

# A Large-Volume, Extended Field-of-View TPC for X-Ray Polarimetry

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# Polarization in the EM spectrum

**M1-Crab nebula**



**Radio**

**Optical**

**X-rays**

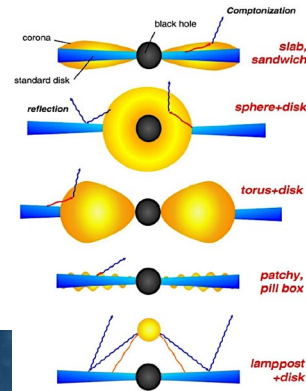
**Widely observed by different missions**

**First mission dedicated to polarimetry  
launched in 9 Dec 2021**



# Why Polarized X-Rays

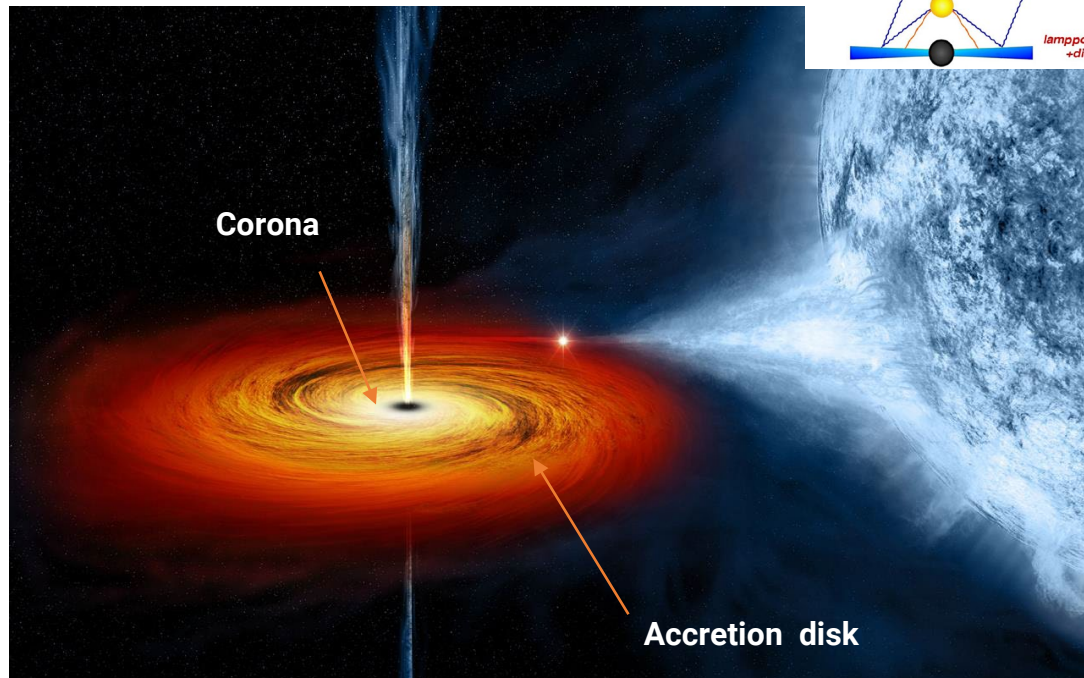
- The polarization of X-rays depends on magnetic field structures, geometry of gas clouds, and fundamental interactions
- Its measurements can unlock knowledge on astrophysical objects no other method can



Acceleration mechanisms  
in jets and shocks  
(Blazars, Super Nova Remnant)

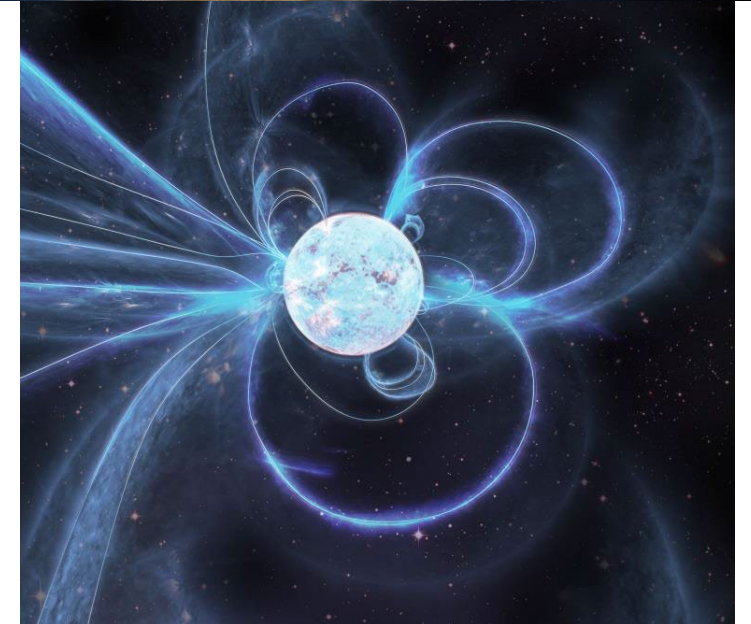


Shape of coronas and accretion geometry  
(Accreting black hole binaries for example)

