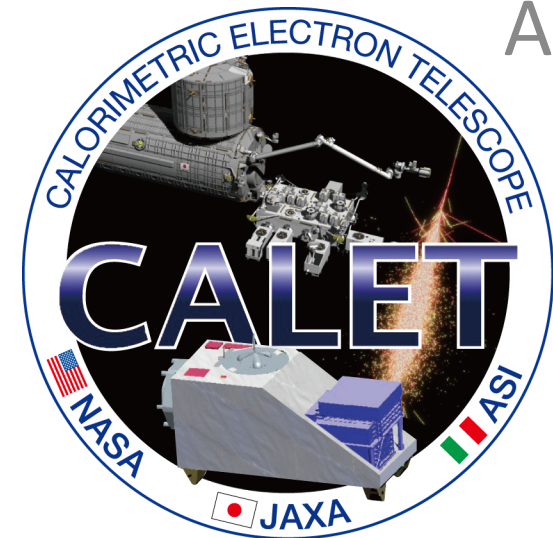


CGBM Hardware status

Aoyama Gakuin University

Yuta Kawakubo

For the CGBM team



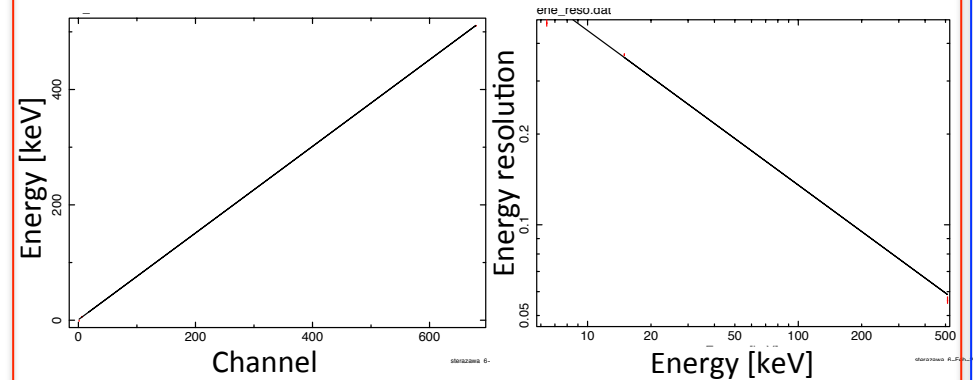
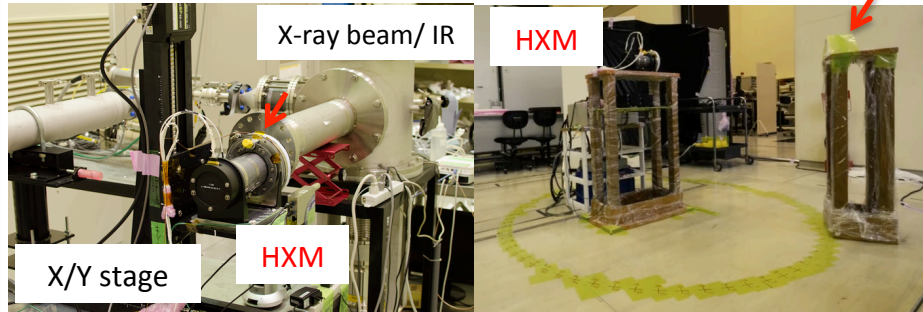
Other view

- Development detector response matrices
 - 1st Ground Calibration test
 - Simulator of CGBM
 - Development HXM response matrices
 - Development SGM response matrix
- Low detection efficiency of X-rays on HXM1
- Long term gain monitoring
- Efficiency of X-ray on HXM0
- Summary

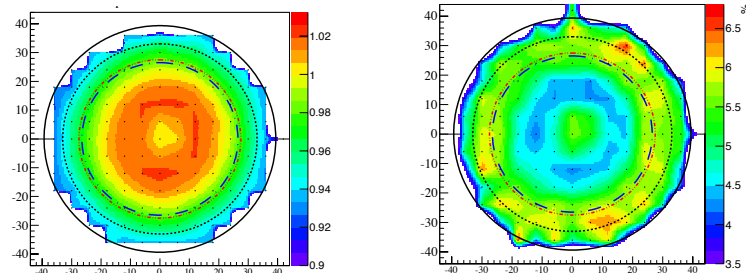
1st Ground Calibration test

2014/1/15-1/28 @ JAXA Tsukuba Space Center

HXM

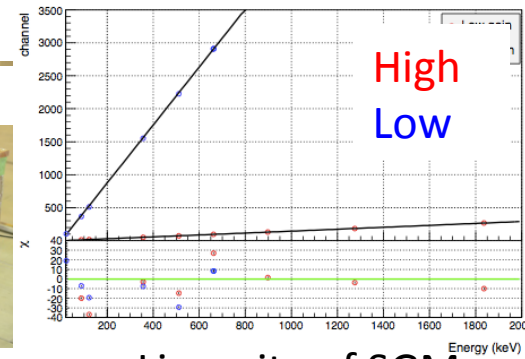
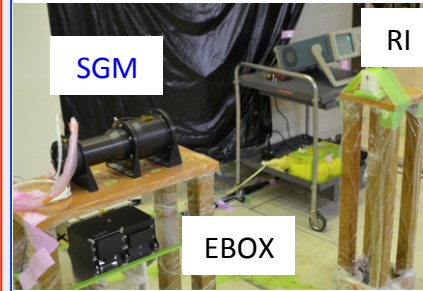


Linearity and energy resolution of HXM

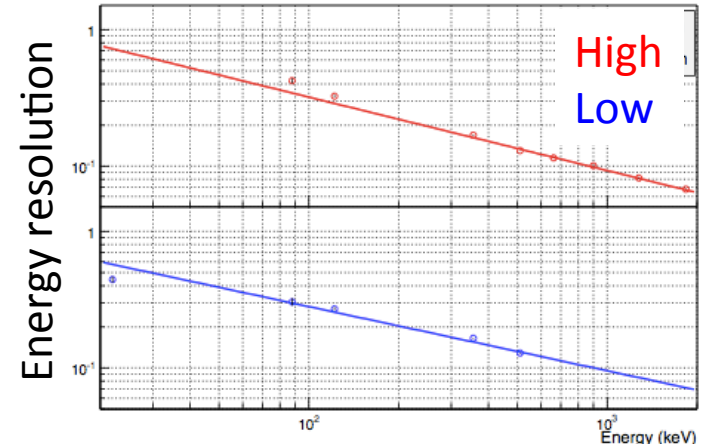


511 keV Peak channel map 511 keV E resolution map

SGM



Linearity of SGM



Energy resolution of SGM

We made calibrations necessary for doing simulations.

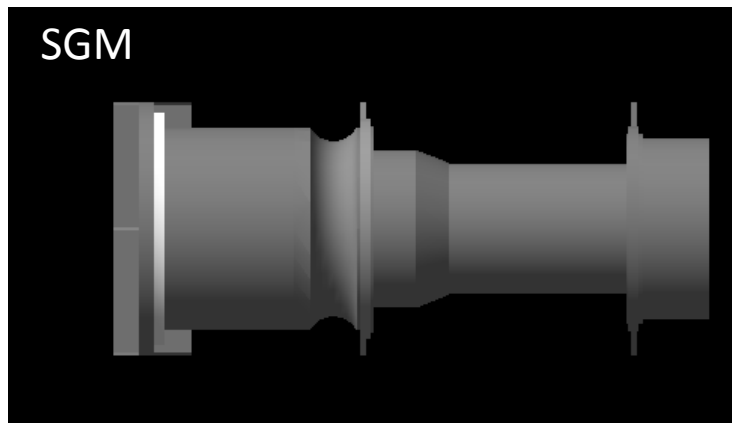
Simulator of CGBM



Red: Not yet

HXM

- Size and shape of detectors
- Structure material (typical)
- Energy resolution of detectors
- Map of peak channel (511 keV)
- Map of peak channel (6.4, 14 keV)



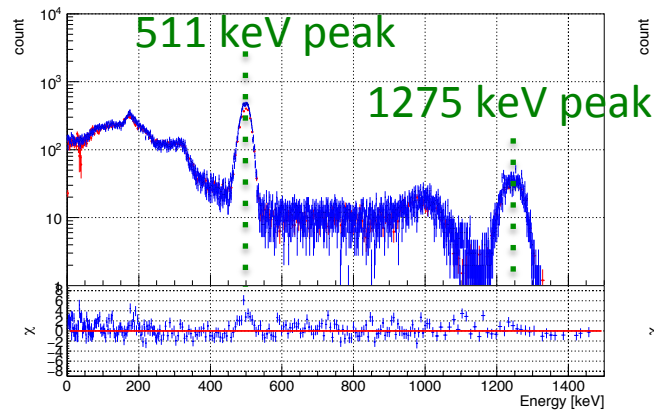
SGM

- Size and shape of detectors
- Structure material (typical)
- Energy resolution of detectors.

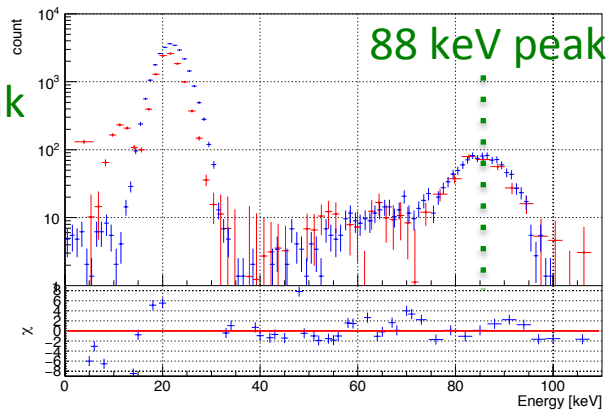
Development HXM response matrices

Red : Measurements (normal incidence)

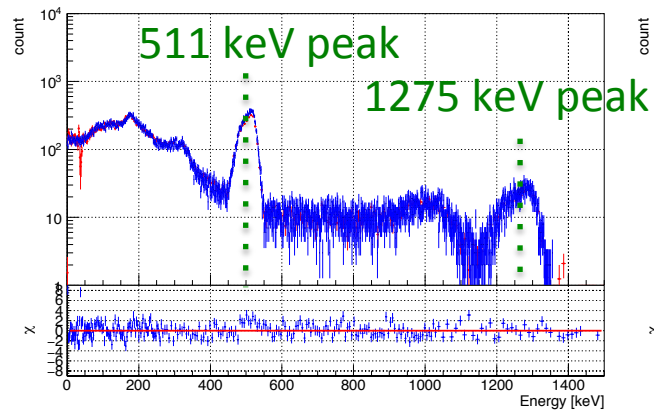
Blue : Simulation (normal incidence)



