

# The ALMA Observation Support Tool (OST)

Adam Avison



# Overview

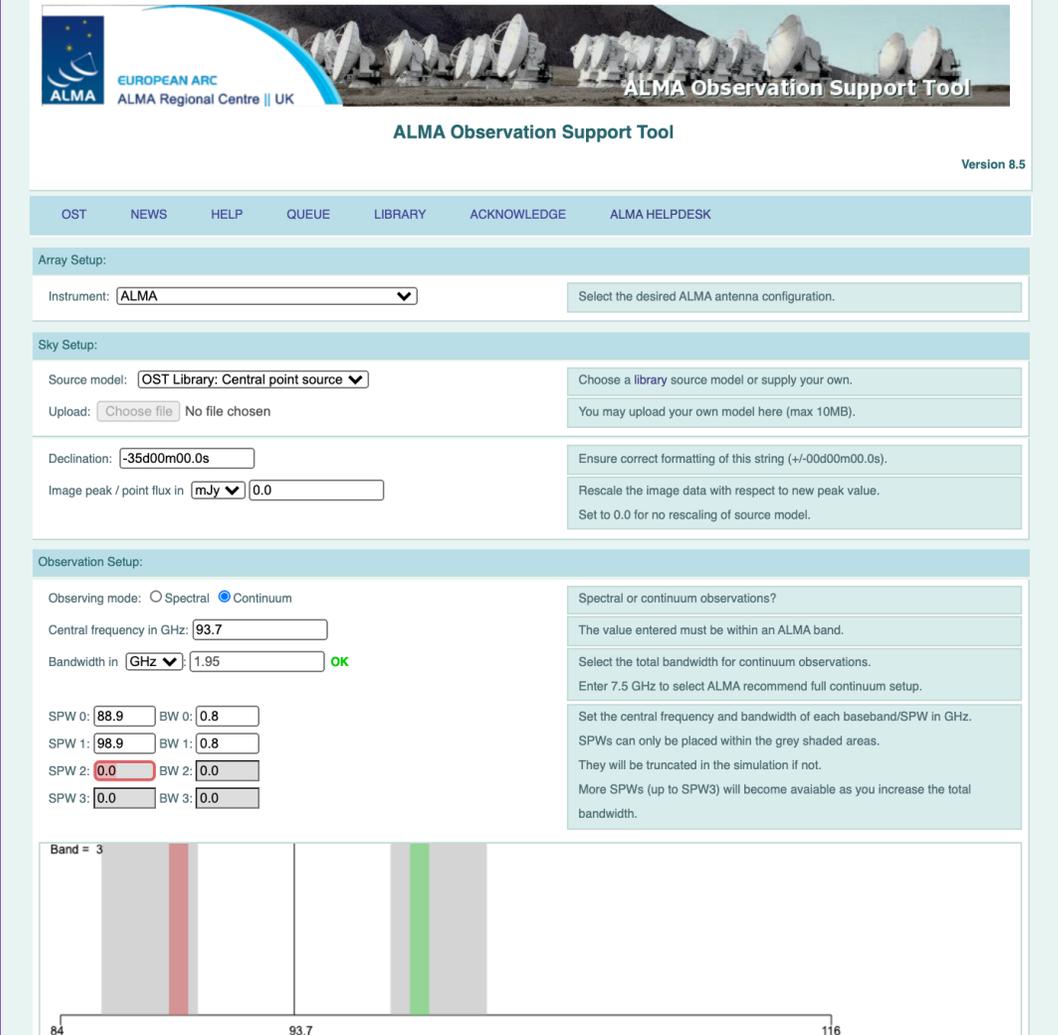
- Introduction to the ALMA OST
- A brief history of the OST
- The OST's mode of operation
- The OST website
- Guided Demonstrations
  - Demo 1: A basic continuum simulation
  - Demo 2: A more complex continuum simulation
  - Demo 3: A spectral cube

# The ALMA Observation Support Tool

The ALMA OST is an online ALMA simulator aimed at the non-interferometry expert.

