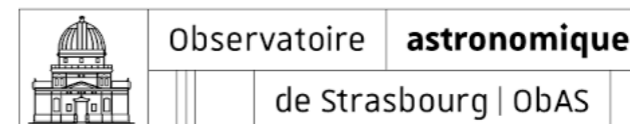


Interoperability in Multimessenger Astrophysics

1st Astro-COLIBRI Multimessenger Astrophysics Workshop

Ada Nebot



□ Index

- Interoperability, the VO and the IVOA
 - What, Who, Where, How, When?
- (Some of the) Multimessenger needs
- Does the IVOA cover those needs?
- VOEvent, status and future evolution?

□ Interoperability

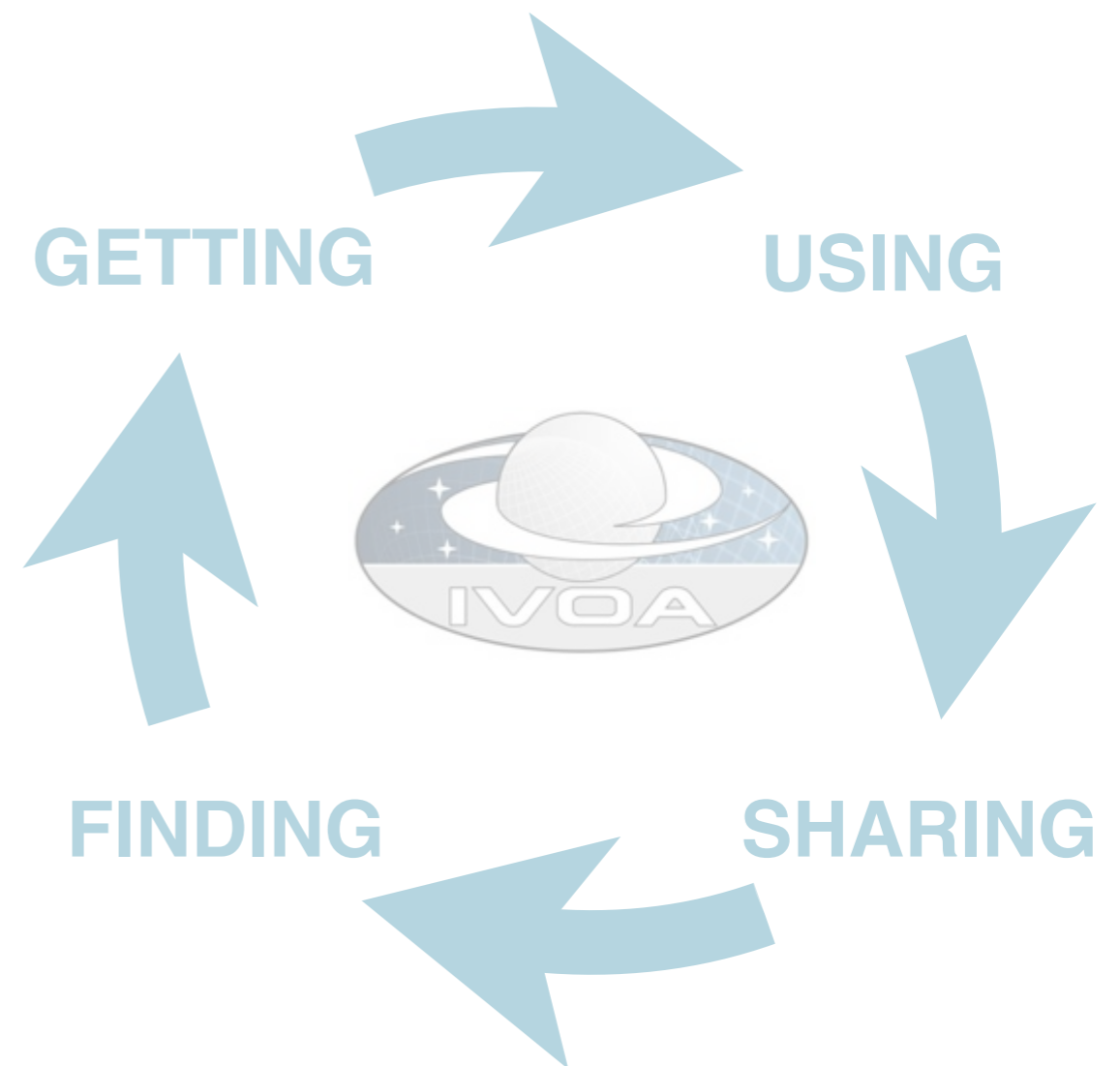
- Few definitions:
 - Interoperability:
 - “The ability of computer systems or software to exchange and make use of information.”
 - “The ability of different systems, devices, applications or products to connect and communicate in a coordinated way, without effort from the end user”
 - The Virtual Observatory: “Framework for astronomical datasets, tools, services to work together in a seamless way”

□ The VO and the IVOA: what?

The VO : “A multi-wavelength digital sky that can be searched, visualised and analysed in new and innovative ways”

What is the International Virtual Observatory Alliance?

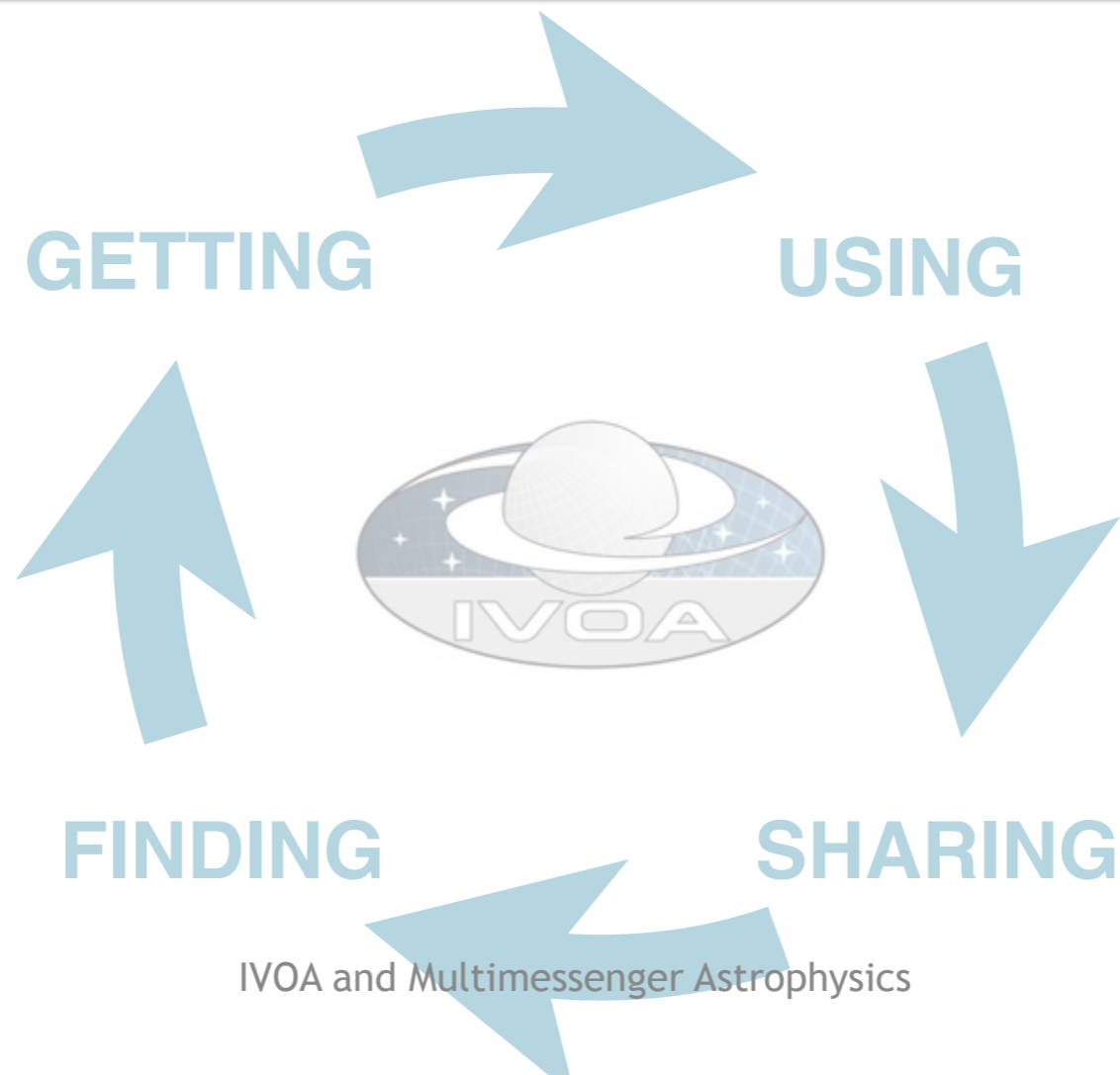
- A science driven organisation that builds the technical standards
- A place for discussing and sharing VO ideas and technology to enable science
- Promoting and publicising the VO



□ The VO and the IVOA: why?

