



Testing quantum photosensors for the BREAD experiment

BREAD
COLLABORATION

Kristin Dona, University of Chicago – Department of Physics
Under the direction of Prof. David Miller as part of the BREAD Collaboration

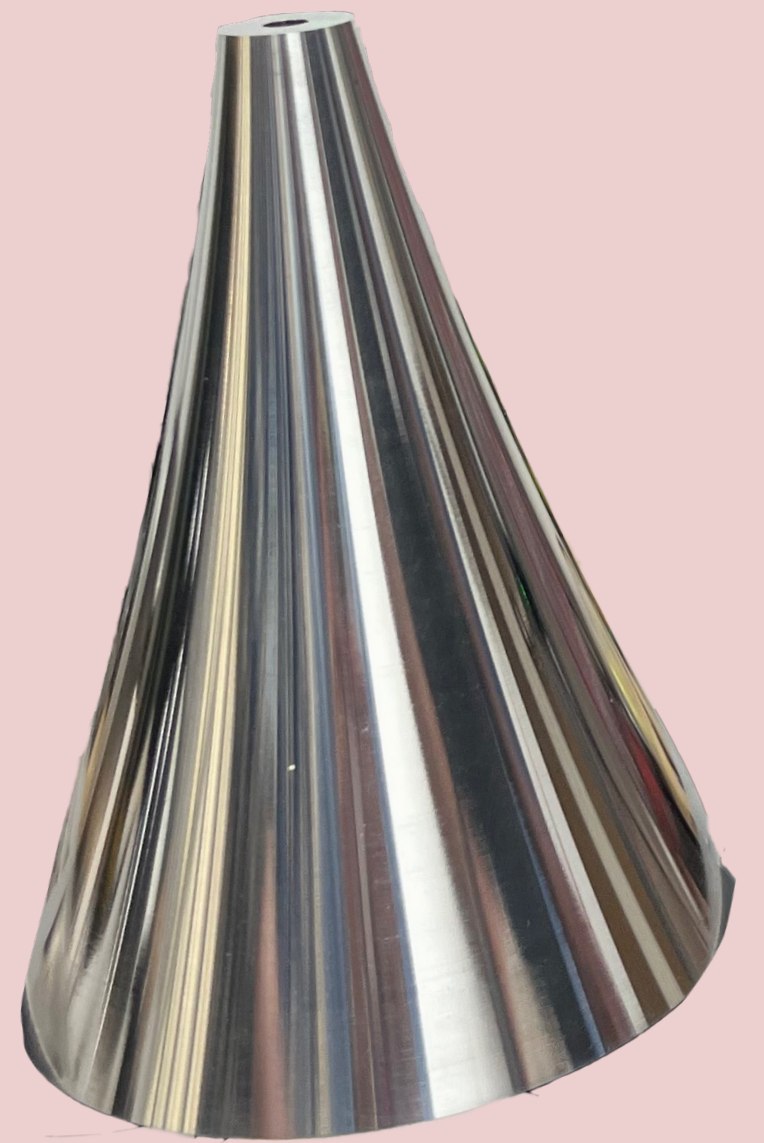
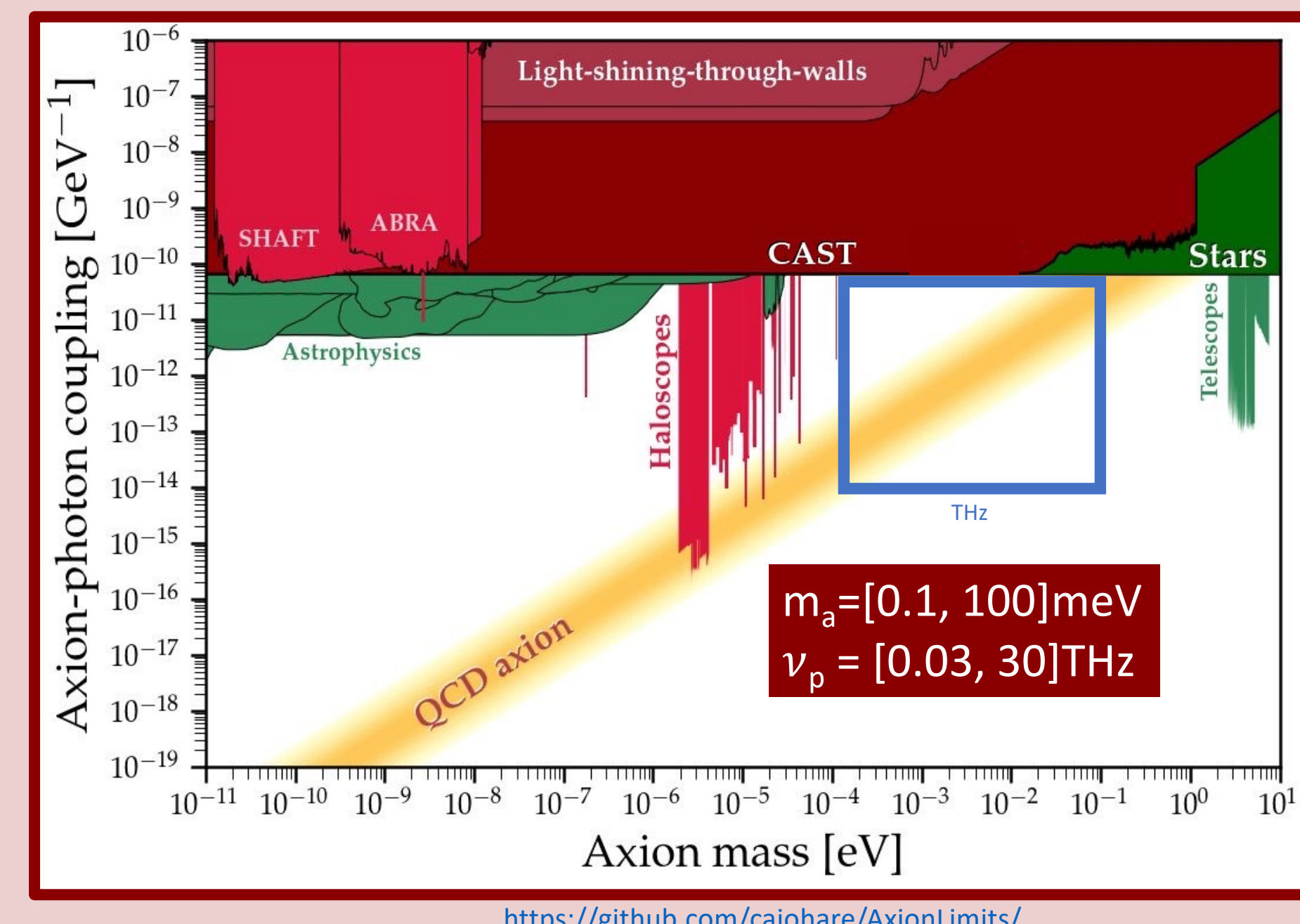
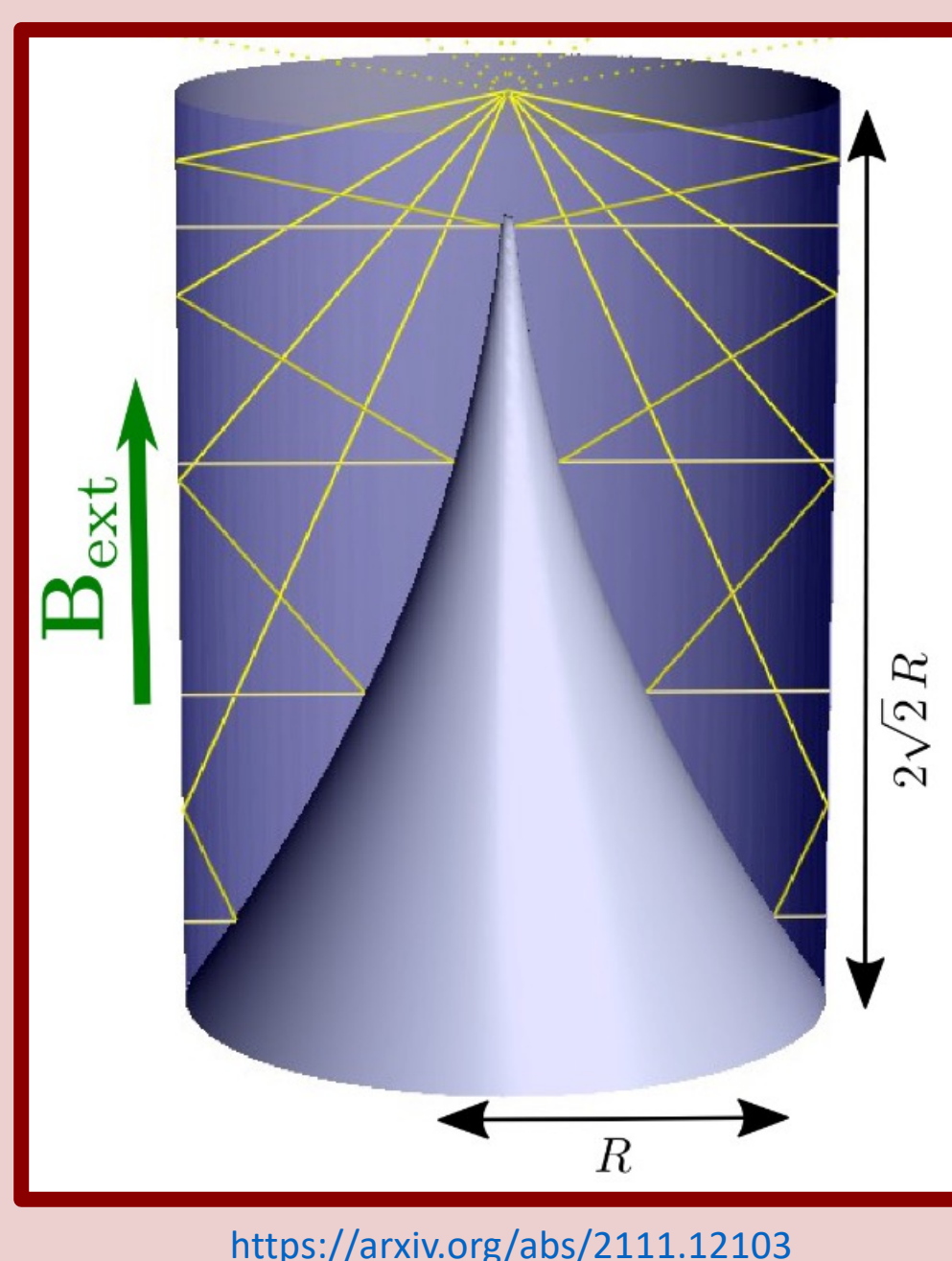
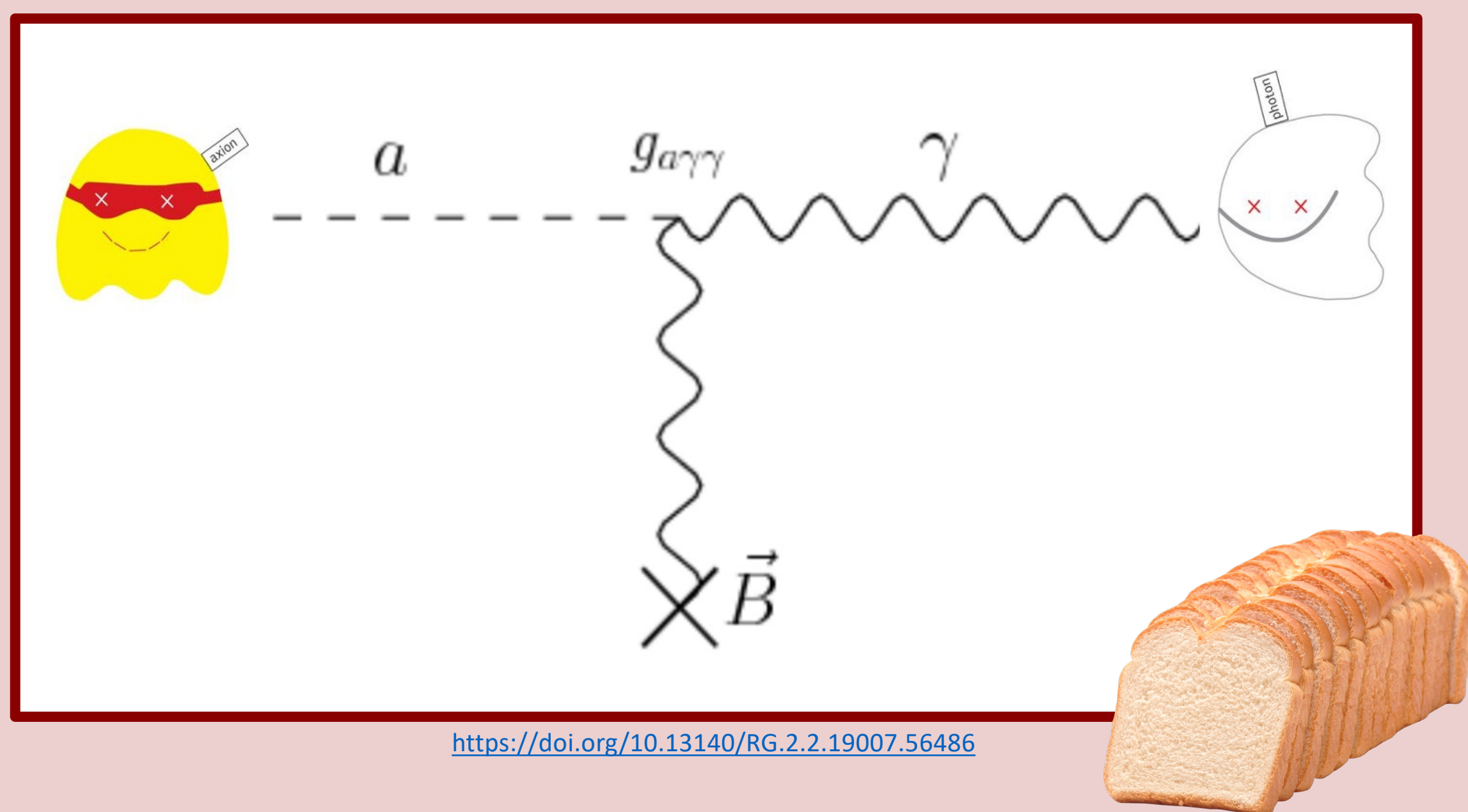
Physics motivation for axion searches

