



End-to-end workflow from searching for data to producing a science-grade image

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Find your target in the archive



Nearby starburst galaxy NGC 4945

Has been observed with Herschel/HIFI

Our goal is to find its data in the ALMA archive...

...and make better images



ALMA Science Archive Query

Query Form

Results Table

Search

Reset

Que

Position

Source name (Resolver)

Source name (ALMA)

NGC4945

RA Dec

Energy

Frequency

Bandwidth

Spectral resolution

Band

Time

Observation date

Integration time

Polarisation

Polarisation type

Observation

Project

Options



Find the data...



Atacama Large Millimeter/Submillimeter Array

In search of our Cosmic Origins

Request Handler

Martin Zwaan [Logout](#)

[Archive Requests](#) [All Requests](#) > [Req #802,541,529](#)

Request #802541529 by Martin Zwaan ✓

[Click to edit](#)

Include raw [Select All](#) [Deselect All](#) [Download Selected](#)

[Requested Projects](#) / [OUSets](#) / [Executionblocks](#)

Data entities 1-4 of 4

Project / OUSet / Executionblock	File	Size	Access
<input checked="" type="checkbox"/> Project 2012.1.00912.S			
<input checked="" type="checkbox"/> Science Goal OUS uid://A002/X5a9a13/X526			
<input checked="" type="checkbox"/> Group OUS uid://A002/X5a9a13/X527			
<input checked="" type="checkbox"/> Member OUS uid://A002/X5a9a13/X528			

Data entities 1-4 of 4

8.0GB





Find out what is in the package



Download the package:

2012.1.00912.S_uid___A002_X5a9a13_X528_001_of_001.tar

and download the raw data as well:

2012.1.00912.S_uid___A002_X5b1929_X57d.asdm.sdm.tar

untar the lot

Name	Date Modified	Size	Kind
2012.1.00912.S	Today 11:26	--	Folder
science_goal.uid___A002_X5a9a13_X526	Today 11:26	--	Folder
group.uid___A002_X5a9a13_X527	Today 11:26	--	Folder
member.uid___A002_X5a9a13_X528	Today 11:21	--	Folder
calibration	7 March 2014 15:18	--	Folder
log	7 March 2014 15:18	--	Folder
product	7 March 2014 15:18	--	Folder
qa	7 March 2014 15:18	--	Folder
raw	24 January 2013 09:52	--	Folder
README	7 March 2014 15:18	7 KB	TextEd...ument
script	7 March 2014 15:18	--	Folder
2012.1.00912.S_uid___A00...9a13_X528_001_of_001.tar	Today 10:54	271.3 MB	tar archive
2012.1.00912.S_uid___A002_X5b1929_X57d.asdm.sdm.tar	Today 11:10	8.35 GB	tar archive
downloadRequest802541529.sh	Today 10:45	2 KB	shell script



Where are the images/cubes?



Inside the directory 'products', you can find FITS images and cubes

- ▼ 2012.1.00912.S
 - ▼ science_goal.uid__A002_X5a9a13_X526
 - ▼ group.uid__A002_X5a9a13_X527
 - ▼ member.uid__A002_X5a9a13_X528
 - ▶ calibration
 - ▶ log
 - ▼ product
 - uid__A002_X5b1929_X57d.continuum.fits
 - ▶ uid__A002_X5b1929_X57d.continuum.mask
 - uid__A002_X5b1929_X57d.fluxcal.continuum.fits
 - ▶ uid__A002_X5b1929_X57d.fluxcal.continuum.mask
 - uid__A002_X5b1929_X57d.NGC4945.spw0.contsub.HCN.fits
 - ▶ uid__A002_X5b1929_X57d.NGC4945.spw0.contsub.HCN.mask
 - uid__A002_X5b1929_X57d.NGC4945.spw1.contsub.HC15N.fits
 - ▶ uid__A002_X5b1929_X57d.NGC4945.spw1.contsub.HC15N.mask
 - uid__A002_X5b1929_X57d.NGC4945.spw2.contsub.CS.fits
 - ▶ uid__A002_X5b1929_X57d.NGC4945.spw2.contsub.CS.mask
 - uid__A002_X5b1929_X57d.phasecal.continuum.fits
 - ▶ uid__A002_X5b1929_X57d.phasecal.continuum.mask
 - ▶ qa
 - ▶ raw
 - README
 - ▶ script