A user can set up a simulated observation by entering simple observing and imaging parameters into the OST webform:

<http://almaost.jb.man.ac.uk>



The screenshot displays the ALMA Observation Support Tool webform interface. At the top, there is a header with the ALMA logo, the text "EUROPEAN ARC ALMA Regional Centre || UK", and the title "ALMA Observation Support Tool" with "Version 8.5" on the right. Below the header is a navigation menu with links for OST, NEWS, HELP, QUEUE, LIBRARY, ACKNOWLEDGE, and ALMA HELPDESK. The main content area is divided into several sections:

- Array Setup:** Includes a dropdown menu for "Instrument" set to "ALMA" and a button to "Select the desired ALMA antenna configuration."
- Sky Setup:** Includes a dropdown for "Source model" set to "OST Library: Central point source", an "Upload" button (labeled "Choose file" and "No file chosen"), and a "Declination" input field set to "-35d00m00.0s".
- Observation Setup:** Includes radio buttons for "Observing mode" (Spectral and Continuum), a "Central frequency in GHz" input field set to "93.7", and a "Bandwidth in GHz" dropdown set to "1.95" with an "OK" indicator. Below this are four rows of "SPW" (Spectral Window) and "BW" (Bandwidth) input fields, with SPW 2 highlighted in red.
- Bandwidth Visualization:** A horizontal bar at the bottom shows the frequency range from 84 to 116 GHz. A red vertical bar is positioned at 93.7 GHz, and a green vertical bar is positioned at 95.65 GHz. The text "Band = 3" is visible above the bar.

Helpful text boxes provide instructions: "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.", and "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. Set the central frequency and bandwidth of each baseband/SPW in GHz. SPWs can only be placed within the grey shaded areas. They will be truncated in the simulation if not. More SPWs (up to SPW3) will become available as you increase the total bandwidth."

# Why simulate?

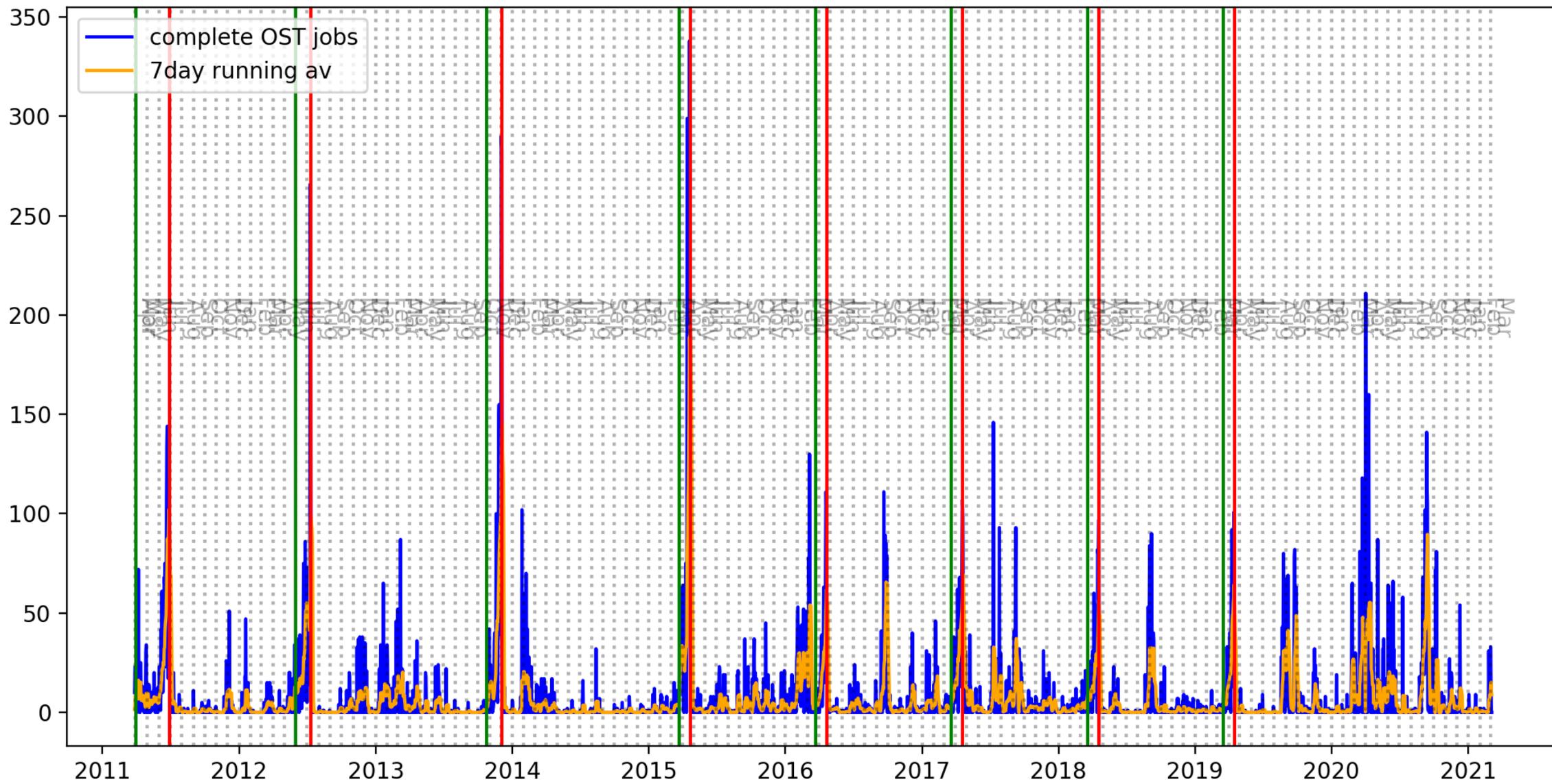
1. *Proposal preparation*: Using your best model or observational analogue to,
  - I. Test the observing set-up you will require to recover the structures you wish to observe with ALMA. For example, the effects of missing spacings (i.e. no total power) and surface brightness sensitivity issues.
  - II. Use the simulated images/data as ‘evidence’ in an ALMA observing proposal to argue for your requested observational set-up.
2. *Comparing models to data*: Using simulations to “observe” a sky-model as closely as possible (antenna config, frequency tunings etc) to real observations. With the aim of comparing your sky-model corrupted by observing effects to the real data.

