

Testing quantum photosensors for the BREAD experiment



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Physics motivation for axion searches

Why are we looking for the QCD axion?

- Solution to the strong CP problem cleans up a mess!
- Potential dark matter candidate

How do we look for the axion?

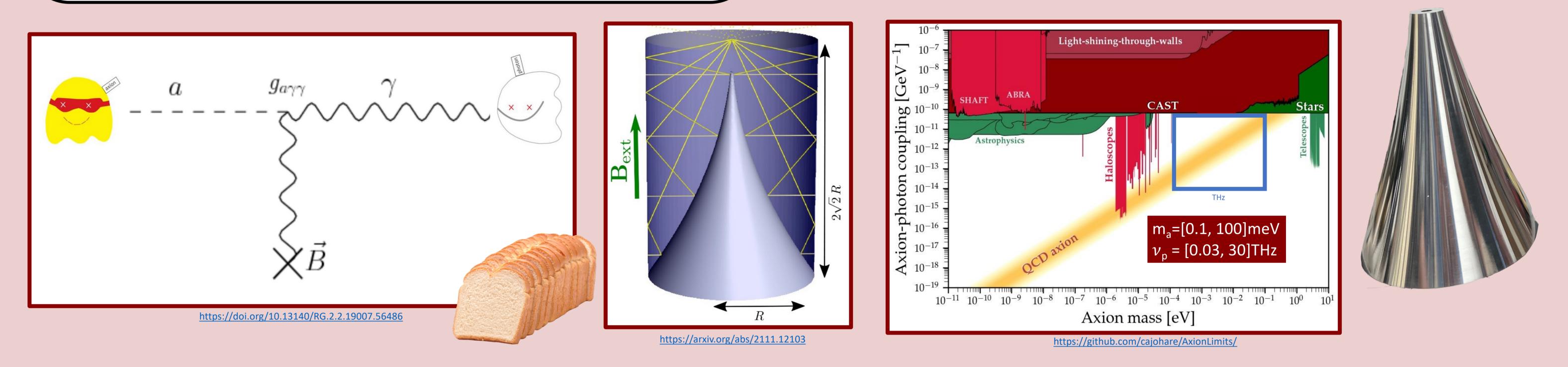
Inverse Primakoff effect: conversion of the dark matter axion into a



- **Broadband Reflector Experiment for Axion Detection** Looking for axions beyond the mass range of traditional resonant cavity techniques (like ADMX)
- Novel reflector design avoids scanning searches, so we are sensitive to a broadband range of axion masses
- Probing the terahertz regime candidate mass range between electronics and photonics instrumentation



- photon
- At a conducting boundary inside a magnetic field, we expect to see this conversion of an axion into a photon
- Requires new sensor technology to detect this signal, which we are validating



Quantum sensor candidate: SNSPD

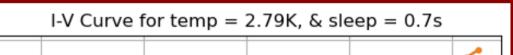
SNSPD: superconducting nanowire single-photon detector

• Single photon counters with dark rates as low as one per day 10.1103/PhysRevLett.123.151802



Testing SNSPDs at Fermilab

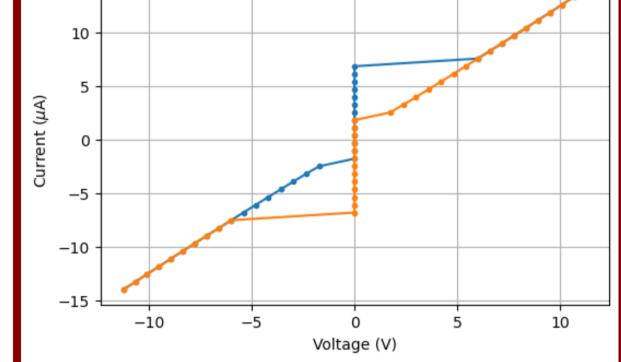
 Using adiabatic demagnetization refrigerator (ADR) operating at 300mK at FNAL

