



# Archive tips and tricks

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# How to check if a target is in the archive?

Search  
06:35:46.5 -75:16:46.8  
including also calibrators  
images  
At 30 arcsec there is  
PKS 0637-752  
(06:35:46.5 -75:16:16.8)

## FACTS

The archive lists the observations which footprint overlaps with the searching region (default radius 10 arcmin)

## TIPS

Make the searching radius as small as possible (0.01 arcmin) to search if a position is within the footprints!!!

Search

Calibration observations: true RA Dec: 06:35:46.5 -75:16:46...

Position	Energy	Project	Publication	Observation
Source name <input type="text"/>	Frequency <input type="text"/>	Project code <input type="text"/>	BibCode <input type="text"/>	Observation Date <input type="text"/>
ALMA source name <input type="text"/>	Band <input type="text"/>	Project Title <input type="text"/>	Publication Title <input type="text"/>	Polarisation Type <input type="text"/>
RA Dec <input type="text" value="06:35:46.5 -75:16:46.8, 0.01"/> <input type="button" value="✓"/> <input type="button" value="X"/>	RA Dec <input type="text"/>	Abstract <input type="text"/>	Member ous id <input type="text"/>	Object type <input type="text"/>
Galactic <input type="text"/>	Info: Right Ascension and Declination Description: Coordinate search with default radius of 10 arcmin or coordinate-range search. RA and Dec may be expressed in sexagesimal or in decimal degrees. An alternative search radius in arcmin can be added to the end separated by a comma. All observations that have footprints overlapping with the search region will be returned. Units: Sexagesimal Examples: <ul style="list-style-type: none"><li><a href="#">13:37:00.89 -29:51:59.8</a></li><li><a href="#">83.633075 22.014494</a></li><li><a href="#">04:31:38.425 18:13:57.242_5</a></li><li><a href="#">181..185 &gt;-0.1928</a></li></ul>	First Author <input type="text"/>	<input type="checkbox"/> Public data only	<input checked="" type="checkbox"/> Calibration observations
Target List <input type="text"/>		Authors <input type="text"/>		
Angular Resolution <input type="text"/>				
Max. Recoverable Scale <input type="text"/>				

# How to check if a target is in the archive?

Search  Calibration observations: true RA Dec: 06:35:46.5 - 75:16:46... Explore and download

Observations (51) Projects (32) Publications (37)

Project code	ALMA source name	RA	Dec	Band	FOV	Con
		h:m:s	d:m:s		arcsec	mJ
2011.0.00471.5	J0637-752	06:35:46.507	-75:16:16.815	3	62.689	0.15
2012.1.00641.5	J0635-7516	06:35:46.507	-75:16:16.824	3	92.694	0.66
2012.1.00554.5	J0635-7516	06:35:46.507	-75:16:16.824	3	95.966	1.34
2012.1.00641.5	J0635-7516	06:35:46.507	-75:16:16.824	3	92.695	0.75
2012.1.00603.5	J0635-7516	06:35:46.507	-75:16:16.824	3	95.962	1.08
2013.1.01042.5	J0635-7516	06:35:46.508	-75:16:16.815	3	92.579	0.78
2012.1.00603.5	J0635-7516	06:35:46.508	-75:16:16.820	3	95.971	1.19
2012.1.00394.5	J0635-7516	06:35:46.508	-75:16:16.815	3	99.731	0.48
2013.1.00700.5	J0635-7516	06:35:46.508	-75:16:16.815	3	61.283	0.03
2013.1.00214.5	J0635-7516	06:35:46.508	-75:16:16.815	3	95.993	0.49
2013.1.01091.5	J0635-7516	06:35:46.508	-75:16:16.820	3	107.003	0.35

## TRICKS

Note that for sake of readability in the following examples I will resort the columns and change the size of the top part of the interface to the best convenience

A small searching areas selects only observations for which the FOV or the mosaicked area is larger than the distance between the searched position and the observed pointing position.

That might prefer lower bands with 7m array where the beam is larger

**FOV =  $21'' \cdot (300\text{GHz}/\text{freq}) \cdot (12\text{m}/\text{ant diam})$**   
**~x2 @ 7m**  
**~x3 @ 100GHz=B3**  
**~/3 @ 900 GHz=B10**  
**Resolution ~ FOV/100-1000**

# How to check if a target is in the archive?

Observations (51) Projects (32) Publications (37)

Project code	ALMA source name	RA	Dec	Band	FOV	Cont. sens.	Frequency support	↑ Release date	Publications	Ang. res.	Min. vel. res.	Array	Max. reco. scale	Collections	Scientific name
		h:m:s	d:m:s		arcsec	mJy/beam				arcsec	km/s		arcsec		
2015.1.01195.S	J0635-7516	06:35:46.508	-75:16:16.815	3	66.186	0.0575	86.622-89.335 GHz	2017-06-08	3	2.206	0.239	12m	20.442	ari_I	ISM ar
2015.1.01046.S	J0635-7516	06:35:46.508	-75:16:16.815	3	62.196	0.0377	86.47-100.774 GHz	2017-06-17	1	2.390	3.322	12m	34.222	ari_I	Active
2015.1.01388.S	J0635-7516	06:35:46.508	-75:16:16.815	3	62.571	0.0638	86.242-99.881 GHz	2017-07-12	3	1.966	0.216	12m	20.905	ari_I	ISM ar
2015.1.01522.S	J0635-7516	06:35:46.508	-75:16:16.815	3	59.722	0.0336	89.516-105.485 GHz	2017-09-06	2	0.653	181.016	12m	14.402		Active
2015.1.00697.S	J0635-7516	06:35:46.508	-75:16:16.815	3	61.125	0.0357	87.419-103.108 GHz	2017-09-19	1	1.087	92.650	12m	11.105	ari_I	Stars
2015.1.01522.S	J0635-7516	06:35:46.508	-75:16:16.815	3	59.722	0.0332	89.516-105.485 GHz	2018-02-28	2	0.430	181.016	12m	9.008		Active
2015.1.01522.S	J063546-751616	06:35:46.330	-75:16:16.800	3	59.722	0.0322	89.516-105.485 GHz	2018-02-28	2	0.377	181.016	12m	11.687		Active
2015.1.01522.S	J0635-7516	06:35:46.508	-75:16:16.815	3	59.722	0.0296	89.516-105.485 GHz	2018-02-28	2	0.375	181.016	12m	12.057		Active
2015.1.00748.S	J0635-7516	06:35:46.508	-75:16:16.815	3	62.665	0.0304	84.998-100.846 GHz	2018-03-17	0	0.463	94.770	12m	9.676	ari_I	Stars a
2015.1.00697.S	J0635-7516	06:35:46.508	-75:16:16.815	3	63.387	0.0356	84.026-99.701 GHz	2018-03-29	1	1.118	95.880	12m	11.274	ari_I	Stars a

Furthermore, remember that **the query lists one row for each source (inc calibrators) per MOUS. The reported values are an estimate of what would be achievable on the basis of the observing conditions.**

Then, **the publications refer to the project a target belong to, not necessarily to the target listed in the query** (so it is possible that even if there are >3 pubs for a row or 37 in total, no one has yet published the data for that specific source in those observing conditions).

# Searching for calibrators

Search

Previews for J0635-7516

ALMA ari\_I

EXPLORE AND DOWNLOAD

EXPLORE AND DOWNLOAD

Lines Redshift 0 estimated

360 kB

member.uid\_A001\_X2fb\_X599\_J0635-7516\_bp.spw17.mfs.l.pbcor.fits

Band: 3  
Frequency type: continuum  
Frequency range: 89.505..91.49  
Frequency resolution: 31,250 kHz  
Continuum sensitivity: 0.034  
Line sensitivity 10km/s (estimate): 1.682 mJy/beam@10km/s  
Line sensitivity native (estimate): 0.065 uJy/beam@native  
Polarizations: XX YY  
Array: 12m

360 kB

member.uid\_A001\_X2fb\_X599\_J0635-7516\_bp.spw19.mfs.l.pbcor.fits

Band: 3  
Frequency type: continuum  
Frequency range: 91.443..93.427  
Frequency resolution: 31,250 kHz  
Continuum sensitivity: 0.034  
Line sensitivity 10km/s (estimate): 1.708 mJy/beam@10km/s  
Line sensitivity native (estimate): 0.067 uJy/beam@native

J2A2 Status	Scan intent	Collections	Science
PASS	PHASE WVR	ari_I	Asympt
PASS	PHASE WVR		Asympt
PASS	BANDPASS		Inter-St
PASS	BANDPASS WVR	ari_I	Disks ar
PASS	BANDPASS WVR	ari_I	Black br
PASS	BANDPASS PHASE		Inter-St
PASS	BANDPASS WVR	ari_I	Inter-St
PASS	BANDPASS PHASE ...	ari_I	Starbur
PASS	BANDPASS WVR	ari_I	High-m
PASS	BANDPASS WVR		Active C
PASS	BANDPASS WVR	ari_I	Supern

Typically, calibrators do not have an image nor a preview in the early cycles.

Search for ari-I images if available in column “Collections” but only if column “Scan Intent” is BANDPASS, CHECK, PHASE or TARGET (and for projid 2013\*, 2015\*, 2016\*).

Also in the preview info you can find the expected sensitivity of an image!

