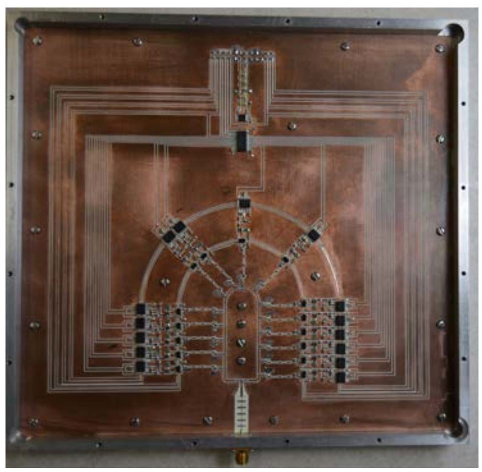
A Four to Twelve GHz Analog Autocorrelating Spectrometer to Measure Spectral Density of System Temperature

R. Kimberk, J. Test, P. Leiker, A. Faris

Smithsonian Astrophysical Observatory

The autocorrelating spectrometer being developed will measure the spectral density of system temperature with a spectral resolution of about 1 GHz. The system temperature will be resolved to about 1 percent rms in 1 second. The autocorrelator is an adding interferometer that is not phase switched, uses Schottky diode power detectors and very low 1/f noise op-amps. A Rabbit microcontroller is used to multiplex the 15 lags and digitize the analog signals to 11 bits. The microcontroller has an ethernet data link to the antenna computer to allow a continuous sampling of the system temperature. The device has amplifiers and a digital attenuator to allow it to operate at optimal input power and to implement a novel calibration scheme of spectral channel power response while observing the ambient temperature RF load. The calculated system temperatures will be used to determine multiplicative weights to be applied to the observational data acquired by the Submillimeter Array. The signal to noise of the SMA observations will be improved by giving greater weight to data taken with smaller system temperatures.

The photo to the right shows the autocorrelator with the RF input at the bottom followed by a microstrip 12 GHz low pass filter. The filter is followed by a resistive 3dB power splitter then a transmission line loop. The loop forms a standing wave which is sampled by the 15 lag electronic sub-assembles that radiate from the center. The lag at the top center is the zero lag which measures the total power. The odd lags are to the left of the zero lag and the even lags are to the right.



The box and whisker diagrams below show the output of the autocorrelator normalized to the hot input . The plot titled 10 dB is the output with a hot input of about -24 dBm. The other plots are the measured power with input power that is one half and one fifth the hot input. The system temperature is derived from the ratio of hot and cold powers after calibration with known temperatures.