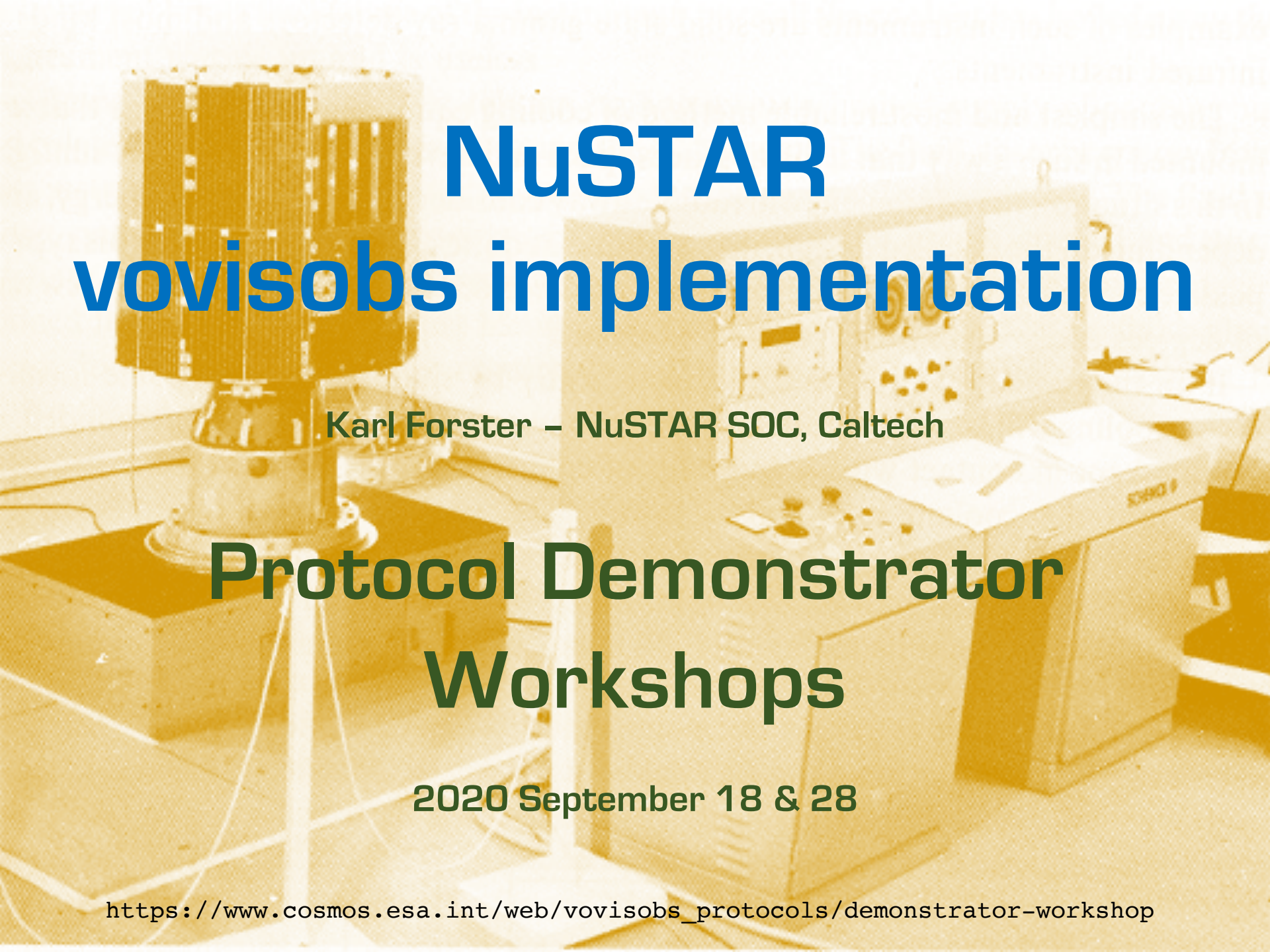


NuSTAR vovisobs implementation

Karl Forster – NuSTAR SOC, Caltech

Protocol Demonstrator Workshops

2020 September 18 & 28

https://www.cosmos.esa.int/web/vovisobs_protocols/demonstrator-workshop

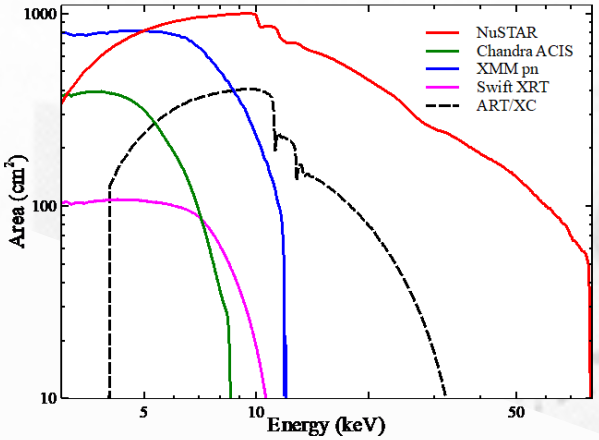
Outline & Lessons learned

- Approached from an Observatory Operations viewpoint
  - Implementation independent of development of VOVISOBS protocols at ESAC
    - With minimal experience in website and webserver installation
- Two short presentations
  - ObsVisSAP and ObsLocTAP implementation
  - Notes on NuSTAR implementation as it progresses is available on googledoc

`docs.google.com/document/d/1gzV0E681vmPsFZK2PPlepLHSpekVf7BYie09R4RFh8w`

- Lessons learned
  - Implementation provides a useful deep-dive into the planning process
    - NuSTAR mission planning database needs upgrading after 8 years of operations
  - Pay attention to operations security considerations
    - Web server for visibility and observation locator queries should be independent of operations servers
  - ObsVisSAP
    - Independent installation of python code for ObsVisSAP
    - Identify use cases specific for your observatory
      - May benefit from implementation of multiple query / result options (within protocol)
  - ObsLocTAP
    - Clearly map information flow before starting implementation
      - Including where/when in planning process to insert information into the database
    - Use cases should determine efficacy of information
    - Implementation is complex but not complicated

