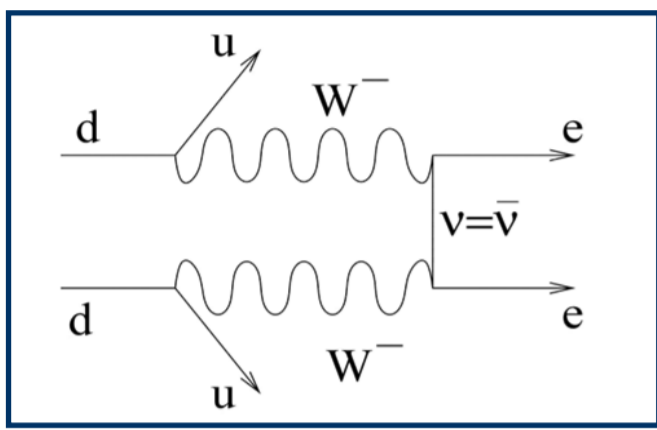
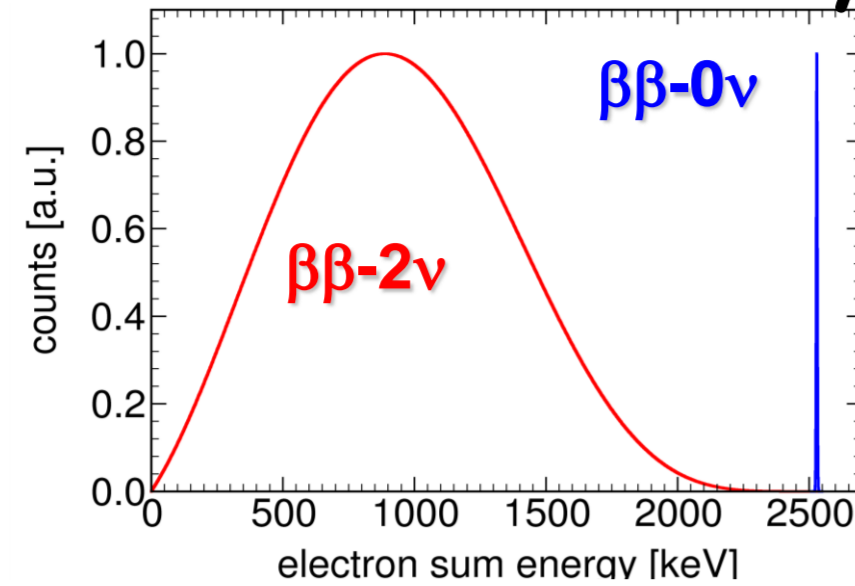
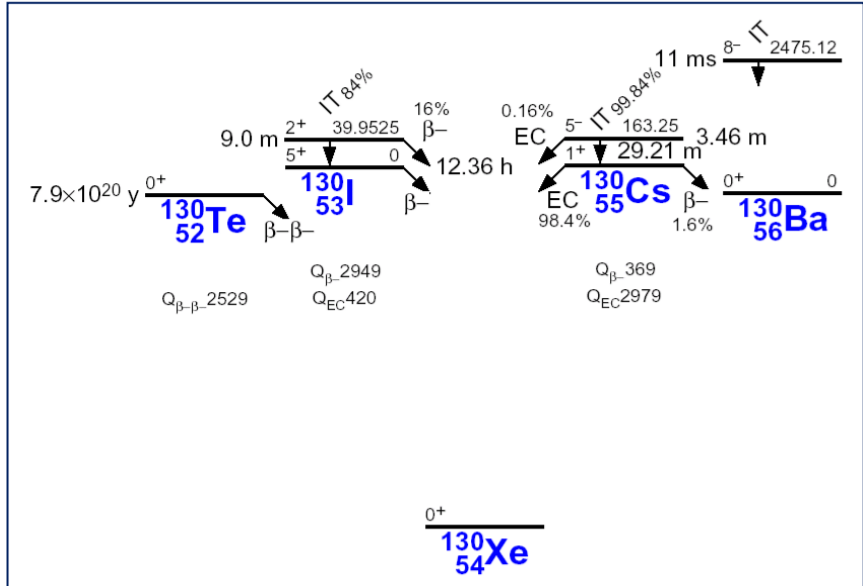


