ALMA / NOEMA
Imaging simulators

AF ALMA/NOEMA
Observatoire de Paris
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Guide To Simulating ALMA Data

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Introduction: About this Document

This document describes why and how to use simulated observations to help understand your ALMA data, or to help you plan an ALMA observation. The document covers:

- Why you might want to simulate ALMA observations
- How simulations can help you plan a proposal
- Examples of simulating ALMA data
- Running your own simulations with the ALMA Observation Support Tool
- Simulating ALMA observations with CASA sim tools (using CASA 4.2)

Why Simulate ALMA Observations?

Observations made with radio interferometers can be tricky to interpret and analyze. Interferometers do not sample all spatial frequencies on the sky, so the image you generate from an interferometric observation does not necessarily represent the full sky brightness distribution. Specifically, interferometers are not sensitive to diffuse emission, and depending on a number of factors including the placement of the individual antennas, the length of the observation, and the location of the target source on the sky, an interferometric observation will be insensitive to structure on some angular scales. Observers therefore should use care when analyzing and interpreting interferometric images.

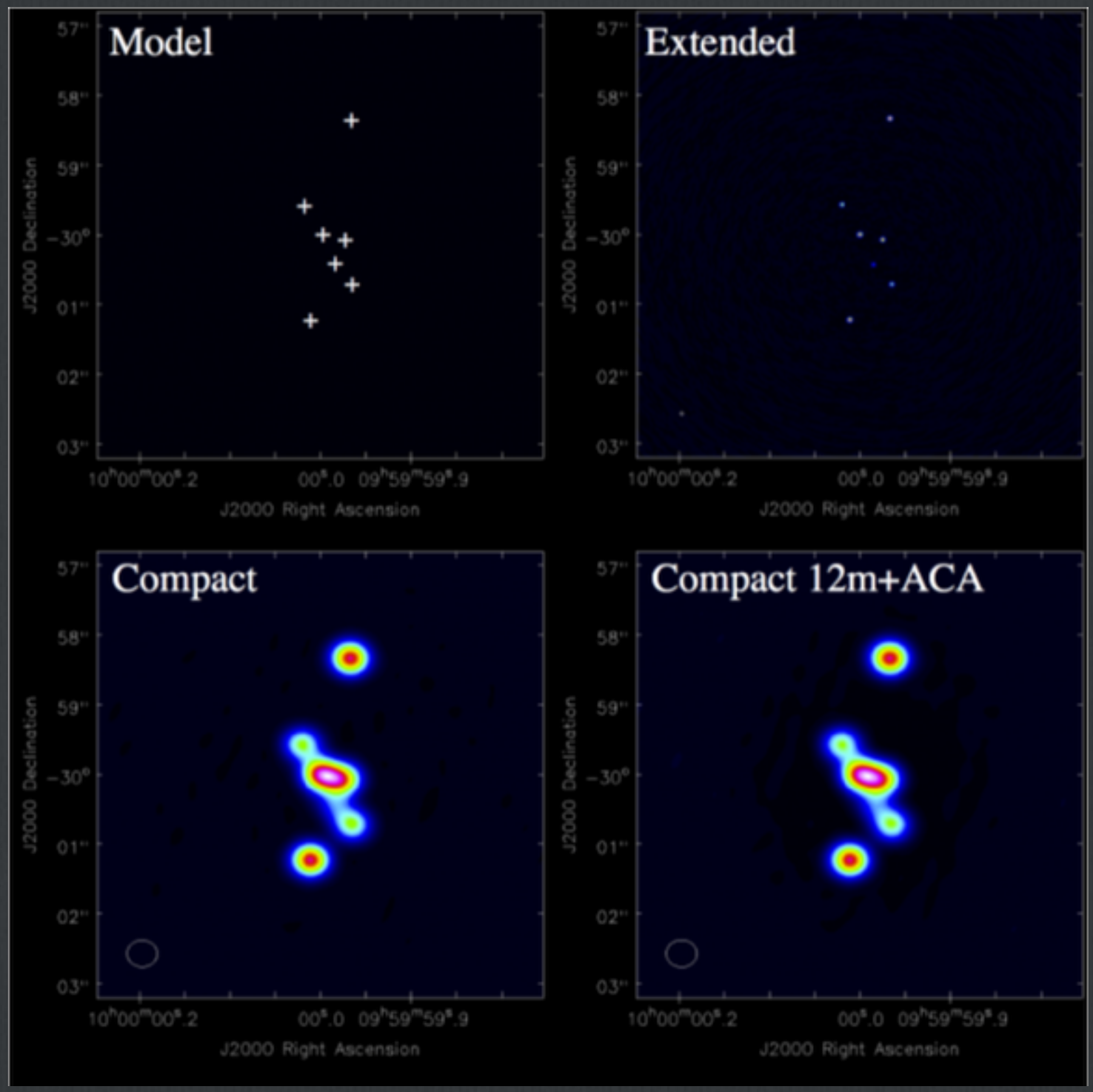
General description of the ALMA imaging simulators :