continuum image

cubes centred around 'main' spectral lines

clean masks

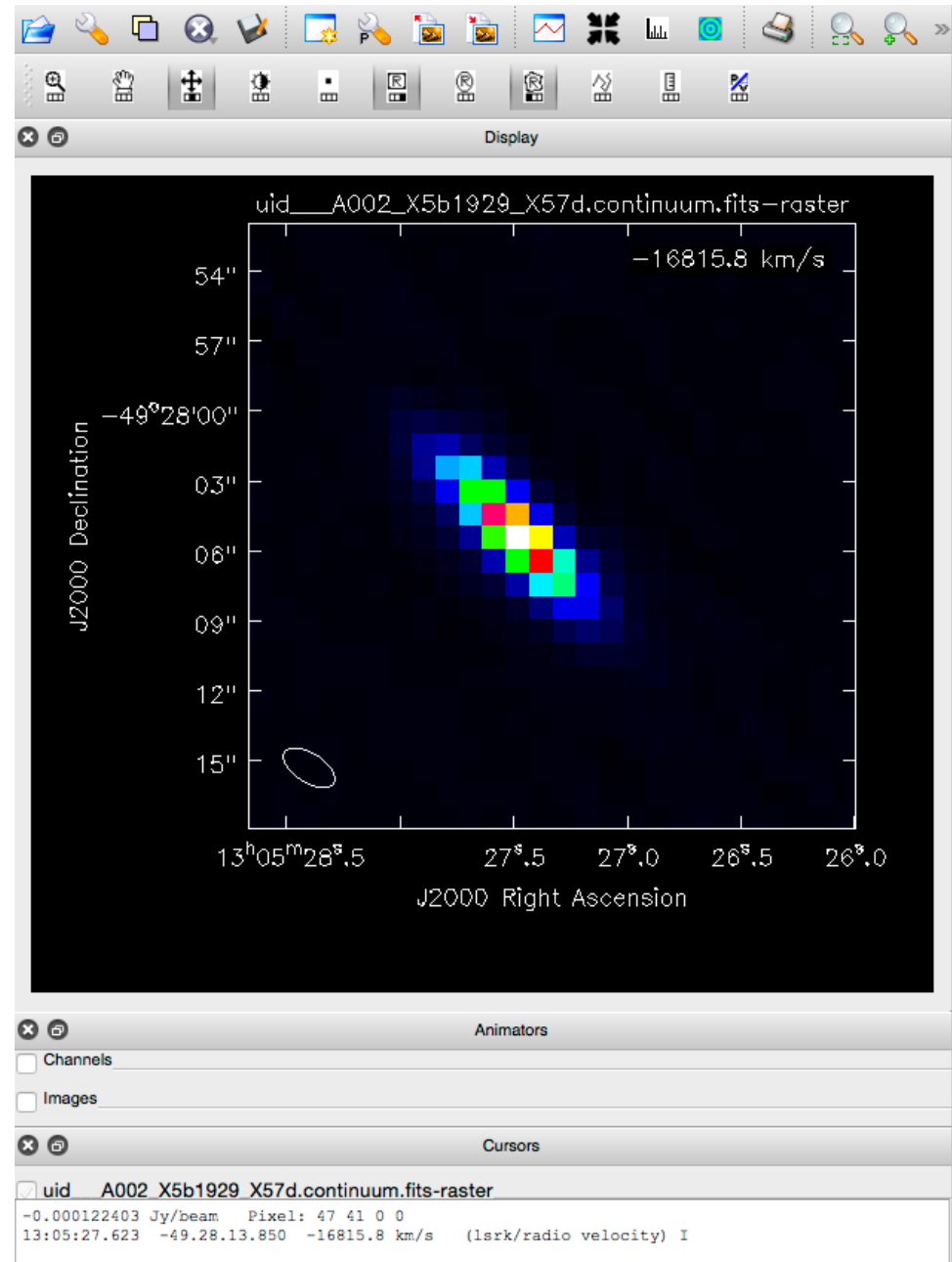


What do the images and cubes look like?



Inside casa, use 'imview' to display the image or cube

```
imview('uidxxx.continuum.fits')
```



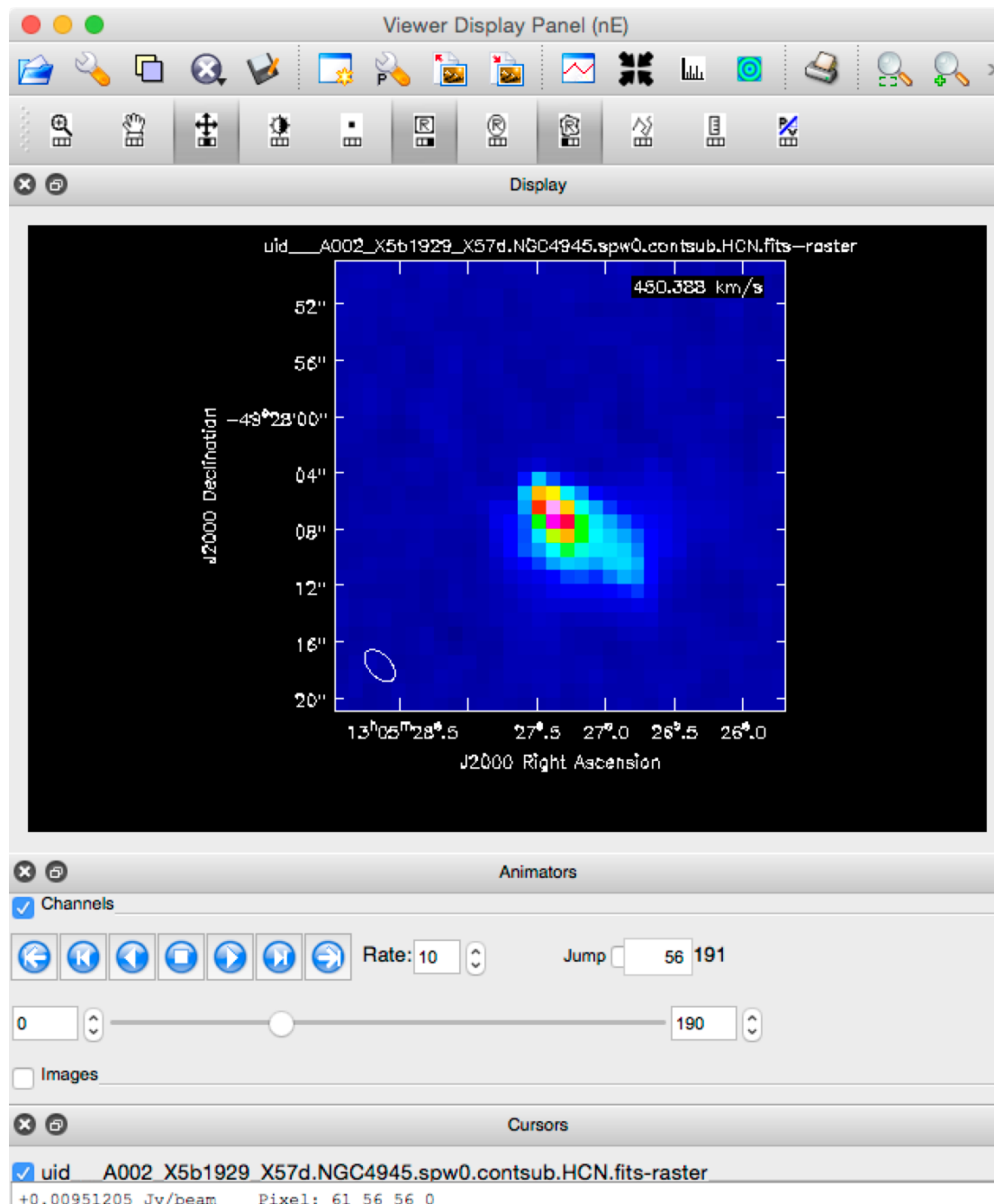


What do the images and cubes look like?



Inside casa, use 'imview' to display the image or cube

```
imview('uidxxx.HCN.fits')
```





But I want other images...



