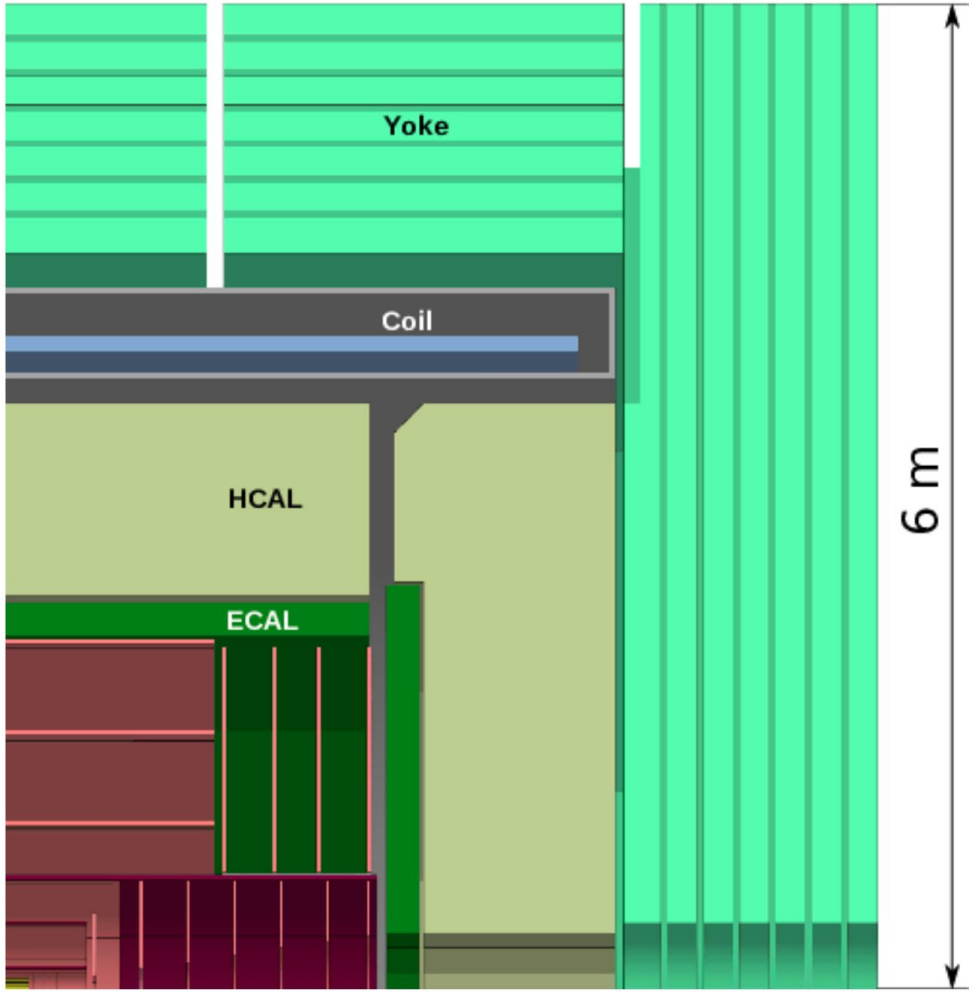
Preliminary Studies of ARC Impact on CLD ECAL Resolution

