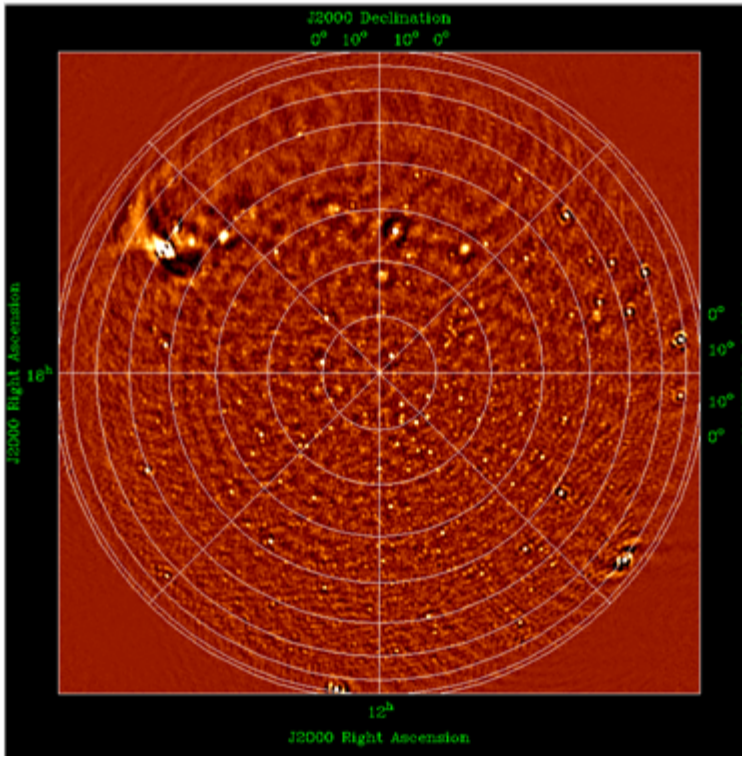
Status of the Standard Imaging Pipeline



Ronald Nijboer (ASTRON)

On behalf of the LOFAR “Off-line” team

Netherlands Organisation for Scientific Research

ASTRON is part of the Netherlands Organisation for Scientific Research (NWO)

Documentation

http://www.lofar.org/operations/doku.php?id=software:standard_imaging_pipeline

OLAP processing

- Subband passband correction at OLAP - John Romein

DPPP

- Pre-flag document - V.N. Pandey
- DPPP documentation
- LOFAR Data Processing School DPPP Exercise

BBS

- Outdated (?) BBS page
- Outdated (?) CS1 BBS page
- Commissioning of BBS
- Initial BBS performance 07Jan08 - Joris van Zwieten
- LOFAR Data Processing School BBS Exercise

MeqTree

- Lions: Ionospheric Simulations

MWImager / CImager

- Specification of the Frequency Resolution - Ger de Bruyn
- Commissioning of the Imager

Source Finding

- TKP Source Extraction System - John Swinbank
- TKP source extraction code description - Hanno Spreeuw
- TKP notes on Duchamp - John Swinbank

Global Sky Model

- Database solutions - Bart Scheers

Integration of the Standard Imaging Pipeline

- Standard Imaging Pipeline: first results 09Dec08 - Marcel Loose
- TKP pipeline framework - John Swinbank

ParSet documentation

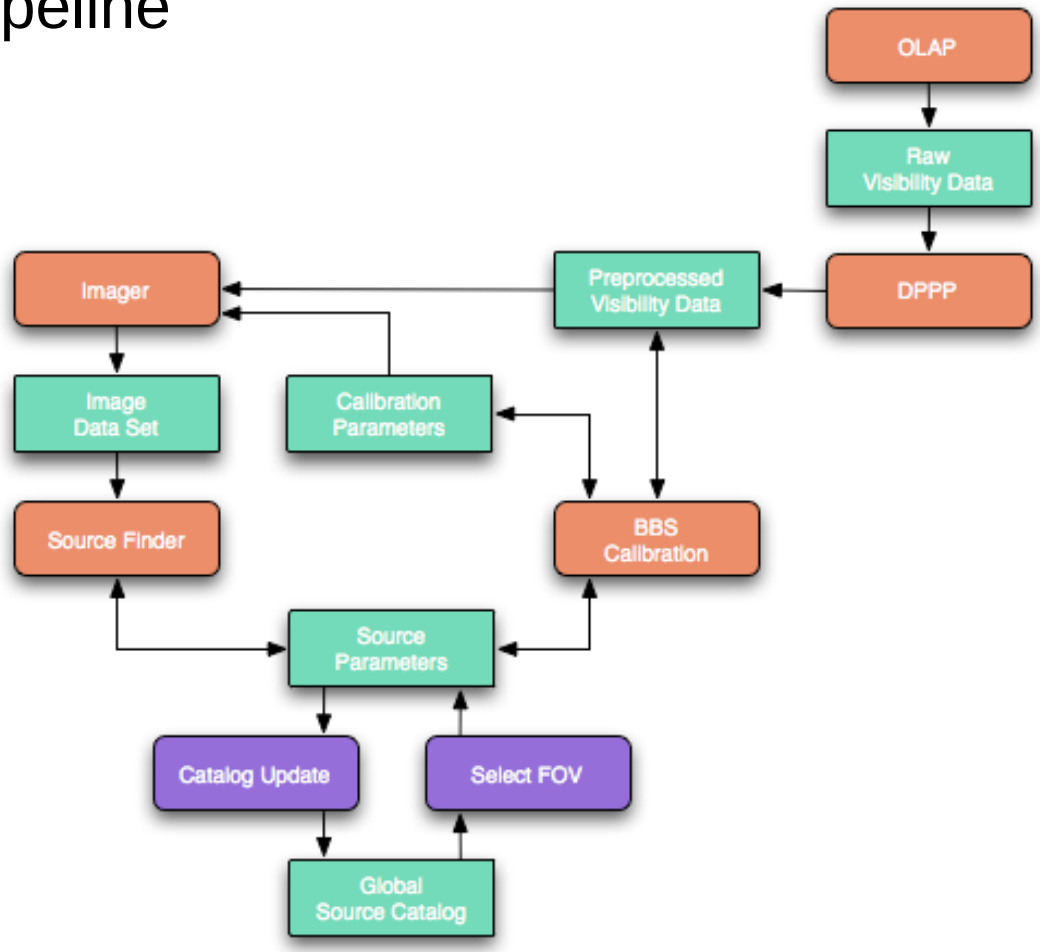
- DPPP: DPPP parameter set documentation
- BBS: BBS parameter set documentation