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 photon*
- At a conducting boundary inside a magnetic field, we expect to see this conversion of an axion into a photon



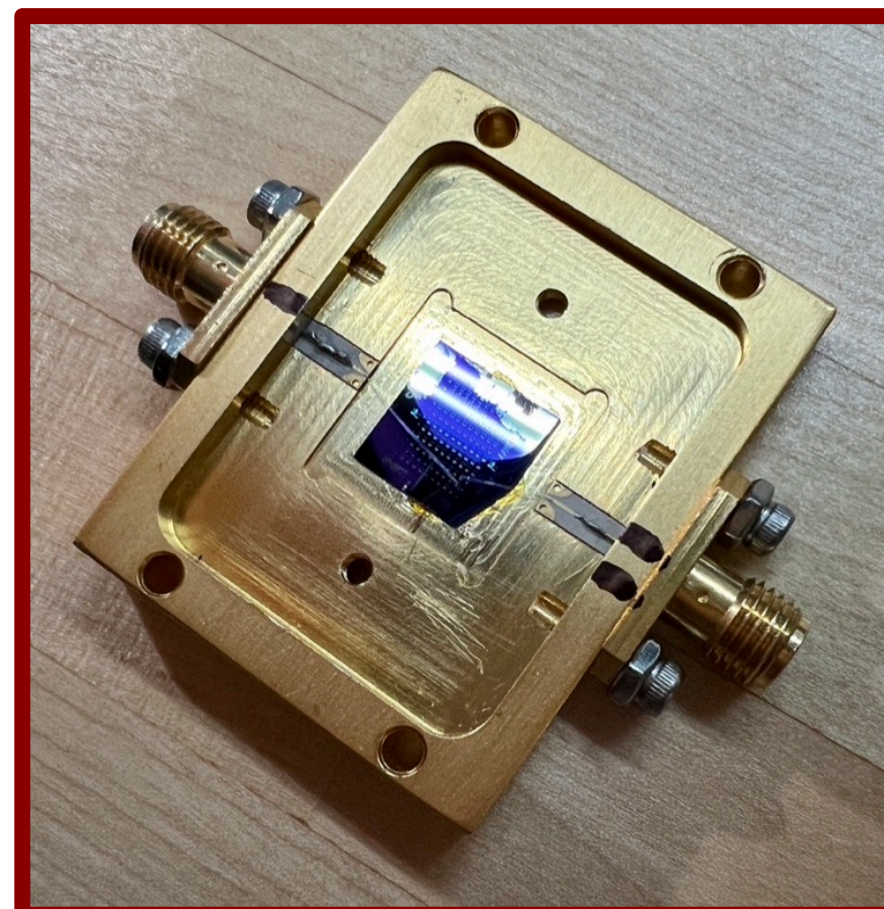
Quantum sensor candidate: SNSPD

SNSPD: superconducting nanowire single-photon detector

- Single photon counters with dark rates as low as one per day [10.1103/PhysRevLett.123.151802](https://doi.org/10.1103/PhysRevLett.123.151802)
- 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 μm x 15 μm area

