First results of CROSS underground measurements with massive bolometers

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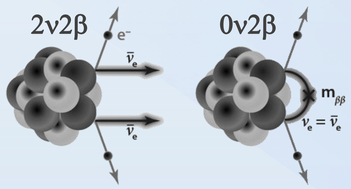
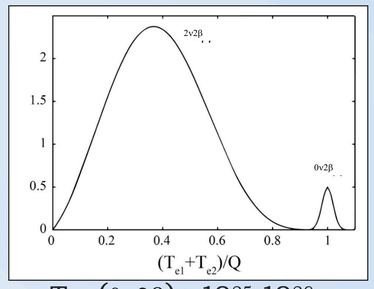
NEUTRINO 2020

Poster #303

Neutrinoless double beta decay ($0\nu2\beta$) searches

- If $0\nu2\beta$ is observed, neutrino is **a Majorana particle**
- **Lepton number violation** gives a clue to leptogenesis (matter-antimatter asymmetry)
- Absolute **neutrino mass scale** determination and information on mass hierarchy

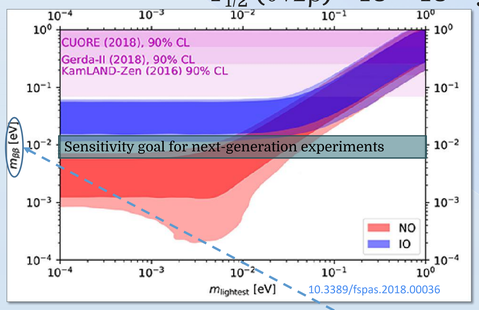




$T_{1/2}\,(0\nu2\beta) > 10^{25}$-$10^{26}$ yr

Complicated task for experiment:

- Few isotopes are suitable for experiments, enrichment is needed
- Very rare decay → extremely low levels of background are required
- Sophisticated technology development nesessary for high sensitivity experiments



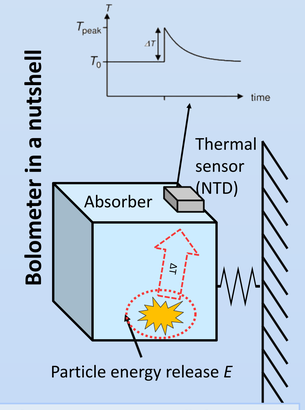
$$(T_{1/2}^{0\nu2\beta})^{-1} = G^{0\nu}(Q,Z)\,|M^{0\nu}|^2 \frac{m_{\beta\beta}^2}{m_e^2}$$

CROSS and CUPID: bolometric experiments with particle identification

^{100}Mo is the isotope of interest - **3034 keV Q-value**, 9.6% isotopic abundance, favorable theoretical predictions for $T_{1/2}$

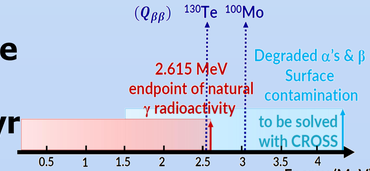
CUPID (CUORE Upgrade with Particle IDentification) - next generation bolometric experiment with double read-out: **$Li_2{}^{100}MoO_4$** crystals+Ge light detectors, aiming to reach sensitivity of $m_{\beta\beta}$~12–20 meV in 10 yr live time.

CROSS (Cryogenic Rare-event Observatory with Surface Sensitivity) aims to use **$Li_2{}^{100}MoO_4$** bolometers with superconducting films to identify and reject near surface events



See also: Poster ID: 308 "The CROSS experiment: rejecting surface events with PSD"

Background supression is a key point for highly sensitive ton-scale experiment → CROSS technology can be used in the second phase of **CUPID to reach b<10^{-4}cnts/keV/kg/yr**



Bandac, I.C. *et al.* The 0*v2β*-decay CROSS experiment: preliminary results and prospects. *J. High Energ. Phys.* **2020,** 18 (2020)

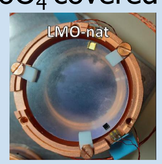
CROSS underground measurements

See also: Poster ID: 246 "The new CROSS cryogenic Underground facility: an overview"

