PE-31

LTD17

Status of the AMoRE experiment searching for neutrinoless double beta decay using low-temperature detectors

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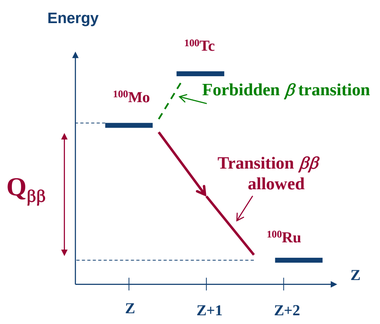
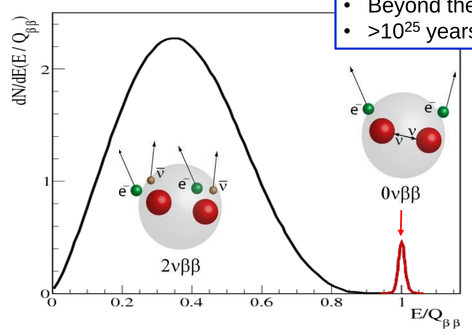
Motivation

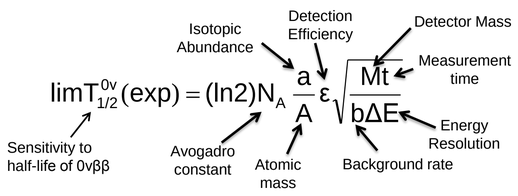
The goal of the AMoRE (**A**dvanced **Mo**-based **R**are process **E**xperiment) project is to search for neutrinoless double beta decay ($0\upsilon\beta\beta$) of ^{100}Mo using Mo-based scintillating crystals and low-temperature sensors.





$0\nu\beta\beta$ decay
- Massive neutrino
- Majorana particle
- Beyond the SM model
- $>10^{25}$ years of half-life

Sizeable background case



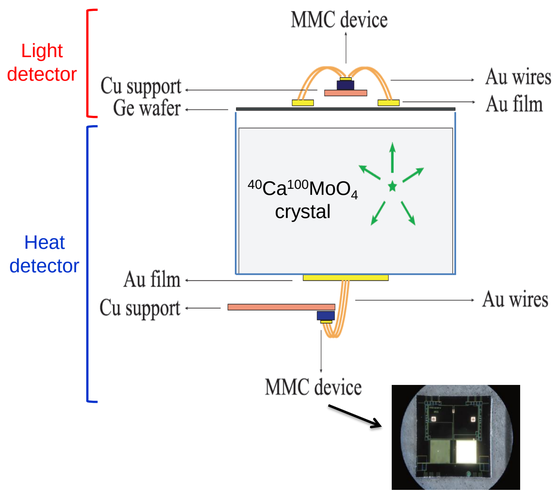
"Zero"-background conditions can be achieved with:
- high energy resolution and particle discrimination performance of low-temperature detectors
- low rates of internal and external backgrounds.

"Zero" background case

$$T^{0\nu}_{1/2}(\exp) = (\ln 2) N_A \frac{a}{A} \varepsilon Mt$$

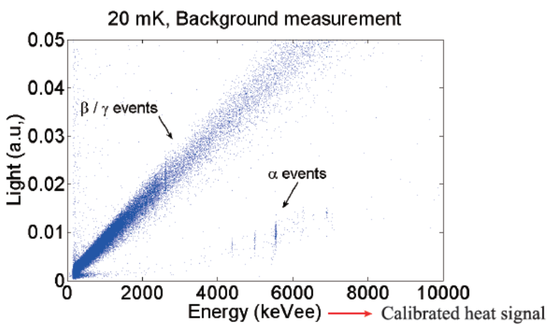
Detector concept

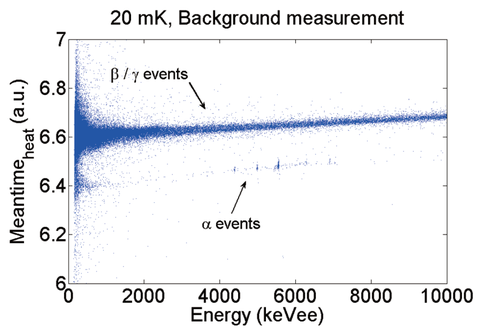
Simultaneous measurement of heat and light using metallic magnetic calorimeters (MMCs)



