INFN – PAVIA
Proposta di Nuovo Esperimento
Consiglio di Sezione, Gruppo II, 14 Luglio 2020

XRO

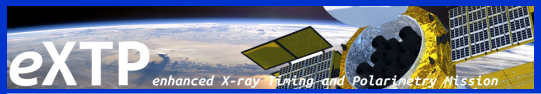
X RAY OBSERVATORIES

Piero Malcovati

University of Pavia and INFN Pavia

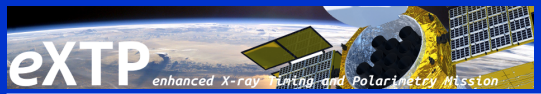
XRO – X-RAY OBSERVATORIES

- Nuova sigla in CSN2
- Riunisce le attività sulle missioni
  - IXPE : Imaging X-Ray Polarimetry Explorer (già in CSN2)
  - eXTP: enhanced X-Ray Timing and Polarimetry (nuova)
- Responsabili nazionali
  - L. Baldini (PI) e V. Bonvicini (TS)
- Strutture partecipanti:
  - TS, PI, TO, MI, PV, BO, TIFPA, PG, RM2
- Man power
  - > 20 FTE complessivi



eXTP Mission

- **eXTP: a flagship X-ray observatory mission**
  - Being developed by the Chinese Academy of Sciences
  - a large contribution by a European Consortium inherited from the ESA-M3 LOFT mission study
- **Currently at the start of its Phase B**
  - The launch date is planned in 2027, mission lifetime goal 8 years
- **Observatory open to the worldwide scientific community**
  - Observing plan based on:
    - Core Program observations
    - Guest Investigator Program



eXTP Consortium

PI – China: Prof. Shuang-Nan Zhang IHEP/CAS – Beijing
PI – Europe: Dr. Marco Feroci – INAF IAPS Roma

CAS

CNSA

IHEP

Tsinghua University

Tongji University

CAST Beijing

Microsat Shanghai

Italy

Spain

Germany

France

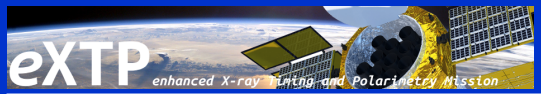
Switzerland

Czech Republic

Poland

Denmark

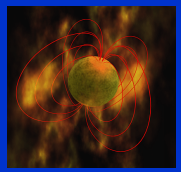
The Netherlands

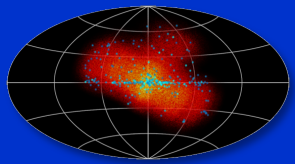


Science Drivers

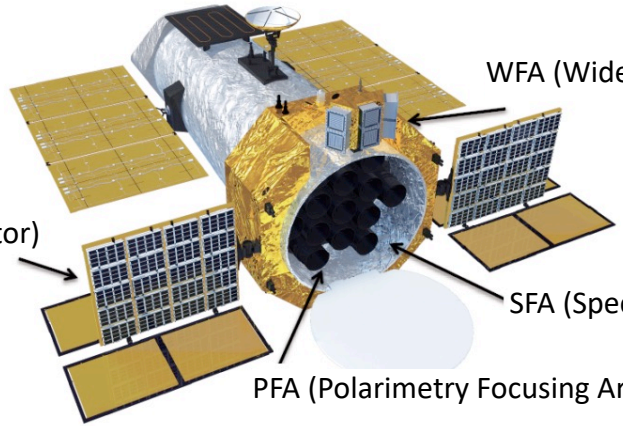
Study of matter under extreme conditions of gravity, density and magnetism. For the first time: simultaneous, high-throughput spectral, timing and polarimetry observations

- Constrain the Equation of state of the supra-nuclear density matter in the interior of neutron stars
- Accretion physics in the strong-field regime of gravity and tests of General Relativity in neutron stars and black holes over the mass scale
- Physics of light and matter in the presence of ultra-strong magnetic fields in magnetars and X-ray pulsars
- Multi-purpose observatory and wide-field monitoring for transients (and e.m. counterparts of GWs) ➜ Rapid follow-up





