ALMA science archive

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Italian node of European ALMA Regional Centre

Credits to Marcella Massardi

UniTo – April 2018

EUROPEAN ARC

ALMA Regional Centre || Italian

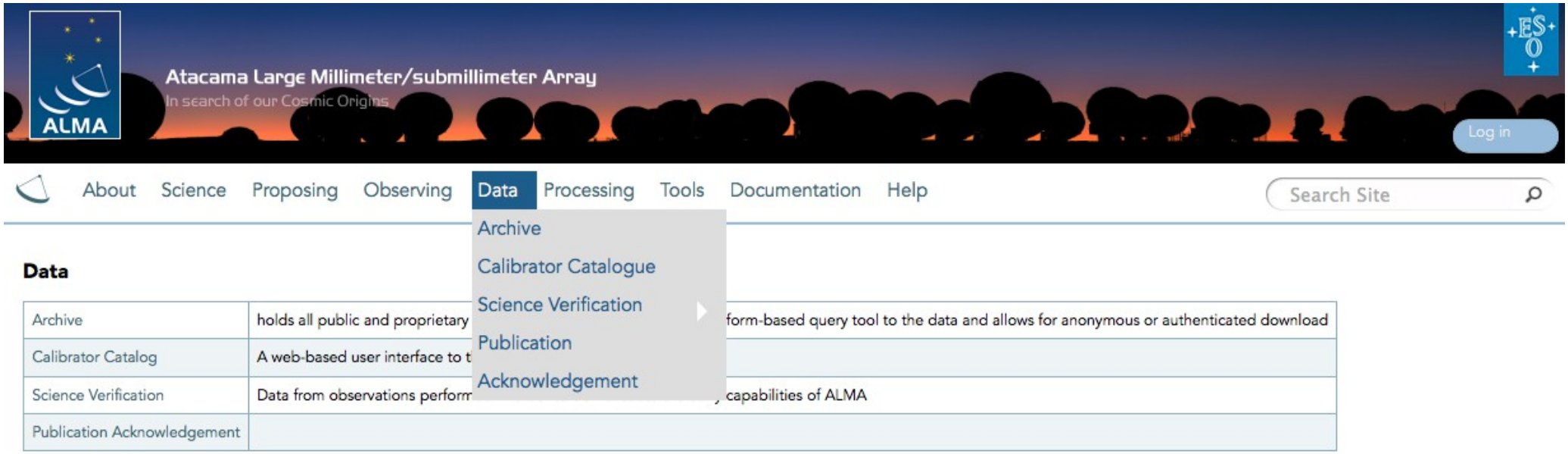
Reasons to use archived data

- Check if data are already available for a target
- Check the feasibility of a project looking for similar targets
- Retrieving information on a large sample of objects (e.g. statistics of populations, stacking, …)
- Retrieving information on a single object but with different configuration (e.g. multifrequency studies) or in different epochs (e.g. variability studies)
- Extracting unpublished information from existing data (e.g. finding additional spectral lines, targets in the same region/time of other observations,)
- **For ALMA in particular avoid the stress of competition and oversubscription**

	Proposal submission	Archive mining
Time to get data	✗	+
Amount of data	✗	+
Data homogeneity	+	✗
Adherence to idea	+	✗

ALMA data on the Science Portal

https://almascience.eso.org/alma-data



ALMA Calibrators

https://almascience.eso.org/alma-data/calibrator-catalogue

Calibrator Catalogue

A web-based user interface to the calibrator database is provided through the

Calibrator Catalogue

button_calibrator_catalogue

The ALMA Calibrator Source Catalogue is a database of astronomical measurements of calibrator sources, mostly bright quasars in the mm and sub-mm regime. It contains over 11000 ALMA measurements of over 1800 sources (1 July 2015). The most important properties are flux density with uncertainty at a given frequency and angular structure information or limits, and polarization measurements for some calibrators. External information had been provided via 'seed' catalogues, such as from VLA (Calibrator Manual), SMA[1], ATCA, CRATES, and coordinates from VLBI, and we acknowledge the institutions and individuals who contributed this effort. Note that the absolute flux density scale does not include the model uncertainty of the solar system object used as primary amplitude calibrator, and in some cases it can exceed the stated flux density error in the catalogue. Also, the observation and reduction procedures changed in mid-2012, so the measurements before this date may state flux density errors that underestimate the true uncertainty.

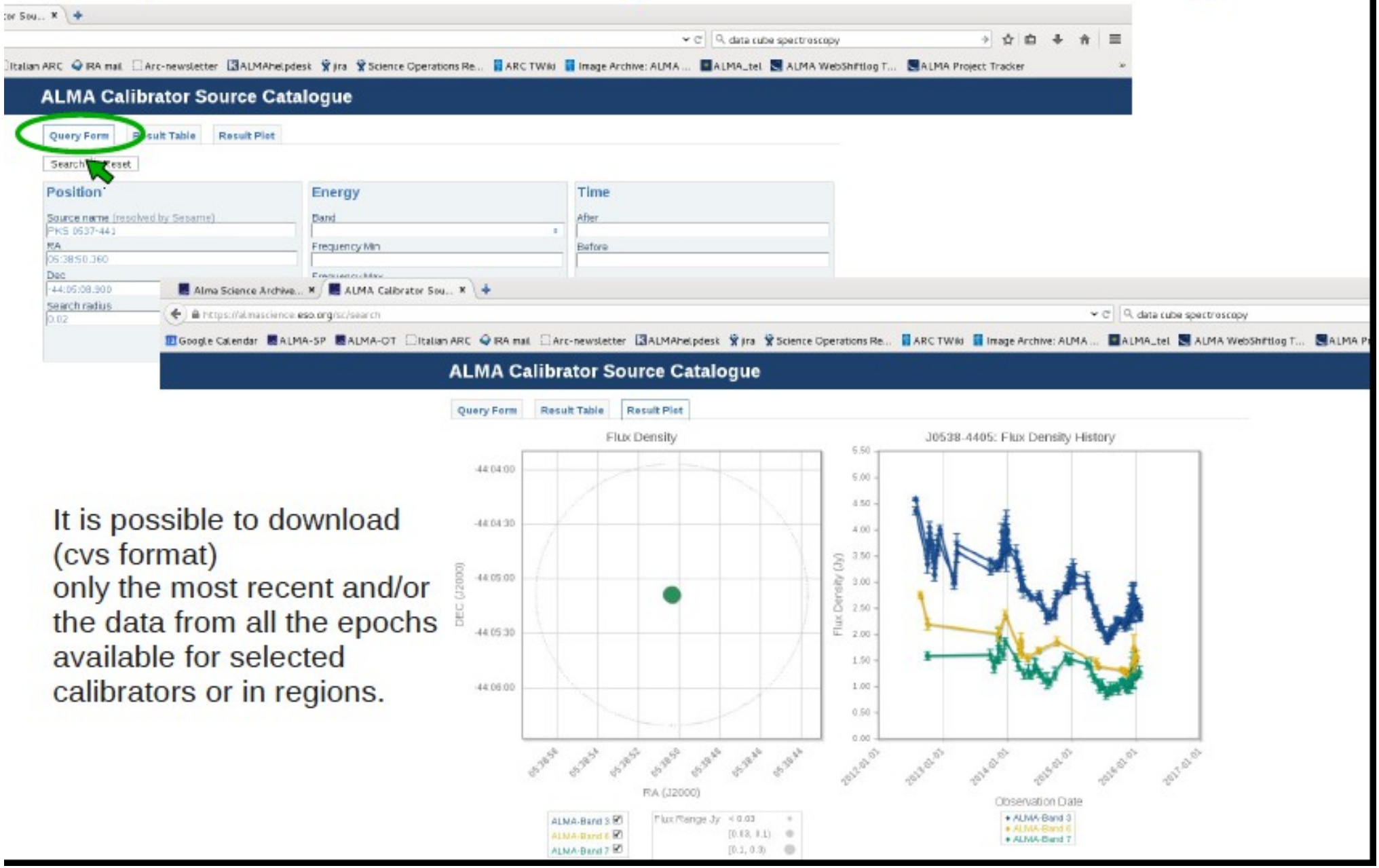
A main use of the database is to allow the selection of bandpass and phase calibrators for science observations. It also contains a set of 30 quasars, grid sources evenly distributed over the sky, which are monitored regularly enough to provide amplitude calibration in addition to solar system objects. Calibrator sources are selected either manually during phase 2 preparation or by the astronomer on duty, or automatically via on-line queries during the execution of the observation. In each case suitable criteria regarding visibility, flux density and proximity to the science targets have to be specified.

