THE AGILE ON-LINE ANALYSIS

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“

Perform an automated scientific analysis as soon as the data is available:

1. to generate internal alerts, to detect gamma-ray flaring sources;

2. to react to external alerts (MM/MWL)

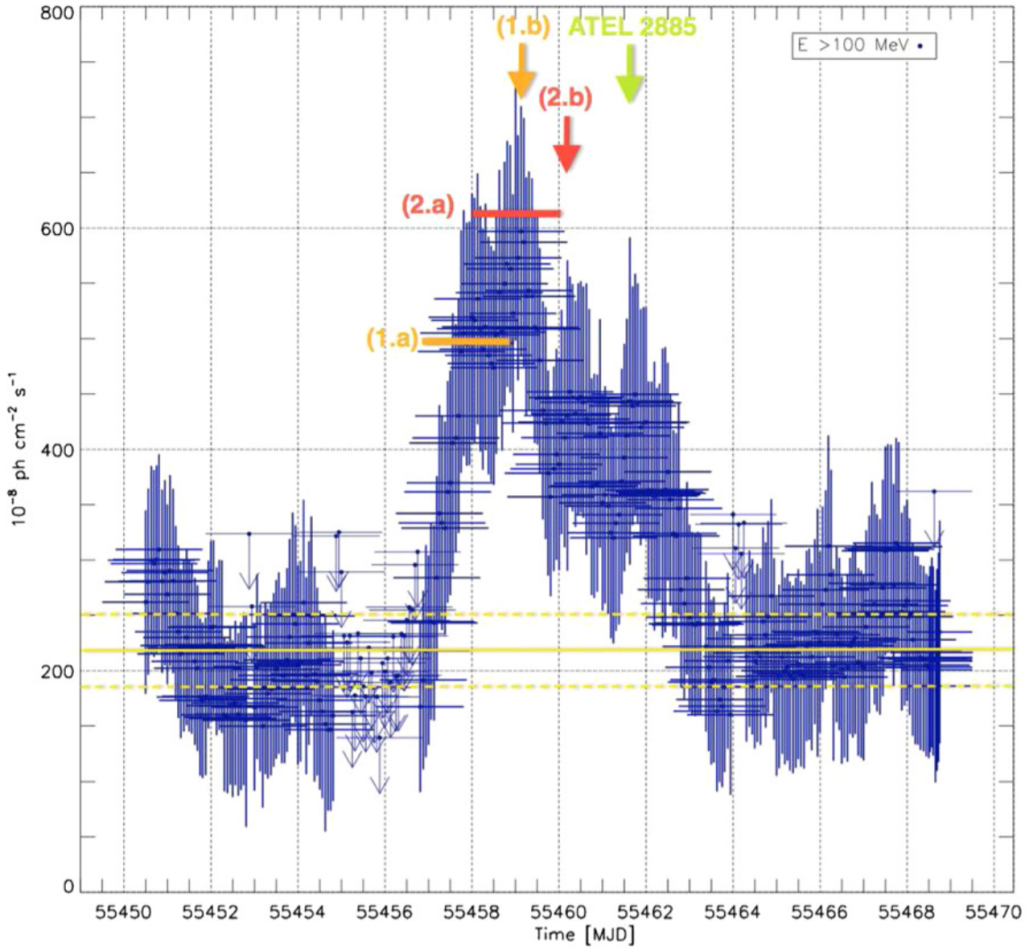
- the AGILE on-line analysis

TRANSIENT SKY

- **γ-ray transient discoveries** and **MWL/MM follow-up** is possible during the AGILE observations, given the large Field of View (80% of the sky) and the AGILE sensitivity
- The search for γ-ray transients (Galactic and extra-Galactic) detectable on timescales of 1-2 days is one of the daily activities performed by the AGILE Team
- See Bulgarelli, A., et al, ApJ 781:19 (13pp), 2014

FAST REACTION

- The most relevant results
  - The first detection of transient γ -ray emission from Cygnus X-3 in the energy range of 100 MeV–50 GeV
  - The discovery of γ -ray flares from the Crab Nebula —> Bruno Rossi Prize
  - First ATels that alerted the astrophysical community of the activities of many blazars



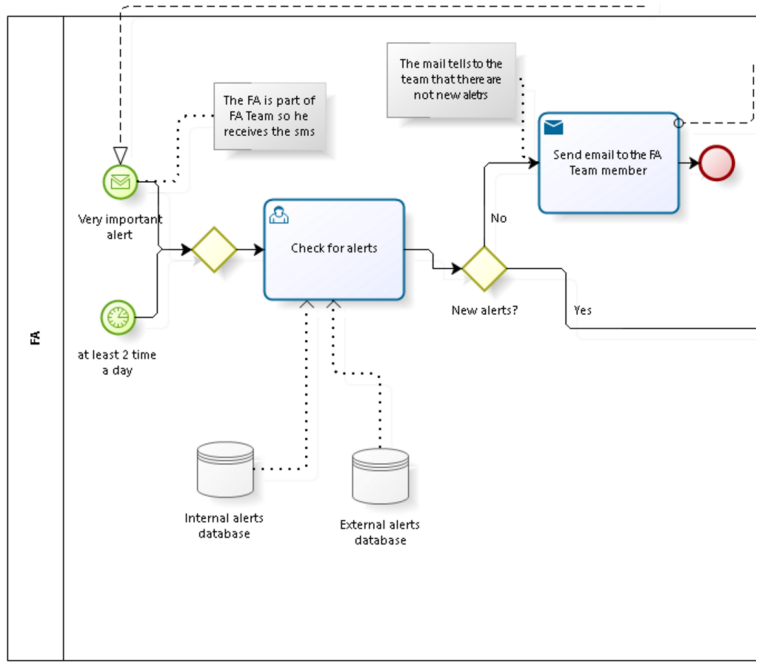
The 2010 Crab flare as seen by the AGILE on-line analysis

ON-LINE ANALYSIS: KEY POINTS

- Management of
  - **external alerts** (via GCN, e.g. Fermi/GBM or LAT, LIGO/VIRGO)
  - **internal alerts** (generated by the automated analysis of the AGILE data)
- Analysis of Single Point Failures
  - **Data flow**: in case of unavailability of nominal data flow to the AGILE Data Center, a backup chain can be activated
  - Two independent and automated **data analysis** pipelines: IASFBO and ASDC

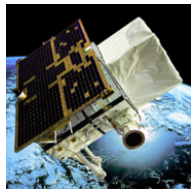
ON-LINE ANALYSIS: KEY POINTS /2

- Analysis of Single Point Failures/2
  - **Team organisation**: FA team (to check AGILE data and external GRB alerts) and AGILE-GW team (to react to LIGO/VIRGO alerts). The process modelled as a Business Process Model
  - Three different **notification systems** to AGILE team members when an alert (internal or external) is received
    - SMS
    - e-mail
    - push notification (for Android and iOs Apps)
- **Mobile App**
  - display scientific results and data quality of the automated pipelines
  - perform scientific analysis via mobile phone



The FA team procedure

GENERAL DATA FLOW



ground-station Malindi

30-35’

Mission Operation Center (Telespazio-Fucino)

5-10’

Pre-processing (IASFBO)

external alert

Pre-processing (ASDC)

10-20’

Science Alert System

RT-PIPE

GRID-PIPE

Science Quick-Look (ASDC)

data-quality (ASDC)

65-85’

Daily Report

alert

e-mail

SMS

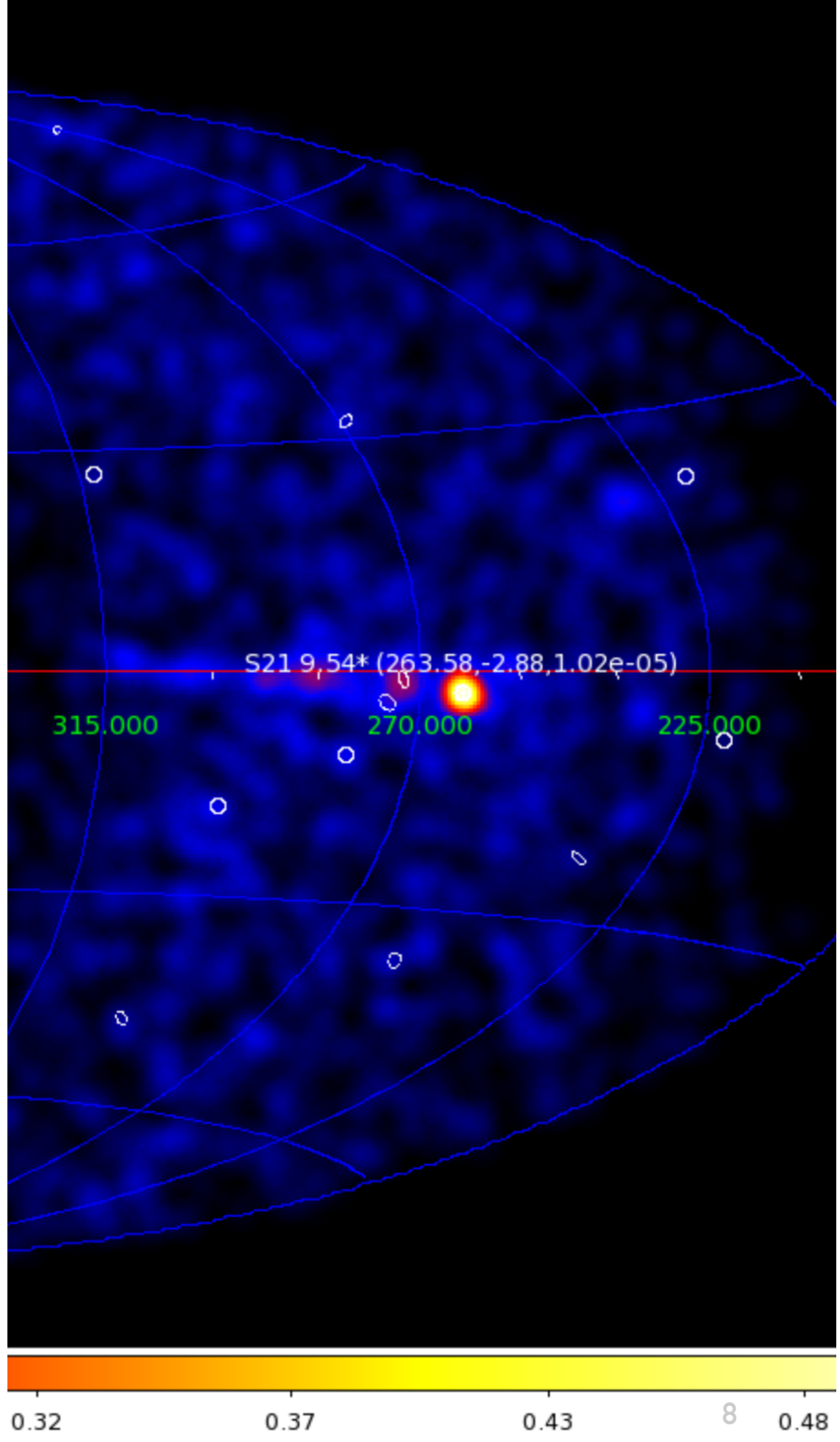
e-mail

push notification

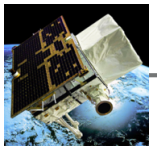
TOT: 2-2.5 h

GRID-PIPE (SPOT6)