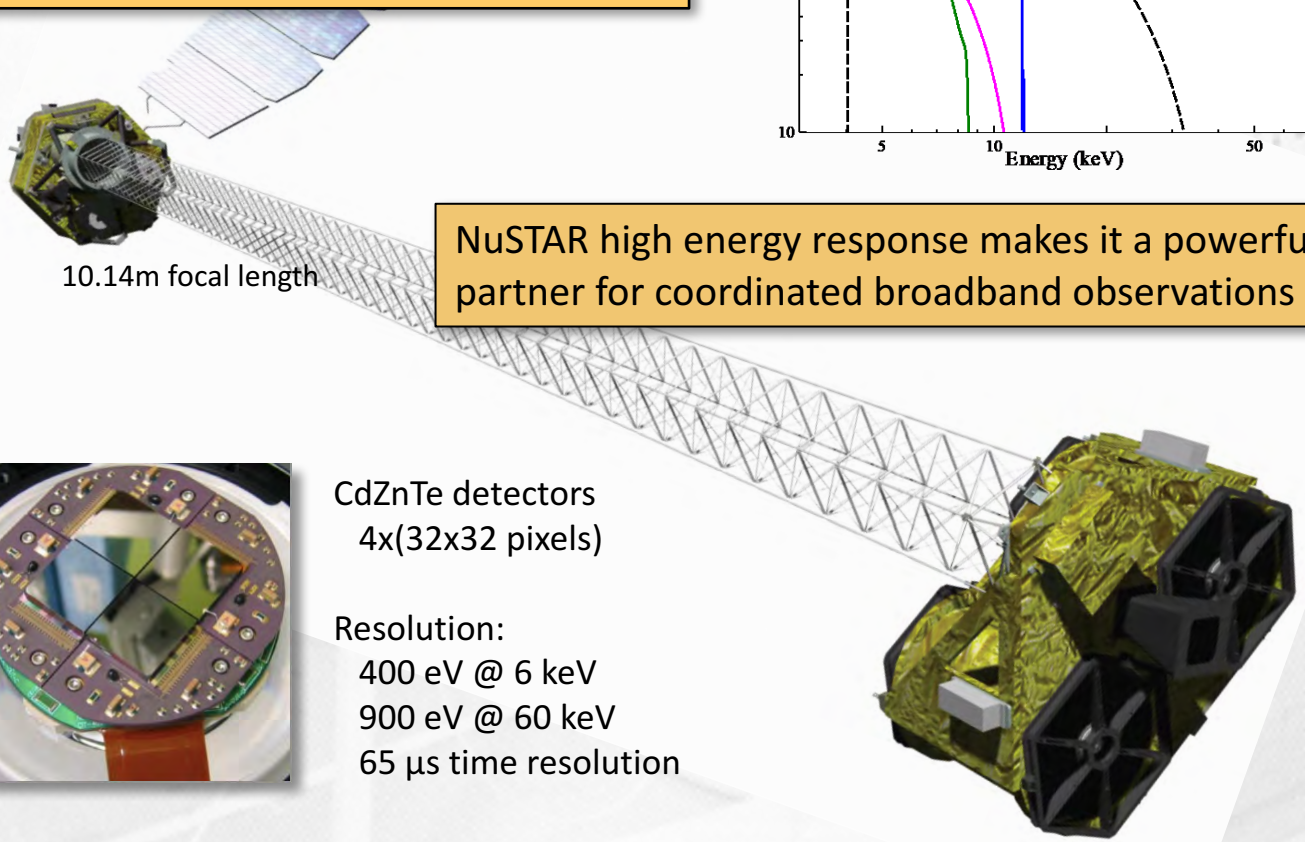
- NASA small explorer astrophysics mission
- PI Fiona Harrison (Caltech)
- Partners: ASI, SSDC, DTK, HEASARC
- Launched on June 2012, 620 km, 6° orbit
  - Orbital-ATK LeoStar-2 spacecraft bus
- Observations are queue scheduled
  - Executed autonomously



Joint observing programs

ESA	NASA
XMM-Newton	Chandra
INTEGRAL	Swift
(XRISM - JAXA)	NICER

40% of observations are coordinated with another observatory



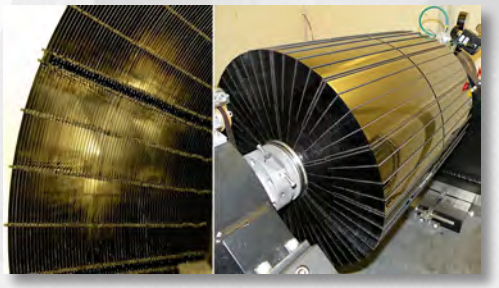
10.14m focal length

NuSTAR high energy response makes it a powerful partner for coordinated broadband observations

CdZnTe detectors
4x(32x32 pixels)

Resolution:
400 eV @ 6 keV
900 eV @ 60 keV
65 µs time resolution

Conical Wolter-I approximation
133 shells (43 W/Si, 90 Pt/C)
HPD = 1 arcminute
FOV = 12’ x 12'

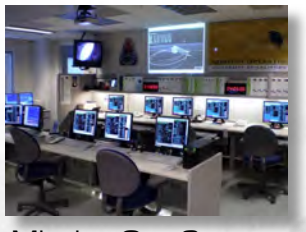


Data and Information flow

Malindi

Ground station

UC Berkeley-SSL



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pipeline processing

HEASARC

SSDC SPACE SCIENCE DATA CENTER

Data archives

GO proposals

NuSTAR
XMM-Newton INTEGRAL
Chandra Gehrels-Swift NICER

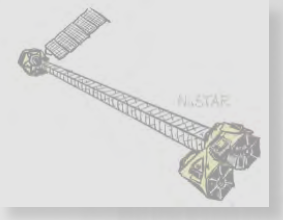
SOC website

Observation Schedules

Target constraint check

L1 data + Products

Data and Information flow

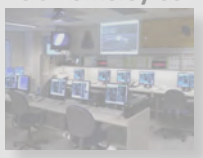


Victoria Grinberg

Malindi

Ground station

UC Berkeley-SSL



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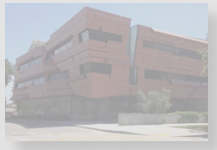

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NuSTAR
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Chandra Gehrels-Swift NICER

ObsLocTAP
service

ObsVisSAP
service

SOC website
client

L1 data
+ Products

HEASARC

SSDC
SPACE SCIENCE DATA CENTER

Data archives

NuSTAR Target constraint (visibility) checking

- Provides ***constraints*** rather than ***visibility***

http://nustarsoc.caltech.edu/NuSTAR_Public/NuSTAROperationSite/CheckConstraint.php

Target details	
Target Name	Resolve Name
RA (J2000 decimal degrees from 0.0 to 360.0)	
Dec (J2000 decimal degrees from -90.0 to 90.0)	
Start UTC Time (YYYY-MM-DD)	2020/06/01 UTC Defaults to start of GO Cycle 6
End UTC Time (YYYY-MM-DD)	2021/05/31 UTC Defaults to end of GO Cycle 6 (use 2022/05/31 for end of cycle-7)
Check Constraints	

Evaluated period (UTC): 2020-Jun-01 to 2021-May-31

Target Name: 3C 273

Target J2000 RA: 187.27791535 degrees.

