ALMA DATA

FROM THE ARCHIVE TO CALIBRATED VISIBILITIES

ALMA Data Reduction Training Day

Aida Ahmadi

ALMA Local Expertise Group (Allegro)

Leiden Observatory
November 27, 2023

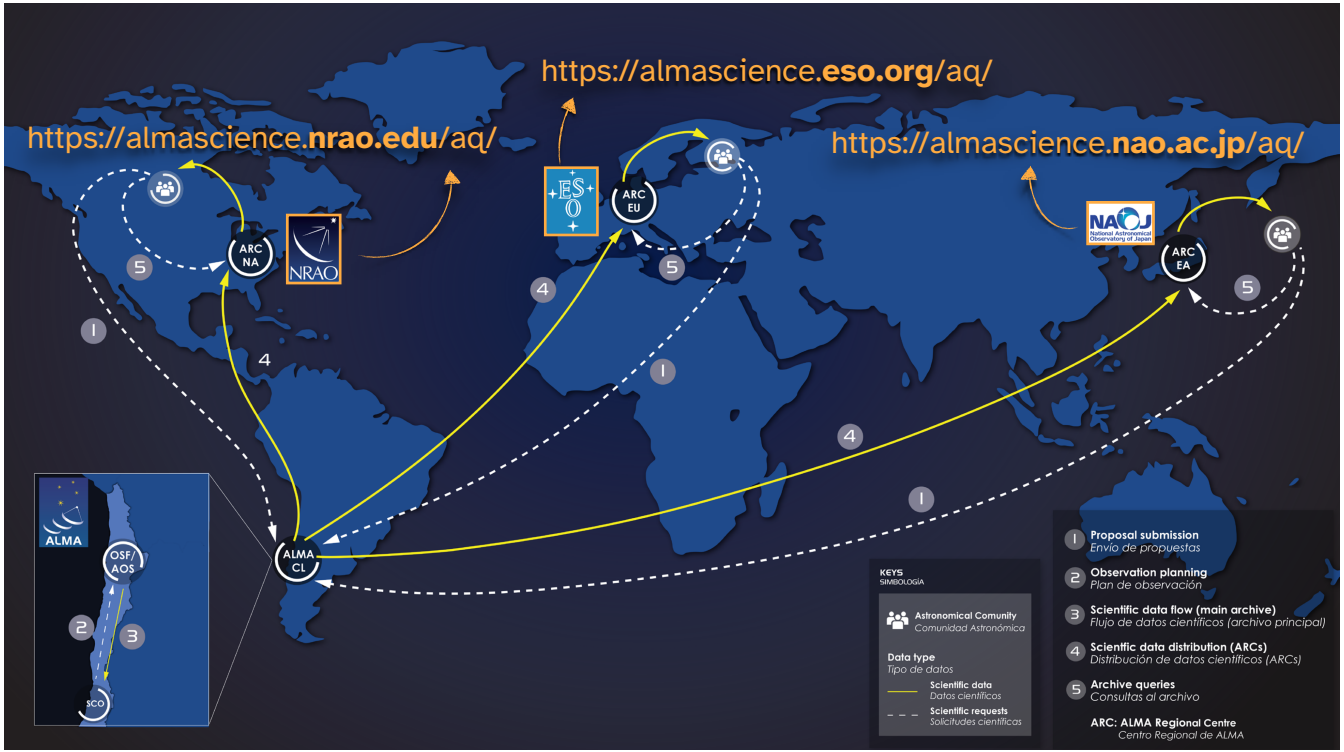
EUROPEAN ARC
ALMA Regional Centre || Allegro

The ALMA Science Archive

ASA includes:

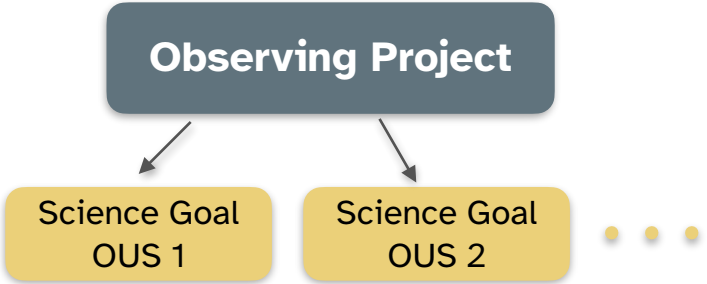
- science verification
- regular projects
- DDT projects
- large programs
- projects that use ALMA as part of VLBI
- calibrators

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



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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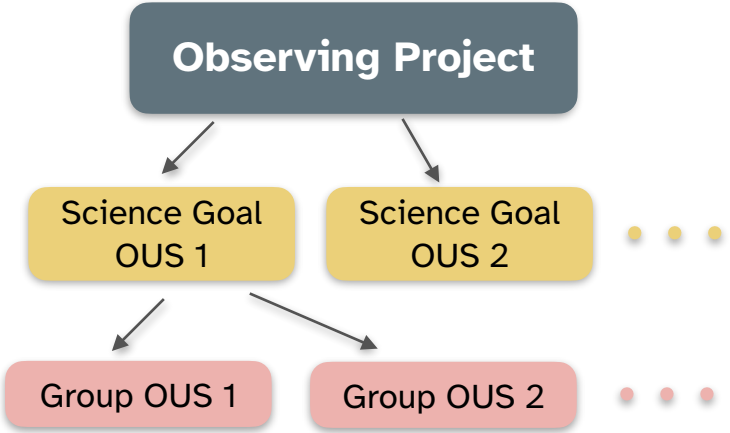

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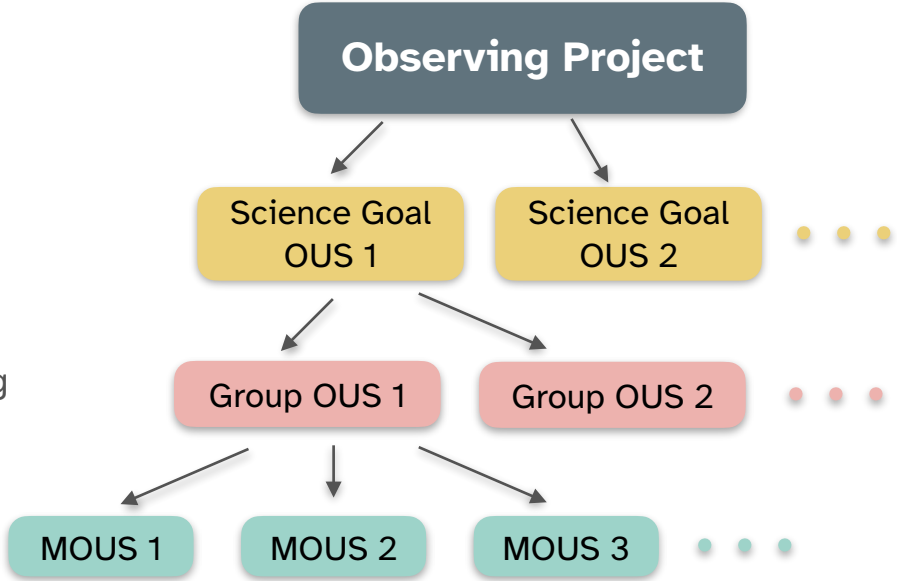

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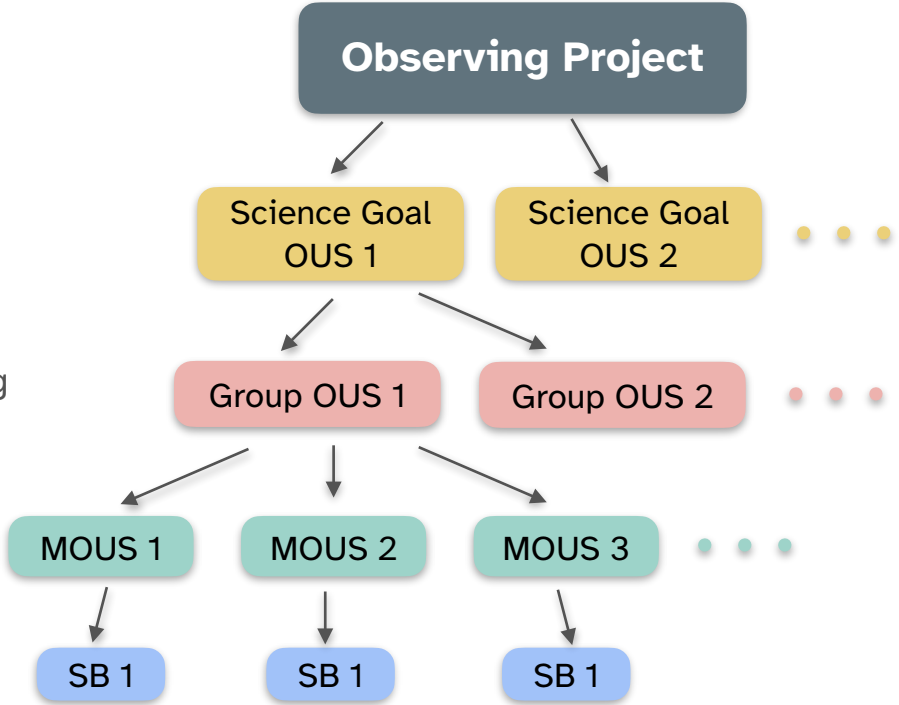

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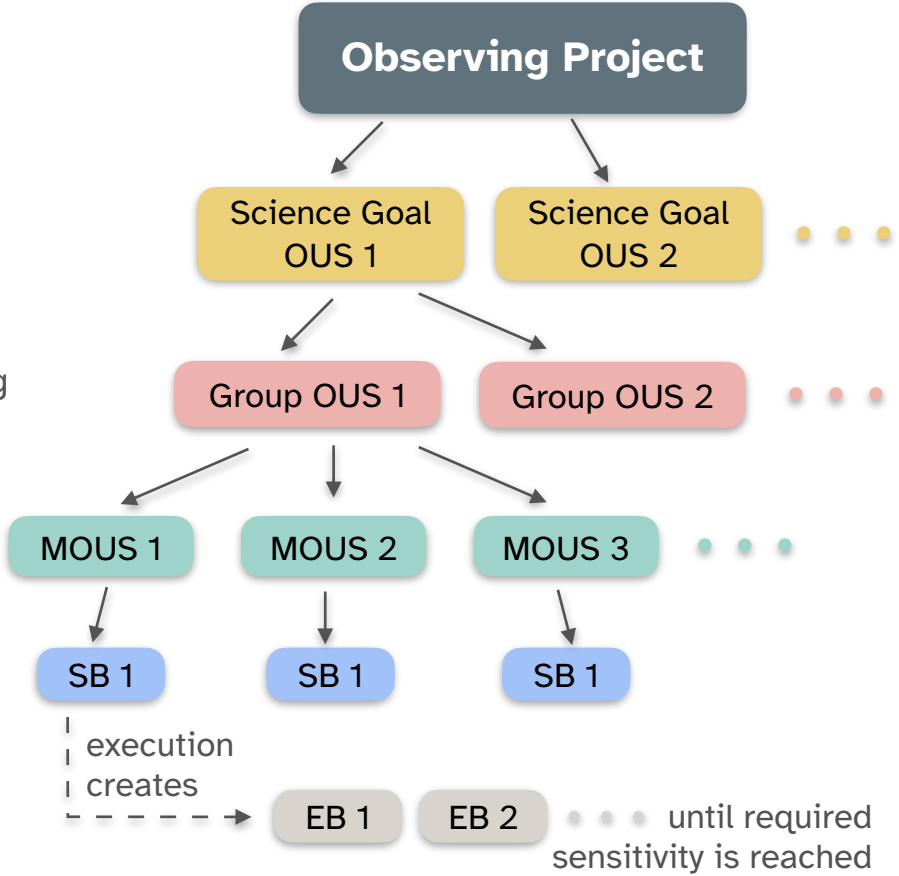
- **Execution Block (EB):** each repetition of a scheduling block (SB)



