ALMA Archive & Data Products–
what to expect after your observations are made

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Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array

The Condensed Version

- Download data from *Archive Query* and *Request Handler* tools on the ALMA Science Portal
- Data delivered after passing Quality Assurance (QA)
- The Pipeline Weblog–Calibration and Imaging Information
- Delivered data include:
  - Calibration tables and diagnostics
  - Preliminary images (better products may be possible with more careful continuum & non-default cleaning parameters)
- Project tracking – SnooPI

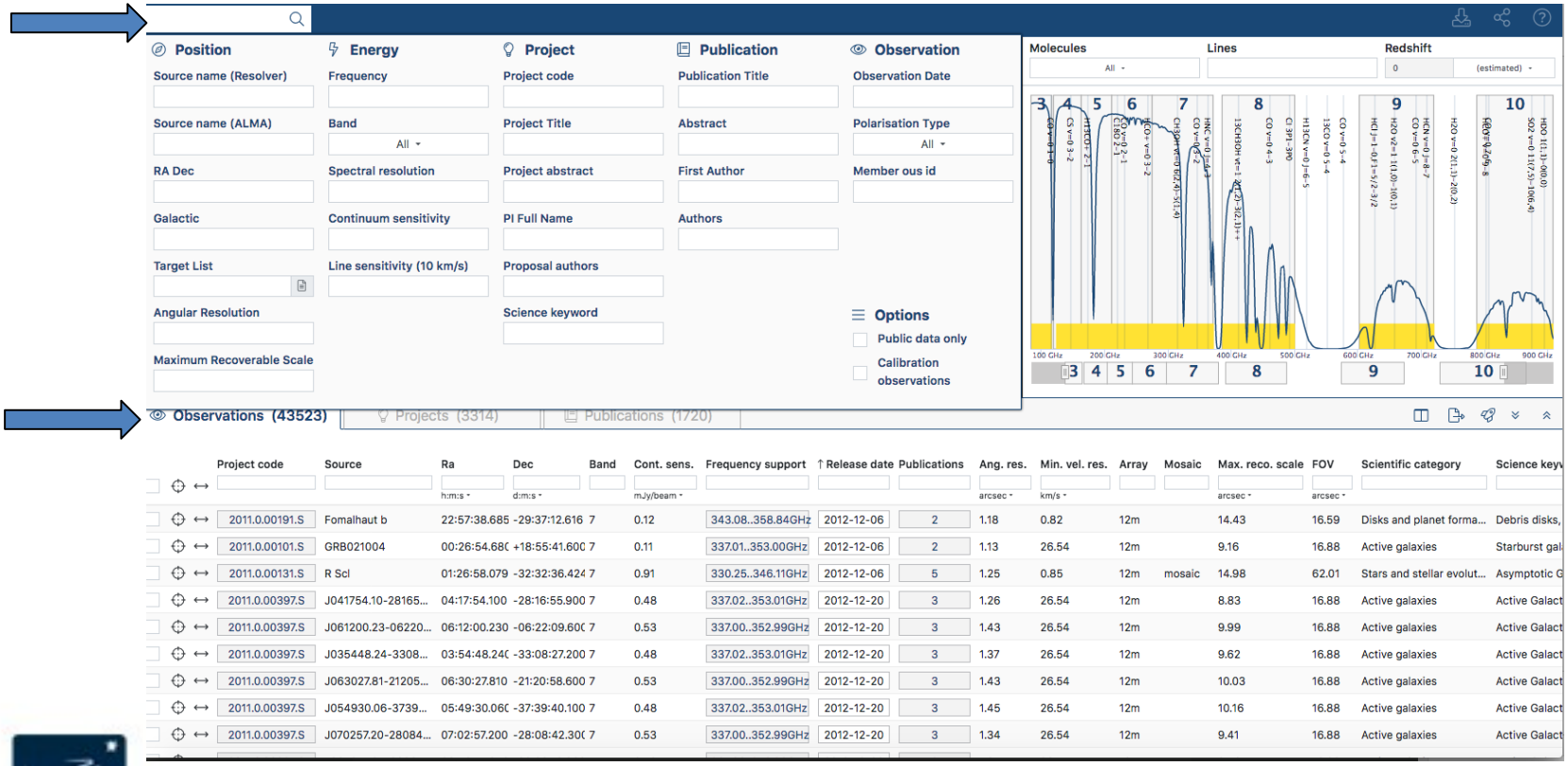
This talk will be available online for reference after this workshop.

Exploring the ALMA Archive

- All projects should start with the ALMA Archive
- Check for duplications. Considered duplication if:
  - Same Target
  - Angular resolution is within a factor of 2
  - RMS is within a factor of 2
  - See Appendix A of the Users' Policies for complete definition
- Use archival data! No need to apply!
- New archive interface
  - http://almascience.nrao.edu/asax/

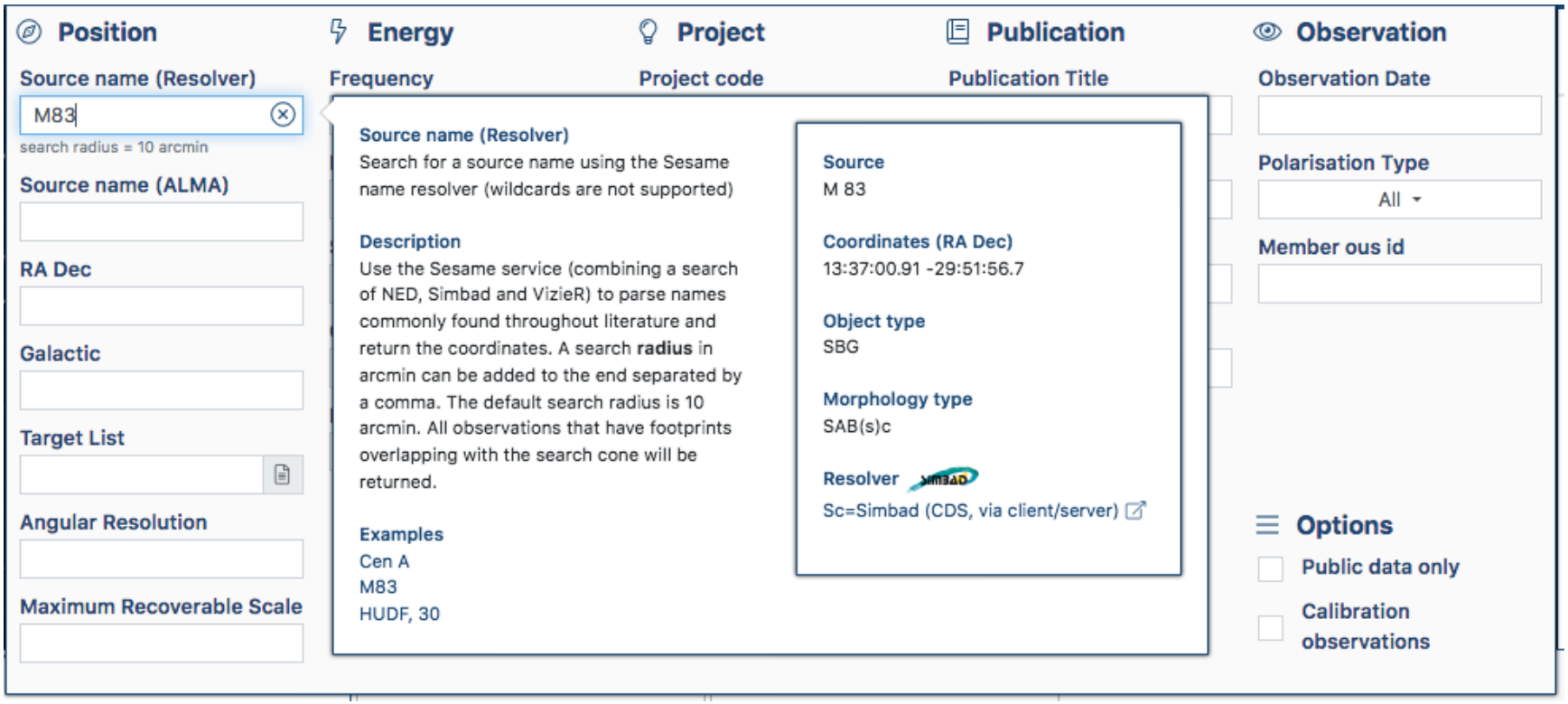
Searching the Archive

- Filter columns based on target, project, or publication
- Hover over the top left search bar for expanded search fields