# Searching for calibrators

## ALMA Calibrator Source Catalogue

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

Query Form Result Table Result Plot

Search Reset

**Position**

Source name (resolved by ALMA)  
J063542-751615 ✓

RA  
06:35:46.50788

Dec  
-75:16:16.8154

Search radius

**Energy**

Band

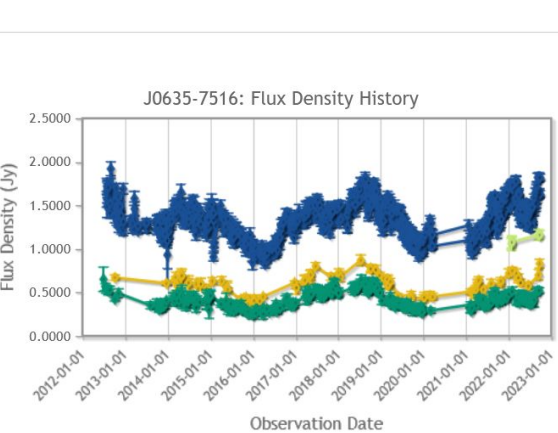
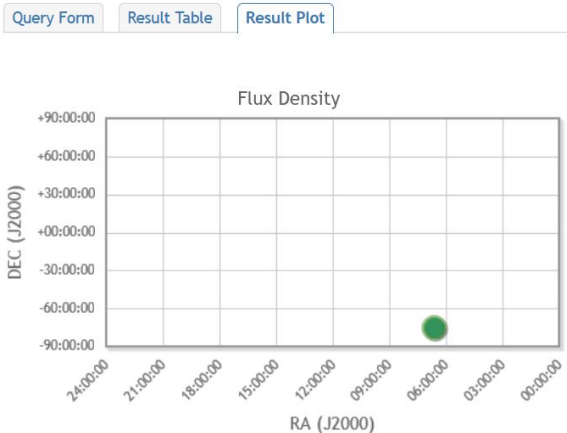
Frequency

Flux Density

**Time**

Query Form Result Table Result Plot

**Polarisation**



The calibrator catalogue lists the value observed in the calibrator monitoring program  
It does not include images, nor the values observed during science observations

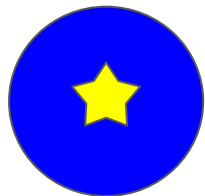
Source Info	Flux Range Jy	Bands
Source Name: J0635-7516	< 0.03	
RA: 06:35:46.507884	[0.03, 0.1)	
DEC: -75:16:16.81542012	[0.1, 0.3)	
Frequency: 343.5	[0.3, 1.0)	ALMA-Band 3 <input checked="" type="checkbox"/>
Flux Density: 0.52	[1.0, 3.0)	ALMA-Band 4 <input checked="" type="checkbox"/>
Date Observed: 2022-09-15		ALMA-Band 6 <input checked="" type="checkbox"/>
		ALMA-Band 7 <input checked="" type="checkbox"/>

# How to measure a flux?

$$1 \text{ Jy} = 10^{-23} \text{ erg/s/cm}^2 / \text{Hz}$$

Jy measures all the energy per time, per frequency bin and per detector area coming from a given solid angle. The solid angle is typically the synthesized beam

Each pixel of an image provides the flux within a beam area centered in that pixel



For a source smaller than the synthesized beam all the flux is within the solid angle

$$\text{Peak flux [Jy/beam]} = \text{Integrated Flux [Jy]}$$

For a source larger than the synthesized beam integrate over the whole source region and correct for the number of pixels in a beam

$$\text{Integrated Flux [Jy]} = \sum_{\text{Pixels}} \text{Flux}_{\text{pixel}} [\text{Jy/beam}] A_{\text{beam}} / A_{\text{pixel}}$$

“FluxDensity” in CARTA      “Sum” in CARTA

Statistics: Region 1 (Active)

Statistic	Value
NumPixels	7.830000000000e+2 pixel(s)
Sum	9.766996445512e+1 Jy/beam
FluxDensity	2.955533659228e+0 Jy
Mean	1.247381410666e-1 Jy/beam
StdDev	2.418775028509e-1 Jy/beam
Min	-1.629138924181e-2 Jy/beam
Max	1.291243910789e+0 Jy/beam
Extrema	1.291243910789e+0 Jy/beam
RMS	2.720103147893e-1 Jy/beam
SumSq	5.793386568843e+1 (Jy/beam)^2

# How to measure a flux?

$$1 \text{ Jy} = 10^{-23} \text{ erg/s/cm}^2 / \text{Hz}$$

Jy measures all the energy per time, per frequency bin and per detector area coming from a given solid angle. The solid angle is typically the synthesized beam

Each channel of a spectrum provides the flux within a range of frequency

For a line narrower than the channel width all the flux is within the channel

$$\text{Line Flux [Jy/beam*km/s]} = \text{Peak flux [Jy/beam]} * \text{channel\_width [km/s]}$$

For a line wider than the channel size integrate over the whole line and correct for the channel width

$$\text{Line Flux [Jy/beam*km/s]} =$$

$$\sum_{\text{Channels}} \text{Flux}_{\text{ch}} [\text{Jy/beam}] * \text{channel\_width [km/s]}$$

Statistics: Region 2 (Active) mom 0 map

Image	Active	Region	Active
Statistic	Value		
NumPixels	5.400000000000e+1 pixel(s)		
Sum	-8.848474074155e+0 Jy/beam.km/s		
FluxDensity	-2.651730261824e-1 Jy.km/s		
Mean	-1.638606310029e-1 Jy/beam.km/s		
StdDev	1.167055398779e-1 Jy/beam.km/s		
Min	-3.685683012009e-1 Jy/beam.km/s		
Max	8.852740377188e-2 Jy/beam.km/s		
Extrema	-3.685683012009e-1 Jy/beam.km/s		
RMS	2.005449175270e-1 Jy/beam.km/s		
SumSq	2.171786253079e+0 (Jy/beam.km/s)^2		



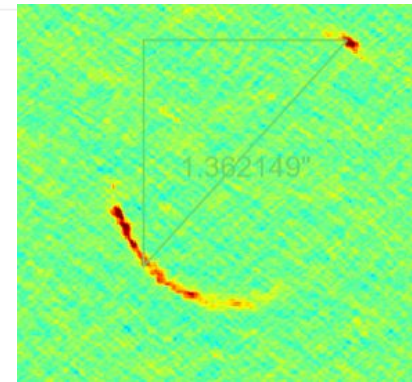
# How to measure a size or a width?

Search SDP9 a lensed star forming galaxy at redshift 1.5  
typical size of Einstein ring  $< 2$  arcsec, typical linewidth few\*100km/s

Project code	ALMA source name	Band	Cont. sens. mJy/beam ▾	Ang. res. arcsec ▾	Min. vel. res. km/s ▾	Array	Max. reco. scale arcsec ▾	FOV arcsec ▾
2011.0.00661.5	HATLAS J090740.0-004...	3	0.0183	1.706	2.754	12m	20.034	59.128
2012.1.00915.5	H-ATLAS_J090740.0-00...	3	0.0175	1.443	2.754	12m	23.333	59.125
2015.1.00415.5	SDP9	6	0.0129	0.020	35.042	12m	0.355	22.404
2016.1.01340.5	SDP.9	4	0.0249	1.302	2.268	12m	12.032	43.681
2016.1.01340.5	SDP.9	3	0.0205	1.836	3.388	12m	17.988	62.992

To measure a size choose an angular resolution  $< \text{size}/5$

To measure a line width choose an spectral resolution  $< \text{size}/3$



# How to measure a size or a width?

File View Widgets Help

member.uid\_\_A001\_X2de\_X28.ari\_I.SDP9\_sci.spw0\_268325MHz.12m.cube.l.pbcor.fits

WCS: (9:07:40.0067, -0:42:01.641); Image: (5246, 4687);  
Value: 1.33992e-4 Jy/beam ;  
Frequency (LSRK): 268.5358 GHz;  
Velocity: 183367.0699 km/s; Polarization: Stokes I

ARI-L

QA2

Declination

Right ascension

Z Profile X

Image 1: mem... Region Active Statistic Mean Polar

QA2

Value (Jy/beam)

[BARYCENT] Frequency (GHz)

Data: (268.577 GHz, 6.46e-5)

Z Profile X

Image 0: mem... Region Active Statistic Mean Polar

ARI-L

Value (Jy/beam)

[LSRK] Frequency (GHz)

Data: (268.536 GHz, 9.06e-6)

Image List X

Image	Layers	Matching	Channel	P
0 member.uid__A001	R	XY Z R	67	S
1 member.uid__A001_	R	XY Z R	4	S

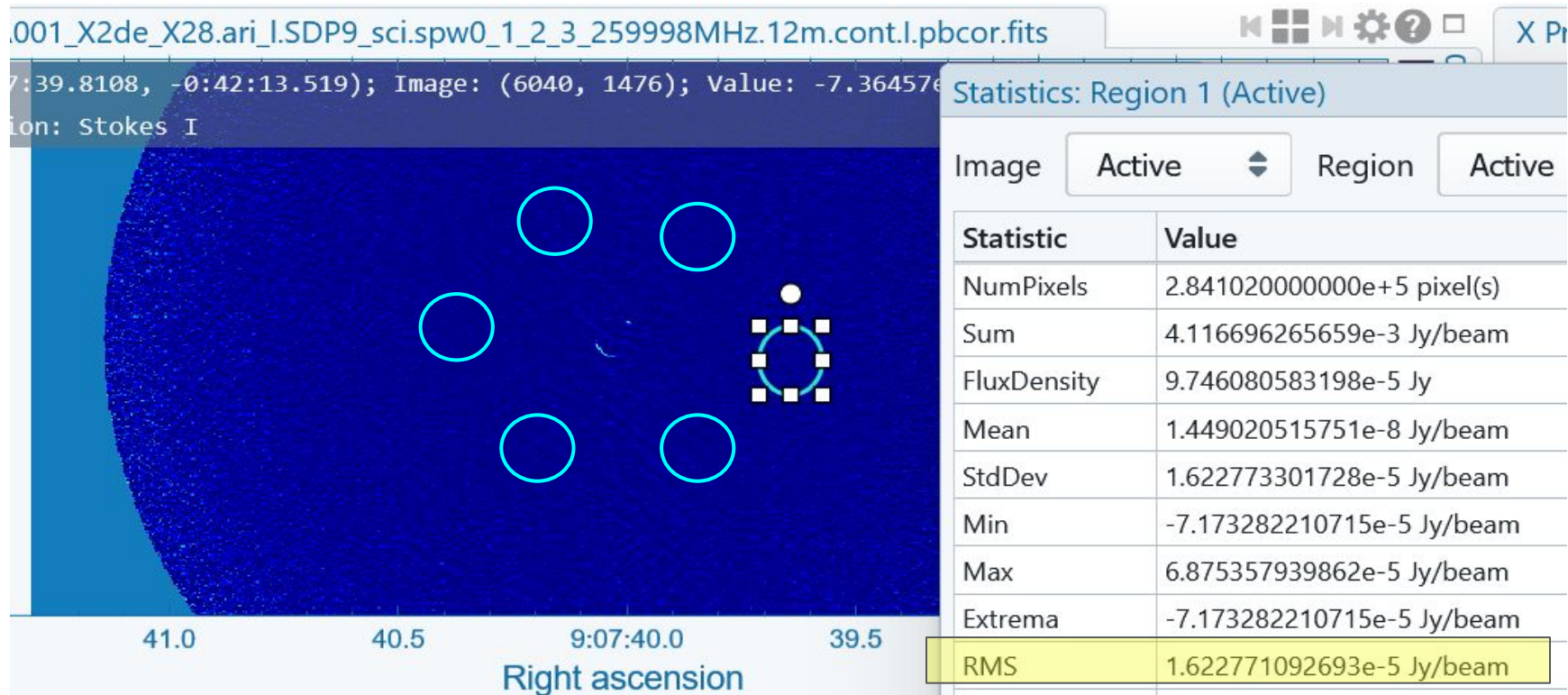
Animator X

Frame Rate 5

Image member.uid\_\_A001\_X2de\_X28.ari\_I.SDP9\_sci.spw0\_268325MHz.12m.cube.l.pbcor.fits

