SDD detectors for the eXTP X-ray Mission

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eXTP - enhanced X-ray Timing and Polarimetry

Science Drivers

➢ Extreme density, gravity, magnetism

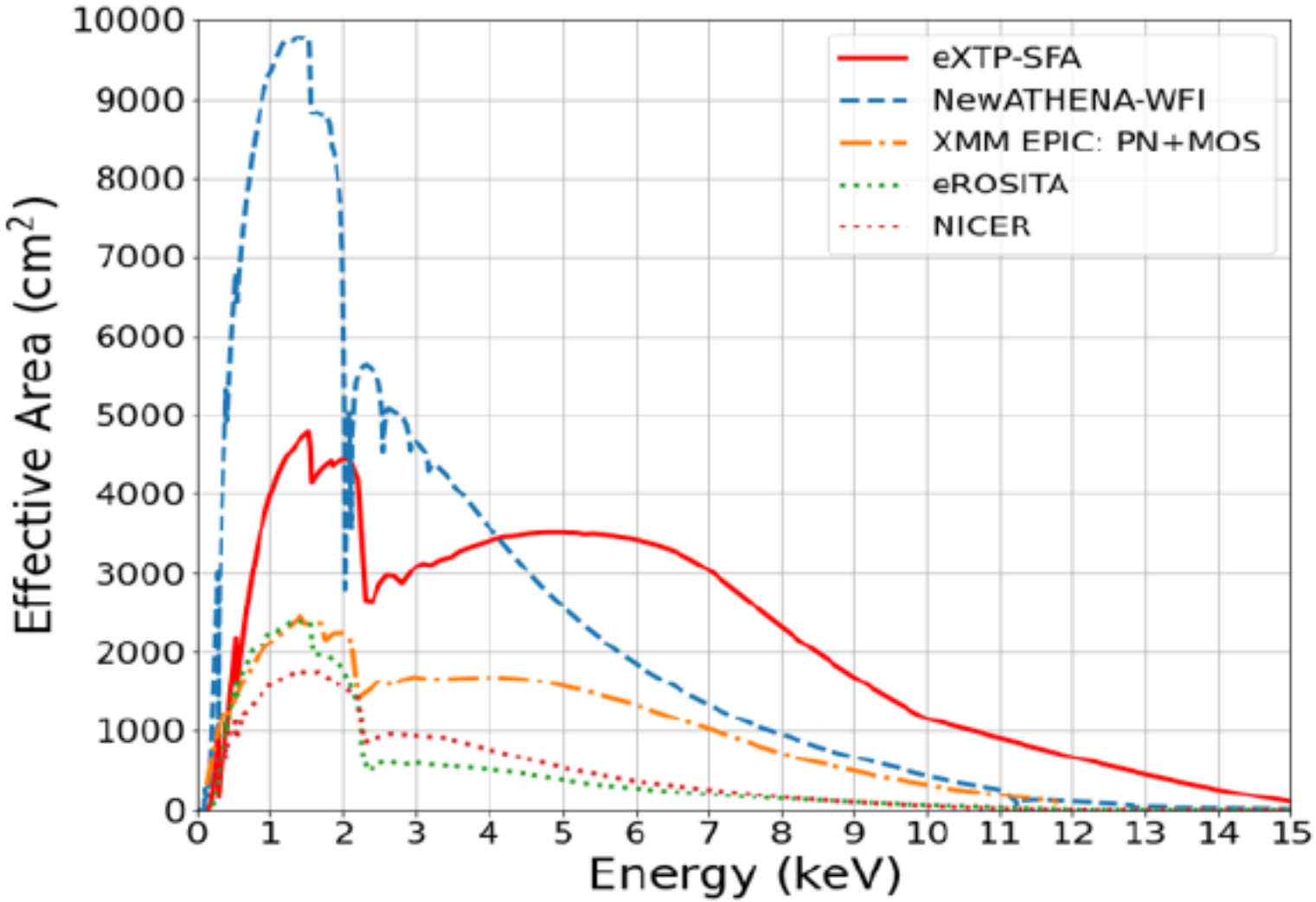
➢ Neutron stars, black holes, etc.

Cutting-edge technology

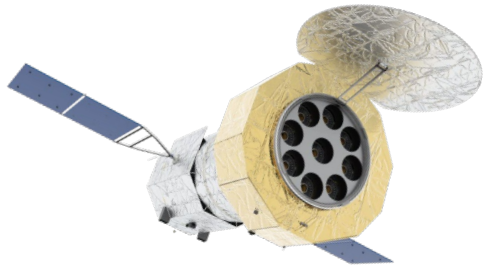
➢ Spectral, polarization, timing, imaging

