MFS Testing and e-MERLIN Data Processing

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Introduction

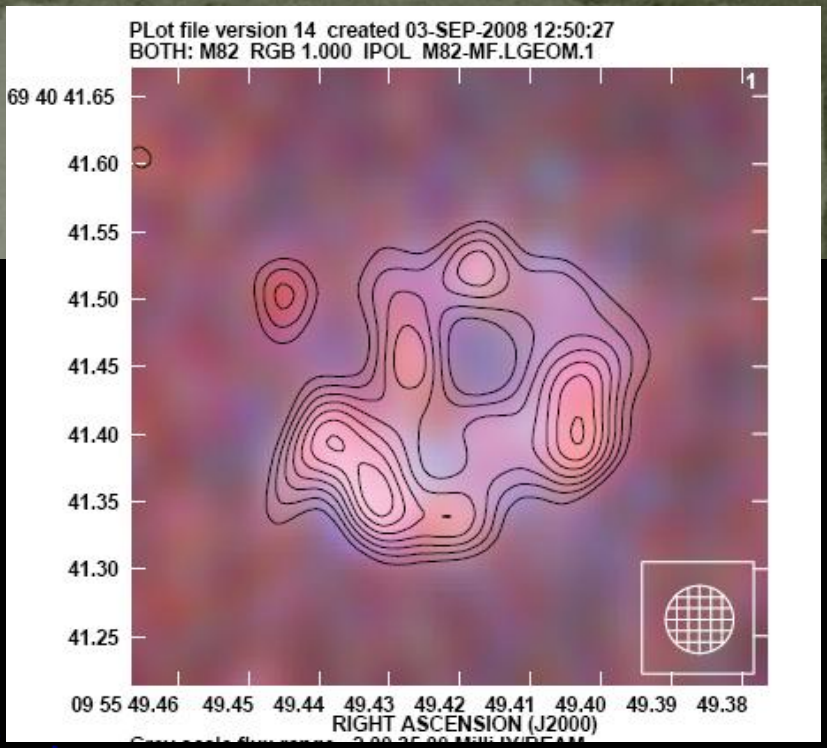
- Ian – Sault-Wieringa python implementation
- Test on real data – MERLIN M82
- Additions – Parseltongue

- e-MERLIN data processing model.
- Pipe-lining.

M82 – test data

- 4.5 - 6.7 GHz – ten frequencies in total.
- 16 MHz bandwidth, 32 channels.
- Most 6 telescopes not Lovell.
- Provides ideal test for the algorithm - more extended emission with changes in spectral index.
- There is science as well! – follow up to very high sensitivity MERLIN observations.

