The Chinese HXMT Mission: the OAS Bologna/Uni Ferrara involvement

Mauro Orlandini

on behalf of the Bologna/Ferrara HXMT group

Rev: 0.2 (2018/12/05)

The Italian HXMT Team

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Lorenzo Amati	Enrico Virgilli
Nicola Masetti	
Eliana Palazzi	
Luciano Nicastro	
Loredana Bassani	
Angela Malizia	
Vito Sguera	

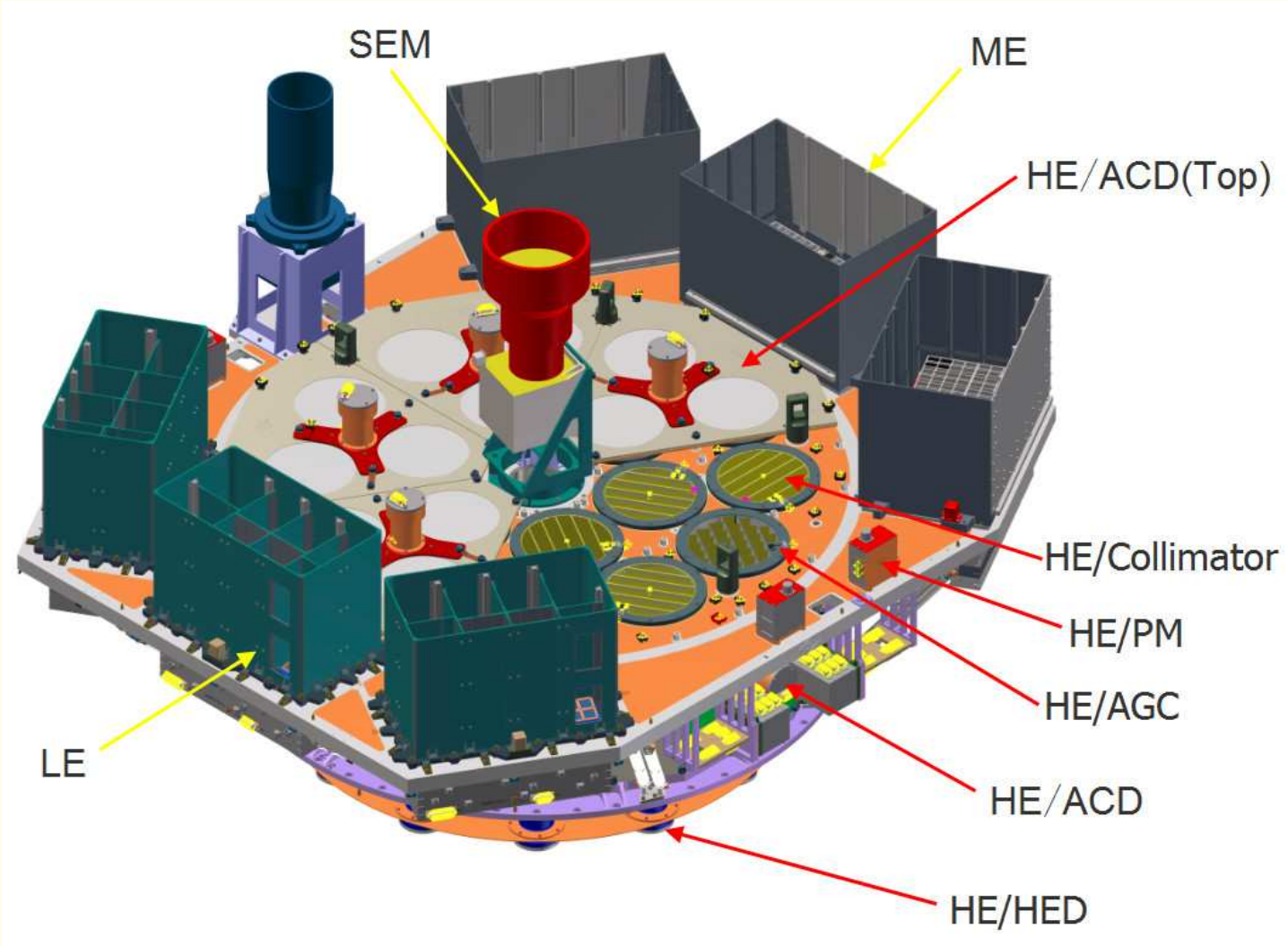
The Italian HXMT Team

Joint HXMT Meeting in Beijing (April 10–13, 2018)

