ALMA DATA

FROM THE ARCHIVE TO CALIBRATED VISIBILITIES

ALMA Data Reduction Training Day

Pascal Keller

ALMA Local Expertise Group (Allegro)

Leiden Observatory
October 23, 2024

EUROPEAN ARC
ALMA Regional Centre || Allegro

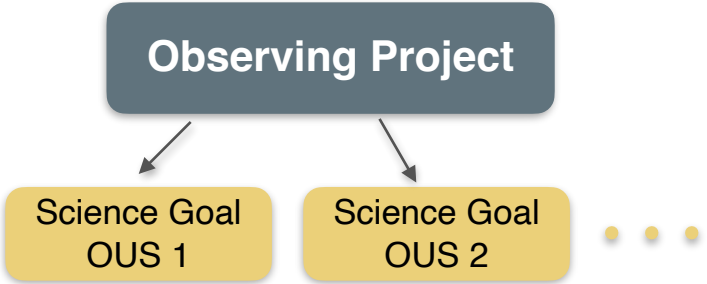
Today's plan

- **Intro to ALMA data**
- **Quick look at the archive and weblogs**
- **Hands on imaging**
- **Hand on image cube analysis**

PROGRAM*	OCTOBER 23, 2024	
10:00-10:15	**WELCOME**	
10:15-1030	Pascal Keller	*ALMA data: From the archive to calibrated visibilities*
10:30-10:45	Pascal Keller	*Overview of calibration and self-calibration*
10:45-11:05	**COFFEE BREAK**	
11:05-11:15	Megan Lewis	*Introduction to CASA + technical setup*
11:15-12:15	Joshiwa van Marrewijk	*Imaging & tclean*
12:15-13:15	**LUNCH BREAK**	
13:15-14:00	Joshiwa van Marrewijk	*Imaging & tclean*
14:00-14:20	**COFFEE BREAK**	
14:20-15:30	Megan Lewis	*Analysis tools and CARTA*

ALMA Data Structure

- **OUS:** Observing Unit Set - smallest unit
- **Science Goal:** Defined by the PI in the observing tool (OT) at the proposal stage



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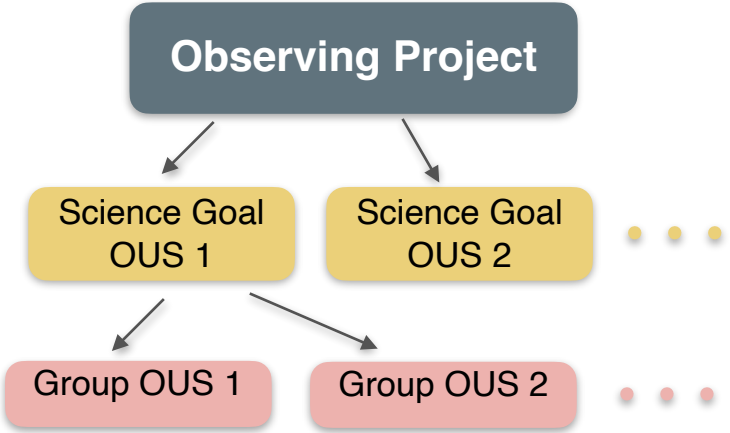

