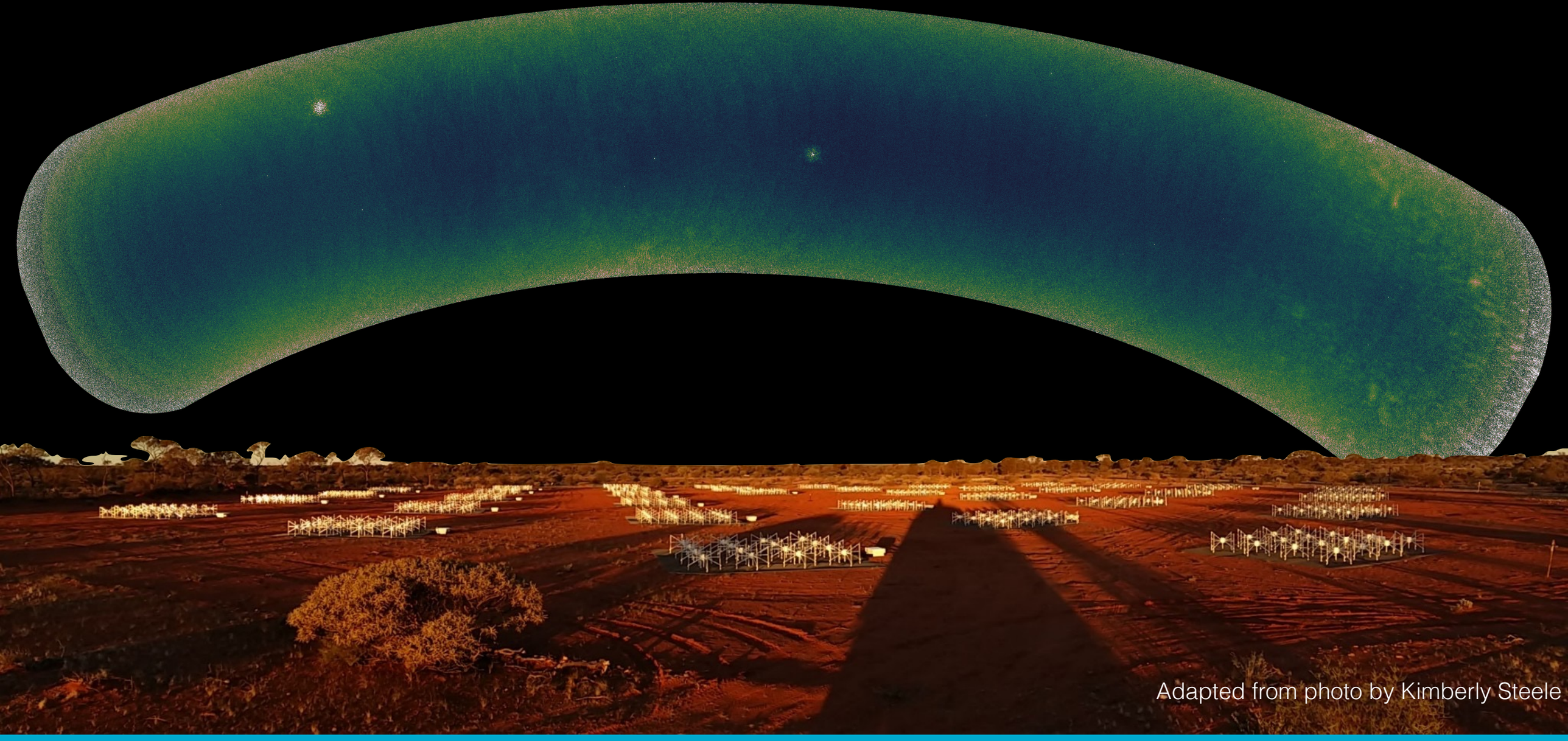


Adapted from photo by Kimberly Steele

POGS: POlarization from the GLEAM Survey

Chris Riseley | OCE Postdoctoral Fellow

13 December 2017

www.csiro.au

with Emil Lenc, Cameron van Eck

THE UNIVERSITY OF SYDNEY

IN·DEI·NOMINE·FELICITER

CSIRO

Talk Layout

- Methods
  - Leakage mitigation
- Initial catalogue
  - Spotlight on selected sources

