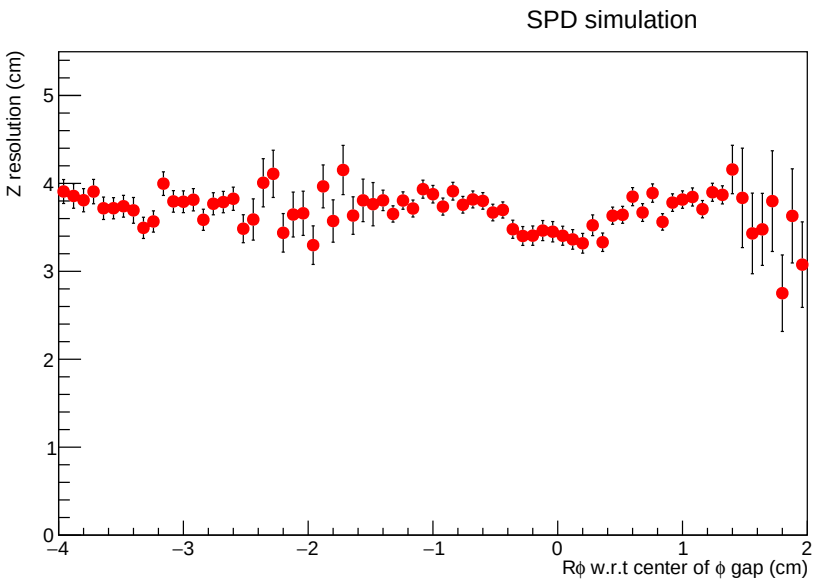
24 mm gap



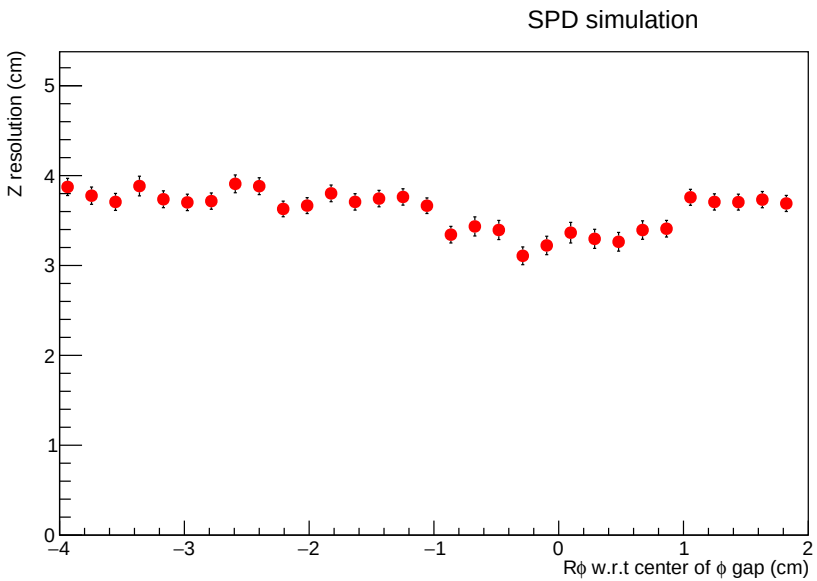
Z position resolution

- 5 GeV photons, perpendicular to the barrel surface
- effect of reconstruction algorithm?

10 mm gap



24 mm gap

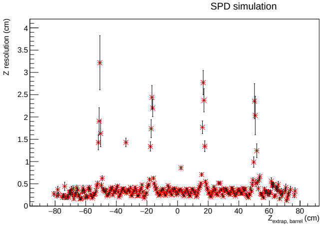


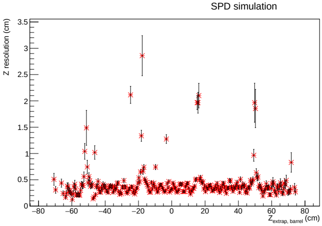
Conclusions

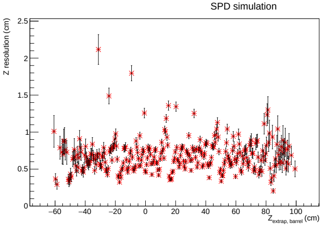
- both sectors in ϕ and slices in Z:
  - significantly worse energy resolution and coordinate resolution perpendicular to the gap;
- sectors in ϕ:
  - photons originating close to beam axis $\rightarrow$ into gap: $\sim$ 50% to be undetected $\rightarrow$ 0.5–3% of photons lost, 1–6% of circumference affected depending on width of gap and number of sectors: independent on position along beam axis;
- slices in Z:
  - photons with angle $< 10^{\circ}$into the gap may not be detected, more efficiency loss for perpendicular photons;
  - simulated distribution of photons along beam axis $\rightarrow$ depending on model: (minimum bias, uniform angle) $\rightarrow$ 0.2–0.3% rejection probability for a photon (uwint efficiencies for 5 GeV photons);

