Single dish polarization calibration results using KAT 7

Mattieu de Villiers

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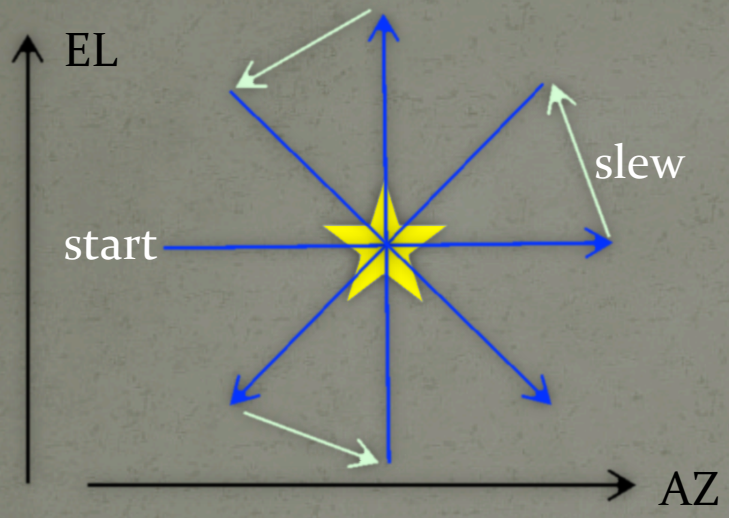
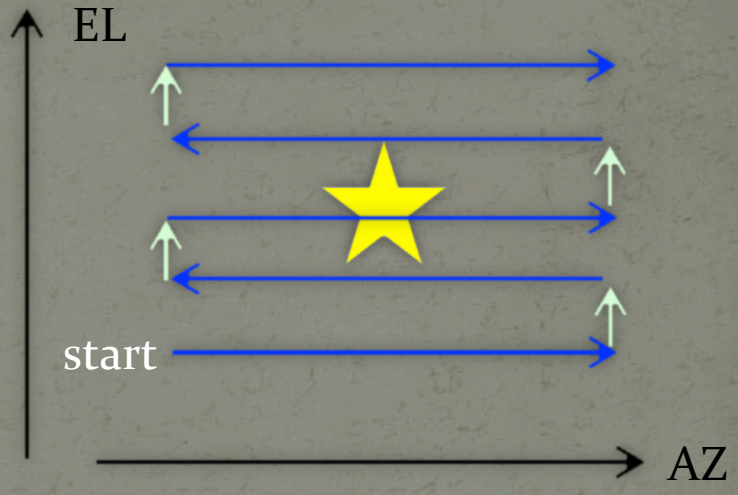
Goals of project:

- To measure primary beam patterns from observations (for comparison to EM simulated results).
- To try out polarization calibration on real data while the interferometer is unavailable.
- Assist in single dish polarization commissioning.
- General system testing/debugging.

Radial scans vs Raster scans

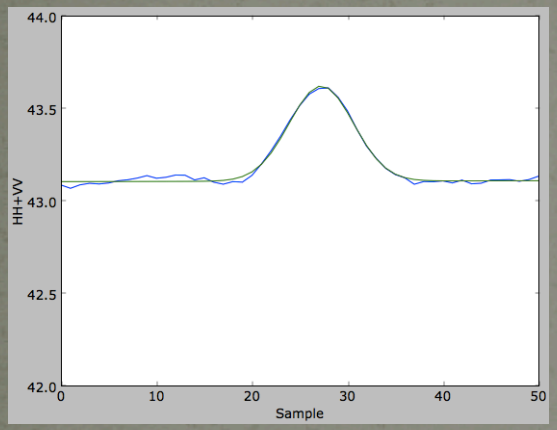


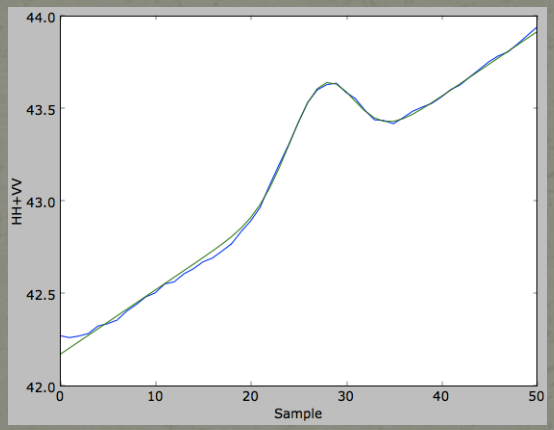
- Maximum source intensity sampled in each scan.
- Baseline subtraction may be more difficult for scans in elevation especially at low elevations.

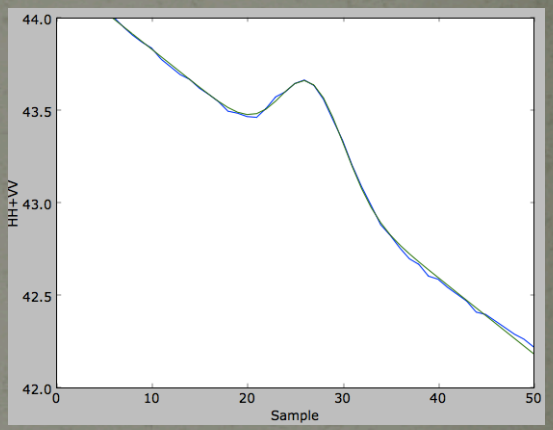


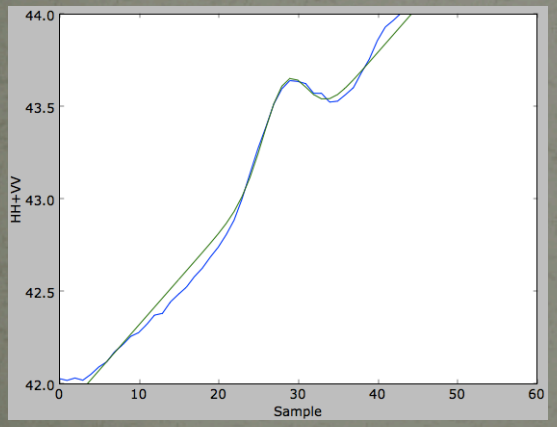
- Baseline subtraction may generally work more reliably.
- More difficult to discard poor scans automatically.

