

Simulating observations

Helping us to see what ALMA sees

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UK ALMA Workshop 2026
The University of Manchester



Why simulate ALMA observations?

Proposal preparation

- Test your technical case — i.e. can you achieve your goals with a realistic ALMA setup?
- Strengthen your science case — showcase what ALMA will be able to detect with your proposed setup, and how this links to your science.

Comparing numerical simulations with real data

- Comparing models and observations crucial. Model data can be ‘corrupted’ with observational noise and artefacts in order to make a fairer comparison, and ultimately strengthen models.

Education

Exploring new observing modes and capabilities

How to simulate ALMA observations?

There are several methods available in CASA

simobserve

- Simulates observation, returns visibilities

simanalyze

- Clean the simulated visibilities, returns images
- Also compares input vs. output, returns results
- If you want more control over imaging, use `simobserve + tclean`

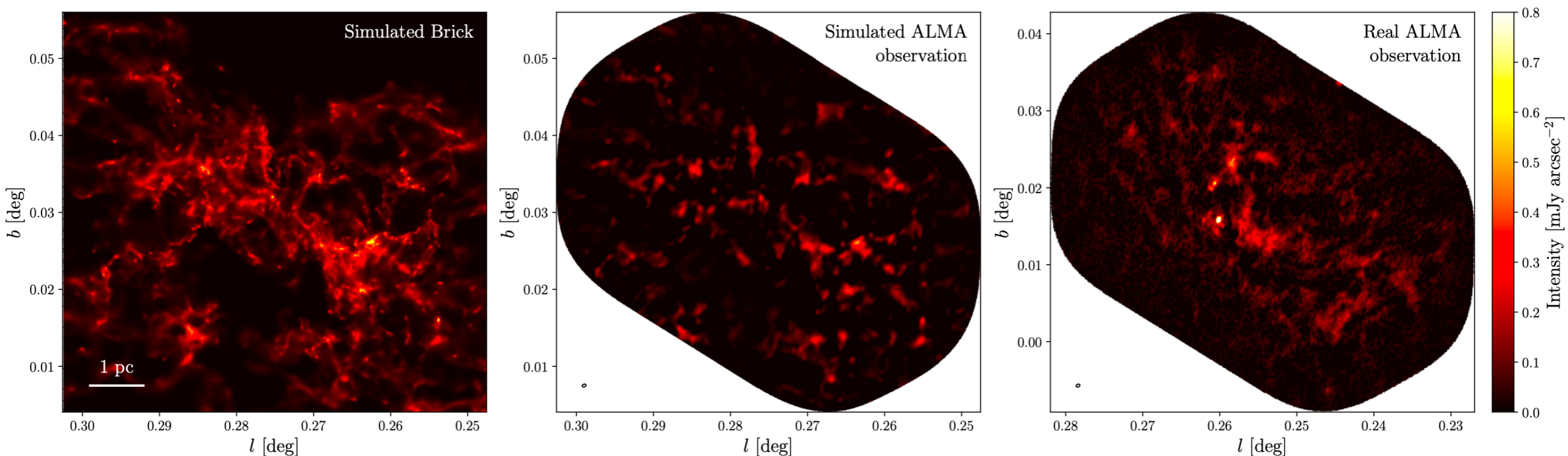
simalma

- Combines `simobserve` & `simanalyze` for you

These tasks are all wrappers around the sm toolkit, which you can also use

How to simulate ALMA observations?

- Snapshot of numerical simulation of a cloud (left)
- `simobserve` + `tclean` simulated observation (centre)
replicating real observation
- Real (Cycle 0, 3mm) ALMA 12m + 7m continuum (right)



The ALMA Observation Support Tool (OST)

- An online ALMA simulator to create a synthetic observations
- Set up an observation by defining some basic parameters (e.g. frequency, resolution, time-on-source)
- Provide your own FITS image to 'observe', or choose from one of the examples

almaost.jb.man.ac.uk

The ALMA Observation Support Tool (OST)

- Available since Cycle 0 (2011)
- OST is aligned with current and past ALMA capabilities, not built for exploratory simulations
- OST is also quite old now. Time for a refresh ...

