

# Status update of the axion helioscope BabyIAXO



Patras Workshop 2022  
Mainz

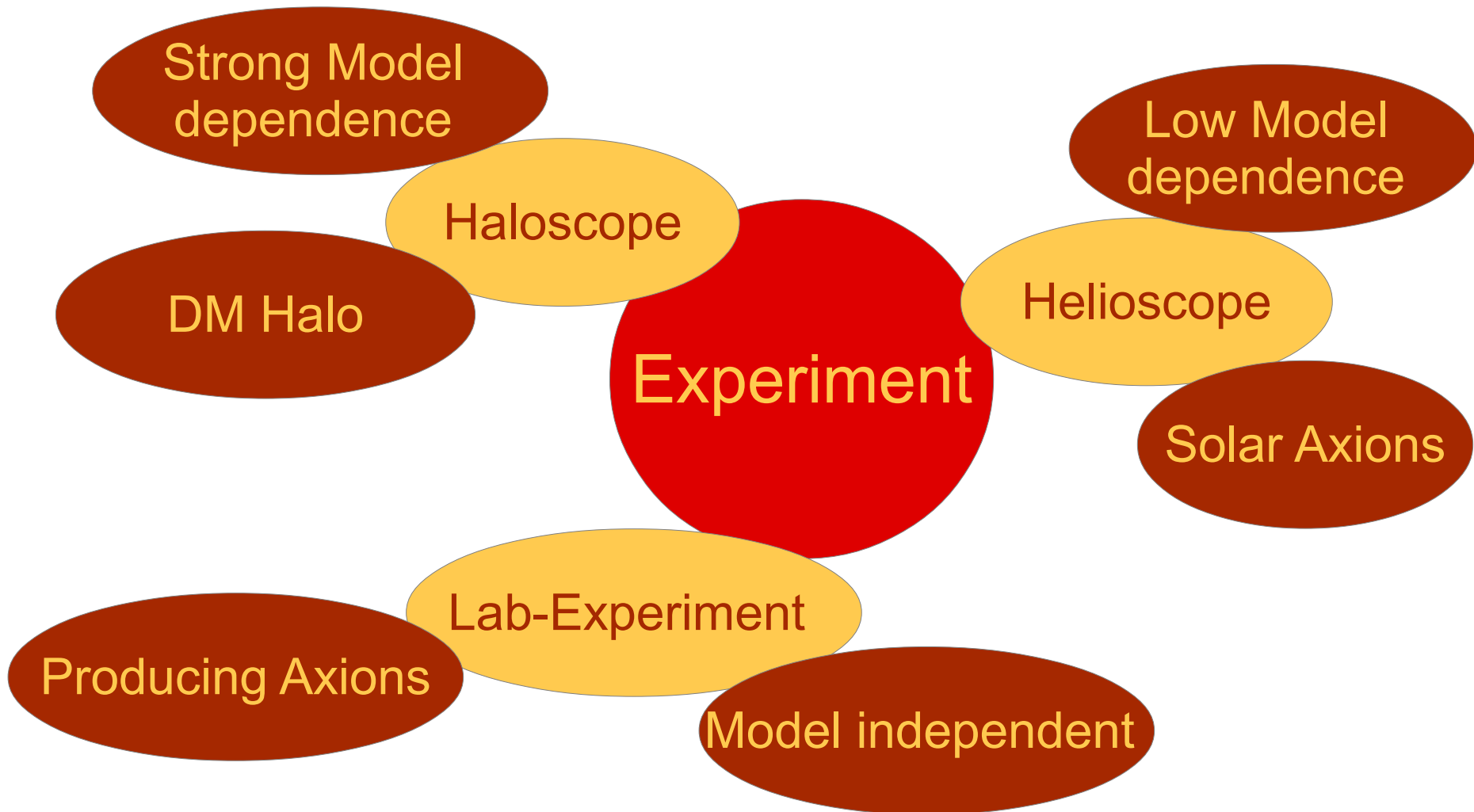
Tobias Schiffer  
University of Bonn

for the IAXO Collaboration

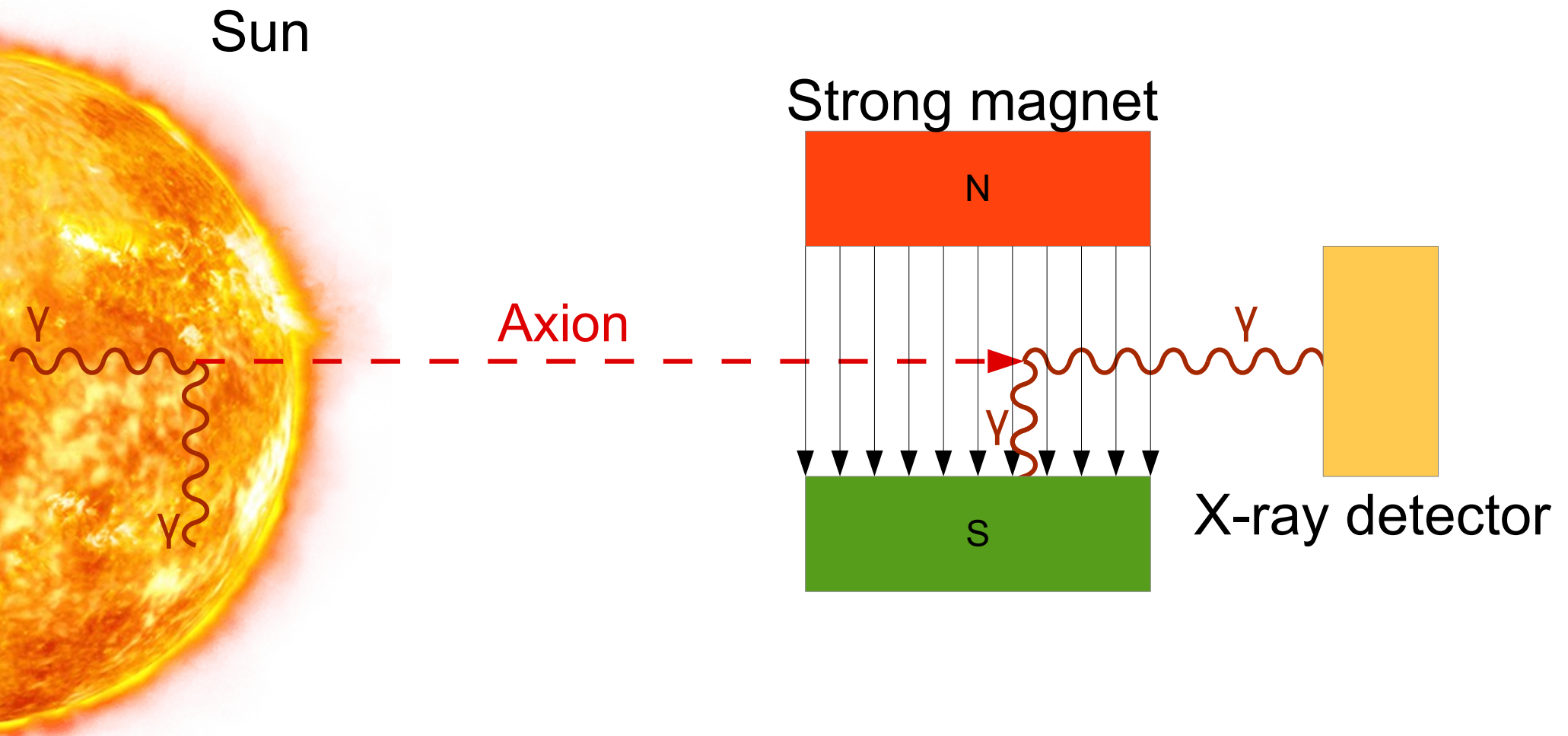
# The Axion



# Detecting The Axion



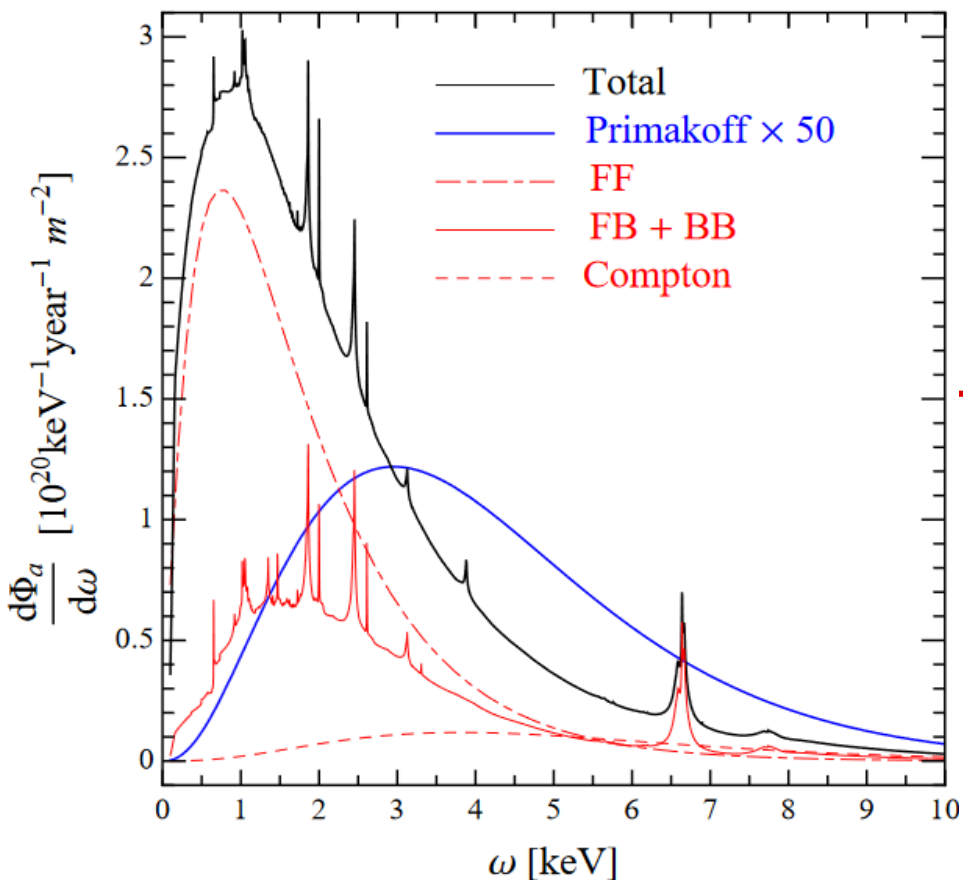