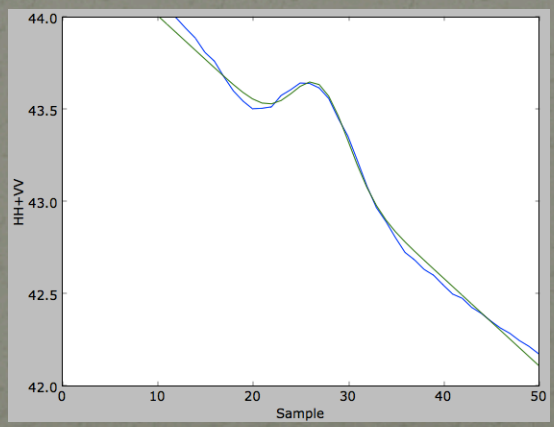
Radial scans (HH+VV for 3C 286)

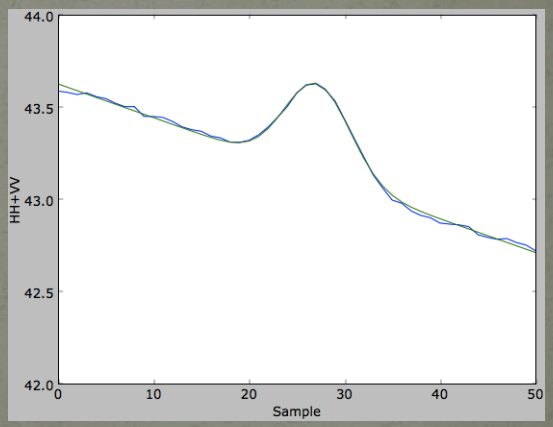






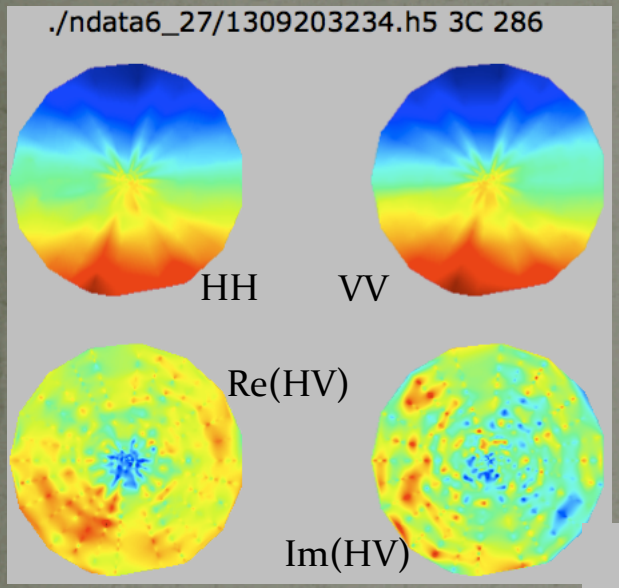




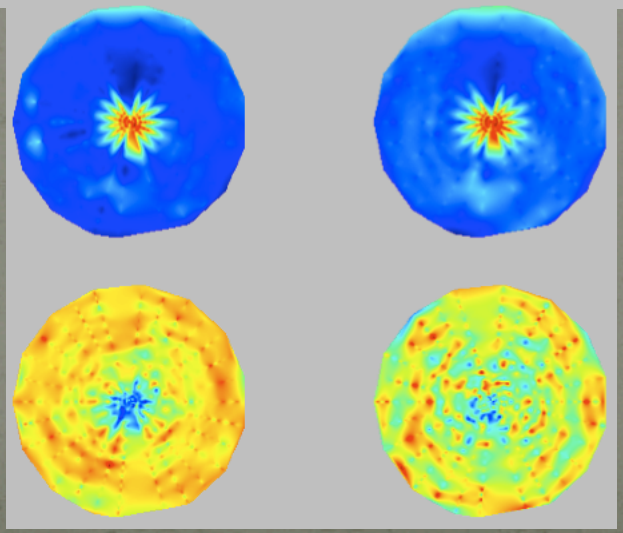


Scan extent 6 degrees for all radial scans shown

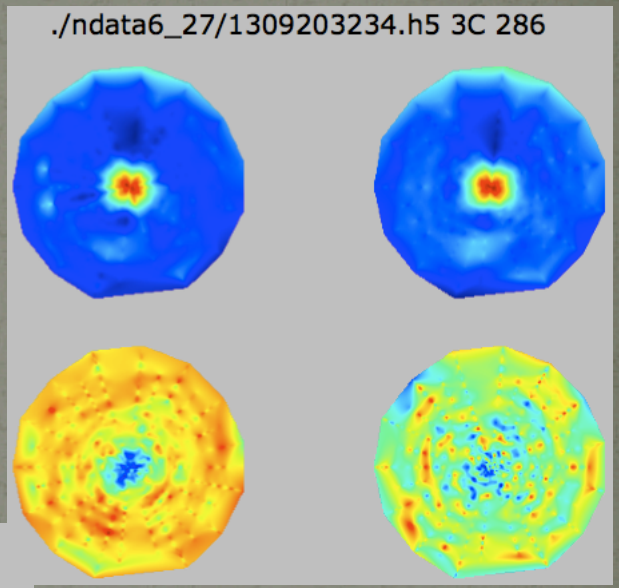
Baseline subtraction in AZ EL plane for 3C 286



