ALMA Pipeline products and restoring calibrated data

Seventeenth Synthesis Imaging Workshop

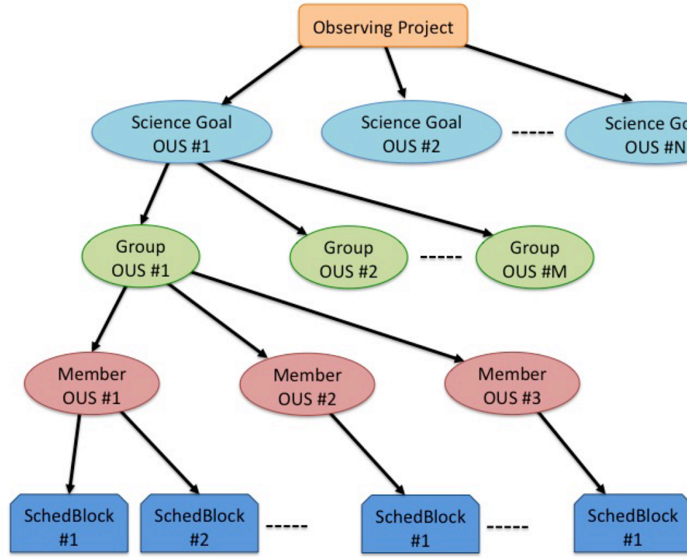
29 June – July 17 2020

ALMA Pipeline products and restoring calibrated data

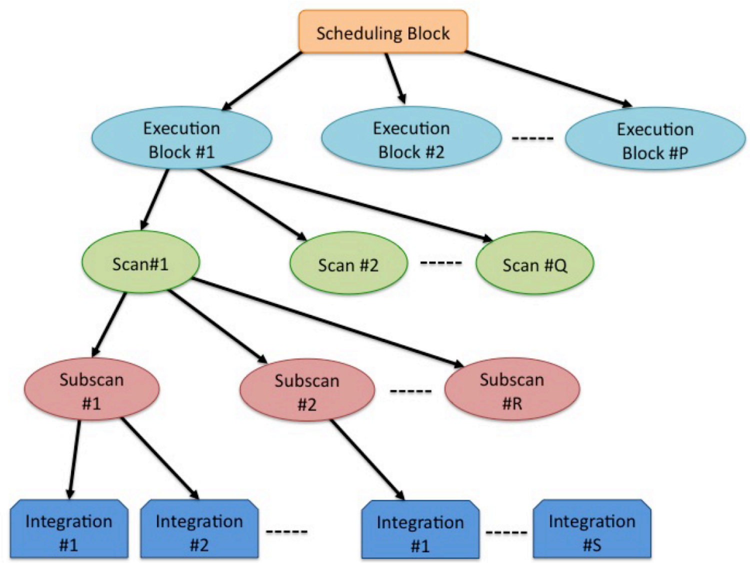
- ALMA Pipeline Tutorial
- Synthesis Imaging Summer School

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

ALMA observing project hierarchy



(SB)



(EB or ASDM: ALMA Science Data Model)

Introduction to ALMA pipeline (PL)

- Used to calibrate ALMA interferometric (IF) and single-dish (SD) data.
- Automated calibration and imaging
- Modular calibration and imaging tasks within CASA, put together based on standard prescriptions or recipes
- Produces a WebLog – a collection of webpages with diagnostic messages, tables, figures and Quality Assurance (QA) scores
- User's guide and other useful documentation: https://almascience.nrao.edu/processing/science-pipeline

Different data reduction paths for ALMA data

- Manually calibrated and imaged (non-standard datasets, e.g. polarization, solar observations, etc.) ~6% (NA)
- Pipeline calibrated and imaged (most standard datasets) ~89% (NA)
- Pipeline calibrated and manually imaged (e.g. PL cannot image because the data products are too large) ~5% (NA)
- Pipeline calibrated and imaged, with additional subset imaging using PL scripts (different robust, manually identified continuum)
- Pipeline calibrated and imaged, with additional manual imaging (self-calibration due to high dynamic range)
- Each MOUS is processed separately, different MOUSes may have different data reduction paths

Obtaining calibrated measurement sets

- Archive stores only raw data, calibration tables, scripts, products, etc.
- Calibrated visibilities for PIs:
  - NA ARC: PIs get a download link through the Helpdesk (https://help.almascience.org/) once their data is delivered, with 30 days to download the file
  - EU ARC: Request through the Helpdesk
  - EA ARC: PI gets a download link
- For non-proprietary data, calibrated measurement sets can be requested through the Helpdesk at any time
- For Cycle 5 and later, NRAO's SRDP initiative (later slides)
- Download archive files and restore calibrated measurement set manually (this tutorial)

Outline

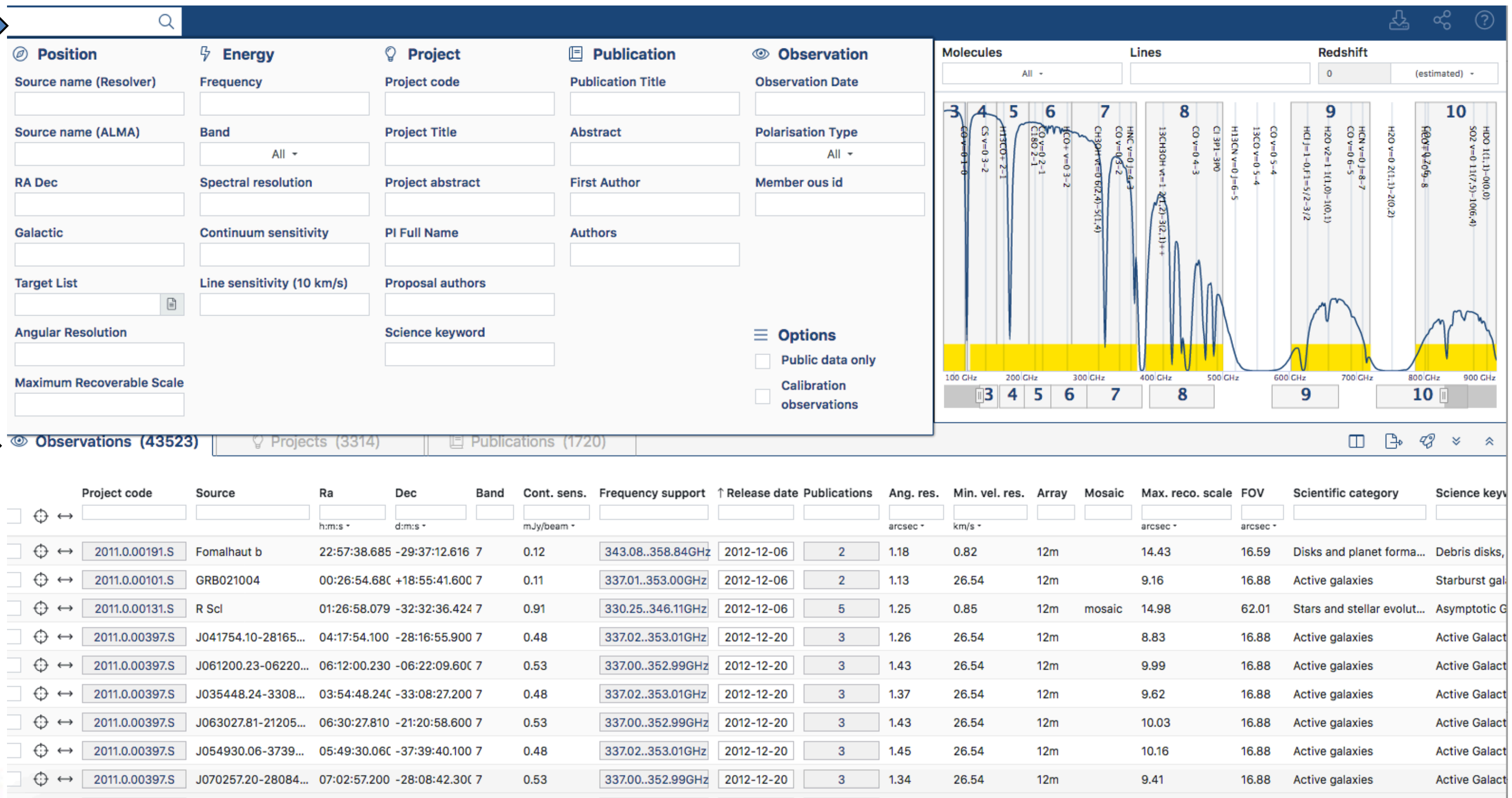
- **ALMA archive and data products**
  - **Download data from *Archive Query* and *Request Handler* tools on the ALMA Science Portal**
  - What's in your downloaded dataset – directory structure and files
- ALMA Pipeline
  - The Pipeline Weblog–Calibration and Imaging Information
  - How to restore the calibrated measurement set
  - How to re-run the pipeline, if needed
  - How to re-do imaging
- Science Ready Data Products Initiative (SRDP)
- Tutorial example

Exploring the ALMA Archive

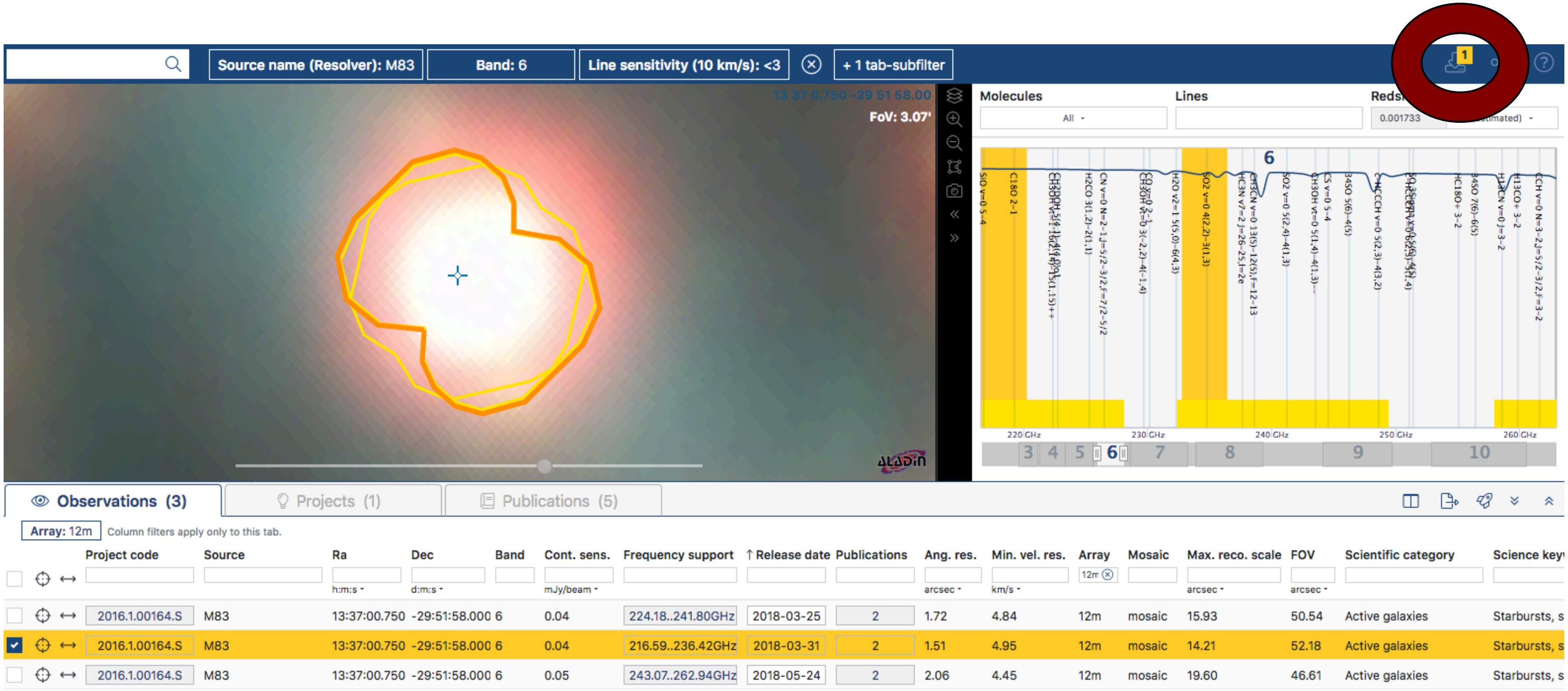
- All projects start with the ALMA Archive – proprietary or public
- New archive interface
  - http://almascience.nrao.edu/asax/