## Search for neutrinoless double beta decay



$(A,Z) \rightarrow (A,Z+2) + 2 e^-$   
Forbidden by standard model ( $\Delta L=2$ )

$\beta\beta 0\nu \Leftrightarrow$

- $m_\nu \neq 0$
- Majorana nature ( $\bar{\nu} = \nu$ )

0ν-DBD rate Phase space Nuclear Matrix Elements Effective Majorana mass

$$1/\tau = G(Q,Z) |M_{\text{nucl}}|^2 |M_{\beta\beta}|^2$$

## Experimental Sensitivity

Experimental sensitivity to  $\tau_{1/2}^{0\nu}$  with no  $\beta\beta 0\nu$  decay observed  
 $N_{\beta\beta} \leq (bkg \cdot \Delta E \cdot M \cdot t_{\text{meas}})^{1/2}$  at  $1\sigma$

$\tau_{1/2}^{0\nu}$  sensitivity

detector mass [kg]

detector efficiency

measuring time [y]

isotopic abundance atomic number

$$\mathcal{S}(\tau_{1/2}^{0\nu}) \propto \epsilon \cdot \frac{a.i.}{A} \sqrt{\frac{M t_{\text{meas}}}{\Delta E bkg}}$$

background [c/keV/y/kg]

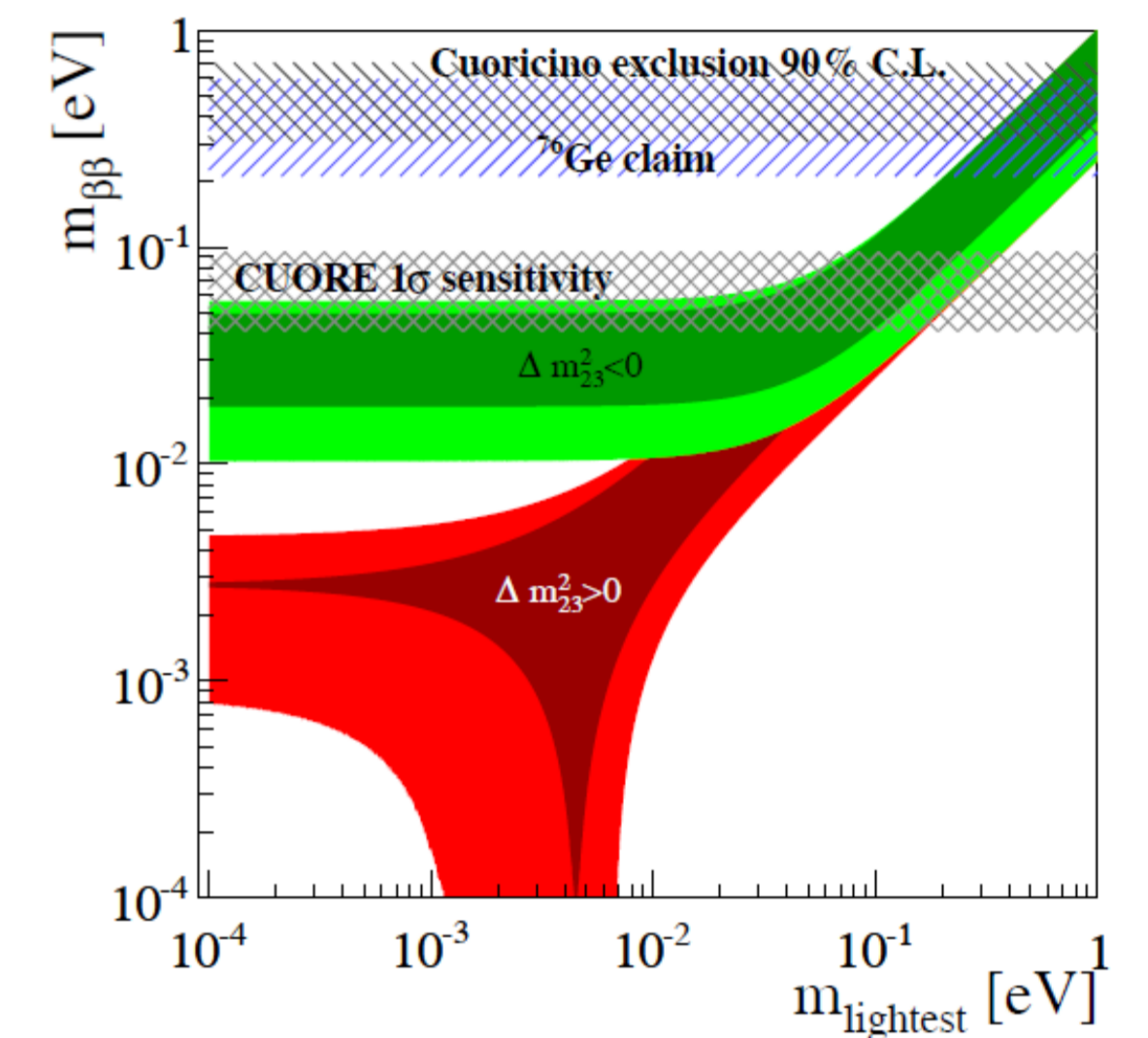
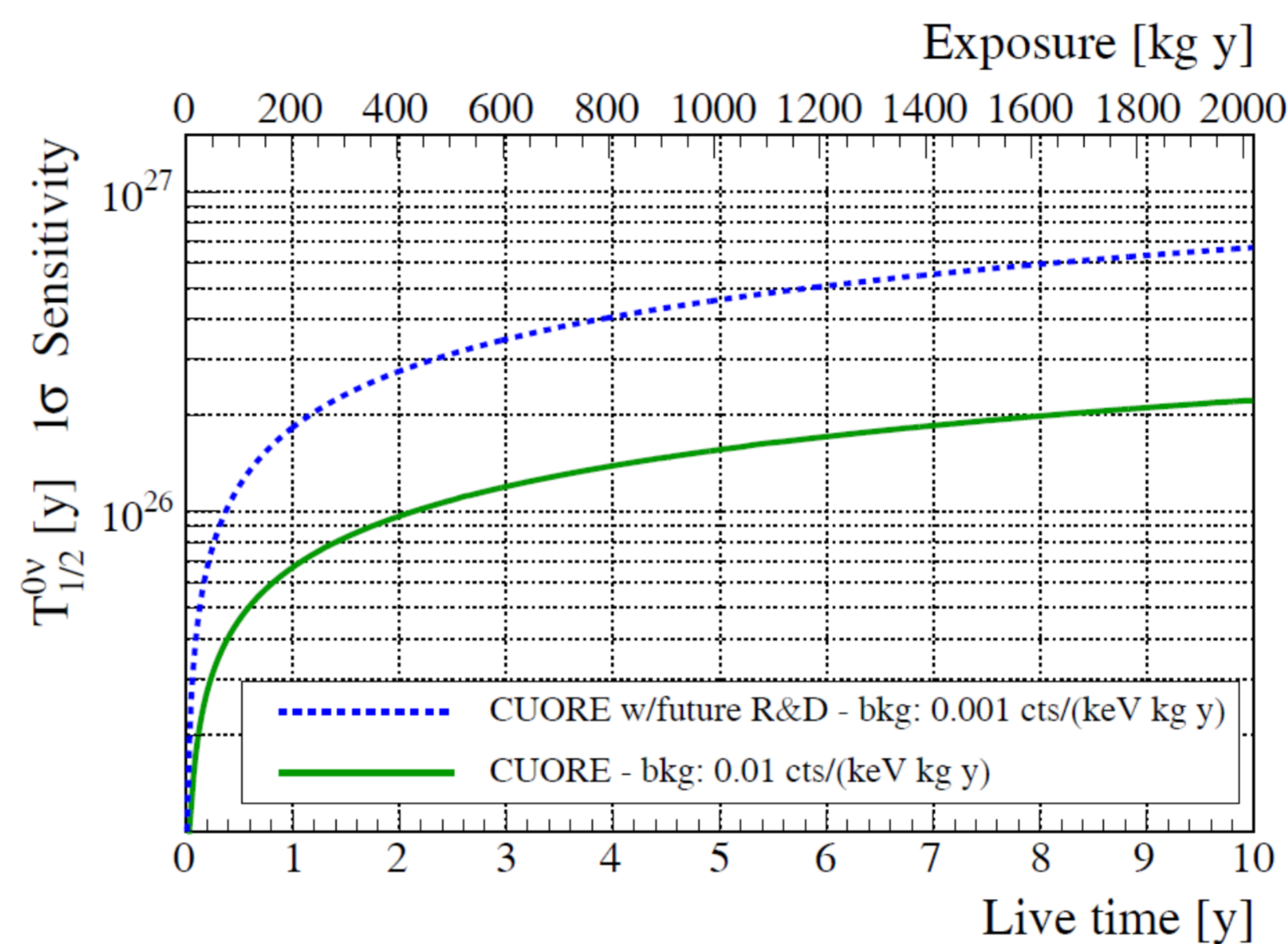
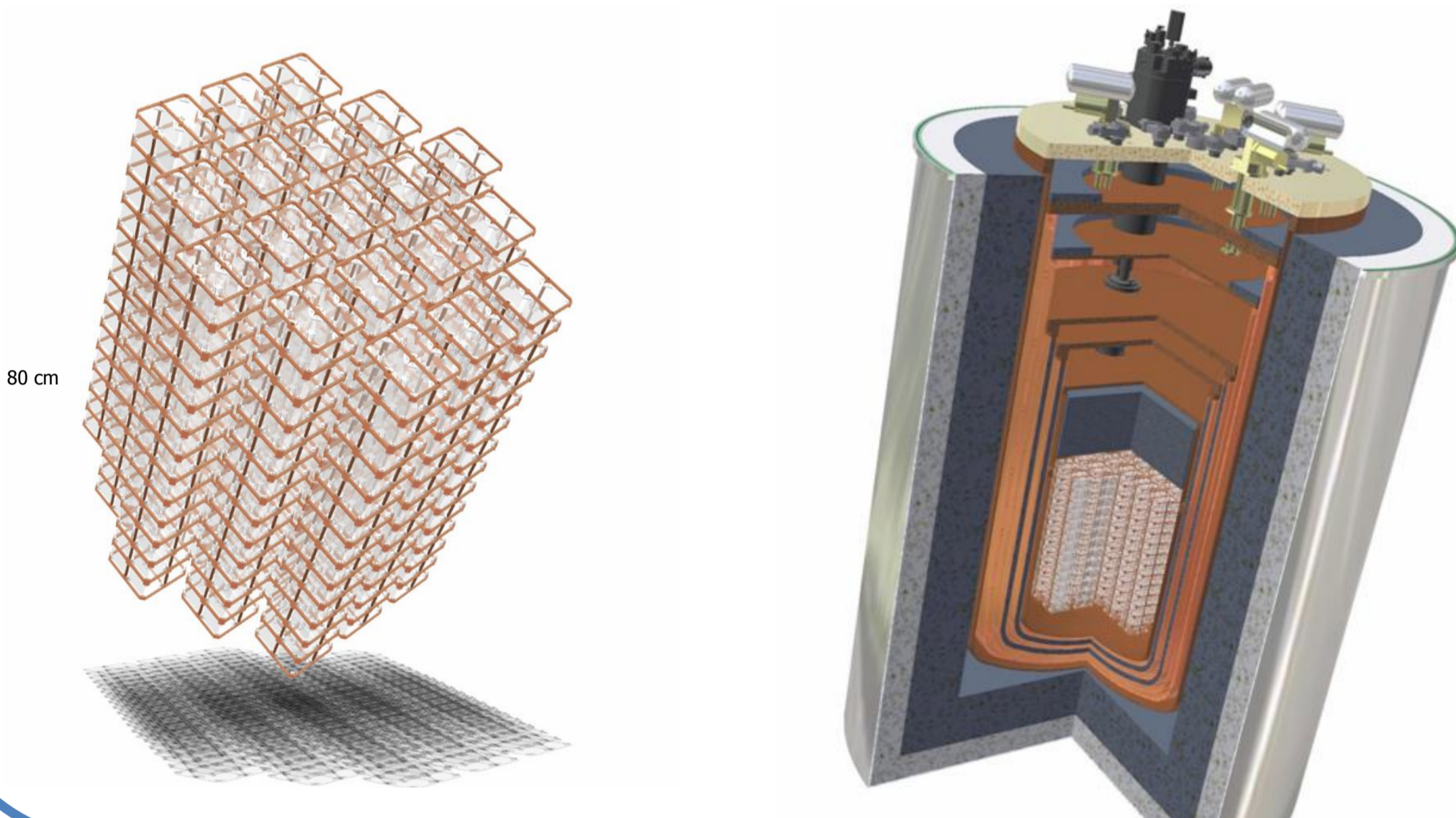
energy resolution [keV]