# A brief history of the OST

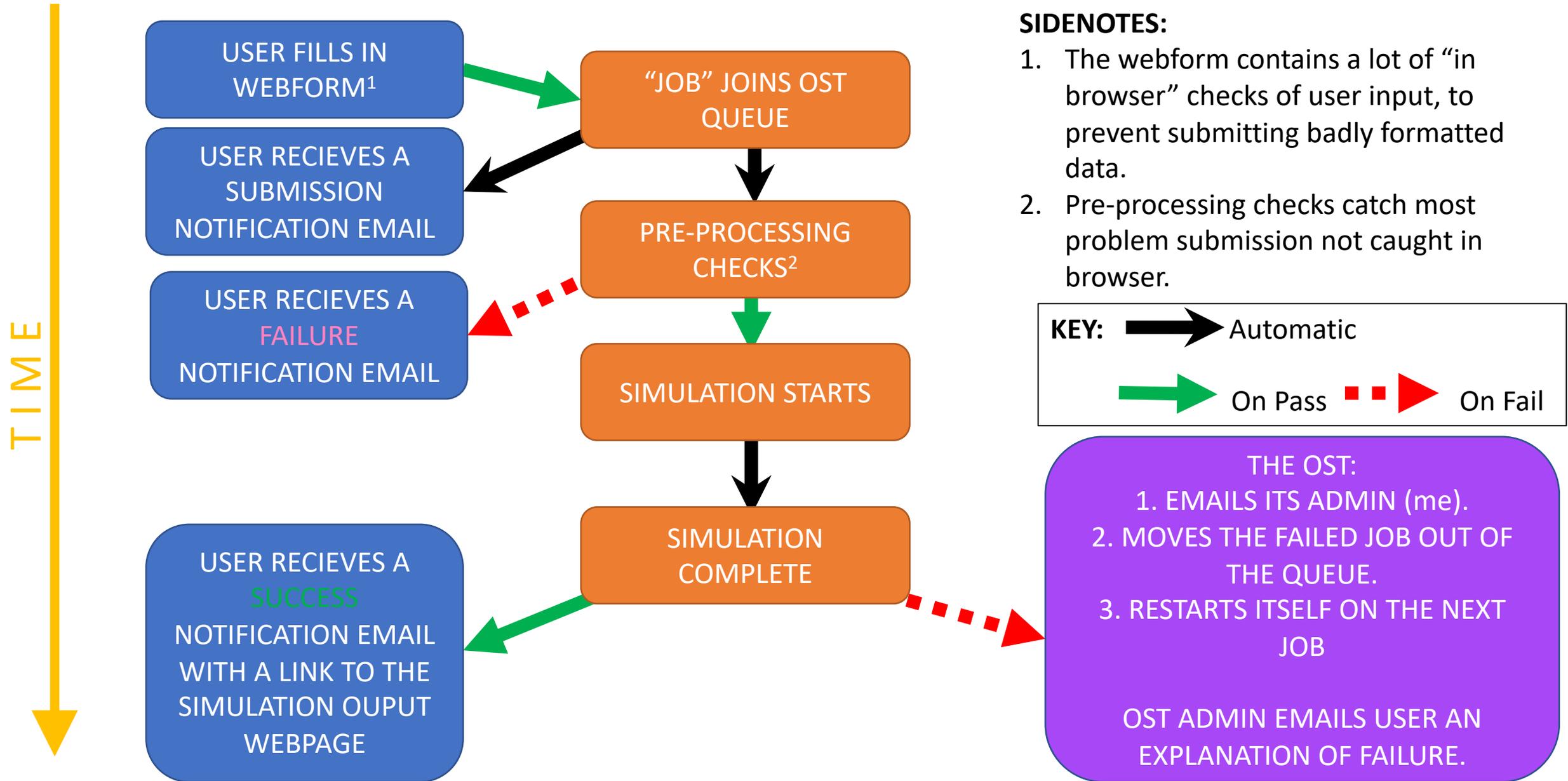
- Became available to the public on 28-Mar-2011.
- Since then it has processed 26,220 simulations for users in 42 different countries.
- A new version is released each year, increasing the OST capabilities. E.g. v3 -> Data Cubes, v5 -> Stokes Cubes, v7 -> user antenna configuration files.