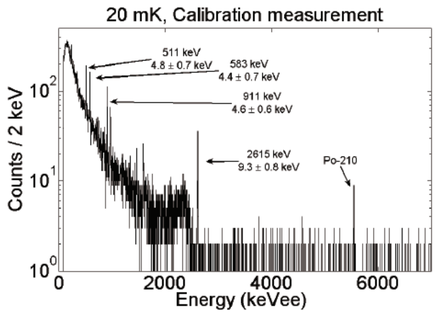
- Mo-based scintillation crystal used as source and detector
- Choice of ^{100}Mo: high Q-value (3.034 MeV) and high natural abundance (9.6 %), relatively short theoretically predicted half-life ($0\nu\beta\beta$)
- High Debye temperature (T_D=438 K)
- MMCs: fast response, high energy resolution, wide operating temperatures

Above-ground measurements (obtained using a wet DR)





Pulse shape discrimination: separation of α and β/γ events

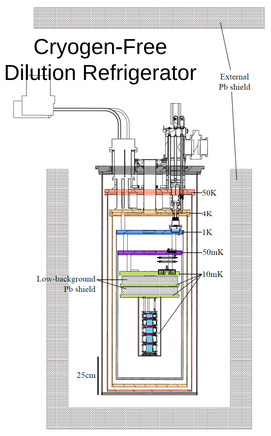


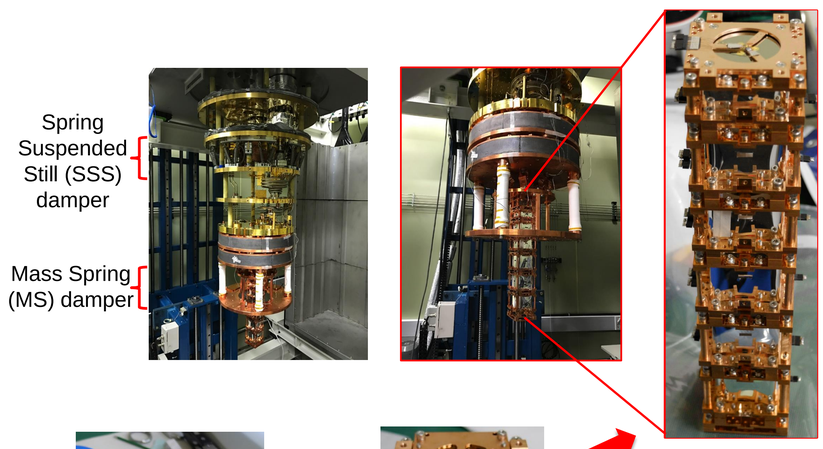
Energy spectrum obtained with an external ^{232}Th source
$\Delta E_{FWHM} \approx 9$ keV @ 2.6 MeV

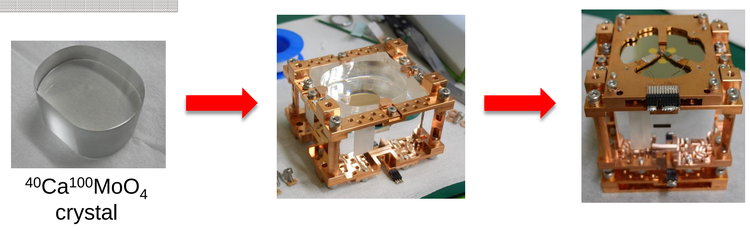
AMoRE-Pilot experiment at Y2L

YangYang Underground Laboratory (Y2L)
- Located in a tunnel of the Yangyang pumped storage power plant (Korea)
- Minimum vertical depth : 700 m
- Access to the lab by car : 2 km