To improve sensitivity we need:

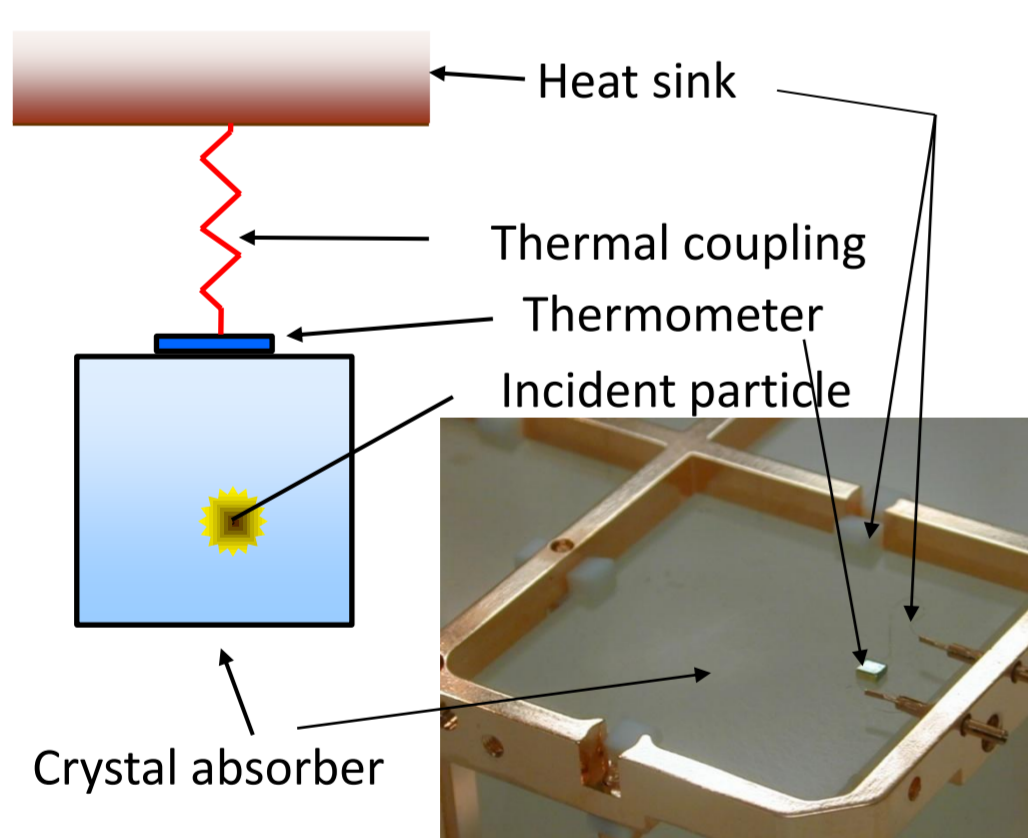
- ✓ M very large - 1 ton scale experiment
- ✓ a.i. high - isotopically enriched materials  
 $^{130}\text{Te}$  a.i. is 34.167% in natural Te
- ✓  $\epsilon$  high - high volume detectors  
single module is 750 g  $\text{TeO}_2$  crystal
- ✓  $\Delta E$  very good - good energy resolution detectors  
 $\text{TeO}_2$  bolometric detectors
- ✓ bkg very low - low radioactivity measurements  
experiment installed in Hall A of LNGS  
low radioactivity material selected  
heavy lead shield for environmental bkg

