EU-VGOS Project

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on behalf of the collaboration

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Motivation for EU-VGOS

- VGOS development delayed. Antennas available and ageing.
- Correlator resources at Bonn planned for VGOS ageing.
- Need to acquire know-how for VGOS observing & data reduction.
- Haystack is developing path for observing, correlation and fringe-fitting (FF).
  - Pseudo Stokes I ignores source polarisation, changes and differences between position of peak in total and polarisation intensity.
  - Polarisation leakage leads to delay errors
  - Source structure and its variation, position as function of frequency
- Different FF programs will become available for VGOS (PIMA, CASA, ??)
- Optimal method for VGOS correlation and FF not scientifically evaluated!!

- To reach 1mm accuracy all steps of VGOS observing and data reduction have to be optimised!
- Get community involved! DiFX is excellent example how this works.

Aims of EU-VGOS

- Define Aims of EU-VGOS (some flexibility, ongoing)
- Find collaborators: Telescopes, experts, correlator, regular meetings
- Scheduling of VGOS observation, depends on aim of observation
  - Find fringes, calibration X/Y & AMP, stability, maps, geodetic parameters (ongoing)
- Observing
- Data transport → Internet
- Correlation including QA & feedback
- Fringe-fitting: initially fourfit, later others
- Polarisation conversion: X/Y → L/R (includes coarse FF and mapping)

Comparison of methods

Source structure effects

Effects of polarisation

…. more

Participating Stations

- **ONSA13NE**: 13.2m, antenna, receiver QRFH,
  VLBI back-end = DBBC3/flexbuff

- **WETTZ13S** (WETTZ13N not equipped with broadband receiver yet): 11-feed, 2xDBBC2/Mark6 units

- **RAEGYEB:** 13.2 m antenna, receiver QRFH, 4xRDBE/1xMark6 units

Collaborators: see 1st slide

Bundesamt für Kartographie und Geodäsie

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Scheduling of first sessions

- Used SKED/SCHED: creates VEX, plots for parallactic angle, UV coverage
- Schedule strong calibrators at regular intervals
  - FF, bandpass, pol. cal, phase stability, amp cal
- ≥ 1 source with a high fractional polarization
- ≥ 1 source with a low fractional polarization
- vgt050 "imaging" session, observed only strong sources

4 hrs sessions - Standard geodetic schedule (time on source = 30 s) +
scans targeting 4 strong calibrators (integration time ~ 120s)

Frequency set-up

- Four bands with dual linear polarization:

  3000.40 MHz - 3480.40 MHz (band A in Haystack nomenclature; band S in Fourfit)
  5240.40 MHz - 5720.40 MHz (band B/ band C)
  6360.40 MHz - 6840.40 MHz (band C/ band X)
  10200.40 MHz - 10680.40 MHz (band D/ band X)

- In each band are sampled 8 channels of 32 MHz bandwidth (sample_rate of 64 Ms/s)
- 2-bit sampling, thus meaning a **data rate of about 8 Gbps**
- Recording on Flexbuff (JIVE)/Mark6 modules

Correlation

Onsala (real data) – 1 VDIF file per scan with 8 threads, 8 channels per thread

Wettzell (real data) – 1 VDIF file per scan with 4 threads (1 for each band), 16 channels (8 channels x 2 linear polarizations) per thread.

Yebes (complex data) – 1 VDIF file per scan with 4 threads, 16 channels/thread

Data are e-transferred to Bonn

Issues with file-based correlation in DiFX due to
1) clumpy time threads
2) too small data buffering in DiFX