Clear benefits

- Growth in the scientific return of data
- Capability to discover and fuse multiple data sets
- Application of the VO in planning new observations and observing strategies



□ The VO and the IVOA: who?

Who is the IVOA?

- **5 Committees:** Exec, Tech Coordination, Standards & processes, Media, Science priorities
- **6 Working Groups (WG):** Applications, data access, models, grid & web services, registry, semantics
- **8 Interest Groups (IG):** **Time-domain**, radio, solar system, theory, operations, data curation, knowledge & discovery, education

Want to get involved?

- Meetings: 2 interoperability meetings per year
- Don't know where to start? Email any chair/vice-chair of a IG/WG, CSP

<http://ivoa.net/>



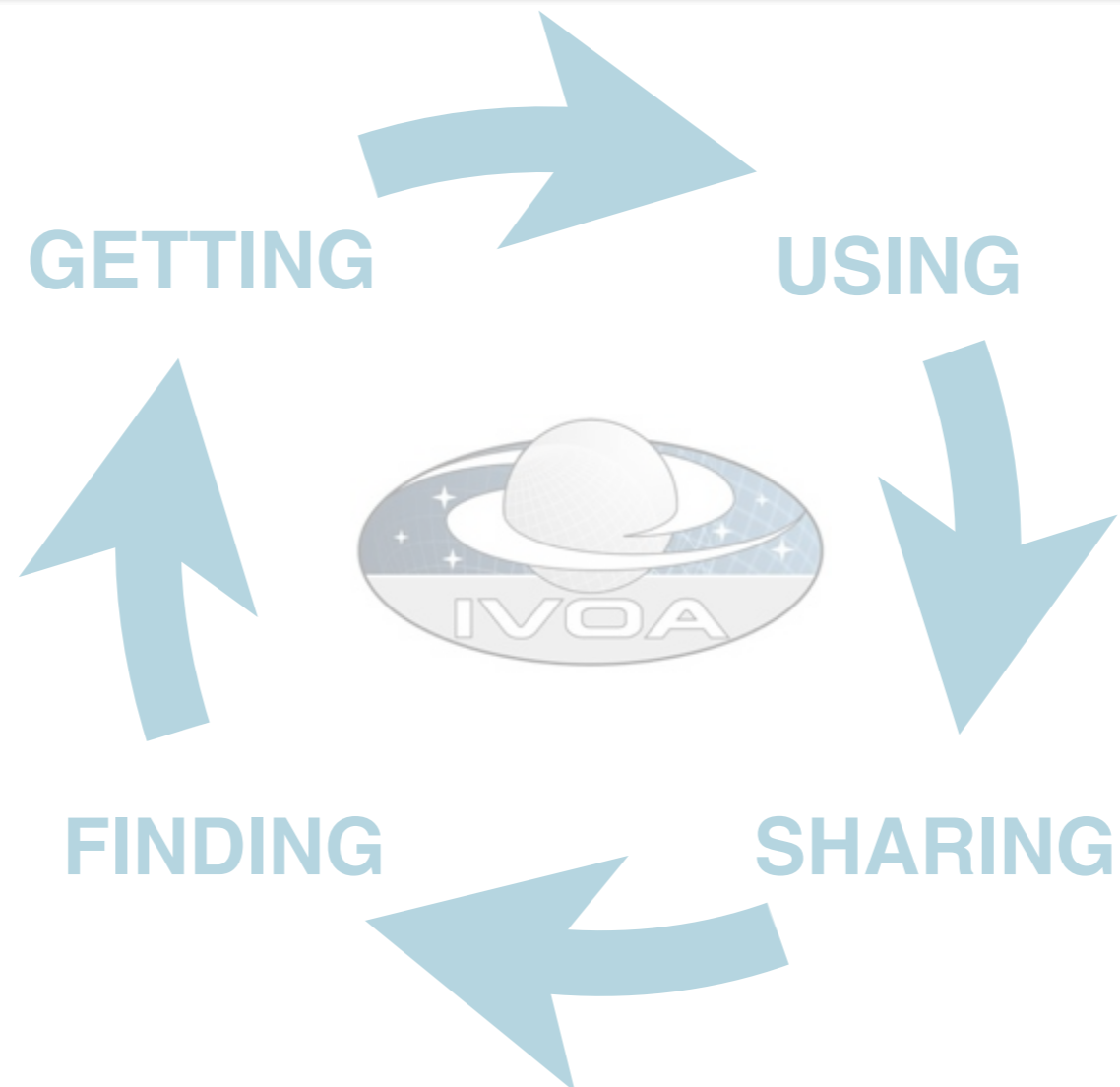
□ The VO and the IVOA: where?

Existing global framework: populated by major data providers (space and ground based) that is heavily used by the community (e.g. Gaia data access is fully VO)



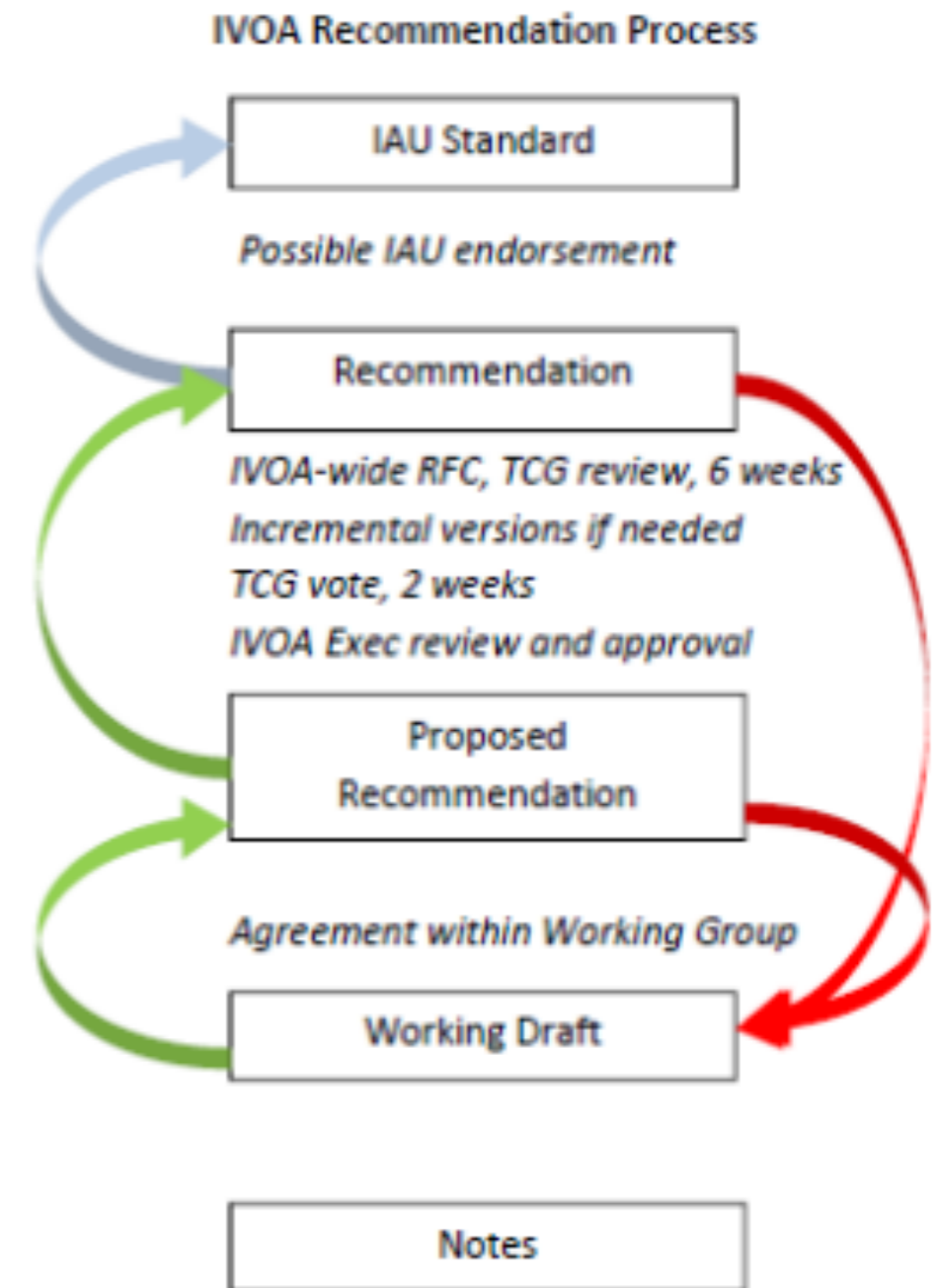
□ The VO and the IVOA: how?

