Shower reconstruction in SPD ECAL

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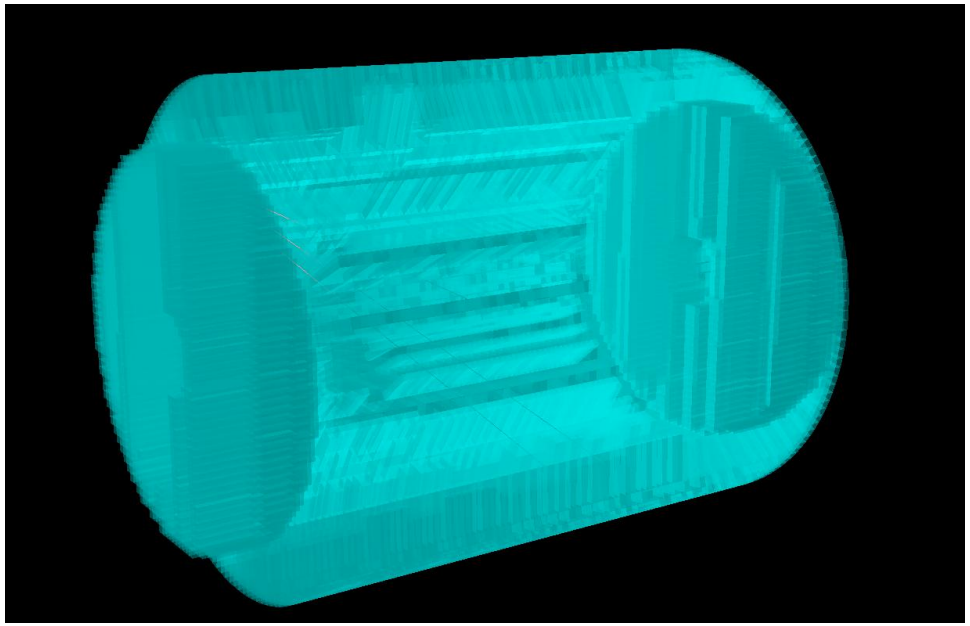
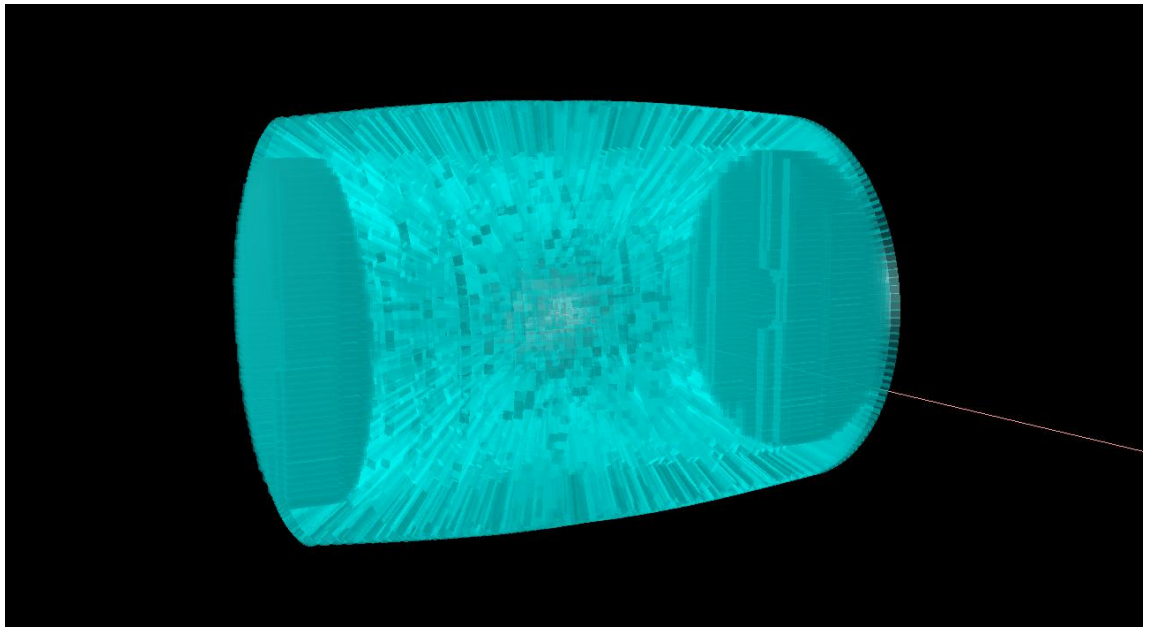
SPD Physics & MC meeting 17.6.2020

ECAL geometries



non-projective (“normal”) geometry

cell size = 5.5 cm



projective geometry

outer face of the outermost barrel module crosses the interaction point

Parametrizable: barrel radius/length, cell inner/outer sizes in theta/phi (also possible to set maximum theta angle for barrel), endcap hole size

https://git.jinr.ru/AndreiMaltsev/spdroot/-/tree/ecal_projective_geometry

ECAL geometries

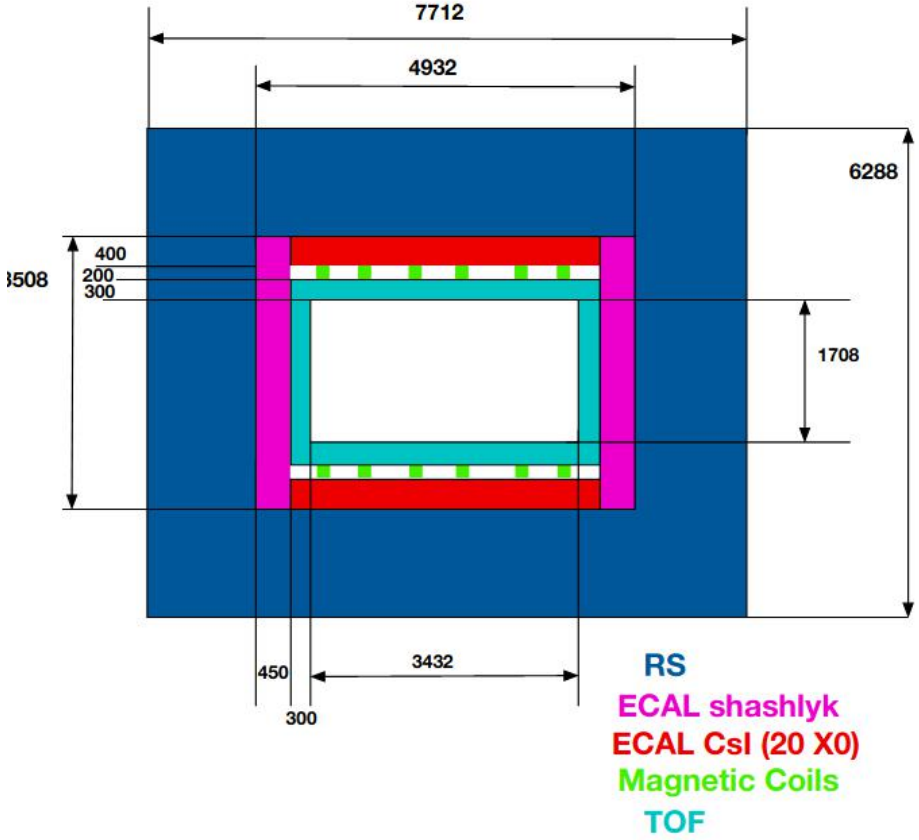
geometry used as a guideline:

http://spd.jinr.ru/wp-content uploads/2020/05/ 2020-05-13_guskov1.pdf

cell size = 5.5 cm

Limitations

- Till now dimensions of our setup were limited by geometry.
- Now we try to fit our setup into 1200 ton.



- we have to keep all subsystems
- we cannot reduce thickness of the RS below ~4 λ_I
- we can assume different types of ECAL in barrel at end-caps
- >15 X_0 in ECAL

Tracking system radius:

~2 m -> ~ 1 m

Shower reconstruction

Two geometries: non-projective/projective

Two algorithms: linear and **logarithmic weighting**

See talk by Adel Terkulov
http://spd.jinr.ru/wp-content/uploads/2020/05/2020-05-13_terkulov.pdf