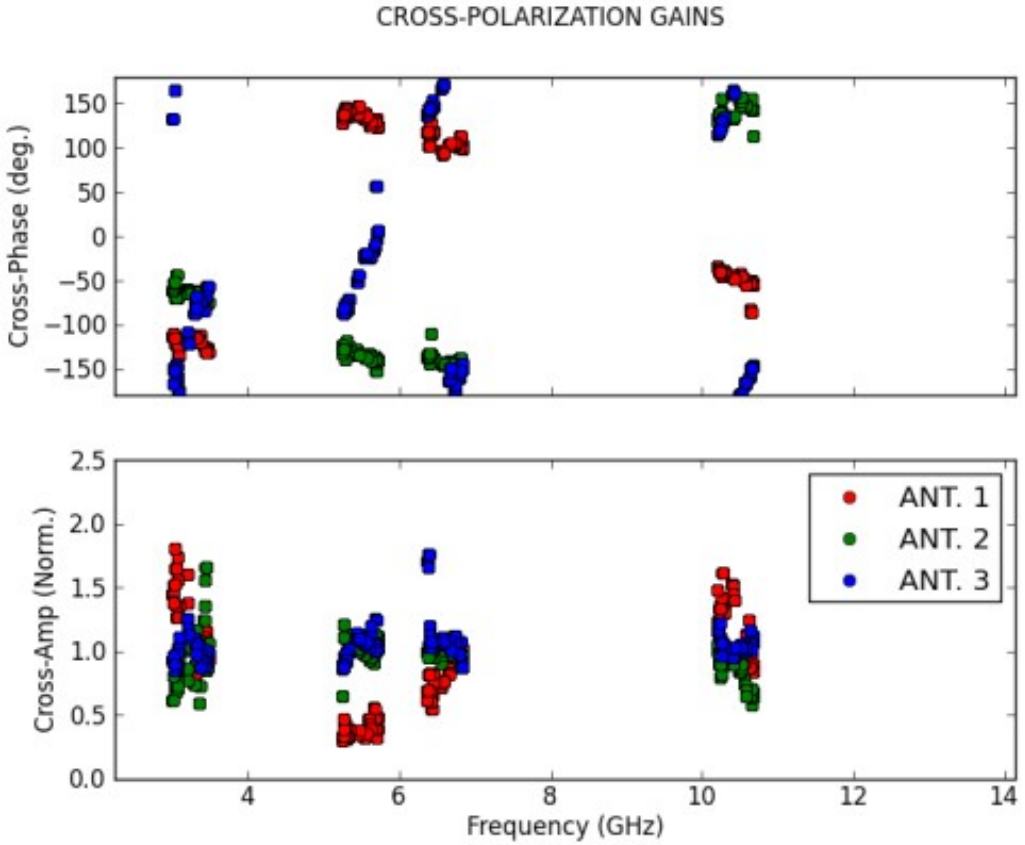
Multi-thread raw data must be converted, else data loss

DiFX produces 4 cross-correlation products (XX,YY,XY,YX) to be fed to the PolConverter

PolConversion

- X/Y relative phases are tracked using the pcal X-Y phase differences.
- Additional (add-hoc) X/Y phases are applied (due to e.g., pcal cabling).
- Need amplitude calibration to track X/Y relative amplitudes.

