Studies on ECAL resolution and efficiency near the azimuthal gaps for different geometry configurations

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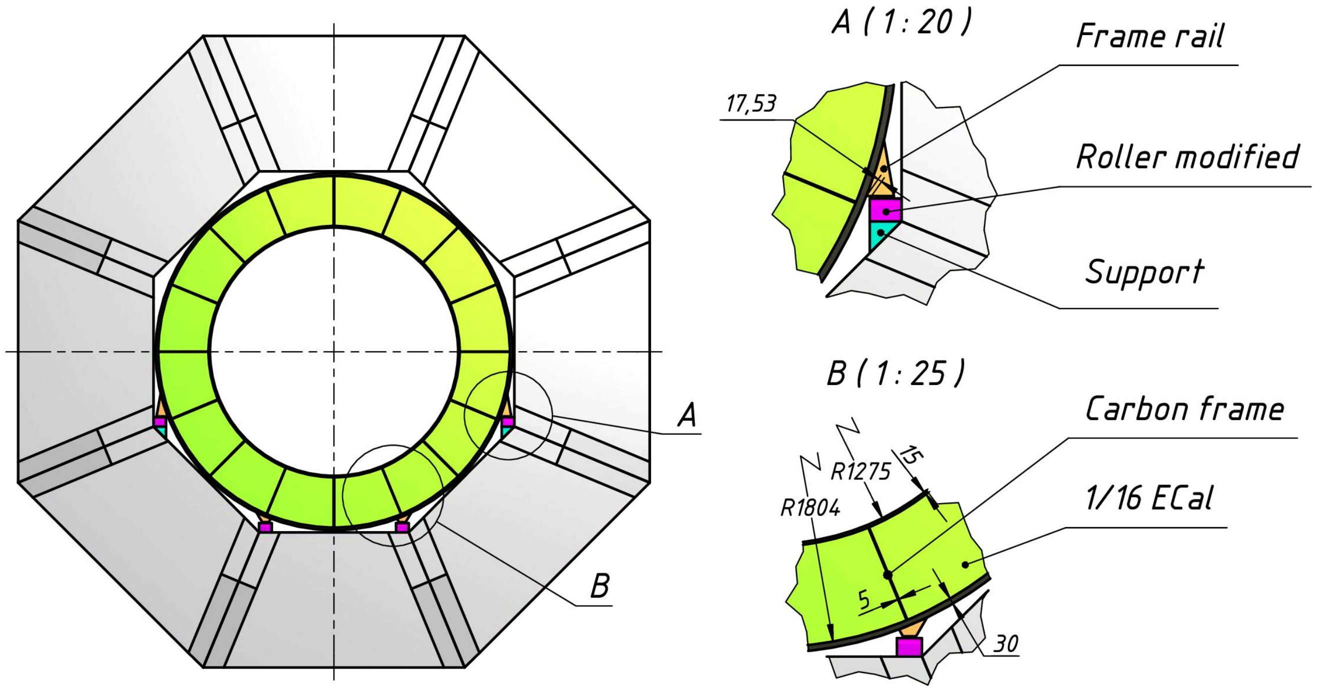
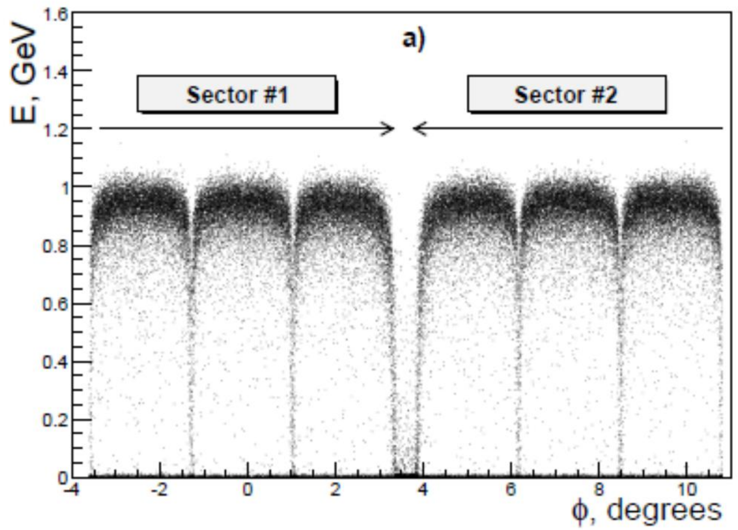
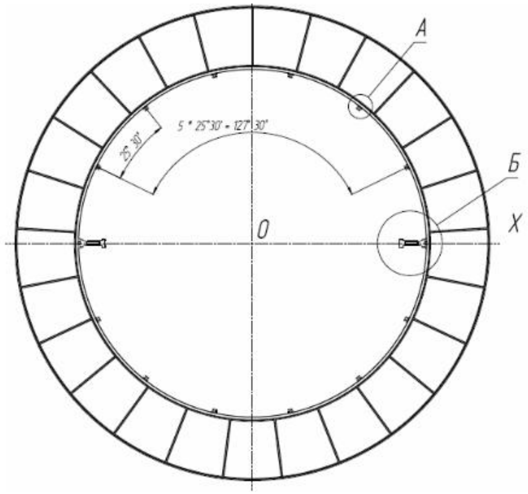
The problem



- 16 azimuthal gaps
- each gap 5-25 mm wide (under discussion)
- carbon or carbon glass inside the gaps

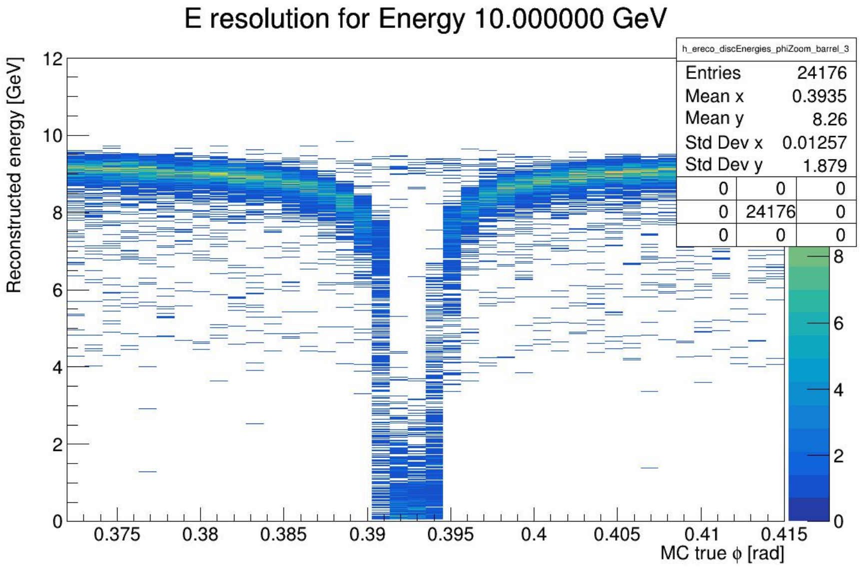
The problem





[MPD setup, Martemianov 2019]

Large gap: sector gap
Smaller gaps: clearance between modules/cells



SPD simulation, @ 5 mm gap
(picture from June SPD P&MC meeting)

Negative impact on measurement of spin asymmetries

On the measurement of TSSA

$$A_N = \frac{\sigma^\uparrow - \sigma^\downarrow}{\sigma^\uparrow + \sigma^\downarrow},$$

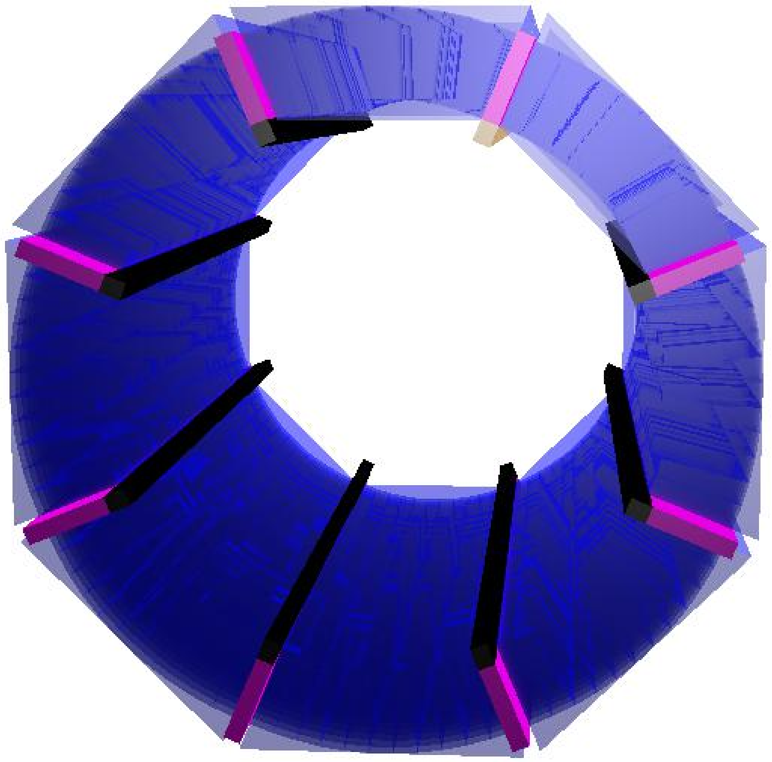
$$d\sigma/d\phi \propto 1 + PA_N \cos(\phi - \phi_0),$$ ⟵ azimuthal distribution for π^0 production

Are we able to correct for photons at gaps? (using ML reconstruction etc.)
Or should we cut out the gap region?

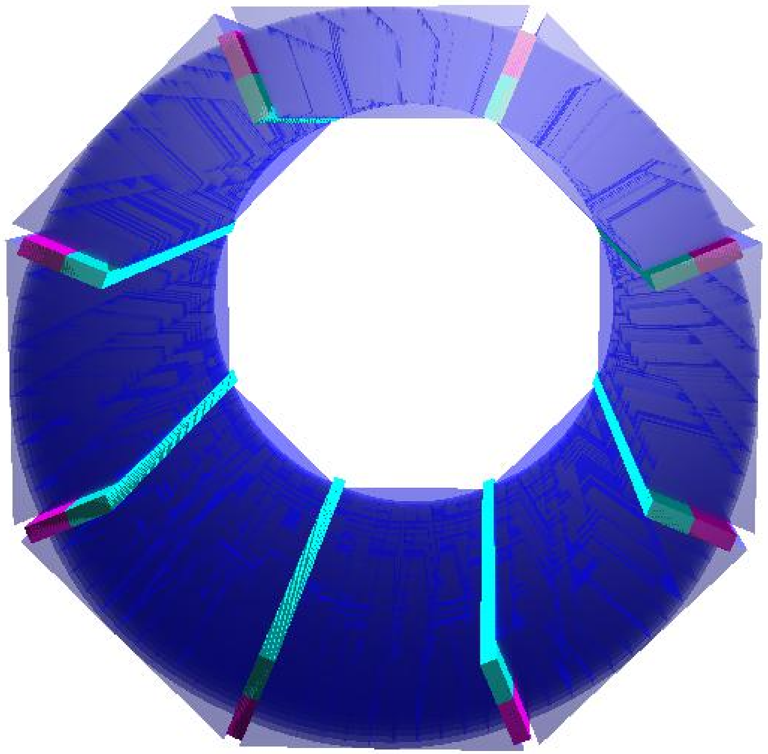
Geometry options under consideration

- Two gap sizes: 5 and 25 mm
- Iron “plug” in front of the carbon gaps, two options:

