



Laboratori Nazionali del Gran Sasso

European Research Council



ERC Advanced Grant n. 247115

Time span: 01.03.10-01.03.16

# The LUCIFER project

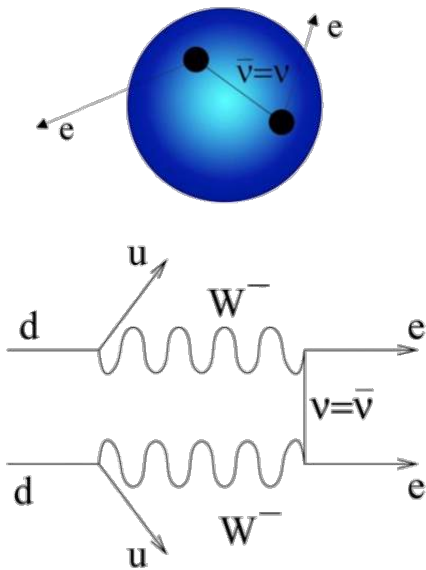
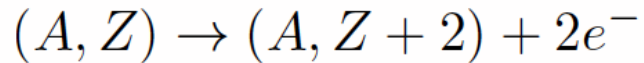
Karoline Schöffner  
on behalf of the collaboration

LNGS - Laboratori Nazionali del Gran Sasso, Italy

LTD16 conference  
July 20-24, 2015, Grenoble (France)

# The motivation ...

“... study the Most Tiny Quantity of Reality ...” F. Reines, ca. 1956

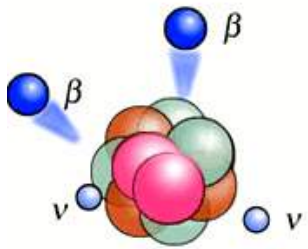


- nature of neutrinos
- absolute neutrino mass scale
- neutrino mass-hierarchy
- CP-violation in neutrino sector

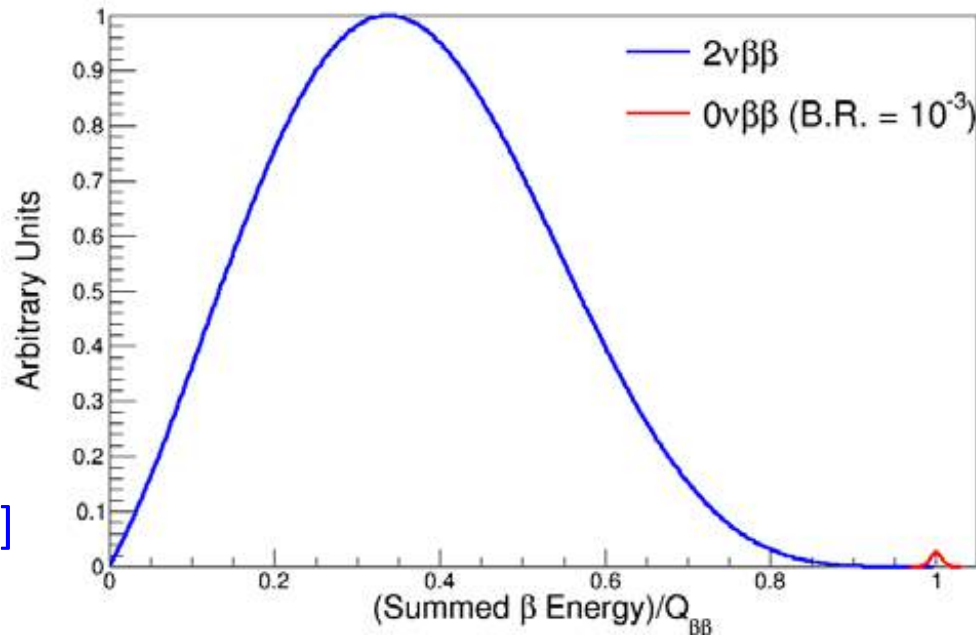
# Signature

Experiments measure the sum of the kinetic energies of the two emitted  $\beta$  s

