

AHEAD 2020



Funded by the Horizon 2020
Framework Program
of the European Union
Grant Agreement No. 871158

AHEAD2020 WP10

Developing and Testing X-ray optics

Final Report

Vadim Burwitz

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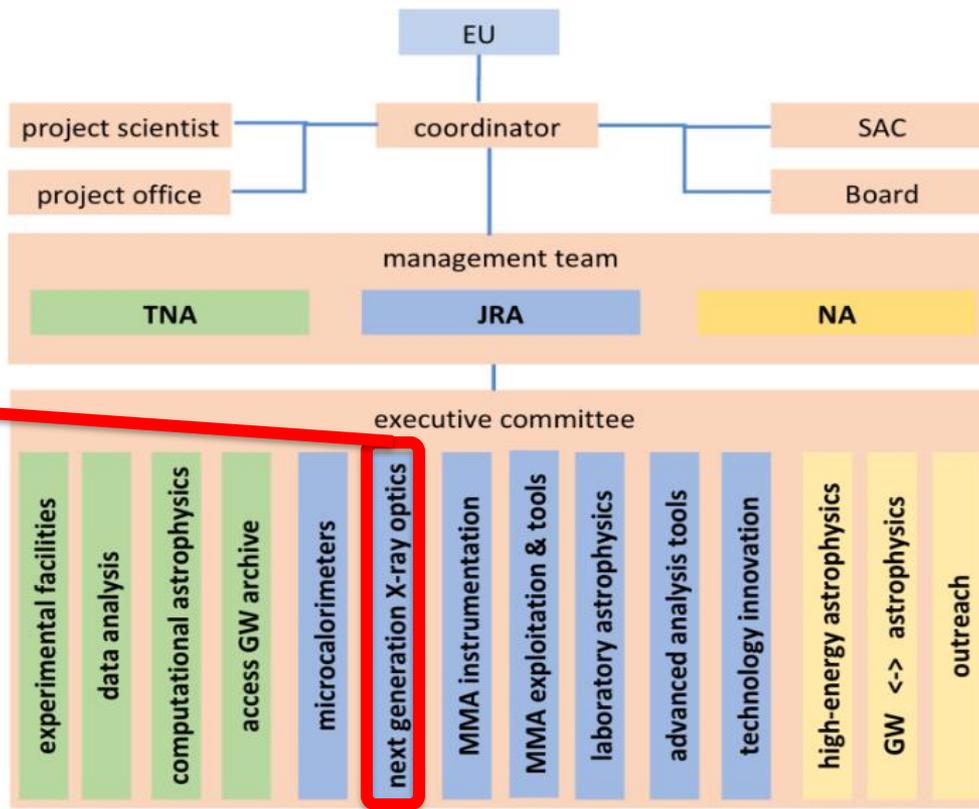
Nov. 26, 2024, Rome, Italy
AHEAD 2020 2nd General Meeting



MAX-PLANCK-INSTITUT
FÜR EXTRATERRESTRISCHE PHYSIK



Overview AHEAD2020



WP10

Funded by the Horizon 2020
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Grant Agreement No. 87158



AHEAD2020 Joint Research Activity

Work Package 10: X-ray optics



- **Task 10.1**
Design, development, simulation and X-ray testing of grazing incidence X-ray mirror systems
(MPG, CVUT, INAF/OAB, ULEIC)
- **Task 10.2**
Development of optics for the beam conditioning in future calibration facilities and high precision metrology
(INAF-OAB, MPG)
- **Task 10.3**
Commissioning and testing of a microchannel plates test stand
(ULEIC, MPG)



Institution Leads

CVUT René Hudec

INAF/OAB Bianca Salmaso

MPG Vadim Burwitz

ULEIC Charly Feldman

WP #	Del. Rel. #	Del. #	Title	Lead Beneficiary	Nature	Est. Del. Date
WP10	D10.1	D61	Report on beam conditioning optics for test facilities	INAF	Report	01 Feb 2021 ✓
WP10	D10.2	D62	Report on the technical assembly including a handbook for MPO test setup	ULEIC	Report	01 Feb 2021 ✓
WP10	D10.3	D63	First report on results of X-ray optics measured at PANTER	MPG	Report	01 Feb 2022 ✓
WP10	D10.4	D64	Report on new high precision metrology systems for testing X-ray optics	INAF	Report	01 Feb 2022 ✓
WP10	D10.5	D65	Report on the characterisation of MPOs using test setup and results comparison	ULEIC	Report	01 Nov 2022 ✓
WP10	D10.6	D66	Report on the preparation of novel K-B and LE X-ray optics modules	CVUT	Report	01 Nov 2022 ✓
WP10	D10.7	D67	Second report on results of X-ray optics measured at PANTER	MPG	Report	01 Nov 2023 ✓
WP10	D10.8	D68	Report on the characterisation of novel optics modules at PANTER	CVUT	Report	01 Feb 2023 ✓

