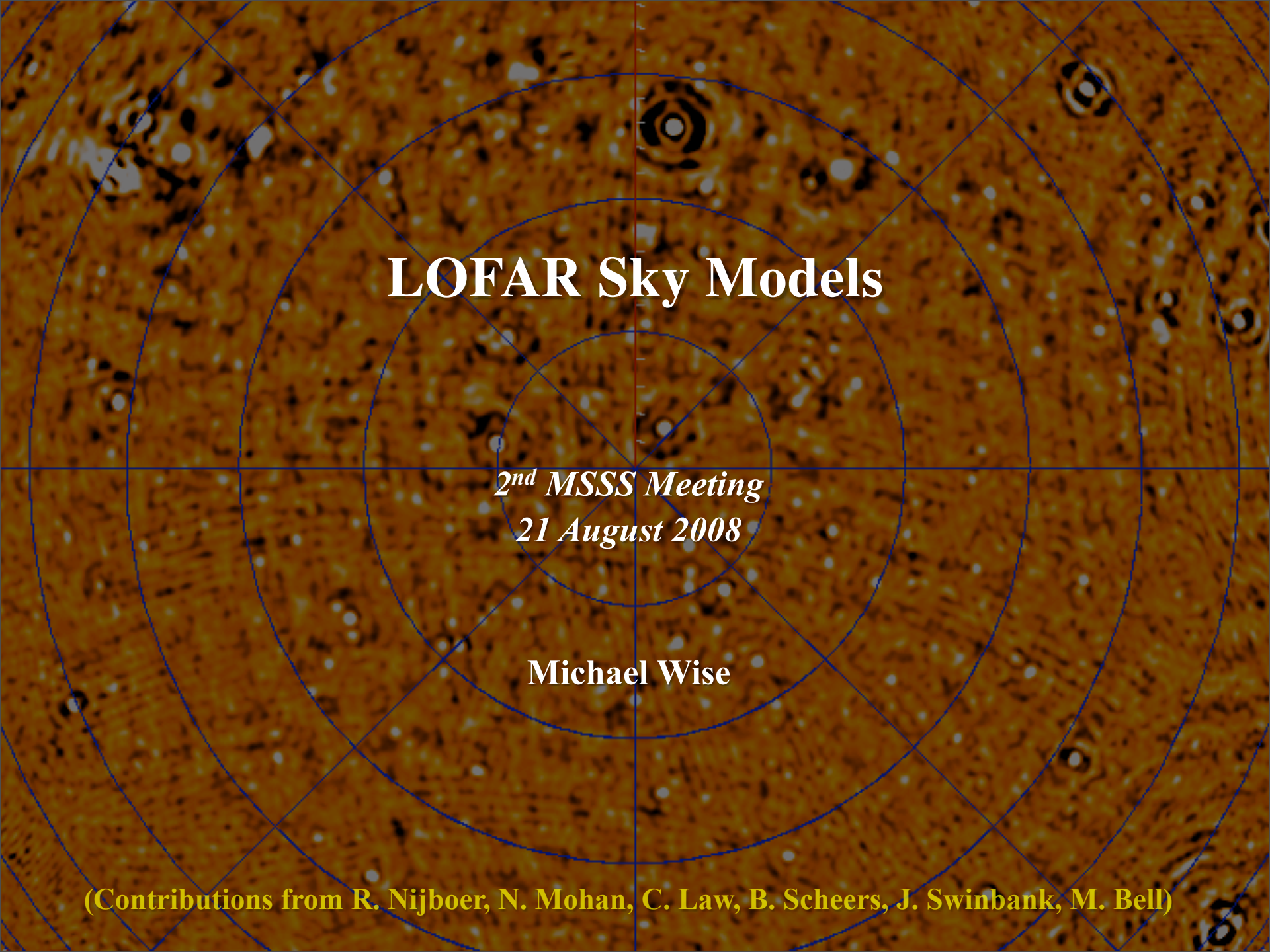