almaost.jb.man.ac.uk

ALMA Observation Support Tool Version 9.0

OST NEWS HELP QUEUE LIBRARY ACKNOWLEDGE ALMA HELPDESK

WARNING: Issues with Gmail accounts. (more info). OST Team

Array Setup:

Instrument:

Select the desired ALMA antenna configuration. Full ALMA means the simulations will be done with the full capabilities ALMA will achieve in the future (e.g. observing with 50 antennas, or Band 10 Configuration 10 observations); some of these may not yet be offered in the current cycle. Selecting cycle-specific configurations will simulate the capabilities of ALMA in that cycle, and therefore some observations might be restricted (you will be notified if this is the case). Please, refer to the [ALMA documentation](#) for each cycle capabilities.

Sky Setup:

Source model:

Upload: No file chosen

Choose a library source model or supply your own. You may upload your own model here (max 10MB). This must be a FITS file with the extension .fits included in the name of the file, e.g. model.fits.

Declination:

Image peak / point flux in

Ensure correct formatting of this string (+/-00d00m00.0s). Rescale the image data with respect to new peak value. Set to 0.0 for no rescaling of source model.

Observation Setup:

Observing mode: Spectral Continuum

Central frequency in GHz:

Bandwidth in :

Use full Stokes parameters: Yes No

Number of polarizations:

Spectral or continuum observations? The value entered must be within an ALMA band. Select the total bandwidth for continuum observations. Enter 7.5 GHz to select ALMA recommend full continuum setup. If your input image contains more than one Stokes plane use them all (Yes), or just Stokes I (no/default). This affects the noise in the final map. Ignored in continuum mode if "Use full Stokes parameters" is set to yes.

Required resolution in arcseconds:

OST will choose array config based on this value if *instrument* is set to ALMA.

Introducing GHOST

Generalised Hybrid Observation Support Tool

- A more modern web-app to allow more flexible and exploratory ALMA simulations, including
 - Homogeneous and heterogeneous arrays
 - Many more antennas (current limit is 300)
 - And much more to be added
- Tool is live, though it is under active development

[**alma-ghost.jb.man.ac.uk**](http://alma-ghost.jb.man.ac.uk)



Submit Simulation Job

Array Configuration ⓘ

- Use standard ALMA configuration
- Use experimental configuration
- Upload custom configuration

ALMA 12m C-1



ALMA Cycle 13 configuration 1 (43 × 12m, most compact)

Current ALMA configs (12m, 7m, TP)

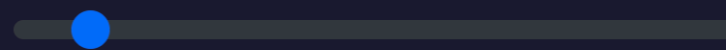
Observation Parameters

Declination * ⓘ

-23d00m00.00

Format: ±DDdMMmSS.SS (e.g., -23d00m00.00). Range: -70° to +40°.

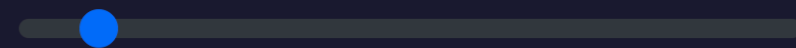
Time on Source



1h

Range: 10s to 12h (e.g., 30s, 5m, 2h)

PWV (mm) ⓘ



1.0

Range: 0.2 - 10 mm



Submit Simulation Job

Array Configuration i

- Use standard ALMA configuration
- Use experimental configuration
- Upload custom configuration

ALMA 12m C-1



ALMA Cycle 13 configuration 1 (43 × 12m, most compact)

Exploratory ALMA configs, including:

- 200x12m antennas
- 150x12m + 12x25m antennas

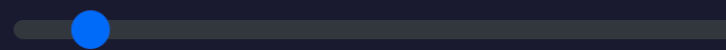
Observation Parameters

Declination * i

-23d00m00.00

Format: ±DDdMMmSS.SS (e.g., -23d00m00.00). Range: -70° to +40°.

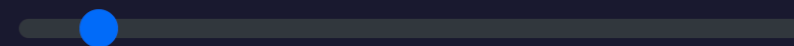
Time on Source



1h

Range: 10s to 12h (e.g., 30s, 5m, 2h)

PWV (mm) i



1.0

Range: 0.2 - 10 mm



Submit Simulation Job

Upload your own configuration

- Up to 300 antennas
- Max 2 unique dish diameters

Array Configuration ⓘ

- Use standard ALMA configuration
- Use experimental configuration
- Upload custom configuration

ALMA 12m C-1 ▼

ALMA Cycle 13 configuration 1 (43 × 12m, most compact)

Observation Parameters

Declination * ⓘ

-23d00m00.00

Format: ±DDdMMmSS.SS (e.g., -23d00m00.00). Range: -70° to +40°.

