Polarization at IRAM Status and Plans

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30-m: EMIR and XPOL

- Credits:
  - Thum, Wiesemeyer, Paubert, Navarro & Morris
  - IRAM receiver group
  - IRAM backend group
- EMIR (Eight Mixer Receiver)
  - 4 frequencies
  - on-axis at Nasmyth focus
  - Dual linear polarization
  - Sideband Separating Mixers, 2 x 8 GHz instantaneous bandwidth each.

30-m XPOL

- A correlation polarimeter
  - I measured from sum and Q from difference of linear polarized intensities
  - U and V from correlations
  - Uses VESPA VErSatile Polarimeter and Spectral Analyzer correlator to compute all cross and parallel products.
- Plus a switchable grid into the calibration system
  - To derive the relative phase between the two linear feeds

VESPA capabilities

- Several modes
  - 40 kHz channel spacing, 120 MHz bandpass
  - 80 kHz, 240 MHz
  - 625 kHz, 480 MHz optimal for continuum
  - 2.5 MHz, two 480 MHz bands at same IF
- Mixed modes and split windows possible within limitations

XPOL tricks

- Matching of IF cable lengths between the two mixers (0.05 m over > 100 m length…)
- A new calibration step with Hot / Cold load with the wire grid at 54° to produce strong linear polarization ➔ gives relative delay
- Decorrelation loss due to phase noise in the LO measured on calibration device ➔ 14 %, consistent with measurement on sky on strong polarized sources
- U and V sign determination…
- Carefull alignment of the two mixers
- Proper orientation of the G3 grid

Performances

- Q 1.5 %
- U 0.6 % perhaps better (contamination by calibrator polarization)
- V 0.3 %
- No elevation dependency for the polarized gains to a level of 1.5 %

- See Thum et al 2008 PASP
- And IRAM web site for updates

Interferometer

- Credit
  - S.Trippe, V.Pietu, Y.W.Tang, S.Guilloteau, D.Broguière
  - IRAM receiver group
  - IRAM backend group
- Dual Frequency receivers on Plateau de Bure
- Correlator(s) only producing parallel hand products HH and VV

Interferometer

- First simple step:
  - use the parallactic angle modulation
  - So called « rotation » polarization method
- Trippe et al 2010: a survey of 86 quasars
  - Position angle to 1.2°
  - Polarization fraction to 0.1 %
  - Multi frequency : 86 to 270 GHz
  - Lab tested receiver polarization < 0.3 %
- Routinely done in standard calibration
  - Otherwise quasar polarization affects amplitude gain calibration

Interferometer

- Towards full Stokes measurement…
- Trick
  - A commutable switch in the IF system can insert either H or V receiver independently for each antenna in the two « parallel » correlators
  - With Walsh functions, all products HH, VV, HV and VH can be measured after one cycle
  - Cycle length depends on number of antennas. 8 steps for 6 antennas

Interferometer Status

- Device inserted in IF path (a cheap retrofit…)
  - 1 k€, plus one man week
- On-line software controls it
  - Currently on « long » timescales (scan length, 45 sec)
  - Software development time dominates the overall cost and schedule…
- Data calibration performed off-line
  - Good bandpass stability ➔ should be OK !
  - Relative H and V delay measurement
  - Simplification of observing procedure possible
- Ultimate performance still unknown
  - Stability is key to the accuracy
  - « rotation » polarization method results suggest stability is good
  - Although « rotation » performances obtained after filtering outliers

Interferometer

- Off-line data processing
  - CLIC modified to automate all the required steps
  - Minor (but subtle) data format modifications
  - GILDAS data format modified to handle full polarization information
  - Mapping imaging program modified to manage the polarization information
- Next steps
  - Real time control software to operate the switch every second
  - New tests foreseen for this summer

NOEMA
Northern Extended Millimeter Array

- Currently funded for 10 antennas
  - Partners for 2 more and longer baselines welcome…
- Polarization not a major design goal
  - Polarization requires a lot of sensitivity
  - ALMA better suited for this (2 types of antennas, polarization in design since the beginning)
- However, not designed out
  - will use same trick with IF switch
  - Switch will be located at different place (in antennas rather than in backend room)