



# Low Temperature MMC Detector Arrays for the IAXO experiment

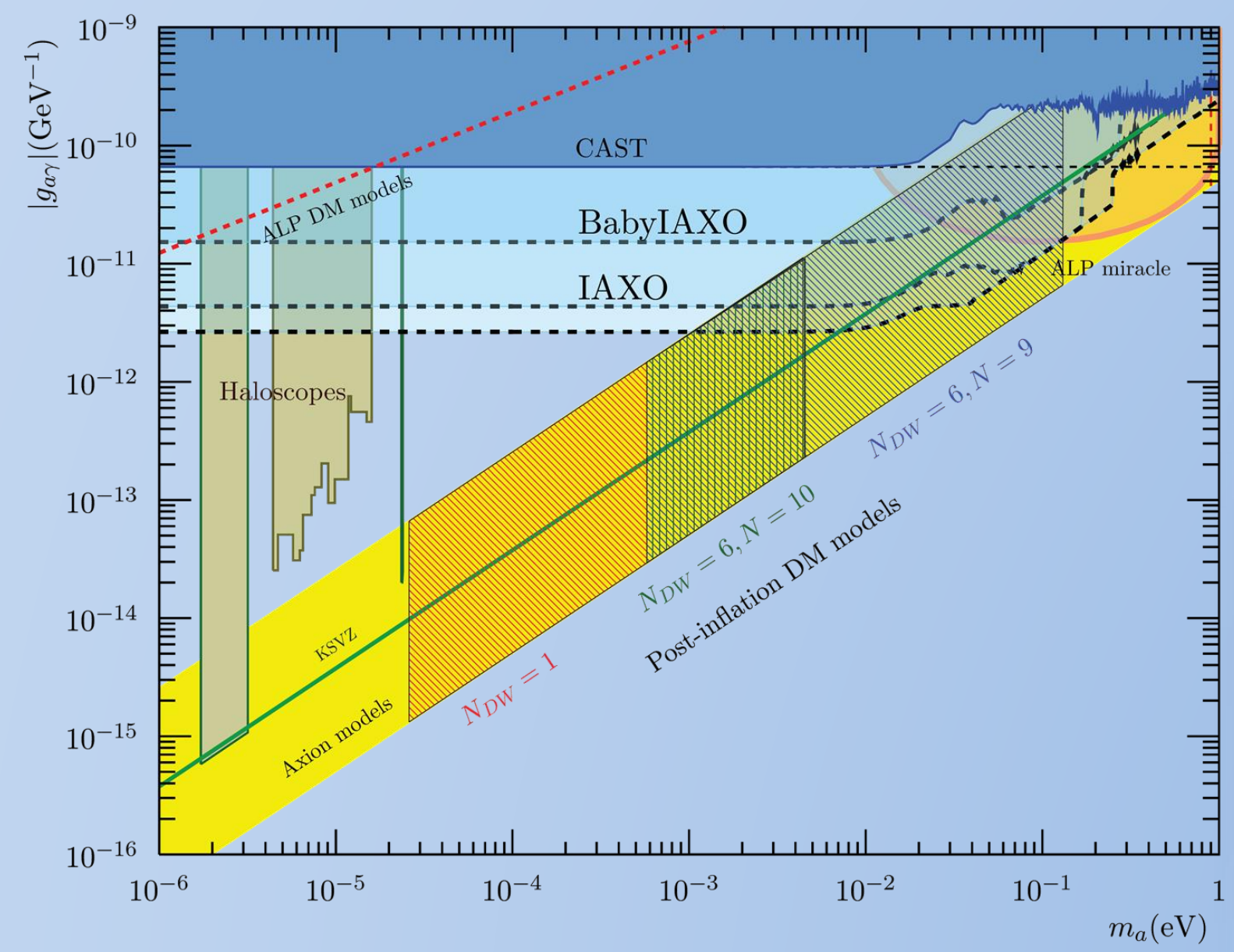
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## Axions search and IAXO

The existence of axions and, more generally, axion-like particles is very well motivated by extensions of the Standard Model

The International Axion Observatory (IAXO) will be a **fourth generation axion helioscope**

- Axions are reconverted into photons in a volume with high **B** field via Primakoff effect