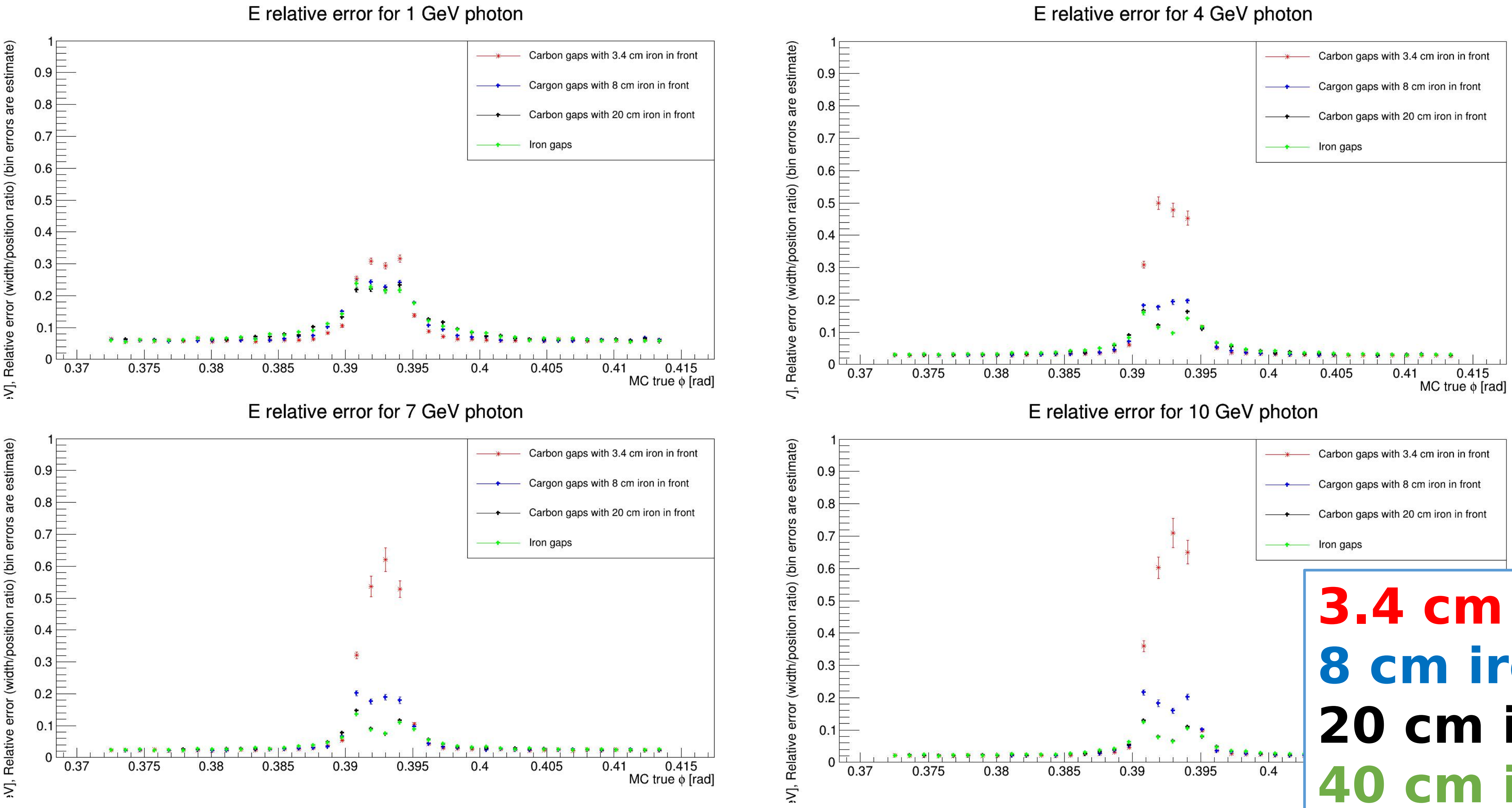
“preshower”, in front of the ECAL



“plug”, replaced a portion of carbon inside the gaps

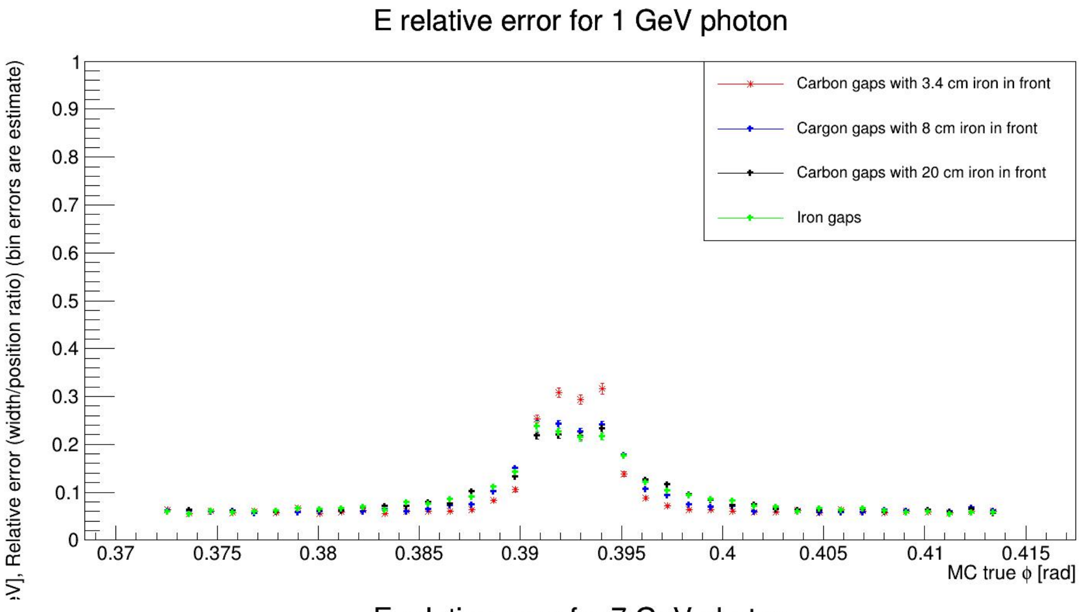


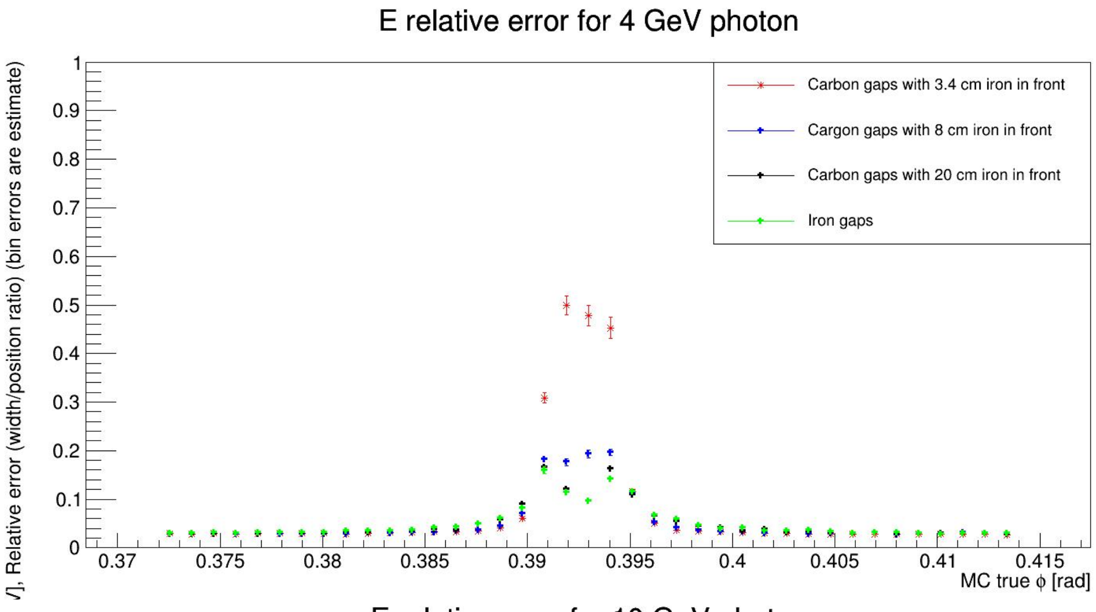
Results: 5 mm gap, “plug”

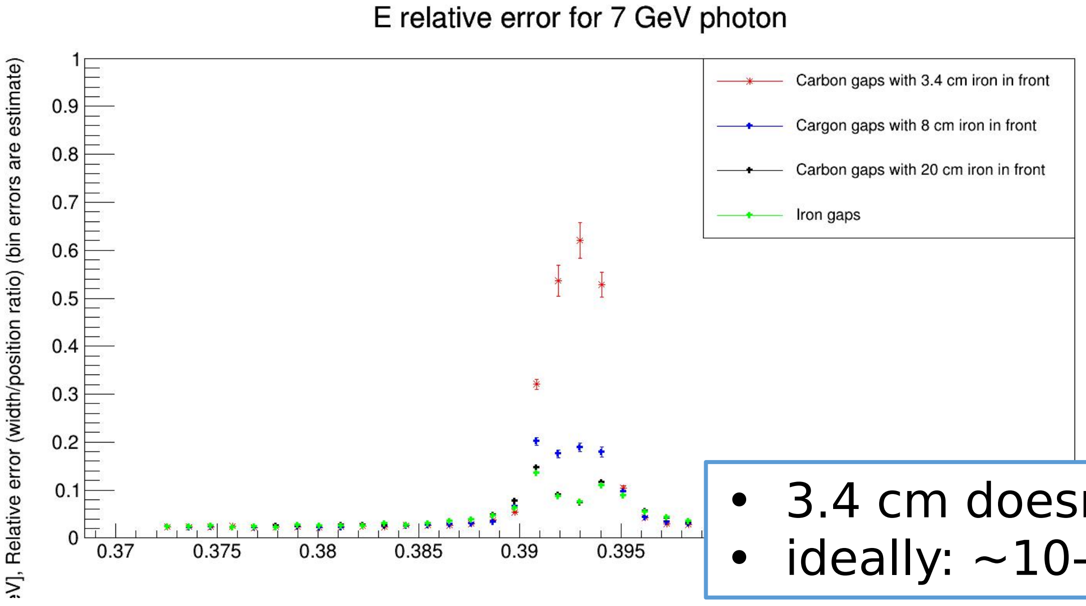


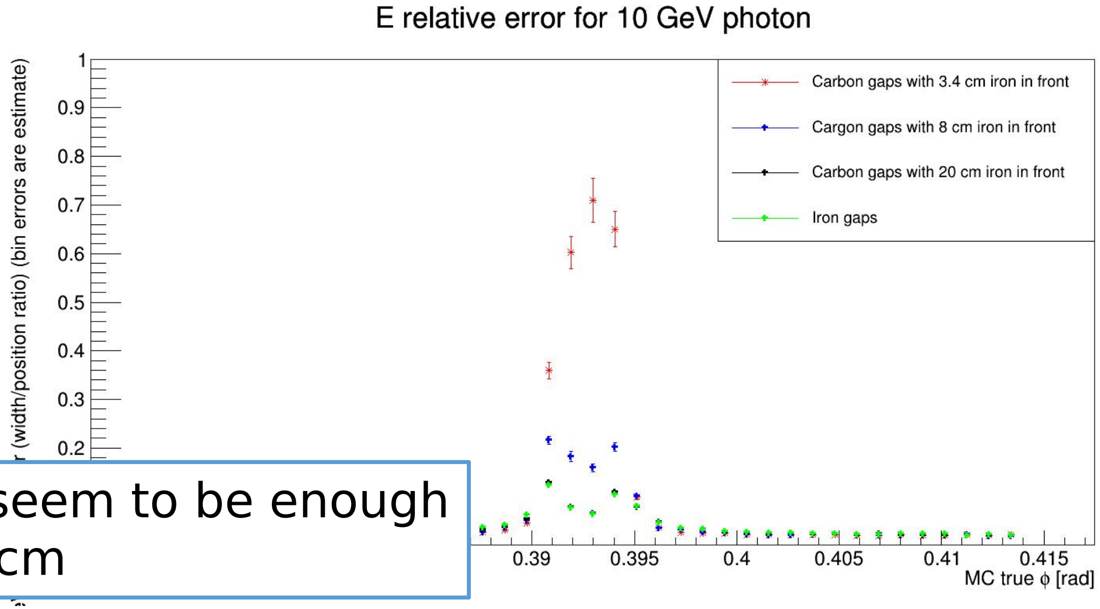
3.4 cm iron
8 cm iron
20 cm iron
40 cm iron

Conclusions: 5 mm gap, “plug”