Searching the Archive

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



Find Data to Download



Select Files to Download

- Newer (Cycle 5+) individual file download available
  - Download auxiliary (contains calibration tables, scripts, etc.) and raw tar files to restore calibrated data and work with visibilities
  - Download the products for just Fits files

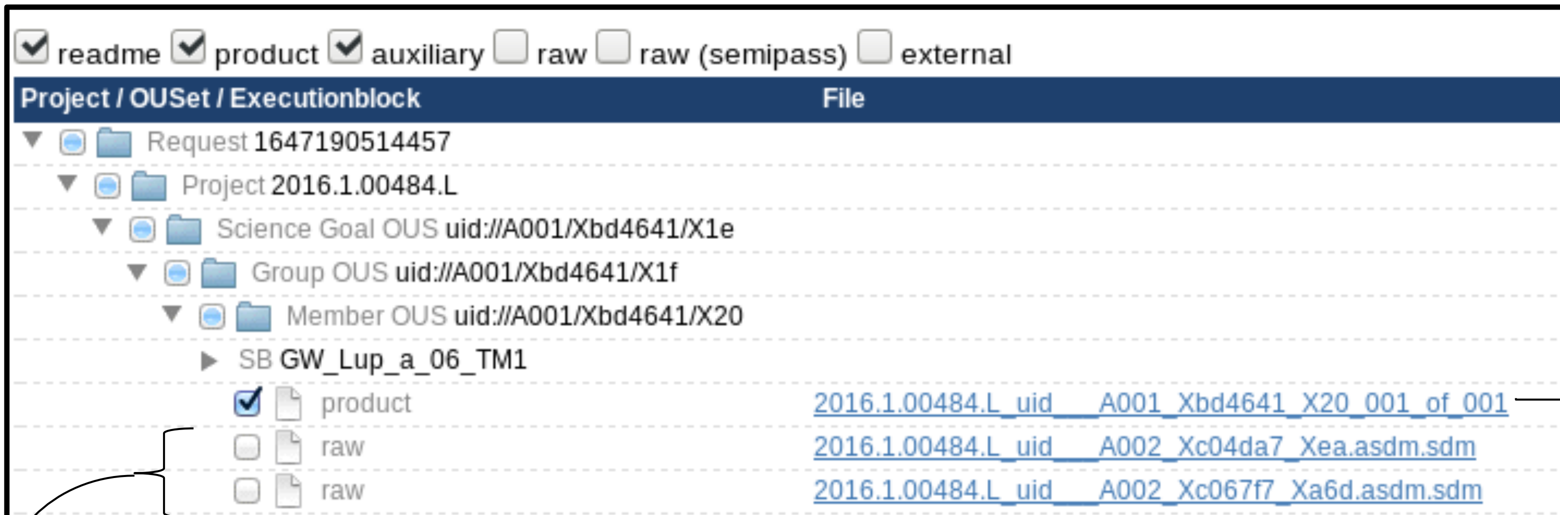
Download Selected

☑ 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 imaging products, logs, calibration tables and scripts.

QA2 Data Products Package:

Cycles 5-Present

Group OUS uid://A001/X885/X19a	
Member OUS uid://A001/X885/X19b	
SB Pluto_a_06_TM1	
product	2016.1.01100.S_uid___A001_X885_X19b_001_of_001.tar
auxiliary	2016.1.01100.S_uid___A001_X885_X19b_auxiliary.tar
auxiliary	member.uid___A001_X885_X19b.PPR_uid___A001_X885_X19c.xml.tar
auxiliary	member.uid___A001_X885_X19b.README.txt.tar
auxiliary	member.uid___A001_X885_X19b.antennapos.csv.tar
auxiliary	member.uid___A001_X885_X19b.calimage.pipeline_manifest.xml.tar
auxiliary	member.uid___A001_X885_X19b.calimage.product_rename.txt.tar
auxiliary	member.uid___A001_X885_X19b.casa_commands.log.tar
auxiliary	member.uid___A001_X885_X19b.casa_piperestorescript.py.tar
auxiliary	member.uid___A001_X885_X19b.casa_pipescript.py.tar
auxiliary	member.uid___A001_X885_X19b.cont.dat.tar
auxiliary	member.uid___A001_X885_X19b.flux.csv.tar
auxiliary	member.uid___A001_X885_X19b.scriptForPI.py.tar
auxiliary	member.uid___A001_X885_X19b.session_3.caltables.tgz.tar
auxiliary	member.uid___A001_X885_X19b.weblog.tgz.tar
auxiliary	uid___A002_Xc4d618_X5750.ms.calapply.txt.tar
auxiliary	uid___A002_Xc4d618_X5750.ms.flagversions.tgz.tar
auxiliary	uid___A002_Xc4d618_X5750_flagtargetstemplate.txt.tar
raw	2016.1.01100.S_uid___A002_Xc4d618_X5750.asdm.sdm.tar

QA2 Data Products Package:

Cycles 5-Present: Auxiliary Tarball

Tar ball

OR

Individual file download

Group OUS uid://A001/X1383/X221	
Member OUS uid://A001/X1383/X222	
SB HC672_b_06_TM1	
readme	member.uid___A001_X1383_X222.README.txt
product	2018.1.00306.S_uid___A001_X1383_X222_001_of_001.tar
auxiliary	2018.1.00306.S_uid___A001_X1383_X222_auxiliary.tar
calibration	member.uid___A001_X1383_X222.hifa_calimage.auxproducts.tgz
calibration	member.uid___A001_X1383_X222.session_1.auxcaltables.tgz
calibration	member.uid___A001_X1383_X222.session_1.caltables.tgz
calibration	uid___A002_Xd64dca_X11d3.ms.calapply.txt
calibration	uid___A002_Xd64dca_X11d3.ms.flagversions.tgz
calibration	uid___A002_Xd64dca_X11d3_target.ms.auxcalapply.txt
calibration	uid___A002_Xd64dca_X1991.ms.calapply.txt
calibration	uid___A002_Xd64dca_X1991.ms.flagversions.tgz
calibration	uid___A002_Xd64dca_X1991_target.ms.auxcalapply.txt
calibration	uid___A002_Xd64dca_X23b0.ms.calapply.txt
calibration	uid___A002_Xd64dca_X23b0.ms.flagversions.tgz
calibration	uid___A002_Xd64dca_X23b0_target.ms.auxcalapply.txt
calibration	uid___A002_Xd64dca_X2d22.ms.calapply.txt
calibration	uid___A002_Xd64dca_X2d22.ms.flagversions.tgz
calibration	uid___A002_Xd64dca_X2d22_target.ms.auxcalapply.txt
log	member.uid___A001_X1383_X222.hifa_calimage.casa_commands.log
qa	member.uid___A001_X1383_X222.hifa_calimage.weblog.tgz
qa	member.uid___A001_X1383_X222.qa2_report.html
qa	member.uid___A001_X1383_X222.qa2_report.pdf
qa	uid___A002_Xd64dca_X11d3.qa0_report.pdf
qa	uid___A002_Xd64dca_X1991.qa0_report.pdf
qa	uid___A002_Xd64dca_X23b0.qa0_report.pdf
qa	uid___A002_Xd64dca_X2d22.qa0_report.pdf
script	member.uid___A001_X1383_X222.calimage.product_rename.txt
script	member.uid___A001_X1383_X222.hifa_calimage.casa_piperestorescript.py
script	member.uid___A001_X1383_X222.hifa_calimage.casa_pipescript.py
script	member.uid___A001_X1383_X222.hifa_calimage.pipeline_manifest.xml
script	member.uid___A001_X1383_X222.hifa_calimage.pprequest.xml
script	member.uid___A001_X1383_X222.scriptForPI.py
raw	2018.1.00306.S_uid___A002_Xd64dca_X11d3.asdm.sdm
raw	2018.1.00306.S_uid___A002_Xd64dca_X1991.asdm.sdm
raw	2018.1.00306.S_uid___A002_Xd64dca_X23b0.asdm.sdm

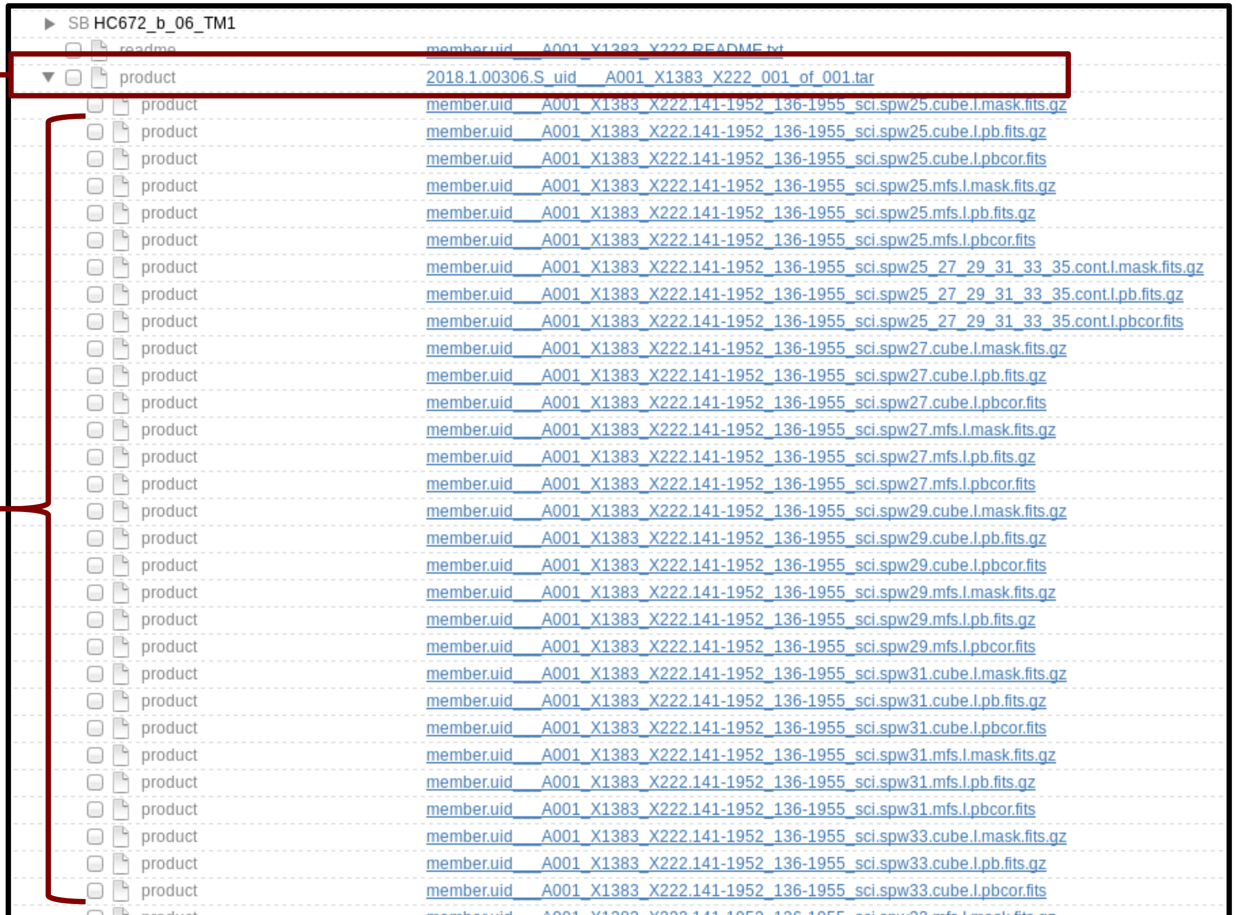
QA2 Data Products Package:

Cycles 5-Present: Product Tarball

Tar ball

OR

Individual file download



QA2 Data Products Package: Cycle 4 - now

https://help.almascience.org/index.php?/Knowledgebase/Article/View/375/

Naming convention for pipeline products

Image products are named according to the following convention:

<MOUS UID>.<Source Name>_<intent>.<spectral window(s)>.<dimensionality>.<imagetype>.fits

MOUS UID is a string that uniquely identifies the dataset (e.g. uid___A001_X88f_X270)

<intent> is the observation intent of the source, e.g. *sci* for science target, *ph* for phase calibrator, *bp* for bandpass calibrator.

