

XRO (X-Ray Observatories) Status & Requests INFN-Pisa 2022

CARMELO SGRO'

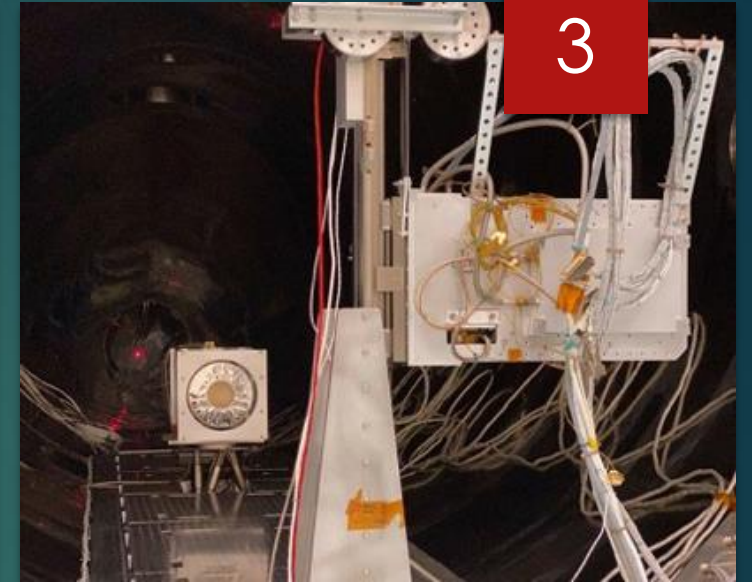
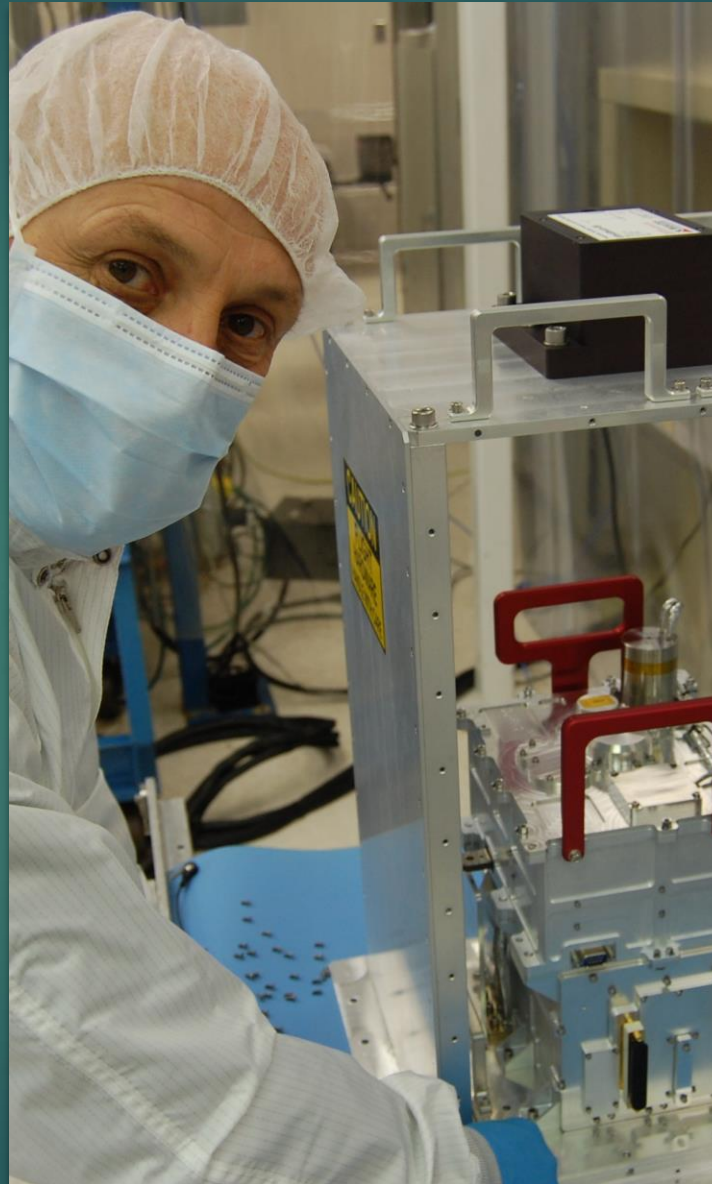
PISA, 28 JUNE 2021

