



Cosmic Microwave Background polarization detector with high efficiency, broad bandwidth, and highly symmetric coupling to transition edge sensor bolometers

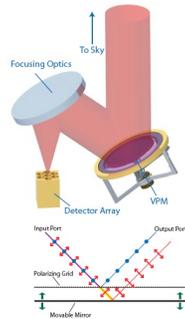
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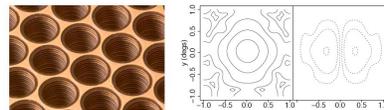


Polarimeter Concept

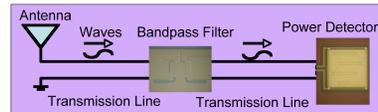
Polarization modulation prior to the main aperture ...



Combined with ...

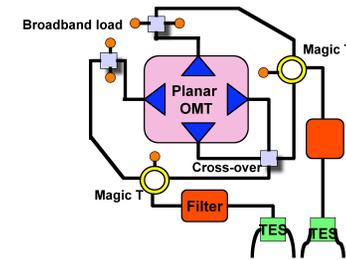


HE11 feedhorn arrays for the best beams, and ...



Antenna-coupled TES bolometers with microstrip filters.

Superconducting Planar Microwave Circuit



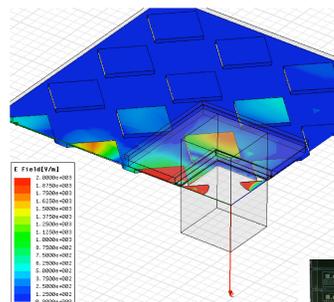
The interface between 3-D horns and 2-D detector circuits ...

... is implemented with a planar orthomode transducer (OMT) and photonic choke.

Results

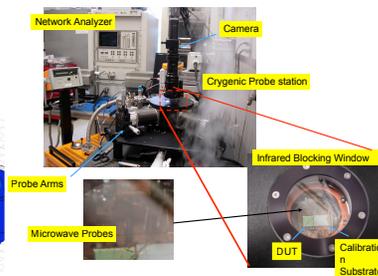
Symmetric Planar OMT and Photonic Choke Waveguide Interface

Four probe antennas transfer signals from waveguide to microstrip lines. The probes not only provide broadband impedance matching, but also thermally isolate waveguide and detector. In addition, we developed a new photonic waveguide choke joint design, with four-fold symmetry, to suppress power leakage at the interface.

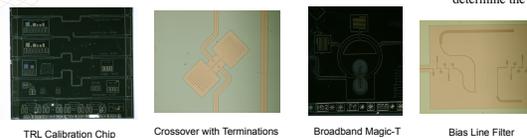


Test Capabilities

We have developed facilities to test superconducting circuit elements using a cryogenic microwave probe station, and more complete systems in waveguide.

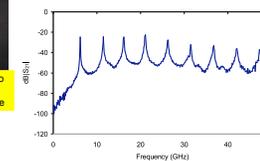
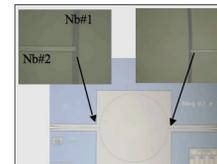


Calibration and Test Circuits



Measured Dielectric Properties

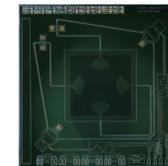
We used the ring resonator shown below to measure a dielectric loss tangent $< 7 \times 10^{-4}$ over 10 - 45 GHz.



Measured Half-wavelength ring resonator to determine the Al_2O_3 substrate dielectric constant

Polarimeter Chips in Fabrication

The chip below is currently being fabricated, together with diagnostic chips for probe station measurements of individual components.



Calculated System Performance

We have combined component simulations to predict the overall coupling from waveguide modes to bolometers. The result below shows the planar circuit and waveguide interface can utilize the high beam symmetry of HE11 circular feedhorns with $> 99\%$ coupling efficiency over 30% fractional bandwidth.

