Algorithm Development

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Requirements

- **EVLA**
  - Full beam, full bandwidth, full Stokes noise limited imaging
- **Algorithmic Requirements:**
  - **PB corrections:**
    - Rotation, Freq. & Poln. dependence, W-term (L-band)
  - **Multi-frequency Synthesis at 2:1 BWR**
    - PB scaling with frequency, Spectral Index variations
    - Scale and frequency sensitive deconvolution
  - **Direction dependent corrections**
    - Time varying PB, pointing offsets, polarization
Time varying gains:

- Field: 3C147
- 11 Antennas, BW=110 MHz
- Integration = 7hrs
- Gain + BandPass Calibration
- Single Baseline based correction
- DR: Peak/OffSource RMS
  - \(~700,000 : 1\)
- Limited by DD errors
  - Due to PB rotation?
  - Errors in the sidelobe

- PB rotationally asymmetric
- PB rotation with PA
- PB scaling with frequency
- Antenna pointing errors
Wide-band Imaging: Error sources

Wide-band power pattern (3 Channels spanning 1 GHz of bandwidth)

Avg. PB Spectral Index (1-2GHz)

Ideal Image

Standard Continuum Imaging

Source spectral variations

PB Effects
Requirements

- **ALMA**
  - Primarily a mosaicking telescope
  - Algorithmic Requirements:
    - **PB corrections:**
      - Imaging with heterogeneous antenna array
      - Rotation, Freq. & Poln. dependence
    - **Direction dependent corrections**
      - Time varying PB, pointing offsets, polarization
    - **Antenna pointing correction likely to be more important**
Dominant PB effects in mosaicking
Priorities and Plan

• Current development driven by EVLA
  • Strong overlap with ALMA requirements
• Narrow field, wide-band imaging (Stokes-I)
  • Ignore PB-scaling with frequency
  • Solve for sky spectral dependence

• Wider field, wide-band imaging (Stokes-I)
  • Correction for frequency dependent PB, PB rotation
  • Solve for sky spectral dependence.
Priorities and Plan

- Current development driven by EVLA

- Full-stokes, wide-band, wide-field imaging
  - Strongest error term: PB polarization
  - Also solve for position and frequency dependent sky polarization

- High dynamic range imaging
  - PB modeling, pointing errors
  - DD effects: Function of time & antenna
Status: Of the algorithms

  - Rotation with Parallactic Angle
  - Linear scaling with frequency to account for wide-band effects
Status: A-Projection (ic2233_regression.py)

Stokes-I

Stokes-V

(10x improvement)
Status: EVLA Imaging

- 3C147 field
- L-Band
- BW = 110 MHz
- 7h integration
- DR ≈ 700,000:1

(Data courtesy: R. Perley)
Status: A-Projection - EVLA Imaging
Status: Of the algorithms

  - Combined Multi-Scale and MFS
  - Sault-Wierenga algorithm a special case

- Tested once for A-Projection + MS-MFS


These data included synthesis runs with VLA A,B,C,D Array at both frequencies. Map has been smoothed to 1 arcsec.
Status: Of the algorithms

- Mosaicking with heterogeneous antennas (in size)
  - Assuming symmetric beams
  - In principle can also handle wide-band case
  - In principle can be combined with MS-MFS

- 7-pointing mosaic at C-band
  - MS-Clean + Mosaicking algorithm used

- More details in talks/demos (George/Kumar)

(Data & Image courtesy: Moellenbrock, Miller-Jones,...)
Status: Of the algorithms

- Stuff still in R&D
  - Pointing SelfCal (pointing_regression.py with simulated data)
  - Correction for pointing errors during imaging
  - Wide-band mosaicking with A-Projection for EVLA

- Wide-band polarization calibration (George's work) (?)
Plan of development

- Integrate A-Projection and MS-MFS
  - PB modeling
- Full-Stokes imaging
  - Extension of A-Projection to full-Stokes
    - Full-Stokes PB models?
  - Extension of MS-MFS to full-Stokes
- Testing of, and integration with Pointing SelfCal/DD-SelfCal
Code development & management

• Needs isolation from active branch

• Proposed solution
  • Separate R&D Branch
  • Check-in often and merge often (active → R&D)
  • Need occasional support for
    – svn merge etc. (active → R&D)
    – Visualization augmentation for R&D needs
  • If possible, make it available for the brave to use
Code development & management

- Full support required
  - In case of change in infrastructure technologies
  - Qt, Dbus, make/cmake/scons/etc.
  - Python
  - Visualization

- Move code to production-line if considered useful and usable
  - svn merge etc. (R&D → active)