(alma)simmos.py

- Requirements by user group
- Model input
- Parameter specification
- Simulation
- Corruption
- Analysis/Assessment

User categories

- Joe [optical] Astronomer
- Synthesis Expert / Commissioning Scientist
- CASA developer
- Pipeline Developer

User categories

- Joe [optical] Astronomer
  - As simple interface as possible, in physical terms (FOV in arcmin, beam in arcsec) ✓
  - Automatic generation of sensible detailed parameters (config, corr setup, etc) [some]
  - seamless interface with OT [future]

User categories

- Expert User or Commissioning Scientist
  - Detailed options for configuration, ✓

    correlator setup ✗ [someday via OT? SB?]
  - Ability to put in complex observing/mosaicing schemes [not effortless but possible – plans for e.g. cal-src-WVR rotation]
  - Batch / noninteractive processing ✓

User categories

- CASA developer: generate MS to test
  - General I/O, display, and performance ✓
  - Calibration ✓ [modulo independence]
  - Imaging ✓

User categories

- Pipeline Developer
  - Generate ASDM -> ms2asdm.py ?
  - Fill ASDM meta-data ✗
  - Include noise and anomalies like misbehaving antenna [some]
  - Program simulator with something like a SB ✗ [maybe someday]

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Model specification/input

- CASA importfits
- idl to casa image [separate python script]
- WCS override in almasimmos:
  - Specify size on sky, pixel scale, flux level
- more robust FITS WCS and header parsing [planned as general CASA capability]