Channel LSRK 268.5358 GHz 183367.0699 km/s

# How to measure noise?



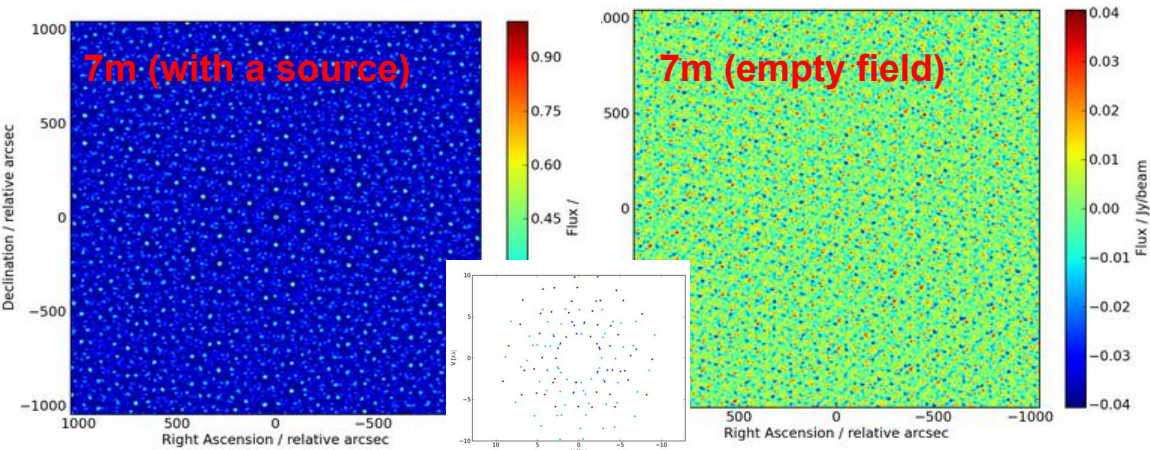
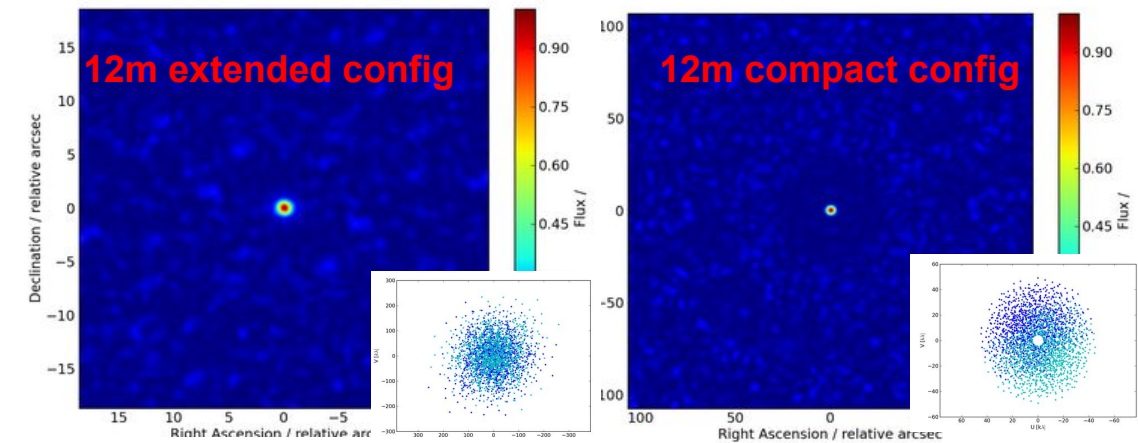
Draw regions far from the source, but not too far because of the pbcorrection  
Get the rms from CARTA and average them...

compare with the 0.0129 mJy/beam of the query interface!!!!

Questions?

# When a spurious detection is a detection?

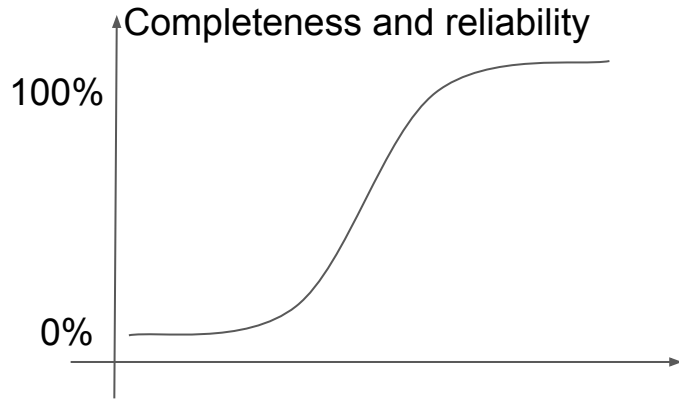
## SIMULATIONS



The noise of an interferometric image is not Gaussian because it is the result of a non linear process.

For this reason it is recommended to measure the noise by averaging over various regions where there is no source (this minimizes the pattern effects).

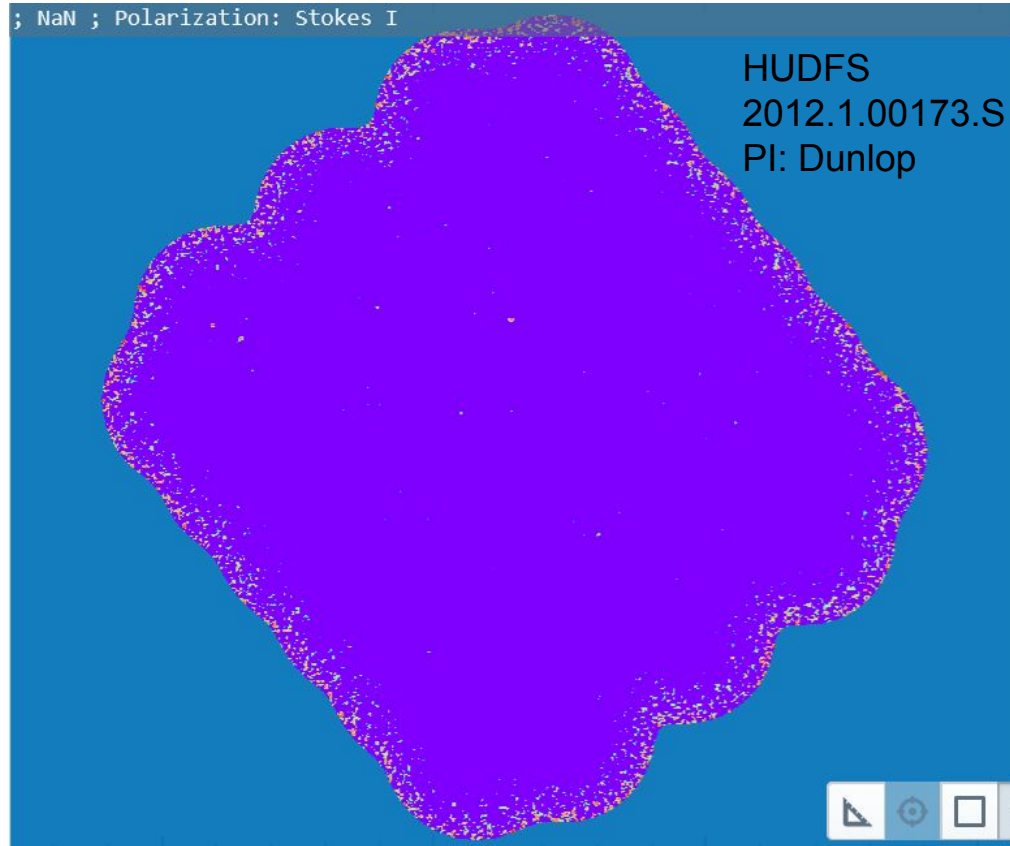
# When a spurious detection is a detection?



**Completeness** = fraction of all the source above a given flux level that have been detected

**Reliability** = fraction of real sources above a given flux level

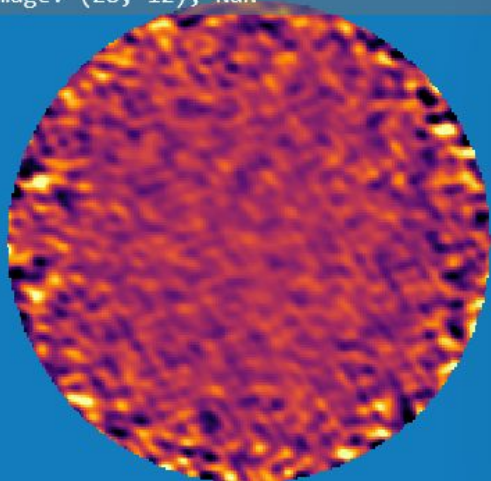
Select pixels going down in flux density  
... but pay attention to the limit of it



# When a spurious detection is a detection?

**ARCHIVED 12m PB CORRECTED IMAGE (VERY FAINT SOURCE IN THE CENTER)**

Image: (28, 12); NaN



Histogram: Image (Active)

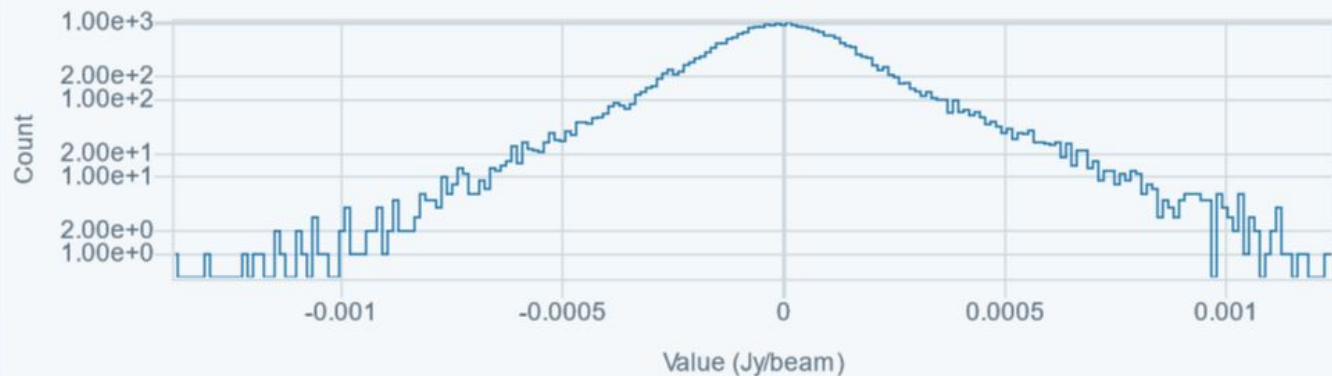
Image

Active



Region

Active



Typically the negative side of the pixel values distribution is used as tracer of the Gaussian noise...  
But not in an interferometric image!!!!

