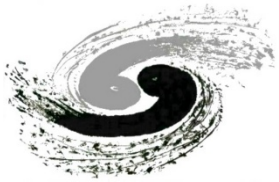

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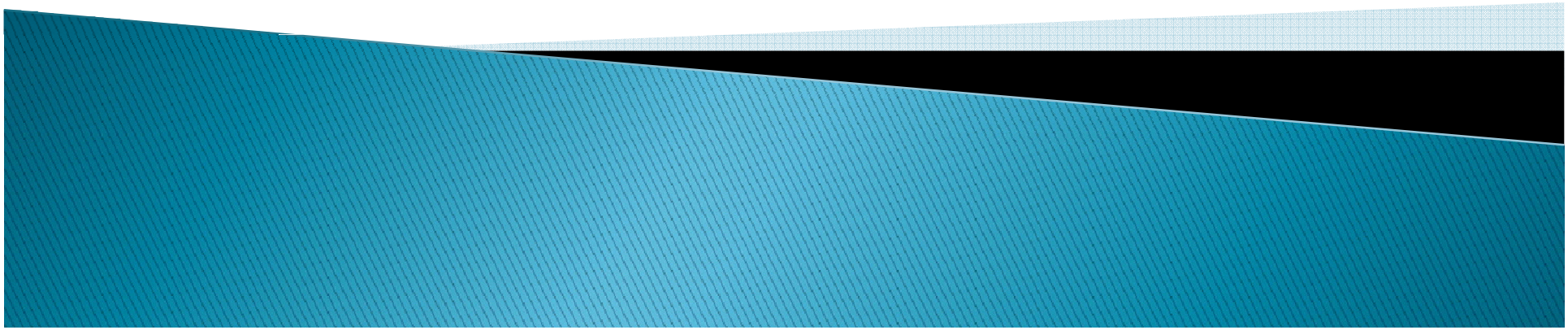
Institute of High Energy Physics
Chinese Academy of Sciences