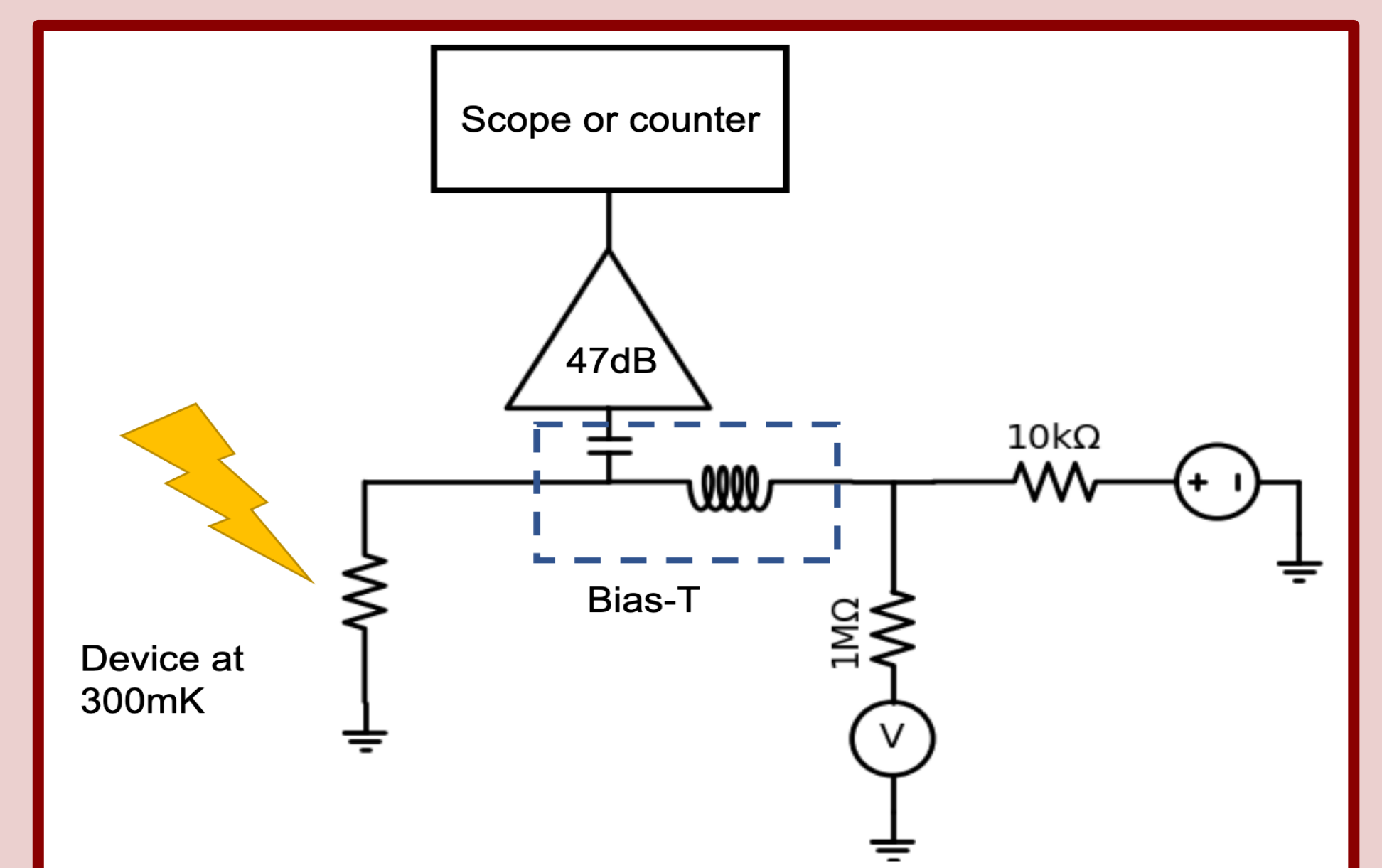