Methods

Leakage mitigation | RM synthesis

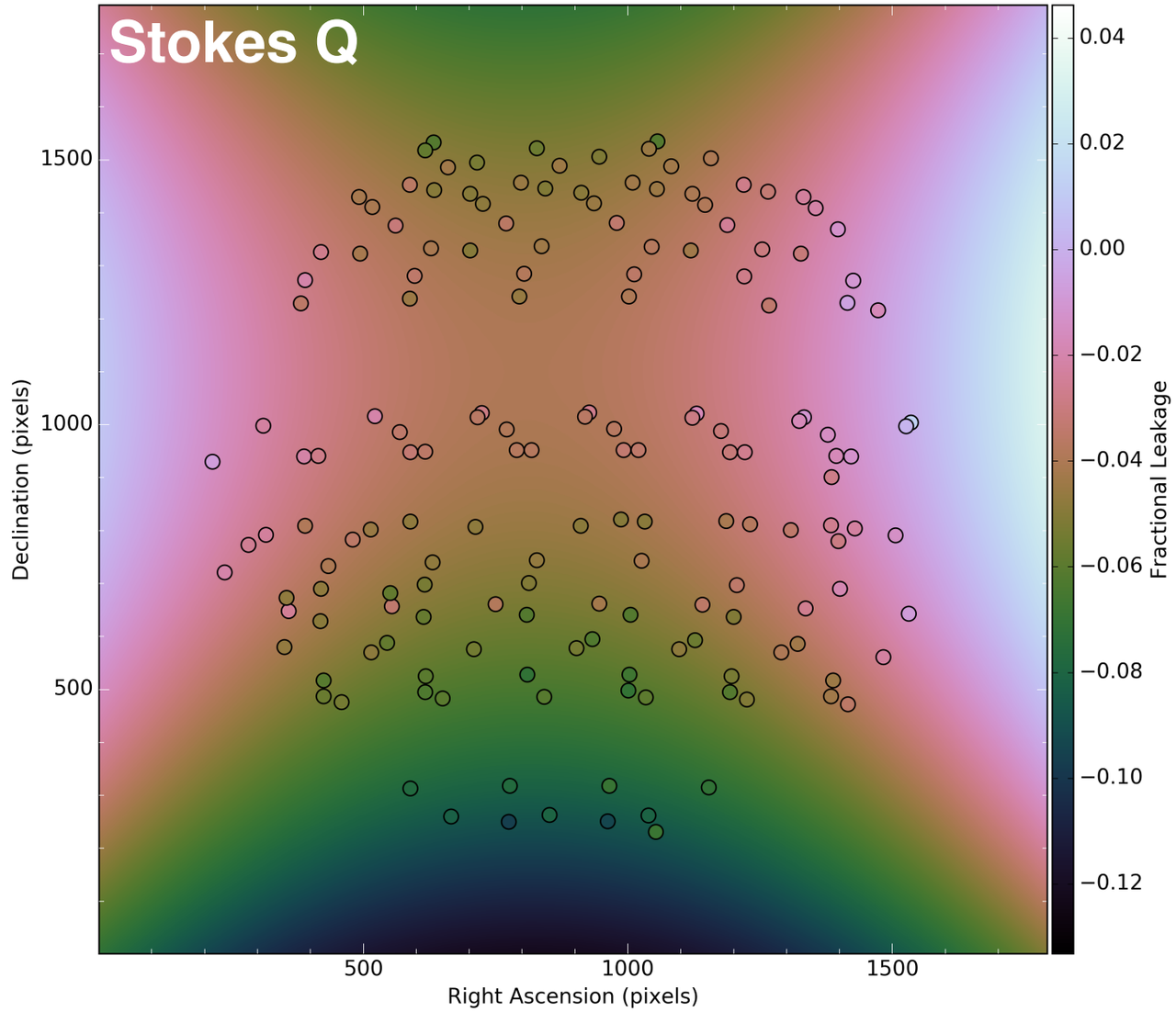
Process

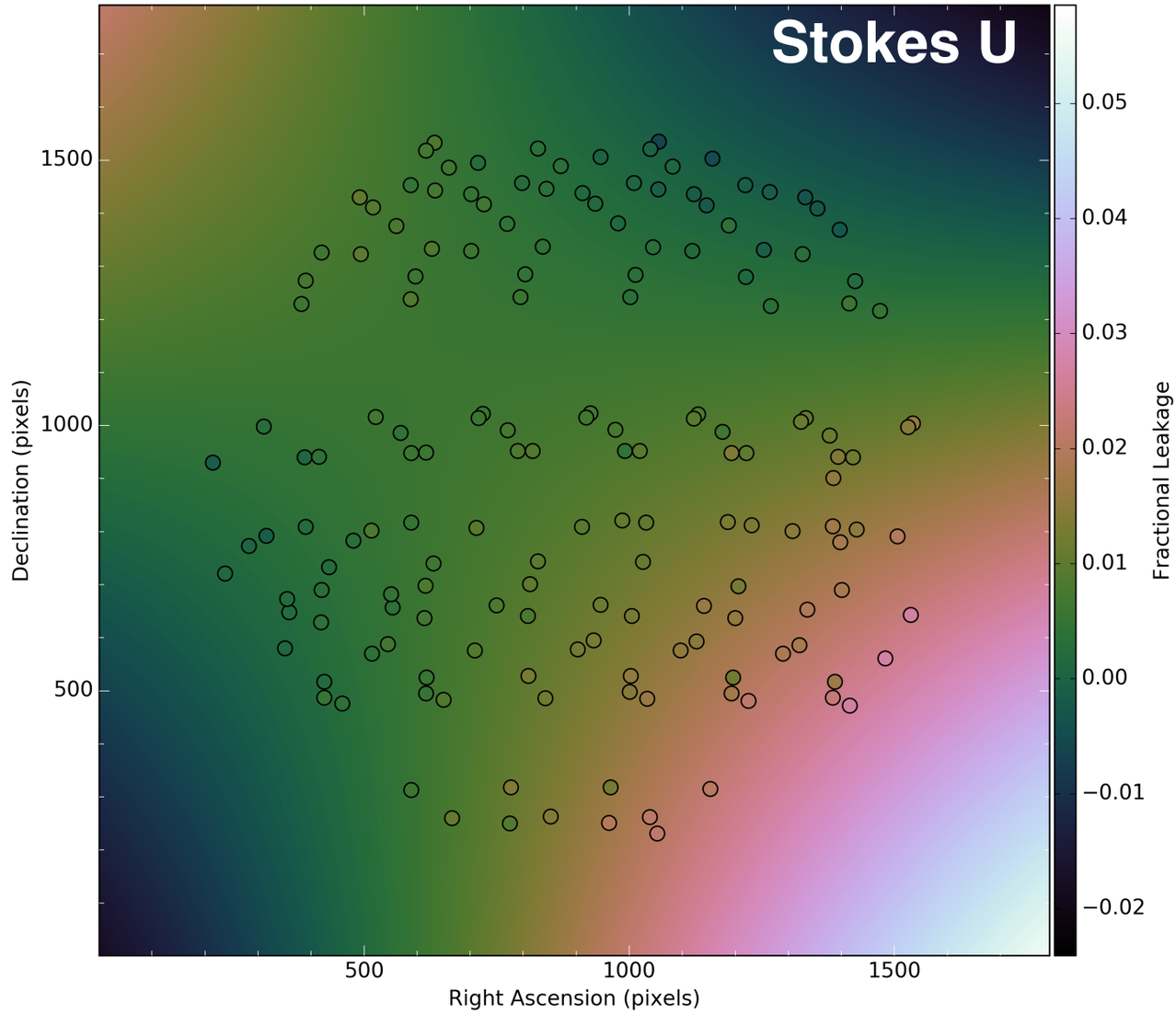
- Standard calibration*
- Per-channel full-Stokes imaging*:
  - 8 channels -> 1 image
  - *No deconvolution*
- Leakage correction
  - See talk by Emil Lenc
- Ionospheric correction
  - RMExtract**
- RM synthesis
  - GPU-based code (see sparkler talk by Sarrvesh Sridhar)
- Mosaicking***
  - Linear polarization
- Find sources

Note: in this talk, only considering GLEAM band ***200-230 MHz***

* using the RTS (Mitchell et al. 2008)
** https://github.com/lofar-astron/RMextract
***using Swarp

How Do You Solve A Problem Like Instrumental Leakage?