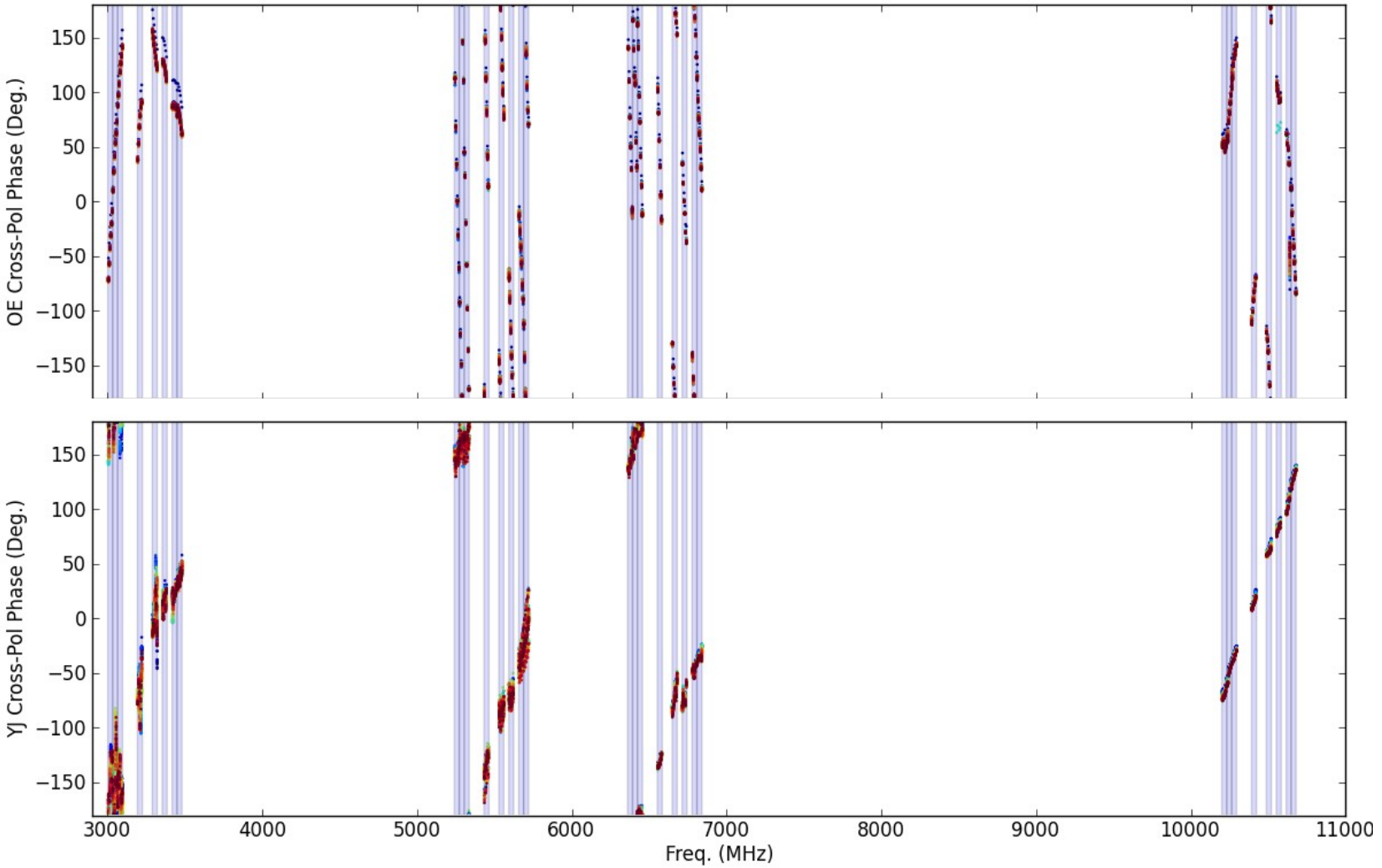
- Add-hoc X/Y phases (and amplitudes) can be derived from calibrator observations (Global Cross-Polarization Fringe Fitting, GCPFF, with PolConvert).



X/Y relative phases and amplitudes for **OE** (ANT. 1), **WS** (ANT. 2) and **YJ** (ANT. 3).