The standard package will contain **a continuum image**, and some **cubes of lines** that were mentioned in the proposal

Perhaps you want more:

- **Better deconvolution** (more careful definition of clean boxes)
- **Self-calibration** to enhance the image dynamic range
- Make cubes of **other spectral lines**
- Something else

If you want to re-image:

you have to **recreate the calibrated measurement set.**

(Note: for Cycle 0 data, this ms is contained within the package)



Rerun the calibration script



in directory `script`, start up casa and execute `scriptForPI.py`

```
> execfile('scriptForPI.py')
```

This will **execute the tailored calibration script.**

(apply flagging, do different kinds of calibration:

T_{sys} , wvr, bandpass, phase, and flux scale)

Note: This runs for one or two hours.

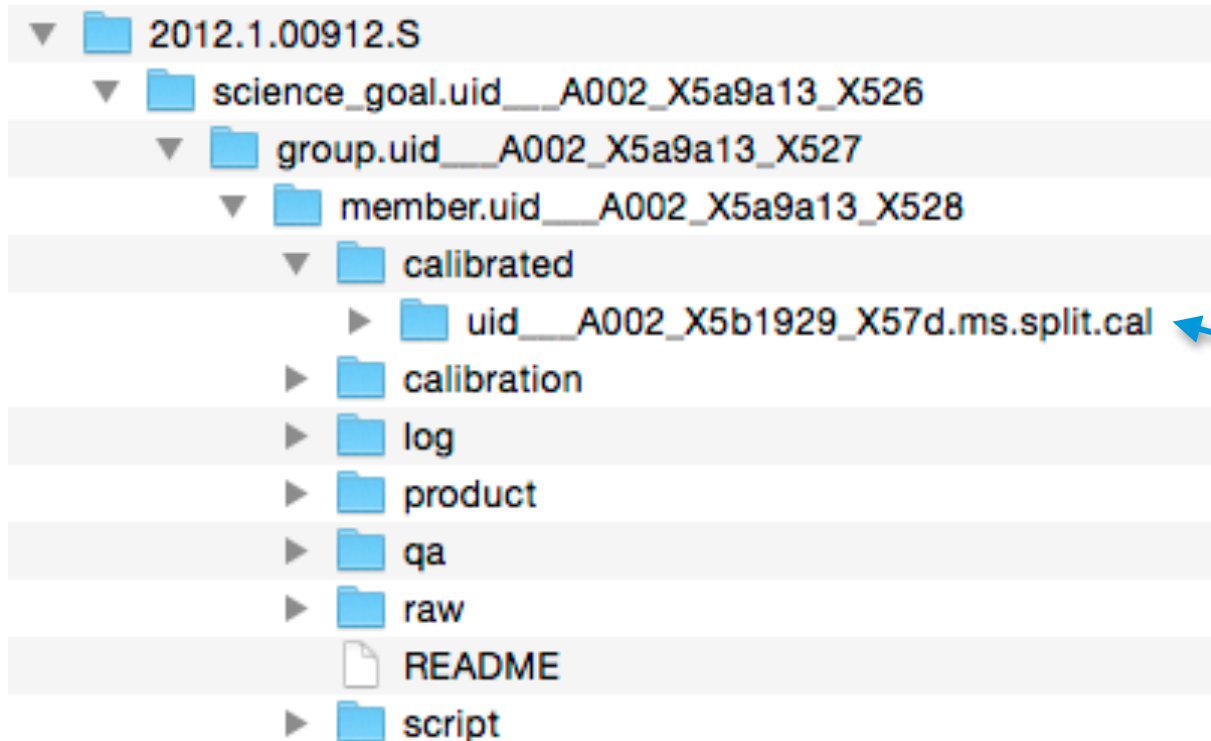
Needs a lot of space! (at least 100 Gb)

The **result is a fully calibrated measurement set**, inside the directory `calibrated`

Now, you are ready to make more images and cubes



After running the calibration script



**Fully calibrated
measurement set.
Ready for imaging!**



For interferometry data, imaging entails two important steps:

1. Fourier transform

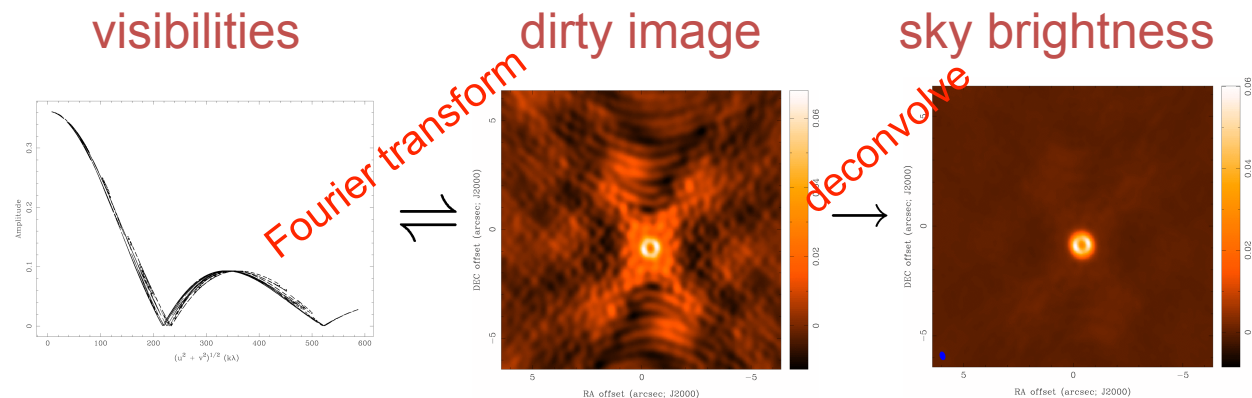
The interference pattern is directly related to the source brightness. The complex visibility, $V(u,v)$, is the 2D Fourier transform of the brightness on the sky, $T(x,y)$

$$V(u, v) = \iint T(x, y) e^{2\pi i(ux+vy)} dx dy$$

$$T(x, y) = \iint V(u, v) e^{-2\pi i(ux+vy)} du dv$$

2. Deconvolution

Unfilled aperture: Incomplete sampling of uv plane: sidelobes





Imaging in CASA



This is done with the task **'clean'**.