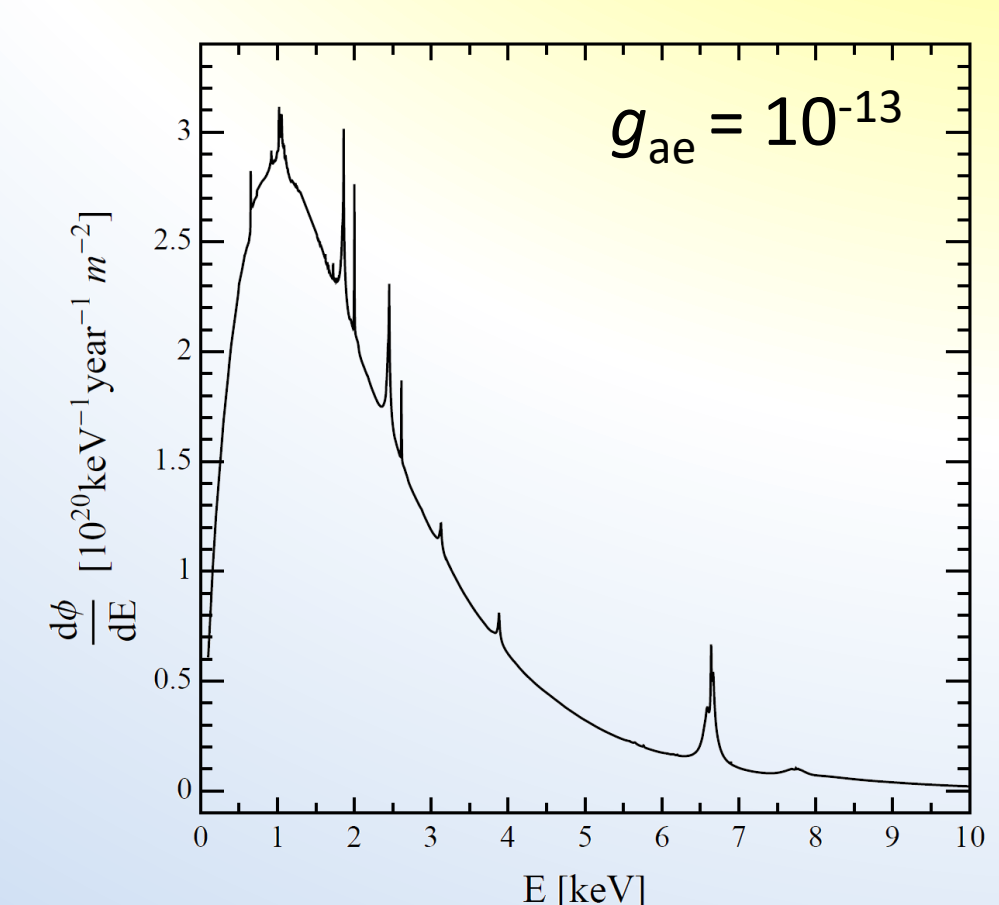
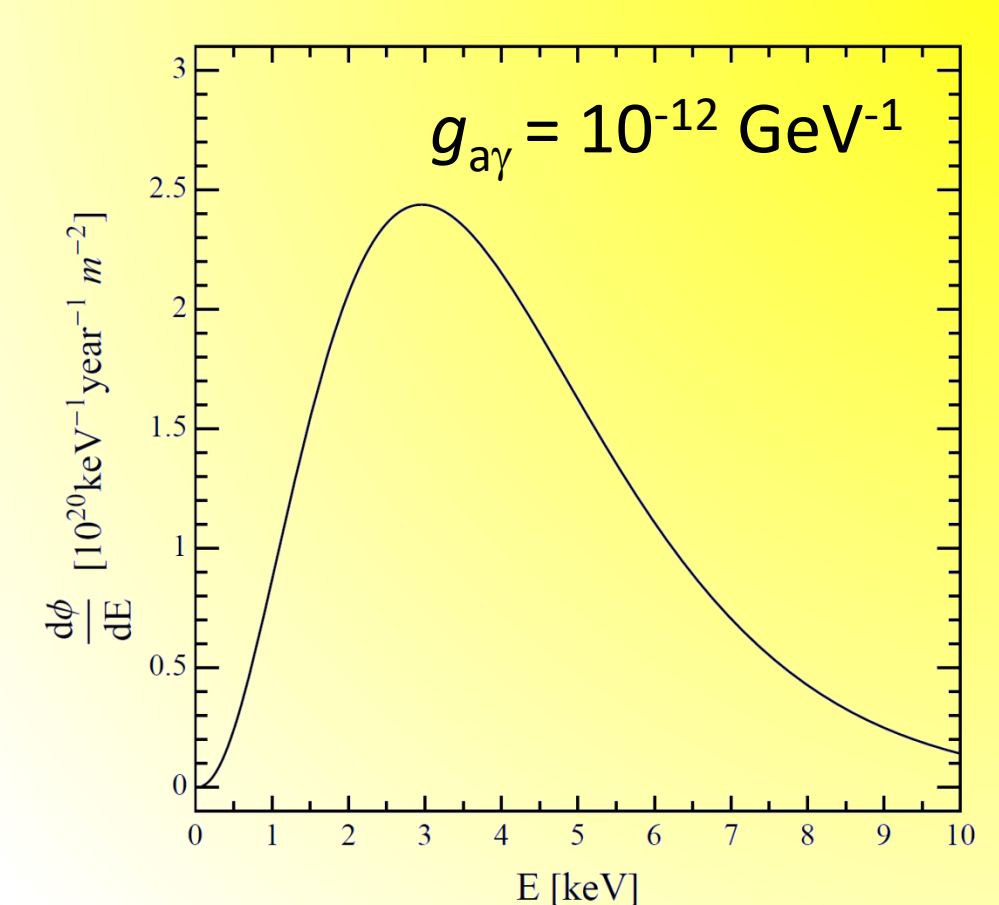


IAXO Physics potential, ArXiv:1904.09155 [hep-ph]

## Solar axions

Axions can be produced in the solar interior by:

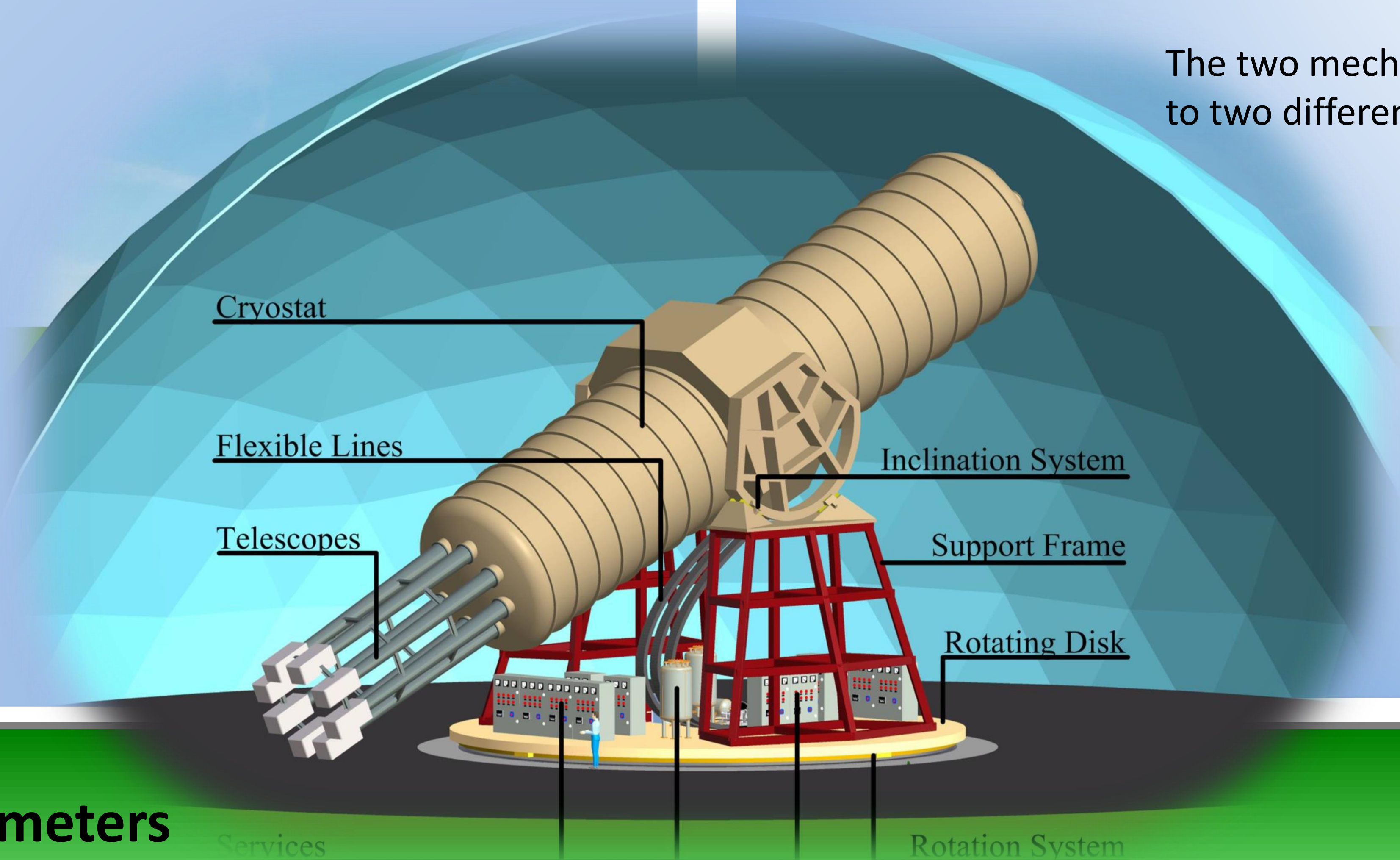
- **Primakoff conversion** of plasma photons into axions
- **Electron-involving processes:** Bremsstrahlung, Compton and axion-recombination