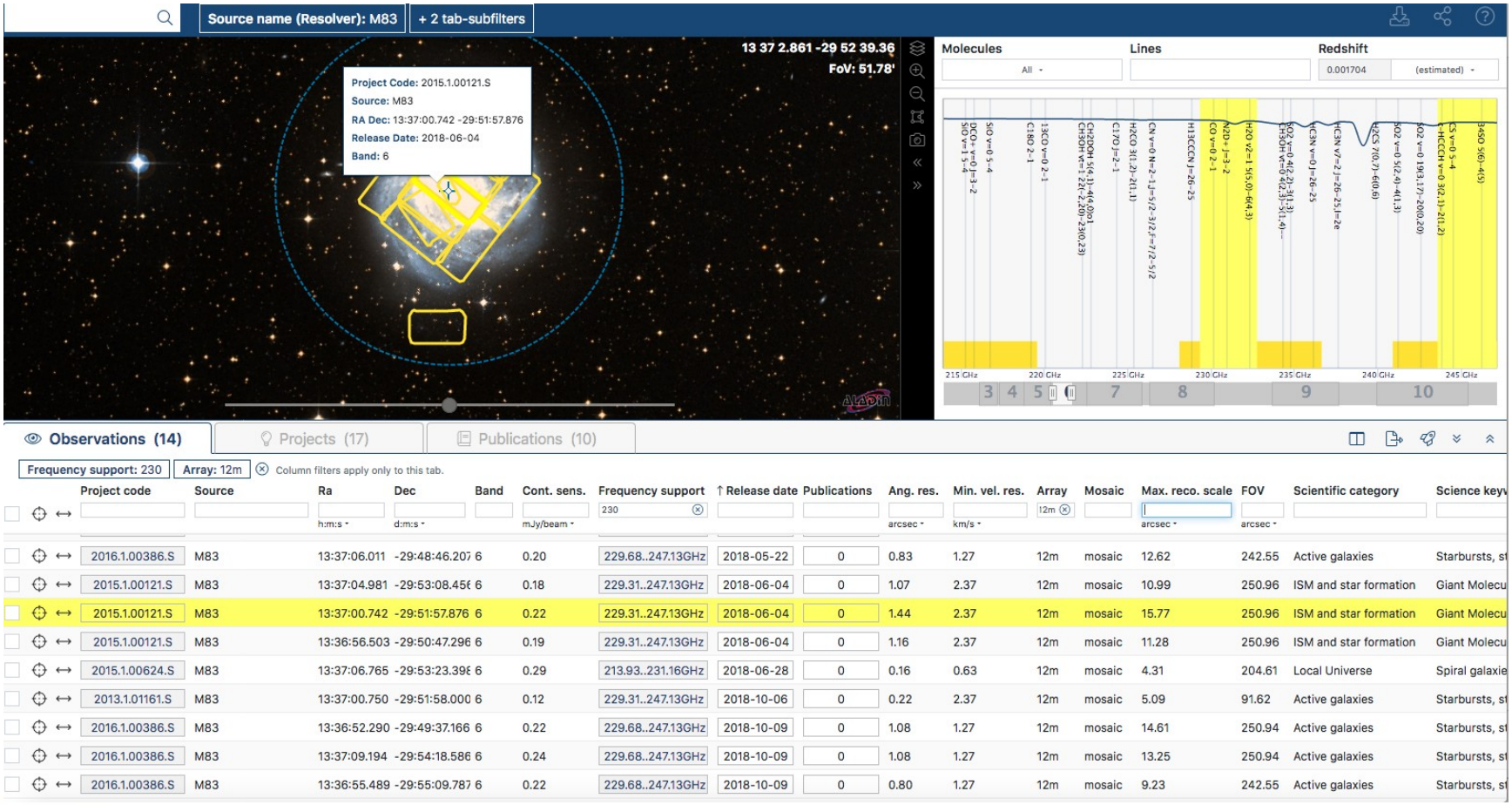


Project code	Source	Ra	Dec	Band	Cont. sens.	Frequency support	↑ Release date	Publications	Ang. res.	Min. vel. res.	Array	Mosaic	Max. reco. scale	FOV	Scientific category	Science keyv
		h:m:s	d:m:s		mJy/beam				arcsec	km/s			arcsec	arcsec		
2011.0.00191.S	Fomalhaut b	22:57:38.685	-29:37:12.616	7	0.12	343.08..358.84GHz	2012-12-06	2	1.18	0.82	12m		14.43	16.59	Disks and planet forma...	Debris disks,
2011.0.00101.S	GRB021004	00:26:54.680	+18:55:41.600	7	0.11	337.01..353.00GHz	2012-12-06	2	1.13	26.54	12m		9.16	16.88	Active galaxies	Starburst gal
2011.0.00131.S	R Scl	01:26:58.079	-32:32:36.424	7	0.91	330.25..346.11GHz	2012-12-06	5	1.25	0.85	12m	mosaic	14.98	62.01	Stars and stellar evolut...	Asymptotic G
2011.0.00397.S	J041754.10-28165...	04:17:54.100	-28:16:55.900	7	0.48	337.02..353.01GHz	2012-12-20	3	1.26	26.54	12m		8.83	16.88	Active galaxies	Active Galact
2011.0.00397.S	J061200.23-06220...	06:12:00.230	-06:22:09.600	7	0.53	337.00..352.99GHz	2012-12-20	3	1.43	26.54	12m		9.99	16.88	Active galaxies	Active Galact
2011.0.00397.S	J035448.24-3308...	03:54:48.240	-33:08:27.200	7	0.48	337.02..353.01GHz	2012-12-20	3	1.37	26.54	12m		9.62	16.88	Active galaxies	Active Galact
2011.0.00397.S	J063027.81-21205...	06:30:27.810	-21:20:58.600	7	0.53	337.00..352.99GHz	2012-12-20	3	1.43	26.54	12m		10.03	16.88	Active galaxies	Active Galact
2011.0.00397.S	J054930.06-3739...	05:49:30.060	-37:39:40.100	7	0.48	337.02..353.01GHz	2012-12-20	3	1.45	26.54	12m		10.16	16.88	Active galaxies	Active Galact
2011.0.00397.S	J070257.20-28084...	07:02:57.200	-28:08:42.300	7	0.53	337.00..352.99GHz	2012-12-20	3	1.34	26.54	12m		9.41	16.88	Active galaxies	Active Galact