Measured correlations

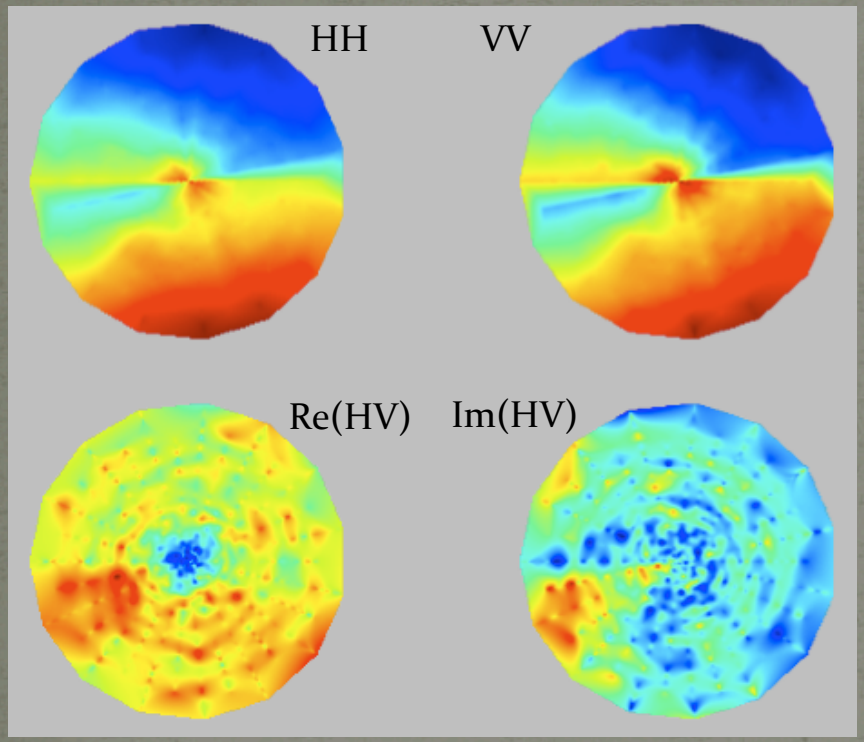


Baseline subtraction

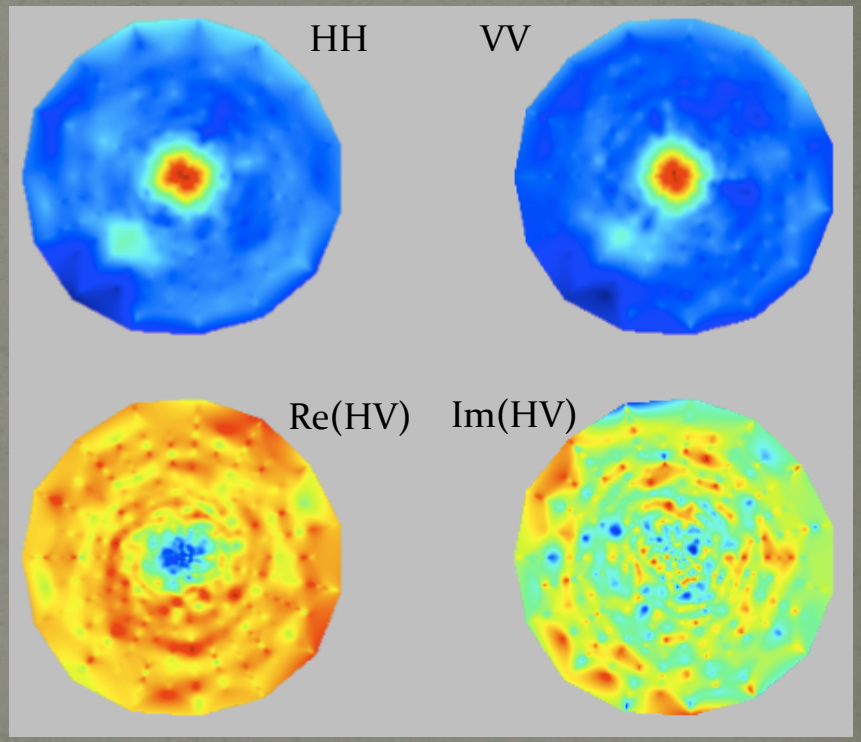


Baseline subtraction and timing correction

More typical results in the AZ EL plane