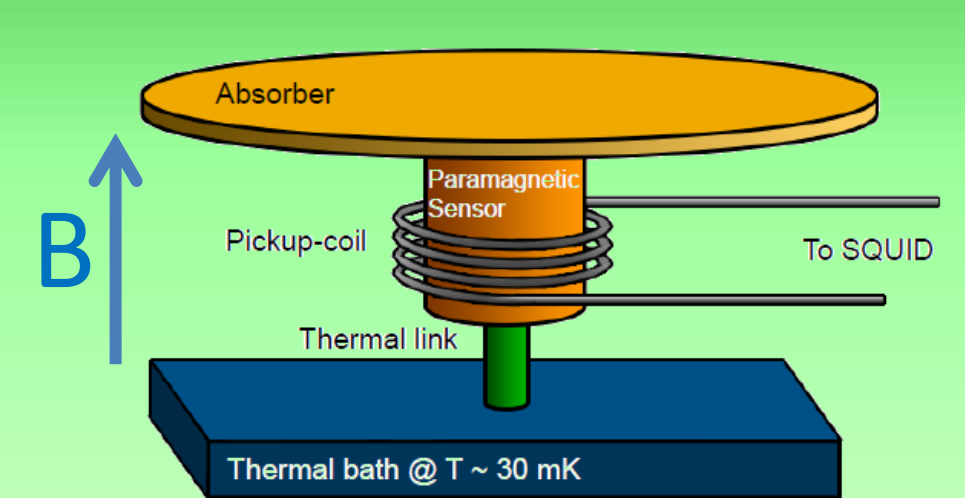
The two mechanisms lead to two different axion fluxes

Detectors with

- **low threshold**
- **high energy resolution**
- **demonstrated low background**
- **large area** → optics focal plane are necessary to resolve production mechanisms