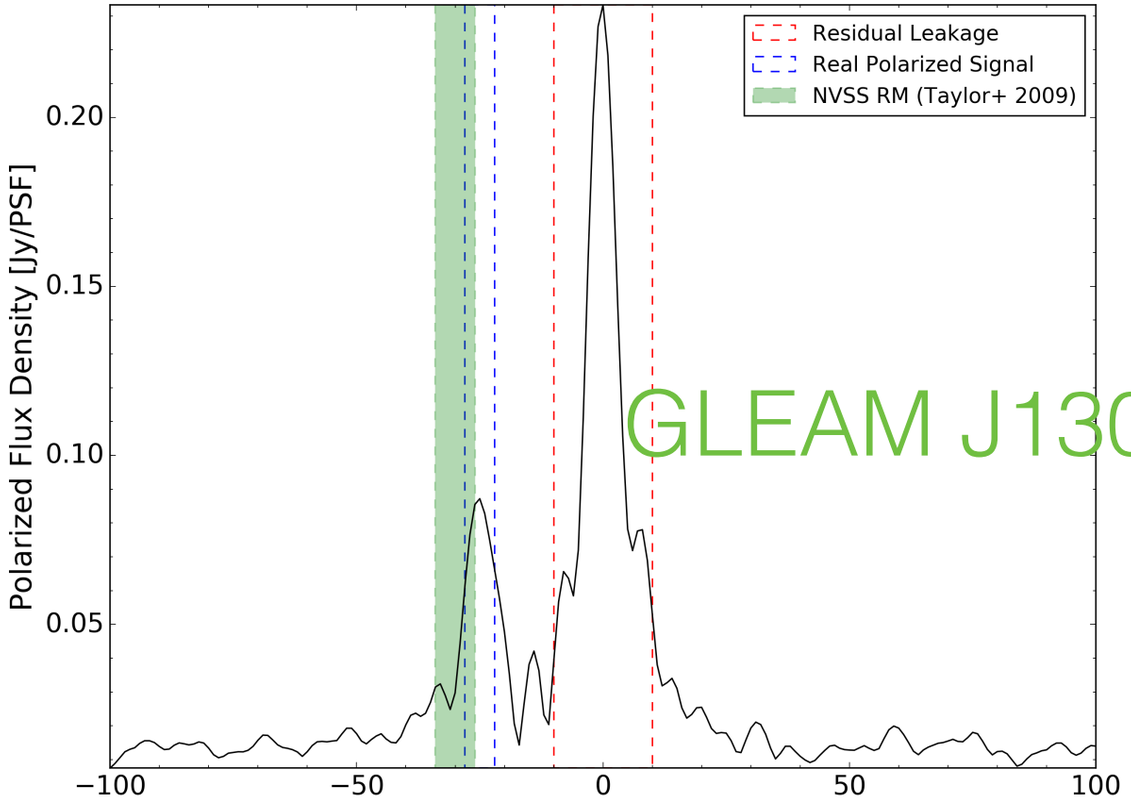


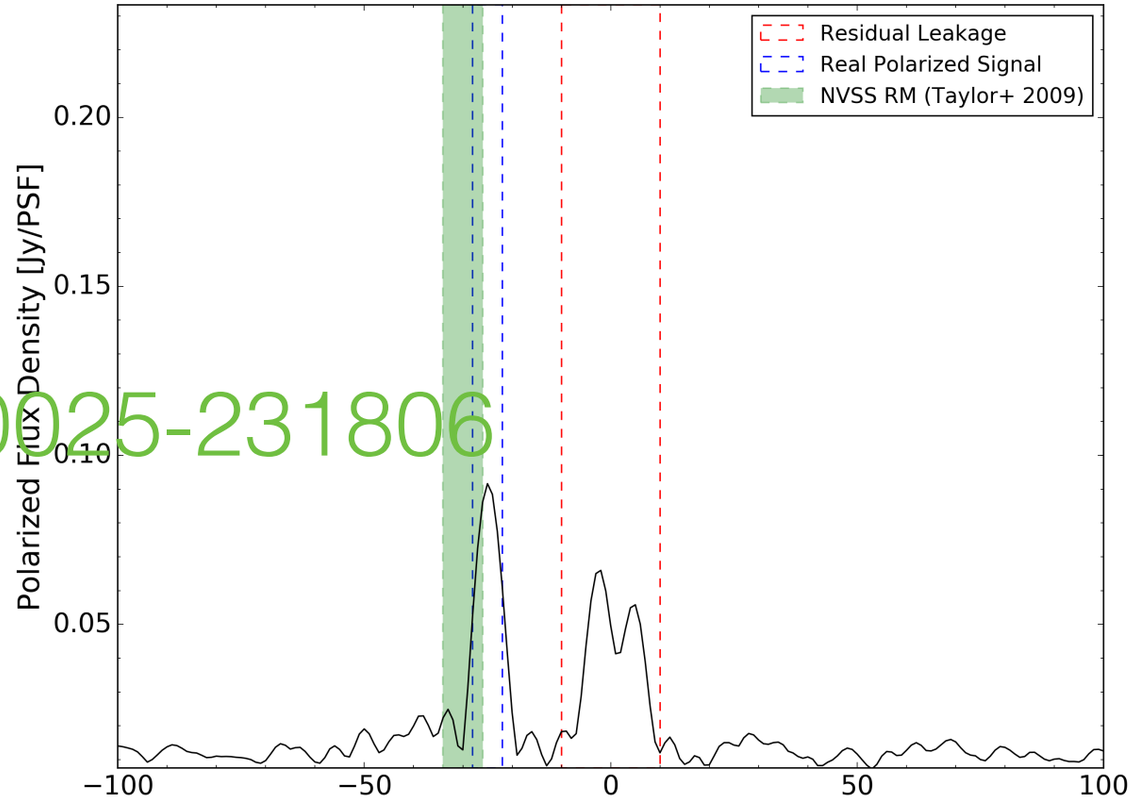
Not shown: Stokes V

No leakage correction

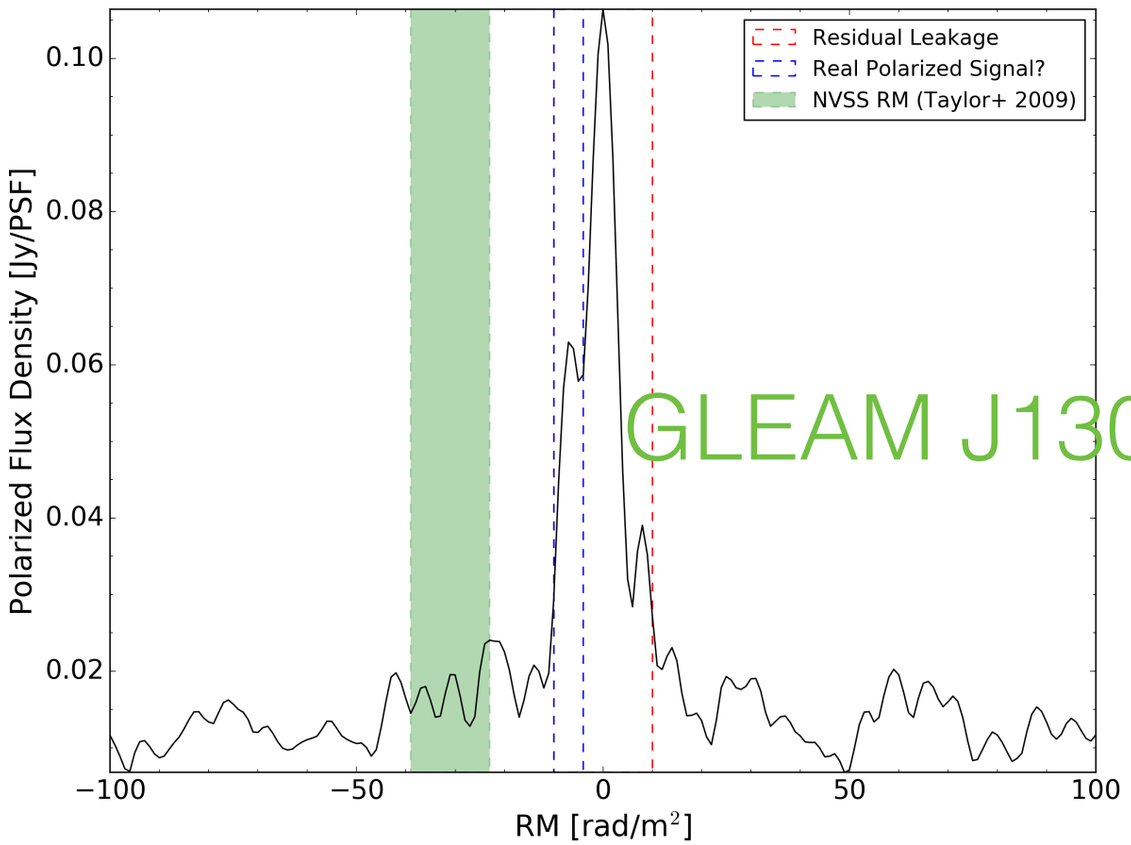
With leakage correction

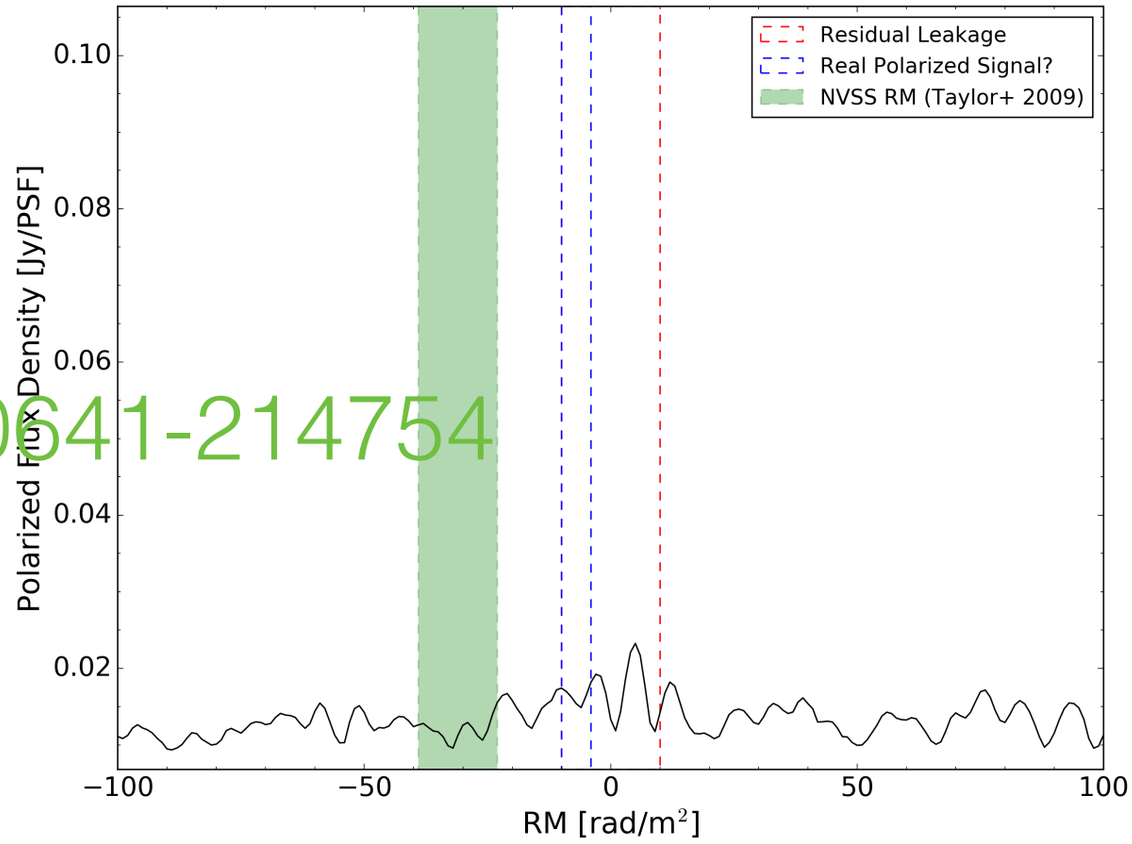
GLEAM J130025-231806





GLEAM J130641-214754





RMSynthesis in a Nutshell

- Polarization position angle rotates on encountering magnetic field (along LOS)
- Strong wavelength dependence:

$$\Delta\Psi = \lambda^2\left(0.81\int n_e \mathbf{B}\,d\mathbf{l}\right) = \lambda^2\,\mathrm{RM}$$

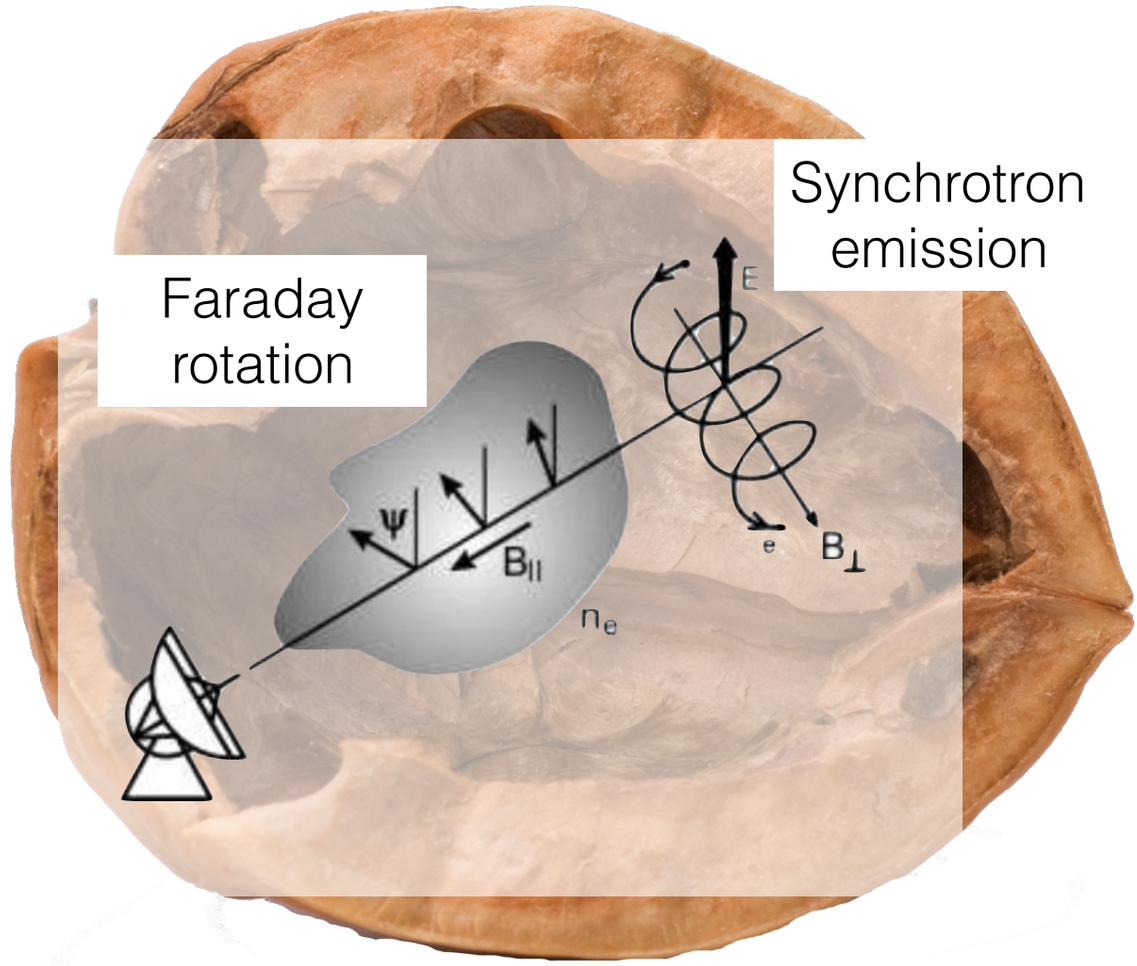
- Multiple rotation / emission components along LOS will superimpose and interfere (in λ^2-space)
- Transform from λ^2-space to RM-space