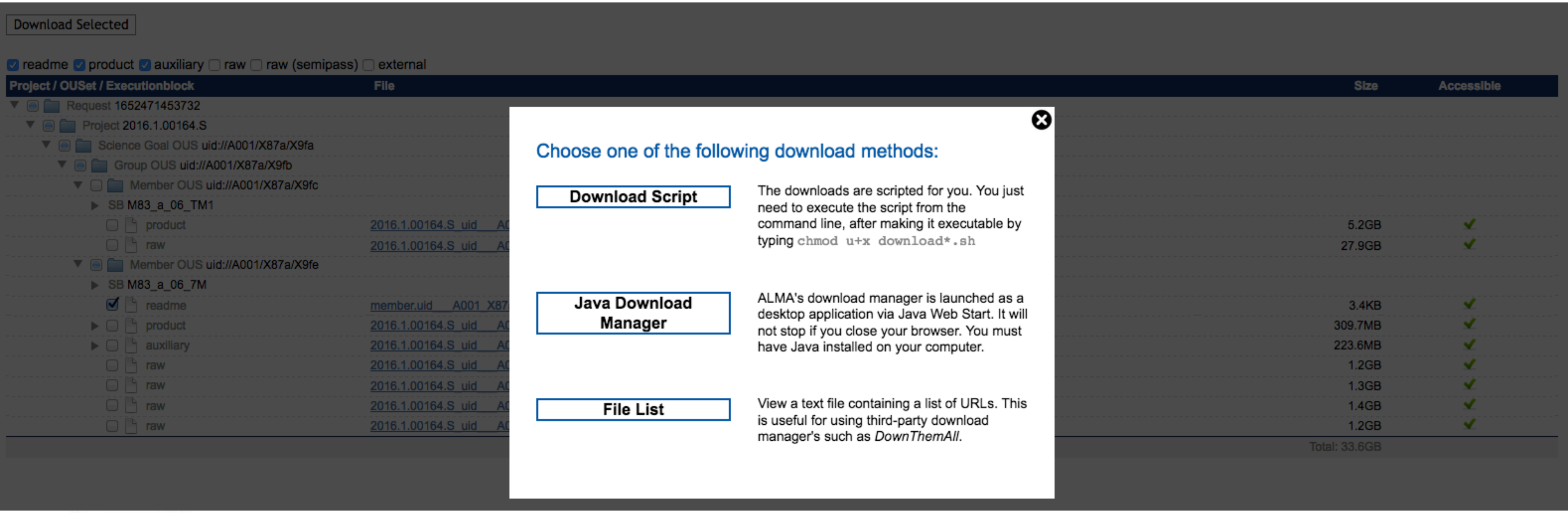
The spectral window list contains the spectral window numbers used in the product (e.g. spw17, spw17_19_21_23). The quickest way to identify which spectral window corresponds to which frequency/resolution combination is to click on the link to the measurement set on the Home page of the weblog, then to click on the "LISTOBS OUTPUT" button.

<dimensionality> is either *mfs* for multifrequency synthesis (resulting in an image with two spatial dimensions), *cont* for continuum aggregated over all spectral windows (two spatial dimensions), or *cube* for a cube with two spatial axes and a frequency/velocity axis. You may also see *tt0* and *tt1* for mfs images made using the the zeroth and first Taylor terms, respectively. The *tt0* image corresponds to the regular image, the *tt1* image is related to the spectral index image.

<imagetype> is *pbcor* for a primary beam corrected image, or *pb* for the primary beam image.

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!



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QA2 Data Products Package: Directory Structure

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

Science goal

Project code

```
2016.1.00164.S
└── science_goal.uid___A001_X87a_X9fa
    └── group.uid___A001_X87a_X9fb
        └── member.uid___A001_X87a_X9fe
            ├── calibration
            ├── product
            ├── qa
            └── script
```

Group OUS: combination of member OUS's

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

Data delivery products…

QA2 Data Products Package: Calibration directory

Pipeline Calibration Tables

```
uid___A002_Xe20b32_X84e7_target.ms.auxcalapply.txt
uid___A002_Xe20b32_X84e7.ms.flagversions.tgz
uid___A002_Xe20b32_X84e7.ms.calapply.txt
member.uid___A001_X146c_Xa2.session_1.caltables.tgz
member.uid___A001_X146c_Xa2.session_1.auxcaltables.tgz
member.uid___A001_X146c_Xa2.hifa_calimage.auxproducts.tgz
```

Contains PL helper files

All flags will be restored during calibration

```
flux.csv
antennapos.csv
cont.dat
uid___A002_Xe20b32_X84e7.flagtargetstemplate.txt
uid___A002_Xe20b32_X84e7.flagtsystemplate.txt
uid___A002_Xe20b32_X84e7.flagtemplate.txt
```

QA2 Data Products Package: Product directory

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: Raw directory

If you also download and untar 2016.1.****.S_uid*.asdm.sdm.tar

```
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/
```

QA2 Data Products Package: Script directory

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: QA directory

QA reports (Cycle 6 – now) and weblog

QA0 report: Quality assurance during observations

```
uid___A002_Xe20b32_X84e7.qa0_report.pdf
member.uid___A001_X146c_Xa2.qa2_report.pdf
member.uid___A001_X146c_Xa2.qa2_report.html
member.uid___A001_X146c_Xa2.hifa_calimage.weblog.tgz
```

Calibration and/or imaging weblog

QA2 report: Quality assurance after calibration and imaging; details about calibration and imaging methods

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

You can download the AQUA quality report for these observations from SnooPI using the following URL...

https://asa.alma.cl/snoopi

If you are not on the project and need the QA2 report of the public data, submit HD ticket

Cycle 6–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)

https://help.almascience.org/index.php?/Knowledgebase/Article/View/268/4/how-are-alma-data-products-packaged

After Observations – QA2

- Calibration by pipeline 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
  - RMS 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 (Cycle 5 to now):

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>

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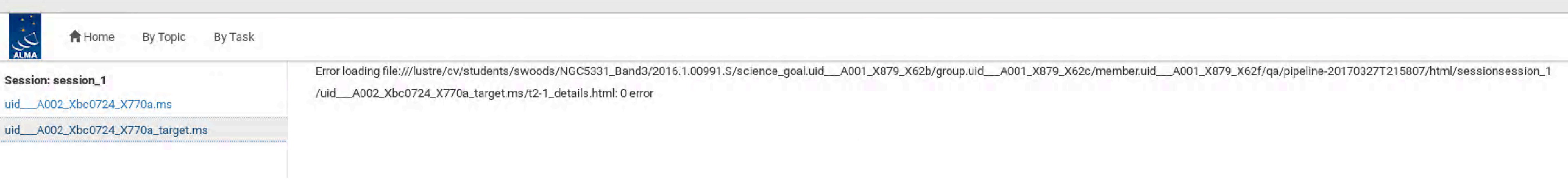
Open the Weblog

- cd to the qa directory
- 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 if you get the following error message:



- Pipeline users guide: https://almascience.nrao.edu/processing/science-pipeline

The Wondrous Weblog!

Your guide to QA2

See Pipeline Users Guide, Chapter 8 for more information.

Home | By Topic | By Task — 2016.1.00164.S

Embedded documentation link

Observation Overview

Project	uid://A001/X5a5/X18b
Principal Investigator	nanaseharada
OUS Status Entity id	uid://A001/X87a/X9fe
Observation Start	2016-10-02 17:31:39 UTC
Observation End	2016-12-29 12:18:43 UTC

Pipeline Summary

Pipeline Version	42254M (Pipeline-CASA54-P1-B) (documentation)
CASA Version	5.4.0-70 (environment)
Pipeline Start	2019-03-12 04:11:24 UTC
Execution Duration	6:09:34

Click EB for information on the observation

Observation Summary

			Time (UTC)			Baseline Length			
Measurement Set	**Receivers**	**Num Antennas**	**Start**	**End**	**On Source**	**Min**	**Max**	**RMS**	**Size**
Observing Unit Set Status: uid://A001/X87a/X9fe **Scheduling Block ID:** uid://A001/X87a/X9e2									
Session: session_1									
uid___A002_Xb8e961_X4eea.ms	ALMA Band 6	9	2016-10-02 17:31:39	2016-10-02 19:09:44	0:49:10	8.9 m	48.9 m	27.4 m	2.6 GB
uid___A002_Xb8e961_X4eea_target.ms	ALMA Band 6	9	2016-10-02 18:07:39	2016-10-02 19:06:55	0:49:10	8.9 m	48.9 m	27.4 m	1.0 GB
Session: session_2									
uid___A002_Xbb44e1_X192b.ms	ALMA Band 6	10	2016-12-01 09:55:32	2016-12-01 11:24:42	0:49:10	8.9 m	45.0 m	24.6 m	2.8 GB
uid___A002_Xbb44e1_X192b_target.ms	ALMA Band 6	10	2016-12-01 10:19:50	2016-12-01 11:21:17	0:49:10	8.9 m	45.0 m	24.6 m	1.2 GB
Session: session_3									
uid___A002_Xbc19b1_X35d9.ms	ALMA Band 6	10	2016-12-24 10:29:33	2016-12-24 12:05:17	0:49:10	8.9 m	45.0 m	24.6 m	3.0 GB
uid___A002_Xbc19b1_X35d9_target.ms	ALMA Band 6	10	2016-12-24 10:59:56	2016-12-24 12:01:53	0:49:10	8.9 m	45.0 m	24.6 m	1.2 GB
Session: session_4									
uid___A002_Xbc4a22_X1f16.ms	ALMA Band 6	10	2016-12-29 10:56:42	2016-12-29 12:18:43	0:49:10	8.9 m	45.0 m	26.6 m	2.6 GB
uid___A002_Xbc4a22_X1f16_target.ms	ALMA Band 6	10	2016-12-29 11:15:55	2016-12-29 12:15:52	0:49:10	8.9 m	45.0 m	26.6 m	1.2 GB

Pipeline users guide:
https://almascience.nrao.edu/processing/science-pipeline

The Wondrous Weblog!

ALMA

Pipeline Users Guide, Chapter 8 for more information.