The pixel distribution is asymmetrical (both in pb and non pb corrected images!!!)  
so detection significance is not just given by the Gaussian fit of the negative pixels distribution.

# When a spurious detection is a detection?

In case of spurious detections in a given field, reproduce the observation conditions with **simulations** to estimate completeness and reliability:

ALMA Observing Support Tool: <https://almaost.jb.man.ac.uk/>

I-TRAIN #5 tutorial: <https://almascience.eso.org/tools/eu-arc-network/i-train>

Simulating ALMA with CASA: [https://casaguides.nrao.edu/index.php/Guide\\_To\\_Simulating\\_ALMA\\_Data](https://casaguides.nrao.edu/index.php/Guide_To_Simulating_ALMA_Data)

I-TRAIN #15 tutorial: <https://almascience.eso.org/tools/eu-arc-network/i-train>

APSYNSIM: <https://github.com/onsala-space-observatory/APSYNSIM>

I-TRAIN #16 tutorial: <https://almascience.eso.org/tools/eu-arc-network/i-train>

Another possibility to verify if a detection is real is to consider **other observations of the same target** assuming reliable conditions of variability or spectral behaviours.



Questions?

# How to build a SED or a timecurve for a source?

If you need to build time series data should refer to the same scales.

If you are sure that the source is a point source choose your data and open images with CARTA to grab the peak flux.

The screenshot shows the ALMA data query interface. At the top, there are search filters: "Calibration observations: true", "Source name: PKS 1921-293", "Band: 3, 6, 7", and "Observation Date: 2016-01-01..2016-03-...". Below these are five main sections: Position, Energy, Project, Publication, and Observation. Each section has several input fields. The "Source name" field in the Position section is highlighted with a red box and contains "PKS 1921-293". The "Band" dropdown menu in the Energy section is also highlighted with a red box and shows "3, 6, 7". The "Observation Date" field in the Observation section is highlighted with a red box and contains "2016-01-01..2016-03-31". In the bottom right corner, there are two radio buttons: "Public data only" (unselected) and "Calibration observations" (selected), with the latter highlighted by a red box. At the bottom, a table of search results is visible, showing columns for RA, Dec, Frequency, Bandwidth, and Observation Date. The first row is highlighted.

RA	Dec	Frequency	Bandwidth	Observation Date
19:24:51.056	-29:14:30.121	6	222.982..242.965 GHz	2016-03-05
19:24:51.056	-29:14:30.121	6	215.801..234.747 GHz	2016-03-22
19:24:51.056	-29:14:30.121	6	225.984..243.902 GHz	2016-03-07
19:24:51.056	-29:14:30.121	6	222.982..242.965 GHz	2016-03-21

Search for all the observations of the calibrator PKS1921-293 in the first 3 months of 2016.

Select one obs for frequency in january and march.

Select only the columns you want

Export the table to save the info only on the selected rows

# How to build a SED or a timecurve for a source

If you need to build time series data should refer to the same scales.

If you are sure that the source is a point source choose your data and open images with CARTA to grab the peak flux.

Observations (46) Projects (0) Publications (0)

Export

Project code	ALMA source name	RA	Dec	Band	Obs. date	Frequency support	Array
		h:m:s	d:m:s				
2015.1.01576.S	J1924-2914	19:24:51.056	-29:14:30.121	3	2016-03-24	90.239..105.994 GHz	12m
2015.1.01289.S	J1924-2914	19:24:51.056	-29:14:30.121	3	2016-01-05	85.409..98.453 GHz	12m
2015.1.00223.S	J1924-2914	19:24:51.056	-29:14:30.121	3	2016-01-30	93.145..105.941 GHz	12m
2015.1.00897.S	J1924-2914	19:24:51.056	-29:14:30.121	3	2016-01-14	98.895..114.849 GHz	7m
2015.1.01084.S	J1924-2914	19:24:51.056	-29:14:30.121	6	2016-03-05	222.982..242.965 GHz	12m
2015.1.00959.S	J1924-2914	19:24:51.056	-29:14:30.121	6	2016-03-22	215.801..234.747 GHz	7m
2015.1.01520.S	J1924-2914	19:24:51.056	-29:14:30.121	6	2016-03-07	225.984..243.902 GHz	7m
2015.1.00997.S	J1924-2914	19:24:51.056	-29:14:30.121	6	2016-03-24	253.919..273.172 GHz	7m

Search for all the observations of the calibrator PKS1921-293 in the first 3 months of 2016.

Select one obs for frequency in january and march.

Select only the columns you want

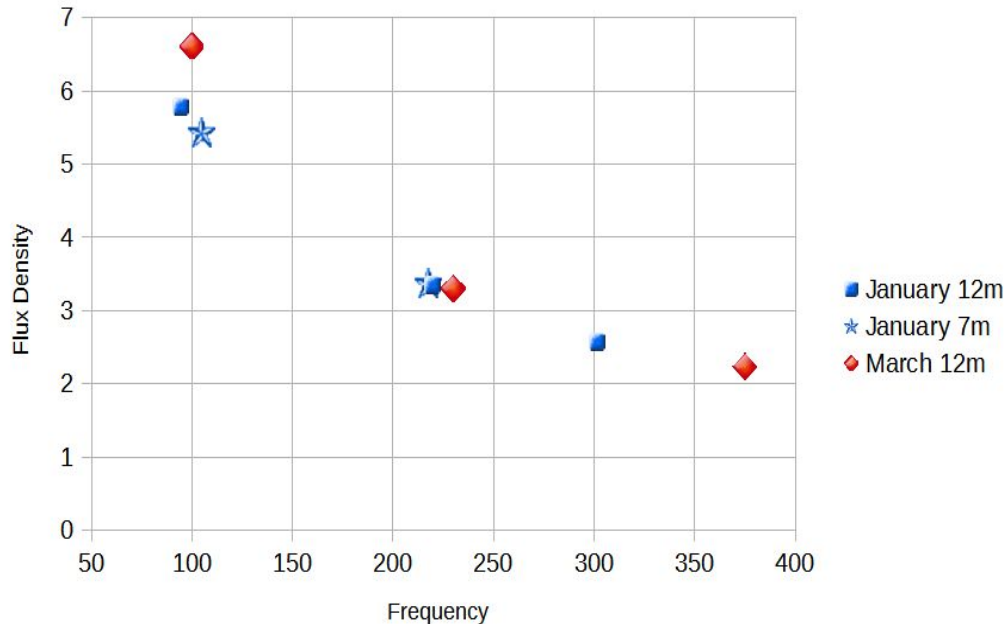
Export the table to save the info only on the selected rows

# How to build a SED or a timecurve for a source

1	Project code	ALMA source name	Ra	Dec	Band	Cont. sens.	Frequency support
2	2015.1.01329.S	J1924-2914	291.2127331541667	-29.241700286111115	3	0.05292610005178721	[95.03..96.91GHz,488.28k
3	2015.1.00149.S	J1924-2914	291.2127331541406	-29.241700286121656	6	0.3148528980746554	[214.69..216.71GHz,1128.
4	2015.1.00897.S	J1924-2914	291.21273315419273	-29.241700286116405	3	0.28161504855196734	[98.89..100.90GHz,1938.4
5	2015.1.00149.S	J1924-2914	291.2127331541667	-29.241700286111115	6	0.04764062061852789	[214.77..216.65GHz,1128.
6	2015.1.00150.S	J1924-2914	291.2127331541667	-29.241700286111115	7	0.05540846408255419	[301.19..303.07GHz,976.5
7	2015.1.01003.S	J1924-2914	291.2127331541667	-29.241700286111115	7	0.07376011393820256	[341.95..343.82GHz,1938.
8	2015.1.00658.S	J1924-2914	291.2127331541667	-29.241700286111115	9	0.9151276372140352	[673.00..674.98GHz,3125]
9	2015.1.01312.S	J1924-2914	291.2127331541667	-29.241700286111115	6	0.04612907160174198	[224.24..226.12GHz,1128.
10	2015.1.01404.S	J1924-2914	291.2127331541331	-29.241700286125223	3	0.31524396288382583	[89.92..91.91GHz,31250.0
11	2015.1.01344.S	J1924-2914	291.2127331541187	-29.24170028612161	3	0.05560090068515236	[91.93..92.05GHz,141.11k
12							