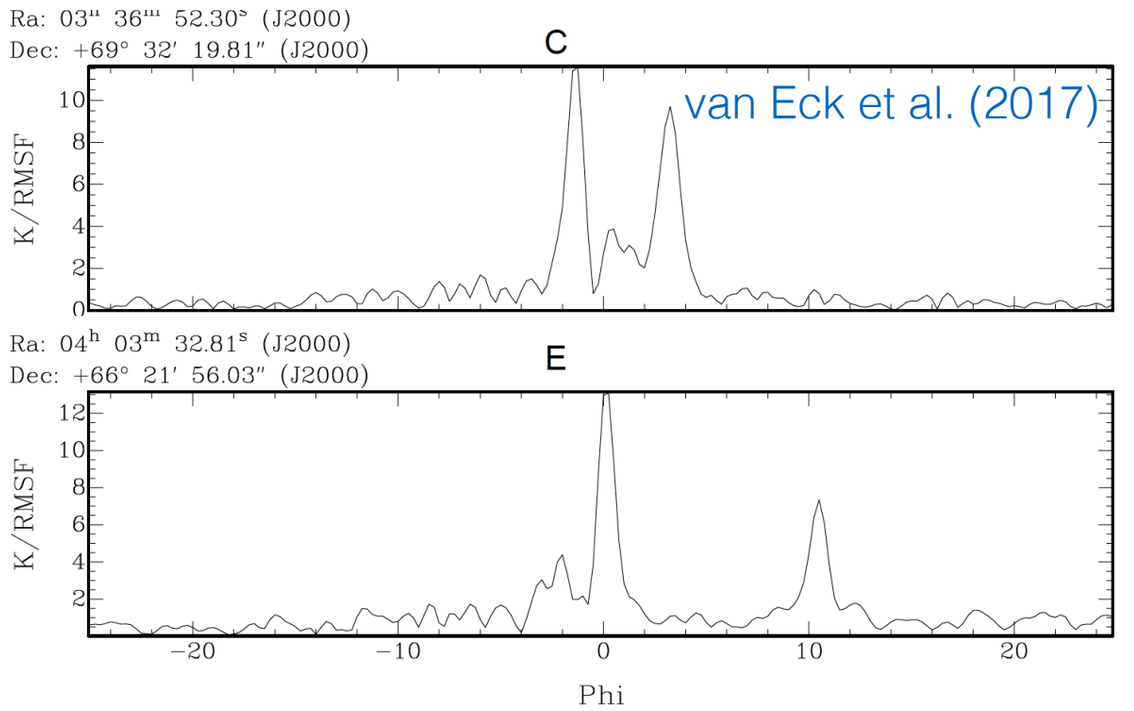
$$P(\lambda^2) \rightarrow P(RM)$$

- Transformation to RM-space allows us to identify and characterize these components.
- Analogy with aperture synthesis holds in terms of resolution, max. scale & max. RM:

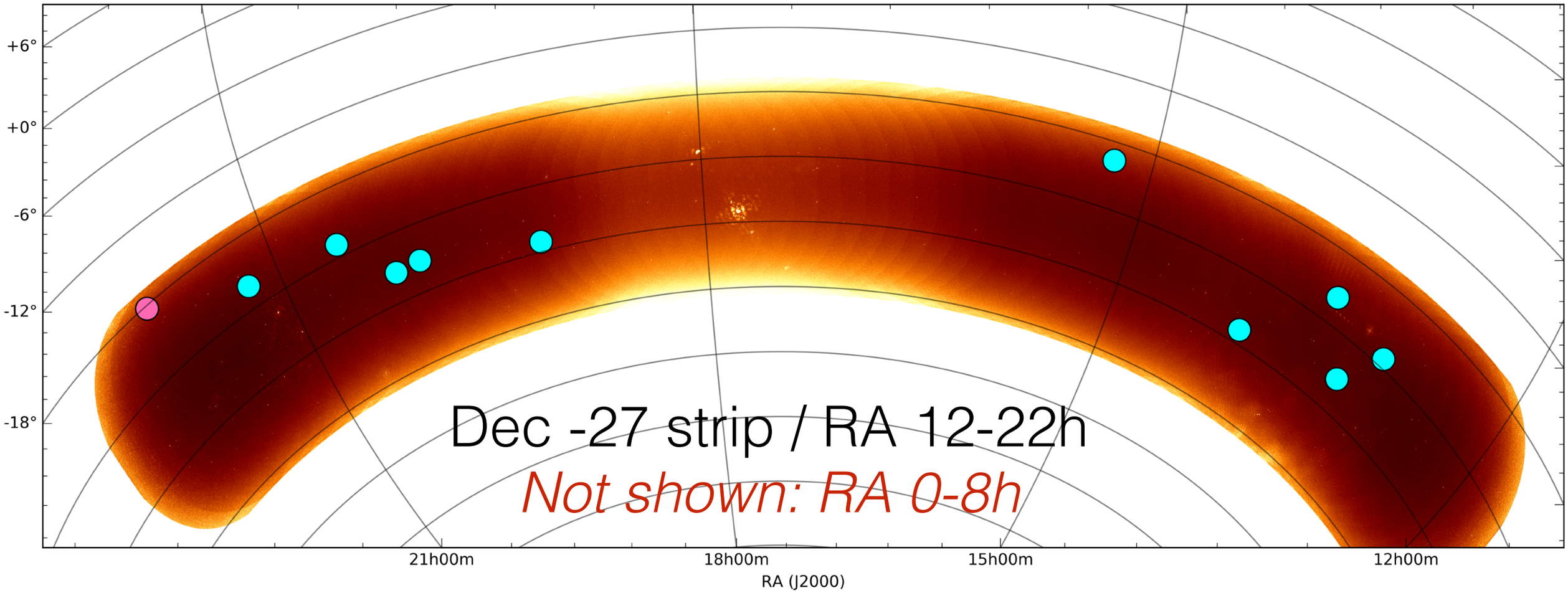
$$\Delta(RM) \propto \Delta(\lambda^2) \qquad \|RM_{max}\| \propto \delta(\lambda^2)$$

$$\text{max-scale} \propto \lambda_{min}^2$$





Drift Scan Mosaic



Key:

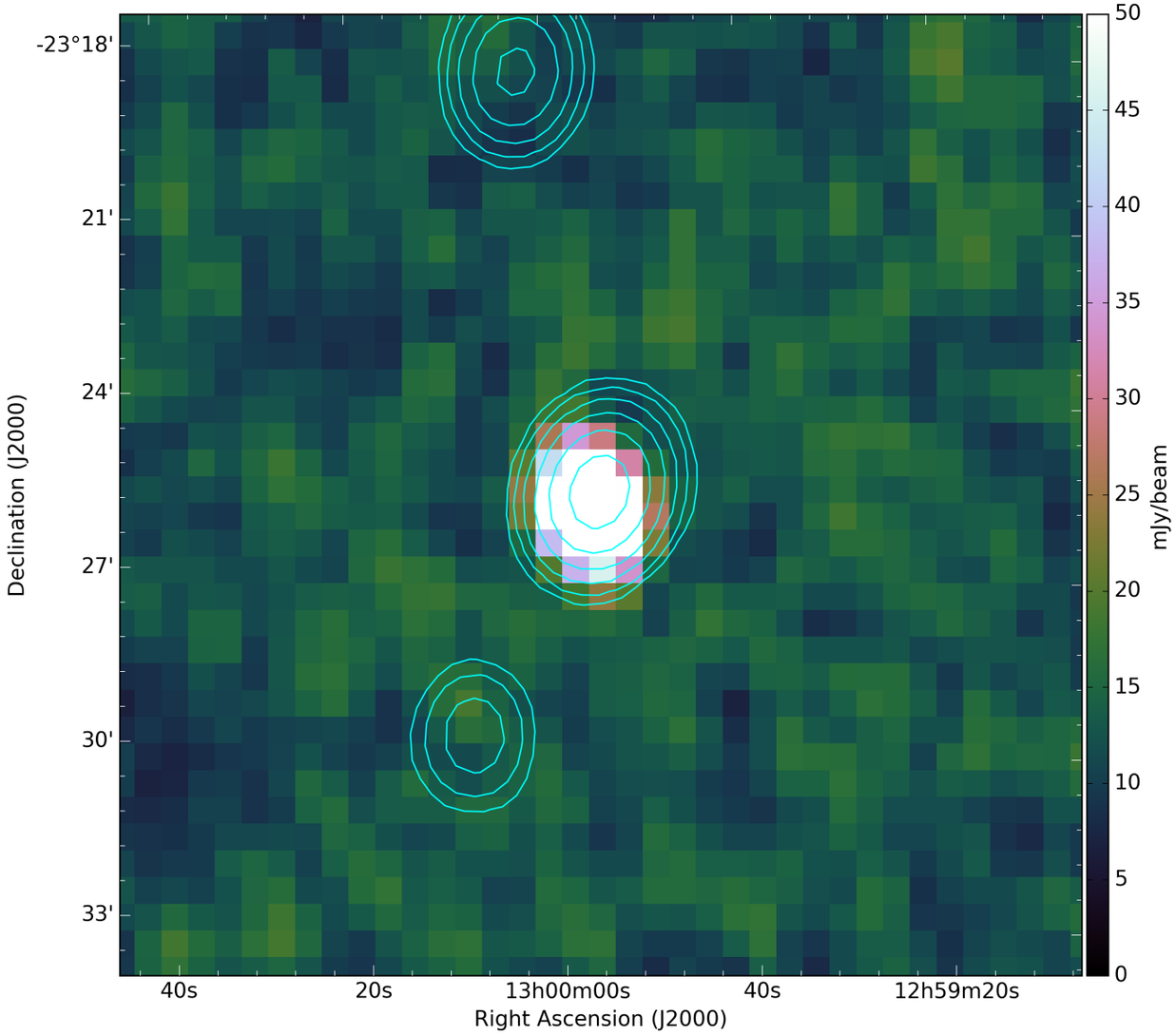
- Peak intensity map derived from P(RM) cube
- Cyan: negative RMs
- Pink: positive RMs
- Spot the Galactic plane…