Other documents

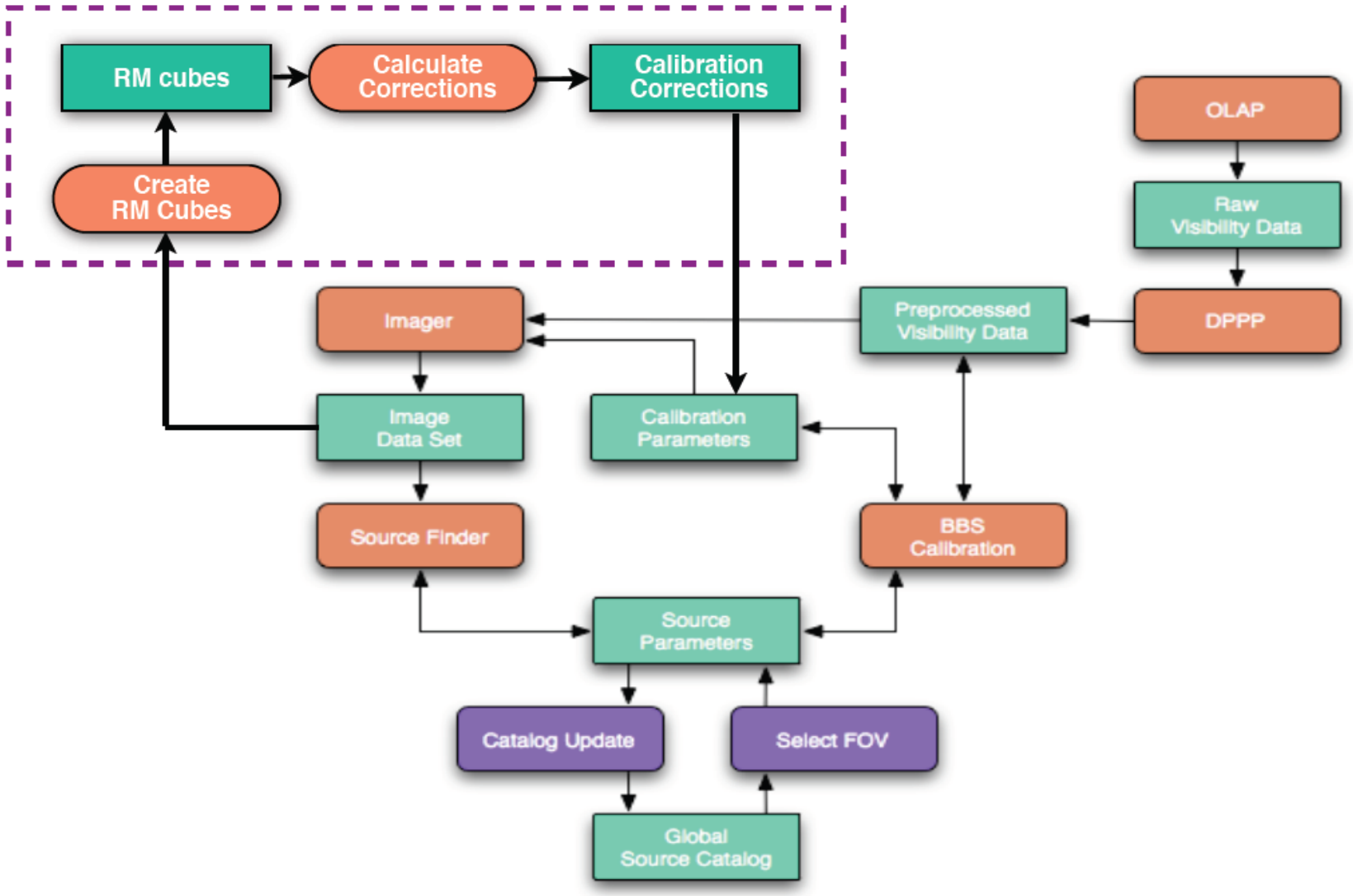
- Notes on IPython - John Swinbank

Imaging pipelines

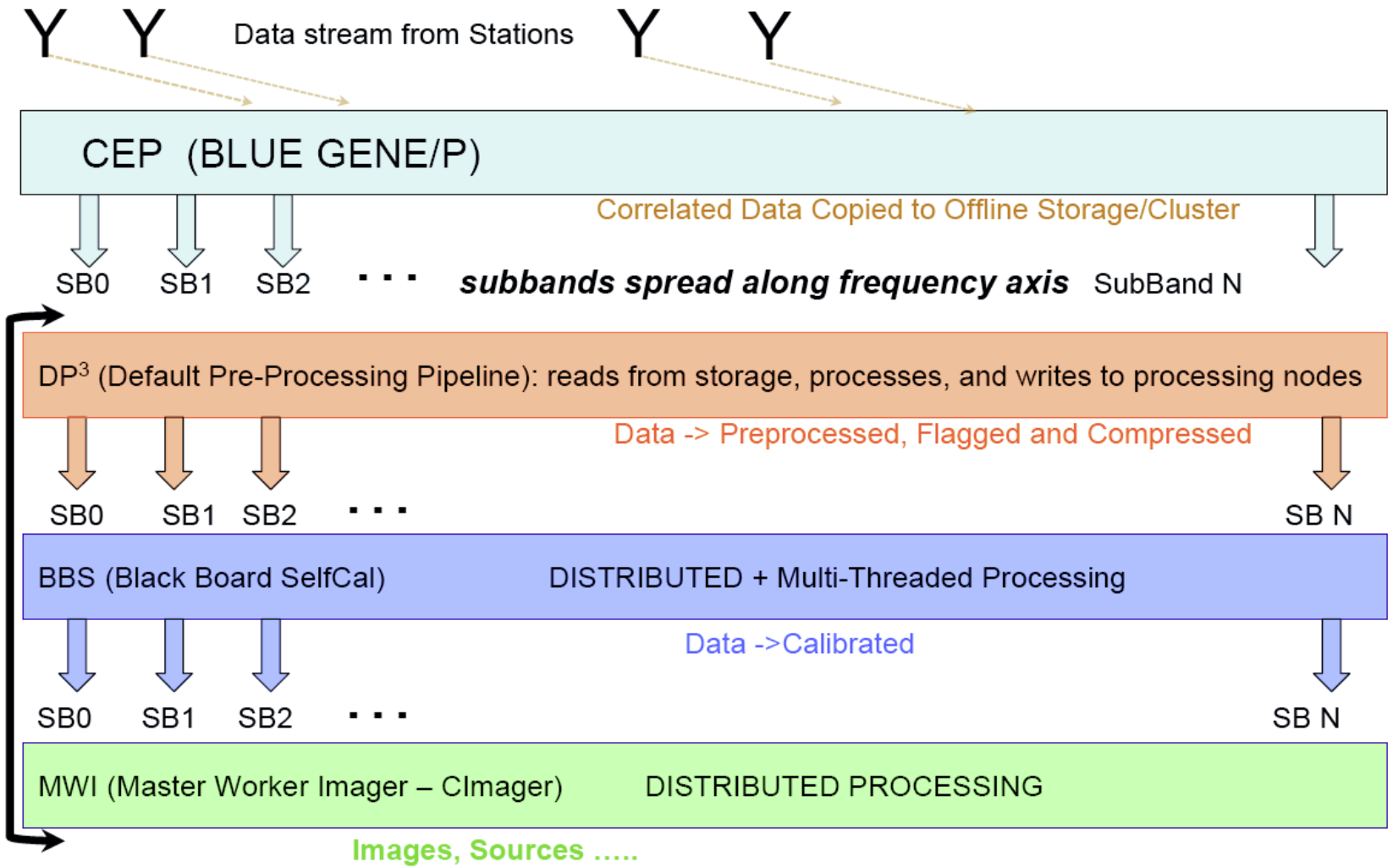
- Standard Imaging Pipeline
- Precursor for
  - Surveys pipeline
  - EoR pipeline
  - Transients pipeline
  - Magnetism pipeline
  - Solar pipeline