Automated analysis of AGILE-GRID data



GRID-PIPE (SPOT6) (E > 100 MeV)



automated science processing

GRID-DETECTION DB

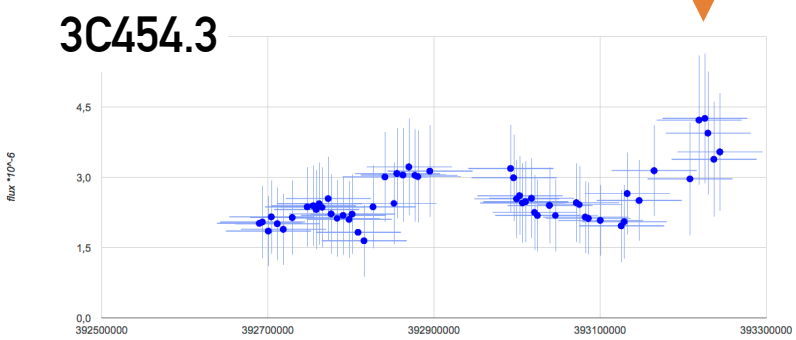
internal alerts

manual analysis

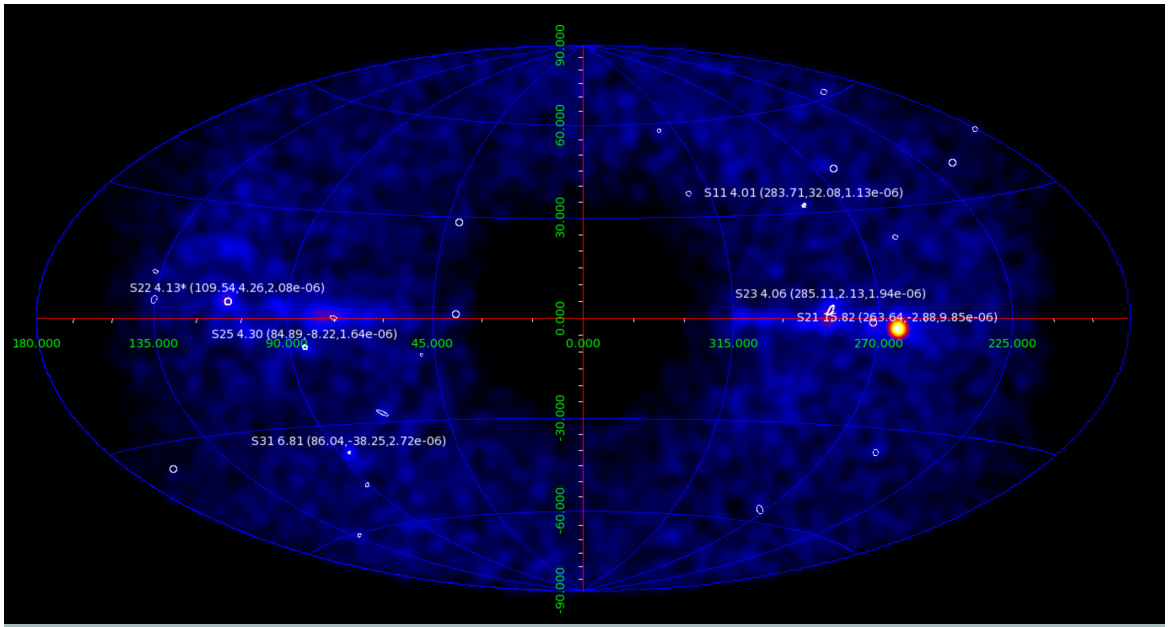
internal alerts from Cygnus region

human in the loop

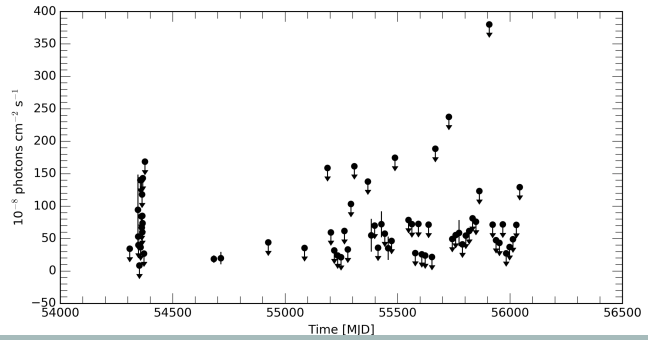
automated light curve generation



Navigation into the GRID-DETECTION DB



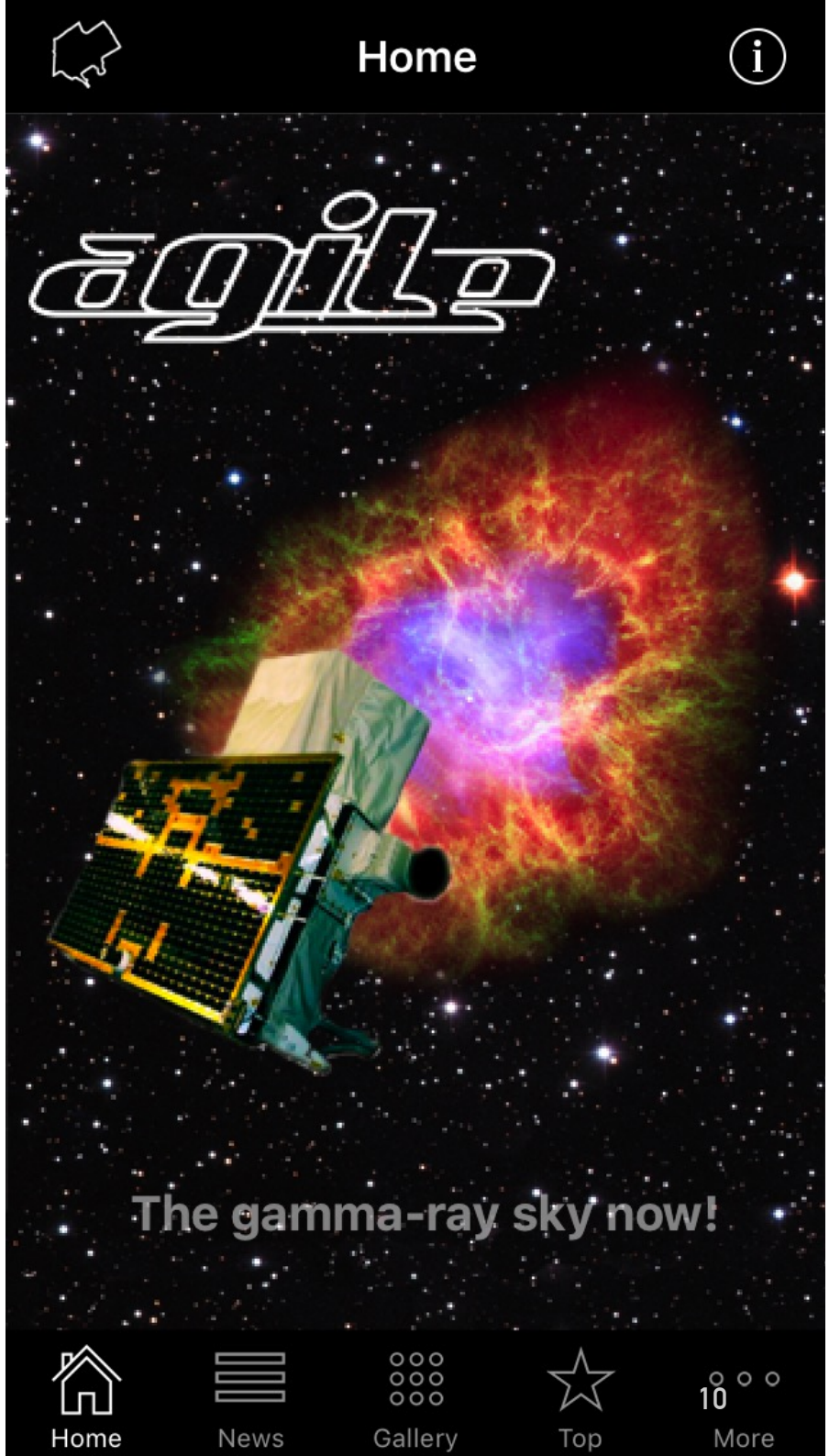
The gamma-ray variable sky with automated detections updated every AGILE orbit



when an alert is generated, a light curve will be build automatically

AGILESCIENCE

The AGILE mobile App



AGILESCIENCE: THE GATEWAY FOR THE AGILE GAMMA-RAY SKY MONITORING

GRID-PIPE (SPOT6)