This task does **both the Fourier transform and the deconvolution** in a nested way

It can be done **interactively** or **'blind'**

One can choose

- frequency range
- continuum or cubes
- width of output channels
- weighting scheme (enhance resolution vs enhance sensitivity)
- tapering of the data
- image size
- and many more advanced options...



Deconvolution with CLEAN



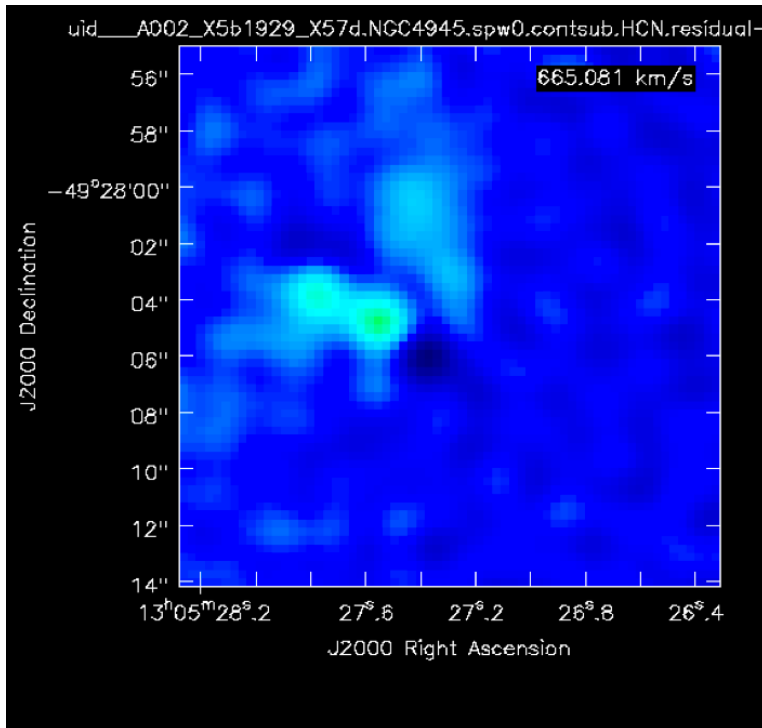
The most common method for deconvolving ALMA maps is **CLEAN**