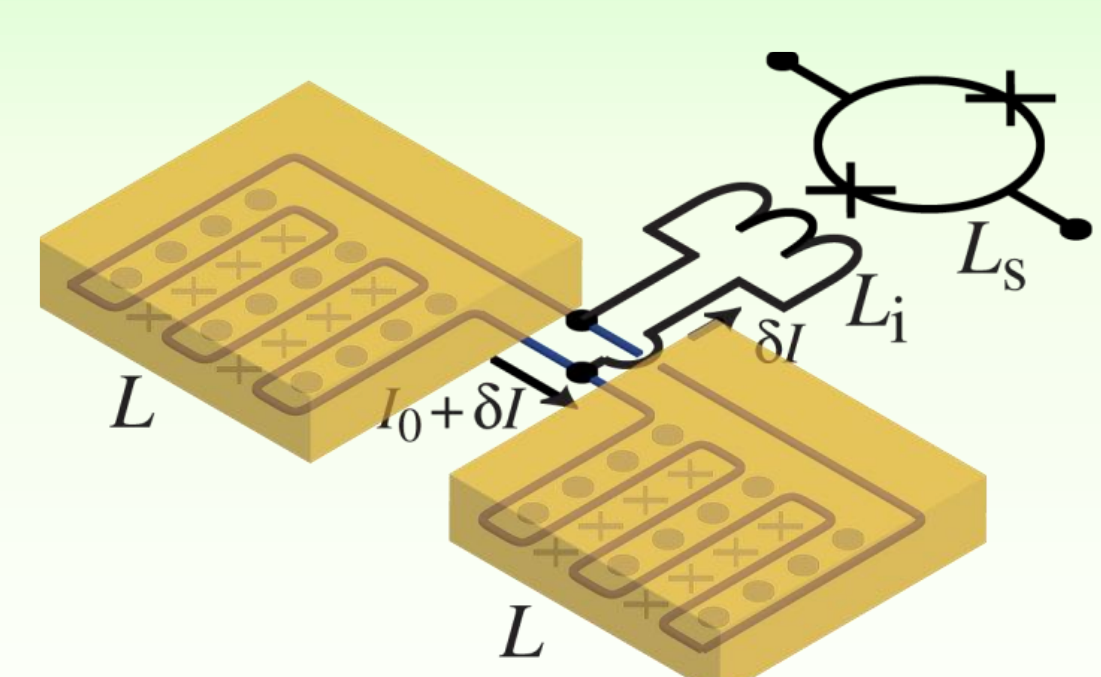
## Metallic Magnetic Calorimeters



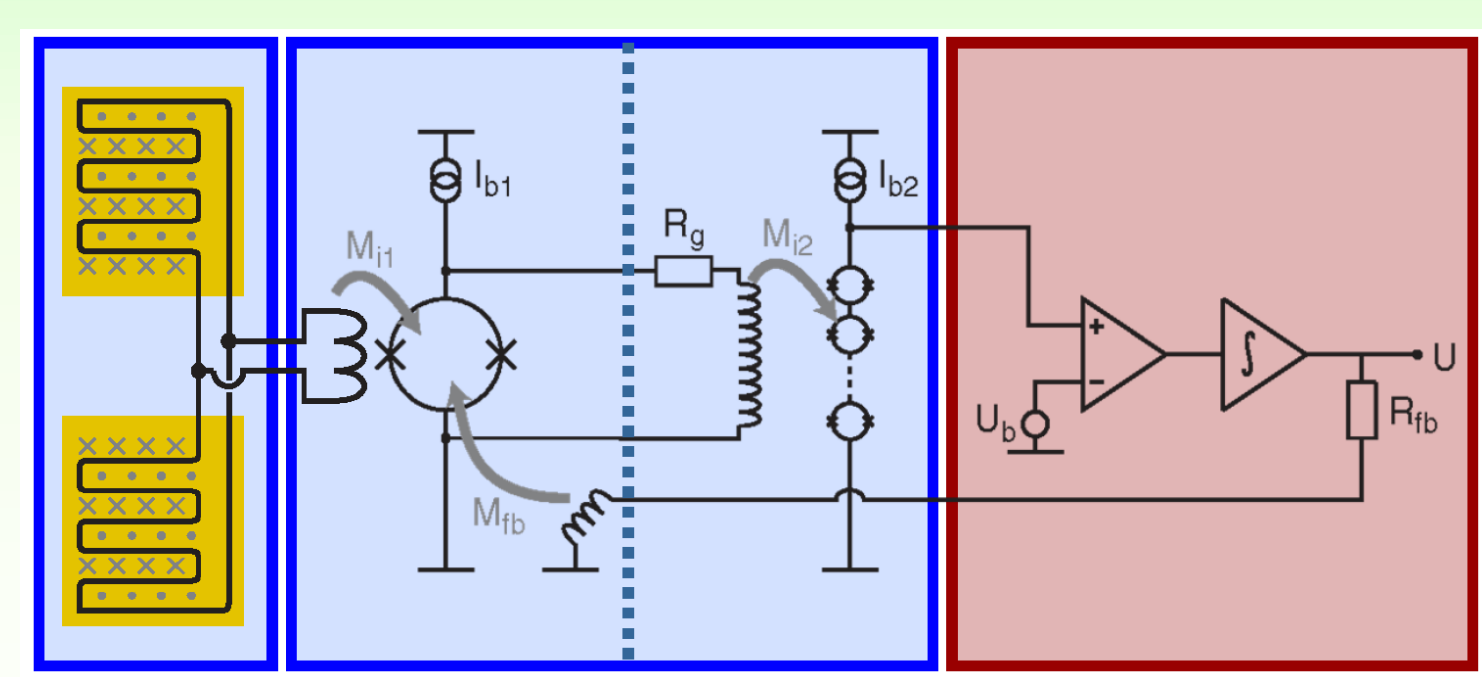
**Paramagnetic temperature sensor:** Au:Er  
Ag:Er

$$\Delta\Phi_s \propto \frac{\partial M}{\partial T} \Delta T \rightarrow \Delta\Phi_s \propto \frac{\partial M}{\partial T} \frac{E}{C_{\text{sens}} + C_{\text{abs}}}$$

