# GBT OTF Calibration/Imaging issues

W. D. Cotton

- OTF Imaging
  - Rasters across region to sample brightness distribution quasi-random samples.
  - Convolve data onto a grid to form image.

- Calibration – the problem:
  - Sky emission variable at cm and shorter wavelengths
  - Very difficult to establish “zero” point for continuum obs.

- Calibration – the strategy:
  - Basket weaving – scan multiple times along different trajectories
  - Scan fast enough that source structure varies response faster than atmosphere – can separate effects in time domain
  - Iteratively solve for sky brightness and atmospheric fluctuations (like self cal in interferometry)
  - Use time domain filtering of residuals (data-model) to model atmospheric fluctuations
  - Multi-pixel detectors are far better constrained than single pixel

# GBT Implementation (DCR)

- Observing strategy
  - Scan rate limited by 10 Hz DCR sample rate (5 samples /beam)
  - GBT raster scanning is very inefficient – most time spent turning telescope around
  - We tried more efficient patterns but servo or control system cannot currently do it.
- External Calibration
  - Tipping scan to get opacity, Trx
  - Measure cal against flux calibrator
  - "cal" on alternating 50 msec – smooth to measure gain fluctuations.
- "Self" calibration
  - "baseline" fit to median values over intervals of data
  - Atmospheric model from low pass filtering of data residuals, residuals are data samples with sky model estimate subtracted