Through the development and adoption of common standards scientifically driven, as an international community effort where astronomers and software engineers are involved



□ IVOA development process of standards

- Build IVOA standards to match users needs:
 - Find and report the community needs
 - Find and report gaps in the existing standards
 - Propose new ways to fill the gaps
 - Implement & validate
 - Standardise when consensus is reached



□ OK, but where do I start?

- A good starting point to newcomers to the IVOA: **the architecture document**

<https://www.ivoa.net/documents/IVOAArchitecture/20211101/index.html>

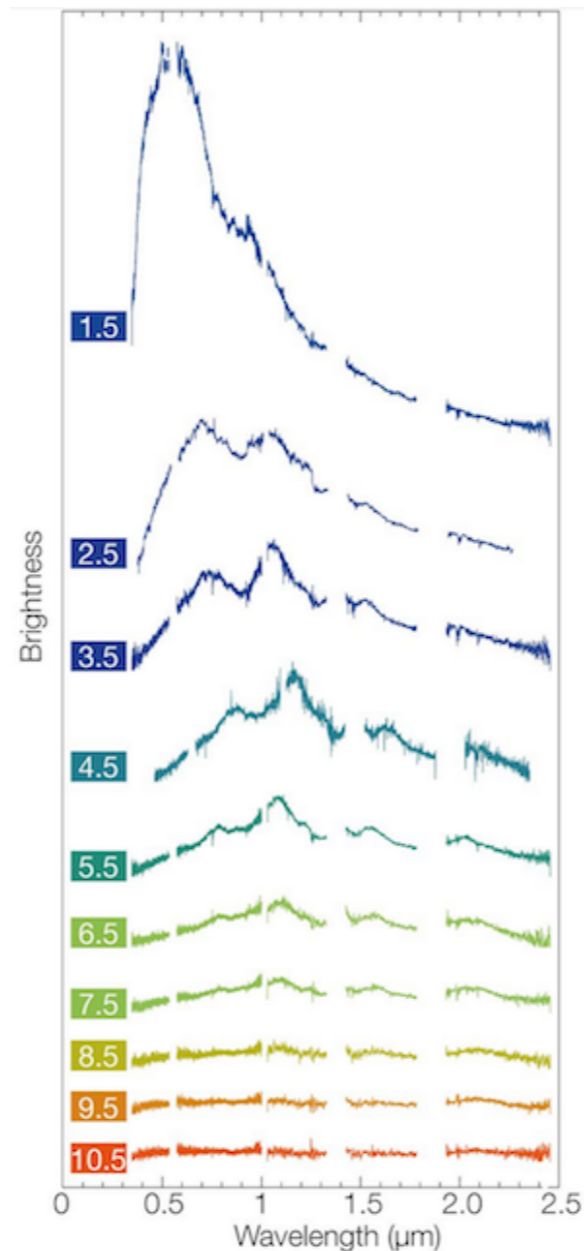
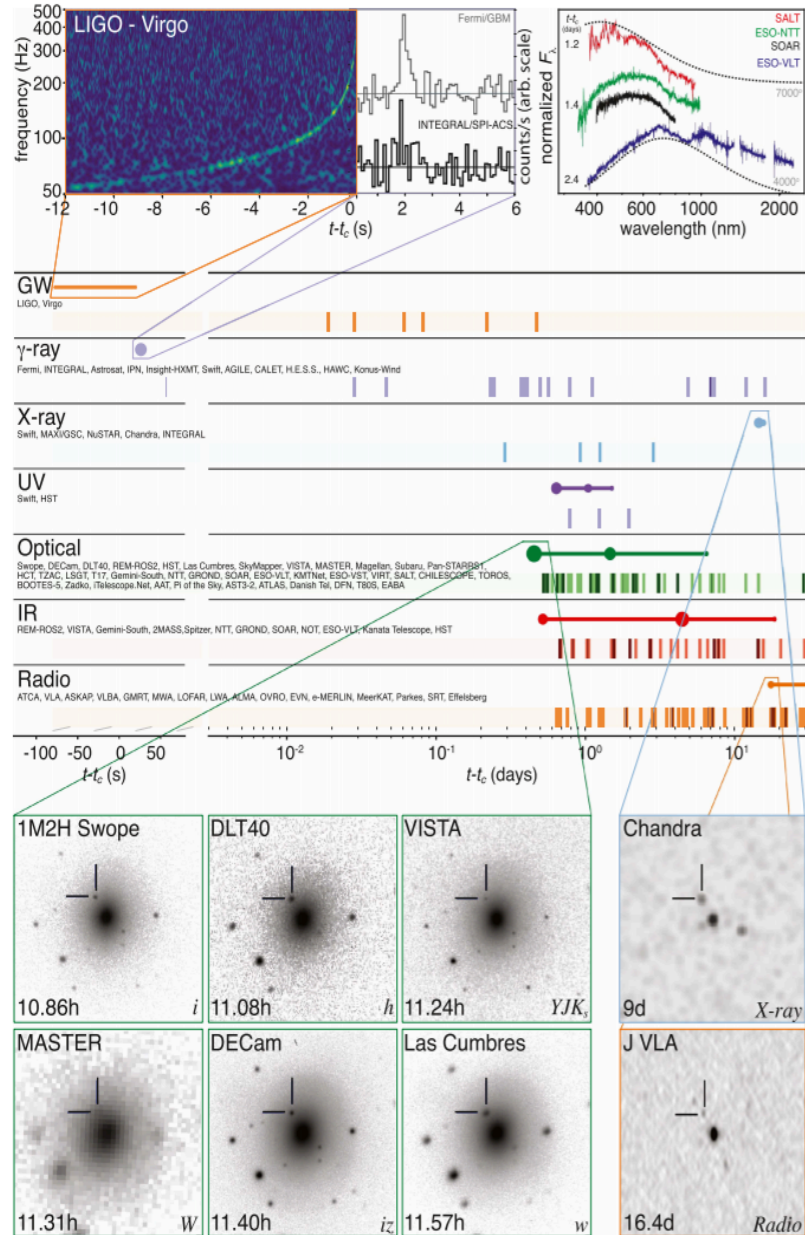
Things to keep in mind:

- The IVOA will not answer your scientific questions nor will it ask the questions for you
- The IVOA provides you with common formats and common ways of describing and accessing the data which when adopted will ease your work

Let's see it with an example

Multi-messenger needs?

THE ASTROPHYSICAL JOURNAL LETTERS, 848:L12 (59pp), 2017 October 20



- Multi-wavelength / messenger approach is needed - different data types
- Follow-up observations and reaction time for that can be crucial - alerts
- Analysis, Visualisation & navigation through the data
- Coordination & transmission of information

The IVOA should match user's needs

□ Some selected standards

1. **VOTable** the format for tabular data for allowing interoperability (coosys, timesys, ucd, utype, VOunits, datalink).
2. **HiPS** more than a format for images - tailored for large data volumes
3. Search for data:
 - **Cone search** — spatial + temporal search
 - **MOC** — spatial and temporal indexing for large data volumes and more complex areas in the sky
 - **TAP + ADQL** — Table Access Protocol & astronomical data query language
 - **ObsCore & ObsTAP** — description of observations
4. Planning of observations:
 - **ObjVisSAP** — visibility of object to plan observations
 - **ObsLocTAP** — facilitate coordination of observations
 - Facilities / observatory list (under dev.)
5. Alerts: **VOEvents**
6. ... many more! **SLAP, SIAP, SSA, Provenance, SAMP...** each tailored to specific use cases

□ VOTable: format for tabular data

Standardisation of coordinate system annotation (time and space), UCD, utypes, VOUnits, datalink

