SKAMP - the Molonglo SKA Demonstrator

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Introduction

Two substantial demonstrator projects have been funded for installation on the Molonglo Telescope:

- **A 96-station, wideband FX correlator**
- **A broad-band line feed system for a cylindrical paraboloid.**

These two projects constitute the SKA Molonglo Prototype – SKAMP. Installed on the Molonglo Telescope they will result in a significant trial of key SKA engineering elements and also significantly enhance the scientific value of the Molonglo Telescope

Background

The Molonglo Telescope was commissioned in 1965 as a 408 MHz Mills Cross with 1600m long arms. It was converted in 1982 to a 843 MHz synthesis telescope, using just the E-W arm. The structure was designed to suit a possible extension to 1400 MHz, which makes the telescope an excellent platform to demonstrate the feasibility of a cylindrical paraboloid for the SKA station.

Cylindrical SKA

The cylindrical reflector provides a low cost reflector for the SKA while providing a large FOV and high speed survey capabilities. However a number of novel design aspects are needed

Wide bandwidth feeds, RF beamformers, Digital beamformers and High capacity spectral line correlators.

SKAMP will prototype these and validate their application to the SKA.

Science Goals

Low-frequency radio spectrometry (300-1420 MHz)

Selection of objects via their radio spectral shape, e.g. candidate high redshift (z>3) galaxies with ultra-steep radio spectra (de Breuck et al. 2000), study the formation of galaxies and massive black holes.

Redshifted HI (300-1420 MHz)

HI in absorption against bright continuum sources over a wide redshift range (z=0 to 3). HI in emission - evolution of the HI mass function from z=0 to 0.5.

Low-frequency Galactic recombination lines

Recombination lines of carbon and hydrogen can be used to probe the partially-ionized ISM.

Gamma Ray Bursters

Electronic beam steering gives a 5% chance of capturing a random event.

Concurrent SETI search, and Pulsars and Source Flux Monitoring

18 to 400 deg^2 accessible around main beam. Real time de-dispersion.

Progress in upgrade of signal path

Feed Development

The radiation characteristics of the cylindrical reflector are currently being modelled to determine the beamwidth, sidelobes and polarization performance of the reflector. Next, a feed will be synthesised to produce the required illumination of the reflector. Testing has also been carried out to see the effects on scanning performance of including a spoiler on the reflector.

Data Acquisition & Beamforming

Signal splitters allowing the current astronomical survey to continue whilst testing the new SKAMP system have been installed. Customised Analogue to Digital converters, as well as delay & phase tracking units have been designed and are currently undergoing testing. It is anticipated that data acquisition & beamforming hardware will be fully installed by early 2004.

Correlator Development

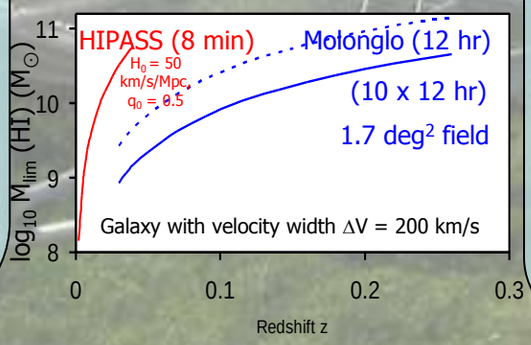
The Correlator is nearing design completion. The layout of the Printed Circuit Board (PCB) is almost finished with expected completion at the end of February 2004. Design has been difficult due to the use of Ball Grid Array FPGA's, and the array like structure of the board.

Testing of the entire Correlator system is expected to begin in March 2004, with a working prototype anticipated for early April 2004.

Signal Processing

A correlator control computer (CCUBED) with external data interface has been setup. Research and design are now needed to establish a protocol for communication with this device. When working, CCUBED will allow for data storage and processing, as well as correlator control (either local or remote). We plan to develop to use RPfits file format to accommodate SKAMP data for processing in Myriad.

Sensitivity of the Molonglo telescope for high-redshift HI observations.



Project Status and Plan

2002-2004 : Continuum Operation (being installed)

New IF Samplers; Digital delay lines; Fringe tracking.
Continuum correlator (96 station; 4 MHz)

2004-2005 : Spectral Line Operation

New LO; New IF distribution; 2048 channel polyphase filter/antenna
Spectral line cross-correlator engine (50 MHz BW)

2004-2007: Wide Band Operation

Wide band feed (300-1400 MHz); RF beamformers distributed along the cylinder
New frontend, Digital beamformer + increased correlator BW