NEUTRINO 2020

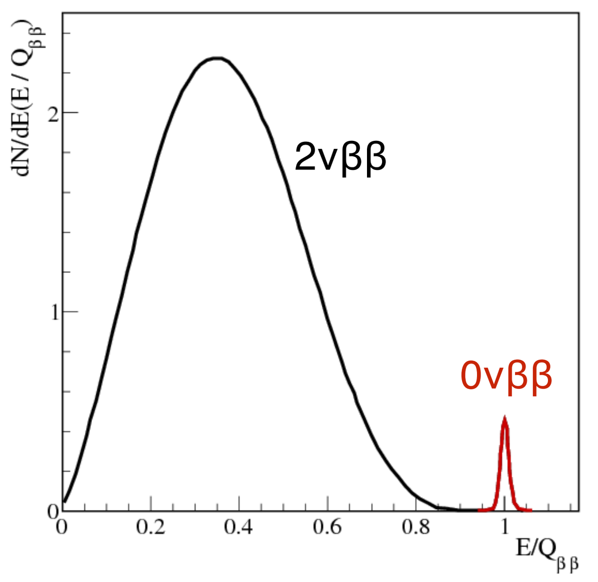
Status of AMoRE

Yoomin Oh
CENTER FOR UNDERGROUND PHYSICS ibs
on behalf of the AMoRE Collaboration*

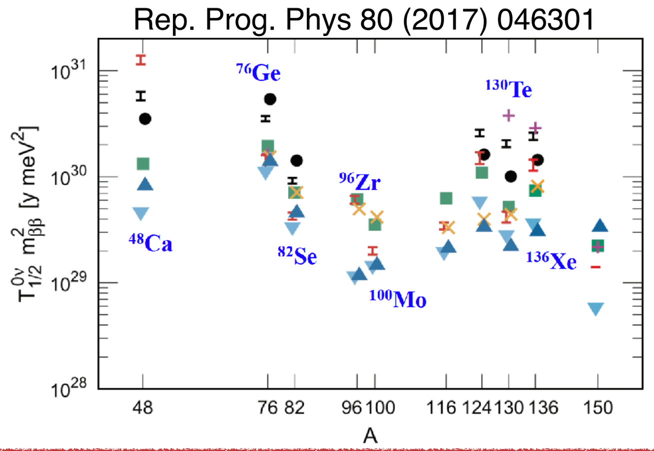
AMoRE 0νββ experiment

- Search for the neutrinoless double beta decay of ^{100}Mo using Mo-based scintillating crystals and a low-temperature detector technique.
- ^{100}Mo: one of the highest Q-value (low background), a relatively short half-life for ββ-decay, a high natural abundance.
- Experimental sensitivity:
  with sizable background: $\lim T^{0\nu}_{1/2} \sim (\ln 2) N_A \frac{a}{A} \varepsilon \sqrt{\frac{Mt}{b\Delta E}}$
  or, with zero background: $T^{0\nu}_{1/2} \sim (\ln 2) N_A \frac{a}{A} \varepsilon M t$

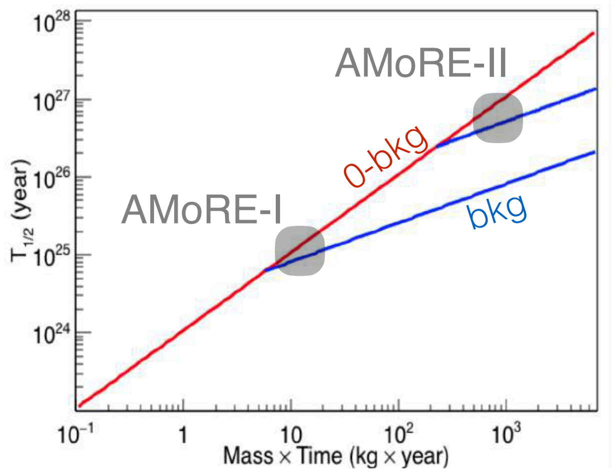
a: isotope abundance, A: atomic mass, ε: detector efficiency, Mt: mass time exposure, b: background counting rate, ΔE: energy resolution