# Monte Carlo simulation for HXMT calibration

Xinqiao Li

28 March, 2012



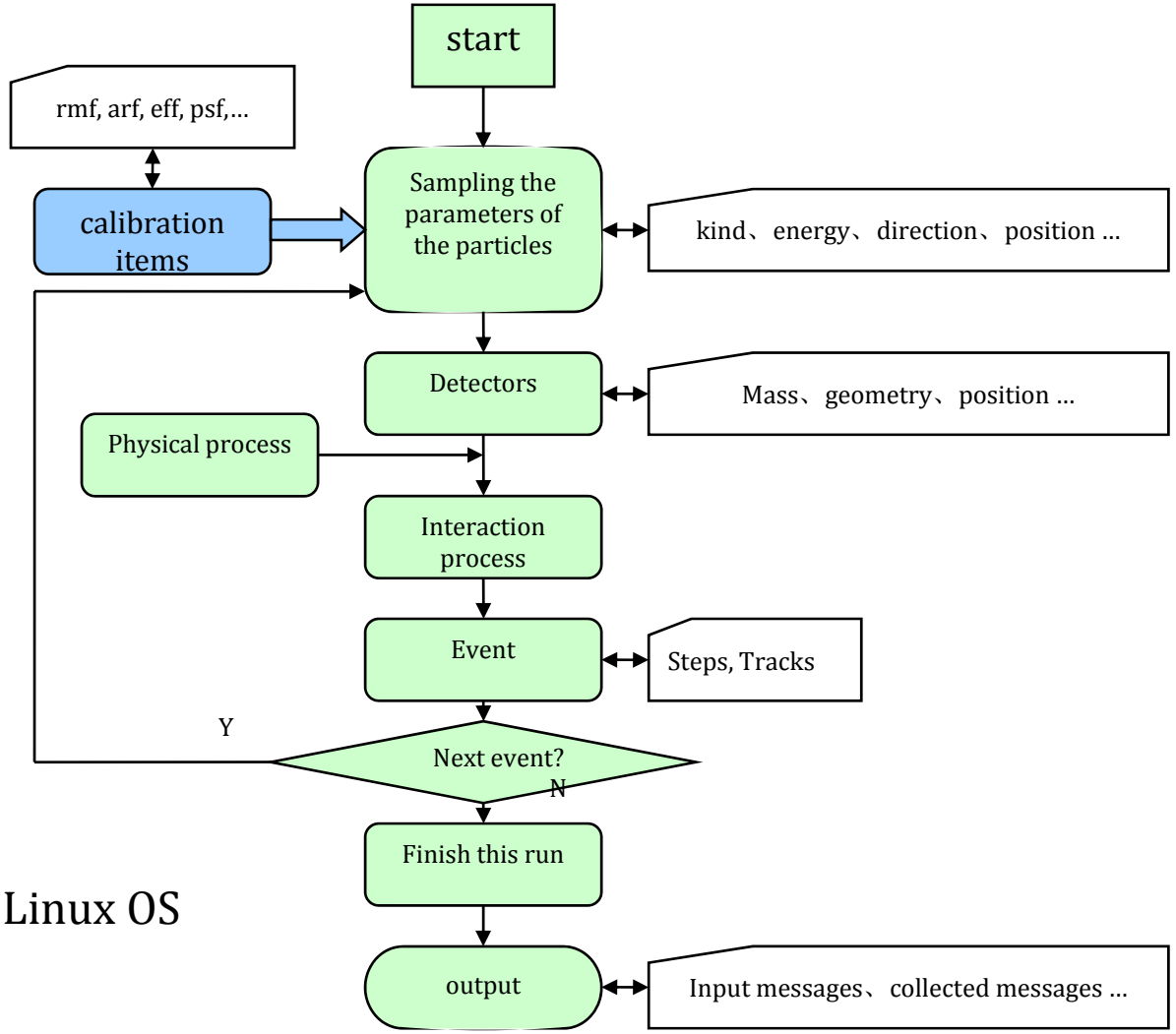
# Outline

- Several primary simulations
  - Introduction of the simulation program
  - The simulated BG spectra
  - The simulated RMF, ARF
- The calibration of the collimator alignment

- Calibration & Simulation
  - The train of thought for ground calibration of HXMT payload in the future
  - Revising the simulation program
  - Question and discussion

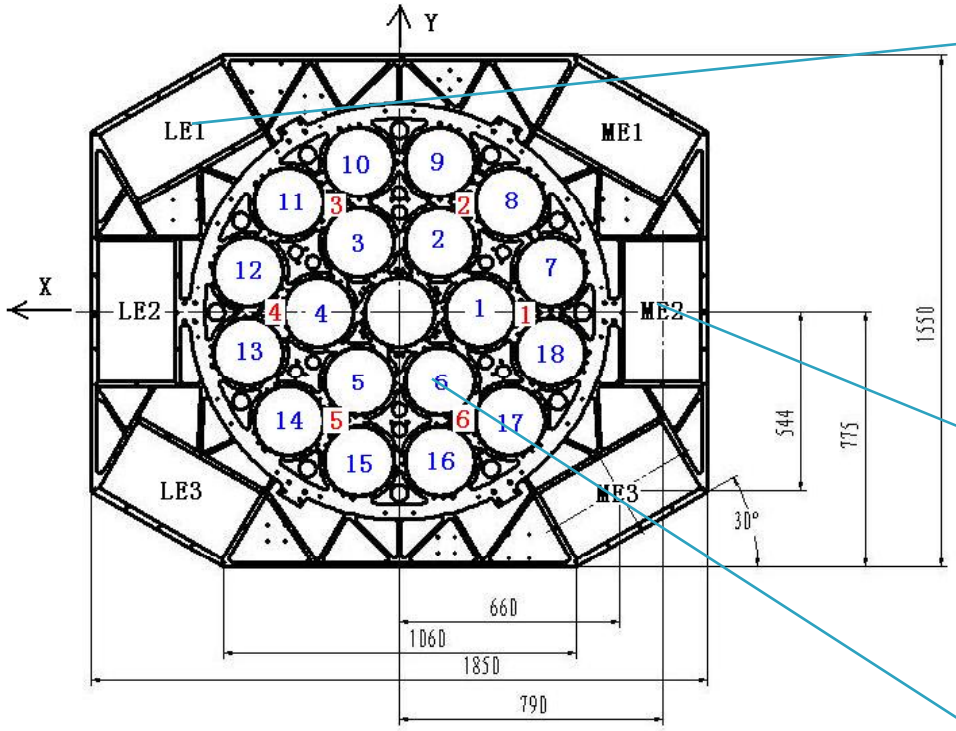
# The background、RMF&ARF simulation

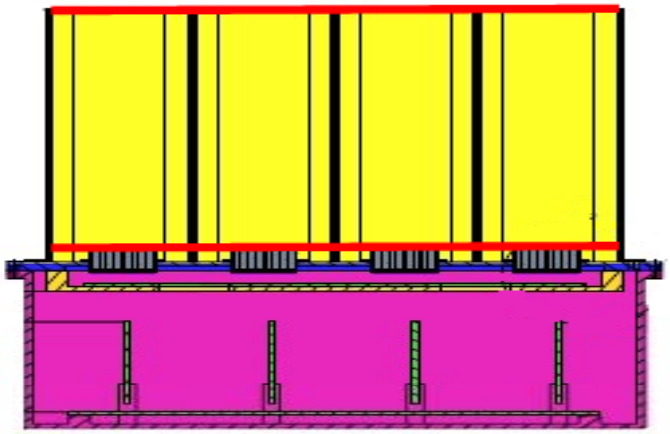
# Simulation of the background in orbit–flow chart