- ‘Raw’ correlator products

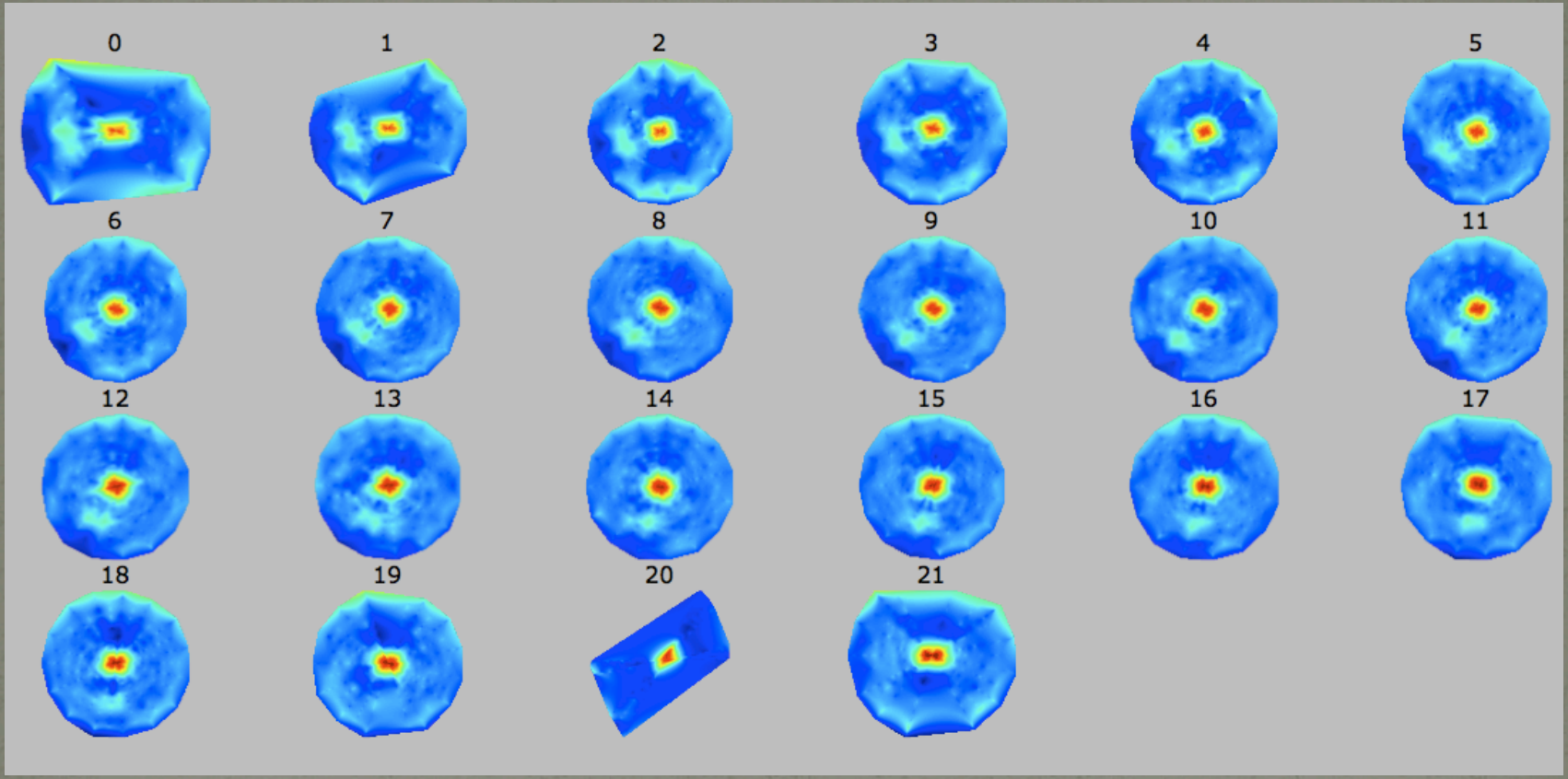


- Baseline subtraction
- Timing correction

HH, 3C 286, over 6 hour period

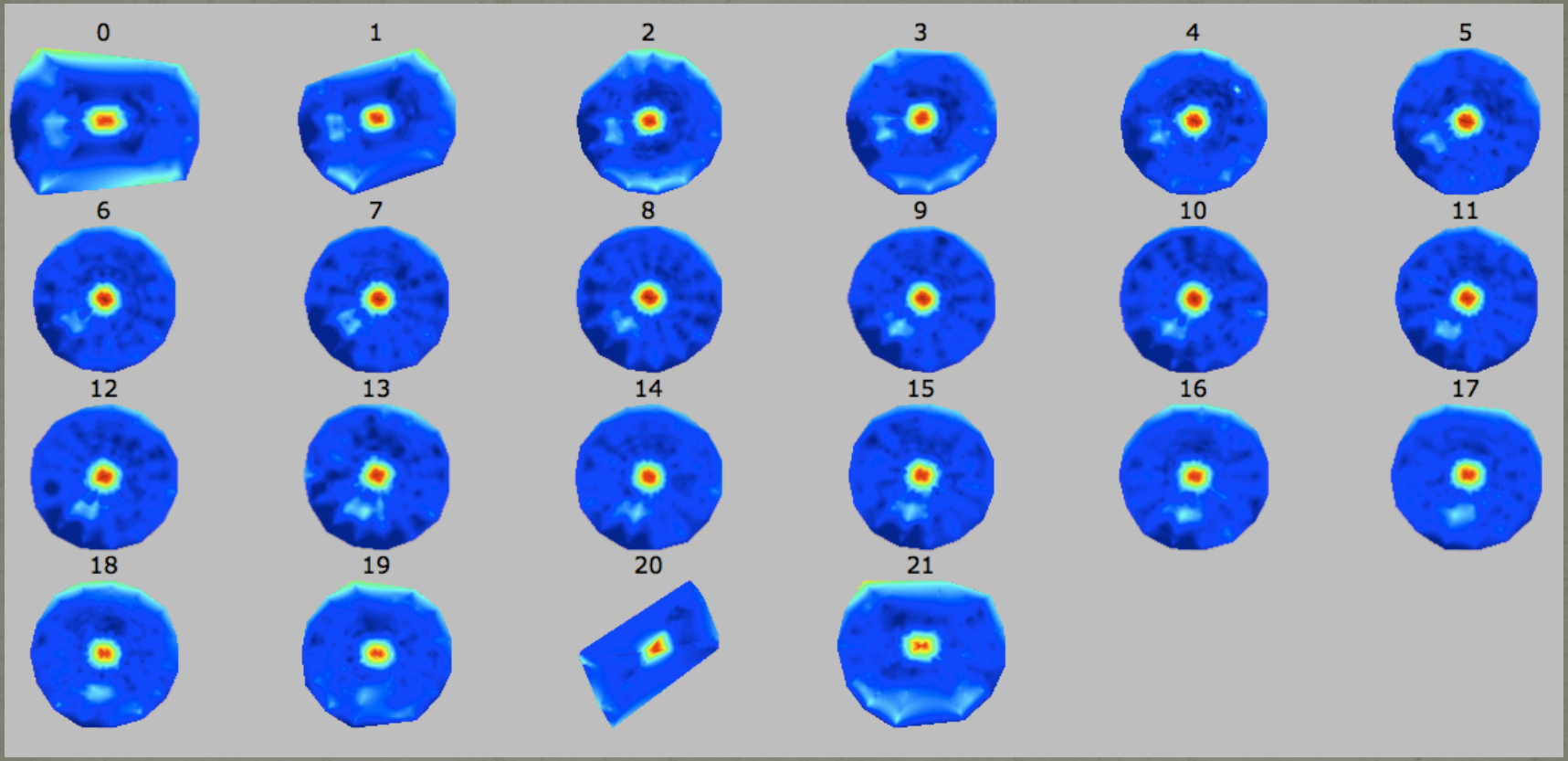
(8% polarized, 13 Jy)