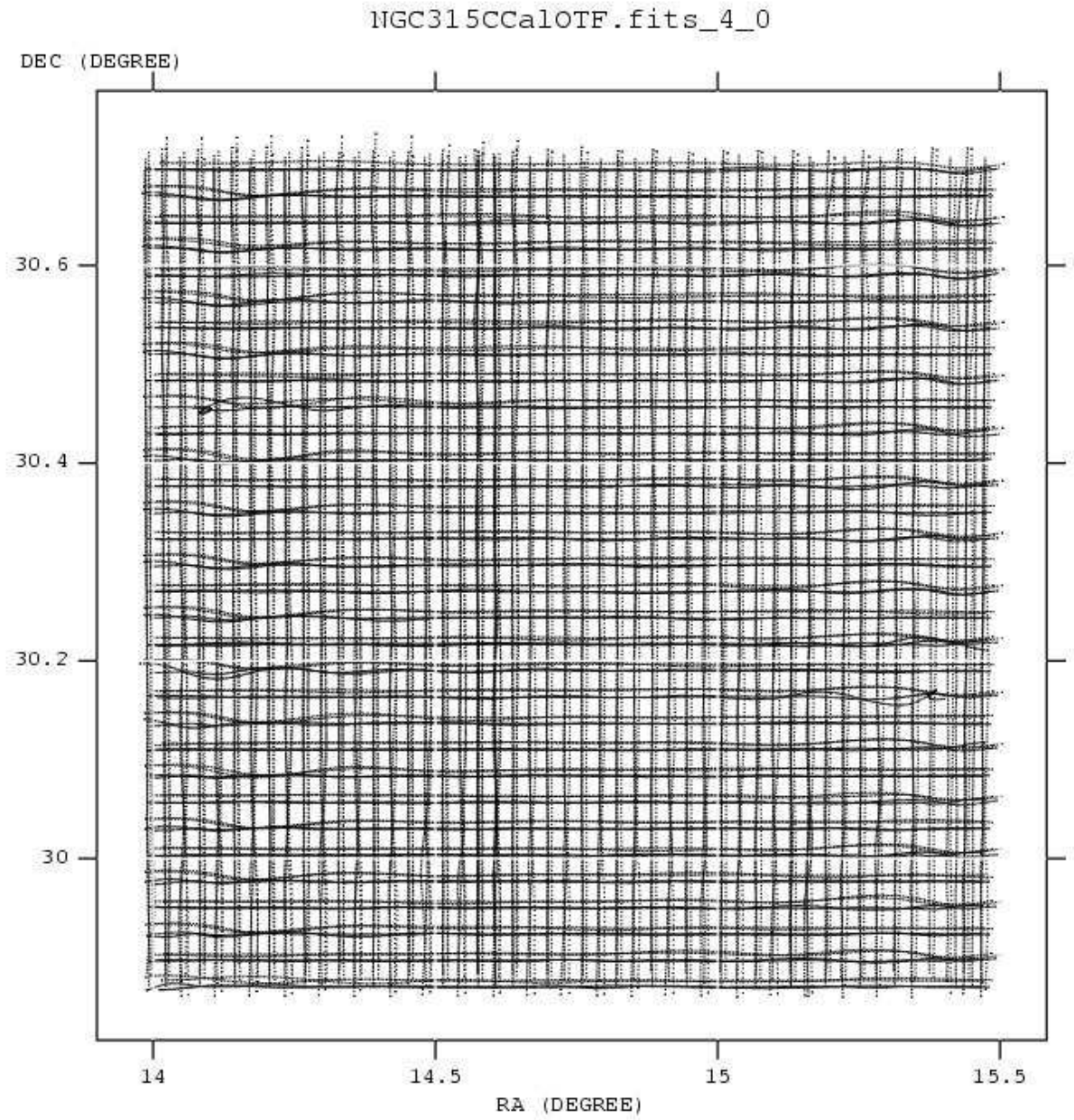
# Imaging Issues

- Convolved image does not accurately represent the data
- Narrow convolution function causes great loss of sensitivity
- Deconvolution (CLEAN) helps:
  - Clean model can be convolved with telescope beam to get better estimate of telescope response.
  - Windows can be used to impose finite support constraint ( sky at high latitudes is mostly empty).
- OTF imaging costs a factor of 2 in sensitivity (?)
  - Optimal (?) convolving function the size of the telescope beam
  - For Gaussian beams, this doubles the beam area
  - Linear deconvolution will increase noise
  - (?) Nonlinear deconvolution does not increase noise – but may add artifacts.

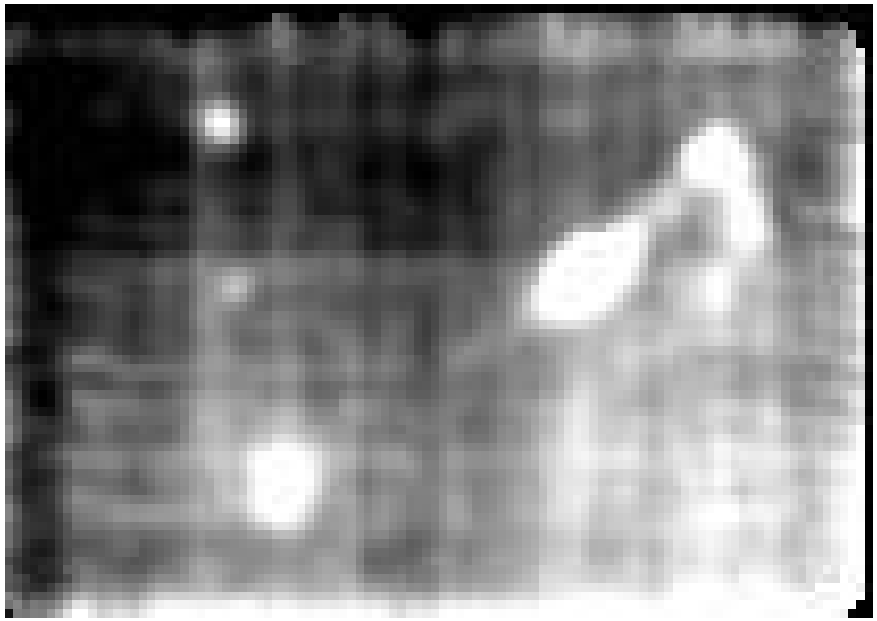
# Example NGC315 @ 6 cm

- Four raster observations doing alternate rows and columns
- Atmospheric and gain corrections
- Median “baseline” removal
- Iterative imaging/deconvolution and filtering residuals with decreasing time constants for improved calibration.

