



EUROPEAN ARC
ALMA Regional Centre | Allegro



Simulating ALMA observations

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(on behalf of the Allegro team)

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Simulating ALMA observations



Motivation

- Investigate proposal feasibility
- Determine optimal configuration/sensitivity
- Improve quality of your proposal (highly appreciated by the TAC)

Tools:

- CASA simulator (terminal)
- Observation Support Tool (OST) (web)

CASA simulator (I): description



CASA command tools (terminal)

- **simobserve** → simulate visibilities
- **simanalyze** → simulate imaging
- **simalma** = simobserve + simanalyze in one go
- Possible inputs:
templates, gaussian components, user's image
- CASA (5.4) guide (incl. examples):

https://casaguides.nrao.edu/index.php/Simulating_Observations_in_CASA_5.4

CASA simulator (II): inputs



- simobserve parameters

```
*simobs.py x simanalyze.py
# simobserve: Basic Configuration
#
# Initialize simanalyze
default("simobserve")
# Basic info
project = "mysimulation"
skymodel = "HD163296_continuum_conv.image"
# Pointings
setpointings = False
ptgfile = "HD163296_pointings.dat"
# Observing mode
obsmode = "int"
antennalist = "alma.cycle7.5.cfg"
totaltime = "1000s"
graphics = "both"
# Run simobserve
simobserve()

# Start sibobserve
# Project name
# Input image
# Let CASA guess the pointings?
# Pointings positions
# Observing mode
# ALMA configuration (e.g. | Cycle7+C41-5)
# Integratio time
# Show plots
```

```
CASA <220>: execfile('simobs.py')
```