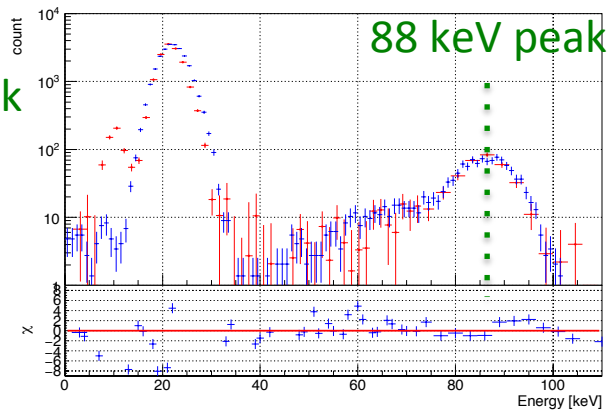
HXM1 ^{22}Na Spectrum



HXM1 ^{109}Cd Spectrum



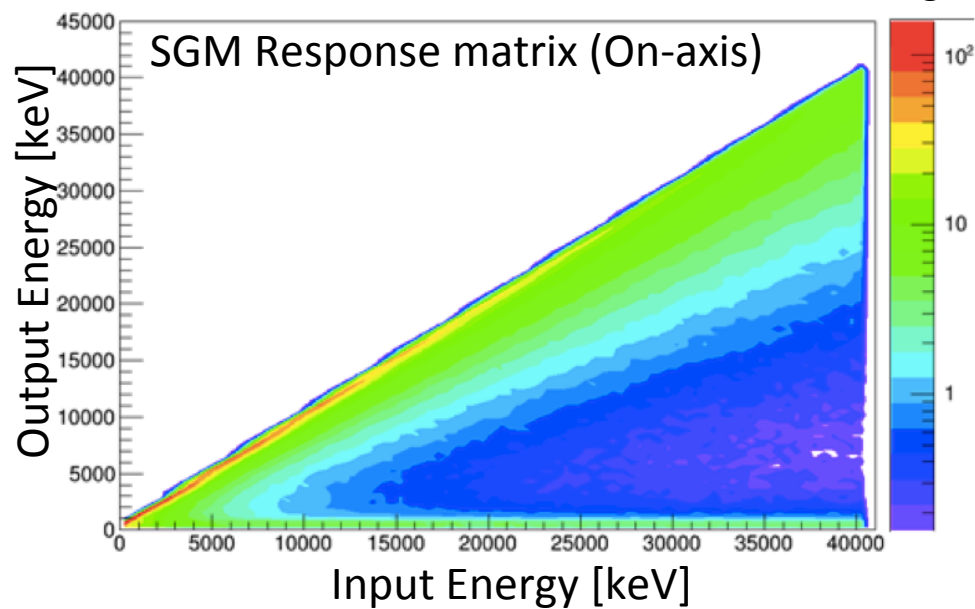
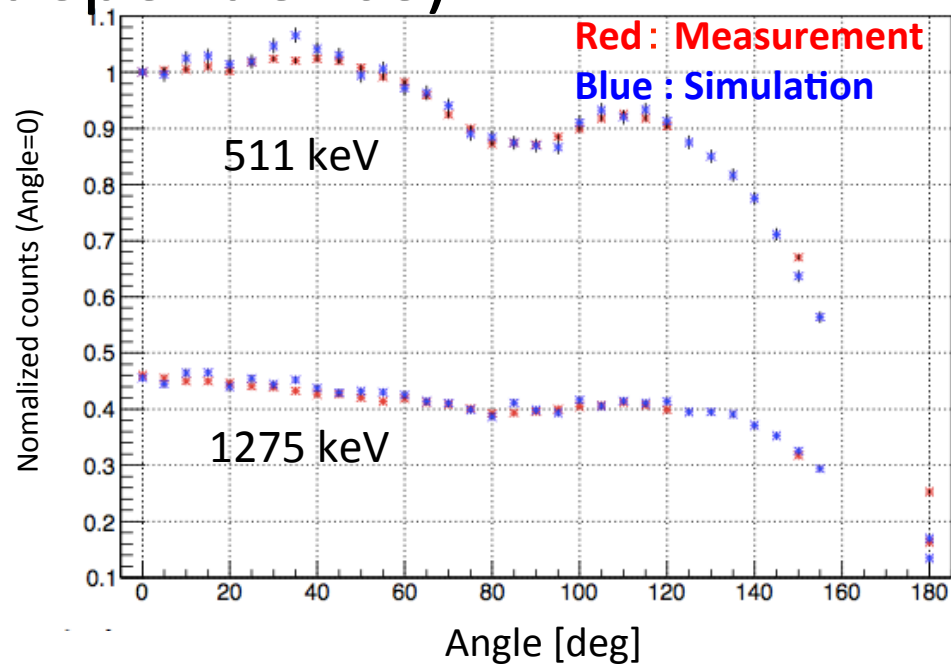
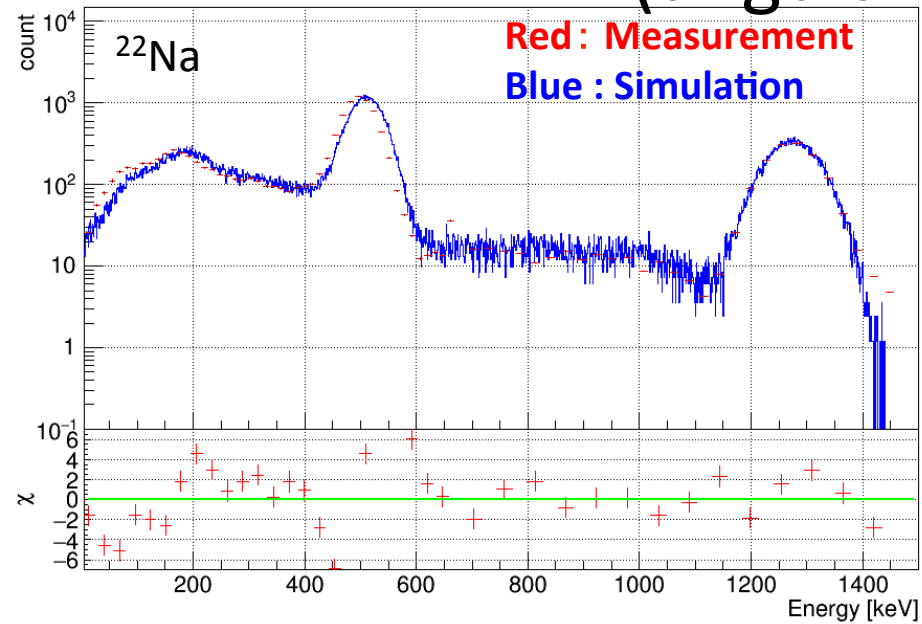
HXM2 ^{22}Na Spectrum



HXM2 ^{109}Cd Spectrum

The simulation reproduce the measurements (> 40 keV).

Development SGM response matrix (angular dependence)



Other view

- Development detector response matrices
 - 1st Ground Calibration test
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 - Development SGM response matrix

- Low detection efficiency of X-rays on HXM1
- Long term gain monitoring
- Efficiency of X-ray on HXM0
- Summary

Low detection efficiency of X-rays on HXM1

Note:

- During the first calibration run at JAXA (Jan 2014), the detection efficiency of X-rays below 10 keV photons was low on HXM1 comparing with that of HXM2.
- We checked HXM low-energy X-ray response at the 2nd and 3rd calibration test.

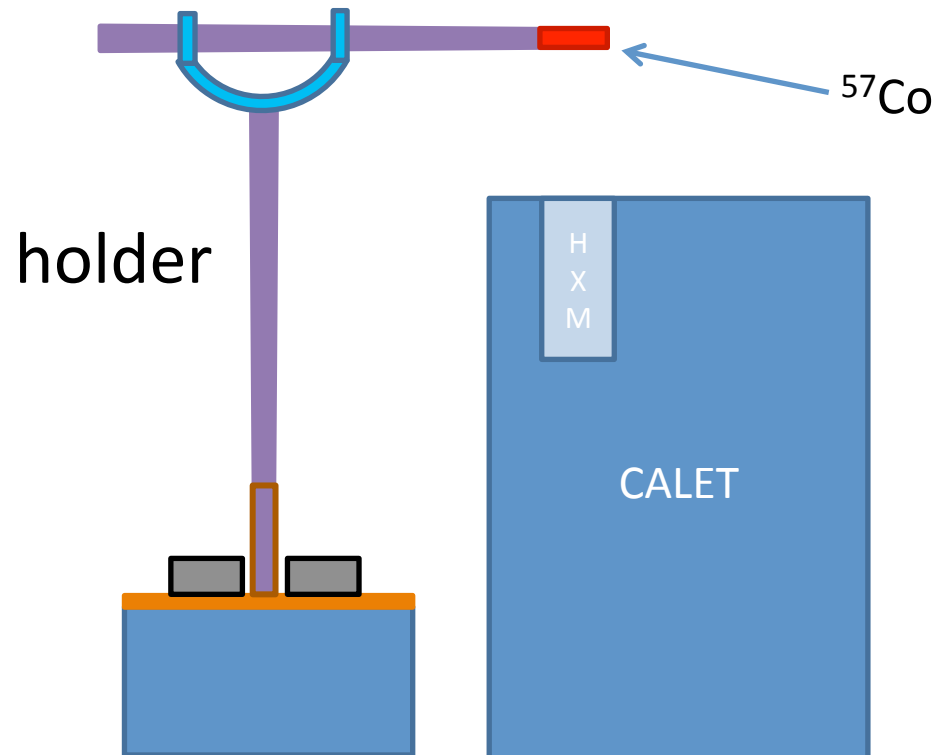
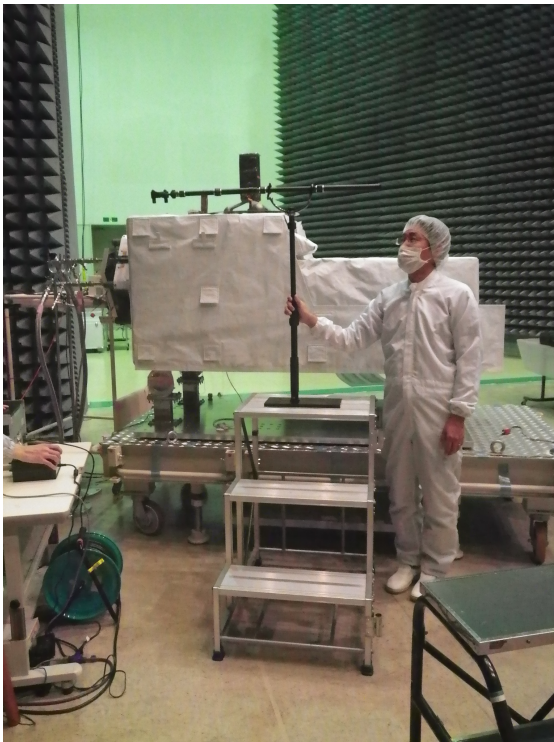
Testing of low-energy X-ray response of HXM after integration

