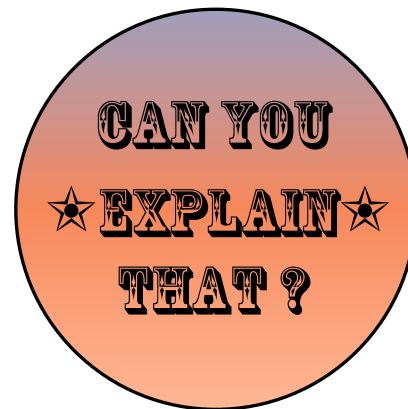


# WSRT 350 MHz Legacy Survey: First results on clusters of galaxies

or:

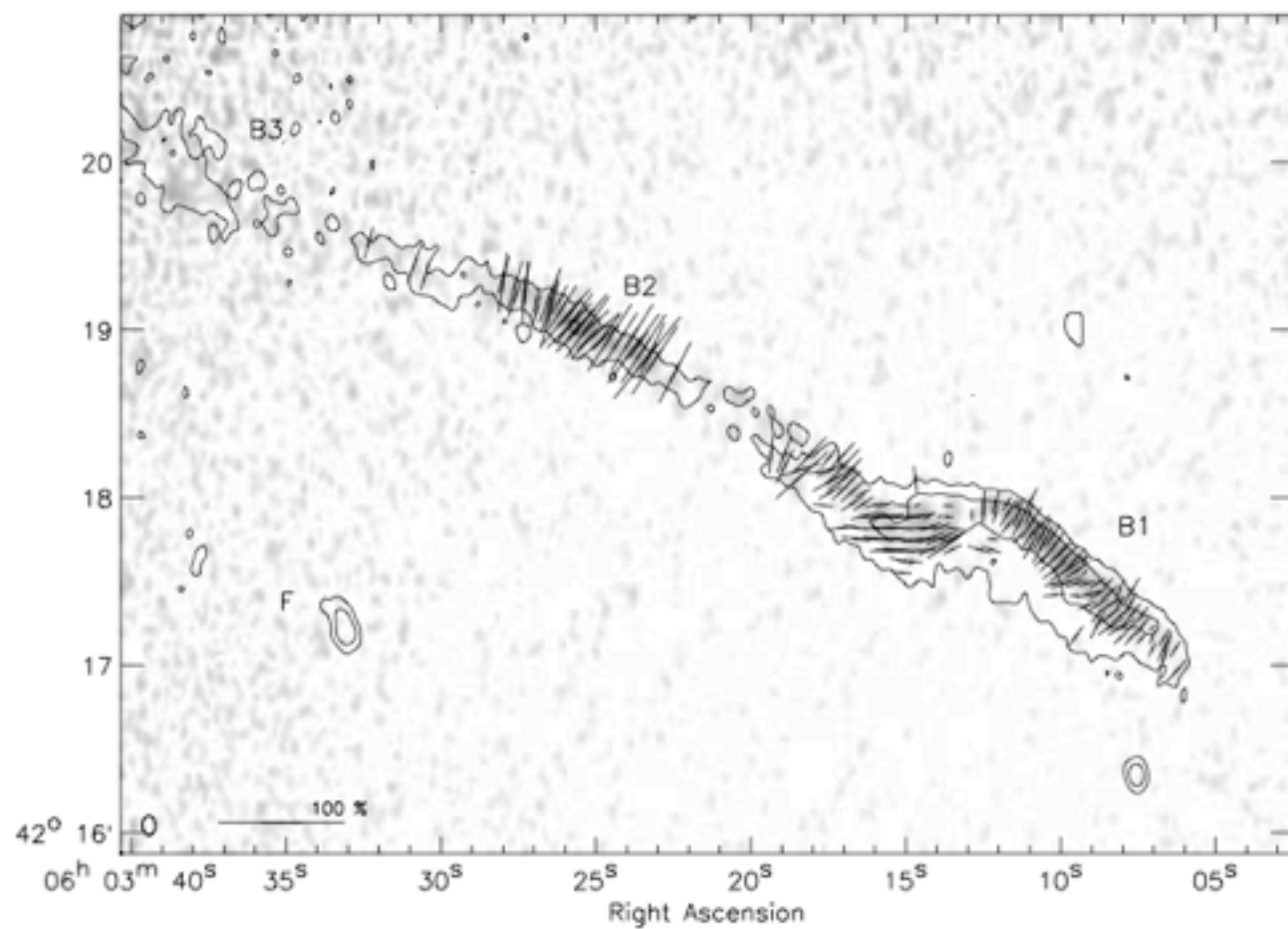


**Matthias Hoeft, Stefan Baar,  
Alexander Drabent**

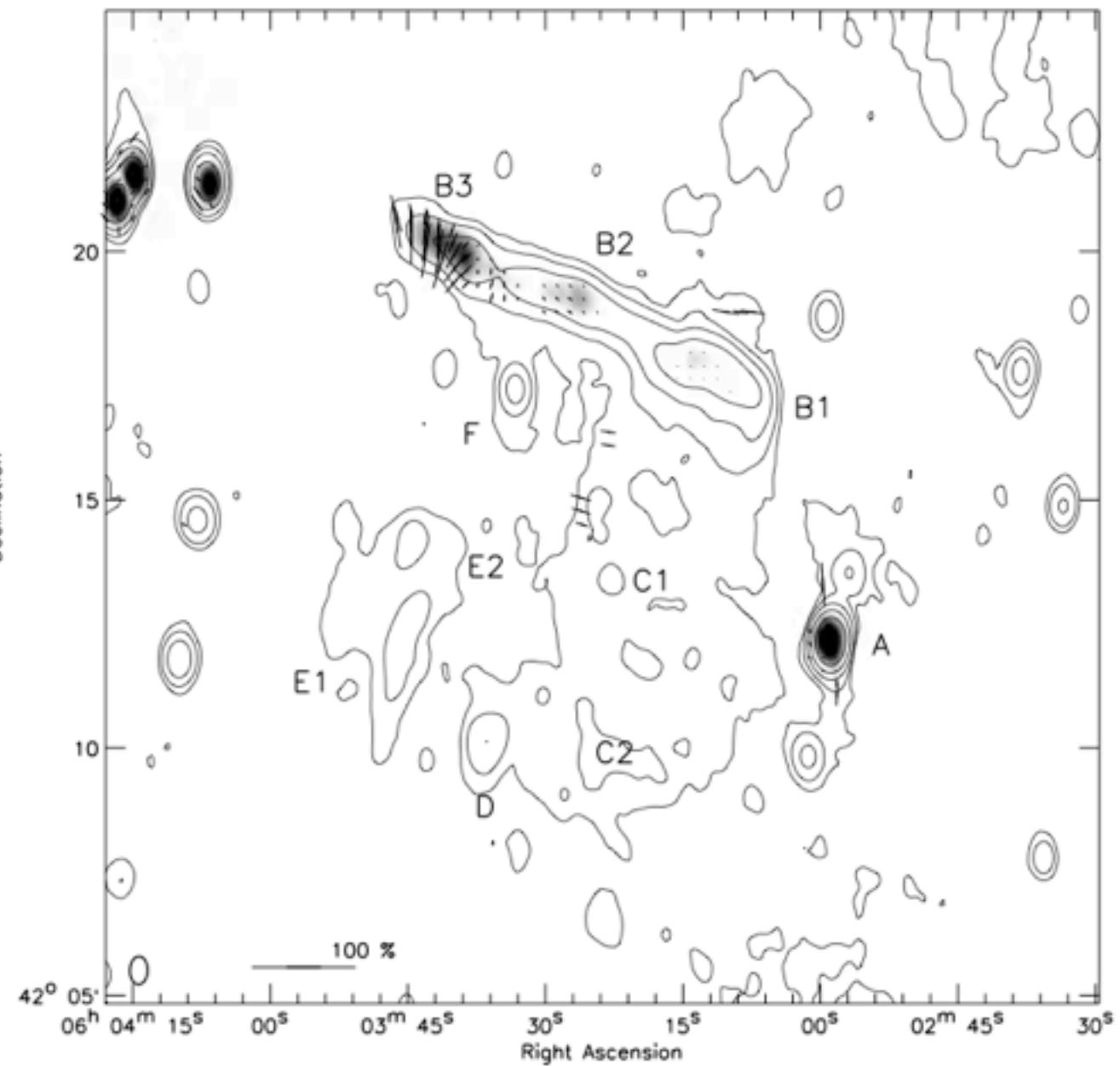
**Roberto Pizzo, Uli Klein,  
Annalisa Bonafede, Emanuela Orru,**

# The 'Toothbrush' in polarization

WSRT 4.9 GHz

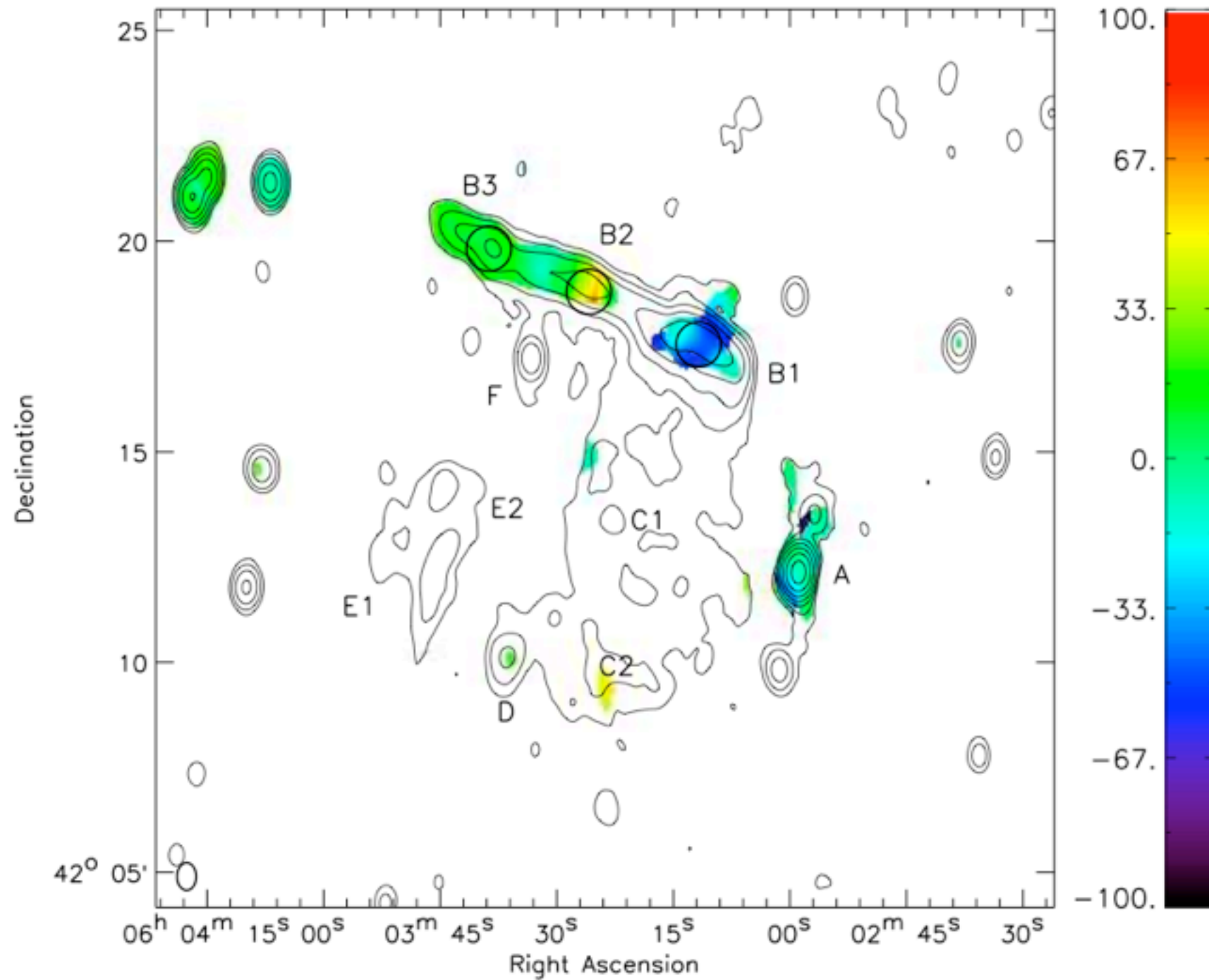


WSRT 1.4 GHz



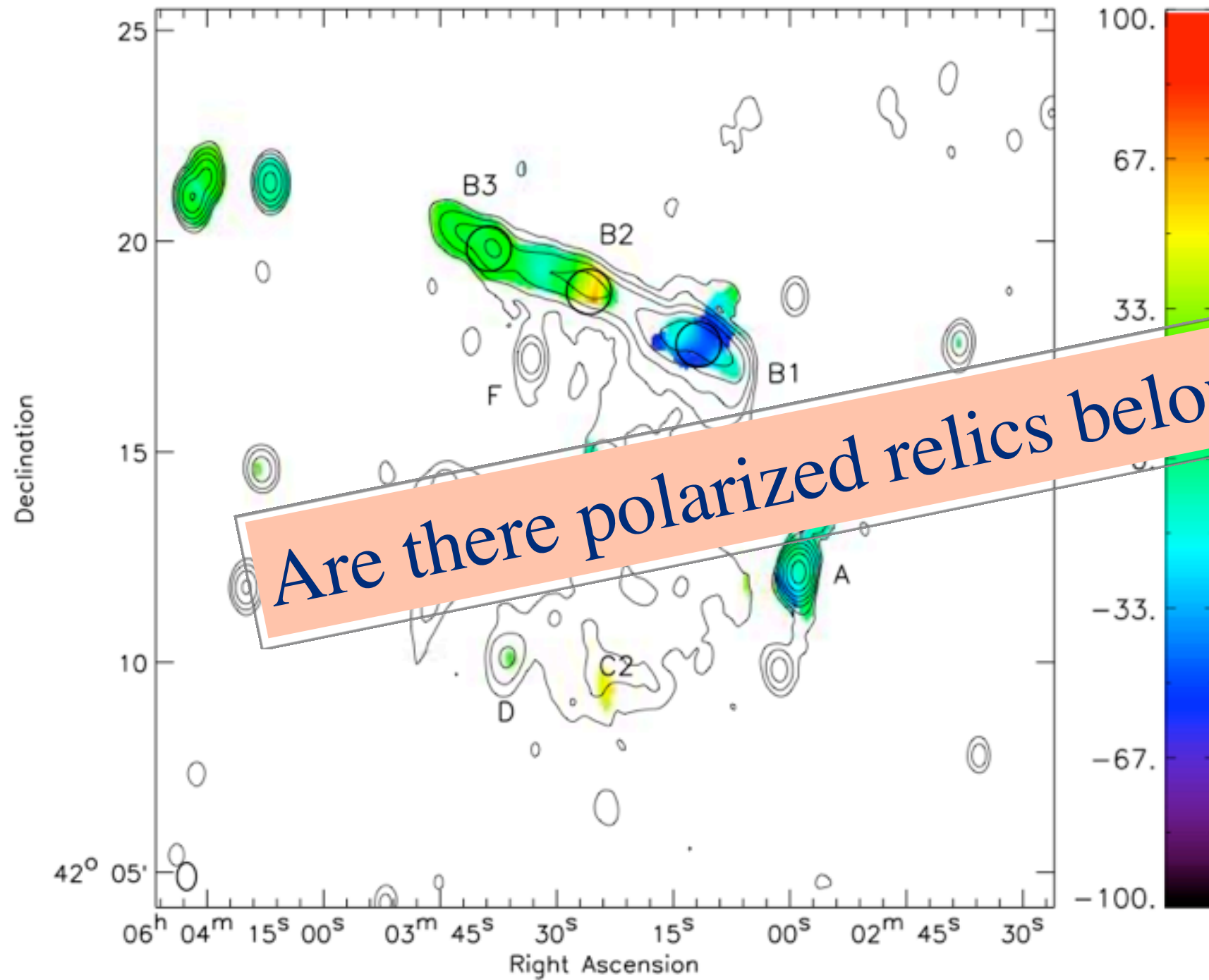
van Weeren, et al. 2012

# 'Toothbrush' results on Rotation Measure



$$\phi = 0.81 \frac{\text{rad m}^{-2}}{\text{cm}^{-3} \mu\text{G pc}} \times \int n_e B dr$$

# 'Toothbrush' results on Rotation Measure



Are there polarized relics below 1GHz ?

$$\phi = 0.81 \frac{\text{rad m}^{-2}}{\text{cm}^{-3} \mu\text{G pc}} \times \int n_e B dr$$



# WSRT 350 MHz Legacy Survey – Clusters

PIs: Uli Klein, Roberto Pizzo

- 19 clusters targets
- 3 nights 12h, 8 bands (each  $\sim 10$  MHz)
- polarization (X-Y feeds)
- calibrators before/after target

# WSRT 350 MHz Legacy Survey – Clusters

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- polarization (X-Y feeds)
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reduction pipeline ?