All OST usage ever

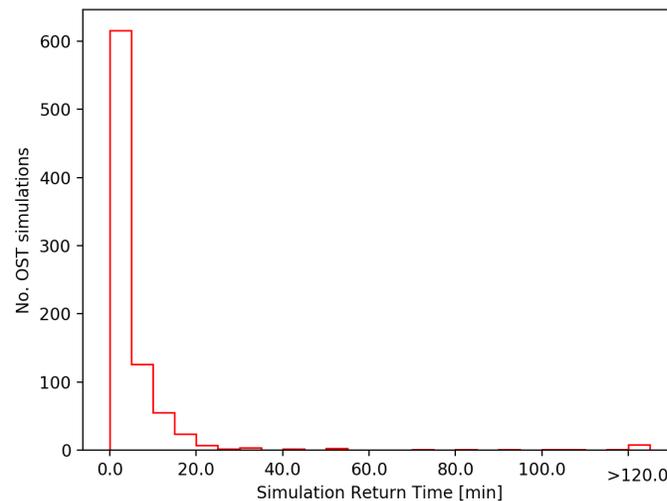
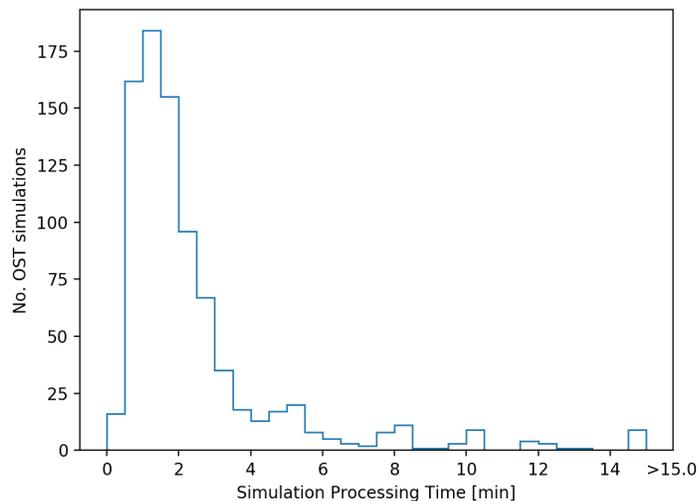


# OST mode of operation



# Comments on the queue:

- The OST operates a queue based system, i.e. your submission joins the back of the queue and waits until all jobs before it are complete before processing starts.
- *Except*, at really busy times when we “switch on” the overflow OST. This takes all jobs after job X in the queue and moves them to a new queue that is processed by a different machine.



Example “job processing” and “return time” plots from during the Cycle 7 call for proposals. The overflow system was not triggered. Job with return times >120min were those which required the intervention of the OST admin.

# Behind the scenes

- The OST v8.5 currently runs in CASA 5.6.2-2
- Simulated measurement sets are created using the CASA simulator 'sm' tool kit **not** simobserve. Therefore, results differ slightly between the two. The simulated MS are imaged using tclean.
- Images are output to the user, measurement sets are **not** retained.
- Everything relating to a given simulation e.g. uploaded images, webform parameters (inc. users email address), and all outputs are deleted at two minutes before midnight two days following their submission.

# Some minor “limitations”

1. The size of a user uploaded FITS image is limited to 10MB
2. Output images are limited to 2048x2048 pixels (or 512x512 for cubes), so even if you simulate a “bigger sky” the image will cut out at these limits.

Both of these are enforced to ensure sufficient disk space to process simulations for all users.

# Where an OST simulation may differ from a real observations.

Though the OST generates robust and accurate simulated images\* it is difficult, in with any simulator, to match real data exactly.

These are the obvious areas in which an OST simulation will differ from real data.

