First Results from the Cuoricino Experiment

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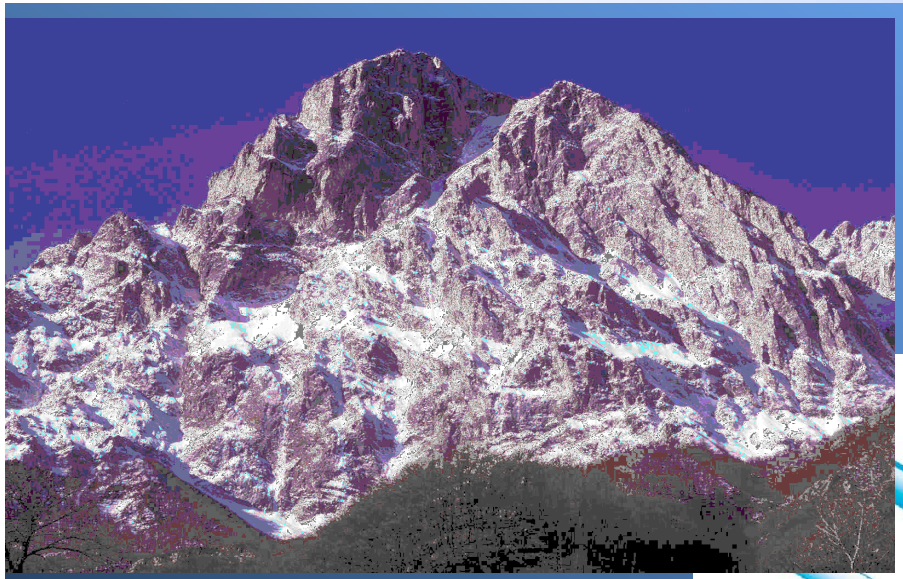
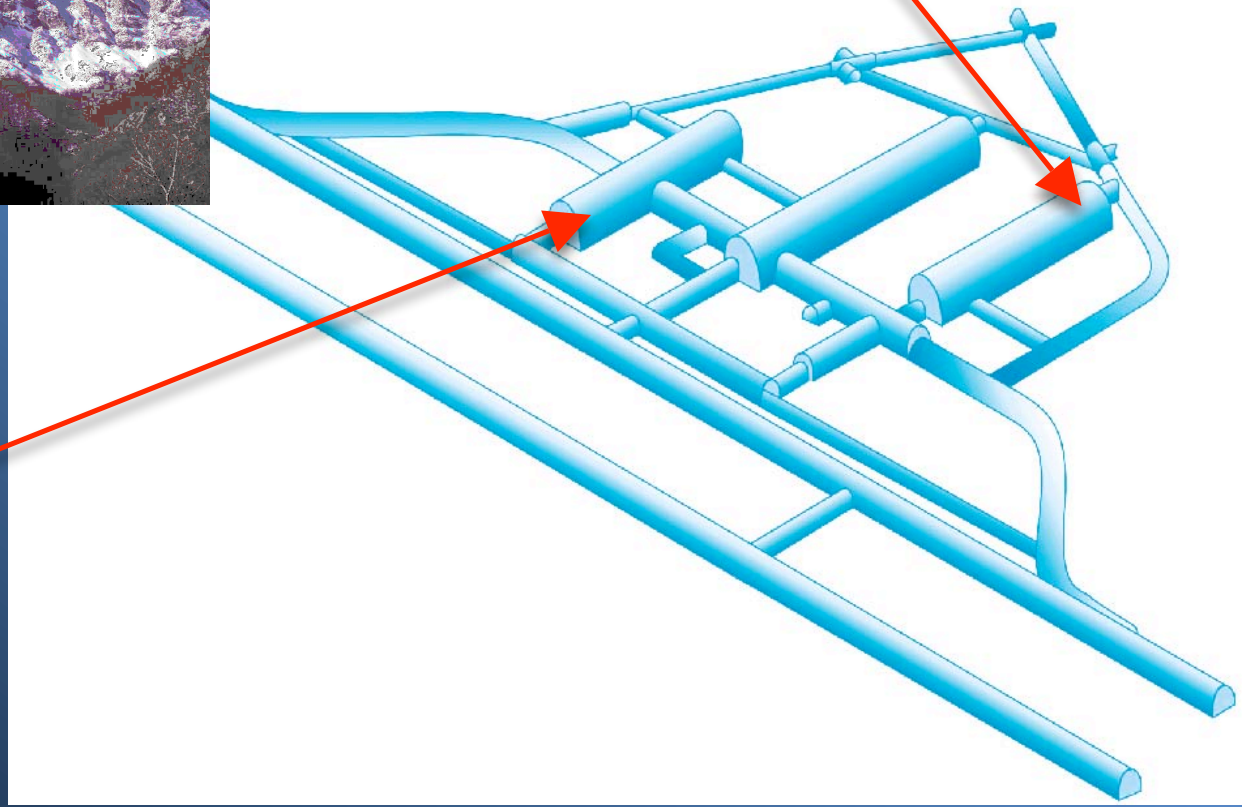
CUORE @ LNGS