Calibrator observations, outside of science observations, are currently carried out in a special observing mode and have to be fully integrated into science operations. Equally, data reduction and database ingestion has to be automated via the ALMA Pipeline. Access for users is provided via a web-based user interface through the ALMA Regional Centers, and VO integration of special queries is planned for a future Cycle. The intention is to provide a more complex, public search tool for calibrator sources, which can also be accessed through the Observing Tool and included into the Scheduling Blocks.

The Query Form allows to specify various search criteria regarding position, frequency, flux density and time of the calibrator measurements. Equatorial coordinates in J2000 (ICRS) can be

ALMA Calibrators

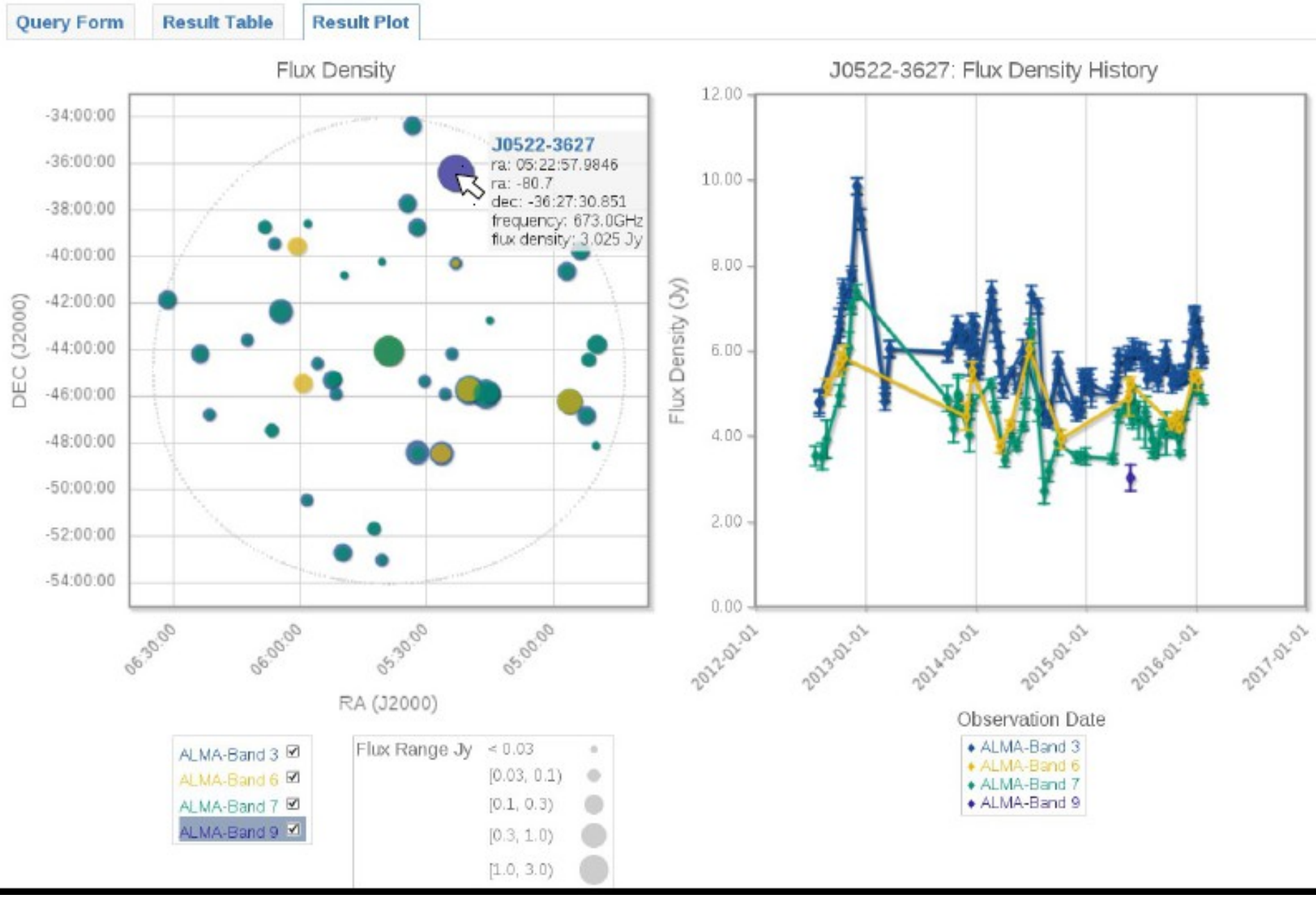
https://almascience.eso.org/alma-data/calibrator-catalogue



It is possible to download (cvs format)
only the most recent and/or the data from all the epochs available for selected calibrators or in regions.

ALMA Calibrators

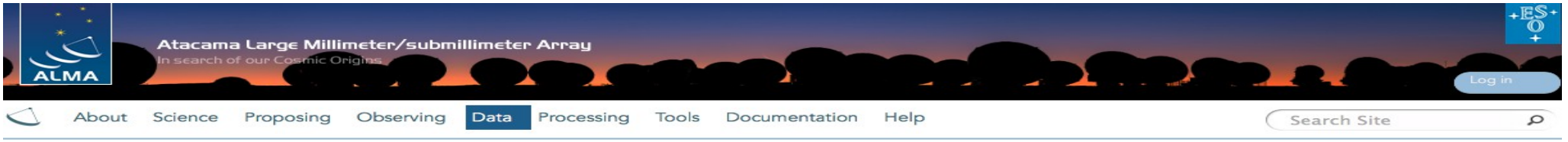
https://almascience.eso.org/alma-data/calibrator-catalogue



ALMA Science Verification Data

https://almascience.eso.org/alma-data/science-verification

Click on the dataset you need and/or the CASAGuides.
Each dataset might have different distribution packages



About Science Proposing Observing **Data** Processing Tools Documentation Help Search Site

Science Verification Data

...

For general information on the Science Verification process as well as the status and future plans of Science Verification projects, please use the link below:

Science Verification Information

...

Currently Available Science Verification Data:

We now have several datasets available to demonstrate the early capabilities of ALMA. In some cases these projects were observed before 16 antennas were available and while many of the subsystems were still being tested, so they should not be construed to represent the quality of the data that can be expected from the system as it is today. They are provided here as a means for the user to become acquainted with the ALMA data structure, observing strategies and reduction techniques. Given that the data have been taken during the construction phase, there may be more idiosyncrasies present than will be expected during full operations, so we ask the user to please review carefully the CASA guides provided with the datasets that represent unique observing modes or strategies, as indicated below.

Note that only data with prepared CASA guides are kept up to date with the current CASA release. For the other data, please consult the following knowledge base article: *"If my data were calibrated and imaged in CASA 3.3 and I want to redo it, are there resources to help?"*

For reference the list of Science Verification targets that was provided with the Cycle 0 Call for Proposals is given in Table 2 which indicates which observations have been completed or are in progress. We do not expect to observe the other sources on that list.

1. **TW Hya: Band 7, high spectral resolution**. Many thanks to the following people for suggesting this source for ALMA Science Verification: *Meredith Hughes, Stuartt Corder, Chunhua Qi, Karin Oberg, Michiel Hogerheide, Andrea Isella, Dmitry Semenov.*

Additional data on TW Hya is available (without a separate CASA guide) here: Band 3, Band 6.

2. **NGC3256: Band 3, low spectral resolution**. Many thanks to the following people for suggesting this source for ALMA Science Verification: *Kazushi Sakamoto, Alison Peck, Satoki Matsushita, Martin Zwaan.*

3. **Antennae galaxies: Band 7, high spectral resolution.** Many thanks to the following people for suggesting this source for ALMA Science Verification: *Christine Wilson, Junko Ueda, Francois Boulanger, Nicole Nesvadba, Cinthya Herrera.*

Additional data on Antennae is available (without a separate CASA guide) here: Band 6

4. **M100 Band 3, low spectral resolution.** Many thanks to the following people for suggesting this source for ALMA Science Verification: *Preben Grosbol and Catherine Vlahakis.*

Update: ACA (7-m Array and TP Array) data on M100, complete with a CASA Guide demonstrating the combination of 12-m, 7-m, and TP Array data, are now available. The combined images are also available. The CASA guide is written for CASA version 4.3. An updated version of the previously released 12-m Array data products are provided for CASA 4.3.