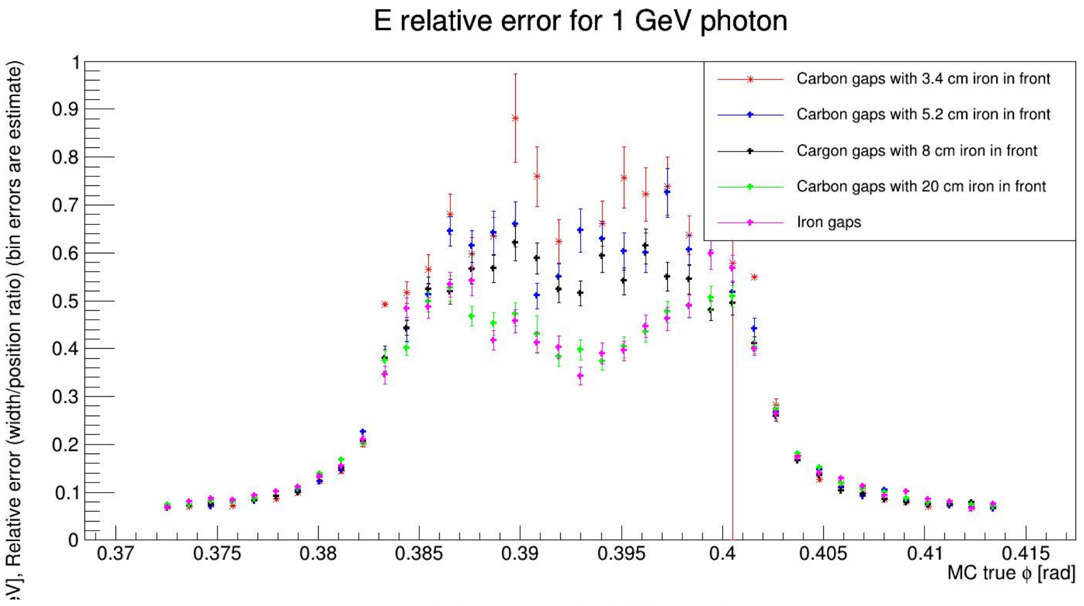


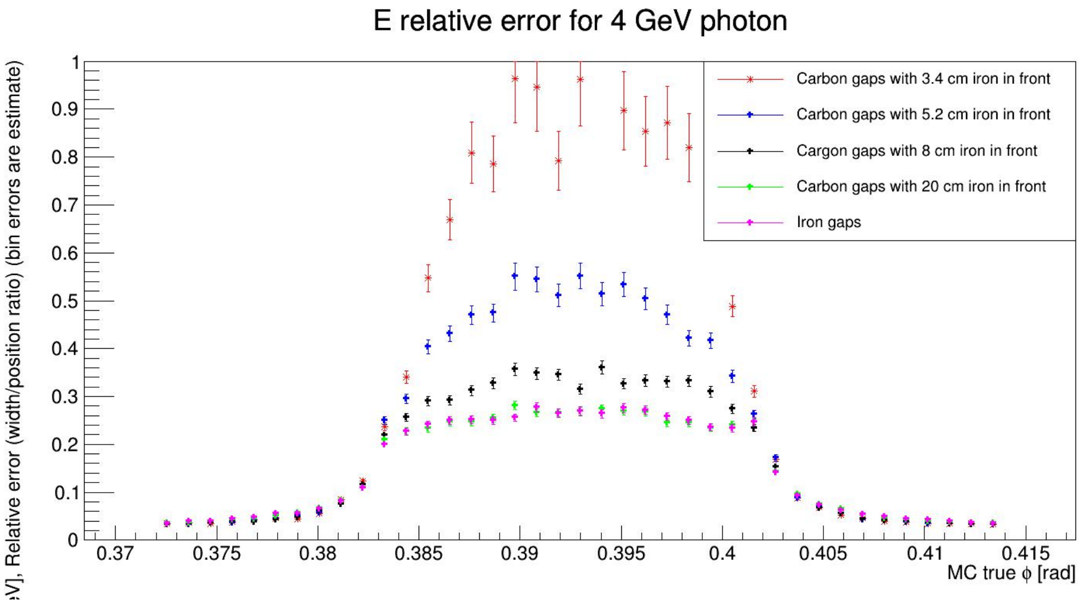


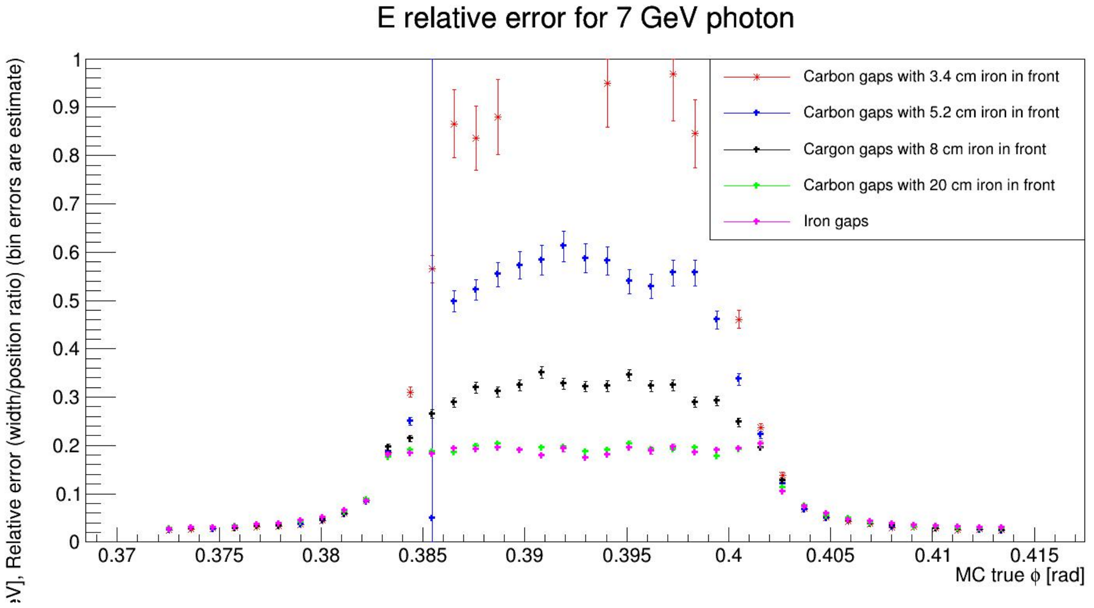


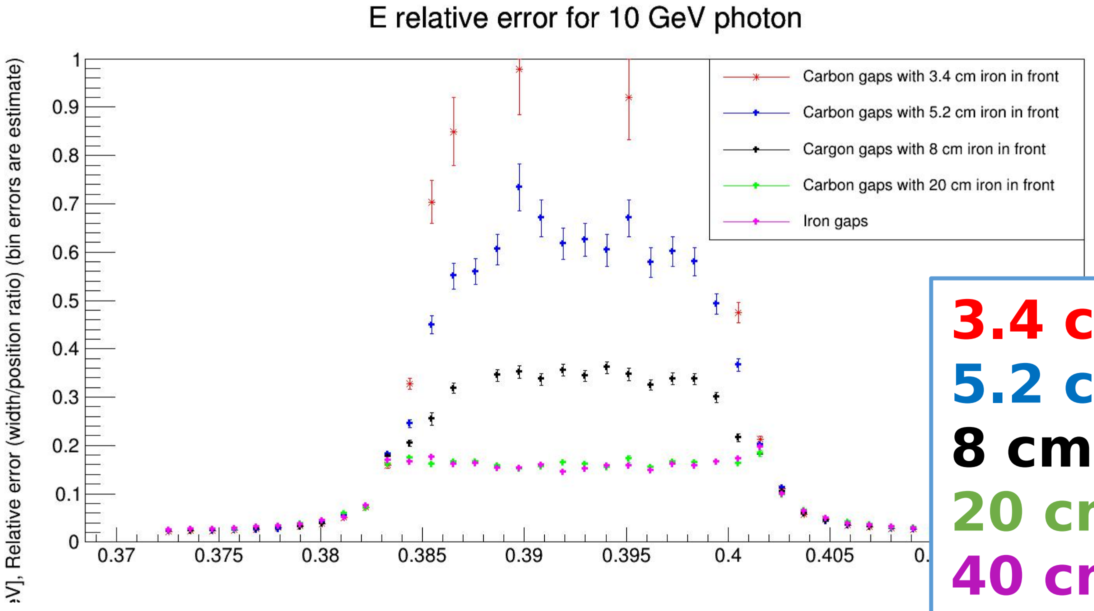
- 3.4 cm doesn't seem to be enough
- ideally: ~10-20 cm

Results: 25 mm gap, “plug”



