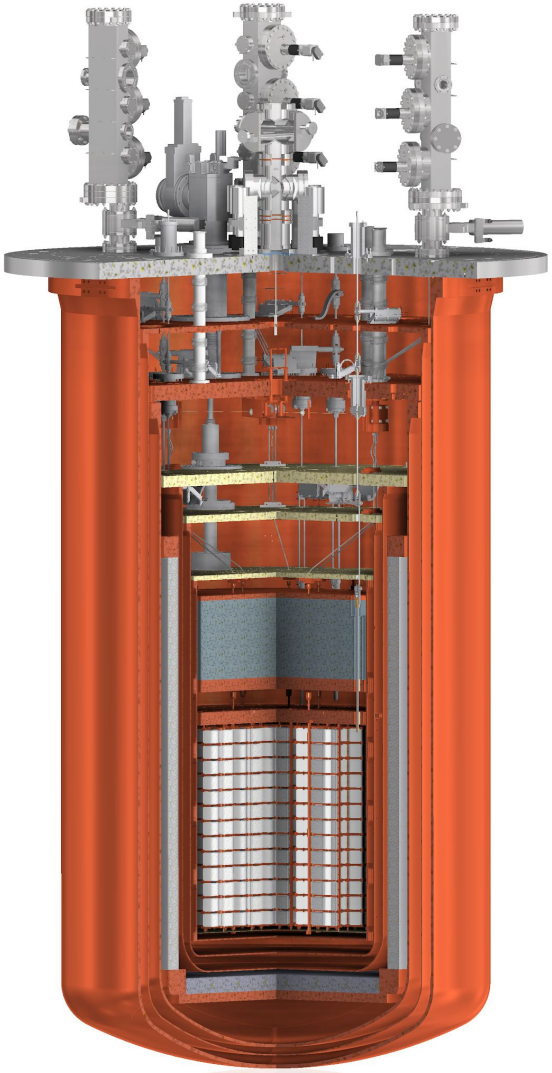


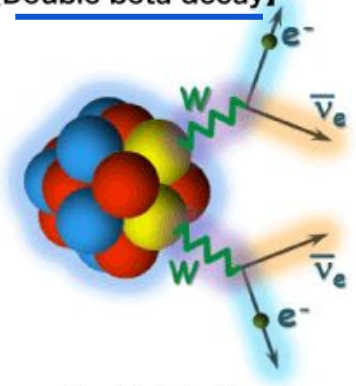
Neutrinoless double beta decay with

CUPID

Beatriz Tapia Oregui on behalf of the CUPID collaboration
August 2023, NuFACT

Dirac, or Majorana that is the question:

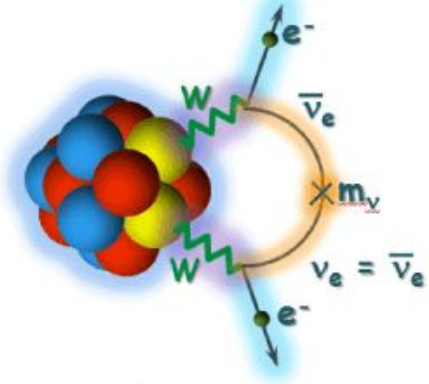
【Double beta decay】



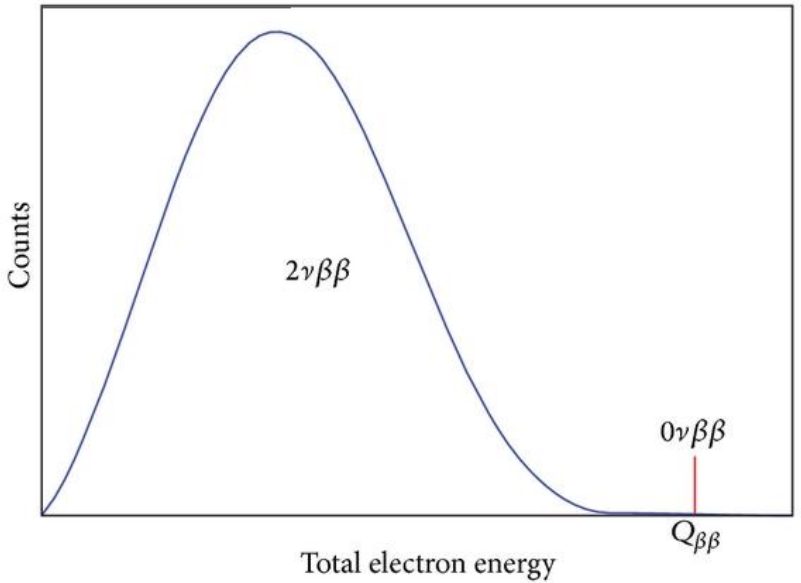
Double beta decay
which emits anti-neutrinos

