

Tutorial3: Imaging and modeling

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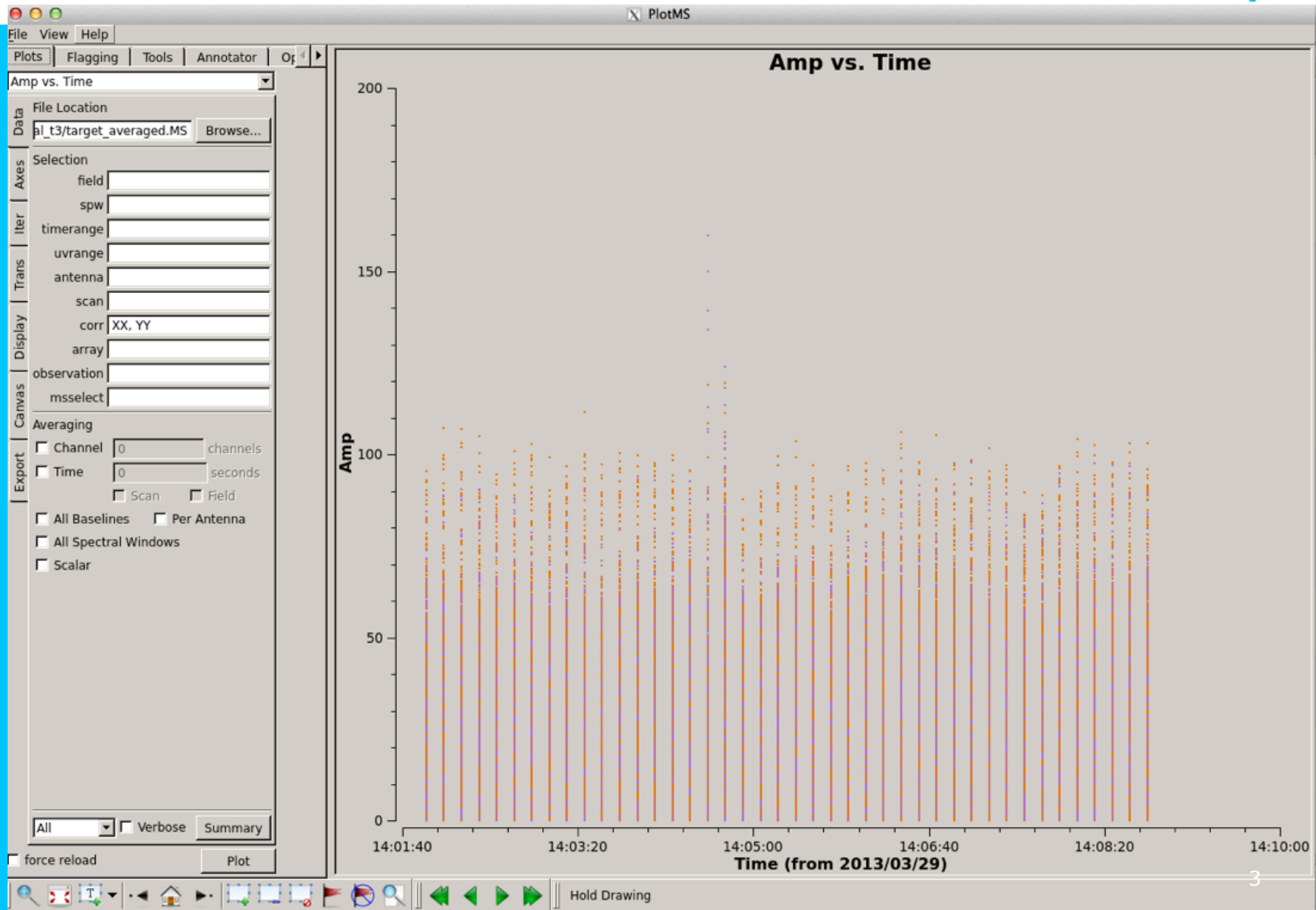
Start with averaged data obtained in T2:
Do setup on CEP3 the same as in T1 and T2.

- in lofXXX: `cp -r /data/dataschool2014/imaging/t3/data .`
- in lofXXX: `cp -r /data/dataschool2014/imaging/t3/parsets .`

Inspect the data after BBS, data and corrected data column to spot residual RFIs or spikes introduced by the calibration.

- `casaplotms &`
- Amp vs time and iterative per baseline

Corrected data



-NDPPP NDPPP_ao.parset > ndppp.log

-casaplotms

NDPPP.parset

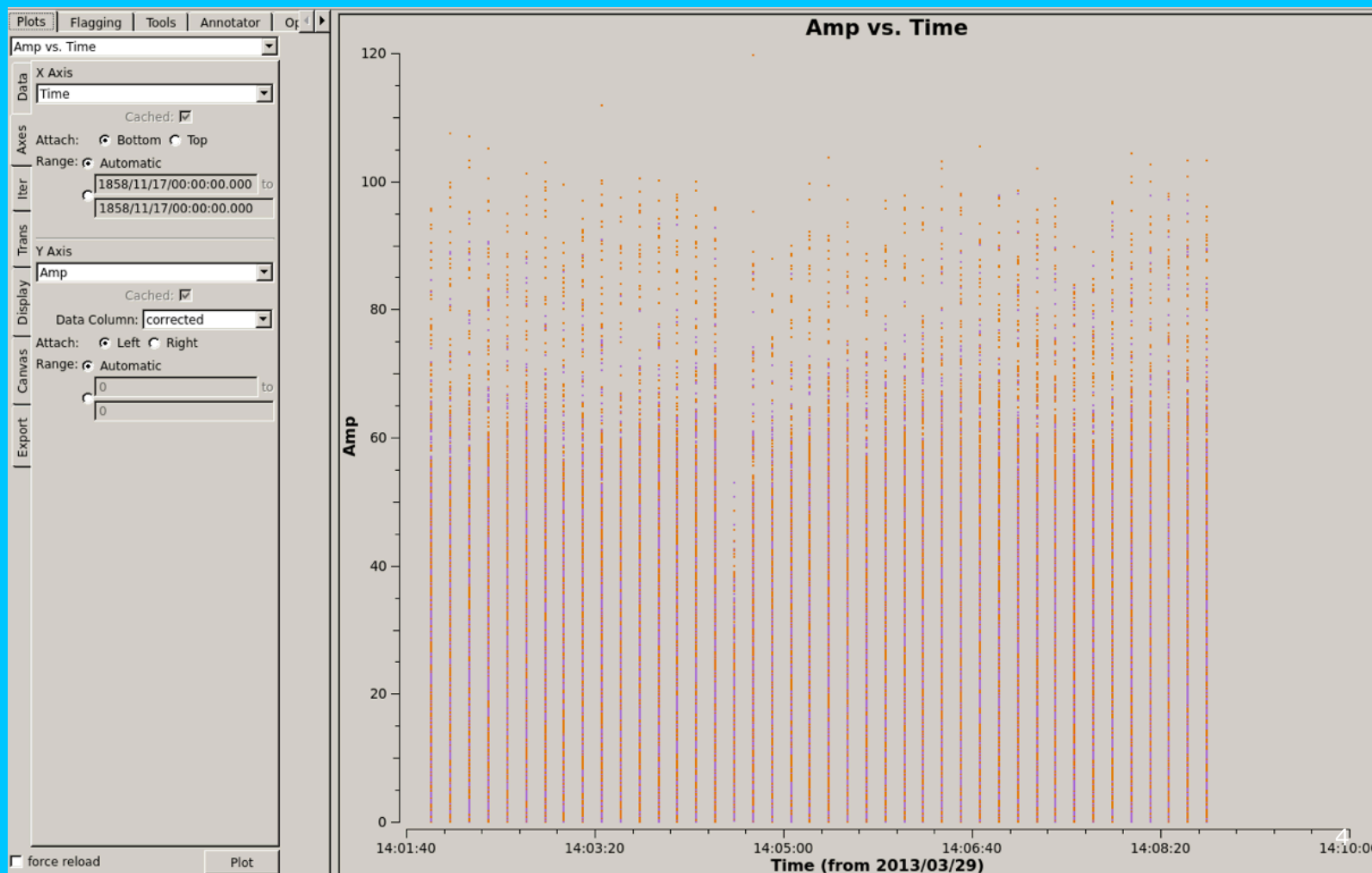
msin = target_averaged.MS

msindatacolumn =CORRECTED_DATA

msout=target_averaged_dppp.MS

steps = [preflag,aoflag]

preflag.baseline = *&&&



```
. /opt/cep/tools/citt/lofarinit.sh
awimager -help ("clean", "empty", "image", "predict")
awimager -help image
```

```
usage: awimager file.parset [parsetkeys]
```

Operation "image": create a dirty image

General parameters:

```
operation      : operation name  string, no default
verbose        : verbosity level int    , default 0
chunksize      : amount of data read at once (0 means automatic) int, default 0
numthreads     : maximum number of threads to use int    , default 8
```

Output parameters:

```
output.image_name : base name for output image string, no default
```

Data parameters:

```
data.ms         : name of input measurement set with uv-data string, no default
data.query      : TaQL selection string for MS string, default "ANTENNA1 != ANTENNA2"
data.uvrange    : UV range, for example 1klambda~10klambda string, default ""
data.baselines  : baseline selection string string, default ""
```

Image parameters:

```
image.npix      : number of pixels int    , default 256
image.cellsize  : pixel width string, default "1arcsec"
image.reffreq   : reference frequency (Hz), only used for multi-term images
                  double, default is reference frequency from ms
image.terms     : number of terms for wideband imaging int    , default 1
```

Gridding parameters:

`gridding.ftmachine` : FTMachine to use string, default FTMachineSplitBeamWStackWB
`gridding.oversample` : oversampling factor int , default 8

Weight parameters:

`weight.type` : weighting scheme, string, default natural (natural, robust, uniform)

`weight.robust` : robustness, float, default 0.0

`weight.mode` : robust weighting mode, string, default norm (norm, abs)

`weight.noise` : robust abs noise

- awimager awimager_dirty_image.parset > awimager_dirty_image.log

- image always CORRECTED_DATA column
- Stokes I by default

awimager_dirty_image.parset

```
operation=image
#operation=clean
numthreads=

output.imagename= target_dirty.img
data.ms=target_averaged.MS
data.uvrange=0~2000lambda

image.npix=1024
image.cellsize=12arcsec

weight.type=robust
weight.robust=0.0

#clean.niter=1000

gridding.padding=1.5
#clean.threshold=1mJy
gridding.timewindow=300
```

```
log4cplus:WARN Property configuration file "awimager.log_prop" not found.
log4cplus:WARN Using basic logging configuration.
INFO - Imager::open() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/Imager.cc, line 512): Opening MeasurementSet /data/scratch/orru/tutorial_t3/target_averaged.MS
INFO - ::: Clearing all model records in MS header.
INFO - imager::data selection: Performing selection on MeasurementSet : /data/scratch/orru/tutorial_t3/target_averaged.MS
INFO - imager::data selection: Selecting on field ids : [0]
INFO - imager::data selection: Selecting on spectral windows
INFO - imager::data selection: Selecting on uvdist : 0~2000lambda
INFO - imager::data selection: Selecting via TaQL : ANTENNA1 != ANTENNA2
INFO - imager::data selection: Selected 45360 out of 74340 rows.
INFO - imager::data selection: Selected: [4 chans in spw 0]
INFO - imager::defineimage(): Defining image properties:nx=1024 ny=1024 cellx='12arcsec' celly='12arcsec' stokes=I' mode=mfs nchan=1 start=0 step=1 spwids=[0] fieldid=0 facets=0 frame=1 distance='0m'
INFO - imager::defineimage(): phaseCenter='field-0 ' mStart='Radialvelocity: 0' qStep='1 km/s' mFreqStart='Frequency: 0 f2: 1.11589e-11 d2: 1
INFO - imager::makeimage() (file /opt/cep/tools/citt/src/LOFAR/CEP/Imager/LofarFT-4.2/src/Imager.cc, line 650): Calculating image (without full skyequation)
INFO - imager::makeimage() (file /opt/cep/tools/citt/src/LOFAR/CEP/Imager/LofarFT-4.2/src/Imager.cc, line 650): Making dirty image from corrected data
INFO - imager::makeimage() (file /opt/cep/tools/citt/src/LOFAR/CEP/Imager/LofarFT-4.2/src/Imager.cc, line 650): Image is : target_dirty.img
itsNGrid: 1
Convolution function wants image polarization: LINEAR
OK, it is a reference.
itsNPol: 4
VisImagingWeightRobust::weight
w_step: 3756.87
make map...done.
2159/2160w_plane: 0
FTMachineSimpleWB::getImages
itsSumWeight[0]: Axis Lengths: [4, 1] (NB: Matrix in Row/Column order)
[6.56664e+13
 6.11218e+13
 6.04872e+13
 5.63004e+13]

[0, 0, 0, 0] [1535, 1535, 0, 0] [1536, 1536, 4, 1]
[0, 0, 1, 0] [1535, 1535, 1, 0] [1536, 1536, 4, 1]
[0, 0, 2, 0] [1535, 1535, 2, 0] [1536, 1536, 4, 1]
[0, 0, 3, 0] [1535, 1535, 3, 0] [1536, 1536, 4, 1]
normalize...spheroidal shape: [1024, 1024]
beam shape: [1024, 1024]
done.
awimager normally ended
```


output

- .imgage
- .avgpb

casaviewer &

load | save image | save region

directory: /data/scratch/paladino/data

input file	type
..	Directory
MERGED_DATA	Directory
aterm	Image
cal_averaged.MS	Measurement Set
concatMS	Measurement Set
target_averaged.MS	Measurement Set
target_dirty.img.avgpb	Image
target_dirty.img.flatnoise	Image

loading options

shape: 1024, 1024, 1, 1

J2000 right ascension: 01:10:13.549, 00:54:12.398

J2000 declination: +29.44.16.050, +33.09.03.824

raster image | vector map

contour map | marker map

update | leave open | LEL | slice | close

```
. /opt/cep/tools/citt/lofarinit.sh  
awimager -help clean
```

```
usage: awimager file.parset [parsetkeys]
```

