Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
ICSC Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

Anomaly Detection with Machine Learning on Time Series Data from the Fermi Anti-Coincidence Detector

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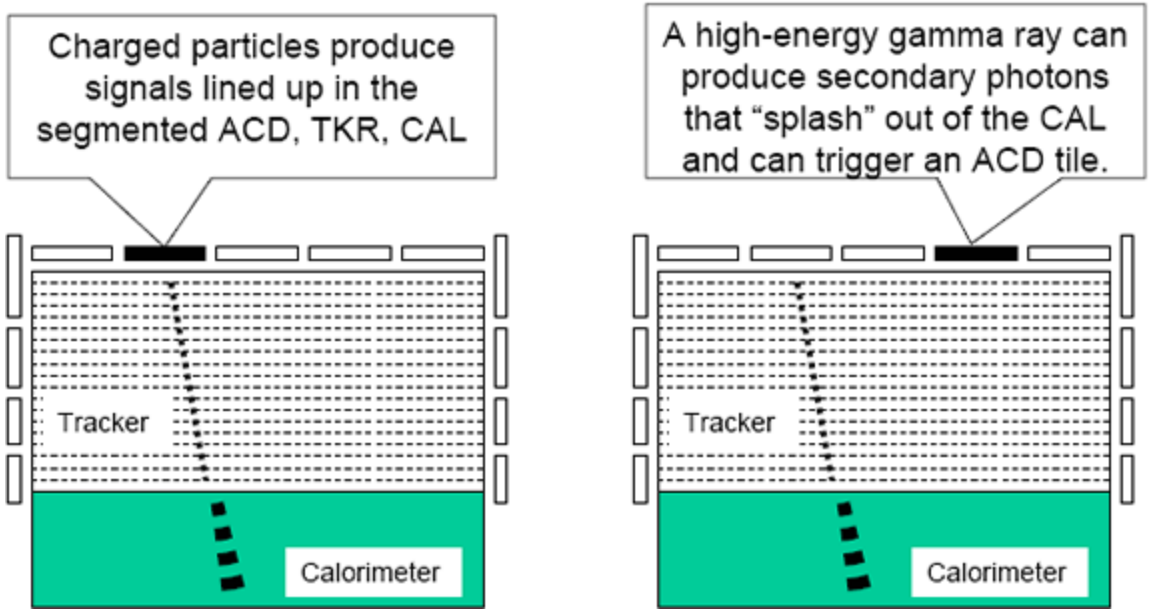
Gravi-Gamma-Nu, Bari, 09/10/2024 - 11/10/2024

Fermi satellite and ACD

The LAT instrument is surrounded by its Anti-Coincidence Detector (ACD), used to filter out unwanted signals, such as cosmic rays, that can mimic gamma-ray signatures.



The ACD consists of an array of plastic scintillator tiles, which emit light when traversed by charged particles. By detecting these particles, the ACD helps identify and reject events caused by charged particles, allowing the LAT to focus on gamma-ray signals.

ACD Data

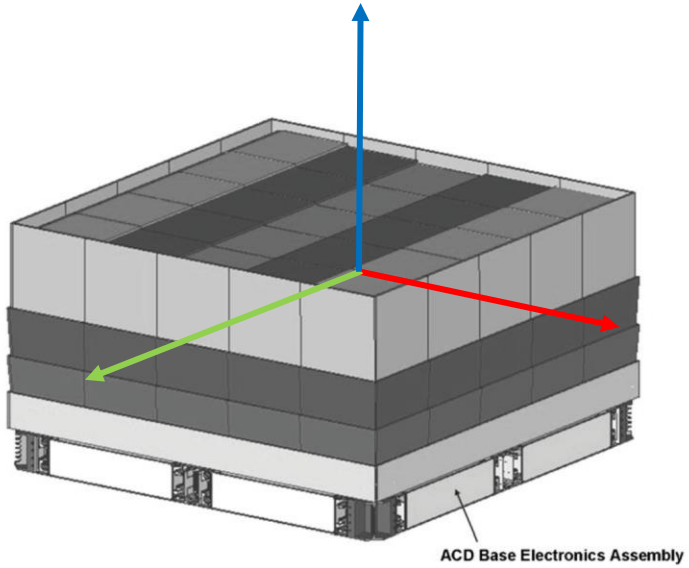
-top (Z)