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

ALMA Data Flow

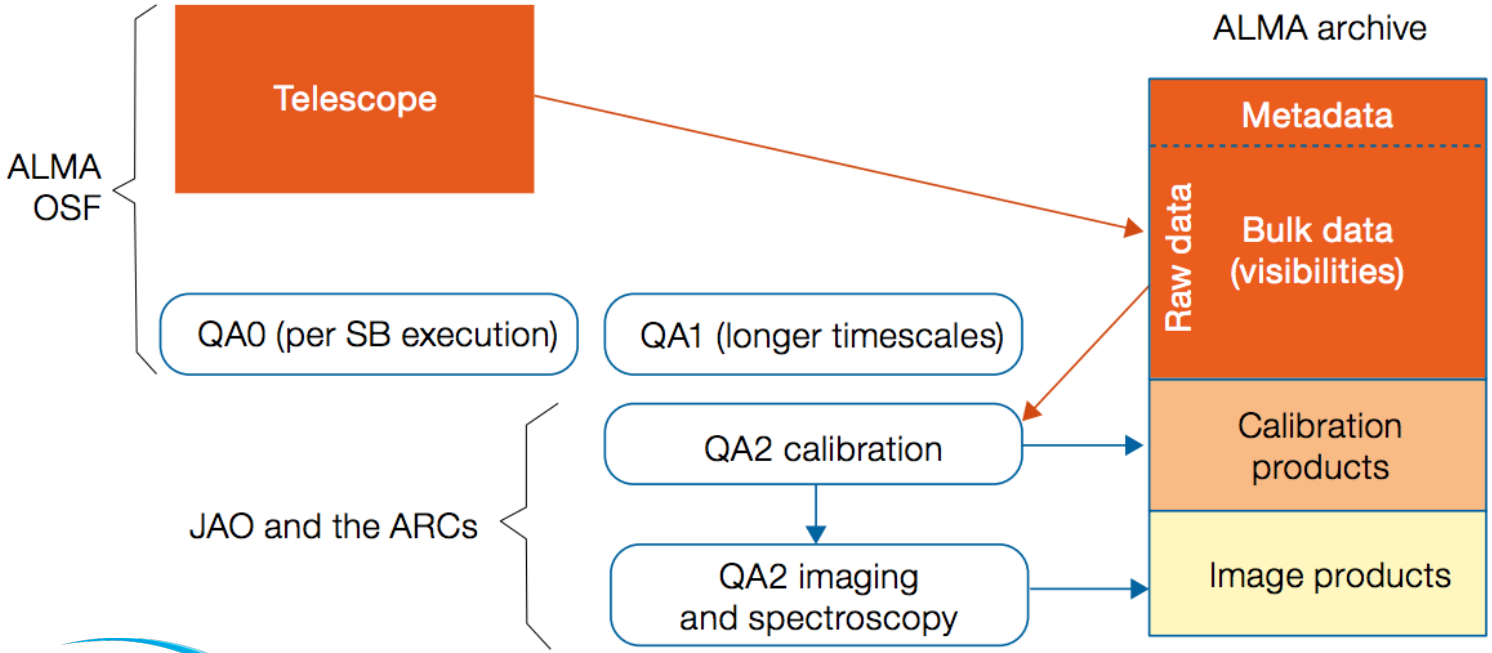
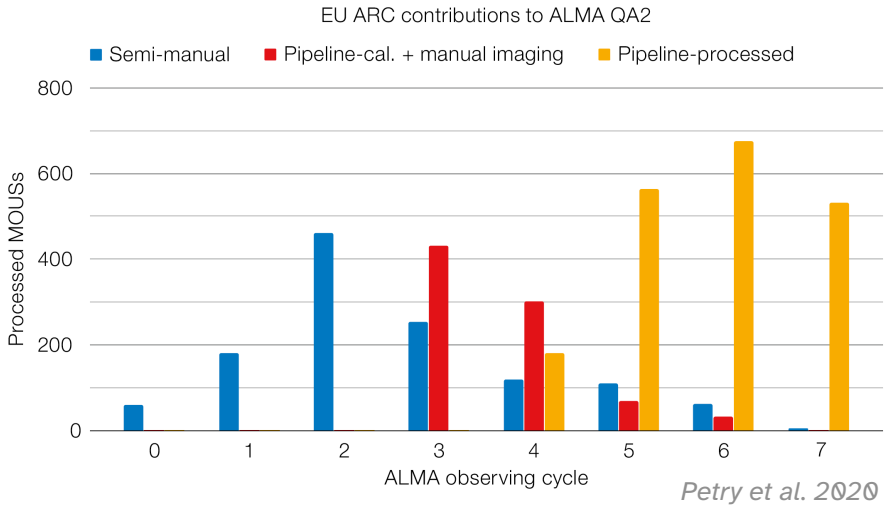


Figure from Petry et al. 2020

Pipeline processing

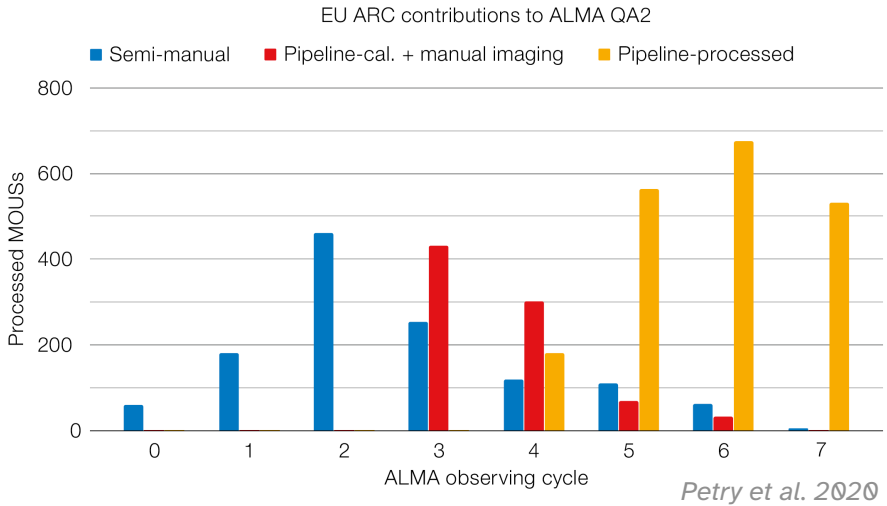
- Earlier cycles: QA2 processing exclusively done semi-manually by analysts in CASA and the Calibration Script Generator
- Since then: fully automated pipeline -> distributed with CASA releases
- Weblogs:
  - The pipeline creates a set of diagnostic plots and tables
  - reviewed manually to judge whether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

What exactly is on the archive?

- README: description of the main actions, categories, and files
- product: FITS images produced by the pipeline process (includes calibrator & target)
- auxiliary: calibration tables, logs, data quality plots, scripts
- qa: Quality Assurance files and plots -> weblog!
- raw data: ALMA Science Data Model (ASDM) files, one per EB of QA2 Pass/Semi-pass
- raw (semipass): ASDM files of QA0-Semipassed data
- external: usually imaging products

Depending on the cycle, the delivered products may vary...
Check for each cycle: https://almascience.org/processing/qa2-data-products

Data on the ALMA Science Archive

- The calibrated datasets on the archive are science-ready
- Users are strongly encouraged to re-image the calibrated datasets manually
- Not all image products are on the archive, but typically
  - continuum-subtracted image cubes at the requested resolution
  - continuum image either combining all SPWs or all line-free channels

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- **ARI-L project:** aims to increase the legacy value of the ASA by reprocessing Cycle 2-4 data to bring them close to the level of more recent cycles (Massardi et al. 2019) -> https://sites.google.com/inaf.it/ari-l/project
  - **Large Programs:** Enhanced data products https://almascience.eso.org/alma-data/lp

Let's go to the archive...

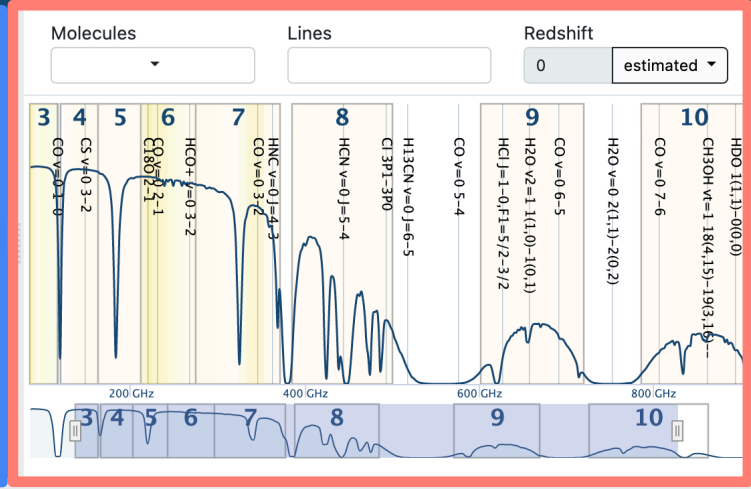
https://almascience.eso.org/aq/

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	Dec	Band	Cont. sens.	Frequency support	↑ Release date	Publications	Ang. res.	Min. vel. res.
			h:m:s	d:m:s		mJy/beam				arcsec	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

Search

Query options

Explore and download

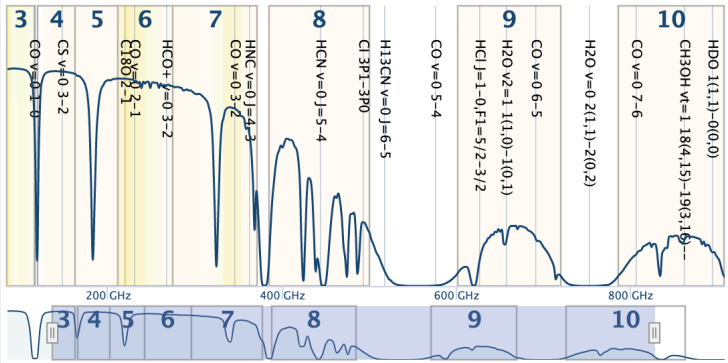
Molecules

Lines

Redshift

0

estimated



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Search

Query options

Explore and download

Position

Source name

ALMA source name

RA Dec

Galactic

Target List

Angular Resolution

Max. Recoverable Scale

Energy

Frequency

Band

Spectral resolution

Continuum sensitivity

Line sensitivity (10 km/s)

Project

Project code

Project Title

Project abstract

PI Full Name

Proposal authors

Science keyword

Publication

BibCode

Publication Title

Abstract

First Author

Authors

Observation

Observation Date

Polarisation Type

Member ous id

Object type

Public data only

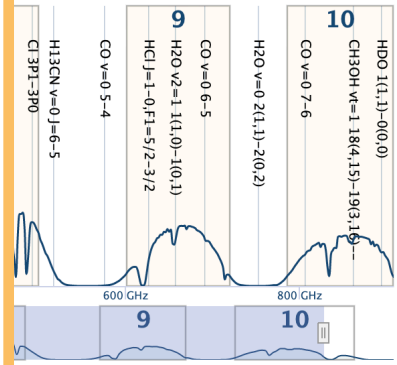
Calibration observations

allowed operators: =, <, >, .., *, ?, |

Redshift

0

estimated



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Search

Source name: Orion KL, 5 | **Frequency:** 200..300 | **Angular Resolution:** <5 | **Public data only:** true

Queried observations

Explore and download

Position

Source name: Orion KL, 5 ✓

Source resolved. See details

ALMA source name

RA Dec

Galactic

Target List

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Max. Recoverable Scale

Energy

Frequency: 200..300 ✓

Band

Spectral resolution

Continuum sensitivity

Line sensitivity (10 km/s)

Project

Project code

Project Title

Project abstract

PI Full Name

Proposal authors

Science keyword

Publication

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Abstract

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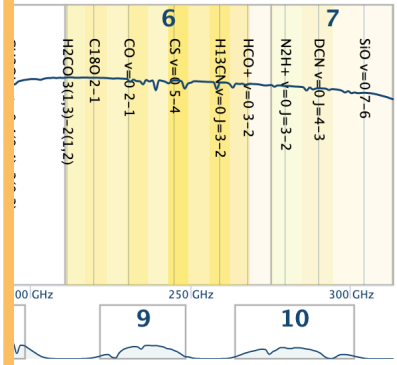