Click By Task for breakdown of pipeline tasks

Home By Topic By Task 2016.1.00164.S

Session: session_1
uid___A002_Xb8e961_X4eea.ms
uid___A002_Xb8e961_X4eea_target.ms

Session: session_2
uid___A002_Xbb44e1_X192b.ms
uid___A002_Xbb44e1_X192b_target.ms

Session: session_3
uid___A002_Xbc19b1_X35d9.ms
uid___A002_Xbc19b1_X35d9_target.ms

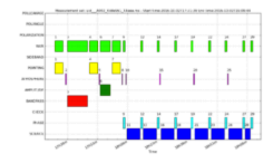
Session: session_4
uid___A002_Xbc4a22_X1f16.ms
uid___A002_Xbc4a22_X1f16_target.ms

Overview of 'uid___A002_Xb8e961_X4eea.ms'

Observation Execution Time

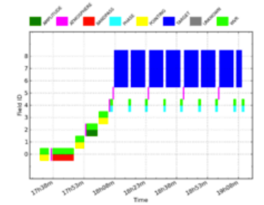
Start Time	2016-10-02 17:31:39
End Time	2016-10-02 19:09:44
Total Time on Source	1:28:09
Total Time on Science Target	0:49:10

LISTOBS OUTPUT



Intent vs Time

Track scan intent vs time



Field vs Time

Track observed field vs time

Spatial Setup

Science Targets	'M83'
Calibrators	'Callisto', 'J1220+0203', 'J1351-2912', 'J1427-3305' and 'J1517-2422'

Spectral Setup

All Bands	'ALMA Band 6'
Science Bands	'ALMA Band 6'

Antenna Setup

Min Baseline	8.9 m
Max Baseline	48.9 m
Number of Baselines	36
Number of Antennas	9

Sky Setup

Min Elevation	54.39 degrees
Max Elevation	80.88 degrees

NRAO

The Wondrous Weblog!

Pipeline Users Guide, Chapter 8 for more information.

Home | By Topic | By Task — 2016.1.00164.S

Task Summaries

Task		QA Score	Duration
1. hifa_importdata: Register measurement sets with the pipeline		1.00	0:17:13
2. hifa_flagdata: ALMA deterministic flagging		1.00	1:25:49
3. hifa_fluxcalflag: Flag spectral features in solar system flux calibrators		1.00	0:00:02
4. hif_rawflagchans: Flag channels in raw data		1.00	0:07:11
5. hif_refant: Select reference antennas		1.00	0:00:09
6. h_tsyscal: Calculate Tsys calibration		1.00	0:05:41
7. hifa_tsysflag: Flag Tsys calibration		1.00	0:09:50
8. hifa_antpos: Correct for antenna position offsets	Nonzero antenna position offsets	0.90	0:00:04
9. hifa_wvrgcalflag: Calculate and flag WVR calibration	No QA	N/A	0:00:04
10. hif_lowgainflag: Flag antennas with low gain		1.00	0:08:12
11. hif_setmodels: Set calibrator model visibilities		1.00	0:13:55
12. hifa_bandpassflag: Phase-up bandpass calibration and flagging		0.98	0:34:41
13. hifa_spwphaseup: Spw phase offsets calibration	Combined spw mapping	0.66	0:00:33
14. hifa_gfluxscaleflag: Phased-up flux scale calibration + flagging		0.98	0:18:52
15. hifa_gfluxscale: Transfer fluxscale from amplitude calibrator		1.00	0:11:37
16. hifa_timegaincal: Gain calibration		0.92	0:20:21
1 hif_applycal: Apply calibrations from conte	23.98% data flagged	0.65	0:33:05
18. hif_makeimlist: Set-up parameters for bandpass calibrator & phase calibrator imaging		1.00	0:00:34

Click on a pipeline task for detailed information and plots

NRAO

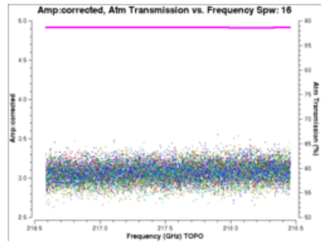
The Wondrous Weblog!

Pipeline Users Guide, Chapter 8 for more information.

Calibrated amplitude vs frequency

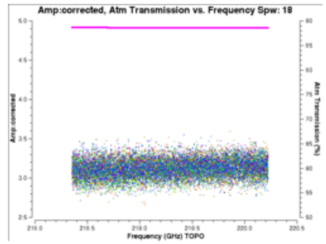
Plots of calibrated amplitude vs frequency for all antennas and correlations, coloured by antenna. The atmospheric transmission for each spectral window is overlayed on each plot in pink.

uid___A002_Xb8e961_X4eea.ms



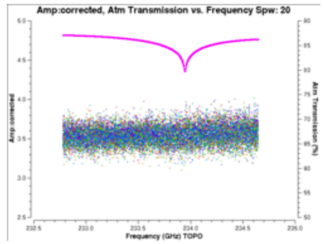
Spw 16
ALMA Band 6

Amplitude calibrator: Callisto.



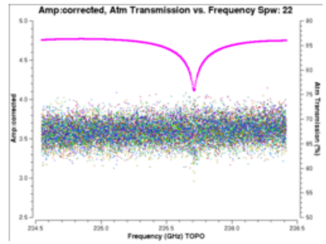
Spw 18
ALMA Band 6

Amplitude calibrator: Callisto.



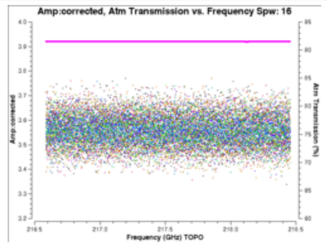
Spw 20
ALMA Band 6

Amplitude calibrator: Callisto.



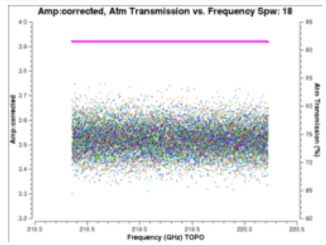
Spw 22
ALMA Band 6

Amplitude calibrator: Callisto.



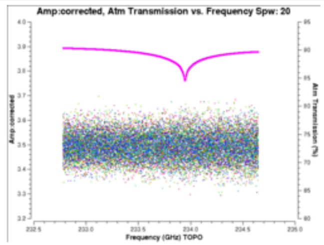
Spw 16
ALMA Band 6

Bandpass calibrator: J1517-2422.



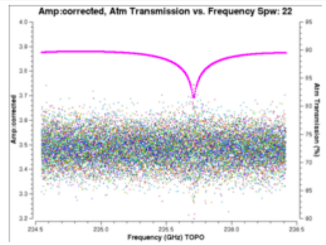
Spw 18
ALMA Band 6

Bandpass calibrator: J1517-2422.



Spw 20
ALMA Band 6

Bandpass calibrator: J1517-2422.



Spw 22
ALMA Band 6

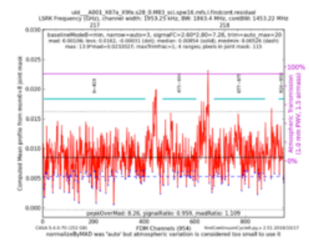
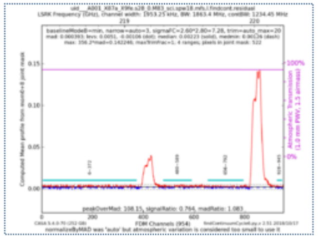
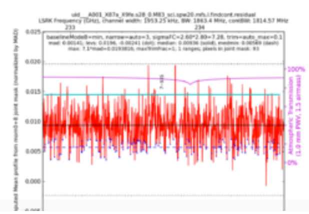
Bandpass calibrator: J1517-2422.

Examine calibrated phase and amplitude in different dimensions!

The Wondrous Weblog!

Pipeline Users Guide, Chapter 8 for more information.

28. Find Continuum

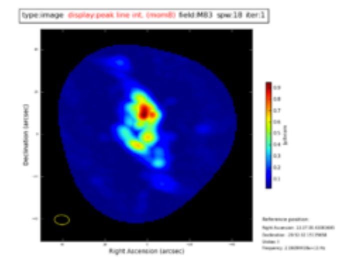
		Continuum Frequency Range				
Field	**Spw**	**Start**	**End**	**Frame**	**Status**	**Average spectrum**
M83	16	216.60872 GHz	217.38612 GHz	LSRK	NEW	
		217.52480 GHz	217.77872 GHz			
		217.91935 GHz	218.30805 GHz			
		218.42134 GHz	218.45454 GHz			
	18	218.37444 GHz	219.09128 GHz			
		219.30028 GHz	219.51513 GHz			
		219.64405 GHz	219.91164 GHz			
		220.17533 GHz	220.21049 GHz			
	20	232.80135 GHz	234.61592 GHz			

Blue sections indicate selected continuum ranges

The Wondrous Weblog!

Pipeline Users Guide, Chapter 8 for more information.

M83 (TARGET)	18 / X188414652#ALMA_RB_06#BB_2#SW-01	I	**centre / rest frequency of cube**	219.2944GHz / 219.6750GHz (LSRK)
			beam	6.99 x 4.50 arcsec
			beam p.a.	86.2deg
			final theoretical sensitivity	0.0072 Jy/beam
			cleaning threshold	0.051 Jy/beam Dirty DR: 1.2e+02 DR correction: 3.5
			clean residual peak / scaled MAD	18.77
			non-pbcor image RMS / RMS_{min} / RMS_{max}	0.0061 / 0.0046 / 0.0078 Jy/beam
			pbcor image max / min	0.991 / -0.137 Jy/beam
			channels	954 x 1.9532MHz (LSRK)
			score	1.00
			image file	uid___A001_X87a_X9fe.s35_0.M83_sci.spw18.cube.I.iter1.image



View other QA images...

Moment 8 maps shown for cubes: Click on "View other QA images..." for the dirty image, mask, PSF, and other diagnostic images.

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Restoring calibrated measurement set

- Recommend using same CASA version used in processing
- Two ways:
  - Method I: Using scriptForPI.py – for pipeline and manually reduced data – the recommended and fastest way
  - Method II: Using casa_piperestorescript.py – to restore pipeline calibrated data only, invoked by scriptForPI.py

Restoring calibrated measurement set: scriptForPI

- https://help.almascience.org/index.php?/na/Knowledgebase/Article/View/267
- 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/index.php?/Knowledgebase/Article/View/379
  - https://help.almascience.org/index.php?/Knowledgebase/Article/View/395
  - For new issues: post a Helpdesk ticket – https://help.almascience.org/index.php?/Core/Default/Index

```
cd 2019.1.00195.L/science_goal.uid___A001_X146c_X95/group.uid___A001_X146c_X9d/member.uid___A001_X146c_Xa2/
calibration/ product/     qa/          raw/           script/
```

Restoring calibrated measurement set: scriptForPI

- https://help.almascience.org/index.php?/na/Knowledgebase/Article/View/26
- cd into script directory
- Start the correct version of casa (casa --pipeline for PL tasks)
- Run scriptForPI.py (with spacesaving options, if needed) – execfile('member.uid___A001_X146c_Xa2.scriptForPI.py')

