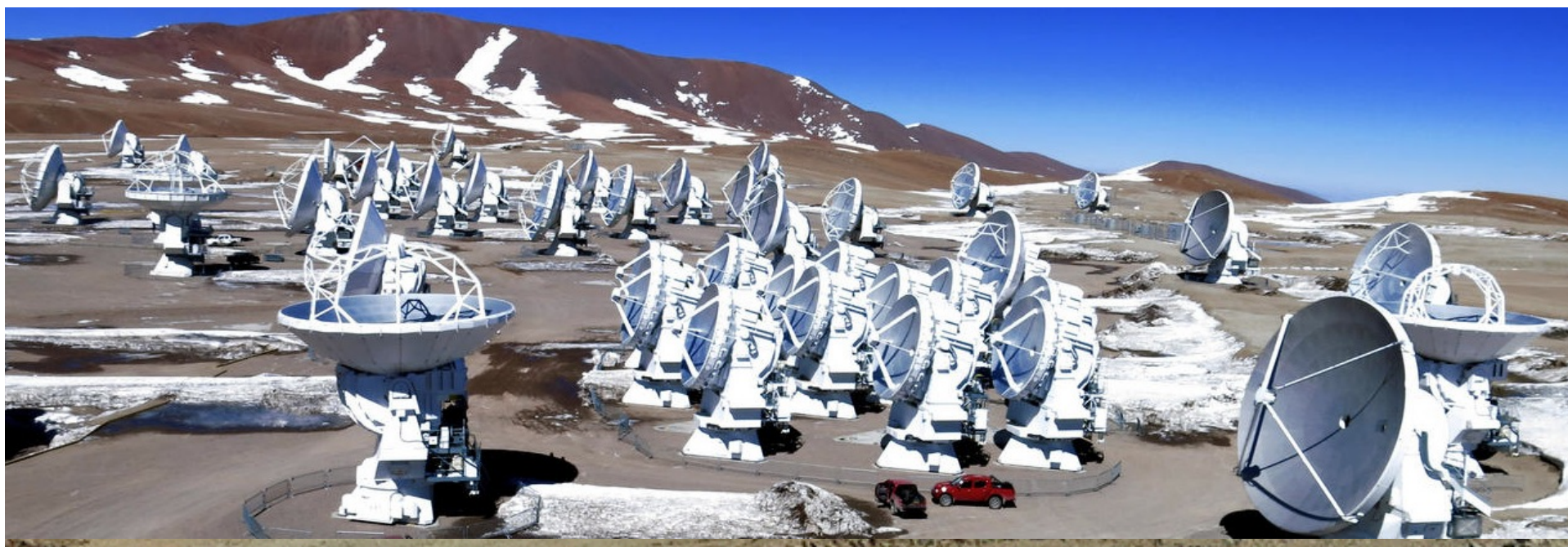


ALMA Data – what to expect after your observations are made



Nathan Brunetti

Anand Crossley, Brian Kirk, and Sarah Wood

NRAO / NA ALMA Science Center



Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array



The Condensed Version



- Data are delivered after passing Quality Assurance (QA) testing.
- Download data from *Archive Query* and *Request Handler* tools in ALMA Science Portal
- Delivered data include:
 - Calibration tables and diagnostics
 - Preliminary images, *PI should plan to re-image*.



Goals of Quality Assurance (QA) Process



- Ensure reliable final data product
 - Desired sensitivity
 - Desired resolution
- Ensure data is free of calibration and imaging artifacts
- Errors in PI-supplied parameters are outside scope
 - Incorrect source coordinates
 - Inadequate frequency specification
 - Inadequate sensitivity limits

See [ALMA Technical Handbook](#) for details.



During Observations – QA0

- Monitoring of calibrations and overall performance
- Rapidly-varying parameters
 - Scheduling block timescales or shorter
 - Atmospheric effects
 - Antenna issues
 - Front-end issues (sideband ratios, antenna temp.)
 - Connectivity issues (System temp., delay measurements...)
 - Back-end issues (total power levels, delays...)
- Tolerances for each are explicitly laid out
 - Fewer than 26 antennas in 12-m array
 - Bandpass calibrator too weak

See [ALMA Technical Handbook](#) for details.

Between Observations – QA I

- Regularly Measured Array Performance
- Slowly Varying Parameters
 - Timescales of a week or longer
- Array Calibrations
 - Baseline measurements
 - Delays
- Antenna Calibrations
 - All-sky pointing
 - Focus curves
 - Beam patterns etc.
- Source Calibrations
 - Solar-system and quasar flux monitoring

After Observations – QA2

- Calibration by pipeline or analyst
 - Extreme T_{sys}
 - Water vapor measurements and corrections
 - Absolute flux scale certainty
 - Noisy or extreme bandpass corrections
 - Proper phase transfer cadence followed
 - Noisy phase and amplitude corrections
- Image data and compare with requested science goals
 - Signal-to-noise (within ~10% of goal)
 - Resolution
 - Artifacts (e.g. sidelobe levels or striping)

After Observations – QA3

- Post-reduction evaluation of **delivered** data products
- Triggered by PI reporting possible underlying problems with:
 - Data
 - Observing procedure
 - Calibration
- Likely results in fix being implemented and products re-ingested into ALMA archive
- May include extension of proprietary period

Monitor Project Status: *Project Tracker*



Project Tracker

[Project](#)

[SB](#)

[OUS](#)

[Export List](#)

[Reports](#)

[Life Cycles](#)

[User Manual](#)

[Alma Portal](#)

[Log out](#)