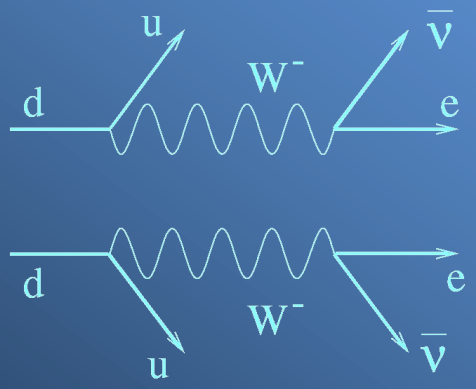
CUORE R&D (Hall C)

Cuoricino (Hall A)

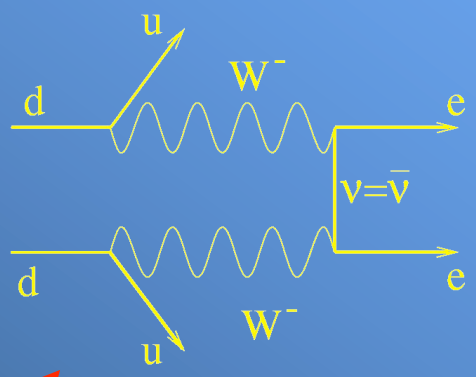


Double Beta Decay

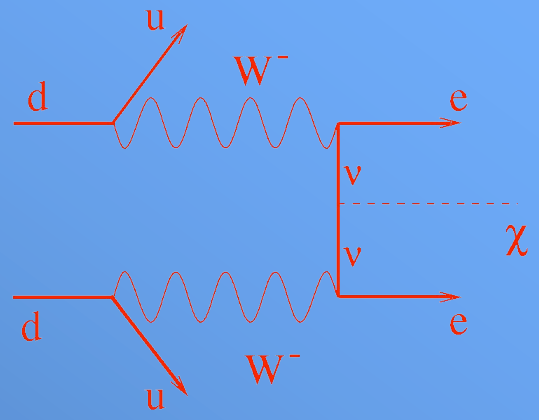
$(A,Z) \rightarrow (A,Z-2) + 2e + 2\bar{\nu}$