General parameters:

```
operation      : operation name string, no default  
verbose        : verbosity level int , default 0  
chunksize      : amount of data read at once (0 means automatic) int , default 0  
numthreads     : maximum number of threads to use int , default 8
```

Output parameters:

```
output.imageName : base name for output image string, no default
```

Data parameters:

```
data.ms         : name of input measurement set with uv-data string, no default  
data.query      : TaQL selection string for MS string, default "ANTENNA1 != ANTENNA2"  
data.uvrange    : UV range, for example 1klambda~10klambda string, default ""  
data.baselines  : baseline selection string string, default ""
```

Image parameters:

```
image.npix      : number of pixels int , default 256  
image.cellsize  : pixel width string, default "1arcsec"  
image.reffreq   : reference frequency (Hz), only used for multi-term images double, default is reference frequency from ms  
image.nterms    : number of terms for wideband imaging int , default 1
```

Gridding parameters:

```
gridding.ftmachine : FTMachine to use string, default FTMachineSplitBeamWStackWB
gridding.oversample : oversampling factor int , default 8
```



Weight parameters:

```
weight.type : weighting scheme, string, default natural (natural, robust, uniform)
weight.robust : robustness, float, default 0.0
weight.mode : robust weighting mode, string, default norm (norm, abs)
weight.noise : robust abs noise, string, default 0Jy
```

Operation "clean": perform a clean cycle Parameters:

```
clean.niter : number of clean iterations int , default 1000
clean.threshold : flux level at which to stop cleaning string, "0Jy"
clean.maskimage : name of the mask image to use in cleaning string, default ""
clean.cyclefactor : see casa documentation double, default 1.5
clean.cyclespeedup: see casa documentation double, default -1
clean.nscale : number of scales for multiscale clean int , default 1
clean.uservector : user-defined scales for multi-scale clean float vector, default [0.]
```

awimager_clean.parset

```
#operation=image  
operation=clean  
numthreads=
```

```
output.imageName= target_clean.img  
data.ms=target_averaged.MS  
data.uvrange=0~2000lambda
```

```
image.npix=1024  
image.cellsize=12arcsec
```

```
weight.type=robust  
weight.robust=0.0
```

```
clean.niter=1000
```

```
gridding.padding=1.5  
clean.threshold=1mJy  
gridding.timewindow=300
```

```
screen  
use Lofar  
. /opt/cep/tools/citt/lofarinit.sh  
awimager awimager_clean.parset >  
awimager_clean.log
```

```
ctrl-a d
```

.....to get the screen back

```
screen -list
```

There is a screen on:

```
3546.pts-8.lof013  
(10/30/2014 10:41:49
```

```
AM) (Detached)
```

```
1 Socket in /var/run/screen/S-orru.
```

```
screen -r -d 3546.pts-8.lof013
```

output

- .img.avgpb
- .img.model.flatnoise
- img.psf
- img.residual.flatnoise
- img.restored.flatnoise

```
INFO - Imager::open() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/Imager.cc, line 512): Opening MeasurementSet /data/scratch/orru/tutorial_t3/ta
rget_averaged.MS
INFO - ::: Clearing all model records in MS header.
INFO - imager::data selection: Performing selection on MeasurementSet : /data/scratch/orru/tutorial_t3/target_averaged.MS
INFO - imager::data selection: Selecting on field ids : [0]
INFO - imager::data selection: Selecting on spectral windows
INFO - imager::data selection: Selecting on uvdist : 0~2000lambda
INFO - imager::data selection: Selecting via TaQL : ANTENNA1 != ANTENNA2
INFO - imager::data selection: Selected 45360 out of 74340 rows.
INFO - imager::data selection: Selected: [4 chans in spw 0]
INFO - imager::defineimage(): Defining image properties:nx=1024 ny=1024 cellx='12arcsec' celly='12arcsec' stokes='I' mode='mfs' nchan=1 start=0 step=1
spwids=[0] fieldid=0 face
ts=0 frame=1 distance='0m'
INFO - imager::defineimage(): phaseCenter='field-0 ' mStart='Radialvelocity: 0' qStep='1 km/s' mFreqStart='Frequency: 0
f2: 1.11589e-11
d2: 1
INFO - imager::clean(): Using multi frequency synthesis algorithm
INFO - imager::clean(): Clean gain = 0.1, Niter = 1000, Threshold = 1 mJy
INFO - imager::clean(): Starting deconvolution
INFO - WBCleanImageSkyModel::solve: MSMFS algorithm (v2.6) with 1 Taylor coefficients and Reference Frequency of 1.34375e+08 Hz
INFO - WBCleanImageSkyModel::solve: Fractional Bandwidth : 0.181691 %.
INFO - WBCleanImageSkyModel::solve: Calculating initial residual images...
Model images are empty
itsNGrid: 1
Convolution function wants image polarization: LINEAR
OK, it is a reference.
itsNPol: 4
VisImagingWeightRobust::weight
w_step: 3756.87
make map...done.
87/2160
165/2160
242/2160
319/2160
396/2160
473/216
```

```
1978/2160
2048/2160
2117/2160
2159/2160w_plane: 0
FTMachineSimpleWB::getImages
itsSumWeight[0]: Axis Lengths: [4, 1] (NB: Matrix in Row/Column order)
[6.56664e+13
 6.11218e+13
 6.04872e+13
 5.63004e+13]
```

```
[0, 0, 0, 0] [1535, 1535, 0, 0] [1536, 1536, 4, 1]
[0, 0, 1, 0] [1535, 1535, 1, 0] [1536, 1536, 4, 1]
[0, 0, 2, 0] [1535, 1535, 2, 0] [1536, 1536, 4, 1]
[0, 0, 3, 0] [1535, 1535, 3, 0] [1536, 1536, 4, 1]
```

```
normalize...spheroidal shape: [1024, 1024]
```

```
beam shape: [1024, 1024]
```

```
done.
```

```
INFO - WBCleanImageSkyModel::solve: Calculating spectral PSFs...
```

```
Number of PSF: 1
```

```
Number of taylor terms: 1
```

```
Number of models: 1
```

```
psf shape: [1024, 1024, 1, 1]
```

```
[1024, 1024, 1, 1]
```

```
=====  
itsNGrid: 1
```

```
Convolution function wants image polarization: LINEAR
```

```
OK, it is a reference.
```

```
itsNPol: 4
```

```
=====
```

```
VisImagingWeightRobust::weight
```

```
w_step: 3756.87
```

```
make map...done.
```

```
87/2160
```

```
165/2160
```

```
242/2160
```

```
319/2160
```

```
396/2160
```

```
1632/2160
1702/2160
1771/2160
1840/2160
1909/2160
1978/2160
2048/2160
2117/2160
2159/2160w_plane: 0
FTMachineSimpleWB::getImages
itsSumWeight[0]: Axis Lengths: [4, 1] (NB: Matrix in Row/Column order)
[6.56664e+13
 6.11218e+13
 6.04872e+13
 5.63004e+13]

[0, 0, 0, 0] [1535, 1535, 0, 0] [1536, 1536, 4, 1]
[0, 0, 1, 0] [1535, 1535, 1, 0] [1536, 1536, 4, 1]
[0, 0, 2, 0] [1535, 1535, 2, 0] [1536, 1536, 4, 1]
[0, 0, 3, 0] [1535, 1535, 3, 0] [1536, 1536, 4, 1]
normalize...spheroidal shape: [1024, 1024]
beam shape: [1024, 1024]
done.
INFO - LOFAR::LofarFT::SkyEquation::makeApproxPSF: Maximum of approximate PSF for field 0 = 1.08318 : renormalizing to unity
INFO - MultiTermMatrixCleaner::verifyScaleSizesC (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 498): Scale
sizes
to be used for deconvolution : [0]
INFO - MultiTermMatrixCleaner::initialiseC (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 129): Using a PSF
patch
of 80 pixels on each side for minor-cycle updates.
INFO - MatrixCleaner::validatePsfC (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MatrixCleaner.cc, line 67): Peak of PSF = 1 at [512, 512]
INFO - WBCleanImageSkyModel::solve: **** Major Cycle 1
INFO - WBCleanImageSkyModel::computeFluxLimit (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementComponents/WBCleanImageSkyModel.cc, line 499): Peak
Residual (a
l pixels) : 16.7124 User Threshold : 0.001 Max PSF Sidelobe : 0.071602 User maxPsfFraction : 0.8 User cyclefactor : 1.5 fractionOfPsf = min(maxPsfFraction,
PSFsidelobe x
cyclefactor) : 0.107403
INFO - WBCleanImageSkyModel::solve: Starting Minor Cycle iterations for field : 0
INFO - MultiTermMatrixCleaner::computeHessianPeak (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 824):
Calculating
PSF and Scale convolutions
INFO - MultiTermMatrixCleaner::computeHessianPeak (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 824): The
Matrix [
H] for 0 pixel scale is : Axis Lengths: [1, 1] (NB: Matrix in Row/Column order)
[1]
INFO - MultiTermMatrixCleaner::mtcleanC (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 316): Calculating
convoluti
ons of residual images with scales
INFO - MultiTermMatrixCleaner::mtcleanC (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 1411): Peak
convolved resid
ual : 16.7124 Minor cycle stopping threshold : 1.79496
I
```

```
NFO - ::: [20] Res: 4.76018 Max: 22.6792 Gain: 0.1 Pos: [6, 615] Scale: 0 Coeffs: 4.76227
INFO - ::: [40] Res: 3.18276 Max: 10.6657 Gain: 0.1 Pos: [184, 784] Scale: 0 Coeffs: 3.26584
INFO - ::: [60] Res: 2.72047 Max: 7.42362 Gain: 0.1 Pos: [191, 798] Scale: 0 Coeffs: 2.72463
INFO - ::: [80] Res: 2.39032 Max: 5.88125 Gain: 0.1 Pos: [185, 781] Scale: 0 Coeffs: 2.42513
INFO - ::: [100] Res: 2.23389 Max: 5.02484 Gain: 0.1 Pos: [768, 603] Scale: 0 Coeffs: 2.24162
INFO - ::: [120] Res: 2.09307 Max: 4.39735 Gain: 0.1 Pos: [60, 213] Scale: 0 Coeffs: 2.09699
INFO - ::: [140] Res: 1.99195 Max: 4.02225 Gain: 0.1 Pos: [312, 728] Scale: 0 Coeffs: 2.00555
INFO - ::: [160] Res: 1.90819 Max: 3.64887 Gain: 0.1 Pos: [393, 3] Scale: 0 Coeffs: 1.9102
INFO - ::: [180] Res: 1.84343 Max: 3.40602 Gain: 0.1 Pos: [585, 469] Scale: 0 Coeffs: 1.84554
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 1342): Reached stopping threshold at iteration 197. Peak residual 1.79275
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 316): Total flux by scale :
  [0]: 58.9793 (in this run)
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line 316): Total flux by Taylor coefficient :
  [0]: 58.9793
INFO - WBCleanImageSkyModel::solve: Calculating new residual images...
Model images are not empty
Convolution function wants image polarization: LINEAR
itsNGrid: 1
Convolution function wants image polarization: LINEAR
OK, it is a reference.
itsNPol: 4
w_step: 3756.87
make map...done.
w_plane: 0
normalize...spheroidal shape: [1024, 1024]
beam shape: [1024, 1024]
done.
VisImagingWeightRobust::weight
w_step: 3756.87
make map...done.
87/2160
165/2160
```