Deconvolution with CLEAN



The most common method for deconvolving ALMA maps is **CLEAN**



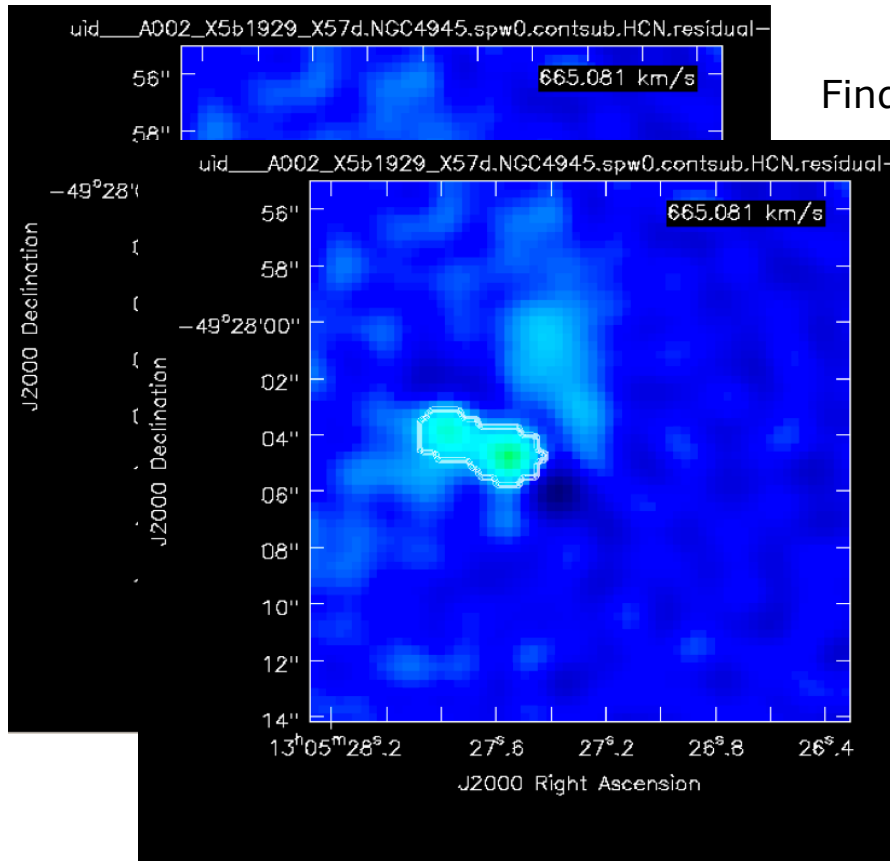
Find highest peaks in image



Deconvolution with CLEAN



The most common method for deconvolving ALMA maps is **CLEAN**



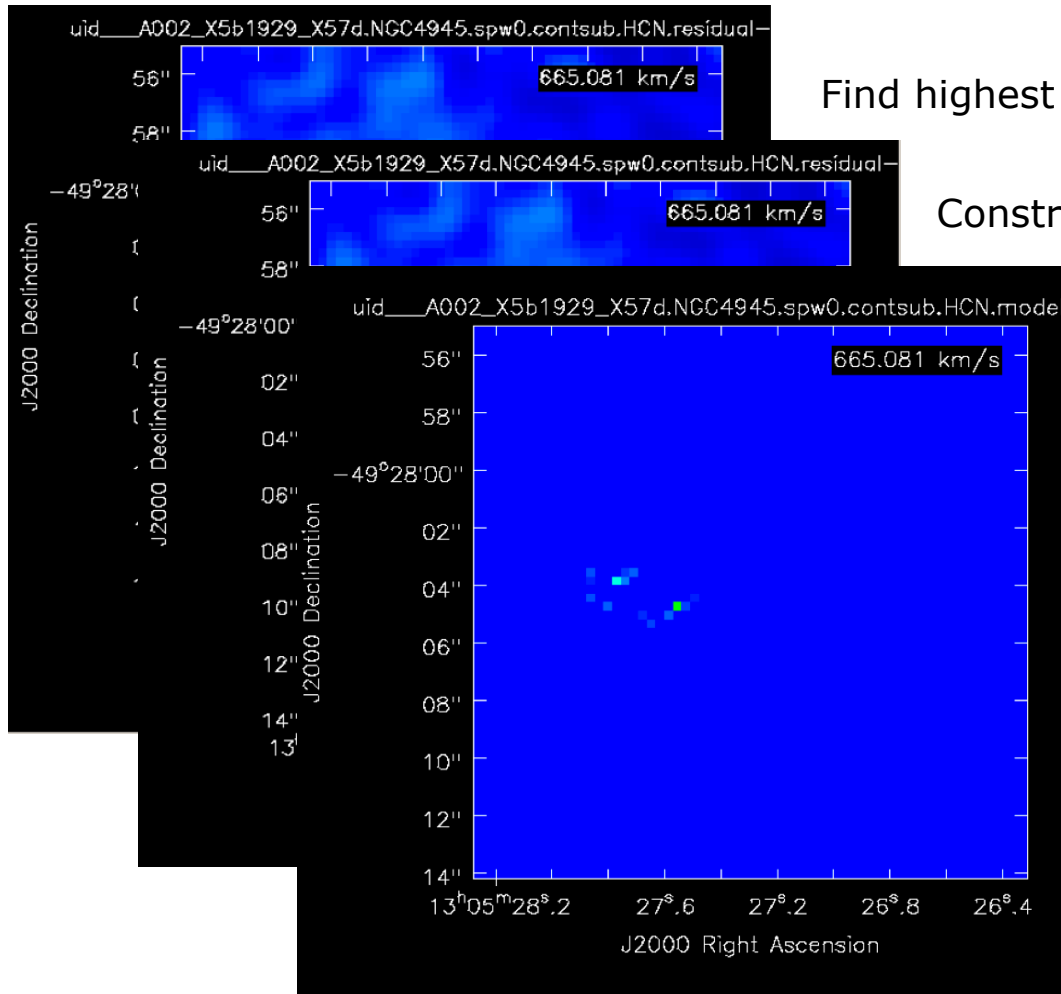
Constrain where to look for peaks: MASK



Deconvolution with CLEAN



The most common method for deconvolving ALMA maps is **CLEAN**



Find highest peaks in image

Constrain where to look for peaks: MASK

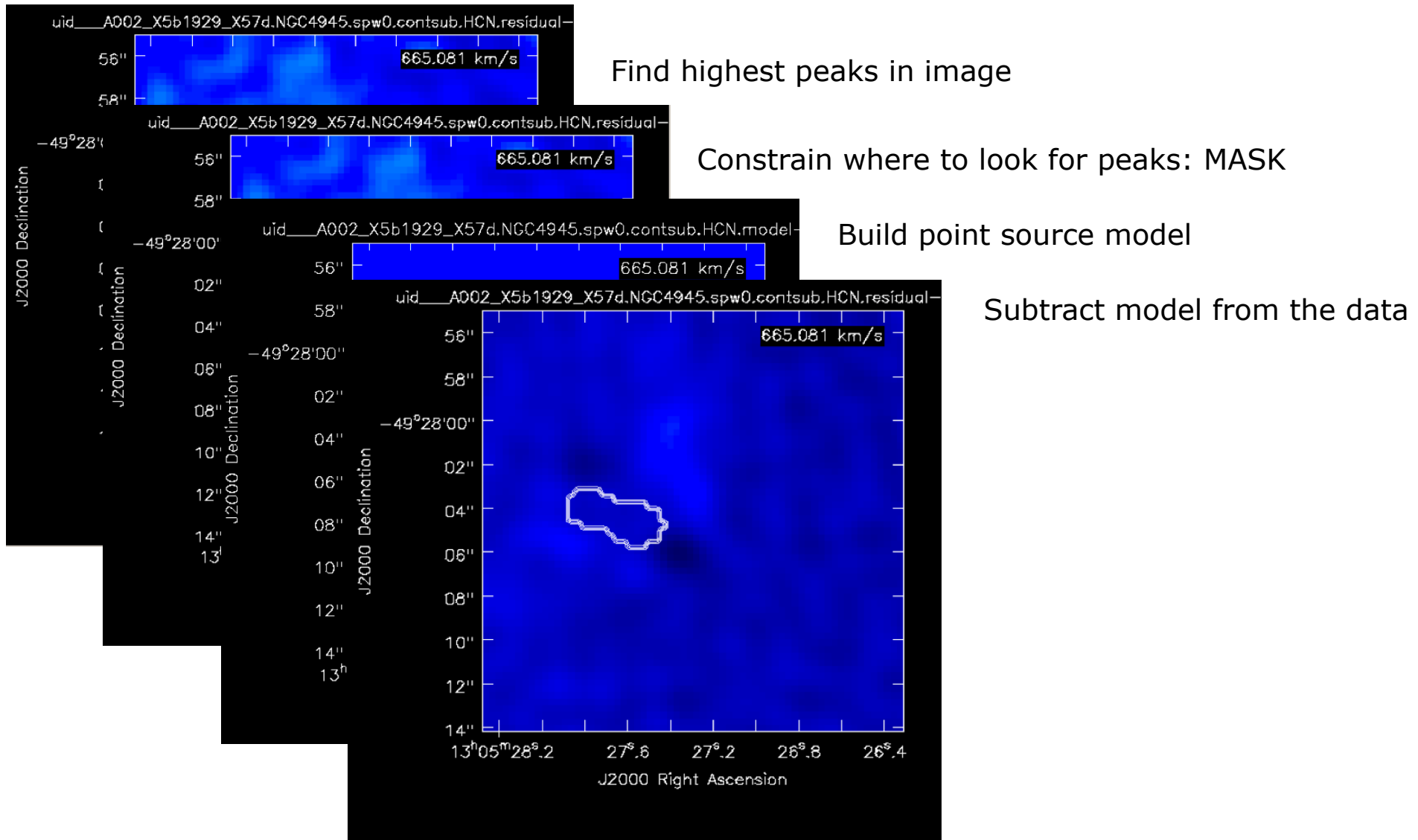
Build point source model



Deconvolution with CLEAN



The most common method for deconvolving ALMA maps is **CLEAN**

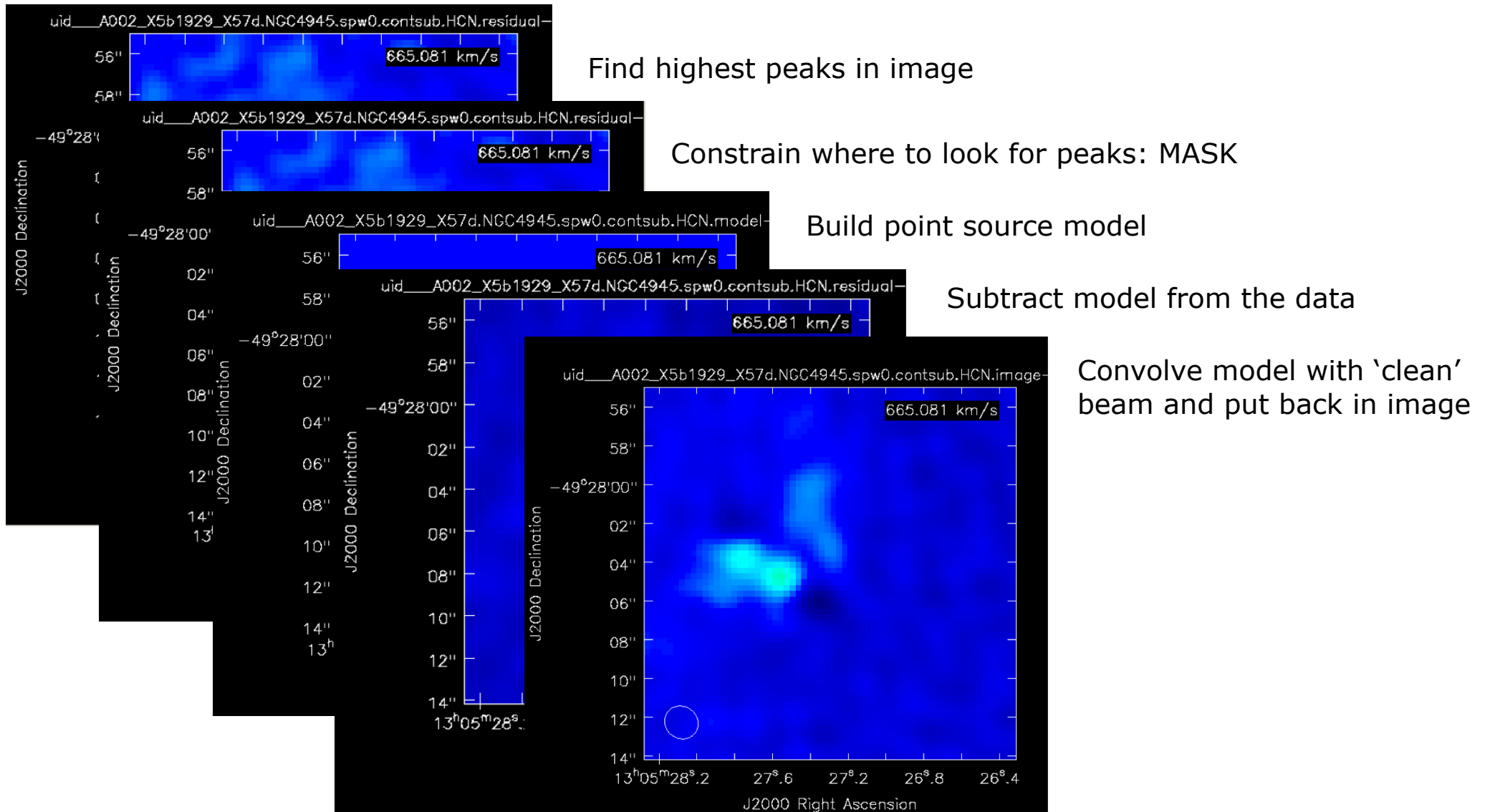




Deconvolution with CLEAN



The most common method for deconvolving ALMA maps is **CLEAN**

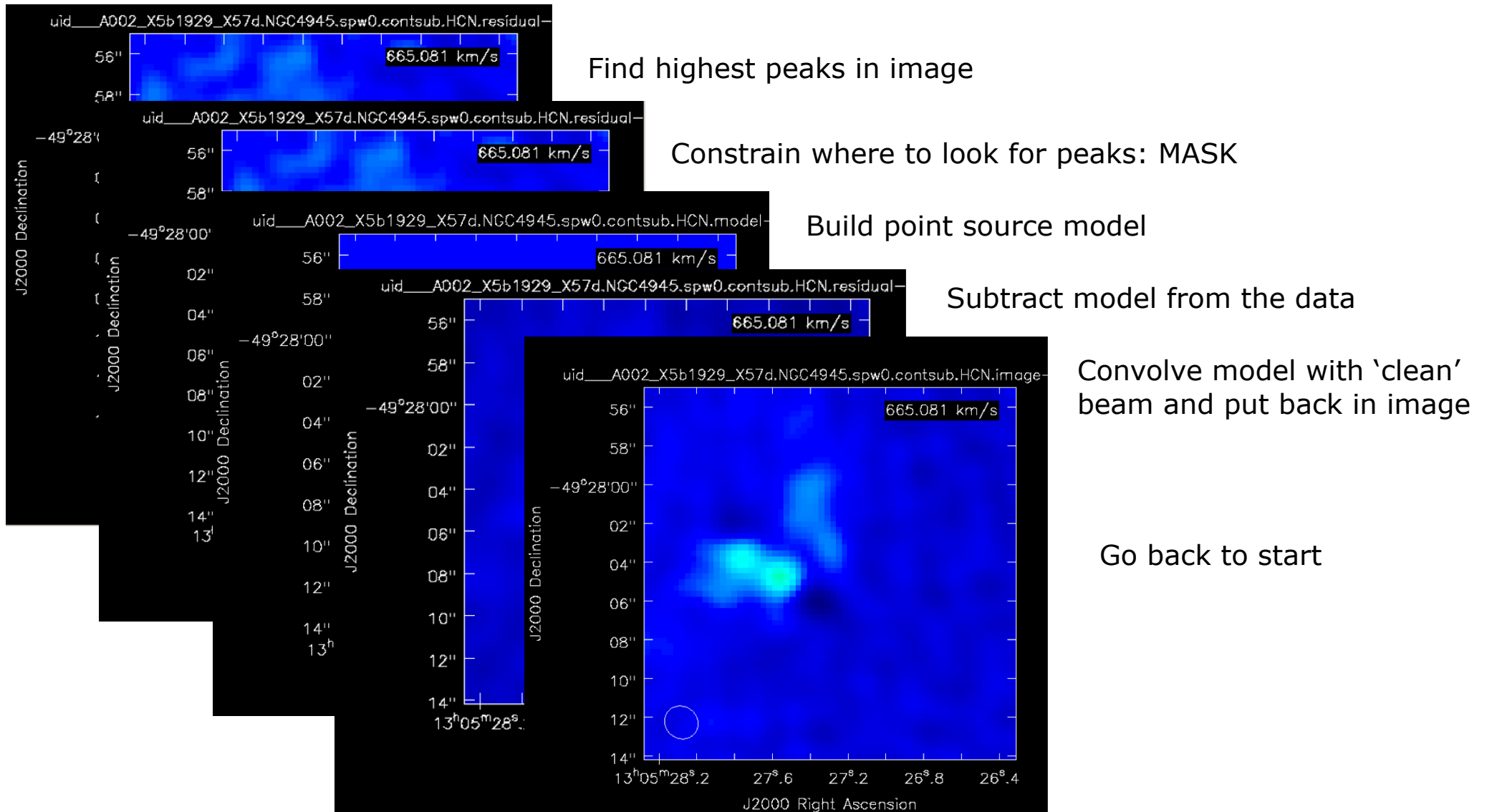




Deconvolution with CLEAN



The most common method for deconvolving ALMA maps is **CLEAN**





