VO standards for Telescope Visibility and Observing Plans

INTEGRAL

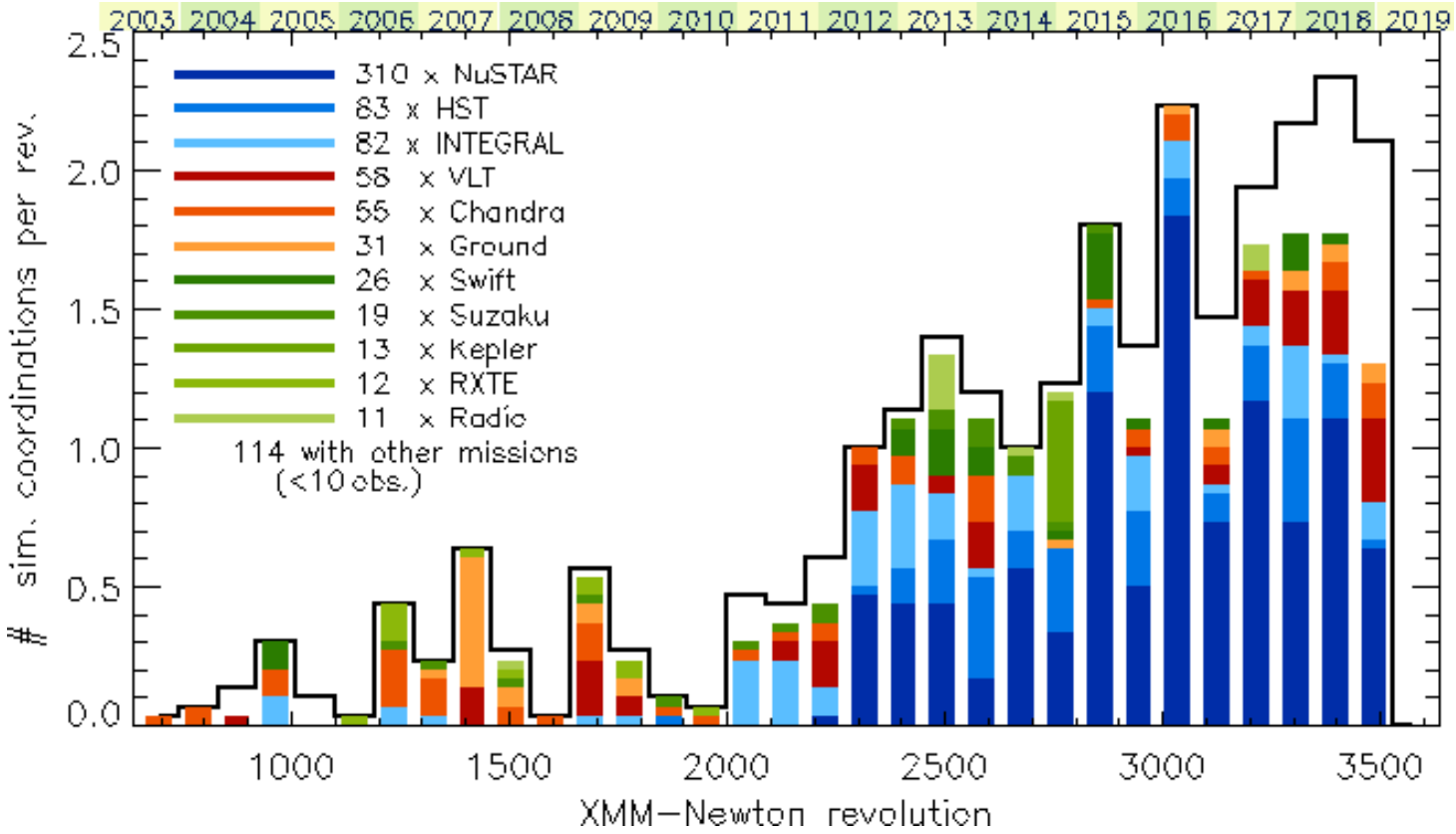
Jan-Uwe Ness[1], Aitor Ibarra[1], Celia Sanchez[1]
Erik Kuulkers[2], Peter Kretschmar[1]
Jesus Salgado[1], Emilio Salazar[1]
Matthias Ehle[1], Carlos Gabriel[1]

XMM-Newton

[1]European Space Astronomy Centre (ESAC), Villafranca del Castillo, Spain
[2]European Space TEchnology Center (ESTEC), Noordwijk, The Netherlands

Increasing Demand for Coordinated observations

Evolution for XMM-Newton



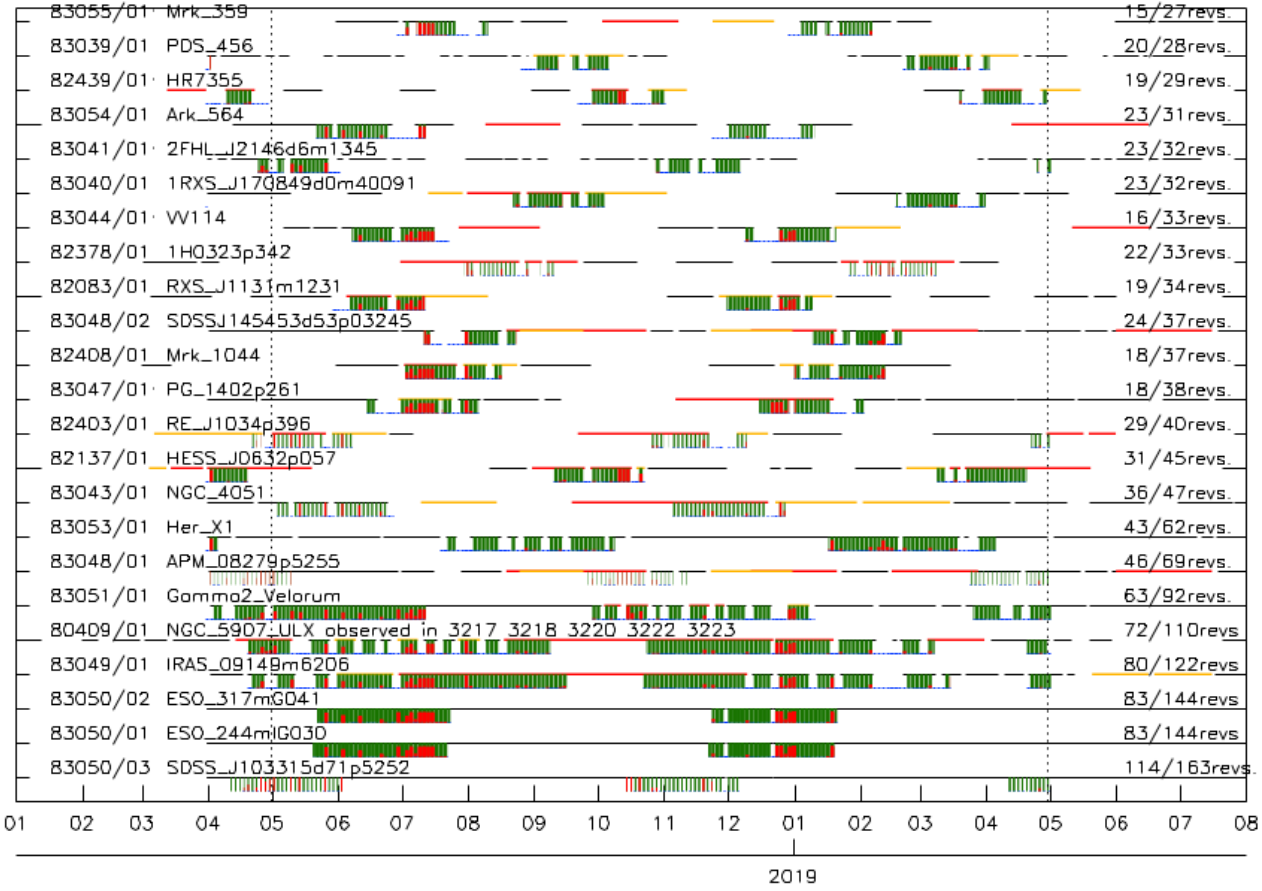
Basic Elements for Coordination:

+ Common Visibility

+ Respecting time-constrained observations

Example: common XMM/NuSTAR Visibility/planning

Example: common XMM/NuSTAR Visibility/planning



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

Target Visibility Constraints

Instrument characteristics

BUT

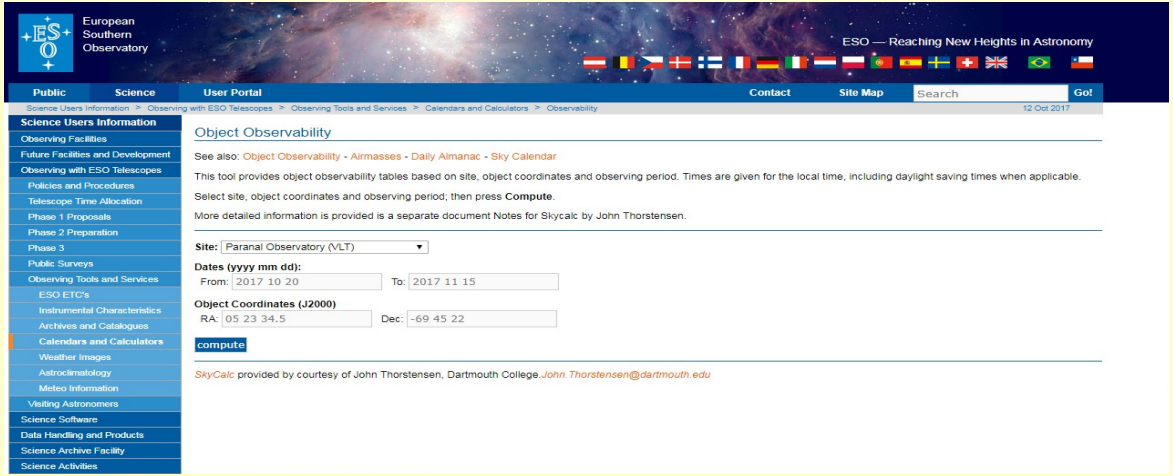
Short-term schedule

Observations info

Long-term schedule

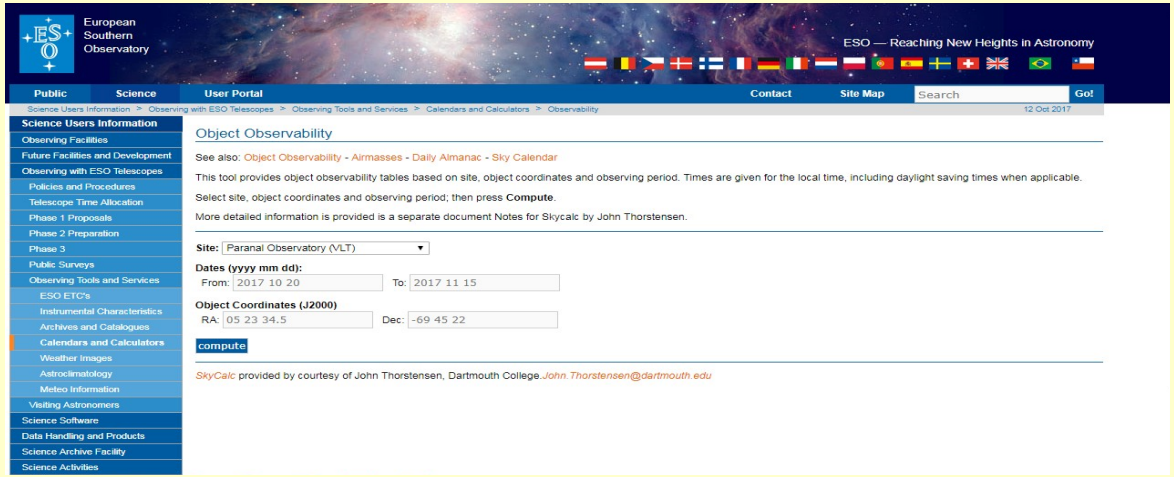
This information is usually shown in a web page statically and is only accessible through forms that have to be manually filled in.

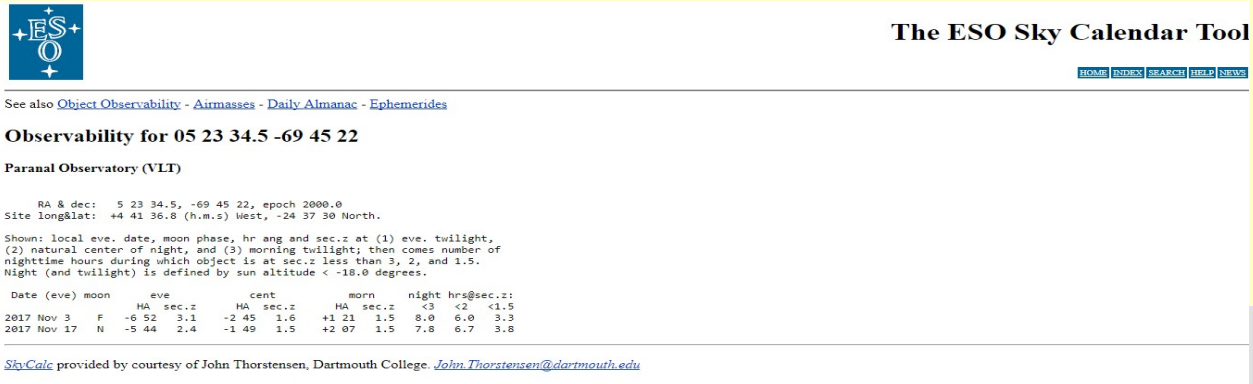
All information about Target Visibility Checks is there...



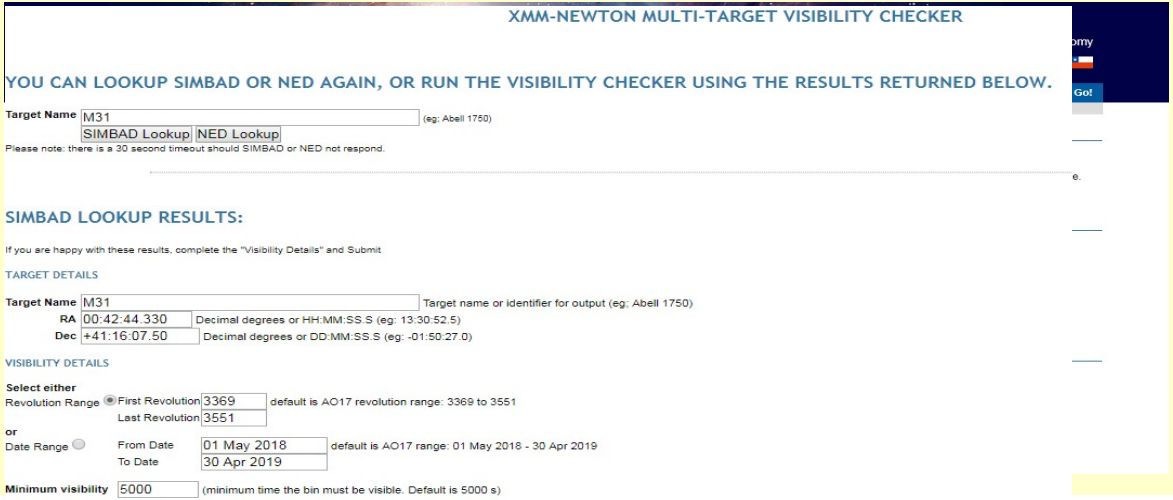
European Space Agency

All information about Target Visibility Checks is there...