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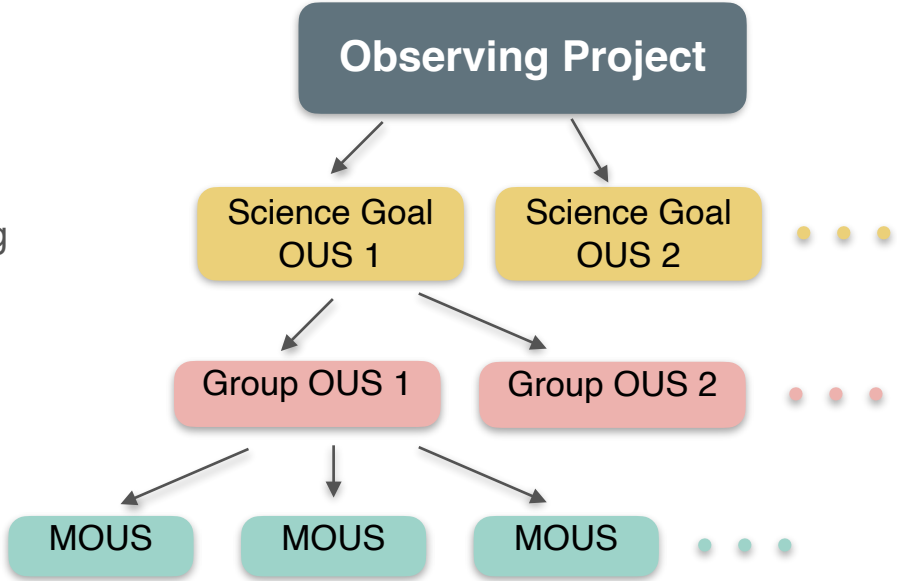

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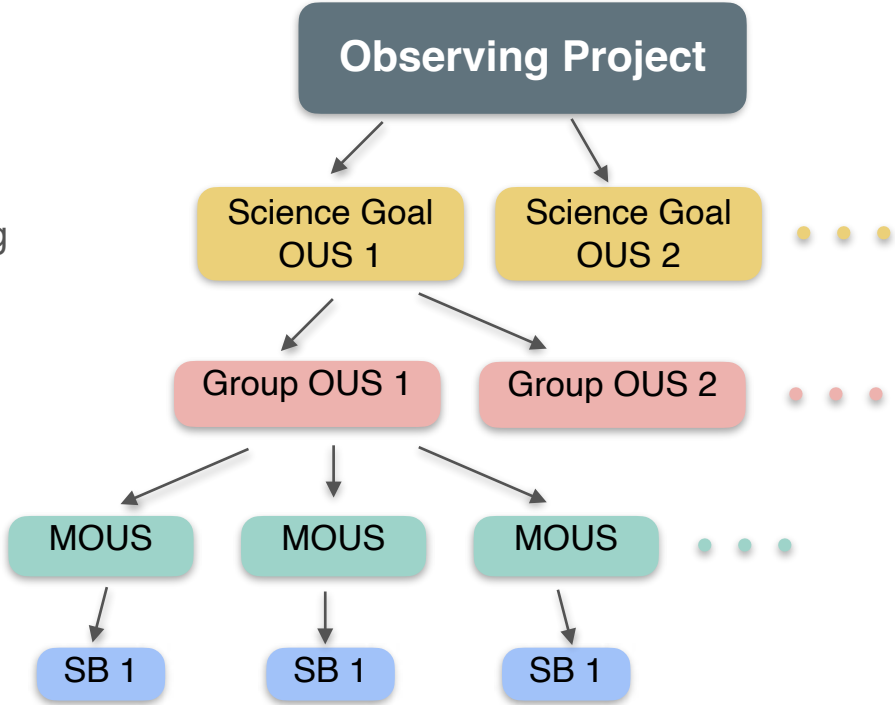