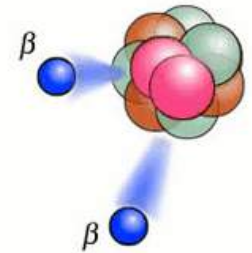
Signature: monochromatic line at the Q-value of the decay



$$(E_1 + E_2) \in [0, Q_{\beta\beta}]$$



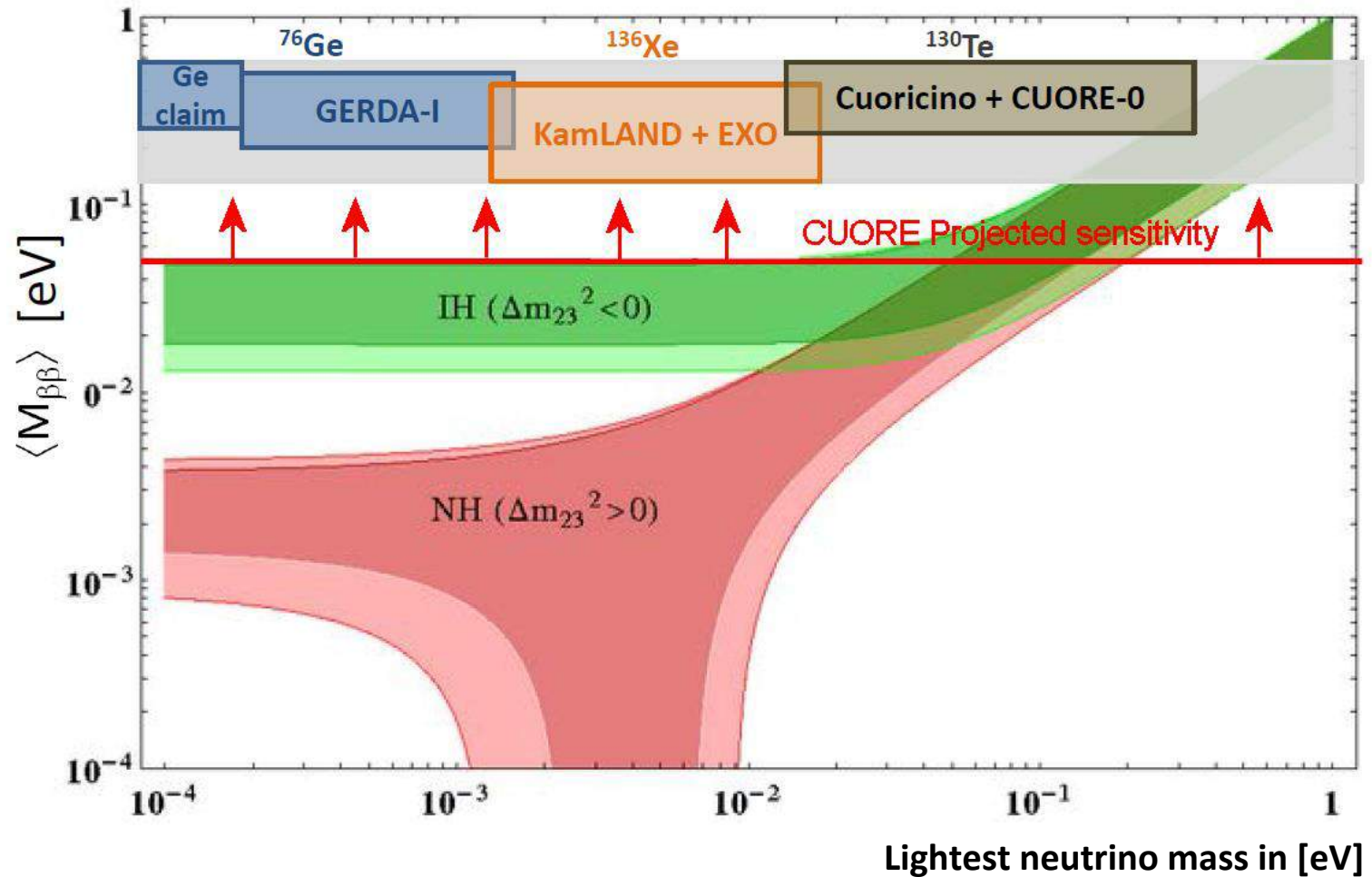
Graphics taken from DOE Nuclear Science Advisory Committee report on  $0\nu\beta\beta$  (24 April 2014)



$$(E_1 + E_2) / Q_{\beta\beta} \approx 1$$

Energy resolution!!