1) within CASA

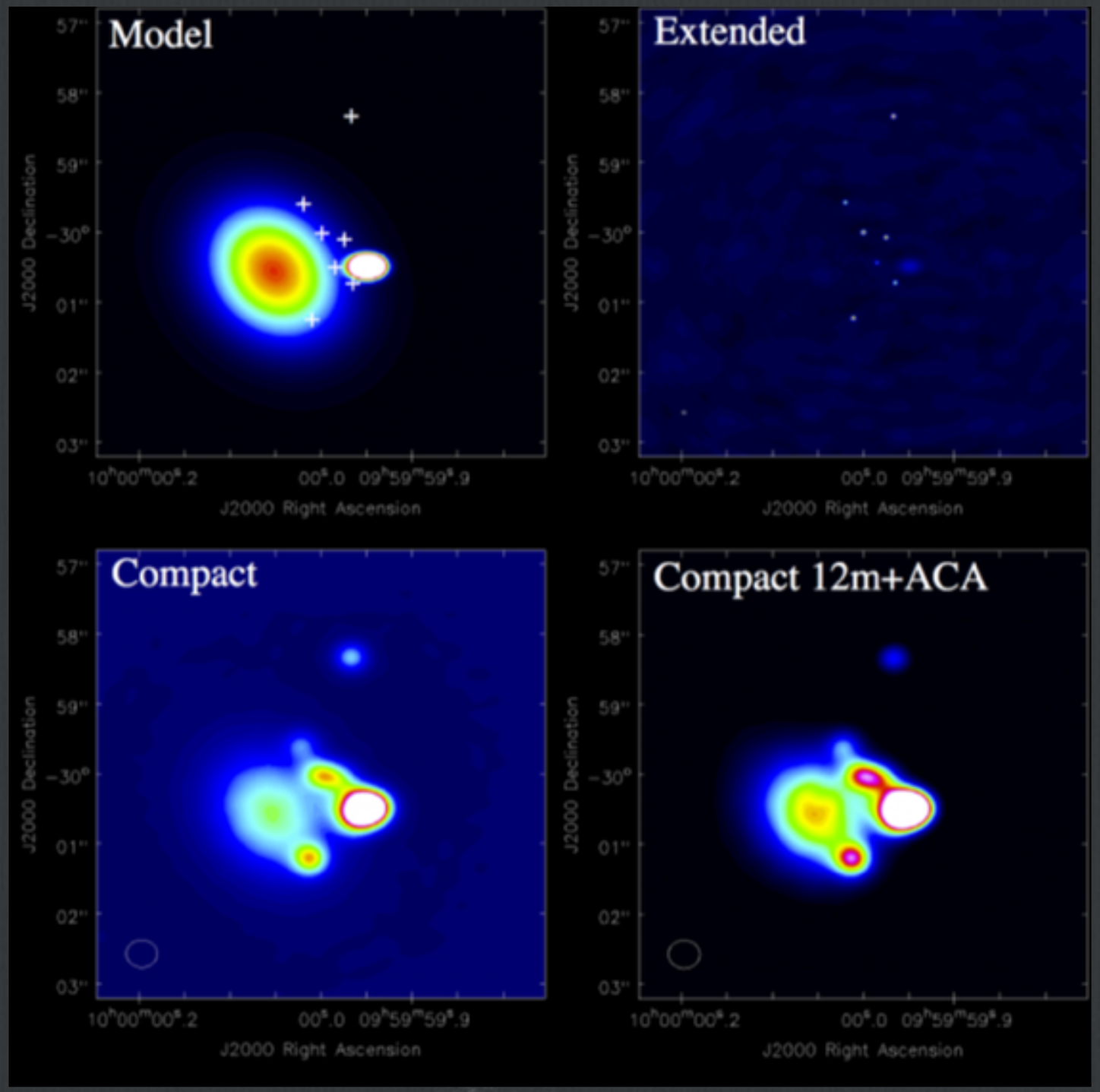
2) from a web-based interface

http://casaguides.nrao.edu/index.php?title=Guide_To_Simulating_ALMA_Data

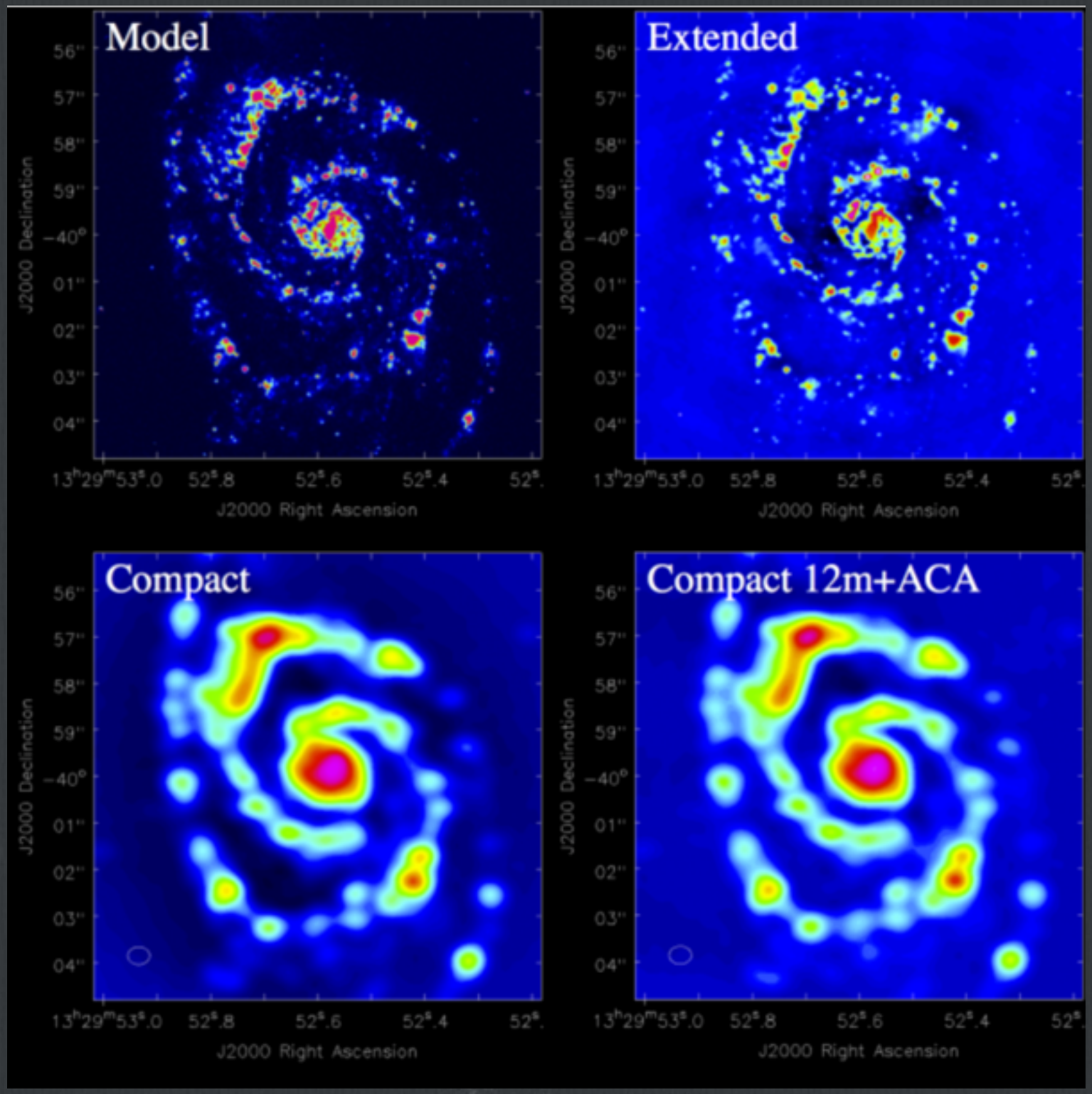
A collection of point-sources



Point Sources and Elliptical Gaussian Brightness Distributions



M51-type Galaxy



ALMA Imaging simulators
1) within CASA

- Two steps to combine :
  - CASA simobserve : generates a data set with simulated visibilities based on an input model image
  - CASA simanalyze : produces a cleaned image based on the simulated visibilities, and it generates some diagnostic images
- CASA simalma (both of simobserve and sumanalyze) : simplifies the simulation of 12 m interferometric + 7 m interferometric + total power ALMA observations (run at least 3 simobserve to model ALMA, ACA and TP uv-coverages)