Majorana decay:

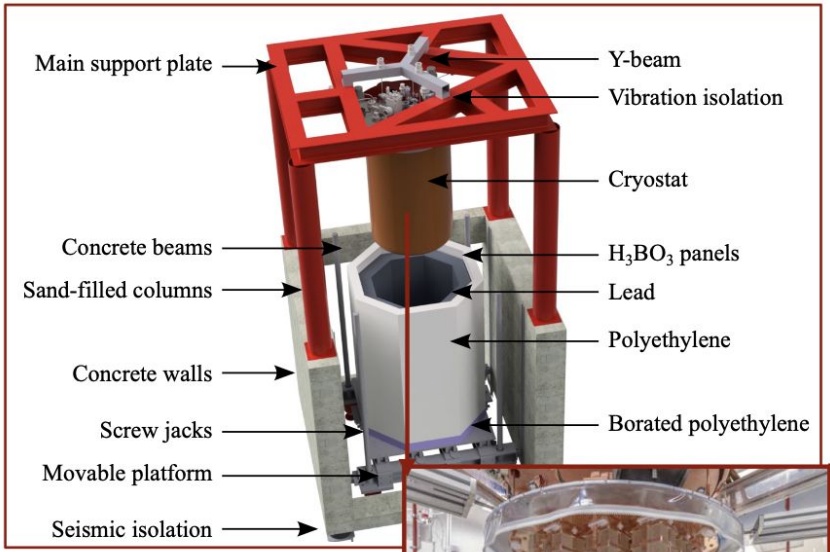
(A,Z) → (A,Z+2) + 2e⁻

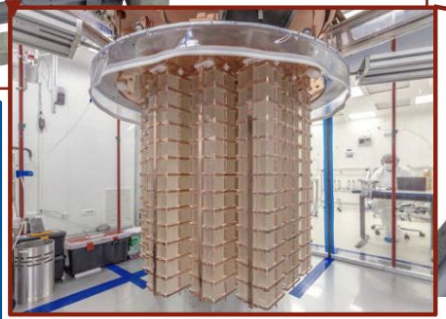


Neutrinoless
double beta decay



CUPID's origin: CUORE

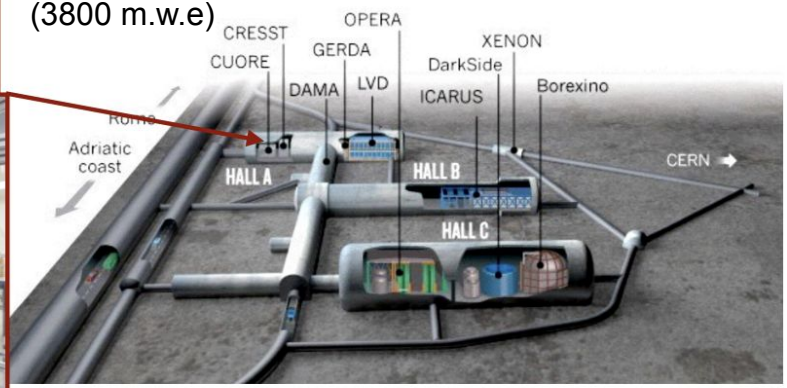




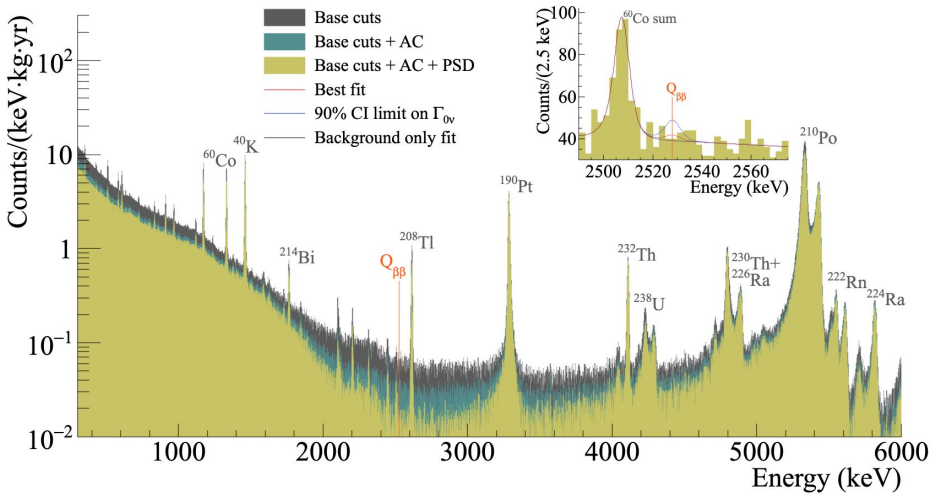
Tonne-scale experiment composed of $^{(nat)}TeO_2$ thermal detectors at 10 mK

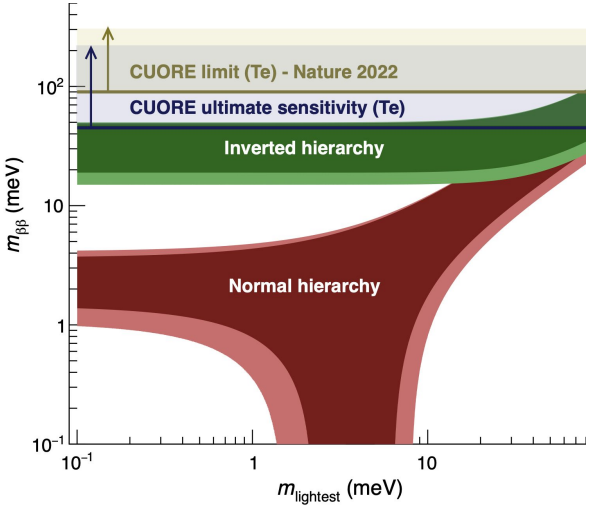
LNGS: Laboratori Nazionali del Gran Sasso

(3800 m.w.e)