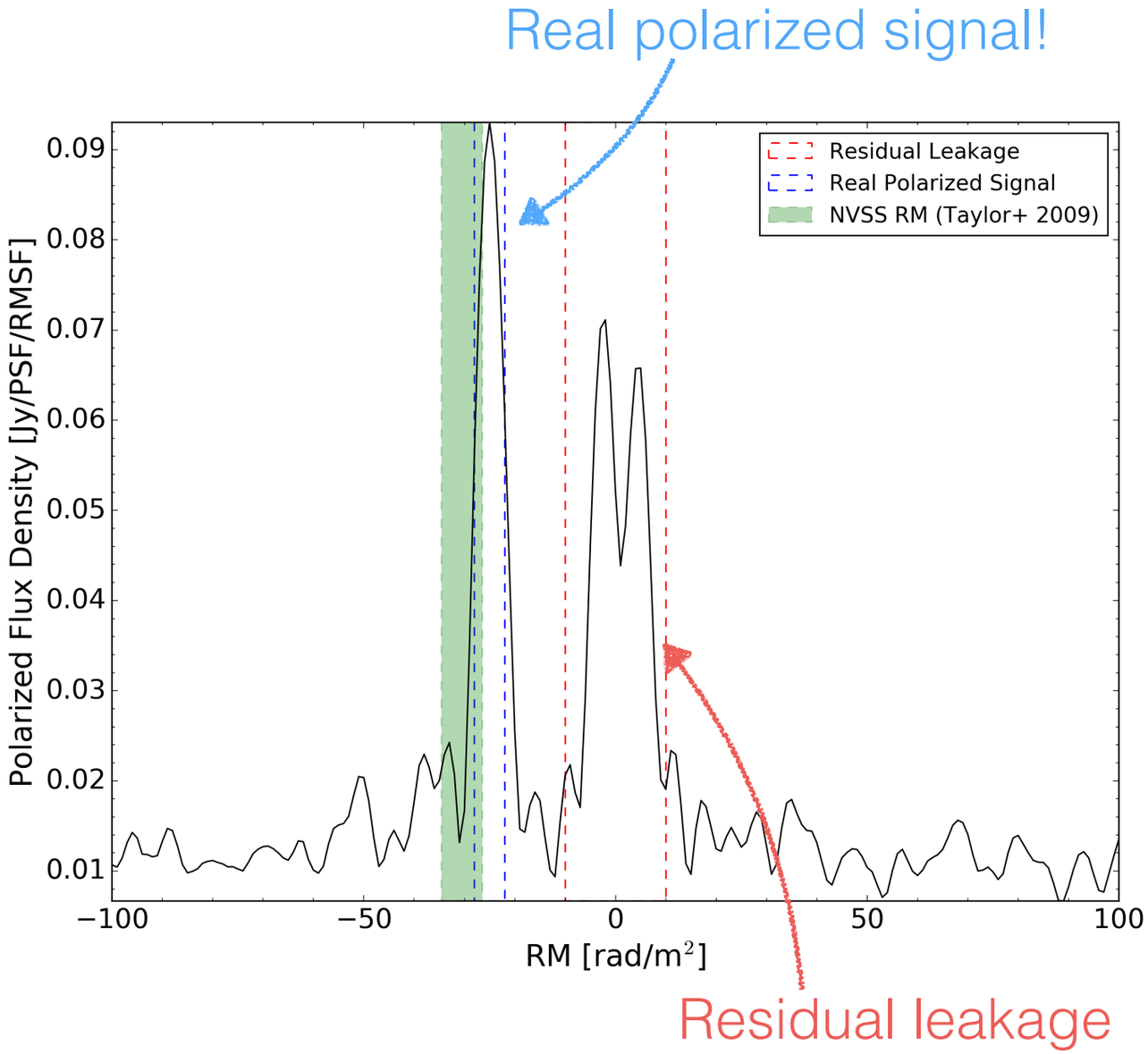
- Sensitivity ~7 mJy/PSF
- 19 sources / 5940 deg^2
- Source density:
  - 1 source per 312 deg^{-2}
  - Or ~80 sources in GLEAM survey area

Results

Highlights from the initial catalogue

GLEAM J130025–231806



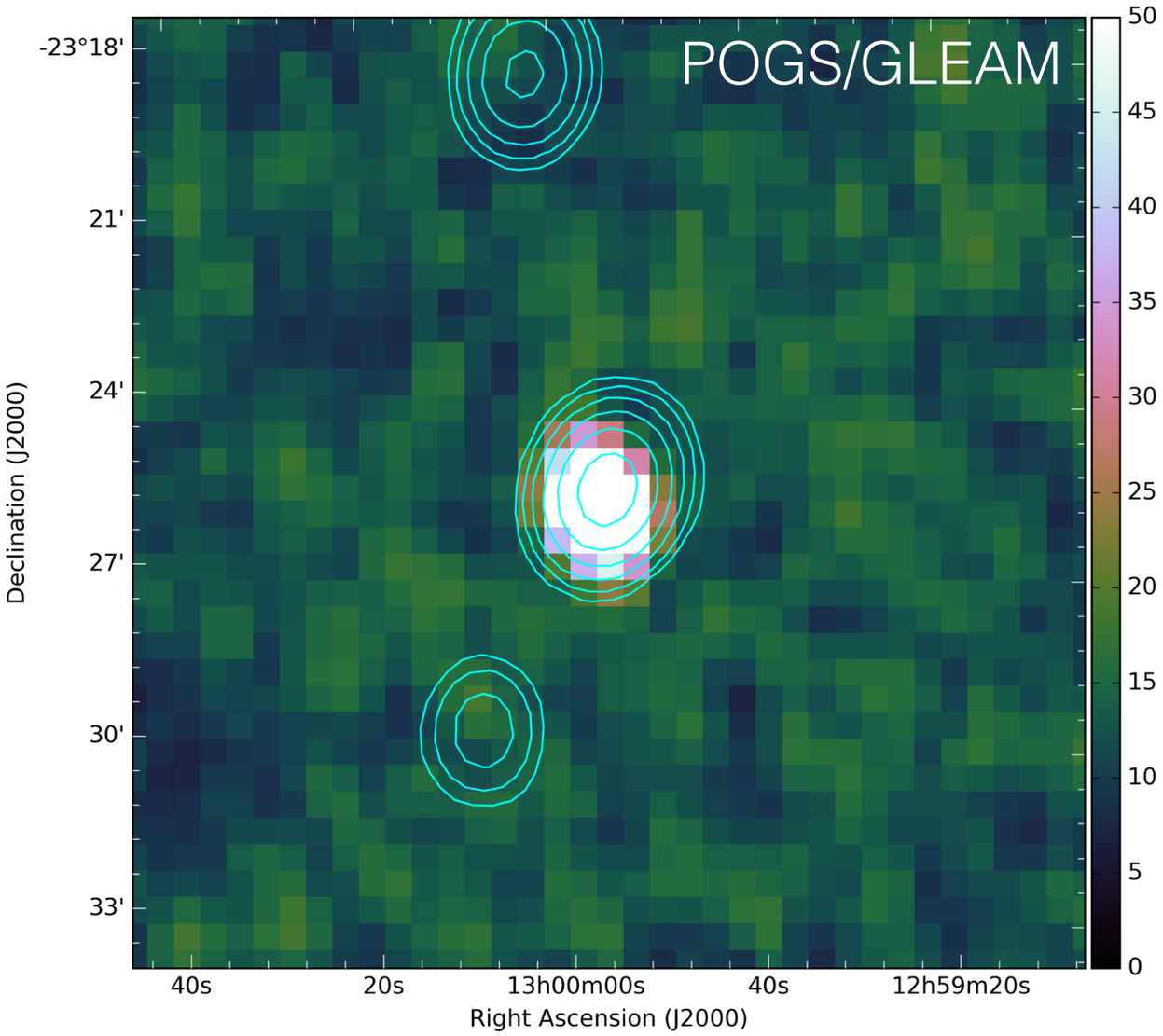


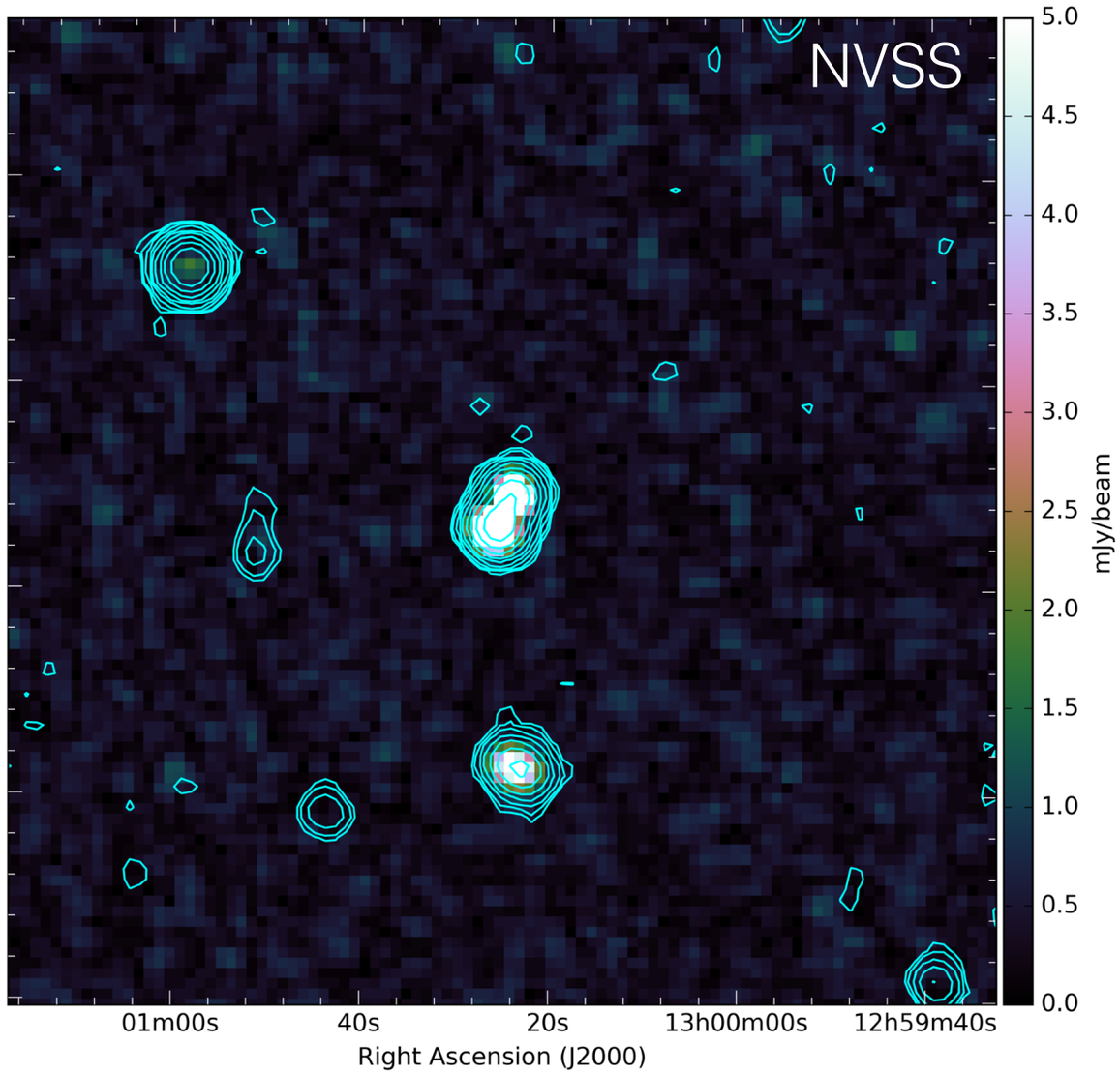
Factsheet:

- Total Intensity: 4.7 Jy @ 220 MHz
- Polarization: 100 mJy/PSF/RMSF @ 220 MHz
- P/I : 2.1%
- Peak RM: -25.0±0.4 rad/m² (c.f. Taylor+ 2009 catalogue: -30.5±4.1 rad/m²)

Cyan contours: GLEAM Stokes I (courtesy of Tom Franzen)

GLEAM J130025–231806





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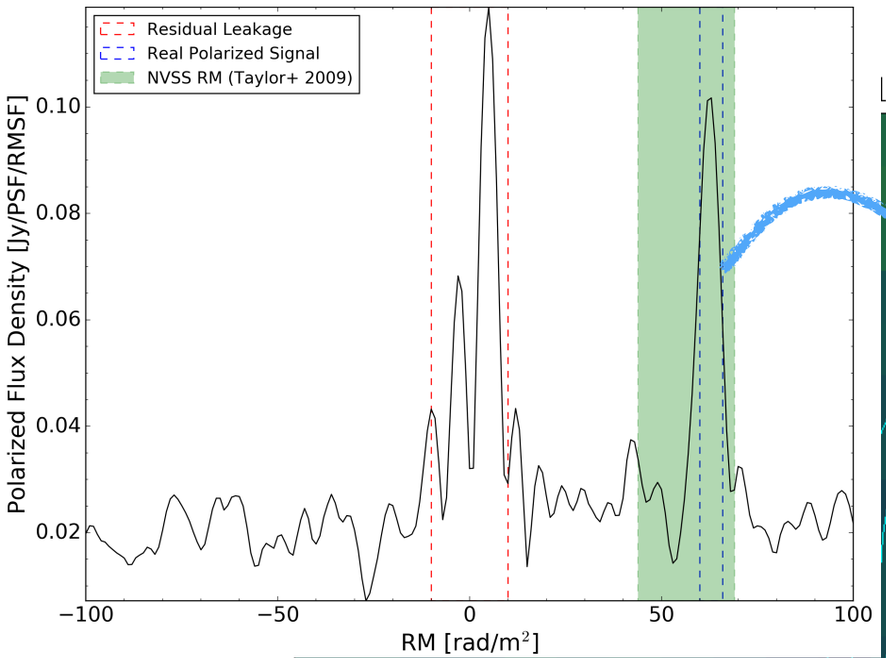
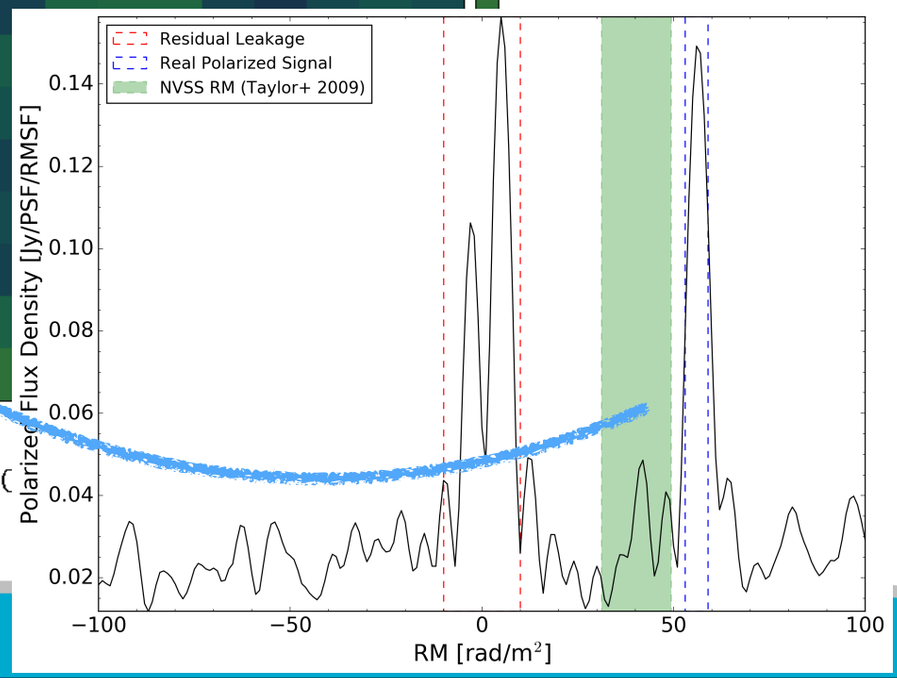
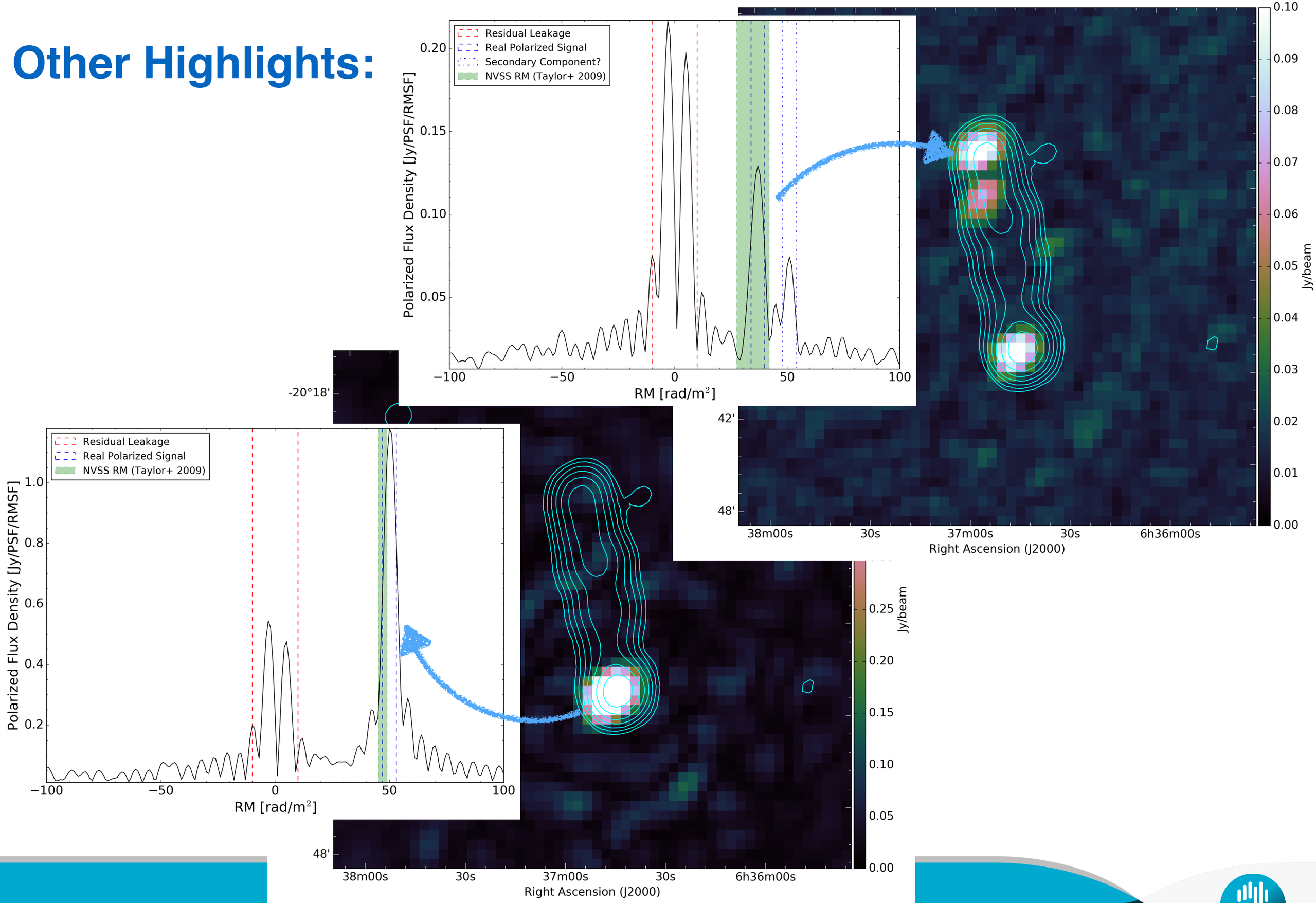
GLEAM J070901-355921 / GLEAM J070934-360341



