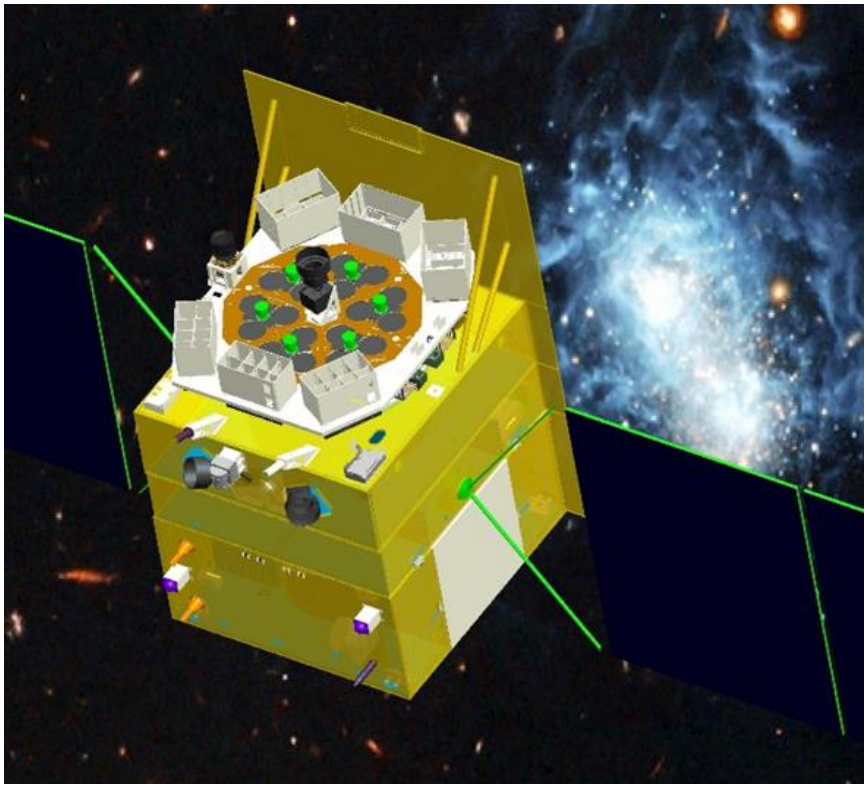


Current Status of the Hard X-ray Modulation Telescope Project

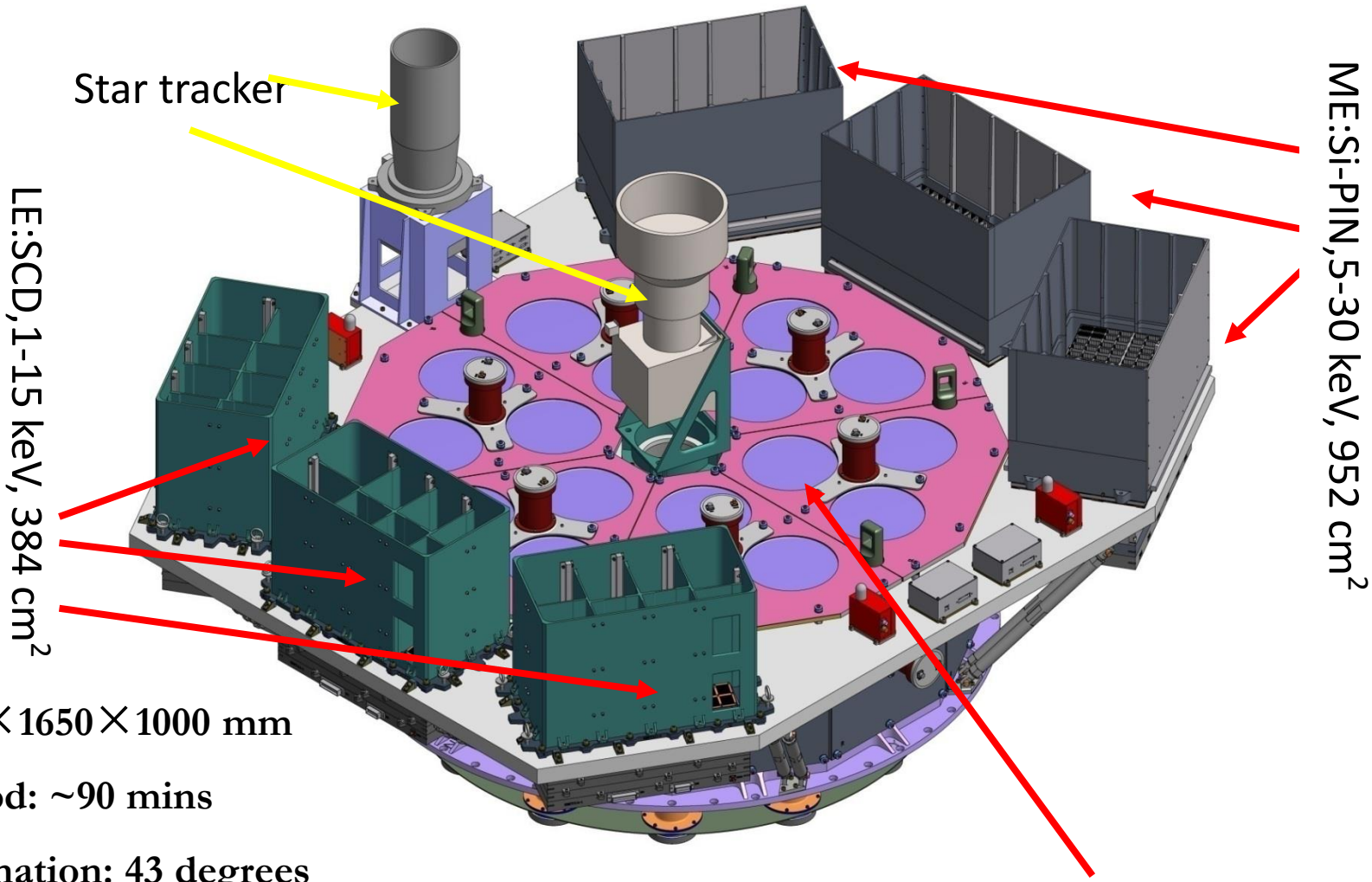
Xiaobo Li, on behalf of the HXMT team
Institute of High Energy Physics, CAS

11th IACHEC @ Pune

Outline:

1. Introduction to the Payloads
2. Scientific objectives of HXMT
3. Ground calibration and simulation of instruments
4. Data flow and development of calibration database
5. Summary