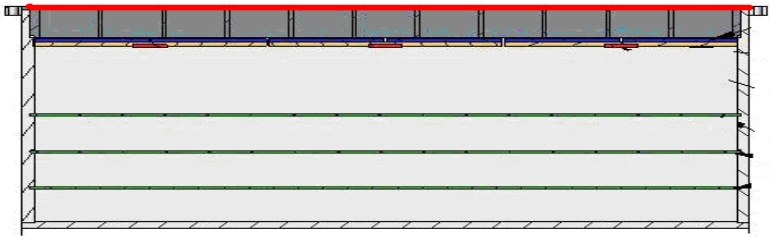


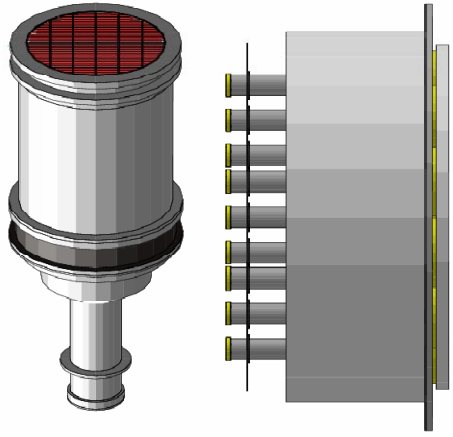

Based on GEANT4 software @ Linux OS

# Simulation of BG in orbit–model

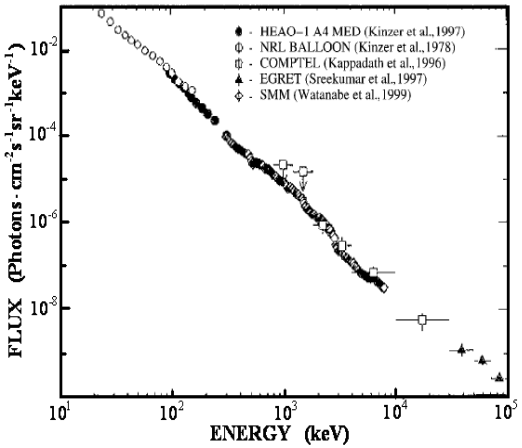




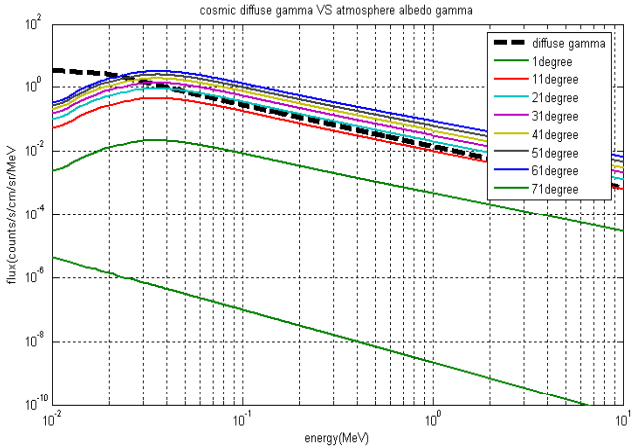


# Simulation of BG in orbit–input spectra

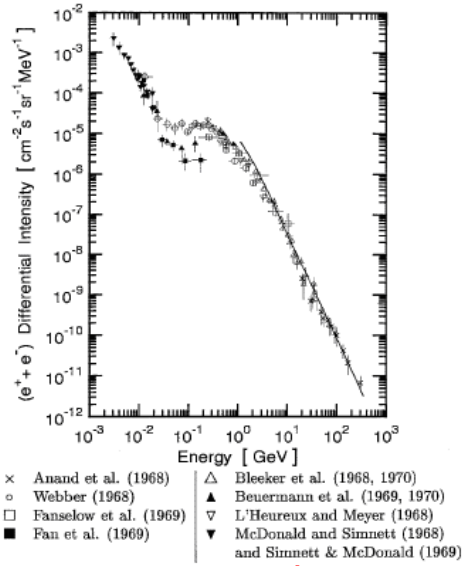



Diffuse gamma

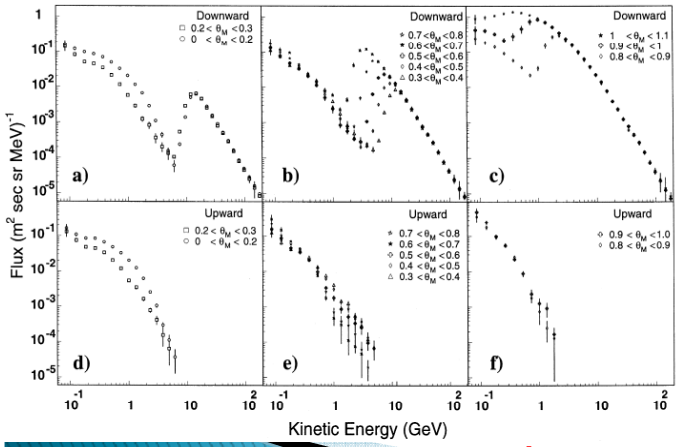
$$\frac{dI(E)}{dE}=\begin{cases}0.54E^{-1.4} & (<0.02MeV)\\ 0.0117E^{-2.38} & (0.02-0.1MeV)\\ 0.014E^{-2.3} & (>0.1MeV)\end{cases}$$