Anna Oliva

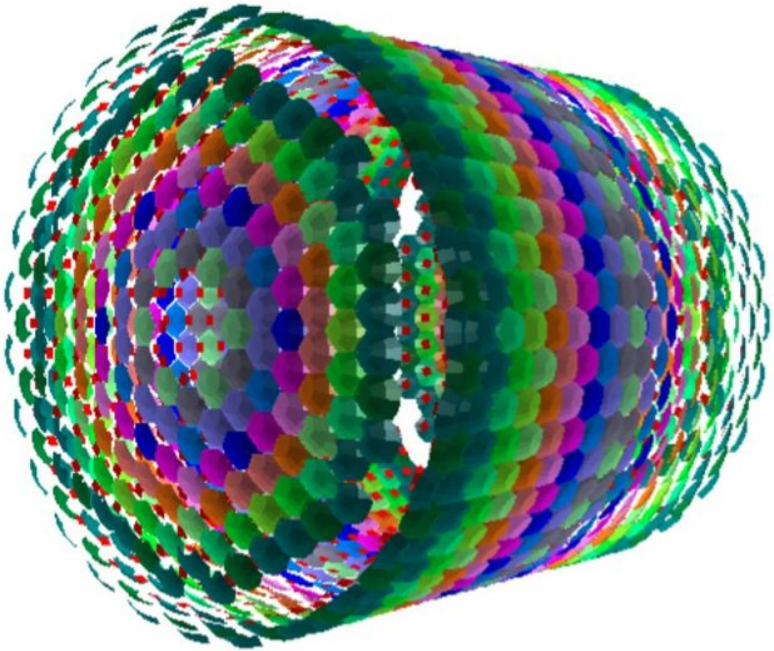
Background

- CLD ~ CLIC-like Detector ~ high granularity detector concept optimized towards particle flow
- Planned silicon-tungsten ECAL
- Great at what it was designed to do (PF tracking and vertex detection), but missing dedicated particle identification components for flavour physics



Background

- ARC ~ Array of RICH Cells ~ modular ring Cherenkov detector for separating hadrons and flavor tagging



  - Developed for silicon-based detectors, like CLD
  - RICH detectors are established in the realm of flavour physics
  - Performance study: https://indico.cern.ch/event/1439509/contributions/6298368/attachments/2996481/5279241/fccphysweek25_ARC_atd_v3.pdf

Background

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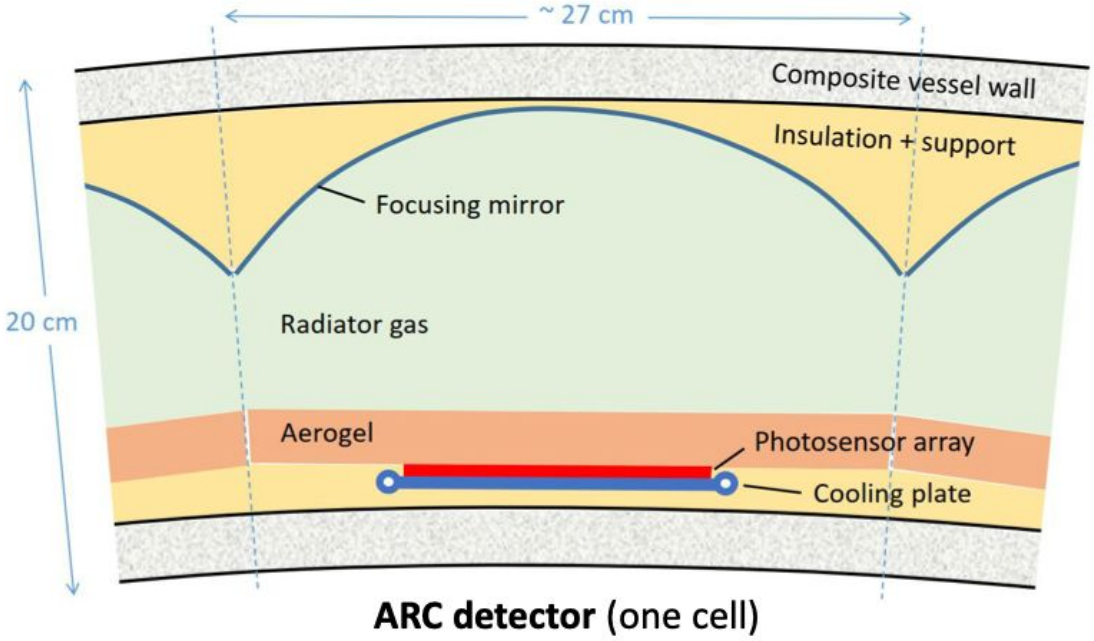
- ARC Cells
  - Each cell is a RICH detector
  - 2 radiators: gas & aerogel
  - Spherical focusing mirror
  - Photosensor array



ARC detector (one cell)

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- How does the presence of ARC material impact CLD ECAL resolution?