- Scan spacing will be different (though it is possible to mitigate this).
- Elevation will likely be different. All OST simulations take place on the same “day”.
- During a real observation the PWV (and other weather effects) will change during an observation.

\*assuming the user provides sensible and robust inputs :D

# The OST website: *Finding your way around*



Link to the OST homepage/simulation webform.

We'll go through this later

# The OST website: *Finding your way around*



Link to the OST homepage/simulation

We'll go thro

Takes you to the News page which has articles on updates, problems and general news.

# The OST website: *Finding your way around*



Link to the OST homepage/simulation

We'll go thro

Takes you to  
has articles o  
and general news.

Link to the extensive Help documentation.

# OST News



EUROPEAN ARC  
ALMA Regional Centre || UK



## ALMA OST: Latest News

Version 8.5

OST

NEWS

HELP

QUEUE

LIBRARY

ACKNOWLEDGE

ALMA HELPDESK

### OST User Message Update: 28/04/2020

Dear OST Users,

With regard to the continuing COVID-19 outbreak the ALMA Director, along with the regional partners, have decided to take the following course of action concerning Cycles 7 and 8.

- The start of ALMA Cycle 8 has been postponed until 2021 October. It is anticipated that the Cycle 8 Call for Proposals will open again in 2021 March.
- ALMA Cycle 7 will continue through 2021 September, with currently non-completed projects ranked A, B and C remaining in the observing queue.

There remain many questions outstanding regarding resuming observations and accepting future proposals during these uncertain times. ALMA is working on these questions and will provide a next update to the community in the coming weeks.

The Regional ARCs continue to provide support to their communities. Please contact the ALMA Helpdesk at <https://help.almascience.org> if you have any questions, comments or concerns. The full statement from ALMA can be found here: <https://almascience.eso.org/news/update-on-the-status-of-alma-cycles-7-and-8>.

We wish you all the best,

Thank you,

**The OST Team.** - 28/04/2020

### OST User Message Update: 20/04/2020

# OST Help



The banner features the ALMA logo on the left, the text 'EUROPEAN ARC ALMA Regional Centre || UK' in the middle, and a photograph of the ALMA radio telescope array on the right. The text 'ALMA Observation Support Tool' is overlaid on the right side of the photograph.

**ALMA OST: Help Documentation**

Version 8.5

OST NEWS HELP QUEUE LIBRARY ACKNOWLEDGE ALMA HELPDESK

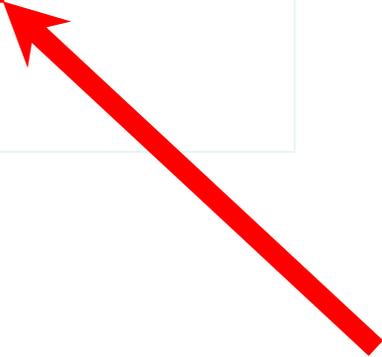
## Help Documentation Menu

Click on the links to be taken to the relevant documentation, or scroll down for documentation in order.

- Overview
- OST Acknowledgement
- Simulation Options on the Web Interface
  - Instrument
  - Sky Setup
    - Source Model
    - Upload a FITS file
    - Declination
    - Image peak / point flux
  - Observation Setup
    - Observing Mode
    - Expected behaviours for the new Spectral mode
    - Continuum Observing mode
      1. Central Frequency in GHz (Continuum Mode)
      2. Bandwidth
      3. Using Stokes Cubes
    - Spectral Observing mode
      1. Central Frequency in GHz (Spectral Mode)
      2. Channel width
    - Number of Polarizations

# OST Help

- FITS Information
  - FITS Header Requirements
  - File Size
  - Rotation



The *most* important bit of the Help documentation.

# The OST website: *Finding your way around*



Link to the OST homepage/simulation webform.

Takes you to the News page which has articles on updates, problems and general news.

Link to the extensive Help documentation.

# The OST website: *Finding your way around*



Where to check the current length  
of the OST queue.

# The OST website: *Finding your way around*



Link to the  
homepage/simulation  
We'll see this during

Where to check the current  
of the OST queue.

Link to the OST image library.  
We'll see this later

# The OST website: *Finding your way around*



Link to the OST homepage/simulation

We'll see this during

Where to check the current status of the OST queue.

Link to the OST image library

We'll see this later

Webpage with the appropriate citation is you use the OST in a published work. (Not needed for proposal prep!).

