ISDC for the INTEGRAL USERS GROUP

Carlo Ferrigno (ISDC)

1-2 December 2021

Organization status

- Swiss funding for 2022: (not yet) approved with minimal direct funding (1.5 FTE). Operations guaranteed.
- Manpower allocation: ½ operator, ½ S/W engineer, ½ Data Base Engineer. Contribution from infrastructure for sysAdmin. Contribution from ESA for operations.
- Synergies with other projects and past savings is essential. ½ scientist in 2019 from ESA; ½ scientist from FNRS.
- Volodymyr will start to work at 50% for INTEGRAL (mainly science) and 50% for CTA in 2022. Enrico will be more involved in INTEGRAL, trying to boost publications.

Routine tasks

- Updates of IC files provided by instrument teams
- monitoring of SPI gain at each revolution with automated procedure (Lorenzo Ducci from Tuebingen)
- SPI gain coefficients updated last time in November
- Processing and archiving of CONS data (difficult with anomalies)

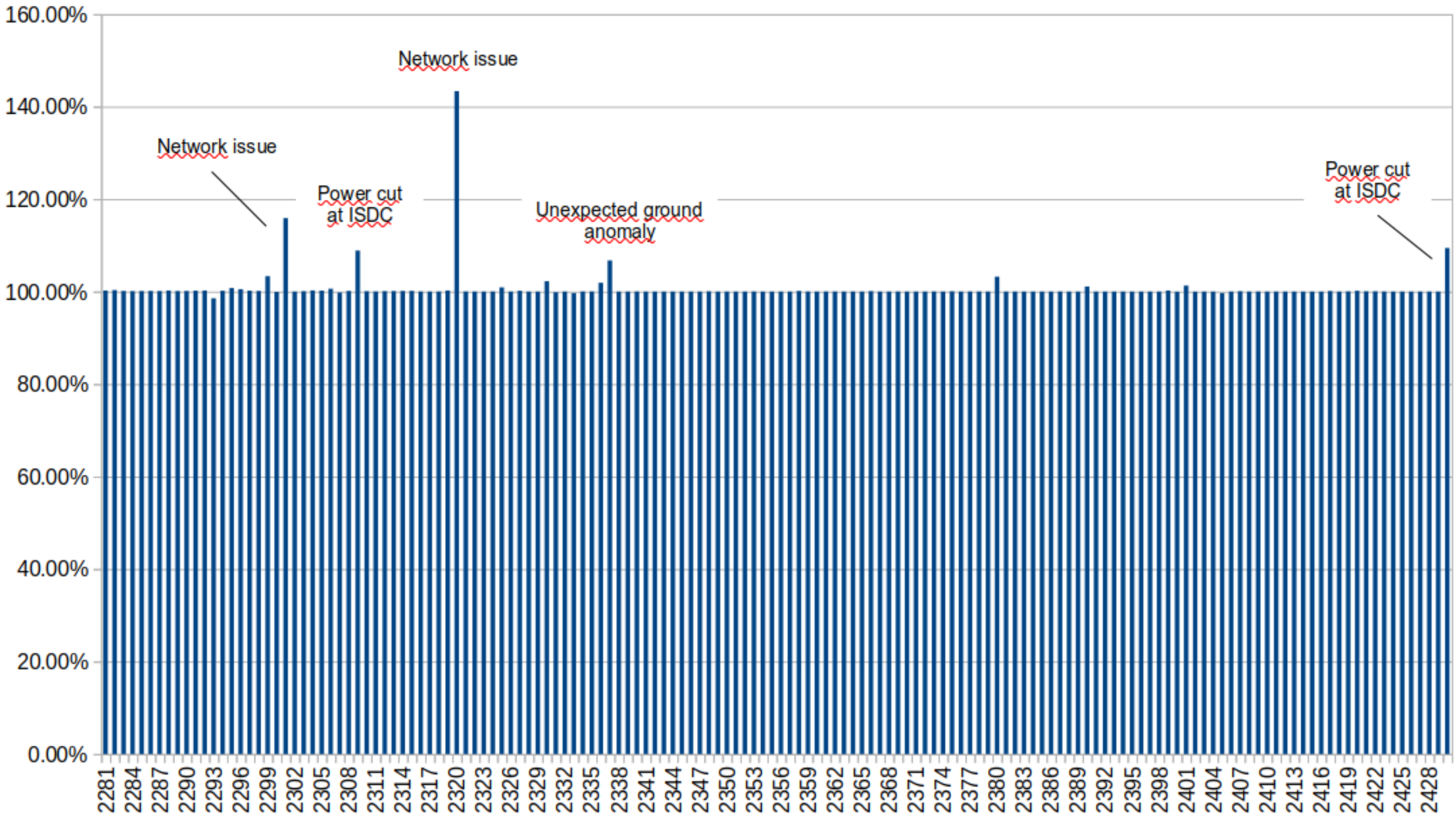
ISDC Operations/data distribution

- NRT data are available within 3 hours. Smooth processing (monitoring issues more closely now for MMA).
- Page to distribute data since AO13, public for serendipitous science. Handled Russian peculiarity.
- Need for OSA energy reconstruction step both for JEM-X and ISGRI. NRT data for JEM-X2 are not always available due to difficult energy reconstruction.
- Occasional gaps in NRT telemetry due to hardware failure of the University infrastructure supporting the data transfer or interruption (switch).
- Service widely used for SPI-ACS data in NRT

Quick look analysis of INTEGRAL data

- 4 GRB in the IBIS FOV in 2021
- ~200 GRB/year in SPI ACS. Used for IPN triangulation.
- Inform all PIs of data rights only in case of outstanding problems or relevant serendipitous sources.
- 27 ATeLs and 18 GCNs related to INTEGRAL discoveries in 2021 (included neutrino follow-up, some still to be done)