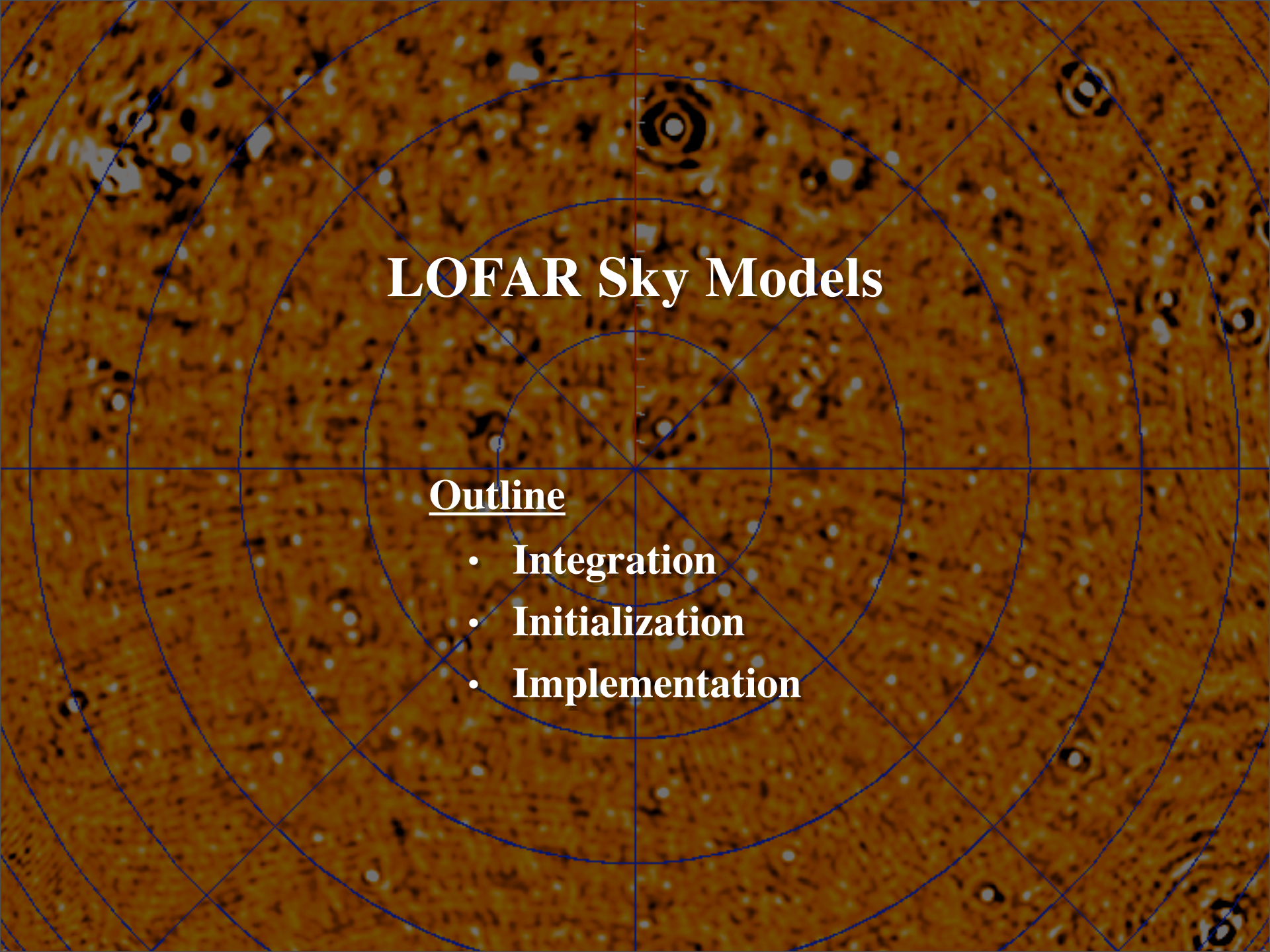