											Ang. res. arcsec	Min. vel. res. km/s
	2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2564	257.962..261.75 GHz	2021-04-28	0		4.562	0.561
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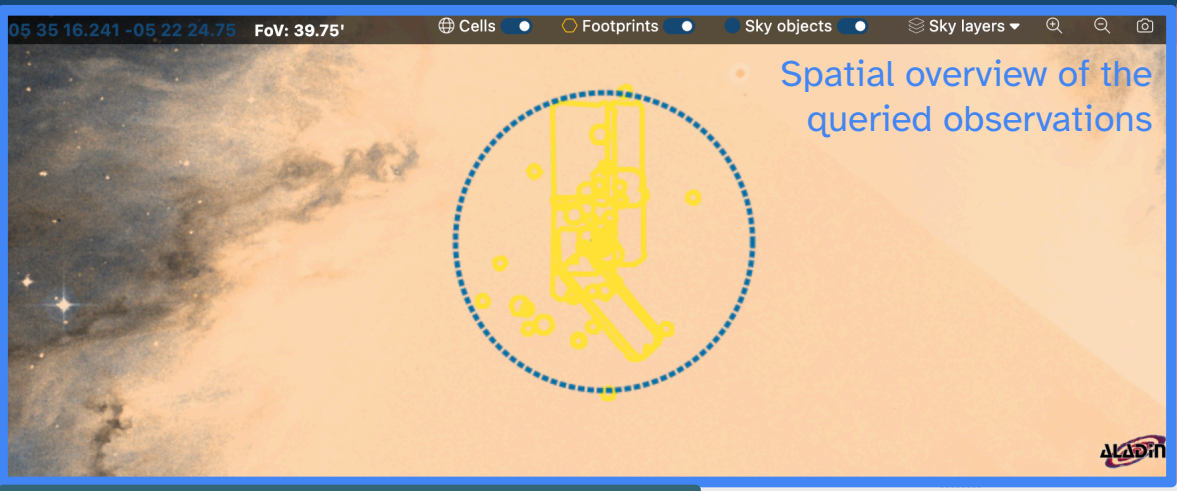

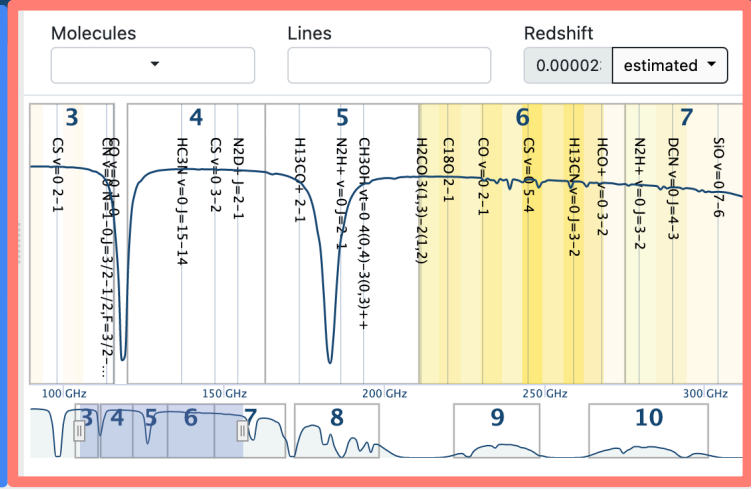

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Observations (79) | **Projects** (19) | **Publications** (60)

Queried results

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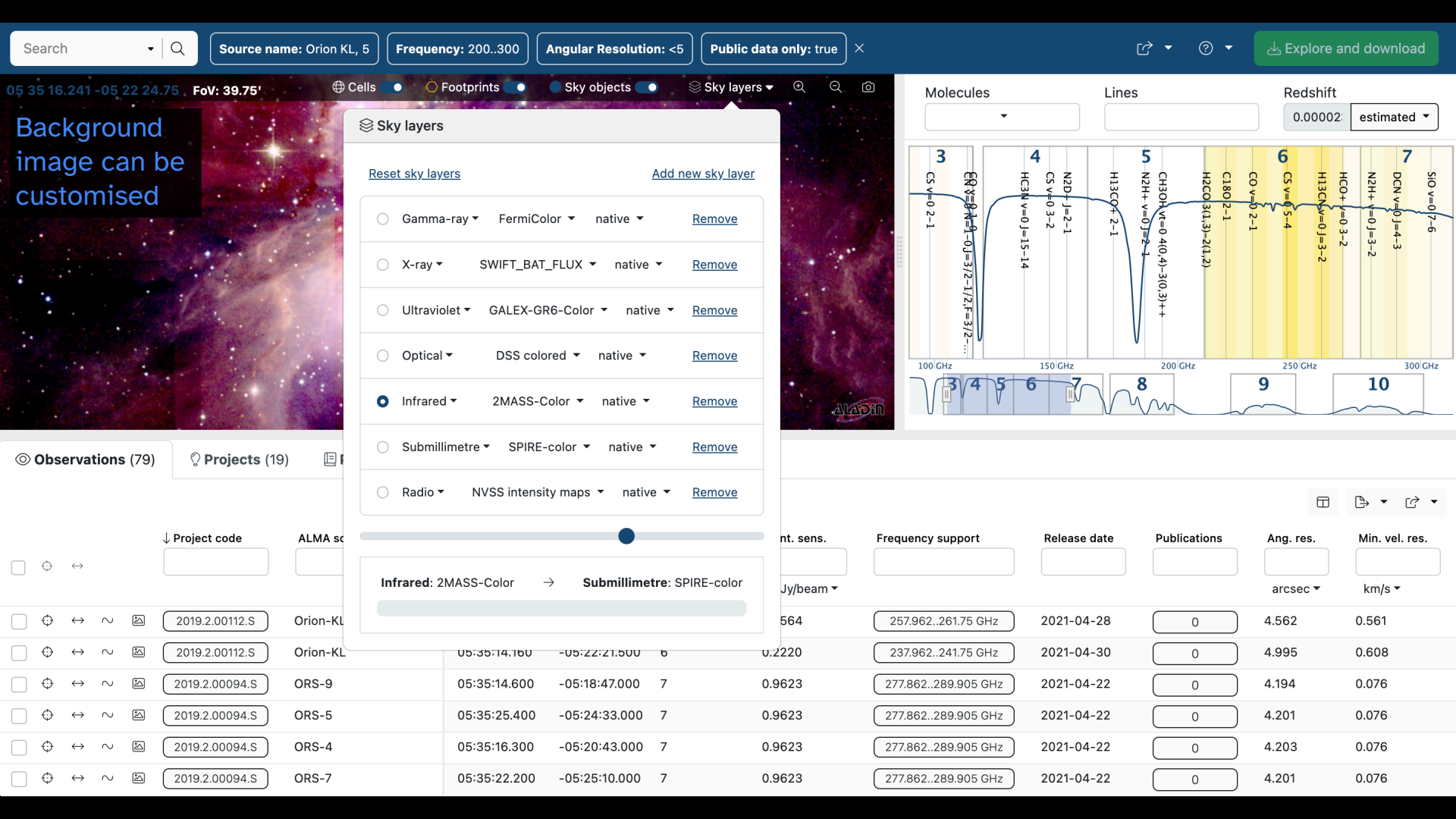
Search
Source name: Orion KL, 5
Frequency: 200..300
Angular Resolution: <5
Public data only: true
Explore and download
05 35 16.241 -05 22 24.75
FoV: 39.75'
Cells
Footprints
Sky objects
Sky layers
Background image can be customised
Sky layers
Reset sky layers
Add new sky layer
Gamma-ray FermiColor native Remove
X-ray SWIFT_BAT_FLUX native Remove
Ultraviolet GALEX-GR6-Color native Remove
Optical DSS colored native Remove
Infrared 2MASS-Color native Remove
Submillimetre SPIRE-color native Remove
Radio NVSS intensity maps native Remove
Infrared: 2MASS-Color → Submillimetre: SPIRE-color
Molecules
Lines
Redshift
0.00002
estimated
CS v=0 2-1
HC3N v=0 J=15-14
CS v=0 3-2
N2D+ J=2-1
H13CO+ 2-1
CH3OH vt=0 4(0,4)-3(0,3)++
C18O 2-1
CO v=0 2-1
CS v=0 5-4
H13CN v=0 J=3-2
HCO+ v=0 3-2
N2H+ v=0 J=3-2
DCN v=0 J=4-3
SiO v=0 7-6
100 GHz
150 GHz
200 GHz
250 GHz
300 GHz
Observations (79)
Projects (19)
Project code
ALMA sc
nt. sens.
Jy/beam
Frequency support
Release date
Publications
Ang. res.
arcsec
Min. vel. res.
km/s
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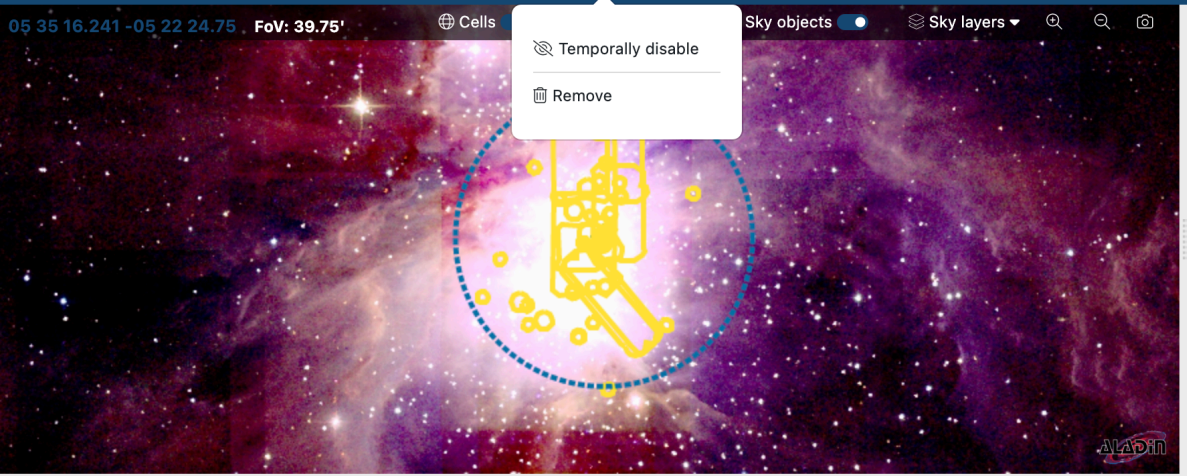
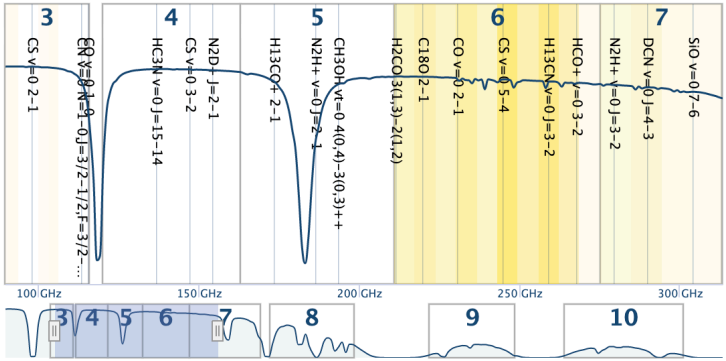


Molecules | Lines | Redshift 0.00002 estimated



Observations (79) | Projects (19) | Publications (60)