# The Axion Helioscope



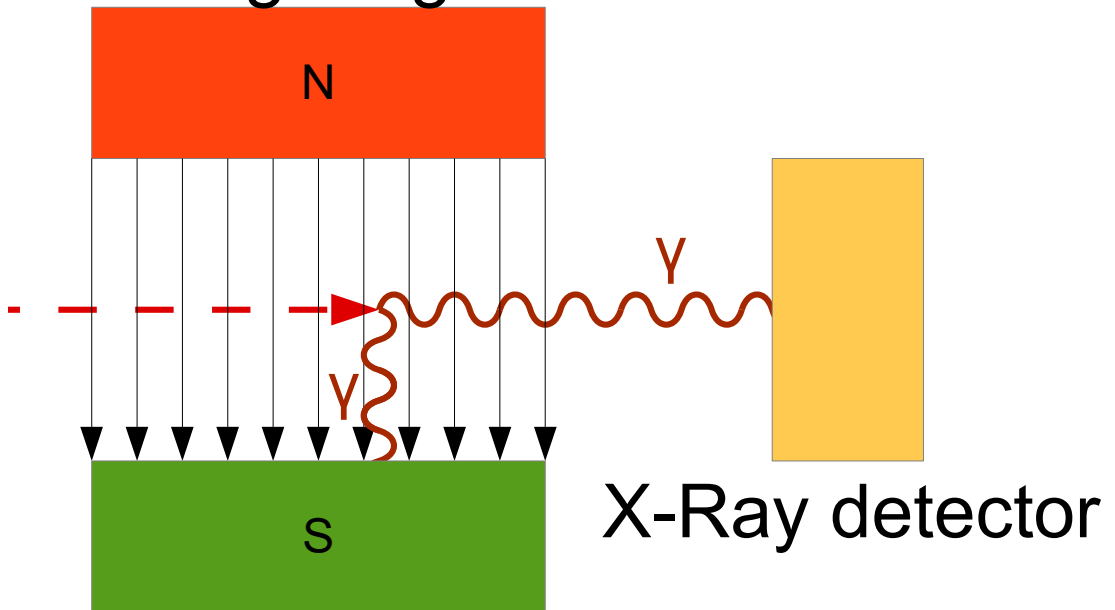
# The Axion Helioscope II



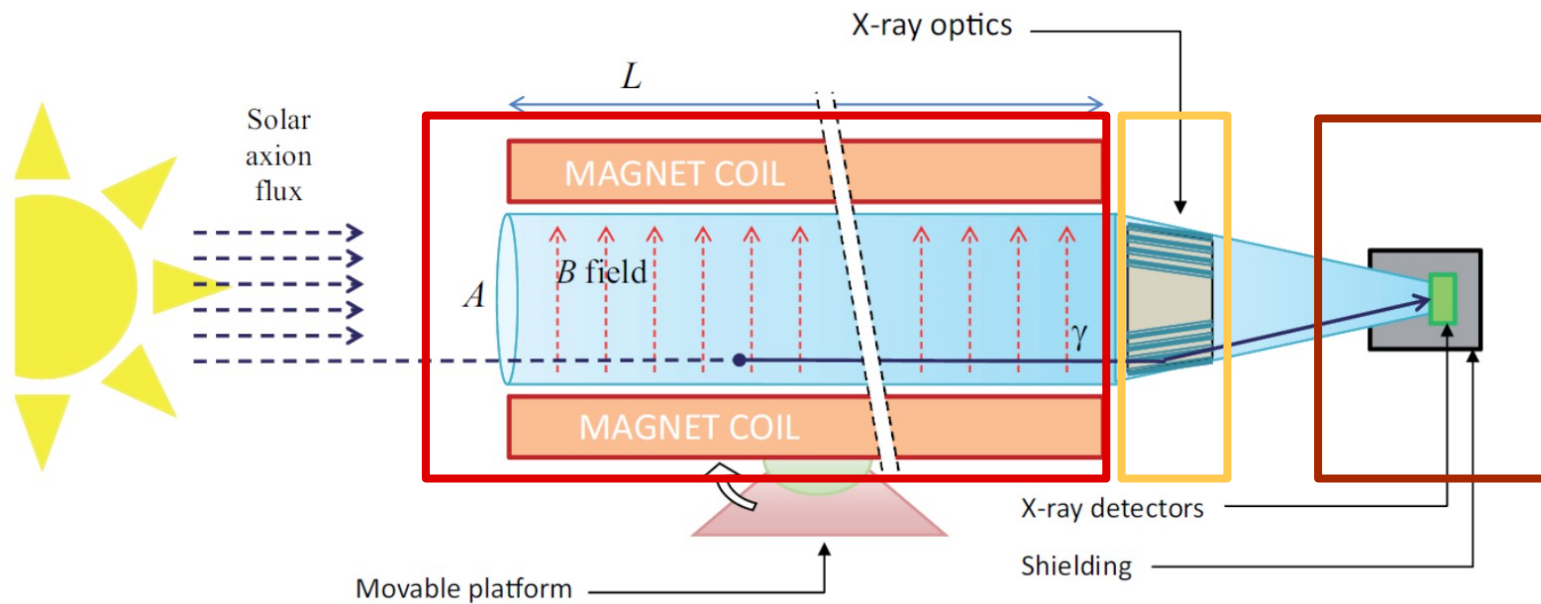
Sun



Strong Magnet



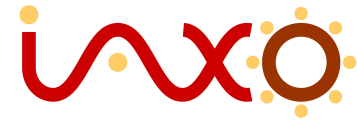
# Advanced Helioscope



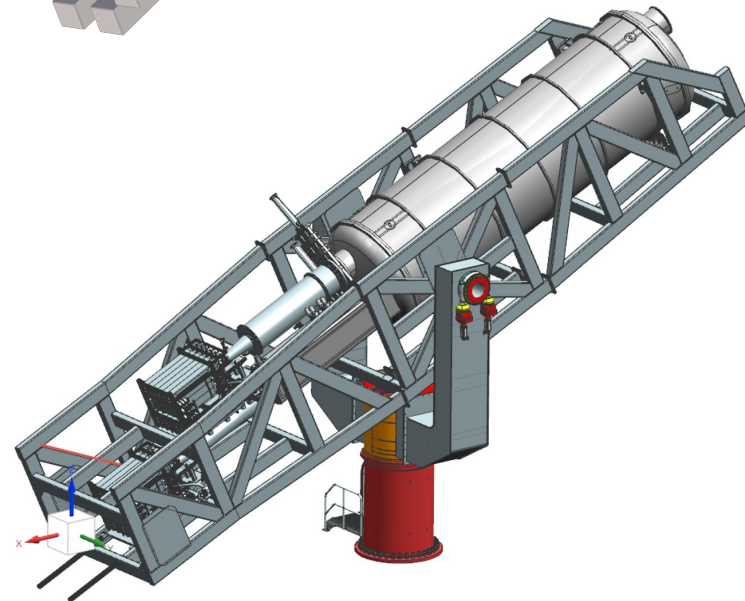