After the integration of CALET including environment testing as thermal vac

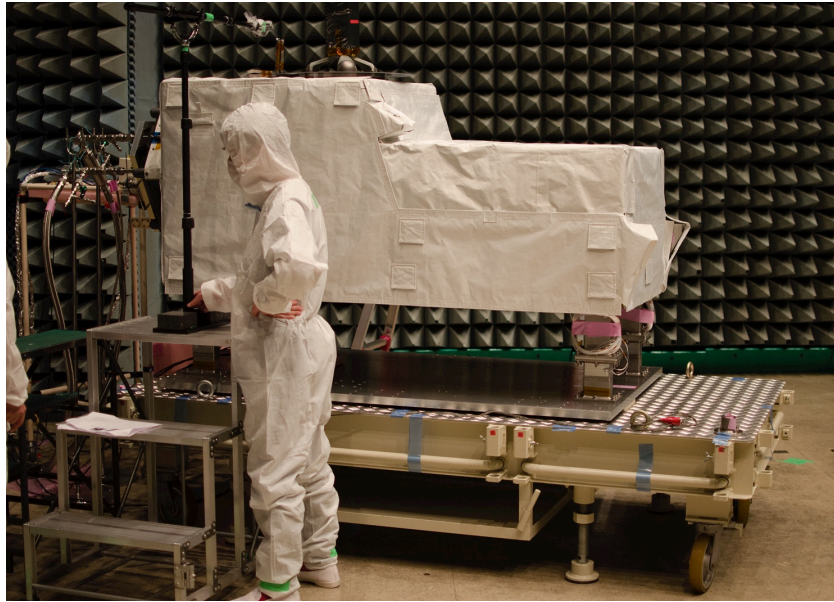
2nd PI cal: 2015/1/5-1/6 @ JAXA Tsukuba

3rd PI cal: 2015/ 3/12 @ JAXA Tsukuba

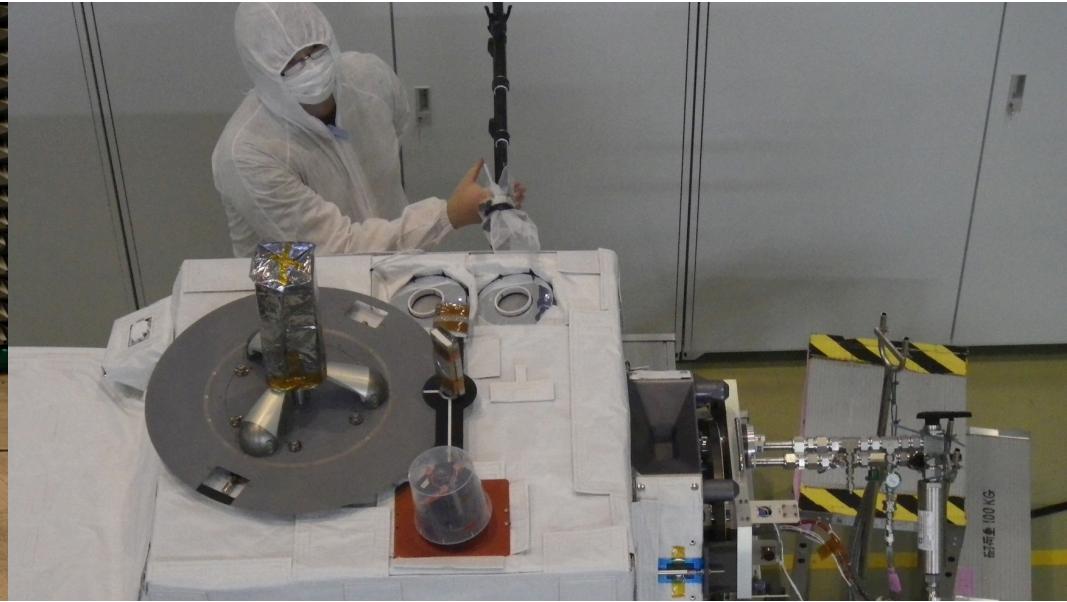
Low-energy response measurement on HXM (^{57}Co)



2nd calibration (Jan 2015) at EMC test



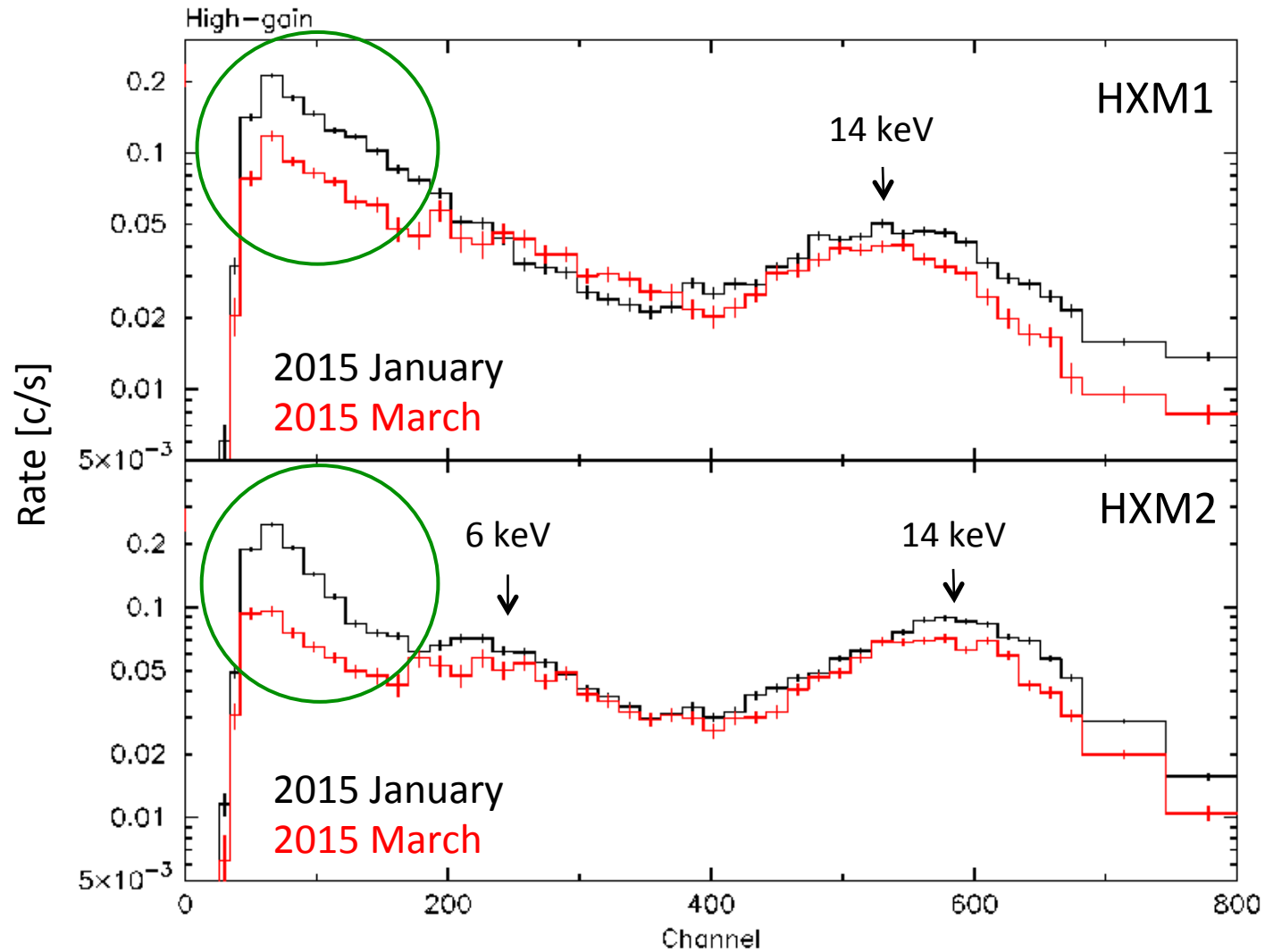
3rd calibration (Mar 2015) during 72 hr running test



- The same folder was used
- Different room
(the configuration around detectors were changed)



Excess counts are seen below 10 keV for both HXM1 and HXM2

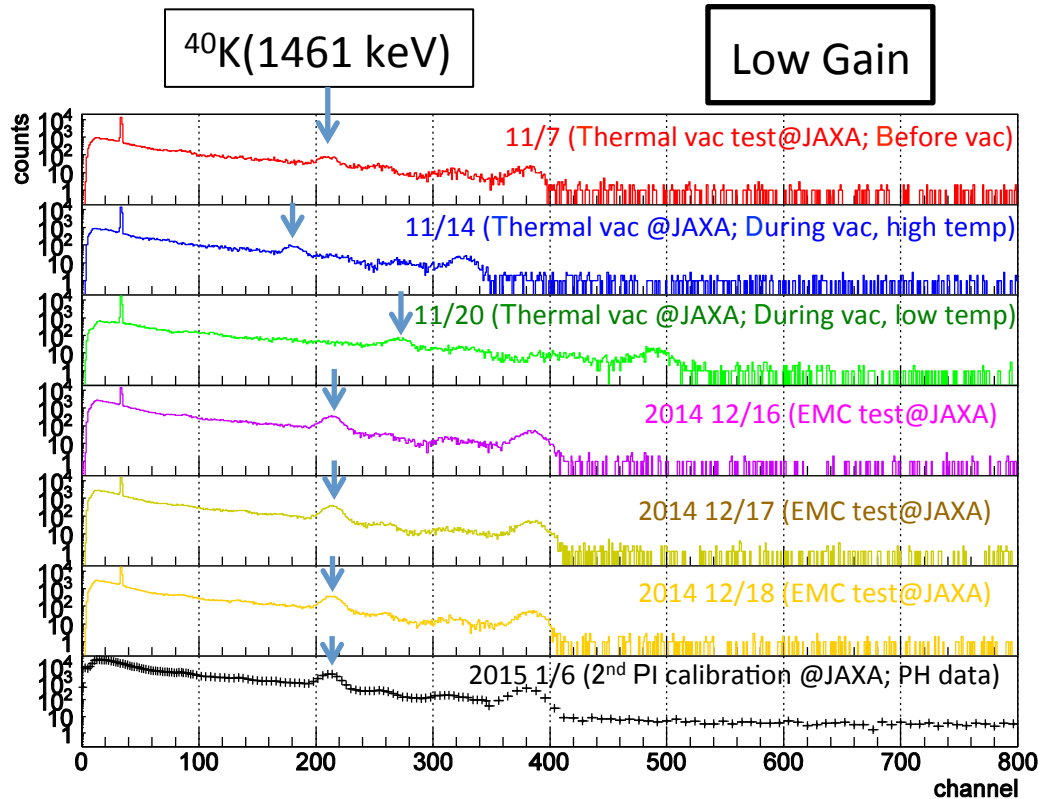


HXM2 degraded to same extent as HXM1.

Other view

- Development detector response matrices
 - 1st Ground Calibration test
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 - Development SGM response matrix
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- Long term gain monitoring
- Efficiency of X-ray on HXM0
- Summary

