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Preliminary calibration test and results analysis of GRM (SVOM)

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- Brief introduction of SVOM and GRM
- Calibration test
  - Radioactive sources
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  - setting and procedure
- Results and conclusion

The SVOM Mission

- Full name -The Space Variable Objects Monitor.
- The SVOM payloads are developed by Chinese teams and France teams.
- Instruments development are still on going and QM stage now.
- Launch time: 2022
- Orbit height：630km
- Scientific objectives:

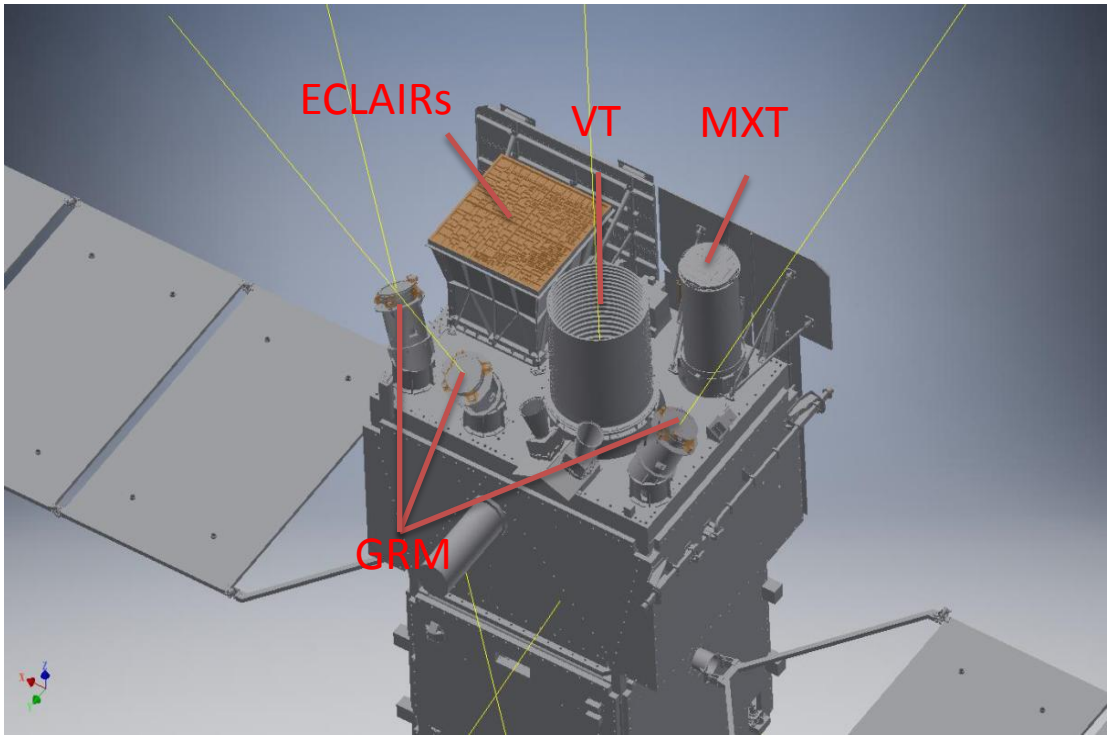
➢ detection, localization and broad-band study of gamma-ray bursts (GRBs)

➢ other high-energy transient phenomena.

➢ wide band GRBs observatory designed from the visible band to the gamma ray band.

➢ Follow-up ground-based instruments are expected to measure the redshifts of the majority of SVOM GRBs.