# Best data reduction software?

WSRT 350MHz

+

CASA

???

- user friendly
- easy(?) to program
- deals with XY feeds

# Main pipeline elements

flagging

- rficonsole

calibration

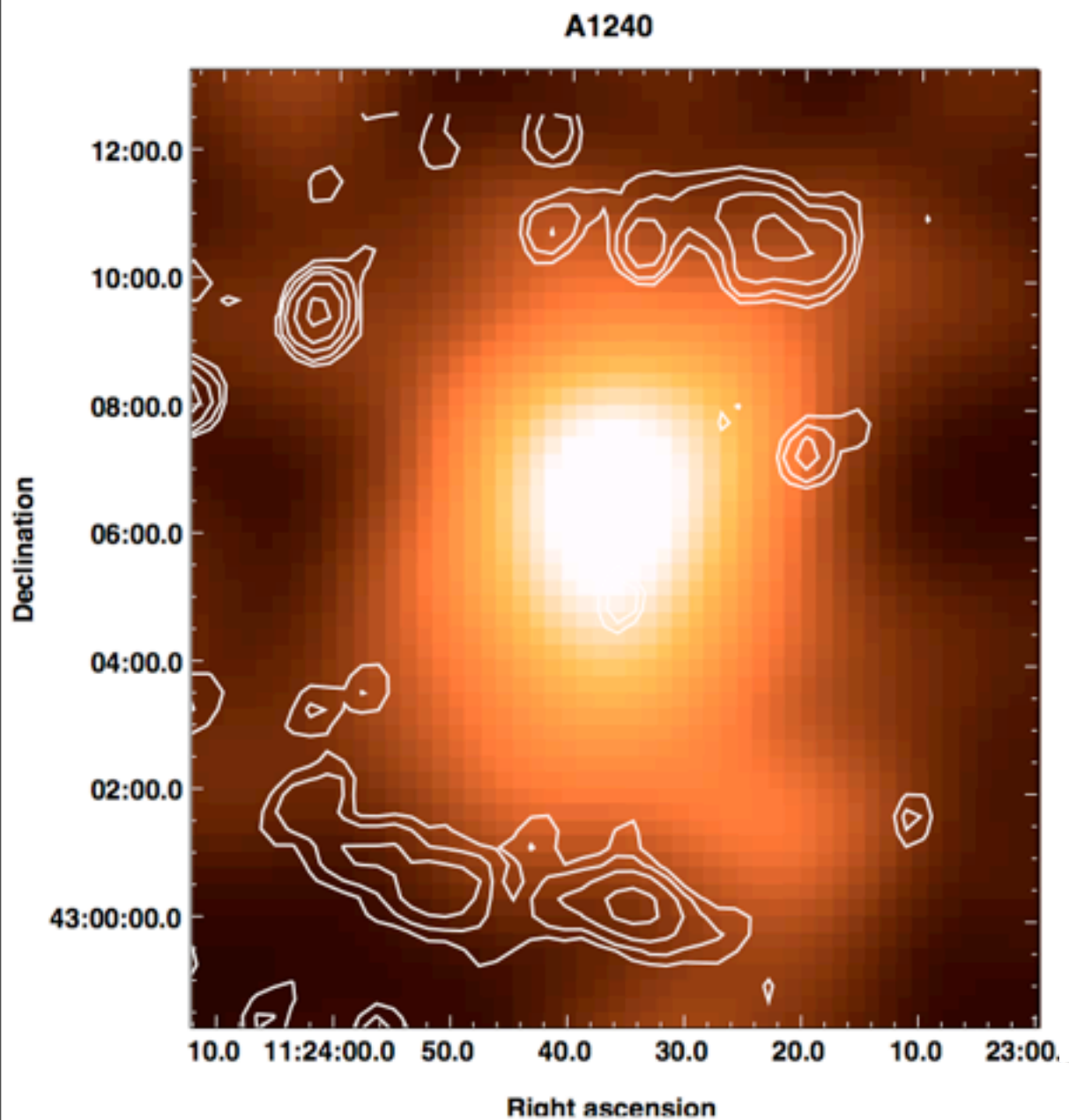
- Tsys
- bandpass/gain
- polcal (leakage, XY phase)

selfcal

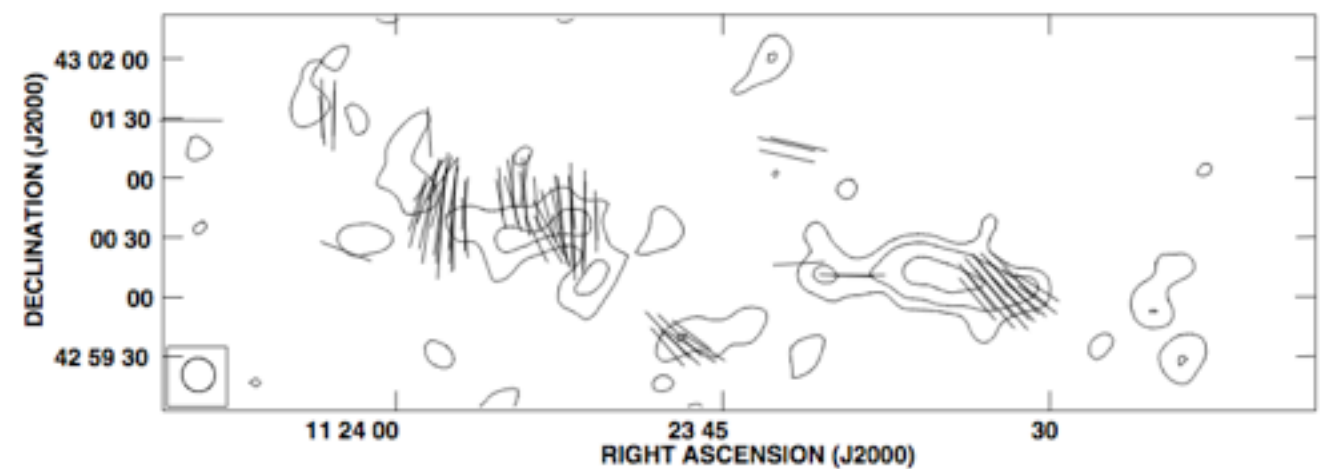
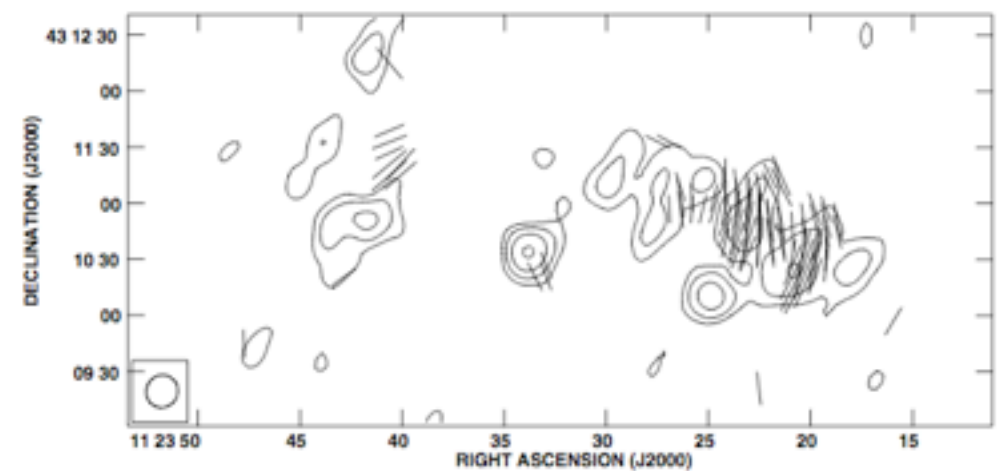
- phase
- amplitude