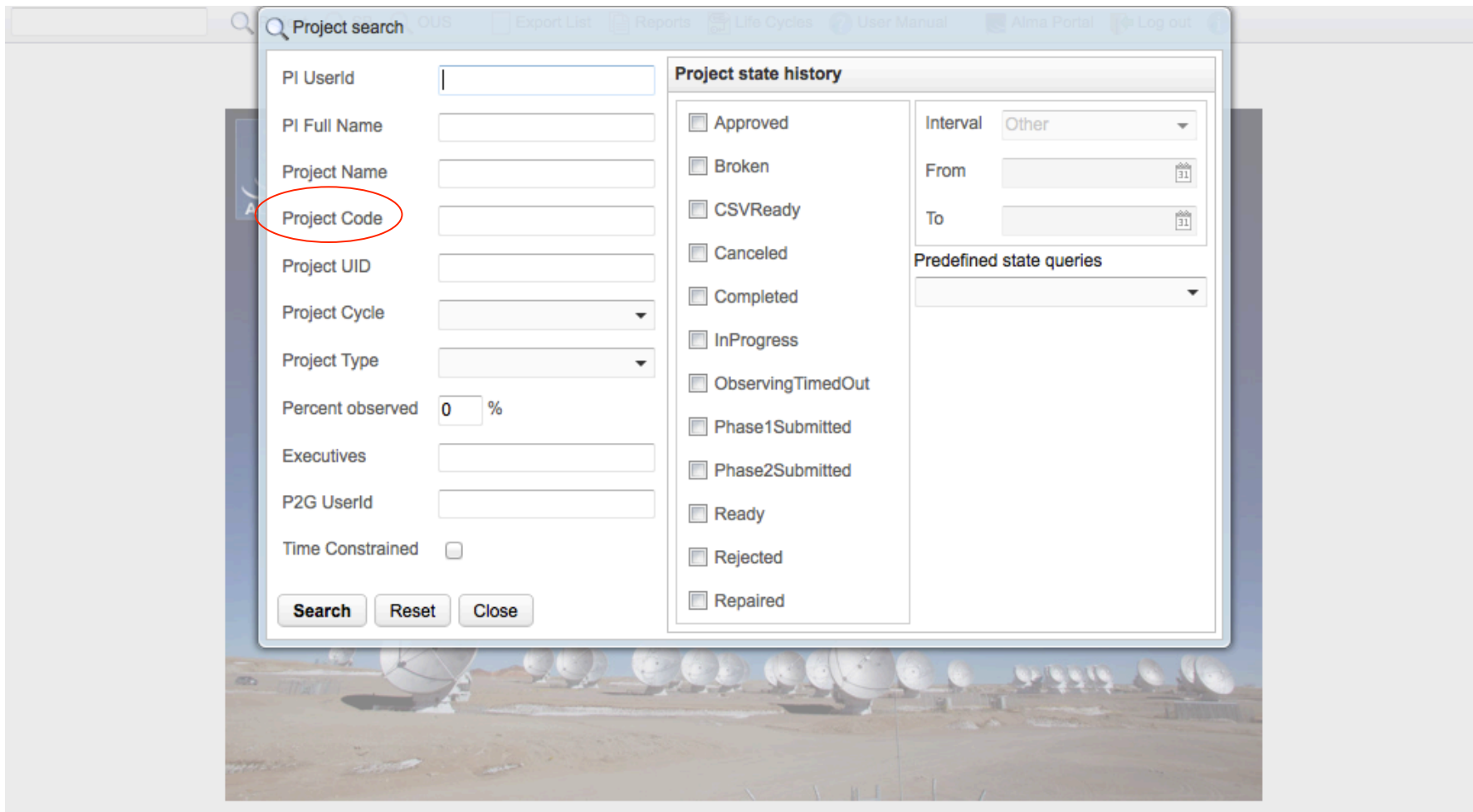


User: nbrunett

Roles: arca, master_user, omc_astronomer_on_duty, user



Project Tracker



Project search

PI Userid

PI Full Name

Project Name

Project Code

Project UID

Project Cycle

Project Type

Percent observed 0 %

Executives

P2G UserId

Time Constrained ☐

Search **Reset** **Close**

Project state history

☐ Approved

☐ Broken

☐ CSVReady

☐ Canceled

☐ Completed

☐ InProgress

☐ ObservingTimedOut

☐ Phase1Submitted

☐ Phase2Submitted

☐ Ready

☐ Rejected

☐ Repaired

Interval Other

From

To

Predefined state queries

Project Tracker

project Tracker																							1 Projects found	
Code	PI Userid	Executives	Project Name	Progress		State	Time Co	Grade	Rank	Version	Time of Creation	Timed Out	Project UID											
00090.S	irs	EU	The bright end of the submm galaxy c	<div><div></div></div>	100 %	Completed		<div></div>	<div></div>	2.3	2012-07-09 12:38:14		uid://A001/Xa0/Xa8											

2.1.00090.S - The bright end of the submm galaxy counts: real or not? v1

	Status
2012.1.00090.S	Completed
Proposal	
Observing Program	PartiallyObserved
SG OUS (Subsample 1)	Delivered
Group OUS	Delivered
Member OUS (S2CLS_UD)	Delivered
S2CLS_UDS_Subsample	FullyObserved
SG OUS (Subsample 2)	Delivered
Group OUS	Delivered
Member OUS (S2CLS_UD)	Delivered
S2CLS_UDS_Subsample	FullyObserved

Project Details

Code: 2012.1.00090.S

PI: [Redacted]

Creation date: 2012-07-09 12:38:14

Executives: EU

Ph1m Priority Flag: [Redacted]

Rank: [Redacted]

Project completion: 100.0%

P2G

Contact Scientist

State: **Completed**

APRC Consensus report

Proposal to study HyLIRG SMGs to investigate possibility that sources identified by single-dish bolometer surveys are, in fact, blends of several, fainter, SMGs

Comments

Cycle: 2012.1

Version: 2.3

Project UID: uid://A001/Xa0/Xa8

Grade: [Redacted]

Score: [Redacted]

Project Report

PDF

HTML

Project Status UID: uid://A001/Xa0/Xac

Project Tracker

Project Tracker <input type="text"/> Project SB OUS Export List Reports Life Cycles User Manual Alma Portal Log out 1 Projects found												
Code	PI Userid	Executives	Project Name	Progress	State	Time Co	Grade	Rank	Version	Time of Creation	Timed Out	Project UID
12.00090.S	irs	EU	The bright end of the submm galaxy c	<input type="text"/> 100 %	Completed				2.3	2012-07-09 12:38:14		uid://A001/Xa0/Xa8

12.1.00090.S - The bright end of the submm galaxy counts: real or not? v1

	Status
2012.1.00090.S	Completed
Proposal	
Observing Program	PartiallyObserved
SG OUS (Subsample 1)	Delivered
Group OUS	Delivered
Member OUS (S2CLS_UD	Delivered
S2CLS_UDS_Subsam	FullyObserved
SG OUS (Subsample 2)	Delivered
Group OUS	Delivered
Member OUS (S2CLS_UD	Delivered
S2CLS_UDS_Subsam	FullyObserved

Timeline

Feb 11

Feb 12

Feb 13

2014

Feb

Mar

Sched Block status history	Timestamp	Timestamp (LST)	Location	User ID	Subsystem	Additional Info
Phase2Submitted	Mon, 25 Mar 2013 14:29:54 GMT	2013-03-25 07:13:46	sco	eelco	stateengine	creation
Ready	Mon, 25 Mar 2013 14:38:41 GMT	2013-03-25 07:22:35	tst	aod	stateengine	no info
Running	Fri, 01 Nov 2013 05:00:25 GMT	2013-11-01 12:14:03	tst	aod	scheduling	no info
Suspended	Fri, 01 Nov 2013 06:24:20 GMT	2013-11-01 13:38:11	tst	aod	scheduling	no info
FullyObserved	Wed, 12 Feb 2014 15:17:36 GMT	2014-02-12 05:19:00	tst	hfrancke	obops	no info