Target J2000 Dec: +2.05238857 degrees.

Observation constraint evaluation

Solar aspect angle violation(s)

- 2020-08-15/12:00 through 2020-11-10/14:00

Moon aspect angle violation(s) See the violations here

Spacecraft star tracker violation(s) See the violations here

Moon angle violation(s):

- 2020-06-01/00:00 through 2020-06-01/23:00
- 2020-06-27/07:00 through 2020-06-29/05:00
- 2020-07-24/13:00 through 2020-07-26/11:00
- 2020-08-20/21:00 through 2020-08-22/17:00
- 2020-09-17/06:00 through 2020-09-19/02:00
- 2020-10-14/17:00 through 2020-10-16/13:00
- 2020-11-11/03:00 through 2020-11-13/00:00
- 2020-12-08/11:00 through 2020-12-10/09:00
- 2021-01-04/16:00 through 2021-01-06/15:00
- 2021-01-31/22:00 through 2021-02-02/21:00
- 2021-02-28/06:00 through 2021-03-02/04:00
- 2021-03-27/17:00 through 2021-03-29/13:00
- 2021-04-24/03:00 through 2021-04-26/00:00
- 2021-05-21/12:00 through 2021-05-23/10:00

Spacecraft star tracker visibility violation period(s) (UTC)::

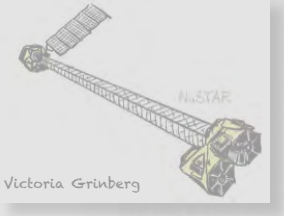
- 2020-Jun-05 1300 through 2020-Jun-07 2000
- 2020-Jul-02 2000 through 2020-Jul-05 0700
- 2020-Jul-30 0200 through 2020-Aug-01 1600
- 2020-Aug-26 0800 through 2020-Aug-28 2000
- 2020-Nov-05 0000 through 2020-Nov-07 0300
- 2020-Dec-02 0000 through 2020-Dec-04 1300
- 2020-Dec-29 0500 through 2020-Dec-31 2100
- 2021-Jan-25 1300 through 2021-Jan-28 0500
- 2021-Feb-21 2300 through 2021-Feb-24 1300
- 2021-Apr-29 1400 through 2021-May-01 1200
- 2021-May-26 2100 through 2021-May-29 0200

Stray light evaluation result: No issues.

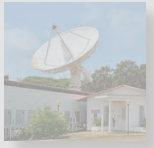
If the stray light evaluation returns "Potential Issues" then proposers may submit a request for a feasibility analysis to the NuSTAR SOC at nustar-help@srl.caltech.edu. The request should include the source name

Not useful for a 'visibility' service

Data and Information flow

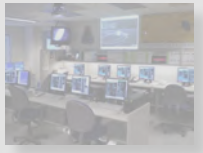


Malindi



Ground station

UC Berkeley-SSL



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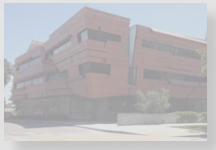

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ObsLocTAP
service

ObsVisSAP
service

SOC website
client

L1 data
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Data archives

ObsVisSAP - implementation

Retain the same interface

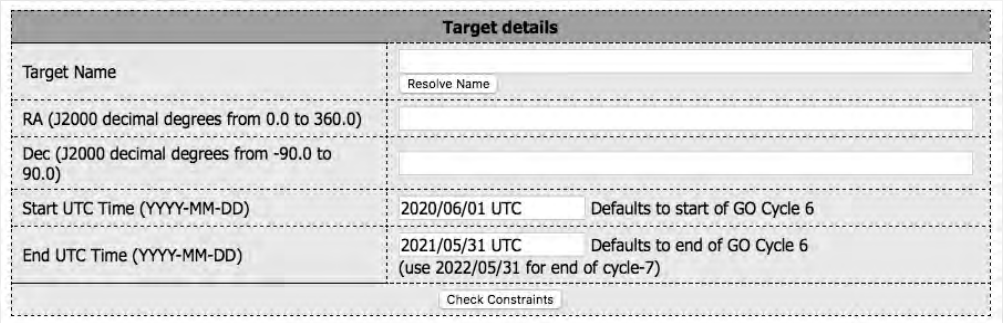
- Translate to create VOVis query

  s_ra, s_dec ICRS decimal degrees
  t_min, t_max MJD
  vis_min minimum visibility optional input parameter

http://nustarsoc.caltech.edu:88/visibility?s_ra=83.633&s_dec=22.0145&t_min=59103.50694&t_max=59130.50694

- Questions to resolve (specific to observatory)

  if t_min not supplied default to now
  t_max limit set to 2 years from now (T_MAX_HARD_LIMIT)
  vis_min (seconds) visibility = exposure time (not duration)



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End UTC Time (YYYY-MM-DD)	2021/05/31 UTC Defaults to end of GO Cycle 6 (use 2022/05/31 for end of cycle-7)
Check Constraints	

Q: what is the useful metric for observers specific to your facility?

ObsVisSAP - implementation

Successful query

- Output VO table (MUST fields only)

t_validity	t_start	t_stop	t_visibility
59833.00	59104.00000	59122.20833	914000.0
59833.00	59124.45833	59129.04167	232000.0

MAY fields: validity_predictor, pos_angle, em_min/max, elevation_min/max, sun/moon_sep_min/max

- Questions to resolve (specific to observatory)

t_start t_stop — Sun, Moon ephemeris is good enough for 10 years
report t_start/stop constraints to nearest hour

t_visibility — Changing target-Earth occultation due to orbit evolution
report to nearest ksec

→ t_validity — Depends on reporting accuracy of t_visibility

ObsVisSAP - implementation

Successful query

- Output VO table (MUST fields only)

t_validity	t_start	t_stop	t_visibility
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report t_start/stop constraints to nearest hour

t_visibility — Changing target-Earth occultation due to orbit evolution
report to nearest ksec

t_validity — Depends on reporting accuracy of t_visibility

informed by use cases

Conclusion: Multiple query options may be required to satisfy use cases

Question: Do we need validity_accuracy as a non-compulsory query parameter input?
allowed values HIGH, MEDIUM, LOW