RM synthesis

# Here: results for A1240



VLA 1.4 GHz



Bonafede et al. 2009



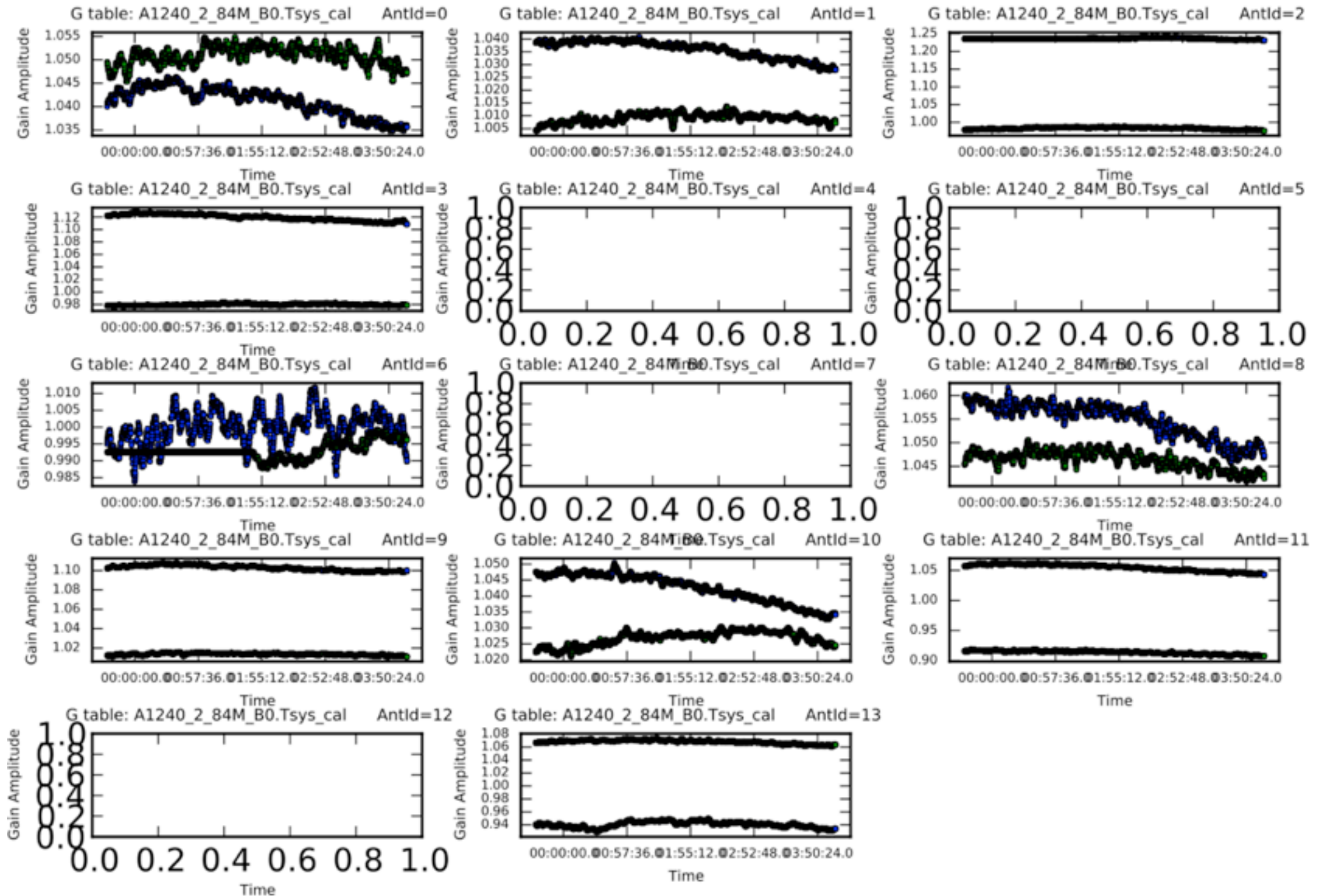
Matthias Hoeft

MKSP Meeting 2013

Sant'Antioco, Sardinia

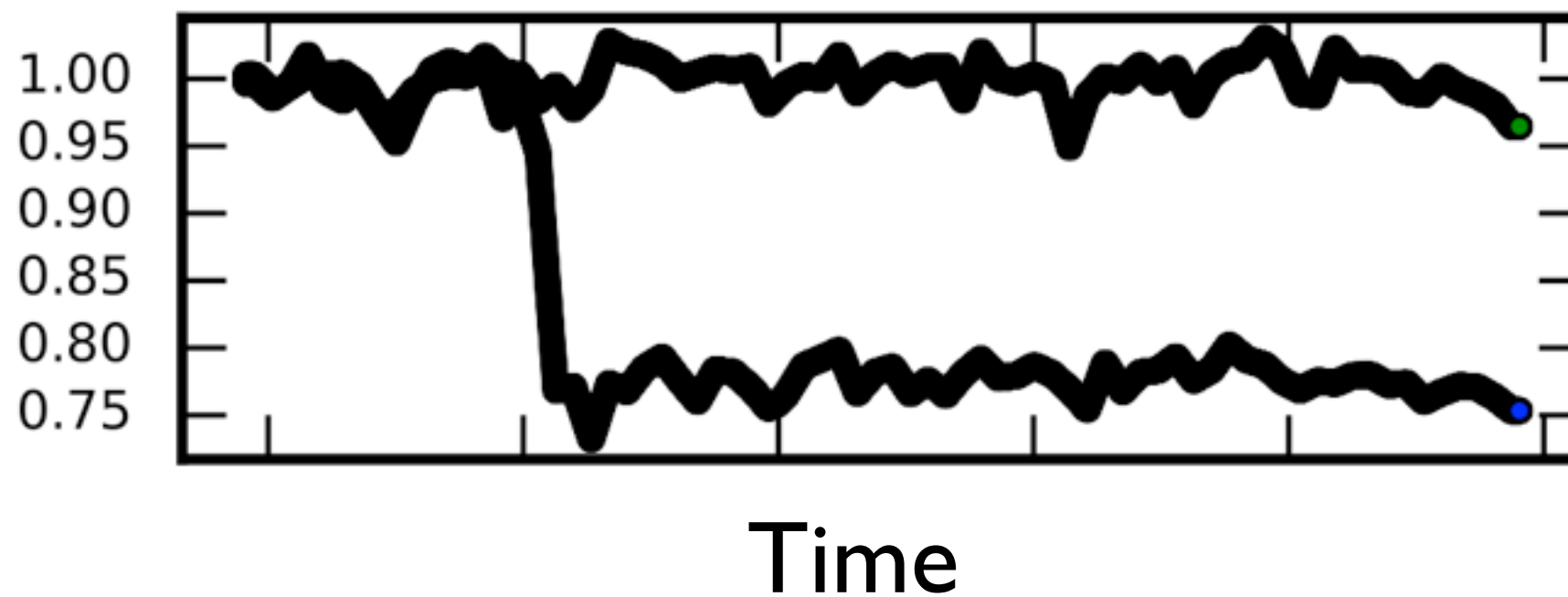


# TP Calibration (i): System temperature



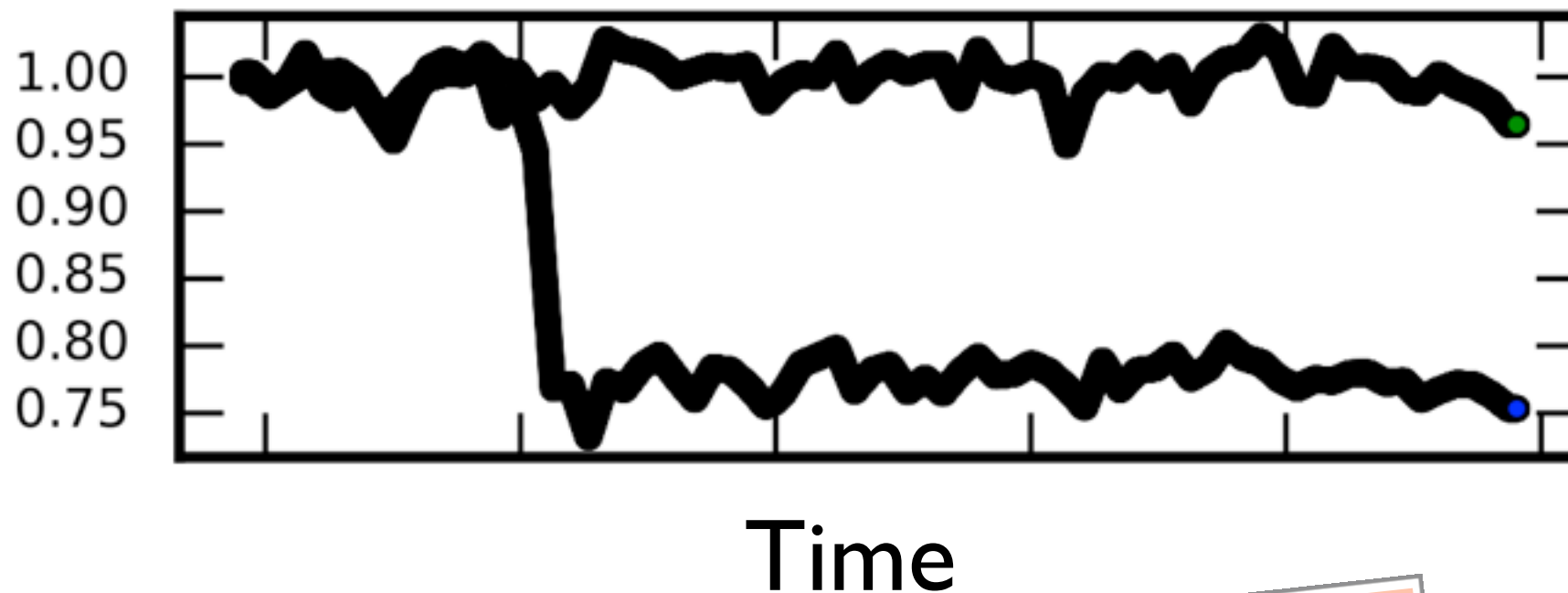
# TP Calibration (ii): Sudden changes in gain

antenna 0,  $T_{\text{sys}}$  cal applied, after selfcal



# TP Calibration (ii): Sudden changes in gain

antenna 0, Tsys cal applied, after selfcal



selfcal on amplitude needed

# Just a reminder: Stokes and XY feeds

•  $XX, YY \leftrightarrow I, Q$        $XY, YX \leftrightarrow U, V$

$$V^{XX} = I + Q$$

$$V^{XY} = U + iV$$

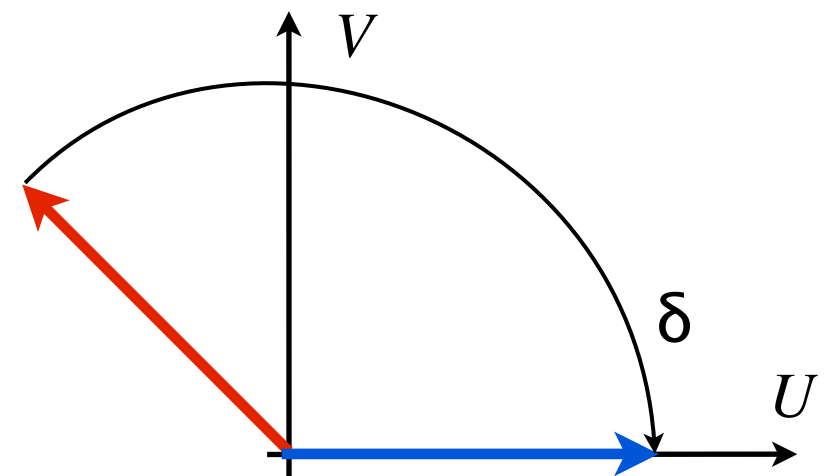
$$V^{YX} = U - iV$$

$$V^{YY} = I - Q$$

(point source in phase center)

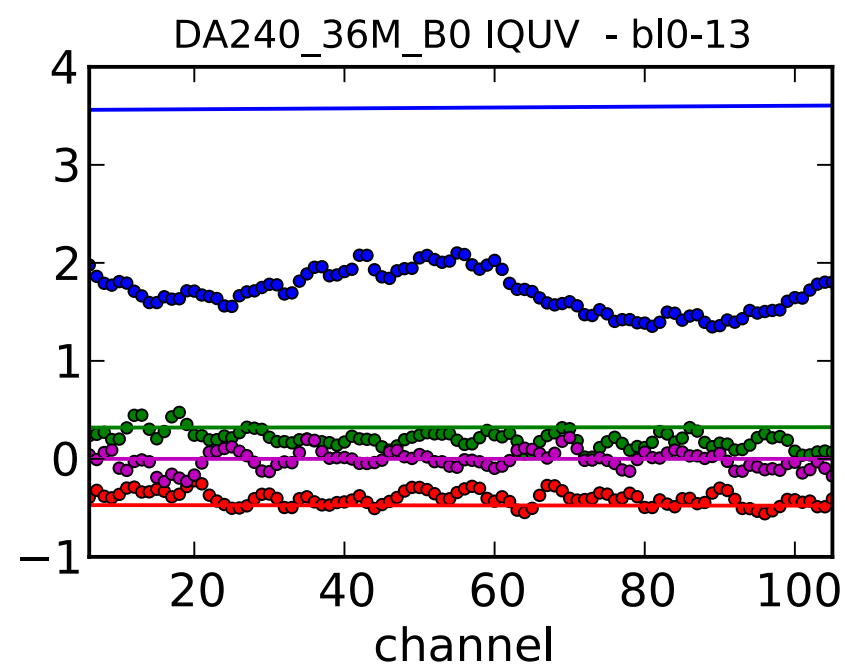
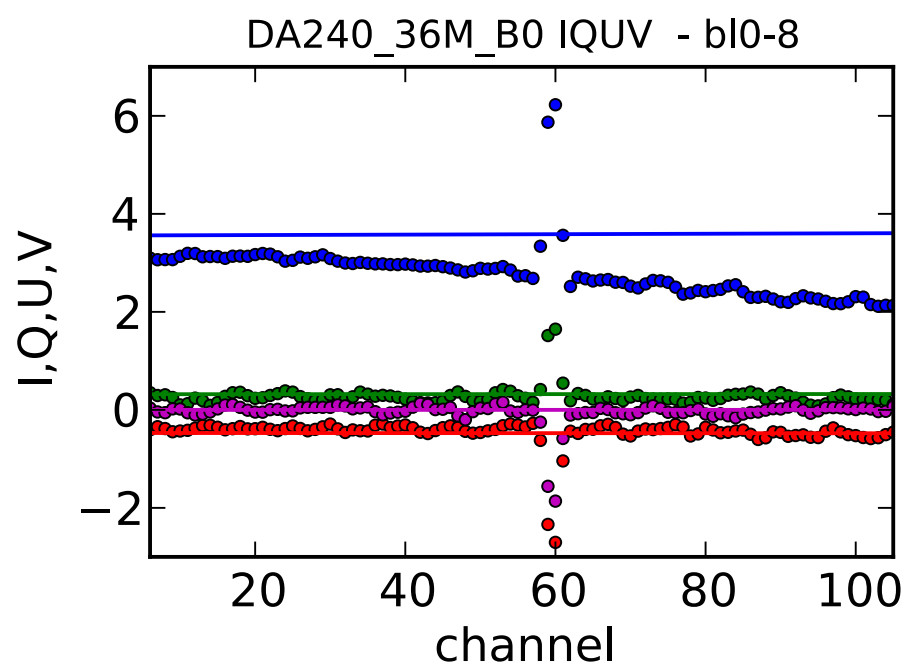
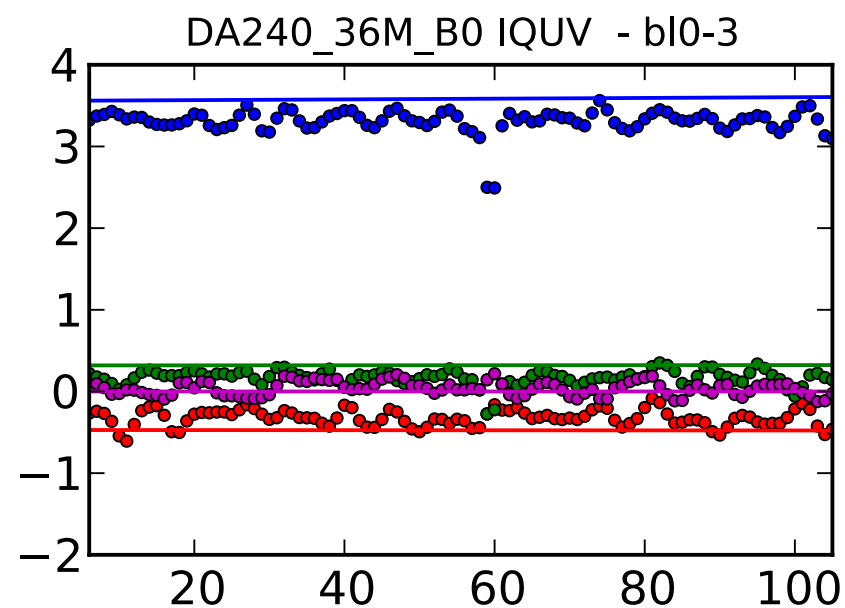
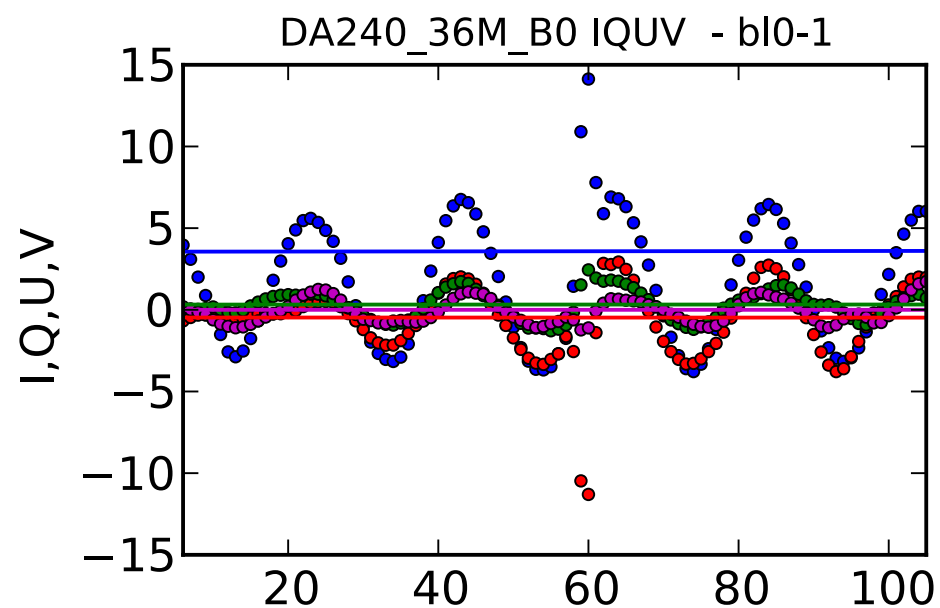
• **polcal: X-Y phase**