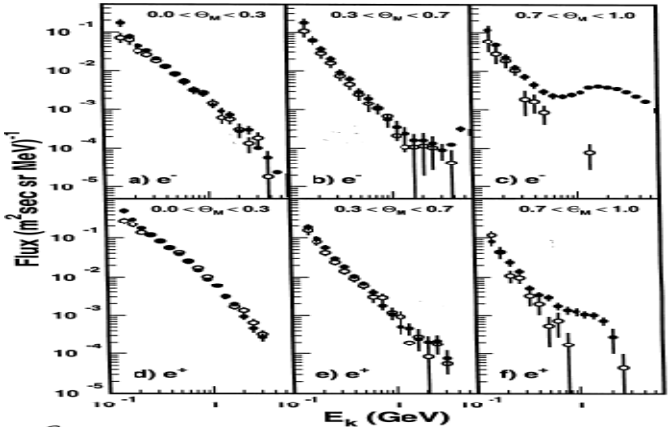

Photons reflected by atmosphere



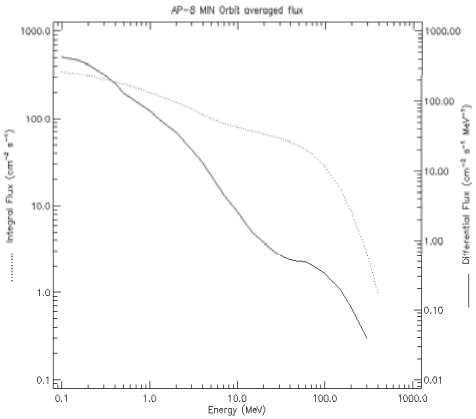

Low energy particles （Proton: 1keV~10MeV，$e^-/e^+$:1keV～1MeV）




Energetic particles —proton

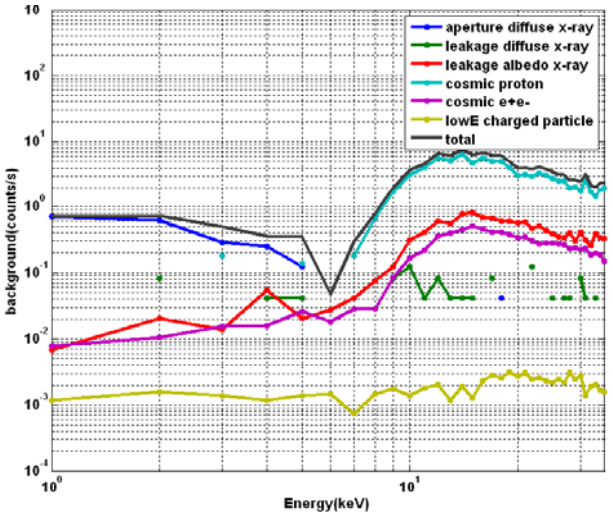


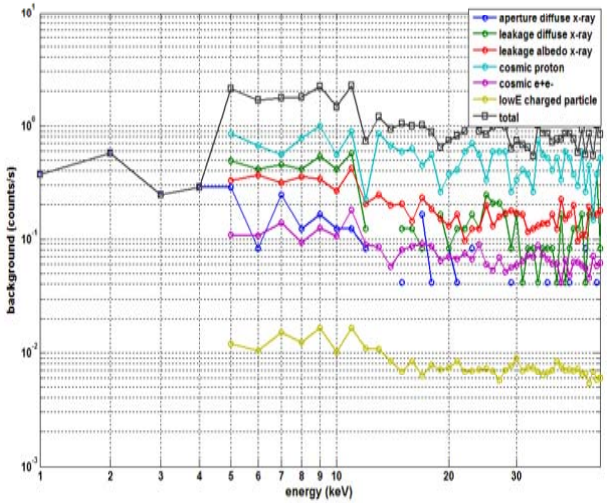

Energetic particles —$e^-/e^+$

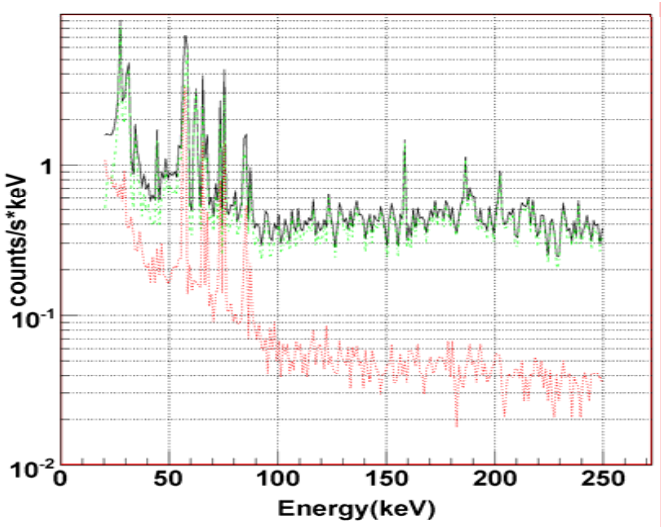



SAA proton (100MeV-400MeV)