Model specification

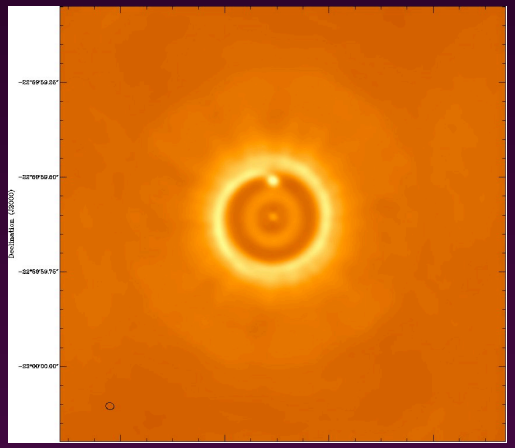
IPy crystal

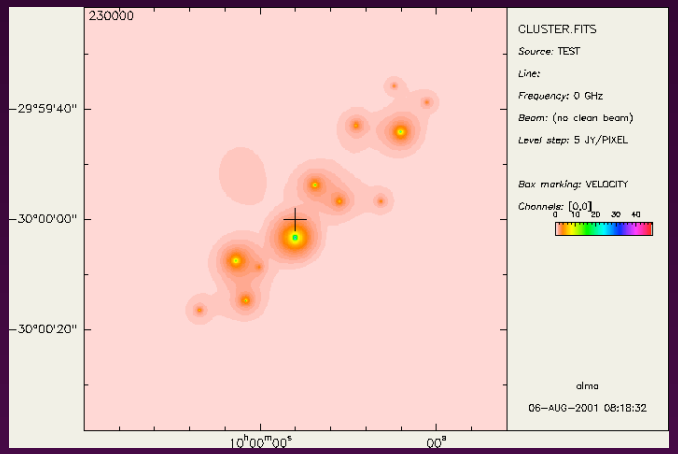
```
CASA <10>: inp
---------> inp()
#  almasimmos :: ALMA mosaic simulation task (prototype):
modelimage          = 'GLM.subim'       #  input image name to look at
incell              =   'header'        #  input image pixel size
inbright            =       0.02        #  input image pk surface brightness (Jy/sq arcsec)
complist            =         ''        #  componentlist table to observe
antennalist         = 'configs/almaconfig.cut02' #  antenna position file
project             = 'crystal6b'       #  root for output files
refdate             = '2012/05/21/22:05:00' #  center time/date of observation
totaltime           =    '7200s'        #  total time of observation
integration         =      '10s'        #  integration (sampling) time
startfreq           =   '345GHz'        #  frequency of first channel
chanwidth           =    '10MHz'        #  channel width
nchan               =         1        #  number of channels
direction           = ['J2000 19h00m00 -40d00m00'] #  mosaic center, or list of pointings
pointingspacing     =  '7arcsec'        #  spacing in between beams in mosaic
relmargin           =       1.0         #  space btw. pointings and edge, relative to pointingspacing
cell                = '0.25arcsec'      #  output cell/pixel size
imsize              = [250, 250]        #  output image size in pixels (x,y)
niter               =       200         #  Maximum number of iterations
threshold           =   '0.0mJy'        #  Flux level (+units) to stop cleaning
psfmode             =    'clark'        #  method of PSF calculation to use during minor cycles
weighting           =  'natural'        #  Weighting to apply to visibilities
uvtaper             =      False        #  Apply additional uv tapering of  visibilities.
stokes              =        'I'        #  Stokes params to image
noise_thermal       =       True        #  Add thermal noise
     t_amb          =      265.0        #  ambient temperature
     tau0           =        0.1        #  zenith opacity

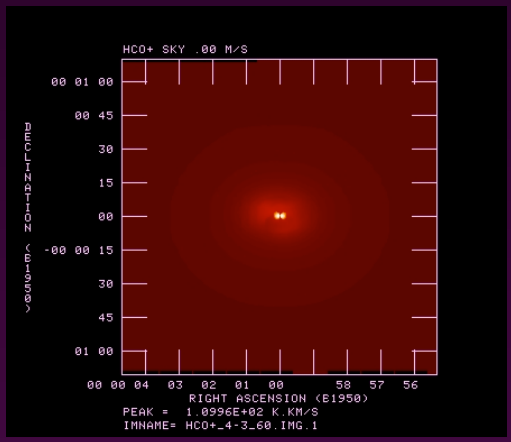
fidelity            =       True        #  Calculate fidelity images
display             =       True        #  Plot simulation result images,figures
async               =      False        #  If true the taskname must be started using almasimmos(...)

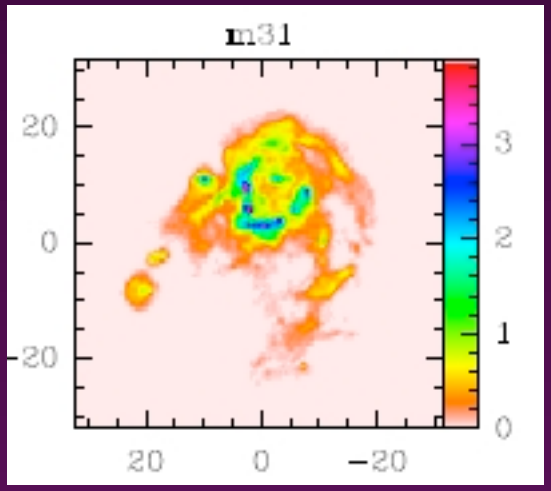
CASA <11>:
```