Queried observations can be further filtered below or temporarily disabled above

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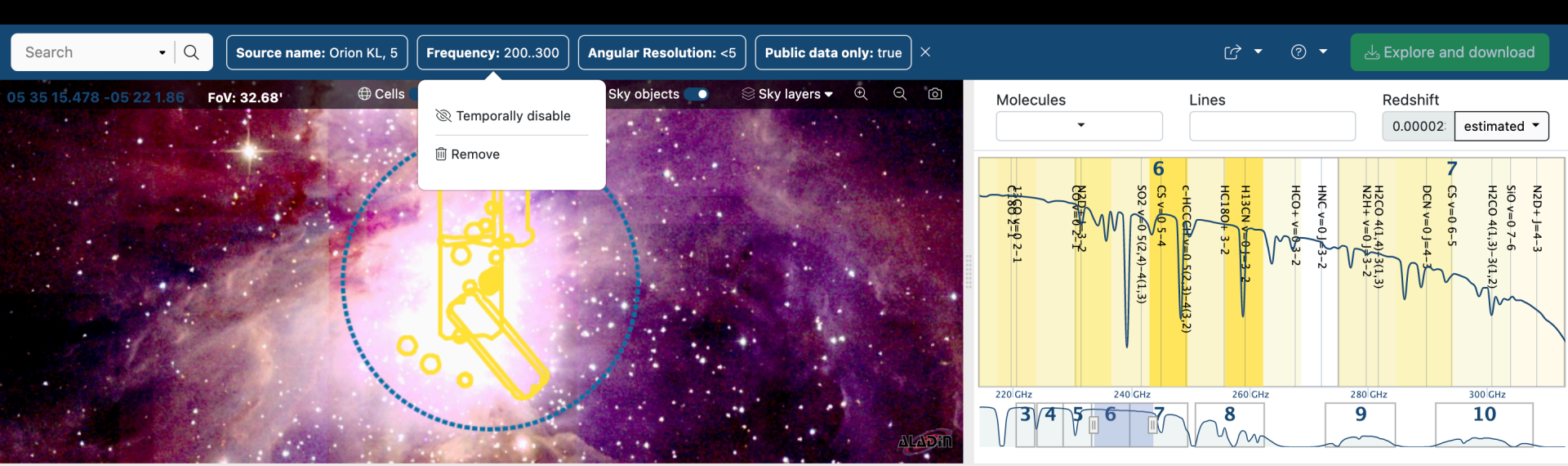
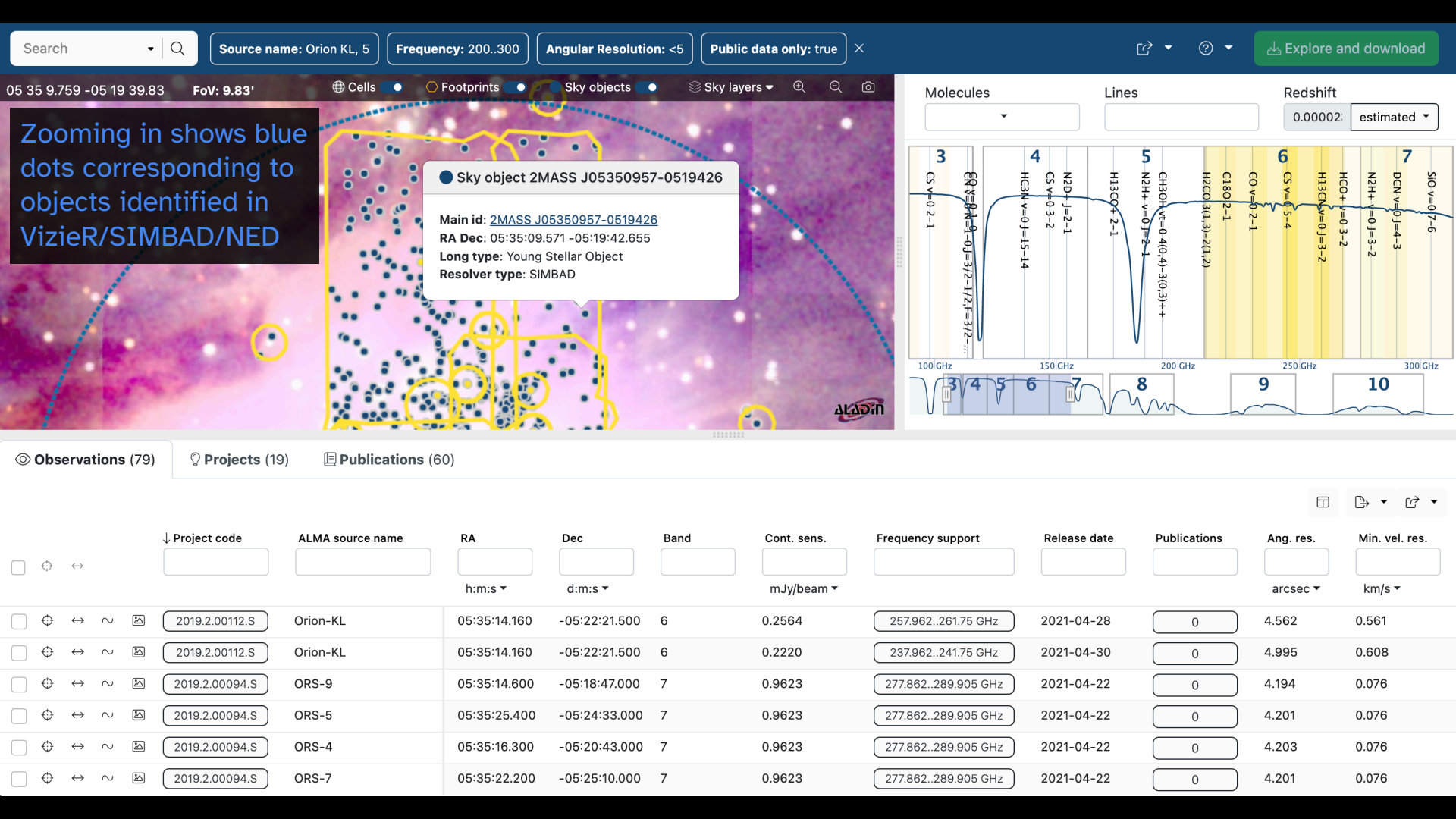


Observations (52) | **Projects (19)** | **Publications (60)**

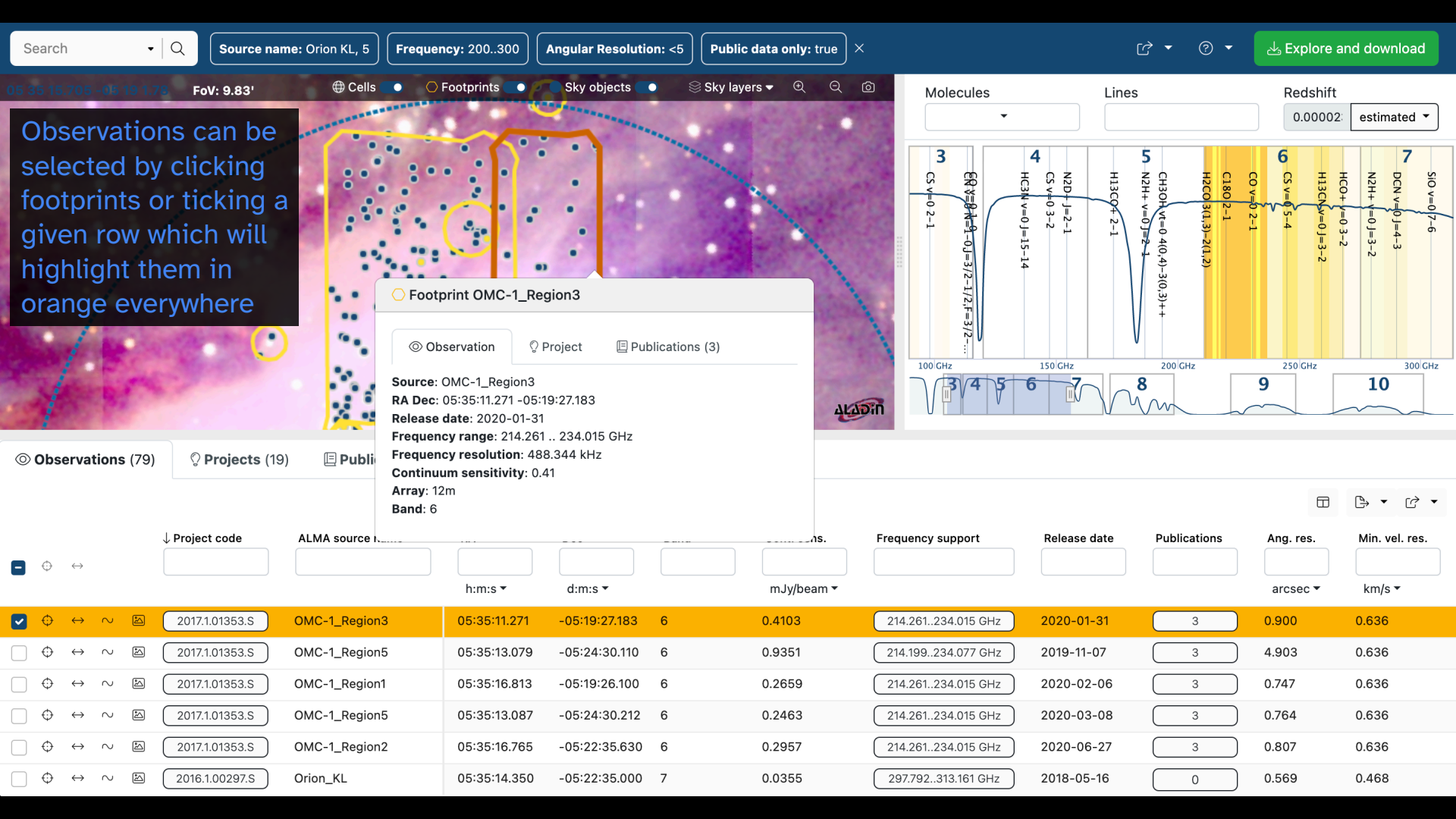
Min. vel. res.: <1

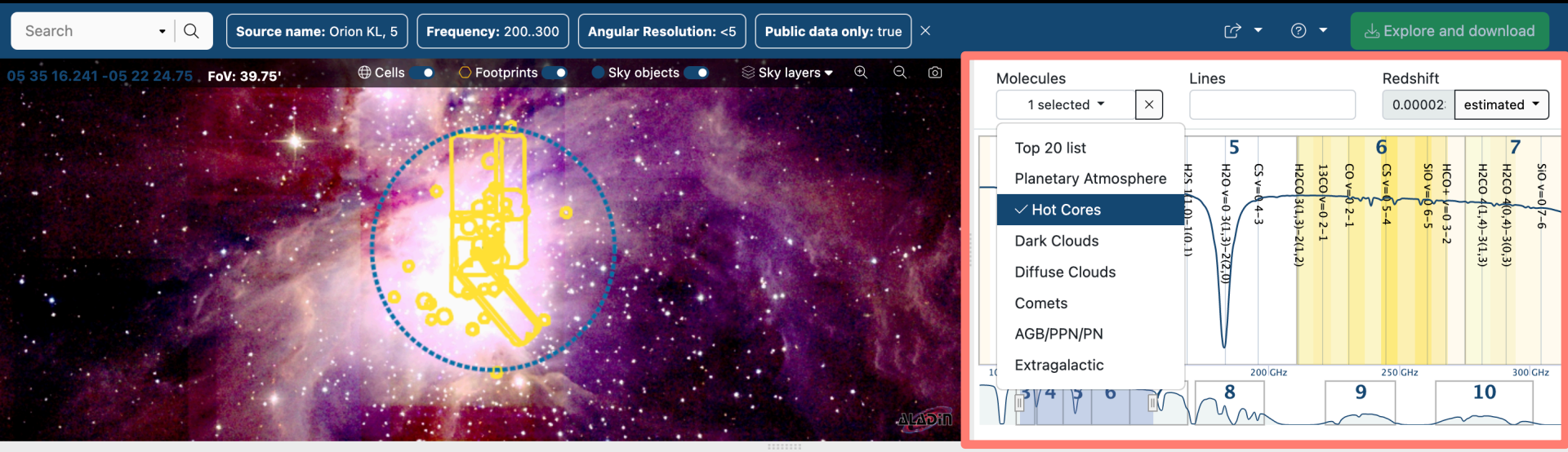
Queried observations can be further filtered below or temporarily disabled above

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)
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2564	257.962..261.75 GHz	2021-04-28	0	4.562	0.561
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2220	237.962..241.75 GHz	2021-04-30	0	4.995	0.608
2019.2.00094.S	ORS-9	05:35:14.600	-05:18:47.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.194	0.076
2019.2.00094.S	ORS-5	05:35:25.400	-05:24:33.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076
2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203	0.076
2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076



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)
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2564	257.962..261.75 GHz	2021-04-28	0	4.562	0.561
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2220	237.962..241.75 GHz	2021-04-30	0	4.995	0.608
2019.2.00094.S	ORS-9	05:35:14.600	-05:18:47.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.194	0.076
2019.2.00094.S	ORS-5	05:35:25.400	-05:24:33.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076
2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203	0.076
2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076