5. **SgrA* Band 6, recombination lines**. Many thanks to the following people for suggesting this source for ALMA Science Verification: *Andreas Eckart, Stephane Leon, Steve Longmore,*

Definitions: SG, SB and EB

At proposal stage the PI makes some choices and requests needed to reach his purposes.
The PI splits the project in

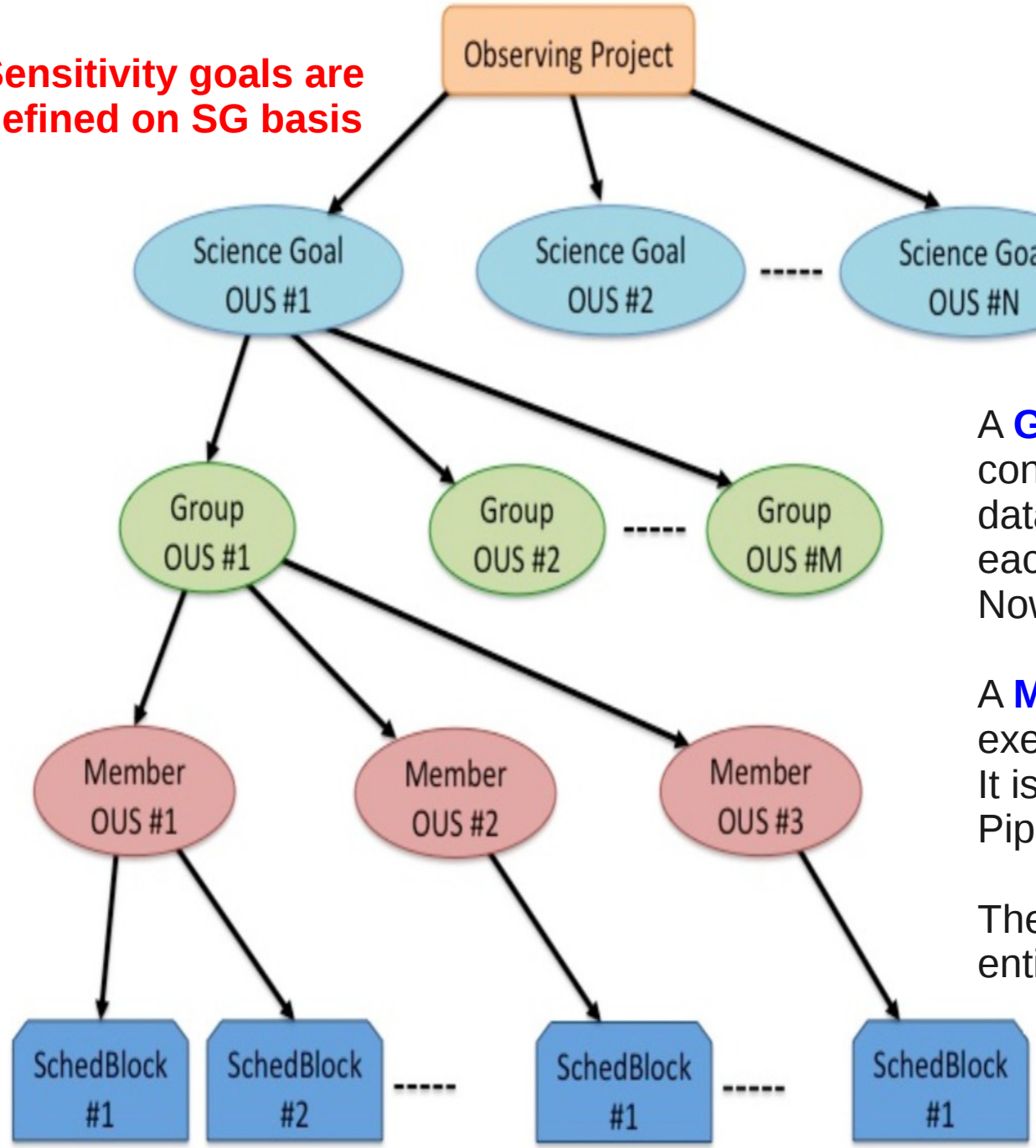
Science Goals **Minimum proposed observational unit including targets**
in the same sky region that roughly share the same calibration
aimed at reaching a requested sensitivity
in a given angular (resolution and LAS) and spectral setup
e.g. Different bands on the same target are in different SG
Different configurations of the array to reach a certain angular scale coverage are in the same SG (ACA+main array)

Each SG is converted into a
Scheduling Block **Minimum observational unit including targets in the same sky region and their calibrators to be observed with the same instrumental setup.**
They are the minimum set of instructions to perform an observation.
To allow flexibility of scheduling they last ~30min
Different configurations cannot stay in the same SB.

It is possible that an SB has to be repeated to reach the requested sensitivity.
Then **at observative stage** we define
Execution Block **Each repetition of the observation of a SB.**
This is the minimum observative unit and the minimum data reduction unit (as they include all the calibrators for an observative session), but might not be enough to reach the PI requests.
It is the minimum archive unit!!!

Data structure

Sensitivity goals are defined on SG basis



Science goal:
Sources in the same sky region that share the same calibration, spectral setup and PI requests

OUS= Observing Unit Set
Smallest unit for data processing

A **Group** can contain several configurations to be combined in data processing (e.g. several arrays), each of them is a Member.
Now for ALMA there is 1 Group/SG

A **Member** can contain multiple executions of Scheduling Blocks.
It is the minimum scheduling entity.
Pipeline operates at this level

The **Scheduling Block** is the smallest entity used for observing

Each repetition of a SB is an **Execution Block**

Data Quality Assessment

The goal of ALMA Quality Assurance (QA) is to deliver to the PI a reliable final data product that has reached the desired control parameters outlined in the SG, that is calibrated to the desired accuracy and free of calibration or imaging artifacts
i.e. ALMA performs **science-goal-oriented service data analysis**

ALMA QA happens on 4 levels:

QA0: near-real time verification of weather and hardware issues carried out on each execution block immediately after the observation.

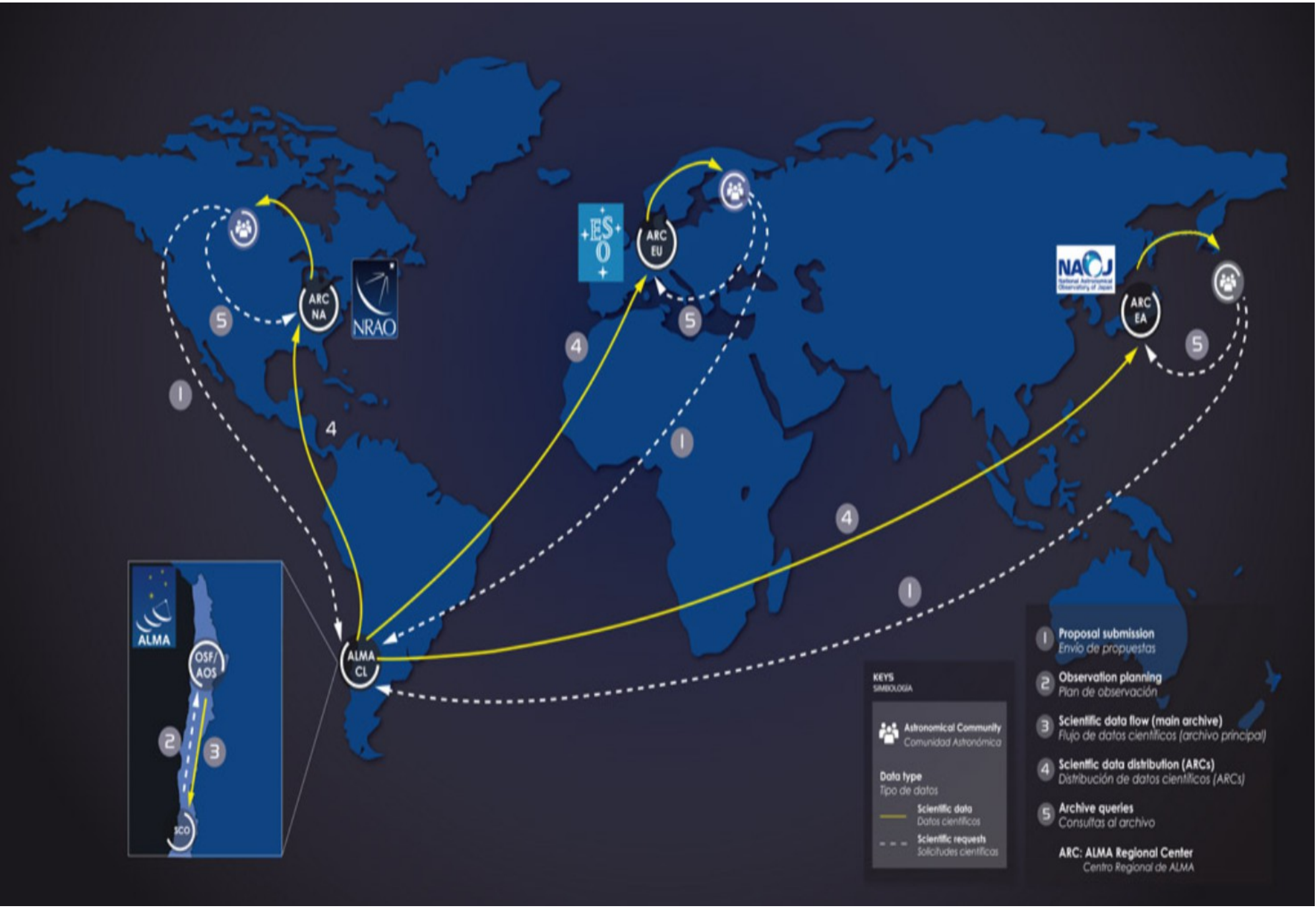
QA1: verification of longer-term observatory health issues like absolute pointing and flux calibration.