M82

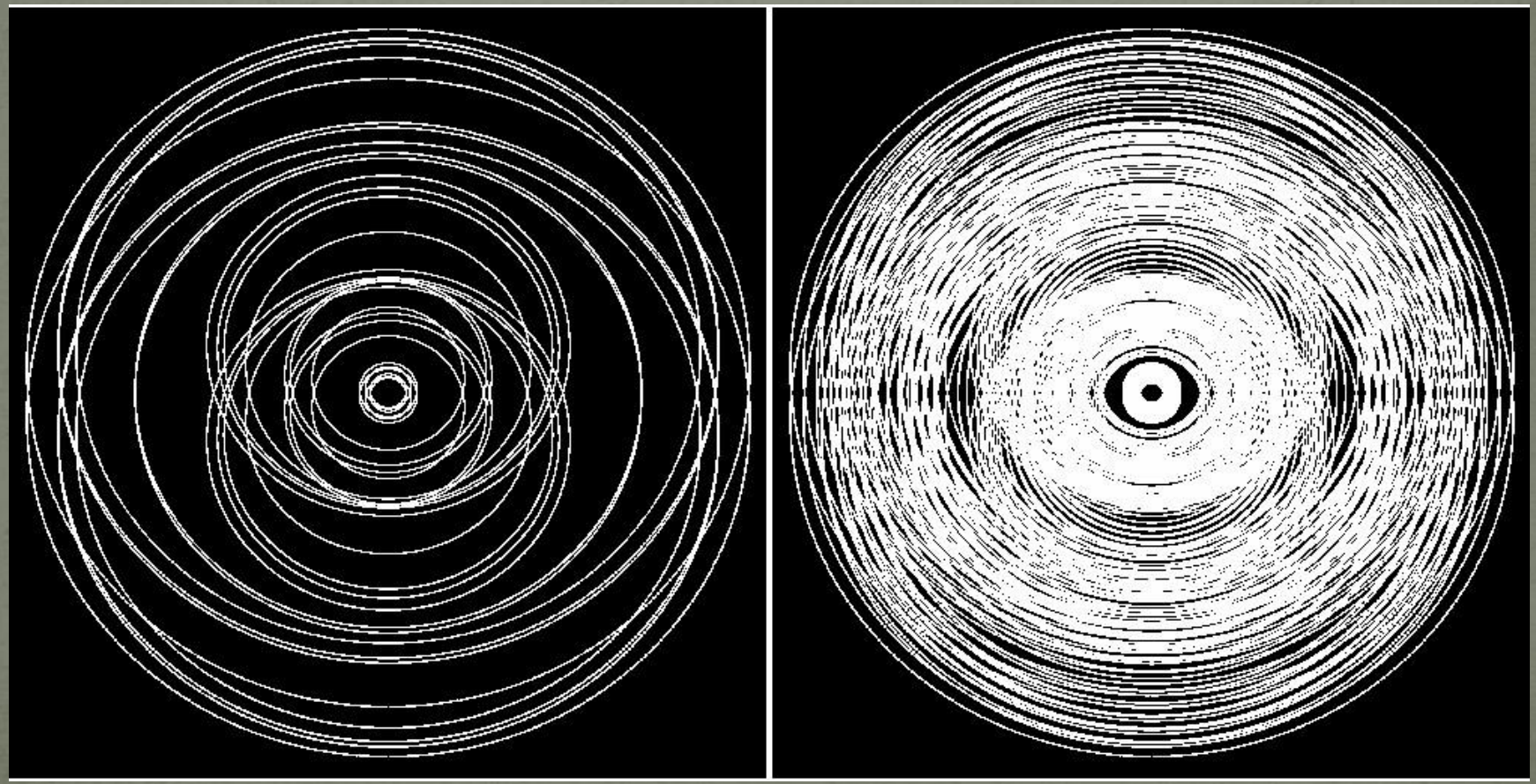


MERLIN+EVN 6cm
T. Muxlow, JBO

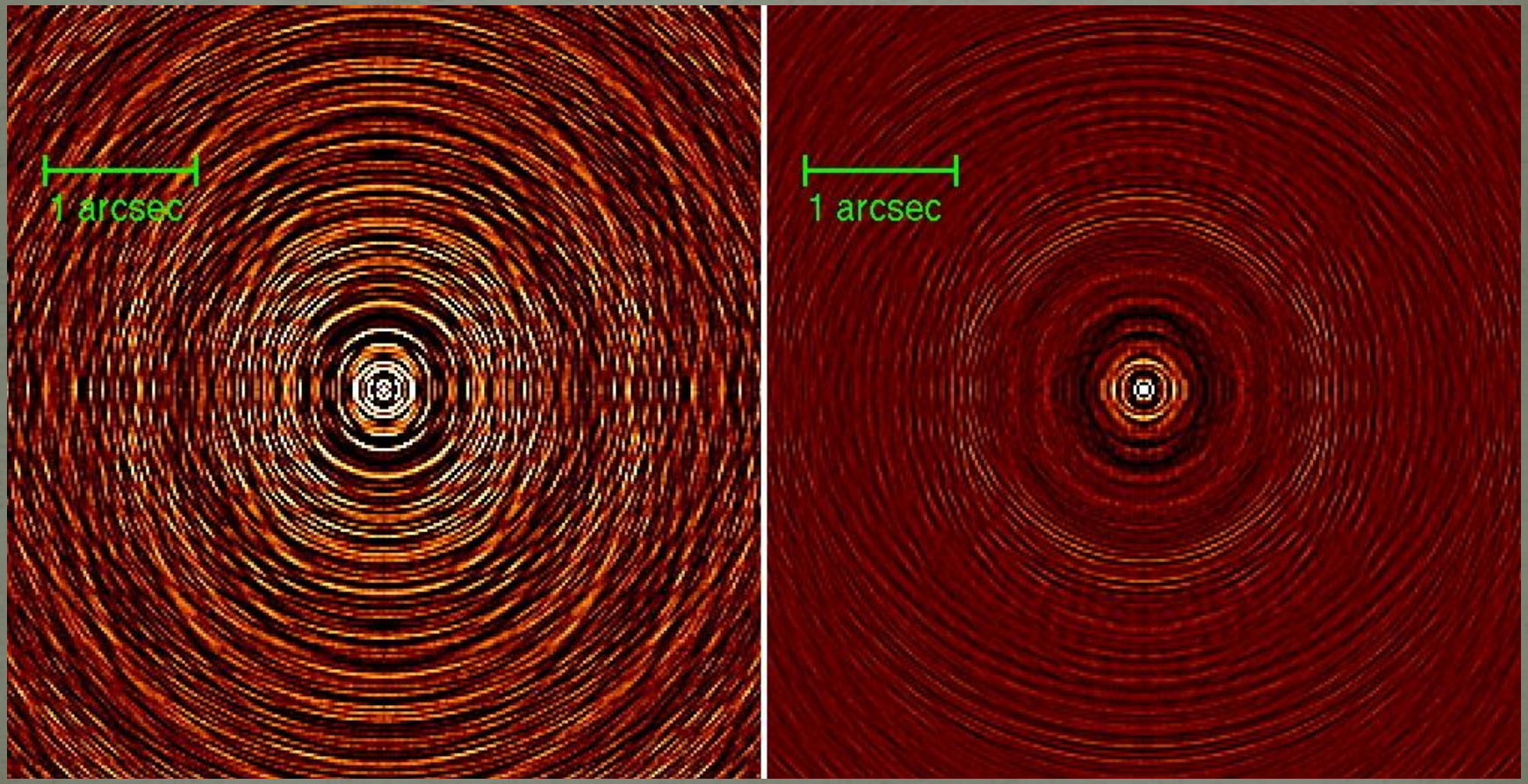
M82 – uv-coverage

Single band at 6.7 GHz