$$\tan \delta_{X-Y} = \frac{V}{U}$$



# Polarization calibration (i)

DA240: PA=122deg RM=3.6rad/m<sup>2</sup>



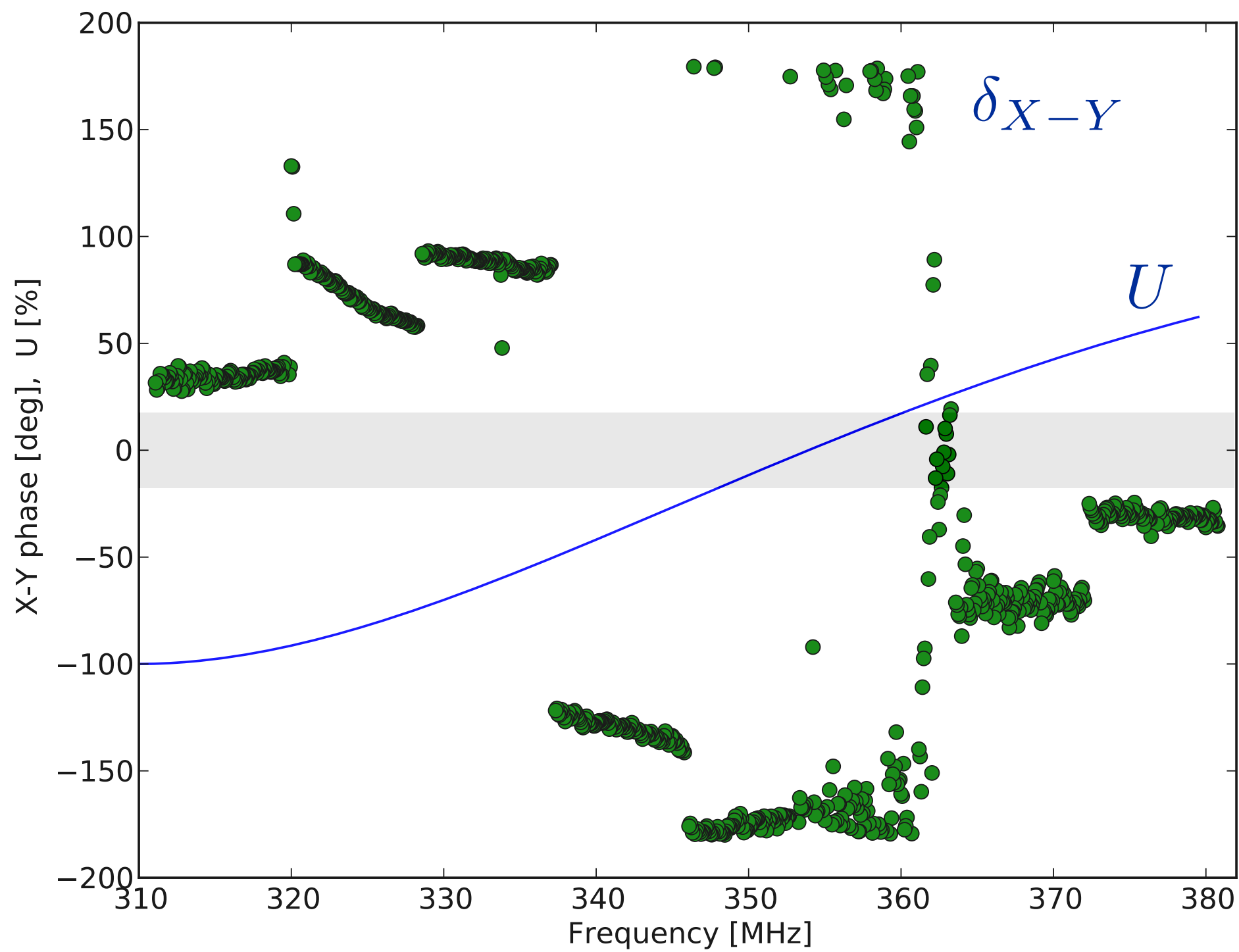
$I = \text{re}(XX+YY)/2$  blue    $Q = \text{re}(XX-YY)/2$  red    $U = \text{re}(XY+YX)/2$  green    $V = \text{im}(XY-YX)/2$  magenta





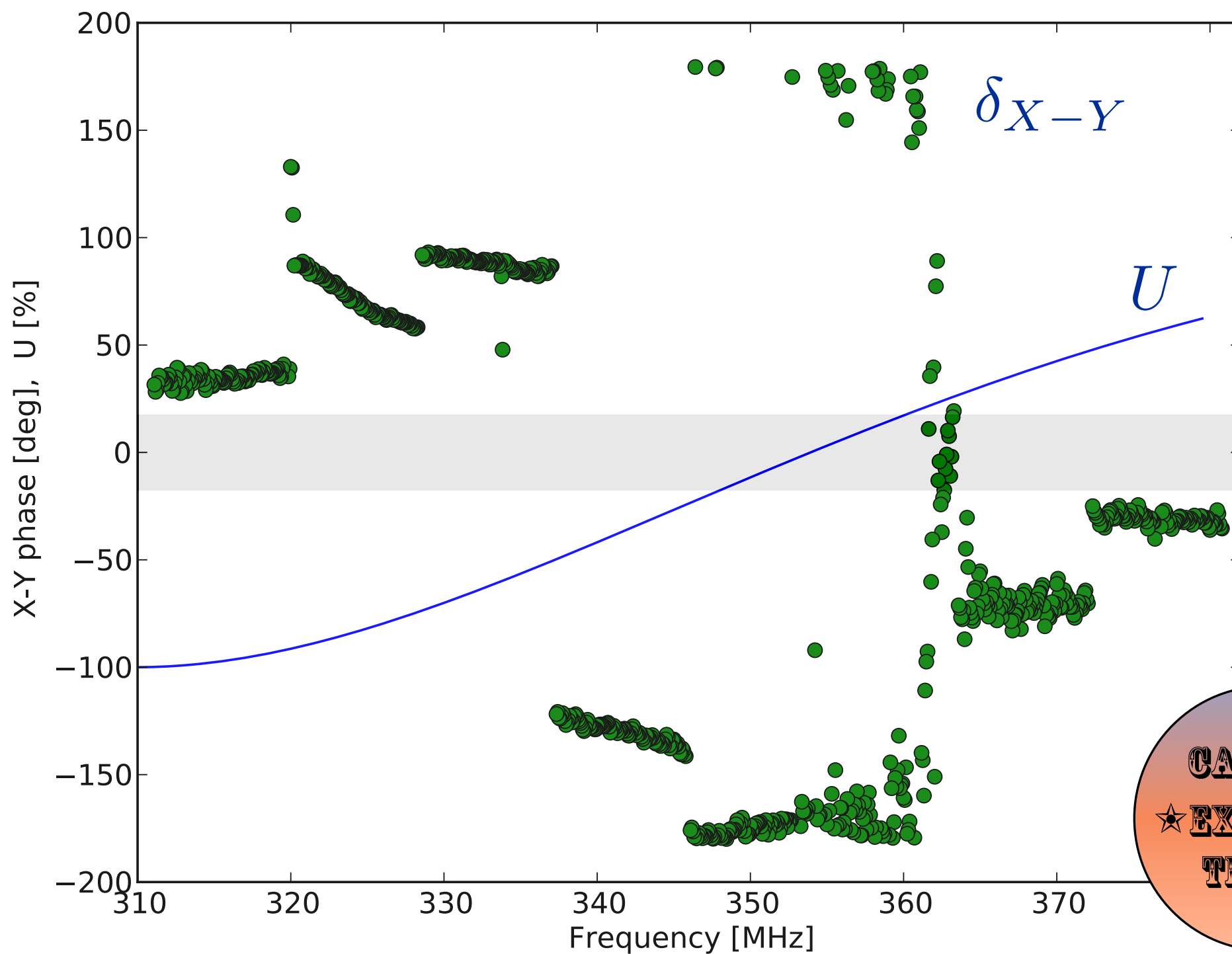
# Polarization calibration (ii): delta X-Y

DA240: PA=122deg RM=3.6rad/m<sup>2</sup>



# Polarization calibration (ii): delta X-Y

DA240: PA=122deg RM=3.6rad/m<sup>2</sup>



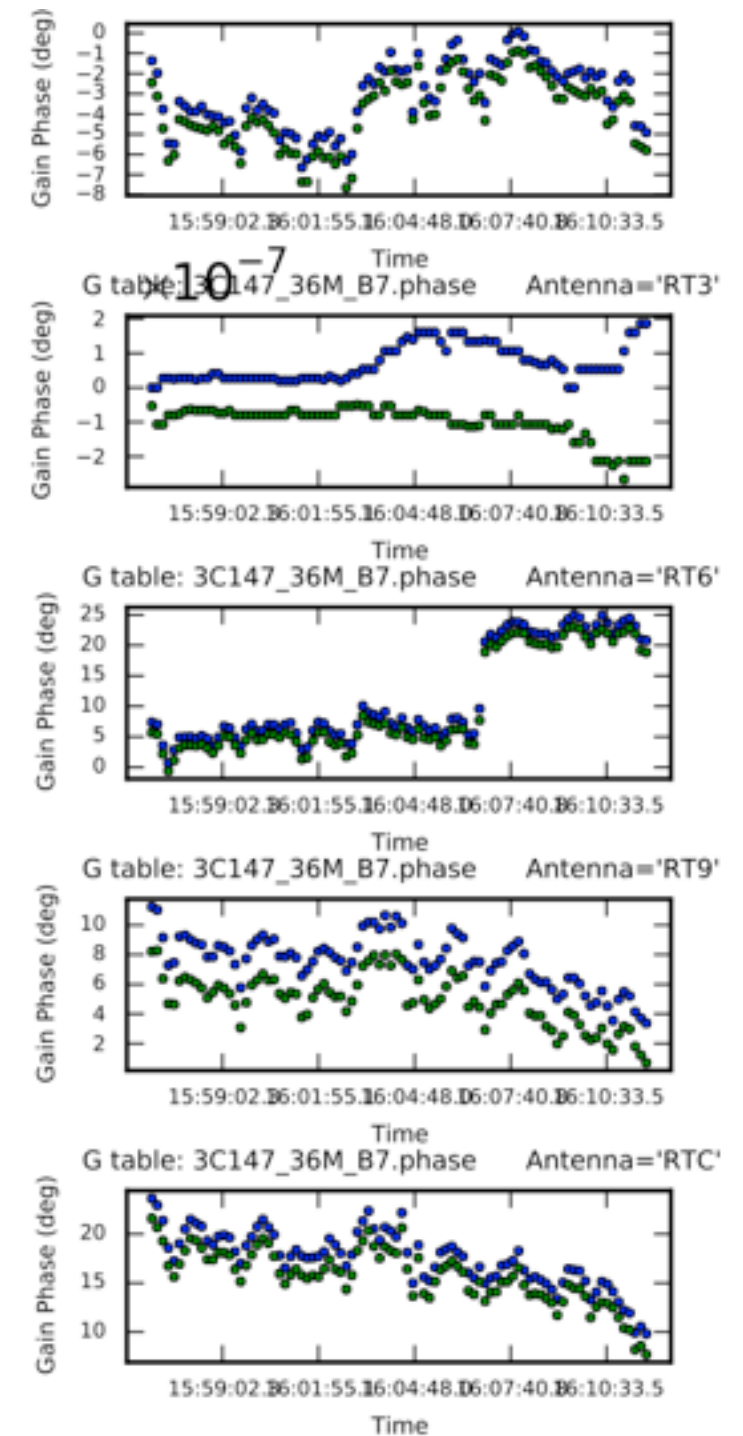
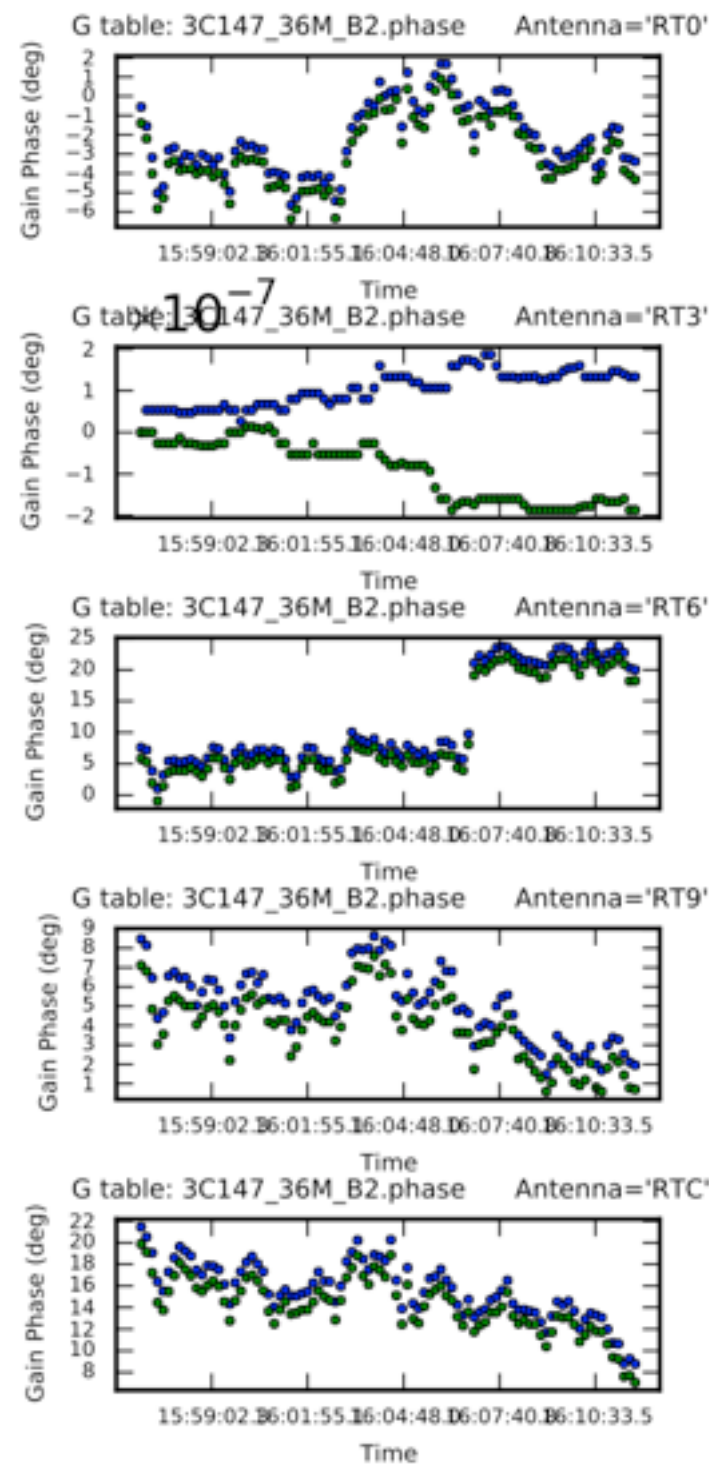
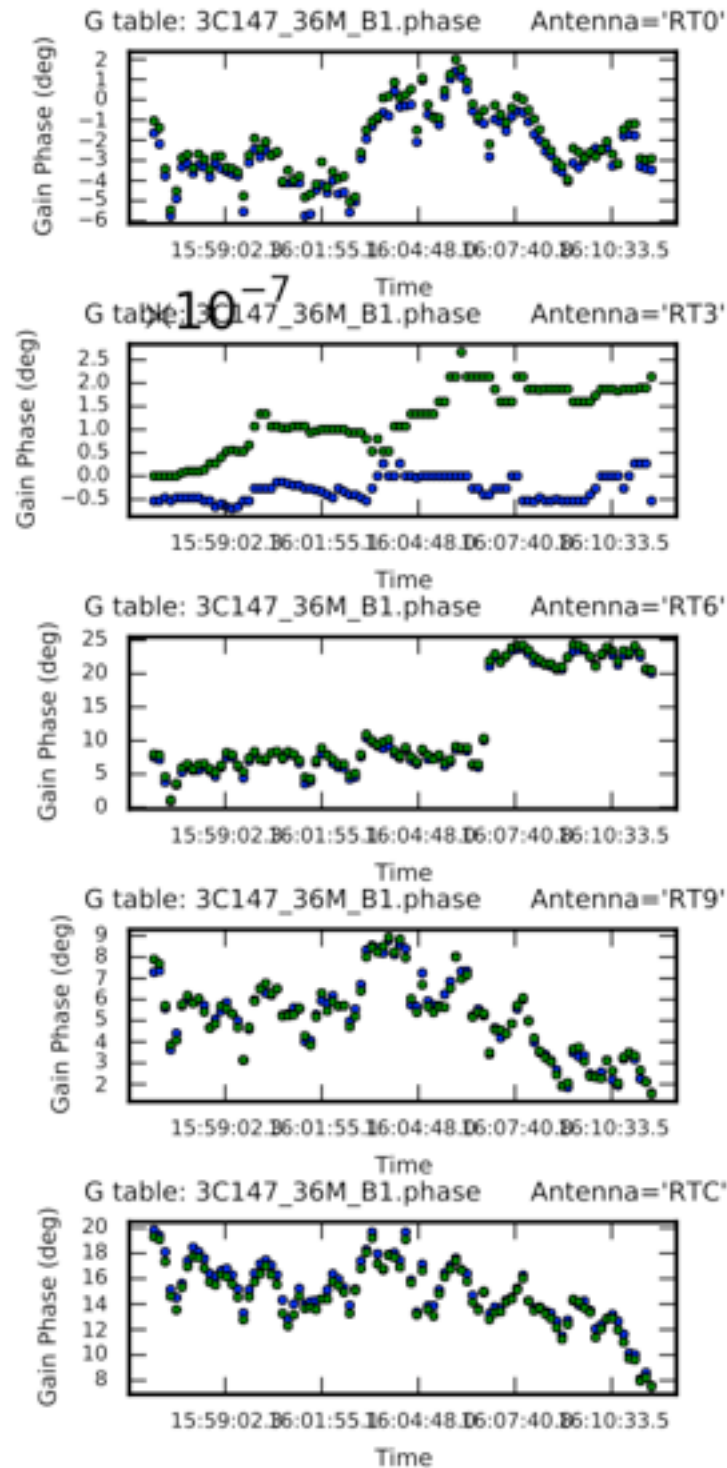
**CAN YOU  
★ EXPLAIN ★  
THAT ?**