Time on Source

1h

Range: 10s to 12h (e.g., 30s, 5m, 2h)

PWV (mm) ⓘ

1.0

Range: 0.2 - 10 mm



Submit Simulation Job

Array Configuration (i)

- Use standard ALMA configuration
- Use experimental configuration
- Upload custom configuration

ALMA 12m C-1

ALMA Cycle 13 configuration 1 (43 × 12m, most compact)

Observation Parameters

Declination * (i)

-23d00m00.00

Format: ±DDdMMmSS.SS (e.g., -23d00m00.00). Range: -70° to +40°.

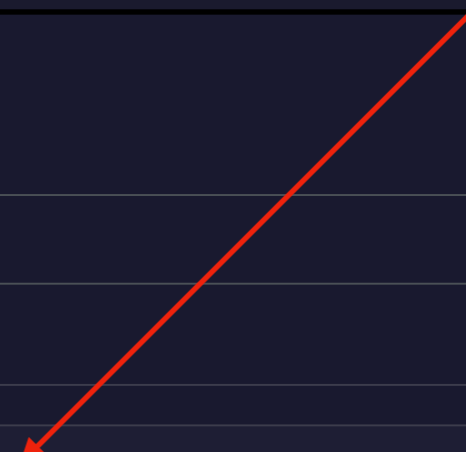
PWV (mm) (i)

1.0

Range: 0.2 - 10 mm

Control source elevation, integration time and water vapour level

More parameters will be added



Time on Source

1h

Range: 10s to 12h (e.g., 30s, 5m, 2h)

Frequency Setup

Central Frequency *

230GHz

e.g., 230GHz, 100GHz

Bandwidth *

7.5GHz

e.g., 7.5GHz, 1.875GHz

Band 6 (211-275 GHz) — Coverage: 226.25-233.75 GHz

Sky Model (i)

Ring (8+1 Gaussians)

Point + Disk

Upload FITS image

Products

Which simulation products would you like?

Just the simulated measurement set (faster)

I'd also like the dirty image (slower)

Weighting (i)

Briggs



Robust (i)

0.5



Success!


CLOUDFLARE
[Privacy](#) · [Help](#)

Select central frequency and bandwidth:

- Must fall within an ALMA band
- Max 7.5 GHz bandwidth
- Full SPW support and increased bandwidth (e.g. WSU, see talk on Wed) will be added later

Submit Simulation Job

Frequency Setup

Central Frequency *

230GHz

e.g., 230GHz, 100GHz

Bandwidth *

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e.g., 7.5GHz, 1.875GHz

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Weighting i

Briggs



Robust i

0.5



Success!



CLOUDFLARE
Privacy · Help

Choose from a built-in library of source models, or upload your own:

- FITS image must contain certain keywords
- 100 MB limit
- Spectral cubes or polarisation not supported yet
- More built-in models to be added

Submit Simulation Job

Frequency Setup

Central Frequency *

230GHz

e.g., 230GHz, 100GHz

Bandwidth *

7.5GHz

e.g., 7.5GHz, 1.875GHz

Band 6 (211-275 GHz) — Coverage: 226.25-233.75 GHz

Sky Model (i)

- Ring (8+1 Gaussians)
- Point + Disk
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Products

Which simulation products would you like?

- Just the simulated measurement set (faster)
- I'd also like the dirty image (slower)

Weighting (i)

Briggs

Robust (i)

0.5

Choose which products you want:

- MS (visibility data) only -> faster, useful if you don't need images or want to do your own imaging
- 'Dirty' (not deconvolved, see tomorrow's session on imaging) image -> gives a quick look at the data
- Full cleaning may be implemented later



Submit Simulation Job

Frequency Setup

Central Frequency *

230GHz

e.g., 230GHz, 100GHz

Bandwidth *

7.5GHz

e.g., 7.5GHz, 1.875GHz

Band 6 (211-275 GHz) — Coverage: 226.25-233.75 GHz

Sky Model (i)

- Ring (8+1 Gaussians)
- Point + Disk
- Upload FITS image

Products

Which simulation products would you like?

