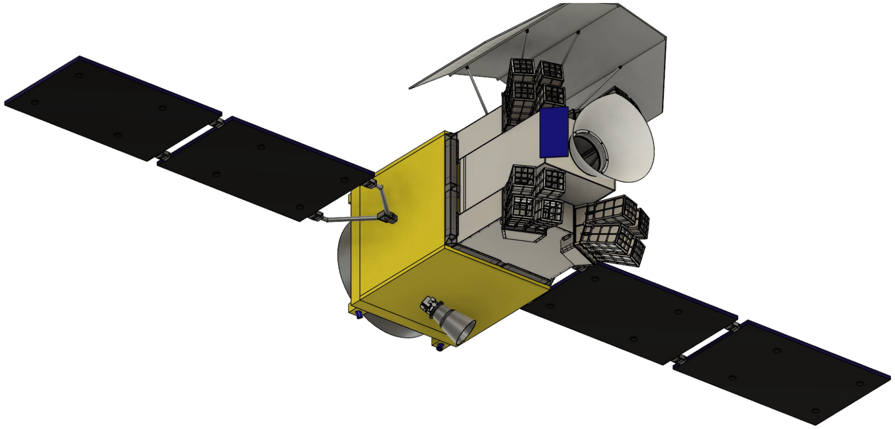
The third annual conference of Transformative Research Areas (A), "Multimessenger Astrophysics"
18 November 2025, 17:35 @Naruko Kanko Hotel



Current Status of On-board Software for HiZ-GUNDAM

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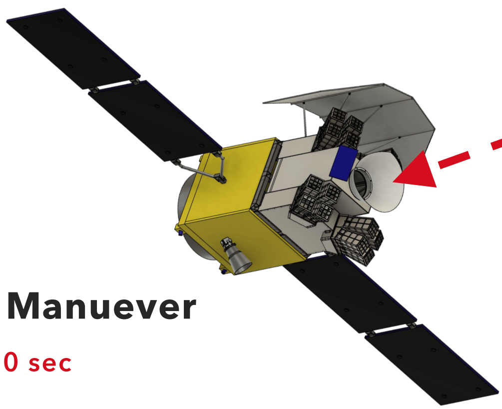
GRB observation sequence and the role of the MPU

Transient Source

t: Time since source discovery

Discovered by EAGLE

t = 0 sec

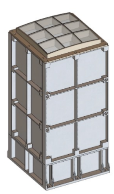


Automatic Manuever

t < 300 sec

Observed by MONSTER

10 min (2 min exposure × 5 times)