➢ Large effective Area @ 6 keV

➢ High spectral resolution

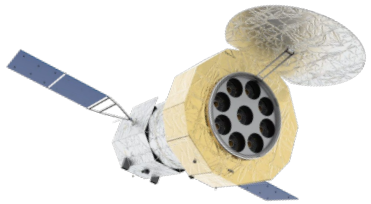


Credit: Zhang 2025

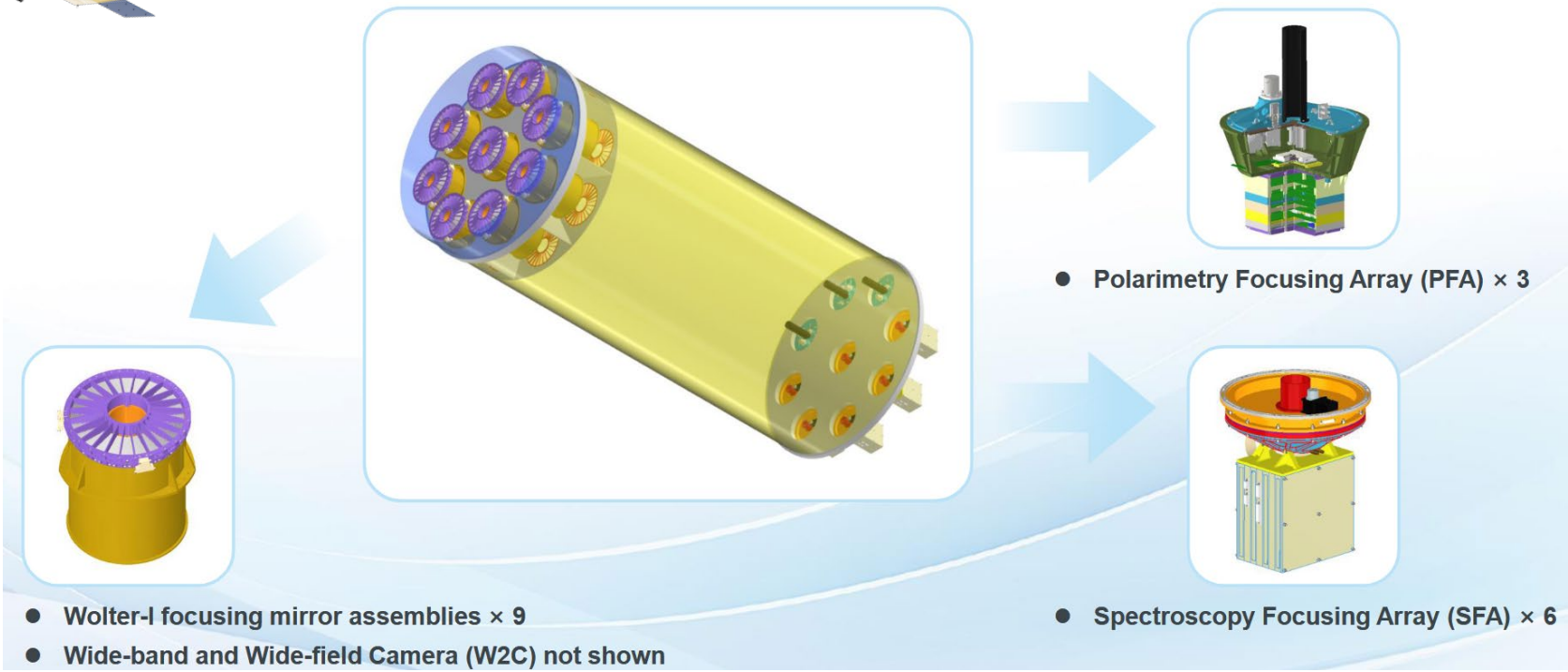


eXTP Mission Overview

Parameter	Value
Orbit	Earth's highly elliptical orbit Apogee >100.000km, perigee 5.000km,
inclination	28°
Pointing	3-axis stabilized, < 3" (3σ)
Launch	LM3B, from XiChang
Launch mass	~4000 kg
Telemetry	1.7 Tb/2 day (Ku-band)
Mission duration	5 years (goal 8 years)
Launch date	~ Jan. 2030



eXTP - enhanced X-ray Timing and Polarimetry



CAS project led by IHEP

MPE contributions:

- Support of development, test and calibration of eXTP optics
- **All 6 SFA detectors**

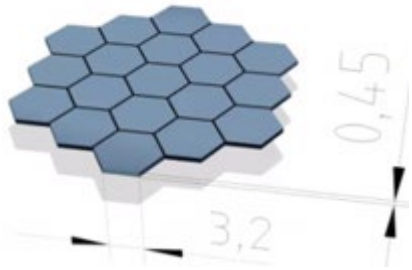
Payload	Configuration	Eff. area (m^2)	Timing res. (μs)
Polarimetry Focusing Array (PFA)	3 telescopes	300 cm^2@ 3 keV	10
Spectroscopy Focusing Array (SFA)	6 telescopes	0.6 m^2@ 1-2 keV	10

New baseline: **5 SDDs (timing) (SFA-T) + 1 PN-CCD (imaging) SFA-I**

eXTP SDD detector

19-cell SDD Detector

Item	Requirement	Goal
Energy range	0.5-10 keV	0.3-12 keV
Energy resolution (FWHM)	≤180 eV @ 6 keV	≤150 eV @ 6 keV
Time resolution	10μs	6μs
Absolute time accuracy	2 μs	1μs
Dead time	≤ 5% @ 1Crab	≤3 % @ 1Crab
Maximum source flux	≥ 15 Crab	≥ 20 Crab



19-cell SDD by HLL (Peter Lechner)

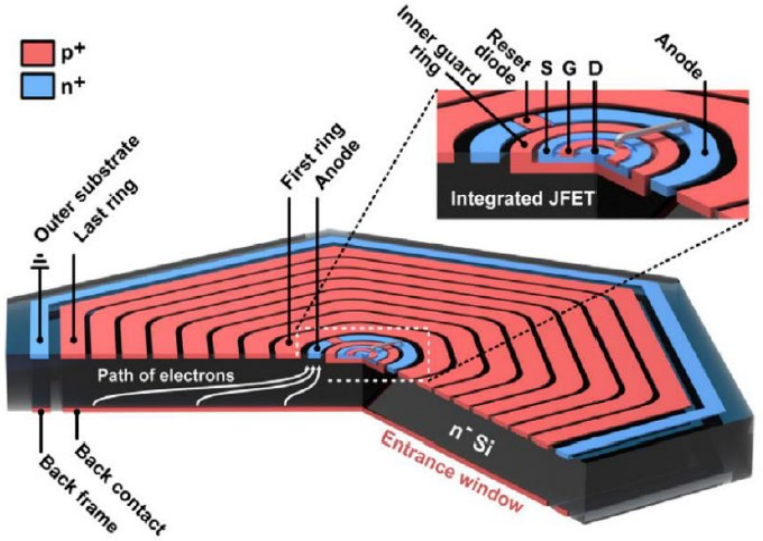
Cells	19
Cell size (edge length)	3.2mm / 2.1´
Cell area	26.6 mm²
Total cell area	5.05 cm²
Angular res.	~W90 (3´, 4.6 mm)