- **COOSYS** ("ICRS", "eq_FK5",...)
- **TIMESYS** (scale: TT, TAI, ..., reposition: barycenter,... timeorigin: JD, MJD,...)
- **Unified Content Descriptor (UCD)**: controlled vocabulary for describing astronomical data quantities - related to the nature of the values
- **UTypes**: relationship between the columns and the data model components
- **VOUnits**: units expressed as a simplified text label (e.g. m.s-2 instead of m s⁻²)
- **Datalink**: links to other associated data

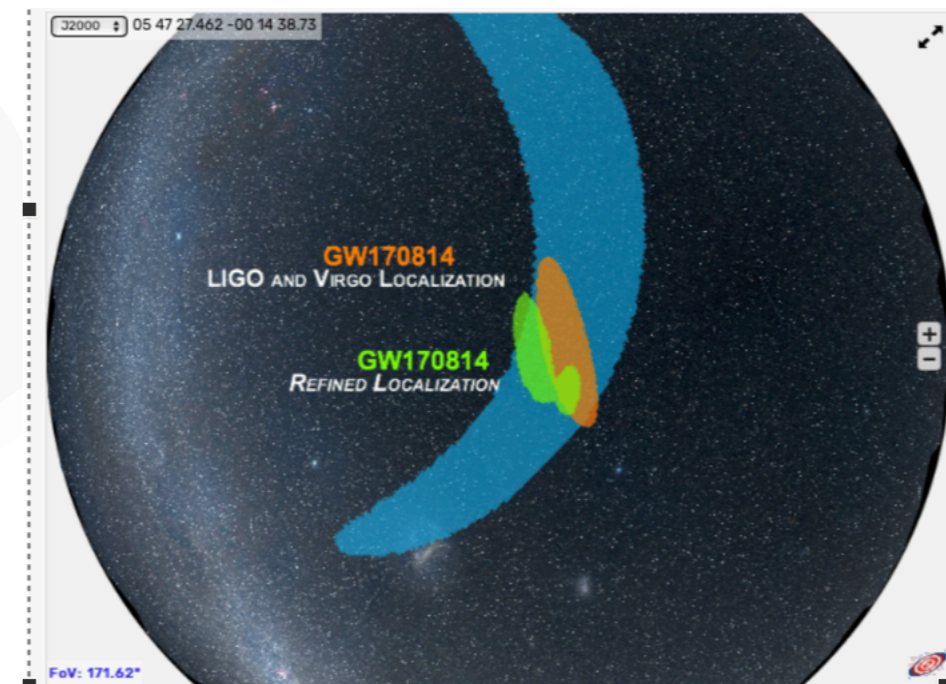
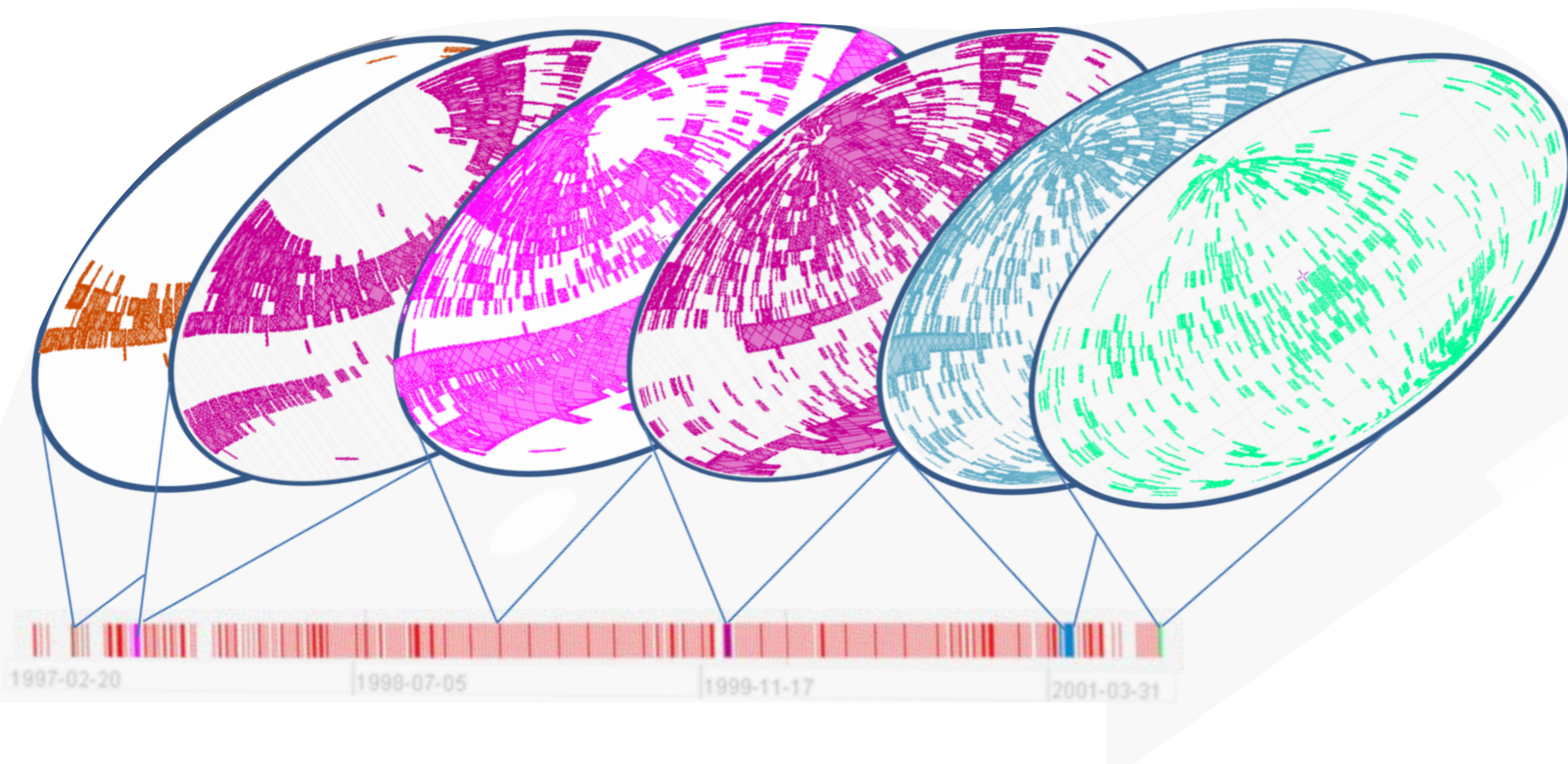
□ HiPS: Hierarchical image Progressive Survey

- A hierarchical scheme for the description, storage and access of sky survey data (the more you zoom-in the more the details)



□ Search: know where & when

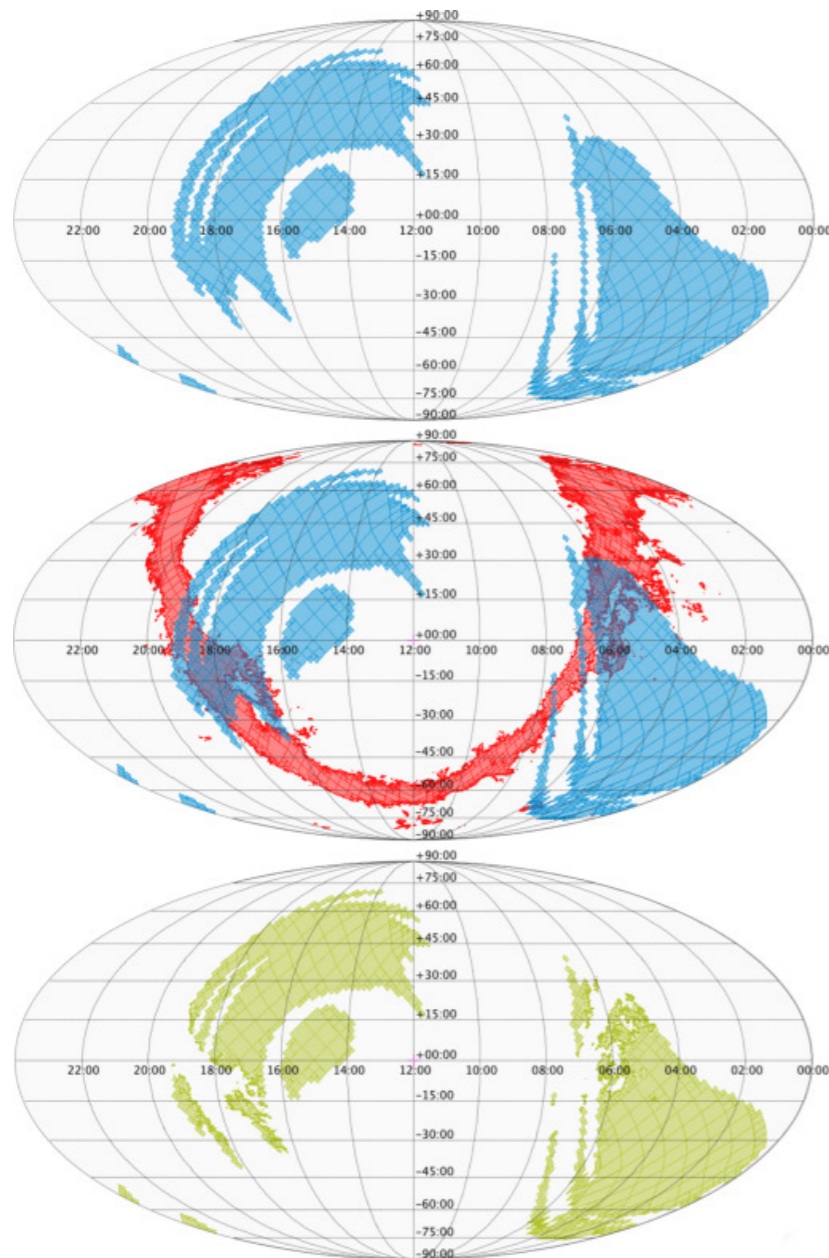
- **Cone search** extension to add a time interval for search in catalogs
- **MOC** : allows to search by temporal+spatial coverage of surveys for the more complicated areas (Simple definition: Associated coverage at a given time)



