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

Authors: Sarah Wood, Erica Keller, Catarina Ubach

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

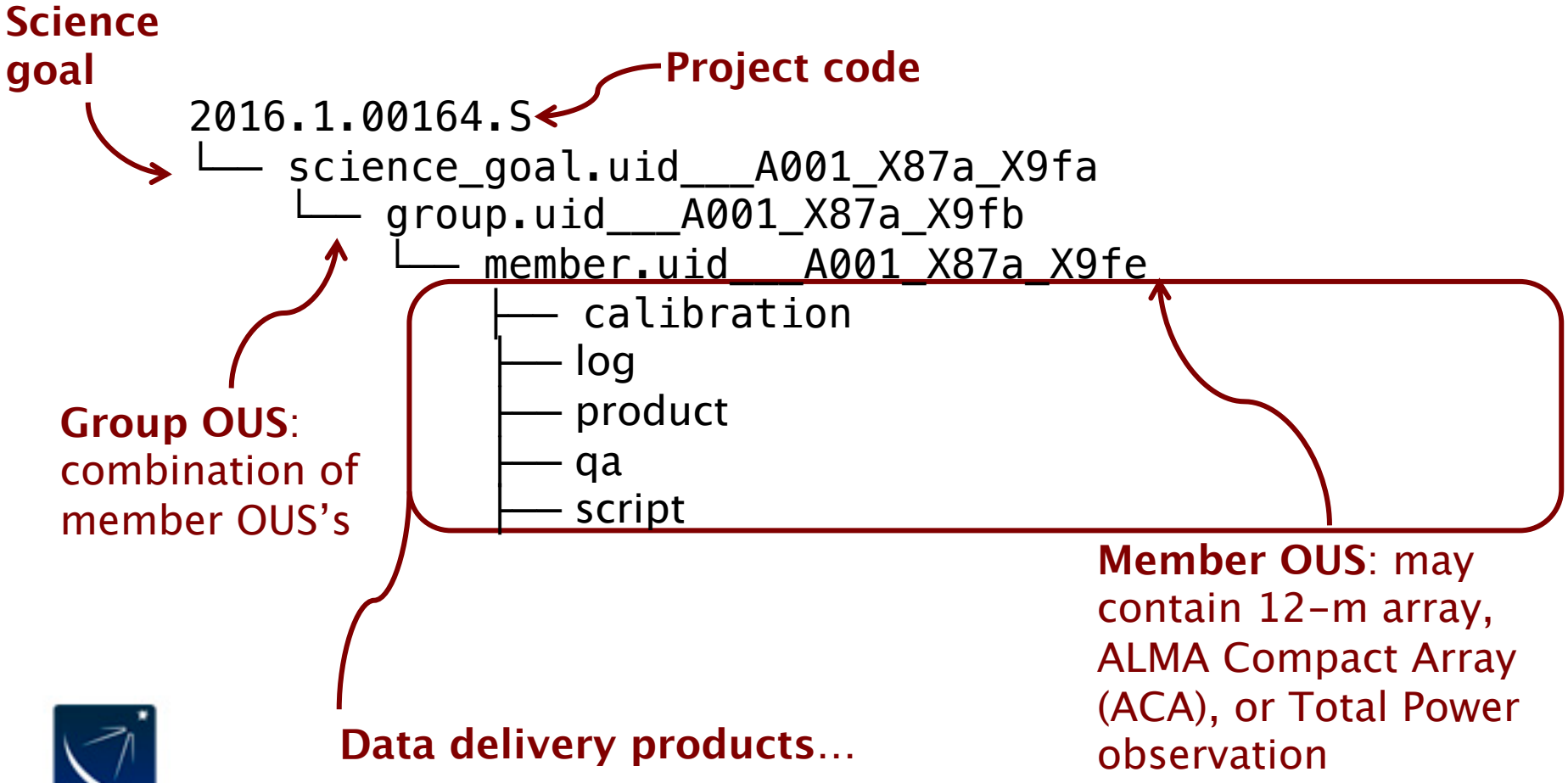
This talk will be available online for reference after this workshop.