CUORE's lesson



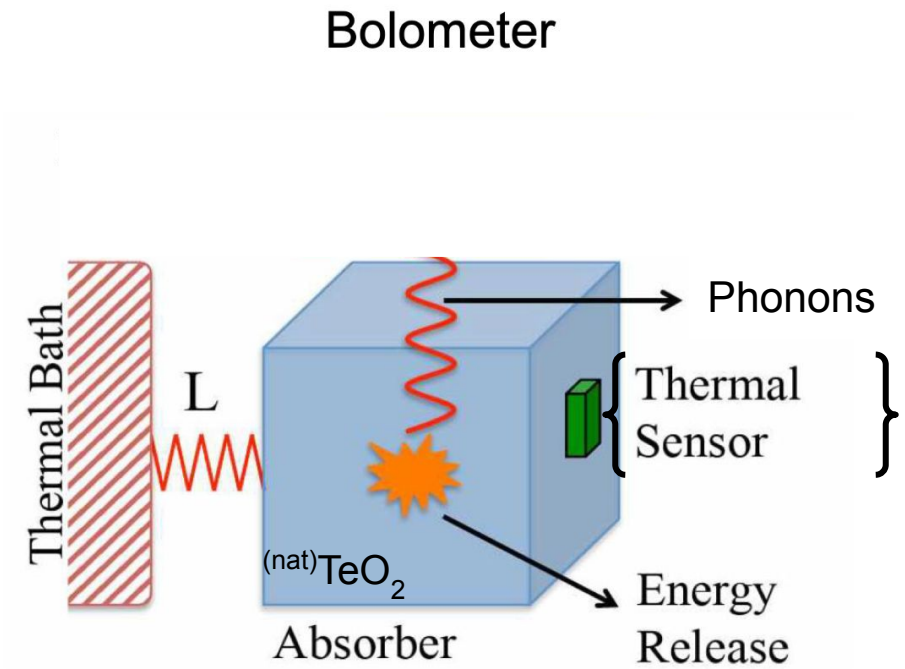


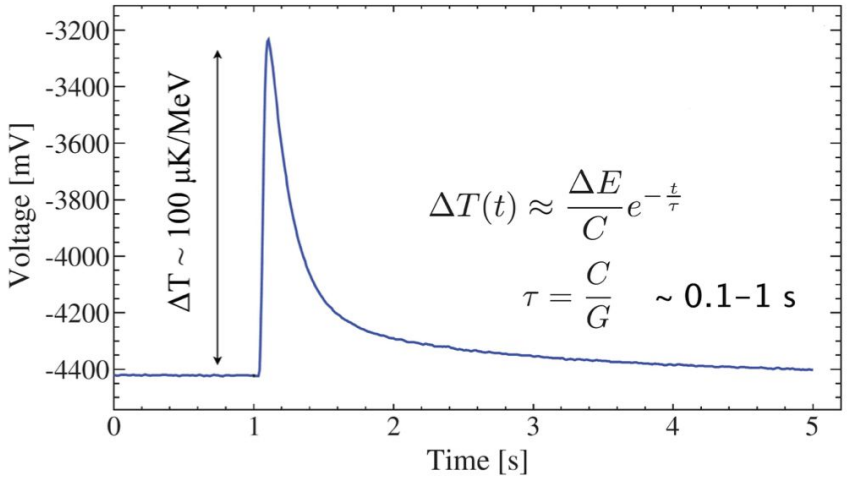
[Nature 2022]

Limiting factor: background coming from radioactive surface contamination

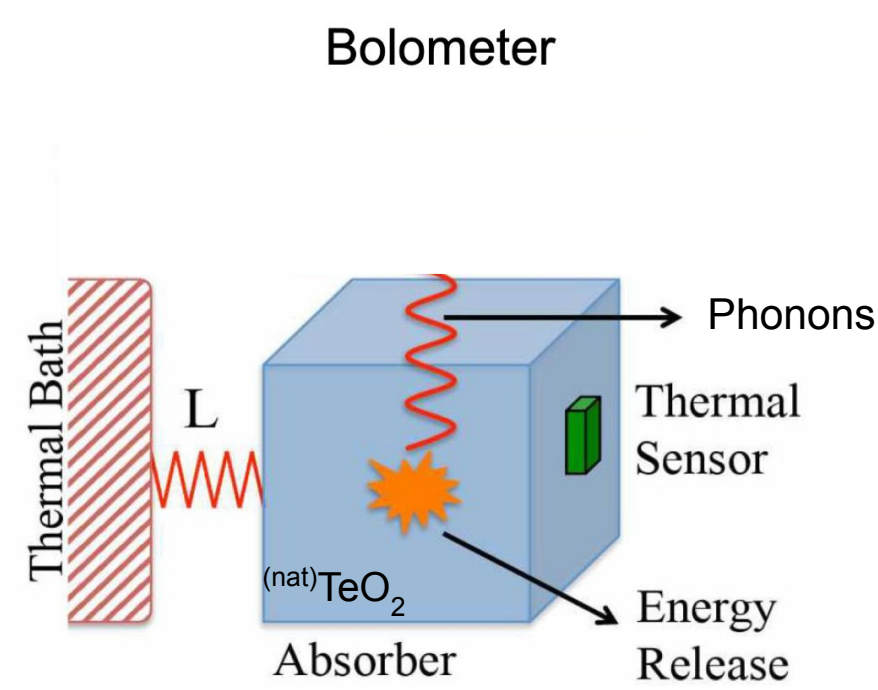
(90% α-particles, 10% β/γ-particles, <1% muons)