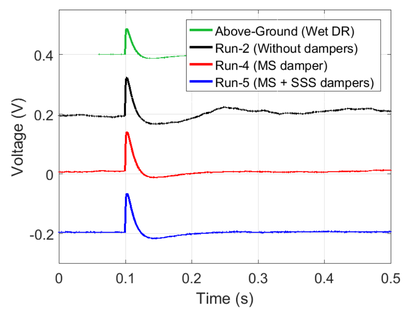
AMoRE-Pilot : six ^{40}Ca^{100}MoO$_4$ crystals (SB28, S35, SS68, SE01, SB29, SE02)
6 heat detectors + 6 light detectors





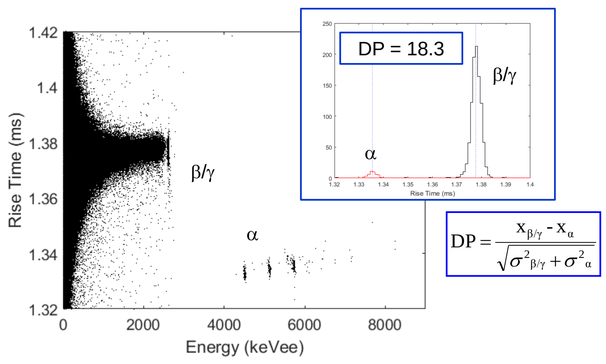


- AMoRE-Pilot consists of several runs corresponding to different experimental setup upgrades. Run-5 is underway.
- Measurements performed at temperatures from 10 mK to 40 mK

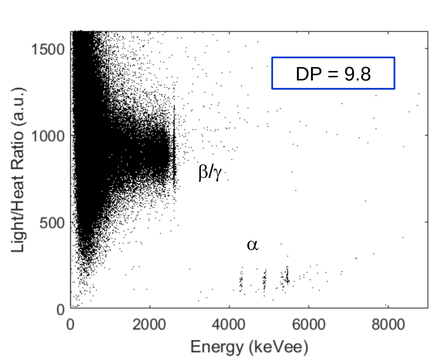


The level of noise observed when using a cryogen-free dilution refrigerator is significantly higher than when using a wet DR due to the pulse tube refrigerator inducing a large amount of vibration noise
→ The installation of vibration dampers resulted in significant noise reduction

Detector performance in Run-5 (preliminary)



β/γ and α particles can be distinguished using pulse shape discrimination via pulse rise time or mean time.



Another good separation method is the use of the light/heat ratio.

The energy resolutions have been improved throughout the different runs

FWHM energy resolution @ 2.6 MeV

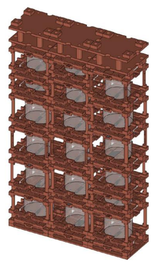
Crystals	Run-1	Run-2	Run-4	Run-5 (very preliminary)
SB28 (0.20 kg)	36.8 keV	25.0 keV	13.6 keV	14.3 keV
S35 (0.25 kg)	N/A	16.3 keV	10.9 keV	11.1 keV
SS68 (0.35 kg)	52.6 keV	22.5 keV	13.5 keV	12.1 keV
SE01 (0.35 kg)	39.7 keV	24.6 keV	N/A	8.7 keV
SB29 (0.40 kg)	42.6 keV	N/A	13.0 keV	16.0 keV
SE02 (0.34 kg)	N/A	N/A	N/A	9.3 keV

Baseline energy resolutions (FWHM @ 0 MeV) are now as low as 3 keV

AMoRE-I and AMoRE-II experiments

	AMoRE-Pilot	AMoRE-I	AMoRE-II
Total mass	1.8 kg (^{40}Ca^{100}MoO$_4$)	5~6 kg (^{40}Ca^{100}MoO$_4$)	200 kg
Number of MMC channels	12	36	1000
$T_{1/2}$ sensitivity (years)	3.2×10^{24}	2.7×10^{25}	1.1×10^{27}
Underground lab	Y2L	Y2L	ARF (new lab)
Schedule	2015-2017	2018-2019	2020-…

AMoRE-I
5~6 kg
(2018~)



AMoRE-II
200 kg
(2020~)

Center for Underground Physics (ibs)

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