Exploring the ALMA Archive

- All projects should start with the ALMA Archive
- Check for duplications
  - Same Target
  - Angular resolution is within a factor of 2
  - RMS is better by 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/

QA2 Data Products Package: Directory Structure

After un-tarring the processed data we have a directory tree:



QA2 Data Products Package: The QA2 Report (previously README)

Different format before Cycle 5

```
|-- member.uid___A001_X1299_X39.README.txt
```

Cycle 0-4

Project code: 2015.1.02572.S
PI name: Bob Hops
Project title: A first look at Space
Configuration: 0.241 km
Proposed rms:
Proposed beam size: 3.44"
CASA version: 4.7.2
Comments from Reducer:
This scheduling block was manually calibrated and imaged.
Several antennas were flagged for particularly high Tsys.
Continuum images were produced using scriptForImaging.py. They include the entire bandwidth.
Continuum:
Beam= 4.33" by 2.59"
RMS = 5.0 Jy/Beam over 7.5 GHz bandwidth

Cycle 5-Now

Details about the quality of the data processing are in

qa/member.uid___A001_X135e_X8f.qa2_report.pdf (or html)

Details about the processing are in

qa/*weblog.tgz

Details about the quality of the raw data are in

qa/*qa0_report.pdf (or html)

SnooPI Access

PI's and Co-I's can download the AQUA quality report for Cycle 5+ observations from SnooPI using the following URL...

https://asa.alma.cl/snoopi

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 – QA I

- "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:

QA2 Report

Project information

Name	Chemical Diagnostics of Extragalactic ISM: Shock-Induced Evolution in M83 Nucleus
Code	2016.1.00164.S
PI	Nanase Harada
Organization	Institute of Astronomy and Astrophysics, Academia Sinica
Co-Is	S. Aalto, R. Aladro, F. Costagliola, S. Martin, D. Riquelme, K. Sakamoto, Y. Watanabe

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)

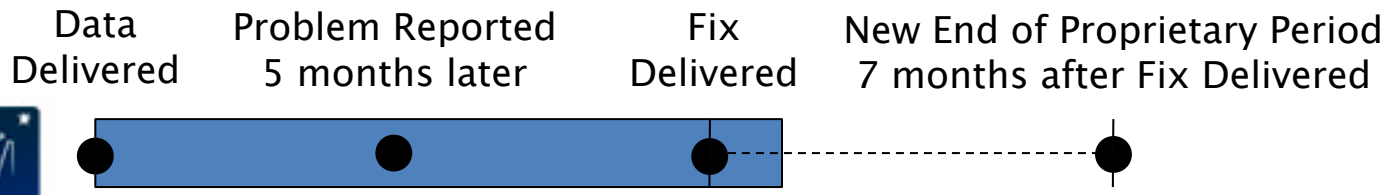
Reduction mode: PL calibration and imaging

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
- Reported within 2 months of delivery
  - Full 12 month proprietary extension after fix delivered
- Reported more than 2 months after delivery
  - Remaining proprietary period extended after fix delivered



Open the Weblog

- Run the command:

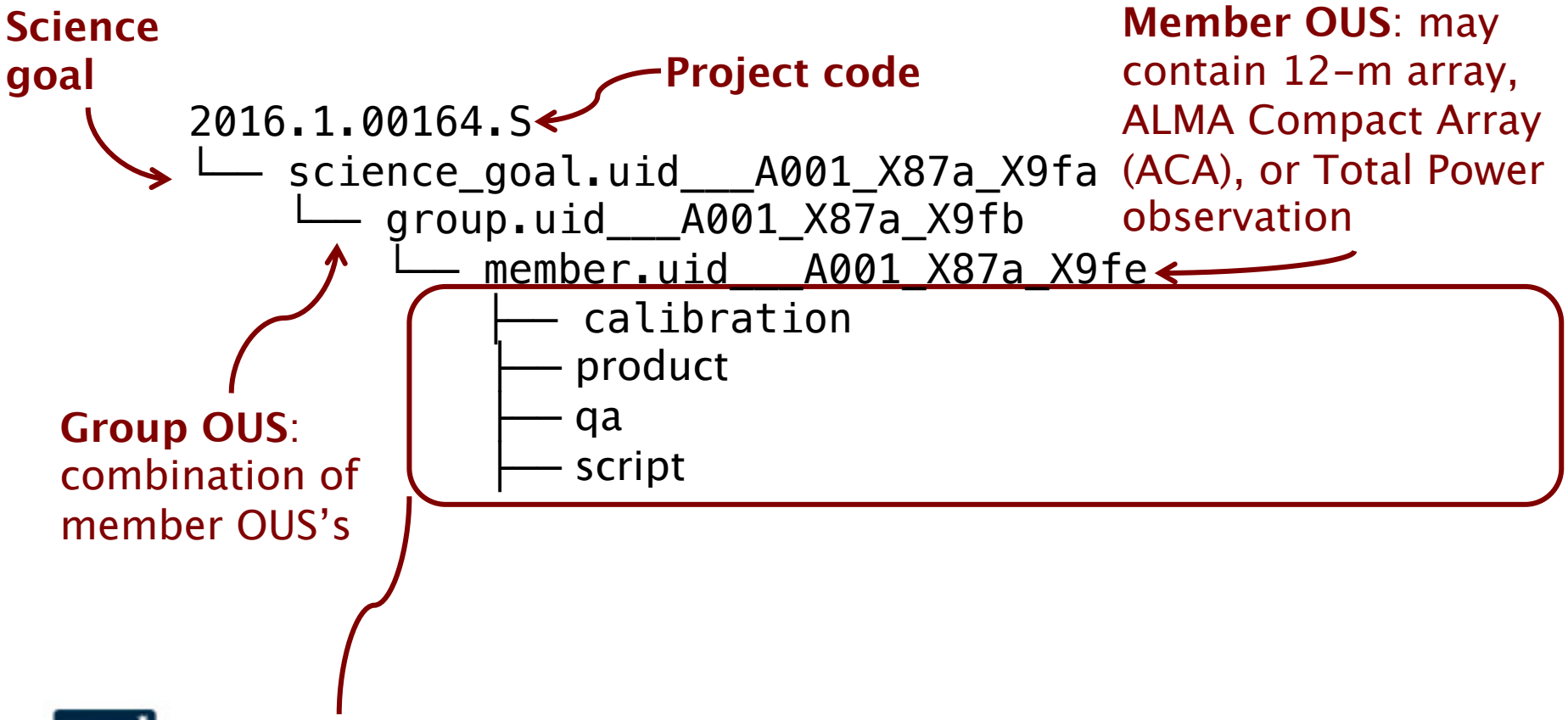
tar -xvzf member.uid___A001_X87a_X9fe.hifa_calimage.weblog.tgz

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

- Coming later this year – Weblog will be viewable through SnooPI!

QA2 Data Products Package: Directory Structure

Return to the directory tree:



QA2 Data Products Package:

Pipeline Calibration Tables

```
member.uid___A001_X87a_X9fe.session_1.auxcaltables.tgz
member.uid___A001_X87a_X9fe.session_1.caltables.tgz
uid___A002_Xbc4a22_X1f16.ms.calapply.txt
uid___A002_Xbc4a22_X1f16.ms.flagversions.tgz
uid___A002_Xbc4a22_X1f16_target.ms.auxcalapply.txt
```

Manual Calibration Tables

```
calibration:
uid___A002_Xd81670_X867e.calibration.plots.tgz
uid___A002_Xd81670_X8a51.calibration.plots.tgz
uid___A002_Xd81670_X8d91.calibration.plots.tgz
uid___A002_Xd81670_X867e.calibration.tgz
uid___A002_Xd81670_X8a51.calibration.tgz
uid___A002_Xd81670_X8d91.calibration.tgz
```

All flags will be restored during calibration

QA2 Data Products Package:

Products:

member.uid___A001_X87a_X9fe.M83_sci.spw16.cube.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw16.cube.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw16.cube.I.pbcor.fits
member.uid___A001_X87a_X9fe.M83_sci.spw16.mfs.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw16.mfs.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw16.mfs.I.pbcor.fits
member.uid___A001_X87a_X9fe.M83_sci.spw16_18_20_22.cont.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw16_18_20_22.cont.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw16_18_20_22.cont.I.pbcor.fits
member.uid___A001_X87a_X9fe.M83_sci.spw18.cube.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw18.cube.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw18.cube.I.pbcor.fits
member.uid___A001_X87a_X9fe.M83_sci.spw18.mfs.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw18.mfs.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw18.mfs.I.pbcor.fits
member.uid___A001_X87a_X9fe.M83_sci.spw20.cube.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw20.cube.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw20.cube.I.pbcor.fits
member.uid___A001_X87a_X9fe.M83_sci.spw20.mfs.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw20.mfs.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw20.mfs.I.pbcor.fits
member.uid___A001_X87a_X9fe.M83_sci.spw22.cube.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw22.cube.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw22.cube.I.pbcor.fits
member.uid___A001_X87a_X9fe.M83_sci.spw22.mfs.I.mask.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw22.mfs.I.pb.fits.gz
member.uid___A001_X87a_X9fe.M83_sci.spw22.mfs.I.pbcor.fits

Calibration and Target images produced from QA2

QA2 Data Products Package: the processed data

Pipeline Calibration Scripts:

Commands to re-run the pipeline from scratch

```
member.uid___A001_X87a_X9fe.calimage.product_rename.txt
member.uid___A001_X87a_X9fe.hifa_calimage.casa_commands.log
member.uid___A001_X87a_X9fe.hifa_calimage.casa_piperestorescript.py
member.uid___A001_X87a_X9fe.hifa_calimage.casa_pipescript.py
member.uid___A001_X87a_X9fe.hifa_calimage.pipeline_manifest.xml
member.uid___A001_X87a_X9fe.hifa_calimage.pprequest.xml
member.uid___A001_X87a_X9fe.scriptForPI.py
```

Run scriptForPI.py to restore calibration

QA2 Data Products Package: the processed data

MANUAL Calibration Scripts and QA2 report:

```
qa:
member.uid___A001_X122e_X2945.qa2_report.html
uid___A002_Xd81670_X867e__qa2_part2.png uid___A002_Xd81670_X8d91.qa0_report.pdf
uid___A002_Xd81670_X8d91__textfile.txt
member.uid___A001_X122e_X2945.qa2_report.pdf
uid___A002_Xd81670_X867e__qa2_part3.png uid___A002_Xd81670_X8d91__qa2_part1.png
uid___A002_Xd81670_X867e.qa0_report.pdf
uid___A002_Xd81670_X867e__textfile.txt  uid___A002_Xd81670_X8d91__qa2_part2.png
uid___A002_Xd81670_X867e__qa2_part1.png
uid___A002_Xd81670_X8a51.qa0_report.pdf uid___A002_Xd81670_X8d91__qa2_part3.png

script:
member.uid___A001_X122e_X2945.calimage.product_rename.txt
member.uid___A001_X122e_X2945.scriptForPolCalibration.py
uid___A002_Xd81670_X8a51.ms.wvrgcal.txt
member.uid___A001_X122e_X2945.scriptForImagingPrep.py
uid___A002_Xd81670_X867e.ms.scriptForCalibration.py
uid___A002_Xd81670_X8d91.ms.scriptForCalibration.py
member.uid___A001_X122e_X2945.scriptForImaging.py
uid___A002_Xd81670_X867e.ms.wvrgcal.txt
uid___A002_Xd81670_X8d91.ms.wvrgcal.txt
member.uid___A001_X122e_X2945.scriptForPI.py
uid___A002_Xd81670_X8a51.ms.scriptForCalibration.py
```

QA2 reports contain plots and images from reduction and imaging. Not as much information as weblog…

Run scriptForPI.py to restore calibration

Restoring calibrated measurement set: scriptForPI

- https://help.almascience.org/kb/articles/how-do-i-obtain-a-file-of-calibrated-visibilities-measurement-set-for-alma-data
- Recommend using same CASA version used in processing
- But if you do want to use a newer version, inspect the measurement set carefully to make sure flags were applied correctly.
- A few known issues are posted here:
  - https://help.almascience.org/kb/articles/why-does-scriptforpi-py-crash-with-the-error-no-such-file-or-directory-rawdata-uid-a002-x12345
  - https://help.almascience.org/kb/articles/why-does-scriptforpi-py-crash-with-nameerror-name-hif-restoredata-is-not-defined