Magnetism pipeline

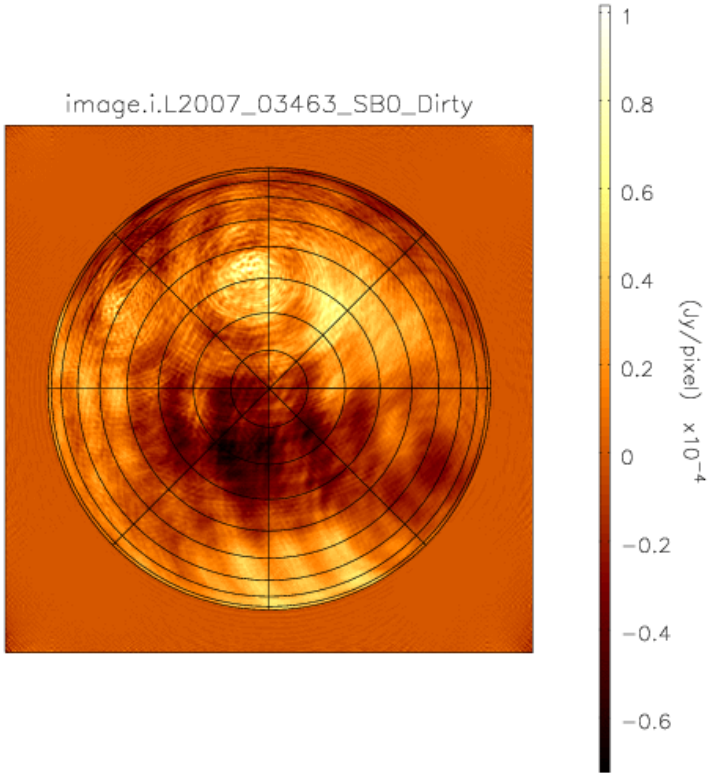


Distributed Processing (1)



Distributed processing (2)

- Uses .vds file for describing the cluster configuration and data distribution



Default Pre-Processing Pipeline (DPPP)

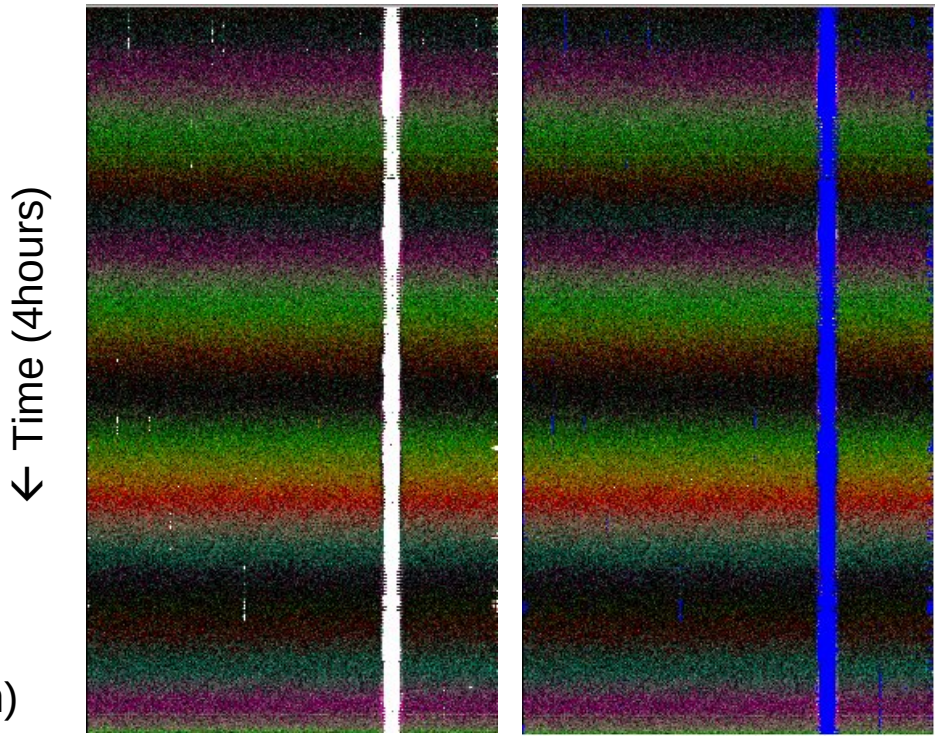
• Sub-component	• Status
– Flagging	– To be commissioned
• A-priori knowledge	
• Algorithmic (RFI, …)	
– Application of global bandpass correction	– To be implemented
– Correction for clock drifts	– Under investigation
– Solving for and subtraction of the A-Team	– To be investigated
– Compression of data	– Ready
• Time	
• Frequency	
• Combining of Subbands / MSs	• Ready

DPPP: RFI Flagging

- Algorithms
  - Frequency Flagger
  - Complex Median Flagger
  - Modified Complex Median Flagger
  - Binning Flagger
  - MAD Flagger
- For details: Pandey / Adriaan Renting

MS9315 (40MHzOct 24,2008)