# OST Library

ALMA EUROPEAN ARC ALMA Regional Centre || UK

ALMA Observation Support Tool

ALMA OST: Image Library

Version 8.5

OST NEWS HELP QUEUE LIBRARY ACKNOWLEDGE ALMA HELPDESK

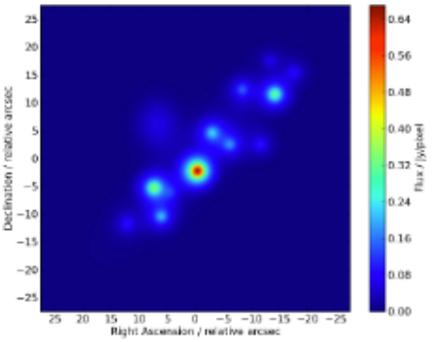
Galactic Objects: Examples of objects to be found within the Milky Way.

**Protostellar Cluster**

Modelled protostellar cluster (Credit K. Takematsu and CASA guides(NRAO)).

Pixel Size = 0.43arcsec/pix.  
Spatial extent = 55 x 55 arcsec.

Selection Name: Protostellar



Right Ascension / relative arcsec

Declination / relative arcsec

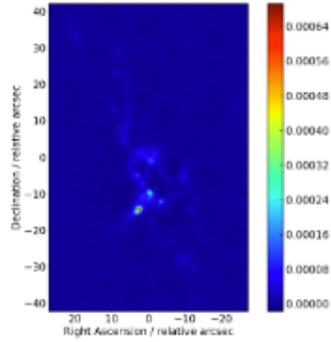
Flux / Jy/pixel

**NGC1333-like**

An image of the star forming region NGC1333 shifted into the southern hemisphere and placed at 8kpc.

Pixel Size = 0.31arcsec/pix.  
Spatial extent = 54.4 x 84.4 arcsec. This image will require multiple ALMA pointings.

Selection Name: NGC1333 at 8kpc



Right Ascension / relative arcsec

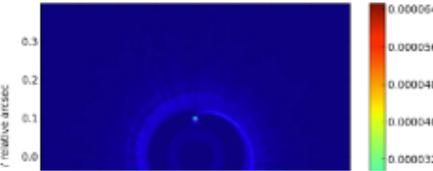
Declination / relative arcsec

Flux / Jy/pixel

**Protoplanetary Disk**

Simulated image of a 1 M<sub>Jup</sub> orbiting a 0.5 M<sub>sol</sub> Star at a distance of 50pc. (Credit S.Wolf and CASA guides(NRAO))

Pixel Size = 0.0031arcsec/pix.  
Spatial extent = 0.8 x 0.8 arcsec.



Right Ascension / relative arcsec

Declination / relative arcsec

Flux / Jy/pixel

# And now the webform:



EUROPEAN ARC  
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ALMA Observation Support Tool

Version 8.5

OST NEWS HELP QUEUE LIBRARY ACKNOWLEDGE ALMA HELPDESK

Array Setup:

Instrument:

Sky Setup:

Source model:

Upload:  No file chosen

Declination:

Image peak / point flux in

Observation Setup:

Observing mode:  Spectral  Continuum   
Central frequency in GHz:    
Bandwidth in      
  
SPW 0:  BW 0:   
SPW 1:  BW 1:   
SPW 2:  BW 2:   
SPW 3:  BW 3:   
  
  
  
  

Band = 3



84 93.7 116

# Array setup

Array Setup:

Instrument:

Select the array configuration you require. The options are:

- Nominal configurations for ALL previous ALMA cycles.
- User uploaded .cfg file.
- ALMA, ACA or ALMA + ACA. These are special cases. One of 28 CASA configuration files are selected based on input to the user Required Resolution.

# Array setup

Array Setup	User upload -----Full ALMA-----	
Instrument	✓ ALMA ACA ALMA + ACA	Select the desired ALMA antenna configuration.
Sky Setup:	-----Cycle 8-----	
Source model	ALMA Cycle 8 C43-1 (b_max= 161m) ALMA Cycle 8 C43-2 (b_max= 314m)	Choose a <a href="#">library</a> source model or supply your own.
Upload:	ALMA Cycle 8 C43-3 (b_max= 500m) ALMA Cycle 8 C43-4 (b_max= 783m) ALMA Cycle 8 C43-5 (b_max= 1398m)	You may upload your own model here (max 10MB).
Declination	ALMA Cycle 8 C43-6 (b_max= 2516m) ALMA Cycle 8 C43-7 (b_max= 3638m) ALMA Cycle 8 C43-8 (b_max= 8548m)	Ensure correct formatting of this string (+/-00d00m00.0s).
Image peak	-----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)	Rescale the image data with respect to new peak value. Set to 0.0 for no rescaling of source model.
Observation	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)	
Observing	ALMA Cycle 7 & 6 C43-7 (b_max= 3638m)	Spectral or continuum observations?
Central frequency	ALMA Cycle 7 & 6 C43-8 (b_max= 8548m)	The value entered must be within an ALMA band.