Restoring calibrated measurement set: scriptForPI

- https://help.almascience.org/kb/articles/how-do-i-obtain-a-file-of-calibrated-visibilities-measurement-set-for-alma-data
- cd into script directory
- Start the correct version of casa (casa --pipeline for PL tasks)
- Run scriptForPI.py (with spacesaving options, if needed) – execfile('*scriptForPI.py')

```
cd script
casa -c "SPACESAVING=N; execfile('scriptForPI.py')"
```

where N is an integer from 0 to 3 with the following meaning:

SPACESAVING	= 0	same as not set (all intermediate MSs are kept)
	= 1	do not keep intermediate MSs named *.ms.split
	= 2	do not keep intermediate MSs named *.ms and *.ms.split
	>= 3	do not keep intermediate MSs named *.ms, *.ms.split, and *.ms.split.cal (if possible)
	= -1	do not check disk space

Restoring calibrated measurement sets: scriptForPI - PL calibration + imaging

```
2020-06-11 16:57:33 INFO: Selecting representative target source 520412 for data set uid___A002_Xe20b32_X84e7.ms
2020-06-11 16:57:33 INFO: Selecting representative target source 520412 for data set uid___A002_Xe20b32_X84e7.ms

2020-06-11 16:57:33 INFO: Saving context to 'pipeline-20200611T164804.context'
Imaging pipeline was used. Will not create uid___A002_Xe20b32_X84e7.ms.split.cal
Linking MS uid___A002_Xe20b32_X84e7.ms into directory "calibrated"
Done. Please find results in directory "calibrated".
```

- Results in calibrated directory, which contains:

```
products -> ../calibration
rawdata
working
uid___A002_Xe20b32_X84e7.ms -> working/uid___A002_Xe20b32_X84e7.ms
```

Measurement set containing data (raw) and corrected (calibrated) columns of all targets (calibrators and science targets)

Restoring calibrated measurement sets: scriptForPI - PL calibration + Manual Imaging

calibrated directory if only calibration pipeline was run:

```
products -> ../calibration
rawdata
uid___A002_Xdd9a29_X17e0.ms.split.cal
working
```

→ **Measurement set containing only science spectral windows (spw) of all sources**

