Current Status of Single-Dish Data Analysis Software for ALMA

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Outline

- Overview of Whole Software System
- Single-Dish Data Reduction Parts
  - Organization
  - Software Configurations and Features
  - Examples
  - New Features of Next Release
- Summary
CASA
(Common Astronomical Software Applications)

- Software for radio astronomical data reduction and analysis
  - For the next generation telescope such as ALMA
  - Interferometric and single-dish data
  - Interactive data reduction
  - Pipeline reduction using Python script

- Configuration
  - CASA and CASACORE C++ libraries and Python interface
  - CLI (IPython) and GUI (Qt, matplotlib)
  - Software for single-dish data (ASAP)
Architectural View of CASA

- Python
- CASA C++ library
- CASACORE C++ library
- ASAP (python, C++)
- GUI Qt
- aatm (ATM library)

- Tools are direct interface to C++ Classes
- Tasks are more user friendly commands
Single-Dish Software Development

Development

✓ Based on ASAP but independent (CASA ASAP is an extension of original ASAP)
✓ We have own subversion repository for development

Member

✓ Management: George Kosugi, Nick Elias (entire CASA)
✓ Support: Takahiro Tsutsumi
✓ Development: Kanako Sugimoto, Wataru Kawasaki, Takeshi Nakazato
Single-Dish Data Reduction and Analysis

■ ASAP (ATNF Spectral Analysis Package)
  ✓ Software for single-dish data reduction and analysis
  ✓ ASAP is imported as ‘sd’ tool (tool for single-dish data reduction) from CASA
  ✓ ASAP depends on both CASA and CASACORE C++ libraries

■ Single-dish tasks (SD tasks)
  ✓ Defined as part of CASA tasks (not included in ASAP)
  ✓ SD tasks are constructed using sd tool (ASAP)
  ✓ SD tasks are defined for each data reduction stage
Software Configuration of ASAP

<table>
<thead>
<tr>
<th>C++ Classes</th>
<th>STSelector</th>
<th>STFiller</th>
<th>STwriter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logger</td>
<td>Data selector</td>
<td>Data filler (reader)</td>
<td>Data writer</td>
</tr>
<tr>
<td>Scantable</td>
<td>IF, Scan No., Polarization, Beam, etc.</td>
<td>Scantable, SDFITS, MS (ASDM), NRO data</td>
<td>Scantable, SDFITS, MS</td>
</tr>
</tbody>
</table>

Boost.Python

Interface to Python

Log, Scantable

ASAP Python Classes and Modules

asaplog, scantable, selector, stfiller, stwriter, GUI Classes, asaplot, asaplotbase, asaplotgui, interactivemask, asapplotter
Software Configuration of ASAP

### C++ Classes

- **STMath**
  - Math utilities
  - Calibration
  - Averaging
  - etc.

- **STLineFinder**
  - Line finder
  - Automatic Spectral line detection

### Fitter

- Fitting functions
  - Baseline fit (polynomial)
  - Line fit (Gaussian)

### STFitEntry

- Fit parameters
  - Function
  - Parameters
  - Components
  - Frame info

### Boost.Python

- **LineCatalog**
  - Spectral Line catalog

### Interface to Python

- **stmath**
- **linefinder**
- **fitter**
- **fitentry**
- **linecatalog**

### ASAP Python Classes and Modules

- **asapmath**
  - Math utilities
- **asaplinefind**
  - Line finder
- **fitter**
- **asapfit**
- **linecatalog**
## Single-Dish Tasks

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Task Name</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Flagging</td>
<td>sdflag</td>
<td>channel based flag only</td>
</tr>
<tr>
<td>Intensity Calibration</td>
<td>sdaverage</td>
<td>GBT data only</td>
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<tr>
<td>Averaging</td>
<td>sdcal</td>
<td></td>
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<tr>
<td>Smoothing</td>
<td>sdsmooth</td>
<td>interactive mask</td>
</tr>
<tr>
<td>Baseline Fitting</td>
<td>sdbaseline</td>
<td></td>
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<tr>
<td>Line Fitting</td>
<td>sdfit</td>
<td>total power data only</td>
</tr>
<tr>
<td>Imaging</td>
<td>sdtpimaging</td>
<td></td>
</tr>
<tr>
<td>Statistics</td>
<td>sdstat</td>
<td></td>
</tr>
</tbody>
</table>
Example: Interactive Baseline Fitting

The user can select a region that is used for baseline fitting interactively.

Fitting is performed except for masked region.
Example: Total Power Imaging

Raster scan image of the Moon @103GHz (ATF data)

Measurement of sidelobe (raster scan of the Sun)
3.0 Release (Dec. 2009)

First Public Release

- Improved calibration capability
  - Intensity calibration (Chopper-Wheel, APEX, ALMA)
  - Support On-The-Fly observation data
- Imaging task for spectral line data (sdimaging)
- More flexible data flagging
- GUI processing
  - Interactive masking for line fitting and line statistics
  - GUI based task processing
- Task to remove scanning effect
  - “Pressed-Out” method (Sofe & Reich 1979)
  - “Basket-Weaving” (Emerson & Gräve 1988)
Summary

We have described a current status of single-dish analysis capability of CASA

- The development is continuing based on ASAP
- Basic data reduction tasks are available
- There are several issues and limitations that should be improved or fixed
- We are now working toward the next release that is scheduled at the end of 2009