Instruments

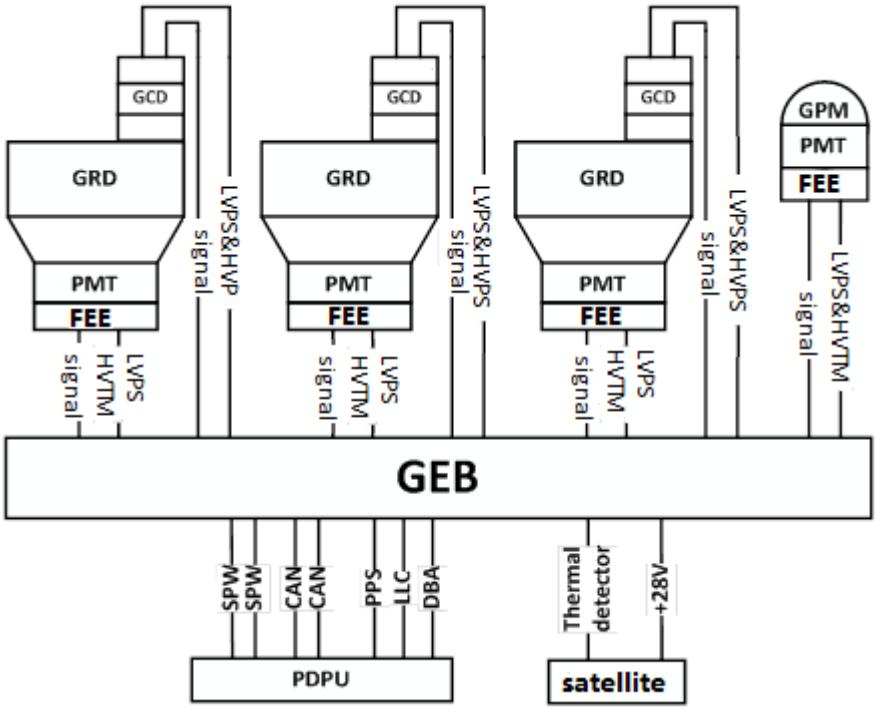


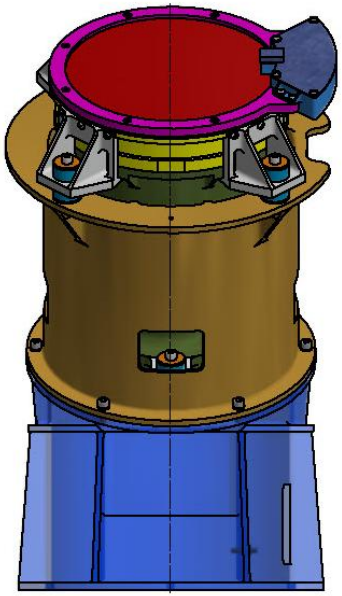
Mass model

Four onboard instruments:
ECLAIRs – a hard X-ray imager and spectrometer;
GRM – Gamma ray monitor which contains 3 units;
MXT – a soft X-ray telescope;
VT – an optical telescope;
Two ground instruments:
GFTs – Ground Follow-up telescope;
GWAC – an array of wide angle optical camera;

GRM

- The gamma ray monitor (GRM) onboard is designed to observe GRBs from 15keV to 5 MeV and provide real-time GRB triggers and localization information. With this instrument, one of the key GRB parameters, *Epeak*, can be easily measured in the hard X-ray band.





One GRD unit with support

GRM

- **GRDs** – As main detectors, they perform energy spectrum observation and GRB triggering of X-rays and soft gamma rays.
- **GPM** – monitor intensity of the space charged particle flow and give SAA early warning information.
- **GEB** – science data collection and management, commands management, and also instrument parameters monitoring.
- **GCDs** – in-orbit calibration detectors, to steady in-orbit gain of GRDs.

Designed indexes of GRM

Designed indexes	Value
Energy band(GRD)	15-5000 keV
FOV (GRD)	+/-60° (1 GRD)
Detection area (GRD)	> 200 cm^2 (1 GRD)
dead time	< 8 μs
Energy resolution (GRD)	≤ 16%@60 keV
GRB detectivity	> 90/year
location	< 5° (fluence >$1*10^{-6}$ erg cm^{-2} @1-1000 keV, 1s)
Total weight	28+/-2 kg
Total consumption	34.5+/-3 W
Reliability	0.97

Calibration test

- We finished twice calibration tests using same 4 sources before(Test No.1) and after(Test No.2) environmental experiments, aiming to acknowledge if the performance of GRM haven been changed.
- Radioactive sources

Source name	**Activity（Bq）**	**Typical energy（keV）**
Am-241	3000	59.5
Ba-133	4.62E+05	356
Na-22	500	511
Cs-137	4.11E+05	661.6

- **Products to be calibrated**

– hardware: 1 GRD QM(including GCD QM and support)+GEB QM

– firmware: QM V1.0, output all raw events data.