□ MOC: Multi-order coverage map

Multi Order Coverage data structure to plan multi-messenger observations

G. Greco, et al. 2022A&C....3900547G



Allows to quickly compute intersections between different surveys

Top: Gravitational-wave sky localisation of GW190425 – 90% credible region

Middle: A selected high Galactic dust extinction region is overlaid. The range of pixel values was set from 0.5 up to the highest value.

Bottom: The resulting sky map defined by the gravitational-wave sky localisation with the dust absorption fields subtracted.

Can be computed for the planning of the observations

Library Mocpy a python package affiliated to astropy

□ TAP & ADQL

- **Table Access Protocol (TAP)** - defines a service protocol for accessing general table data, including astronomical catalogs as well as general database tables. Access is provided for both database and table metadata as well as for actual table data.
- **Astronomical Data Query Language (ADQL)** Based on Structured Query Language (SQL) with special restrictions and extensions in order to support generic and astronomy specific operations

```
SELECT DISTANCE (  
    POINT('ICRS', 266.41683, -29.00781),  
    POINT('ICRS', ra, dec)) AS dist, *  
FROM gaiaedr3.gaia_source  
WHERE 1=CONTAINS(  
    POINT('ICRS', 266.41683, -29.00781),  
    CIRCLE('ICRS',ra, dec, 0.08333333))  
ORDER BY dist ASC
```

Visibility of an object

European Southern Observatory
ESO — Reaching New Heights in Astronomy

Public Science User Portal Contact Site Map Search Got

Science Users Information
Observing Facilities
Future Facilities and Development
Observing with ESO Telescopes
Policies and Procedures
Telescope Time Allocation
Phase 1 Proposals
Phase 2 Preparation
Phase 3
Public Surveys
Observing Tools and Services
ESO ETC's
Instrumental Characteristics
Archives and Catalogues
Calendars and Calculators
Weather Images
Astroclimatology
Meteo Information
Visiting Astronomers
Science Software
Data Handling and Products
Science Archive Facility
Science Activities

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, (2) natural center of night, or nighttime hours during which object (and twilight) is defined.

The ESO Sky Calendar Tool

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	

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

XMM-NEWTON MULTI-TARGET VISIBILITY CHECKER

YOU CAN LOOKUP SIMBAD OR NED AGAIN, OR RUN THE VISIBILITY CHECKER USING THE TARGET NAME

Target Name: (eg: Abell 1750)

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: Target name or identifier for output (eg: Abell 1750)

RA: Decimal degrees or HH:MM:SS.S (eg: 13:30:52.5)

Dec: Decimal degrees or DD:MM:SS.S (eg: -01:50:27.0)

VISIBILITY DETAILS

Select either

Revolution Range: First Revolution: default is AO17 revolution range: 3369 to 3551
 Last Revolution:

or

Date Range: From Date: default is AO17 range: 01 May 2018 - 30 Apr 2019
 To Date:

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

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 phase.

SEARCH RESULTS PER TARGET

Target Name	RA	Dec
M31	10.6847	41.2687

Rev.	Via. Start (yyyy-mm-dd hh:mm)	Via. Window Duration (s)	Via. End (yyyy-mm-dd hh:mm)	Rounded Vis. (s)	Visibility Start Phase
3397	2018-06-28 02:58	27036	2018-06-28 10:29	25000	0.76
3398	2018-06-29 12:49	78126	2018-06-30 10:31	75000	0.47
3399	2018-07-01 12:42	78063	2018-07-02 10:23	75000	0.47
3400	2018-07-03 12:35	77939	2018-07-04 10:14	75000	0.47
3401	2018-07-05 12:29	77804	2018-07-06 10:06	75000	0.47
3402	2018-07-07 12:22	77715	2018-07-08 09:58	75000	0.47
3403	2018-07-09 12:15	78302	2018-07-10 10:00	75000	0.47
3404	2018-07-11 12:07	78348	2018-07-12 09:53	75000	0.47

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.

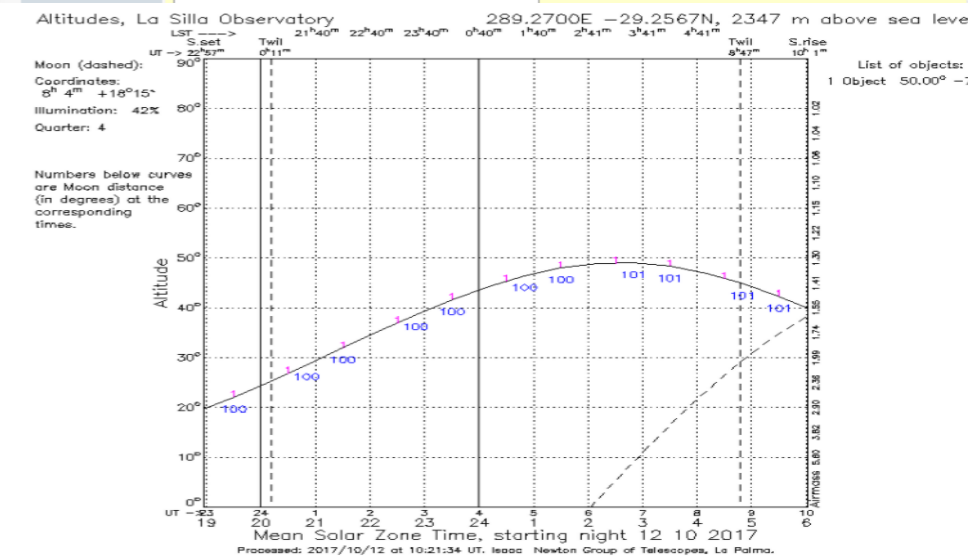
Mode:

Night: or date when the local night starts. Staralt, Startrack only.

Observatory: 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 i dd mm ss
name hh:mm:ss i 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 recommend a maximum of 100 targets per submission.