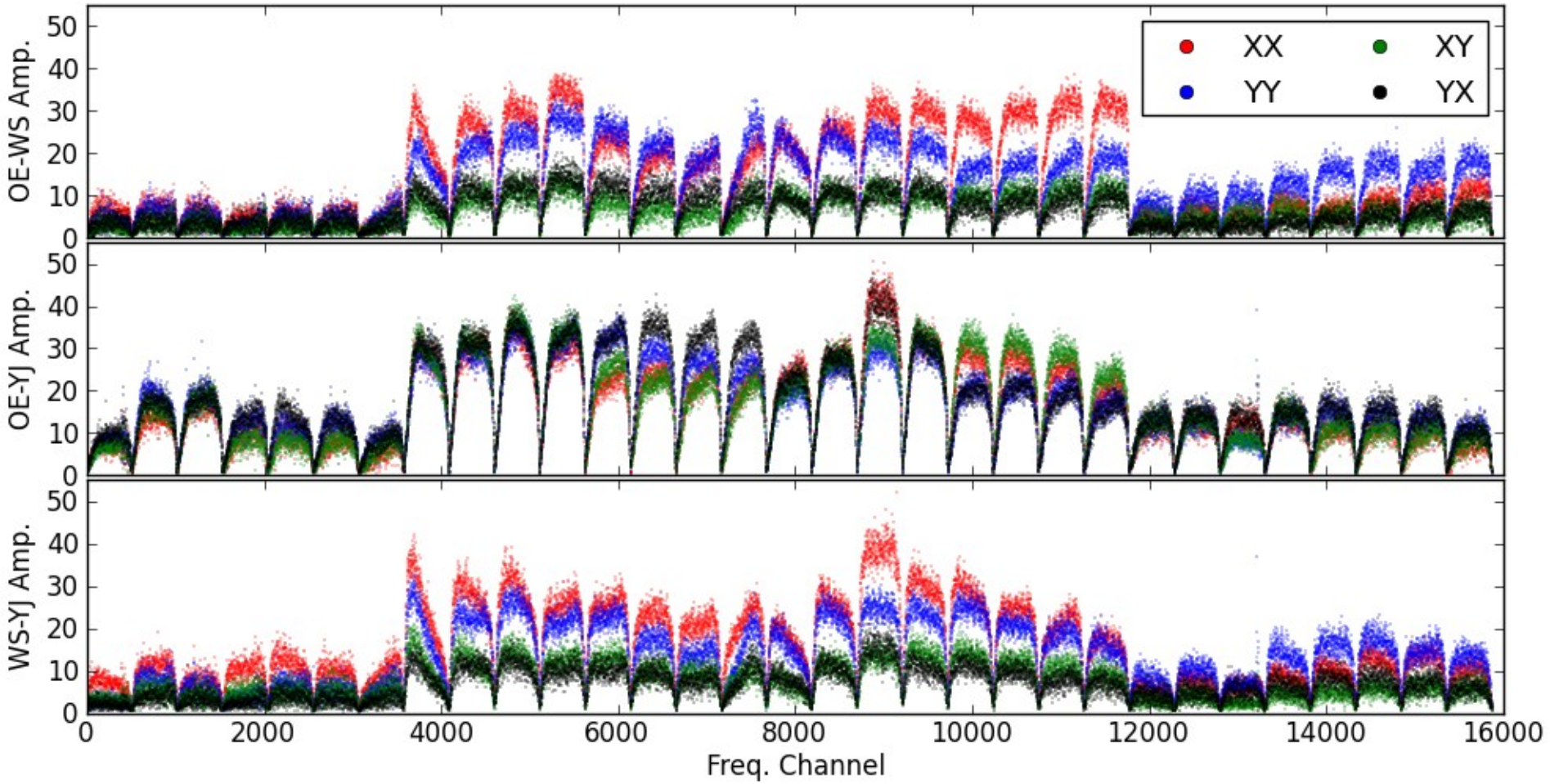
Experiment **VGT274**.