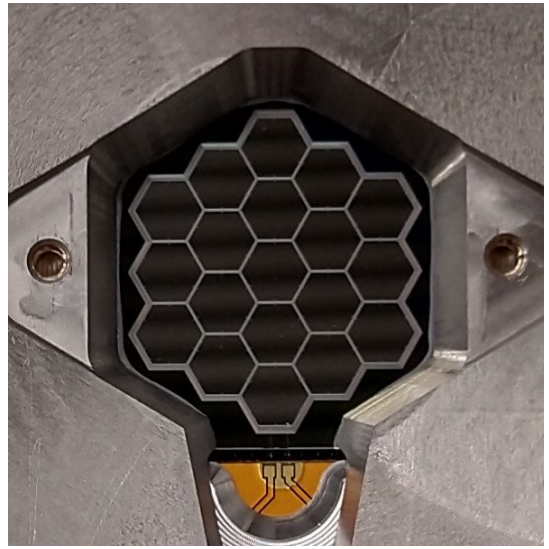
eXTP Detector development

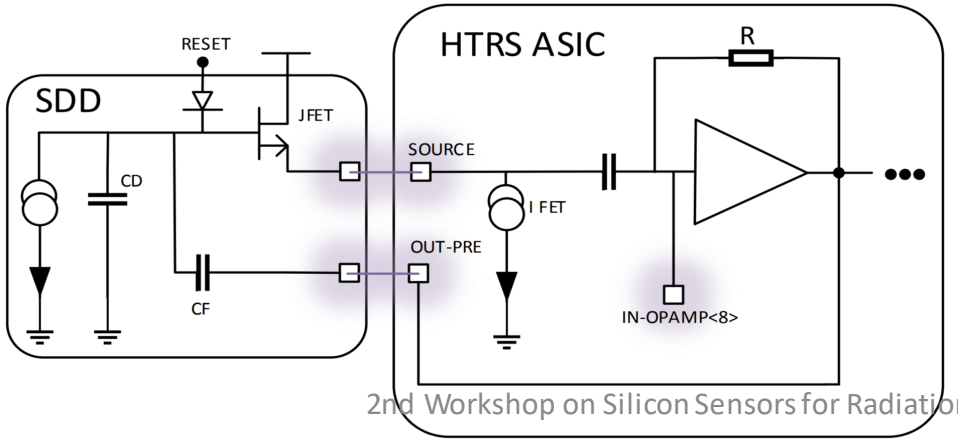
- **19-cell SDD detector** development started at MPE in **2018**

  → technology development phase:

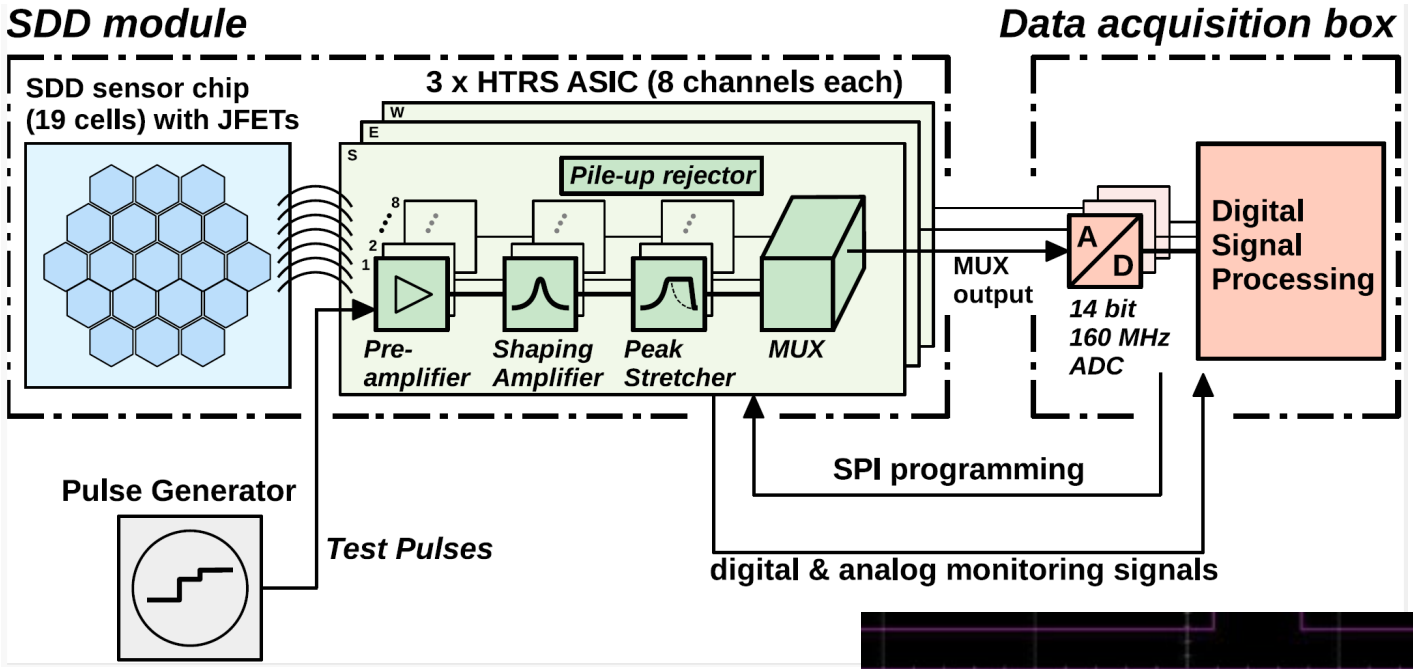
  - **SDD sensor** development (**HLL**)
  - **HTRS ASICs** (**Politecnico di Milano**)
  - **BB detector design + assembly** (**MPE**)
  - **X-ray test (Fe^{55} source) + data analysis** (**MPE**)