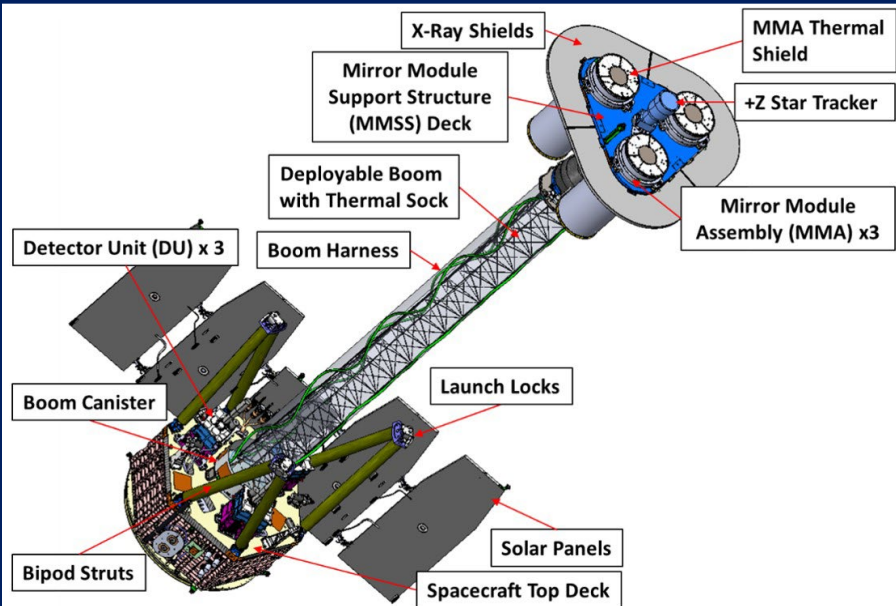


New physics can be searched  
too (QG, LIV, vacuum  
birefringence, ALPs)

Behaviour in extremely  
strong magnetic fields  
(Magnetars)



# IXPE mission



- The Imaging X-ray Polarimetry Explorer (IXPE) was launched in December 2021
- 3 Photoelectric detectors (GPD) in the optics of 3 mirror telescopes (reduces background, focuses sources)
- Onboard calibration system with polarized and unpolarized sources

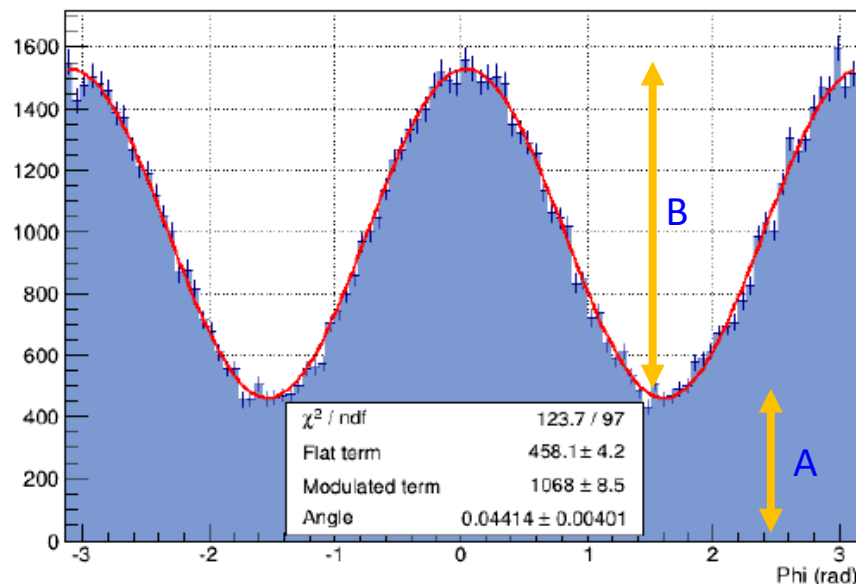
$$\mathcal{M}(\phi) = A + B \cos^2(\phi - \phi_0)$$