PolConversion



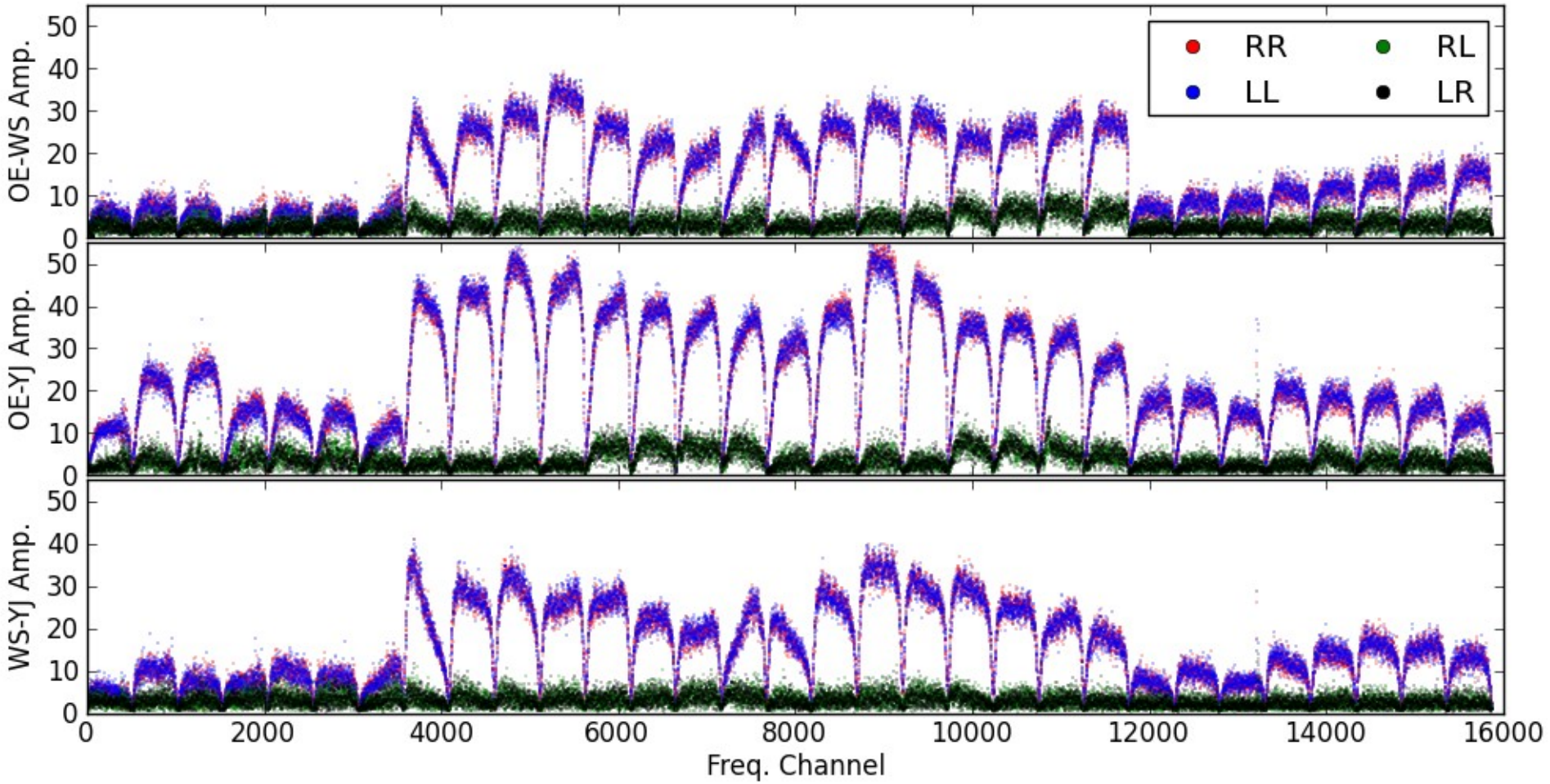
X/Y relative pcal phases for all scans of experiment **VGT274**