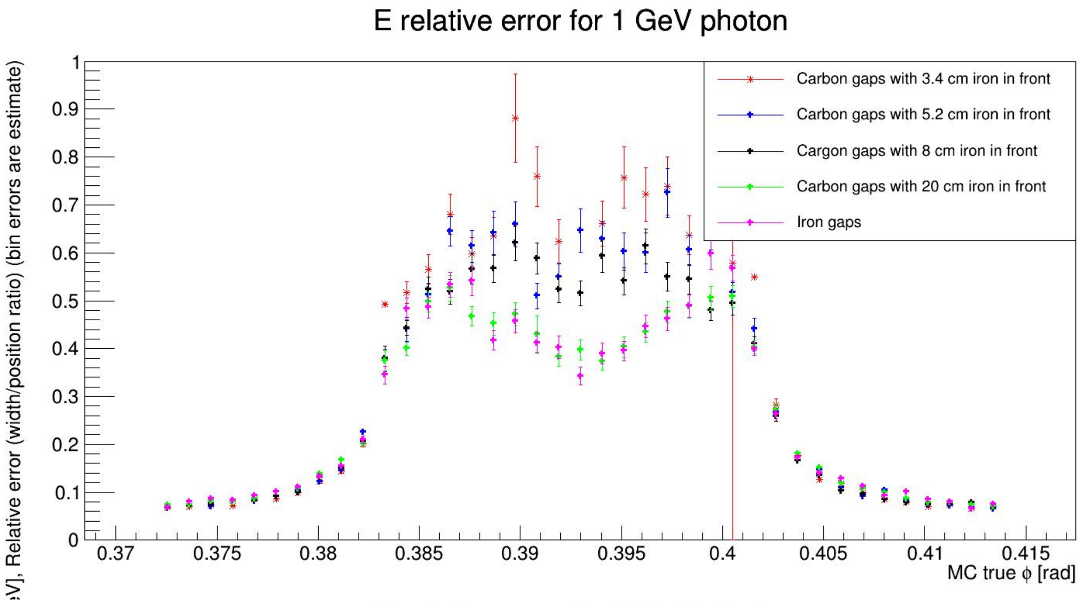


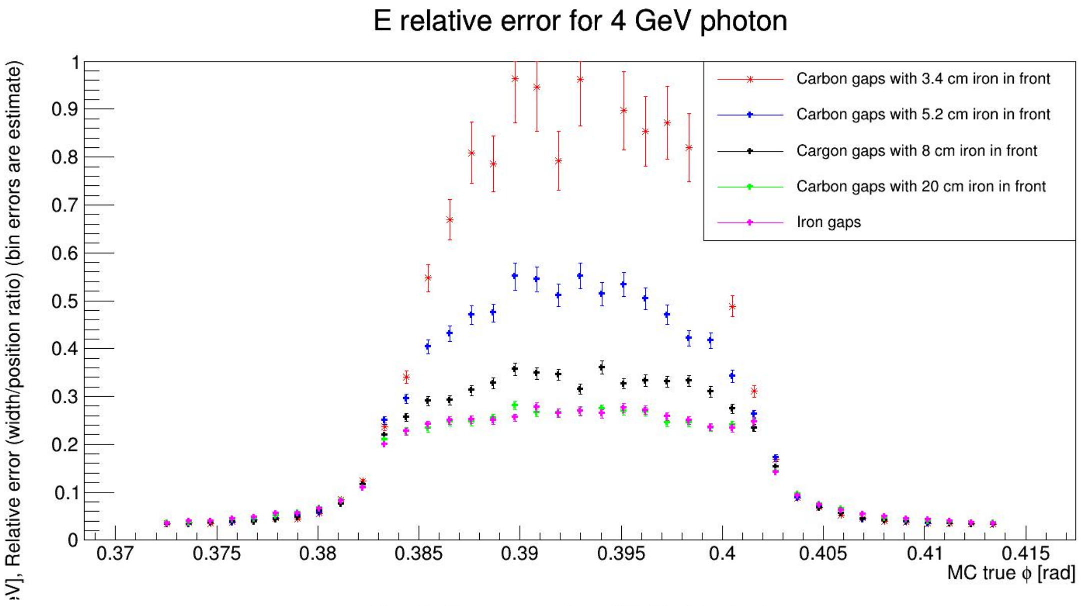


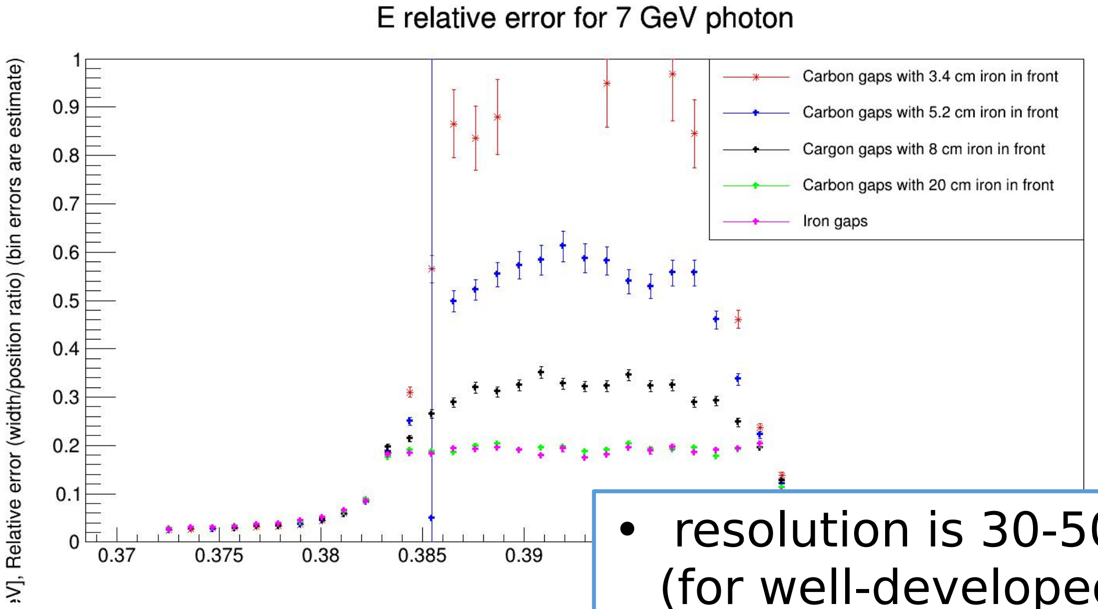


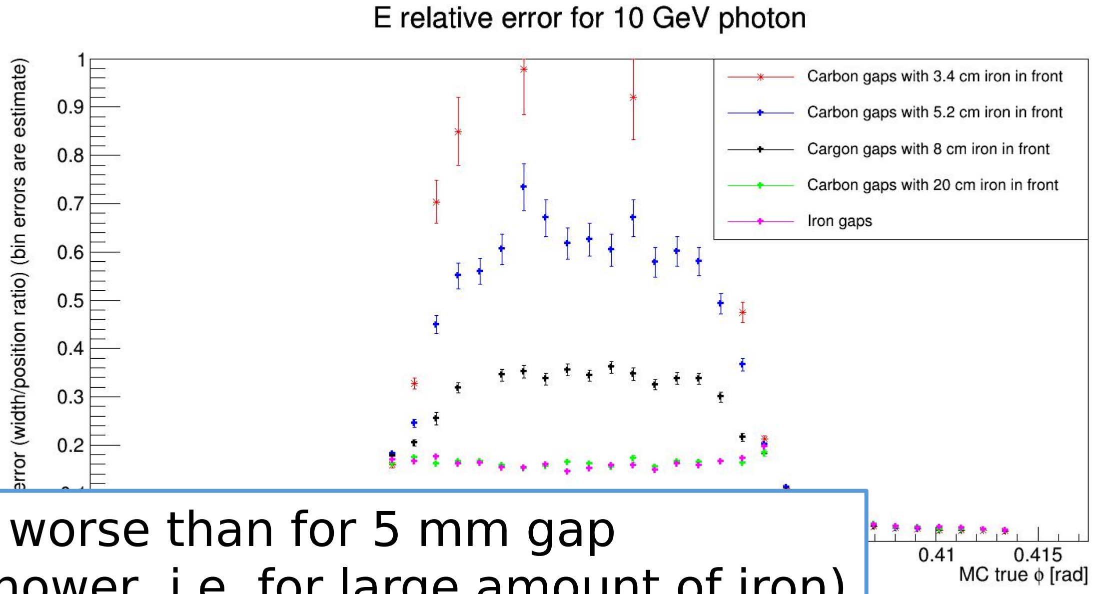
3.4 cm iron
5.2 cm iron
8 cm iron
20 cm iron
40 cm iron

Conclusions: 25 mm gap, “plug”



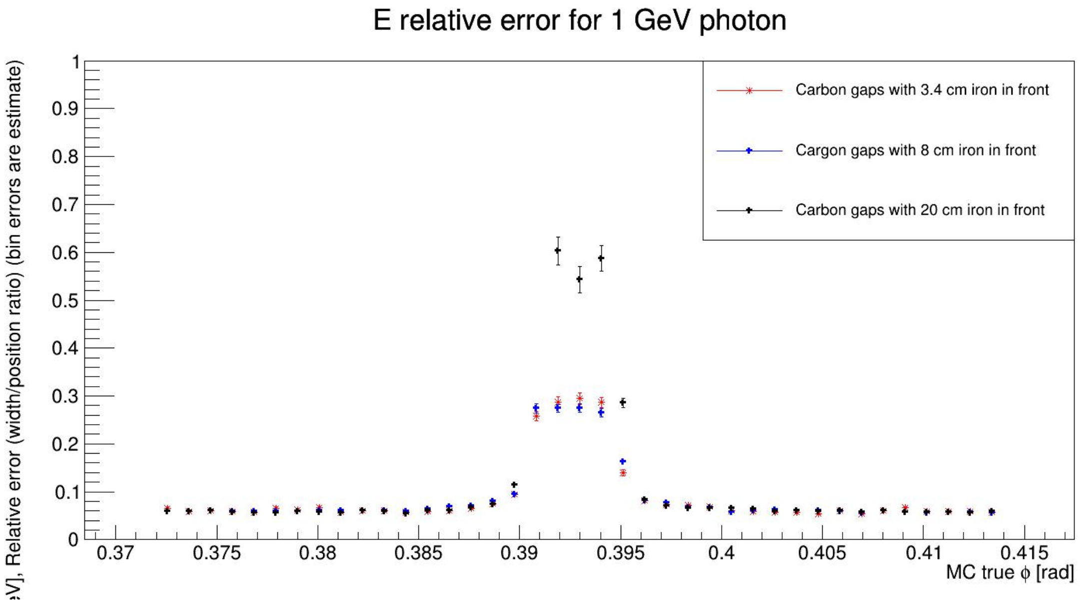


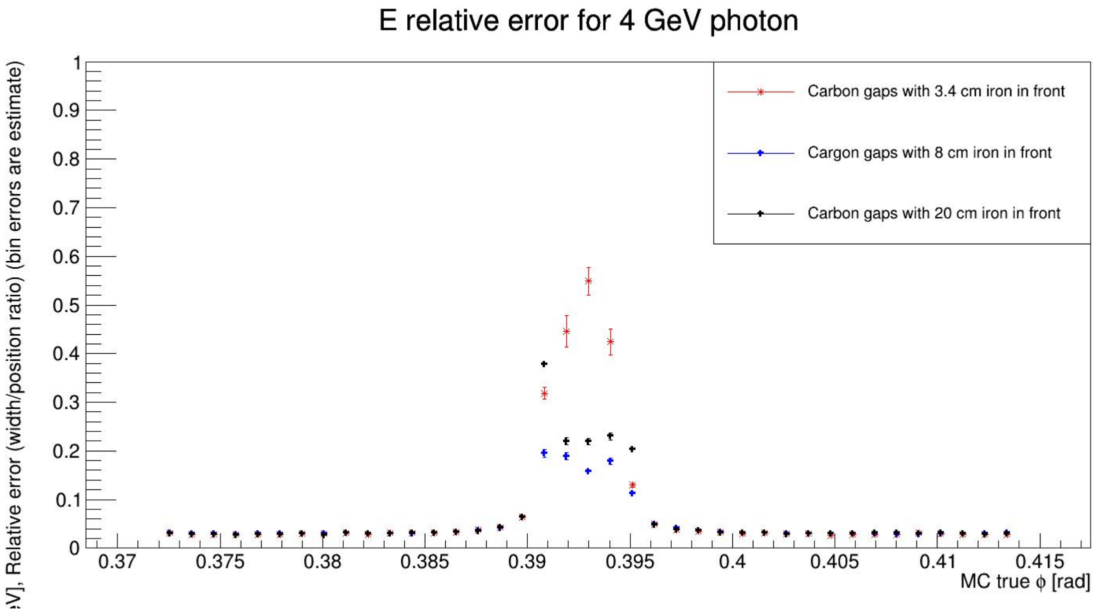


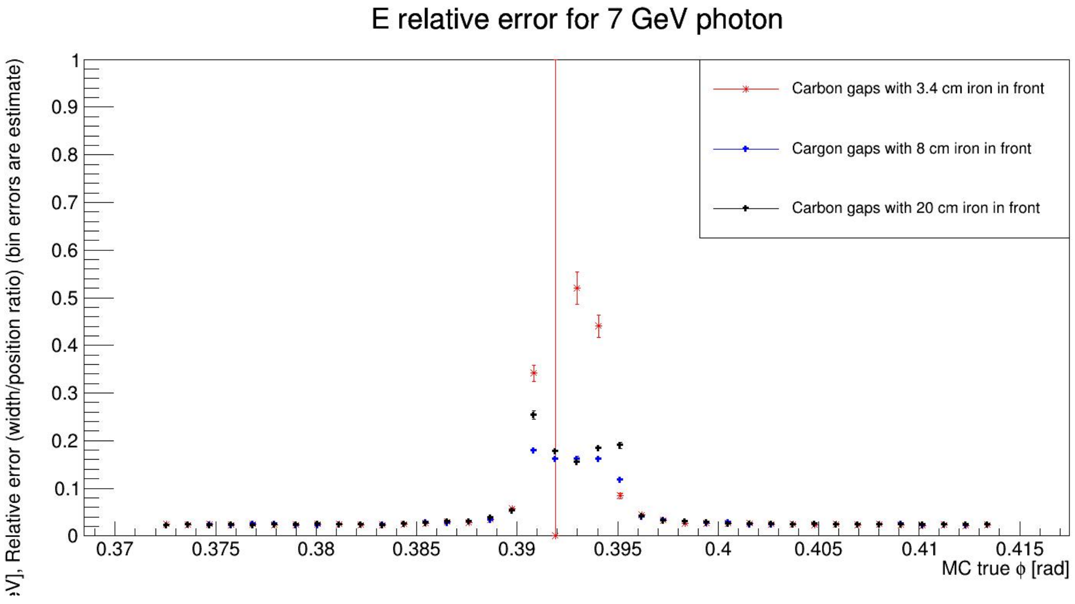


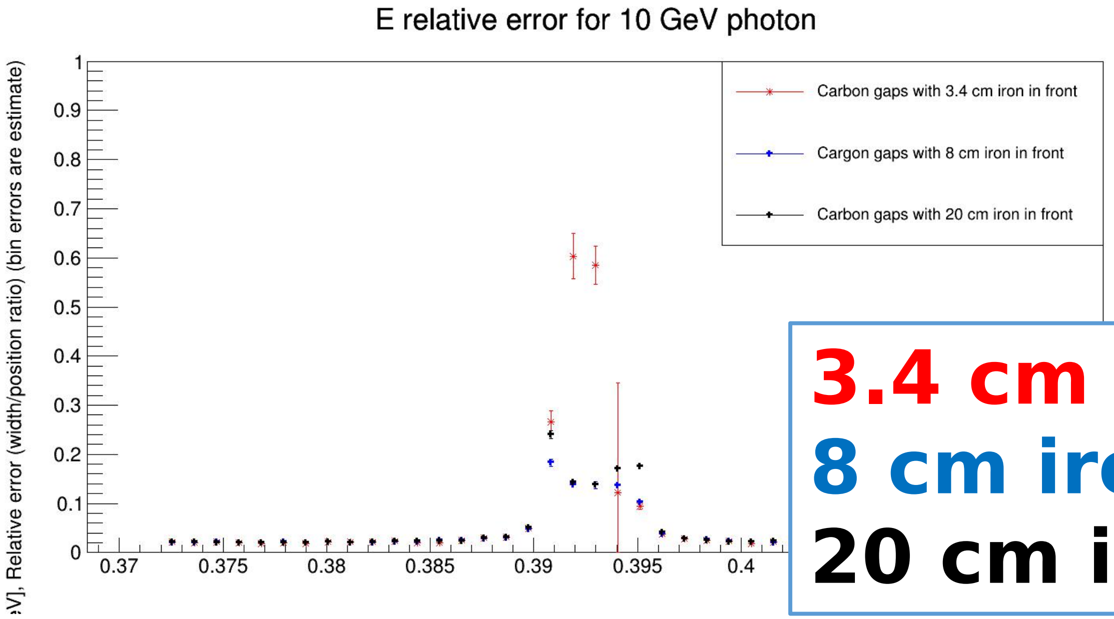
- resolution is 30-50% worse than for 5 mm gap (for well-developed shower, i.e. for large amount of iron)