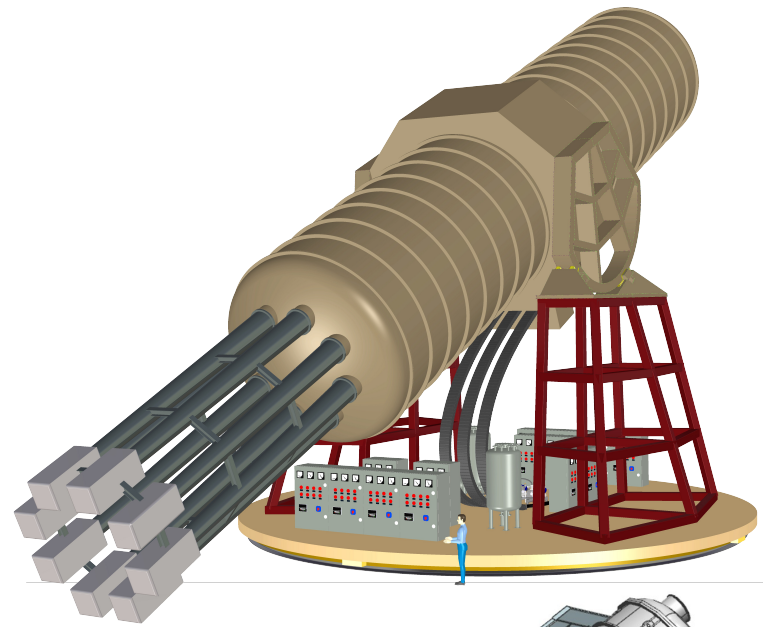
Sensitivity to axion-photon coupling

$$g_{a\gamma}^4 \propto \underbrace{B^2 L^2 A}_{\text{Magnet}} \cdot \underbrace{\epsilon_o \alpha^{-1/2}}_{\text{Optics}} \cdot \underbrace{\epsilon_d b^{-1/2}}_{\text{Detector}} \cdot \underbrace{\epsilon_t t^{-1/2}}_{\text{Time}}$$