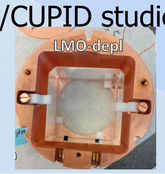
See also: Poster ID:383 Title: "A low energy threshold $CdWO_4$ scintillating bolometer for g_A measurement"

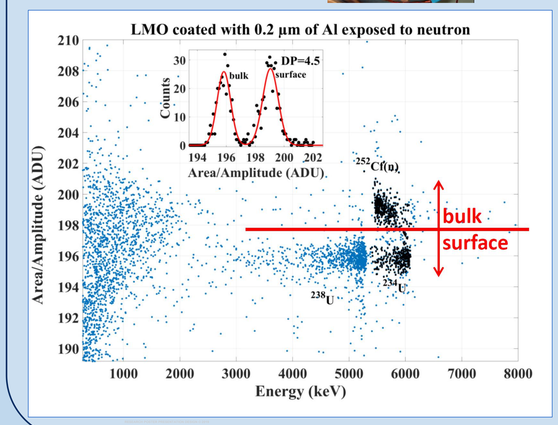
A run was performed to verify perfomances of Li_2MoO_4 detectors coupled to Ge light detectors - performing both CROSS/CUPID studies

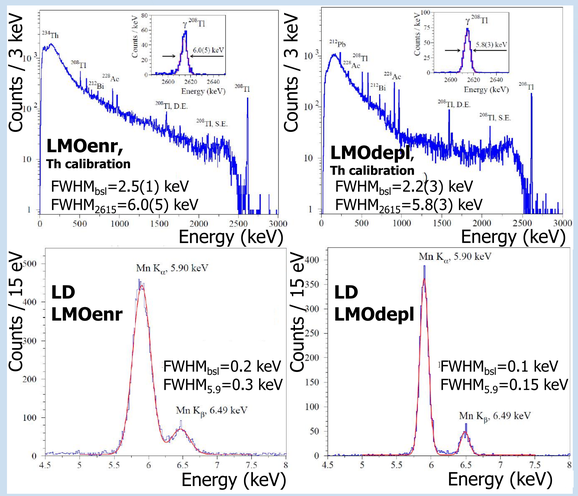
CROSS study: Li_2MoO_4 covered with 0.2 μm Al foil
Full discrimination of bulk\surface α events achieved

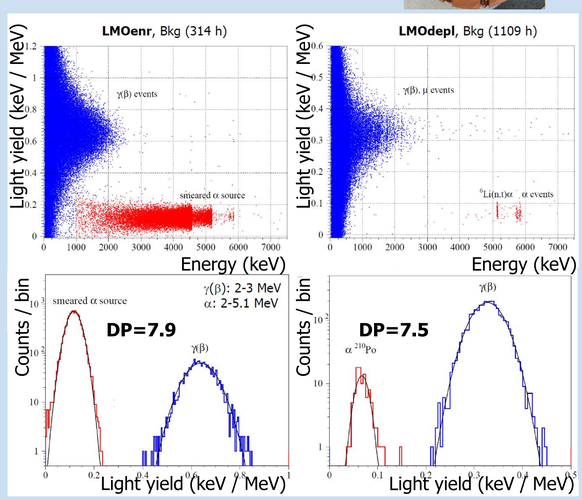


CROSS/CUPID study: cubic (45x45x45 mm) $Li_2{}^{100}MoO_4$ and $Li_2{}^{100depl}MoO_4$ coupled to Ge light detectors. Excellent performance of both heat and light channels is achieved → compatible with CUPID goals









Conclusions

- **CROSS** cryogenic underground facility is validated for operation of scintillating bolometers over long-term runs (>90% duty cycle) and it is now considered as the **CUPID** test facility too
- Two 45-mm-side cubic Li_2MoO_4 show **excellent performance**, PID by light, hint on high crystal radiopurity
- **CROSS:** PID with surface sensitive bolometer is achieved using pulse area

Next steps:

- **CROSS/CUPID** joined detector test: 12 enriched crystals + 16 light detectors(4 $Li_2{}^{100}MoO_4$ will be equipped with Al films), goal is performance and particle discrimination studies
- **Full CROSS** experiment: about ~80 enriched $Li_2{}^{100}MoO_4$ (+ few $^{130}TeO_2$) bolometers to prove stability and reproducibility of surface sensitive bolometers for $0\nu2\beta$ searches