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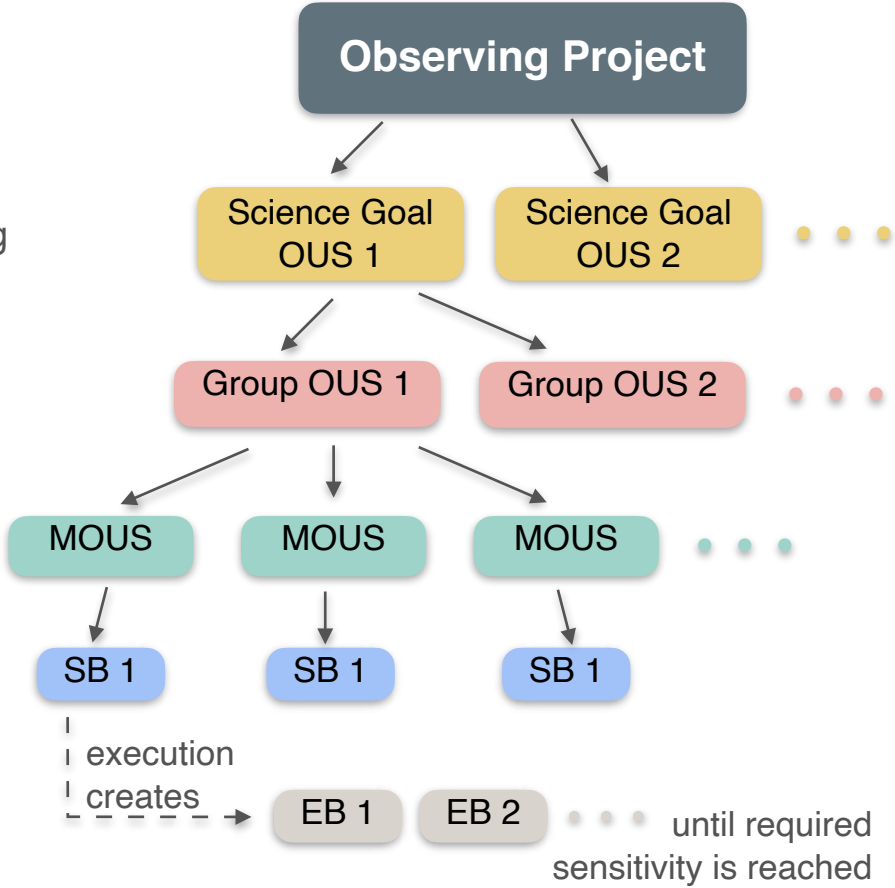
- **Execution Block (EB):** each repetition of a scheduling block (SB)



Quality Assurance (QA)

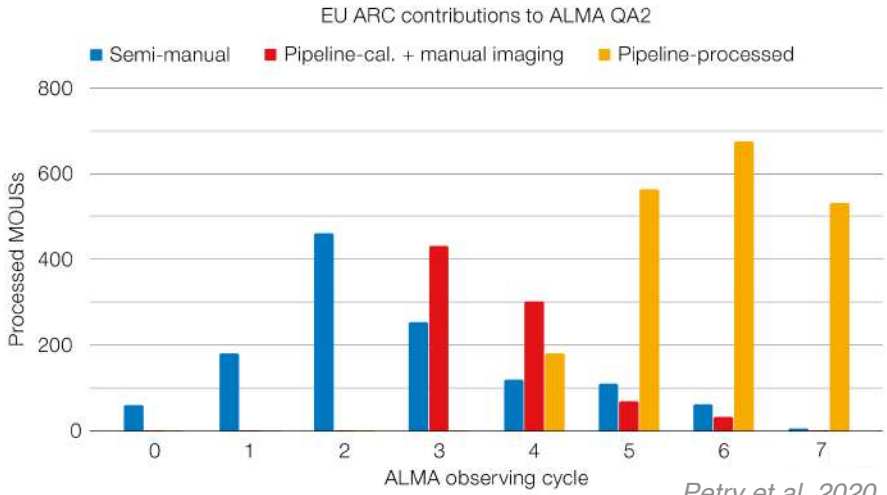
QA consists of 3 (+1) steps:

- **QA0(+):** performed at the telescope shorty after execution of a SB -> check the correct setup of antennas & receivers, stability of atmosphere, verifying that the flux calibrator used has a recent flux measurement
- **QA1:** longer-term monitoring of observatory parameters
- **QA2:** offline calibration and imaging on MOUSs to confirm the science goal was met
  - If the requested sensitivity & angular resolution achieved -> data delivered
  - If not (<10% of cases): re-observe SB & new QA2 process until requests are met

- **QA3:** (optional) triggered if errors are discovered by the PI or ALMA staff after data delivery