$$x_c = \frac{\Sigma_i W_i(E_i) x_i}{\Sigma_i W_i(E_i)}$$

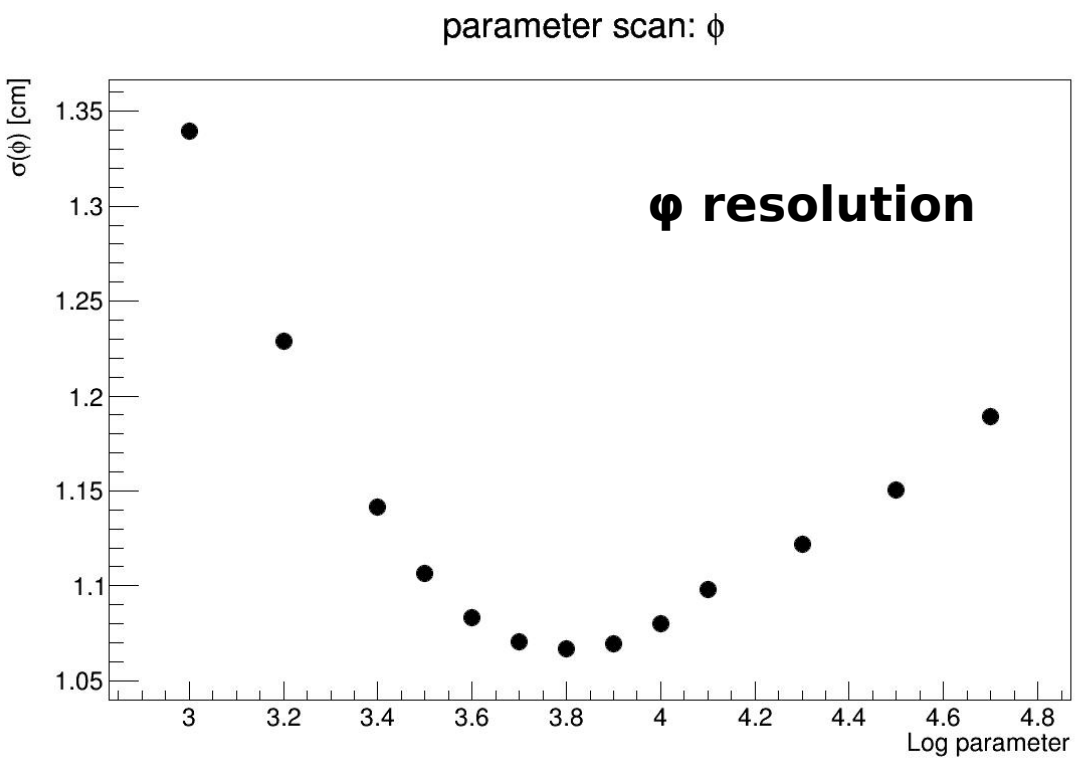
$$W_i^{(linear)}(E_i) = E_i,$$

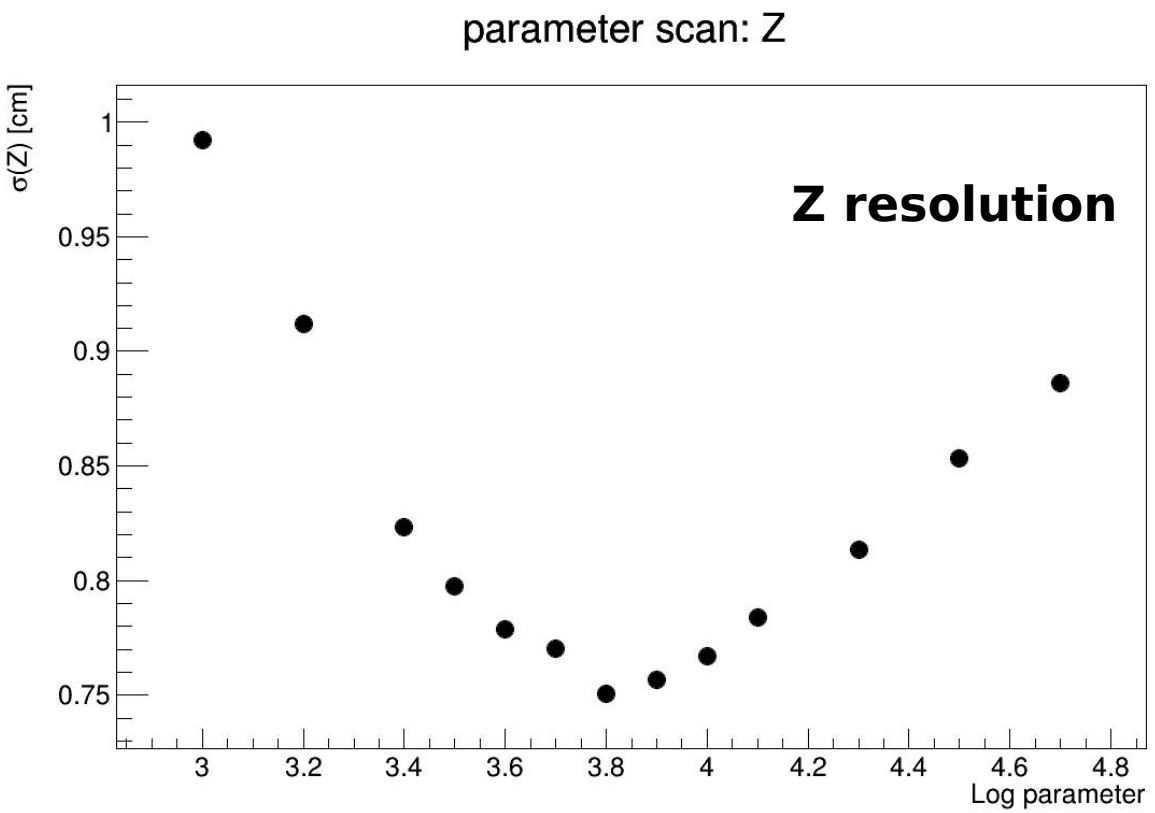
$$W_i^{(log)}(E_i) = Max\{0, a_0 + ln(E_i) - ln(E_{total})\}.$$