Different services have different inputs / outputs

Facilitate the work by having some level of standardised input / output

Object Visibility Simple Access Protocol, Aitor Ibarra, Richard Saxton, Jesús Salgado et al. 2020
<http://www.ivoa.net/documents/ObjVisSAP/index.html>

Coordination of observations



Integral Target and Scheduling Information

Schedule: [All executed](#) [Current revolution \(1872\)](#) [Future schedule](#) Revolution to [Show...](#) show plot

Schedule for revolution 1872

(this list is also available in csv-format, click [here](#) to download)

Rev	Start time (UTC)	End time (UTC)	Exp. time (s)	Target	Ra (J2000)	Dec (J2000)	Pattern	PI	Propo
1872	2017-10-10 13:29:15	2017-10-10 17:10:51	12600	Gal. Bulge region	17:45:36.00	-28:56:00.0	HEX	Erik Kuulkers	14200
1872	2017-10-10 17:13:34	2017-10-11 07:55:55	50000	Galactic Center	17:52:11.21	-25:21:49.7	5x5 Seq	Joern Wilms	14200
1872	2017-10-11 08:16:46	2017-10-11 11:58:32	12600	Galaxy (l=0, b=0)	17:42:23.76	-29:38:02.4	HEX	Rashid Sunyaev	14200
1872	2017-10-11 12:26:36	2017-10-11 12:56:36	1800	Galaxy (l=0, b=-30)	20:02:16.80	-41:20:31.2	HEX	Rashid Sunyaev	14200
1872	2017-10-11 13:27:21	2017-10-11 14:29:17	3600	Galaxy (l=0, b=-30)	19:59:40.80	-41:05:16.8	HEX	Rashid Sunyaev	14200
1872	2017-10-11 15:00:12	2017-10-11 17:38:07	9000	Galaxy (l=0, b=-30)	19:59:40.80	-41:05:16.8	HEX	Rashid Sunyaev	14200
1872	2017-10-11 18:41:00	2017-10-12 08:01:56	45000	GRS 1915+105	19:15:11.79	+10:56:45.7	5x5 Seq	Jerome Rodriguez	14200
							HEX	Rashid Sunyaev	14200
							HEX	Rashid Sunyaev	14200

Short Term Schedule

XMM-NEWTON SHORT-TERM SCHEDULE

The Short-term Schedule gives an overview of scheduled observations covering the time range from the past week until the upcoming ~2-4 weeks.

Background: The planning and scheduling procedure is described in Sect. 8.2 of the Policies and Procedures. In addition, the process of scheduling XMM-Newton observations is described in A guided tour to the scheduling of an XMM-Newton orbit.

Description: Each row lists the revolution number (REV#), Observation Identifier (ObsID), target name, pointing coordinates plus position angle (PA), start and stop times, prime instrument, accumulated exposure times (in kiloseconds) for each instrument (without overhead), and name of the Principal Investigator (PI). The start and stop times refer to the instrument activities required to perform the observation. The exposure times are accumulated over all exposures taken with the same instrument. Especially for OM, the observation can be split in shorter exposures with different filter/mode. EPIC exposure times in brackets indicate that one or all exposures use the closed filter. Details can be seen when clicking on the ObsID.

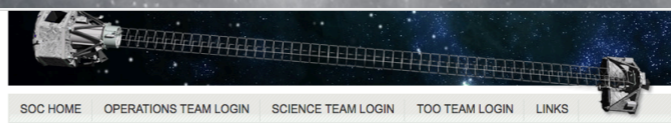
The row marked in blue indicates the target that is scheduled for the time of the last table update. The creation date is given at the top of the table.

Caveats: The scheduling of an XMM-Newton revolution may have to be revised (see Sects. 8.2, 8.3, and 5.2.2 of the Policies and Procedures). Contingencies of any type and solar flaring activity may impact at different levels the scheduled programme. The [Observation Log Browser](#) can be checked to see what was actually done.

Update frequency: Every 8 hours or when the schedule is updated (new revolution planned or any existing updated). The latest available version can be viewed after clearing the browser buffer from the contents of any previous sessions.

Last updated on: 2017-10-10 12:42:00 UT (Current Rev = 3267)

Rev#	Obs Id.	Target Name	RA hh:mm:ss	DEC dd:mm:ss	PA ddd.dd	UTC Obs Start yyyy-mm-dd hh:mm:ss	UTC Obs End yyyy-mm-dd hh:mm:ss	Prime Instr.	PN Dur Ks	MOS1 Dur. Ks	MOS2 Dur. Ks	RGS1 Dur. Ks	RGS2 Dur. Ks	OM Dur. Ks	PI
3276	0805150401	ESO 018-G009	08:24:07	-77:46:57	88.63	2017-10-29 19:34:26	2017-10-30 00:54:26	EPIC	16.7	18.1	18.1	18.2	18.2	18.0	Peter Boorman
3276	0801870801	HD 81809	09:27:46	-06:04:17	92.00	2017-10-29 15:00:13	2017-10-29 18:20:13	EPIC	9.5	10.9	10.9	11.0	11.0	10.8	Fabio Favata
3276	0561381201	zeta Puppis	08:03:40	-40:00:36	112.00	2017-10-29 01:21:41	2017-10-29 14:08:21	RGS	44.5	44.9	44.9	45.0	45.0	37.3	Fred Jansen XMM-Newton MM
3276	0803950401	SDSS 102714.77+35431	10:27:14	+35:43:17	119.93	2017-10-28 15:44:35	2017-10-28 23:31:15	EPIC	25.5	26.9	26.9	27.0	27.0	26.8	Guido Risaliti
3276	0803240201	J072637.95+394556.0	07:26:37	+39:45:58	91.37	2017-10-28 11:02:32	2017-10-28 14:55:52	EPIC	11.5	12.9	12.9	13.0	13.0	12.9	Nathan Secrest
3275	0801990201	0457-6739	04:57:33	-67:39:06	136.67	2017-10-27 12:22:47	2017-10-27 01:07:47	EPIC	43.4	44.8	44.8	44.9	44.9	43.7	Patrick Kavanagh
3275	0801990401	0449-6903	04:49:34	-69:03:34	138.62	2017-10-26 23:32:47	2017-10-27 12:02:47	EPIC	42.5	43.9	43.9	44.0	44.0	42.8	Patrick Kavanagh
3275	0803952601	SDSS 082619.71+34464	08:26:19	+34:46:48	101.78	2017-10-26 14:44:48	2017-10-26 21:55:02	EPIC	36.0	37.4	37.4	37.5	37.5	37.3	Guido Risaliti



Observing schedules

Short Range Observatory Schedule [Download](#)

This is the confirmed schedule of NuSTAR observations. This sequence of observations has been uploaded to the spacecraft and will execute autonomously unless interrupted by a new schedule, Target of Opportunity, or instrument and spacecraft anomalies. This schedule will cover various time ranges depending on the exposure time goal of the observations, but will usually be for a period of at least one week.

The times reported here are the start and end of the on-target period (day of year UTC). The estimated exposure time takes into account Earth occultation and the SAA passage time where detector background is increased. The end time of the observation is the start of the slew to the next target. Please examine the NuSTAR As-Flown Timeline (AFT) for the log of past observations.

Table Header Explanations

obs_start	obs_end	sequenceID	Name	J2000_RA	J2000_Dec	Exp	Notes
2017:281:19:05:02	2017:283:00:30:00	90201021006	Kepler	262.671620	-21.491957	60.6	DDT
2017:283:01:11:23	2017:283:02:40:00	90311211001	Sol_17282_AR2683_POS11	195.15715	-6.38520	3.4	ToO
2017:283:02:40:32	2017:283:04:20:00	90311212001	Sol_17282_AR2683_POS12	195.21879	-6.41062	3.4	ToO
2017:283:04:20:32	2017:283:05:50:00	90311213001	Sol_17282_AR2683_POS13	195.28046	-6.43604	3.4	ToO
2017:283:06:55:11	2017:284:09:20:00	60376001002	2MASXJ19301380p3410495	292.557500	34.180500	55.3	Extragalactic Legacy Survey
2017:284:09:45:09	2017:284:20:35:00	60360008002	SDSSJ152132d21p39120609	230.3874232	39.2007671	22.0	Extragalactic Legacy Survey
2017:284:21:10:03	2017:285:21:00:00	90301320002	NGC_6440	267.218083	-20.358944	49.5	ToO
2017:285:21:20:06	2017:286:08:20:00	30302020004	GRS_1915p105	288.79813	10.94578	21.9	(2/4) coordinated with XMM and VLT
2017:286:08:35:06	2017:286:19:30:00	60160701002	2MASXJ18560128p1538059	284.00210000	15.63200000	23.3	BAT AGN
2017:286:20:05:11	2017:287:15:05:00	60376007002	UGC06728	176.316800	79.681500	61.4	Extragalactic Legacy Survey
2017:287:15:50:11	2017:288:03:20:00	60368001002	NGC_1144	43.80083	-0.18361	22.0	
2017:288:04:05:09	2017:288:23:00:00	60301004002	ESO_103m35	279.58458	-65.4275	50.3	
2017:288:23:30:08	2017:290:05:45:00	30301026002	AX_11841d0m0536	280.25179	-5.59625	59.7	phase constrained
2017:290:06:00:04	2017:290:17:00:00	60160670002	2E1739d1m1210	265.47600000	-12.19700000	23.5	BAT AGN
2017:290:17:15:01	2017:291:04:20:00	30363001002	GX_3p1	266.98333	-26.56361	21.8	

Long Range Observatory Schedule

This is the latest NuSTAR long-term schedule. Observations have been sorted into one-week intervals, taking into account Sun, Moon, required exposure time, and other constraints. So the date is the Monday of the week in which the observation is scheduled to begin.