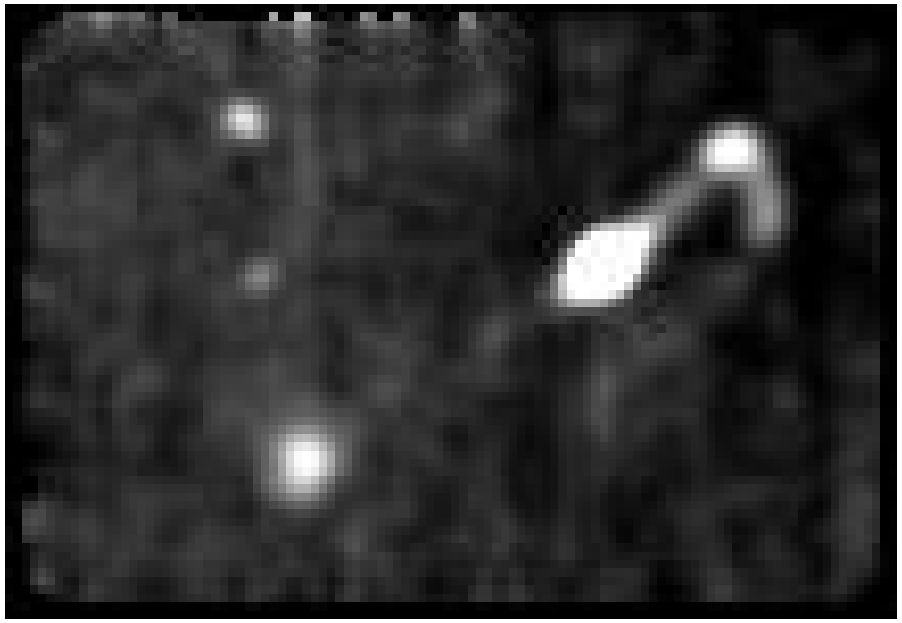
# Example NGC315 @ 6 cm – raster pattern