CASA simulator (II): inputs

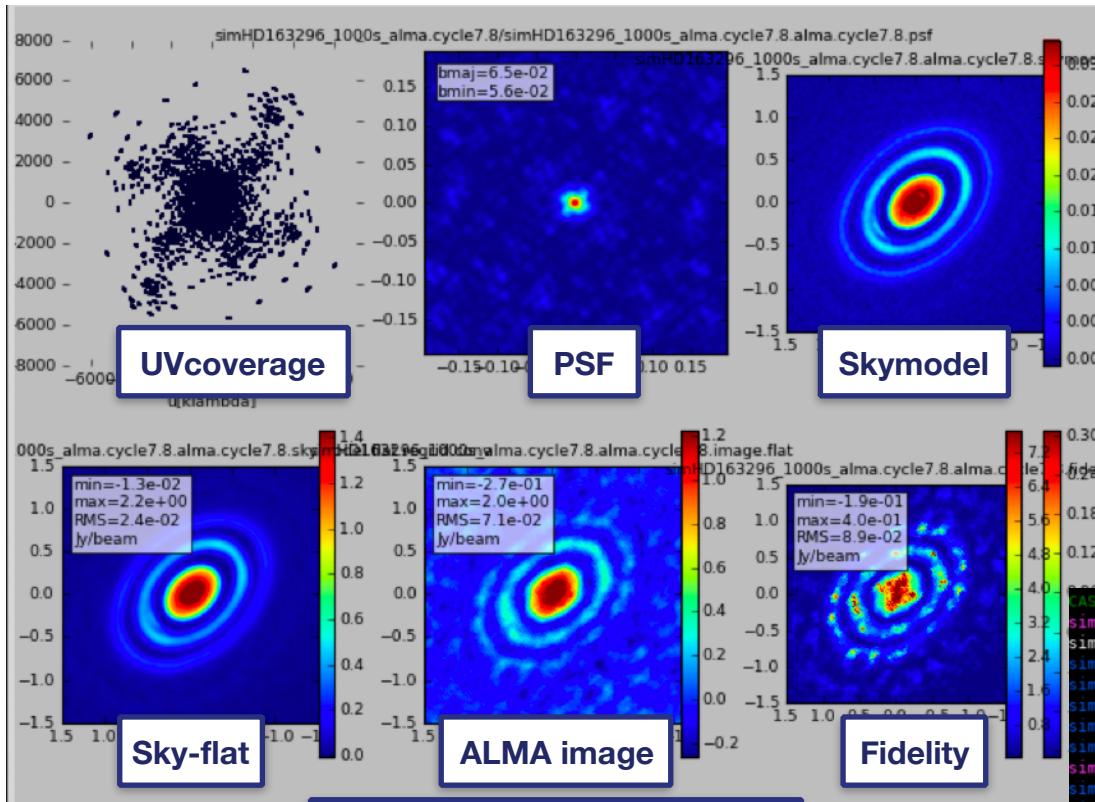


- simanalyze parameters

```
*simobs.py x simanalyze.py
# simanalyze: Basic Configuration
#
# Initialize simanalyze
default("simanalyze")
# Basic info
project           = "myproject"           # Project name
vis               = "myproject.alma.cycle7.5.ms" # visibilities produced by simobs
# CLEAN parameters
imsize           = [300,300]              # Map size
cell             = '0.01arcsec'           # cell spacing
niter            = 2000                    # Number of iterations
threshold        = "5mJy"                 # CLEANing threshold
weighting        = "natural"              # CLEAN weight
# Graphical parameters
analyze          = True
showpsf          = True
showresidual     = False
showconvolved   = True
# Run simanalyze
simanalyze()
```

```
CASA <220>: execfile('simanalyze.py')
```


CASA simulator (III): outputs



Output files:

- Sky model
- Simulated images
- Dirty beam (PSF)
- ...

```
CASA <221>: ls simHD163296_1000s_alma.cycle7.5/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.analysis.png
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.clean.last
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.diff/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.fidelity/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.flux/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.image/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.image.flat/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.image.png
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.model/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.ms/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.noisy.ms/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.observe.png
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.psf/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.ptg.txt
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.residual/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.simobserve.last
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.skymodel/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.skymodel.flat/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.skymodel.flat.regrid/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.skymodel.flat.regrid.conv/
simHD163296_1000s_alma.cycle7.5.alma.cycle7.5.skymodel.png
simHD163296_1000s_alma.cycle7.5.simanalyze.last
```