EAGLE

Accuracy ~1.5 arcmin

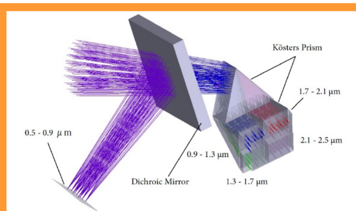
MPU

Mission data Processing Unit

Determine the source **Position** ~1.5 arcmin

Determine the source **Position** ~3 arcsec

+ **Rough z**



MONSTER

Accuracy ~3 arcsec

Attitude Change Request

X-ray Alert

t < 1 min

Near Infrared Alert

t < 30 min

t < 1 hour

Attitude System

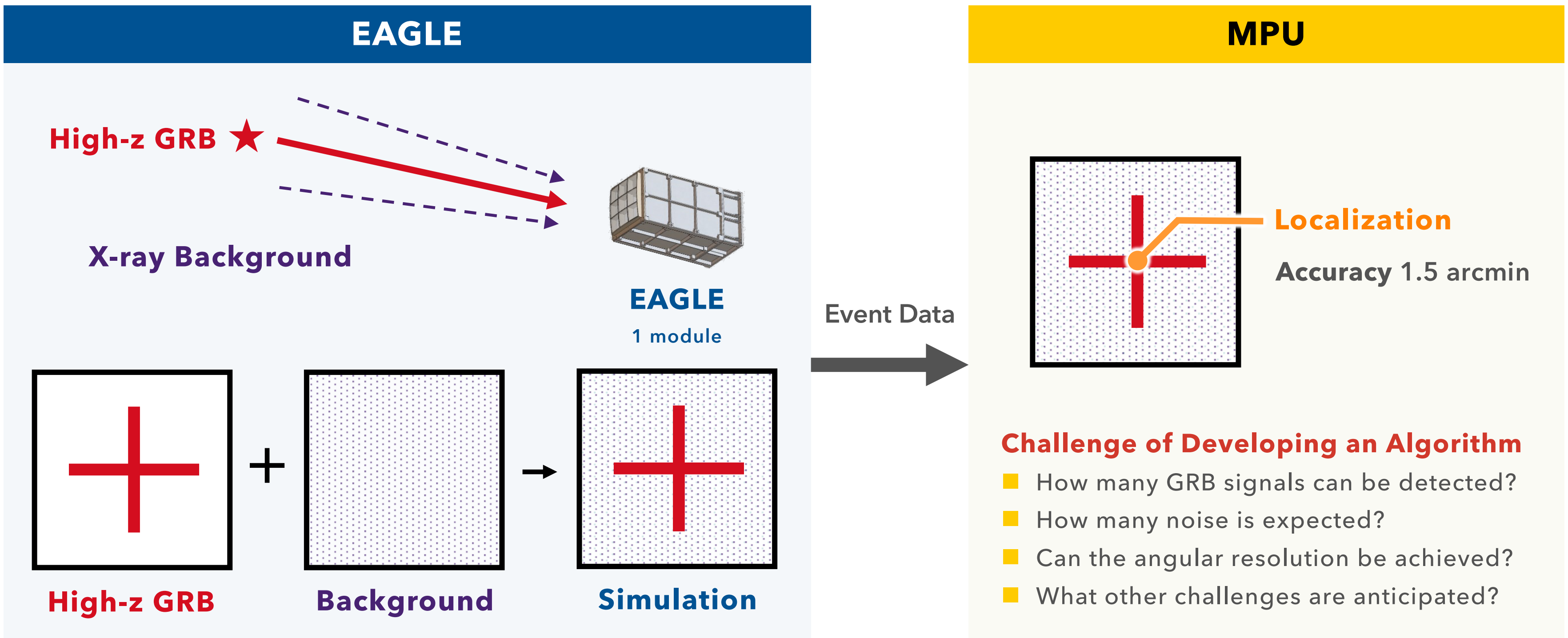
Alert System

Ground Station

1 EAGLE

Objective

Our goal is to achieve the localization accuracy within 1.5 arcmin (1σ one-side).



The localization accuracy depends on the number of photons detected by EAGLE.

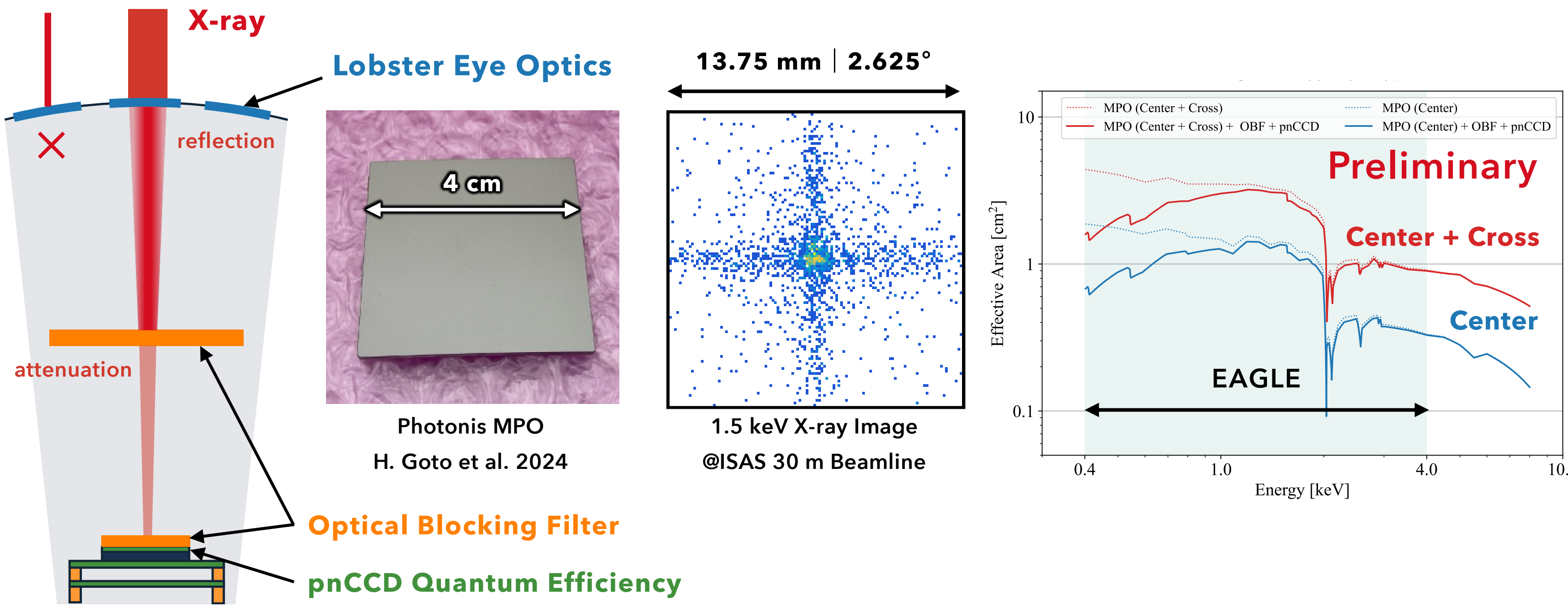
If high-z GRB and X-ray background fluxes are unknown, the accuracy can't be estimated.

To develop the GRB detection algorithm, it is important to simulate EAGLE images.

Effective Area

To calculate the number of photons, it is important to estimate the effective area.

The effective area is determined from the LEO's focusing performance and OBF.