ALMA Imaging simuators

1) within CASA

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Simulating Observations in CASA 4.2

- This guide describes steps used to simulate interferometric observations in CASA.
- For an introduction to simulations, with examples and a discussion of their relevance to ALMA observing proposals, start at the Guide to Simulating ALMA Data.
- **This guide is applicable to CASA version 4.2. For older versions of CASA please see Simulating Observations in CASA 4.1.**

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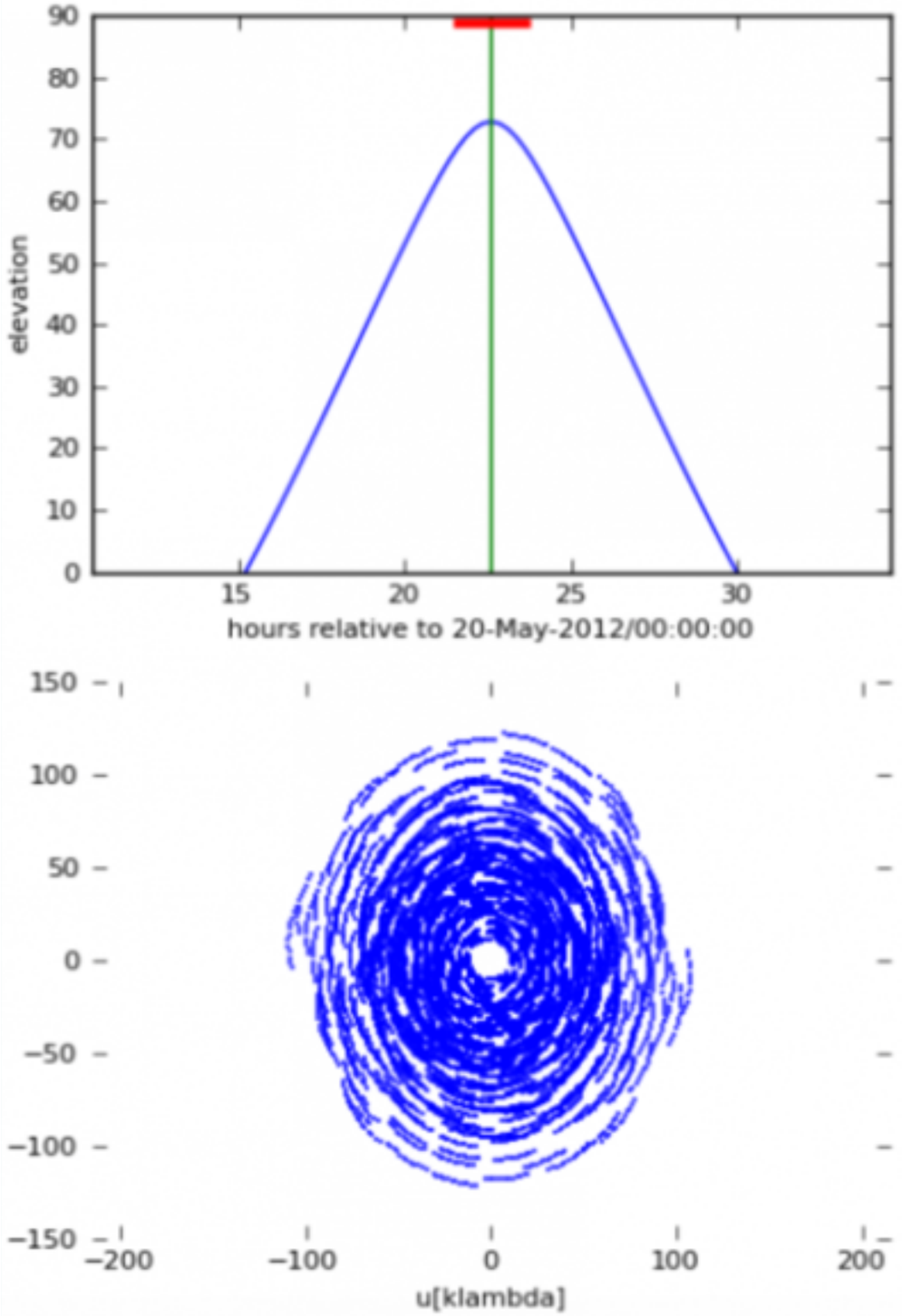
Simulating Interferometric Observations in CASA