QA2: offline calibration and imaging (using CASA) of a completely observed MOUS.

- Performed by expert analysts with the help of a semi-automatic procedures, based on common practice.
- Calibration can be “Manual” or based on the “Pipeline”
- Imaging so far is always manual (partially depends upon the analyst “taste”)
- It is limited to verify the achievement of the PI requests for each MOUS (do not even consider other data possibilities)
- Results are archived and given to the PI.

QA3: (optional) PIs may request rereduction, problem fixes, possibly reobservation

Project travels & archive mirrors



Data format

ALMA Science Data Model (ASDM) **Final archived product from each observation**

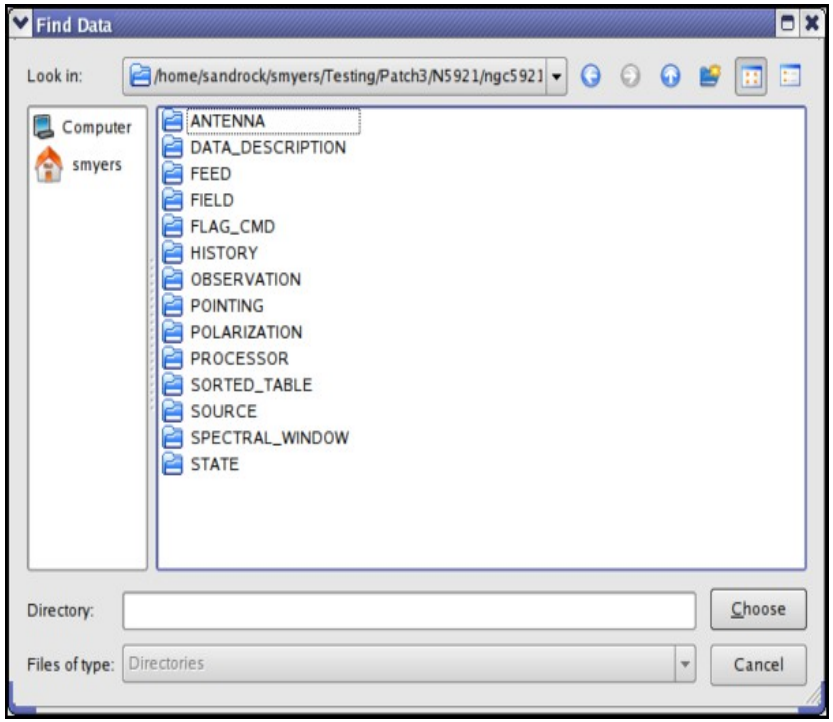
Each has an unique hexadecimal name (eg uid://A002/X2fed6/X3f).
Each contains the meta-data (headers, descriptions of the observation setup, etc), and the binary data (the raw data)

The first step of any data processing is importing the ASDM in the format suitable for the software used

Measurement Set (MS)

Data format used in CASA

Constituted by several tables referring each other and collecting most (not all!) the information in the ASDM



What is in the archive?

For each project the main deliverables are
Raw Data, Calibration Scripts and Tables

Users need to run the proper version of CASA to generate the Calibrated Data.
The resulting calibrated data is considered science-ready.

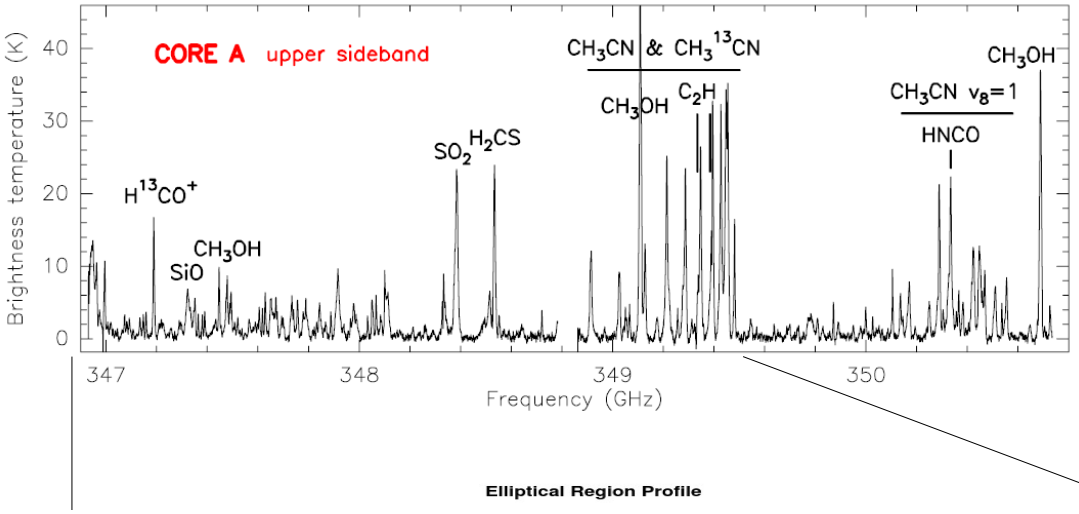
As a consequence of the process only data that passed QA2 (at least in part) are in the archive

Some Imaging Products are delivered too, as result of QA2 processing
(in Early Science provided on a best effort basis, not necessarily science-ready)
a) for Line Observations:
- continuum-subtracted (where needed) image cubes at the requested resolution
- a continuum image for all line-free channels (where possible)

b) for Continuum Observations:
- a continuum image combining all SPWs

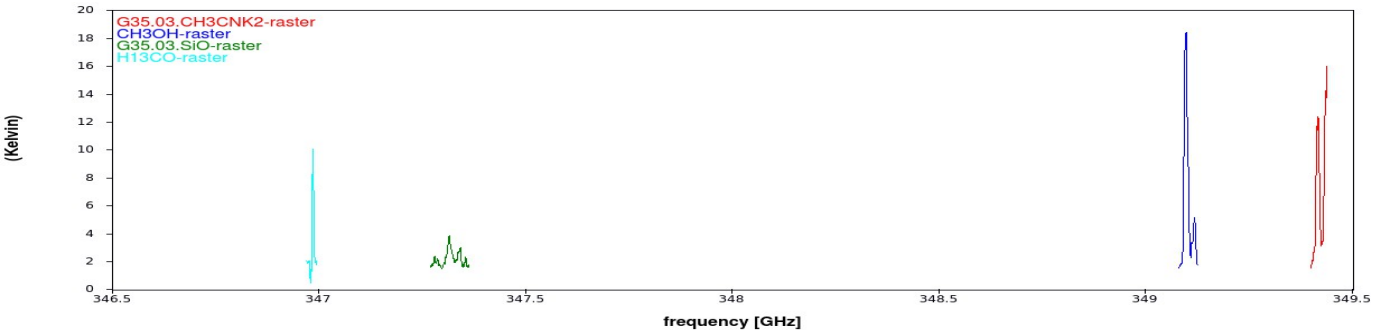
Images in the archive are provided as starting point on the way to obtain the final images and a valuable basis for archive researchers
(i.e. they are not considered science-ready!!!)

What is in the archive?

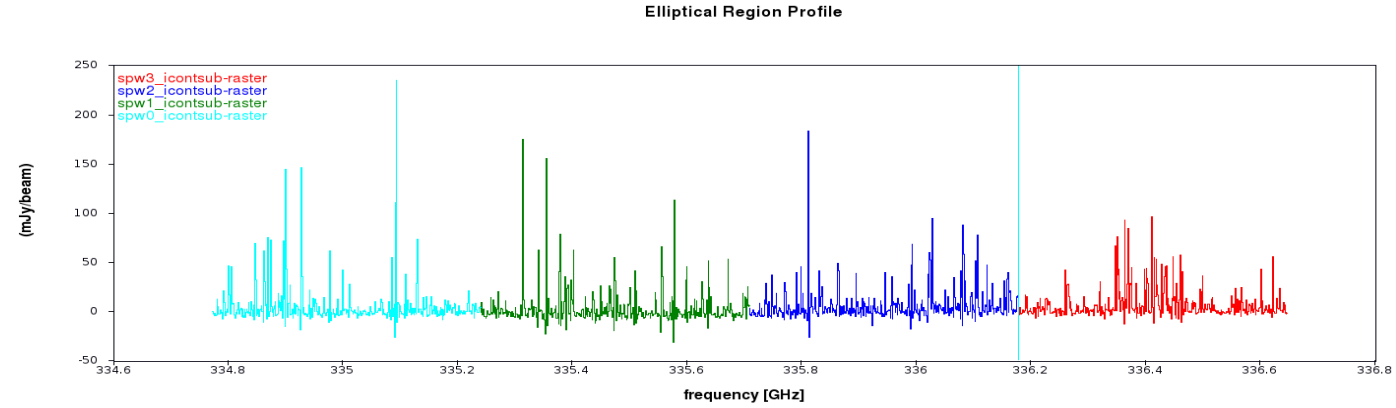


Images in the archive might cover only a fraction of the spectrum available

Spectrum observed
(and available in the raw data)



Imaged data for QA2



Different data and PI requests on different sources generate different products
In the archived images
but raw data contain the full spectral windows

Differences among the cycles

Early science cycles might differ in
product formats, pipeline availability, CASA version to run calibration scripts.