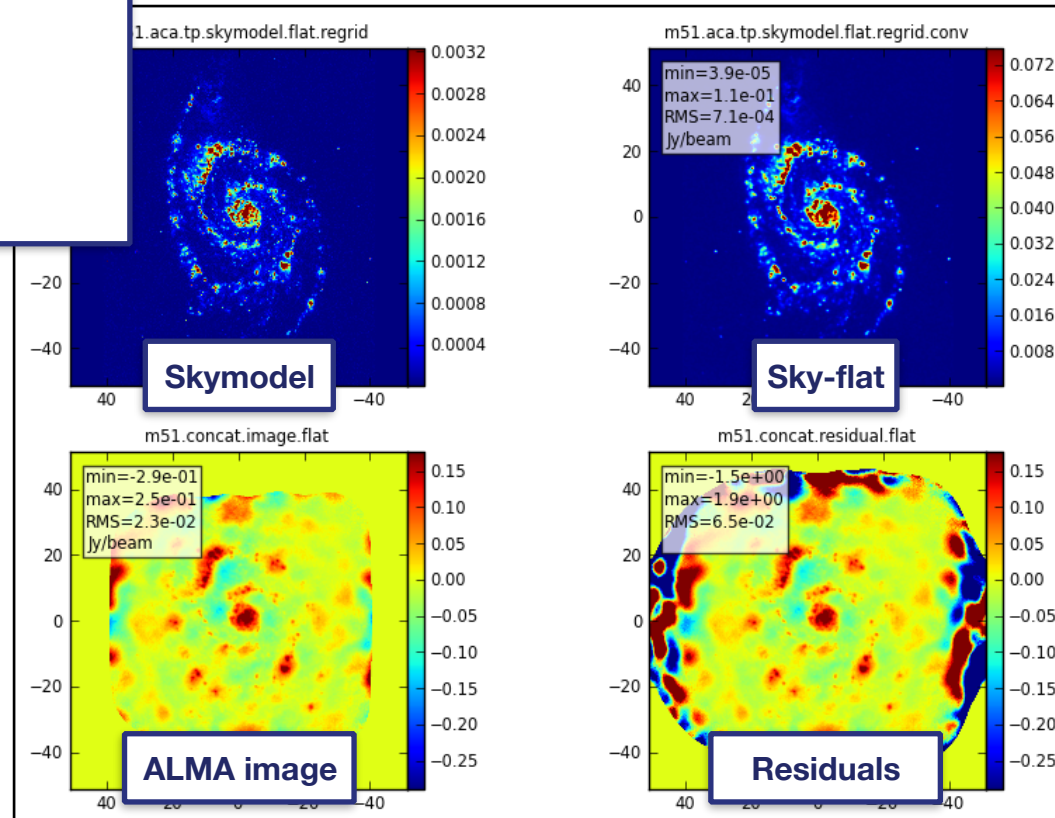
Graphic interface

CASA simulator (IV): simalma



simalma = simobserve + simanalyze

- CASA 5.1+
- same I/O
- All in one go
- Allows array combination



Graphic interface

OST (I): Description

Observation Support Tool (OST)

- Developed by the UK ARC node
- Web interface: <http://almaost.jb.man.ac.uk/>
- Runs CASA simulator in their servers



The screenshot displays the ALMA Observation Support Tool (OST) web interface. At the top left, there is a logo for the ALMA European ARC ALMA Regional Centre || UK. The main title is "ALMA Observation Support Tool" with "Version 8.0" on the right. A navigation bar includes links for OST, NEWS, HELP, QUEUE, LIBRARY, and ALMA HELPDESK. A yellow banner contains the text: "OST User Notice: Version 8.0 release -17/03/2020 !!! (more info). OST Team".

The interface is divided into several sections:

- Array Setup:** Instrument: ALMA (dropdown menu). Select the desired ALMA antenna configuration.
- Sky Setup:** Source model: OST Library: Central point source (dropdown menu). Choose a library source model or supply your own.
Upload: Choose file | No file chosen. You may upload your own model here (max 10MB).
Declination: -35d00m00.0s. Ensure correct formatting of this string (+/-00d00m00.0s).
Image peak / point flux in: mJy | 0.0. 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. Spectral or continuum observations?

OST (II): inputs

Instrument
=
ALMA configuration

ALMA
EUROPEAN ARC
ALMA Regional Centre || UK

ALMA Observation Setup

OST NEWS HELP QUEUE LIBRARY ALMA HELPDESK

OST User Notice: Version 8.0 release -17/03/2020 !!! (more info). OST Team

Array Setup:

Instrument: ALMA

Sky Setup:

Source model: OST Library: Central point source

Upload: Choose file No file chosen

Declination: -35d00m00.0s

Image peak / point flux in mJy 0.0

Observation Setup:

Observing mode: Spectral Continuum

User upload

-----Full ALMA-----

ALMA
ACA
ALMA + ACA

-----Cycle 8-----

ALMA Cycle 8 C43-1 (b_max= 161m)
ALMA Cycle 8 C43-2 (b_max= 314m)
ALMA Cycle 8 C43-3 (b_max= 500m)
ALMA Cycle 8 C43-4 (b_max= 783m)
ALMA Cycle 8 C43-5 (b_max= 1398m)
ALMA Cycle 8 C43-6 (b_max= 2516m)
✓ ALMA Cycle 8 C43-7 (b_max= 3638m)
ALMA Cycle 8 C43-8 (b_max= 8548m)

-----Cycle 7 & 6-----

ALMA Cycle 7 & 6 C43-1 (b_max= 161m)
ALMA Cycle 7 & 6 C43-2 (b_max= 314m)
ALMA Cycle 7 & 6 C43-3 (b_max= 500m)
ALMA Cycle 7 & 6 C43-4 (b_max= 783m)
ALMA Cycle 7 & 6 C43-5 (b_max= 1398m)
ALMA Cycle 7 & 6 C43-6 (b_max= 2516m)
ALMA Cycle 7 & 6 C43-7 (b_max= 3638m)
ALMA Cycle 7 & 6 C43-8 (b_max= 8548m)
ALMA Cycle 7 & 6 C43-9 (b_max= 13895m)
ALMA Cycle 7 & 6 C43-10 (b_max= 16197m)
ACA Cycle 7 & 6: 7m (Standard)