LOFAR Sky Models

2nd MSSS Meeting
21 August 2008

Michael Wise

(Contributions from R. Nijboer, N. Mohan, C. Law, B. Scheers, J. Swinbank, M. Bell)

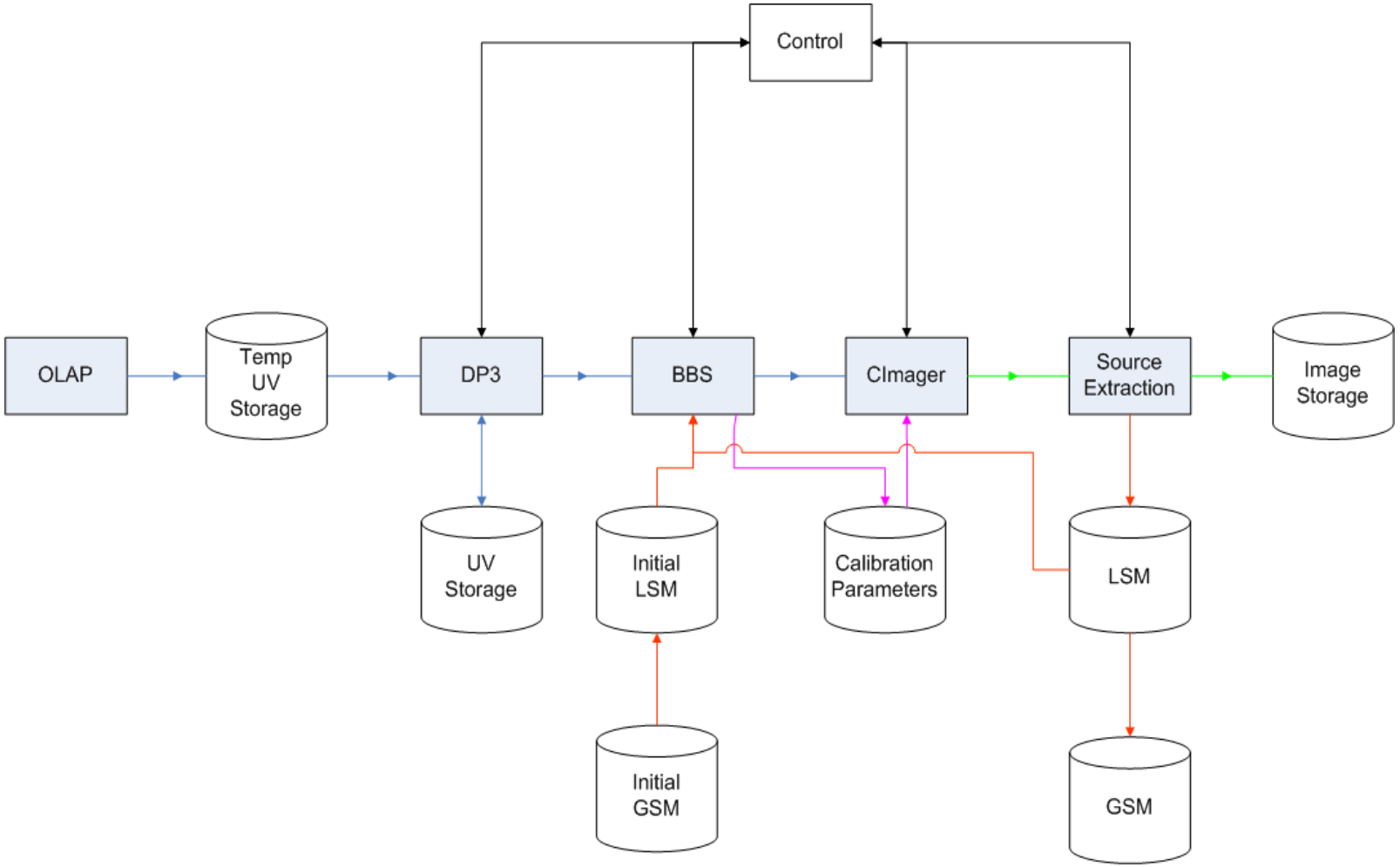


LOFAR Sky Models

Outline

- Integration
- Initialization
- Implementation

Standard Imaging Pipeline



Sky Models

Global Sky Model (GSM)

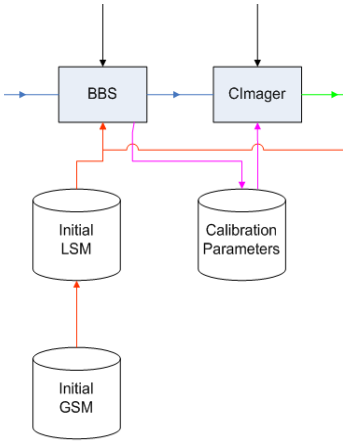
- All-sky source database
- Spatial, spectral, and temporal(?) information
- Provides initial values for pipeline LSM(s)
- Ingests refined LSM(s) from pipelines
- Improves over time

