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

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SPD Sofware and Computing meeting
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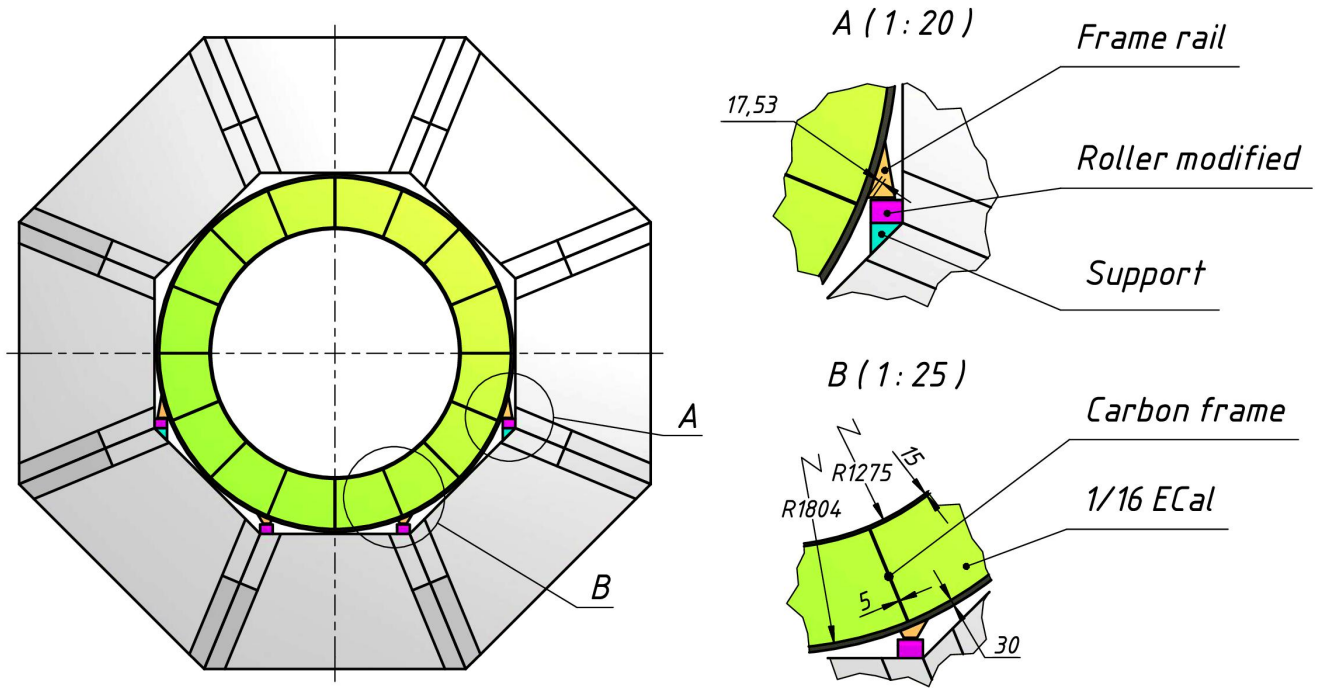
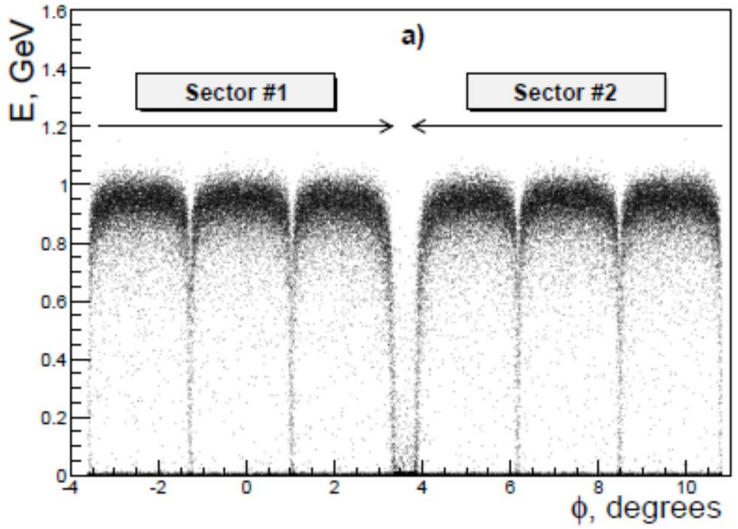
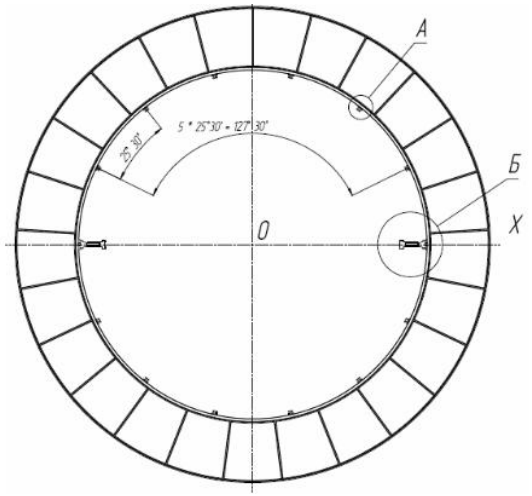
The problem



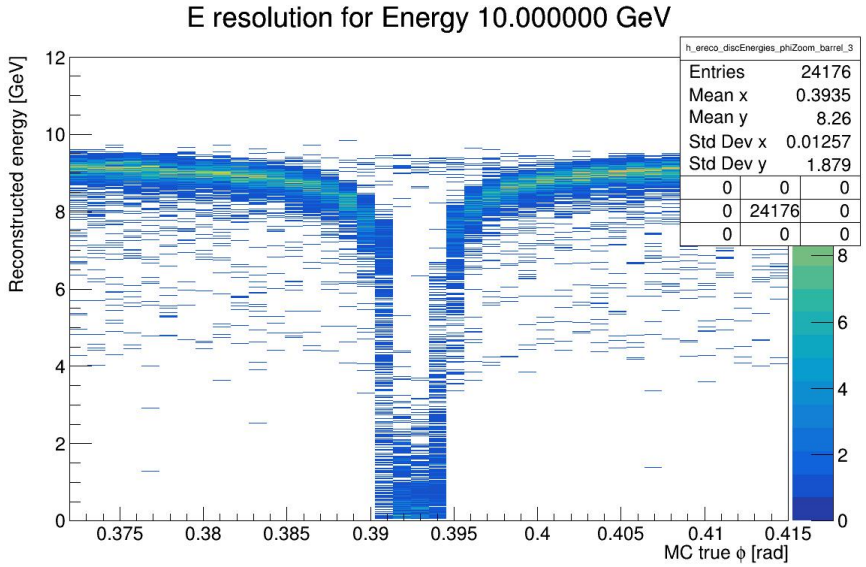
- 16 azimuthal gaps
- each gap 5-25 mm wide (under discussion)
- carbon or carbon glass inside the gaps

The problem





[MPD setup, Martemianov 2019]



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

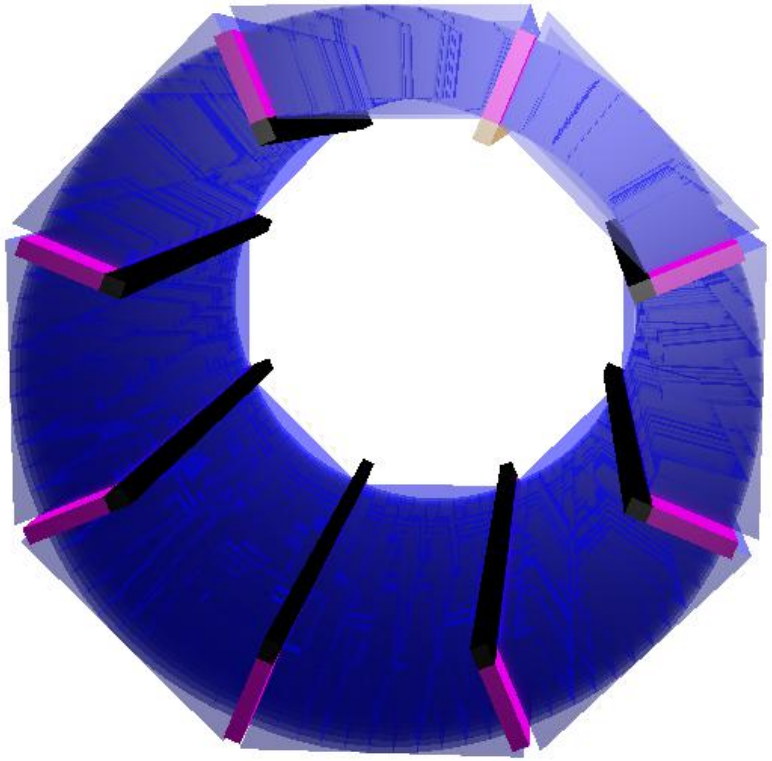
Large gap: sector gap
Smaller gaps: clearance between modules/cells