- **Facilities**

– EGSE + power supply

– collimation hole set up by *Pb* brick

– analysis software

- **Setting**

– HV=1063V, V_thr=40mV

- **Procedure**

– test duration = 10mins

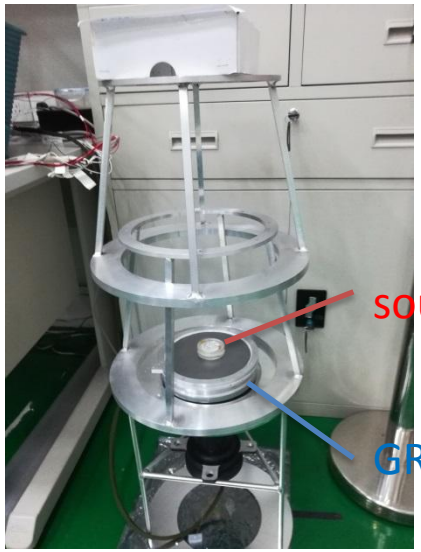
– test all sources one by one

– collect background with no source and same duration

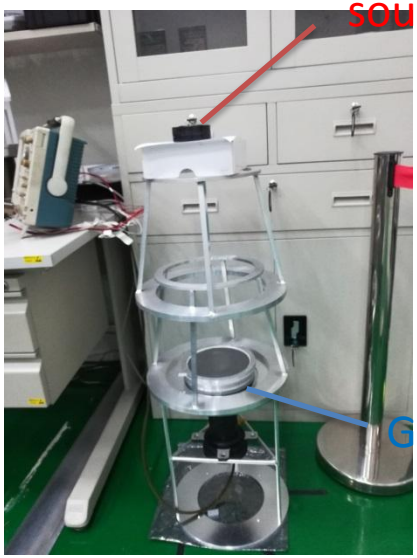
- **How to place source**

– according to activity of each source, we place them to the surface of GRD with different distance.

– In test No.1



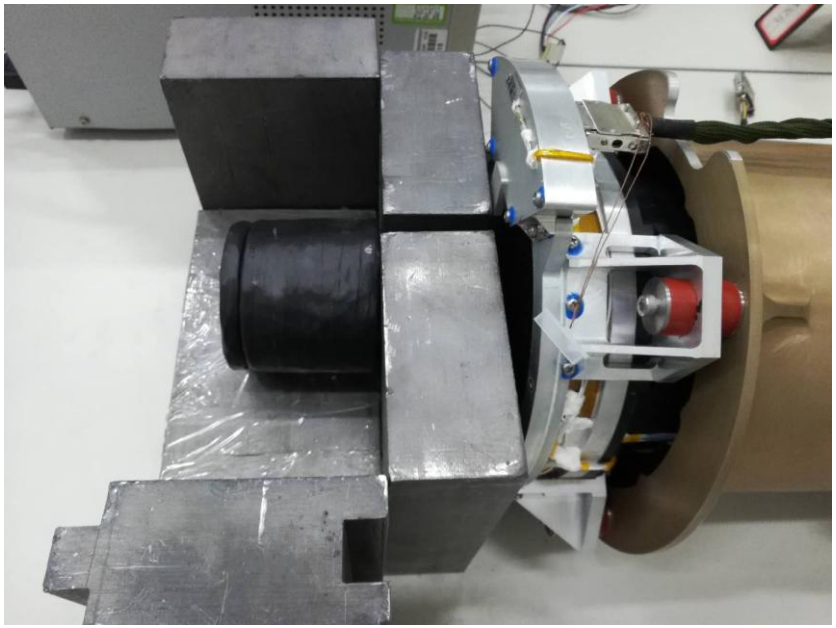
Lay Am-241、Na-22 on detector surface directly