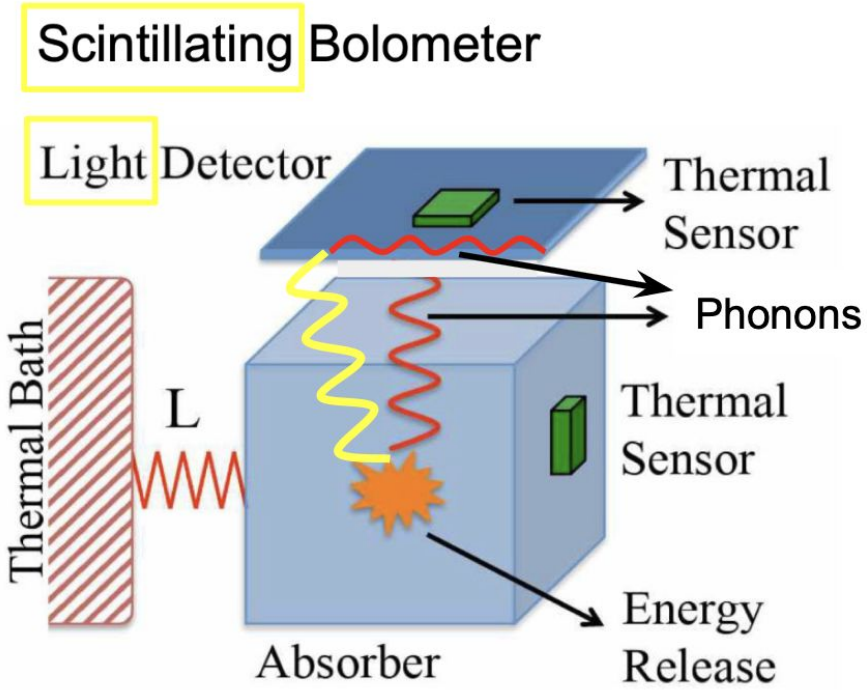
The CUORE technique



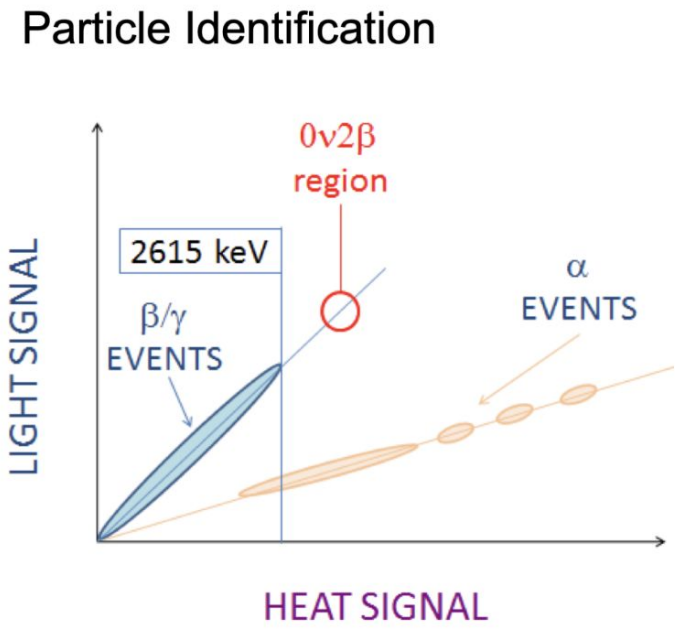


The CUORE vs CUPID technique





CUORE Upgrade with Particle IDentification



- Distinguish between α and β/γ-particles