- Just the simulated measurement set (faster)
- I'd also like the dirty image (slower)

Weighting (i)

Briggs



Robust (i)

0.5

We'll discuss weighting more tomorrow. In brief, you can weight in favour of resolution (uniform) or sensitivity (natural)



Success!



Submit Simulation Job



My Jobs

Each job gets a unique 8-char ID

[Clear All](#)[New Job](#)

Job Code	Config	Status	Created	Action
ALMA-GHOST-7C568WQP	cycle13.1	COMPLETED	Mar 21, 2026, 8:31 AM	View
ALMA-GHOST-VTTDTKGJ	cycle13.1	COMPLETED	Mar 21, 2026, 8:31 AM	View
ALMA-GHOST-23BUZ8M9	cycle13.1	COMPLETED	Mar 19, 2026, 10:13 AM	View
ALMA-GHOST-44797ENA	cycle13.3	COMPLETED	Mar 18, 2026, 11:39 AM	View
ALMA-GHOST-5YJU6CM0	cycle13.6	COMPLETED	Mar 16, 2026, 11:58 AM	View
ALMA-GHOST-ATI03KQV	cycle13.1	COMPLETED	Mar 16, 2026, 11:28 AM	View
ALMA-GHOST-FY1JT05D	cycle13.6	COMPLETED	Mar 13, 2026, 9:29 PM	View
ALMA-GHOST-ZG2GDU0R	cycle13.1	CANCELLED	Mar 13, 2026, 9:38 AM	View
ALMA-GHOST-CR57GY1U	cycle13.1	COMPLETED	Mar 12, 2026, 9:21 PM	View

All jobs are stored in your browser. Clearing browser data removes them from this view, but they remain accessible if you know the ID.

Simulation Results

Job Code: ALMA-GHOST-5YJU6CM0

Results available for 14 days

[Back to Status](#)

i Results available until 30/03/2026 (9 days remaining).

Array Type

Homogeneous

Synthesised Beam

0.20 × 0.15"
PA -82.8°

Peak Flux

1093.86 mJy/beam

RMS Noise

22.30 mJy/beam

Dynamic Range

49.0

Image Size

1728 × 1728 px
0.026"

Antennas / Baselines

43 / 903

Integration Time

10s

Centre Freq / BW

230GHz
7.5GHz

Weighting

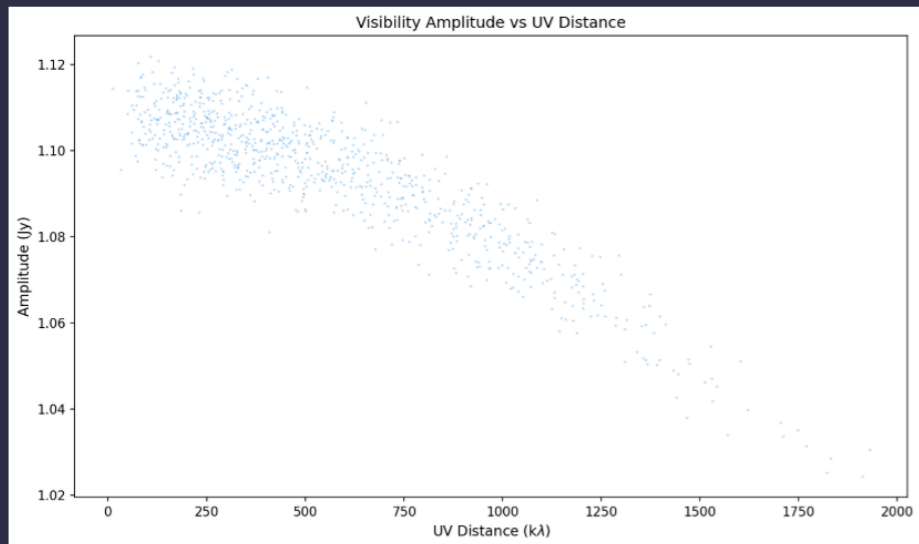
briggs (0.5)