Photonis MPO
H. Goto et al. 2024

1.5 keV X-ray Image
@ISAS 30 m Beamline

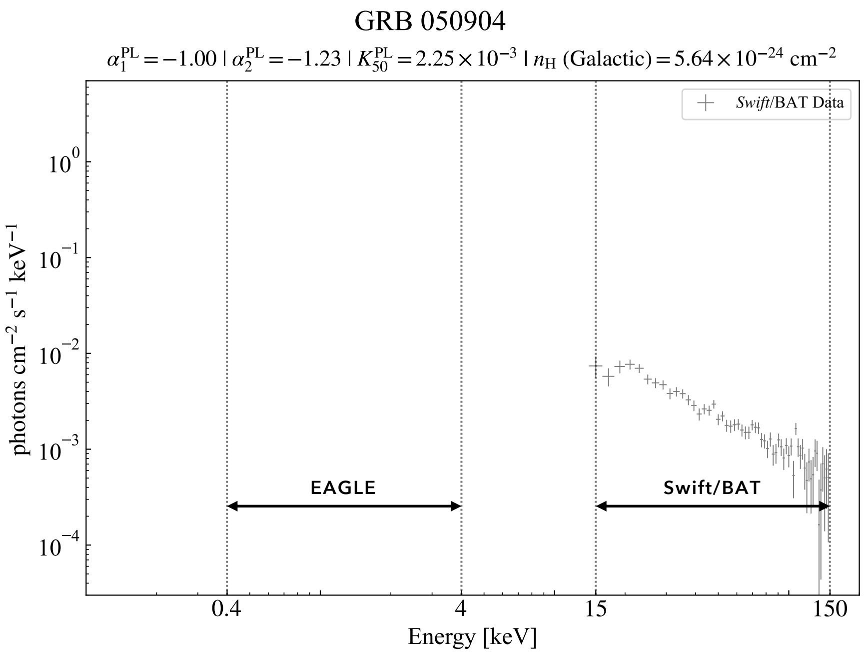
In this case, we considered the effective area using only a single LEO.

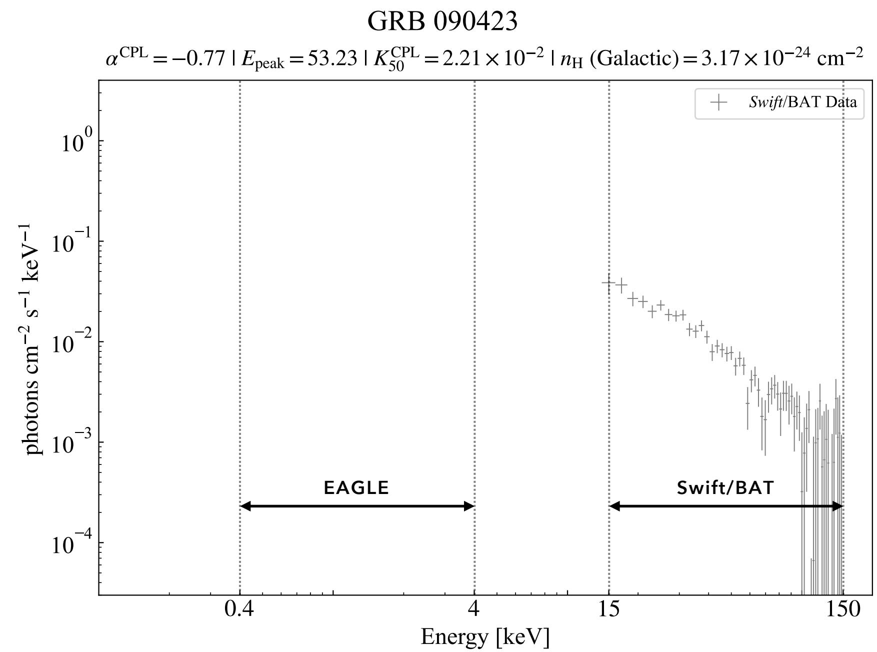
Using these values, we then calculated the number of photons.

High-z GRB

Swift/BAT has observed 9 GRBs with z > 6 (6 spectroscopic & 3 photometric).

We estimated the number of photons from high-z GRBs detectable with EAGLE.





However, the Swift/BAT data are available only in the 15–150 keV range.