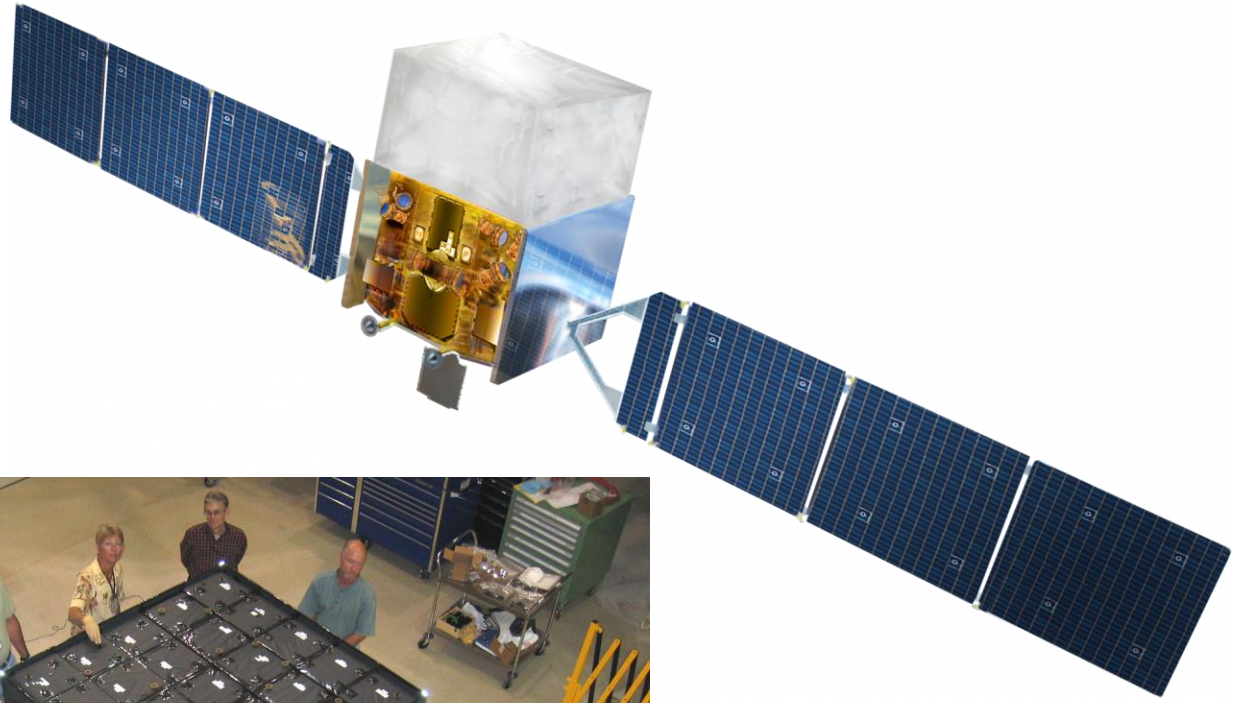
-Xpos (X+)

-Xneg (X-)

-Ypos (Y+)

-Yneg (Y-)





ACD Data

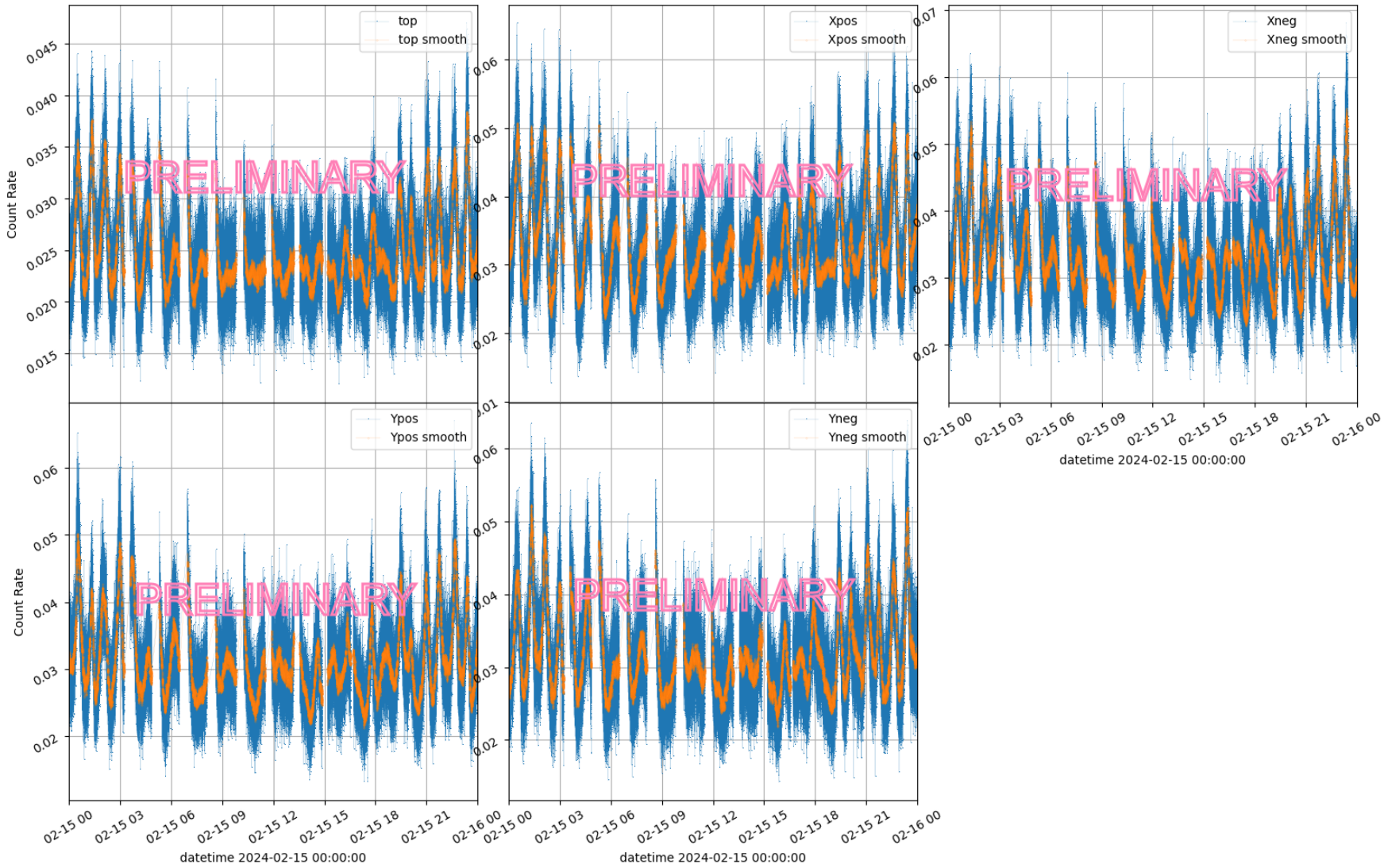
-top (Z)

