Multi-mission Coordinations

An example Use Case for needing:

VO standards for Telescope Visibility and Observing Plans

INTEGRAL

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Jesus Salgado[1], Emilio Salazar[1],

Richard Saxton[1], Aitor Ibarra[1],

Peter Kretschmar[1], Matthias Ehle[1]

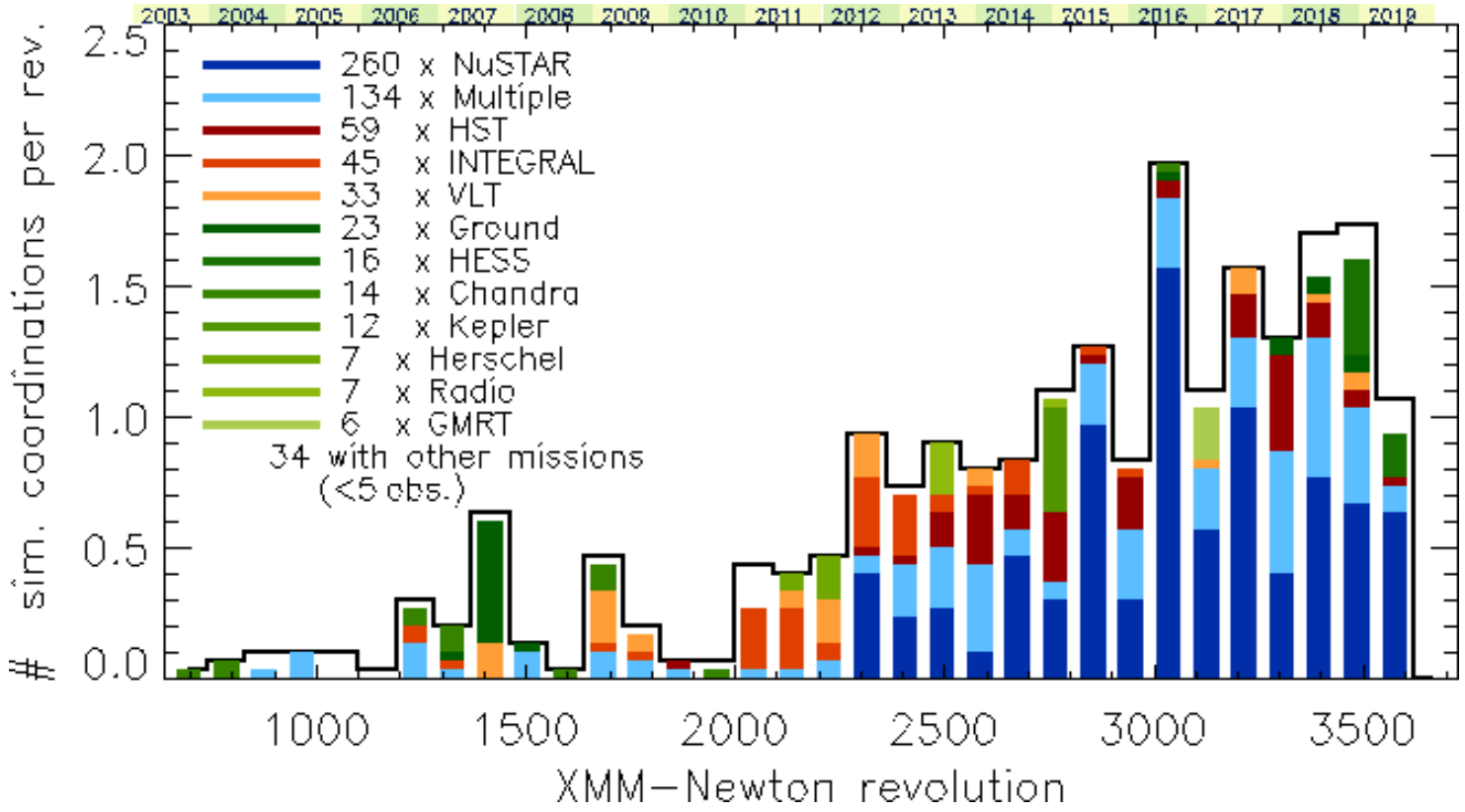
XMM-Newton

[1]European Space Astronomy Centre (ESAC), Villafranca del Castillo, Spain

[2]European Space TEchnology Center (ESTEC), Noordwijk, The Netherlands

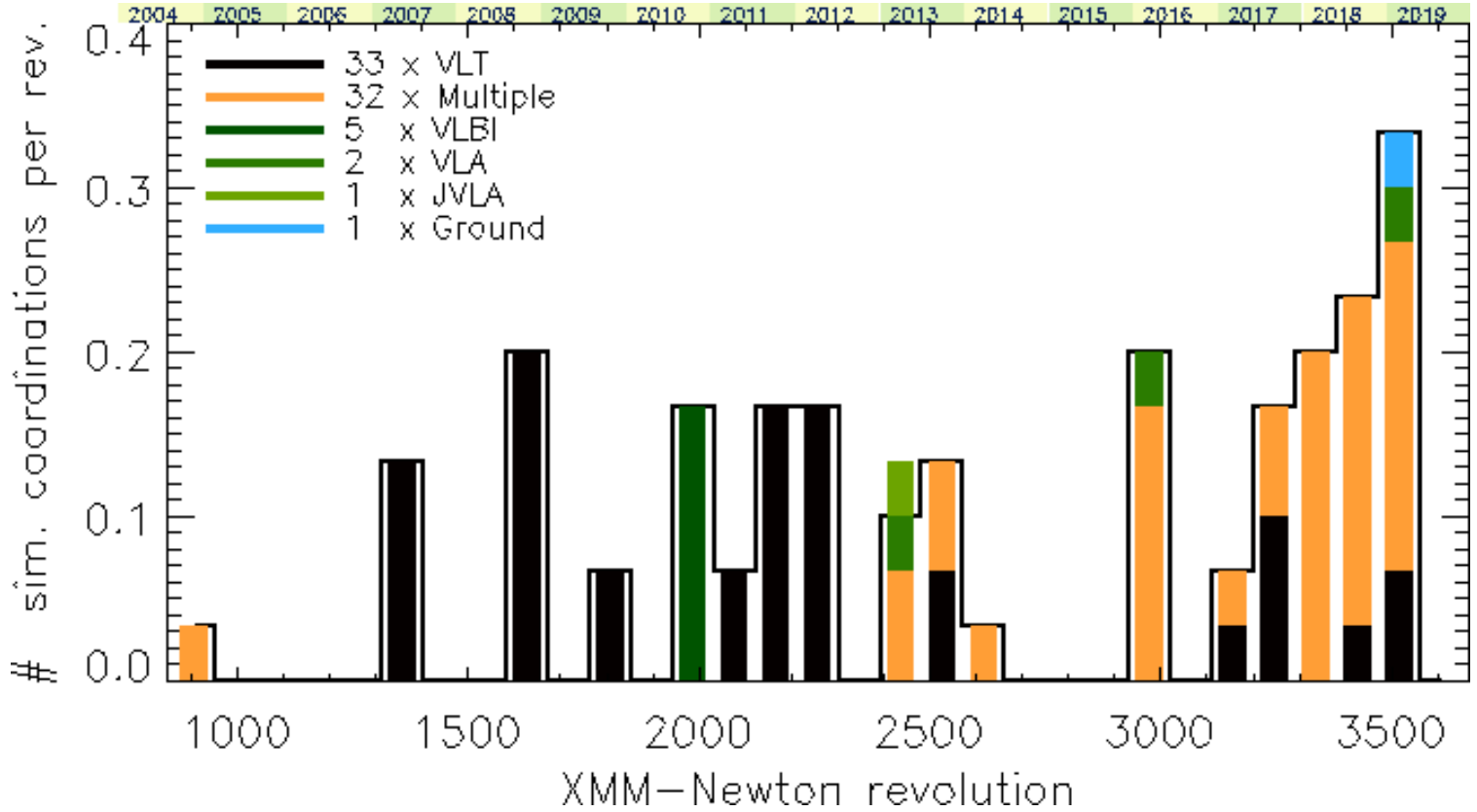
Demand for coordinated observations *increasing*

Evolution for XMM-Newton



Demand for coordinated observations ***increasing***

Evolution for XMM-Newton also with ESO facilities



Basic Elements for Coordination:

+ Common Visibility

+ Respecting time-constrained observations

Example: common XMM/NuSTAR Visibility/planning

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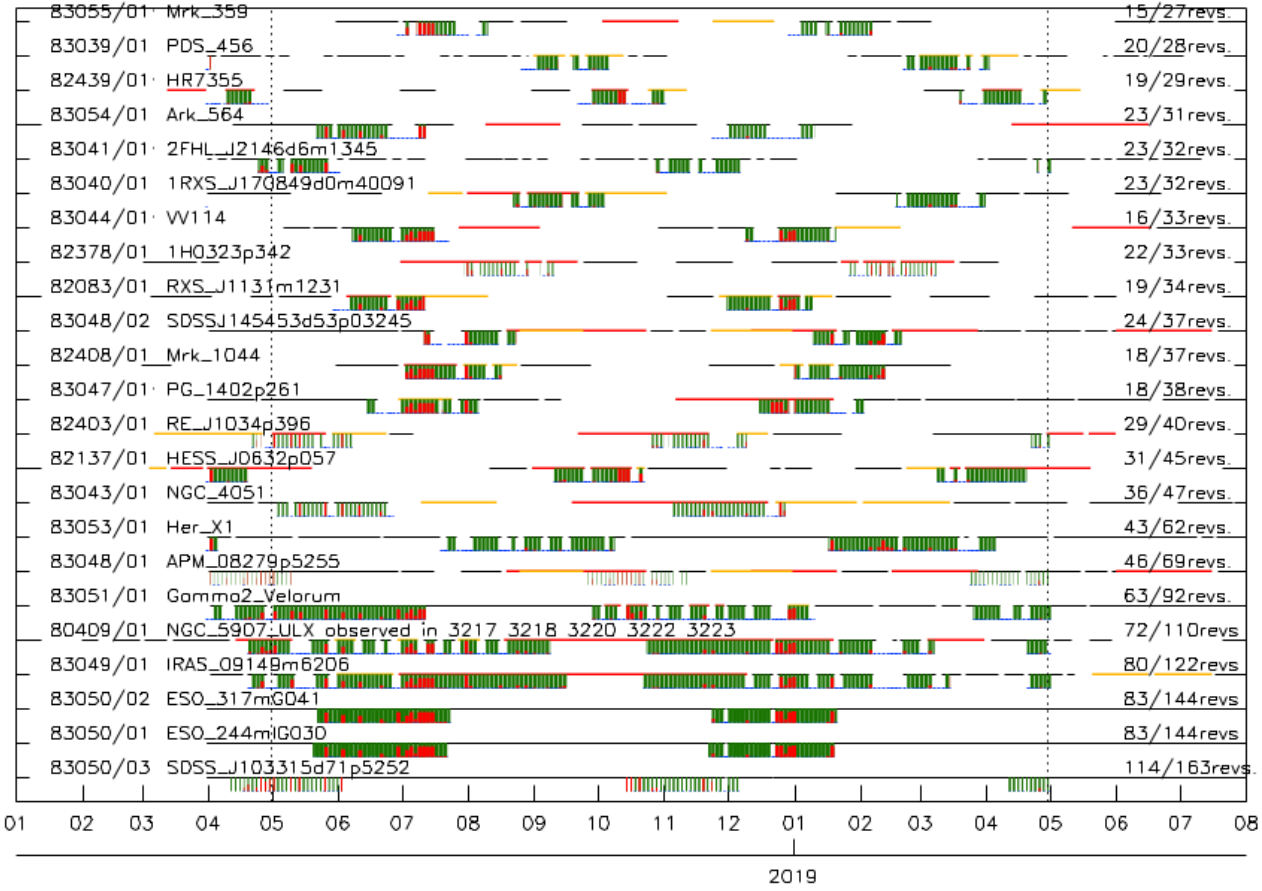


Information needed to plan an observation (AO or ToO) in Individual facilities web pages

Target Visibility Constraints

Instrument characteristics

BUT

Short-term schedule

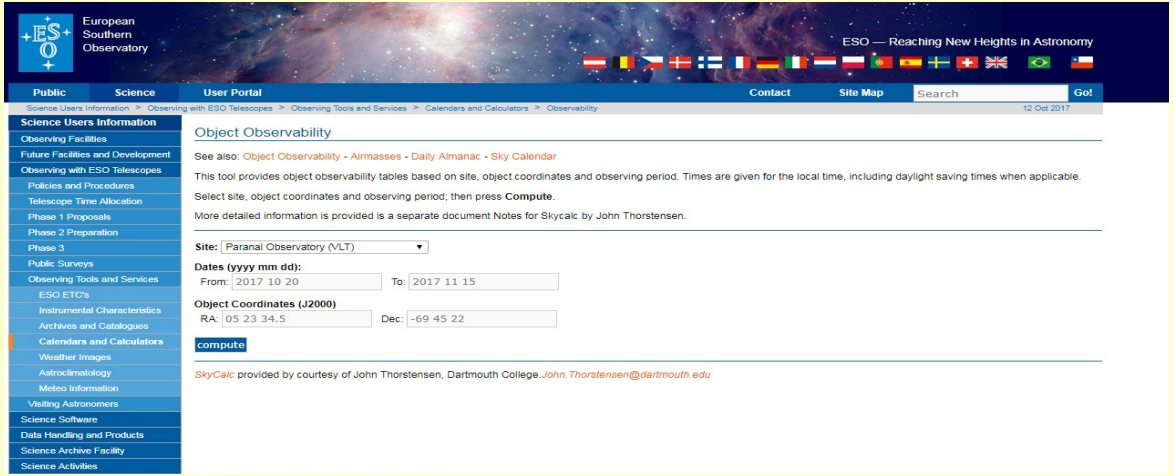
Observations info

Long-term schedule

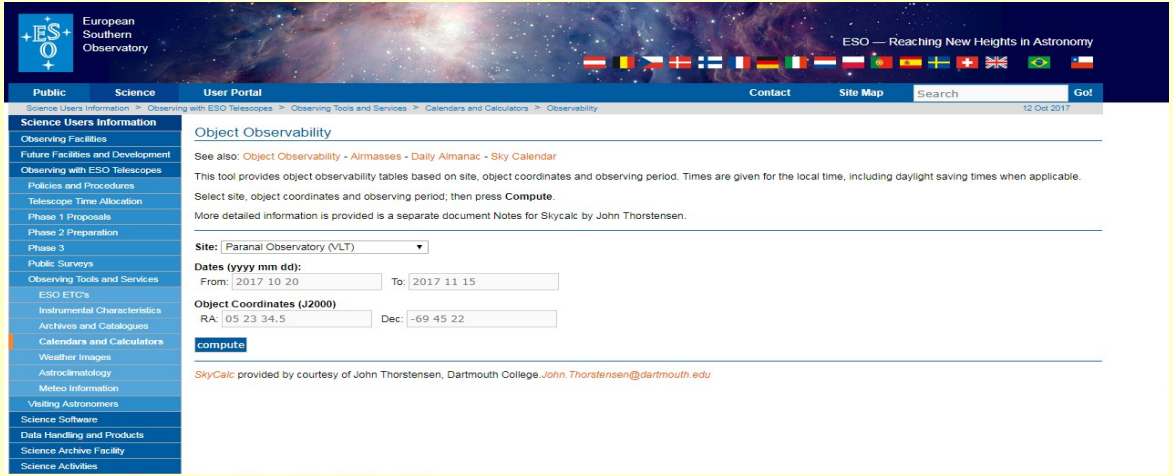
This information shown in a *static web page* and only accessible through forms that have to be filled in *manually*.