Telemetry


160.00%
140.00%
120.00%
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Network issue
Network issue
Power cut at ISDC
Unexpected ground anomaly
Power cut at ISDC
2281
2284
2287
2290
2293
2296
2299
2302
2305
2308
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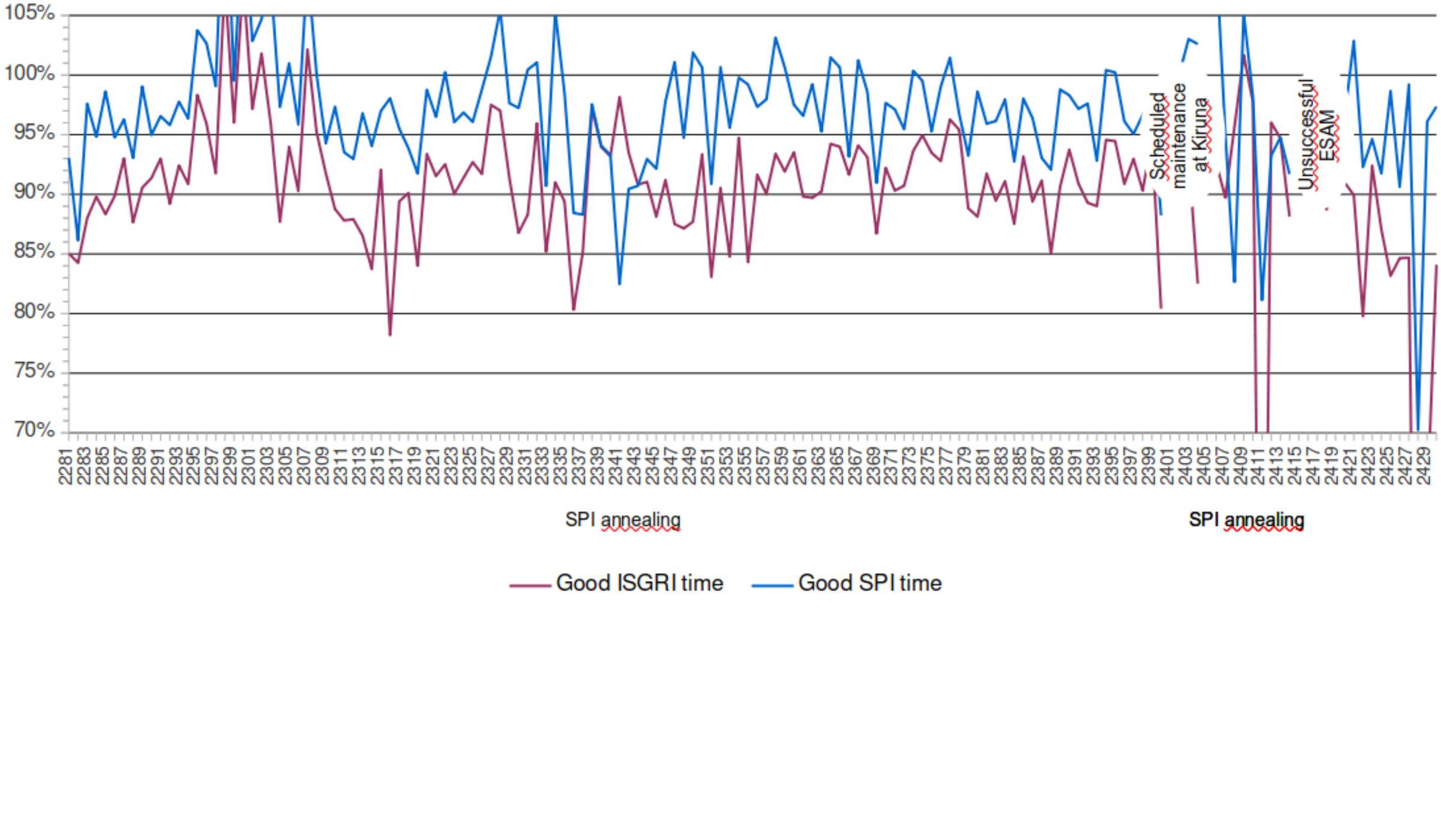
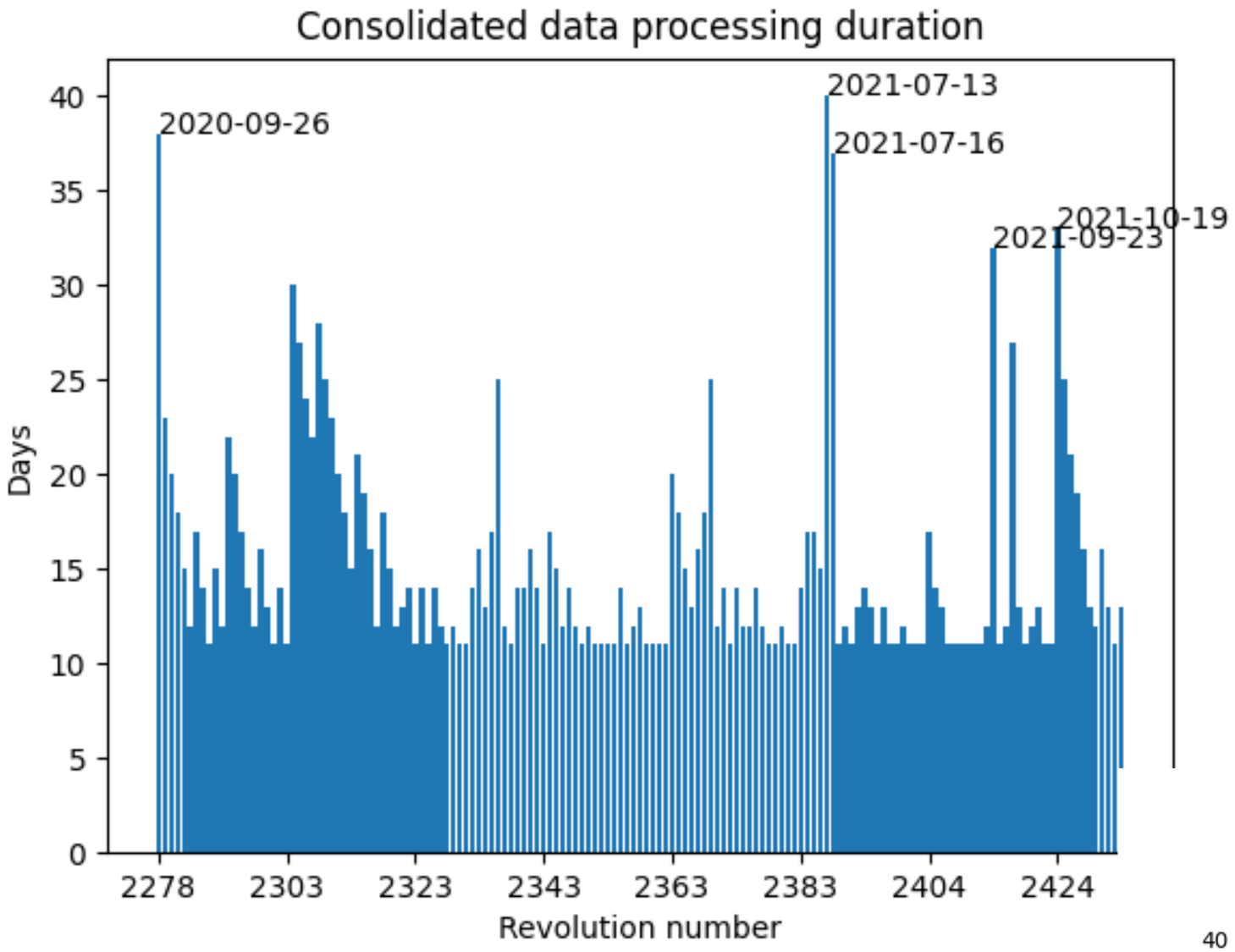
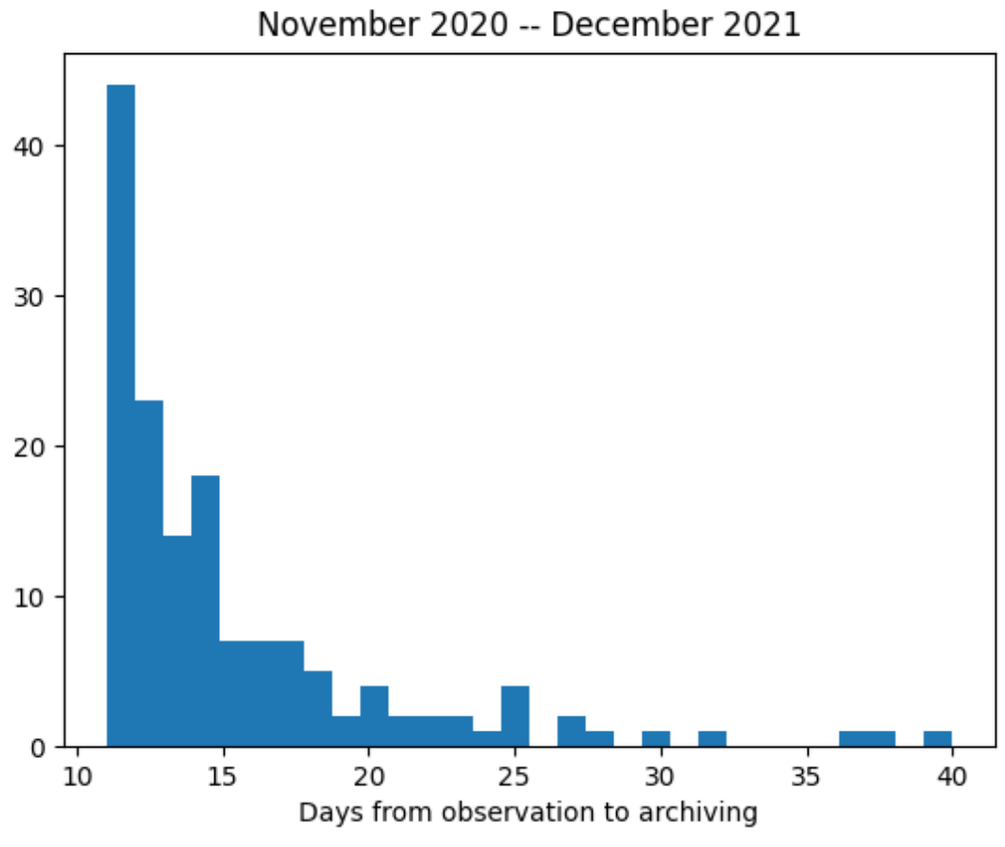
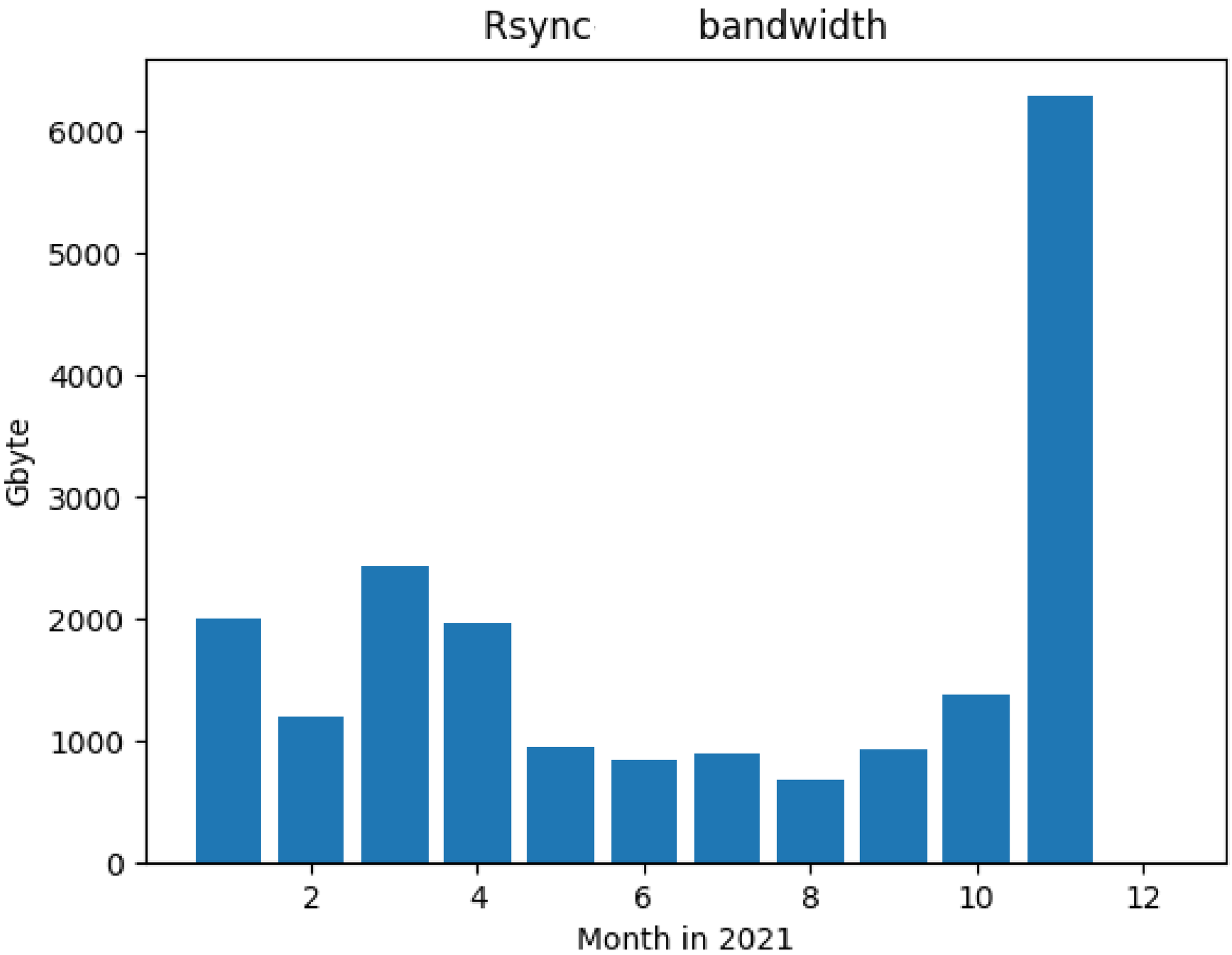
2428