Exec Status List	QA0 Status	Exec. Fraction	Time on Source	Start Time (UTC)	End Time (UTC)	Start Time (LST)	End Time (LST)
FullyObserved	Pass	1	0s	2013-11-01 05:00:42	2013-11-01 06:24:20	2013-11-01 12:14:19	2013-11-01 12:14:19

Monitor Project Status:


Optional emails




- Subscribe to email notification for updates on changes to project status
 - ...
 - Phase2Submitted
 - Running
 - Partially Observed
 - Fully Observed
 - Pipeline Processing
 - ...
- With or without optional emails, PIs always receive notification when new data are available



Optional emails



Atacama Large Millimeter/submillimeter Array
In search of our Cosmic Origins



[ESO](#) [NRAO](#) [NAOJ](#) [Log in](#) | [Register](#) | [Reset Password](#) | [Forgot Account](#)


- About
- Science
- Proposing
- Observing
- Data
- Documents & Tools
- Knowledgebase/FAQ

User Services at ARCs

- Helpdesk
- [ALMA Calendars](#)
- [EU ARC](#)
- [NA ARC](#)
- [EA ARC](#)

You are here: Home

Welcome to the Science Portal at ESO



This is the website for **The ALMA Science Portal**, served from one of the **ALMA Regional Centers (ARCs)** of the ALMA partner organizations: ESO, NRAO or NAOJ. You may switch between the different instances of the portal through the links to the appropriate ALMA partner at the top banner. Through this portal you can find details about the technical capabilities of ALMA, how to propose for observing time, and how to access ALMA data. It includes links to all official ALMA documents and tools, including those for preparing and submitting proposals and processing ALMA data. In order to access some of the tools, users must register with the project and login to the portal via the links at the top banner.

Each of the three ARCs provides additional **User Services**, including a **Helpdesk** for all user queries. Each ARC maintains additional web pages with information on region-specific user services, such as visitor and student programs, schools, workshops, financial programs and public outreach activities. These are accessed via the links under the **User Services at the ARCs** area in the left menu.

General News

Announcement of intent to release a new installment of Science Verification data
[Feb 02, 2015](#)

[ALMA Cycle 3 Pre-announcement](#)
[Dec 08, 2014](#)

[ALMA Status Report: November 2014](#)
[Nov 12, 2014](#)

[Additional Scope for Long Baseline Science Verification Targets](#)
[Oct 30, 2014](#)

[First Release of the ALMA Science Pipeline](#)
[Oct 20, 2014](#)

[More...](#)

Local News

One or two postdoctoral positions at the Allegro node
[Dec 18, 2014](#)

Optional emails



ALMA Central Authentication Service (CAS)

ALMA
username
and password



Enter your NetID and Password

NetID:

Password:

☐ Warn me before logging me into other sites.

LOGIN

clear

For security reasons, please Log Out and Exit your web browser when you are done accessing services that require authentication!

If you don't have an account, you can create one in the following link:
[Registration web form](#)

If you forgot you account ID, you can go to the following link:
[Forgot account ID page](#)

If you want to reset your password, you can go to the following link:
[Reset password page](#)

You may find a solution to your problem in the Support Center/Knowledgebase:
[Helpdesk](#)

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Powered by [JA-SIG Central Authentication Service 3.4.10](#)

Optional emails



Atacama Large Millimeter/submillimeter Array
In search of our Cosmic Origins

ESO NRAO NAOJ





- About
- Science
- Proposing
- Observing
- Data
- Documents & Tools
- Knowledgebase/FAQ

User Services at ARCs

- Helpdesk
- ALMA Calendars
- EU ARC
- NA ARC
- EA ARC

You are here: Home

Welcome to the Science Portal at NRAO



Atacama Large Millimeter/submillimeter Array

This is the website for **The ALMA Science Portal**, served from one of the **ALMA Regional Centers (ARCs)** of the ALMA partner organizations: ESO, NRAO or NAOJ. You may switch between the different instances of the portal through the links to the appropriate ALMA partner at the top banner. Through this portal you can find details about the technical capabilities of ALMA, how to propose for observing time, and how to access ALMA data. It includes links to all official ALMA documents and tools, including those for preparing and submitting proposals and processing ALMA data. In order to access some of the tools, users must register with the project and login to the portal via the links at the top banner.

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Click Name

Click Profile

Profile

Log out

release a new installment of
Science Verification data

Feb 02, 2015

ALMA Cycle 3
Pre-announcement

Dec 08, 2014

ALMA Status Report:
November 2014

Nov 12, 2014

**Additional Scope for Long
Baseline Science**
Verification Targets

Oct 30, 2014

**First Release of the ALMA
Science Pipeline**

Oct 20, 2014

More...

NRAO Events


**AAAS 2015 Science
Symposium**

Feb 15, 2015




San Jose, CA

<https://almascience.nrao.edu/useractions>

Optional emails



Atacama Large Millimeter/submillimeter Array
In search of our Cosmic Origins



















[ESO](#)
[NRAO](#)
[NAOJ](#)

Account info [Project delegation](#) [Account linking](#)

Edit Profile

(Fields marked with a red dot are mandatory)

First name	 	<input type="text" value="Nathan (ALMA)"/>
Middle initials		<input type="text"/>
Surname	 	<input type="text" value="Brunetti"/>
E-mail	 	<input type="text" value="nbrunett+test6@nrao.edu"/>
Receive optional emails	 <input type="checkbox"/>	
Account name	 	<input type="text" value="nbrunett"/>
Password		<input type="password"/>
Re-type password		<input type="password"/>
Institution	 	<input type="text" value="United States"/> <input type="text" value="VA"/> <input type="text" value="National Radio Astronomy Observatory; North American ALMA Science"/>

Click Checkbox

In case of problems with the registration, please use [this Web form](#) to contact us
You may find a solution to your problem in the [Support Center/Knowledgebase](#)

[Site Map](#) [Accessibility](#) [Contact](#) [Privacy Statement](#)

Data Delivery Email

- Sent when Member Observation Unit Set (MOUS) passes QA2 and data is copied to PI's Regional Center
- Triggers Start of Proprietary Period
 - Usually 12 months
- Only Sent to PI

Data Delivery Email

- Included Metadata:
 - MOUS ID, Scheduling Block (SB) name, project title
- Included Instructions:
 - Downloading data
 - Delegating access for registered ALMA users
- Included Descriptions:
 - Proprietary period
- Included Links:
 - Archive query for MOUS package
 - Fully-calibrated MSs (NA ARC only)
 - CASA download and mailing lists

Data Delivery Email

- Included Warnings:
 - Early science data cannot be guaranteed to meet expectations of full scientific operations
- Publication Requirements:
 - ALMA acknowledgement
 - ARC specific acknowledgement
- Additional Support:
 - Funded face-to-face reduction visits to your home ARC
 - Contact info for ARC PR personnel

Find data in archive: Archive Query



ALMA Science Archive Query

Query Form

Results Table

Search

Reset

[Query Help](#)

Position

Source name (Sesame)
Source name (ALMA)
RA Dec

Energy

Frequency
Bandwidth
Spectral resolution
Band

Time

Observation date
Integration time

Polarisation

Polarisation type

Observation

Water vapour

Project

Project code

Project title
PI name

Options

View: ☒ raw data ☐ project
☒ public data only
☒ science observations only

Project code
Project code.