$(A,Z) \rightarrow (A,Z-2) + 2e$



$(A,Z) \rightarrow (A,Z-2) + 2e + \chi$

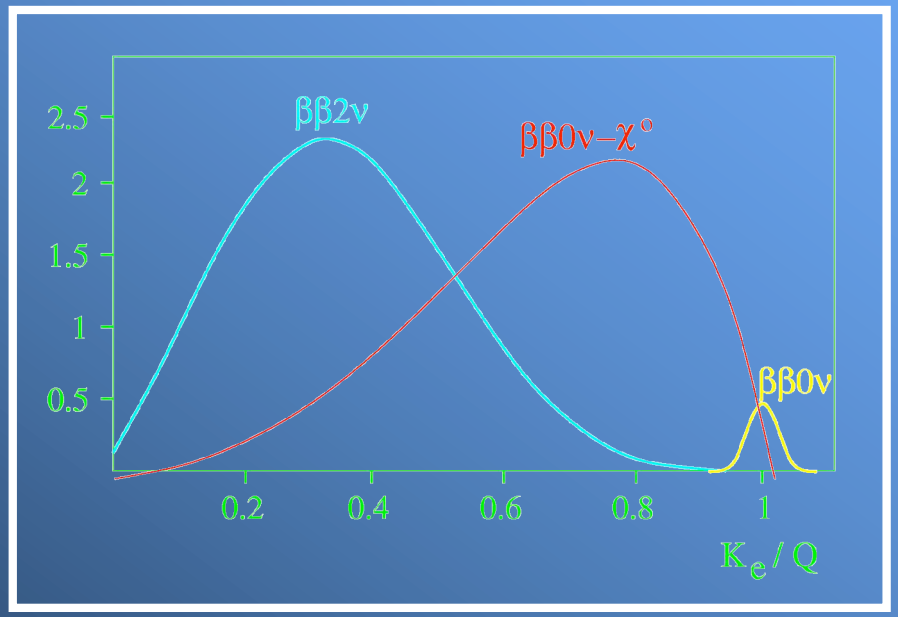


Allowed in SM

observed in several nuclei with

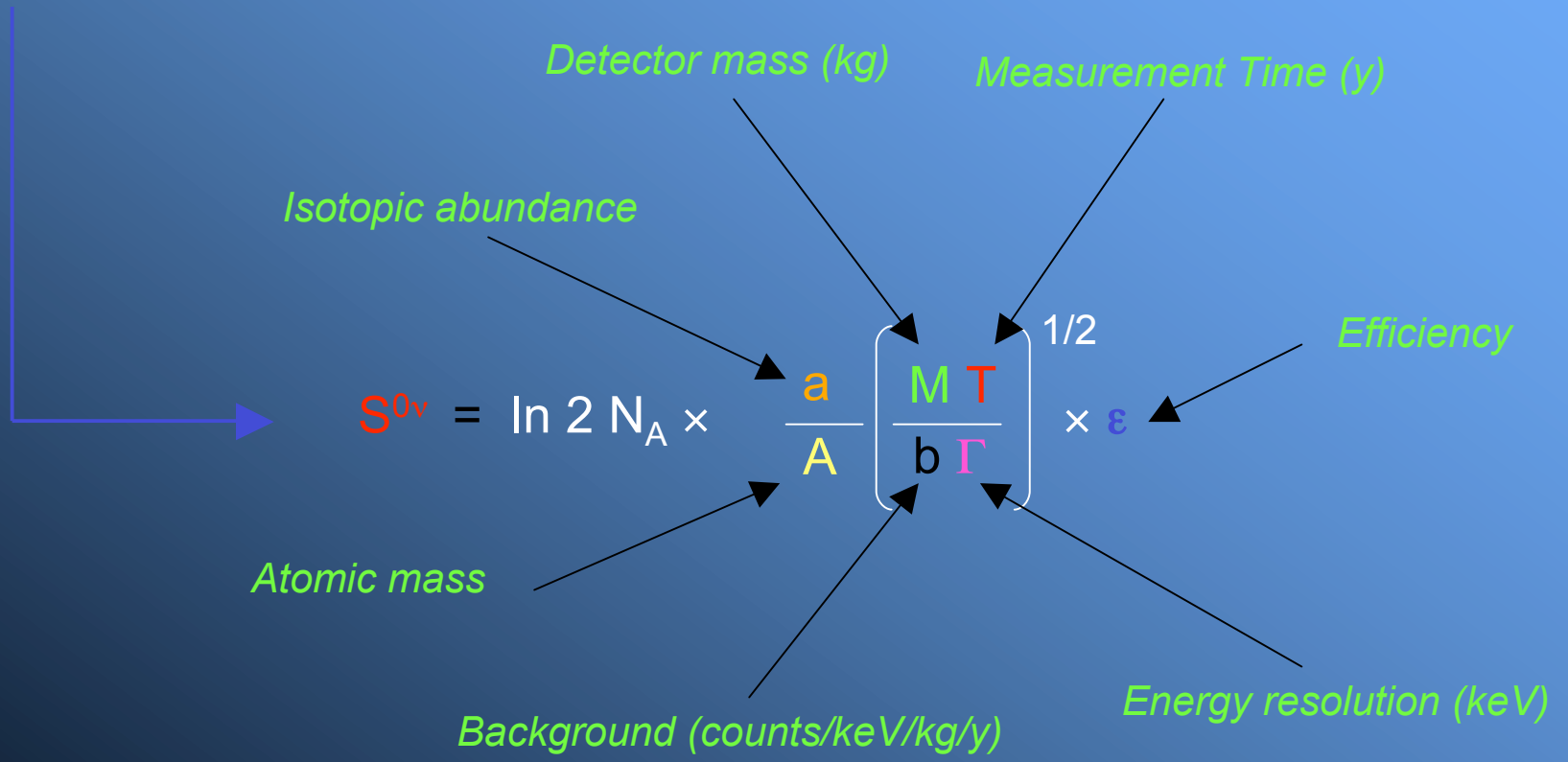
$\tau^{2\nu} \sim 10^{18} - 10^{21}$ y

- Leptonic number violation
- Majorana neutrino
- $n = n^c$
- $m_n \neq 0$



DDB-0ν Sensitivity