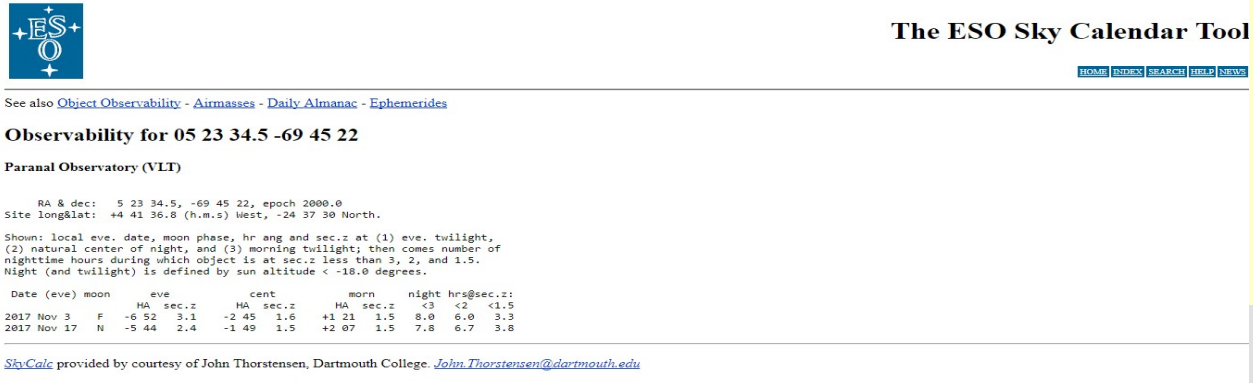
European Space Agency

Target Visibility



Target Visibility





The ESO Sky Calendar Tool

HOME INDEX SEARCH HELP NEWS

See also Object Observability - Airmasses - Daily Almanac - Ephemerides

Observability for 05 23 34.5 -69 45 22

Paranal Observatory (VLT)

```
     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 (1) eve. twilight,
(2) natural center of night, and (3) morning twilight; then comes number of
nighttime hours during which object is at sec.z less than 3, 2, and 1.5.
Night (and twilight) is defined by sun altitude < -18.0 degrees.

 Date (eve) moon      eve            cent           morn      night hrs@sec.z:
                   HA  sec.z      HA  sec.z      HA  sec.z    <3   <2   <1.5
2017 Nov 3    F   -6 52   3.1    -2 45   1.6    +1 21   1.5   8.0   6.0   3.3
2017 Nov 17   N   -5 44   2.4    -1 49   1.5    +2 07   1.5   7.8   6.7   3.8
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SkyCalc provided by courtesy of John Thorstensen, Dartmouth College. John.Thorstensen@dartmouth.edu

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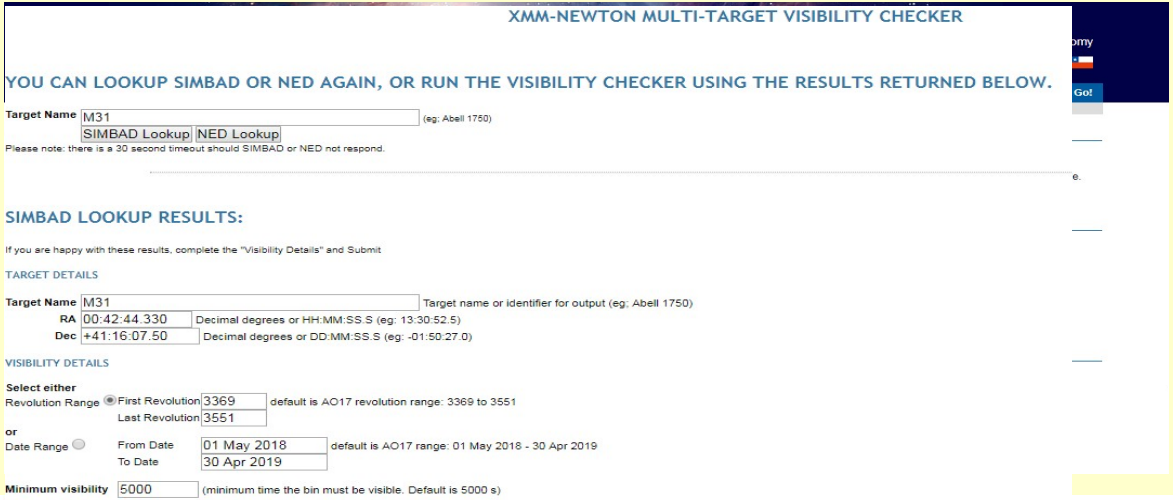


XMM-NEWTON MULTI-TARGET VISIBILITY CHECKER

YOU CAN LOOKUP SIMBAD OR NED AGAIN, OR RUN THE VISIBILITY CHECKER USING THE RESULTS RETURNED BELOW.

Target Name M31 (eg: Abell 1750)
SIMBAD Lookup NED Lookup
Please note: there is a 30 second timeout should SIMBAD or NED not respond.

SIMBAD LOOKUP RESULTS:

If you are happy with these results, complete the "Visibility Details" and Submit

TARGET DETAILS

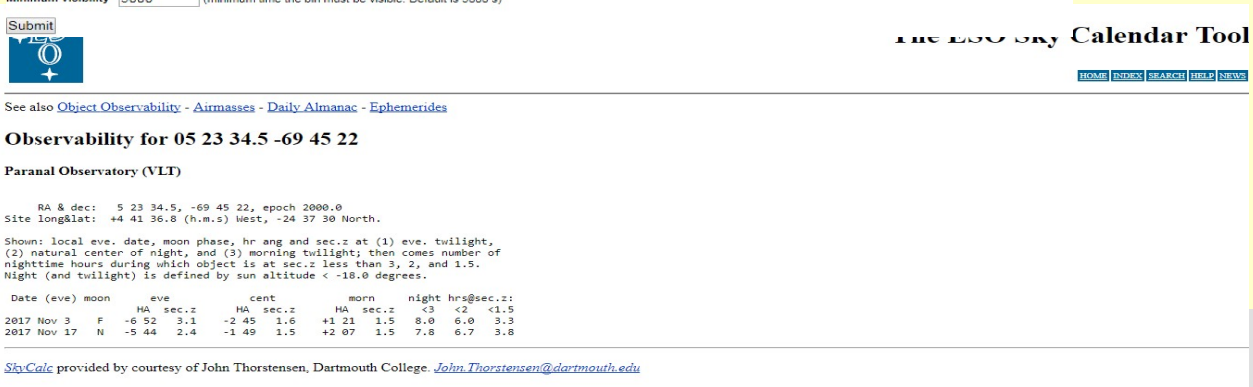
Target Name M31 Target name or identifier for output (eg: Abell 1750)
RA 00:42:44.330 Decimal degrees or HH:MM:SS.S (eg: 13:30:52.5)
Dec +41:16:07.50 Decimal degrees or DD:MM:SS.S (eg: -01:50:27.0)

VISIBILITY DETAILS

Select either
Revolution Range First Revolution 3369 default is AO17 revolution range: 3369 to 3551
Last Revolution 3551
or
