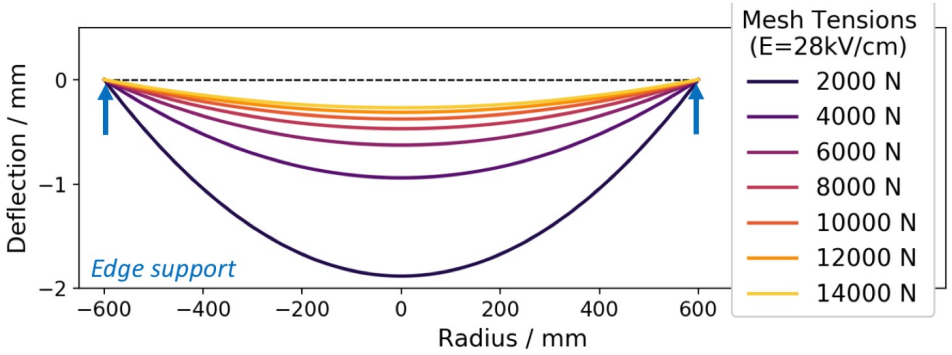
FAT-GEM detectors for operation in noble elements

Sara Leardini

State – of – art

- Meshes (woven, calendered, electroformed, or set as an array of wires) are widely used as secondary scintillation structures in the field of rare event searches
- Excellent energy resolution and ability to detect single-electrons
- Difficult scalability



Rogers et al., 2018 *JINST* **13** P10002

Loss of tension

mesh-stretching on large areas is complicated

vulnerability to weak points

lack of modularity complicates testing

State – of – art

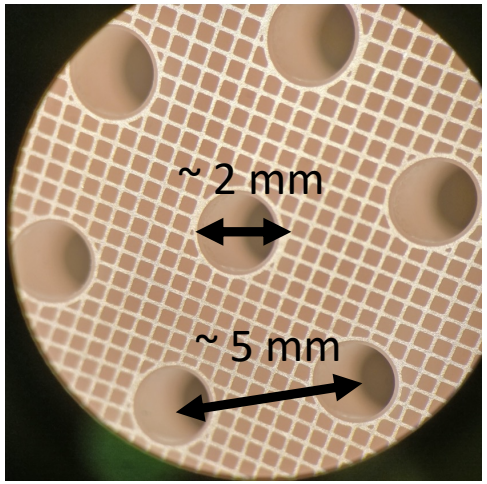
FAT-GEMs

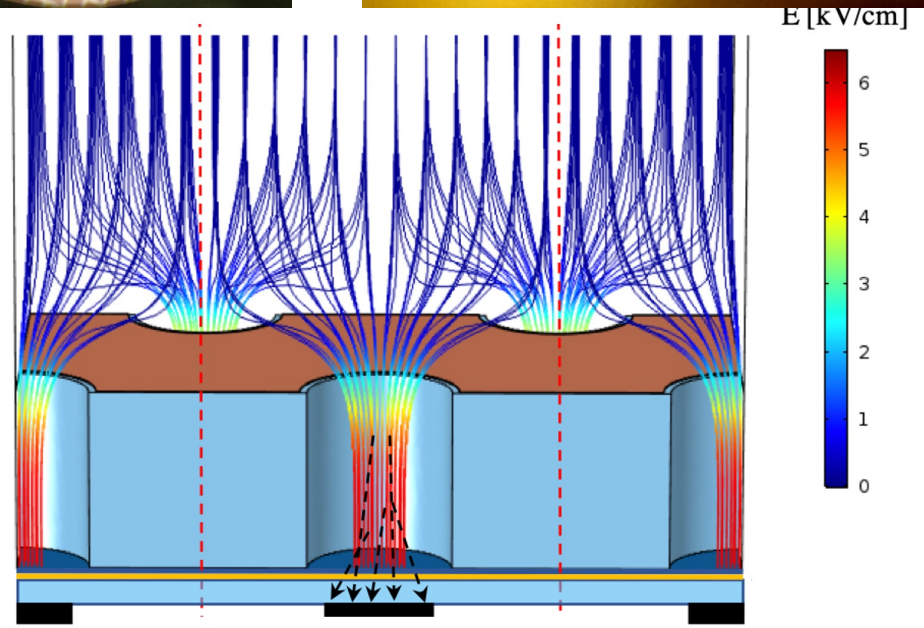
(Field-Assisted Transparent Gaseous Electroluminescence Multiplier)