ObsVisSAP – NuSTAR status

- Transition to new operations server
  CPU: 2 x 2.1 GHz 1128 GB RAM 5 TB harddrive Linux RedHat v7.6
  Database: MySQL v15.1 and PostgreSQL v9.2.24
- Installation of python
  - **Recommend installation in a separate virtual environment**
    - Install Django and astropy (numpy)
- Clone git visibility service code from Emilio Salazar github

```
cd <where you want to install>
git clone https://github.com/emiliosalazardonate/visibility-service/find/master
```

  - Code is now in visibility-service directory
- Test run development server

```
python manage.py runserver
```

  - Development server is available locally at http://127.0.0.1:8000
  - Try visibility test query
    http://127.0.0.1:8000/visibility?s_ra=166&s_dec=-19&t_min=58910.43263&t_max=59094.4
  - Successful but VERY slow -> inhibits remote development (Caltech campus is closed)

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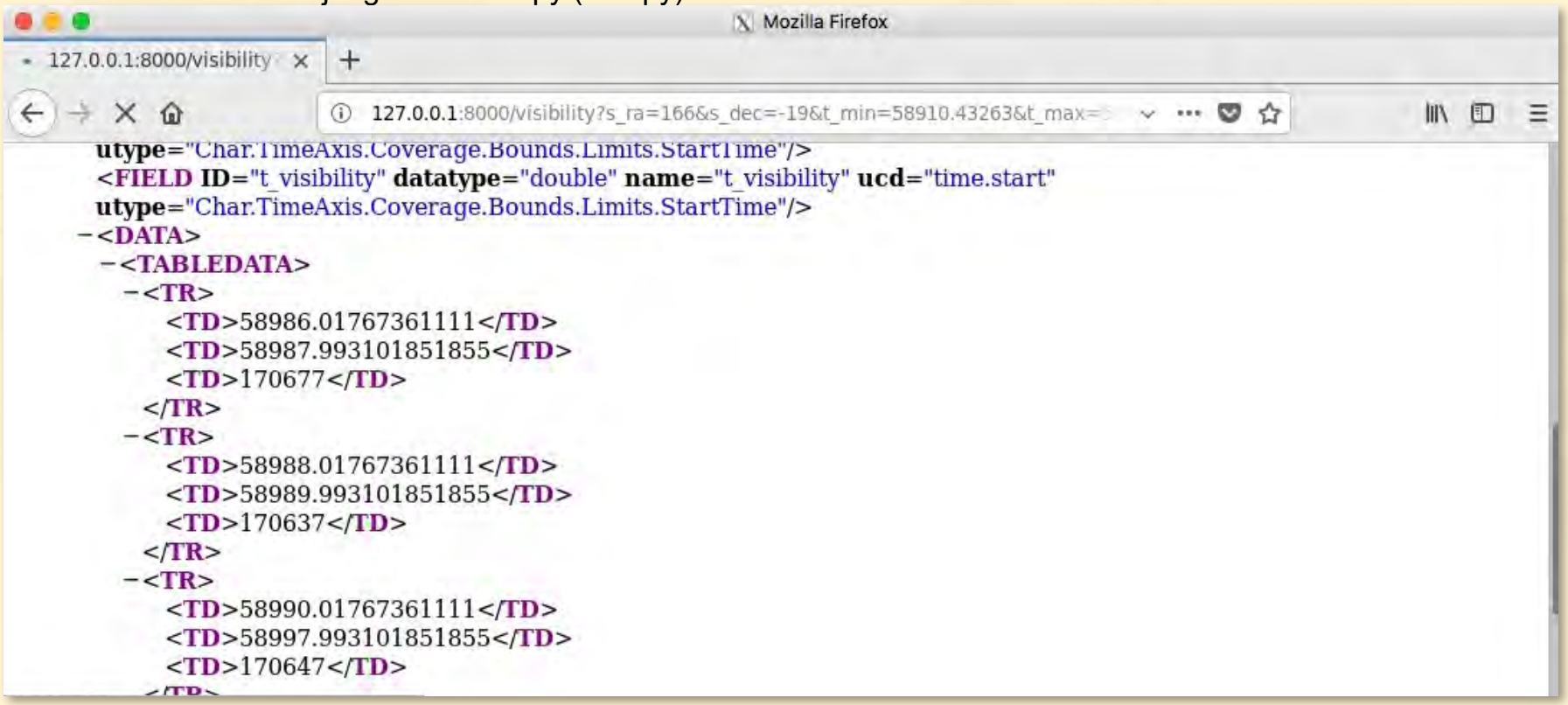

ObsVisSAP – NuSTAR status

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  - Successful but VERY slow -> inhibits remote development (Caltech campus is closed)
- Install nginx server for visibility server http://nustarsoc.caltech.edu:88
  - Port 80 was already in use

Next steps

- Edit views.py to calculate NuSTAR visibility

obsVisSAP
Level of effort so far: 8 hours

ObsVisSAP – notes

- Suggested adjustments to ObjVisSAP document

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

  - Standard output field t_visibility is referenced as

    "... the visibility window duration in seconds."

    - this is just t_max minus t_min
    - Can this instead be defined as "science quality time"?
  - POS interface modified to s_ra,s_dec so need to adjust
    - section 3.1.1.3
    - example page 8
    - example page 9
    - section 5 examples
  - Does s_ra,s_dec need to be added in Appendix A?
  - em_min and em_max in meters not keV (matching obsLocTAP)
  - Should optional (MAY) fields that do not vary with visibility be returned in a XML header line, e.g.
    - Sun, Moon constraints, em_min, em_max

      <INFO name="moon_sep_min" value="14.0"/>

No – these should be query result fields

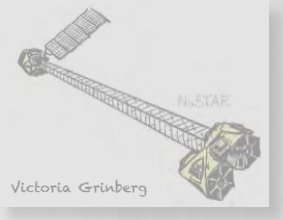
ObsVisSAP – notes

- Add validity_accuracy as an input parameter?
  - Operationally perhaps link this to t_min to t_max range
    - and/or vis_min, MAXREC etc. (tabulated in validity_predictor field)
  - resulting in visSAP query matrix (Sun and Moon constraints included in all calculations)

t_max – t_min	validity_accuracy	vis_min (s)	max # rows returned (MAXREC)	Speed	Earth Occultation +/- 600s	SAA passage +/- 300s	Startracker blockage +/- 1800s
< 7 days	HIGH	100	200	fast	Yes	Yes	Yes
7 to 60 days	MEDIUM	1000	20	fast	no	no	Yes
60 days to 2 years	LOW	5000	40	fast	No	No	Yes (+margin)