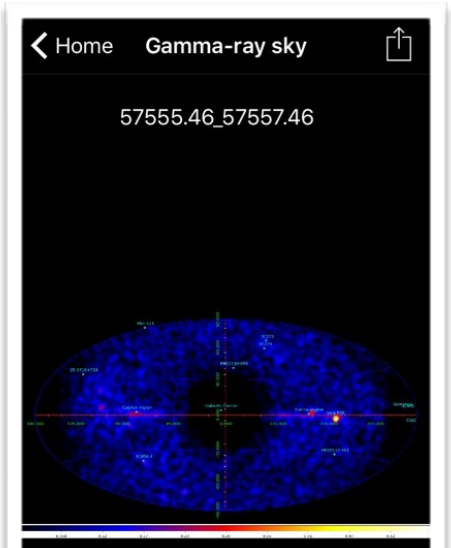
automated science processing

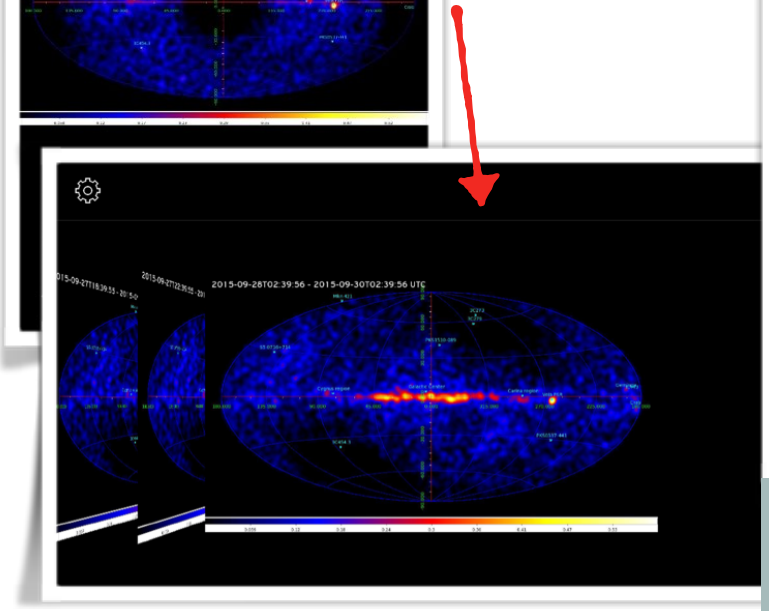
GRID-DETECTION DB

internal alerts

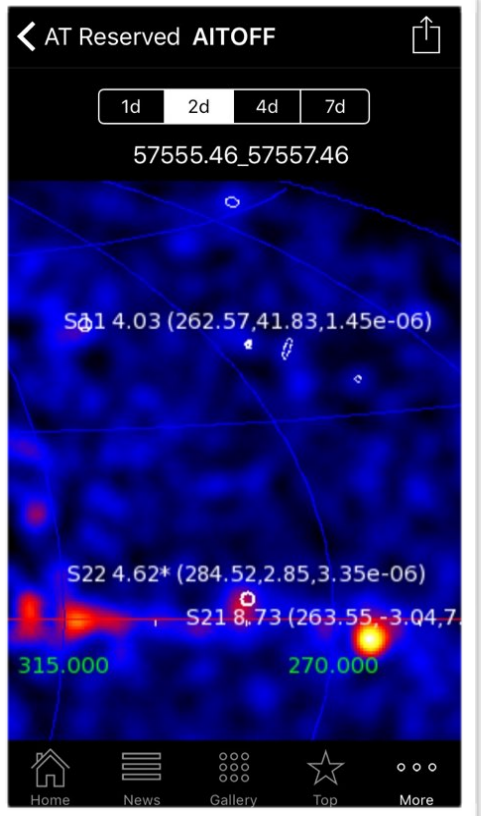
data-quality (ASDC)

The gamma-ray sky now!





The history of the gamma-ray sky



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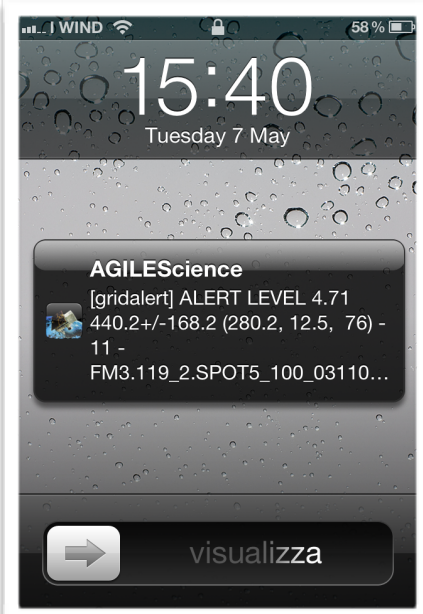
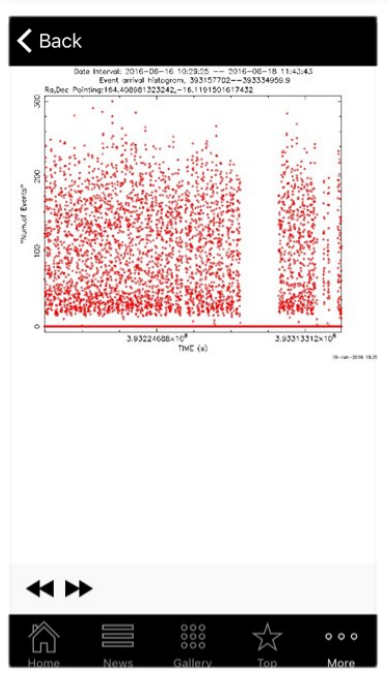


Push notifications for new alerts

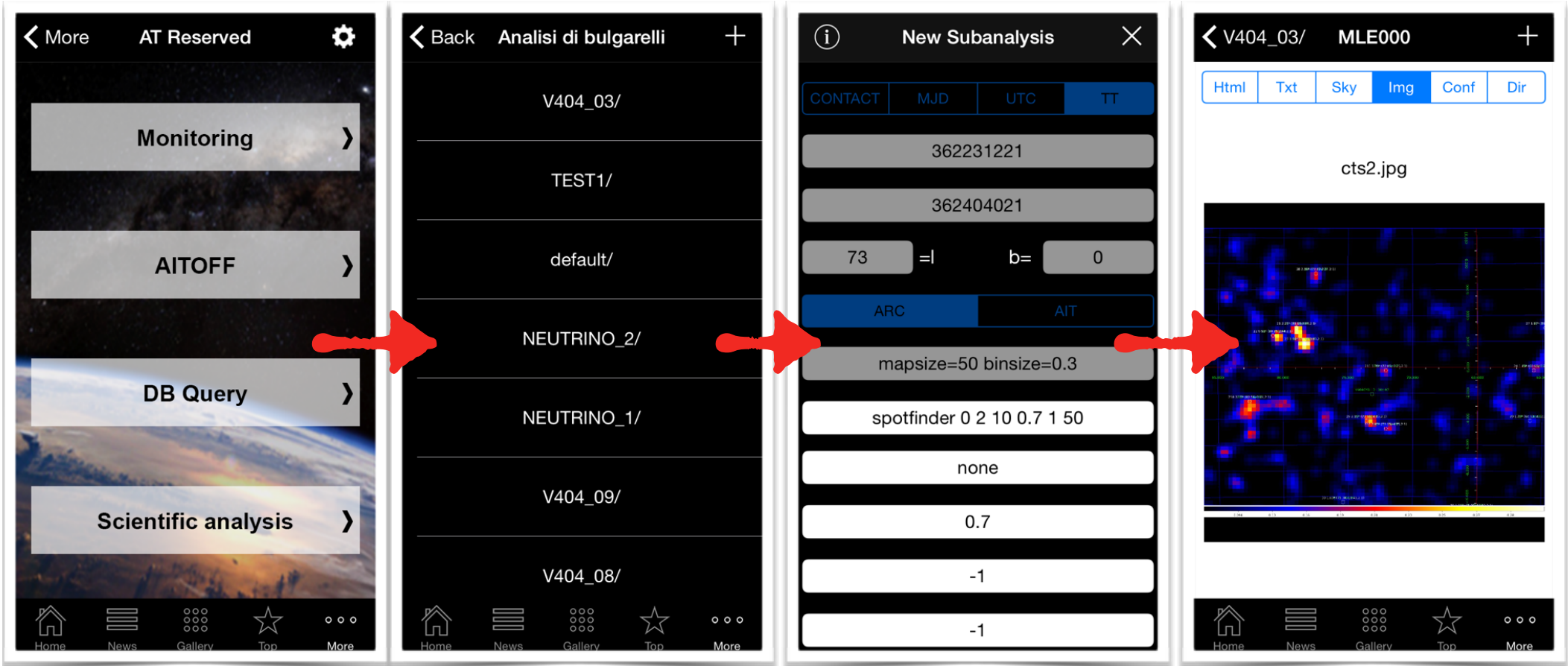


Data quality display

SCIENCE FROM AGILESCIENCE APP (AGILE TEAM ONLY)

manual analysis

- Full scientific gamma-ray analysis from smartphone with AGILEScience App, and display of the results (for manual analysis)



Select 'Scientific Analysis'

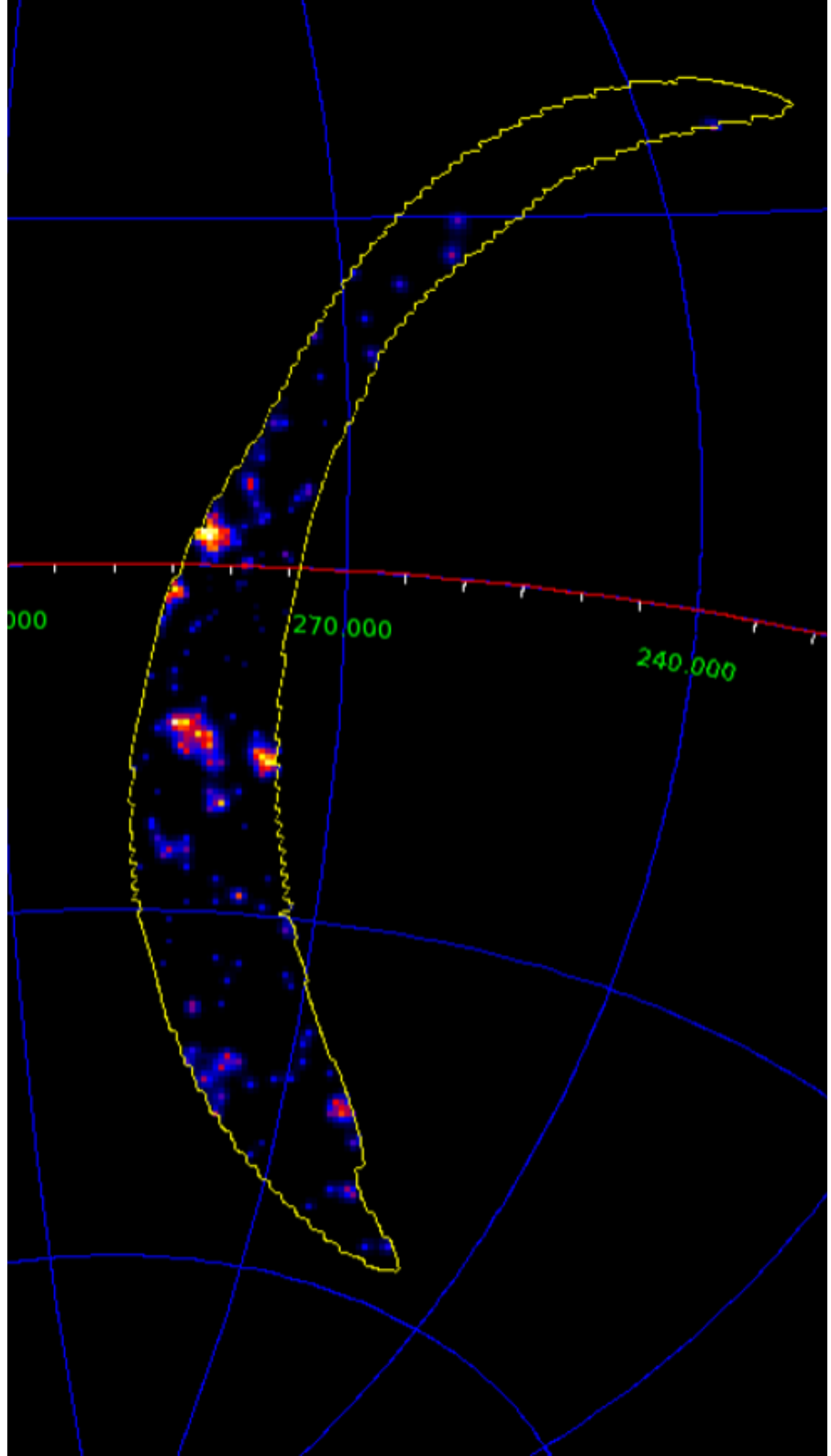
create a new analysis or select an existing one

