First steps to standardise observatory services via VO standard protocols

Aitor Ibarra[1], Richard Saxton[2], Emilio Salazar[3], Erik Kuulkers[4],

Jesús Salgado[1], Carlos Gabriel[4], Bruno Merin[4], Peter Kretschmar[4]

[1] Quasar for ESA

[2] TPZ-VEGA for ESA

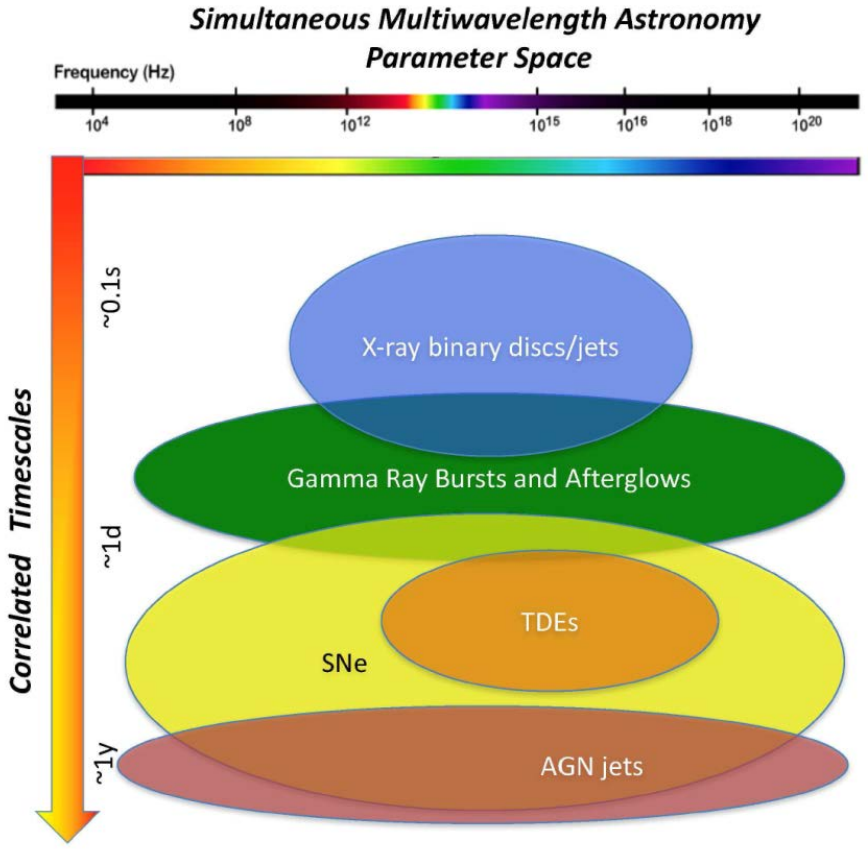
[3] ATG for ESA

[4] ESA

Scientists Require Coordinated Multiwavelength Observations

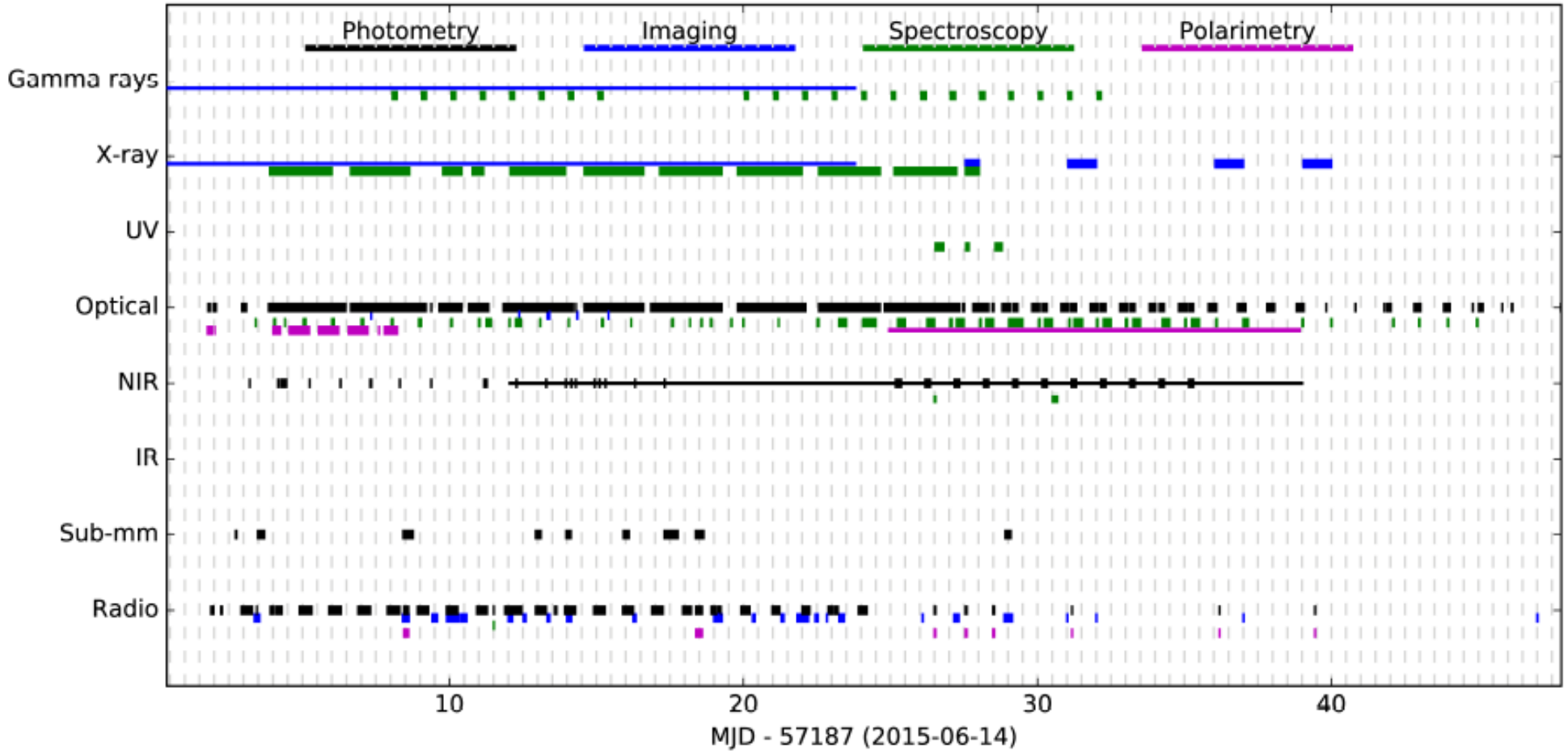
- Increasing interest to simultaneously observe the same target at different wavelengths. Example use cases:
  - X-ray binary ToOs
  - Gaia transients
  - Optical & radio transients
  - TDEs, GRBs
  - GW & neutrino follow-up