Polarization Angle

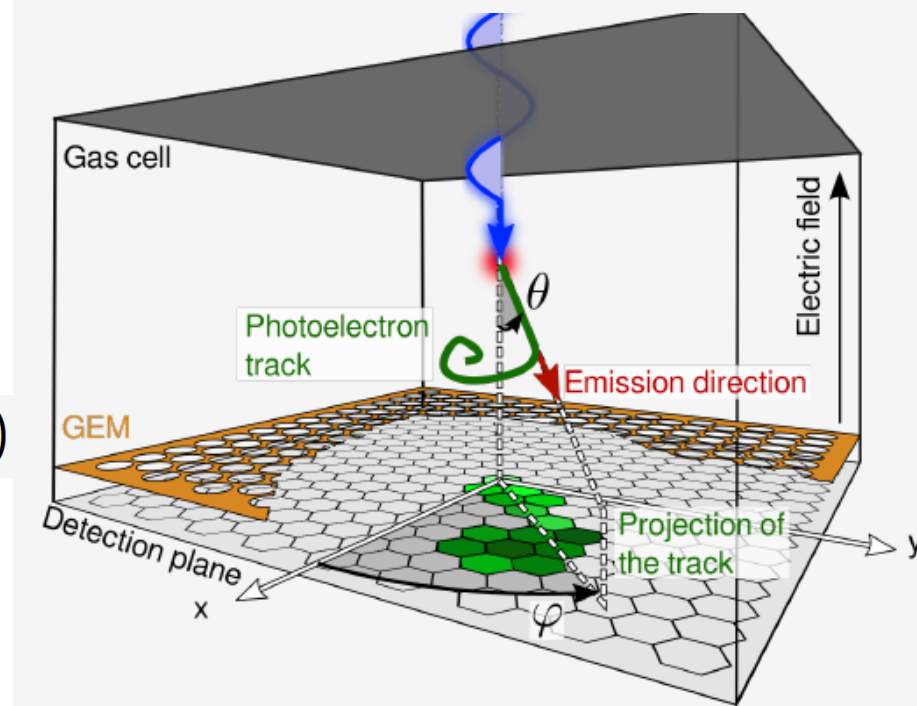
$$p = \frac{1}{\mu} \frac{B}{B + 2A}$$

Polarization Degree

Modulation Factor



$$\frac{d\sigma}{d\Omega} \propto \cos^2 \phi \frac{\sin^2 \theta}{(1 - \beta \cos \theta)^4}$$