Pipeline processing

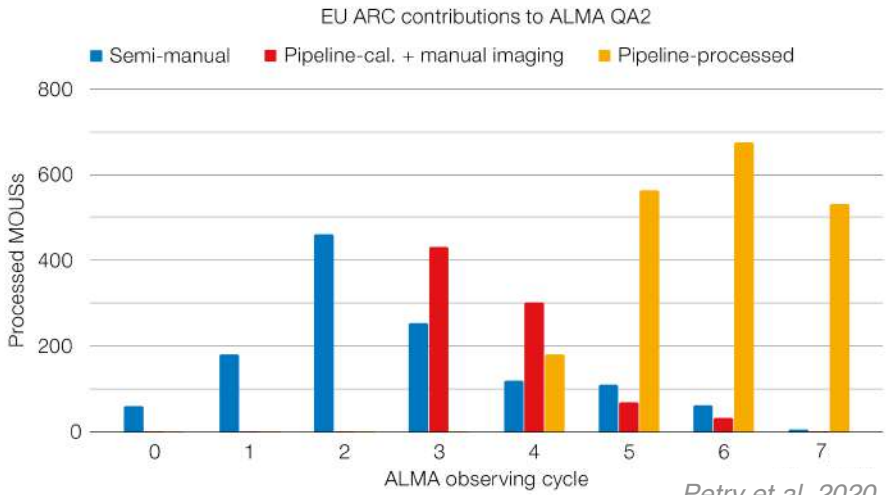
- Earlier cycles: QA2 processing exclusively done semi-manually by analysts in CASA and the Calibration Script Generator
- Since then: fully automated pipeline -> distributed with CASA releases
- Weblogs:
  - The pipeline creates a set of diagnostic plots and tables
  - reviewed manually to judge whether the pipeline run was successful, and the observing parameters were met



Petry et al. 2020

Pipeline processing

- <10% of cases require semi-manual processing by analysts
- 90% of the deliveries done within 1 month after the observation
  - Median of 2 weeks
- calibrated visibilities & single-dish data are not stored in the Archive & are not part of the data delivery