# Simulated BG spectra in orbit



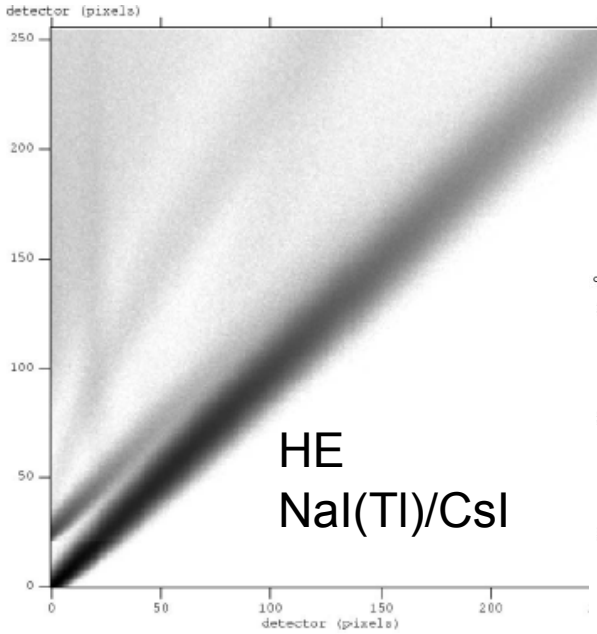




LE, FOV: 1°×1°

ME, FOV: 1°×1°

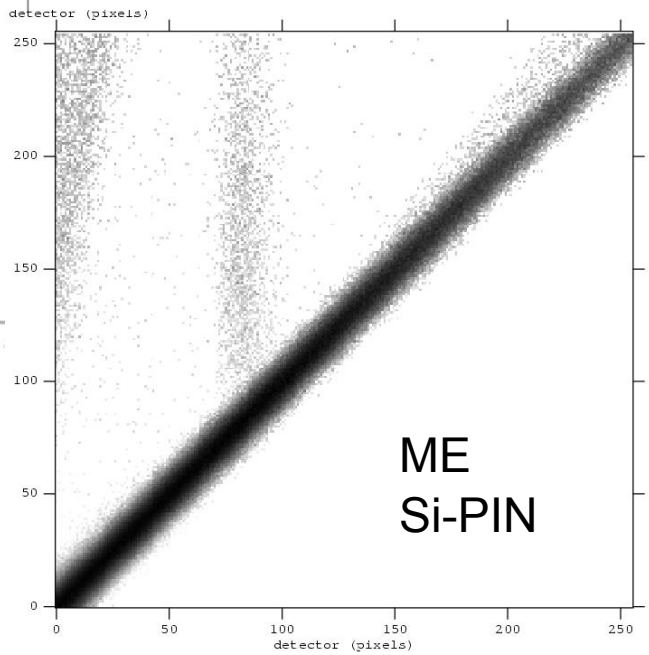
HE, FOV: 1°×6°

# Simulation result–RMF



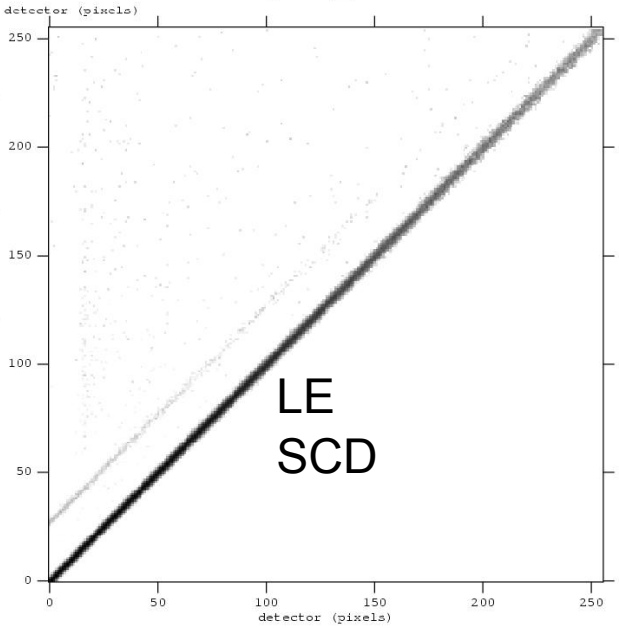

HE
NaI(Tl)/CsI

15-250keV




ME
Si-PIN

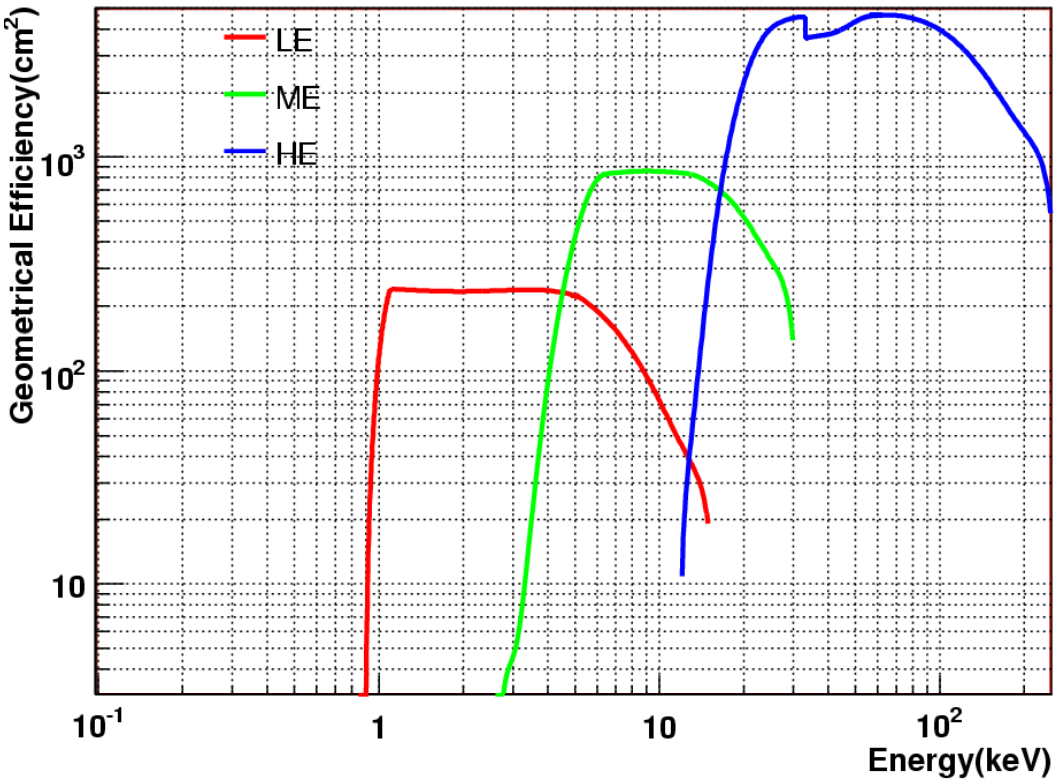
5-30keV




LE
SCD

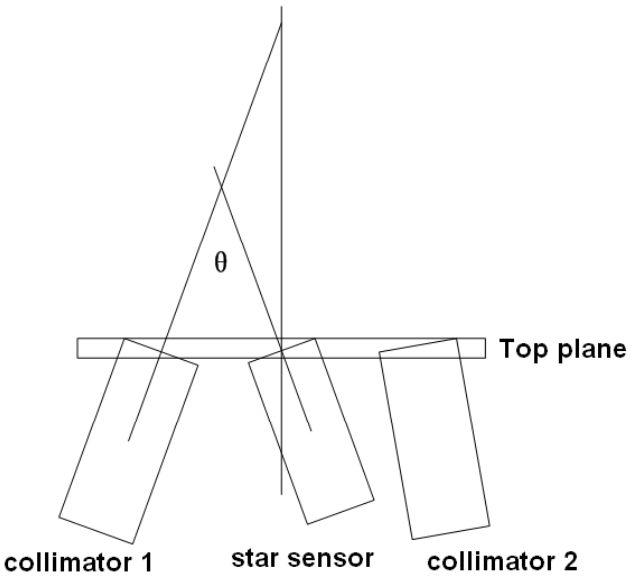
1-15keV

# Simulation result–efficiency

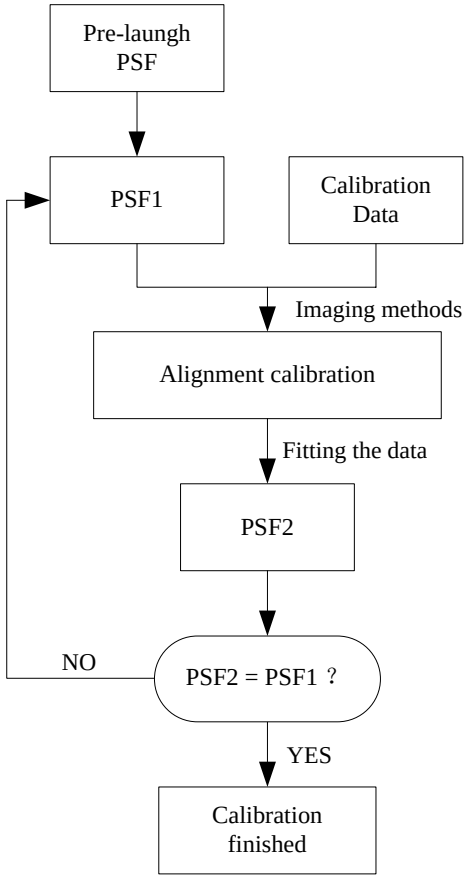


# The simulation of the in-flight calibration of the collimator alignment and PSF for HXMT

# Why do? & The flow chart




Small deviations in both boresight and PSF are expected due to the fabrication uncertainty, launch vibrations as well as thermal variations and relaxation in zero gravity in orbit.




The flow chart of in-flight alignment and PSF calibration with the imaging method

# The measurement errors of the collimator alignment

$$\sigma_{col} = \sigma_{star} + \sigma_{cal} + \sigma_{\mathrm{var}\_random} + \sigma_{\mathrm{var}\_sys}$$