  - Speed of calculation may also be a concern for clients
    - e,g, for response to TOBY request http://integral.esa.int/toby/
    - Clients will need to optimize query parameter choice or perhaps screen query results (or limit number of returned rows?)
  - The input value of vis_min could lead to a similar visSAP matrix

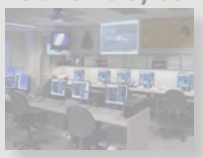
Data and Information flow



Malindi

Ground station

UC Berkeley-SSL



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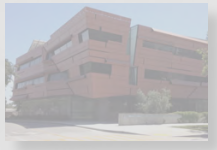

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ObsLocTAP

- Observation schedules currently available on SOC website

  http://nustarsoc.caltech.edu/NuSTAR_Public/NuSTAROperationSite/Schedule.php

  - Short-term (up to 10 days ahead)
  - Long-term (up to 2 years ahead)

- obsplan database will be populated with information from:
  - Mission planning database
  - As-Flown Timeline (observations executed during the mission)
  - Archive master catalog of observations at HEASARC (numaster)

    https://heasarc.gsfc.nasa.gov/W3Browse/all/numaster.html

- Observation schedules currently available on SOC website

  http://nustarsoc.caltech.edu/NuSTAR_Public/NuSTAROperationSite/Schedule.php

  - Short-term (up to 10 days ahead)

Short Range Observatory Schedule

Download ASCII table | Download ObsLoc csv file

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.

obs_start	obs_end	sequenceID	Name	J2000_RA	J2000_Dec	Exp	Notes
2020:169:22:30:07	2020:171:11:25:00	60601014004	AKARI_FIS_J0916A	139.10313	7.50606	70.4	(2/2)
2020:171:12:00:07	2020:172:00:20:00	60660001002	ZTF18AAJUPNT	233.283375	44.535611	24.2	Coordinated with XMM
2020:172:00:45:03	2020:172:11:45:00	60660004002	ZTF18AAHMKAC	179.575083	10.056278	23.0	Coordianted with XMM
2020:172:12:30:08	2020:173:01:40:00	60662001002	NGC6921_MCG04	307.13296	25.72853	26.2	
2020:173:02:20:08	2020:173:13:15:00	60662004002	NGC3079	150.49079	55.67983	26.8	
2020:173:13:40:06	2020:176:02:30:00	60668001002	NGC3094	150.35808	15.77008	111.5	

t_planning	target_name	obs_id	obs_collectior	s_ra	s_dec	s_fov	s_resolution	t_min	t_max	t_exptime	t_resolution	em_r
MJD	NULL	NULL	NULL	deg	deg	deg	arcec	MJD	MJD	s	s	m
double	String	String	String	double	double	double	double	double	double	double	double	doul
59016.82222	CGCG187m022	60160481002	NULL	183.2888	32.5964	0.2	58	59015.00007	59015.45139	NULL	0.002	1.57E
59016.82226	RX_J1131m1231	60502021010	NULL	172.965	-12.5325	0.2	58	59015.4688	59016.05208	NULL	0.002	1.57E
59016.8223	AKARI_FIS_J0916A	60601014002	NULL	139.10313	7.50606	0.2	58	59016.06608	59016.93056	NULL	0.002	1.57E
59016.82235	1RXS_J093117d6p033146	80661601002	NULL	142.824196	3.522092	0.2	58	59016.93757	59017.93056	NULL	0.002	1.57E
59016.82238	AKARI_FIS_J0916A	60601014004	NULL	139.10313	7.50606	0.2	58	59017.93758	59019.47569	NULL	0.002	1.57E
59016.82243	ZTF18AAJUPNT	60660001002	NULL	233.283375	44.535611	0.2	58	59019.50008	59020.01389	NULL	0.002	1.57E
59016.82248	ZTF18AAHMKAC	60660004002	NULL	179.575083	10.056278	0.2	58	59020.03128	59020.48958	NULL	0.002	1.57E
59016.82251	NGC6921_MCG04	60662001002	NULL	307.13296	25.72853	0.2	58	59020.52093	59021.06944	NULL	0.002	1.57E
59016.82256	NGC3079	60662004002	NULL	150.49079	55.67983	0.2	58	59021.09731	59021.55208	NULL	0.002	1.57E
59016.82259	NGC3094	60668001002	NULL	150.35808	15.77008	0.2	58	59021.56951	59024.10417	NULL	0.002	1.57E

- Observation schedules currently available on SOC website

  http://nustarsoc.caltech.edu/NuSTAR_Public/NuSTAROperationSite/Schedule.php

  - Short-term (up to 10 days ahead)
  - Long-term (up to 2 years ahead)

Long Range Observatory Schedule

Download ASCII table

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 **2020-07-01** in this table is scheduled to have the observation ***starting*** sometime between **2020-06-29 0000Z** (DOY 2020:181) and **2020-07-06 0000Z**.