Planar sensor geometry



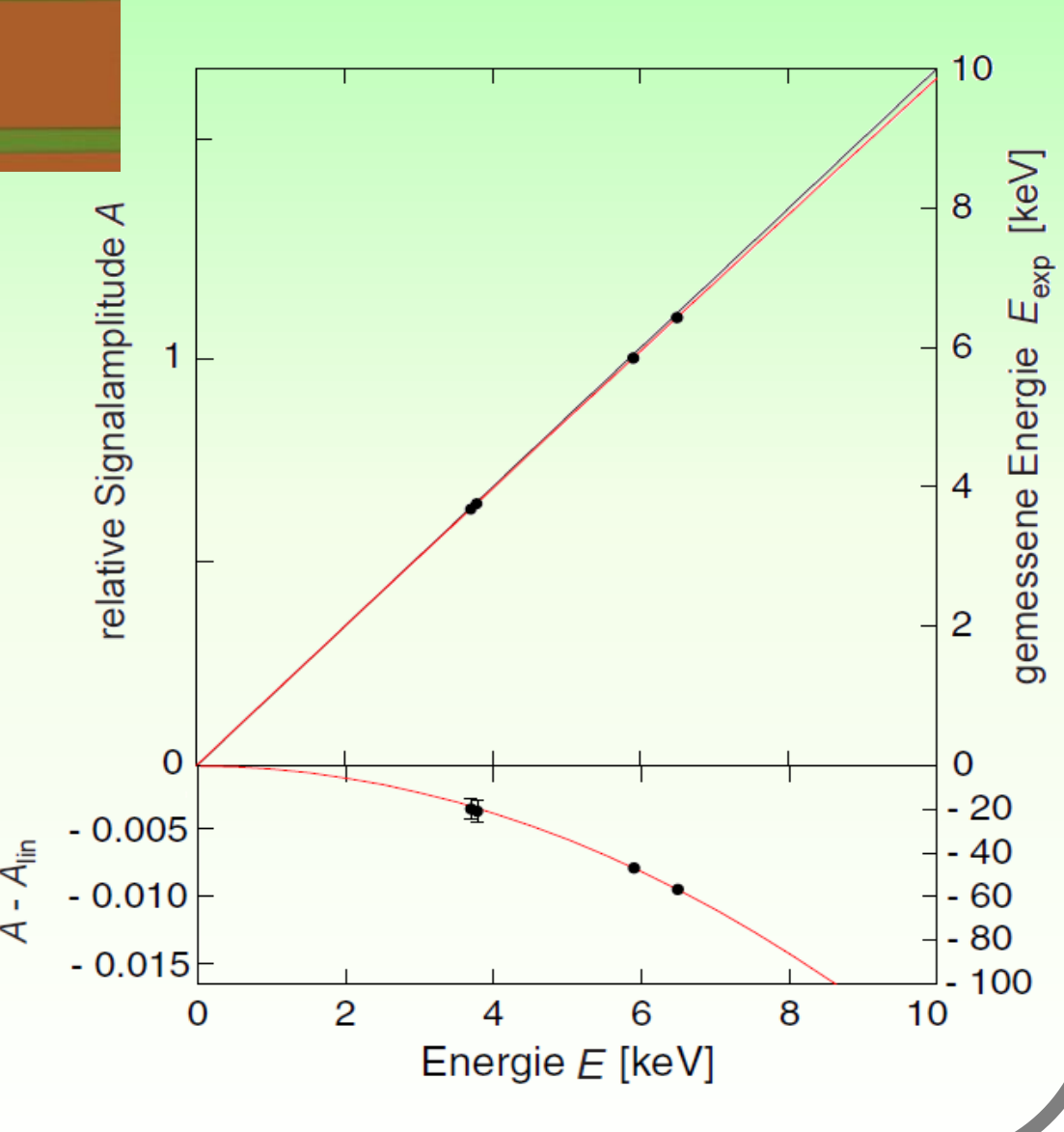
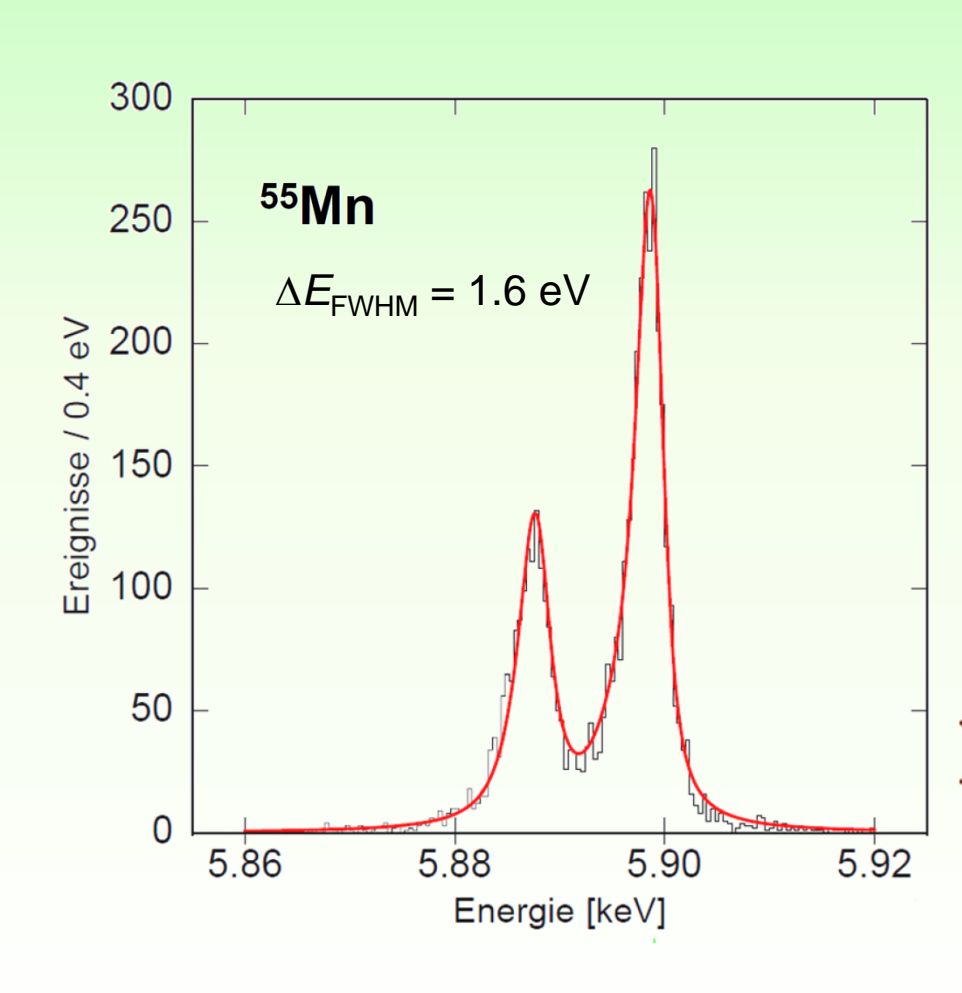
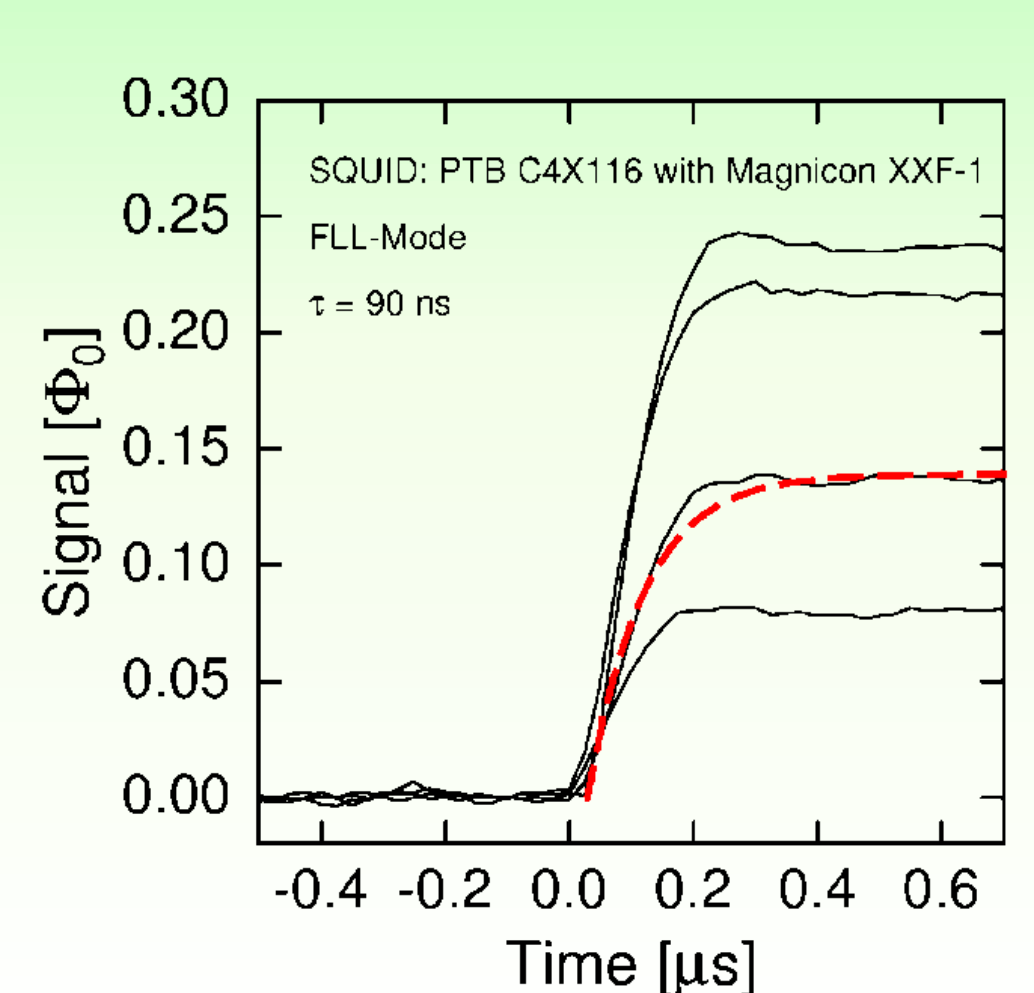
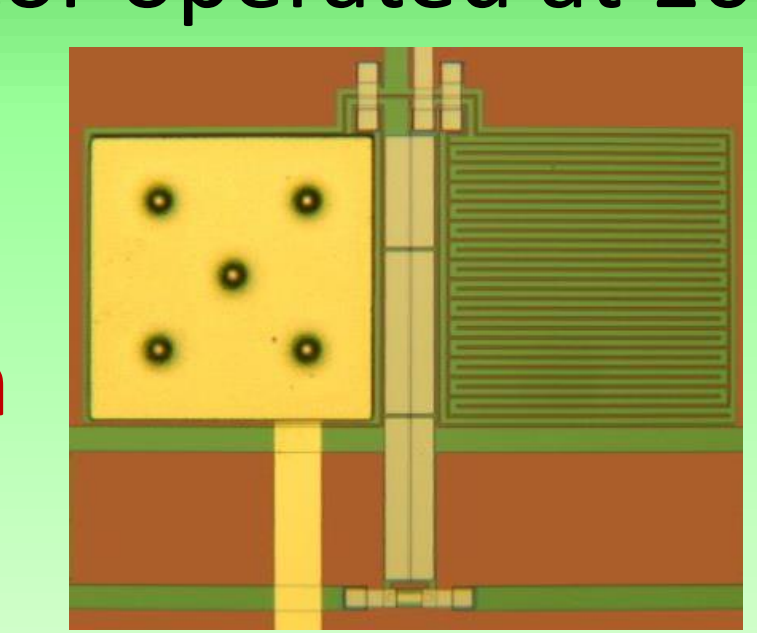
2-stage SQUID read-out