Negative impact on measurement of spin asymmetries

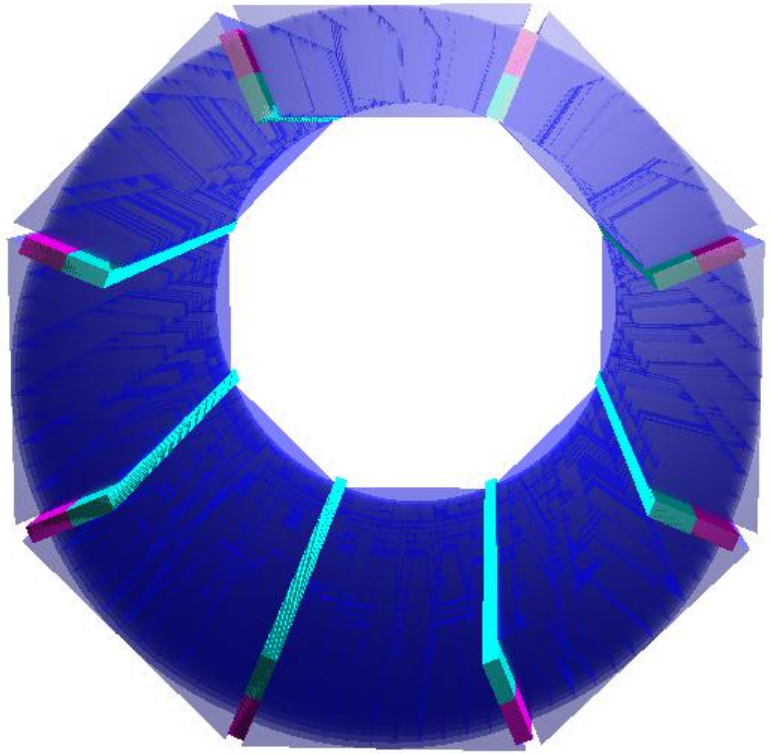
Geometry options under consideration

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

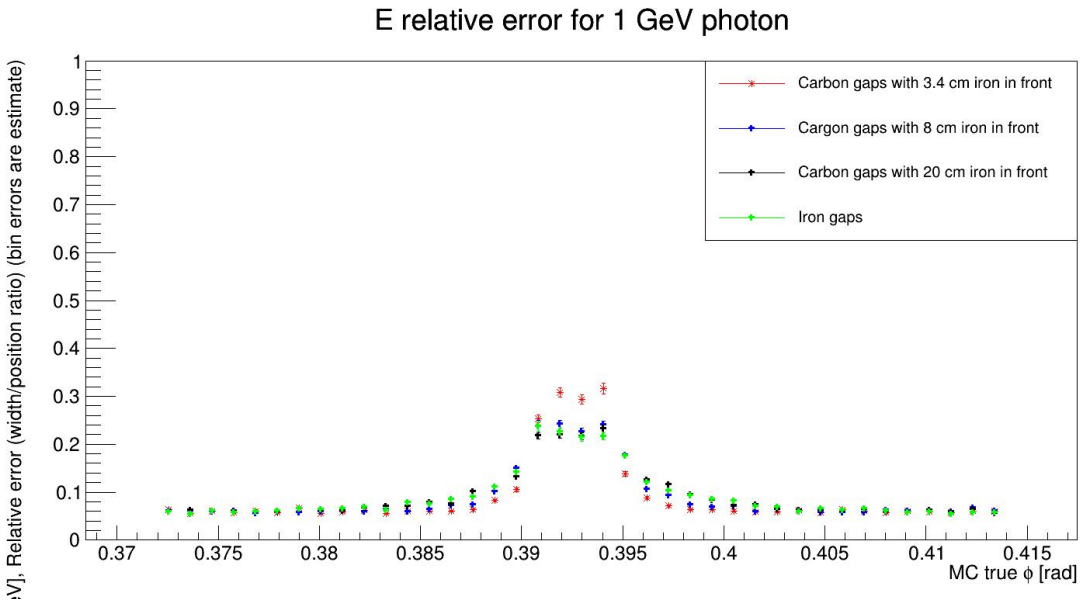
“preshower”, in front of the ECAL

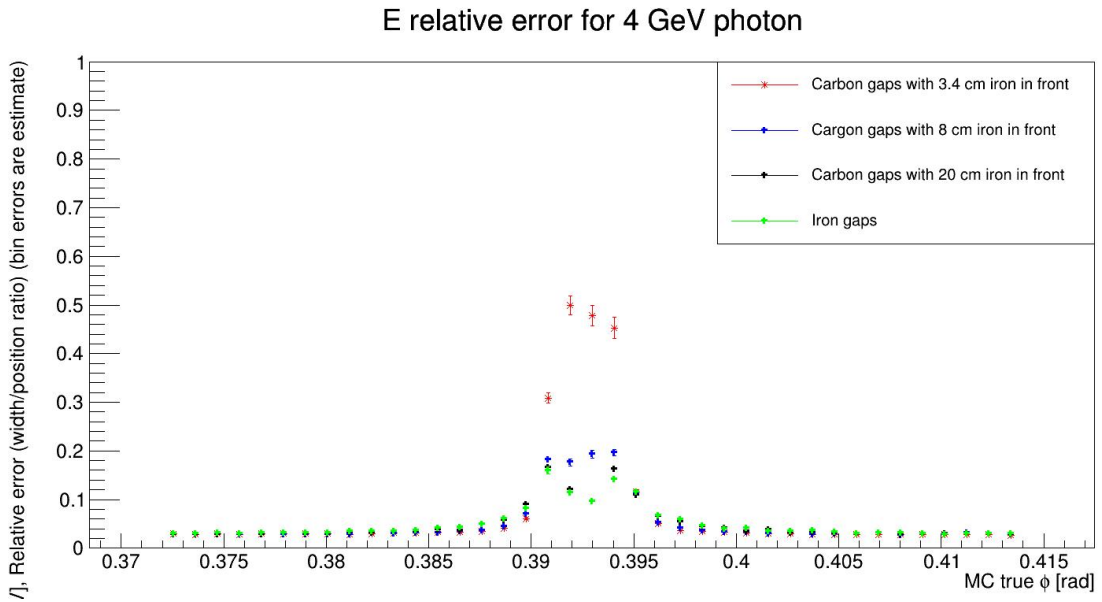


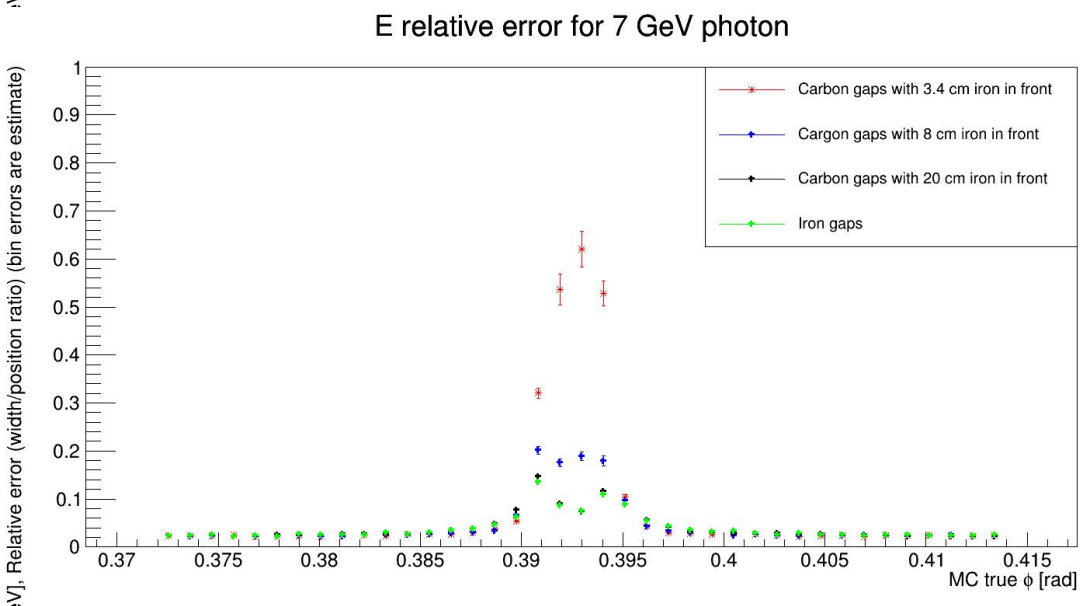
“plug”, replaced a portion of carbon inside the gaps

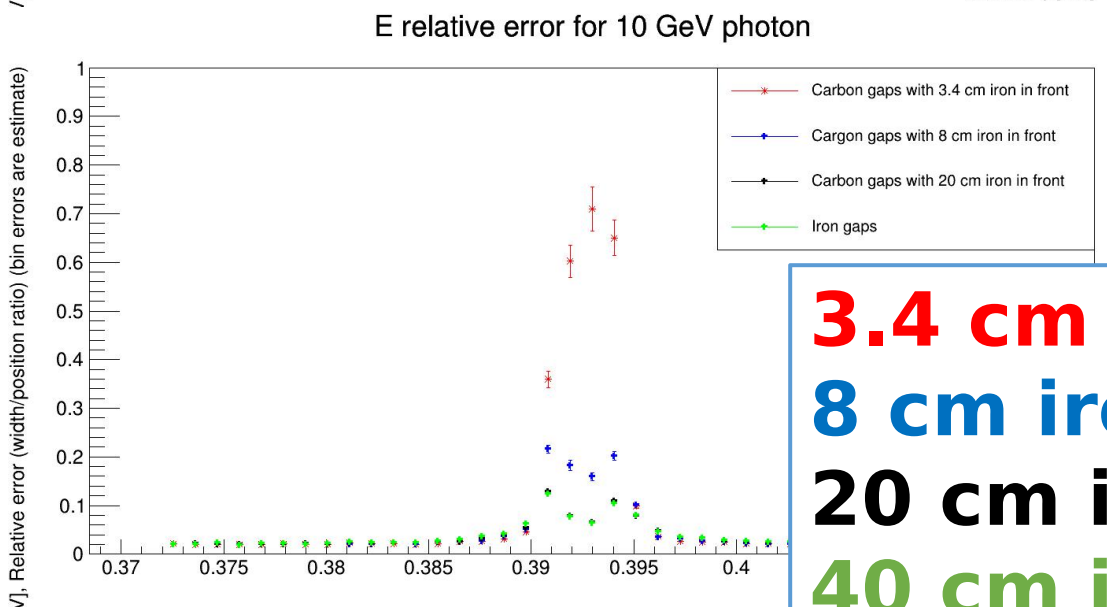


Results: 5 mm gap, “plug”



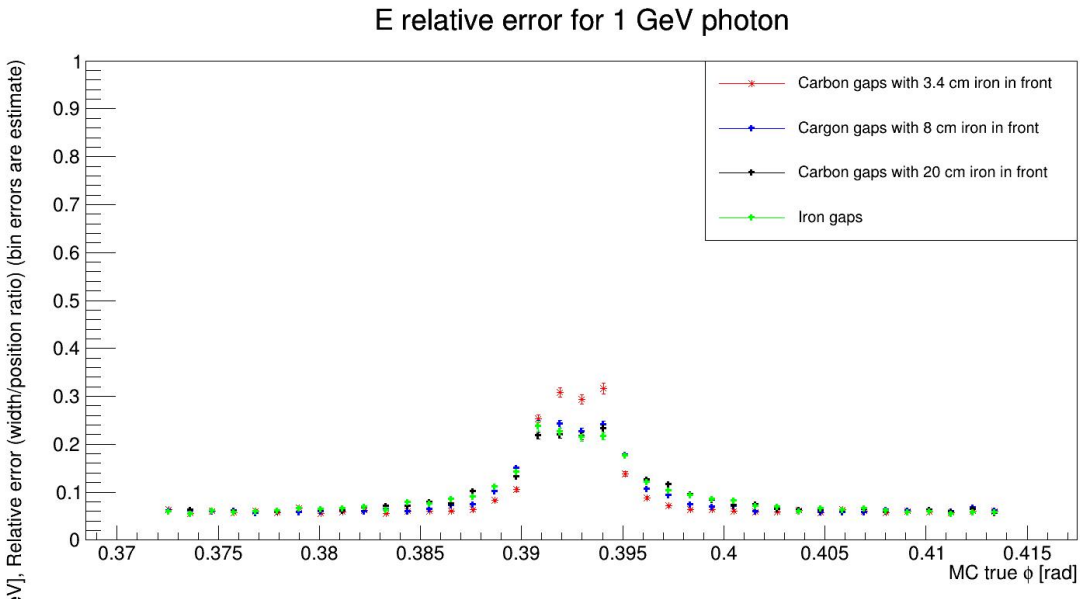


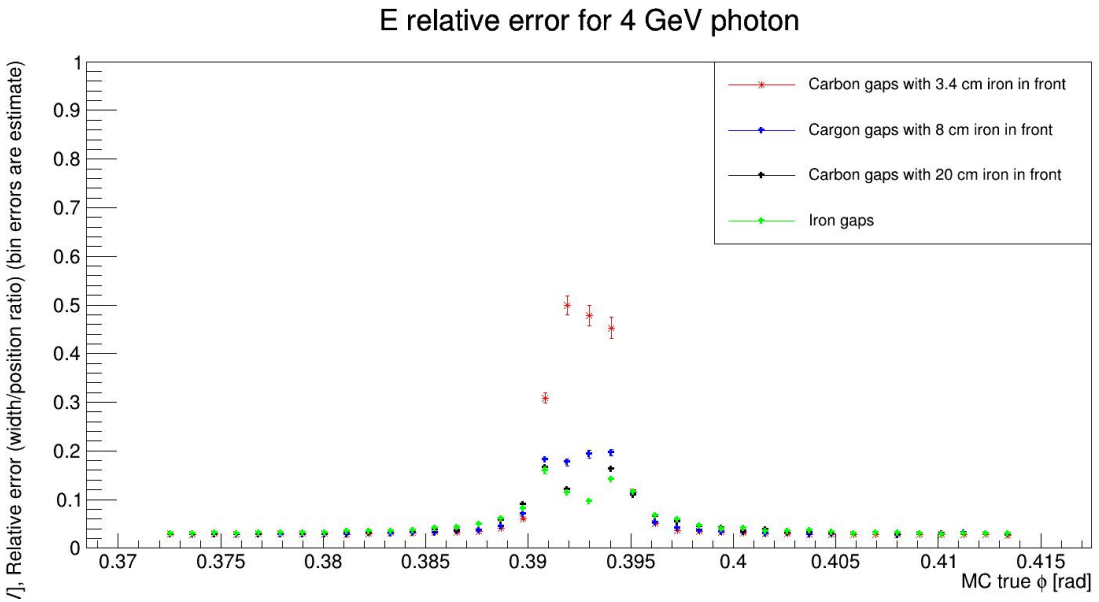


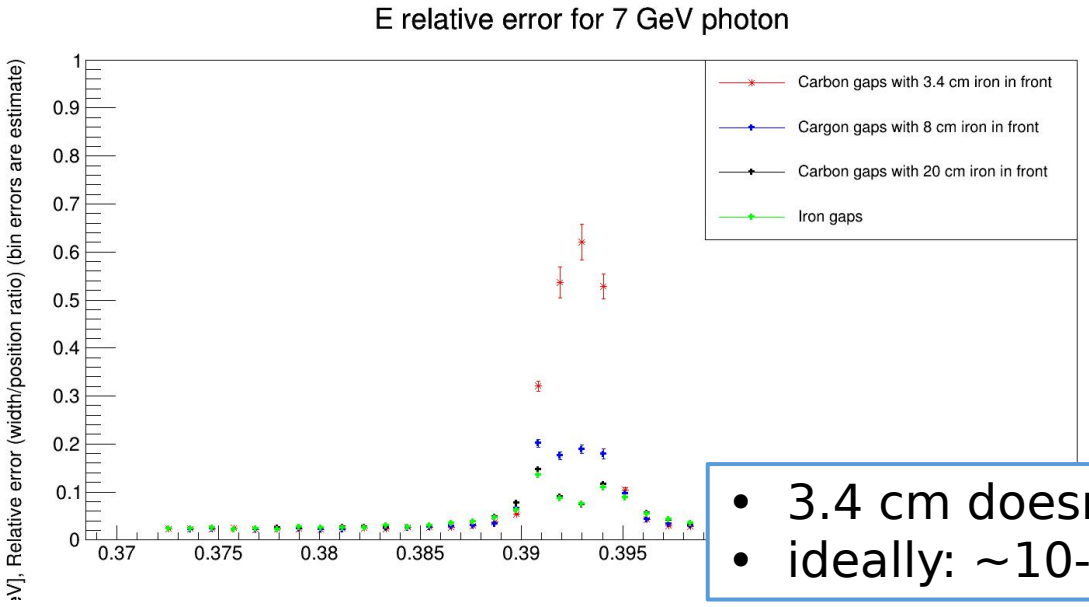


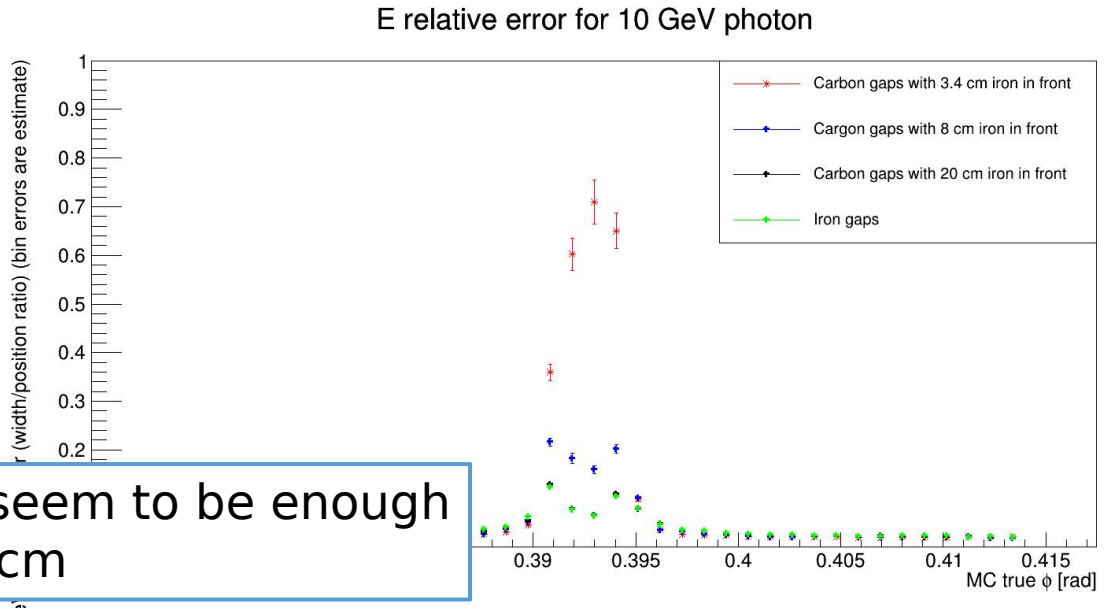
3.4 cm iron
8 cm iron
20 cm iron
40 cm iron