The HXMT Mission

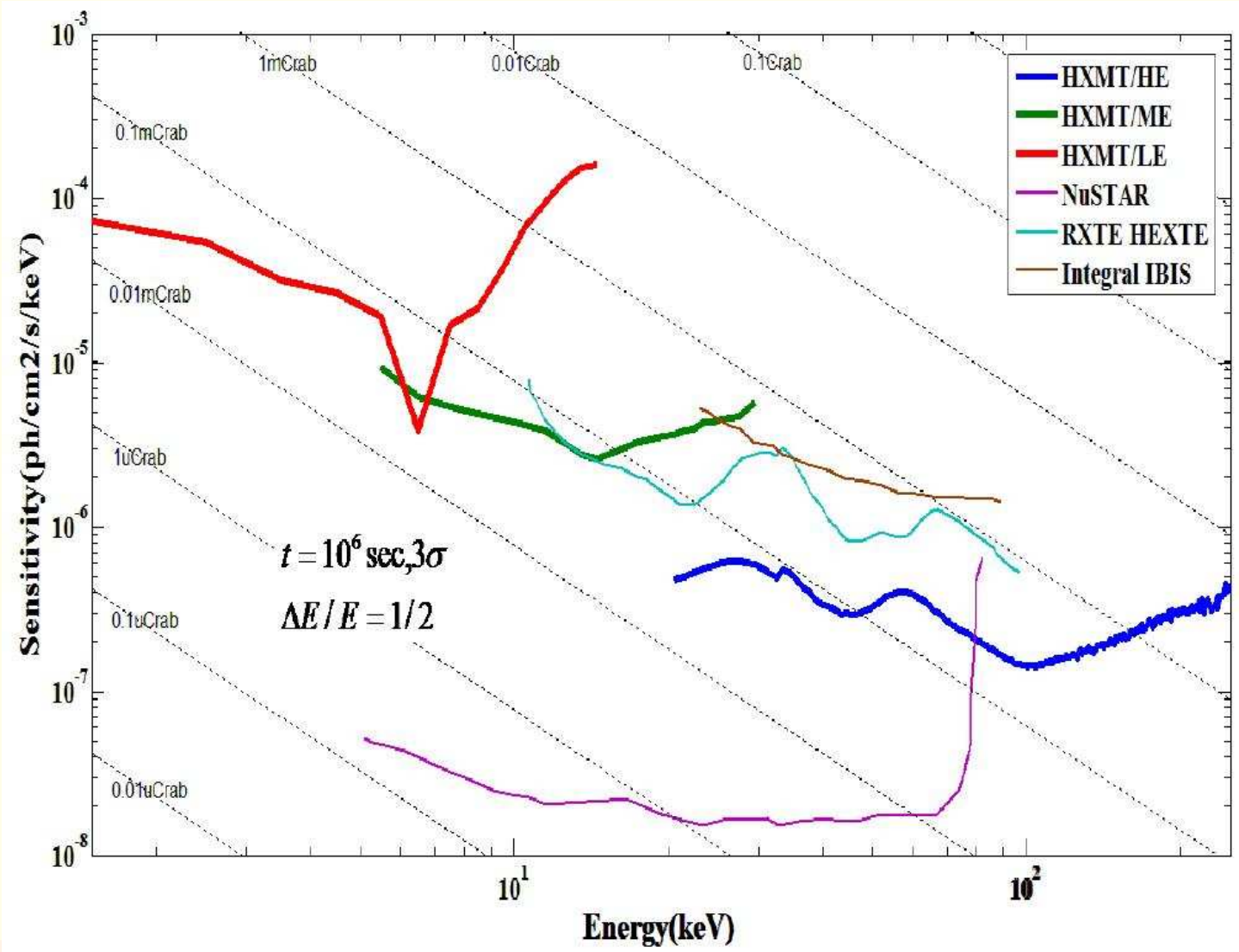
Long March 4B rocket carrying the Hard X-ray Modulation Telescope (HXMT) blasts off from Jiuquan Satellite Launch Center on June 15, 2017.