Search
Source name: Orion KL, 5
Frequency: 200..300
Angular Resolution: <5
Public data only: true
Explore and download
FoV: 9.83'
Cells
Footprints
Sky objects
Sky layers
Observations can be selected by clicking footprints or ticking a given row which will highlight them in orange everywhere
Molecules
Lines
Redshift
0.00002
estimated
CS v=0 2-1
HC3N v=0 J=15-14
CS v=0 3-2
N2D+ J=2-1
H13CO+ 2-1
N2H+ v=0 J=3-2
CH3OH vt=0 4(0,4)-3(0,3)++
H2CO 3(1,3)-2(1,2)
C18O 2-1
CO v=0 2-1
CS v=0 5-4
H13CN v=0 J=3-2
HCO+ v=0 3-2
N2H+ v=0 J=3-2
DCN v=0 J=4-3
SiO v=0 7-6
100 GHz
150 GHz
200 GHz
250 GHz
300 GHz
Footprint OMC-1_Region3
Observation
Project
Publications (3)
Source: OMC-1_Region3
RA Dec: 05:35:11.271 -05:19:27.183
Release date: 2020-01-31
Frequency range: 214.261 .. 234.015 GHz
Frequency resolution: 488.344 kHz
Continuum sensitivity: 0.41
Array: 12m
Band: 6
Observations (79)
Projects (19)
Project code
ALMA source
Frequency support
Release date
Publications
Ang. res.
Min. vel. res.
h:m:s
d:m:s
mJy/beam
arcsec
km/s
2017.1.01353.S OMC-1_Region3 05:35:11.271 -05:19:27.183 6 0.4103 214.261..234.015 GHz 2020-01-31 3 0.900 0.636
2017.1.01353.S OMC-1_Region5 05:35:13.079 -05:24:30.110 6 0.9351 214.199..234.077 GHz 2019-11-07 3 4.903 0.636
2017.1.01353.S OMC-1_Region1 05:35:16.813 -05:19:26.100 6 0.2659 214.261..234.015 GHz 2020-02-06 3 0.747 0.636
2017.1.01353.S OMC-1_Region5 05:35:13.087 -05:24:30.212 6 0.2463 214.261..234.015 GHz 2020-03-08 3 0.764 0.636
2017.1.01353.S OMC-1_Region2 05:35:16.765 -05:22:35.630 6 0.2957 214.261..234.015 GHz 2020-06-27 3 0.807 0.636
2016.1.00297.S Orion_KL 05:35:14.350 -05:22:35.000 7 0.0355 297.792..313.161 GHz 2018-05-16 0 0.569 0.468



Molecules can be selected from a category to be shown in the spectral overview

Observations (79) | **Projects (19)** | **Publications (60)**

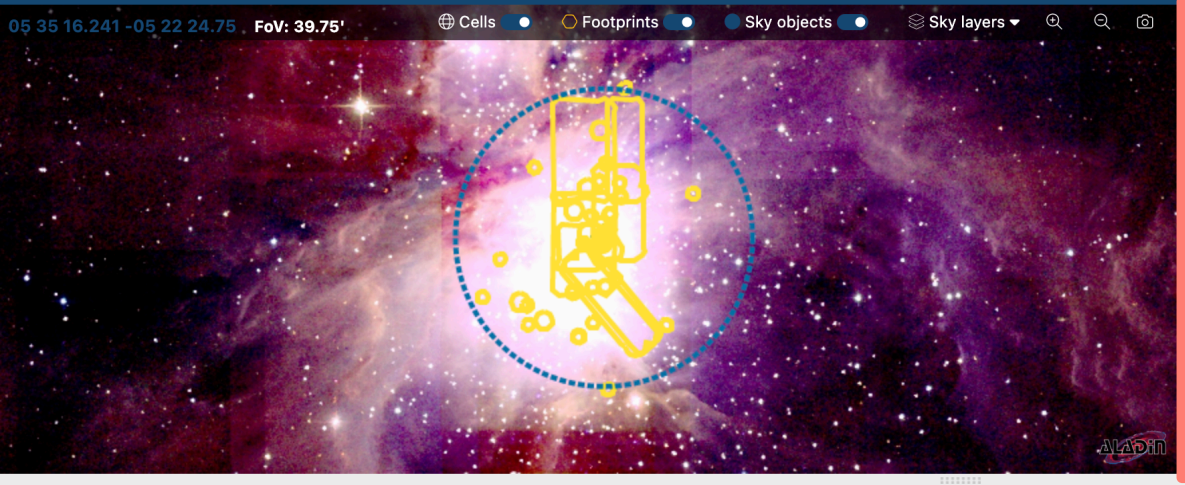
Project code	ALMA source name	RA (h:m:s)	Dec (d:m:s)	Band	Cont. sens. (mJy/beam)	Frequency support	Release date	Publications	Ang. res. (arcsec)	Min. vel. res. (km/s)
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2564	257.962..261.75 GHz	2021-04-28	0	4.562	0.561
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2220	237.962..241.75 GHz	2021-04-30	0	4.995	0.608
2019.2.00094.S	ORS-9	05:35:14.600	-05:18:47.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.194	0.076
2019.2.00094.S	ORS-5	05:35:25.400	-05:24:33.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076
2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203	0.076
2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076

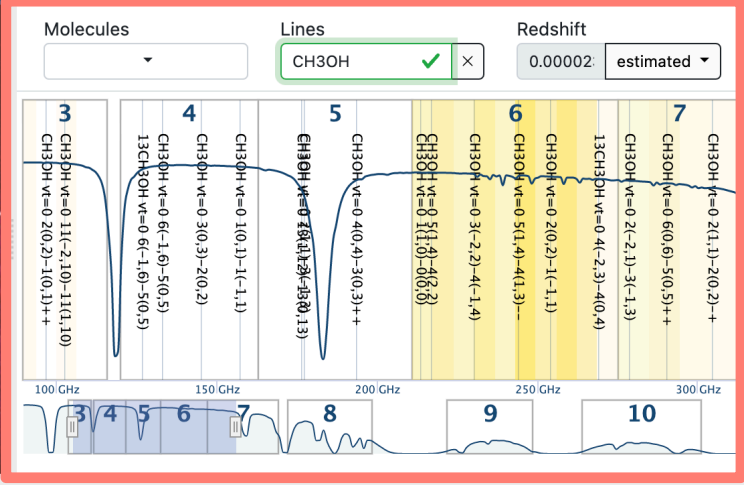
Search

Source name: Orion KL, 5 | **Frequency:** 200..300 | **Angular Resolution:** <5 | **Public data only:** true

Explore and download

05 35 16.241 -05 22 24.75 **FoV: 39.75'** Cells Footprints Sky objects Sky layers



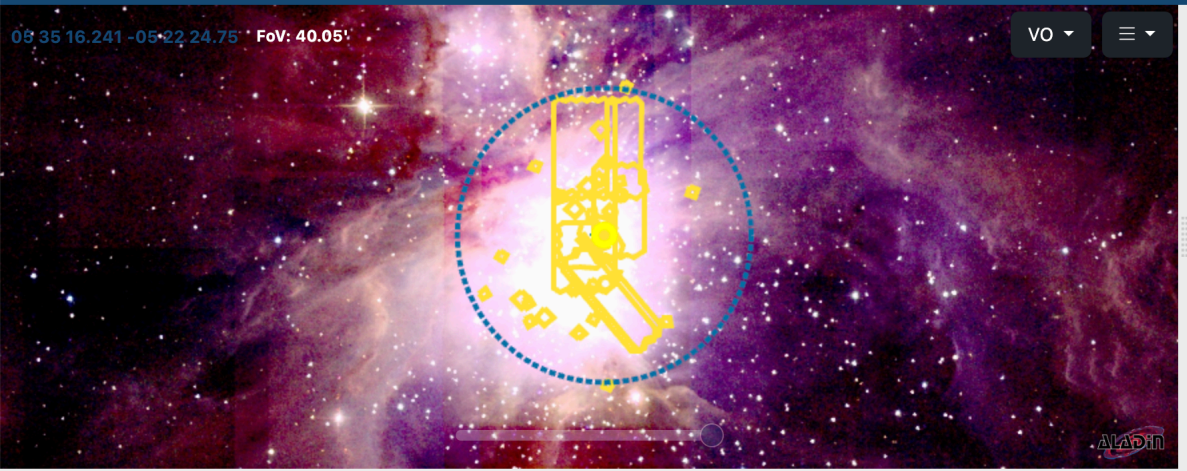


Specific molecules can be selected to be shown in the spectral overview

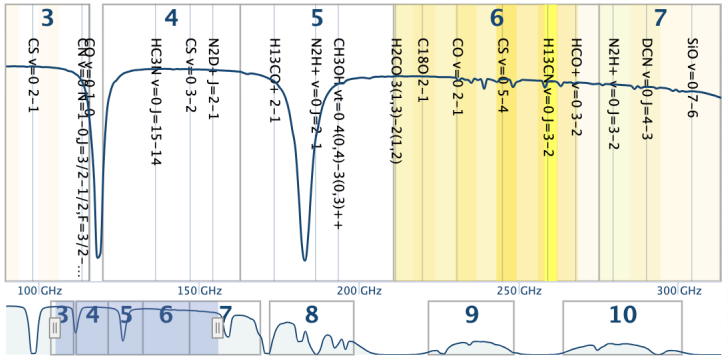
Observations (79) | **Projects** (19) | **Publications** (60)

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)
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2564	257.962..261.75 GHz	2021-04-28	0	4.562	0.561
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2220	237.962..241.75 GHz	2021-04-30	0	4.995	0.608
2019.2.00094.S	ORS-9	05:35:14.600	-05:18:47.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.194	0.076
2019.2.00094.S	ORS-5	05:35:25.400	-05:24:33.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076
2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203	0.076
2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076

Search | Angular Resolution: <5 | Frequency: 200..300 | Public data only: true | Source name: Orion KL, 5 | Remove filters | Explore and download



Molecules | Lines | Redshift 0.000023 estimated



Observations (80) | Projects (19) | Publications (66)

Publications

BibCode	Author	Journal	Year	Title
2023A&A...678A.137C	Chen, Y.	A&A	2023	CoCCoA: Complex Chemistry in hot Cores with ALMA. Selected oxygen-bearing species

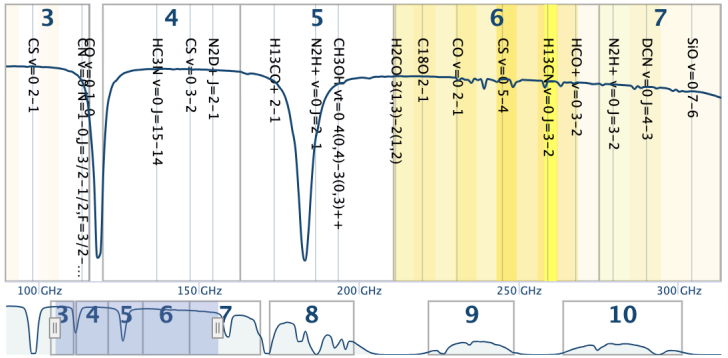
Publications linked to ADS

Project code	ALMA source name						Publications	Ang.res. arcsec
2019.2.00112.S	Orion-KL						1	4.562
2019.2.00112.S	Orion-KL						1	4.995
2019.2.00094.S	ORS-9						0	4.194
2019.2.00094.S	ORS-5						0	4.201
2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203
2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201
2019.2.00094.S	ORS-8	05:35:18.100	-05:21:29.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203

Search | **Source name:** Orion KL, 5 | **Frequency:** 200..300 | **Angular Resolution:** <5 | **Public data only:** true | Remove filters | Explore and download

08 35 16.241 -05 22 24.75 FoV: 40.05' VO

Molecules | Lines | Redshift | manual



Text-based similarity for Orion-KL

Projects | Publications

Project code	Title	Abstract
2019.2.00112.S	Moving Past Small Number Statistics in Astrochemistry: An ACA Molecular Survey of 25 Hot Cores	Studies of chemical evolution have traditionally focused on a small number of exceptionally molecularly rich and bright sources due to the historical difficulty in detecting complex interstellar molecules. This small sample size biases our understanding of 'standard' chemical evolution, and prevents calibration of chemical models to standard conditions. Single-dish surveys that have attempted to address this issue by surveying substantially larger sample sizes have suffered from extreme beam dilution, due to the very small angular size of typical chemically rich hot cores. Here, we propose to exploit both the sensitivity and spatial resolution of ALMA to conduct a distance-limited survey of twenty five hot core sources. We target several spectral windows designed to provide the maximal scientific return, and will use the results to calibrate several of the industry-standard models and identify critical areas in which these models need refinement. These ACA observations complement an approved Cycle 7 12-m array for an identical set of sources and spectral coverage.