Introduction

- XRO includes 2 space missions
 - It replaces IXPE_INFN and extends to eXTP
- Imaging X-ray Polarimeter Explorer (**IXPE**) mission
 - NASA Small Explorer devoted to polarimetry in 2-8 keV band
 - Exploit the Gas Pixel Detector developed at INFN
 - Launch and operations ~ 2021-2024
- enhanced X-ray Timing and Polarimetry (**eXTP**) mission
 - A flagship X-ray observatory mission, being developed by the Chinese Academy of Sciences, with a large contribution by a European Consortium
 - Pisa is involved in the PFA instrument, which is based on the same type of polarization-sensitive GPD
 - Other INFN sections are working on other instruments, based on SDD technology
 - Launch not earlier than 2027...

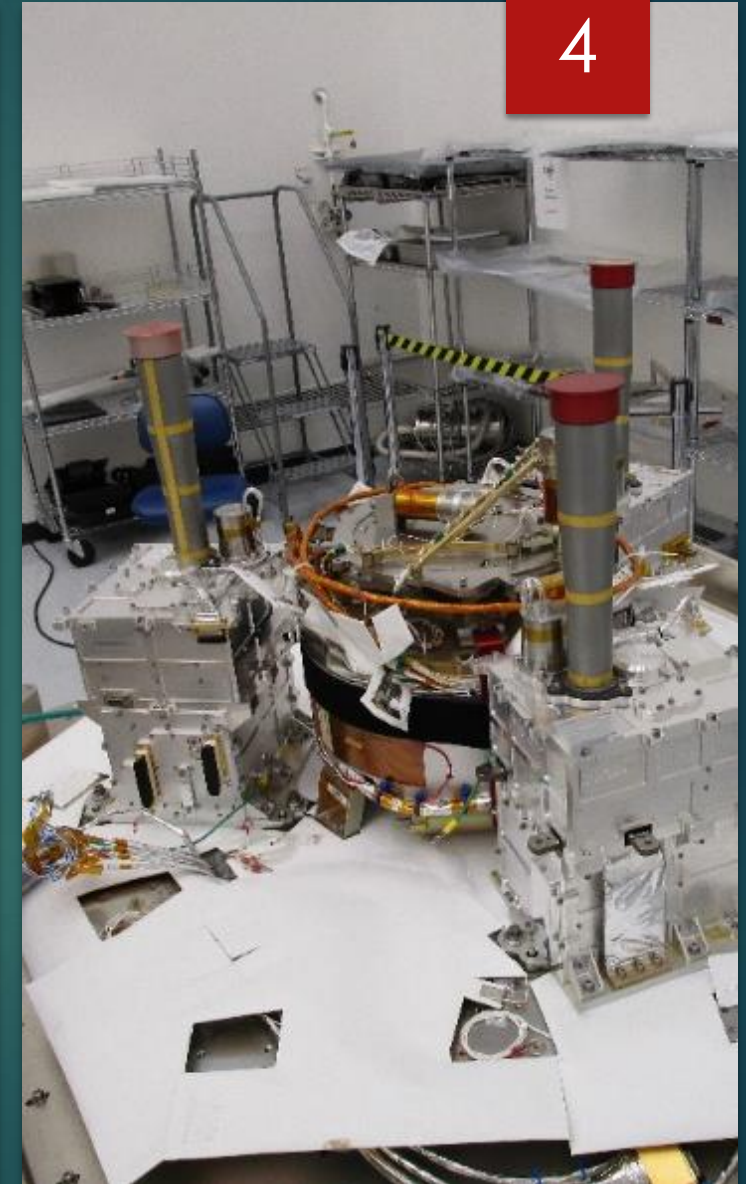
IXPE DUs status

- ▶ Delivery of 4 DU FM is completed
 - ▶ Thanks to the effort of many people here in Pisa
- ▶ First DU delivered to MSFC in person
 - ▶ Incoming test and a small rework
 - ▶ Traveling was forbidden just after that...
- ▶ Other DUs were ready for shipment
 - ▶ Luckily, no delay on our side
- ▶ Remote support to the activity in US
 - ▶ Train US personnel for handling and operating the DUs
 - ▶ Analyze collected data
- ▶ Calibration of spare DU with X-ray optics



IXPE satellite status

- ▶ Satellite is now fully integrated at Ball Aerospace (Colorado, USA)
- ▶ Environmental test campaign in progress
 - ▶ TVAC foreseen this summer
- ❑ Only remote support
 - ❑ Procedure review
 - ❑ DU operations training
 - ❑ Expert support on demand
 - ❑ Offline data analysis and test data review
- ❑ Launch at the end of 2021