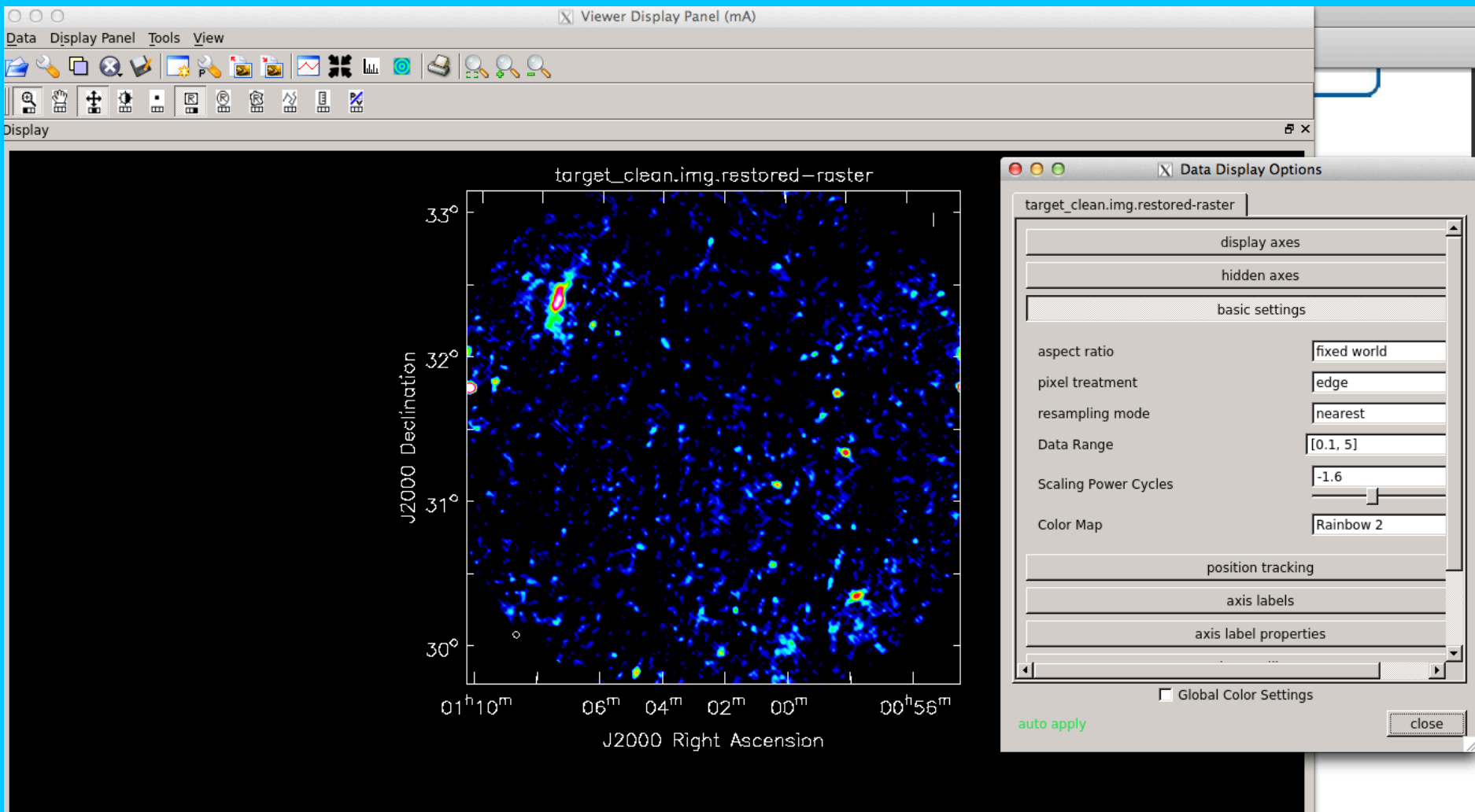
```
[0, 0, 0, 0] [1535, 1535, 0, 0] [1536, 1536, 4, 1]
[0, 0, 1, 0] [1535, 1535, 1, 0] [1536, 1536, 4, 1]
[0, 0, 2, 0] [1535, 1535, 2, 0] [1536, 1536, 4, 1]
[0, 0, 3, 0] [1535, 1535, 3, 0] [1536, 1536, 4, 1]
normalize...spheroidal shape: [1024, 1024]
beam shape: [1024, 1024]
done.
INFO - WBCleanImageSkyModel::solve: **** Major Cycle 2
INFO - WBCleanImageSkyModel::computeFluxLimit (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementComponents/WBCleanImageSkyModel.cc,
line 499): Peak Residual (al
l pixels) : 2.02848 User Threshold : 0.001 Max PSF Sidelobe : 0.071602 User maxPsfFraction : 0.8 User cyclefactor : 1.5 fractionOfPsf =
min(maxPsfFraction, PSFsidelobe x
cyclefactor) : 0.107403
INFO - WBCleanImageSkyModel::solve: Starting Minor Cycle iterations for field : 0
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line
316): Calculating convoluti
ons of residual images with scales
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line
1411): Peak convolved resid
ual : 3.20414 Minor cycle stopping threshold : 0.344134
INFO - :: [200] Res: 2.46143 Max: 6.76571 Gain: 0.1 Pos: [352, 22] Scale: 0 Coeffs: -2.6011
INFO - :: [220] Res: 1.61495 Max: 2.61375 Gain: 0.1 Pos: [5, 616] Scale: 0 Coeffs: -1.61671
INFO - :: [240] Res: 1.41134 Max: 2.00175 Gain: 0.1 Pos: [1022, 684] Scale: 0 Coeffs: 1.41483
INFO - :: [260] Res: 1.24276 Max: 1.60493 Gain: 0.1 Pos: [633, 248] Scale: 0 Coeffs: 1.26686
INFO - :: [280] Res: 1.15834 Max: 1.34419 Gain: 0.1 Pos: [556, 149] Scale: 0 Coeffs: -1.15939

INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line
316): Reached max number of
iterations for this minor cycle
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line
316): Total flux by scale :
[0]: 63.8902 (in this run)
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/MultiTermMatrixCleaner.cc, line
316): Total flux by Taylor
coefficient : [0]: 63.8902
INFO - WBCleanImageSkyModel::solve: Calculating final residual images...
Model images are not empty
Convolution function wants image polarization: LINEAR
itsNGrid: 1
Convolution function wants image polarization: LINEAR
OK, it is a reference.
itsNPol: 4
w_step: 3756.87
make map...done.
w_plane: 0
normalize...spheroidal shape: [1024, 1024]
beam shape: [1024, 1024]
done.
```

Wednesday, 19 November 14

```
840/2160
1909/2160
1978/2160
2048/2160
2117/2160
2159/2160w_plane: 0
FTMachineSimpleWB::getImages
itsSumWeight[0]: Axis Lengths: [4, 1] (NB: Matrix in Row/Column order)
[6.56664e+13
 6.11218e+13
 6.04872e+13
 5.63004e+13]

[0, 0, 0, 0] [1535, 1535, 0, 0] [1536, 1536, 4, 1]
[0, 0, 1, 0] [1535, 1535, 1, 0] [1536, 1536, 4, 1]
[0, 0, 2, 0] [1535, 1535, 2, 0] [1536, 1536, 4, 1]
[0, 0, 3, 0] [1535, 1535, 3, 0] [1536, 1536, 4, 1]
normalize...spheroidal shape: [1024, 1024]
beam shape: [1024, 1024]
done.
INFO - imager::clean(): Threshold not reached yet.
INFO - imager::clean(): Fitted beam used in restoration: 164.822 by 141.283 (arcsec) at pa 64.9802 (deg)
INFO - imager::clean(): Exiting Imager::clean
awimager normally ended
```



use Lofar
pybdsM
inp process_image

Create a mask for the clean



```
BDSM [1]: inp process_image
-----> inp(process_image)
PROCESS_IMAGE: Find and measure sources in an image.

=====
filename ..... **: Input image file name
adaptive_rms_box ..... False : Use adaptive rms_box when determining rms and mean maps
advanced_opts ..... False : Show advanced options
atrous_do ..... False : Decompose Gaussian residual image into multiple scales
beam ..... None : FWHM of restoring beam. Specify as (maj, min, pos ang E of N) in degrees. E.g., beam = (0.06, 0.02, 13.3). None => get from header
flagging_opts ..... False : Show options for Gaussian flagging
frequency ..... None : Frequency in Hz of input image. E.g., frequency = 74e6. None => get from header.
interactive ..... False : Use interactive mode
mean_map ..... 'default': Background mean map: 'default' => calc whether to use or not, 'zero' => 0, 'const' => clipped mean, 'map' => use 2-D map
multichan_opts ..... False : Show options for multi-channel images
output_opts ..... False : Show output options
polarisation_do ..... False : Find polarisation properties
psf_vary_do ..... False : Calculate PSF variation across image
rms_box ..... None : Box size, step size for rms/mean map calculation. Specify as (box, step) in pixels. E.g., rms_box = (40, 10) => box of 40x40 pixels, step of 10 pixels. None => calculate inside program
rms_map ..... None : Background rms map: True => use 2-D rms map; False => use constant rms; None => calculate inside program
shapelet_do ..... False : Decompose islands into shapelets
spectralindex_do ..... False : Calculate spectral indices (for multi-channel image)
thresh ..... None : Type of thresholding: None => calculate inside program, 'fdr' => use false detection rate algorithm, 'hard' => use sigma clipping
thresh_isl ..... 3.0 : Threshold for the island boundary in number of sigma above the mean. Determines extent of island used for fitting
thresh_pix ..... 5.0 : Source detection threshold: threshold for the island peak in number of sigma above the mean. If false detection rate thresholding is used, this value is ignored and thresh_pix is calculated inside the program

BDSM [2]: █
```

```
--> Opened 'target_clean.img.restored'
Image size ..... :
(1024, 1024) pixels
Number of channels ..... : 1
Number of Stokes parameters ..... : 1
Beam shape (major, minor, pos angle) .... :
(0.04578, 0.03925, 65.0) degrees
Frequency of image ..... :
134.377 MHz
Number of blank pixels ..... : 0
(0.0%)
Flux from sum of (non-blank) pixels ..... :
68.169 Jy
--> Calculating background rms and mean images
Derived rms_box (box size, step size) ... :
(265, 88) pixels
--> Size of rms_box larger than 1/4 of image size
--> Using constant background rms and mean
Value of background rms ..... :
0.14994 Jy/beam
Value of background mean ..... :
-0.00332 Jy/beam
--> Expected 5-sigma-clipped false detection rate < fdr_ratio
--> Using sigma-clipping ('hard') thresholding
Minimum number of pixels per island ..... : 61
Number of islands found ..... : 20
```

BDSM [2]: filename='target_clean.img.restored.flatnoise'
BDSM [3]: stop_at='isl'
BDSM [4]: go

```
BDSM [1]: inp export_image
-----> inp(export_image)
EXPORT_IMAGE: Write an image to disk.
```

```
=====
outfile ..... None : Output file name. None => file is named
                        automatically; 'SAMP' => send to SAMP hub (e.g.,
                        to TOPCAT, ds9, or Aladin)
clobber ..... False : Overwrite existing file?
img_format ..... 'fits': Format of output image: 'fits' or 'casa'
img_type ..... 'gaus_resid': Type of image to export: 'gaus_resid',
                        'shap_resid', 'rms', 'mean', 'gaus_model',
                        'shap_model', 'ch0', 'pi', 'psf_major',
                        'psf_minor', 'psf_pa', 'psf_ratio',
                        'psf_ratio_aper', 'island_mask'
mask_dilation ..... 0 : Number of iterations to use for island-mask
                        dilation. 0 => no dilation
pad_image ..... False : Pad image (with zeros) to original size
```