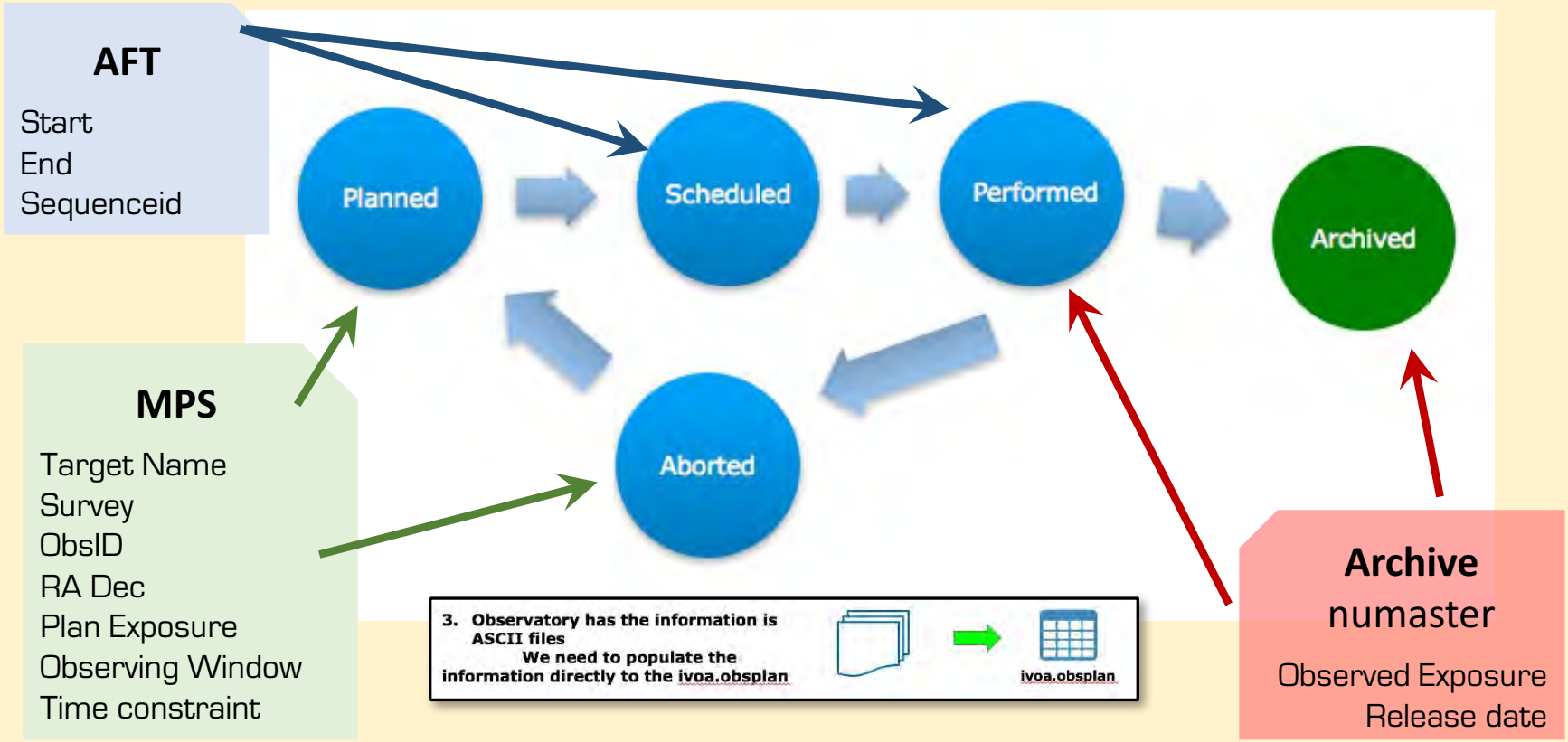
The NuSTAR observing schedule is driven by the large number of observations coordinated with other observatories and the need to complete th

ToO = Target of Opportunity **DDT** = Directors Discretionary Time **EGS** = Extragalactic legacy surveys **CAL** = Calibration
N06 = NuSTAR GO6 cycle-6 **I15** = INTEGRAL GO cycle-15 **X19** = XMM-Newton GO cycle-19 **C21** = Chandra GO cycle-21
S16 = Swift GO cycle-16 **R02** = NICER GO cycle-2

DOY week	week of observation	obsID	name	J2000_RA	J2000_Dec	Exp	Notes
2020:167	2020-06-15	60502021	RX_J1131m1231	172.965	-12.5325	20	(5/6) N05
		60601014	AKARI_FIS_J0916A	139.10313	7.50606	100	(1/2) N06
		80661601	1RXS_J093117d6p033146	142.82419	3.522092	40	N06 ToO
		60601014	AKARI_FIS_J0916A	139.10313	7.50606	100	(2/2) N06
		60660001	ZTF18AAJUPNT	233.283375	44.535611	20	X19
		60660004	ZTF18AAHMKAC	179.575083	10.056278	20	X19
		60662001	NGC6921_MCG04	307.13296	25.72853	20	(1/3) N06
		60662004	NGC3079	150.49079	55.67983	21	N06
		60668001	NGC3094	150.35808	15.77008	100	N06
2020:181	2020-06-29	80402308	Swift_J1818d0m1607	274.500917	-16.1311944	80	(4/4) X17
		60662001	NGC6921_MCG04	307.13296	25.72853	20	(2/3) N06
		60601026	2MASX_J02051994m023	31.33308	-2.55161	30	N06 (XMM)
		10602606	3C273	187.277920	2.05250	30	IACHEC cross calibration (XMM Chandra INTEGRAL Swift NICER)
		30602001	GX_5m1	270.290542	-25.078925	20	(1/6) C21