- 100% rejection of α-particles at $Q_{\beta\beta}$
- Reduction of 90% of background compared to CUORE

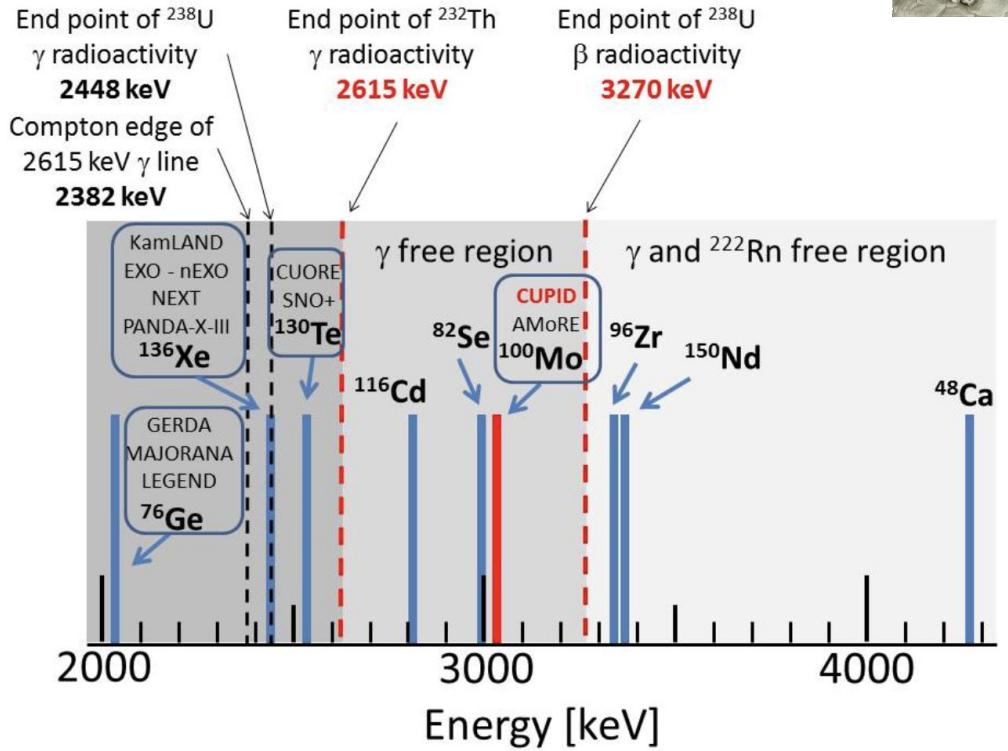
Picking the double beta decay isotope: ^{100}Mo

