#256-245

Detector Design for AMoRE-I

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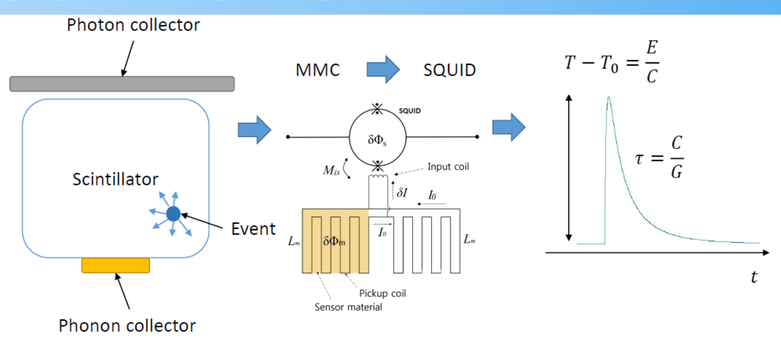
CENTER FOR UNDERGROUND PHYSICS

I. Introduction

AMoRE

- Advanced Mo-based Rare process Experiment (AMoRE) is an international collaboration project to search for neutrinoless double beta decay (0νββ) of ^{100}Mo using Molybdenum-based crystals.
- Features:
  - Q (Mo-100 bb is 3034 MeV) is higher than most gamma backgrounds.
  - Simultaneous heat and light detection based on MMC readout.
  - Strong discrimination power from PSD and L/H ratios
  - High energy resolution
  - Fast rise-time on heat and light signals
- During the AMoRE Pilot measurement, we identified and reduced various background sources. We are presently upgrading the detector system to the first phase of the project, AMoRE-I.

Structure of AMoRE detector

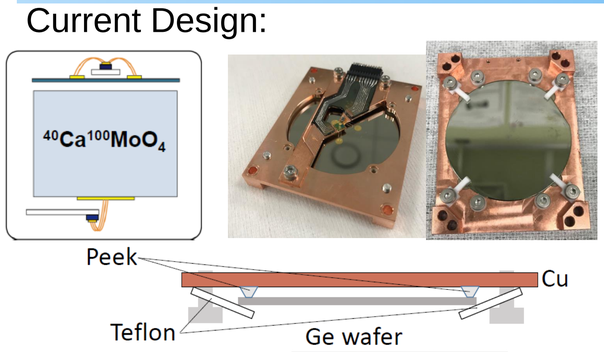


- Crystal / Ge wafer: the phonon/scintillation detection
- Metallic Magnetic Calorimeter (MMC) is a sensitive thermometer sensor
- When energy is deposited, MMCs read temperature increases by measuring its magnetization changes.

II. Detector Improvement

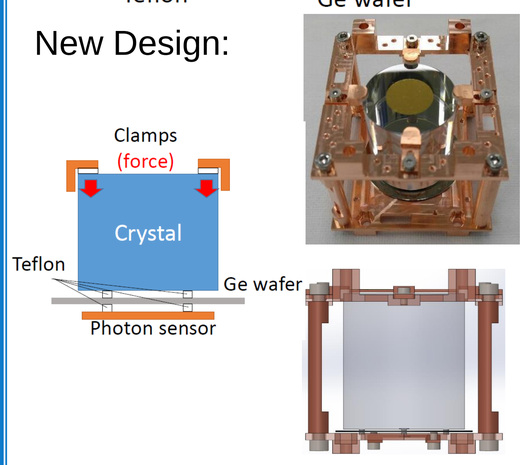
Photon sensor & wafer

Current Design:



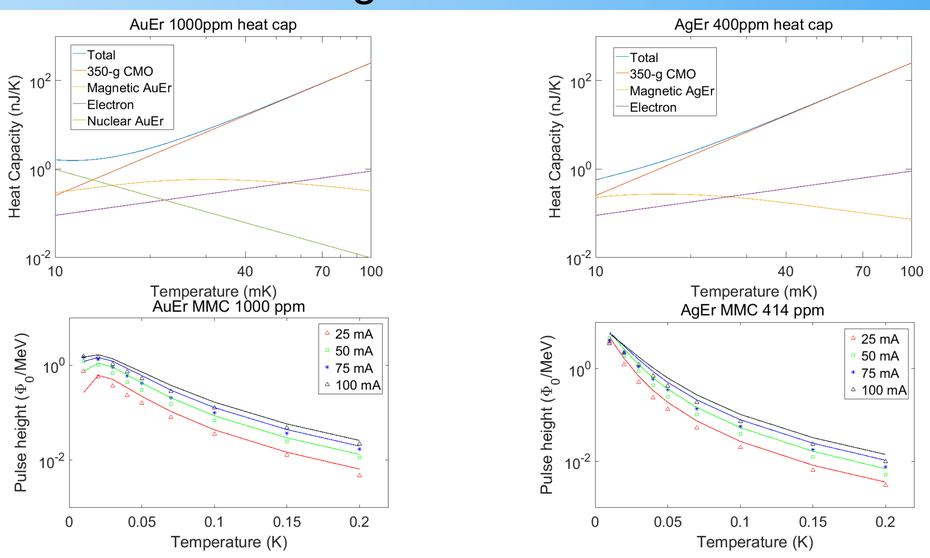
- Wafer is fixed by Teflon supports & bolts on the EDGE.
- No direct thermal connection with crystal
- Vulnerable to vibration (low frequency noise)

New Design:



- The wafer is fixed by spacers & force by clamps NEAR the CENTRE (expect stronger force)
- Thermal connection: wafer-Teflon-crystal (expect little influence on signal because of relatively long time constant)
- To be expected to reduce vibration noise

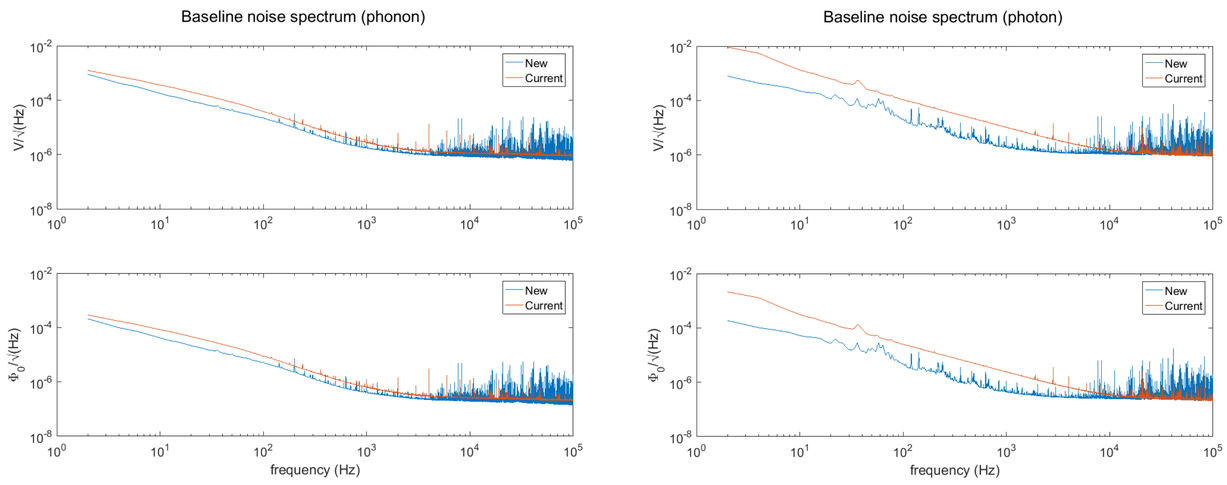
MMC – Au:Er → Ag:Er



- Au:Er has ~1/T^2 heat capacity component associated with nuclear quadruple moments of gold that do not exist in Ag:Er. The heat and light signals made of AgEr MMC sensor should be larger and faster than those with Au:Er MMC sensors.