- Scalable
- Radiopure (Radiopurity studied at Canfranc Underground Laboratory (thanks to I. Catalin Bandac and S. Cebrián)

  No isotope detected in 47.7 days!

- Transparent to scintillation

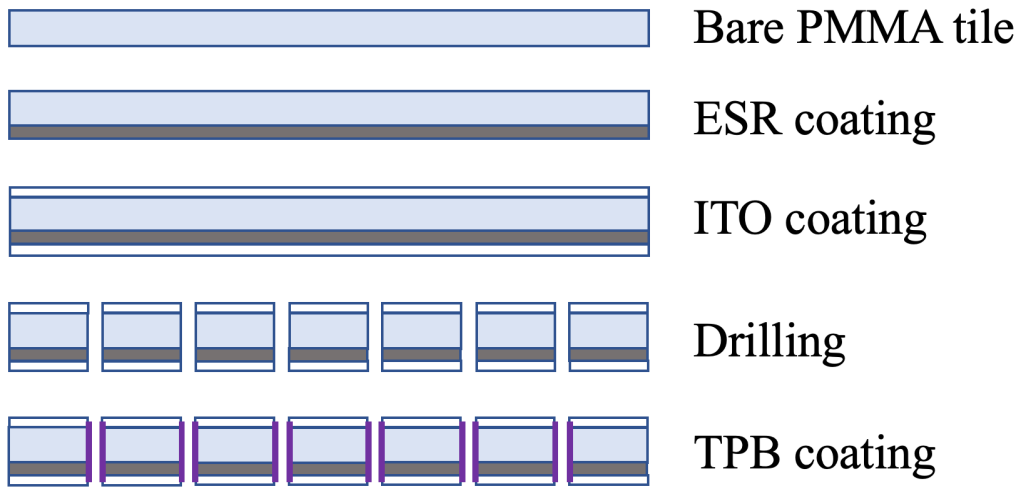


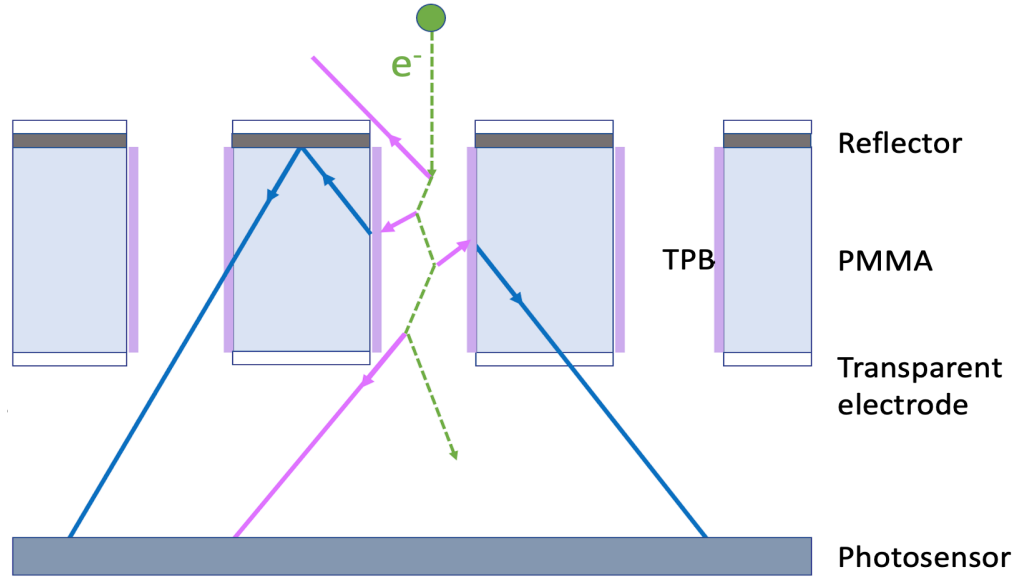


Saa et al., journal of synchrotron radiation, 2021, Volume 28, Part 5