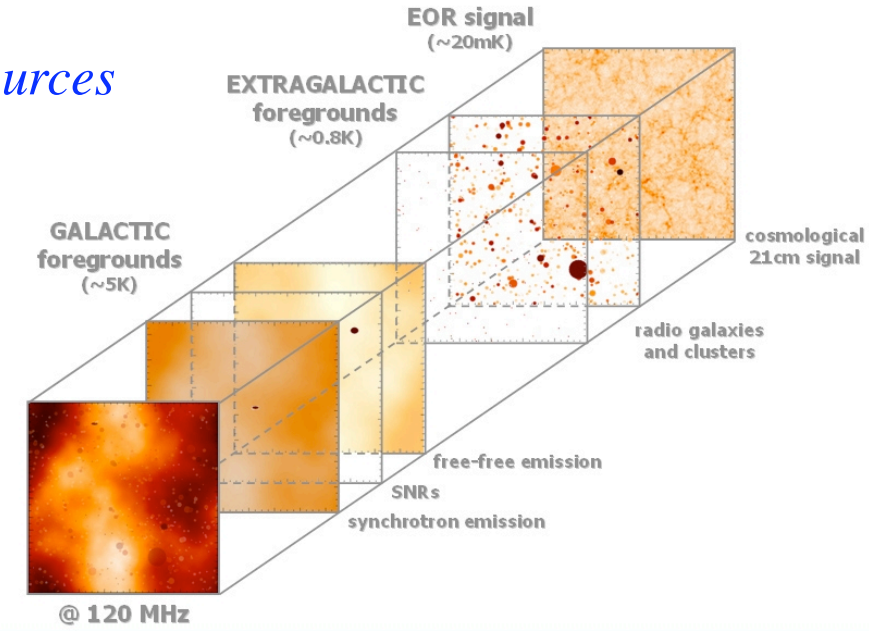
Local Sky Model (LSM)

- Subset of GSM used by a particular pipeline
- Both input and output for pipeline components
- Multiple interfaces required (*GSM*, *BBS*, *DP*^{3},...)
- May need pipeline-specific implementations
- Potential data product

Multiple Applications

- Calibration
  - *Used as initial inputs to BBS*
  - *Final LSM useful for diagnosis and reprocessing*
- Surveys
  - *Used to construct master source lists*
  - *Estimate spectral indices for sources*
- Transients
  - *Identify and monitor known sources*
  - *Detect new transient sources*
- EoR
  - *Subtract foregrounds*





Content

Source parameters

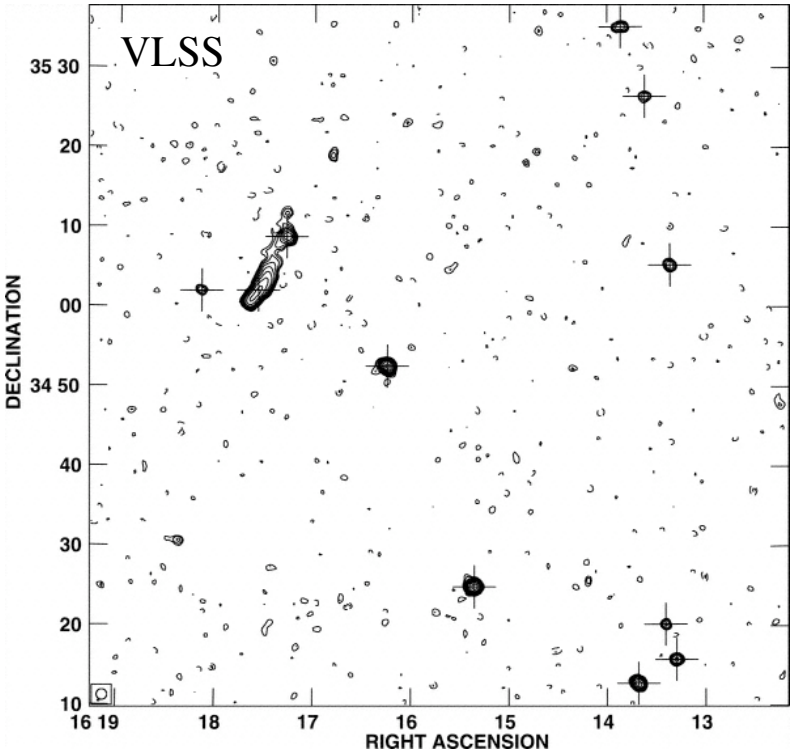
- Positions, fluxes (IQUV), polarization properties
- Size and shape characterization (Gaussians, shapelets, Bessel functions, etc.)
- All as functions of frequency coverage
- Derived quantities (spectral index)
- Source classification information
- Temporal information (time tagging)
- Ephemeris for moving objects(?)
- Errors on everything