# CAST, BabyIAXO, IAXO



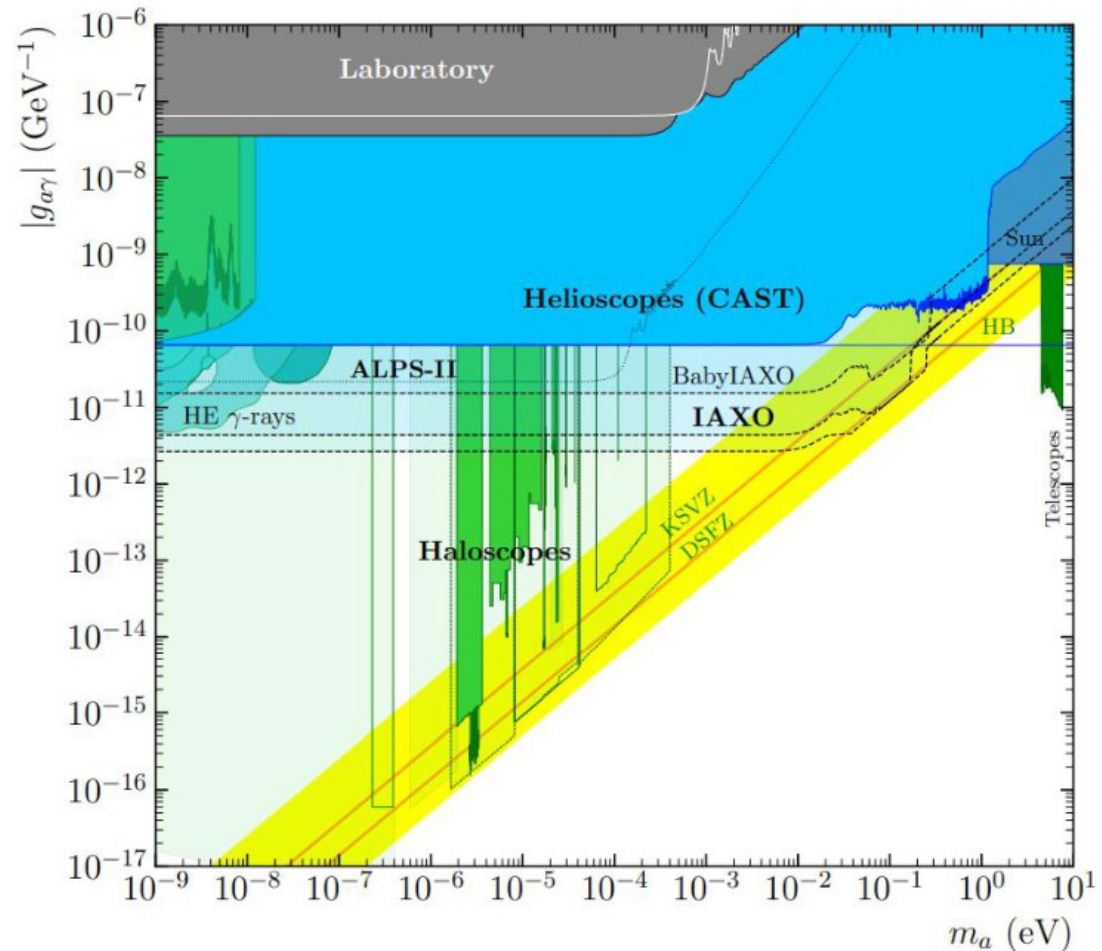
- 20 years experience from CAST
- IAXO will have a 300 times better magnet Figure of merit (FoM)
- BabyIAXO an intermediate state technology demonstrator
- BabyIAXO will be built at DESY (Hamburg)



# Sensitivity



- BabyIAXO and IAXO will push the limits
- BabyIAXO is about 100 times more sensitive than CAST
- IAXO will be in the order of  $10^4$  more sensitive than CAST

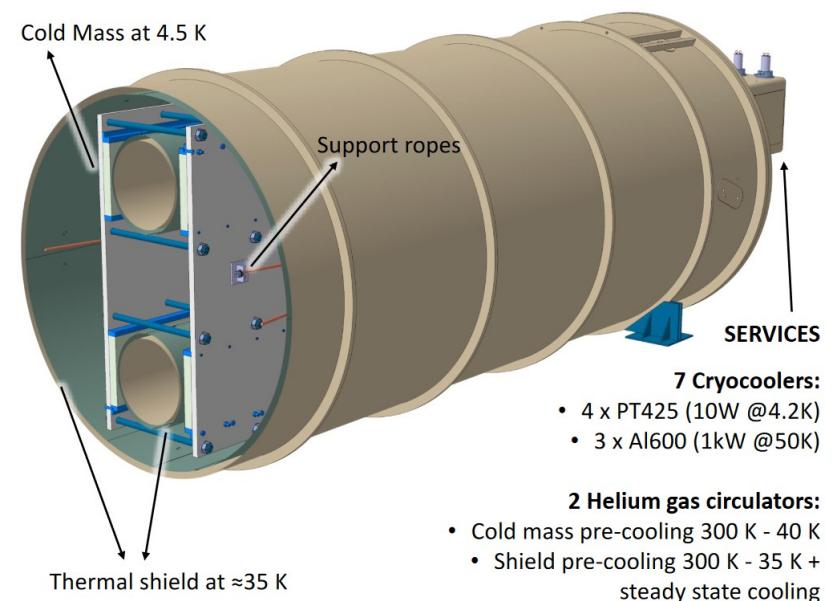
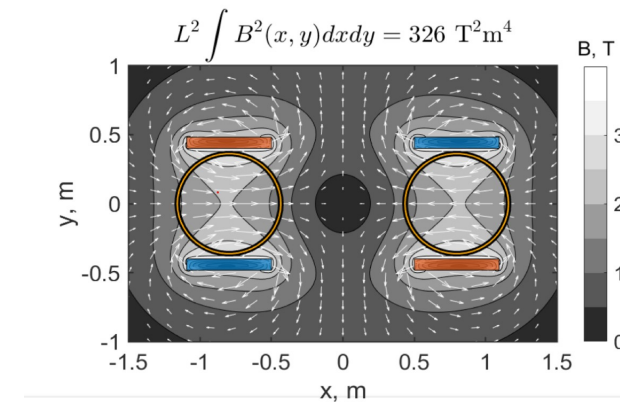