Results: 5 mm gap, “preshower”



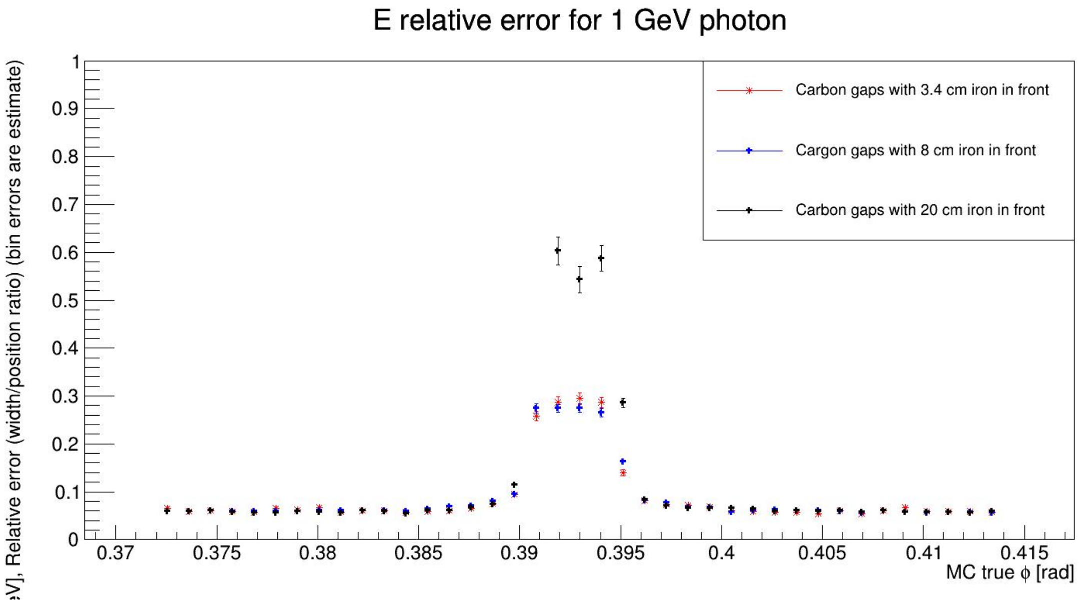


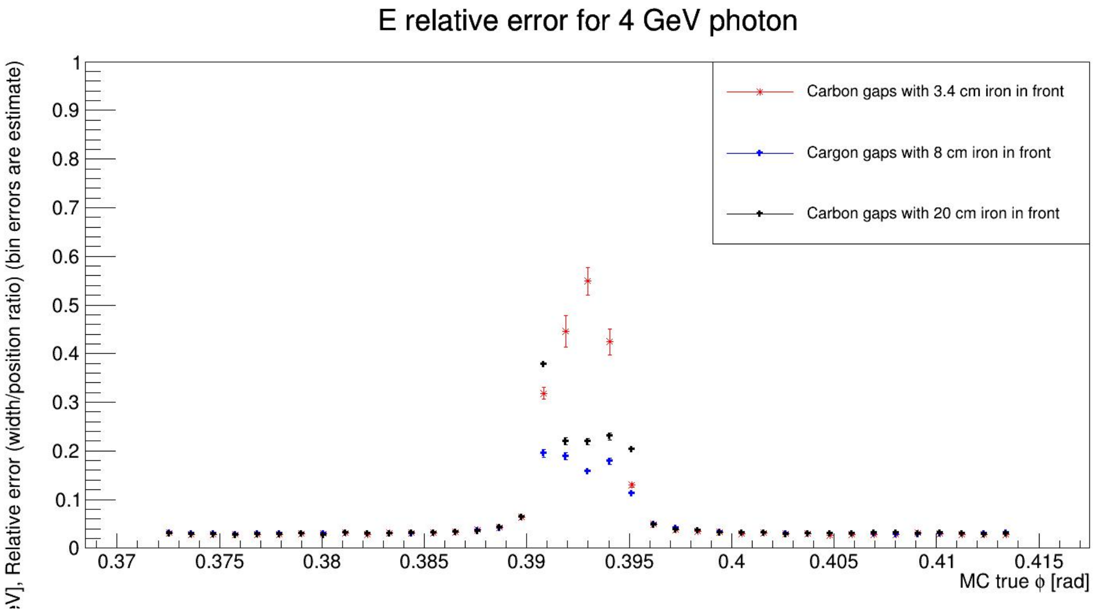


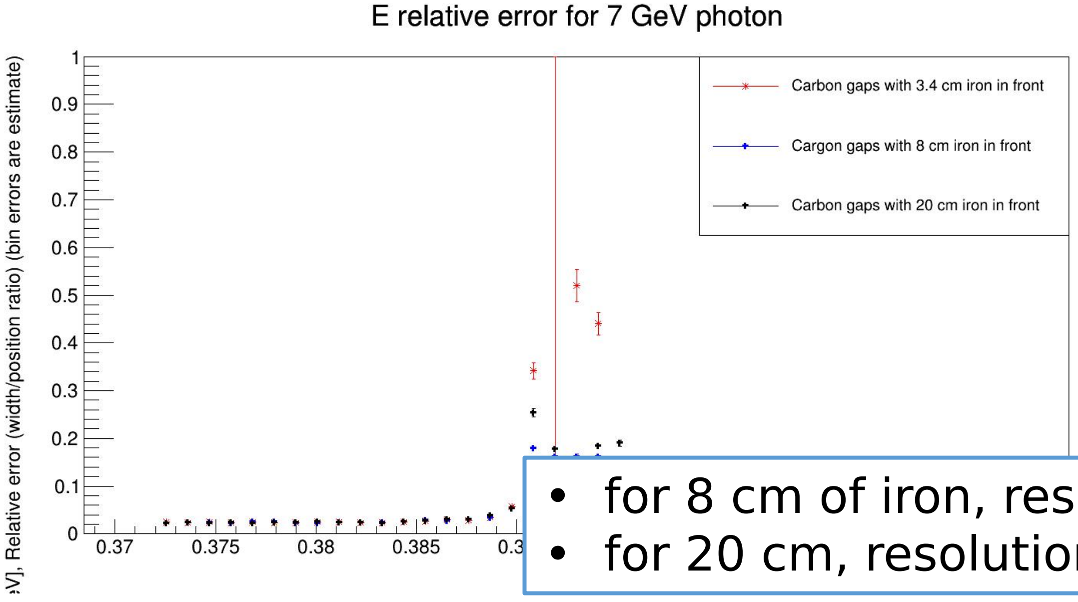


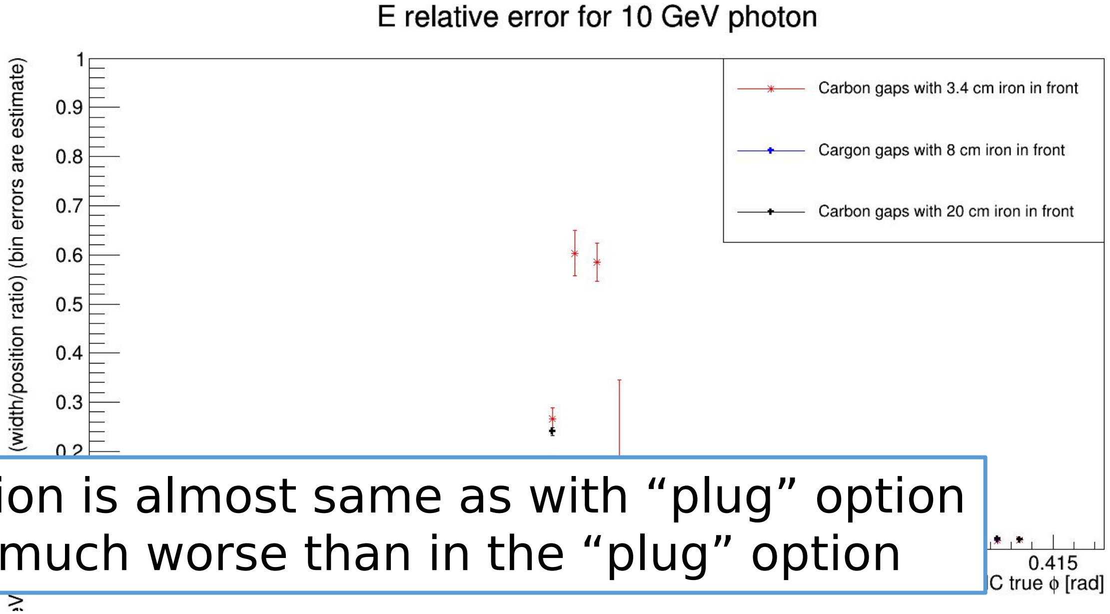
3.4 cm iron
8 cm iron
20 cm iron

Conclusions: 5 mm gap, “preshower”