Look for scriptForImaging.py in the script directory

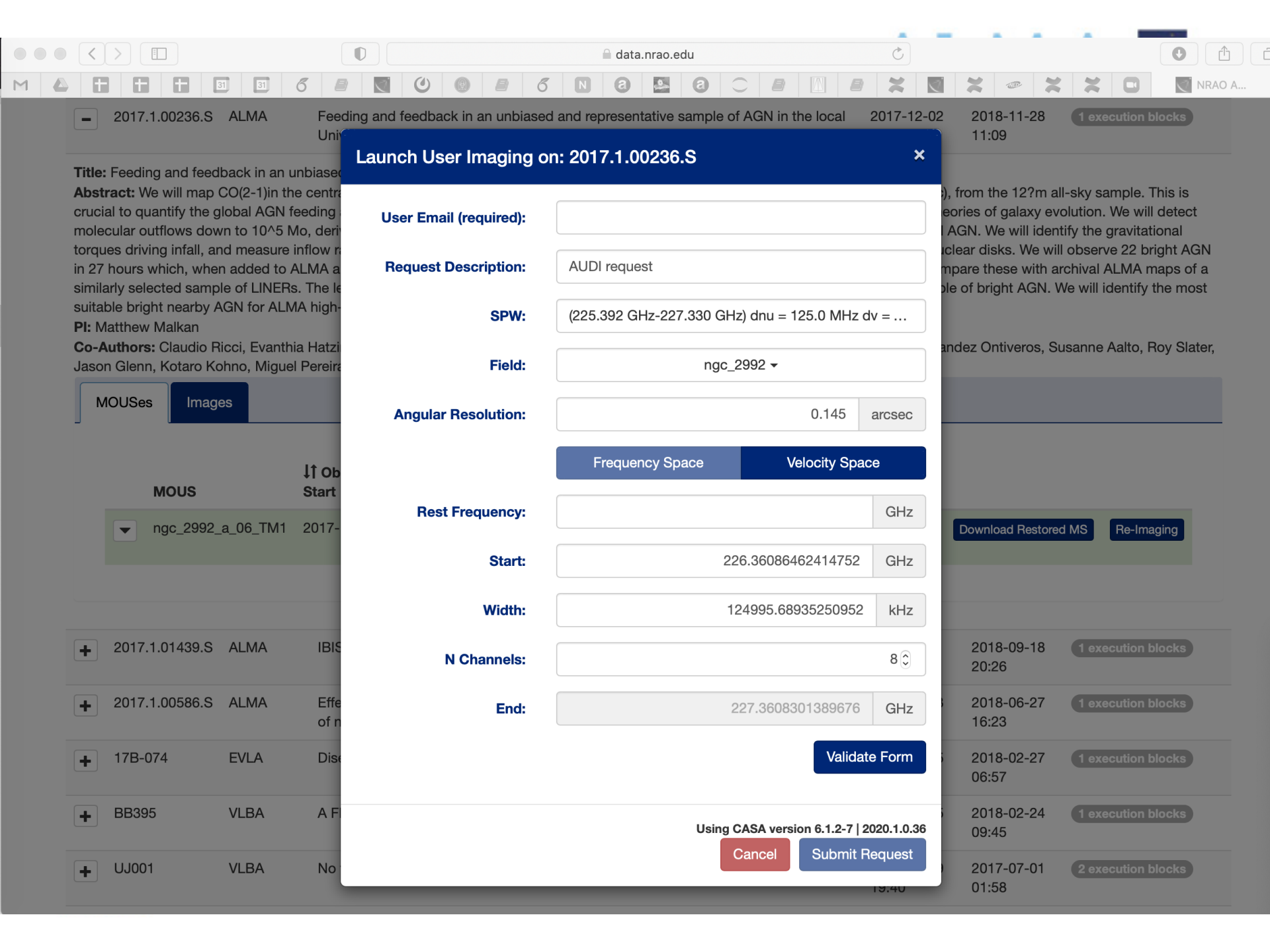
```
member.uid___A001_X131c_X167.scriptForPI.py
member.uid___A001_X131c_X167.scriptForImaging.py
member.uid___A001_X131c_X167.image.product_rename.txt
member.uid___A001_X131c_X167.hifa_cal.pprequest.xml
member.uid___A001_X131c_X167.hifa_cal.pipeline_manifest.xml
member.uid___A001_X131c_X167.hifa_cal.casa_pipescript.py
member.uid___A001_X131c_X167.hifa_cal.casa_piperestorescript.py
member.uid___A001_X131c_X167.hifa_cal.casa_commands.log
member.uid___A001_X131c_X167.cal.product_rename.txt
```

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

Current SRDP capabilities for ALMA Data

- **Accessible via the NRAO archive interface (data.nrao.edu)**
- **ALMA Calibrated Measurement set download**
  - Cycle 5 data and beyond: subject to proprietary periods
  - only available for data calibrated by pipeline (no manual reductions)
- **ALMA User-Defined Imaging**
  - Generate datacube with a custom spectral axis from a pipeline-reduced dataset
  - User-defined spectral width of cube
  - Velocity or frequency definitions supported
  - Channel averaging
  - Angular resolution modification (higher or lower resolution). This is limited by what data will allow, one may not exactly get their requested resolution.