Conclusions: 5 mm gap, “plug”



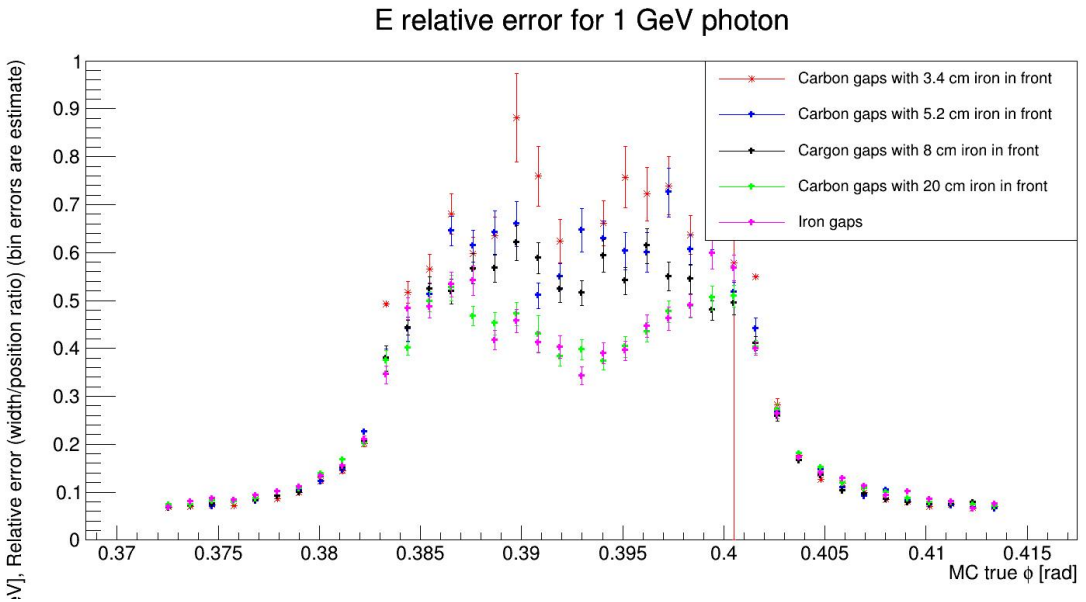


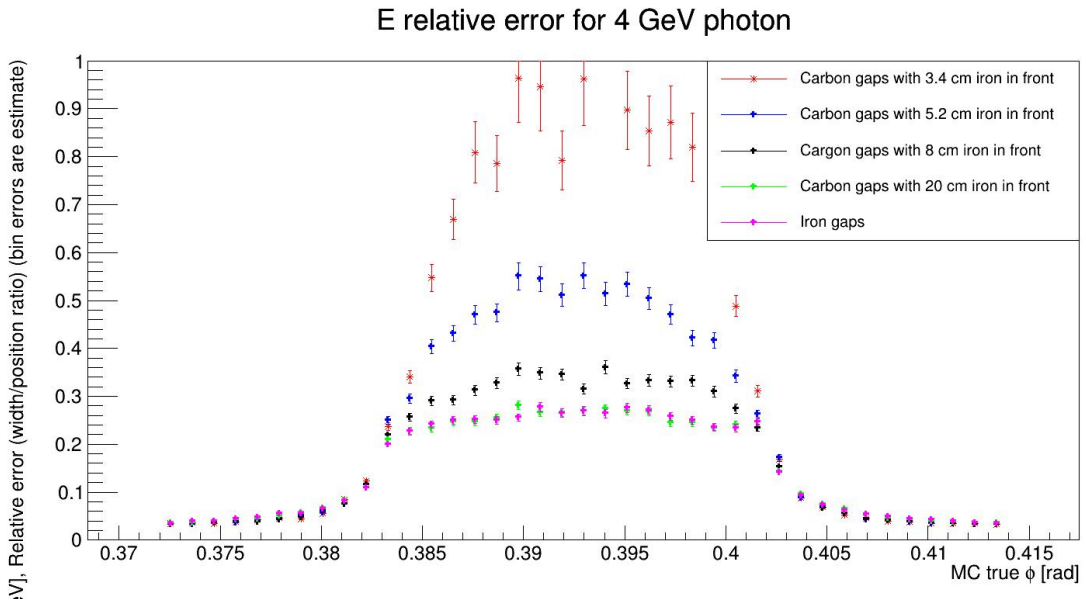


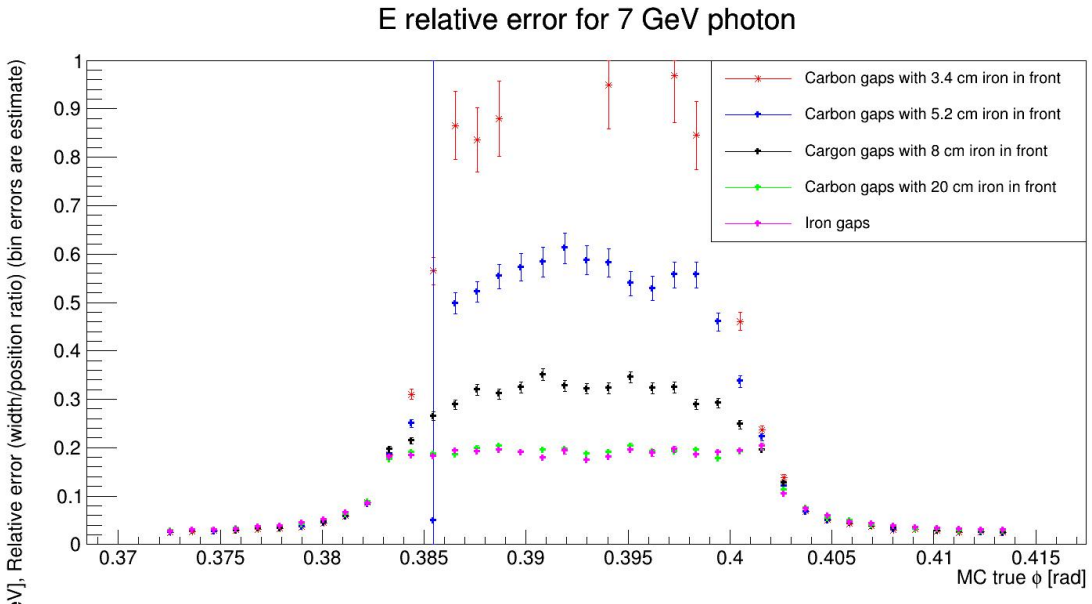


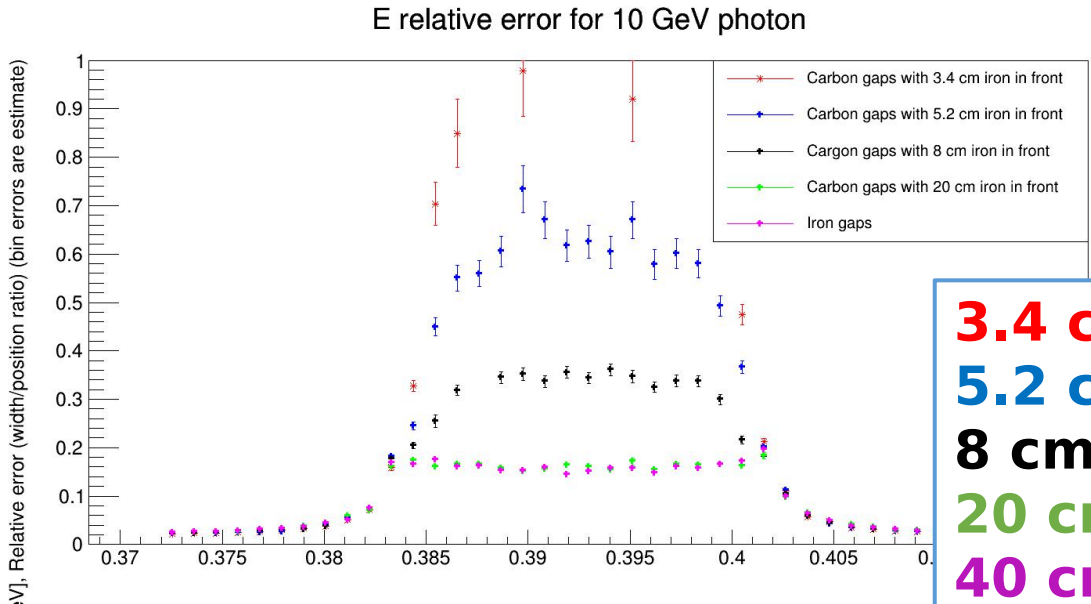
- 3.4 cm doesn't seem to be enough
- ideally: ~10-20 cm

Results: 25 mm gap, “plug”