-----Cycle5-----

ALMA Cycle 5 C43-1 (b_max= 160m)
ALMA Cycle 5 C43-2 (b_max= 313m)
ALMA Cycle 5 C43-3 (b_max= 500m)
ALMA Cycle 5 C43-4 (b_max= 783m)
ALMA Cycle 5 C43-5 (b_max= 1398m)
ALMA Cycle 5 C43-6 (b_max= 2516m)
ALMA Cycle 5 C43-7 (b_max= 3638m)

Version 8.0

OST (II): inputs



Source Model
=
Templates

ALMA Observations

OST NEWS HELP QUEUE LIBRARY ALMA H

OST User Notice: Version 8.0 release -17/03/2020 !!! (more info). OST Team

Array Setup:

Instrument: ALMA

Sky Setup:

Source model: OST Library: Central point source

Upload: Choose file No file chosen

Declination: -35d00m00.0s

Image peak / point flux in mJy 0.0

Observation Setup:


Observing mode: Spectral Continuum

Spectral or continuum observations?


Uploaded FITS image
OST Library: Central point source
OST Library: NGC1333 at 8 kpc
OST Library: Protostellar Cluster
OST Library: Protoplanetary Disk
✓ OST Library: Nova Model
OST Library: W49 in Leo T
OST Library: M51
OST Library: Watchmen logo
OST Library: 568ml
OST Library: Test cube 64x64x16

OST (II): inputs





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ALMA Observation Support Tool

Version 8.0

OST NEWS HELP QUEUE LIBRARY ALMA HELPDESK

OST User Notice: Version 8.0 release -17/03/2020 !!! (more info). OST Team

Array Setup:

Instrument: ALMA

Sky Setup:

Source model: OST Library: Central point source

Upload: Choose file No file chosen

Declination: -35d00m00.0s


Image peak / point flux in mJy 0.0

Observation Setup:

Observing mode: Spectral Continuum

Spectral or continuum observations?

Upload
=
User defined image



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.

Spectral or continuum observations?

1

OST (II): inputs



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ALMA Observation Support Tool

Version 8.0


OST NEWS HELP QUEUE LIBRARY ALMA HELPDESK

OST User Notice: Version 8.0 release -17/03/2020 !!! (more info). OST Team

Array Setup:


Instrument: 

Sky Setup:

Source model: 

Upload: No file chosen

Declination:

Image peak / point flux in 

Observation Setup:

Observing mode: Spectral Continuum

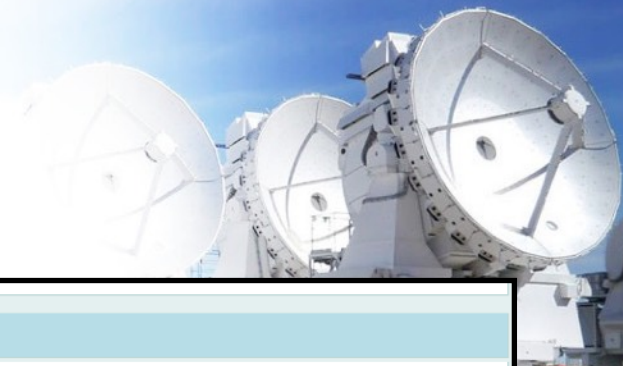
Observation & Re-scaling parameters



Declination:

Image peak / point flux in 

OST (II): inputs



Observation Setup:

Observing mode: Spectral Continuum

Central frequency in GHz:

Bandwidth in :

Use full Stokes parameters: Yes No

Number of polarizations:

Required resolution in arcseconds:

Pointing strategy:

On-source time in :

Start hour angle:

Number of visits:

Include cycling to phase calibrator?: Yes No

Atmospheric Corruption:

Atmospheric conditions:

Spectral or continuum observations?
The value entered must be within an ALMA band.

