New generation of 3D detectors for X-ray polarimetry: simulation of performances

Team:

- **PI: Alessandro Di Marco**
- Paolo Soffitta
- Fabio Muleri
- Enrico Costa
- Sergio Fabiani
- Dawoon Kim (PhD student)

Summary and goals:

- This grant is part of the "Scheda INAF" PAX
- Important also for the following ones: BabyIAXO and GEANT4-SIM
- Grant relevant to drive the design of a new generation of 3D detectors for X-ray polarimetry
- Two main software tools:
  - ➥ Geant4 based simulator for gas detectors with capability of 3D track imaging and including polarimetric physics libraries
 - ➥ Track reconstruction software for 3D imaged tracks

3D track reconstruction

In publication: *The future of X-ray polarimetry towards the 3-Dimensional photoelectron track reconstruction*, D. Kim, A. Di Marco, P. Soffitta, et al. arXiv:2309.17206

To determine the ph.e. emission (related to X-ray polarization) the following steps are followed:

- Finding a 3D regression plane of the 3D track from the 3D charge distribution
- Projected the track onto the regression plane
- Barycenter calculation (x_b, y_b) in the regression plane
- Finding a principal axis (ϕ_{max}) and fitting ellipsoid of inertia
- Finding the absorption point (x_b', y_b') by weighting by distance and excluding the region where the Bragg peak is present
- Estimating the initial direction in 3D (ϕ, θ)

Modulation factor as function of *Energy*
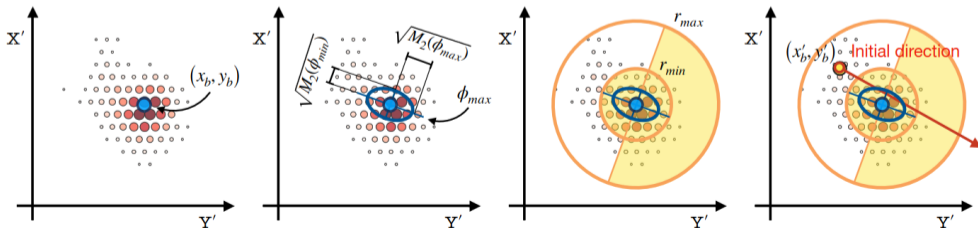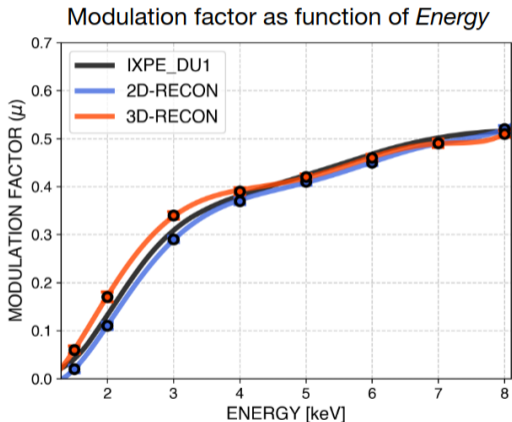
Milestones:

- release of the new Geant4 simulation tool (**in development**)
- release of the new reconstruction algorithm (**presented at IWORID 2023 and in publication arXiv:2309.17206**)
- An improvement with respect to 2D read-out as in IXPE has been observed in a preliminary version of the simulation
- The repository of the software is in development and periodically updated

- Criticality: delay in the Monte Carlo development partially due to delay in the purchase of server/NAS system for the storage of the simulated data-sets