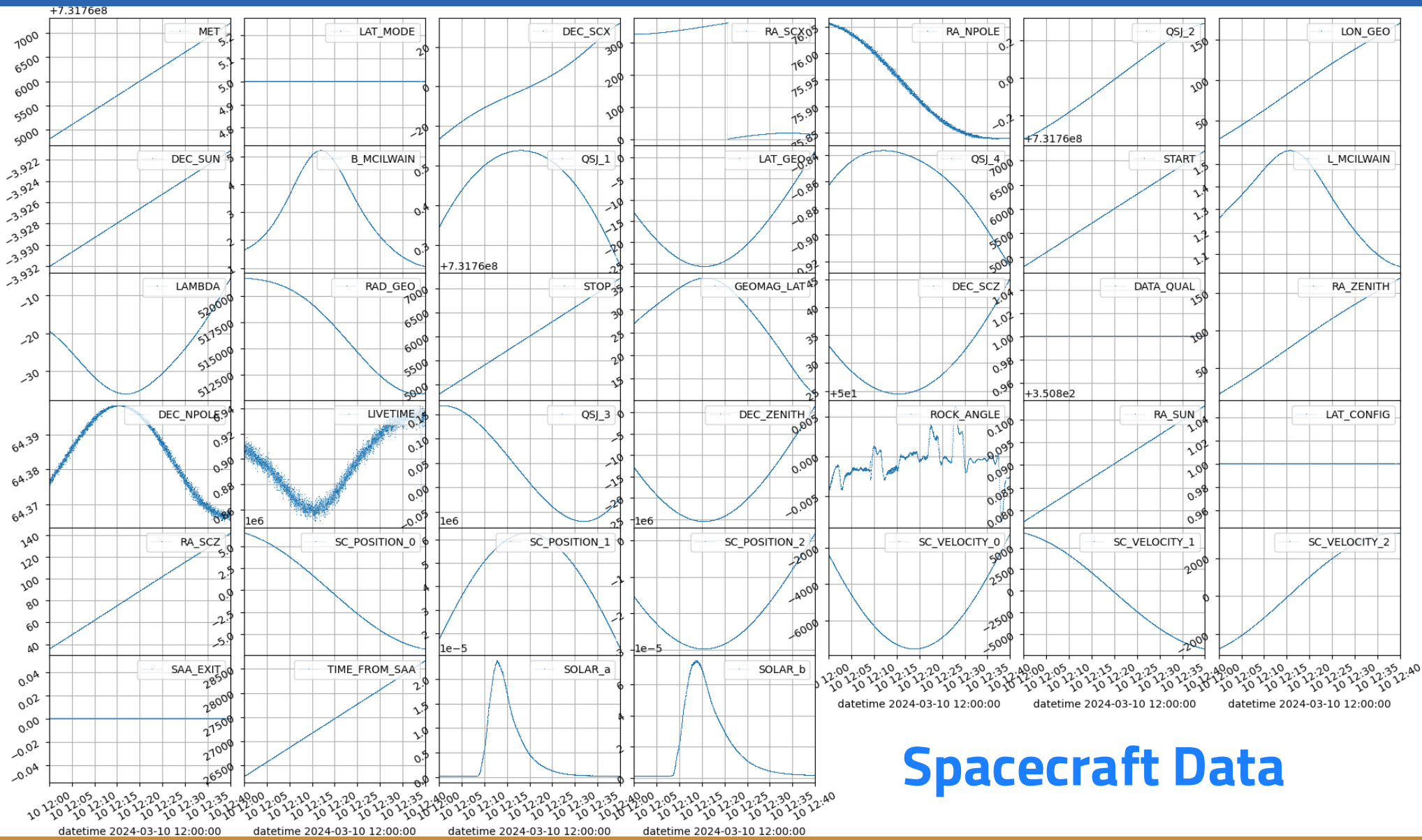
-Xpos (X+)