# Polarization calibration (ii): delta X-Y (cont.)

## B1

## B2

## B7



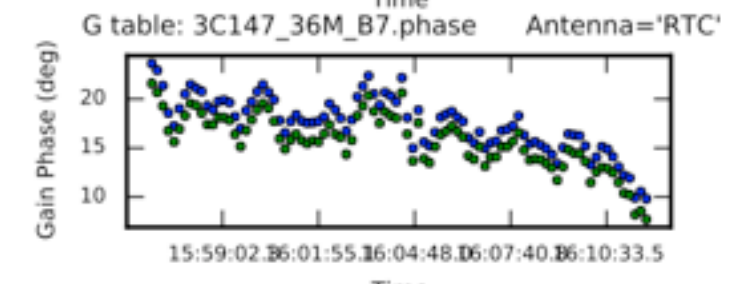
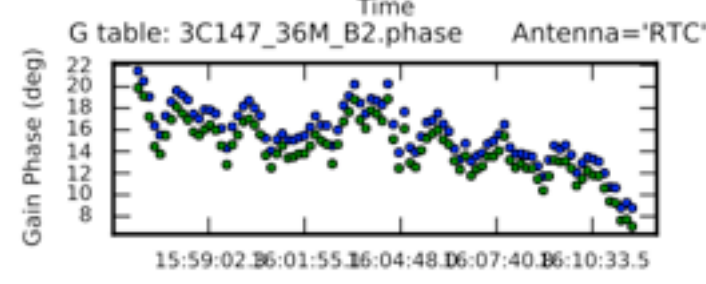
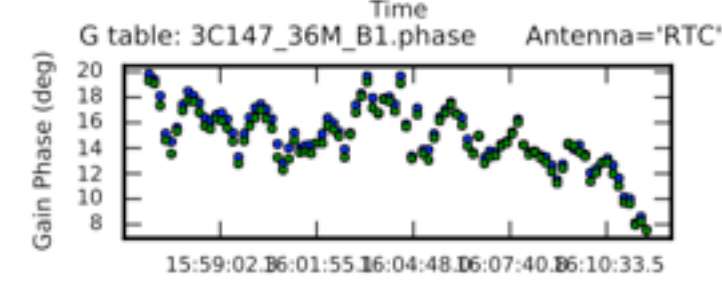
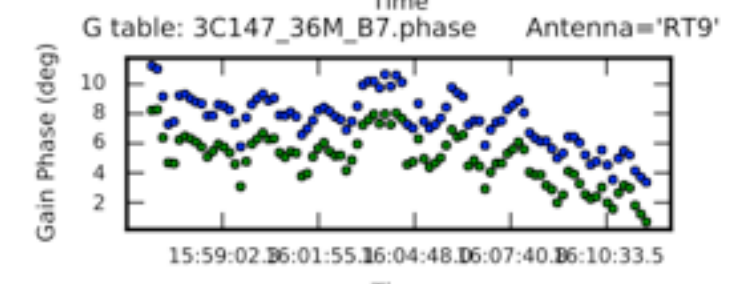
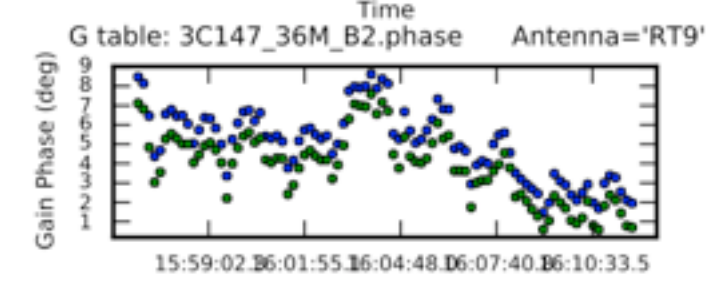
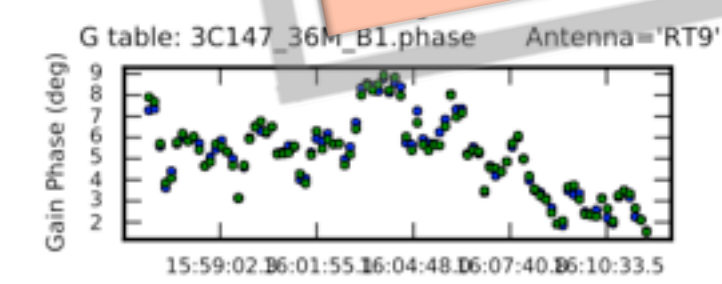
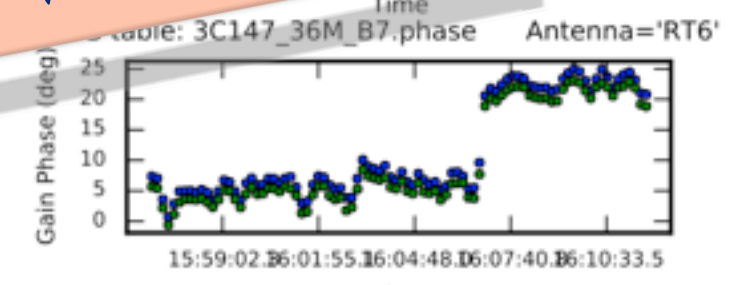
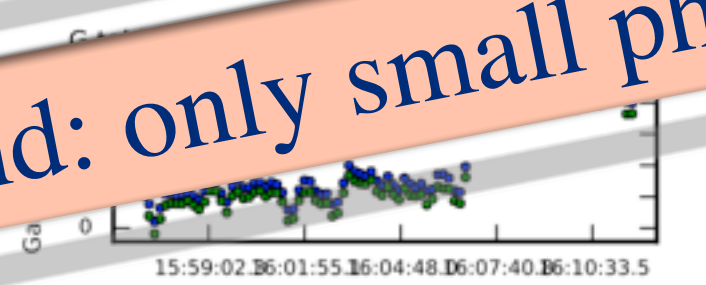
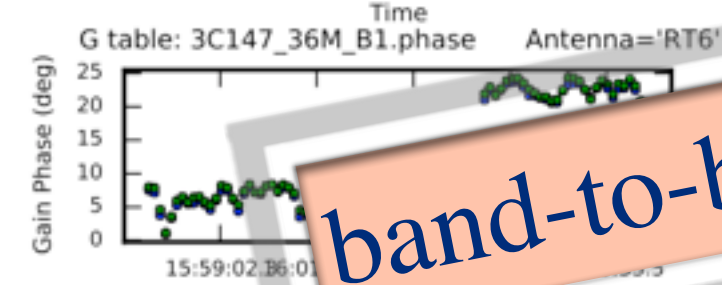
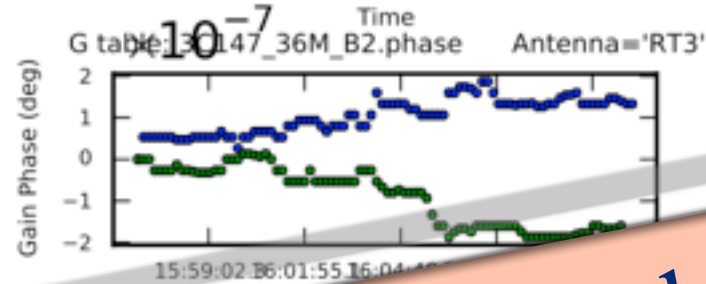
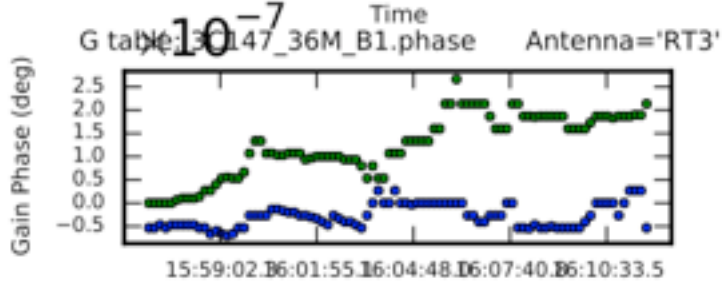
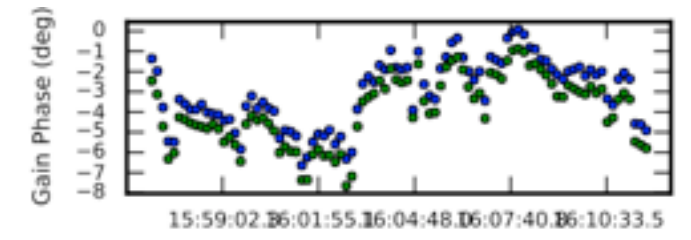
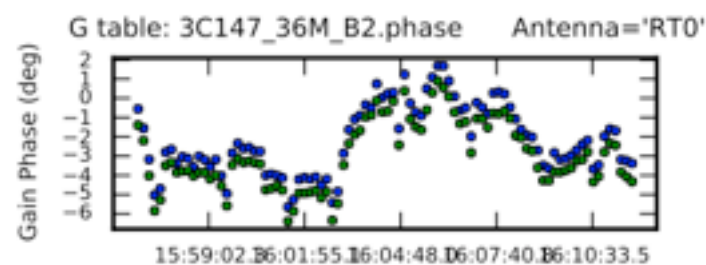
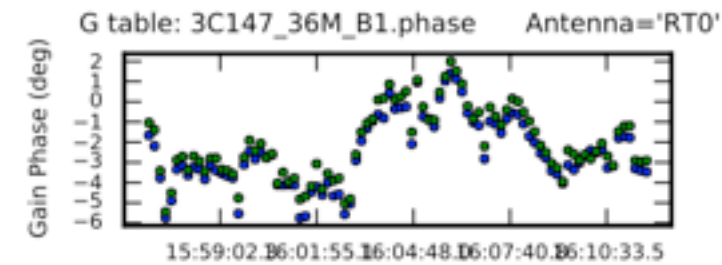