28 June 2011, antenna 4, 1780MHz



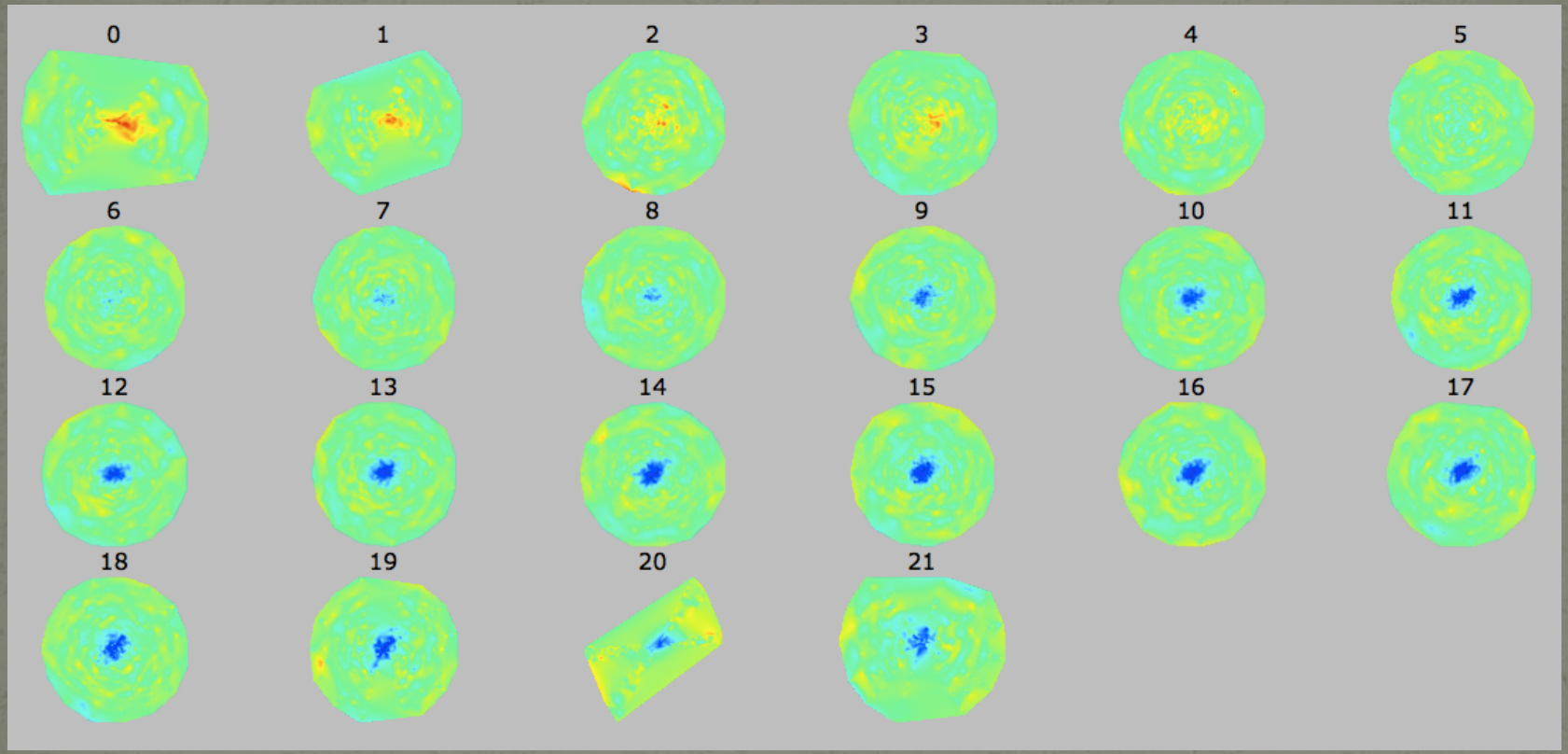
VV, 3C 286

28 June 2011, antenna 4, 1780MHz



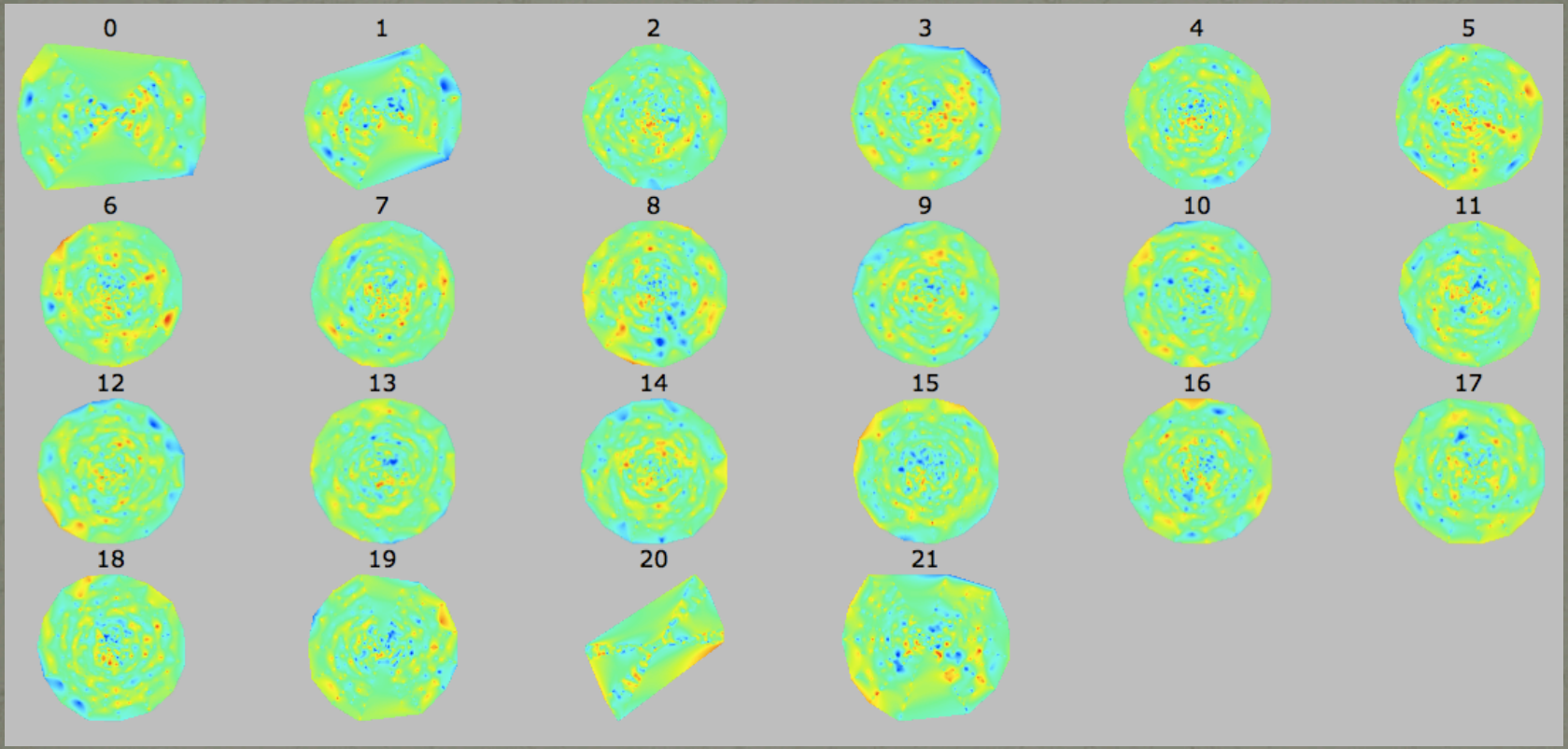
Real (HV), 3C 286

28 June 2011, antenna 4, 1780MHz



Imag(HV), 3C 286

28 June 2011, antenna 4, 1780MHz



Solving for leakages and source parameters

Model visibilities

$$\begin{bmatrix} VV \\ VH \\ HV \\ HH \end{bmatrix} = \frac{1}{2} \begin{bmatrix} I\cdot(1+D_x\cdot D_x^*) - V_j\cdot(D_x - D_x^*) \\ +Q\cdot(\cos(2\cdot\chi)\cdot(1-D_x\cdot D_x^*) - (D_x+D_x^*)\cdot\sin(2\cdot\chi)) \\ +U\cdot(\sin(2\cdot\chi)\cdot(1-D_x\cdot D_x^*) + (D_x+D_x^*)\cdot\cos(2\cdot\chi)) \\ I\cdot(D_x+D_y^*) + V_j\cdot(1-D_x\cdot D_y^*) \\ -Q\cdot((1+D_y^*\cdot D_x)\cdot\sin(2\cdot\chi) + (D_x-D_y^*)\cdot\cos(2\cdot\chi)) \\ +U\cdot((1+D_x\cdot