No absolute Threshold Flagging

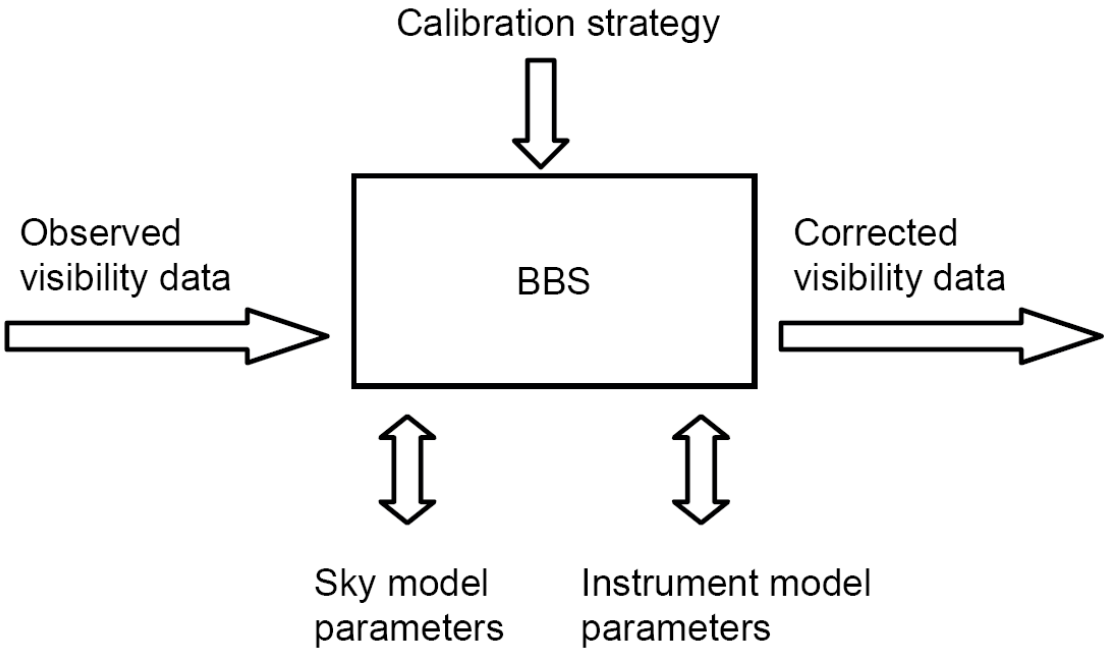


BlackBoard Selfcal (BBS)

- Two calibration packages are being used and developed:
  - MeqTrees is being used to increase our understanding
  - In BBS we will implement what we have learned
- BBS
  - Emphasis on performance, batch-mode operation, and distributed processing of large data volumes
  - Integrated with SAS / MAC / OLAP
  - Performance is being optimized
    - Disk I/O is being minimized
    - Memory I/O is being optimized
  - BlackBoard design pattern for distributed processing
    - Pool of independent processes operate on shared memory
    - A central control process examines the black board and decides what is to be done next depending on the current state
    - BlackBoard implemented as a database

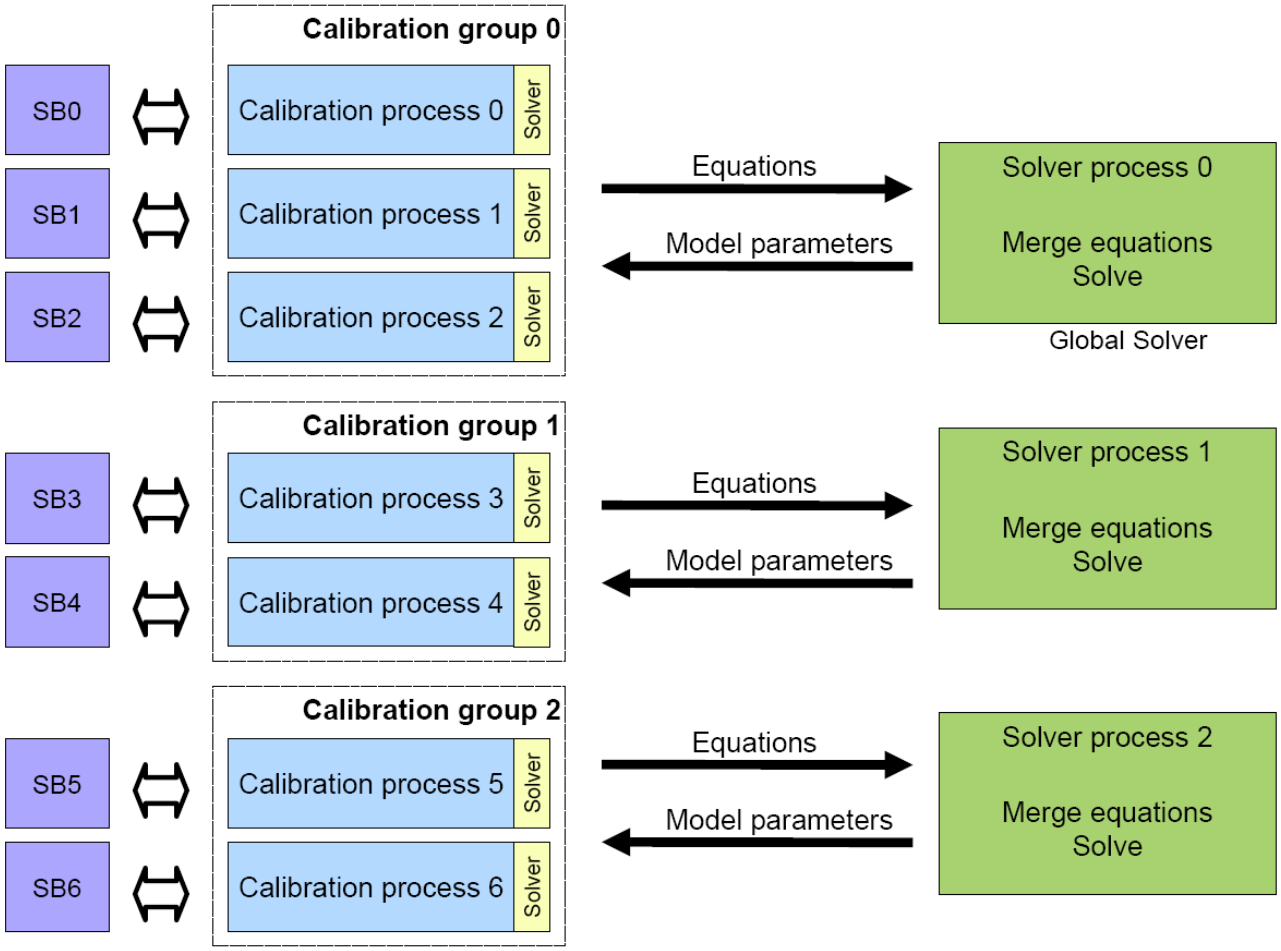
BBS: calibration Strategy

- Calibration strategy
  - List of processing steps to perform
    - Predict, Solve, Subtract, Correct
  - Hierarchical specification
  - Calibration steps are defined in a parset file