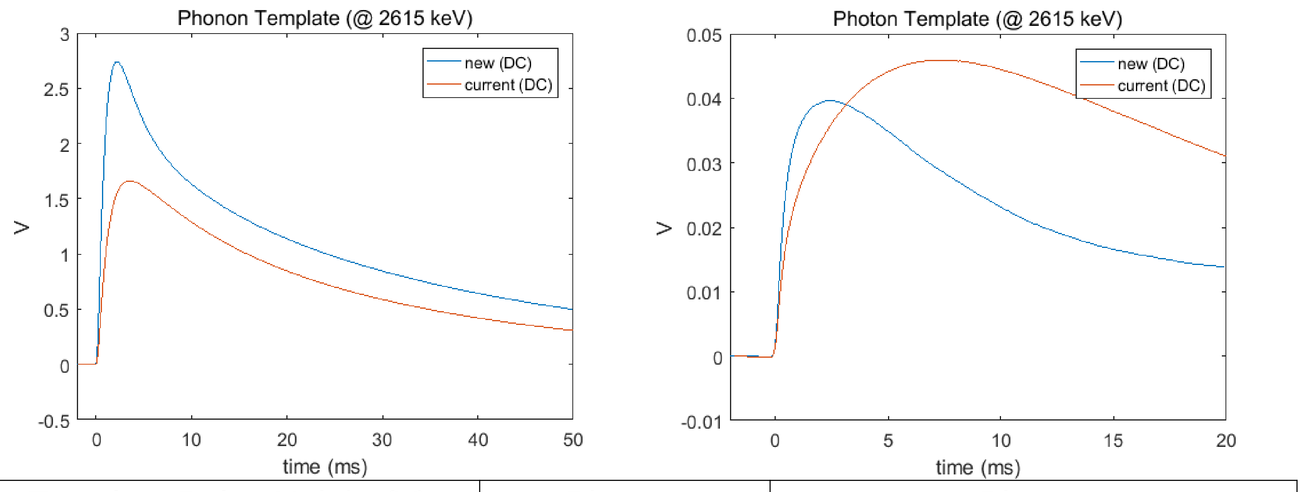
III. Result

Noise



- Smaller noise in low frequency in both phonon and photon signals

Signal Size



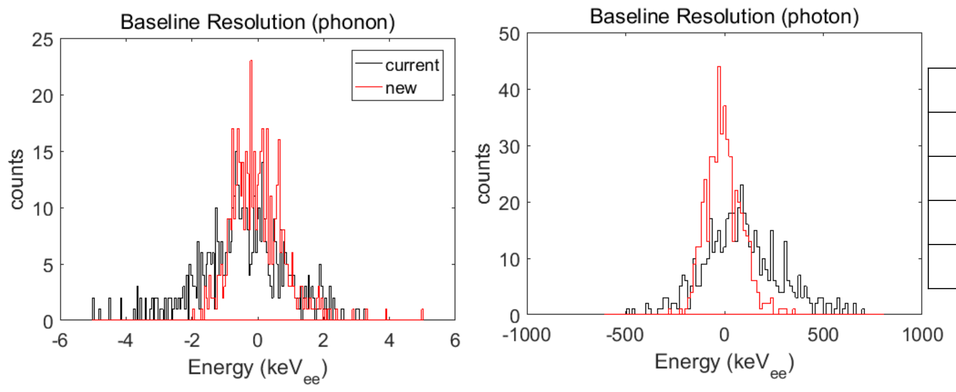
Template Pulse Height (V)	Phonon	Photon
Current	1.66	0.0459 (large in low frequency)
New	2.74	0.0397

Integrated NEP (FWHM): $\frac{2.35482}{2\sqrt{\int_0^B \left|\frac{S(f)}{N_{rms}(f)}\right| df}}$

(f: frequency, S: template, N_{rms}: RMS noise spectrum, B : ½ of sampling rate)

Design	Phonon	Photon
Current	4.2×10^{-4}	8.3×10^{-3}
New	1.6×10^{-4}	7.2×10^{-3}

Baseline Resolution



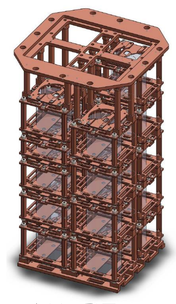
FWHM (keV)	
Phonon	Photon
2.35±0.29	349±44
1.57±0.18	190±23

IV. Summary & Plan

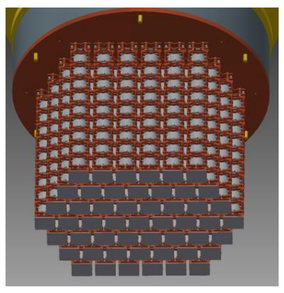
- The detector structure of heat and light sensors has been modified to reduce the vibration noise of the light signals and to increase the light collection efficiency.
- The new detector module with the combined light/heat sensors design certainly improved the vibration noise of photon signals.
- The both of heat and light signals with Ag:Er MMCs yield larger signals and lower noise levels at 20 mK leading to better noise- equivalent power in comparison of those values of Au:Er MMCs.

AMoRE Phase-I

AMoRE Pilot
1.9 kg/6 crystals



AMoRE-I
6.1 kg/18 crystals



AMoRE-II
200 kg/8×64 crystals

- Next step of AMoRE project:
  - 2.9 kg of ^{100}Mo
  - 13 CMOs, 5 LMOs
- Based on this result, develop a best optimized detector for AMoRE-I