All information about Target Visibility Checks is there...



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

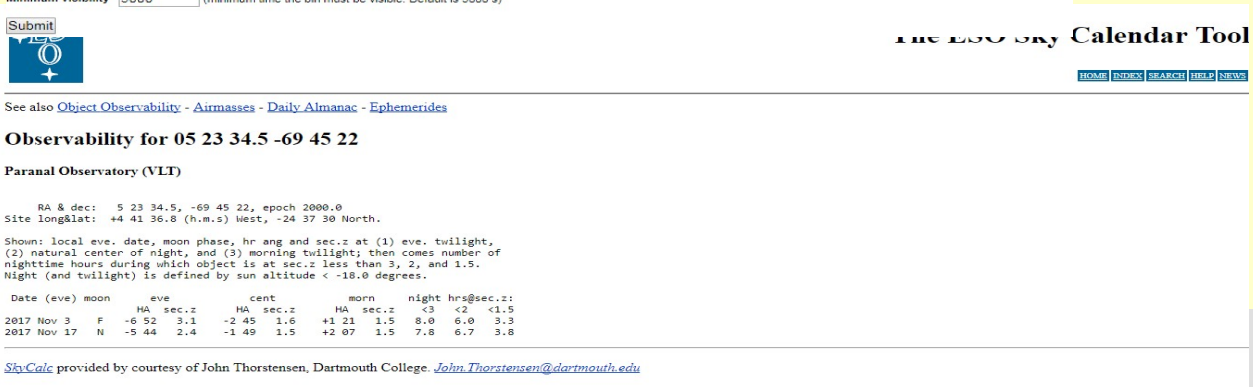
Target Name M31 Target name or identifier for output (eg: Abell 1750)
RA 00:42:44.330 Decimal degrees or HH:MM:SS.S (eg: 13:30:52.5)
Dec +41:16:07.50 Decimal degrees or DD:MM:SS.S (eg: -01:50:27.0)

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



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)

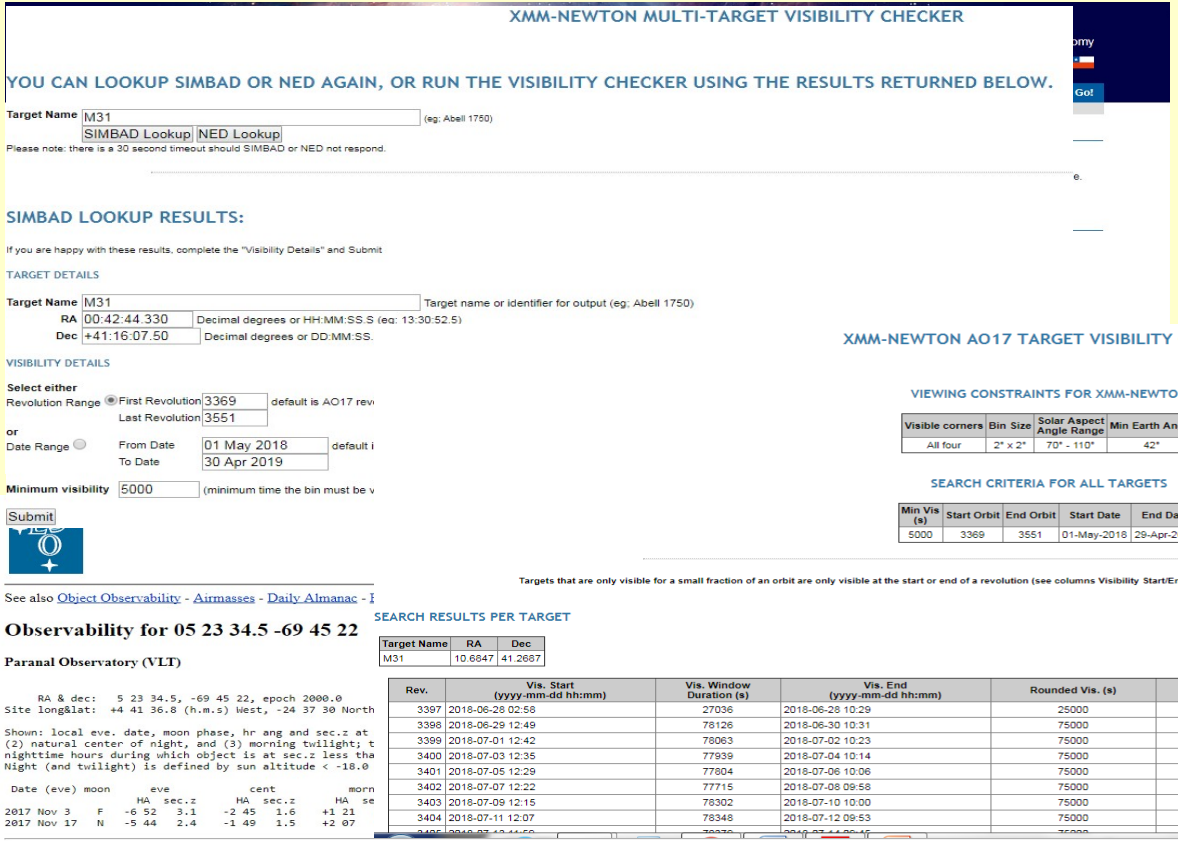
RA & dec: 5 23 34.5, -69 45 22, epoch 2000.0
Site long&lat: +4 41 36.8 (h.m.s) West, -24 37 30 North.

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 HA	eve sec.z	cent HA	cent sec.z	morn HA	morn sec.z	night <3	night <2	night <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

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

All information about Target Visibility Checks is there...



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.

VISIBILITY DETAILS

Select either
Revolution Range First Revolution 3369 default is AO17 rev
Last Revolution 3551
or
Date Range From Date 01 May 2018 default i
To Date 30 Apr 2019