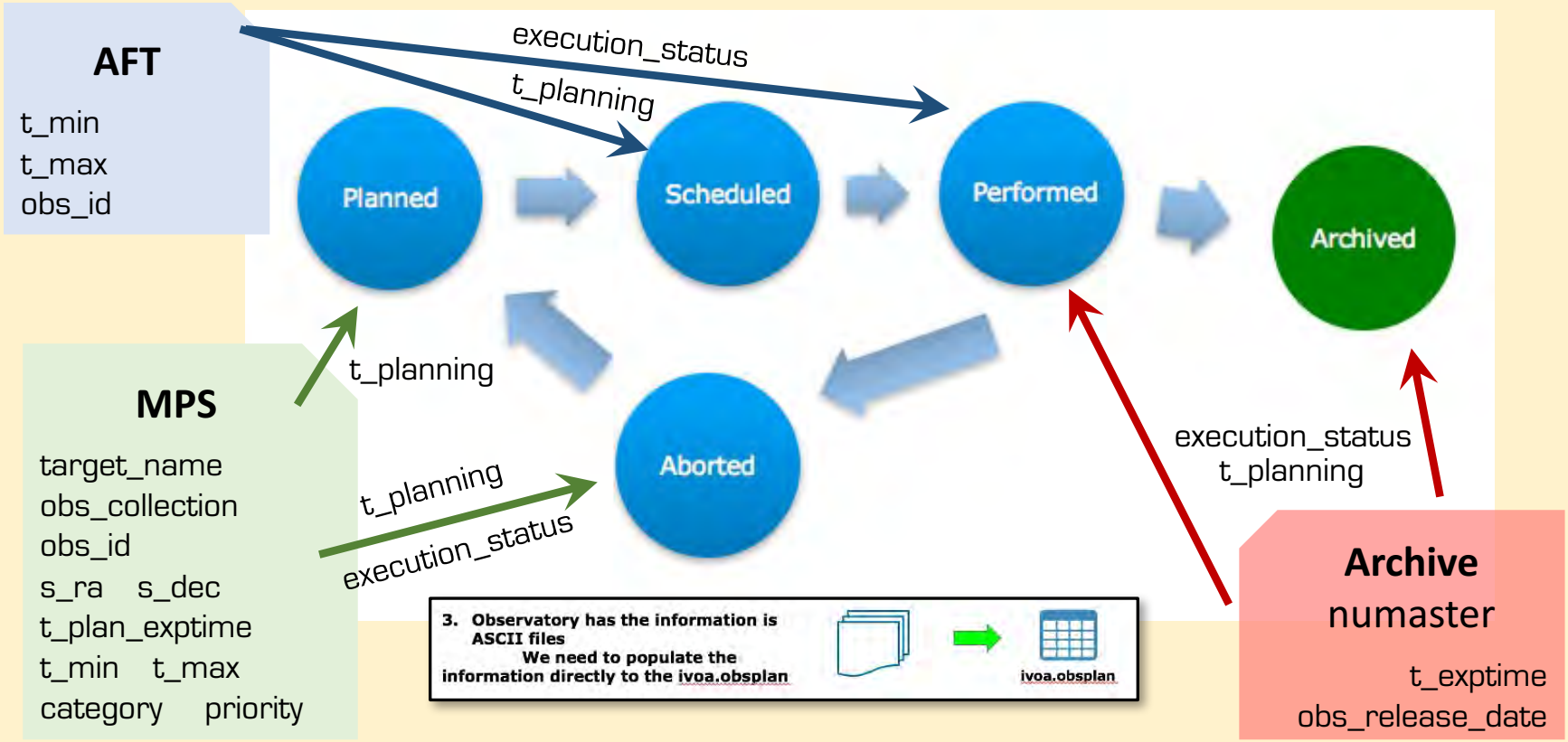
ObsLocTAP - data flow

- obsplan database will be populated with information from:
  - Mission planning database (and MPS system)
  - As-Flown Timeline (observations executed during the mission)
  - Archive master catalog of observations (numaster)



ObsLocTAP - translation

- obsplan database will be populated with information from:
  - Mission planning database (and MPS system)
  - As-Flown Timeline (observations executed during the mission)
  - Archive master catalog of observations (numaster)



ObsLocTAP - workflow

- obsplan workflow
  - When in the planning process is information inserted or updated into the obsplan table?
    - Note: t_min and t_max are NOT NULL
      - Recommend additional **category = window**
      - For selected observations with no (or broad) scheduling information
        - Set t_min and t_max to observing cycle dates (and priority=0)
    - psql INSERT UPDATE /copy and DELETE
  - Action: will need to create scripts to check the validity of the table entries, particularly when updating entries!
- Fixed fields should hold representative values
  - E.g. spectral resolution varies with energy but choose

    em_res_power = 10 keV / 400 eV = 25

Question: Can there be entries in obsplan with overlapping t_min and t_max ?

Use case: Multiple instruments on one telescope observing the same target concurrently

ObsLocTAP - workflow

NuSTAR example

	ivoa.obsplan fields													
PLANNING STAGE	t_planning	target_name	obe_id	obs_collection	s_ra	s_dec	t_min	t_max	t_exptime	t_plan_exptime	category	priority	execution_status	obs_release_date
GO program selection	c	c	c	c	c	c	c	c		c	c	c	c	
ToO / DDT	i	i	i	i	i	i	i	i		i	i	i	i	
Long range planning	u						u	u		u	u	u		
Short range planning (AFT)	u	(u)	u		(u)	(u)	u	u		(u)	(u)	u	u	
Completed (Mission clock)	u												u	
Archived	u								i				u	u
Aborted	u									(u)			u	
Old entries	d	d	d	d	d	d	d	d	d	d	d	d	d	d

c = /copy from list i = INSERT u = UPDATE (u) = maybe UPDATE d = DELETE

ObsLocTAP - workflow

NuSTAR example

PLANNING STAGE	ivoa.obsplan fields													
	t_planning	target_name	obe_id	obs_collection	s_ra	s_dec	t_min	t_max	t_exptime	t_plan_exptime	category	priority	execution_status	obs_release_date
GO program selection	c	c	c	c	c	c	c	c		c	c	c	c	
ToO / DDT	i	i	i	i	i	i	i	i		i	i	i	i	
Long range planning	u						u	u		u	u	u		
Short range planning (AFT)	u	(u)	u		(u)	(u)	u	u		(u)	(u)	u	u	
Completed (Mission clock)	u												u	
	u								i				u	u
	u									(u)			u	
~~Old entries~~	d	d	d	d	d	d	d	d	d	d	d	d	d	d

c = /copy from list i = INSERT u = UPDATE (u) = maybe UPDATE d = DELETE

No deletion of information
(maybe archive to another table?)

ObsLocTAP - status

- PostgreSQL (v9.2.24) installed on new web server
  - Only complete TAP implementation is, for the time being, under postgreSQL
    - Translation of ADQL to mySQL may be possible if there is sufficient interest
  - `pg_sphere` module installed
    - Remember to run `CREATE EXTENSION pg_sphere;`
  - Created ivoa.obsplan table as described in implementation guide (step B.3)

    www.cosmos.esa.int/web/vovisobs_protocols/implementation-guides
  - NOTE: to be able to see tables in ivoa schema you need to add it to the search path, i.e.

    ```
    SET search_path TO ivoa,public;
    ```
  - Added option `category = window` for poorly defined schedules
    - The number of options should be small (and adopted in protocol) to make this field useful
  - `s_fov` is a general prescription for the field of view of an instrument
    - Can make this more complicated by introducing polygon in `s_region` field
    - For NuSTAR this would be projection of square detectors onto sky, including planned PA

ObsLocTAP - status

- PostgreSQL (v9.2.24) installed on new web server

```
SELECT o.s_ra, o.s_dec, o.target_name, o.t_min, o.t_max
FROM ivoa.obsplan AS o
WHERE o.t_max > 59104 ORDER BY o.s_ra;

    s_ra     |    s_dec     |  target_name   |     t_min      |     t_max
-------------+--------------+----------------+----------------+---------------
  42.918499 | -16.650499 | NGC1125        | 59104.346528 | 59104.822917
  96.577556 | -54.387906 | ABELL_3395     | 59101.729861 | 59104.333333
  246.39642 |  -23.44719 | Rho_Oph_A      | 59104.852778 | 59108.333333
   247.1556 |     39.5361 | ABELL_2199     |          59106 |          59113
 281.603917 |  -2.975028 | PSR_J1846m0258 | 59109.619444 |          59110
 291.831417 |  65.565056 | 1ES1927p654    |          59108 | 59109.086806
(6 rows)
```

Q: Should target names be standard astronomical names? (i.e. without all the '_')

ObsLocTAP - status

Some questions are outside the scope of the protocols and are more relevant for a 'best practices' discussion

ObsLocTAP questions

- **Q:** If cancelled observations should not be deleted but have `execution_status -> Aborted` how long should they remain in the table?
  - **A:** Whatever makes sense for each observatory
- **Q**: ObsLocTAP document Page 12 says t_plan_exptime must exactly match t_exptime otherwise this "..will reflect problems or deviations between scheduled observations and performed observations"

  > However, the planned exposure time is just an estimate for NuSTAR and the final exposure time will depend on a number of factors and will never be identical.