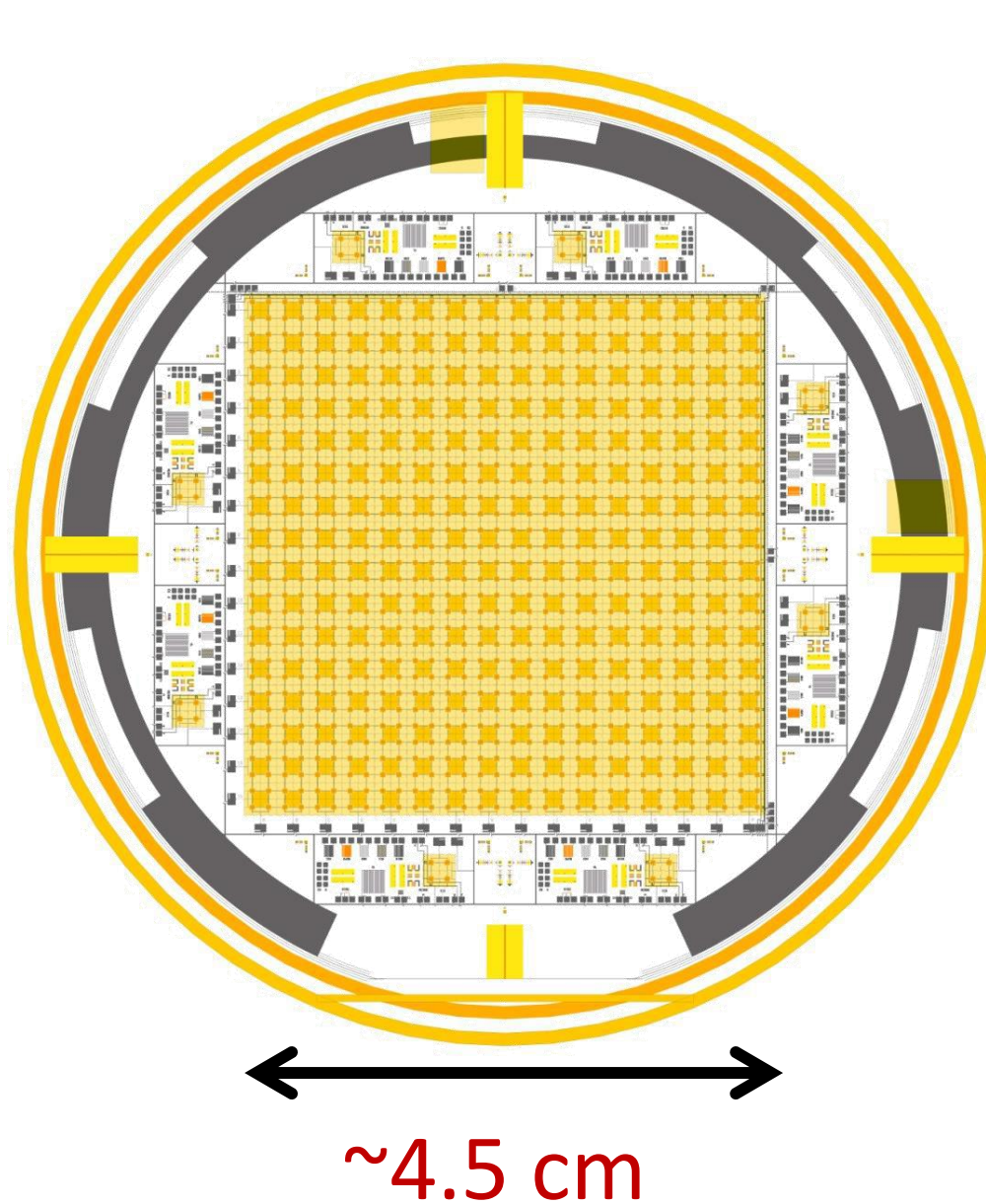
## MMC performance

Fully micro-structured detector operated at 10-30 mK

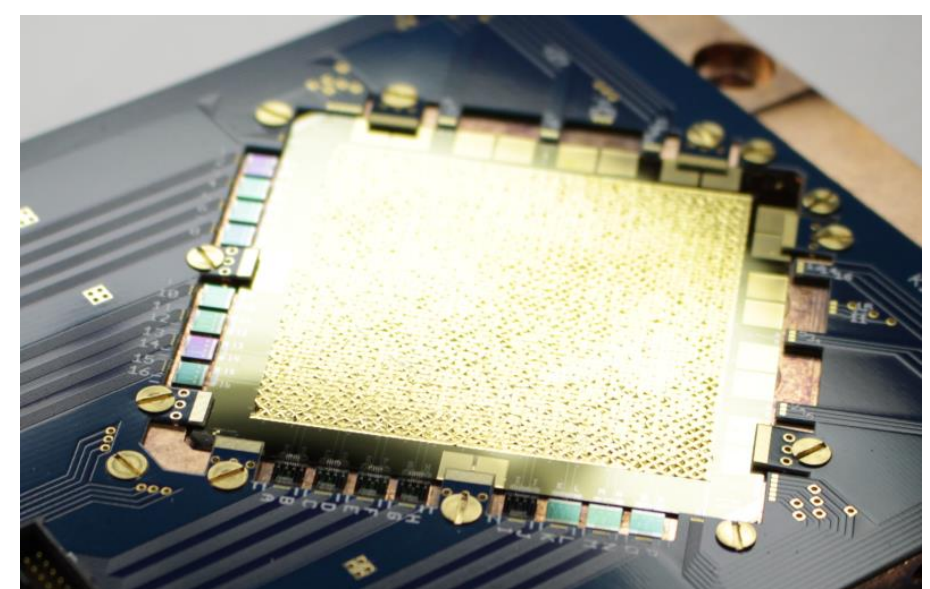
- ✓ **Fast response time**
- ✓ **Large dynamic range**
- ✓ **Reliable energy calibration**
- ✓ **High energy resolution**



