MANCHESTER 1824

The University of Manchester

Simulating interferometric data

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What you will need…

- A sensible model image (FITS/CASA image).

- An idea of the resolution you will need to recover the emission you're trying to detect.

$$\theta \sim \frac{\lambda}{b_{max}}$$

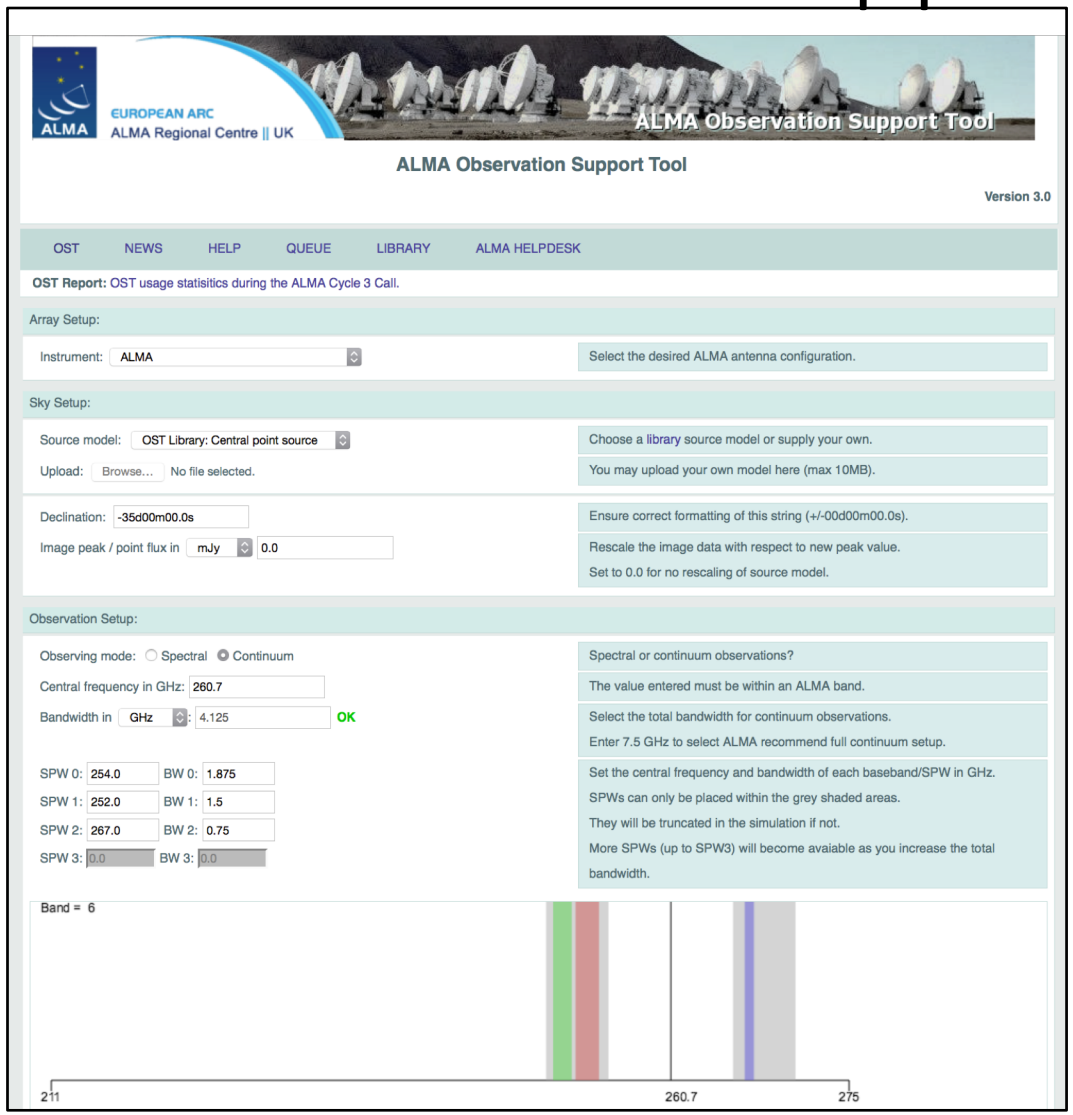
- An idea of the largest angular scale of the emission, to avoid missing spacings problems.

$$LAS \sim 0.6 \frac{\lambda}{b_{min}}$$

… then you'll need some simulation tools…

THE OST	CASA
• Introduction to the OST	• simobserve • simanalyse • simalma

The Observation Support Tool



A web-based ALMA simulator aimed at the non-interferometry expert user.