The exported csv files can easily be managed as tables

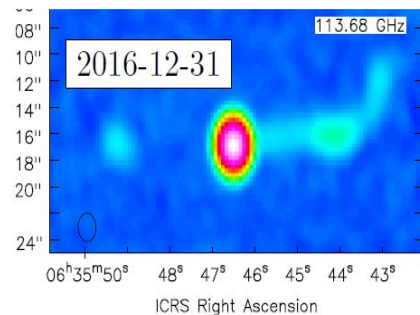
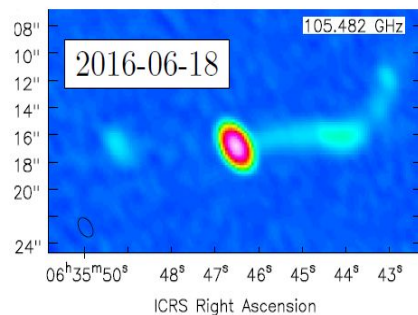
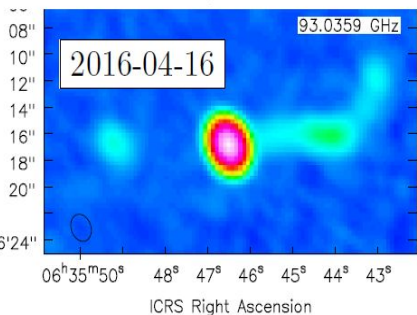
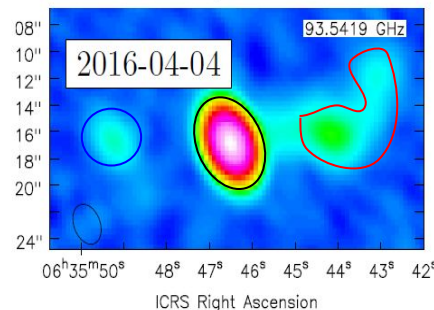
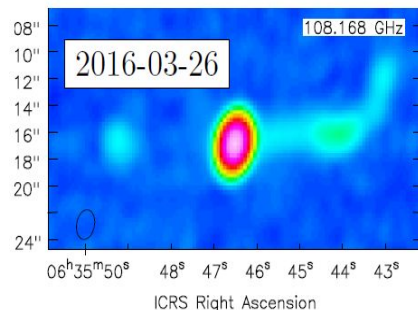
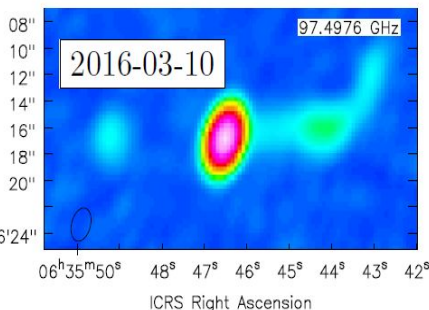
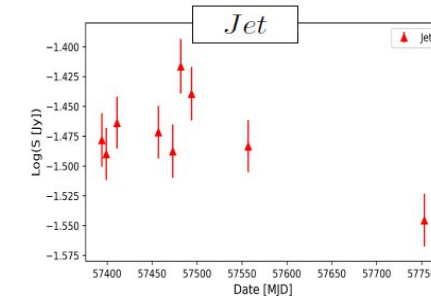
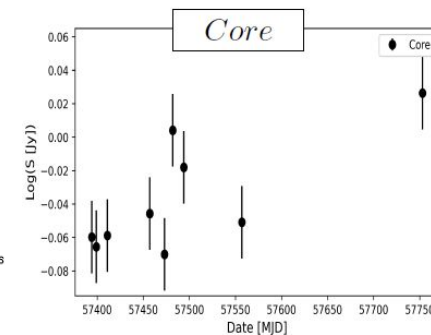
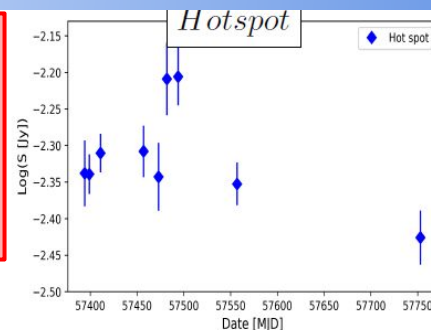
**SEDs and timelines for point sources can be reasonably built by extracting peak flux densities from CARTA on archival images**  
(remember that they are only representative!).



# How to build a SED or a timecurve for a source

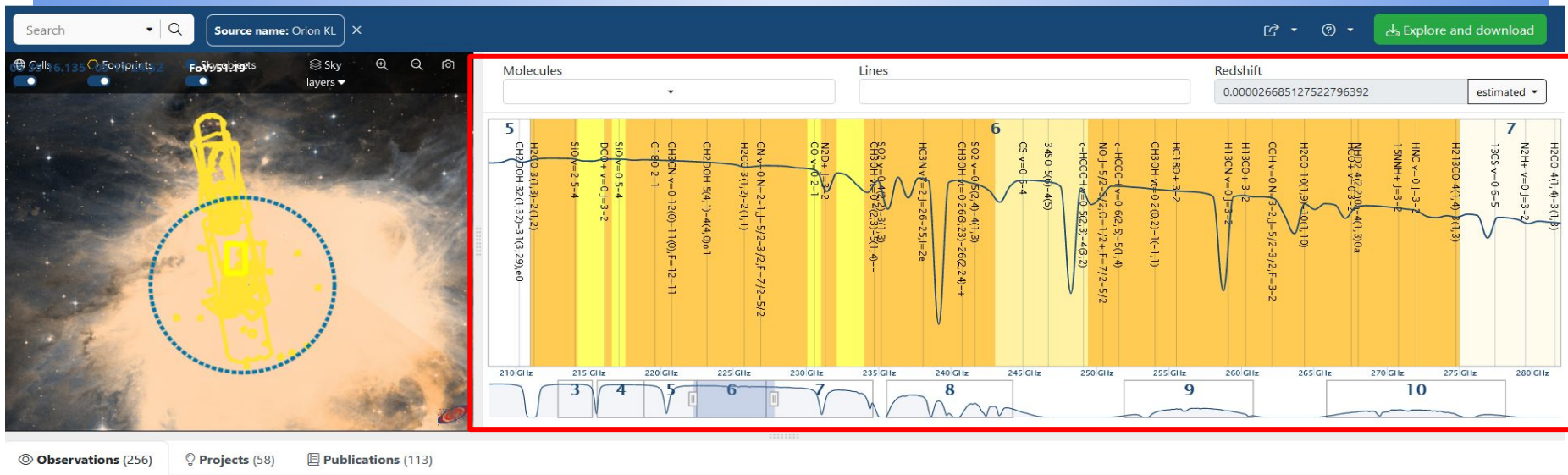
If you need to build SED data should refer to the epochs and scales.

If a source is extended wrt the image resolution a region has to be defined to collect the flux density.



PKS 0635-752

# How to search for lines in a source?



Observations (256) Projects (58) Publications (113)

Project code	ALMA source name	RA	Dec	Band	Cont. sens.	Frequency support	Release date	Publications	Ang. res.	Min. vel. res.	Array	Mosaic
2017.1.01353.3	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	12m	mosaic
2017.1.01353.3	OMC-1_Region1	05:35:11.210	-05:17:20.900	6	0.1000	248.483..268 GHz	2019-12-14	1	0.704	1.267	12m	

## Search for Orion KL

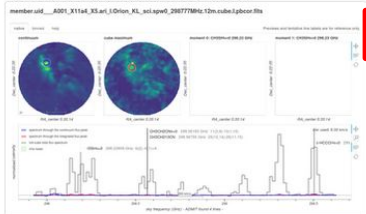
The spectral window give indications of which lines fall in the selected observed frequency range (no indication of detection here! It lists all the lines as given by splatalogue <https://splatalogue.online/> or selected by archive user) The preview helps in identifying which lines can be detected

# How to search for lines in a source?

Orion\_KL Main products. For all products go here

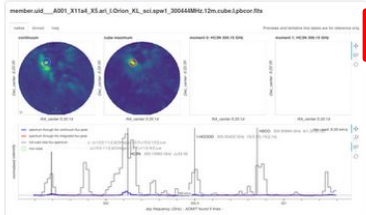
ALMA ari\_I

SPW 0: 297.79..299.78 GHz, 31250.00kHz, XX YY



member.uid\_\_A001\_X11a4\_X5.ari\_I.Orion\_KL\_sci.spw2\_311461MHz.12m.cube.l.pbcor.fits  
continuum  
Band: 7  
Frequency range: 297.79..299.78 GHz  
Frequency resolution: 31250.00 kHz  
Continuum sensitivity (estimate): 0.04 Jy/beam  
Line sensitivity 10km/s (estimate): 0.8  
Line sensitivity native (estimate): 0.06  
Polarizations: XX YY  
Array: 12m

SPW 1: 299.46..301.44 GHz, 31250.00kHz, XX YY



member.uid\_\_A001\_X11a4\_X5.ari\_I.Orion\_KL\_sci.spw1\_300488MHz.12m.cube.l.pbcor.fits  
continuum  
Band: 7  
Frequency range: 299.46..301.44 GHz  
Frequency resolution: 31250.00 kHz  
Continuum sensitivity (estimate): 0.04 Jy/beam  
Line sensitivity 10km/s (estimate): 0.8  
Line sensitivity native (estimate): 0.06  
Polarizations: XX YY  
Array: 12m

SPW 2: 310.99..311.93 GHz, 488.28kHz, XX YY



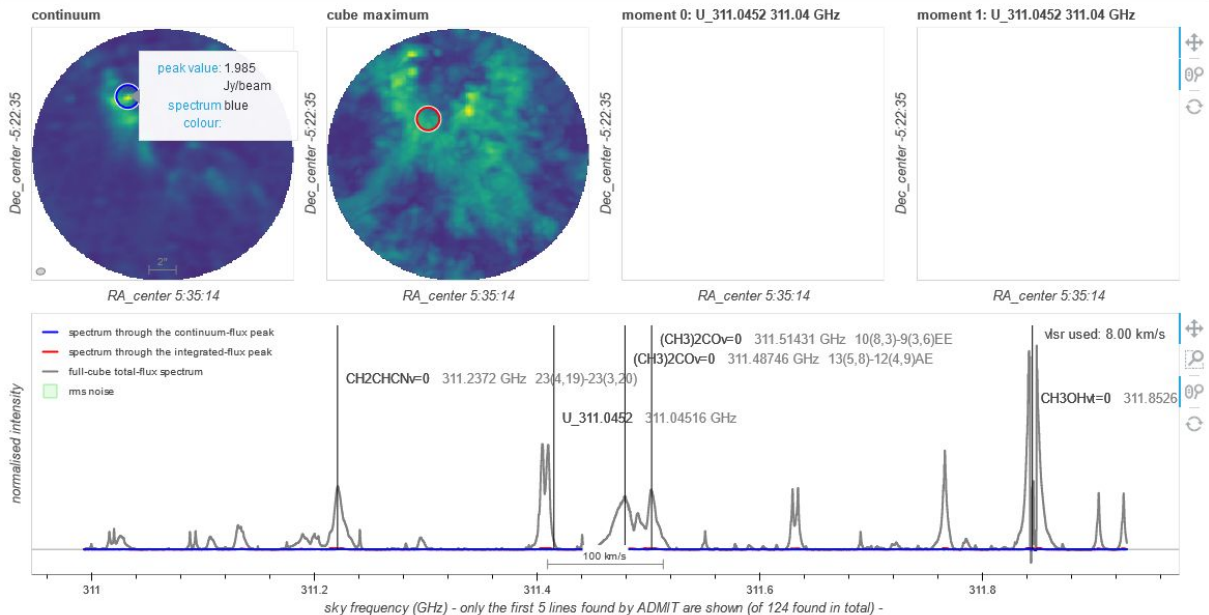
member.uid\_\_A001\_X11a4\_X5.ari\_I.Orion\_KL\_sci.spw2\_311461MHz.12m.cube.l.pbcor.fits  
line

Interactive preview

member.uid\_\_A001\_X11a4\_X5.ari\_I.Orion\_KL\_sci.spw2\_311461MHz.12m.cube.l.pbcor.fits

native binned help

Previews and tentative line labels are for reference only.