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

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

cd 2019.1.00195.L/science_goal.uid___A001_X146c_X95/group.uid___A001_X146c_X9d/member.uid___A001_X146c_Xa2/

calibrated   calibration   product   qa   raw   script

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) cd 2019.1.00195.L/science_goal.uid___A001_X146c_X95/group.uid___A001_X146c_X9d/member.uid___A001_X146c_Xa2/

calibrated   calibration   product   qa   raw   script

products   rawdata   uid___A002_Xe20b32_X84e7.ms   working

Restoring calibrated measurement sets: scriptForPI - PL calibration + imaging

Working directory:

```
uid___A002_Xe20b32_X84e7.ms.hifa_spwphaseup.s13_3.spw16_18_20_22.solintinf.gpcal.tbl
uid___A002_Xe20b32_X84e7.ms.hifa_timegaincal.s16_3.spw16_18_20_22.solintinf.gpcal.tbl
uid___A002_Xe20b32_X84e7.ms.hifa_timegaincal.s16_4.spw16_18_20_22.solintint.gpcal.tbl
uid___A002_Xe20b32_X84e7.ms.hifa_timegaincal.s16_6.spw16_18_20_22.solintinf.gacal.tbl
h_init.last
hifa_restoredata.last
importasdm.last
flux.csv
flagmanager.last
uid___A002_Xe20b32_X84e7.ms.s1.3.callibrary
uid___A002_Xe20b32_X84e7.ms.s1.3.calstate
applycal.last
uid___A002_Xe20b32_X84e7.ms
uid___A002_Xe20b32_X84e7.ms.flagversions
flagdata.last
pipeline-20200611T200458
listobs.last
plotms.last
h_save.last
pipeline-20200611T200458.context
```

```
cd 2019.1.00195.L/science_goal.uid___A001_X146c_X95/group.uid___A001_X146c_X9d/member.uid___A001_X146c_Xa2/
calibrated     calibration     product     qa     _     raw     script
```

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
```

```
cd 2019.1.00195.L/science_goal.uid___A001_X146c_X95/group.uid___A001_X146c_X9d/member.uid___A001_X146c_Xa2/
calibrated    calibration    product    qa    raw    script
```

Restoring calibrated measurement sets: PL calibration + imaging + subset imaging

- Results of running scriptForPI.py same as that for PL calibration + imaging
- Subset imaging reasons: self-calibration, improved continuum selection, different robust parameter, etc.
- If subset imaging was done manually, look for scriptForImaging.py in script directory
- If additional subset PL imaging was done after the imaging pipeline was run, look for member.uid*.manual_imaging.tgz in the script directory

```
(base) agrellite:script dkunneri$ tar xvzf member.uid___A001_X133f_X276.manual_imaging.tgz
x products/uid___A001_X133f_X276.weblog.tgz
x scriptForImaging_PL.py
x casa-20181128-121059.log
x cont.dat
```

Additional weblog (products/uid___A001_X133f_X276.weblog.tgz)

PL imaging script (scriptForImaging_PL.py)

Manual continuum selection file (cont.dat)

Restoring calibrated measurement sets: using PL script casa_piperestorescript.py

- Create **rawdata/**, **working/**, and **products/** subdirectories.
- Download the raw ASDMs from the archive and put them in **rawdata**/. Make sure the naming of the raw ALMA data is consistent with those provided in the script (e.g. if the data ends in **.asdm.sdm** then move to names which do not have this suffix).
- Copy or move ***manifest.xml, *caltables.tgz, *flagversions.tgz,** and ***calapply.txt** to **products/.**
- Copy **uid*casa_piperetorescript.py** to **casa_piperestorescript.py** to **working/.**
- In **working/,** start casa –pipeline, and execfile("casa_piperestorescript.py").

Resulting uid*.ms in working directory
For more information, refer to the user's guide:
https://almascience.nrao.edu/processing/science-pipeline

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Re-running the pipeline using casa_pipescript.py

```
__rethrow_casa_exceptions = True
context=h_init()
try:
    hifa_importdata(dbservice=False,
      vis=['uid___A002_X877e41_X452'], session=['session_1'])
                                            ## Uses flux.csv
    hifa_flagdata(pipelinemode="automatic")##Uses *flagtemplate.txt
    hifa_fluxcalflag(pipelinemode="automatic")
    hif_rawflagchans(pipelinemode="automatic")
    hif_refant(pipelinemode="automatic")
    h_tsyscal(pipelinemode="automatic")
    hifa_tsysflag(pipelinemode="automatic")
    hifa_antpos(pipelinemode="automatic") ## Uses antennapos.csv
    hifa_wvrgcalflag(pipelinemode="automatic")
    hif_lowgainflag(pipelinemode="automatic")
    hif_setmodels(pipelinemode="automatic")
    hifa_bandpassflag(pipelinemode="automatic")
    hifa_spwphaseup(pipelinemode="automatic")
    hifa_gfluxscaleflag(pipelinemode="automatic")
    hifa_gfluxscale(pipelinemode="automatic")
    hifa_timegaincal(pipelinemode="automatic")
    hif_applycal(pipelinemode="automatic")
    hif_makeimlist(intent='PHASE,BANDPASS,AMPLITUDE')
    hif_makeimages(pipelinemode="automatic")
    hif_makeimlist(per_eb=True, intent='CHECK')
    hif_makeimages(pipelinemode="automatic")
    hifa_imageprecheck(pipelinemode="automatic")
    hif_checkproductsize(maxproductsize=350.0, maxcubesize=40.0,
maxcubelimit=60.0)
    hifa_exportdata(pipelinemode="automatic")

# Start of pipeline imaging commands
    hif_mstransform(pipelinemode="automatic")
    hifa_flagtargets(pipelinemode="automatic")
                                ## Uses *flagtargetstemplate.txt
    hif_makeimlist(specmode='mfs')         ## Uses cont.dat
    hif_findcont(pipelinemode="automatic")  ## Modifies cont.dat
    hif_uvcontfit(pipelinemode="automatic") ## Uses cont.dat
    hif_uvcontsub(pipelinemode="automatic")
    hif_makeimages(pipelinemode="automatic")## Uses cont.dat
    hif_makeimlist(specmode='cont')        ## Uses cont.dat
    hif_makeimages(pipelinemode="automatic")## Uses cont.dat
    hif_makeimlist(specmode='cube')        ## Uses cont.dat
    hif_makeimages(pipelinemode="automatic")## Uses cont.dat
    hif_makeimlist(specmode='refBW')       ## Uses cont.dat
    hif_makeimages(pipelinemode="automatic")## Uses cont.dat