BBS: Global Solver

- BBS supports parameter fitting across subbands



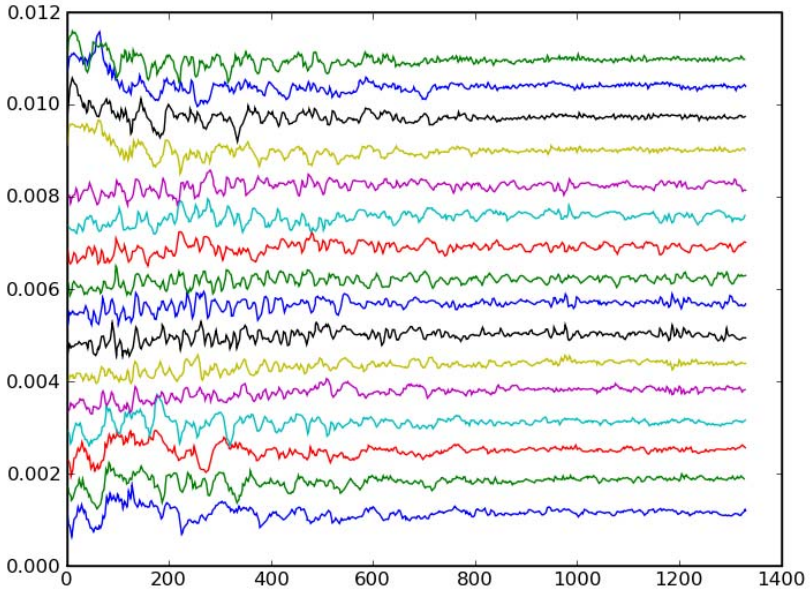
BBS: capabilities

- Parameter types
  - Constants
  - Polynomials of frequency and/or time
- Source models
  - Point source
  - Elliptical Gaussian: to be tested
  - Shapelets: to be implemented
  - (Higher order) Spectral index: to be implemented
- Instrument models
  - Bandpass
  - (Directional) Gain (Simultaneous)
  - Basic Ionospheric model (SPAM based; Mevius, Intema): to be further tested
  - Beam
    - Analytical dipole model (S. Yatawatta)
    - Semi-analytical dipole model (J.P. Hamaker)
    - Full station beam: to be implemented
  - Excising unphysical solutions: in progress

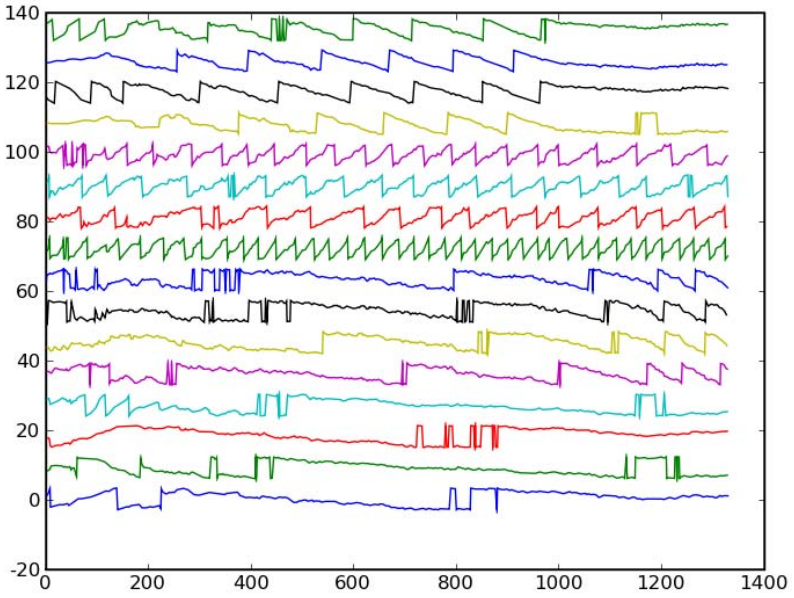
BBS: data inspection

- Calibration parameter values are stored in a database
- Parm Facade, a Python interface, is available