## CUORE - Cryogenic Underground Observatory for Rare Events

Array of 988  $\text{TeO}_2$  bolometers,  $5 \times 5 \times 5 \text{ cm}^3$  each, total detector mass 741 kg,  $^{130}\text{Te}$  mass 206 kg,  $^{128}\text{Te}$  mass 189 kg  
CUORE detector will be operated at 8-10 mK in specifically designed cryostat



## Thermal Detector Technique



Detection Principle

$$DT = E/C$$

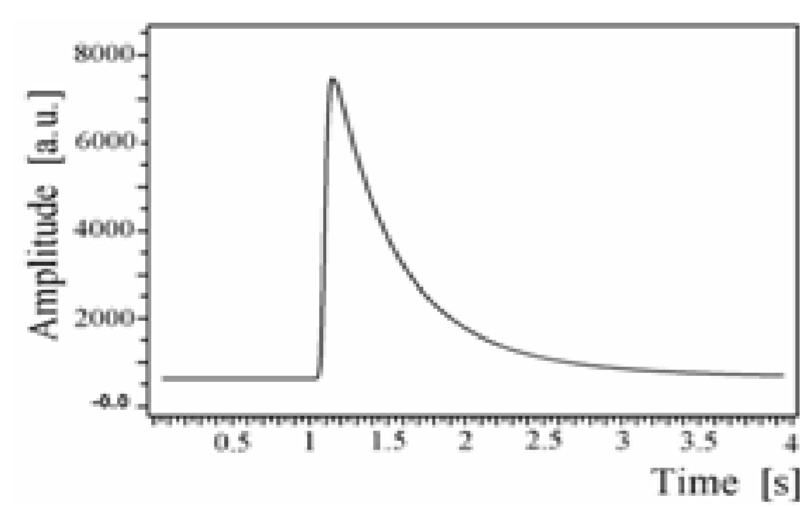
C: thermal capacity

low C  $\Rightarrow$  low T (i.e.  $T \approx 10 \text{ mK}$ )