Cycle 0 caveats:

- Packaged differently from other cycles (check “Delivery lists” contents to download only images)
- Archive download does not refer to data tree structure
- Calibrated with CASA 3.2-3.4 (updates since then)
- No pipeline available
- Many Knowledgebase articles available to deal with them

→ **Rule of Thumb: download them and reduce them from scratch, if possible with a new CASA version. Rely on experts for it**

Cycle 1 onwards:

- Allow download of “ligth” (<1GB) products (QA2 images and READme) and/or “heavy” (>10GB) raw data
- Check in the downloaded README files and script the CASA version used

→ **Rule of Thumb: download the product first, check that they are what you need and their quality, then download the raw data. Reproduce the products running the scripts. Change the images modifying the imaging scripts. Rely on experts for changes in the calibration**

Tha Science ALMA Archive

https://almascience.eso.org/alma-data/archive

About Science Proposing Observing Data Processing Tools Documentation Help

Search Site

- Archive
- Calibrator Catalogue
- Science Verification
- Publication
- Acknowledgement

Archive

Archive Query

Documentation

We provide a comprehensive ALMA Science Archive Manual.

Data delegation

PIs can grant access to one of their projects to a registered ALMA user by logging into the Science Portal, going to the user profile page in the top right corner and then adding delegees in the "Project delegation" tab.

Cycle 0 content

Please go here to see the content of the Cycle 0 deliveries.

Tha Science ALMA Archive

https://almascience.eso.org/alma-data/archive

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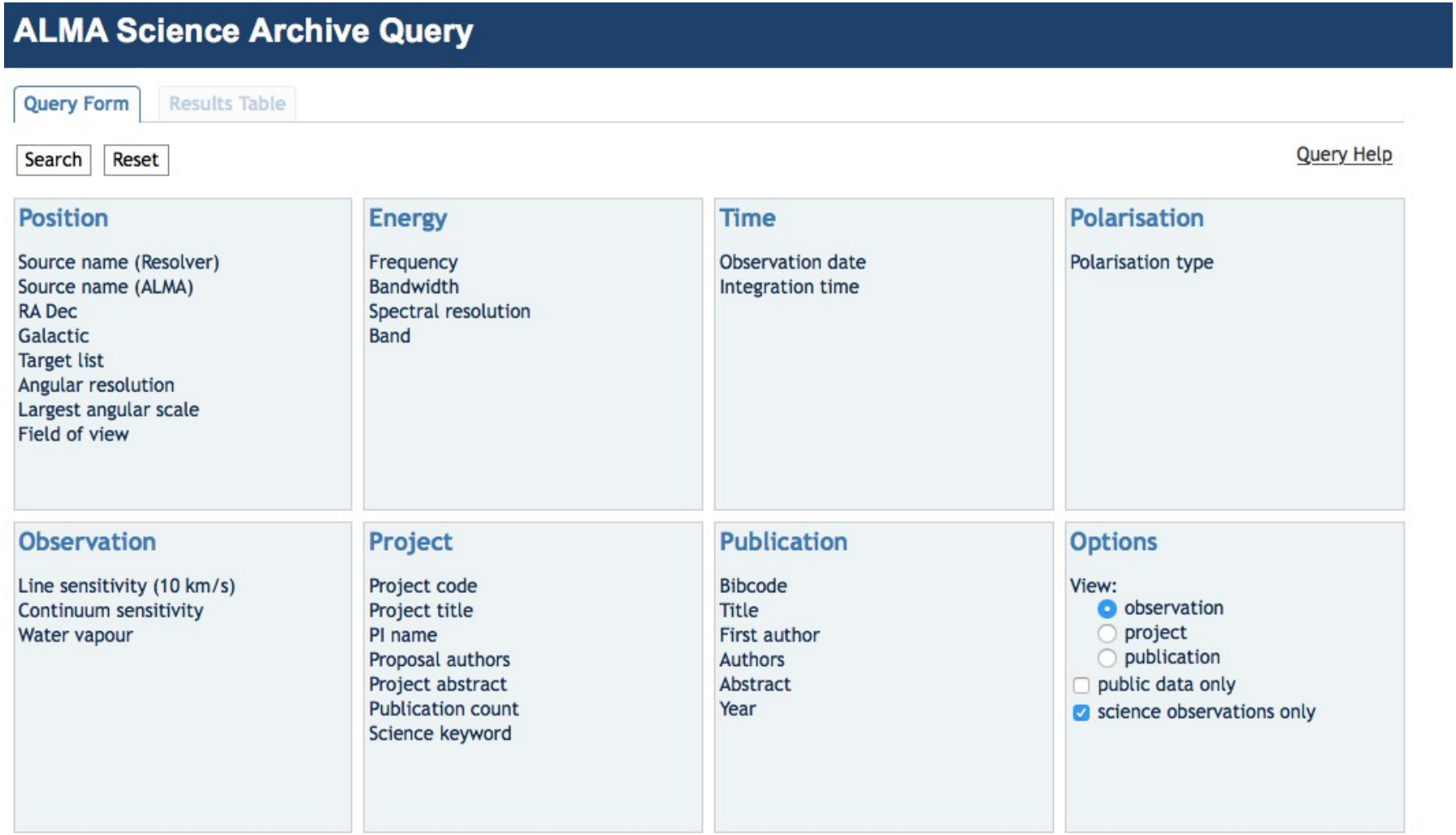
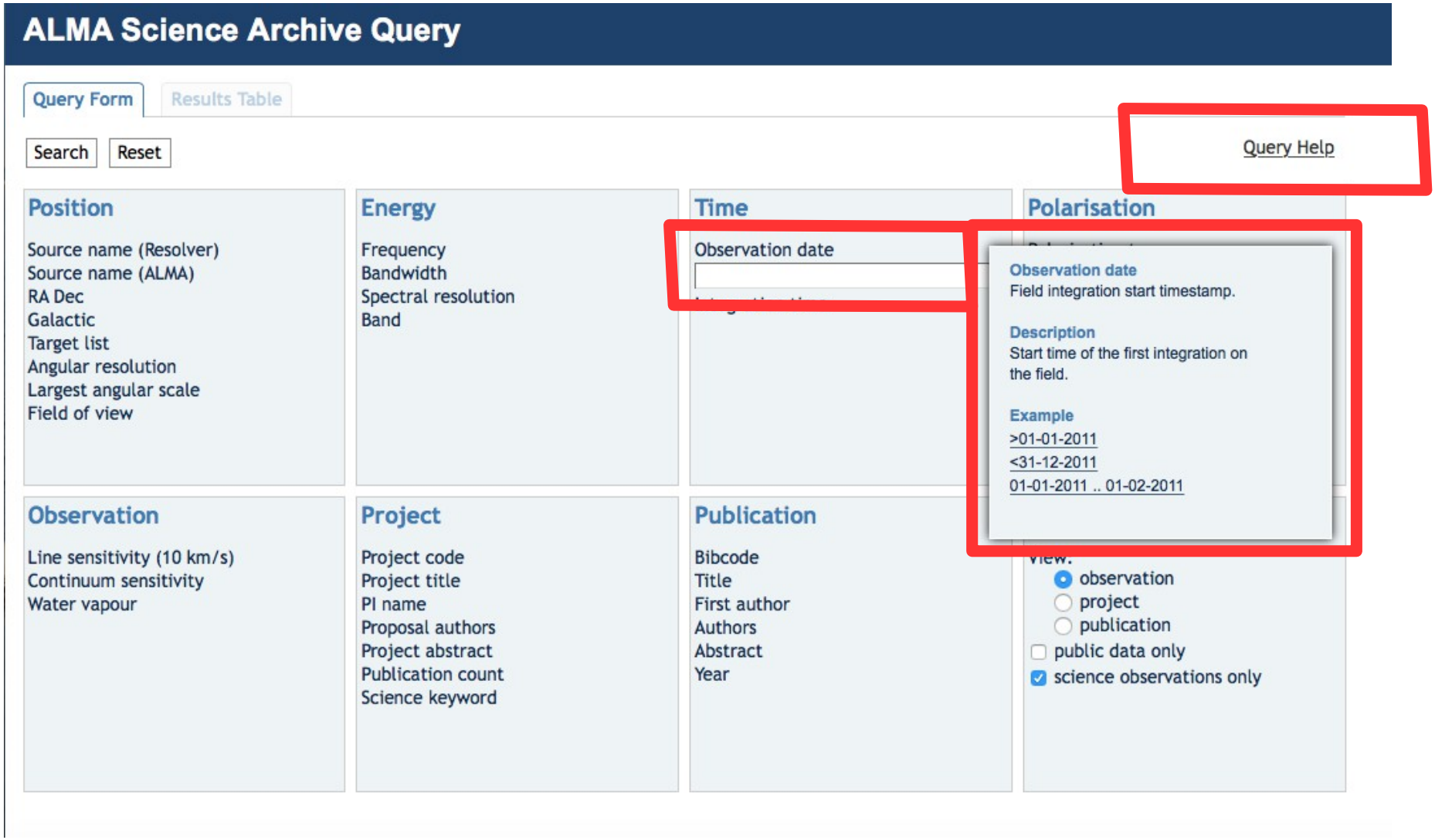
Cycle 0 content