The primary version is for ALMA and has been available since ALMA Cycle 0 CfP. Since when it has been extensively used (>20k simulations) by the international community in all ALMA call for proposals.

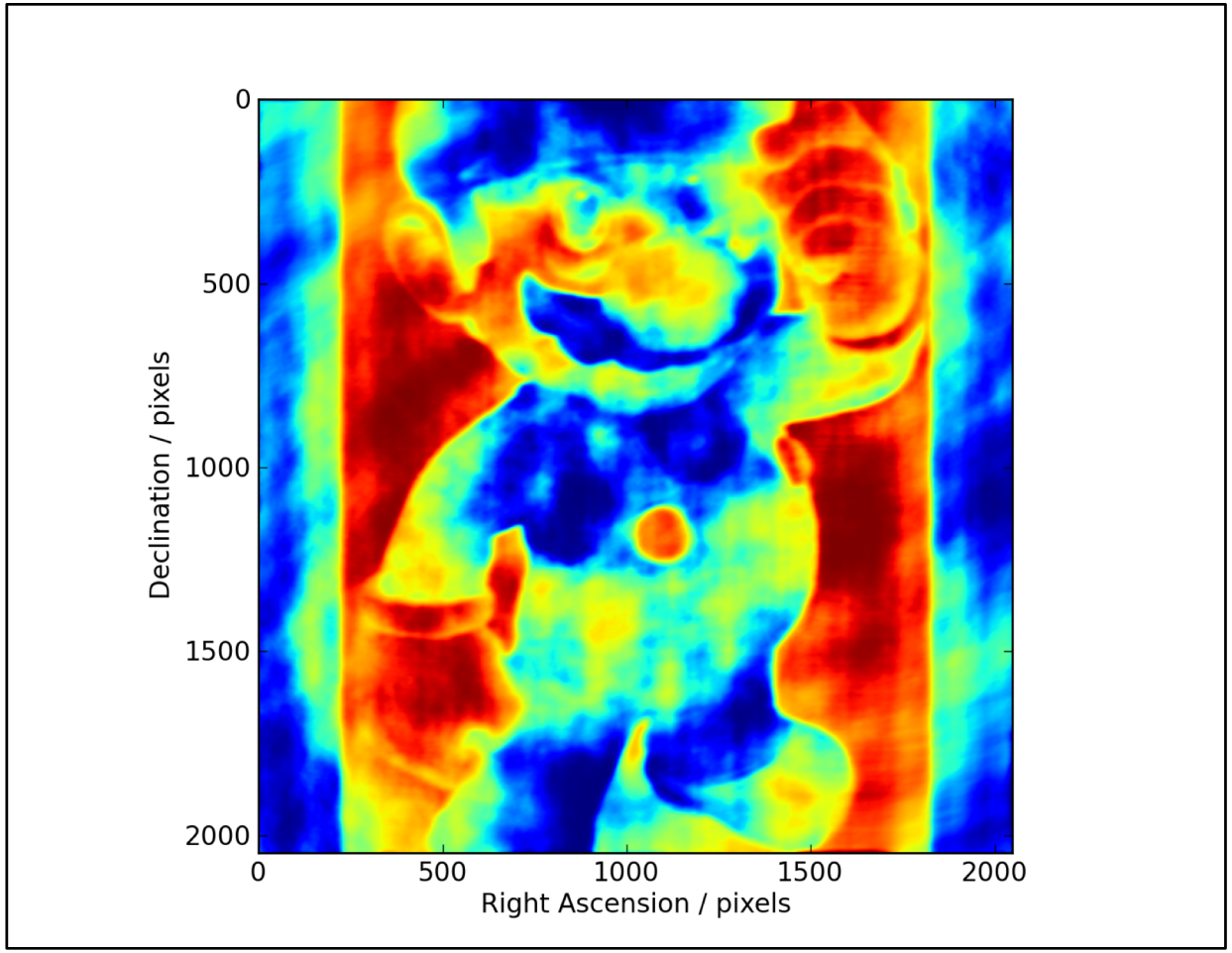
See
http://almaost.jb.man.ac.uk

There are also eMerlin and an AVN* version.