Constraints:
isotopic abundance,
scintillating compound,
possibility of mass-scale enrichment

Higher $Q_{\beta\beta}$ than ^{130}Te:
removes ɣ-background,
increases decay rate of $0\nu\beta\beta$

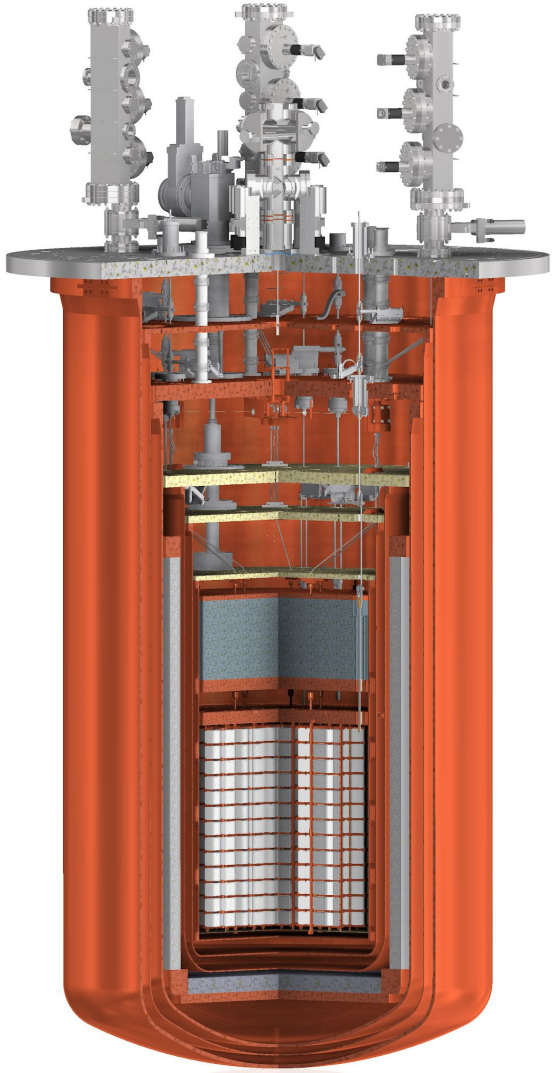
$$\frac{1}{T^{0\nu}_{1/2}} = G_{0\nu}(Q,Z)\,|M_{0\nu}|^2 \frac{|\langle m_{\beta\beta}\rangle|^2}{m_e^2}$$

- Cupid-Mo (^{100}Mo)
- Cupid-0 (^{82}Se)