insert/change the parameters of analysis

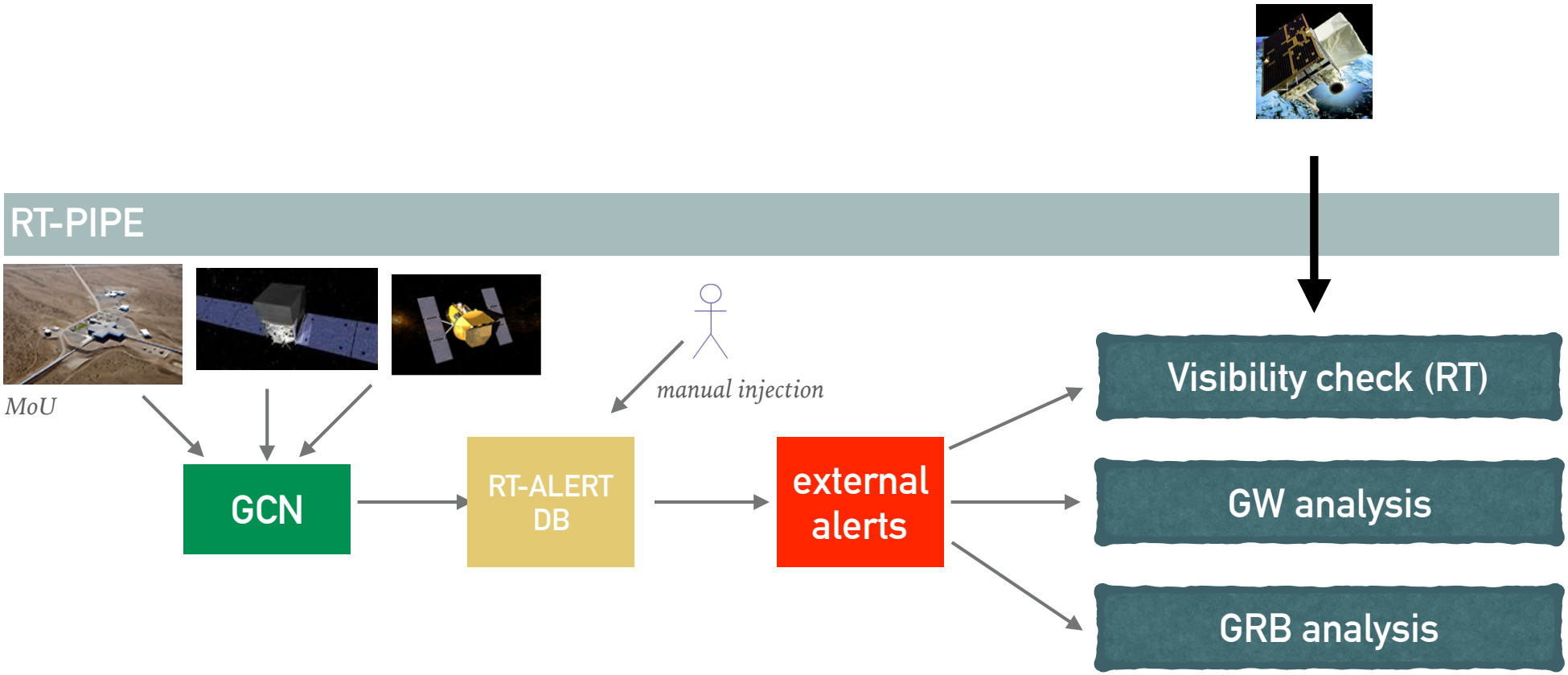
display results

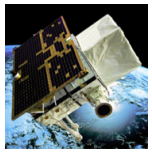
RT-PIPE

Automated reaction to GCN alerts



AGILE ON-LINE ANALYSIS @ IASFBO





data

GCN

The shifter checks "where is my data?" web page

T0

T(notice) + 30 s

T(notice) + mins

time

T0 - [0 - 2.5 h]

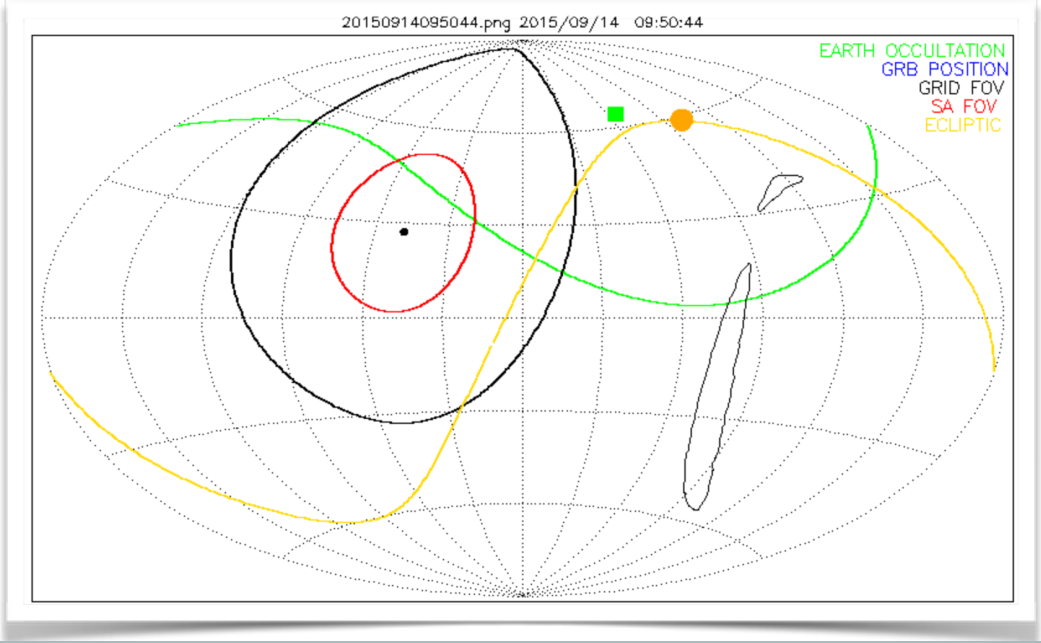
T(notice)

T(notice) + 2 s

to shifter

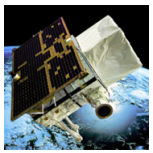
+ *e-mail*

+ *SMS*



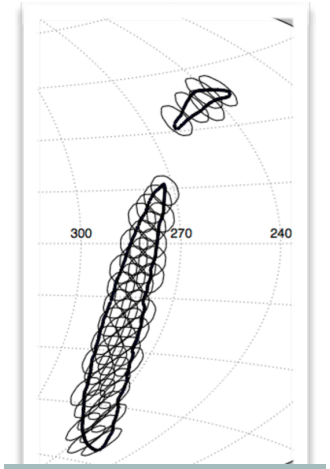
visibility check (expected) at T0

Simulation of the RT-PIPE reaction to a GW event (e.g. GW150914 event).
T0 —> time of the GW event
T(notice) —> time of the GCN notice
if T0 is near T(notice)

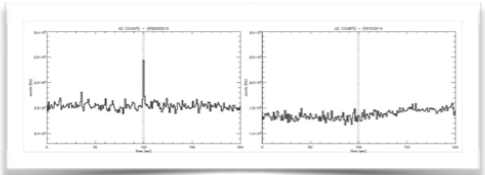


new data

T(data) =T0 + [0 - 2 h]

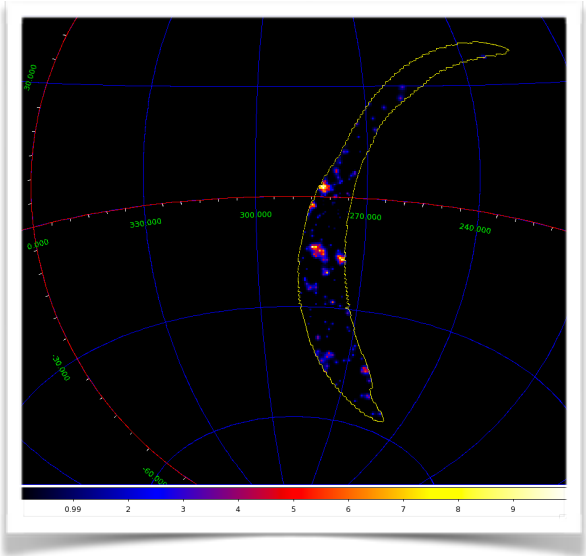


GRID prompt analysis (Li&Ma)