First step at making images



First try:

use the script that comes with the package: `scriptForImaging.py`

in directory `'calibration'`, run

```
>execfile('scriptForImaging.py')
```

This will reproduce the imaging products (FITS) that were contained in the package

It will normally produce continuum maps and line cubes, and will deconvolve using the mask files



Example: remake the continuum image



Use the script that comes with the package: `scriptForImaging.py` but **edit** the part where the **continuum image** is made

```
clean(vis='uid__blabla.ms.split.cal',  
      imagename='mycontinuum',  
      field='3',  
      spw='0:20~180;350~460,1:60~80;120~180,2:20~400;700~940,3:80~110',  
      mode='mfs',  
      niter=500,  
      imsize=100,  
      cell='1arcsec',  
      weighting='briggs',  
      robust=0.0,  
      interactive=True,  
      usescratch=False,  
      outframe='BARY')
```

All the channels that contain no line emission

multi-frequency synthesis = continuum

clean iterations

image size

pixel size



Interactive cleaning of the map



Perform N iterations

and return - every time the residual is displayed is a major cycle

continue until # cycles or threshold reached or user stop

Iterations: 100, cycles: 3, threshold: 4.5 mJy

Buttons: Add, Erase, This Channel, All Channels, This Polarization, All Polarizations, Next Action (X, Play, G)

Display: uid_A002_X5b1929_X57d.NGC4945.spw0.contsub.HCN.residual

Animators: Channels (Rate: 10, Jump: 48 191), Images (Rate: 10, Jump: 0 1)

Cursors: uid_A002_X5b1929_X57d.NGC4945.spw0.contsub.HCN.residual-raster

+0.00523306	Pixel: 122 75 0 48
13:05:25.479	-49.28.01.201 I 423.965 km/s (lsrk/radio velocity)

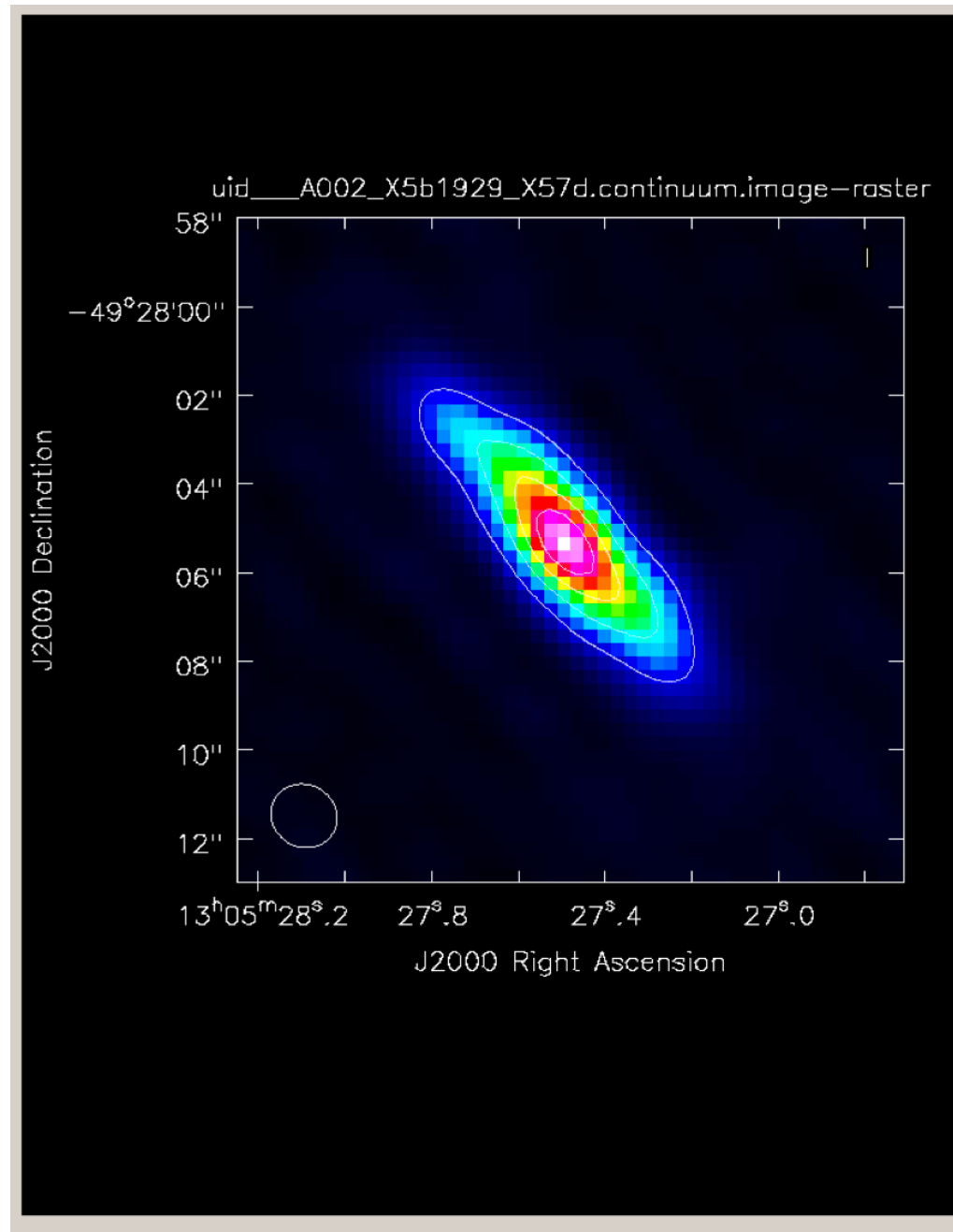
uid_A002_X5b1929_X57d.NGC4945.spw0.contsub.HCN.mask