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  - ARC to be placed between the outer tracker and ECAL
  - Material budget planned to be at most 0.1X0
  - Most recent ARC plans:
    https://indico.cern.ch/event/1588696/contributions/6857311/attachments/3208774/5714999/ARC_PW2026.pdf
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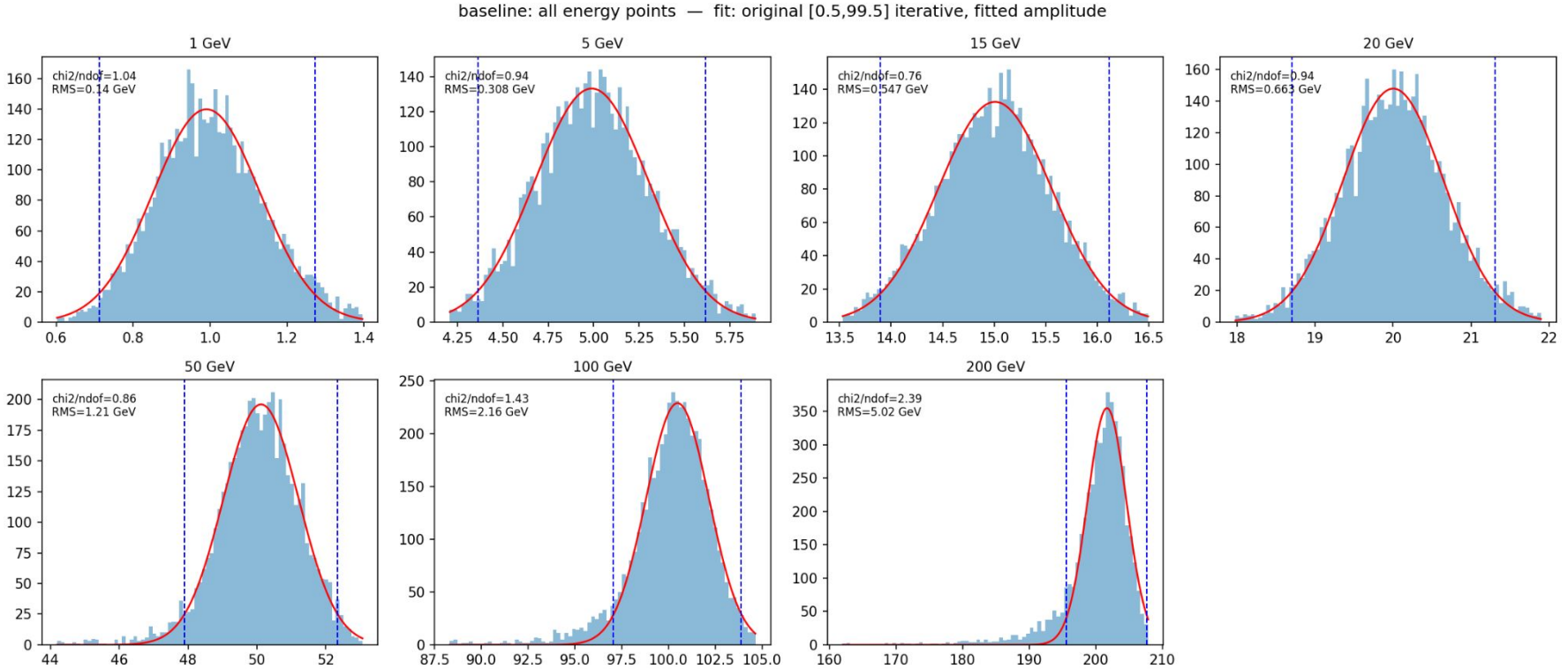
- How does the presence of ARC material impact CLD ECAL resolution?
  - Roughly simulated ARC addition by introducing various X0's of passive material between tracker and ECAL
  - Ran simulation of single photon and single electron detection events in ECAL
  - Studied resolution from both
  - Github: https://github.com/AnnaTiparticle/FCCee/blob/2a81acf0021023caf7a67d9605873d792e58d7ba/Readme.md

