2° Forum della Ricerca Sperimentale e Tecnologica

Development of a facility for high accuracy and precision characterization of collimator Micro-Pore Optics

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INTRODUCTION

The Large Area Detector (LAD) is an instrument concept proposed for the eXTP and STROBE-X space astronomy missions, operating in the 2-30 keV range with an active area exceeding 3 m^2 at 8 keV, thanks to an array of 640 large-area linear Silicon Drift Detectors (see poster by E. Del Monte). Each detector is paired with a lightweight collimator plate, based on lead-glass Micro-Pore Optics (MPO) technology, to restrict its field of view. To allow an extensive study and characterization of collimator performance parameters, a dedicated X-ray measurement facility was developed and constructed at INAF/IAPS. This facility is specifically designed to be versatile and support various measurements on large batches of collimators.

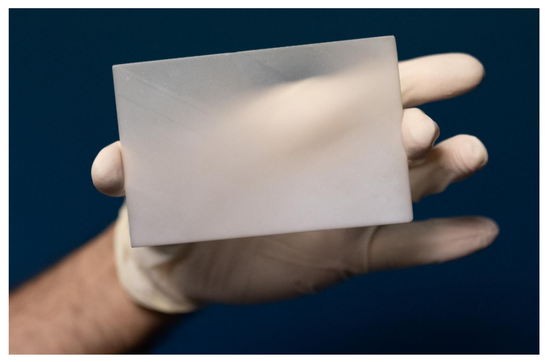


Fig.1 Micro-pore collimator plate

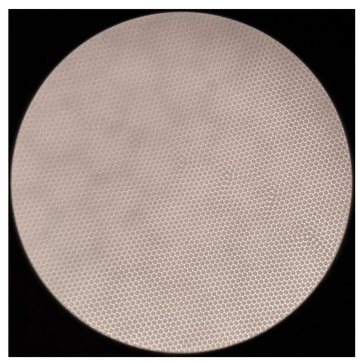


Fig.2 Micro-pore detail

SETUP OVERVIEW

The setup uses two diaphragms to produce the collimated X-ray beam, and employs five positioning stages to control all the degrees of freedom of the collimator excluding translation along the beam direction.

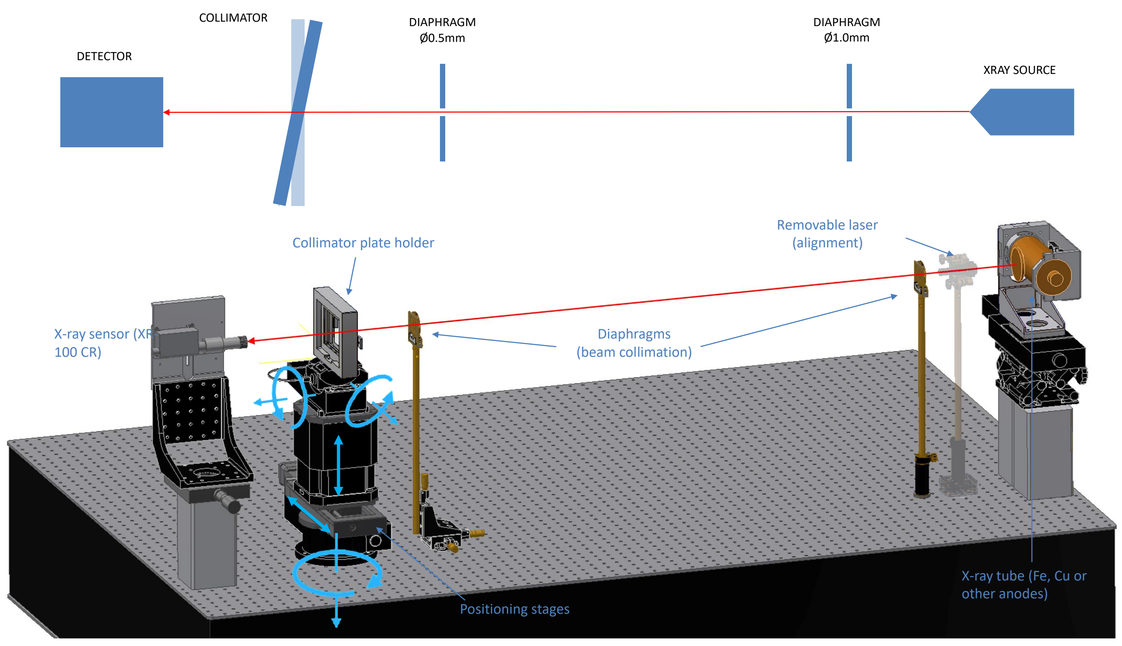


Fig.3 Measurement setup concept and detailed schematic

FEATURES

Beam characteristics:

- Angular accuracy: ≤ 1 arcmin
- Beam divergence: 1.6 arcmin
- Spot on MPO: 0.56 mm (≈ 44 pores)
- Detector-MPO distance: 10-100 mm, adjustable

Test facility control and automation:

- Beam flux calibration and subsequent measurements are fully automated and can be executed in batches without constant supervision
- Collimator movements follow pre-determined sequences to avoid collisions