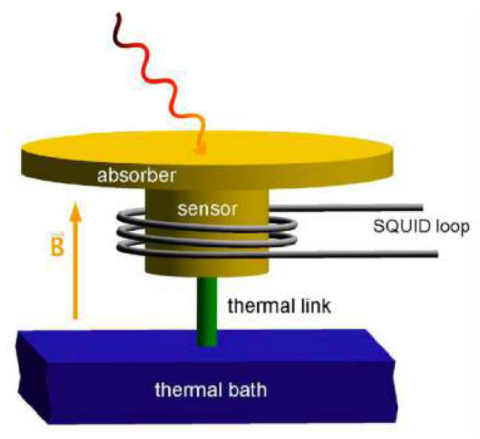
J.Engel, J. Menendez, Rep. Prog. Phys 80 (2017) 046301

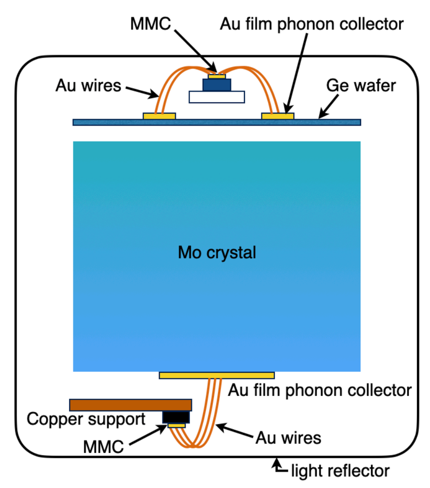


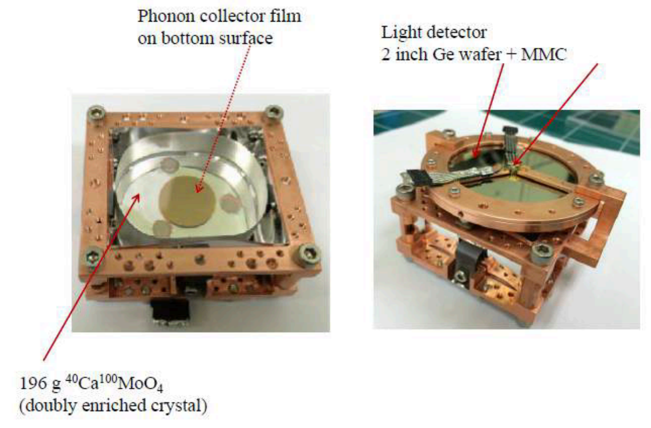
Candidate	Q (MeV)	Abund. (%)
^{48}Ca	4.271	0.19
^{76}Ge	2.040	7.8
^{82}Se	2.995	8.7
^{100}Mo	3.034	9.7
^{116}Cd	2.802	7.5
^{124}Sn	2.228	5.8
^{130}Te	2.533	34.1
^{136}Xe	2.479	8.9
^{150}Nd	3.367	5.6