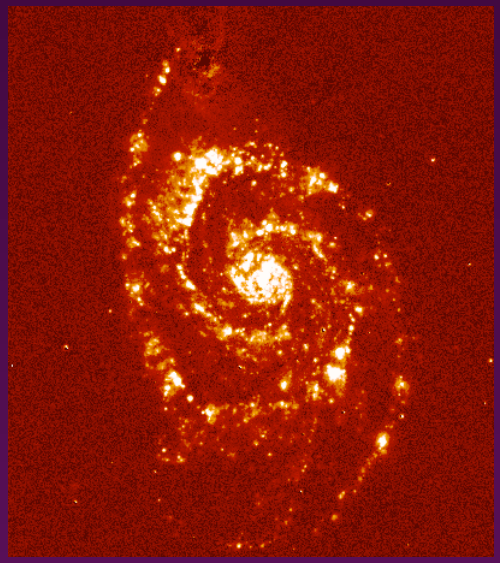
Model Library







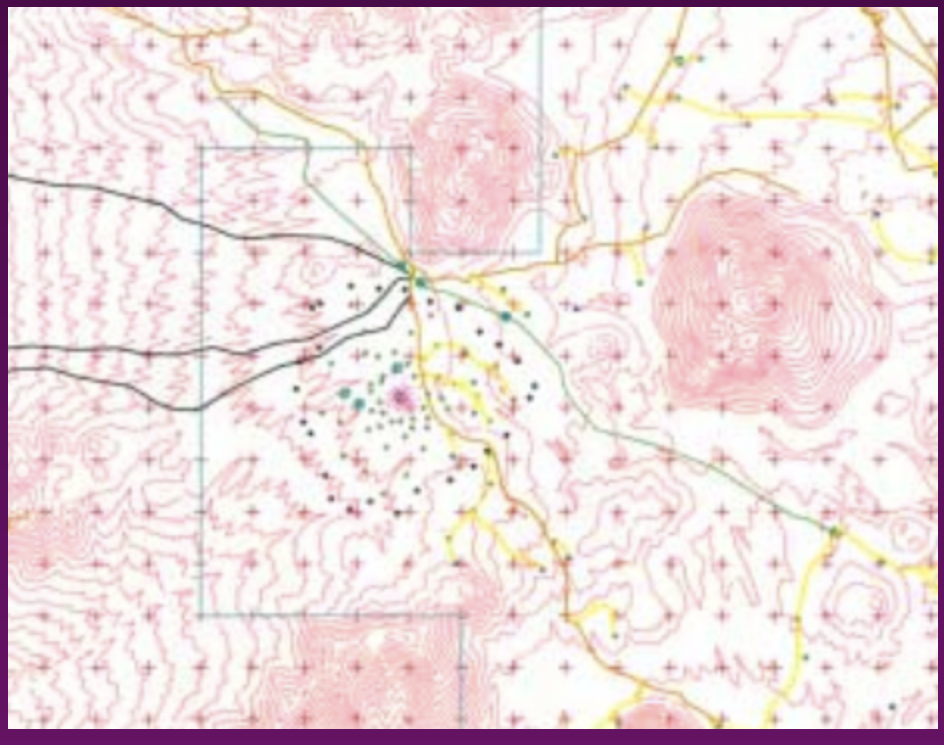




- Distance/flux scaling?
- High redshift cluster?