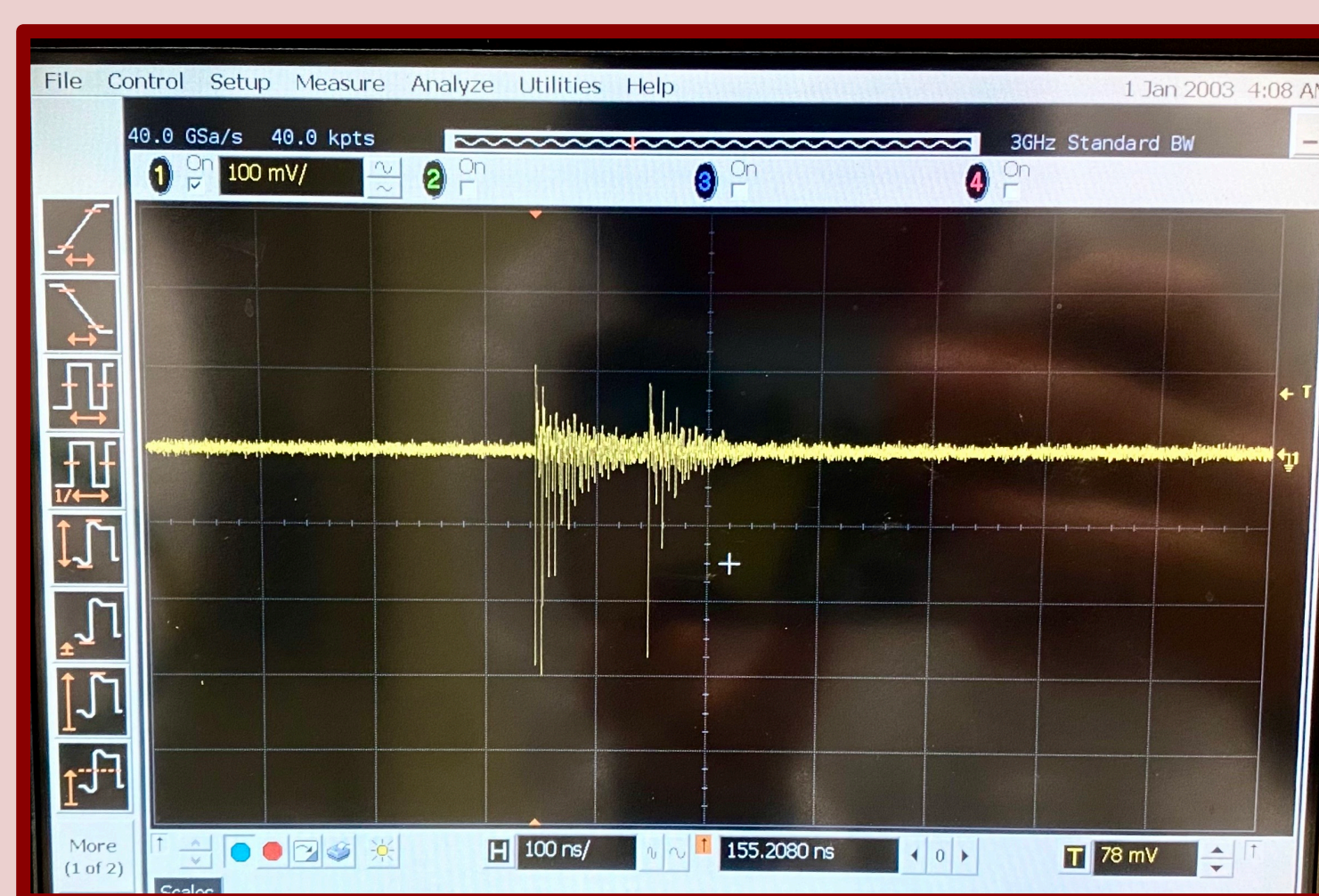
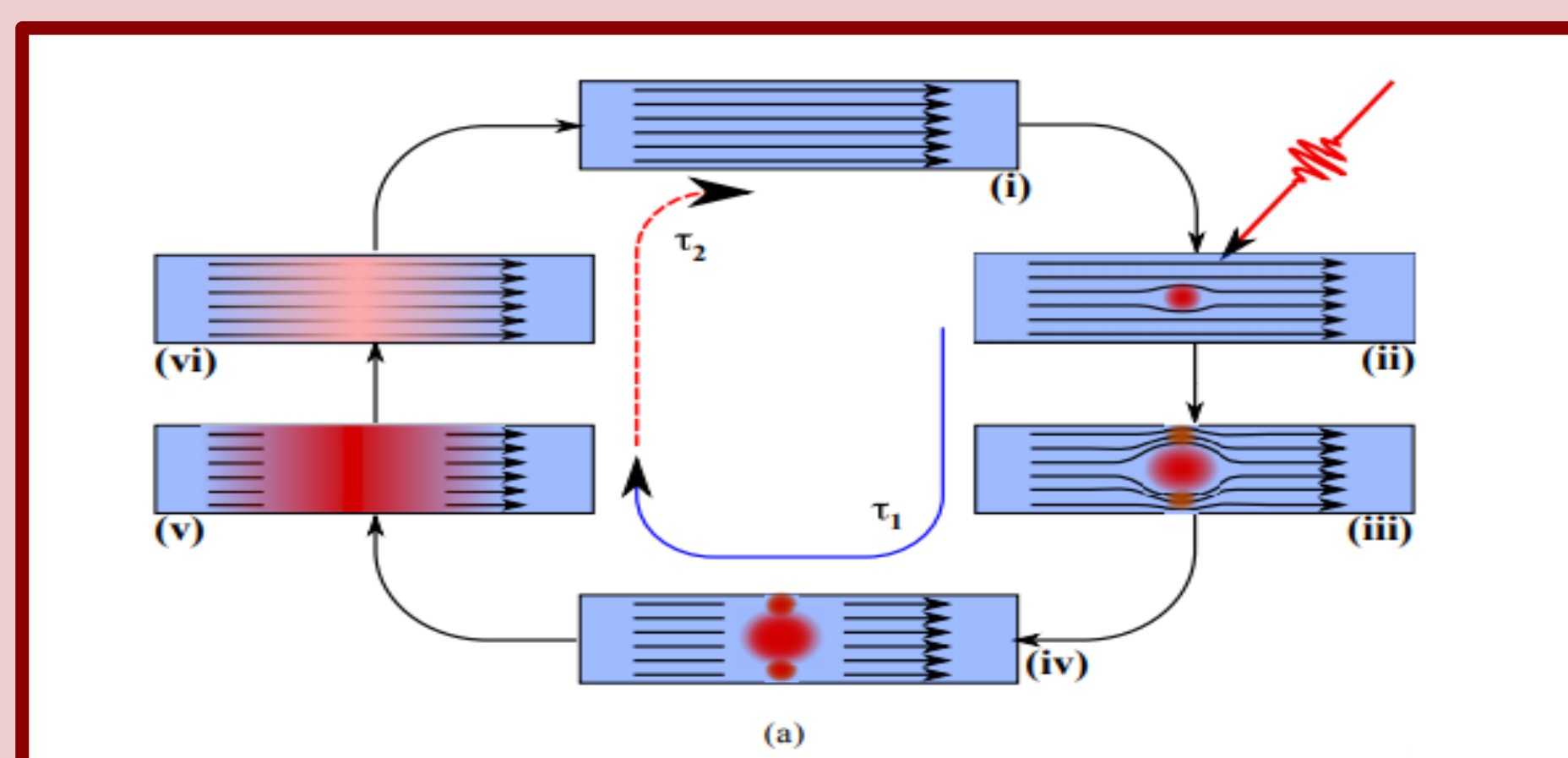