AC ratemeters

Super-AGILE analysis

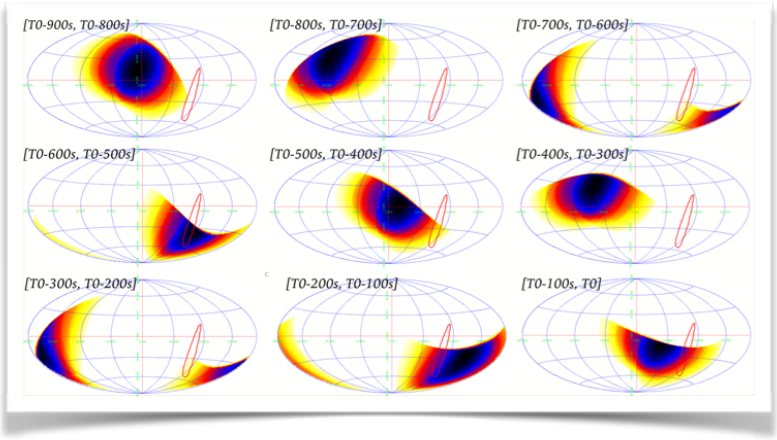


GRID significance map

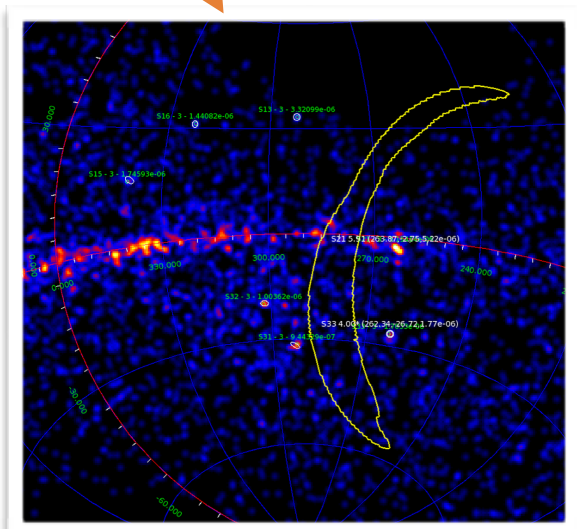
processing

time

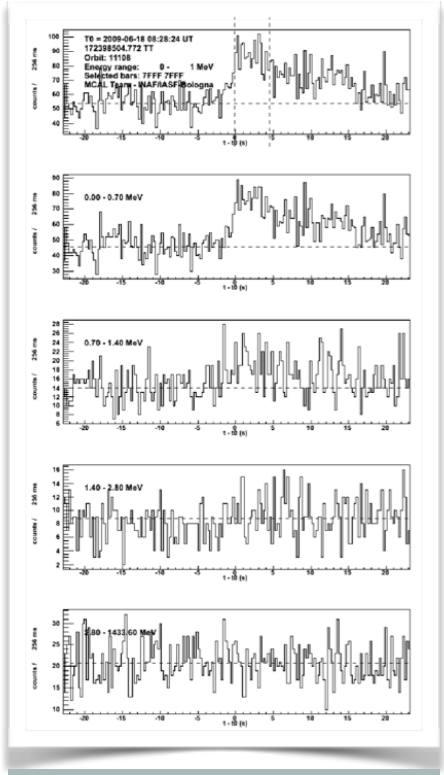
T(proc) = T(data) + [60-80 min]



visibility check (real data)

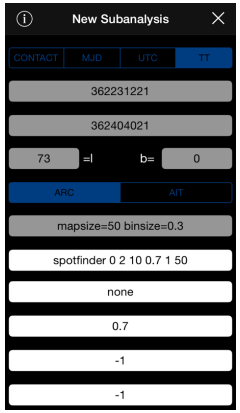


blind search on counts map (GRID data)



MCAL analysis

manual analysis (also with App)



T(proc) + 30 s

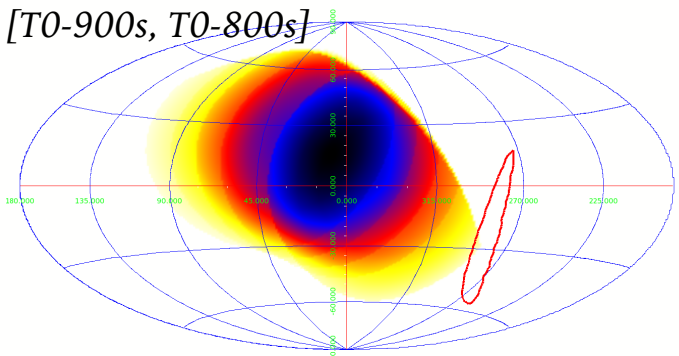
time

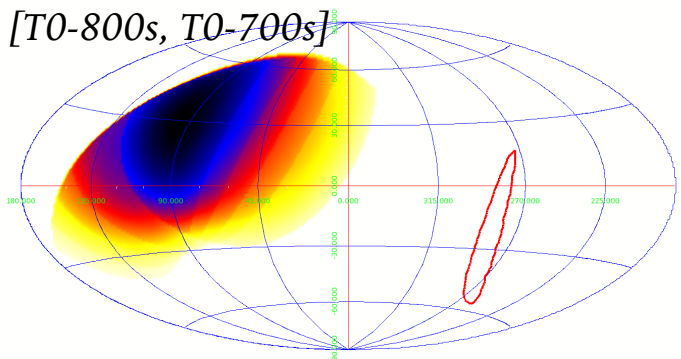
e-mail with results to AGILE-GW team

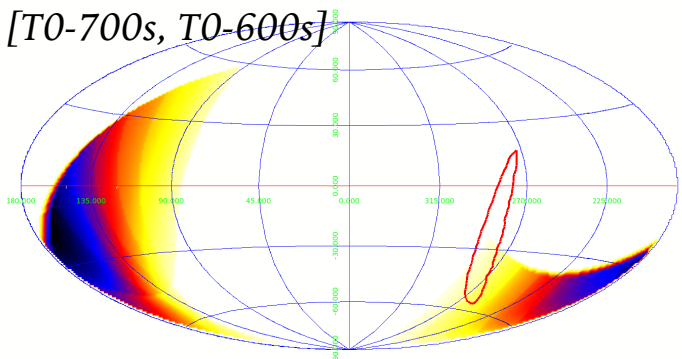
GCN circular submission

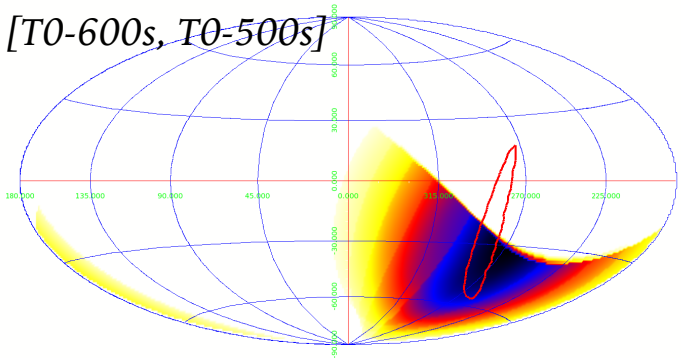
TOT: 2-2.5 h (worst case)

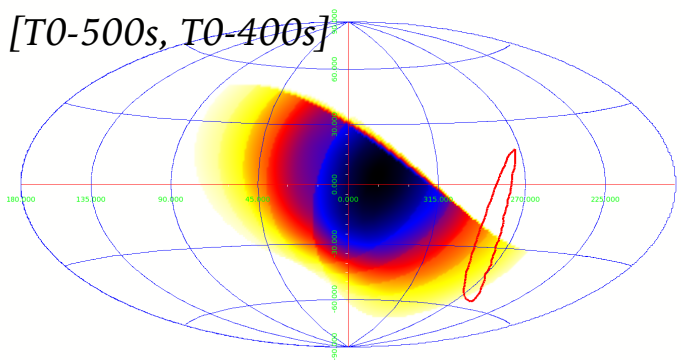
VISIBILITY CHECK (AUTOMATED, REAL DATA)