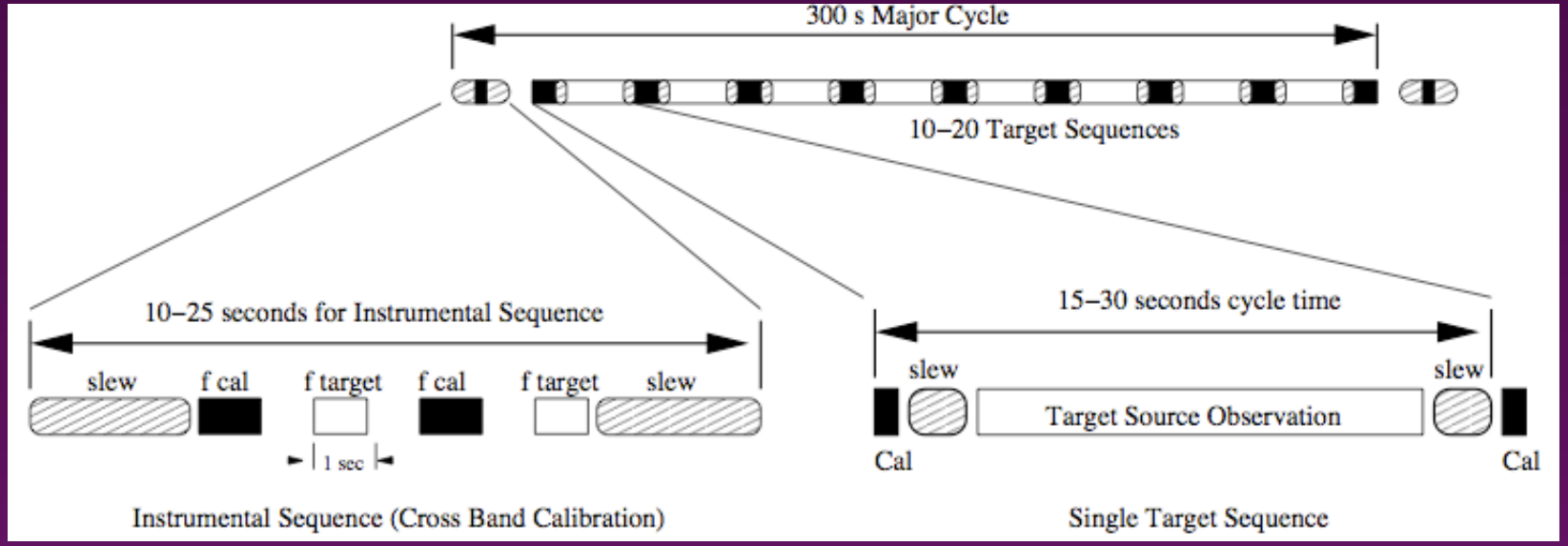
Parameter specification: array

- [built-in] ALMA, EVLA
- suggestalmaconfig.py [script]
- [currently manual, future addition] ACA!, SMA, CARMA, PdB, ATCA
- Custom e.g. SKA



Parameter specification: observation

- One track (possible mosaic target) ✓
- Cal-src-WVR [planned]
- SB2ASDM? SB2params? [future]