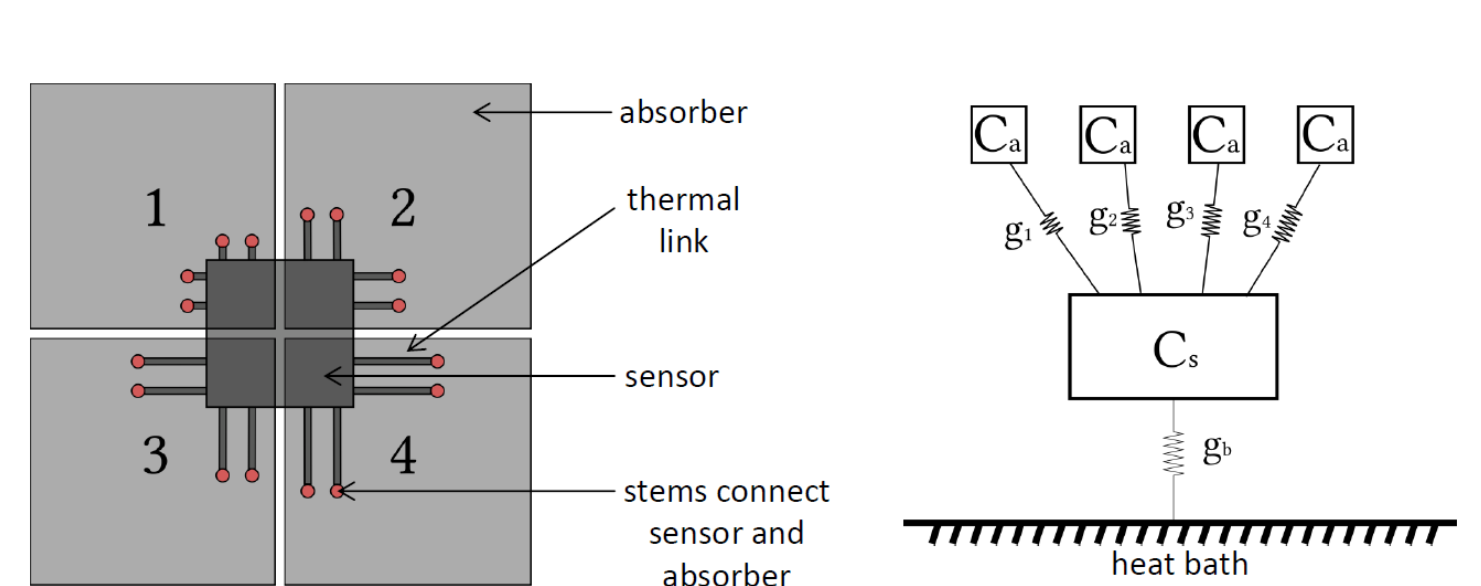
## MOCCA design



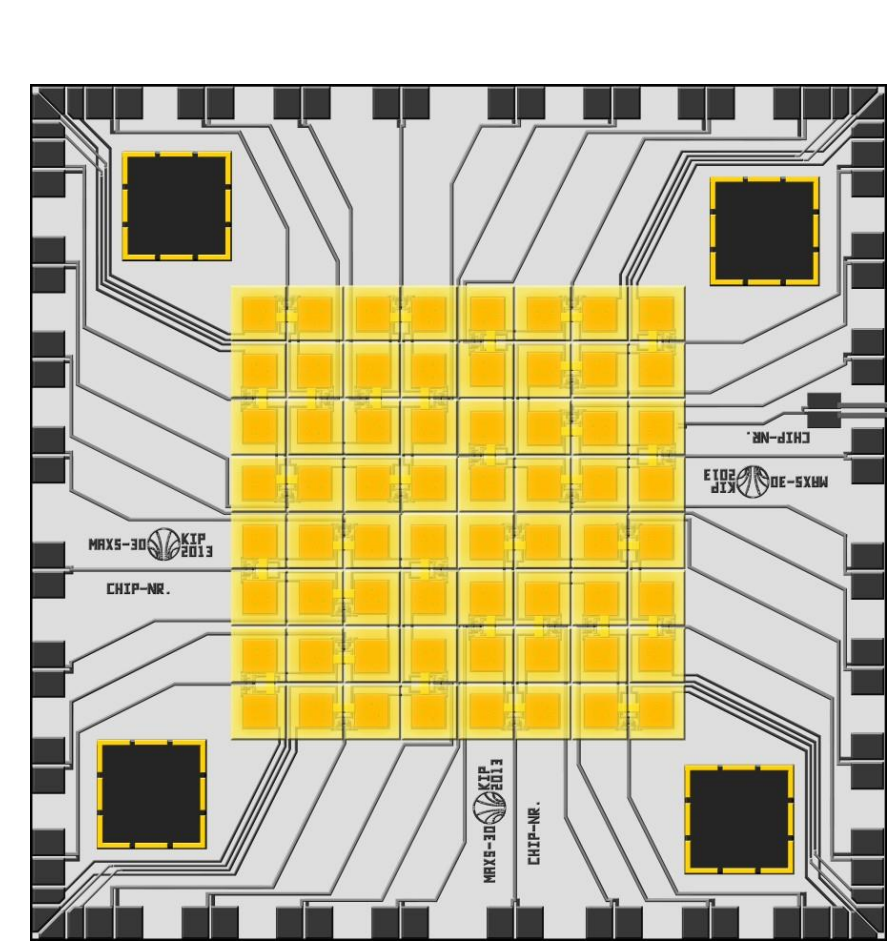
- 64 × 64 pixels
- 200 eV (FWHM)
- 32 × 32 temperature sensors
- Read out by 16 + 16 SQUIDs
- First tests