amplitude

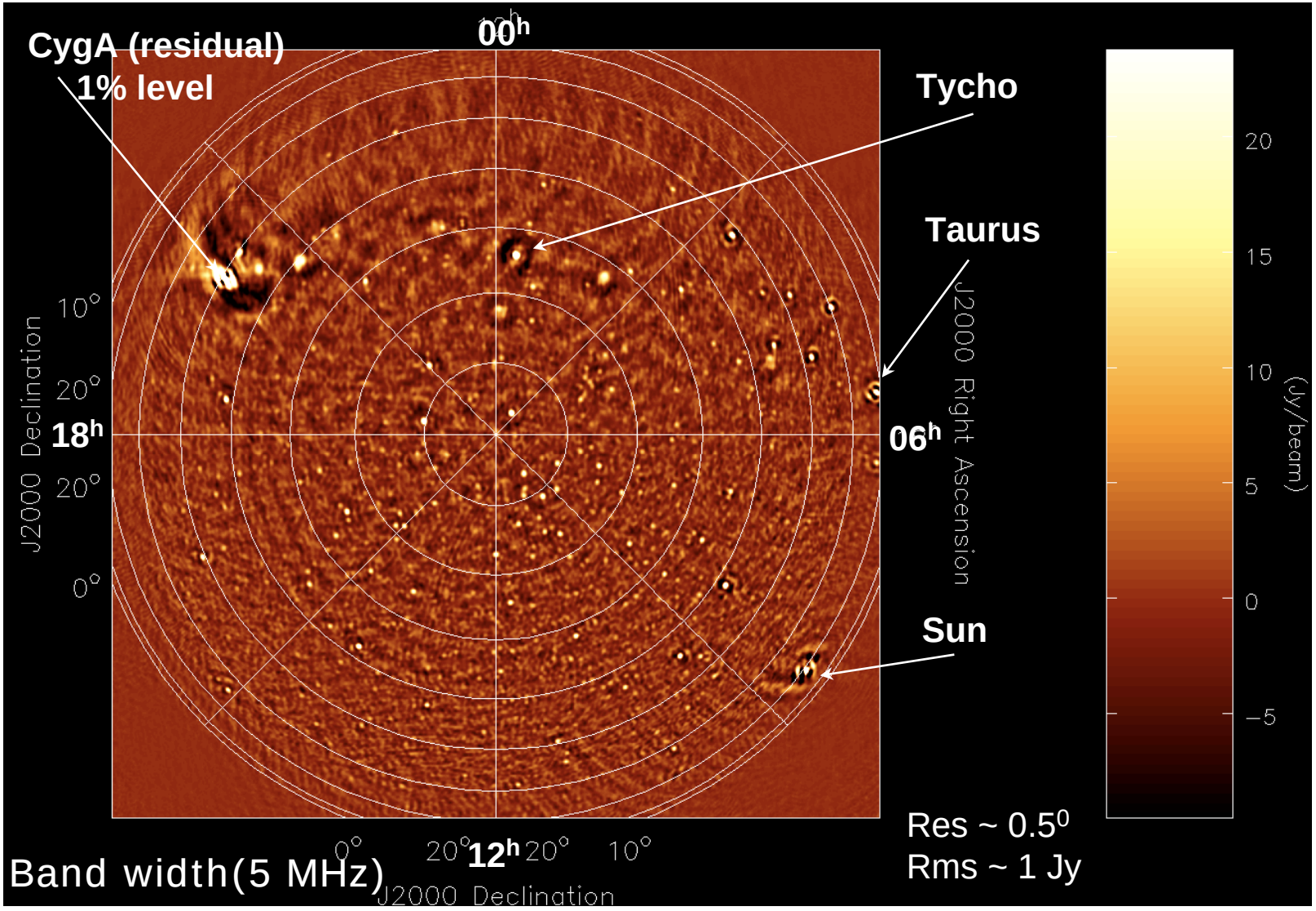


phase



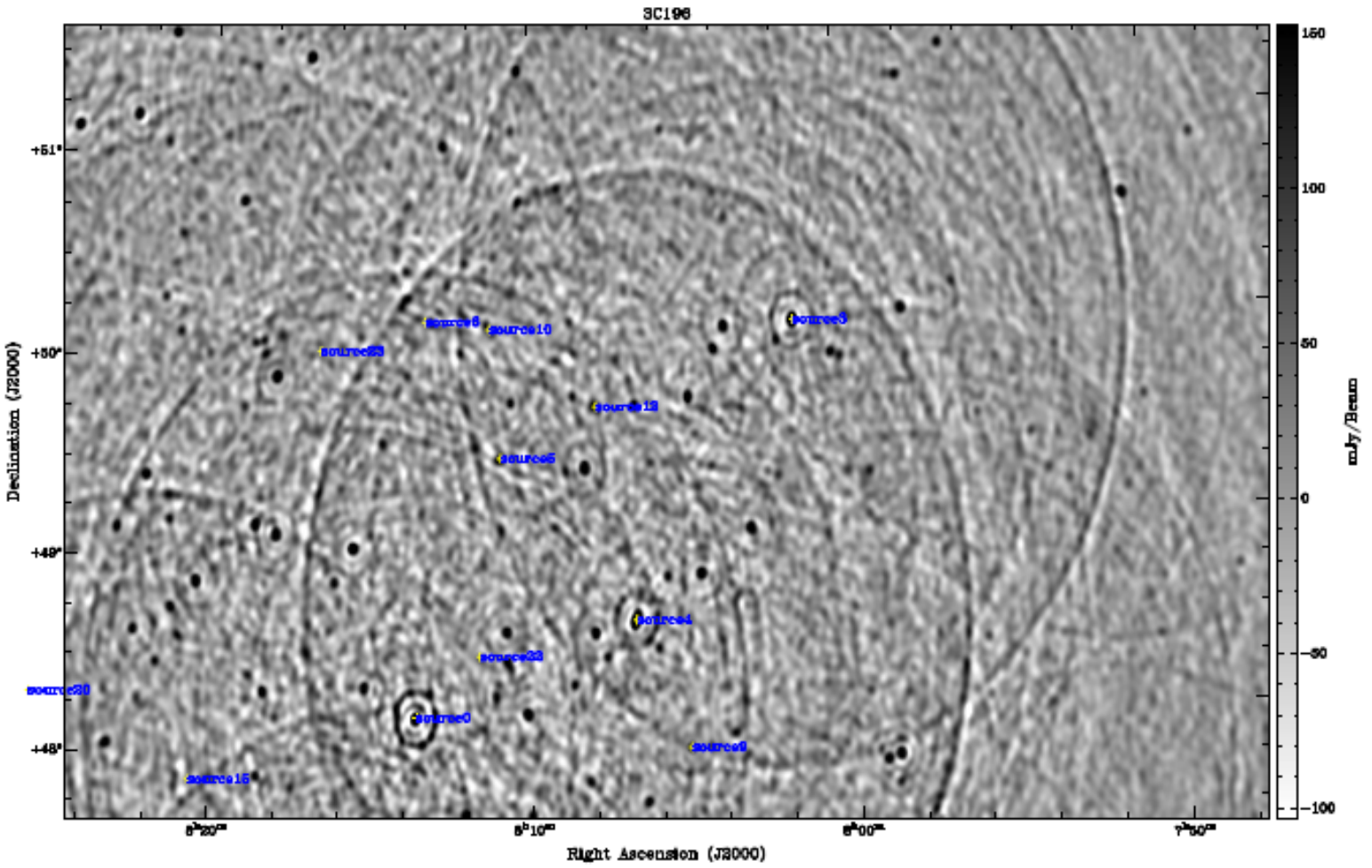
time

BBS: CS1 all sky image



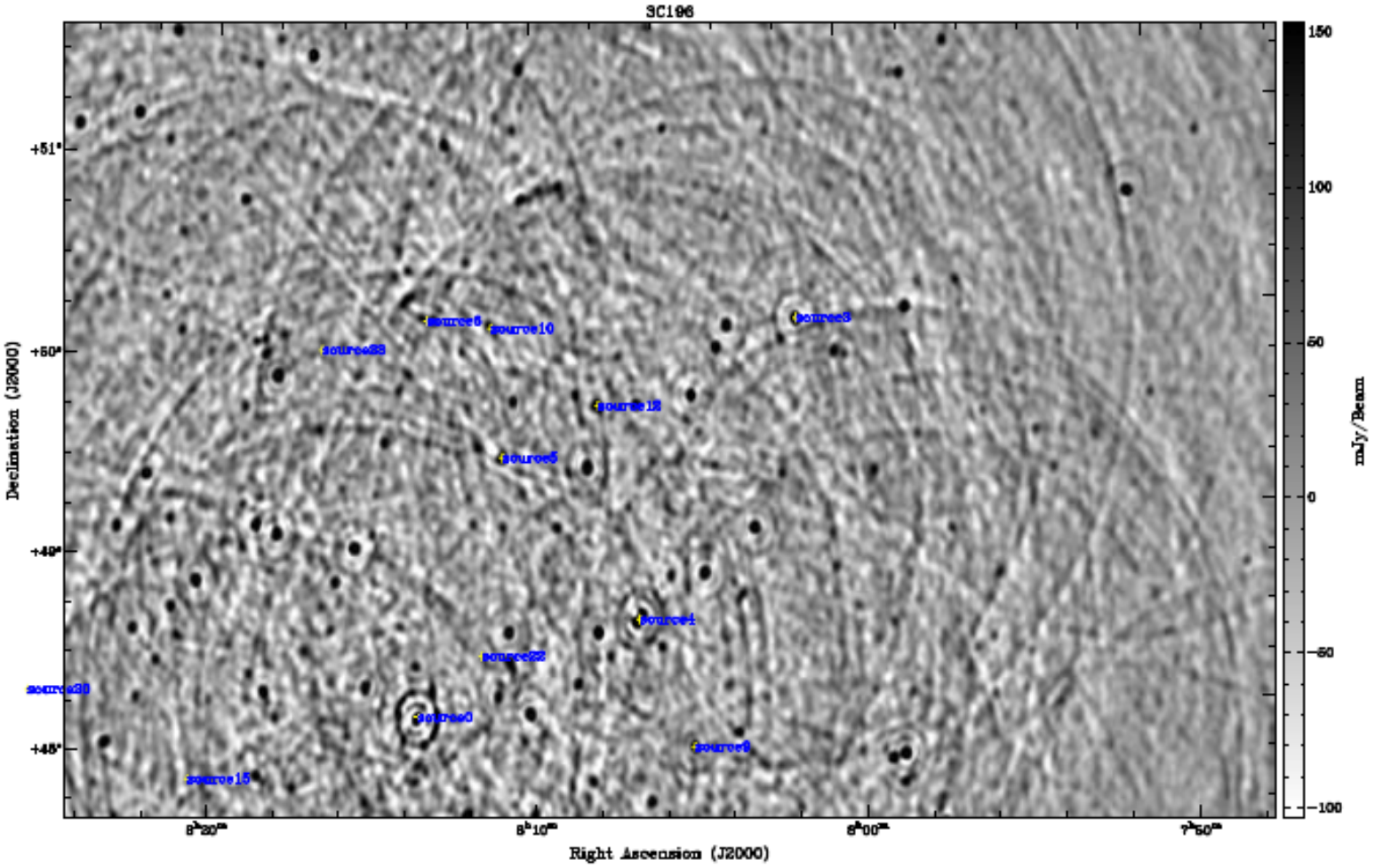
Deep all sky wide field (full hemisphere centered on North Celestial Pole)

BBS: WSRT Ionosphere (1)



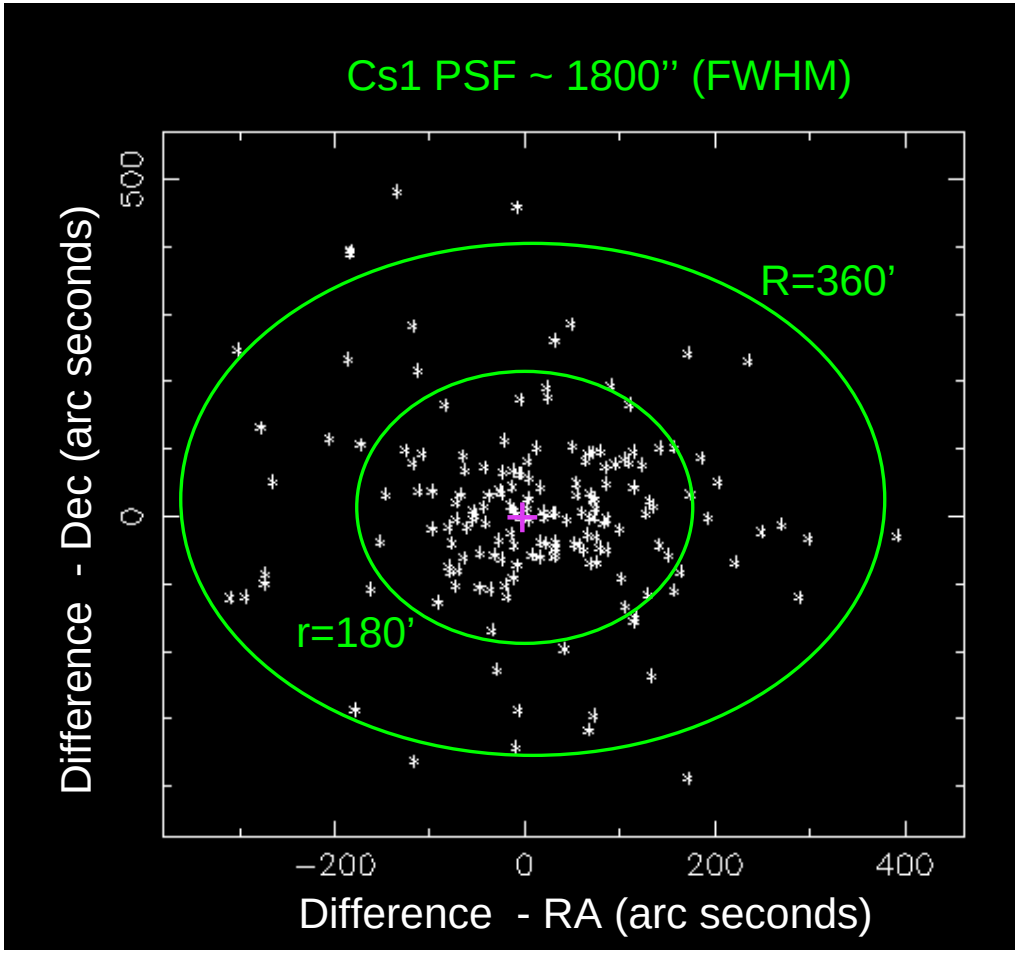
Residual image using 5 Peeling solutions

BBS: WSRT Ionosphere (2)



Residual image using 8 parameter phase screen

BBS: consistency of source positions



- Self consistent
- mean RA offset =1/150 (PSF)
- mean Dec offset =1/250 (PSF)

Comparison NVSS

- Position accurate to
- mean RA offset =2.5% of the PSF
- mean Dec offset =3% of the PSF

Further improvements

- Use more subbands
- Include dipole beam (2 pass solution)
- Exclude data when calibrator sources are near the horizon

Imager

CImager

- Distributed use through MWImager
  -
- Full polarization: not available
- Weighting schemes: available
  - Go through the data once (Wiener filtering technique)
- Facet imaging: being implemented
  - Problems with efficiency being investigated
- Facet based correction (to be done)
  - Also needs interface to interpolated calibration solutions
- W-projection: available
- Deconvolution: available
  - Also global deconvolution (Global Solver).
- Uv-taper: available
- Channel imaging: almost done
- AW-Projection: availability for LOFAR unknown.