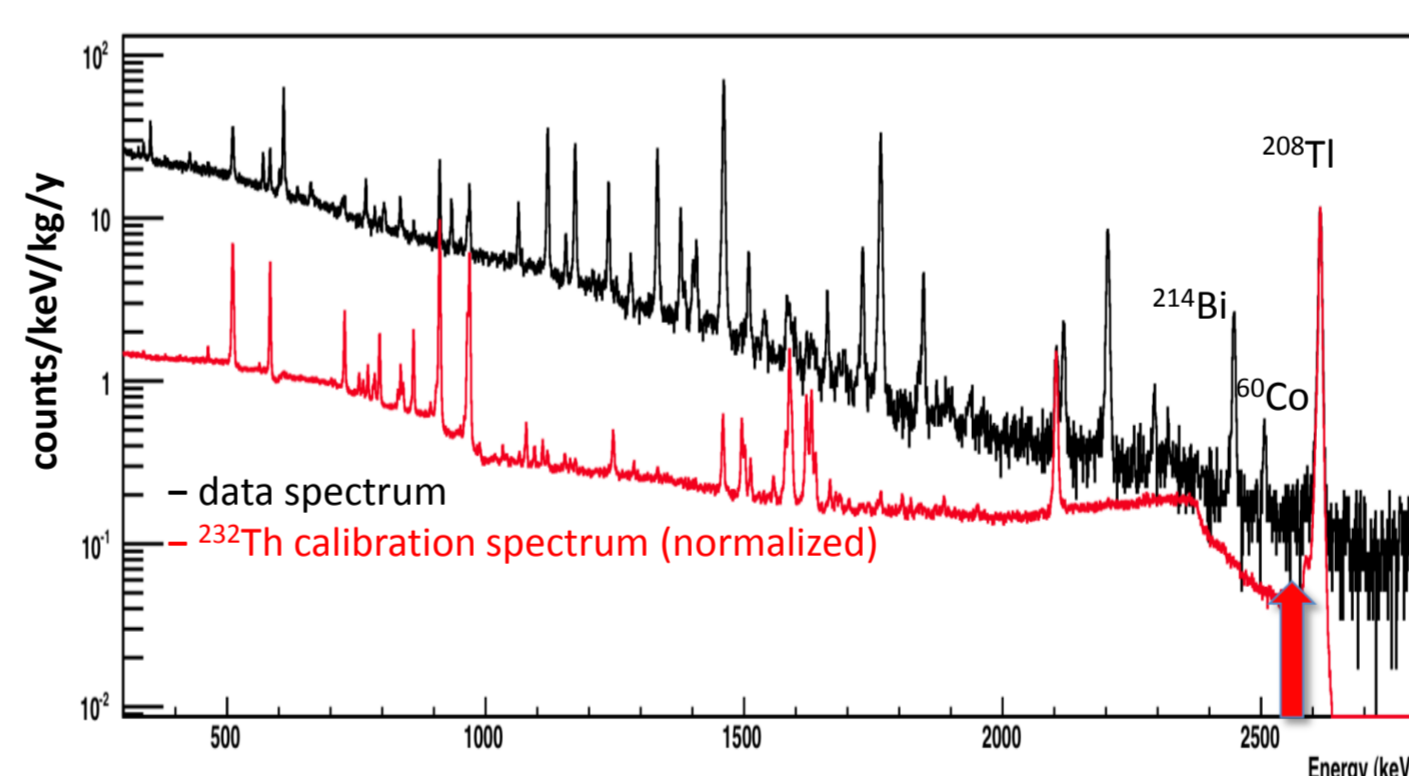
$C \approx 2 \text{ nJ/K @ } 10 \text{ mK} \Rightarrow 1 \text{ MeV} \Rightarrow 100 \text{ mK}$   
e.g.  $\text{TeO}_2$   
 $I \approx 0.1 \text{ nA}$   
 $dR/dT \approx 0.1 \text{ M}\Omega/\text{mK}$   
 $dV \approx 1 \text{ mV}$   
 $\Delta E \text{ (FWHM)} \approx 1 \text{ keV}$

### Thermal Detectors Properties

- ▲ good energy resolution
- ▲ wide choice of absorber materials
- ▲ true calorimeters
- ▼ slow  $t = C/G \sim 10^3 \text{ ms}$



## Radioactive Background Evaluation



Backgrounds in region of interest (2430-2630 keV):

- (~40%) Compton events from 2615 keV peak of  $^{208}\text{Tl}$
- (~50%) Degraded alphas from copper surfaces
- (~10%) Degraded alphas from crystal surfaces

### Three Tower Test (TTT) run

Measurement in Hall A cryostat: same as Cuoricino Crystals from Cuoricino and repolished on surfaces  
Three different copper cleaning were tested

Total statistics, no anticoincidence cut

Tower	c/keV/kg/y	2.7-3.9 MeV (excluded Pt peak)	Error (1 $\sigma$ )
T1		0.068	0.006
T2		0.120	0.012
T3		0.072	0.008