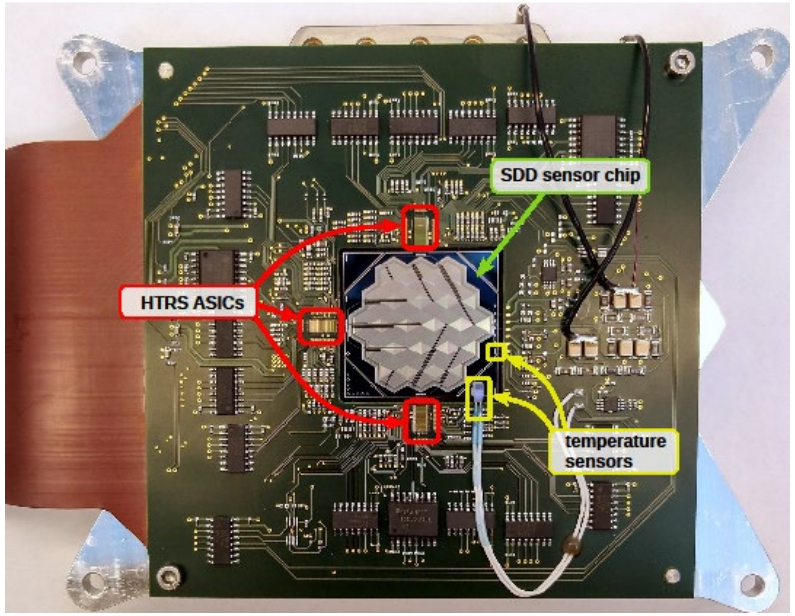




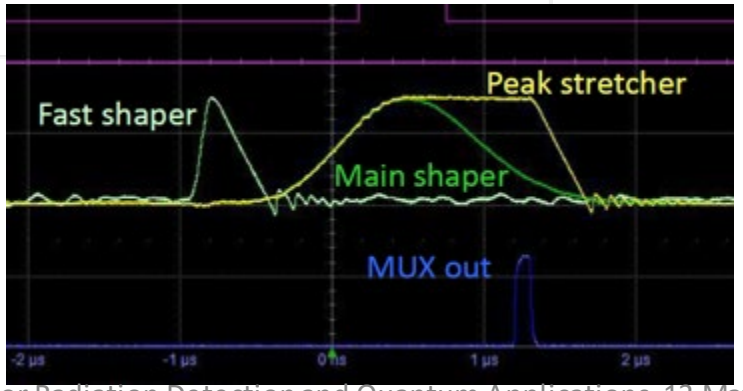


eXTP Detector development





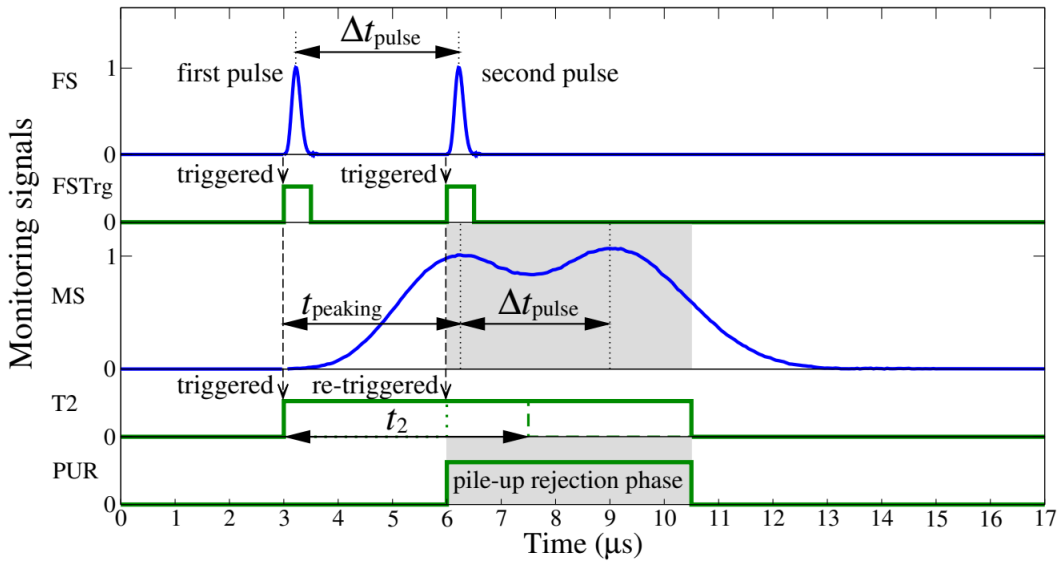
Photon detection chain

