MeerKAT Simulation with CASA

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Executive Summary

The main goal of this project is to develop a MeerKAT simulation capability within CASA using the existing simulator.

To do this I will:

1. Incorporate MeerKAT specific properties into CASA.
2. Test the simdata/simdata2 toolbox against images obtained with KAT-7.

Outputs of this project will be:

1. Simulator functionality for MeerKAT simulation.
2. Feedback for simdata and imaging performance, as specified by Remy.
3. Developer and user documentation for simulation of MeerKAT.

Support needed from CASA/NRAO are:

1. Assistance with understanding the CASA framework and code structure, wherever relevant for simulation and imaging purposes.
2. A software contact for help with technical issues, if needed.
3. Version of the simdata simulator that will provide intermediate data products, e.g. uv data.

1 Introduction

Simulation has become central to array design and characterization, and plays a strong role in developing realistic expectations for next generation instruments, such as MeerKAT, ASKAP and the SKA.

In particular, the tight timelines for MeerKAT development (scientifically and operationally) neccesitates a comprehensive sets of simulations to characterize array performance.

As such, it makes sense to incorporate MeerKAT specific characteristics into CASA since it is likely that CASA will be the preferred radio interferometric reduction tool.

In addition, the reference design of MeerKAT assumes that the dirty beam will be tapered to achieve desired resolutions. Simulations are central to establishing how to perform this for the 80-dish MeerKAT.

This project will aim to add MeerKAT specific characteristics and functionality into CASA. We will also assist in characterizing the performance of the simulation toolbox as it develops, from a scientific-user's perspective.

These results will then be compared against first-light spectral line imaging with KAT-7.

A secondary outcome of this project is the development of local (South African) expertise in CASA usage.

2 MeerKAT Specifics

The MeerKAT specific characteristics that will be imported into the simulation toolbox are as follows:

1. Atmospheric and RFI characterization (as from on-site measurements).
2. T_{sys} estimations, based on current hardware designs and laboratory/commissioning tests.
3. Noise factors.
4. System stability.
5. MeerKAT configurations. This will include KAT-7, KAT-30, KAT-64 and the 80 dish MeerKAT.

3 Implementation and Involvement

Implementation will proceed as follows:

1. Work and development will be performed off-line.
2. Simulations will be tested against standard cases, such as:

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   (a) Point source.
   (b) Gaussian source.
   (c) Known complex source structure.

3. Write developer documentation.
4. Write user documentation and verify it with local (South African) astronomers.
5. Work with a CASA developer to incorporate the new functionality (e.g. data tables, scripts) into the standard CASA simulation task.

Each month a status report will be submitted to the CASA project, inviting comments and suggestions.

It is anticipated that the following involvement from NRAO/CASA will be required:

1. Latest versions of simdata/simdata2 and assistance on changes.
2. A developer contact to assist with technical issues.

4 Deliverables and Estimated Schedule

Tasks and deliverables will be completed as according to the following preliminary schedule:

- 1 May 2010: Start
  - Define MeerKAT specific characteristics, e.g. T_{sys}, system stability.
  - Perform simulations with simdata to understand simulator structure and input requirements.
- + 2 months: Characterizing simdata usage
  - Start off-line local incorporation of MeerKAT specifics into CASA.
  - Use simdata2 to produce MeerKAT simulations.
- + 4 months: End in South Africa
  - Produce developer and user documentation and scripts used for simulation, to be used by local astronomers.
- +6 months: Final delivery
  - Produce updated tables and scripts for incorporation in CASA release.