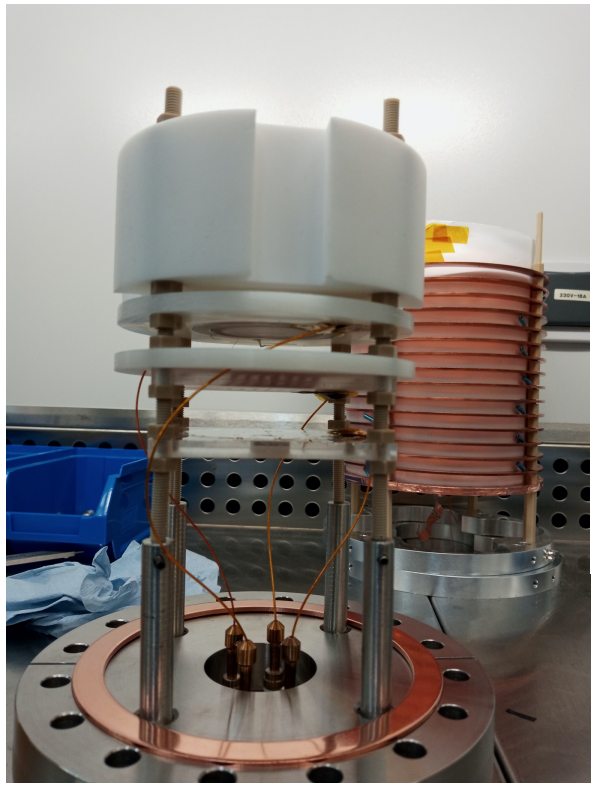
How it’s made

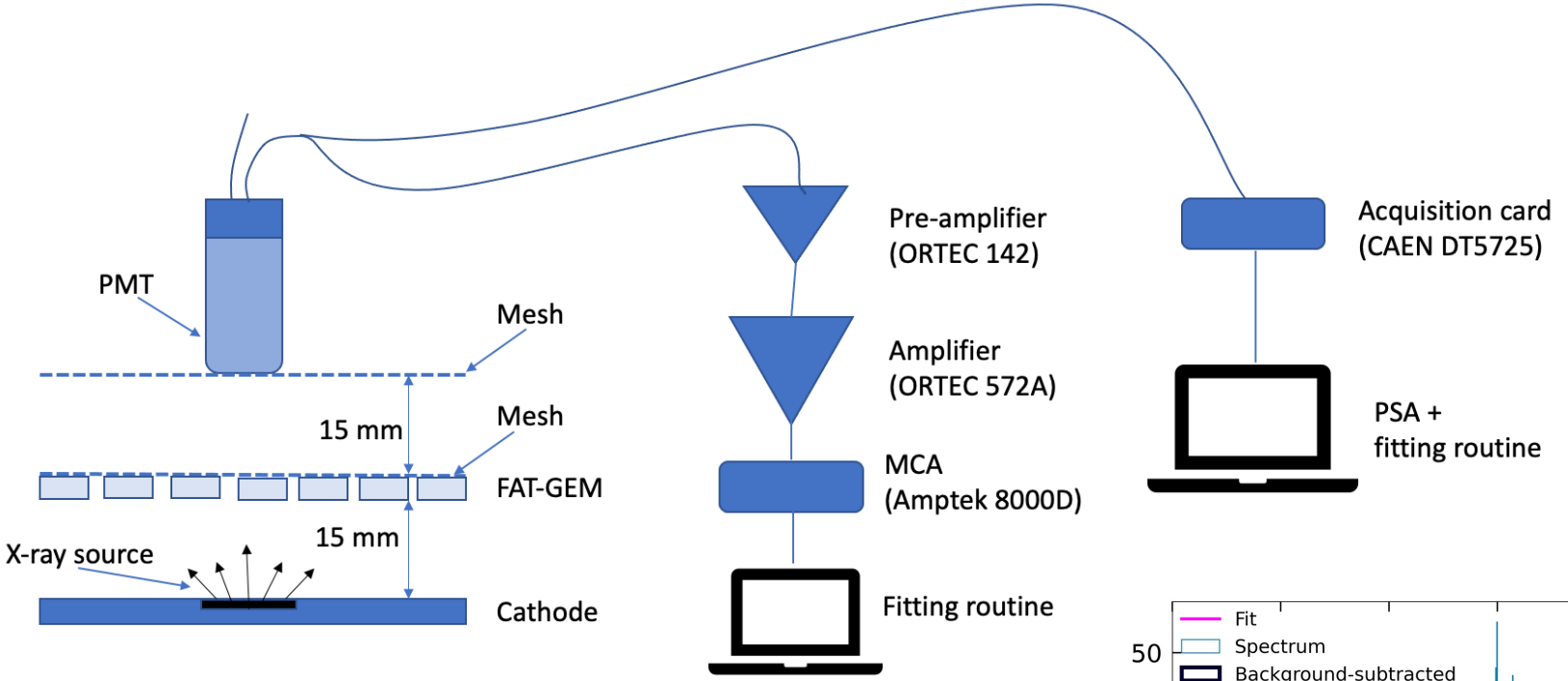
- Fabricated at AstroCeNT (Poland)
- Bulk made of PMMA (Polymethyl methacrylate)
- ITO coating + TPB in the holes
- Area up to 50 cm x 50 cm at least (easily tiled)
- Thickness = 5 mm (!)
  (important for high electroluminescence yields)