Select the total bandwidth for continuum observations.

Observing setup:

- Frequency
- Bandwidth + spec.res.
- Mapping strategy
- Integration time
- ...

How many times the observation is repeated.

This affects the *uv*-coverage of your simulation.

Determines level of noise due to water vapour.

OST (II): input values



Weather conditions (PWV)
will determine noise level

Atmospheric Corruption:

Atmospheric conditions: PWV = 0.472 mm (1st Octile)

Determines level of noise due to water vapour.

Imaging Product:

Imaging weights: Natural

Perform deconvolution?: No (Return dirty image)

Output image format: FITS

This allows a resolution / sensitivity trade-off.

Apply the CLEAN algorithm to deconvolve the image.

CASA format images are returned as a tar file

Submission:

Your email address is

(Information on how we use your email address here).

OST (II): input values



Atmospheric Corruption:

Atmospheric conditions: PWV = 0.472 mm (1st Octile) ▾

Imaging Product:

Imaging weights: Natural ▾

Perform deconvolution?: No (Return dirty image) ▾

Output image format: FITS ▾

Submission:

Your email address is

(Information on how we use your email address here).

Requested outputs:

- Dirty vs Clean images
- Weights
- Format

OST (II): inputs



Atmospheric Corruption:

Atmospheric conditions: Determines level of noise due to water vapour.

Imaging Product:

Imaging weights:

Perform deconvolution?:

Output image format: CASA format images are returned as a tar file

Submission:

Your email address is

(information on how we use your email address here).

Contact Email (required)



Submit job

OST (III): output



ALMA EUROPEAN ARC ALMA Regional Centre || UK

ALMA Observation Support Tool

Job ID: 20200319114204ypTNB / Submitted by: hacar@strw.leidenuniv.nl

al channels or Stokes axes.
ve been extracted.
okes axes.

er scale, right: with histogram equalization.

MA Cycle 8, 7 & 6 C43-4 (783 m baseline)

C 1333 at 8 kpc

Maximum elevation: 77.88 degrees

Central frequency: 93.7 GHz (ALMA Band 3)

Total Bandwidth: 0.032 GHz

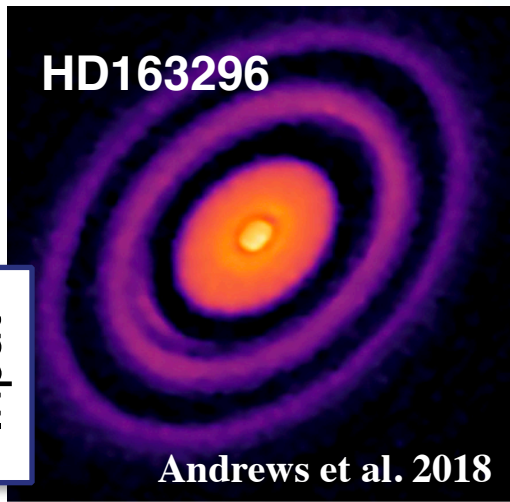
Screenshot

After few minutes you will get an automatic email with a link to the OST results:

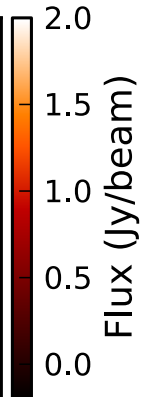
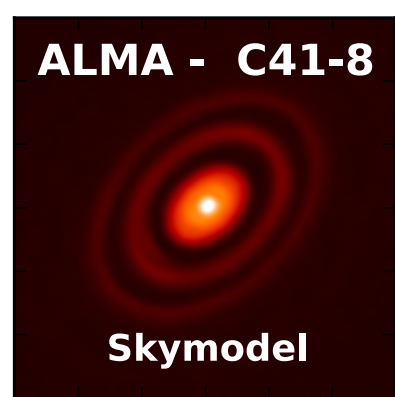
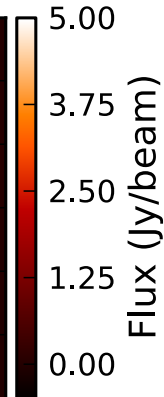
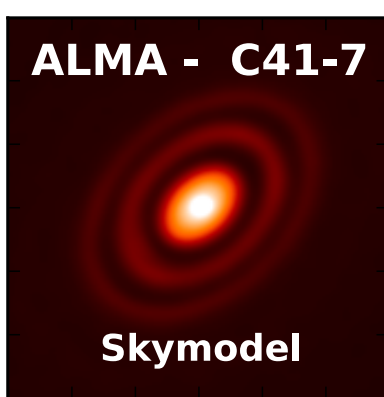
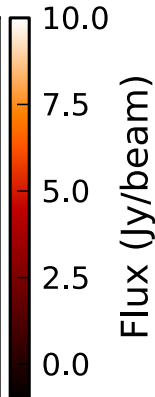
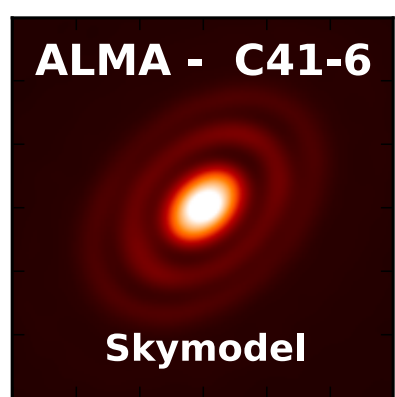
- Sky model (input)
- Simulated (dirty/clean) images
- Dirty beam (PSF)
- UV-coverage

Simulation examples

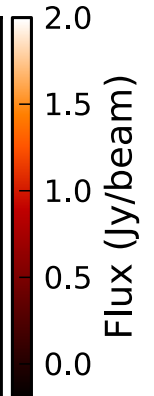
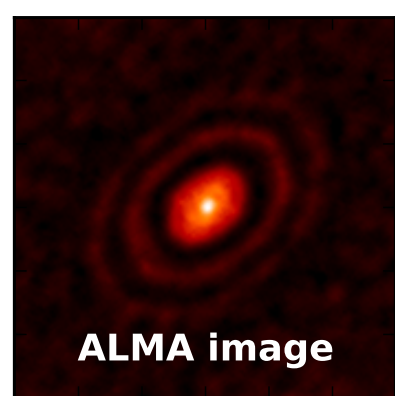
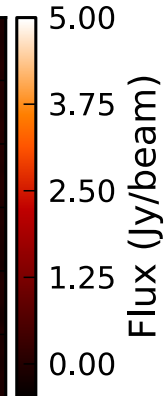
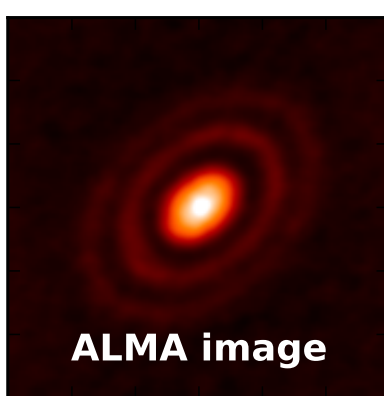
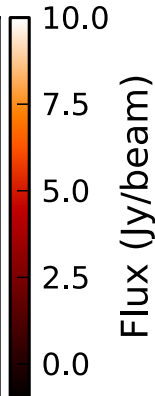
Input



Expected emission



Simulated ALMA observation



ALMA Proposal Preparation



Allegro toolbox:

- <https://www.alma-allegro.nl/toolbox>

Allegro videos available online

- ALMA CfP & Capabilities
- Dual-anonymous review
- Observing Tool (OT)
- Simulating ALMA observations



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Contact us

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Information & news

Allegro website: <https://www.alma-allegro.nl>