CASA Imager

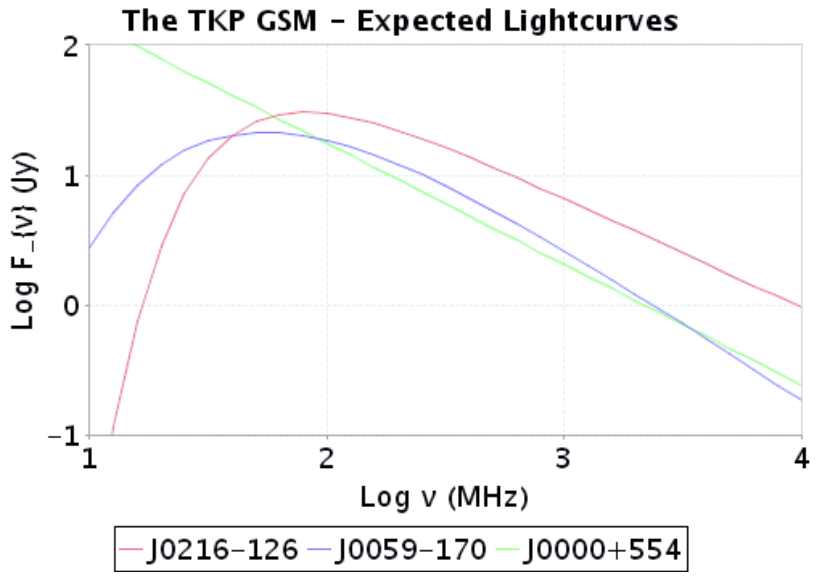
- Building of Python bindings may be tricky
- Distributed use through MWImager possible
  - ParSet needs conversion to Python script input (to be done)
- Full polarization: available
- Weighting schemes: available
  - Go through the data twice (may not be a problem for MSSS)
  - Otherwise: natural weighting
- Facet imaging: available
- Facet based correction (to be done)
  - Also needs interface to interpolated calibration solutions
- W-projection: available (also per facet)
- Deconvolution: available per MS
  - No global deconvolution.
- Uv-taper: available
- Channel imaging: available
- A-Projection: to be put into CASA
- Construction of Model and Corrected Data column to be removed

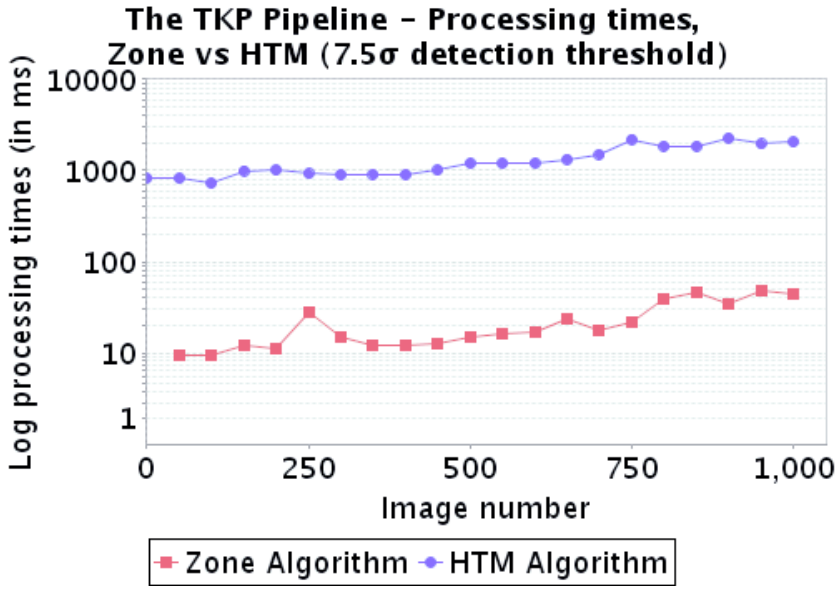
Source Finding

- Procedure
  - Find sources in image cubes per frequency plane
  - Find source parameters / associate over freq. planes
  - Update Local Sky Model for next iteration of Major Cycle
  - Merge final results in Global Sky Model
- Current implementations
  - (py)BDSM by N. Mohan (extensive features)
  - Transient module (fast)

Local and Global Sky Models (LSM / GSM)

- GSM stored as a database
  - Many predictive functions available
  - Python interface for access
  - Filled with VLSS, WENSS, NVSS, 3C, 8C, …
- LSM currently a text file
  - To be upgraded to a database





Summary (MSSS) Processing steps

Software Component	Status
• External calibration	
– Global Bandpass	• Non-existent
	– To be investigated
• Pre-processing of the data	• Existent
– Flagging of RFI, …	– To be commissioned
– Application of global bandpass correction	– To be implemented
– Correction for clock drifts	– Under investigation
– Solving for and subtraction of the A-Team	– To be investigated
– Compression of data	– Ready
• Uv-plane calibration	• Existent
– Phases	– Needs complex source models to be implemented
– Gains	
• Direction dependent calibration	• Existent
– Total Intensity calibration (using Cat I sources)	– Approach needs to be updated
• Ionospheric phase: SPAM based	• To be commissioned
• Station beams	• To be investigated
• Cat II subtraction	• Ready
• Imaging in facets	• Existent
– Correction per facet	– To be implemented
• Image combining	• Unknown
• Source finding	• Existent
– Sky model update	– To be implemented

Summary SIP additional tasks

• Characterization of A-team sources	• To be investigated
• Solution based flagging in BBS	• In progress
• LSM / GSM	• In progress
• Filling of initial GSM	• In progress
• Integration of components in the pipeline	• In progress
• Closing of Major Cycle	• To be implemented
• Deployment of code on multi-core machines	• To be implemented
• MSSS preparation – Observational issues – Absolute flux scale – Data quality checks	• To be investigated

Development and commissioning team

- DPPP
  - Adriaan Renting
  - V.N. Pandey

- BBS
  - Joris van Zwieten
  - Marcel Loose
  - Maaijke Mevius
  - V.N. Pandey

MM

- Imager
  - Ger van Diepen
  - ASKAP team
  - Evert Rol

ER

- Source Finding
  - John Swinbank

- RM Synthesis
  - Sven Duscha

- LSM / GSM
  - Ger van Diepen
  - Bart Scheers

- Pipeline Integration
  - Marcel Loose

- Calibration Project Scientist
  - Ger de Bruyn

- Calibration Project Manager
  - Ronald Nijboer