E.g. An observation with a date 2017-12-18 in this table is scheduled to have the observation starting sometime between 2017-12-18 0000Z and 2017-12-25 0000Z.

Currently the schedule is driven by the large number of observations coordinated with other observatories and the need to complete the NuSTAR Guest Observer programs. The exposure goal for targets allotted within one week may appear to fill more than the available NuSTAR exposure time in that week (average is 330 ks per week) but many observations start in one week and complete in the following week.

Targets of opportunity and any instrument or spacecraft anomalies may also cause the observing times of targets to shift. This long-term schedule is our present estimate of the future order of observations. Please be aware of the uncertainties.

ToO = Target of Opportunity DDT = Directors Discretionary Time N03 = NuSTAR GO cycle-3 I15 = INTEGRAL GO cycle-15 X16 = XMM-Newton GO cycle-16 C18 = Chandra GO cycle-18 ELS/GLS = Extragalactic/Galactic legacy surveys

09-Oct-2017 18:48:29 --- Preliminary HST Observing Timeline Report for SMS: 1728884 --- Page 1
SMS Start: 2017.288:22:10:00 (15-OCT-2017 22:10:00), End: 2017.296:00:00:00 (23-OCT-2017 00:00:00)

Scheduling Unit	Begin UT	End UT	SU Id	Principal Investigator	Exp #	Target	Science Instrume Mode	Apertures	Spectral Elements	Exposure Time(sec)	OB AL	EX
2017.288	23:00:00	23:35:07	1483521	Lockwood	E1-001	DARK	STIS/MAZ TIME-T	F28X50LP	MIRVIS	1300.00	F1	01
2017.288	23:14:45	06:30:55	1476735	Sing	35-001	WASP-69	COS/NUV ACQ/PE PSA		G230L	12.00	35	01
2017.288	23:14:45	06:30:55	1476735	Sing	35-002	WASP-69	COS/NUV ACQ/PE PSA		G230L	12.00	35	02
2017.288	23:14:45	06:30:55	1476735	Sing	35-003	WASP-69	COS/NUV ACQ/PE PSA		G230L	12.00	35	03
2017.288	23:14:45	06:30:55	1476735	Sing	35-004	WASP-69	COS/FUV TIME-T PSA		G130M	1917.00	35	01
2017.288	23:14:45	06:30:55	1476735	Sing	35-005	WASP-69	COS/FUV TIME-T PSA		G130M	2706.00	35	02
2017.288	23:14:45	06:30:55	1476735	Sing	35-006	WASP-69	COS/FUV TIME-T PSA		G130M	2706.00	35	03
2017.288	23:14:45	06:30:55	1476735	Sing	35-007	WASP-69	COS/FUV TIME-T PSA		G130M	2706.00	35	04
2017.288	23:14:45	06:30:55	1476735	Sing	35-008	WASP-69	COS/FUV TIME-T PSA		G130M	2706.00	35	05
2017.289	00:00:00	00:28:32	1481937	Riley	JP-001	DARK	STIS/CCD ACCUM	F28X50LP	MIRVIS	1100.00	JP	01
2017.289	00:00:00	00:28:32	1481937	Riley	JP-002	DARK	STIS/CCD ACCUM	F28X50LP	MIRVIS	60.00	JP	02
2017.289	00:00:00	00:28:32	1481937	Riley	JP-003	DARK	STIS/CCD ACCUM	F28X50LP	MIRVIS	60.00	JP	03
2017.289	00:00:00	00:46:10	1453338	Bourque	3B-001	DARK-NM	WF3/UVI ACCUM	UVIS	F373N	900.00	3B	01
2017.289	00:00:00	00:46:10	1453338	Bourque	3B-001	DARK-NM	WF3/UVI ACCUM	UVIS	F373N	900.00	3B	02
2017.289	00:39:46	01:08:18	1481930	Riley	JC-001	DARK	STIS/CCD ACCUM	F28X50LP	MIRVIS	1100.00	JC	01
2017.289	00:39:46	01:08:18	1481930	Riley	JC-002	DARK	STIS/CCD ACCUM	F28X50LP	MIRVIS	60.00	JC	02
2017.289	00:39:46	01:08:18	1481930	Riley	JC-003	DARK	STIS/CCD ACCUM	F28X50LP	MIRVIS	60.00	JC	03
2017.289	00:46:10	01:32:20	1453330	Bourque	3C-001	DARK-NM	WF3/UVI ACCUM	UVIS	F467M	800.00	3C	01
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	01
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	02
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	03
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	04
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	05
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	06
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	07
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	08
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	09
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	10
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	11
2017.289	01:27:12	01:56:24	1482190	Riley	90-001	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	12
2017.289	01:27:12	01:56:24	1482190	Riley	90-002	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	01
2017.289	01:27:12	01:56:24	1482190	Riley	90-002	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	02
2017.289	01:27:12	01:56:24	1482190	Riley	90-002	BIAS	STIS/CCD ACCUM	F28X50LP	MIRVIS	0.00	90	03
2017.289	01:27:12	01:56:24	1482190									

□ Publishing your data in the VO

Do you have data and you would like to publish it?

<https://wiki.ivoa.net/twiki/bin/view/IVOA/PublishingInTheVO>

Depending of your needs and your technical experience, there are several ways to publish you data into the VO:

- if you have very little technical expertise, you might want to contact your national VO projects who might already have the infrastructure to host your data and make it available to the VO. See the [list of national VO projects](#) and the [selection of open data centers](#) offering publication as a service
- if you would like to find your VO services in client applications, please publish your service in a [VO Registry](#).
- if you have some technical expertise but don't want to spend time to development, you might want to use directly some existing [VO Publishing toolkits](#).
- if you prefer VO interfaces to your data yourself, you might find some useful [VO software tools and libraries](#). A good start would be to determine what [type of data](#) you want to publish (images, catalogues, spectra, ...). Reading through the [IVOA Architecture document](#) might also be useful before going into the more details of the specific [IVOA standards](#) that you might need to use

□ Access data in the VO

There are different ways to access the VO, eg via Aladin, Topcat, python

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- [Getting started](#)
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 - [Registry search](#)
- [Using `pyvo`](#)

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PyVO

Introduction

This is the documentation for PyVO, an affiliated package for the [astropy](#) package.

PyVO lets you find and retrieve astronomical data available from archives that support standard [IVOA](#) virtual observatory service protocols.

- [Table Access Protocol \(TAP\)](#) – accessing source catalogs using sql-ish queries.
- [Simple Image Access \(SIA\)](#) – finding images in an archive.
- [Simple Spectral Access \(SSA\)](#) – finding spectra in an archive.
- [Simple Cone Search \(SCS\)](#) – for positional searching a source catalog or an observation log.
- [Simple Line Access \(SLAP\)](#) – finding data about spectral lines, including their rest frequencies.

Note

If you need to access data which is not available via the Virtual Observatory standards, try the astropy affiliated package [astroquery](#) (and, of course, ask the data providers to do the right thing and use the proper standards for their publication).