Date Range From Date 01 May 2018 default is AO17 range: 01 May 2018 - 30 Apr 2019
To Date 30 Apr 2019

Minimum visibility 5000 (minimum time the bin must be visible. Default is 5000 s)

Submit



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Date (eve)	moon	eve		cent		morn		night hrs@sec.z:		
		HA	sec.z	HA	sec.z	HA	sec.z	<3	<2	<1.5
2017 Nov 3	F	-6 52	3.1	-2 45	1.6	+1 21	1.5	8.0	6.0	3.3
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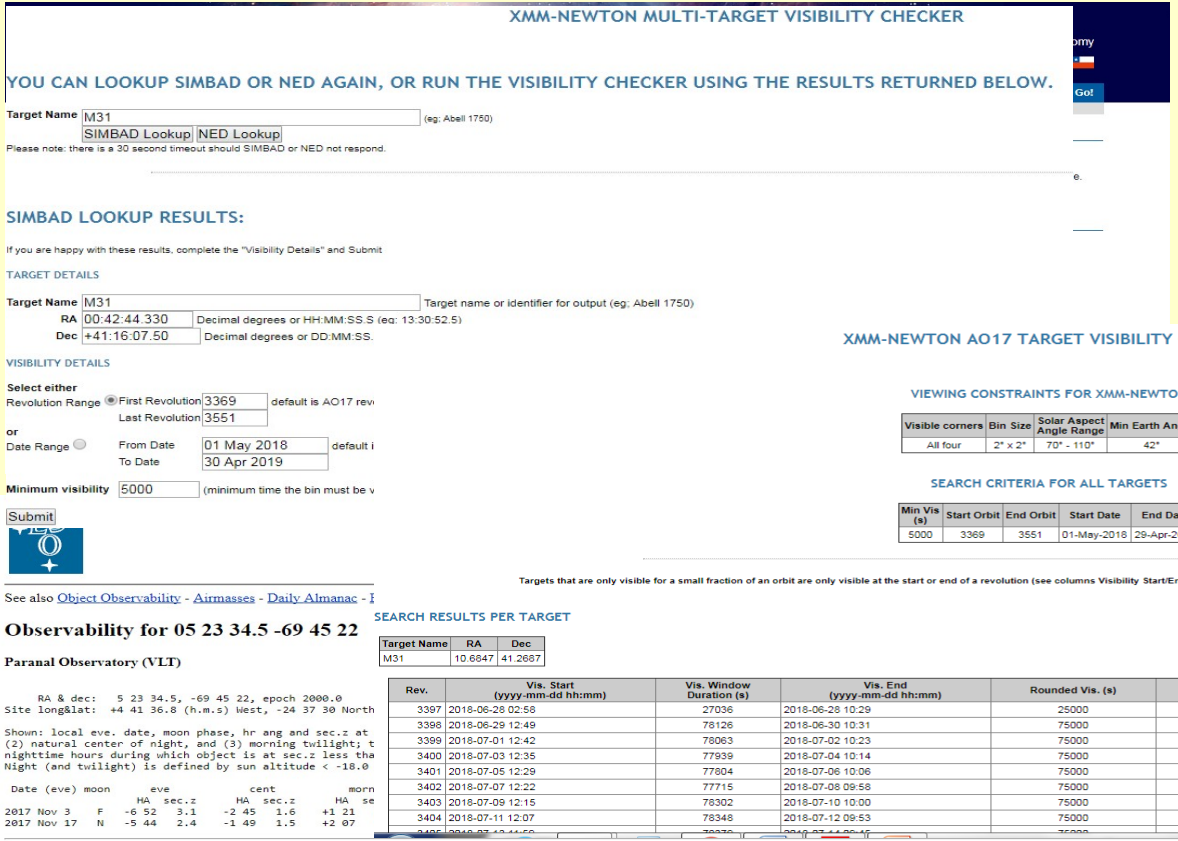

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VISIBILITY DETAILS

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Last Revolution 3551

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Date (eve)	moon	eve HA	eve sec.z	cent HA	cent sec.z	morn HA	morn se
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XMM-NEWTON AO17 TARGET VISIBILITY CHECKER

VIEWING CONSTRAINTS FOR XMM-NEWTON

Visible corners	Bin Size	Solar Aspect Angle Range	Min Earth Angle
All four	2° x 2°	70° - 110°	42°

SEARCH CRITERIA FOR ALL TARGETS

Min Vis (s)	Start Orbit	End Orbit	Start Date	End Date
5000	3369	3551	01-May-2018	29-Apr-2019

Targets that are only visible for a small fraction of an orbit are only visible at the start or end of a revolution (see columns Visibility Start/End Phase) and therefore have a higher likelihood for increased background radiation.

SEARCH RESULTS PER TARGET

Target Name	RA	Dec
M31	10.6847	41.2687

Rev.	Vis. Start (yyyy-mm-dd hh:mm)	Vis. Window Duration (s)	Vis. End (yyyy-mm-dd hh:mm)	Rounded Vis. (s)	Visibility Start Phase	Visibility End Phase	Solar Aspect Angle(°)	Mean Astronomical Position Angle(°)
3397	2018-06-28 02:58	27036	2018-06-28 10:29	25000	0.76	0.92	71.3	74.2
3398	2018-06-29 12:49	78126	2018-06-30 10:31	75000	0.47	0.92	72.6	72.8
3399	2018-07-01 12:42	78063	2018-07-02 10:23	75000	0.47	0.92	74.2	71.7
3400	2018-07-03 12:35	77939	2018-07-04 10:14	75000	0.47	0.92	75.7	70.6
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

Target Visibility

ISAAC NEWTON GROUP OF TELESCOPES