Detector technique

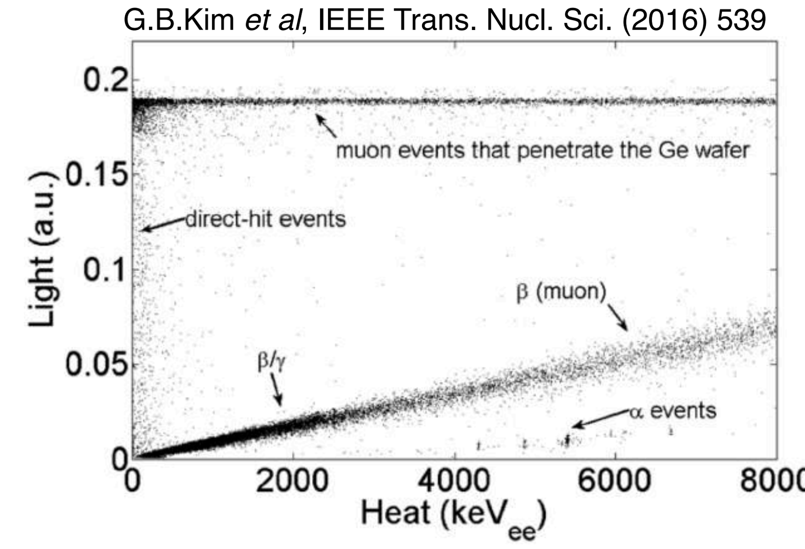






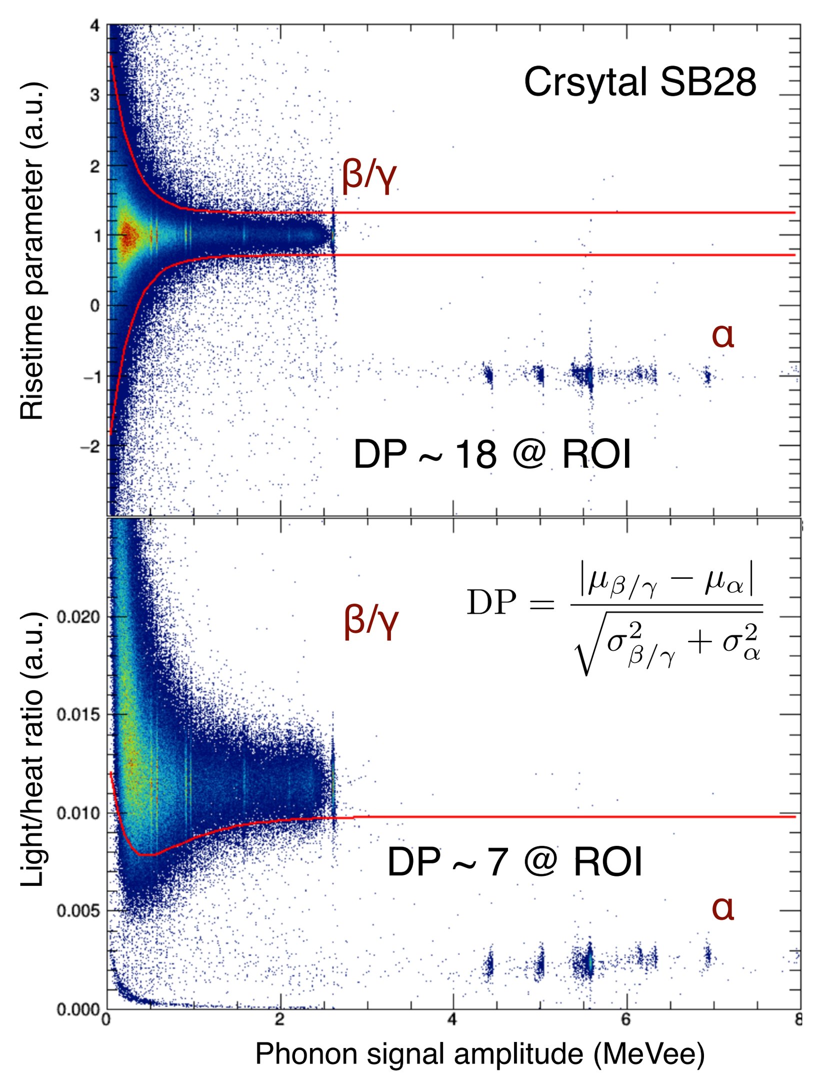
- **Principle of operation:**
  - Energy absorption in CMO crystal,
  - > Phonon & photon generation,
  - > Temperature increase (Au film)
  - > Magnetization in MMC decreases,
  - > Squid pick up the charge.
- **Advantage of MMC:**
  - Fast signal rising: ~0.5 ms, critical to reduce random coincidences,
  - Fairly easy to attach to absorber,
  - Excellent energy resolution.