1.Science payloads



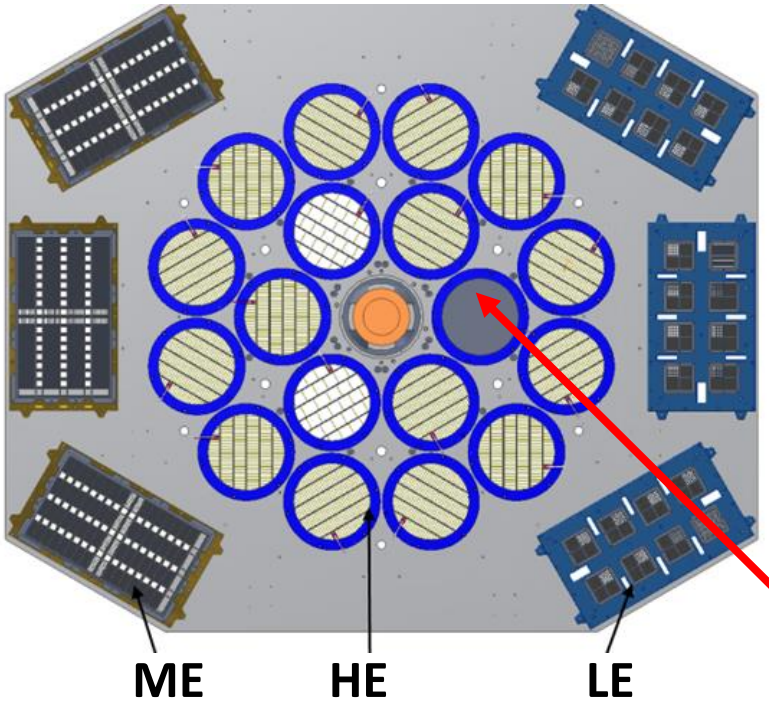
Size：1900×1650×1000 mm

orbital period: ~90 mins

orbital inclination: 43 degrees

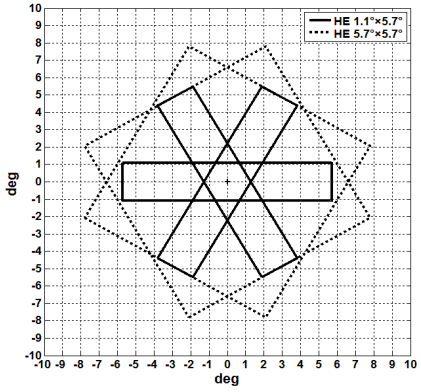
Launch time：2016.11

The high energy Instrument



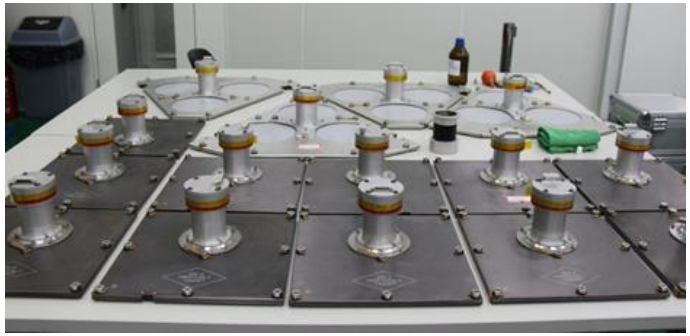
- 18 identical detecting modules , a collimator is equipped in front of each module to form the field of view (FOV)
- 18 anticoincidence detectors (6 top +12 side)
- 18 calibration detectors(automatic gain control)
- 3 particle monitors

FOV size	number	
1.1°×5.7°	15	measure CXB
5.7°×5.7°	2	
Covered (2mm Ta)	1	measure particle background

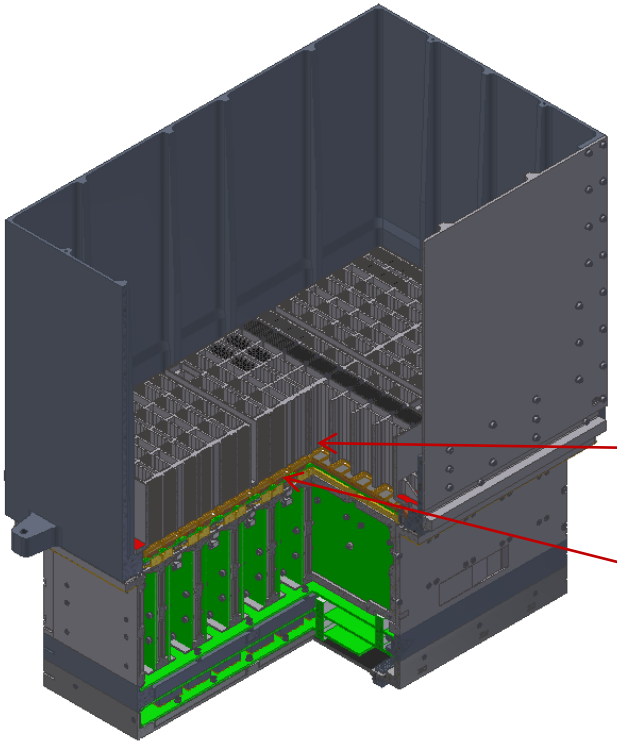


Detecting modules

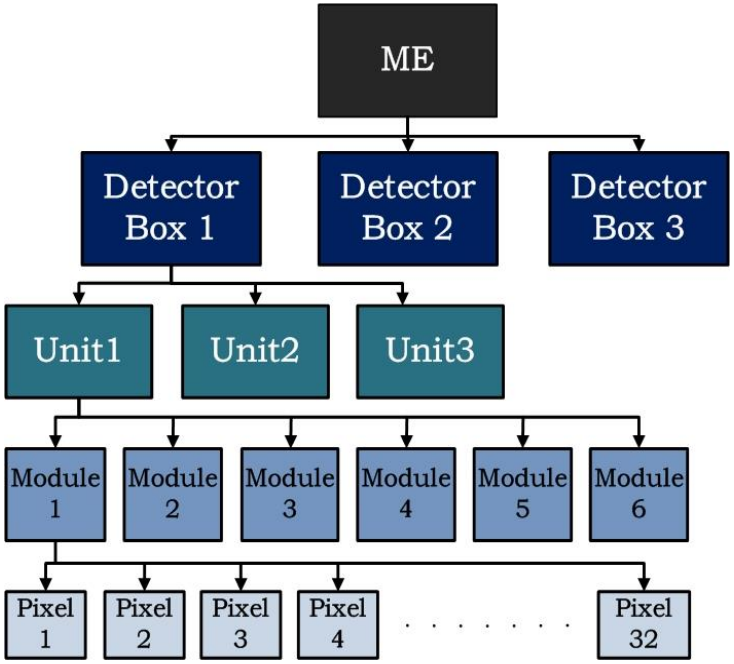
anticoincidence detectors

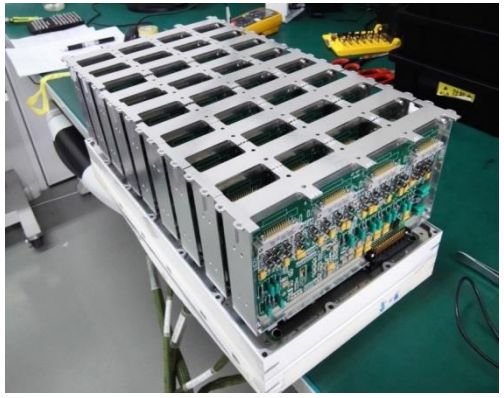


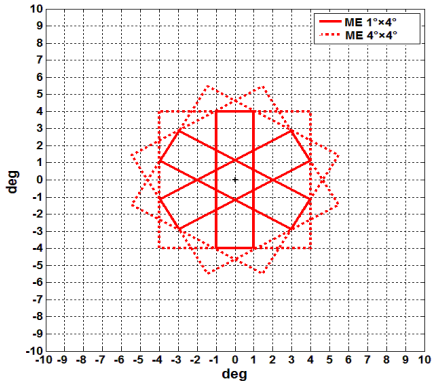
The medium energy Instrument



ME uses 1728 Si-PIN detectors read out by 54 ASIC (application specified integrated circuit).