Minimum visibility 5000 (minimum time the bin must be v

Submit

See also Object Observability - Airmasses - Daily Almanac - I

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
(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
```

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

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.

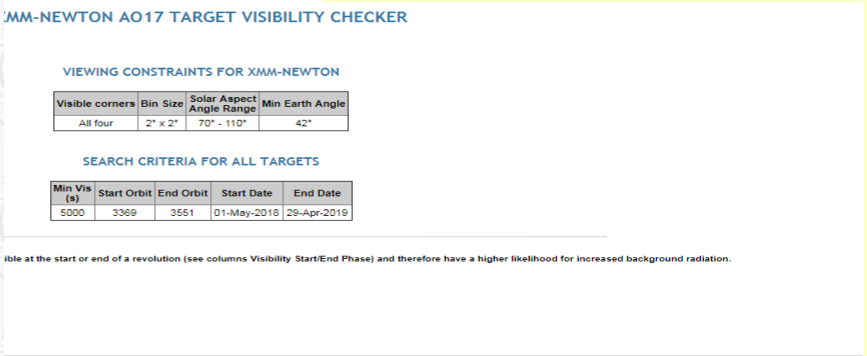
SEARCH RESULTS PER TARGET

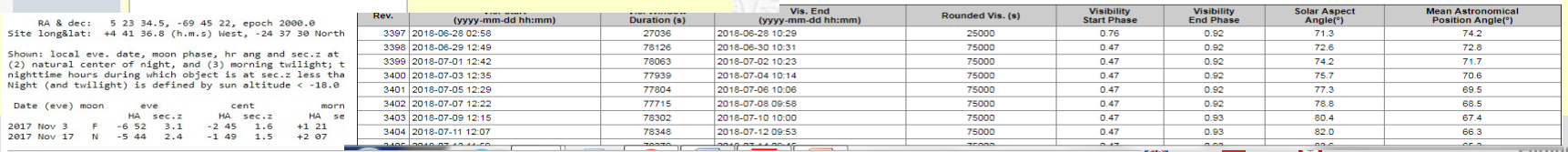
Target Name	RA	Dec
M31	10.6847	41.2687

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

European Space Agency

All information about Target Visibility Checks is there...

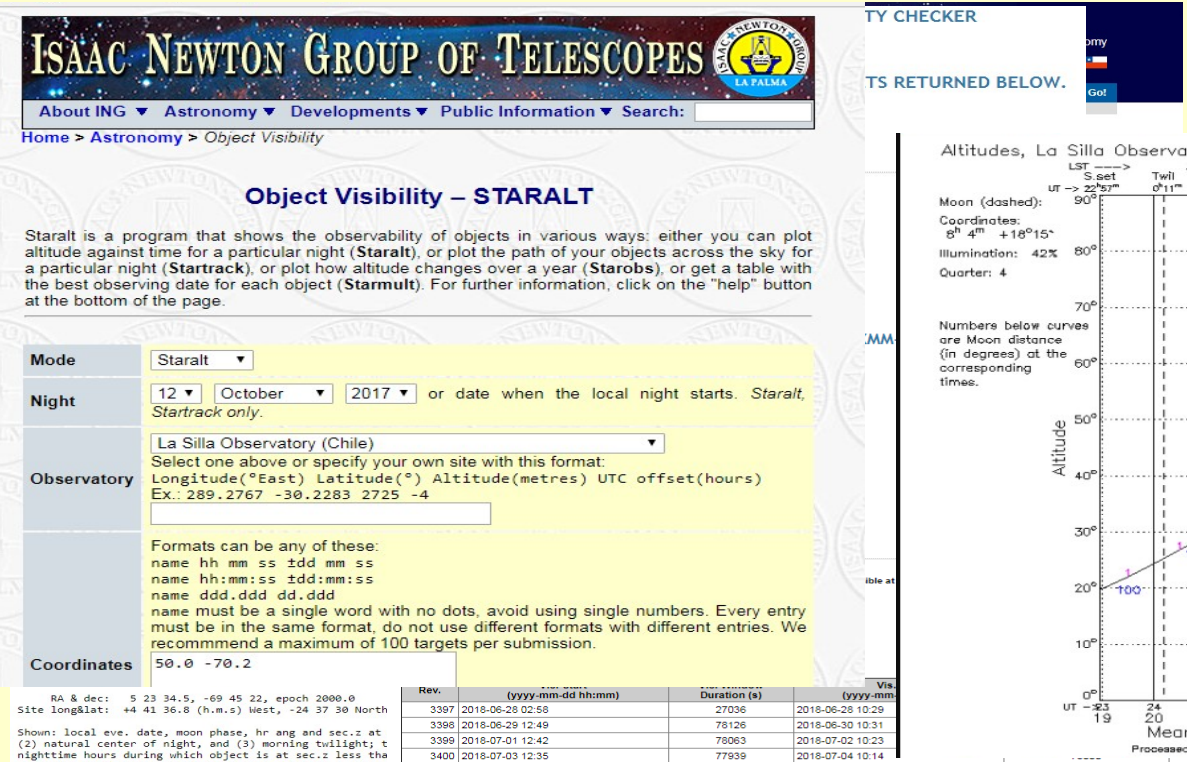


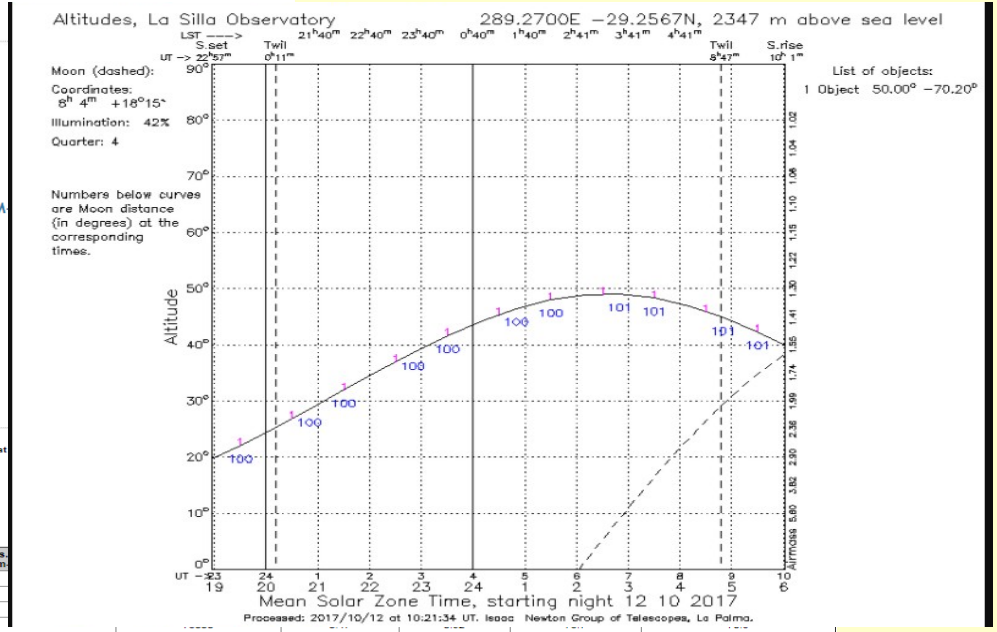


SkyCalc provided by courtesy of John Thorstensen, Dartmouth College. John.Thorstensen@dartmouth.edu

European Space Agency

All information about Target Visibility Checks is there...



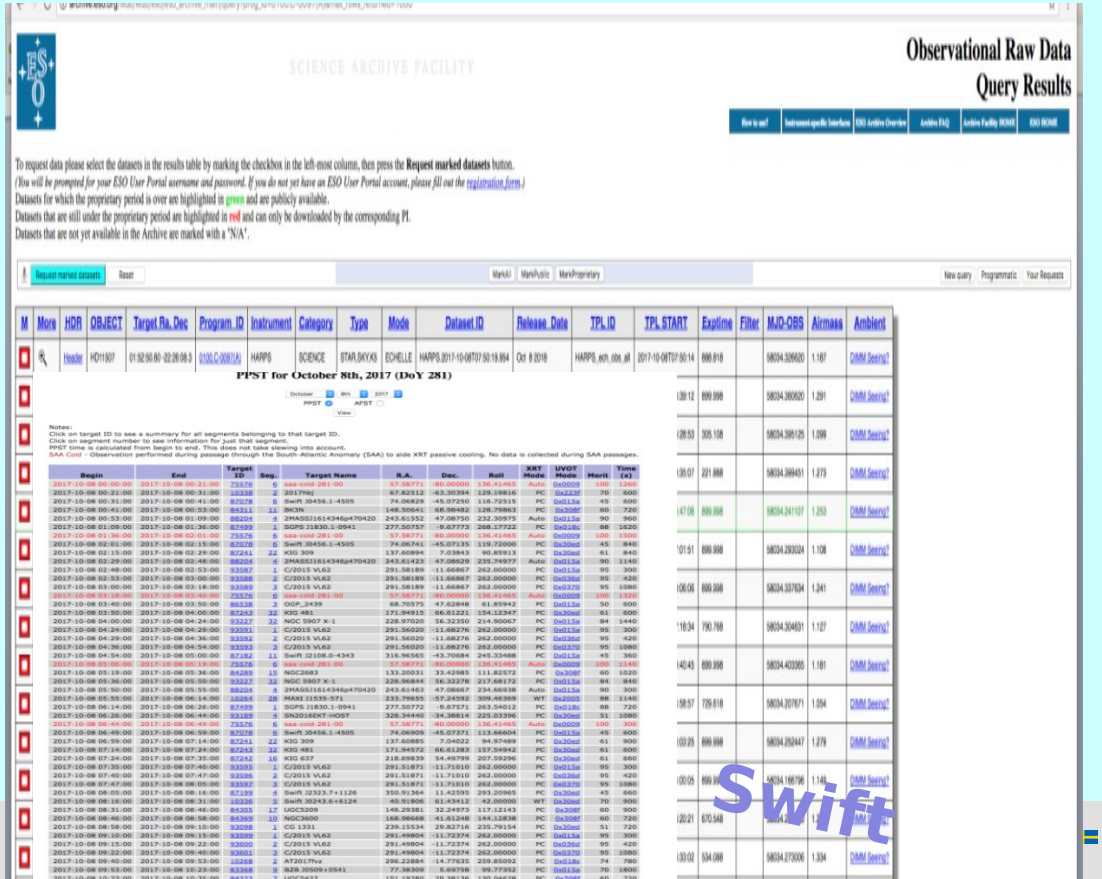


Rev.	(yyyy-mm-dd hh:mm)	Duration (s)	(yyyy-mm-				
3397	2018-06-28 02:58	27036	2018-06-28 10:29				
3398	2018-06-29 12:49	78126	2018-06-30 10:31				
3399	2018-07-01 12:42	78063	2018-07-02 10:23				
3400	2018-07-03 12:35	77939	2018-07-04 10:14				