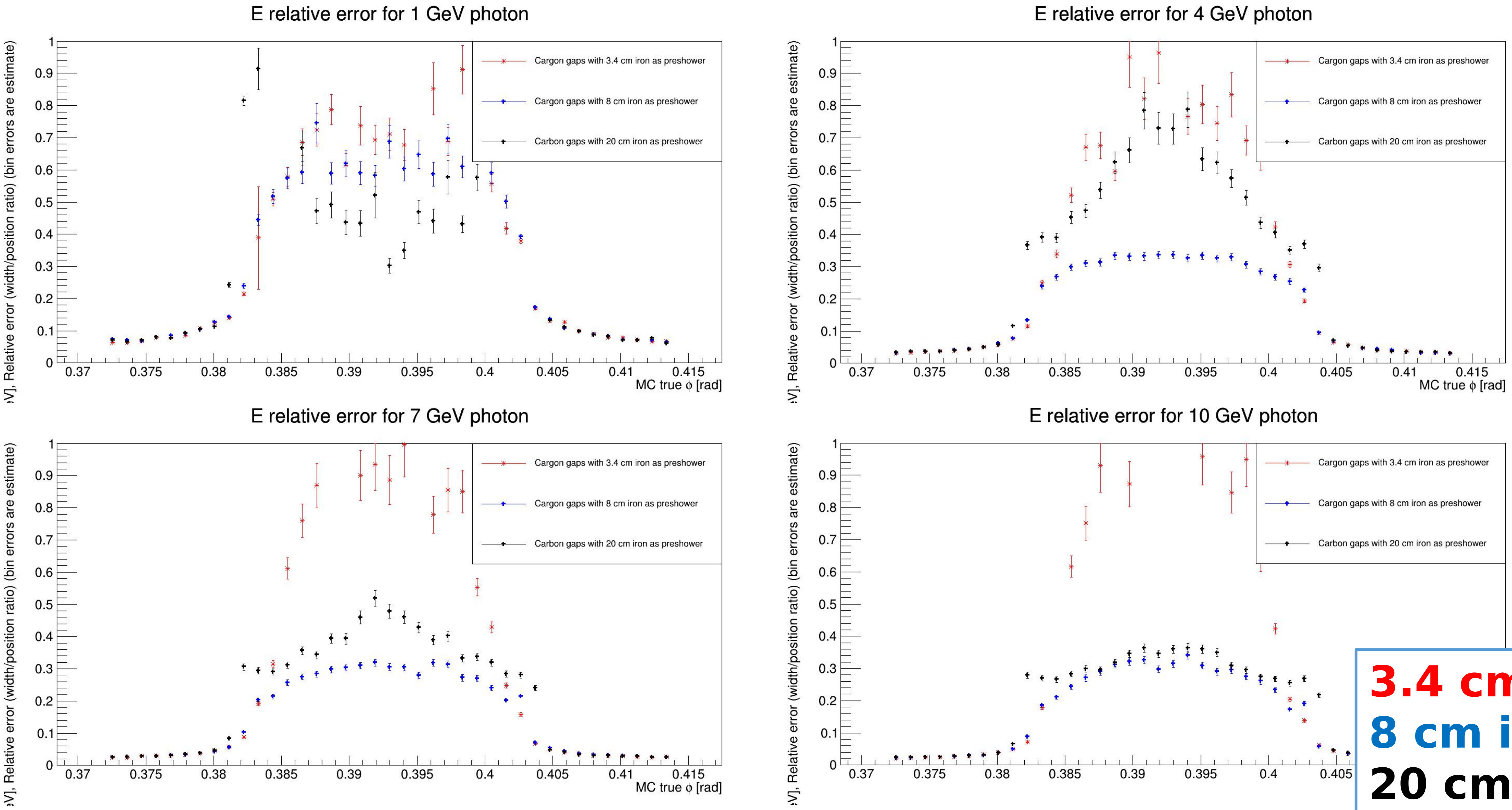






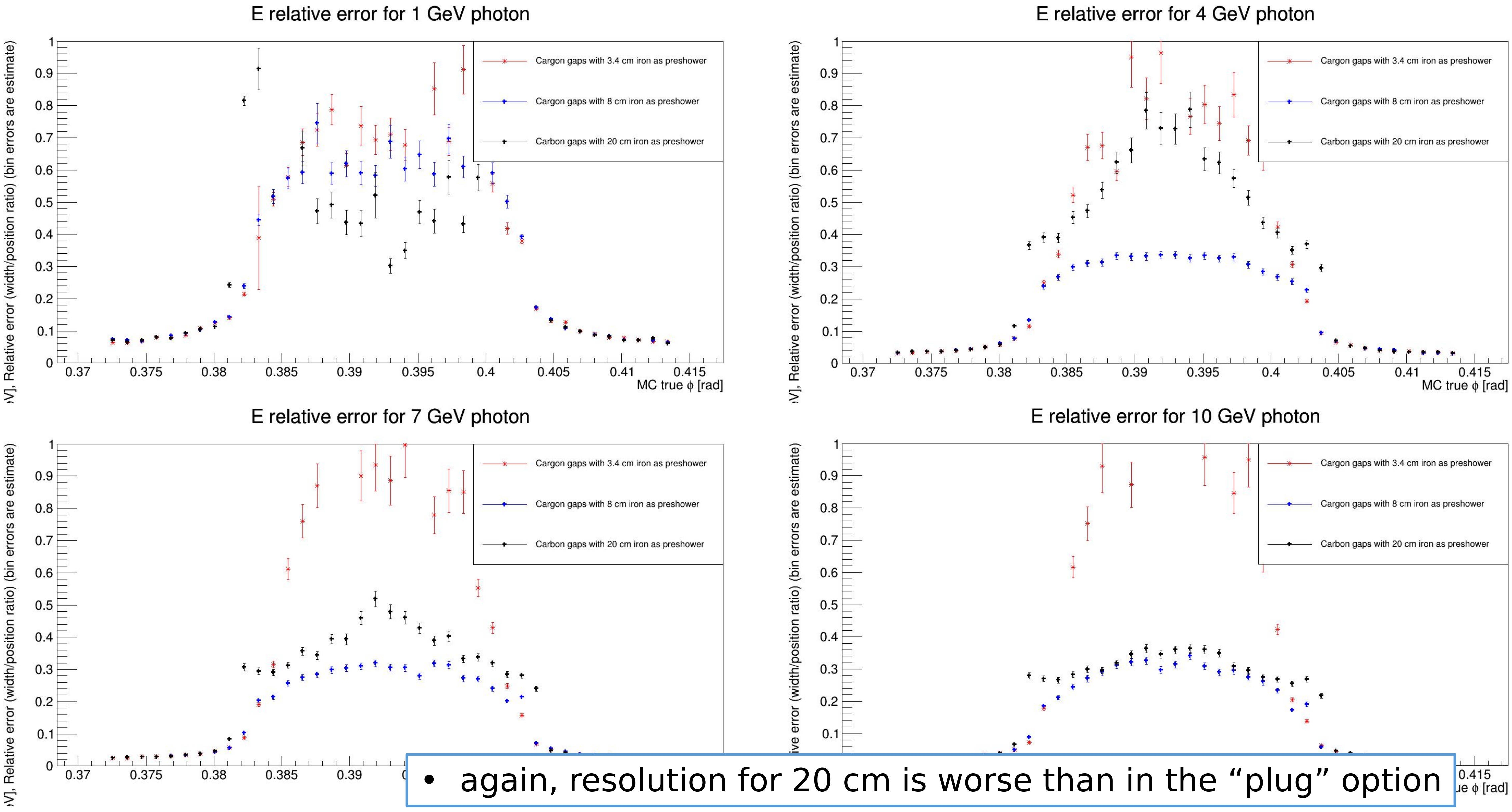
- for 8 cm of iron, resolution is almost same as with “plug” option
- for 20 cm, resolution is much worse than in the “plug” option

Results: 25 mm gap, “preshower”