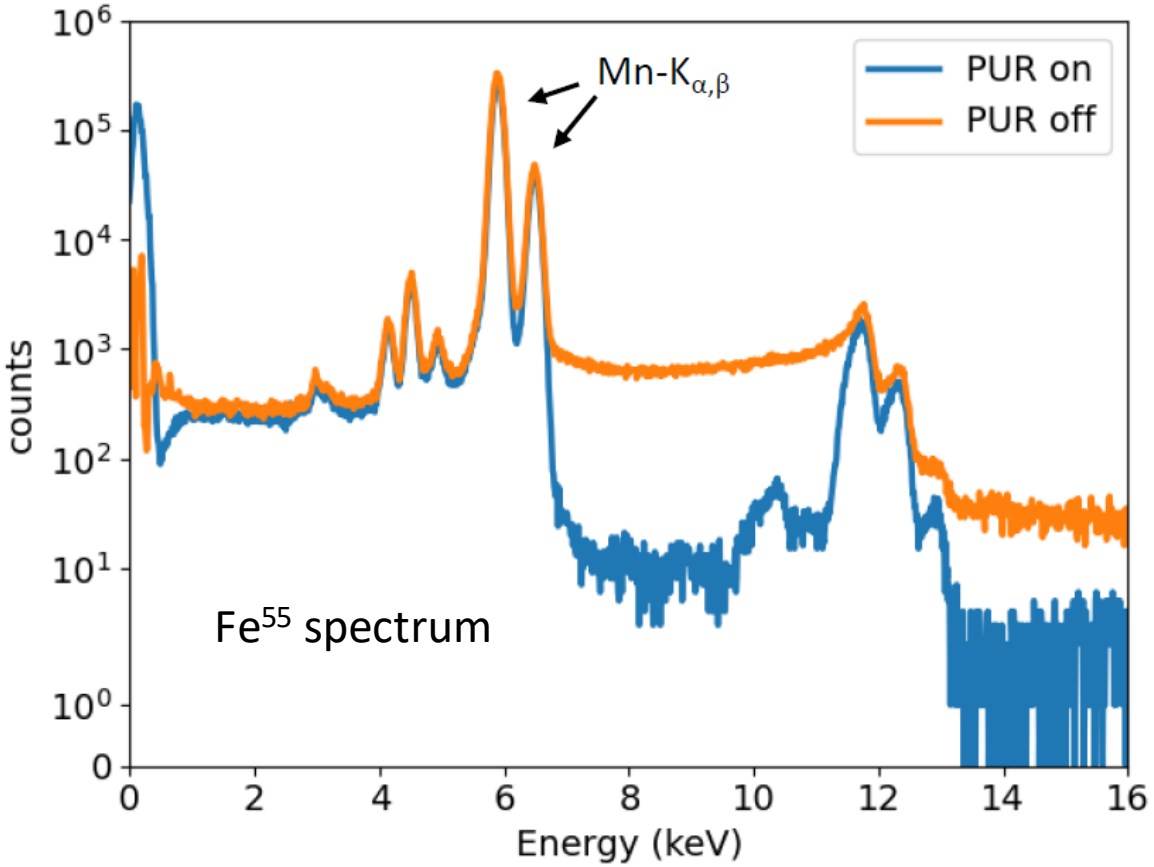


Prototype SDD detector module

eXTP Detector development

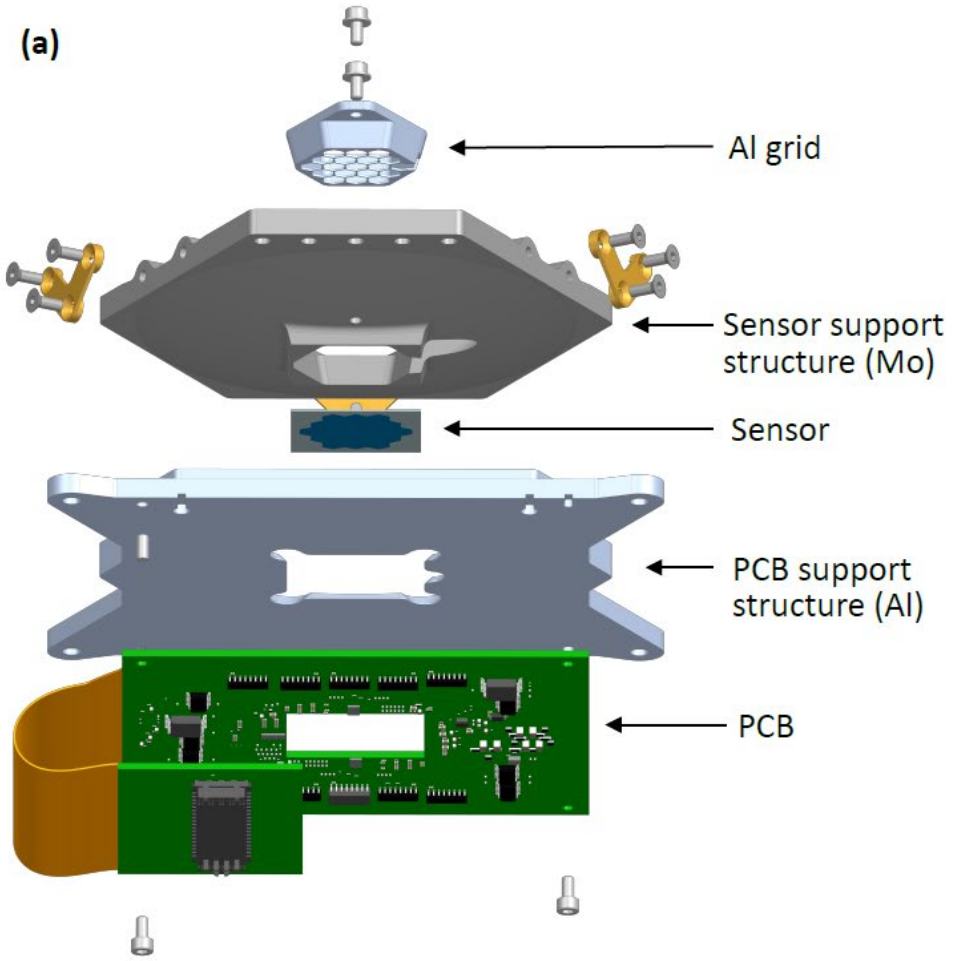
Pile-up rejection:
(important at high photon rates)

