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Design and Implementation of an Antenna Noise Temperature Measurement System for the Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX)

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The Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX) is a 21 cm neutral hydrogen intensity mapping experiment to be deployed in the Karoo Desert in South Africa. It will consist of 1024 six-meter parabolic dishes, and will map much of the southern sky over the course of four years. HIRAX will operate at 400-800MHz, exploring the redshift range $0.8 < z < 2.5$ and improving constraints on the dark energy equation of state through measurements of large scale structure. As with all 21cm science, galactic foregrounds contaminate our band, and so meeting the HIRAX science goals will require precise characterization of the instrument. Understanding the noise performance of the antennas, and thereby the system temperature of the telescope, is a critical aspect of this characterization.

I will discuss an apparatus for determining antenna noise temperature in which we use identical loads, one cryogenic and the other at room temperature, to take a differential measurement (Y-factor measurement) from which we infer the noise of the system. These loads consist of 4ft. cylindrical cavities lined with RF absorber and a custom insulation capable of containing >550L of liquid nitrogen. The apparatus has been constructed at Yale, and over the course of the past year has undergone detailed verification tests. We have conducted several measurement sets using the system, involving HIRAX-style passive feeds as well as four of the HIRAX active feeds. These measurements give the first noise temperature measurements of the HIRAX feed, and provide the first analysis of feed repeatability. I will report updates and results, from data over the past year, as well as ongoing challenges and next steps.