About ING ▼ Astronomy ▼ Developments ▼ Public Information ▼ Search:

Home > Astronomy > *Object Visibility*

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

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Go!

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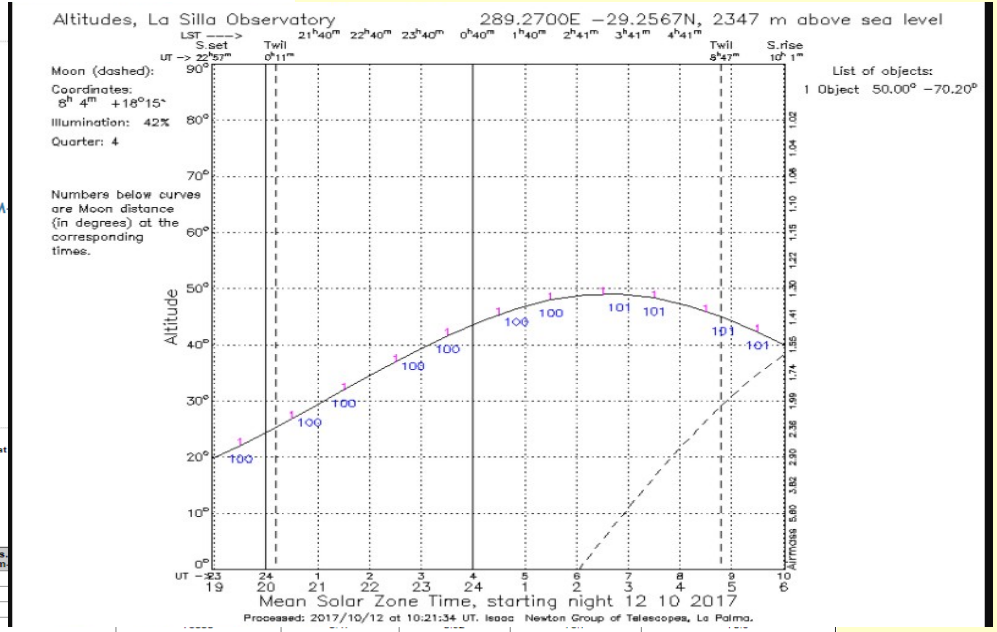


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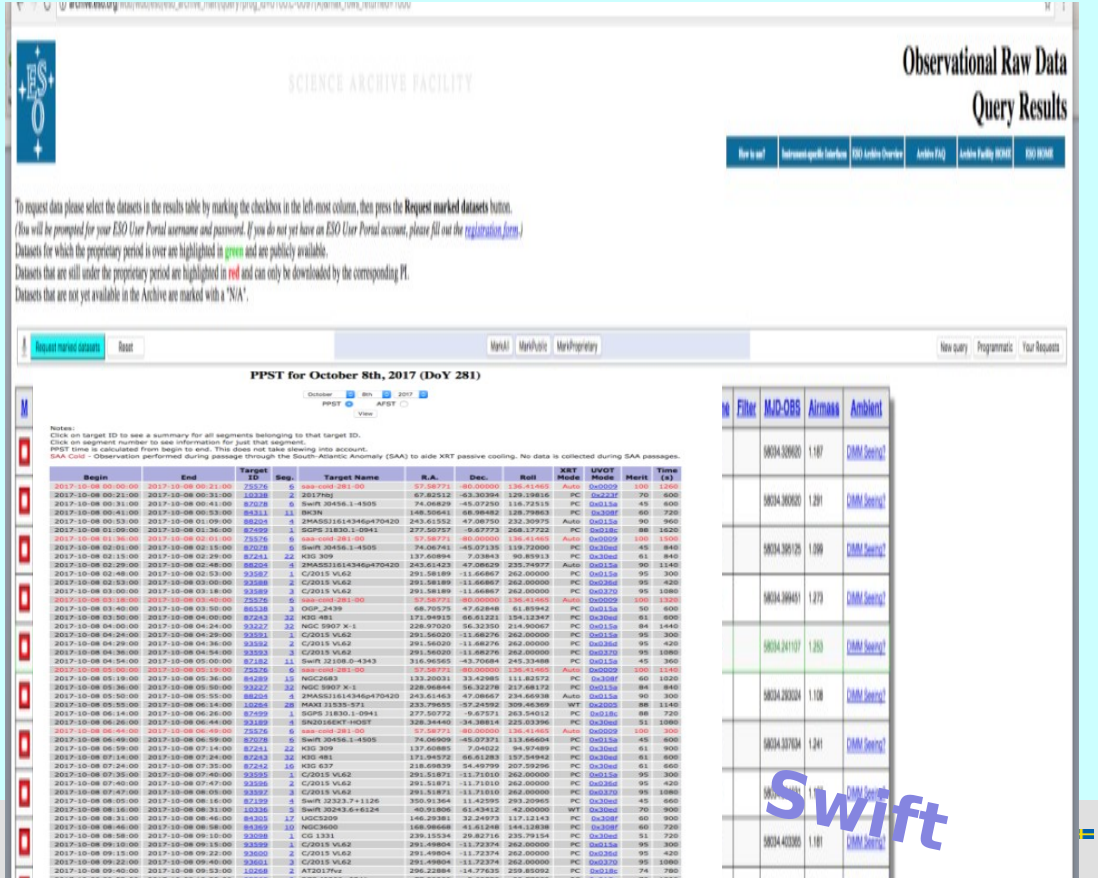
Observing Plans:



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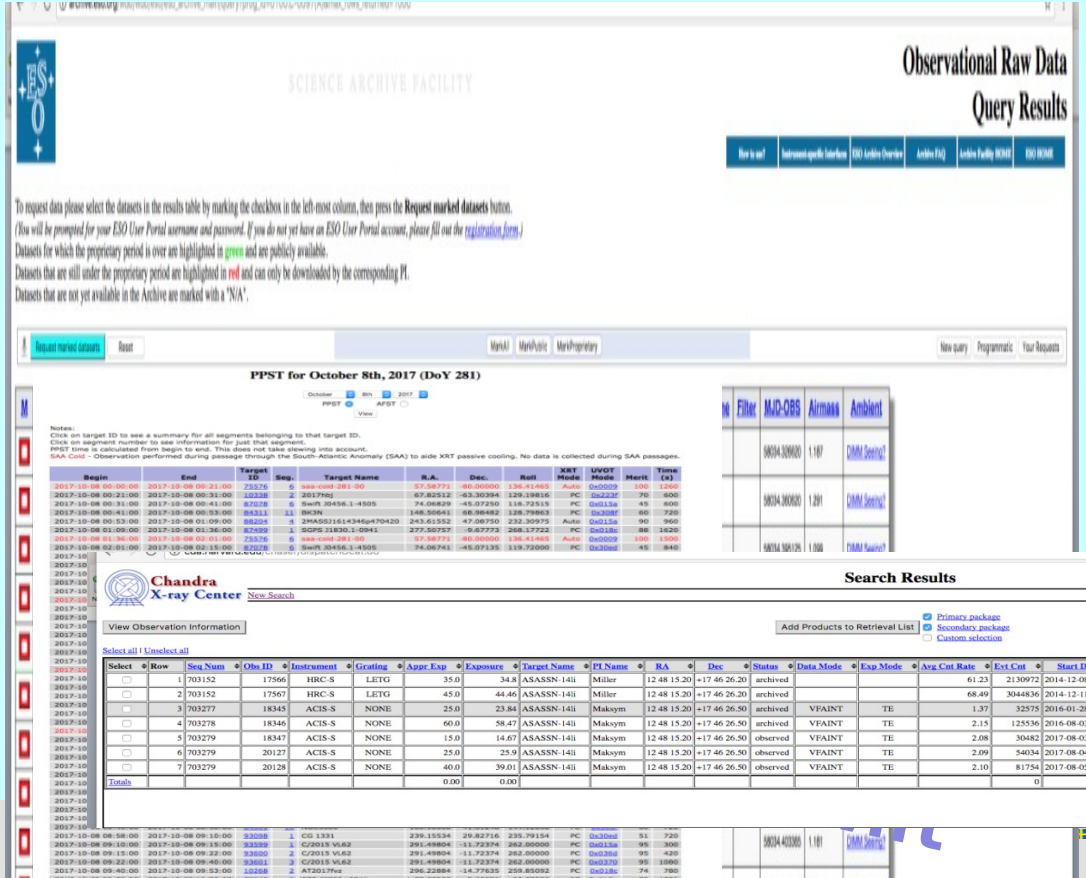

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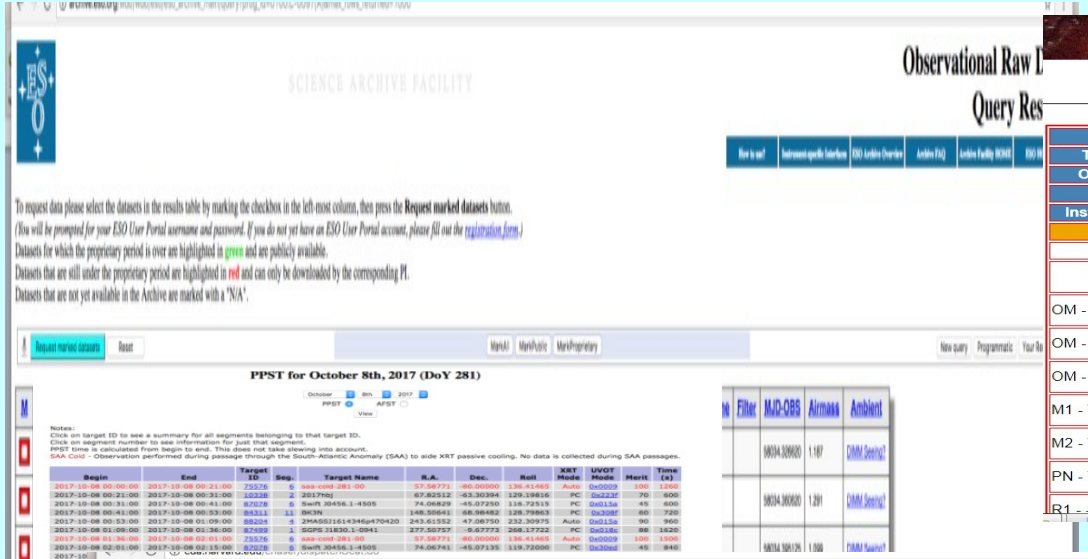
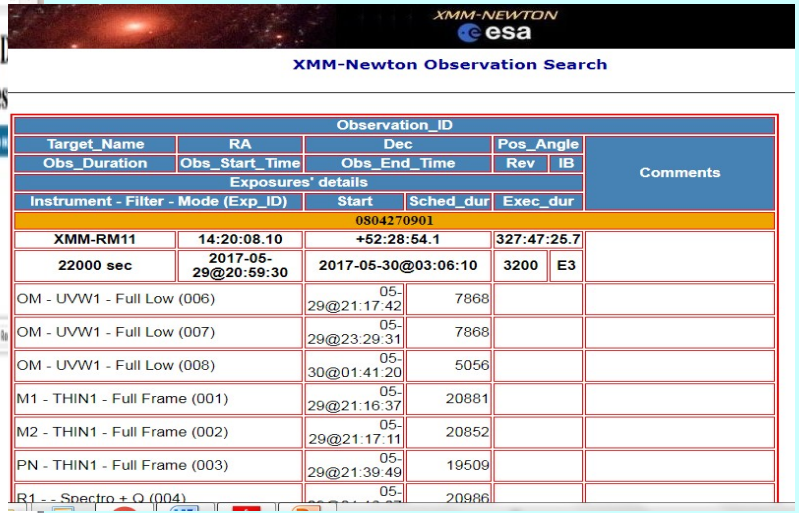
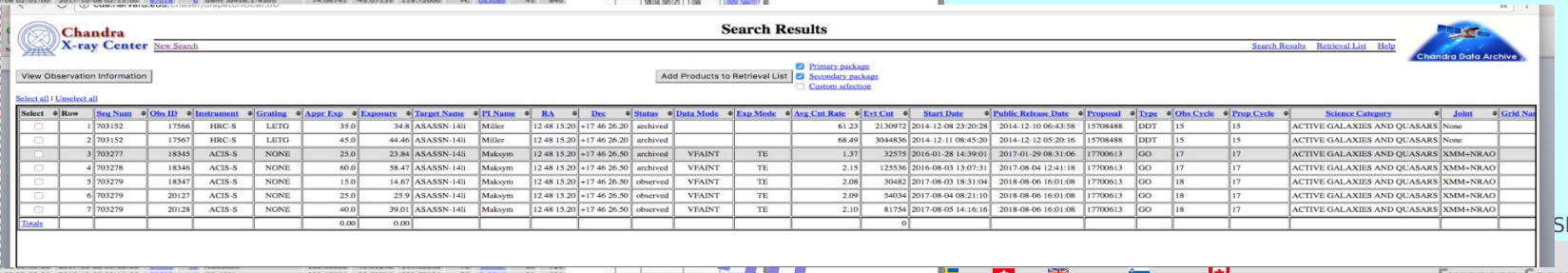


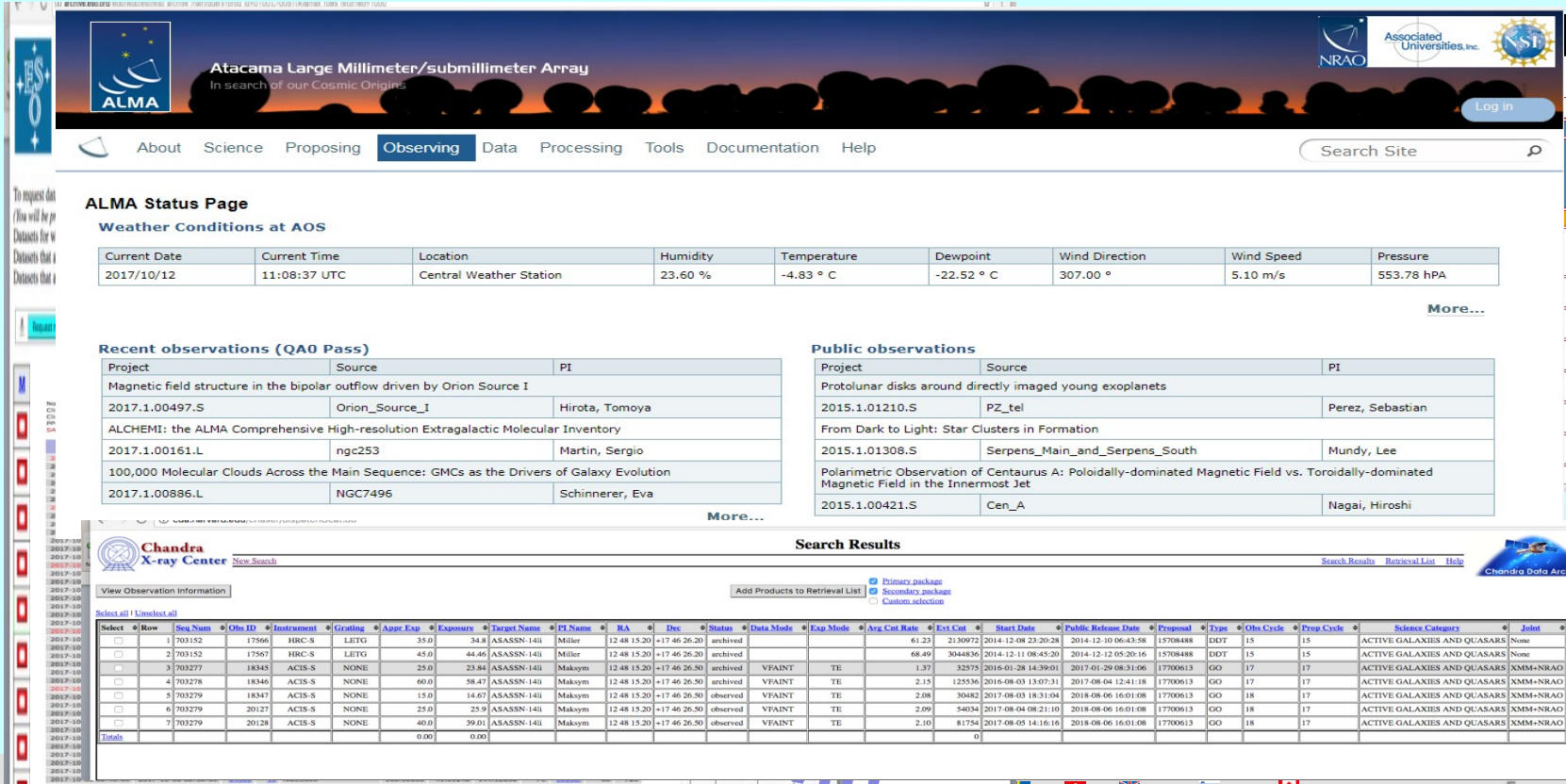




Observing Plans:

ALMA

Chandra




“Diversity is about embracing differences, and recognizing the amazing things that are possible when it’s woven into an organization’s culture”

Standard VO Protocols

- Initial definition by ESA team, then discussed with about 60 supporting partners (observatory operators, platform operators, institutions, scientists etc.)
  - Workshop held on 21st September 2018 in ESAC
- Consolidated protocol descriptions presented to Virtual Observatory
  - Positive response, certification expected soon
- INTEGRAL, Chandra, GAIA, and HXMT have developed prototypes used here to demonstrate how it works:

Example Use Case:

I have a target and want to know how long I have to wait until it can be observed by multiple observatories

Demonstration for INTEGRAL

Example URL Query:

GRS 1915+105 date range
RA=288.8, DEC=10.95

cURL -s “**http:intergral.esa.int/isocweb/tvp.html?**startDate=26-04-2019&endDate=26-05-2019&duration=12.600&action=predict&ra=288.8&dec=10.95&format=json”

cURL -s “**http:intergral.esa.int/isocweb/tvp.html?**startDate=26-04-2019&endDate=26-05-2019&
duration=12.600&action=predict&ra=288.8&dec=10.95&format=json”

Output in JSON Format

Demonstration for INTEGRAL