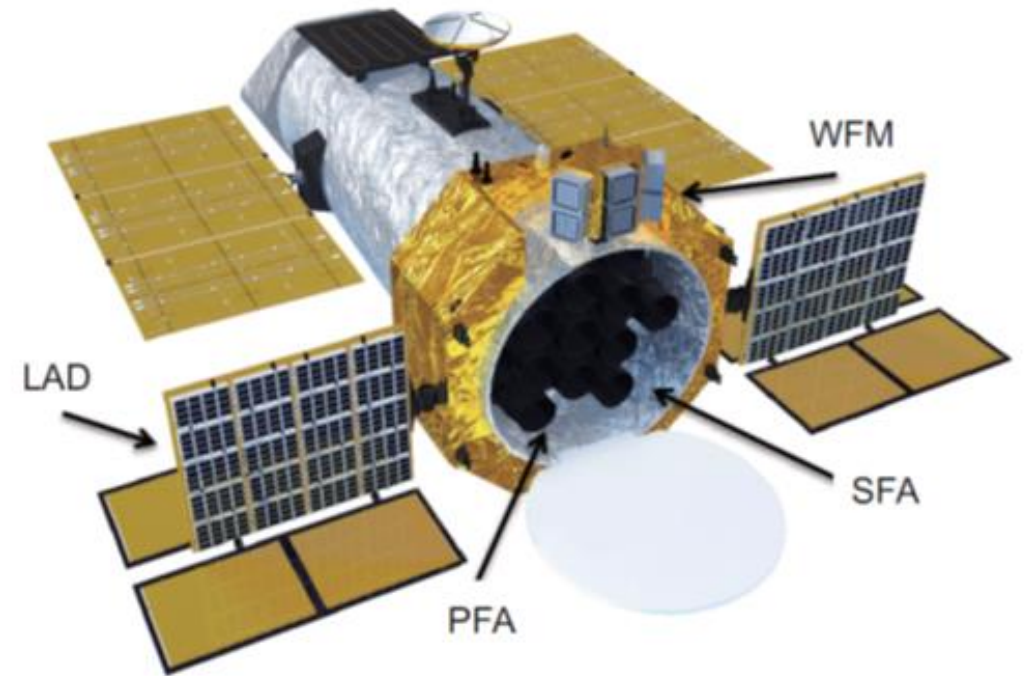
eXTP program

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INFN key technologies

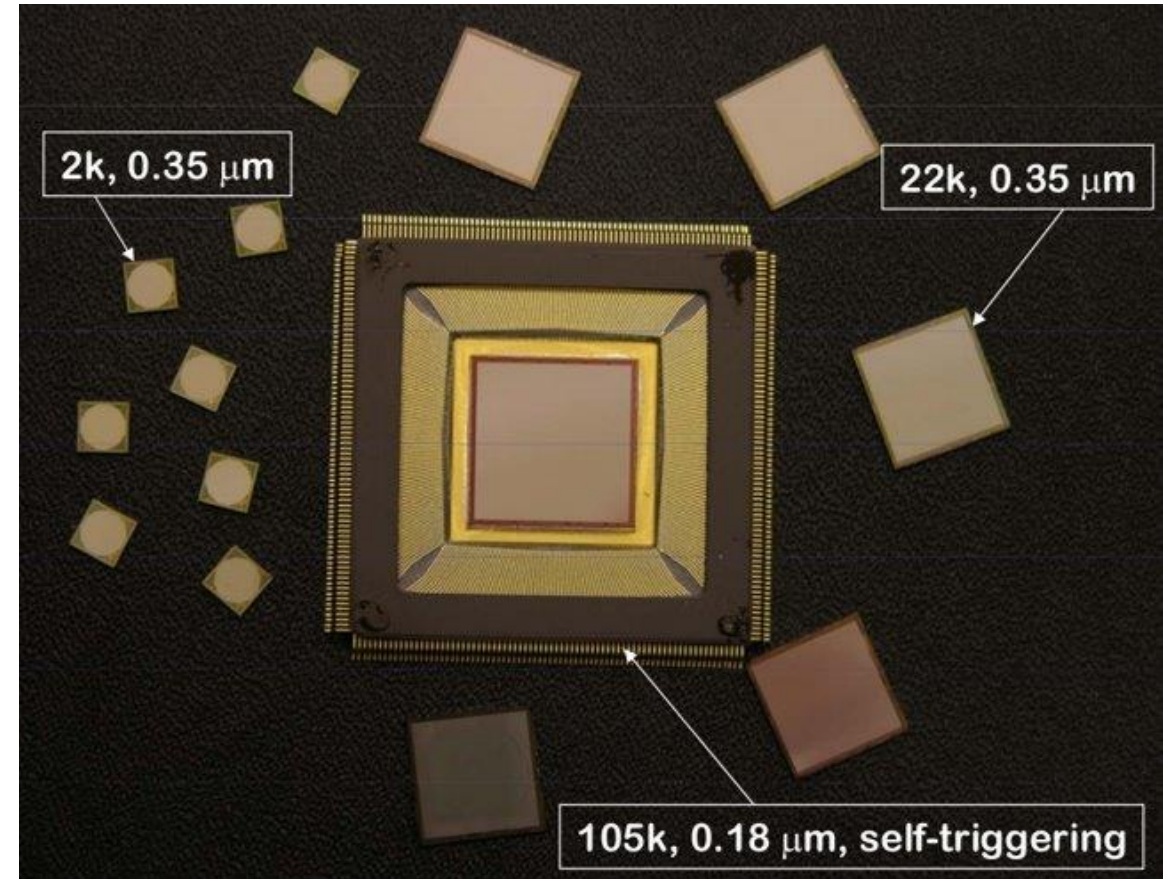
- SFA: Spectroscopic Focusing Array
- PFA: Polarimetry Focusing Array
- LAD: Large Area Detector
- WFM: Wide Field Monitor

- Pisa and Torino will work on the X-ray Polarimeter
 - Evolution of IXPE detector
 - Focus on high-rate capability
- Prototype development in Italy, but flight production directly in China
 - New GPDs will be developed and tested in our facilities