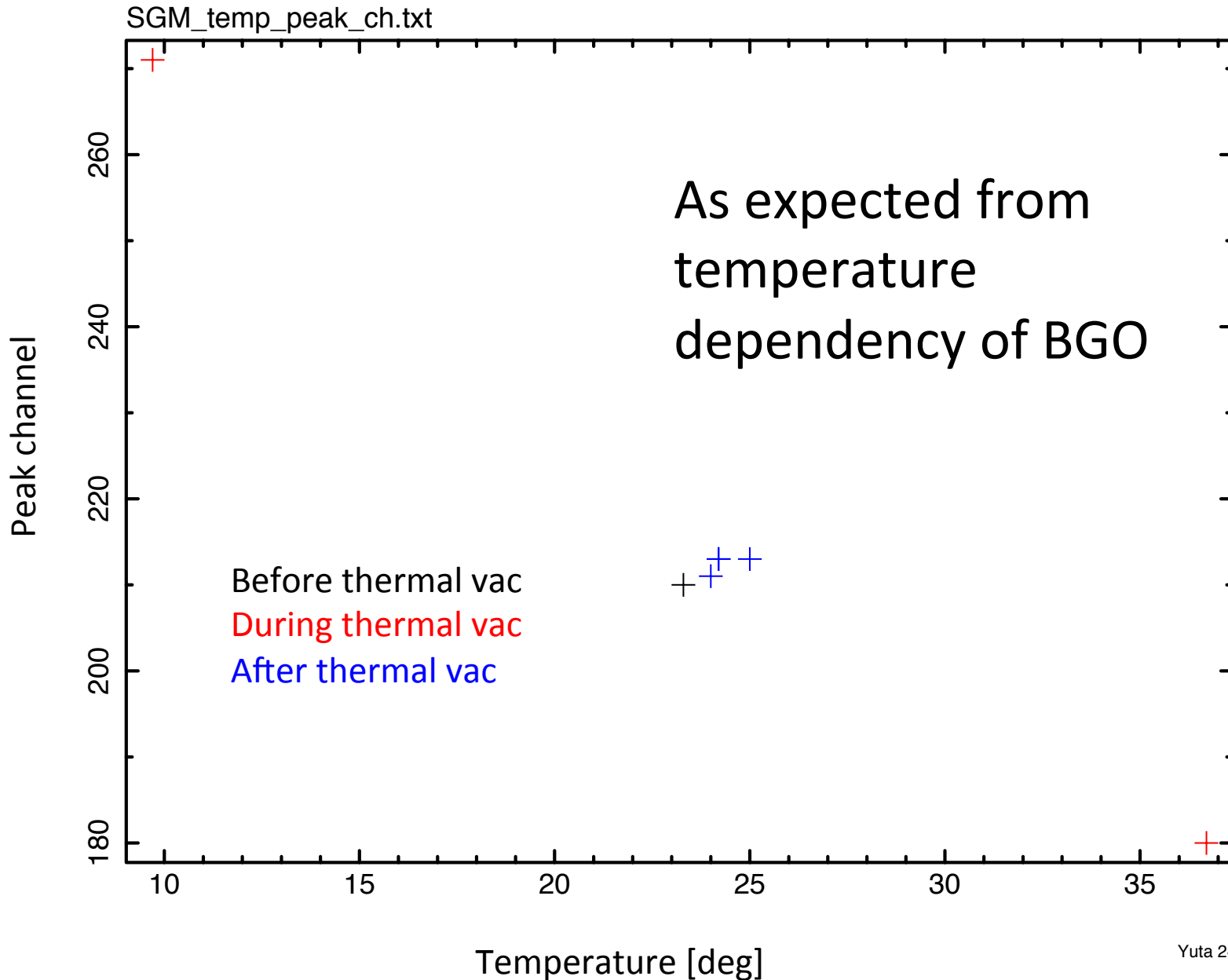
SGM: Background data



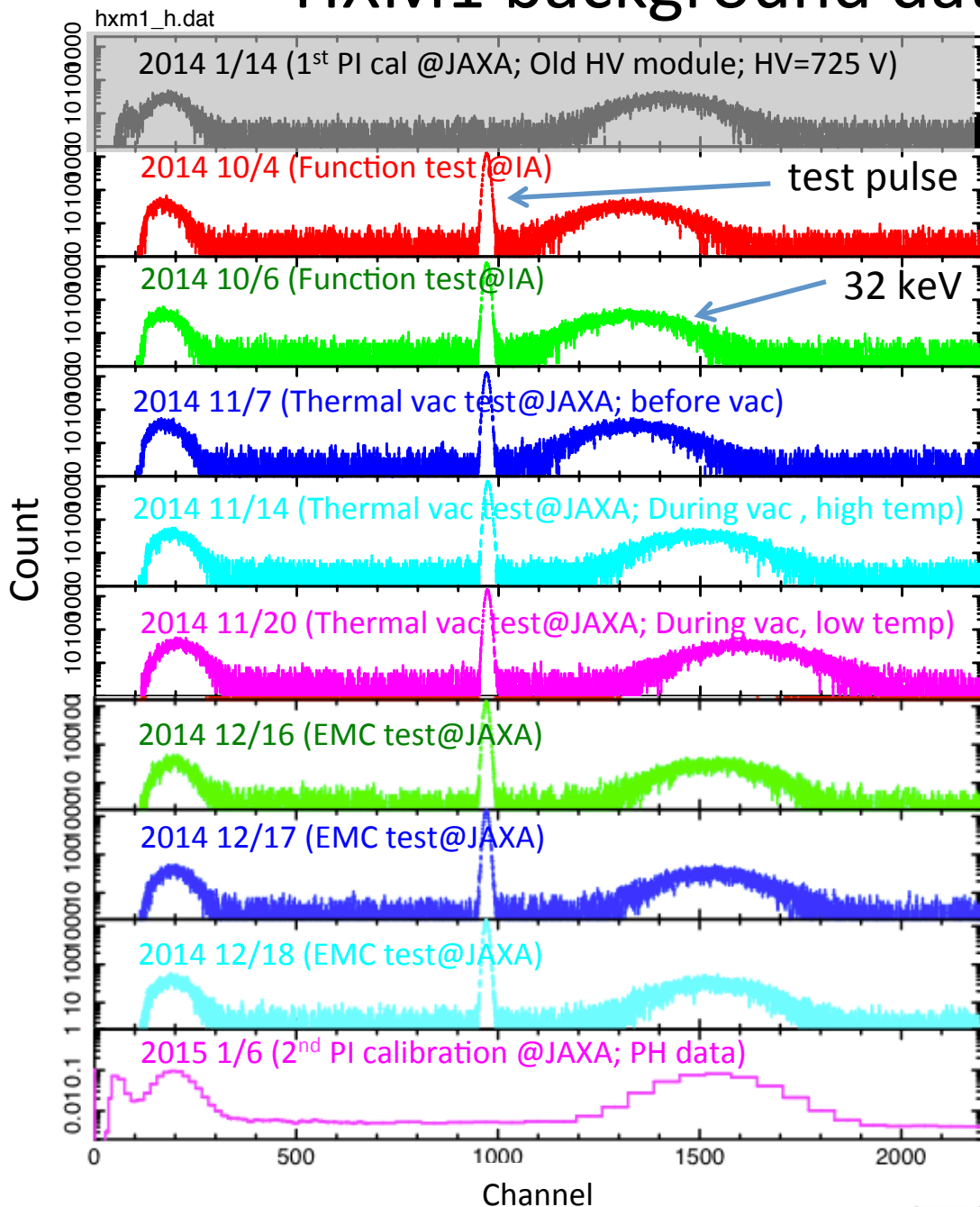
Using 1461 keV of ^{40}K (potassium).

^{40}K (1461keV)	11/7	11/14	11/20	12/16	12/17	12/18	2015 1/6
Temp [°C]	23.3°C	36.7°C	9.7 °C	24.2°C	24.2 °C	25.0 °C	24.0 °C
Peak ch	210.4±0.2	179.6±0.1	271.2±0.2	213±0.1	213±0.3	213±0.3	211±0.04
E-res [%]	7.5±0.2	7.9±0.2	6.8±0.2	7.3±0.1	7.5±0.3	7.6±0.3	7.6±0.1

SGM: 1461 keV peak



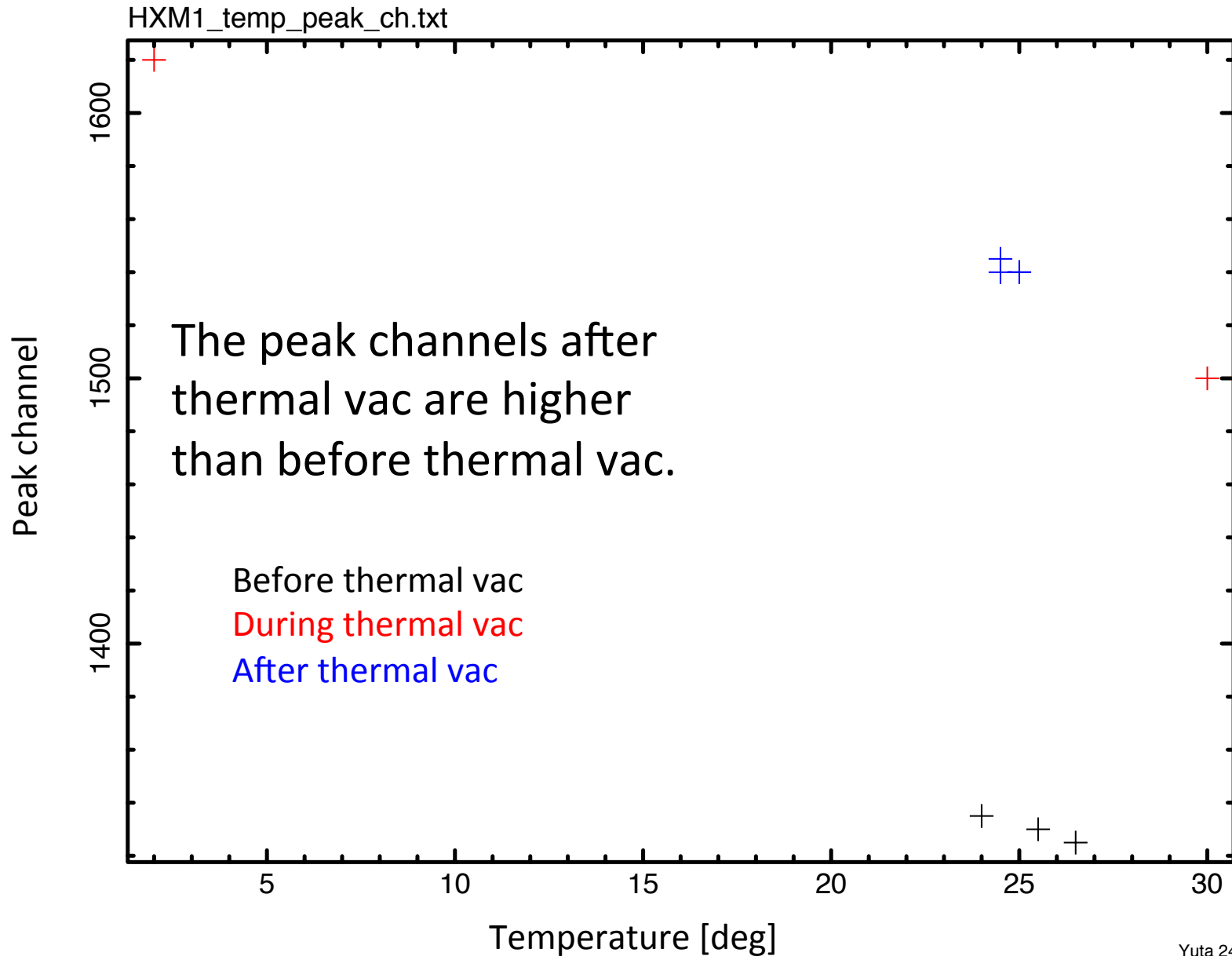
HXM1 background data (High-gain)



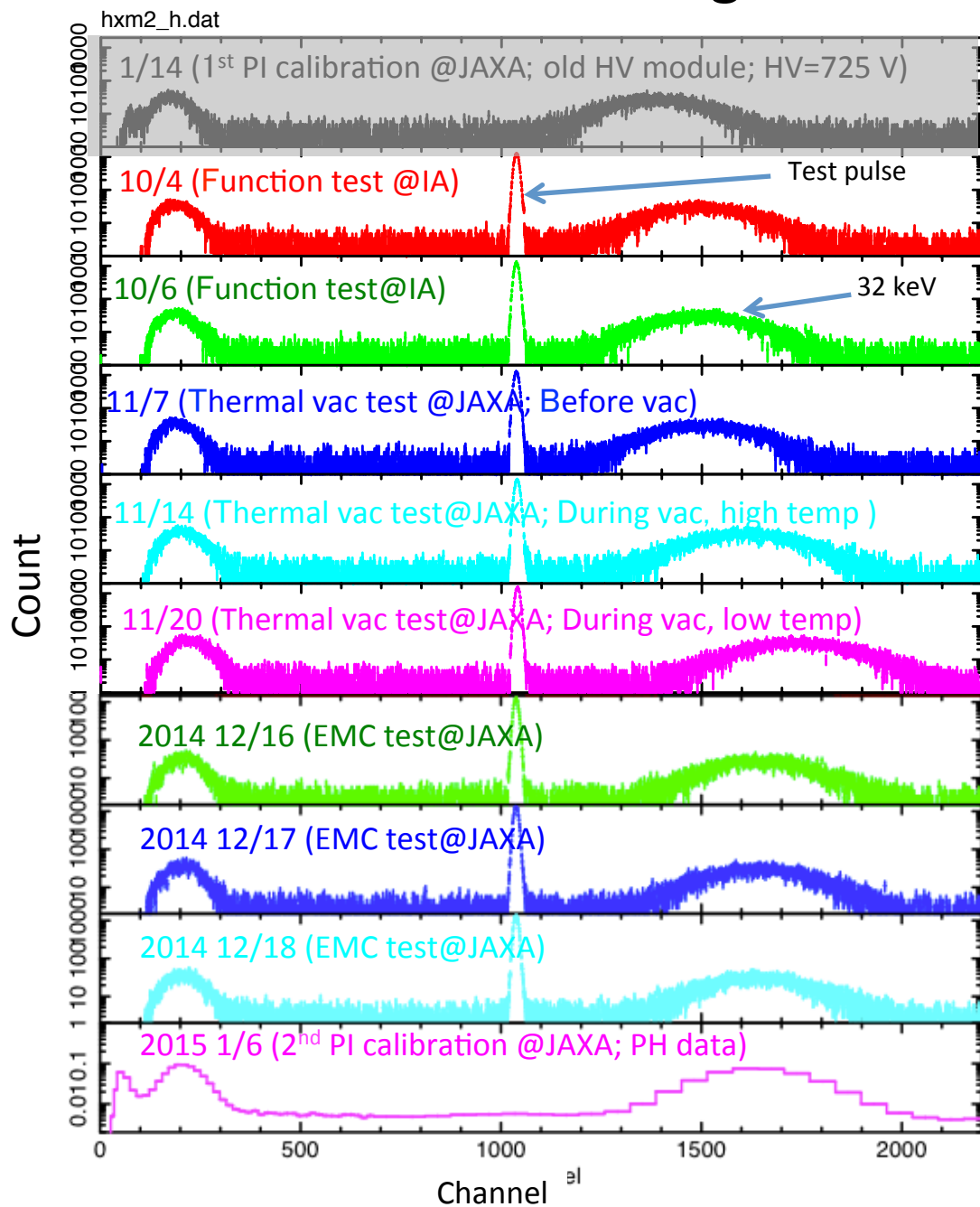
Using 32 keV line of background.