  - **A:** Documentation language will be updated but clear explanations of output should be given in query results page
- **Q:** Can `execution_status = Archived` be included as an option? (maybe also Archived+Public)?
  - **A: Out of scope of protocol** - So set limit on date/status at which information should be deleted from ivoa.obsplan
- **Q:** When should information (table rows) be removed from ivoa.obsplan?
  - **A:** This protocol is not appropriate for querying historical use of a facility. So set a limit that makes sense for your observatory. (bot don't delete information)
- **Q:** Can scheduling information be kept securely (authorized users)?
  - **A:** Fields target_name, s_ra, and s_dec can be NULL so the table entry will indicate that the facility is booked for an observation from t_min to t_max
    - May still assign a category and priority to indicate if the observation can be moved/replaced
- **Q:** What if schedule is not determined until just before the observation? (e.g. ToO's)
  - **A:** Dynamic updating of the obsplan table could be useful for robotic telescopes

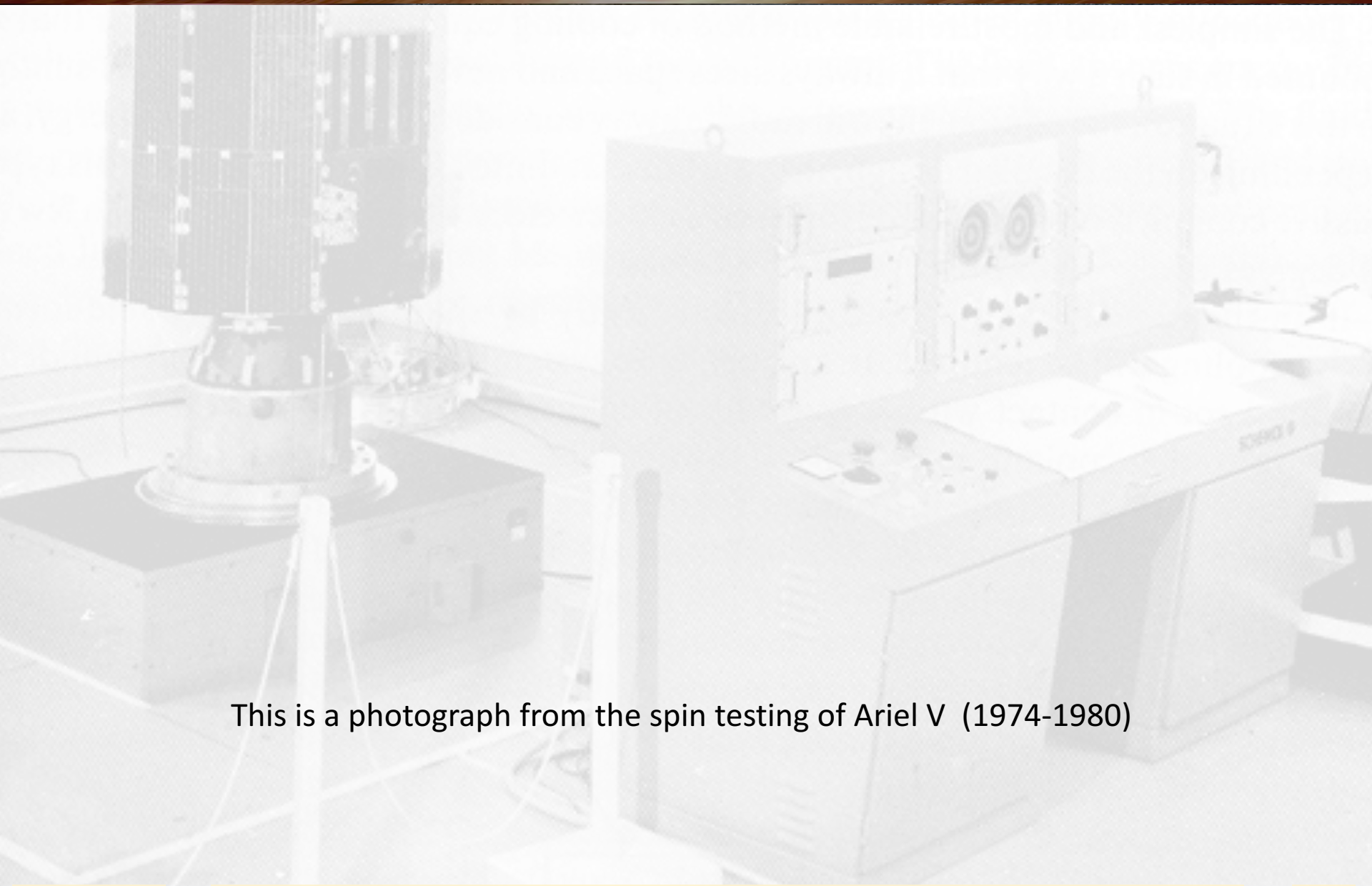
ObsLocTAP - status

- Summary
  - psql database is configured
  - Interface with MPS and planning procedures are ready
- Next steps
  - Will try TAPTuto toolkit & Tomcat server
    - Once working will provide information for integration into INTEGRAL toby client
  - May also try to use DOCKER

obsLocTAP
Level of effort so far: 4 hours

- Lessons learned
  - Clearly map information flow before starting implementation
    - Including where/when in planning process to insert information into the database
  - Use cases should determine efficacy of information
  - Implementation is complex but not complicated

Additional information slides



This is a photograph from the spin testing of Ariel V (1974-1980)

ObsVisSAP - status

- Transition to new operations server
  CPU: 2 x 2.1 GHz 1128 GB RAM 5 TB harddrive Linux RedHat v7.6
  Database: MySQL v15.1 and PostgreSQL v9.2.24
- Installation of python
  - Recommend installation in separate virtual environment (e.g. env0)
    - To avoid needing to use sudo
    - Add path to $path e.g. in .bash_profile `PATH=$PATH:/usr/local/anaconda3/bin`

```
python3 –m venv $HOME/python/env0
bash
source $HOME/python/env0/bin/activate
```

    - update pip `pip install –upgrade pip`
  - Install Django and astropy (numpy)

```
python –m pip install Django
python –m pip install astropy
```

    - Django 3.1.1 astropy 4.0.1 installed satisfies requirements

- Clone git visibility service code from Emilio Salazar github
- Test run development server
- Install nginx server for visibility server http://nustarsoc.caltech.edu:88

Next steps

- Edit views.py to calculate NuSTAR visibility