Please go here to see the content of the Cycle 0 deliveries.

The ALMA archive: query



The ALMA archive: help



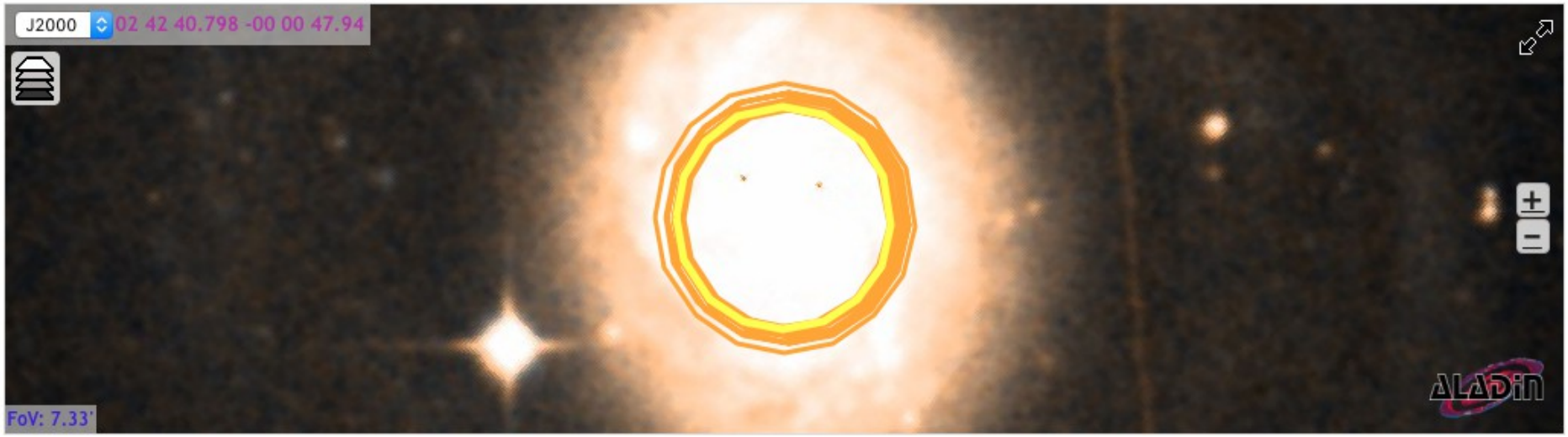
The ALMA archive: result table

ALMA Science Archive Query

Query Form | Results Table

Submit download request

Results Bookmark Export Table Results Help



More columns Showing 12 of 12 rows.

	Project code	Source name	RA	Dec	Band	Integration	*Release date*	Velocity resolution	Frequency support	Pub
Filter:			H:M:S	D:M:S		seconds		m/s		
☐	2013.1.01151.S	NGC1068	02:42:40.70	-00:00:48.0	3	1481.760	2016-01-13	45516.74	95.42..110.71GHz	0
☐	2013.1.01151.S	NGC1068	02:42:40.70	-00:00:48.0	3	272.160	2016-01-27	44015.10	98.74..113.98GHz	0
☐	2013.1.00060.S	NGC1068	02:42:40.71	-00:00:47.9	3	5140.800	2016-04-01	1340.39	96.24..110.03GHz	0
☐	2013.1.00060.S	NGC1068	02:42:40.71	-00:00:47.9	3	8678.880	2016-08-28	1340.19	96.25..110.05GHz	0

The query runs on the raw data so returns one entry per target per Execution Block.
It is possible that for a project several rows are displayed for the same source.
Projects that contain many sources, many Sbs or mosaics might returns many lines.
Columns values are only indicative. Data structure can be more complex than what shown.

The ALMA archive: download manager

3) Select the data you want

Remember that a Member OUS
is the smaller data processing unit

Download products only for quick view of images
Product data are typically <1GB
Raw data for whole projects are typically >10GB
Processing might increase folder size by factors 2-8

10 GB or more?????

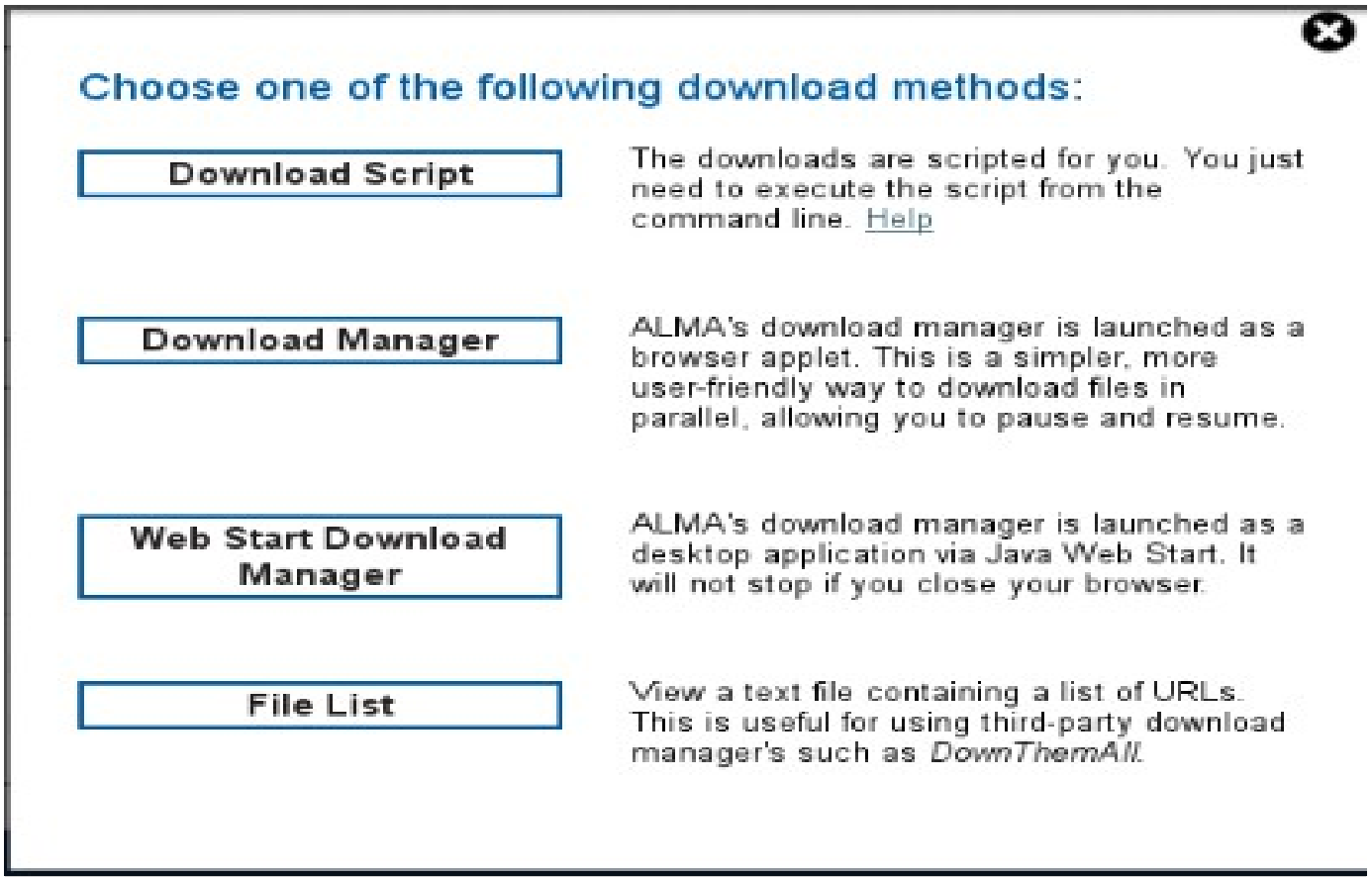
“OPS...
This could be a problem
for my laptop”