Description
Project code, in the form
YYYY.NNNNN.C.AAA, where:

Example
2010.2.00010.N
2010.*
2010.?.*.CSV
*.CSV
!(*.CSV | *.SIM)



Archive Query

[Query Form](#)
[Results Table](#)
[Submit download request](#)
[Results Bookmark](#) [Export Table](#) [Results Help](#)

Showing 30 rows (30 before filtering).

[More columns](#)

<input type="checkbox"/>	Project code	Source name	RA	Dec	Band	Integration	Release date ▲	Velocity resolution	Frequency support
Filter:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="m/s"/> <input type="button" value="÷"/>	<input type="text"/>
<input checked="" type="checkbox"/>	2012.1.00090.S	S2CLS_UDS110	02:18:48.44	-05:18:05.0	7	9.326	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input checked="" type="checkbox"/>	2012.1.00090.S	S2CLS_UDS156	02:18:24.23	-05:22:53.4	7	8.836	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input checked="" type="checkbox"/>	2012.1.00090.S	S2CLS_UDS160	02:18:23.86	-05:11:36.2	7	8.842	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS168	02:18:20.34	-05:31:41.6	7	8.843	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input checked="" type="checkbox"/>	2012.1.00090.S	S2CLS_UDS199	02:18:07.38	-04:44:11.7	7	8.812	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS204	02:18:03.01	-05:28:39.8	7	8.873	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS216	02:17:56.80	-04:52:39.6	7	8.82	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS252	02:17:37.79	-05:20:10.2	7	8.827	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS286	02:17:25.76	-05:25:36.5	7	9.657	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS292	02:17:21.85	-05:19:03.3	7	8.815	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS298	02:17:19.90	-05:09:36.4	7	9.55	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS334	02:17:02.81	-04:57:24.9	7	8.856	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS408	02:16:22.59	-05:11:06.0	7	8.819	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS421	02:16:17.62	-05:09:02.0	7	8.803	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz
<input type="checkbox"/>	2012.1.00090.S	S2CLS_UDS47	02:19:24.97	-05:09:19.9	7	8.785	2014-11-07T09:35:00.000	27236.96	336.00..351.99GHz

Downloading the data:

Request Handler



- All data downloaded as tar files
- Large data sets may be broken into several pieces
 - Name is [project_code]_[OUS_ID]_m_of_n.tar
 - Raw data packaged as one tar file per execution block (EB)
 - name is [project_code]_[EB_ID].asdm.sdm.tar
- Cannot directly download individual data products yet...
 - FITS images
 - Diagnostic plots, etc.



Request Handler



Atacama Large Millimeter/Submillimeter Array
In search of our Cosmic Origins

Request Handler

Logout

Archive Requests All Requests > Req #223,292,105

Request #223292105 by  ✓

[Click to edit](#)

☐ Include raw [Select All](#) [Unselect All](#) [Download Selected](#)

Requested Projects / OUSets / Executionblocks

UNIX/Linux Shell script if you prefer command line download of complete request: [downloadRequest223292105script.sh](#)

Data entities 1-4 of 4

Project / OUSet / Executionblock	File	Size	Access
<input type="checkbox"/> Project 2012.1.00090.S			
<input type="checkbox"/> Science Goal OUS uid://A002/X5eed86/X29			
<input type="checkbox"/> Group OUS uid://A002/X5eed86/X2a			
<input type="checkbox"/> Member OUS uid://A002/X5eed86/X2b			
<input type="checkbox"/>	2012.1.00090.S uid A002 X5eed86 X2b 001 of 001.tar	377.8MB	✓
<input type="checkbox"/>	2012.1.00090.S uid A002 X7143f6 Xf9b.asdm.sdm.tar	4.0GB	✓

Data entities 1-4 of 4


4.3GB

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ALMA, a worldwide collaboration



Request Handler



Astronomy Picture of the Day
Atacama Large Millimeter/Submillimeter Array
In search of our Cosmic Origins

Request Handler

Archive Requests

Request #22329
[Click to edit](#)

Requested Project

UNIX/Linux Shell script

Project / OUSet / Execute

☐ Project 2012.1.00090

☐ Science Goal C

☐ Group OUS

☐ Me

Filename	Status	Progress
2012.1.00090.S_uid__A002_X5eed86_X2b_001_of_001.tar	Downloading	13% - 49.2MB of 377.8MB
2012.1.00090.S_uid__A002_X7143f6_Xf9b.asdm.sdm.tar	Downloading	0% - 303.7KB of 4.0GB

Using JAVA
browser-based GUI

13:36:54 2012.1.00090.S_uid__A002_X5eed86_X2b_001_of_001.tar Queued ----> 13:36:54 Downloading
13:36:54 2012.1.00090.S_uid__A002_X7143f6_Xf9b.asdm.sdm.tar Queued ----> 13:36:54 Downloading

Retry failed

Pause all

Speed: 1.3MB/s | Completed 0 of 2 files, failed 0 | 87.9MB of 4.3GB

Conc. Downloads 1..5 2


Logout

Download Selected

Access

4.3GB

worldwide collaboration



Request Handler



From do-not-reply@nrao.edu ☆
Subject ALMA Archive at NRAO: Request 223292105

Reply Reply All Forward Archive Junk Delete

1:24 PM

Reply to
To

Other Actions

Dear ,

Thank you for using the ALMA archive.

Your data selection (4.3GB) is available from this link

<https://almascience.nrao.edu/rh/requests/nbrunett/223292105>

We hope they meet your expectations and will lead to a successful completion of your scientific program.

Publications making use of these data must include the following statement in the acknowledgment:

"This paper makes use of the following ALMA data: ADS/JAO.ALMA#2012.1.00090.S. ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada) and NSC and ASIAA (Taiwan), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ."