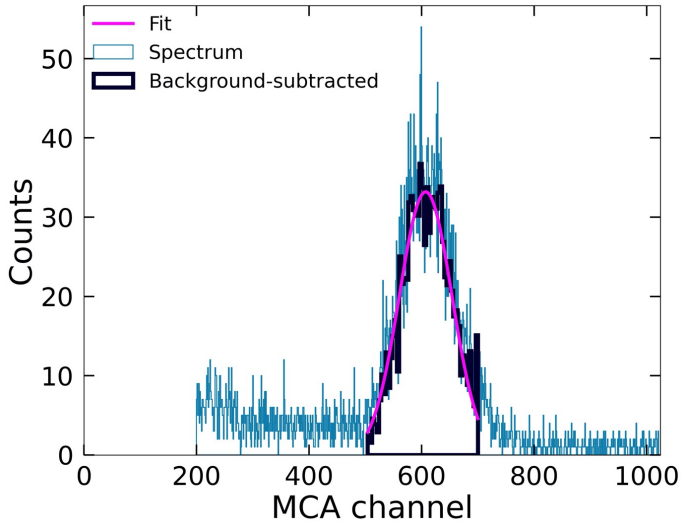


Setup



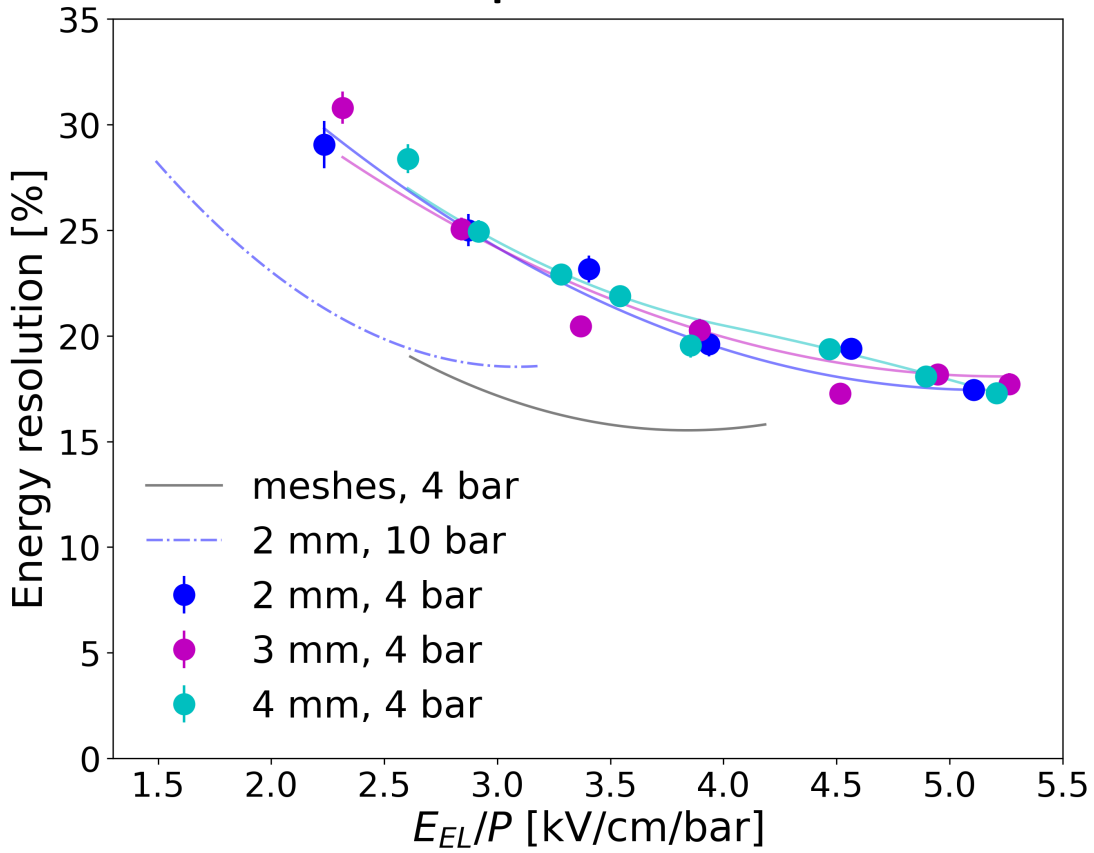


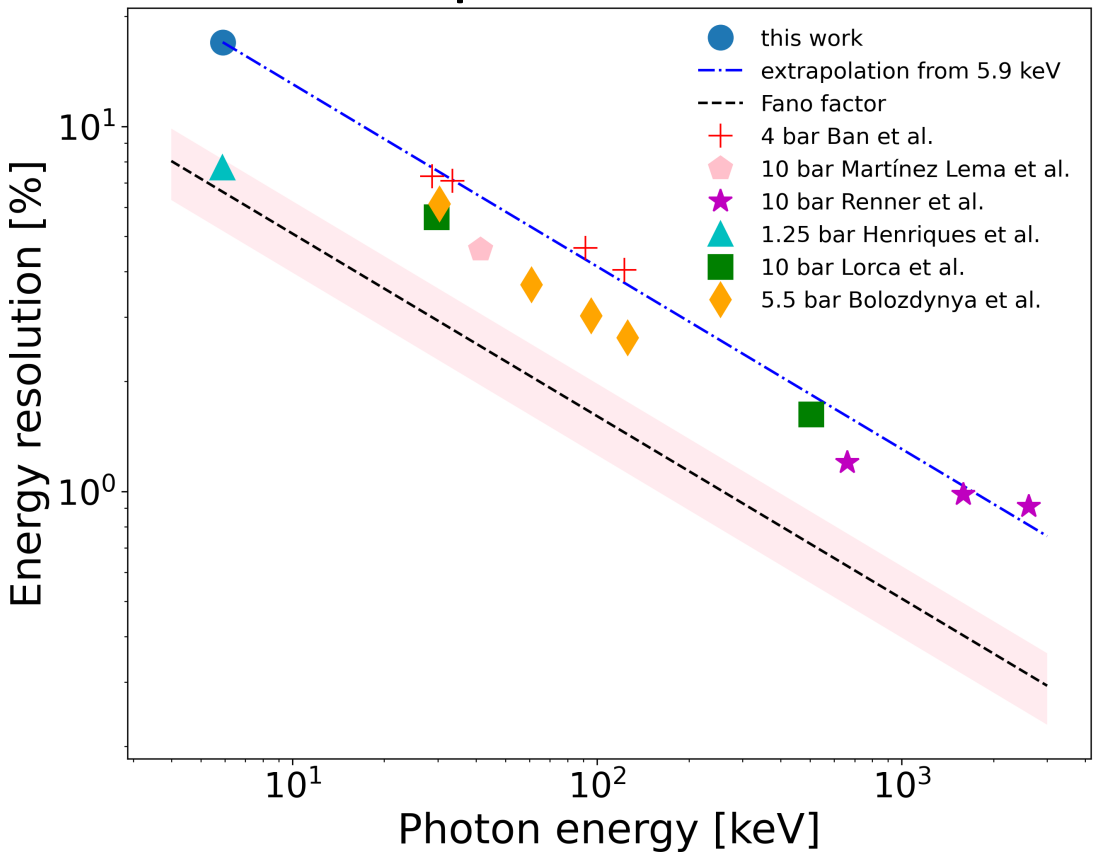
- scan of drift field with a fixed electroluminescence field (E_{EL})
- find the optimal drift field (E_{Dr})
- scan of E_{EL}