Noise Validation

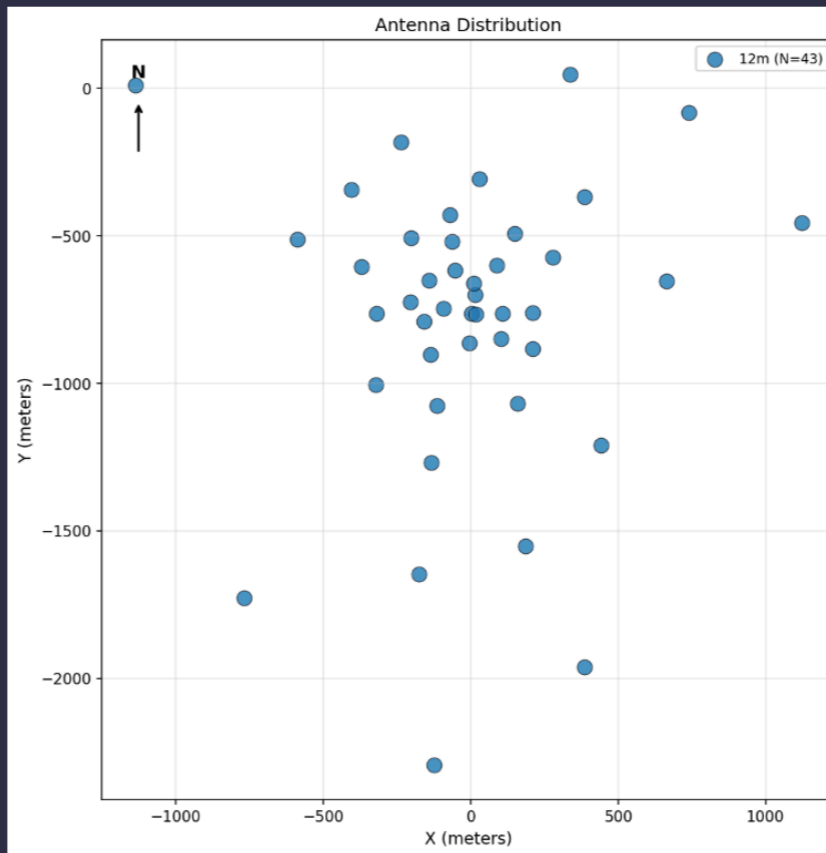
[Overview of basic stats](#)

Baseline Group	σ_{calc}	σ_{meas}	Ratio
ALL	0.214	0.206	0.962

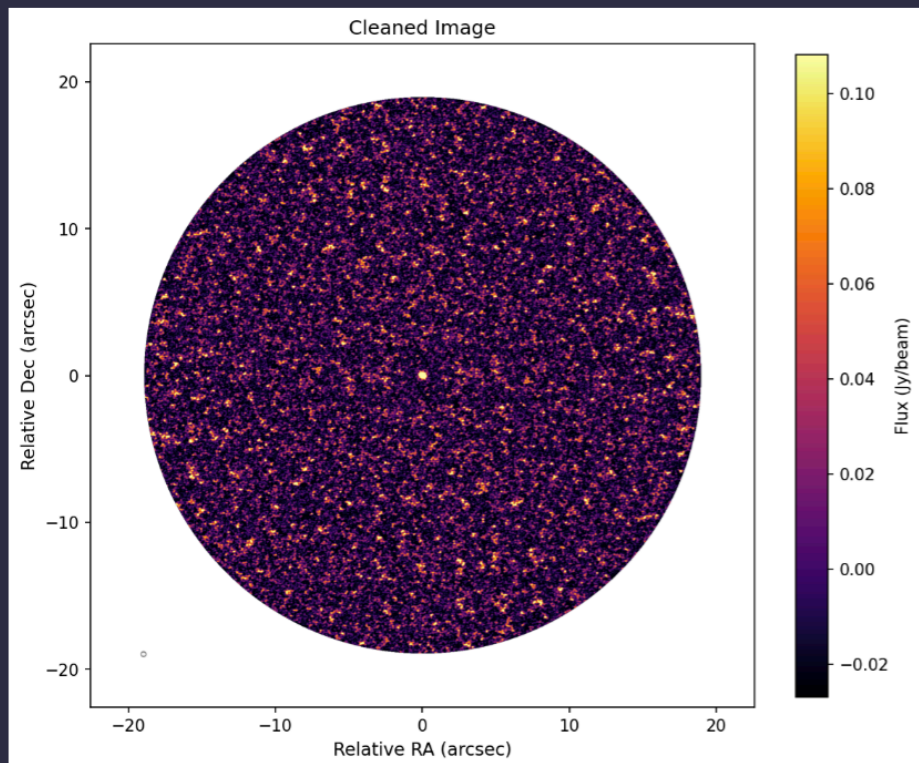
All noise values in mJy/beam.