Select the array configuration you require. The options are:

- Nominal configurations for ALL previous ALMA cycles.
- User uploaded .cfg file.
- ALMA, ACA or ALMA + ACA. These are special cases. One of 28 CASA configuration files are selected based on input to the user Required Resolution.

# Sky setup

Sky Setup:	
Source model: <input type="text" value="OST Library: Central point source ▼"/>	Choose a library source model or supply your own.
Upload: <input type="button" value="Choose file"/> No file chosen	You may upload your own model here (max 10MB).
Declination: <input type="text" value="-35d00m00.0s"/>	Ensure correct formatting of this string (+/-00d00m00.0s).
Image peak / point flux in <input type="text" value="mJy ▼"/> <input type="text" value="0.0"/>	Rescale the image data with respect to new peak value. Set to 0.0 for no rescaling of source model.

# Observing Setup

Observation Setup:	
Observing mode: <input type="radio"/> Spectral <input checked="" type="radio"/> Continuum	Spectral or continuum observations?
Central frequency in GHz: <input type="text" value="93.7"/>	The value entered must be within an ALMA band.
Bandwidth in <input type="text" value="MHz"/> : <input type="text" value="32"/>	Select the total bandwidth for continuum observations. Enter 7.5 GHz to select ALMA recommend full continuum setup.
Use full Stokes parameters: <input type="radio"/> Yes <input checked="" type="radio"/> No	If your input image contains more than one Stokes plane use them all (Yes), or just Stokes I (no/default).
Number of polarizations: <input type="text" value="2"/>	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: <input type="text" value="1.0"/>	OST will choose array config based on this value if <i>instrument</i> is set to ALMA.
Pointing strategy: <input type="text" value="Mosaic"/>	Selecting single will apply primary beam attenuation.
On-source time in <input type="text" value="hours"/> : <input type="text" value="3"/>	Per pointing for Pointing Strategy = 'mosaic'. Total time over all pointings Pointing Strategy = 'single' and 'User pointing' See <a href="#">here</a> for more information.
Start hour angle: <input type="text" value="0.0"/>	Deviation of start of observation from transit.
Number of visits: <input type="text" value="1"/>	How many times the observation is repeated.
Include cycling to phase calibrator?: <input type="radio"/> Yes <input checked="" type="radio"/> No	This affects the <i>uv</i> -coverage of your simulation.

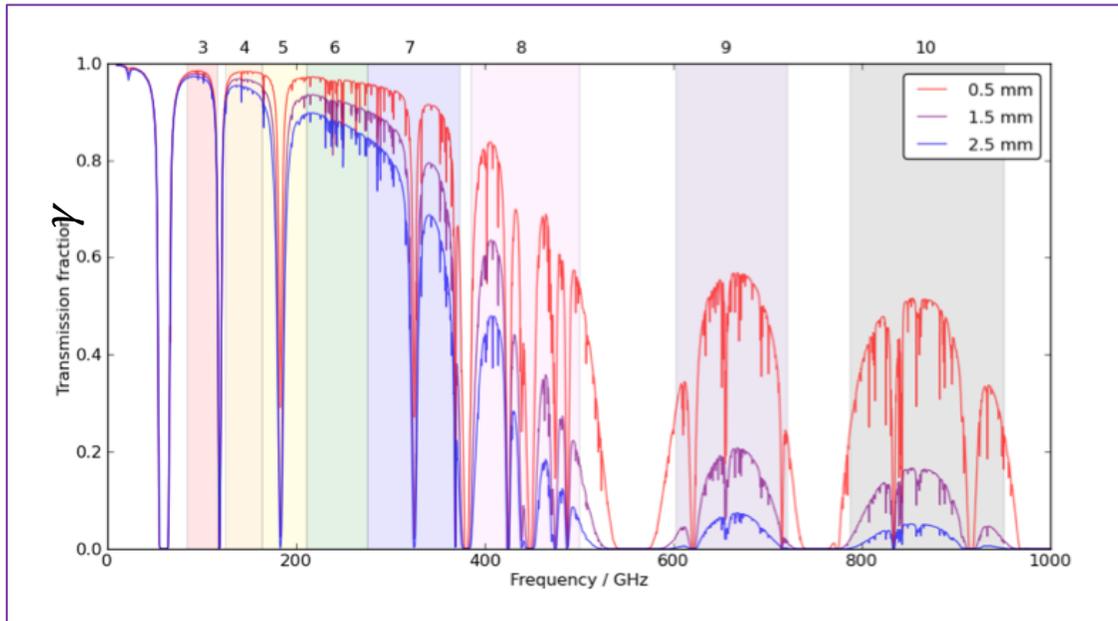
This is the section with a lot of different features, which will be shown during the demos. Please consult the associated video to see these in action.