# Magnet



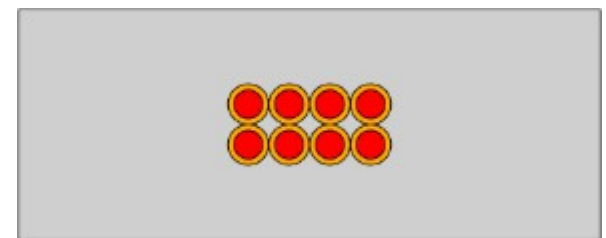
- Design of cryostat finished
- Quotations received for some parts
- 2 T central field
- 70 cm bore diameter
- Late state design, price enquiries for subsystem



# Magnet conductor



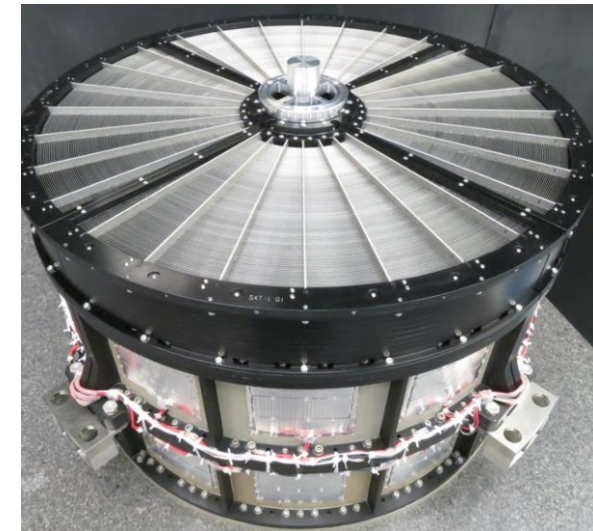
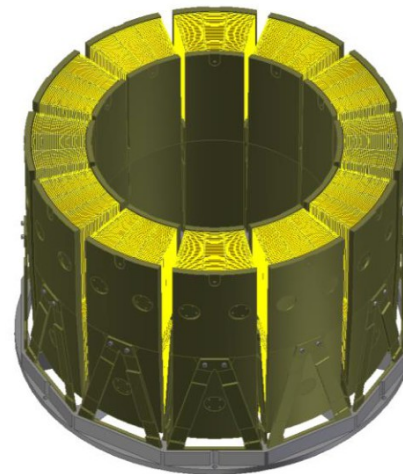
- Tried to use old conductor from INR (too many defects)
- Copper is no option (weight, thermal properties)
- Aluminium stabilized conductor is needed
- Specifications for tendering making good progress



# Optics



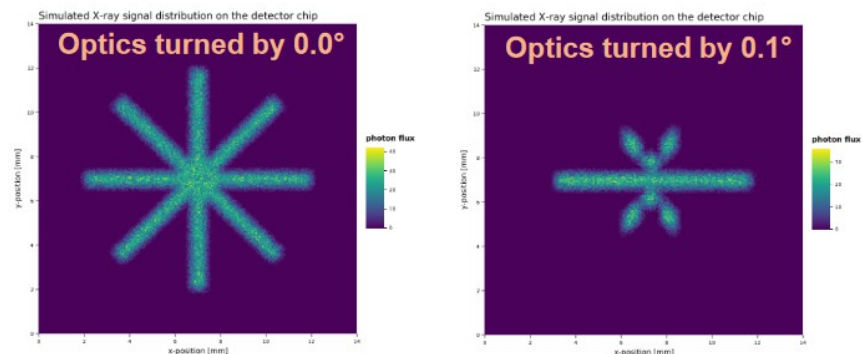
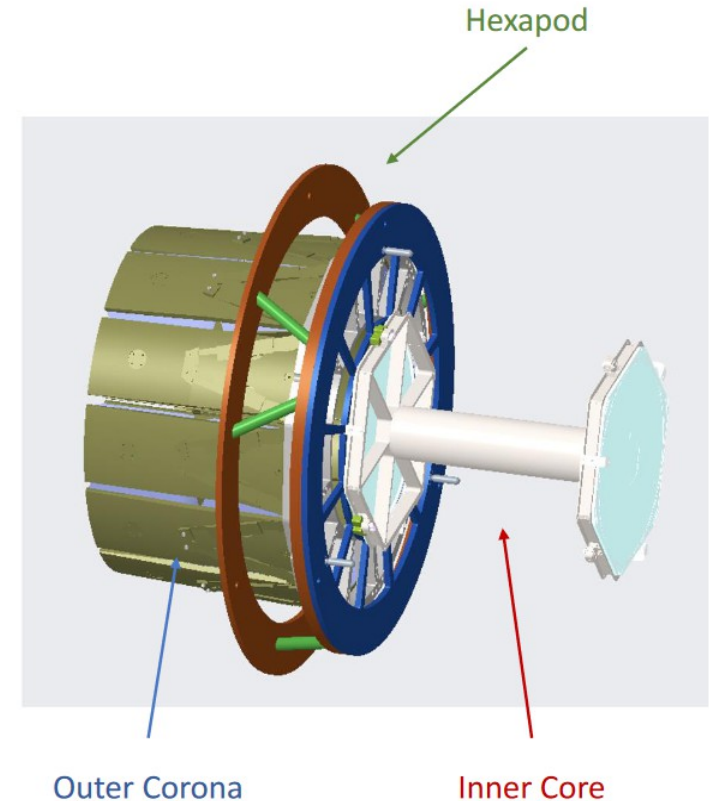
- XMM flight spare from ESA (ready to loan)
- Hybrid optic made from:
  - NuSTAR or XRISM like core with outer CSGO corona optic
  - Different technologies (cold-slumped glass, segmented glass, foil)



