Low energy calibration of novel dark matter detectors with a scanning laser device
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Near-threshold calibration is required for novel dark matter detectors:

**Motivation:** Growing interest in low-mass dark matter requires novel, low-threshold detectors. To enable discovery, we need to calibrate near threshold for this wide variety of devices.

**Outcome:** We have developed a calibration setup that
- Delivers photons over an energy range of 60meV - 5eV
- Scans over full area of device with <100μm precision
- Produces time-resolved, low-intensity pulses
- Operates *in situ* (cryogenic, no parasitic backgrounds)
- Is device independent, flexible, and modular
- Is relatively inexpensive

Careful design and technology choices allow for desired operating specifications:

**Challenge:** cryogenic movement  
**Solution:** modified MEMS mirrors for use at 10mK (upper left)  
- Dissipates <nW of power on average

**Challenge:** small beam spot size at many wavelengths  
**Solution:** homebrew reflective focusing mechanism  
- Reflective collimator (center left) + off-axis parabolic mirror (lower left)

**Target technical specifications:**
- ~1.5" x 1.5" scanning area
- <100μm spot size
- ~10μm position resolution
- O(100)Hz scanning speed
- O(μs) pulse width
- Operating temperature as low as 10mK

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Pulsed, scanning laser device concept:

1. Light source of choice
2. Filter light to desired wavelength/intensity
3. Focus light to small spot size
4. Chop light to create a pulsed beam
5. Steer pulsed beam to desired location...
6. ...to produce energy deposits in your device

Current status: First 100mK scanning test imminent

**Upper left:** Final design of scanning device, machined in copper
**Lower left:** Full ~1.5” x 1.5” scanning area can be targeted with arbitrary pattern of laser light
**Below:** H. Magoon installing scanning device into dilution refrigerator

Early science goals of testing program:
- Functionality demonstration of modified MEMS mirrors at 100mK
- Investigation of MKID detector position sensitivity
- Measurement of phonon transport and collection to inform simulations of variety of quantum devices and detectors
- Study of quasiparticle poisoning in qubits