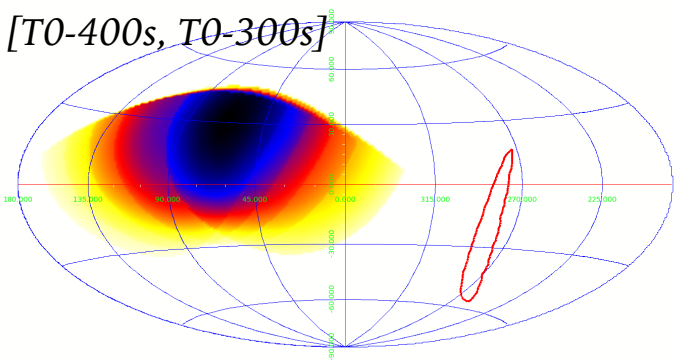


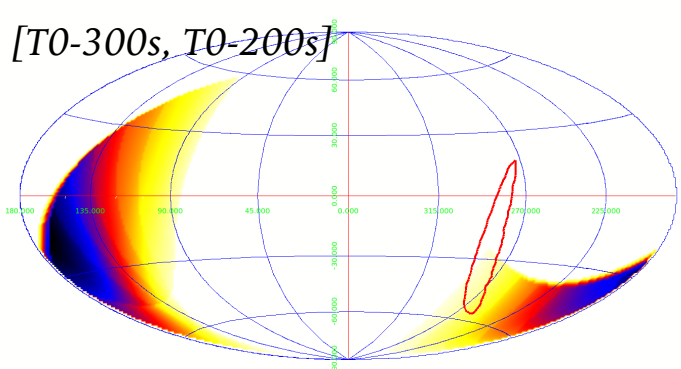


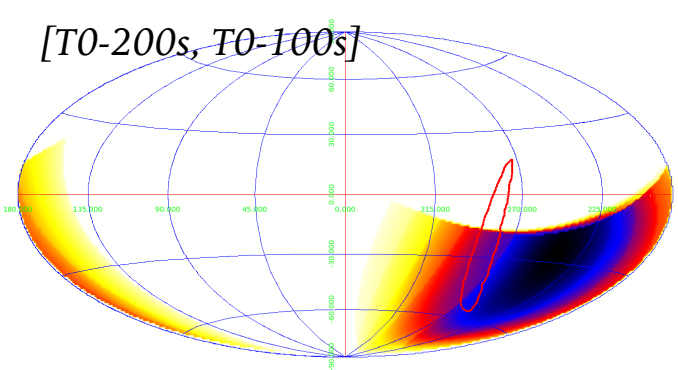


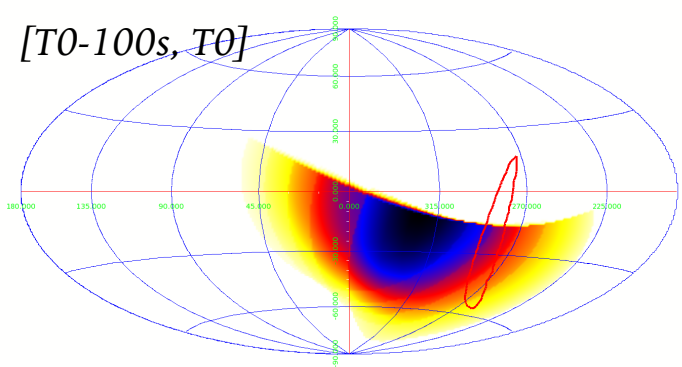










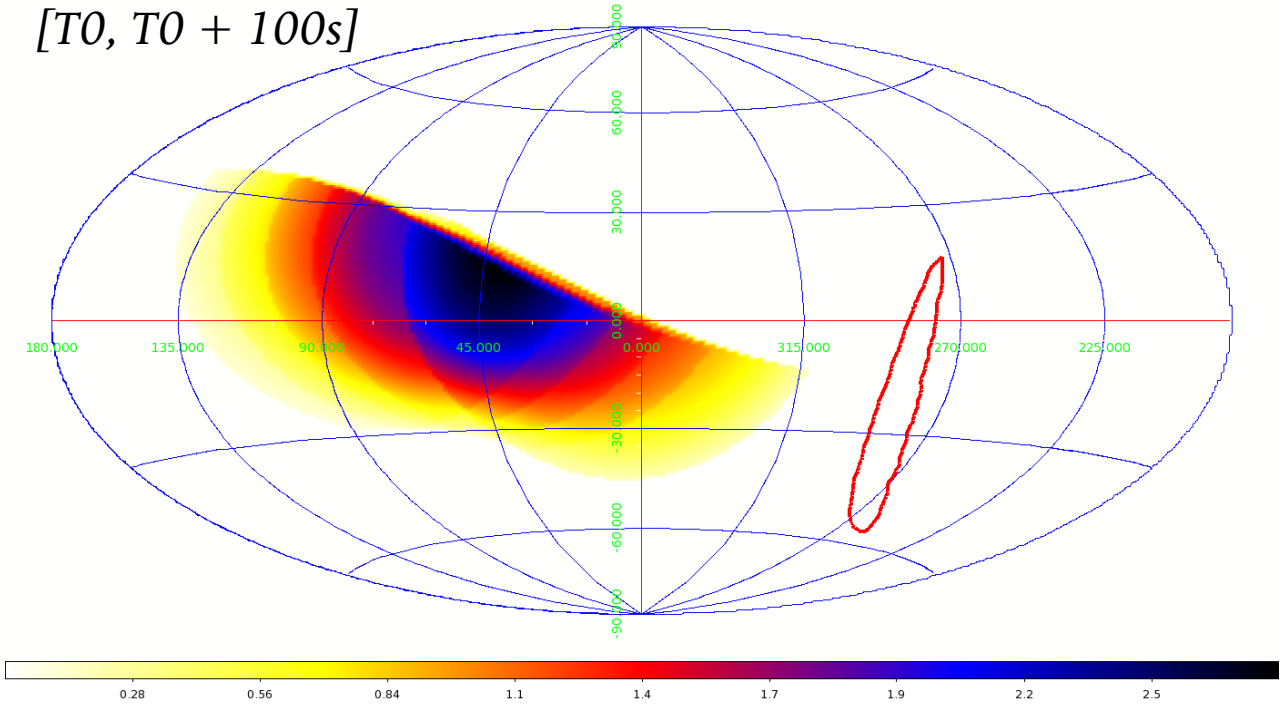


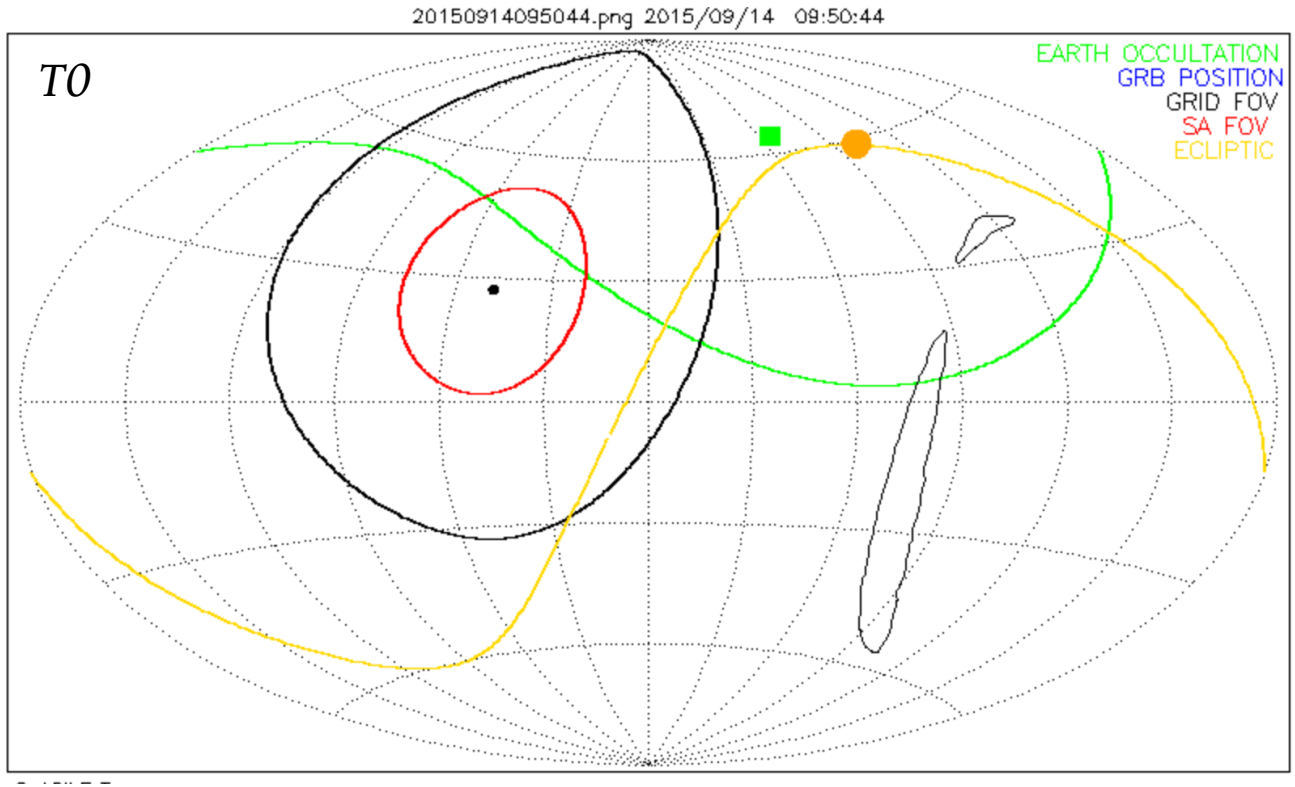
Aitoff projections in Galactic coordinates of the AGILE satellite rotation. A sequence of gamma-ray exposure maps (in cm2 s sr, using a 0.5○ pixel size) as the satellite rotates in spinning mode scanning 80% of the sky in about 7 minutes. Each map is a 100 s integration time, from T0 - 900 s to T0

real

auxiliary

[T0, T0 + 100s]

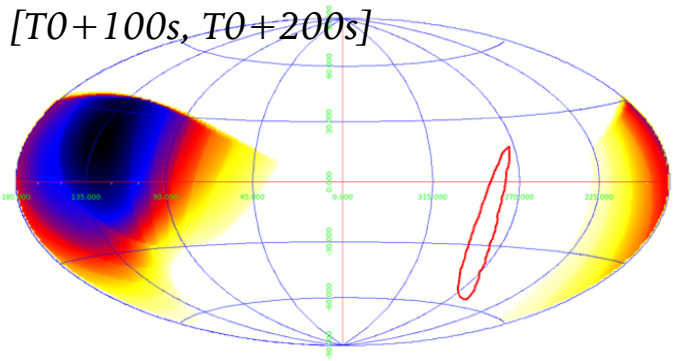




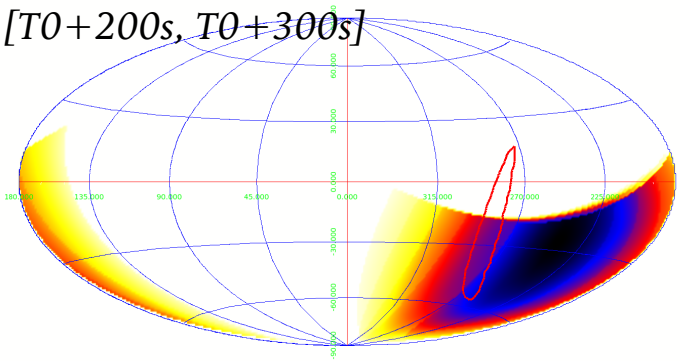
Visibility check: comparison between real data and auxiliary data provided by TPZ

VISIBILITY CHECK (AUTOMATED, REAL DATA) /3

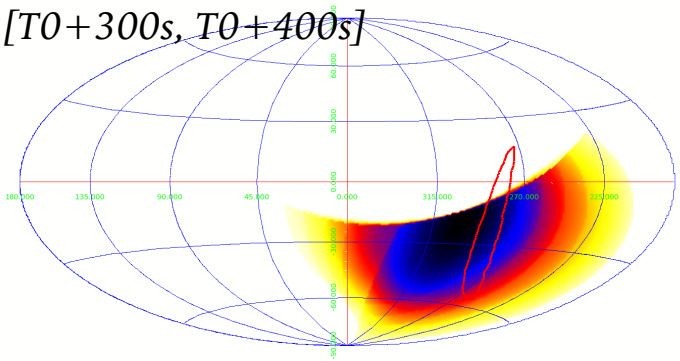
[T0+100s, T0+200s]



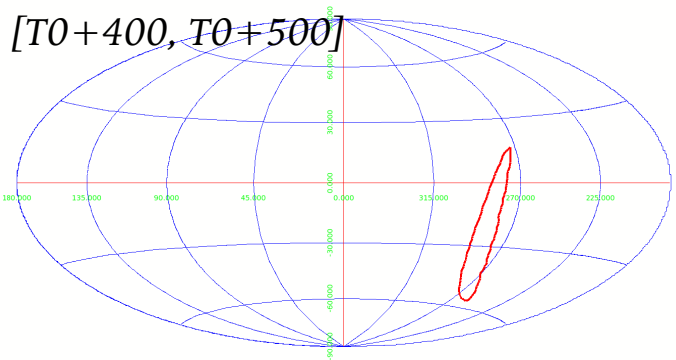
[T0+200s, T0+300s]