Combination bands between 4.5 and 6.7 GHz

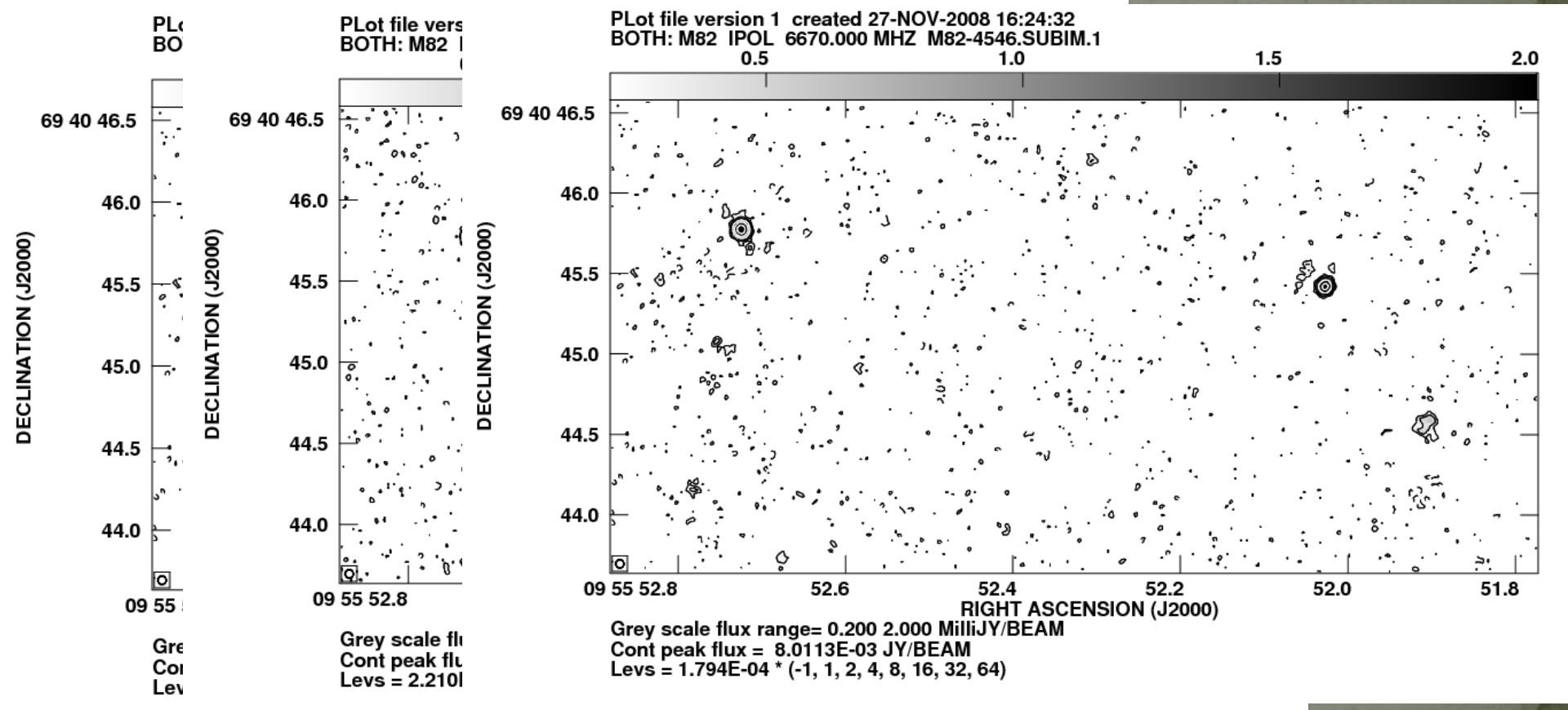


M82 - Resulting beams

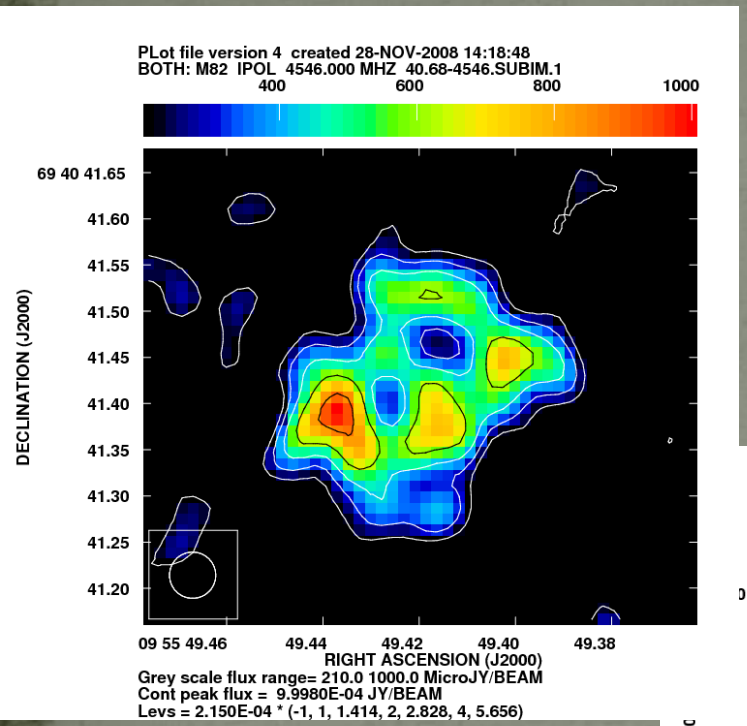