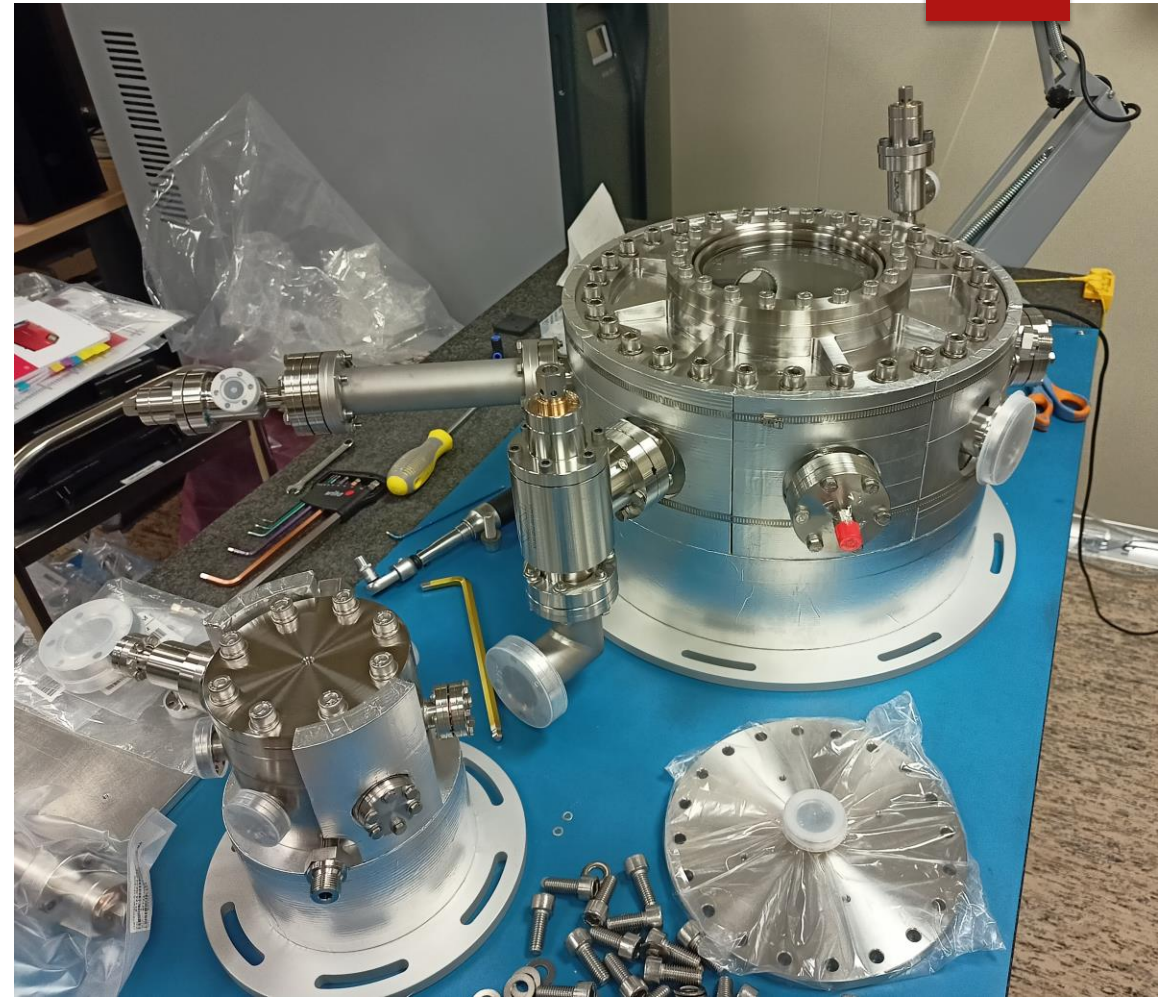
Activity in Pisa: a new ASIC

- ▶ eXTP optics expected to have a much larger effective area than IXPE
 - ▶ Current ASIC may suffer from a too high dead time
- ▶ A new generation of ASIC is needed
- ▶ Based on heritage of the 20+ year of R&D and IXPE construction
 - ▶ Same 180nm technology
 - ▶ Same pixel pitch and hexagonal matrix
 - ▶ Specific fixes to improve readout speed
 - ▶ Readout clock, ROI padding, signal reset, etc.
- ▶ ASIC is currently in production
- ▶ Need to build readout board and new DAQ
- ▶ Need to build GPDs for testing with polarized X-rays