G.B.Kim *et al*, IEEE Trans. Nucl. Sci. (2016) 539



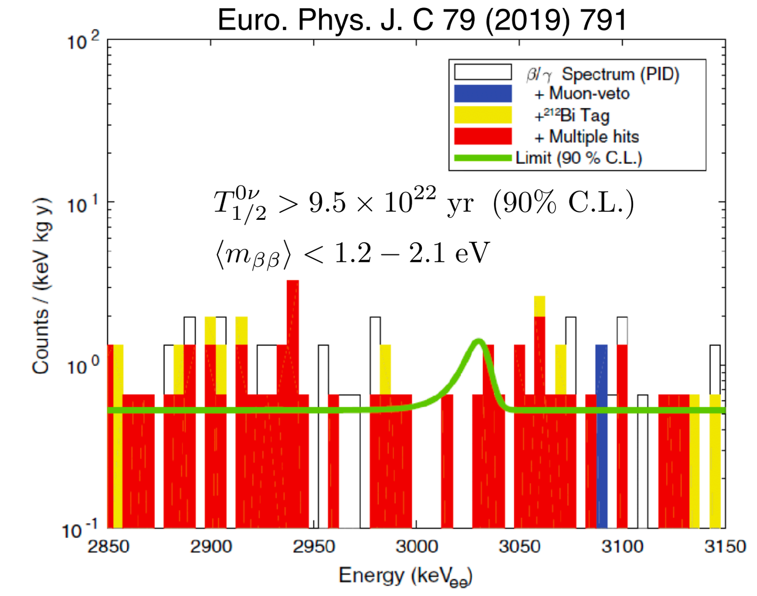
Detector performance and results of AMoRE-pilot