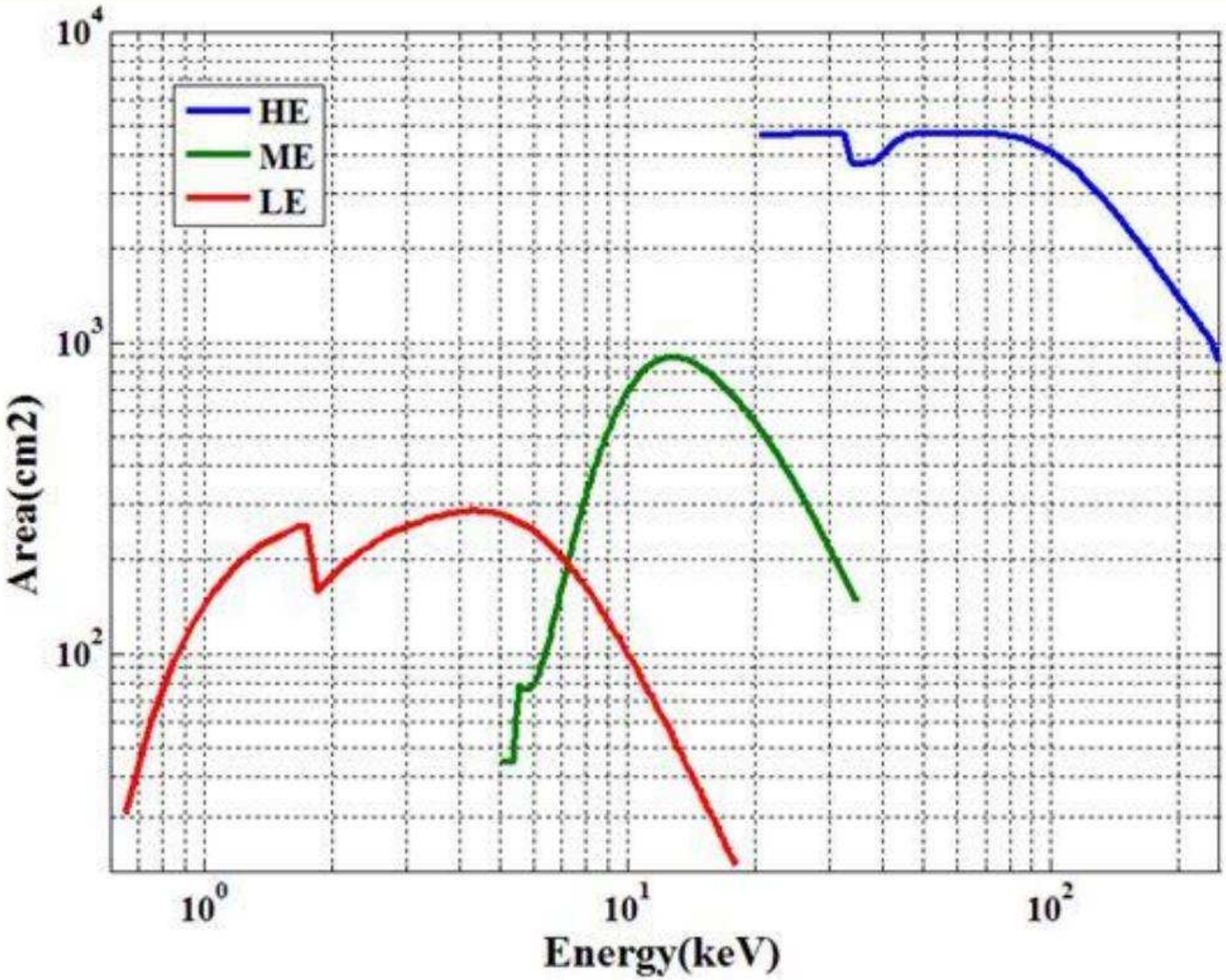
The HXMT Mission



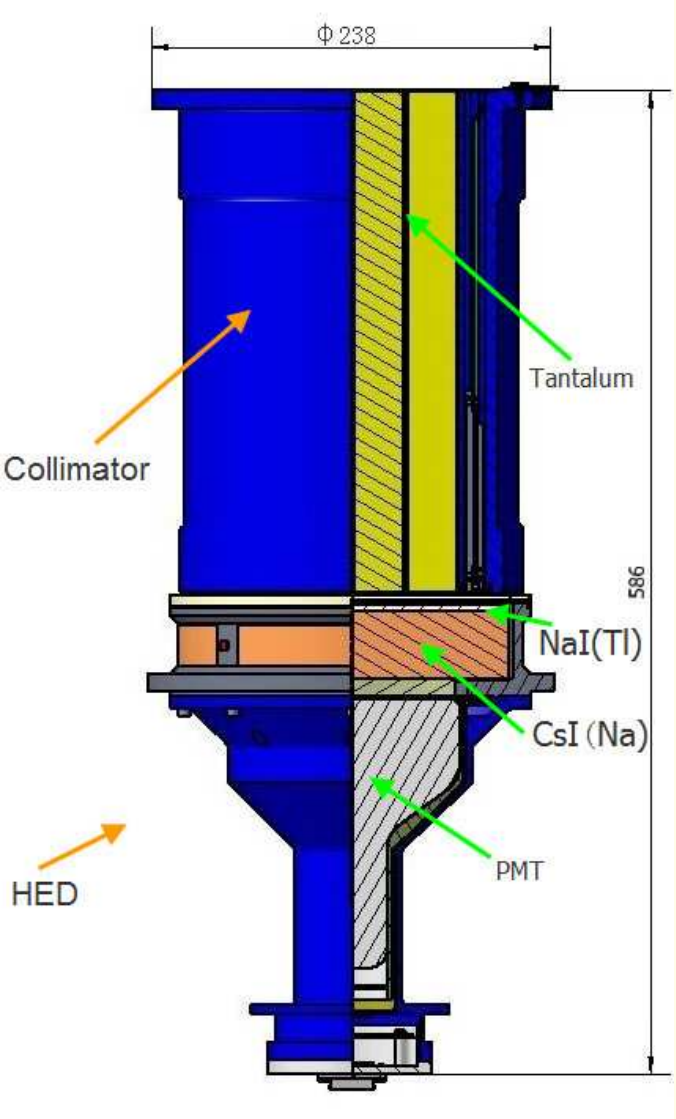
The HXMT Mission

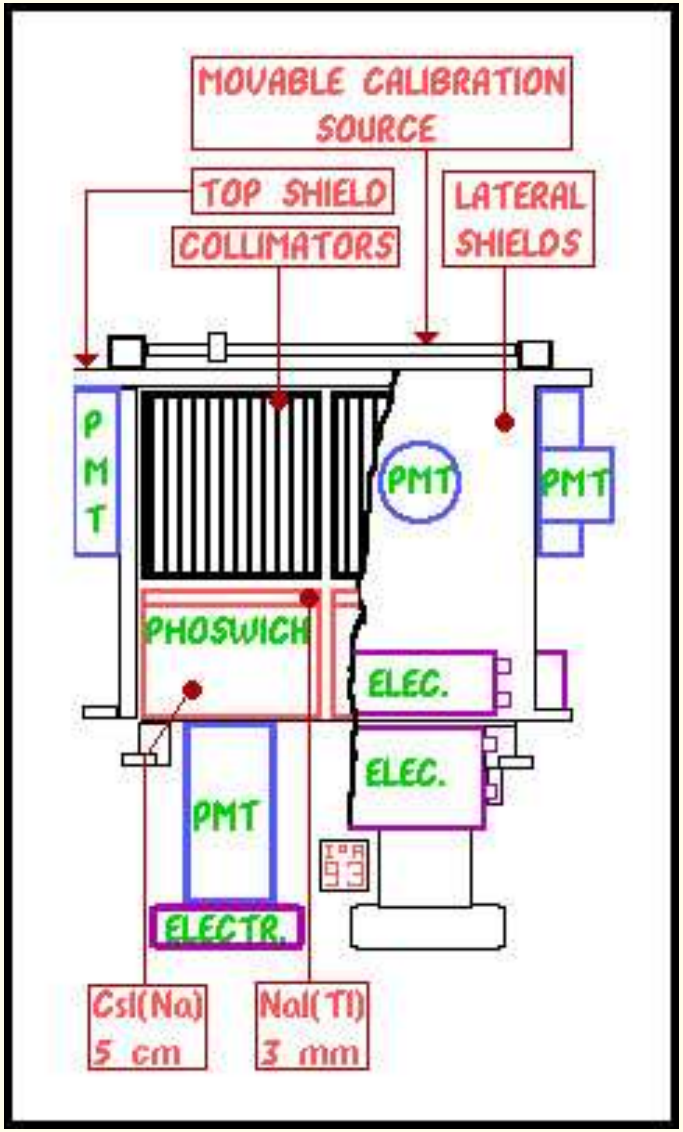
Detectors	LE: SCD, 384 cm^2 ME : Si-PIN, 952 cm^2 HE : NaI/CsI, 5000 cm^2
Energy Range	LE: 1-15 keV ME: 5-30 keV HE: 20-250 keV
Time Resolution	HE: 25 μ s ME: 280 μ s LE: 1 ms
Energy Resolution	LE: 2.5% @ 6 keV ME: 14% @ 20 keV HE: 19% @ 60 keV
Field of View of one module	LE: 6°x1.6°; 6°x4°,60°x3°,blind ME: 4°x1°, 4°x4°,blind HE: 5.7°x1.1°,5.7°x5.7°,blind
Angular Resolution (20 σ source)	< 5'
Source Location (20 σ source)	<1'
Sensitivity (3 σ , in 10^5s)	0.5 mCrab (only statistical uncertainties included）
Orbit	Altitude: ~550 km
Attitude	Inclination: ~43° Three-axis stabilized
	Control precision: 0.1°
	Measurement accuracy: 0.01°
Data Rate	LE: 3 Mbps ME: 3 Mbps HE: 300 kbps
Payload Mass	~1000 kg
Nominal Mission Lifetime	4 years
Working Mode	Scan, pointing, GRB