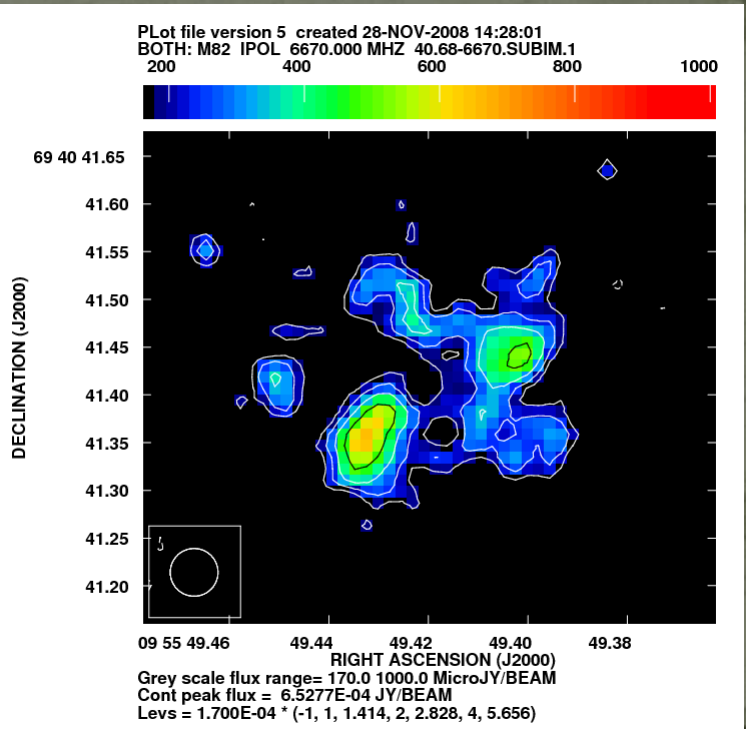
M82 – MERLIN Data

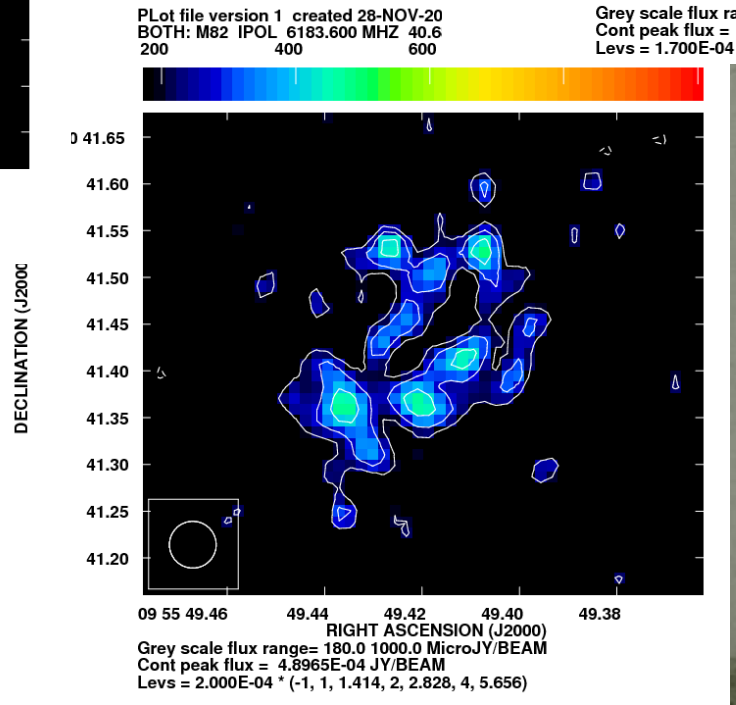
- Example fields from 3 frequencies:



M82 – MERLIN Data

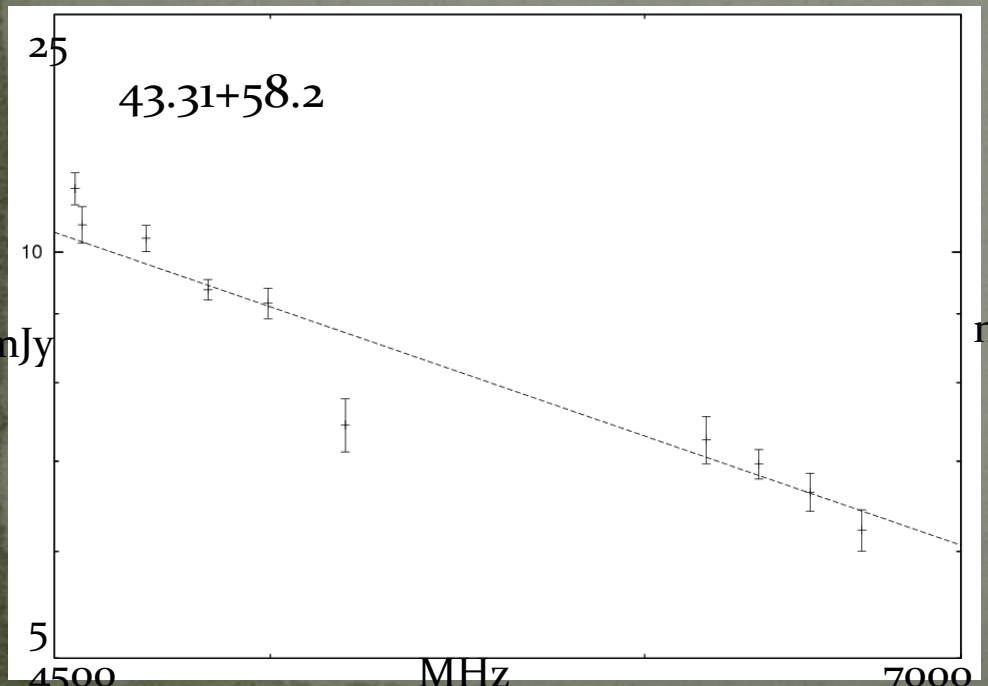


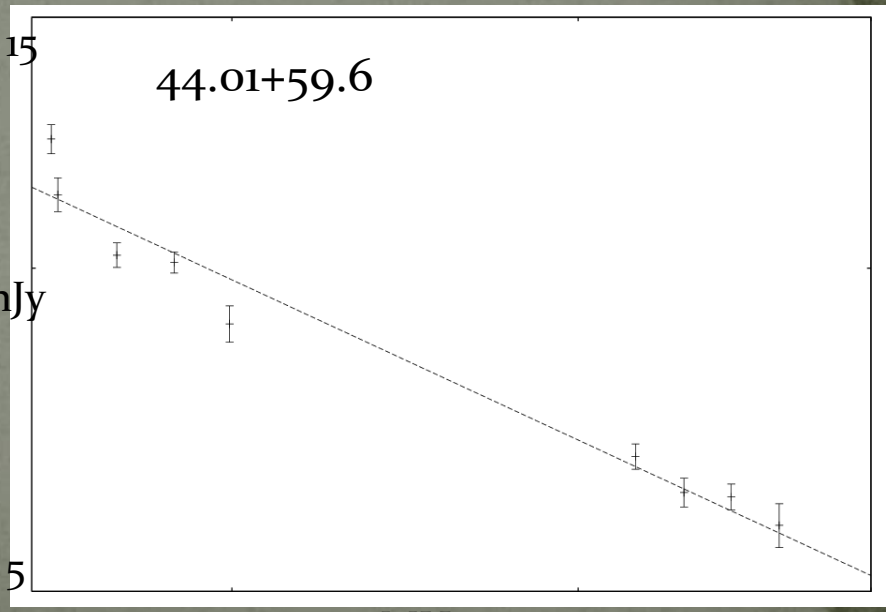




M82 – MERLIN Data

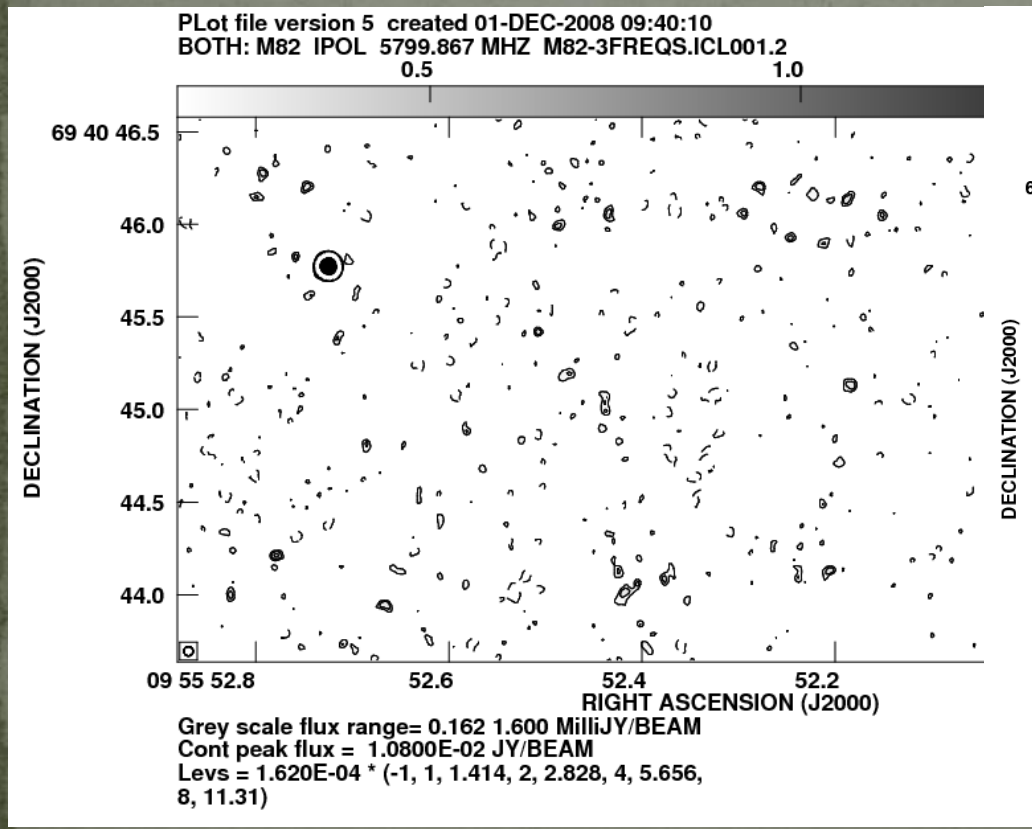
- Just a couple of spectra:
  - Two supernova remnants – compact with MERLIN