data.nrao.edu
2017.1.00236.S ALMA Feeding and feedback in an unbiased and representative sample of AGN in the local 2017-12-02 2018-11-28 11:09 1 execution blocks
Launch User Imaging on: 2017.1.00236.S
User Email (required):
Request Description: AUDI request
SPW: (225.392 GHz-227.330 GHz) dnu = 125.0 MHz dv = …
Field: ngc_2992
Angular Resolution: 0.145 arcsec
Frequency Space
Velocity Space
Rest Frequency: GHz
Start: 226.36086462414752 GHz
Width: 124995.68935250952 kHz
N Channels: 8
End: 227.3608301389676 GHz
Validate Form
Using CASA version 6.1.2-7 | 2020.1.0.36
Cancel
Submit Request
MOUSes
Images
MOUS
ngc_2992_a_06_TM1
Download Restored MS
Re-Imaging
2017.1.01439.S ALMA 2018-09-18 20:26 1 execution blocks
2017.1.00586.S ALMA 2018-06-27 16:23 1 execution blocks
17B-074 EVLA 2018-02-27 06:57 1 execution blocks
BB395 VLBA 2018-02-24 09:45 1 execution blocks
UJ001 VLBA 2017-07-01 01:58 2 execution blocks

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/kb/articles/where-can-i-get-additional-information-for-my-na-added-value-data-products

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

Monitor Project Status: *SnooPI*

QA Report:

Coming soon: Link to pipeline weblog

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

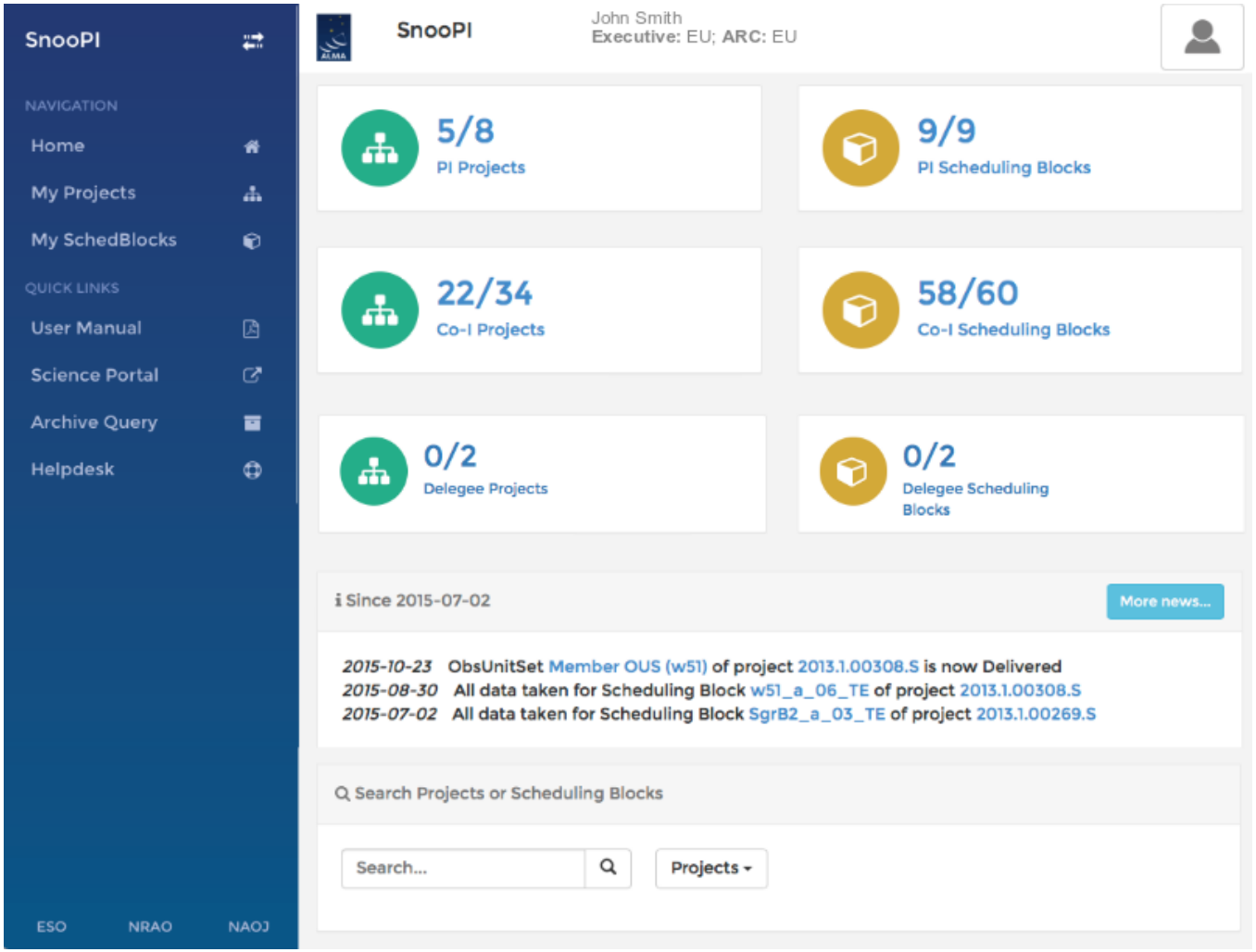
Temperatures [°K]		Array	
Average T_{sys}	41.79	Number of antennas	8
σ	21.35	Shortest baseline	8.903 m
$T_{sys,min}$	N/A	Longest baseline	47.986 m
$T_{sys,max}$	64.55	Angular resolution	13.65 arcsec
		Maximum Recoverable Scale	73.291 arcsec