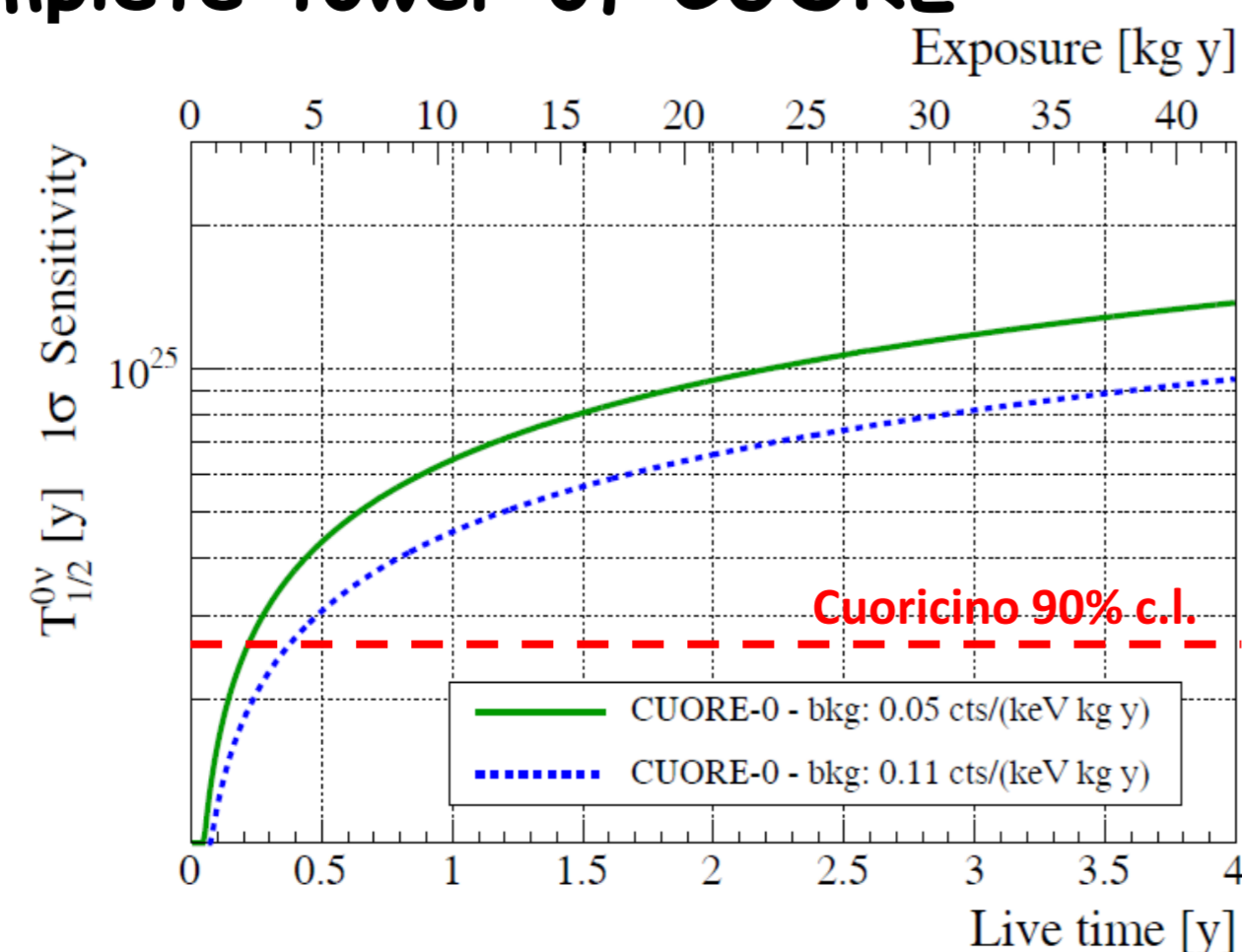
T1 and T3 are compatible and show lower background than Cuoricino

## CUORE-0 the first complete tower of CUORE

CUORE-0 is realized:  
with the same procedure of CUORE crystals from the same production line  
same copper and PTFE spacers  
CUORE-like copper surface cleaning  
same assembly line  
installed in Hall A cryostat (as Cuoricino)

Many aspects will be analyzed with CUORE-0:  
detector performances  
radioactive background  
electronics and data acquisition  
data analysis

But also new very sensitive measurements on  $\beta\beta 0\nu$  decay of  $^{130}\text{Te}$  can be done



In one year of live running time we double the Cuoricino limit

## CUORE-0 Assembly Phases

Assembly of CUORE-0 was done with the tools that will be used in CUORE  
Specific glow boxes were installed in the CUORE Clean Room  
Continuous flux of nitrogen was maintained to prevent Rn exposure  
NTDs and heaters were bonded in place directly on the tower  
A nitrogen fluxed "garage" store CUORE-0 before the installation