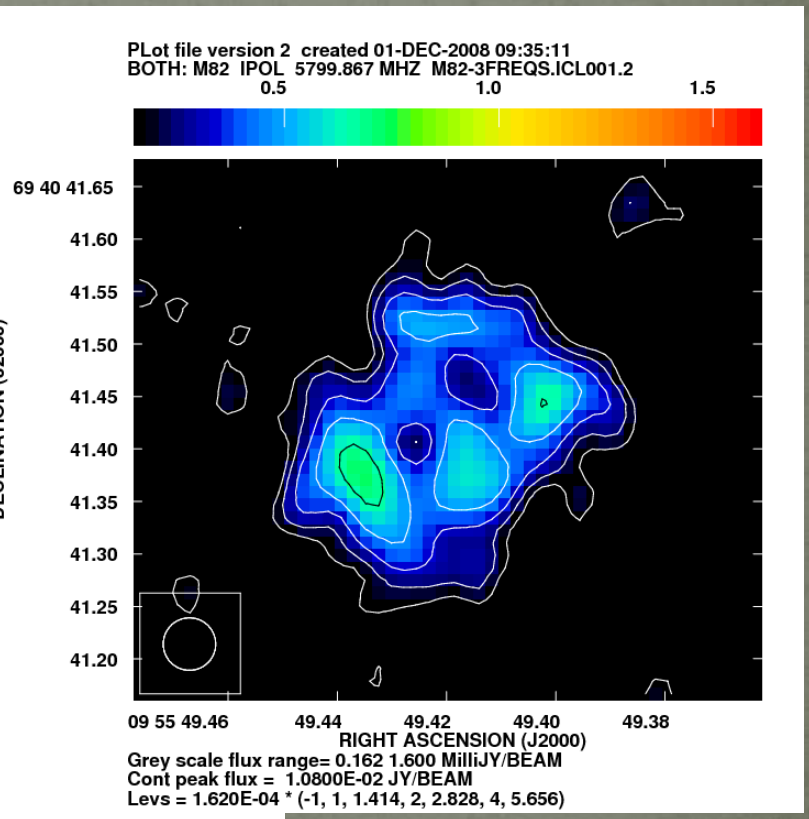




M82 - IMAGR

- Using three frequencies: processed through IMAGR using generic -0.7 spectral index individually:



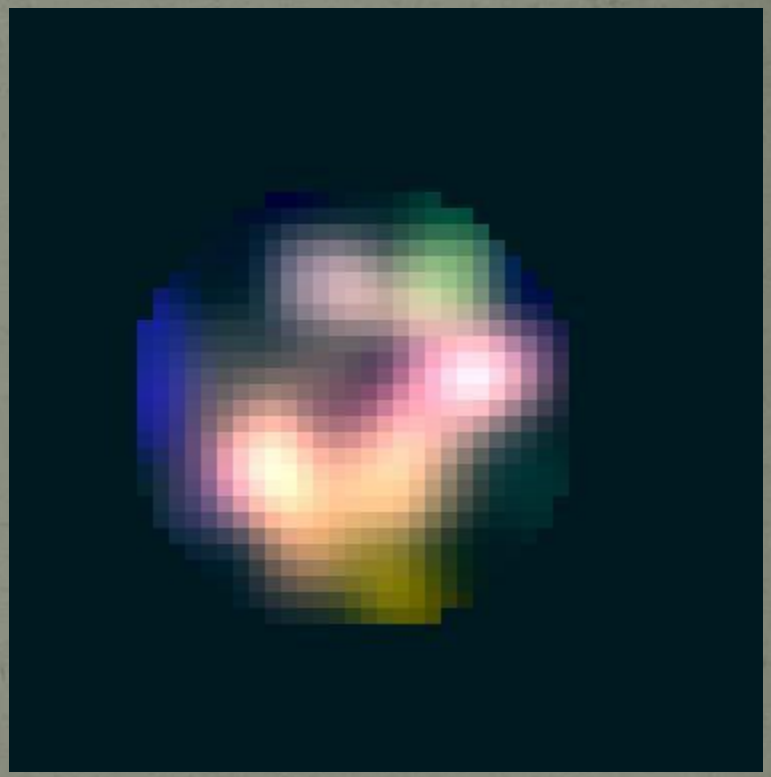


M82 – Sault-Wieringa

- Processed with SW – using the 3 individual frequency beams as input beams.
- 6670, 6183.6 and 4546 MHz.
- Single large image for the moment.
- Focus on diffuse remnant.
- Image statistics
- Will eventually process with Taylor expansion beams using the all of data……

M82 – Sault-Wieringa

- Hot of the press – 40.68+55.1.
- Processed with 2000 iterations, gain 0.01
- 4546,6183.6,6670 – RGB
- Work in progress, but first attempts look good!
- A large thank you to Ian for processing this.



M82 – data combination

- Each observation calibrated individually and then combined.
- But, need to retain frequency information.
- AIPS does not know how to do this correctly.
- Use a combination of tasks including DBCON and written/amended tasks to enable correct combination of the individual datasets.
- Can now use to test as pseudo e-MERLIN dataset.
- May be used (initially) to split and recombine e-MERLIN data to carry out calibration on sections of the data.

Parseltongue - SW

- Included access to/from AIPS to enable direct use of uv-data/image files.
- At the moment, designed to use each sub-band individually.
- So uses IMAGR to create dirty images and dirty beams.
- Combines the images, passes image and beams to SW.
- Currently, Ian's code produces cleaned image outside of AIPS.
- Will change to use 'normal' dirty image and beam for whole dataset, then process using spectral dirty beams as-per Taylor expansion

Parseltongue - SW

- Not yet completely tested –
- Added a ‘major cycle’ to the code – so will be able to incorporate wide-field faceted imaging via IMAGR.
- Need to create/input cleaned images back into AIPS
- Will include spectral information.

- Need access to visibilities via parseltongue – any takers?!

M82 – more testing!

- The plan now –
- Tested three datasets using the SW.
- Gradually increase up to all ten.
- Will also test model/full aperture image of diffuse non-compact object.