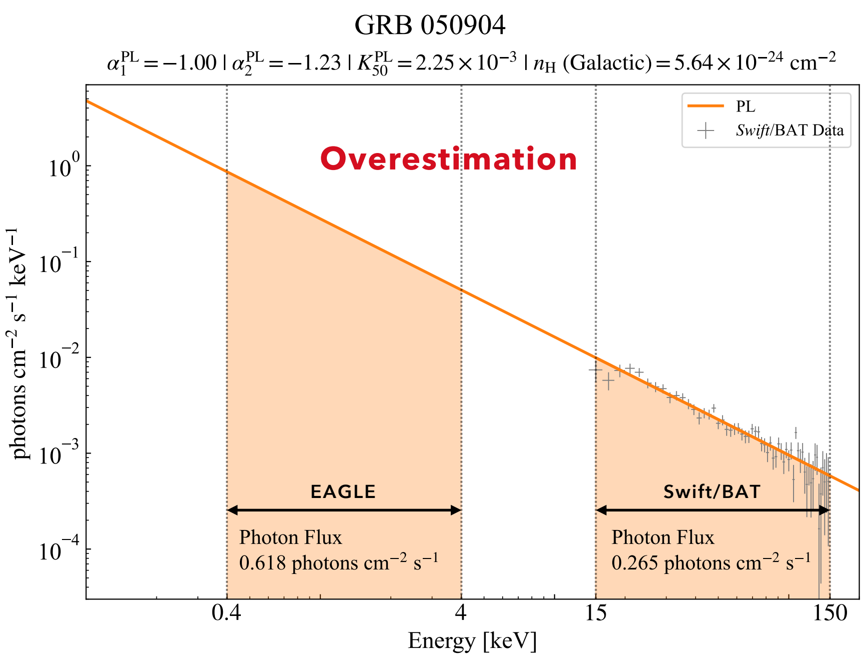
It is necessary to define a model function and extrapolate it to lower energies

1 | EAGLE

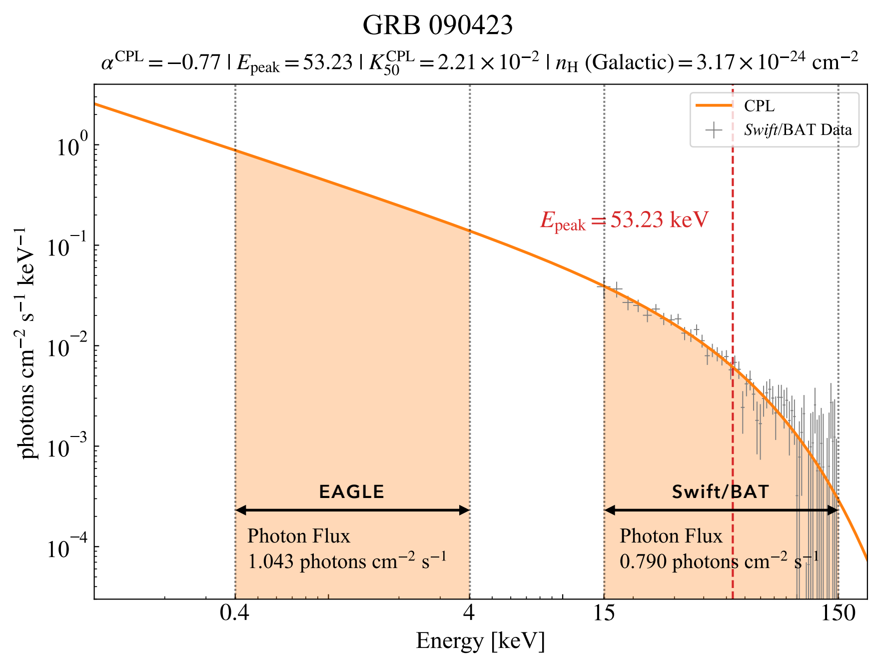
High-z GRB

The best-fit models obtained from Swift/BAT are either a PL or a CPL.

Using these best-fit functions, we extrapolated them to lower energies.



Power Law (PL)



Cutoff Power Law (CPL)

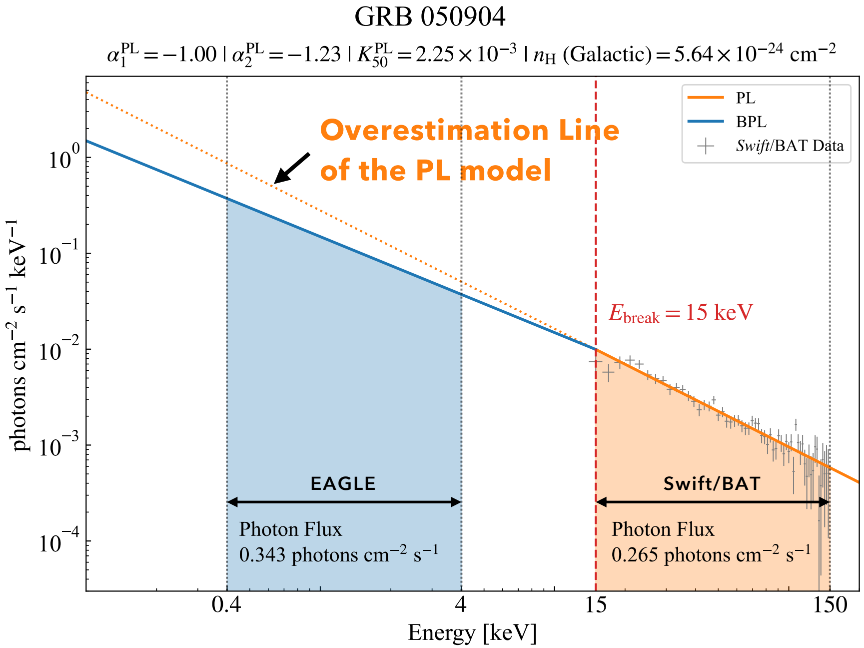
However, the typical GRB spectrum exhibits a break at a certain energy.