Baseline energies for photons

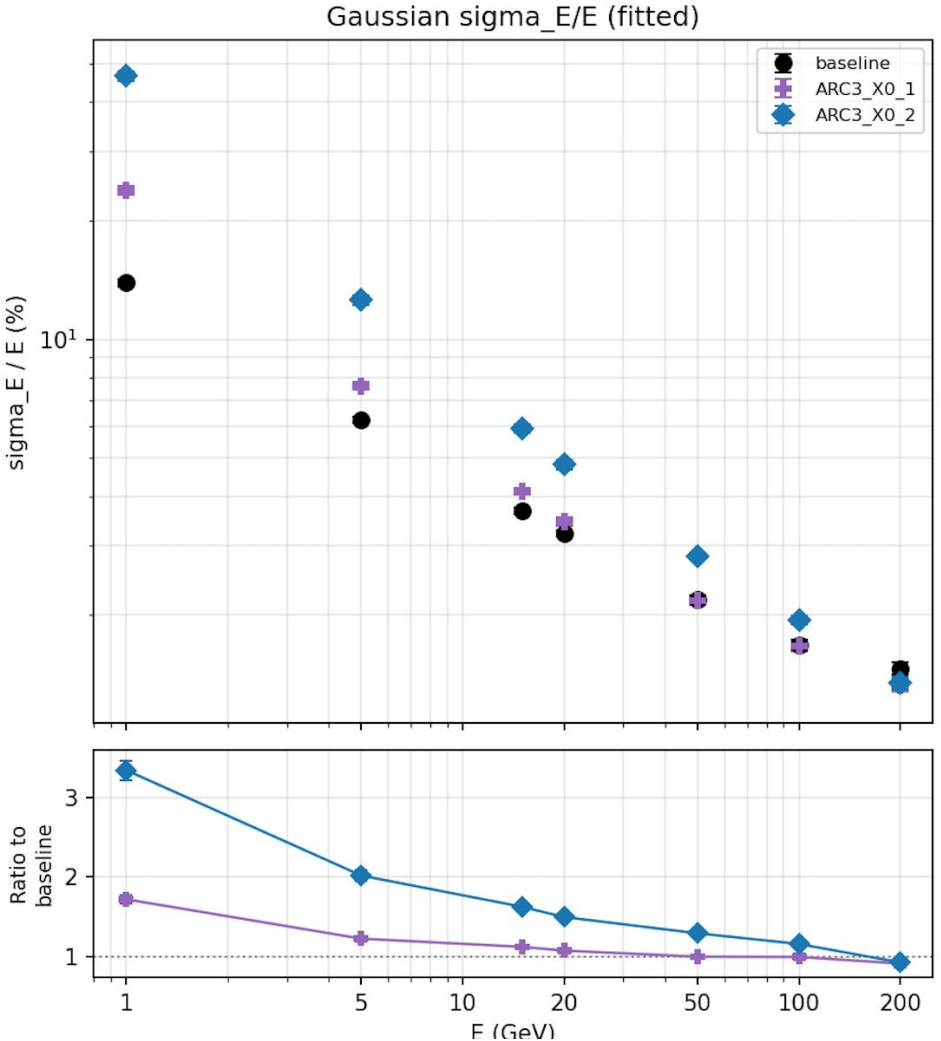


We pooled the reconstructed energy for each configuration studied, as shown above for photon events at baseline geometry (current CLD)

Photon resolution with 1X0 and 2X0 inserts and baseline:

Adding material can affect resolution!