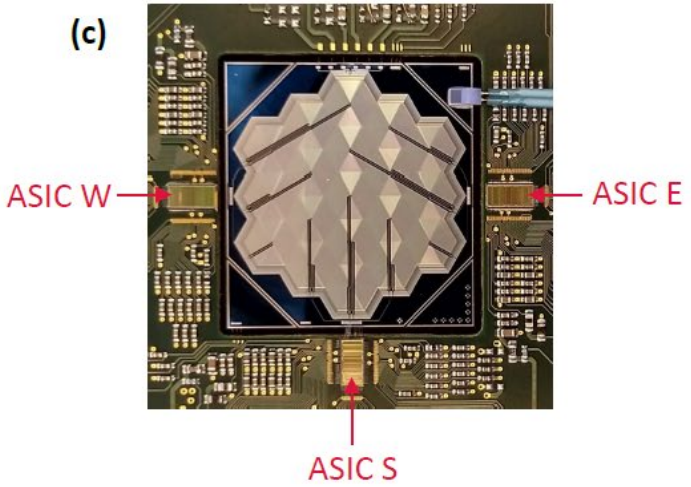




19-cell SDD Detector

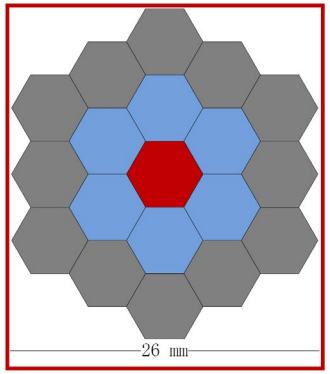
BB SDD detector:

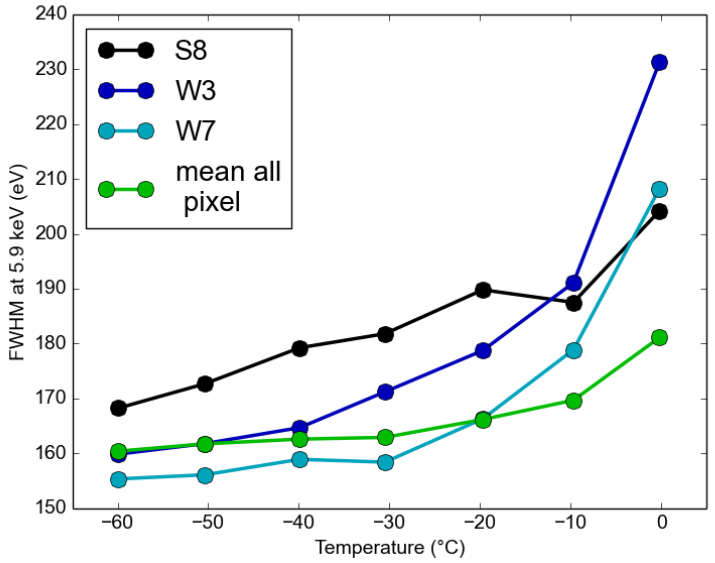




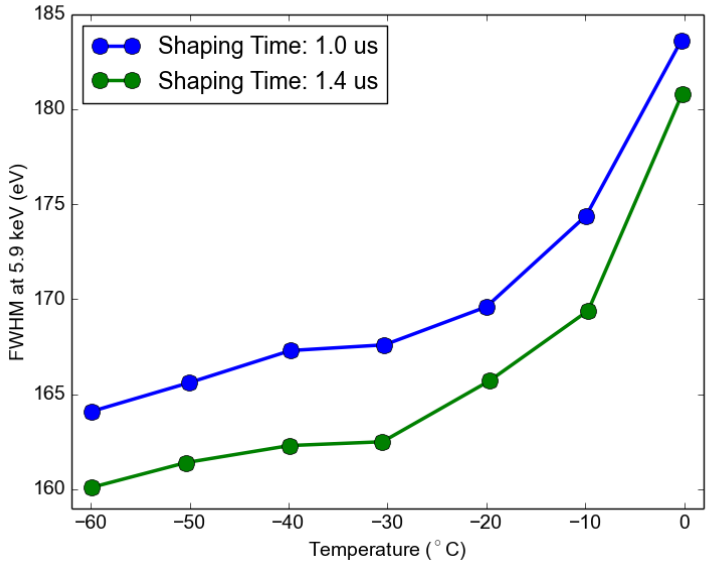
eXTP Detector development

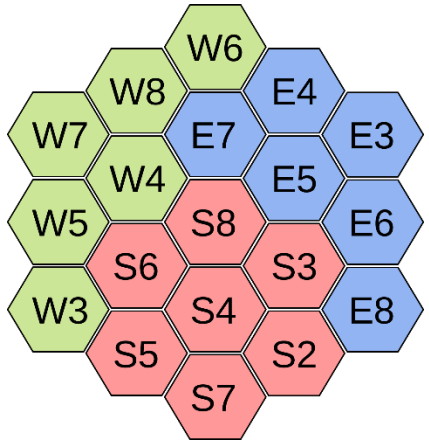
BB SDD detector results with Fe^{55} source