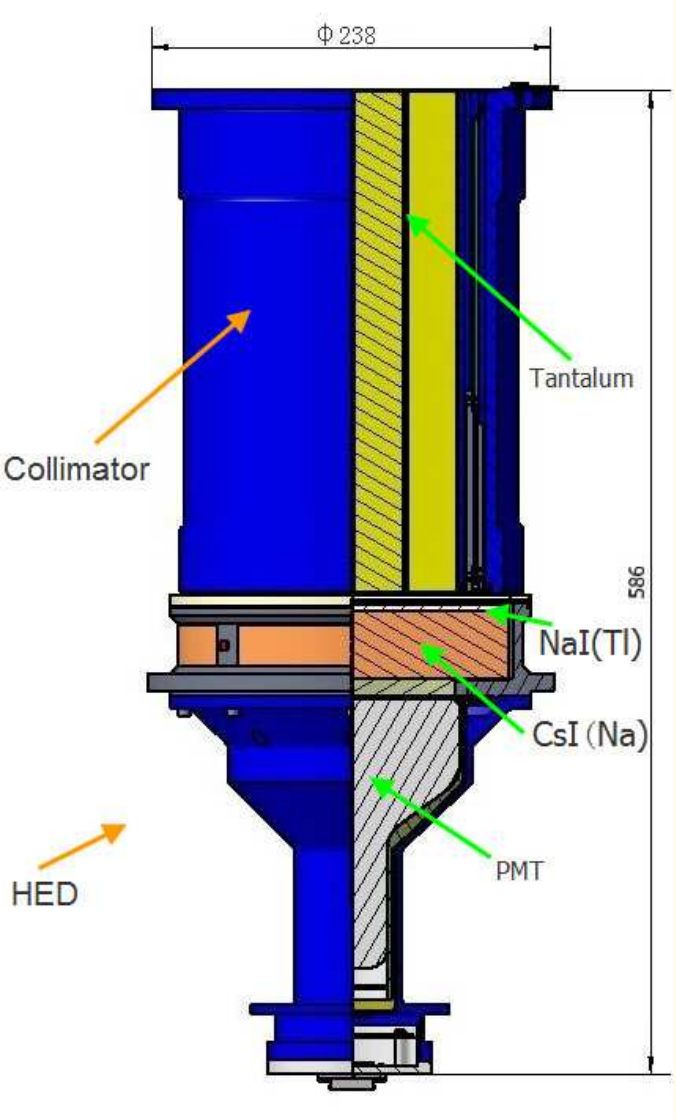


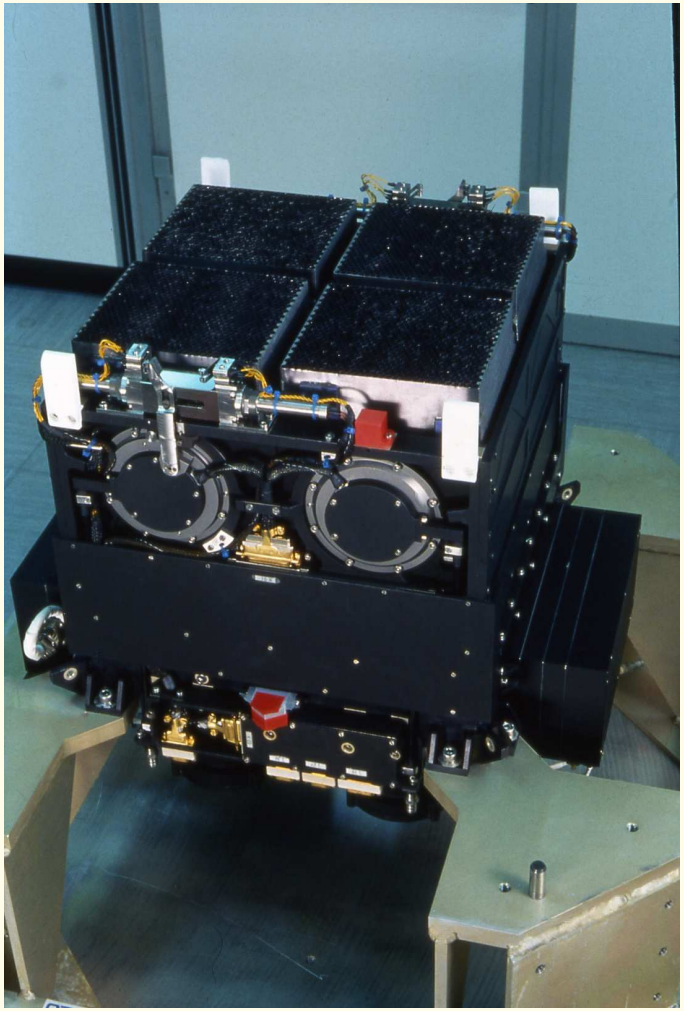
PDS/HE Analogies





PDS/HE Analogies





Because of the analogies of the HE instrument aboard HXMT and the PDS experiment aboard BeppoSAX, we were contacted by the Chinese team in 2002 for a possible collaboration.
Approved proposals:

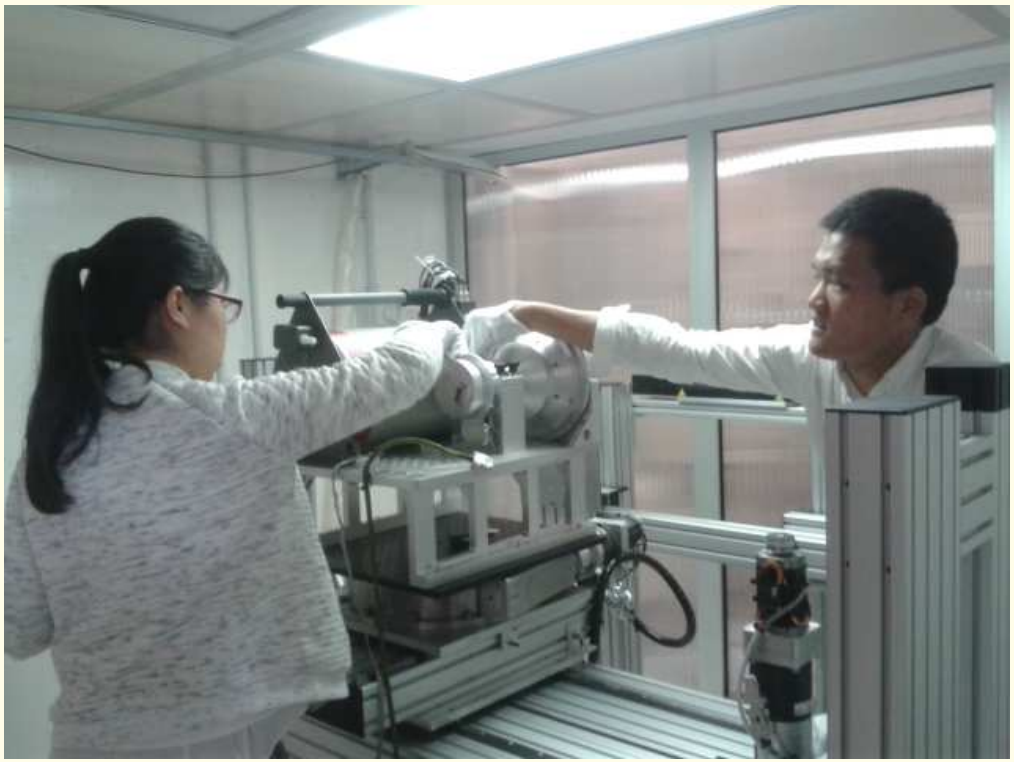
Chinese–Italian Cooperation in X-ray Astronomy on Mobility (MEF). 2002

A polarimeter for the HXMT Mission (ASI). 2006

Calibration of HE Modules at the LARIX Facility in Ferrara (ASI). 2015

Scientific Exploitation of Data from the Chinese Insight-HXMT Mission (ASI). 2017

The HE/HXMT Module calibrations at the LARIX facility at the Ferrara University Physics Department (5–15 October 2015):



Scan of the Galactic Plane:

looking at new transient sources and monitoring of known variable sources;

Pointing observations of X–ray binaries:

broad band spectral studies and temporal studies, for exploring emission mechanisms in strong gravitational and magnetic fields;

Observations of Gamma–Ray Bursts (GRBs)

All the detectors aboard HXMT have not imaging capability. The imaging is obtained *post-facto* by combining the counts observed from units with different collimator direction. The technique is called **Direct Demodulation**.

Astronomy & Astrophysics manuscript no. syndd
September 5, 2018

Synthetic direct demodulation method and its applications in *Insight*-HXMT data analysis ⋆