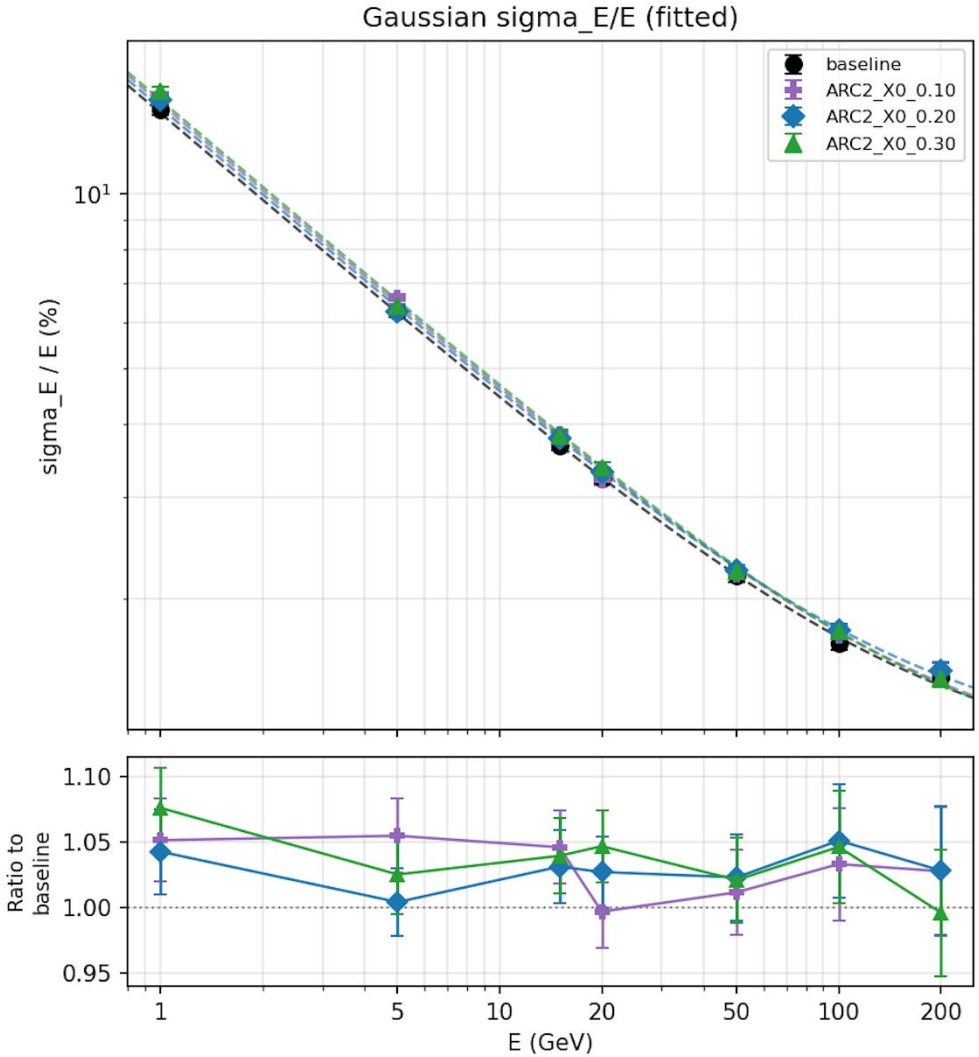
*error bars are present throughout, but small and so hard to see



Photon resolution with 0.10X0, 0.20X0, and 0.30X0 inserts and baseline:

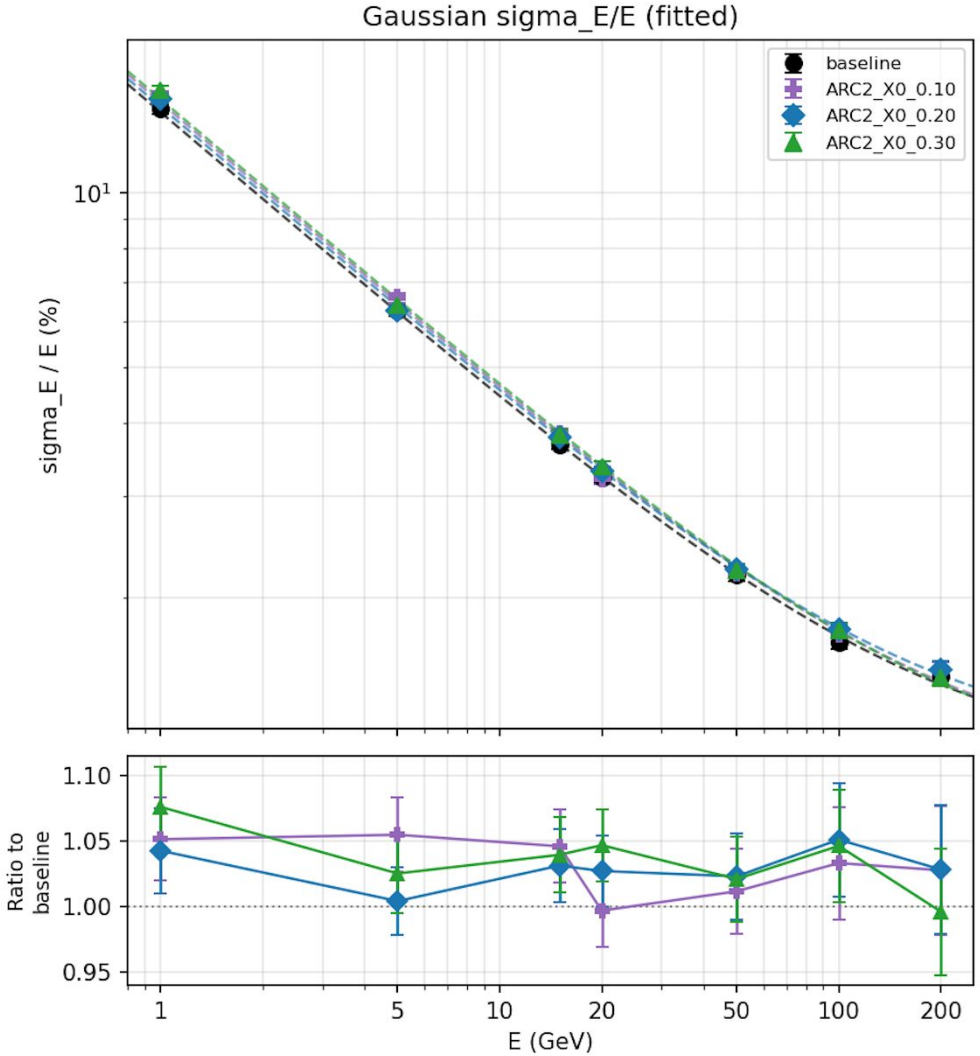
We fit our curves to minimize chi-square error on