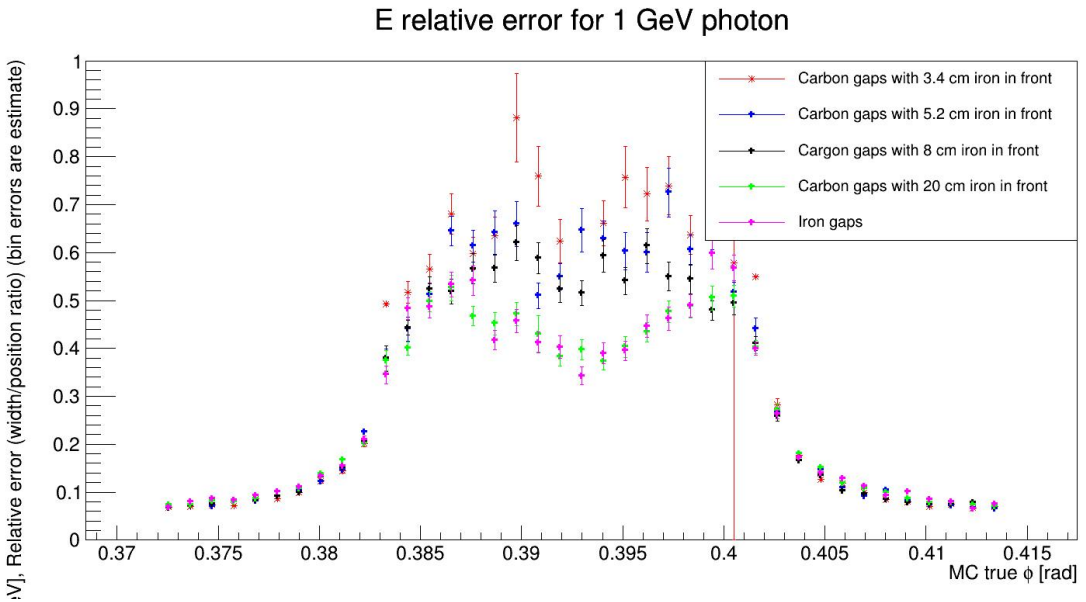


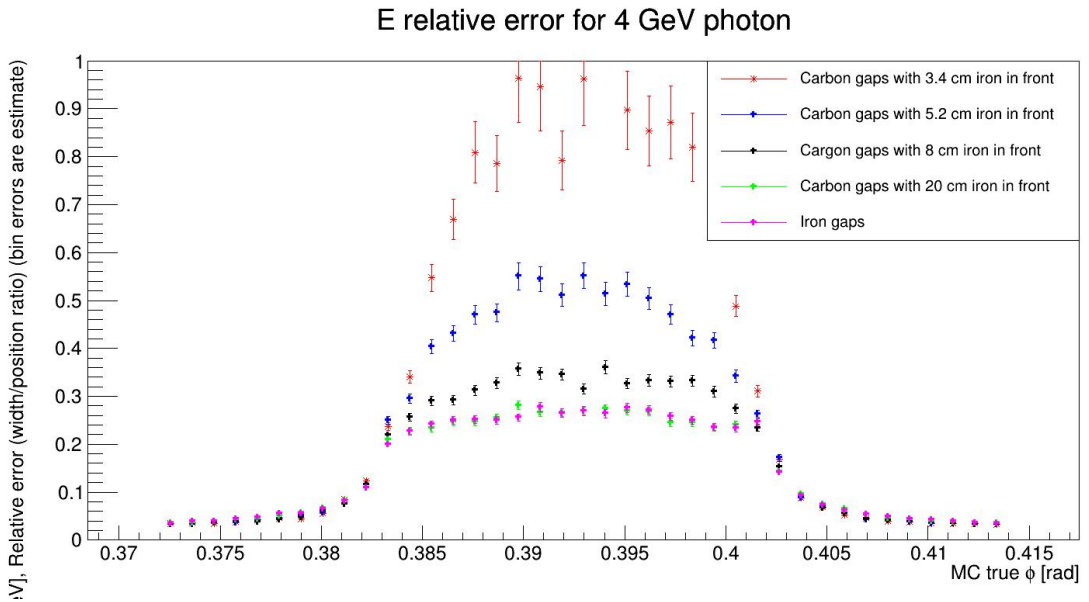


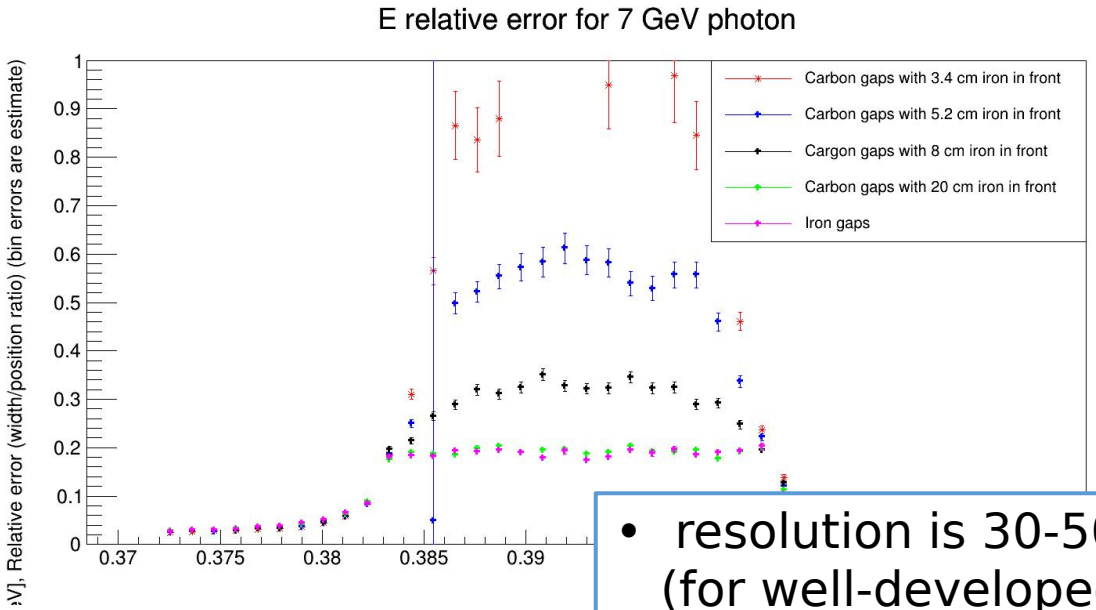


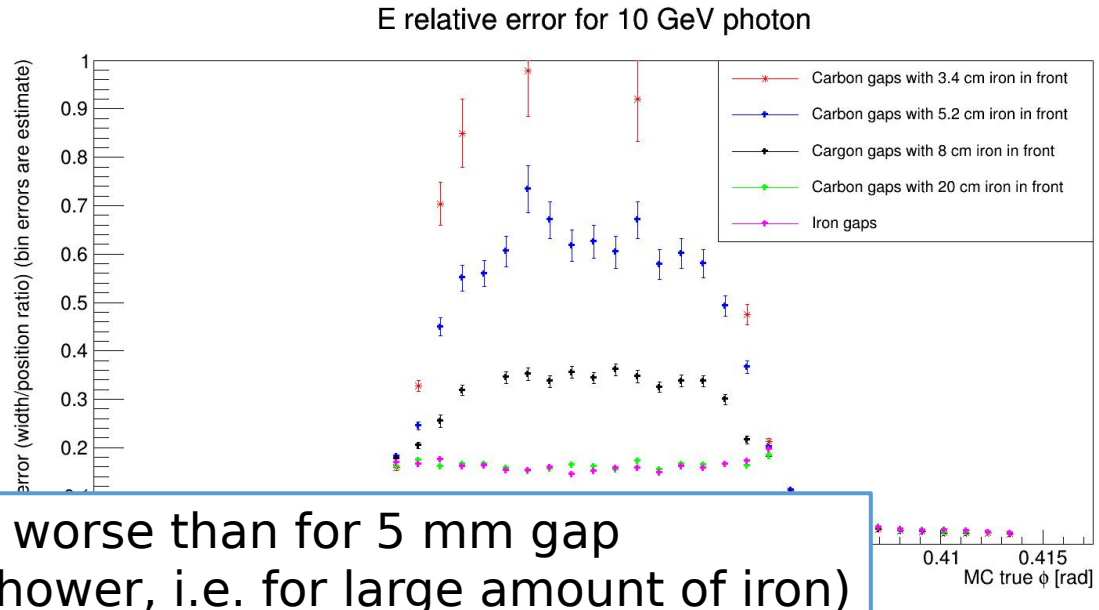
3.4 cm iron
5.2 cm iron
8 cm iron
20 cm iron
40 cm iron

Conclusions: 25 mm gap, “plug”



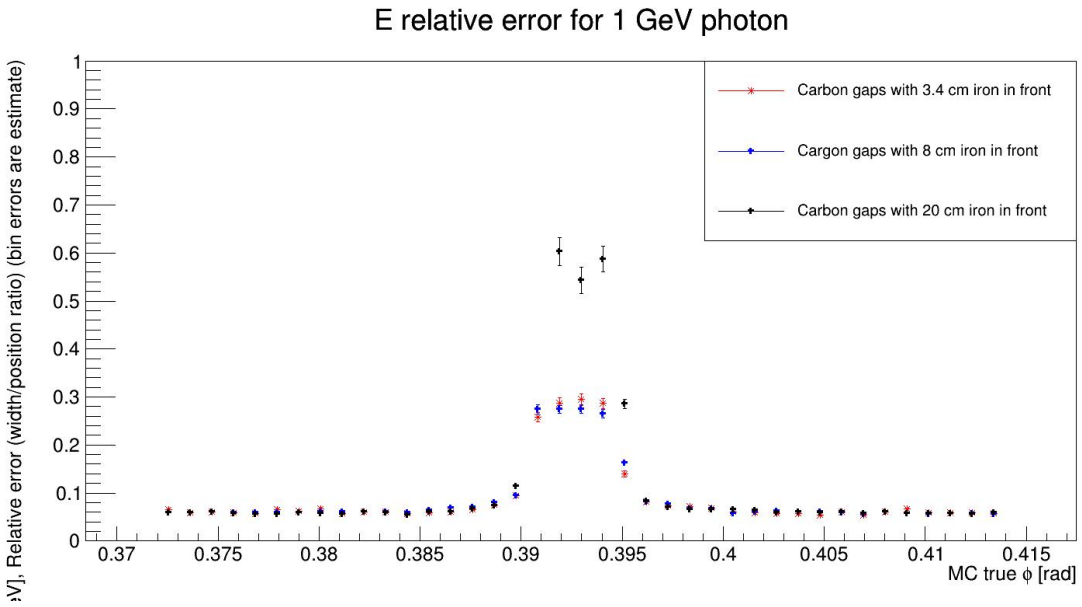


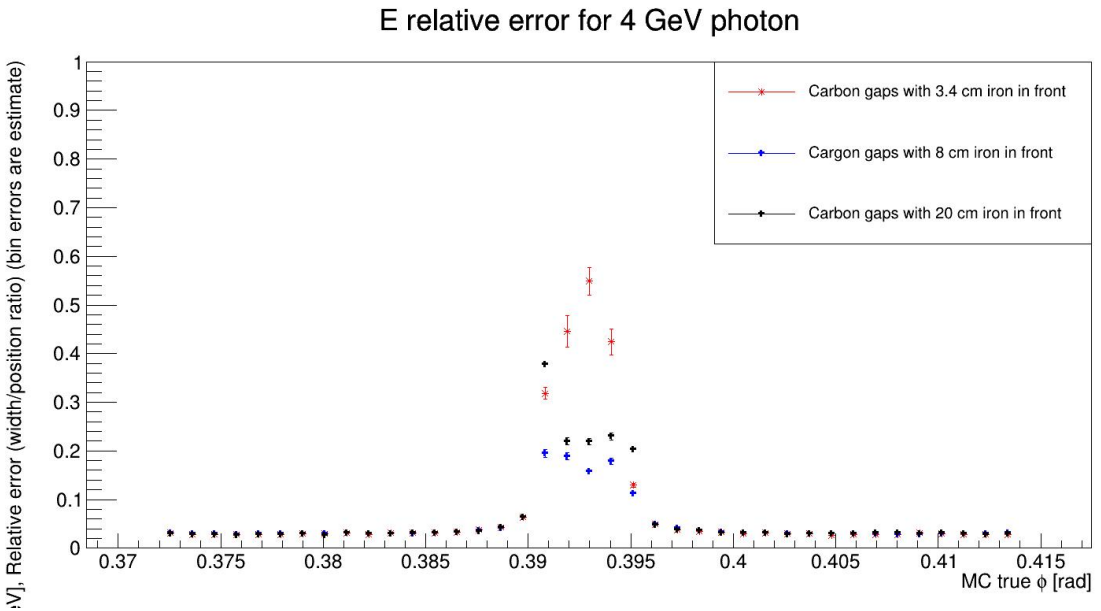


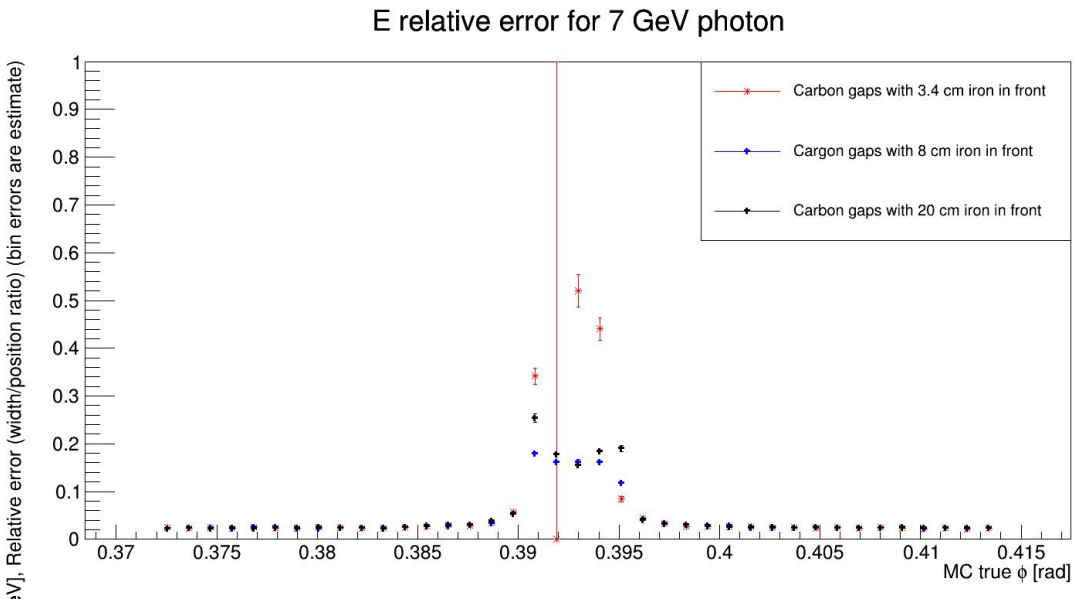


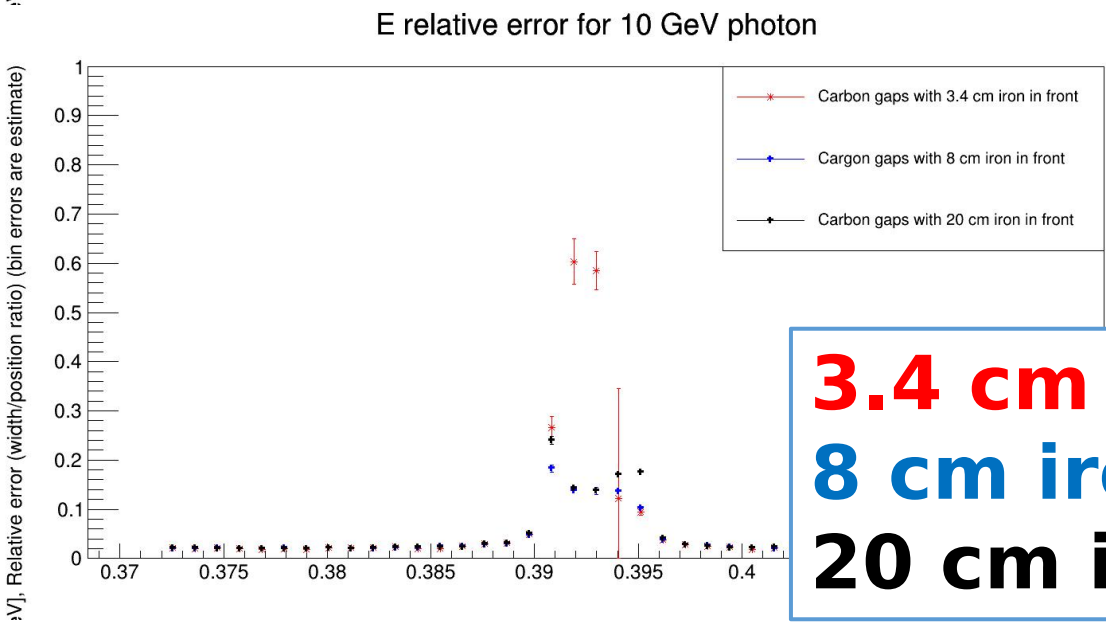
- resolution is 30-50% worse than for 5 mm gap (for well-developed shower, i.e. for large amount of iron)

Results: 5 mm gap, “preshower”



