LOFAR Data Products

First LOFAR Data Processing School
10 February 2009

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Science Pipelines

⇒ Derived from combined KSP science
Science Pipelines

Available in 2009

⇒ Derived from combined KSP science
Standard Data Products

• Standard Imaging
  – Visibilities
  – Image Cubes
  – Calibration model parameters
  – Sky models (LSM/GSM)

• Known Pulsars
  – Beam-formed time series
  – Frequency-phase cubes
  – Dynamic spectra
  – Pulse profiles

• VHECR
  – TBB time series
  – Dynamic spectra
  – Near-field image cubes

For all products:
Parsets
Processing logs
Version info
Other metadata
......
45 Mhz, 24 hrs

Standard Sky Image Cubes

(RA, Dec, freq, pol)

(courtesy S. Yatawatta)
RM Synthesis Data Cubes

(RA, Dec, RM, pol)

(courtesy E. Carretti and G. Bernardi)
Cosmic Ray Image Cubes

- Cosmic Ray Air Showers produce radio pulses as liberated electrons spiral in the earth’s magnetic field (geosynchrotron emission)
- Pulse can be imaged as a function position, frequency, and time

Near-field imaging
\((x, y, z, \text{freq}, \text{pol}, \text{time})\)
Known Pulsars

Beam-formed data product
Pulsar Data

B0329+54 (courtesy J. Hessels)
TBB Time Series
Dynamic Spectra

Jupiter bursts (courtesy J.-M. Grießmeier)
Data Descriptions

• LOFAR Common Headers
  – Minimum observation information (observer, OBSID, etc.)
  – Coordinates, data scales, etc.
  – Definitions for all data products (ICDSs)

• Image Headers
  – LOFAR specific (sky, RM, near-field, etc.)
  – FITS versions for 2D (3D?) slices

• Updated MS Description
  – Extension of MS2.0 for phased-arrays (SKA?)
  – Keyword updates? Flag bit-masks? Etc., etc.

• Modification Tracking
  – Changes logged to header
## Data Descriptions

### Common header info

#### 3.2.2 LOFAR common metadata

<table>
<thead>
<tr>
<th>Field/Keyword</th>
<th>Type</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TELESCOPE</td>
<td>string</td>
<td>—</td>
<td>Name of the telescope</td>
</tr>
<tr>
<td>OBSERVER</td>
<td>string</td>
<td>—</td>
<td>Name(s) of the observer(s)</td>
</tr>
<tr>
<td>PROJECT_ID</td>
<td>string</td>
<td>—</td>
<td>Unique identifier for the project</td>
</tr>
<tr>
<td>PROJECT_NAME</td>
<td>string</td>
<td>—</td>
<td>Name of the project</td>
</tr>
<tr>
<td>PROJECT_DESCRIPTION</td>
<td>string</td>
<td>—</td>
<td>Brief project description</td>
</tr>
<tr>
<td>OBSERVATION_ID</td>
<td>string</td>
<td>—</td>
<td>Unique identifier for the observation</td>
</tr>
<tr>
<td>OBSERVATION_MODE</td>
<td>string</td>
<td>—</td>
<td>Observation mode (i.e. Mode 1: 30–90MHz, Mode 2: 120–190MHz etc.)</td>
</tr>
</tbody>
</table>

### Beam-formed data header
Data Formats

Visibility Data
- Continue to support CASA MS sets
- Native support for CASA tables and HDF5
- No FITS support (except through translators)
- MS 3.0 specification under development

Image Cubes
- Native support for CASA tables and HDF5
- Support for both already in casacore, DAL
- FITS supported provided through translators

Time Series
- BF and TBB time series stored as HDF5 tables
- Support for PRESTO pulsar formats
- Support for ROOT, LOPES, etc.
## Current ICDs

<table>
<thead>
<tr>
<th>Data</th>
<th>Formats</th>
<th>ICD</th>
<th>I/O</th>
<th>Availability</th>
</tr>
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<tbody>
<tr>
<td>Time series</td>
<td>HDF5</td>
<td>1.0</td>
<td>R+W</td>
<td>Now</td>
</tr>
<tr>
<td>Beam-formed</td>
<td>HDF5</td>
<td>1.0</td>
<td>R+W</td>
<td>Now</td>
</tr>
<tr>
<td>Image cubes</td>
<td>CASA/HDF5</td>
<td>1.0</td>
<td>R+W</td>
<td>Now</td>
</tr>
<tr>
<td>UV data</td>
<td>CASA/HDF5</td>
<td>2.0/0.0</td>
<td>R+W/R</td>
<td>Q2 09</td>
</tr>
</tbody>
</table>

### Supporting several formats

- CASA measurement sets, tables (*CASACORE*)
- FITS images, tables (*CFITSIO*)
- HDF5 tables, image cubes (*HDF5IO*)
- Raw telemetry formats (*TBB, beam-formed, etc.*)
- LOPES, ROOT, PRESTO, etc...
Sky Model Database

- GSM stored as a database (*MySQL, PostgreSQL, MonetDB*)
- Many predictive functions implemented in database
- Python interfaces provided for database access
- Simulated maps created using external tools (*SKP, N. Mohan*)
LOFAR Archive

Collaboration with ASTRO-WISE
LOFAR Archive

Collaboration with ASTRO-WISE

(courtesy W.-J. Friend and J. McFarland)
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