A 230GHz unilateral finline mixer on a silicon substrate

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***Abstract*— The design and preliminary results from testing the performance of a 230GHz unilateral finline SIS mixer, fabricated on a silicon substrate are presented. The mixer will be employed in the single baseline heterodyne interferometer-GUBBINS (220-GHz Ultra-BroadBand INterferometer for S-Z), which aims to measure the null frequency in the Sunyaev-Zel'dovich spectrum at ~227GHz. The mixer is operated in the frequency range of 180GHz~280GHz with an IF bandwidth of 1-13 GHz. An important feature of this mixer is its ultra-wide IF bandwidth, so as to achieve very high brightness sensitivity in the observation of the galaxy clusters in the faint cosmic microwave background radiation.**

This SIS mixer described is deposited on an 80um silicon substrate with the dielectric constant of 11.9. The incoming RF signal from the feed horn is coupled via the waveguide mode to a unilateral finline, which is tapered to a 2.5um slotline. The signal is coupled from the slotline to the microstrip with the aid of two radial stubs. The employment of a silicon substrates gives a slotline impedance of 36Ω , which is ideal for coupling to the microstrip, where the SIS junction is fabricated. Also, the employment of silicon allows the generation of the trenches around the device so that individual devices can be separated from the batch without dicing. A 2-stage notch was fabricated at the front end of the substrate to match the loaded waveguide to the free space. The capacitance of the SIS junction was tuned out using a wide band circuit consisting of two stubs and a 3-stage Chebyshev transformer. This is followed by a 3-stage RF choke to prevent RF signal from leaking into the IF output port.

The mixer chip was fabricated at KOSMA, Cologne using Nb-AlO_x-Nb tunnel junction defined with E-beam lithography. The device used in this experiment had a normal resistance of 20Ω, a current density of 14KA/cm^2, an area of 1μm^2 and an intrinsic capacitance of 75fF. Measurement of the mixer performance was done using a local oscillator which gives sufficient power to pump the mixer in the frequency range 200GHz~260GHz using 12μm beam splitter. Measurement of the mixer sensitivity was done using the hot/cold Y-factor method. Uncorrected noise temperature of 75K was obtained at 208GHz, with 30 K contributed by mismatch to the IF system. Future characterization and improvements of the IF system and the measurement with better-tuned devices will also be reported.