-Xneg (X-)

-Ypos (Y+)

-Yneg (Y-)

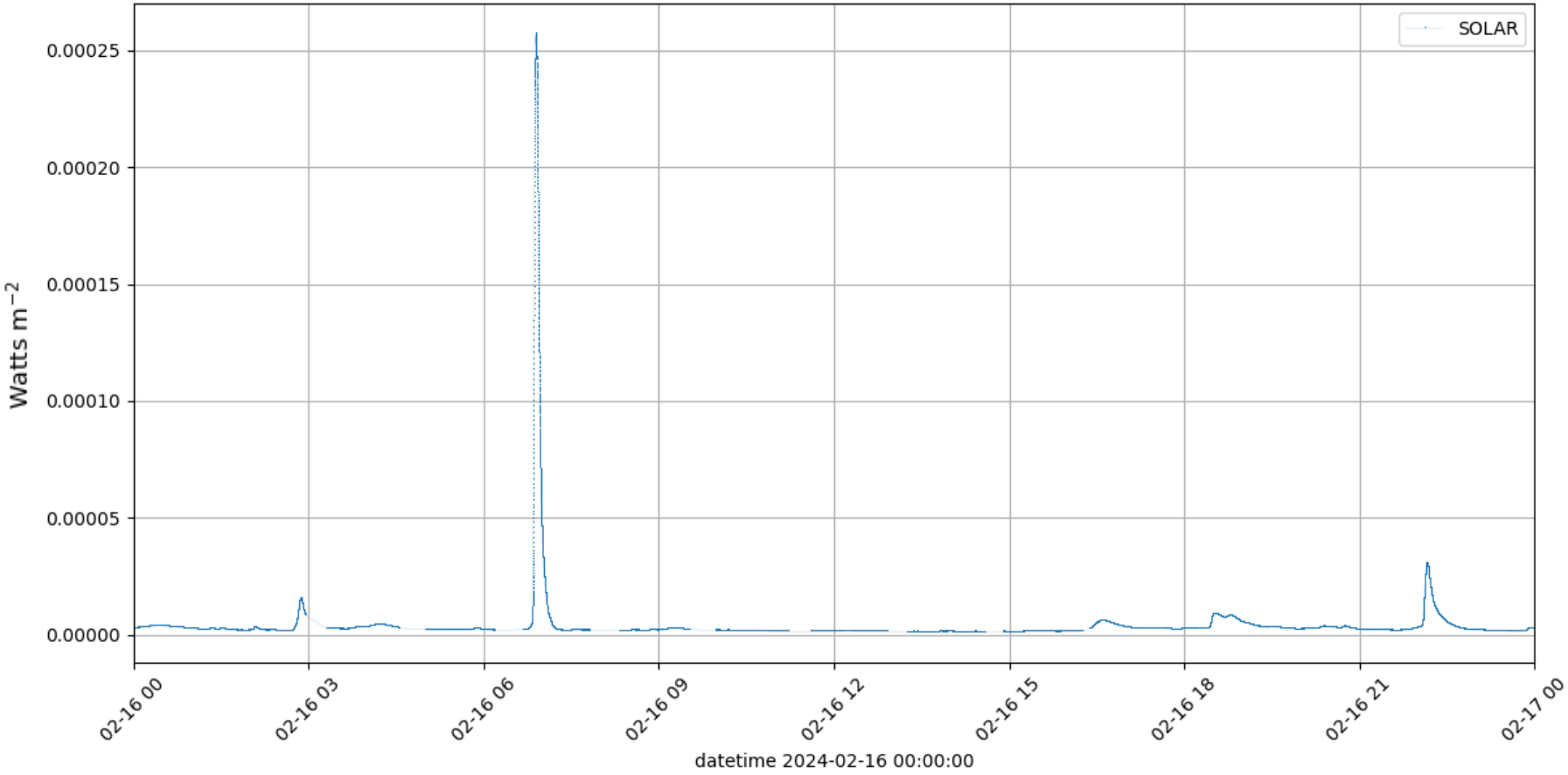




Spacecraft Data

Solar Activity Data from GOES X-Ray Sensor (XRS)

It describes the intensity of X-rays coming from the Sun.