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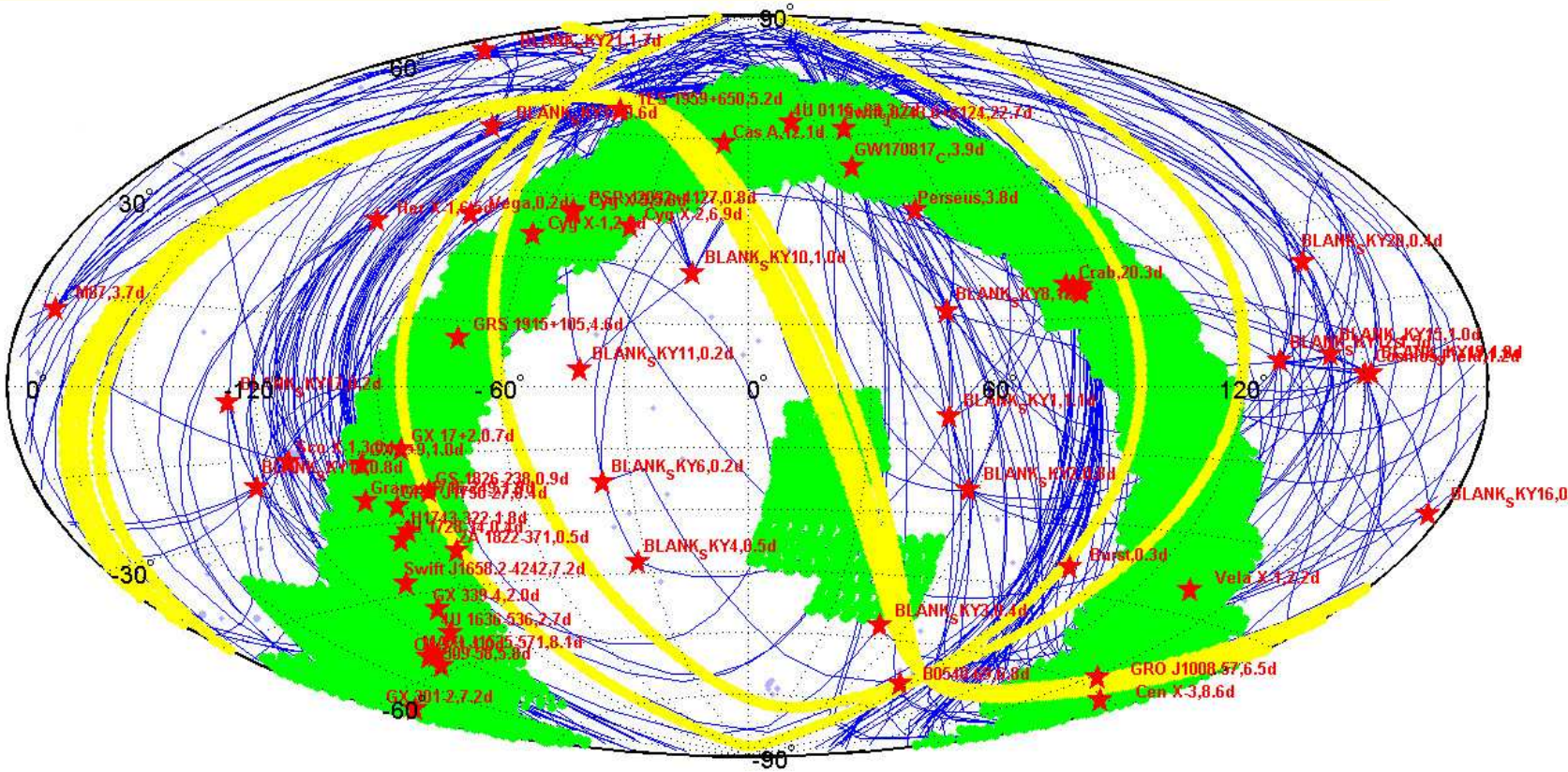
September 5, 2018

ABSTRACT

Aims. A modulation equation relates the observed data to the object where the observation is approximated by a linear system. Reconstructing the object from the observed data is therefore is equivalent to solving the modulation equation. In this work we present the synthetic direct demodulation (synDD) method to reduce the dimensionality of a general modulation equation and solve the equation in its sparse representation.
Methods. A principal component analysis is used to reduce the dimensionality of the kernel matrix and k-means clustering is applied to its sparse representation in order to decompose the kernel matrix into a weighted sum of a series of circulant matrices. The matrix-vector and matrix-matrix multiplication complexities are therefore reduced from polynomial time to linear-logarithmic time. A general statistical solution of the modulation equation in sparse representation is derived. Several data-analysis pipelines are designed for the Hard X-ray modulation Telescope (*Insight*-HXMT) based on the synDD method.
Results. In this approach, a large set of data originating from the same object but sampled irregularly and/or observed with different instruments in multiple epochs can be reduced simultaneously in a synthetic observation model. We suggest using the proposed synDD method in *Insight*-HXMT data analysis especially for the detection of X-ray transients and monitoring time-varying objects with scanning observations.

Key words. methods: data analysis – methods: numerical – techniques: image processing – x-rays: general

Scientific Results



Insight-HXMT Observations（till 2018.5.31）

	Mode	Type	Source Name	Obs. Frequency	Obs. Time（ks）
1	Point	SNR	Cas A	9	530
2		Pulsar	Crab	86	1530
3			PSR B0540-69	7	250
4			PSR B1509-58	12	310
5		BH Binary	Cyg X-1	12	270
6			Granat 1716-249	2	250
7			GRS 1915+105	24	720
8			GX 339-4	1	100
9			H 1743-322	15	180
10			MAXI J1535-571	18	430
11			MAXI J1543-564	1	80
12			MAXI J1820+070	61	1360
13			Swift J1658.2-4242	23	470
14		NS Binary	Aql X-1	3	30
15			Cen X-3	14	400
16			Cir X-1	6	100
17			Cyg X-2	22	540
18			Cyg X-3	15	390
19			GRO J1008-57	11	340
20			GRO1750-27	1	15
21			GS 1826-238	1	40
22			GX 301-2	15	400
23	Point	NS Binary	GX9+9	4	80
24			GX 13+1	1	30
25			GX 17+2	9	210
26			Her X-1	12	380
27			Sco X-1	6	180
28			Vela X-1	1	120
29			2A 1822-371	1	30
30			4U 1728-34	4	90
31			4U 0115+63	11	150
32			4U1636-536	19	200
33			PSR J2032+4127	4	40
34			NGC 6624	1	30
35			H 1417-624	21	210
36			IGR J16328-4726	2	20
37			Swift J1756.9-2508	1	40
38		TBD	Swift J0243.6+6124	97	1200
39		Extra-galactic	1ES 1959+650	25	255
40			Perseus	2	200
41			M87	4	180
42			Cosmos Field	4	80
43		BlankSky	21	84	840
44	Small Area Scan (SAS)	Crab Area		9	550
45		Galactic Plane	22 regions	324	3600