- Some observatory numbers:
  - **NuSTAR**: 30% of the observations are coordinated with other observatories.
  - **XMM-Newton**: ~12% coordinated observations (NuSTAR, HST, Chandra, VLT, Swift).
  - ***INTEGRAL****: ~10%* of the observations are coordinated with other observatories.
  - ***Chandra*** *has expanded the time available via joint programs.*



Middelton et al. 2017

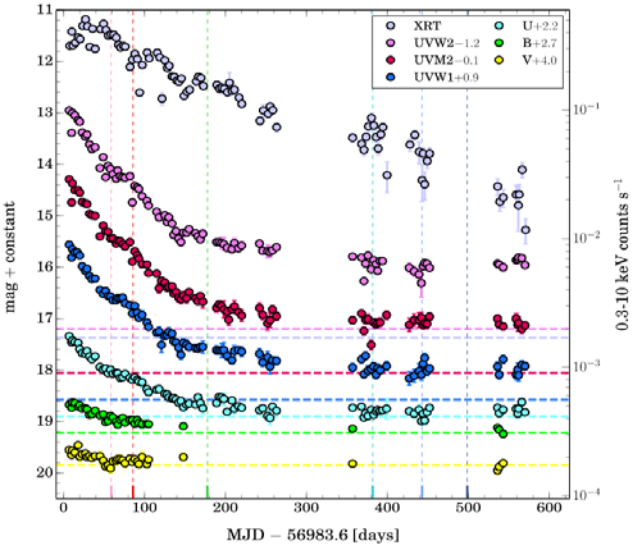
Multi-wavelength campaigns can be large and complex



Real Multi-wavelength campaign during the 2015 outburst of V404 Cygni (Credit: Tom Marsh)

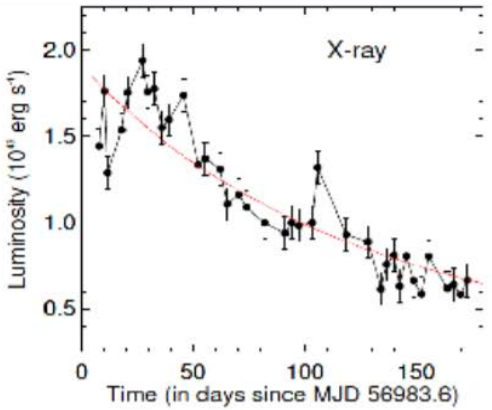
ASASSN 14li – TIDAL DISRUPTION EVENT

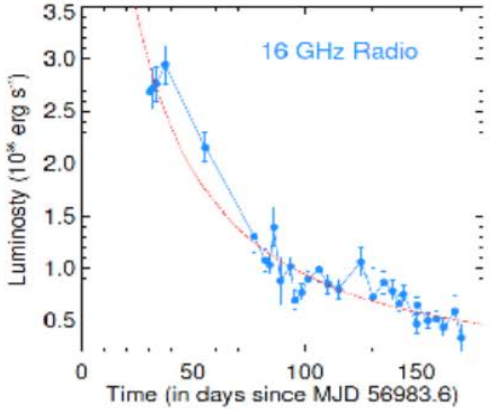
ASAS-SN wide field transient detector

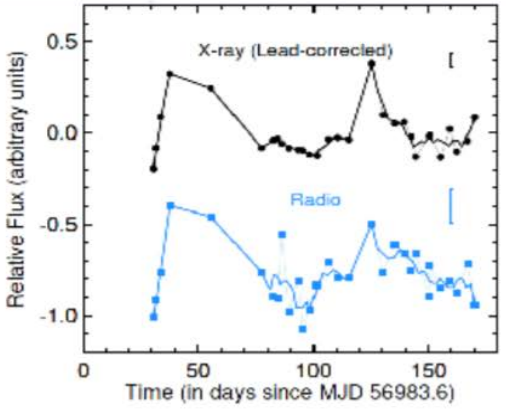


Brown et al. 2017

Discovered in Nov. 2014, ASASSN-14li, an optical transient in a galaxy at z=0.02 believed to be due to the disruption of a star by a supermassive black hole