Search for your Favorite Source

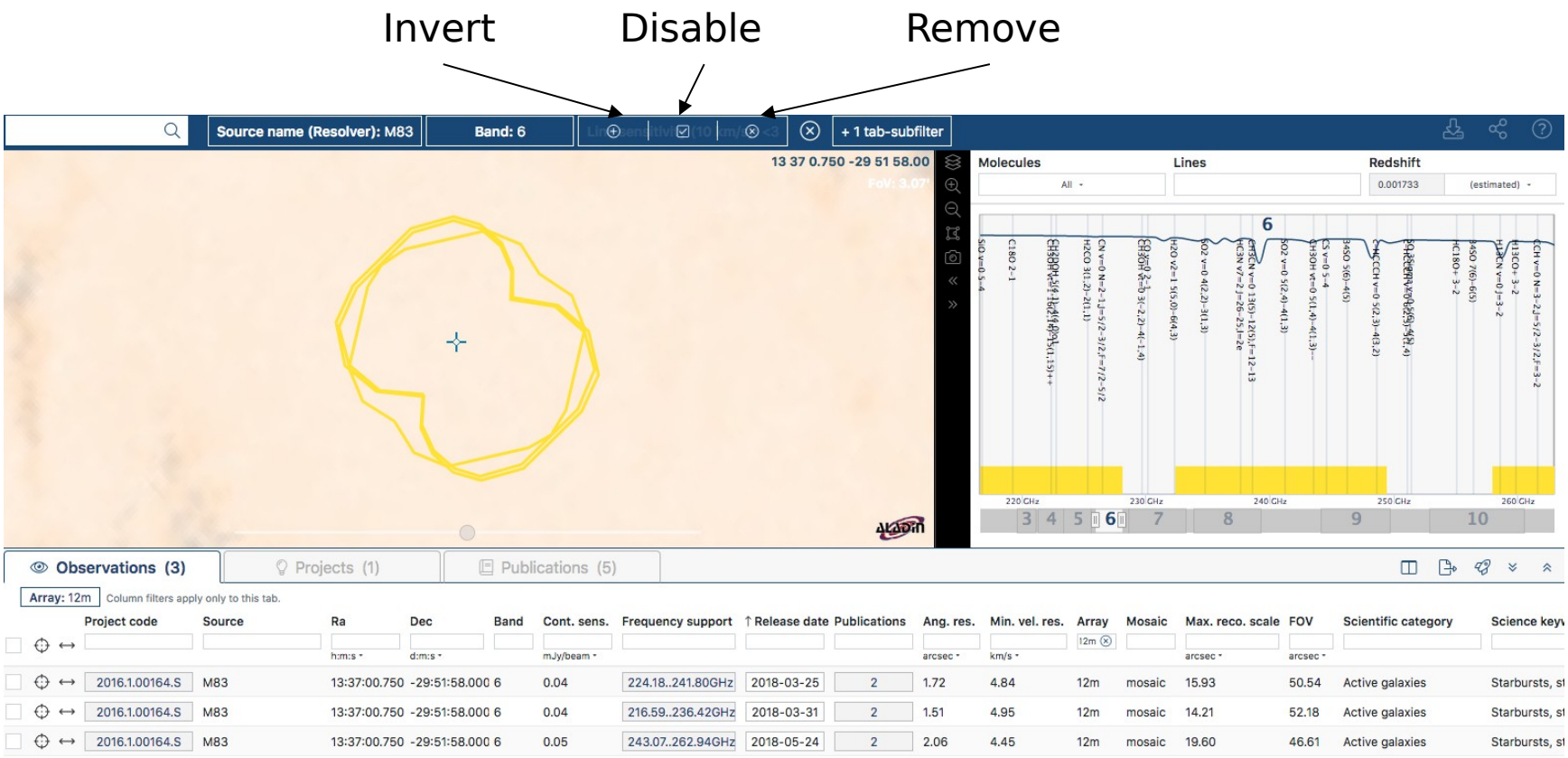


Apply Column Sub-Filters



Project code	Source	Ra	Dec	Band	Cont. sens.	Frequency support	↑ Release date	Publications	Ang. res.	Min. vel. res.	Array	Mosaic	Max. reco. scale	FOV	Scientific category	Science keyv
		h:m:s	d:m:s		mJy/beam	230			arcsec	km/s	12m		arcsec	arcsec		
2016.1.00386.S	M83	13:37:06.011	-29:48:46.207	6	0.20	229.68..247.13GHz	2018-05-22	0	0.83	1.27	12m	mosaic	12.62	242.55	Active galaxies	Starbursts, st
2015.1.00121.S	M83	13:37:04.981	-29:53:08.45(	6	0.18	229.31..247.13GHz	2018-06-04	0	1.07	2.37	12m	mosaic	10.99	250.96	ISM and star formation	Giant Molecu
2015.1.00121.S	M83	13:37:00.742	-29:51:57.876	6	0.22	229.31..247.13GHz	2018-06-04	0	1.44	2.37	12m	mosaic	15.77	250.96	ISM and star formation	Giant Molecu
2015.1.00121.S	M83	13:36:56.503	-29:50:47.296	6	0.19	229.31..247.13GHz	2018-06-04	0	1.16	2.37	12m	mosaic	11.28	250.96	ISM and star formation	Giant Molecu
2015.1.00624.S	M83	13:37:06.765	-29:53:23.39(	6	0.29	213.93..231.16GHz	2018-06-28	0	0.16	0.63	12m	mosaic	4.31	204.61	Local Universe	Spiral galaxie
2013.1.01161.S	M83	13:37:00.750	-29:51:58.000	6	0.12	229.31..247.13GHz	2018-10-06	0	0.22	2.37	12m	mosaic	5.09	91.62	Active galaxies	Starbursts, st
2016.1.00386.S	M83	13:36:52.290	-29:49:37.166	6	0.22	229.68..247.13GHz	2018-10-09	0	1.08	1.27	12m	mosaic	14.61	250.94	Active galaxies	Starbursts, st
2016.1.00386.S	M83	13:37:09.194	-29:54:18.586	6	0.24	229.68..247.13GHz	2018-10-09	0	1.08	1.27	12m	mosaic	13.25	250.94	Active galaxies	Starbursts, st
2016.1.00386.S	M83	13:36:55.489	-29:55:09.787	6	0.22	229.68..247.13GHz	2018-10-09	0	0.80	1.27	12m	mosaic	9.23	242.55	Active galaxies	Starbursts, st