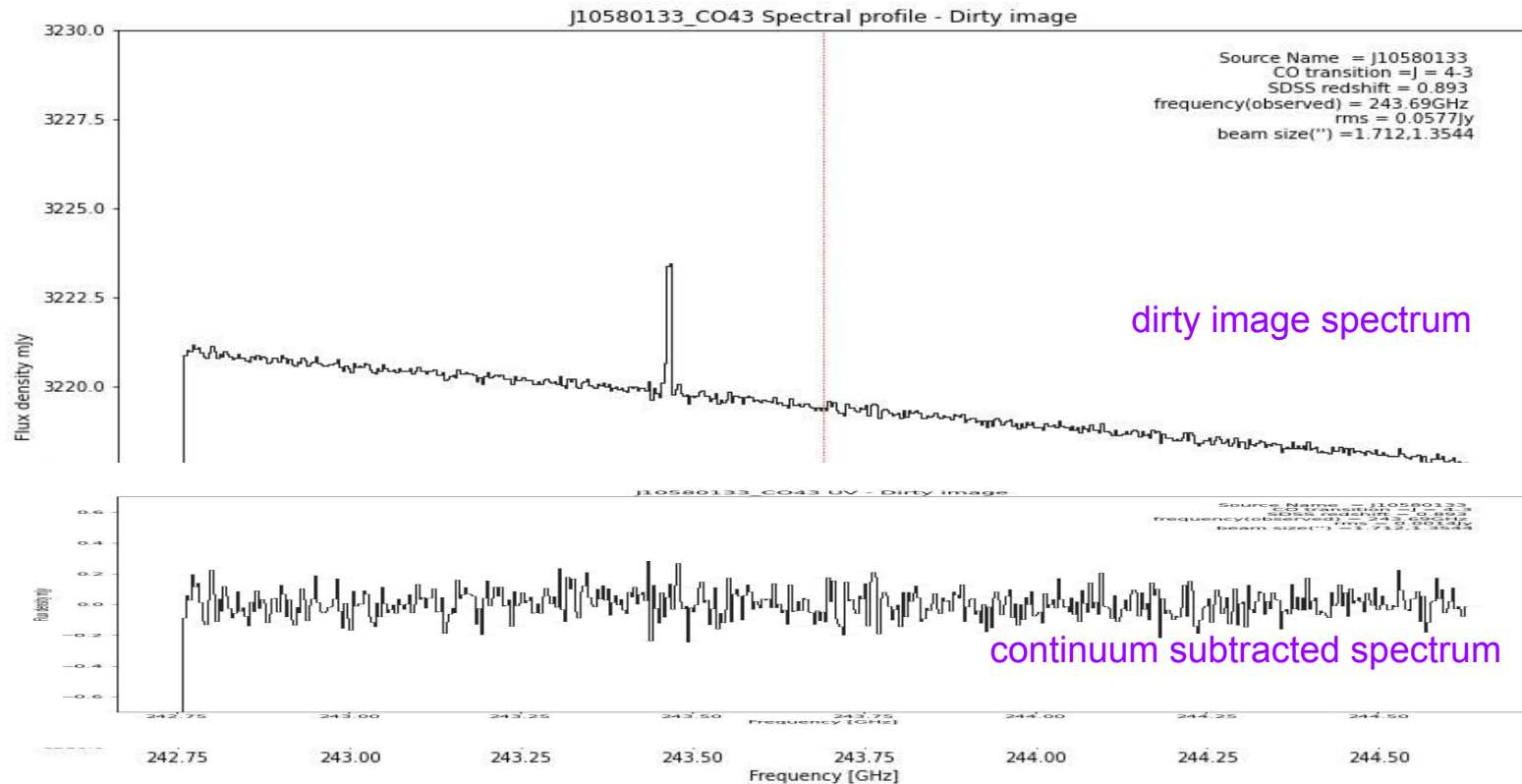


Interactive preview allows to bin spectra. Remember they are supposed to be previews, not final spectra for science

# When a line is a line?

A bandpass calibrator observed in cycle 4.

Courtesy Chandana Hedge

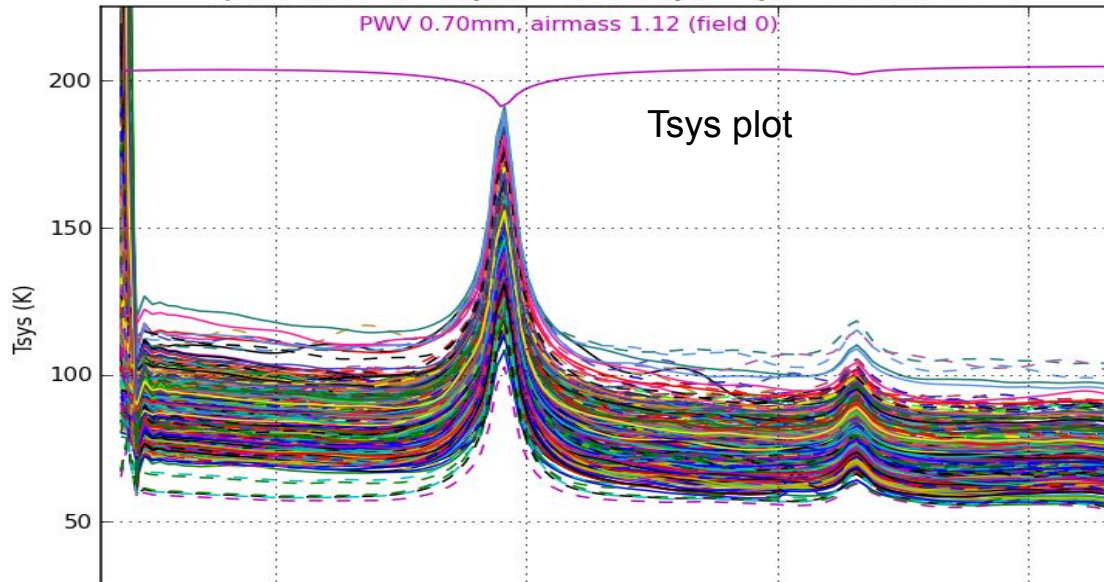
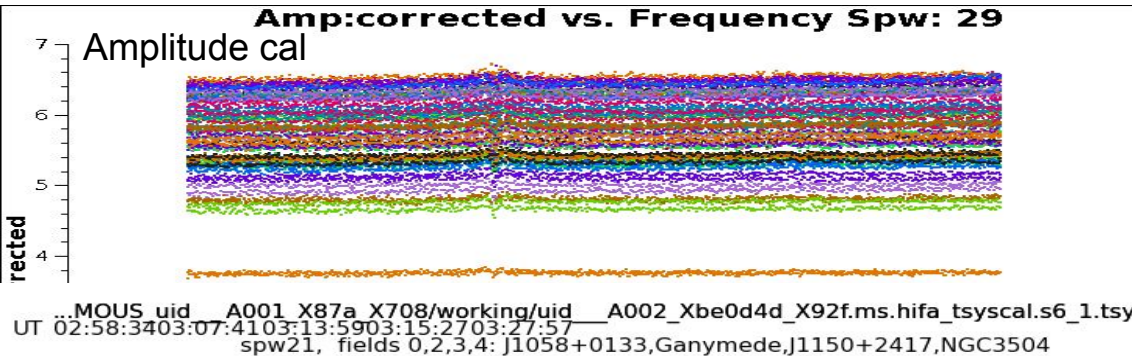
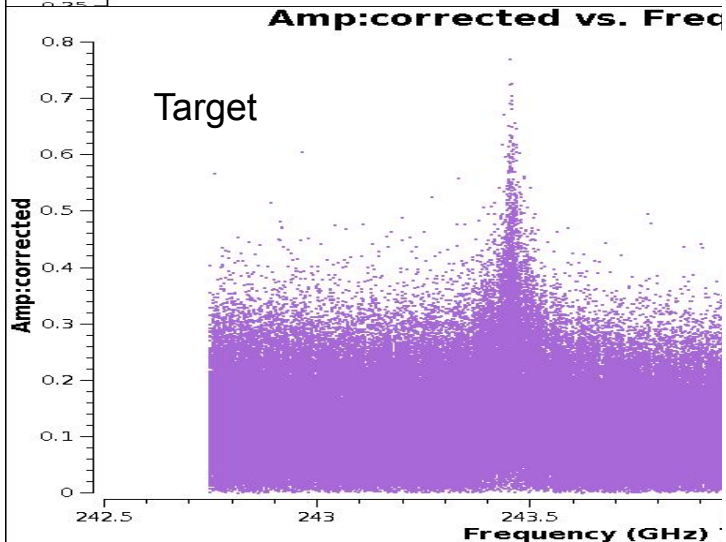
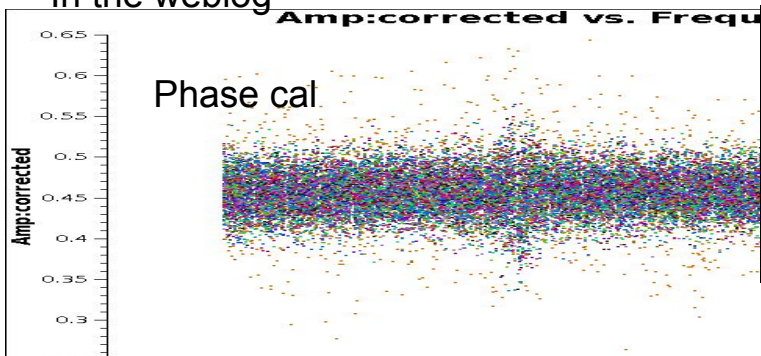