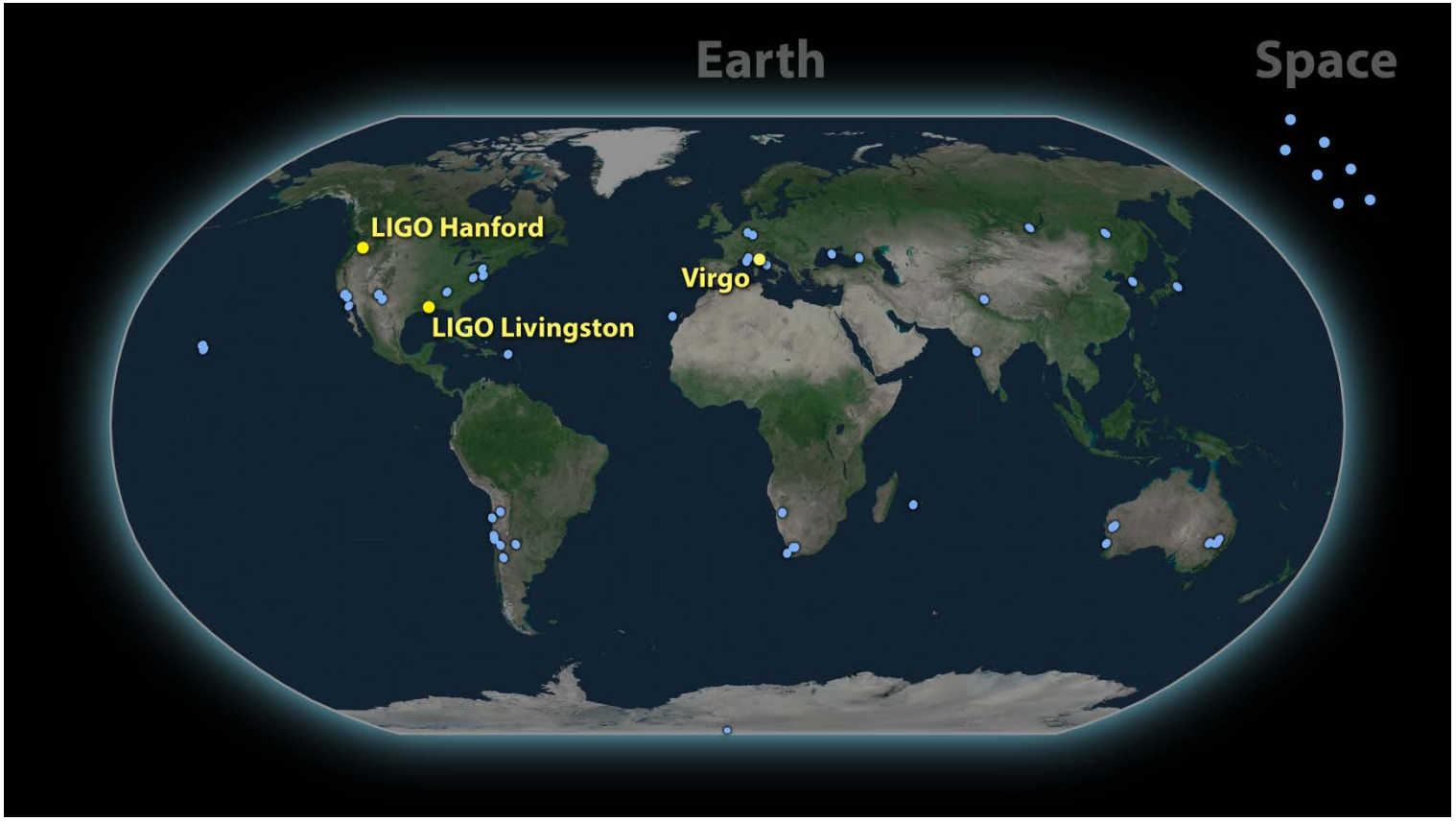
Pasham & van Velzen al. 2017

Rapid follow-ups by Swift, XMM, AMI, WSRT show 15 day lag between radio and X-ray indicating disk-jet coupling not seen previously in a Tidal Disruption Event

If it is not enough…

GW170817: A Global Astronomy Event (LIGO&VIRGO press release)

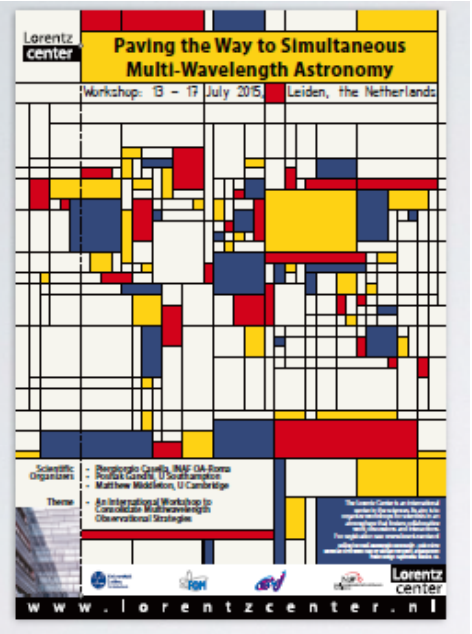
- **First detection of a GW produced by colliding neutron stars**
- **~70 ground- and space-based observatories**
- **Quick reaction time**



“This detection opens the window of a long-awaited ‘multi-messenger’ astronomy”
Dr. David H. Reitze

Need For Improved Methods

- Recent workshops have discussed this issue:
  - **Paving the Way to Simultaneous Multi-Wavelength Astronomy (Leiden: July 13, 2017)**
    - White paper: (arXiv/1709.03520v3)
  - **Astrophysics Mission Synergy Workshop (Caltech: March 31, 2017)**
    - What coordinated observing could reveal
    - Issues faced in coordinated observing
    - Issues specific to coordinated simultaneous observing
    - Increasing demand for rapid follow-up & coordination



- •What needs to be done
  - •Identify areas to improve coordination/communication (**keeping track what is going on**)
  - •Collaborative tools to share information efficiently (No more endless email discussions, please ;-))
  - •Standardised, **automatically retrievable information from available facilities**

The information is out there

All information needed to plan an observation (via AO or ToO) is currently in facilities own web pages.

Target Visibility Constraints

Observations info

BUT

Instrument characteristics

Short-term schedule

Long-term schedule

This information is usually shown in a web page statically and is only accessible trough forms that have to be manually filled in.

All information about Target Visibility Checks is there...

Object Visibility – STARALT

Staralt is a program that shows the observability of objects in various ways: either you can plot altitude against time for a particular night (**Staralt**), or plot the path of your objects across the sky for a particular night (**Startrack**), or plot how altitude changes over a year (**Starobs**), or get a table with the best observing date for each object (**Starmult**). For further information, click on the "help" button at the bottom of the page.

Mode	Staralt ▼
Night	12 ▼ October ▼ 2017 ▼ or date when the local night starts. *Staralt, Startrack only.*
Observatory	La Silla Observatory (Chile) ▼ Select one above or specify your own site with this format: `Longitude(°East) Latitude(°) Altitude(metres) UTC offset(hours)` Ex.: `289.2767 -30.2283 2725 -4`