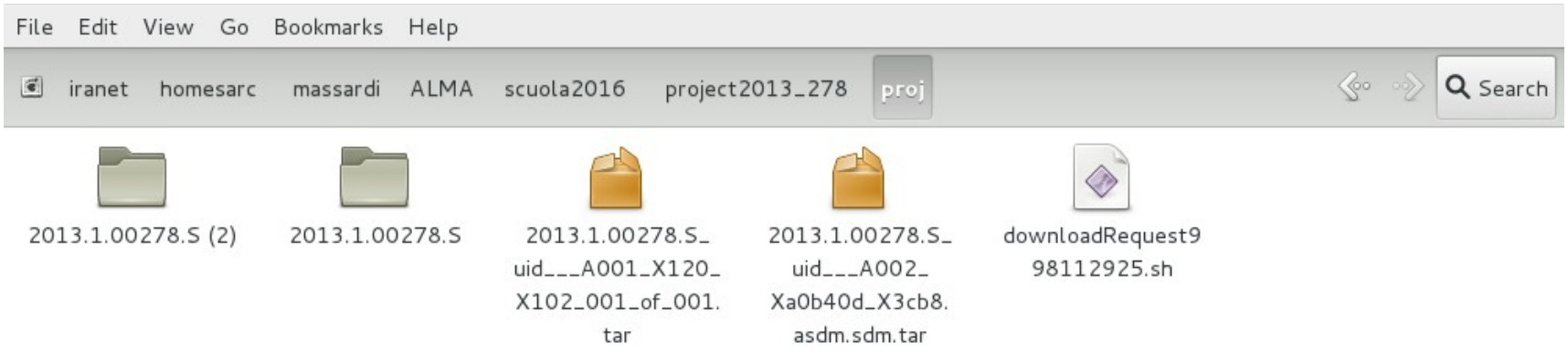
Don't struggle on it!!!
You can ask an account on our ARC cluster to deal with ALMA data!

Just sent an email to help-desk@alma.inaf.it indicating the reason of your request
And visit our webpage http://www.alma.inaf.it/index.php/The_ARC_cluster

The ALMA archive: download manager

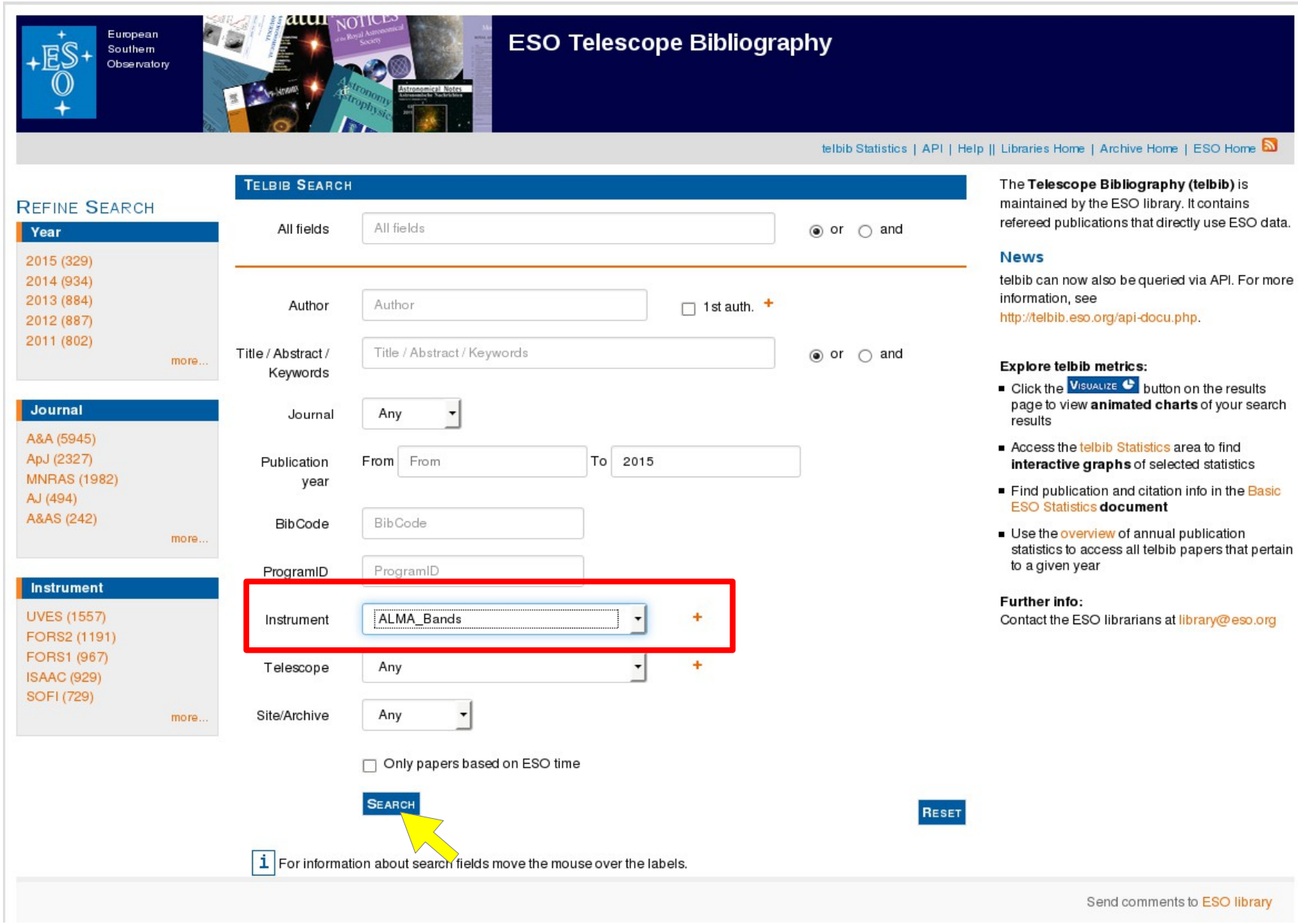
4) Choose the download method





The ESO telbib

http://telbib.eso.org/



The ESO telbib

REFINE SEARCH

Year

2015 (40)
2014 (97)
2013 (65)
2012 (20)

Journal

ApJ (121)
A&A (54)
MNRAS (16)
Nature (11)
PASJ (6)
more...

Instrument

ALMA_Bands (222)
LABOCA (14)
XSHOOTER (6)
FORS2 (5)
SHFI (5)
more...

NEW SEARCH | EDIT SEARCH | VISUALIZE | EXPORT

Results **1** - **25** of **222** found for (instrument:ALMA_Bands)

« Previous Next »

YEAR ▼	AUTHOR	TITLE	INSTRUMENTS	ACCESS TO DATA	FULLTEXT ADS
2015	Sakai, Yusuke et al.	An ALMA Imaging Study of Methyl Formate (HCOOCH3) in Torsionally Excited States toward Orion KL	***ALMA_Bands***	2011.0.00009.SV	2015ApJ...803...97S
2015	Brouillet, N. et al.	Antifreeze in the hot core of Orion. First detection of ethylene glycol in Orion-KL	***ALMA_Bands***	2011.0.00009.SV	2015A&A...576A.129B
2015	Saito, Toshiki et al.	ALMA Multi-line Observations of the IR-bright Merger VV 114	***ALMA_Bands***	2011.0.00467.S	2015ApJ...803...60S
2015	Olofsson, H. et al.	ALMA view of the circumstellar environment of the post-common-envelope-evolution binary system HD 101584	***ALMA_Bands***	2012.1.00248.S	2015A&A...576L..15O
2015	Sakai, Takeshi et al.	ALMA Observations of the IRDC Clump G34.43+00.24 MM3: DNC/HNC Ratio	***ALMA_Bands***	2011.0.00656.S	2015ApJ...803...70S
2015	Gullberg, B. et al.	The nature of the [C II] emission in dusty star-forming galaxies from the SPT survey	***ALMA_Bands***	2011.0.00957.S, 2011.0.00958.S, 2012.1.00844.S	2015MNRAS.449.2883G
2015	Rathborne, J. M. et al.	A Cluster in the Making: ALMA Reveals the Initial Conditions for High-mass Cluster Formation	***ALMA_Bands***	2011.0.00217.S	2015ApJ...802..125R