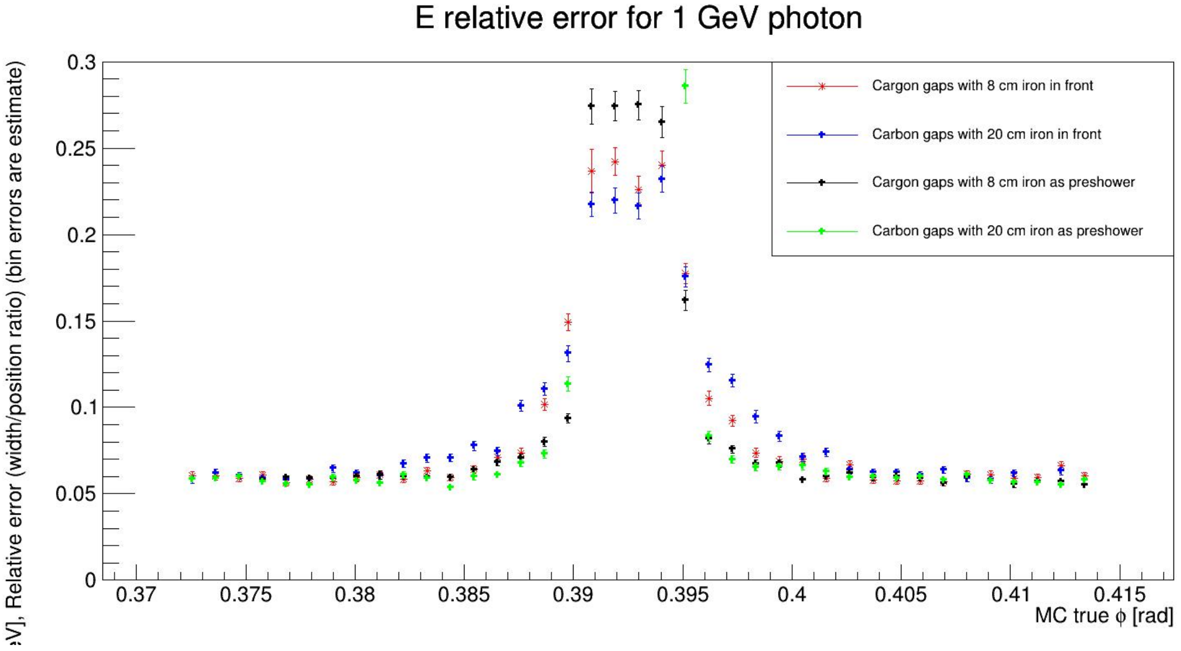


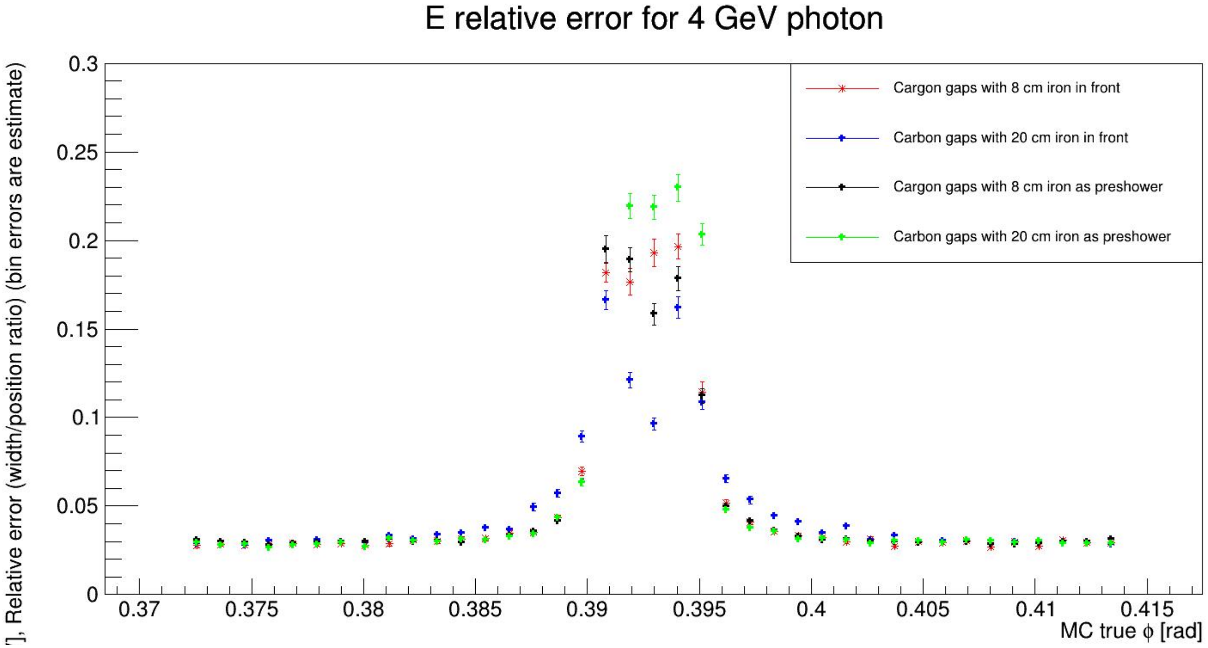
3.4 cm iron
8 cm iron
20 cm iron

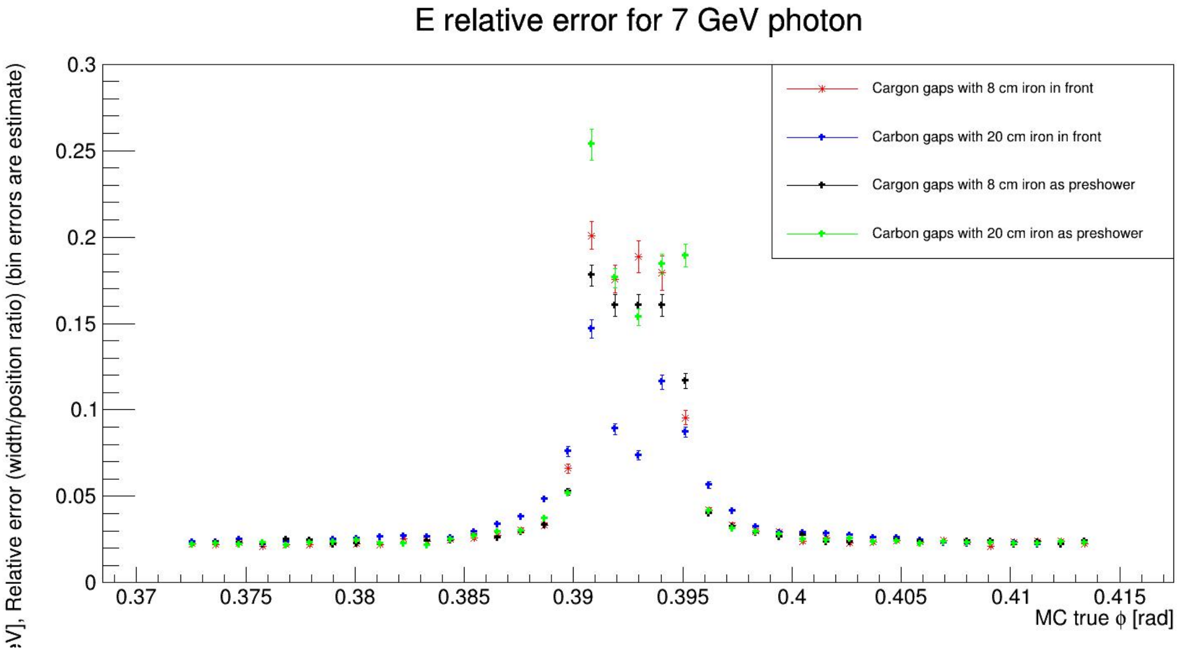
Conclusions: 25 mm gap, “preshower”