# Optics



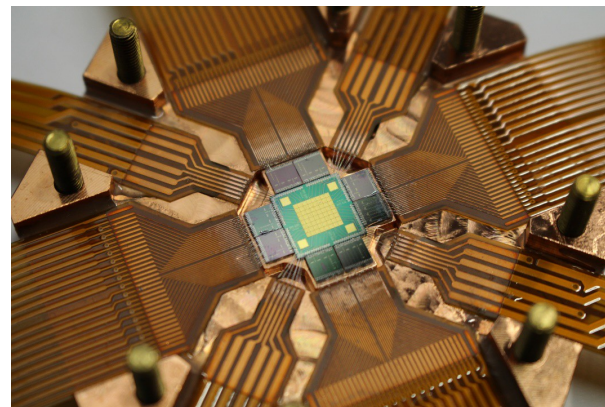
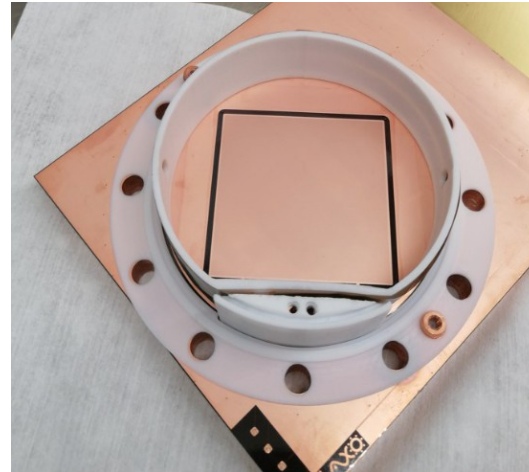
- Mounting of hybrid optics making progress
- Studies on positioning ongoing
- Focal spot optimisation
- Focal length has to be adapted



# Detectors



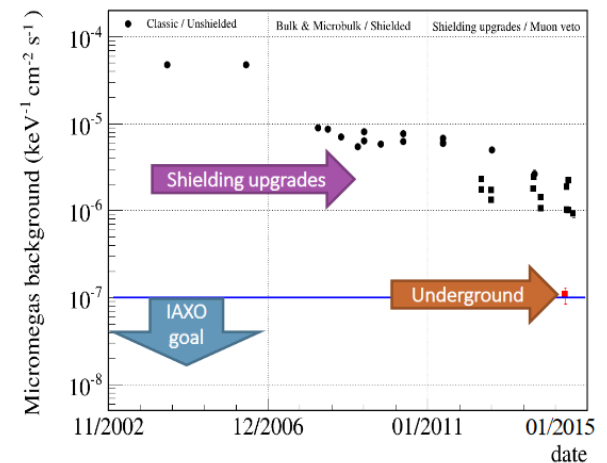
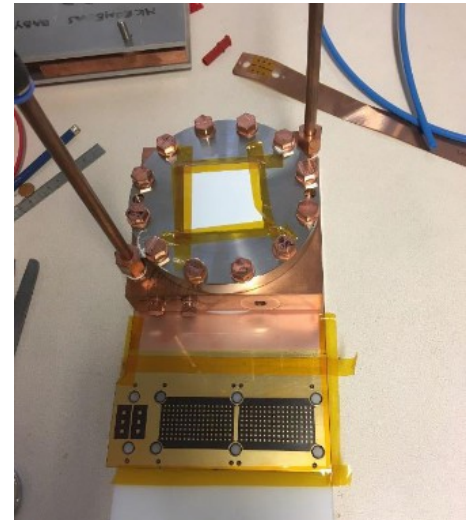
- Two bores will be equipped with detectors
- Baseline: Micromegas
- Variety of other technologies under development (SDD, MMC, TES, GridPix, ...)



# Detectors



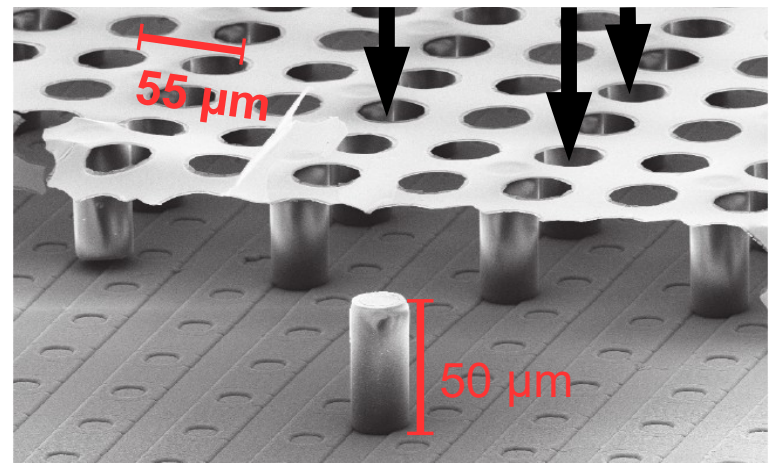
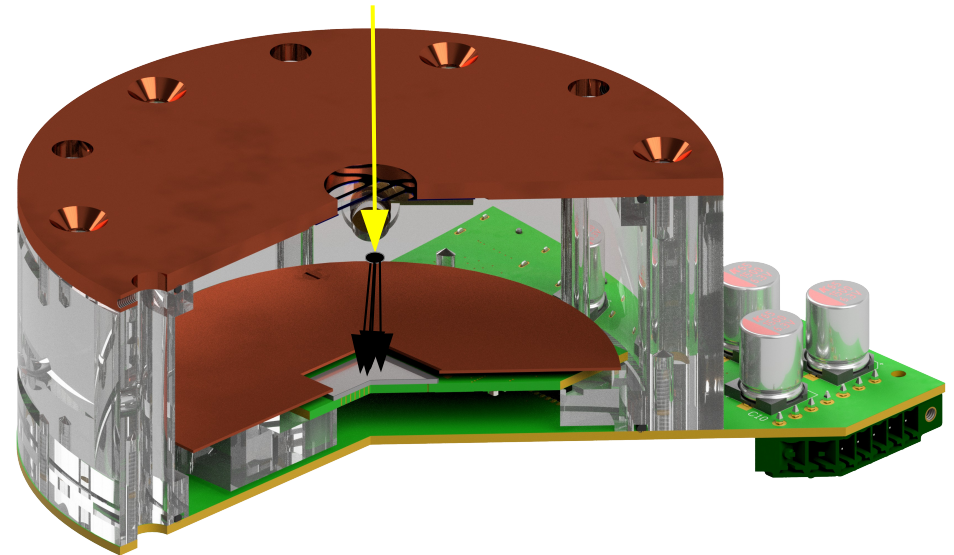
- Micromegas Detector (very much experience from CAST), making very good progress, first characterisations in progress
- Other detector options have specialities:
  - MMC: Fantastic energy resolution
  - SDD: In vacuum mountability
  - GridPix: Very low energy threshold