Modify Searches



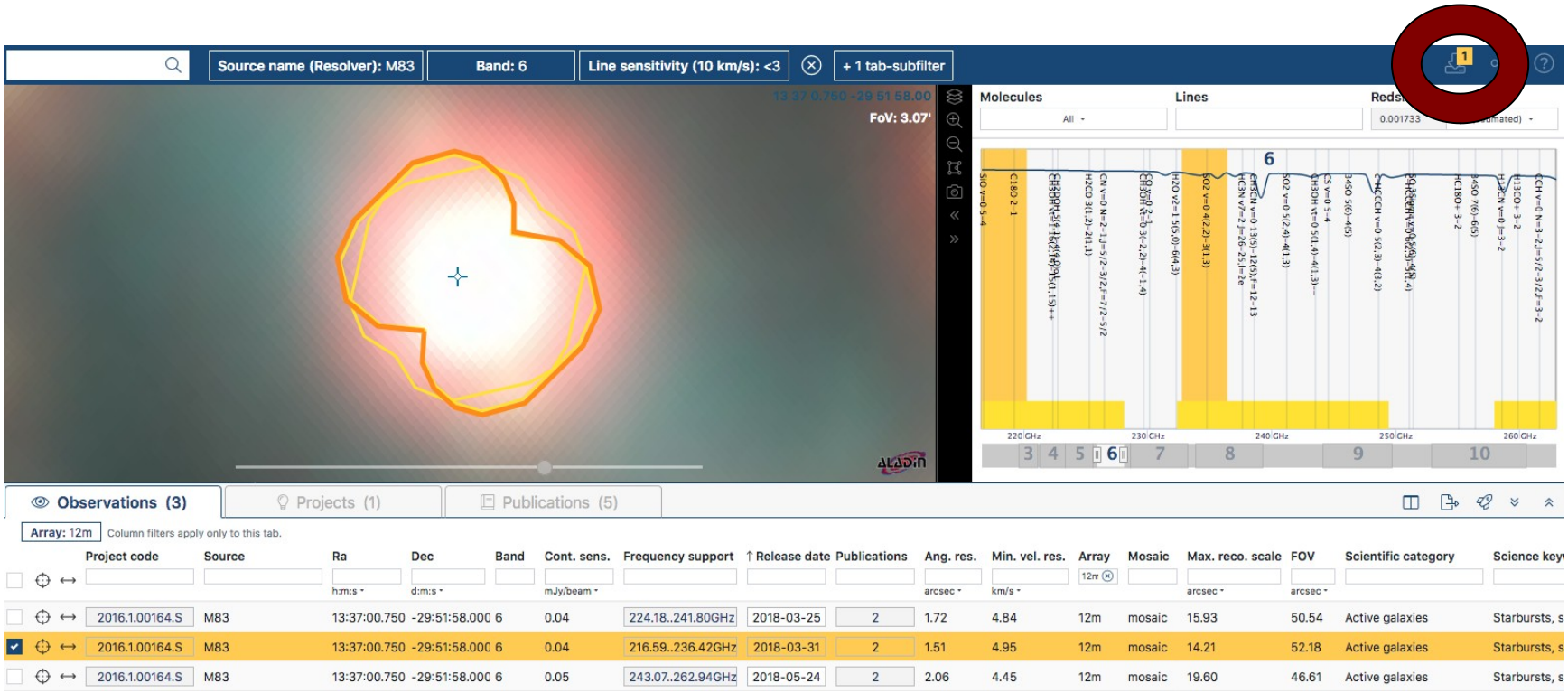
Project code	Source	Ra	Dec	Band	Cont. sens.	Frequency support	↑ Release date	Publications	Ang. res.	Min. vel. res.	Array	Mosaic	Max. reco. scale	FOV	Scientific category	Science keyw
		h:m:s	d:m:s		mJy/beam				arcsec	km/s	12m		arcsec	arcsec		
2016.1.00164.S	M83	13:37:00.750	-29:51:58.000	6	0.04	224.18..241.80GHz	2018-03-25	2	1.72	4.84	12m	mosaic	15.93	50.54	Active galaxies	Starbursts, st
2016.1.00164.S	M83	13:37:00.750	-29:51:58.000	6	0.04	216.59..236.42GHz	2018-03-31	2	1.51	4.95	12m	mosaic	14.21	52.18	Active galaxies	Starbursts, st
2016.1.00164.S	M83	13:37:00.750	-29:51:58.000	6	0.05	243.07..262.94GHz	2018-05-24	2	2.06	4.45	12m	mosaic	19.60	46.61	Active galaxies	Starbursts, st

Did you know?

- You can search for unpublished data by filtering on 0 Publications
- You can use astroquery[1] to programmatically search for and download data

1 https://astroquery.readthedocs.io/en/latest/alma/alma.html

Find Data to Download



Project code	Source	Ra	Dec	Band	Cont. sens.	Frequency support	↑ Release date	Publications	Ang. res.	Min. vel. res.	Array	Mosaic	Max. reco. scale	FOV	Scientific category	Science key
		h:m:s	d:m:s		mJy/beam				arcsec	km/s	12m		arcsec	arcsec		
2016.1.00164.S	M83	13:37:00.750	-29:51:58.000	6	0.04	224.18..241.80GHz	2018-03-25	2	1.72	4.84	12m	mosaic	15.93	50.54	Active galaxies	Starbursts, s
2016.1.00164.S	M83	13:37:00.750	-29:51:58.000	6	0.04	216.59..236.42GHz	2018-03-31	2	1.51	4.95	12m	mosaic	14.21	52.18	Active galaxies	Starbursts, s
2016.1.00164.S	M83	13:37:00.750	-29:51:58.000	6	0.05	243.07..262.94GHz	2018-05-24	2	2.06	4.45	12m	mosaic	19.60	46.61	Active galaxies	Starbursts, s

Select Files to Download

- Newer (Cycle 5+) individual file download available
  - “auxiliary” and “raw” tar files necessary to restore calibrated data and work with visibilities
  - “product” contains pipeline-generated FITS files