Petry et al. 2020

Let’s go to the archive…

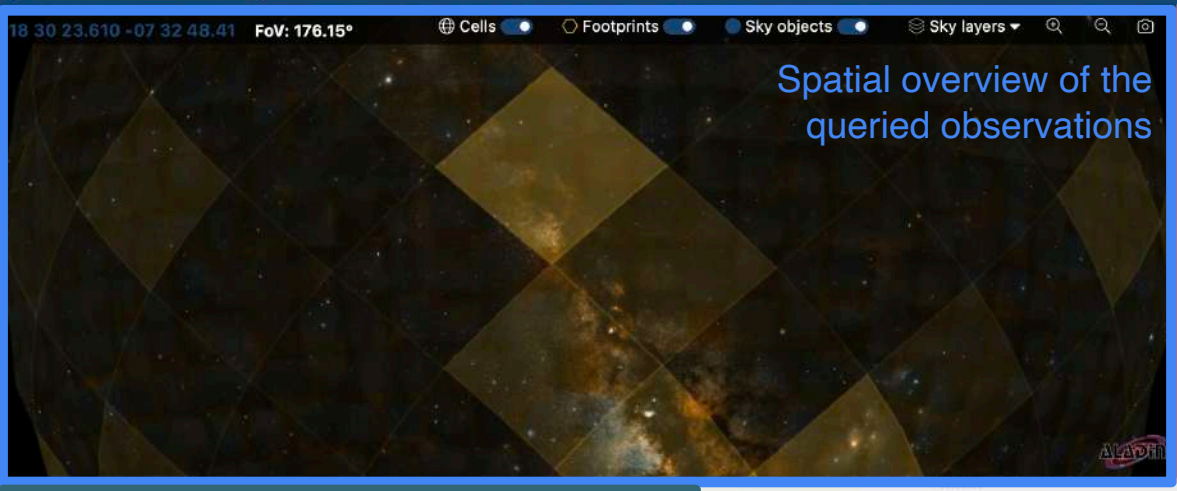
https://almascience.eso.org/aq/

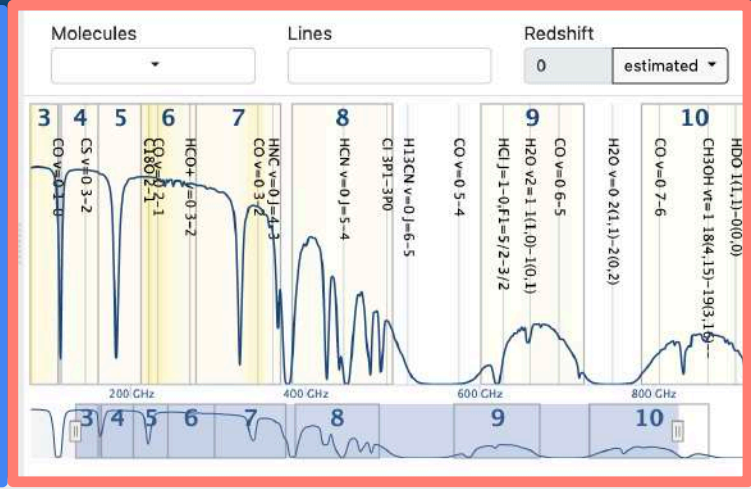
Search

Query options

Data preview & download

Explore and download





Spectral overview of the queried observations

Observations (60024) | **Projects** (4072) | **Publications** (2912)

Queried results

Filter options

Project code	ALMA source name	RA (h:m:s)	Dec (d:m:s)	Band	Cont. sens. (mJy/beam)	Frequency support	↑ Release date	Publications	Ang. res. (arcsec)	Min. vel. res. (km/s)
2011.0.00191.S	Fomalhaut b	22:57:38.685	-29:37:12.616	7	0.1181	343.077..358.839 GHz	2012-12-06	2	1.047	0.816
2011.0.00131.S	R Scl	01:26:58.079	-32:32:36.424	7	0.9115	330.246..346.109 GHz	2012-12-06	5	1.043	0.846
2011.0.00101.S	GRB021004	00:26:54.680	+18:55:41.600	7	0.1136	337.009..353.001 GHz	2012-12-06	2	1.107	26.541
2011.0.00397.S	J061200.23-062209.6	06:12:00.230	-06:22:09.600	7	0.5346	337.005..352.989 GHz	2012-12-20	3	1.183	26.541
2011.0.00397.S	J063027.81-212058.6	06:30:27.810	-21:20:58.600	7	0.5346	337.007..352.992 GHz	2012-12-20	3	1.183	26.541
2011.0.00397.S	J035448.24-330827.2	03:54:48.240	-33:08:27.200	7	0.4848	337.026..353.011 GHz	2012-12-20	3	1.128	26.541

ALMA Data Products

- Possible FITS images and what they are

`*spw##.cube.I.*`	A spectral image cube of a single spectral window
`*spw##.mfs.I.*`	A continuum image for a single spectral window
`*spw##_##_##_##.cont.I.*`	An aggregate bandwidth or continuum image
`*spw##_##_##_##.cont.I.alpha.*`	A spectral index image
`*spw##_##_##_##.cont.I.tt0.*`	An image containing the zeroth Taylor term for a continuum image
`*spw##_##_##_##.cont.I.tt1.*`	An image containing the first Taylor term for a continuum image
`*spw##_##_##_##.cont.IQUV.*`	An aggregate bandwidth or continuum full Stokes cube

ALMA Data Products

- Possible FITS images and what they are

`*.mask.fits`	The mask that was used when the image was created
`*pb.fits` or `*.flux.fits`	The primary beam response for a field
`*pbcor.fits`	A primary-beam corrected image
`*sd.im.fits`	A single dish image
`*.mfs.A.*` or `*mfs.POLA*`	A polarization angle map
`*.mfs.P.*` or `*mfs.POLI*`	A linear polarization intensity map