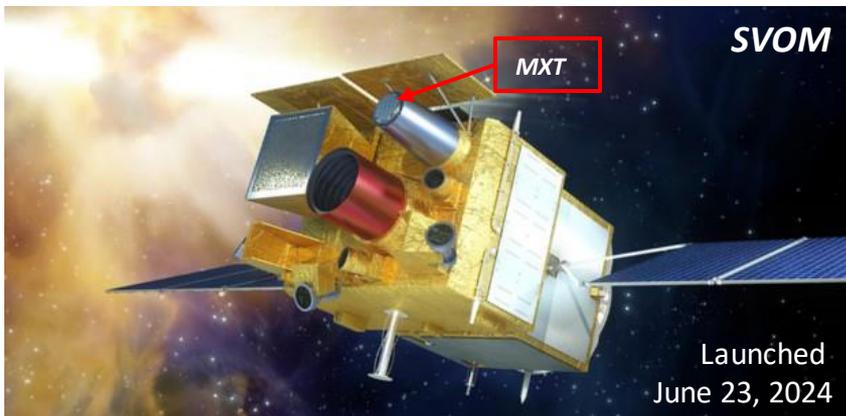
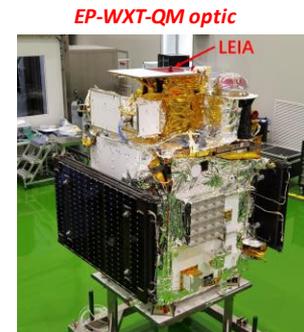
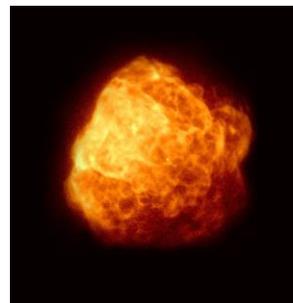
Milestone #	Date	Date Held	Objective	Output
10.1	T0	2020-03-25	Kick-off and task detailing	MoM ✓
10.2	T0+12 mo.	2021-03-18	Status of progress	MoM ✓
10.3	T0+24 mo.	2022-02-17	Status of progress	MoM ✓
10.4	T0+36 mo.	2023-02-23	Summary of work	MoM ✓

AHEAD2020 X-ray Optics WP10: Task 10.1

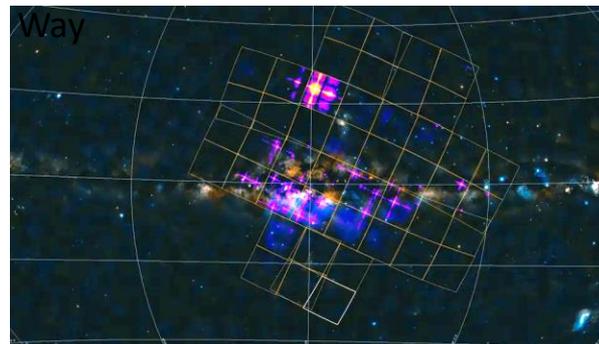
Recently launched Missions supported



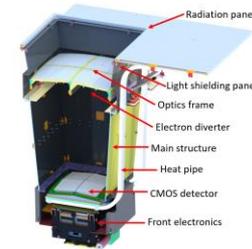
EP-FXT supernova remnant Puppis A



EP-WXT panoramic view of the Milky Way

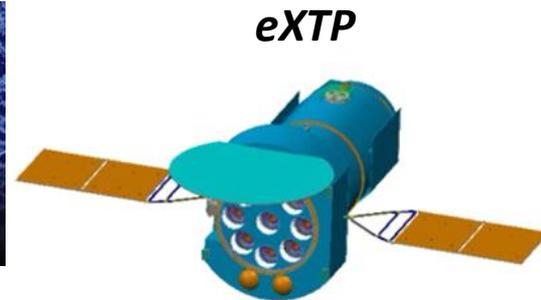
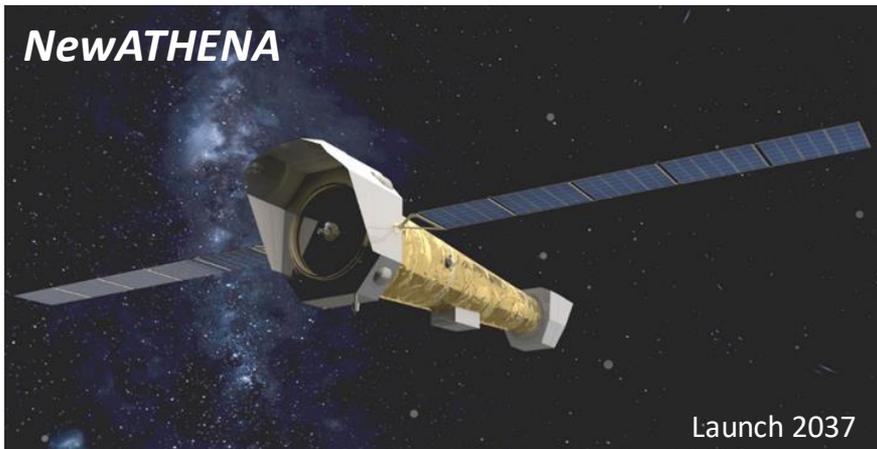


