Dixie, D–Mixer

T_{dsb}=850K at 702GHz

Since April 1992, as part of in–house research at HIA, we have been developping an SIS mixer for D–band (620GHz to 720GHz). The receiver is sometimes referred to as "Dixie". This is the first submillimetre mixer block manufactured at HIA, and despite its simple design, we are measuring rather good noise temperatures in the lab with a best result to date of 850K (Double Side Band) at 702GHz.

The mixer block follows the now conventional design with the SIS device lying across a waveguide, and a single tuning backshort. In Dixie's case, the waveguide is circular which usually means poor RF coupling because of the high waveguide impedence, but we have tried to minimise this problem by oversizing the guide. This results in a waveguide with a slightly lower impedence, and also, manufacturing a larger waveguide and especially a larger backshort is an easier task. One might be concerned that unwanted, sidelobe generating modes are allowed to propagate in the oversized guide, however the central location of the SIS junction inhibits the generation of these modes.

In order to concentrate the received radiation onto the SIS junction, the mixer block features an integrated a dual mode horn, often called a Potter horn. This is simply a funnel with a step in it which generates the right forms of propagation (modes) that mix together to create an acceptable beam profile. Our RF measurements haven't yet reached the point where we are measuring beam profiles, but we expect the receiver to have good far–field behaviour with similar E and H plane profiles.

The Josephson current in the SIS device is suppressed in the usual way with magnetic field provided by a coil of superconducting wire. Additionally, magnetic field concentrators lie on either side of the SIS junction. By squeezing together the magnetic field lines, a reasonable current through the coils creates a high magnetic field across the junction.

For a Local Oscillator source, we are using the Carcinotron from RxB, which was decommissioned in 1991. The signal is doubled in frequency by a multiplier fabricated, and eventually delivered, by Millitech Corp. While waiting for the Millitech doubler last May, we tried pumping Dixie with the solid state LO from the soon-to-be-delivered RxB3CU. Relying on the fifth harmonic of the frequency quadrupler, the receiver actually showed photon steps at 430GHz and we measured a double side band noise temperature of 2000K, which is not bad for a receiver designed to be used at 700GHz!

Deep in the heart of Dixie is a lead based SIS junction fabricated at the University of Kent at Canterbury by Steve Davies. He also provided the SIS junctions for both RxA2 and RxB3(i). There is a lead alloy junction in RxC2 as well (fabricated at RAL). While niobium has now been shown to work well at frequencies up to 700GHz, we have decided not to abandon lead which has been so successful up to now. With a bit of bismuth added to the lead–gold–indium alloy, the resulting device has a high bandgap. Dixie has been working up to now with a junction that has a bandgap of 2.8mV. With a modified alloy, the latest batch of junctions have a higher bandgap and we have now mounted a device with a bandgap of 3.2mV.

Dixie D–Band Mixer was crafted by Luc Martin in the HIA machine shop, and he is presently working on a reduced height rectangular waveguide mixer block. The next generation 690GHz mixer should have even better performance with the RF match closer to optimum.

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