Please submit your requests for help, for a visit to the ARC, or to report any problems discovered in your data through the ALMA Helpdesk at <https://help.almascience.org>.

Best regards,

The North American ALMA Archive at the NAASC

Summary:

Files available: 2 (4.3GB)

Files under proprietary period: 0 (-)

Files not available: 0 (-)

Details:

Files available:

- 2012.1.00090.S_uid__A002_XSeed86_X2b_001_of_001.tar : AUTHORIZED
- 2012.1.00090.S_uid__A002_X7143f6_Xf9b.asdm.sdm.tar : AUTHORIZED

Files under proprietary period:



Request Handler

Using auto-generated shell script (wget)

```
#!/bin/bash
#Please use the current script to download the whole content of request
223732763

echo "Please provide a password"
read -s PASSWORD

wget --auth-no-challenge --no-check-certificate --http-user="nbrunett" --
http-password=$PASSWORD https://almascience.nrao.edu/dataPortal/api/requests/
nbrunett/223732763/ALMA/2012.1.00090.S_uid__A002_X5eed86_X2b_001_of_001.tar/
2012.1.00090.S_uid__A002_X5eed86_X2b_001_of_001.tar
.
.
.
```

QA2 Data Products Package: the processed data



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

Science
goal

Project code

```
2012.1.00437.S  
├── science_goal.uid___A002_X5ce05d_X126/  
│   ├── group.uid___A002_X5ce05d_X127/  
│   │   └── member.uid___A002_X5ce05d_X128/
```

Group OUS:
combination of
member OUS's

```
├── README  
├── calibration/  
├── log/  
├── product/  
├── qa/  
└── script/
```

Member OUS: may contain
12-m array, ALMA Compact
Array (ACA), or Total Power
observation

Data delivery products...



QA2 Data Products Package: the README file



Contains a summary of
the QA2 results:
achieved resolution
and image noise RMS.

Shown here is an
example README for a
Cycle 2 project.
(Blurred information
protected by
proprietary period.)

```
#####

Cycle: 2 (Early science)
Project code: 2013.1.00857.S
SB name: Circumnu_a_03_TE
PI name: Elisabeth Mills
Project title: The Density (and Destiny) of the Circumnuclear Disk
Configuration: " x " (natural)
Proposed rms: mJy per MHz channel ( km/s for GHz)
CASA version used for reduction: 4.2.1
Comments from Reducer:

These data appear very good, requiring little flagging. The PI should
note there do seem to be a few bad channels in the reconstructed image
cube ( and ) that they may wish to flag out.
The rms achieved in channels which appear empty of emission or
absorption is mJy in natural weighting. The beam of " x "
is slightly bigger than the requested ", but since the proposers note
in the TJ that they mean to separate sources about " in size, this
resolution should meet their requirements. Slightly better resolution is
achieved in uniform weighting ( "x ").
The image cubes are continuum subtracted. The continuum peak is
Jy, a S/N of .
Several line detections can be seen in the spectra.
```



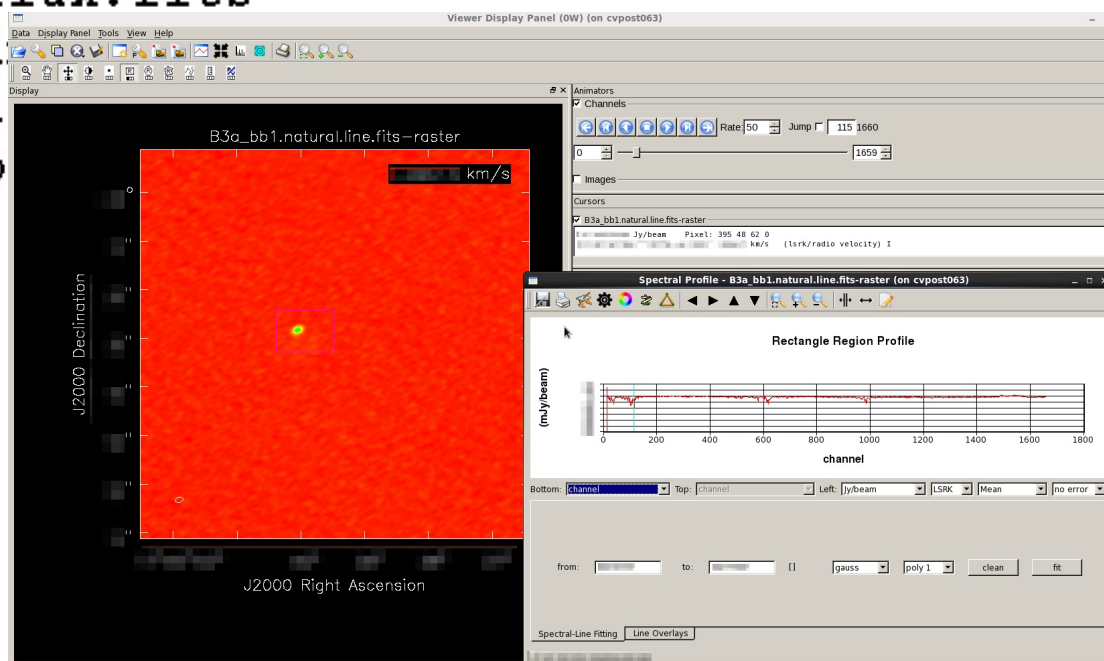
QA2 Data Products Package: product directory



- Contains “best efforts” images of science target
 - used to confirm PI requirements for sensitivity and resolution.
 - PI should re-image target prior to publication.

product

```
└-- B3a_bb1.natural.cont.fits
└-- B3a_bb1.natural.flux.fits
└-- B3a_bb1.natural.i
└-- B3a_bb1.natural.l
└-- B3a_bb1.natural.p
```