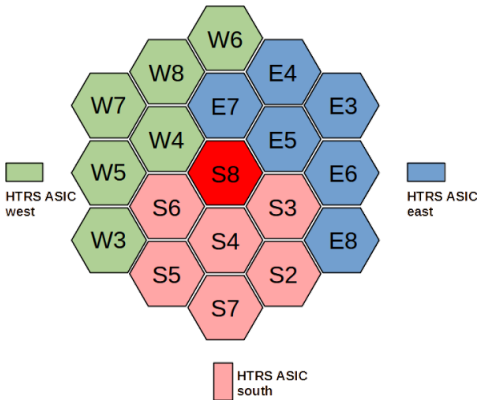
A. Altmann, SPIE 2024

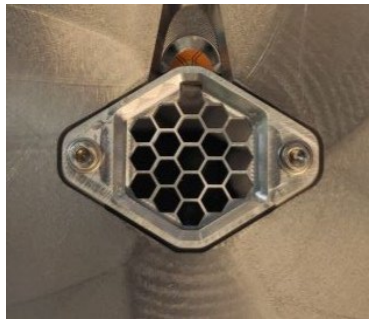


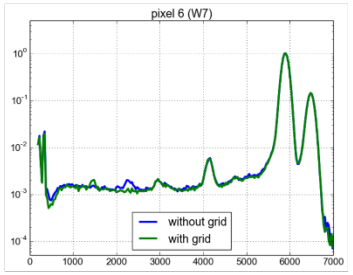


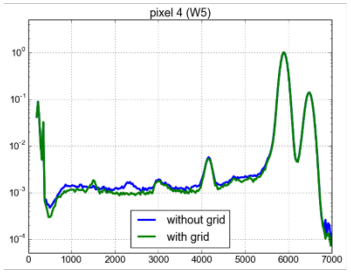
LEO: T=-30°C (TEC)
Jan. 2025: Orbit change
HEO: T=-55°C (pass. cooling)