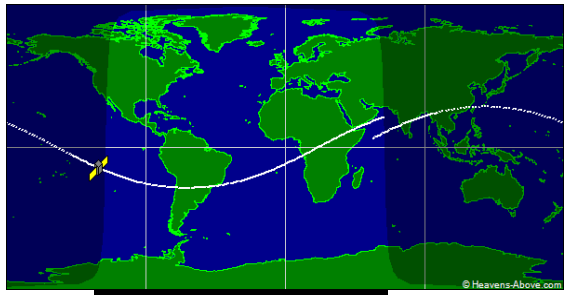


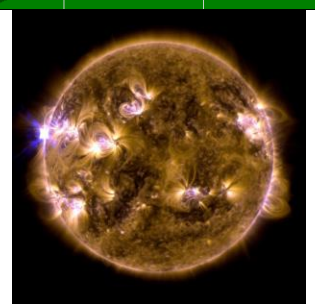
Dataset

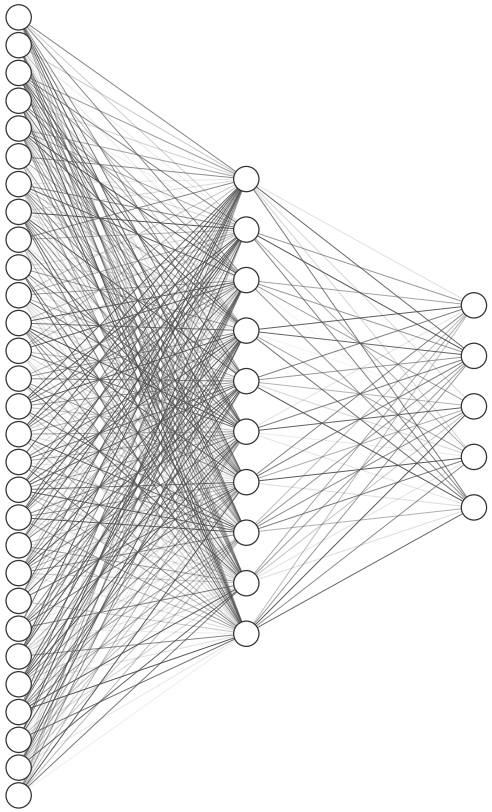
It is divided in around 30 input parameters from Spacecraft files + 1 from GOES data for the solar activity, and the signals from the 5 faces of the ACD.

Input parameters (FT2):