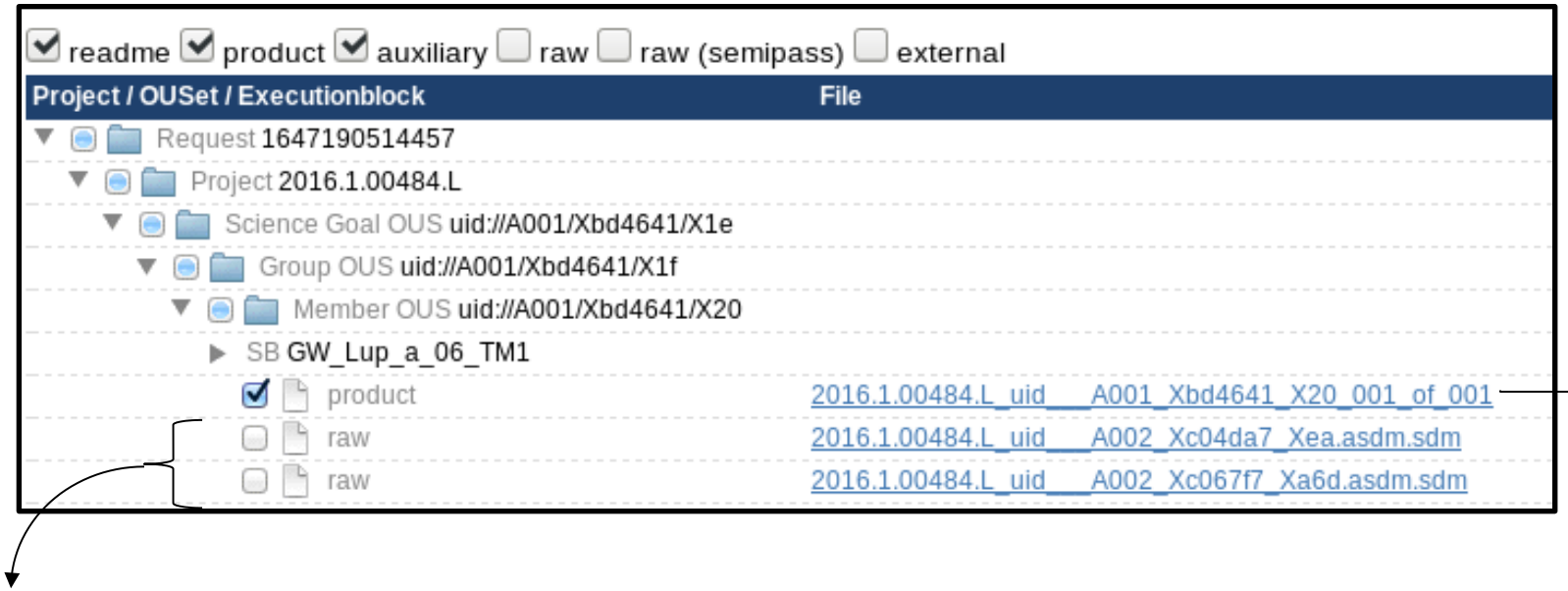
Download Selected

readme product auxiliary raw raw (semipass) external

Project / OUSet / Executionblock	File	Size	Accessible
Request 1652471453732			
Project 2016.1.00164.S			
Science Goal OUS uid://A001/X87a/X9fa			
Group OUS uid://A001/X87a/X9fb			
Member OUS uid://A001/X87a/X9fc			
SB M83_a_06_TM1			
product	2016.1.00164.S_uid___A001_X87a_X9fc_001_of_001.tar	5.2GB	✓
raw	2016.1.00164.S_uid___A002_Xbdcd3c_X13fb.asdm.sdm.tar	27.9GB	✓
Member OUS uid://A001/X87a/X9fe			
SB M83_a_06_7M			
readme	member.uid___A001_X87a_X9fe.README.txt	3.4KB	✓
product	2016.1.00164.S_uid___A001_X87a_X9fe_001_of_001.tar	309.7MB	✓
auxiliary	2016.1.00164.S_uid___A001_X87a_X9fe_auxiliary.tar	223.6MB	✓
raw	2016.1.00164.S_uid___A002_Xb8e961_X4eea.asdm.sdm.tar	1.2GB	✓
raw	2016.1.00164.S_uid___A002_Xbb44e1_X192b.asdm.sdm.tar	1.3GB	✓
raw	2016.1.00164.S_uid___A002_Xbc19b1_X35d9.asdm.sdm.tar	1.4GB	✓
raw	2016.1.00164.S_uid___A002_Xbc4a22_X1f16.asdm.sdm.tar	1.2GB	✓
		Total: 33.6GB	

QA2 Data Products Package:

Cycles 1-4 Packages

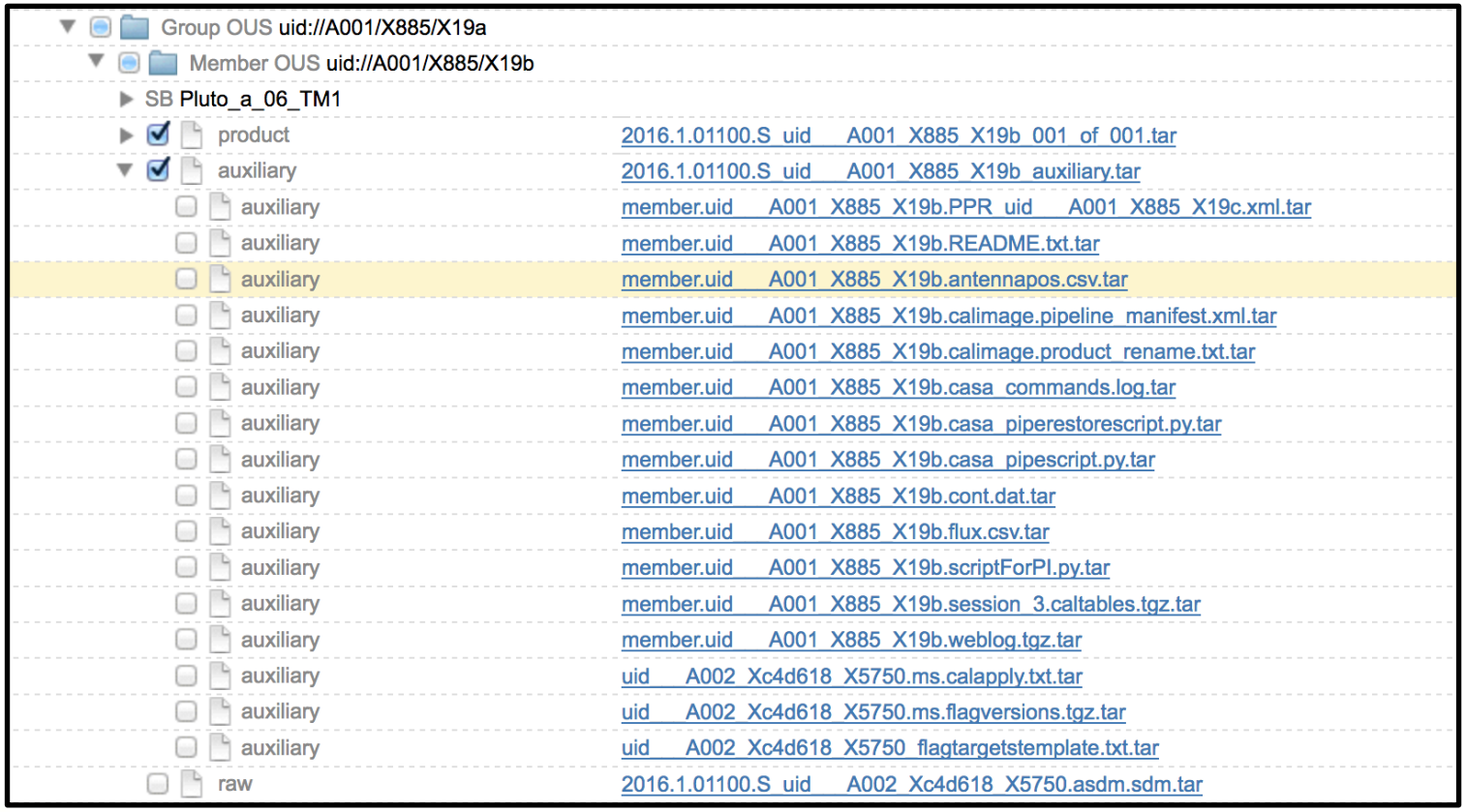


Raw data tar balls.

Tar ball with the processed data.

QA2 Data Products Package:

Cycles 5-Present



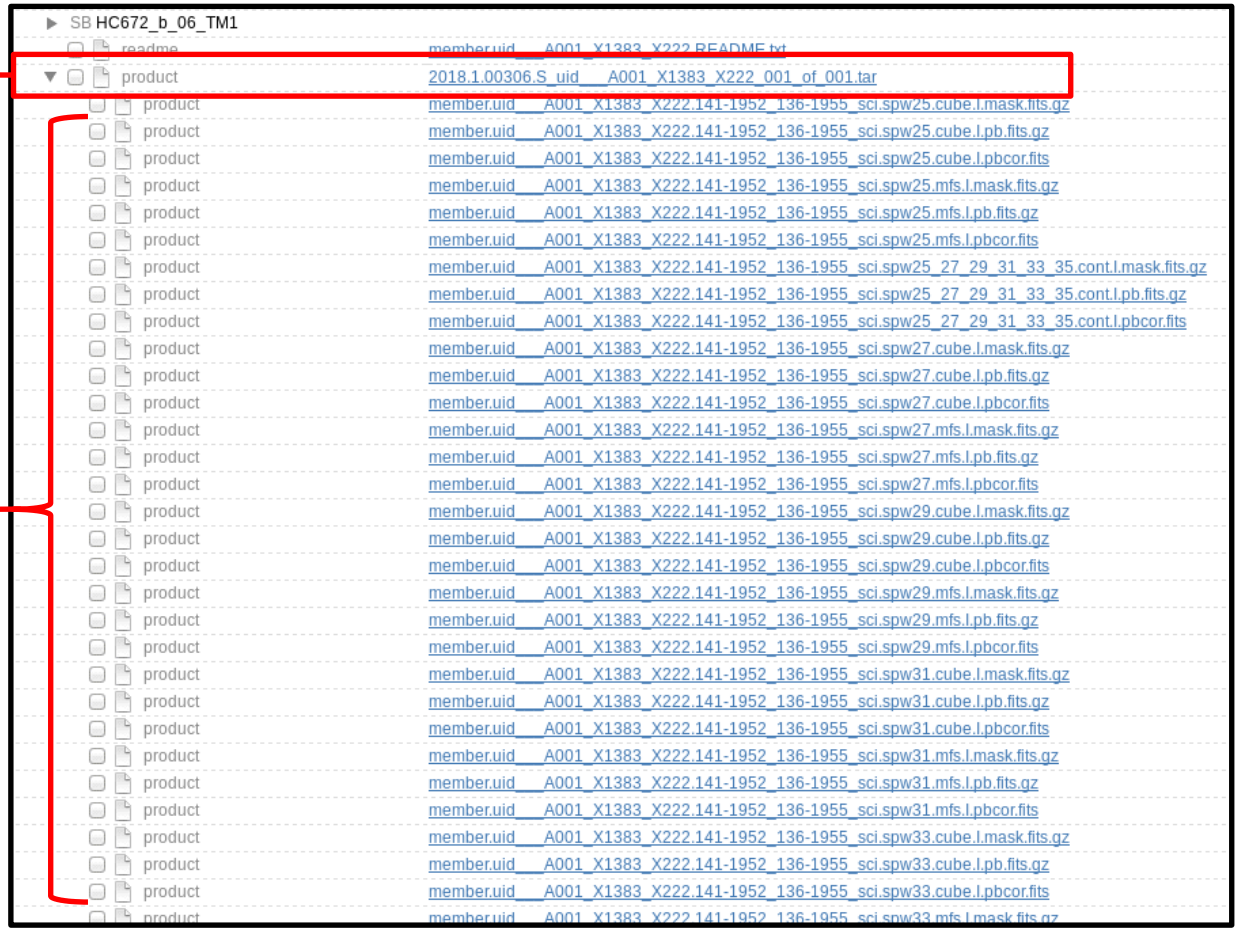
QA2 Data Products Package:

Cycles 5-Present: Product Tarball

Tar ball

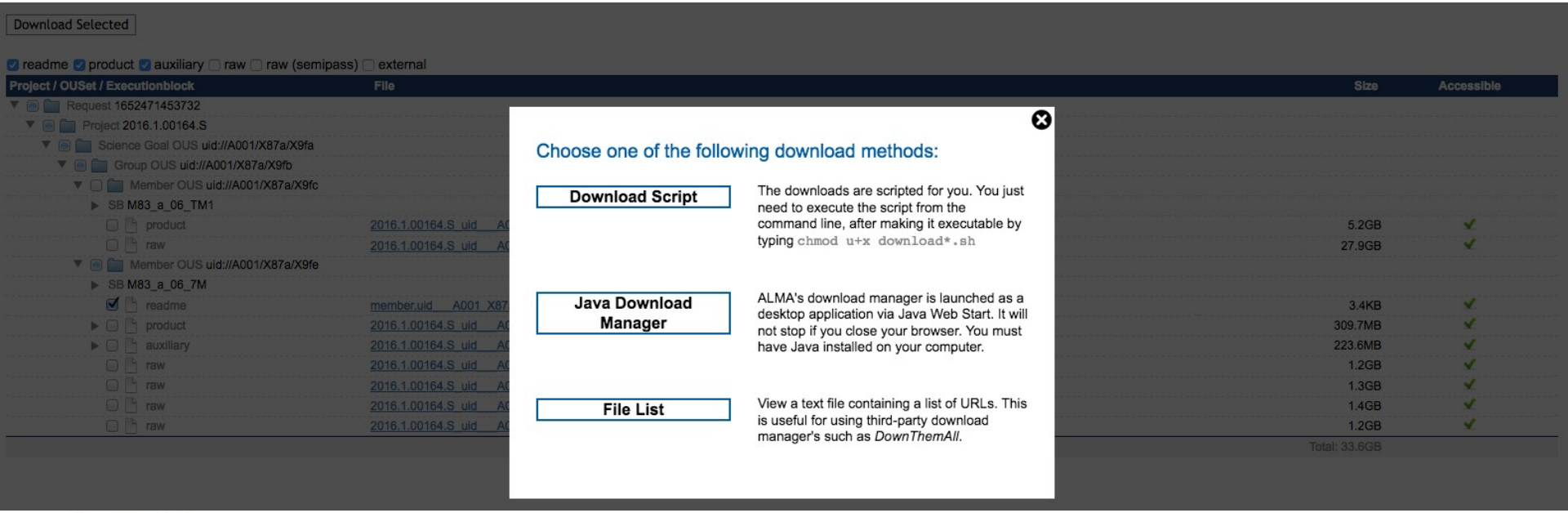
OR

Individual file download



Select the Download Method

- If you have problems running the Java Download Manager
  - Try the download script
  - If you have errors, run the script again and it will resume
  - File a Helpdesk ticket!



Goals of Quality Assurance (QA) Process

- Ensure reliable final data product
  - Desired sensitivity (as specified by PI)
  - Desired resolution (as specified by PI)
- Ensure calibration and QA imaging free from major artifacts

- Warning: Errors in PI-supplied parameters are outside scope of QA process, including:
  - Incorrect source coordinates
  - Inadequate frequency specification
  - Inadequate sensitivity limits

See ALMA Technical Handbook for details.

During Observations – QA0

- Monitoring of on-the-fly calibration and system performance
- Rapidly-varying parameters (~SB/EB timescales)
  - Atmospheric effects
  - Antenna issues
  - Front-end issues
  - Connectivity issues
  - Back-end issues
- Tolerances for each are explicitly laid out
  - No fewer than 34 antennas in 12m array
  - Bandpass calibrator is strong enough
- Quick reduction may be run to check flux measurements and phase stability

QA0 Report

QA0 Report

Project Code	2016.1.00164.S
Session	uid://A001/X87a/X9fe
SchedBlock	uid://A001/X87a/X9e2 (M83_a_06_7M)
ExecBlock	uid://A002/Xb8e961/X4eea ✔ Pass
Sources	Callisto, J12200203, J13512912, J14273305, J15172422, M83
# Antennas	10 (90.0 % for Cycle 4)
Array	7 [m]
Baselines	8m -- 48m
Band	ALMA_RB_06
Weather	null
Atmosphere	Tsys (Min/Avg/Max) : 78.6/84.9/96.9 Trec (Min/Avg/Max) : 29.4/41.6/56.6

Final QA0 comment

```
  === QA0 summary for id___A002_Xb8e961_X4eea ===
| Usable antennas: 9
| Phase rms (Antenna,phaseCal): 5.9 deg (=21.1um)
| Baseline limit with good phase: 5078m. Longest baselines (80%): 34m.
| No online WVR-corrected data available: assuming correction factor of 1.0 in above
| Bandpass cal:  J1517-2422   flux: 3.25 Jy
| Phase cal:  J1351-2912   flux: 0.201 +/- 0.004 Jy
| Number of cycles of science/phaseCal: 8
| Band observed: 6   Highest recommended: 10-10 based only on phase rms
|  QA0 PASS
|  no significant problems
  ==  ==  ==  ==  ==  ==  ==  ==  ==  ==  ==  ==
```

Between Observations – QA1

- “Regular array maintenance” timescales
- Slowly Varying Parameters (~MOUS timescales)
- General array calibration
  - Baseline measurements
  - Delays
- Antenna Calibrations
  - All-sky pointing
  - Focus curves
  - Beam patterns, etc.
- Observatory Calibrator Surveys
  - Solar-system and quasar flux monitoring

After Observations – QA2

- Calibration by pipeline (~70%) or DA/staff.
- Final QA checks include
  - RMS of complex antenna-based gains
  - Absolute flux calibration scale
  - T_{sys} within acceptable range
  - Proper phase transfer cadence
  - Proper bandpass corrections
- Assessment of Imaging Products
  - Signal-to-noise and angular resolution
  - No strong artifacts
  - Performed on the reference source/spectra
- Information about QA review is aggregated for delivery in the QA2 Report