$$\frac{\sigma(E)}{E} = \frac{a}{\sqrt{E}} \oplus c$$



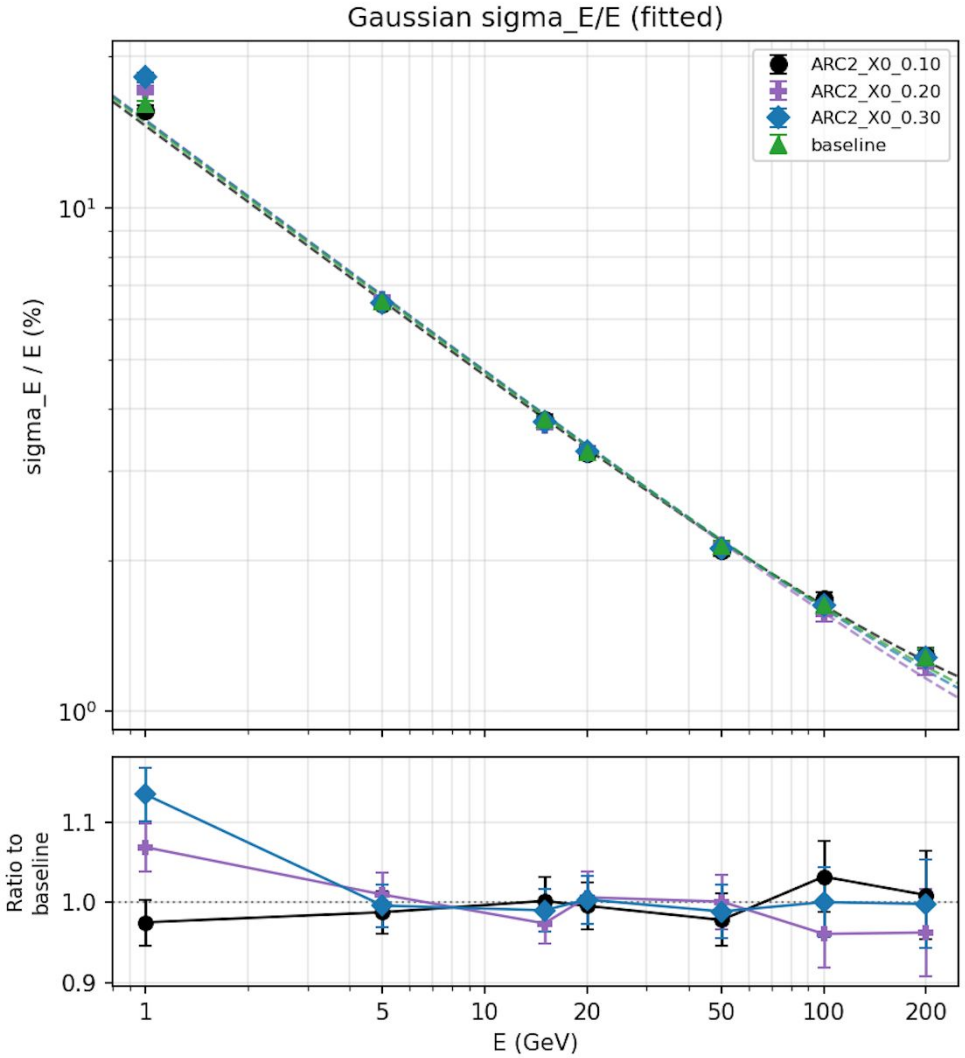
Photon resolution with 0.10X0, 0.20X0, and 0.30X0 inserts and baseline:

So, we can conclude that adding a 0.1X0 ARC layer does not significantly worsen Si-W ECAL resolution for photon detection.