Operations: Good times vs Schedule




Consolidated data processing duration
2020-09-26
2021-07-13
2021-07-16
2021-09-23
2021-10-19
Days
0
5
10
15
20
25
30
35
40
2278
2303
2323
2343
2363
2383
2404
2424
Revolution number


November 2020 -- December 2021
0
10
20
30
40
10
15
20
25
30
35
40
Days from observation to archiving


Rsync bandwidth
Gbyte
6000
5000
4000
3000
2000
1000
0
2
4
6
8
10
12
Month in 2021

ISDC catalog

- Released catalog v. 43 in June 2019 (+5 sources)

Transient event dashboard

- Every input (GCN notice) is automatically processed and it generates results.
- Link to the workflow is private
- For the moment, we take care of neutrino upper limits.

The private dashboard to work on data

INTEGRAL status

Snapshot at 2019-06-09T18:16:25 UTC

Orbit 2100, 151.93 Mm to Earth

	State/last	Latency	RA	Dec
Real-time	ONLINE	66.0 s	4.7	59.6
NRT	210000250010	1.2 h	4.3	61.7
CONS	209000990010	25.3 d	320.0	-45.0

INTEGRAL status Schedule

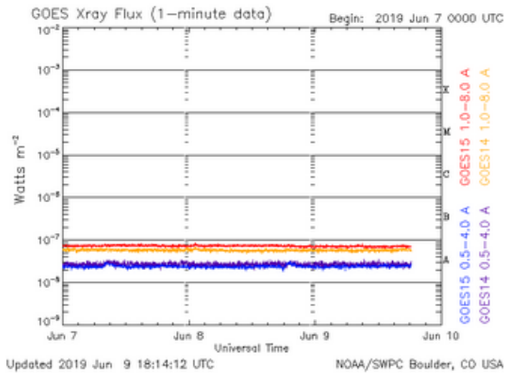
next break in data in 29 hr: 2019-06-10T23:32:59, for 9.6 hr

Gravitational Wave Detector Network

Operational Snapshot as of Jun 09, 18:16 UTC

Detector	Status	Duration
GEO 600	Observing	2:40
LIGO Hanford	Observing	15:40
LIGO Livingston	Observing	9:08
Virgo	Troubleshooting	2:53
KAGRA	Future addition	

Detector status summary pages LVC links



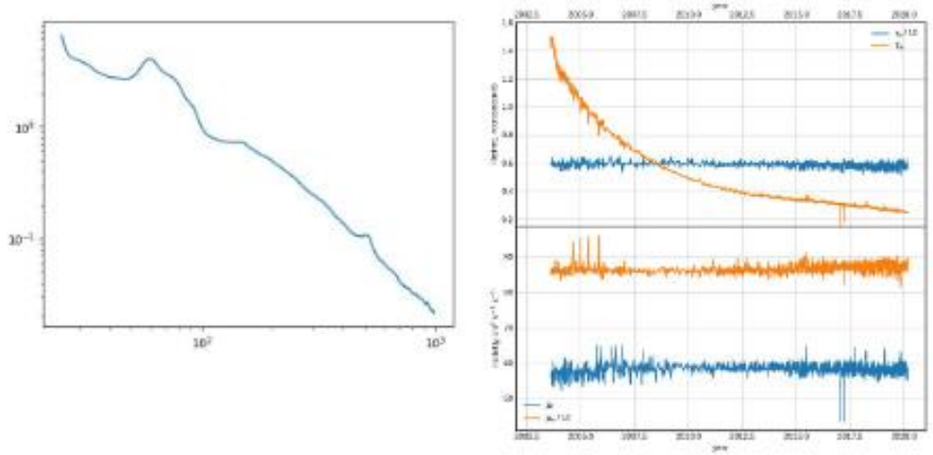
Events Observations LIGO/Virgo AMON/IceCube INTEGRAL SPI-ACS Fermi All

Event	Origin	Role	UTC	Sky Location	Orientation (θ, φ)	FoV exposure	ScW	Data	Visibility	Planning urgency	Raw Notice
S190602aq	LIGO Virgo	observation	2019-06-02T17:59:27.0	73.39 -7.03	bottom (127.8, -20.2)	0.0 ks	209700520010	NRT	1.3%		VOEvent JSON
S190602aq	LIGO Virgo	observation	2019-06-02T17:59:27.0	73.39 -7.03	bottom (127.8, -20.2)	0.0 ks	209700520010	NRT	1.3%		VOEvent JSON
S190602aq	LIGO Virgo	observation	2019-06-02T17:59:27.0	73.39 -7.03	bottom (127.8, -20.2)	0.0 ks	209700520010	NRT	1.3%		VOEvent JSON