Simply extrapolating the PL model to lower energies can lead to an overestimation.

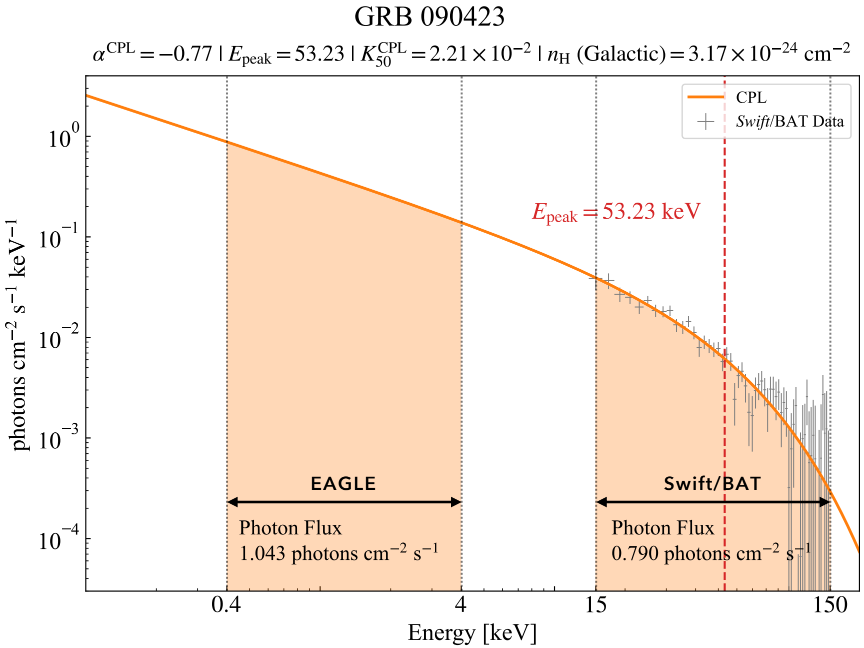
High-z GRB

To avoid overestimation, we defined a **Broken Power Law Model (BPL)** for the PL model.

We assumed a break energy of 15 keV and a photon index of −1 on the lower-energy side.



Broken Power Law (BPL)



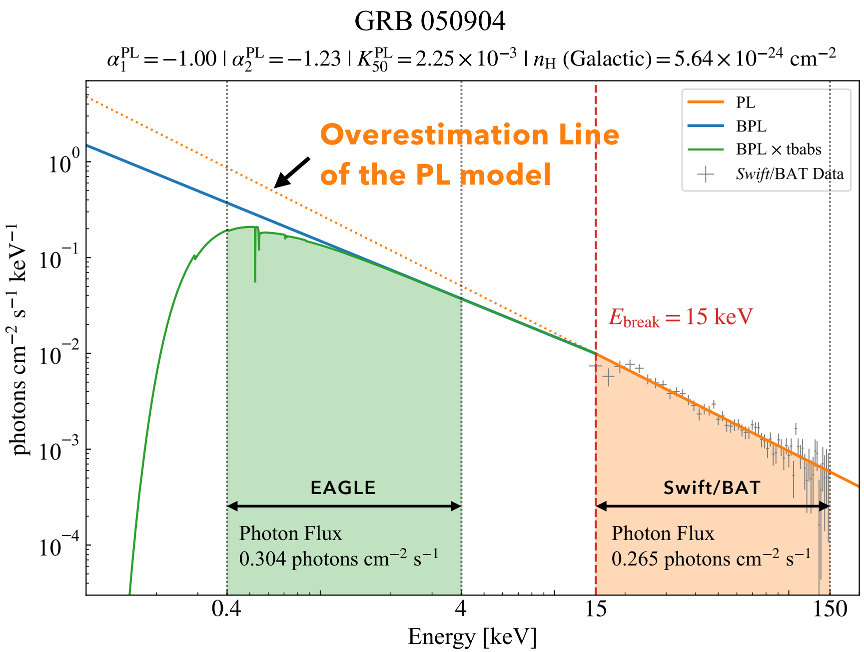
Cutoff Power Law (CPL)