log weighting: exponential transverse shower profile
a_0 - energy cutoff

Projective geometry

Scan for the log weighting parameter

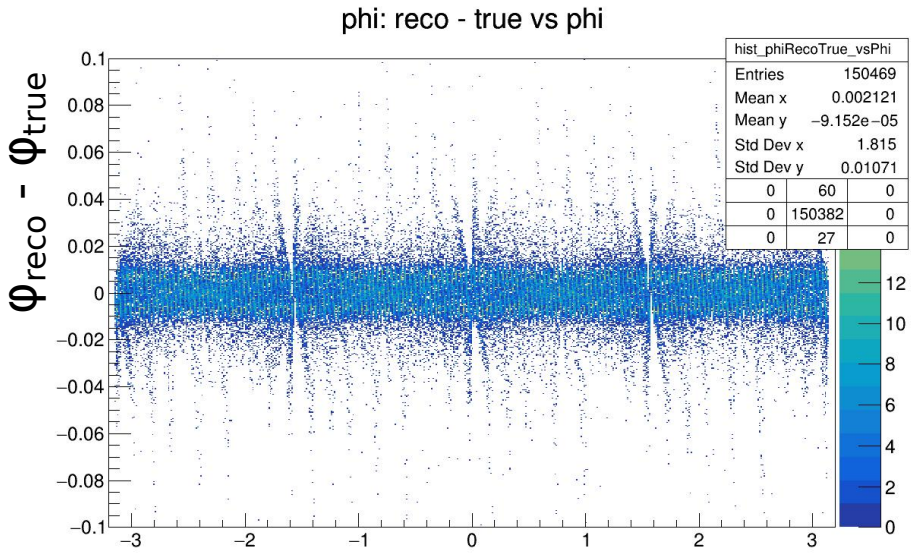


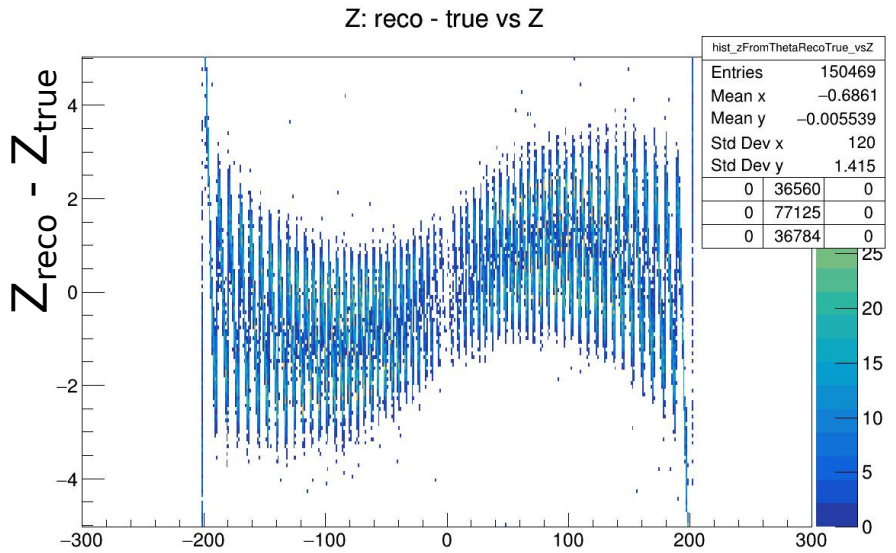


φ -> Rφ, R = barrel radius

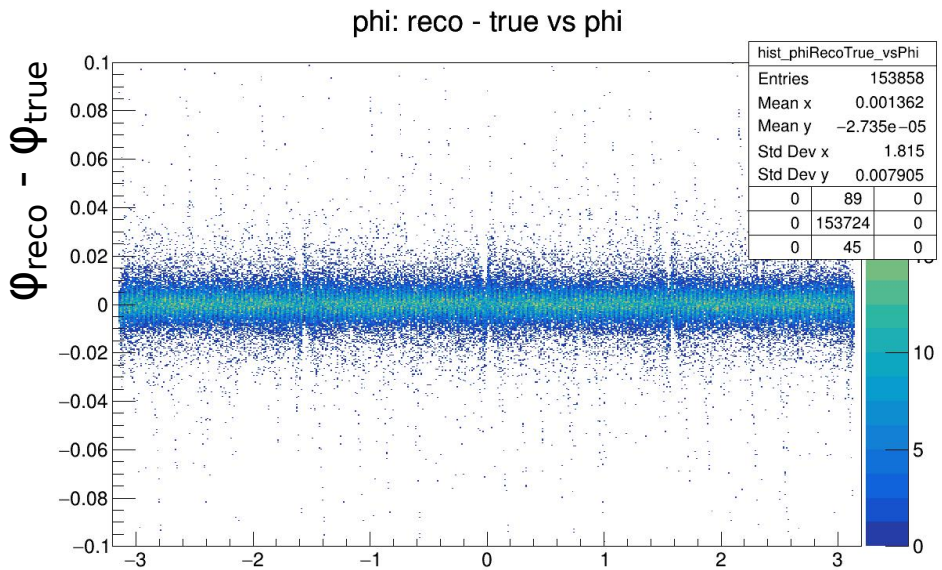
Projective geometry

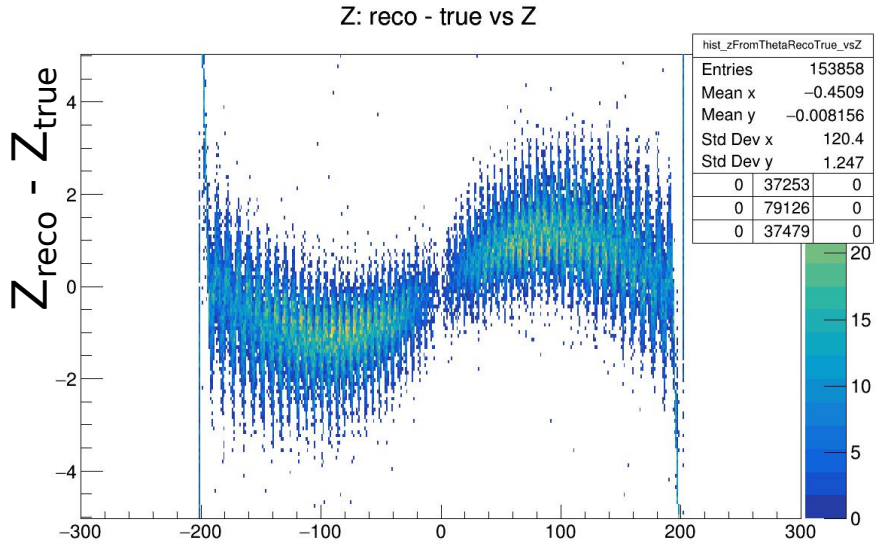
Linear weighting:



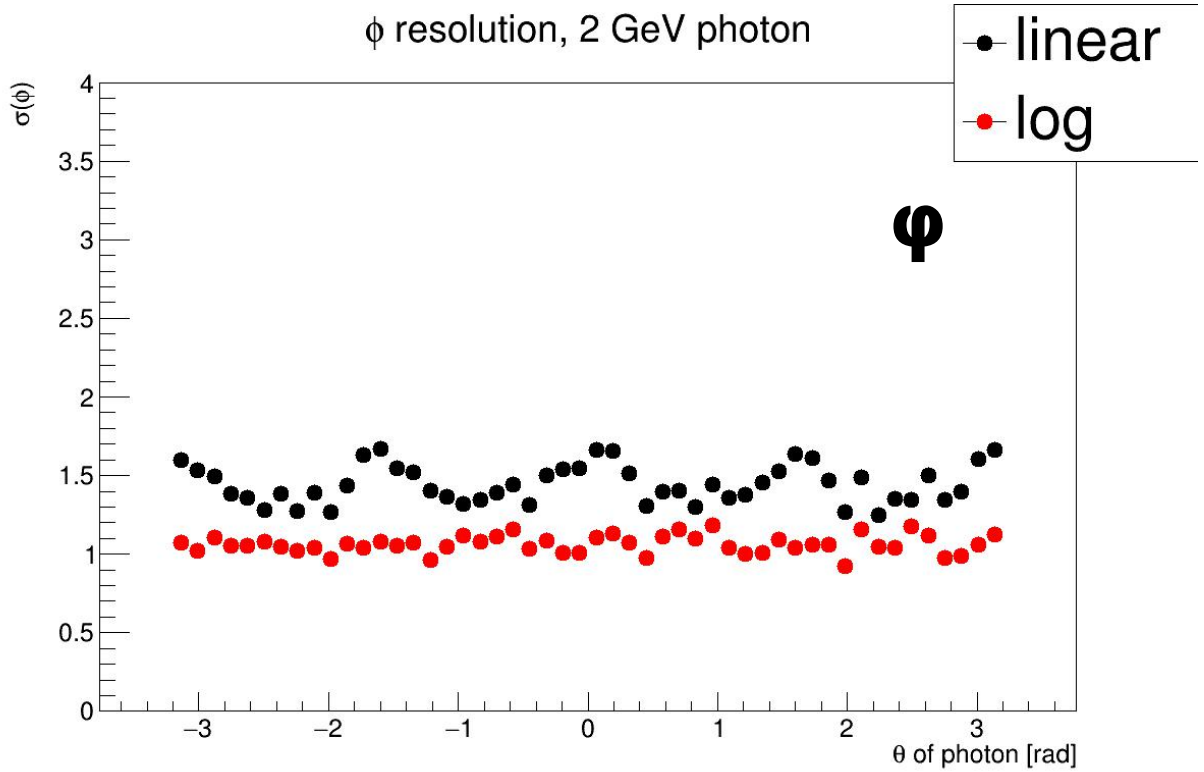


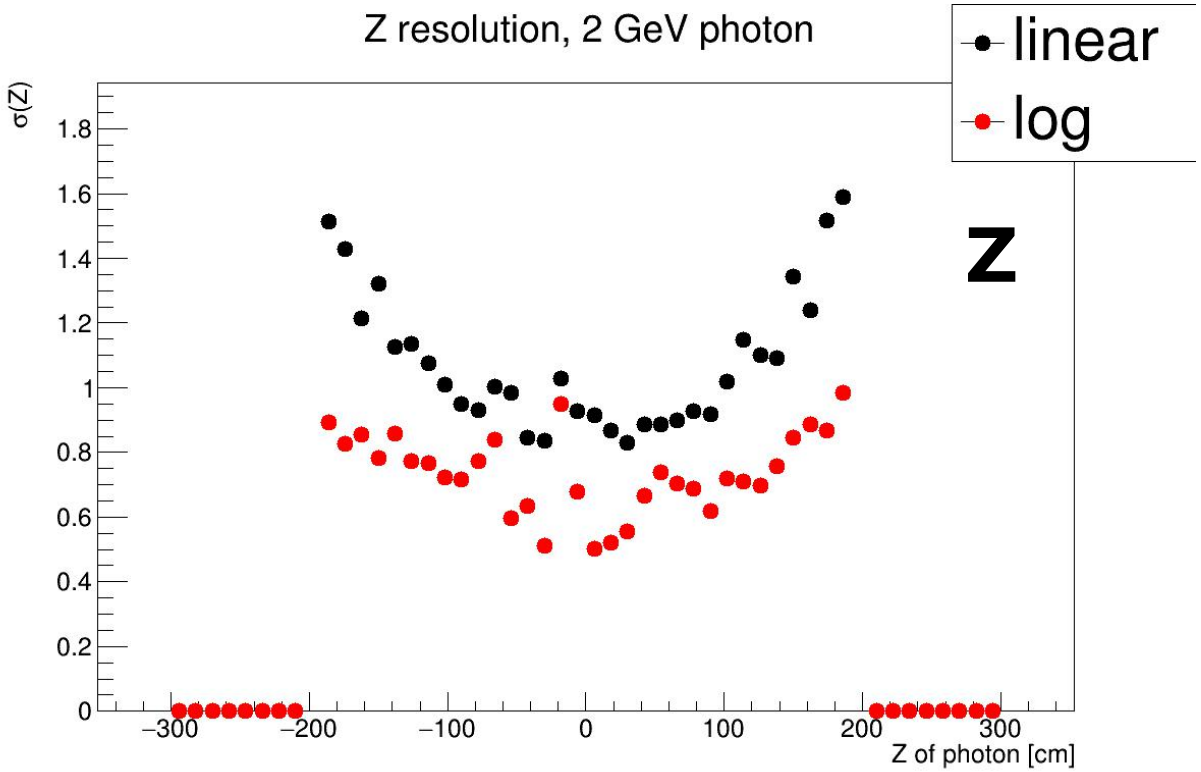
Log weighting:





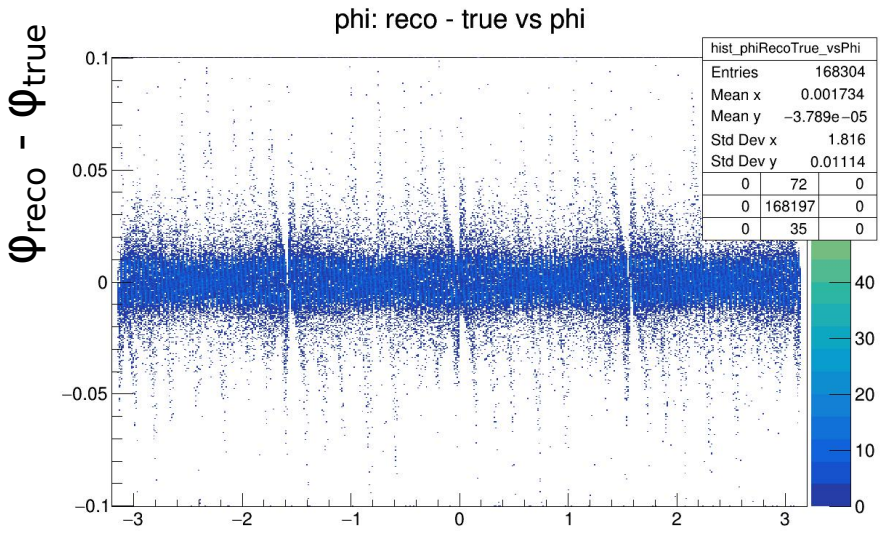
Projective geometry: resolutions

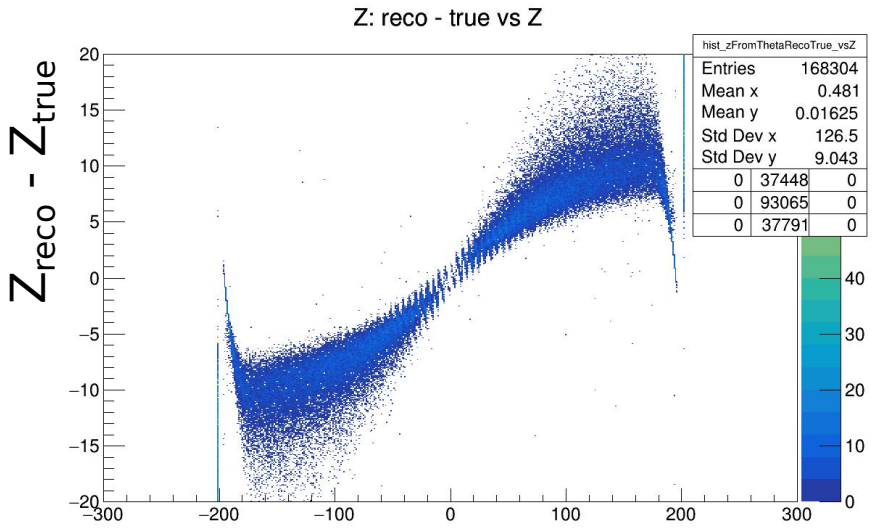




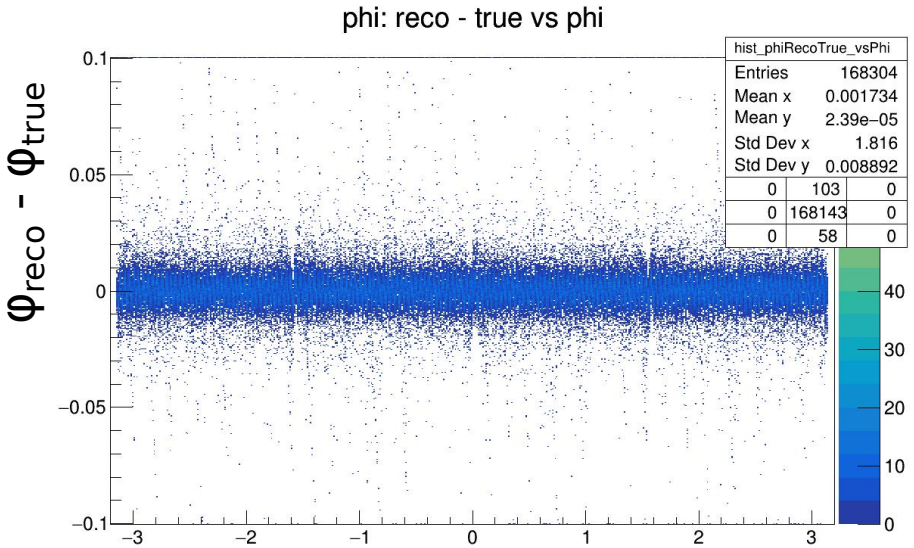
Non-projective geometry

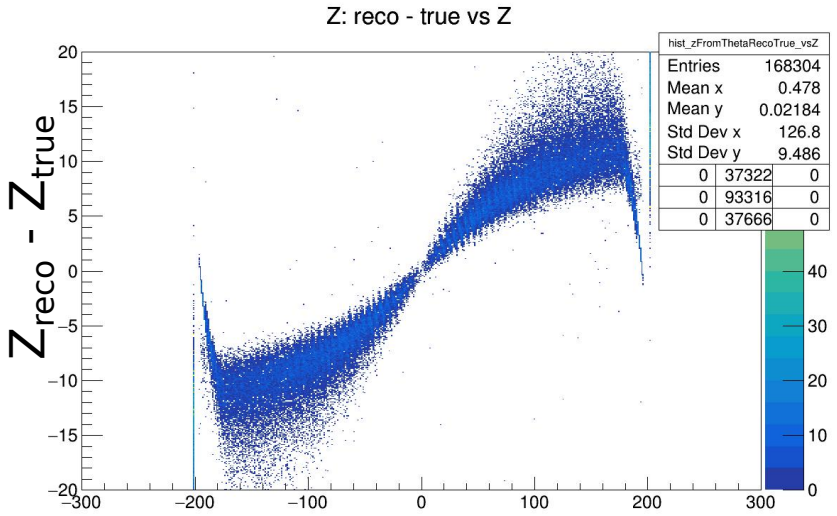
Linear weighting:



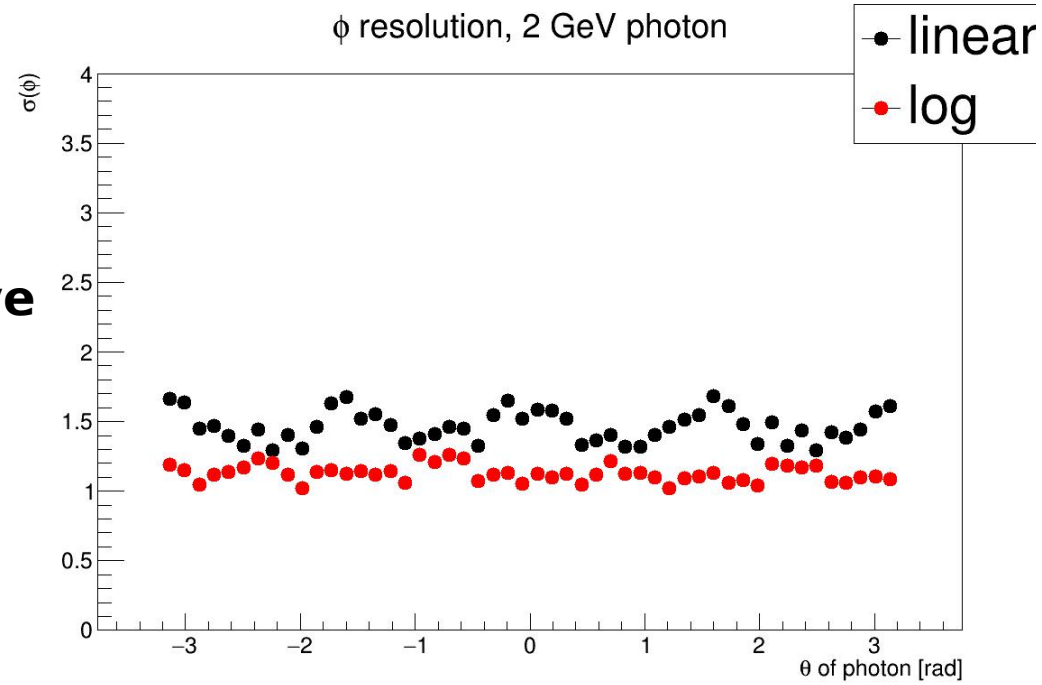


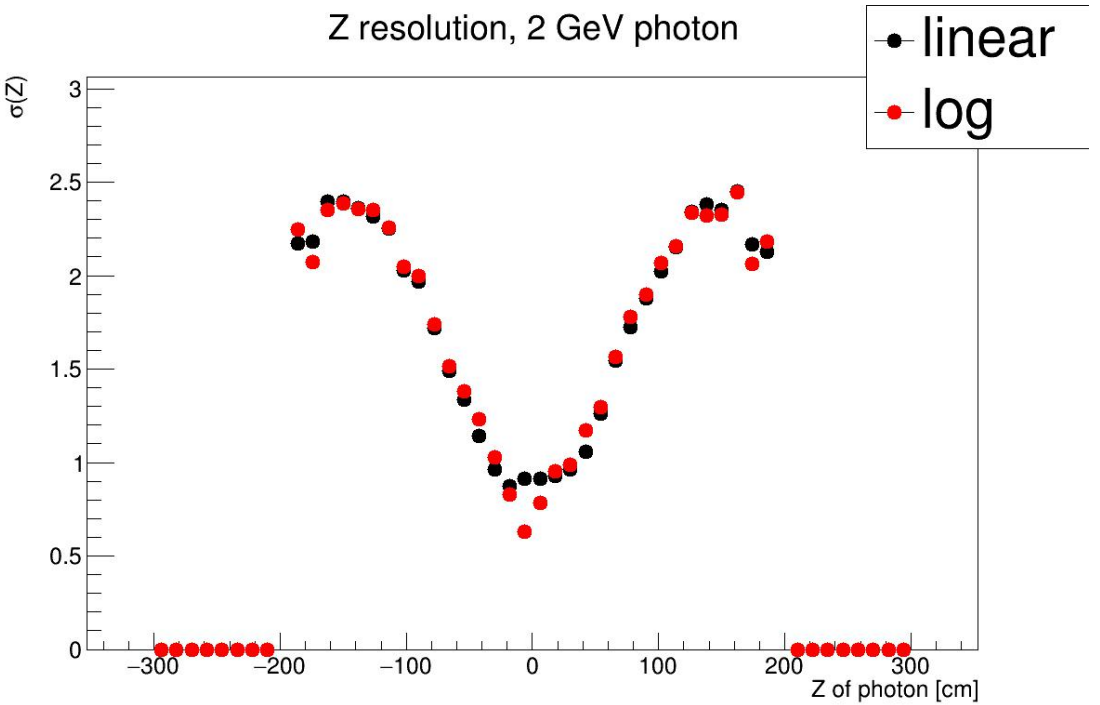
Log weighting:



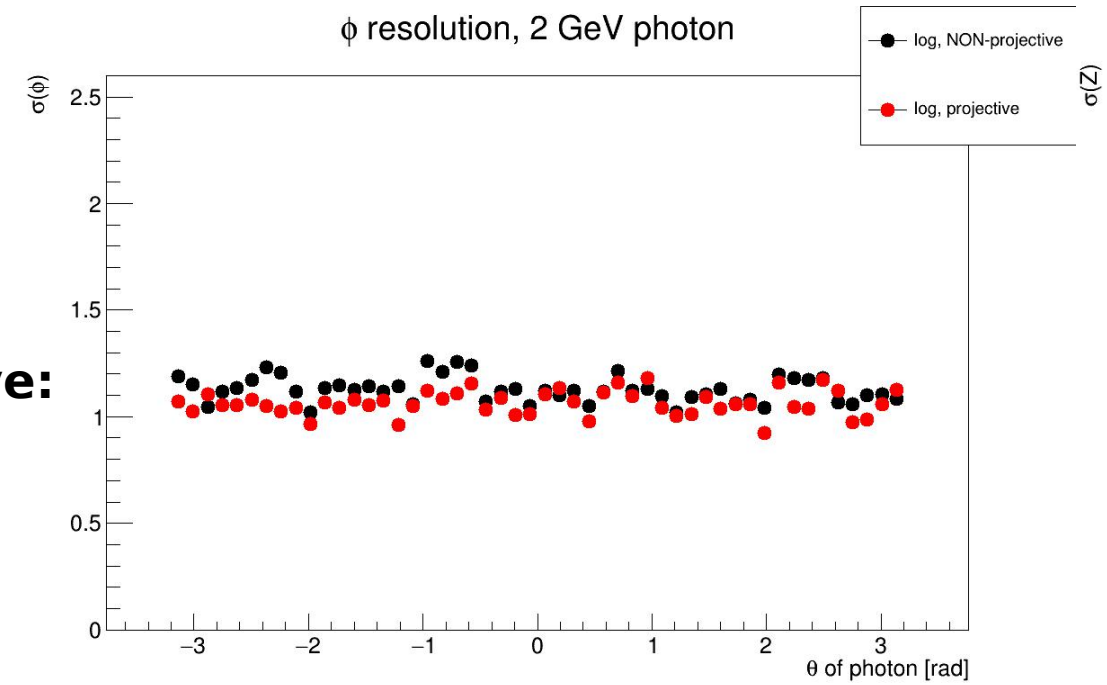


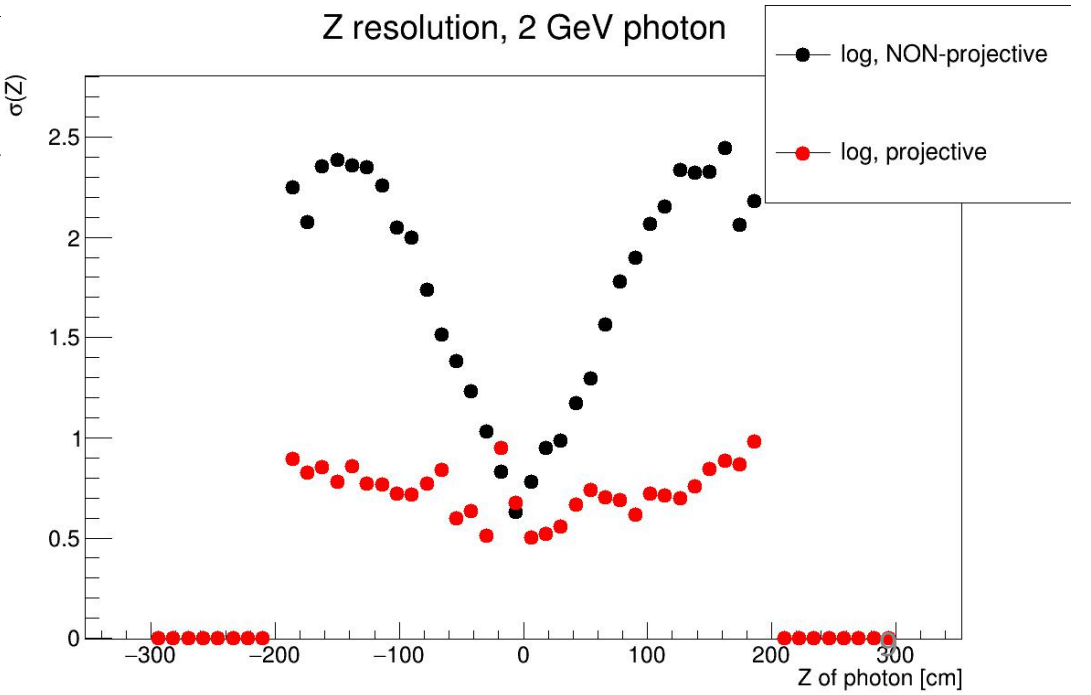
Non-projective geometry:





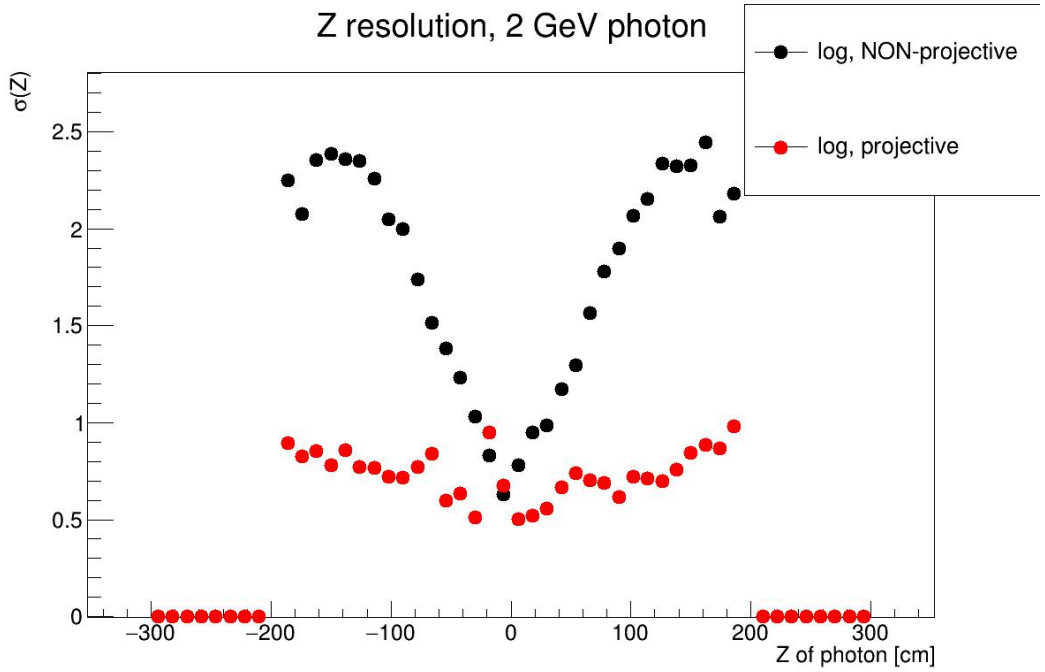
Projective vs non-projective:

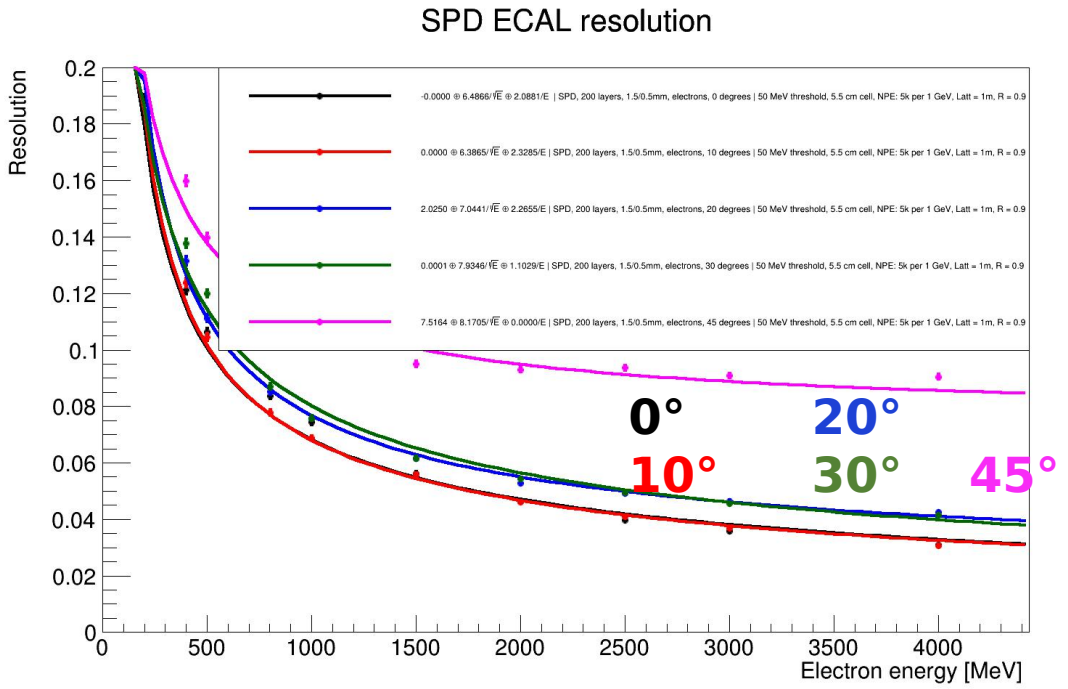




Summary

- Logarithmic weighting gives significant improvement for φ,Z coordinate resolutions