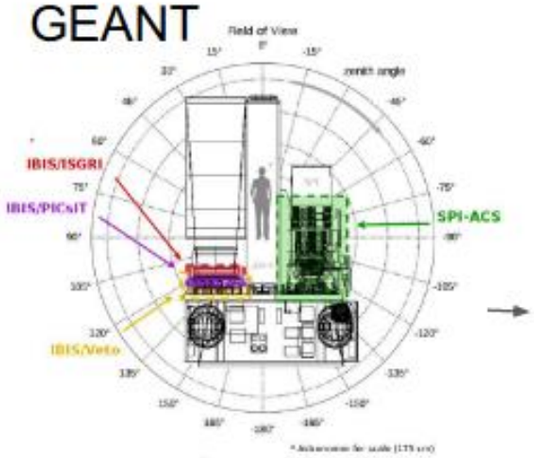
OSA 11.2 Beta – IBIS (VS)

Calibration

Fit charge loss model to background



GEANT



Fit low-energy RMF and efficiency

3ML Multi-Mission Maximum Likelihood Framework

OSA

Reconstruct **deposited "photon" energies**

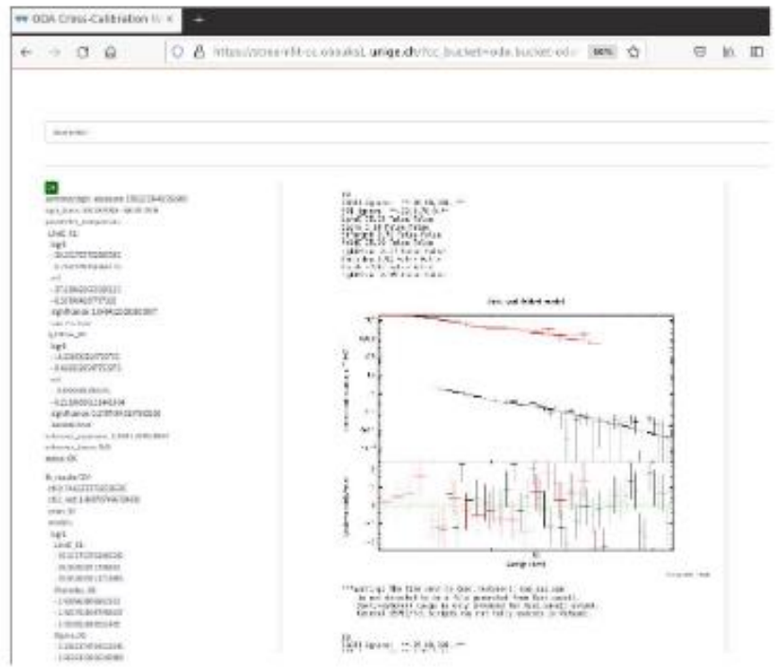
Reconstruct **"equivalent" count rates** dividing by efficiency

Fit detector plane with model shadows

Verification

No ARF fitting
(even if it's not necessarily a bad thing)

Fitting spectra
(xspec)



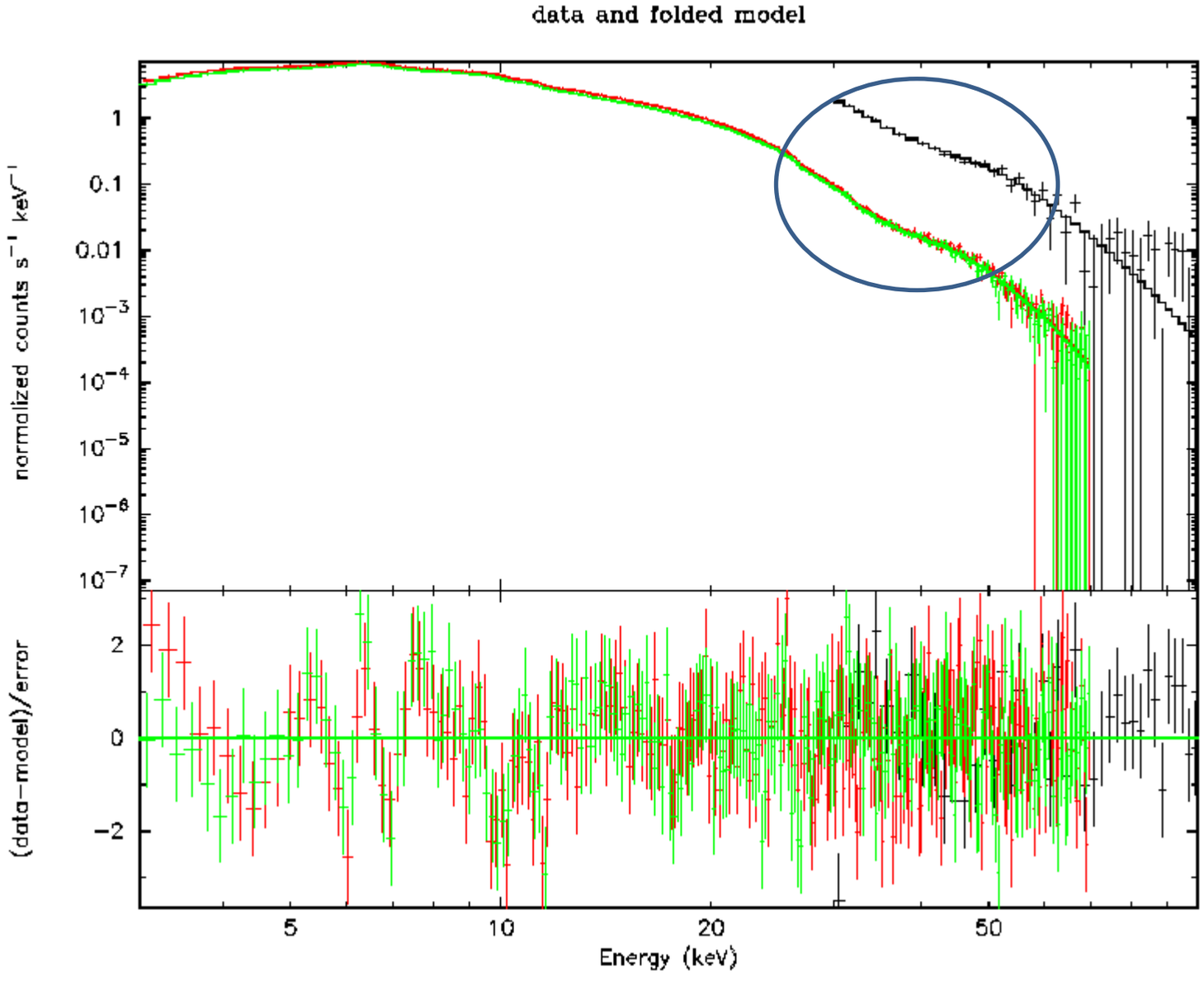
https://indico.ict.inaf.it/event/1001/contributions/10148/attachments/5053/10366/OSA11%20-%20ISGRI.pdf

