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