START
STOP
SC_POSITION
SC_VELOCITY
LAT_GEO
LON_GEO
...
SOLAR ACTIVITY

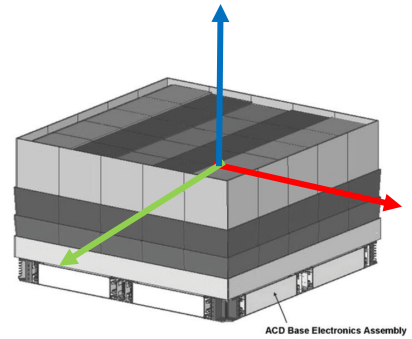






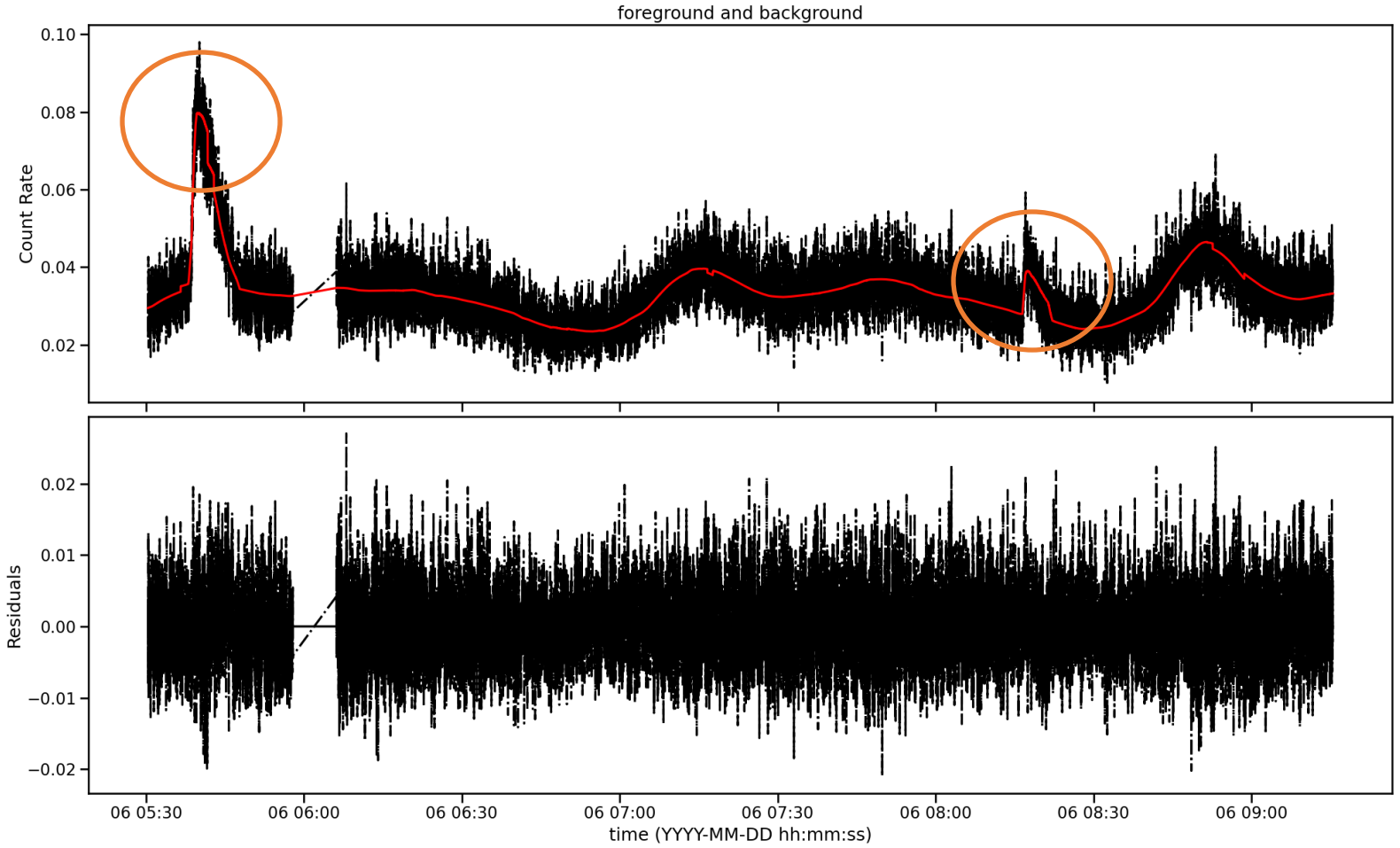
Output parameters:

top signal
Xpos signal
Xneg signal
Ypos signal
Yneg signal



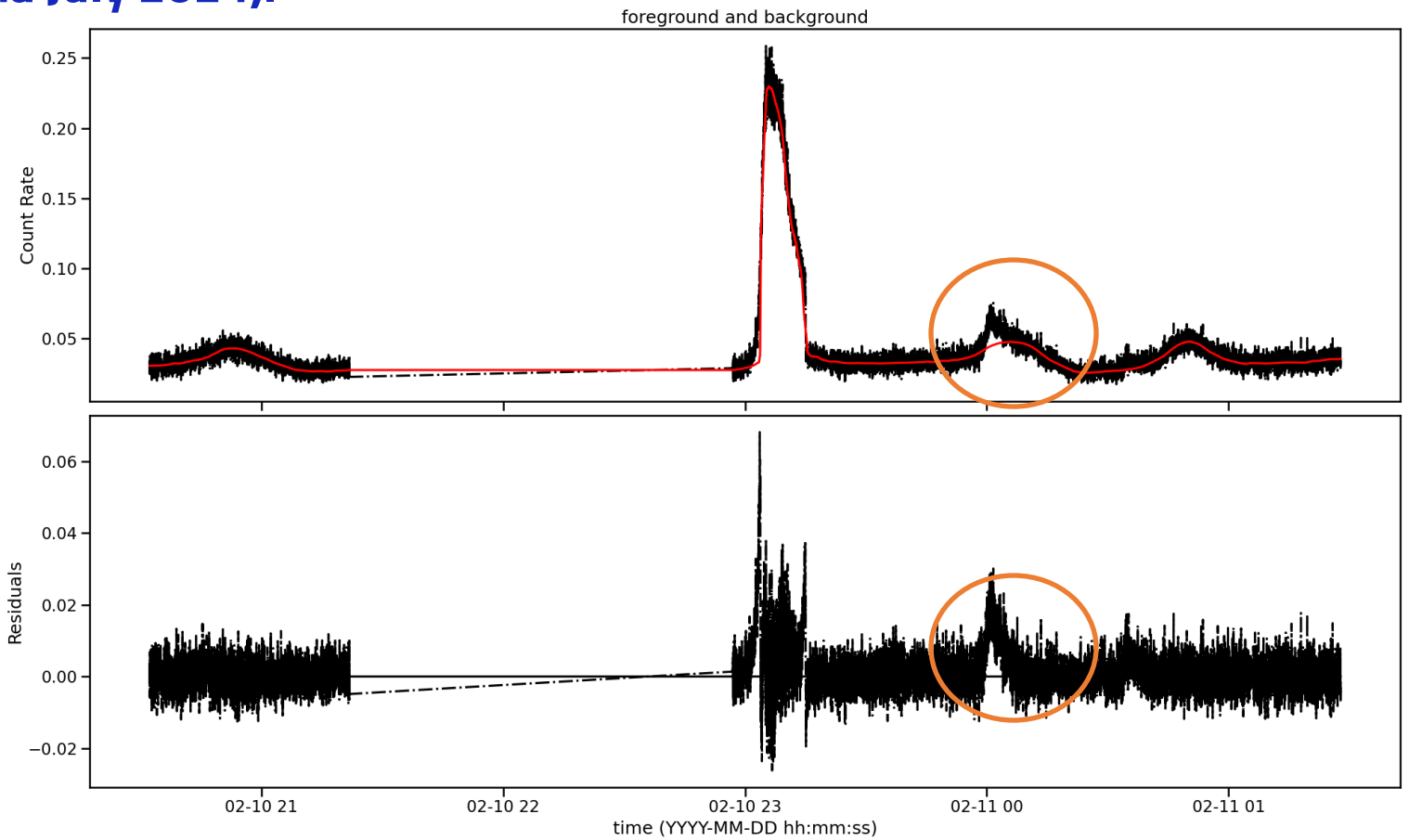
NN Results

This is the prediction of the model for the Xpos signal.