- inp export_image
- img_format='casa'
- img_type='island_mask'
- outfile = 'target_clean.mask'
- go

- screen
- . /opt/cep/tools/citt/lofarinit.sh
- awimager awimager_clean_mask.parset > awimager_msk.log
- casaviewer

awimager_clean_mask.parset

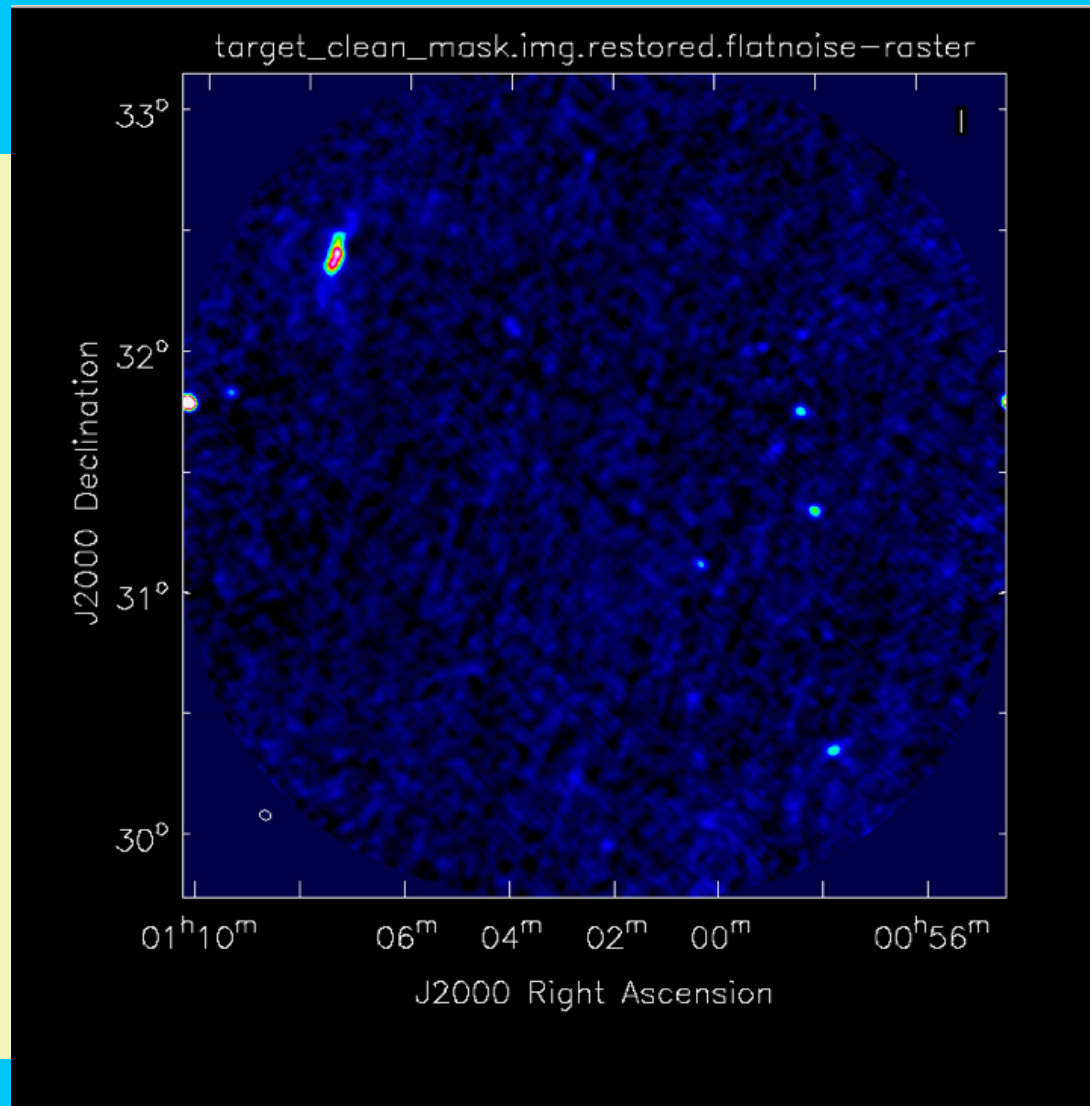
```
#operation=image
operation=clean
numthreads=

output.imageName=target_clean_mask.img
data.ms=target_averaged.MS
data.uvrange=0~2000lambda

image.npix=1024
image.cellsize=12arcsec

weight.type=robust
weight.robust=0.0

clean.niter=1000
clean.maskimage=target_clean.mask
gridding.padding=1.5
clean.threshold=1mJy
gridding.timewindow=300
```



Create a model for the selfcalibration

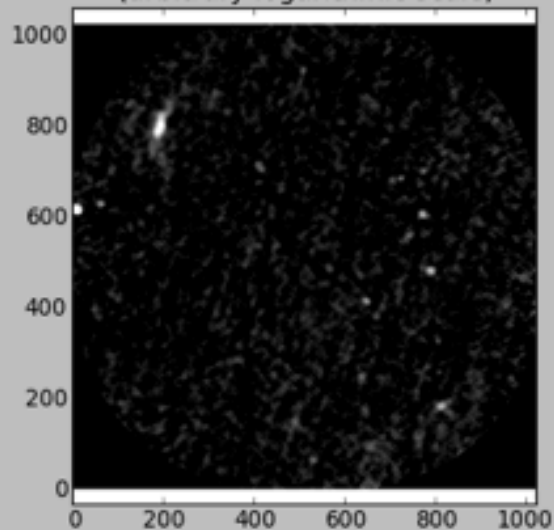


- pybdsf
- inp process_image

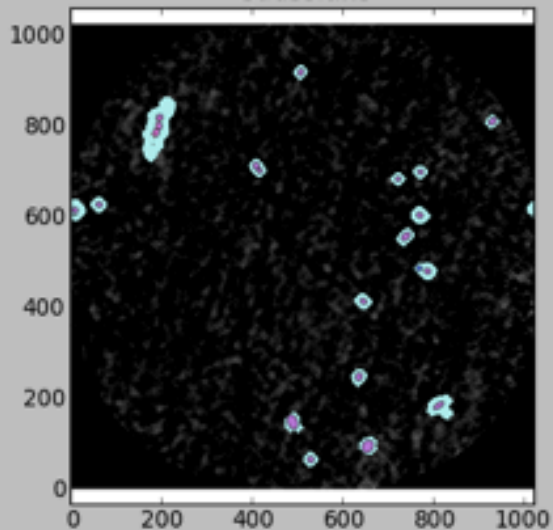
```
filename .. 'target_clean_mask.img.restored': Input image file name
adaptive_rms_box ..... False : Use adaptive rms_box when determining rms and mean maps
advanced_opts ..... False : Show advanced options
atrous_do ..... False : Decompose Gaussian residual image into multiple scales
beam ..... None : FWHM of restoring beam. Specify as (maj, min, pos ang E of N) in degrees. E.g.,
beam = (0.06, 0.02, 13.3). None => get from header
flagging_opts ..... False : Show options for Gaussian flagging
frequency ..... None : Frequency in Hz of input image. E.g., frequency = 74e6. None => get from header.
interactive ..... True : Use interactive mode
mean_map ..... 'default': Background mean map: 'default' => calc whether to use or not, 'zero' => 0, 'const'
=> clipped mean, 'map' => use 2-D map
multichan_opts ..... False : Show options for multi-channel images
output_opts ..... True: Show output options
polarisation_do ..... False : Find polarisation properties
psf_vary_do ..... False : Calculate PSF variation across image
rms_box ..... None : Box size, step size for rms/mean map calculation. Specify as (box, step) in pixels.
E.g., rms_box = (40, 10) => box of 40x40
                        pixels, step of 10 pixels. None => calculate inside program
rms_map ..... None : Background rms map: True => use 2-D rms map; False => use constant rms; None =>
calculate inside program
shapelet_do ..... False : Decompose islands into shapelets
spectralindex_do ..... False : Calculate spectral indices (for multi-channel image)
thresh ..... None : Type of thresholding: None => calculate inside program, 'fdr' => use false
detection rate algorithm, 'hard' => use sigma clipping
thresh_isl ..... 3.0 : Threshold for the island boundary in number of sigma above the mean. Determines
extent of island used for fitting
thresh_pix ..... 5.0 : Source detection threshold: threshold for the island peak in number of sigma above
the mean. If false detection rate thresholding
                        is used, this value is ignored and thresh_pix is calculated inside the program
```

- go

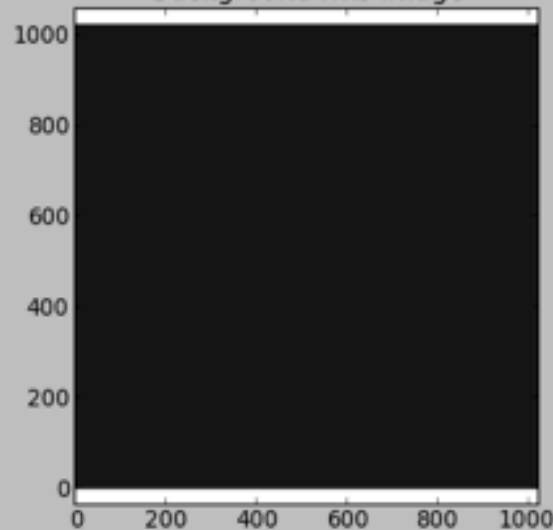
Original (ch0) Image
(arbitrary logarithmic scale)



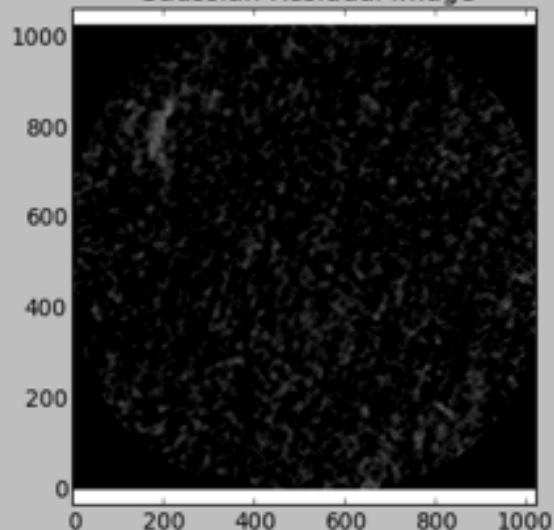
Islands (hatched boundaries) and
Gaussians