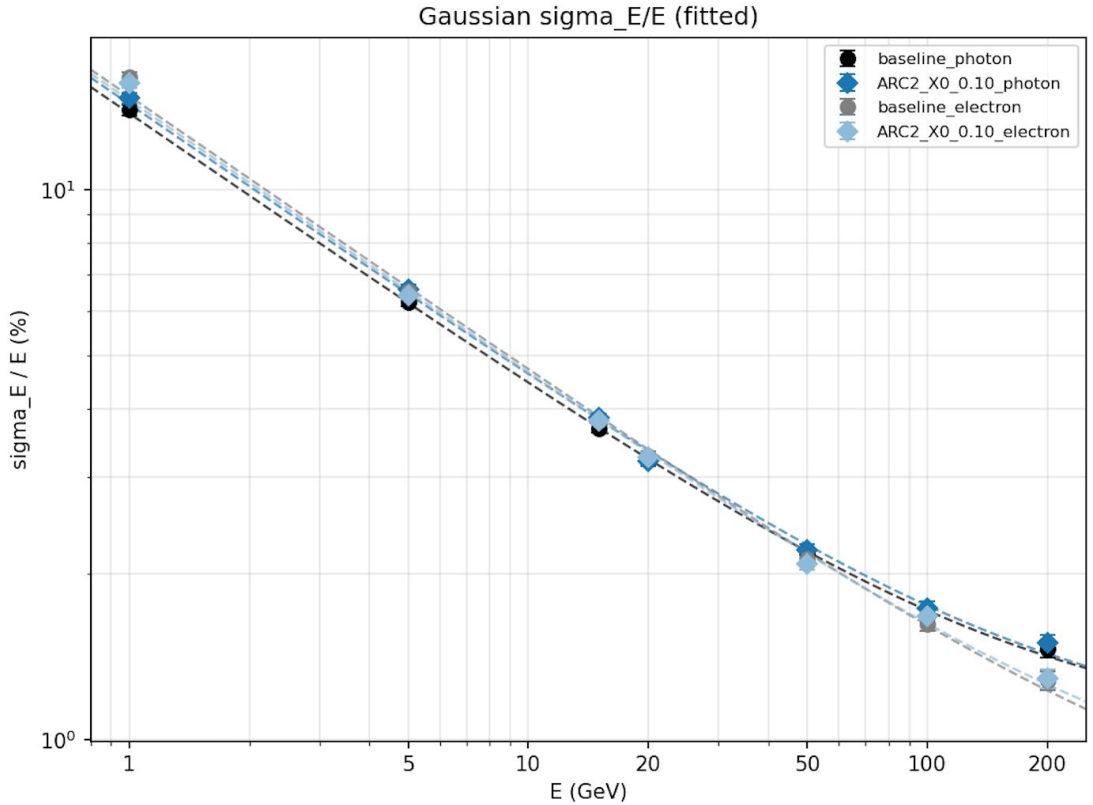
Electron resolution with 0.10X0, 0.20X0, and 0.30X0 inserts and baseline:

Adding a 0.1X0 ARC layer does not significantly worsen Si-W ECAL resolution for electrons, either.



Comparing photon and electron 0.10X0 inserts and baseline:

We expect electrons to be more affected than photons, but the magnitude of the effect is smaller than the resolution possible in this study



Comparing simulated *a* values with predictions from https://arxiv.org/pdf/2606.07564:

- The literature gives, for small amounts of dead material,

$$a_{new} = a \oplus \Delta a$$ with predicted

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- We observed negligible changes in the stochastic term consistent with the predictions
  - In any case, the changes induced are on a scale below that of the CLD ECAL energy resolution

We can conclude...

Addition of an ARC component has little impact on CLD Si-W ECAL energy resolution.

Thank you to Charlie and Prajita for your time and mentorship!