# $0\nu\text{DBD}$ landscape



# Its all about background...

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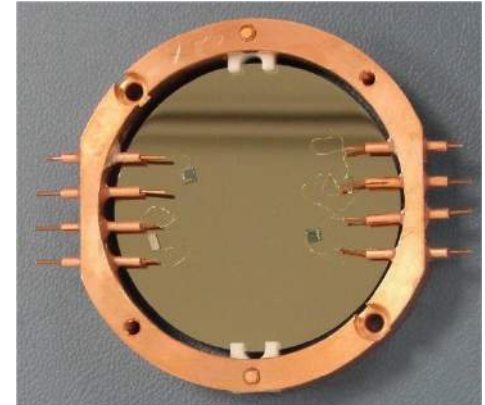
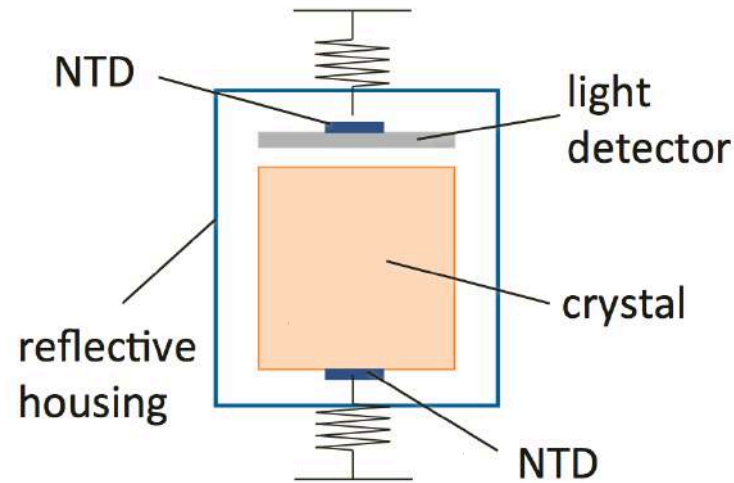
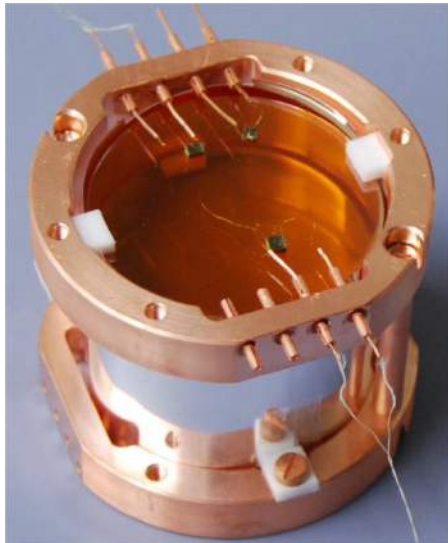
Experiment with background:

$$S_{0\nu} = \ln(2) N_A \frac{\eta \cdot \epsilon}{W} \sqrt{\frac{M \cdot T}{\Delta E \cdot B}}$$

Zero background framework:

