CS10 Imaging Demonstration

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Least squares image estimation

$$\boldsymbol{\sigma} = \text{argmin} \, || \, \text{vec}(\mathbf{R}) - \mathbf{M}\,\boldsymbol{\sigma} - \text{vec}(\boldsymbol{\Sigma}_n) ||_F^2$$

where

$\boldsymbol{\sigma}$: Qx1 vector of fluxes for each map

$\mathbf{R}$: PxP matrix with visibilities

$\mathbf{M}$: P^2 x Q matrix describing data model

$\boldsymbol{\Sigma}_n$: PxP matrix describing noise covariance

solution: $\boldsymbol{\sigma} = \mathbf{M}^{+} \, \text{vec}(\mathbf{R} - \boldsymbol{\Sigma}_n)$

Interesting results

snapshot: $\boldsymbol{\sigma} = \mathbf{M}_d^{-1} (\mathbf{M}_0^{H} \mathrm{vec}(\mathbf{R} - \boldsymbol{\Sigma}_n)) = \mathbf{M}_d^{-1} \boldsymbol{\sigma}_d$

synthesis: $\mathbf{M}_d = \sum_i \mathbf{M}_{di}$ and $\boldsymbol{\sigma}_d = \sum_i \boldsymbol{\sigma}_{di}$

deconvolution matrix properties:

- max size QxQ
- arbitrary time varying gain variations
- arbitrary time varying (primary) beams
- no explicit inversion required
- condition number determines resolution

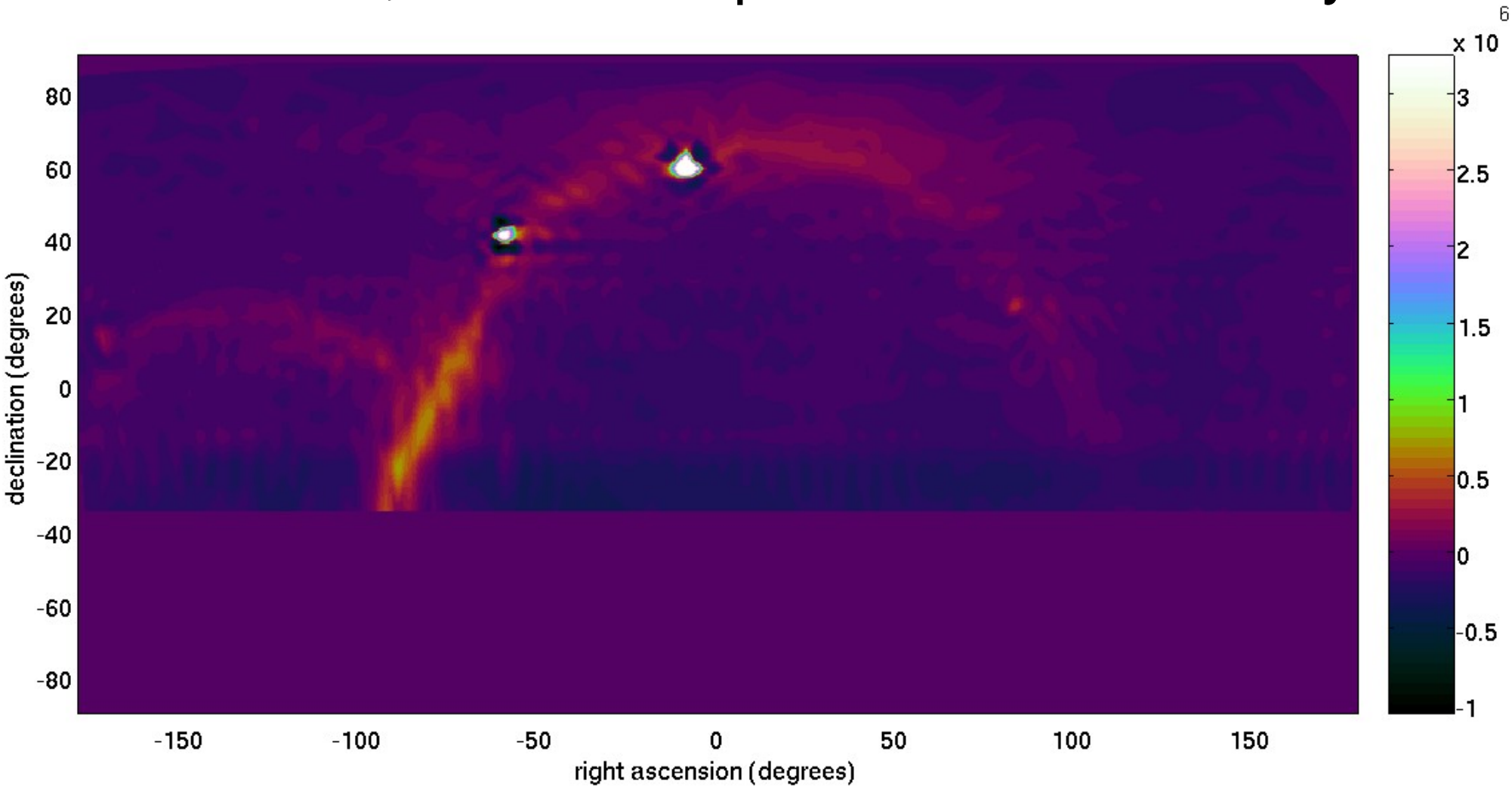
Live demonstration with CS10

Parameters:

- 30-90 MHz filter
- 160 MHz (156 kHz/sb, aliasing above 70 MHz)
- 27 subbands between 45.3 and 67.3 MHz
- 10 s integration per subband
- online reduction including calibration
- gradual build-up of image
- resolution: 0.75 λ_{min}/D

CS10 all-sky map at 58.398 MHz

1 195 kHz sb, 508 1s snapshots over three days



CS10 all-sky map with primary beam correction

assumed element beam from EM-simulations