Particle identification



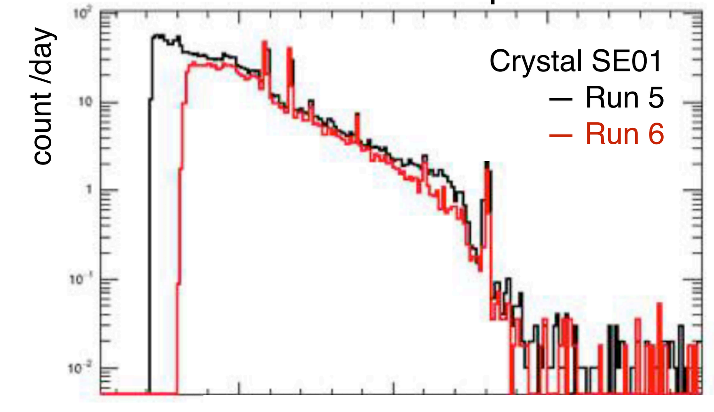
Physics result from the Pilot-run5 data

Euro. Phys. J. C 79 (2019) 791

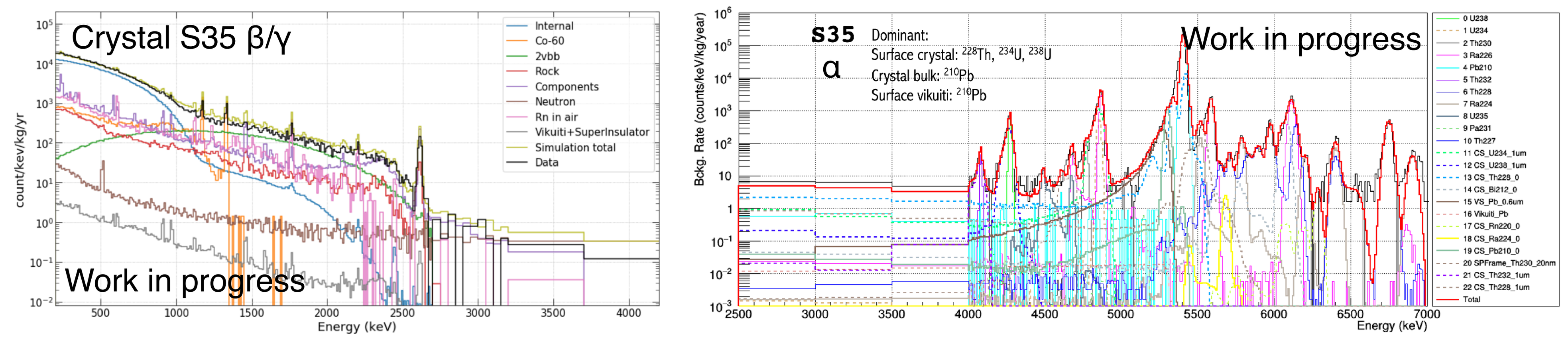


Background reduction during Pilot

by removing high-radioactive components of the setup

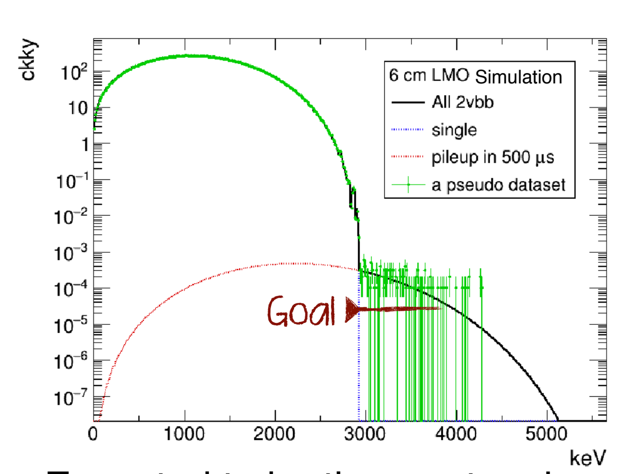


Background simulation

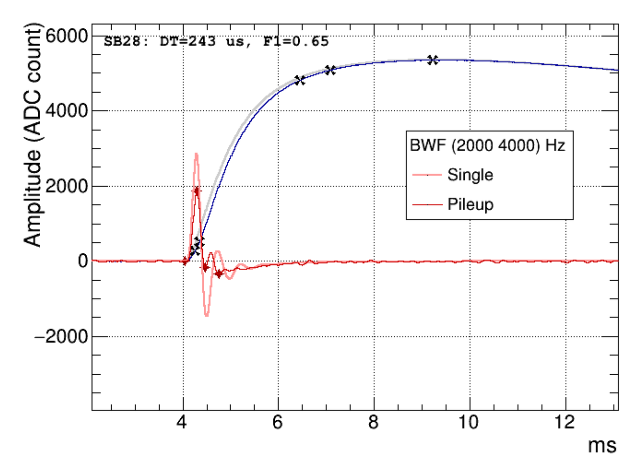


- Internal (bulk/surface) activity of each crystal is estimated from the alpha spectrum.