3401	2018-07-05 12:29	77804	2018-07-06 10:06	75000	0.47	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

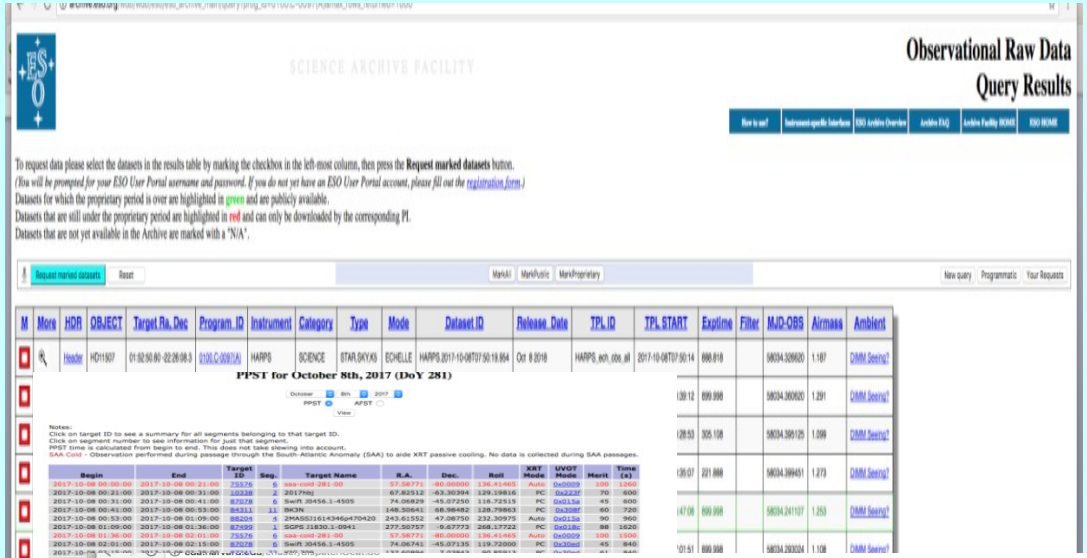
SkyCalc provided by courtesy of John Thorstensen, Dartmouth College. John.Thorstensen@dartmouth.edu

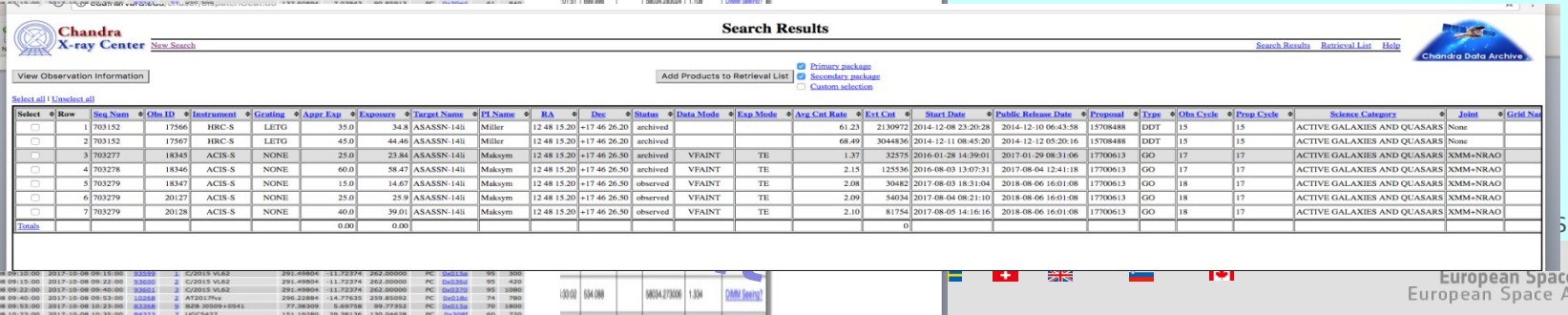
European Space Agency

.. and information about scheduled observations...

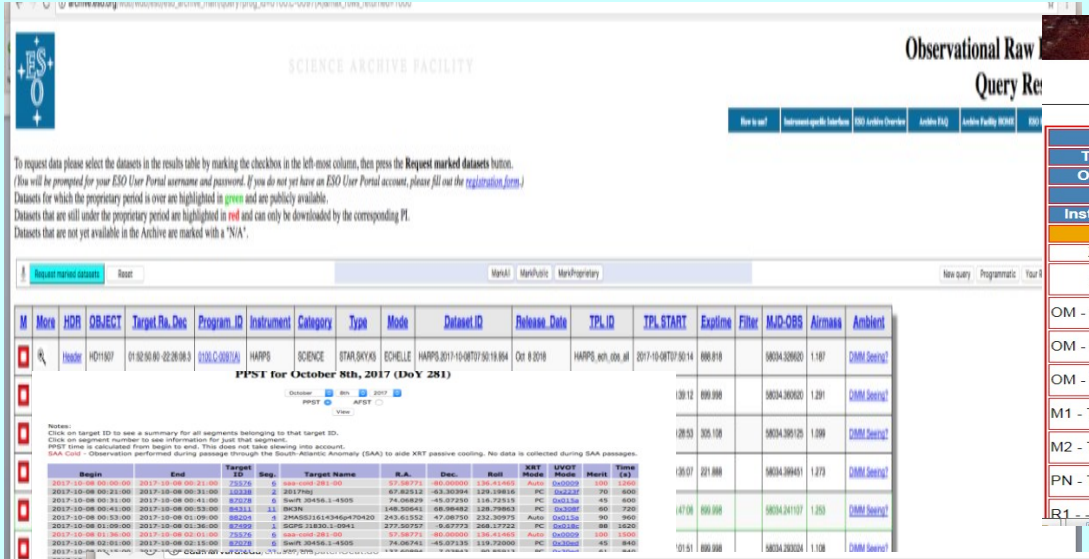


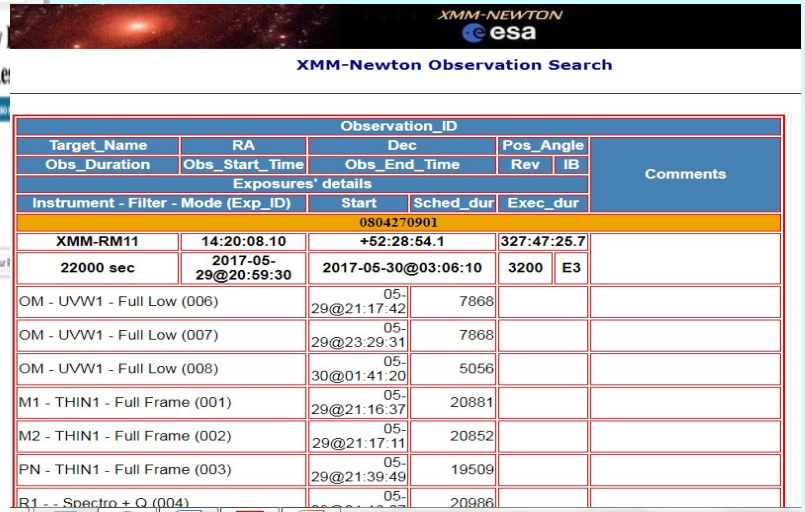
.. and information about scheduled observations...

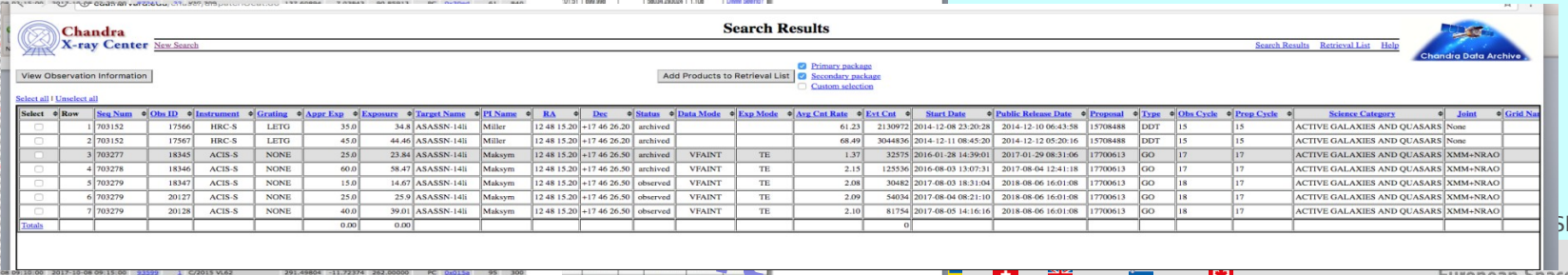




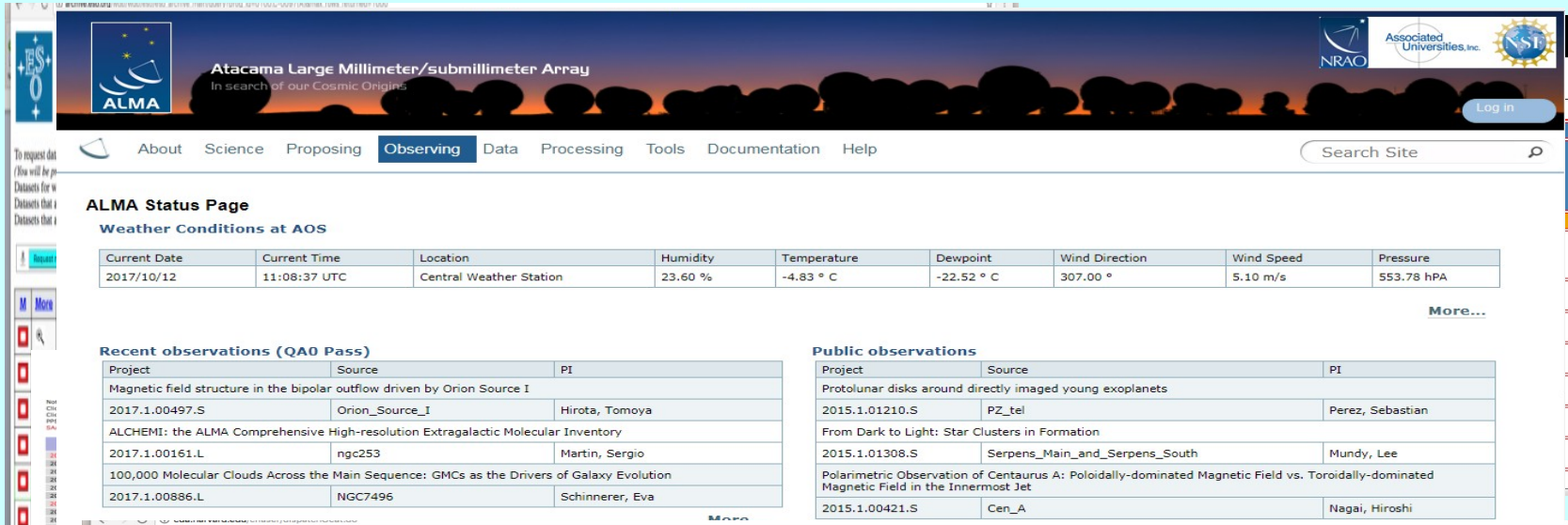
.. and information about scheduled observations...

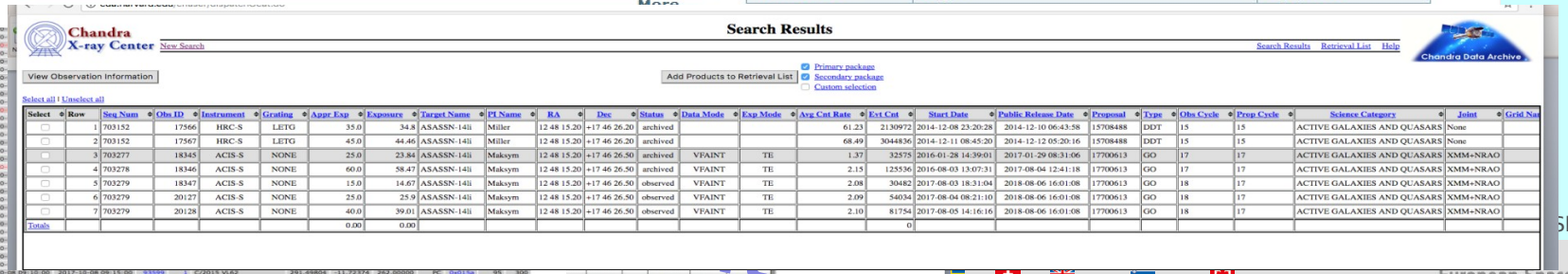






.. and information about scheduled observations...

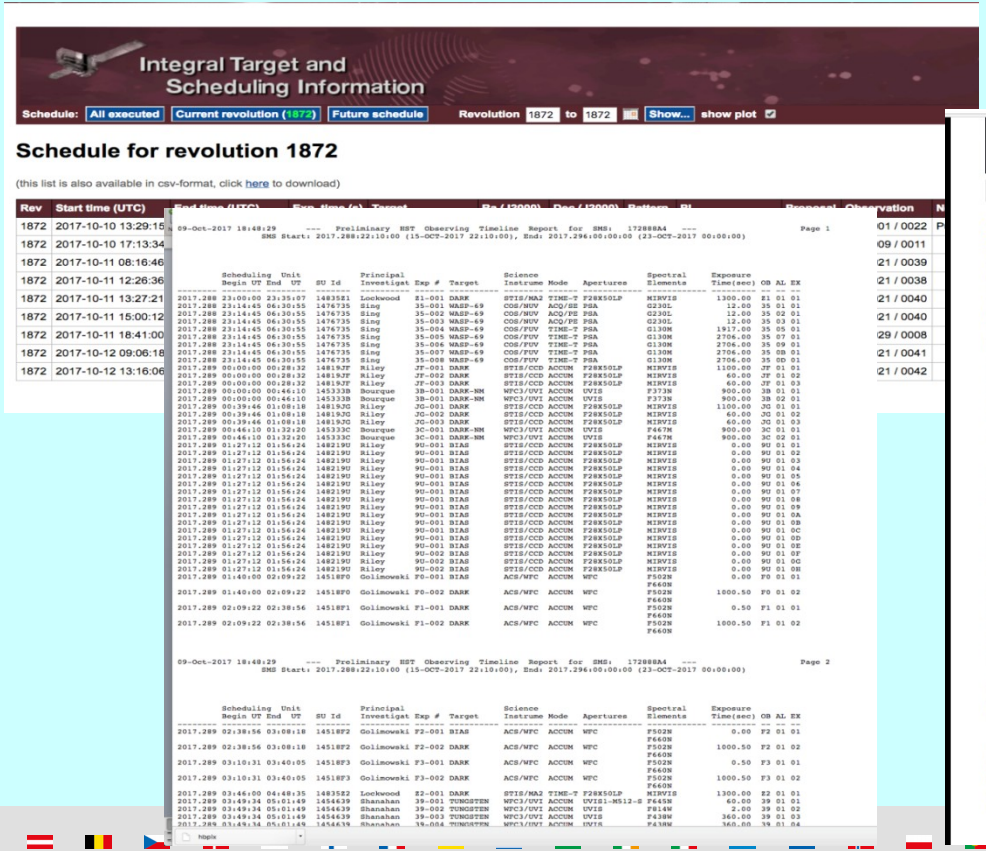


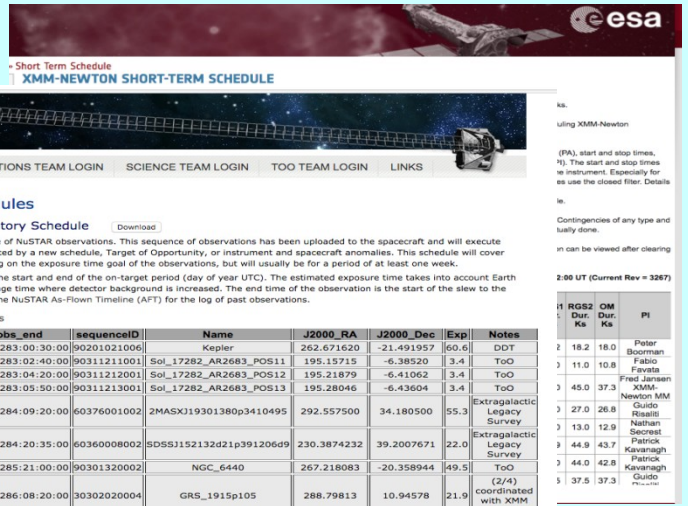


ALMA

Chandra

.... and planned observations





integral.esa.int/mySpaceCal/

format exfat rhel6

mySpaceCal

High energy: ☑ AGILE ☑ Chandra ☑ Fermi ☑ INTEGRAL ☑ NuSTAR ☐ RXTE ☐ Suzaku ☐ Swift ☑ XMM-Newton

Other: ☐ Herschel ☐ Spitzer

Filter: Search Show: ☐ saa-cold-*

☐ Dummy pointings Login Register Export Help

today **February 2019** month week day

Sun	Mon	Tue	Wed	Thu	Fri	Sat
27	28	29	30	31	1	2
Spinning Mode						