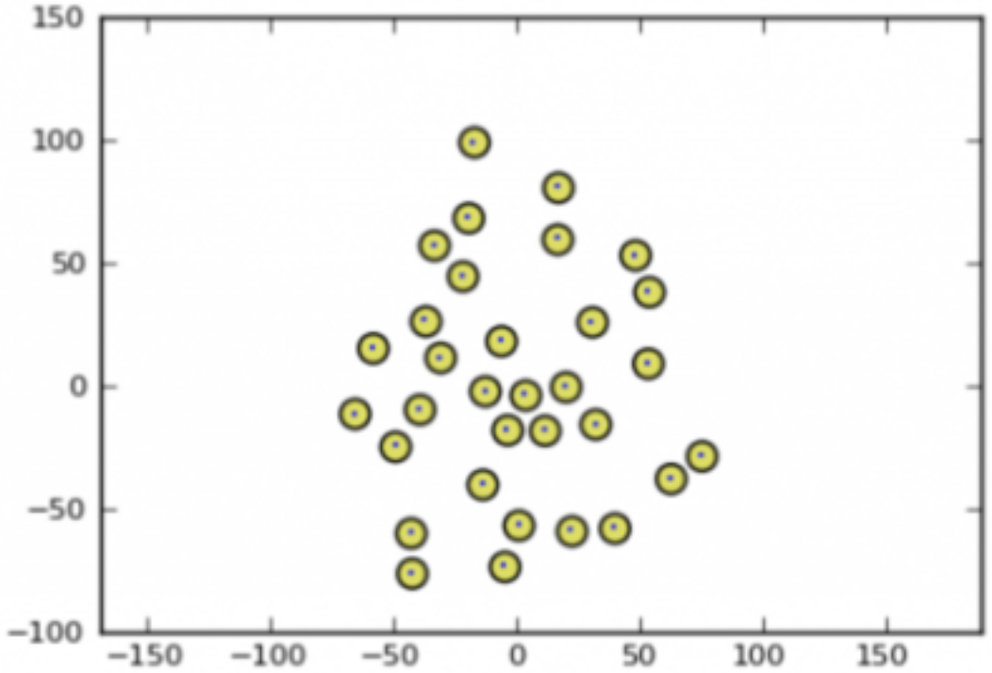
Simulating interferometric observations in CASA proceeds in the following steps:

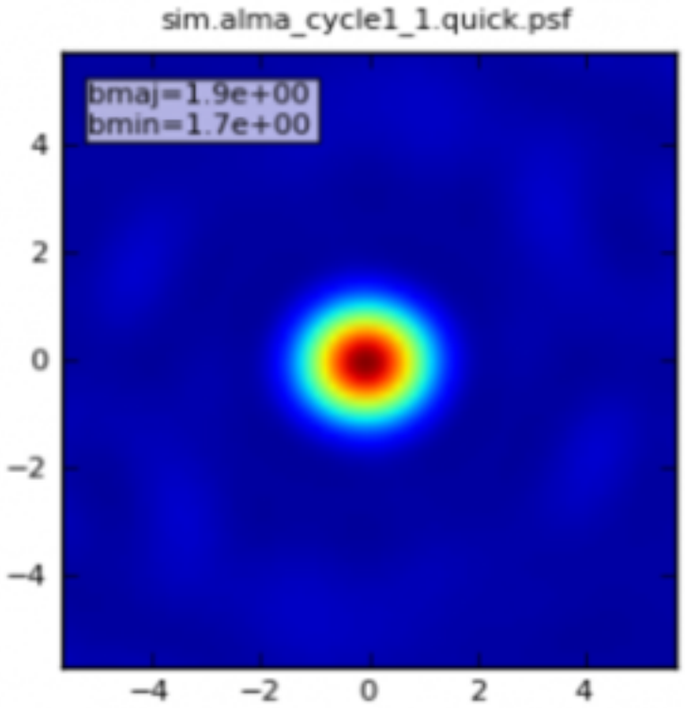
1. Make a model image. The model image is a representation of the sky brightness distribution that you would like to simulate observing, stored initially as a FITS file. There are several paths to making the FITS file, discussed below.
2. Generate uv data with the `simobserve` task.
3. Image the simulated observation with the `simanalyze` task.