http://www.hxmt.org/index.php/plan/lplan

#	Bibcode Authors	Score Title	Date	List of Links Access Control Help
1	2018ApJ...866..122H Huang, Y.; Qu, J. L.; Zhang, S. N.; Bu, Q. C.; Chen, Y. P.; Tao, L.; Zhang, S.; Lu, F. J.; Li, T. P.; Song, L. M.; and 114 coauthors	1.000 INSIGHT-HXMT Observations of the New Black Hole Candidate MAXI J1535-571: Timing Analysis	10/2018	A E F X R C S U
2	2018ApJ...864L..30C Chen, Y. P.; Zhang, S.; Qu, J. L.; Zhang, S. N.; Ji, L.; Kong, L. D.; Cao, X. L.; Chang, Z.; Chen, G.; Chen, L.; and 102 coauthors	1.000 Insight-HXMT Observations of 4U 1636-536: Corona Cooling Revealed with Single Short Type-I X-Ray Burst	09/2018	A E F R C S U
3	2018cosp...42E3443T Tuo, Youli; Zhang, Yue	1.000 The Insight-HXMT observation of the newly discovered transient X-ray pulsar Swift J0243.6+6124	07/2018	A U
4	2018ATel11799....1H Huang, Yue; Liao, Jinyuan; Ge, Mingyu; Xiong, Shaolin; Zhang, Shu; Qu, Jinlu; Lu, Fangjun; Song, Lingming; Zhang, Shuangnan; Insight-HXMT Collaboration	1.000 AT2018cow: Insight-HXMT/HE data search	06/2018	A E U
5	2018SCPMA..61c1011L Li, TiPei; Xiong, ShaoLin; Zhang, ShuangNan; Lu, FangJun; Song, LiMing; Cao, XueLei; Chang, Zhi; Chen, Gang; Chen, Li; Chen, TianXiang; and 100 coauthors	1.000 Insight-HXMT observations of the first binary neutron star merger GW170817	03/2018	A E X R C U
6	2017ATel10907....1G Ge, Mingyu; Zhang, ShuangNan; Lu, FangJun; Zhang, Shu; Weng, Shanshan; Xiong, Shaolin; Liu, Yuan; Song, Liming; HXMT-Collaboration	1.000 Orbital ephemeris of Swift 0243.6+6124 estimated jointly with Insight-HXMT and Fermi/GBM	10/2017	A E D S U
7	2017ATel10653....1C Chen, Y.; Chen, Y. P.; Liao, J. Y.; Li, C. K.; Ge, M. Y.; Guan, J.; Liu, Y.; Li, T. P.; Lu, F. J.; Song, L. M.; and 5 coauthors	1.000 IGR J17329-2731: Insight-HXMT observation	08/2017	A E

...and 41 GCN.

There are two major research programs:

HXMT Core Science Program

Data shared within the Core Science Team, composed by

1. Hardware Institute Members;
2. Domestic key scientists;
3. International scientists who have either made valuable contribution to HXMT project or recommended by cooperating organizations;

HXMT Guest Observer Program

Users (both domestic and foreign) propose observations not included in the Core Science Program.

`http://www.hxmt.org/index.php/2013-03-22-08-08-48/docs/319-hxmt-data-polocy-of-hxmt`

HXMT Core Science Groups

Group 1: Accreting X-ray binaries

leaders: Qu Jin Lu (qujl@ihep.ac.cn), Zhang Shu (szhang@ihep.ac.cn)

Group 2: Galactic survey and diffuse emission research

leader: Liu Yuan (liuyuan@ihep.ac.cn)

Group 3: Multi-wavelength observations

leader: Liu JiFeng (jfliu@nao.cas.cn)

Group 4: Calibration and background model

leader: Song LiMing (songlm@ihep.ac.cn)

Group 5: Pulsar navigation

leader: Zheng Shi Jie (zhengsj@ihep.ac.cn)

Group 6: Extragalactic sources

leader: Yuan Wei Min (wmy@nao.cas.cn)

Group 7: Gamma-ray bursts and gravitational wave EM counterparts

leader: Xiong Shao Lin (xiongsl@ihep.ac.cn)

Group 8: Non-accreting pulsars

leader: Zhang Shuang Nan (zhangsn@ihep.ac.cn)

http://www.hxmt.org/index.php/2013-03-22-08-08-48/docs/318-scigroup

The Analysis Software

In January 2019 Ji Long, a postdoc at Tuebingen, will be in Ferrara for two weeks, to show how to analyze HXMT data.
The `HXMTDAS` package, part of the standard HEASOFT software, is actually at its release 2.0, available at

`http://www.uu-world.cn/hxmt/hxmtsoft/index2.html`

Thank you!

谢谢