Related information

- Ionosphere model parameters (time, frequency)
- RFI sources (time, position, frequency)

Input Catalogs

- VLSS
  - *74 MHz, 80 arcsec FWHM*
  - *70,000 sources*
- WENSS
  - *325 MHz, 54 arcsec FWHM*
  - *~300,000 sources*
- NVSS
  - *1.4 GHz, 45 arcsec FWHM*
  - *1.8x10^6 sources*
- 8C
  - *38 Mhz, 4.5 arcmin FWHM*
  - *~5000 sources*



Cohen et al. (2007)

MSSS ⇒ 60 MHz, ~82 arcsec FWHM
150 MHz, ~33 arcsec FWHM

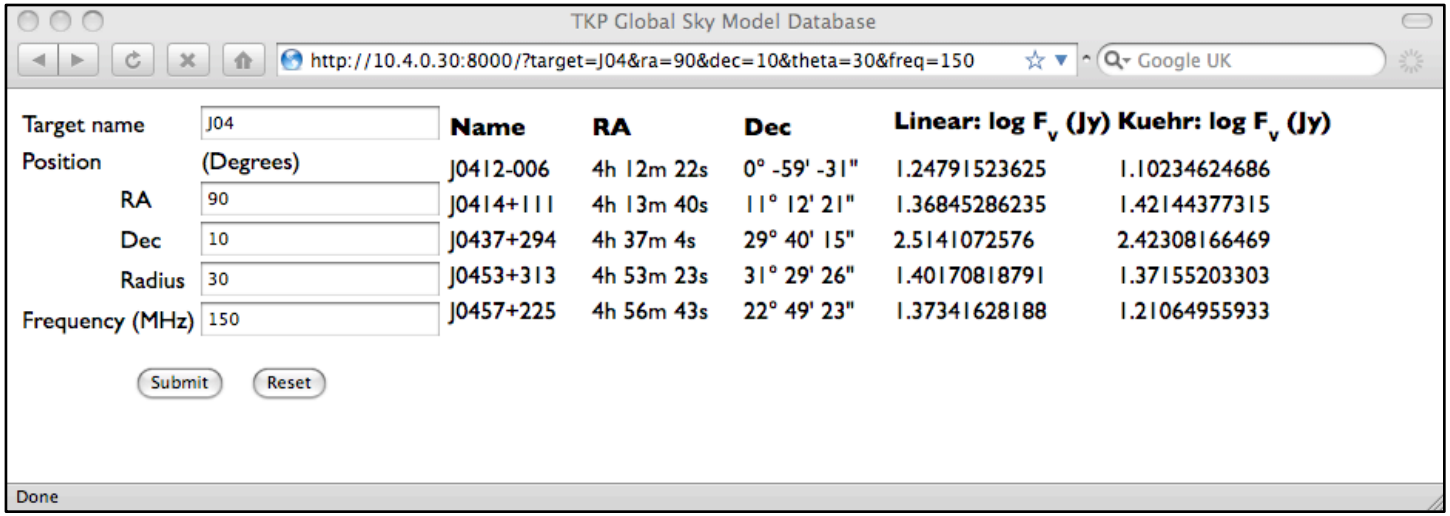
Required Functionality

- Extract LSM from GSM
  - *Return source lists and parameters for FOV*
  - *Fast cone search on position and radius*
- Predicted source fluxes
  - *Return predicted flux at intermediate frequencies*
  - *Support various standard spectral models*
  - *Helmboldt et al. (2008) spectral fits to 74 MHz sources*
- Predicted sky maps
  - *Convolve source shape models to desired resolution*
  - *How to handle poorly resolved sources?*
- Associate catalog source lists