Muscae Region, 282.5		MAXI J1348-630			MAXI J1348-630	
Muscae Region, 282.5						
3	4	5	6	7	8	9
Spinning Mode						
MAXI J1348-630						
OMC FF #32						
10	11	12	13	14	15	16
Spinning Mode						
MAXI J1348-630		Galactic Center		Gal. Bulge region	Galactic Center	
	Galactic Center			Galactic Center		
	Gal. Bulge region					
17	18	19	20	21	22	23
Spinning Mode						
Perseus OB2 (2)						
Crab						


It's the
economy,
Stupid!


It's the
Standards,
Stupid!

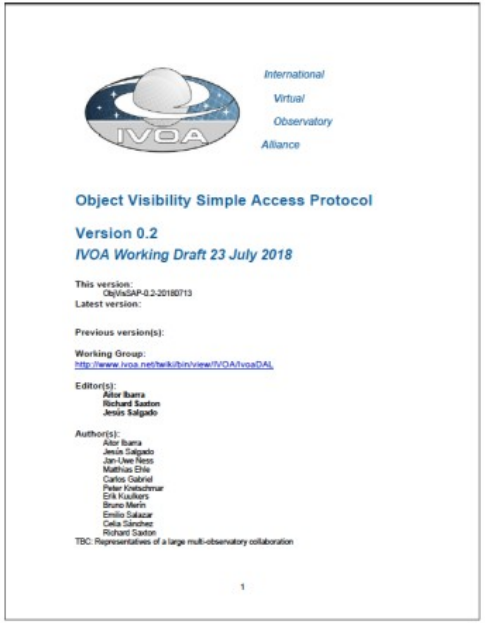
Object Visibility Simple Access Protocol

1. Initial note modified to create ObjVisSAP v0.5 WD

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

Properties:

2. S*AP protocol – different implementation at different observatories (adaptation)
3. Based on “parameter=value” approach
4. Basic interface:
    a. Coordinates
    b. Time Range



International Virtual Observatory Alliance

Object Visibility Simple Access Protocol

Version 0.2

IVOA Working Draft 23 July 2018

This version:
ObjVisSAP-0.2-20180713
Latest version:

Previous version(s):

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

Editor(s):
Aitor Ibarra
Richard Saxton
Jesús Salgado

Author(s):
Aitor Ibarra
Jesús Salgado
Jan-Uwe Ness
Matthias Ehle
Carlos Gabriel