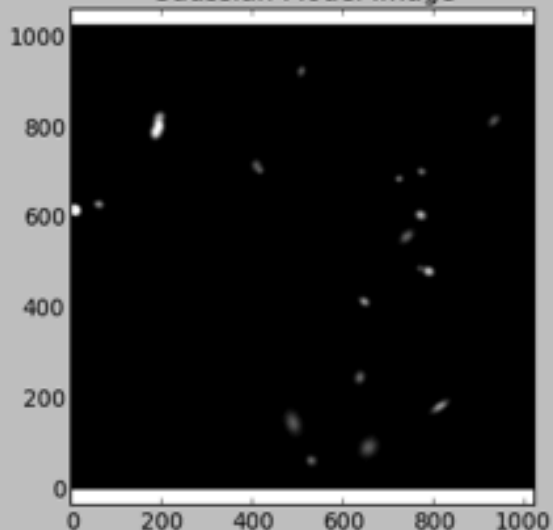
Background rms Image



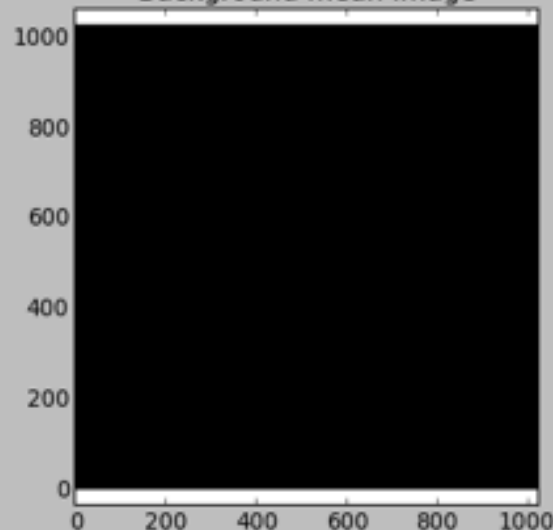
Gaussian Residual Image



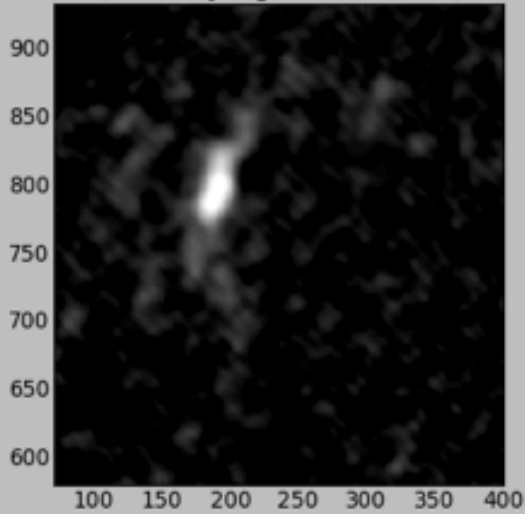
Gaussian Model Image



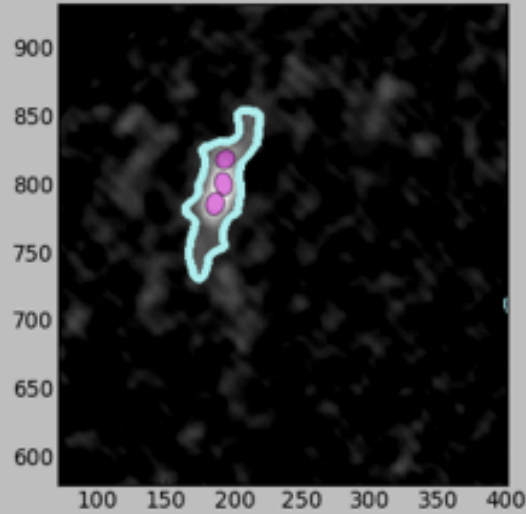
Background mean Image



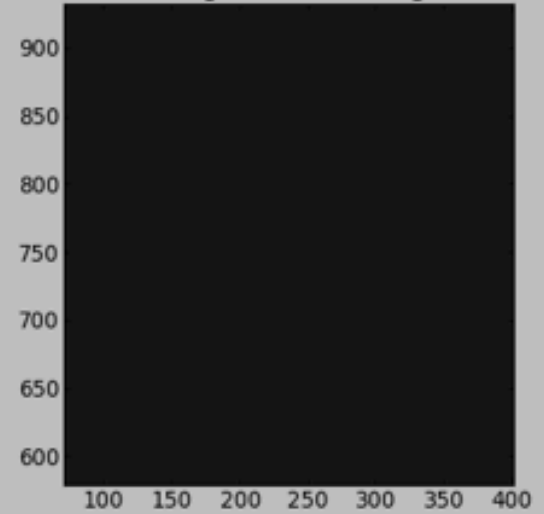
Original (ch0) Image
(arbitrary logarithmic scale)



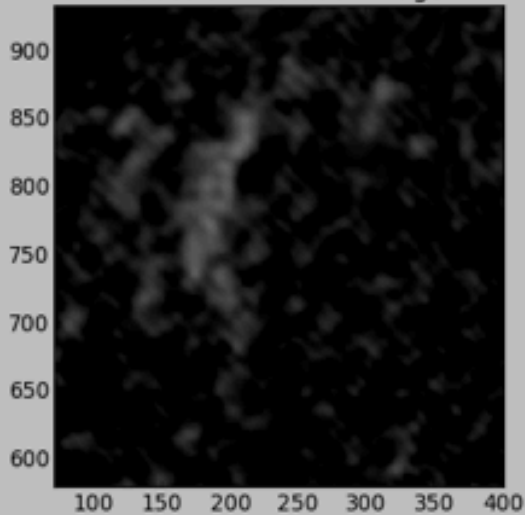
Islands (hatched boundaries) and
Gaussians



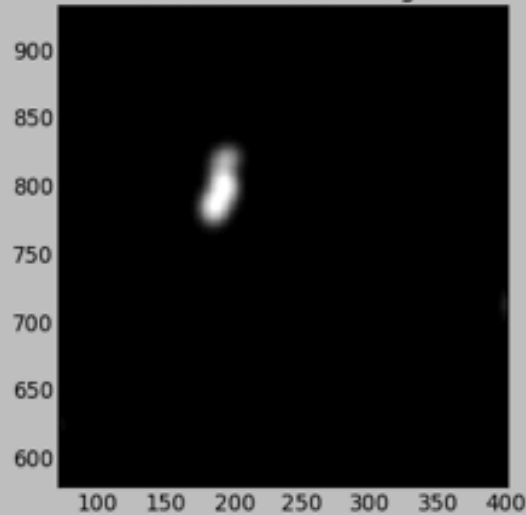
Background rms Image



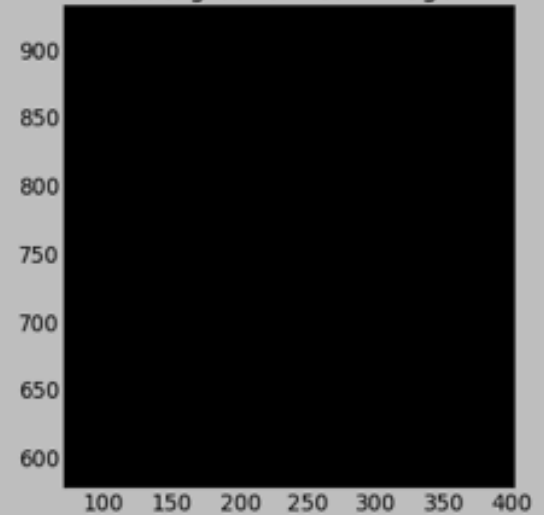
Gaussian Residual Image



Gaussian Model Image



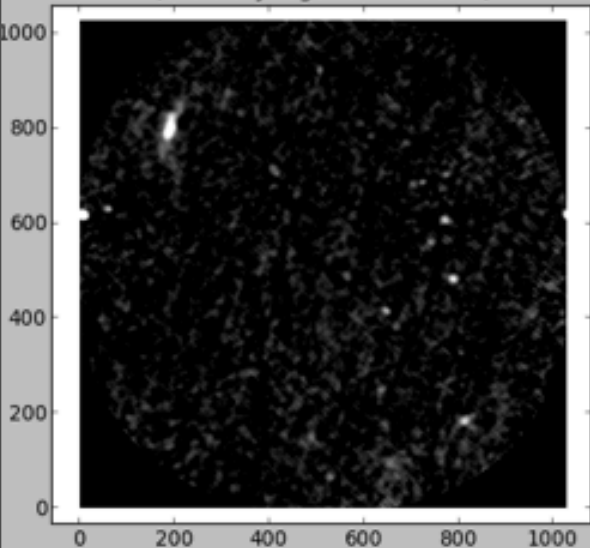
Background mean Image



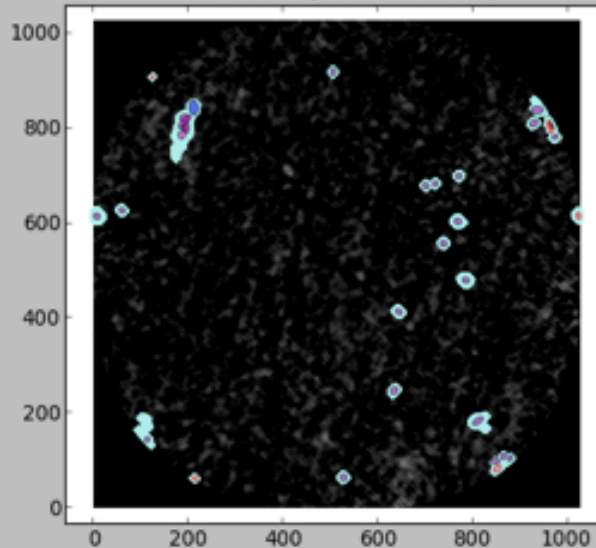
- inp process_image

```
filename .. 'target_clean_mask.img.restored': Input image file name
adaptive_rms_box ..... False : Use adaptive rms_box when determining rms and mean maps
advanced_opts ..... False : Show advanced options
atrous_do ..... True : Decompose Gaussian residual image into multiple scales
  atrous_bdsm_do ..... True : Perform source extraction on each wavelet scale
  atrous_jmax ..... 0 : Max allowed wavelength order, 0 => calculate inside program
  atrous_lpf ..... 'b3': Low pass filter, either 'b3' or 'tr', for B3 spline or Triangle
  atrous_orig_isl .... False : Restrict wavelet Gaussians to islands found in original image
  atrous_sum ..... True : Fit to the sum of remaining wavelet scales
beam ..... None : FWHM of restoring beam. Specify as (maj, min, pos ang E of N) in degrees. E.g., beam =
(0.06, 0.02, 13.3). None => get from header
flagging_opts ..... False : Show options for Gaussian flagging
frequency ..... None : Frequency in Hz of input image. E.g., frequency = 74e6. None => get from header.
interactive ..... True : Use interactive mode
mean_map ..... 'default': Background mean map: 'default' => calc whether to use or not, 'zero' => 0, 'const' =>
clipped mean, 'map' => use 2-D map
multichan_opts ..... False : Show options for multi-channel images
output_opts ..... False : Show output options
polarisation_do ..... False : Find polarisation properties
psf_vary_do ..... False : Calculate PSF variation across image
rms_box ..... (100.0,50.0) : Box size, step size for rms/mean map calculation. Specify as (box, step) in pixels.
E.g., rms_box = (40, 10) => box of 40x40 pixels, step of 10 pixels. None => calculate inside program
rms_map ..... None : Background rms map: True => use 2-D rms map; False => use constant rms; None =>
calculate inside program
shapelet_do ..... False : Decompose islands into shapelets
spectralindex_do ..... False : Calculate spectral indices (for multi-channel image)
thresh ..... None : Type of thresholding: None => calculate inside program, 'fdr' => use false detection
rate algorithm, 'hard' => use sigma clipping
thresh_isl ..... 3.0 : Threshold for the island boundary in number of sigma above the mean. Determines extent
of island used for fitting
thresh_pix ..... 5.0 : Source detection threshold: threshold for the island peak in number of sigma above the
mean. If false detection rate thresholding is used, this value is ignored and thresh_pix is calculated inside the
program
```

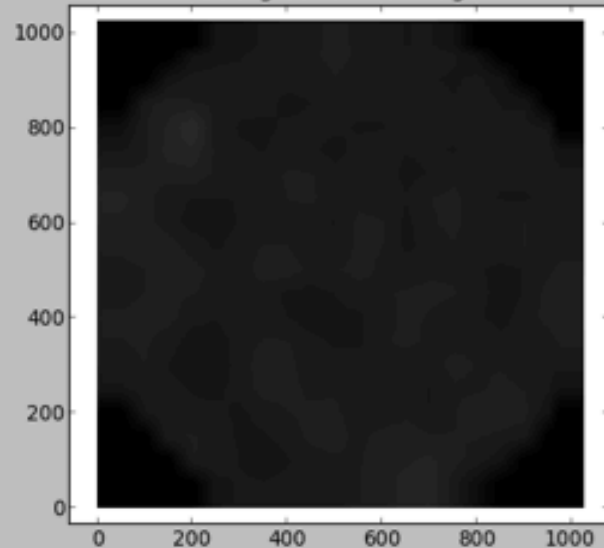
Original (ch0) Image
(arbitrary logarithmic scale)



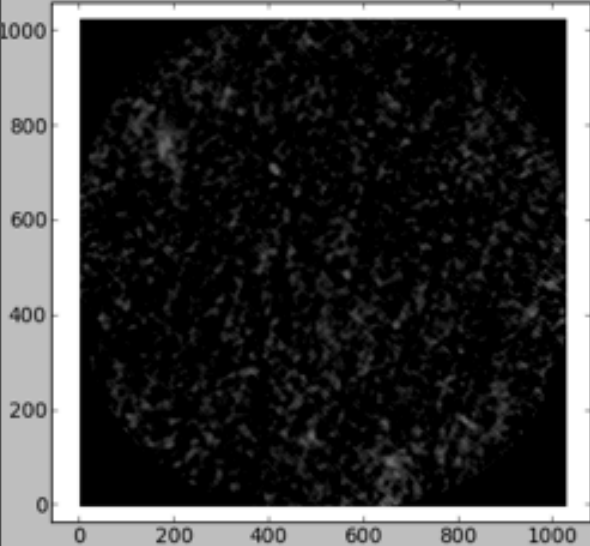
Islands (hatched boundaries) and
Gaussians (red = wavelet)