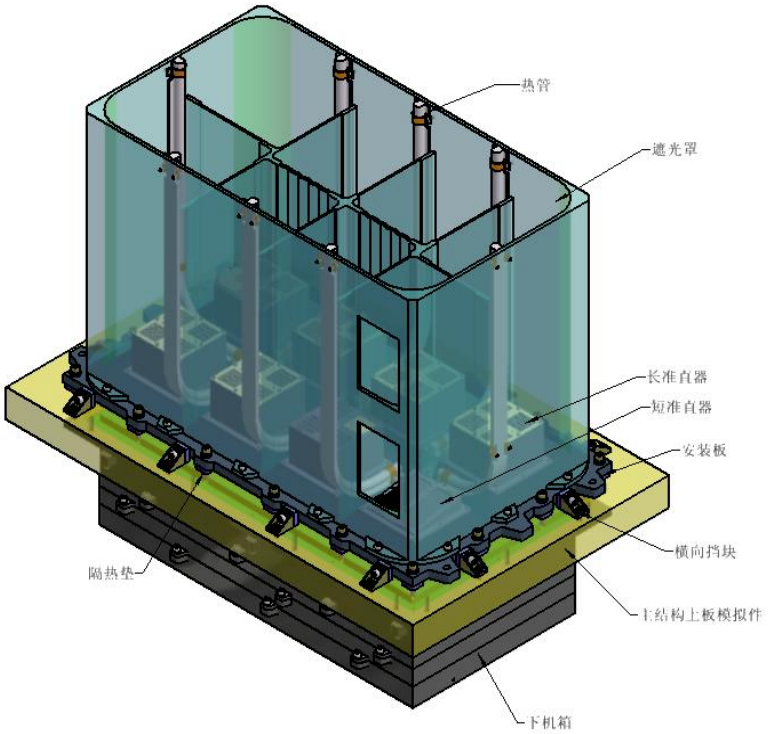




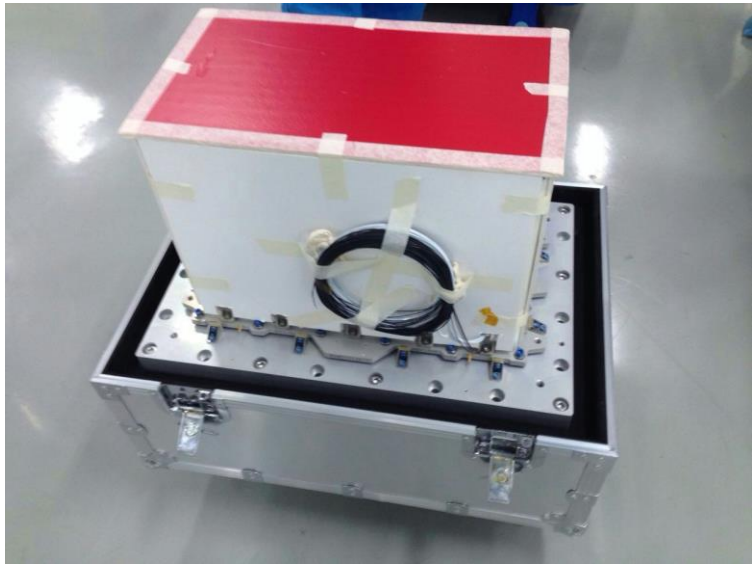


size	number
1° ×4°	45*32
4° ×4°	6*32
Covered (0.6mm Ta)	3*32

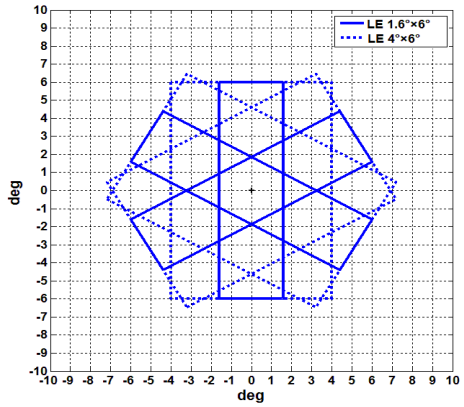
The low energy Instrument



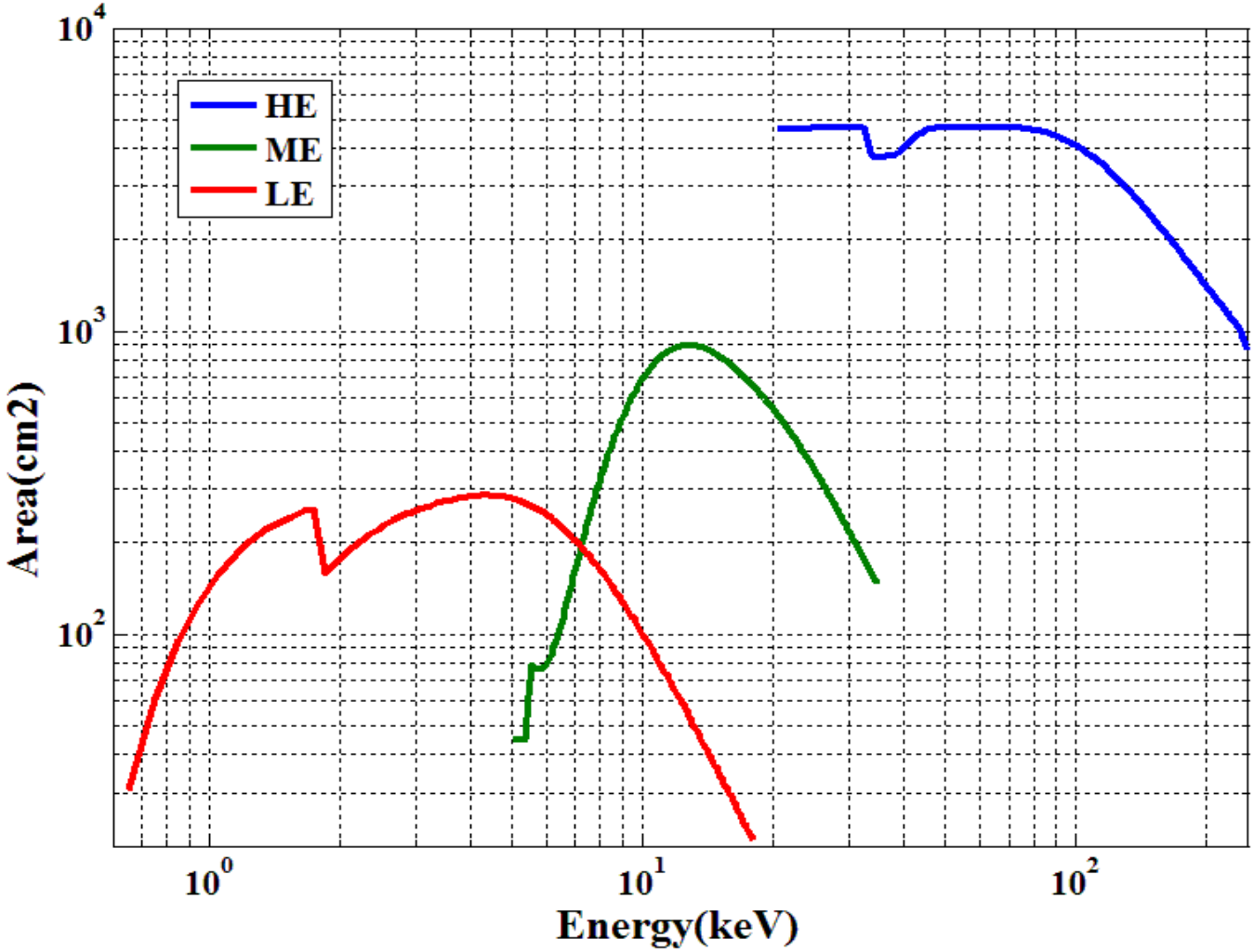
LE consists of 3 detector boxes, and each boxes contains 32 SCDs.