PolConversion



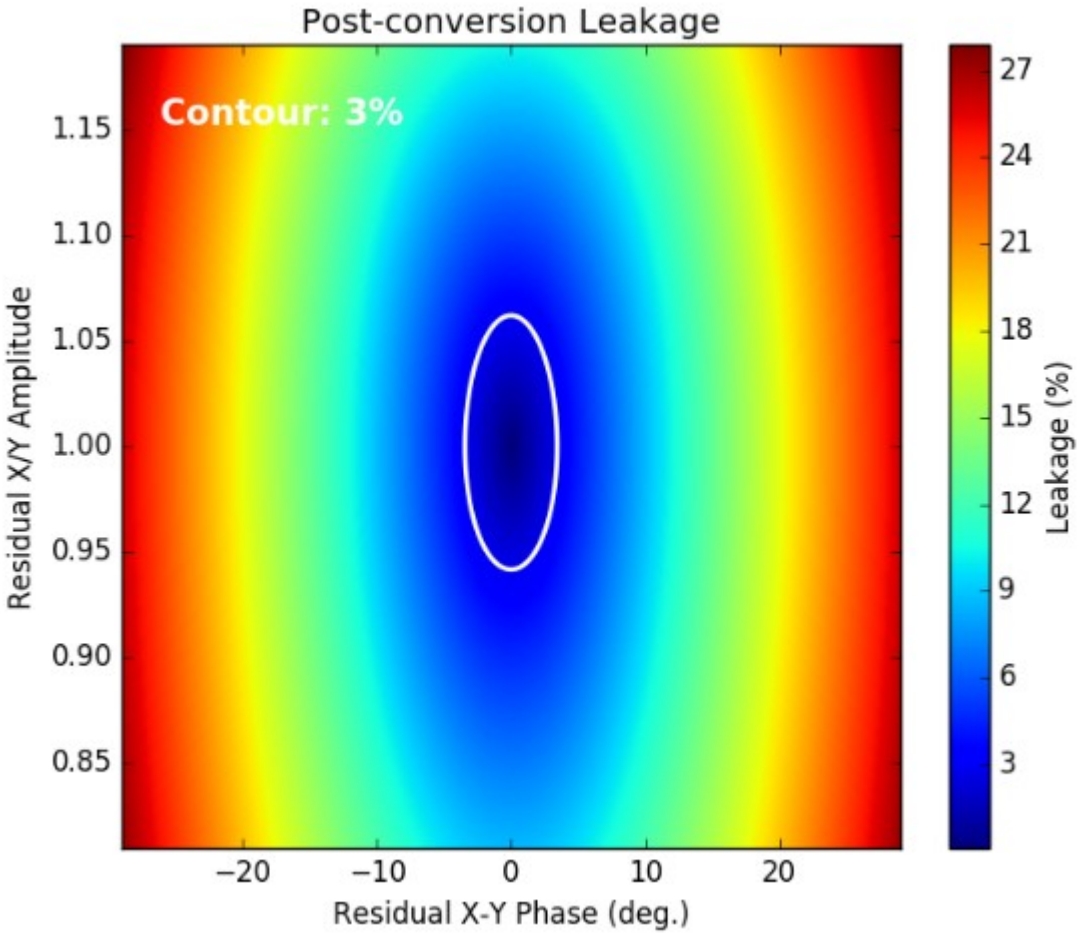
Amplitudes for all IFs (RAW correlation) for a scan on 3C84 (calibrator).