QA2 Data Products Package: qa directory



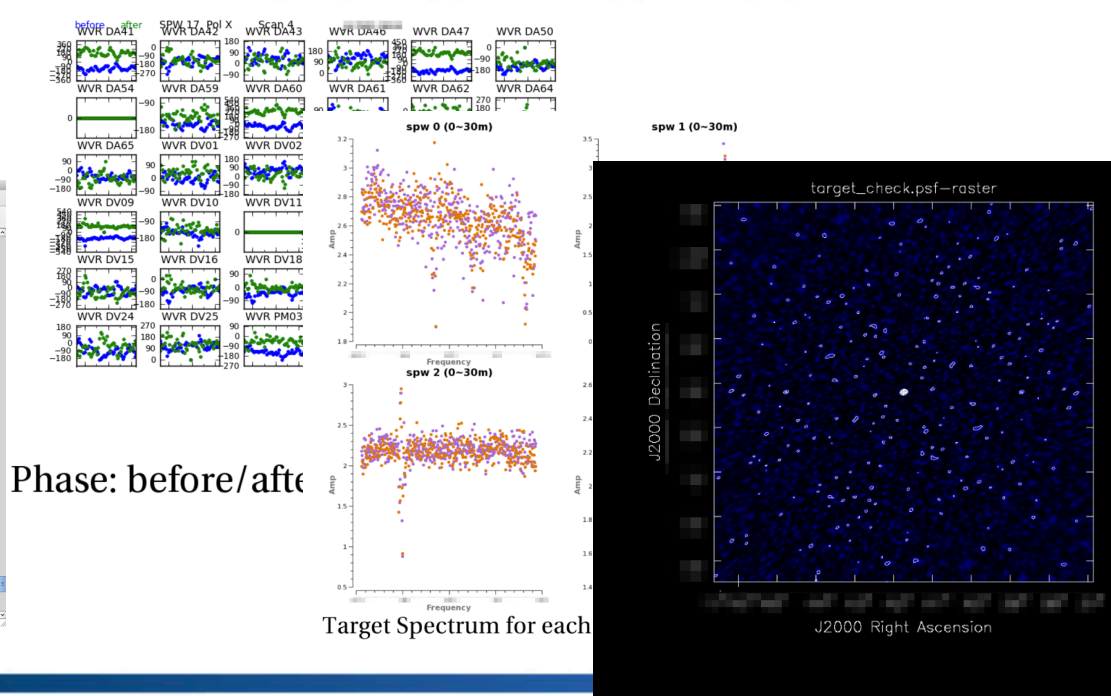
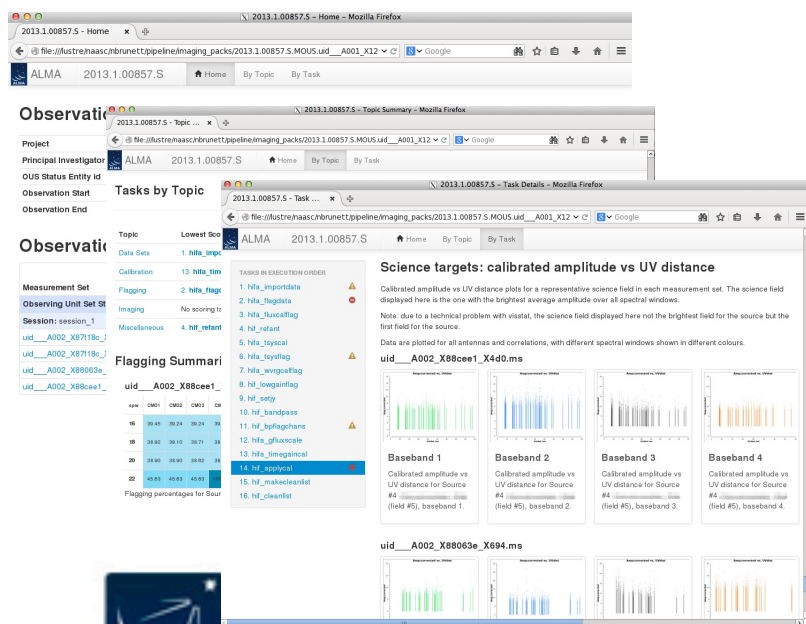
Contains diagnostic information, tables, and plots. Pipeline produces an HTML weblog for convenient viewing of information.

Pipeline calibration

Manual calibration

```
qa
├── pipeline-20141111T191030/
│   └── html/
└── uid___A001_X121_X2f5.weblog.tar.gz
```

```
qa
├── uid___A002_X87544a_X22d1_qa2_part1.png
├── uid___A002_X87544a_X22d1_qa2_part2.png
├── uid___A002_X87544a_X22d1_qa2_part3.png
└── uid___A002_X87544a_X22d1_textfile.txt
```



Target Spectrum for each

Target psf



QA2 Data Products Package: Log Directory – *Pipeline Calib.*



Contains CASA log files from QA2 processing

```
log
|-- casapy-20141129-145932.log
|-- casapy-20141129-150412.log
|-- casapy-20141129-150456.log
|-- casapy-20141223-170951.log
|-- casapy-20141229-164757.log
|-- uid___A001_X121_X2e5.casa_commands.log
```

- casapy log files contain pipeline logs for data import, applying calibration, flagging, and imaging
- casa_commands log file:
 - Record of all CASA commands run
 - Does not include heuristic and flagging calculations
 - Cannot be executed
 - Shows which CASA tasks are run by each pipeline task



QA2 Data Products Package: Log Directory – *Manual Calib.*



Contains CASA log files from QA2 processing

```
log
|-- casapy-20140918-205633.log
|-- uid___A002_x87544a_x22d1.log.tgz
```

Contains some or all CASA logs for data reduction process. Number of files varies, depending on the approach taken by the manual reducer.



QA2 Data Products Package: Calibration directory



Contains CASA calibration tables, flagging inputs, diagnostic plots (manual calibration only)

Pipeline calibration

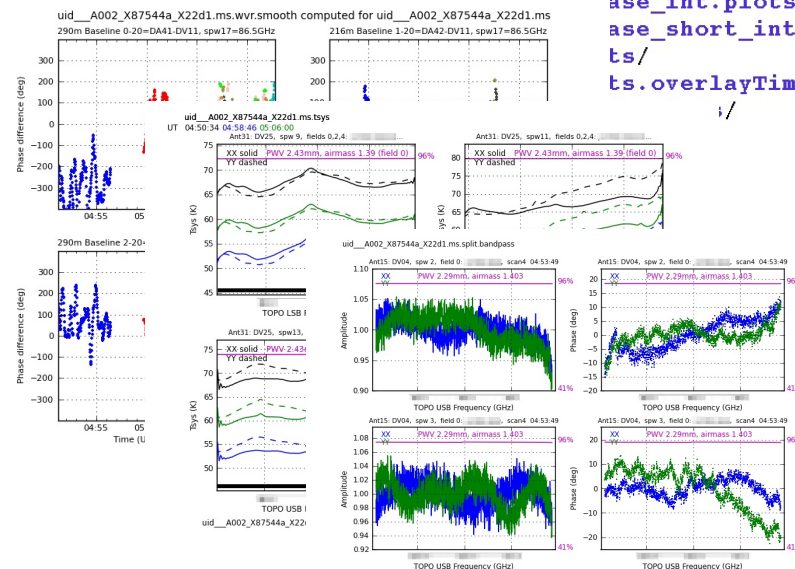
calibration

```
└─ flux.csv
└─ uid__A001_X121_X2f5.session_1.caltables.tar.gz
└─ uid__A002_X87f18c_X116b_flagtemplate.txt
└─ uid__A002_X87f18c_X116b_flagtemplate.txt~
└─ uid__A002_X87f18c_X116b.ms.calapply.txt
└─ uid__A002_X87f18c_X116b.ms.flagversions.tar.gz
└─ uid__A002_X87f18c_Xed9_flagtemplate.txt
└─ uid__A002_X87f18c_Xed9_flagtemplate.txt~
└─ uid__A002_X87f18c_Xed9.ms.calapply.txt
└─ uid__A002_X87f18c_Xed9.ms.flagversions.tar.gz
└─ uid__A002_X88063e_X694_flagtemplate.txt
└─ uid__A002_X88063e_X694_flagtemplate.txt~
└─ uid__A002_X88063e_X694.ms.calapply.txt
└─ uid__A002_X88063e_X694.ms.flagversions.tar.gz
└─ uid__A002_X88ceel_X4d0_flagtemplate.txt
└─ uid__A002_X88ceel_X4d0_flagtemplate.txt~
└─ uid__A002_X88ceel_X4d0.ms.calapply.txt
└─ uid__A002_X88ceel_X4d0.ms.flagversions.tar.gz
```