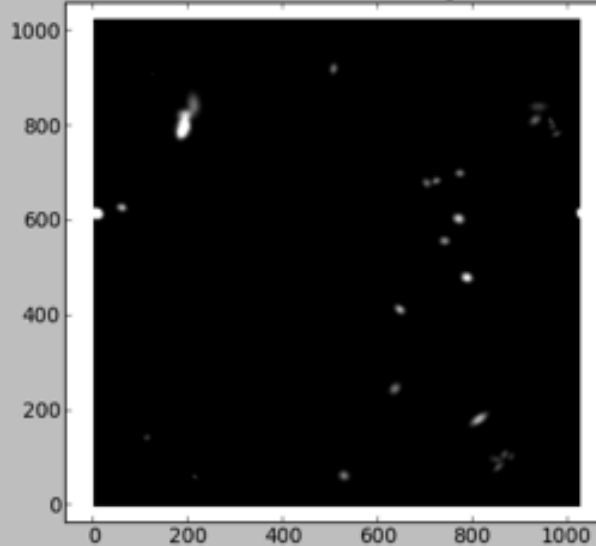
Background rms Image



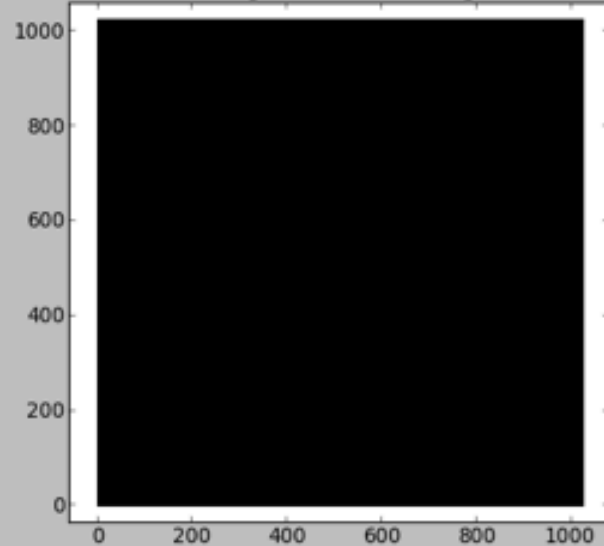
Gaussian Residual Image



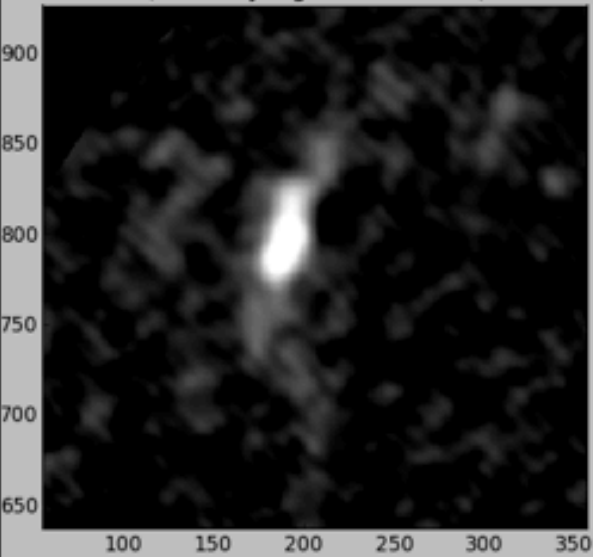
Gaussian Model Image



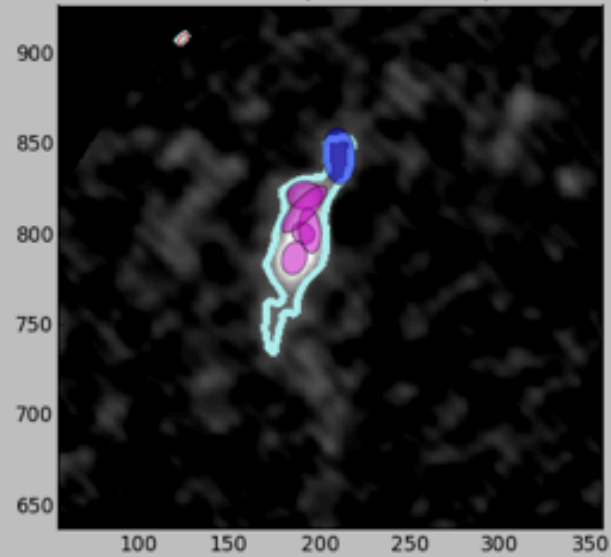
Background mean Image



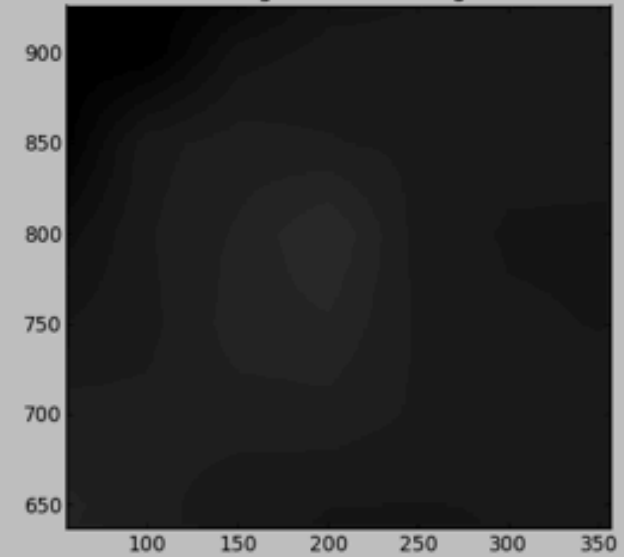
Original (ch0) Image
(arbitrary logarithmic scale)



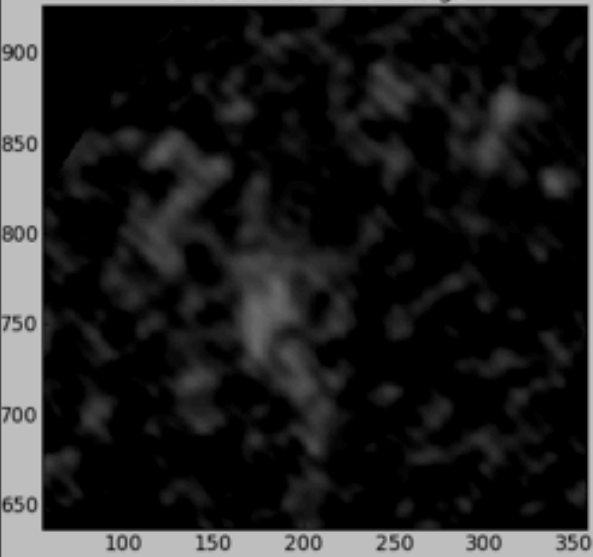
Islands (hatched boundaries) and
Gaussians (red = wavelet)



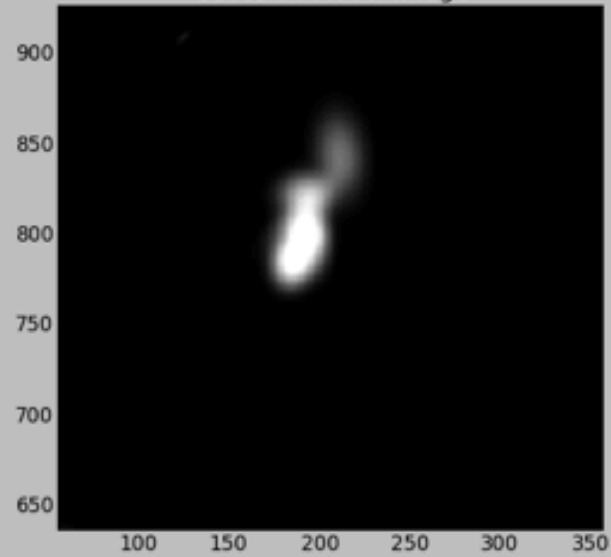
Background rms Image



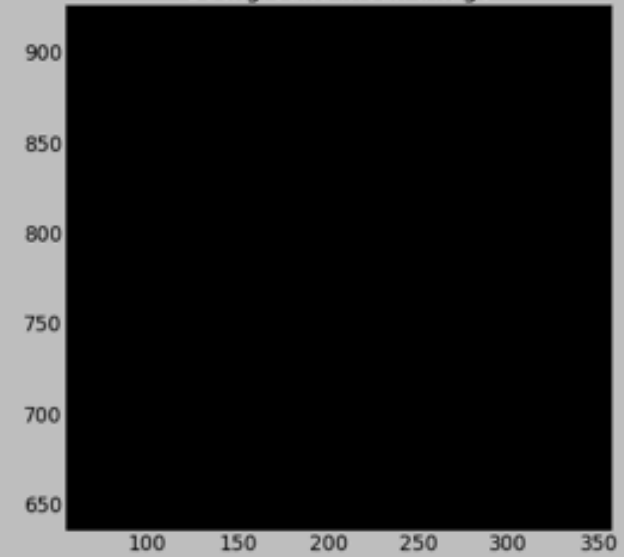
Gaussian Residual Image



Gaussian Model Image



Background mean Image



Multiscale clean



- screen
- . /opt/cep/tools/citt/lofarinit.sh
- awimager awimager_clean_mask_multiscale.parset > awimager_msk_mltscale.log
- use Casa
- casaviewer

awimager_clean_mask_multiscale.parset

```
#operation=image
operation=clean
numthreads=

output.imagename= target_clean.img
data.ms=target_averaged.MS
data.uvrage=0~2000lambda

image.npix=1024
image.cellsize=12arcsec

weight.type=robust
weight.robust=0.0

clean.niter=1000
clean.maskimage='target_clean.mask'
clean.nscales=5

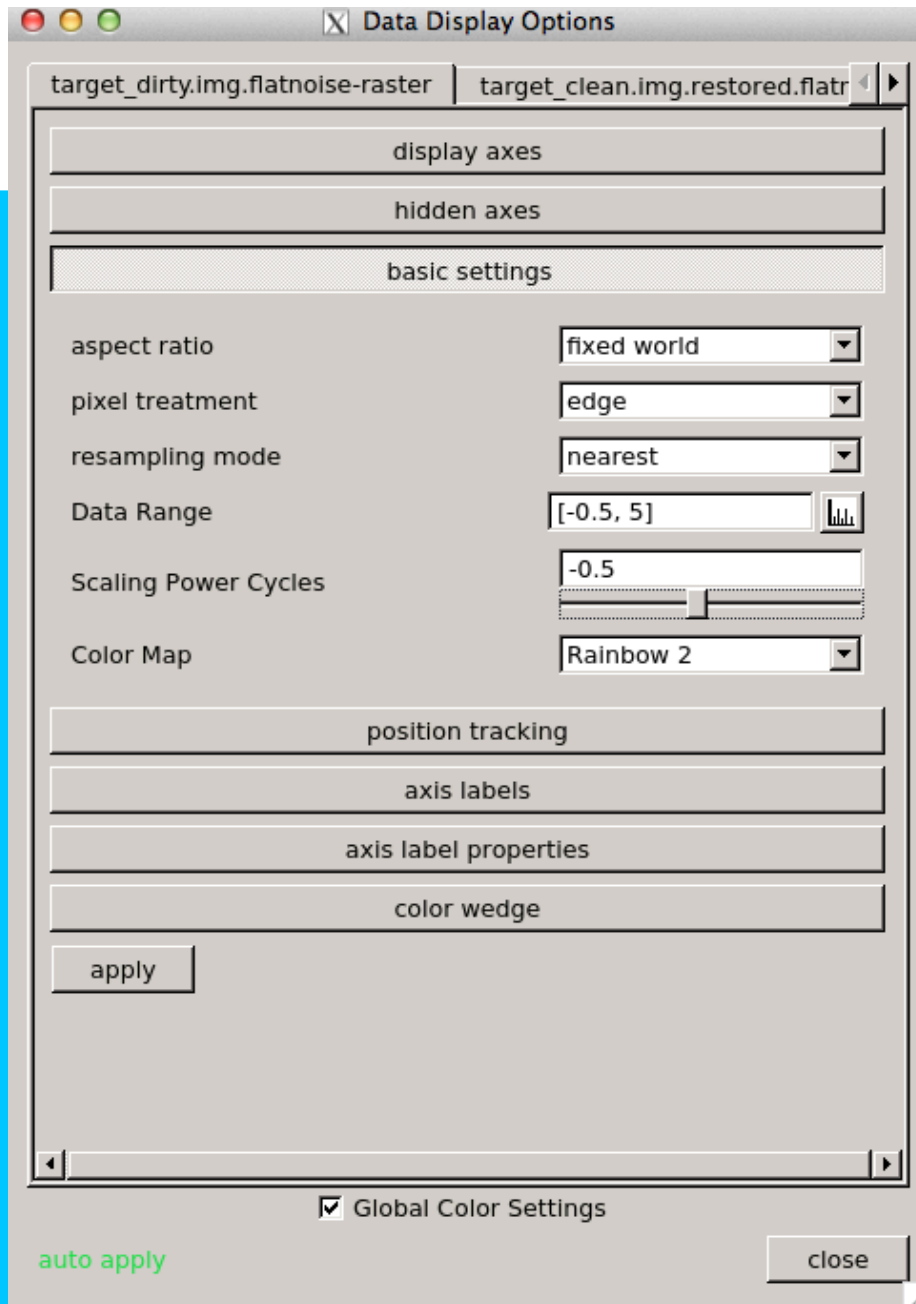
gridding.padding=1.5
clean.threshold=1mJy
gridding.timewindow=300
```