Activity in Pisa: GPD filling

- ▶ We are building Bakeout and Filling System (**BFS**) facility for GPD
 - ▶ For IXPE we used a facility in Finland
- ▶ Facility will be in clean room with:
 - ▶ Vacuum vessel for GPD filling
 - ▶ Pumping system
 - ▶ Temperature control
 - ▶ Gas system (He, DME, Ar/CO₂)
 - ▣ Temperature and pressure monitoring
 - ▶ Leak detector
 - ▶ Ex. interface for GPD operation
- ▶ Other usage are possible (e.g. GEM testing)
- ▶ Currently under construction



Activity in Pisa: GPD X-ray test

- ▶ X-ray testing are obviously crucial for GPD performance evaluation
- ▶ Test in the IXPE framework showed unanticipated behavior
 - ▶ Residual modulation at low energy (mainly due to the GEM)
 - ▶ Internal gas absorption and pressure decrease
- ▶ We are building a dedicate low-energy X-ray facility
 - ▶ Tube with 2.7 keV peak
 - ▶ Direct (non-polarized) beam already in use
 - ▶ Bragg polarizer under construction



Anagrafica XRO Pisa

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Nome	Affiliazione	FTE
Baldini Luca [‡]	Universita' di Pisa	0.6
Bellazzini Ronaldo	INFN	0
Bombaci Ignazio	Universita' di Pisa	0.2
Brez Alessandro	INFN	0.5
Castellano Simone	Assegnista INFN	1
Logoteta Domenico	TD Universita' di Pisa	0.2
Lucchesi Leonardo	TD INFN (tecnologo)**	1
Manfreda Alberto	Assegnista INFN	1
Minuti Massimo	INFN	1
Nuti Alessio	TD INFN (tecnologo)**	1
Orsini Leonardo	TD INFN (tecnologo)**	1
Pesce-Rollins Melissa	INFN	0.5
Pinchera Michele	INFN	0.7
Sgro' Carmelo*	INFN	0.5
Shore Steven	Universita' di Pisa	0.5
Spandre Gloria	INFN	0.5

Nome	Affiliazione	FTE
Burgio Giuseppina Fiorella	INFN Catania	0.1
Drago Alessandro	Universita' di Ferrara	0.1
Pagliara Giuseppe	Universita' di Ferrara	0.1
Vidana Haro Isaac	INFN Catania	0.15

[‡] Responsabile Nazionale insieme a V. Bonvicini (TS)

* Responsabile Locale

** under ASI-INFN agreement n.2017-13-H.0

Total: 10.2 + 0.45 FTE

Richieste alla sezione per il 2022

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- Supporto al commissioning di IXPE e analisi dati scientifici
 - Lancio attualmente previsto per fine 2021
 - Prevista presenza del personale INFN presso il MOC (@ LASP in Colorado)
 - Assumendo riduzione delle limitazioni COVID
- Attività di costruzione prototipi per PFA di eXTP
 - Schedule non perfettamente definita a causa della pausa-COVID
 - Attività di sviluppo e test nuovi GPD in pieno svolgimento
- Supporto del personale dalla Sezione:
 - Minuti full time sul progetto
 - Alte tecnologie: Ceccanti per incollaggi e metrologia, Profeti per microsaldatura ASIC
- Spazi e attrezzature nella camera pulita
 - Assemblaggio detector (classe 10k)
 - Test stand per sviluppo elettronica
 - Test stand per tubo raggi X
 - Stazione di bakeout e filling dei rivelatori
- Laboratorio n.13 (Fermi)
- Richieste finanziarie in fase di definizione
 - Fondi ASI coprono la maggior parte delle esigenze