

# Imaging and calibration errors

- Most data corruptions are separable

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

↑ Data
 ↑ Corruptions
 ↑ Sky

$G_{ij} = G_i G_j^*$  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  $P_{ij} = I$ , direction independent terms can be solved by minimizing:  $\sum_{ij} |V_{ij}^{Obs} - G_i G_j^* V^M|^2$  w.r.t.  $G_i$ 's
- Direction dependent terms remain separable in the visibility domain, but more expensive to apply (not simple division)

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

# 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