Searching for Axions with Superconducting Nanowires
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BREAD
The Broadband Reflector Experiment for Axion Detection (BREAD) uses a strong magnetic field that is parallel to an outer cylindrical dish antenna to generate photons via coupling with incident axions. Photons are then directed to a detector by the optics of the reflector.

Optical Absorption Model and Results
An important consideration of this experiment is how the detection efficiency of the SNSPD is affected by the angle of incidence and polarization of the photon. Photons can be incident from a polar angle of 0 to $\pi/2$ radians, and an azimuthal angle of 0 to $2\pi$ radians. Comsol Multiphysics software was used to construct an optical model of the SNSPDs.

SNSPDs
In the optical regime of photon wavelengths, BREAD uses Superconducting Nanowire Single Photon Detectors (SNSPDs) to detect when a photon has been generated by the axion coupling system. SNSPDs are superconducting periodic structures. When a photon becomes incident on the SNSPD, the superconductivity of the wires is broken. This can be measured, and photon events can be counted.

Conclusions
The optical absorption model yielded a theoretical upper limit on the detection efficiency of the devices and a qualitative understanding of the relationship between angle of incidence and detection efficiency. However, it is also important to experimentally characterize the performance of the SNSPD devices at millikelvin temperatures. To this end, the SNSPDs were installed in an Adiabatic Demagnetization Refrigerator (ADR). The SNSPDs were mounted in the ADR and connected to amplifiers and bias tees that allow for the sensing of superconductivity breaking. Next steps include characterizing the switching current and the dark count rate of the SNSPDs.

References
Broadband Solenoidal Haloscope for Terahertz Axion Detection – (Liu, 2022)