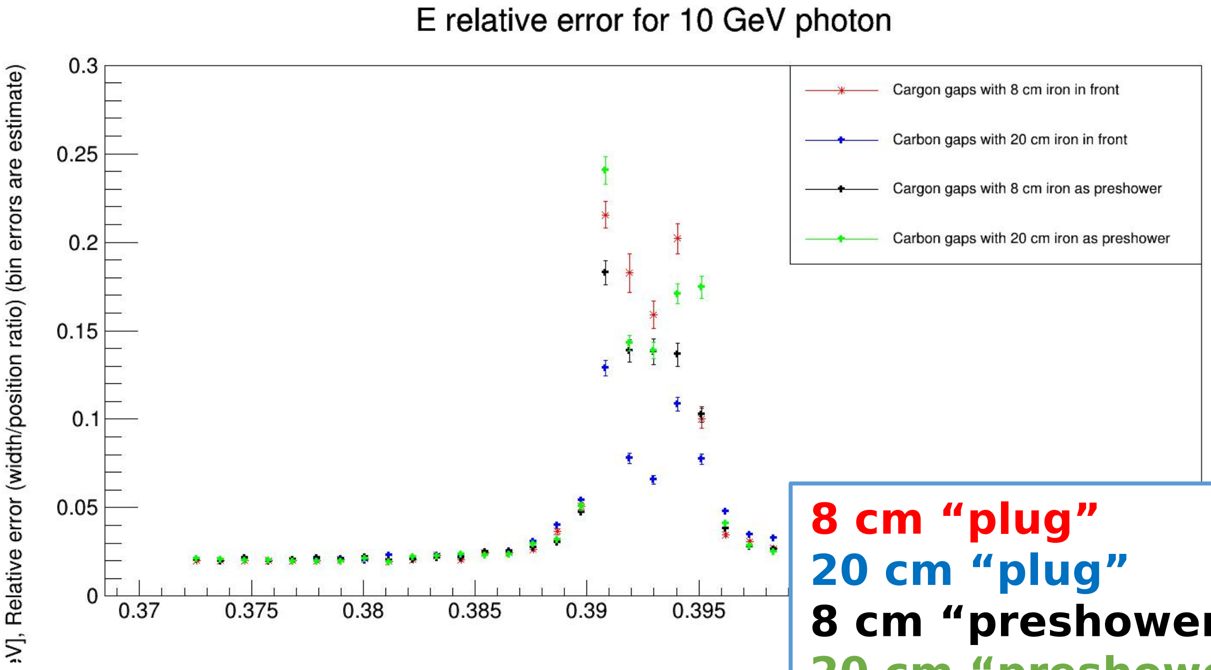


- again, resolution for 20 cm is worse than in the “plug” option

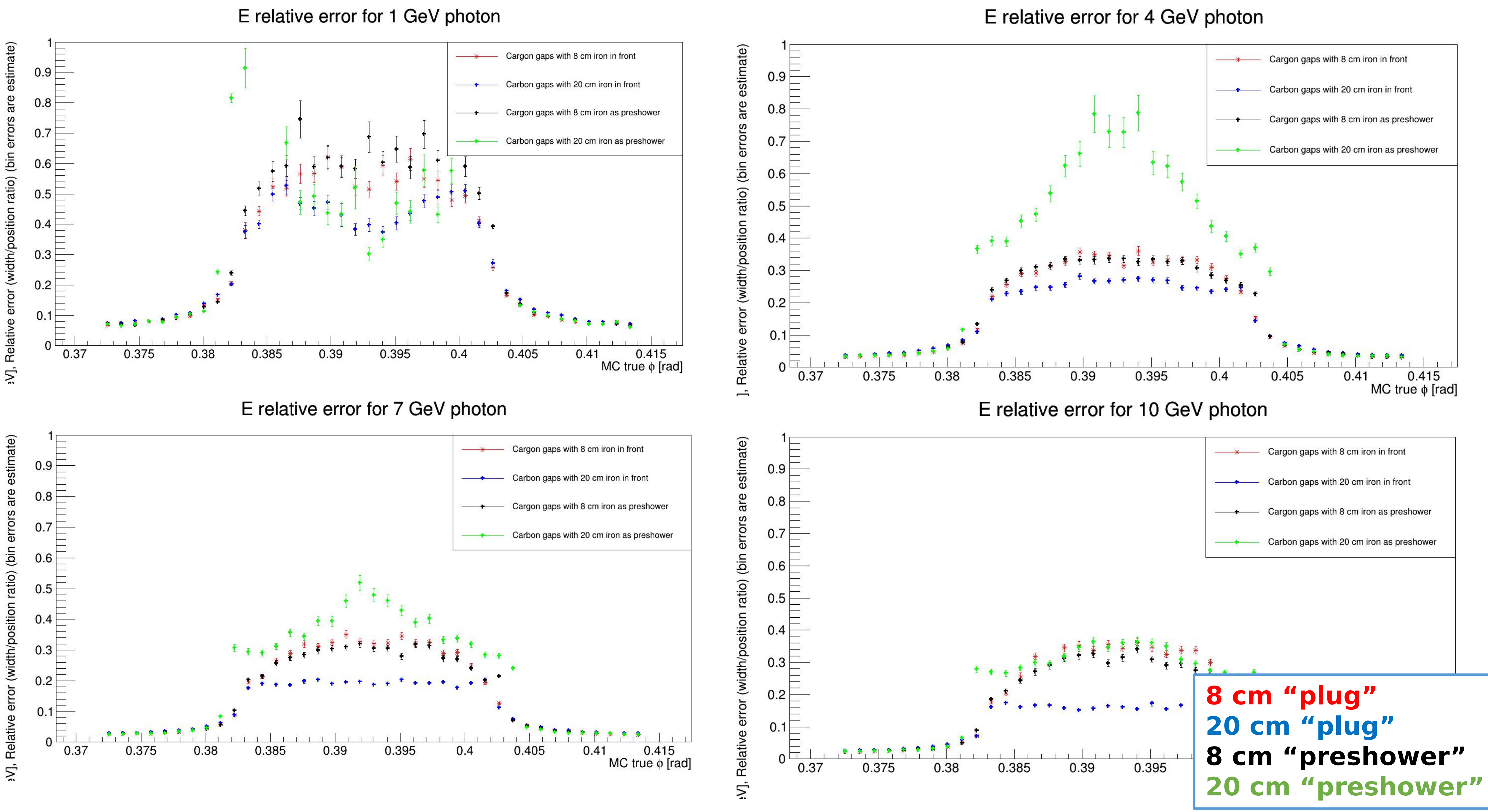




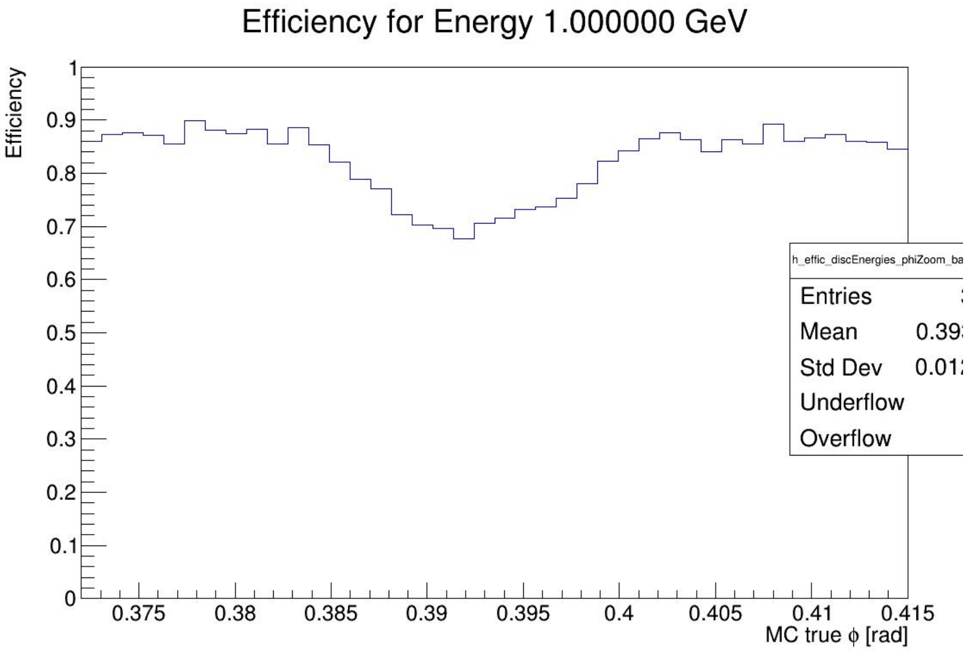


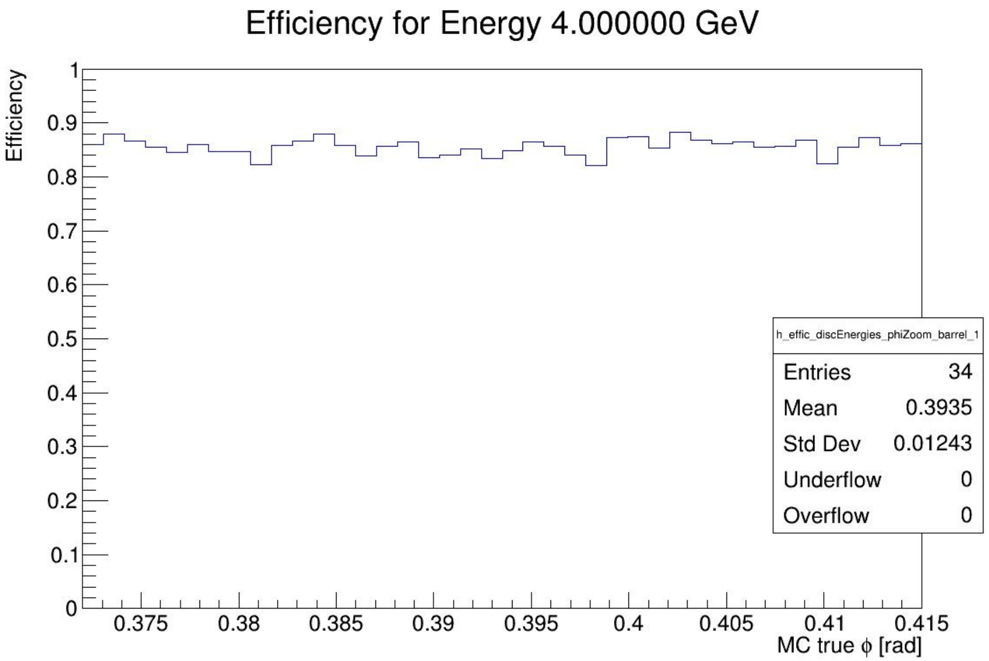


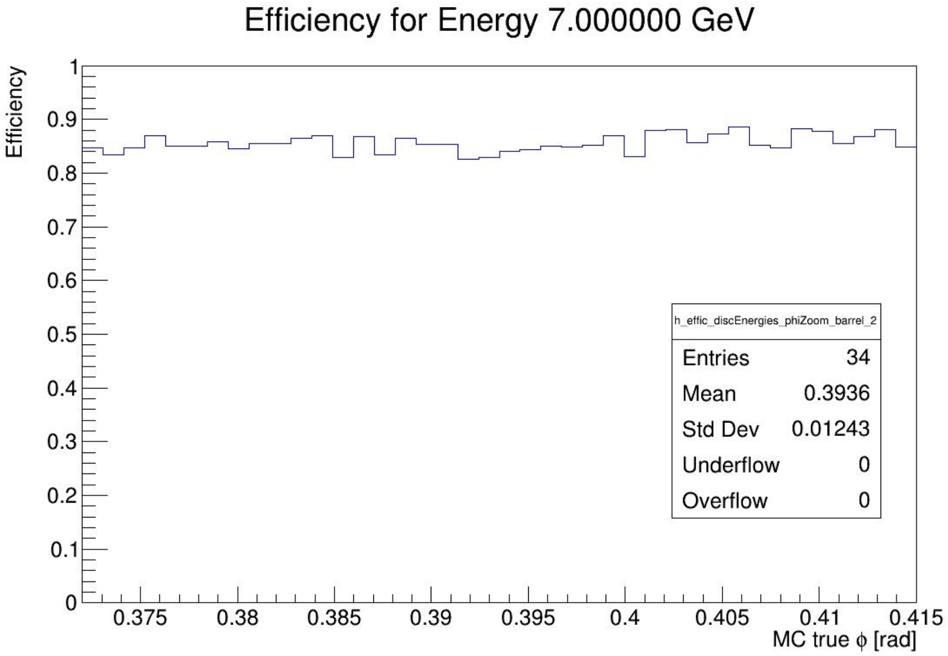
8 cm “plug”
20 cm “plug”
8 cm “preshower”
20 cm “preshower”

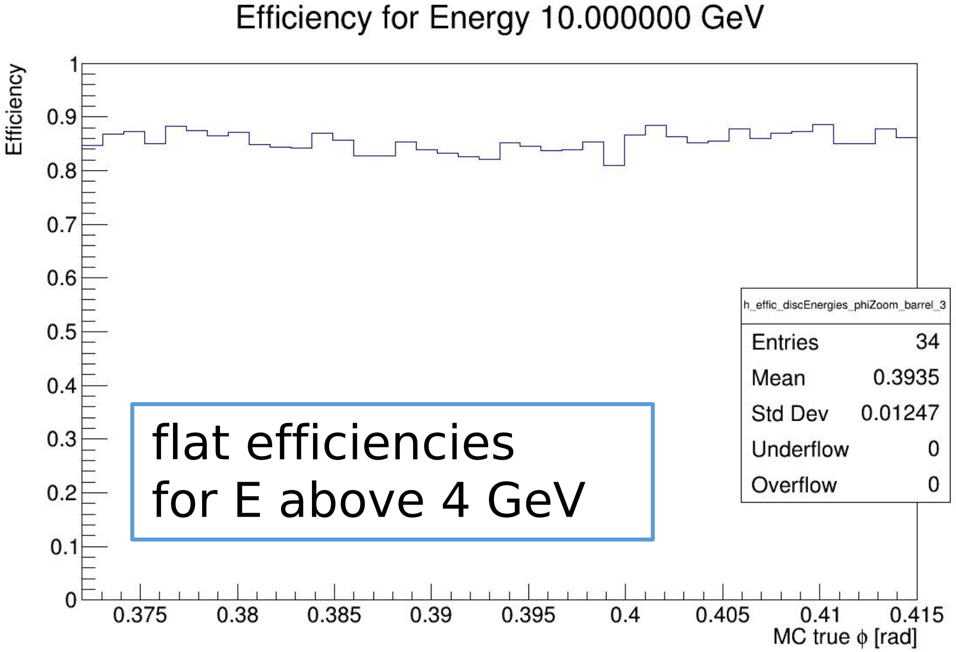

E relative error for 1 GeV photon
E relative error for 4 GeV photon
E relative error for 7 GeV photon
E relative error for 10 GeV photon
Relative error (width/position ratio) (bin errors are estimate)
MC true ϕ [rad]
Cargon gaps with 8 cm iron in front
Carbon gaps with 20 cm iron in front
Cargon gaps with 8 cm iron as preshower
Carbon gaps with 20 cm iron as preshower
8 cm "plug"
20 cm "plug"
8 cm "preshower"
20 cm "preshower"

Efficiencies



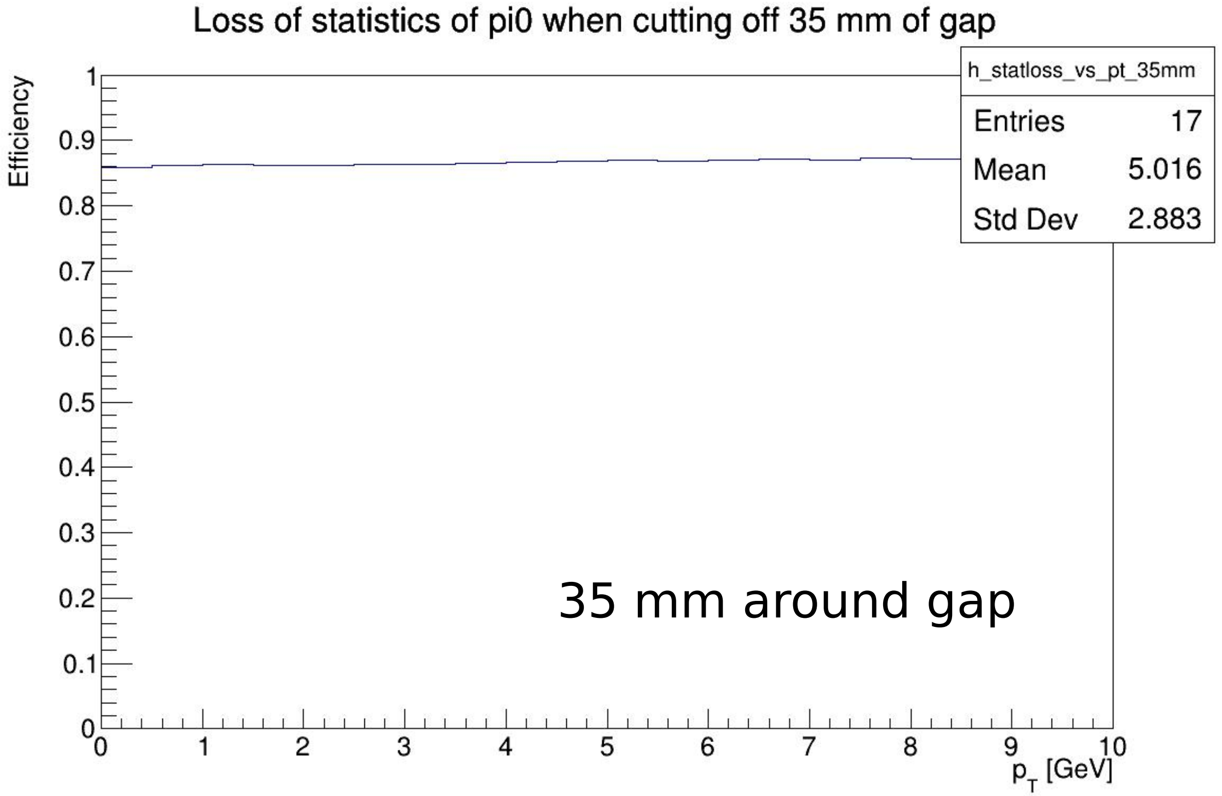


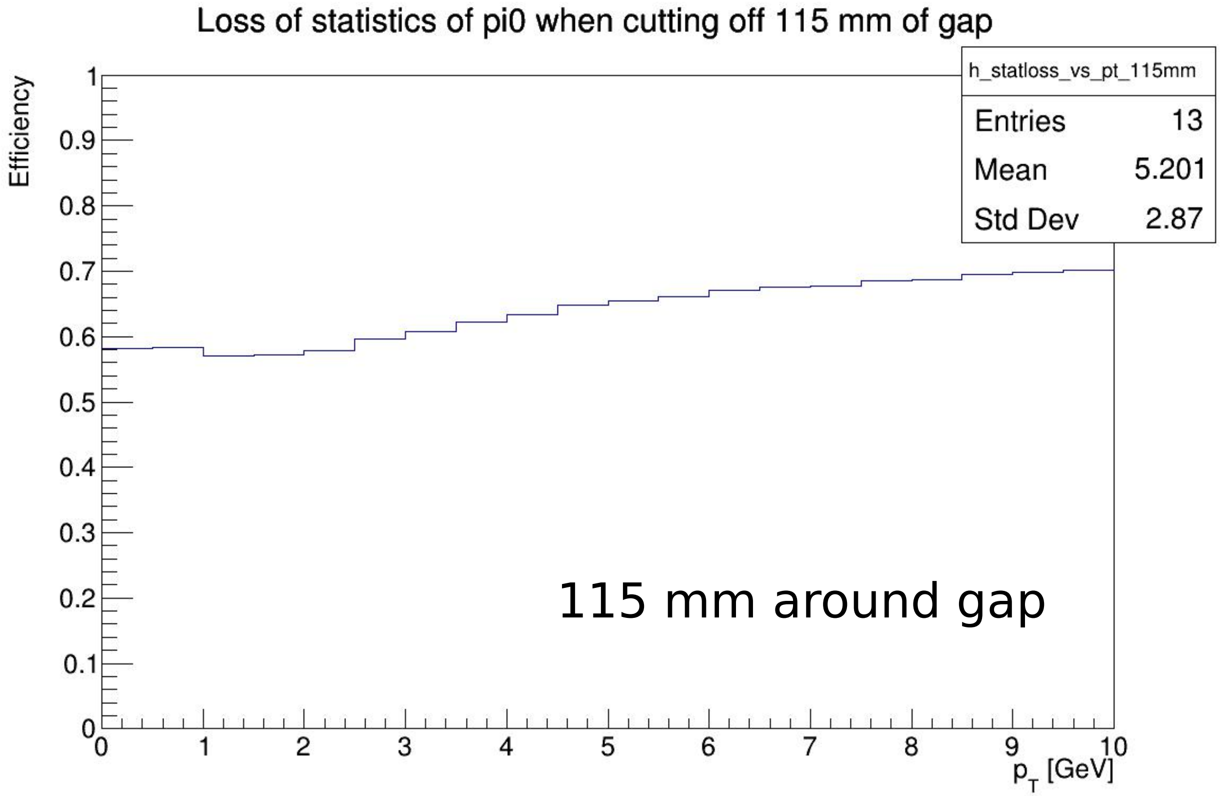




flat efficiencies
for E above 4 GeV

Generator-level: π^0 production





How many π^0 are rejected if areas around gaps are forbidden (for at least one photon)?

Conclusions

- No easy solution
- Ideally, the best solution would be to replace the carbon to some other material ($R_{Moliere}$ > gap size, X_0 < 8 cm), or at least replace the front part of the gap
- If this is not possible, using “preshower” improves the resolution, but, in case of using iron, more than 8 cm doesn't give any relative improvement
- 8 cm iron “preshower” option gives ~30% energy resolution for photons inside the gap for 25 mm gap and ~20% resolution for 5 mm gap

To do:

- try MC reconstruction of π^0 TSSA start to finish