Lots of tutorials on how to access data

<https://nasa-navo.github.io/navo-workshop/>

<https://github.com/cds-astro/tutorials>

<https://github.com/cds-astro/mocpy/tree/master/notebooks>

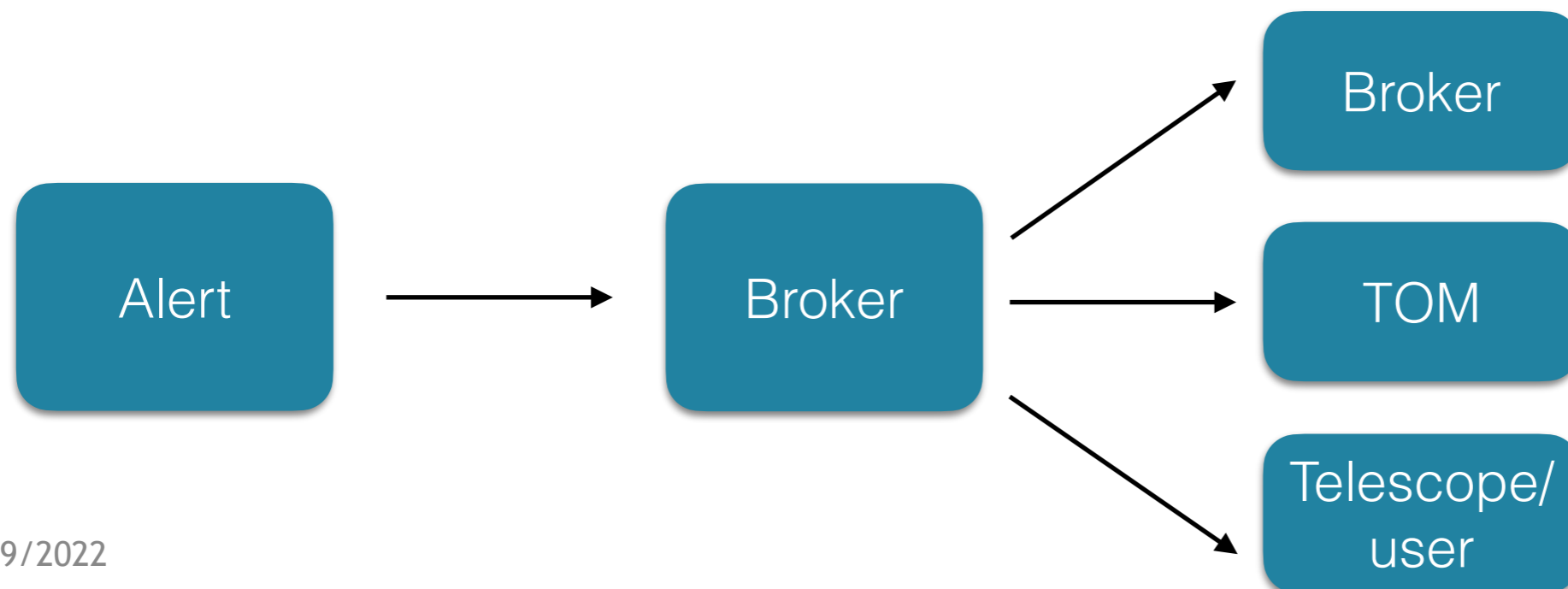
☐ Alerts

1. VOEvent (REC):

- Content: a core data model for alerts
 - Who, What, WhereWhen, Why, and How
 - Defined by the community (e.g. FRB)
- A format: a serialization of that data model (xml)

2. VTP - VOEvent Transport protocol (REC):

- a communication protocol for publishing, and subscribing to alerts



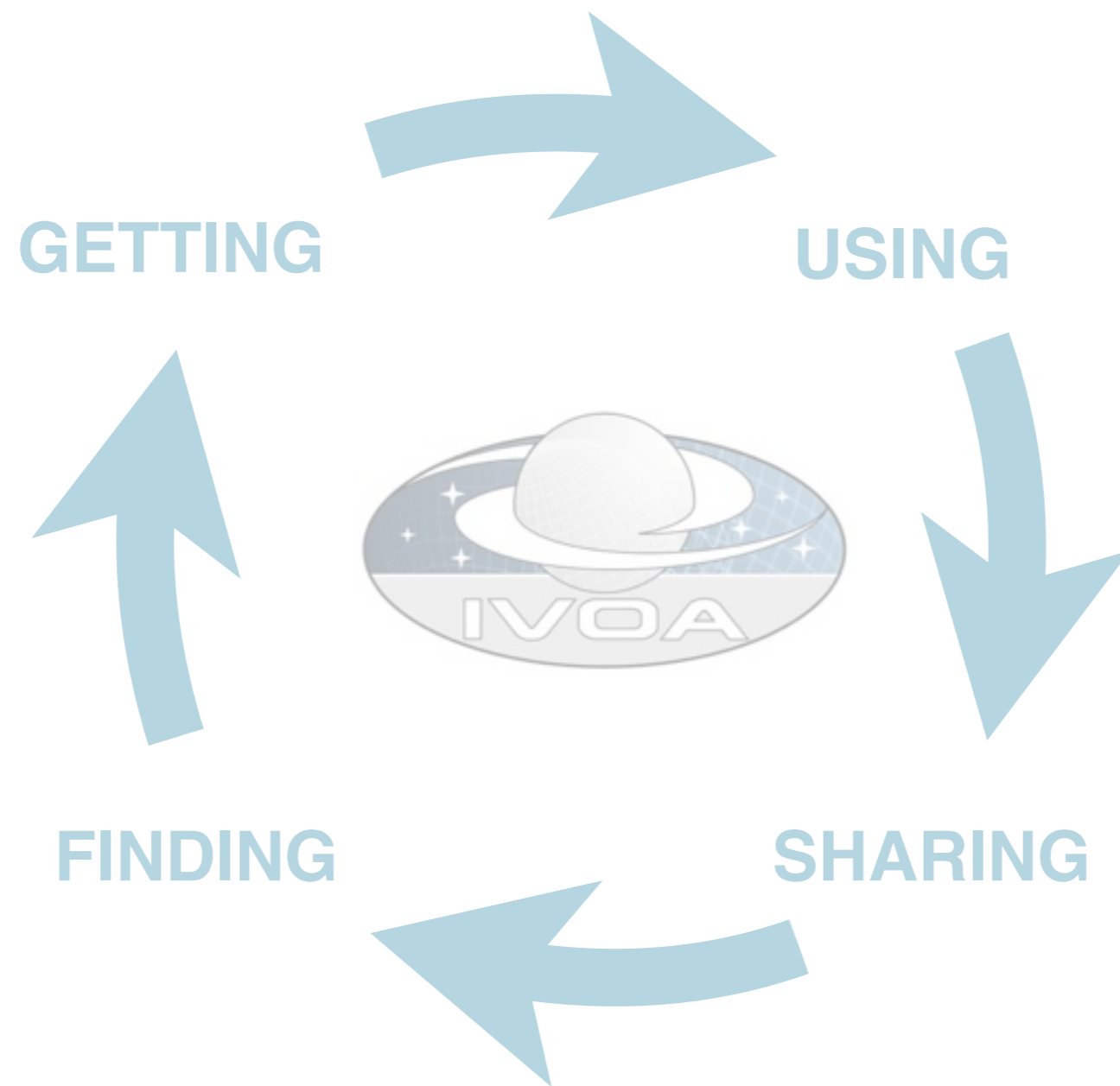
□ VOEvent: Sky Event Reporting Metadata

- “Defines the content and meaning of a standard information packet for representing, transmitting, publishing and archiving information about a transient celestial event, with the implication that timely follow-up is of interest”
 - **Who**: Identification of scientifically responsible Author
 - **What**: Event Characterization modeled by the Author
 - **WhereWhen**: Space-Time Coordinates of the event
 - **How**: Instrument Configuration
 - **Why**: Initial Scientific Assessment
 - **Citations**: Follow-up Observations
 - **Description**: Human Oriented Content
 - **Reference**: External Content

□ Open questions

- Are the existing standards enough or do we need changes / new developments?
- In the context of alerts:
 - VOEvent : model (content) + serialization (format)
 - VTP : transport protocol works for low rates (10 Hz) doesn't scale well for very high rates ($>10^3\text{Hz}$)
- Is this still what the community needs?
- New technologies and serialisations are used, in particular GCN adopting and moving towards Kafka / Avro (ZTF, Rubin, LVK,...)
- What is the impact on the existing VOEvent infrastructure & community?
- How to find who distributes alerts in the VO land? Register in the registry? Or the community knows where to find alerts?
- **Is there a need to standardize event types (Who, What, WhereWhen, Why, and How) — the core model?**
 - Extending the work on FRBs to cover other Types?
 - If so, smaller working groups within transient sub-fields develop a proposed standard to be iterated upon within the wider user base. Once a standard is developed, it can be submitted to the IVOA and published as an IVOA Note.
 - How do we store information in a way that it can be easily extracted and interpreted later? What types of queries do people want to perform on archived VOEvents? How do we make VOEvent streams findable

□ Thanks!



□ Some useful links

- <https://www.ivoa.net>
- Docs : <https://www.ivoa.net/documents/>
- GitHub : <https://github.com/ivoa>
- Mailing list : <https://www.ivoa.net/members/index.html>
- Architecture: <https://www.ivoa.net/documents/IVOAArchitecture/20211101/index.html>
- Slack: https://join.slack.com/t/ivoa/shared_invite/zt-17kd0v93b-b32~KReWd1T96gDyYFDLPQ