```
jness-Lenovo-G50-80:~> curl -s "http://integral.esa.int/isocweb/tvp.html?startDate=26-04-2019&&endDate=26-05-2019&
duration=12.600&action=predict&ra=288.8&dec=10.95&format=json" | sed '/^$/d'
{"RA":"288.8", "RAHMS": "19:15:12.00",
"DEC":"10.95", "DECHMS": "+10:57:00.0",
"START_DATE":"2019-04-26",
"END_DATE":"2019-05-26",
"DITHER_PATTERN":"Raster",
"MINUMUM_DURATION":"12.6",
"TOTAL_DURATION":"1417164",
"INTERVALS":
[
{"revolution" : "2083",  "start": "2019-04-24 14:07:48 GMT",
"end": "2019-04-26 18:25:00 GMT" ,"duration": "188232"}
,
{"revolution" : "2084",  "start": "2019-04-27 05:56:36 GMT",
"end": "2019-04-29 10:14:40 GMT" ,"duration": "188284"}
,
{"revolution" : "2085",  "start": "2019-04-29 21:45:43 GMT",
"end": "2019-05-02 02:05:08 GMT" ,"duration": "188365"}
,
{"revolution" : "2086",  "start": "2019-05-02 13:35:23 GMT",
"end": "2019-05-04 17:56:04 GMT" ,"duration": "188441"}
,
{"revolution" : "2087",  "start": "2019-05-05 05:25:42 GMT",
"end": "2019-05-07 09:46:48 GMT" ,"duration": "188466"}
,
{"revolution" : "2088",  "start": "2019-05-07 21:16:20 GMT",
"end": "2019-05-10 01:36:28 GMT" ,"duration": "188408"}
,
{"revolution" : "2089",  "start": "2019-05-10 13:06:24 GMT",
"end": "2019-05-12 17:25:02 GMT" ,"duration": "188318"}
,
{"revolution" : "2090",  "start": "2019-05-13 04:55:13 GMT",
"end": "2019-05-14 08:19:23 GMT" ,"duration": "98650"}