@ 2 GeV:

- σ(φ) ~ 1 cm
- σ(Z) ~ 1-2 cm for non-projective geometry
- σ(E)/E worsens from ~ 10% to 12% @ 400 MeV and from ~ 2.5% to 4% @ 4 GeV

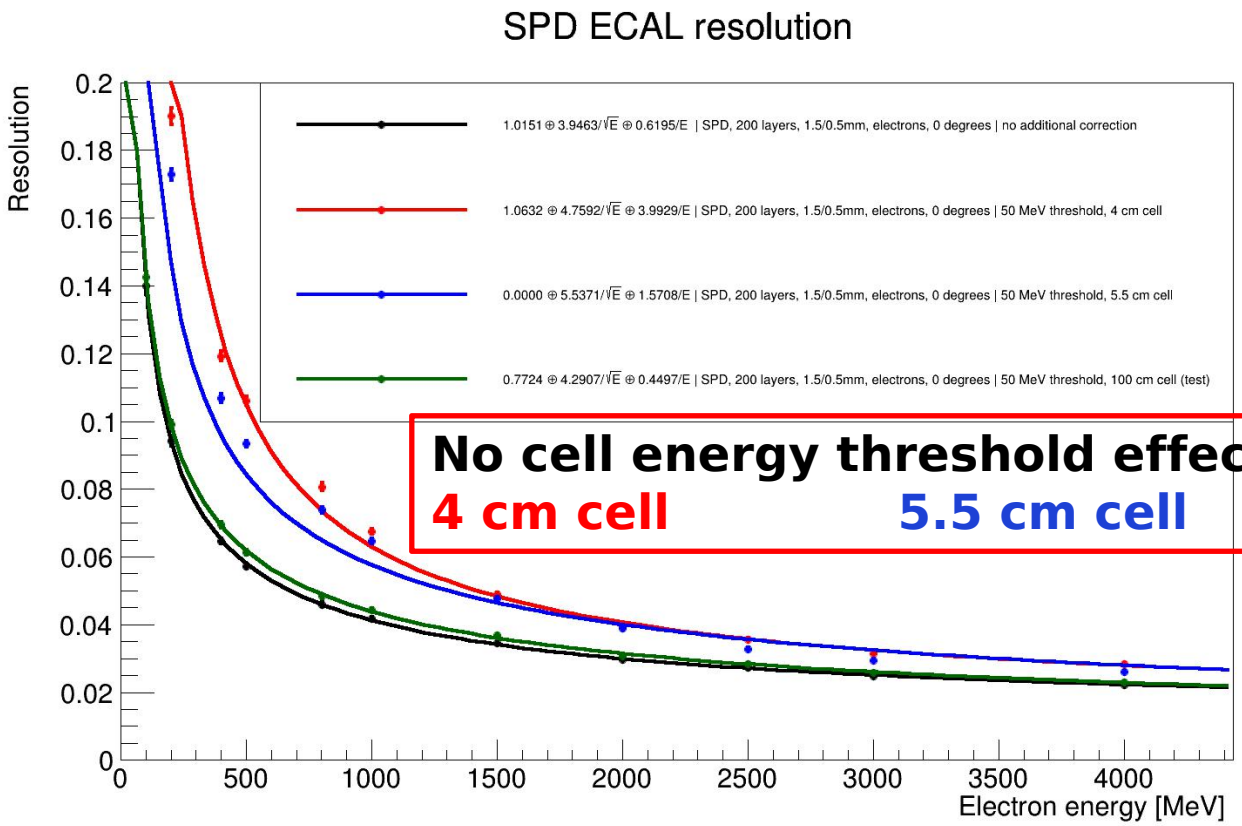
for showers at 30 degree angles

Is it enough for physics cases?

BACKUP

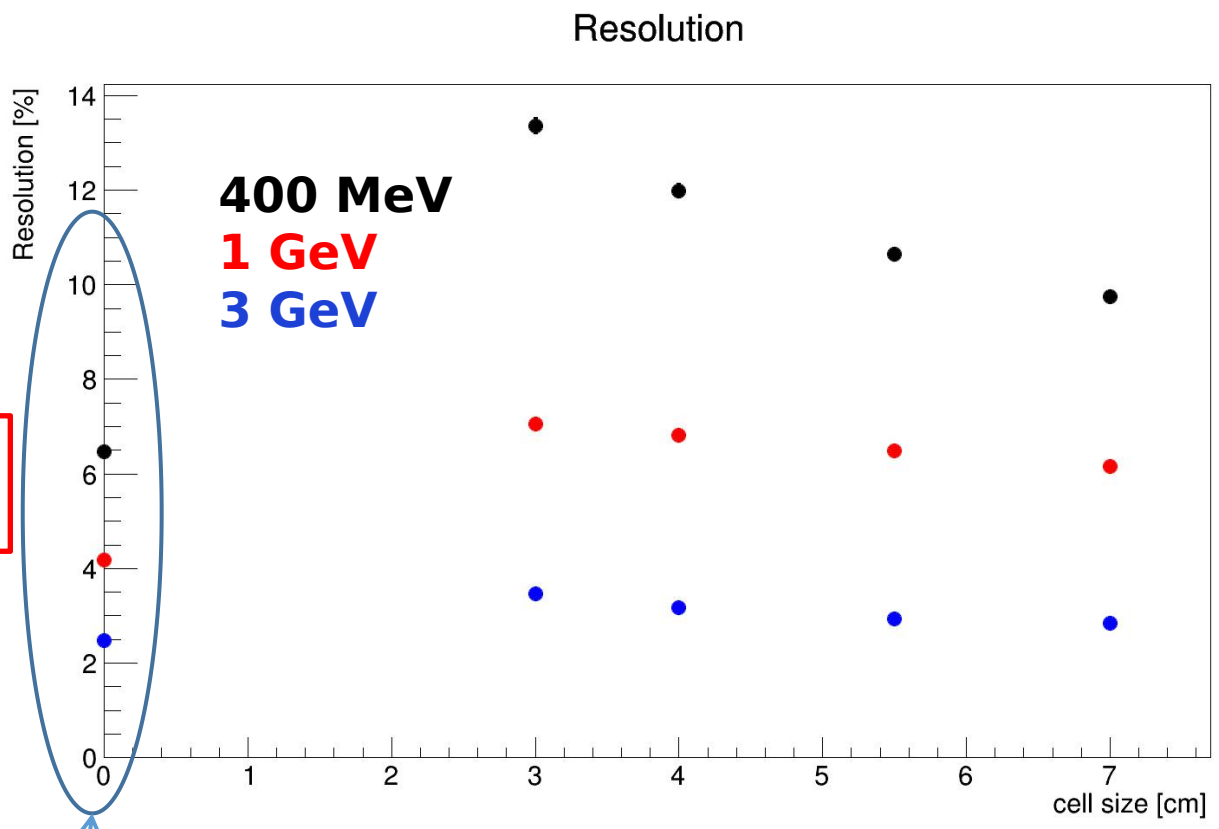
Effect of ECAL cell size on energy resolution

