BRAVOSUN: BabyIAXO Research on Axions via Observation of the Sun

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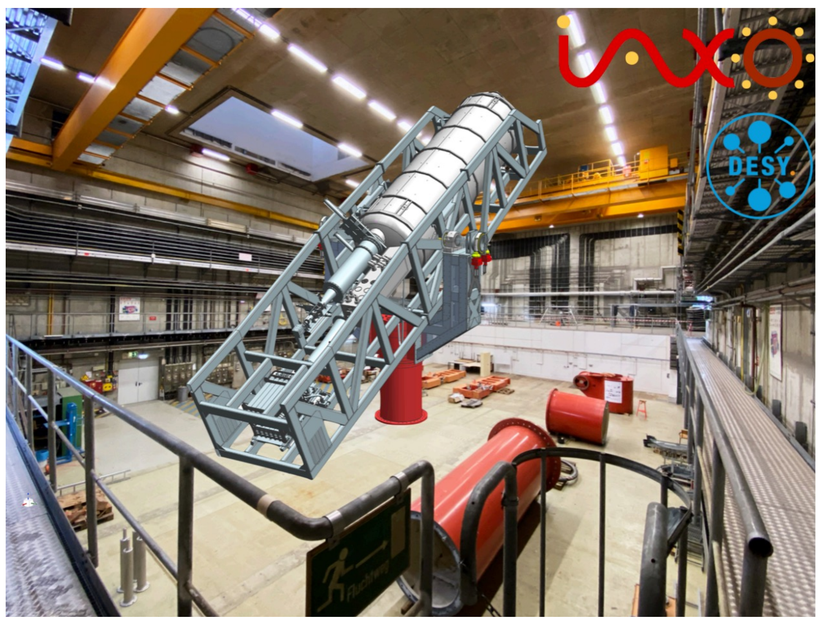
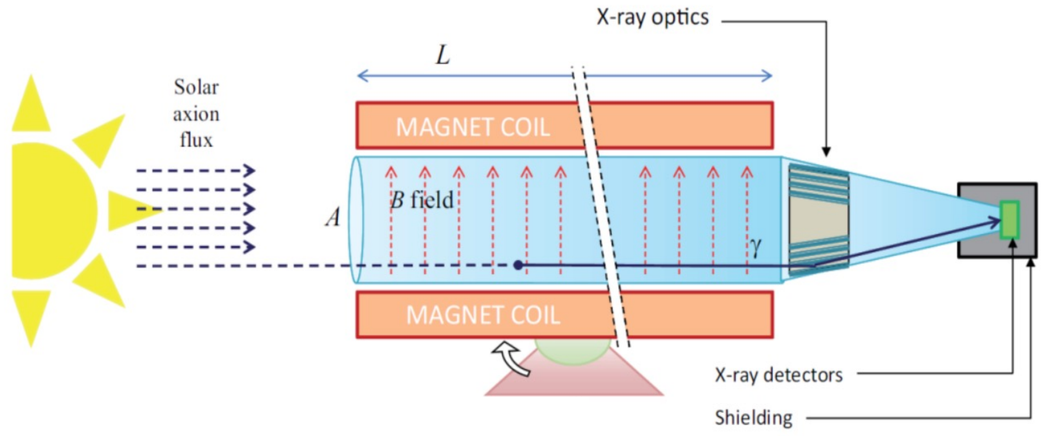
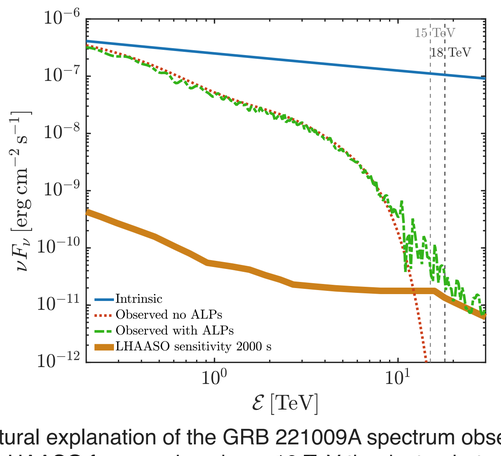




Axions, predicted decades ago, could account for anomalies associated with particular stellar evolutionary phases, gamma-ray propagation and for a valuable fraction of dark matter. BabyIAXO collaboration is aimed to build an helioscope able to detect axions, potentially produced in the solar core, through the conversion into X-rays in a strong magnetic field. INAF participation is based on the solid expertise in several technological and scientific areas, e.g. X-ray optics, calibration of X-ray detectors and astrophysical modeling. This grant aims to boost INAF involvement providing technological facilities advancement, modeling consolidation and a first prototype of the BabyIAXO optics. It will ensure INAF participation in the quest for the axion, the next messenger in Astronomy.