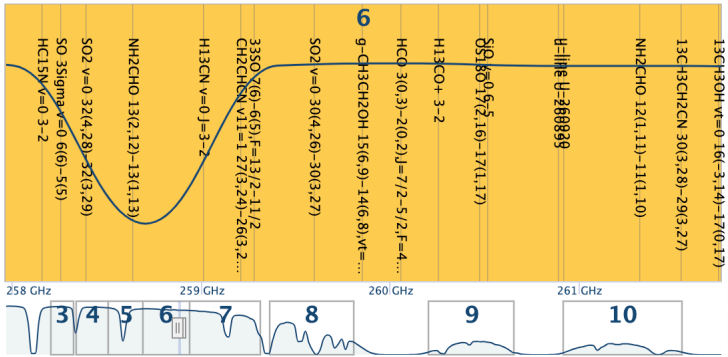
Click to find similar projects

Observations

						mJy/beam	Frequency support	Release date	Publications	Ang.res. arcsec
							257.962..261.75 GHz	2021-04-28	1	4.562
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2220		237.962..241.75 GHz	2021-04-30	1	4.995
2019.2.00094.S	ORS-9	05:35:14.600	-05:18:47.000	7	0.9623		277.862..289.905 GHz	2021-04-22	0	4.194
2019.2.00094.S	ORS-5	05:35:25.400	-05:24:33.000	7	0.9623		277.862..289.905 GHz	2021-04-22	0	4.201
2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623		277.862..289.905 GHz	2021-04-22	0	4.203
2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623		277.862..289.905 GHz	2021-04-22	0	4.201
2019.2.00094.S	ORS-8	05:35:18.100	-05:21:29.000	7	0.9623		277.862..289.905 GHz	2021-04-22	0	4.203

Search | Angular Resolution: <5 | Frequency: 200..300 | Public data only: true | Source name: Orion KL, 5 | Remove filters | Explore and download

Molecules | Lines | Redshift 0.000023 estimated



Observations (80) | Projects (19) | Publications (66)

Center spectral coverage viewer on frequency coverage of the selected observations

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
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2564	257.962..261.75 GHz	2021-04-28	1	4.562
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2220	237.962..241.75 GHz	2021-04-30	1	4.995
2019.2.00094.S	ORS-9	05:35:14.600	-05:18:47.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.194
2019.2.00094.S	ORS-5	05:35:25.400	-05:24:33.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201
2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203
2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201
2019.2.00094.S	ORS-8	05:35:18.100	-05:21:29.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203

Search

Explore and download

05 35 16.241 -05 22 2

Lines

Redshift

0.00002

estimated

Previews for Orion-KL

Preview of data products

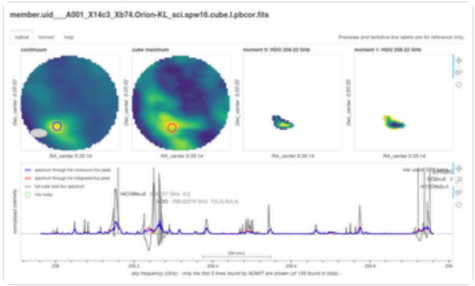
Explore and download

ALMA

README QA2 report Weblog

interactive preview

SPW 0: 257.962..258.961GHz, 488.281 kHz, XX YY

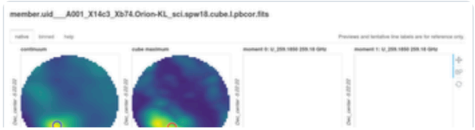


member.uid___A001_X14c3_Xb74.Orion-KL_sci.spw16.cube.I.pbcor.fits 127 MB

Band: 6
Frequency type: line
Frequency range: 257.962..258.961
Frequency resolution: 488.281 kHz
Continuum sensitivity: 0.256
Line sensitivity 10km/s (estimate): 5.694 mJy/beam@10km/s
Line sensitivity native (estimate): 0.529 uJy/beam@native
Polaritazions: XX YY
Array: 7m

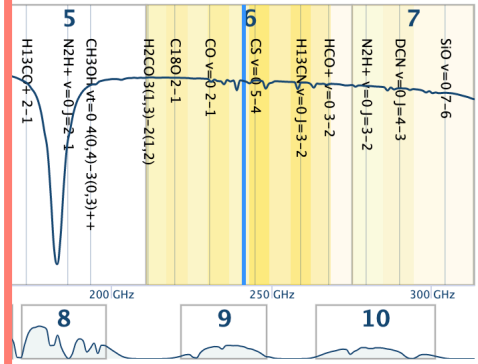
open in CARTA

SPW 1: 258.891..259.891GHz, 488.281 kHz, XX YY



member.uid___A001_X14c3_Xb74.Orion-KL_sci.spw18.cube.I.pbcor.fits 127 MB

Band: 6
Frequency type: line
Frequency range: 258.891..259.891
Frequency resolution: 488.281 kHz
Continuum sensitivity: 0.256



Observations (79)

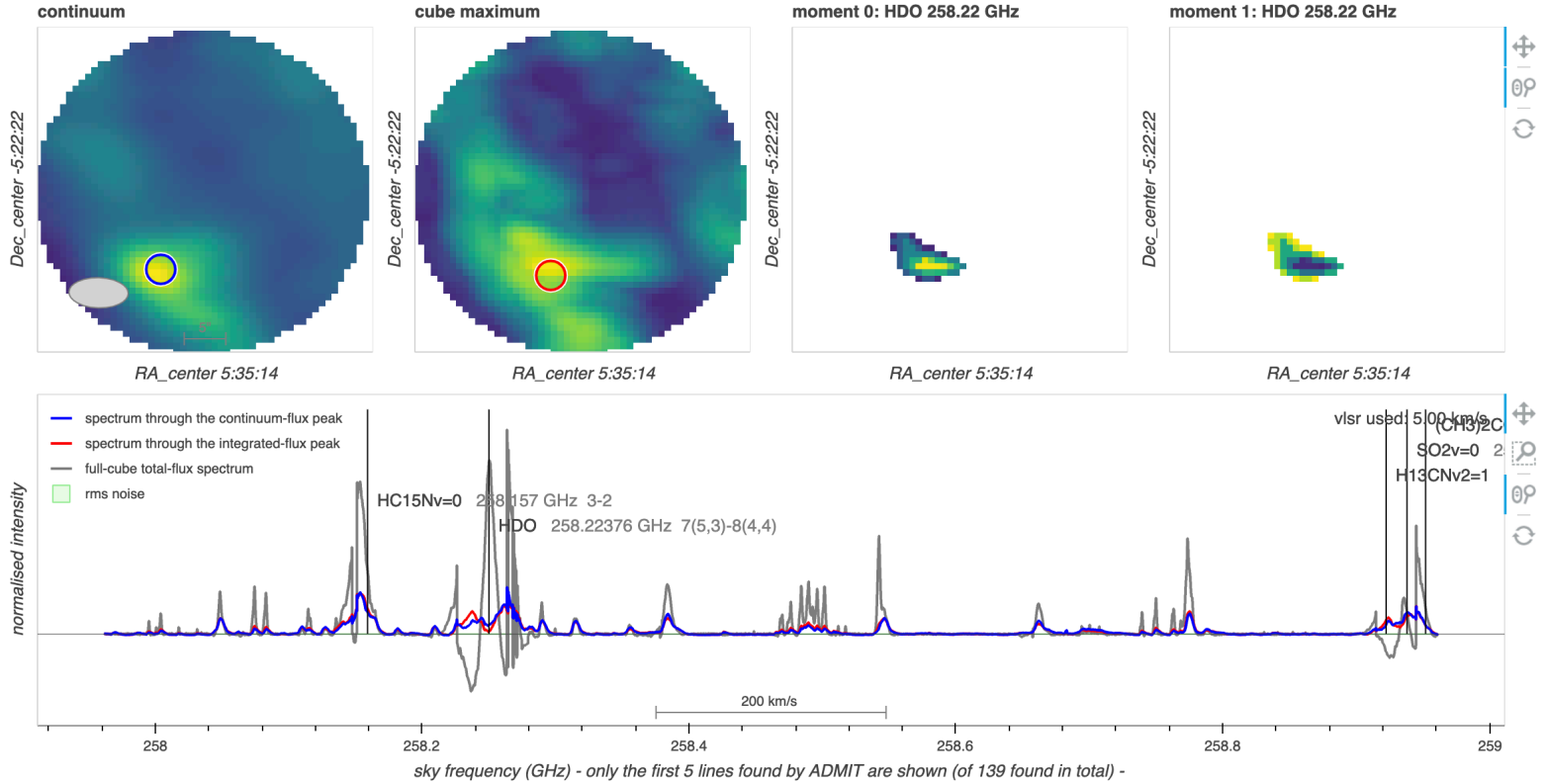
									Publications	Ang. res. arcsec	Min. vel. res. km/s
								8	0	4.562	0.561
	2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2220	237.962..241.75 GHz	2021-04-30	0	4.995	0.608
	2019.2.00094.S	ORS-9	05:35:14.600	-05:18:47.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.194	0.076
	2019.2.00094.S	ORS-5	05:35:25.400	-05:24:33.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076
	2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203	0.076
	2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076

member.uid___A001_X14c3_Xb74.Orion-KL_sci.spw16.cube.I.pbcor.fits

interactive preview example

native | binned | help

Previews and tentative line labels are for reference only.

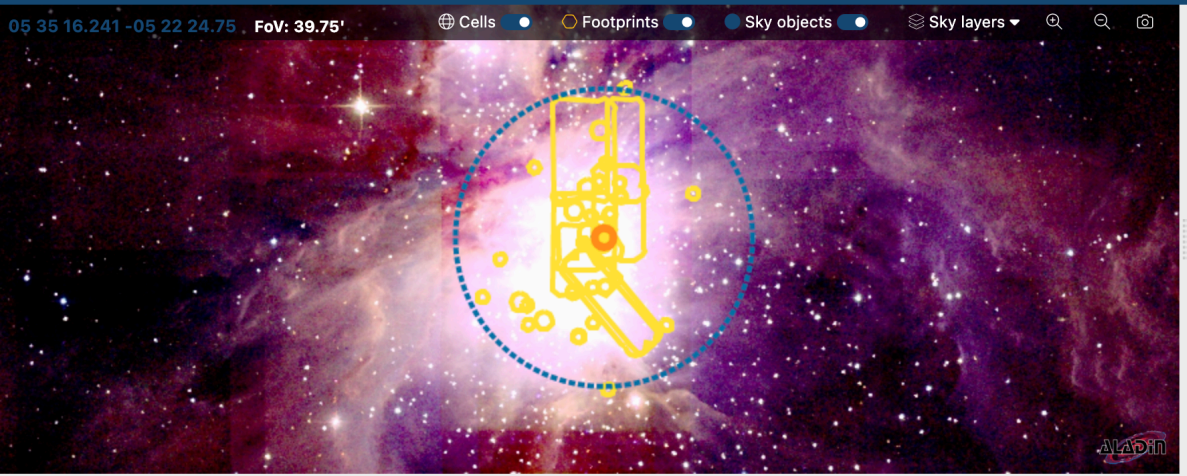


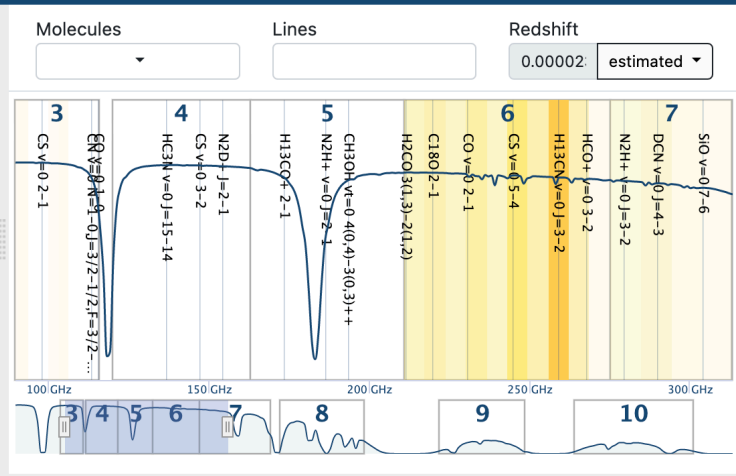
Search

Angular Resolution: <5 | **Frequency:** 200..300 | **Public data only:** true | **Source name:** Orion KL, 5