http://casaguides.nrao.edu/index.php?title=Simulating_Observations_in_CASA_4.2

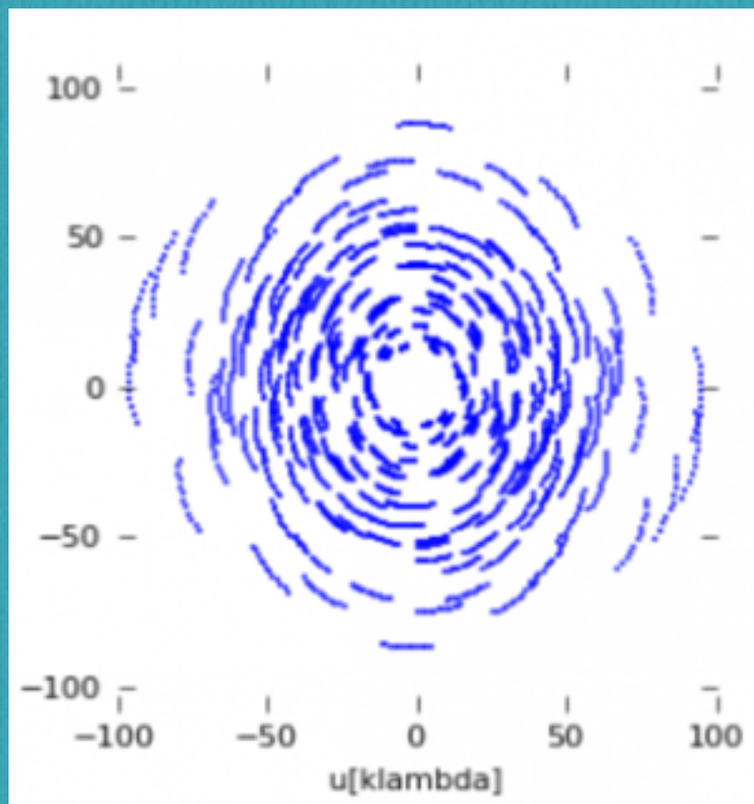
CASA : simobserve

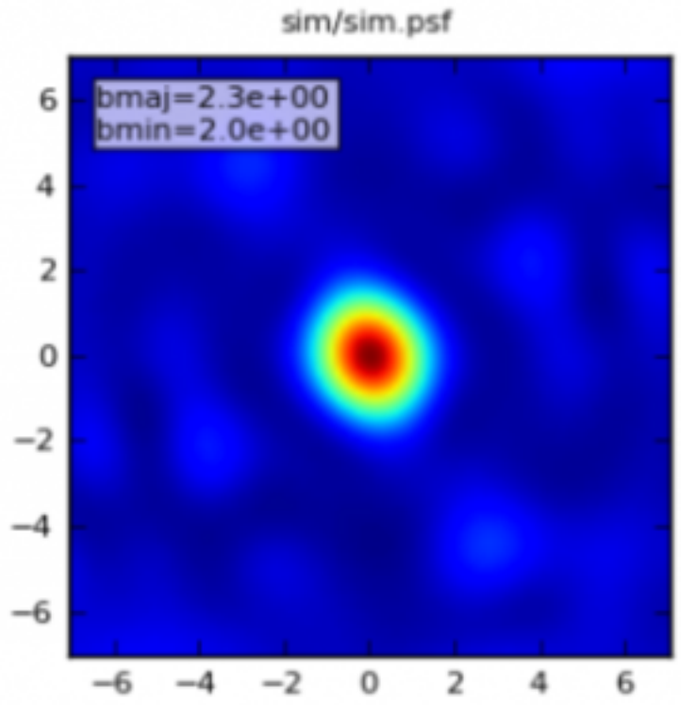


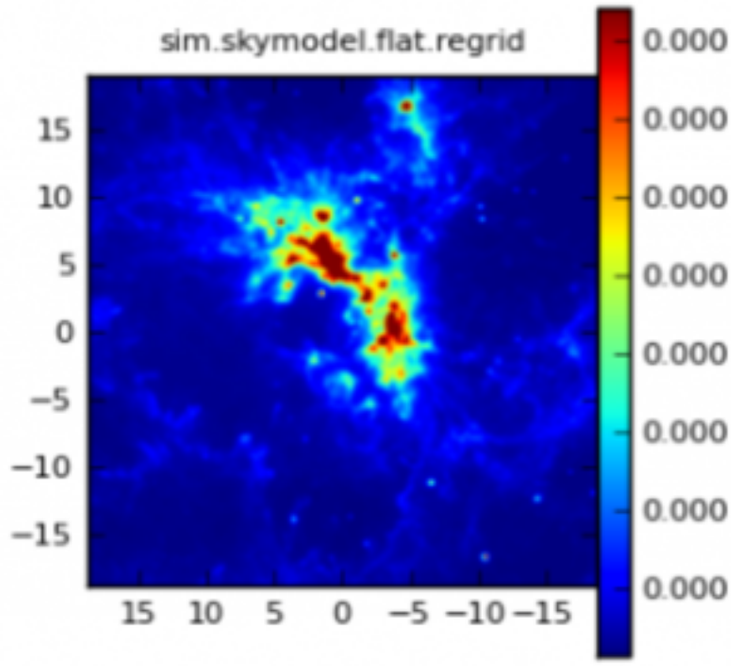


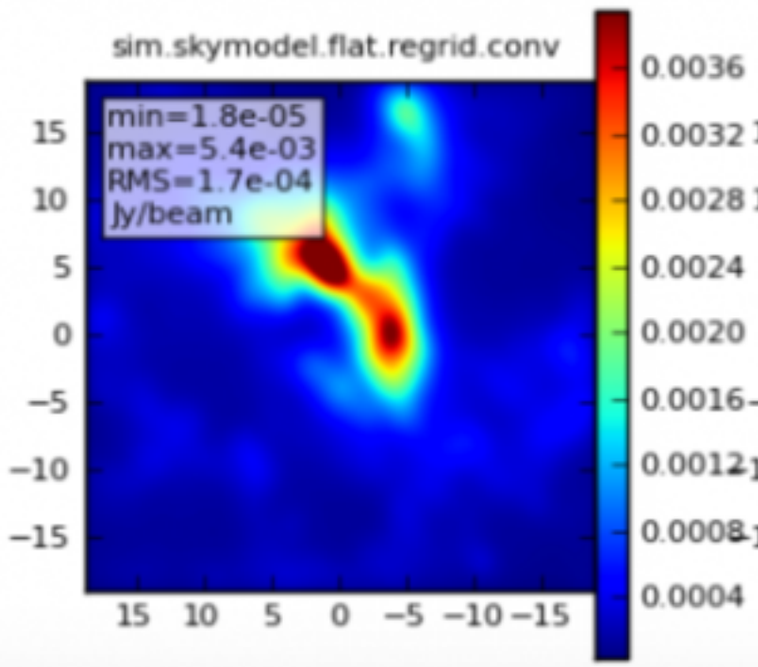


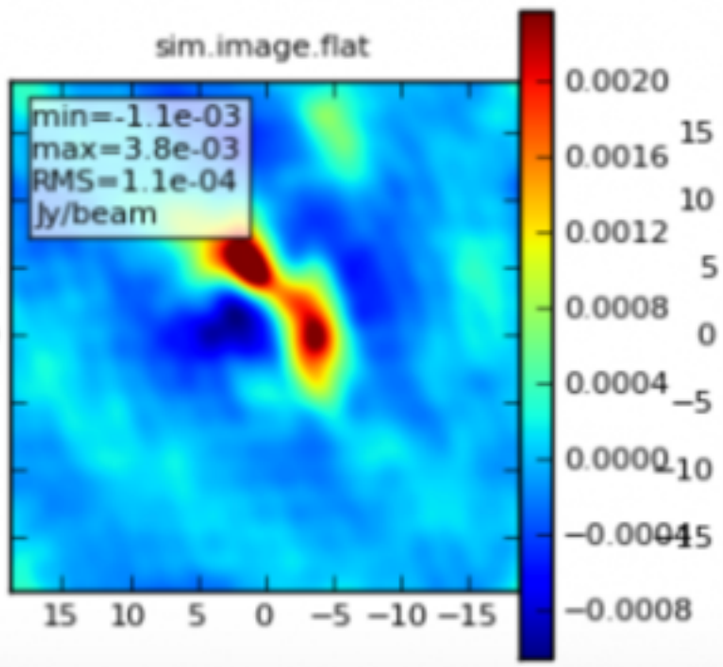
CASA : simanalyze

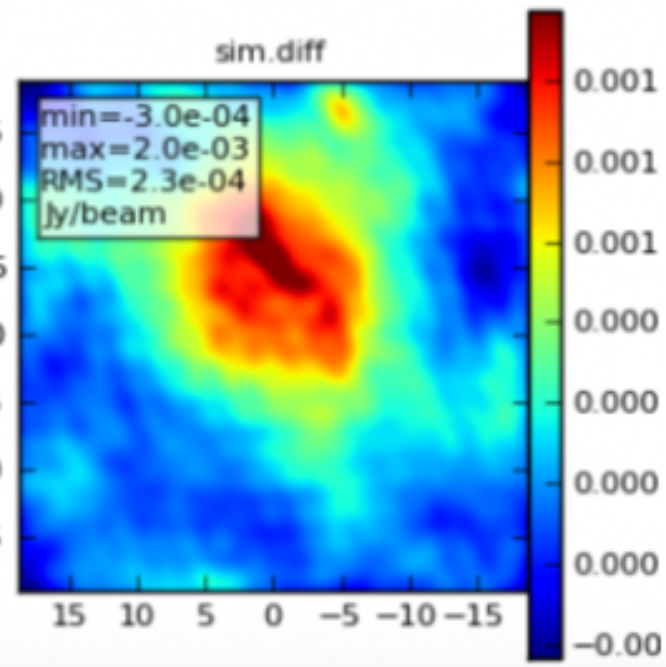












CASA simalma inputs

```
CASA <2>: inp simalma
--------> inp(simalma)
#  simalma :: Simulation task for ALMA
project             =      'sim'        #  root prefix for output file names
dryrun              =       True        #  dryrun=True will only produce the informative report, not run simobserve/analyze
skymodel            =         ''        #  model image to observe
complist            =         ''        #  componentlist to observe
setpointings        =       True
     integration    =      '10s'        #  integration (sampling) time
     direction      =         ''        #  "J2000 19h00m00 -40d00m00" or "" to center on model
     mapsize        =   ['', '']        #  angular size of map or "" to cover model

antennalist         = ['alma.cycle1.1.cfg', 'aca.cycle1.cfg'] #  antenna position files of ALMA 12m and 7m arrays
hourangle           =  'transit'        #  hour angle of observation center e.g. -3:00:00, or "transit"
totaltime           = ['20min', '1h']   #  total time of observation; vector corresponding to antennalist
tpnant              =           0       #  Number of total power antennas to use (0-4)
pwv                 =         0.5       #  Precipitable Water Vapor in mm. 0 for noise-free simulation
image               =       True        #  image simulated data
     imsize         =          0        #  output image size in pixels (x,y) or 0 to match model