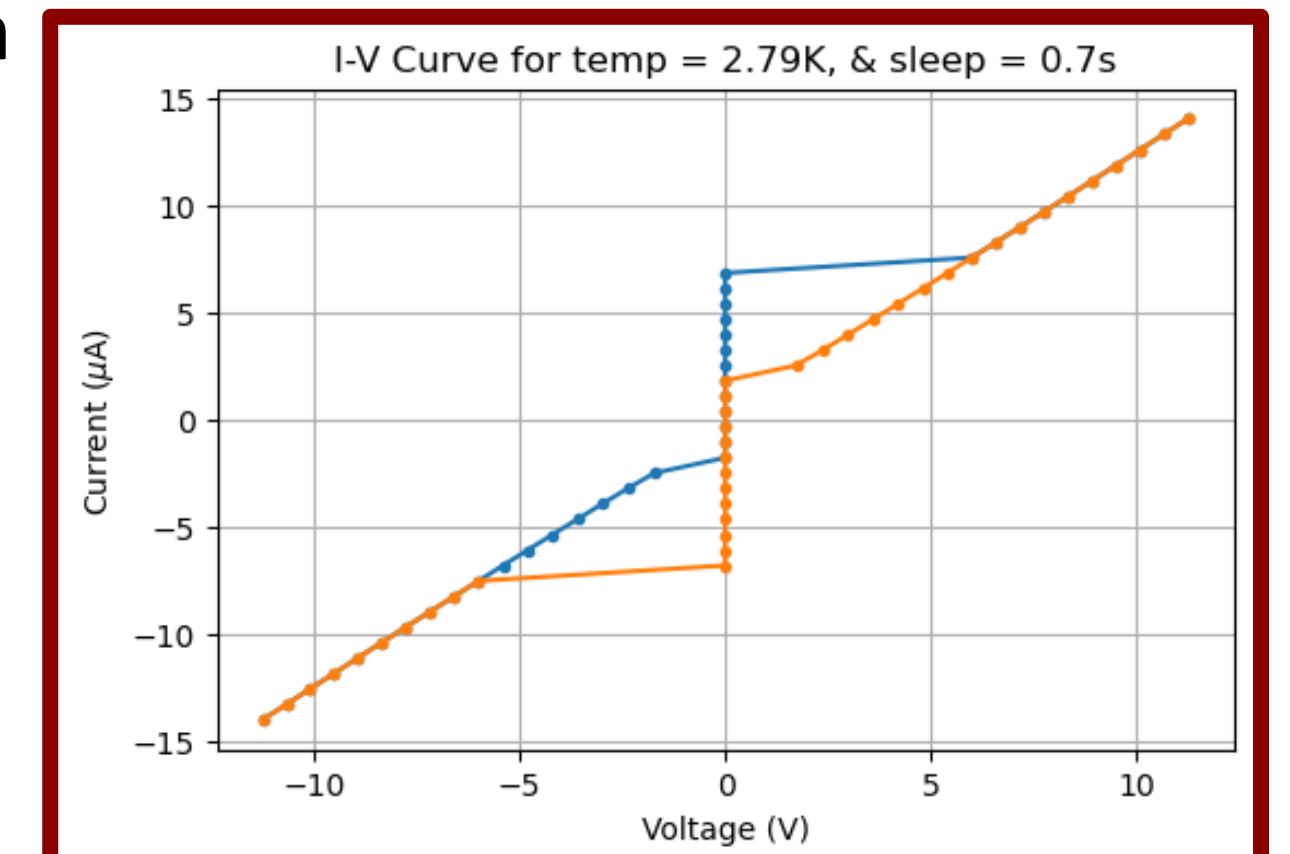