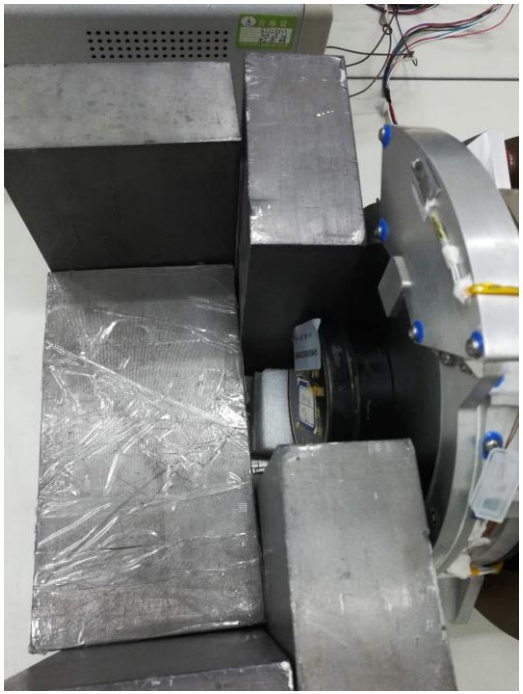
Lay Ba-133、Cs-137 ~1m away from detector surface via bracket

– In test No.2

we set up a collimation hole using *Pb* brick with size 5cm×1cm.