Launched on CAS → SATech-08 July 27, 2023

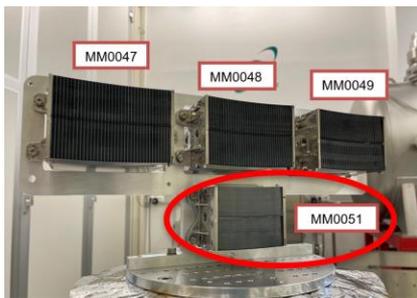


AHEAD2020 X-ray Optics WP10: Task 10.1

Future Missions supported



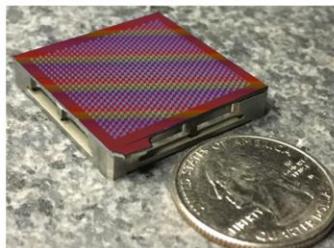
Testing
SPO Optics + CAT Gratings



ATHENA SPO Modules

Row8 : 2.4mm rib spacing

mid radius : 1 mm rib spacing

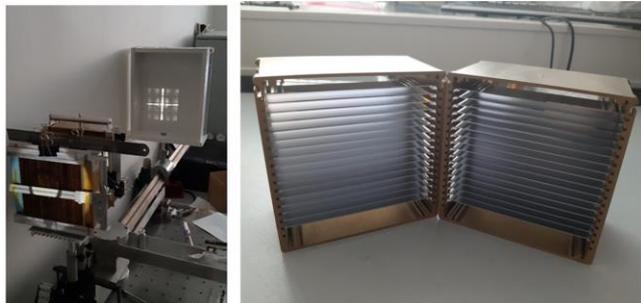


eXTP optics

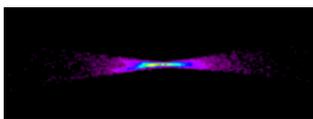
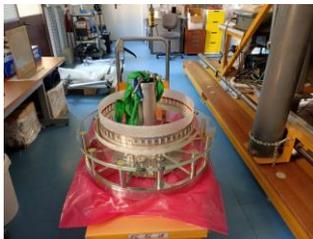
- 9 Mirror Modules
 - 3 Polarimetry
 - 6 Fast Spectroscopy SDDs

Novel Optics Technology Development

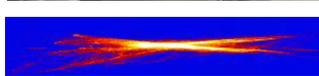
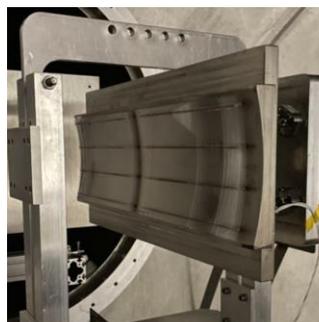
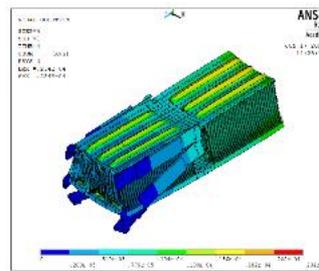
Novel K-P Baez optics
see talk by Rene Hudec



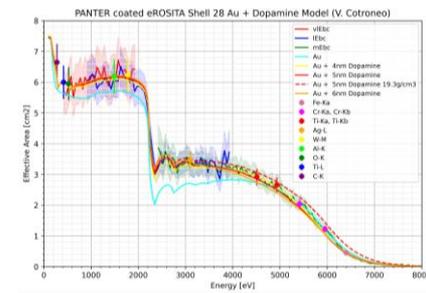
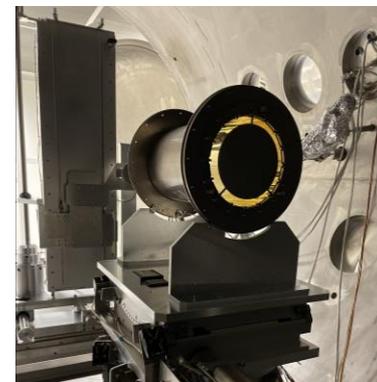
Monolithic Thin Shell optics
work led by Marta Civitani