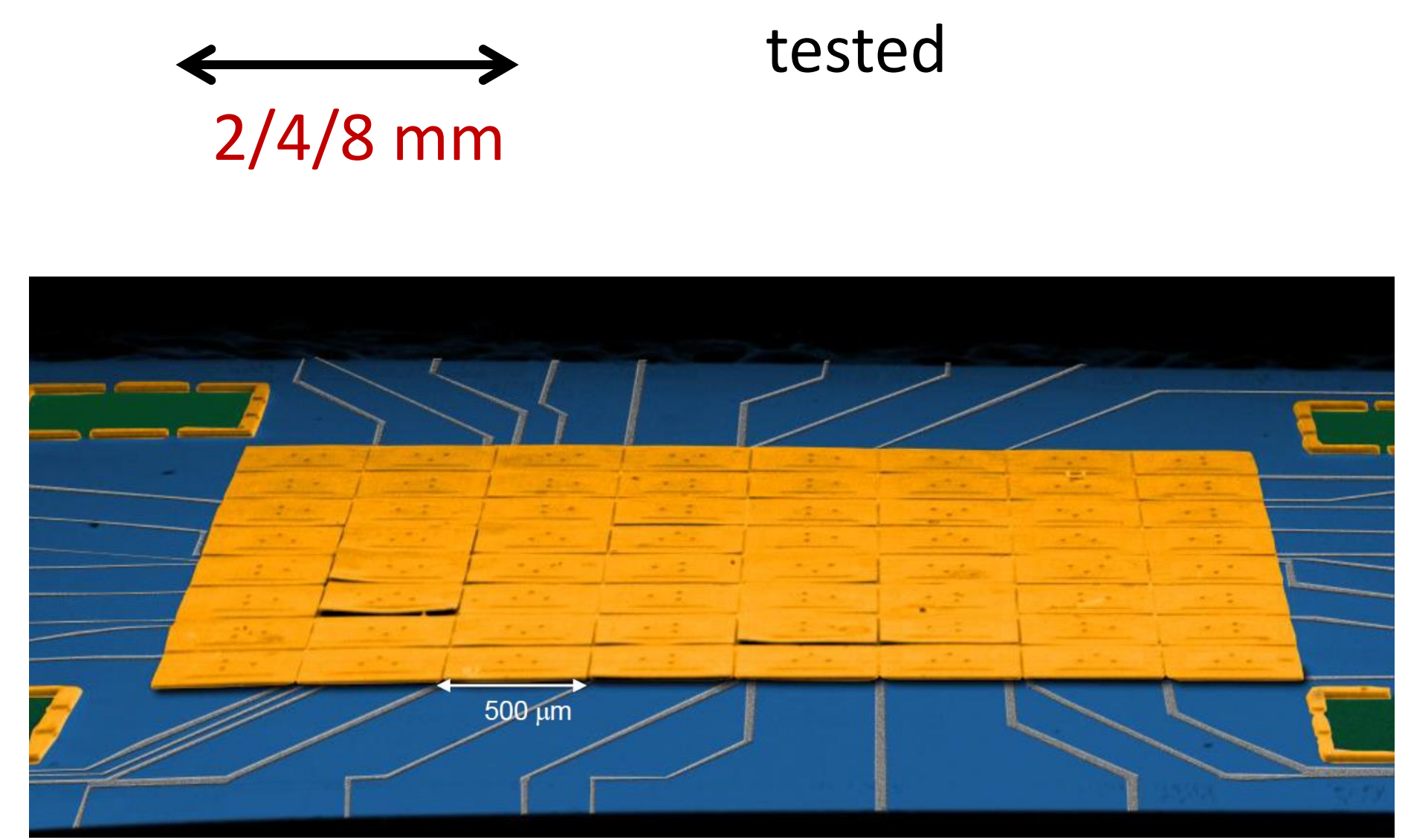
Matrix read-out + hydra concept



## maXs design

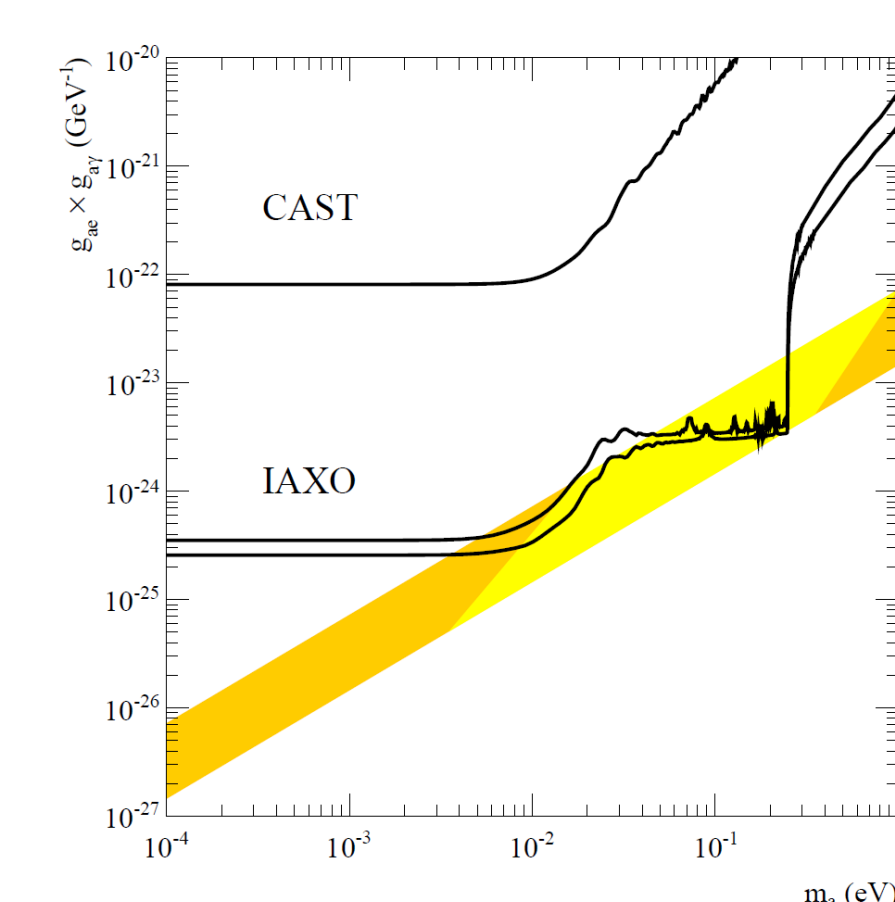


- maXs-20/30/200:**
  - 8×8 pixels for photons up to 20/30/200 keV
  - with  $\Delta E_{FWHM} = 2/5/30$  eV
  - 32 two-stage dc-SQUIDs
- maXs-30 fabricated and tested



## Summary and outlook

- **IAXO needs high energy resolution and low background detectors**
- ✓ MMC are **suitable** for axion searches
- ✓ 2D MMC arrays have been successfully produced and tested
- Characterization of MMC intrinsic background
- Study and design of a cryogenic platform compatible with IAXO



\*improve  $g_{ae}$  sensitivity