# Example NGC315 @ 6 cm

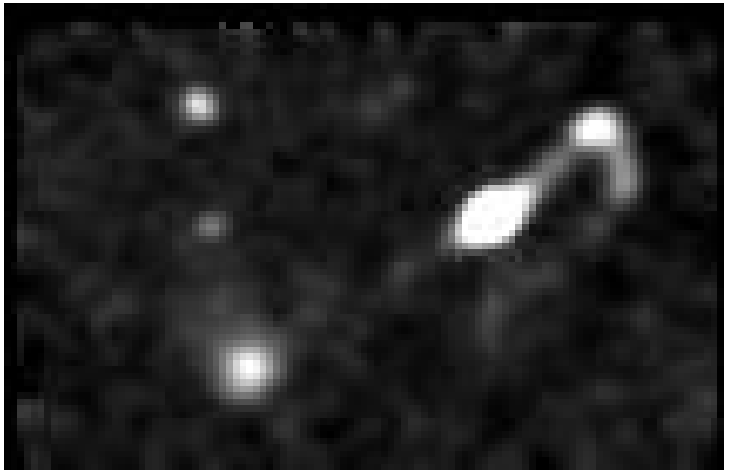


Atmosphere and gain calibration

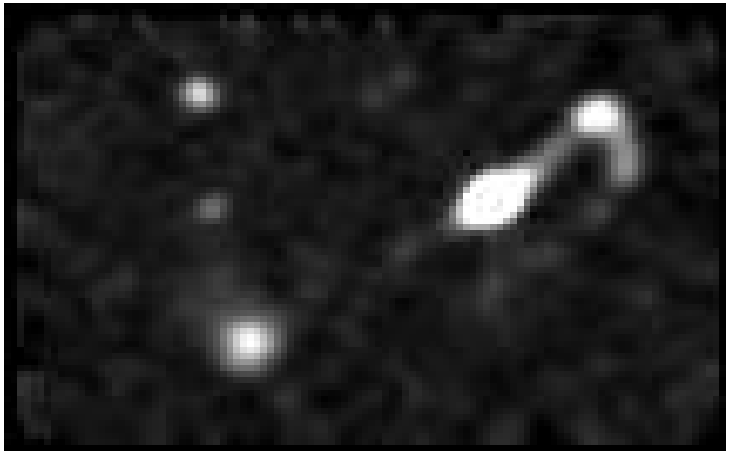


Baseline calibration

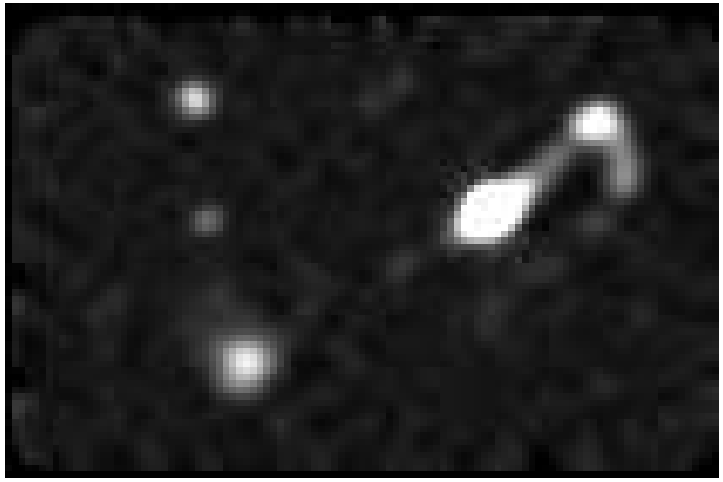
# Example NGC315 @ 6 cm



12 sec dirty

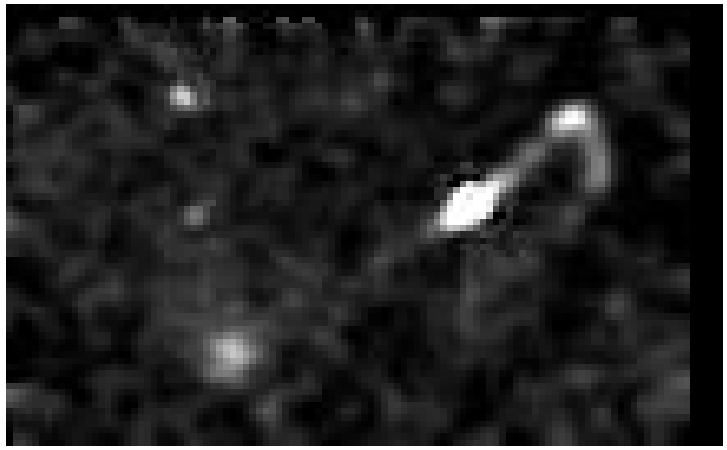


6 sec dirty

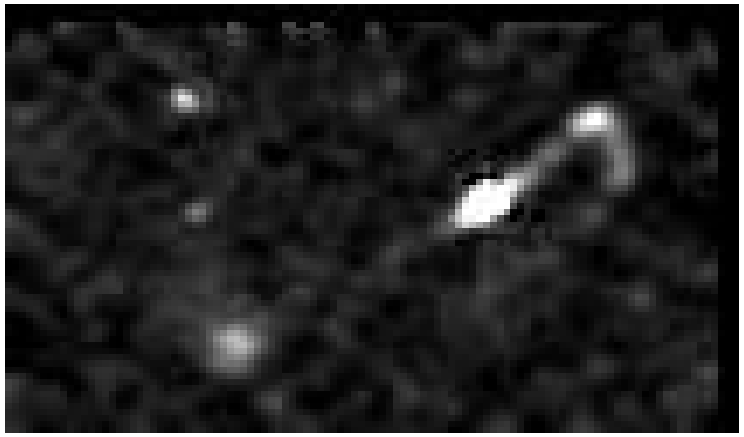


3 sec dirty

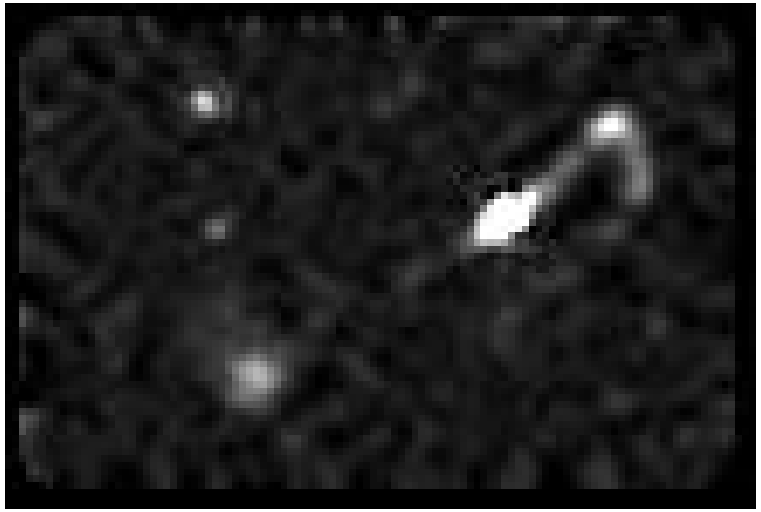
# Example NGC315 @ 6 cm



12 sec clean



6 sec clean



3 sec clean