The QA2 Report:

ObsUnitSet information	
Name	Member OUS (M83)
QA2 Status	Pass
Member OUS Status ID	uid://A001/X87a/X9fe
SchedBlock name	M83_a_06_7M
SchedBlock UID	uid://A001/X87a/X9e2
Array	7M
Mode	Standard
Band	ALMA_RB_06
Repr.Freq. (sky)	217.12 [GHz]
Spectral setup	ACA
Sources	M83
Other SBs in this Group OUS (Member OUS Status ID in brackets):	M83_a_06_TM1 (uid://A001/X87a/X9fc)
Execution count	4.00 of 4 expected

Final QA2 comment

Comments from Reducer

CASA version: 5.4.0-70, Pipeline:42254M (Pipeline-CASA54-P1-B)

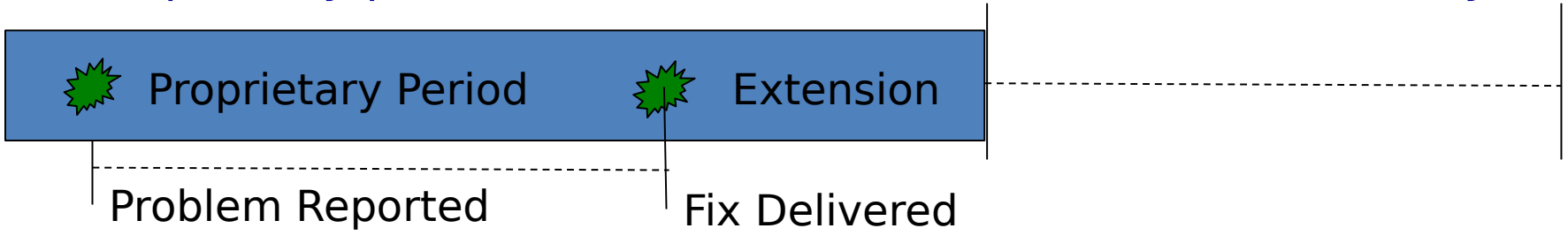
Reduction mode: PL calibration and imaging

Calibration issues: None.

Imaging issues:
This SB has been reprocessed with CASA 5.4.0 due to the issues in previous versions of CASA described at the following links:
See the "Imaging" section at: https://casa.nrao.edu/casadocs/casa-5.4.0 <https://casa.nrao.edu/casadocs/casa-5.4.0>

After Delivery – QA3

- Additional QA stage possibly triggered by PI reporting any issues underlying:
  - Data, observing procedure, calibration
- Re-evaluation of calibrated data products
  - Only occurs if QA0 -> QA2 miss something
- Likely results in fix being implemented and products re-ingested into ALMA archive
- Proprietary period extension *(within two months of delivery)*



- After two months, extension only until fix is delivered

Open the Weblog

- Run the command:

tar –xvzf member.uid___A001_X87a_X9fe.hifa_calimage.weblog.tgz

- Open pipeline-20190312T041124/html/index.html in a browser
- Note: If using Firefox version >= 68.0, open about:config and change ”privacy.file_unique_origin” property to false

Pipeline Image Reprocessing

- Pipeline images are quality assessed but may not be science ready
  - All sources/spws may not be imaged
  - Change continuum selection
  - Change weighting, channel width, automasking, etc.
- See https://casaguides.nrao.edu/index.php/ALMA_Imaging_Pipeline_Reprocessing
- Automasking Guide https://casaguides.nrao.edu/index.php/Automasking_Guide
- Manual imaging template available at: https://casaguides.nrao.edu/index.php/ALMA_Imaging_Pipeline_Reprocessing_for_Manually_Calibrated_Data

OTHER CONSIDERATIONS FOR THE PI

Data Delivery Email

- Sent when an individual MOUS passes QA2
- Data are ingested into the archive and made available at all Regional Centers
- Triggers Start of Proprietary Period
  - Usually 12 months
- Only Sent to PI
- Includes information on:
  - Downloading data
  - Proprietary period
  - Available support
  - Publication requirements

Data Delivery Email –ADDED VALUE!

- NA PIs get two delivery emails
  1. From JAO with links:
     - Archive query for MOUS package
  2. From NAASC:
     - Fully-calibrated MS (North America Only)
     - Calibration and Imaging Report (Weblog)
     - ALMA Data Mining Toolkit (ADMIT) products[1]
     - Knowledgebase Article: “Where can I get additional information for my NA added value data products?”
     - https://help.almascience.org/index.php?/Knowledgebase/Article/View/412

[1] https://casaguides.nrao.edu/index.php/ADMIT_Products_and_Usage

Monitor Project Status: *SnooPI*

QA Report:

- 2013.1.06789. ✔ Observing the centre of the galaxy with ALMA
  - ObsUnitSet
    - SG OUS (CH3CN 5-4 & isotopolog...
      - Group OUS
        - Member OUS (SgrB2)
          - SgrB2_a_03_TP
        - Member OUS (SgrB2)
          - SgrB2_a_03_TC
        - Member OUS (SgrB2)
          - SgrB2_a_03_7M
        - Member OUS (query)
          - 3c454.3_SgrB2_a_03_TP
        - Member OUS (SgrB2)
          - SgrB2_a_03_TE

Scheduling Block Name	SgrB2_a_03_7M ✔ History
Scientific Goal Name	7m observations of my most favourite objects in the whole Universe
Member ObsUnitSet	uid://A001/X121/X4bc History Archive query
Array	7m Array
Band	3
RA	$17^h\ 47^m\ 19.438^s$
Dec	-28° 23' 29.780"
Representative Frequency, GHz	91.28
Successful Executions	4 / 4

End time	Duration [min]	Execution Block UID	QA0
2014-07-03 05:59:44	64.07	uid://A002/X85dcf7/Xefe	✔ Report
2014-07-03 04:39:10	64.49	uid://A002/X85dcf7/Xc7c	✔ Report
2014-07-02 06:49:28	70.38	uid://A002/X85c183/X1434	✔ Report
2014-07-01 07:02:06	70.18	uid://A002/X85b7b2/Xb3	✔ Report