     imdirection    =         ''        #  set output image direction, (otherwise center on the model)
     cell           =         ''        #  cell size with units or "" to equal model
     niter          =          0        #  maximum number of iterations (0 for dirty image)
     threshold      =   '0.1mJy'        #  flux level (+units) to stop cleaning

graphics            =     'both'        #  display graphics at each stage to [screen|file|both|none]
verbose             =      False
overwrite           =      False        #  overwrite files starting with $project
async               =      False        #  If true the taskname must be started using simalma(...)

CASA <3>:
```

ALMA Imaging simuators
2) from a web-base interface

- OST : For users with no experience with CASA, and with no need of full control of the simulation and imaging process in CASA

Version 2.0
(ALMA Cycle 2)

UPDATE: User Message 03/12/2013

Queue Status • Help • ALMA Helpdesk
OST Latest News

Array	Instrument	ALMA	
Sky Setup	Source model	OST Library: Central point source	Choose a library source model or supply your own
	Upload a FITS file	Choisir le fichier CenA.fits	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	10.0	Set to 0.0 for no rescaling of source model
Observation Setup	Central frequency in GHz	90	The value entered must be within an ALMA band
	Bandwidth in MHz	32	Use broad for continuum, narrow for single channel
	Use recommended continuum setup?	◉ No ○ Yes	If Bandwidth = 7.5GHz use the ALMA recommended spectral window spacing for continuum simulations.
	Required resolution in arcseconds	1.0	OST will choose config if instrument is set to ALMA
	Pointing strategy	Mosaic	Selecting single will apply primary beam attenuation
	Start hour angle	0.0	Deviation of start of observation from transit