Sensitivity: Lifetime corresponding to the minimum number of detectable events above background at a given C.L.



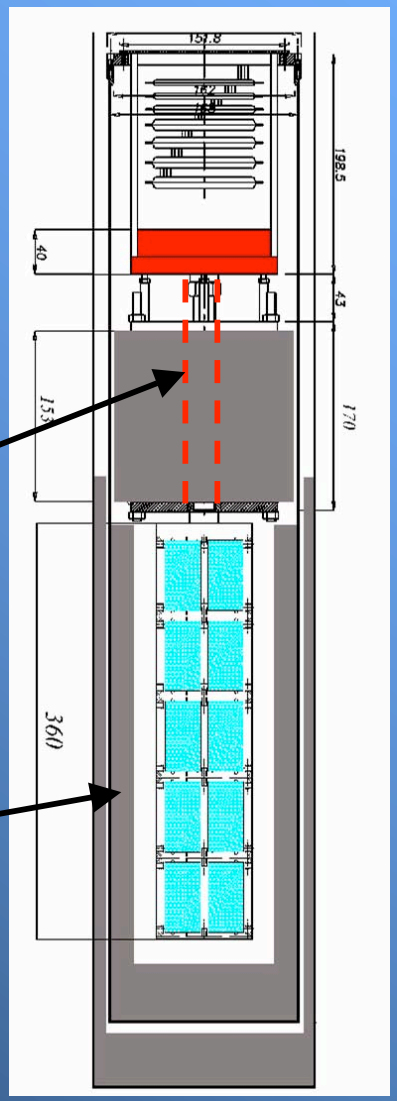
Mibeta (^{130}Te)

5 modules, 4 detectors each, arranged in a tower-like structure (6.8 kg)

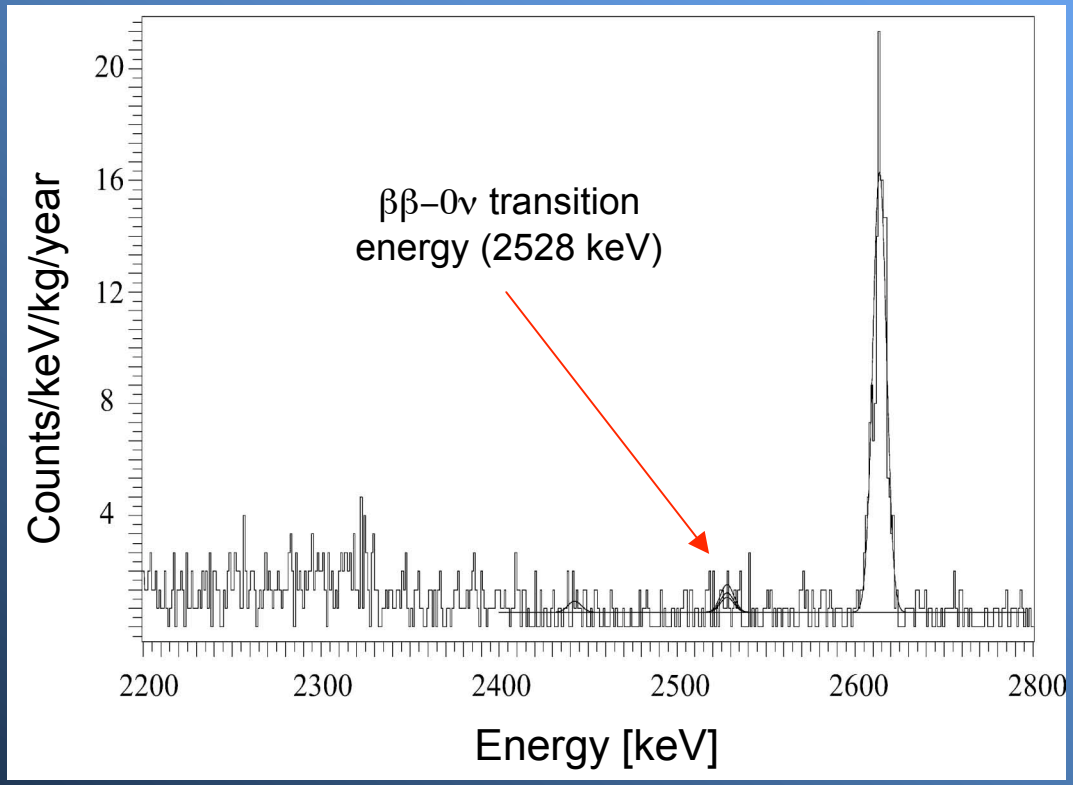
Every detector was a TeO_2 crystal 3x3x6 cm^3 (340 g)