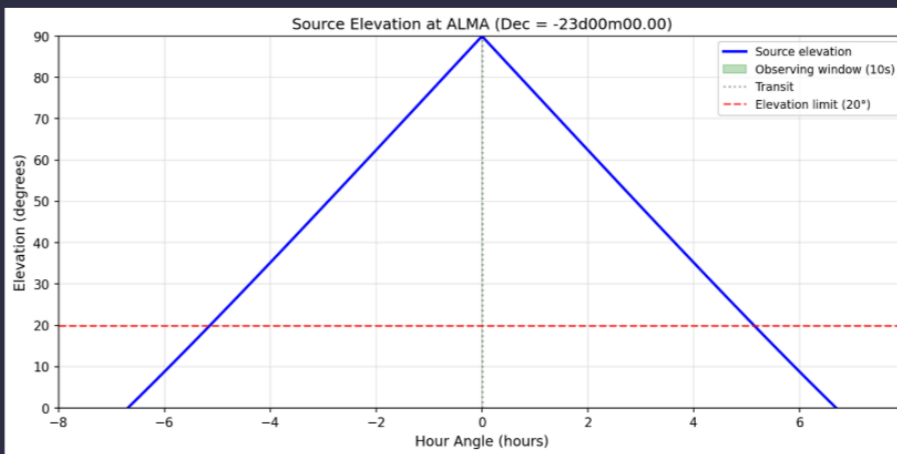
Visibility amplitude vs UV-distance



Array antenna positions



Final image visualisation



Source elevation during observation



Output page gives some quick look preview images:

- Amp vs. uv distance
- Antenna layout
- Dirty image
- Elevation plot
- And more

Output Files

Links to download the measurement set, output images, and some log files



Final Image

The final cleaned or dirty image from the simulation

`ALMA-GHOST-5YJU6CM0.dirty.image.fits`

Final cleaned/dirty image

11.4 MB

[Download](#)



Measurement Set

Simulated visibility data for use in CASA/plotms

1

`simulated.ms.tar.gz`

Simulated measurement set (for plotms inspection)

66.9 KB

[Download](#)



Logs & Configuration

Pipeline logs and simulation parameters

2

`config.json`

Simulation configuration

709.0 B

[Download](#)

`pipeline_log.json`

Pipeline execution log

5.1 KB

[Download](#)



Other Files

Additional output files

2

`ALMA-GHOST-5YJU6CM0.dirty.psf.fits`

FITS file

11.4 MB

[Download](#)

`PplusDisk_SIM_decm2300m0000.fits`

Input sky model FITS file

267.2 KB

[Download](#)

Limitations and roadmap

Current limits

- 2D images only
 - No spectral cubes
 - No polarisation
- Single pointing only
- No cleaning (dirty image)
- No SPW support
- Max 300 antennas & 2 unique dish diameters per config
- Per user: Max 5 jobs per hour, 2 concurrent

Roadmap items

- Full spectral cube support
- Polarisation support
- Mosaicking
- Multiple array simulations per job (e.g. 12m + 7m + TP)
- Cleaning (inc. array combination)
- Full SPW support
- Downloadable scripts
- Email notifications

What else would you like to see?

GHOST

Generalised Hybrid Observation Support Tool

- Try submitting some jobs with dirty imaging selected
 - Tweak parameters such as frequency, PWV, time on source, image weighting — how does parameter choice affect the output?
- Note: current limit is 2 concurrent jobs and 5 jobs per hour, per user

alma-ghost.jb.man.ac.uk