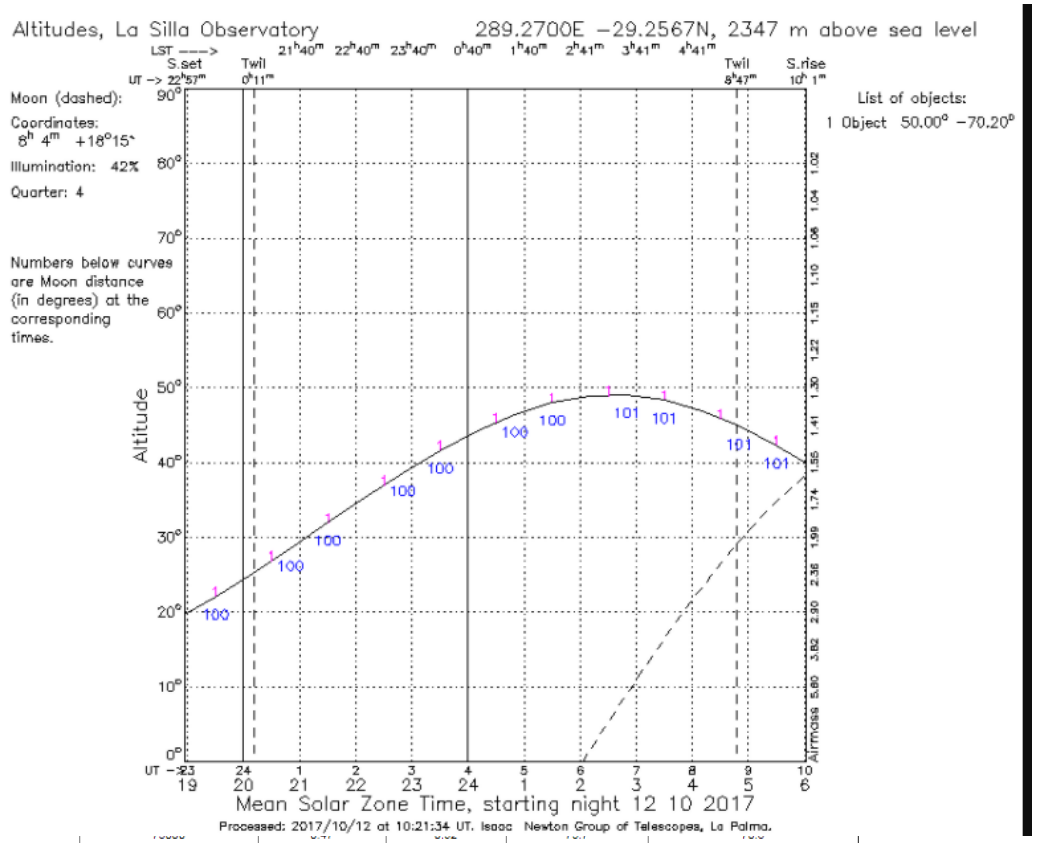
Coordinates	Formats can be any of these:
	`name hh mm ss ±dd mm ss`
	`name hh:mm:ss ±dd:mm:ss`
	`name ddd.ddd dd.ddd`
	`name` must be a single word with no dots, avoid using single numbers. Every entry must be in the same format, do not use different formats with different entries. We recommmend a maximum of 100 targets per submission.
	`50.0 -70.2`

TY CHECKER

TS RETURNED BELOW.

omy

Go!




```
    RA & dec:   5 23 34.5, -69 45 22, epoch 2000.0
Site long&lat:  +4 41 36.8 (h.m.s) West, -24 37 30 North

Shown: local eve. date, moon phase, hr ang and sec.z at
(2) natural center of night, and (3) morning twilight; t
nighttime hours during which object is at sec.z less tha
Night (and twilight) is defined by sun altitude < -18.0

 Date (eve) moon      eve            cent           morn
                    HA  sec.z      HA  sec.z      HA  se
2017 Nov 3    F   -6 52   3.1    -2 45   1.6    +1 21
2017 Nov 17   N   -5 44   2.4    -1 49   1.5    +2 07
```

Rev.	Vis. Start (yyyy-mm-dd hh:mm)	Vis. Window Duration (s)	Vis. (yyyy-mm-				
3397	2018-06-28 02:58	27036	2018-06-28 10:29				
3398	2018-06-29 12:49	78126	2018-06-30 10:31				
3399	2018-07-01 12:42	78063	2018-07-02 10:23				
3400	2018-07-03 12:35	77939	2018-07-04 10:14				
3401	2018-07-05 12:29	77804	2018-07-06 10:06	75000	0.47	0.92	77.3	69.5
3402	2018-07-07 12:22	77715	2018-07-08 09:58	75000	0.47	0.92	78.8	68.5
3403	2018-07-09 12:15	78302	2018-07-10 10:00	75000	0.47	0.93	80.4	67.4
3404	2018-07-11 12:07	78348	2018-07-12 09:53	75000	0.47	0.93	82.0	66.3

SkyCalc provided by courtesy of John Thorstensen, Dartmouth College. John.Thorstensen@dartmouth.edu

And information about scheduled observation...

ALMA

Atacama Large Millimeter/submillimeter Array
In search of our Cosmic Origins

About | Science | Proposing | Observing | Data | Processing | Tools | Documentation | Help

Search Site

Log in

ALMA Status Page

Weather Conditions at AOS

Current Date	Current Time	Location	Humidity	Temperature	Dewpoint	Wind Direction	Wind Speed	Pressure
2017/10/12	11:08:37 UTC	Central Weather Station	23.60 %	-4.83 ° C	-22.52 ° C	307.00 °	5.10 m/s	553.78 hPA

More...

Recent observations (QA0 Pass)

Project	Source	PI
Magnetic field structure in the bipolar outflow driven by Orion Source I		
2017.1.00497.S	Orion_Source_I	Hirota, Tomoya
ALCHEMI: the ALMA Comprehensive High-resolution Extragalactic Molecular Inventory		
2017.1.00161.L	ngc253	Martin, Sergio
100,000 Molecular Clouds Across the Main Sequence: GMCs as the Drivers of Galaxy Evolution		
2017.1.00886.L	NGC7496	Schinnerer, Eva

Public observations

Project	Source	PI
Protolunar disks around directly imaged young exoplanets		
2015.1.01210.S	PZ_tel	Perez, Sebastian
From Dark to Light: Star Clusters in Formation		
2015.1.01308.S	Serpens_Main_and_Serpens_South	Mundy, Lee
Polarimetric Observation of Centaurus A: Poloidally-dominated Magnetic Field vs. Toroidally-dominated Magnetic Field in the Innermost Jet		