After thermal vac test, HXM1 gain become higher than before.

HXM1: 32 keV peak

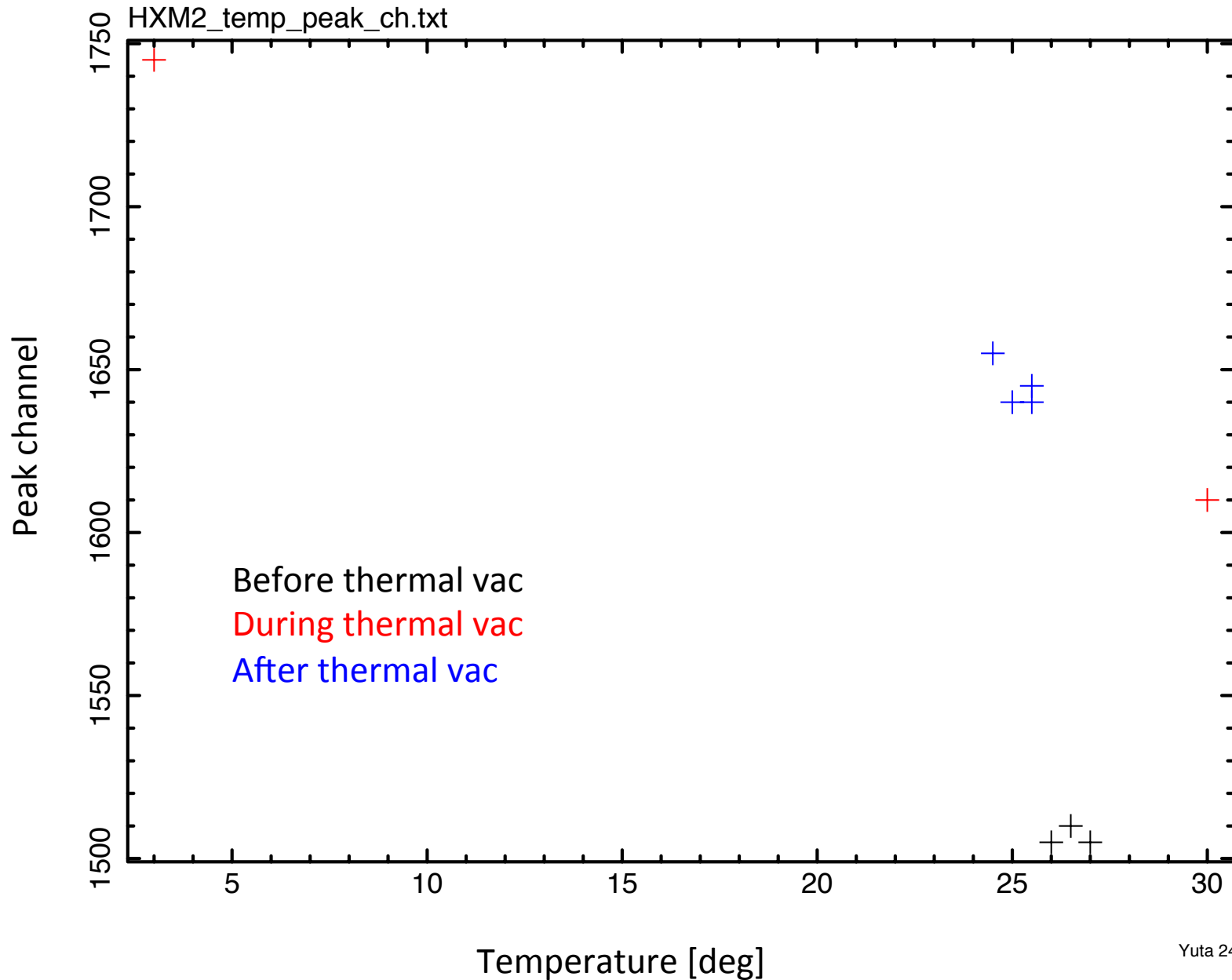


HXM 2: background data (High Gain)



Similar trend to HXM1.

HXM2: 32 keV peak

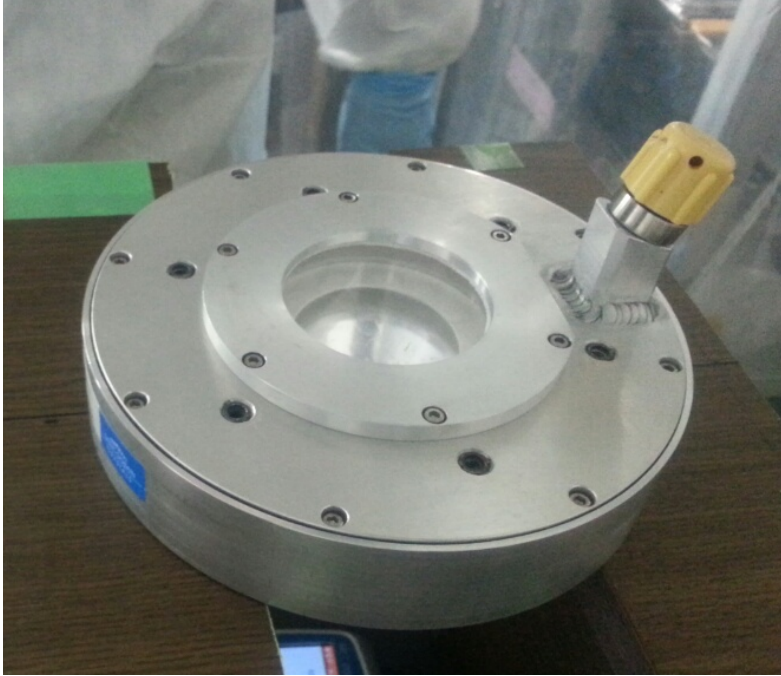


Other view

- Development detector response matrices
 - 1st Ground Calibration test
 - Simulator of CGBM
 - Development HXM response matrices
 - Development SGM response matrix
- Low detection efficiency of X-rays on HXM1
- Long term gain monitoring
- Efficiency of X-ray on HXM0
- Summary