Cold finger: ~7 mK

The tower was surrounded by a Roman lead inner shield



Mibeta Results



Total background spectrum of the 20 crystal array around the DDB0ν region

Total statistic ~ 4.3 kg × y.

$$\tau_{1/2}^{0\nu} \geq 2.1 \cdot 10^{23}\, y \,(90\%\, CL)$$

C .Arnaboldi et al, Phys. Lett. B 557 (2003) 167

$$\langle m_\nu \rangle \leq 1.1 - 2.6\, eV\, *\quad (90\%\ CL)$$

* Dependent on the value for the nuclear matrix elements

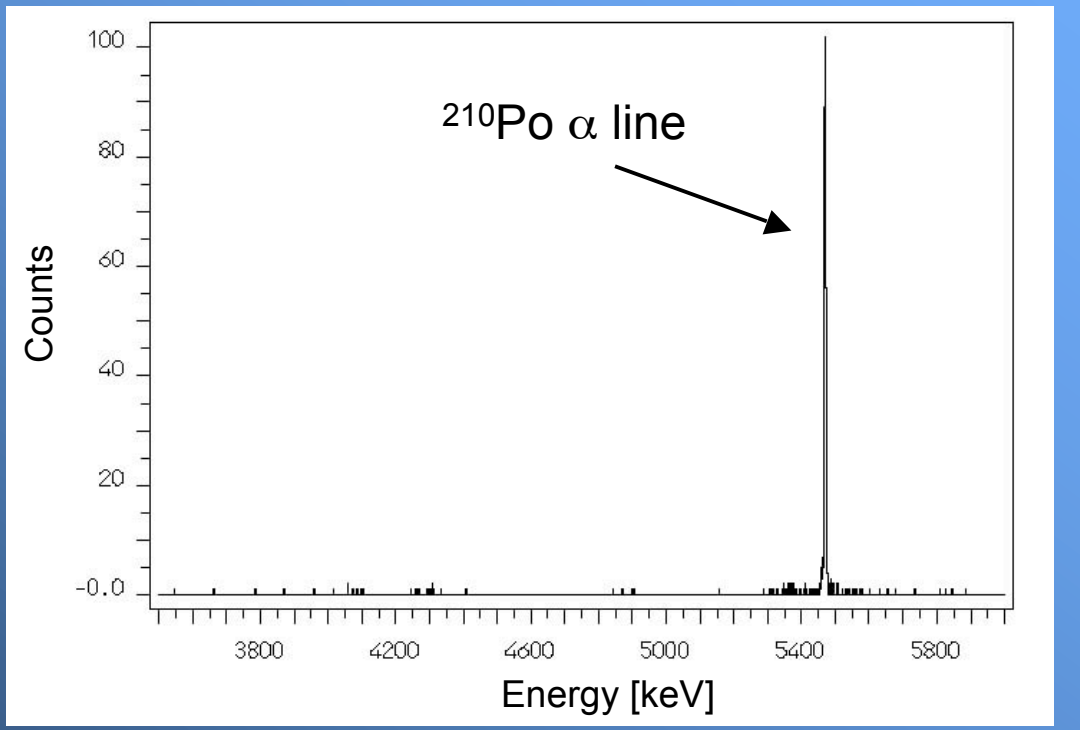
The 790 g detectors

R&D on new detectors 5x5x5 cm^3 of TeO_2 (790 g)