Comments

Chandra

Chandra X-ray Center — New Search

Search Results

Search Results | Retrieval List | Help

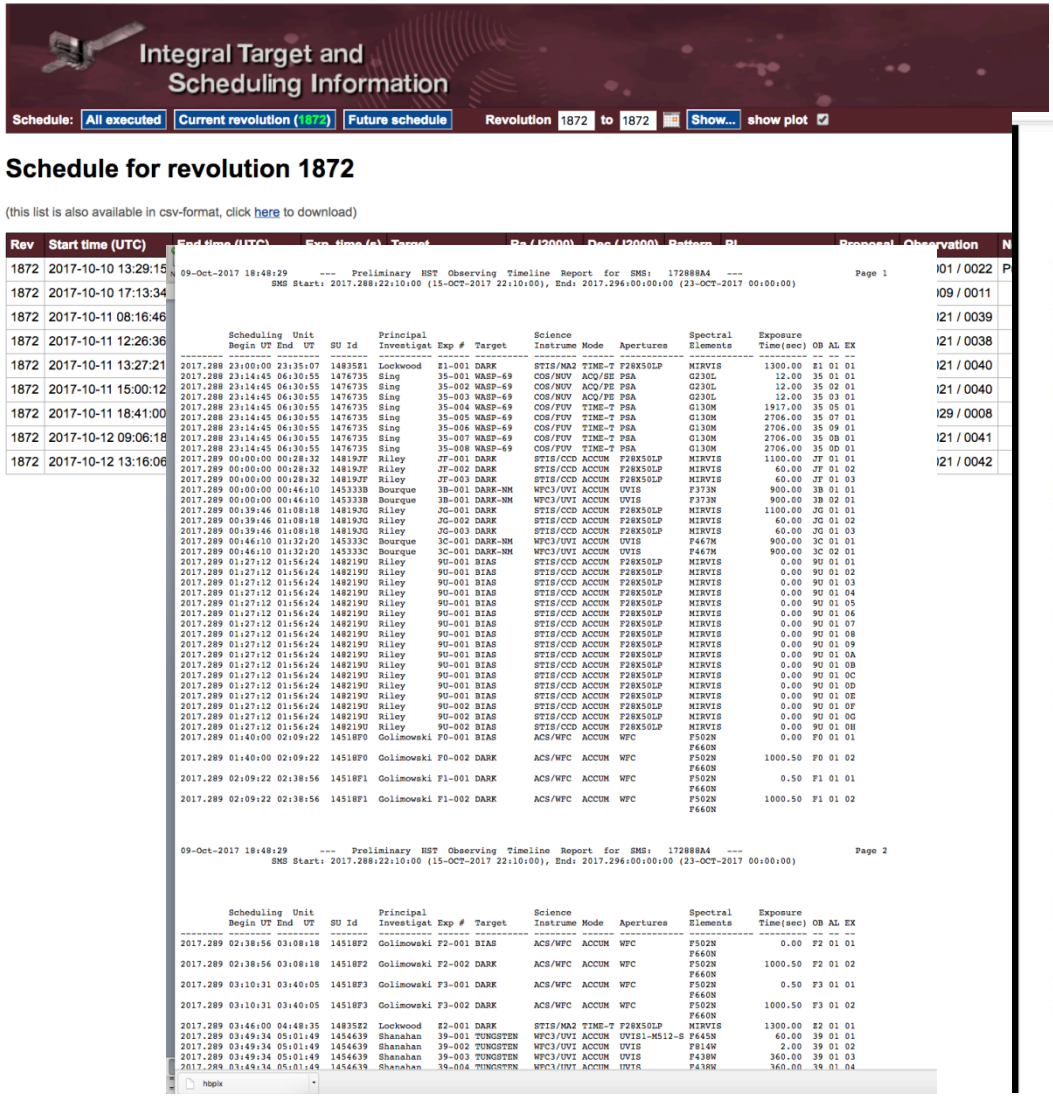
Chandra Data Archive

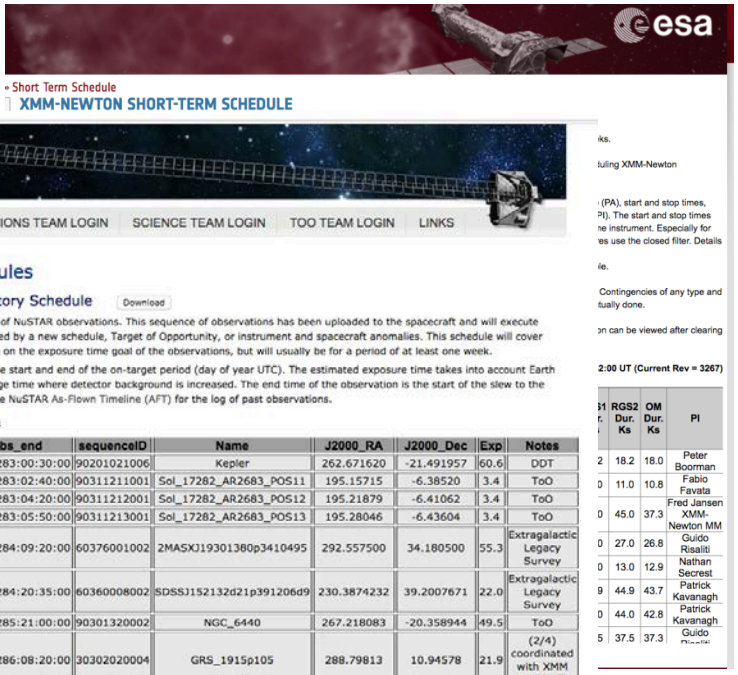
View Observation Information | Add Products to Retrieval List | Primary package | Secondary package | Custom selection

Select all | Unselect all

Select	Row	Seq Num	Obs ID	Instrument	Grating	Appr Exp	Exposure	Target Name	PI Name	RA	Dec	Status	Data Mode	Exp Mode	Avg Cnt Rate	Evt Cnt	Start Date	Public Release Date	Proposal	Type	Obs Cycle	Prop Cycle	Science Category	Joint	Grid Nar
☐	1	703152	17566	HRC-S	LETG	35.0	34.8	ASASSN-14li	Miller	12 48 15.20	+17 46 26.20	archived			61.23	2130972	2014-12-08 23:20:28	2014-12-10 06:43:58	15708488	DDT	15	15	ACTIVE GALAXIES AND QUASARS	None	
☐	2	703152	17567	HRC-S	LETG	45.0	44.46	ASASSN-14li	Miller	12 48 15.20	+17 46 26.20	archived			68.49	3044836	2014-12-11 08:45:20	2014-12-12 05:20:16	15708488	DDT	15	15	ACTIVE GALAXIES AND QUASARS	None	
☐	3	703277	18345	ACIS-S	NONE	25.0	23.84	ASASSN-14li	Maksym	12 48 15.20	+17 46 26.50	archived	VFAINT	TE	1.37	32575	2016-01-28 14:39:01	2017-01-29 08:31:06	17700613	GO	17	17	ACTIVE GALAXIES AND QUASARS	XMM+NRAO	
☐	4	703278	18346	ACIS-S	NONE	60.0	58.47	ASASSN-14li	Maksym	12 48 15.20	+17 46 26.50	archived	VFAINT	TE	2.15	125536	2016-08-03 13:07:31	2017-08-04 12:41:18	17700613	GO	17	17	ACTIVE GALAXIES AND QUASARS	XMM+NRAO	
☐	5	703279	18347	ACIS-S	NONE	15.0	14.67	ASASSN-14li	Maksym	12 48 15.20	+17 46 26.50	observed	VFAINT	TE	2.08	30482	2017-08-03 18:31:04	2018-08-06 16:01:08	17700613	GO	18	17	ACTIVE GALAXIES AND QUASARS	XMM+NRAO	
☐	6	703279	20127	ACIS-S	NONE	25.0	25.9	ASASSN-14li	Maksym	12 48 15.20	+17 46 26.50	observed	VFAINT	TE	2.09	54034	2017-08-04 08:21:10	2018-08-06 16:01:08	17700613	GO	18	17	ACTIVE GALAXIES AND QUASARS	XMM+NRAO	
☐	7	703279	20128	ACIS-S	NONE	40.0	39.01	ASASSN-14li	Maksym	12 48 15.20	+17 46 26.50	observed	VFAINT	TE	2.10	81754	2017-08-05 14:16:16	2018-08-06 16:01:08	17700613	GO	18	17	ACTIVE GALAXIES AND QUASARS	XMM+NRAO	
Totals						0.00	0.00									0									

And information about planned observations





Observatory services: Standardisation

- Knowing that the information already exists in all facilities, the question is:

Why don't we standardise the information exchange to improve the efficiency to plan observations or coordinate observation campaigns?