finally:
    h_save()
```

Calibration tasks;
indicates the use of pipeline helper files

Imaging tasks;
indicates the use of pipeline helper files

Re-running the calibration pipeline using casa_pipescript.py

- Create rawdata/, working/, and products/ subdirectories
- Copy uid*casa_pipescript.py to casa_pipescript.py in the working/ directory (edit to include PL steps you wish to repeat)
- Copy flux.csv, antennapos.csv (if present) and uid*flagtemplate.py (one flagtemplate.py per execution, modify as needed) to the working directory (found in uid*auxproducts.tgz from cycle 6-now)
- Copy raw ASDMs (rename without suffix .asdm.sdm) to rawdata/ directory
- Start CASA using casa --pipeline
- Run the script using execfile('casa_pipescript.py')

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Pipeline Image Reprocessing

- To re-run imaging tasks also, copy uid*flagtargetstemplate.txt and cont.dat to the working/ directory
- Pipeline images are quality assessed but may not be science ready
  - All sources/spws may not be imaged (image mitigation to avoid long PL runs)
  - Change continuum selection
  - Change weighting, channel width, automasking, etc.
- For pipeline calibrated data, see https://casaguides.nrao.edu/index.php/ALMA_Imaging_Pipeline_Reprocessing
- For manually calibrated data, see https://casaguides.nrao.edu/index.php?title=ALMA_Imaging_Pipeline_Reprocessing_for_Manually_Calibrated_Data

Manual Imaging following PL calibration

- Automasking Guide
  https://casaguides.nrao.edu/index.php/Automasking_Guide
- Manual imaging template available at:
  https://casaguides.nrao.edu/index.php?title=Guide_to_the_NA_Imaging_Template
- Combining multiple MOUS:
  https://casaguides.nrao.edu/index.php?title=M100_Band3_Combine_5.4
- casa_commands.log in the script directory
  - list of equivalent CASA task commands used by the PL
  - comments indicate which Pipeline stage the tasks were called from, and why
  - Imaging commands can be modified to produce new imaging products with more finely tuned inputs (e.g. interactive masks and deeper cleaning thresholds)

Image analysis

- ADMIT (ALMA data-mining toolkit)
  - Tools for analyzing image data cubes
  - http://admit.astro.umd.edu/
  - CASA guide: https://casaguides.nrao.edu/index.php?title=ADMIT_Products_and_Usage
- CARTA (Cube Analysis and Rendering Tool for Astronomy)
  - https://cartavis.github.io/

Outline

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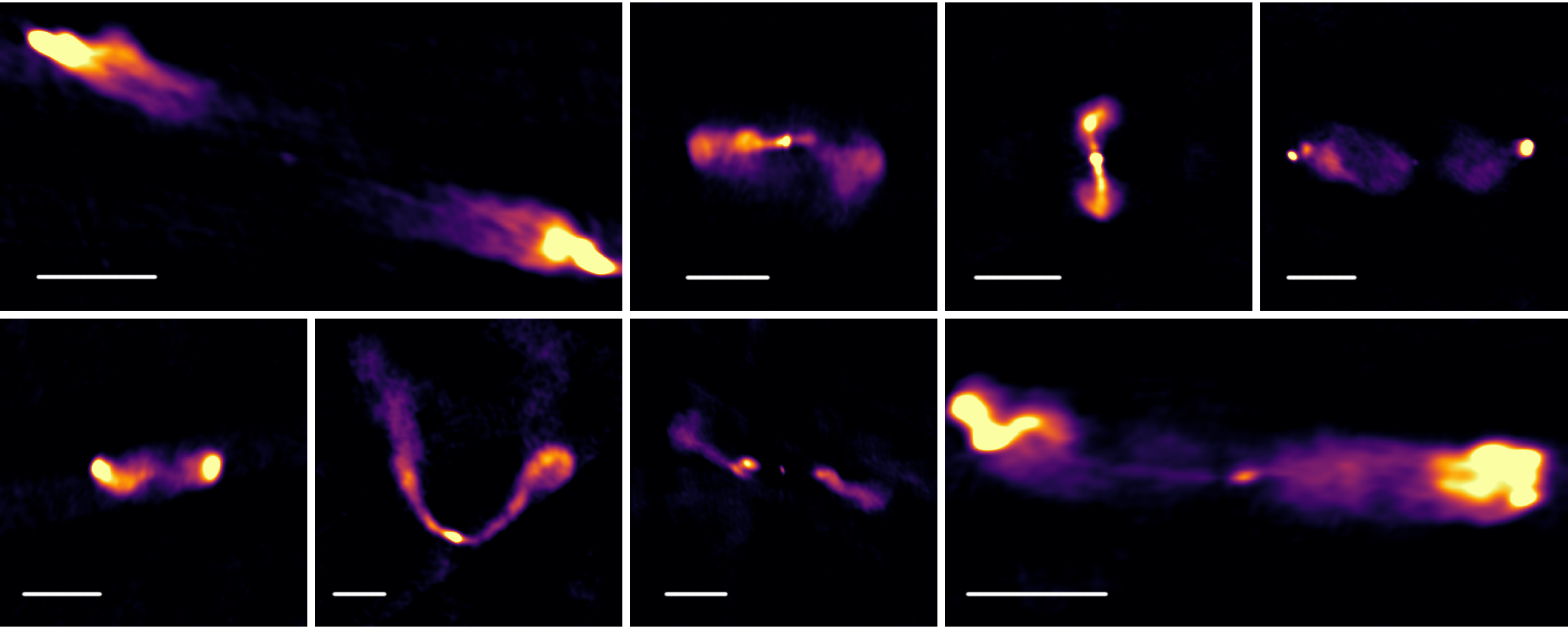
- ALMA Pipeline
  - The Pipeline Weblog–Calibration and Imaging Information
  - How to restore the calibrated measurement set
  - How to re-run the pipeline, if needed
  - How to re-do imaging
- **Science Ready Data Products Initiative (SRDP)**
- Tutorial example



B. Kent+NINE program

NRAO Science Ready Data Products

https://science.nrao.edu/srdp

https://archive-new.nrao.edu/portal/#/

What is the SRDP Project?

- Data from modern radio interferometers such as the VLA and ALMA are both very large in terms of volume, and complicated in terms of what the data model allows.
- Significant barriers now exist for newcomers to data from these instruments, and even individuals with expertise find data processing very burdensome.
- This reduces the scientific output of these facilities – rather than being limited by the technical capabilities of the instruments, scientists are limited by the logistics of data processing

SRDP

Aims to deliver data products that have been produced by an observatory-standard pipeline, quality-assured to a consistent standard, and have bad data removed.

- Overall plan:
  - Five Waves (waterfall development) expanding from basic capabilities to a full program over five years.
- Initial pilot & Wave 1:
  - Apply calibration tables to previously calibrated VLA and ALMA raw data (working).
  - Produce calibrated visibility (uv) data for VLA high frequency observations (working).
  - Produce bespoke images from calibrated ALMA visibilities to include only the channel range needed by the user (working).
  - Ingest products from large programs such as the VLA Sky Survey

Waves 2-5

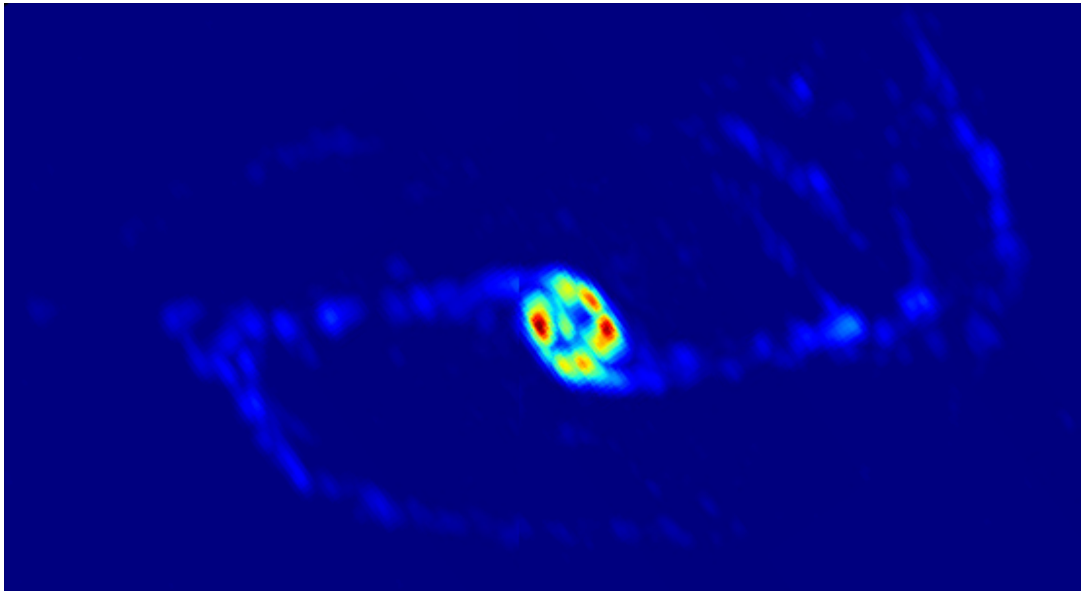
- Future waves will include imaging of VLA data, special workflows for time-critical VLA observations, and multi-configuration/array imaging for VLA and ALMA.
- Remote (server-side) visualization and simple analysis using CARTA.
- Reruns of pipeline calibrations with user-tuned parameters for VLA and ALMA will be allowed.
- A new system for observing proposals and the generation of scheduling blocks will ensure that observations are more compatible with the pipeline's expectations regarding calibration strategies etc.

The SRDP pilot

- VLA calibration began in mid-June 2019
  - Initially restricted to high frequencies (where interference is negligible) > 12GHz (Ku-band and above), and to single-band datasets that followed standard calibration procedures.
  - Included X-band (8-12 GHz) in September.
- Procedure:
  - Standard pipeline run on data (as usual)
  - Results reviewed by a data analyst, and suggestions for flagging or other changes made.
  - Suggestions are reviewed by an "Astronomer on Duty" (AoD) (a scientist or an experienced analyst).
  - Pipeline is rerun.
  - Process above is iterated until AoD signs off on a QA pass or fail.

ALMA Imaging (currently under test)

- Users can select their own imaging parameters via a web interface
- Pipeline software will apply the calibration to the raw data, then make the image per the users' request.
- Allows the user to image the part of the cube they want, at the resolution they need.



https://archive-new.nrao.edu/portal/#/

outburst. Because this outburst has been caught in a much earlier stage, we have the best opportunity yet to explore and understand the underlying mechanism. Much like NGC6334I-MM1, the lack of a near-IR counterpart indicates a very deeply-embedded protostar. ALMA DDT observations are now critical to provide a clear picture of star formation in this protocluster by pinpointing the outbursting protostar with respect ... al gas structures that trace protostellar accretion and outflow.

PI: Crystal Brogan

Co-Authors: Todd Hunter, Claudia Cyganowski, Gordon MacLeod, Andrey Sobolev, Karl Menten, Koichiro Sug...

MOUSes | Images

Launch User Imaging on: 2018.A.00031.T

User Email (required):

Request Description: AUDI request

SPW: (188.776 GHz-189.244 GHz) dnu = 488.2 kHz dv = 0...

Field: G358.93

Frequency Space | Velocity Space

Rest Frequency: GHz

Start: 189.0101039775315 GHz

Width: 488.222856549815 kHz

N Channels: 480

End: 189.2444509486754 GHz

Validate Form

Using CASA version 5.6.2-6

Cancel | Submit Request

MOUS	Observation Start	Obs...		...ds	EBs
G358.93_d_06_TM1	2019-07-17 04:14	2019-0...			1

0/10: selected (0/10.0 TB)

View Selection(s) | Clear All | Download

Archive File	Project	Instrume...	...Size	Array Config	Bands	Type	Cals	Scans
uid___A002_Xdee82d_X77b6	2018.A.00031.T	ALMA	...14 GB	12M	06	visibility		84

MOUS	Observation Start	Obs...		...ds	EBs
G358.93_c_06_TM1	2019-06-11 07:11	2019-0...			1

0/10: selected (0/10.0 TB)

View Selection(s) | Clear All | Download

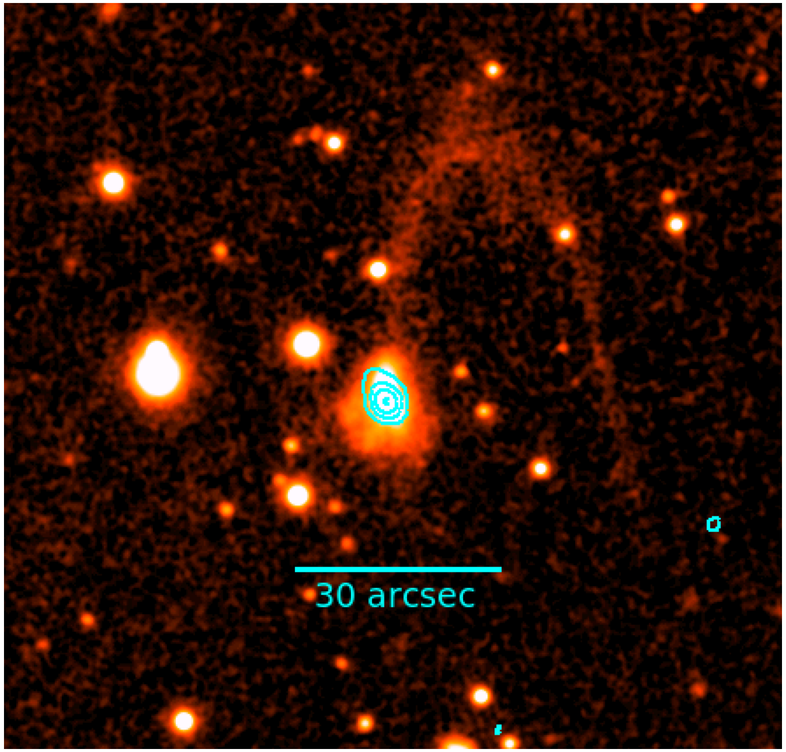
Archive File	Project	Instrume...	...Size	Array Config	Bands	Type	Cals	Scans
uid___A002_Xdd7b18_X68be	2018.A.00031.T	ALMA	...58 GB		06	visibility		109

MOUS	Observation Start	Observation End	Size	Bands	EBs		
G358.93_a_05_TM1	2019-04-16 08:57	2019-04-16 09:44	71.163 GB	05	2	Download Restored MS	Re-Imaging
G358.93_a_06_TM1	2019-04-16 07:12	2019-04-16 07:53	89.968 GB	06	2	Download Restored MS	Re-Imaging
G358.93_a_07_TM1	2019-04-12 07:34	2019-04-12 08:45	41.514 GB	07	1	Download Restored MS	Re-Imaging

Project	Instrument	Title	Start	End	EBs
2018.1.00470.S	ALMA	Millimeter Monitoring of the Closest Planetary System - Stellar and Dust Emission from Proxima Centauri	2019-04-26 03:21	2019-07-17 03:15	41 execution blocks
2017.1.01167.S	ALMA	ALMA CHARACTERIZATION OF T TAURI DISKS	2017-11-10 21:51	2019-07-16 23:22	10 execution blocks
2018.1.00663.S	ALMA	Revealing GMCs in a new superbright lensed z=2.04 Submillimeter Galaxy	2019-07-16 20:45	2019-07-16 21:33	1 execution blocks
2018.1.01236.S	ALMA	Resolving the Super Star Clusters in the Nuclear Starburst of NGC 4945	2018-10-02 18:46	2019-07-16 19:43	15 execution blocks
2018.1.01647.S	ALMA	Origin of Striking Difference of Spectral Line Richness in Intermediate-Mass Binary	2018-12-23 06:21	2019-07-16 18:19	2 execution blocks
2018.1.00566.S	ALMA	A Magnified View of Black Hole/Galaxy Co-Evolution at the Epoch of Reionization	2018-10-24 05:22	2019-07-16 11:45	8 execution blocks

SRDP Summary

- NRAO's SRDP program aims to take care of routine radio data processing, leaving users to focus on analysis and science.
- Will make radio astronomy more accessible to multiwavelength astronomers.
- Our pilot program has begun, no severe problems have been identified so far.
- SRDP will also support ingest of large programs, including contributions by users.



VLASS source (cyan), identified as a candidate quasar using Gaia DR2 and imaged in PanSTARRS

Outline

- ALMA archive and data products
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- ALMA Pipeline
  - The Pipeline Weblog–Calibration and Imaging Information
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- **Tutorial example**

Getting and starting CASA

- Download and installation instructions available here: http://casa.nrao.edu/casa_obtaining.shtml
- Restore data using the same CASA version used to process the data
- For this tutorial, we use CASA 5.6.1-8
- To run pipeline tasks, start CASA with

casa --pipeline

Example dataset

- ALMAGAL: ALMA Evolutionary study of High Mass Protocluster Formation in the Galaxy
- 2019.1.00195.L – Cycle 7 large program
- PI: Sergio Molinari
- 7m (ACA)
- Scheduling Block (SB) name: 520412_a_06_7M
- Two science targets: G221.9605-01.9926 and 520412
- 4 science spectral windows (spw)

Archive search: by ALMA target name (520412)

almascience.nrao.edu/rh/submission

Apps | Google | catpublic.etaspot.... | Astronomy | Work | General | Other Bookmarks

Login

Anonymous User: Request #1653590835147

Request Title: request description

Download Selected

☑ readme ☑ product ☑ auxiliary ☐ raw ☐ raw (semipass) ☐ external

Project / OUSet / Executionblock	File	Size	Accessible
Request 1653590835147		2.2 TiB	
Project 2019.1.00195.L		2.2 TiB	
Science Goal OUS uid://A001/X146c/X95		2.2 TiB	
Group OUS uid://A001/X146c/X9d		27 GiB	
Member OUS uid://A001/X146c/Xa0		25 GiB	
SB 520412_a_06_TM2			
readme	member.uid___A001_X146c_Xa0.README.txt	3 KiB	✓
product	2019.1.00195.L_uid___A001_X146c_Xa0_001_of_001.tar	14 GiB	✓
auxiliary	2019.1.00195.L_uid___A001_X146c_Xa0_auxiliary.tar	199 MiB	✓
raw	2019.1.00195.L_uid___A002_Xe2ada9_X196b1.asdm.sdm.tar	11 GiB	✓
☑ Member OUS uid://A001/X146c/Xa2		2 GiB	
SB 520412_a_06_7M			
☑ readme	member.uid___A001_X146c_Xa2.README.txt	3 KiB	✓
☑ product	2019.1.00195.L_uid___A001_X146c_Xa2_001_of_001.tar	785 MiB	✓
☑ auxiliary	2019.1.00195.L_uid___A001_X146c_Xa2_auxiliary.tar	73 MiB	✓
☑ raw	2019.1.00195.L_uid___A002_Xe20b32_X84e7.asdm.sdm.tar	1 GiB	✓
Group OUS uid://A001/X146c/Xf1		142 GiB	
Member OUS uid://A001/X146c/Xf4		125 GiB	
SB 683688_a_06_TM2			
readme	member.uid___A001_X146c_Xf4.README.txt	3 KiB	✓
product	2019.1.00195.L_uid___A001_X146c_Xf4_001_of_001.tar	95 GiB	✓
auxiliary	2019.1.00195.L_uid___A001_X146c_Xf4_auxiliary.tar	497 MiB	✓
raw	2019.1.00195.L_uid___A002_Xe34c04_X10e07.asdm.sdm.tar	29 GiB	✓

Exploring the dataset

- Untar the files: tar xvf *.tar (* – file name)
- Creates a directory called 2019.1.00195.L
- cd into this directory, and explore:

```
cd 2019.1.00195.L/science_goal.uid___A001_X146c_X95/group.uid___A001_X146c_X9d/member.uid___A001_X146c_Xa2/
```

- ls to list contents of directory

```
raw
product
qa
script
calibration
```

qa → cd qa

ls

```
uid___A002_Xe20b32_X84e7.qa0_report.pdf
member.uid___A001_X146c_Xa2.qa2_report.pdf
member.uid___A001_X146c_Xa2.qa2_report.html
member.uid___A001_X146c_Xa2.hifa_calimage.weblog.tgz
```

QA2 report (qa directory)

QA2 Report

Project information

Name	ALMAGAL: ALMA Evolutionary study of High Mass Protocluster Formation in the Galaxy
Code	2019.1.00195.L
PI	Sergio Molinari
Organization	IAPS Rome, INAF
Co-Is	A. Ahmadi, J. Bally, C. Battersby, M. Beltran, E. Bergin, H. Beuther, C. Brogan, L. Bronfman, R. Cesaroni, V. Chen, Y. Contreras, D. Elia, G. Fuller, T. Henning, P. Ho, M. Hoare, K. Johnston, K. Kim, P. Klaassen, R. Klessen, P. Koch, Y. Kuan, R. Kuiper, D. Lis, S. Liu, T. Liu, S. Lumsden, L. Maud, M. Merello, L. Moscadelli, F. Nakamura, N. Peretto, S. Pfalzner, R. Plume, S. Qin, K. Rygl, A. Sanchez-Monge, P. Schilke, E. Schisano, Y. Su, B. Svoboda, Y. Tang, L. Testi, A. Traficante, F. van der Tak, S. Walch, F. Wyrowski, Q. Zhang, H. Zinnecker

ObsUnitSet information

Name	Member OUS (520412)
QA2 Status	✔Pass
Member OUS Status ID	uid://A001/X146c/Xa2
SchedBlock name	520412_a_06_7M
SchedBlock UID	uid://A001/X146c/X6c
Array	7M
Mode	Standard
Band	ALMA_RB_06
Repr.Freq. (sky)	217.89 [GHz]
Spectral setup	ACA
Sources	520412, G221.9605-01.9926
Other SBs in this Group OUS (Member OUS Status ID in brackets):	520412_a_06_TM2 (uid://A001/X146c/Xa0), 520412_a_06_TM1 (uid://A001/X146c/X9e)
Execution count	1.50 of 1 expected

Final QA2 comment

####################
Comments from Reducer

CASA version: 5.6.1-8

Reduction mode: PL calibration and imaging.

Calibration issues: None.
Imaging issues: None.

General info: The continuum in each spectral window was identified and subtracted by the pipeline before cube imaging. It is recommended that the PI carefully assess the results on the hif_findcont weblog page, and in the "line-free moment 0" images on the cube imaging weblog page. Self-calibration was not performed.
Note that while for the Cycle 7 Pipeline the "perchanweightdensity" parameter from the imaging task tclean is set to "False" during cube imaging, in CASA this parameter is set to "True" by default. This causes some differences in the beam size and in the noise properties of image cubes produced by the pipeline when compared to other images generated with the default "perchanweightdensity=True".
See "perchanweightdensity" section in https://casa.nrao.edu/casadocs/casa-5.6.0/global-task-list/task_tclean/parameters for details.

QA2 was performed on the Aggregate Continuum and the PI specified representative spectral window. Both the beam size and the RMS meet the PI requested performance parameters. Therefore, this scheduling block has been deemed a QA2 PASS.

QA directory: WebLog

- tar xvzf member.uid___A001_X146c_Xa2.hifa_calimage.weblog.tgz
- cd pipeline-20191013T211357/html/
- Open index.html in a browser, click through to review weblog

Home By Topic By Task 2019.1.00195.L

Observation Overview

Project	uid://A001/X13b9/X1ca
Principal Investigator	smolinari
OUS Status Entity id	uid://A001/X146c/Xa2
Observation Start	2019-10-11 09:35:04 UTC
Observation End	2019-10-11 10:09:47 UTC

Pipeline Summary

Pipeline Version	42866M (Pipeline-CASA56-P1-B) (documentation)
CASA Version	5.6.1-8 (environment)
Pipeline Start	2019-10-13 21:13:57 UTC
Execution Duration	5:10:30

Observation Summary

			Time (UTC)			Baseline Length			
Measurement Set	**Receivers**	**Num Antennas**	**Start**	**End**	**On Source**	**Min**	**Max**	**RMS**	**Size**
Observing Unit Set Status: uid://A001/X146c/Xa2 **Scheduling Block ID:** uid://A001/X146c/X6c **Scheduling Block Name:** 520412_a_06_7M									
Session: session_1									
uid___A002_Xe20b32_X84e7.ms	ALMA Band 6	10	2019-10-11 09:35:04	2019-10-11 10:09:47	0:07:34	8.9 m	48.0 m	25.7 m	2.7 GB
uid___A002_Xe20b32_X84e7_target.ms	ALMA Band 6	10	2019-10-11 09:58:44	2019-10-11 10:07:56	0:07:34	8.9 m	48.0 m	25.7 m	783.8 MB

Restoring calibrated measurement set

- cd into script directory
- Start casa using casa --pipeline
- execfile('member.uid___A001_X146c_Xa2.scriptForPI.py')

```
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".
```

- Exit casa, cd into calibrated directory

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

Imaging pipeline reprocessing

- https://casaguides.nrao.edu/index.php?title=ALMA_Cycle_7_Imaging_Pipeline_Reprocessing – for examples of imaging recipes
- Common re-imaging examples:
  - Make pipeline aggregate continuum image with all channels
  - Revise continuum selection before PL continuum subtraction
  - Restore PL continuum subtraction and use channel binning for subset of spws and fields for PL imaging of cubes
  - Remake images with uvtaper

Example imaging recipe

Make Pipeline Aggregate Continuum Image With All Channels [edit]

This example moves the cont.dat file to a backup name so it is not picked up by pipeline, in which case all unflagged channels are used to make an aggregate continuum image with no continuum subtraction and default pipeline cleaning. This may be beneficial for continuum only projects for which the hif_findcont stage of the weblog shows that more continuum bandwidth is possible than it identified (i.e. due to noise spikes etc).

```
## Edit the USER SET INPUTS section below and then execute
## this script (note it must be in the 'calibrated/working' directory.

import glob as glob
__rethrow_casa_exceptions = True
pipelinemode='automatic'
context = h_init()

###########################################################
## USER SET INPUTS

## Select a title for the weblog
context.project_summary.proposal_code='NEW AGGREGATE CONT'

## Delete uid*_target.ms and flagversions if it exists
os.system('rm -rf uid*_target.ms')
os.system('rm -rf uid*_target.ms.flagversions')


############################################################


## Move cont.dat to another name if it exists
os.system('mv cont.dat original.cont.dat')

## Make a list of all uv-datasets appended with *.ms
MyVis=glob.glob('*.ms')

try:
    ## Load the *.ms files into the pipeline
    hifa_importdata(vis=MyVis,dbservice=False,pipelinemode=pipelinemode)

    ## Split off the science target data into its own ms (called
    ## *target.ms) and apply science target specific flags
    hif_mstransform(pipelinemode=pipelinemode)
    hifa_flagtargets(pipelinemode=pipelinemode)


    ## calculate the synthesized beam and estimate the sensitivity
    ## for the aggregate bandwidth and representative bandwidth
    ## for three values of the robust parameter.
    hifa_imageprecheck(pipelinemode="automatic")

    ## check the imaging product size and adjust the relevent
    ## imaging parameters (channel binning, cell size and image size)
    ## User can comment this out if they don't want size mitigation.
    hif_checkproductsize(maxproductsize=350.0, maxcubesize=40.0, maxcubelimit=60.0)

    ## Skip the continuum subtraction steps and make an aggregate
    ## continuum image with all unflagged channels (file named
    ## cont.dat should NOT be present in directory).
    hif_makeimlist(specmode='cont',pipelinemode=pipelinemode)
    hif_makeimages(pipelinemode=pipelinemode)

    ## Export new images to fits format if desired.
    hifa_exportdata(pipelinemode=pipelinemode)

finally:
    h_save()
```

Select different imaging modes

Example imaging recipe

Revise the Continuum Ranges (cont.dat) Before Pipeline Continuum Subtraction and Remake Pipeline Images [edit]

This example uses the pipeline imaging tasks to remake the pipeline imaging products for one spw (17 in the example) after manually editing the cont.dat file.

```
## Edit the cont.dat file(s) for the spw(s) you want
## to change the continuum subtraction for. In this example
## spw 17 was changed.