1arcmin for 20σ source

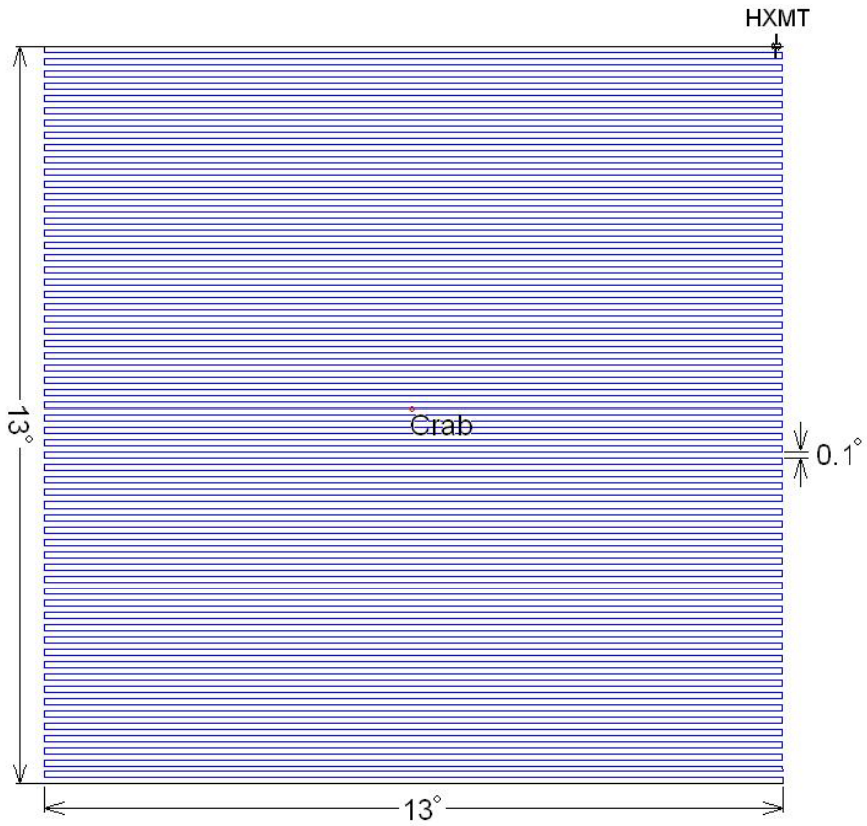
$\sigma_{star}$ : the measurement error of the star sensors

$\sigma_{cal}$ : the calibration error of the collimator alignment. ≤ 0.5 arcmin

$\sigma_{\mathrm{var}}$ : other errors, e.g.: thermal deformation error

$\sigma_{\mathrm{var}\_sys}$ : the system error

# The simulation of the collimator alignment calibration observation

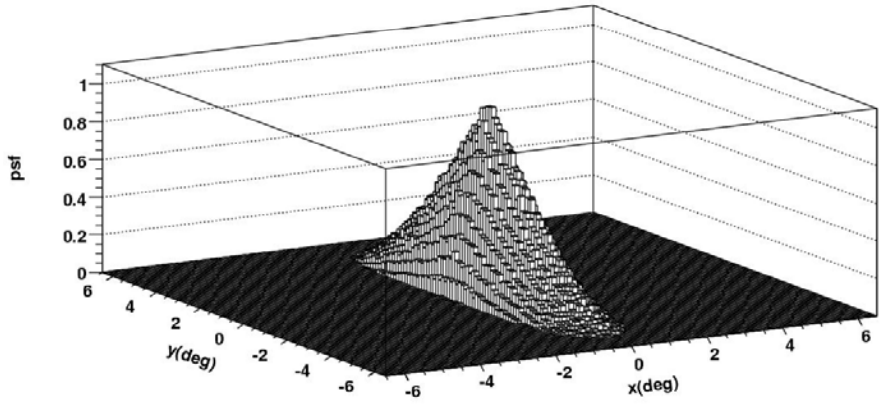



Simulated detector: HE
(18 detectors)
FOV: 5.7 deg * 1.1 deg
Source: Crab, $f=8.97*E^{-2.08}$
BG: ~200 cts/s
Observation area: 13d*13d sky
The orbits spacing: 0.1deg
The observation mode: survey
The predefined misalignment :
-0.003° (X) and 0.002° (Y)

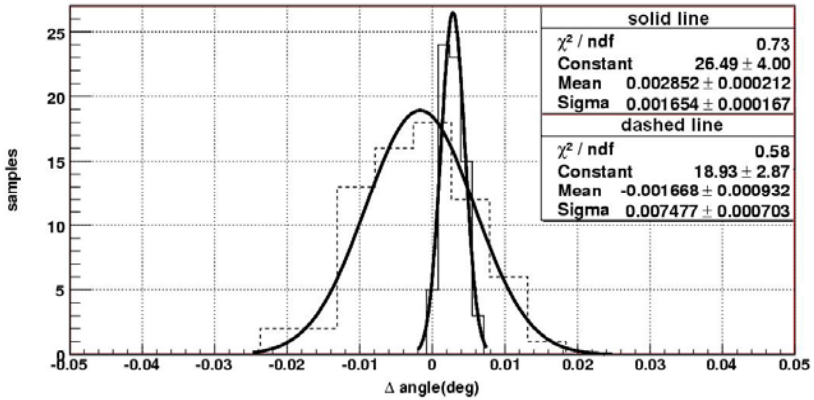
The simulated statistics

| Energy (keV) | 1Crab flux (counts/cm2/s) | Efficiency | Observation time(s) | Photons detected by each detector (counts) |
|---|---|---|---|---|
| 20~50 | 0.2053 | 0.92 | 35.8 | 1880 |
| 50~100 | 0.064 | 0.92 | 35.8 | 586 |
| 100~250 | 0.0361 | 0.65 | 35.8 | 234 |
| 20-250 | 0.3054 | | | 2700 |

# The simulated results for the collimator alignment calibration




PSF




The simulated accuracy

**Alignment calibration accuracy**

| Observation time/day | Wide FOV/arcmin | Narrow FOV/arcmin |
|---|---|---|
| 1 | 0.45 <0.5 | 0.099 |
| 4 | 0.22 | 0.046 |
| 8 | 0.13 | 0.030 |
| 16 | 0.11 | 0.023 |

The calibration accuracy derived from one day scanning observation of the Crab is sufficient to the requirement of localization accuracy of HXMT.