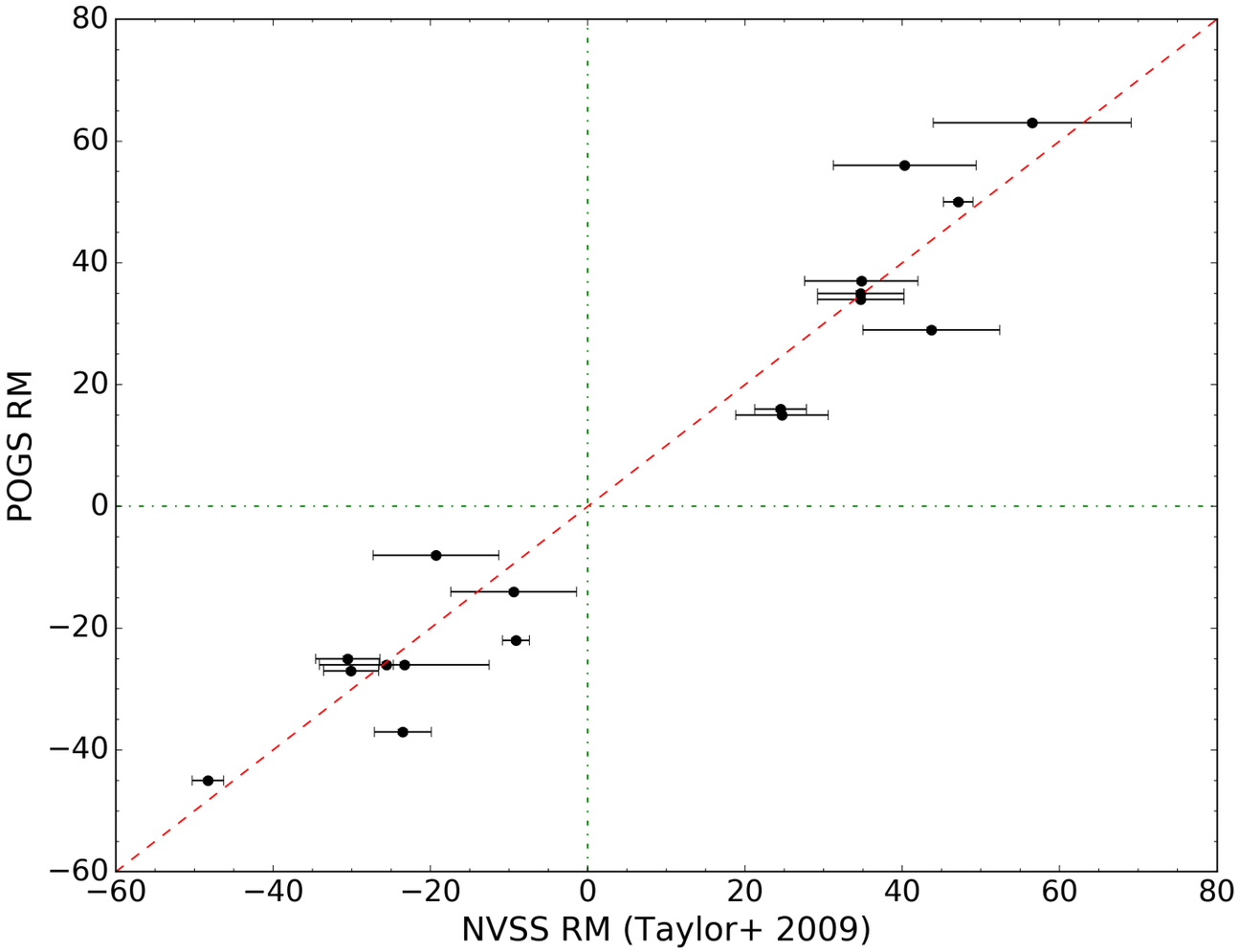


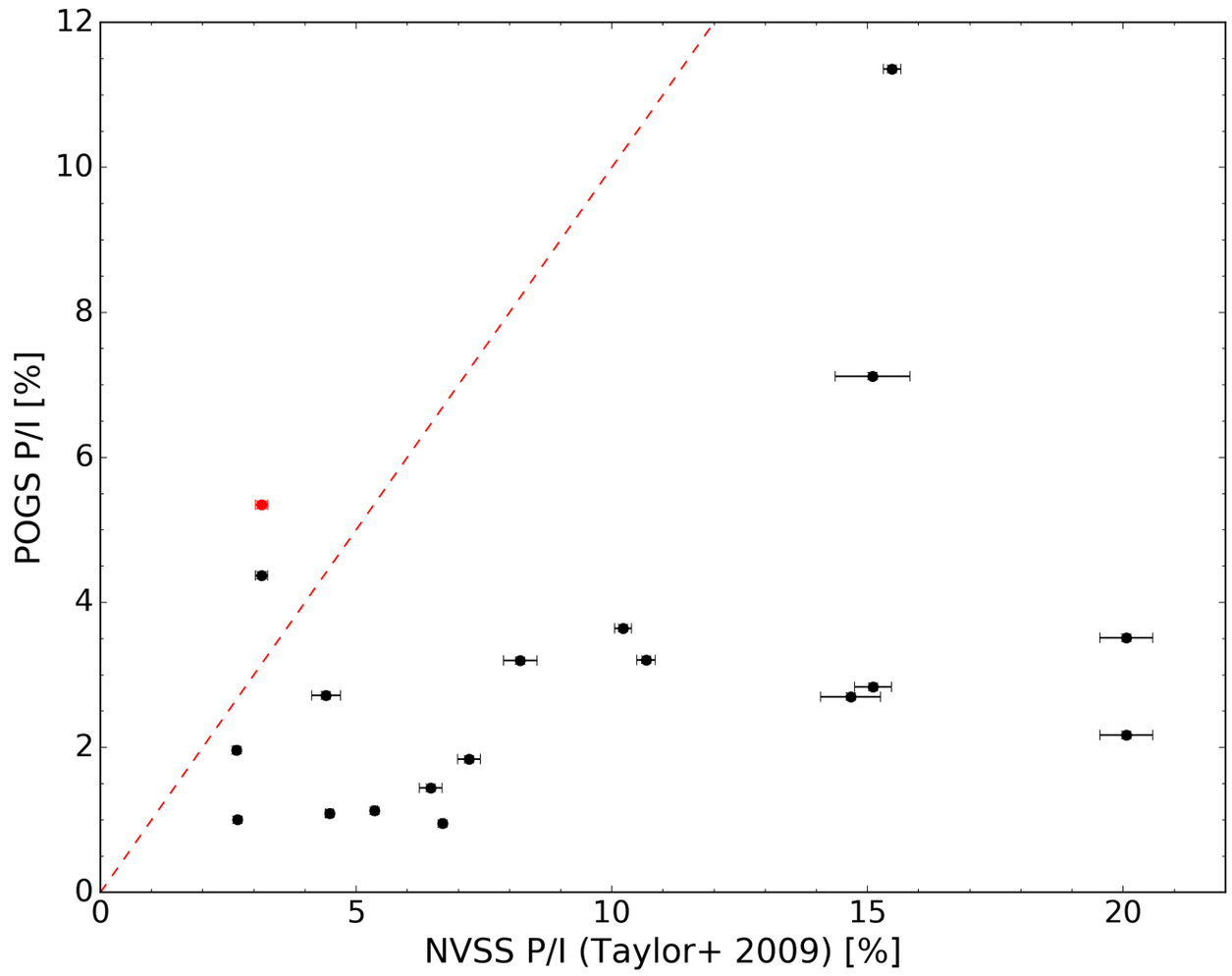
- PKS 0707-35 (z=0.11)
- LLS ~1Mpc => GRG
- Stepping through cube:
  - 40 < RM < 67
- Polarized emission from both lobes!
- NW lobe:
  - RM = 63 rad/m²
  - P = 110 mJy/PSF/RMSF
- SE lobe:
  - RM = 56 rad/m²
  - P = 149 mJy/PSF/RMSF

Other Highlights:



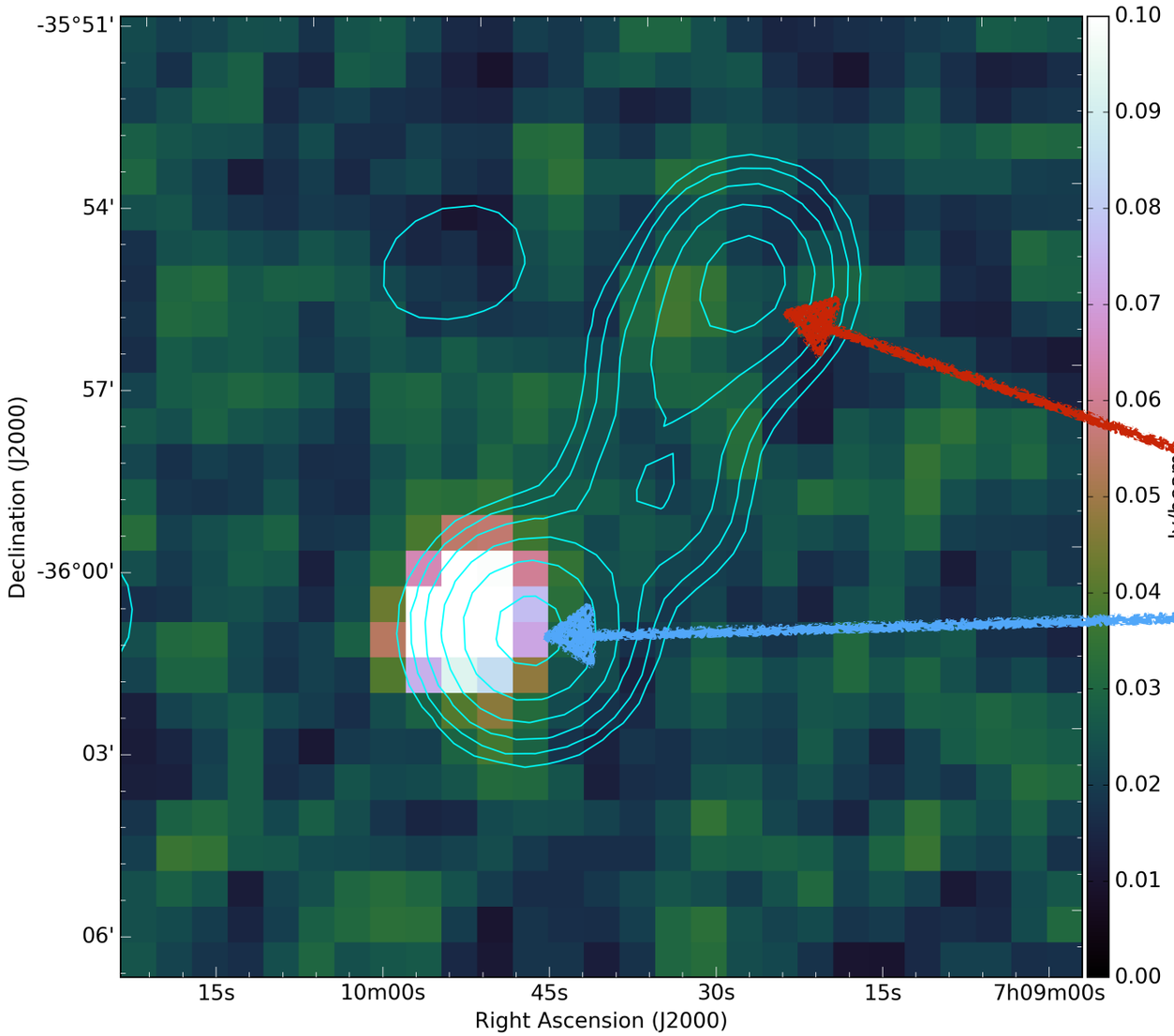
Comparison with the NVSS

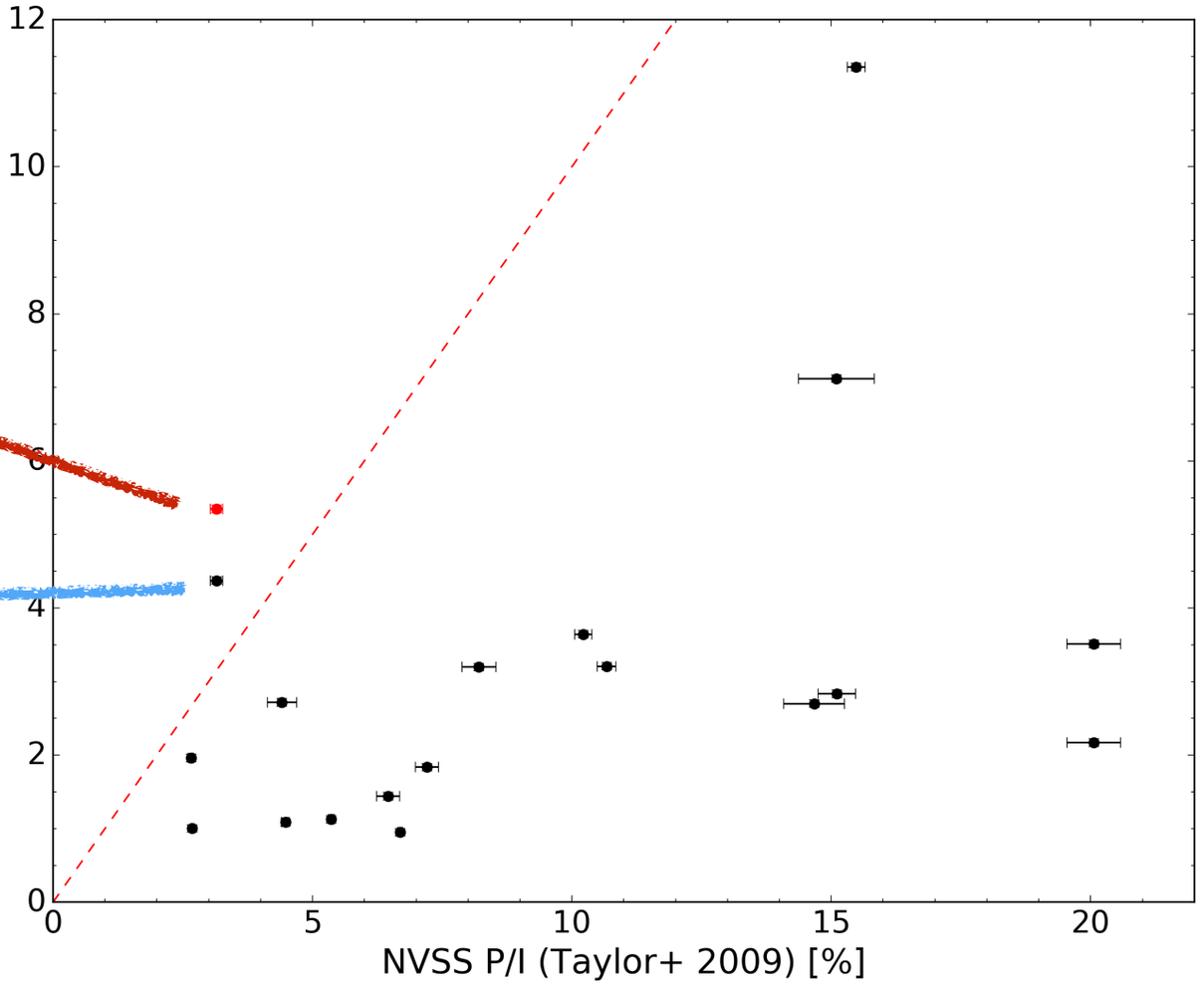




- Good correspondence between NVSS RM and POGS RM!
- Clear evidence of depolarization
  - Although single exception… Anomalous depolarization?

Comparison with the NVSS





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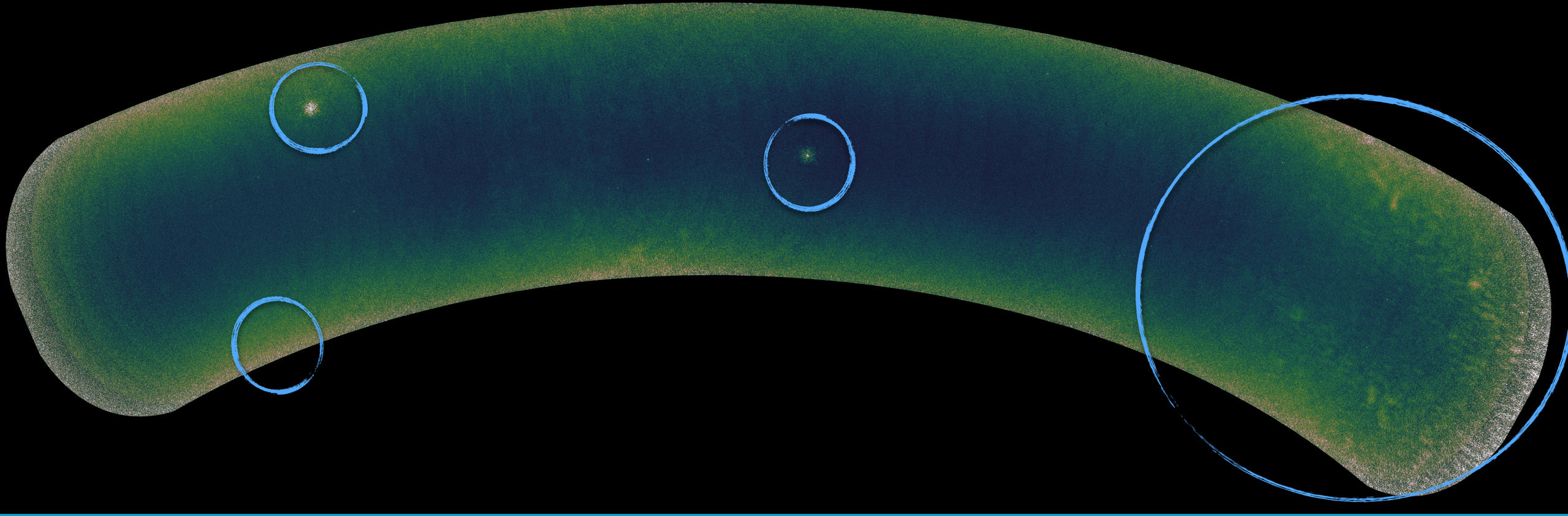
  - Although single exception… Anomalous depolarization?

Conclusions

- Low-frequency polarimetry with GLEAM is possible!
  - Beam depolarization & Faraday depolarization don't eliminate all sources
- Compiled catalogue from two drift scans covering approx. 5940 square degrees
  - Manually catalogued 19 sources above approx. 35 mJy/PSF/RMSF
  - Majority of these appear to be associated with AGN hotspots
  - Good correspondence with NVSS RMs

Next Steps

- Automated source-finding and verification
- Make better (/full?) use of GLEAM bandwidth
  - Leakage improves at lower frequencies
  - Study depolarization rate with observing frequency
  - *BUT lose sensitivity to large RMs*
- Improved leakage modelling
  - Frequency dependence
- Extend POGS to cover full GLEAM survey (and GLEAM-X!)



Thank you

CASS/Perth
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We acknowledge the Wajarri Yamatji people as the traditional owners of the Murchison Radioastronomy Observatory site