Manual calibration

calibration/

```
uid__A002_X87544a_X22d1.calibration.plots/
└─ uid__A002_X87544a_X22d1.ms.split.ampli_short_inf.plots/
└─ uid__A002_X87544a_X22d1.ms.split.ap_pre_bandpass.plots/
└─ uid__A002_X87544a_X22d1.ms.split.bandpass.plots/
└─ uid__A002_X87544a_X22d1.ms.split.bandpass_smooth20ch.plot
└─ uid__A002_X87544a_X22d1.ms.split.flux_inf.plots/
└─ uid__A002_X87544a_X22d1.ms.split.phase_inf.plots/
    ase_int.plots/
    ase_short_int.plots/
    ts/
    ts.overlayTime/
    /
```



QA2 Data Products Package: Script Directory - *Pipeline Calib.*



Contains scripts for calibration, imaging and (optionally) flux equalization

```
script
4 |-- casa_piperestorescript.py
3 |-- casa_pipescript.py
5 |-- PPR_uid___A001_X121_X2e6.xml
2 |-- scriptForImaging.py
1 |-- scriptForPI.py
```

1. top-level wrapper restores calibrated MS(s)
2. regenerates imaging products
3. calibrates data from scratch using pipeline tasks
4. Restores calibrated MS – called by scriptForPI.py
5. pipeline input parameters



QA2 Data Products Package: Script Directory - *Manual Calib.*



Contains scripts for calibration, imaging and (optionally) flux equalization

```
script
2 { |-- scriptForImaging_22d1_natural.py
  |-- scriptForImaging_22d1_uniform.py
1 |-- scriptForPI.py
3 |-- uid__A002_X87544a_X22d1.ms.scriptForCalibration.py
```

1. top-level wrapper restores calibrated MS(s)
2. regenerates imaging products
3. calibrates single Execution Block

`scriptForFluxCalibration.py` – combines calibrated MSs and sometimes sets all data to same absolute flux scale



Raw Data

- Downloaded through the Request Handler.
- Format: ALMA Science Data Model (ASDM)
 - Directory tree containing binary and XML files
 - Converted to Measurement Set by CASA
- Must be placed in “raw” directory when re-running calibration scripts.

```
|-- calibration/
|-- log/
|-- product/
|-- qa/
|-- raw/
|-- script/
```

→

```
raw
|-- uid____A002_X87f18c_X116b.asdm.sdm/
|-- uid____A002_X87f18c_Xed9.asdm.sdm/
|-- uid____A002_X88063e_X694.asdm.sdm/
|-- uid____A002_X88cee1_X4d0.asdm.sdm/
```


Calibration Process

- Remove affects of atmospheric water vapor
- Correct frequency-dependent
- Correct time-varying phases and amplitudes
- Set absolute flux scale
- Remove problematic data (flagging)

Example pipeline calibration

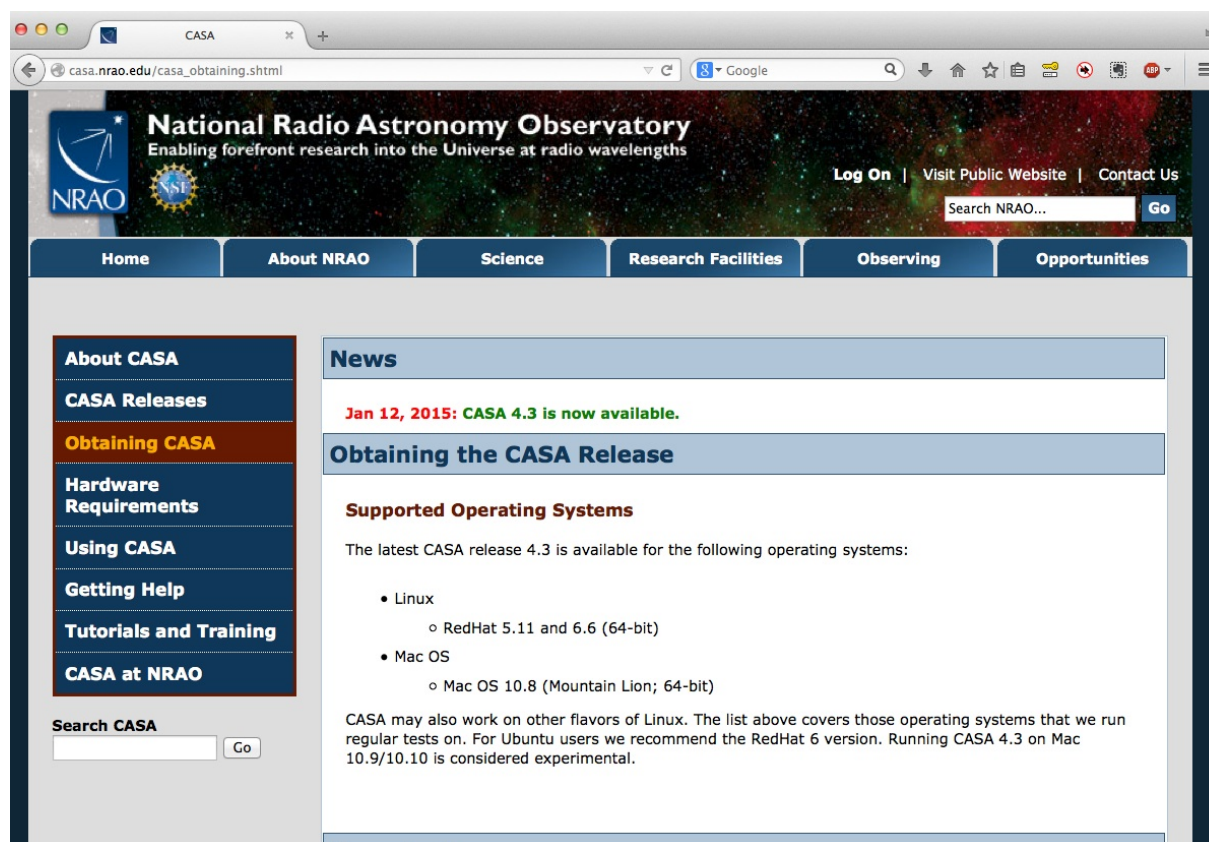
```
from recipes.almahelpers import fixsyscaltimes
__rethrow_casa_exceptions = True
h_init()
try:
    hifa_importdata(vis=['uid__A002_X88e746_X735'], sess
    fixsyscaltimes(vis = 'uid__A002_X88e746_X735.ms')
    fixplanets(vis = 'uid__A002_X88e746_X735.ms', field
    hifa_flagdata(pipeline="automatic")
    hifa_fluxcalflag(pipeline="automatic")
    hif_refant(pipeline="automatic")
    hifa_tsyscal(pipeline="automatic")
    hifa_tsysflag(pipeline="automatic")
    hifa_wvrgcalflag(pipeline="automatic")
    hif_lowgainflag(pipeline="automatic")
    hif_setjy(pipeline="automatic")
    hif_bandpass(pipeline="automatic")
    hif_bpflagchans(pipeline="automatic")
    hifa_gfluxscale(pipeline="automatic")
    hifa_timegaincal(pipeline="automatic")
    hif_applycal(pipeline="automatic")
    hif_makecleanlist(intent='PHASE,BANDPASS,CHECK')
    hif_cleanlist(pipeline="automatic")
finally:
    h_save()
```