In the calibrated MS plot the Real part of visibilities: that shows also negative fluctuations due to noise



# When a line is a line?

In the weblog

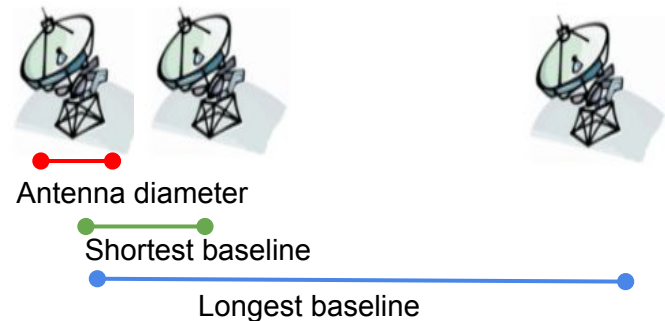
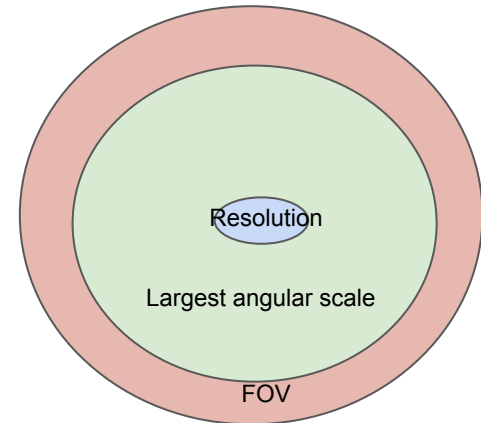
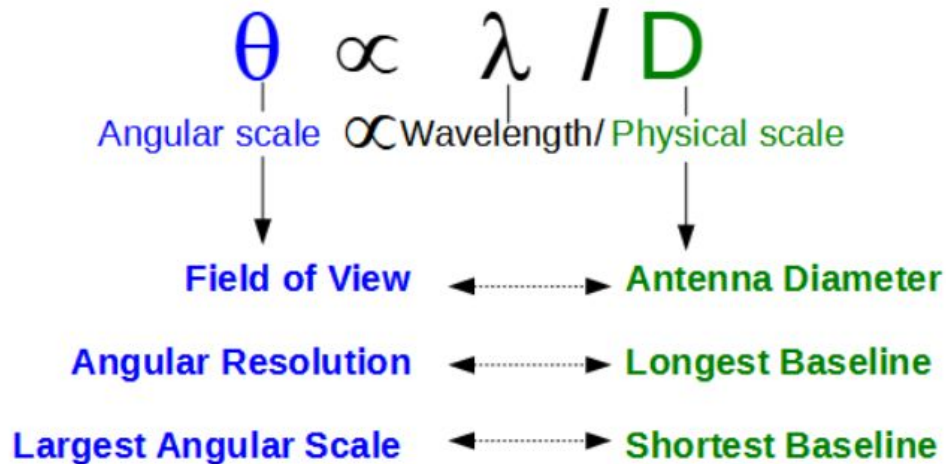


Questions?

# The interferometer is a filter in angular scales

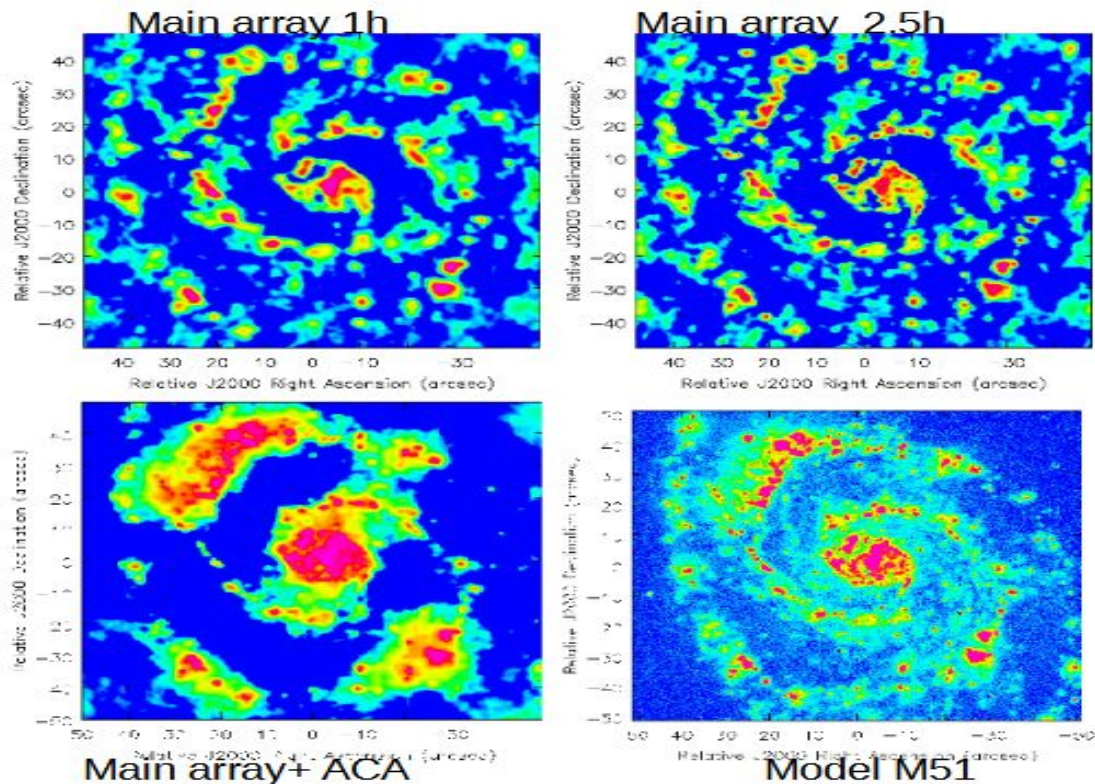
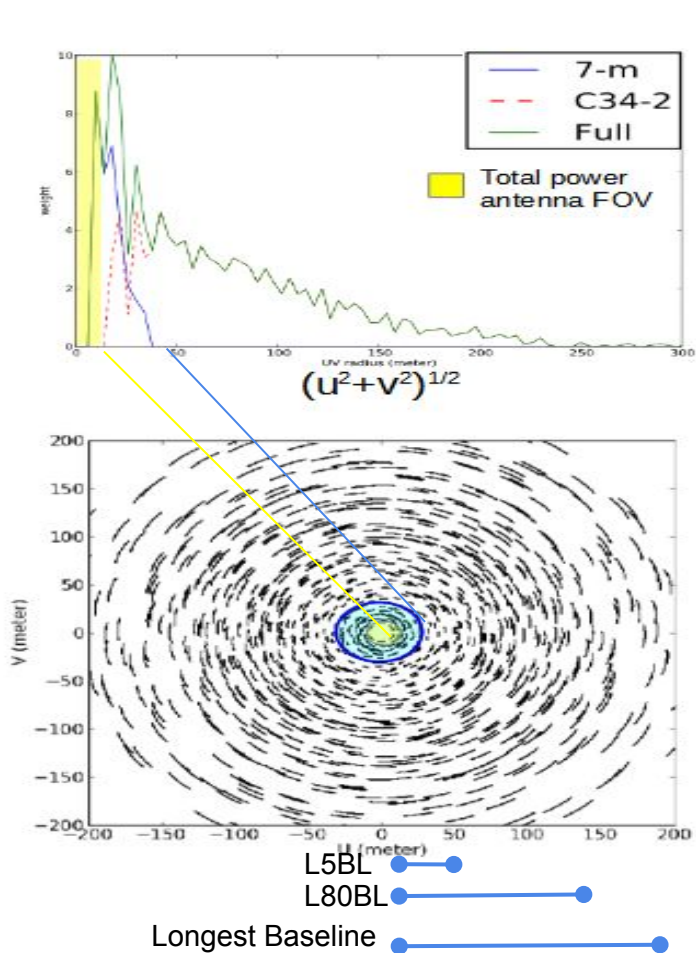
The interferometer is a filter in angular scales:  
scales smaller than resolution are smoothed,  
scales larger than the maximum recoverable scale are not observed.

Remember that observed angular scales are associated to array lengths and observed wavelength according to



and that noise decrease with increasing the observing time

# The interferometer is a filter in angular scales



**Data on the same scales improve sensitivity on those scales.  
Data on different scales reconstruct different structures/emission**

# How to combine data?

Mind the gaps in scales when choosing the data

To improve a detection -> combine images or ms on the same scales

To build an image over a broader range of scales -> combine ms on different scales

Search for M100  
(NGC4321) in B6

Combine data at same  
frequency

Check for resolution and  
maximum recoverable  
scale

L5BL and L80BL give the  
length in which 5 and  
80% of baselines are and  
provide good estimate of  
effective coverage.

ms (34)

Band	Cont. sens.	Frequency support	Min. vel. res.	Array	Ang. res.	↓ Max. reco. scale	L5 BL	L80 BL	FOV	Mosaic
	mJy/beam		km/s		arcsec	arcsec	m	m	arcsec	
6	0.4167	214.263-231.978 GHz	0.640	TP	23.557	417.564	12.000	12.000	26.098	
6	0.4728	214.264-231.978 GHz	0.640	TP	23.557	417.564	12.000	12.000	26.098	
6	1.7128	214.263-231.978 GHz	0.640	7m	5.710	38.919	6.590	27.248	244.905	mosaic
6	1.6285	214.264-231.978 GHz	0.640	7m	5.858	35.900	8.045	26.733	244.905	mosaic
6	0.2118	250.197-267.141 GHz	2.192	7m	4.977	33.570	8.054	27.201	38.591	
6	0.2158	214.265-231.977 GHz	0.640	12m	1.216	11.836	23.795	128.596	233.676	mosaic
6	0.0468	217.474-235.207 GHz	1.537	12m	0.784	8.055	35.508	194.743	52.969	mosaic
6	0.1867	214.264-231.978 GHz	0.640	12m	0.825	7.714	35.738	192.495	233.676	mosaic
6	0.0450	216.911-234.321 GHz	0.739	12m	0.207	4.309	66.849	721.619	51.361	mosaic
6	0.0325	216.808-232.726 GHz	0.640	12m	0.122	3.309	95.652	1087.453	76.460	mosaic