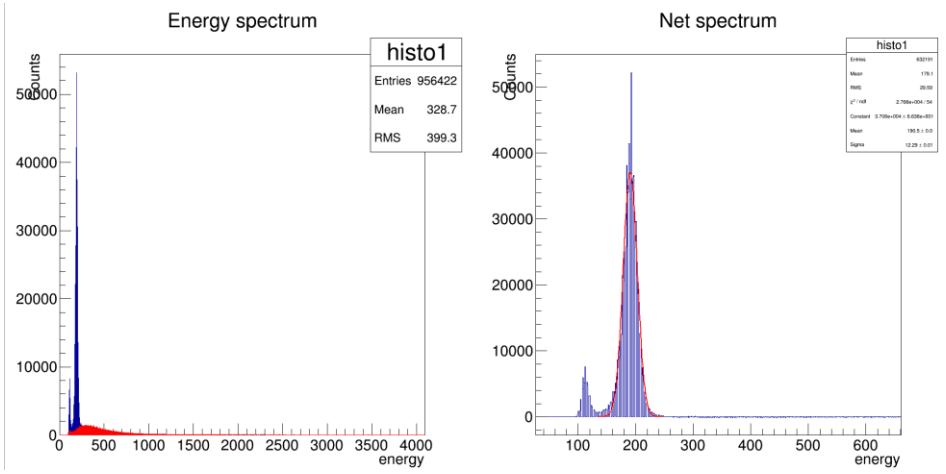


Ba-133 placement

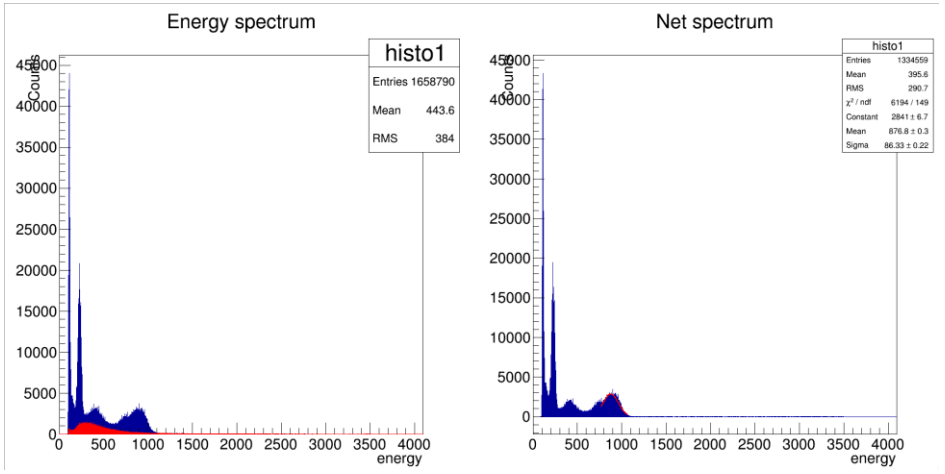


Am-241、Na-22 and Cs-137 placement

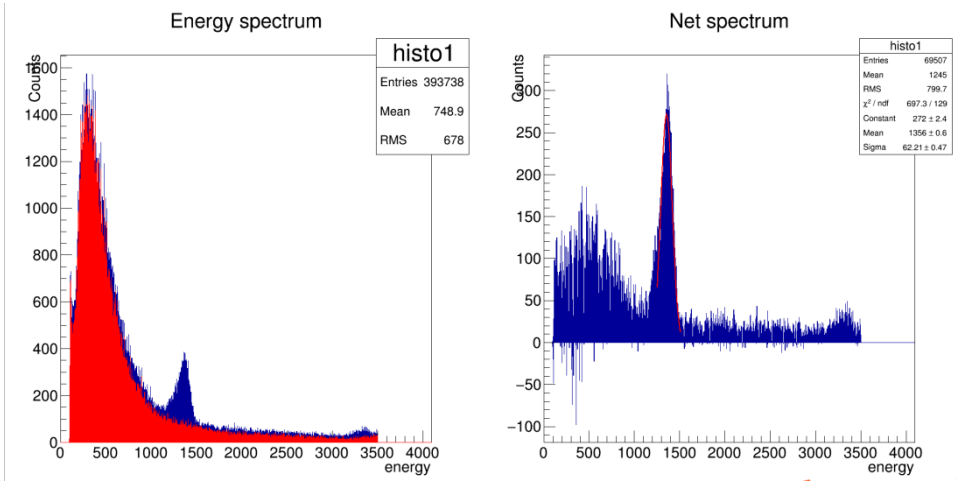
Results analysis-test No.1



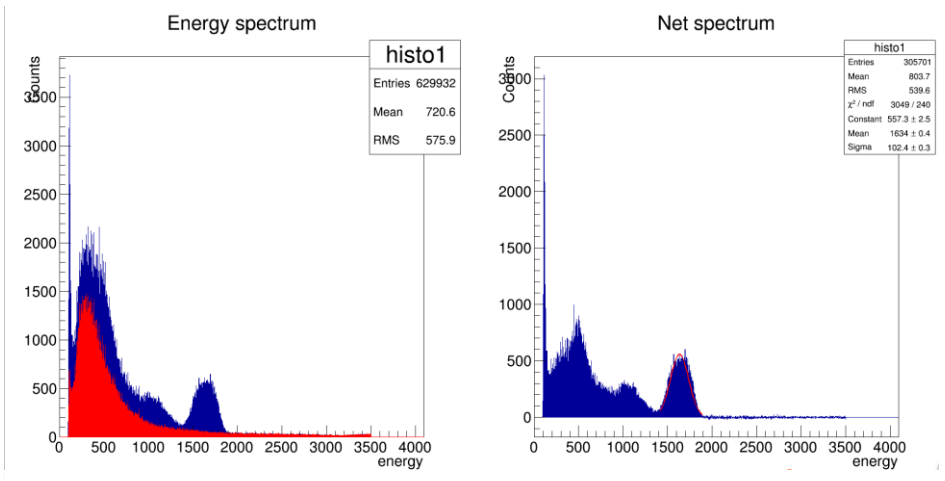
- Am-241, E-res=15.2%



- Ba-133, E-res=23.2%

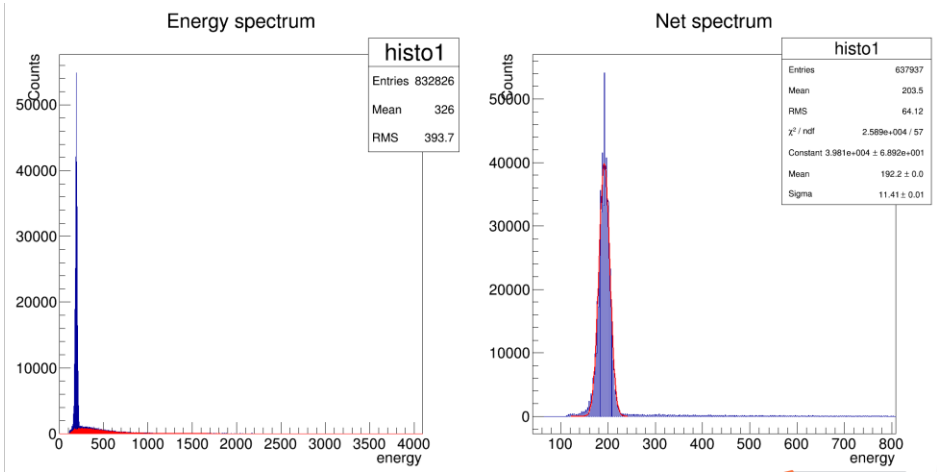


- Na-22, E-res=10.8%

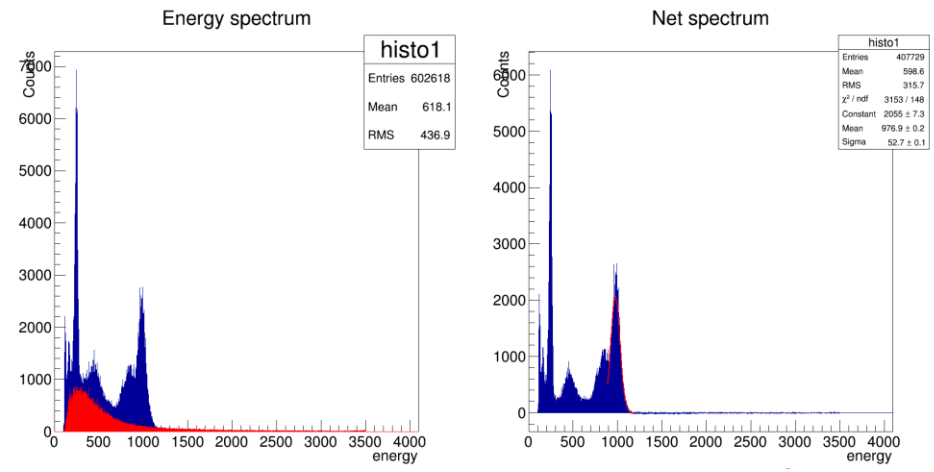