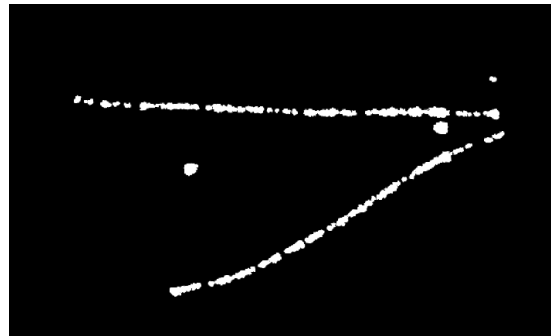
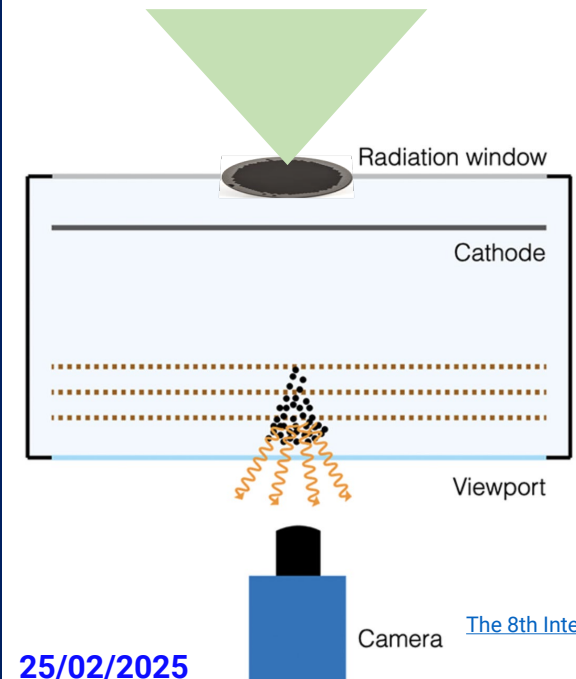
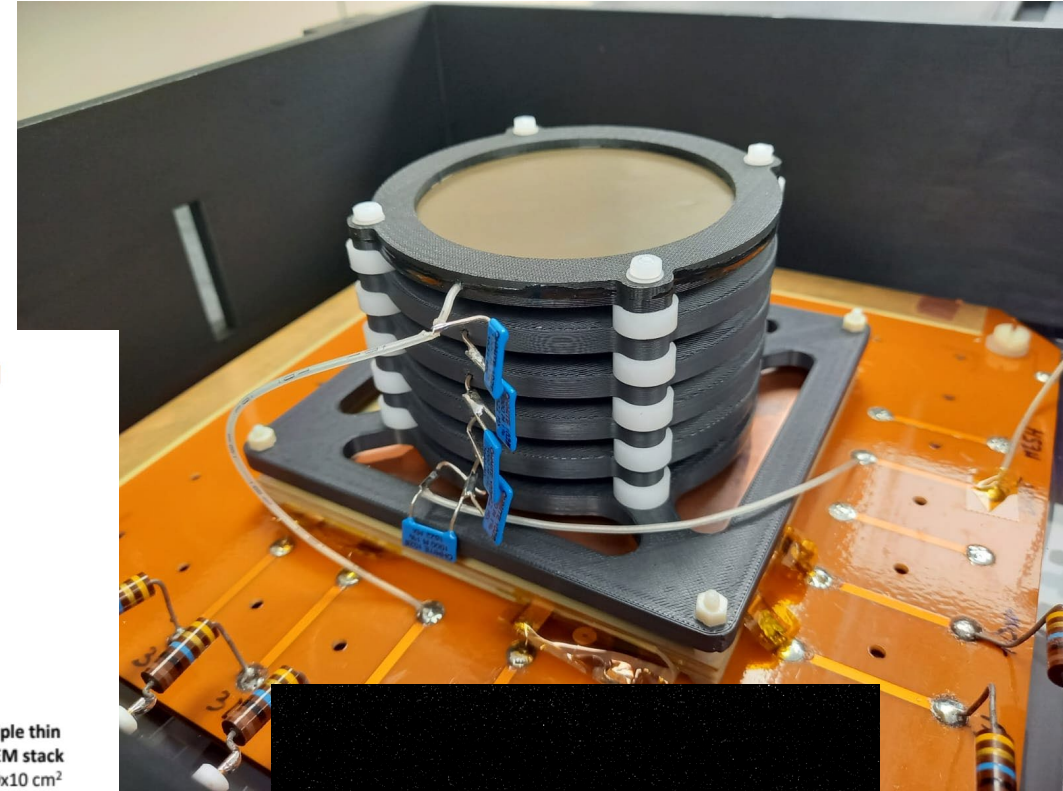
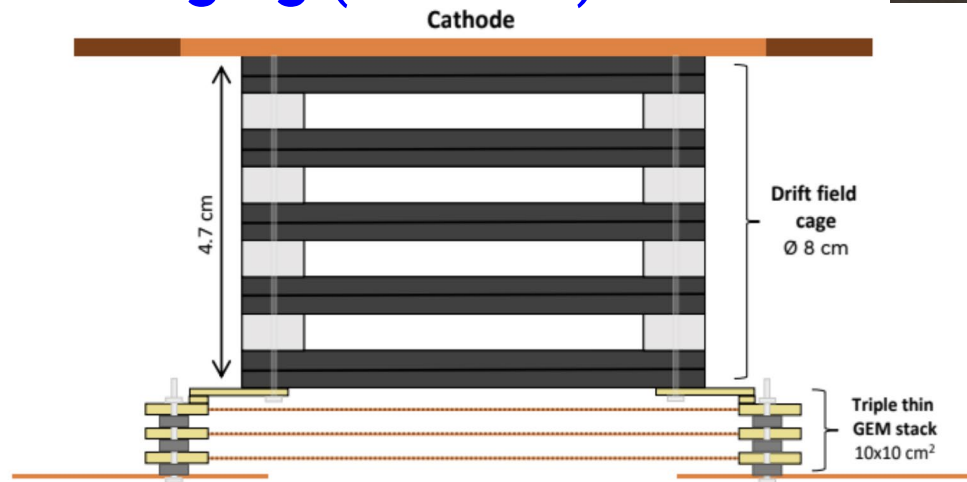
- DME gas @ 0.8 bar (diffusion of  $\sim 90-100 \frac{\mu\text{m}}{\sqrt{\text{cm}}}$ )
- 50  $\mu\text{m}$  thick Be window (transparent to X-rays)
  - Single GEM amplification (50  $\mu\text{m}$  pitch)
  - Hexagonal custom ASIC pixelated charge detector ( $10^5$  channels)
    - Energy resolution 15% @ 6.4 keV
- Position resolution less than 120  $\mu\text{m}$  @ 2 keV