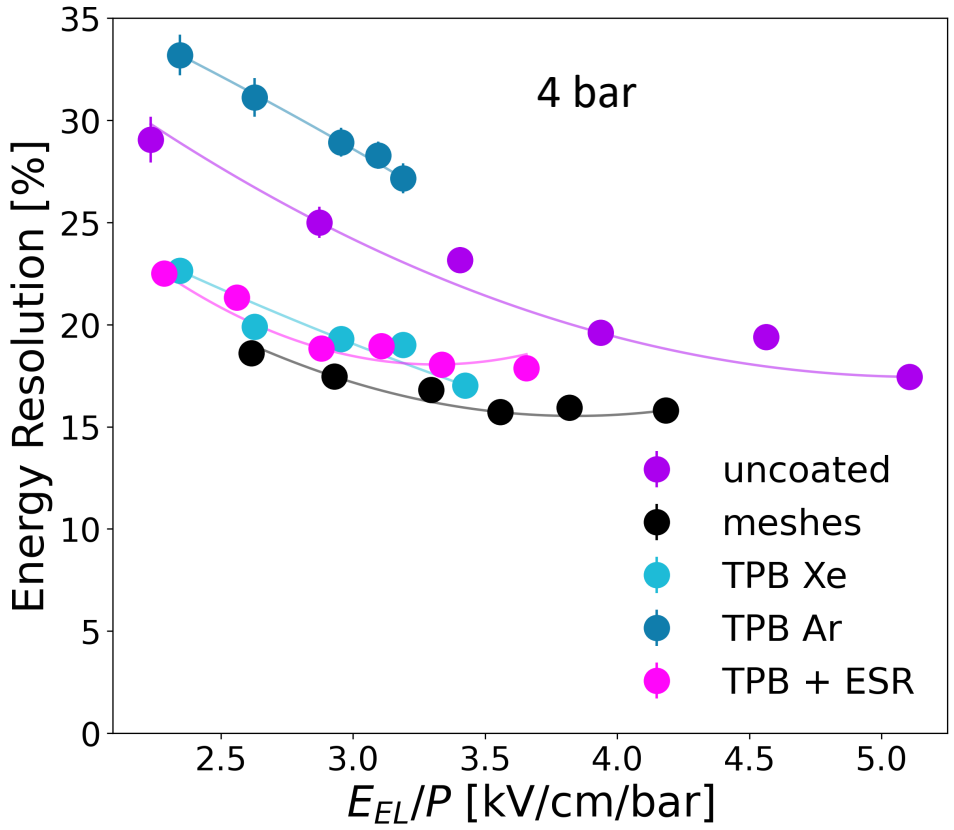
Results – energy resolution

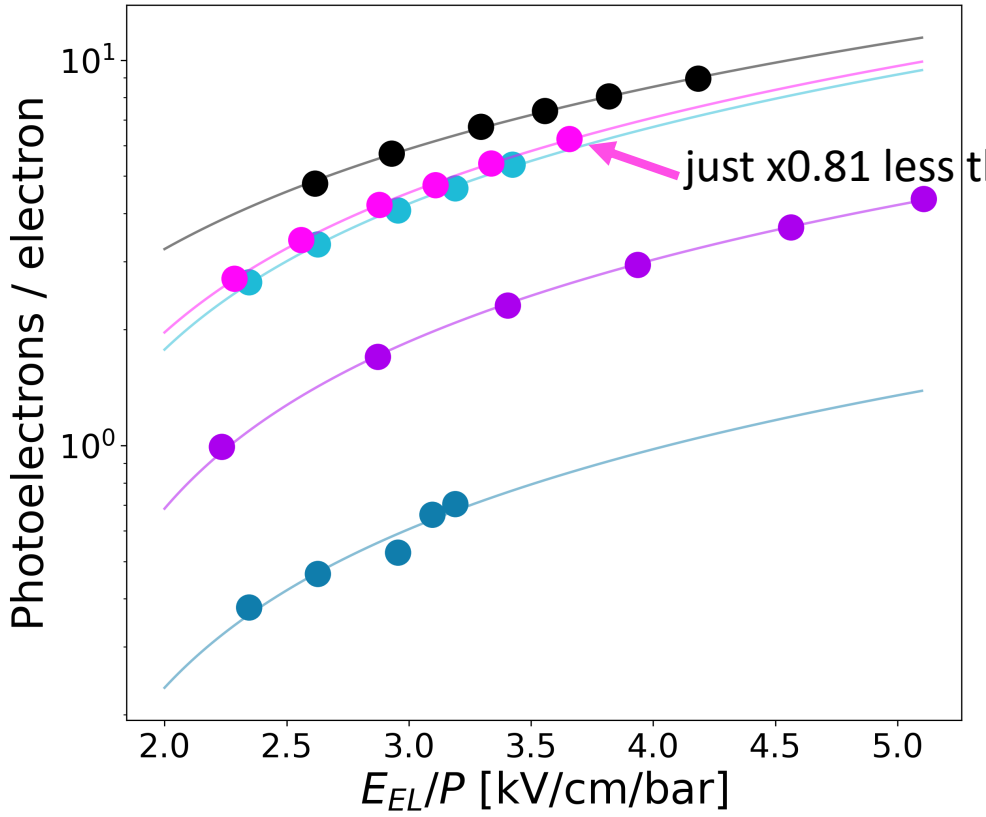
- Best FAT-GEM ER 17% FWHM
- Extrapolated @2615 keV -> 0.85% FWHM
- Result compatible with meshes in the same setup





Results from structures with TPB-coated holes





- Coupling of ESR not ideal
- Optical transparency of ITO we used ~75%

-> room for improvement!

Conclusions and outlook

- FATGEMs are promising radiopure and scalable structures for electroluminescence – based noble gas detectors
- We were able to reach (and slightly exceed) the energy resolution scale of neutrinoless double beta decay experiments
- The observed scintillation yields are within x0.81 of those achievable with meshes
- Room for optimization improving ITO transparency and ESR coupling seems possible. Stay tuned!

Thanks for your attention!