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

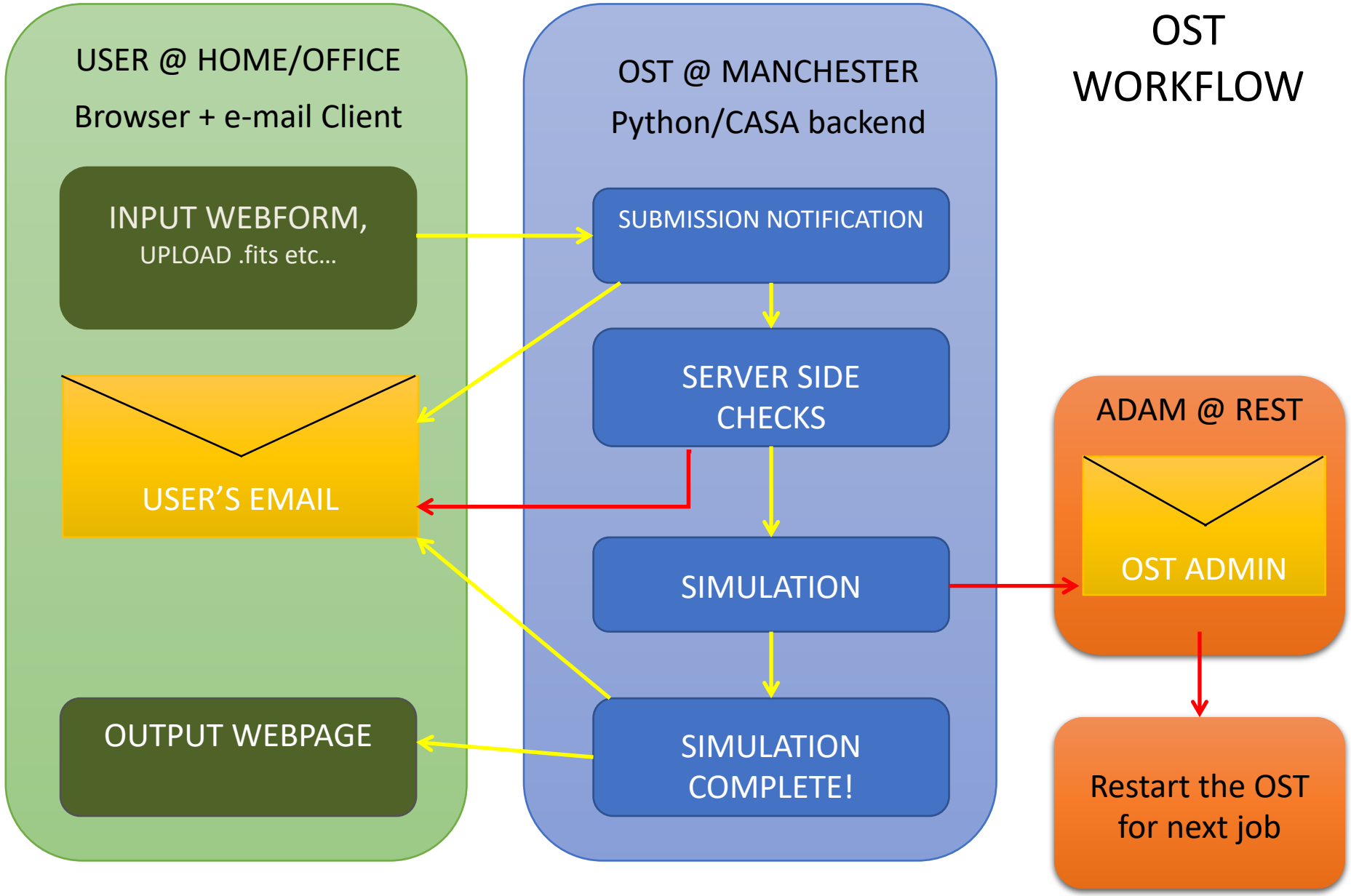
* For a hypothetical AVN telescope

OST Walkthrough



- OST Simulation of the ‘Super’ M-4R10 Galaxy

OST WORKFLOW



We’ll let the OST run for a bit... on with...