(Cross)Calibration activities

- We have setup a series of tests for consistency between SPI and NuSTAR with IBIS/ISGRI.
- They are all available online (protected)
- In principle, it is relatively easy to design cross calibration tests with different instruments:
- JEM-X and ISGRI are available online through MMODA
- SPI products can be provided for target sources

CROSS-calibration
Her X-1 checks for cyclotron line energy

- We collected all simultaneous observation of INTEGRAL and NuSTAR and compare them (preliminary results)
- We are using SPI or NuSTAR data to benchmark ISGRI energy calibration (systematic differences in OSA11 to be understood)



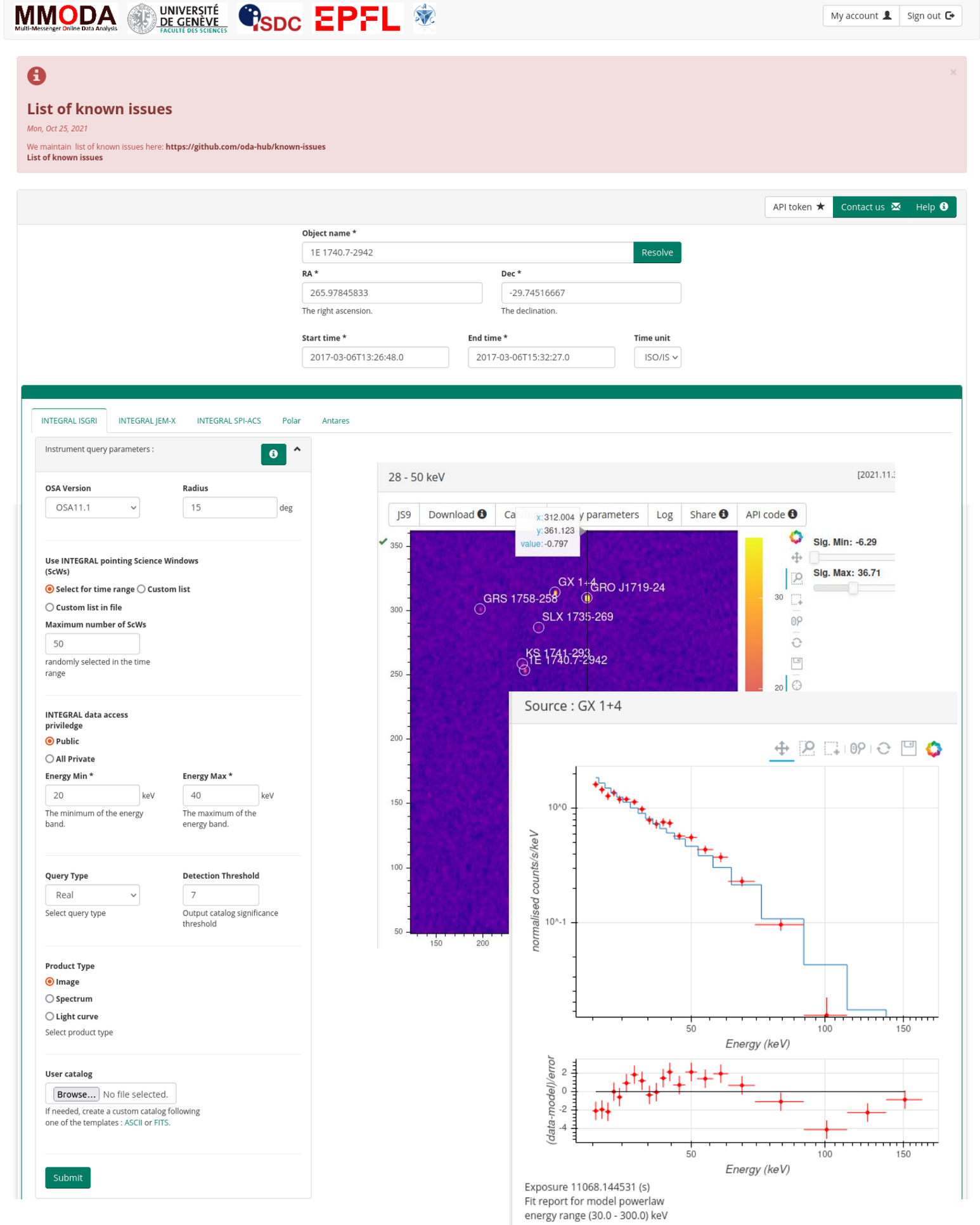
REV 2105

Par ISGRI Reference (sigma)
LineE 36.02 +/- 0.39 ; 35.37 +/- 0.16 ; 1.6
lg10Flux -7.89 +/- 0.01 ; -7.89 +/- 0.00 ; 0.4

'status': 'OK',

Multi-Messeger Offline Data Analysis (MMODA)

- We also run OSA executable from a web tool or python API (IBIS/ISGRI, JEM-X, and SPI-ACS)
- Fully linked to local HPC cluster
- 50 scw for not logged, 500 for logged-in
- Access to private data and beta version upon login and approval



A python API for OSA

- It is possible to call OSA runs using python
- For logged user, at each request, python code is emailed for use