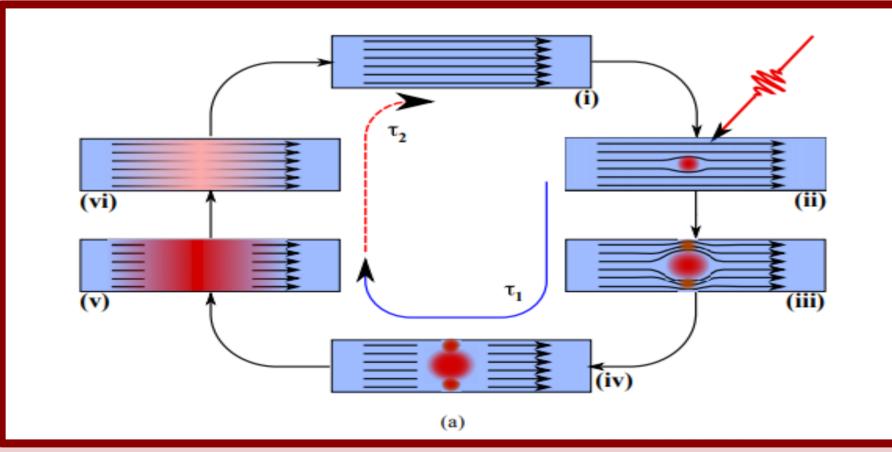


- Sensitive to single photons up to 10µm https://doi.org/10.1063/5.0048049 Our device's properties:
- Produced by Berggren group at MIT
- Meandering superconducting wire (NbN) on board with a bias current across it near switching current
- 100nm wide on 15 μ m x 15 μ m area
- Delays in testing due to various fridge and noise issues