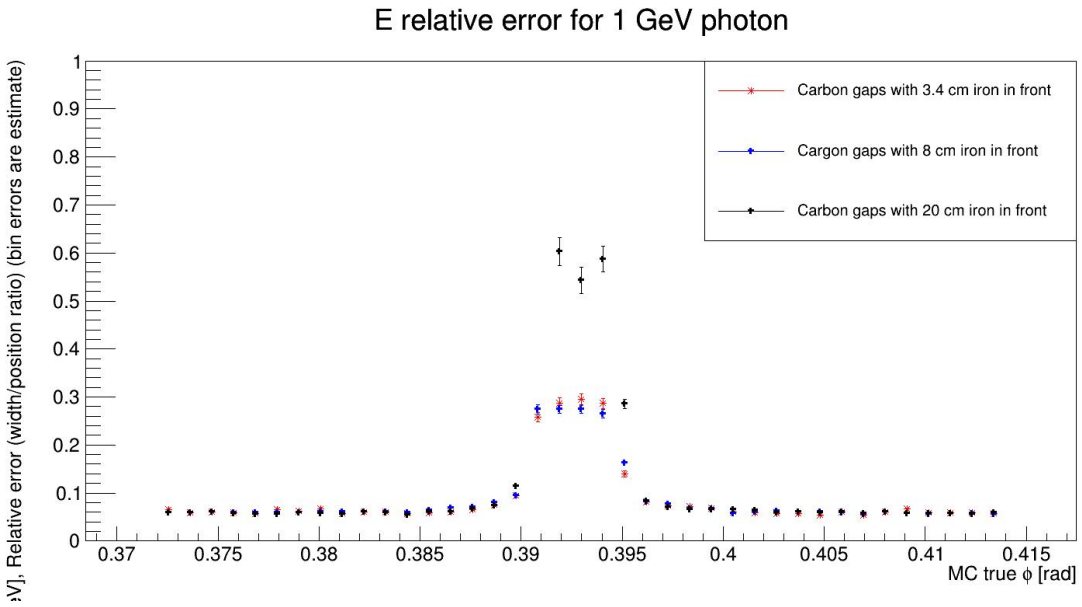


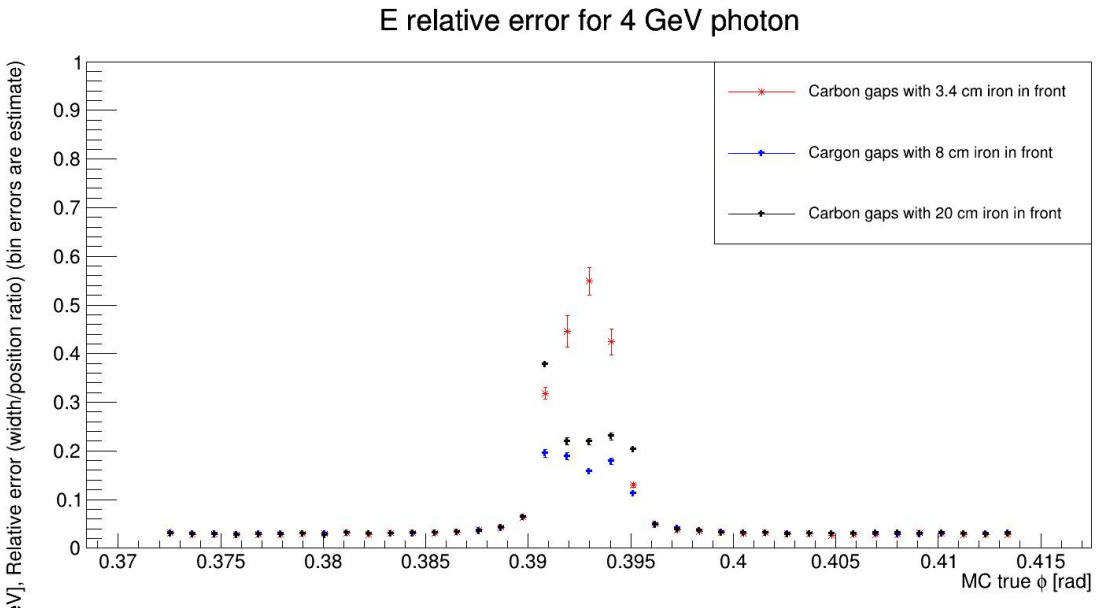


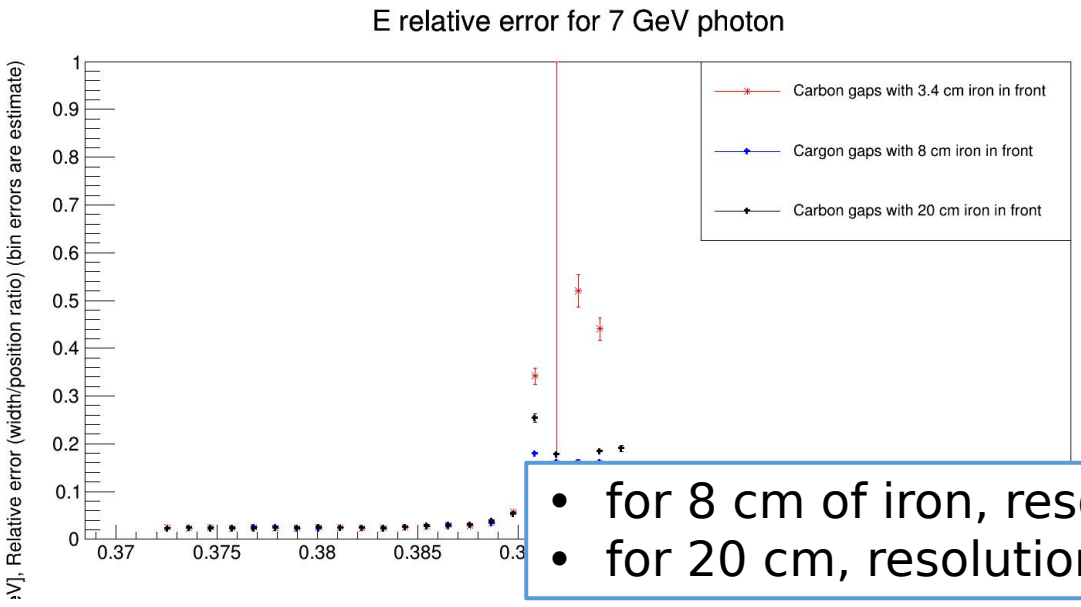


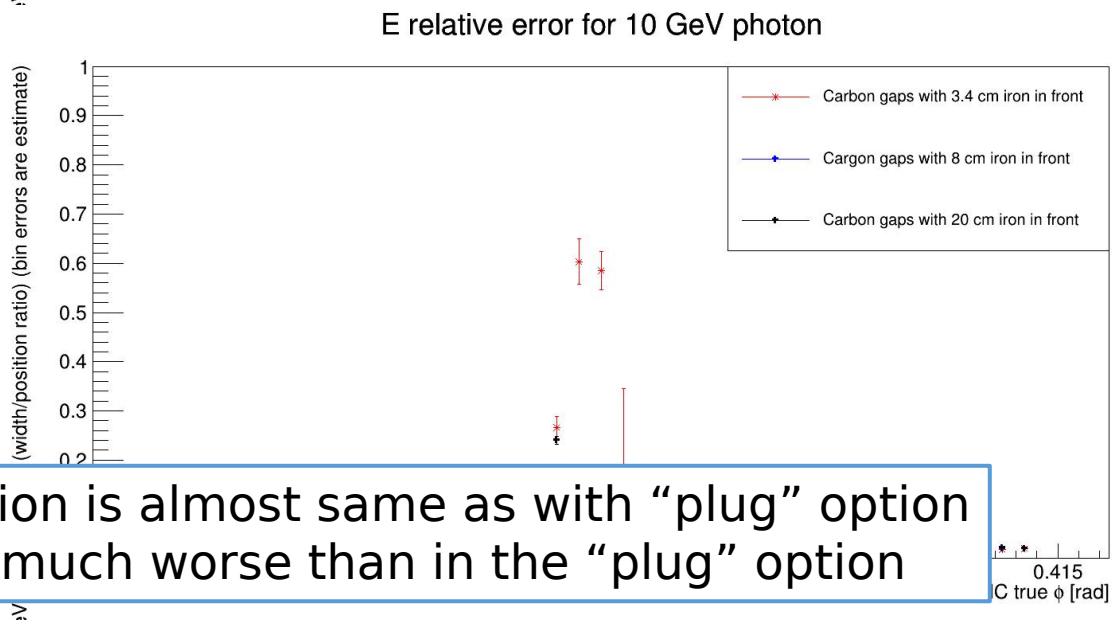
3.4 cm iron
8 cm iron
20 cm iron

Conclusions: 5 mm gap, “preshower”