Simulating within CASA

Simobserve

simobserve is used to create the simulated interferometric observations within CASA and simanalyze is used to analyze the output of simobserve *(suprise suprise).*

Creating simulations in CASA, a recipe:

- First select an existing image of the region or type of object you want to simulate, for use as your skymodel.
- Your input sky model can then be rescaled in pixel size, brightness, sky position, central frequency and channel width with e.g. incell
- The setpointings and observe parameters are then used to define the simulated observation, with similar parameters to defining real observations.
- The corruption due to the atmosphere can then be set in thermalnoise.
- With antennalist you can define which telescope you are using. CASA knows a lot... eMerlin, ALMA, VLA, ATCA, PdBI, EVN, etc etc.

```
CASA <1>: inp simobserve
--------> inp(simobserve)
#  simobserve :: visibility simulation task
project             =       'sim'        #  root prefix for output file names
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
     maptype        =     'ALMA'         #  hexagonal, square (raster), ALMA, etc
     pointingspacing =        ''         #  spacing in between pointings or
                                         #   "0.25PB" or "" for ALMA default
                                         #   INT=lambda/D/sqrt(3), SD=lambda/D/3

obsmode             =       'int'        #  observation mode to simulate [int(int
                                         #   erferometer)|sd(singledish)|""(none)
                                         #   ]
     antennalist    = 'alma.out10.cfg'   #  interferometer antenna position file
     refdate        = '2014/05/21'       #  date of observation - not critical
                                         #   unless concatting simulations
     hourangle      =  'transit'         #  hour angle of observation center e.g.
                                         #   "-3:00:00", "5h", "-4.5" (a number
                                         #   without units will be interpreted as
                                         #   hours), or "transit"
     totaltime      =    '7200s'         #  total time of observation or number
                                         #   of repetitions
     caldirection   =         ''         #  pt source calibrator [experimental]
     calflux        =      '1Jy'

outframe            =      'LSRK'        #  spectral frame of MS to create
thermalnoise        = 'tsys-atm'         #  add thermal noise: [tsys-atm|tsys-
                                         #   manual|""]
     user_pwv       =        0.5         #  Precipitable Water Vapor in mm
     t_ground       =      269.0         #  ambient temperature
     seed           =      11111         #  random number seed

leakage             =        0.0         #  cross polarization (interferometer
                                         #   only)
graphics            =      'both'        #  display graphics at each stage to
                                         #   [screen|file|both|none]
verbose             =      False
overwrite           =       True         #  overwrite files starting with
                                         #   $project
```

Simanalyze

Here we convert the CASA MS into an image file.

- The image parameter effectively acts like CLEANing a real dataset with iteration, weighting etc
- Next the analyze parameter defines which output images you would like from your analysis. Such as Clean image, UV coverage and image