Implementation

Sky Models

- GSM is a database (*MySQL, PostgreSQL?, MonetDB?, Oracle?*)
- Many predictive functions implemented in database
- Python interfaces provided for database access
- Prototype already exists
- Simulated maps created using external tools *(ORGSM, N. Mohan)*



Example query on prototype GSM database

Implementation

Sky Models

- GSM is a database (*MySQL, PostgreSQL?, MonetDB?, Oracle?*)
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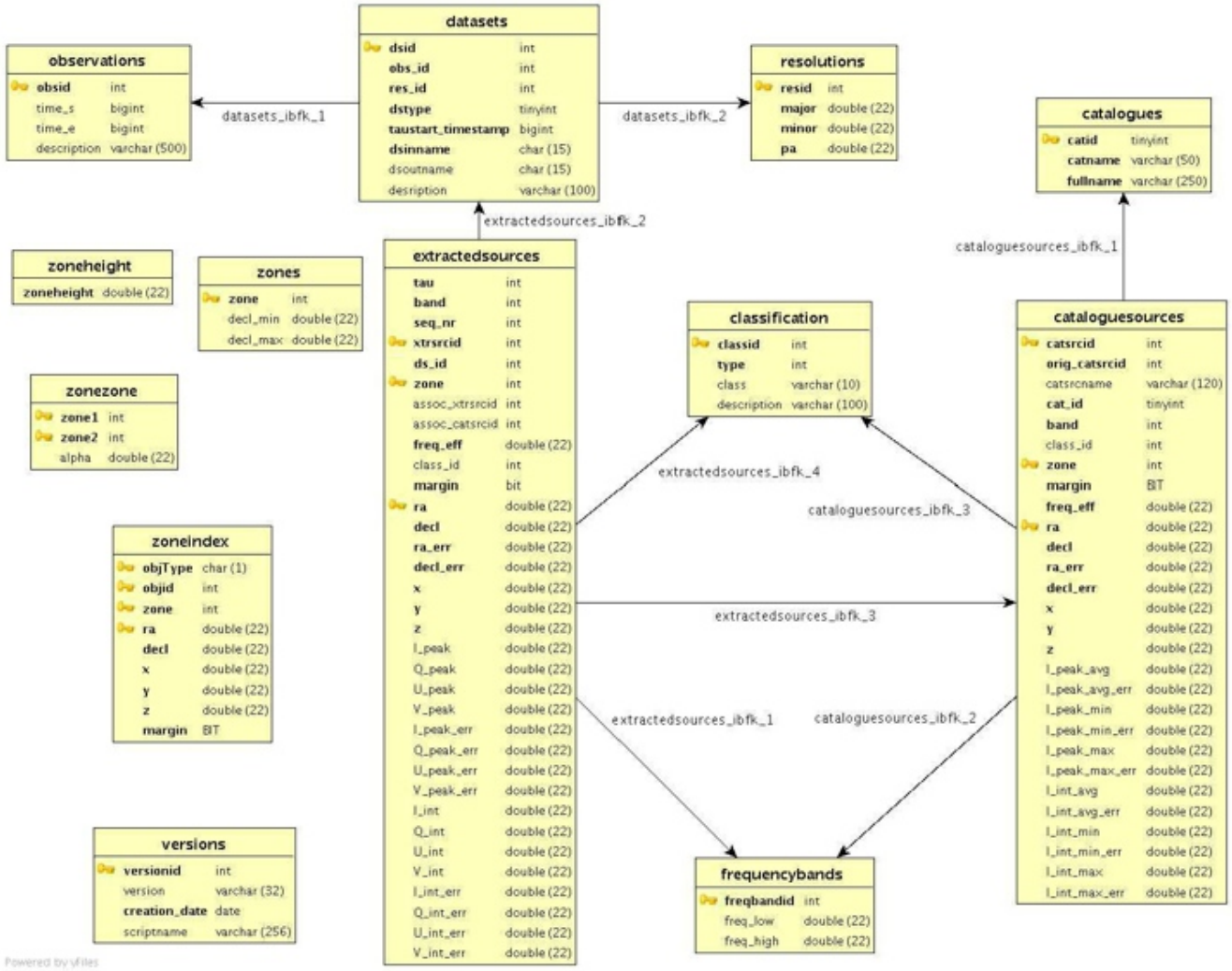
```
SELECT alpha_gt_300 * LOG10(@nu/74) + LOG10(f_ext) AS 'linear: log F_{nu} (Jy)'
    ,CASE WHEN param_a IS NULL
        THEN NULL
        ELSE param_a +
            IFNULL(param_b, 0) * LOG10(@nu/74) +
            IFNULL(param_c, 0) * EXP(IFNULL(param_d, 0) * LOG10(@nu/74))
        END AS 'Kuehr: log F_{nu} (Jy)'
 FROM sources src
    ,spectralparameters sp
WHERE spectral_params_id = spectral_paramsid
 AND src_name = @source_name
```