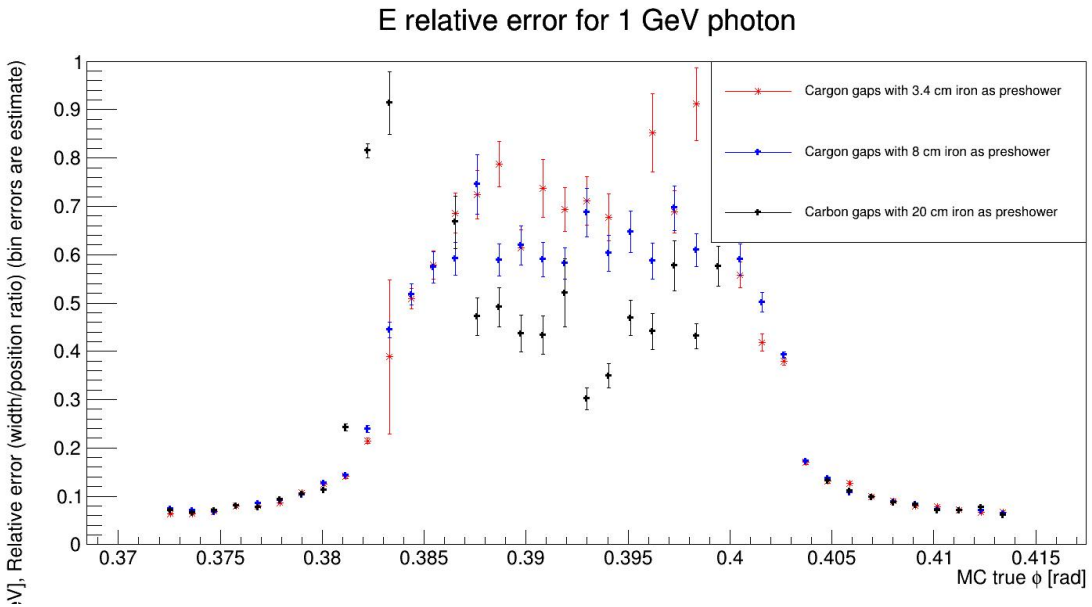


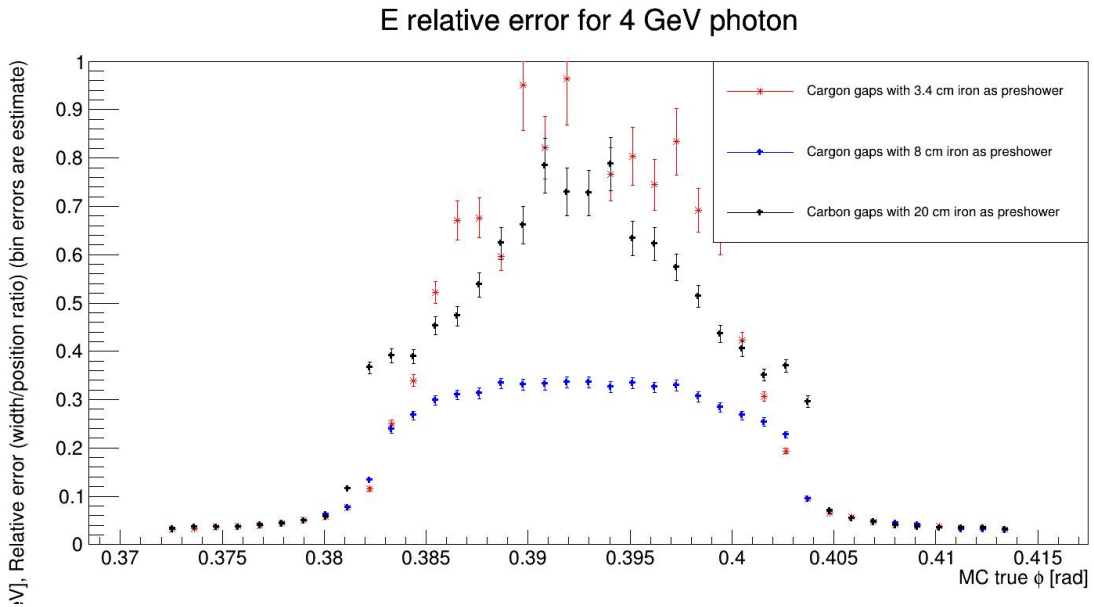


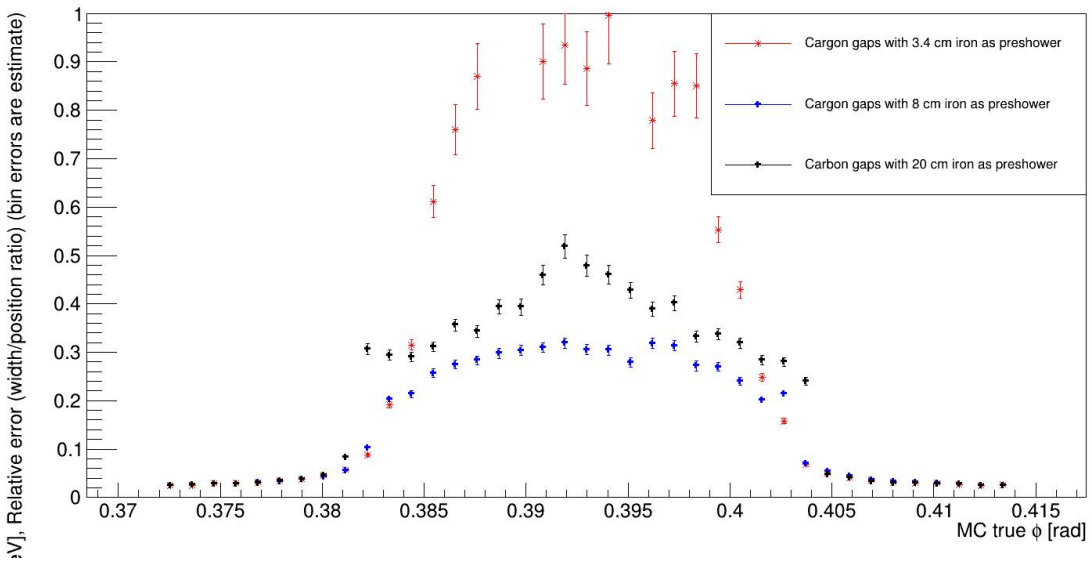


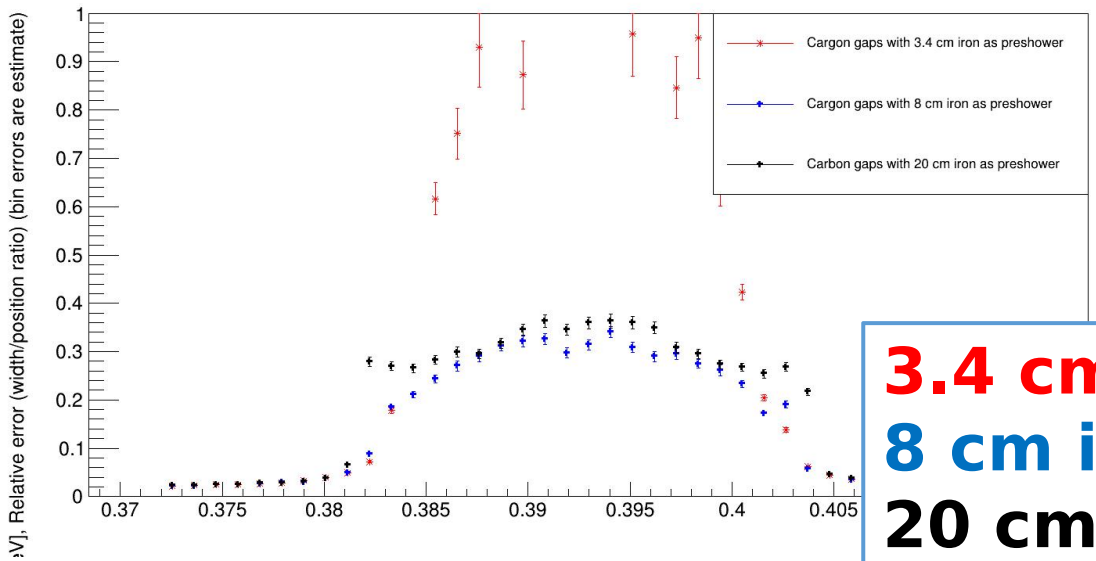
- for 8 cm of iron, resolution is almost same as with “plug” option
- for 20 cm, resolution is much worse than in the “plug” option

Results: 25 mm gap, “preshower”



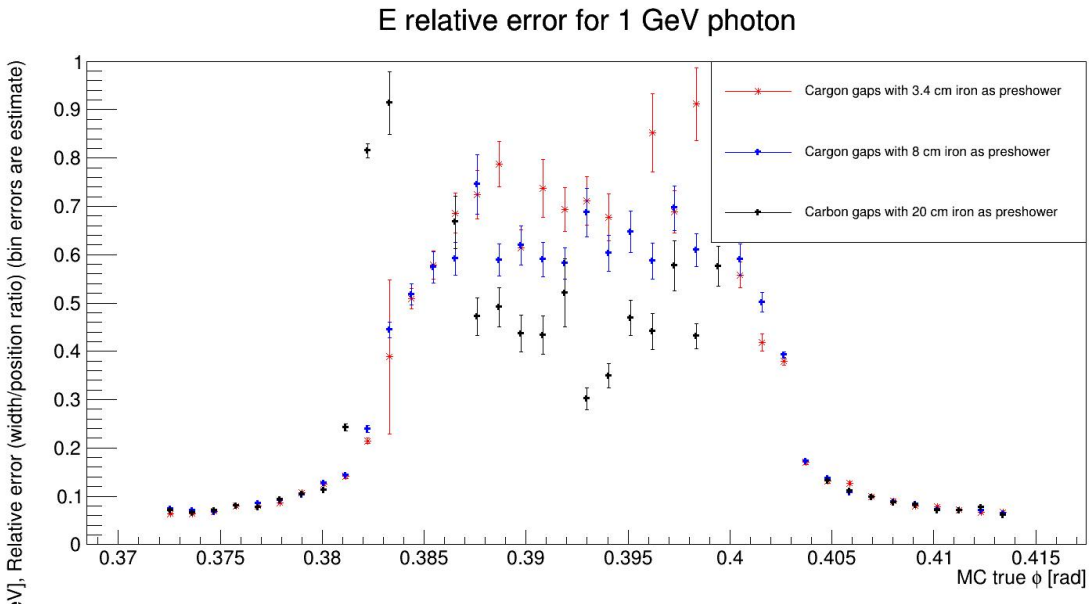


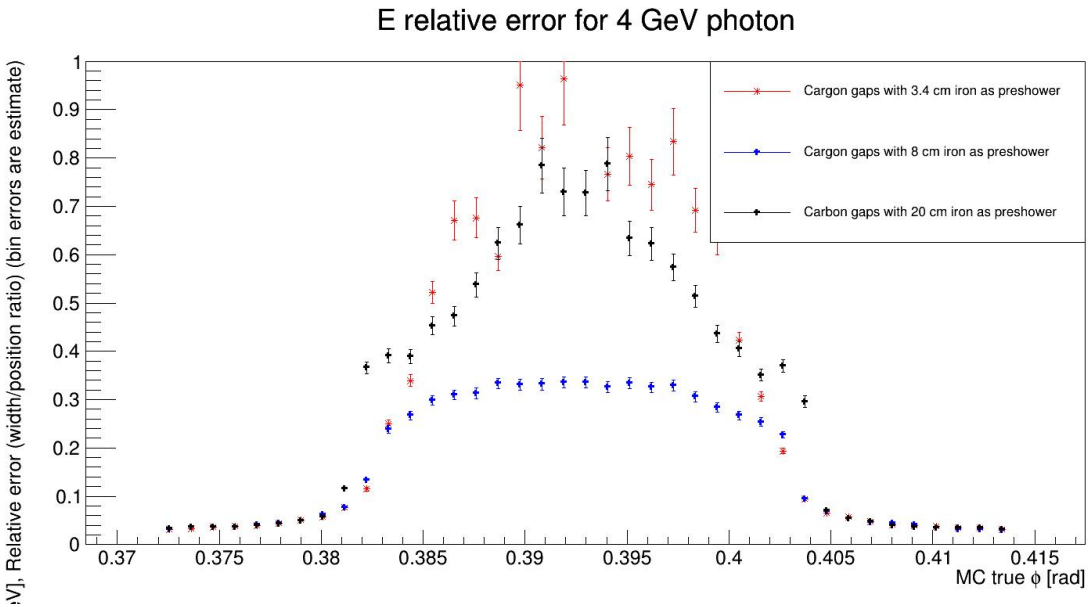


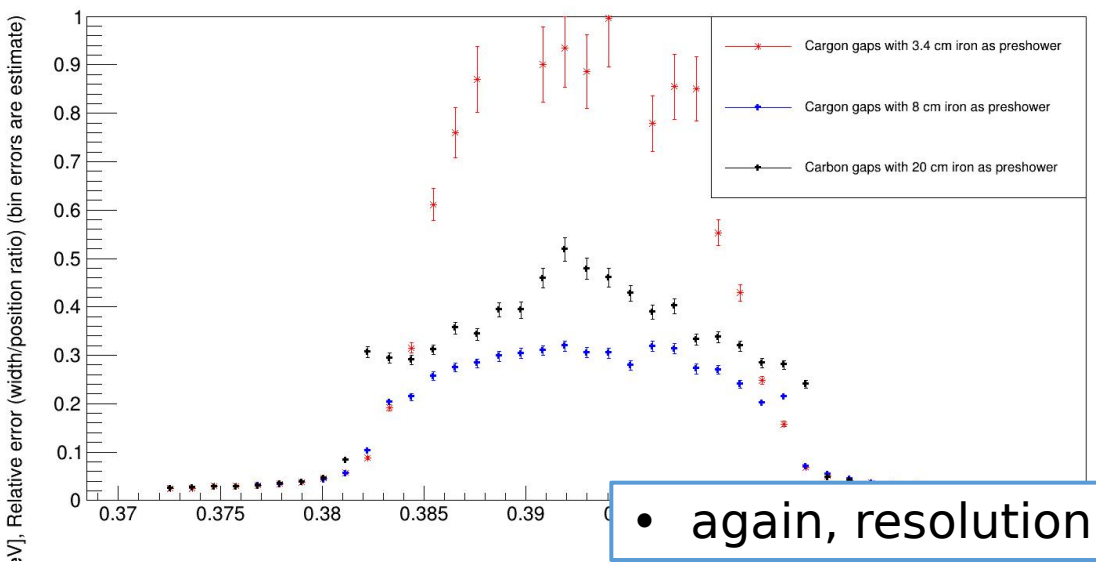


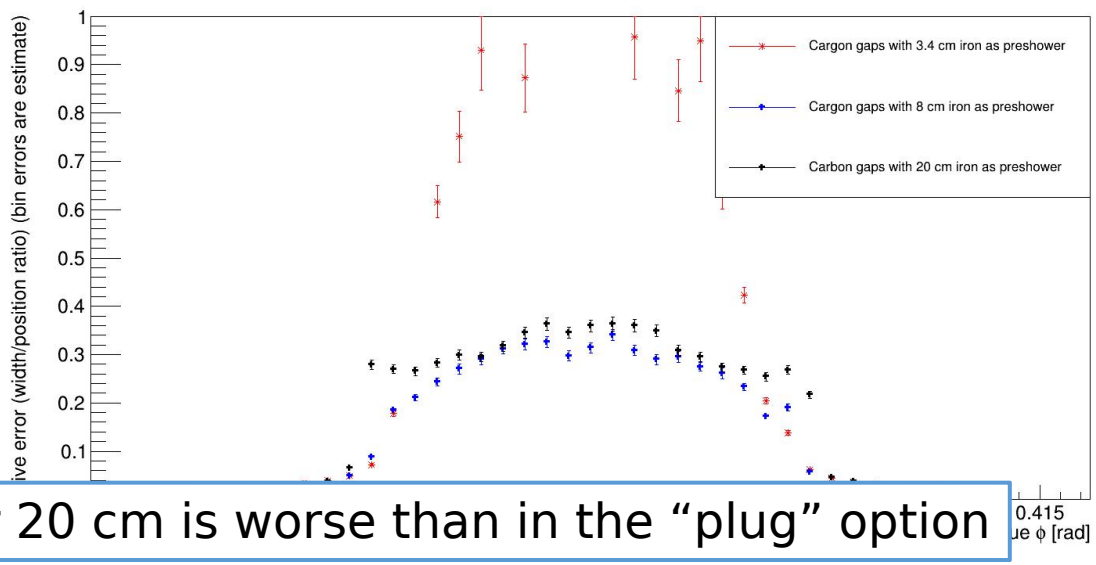
3.4 cm iron
8 cm iron
20 cm iron

Conclusions: 25 mm gap, “preshower”