size	number
1.6° ×6°	60
4° ×6°	18
Covered (1mm Al)	6
50~60° ×2~6° (sky monitor)	6

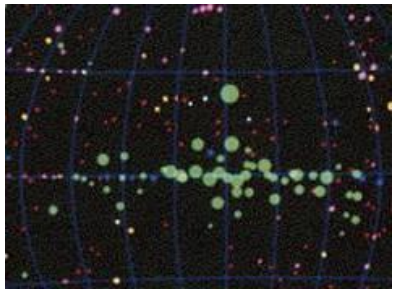


Effective Areas of HXMT instruments

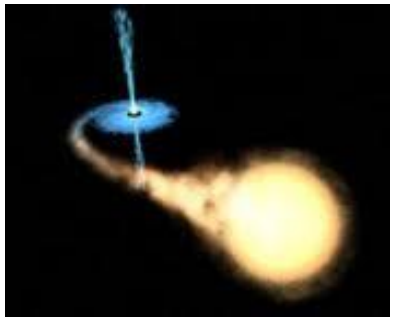


2.Scientific objectives

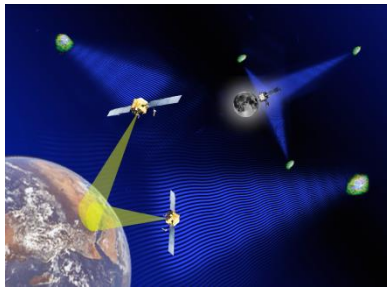
broad band X-ray survey;
detection of new sources,
especially for burst objects.



Observe fast X-ray variability and spectra in black hole systems and investigate fundamental physical processes in strong gravitational field.

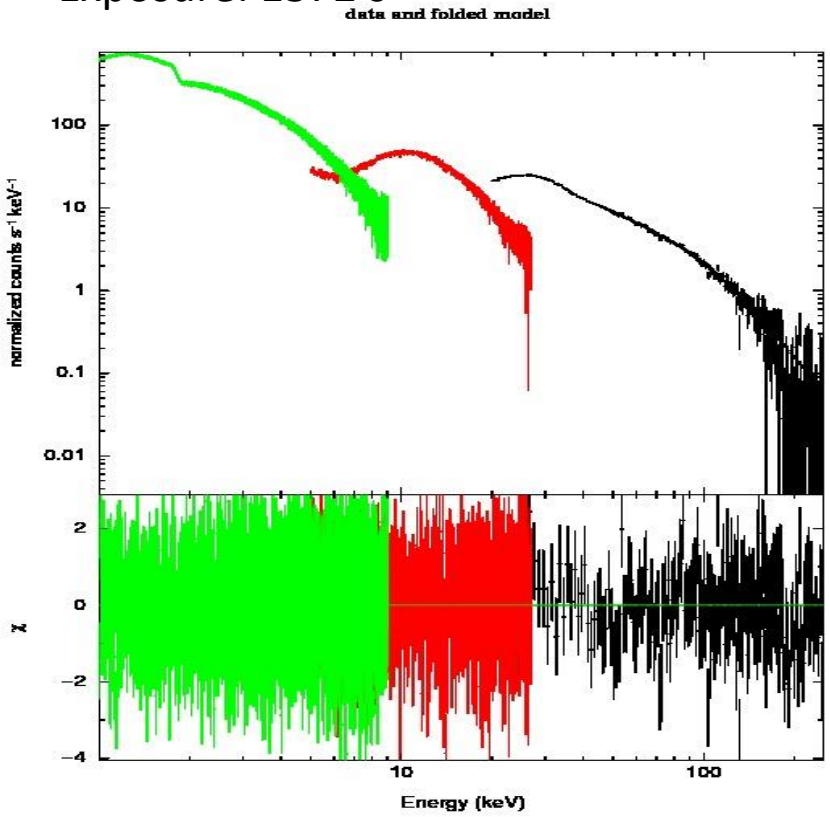


study the X-ray timing characteristic of neutron stars.



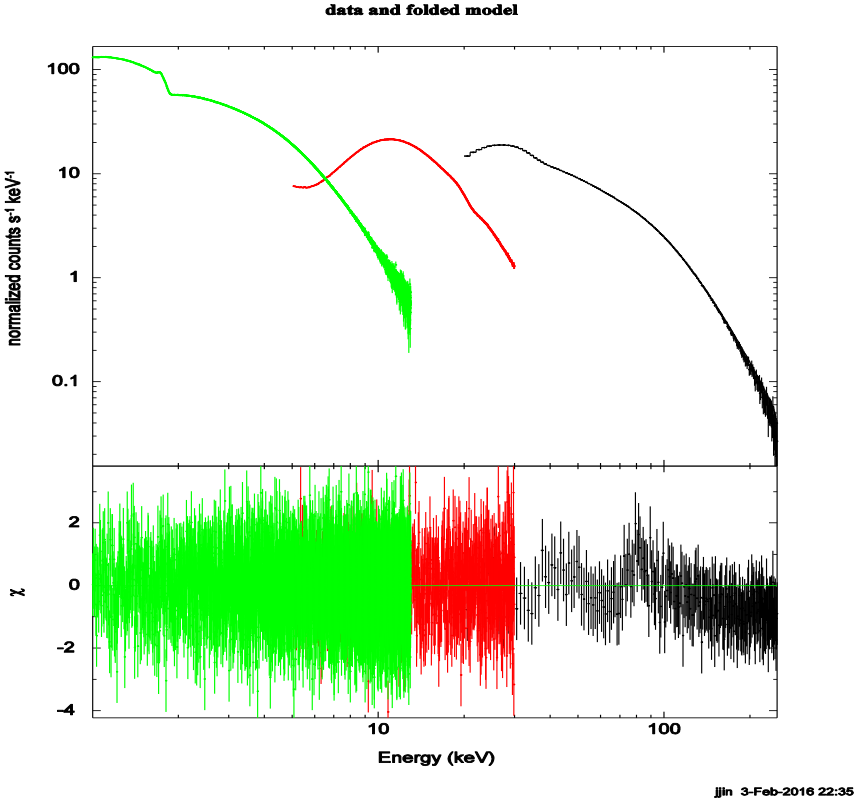
HXMT simulation

- Target: Crab
- Model: wabs*powerlaw
- Exposure: 1372 s



	nH (10^21 cm^{-2})	PhoIndex
HXMT	3.446 ± 0.030	2.1079 ± 0.0016
XMM	3.45 ± 0.02	2.108 ± 0.006