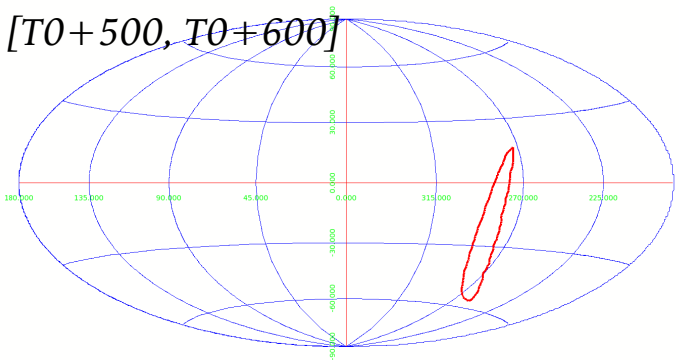
[T0+300s, T0+400s]



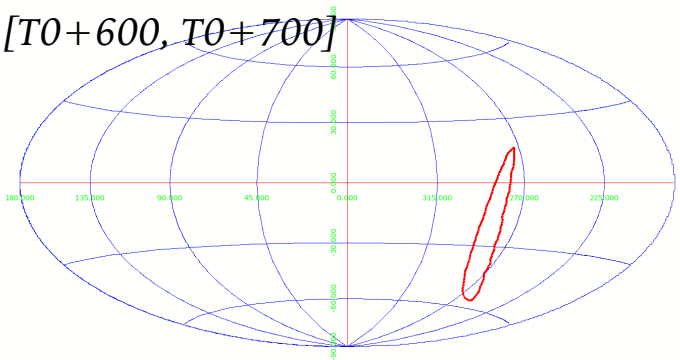
[T0+400, T0+500]



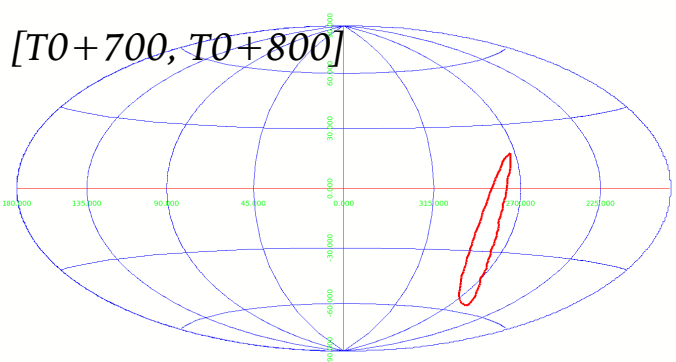
[T0+500, T0+600]



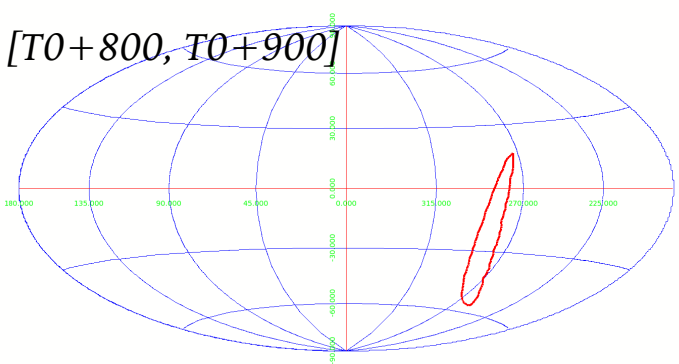
[T0+600, T0+700]



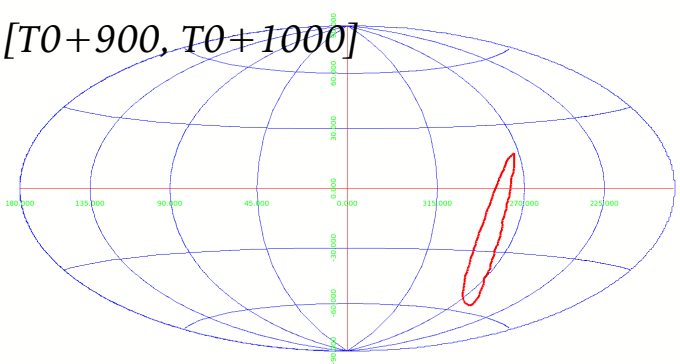
[T0+700, T0+800]



[T0+800, T0+900]



[T0+900, T0+1000]



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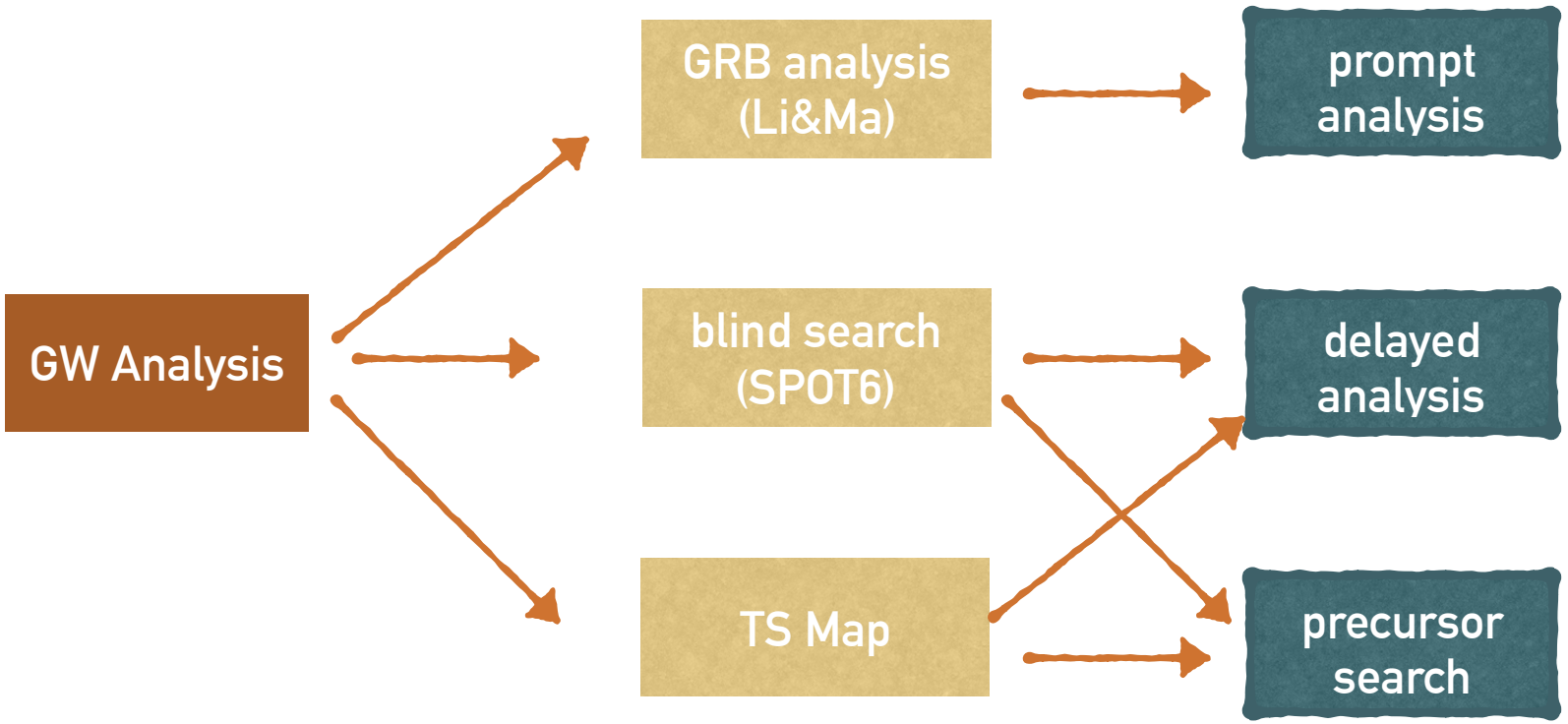
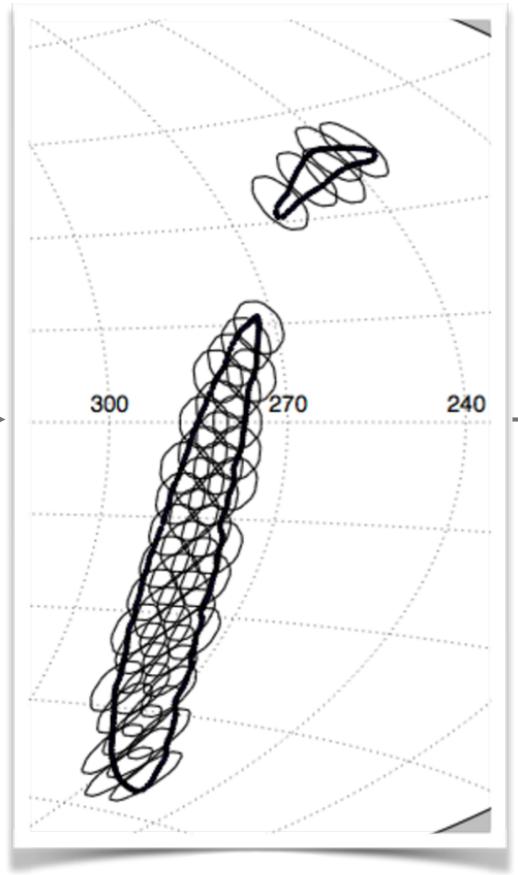
GW ANALYSIS


GW Analysis
GRB analysis (Li&Ma)
blind search (SPOT6)
TS Map
prompt analysis
delayed analysis
precursor search

GW ANALYSIS: GRID PROMPT ANALYSIS

T0
deltaT
Ts_bkg
Te_bkg
...