1 | EAGLE

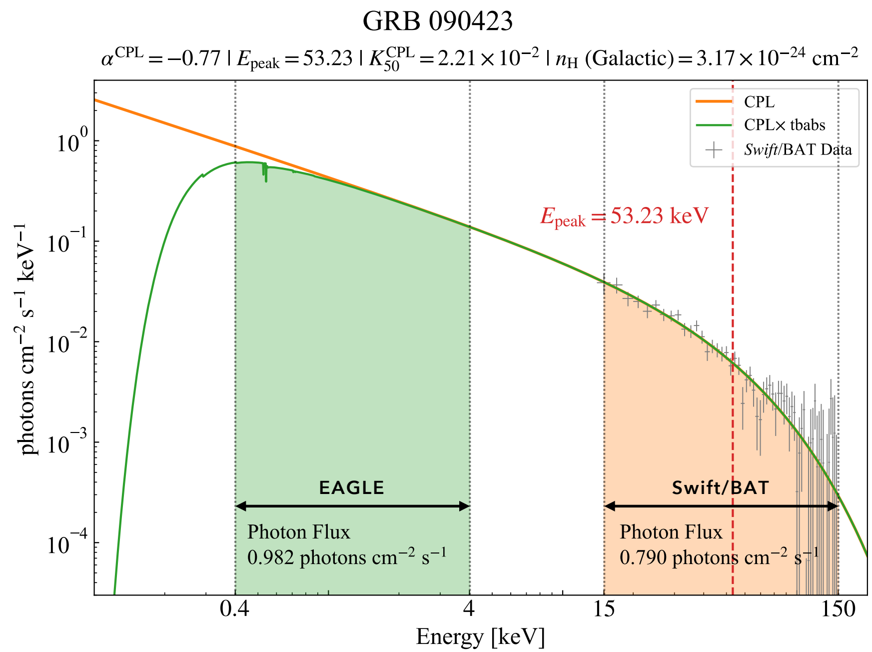
High-z GRB

We created graphs using Xspec's tbabs model to account for interstellar absorption.

From these results, we calculated the number of photons detectable by EAGLE.



Broken Power Law (BPL) * tbabs



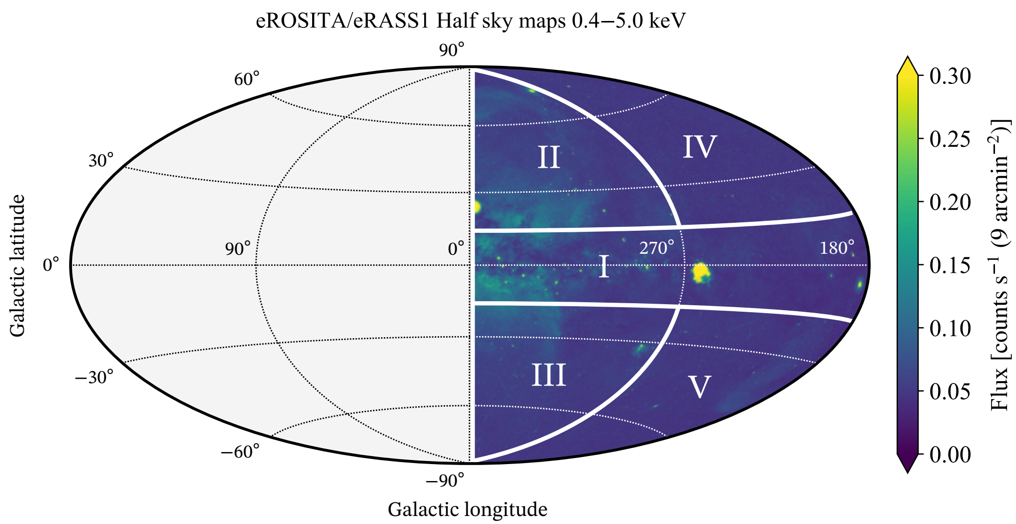
Cutoff Power Law (CPL) * tbabs

The expected count rate is 0.4–2.0 counts s^{-1}. Depending on the GRB duration, the total number of counts is expected to vary from a few to several hundred.

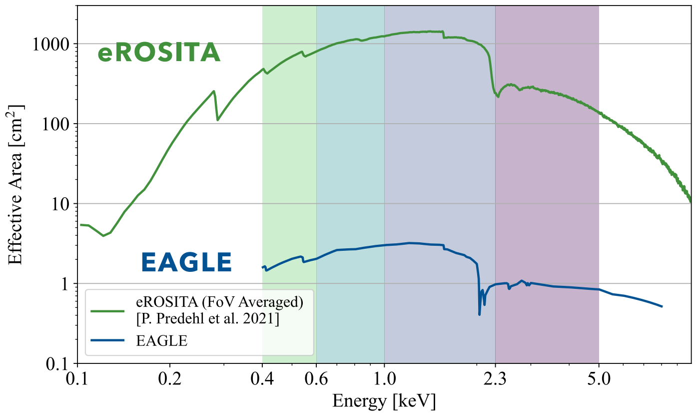
X-ray Background

In the eROSITA paper, the X-ray background is divided into five regions for analysis.

Based on these values, we estimated the background count rate for EAGLE.