ALMA-90.03.00.00-00x-A-SPE

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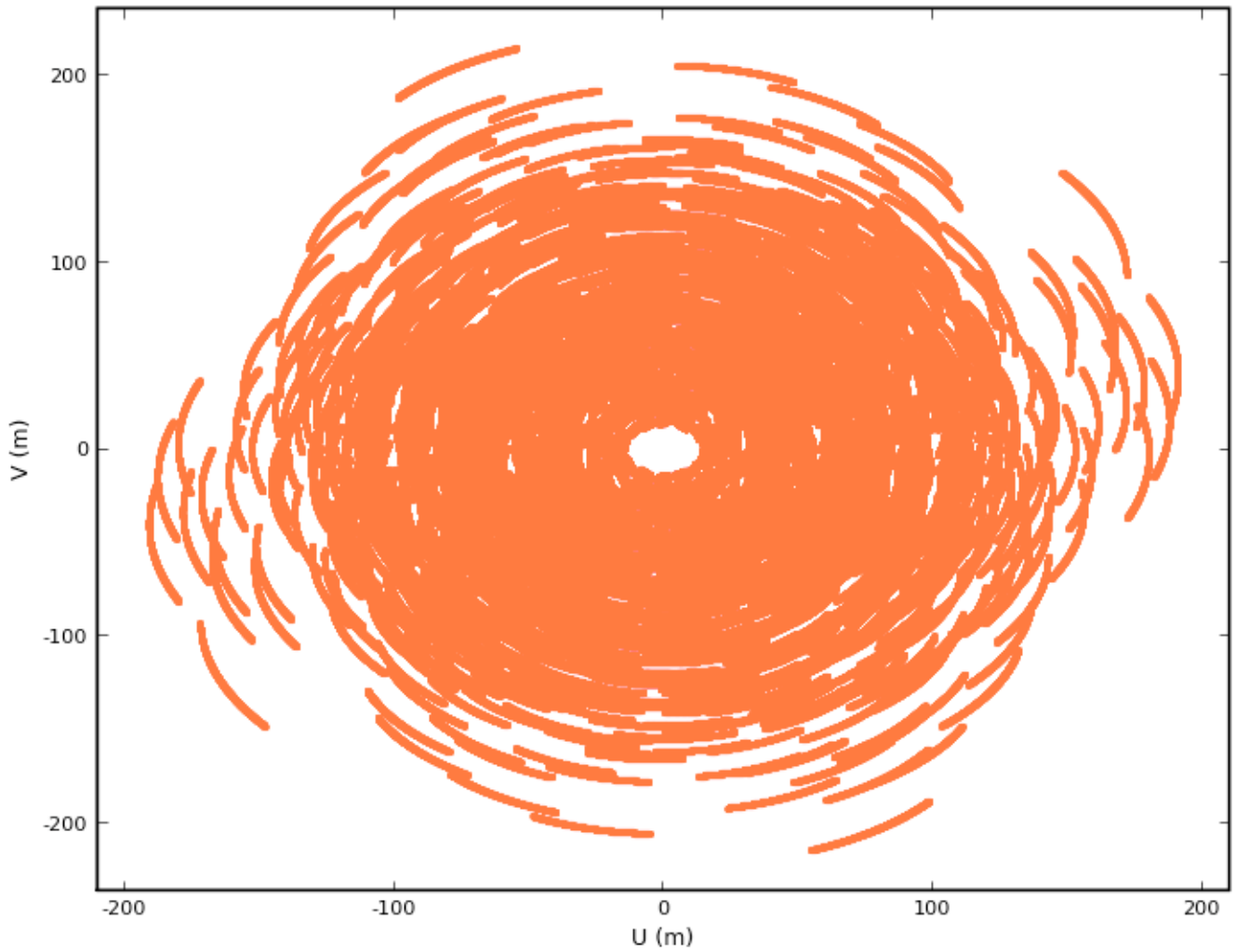
CASA <11>:
```

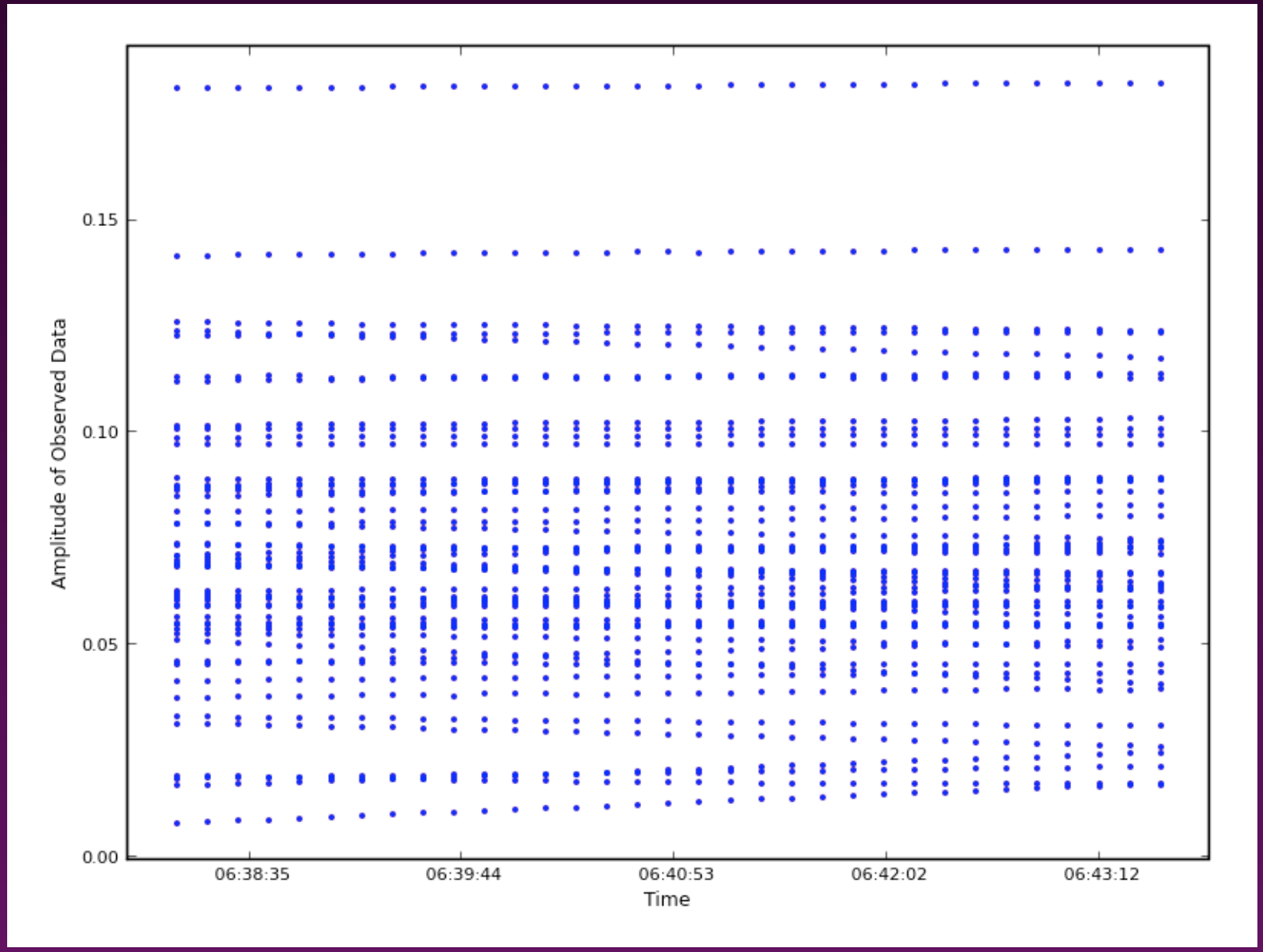
Model Verification/Quick Prediction

- Complex in current XML implementation of CASA, but there is a mechanism
- Desired quick feedback given a set of parameters:
  - Are all parameters valid? ✓
  - Beam size