healpix centers



for each center

for each deltaT

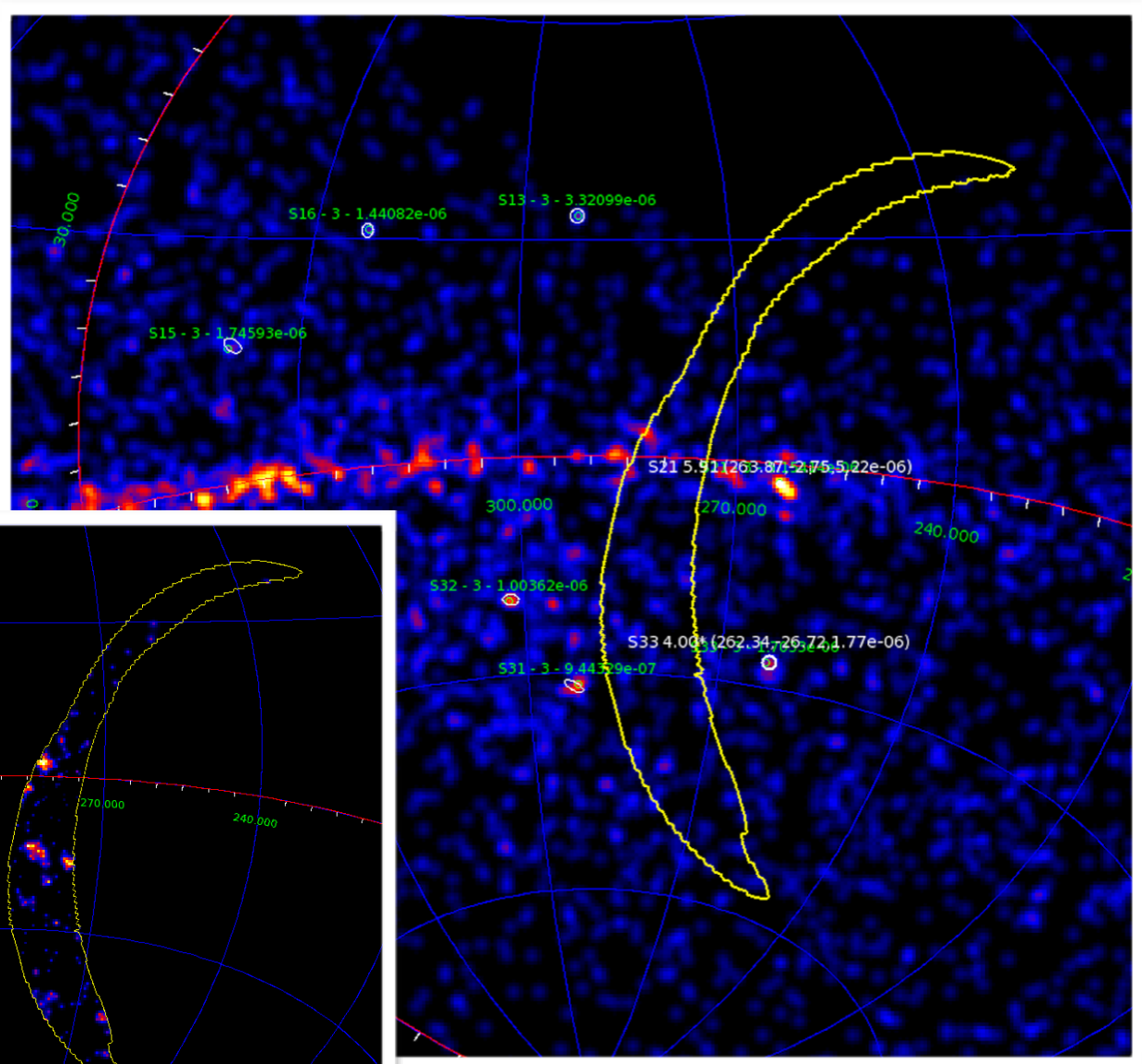
GRB analysis (Li&Ma)

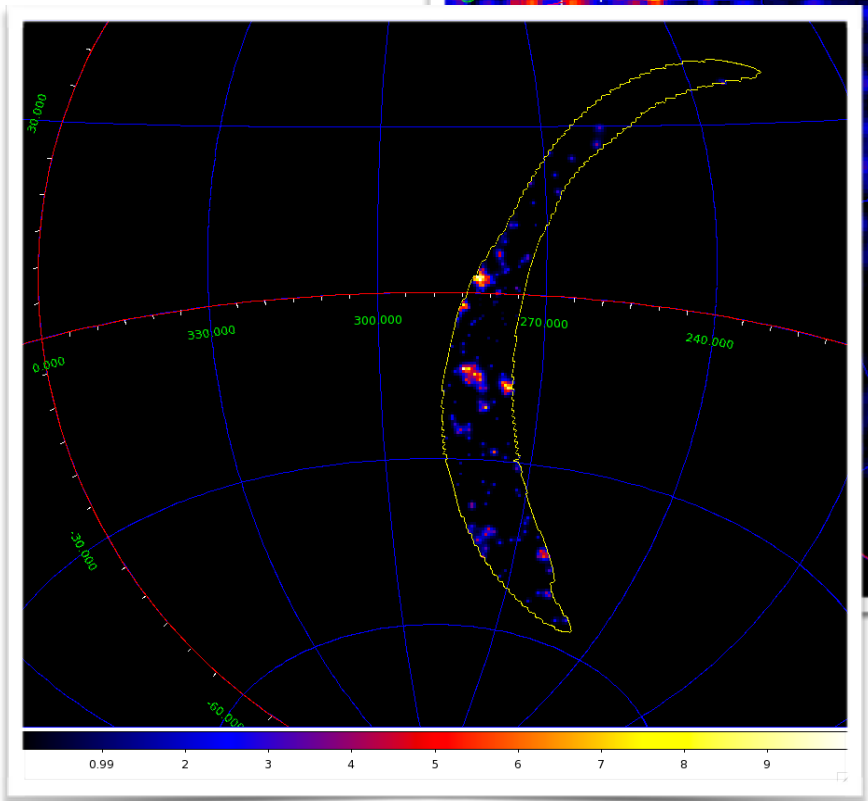
results with post-trial correction

GW ANALYSIS: GRID LONG INTEGRATION TIME ANALYSIS (DELAYED AND PRECURSOR SEARCH)

GRID Long Integration time Analysis (with Max Lik. Est.)

Interval	Duration
-4d	4d
-3d	3d
-2d	2d
-1d	1d
-12h	0.5 d
-6h	0.25 d
-3h	3 h
-3h +3h	6 h
+3h	3 h
+ 6h	6 h
+12 h	0.5 d
+1d	1 d
+2d	2 d
+3d	3d
+4d	4d



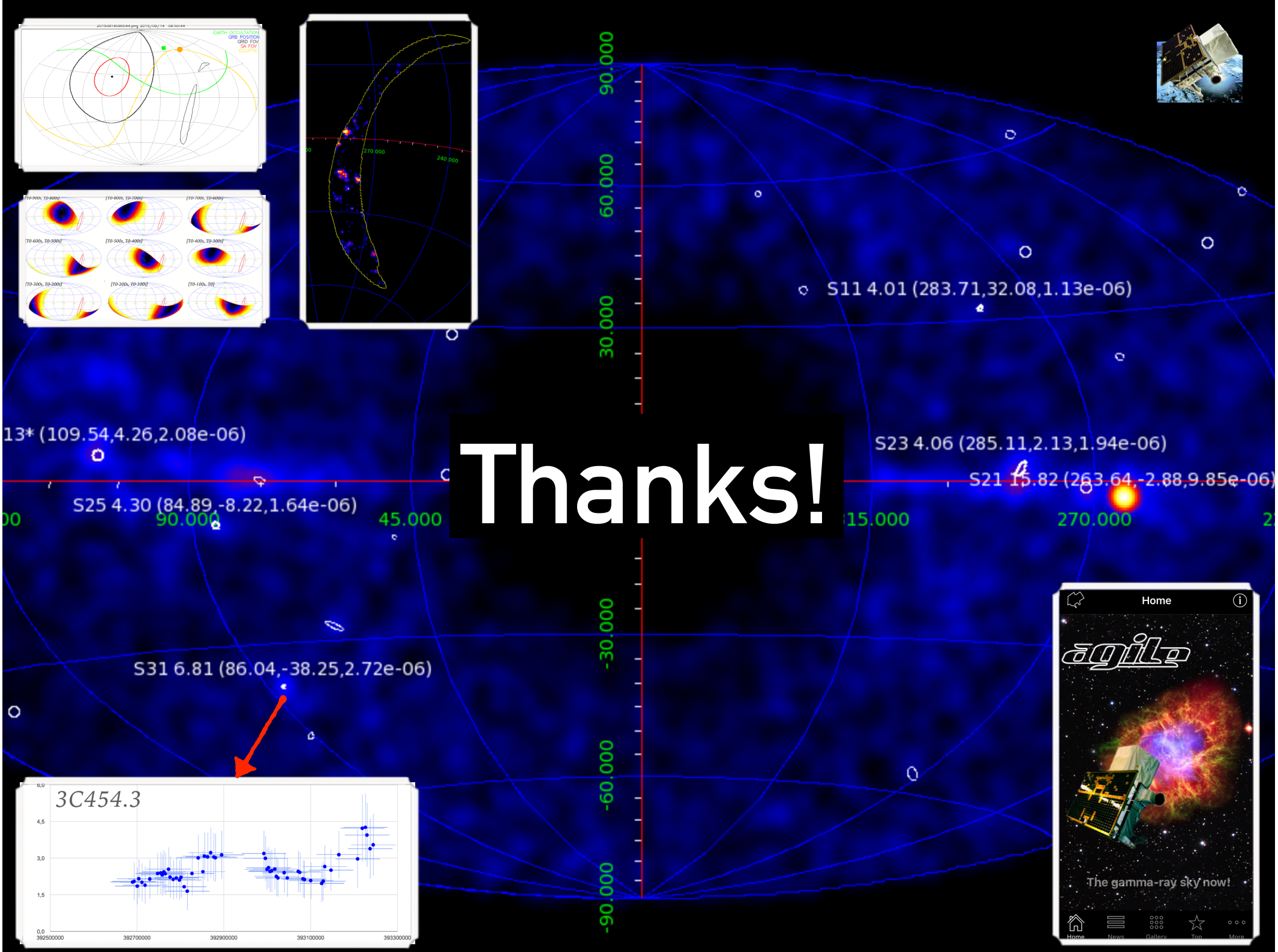


Significance map: scan of the GW error region

Counts map. Blind search: extraction of “candidate γ -ray flares” from Gaussian-smoothed γ -ray sky maps and significance evaluation

PERSPECTIVE FOR AFTER THE SUMMER

- MCAL-PIPE under re-design
- The AGILEScience with the full gamma-ray data analysis will be released soon
- July-August: scientific validation of the automated GW analysis


S11 4.01 (283.71,32.08,1.13e-06)
13* (109.54,4.26,2.08e-06)
S25 4.30 (84.89,-8.22,1.64e-06)
S23 4.06 (285.11,2.13,1.94e-06)
S21 15.82 (263.64,-2.88,9.85e-06)
S31 6.81 (86.04,-38.25,2.72e-06)
90.000
60.000
30.000
-30.000
-60.000
-90.000
45.000
270.000
3C454.3
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Thanks!