PolConversion

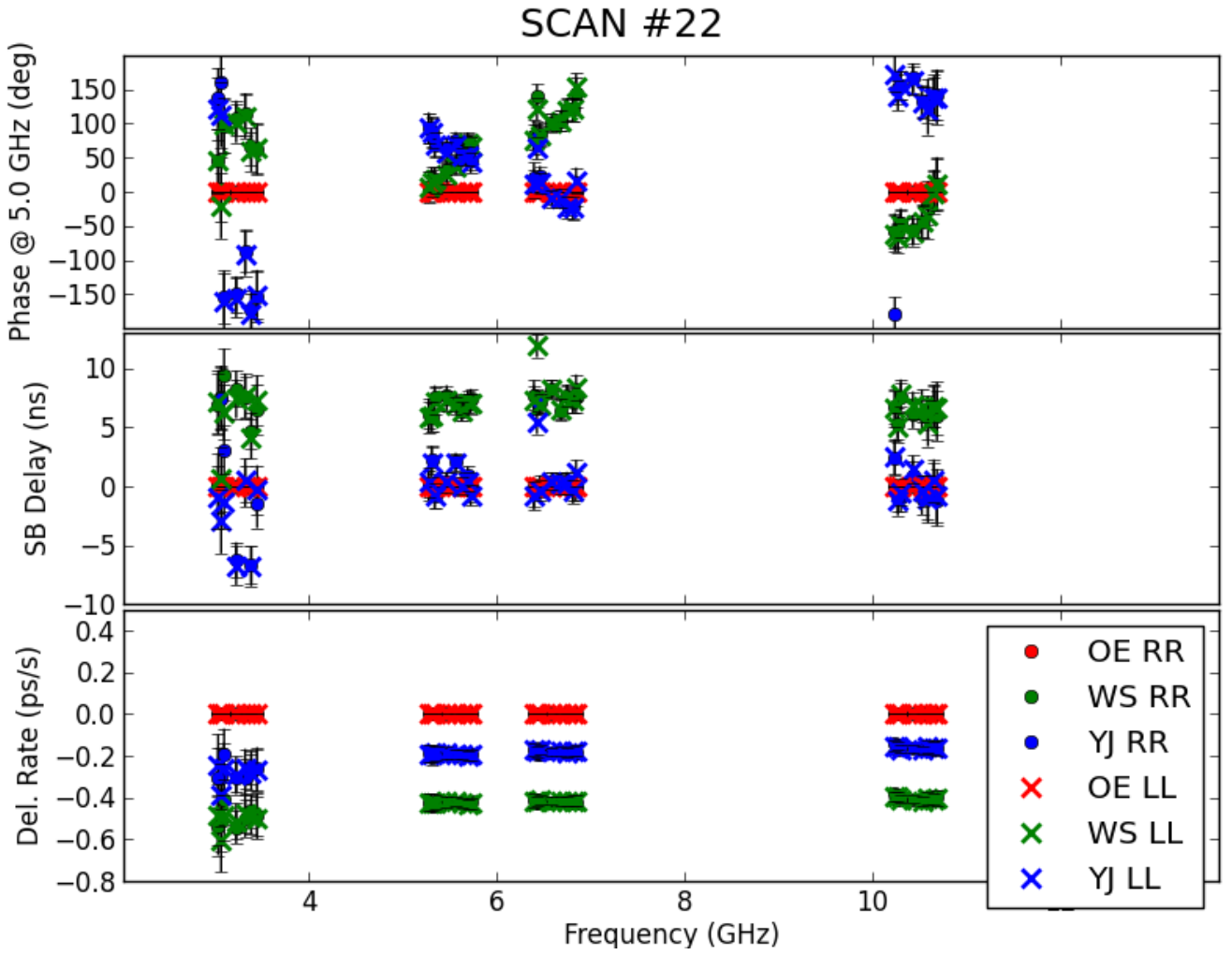


Amplitudes for all IFs (PolConverted) for a scan on 3C84 (calibrator).