# Polarization calibration (ii): delta X-Y (cont.)

## B1

## B2

## B7



band-to-band: only small phase variations



# Polarization calibration (ii): delta X-Y (cont.)

**Faraday rotation?**

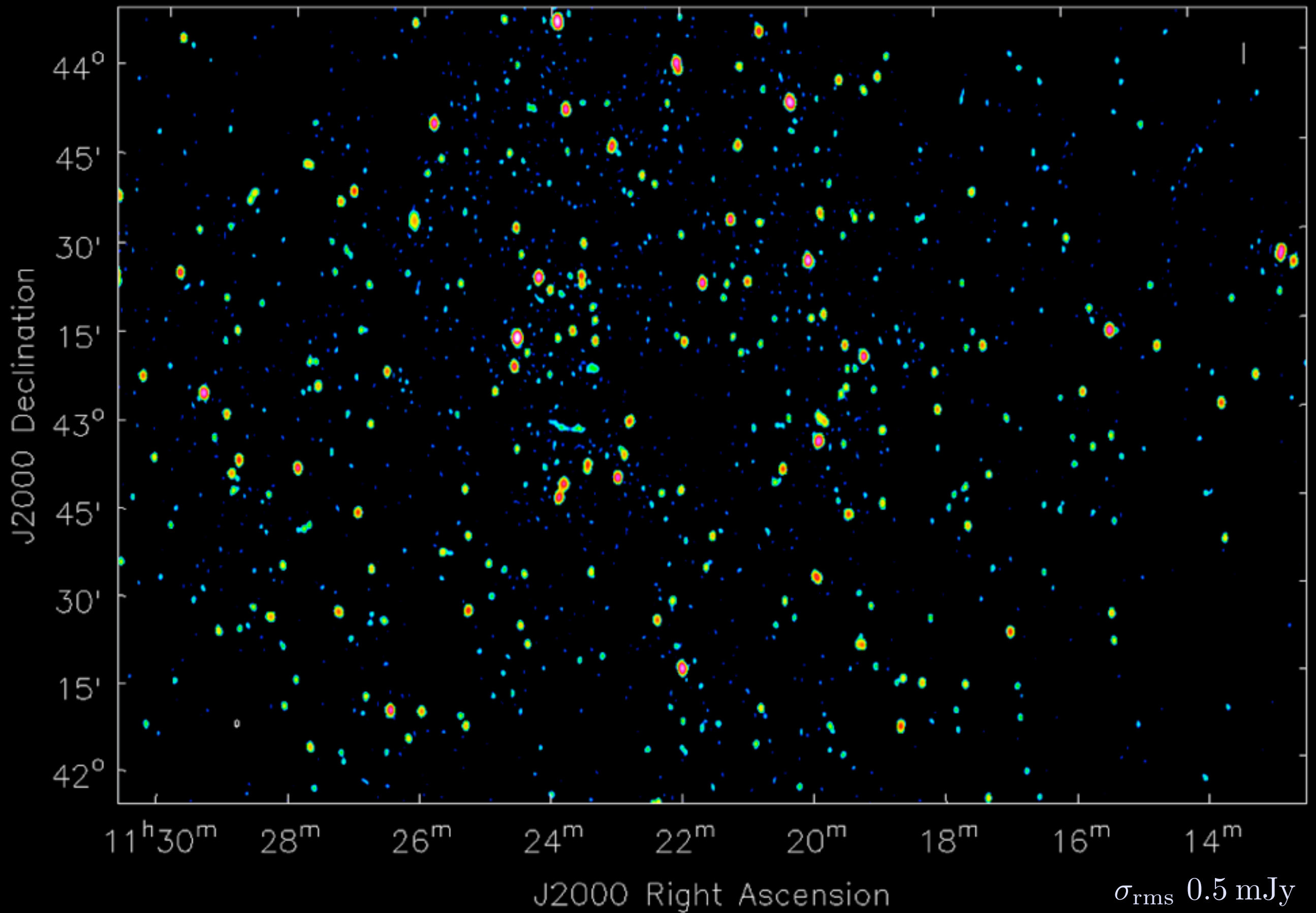


# Polarization calibration (ii): delta X-Y (cont.)

## Faraday rotation?

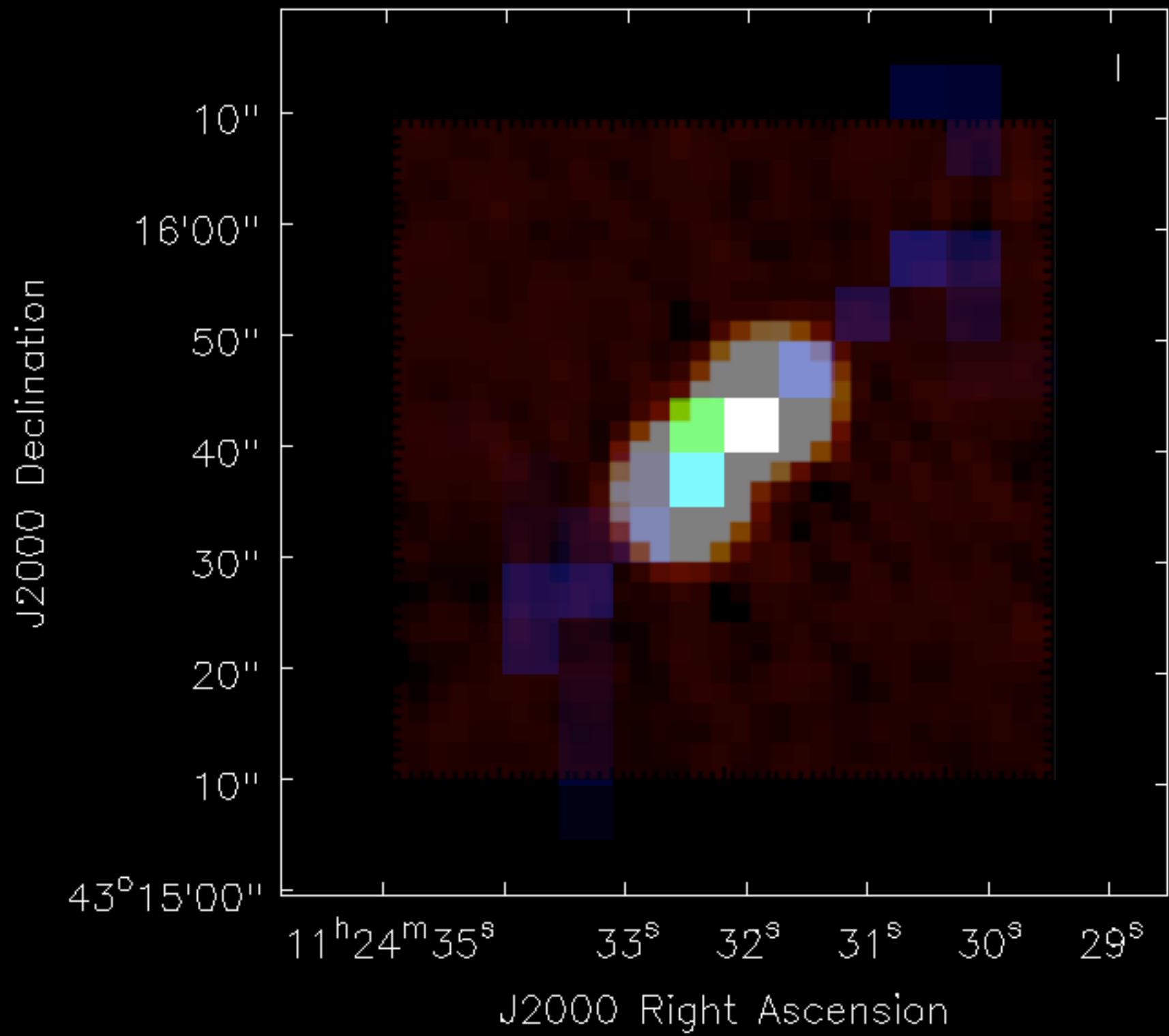
- not likely, since
- $\tan \delta_{X-Y} = V/U$
  - RM considered in model QU
  - jumps between bands

# A1240 Total power, B0

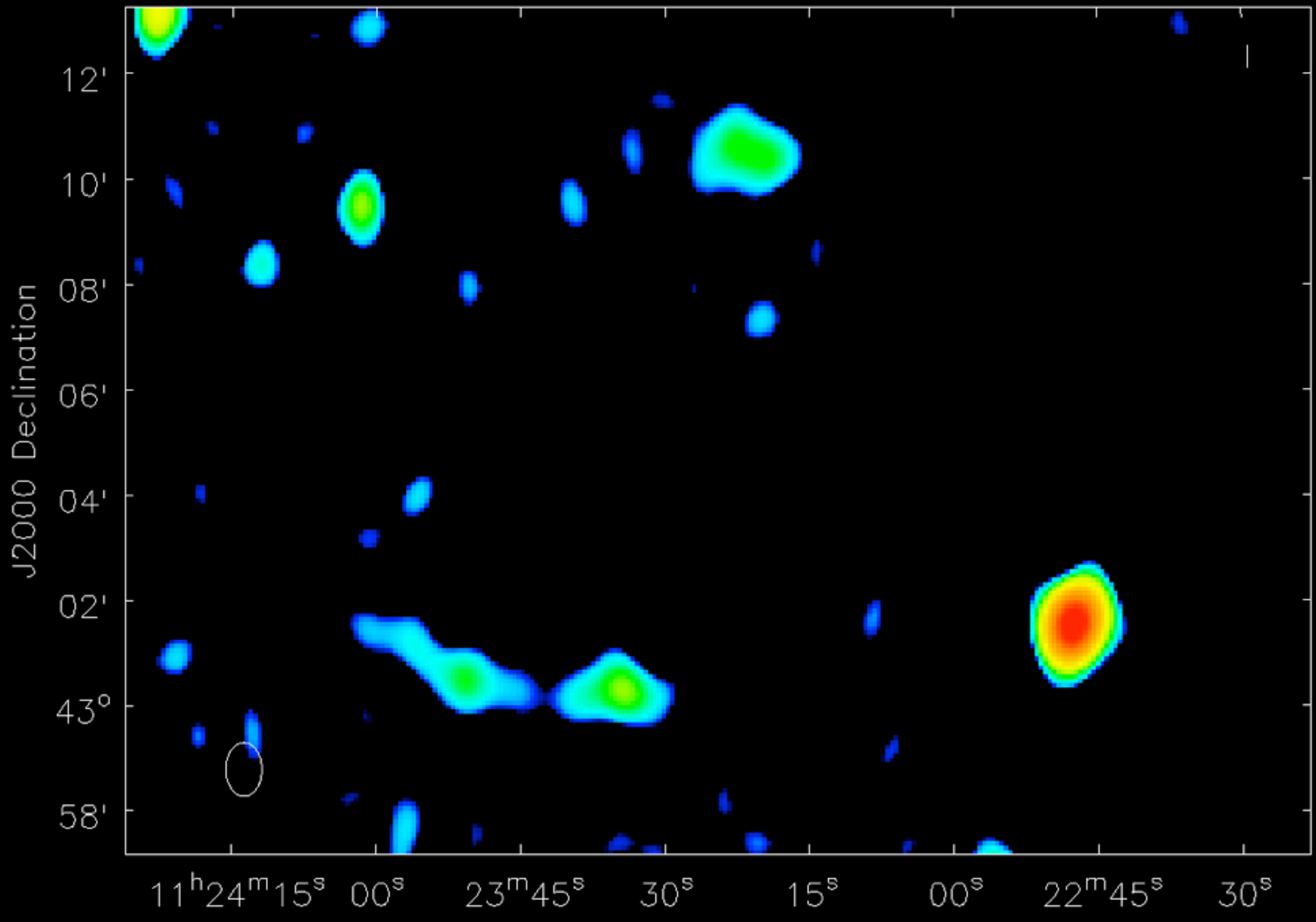




clean\_B0\_21.model



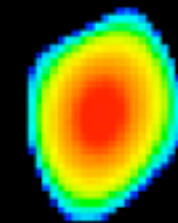
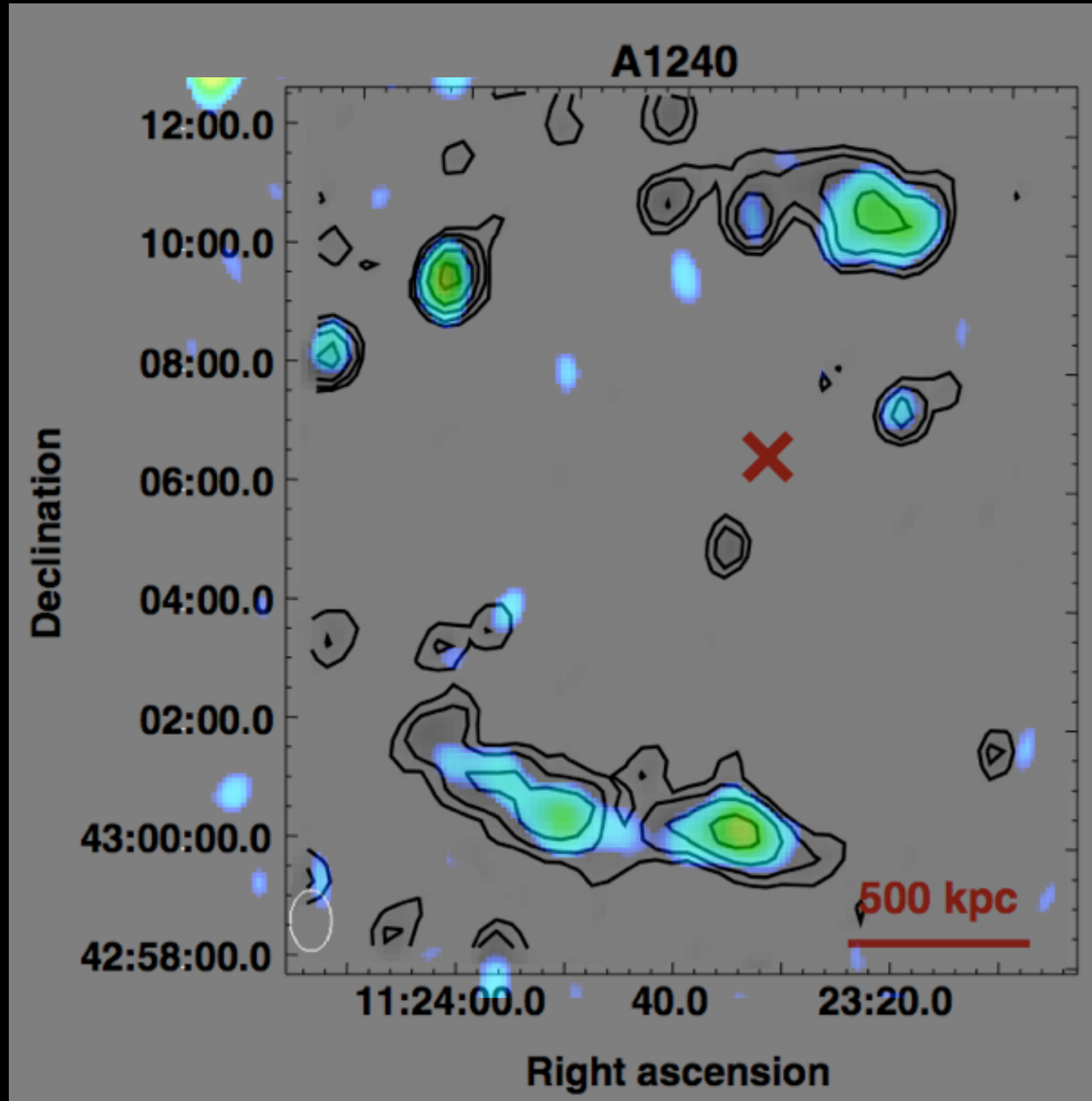
clean\_B0\_21.image