AXION SCIENCE

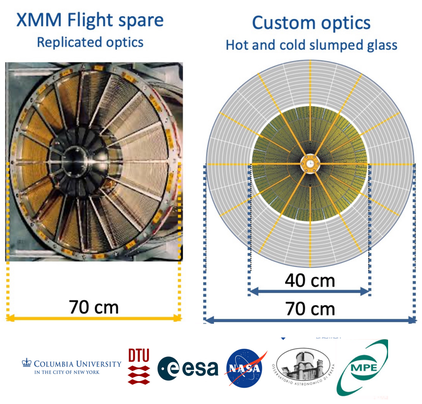
Immediate goal: the use of astronomical sources as natural laboratories to constrain axion and axion-like-particles physics. Future perspective: the use of axions/ALPs as new astronomical messengers.
Science Cases:
The Sun: possible detection with axion helioscopes (CAST, IAXO)
Globular cluster stars: RGB and HB stars: stringent bounds on couplings with electrons and photons
Compact remnants of stellar evolution: WDs and NSs: axion-electron coupling, bounds from cooling (WDs) or conversion in stellar *B* field (NSs, magnetars…)
Supernova progenitors: late evolution of massive stars, possible detection with X-ray telescope (by axion-photon conversion in the galactic *B* field)
Core collapse Supernovae: axions, like neutrinos, imply trapping and forward transport of explosion energy, effects on SN outcomes
Blazars: photon-axion conversion, anomalies in X-ray spectra
Axions as Dark Matter: possible detection with haloscopes (e.g., resonant cavities, ADMX like)
GRBs: photon-axion-photon conversion, unexpected g-ray excess

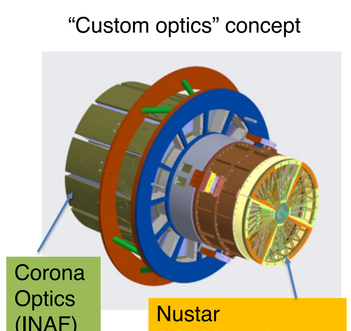


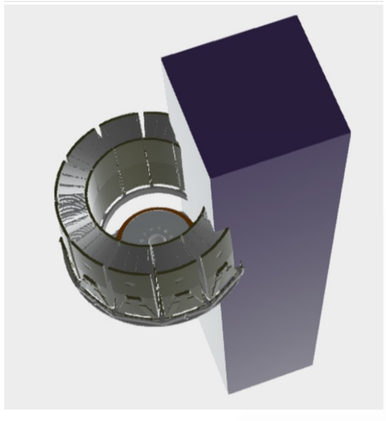
Natural explanation of the GRB 221009A spectrum observed by LHAASO for energies above 10 TeV thanks to photon-ALP interaction, while a conventional physics justification is extremely problematic (Galanti 2023). IAXO has the capability to study the ALP parameter space suggested by GRB 221009A, which represents the strongest hint at ALP existence to date.

X-RAYS OPTICS

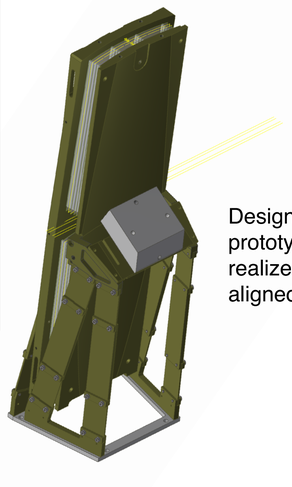
INAF-OABrera expertise in x-ray optics to boost the **Cold Slumping Glass Optics Technology from TRL2 to TRL5**. The CSGO is a cost-effective process, developed at OABrera and **patented in 2015 (TO2015A000219)**, aimed at fast and cheap production of X-ray Optical Units (XOU).







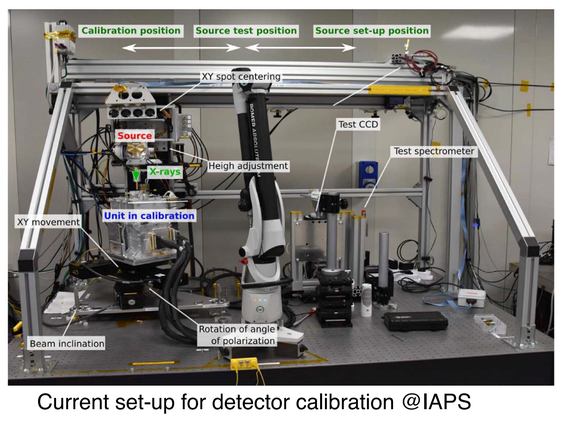
“Corona Optics” alignment on UV bench @OABrera



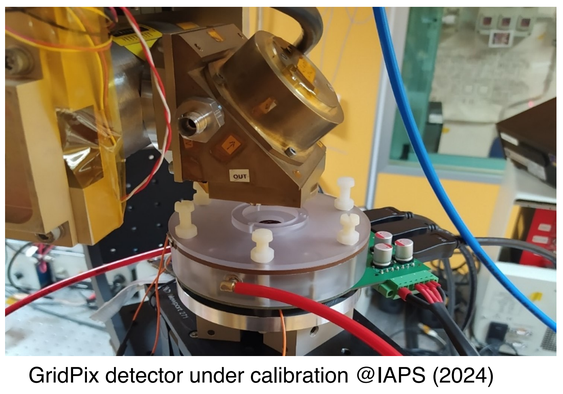
Design for the prototypes to be realized and aligned.

DETECTORS CALIBRATIONS

Another important INAF contribution is through the **detector calibration facility at IAPS**. The flux of Primakov events in the 1.5-10 keV energy range is well matched with the present configuration of the IXPE calibration equipment. Such facility will permit **calibration of the GridPIX detector** (an evolution of the Micromegas technology, where a fine mesh (grid) as an amplification stage is produced via photolithographic post processing on top of a pixelated readout ASIC).



Current set-up for detector calibration @IAPS



GridPix detector under calibration @IAPS (2024)