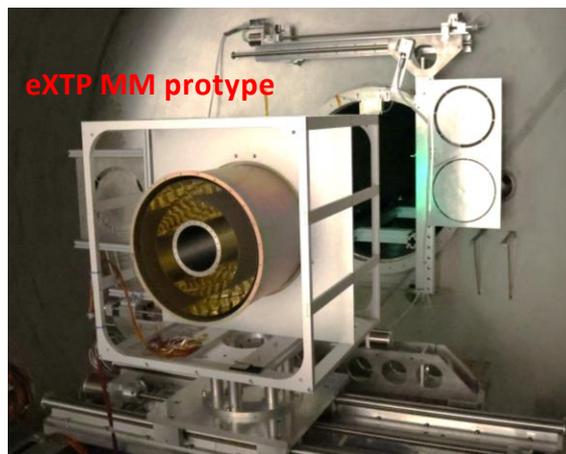
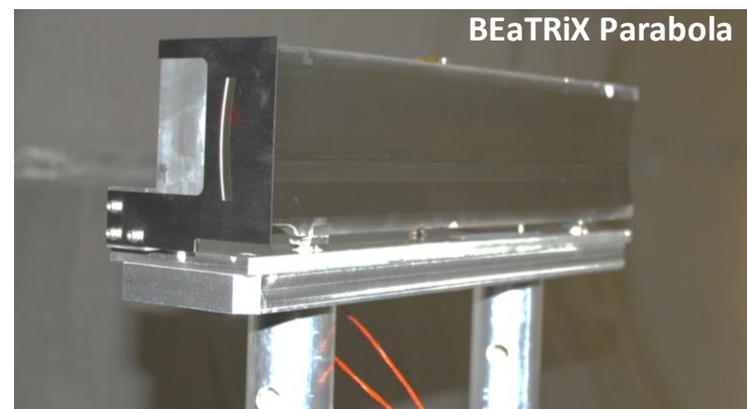
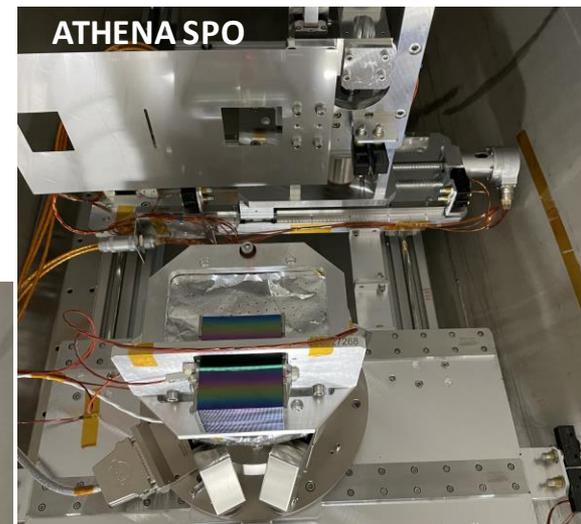
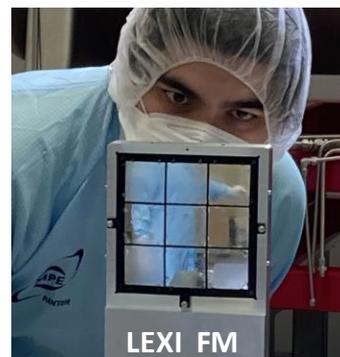
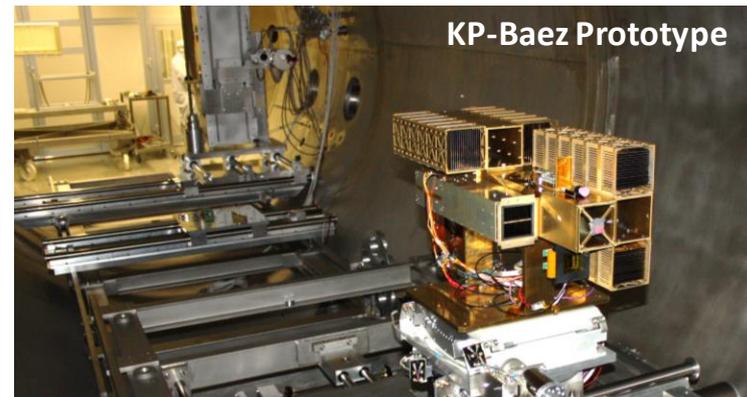
Cold Slumped Glass Module Optics
work led by Stefano Basso



Dopamine coatings
see talk by Daniele Spiga



Selected Campaign Photos – New Missions



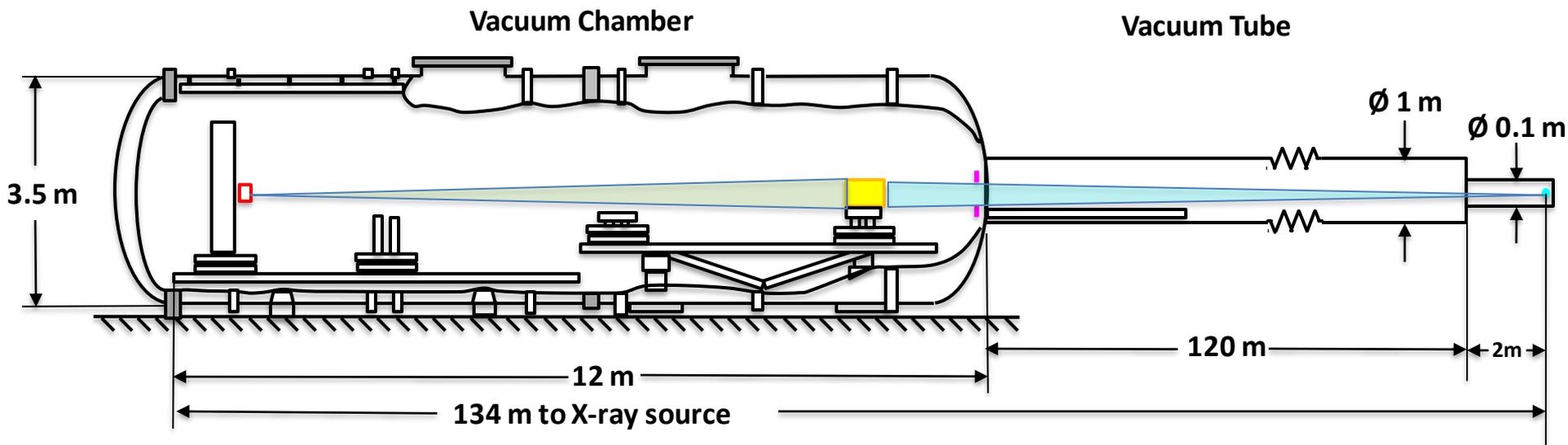
The MPE PANTER X-Ray Test Facility

- Located in Neuried, south west of Munich
- 120 m X-ray beamline, 1 m diameter
- 12 m instrument chamber, 3.5 m diameter
- Large cleanroom for handling X-ray optics
- Movable 10 m extension with 0.25 m diameter and a 3 m instrument chamber, 1.2 m diameter