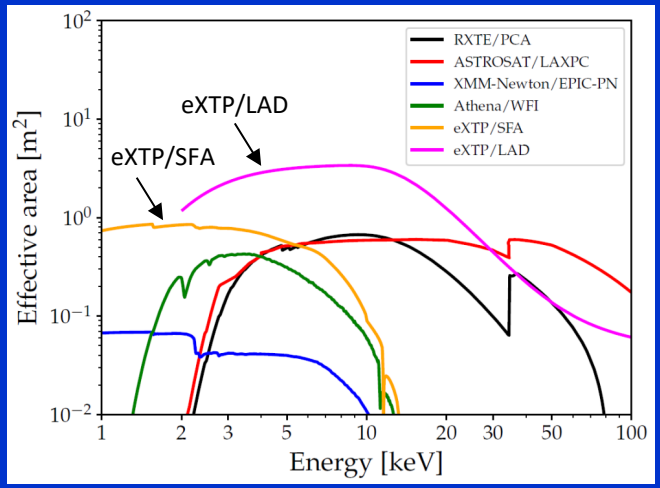
eXTP Concept



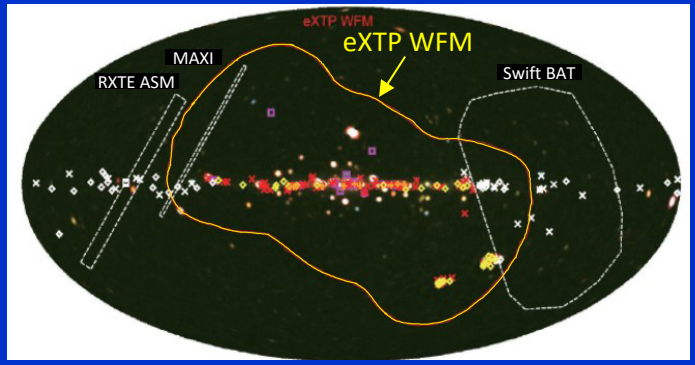
Payload	Configuration	Optics	Detector	Eff. Area (cm^2)	Energy Range (keV)
SFA	9 Telescopes	Nickel Replica	SDD	5000 – 7000	0.5 - 10
LAD	40 Modules	MCP Collimator	SDD	34000	2 - 30
PFA	4 Telescopes	Nickel Replica	GPD	900	2 - 10
WFM	6 Cameras	1.5 Coded Mask	SDD	FOV > 4sr	2 - 50

eXTP: Key Performance

Effective Area of SFA and LAD

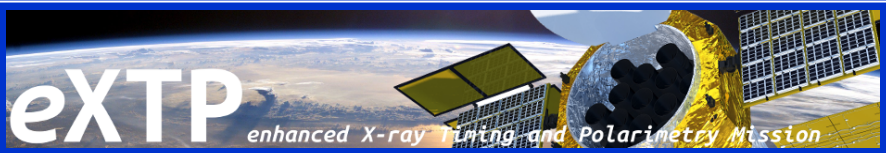


Simultaneous FoV of WFM



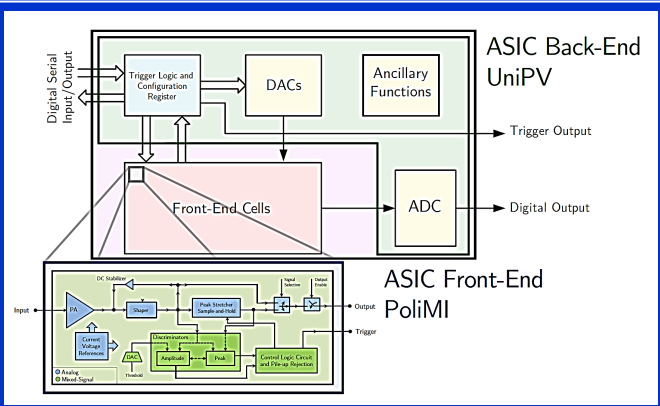
- ❖ LAD: 6x RXTE/PCA, 35x XMM-Newton (*but collimated*!) + hard-X response
- ❖ SFA: 8x XMM-Newton and 0.3-2x Athena/WFI (*but multiple optics and larger PSF*!). Limiting sensitivity ~10^{-14}-10^{-15} erg cm^{-2} s^{-1}
- ❖ PFA: 5x IXPE. Sensitivity: 1% MDP in 50ks for a 100 mCrab source
- ❖ WFM: Largest FoV ever, first time with 300 eV resolution. 3 mCrab in 50 ks

Mission Profile



Parameter	Value
Orbit	550 km, <2.5° inclination
Launcher	Long-March CZ-7 + upper stage, from Wenchang
Mass	4500 kg
Power	3.6 kW
Telemetry	3.2 Tb/day (X-band)
Ground Stations	Sanya, Malindi
Pointing	3-axis stabilized, < 0.01° (3-sigma)
Sky visibility	50% (goal 75%)
Mission Duration	5 years (goal 8 years)
Launch date	2027