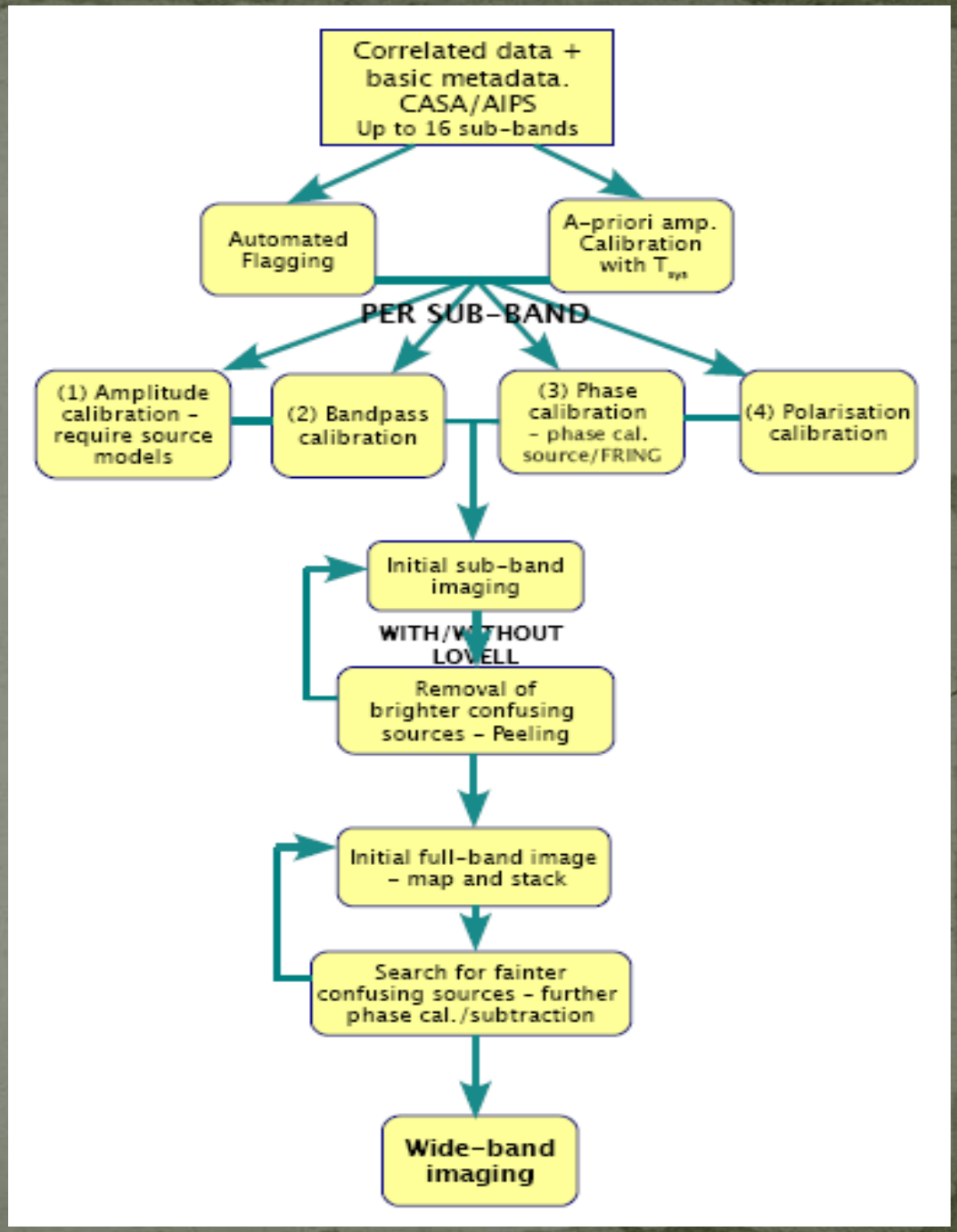
e-MERLIN Data Processing

e-MERLIN Data Processing

- Provide dataflow to the user
- Needs to be feasible for non-radio astronomer.
- Including pipelines where possible
- Guidelines of data reduction procedures
  - Using both AIPS and CASA
- Pipelines written in Python/Parseltongue.

Dataflow

- Simplified outline of perceived stages in data reduction.
- Will focus on a few areas.



e-MERLIN data

- Usable in either AIPS or CASA for processing
- Format will be ~ 16 sub-bands ~ 128 MHz each (C-band), ~ 32 MHz each (L-band).
  - Similar to largest present-day VLBI data
- Some meta-data included – telescope dropouts etc.
- Eventually, will have Tsys measurements, but not at start.

Dataflow - Amplitude

- Amplitude calibration – build up source model (including spectra) of calibrators.
- Initially no Tsys information – may well be implemented during commissioning.
- Start be forming model of 3C286.
- Use a number (~10) MERLIN observations at C-band.
- Will calibrate each sub-band separately.
- May require a temporary splitting of dataset.

Dataflow - Bandpass

- Performed on each sub-band individually.
- Assume strong source not confused
- At least initially – use existing procedures within AIPS/CASA

Dataflow - Phase

- Again each ‘sub-band’ handled individually
- Phase calibrator assumed bright enough not to be confused.
- Use FRING to correct phase rate, delay within AIPS
- Existing procedures for VLBI experiments.