]
```

Demonstration for INTEGRAL

```
#!/bin/bash

out=`mktemp tempXXXXXX` || exit 1
trap "rm -f $out*" 0 1 2 3 5

ra=$1
if test x${2} = x; then
   echo Need to provide coordinates in decimal units
   exit 1
else
   dec=$2
fi

root="http://integral.esa.int/isocweb/tvp.html"

dstart=$(date +%d-%m-%Y)
dend=$(date -d "+30 days" +%d-%m-%Y)

#dstart="08-02-2019"

echo "${root}?startDate=${dstart}&duration=12.600&action=predict&endDate=${dend}&coordinates=equatorial&ra=$ra&dec=${dec}&format=json"

curl -s "${root}?startDate=${dstart}&duration=12.600&action=predict&endDate=${dend}&coordinates=equatorial&ra=$ra&dec=${dec}&format=json" > $out.json
less $out.json | jq '.INTERVALS[].revolution' | cut -d'"' -f2 > $out.rev
less $out.json | jq '.INTERVALS[].start' | cut -d'"' -f2 > $out.start
less $out.json | jq '.INTERVALS[].end' | cut -d'"' -f2 > $out.end

n=$(wc -l $out.rev | cut -d' ' -f1)
d=$(date +%y-%m-%d)
d=$dstart
echo "Visibility from Today ($d) to ${dend}"
for ((i=1; i<n; i++)); do
    a=$(sed -n "${i},${i} p" $out.rev)
    b=$(sed -n "${i},${i} p" $out.start)
    c=$(sed -n "${i},${i} p" $out.end)
    echo " $a   $b   $c"
done
```

Bash script

Take RA/Dec as input

Display visibility intervals

from start date to 30 days in future

Demonstration for INTEGRAL

```
#!/bin/bash

out=`mktemp tempXXXXXX` || exit 1
trap "rm -f $out*" 0 1 2 3 5

ra=$1
if test x${2} = x; then
   echo Need to provide coordinates in decimal units
   exit 1
else
   dec=$2
fi

root="http://integral.esa.int/isocweb/tvp.html"

dstart=$(date +%d-%m-%Y)
dend=$(date -d "+30 days" +%d-%m-%Y)

#dstart="08-02-2019"

echo "${root}?startDate=${dstart}&duration=12.600&action=predict&endDate=${dend}&coordinates=equatorial&ra=$ra&dec=${dec}&format=json"

curl -s "${root}?startDate=${dstart}&duration=12.600&action=predict&endDate=${dend}&coordinates=equatorial&ra=$ra&dec=${dec}&format=json" > $out.json
less $out.json | jq '.INTERVALS[].revolution' | cut -d'"' -f2 > $out.rev
less $out.json | jq '.INTERVALS[].start' | cut -d'"' -f2 > $out.start
less $out.json | jq '.INTERVALS[].end' | cut -d'"' -f2 > $out.end

n=$(wc -l $out.rev | cut -d' ' -f1)
d=$(date +%y-%m-%d)
d=$dstart
echo "Visibility from Today ($d) to ${dend}"
for ((i=1; i<n; i++)); do
    a=$(sed -n "${i},${i} p" $out.rev)
    b=$(sed -n "${i},${i} p" $out.start)
    c=$(sed -n "${i},${i} p" $out.end)
    echo " $a   $b   $c"
done
```

Bash script
- Take RA/Dec as input
- Display visibility intervals
- from start date to 30 days in future