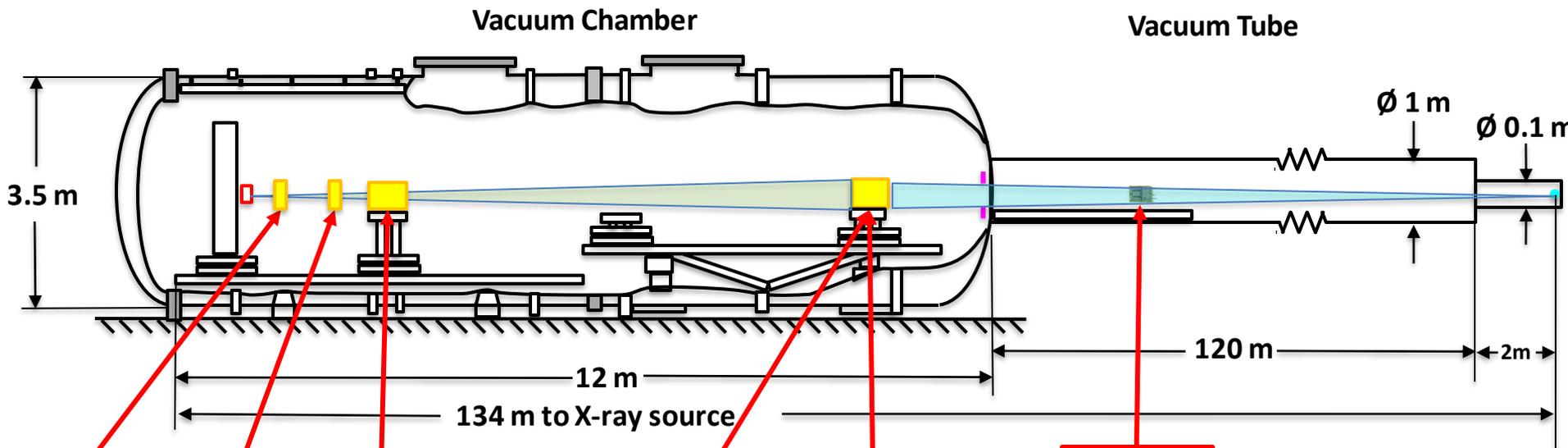
The MPE PANTER X-Ray Test Facility

- Open Multitarget Electron Impact source
- TRoPIC single photon counting pnCCD image detector 75 μ m pixels (256 x 256)
- PIXI imaging detector 20 μ m pixels (1300 x1340)
- Translation + rotary stages and Hexapods
- SDD beam stability monitor



□ **Detector**
 ◁ **Convergent X-ray Beam**
 ■ **Optic(s)**
 | **Mask**
 ▷ **Divergent X-ray Beam**
 ● **X-ray Source**