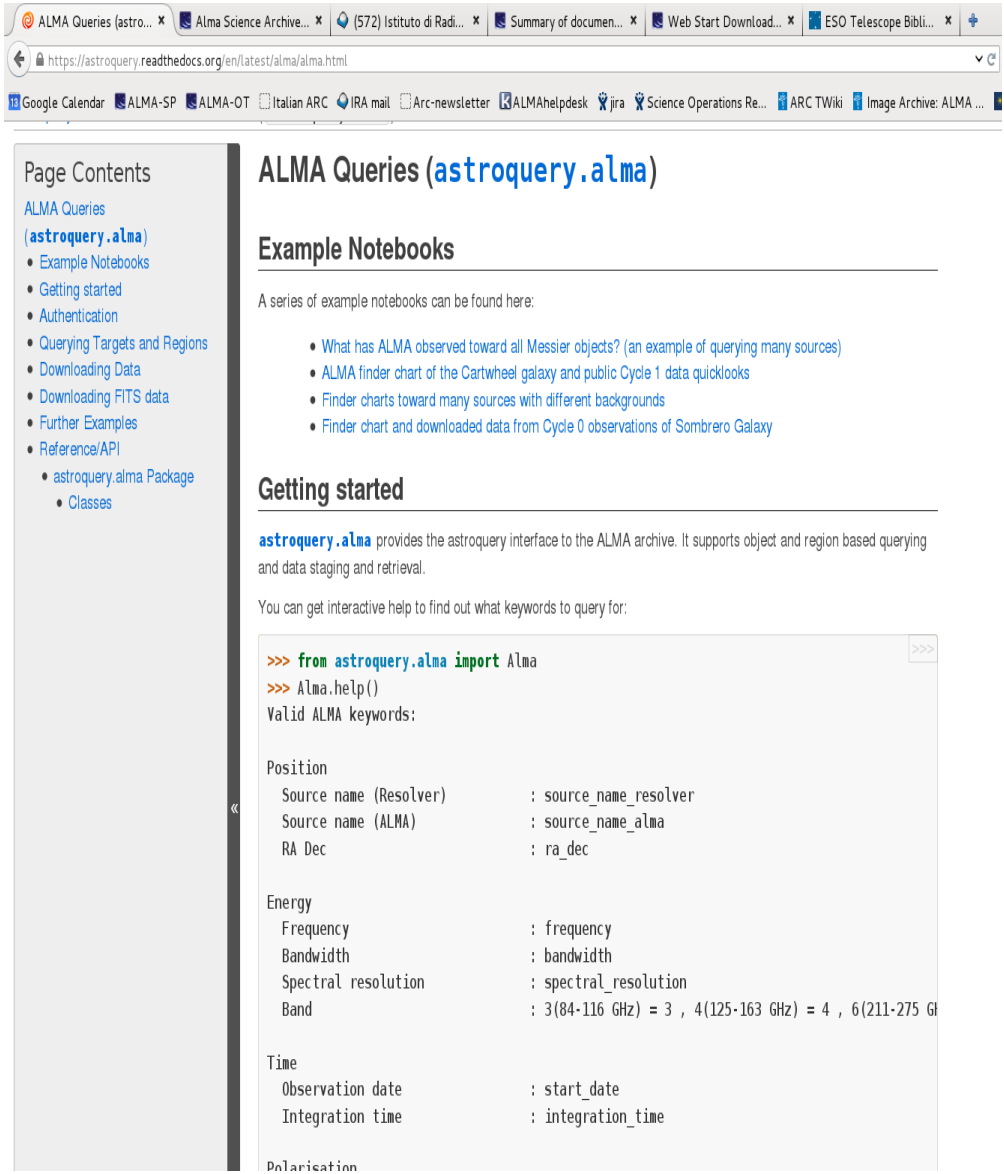
Direct link to the ALMA Archive

ASTROquery.alma
(https://astroquery.readthedocs.org/en/latest/alma/alma.html)

- Python library for archival query
  (not developed by ALMA)

- Allows batch searches (i.e. lists of sources)
  and full download
- Allows the same criteria as the archive
- Allows scripting for downloads
  (if anyone needs we can distribute examples)

- However, it is computer sensitive
  (download may not work...)



What is in the packages?

When untarred, the Product Package standard directory structure contains

Untarred products only

```
|-- project_id/
| |-- sg_ouss_id/
| | |-- group_ouss_id/
| | | |-- member_ouss_id/
| | | | |-- README ..... important summary of the contents
| | | | |-- product/ .....all the imaging products as result of QA2
| | | | |-- calibration/ .....calibration and flagging tables
| | | | |-- qa/ ..... diagnostic plots generated during QA2
| | | | |-- script/ ..... the scripts necessary to regenerate the products
| | | | |-- log/ .....CASA log files from QA2 calibration and imaging
```

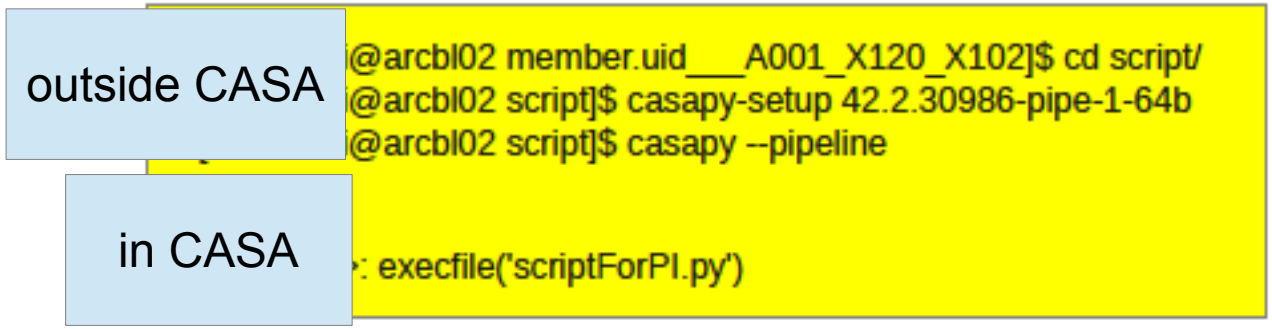
Untarred ASDM (raw data)

```
| | | | |-- raw/ .....for calibration move it in the products folder at the
                                                    right level  (follow the README)
```

Untarred ASDM (Raw data)

Untarred products

What to do after download?



1) Untar the packages

2) Look at weblog and/or QA reports

3) Read the README file and follow the instructions: typically

- Launch the correct CASA (with pipeline) version in the script folder
- Run the “Script_for_PI” to generate the calibrated MS
- Run the “Script_for_Imaging” to regenerate the images

4) Edit the scripts where needed according to your purposes

What is in the packages?

After running the ScriptForPI.py

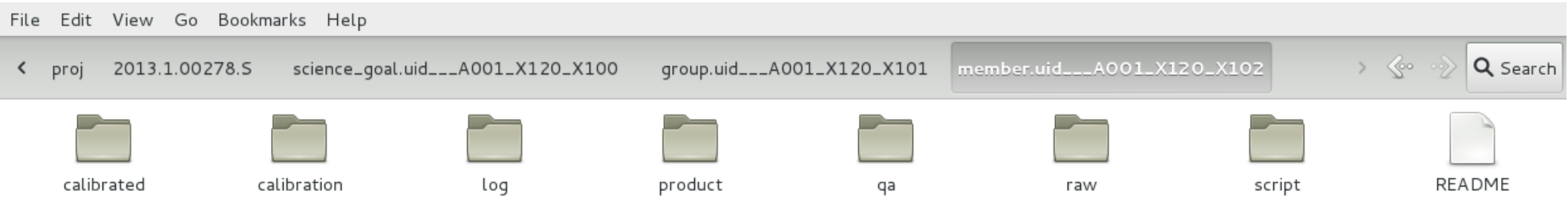
Down loaded data

New folder produced by script

```
|-- project_id/
| |-- sg_ouss_id/
| | |-- group_ouss_id/
| | | |-- member_ouss_id/
| | | | |-- README ..... important summary of the contents
| | | | |-- product/ ..... all the imaging products as result of QA2
| | | | |-- calibration/ ..... calibration and flagging tables
| | | | |-- qa/ ..... diagnostic plots generated during QA2
| | | | |-- script/ ..... the scripts necessary to regenerate the products
| | | | |-- log/ ..... CASA log files from QA2 calibration and imaging

| | | | |-- raw/ ..... moved in the main folder from raw data download

| | | | |-- calibrated/ ..... calibrated ms, flagging and calibration tables
```



Caveats

- **This is the CURRENT version of the archive**
- **Philosophy will remain the same, access interfaces and information available might change in the future**
- **There are differences between cycles**
- **There are differences between pipeline and manual data reduction, calibration and imaging**
- **Images are not science-ready!!!**

In publications with ALMA data!

Acknoweledgement Statement:

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