....Scale sizes to be used for deconvolution : [0, 0.632456, 2, 6.32456, 20]

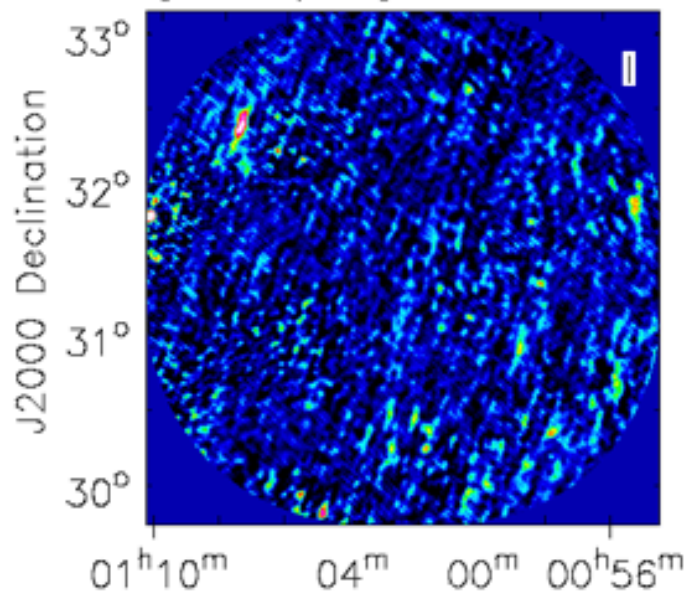


```
.....
INFO - WBCleanImageSkyModel::solve: **** Major Cycle 2
INFO - WBCleanImageSkyModel::computeFluxLimit (file /home/dijkema/citt-release/casa/src/synthesis/
MeasurementComponents/WBCleanImageSkyModel.cc, line 499): Peak Residual
  (all pixels) : 2.22383 User Threshold : 0.001 Max PSF Sidelobe : 0.0742973 User maxPsfFraction : 0.8 User
cyclefactor : 1.5 fractionOfPsf = min(maxPsfFraction, PSFs
idelobe x cyclefactor) : 0.111446
INFO - WBCleanImageSkyModel::solve: Starting Minor Cycle iterations for field : 0
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/
MultiTermMatrixCleaner.cc, line 316): Calculating convo
lutions of residual images with scales
INFO - MultiTermMatrixCleaner::mtclean() (file /home/dijkema/citt-release/casa/src/synthesis/MeasurementEquations/
MultiTermMatrixCleaner.cc, line 1411): Peak convolved r
esidual (within mask) : 2.9788 Minor cycle stopping threshold : 0.331975
INFO - ::: [120] Res: 1.78544 Max: 3.41391 Gain: 0.1 Pos: [785, 480] Scale: 0 Coeffs: 1.84768
INFO - ::: [140] Res: 1.35531 Max: 1.88741 Gain: 0.1 Pos: [353, 17] Scale: 6.32456 Coeffs: -1.52811
INFO - ::: [160] Res: 1.16524 Max: 1.3899 Gain: 0.1 Pos: [768, 604] Scale: 0 Coeffs: 1.17894
INFO - ::: [180] Res: 1.03703 Max: 1.08646 Gain: 0.1 Pos: [644, 414] Scale: 0 Coeffs: 1.04233
INFO - ::: [200] Res: 0.932428 Max: 0.889926 Gain: 0.1 Pos: [187, 789] Scale: 2 Coeffs: 0.95513
INFO - ::: [220] Res: 0.863085 Max: 0.754115 Gain: 0.1 Pos: [665, 88] Scale: 20 Coeffs: 1.54207
INFO - ::: [240] Res: 0.78821 Max: 0.632925 Gain: 0.1 Pos: [667, 68] Scale: 20 Coeffs: 1.41274
INFO - ::: [260] Res: 0.73698 Max: 0.544194 Gain: 0.1 Pos: [720, 683] Scale: 0 Coeffs: 0.737695
INFO - ::: [280] Res: 0.676471 Max: 0.458107 Gain: 0.1 Pos: [557, 151] Scale: 6.32456 Coeffs: -0.752847
INFO - ::: [300] Res: 0.633752 Max: 0.409841 Gain: 0.1 Pos: [829, 165] Scale: 20 Coeffs: 1.13683
INFO - ::: [320] Res: 0.596842 Max: 0.360639 Gain: 0.1 Pos: [815, 187] Scale: 0 Coeffs: 0.600532
INFO - ::: [340] Res: 0.569977 Max: 0.326696 Gain: 0.1 Pos: [194, 736] Scale: 20 Coeffs: 1.01498
INFO - ::: [360] Res: 0.534013 Max: 0.286821 Gain: 0.1 Pos: [44, 615] Scale: 20 Coeffs: -0.951025
INFO - ::: [380] Res: 0.510511 Max: 0.261389 Gain: 0.1 Pos: [794, 174] Scale: 2 Coeffs: 0.517642
INFO - ::: [400] Res: 0.484629 Max: 0.236433 Gain: 0.1 Pos: [738, 557] Scale: 0 Coeffs: 0.486243
INFO - ::: [420] Res: 0.470065 Max: 0.221436 Gain: 0.1 Pos: [768, 604] Scale: 0 Coeffs: 0.47057
INFO - ::: [440] Res: 0.447921 Max: 0.203442 Gain: 0.1 Pos: [194, 724] Scale: 20 Coeffs: 0.800953
INFO - ::: [460] Res: 0.433874 Max: 0.189856 Gain: 0.1 Pos: [720, 683] Scale: 0 Coeffs: 0.435725
INFO - ::: [480] Res: 0.418726 Max: 0.17619 Gain: 0.1 Pos: [1019, 607] Scale: 2 Coeffs: -0.424987
INFO - ::: [500] Res: 0.404498 Max: 0.170272 Gain: 0.1 Pos: [720, 695] Scale: 20 Coeffs: -0.732755
INFO - ::: [520] Res: 0.390438 Max: 0.152593 Gain: 0.1 Pos: [826, 195] Scale: 6.32456 Coeffs: 0.434501
INFO - ::: [540] Res: 0.374844 Max: 0.142703 Gain: 0.1 Pos: [794, 174] Scale: 0 Coeffs: 0.37776
INFO - ::: [560] Res: 0.364922 Max: 0.13431 Gain: 0.1 Pos: [505, 916] Scale: 6.32456 Coeffs: 0.407641
INFO - ::: [580] Res: 0.353032 Max: 0.124811 Gain: 0.1 Pos: [668, 67] Scale: 20 Coeffs: 0.627355
INFO - ::: [600] Res: 0.341845 Max: 0.117171 Gain: 0.1 Pos: [192, 797] Scale: 0 Coeffs: 0.342302
.....
```

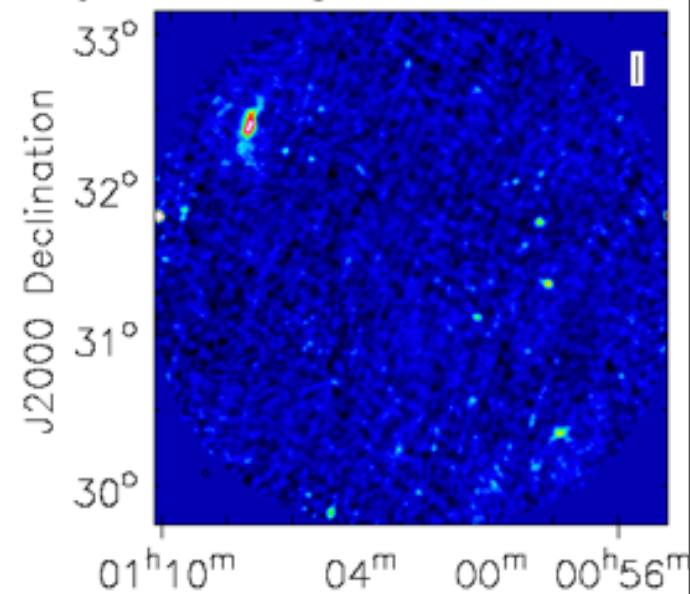
Total flux by scale : [0]:2.34107 [0.632456]:0 [2]:7.78788 [6.32456]:7.39504 [20]:12.4
507 (in this run)



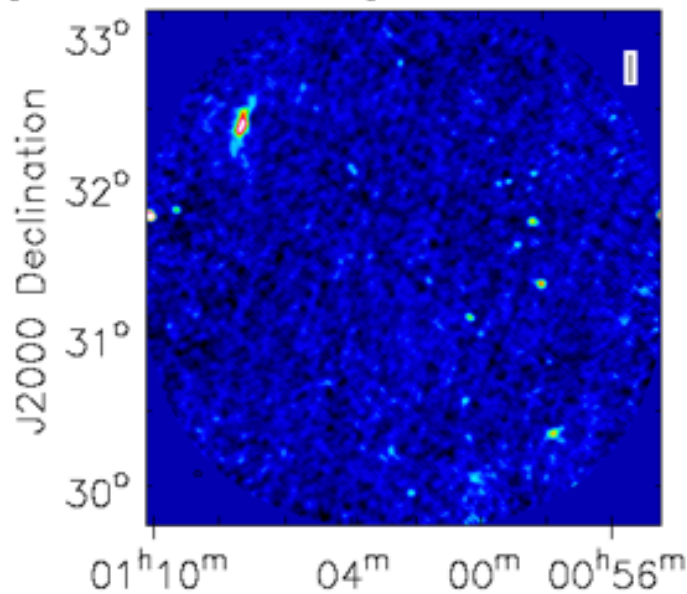
target_dirty.img.flatnoise-raster



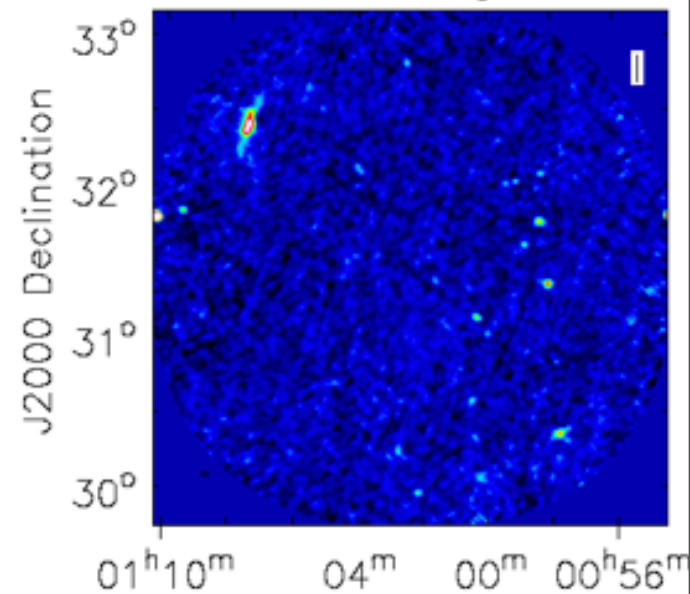
target_clean.img.restored.flatnoise-



target_clean_mask.img.restored.flatnoise-raster



target_clean_mask_multiscale.img.restored.f




```

-----
(target_dirty.img.flatnoise)
  Stokes      Velocity      Frame      Doppler      Frequency
    I          0km/s        LSRK       RADIO        1.34377e+08
BrightnessUnit Npts          Sum          Mean          Rms
  Jy/beam     9752  -1.335633e+03 -1.369599e-01  3.972821e-01
  Std dev     Minimum      Maximum      region count
  3.729468e-01 -1.094544e+00  1.187107e+00      1
-----