# MetalMANGO prototype



- Large FoV  $\approx 20^\circ$  (IXPE is  $0.2^\circ$ )
- Larger energy band **10-60 keV** (IXPE 2-8 keV)
- ~~3D imaging~~ (IXPE 2D)



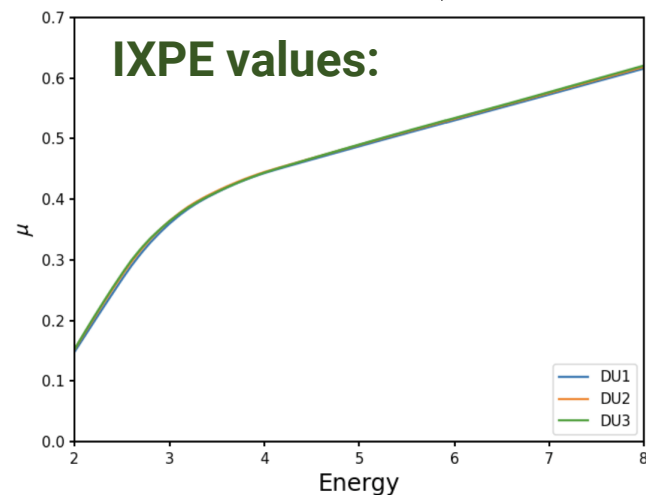
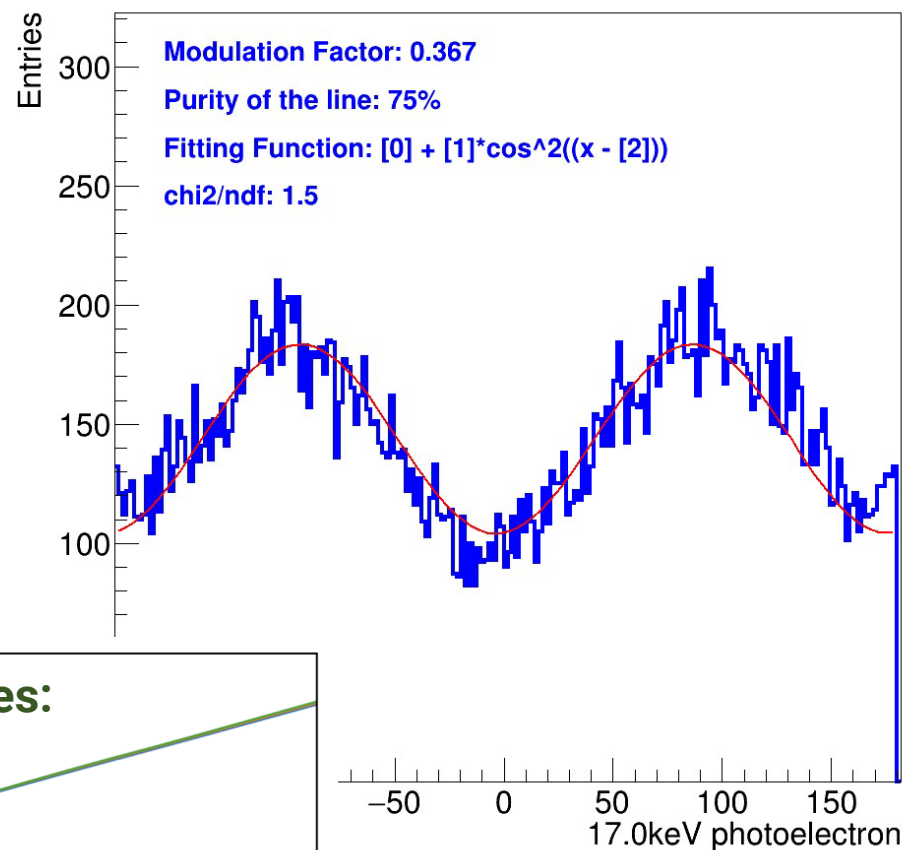
Camera

[The 8th International Conference on Micro Pattern Gaseous Detectors \(MPGD2024\) \(14-18 October 2024\): Development and Preliminary Results of a Large-Volume Time Projection Chamber for X-ray Polarimetry - Indico](#)

Davide Fiorina - GSSI & INFN

# Detector Performance

17 keV fully  
polarized  
beam



IXPE values:  
0.11 @ 2.6 keV  
0.074 @ 6.4 keV

Our value are in the ballpark.  
This does not mean we are similarly good!

figure-of-merit vs Photon Energy (keV)