## Edit the USER SET INPUTS section below and then execute
## this script (note it must be in the 'calibrated/working' directory.

import glob as glob
__rethrow_casa_exceptions = True
pipelinemode='automatic'
context = h_init()

###########################################################
## USER SET INPUTS

## Select a title for the weblog
context.project_summary.proposal_code = 'NEW CONTSUB'

## Delete uid*_target.ms and flagversions if it exists
os.system('rm -rf uid*_target.ms')
os.system('rm -rf uid*_target.ms.flagversions')

## Select spw(s) that have new cont.dat parameters
## If all spws have changed use MySpw=''
MySpw='17'

###########################################################

## Make a list of all uv-datasets appended with *.ms
MyVis=glob.glob('*.ms')

try:
    ## Load the *.ms files into the pipeline
    hifa_importdata(vis=MyVis,dbservice=False,pipelinemode=pipelinemode)

    ## Split off the science target data into its own ms (called
    ## *target.ms) and apply science target specific flags
    hif_mstransform(pipelinemode=pipelinemode)
    hifa_flagtargets(pipelinemode=pipelinemode)

    ## Fit and subtract the continuum using revised cont.dat for all spws
    hif_makeimlist(specmode='mfs',spw=MySpw)
    hif_uvcontfit(pipelinemode=pipelinemode)
    hif_uvcontsub(pipelinemode=pipelinemode)
    hif_makeimages(pipelinemode=pipelinemode)

    ## calculate the synthesized beam and estimate the sensitivity
    ## for the aggregate bandwidth and representative bandwidth
    ## for three values of the robust parameter.
    hifa_imageprecheck(pipelinemode=pipelinemode)

    ## check the imaging product size and adjust the relevent
    ## imaging parameters (channel binning, cell size and image size)
    ## User can comment this out if they don't want size mitigation.
    hif_checkproductsize(maxproductsize=350.0, maxcubesize=40.0, maxcubelimit=60.0)

    ## Make new aggregate cont

    hif_makeimlist(specmode='cont',pipelinemode=pipelinemode)
    hif_makeimages(pipelinemode=pipelinemode)

    ## Make new continuum subtracted cube for revised spw(s)
    hif_makeimlist(specmode='cube',spw=MySpw,pipelinemode=pipelinemode)
    hif_makeimages(pipelinemode=pipelinemode)

    ## Export new images to fits format if desired.
    hifa_exportdata(pipelinemode=pipelinemode)

finally:
    h_save()
```

Select different spws

Continuum subtraction using revised selection

Example imaging recipe

Restore Pipeline Continuum Subtraction for Subset of SPWs and Fields and Use Channel Binning for Pipeline Imaging of Cubes [edit]

Using Pipeline Tasks [edit]

This example uses the pipeline imaging tasks to remake the cubes for a subset of spws and fields with channel binning and a more naturally-weighted Briggs robust parameter.

```
## Edit the USER SET INPUTS section below and then execute
## this script (note it must be in the 'calibrated/working' directory.

import glob as glob
__rethrow_casa_exceptions = True
pipelinemode='automatic'
context = h_init()

###########################################################
## USER SET INPUTS

## Select a title for the weblog
context.project_summary.proposal_code = 'SUBSET CUBE IMAGING'

## Delete uid*_target.ms and flagversions if it exists
os.system('rm -rf uid*_target.ms')
os.system('rm -rf uid*_target.ms.flagversions')

## Select spw(s) to image and channel binning for each specified
## MySpw. All spws listed in MySpw must have a corresponding MyNbins
## entry, even if it is 1 for no binning.
MySpw='17,23'
MyNbins='17:8,23:2'

## Select subset of sources to image by field name.
## To select all fields, set MyFields=''
MyFields='CoolSource1,CoolSource2'

## Select Briggs Robust factor for data weighting (affects angular
## resolution of images)
MyRobust=1.5

###########################################################

## Make a list of all uv datasets appended with *.ms
MyVis=glob.glob('*.ms')

try:
    ## Load the *.ms files into the pipeline
    hifa_importdata(vis=MyVis, dbservice=False, pipelinemode=pipelinemode)

    ## Split off the science target data into its own ms (called
    ## *target.ms) and apply science target specific flags
    ## In this example we split off all science targets and science
    ## spws, however hif_mstransform could also contain the spw and field
    ## selections
    hif_mstransform(pipelinemode=pipelinemode)
    hifa_flagtargets(pipelinemode=pipelinemode)

    ## Fit and subtract the continuum using existing cont.dat
    ## for selected spws and fields only.
    hif_makeimlist(specmode='mfs')
    hif_uvcontfit(spw=MySpw,field=MyFields,pipelinemode=pipelinemode)
    hif_uvcontsub(spw=MySpw,field=MyFields,pipelinemode=pipelinemode)
    hif_makeimages(pipelinemode=pipelinemode)

    ## calculate the synthesized beam and estimate the sensitivity
    ## for the aggregate bandwidth and representative bandwidth
    ## for three values of the robust parameter.
    ## Don't need to run this task if you will use a different robust value anyway.
    ## hifa_imageprecheck(pipelinemode=pipelinemode)

    ## check the imaging product size and adjust the relevent
    ## imaging parameters (channel binning, cell size and image size)
    ## User can comment this out if they don't want size mitigation.
    hif_checkproductsize(maxproductsize=350.0, maxcubesize=40.0, maxcubelimit=60.0)

    ## Make new continuum subtracted cube for selected spw(s) and fields
    hif_makeimlist(specmode='cube',spw=MySpw,nbins=MyNbins,field=MyFields,robust=MyRobust, pipelinemode=pipelinemode)
    hif_makeimages(pipelinemode=pipelinemode)

    ## Export new images to fits format if desired.
    hifa_exportdata(pipelinemode=pipelinemode)

finally:
    h_save()
```

Select channel binning for spws, subset of sources, different weighting

ALMA

NRAO

Imaging pipeline reprocessing

- https://casaguides.nrao.edu/index.php?title=ALMA_Cycle_7_Imaging_Pipeline_Reprocessing – for examples of imaging recipes
- cd into calibrated/working
- Copy PL helper files cont.dat and uid*flagtargetstemplate.py from calibration/ directory to working
- Select imaging pipeline recipe, edit and save into a file, e.g. scriptForImaging_robust0.py (aggregate continuum image using all channels for target 520412 with robust 0.0)
- Start casa --pipeline
- execfile('scriptForImaging_robust0.py')

Example imaging script

```
## Edit the USER SET INPUTS section below and then execute
## this script (note it must be in the 'calibrated/working' directory.

import glob as glob
__rethrow_casa_exceptions = True
pipelinemode='automatic'
context = h_init()

###################################################################
## USER SET INPUTS

## Select a title for the weblog
context.project_summary.proposal_code='NEW AGGREGATE CONT'

## Delete uid*_target.ms and flagversions if it exists
os.system('rm -rf uid*_target.ms')
os.system('rm -rf uid*_target.ms.flagversions')

## Select subset of sources to image by field name.
## To select all fields, set MyFields=''
MyFields='520412'

## Select Briggs Robust factor for data weighting (affects angular
## resolution of images)
MyRobust=0.0

###################################################################


## Move cont.dat to another name if it exists
os.system('mv cont.dat original.cont.dat')

## Make a list of all uv-datasets appended with *.ms
MyVis=glob.glob('*.ms')

try:
    ## Load the *.ms files into the pipeline
    hifa_importdata(vis=MyVis,dbservice=False,pipelinemode=pipelinemode)

    ## Split off the science target data into its own ms (called
    ## *target.ms) and apply science target specific flags
    hif_mstransform(pipelinemode=pipelinemode)
    hifa_flagtargets(pipelinemode=pipelinemode)


    ## calculate the synthesized beam and estimate the sensitivity
    ## for the aggregate bandwidth and representative bandwidth
    ## for three values of the robust parameter.
    hifa_imageprecheck(pipelinemode="automatic")

    ## check the imaging product size and adjust the relevent
    ## imaging parameters (channel binning, cell size and image size)
    ## User can comment this out if they don't want size mitigation.
    hif_checkproductsize(maxproductsize=350.0, maxcubesize=40.0, maxcubelimit=60.0)

    ## Skip the continuum subtraction steps and make an aggregate
    ## continuum image with all unflagged channels (file named
    ## cont.dat should NOT be present in directory).
    hif_makeimlist(specmode='cont',field=MyFields,robust=MyRobust,pipelinemode=pipelinemode)
    hif_makeimages(pipelinemode=pipelinemode)

    ## Export new images to fits format if desired.
    hifa_exportdata(pipelinemode=pipelinemode)

finally:
    h_save()
```

Select a subset of sources, use different weighting

Make aggregate continuum image

Imaging pipeline reprocessing

- Will create:
  - new pipeline-*/html directory with weblog and casa_commands.log file
  - Images (PL imaging products are always named the same)
  - Calibrated MS for each ASDM containing only science targets and spectral windows (uid*_target.ms)
    - After hif_mstransform, the DATA column has calibrated continuum+line data
    - After hif_uvcontsub, the DATA column has calibrated continuum + line data and CORRECTED column has calibrated continuum subtracted data

Imaging pipeline reprocessing

Home | By Topic | By Task | NEW AGGREGATE CONT

Tasks in execution order

1. hifa_importdata
2. hif_mstransform
3. hifa_flagtargets
4. hifa_imageprecheck
5. hif_checkproductsize
6. hif_makeimlist (cont)
7. hif_makeimages (cont)
8. hifa_exportdata

6. Make image list

Set-up parameters for target aggregate continuum imaging

BACK

List of Clean Targets

field	intent	spw	phasecenter	cell	imsize	imagename	specmode	start	width	nbin	nchan	restfreq (LSRK)	robust	nterms	uvran
"520412"	TARGET	16,18,20,22	ICRS 06:59:44.9100 -004.48.53.260	['1arcsec']	[80, 80]	oussid.sSTAGENUMBER._520412__sci.spw16_18_20_22.cont	cont			-1	-1	None	0.0		

Clean Targets Summary

Pipeline QA

Input Parameters

Tasks Execution Statistics

CASA logs for stage 6

- View or download stage6/casapy.log (15.9 KB)

Imaging pipeline reprocessing

Home | By Topic | By Task | NEW AGGREGATE CONT

Tasks in execution order

1. hifa_importdata
2. hif_mstransform
3. hifa_flagtargets
4. hifa_imageprecheck
5. hif_checkproductsize
6. hif_makeimlist (cont)
7. hif_makeimages (cont)
8. hifa_exportdata

Task notifications

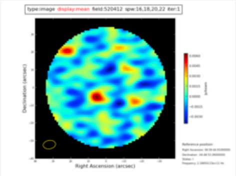
Warning! No continuum frequency selection for Target Field "520412" SPW 16

Warning! No continuum frequency selection for Target Field "520412" SPW 18

Warning! No continuum frequency selection for Target Field "520412" SPW 20

Warning! No continuum frequency selection for Target Field "520412" SPW 22

Image Details

Field	Spw	Pol	Image details		Image result
520412 (TARGET)	16, 18, 20, 22 / X1222766920#ALMA_RB_06#BB_1#SW-01, X1222766920#ALMA_RB_06#BB_2#SW-01, X1222766920#ALMA_RB_06#BB_3#SW-01, X1222766920#ALMA_RB_06#BB_4#SW-01	I	**centre frequency of image**	218.9501GHz (LSRK)	 View other QA images...
			beam	7.10 x 4.77 arcsec	
			beam p.a.	-80.6deg	
			final theoretical sensitivity	0.00071 Jy/beam	
			cleaning threshold	0.0022 Jy/beam Dirty DR: 8.9 DR correction: 1.5	
			clean residual peak / scaled MAD	4.71	
			non-pbcor image RMS	0.0012 Jy/beam	
			pbcor image max / min	0.0169 / -0.0106 Jy/beam	
			fractional bandwidth / nterms	1.9% / 1	
			aggregate bandwidth	5 GHz (LSRK)	
			score	1.00	
			image file	oussid.s7_0._520412__sci.spw16_18_20_22.cont.I.iter1.image	