```

```

-----
(target_clean.img.restored.flatnoise)
  Stokes      Velocity      Frame      Doppler      Frequency
    I          0km/s        LSRK       RADIO        1.34377e+08
BrightnessUnit BeamArea      Npts          Sum          FluxDensity
  Jy/beam     180.996  9752  -8.446398e+02 -4.666625e+00
  Mean        Rms          Std dev      Minimum      Maximum
 -8.661196e-02  1.577226e-01  1.318202e-01 -4.767742e-01  3.310935e-01
  region count
    1
-----

```

```

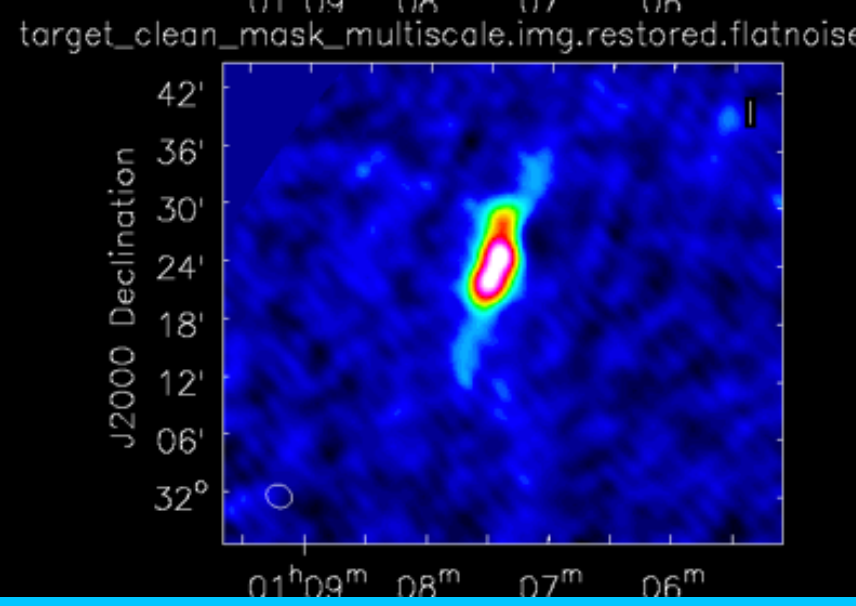
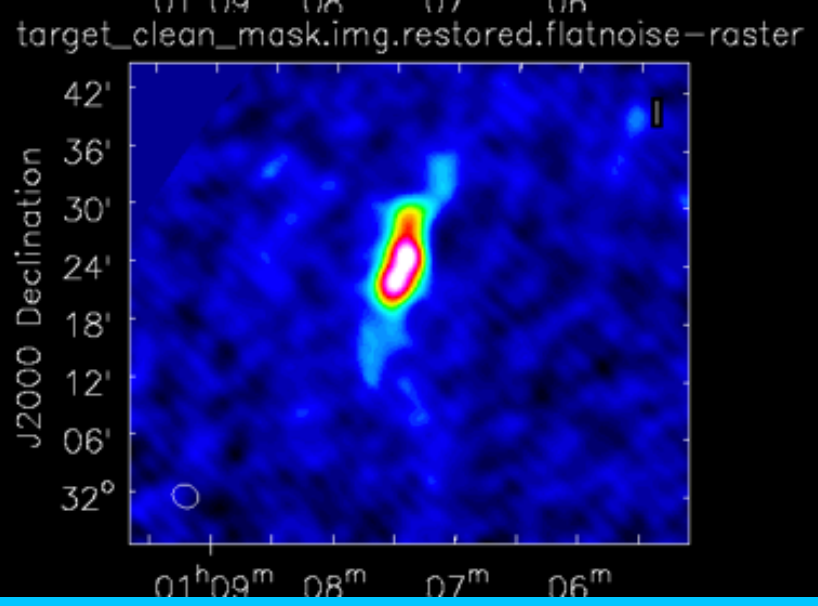
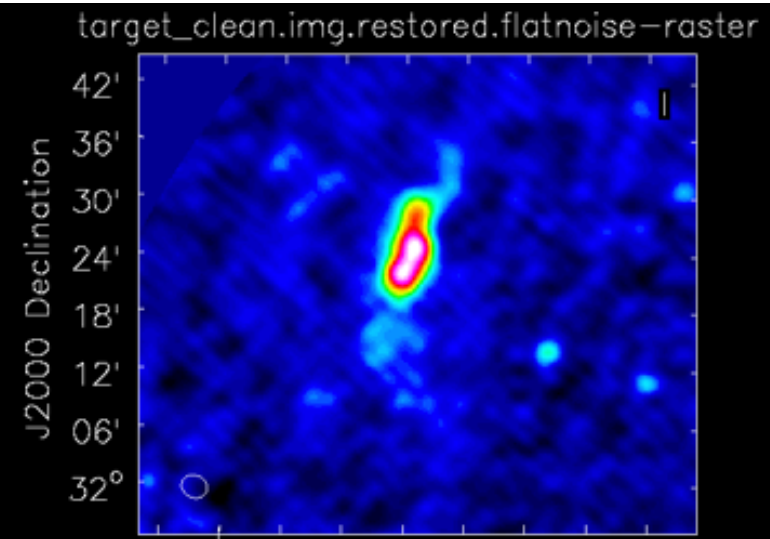
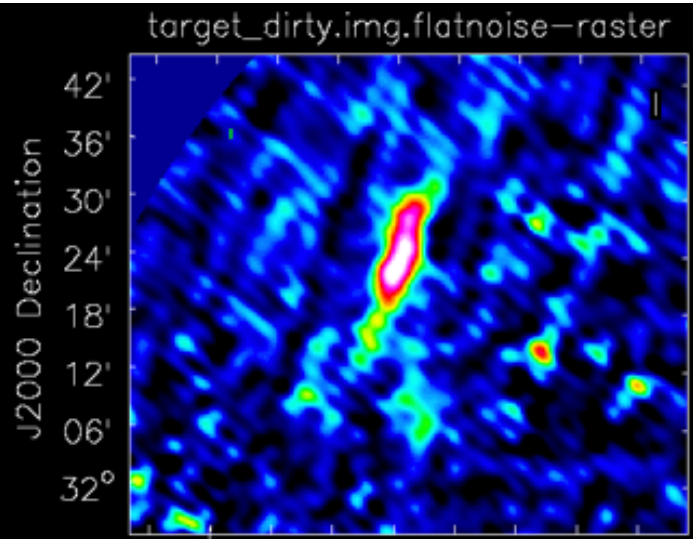
-----
(target_clean_mask.img.restored.flatnoise)
  Stokes      Velocity      Frame      Doppler      Frequency
    I          0km/s        LSRK       RADIO        1.34377e+08
BrightnessUnit BeamArea      Npts          Sum          FluxDensity
  Jy/beam     180.996  9752  -7.667019e+02 -4.236019e+00
  Mean        Rms          Std dev      Minimum      Maximum
 -7.861997e-02  1.613521e-01  1.409094e-01 -5.364869e-01  3.065360e-01
  region count
    1
-----

```

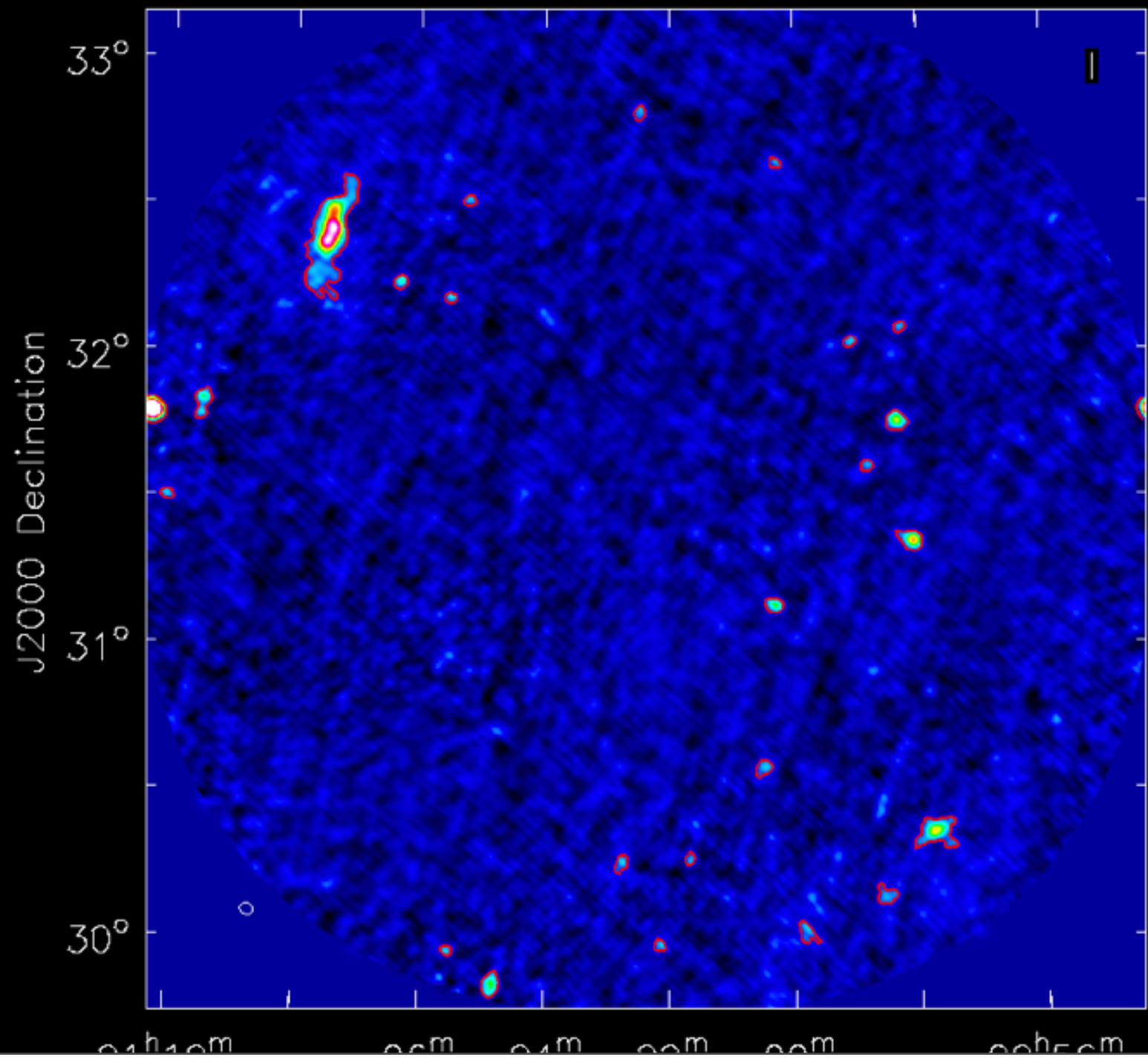
```

-----
(target_clean_mask_multiscale.img.restored.flatnoise)
  Stokes      Velocity      Frame      Doppler      Frequency
    I          0km/s        LSRK       RADIO        1.34377e+08
BrightnessUnit BeamArea      Npts          Sum          FluxDensity
  Jy/beam     180.996  9752  -7.094110e+02 -3.919487e+00
  Mean        Rms          Std dev      Minimum      Maximum
 -7.274518e-02  1.554044e-01  1.373339e-01 -5.193537e-01  3.073898e-01
  region count
    1
-----

```



target_cleaning_vector_bamthorpe_factor



ON

- different weightings
- different uvrange
- deeper image
- repeat all t3 using concatenated SBs
- `lhd002:/data/dataschool2014/t3/dataconcatMS`
- `lhd002:/data/dataschool2014/t3/dataMERGED_DATA`