D_y^*)\cdot\cos(2\cdot\chi) - (D_x-D_y^*)\cdot\sin(2\cdot\chi)) \\ I\cdot(D_y+D_x^*) - V_j\cdot(1-D_y\cdot D_x^*) \\ -Q\cdot((1+D_y\cdot D_x^*)\cdot\sin(2\cdot\chi) - (D_y-D_x^*)\cdot\cos(2\cdot\chi)) \\ +U\cdot((1+D_y\cdot D_x^*)\cdot\cos(2\cdot\chi) + (D_y-D_x^*)\cdot\sin(2\cdot\chi)) \\ I\cdot(D_y\cdot D_y^*+1) + V_j\cdot(D_y - D_y^*) \\ -Q\cdot((1-D_y\cdot D_y^*)\cdot\cos(2\cdot\chi) + (D_y+D_y^*)\cdot\sin(2\cdot\chi)) \\ -U\cdot((1-D_y\cdot D_y^*)\cdot\sin(2\cdot\chi) - (D_y+D_y^*)\cdot\cos(2\cdot\chi)) \end{bmatrix}$$

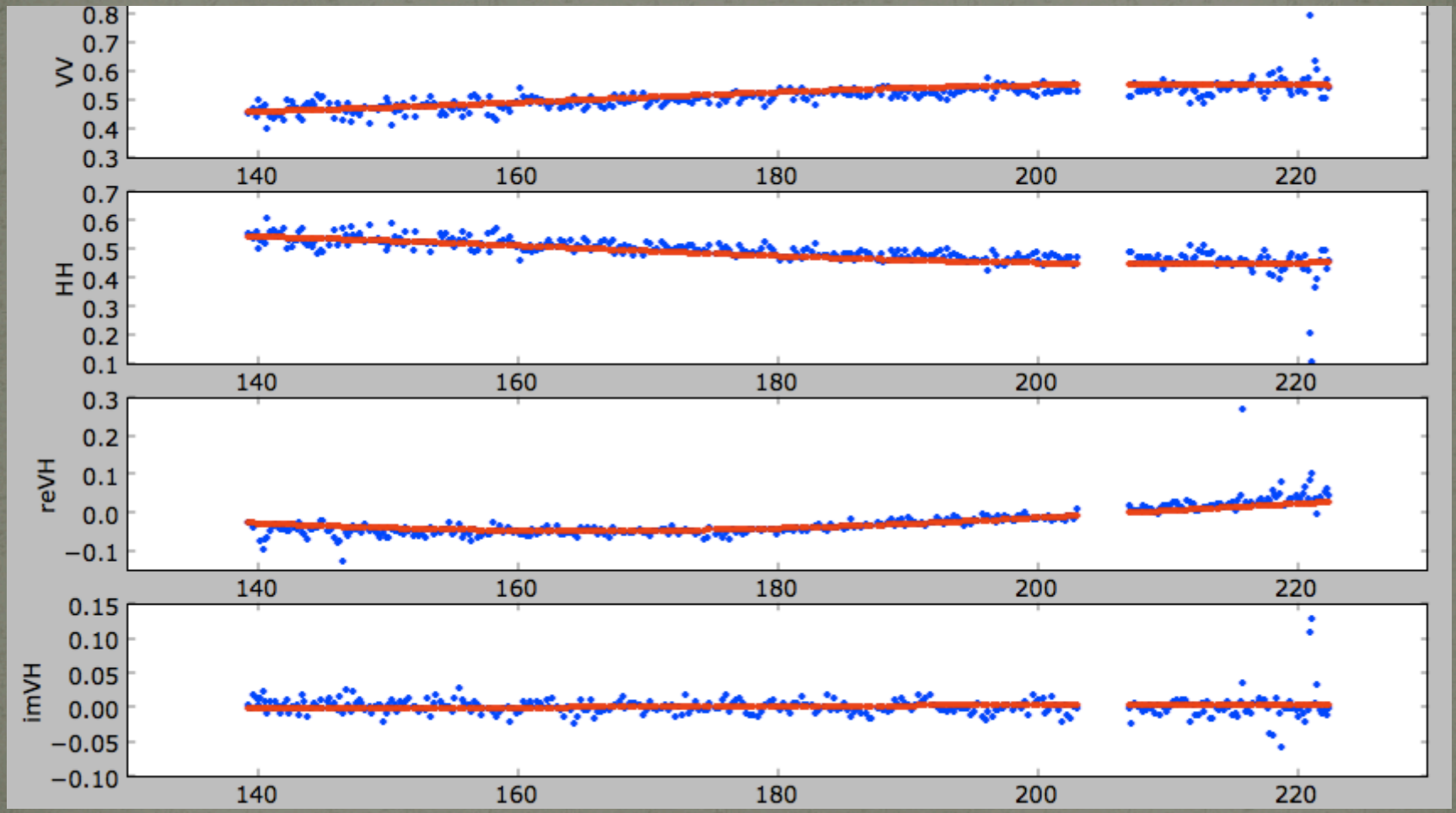
Normalized, data already gain-calibrated

$$I=1$$
$$Q=p\cdot\cos(2\cdot\theta)$$
$$U=p\cdot\sin(2\cdot\theta)$$
$$V=0$$

Model fit to data, 3C 286

28 June 2011, antenna 4, 1780MHz

Solve for: leakages at beam center, fraction of polarization, position angle of source.