- Target: Cygnus X-1
- Model: highecut(powerlaw)
- Exposure: 2.05Ms

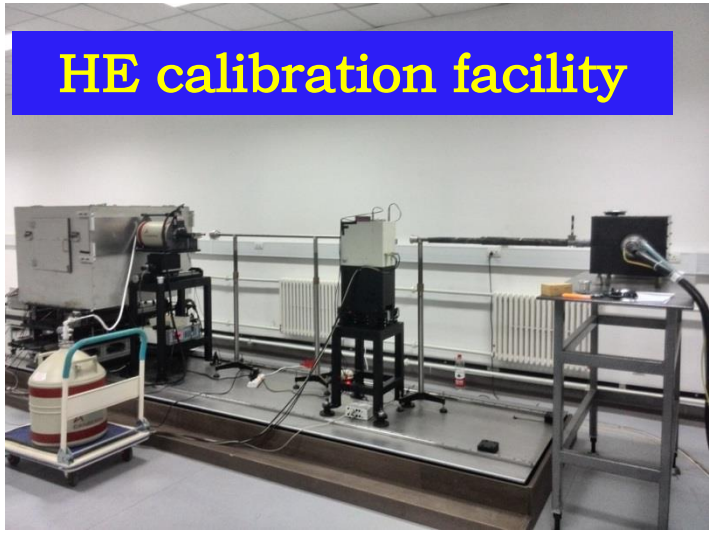


	E_{cut}(keV)	E_{fold}(keV)	Γ
HXMT	7.63 ± 0.05	154.19 ± 0.23	1.43004 ± 0.00017
INTEGRAL	<=12	155 ± 4	1.43 ± 0.01

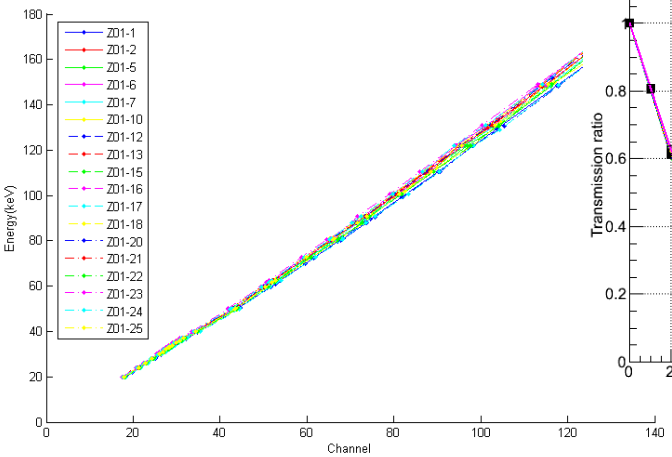
3.Ground Calibration and simulation of instruments

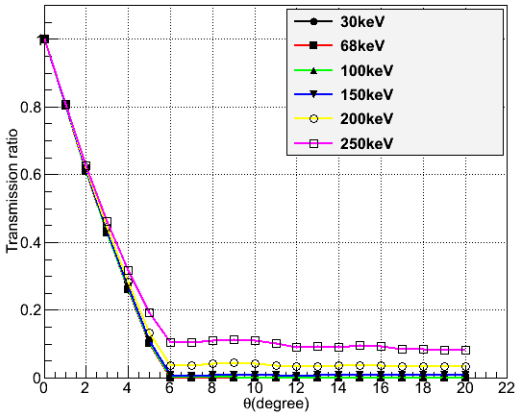
- X-ray double crystal monochromator and radioactive sources are used, supplemented by Geant4 simulation
  - Energy to Channel relation
  - Energy resolution
  - Quantum efficiency
  - Timing
  - Point Spread Function
  - Temperature effect and instrument settings
- Calibration products are generated and saved in HEASARC CALDB format.
- Calibration software for users is under integrated test.