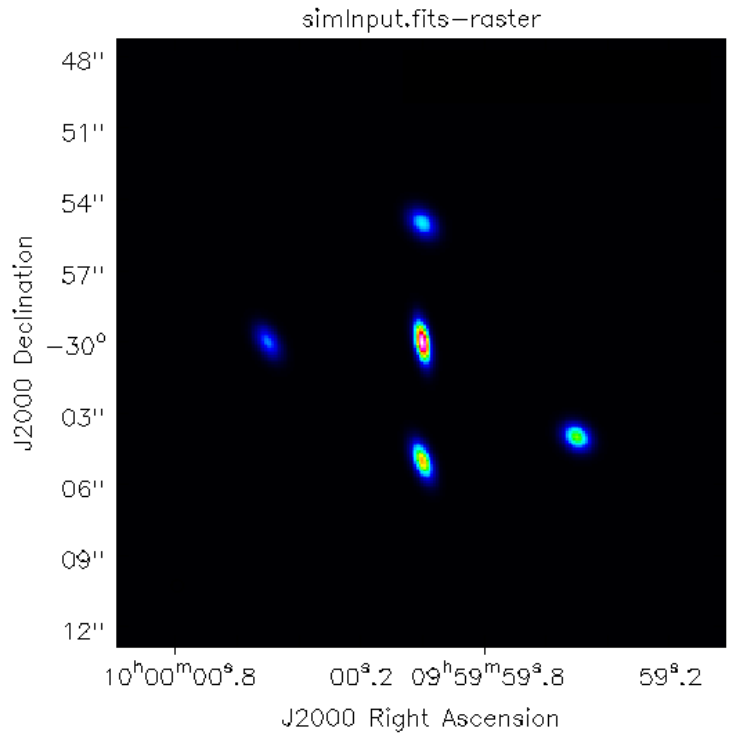
```
CASA <2>: inp simanalyze
--------> inp(simanalyze)
#  simanalyze :: image and analyze measurement sets created with simobserve
project             =      'sim'        #  root prefix for output file names
image               =       True        #  (re)image $project.*.ms to
                                        #   $project.image
     vis            =  'default'        #  Measurement Set(s) to image
     modelimage     =         ''        #  lower resolution prior image to use
                                        #   in clean e.g. existing total power
                                        #   image
     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 e.g. "10arcsec"
                                        #   or "" to equal model
     interactive    =      False        #  interactive clean?  (make sure to set
                                        #   niter>0 also)
     niter          =          0        #  maximum number of iterations (0 for
                                        #   dirty image)
     threshold      =   '0.1mJy'        #  flux level (+units) to stop cleaning
     weighting      =  'natural'        #  weighting to apply to visibilities.
                                        #   briggs will use robust=0.5
     mask           =         []        #  Cleanbox(es), mask image(s),
                                        #   region(s), or a level
     outertaper     =         []        #  uv-taper on outer baselines in uv-
                                        #   plane
     pbcor          =       True        #  correct the output of synthesis
                                        #   images for primary beam response?
     stokes         =        'I'        #  Stokes params to image
     featherimage   =         ''        #  image (e.g. total power) to feather
                                        #   with new image

analyze             =      False        #  (only first 6 selected outputs will
                                        #   be displayed)
graphics            =     'both'        #  display graphics at each stage to
                                        #   [screen|file|both|none]
verbose             =      False
overwrite           =       True        #  overwrite files starting with
                                        #   $project
dryrun              =      False        #  only print information [experimental;
                                        #   only for interfermetric data]
logfile             =         ''
```

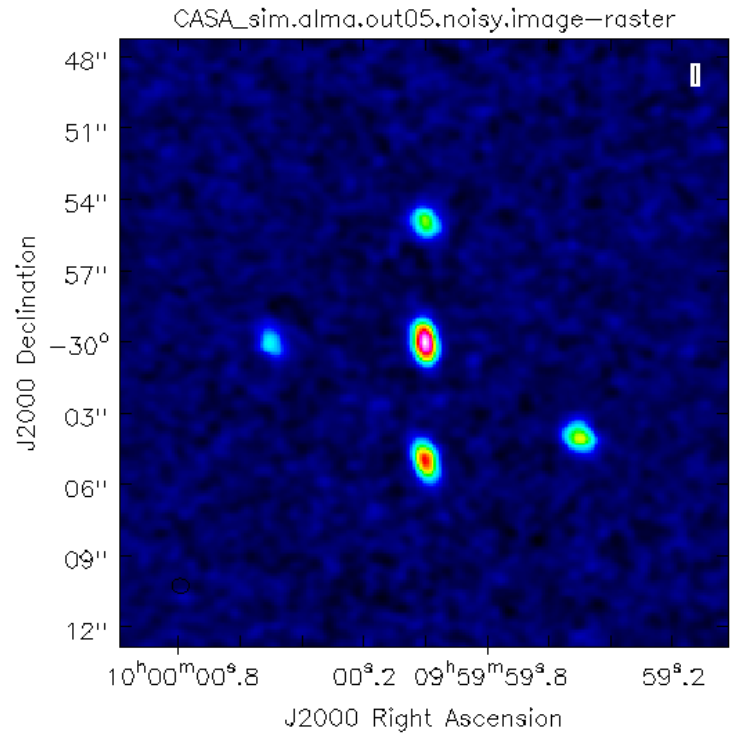
Simalma

- A wrapper of simobserve and simanalyze which has some of these tasks parameters set to typical ALMA values.