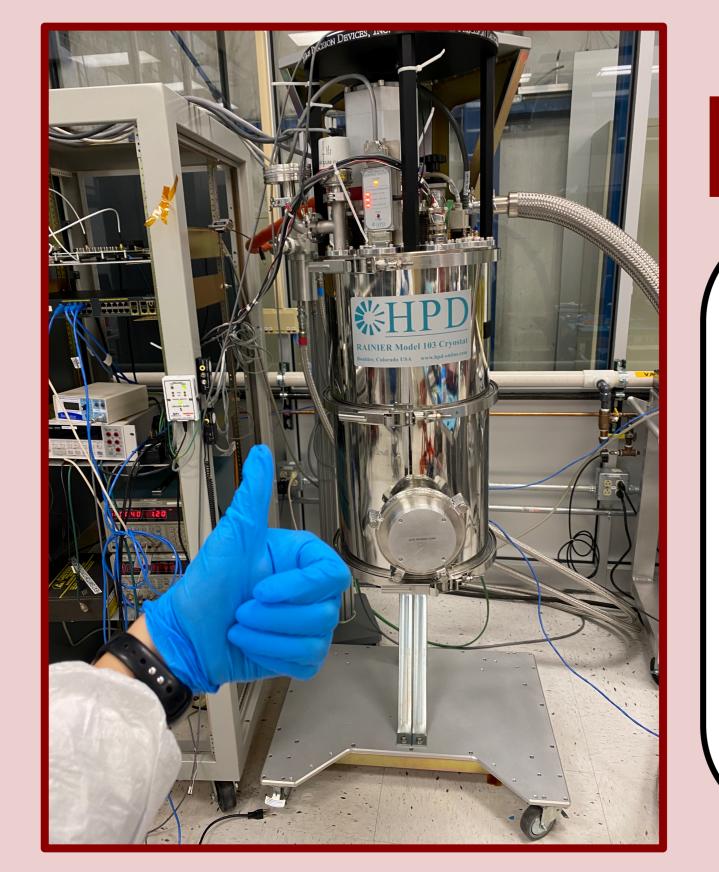
Successes

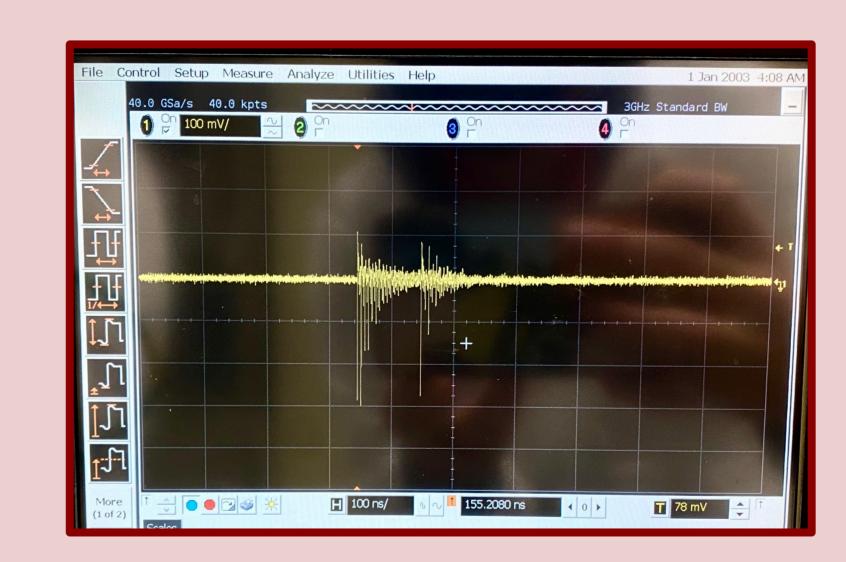
- First dark pulses on the devices
- Observing switching current behavior of device



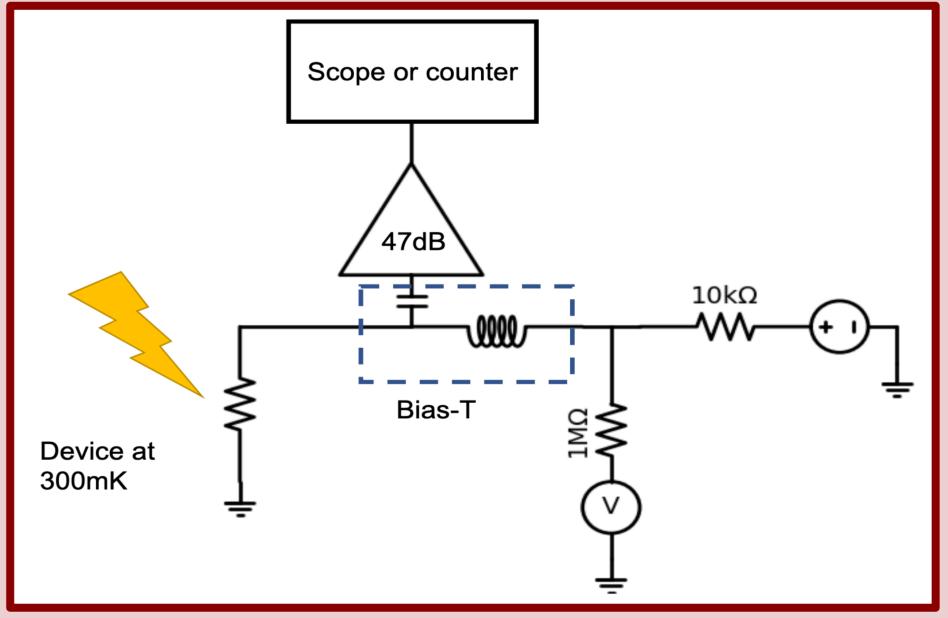


http://stacks.iop.org/SUST/25/063001





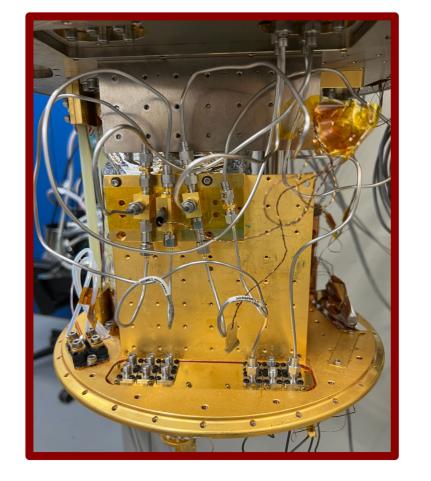




Internal -- Tony X. Zhou <u>zhou01@mit.edu</u>



Relocating the setup (ADR included) to a new lab after months of cooling issues



Cryogenic wiring to amplifiers inside the ADR for testing

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https://doi.org/10.1103/PhysRevLett.128.131801

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