PolConversion

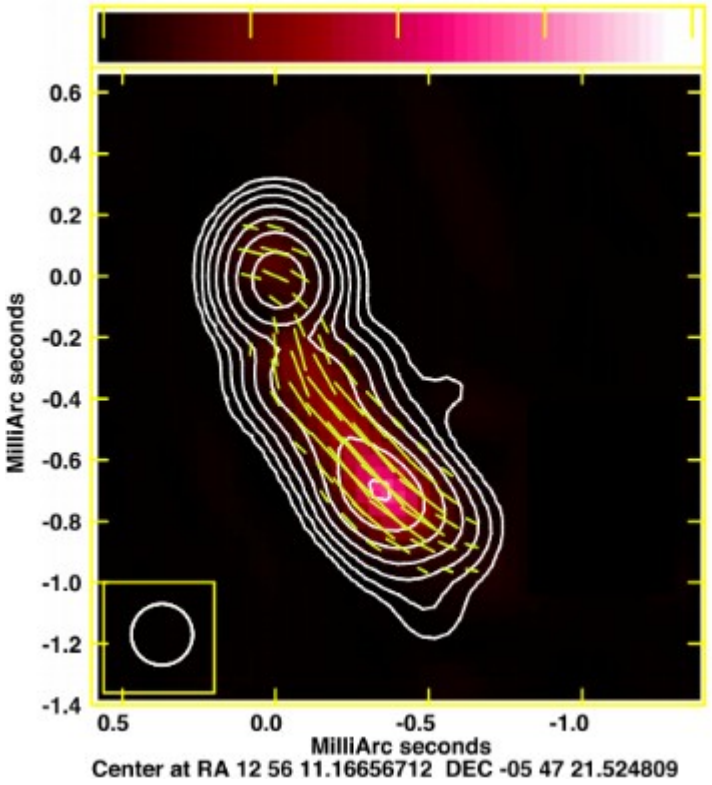


PolConversion

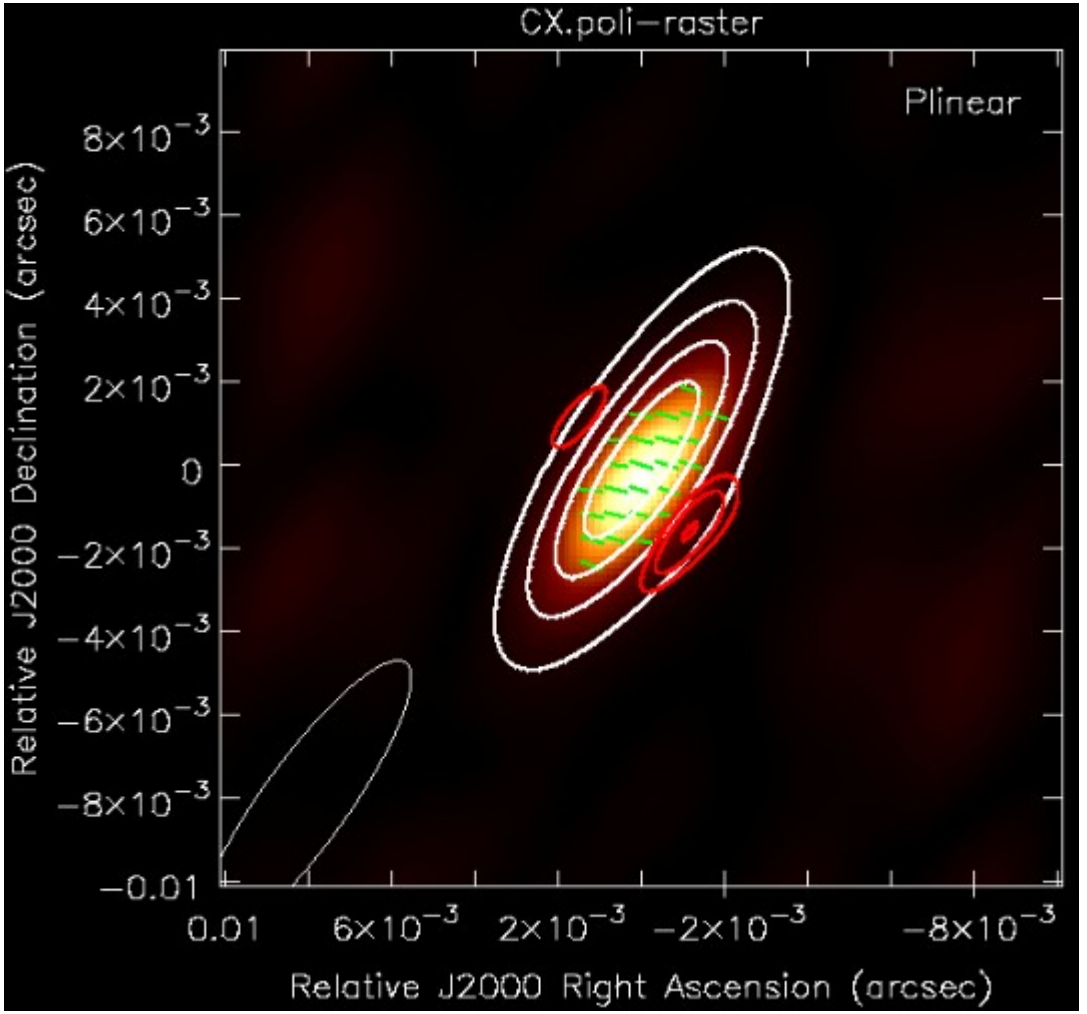


Global Fringe Fitting (per IF) on a PolConverted scan of 3C84.

Full-Stokes Imaging



3C279 at 43GHz
(Rani et al. 2018)



3C279 at 5-11GHz
(EU-VGOS, Exp. VGT260)

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Thank you!

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