HXMO

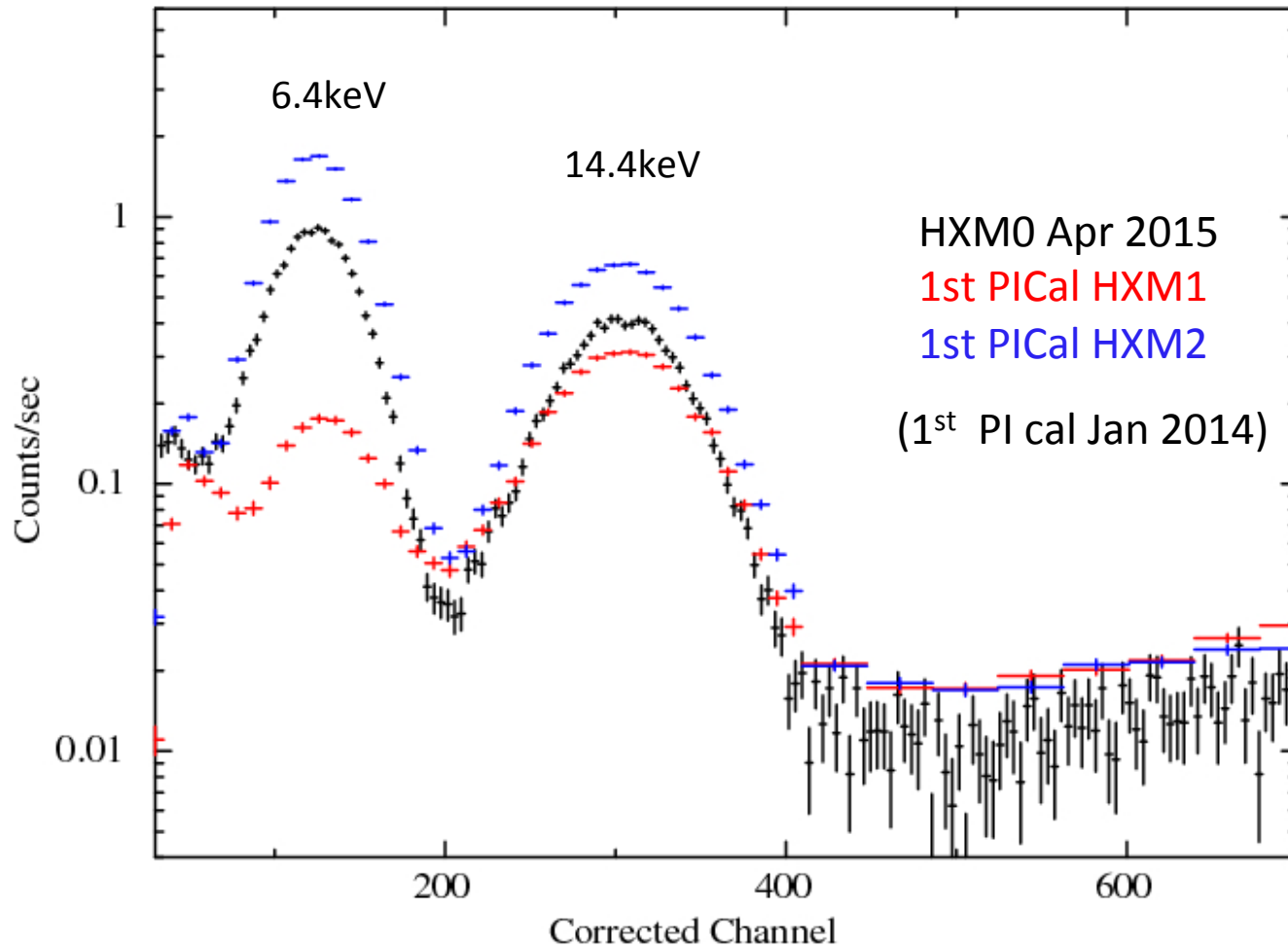
HXMO



HXMO + PMT



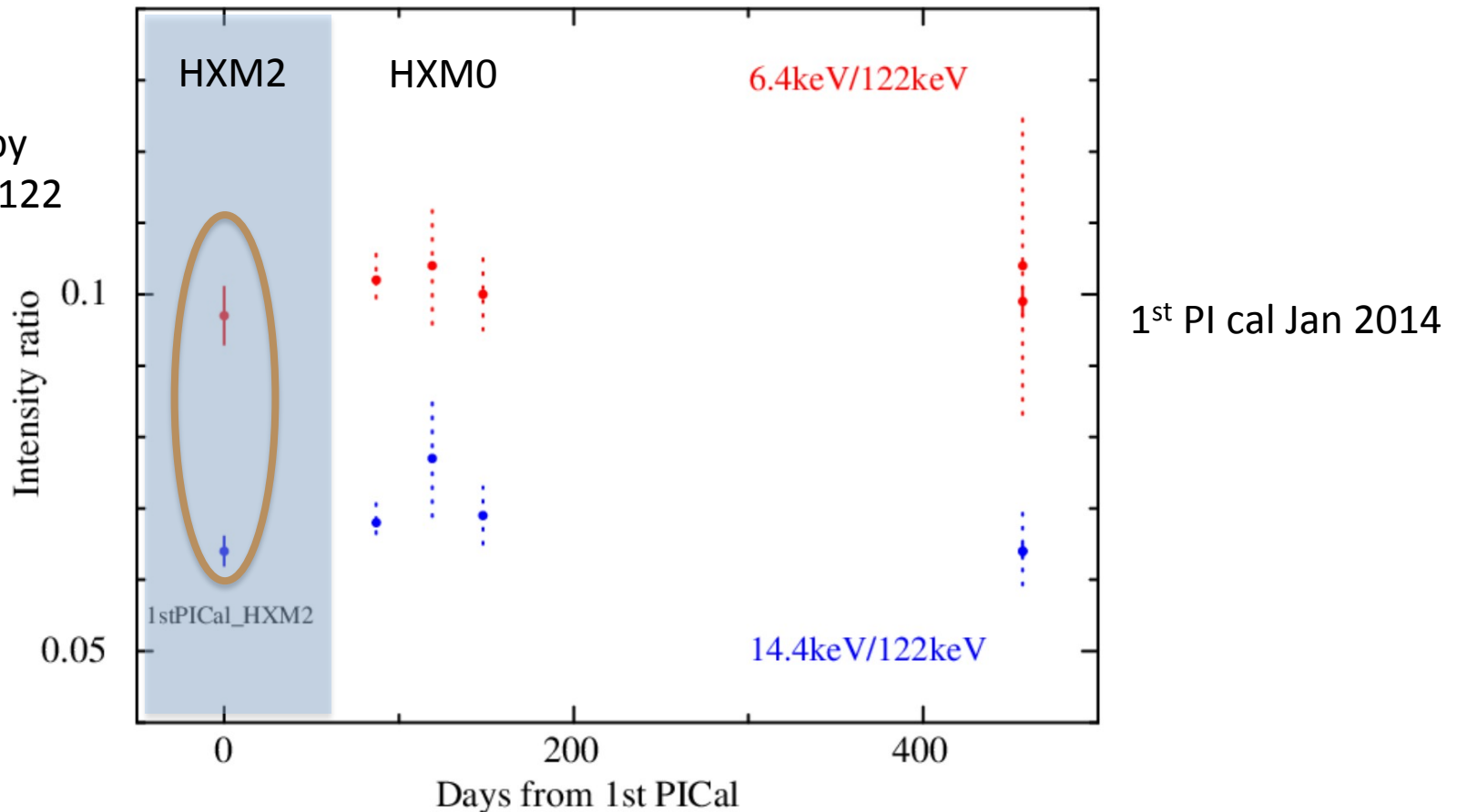
^{57}Co Spectrum



- The HXM0 spectrum shows that 6.4 keV line is stronger than 14 keV line. (not same as HXM1 at 1st PI cal)

HXM0:long term efficiency monitoring

We compared HXM0 efficiency and HXM2 efficiency at 1st PI CAL.



The efficiency of HXM0 is same HXM2 at 1st PI cal.

Summary

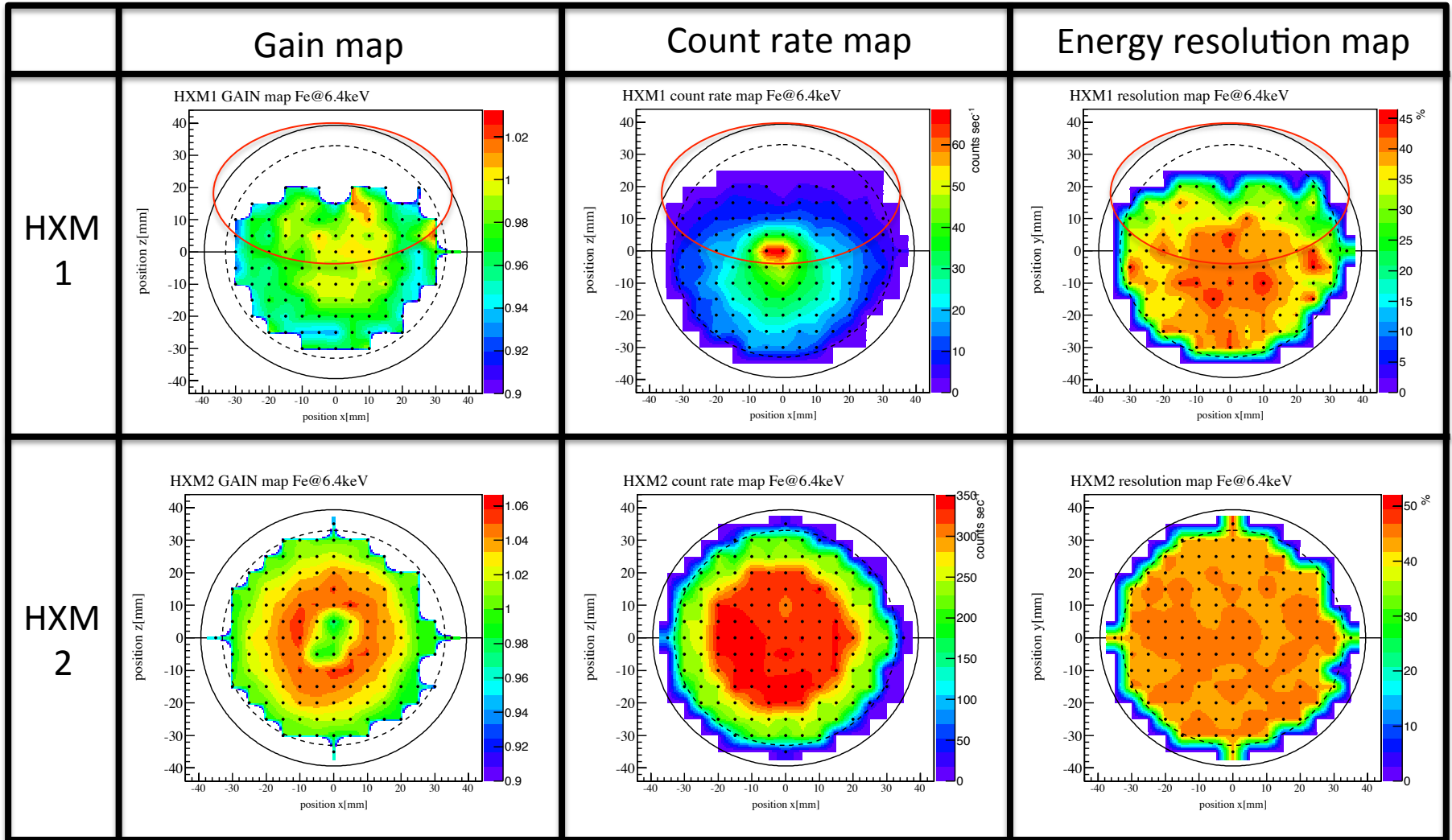
- Development detector response matrices
 - HXM
 - The simulation reproduce the measurement well above 40 keV.
 - SGM
 - The angular dependences for 511keV and 1275 keV are well reproduced by the simulations.
- Low detection efficiency of X-rays on HXM1
 - 2nd + 3rd PI cal: Excess counts are seen below 10 keV both HXM1 and HXM2.
 - HXM2 was degraded to same extent as HXM1
- Long term gain monitoring
 - HXM gain is higher after the thermal vac test than before thermal vac test.
- Efficiency of X-ray on HXM0
 - The efficiency of HXM0 that have never been used at environment test is same HXM2 at 1st PI cal.
 - We can not see degradation of HXM0.

Back up

Summary

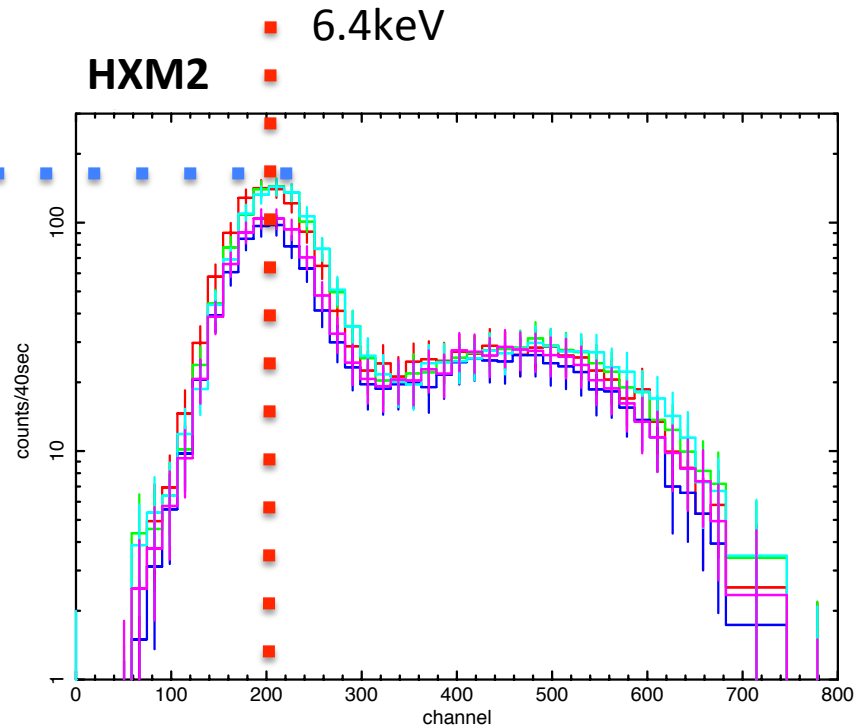
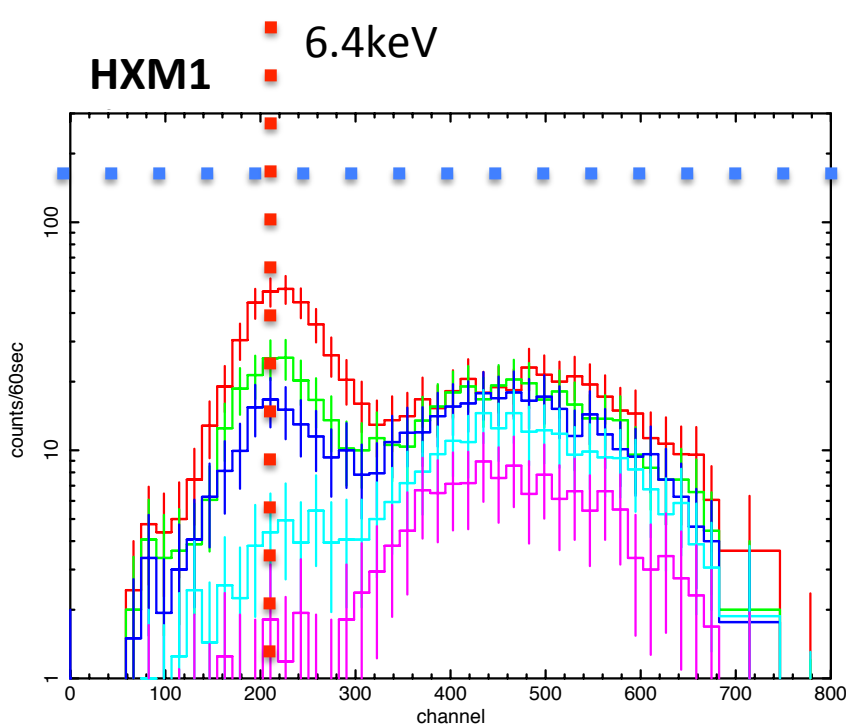
- Development detector response matrices
 - 1st Ground Calibration test
 - We could collect enough data to calibrate the detectors.
 - Development HXM response matrices
 - The simulation spectra reproduce the on-axis calibration source spectra(>80 keV).
 - Development SGM response matrix
 - The simulation spectra reproduce the calibration source spectra from arbitrary direction.
 - The SGM response matrix was developed using current SGM simulators.