Execution block uid://A002/X85dcf7/Xefe

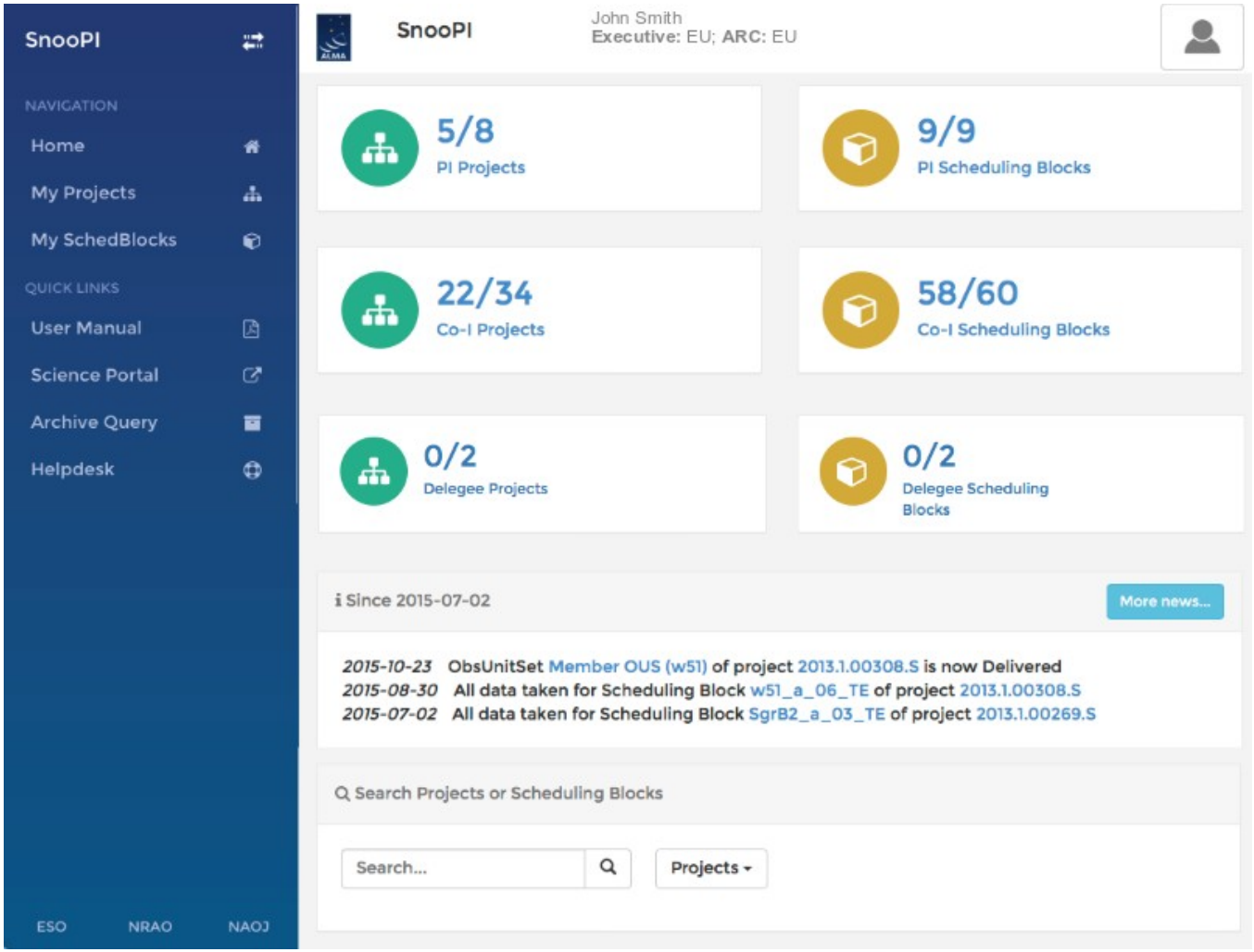
Temperatures [°K]		Array	
Average T_{sys}	41.79	Number of antennas	8
σ	21.35	Shortest baseline	8.903 m
$T_{sys,min}$	N/A	Longest baseline	47.986 m
$T_{sys,max}$	64.55	Angular resolution	13.65 arcsec
		Maximum Recoverable Scale	73.291 arcsec

Sources

Intent	Object	RA	Dec	Time [min]
Science Target	SgrB2	$17^h\ 47^m\ 19.4^s$	-28° 23' 29.8"	26.21
Amplitude Calibrator	J1733-130	$17^h\ 33^m\ 2.7^s$	-13° 4' 49.5"	5.04
Atmospheric Calibrator	J1733-130	$17^h\ 33^m\ 2.7^s$	-13° 4' 49.5"	0.29
Atmospheric Calibrator	J1700-2610	$17^h\ 0^m\ 53.2^s$	-26° 10' 51.7"	0.29
Atmospheric Calibrator	SgrB2	$17^h\ 47^m\ 19.4^s$	-28° 23' 29.8"	0.58
Bandpass Calibrator	J1700-2610	$17^h\ 0^m\ 53.2^s$	-26° 10' 51.7"	10.08
Flux Calibrator	J1733-130	$17^h\ 33^m\ 2.7^s$	-13° 4' 49.5"	5.04
Phase Calibrator	J1744-3116	$17^h\ 44^m\ 23.6^s$	-31° 16' 36.3"	5.04
Pointing Calibrator	J1700-2610	$17^h\ 0^m\ 53.2^s$	-26° 10' 51.7"	2.02

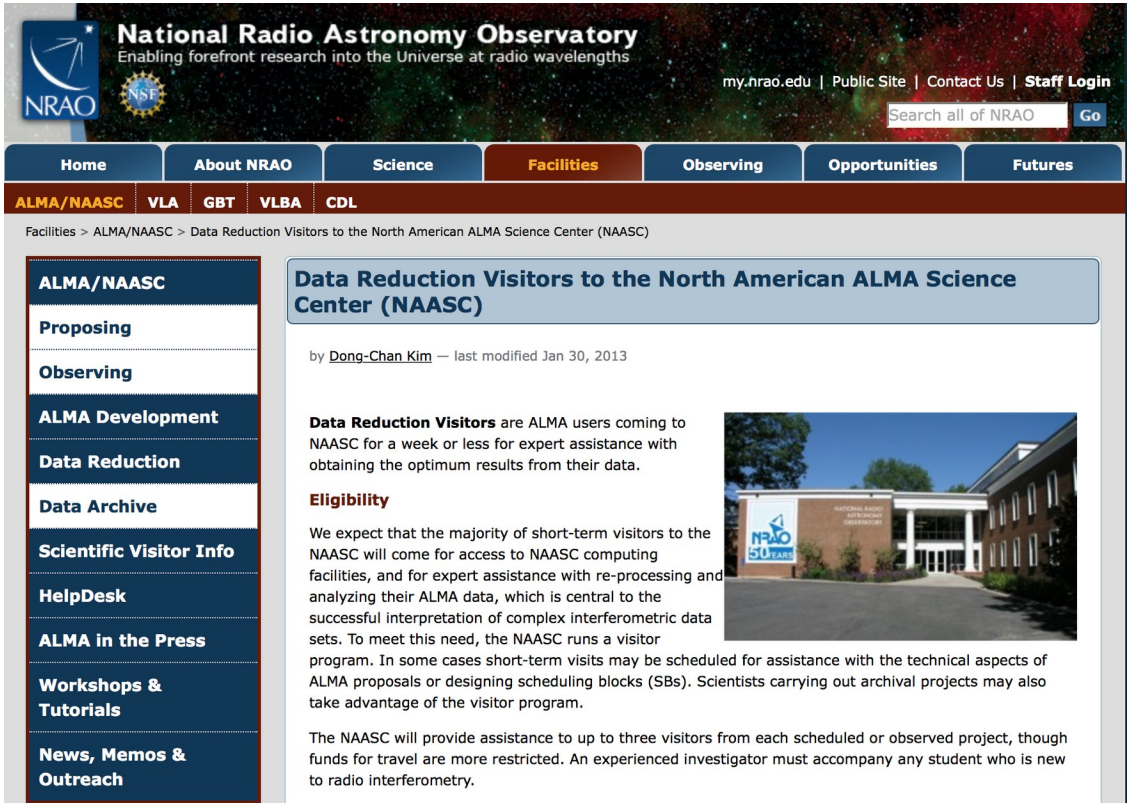
Monitor Project Status: *SnooPI*

https://asa.alma.cl/snoopi



Resources After Delivery

- HelpDesk: help.almascience.org
- Face to Face visits (currently virtual-only): http://science.nrao.edu/facilities/alma/visitors-shortterm



ALMA

For more info:

https://almascience.nrao.edu/

ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada), MOST and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile. ALMA construction and operations are led on behalf of Europe by ESO, on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI), and on behalf of East Asia by the National Astronomical Observatory of Japan (NAOJ). The Joint ALMA Observatory (JAO) provides the unified leadership and management of the construction and operation of ALMA. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ.

NRAO