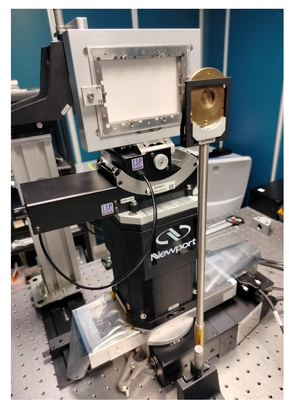


Fig.4 MPO positioning

Fig.5 X-ray generation

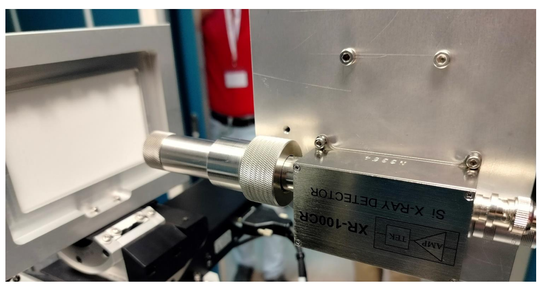
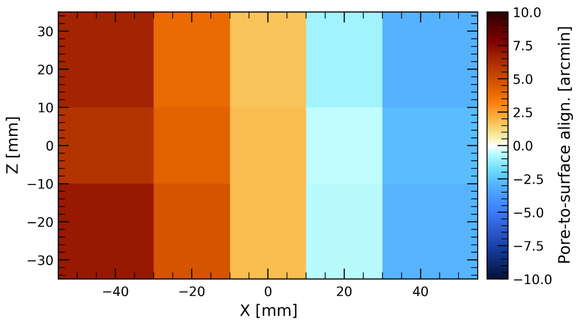


Fig.6 X-ray detection

RESULTS

An analytical model of the MPO response was developed to simulate and fit the experimental data, thus estimating its microscopic and macroscopic properties. Examples of possible measurements and their analysis are:

- Angular response with respect to an arbitrary direction (rocking curve), at multiple locations across the collimator surface
- MPO peak transmission, measured with respect to X-ray source flux at the chosen location on the collimator
- Angle of peak transmission with respect to the collimator mounting interface (pore-to-surface alignment)



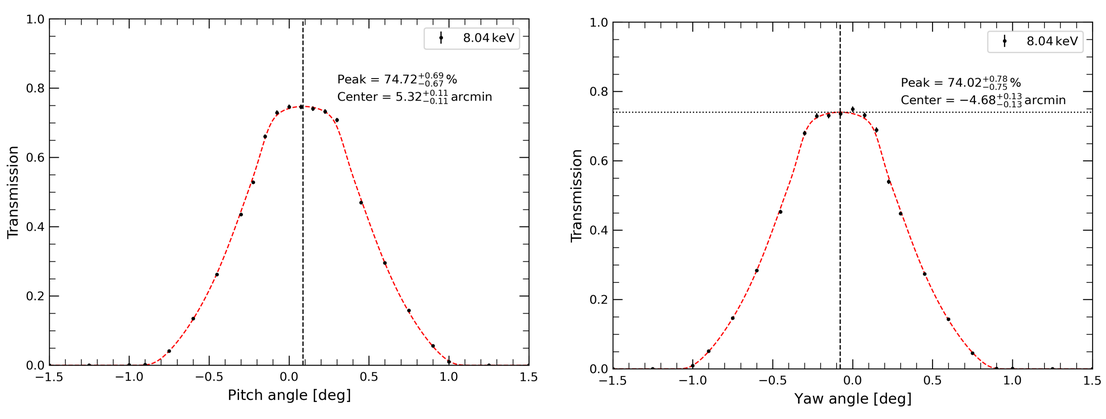


Fig.7 Rocking curves about two orthogonal directions, peak highlighted

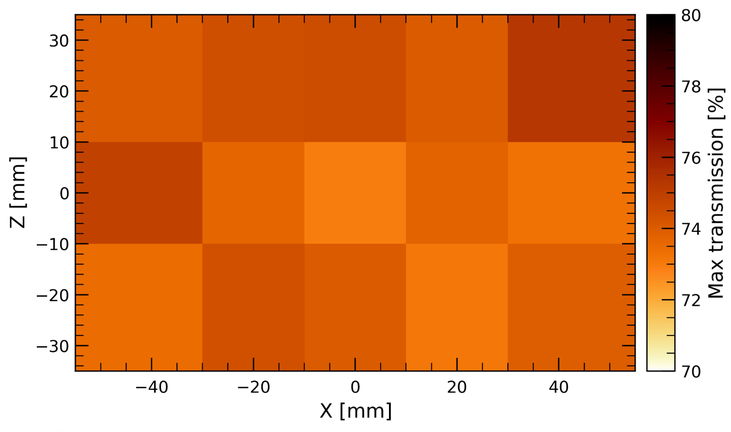


Fig.8 MPO peak transmission at multiple locations across the collimator

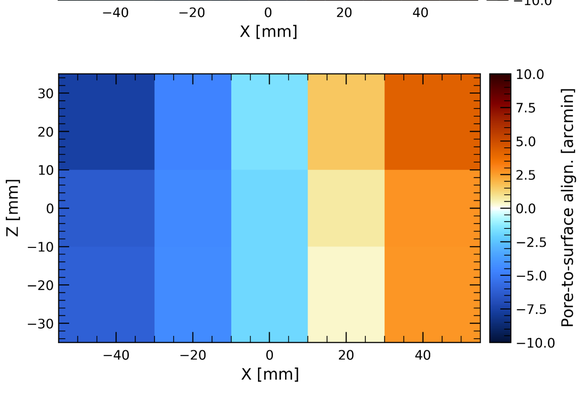


Fig.9 MPO peak transmission angle at multiple locations, MPO rotated 180° between the two measurements

CONCLUSIONS

The facility presented was designed to support extensive characterization campaigns on micro-pore X-ray collimators. Initial measurements conducted have demonstrated that the facility is capable of ensuring the necessary accuracy for precise assessment of collimator performance in astrophysics applications.