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

ALMA OST Help Documentation

Help Documentation Menu

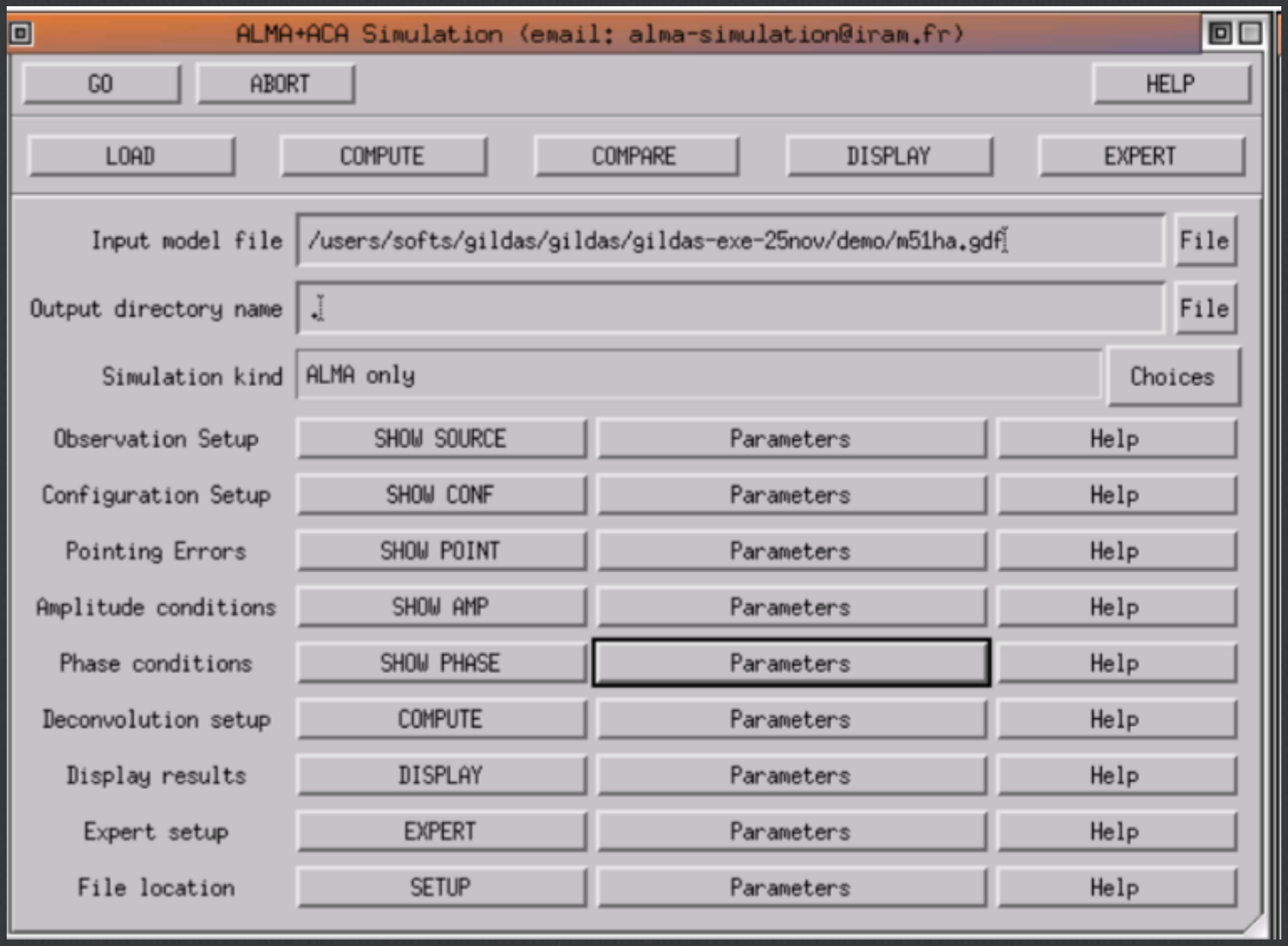
Click on the links to be taken to the relevant documentation, or scroll down for documentation in order.