The best 790 g detector:

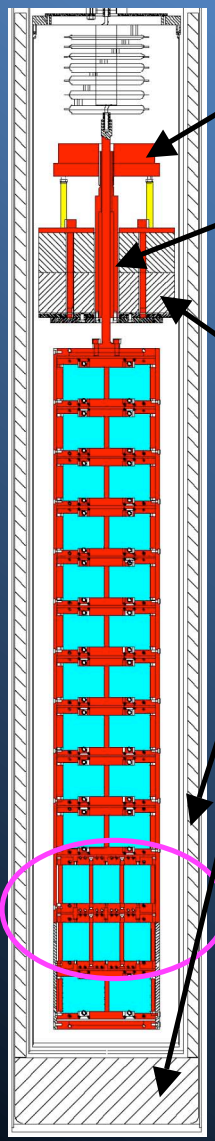
1.4 keV FWHM @ 0.351 MeV
2.1 keV FWHM @ 0.911 MeV
2.6 keV FWHM @ 2.615 MeV
3.2 keV FWHM @ 5.407 MeV

(the best α spectrometer realized)
A.Alessandrello et al, NIM A440 (2000) 397-402



Better design of the 790 g detectors allowed performances comparable with the 340 g crystals

Cuoricino



11 modules
4 detectors each
Dimension: 5x5x5 cm^3
Mass: 790 g

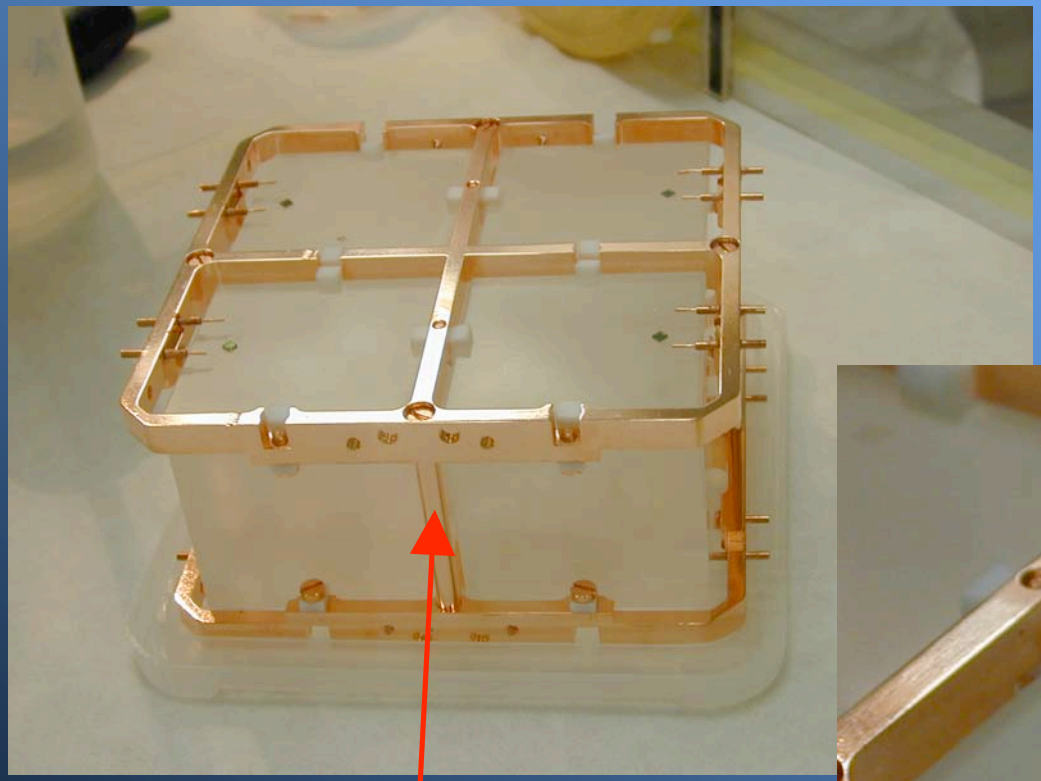
2 modules
9 detectors each,
Dimension: 3x3x6 cm^3
Mass: 330 g