50 MeV cell energy threshold



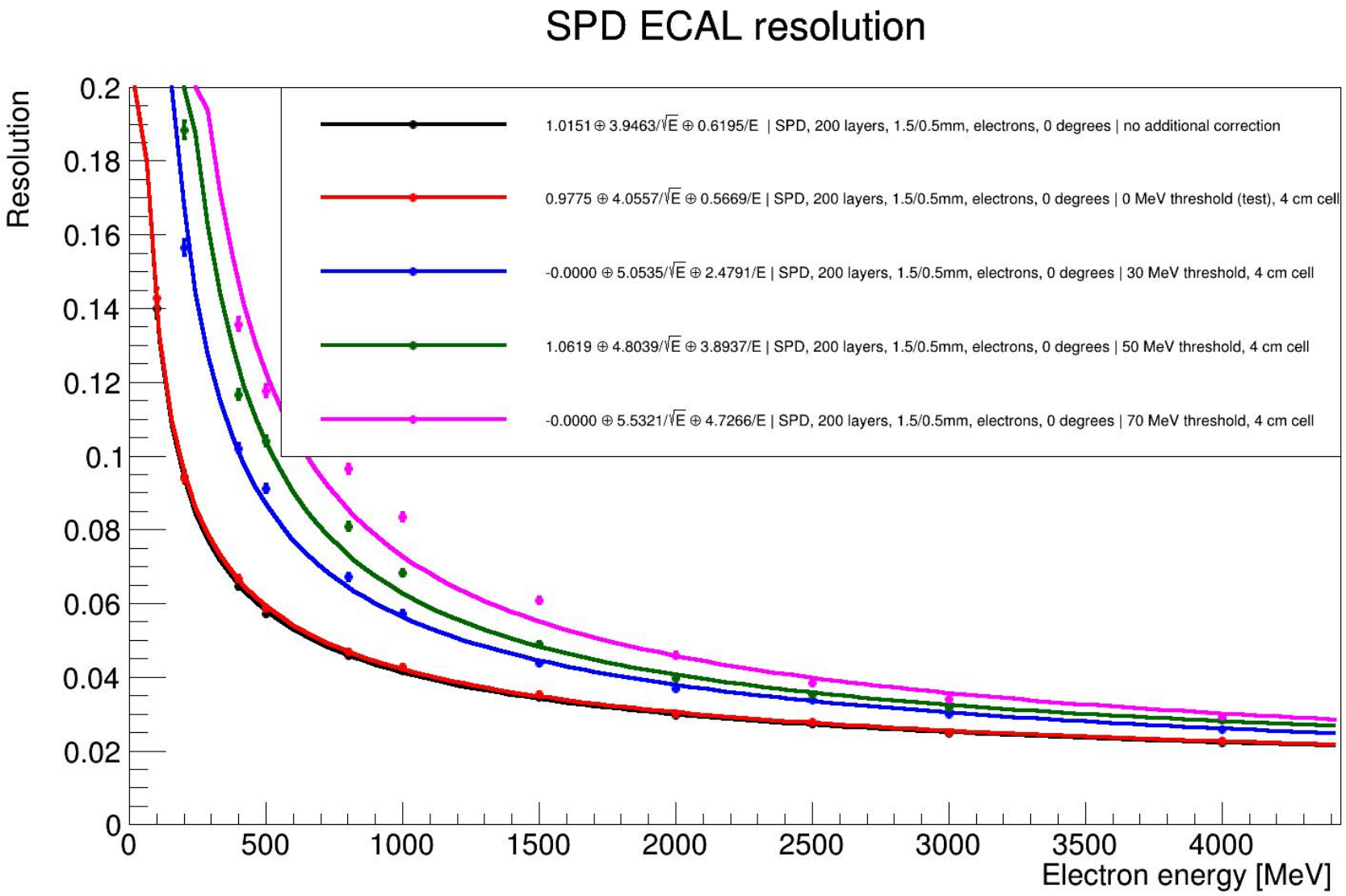
No cell energy threshold effect

4 cm cell **5.5 cm cell**



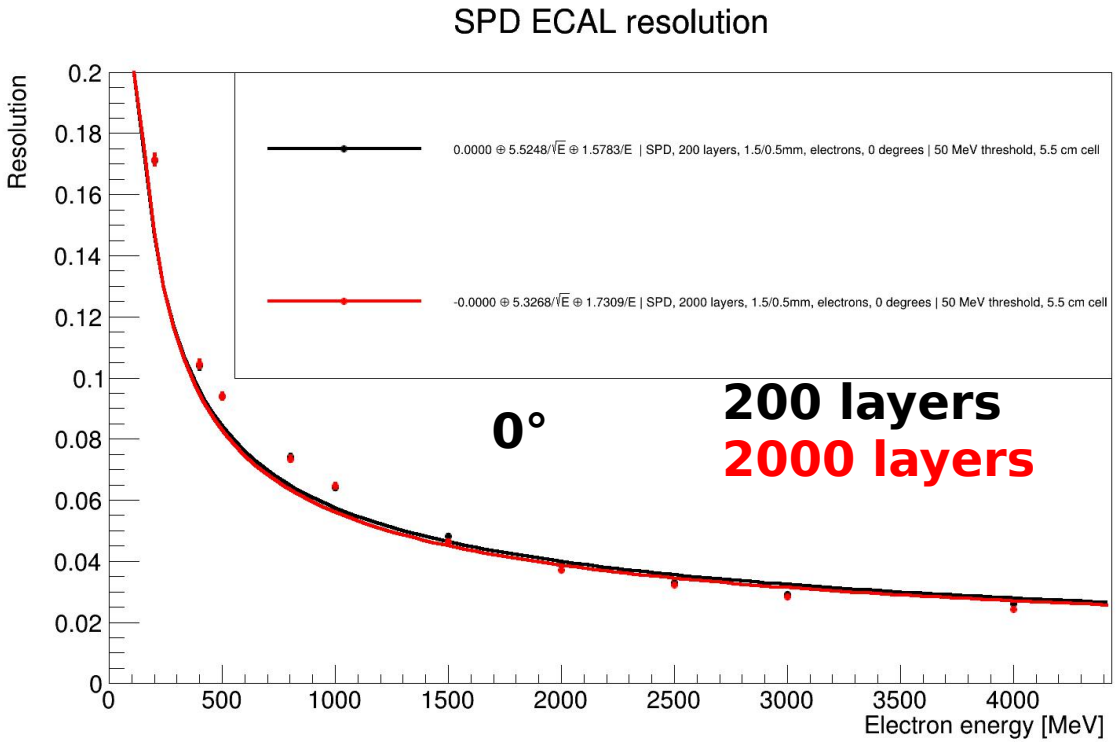
“infinitely large cells”: no cell energy threshold effect