Data preview & download

Explore and download





Observations (79) | **Projects** (19) | **Publications** (60)

Project code	ALMA source name	RA	Dec	Band	Cont. sens.	Frequency support	Release date	Publications	Ang. res.	Min. vel. res.
		h:m:s	d:m:s		mJy/beam				arcsec	km/s
2019.2.00112.S	Orion-KL	05:35:14.160	-05:22:21.500	6	0.2564	257.962..261.75 GHz	2021-04-28	0	4.562	0.561
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2019.2.00094.S	ORS-4	05:35:16.300	-05:20:43.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203	0.076
2019.2.00094.S	ORS-5	05:35:25.400	-05:24:33.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076
2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201	0.076

Search | Frequency: 200..300 | Source name: Orion KL, 5 | Public data only: true | Remove filters | 1 column filter active | Explore and download

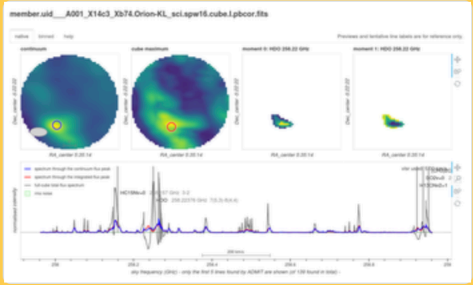
Download 610 MB | Open legacy Request Handler

New data download interface (under rapid development)

Login

- Project (1)
- Group ObsUniSet (1)
- Member ObsUniSet (1)
- Source (1)
- Collection (1)
- Array (1)
- File type (8)
- File class (11)

Name		Size	Project	G
member.uid___A001_X14c3_Xb74.hifa_calimage.casa_commands.log	(auxiliary, script)	202 kB	2019.2.00112.S	uid
member.uid___A001_X14c3_Xb74.session_1.caltables.tgz	(auxiliary, calibration)	13 MB	2019.2.00112.S	uid
member.uid___A001_X14c3_Xb74.Orion-KL_sci.spw16.cube.I.pbcor.fits	(product)	127 MB	2019.2.00112.S	uid



Band: 6
Frequency range: 257.962..258.961
Frequency resolution: 488.281 kHz
Line sens. (10km/s): 5.694mJy/beam
Line sens. (native): 0.529uJy/beam
Polaritazions: XX YY
Array: 7m

member.uid___A001_X14c3_Xb74.Orion-KL_sci.spw16_18_20_22.cont.I.pbcor.fits	(product)	45 kB	2019.2.00112.S	uid

Band: 6
Array: 7m

2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201
2019.2.00094.S	ORS-8	05:35:18.100	-05:21:29.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203

Search | Frequency: 200..300 | Source name: Orion KL, 5 | Public data only: true | Remove filters | 1 column filter active | Explore and download

Download 506 MB | Open legacy Request Handler

Select what type of data you are interested in downloading

Login

Group ObsUniSet (1)

Member ObsUniSet (1)

Source (1)

Collection (1)

Array (1)

File type (3)

search for file type

- application/x-gzip 9
- image/x-fits 9
- application/tar 2

File class (1)

- science 9

Name		Size	Project	G
member.uid___A001_X14c3_Xb68.Orion-KL_sci.spw20.mfs.l.pbcor.fits	(product)	45 kB	2019.2.00112.S	uid

Band: 6
Frequency range: 239.821..240.821
Frequency resolution: 488.281 kHz
Line sens. (10km/s): 4.926mJy/beam
Line sens. (native): 0.441uJy/beam
Polaritazions: XX YY
Array: 7m

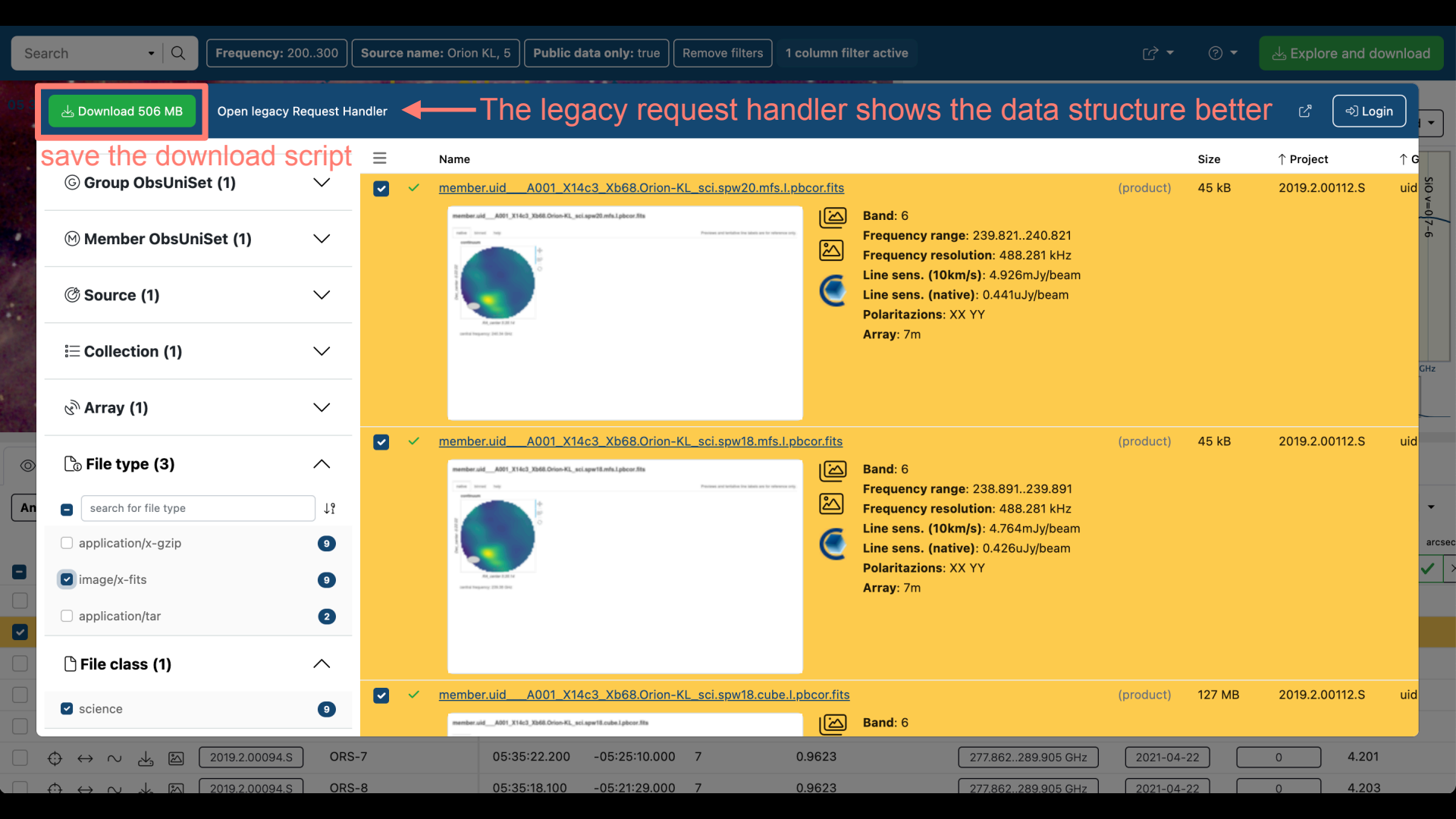
member.uid___A001_X14c3_Xb68.Orion-KL_sci.spw18.mfs.l.pbcor.fits	(product)	45 kB	2019.2.00112.S	uid

Band: 6
Frequency range: 238.891..239.891
Frequency resolution: 488.281 kHz
Line sens. (10km/s): 4.764mJy/beam
Line sens. (native): 0.426uJy/beam
Polaritazions: XX YY
Array: 7m

member.uid___A001_X14c3_Xb68.Orion-KL_sci.spw18.cube.l.pbcor.fits	(product)	127 MB	2019.2.00112.S	uid

Band: 6

2019.2.00094.S	ORS-7	05:35:22.200	-05:25:10.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.201
2019.2.00094.S	ORS-8	05:35:18.100	-05:21:29.000	7	0.9623	277.862..289.905 GHz	2021-04-22	0	4.203


Search
Frequency: 200..300
Source name: Orion KL, 5
Public data only: true
Remove filters
1 column filter active
Explore and download
Download 506 MB
Open legacy Request Handler
The legacy request handler shows the data structure better
Login
save the download script
Group ObsUniSet (1)
Member ObsUniSet (1)
Source (1)
Collection (1)
Array (1)
File type (3)
search for file type
application/x-gzip 9
image/x-fits 9
application/tar 2
File class (1)
science 9
Name
Size
Project
member.uid___A001_X14c3_Xb68.Orion-KL_sci.spw20.mfs.I.pbcor.fits
(product)
45 kB
2019.2.00112.S
Band: 6
Frequency range: 239.821..240.821
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Line sens. (10km/s): 4.926mJy/beam
Line sens. (native): 0.441uJy/beam
Polaritazions: XX YY
Array: 7m
member.uid___A001_X14c3_Xb68.Orion-KL_sci.spw18.mfs.I.pbcor.fits
(product)
45 kB
2019.2.00112.S
Band: 6
Frequency range: 238.891..239.891
Frequency resolution: 488.281 kHz
Line sens. (10km/s): 4.764mJy/beam
Line sens. (native): 0.426uJy/beam
Polaritazions: XX YY
Array: 7m
member.uid___A001_X14c3_Xb68.Orion-KL_sci.spw18.cube.I.pbcor.fits
(product)
127 MB
2019.2.00112.S
Band: 6
2019.2.00094.S ORS-7 05:35:22.200 -05:25:10.000 7 0.9623 277.862..289.905 GHz 2021-04-22 0 4.201
2019.2.00094.S ORS-8 05:35:18.100 -05:21:29.000 7 0.9623 277.862..289.905 GHz 2021-04-22 0 4.203

ALMA Request Handler

Login

Anonymous User: Request #2166926188317

Request Title: click to edit

Legacy download interface

Need to select readme+auxiliary+raw to be able to run pipeline calibration/imaging

Download Selected

readme product auxiliary raw raw (semipass) external

Project / OUSet / Executionblock	Updated	File	Size	Accessible	Actions
Request 2166926188317			9 GB		
Project 2019.2.00112.S					
Science Goal OUS uid://A001/X14c3/Xb66					
Group OUS uid://A001/X14c3/Xb67					
Member OUS uid://A001/X14c3/Xb68	2020-01-30				
SB Orion-KL_a_06_7M					
readme		member.uid___A001_X14c3_Xb68.README.txt	4 kB	✓	
product		2019.2.00112.S_uid___A001_X14c3_Xb68_001_of_001.tar	539 MB	✓	
auxiliary		2019.2.00112.S_uid___A001_X14c3_Xb68_auxiliary.tar	104 MB	✓	
raw		2019.2.00112.S_uid___A002_Xe64b7b_X288f.asdm.sdm.tar	4 GB	✓	
Member OUS uid://A001/X14c3/Xb6a	2021-10-14				
SB Orion-KL_a_06_TP					
readme		member.uid___A001_X14c3_Xb6a.README.txt	4 kB	✓	
auxiliary		2019.2.00112.S_uid___A001_X14c3_Xb6a_auxiliary.tar	864 kB	✓	
raw (semipass)		2019.2.00112.S_uid___A002_Xe5808e_Xda6b.asdm.sdm.tar	2 GB	✓	
raw (semipass)		2019.2.00112.S_uid___A002_Xe59f51_X21a0.asdm.sdm.tar	2 GB	✓	

ALMA Request Handler

Login

Anonymous User: Request #1658068127545

Request Title: click to edit

Download Selected

readme product auxiliary raw raw (semipass) external

Project / OUSet / Executionblock	Updated		Size	Accessible	Actions
Request 1658068127545			10 GB		
Project 2019.2.00112.S					
Science Goal OUS uid://A001/X14c3/Xb72					
Group OUS uid://A001/X14c3/Xb73					
Member OUS uid://A001/X14c3/Xb74	2020-01-24				
SB Orion-KL_b_06_7M					
readme		me	4 kB	✓	
product		20	538 MB	✓	
auxiliary		20	102 MB	✓	
raw		20	4 GB	✓	
Member OUS uid://A001/X14c3/Xb76	2020-03-24				
SB Orion-KL_b_06_TP					
readme		me	4 kB	✓	
product		20	71 MB	✓	
auxiliary		20	445 MB	✓	
raw		2019.2.00112.S_uid___A002_Xe539c7_X15bb8.asdm.sdm.tar	2 GB	✓	
raw		2019.2.00112.S_uid___A002_Xe5808e_Xc6ea.asdm.sdm.tar	2 GB	✓	
raw (semipass)		2019.2.00112.S_uid___A002_Xe5731a_X437a.asdm.sdm.tar	945 MB	✓	

Choose one of the following download methods:

Download Script

The downloads are scripted for you. You just need to execute the script from the command line, after making it executable by typing `chmod u+x download*.sh`

Java Download Manager

ALMA's download manager had to be discontinued due to changes in java. Please use one of the other options instead.