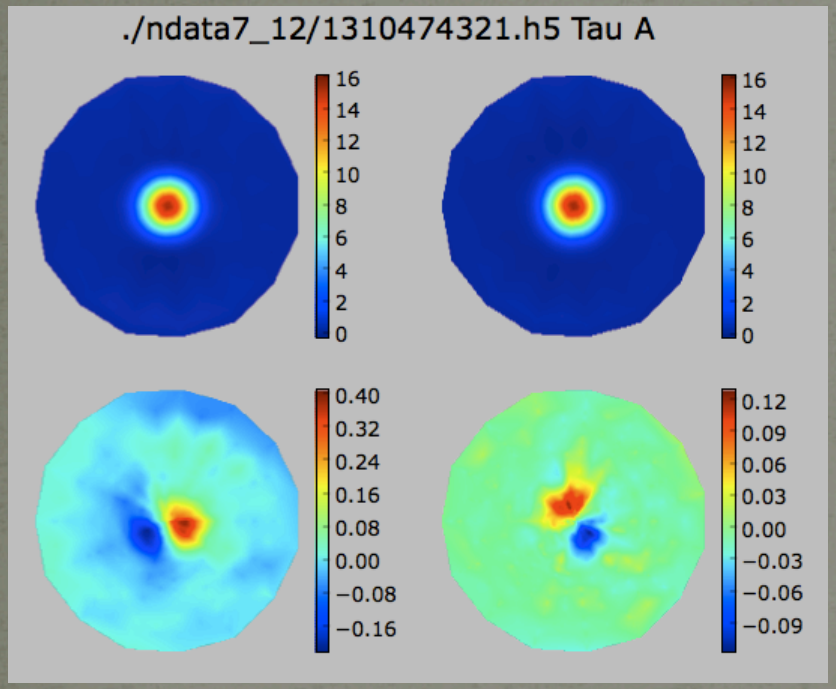


Parallactic angle

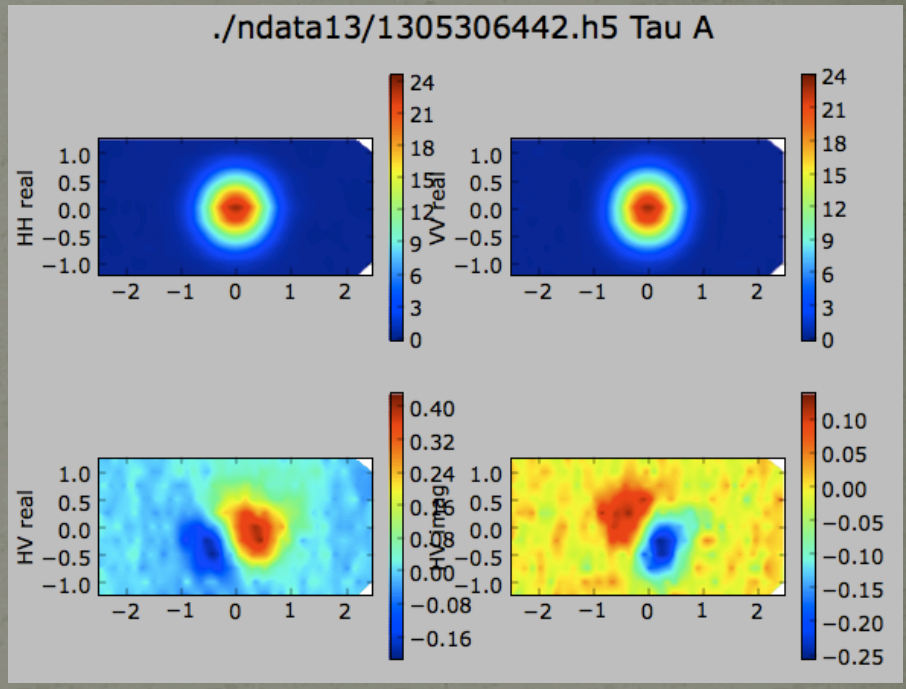
Tau A

1.2% polarized, 870Jy

Antenna 3
15 radial scans, 1780MHz

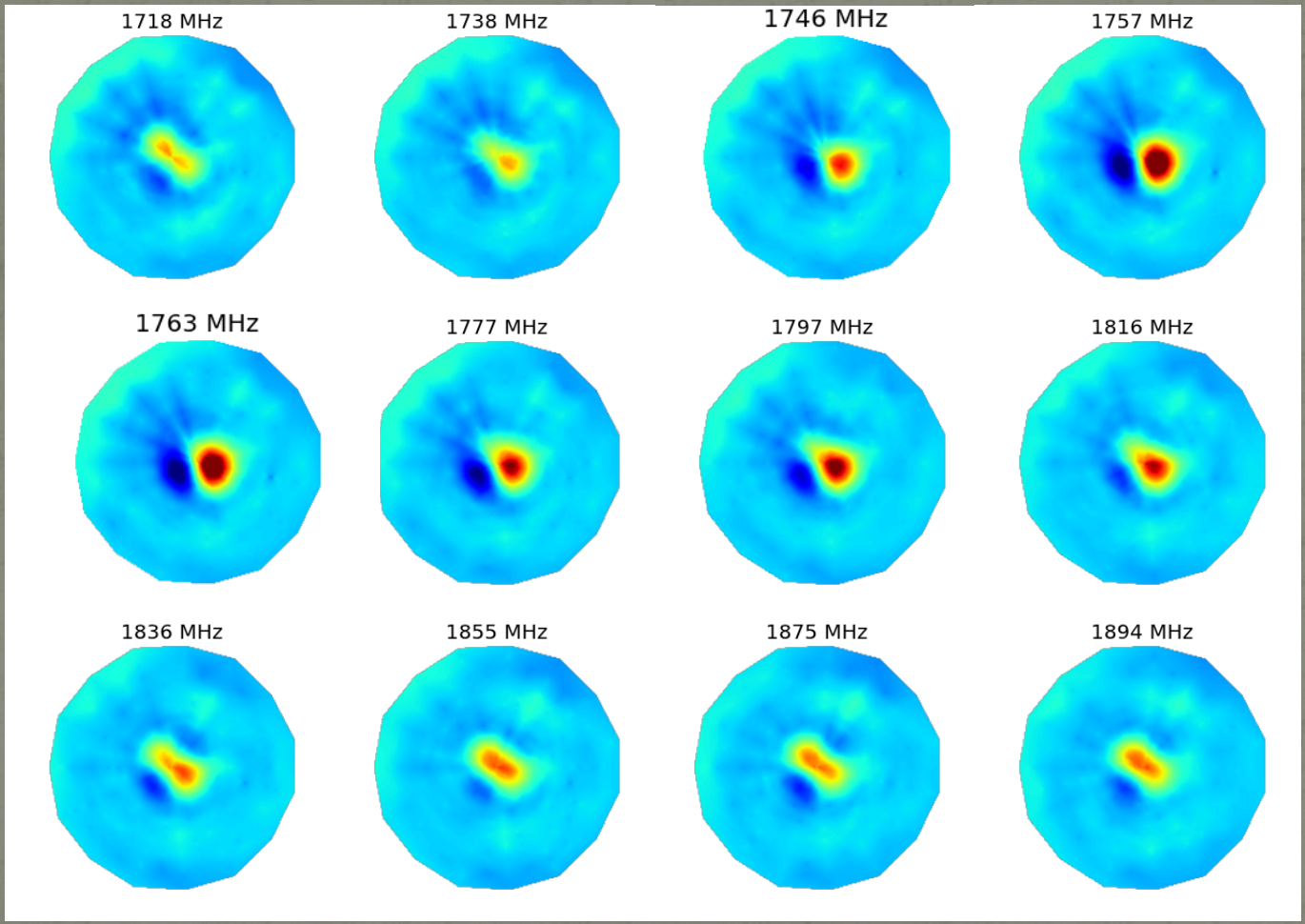


Antenna 2
21 raster scans, 1780MHz



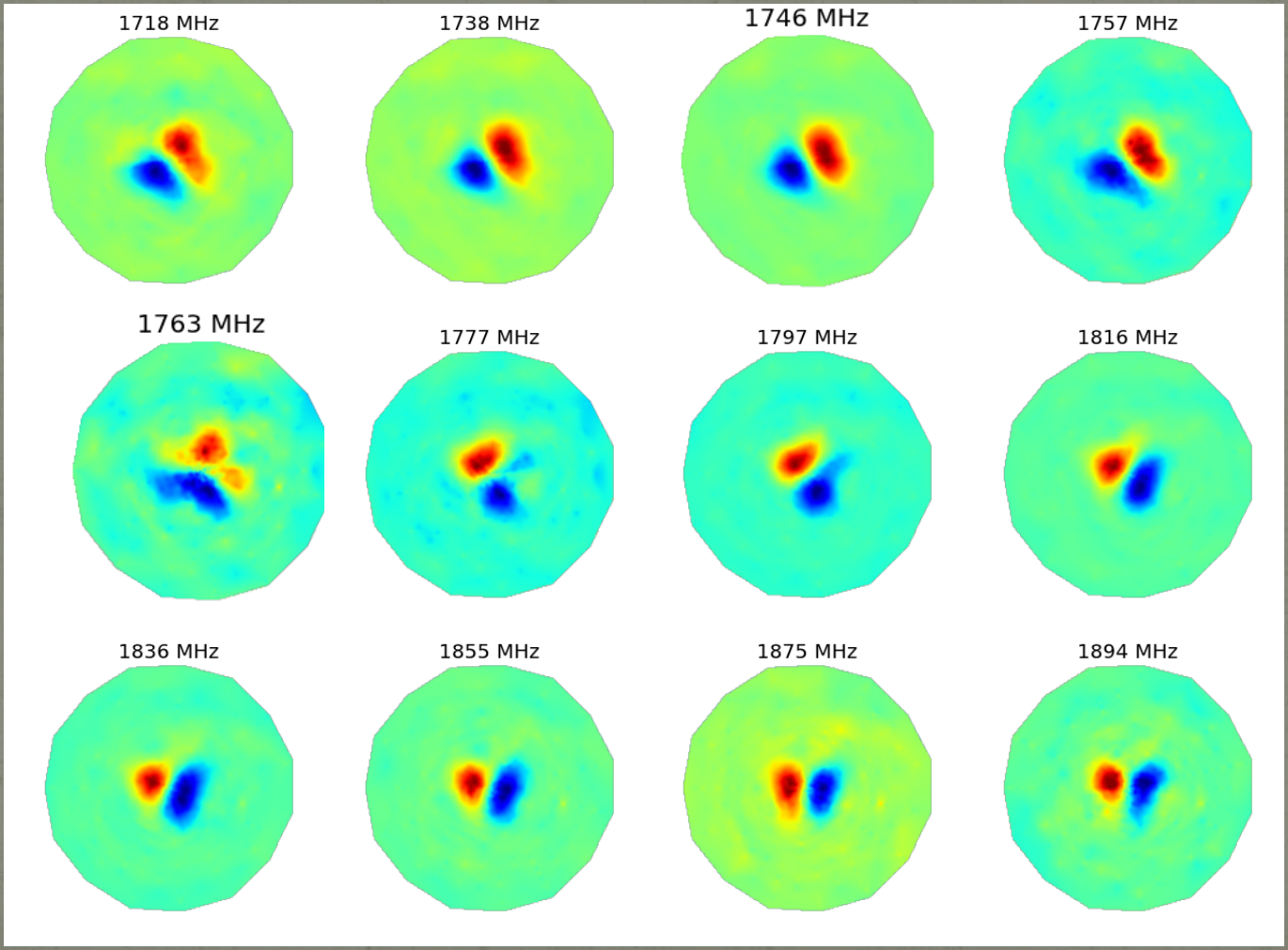
Tau A

Real(HV) frequency response antenna 3



Tau A

Imag(HV) frequency response antenna 3



Conclusion

- Two scanning modes – raster or radial.
- It is possible to do an on-axis polarization calibration on 3C 286 using single antenna.
- Beam response patterns can be measured on stronger sources.
- Extracting full Mueller matrix beam pattern is not done yet.