Total mass
40.7 kg

Detectors assembling

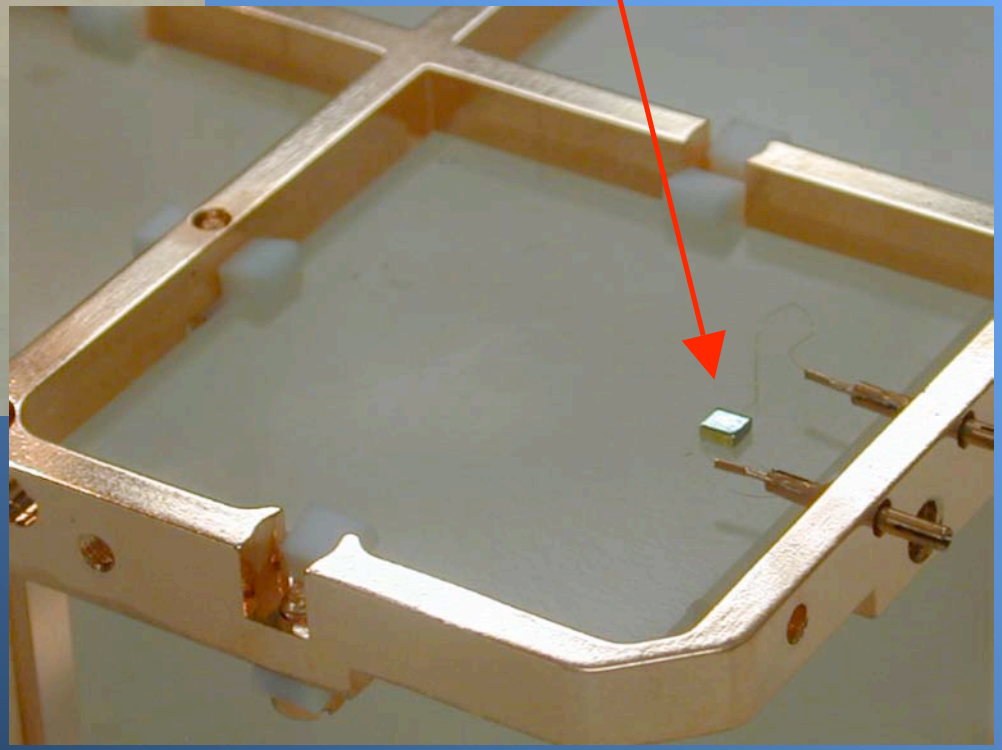
All the operations done in nitrogen atmosphere