Optics in the PANTER chamber



EP-WXT
f = 0.375 m

SVOM-MXT
f = 1.15 m

EP-FXT
f = 1.6 m

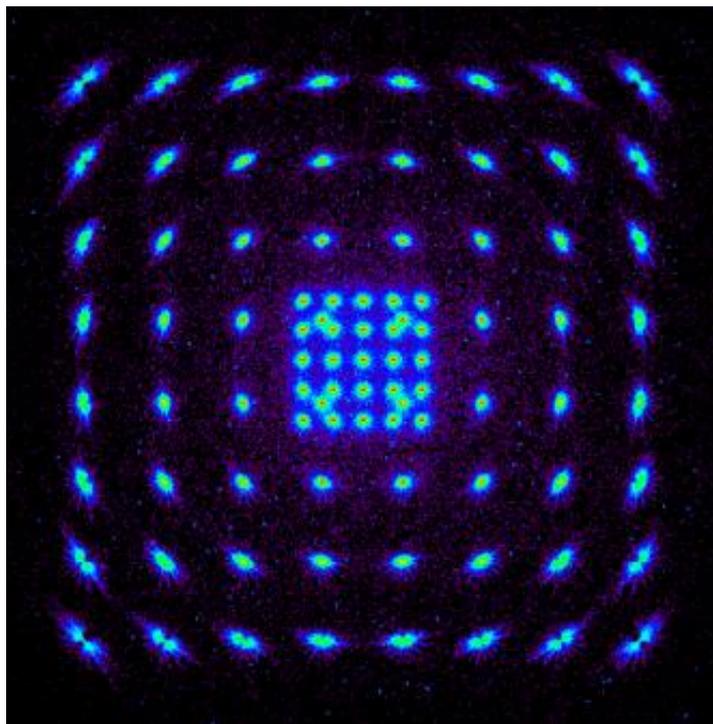
eXTP
f = 5.25 m

PSO Optics
with f = 9.0 m

ATHENA
SPO MM
f = 12.0 m

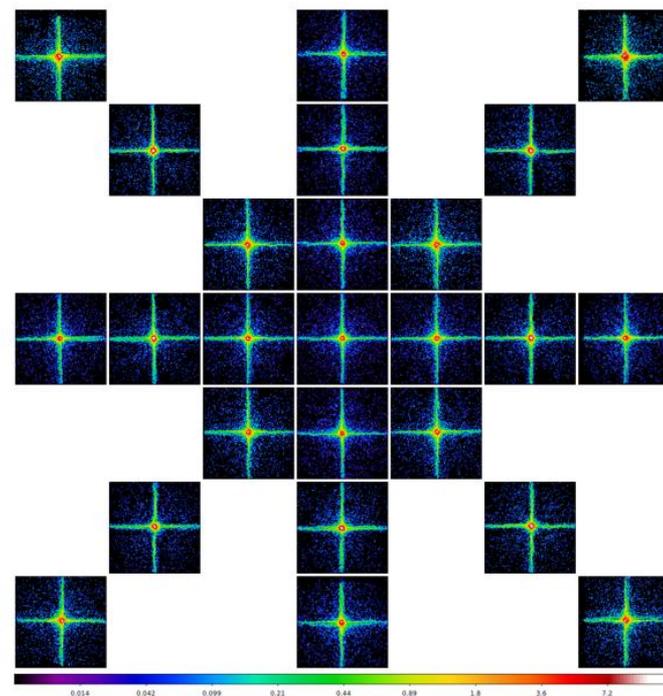
□ **Detector**
 ◀ **Convergent X-ray Beam**
 ■ **Optic(s)**
 | **Mask**
 ▶ **Divergent X-ray Beam**
 ● **X-ray Source**

EP-FXT-QM



Al-K

EP-WXT-QM optics

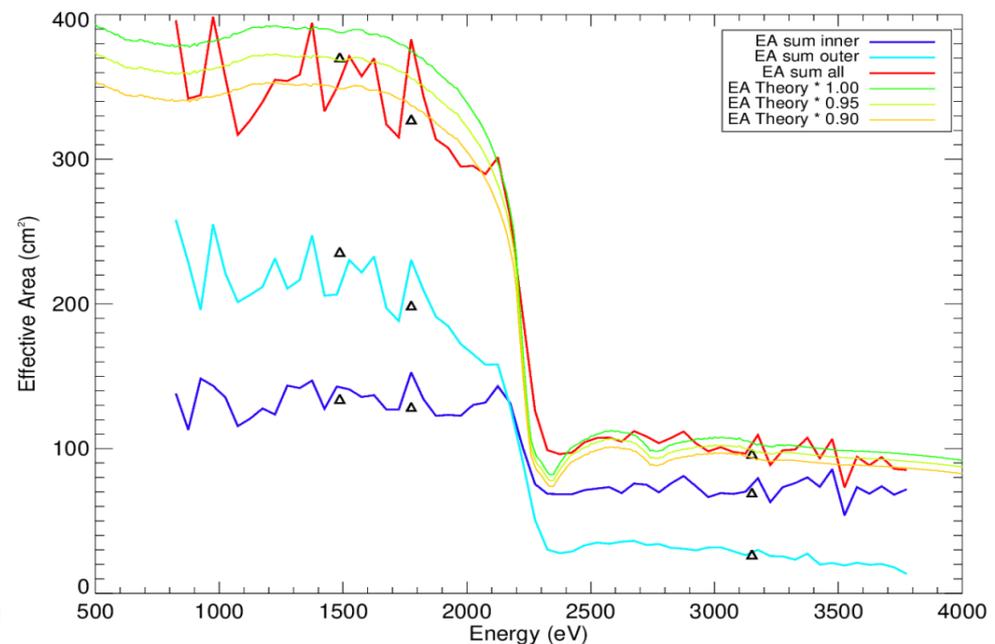
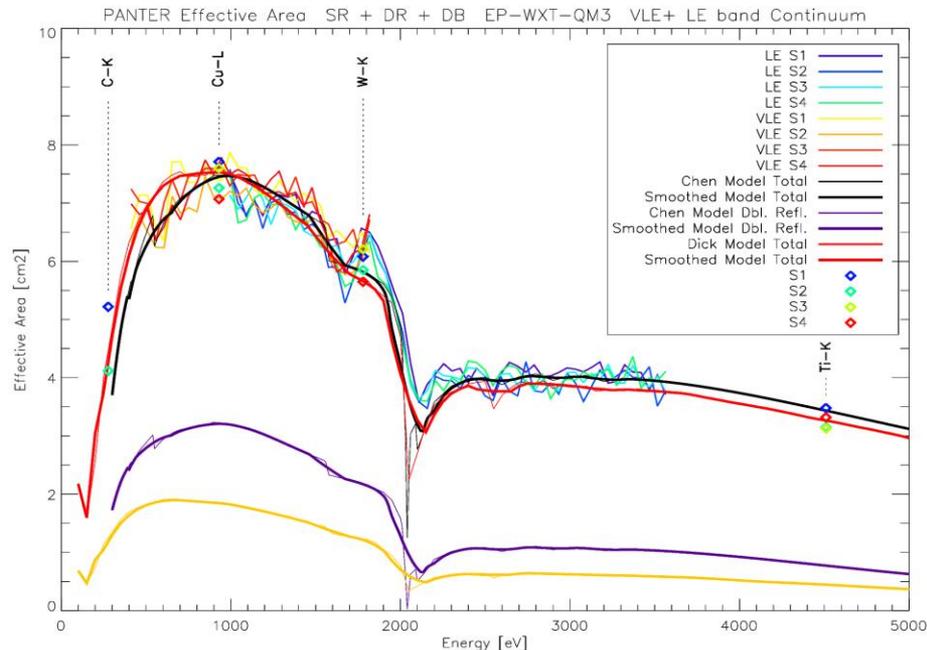