  - Ephemeris [obs time, shadowing?]
  - Expected RMS
  - ?

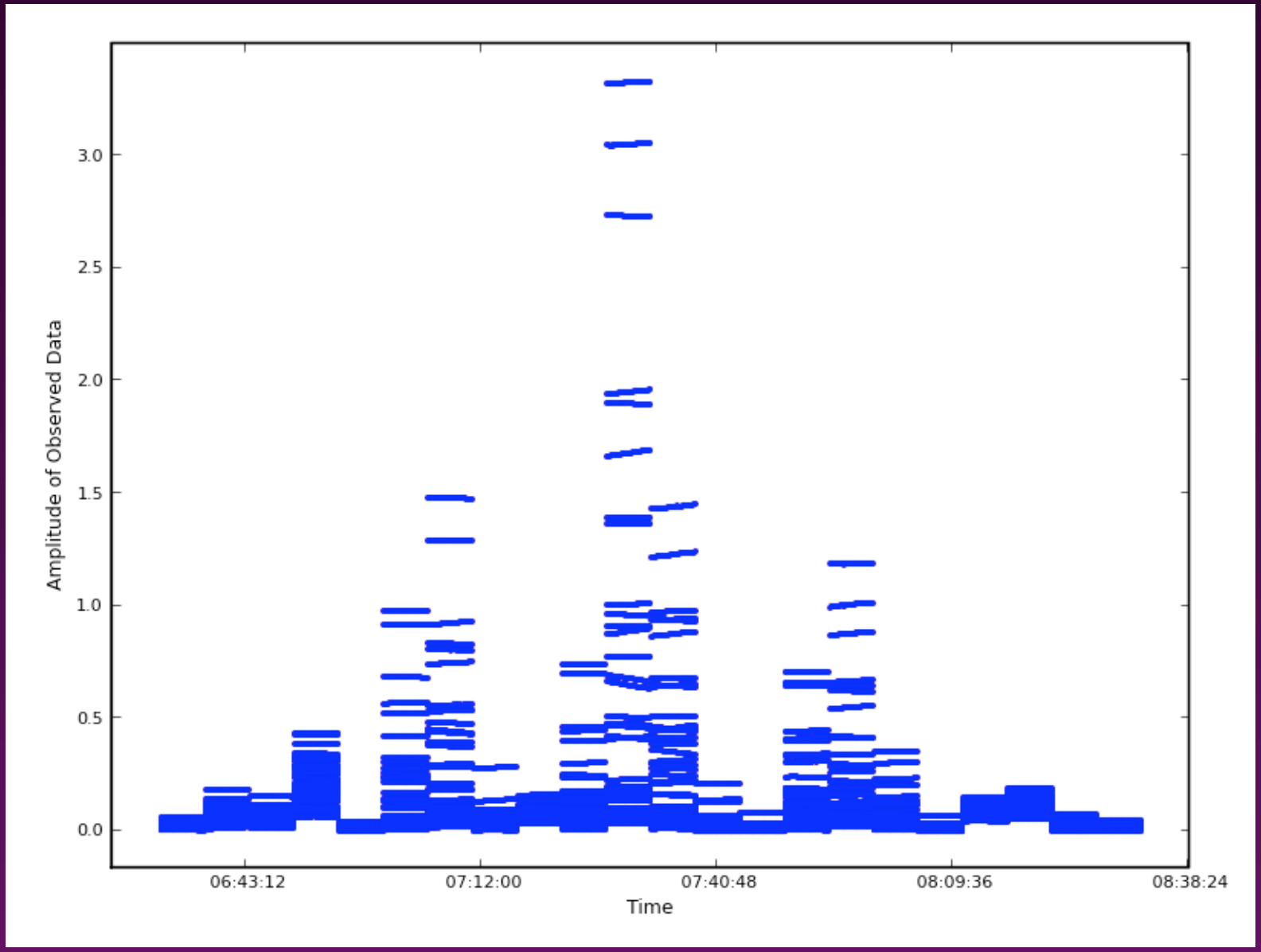
Noiseless Visibilities ✓



Noiseless Visibilities ✓



Noiseless Visibilities ✓



Noise

- Thermal – Atmos & Rx ✓
- Atmospheric phase screen – Nikolic algorithm
- Atmospheric absorption & system efficiencies ✓
- Pointing errors [Sanjay's mechanism?]
- measured primary beams
- Antenna position errors