# Comparison to 1.4 GHz

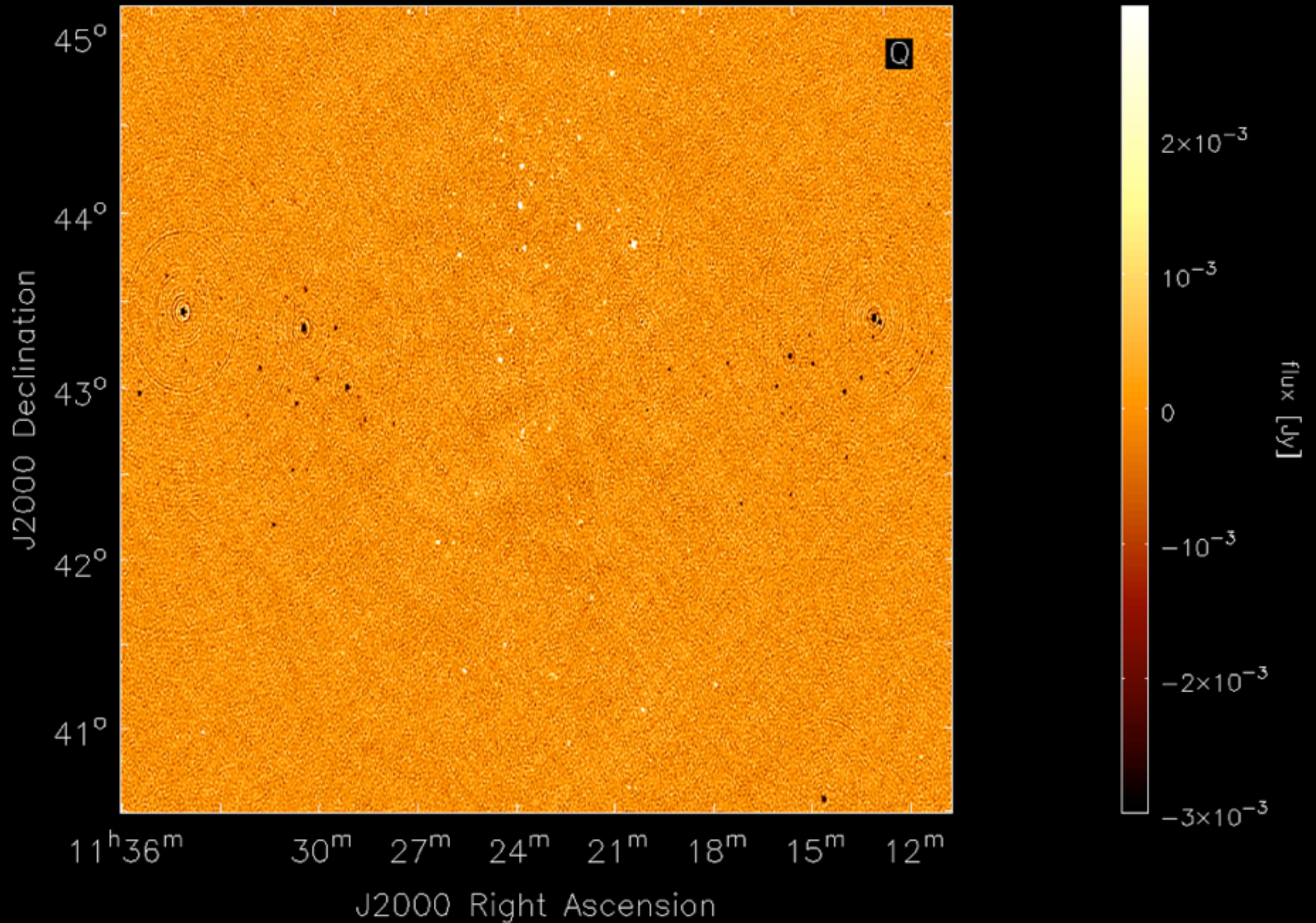
Bonafede et al. 2009





# Stokes Q for one band

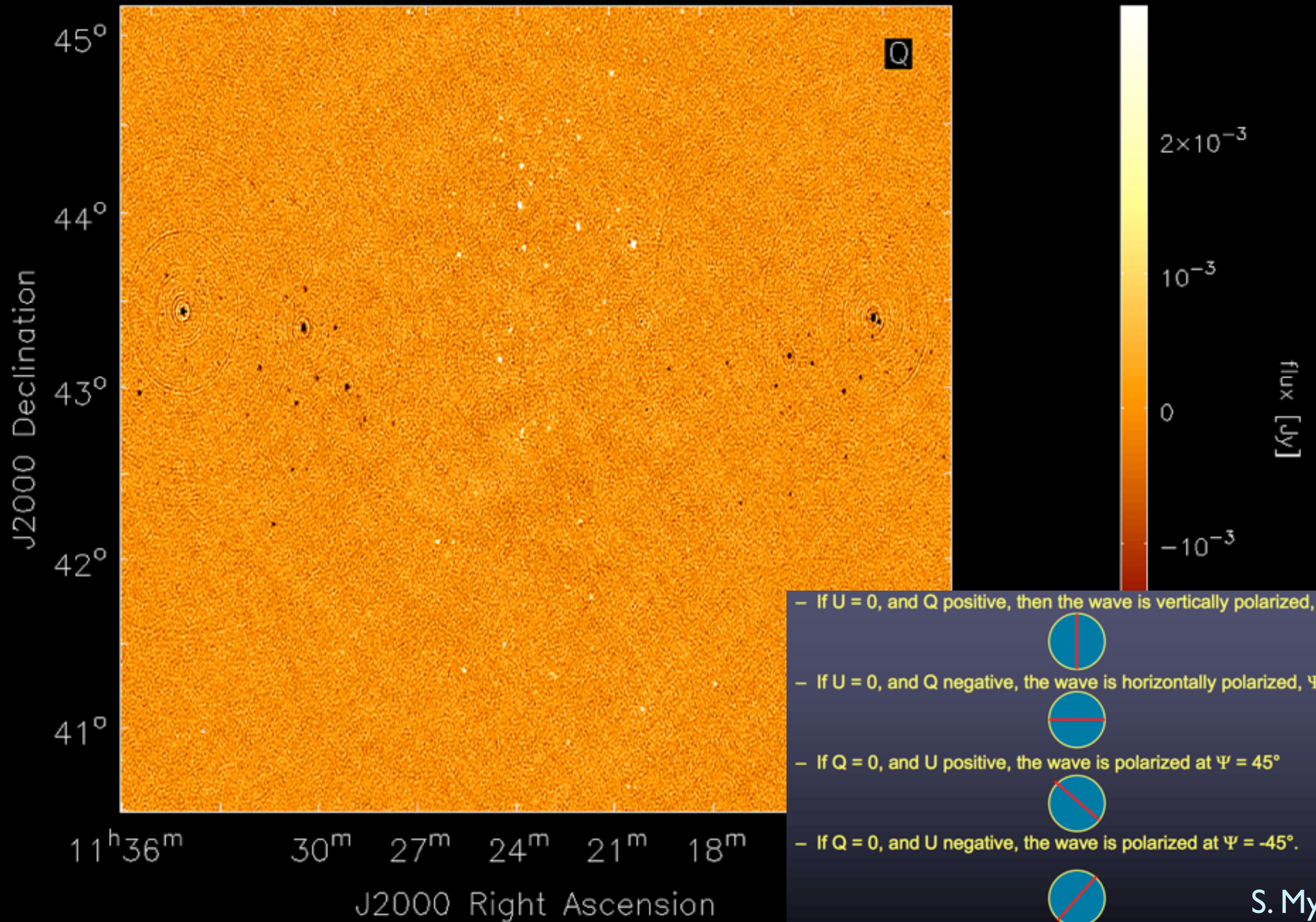
clean\_B0\_21.image





# Stokes Q for one band

clean\_B0\_21.image

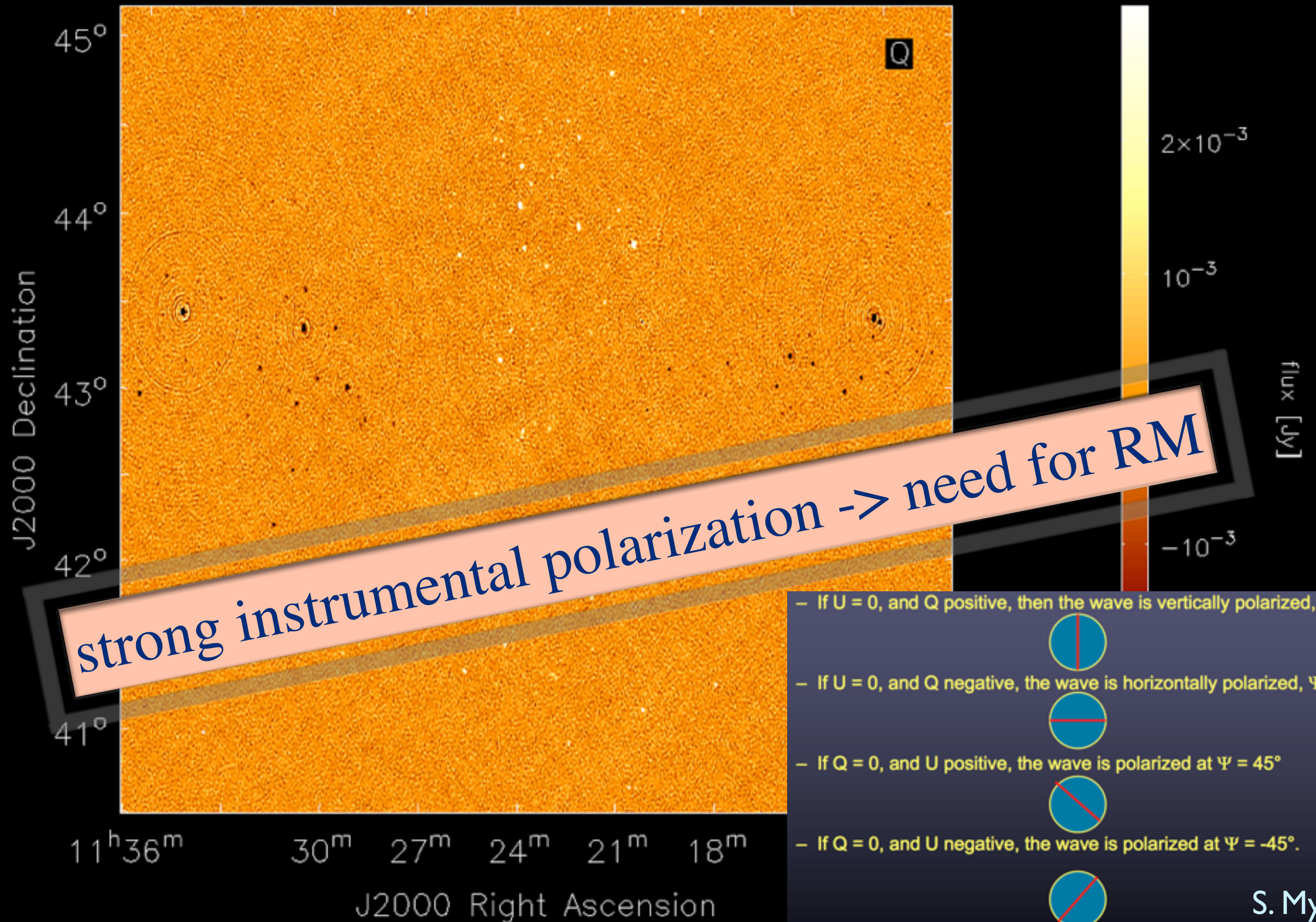


S. Myers



# Stokes Q for one band

clean\_B0\_21.image

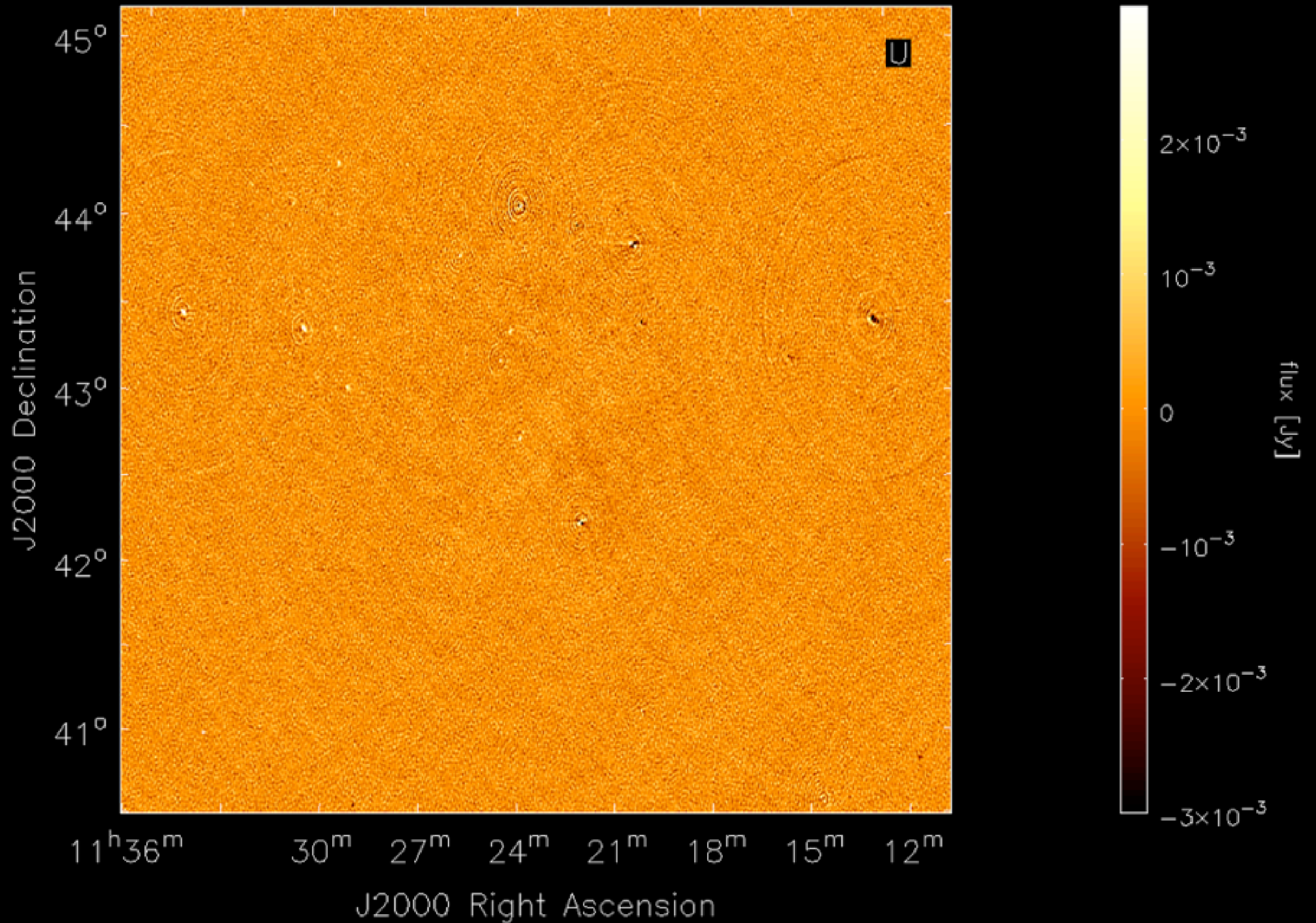


S. Myers



# Stokes U for one band

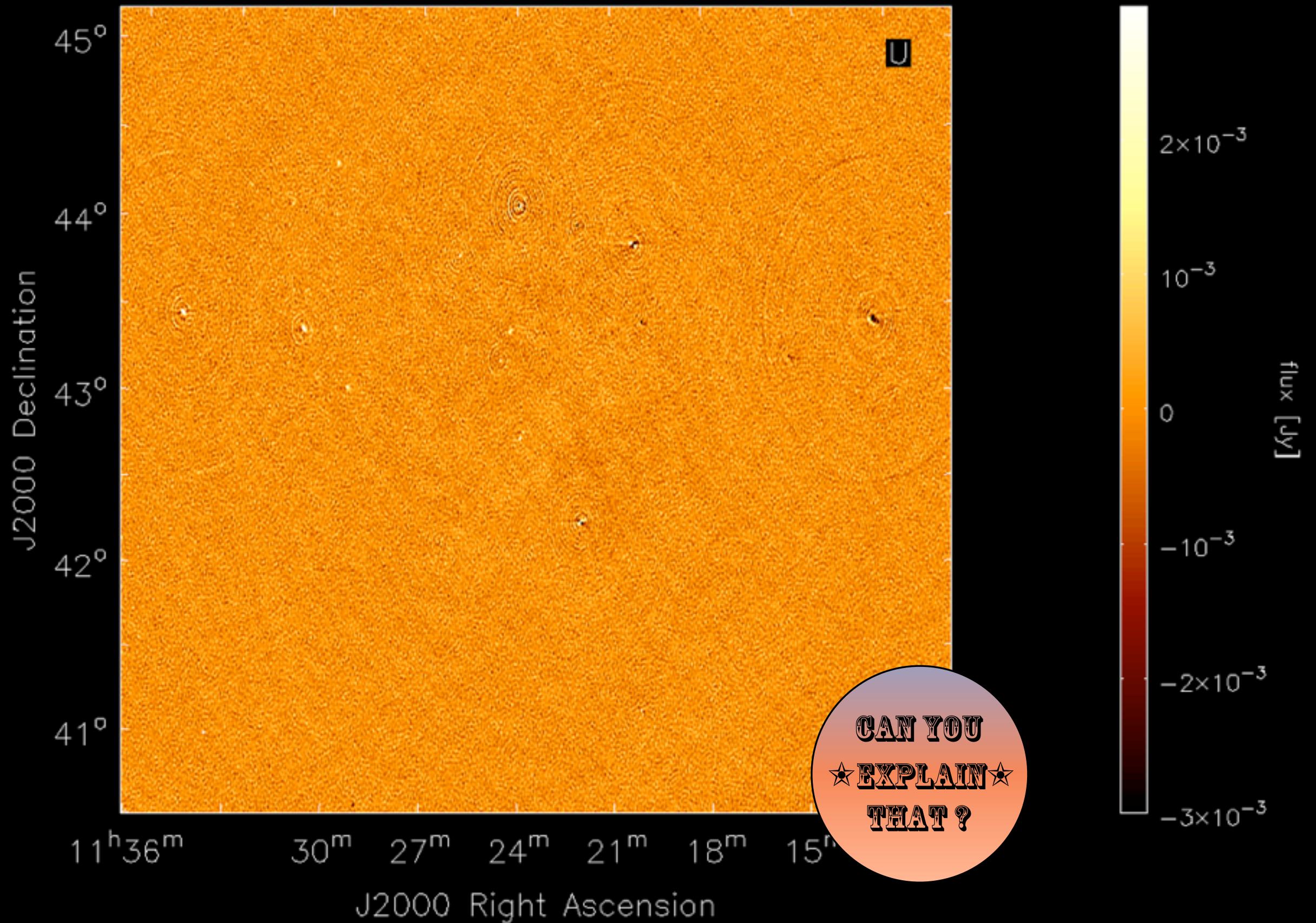
clean\_B0\_21.image





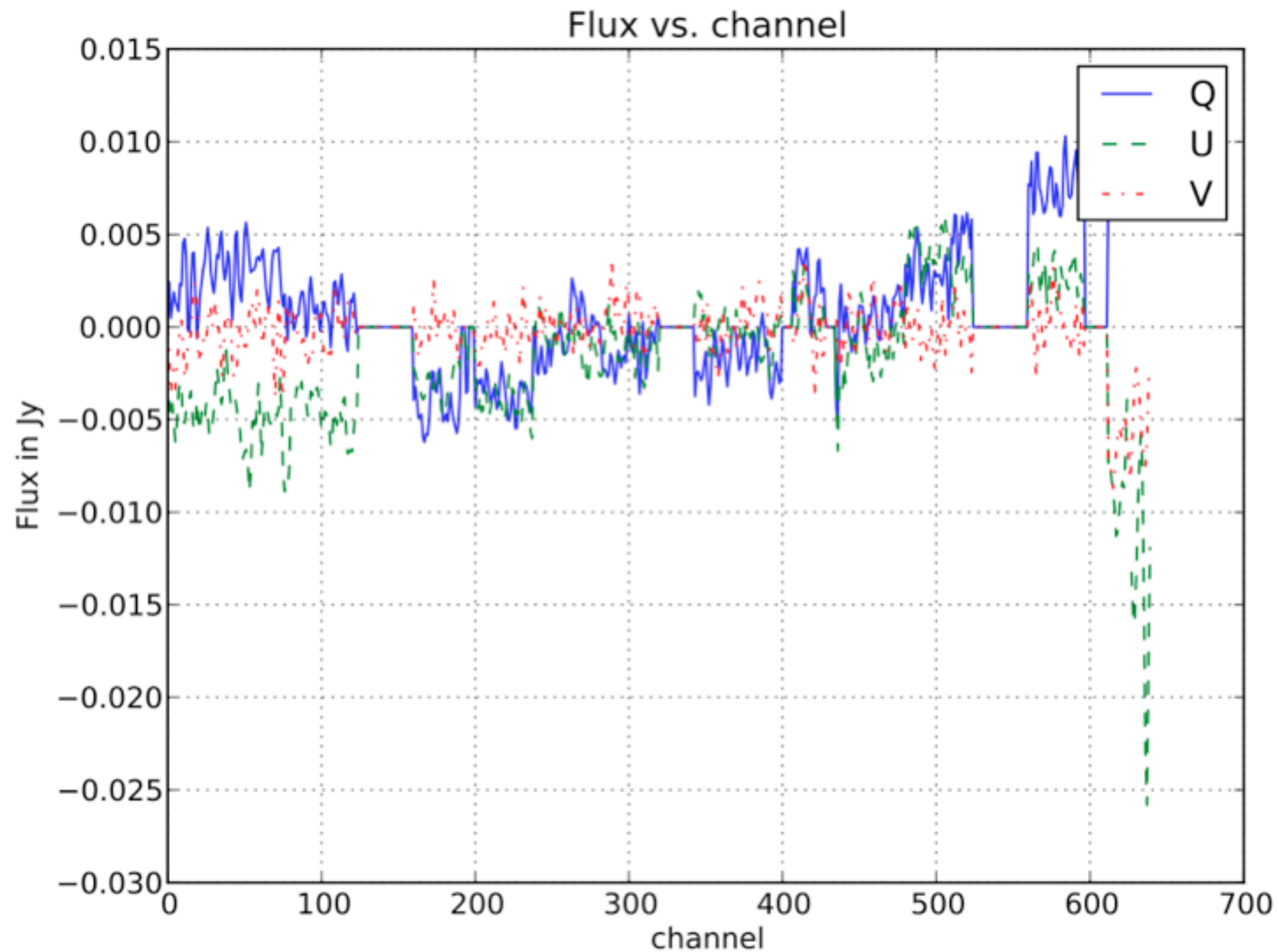