Peter Kretschmar
Erik Kuulkers
Bruno Merin
Emilio Salazar
Celia Sánchez
Richard Saxton
TBC: Representatives of a large multi-observatory collaboration

1

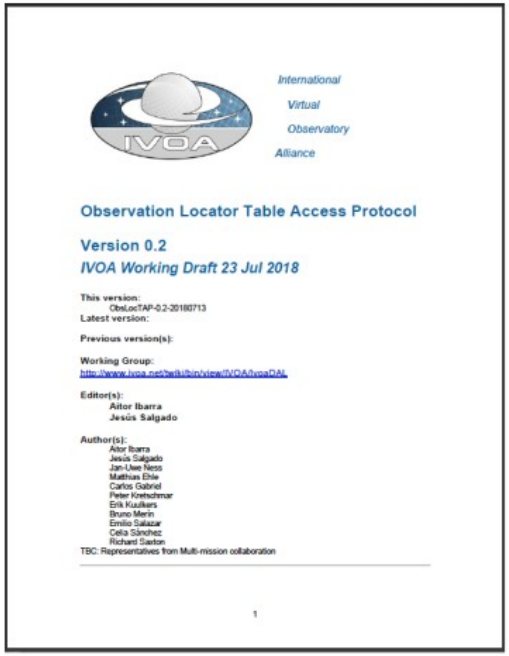
ObsLocTAP: Observation Locator Table Access Protocol

1. Initial note modified to create ObsLocTAP v0.5 WD

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

Properties:

2. TAP protocol – Similar to ObsTAP
3. Data Model contains:
    a. Observation Characterization
    b. Axes:
        - Spatial Coverage
        - Spectral Coverage
        - Polarization
    c. Observatory provenance



International Virtual Observatory Alliance

Observation Locator Table Access Protocol

Version 0.2

IVOA Working Draft 23 Jul 2018

This version:
ObsLocTAP-0.2-20180713
Latest version:

Previous version(s):

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

Editor(s):
Aitor Ibarra
Jesús Salgado

Author(s):
Aitor Ibarra
Jesús Salgado
Jan-Uwe Ness
Matthias Ehle
Carlos Gabriel
Peter Kretschmar
Erik Kuulkers
Bruno Merin
Emilio Salazar
Celia Sánchez
Richard Saxton
TBC: Representatives from Multi-mission collaboration

1

Standard VO Protocols

- Initial definition by ESAC 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 only a matter of time