File List

View a text file containing a list of URLs. This is useful for using third-party download manager's such as *DownThemAll*.

ALMA Data Products

- The downloaded and unpacked data fall into a standardized directory structure

```
project_id/
└─ science_goal_ouss_id/
   └─ group_ouss_id/
      └─ member_ouss_id/
         ├─ README ..... summary of directory contents (READ FIRST!)
         ├─ product/ ..... imaging data products in FITS format
         ├─ calibration/ ..... calibration & flagging tables
         ├─ qa/ ..... pipeline weblog + QA0 & QA2 reports
         ├─ script/ ..... calibration & imaging scripts
         ├─ log/ ..... CASA log files from QA2 processing
         └─ raw/ ..... raw data in ASDM format - must be downloaded & unpacked
```

- Note: depending on the cycle, the delivered products may vary...

  Check for each cycle: https://almascience.org/processing/qa2-data-products

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

Check data quality

- Assess data quality through the weblog created by the pipeline
- The weblog resides in the qa folder as a tar file that must be unpacked

```
member_ouss_id/
    README
    product/
    calibration/
    qa/
        *.qa2_report.{pdf,html}
        *.weblog.tgz
    script/
    log/
    raw/
```

❶ Go into the `qa` folder
❷ unpack the *.weblog.tgz file
`> tar -xvzf *.weblog.tgz`
❸ Go inside the newly-created `pipeline-timestamp` folder
❹ Go inside the `html` folder
❺ open the weblog with Firefox
`> firefox index.html`

- Note: Sometimes Firefox has issues opening the weblog. Alternatively one can open the weblog from within CASA via `h_weblog()`
https://help.almascience.org/kb/articles/what-is-the-best-way-to-view-the-weblog

Calibrated Visibilities

- To retrieve calibrated visibilities for your own or archival data:
  - Request them via a Helpdesk ticket: https://almascience.eso.org/local-news/requesting-calibrated-measurement-sets-in-europe
  - If ARI-L products exist, the calibrated .MS files can be requested from the ARI-L team for at least 3 years after June 2022 (https://sites.google.com/inaf.it/ari-l)
  - **Recreate them yourself!**

More information:
https://help.almascience.org/kb/articles/how-do-i-obtain-a-file-of-calibrated-visibilities-measurement-set-for-alma-data

Recreating Calibrated Visibilities

- The calibration of both pipeline calibrated and manually calibrated ALMA data is performed by running `*.scriptForPI.py` in the `script` directory.

pipeline-calibrated MOUS

```
script/
  scriptForPI.py
  casa_pipescript.py
  casa_piperestorescript.py
  PPR*.xml or *pprequest.xml
```

manually-calibrated MOUS

```
script/
  scriptForPI.py
  scriptForCalibration.py (per EB)
  scriptForFluxCalibration.py
  scriptForImagingPrep.py (sometimes)
```

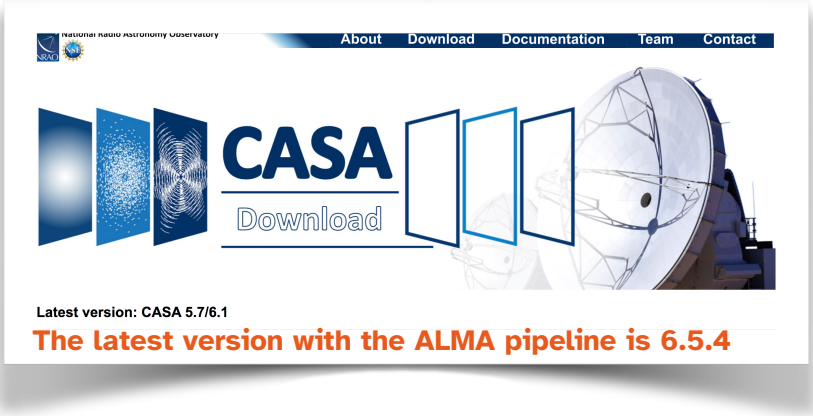
YOU NEED:

- The raw data in ALMA Science Data Model (ASDM) Format
- The correct version of CASA with the ALMA pipeline included

Obtain CASA

- Determine the version needed:
  - Cycle 5+: Find this information in the QA2 pdf report (in the `qa` directory)
  - At the top of the CASA log files (in the `log` directory or in `qa/pipeline*/html`)
  - If pipeline-calibrated: on the first page of the WebLog
  - If manually-calibrated/early cycles:
    - in the `README` file
    - Near the top of the script `scriptForCalibration.py`
- Install the version ***with the ALMA Pipeline!***

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



Run scriptForPI

pipeline calibration

❶ Go to the `script` folder & launch CASA with the pipeline extension:

```
> casa --pipeline
```

❷ execute the `*.scriptForPI.py` file:

```
CASA <x>: execfile('member.uid*.scriptForPI.py')
```

manual calibration

❶ Go to the `script` folder & launch CASA without the pipeline extension:

```
> casa
```

❷ execute the `*.scriptForPI.py` file:

```
CASA <x>: execfile('member.uid*.scriptForPI.py')
```

After running scriptForPI

- After successful completion of `scriptForPI.py` a new folder is created

```
project_id/
└ science_goal_ouss_id/
  └ group_ouss_id/
    └ member_ouss_id/
      ├ README
      ├ product/
      ├ calibration/
      ├ qa/
      ├ script/
      ├ log/
      ├ raw/
      └ calibrated
        └ 1 calibrated .ms file per EB
```

Typical Problems

- “Not enough disk space”
  - run the script in space saving mode by starting it in the following way

```
> casa -c "SPACESAVING -N; execfile('scriptForPI.py')"
```

N = 0 -> no space saving mode
N = 1 -> all intermediate measurement sets *ms.split are deleted
N = 2 -> all intermediate measurement sets *ms.split and *.ms are deleted
N >= 3 -> all intermediate measurement sets *ms.split, *.ms, and *ms.split.cal are deleted

- “TypeError” or “NameError”
  - most likely using the wrong CASA version

Typical Problems

- "No such file or directory"
  - change file extension names in the calibration folder from `*.tar.gz` to `*.tgz`

- "The `calibrated` directory already exists"
  - This folder is created every time you execute the `scriptForPI.py` script, so remove it before you want to run the script again

need help?

contact Allegro!

alma@strw.leidenuniv.nl

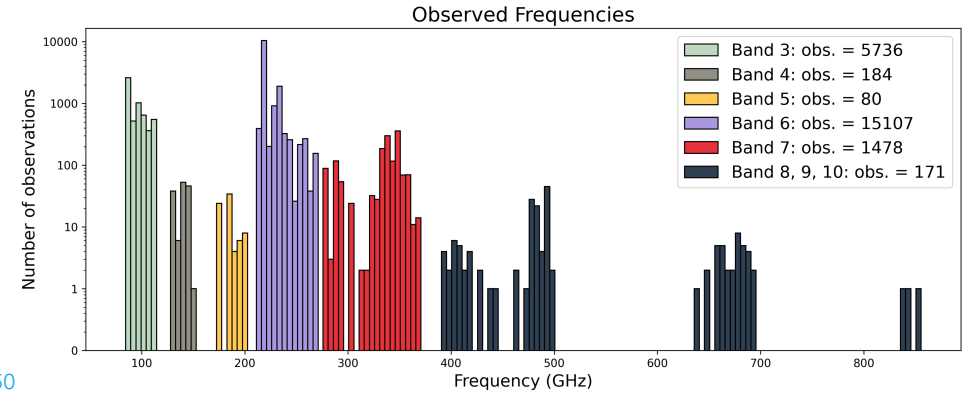
Querying the archive programmatically

- **pyVO** - ADQL queries through Table Access Protocol (TAP) service
  - Documentation
  - Example notebooks for ALMA
- **Astroquery**
  - Documentation
- **ALminer**: ALMA Archive Mining & Visualization Toolkit
  - Documentation

Almaminer

ALMA archive mining and visualization toolkit

Python-based code to effectively **query**, **analyse**, and **visualise** the ALMA Science Archive + **download** raw/products data



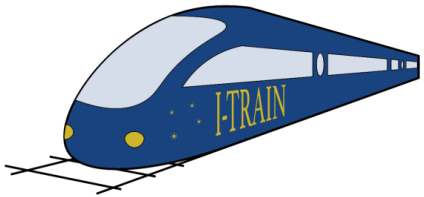
I wonder what ALMA data exists for X, Y, Z

Where to find ALminer

Documentation: https://alminer.readthedocs.io/

GitHub: https://github.com/emerge-erc/ALminer

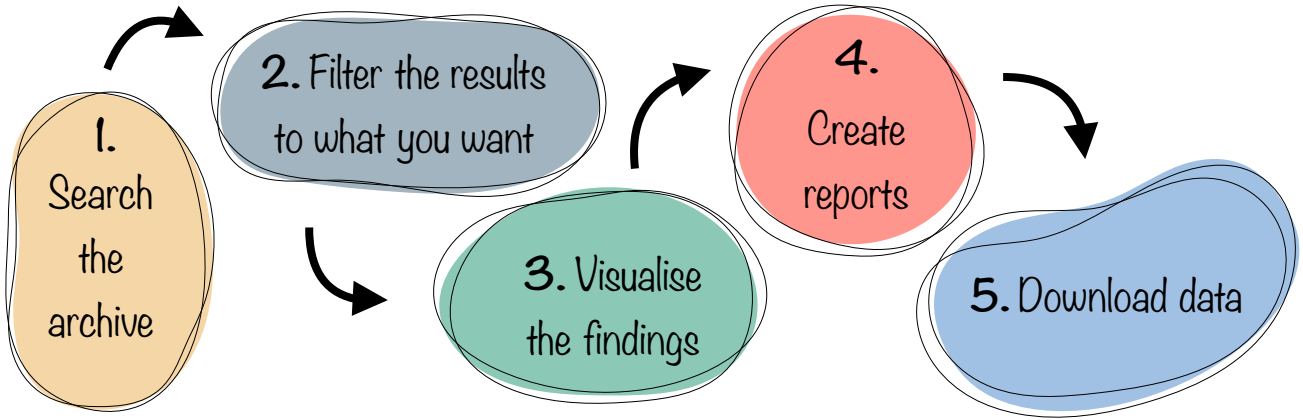
I-TRAIN video: https://bit.ly/ALminer_I-TRAIN_video



ALminer's extensive tutorial

Static version at https://alminer.readthedocs.io/

Live Jupyter Notebook launch Jupyter Notebook



References

- ALMA Science Archive: http://almascience.org/aq/
- Science Archive Manual: https://almascience.eso.org/documents-and-tools/latest/science-archive-manual
- Science Archive Primer: https://almascience.eso.org/documents-and-tools/cycle9/archive-primer
- Data processing overview: https://almascience.eso.org/processing
- Petry et al. 2020: https://ui.adsabs.harvard.edu/abs/2020Msngr.181...16P/abstract

Next up:

- Calibration fundamentals
- Imaging techniques
- Analysis & visualisation Tools