HE

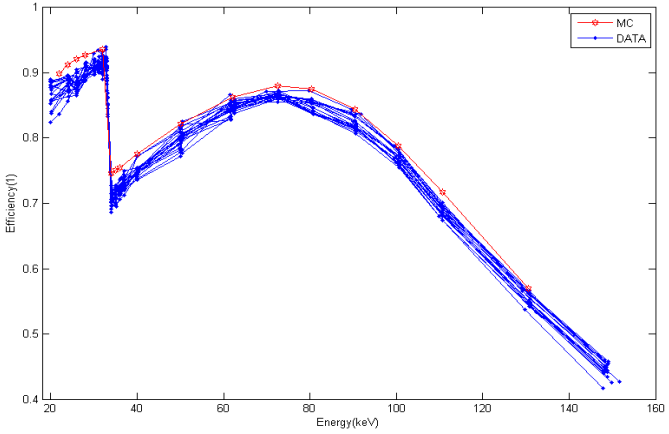


E-C relation

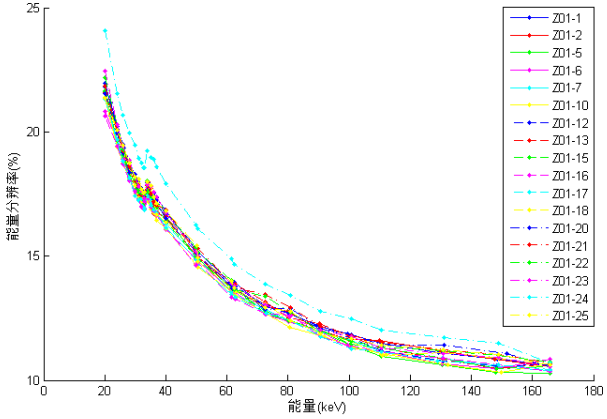




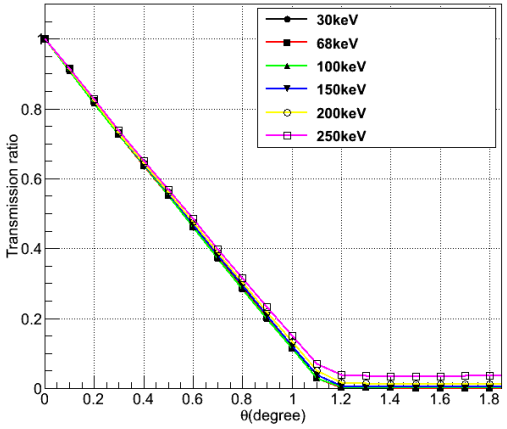
Efficiency



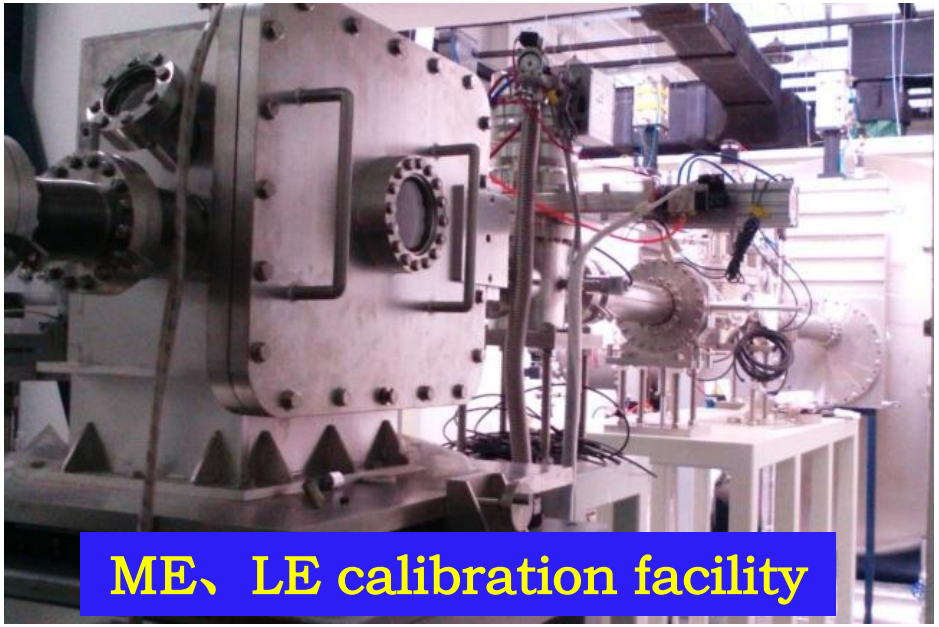
Energy Resolution

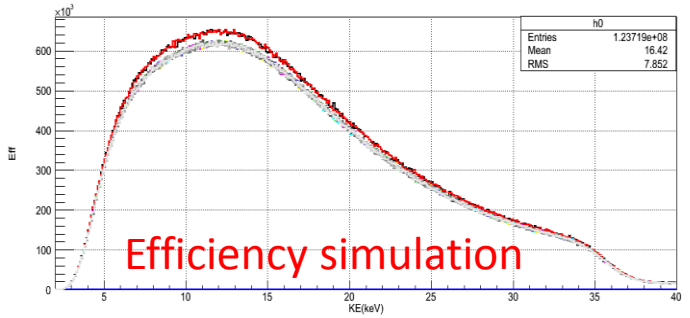


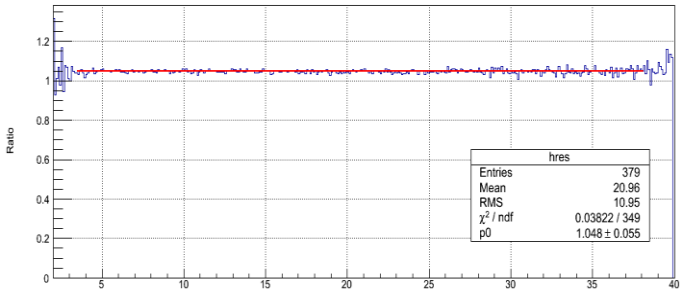
PSF simulation

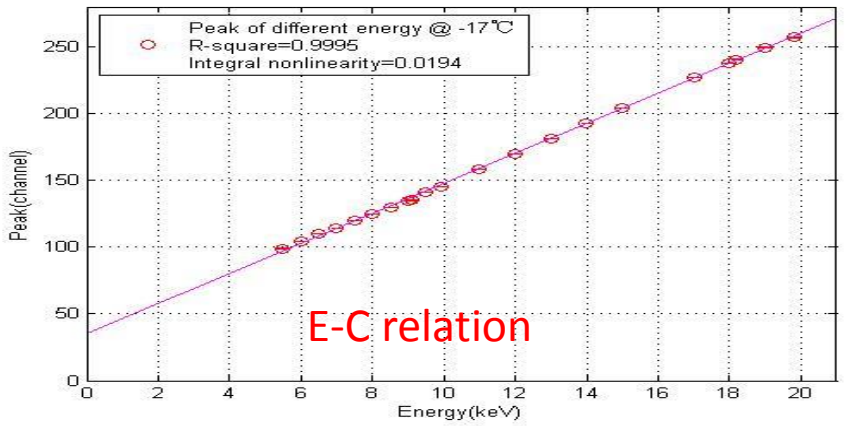


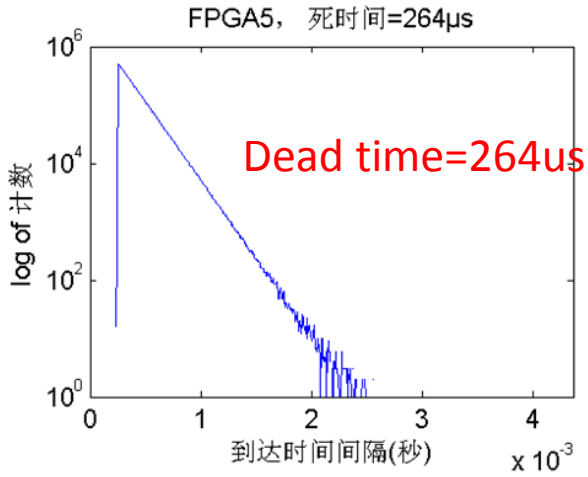