MOVE FROM OBSERVATORY TOOLS TO OBSERVATORY SERVICES

Identify which observatory tools could be easily transform in services (if they are not already a service)

Target visibility checks
Scheduled and planned observation logs

- Standardise the input parameters
- Standardise the output information and format

Virtual Observatory protocols

ObsTap as existing standard

… Core components of the Observation data model that are necessary to perform data discovery when querying data centres for astronomical observations of interest …

Extend this standard to be used for visibility check and scheduled observation info

obs_id	unitless	String	Observation ID	OBS_ID
obs_publisher_did	unitless	String	Dataset identifier given by the publisher	?
access_url	unitless	String	URL used to access (download) dataset	TBD
access_format	unitless	String	File content format (see in App. **Error! Reference source not found.**)	NULL
access_estsize	kbyte	integer	Estimated size of dataset in kilo bytes	NULL
target_name	unitless	String	Astronomical object observed, if any	"Target" ?
s_ra	deg	double	Central right ascension, ICRS	RA
s_dec	deg	double	Central declination, ICRS	DEC
s_fov	deg	double	Diameter (bounds) of the covered region	Fixed value for each XMM-Newton Instrument
s_region	unitless	String	Sky region covered by the data product (expressed in ICRS frame)	TBD, not easy for RGS

International Virtual Observatory Alliance

Observation Data Model Core Components and its Implementation in the Table Access Protocol

The XMM-Newton & Integral: Visibility Check Use Case

XMM-Newton

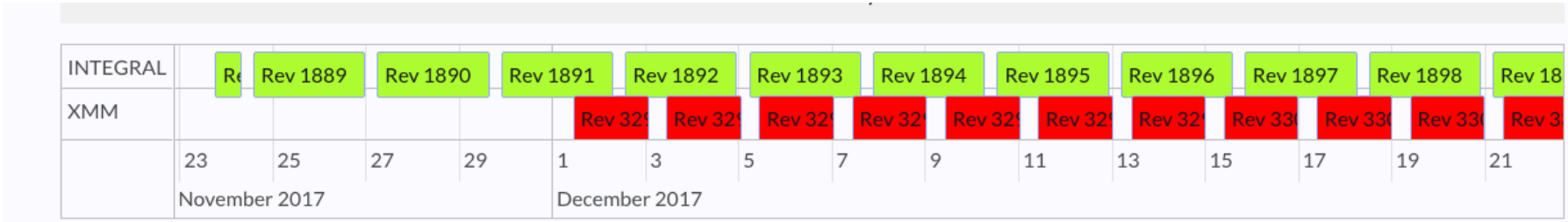
http://xmm.esac.esa.int/XMMVisCheck?
startDate=11-10-2017&
minduration=12.000&
coordinates=equatorial&
ra=192.063458&
dec=17.77394

INTEGRAL

http://integral.esac.esa.int//IntegralVisCheck?
startDate=11-10-2017&
minduration=12.000&
coordinates=equatorial&
ra=192.063458&
dec=17.77394

xmm.esac.esa.int/XMMVisCheck?ra=321&dec=34&minDuration=5000&startdate=20-Dec-2017&enddate=20-Dec-2018&coordinates=equatorial


```
[{"SolarA":"89.3","Rev":"3293","VisStar":"2017-12-01 10:19","AstroA":"241.2","VisEnd":"2017-12-03 01:12","StarPh":"0.12","Round":"130000","VisDur":"139962","EndPh":"0.93"},
{"SolarA":"87.9","Rev":"3294","VisStar":"2017-12-03 10:11","AstroA":"239.7","VisEnd":"2017-12-05 00:54","StarPh":"0.12","Round":"130000","VisDur":"139376","EndPh":"0.93"},
{"SolarA":"86.5","Rev":"3295","VisStar":"2017-12-05 10:05","AstroA":"238.2","VisEnd":"2017-12-07 00:47","StarPh":"0.12","Round":"130000","VisDur":"139318","EndPh":"0.93"},
{"SolarA":"85.1","Rev":"3296","VisStar":"2017-12-07 09:59","AstroA":"236.8","VisEnd":"2017-12-09 00:39","StarPh":"0.12","Round":"130000","VisDur":"139189","EndPh":"0.93"},
{"SolarA":"83.7","Rev":"3297","VisStar":"2017-12-09 09:53","AstroA":"235.3","VisEnd":"2017-12-11 00:31","StarPh":"0.12","Round":"130000","VisDur":"139045","EndPh":"0.93"},
{"SolarA":"82.3","Rev":"3298","VisStar":"2017-12-11 09:46","AstroA":"233.8","VisEnd":"2017-12-13 00:12","StarPh":"0.12","Round":"130000","VisDur":"138334","EndPh":"0.92"},
{"SolarA":"80.9","Rev":"3299","VisStar":"2017-12-13 09:39","AstroA":"232.3","VisEnd":"2017-12-15 00:03","StarPh":"0.12","Round":"130000","VisDur":"138278","EndPh":"0.92"},
{"SolarA":"79.5","Rev":"3300","VisStar":"2017-12-15 09:31","AstroA":"230.7","VisEnd":"2017-12-16 23:55","StarPh":"0.12","Round":"130000","VisDur":"138259","EndPh":"0.92"},
{"SolarA":"78.1","Rev":"3301","VisStar":"2017-12-17 09:23","AstroA":"229.2","VisEnd":"2017-12-18 23:47","StarPh":"0.12","Round":"130000","VisDur":"138228","EndPh":"0.92"},
{"SolarA":"76.7","Rev":"3302","VisStar":"2017-12-19 09:17","AstroA":"227.7","VisEnd":"2017-12-20 23:29","StarPh":"0.12","Round":"130000","VisDur":"137542","EndPh":"0.92"},
{"SolarA":"75.4","Rev":"3303","VisStar":"2017-12-21 09:12","AstroA":"226.1","VisEnd":"2017-12-22 23:21","StarPh":"0.12","Round":"130000","VisDur":"137392","EndPh":"0.92"},
{"SolarA":"74.0","Rev":"3304","VisStar":"2017-12-23 09:06","AstroA":"224.5","VisEnd":"2017-12-24 23:03","StarPh":"0.12","Round":"130000","VisDur":"136627","EndPh":"0.92"},
{"SolarA":"72.7","Rev":"3305","VisStar":"2017-12-25 08:59","AstroA":"222.9","VisEnd":"2017-12-26 22:54","StarPh":"0.12","Round":"130000","VisDur":"136509","EndPh":"0.92"},
{"SolarA":"71.6","Rev":"3306","VisStar":"2017-12-27 08:52","AstroA":"222.3","VisEnd":"2017-12-28 01:42","StarPh":"0.12","Round":"60000","VisDur":"60634","EndPh":"0.48"}]
```