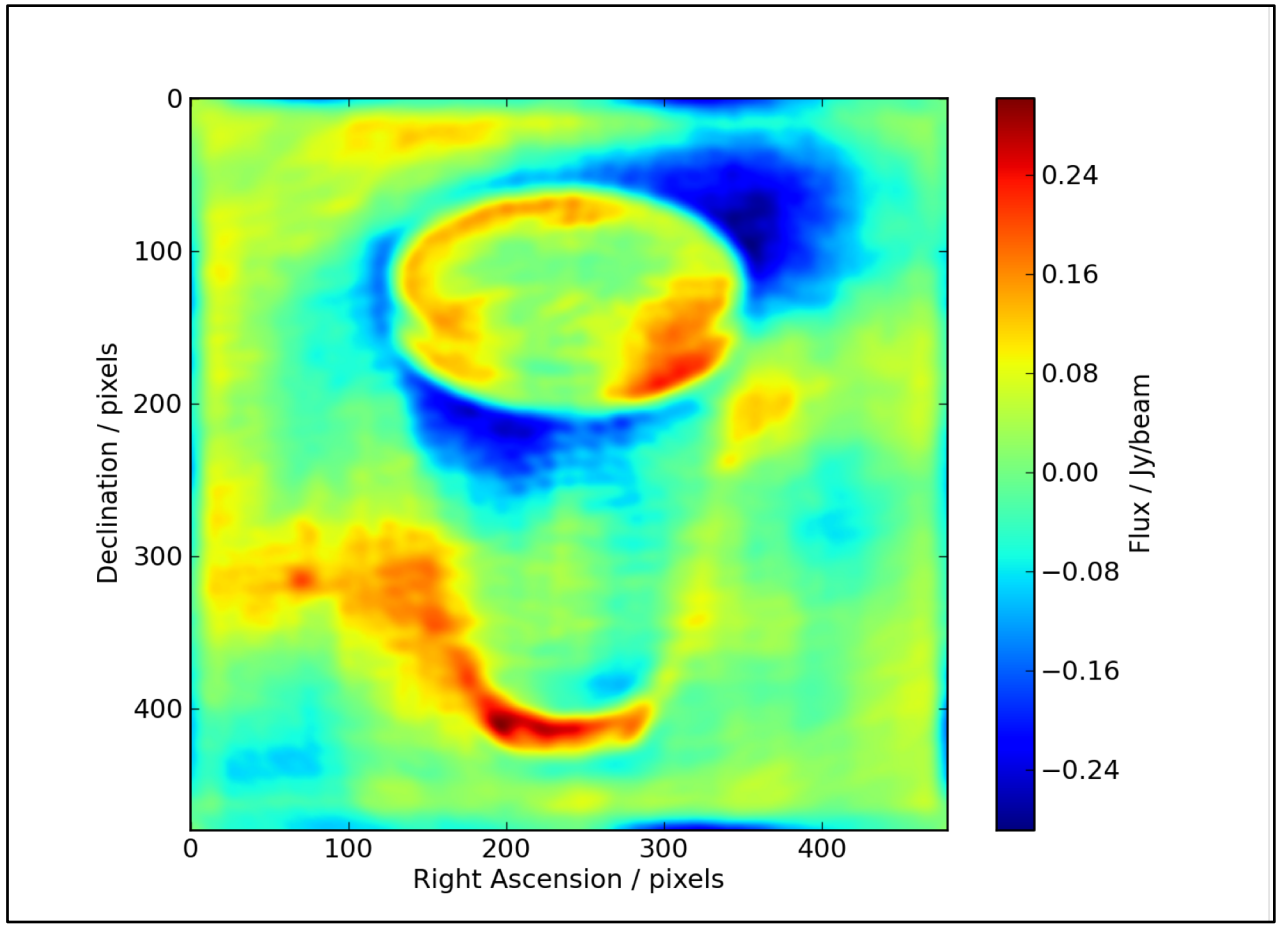
Simobserve/analyse

- There is a (heavily commented) example script and associated fits file on this meeting's webpage for running simobserve/analyse within CASA.