ME


ME、LE calibration facility


h0
Entries 1.23719e+08
Mean 16.42
RMS 7.852
Eff
KE(keV)
Efficiency simulation

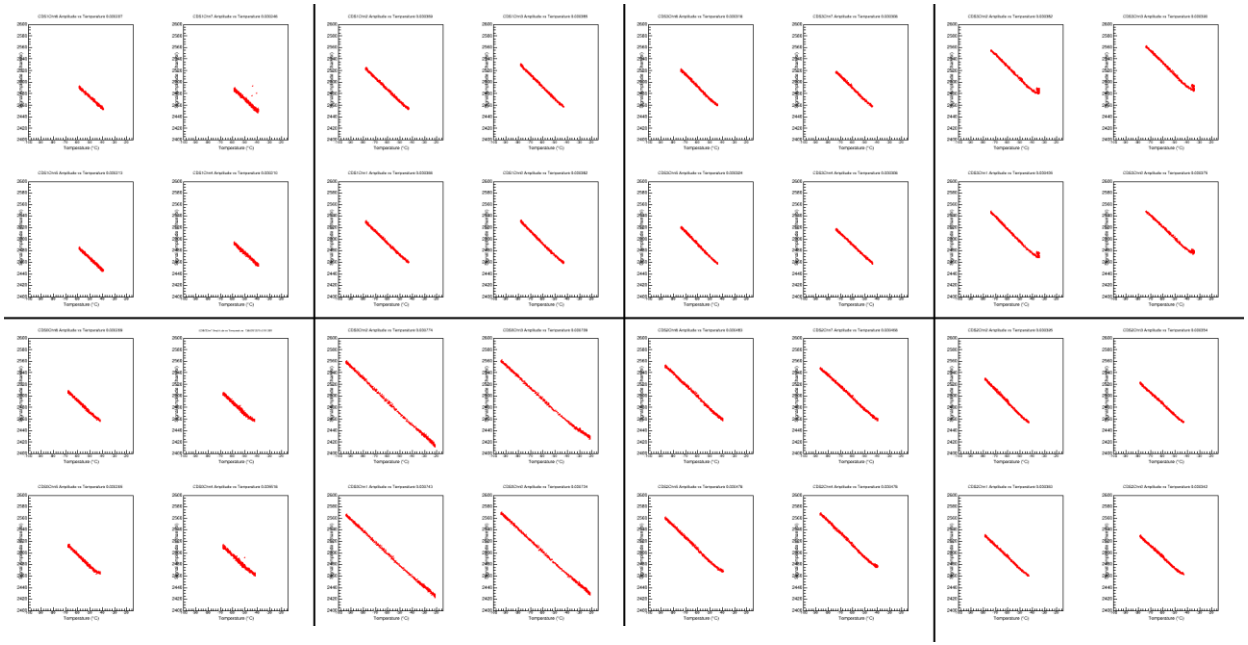

Ratio
hres
Entries 379
Mean 20.96
RMS 10.95
χ² / ndf 0.03822 / 349
p0 1.048 ± 0.055

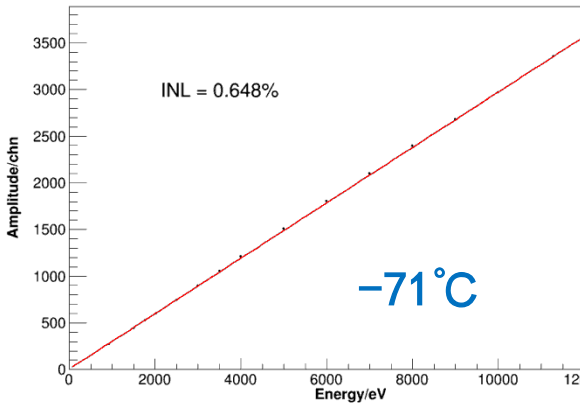

Peak of different energy @ -17℃
R-square=0.9995
Integral nonlinearity=0.0194
Peak(channel)
Energy(keV)
E-C relation