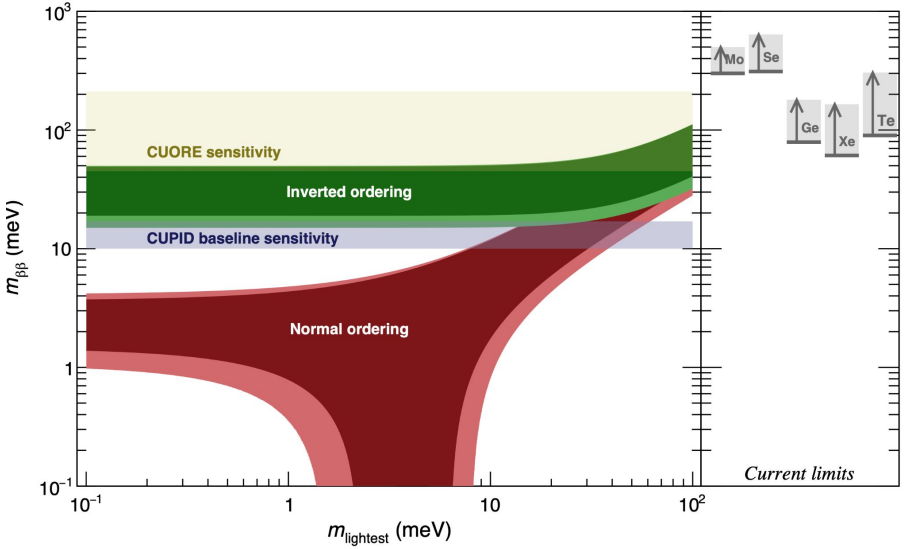


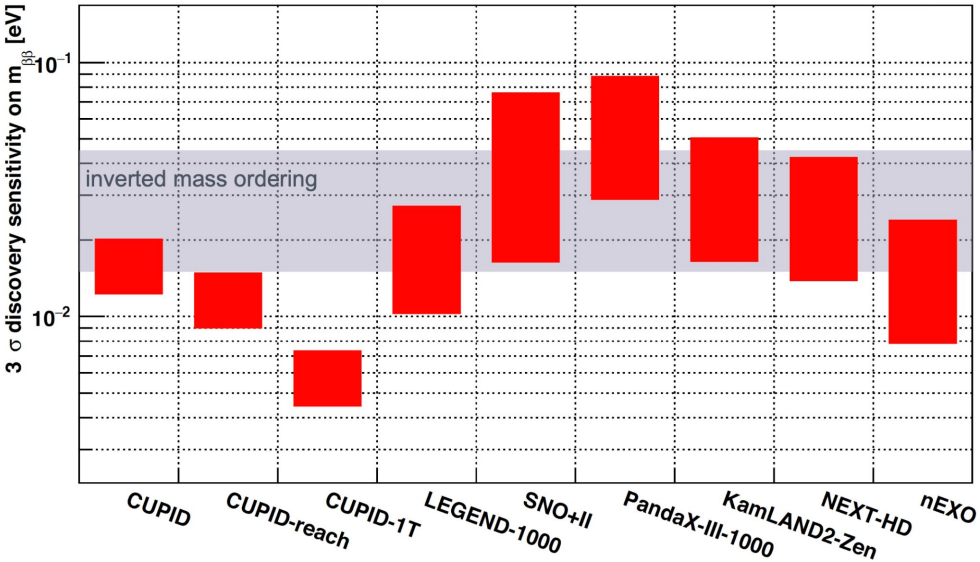
CUPID baseline

- $Li_2{}^{100}MoO_4$ scintillating bolometers
- Enrichment >95%
- 1596 crystals: 450 kg (240 kg) of $Li_2{}^{100}MoO_4$ (^{100}Mo)
- 1710 Ge light detectors with SiO anti-reflective coating
- Energy resolution: 5 keV FWHM at $Q_{\beta\beta}$ (3034 keV)
- Background: 10^{-4} cts/keV.kg.yr
- Same mass scale as CUORE, same cryostat, ~10 mK
- 10 yr runtime

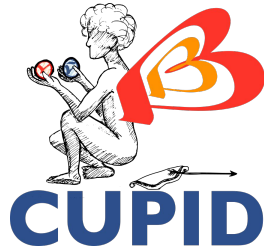


Discovery potential





Take home message



- CUPID is CUORE's upgrade:
  - reusing the **CUORE cryostat** + muon veto
  - using **scintillating Li_2MoO_4 bolometers** and Ge light detectors with SiO anti-reflective coating
- Fully **probes the Inverted Ordering** region
- **Baseline design targets 90% C.L. half-life sensitivity of 2.1×10^{27} yr**

On behalf of the CUPID collaboration, thank you!