Modified from X. Zheng et al. 2024



Region	EAGLE Count Rate (Average) [counts s^{-1}]
I	0.27
II	0.30
III	0.25
IV	0.18
V	0.18

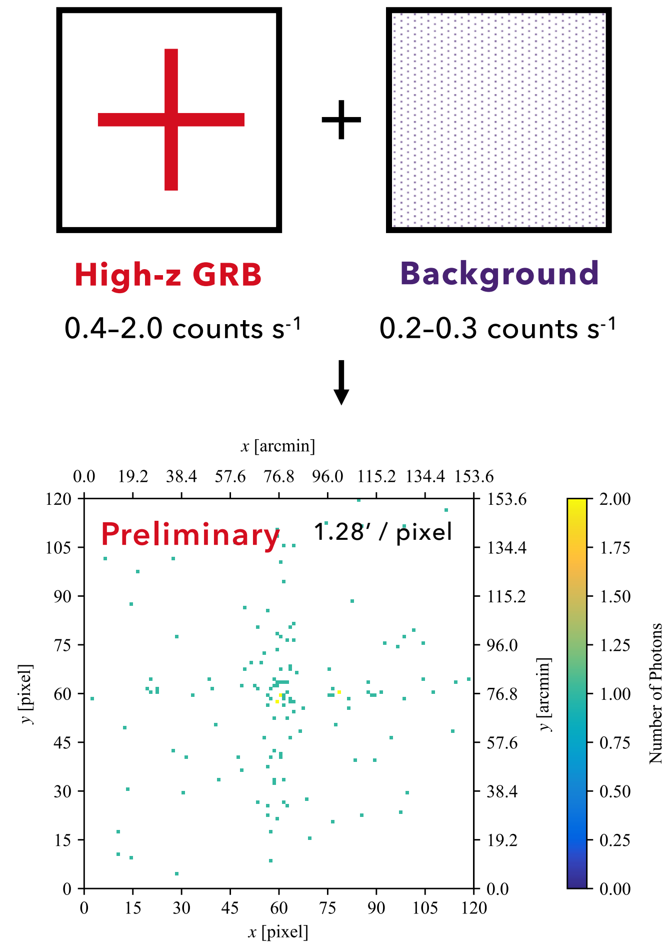
Within the MPU analysis range, the count rate was estimated to be 0.2–0.3 counts s^{-1}.

1 | EAGLE

Summary

To bring high-z GRBs into MONSTER's field of view, the localization accuracy of EAGLE is required to be within 1.5 arcmin (1σ one-side).

We estimated the expected count rates with EAGLE and simulated the X-ray images.



Source: 120 counts **Background**: 20 counts

Future Work

X-ray photons from existing sources could contribute additional background.

We aim to develop an algorithm that accounts for contamination from existing sources.

2 | MONSTER

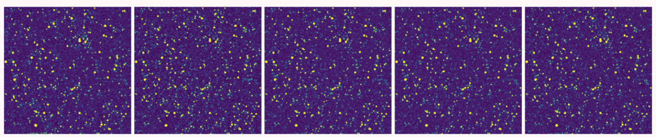
Objective

MONSTER observes high-z GRB afterglows for 10 minutes in 5 bands simultaneously.

In addition to the GRB afterglow, ~1,000 other sources lie within MONSTER's FoV.

MONSTER

12 arcmin × 12 arcmin



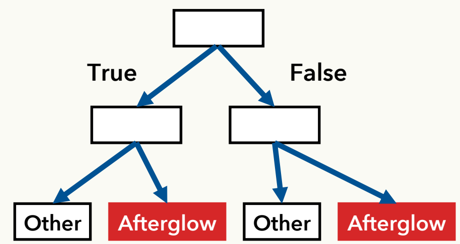
0.5-0.9 0.9-1.3 1.3-1.7 1.7-2.1 2.1-2.5 μm

5 bands × (120 s 5 frames)

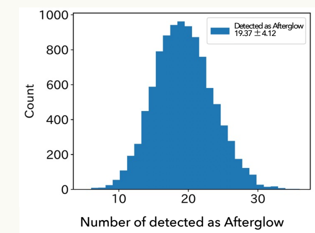
~1000 objects

MPU

Decision Tree



optimize the branches



~20 candidates

It is important to extract GRB afterglow candidates from existing celestial objects.

We identify GRB afterglow by optimizing decision trees using machine learning.