- External background is simulated from the measured radioactivities of the surrounding materials.
- Combining and fitting of the simulation results to the data.

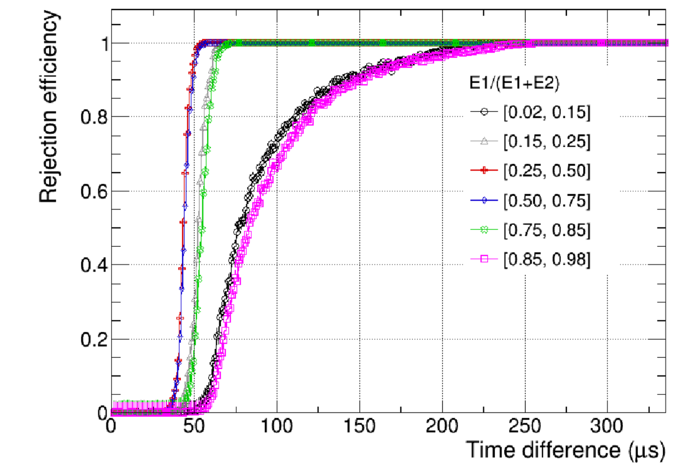
Reduction of the random coincidence background



Expected to be the most serious background source in AMoRE-II



Various pulse shape analysis

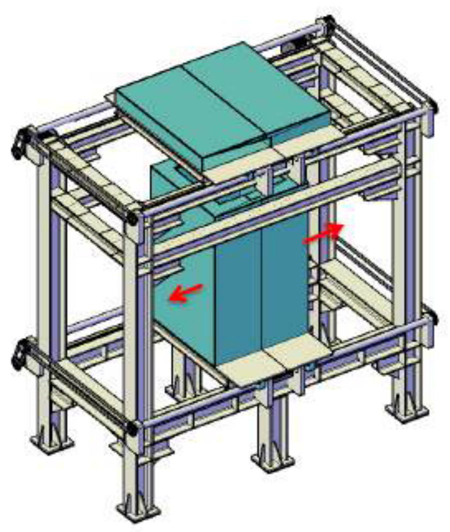


Rejection of ~90% coincidences in 500 μs.