Cu-L

Einstein Probe spectral results

EP-WXT-QM3

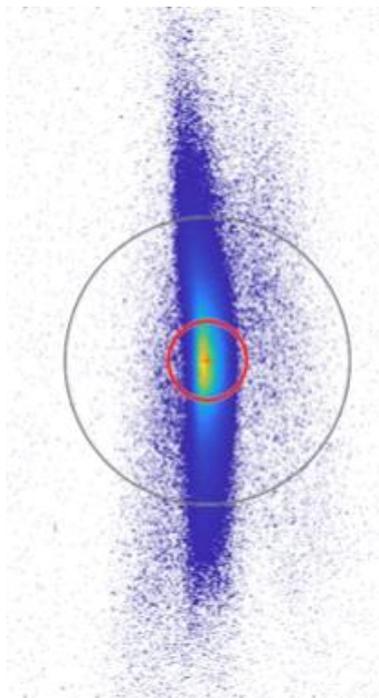
EP-FXT-QM



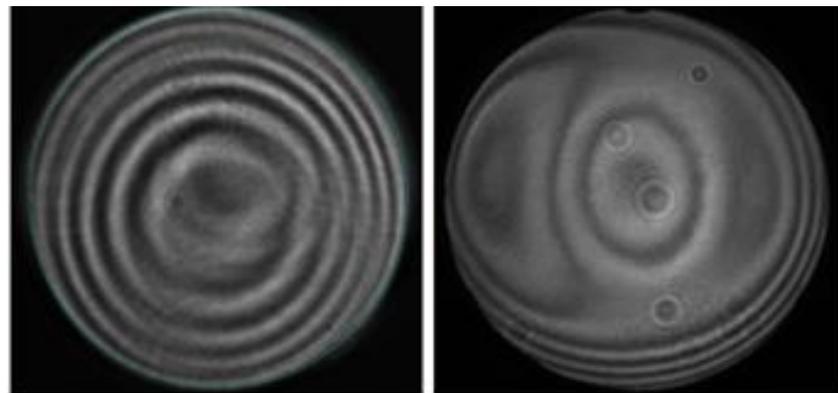
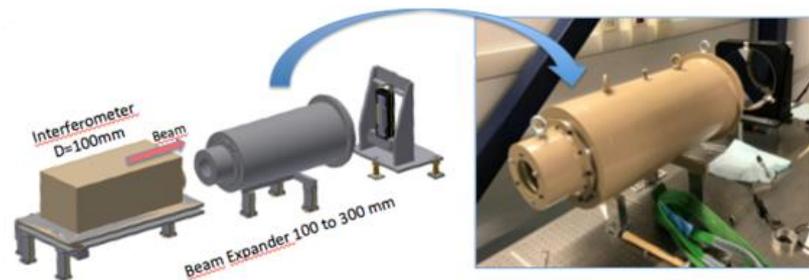
Campaigns (2024)

Campaign Name	Type of Optic	Measurement Quarter/Year
ATHENA first flight like Row-08 SPO MM-0058 : characterise	SPO	Q1 2023
Commission eROSITA/EP type pnCCD for PANTER – PIC02: setup	Detector	Q2 2024
OAB Dopamine Coated Optic with TRoPIC	Nickel	Q2 2024
eXTP – MM prototype	Nickel	Q3 2024
Commission eROSITA/EP type pnCCD for PANTER – PIC02: calibration	Detector	Q3 2024
OAB Dopamine Coated Optic with PIC02	Nickel	Q3 2024
ATHENA first flight like Row-08 SPO MM-0058 : post thermal cycling	SPO	Q2 2024