Obtaining CASA

http://casa.nrao.edu/casa_obtaining.shtml

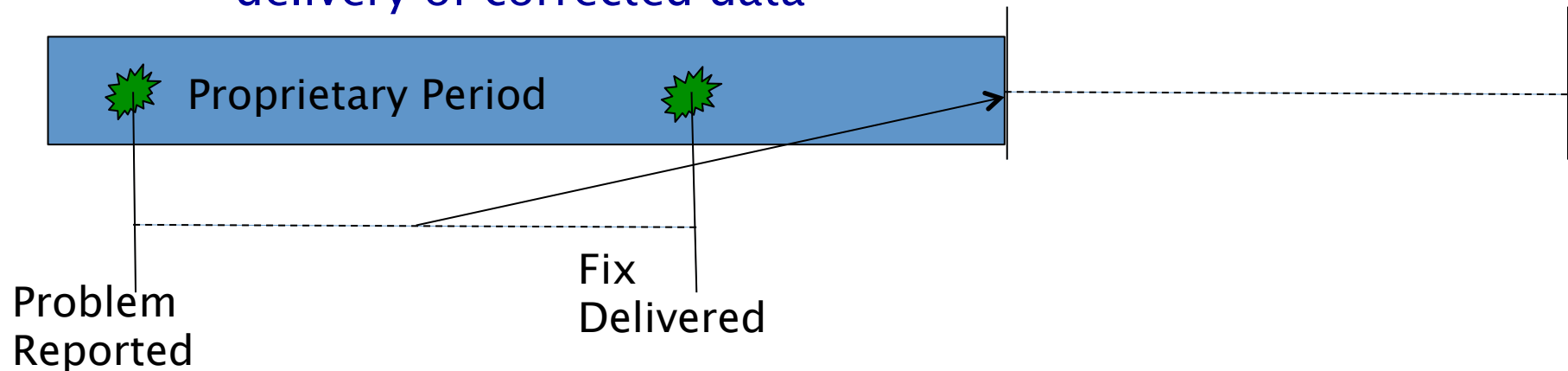


- Supported OS's
 - Linux – RedHat 5 and 6
 - Mac OS (10.8)
- Binary distribution for each OS, *with and without pipeline*
- Source distribution



QA3

- May Affect Proprietary Period
 - *If reported within 2 months of delivery:*
 - Period extended by interval from original delivery to delivery of corrected data



- Else:
 - Period extended until delivery of corrected data

Calibration Process

- Initial Calibration
 - Water vapor radiometer (WVR)
 - System temperature (T_{sys})
 - Antenna positions

Calibration Process

- WVR
 - 183 GHz radiometers
 - Mounted on each antenna
 - Estimates corrections for path fluctuations
 - See CASA Cookbook section 4.3.7 for more info
- T_{sys}
 - ALMA records raw correlation coefficients
 - Multiply by T_{sys} to convert to Kelvins
 - Later multiply by antenna gain (Jy/K) to convert to correlated flux density
 - CASA Cookbook 4.3.1 for more info
- Antenna Positions
 - Small corrections to antenna positions included in raw data

Calibration Process

- Next Correct Time and Frequency Dependent Fluctuations
 - Bandpass
 - Temporal phase and amplitude (gain)
- Types of Calibrator Sources
 - Point sources offer simple phase and amplitude behavior (constant w/ UV distance)
 - Bandpass calibrator should be bright for adequate S/N
 - Phase calibrator should be close to science target to minimize differences in atmospheric effects
 - Flux calibrator needs well understood flux densities

Calibration Process

- Bandpass
 - First solve for (additive) temporal phase corrections
 - Usually fine solution interval (integration)
 - Then derive phase and (multiplicative) amplitude corrections as function of frequency
 - Corrects antenna-based frequency responses
 - All derived from bandpass calibrator target
- Gain
 - Solve for short interval temporal phase corrections on all calibrators
 - Then long interval (scan) amplitude corrections
 - Derive flux scaling relation
 - Long interval phase corrections (for transfer to science)

Calibration Process

- A Bit More on Flux Scaling
 - After applying short interval gain corrections data is now in units of flux density
 - Flux calibrator has known flux density (model)
 - Compare observed flux density to model
 - Derive solutions that scale observed flux density to match the model
 - Assume antenna gain does not change between targets
 - Apply same scaling corrections to other target flux densities

Calibration Process

- Once All Calibration Applied, Inspect Bandpass, Flux and Phase Calibrators
 - Look at visibility amplitude and phase vs. time and frequency
 - Amplitudes should be centered around flux scaled values
 - Phase should be centered around zero (calibrator at center of field of view)
- Flag Any Misbehaving Antennas, Scans, Integrations etc.
- Re-Derive and Re-Apply Calibration Solutions
- Inspect Data
- Rinse, Repeat Until Satisfied