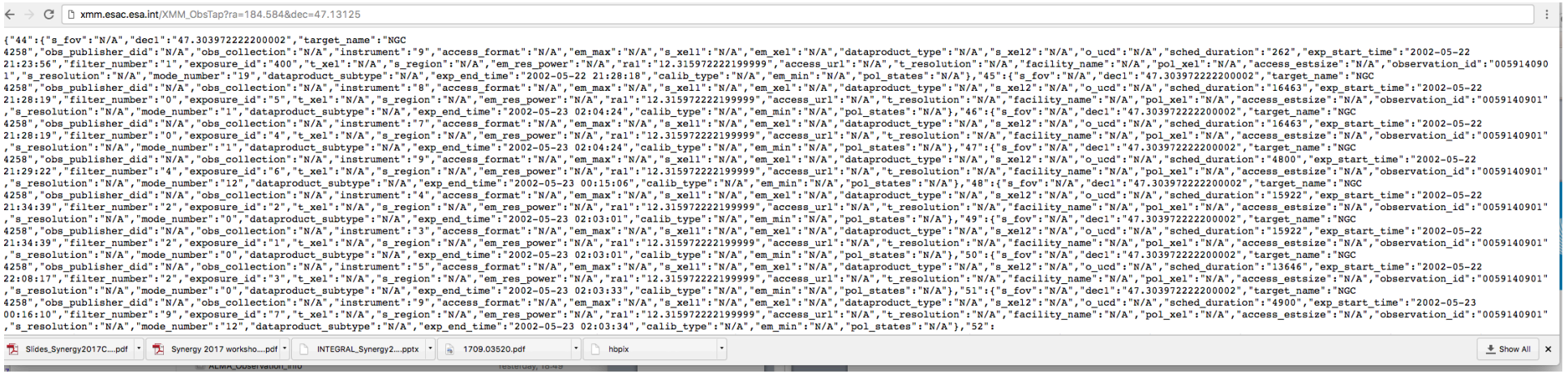
The XMM-Newton & Integral: Observation Info Use Case

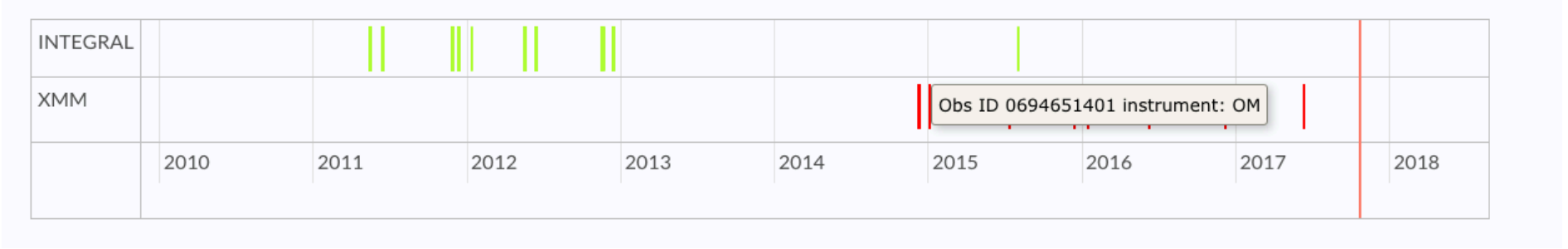
XMM-Newton

http://xmm.esac.esa.int/XMMVisCheck?
coordinates=equatorial&
ra=192.063458&
dec=17.77394

INTEGRAL

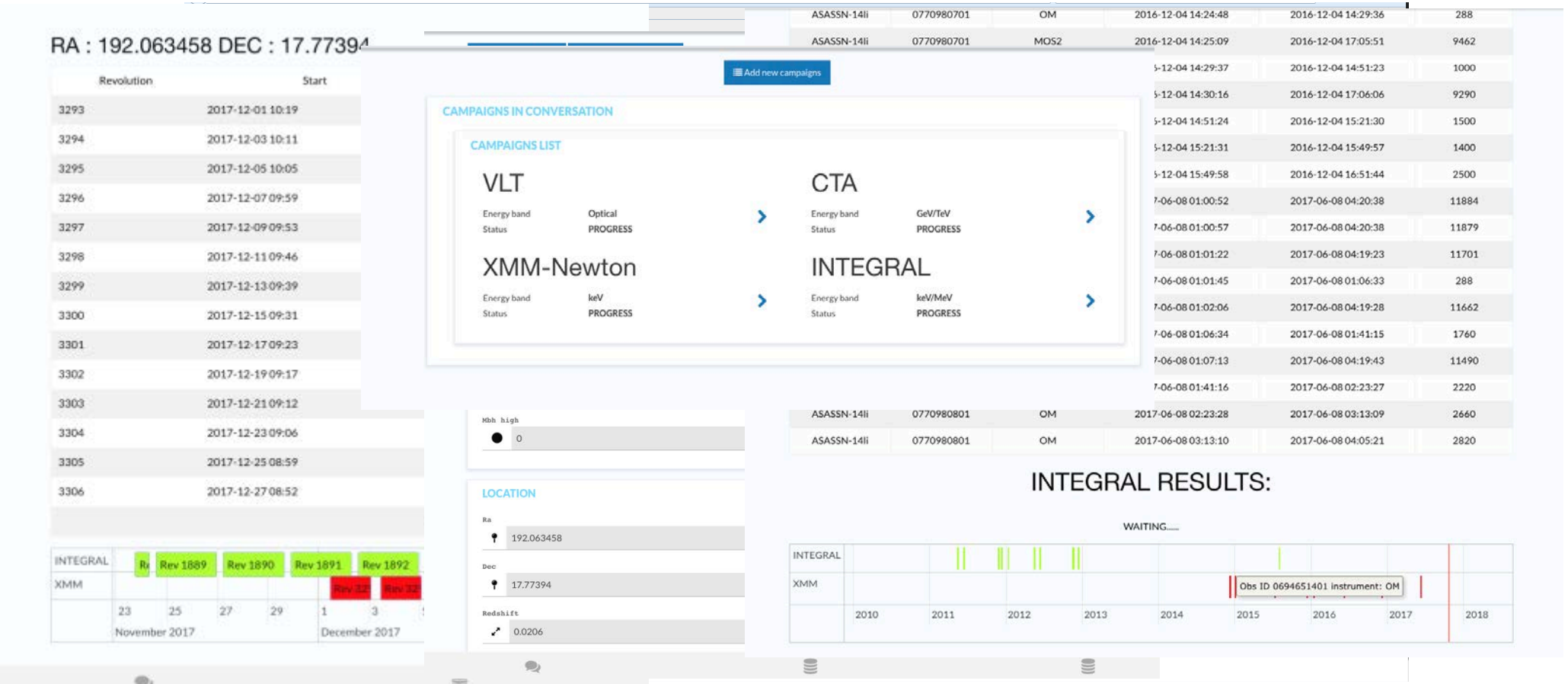
http://integral.esac.esa.int//IntegralVisCheck?
coordinates=equatorial&
ra=192.063458&
dec=17.77394