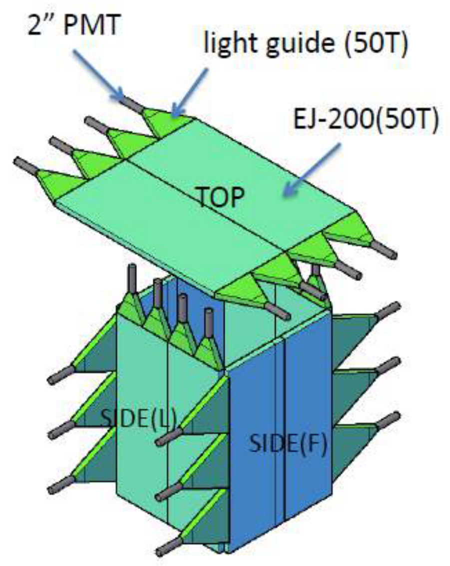
AMoRE stages

AMoRE-pilot & AMoRE-I

Pilot crystal tower

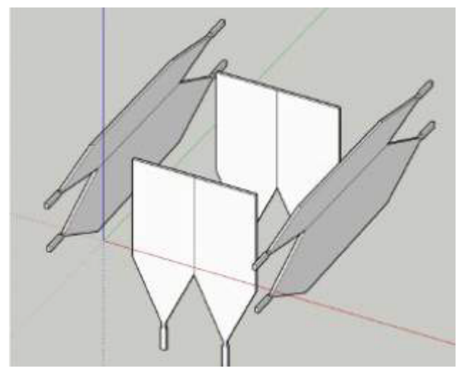


Shielding structure

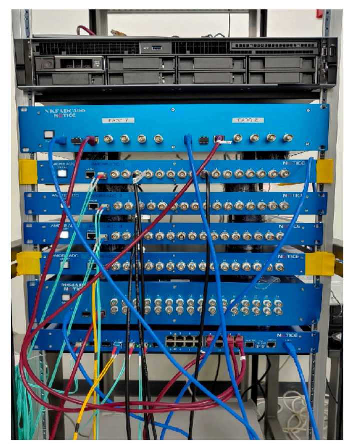


Muon counter

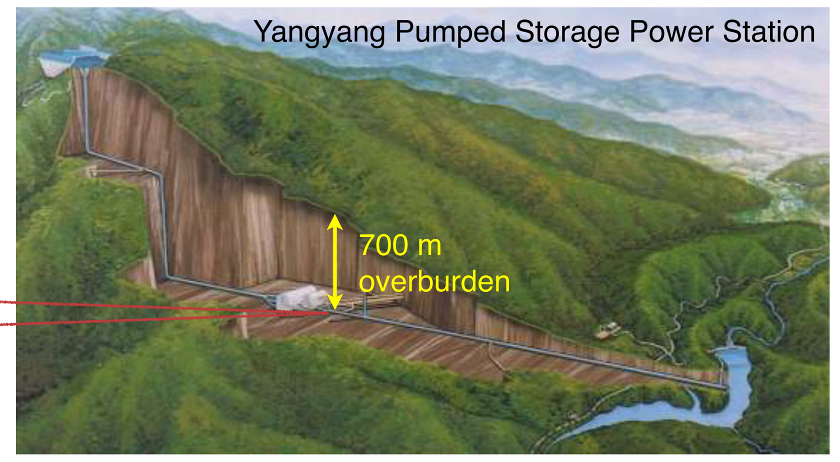
AMoRE-I crystal tower



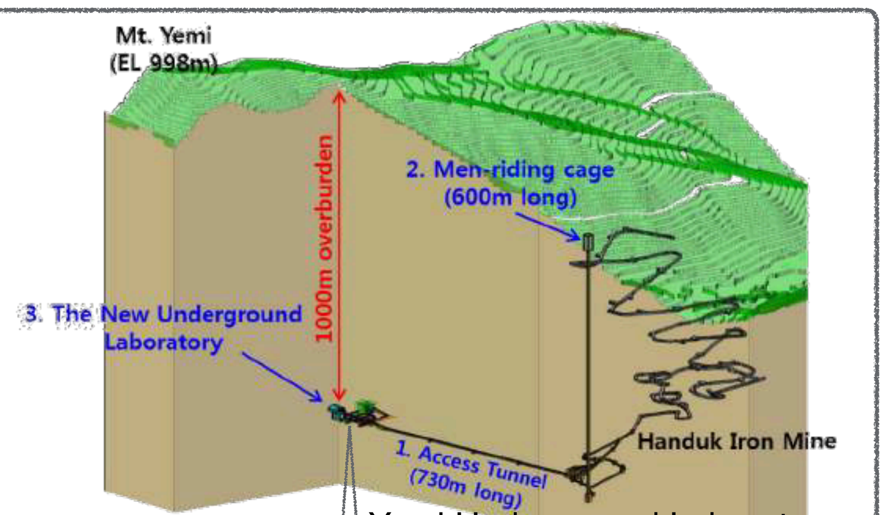
Additional muon counter for AMoRE-I



DAQ for AMoRE-I



Yangyang Underground Laboratory (Y2L)

