We developed a "primary cut" using on-ground calibration angle, each hit position, etc. should be investigated. It is essential to distinguish the signal from the background event selection of Compton camera by the preliminary result using both on-ground experimental data with good photon statistics and flight data with a real in-orbit background and signal data.

1. Introduction

- Soft Gamma-ray Detector (SGD) onboard Hitomi
- Multi-layer Si-CdTe Compton camera - active shield - extremely low BGD
- Anisotropy of Compton scattering azimuthal angle - polarization measurement
- First time in-orbit operation for Si-CdTe Compton camera

It is essential to distinguish the signal from the background for astronomical observations in 60—600 keV energy band with high sensitivity. Development of optimum event selection criteria is essential to derive the best observational performance of SGD but it is challenging because many parameters such as detected photon energy, Compton scattering angle, distance of each hit etc. would be correlated non-linearly. Here, we propose a new method to distinguish the signal from the background from multi-parameter space utilizing machine learning approach. We found the possibility that this approach could be a good guide for the physical understandings for a optimum event selection of Compton camera by the preliminary result using both on-ground experimental data with good photon statistics and flight data with a real in-orbit background and signal data.

2. New approach for multi-parameter event selection

Problem: To distinguish the signal to the background utilizing multi-parameter relations which could be correlated non-linearly.

Solution: Non-linear classification with machine learning. Classification that maximize Figure Of Merit (FOM) could provide guide to physical understanding

Support Vector Machine (SVM)

One of the classifier using supervised learning. It determines the boundary of two (or multi) groups by maximizing the "margin", which means the shortest distance between the data and boundary.

Complicated non-linear boundary can be projected to simpler one by utilizing Kernel function.

3. Application of the new event selection

Application 1: Thermal-vacuum test on-ground

First of all, we applied our new event selection based on non-linear SVM classification to the on-ground calibration data.

- Enough photon statistics are available but not identical data to in-orbit background.
- Good application for verification of the method and 2D SVM characteristics

- Learning data
- Apply data
- Spectral analysis procedures
- 1. SVM learning by energy-binned learning data
- 2. Use SVM for energy-binned apply data
- 3. Evaluate FOM for each energy bin
- 4. Compare FOM to other cut conditions

Application 2: Crab observation data in orbit

After validating our new event selection by Application 1, we applied this method to in-orbit Crab observation data. Limited exposure time (~5ks) is problem for both learning and apply data. But background and astronomical data obtained by Si-CdTe Compton camera in orbit.

Crab spectrum (input)

Re-visit to check multi-parameter distribution to understand physical property of SVM event selection and find parameter correlation.

4. Conclusions

- New event selection technique using multi-parameter classification with SVM is being developing to maximize performance of S-CdTe Compton camera
- Consistent result with standard cut is obtained and possibility of new parameter correlation is found
- Further optimization/understanding are needed for future application