Scientific collaborative tool: SciApp

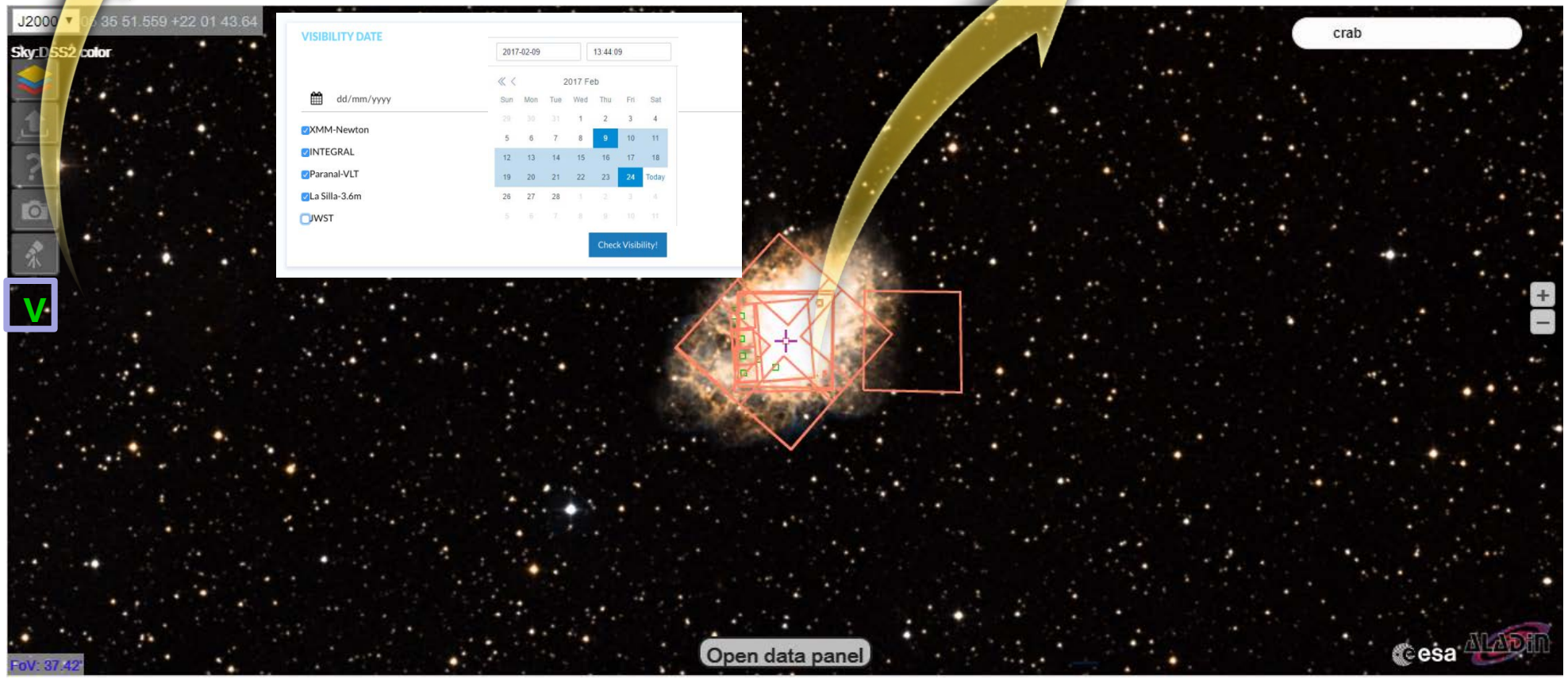
- **Web tool focused on the information sharing between scientist**
- **It is based on astronomical source conversations (candidate list DB)**
- **Interface with services provided by observing facilities**
- **Observation campaign functionality**



ESASky v3.0 New Time-Domain exploration

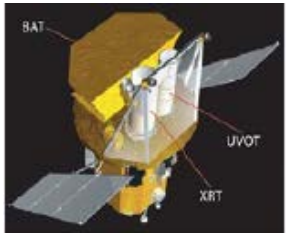
Constraint visibility checker option

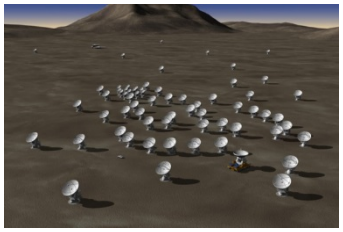
Footprints for scheduled observations



Bringing Facilities on-board



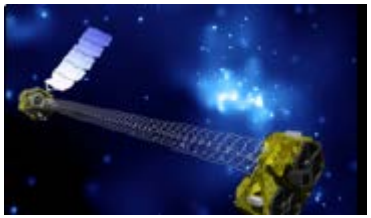





integral

ObsTAP Protocol for Visibility & Observation DISCOVERY SERVICES

xmm-newton




cta cherenkov telescope array

SKA SQUARE KILOMETRE ARRAY