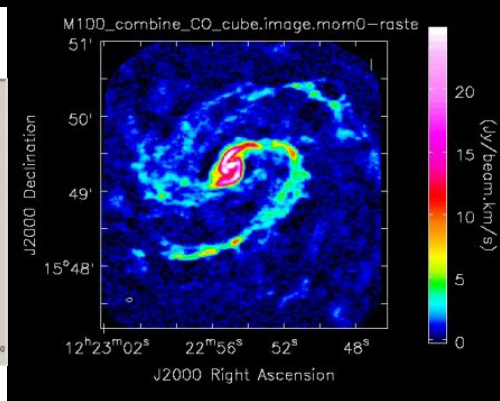
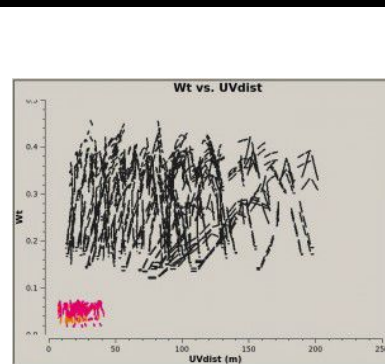
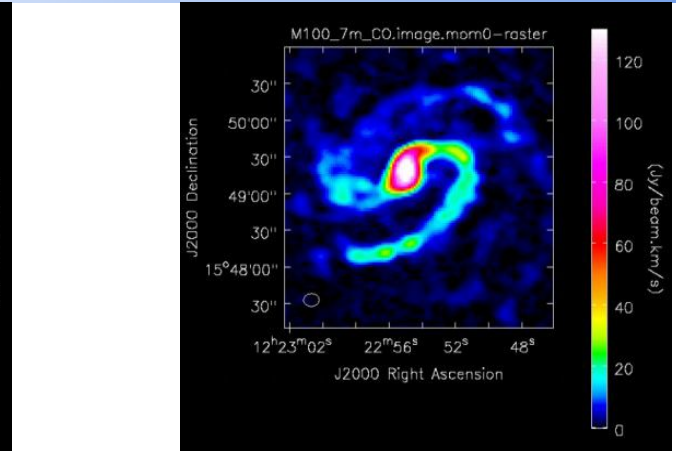
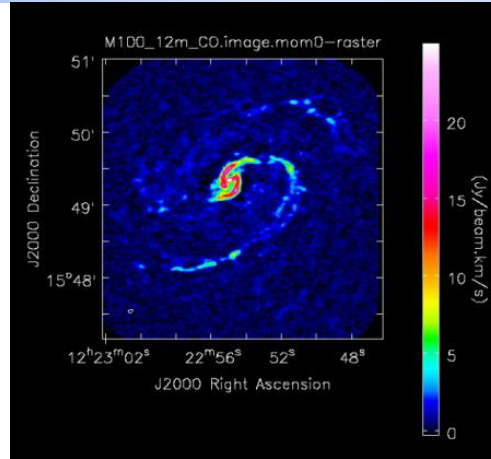
# How to combine data from different arrays?

Download raw data  
and calibrated them  
separately

Concatenate data and  
select the same  
frequency range

Properly weight the  
different datasets

Perform imaging of  
concatenated data



CASA Guide on array combination

[https://casaguides.nrao.edu/index.php?title=M100\\_Band3\\_Combine\\_6.2](https://casaguides.nrao.edu/index.php?title=M100_Band3_Combine_6.2)

# How to stack images?

**IF you know the distribution of emission as a function of angular scales** (e.g. for a point source)

or

**IF you know you are combining data on the same angular scales** (e.g. from data observed in the same array conditions, but on different time otherwise also noise non-gaussianity would sum)

then

**it is possible to do stacking of the images to improve the sensitivity of the detections**

Download the images

Rebin the cubes to the same rest frame frequency grid

Smooth the images to the same pixelization grid

Average the images per pixel and channel

## **CAVEATS!!!!**

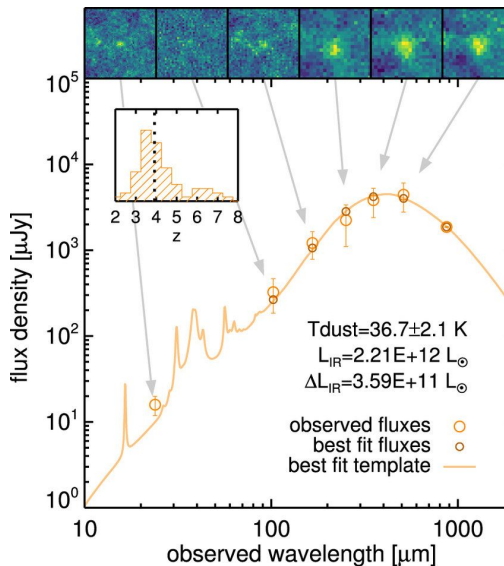
**Rebinning channels in a cube is not equal to make a cube with a different spectral resolution (as uv coverage varies with the observed wavelength)**

- > it can be an approximation in case of flat spectra and compact objects
- > better to start with high resolution images

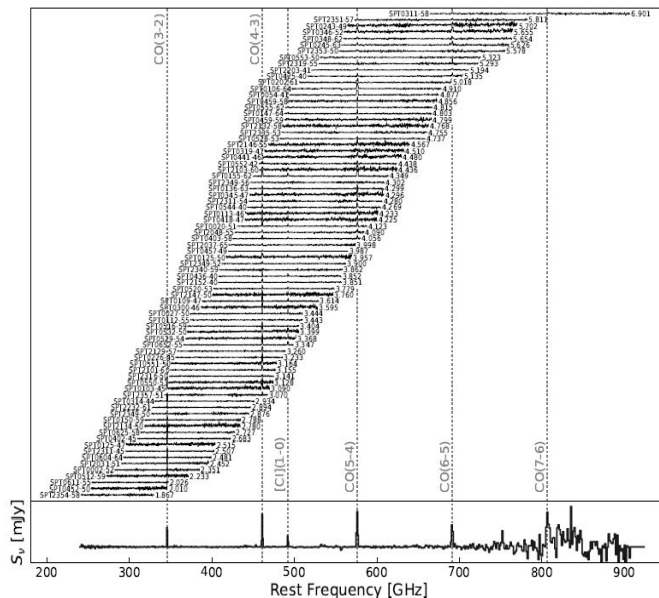
**Smoothing pixels in the image (=averaging close pixels) is not equal to make an image with lower resolution (=selecting/weighting baselines)**

- > it can be an approximation in case the source size is always smaller than the observed largest angular scale.
- > consider that the observed scales are the same among images

# How to stack images?



Wang et al. 2019  
stacking of 39 H-dropouts



Reuter et al. 2020  
stacking of 57 lensed galaxies

Typically stacking is performed on sources from the same project to guarantee the same observing conditions.

However, as it should be performed in the same rest-frame archival data from different projects might work as well.

Linestacker: <https://ibjolly.github.io/LineStacker/> (Jolly et al. 2020)

I-TRAIN #9 tutorial: <https://almascience.eso.org/tools/eu-arc-network/i-train>

<https://www.youtube.com/watch?v=1WtImPA0jcY>



# How to stack images?

Search

Position	Energy	Project	Publication	Observation
Source name	Frequency	Project code	BibCode	Observation Date
ALMA source name	Band	Project Title	Publication Title	Polarisation Type
RA Dec	Spectral resolution	Project abstract	Abstract	Member ous id
Galactic	Continuum sensitivity	PI Full Name	First Author	
	Line sensitivity (10 km/s)	Proposal authors	Authors	
	Science keyword			

Object type

Public data only

Calibration observations

Source name	Frequency	Project code	BibCode	Observation Date
	mJy/beam			
	0.1181	343.000.358.839 GHz		2012-12-06
	0.9115	330.246.346.109 GHz		2012-12-06
	0.1136	337.000.353.001 GHz		2012-12-06
	0.5346	337.000.352.989 GHz		2012-12-20
	0.5346	337.000.352.992 GHz		2012-12-20

Enter keywords

- Active galaxies
- Active Galactic Nuclei (AGN)/Quasars (QSO)
- Galactic centres/nuclei
- High-z Active Galactic Nuclei (AGN)
- Outflows, jets, feedback
- Starburst galaxies
- Starbursts, star formation

Molecules

Line:

If you want to stack objects of the same kind, a good starting point could be to query for “Science keyword” (according to PI indication in proposals) or “Object type” (according to NED definition).

**Object type**

**Info:** Only show ALMA observations for which [SIMBAD](#) or [NED](#) contain at least one object with the given object type in ALMA's observation footprint. If **'Best match'** is selected, then show those ALMA observations, where the selected object type matches the object type of the SIMBAD or NED source that has most likely been targeted by the ALMA PI.

**Warning:** Use with great care! The object type identification is by construction incomplete. There will be false-positives and false-negatives. Identifications may change with time as is true for all scientific measurements. Also several categories may apply to a single object but only the main type is used here.

**Description:** The SIMBAD or NED objects that fall within an ALMA observation's footprint are retrieved. That ALMA observation is shown in the result table in case any SIMBAD or NED object with the selected object type falls within the ALMA observation's footprint. ALMA observations mostly target a single object per footprint. We try to identify the 'best' object out of the many SIMBAD or NED objects for each ALMA observation by taking the object that has the best combination of having a close name to the ALMA source name given by the PI, being a strong source and finally of being close to the RA/Dec position given by the PI.

# Questions?

**For any ALMA related issue remember that you can always contact us**



EUROPEAN ARC  
ALMA Regional Centre

<https://help.almascience.org/>

# Now let's try to...

- 1) ... search if a position/source has been observed as target, calibrator or spuriously in other observations (try with your favourite source, giving coordinates and/or source name...  
one of my favourite is Centaurus A at 13:25:27.60 -43:01:09.4)
- 2) ... choose a target field and identify candidate sources in the field using CARTA  
(try with projID= "2013.1.00718.S" PI= "Dunlop"  
or projID= "2013.1.00718.S" PI= "Aravena"  
or projID= "2018.1.00035.L" PI= "Kohn" )
- 3) ... build the SED and/or a time series for a source  
(try with Centaurus A, PKSJ1921-293, 3C273, 3C279)
- 4) ... select a set of images that could be averaged or ms that could be combined  
(try with local galaxies as Centaurus A, NGC5135 or NGC2992, or 3C273 and 3C279)
- 5) ... select a set of images that could be stacked  
(try searching all the "high-z Active Galactic Nuclei", of which you know the redshift)