BEaTriX 1st light – commissioned – ready for use



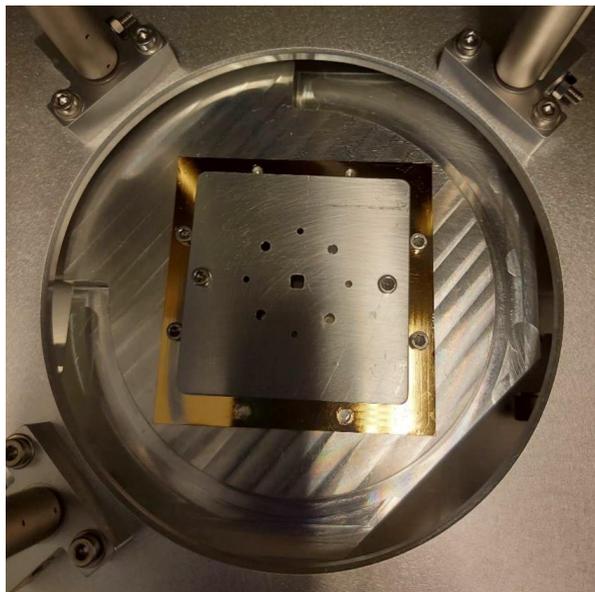
Beam Expander improvements ongoing



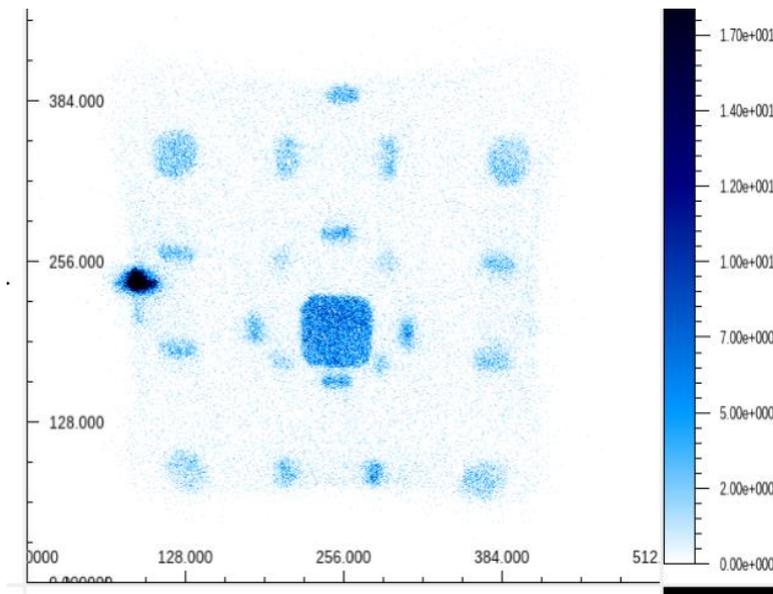
VTF MCP test Facility



Mask in Place



1st MPO image



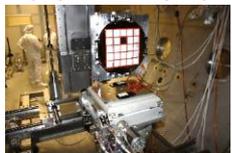
Facility now operational

Institution	Task Leads	Task	Description (Institutions)
CVUT	René Hudec	10.1	Design, development, simulation and X-ray testing of grazing incidence X-ray mirror systems (MPG, CVUT, INAF/OAB, ULEIC)
INAF/OAB	Bianca Salmaso	10.2	Development of optics for the beam conditioning in future calibration facilities and high precision metrology (INAF-OAB, MPG)
MPG	Vadim Burwitz	10.3	Commissioning and testing of a microchannel plates test stand (ULEIC, MPG)
ULEIC	Charly Feldman	10.3	Commissioning and testing of a microchannel plates test stand (ULEIC, MPG)

WP10 in numbers

- 4 Milestones (all achieved)
- 10 Deliverables (all completed)
- 42 PANTER campaigns supported (Apr. 2020- Nov. 2024)
- 3 Launches LEIA (07/2022), Einstein Probe (01/2024), SVOM(06/2024)
- 2 Flight Optics tested (LEXI, OGRE launch planned 2025/26)
- 2 facilities commissioned (BEaTriX, MCP Vert. Facility)

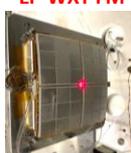
SVOM MXT MOP FS



LEXI FM



EP WXT FM



Einstein Probe



SVOM

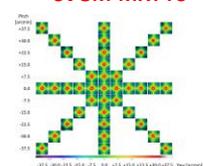
ATHENA SPO



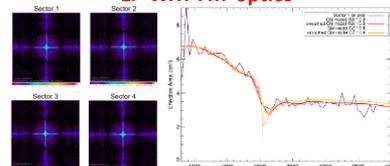
ATHENA Petal Thermo optical Tests



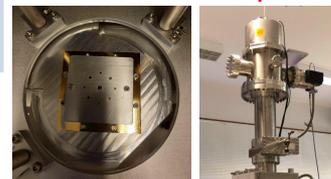
SVOM-MXT-FS



EP-WXT-FM optics



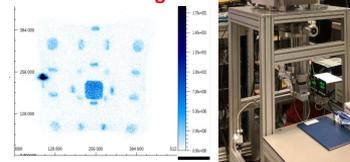
VTF MCP test Facility



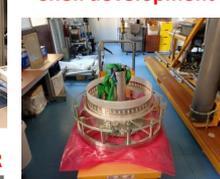
BEaTriX 1st light – commissioned – already in use



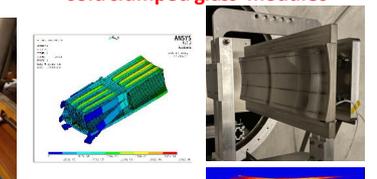
1st MPO image



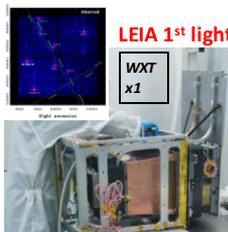
Thin Monolithic Shell development



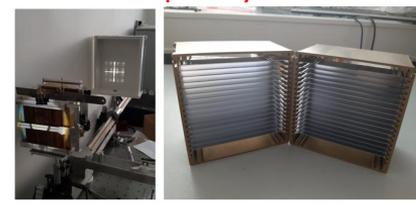
Designing and Testing cold slumped glass modules



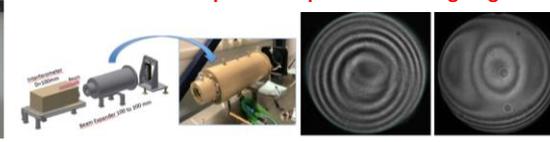
LEIA 1st light



Novel K-P Baez optic X-ray tested at PANTER



Beam Expander improvements ongoing





Summary

- The joint research activity WP10: X-ray optics has been supported through AHEAD2020
- This activity was structured into 3 tasks
 - The Development and testing of new optics for upcoming and future missions
 - Supporting BEaTriX and upgrading Mirror Metrology systems
 - Supporting finalization of the VTF for characterising MPOs
- Most of the optics testing was done at MPEs PANTER X-ray test facility
- Since Apr 2020 more than 42 test campaigns have been performed and have been in part supported the AHEAD2020 Joint research Activity on X-ray optics
- Both the BEaTriX and the VTF facilities have been commissioned and are in operation.
- All deliverables have been completed and the milestones reached.