DOCUMENTATION : http://almaost.jb.man.ac.uk/help/

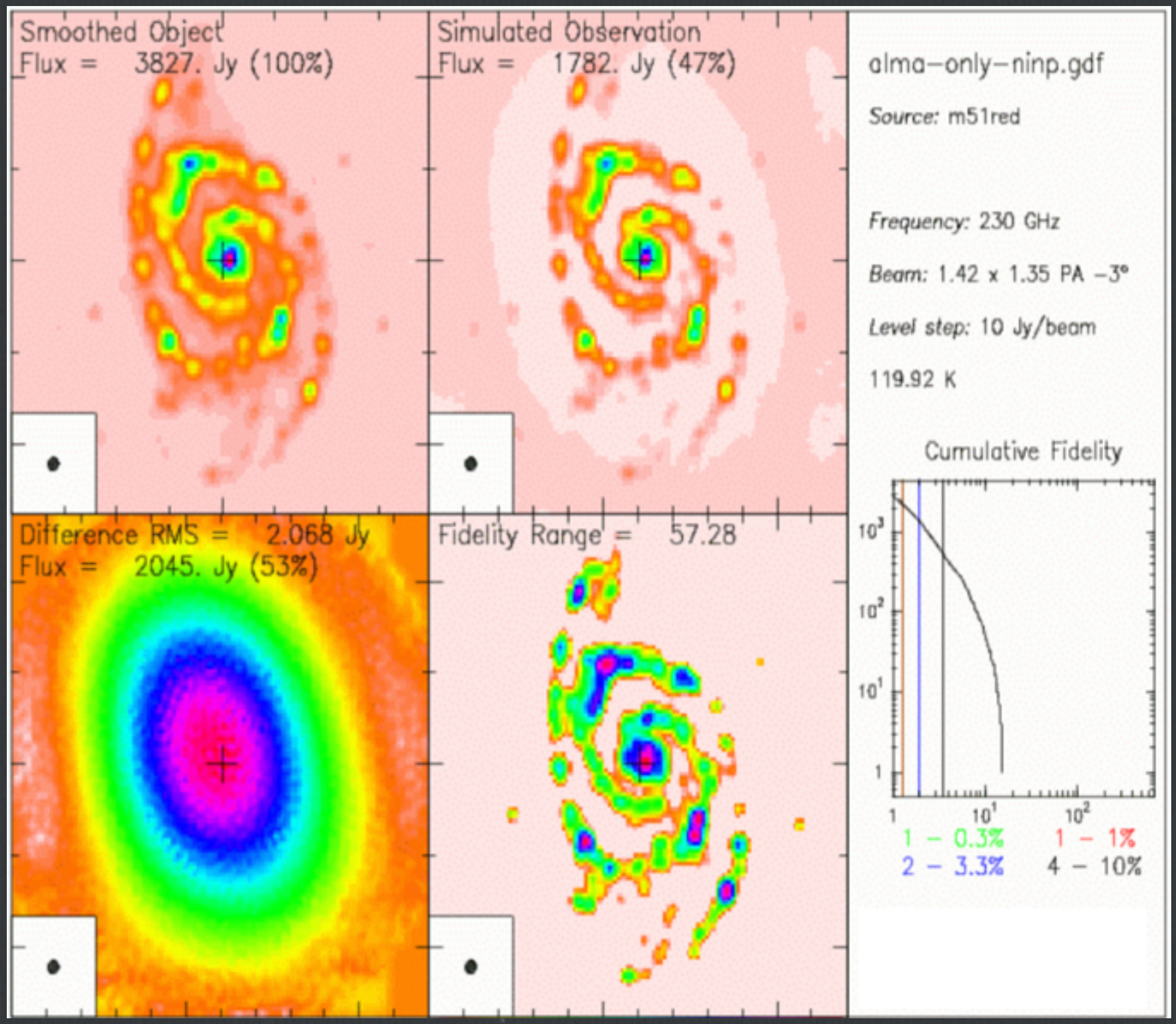
GILDAS imaging simulator

- Use GILDAS/Mapping
- Not an official ALMA software
- Documentation (Pety, Gueth, Guilloteau) in ALMA memo 398 : http://legacy.nrao.edu/alma/memos/html-memos/alma398/memo398.pdf

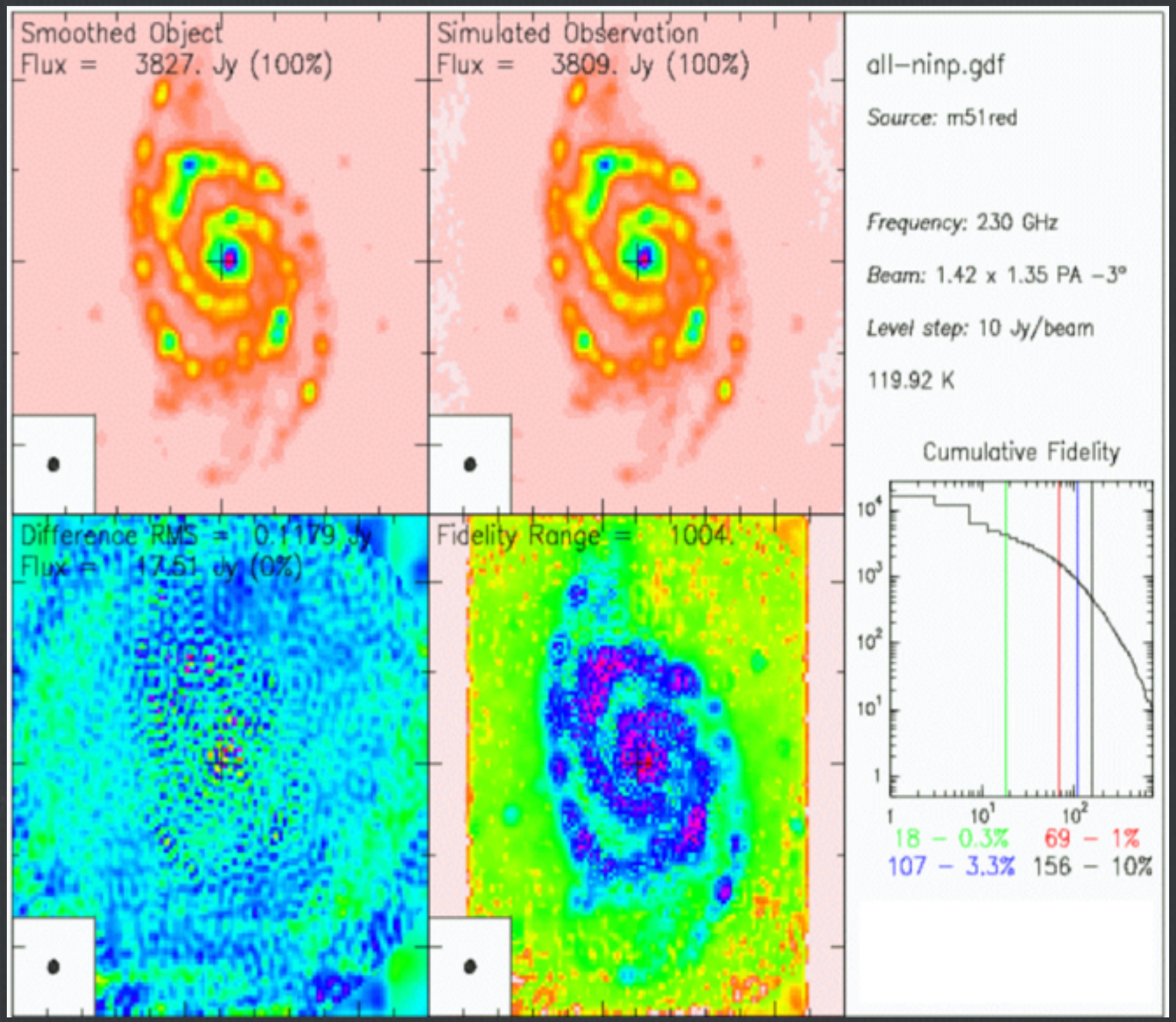
GILDAS imaging simulator



M51-type Galaxy : ALMA



M51-type Galaxy : ALMA+ACA+SD



Conclusions

- OST (web-interface) : enough but limited : for a single image, limited size of fits files upload (model), limited options : good for a first start

- CASA simalma / GILDAS imaging simulator : can also add noise, scriptable (if many sources or channel maps) : good for detailed studies