Testing SNSPDs at Fermilab

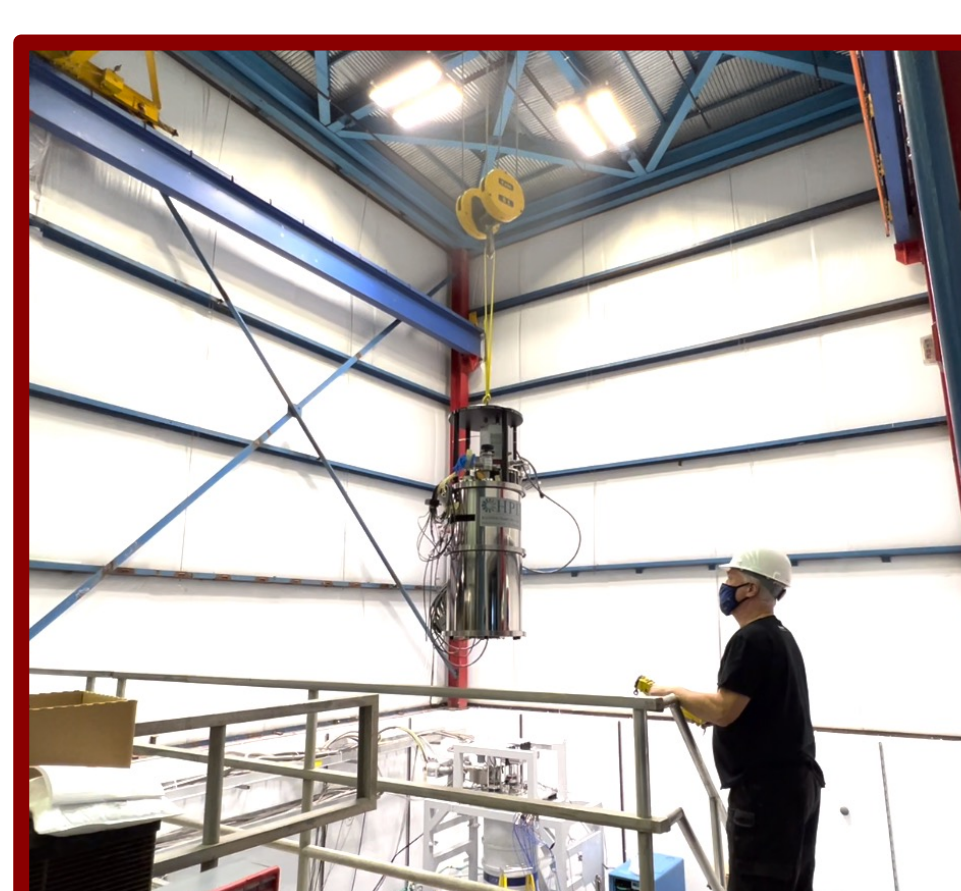
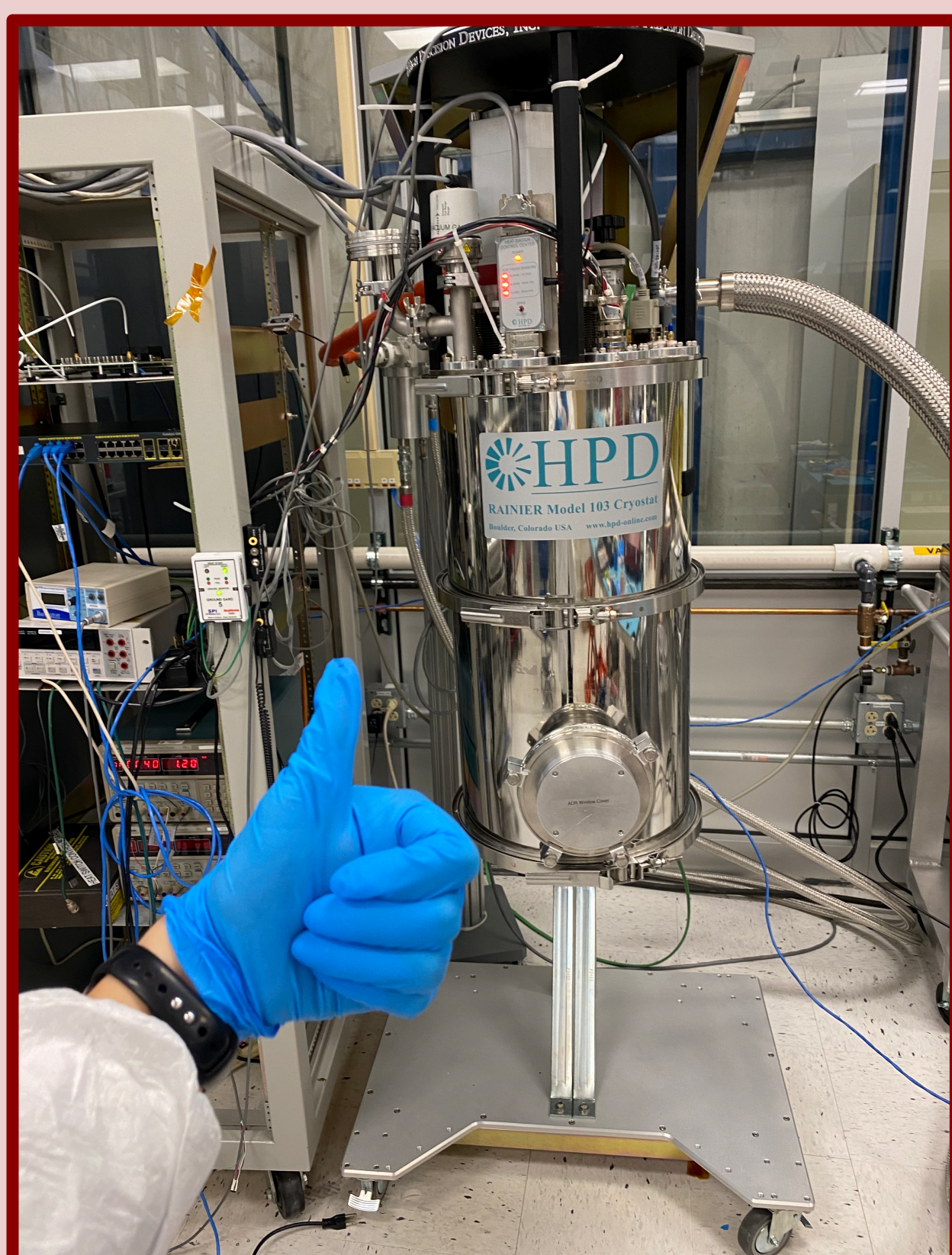
- Using adiabatic demagnetization refrigerator (ADR) operating at 300mK at FNAL
- Delays in testing due to various fridge and noise issues