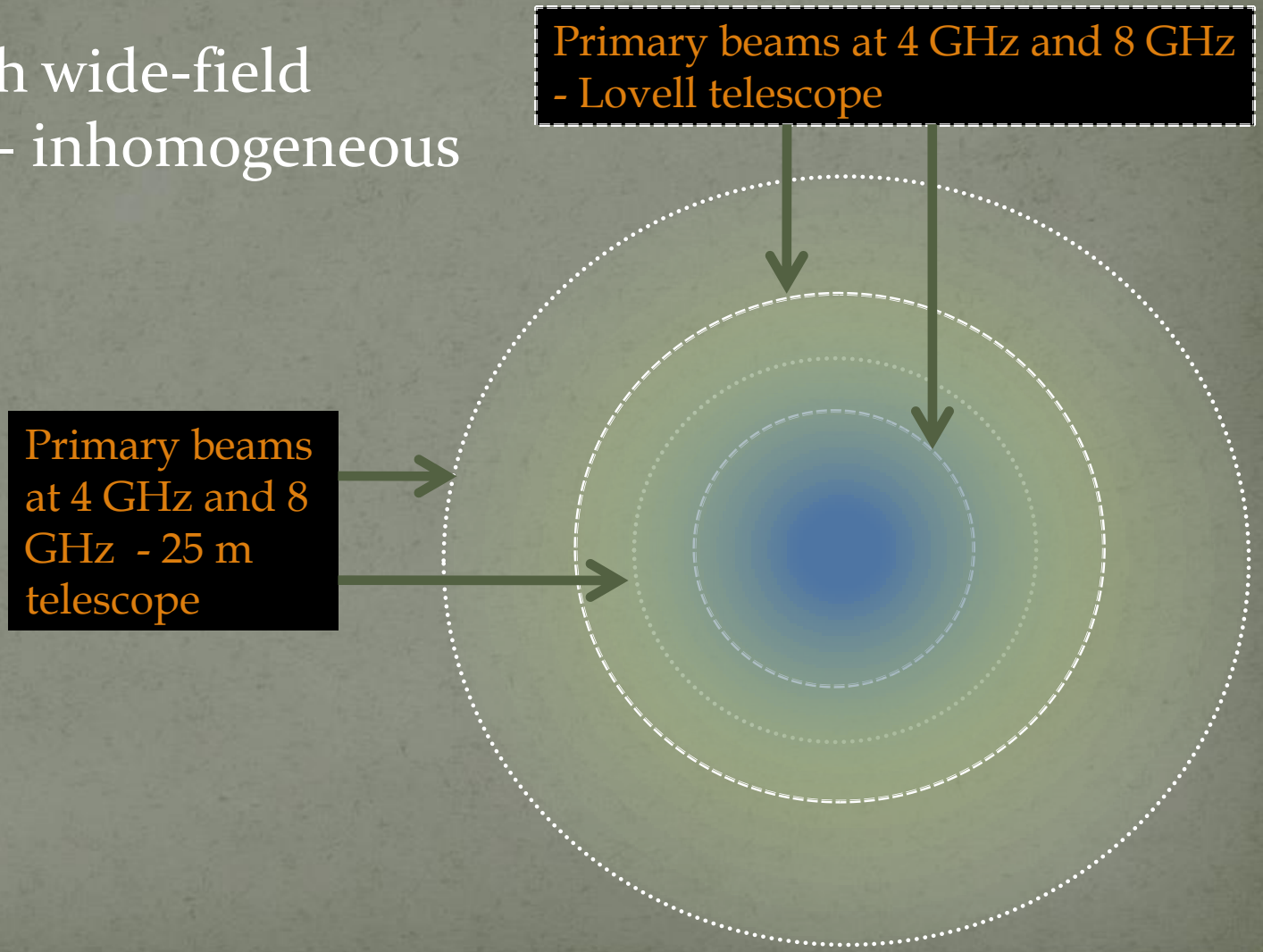
Dataflow - Polarisation

- Will be part of the sub-band calibration
- Not well-known at this stage

- A lot of discussion yesterday afternoon
- So plenty of information to take away and work with
- But, clearly going to have to think about this to ensure can reach dynamic ranges required for just stokes I imaging.

Peeling with e-MERLIN

- Issue with wide-field imaging - inhomogeneous array.



Peeling with e-MERLIN

- Was the plan – clearly a lot discussion yesterday about peeling
- This will be revised:
  - Will struggle solving for many sources at once on a per channel basis - S/N
  - Adopt Bill Cotton's plan of
    - Making a copy of the data
    - Rotation of phase centre of copied data to confusing source
    - Take solutions – apply inverse of corrections to original data i.e. rotating source to pointing centre
    - Then subtract from data.
  - Any advice on how to implement? – General plea.

Peeling with e-MERLIN – Testing.

- Will begin to test peeling process with HDF data
- Will initially be by hand for testing
- Started to pipeline process (loosely) –
  - Identifies source – currently via a list
  - Loops through IMAGR, CLCAL and CALIB for non-Lovell
  - Applies to data.
- Though will need regular checks of models and results.

Imaging

- Once confusing sources removed:
- Image sub-bands, stack, look for any fainter sources, may be able to tweak phase calibration with.
- Then will process using the Sault-Wieringa algorithm to produce wide-band images.
- Will require a varying weighting over e-MERLIN beam to incorporate changes over sensitivity when using all of the data.

Mosaicing

- Main issue here is again the inhomogeneous array.
- Mostly not a problem if not including the Lovell.
- However, if including Lovell, will most likely plan observations around the Lovell primary beam

Mosaicing

- Assuming have figured out imaging of individual pointings – can just add images together – i.e. FLATN.
- Otherwise will probably create two mosaics – one without the Lovell information, one with only Lovell information and then combine images.
- Will be an image plane combination.

Note about parallel processing

- Can see obvious use for parallel processing at the task level.
- Can AIPS handle this?
- Can it get any more sophisticated?