# Atmospheric Corruption

Atmospheric Corruption:

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

Determines level of noise due to water vapour.



$$T_{sky} = T_{atmos} (1 - \gamma) \quad (1)$$

$$T_{sys} = T_{rec} + T_{sky} \quad (2)$$

$$\sigma = \frac{2k_B T_{sys}}{\eta_q A_{eff} \sqrt{\Delta\nu \Delta t}} \quad (3)$$

We provide the same 7 octiles of measured precipitable water vapour (PWV) as are used by the observatory when scheduling observations.

These are used to calculate the Sky Temperature (1) based on atmospheric transmission,  $\gamma$ . This temperature added to the Receiver Temperature define System temperature (2). Which finally sets the RMS visibility noise, the noise threshold of your simulation (3).

For more information please refer to the ALMA Technical Handbook (<https://almascience.eso.org/documents-and-tools/cycle7/alma-technical-handbook>) (section 9.1)

# Imaging Setup

Imaging Product:

Imaging weights: <input type="text" value="Natural"/>	This allows a resolution / sensitivity trade-off.
Perform deconvolution?: <input type="text" value="No (Return dirty image)"/>	Apply the CLEAN algorithm to deconvolve the image.
Output image format: <input type="text" value="FITS"/>	CASA format images are returned as a tar file

A note on image weights:

Natural -> better SNR, lower resolution

Uniform -> poorer SNR, higher resolution

Briggs -> Somewhere in between.

We fix the associated robust parameter to 0.5, meaning the resultant image is “a bit more” natural than uniform. This is in line with typical ALMA pipeline behaviour.

Please see e.g. the CASA documentation for further description of weighting schemes.

(<https://casa.nrao.edu/casadocs-devel/stable/imaging/synthesis-imaging/data-weighting>)

# Submission

Submission:

Your email address is

Submit

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

We need an email address to send you some emails about your submission and results.  
We only keep this address for up to 48hours.

# Guided OST Demonstrations:

- 1) A simple continuum mode observation of a point source.
- 2) A slightly more complex continuum.
- 3) A spectral line/cube demonstration.

For these demonstrations the tutor will switch from these slides to using a web browser. Please watch the associated video to follow the demonstrations.

Note: All input parameters used in the demos are provided on the next slide.

OST PARAMETER	DEMO 1: Point Source Continuum	DEMO 2: Full BW Model Image Continuum	DEMO 3: Spectral Cube
INSTRUMENT	ALMA	ALMA Cycle 8 C43-42	ALMA Cycle 8 C43-6
SOURCE MODEL	OST Library: Central Point Source	OST Library: Protostellar Cluster	OST Library: Test Cube 64x64x16
DECLINATION	-40d00m00.0s	-25d30m00.0s	-35d00m00.0s
IMAGE PEAK/POINT FLUX	0.5mJy	0.0mJy	0.0mJy
OBSERVING MODE	Continuum	Continuum	Spectral
CENTRAL FREQ. IN GHZ	230	333.0	90
BANDWIDTH	0.5GHz	2.2GHz [SPW 0: 328.0 / BW 0: 1.1] [SPW 1: 338.0 / BW 1: 1.1]	144.8kHz
USE FULL STOKES PARAMETER?	No	No	No
NUMBER OF POLS.	2	2	2
REQUIRED RES. IN ARCSEC	0.2	1.0*	1.0*
POINTING STRATEGY	Single	Mosaic	Mosaic
ON-SOURCE TIME	2hours	4hours	2hours
START HOUR ANGLE	-1.0	+1.0	0.0
NUMBER OF VISITS	1	2	1
CYCLE TO PHASE CALIBRATOR?	No	Yes [Phase Cycle: 300s / On Phase: 30]	No
ATMOSPHERIC CONDITIONS	0.913mm (3 <sup>rd</sup> Octile)	0.472mm (1 <sup>st</sup> Octile)	5.186mm (7 <sup>th</sup> Octile)
IMAGING WEIGHTS	NATURAL	BRIGGS	UNIFORM
PERFORM DECONVOLUTION	YES	YES	YES
OUTPUT IMG FORMAT	FITS	FITS	FITS
EMAIL	<YOUR EMAIL>	<YOUR EMAIL>	<YOUR EMAIL>