HXM: 6.4 keV (Fe) 2D map



HXM1: No count-rate at the upper part ($Y > 0$) of the crystal
HXM2: Donuts shape feature in the gain map
HXM1 & 2: Count-rate is not uniform across the crystal surface

HXM: 6.4 keV spectrum

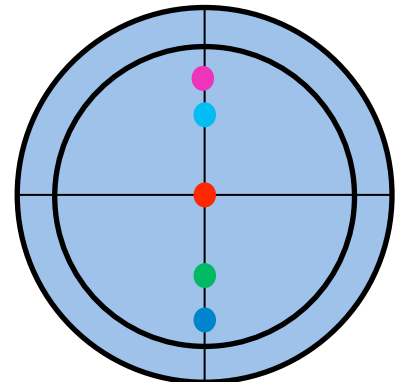


HXM1: 6.4 keV spectrum at X=0

HXM2: 6.4 keV spectrum at X=0

Red: Y=0, green: Y=-20, blue: Y=-30, light blue: Y=20, pink: Y=30

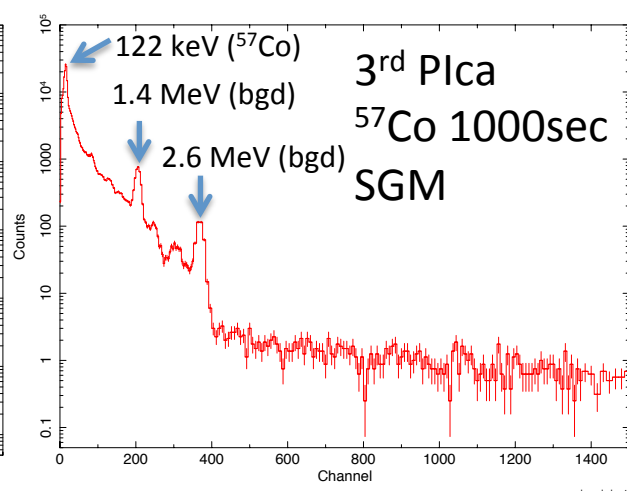
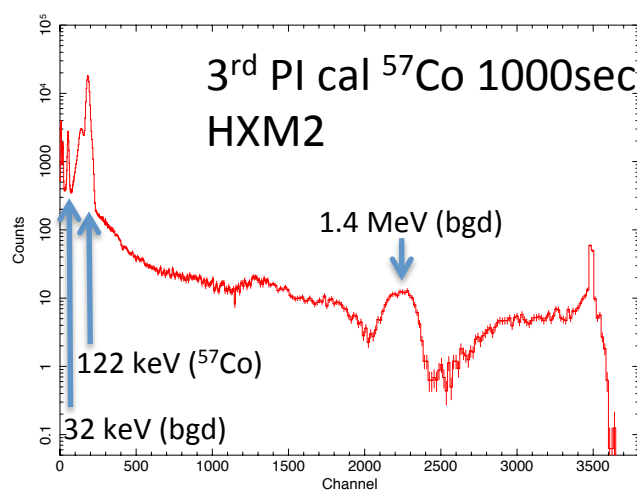
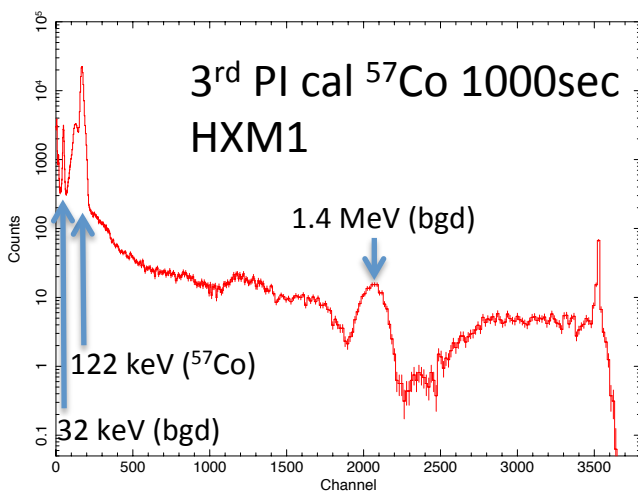
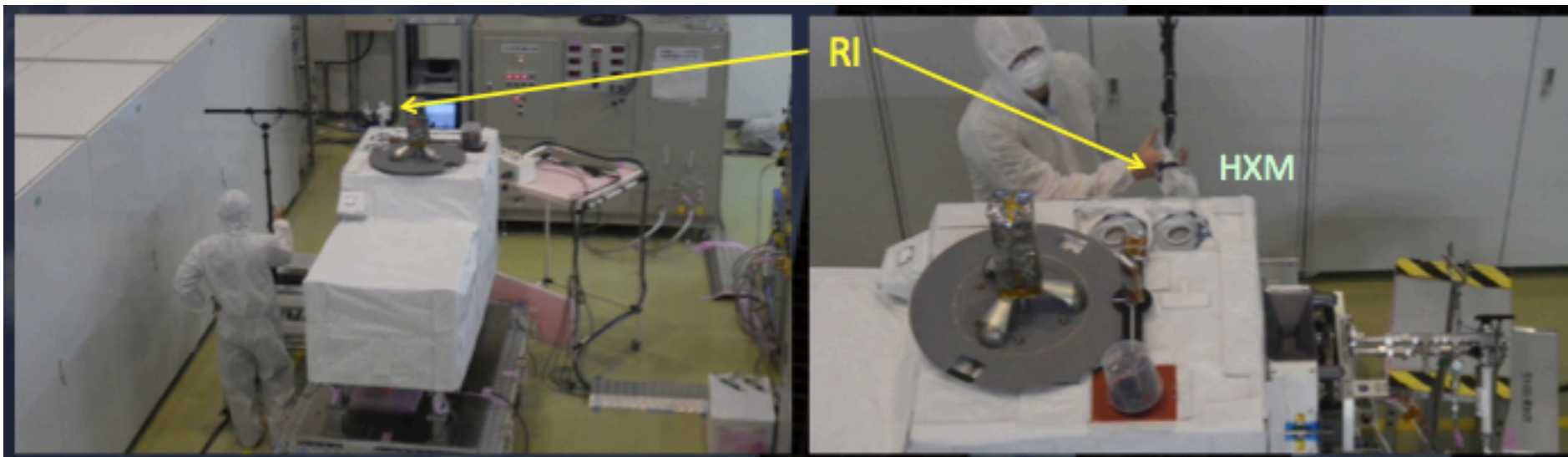
- Strength of 6.4 keV line of HXM1 decrease at off-center points. Overall strength of 6.4 keV line is weaker for HXM1 comparing to that of HXM2.
- HXM2 doesn't show a strong position dependence.



2nd and 3rd Ground Calibration test

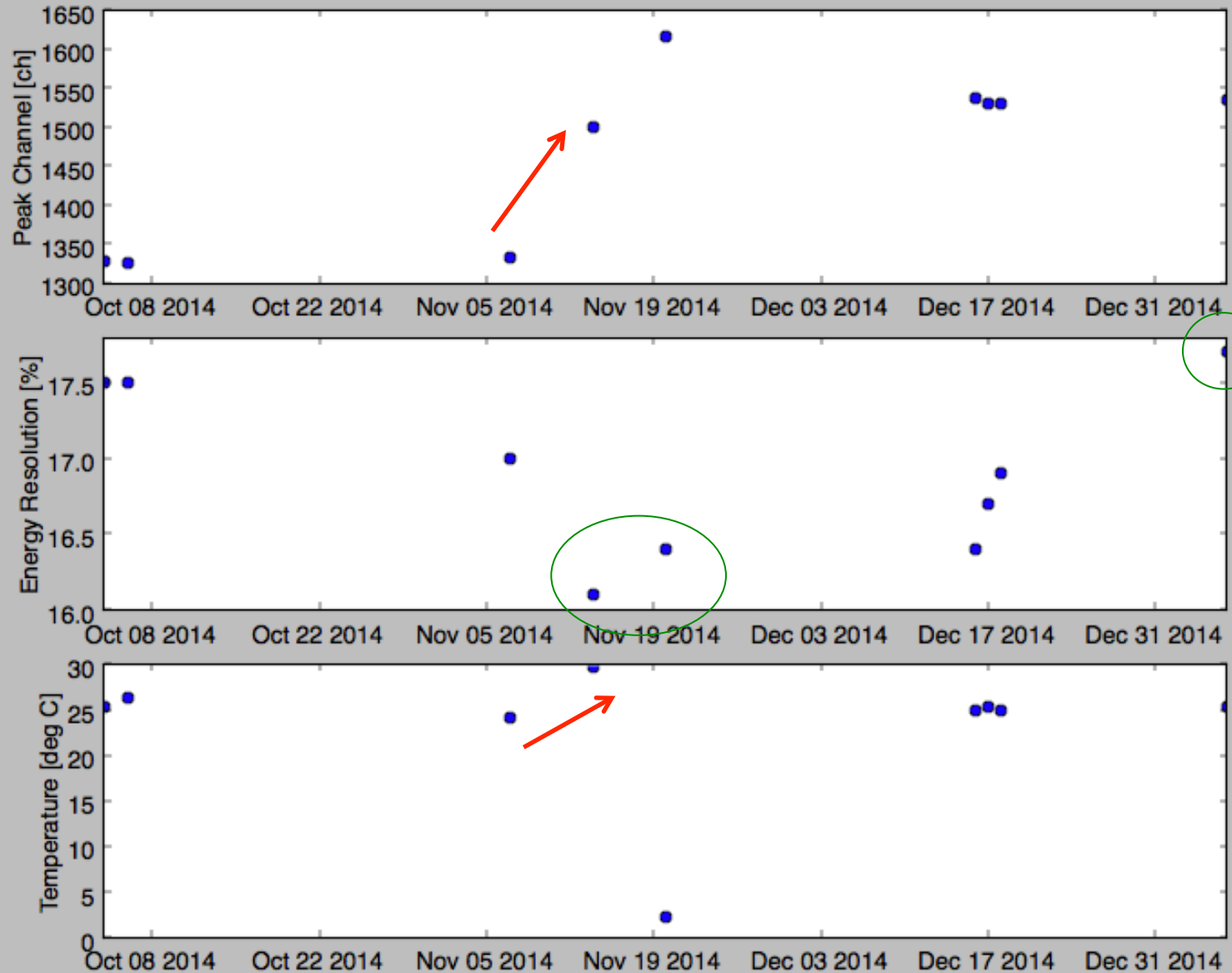
2nd ground calibration test: 2015/1/5-1/6 @ JAXA Tsukuba