- INTEGRAL has provided a prototype used here to demonstrate how it works:

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 right now
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

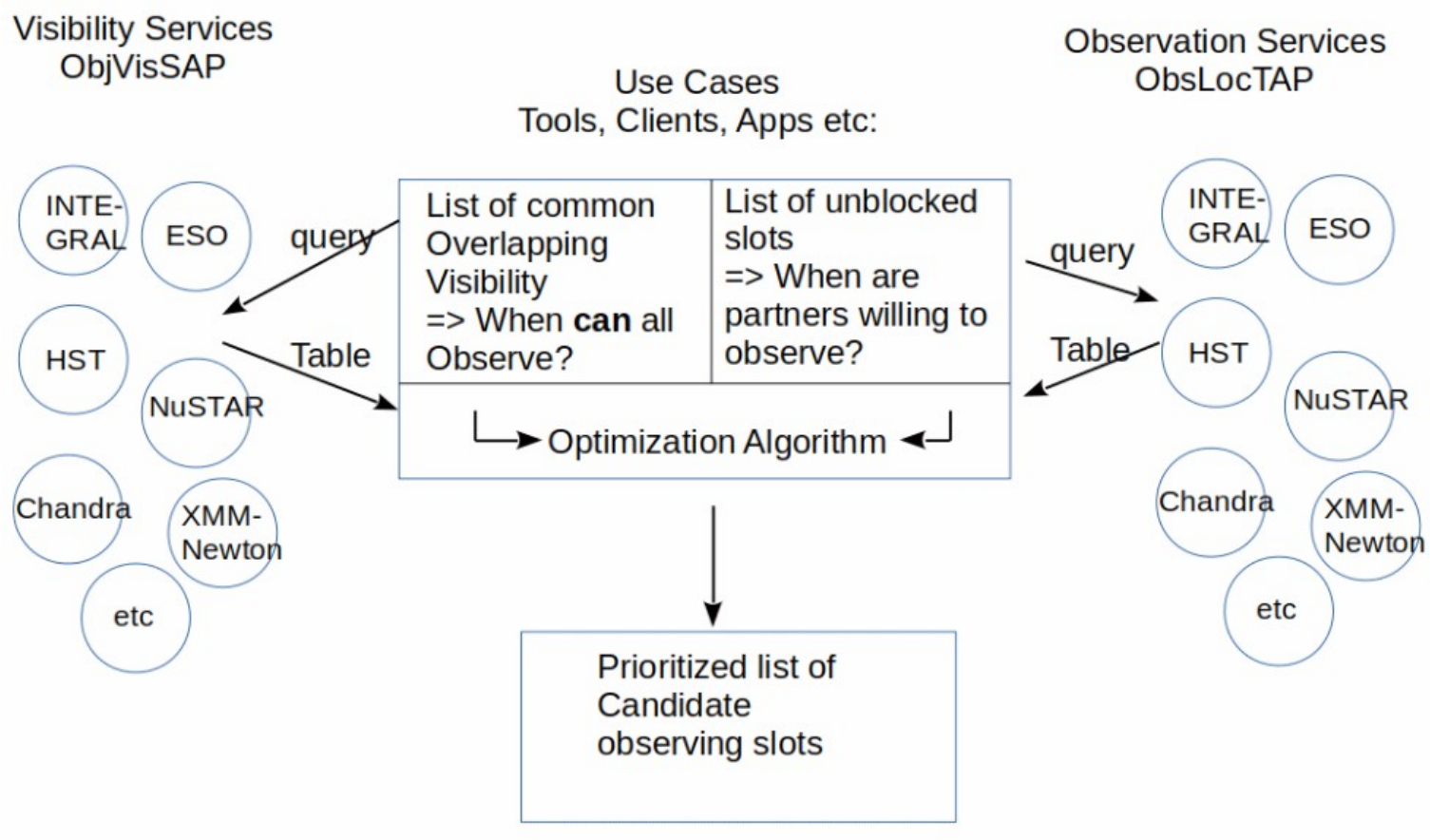
from today to 30 days in future

Demonstration for INTEGRAL

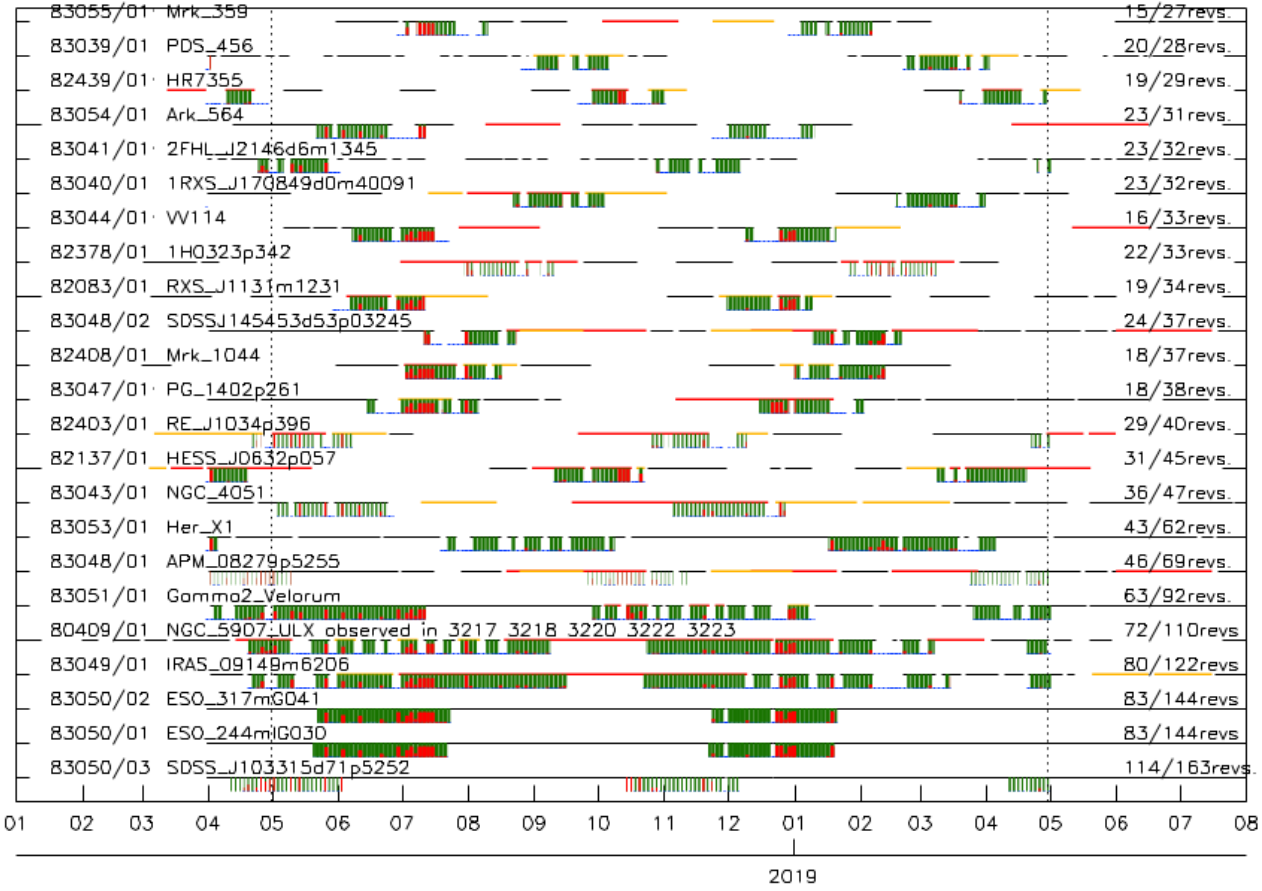
```
#!/bin/bash

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 today 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
```


Visibility Services
ObjVisSAP
Use Cases
Tools, Clients, Apps etc:
Observation Services
ObsLocTAP
INTE-GRAL
ESO
HST
NuSTAR
Chandra
XMM-Newton
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

Example: common XMM/NuSTAR Visibility/planning



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)

Status

- Implementation status:
  - INTEGRAL: public test version (see examples)
  - GAIA: Implemented ObjVisSAP (access to scanning laws)
  - Chandra: Implemented both services (testing phase)
- Applications:
  - ASTERICS: Working on Multimessenger Platform
  - Visualization of Observing Plans and visibility in Sky.esa.int

Always happy to welcome new collaborators!

You can help us to convince observing facilities to implement VO services