- Cs-137, E-res=14.7%

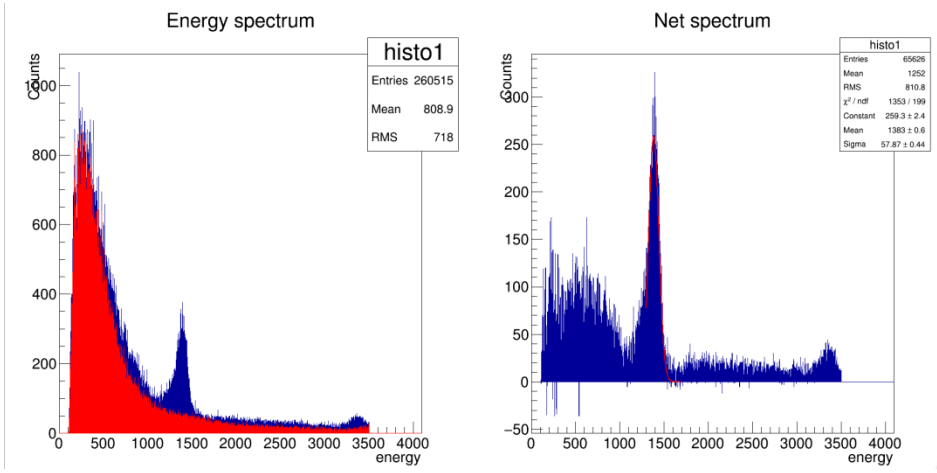
Results analysis-test No.2



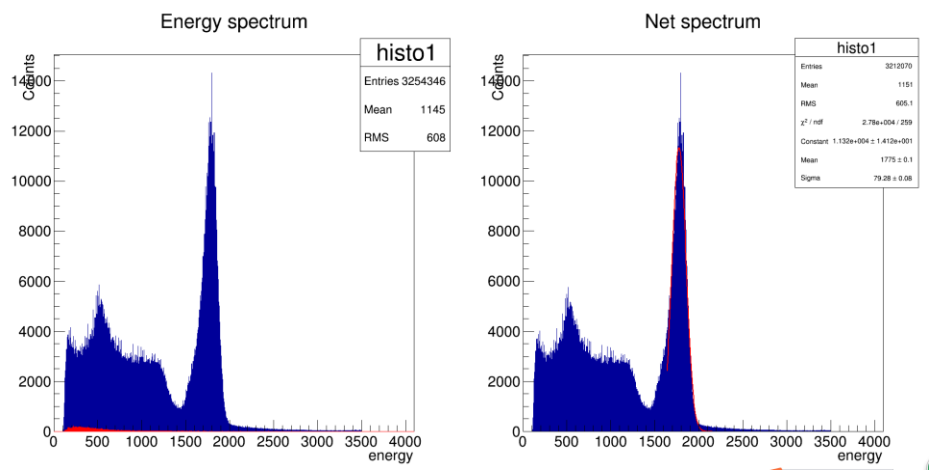
- Am-241, E-res=13.98%



- Ba-133, E-res=12.7%

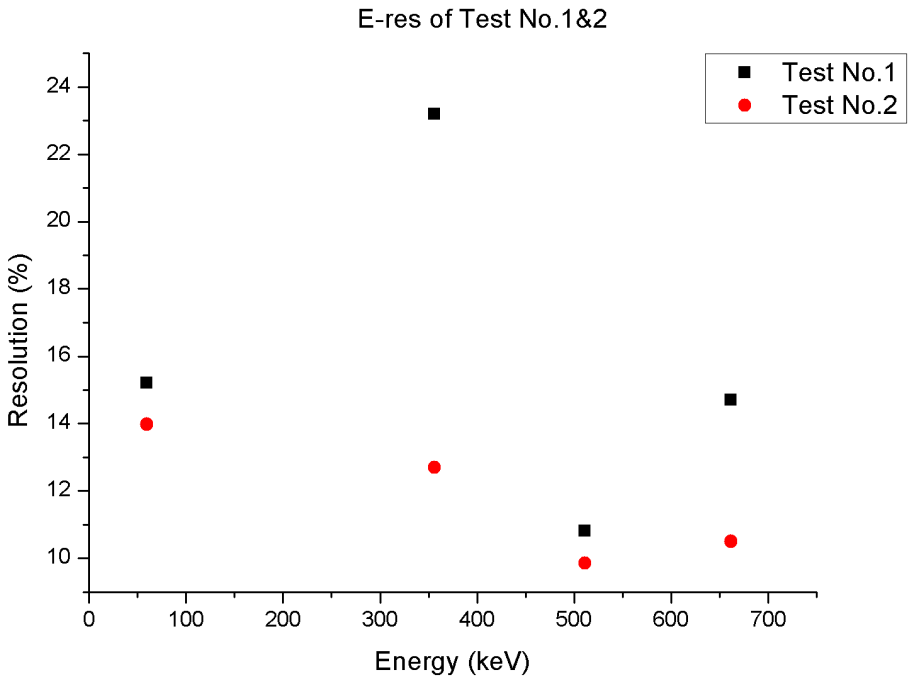


- Na-22, E-res=9.85%



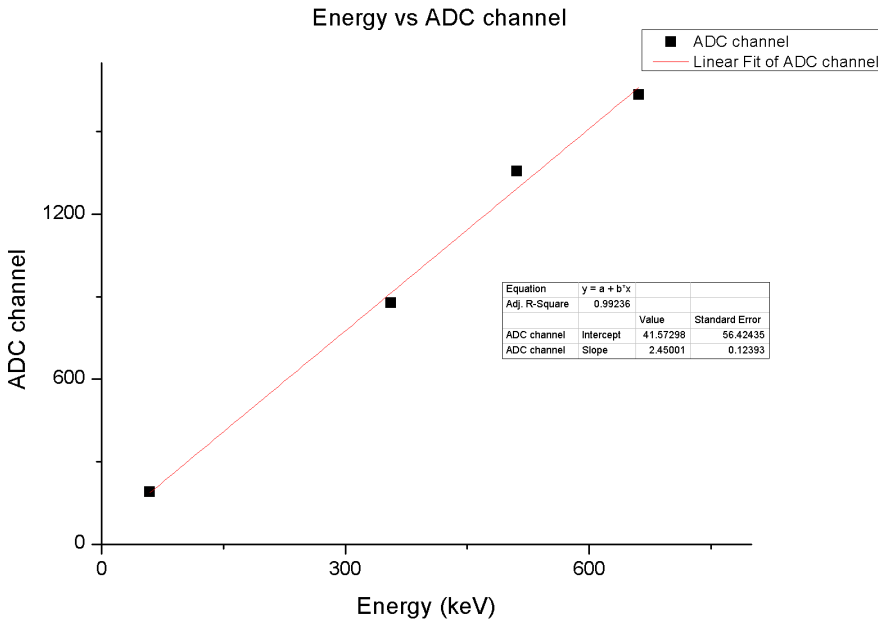
- Cs-137, E-res=10.5%

Sources	Energy(keV)	Test No.1		Test No.2	
		ADC channel	E-res	ADC channel	E-res