# Stokes U for one band

clean\_B0\_21.image

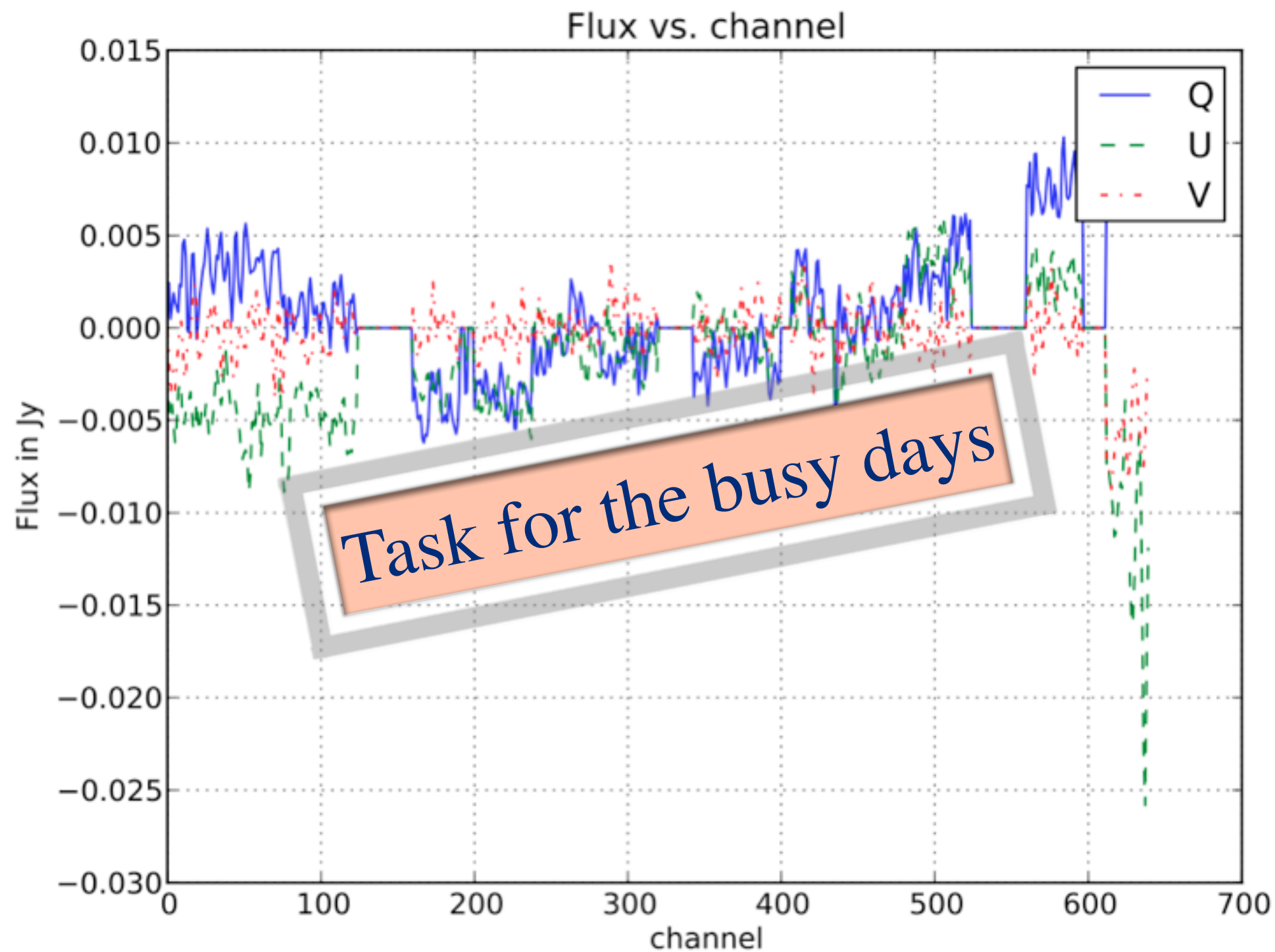




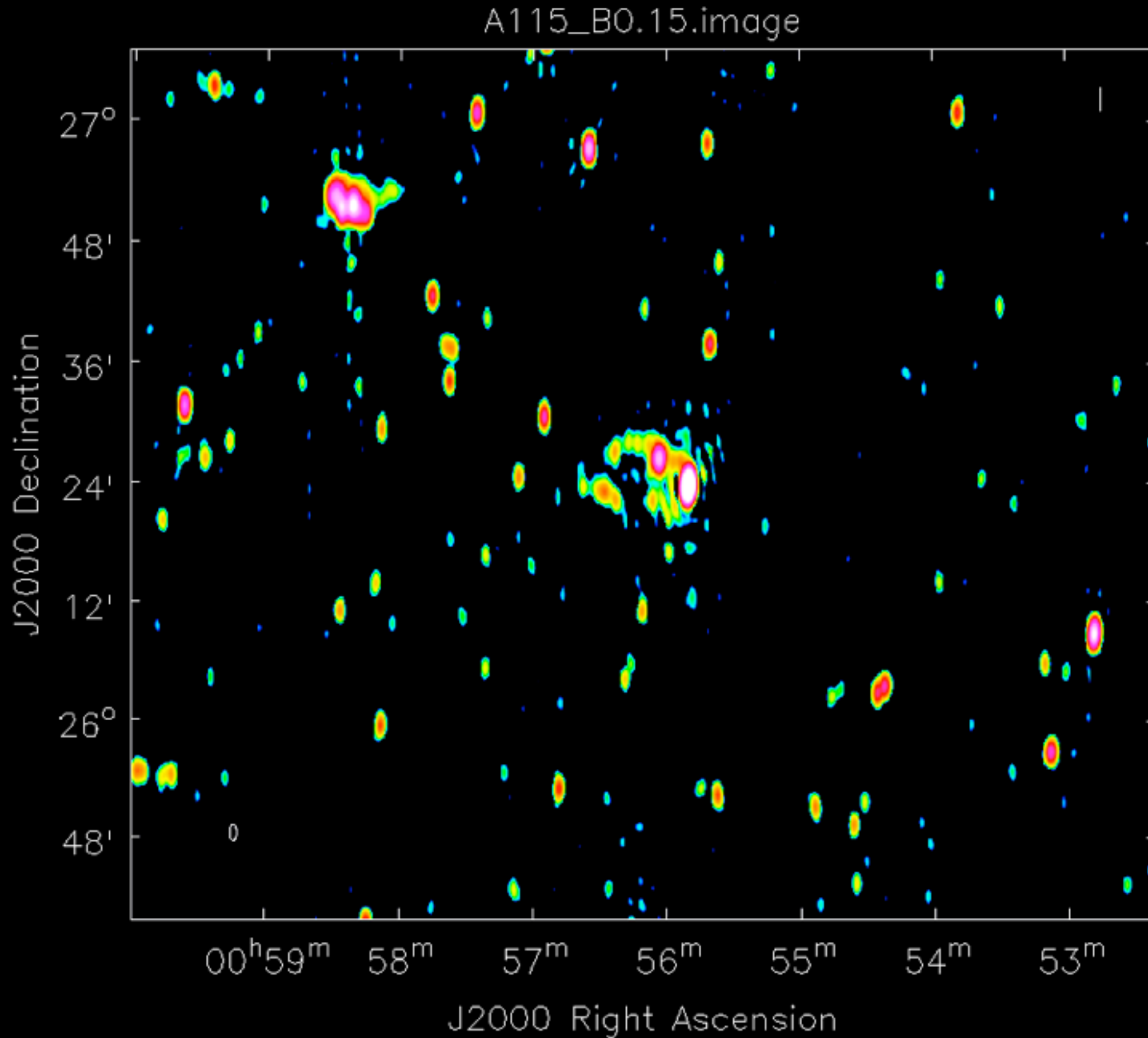
# Rotation Measure Synthesis



# Rotation Measure Synthesis

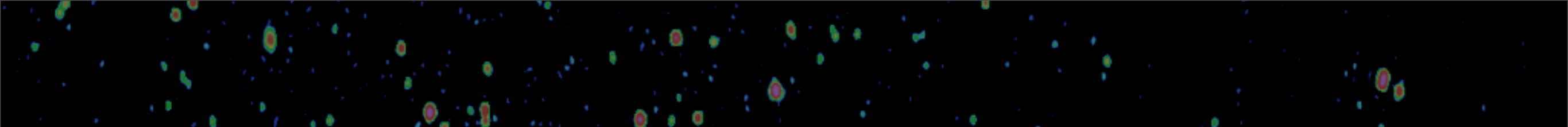


# Pipeline applied to another target (A115)



# Summary

- **WSRT 350MHz + CASA pipeline**
- **Polcal: seems to work, but not fully understood**
- **RM clearly needed**
- **A1240 relic spectral index confirmed**



**Matthias Hoefft**

**MKSP Meeting 2013**

**Sant'Antioco, Sardinia**