The wSMA receivers – a new wideband receiver system for the Submillimeter Array

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Abstract— The current Submillimeter Array (SMA) receiver systems were designed in the mid-1990s and have been operating for more than fifteen years. With regular upgrades to the receiver inserts installed within each antenna's receiver cryostat, the deployment of the SWARM correlator, expansion of the IF signal transport bandwidth via improvements to the analog IF signal processing hardware, and many other enhancements, the SMA currently greatly outperforms its original specifications in terms of sensitivity and instantaneous bandwidth. It also supports additional observing modes such as full-Stokes polarization at 0.86 mm and 1.3 mm and dual polarized phased array operation for mm-VLBI.

Further significant upgrades to the SMA's performance will require major changes to the receivers and IF signal transport systems, as well as further expansion of the correlator. We have begun development of a program of major upgrades to these systems with the aim of significantly increasing the SMA's instantaneous bandwidth, which will result in a significantly upgraded instrument called the wSMA (wideband Submillimeter Array). This program will include completely replacing the cryostats, receiver inserts and several other elements of the receiver systems, building additional segments of the SWARM correlator and upgrading the IF signal optical fiber transport to >20 GHz analog bandwidth on multiple channels using a commercial 1550nm DWDM system.

The new receiver system will operate with an IF of 4 – 18 GHz. Since the correlator of the interferometer separates the two sidebands of the DSB mixers, the wSMA will deliver 14 GHz bandwidth per polarization per sideband, for a total of 56 GHz of processed on-sky bandwidth. The new receiver system also features simplified receiver optics. Instead of the current use of heterogeneous single polarized receivers combined using a wire grid polarizer, the polarization performance of the wSMA will be enhanced by the use of a single dual-polarized feedhorn and an ortho-mode transducer feeding two identical SIS mixers to receive the two polarizations. The further simplification of the ambient temperature optics enabled by the use of waveguide LO coupling within the cooled receiver and use of cooled receiver selection optics will reduce ambient temperature optical losses and thus improve sensitivity. This upgrade will also have the significant operational benefit of replacing the current aging and commercially obsolete GM/JT cryogenic coolers with modern pulse-tube coolers having significantly reduced maintenance requirements.

In this paper we will describe the proposed receiver systems, including the new receiver optics and cryostats, the dual-polarization double sideband front-ends, wide band isolators and IF LNAs, and new LO systems, as well as required enhancements to the SMA's IF transport and signal processing capabilities to fully utilize the increased bandwidth of the front-end receivers. We will also discuss the current and future capabilities of the SMA, and the potential for further upgrades and guest/PI instrumentation that will be enabled by this upgrade.