3rd ground calibration test: 2015/ 3/12 @ JAXA Tsukuba

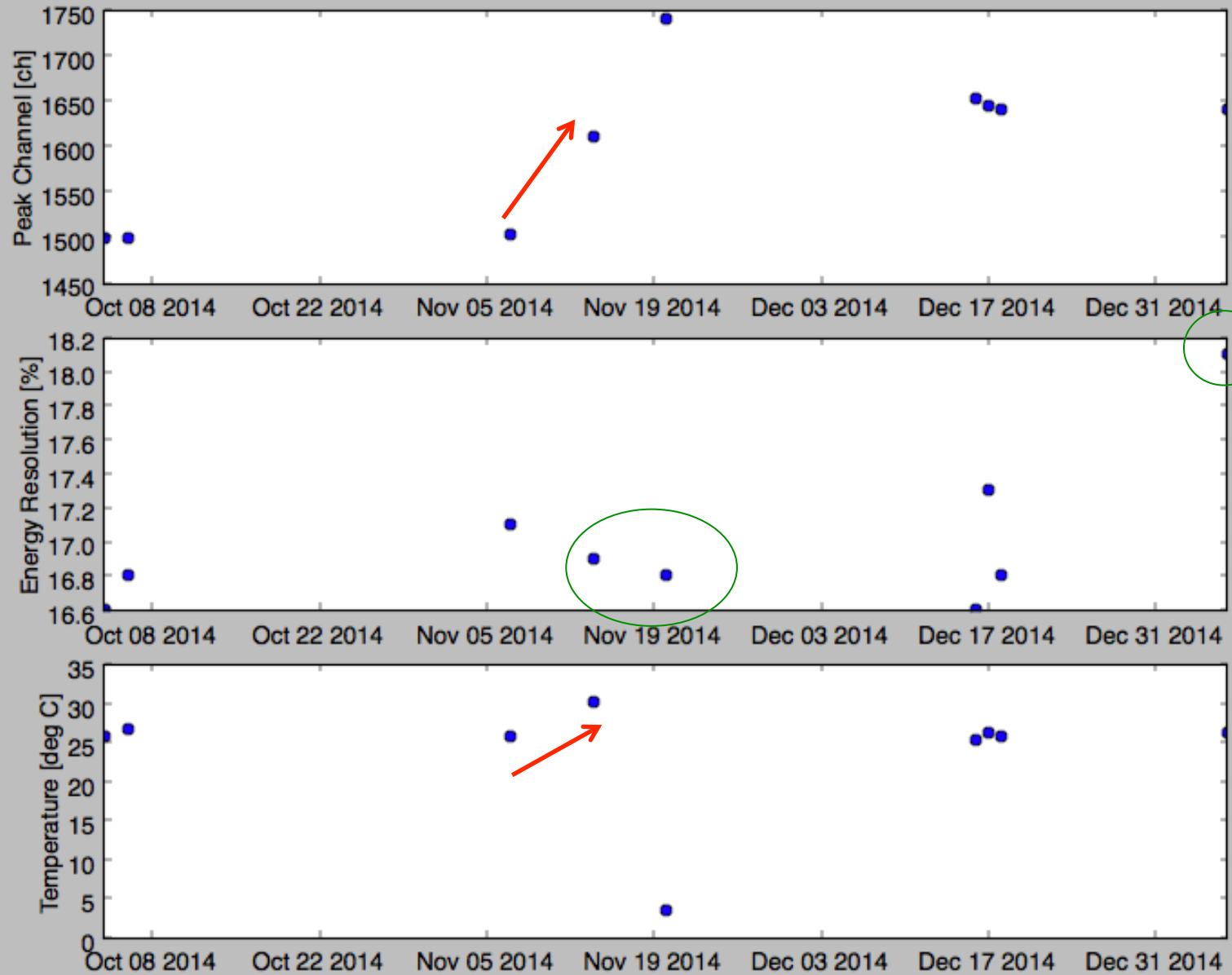


CGBM could resolve some lines of BG and ⁵⁷Co clearly.

HXM1: 32 keV peak



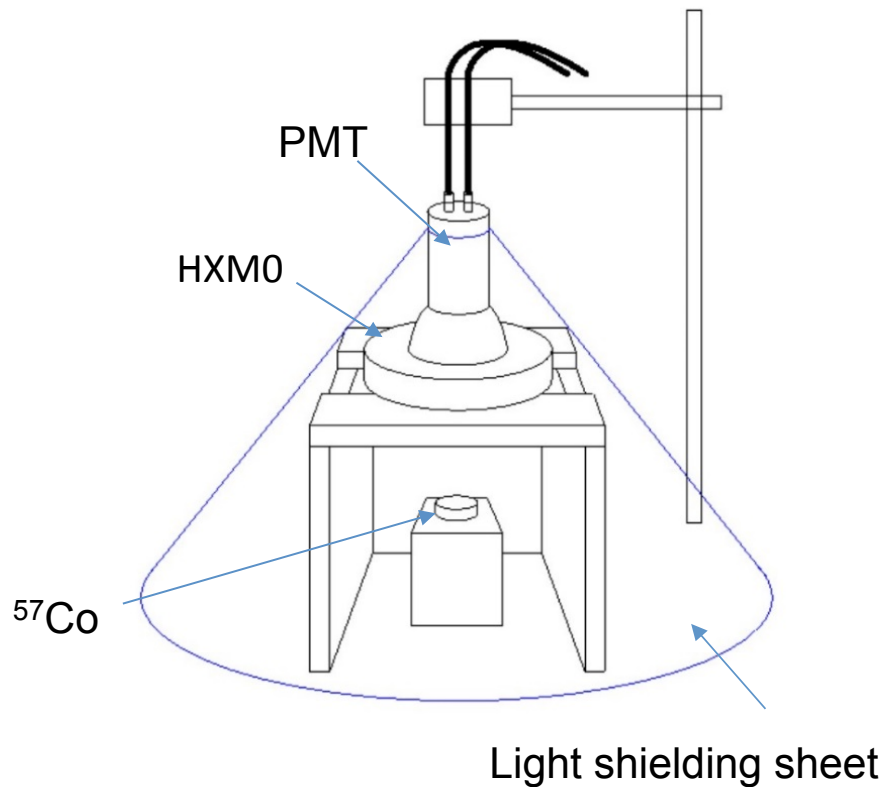
HXM2 : 32 keV peak



Summary

- Low energy response of HXM
 - 1st PI calibration: Low detection efficiency in HXM1 (HXM2 looked normal)
 - 2nd PI calibration: Excess counts below 10 keV (both HXM1 and HXM2). This excess is not visible in the background spectrum.
 - 3rd PI calibration: Same trend to 2nd PI cal. Amount of the excess is more or less similar to the 2nd PI cal.
- Long term gain monitoring
 - HXM1 and HXM2 gain gets higher during the thermal vacuum test. After that, the gain is gradually decreasing. This gain change can't be understood by the PMT ' characteristics.
 - SGM gain change is consistent with the BGO temperature characteristics.

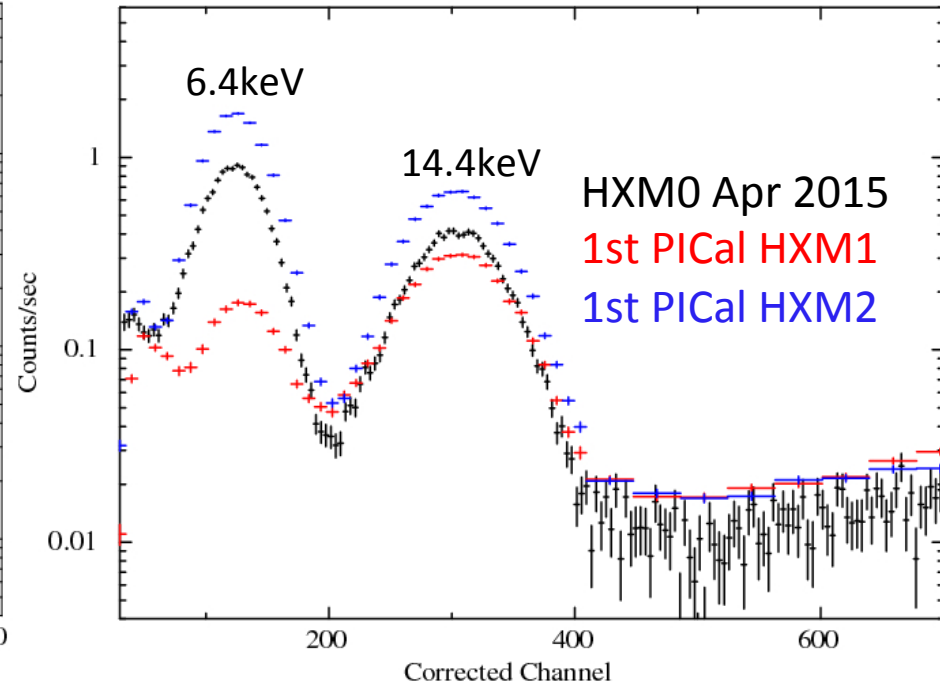
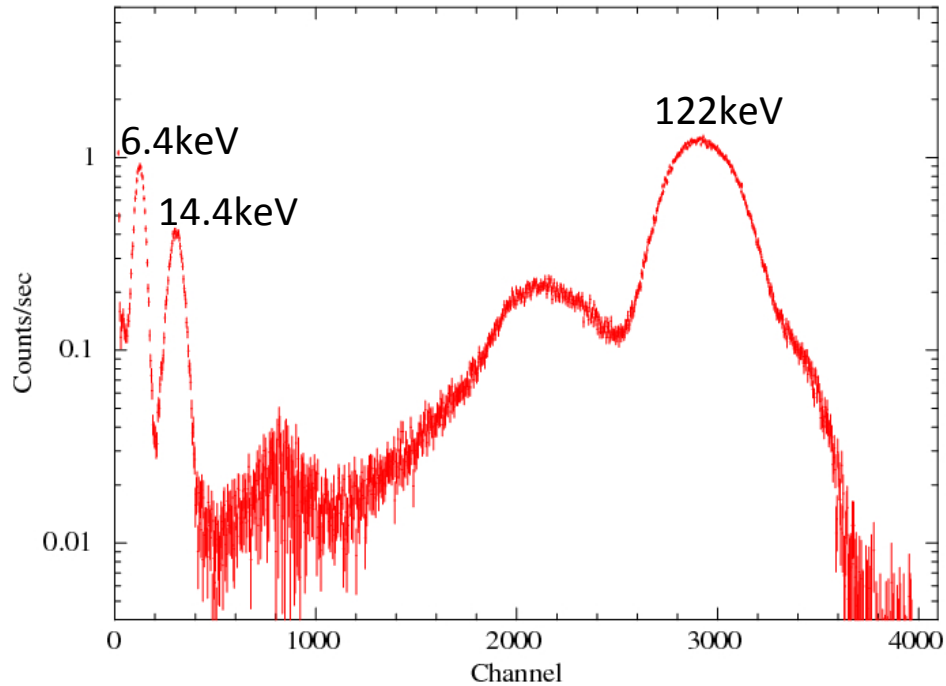
HXM0:low-energy response check



^{57}Co Spectrum

57Co HXM0 04/29/2015

1st Jan 2014



- The HXM0 spectrum shows that 6.4 keV line is stronger than 14 keV line. (not same as HXM1 at 1st PI cal)