# GridPix



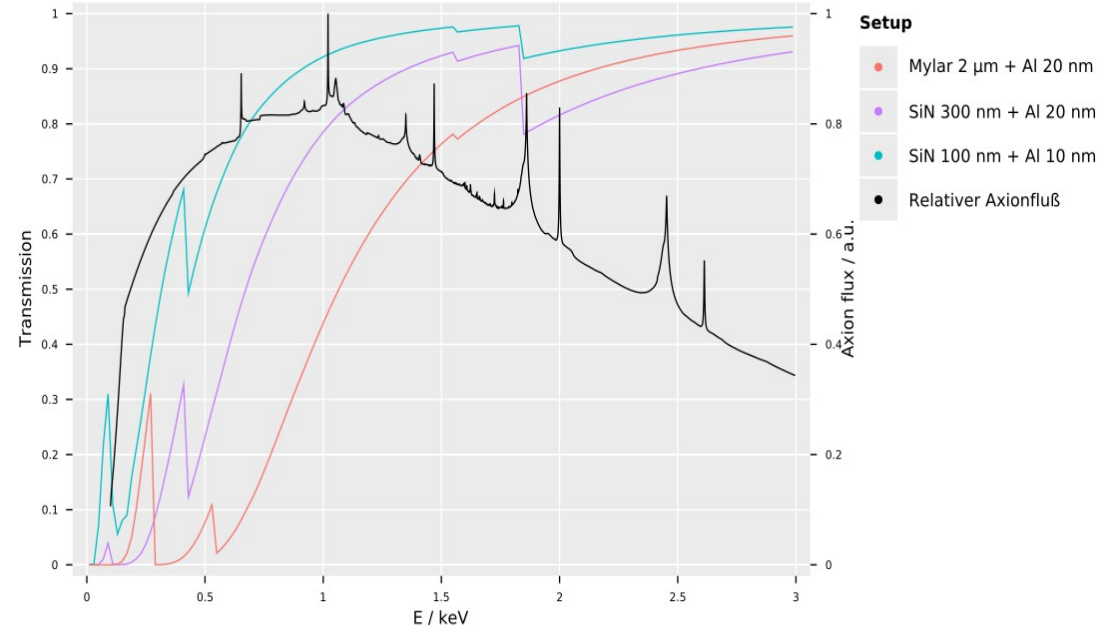
- Highly granular Micromegas like detector
- Based on Timepix3
- Predecessor successfully operated at CAST
- 256 x 256 channels on 2 cm<sup>2</sup>



# Ultra thin windows

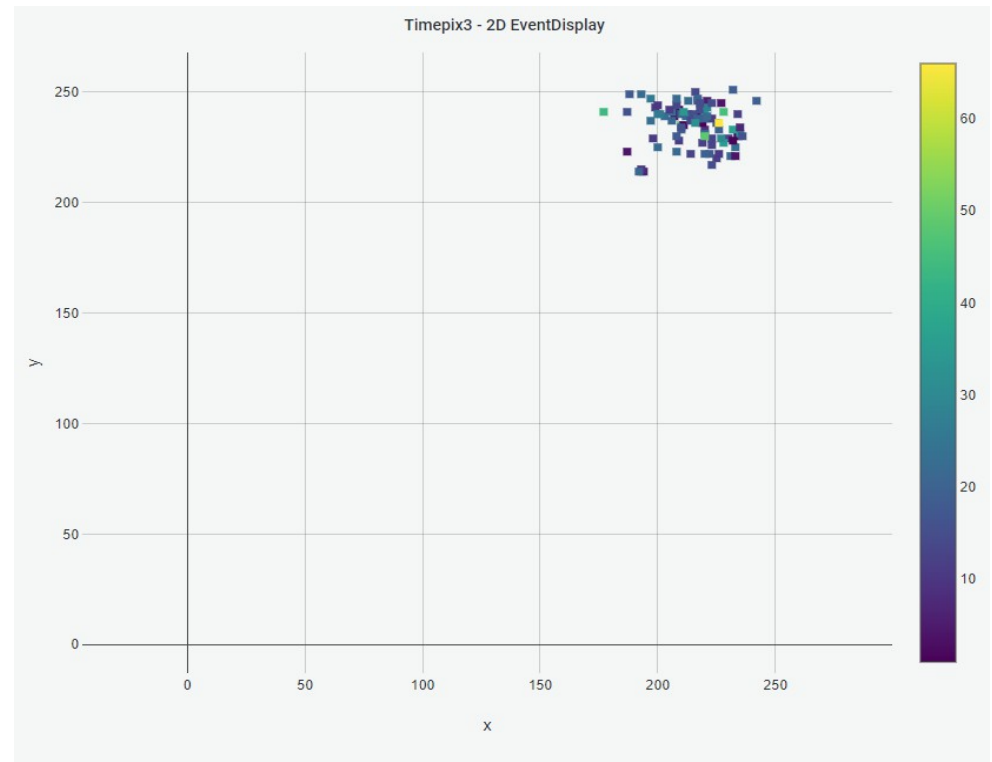
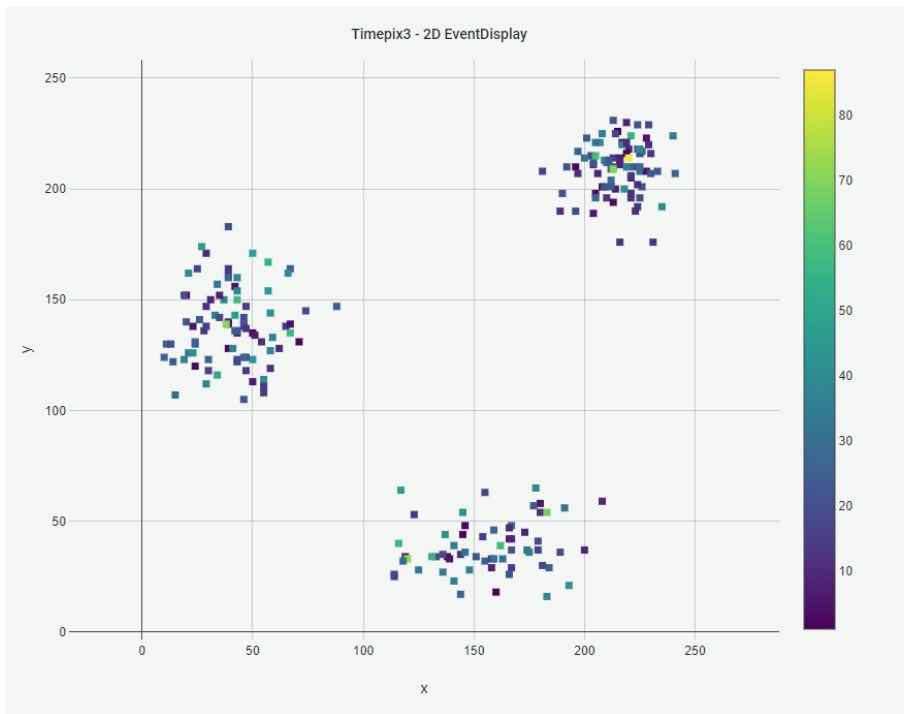