Example of MySQL stored procedure

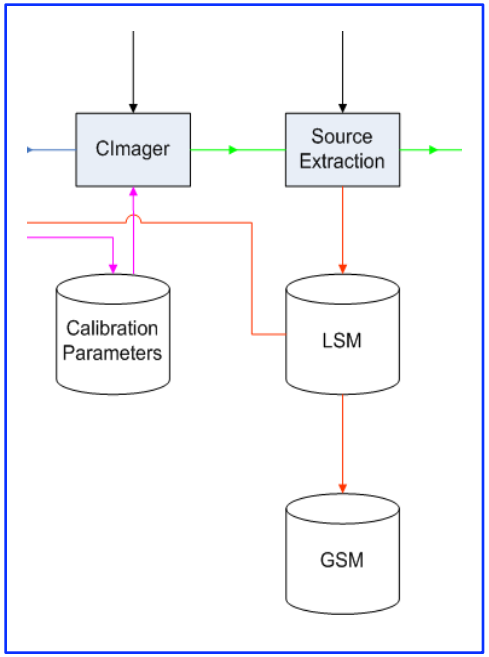
Implementation

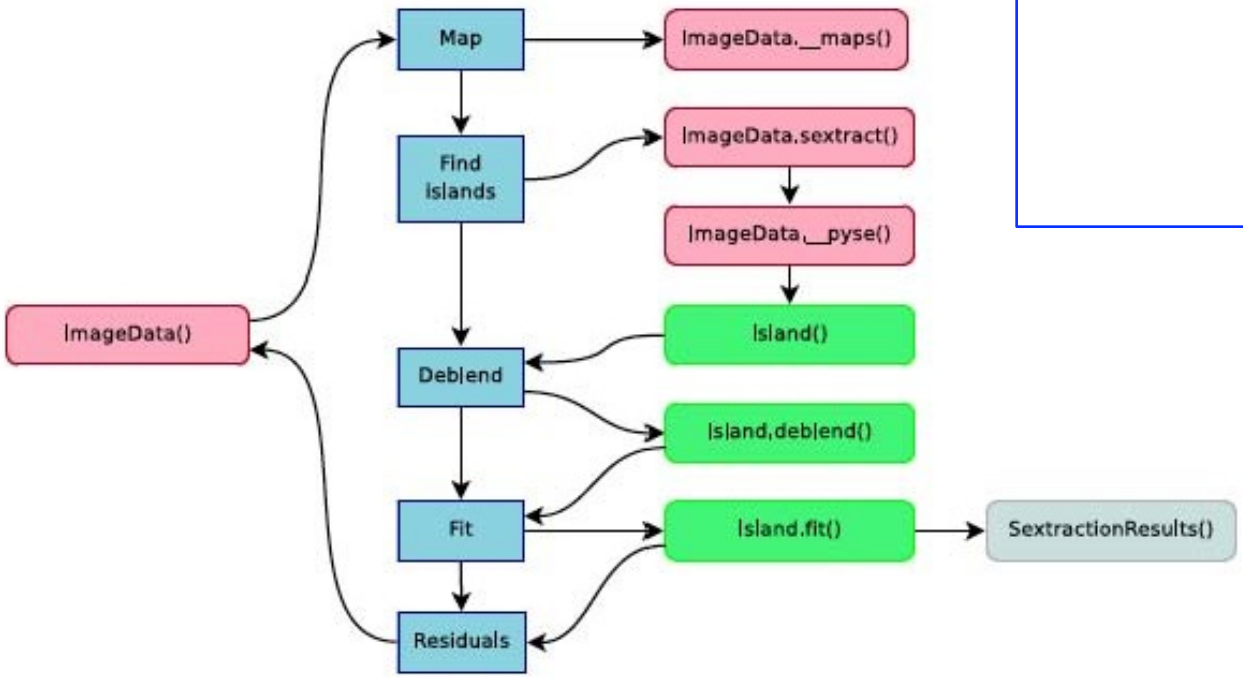


Database scheme for the Transients pipeline area (B. Scheers 2008)

Source Finding

- Detect sources in image cubes
- Determine source parameters
- Update LSM for next major cycle loop
- Merge final results into GSM database

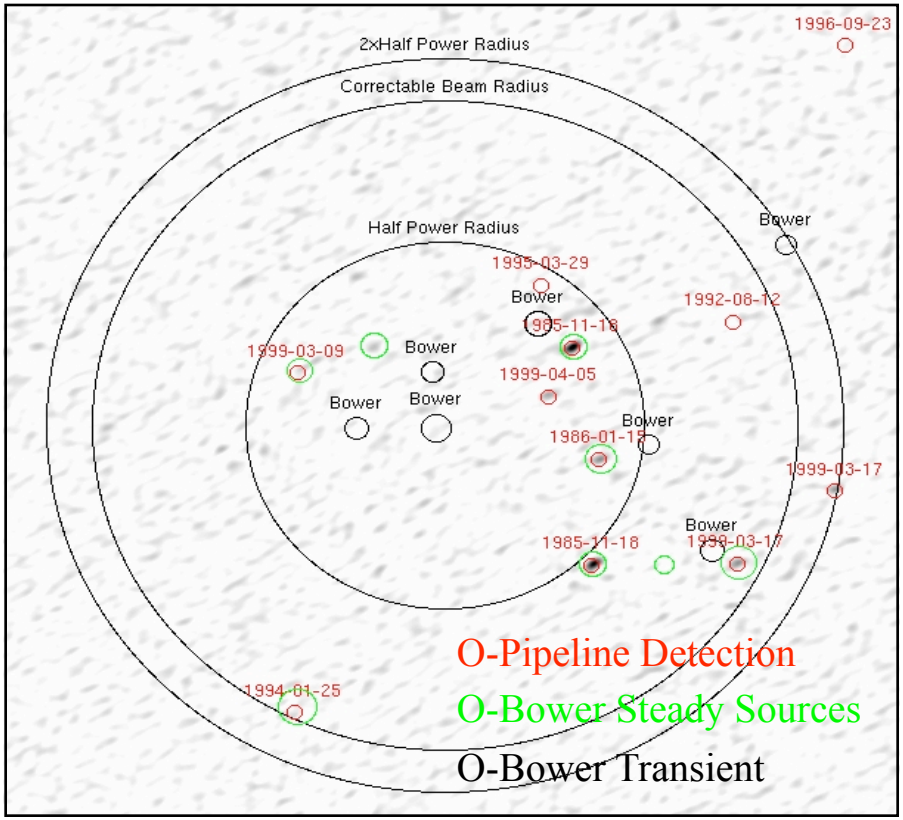




Source Finding

- Two implementations currently available
- Transient pipeline version optimized for speed
- PyBDSM version has more functions and visualization
- Both python-based
- Both being tested
- Both easily connected to GSM database

Bower VLA deep field



M. Bell (2008)

Summary

Next steps for MSSS

- Set-up prototype on output cluster
- Integrate into MSSS pipeline structure
- Connect source-finding package to database
- Create LSM for BBS using database

Open questions

- How do we handle sources which are multiple sources at different frequencies?
- GSM on european baselines?
- How represent extended sources?
- What do we do about polarized sources?
- Need to specify LSM format(s)