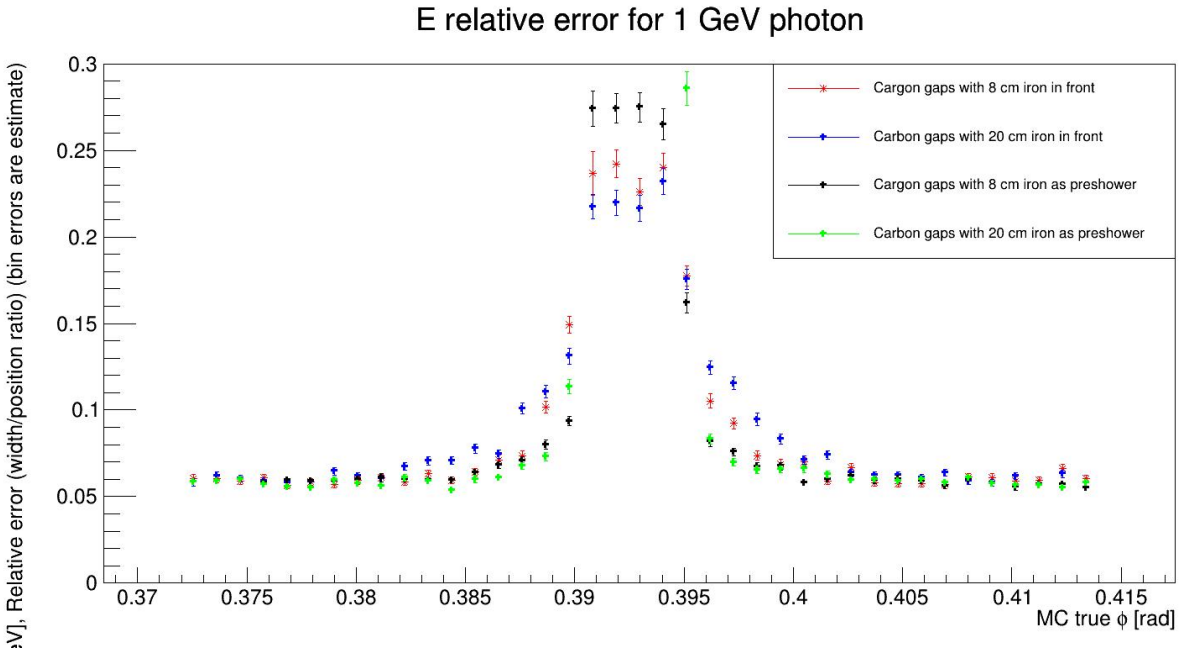


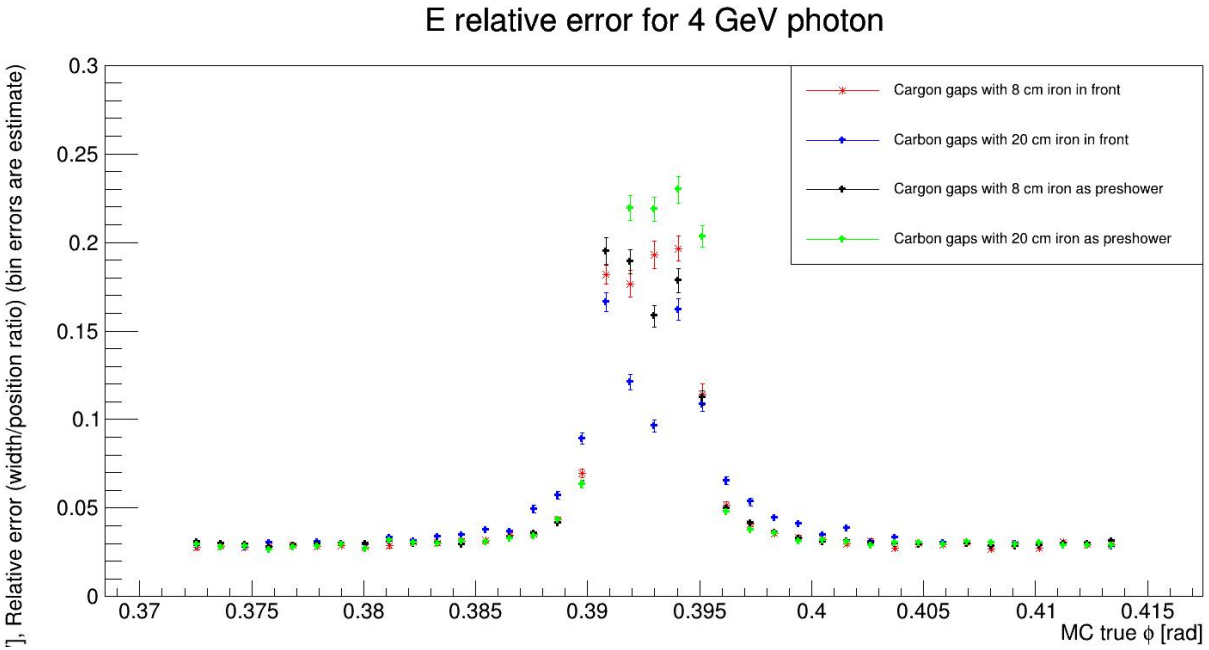


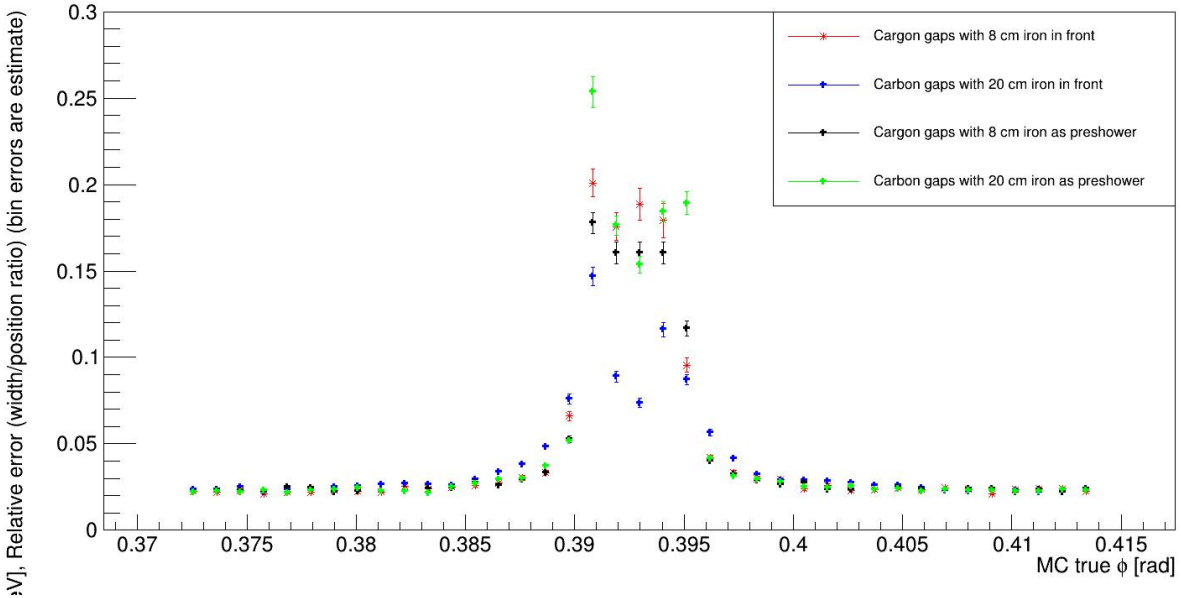


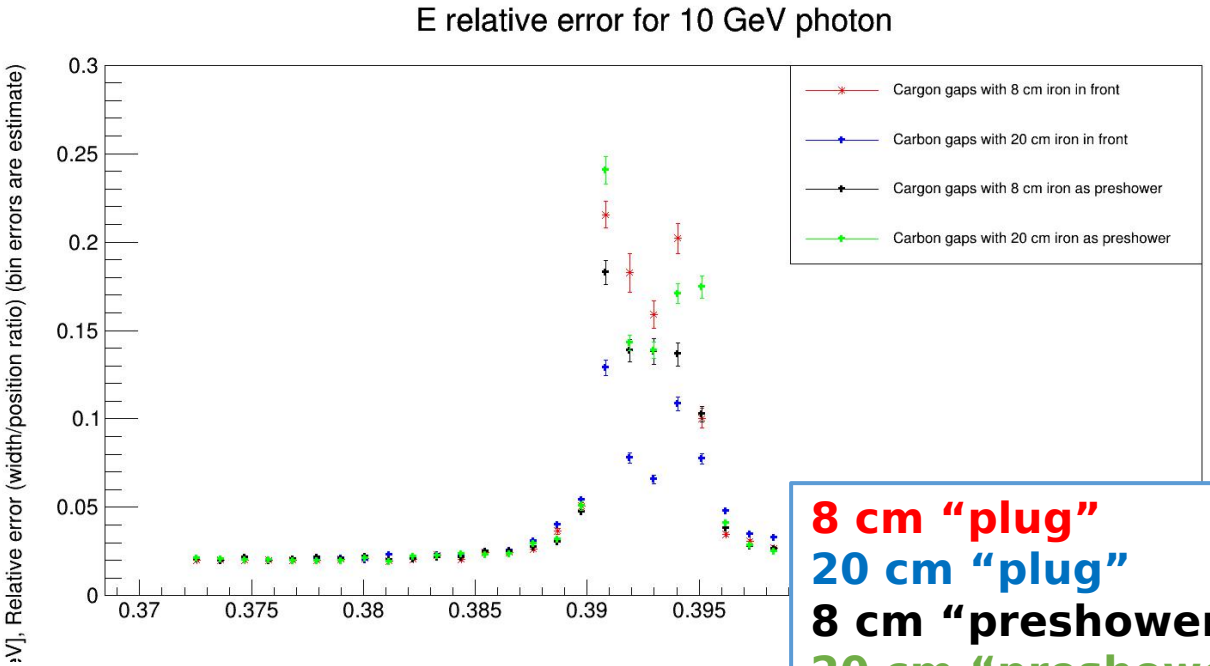


- again, resolution for 20 cm is worse than in the “plug” option

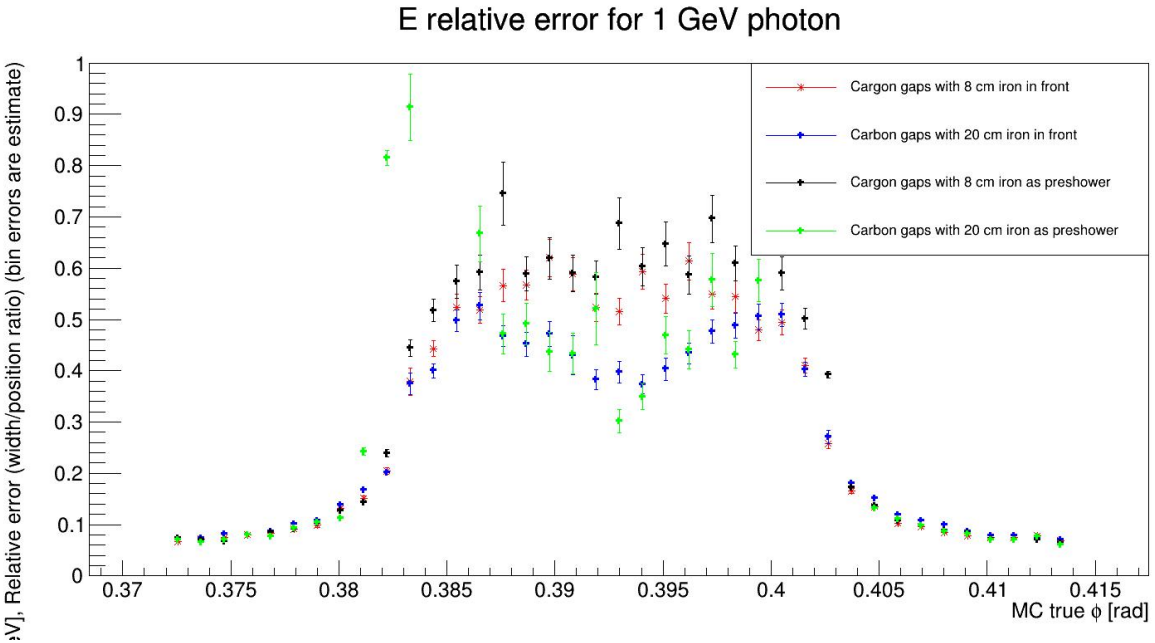


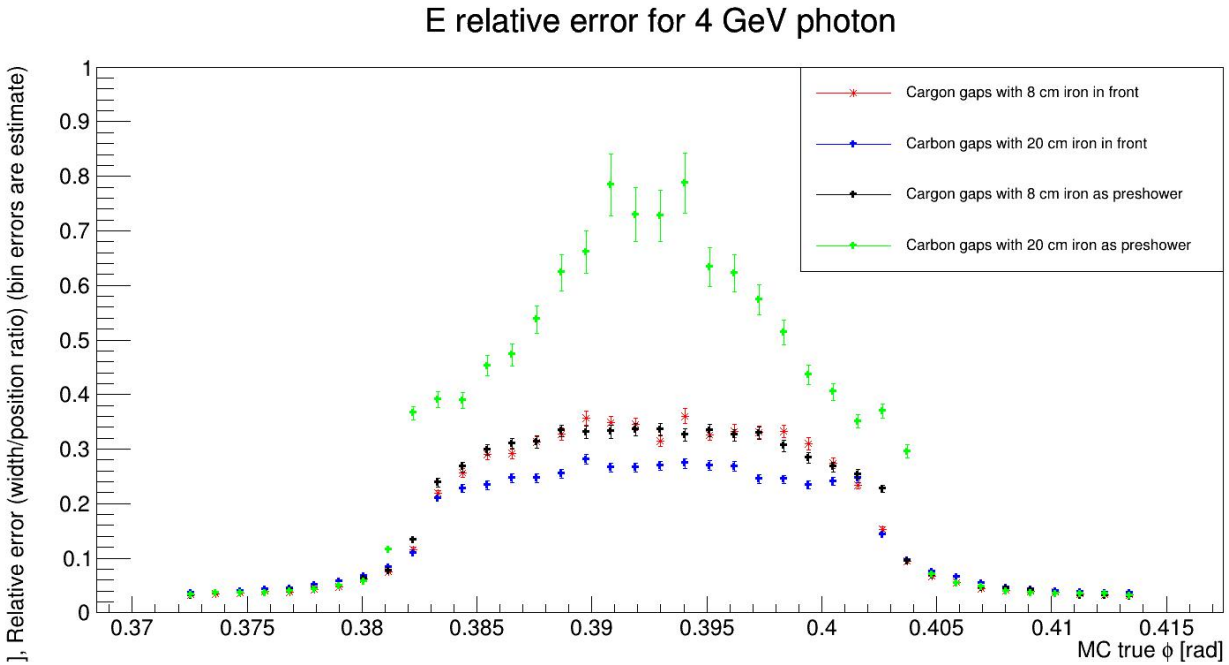


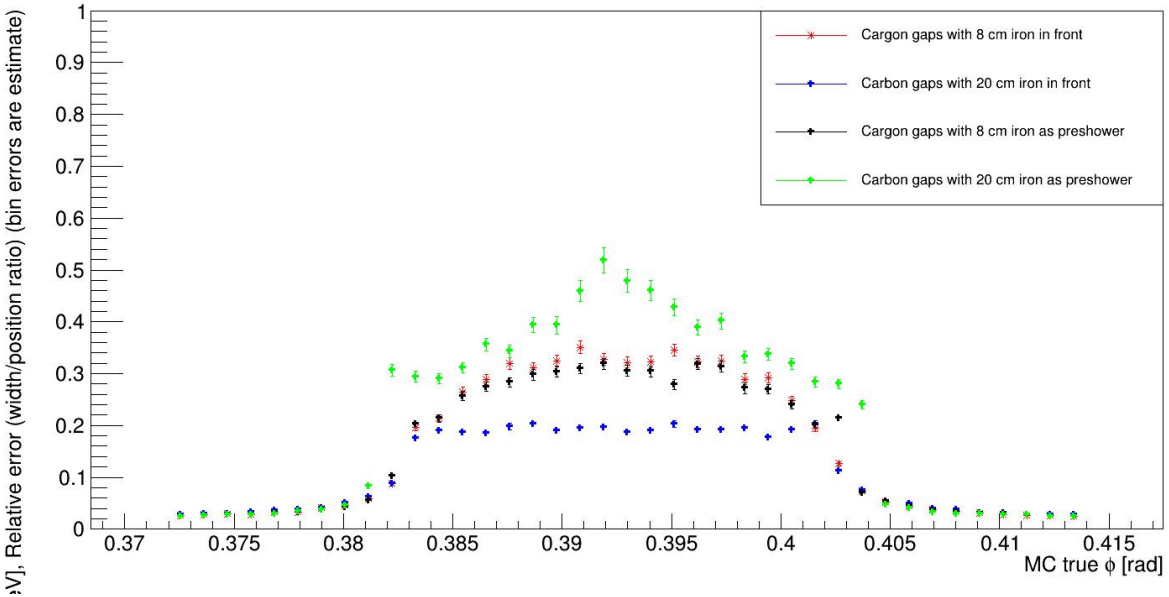


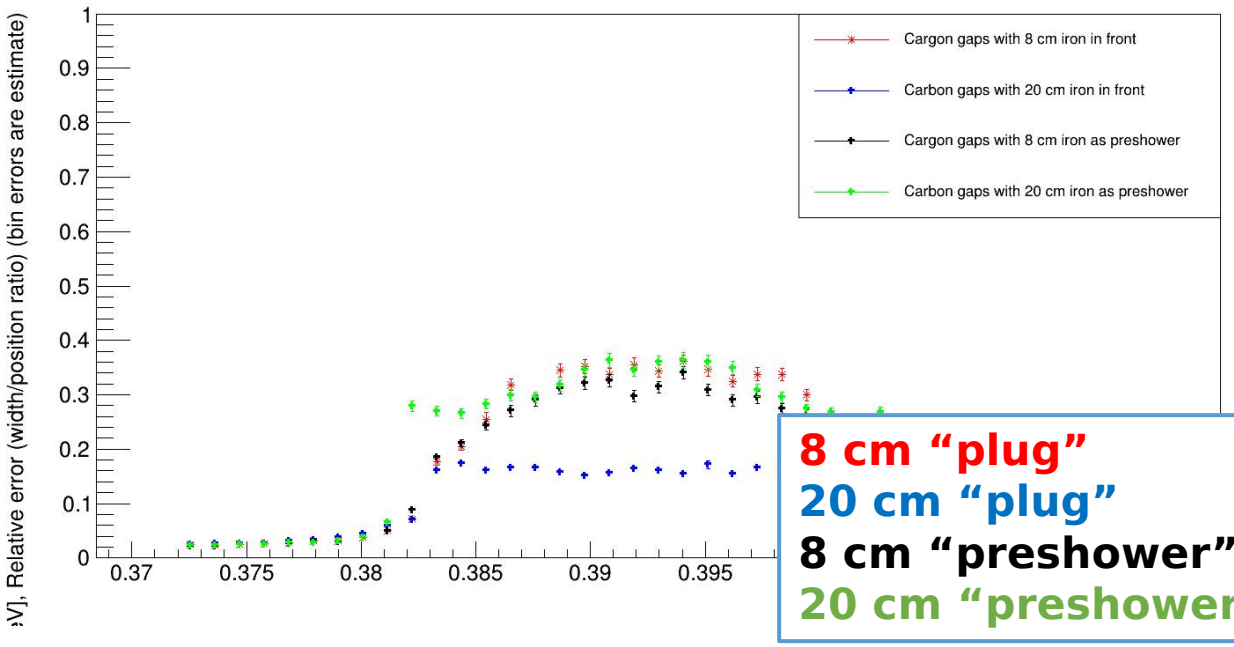


8 cm "plug"
20 cm "plug"
8 cm "preshower"
20 cm "preshower"

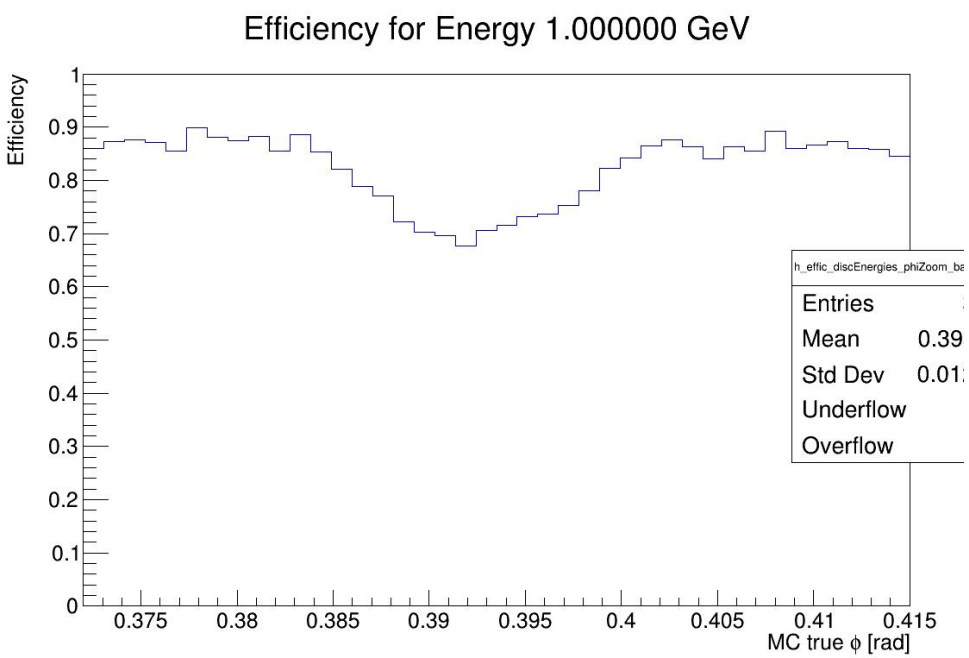

E relative error for 1 GeV photon
Cargon gaps with 8 cm iron in front
Carbon gaps with 20 cm iron in front
Cargon gaps with 8 cm iron as preshower
Carbon gaps with 20 cm iron as preshower
MC true ϕ [rad]

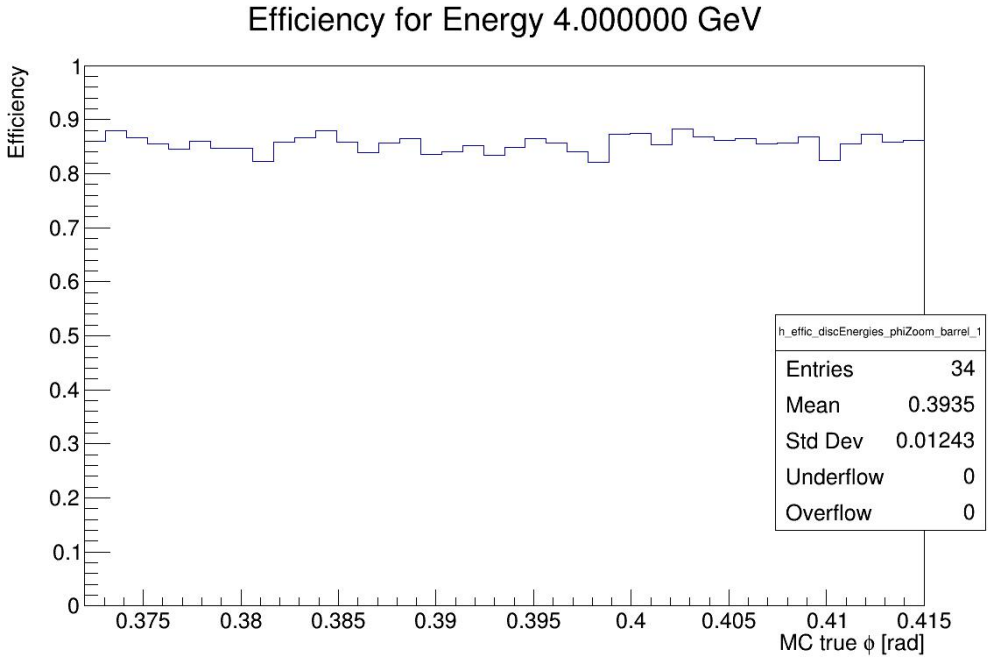

E relative error for 4 GeV photon
Cargon gaps with 8 cm iron in front
Carbon gaps with 20 cm iron in front