ASIC Design Team



ASIC Front-End - Politecnico and INFN Milano

- Prof. Giuseppe Bertuccio
- Dr. Massimo Gandola (Post-Doc Researcher)
- Ms.Sc. Filippo Mele (PhD student)

ASIC Back-End - Univ. and INFN Pavia

- Prof. Piero Malcovati
- Dr. Marco Grassi (Post-Doc Researcher)
- Ms.Sc. Rashid Karim (PhD student)

Milano-Pavia Heritage on ASICs for Space

Project/Mission	LFDR	LOFT	PiXDD	HERMES	THESEUS
Years	2003-10	2013-14	2018-20	2018 - 20	2019
Institution	ESA-Thales	ESA-ASI-INAF	ASI-INAF	ASI-INAF	ESA-ASI-INAF
ASIC Name	STARX-32	VEGA	RIGEL	LYRA	ORION
Detector Type	GaAs Pixel	Linear SDD	Pixel SDD	Square SDD	Matrix SDD
Architecture	Matrix	Linear	Matrix	Distributed	Distributed
Dynamic Range [keV]	0.5 - 50	0.2 - 60	0.5 - 30	0.5 - 120	2 - 5000
Noise (ENC) [e^-_{rms}]	12	12	9	16	14 - 35
Power Consumption [µW/ch]	555	422	550	520	582
Chip Area	3 cm^2	16 mm^2	51 mm^2	16 mm^2	TBD

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Noise (ENC) [e^-_{rms}]	12	**12**	9	16	14 - 35
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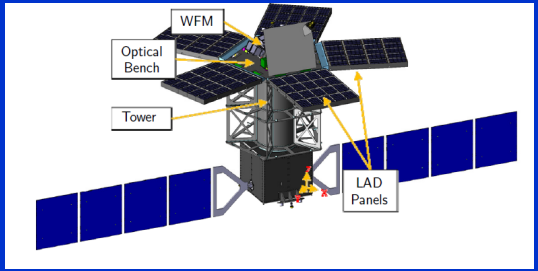
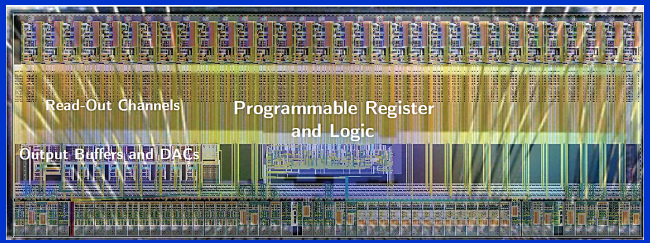
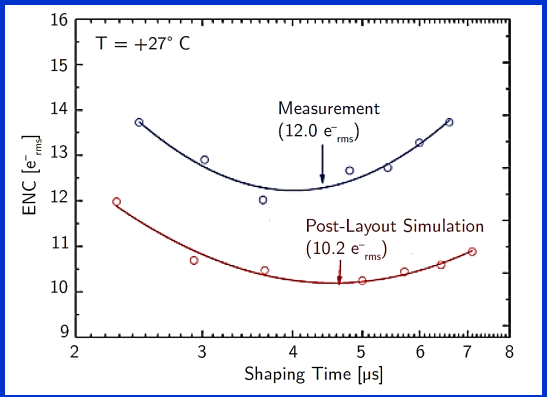
Chip Area	3 cm^2	**16 mm^2**	51 mm^2	16 mm^2	TBD

VEGA ASIC



VEGA ASIC (32 Channels)





Originally designed for LOFT

Baseline ASIC for eXTP

LAD and WFM detector tests

XRO: X-Ray Observatories

- **Responsabili nazionali:** L. Baldini (PI) e V. Bonvicini (TS)
- **Strutture partecipanti:** TS, PI, TO, MI, PV, BO, TIFPA, PG, RM2
- **INFN Pavia:**

Piero Malcovati – Responsabile locale	(0.5 FTE)
Marco Grassi – Postdoc	(0.5 FTE)
Rashid Karim – PhD student	(1.0 FTE)

- **Richieste finanziarie:**
  - Fondi ASI: 20 k€
  - INFN: in fase di definizione/coordinamento con le altre sezioni
    - Copertura costi missioni: 10 keuro (5 k€/FTE)
    - Run ASICs: 10 k€
    - PCB e componenti per test SDD-ASICs: 5 k€