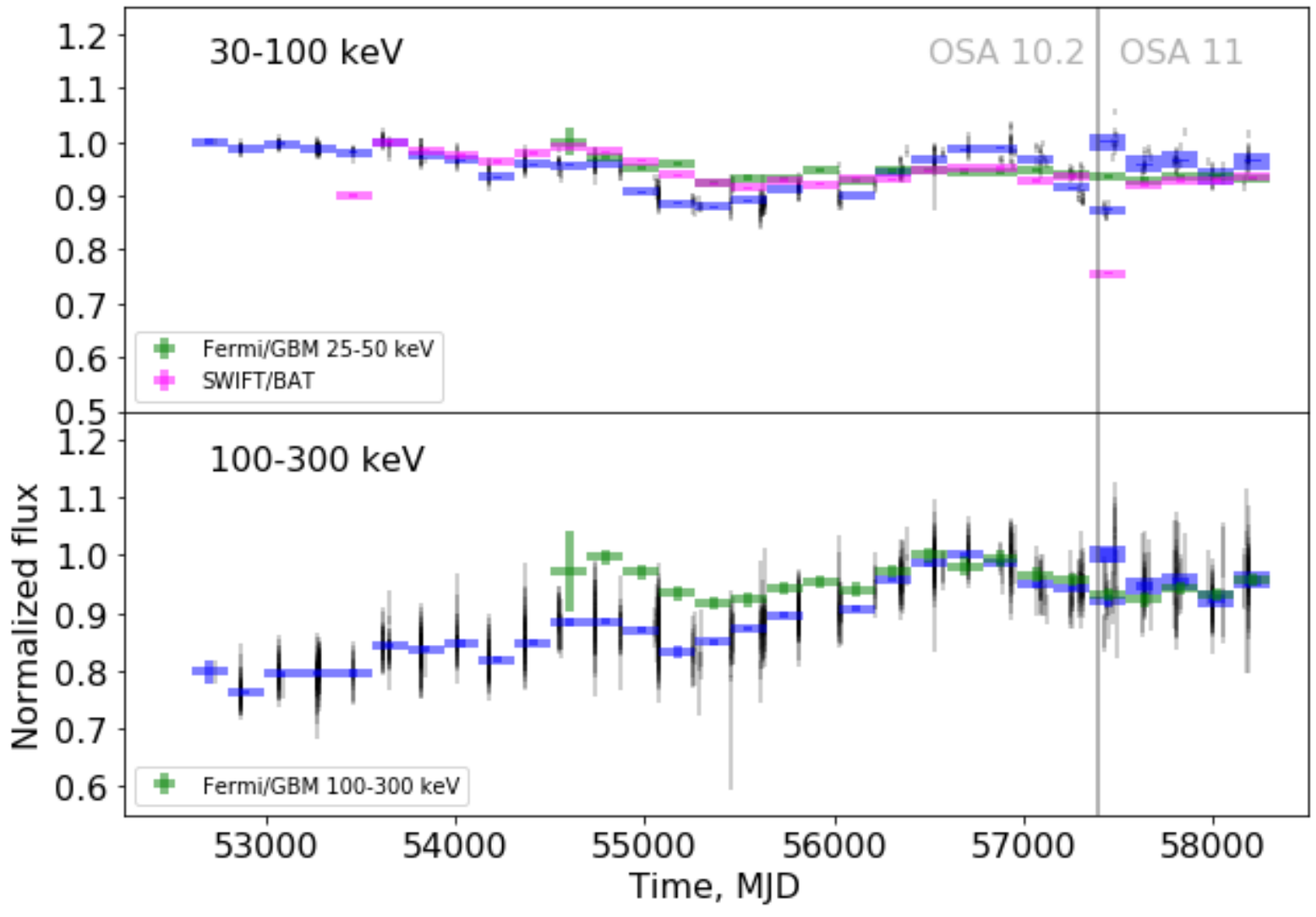
```
jemx2_spectrum = disp.get_product(instrument="jemx",
                 jemx_num='2',
                 product="jemx_spectrum",
                 product_type="Real",
                 osa_version='OSA10.2',
                 E1_keV=3.0,
                 E2_keV=20.0,
                 scw_list=scw_list_str)
```

```
171500630010.001,171500870010.001,171500650010.001
waiting for remote response, please wait run_analysis https://www.astro.unige.ch/cdci/astrooda/dispatch-data
the job has been submitted on the remote server
 / the job is working remotely, please wait status=done - job_id=-67562939370046012 53

query done succesfully!
```

Docs

https://oda-api.readthedocs.io/en/latest/




```
data=disp.get_product(instrument
='isgri',
product='isgri_lc',
T1=T1_utc,
T2=T2_utc,
T_format=T_format,
E1_keV=E1_keV,
E2_keV=E2_keV,
query_type='Real',
osa_version='OSA10.2',
                    RA=ra,
                    DEC=dec,
product_type='Real',
time_bin=time_bin,
selected_catalog=api_cat)
```