$$S_{0\nu} = \ln(2) N_A \frac{\eta \cdot \epsilon}{W} \boxed{M \cdot T}$$

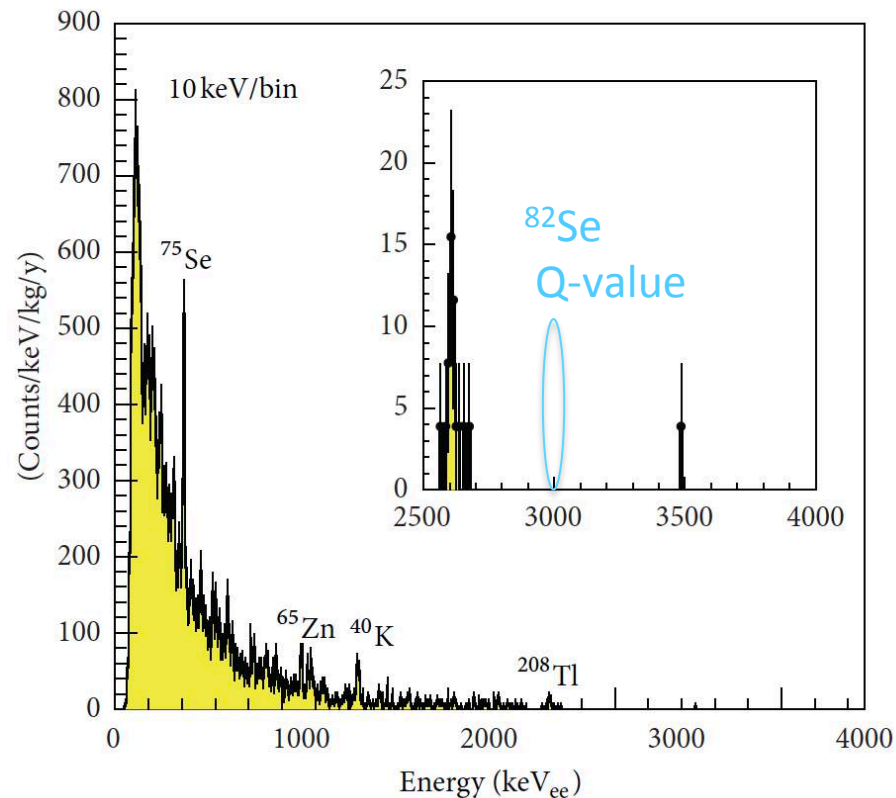
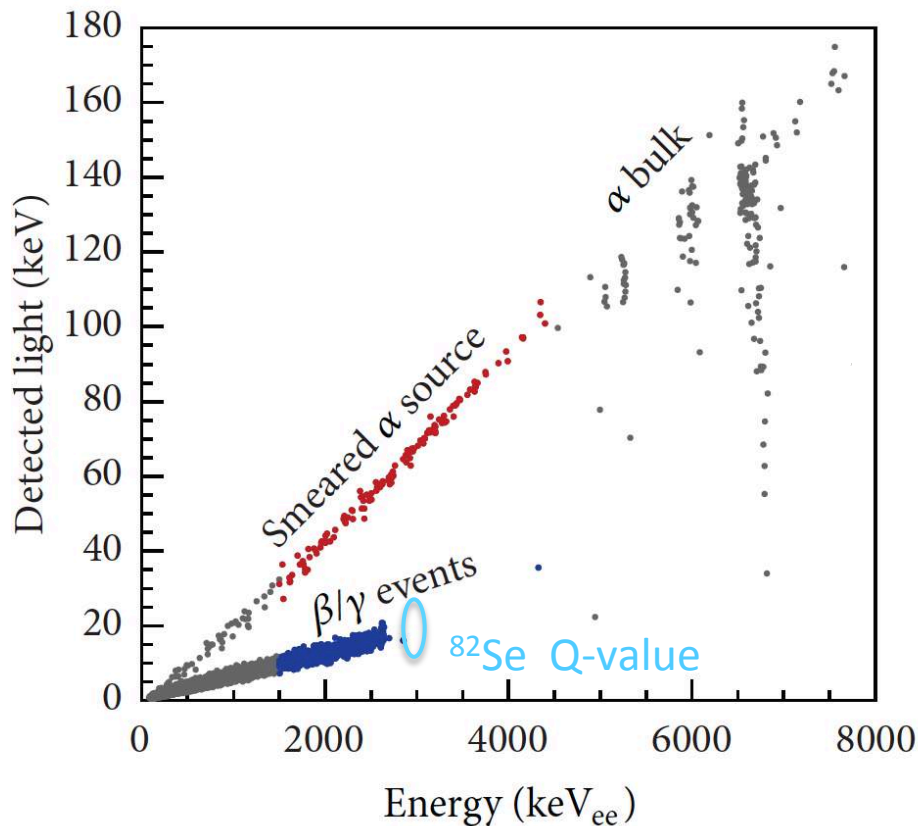
# Scintillating bolometers



- enriched  $\text{Zn}^{82}\text{Se}$  (96.3 %) crystals
- crystal about 430 g
- Ge-NTD as sensor
- decay:  $^{82}\text{Se} \rightarrow ^{82}\text{Kr} + 2e^-$
- Q-value: 2997 keV
- energy resolution in ROI  $\sim 15$  keV (FWHM)
- Ge disks  $\varnothing=44.5\text{mm}$ ,  $h=180 \mu\text{m}$
- Ge-NTD sensor
- performances evaluated on  $^{55}\text{Fe}$ :
  - energy resolution:  $\sigma \sim 110$  eV
  - intrinsic resolution  $\sigma \sim 60$  eV

# Results

	$Q_{\beta\beta}$ [keV]	active isotope	$LY_{\beta/\gamma}$ [keV/MeV]	$QF_{\alpha}$
Zn <sup>82</sup> Se	2997	56%	6.5	4.2