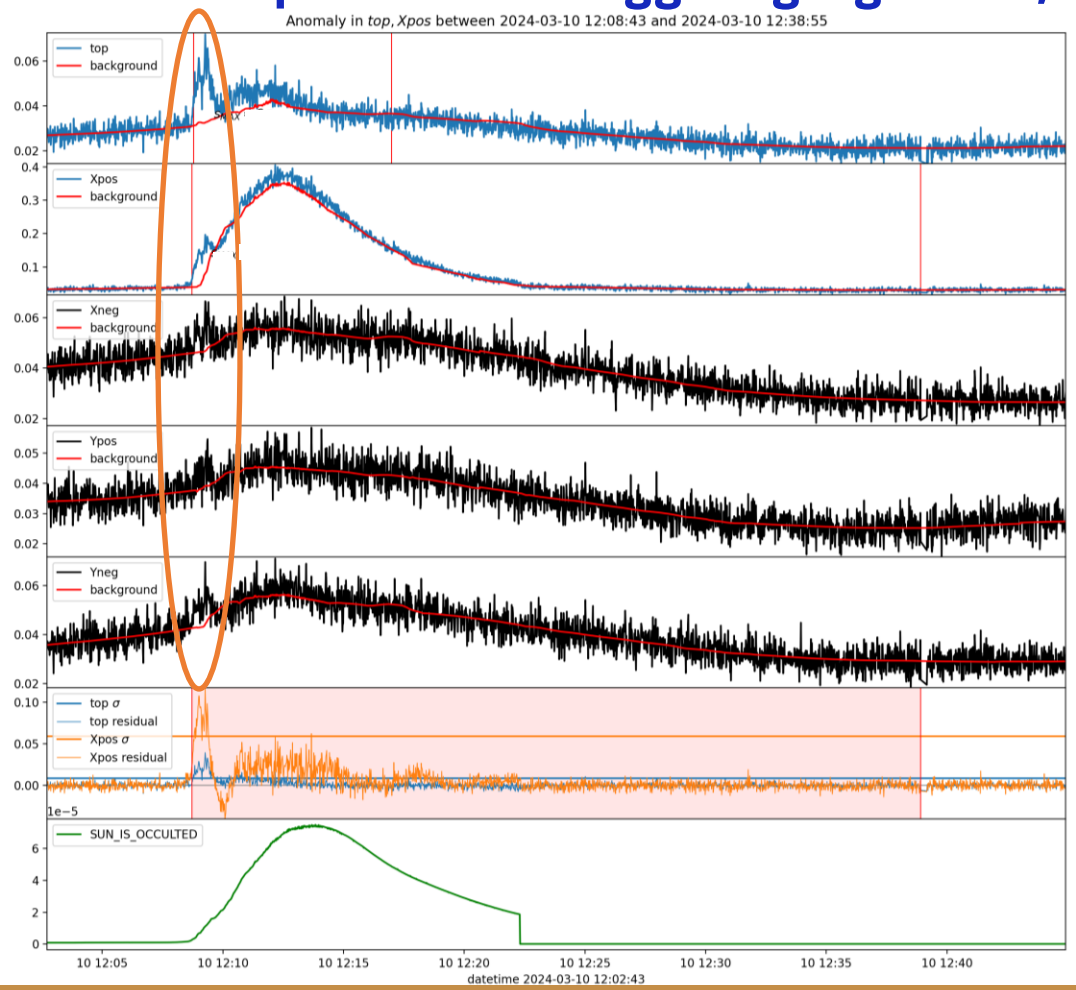
NN Results

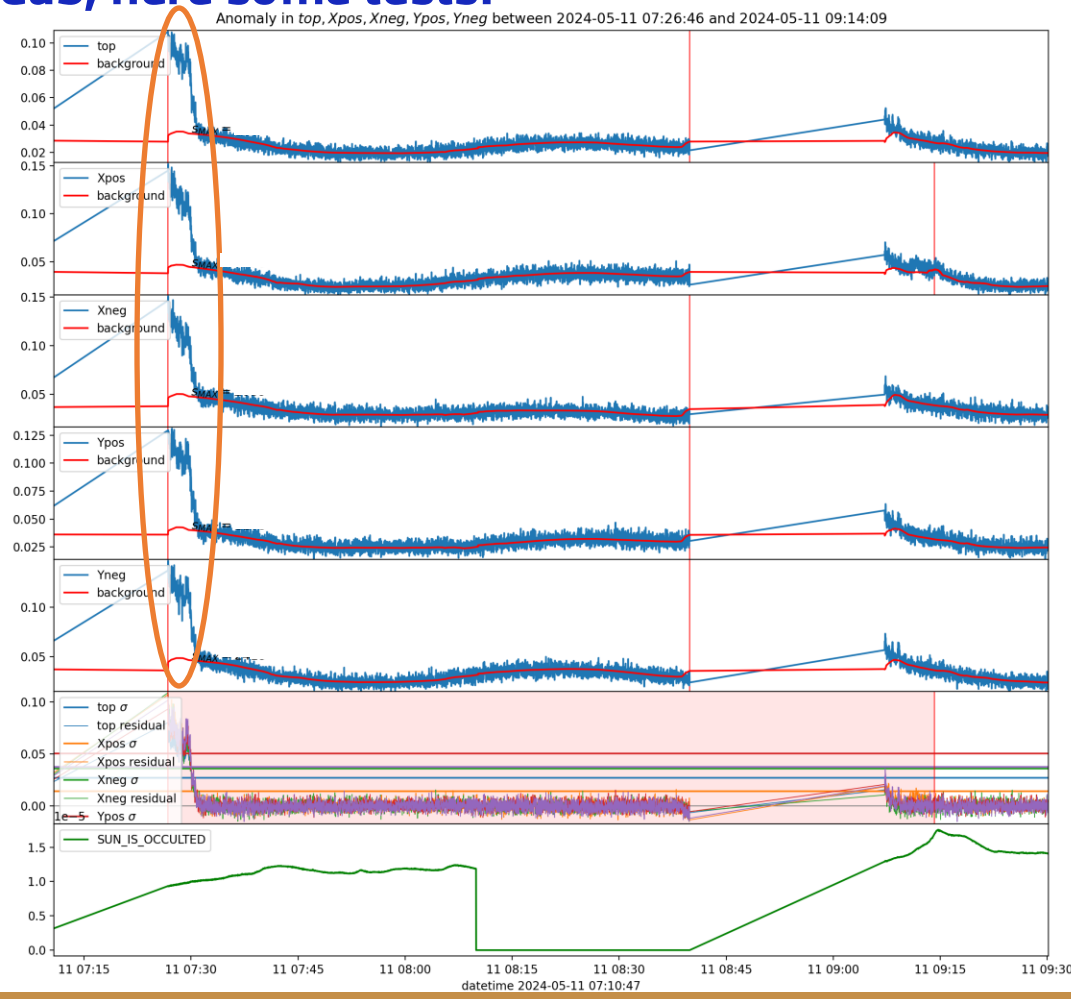
It still has some troubles with solar activity, especially in periods when the sun is very active (e.g. between May and July 2024).



Trigger algorithm: WORK IN PROGRESS

We implemented a triggering algorithm, the Gaussian-FOCuS, here some tests:





Work in progress...

Thank you

(1) Atwood 2009 - THE LARGE AREA TELESCOPE ON THE FERMI GAMMA-RAY SPACE TELESCOPE MISSION

(2) Meegan 2009 - THE FERMI GAMMA-RAY BURST MONITOR

(3) Crupi, R., Dilillo, G., Bissaldi, E. et al. Searching for long faint astronomical high energy transients: a data driven approach