Cargon gaps with 8 cm iron as preshower
Carbon gaps with 20 cm iron as preshower
MC true ϕ [rad]

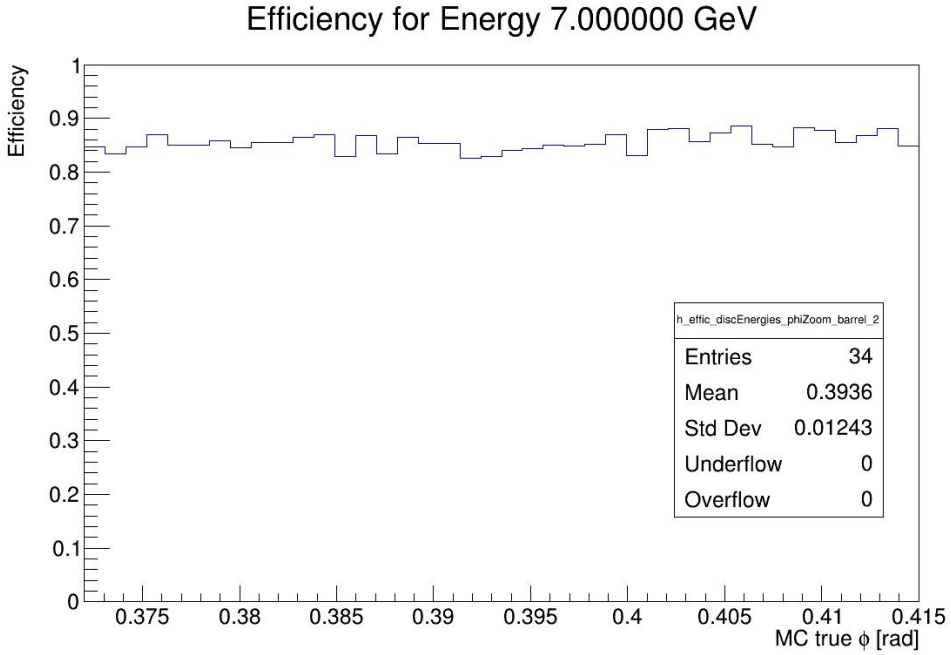

E relative error for 7 GeV photon
Cargon gaps with 8 cm iron in front
Carbon gaps with 20 cm iron in front
Cargon gaps with 8 cm iron as preshower
Carbon gaps with 20 cm iron as preshower
MC true ϕ [rad]

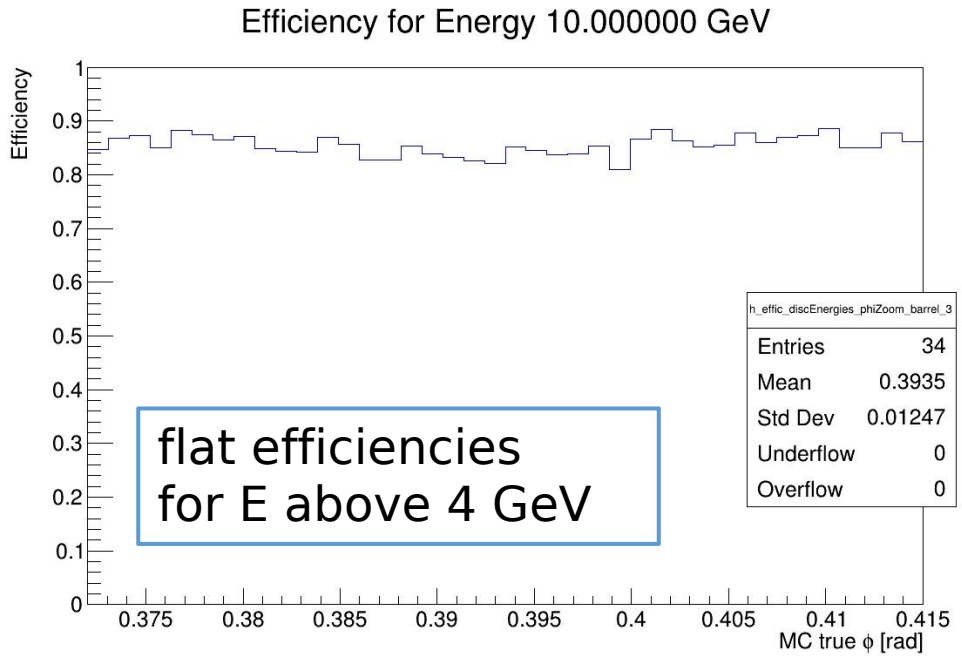

E relative error for 10 GeV photon
Cargon gaps with 8 cm iron in front
Carbon gaps with 20 cm iron in front
Cargon gaps with 8 cm iron as preshower
Carbon gaps with 20 cm iron as preshower
8 cm “plug”
20 cm “plug”
8 cm “preshower”
20 cm “preshower”

Efficiencies









Conclusions

- 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

Which of these options are feasible?

To do:

- try other materials? Aluminum?
- finely tune the preabsorber thickness!
- study impact on spin assymetries measurement?