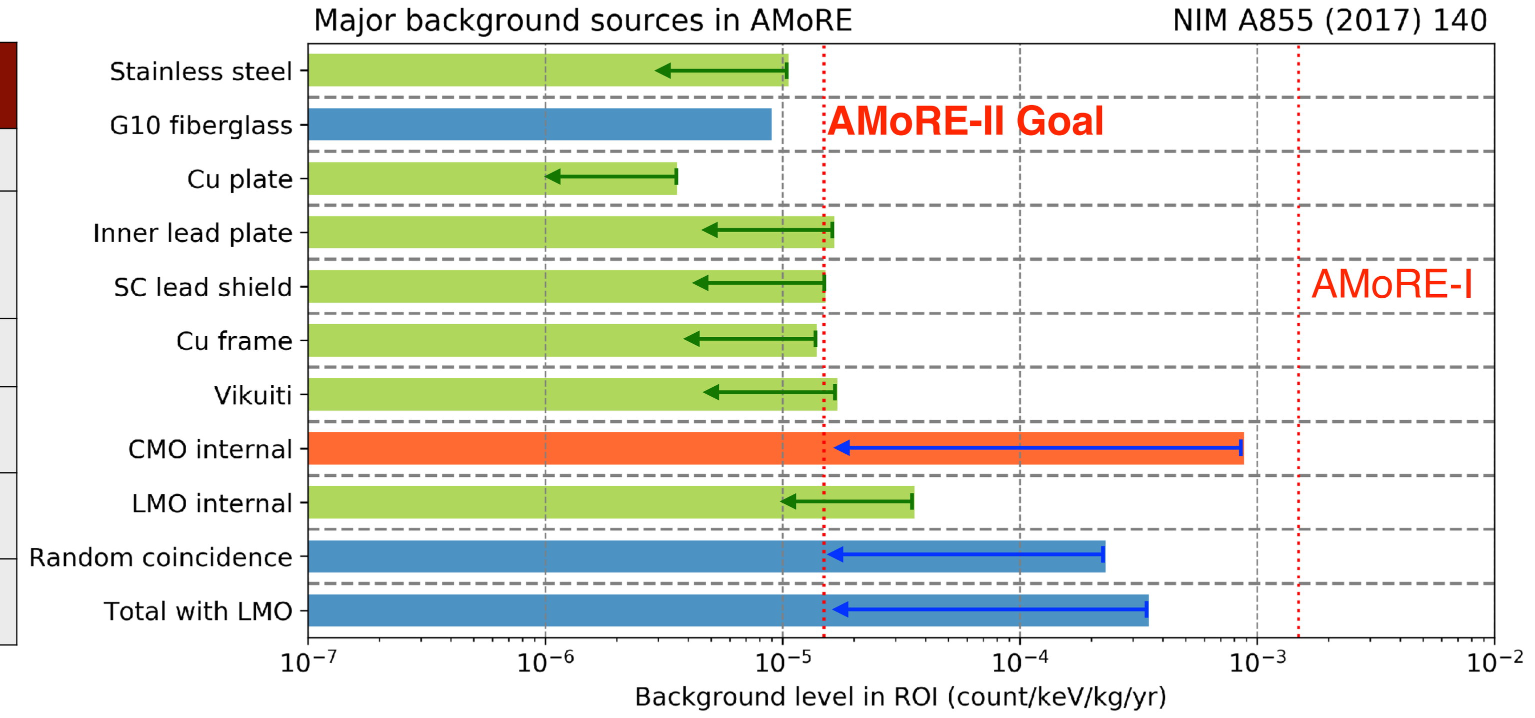


Yemi Underground Laboratory (YemiLab, 2021~)

AMoRE-II

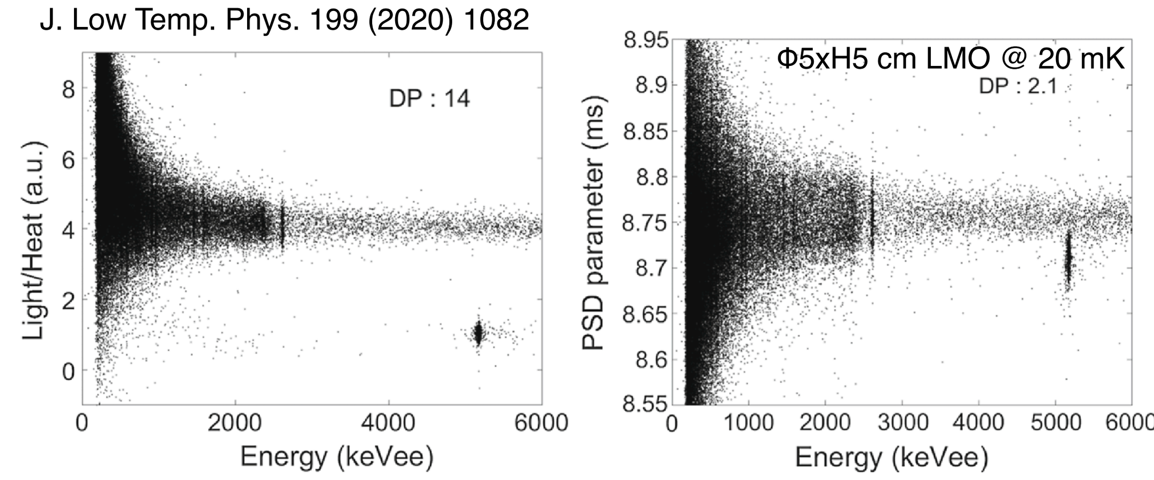
Stage	Pilot	Phase-I	Phase-II
Crystals	CMO 1.9 kg	CMO, LMO 6 kg	CMO, LMO, XMO 200 kg
Background level (keV kg yr)$^{-1}$	$< 10^{-2}$	$< 10^{-3}$	$< 5\times10^{-5}$
$T_{1/2}^{0\nu bb}$ sensitivity (yrs)	$\sim10^{24}$	$\sim10^{25}$	$\sim8\times10^{26}$
$\langle m_{\beta\beta} \rangle$ sensitivity (meV)	380~640	120~200	17~29
Location	Y2L		YemiLab
Operation year	2016-8	2020~	2022~

Major background sources in AMoRE — NIM A855 (2017) 140



Li_2MoO_4 (LMO) crystal R&D

J. Low Temp. Phys. 199 (2020) 1082



- $CaMoO_4$ (CMO) crystals (for AMoRE-pilot & I) has good scintillation property, but requires depletion of ^{48}Ca to reduce the 2νββ background.
- LMO has lower light yield than CMO, but shows good enough performance for phonon/photon detection and an excellent radiopurity level.

*The **A**dvanced **Mo**lybdenum-based **R**are Process **E**xperiment (AMoRE) collaboration consists of about 105 researchers from 23 institutes in 8 countries.