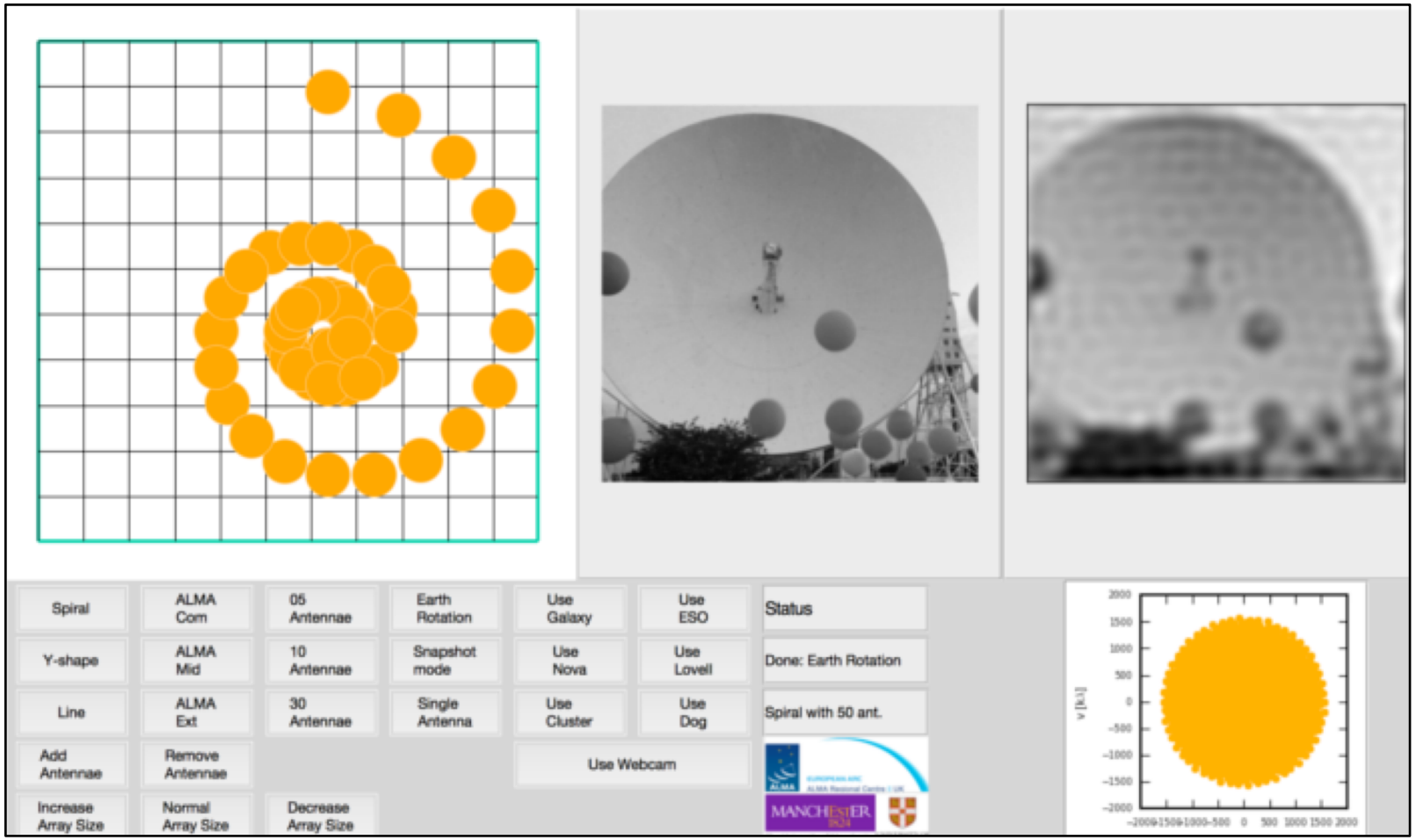
Back to OST output



And just for fun, some toy interferometers

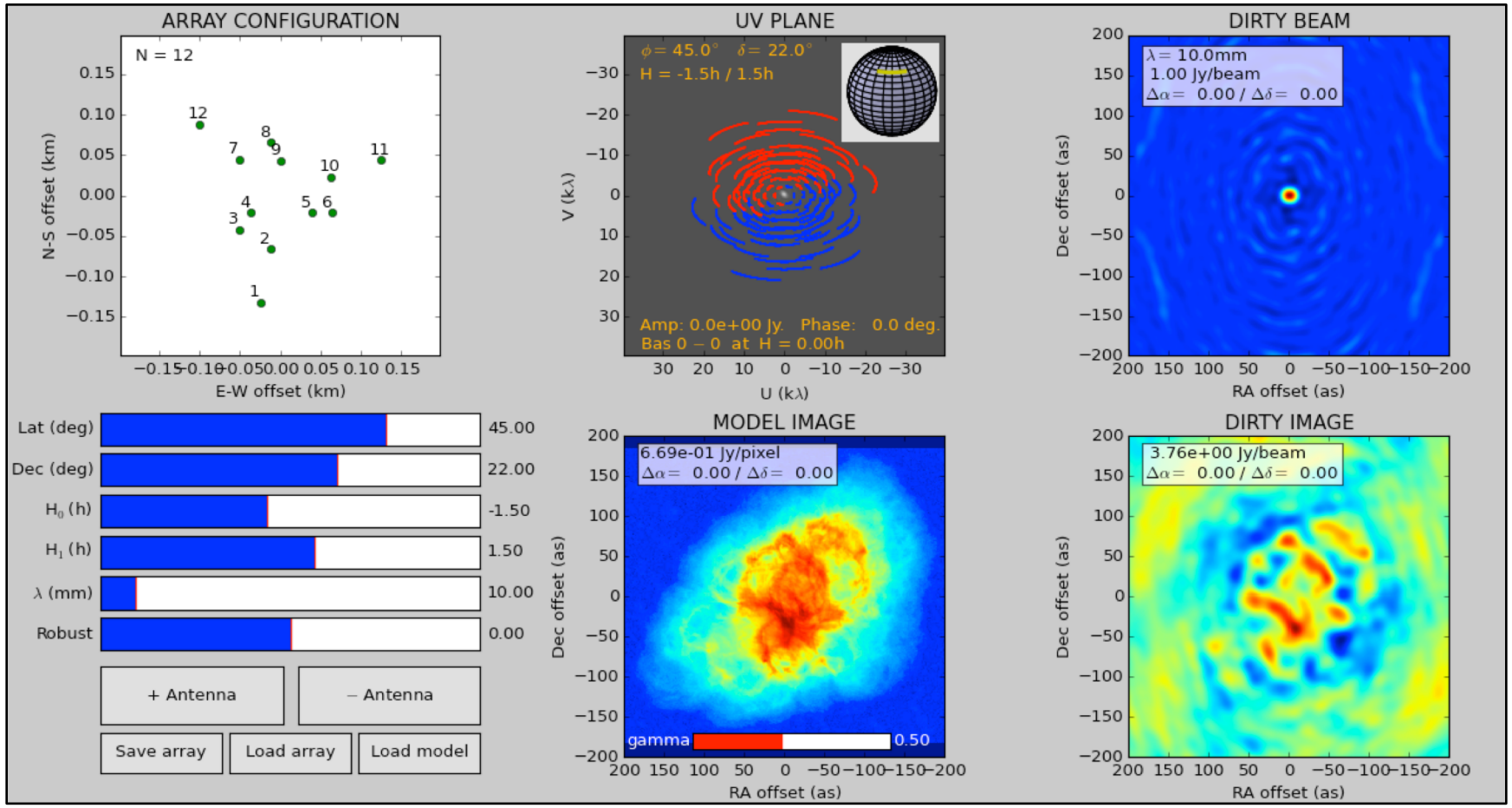
Pynterferometer

- http://www.jb.man.ac.uk/pynterferometer/



APSYNSIM

- http://www.nordic-alma.se/support/software-tools



Have a go with a toy interferometer

http://www.jb.man.ac.uk/~aavison/ESO_javascript/gridIndex.html

Useful for considering effects of multiple arrays