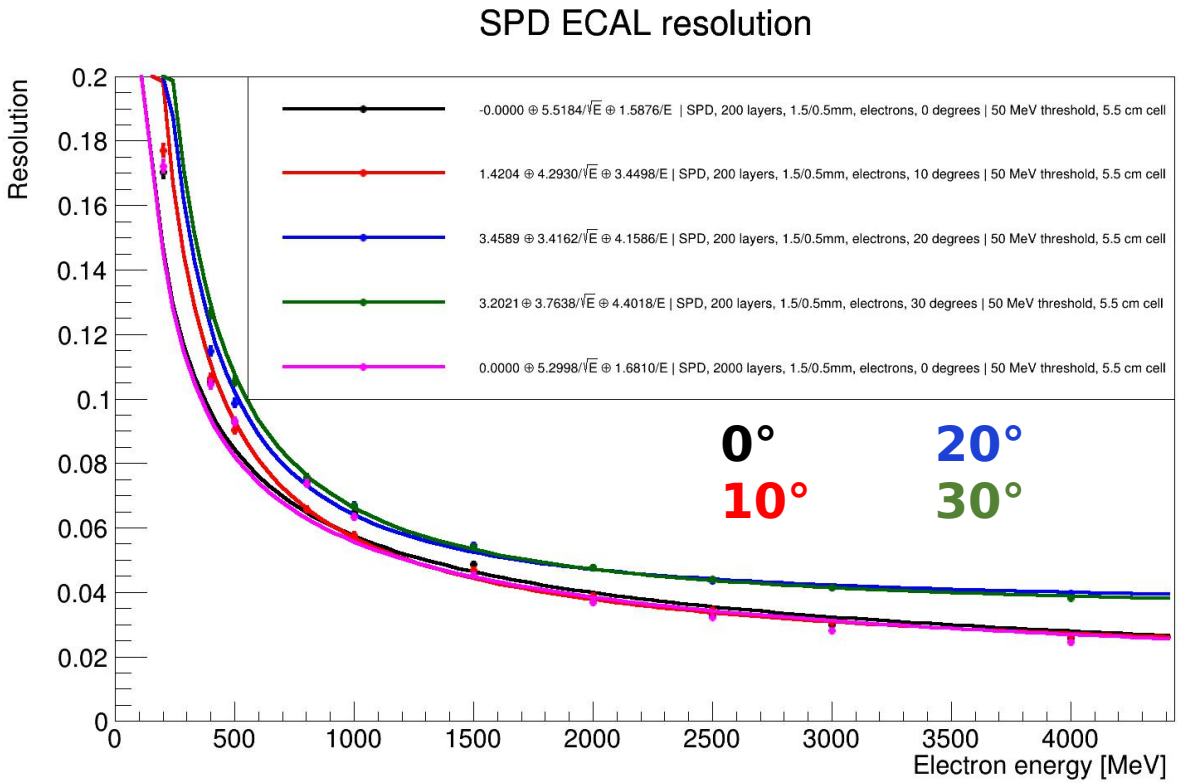
Effect of cell threshold on resolution



NO CORRECTION
30 MeV THRESHOLD
50 MeV THRESHOLD
70 MeV THRESHOLD

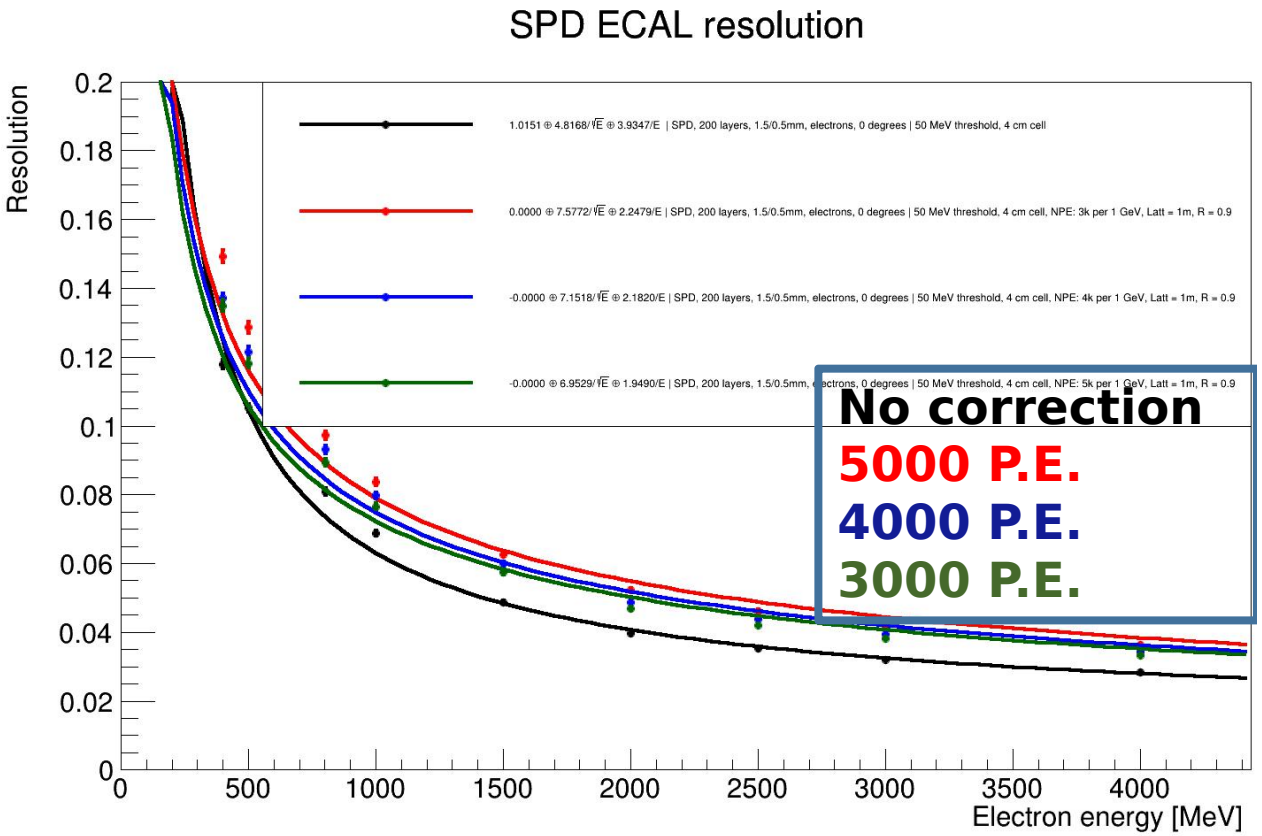
ECAL resolution for different angles

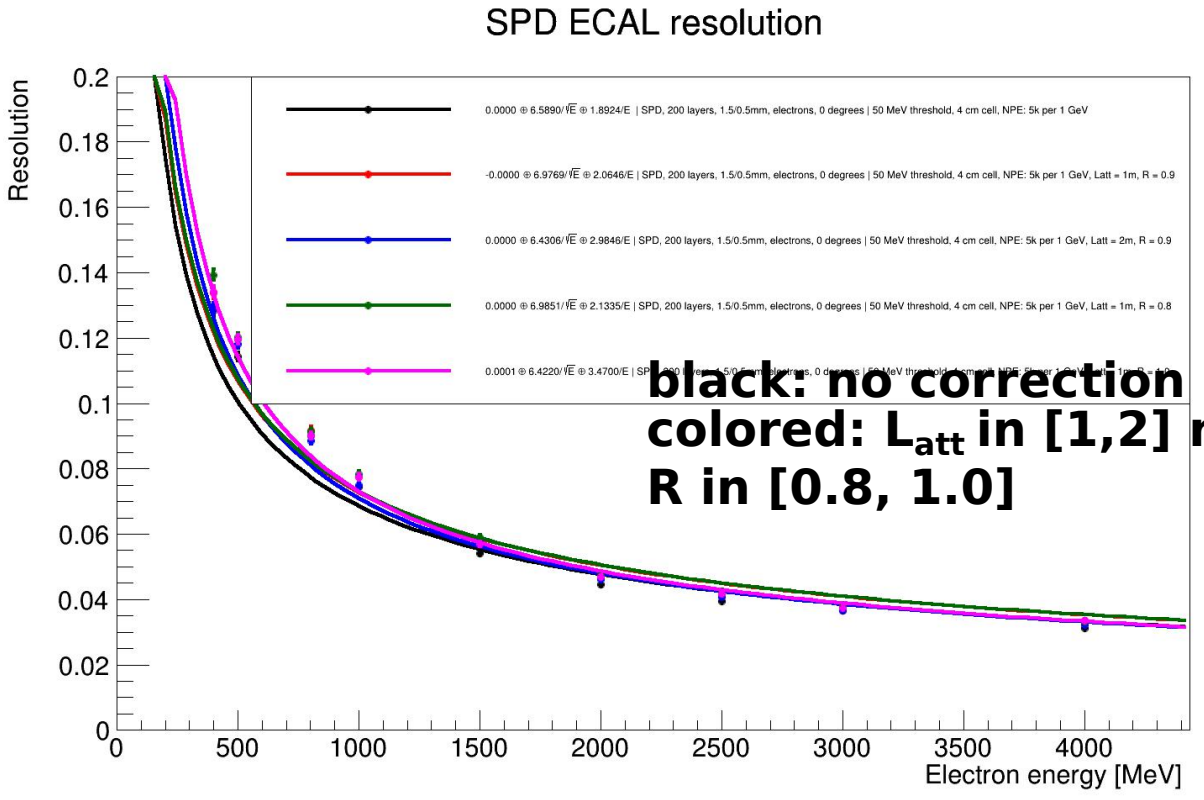




The angle effect is not caused by increasing the effective width of ECAL

Effect of corrections on ECAL resolution

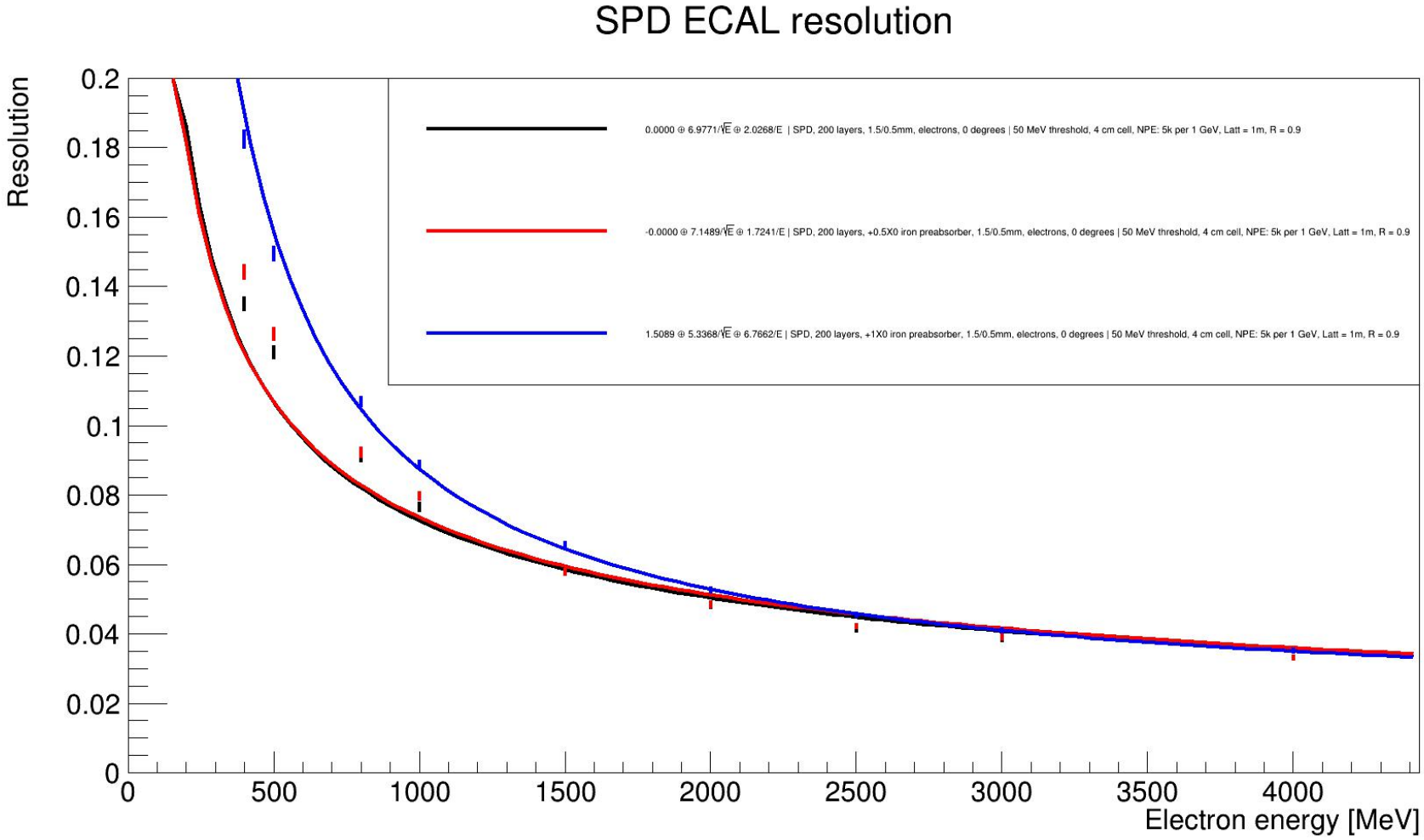




All other corrections are also applied

Bigger contribution is from photoelectron statistics

What is the effect of magnet coils on ECAL resolution?



no “preabsorber”

0.5 X_0 “preabsorber”

1.0 X_0 “preabsorber”