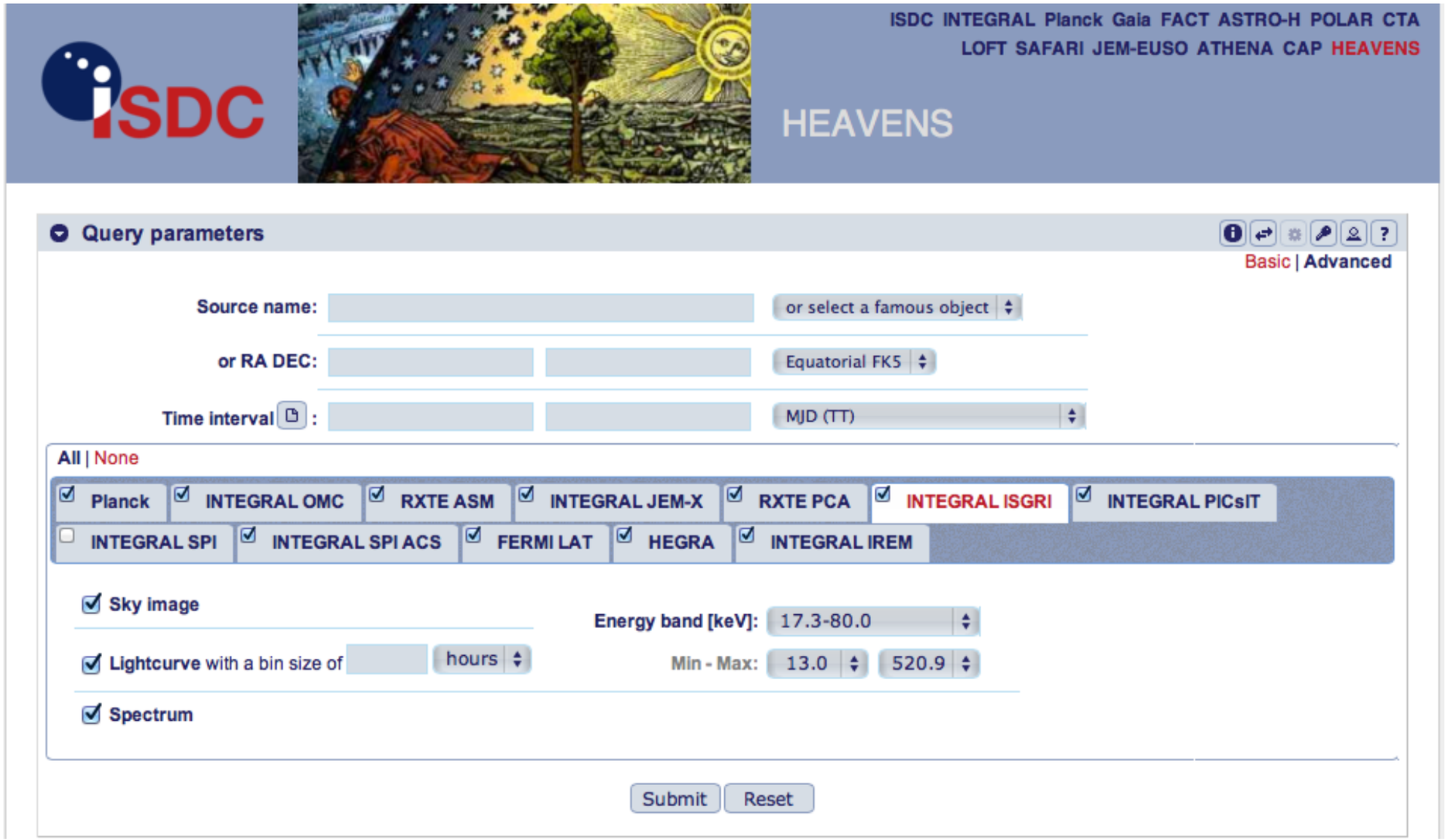
Reproducible and storable

- The system is built with internal cache to save intermediate products and optimize computing resources
- The second time you make the same query, results are very fast
- Backend can be deployed virtually anywhere, because it is based on a “singularity” cluster, which runs science windows in parallel.

MMODA known issues

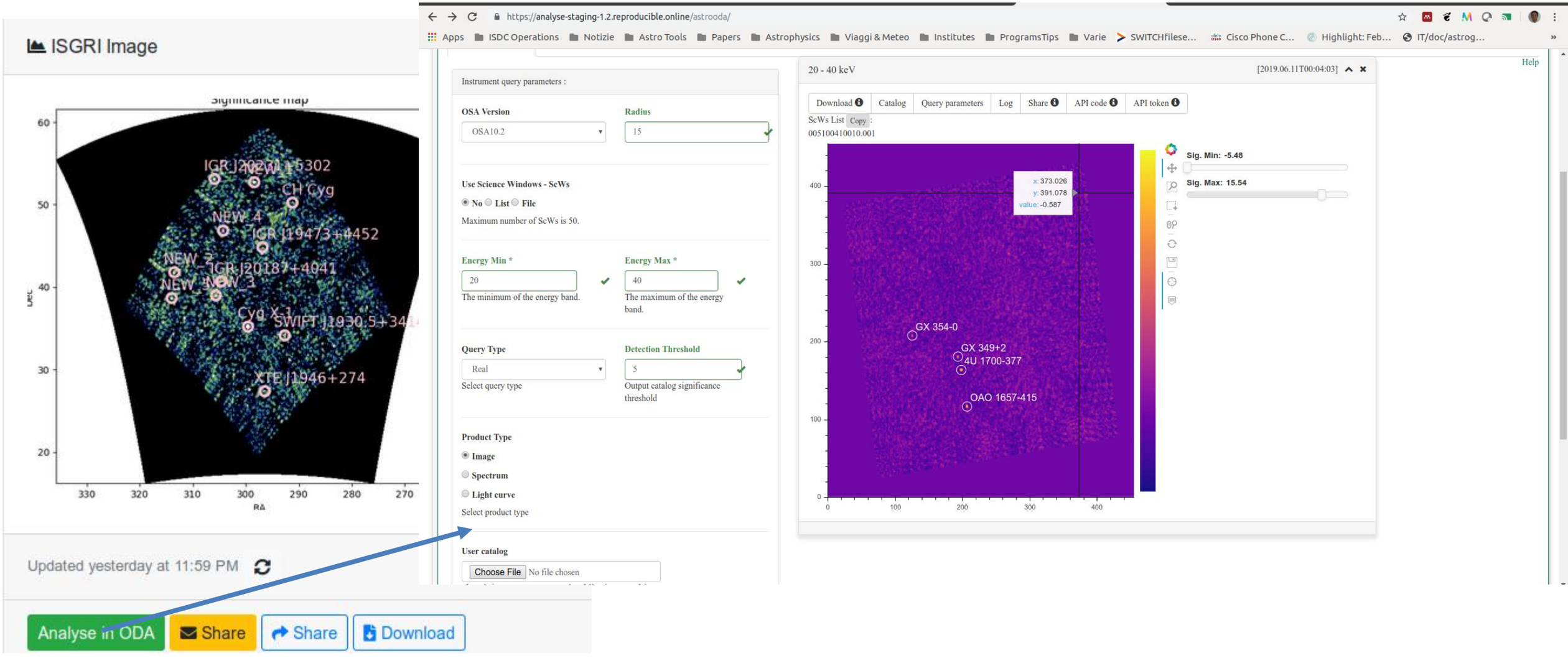
- https://github.com/oda-hub/known-issues
- Frontend
- Catalog parsing has rare errors
- It is not possible to change the Xspec model in the Fit of spectra. However, spectra can be downloaded and fit with another package.
- If you submit a job and the error "Forbidden" appears, it means that you should logout and login again from the web interface.
- ISGRI
- In some cases, especially for large observations with many sources and noisy obserations, ISGRI mosaic produces too many sources and mosaic extraction (standard OSA, which is used internally) crashes. This leads to an AnalysisException error.
- Fractional numbers in energy ranges (e.g. 20.32 - number which do not align with "standard" energy bins used in background maps) cause a known issue in OSA.
- Suggested workaround: please use more even energy ranges, e.g. 20.5 vs 20.32. Rounding ranges to 0.5 should work most of the time, except for the higher energies.
- JEM-X
- A source named "NEW SOURCE" will not be used in extracting JEM-X spectrum and light curves. It is necessary to name it differently.

High level quick-look products, HEAVENS



- Development on hold
- Used OSA9
- Updated IREM on request

A product gallery



- We wish to populate an archive of relevant results with links to the online analysis results (images,spectra lightcurve), but above all to the workflow having generated it.

- With a simple click, we can pass from the image to the workflow producing it. Access source files and in case modify the analysis.