^{241}Am	59.5	190.5	15.2%	192.2	13.98%
^{133}Ba	356.01	876.8	23.2%	976.9	12.7%
^{22}Na	511	1356	10.8%	1383	9.85%
^{137}Cs	661.65	1634	14.7%	1775	10.5%

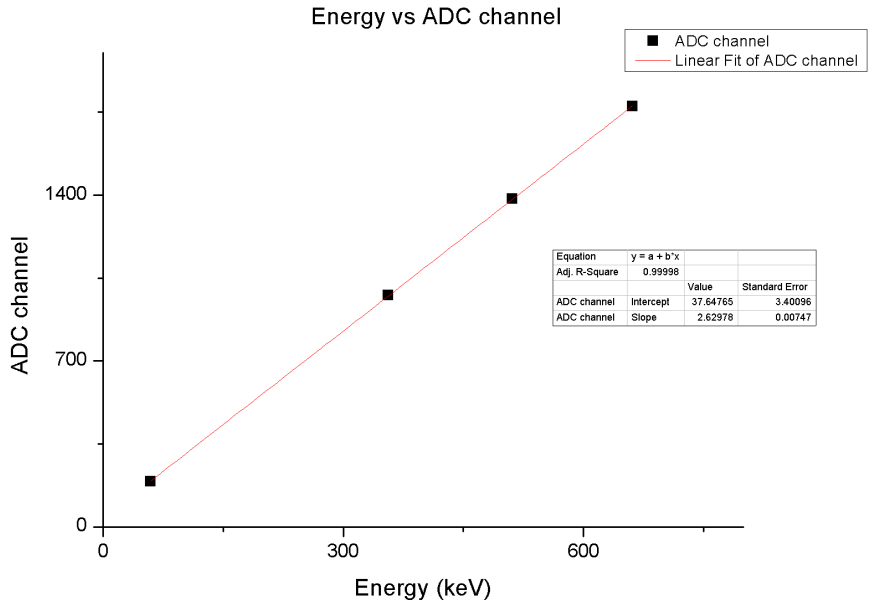


The resolutions of test No.2 are better than No.1 due to collimation system has been used in test No.2 and sources were more closer to detector surface.

Linear relation between Energy and ADC channel of Test No.1 & No.2



Test No.1



Test No.2

Summary

- The spectrum, Energy resolution and *E-I* of the 4 sources produced by GRM meet designed expectation
- Results show the performance of GRM stay consistent before and after environmental experiment
- Next calibration plans with GRM QM:

➢ More sources calibration, especially high energy in MeV.

➢ Beamline calibration.

➢ ……

Thank you for your attention