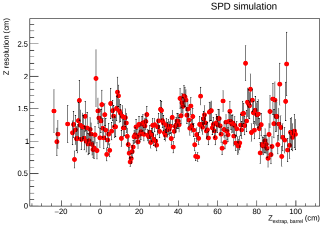
BACKUP

BACKUP: Z resolution for different angles of incidence

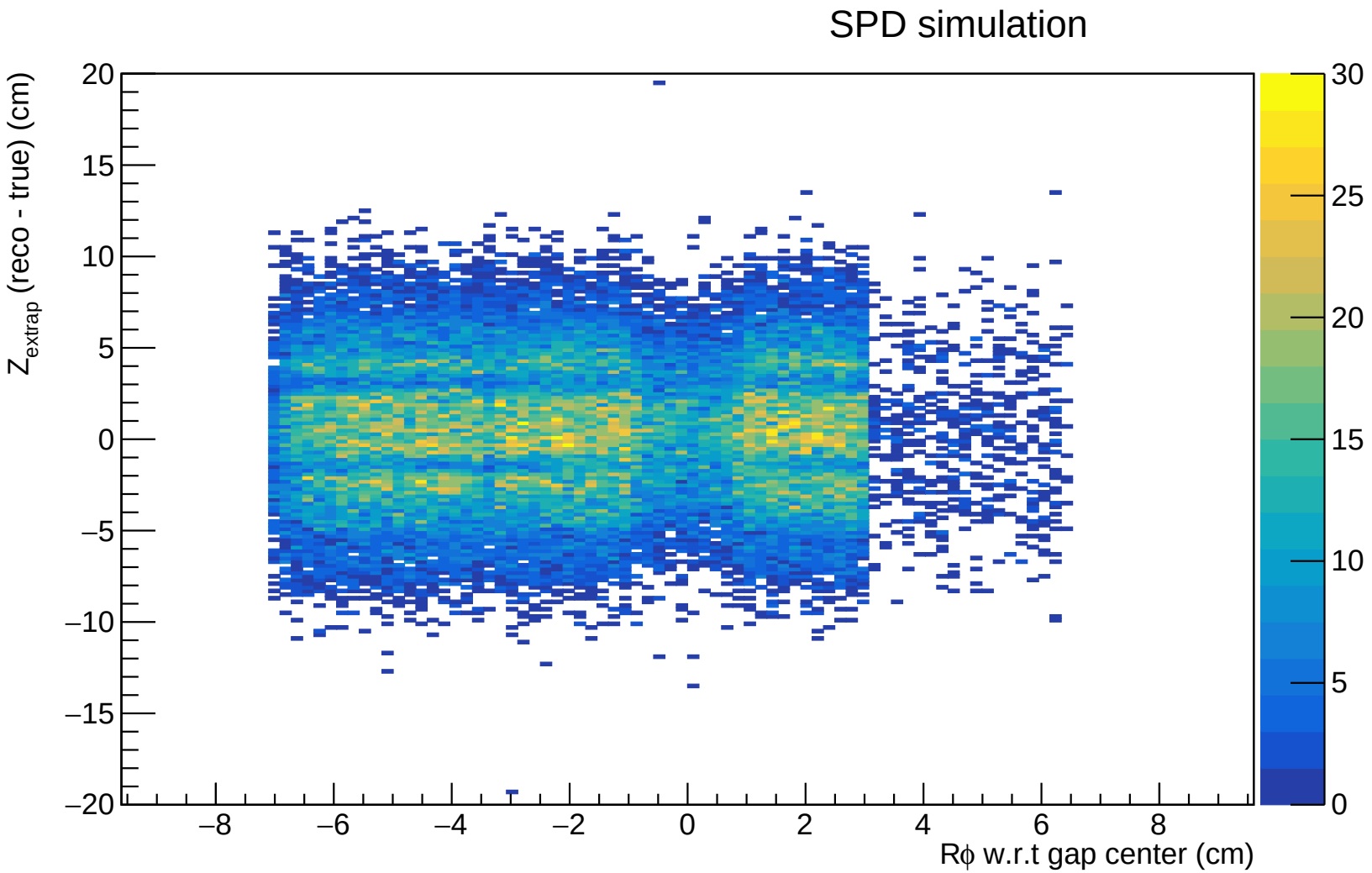




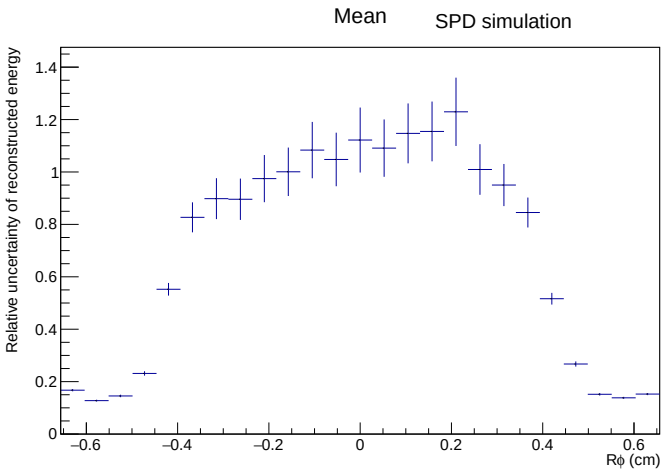


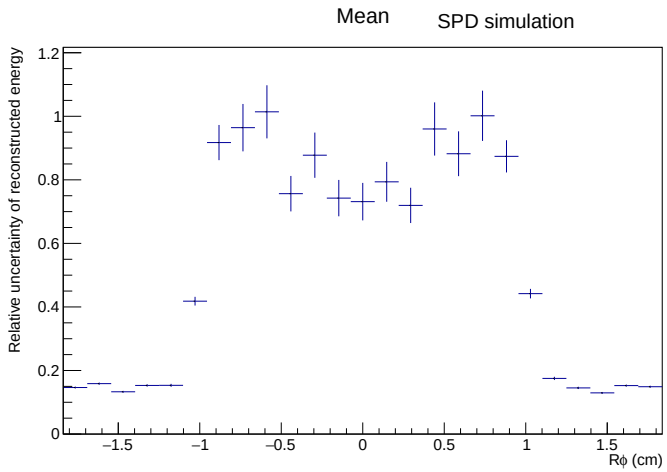


BACKUP: difference in Z (measured/true) close to the ϕ gap



BACKUP: energy resolution for ϕ slices





BACKUP: energy portion for ϕ slices