Imaging and calibration errors

- Most data corruptions are separable

$$V_{ij}^{Obs}(\nu,t)=G_{ij}(\nu,t)\left(\int\int P_{ij}(\nu,t)\,I^{M}(l,m,\nu)\,e^{2\pi\iota(u_{ij}l+v_{ij}m)}\,dl\,dm\right)$$

Data — Corruptions — Sky

$G_{ij}=G_iG_j^*$ where G_i is the complex antenna based gains (direction independent)

$P_{ij}=P_i(l,m)P_j(l,m)$ where P_i is the image plane errors (direction dependent).

- Assuming $P_{ij}=1$, direction independent terms can be solved by minimizing: $\sum_{ij}|V^{Obs}-G_iG_j^*V^M|^2 \;\; w.r.t. \;\; G_i's$

- Direction dependent terms remain separable in the visibility domain, but more expensive to apply (not simple division)

$$V_{ij}^{Obs}=E_{ij}*V_{ij}^{M} \;\; where \;\; E_{ij}=E_i*E_j^* \;\; ; \;\; E_i=FT\left[P_i\right]$$

Challenges

- Explicitly incorporate the scale information in the deconvolution algorithms.
  - Widely separated pixels are coupled due to the sidelobes of the Point Spread Function (PSF). Fast computation of this coupling is a challenge.
  - Decoupling the various scales in the image, or controlling the dimensionality of the search space is a challenge.
- Solving for direction dependent corruptions as a function of time, frequency and polarization.
- Incorporate these direction dependent effects while predicting the model visibilities.
- Modeling the sky as a function of frequency and polarization

Roadmap: Wide-band imaging

(Note on "Imaging/calibration algorithm research", Aug. 2004)

- Wide-band imaging
  - Formulate the problem
  - Simulations/tests with existing algorithms
  - Scale-sensitive decomposition as a function of frequency
  - Incorporating PB effects in deconvolution

Roadmap: PB effects

- PB effects (pointing, squint, ionospheric/atmospheric)
  - Formulate the problem: Done (EVLA Memo 84)
  - Test cases: Done (EVLA Memo for the solver)
  - Single pointing imaging tests: Done (in preparation)
  - Solver: Tested for basic correctness.
  - User level tool: Work in progress
    - Application of squint and pointing correction during imaging
    - Solver for pointing offsets

Roadmap: Component based Imaging

- Scale sensitive decomposition: Asp-Clean, MS-Clean
  - Extend it to incorporate frequency dependence
  - Simulations
  - Extend the work on PB effects to work with the above during imaging

Roadmap: Inter-dependence

- Wide-band imaging needs
  - The basic Asp-Clean machinery for $I(l, m, \nu)$
  - The basic PB machinery for forward and inverse transforms $P_{ij}(l, m, \nu)$
  - Both the above for tests/simulations/actual algorithm development
- Full beam polarimetry
  - The basic PB machinery for the transforms
  - More sophisticated PB modeling
- Mosaicking
  - Pointing Selfcal + all the above
- Estimation of computing/Data I/O needs