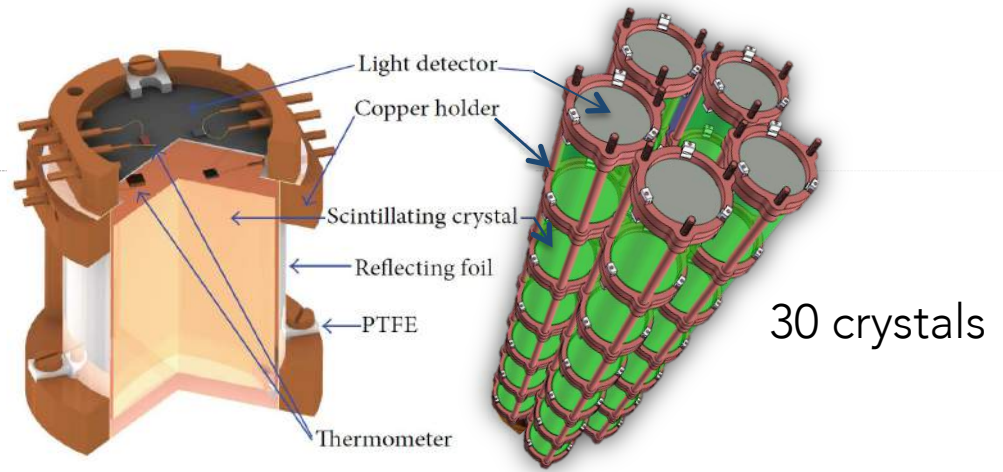
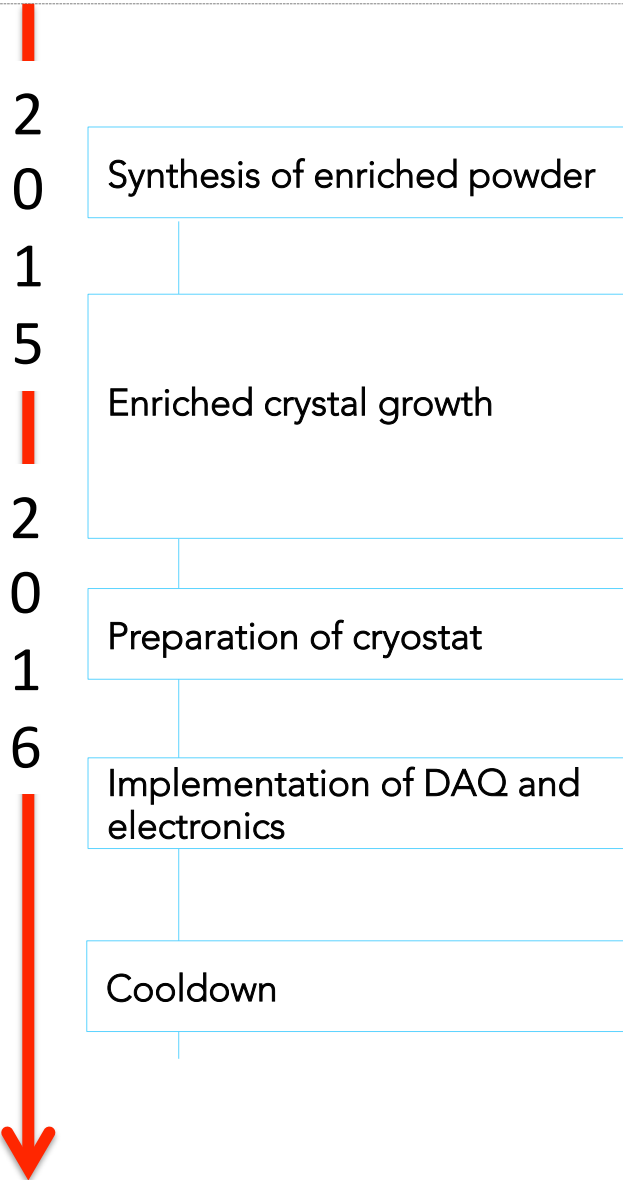


PID with high  
discrimination power

1 event in ROI  
in 5 y and 20 kg detector



# Outlook



GOAL

live time [y]	half-life sensitivity [ $10^{25}$ y]
5	4.5

- total  $^{82}\text{Se}$  nuclei  $\sim 5 \times 10^{25}$
- expected background in ROI (2997 keV):  
 $1 \div 2 \times 10^{-3}$  counts / (keV kg y)
- energy resolution of the single detector:  
expected  $10 \div 20$  keV FWHM

POSTER  
G 3.38