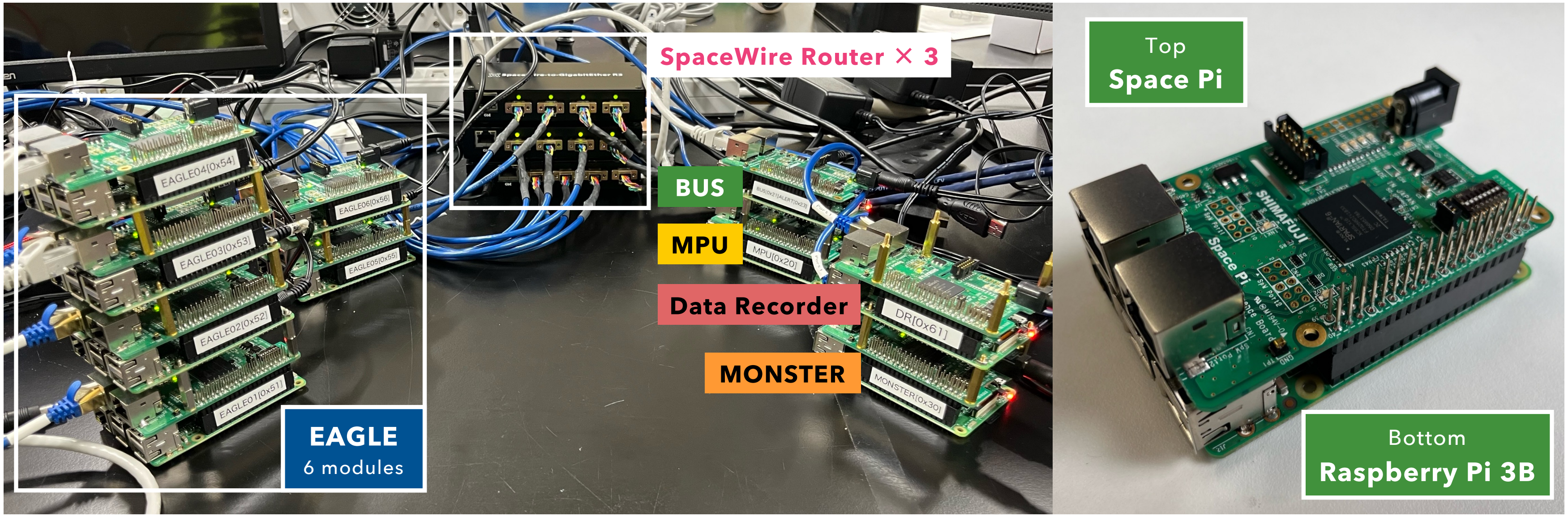
➡ See **Haruaki Niinuma**'s Poster

57. Development of on-board software for the image data of MONSTER on HiZ-GUNDAM

3 | Hardware

Objective

To test the basic GRB observation sequence based on SpaceWire standards, we have developed a dummy network system using Raspberry Pi and Space Pi.



It is important to verify that all EAGLE module data can be acquired within 1 s.

We conducted data transfer tests and estimated transmission times.

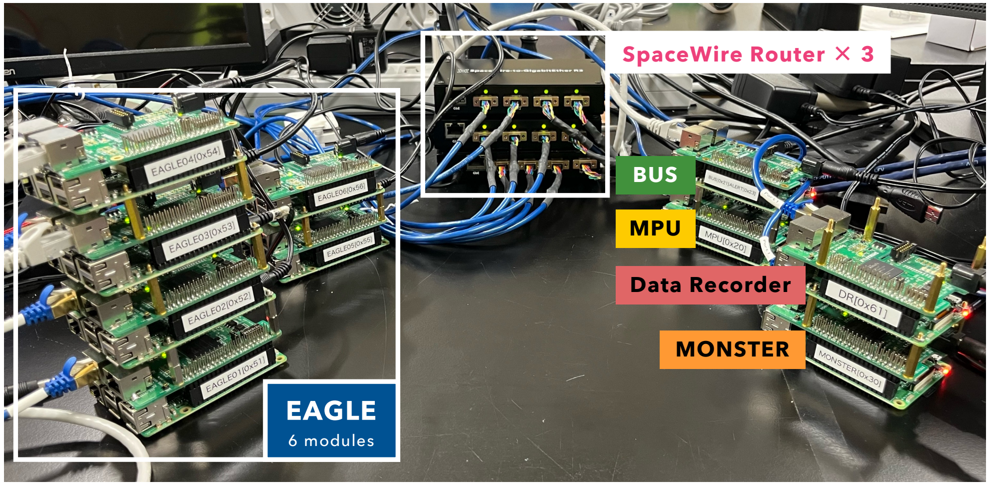
➡ See **Keito Watanabe**'s Poster

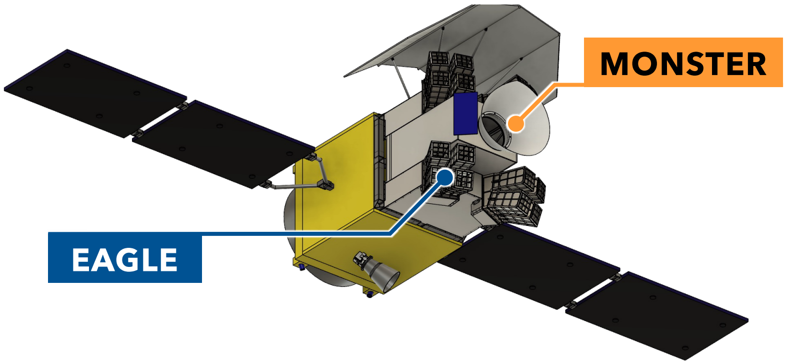
55. Data Transfer Test due to SpaceWire Network for HiZ-GUNDAM

Summary

Summary

EAGLE	Estimated High-z GRB and X-ray background count rates by EAGLE.
MONSTER	Developing methods to extract GRB candidates from other sources.
Hardware	Measured data transmission times using the SpaceWire network.





Future Work

We will develop EAGLE and MONSTER data analysis algorithms.

With this system, we will demonstrate the overall processing time,

including data analysis and data transfer from GRB detection to alert issuance.