```
> ./too.sh 288.8 10.95
  Visibility from Today (26-04-2019) to 26-05-2019
 2083   2019-04-24 14:07:48 GMT   2019-04-26 18:25:00 GMT
 2084   2019-04-27 05:56:36 GMT   2019-04-29 10:14:40 GMT
 2085   2019-04-29 21:45:43 GMT   2019-05-02 02:05:08 GMT
 2086   2019-05-02 13:35:23 GMT   2019-05-04 17:56:04 GMT
 2087   2019-05-05 05:25:42 GMT   2019-05-07 09:46:48 GMT
 2088   2019-05-07 21:16:20 GMT   2019-05-10 01:36:28 GMT
 2089   2019-05-10 13:06:24 GMT   2019-05-12 17:25:02 GMT
```

IVOA Working Draft

International Virtual Observatory Alliance

IVOA Documents

ObjVisSAP

http://ivoa.net/documents/ObjVisSAP/

Simple Access Protocol (SAP)

Implementation depends on Observatory (adaptation)

Based on parameter=value approach

Basic interface Coordinates/Time

Object Visibility Simple Access Protocol Version 0.5

IVOA Working Draft 19 March 2019

Interest/Working Group:
http://www.ivoa.net/twiki/bin/view/IVOA/IvoaDAL

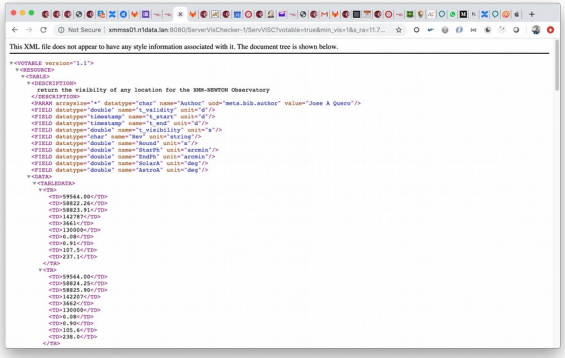
Author(s):
Aitor Ibarra, Richard Saxton, Jesús Salgado, Matthias Ehle, Carlos Gabriel, James Dempsey, María Díaz Trigo, Yue Huang, Jaime Keenea, Mark Kettenis, Peter Kretschmar, Erik Kuulkers, Uwe Lammers, Giorgio Matt, Bruno Merín, Marco Molinaro, Jan-Uwe Ness, Julian Osborne, Emma de Oña Wilhelmi, Edward J. Salbol, Emilio Salazar, Celia Sánchez, Gregory Sivakoff, Lian Tao, Aaron Tohuvavohu, Bill Workman

Editor(s):
Aitor Ibarra, Richard Saxton, Jesús Salgado

Implementation of ObjVisSAP

Needs:

- Algorithm to calculate visibility of a point in the sky in any language. It could interact with a database, a file, or nothing at all. (Mission dependent)
- Web server which interfaces with the user/client. Most missions have already a web interface that shows the visibility
- Response as VOTable (specific XML format)



Implementation of ObjVisSAP

Implementation Examples:

- PHP + Apache server (easy to implement, usually included the PHP support in the Apache web server)

- Java + Tomcat (servlet container), more robust development, easy to decouple the view (webpage) from the model (the visibility algorithm)

- Python (django). Very popular within the astronomy community.


Ask the expert: Emilio Salazar

International Virtual Observatory Alliance

IVOA Documents

ObsLocTAP

http://ivoa.net/documents/ObsLocTAP/

TAP Protocol Similar to ObsTAP

Data Model Constraints:

a. Observation Characterization

b. Axes:

- Spatial Coverage
- Spectral Coverage
- Poloarization

c. Observatory provenance

Observation Locator Table Access Protocol Version 0.5

IVOA Working Draft 09 September 2019

Interest/Working Group:
http://www.ivoa.net/twiki/bin/view/IVOA/IvoaDAL
Author(s):
Aitor Ibarra, Jesús Salgado, Matthias Ehle, Carlos Gabriel, James Dempsey, Markus Demleitner, María Díaz Trigo, Yue Huang, Jaime Keenea, Mark Kettenis, Peter Kretschmar, Erik Kuulkers, Uwe Lammers, Giorgio Matt, Bruno Merín, Marco Molinaro, Jan-Uwe Ness, Julian Osborne, Emma de Oña Wilhelmi, Edward J. Salbol, Emilio Salazar, Celia Sánchez, Richard Saxton, Gregory Sivakoff, Lian Tao, Aaron Tohuvavohu, Bill Workman
Editor(s):
Jesús Salgado, Aitor Ibarra

Creating a Observation Locator Service

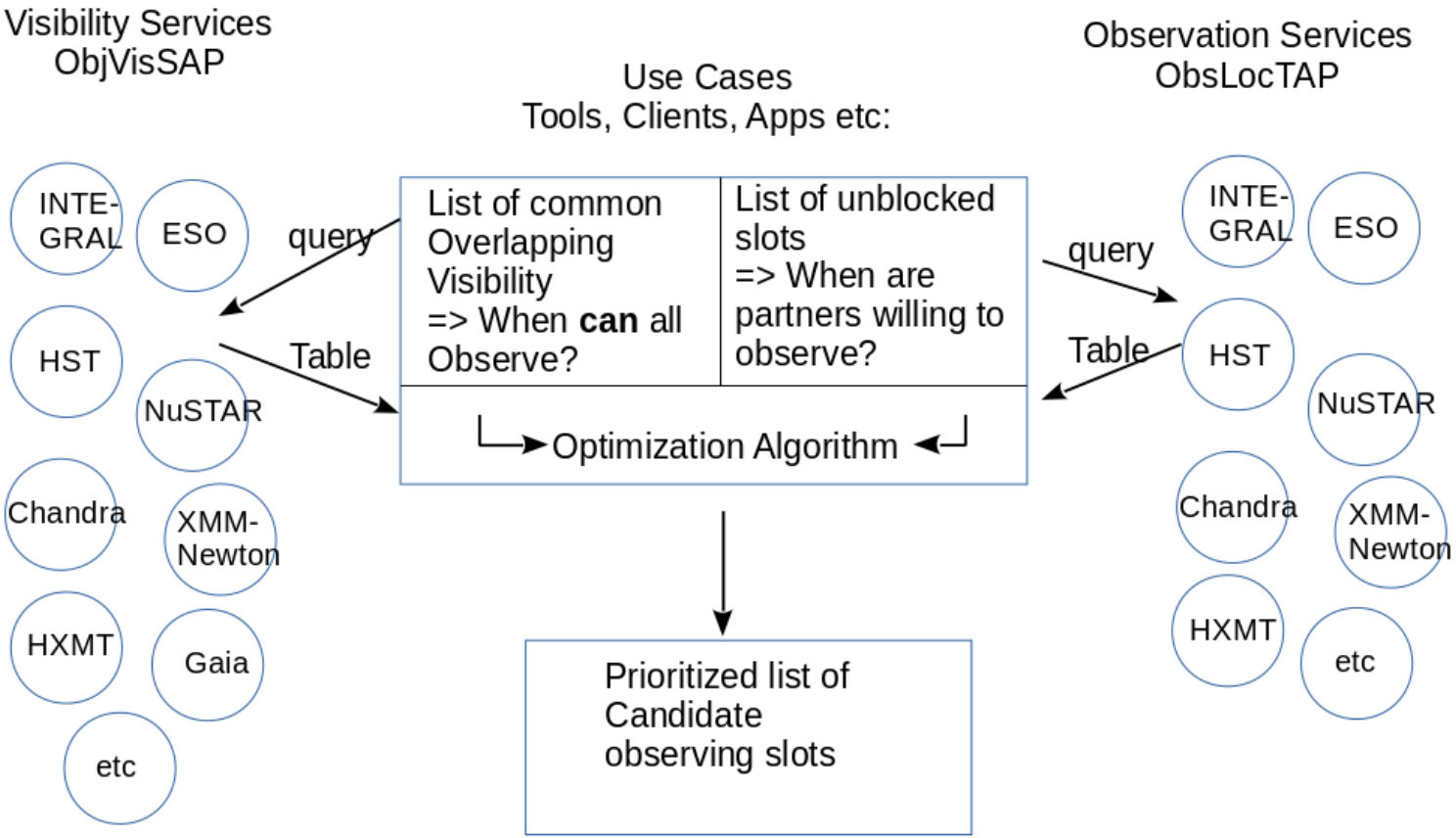
1. For an Observation Locator Service (ObsLocTAP) you need:
    a. A **database** (usually PostgreSQL) with a table that contains future observations
    b. A **TAP** (Table Access Protocol) service
2. There are some **toolkits** that allow deployment of a TAP server without major effort:
    - TAPTuto: http://cdsportal.u-strasbg.fr/taptuto/
    - DACHS from GAVO:
        http://soft.g-vo.org/dachs
        https://dachs-doc.readthedocs.io/tutorial.html
    - SAADA:
        http://saada.unistra.fr/saada/

Creating a Observation Locator Service

- ObsLocTAP table is described in the specification:
    - http://www.ivoa.net/documents/ObsLocTAP/index.html
    - and in our implementation guide
    - https://www.cosmos.esa.int/web/vovisobs_protocols/obsloctapimplguide

  FINALLY… as a bonus!
- Observatories could also use the same TAP server to publish **other** tables/catalogues
- ADQL (Astronomical Data Query Language) allows complex astronomical queries using Virtual Observatory clients (e.g. TOPCAT) on your tables

Ask the expert: Jesus Salgado


Visibility Services
ObjVisSAP
Use Cases
Tools, Clients, Apps etc:
Observation Services
ObsLocTAP
INTE-GRAL
ESO
HST
NuSTAR
Chandra
XMM-Newton
HXMT
Gaia
etc
query
Table
List of common Overlapping Visibility => When **can** all Observe?
List of unblocked slots => When are partners willing to observe?
Optimization Algorithm
Prioritized list of Candidate observing slots


J2000
01 44 04.083 -15 56 14.93
FoV: 18' X 11'
Sci. Mode
Feedback
Search...
363
9 643
38
sky.esa.int
Welcome to ESASky!
esa
ESASky is an application that allows you to visualise and download public astronomical data.
Choose a mode
Science
Explorer
Don't show this dialog again
(Read our cookie policy)
Close

http://integral.esa.int/visObsTap/

MULTIMISSION VISIBILITY AND SCHEDULE

Source name

Look up

Coordinates (RA, DEC) in degrees *

255.2 -41.67

Start and End (UTC) *

2019-11-18T14:24 2020-05-18T13:24

Start and End (MJD)

Calculate

http://integral.esa.int/visObsTap/

MULTIMISSION VISIBILITY AND SCHEDULE

Source name

NGC 3227 | Look up

Coordinates (RA, DEC) in degrees *

155.87737 | 19.86508

Start and End (UTC) *

2019-11-15T14:24 | 2019-12-10T13:24

Start and End (MJD)

58802.600509259 | 58827.558842592

Calculate

MULTIMISSION VISIBILITY AND SCHEDULE

http://integral.esa.int/visObsTap/

Source name

NGC 3227 | Look up

Coordinates (RA, DEC) in degrees *

155.87737 | 19.86508

Start and End (UTC) *

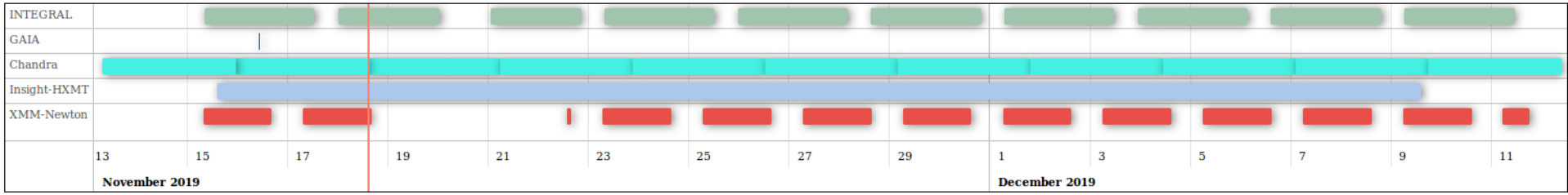
2019-11-15T14:24 | 2019-12-10T13:24

Start and End (MJD)

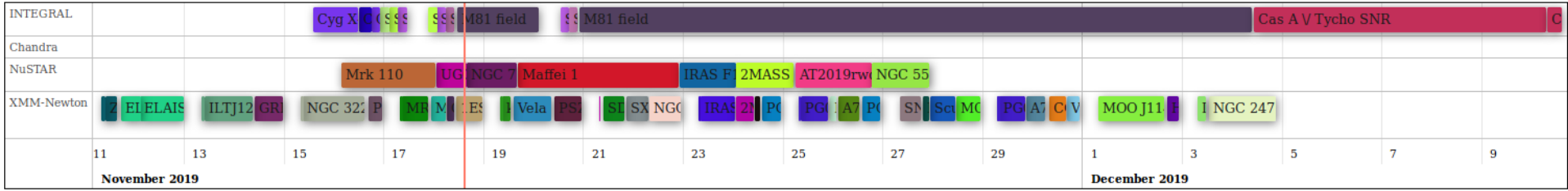
58802.600509259 | 58827.558842592

Calculate

Visibility



Schedule



Looking for a more fancy name – Ideas?

http://integral.esa.int/visObsTap/

MMPlan = Multi-Messenger Planning tool

TOBY=Tool for Observation visiBilitY and schedule

MMAMVO =Multi Mission Approach
for the Modern Virtual Observatory

OOPS = OurObsPlanS

EMOOJI - Explore Multi-Observatory
Opportunities for Joint Investigations

Summary

- Increasing demand for multi-mission coordinations
- Challenges:
  - Diverse formats of hard constraints (visibility)

    => Needed to find common slots
  - Diverse formats of observing plans

    => Needed to find common slots with lowest scientific impact
- Solutions:

  Standard of visibility and observing information

  => machine readable, interface with optimization routines (clients)

Always happy to welcome new collaborators!

You can contribute:

- Additional Use Cases
- Convince observing facilities to implement VO services
  - So they become widely used

Write us an email: jan.uwe.ness@esa.int