# Experimental Studies of IF Impedance of $MgB_2$ HEB Mixers at Various Bias Conditions and Operation Temperatures

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Accurate measurements of IF impedance for hot-electron bolometers (HEB) mixers is very important for designing matching circuits between the HEBs and the first stage Low Noise Amplifiers (LNA). Apart of giving rise to the receivers noise temperature, IF impedance mismatch leads to ripples in the receiver gain, which reduces accuracy of the base line subtraction during the receiver calibration.

IF impedance can be obtained from vector measurements of the reflection coefficient (S11) in the frequency range of interest. It is 0.1-10GHz in our case. Accuracy of the S11 measurements depends on the calibration precision. The main problem here is that HEB mixers operate at cryogenic temperatures, 4K-20K. Therefore, they are frequently packaged in a mixer block. There have been several ideas explored in the literature for how to deduce the HEB mixer IF impedance from the measurements. Furthermore, IF impedance measurements on HEB mixers has also a more fundamental importance. It is one of the methods to explore the physics behind the HEB operation. Furthermore, it is one of the methods to measure the HEB mixer gain bandwidth (GBW).

In our work we will present and experimentally compare several methods for S11 calibration procedures for packaged HEB mixers. We have used magnesium diboride ($MgB_2$) HEB mixers with critical temperatures of 22K and 30K. Different calibration procedures have been used. Furthermore, HFSS modeling of the complete mixer block was done and experimental results will be compared to the simulations. As a final step, calibration loads were made of (non-superconducting) NiCr thin films in the exact layouts of $MgB_2$ HEB mixers. Their frequency and temperature independent microwave impedance allow for verification of the HEB mixers measurements procedure.

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