- Polarization (instrumental, leakage)
- Bandpass variations
- (de)focus

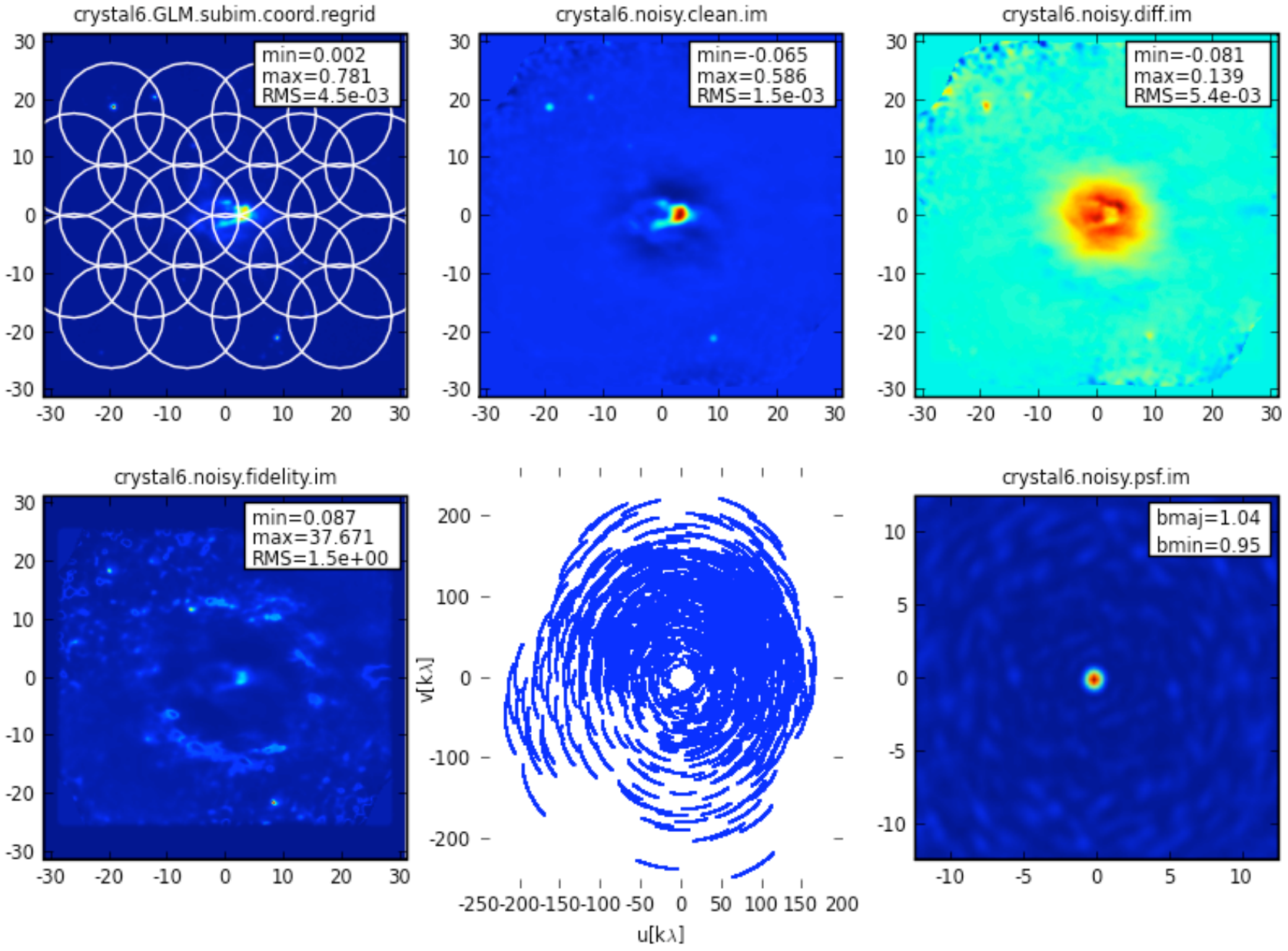
Thermal Noise

$$T_{noise} = \frac{\sqrt{2}k_B T_{sys}}{\eta_b \eta_t \eta_s \eta_p \eta_c a \sqrt{\Delta \nu t_{\text{int}}}}$$

.99 .86 .96 .95 Ruze(25μm) 12m

$$T_{sys} = T_{rx} e^{\tau_0 A} + \eta_s T_{atm}(e^{\tau_0 A} - 1) + (1 - \eta_s) T_{amb} e^{\tau_0 A} + T_{cmb}$$

Diagnostic Output



Miscellaneous

- Generates ds9 region file of pointings
- [separate python] kvis annot file of ptgs
- What else do you want?

[more distant] Future

- Simultaneous TP simulation
- 12+7 X-correlations (deconvolution?)
- SB/OT interface
- more complex correlator setup
- Web interface:
  - ingest (2D) model file, specify freq, beam, area
  - return fits cube