Phased-ALMA and VLBI polarimetry

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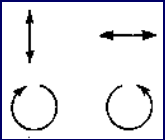
Linear pol. vs. circular pol. feeds.



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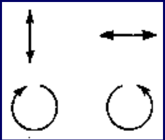

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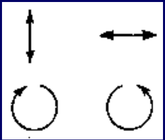

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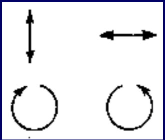

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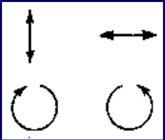

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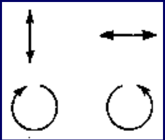

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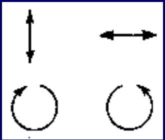

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ALMA antennas have LINEAR feeds!!

ALMA polarization for VLBI

Roy et al. (2013). *APP polarization White Paper*

Final strategy is

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The main advantages are

- Minimum hardware implementation.
- Flexibility for post-processing.
- Easy adaptability for future X/Y-based stations.

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- Conversion fully implemented in our software, PolConvert.
- We DO need the ALMA-only data and calibrate them completely!

Software implementation: PolConvert

- Written in C++. Can be used in multi-threaded environment.
- Uses `casacore` to interact with measurement sets and CASA tables.
- Reads and converts FITS-IDI data. Full support for SWIN data is on the way.

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- Re-arranges pol. products if needed.
- Interpolates the K_+^i matrices and computes $(K_+)^{-1}$.
- Applies the matrices, converts the VLBI visibilities to a pure circular basis, and writes a new FITS-IDI file.

How to get a cross-phase on mixed-polarization data?

We can use the RR/LL visibility ratios, written in mixed-polarization basis

$$\chi^2 = \sum_k \omega_k \left[\frac{V_{xr}^k G_{x/y}^{-1} - i\, V_{yr}^k}{V_{xl}^k G_{x/y}^{-1} + i\, V_{yl}^k} (G_{k,R/L}^*)^{-1} - 1 \right]^2 + \chi^2_{\odot\odot}$$

Once the χ^2 is minimized as a function of $G_{x/y}$ and $G_{k,R/L}$, we can calibrate and convert the mixed-polarization visibilities with the equation

$$V_{\odot\odot}^k = C_{\odot +} \begin{pmatrix} G_{x/y}^{-1} & 0 \\ 0 & 1 \end{pmatrix} V_{+\odot}^k$$

Software implementation: PolConvertSD

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- Useful if
  - The station with linear feed is a single dish (i.e., not a phased array).
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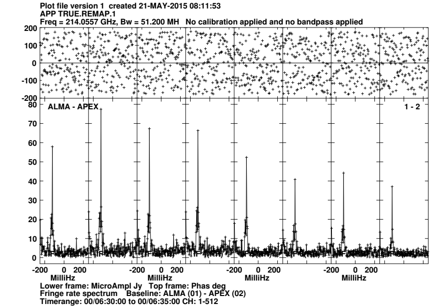
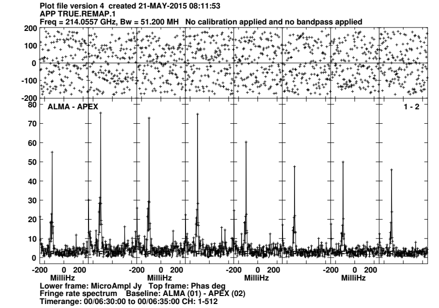
- Uses the RR and LL visibility ratios to derive the gain ratios.
- No linear polarization information (nor ψ coverage!) is needed!
- BUT it assumes that
  - The leakage in the circular-feed antennas has been calibrated.
  - The leakage in the linear-feed antennas is small (negligible).
  - The source has no circular polarization.

ALMA-APEX full-polarization fringes!





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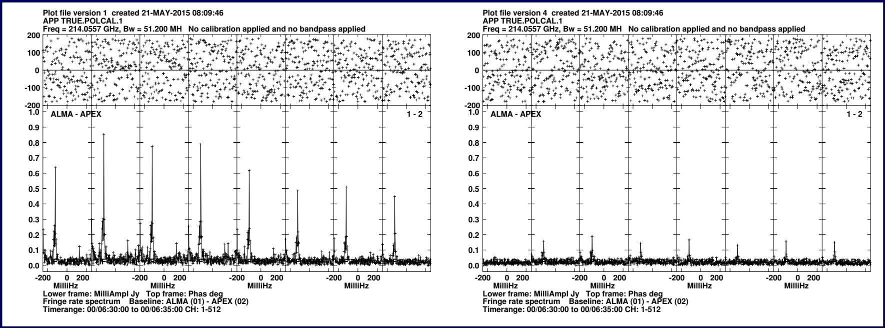

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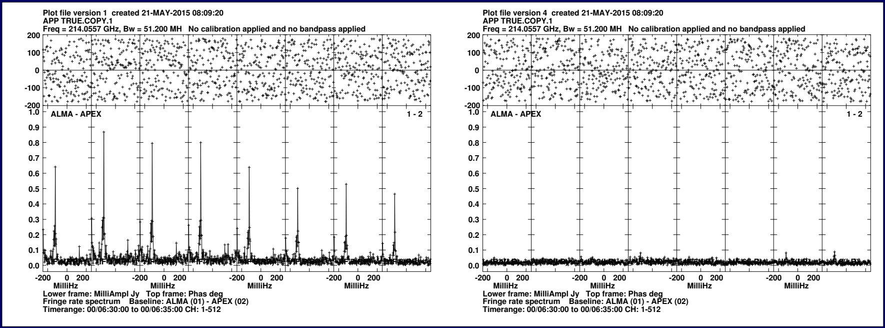

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