- Low-energy X-rays are easily absorbed
- Thin windows are crucial for most solar Axion flux
- Necessity to withstand pressure difference (1.5 bar)
- Vacuum tightness (smaller  $3 \times 10^{-9}$  mbar l/s)



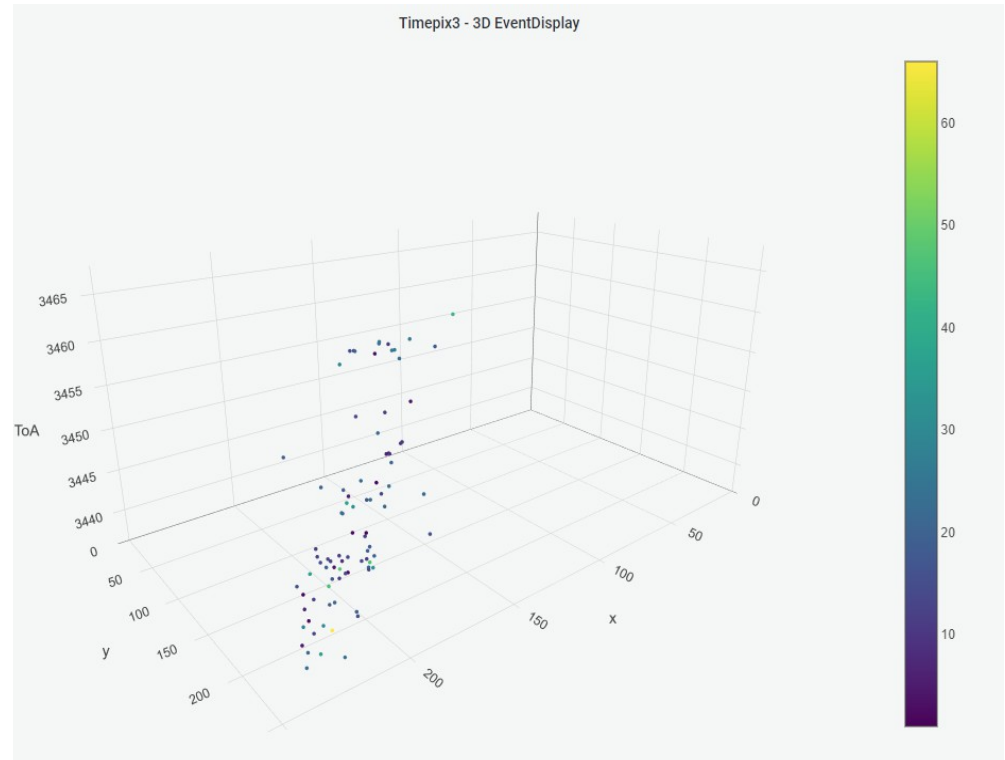
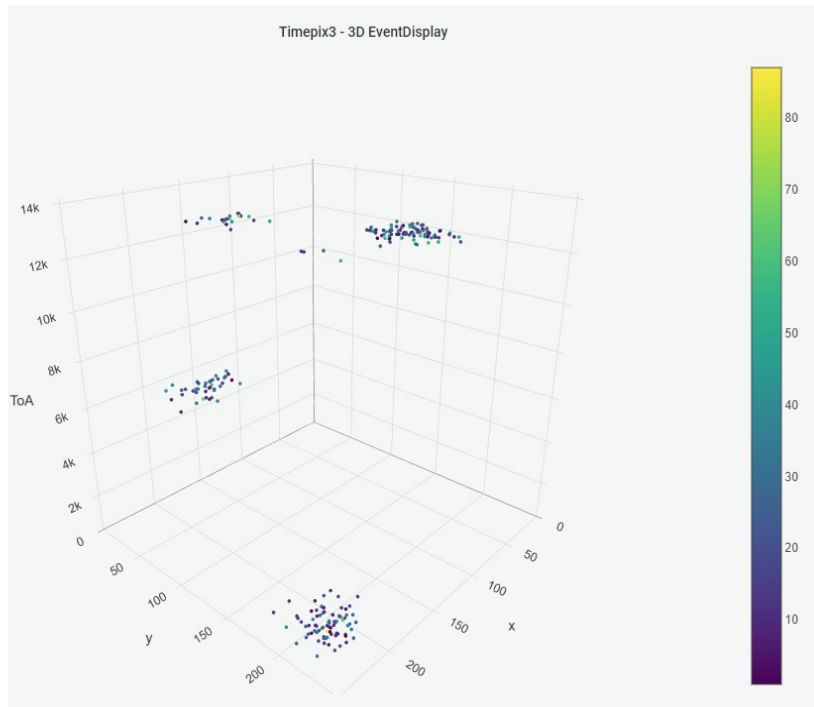


# Events



- High granularity allows separation of events and determine shape variables for BG reduction

# Events



- ToA and ToT information (allows separation of perpendicular Muons from photons and also separation of events)

# Collaboration



# Summary



- Design of BabyIAXO ready
- Magnet delayed due to cable manufacturing
- Optics making good progress
- Many detector technologies under investigation
- Site for BabyIAXO at DESY is progressing good