# The status of simulation in the payload calibration

# Calibration simulation-status

(1)As the important supplement of calibration

- consistent @ test points
- simulate other points.

(2)To estimate the key parameters before an experiment

- e.g.: how to set the experimental layout
- e.g.: To estimate the background of the experiment

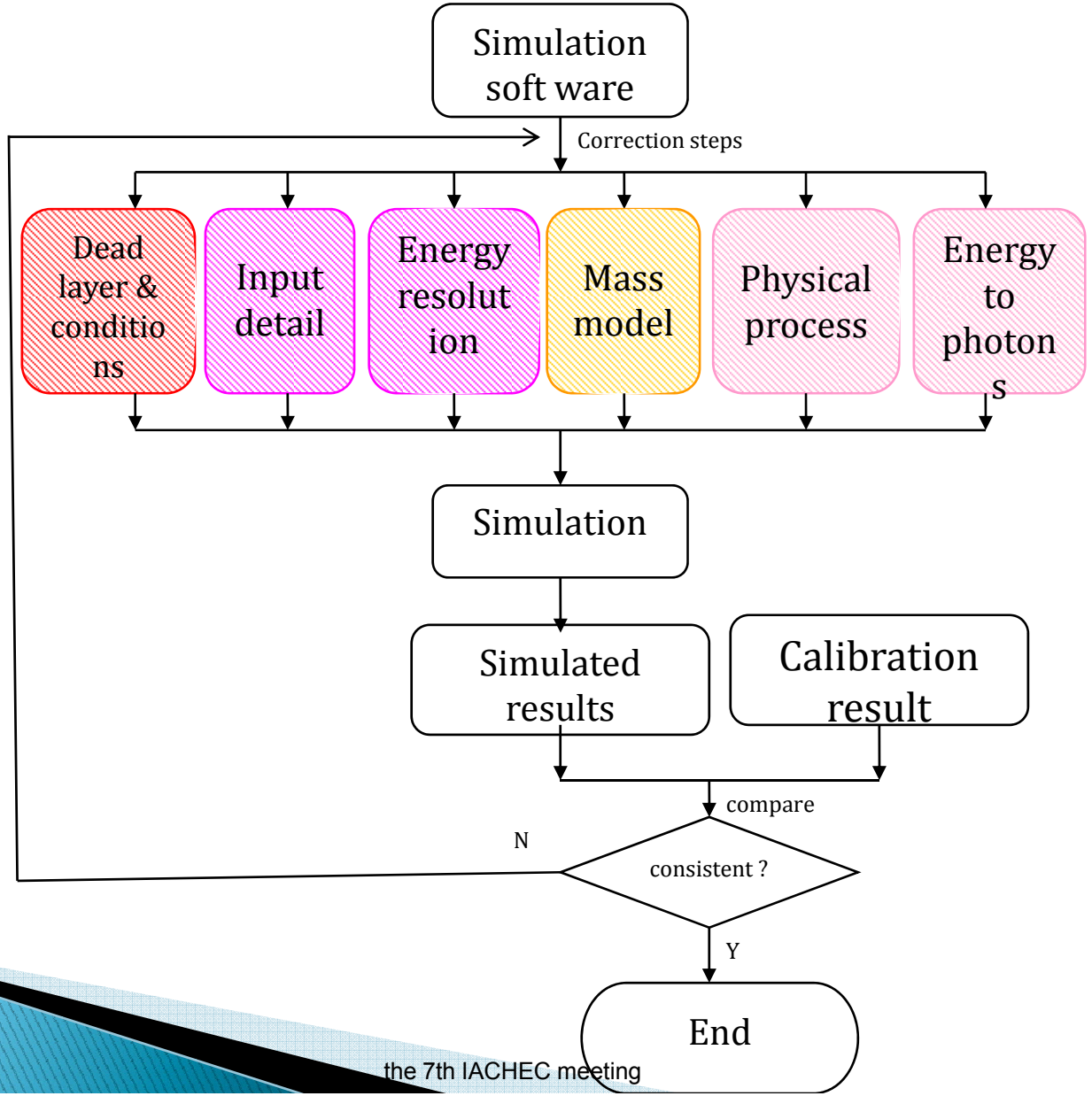
(3)To support making the calibration scheme

- To set the test points by analyzing the construction of the simulated preliminary efficiency、RMF

# Calibration<->Simulation

- We need to know the total relation of "environment-detectors-simulation-the calibration parameters" :
  - The environment -> the calibration parameters
    PE: to parameterize the environment parameters;
  - The working condition of detector -> calibration parameters
    PD: to parameterize the detector;
  - PE & PD -> simulation program
    -> the parameterized calibration results
    -> the calibration production

# The flow chart of the correction of the simulation program during ground calibration



# Question and discussion

- Can we get any help with the simulation program correction during the ground calibration?
- How to simulate the varied BG in the calibration observation in-orbit?
- We need help for the construction of the calibration database.

# Thank you !