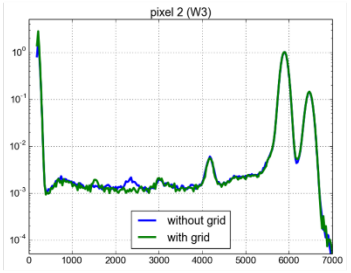
eXTP Detector development

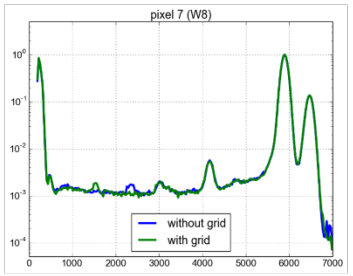


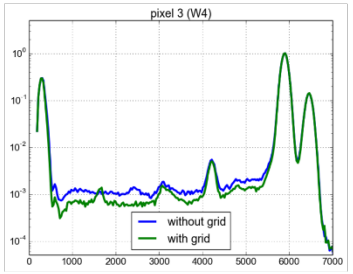


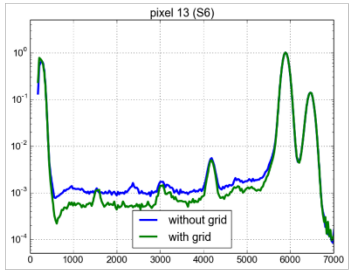


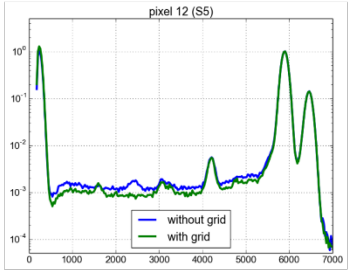


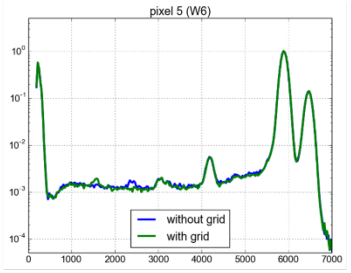


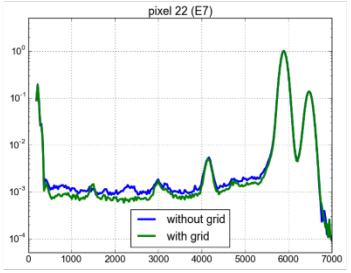


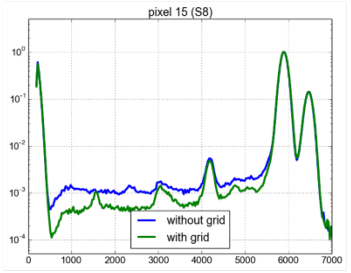


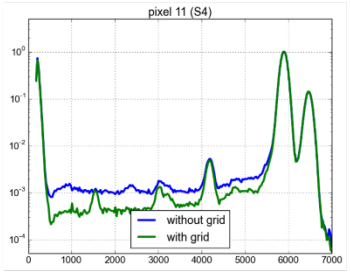


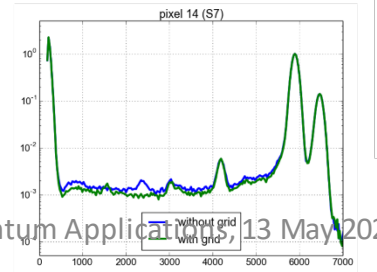


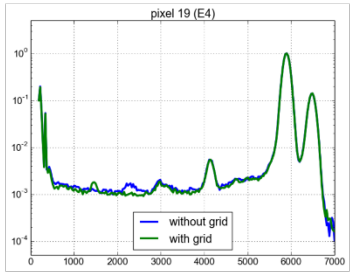


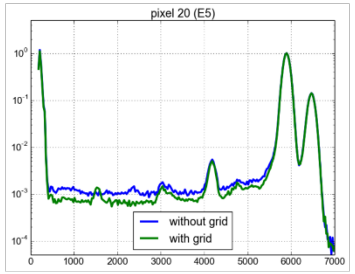


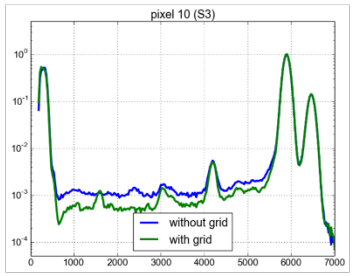


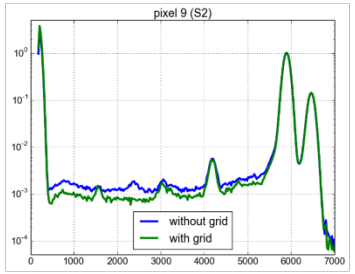


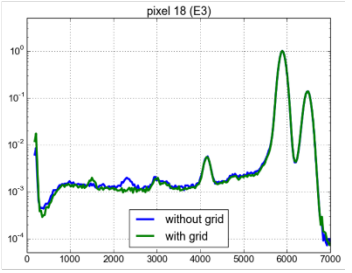


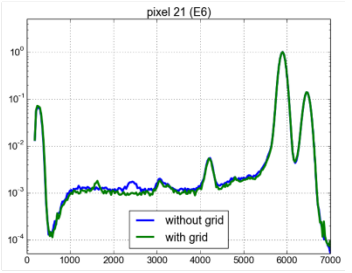


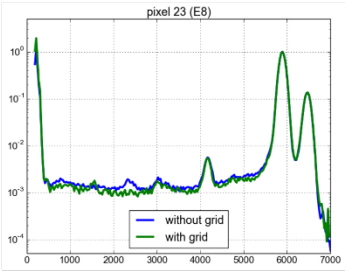








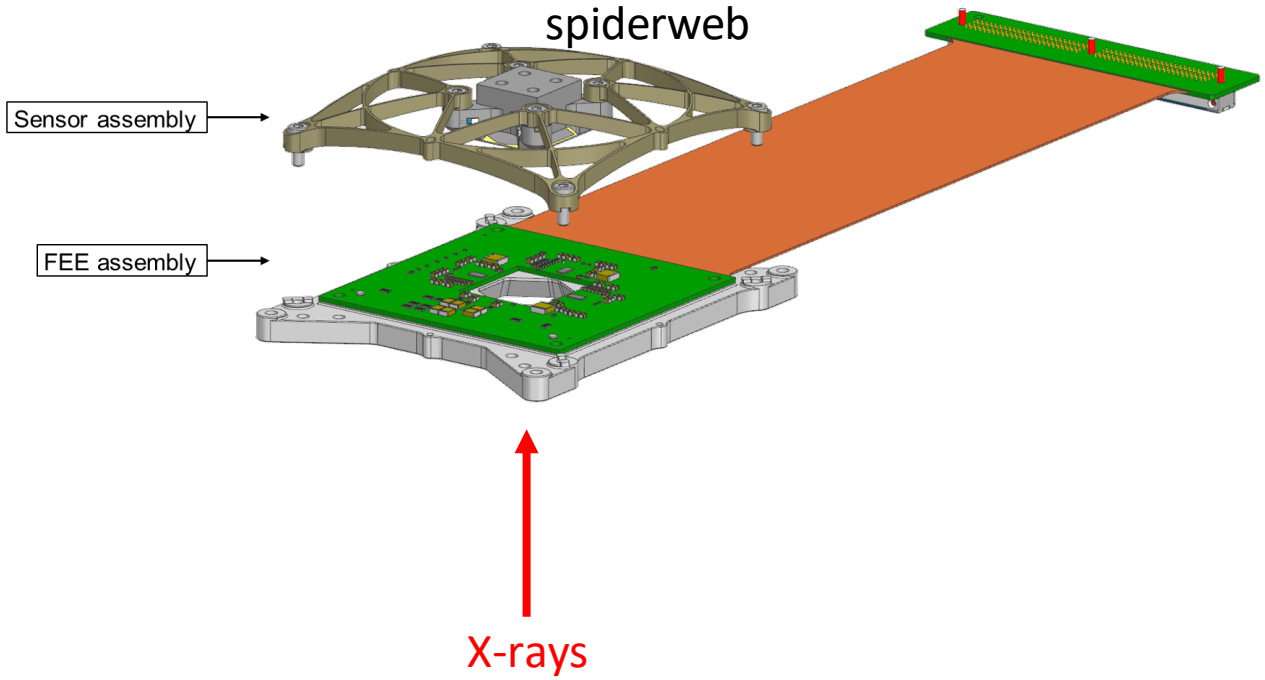




eXTP Detector development for flight

EFM detectors:

- PCB redesigned and assembled
- Redesign of mech-thermal assembly
- Structural + thermal analysis
- Parts currently manufactured at MPE workshop
  → assembly
  → tests + data analysis
- Preparation of documentation (ICD, operating manual)
- Preparation of low-energy X-ray performance tests



eXTP Detector development for flight

Schedule:

2024: eXTP selected by CAS

Early 2025: eXTP approved in China

- **MoU IHEP/CAS with MPE in preparation**
- **Delivery of eXTP ASIC module – asap**
- **Delivery of 2 EFM SDD modules – IHEP request: September 2025**

Sept. 2025 eXTP PDR

- **Delivery of 2 QM SDD modules – IHEP request: June 2026**
- **Delivery of 9 SDD FM + FS SDD modules – IHEP request: June 2027**
- ***Dec. 2027: eXTP CDR (tbc)***
- **January 2030: eXTP *satellite launch***

High urgency to start flight SDD production at HLL asap!

Thank you!