+0 Jy/beam	Pixel: 122 75 0 48
13:05:25.479	-49.28.01.201 I 423.73 km/s (lsrk/radio velocity)

Contours: 0.2 0.4 0.6 0.8



Example: your new continuum image

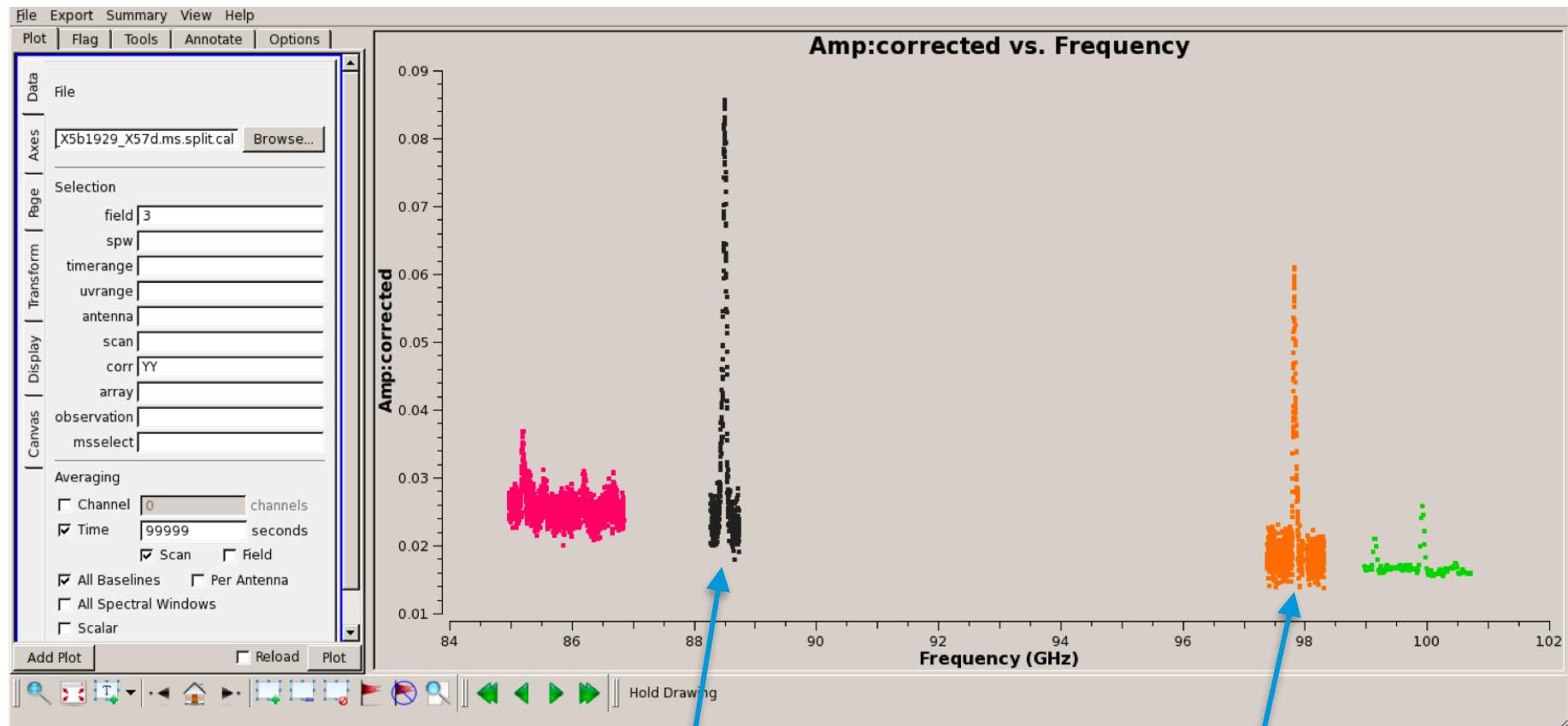




Make cube of your favourite line emission



First inspect your data. What frequency range is covered? Which lines have been observed? Use CASA task 'plotms'



HCN

CS



Make cube of your favourite line emission



Use the script that comes with the package: `scriptForImaging.py` but **edit** the part where the **line cube** is made

```
clean( vis='uid__blabla.ms.split.cal',
        imagename='mycube.HCN',
        field='0', # target
        outframe='BARY',
        spw='0', start=170, nchan=191, width=1,
        restfreq='88.63160GHz',
        selectdata=T,
        mode='channel',
        niter=300, gain=0.1,
        mask=[51,50,76,71],
        interactive=True,
        imsize=128,
        cell='1arcsec',
        weighting='briggs', robust=0.0,
        threshold='4.5mJy',
        usescratch=False)
```

Select the channels to image

Rest frequency of the HCN line

Make cube 'per channel'

First guess at a mask



Make new images from ALMA archive data



- Deconvolution uses non-linear techniques
- Synthesis imaging: it is easy to make an image, but not easy to know if your image is right!
- Need help? Use the ALMA Helpdesk or visit one of the European ARC nodes for face-to-face help!