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

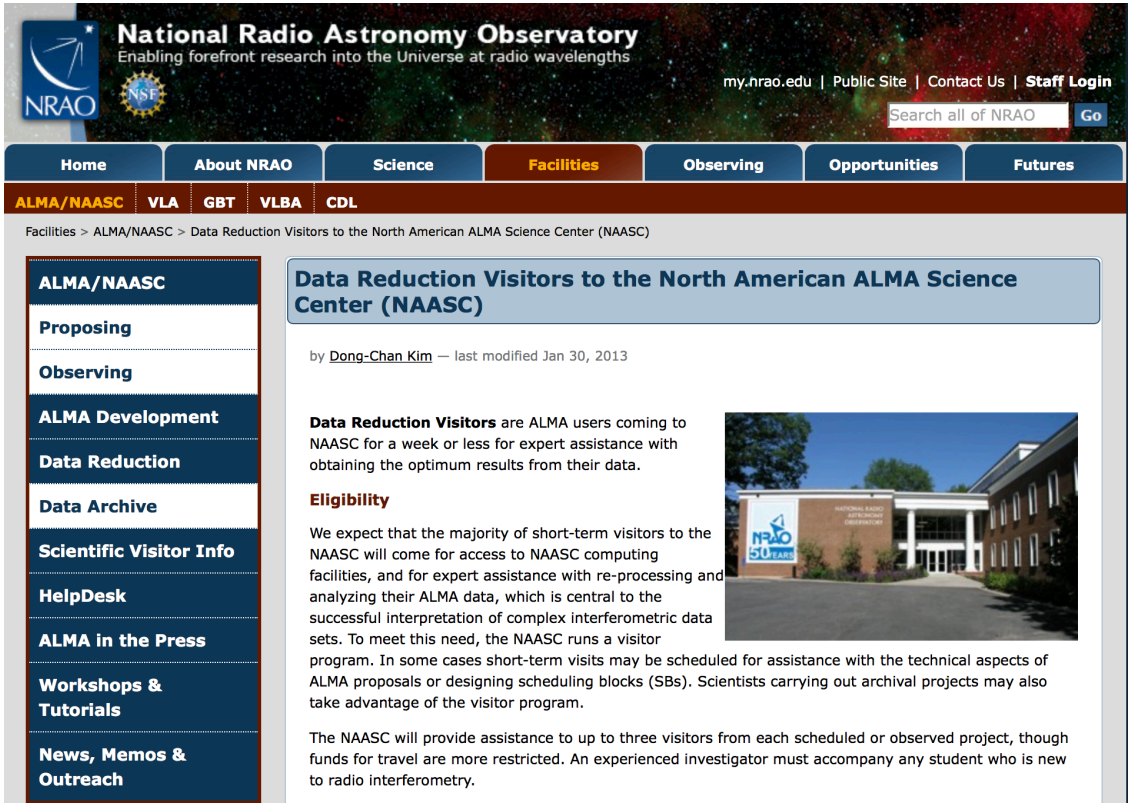
Monitor Project Status: *SnooPI*

https://asa.alma.cl/snoopi



Resources After Delivery

- HelpDesk: help.almascience.org
- Face to Face visits in Charlottesville- Now virtual over Slack/Zoom: 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