

A Unique Wide Band Receiver, Warm Electronics, for the FAST Telescope

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Abstract— A unique wide band receiver for radio astronomy has been designed and constructed. Receivers used for radio astronomy consist of two parts, the front end cold electronics and the back end warm electronics. While the cold electronics provides for a low noise amplifier and receiver calibrations, the warm electronics provides analog signal processing that shapes and filters the signals before digitizing. The following describes the unique features of the warm electronics receiver built by Caltech for installation on China's Five hundred meter Aperture Spherical Telescope (FAST).

The wide band receiver built for FAST operates in a frequency band of 260 to 1670 MHz. The wide band operation of the receiver is one of the unique features of this telescope receiver. Interference from radio sources (RFI) and gain instabilities become a significant problem. This receiver has an integrated spectrum analyzer connected to the unfiltered signal path. The spectrum analyzer measures all signals both in band and out of band. The strength of the interference signals can be analyzed in real time and the parameters of the receiver can be adjusted accordingly. This allows the receiver to adapt to changing environmental conditions. In addition to the spectrum analyzer, the receiver incorporates wide band total power detectors and monitors the total RFI power. This insures that the receiver is operating within the gain that provides the best receiver linearity. Several features have been incorporated to reduce the effects of these additional interference signals. These features include Digital Step attenuators use to vary the receiver gain, low pass and high pass band shaping filters to eliminate out of band RFI, a narrow band output that further reduces RFI.

The receiver is located outside and exposed to the environment. The receiver is constructed in a water tight box. The outside temperature can vary from 9°C to 23°C. The gain of the receiver is high (77dB) and temperature fluctuations cause gain fluctuations. To reduce this variation, the warm electronics resides on a Thermal Electric Cooler/Heater. The TEC will maintain the ambient temperature of the electronics to 40°C. The receiver gain is stable under all environmental conditions.

In addition to the salient features mentioned above, the warm electronics also provides, 2 channel (Vertical and Horizontal polarization) input, 4 channel outputs, linear to circular polarization conversion, monitors for dewar temperature and vacuum, warm electronics temperature and voltage and currents. 2 GHz fiber optic links provide the RF interface to the spectrometers. Receiver monitor and control provided via Ethernet through a digital fiber optic link. The receiver has been constructed and is currently undergoing tests at Caltech. The receiver will be mounted and commissioned on the telescope from mid-June until mid-September.