FPGA5， 死时间=264μs
log of 计数
到达时间间隔(秒)
x 10⁻³
Dead time=264us

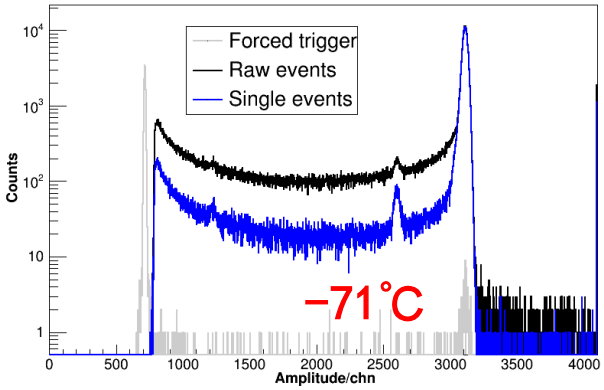
LE

Full energy peak varies with temperature

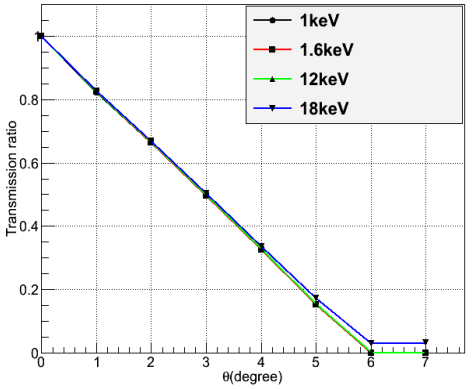


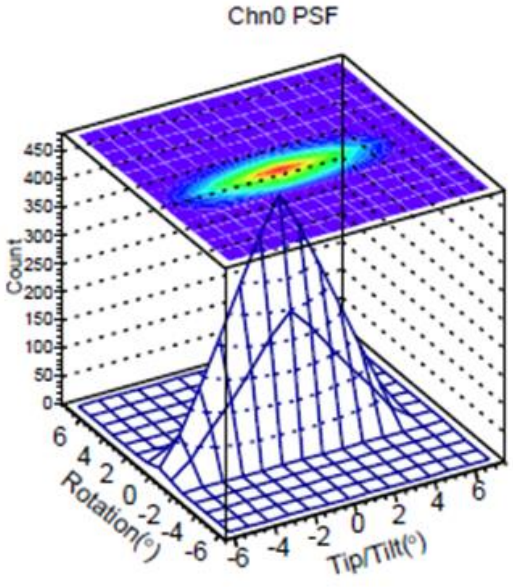


The Spectra of CHN07



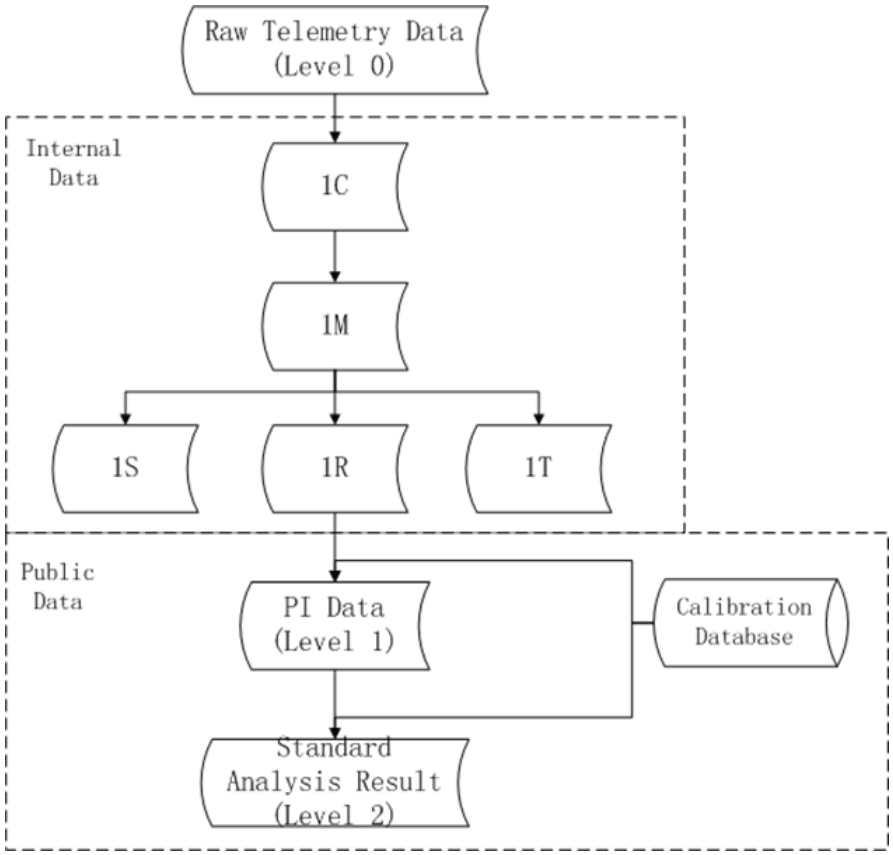
PSF simulation



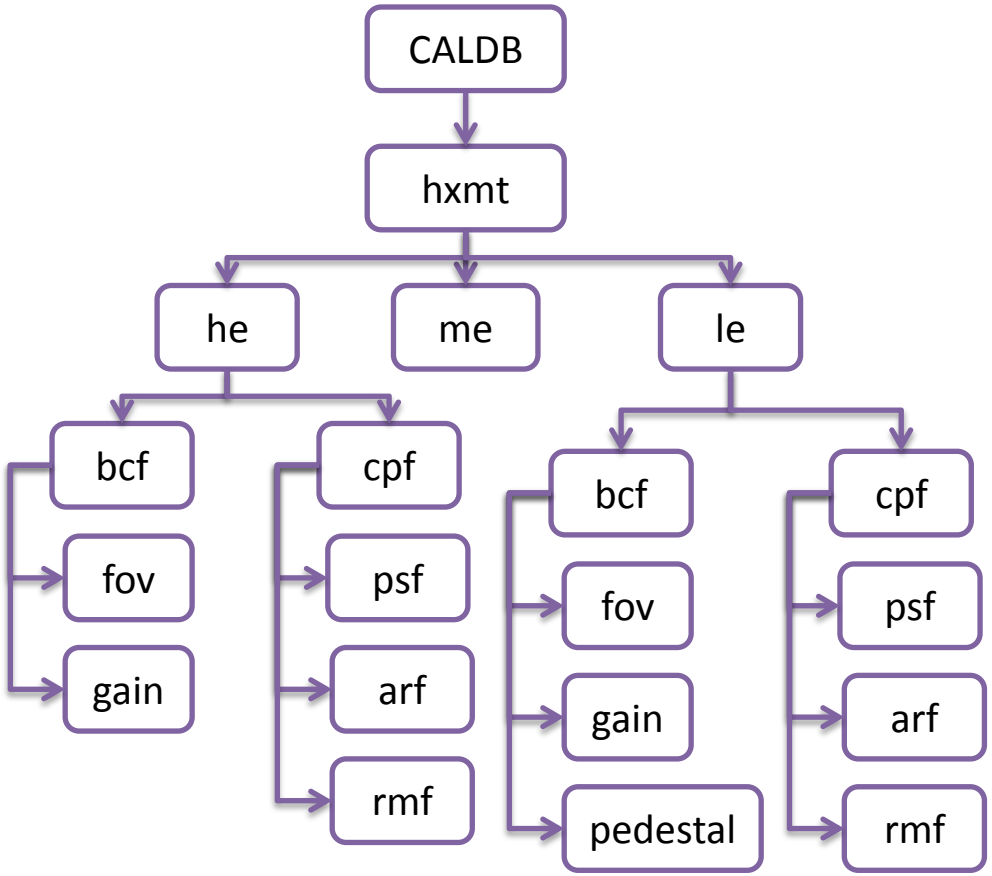


4. Data flow and development of CALDB

Data flow of HXMT:



Basic structure of HXMT-CALDB:

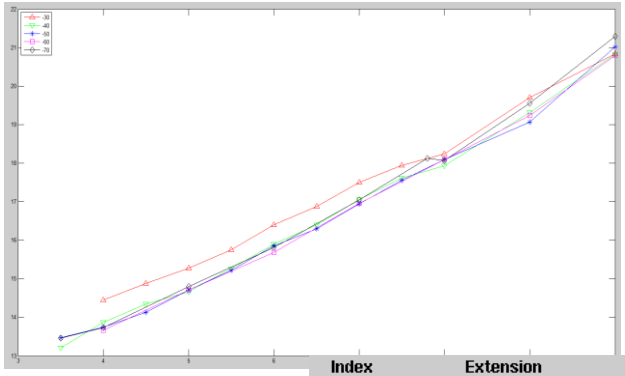


ARF and RMF file for LE

Two event grades for LE:

- Single events
- Reconstructed split events

Energy resolution @ different temperature



Two RMFs was used in (-80, -20) degree.

Select	Temp_LO 1E	Temp_HI 1E
All		
Invert	Modify	Modify
1	-8.000000E+01	-3.500000E+01
2	-3.500000E+01	-2.000000E+01

File Edit Tools Help

Index	Extension	Type	Dimension	View
0	Primary	Image	0	Header Image
1	SPECRESP	Binary	3 cols X 4500 rows	Header Hist Pl
2	SPECRESP	Binary	3 cols X 4500 rows	Header Hist Pl

Index	Extension	Type	Dimension	View
0	Primary	Image	0	Header Image Table
1	MATRIX	Binary	6 cols X 4500 rows	Header Hist Plot All Select
2	MATRIX	Binary	6 cols X 4500 rows	Header Hist Plot All Select
3	MATRIX	Binary	6 cols X 4500 rows	Header Hist Plot All Select
4	MATRIX	Binary	6 cols X 4500 rows	Header Hist Plot All Select
5	TempInterval	Binary	2 cols X 2 rows	Header Hist Plot All Select

```
TELESCOP= 'HXMT    '           / telescope name
INSTRUME= 'LE      '           / instrument name
DETNAM  = 'LE      '           / detector name
FILTER  = 'NONE    '           / filter name
CCLS0001= 'BCF     '           / This is a Basic Calibration File
HDUCLASS= 'OGIP    '           / format devised by the OGIP
CDTP0001= 'DATA    '           / Data Type
CCNM0001= 'ARFGrade0'          / Dataset code name
CVSD0001= '2014-12-02'         / Data when dataset becomes valid
CVST0001= '16:00:00'           / Time when dataset becomes valid
CDES0001= 'LE SPECRESP'        / Description
DATE    = '2014-12-03T10:12:15' / file creation data (YYYY-MM-DDThh:mm:ss UT)
```

```
TELESCOP= 'HXMT    '           / telescope name
INSTRUME= 'LE      '           / instrument name
DETNAM  = 'LE      '           / detector name
FILTER  = 'NONE    '           / filter name
DETCHANS=                  512 / total number of detector channels
TEMPN   =                    2 / Number of Temperature Section
CHANTYPE= 'PI      '           / Detector Channel Type in use (PHA or PI)
CCLS0001= 'BCF     '           / This is a Basic Calibration File
HDUCLASS= 'OGIP    '           / format devised by the OGIP
CDTP0001= 'DATA    '           / Data Type
CCNM0001= 'RMFGrade0_Temp0'    / Dataset code name
CVSD0001= '2014-12-02'         / Data when dataset becomes valid
CVST0001= '16:00:00'           / Time when dataset becomes valid
CDES0001= 'LE Matrix'          / Description
DATE    = '2014-12-03T10:12:15' / file creation data (YYYY-MM-DDThh:mm:ss UT)
```

Flight models is ready!