Successes

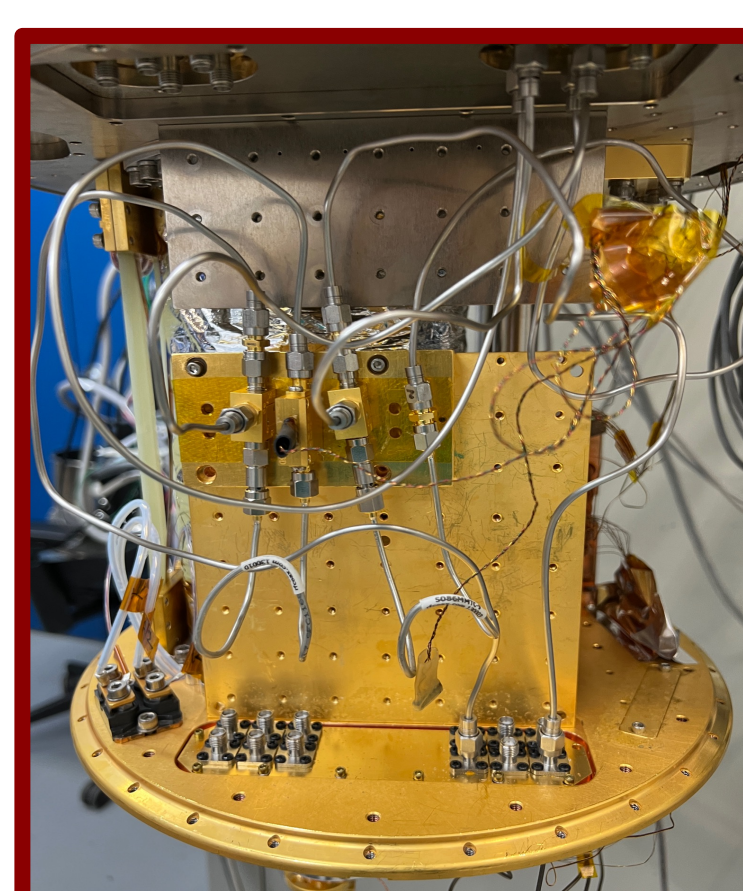
- First dark pulses on the devices
- Observing switching current behavior of device



Fermilab lab work



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



Cryogenic wiring to amplifiers inside the ADR for testing