Cuoricino module



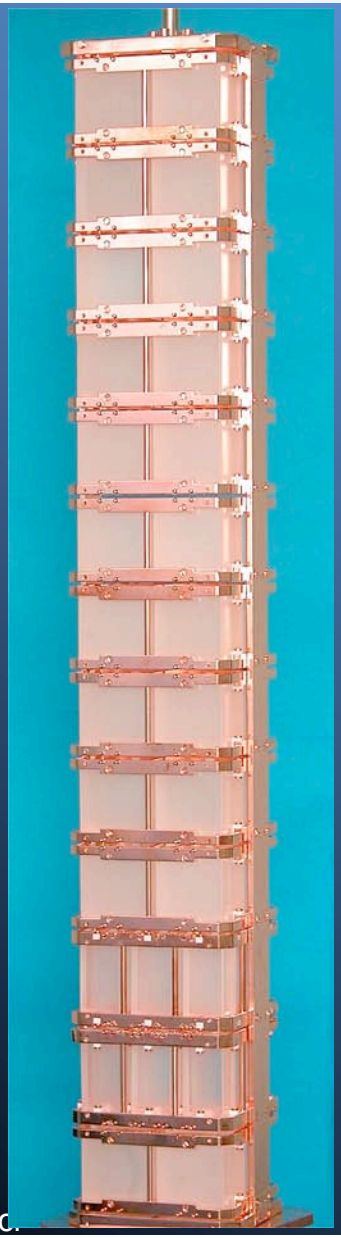
A Cuoricino module

Ge NTD thermistor



Tower assembling

Cuoricino



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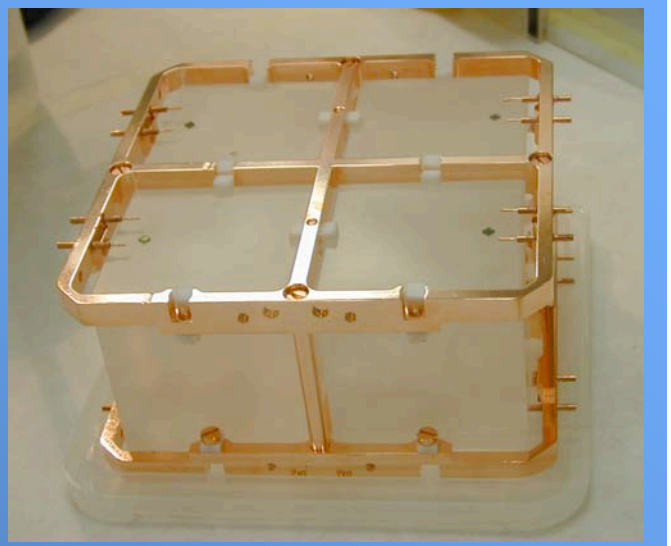
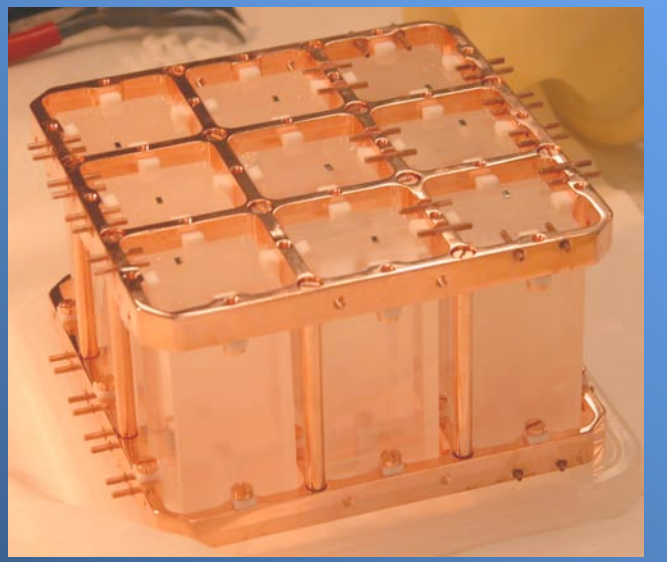
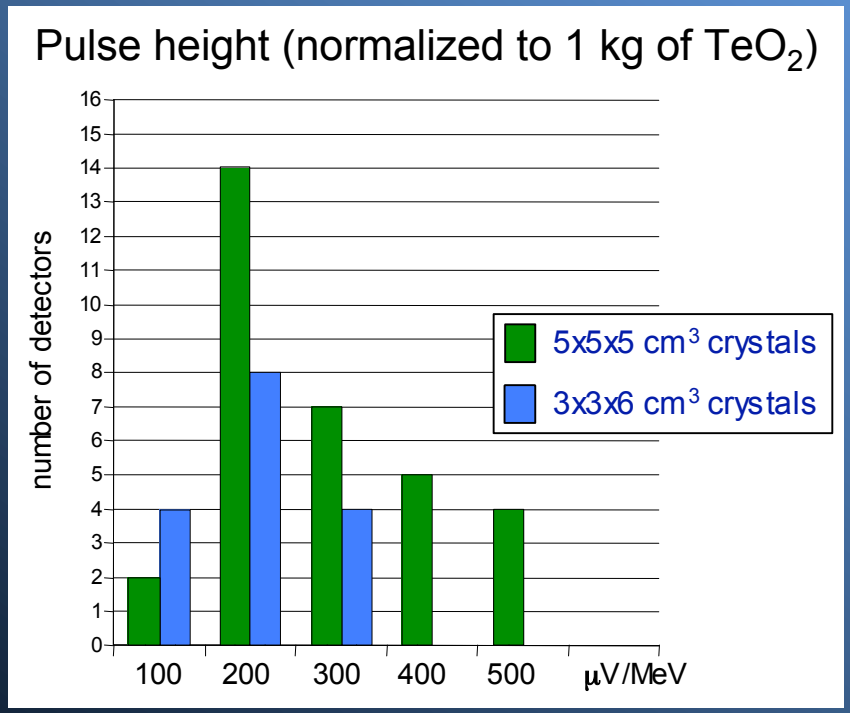




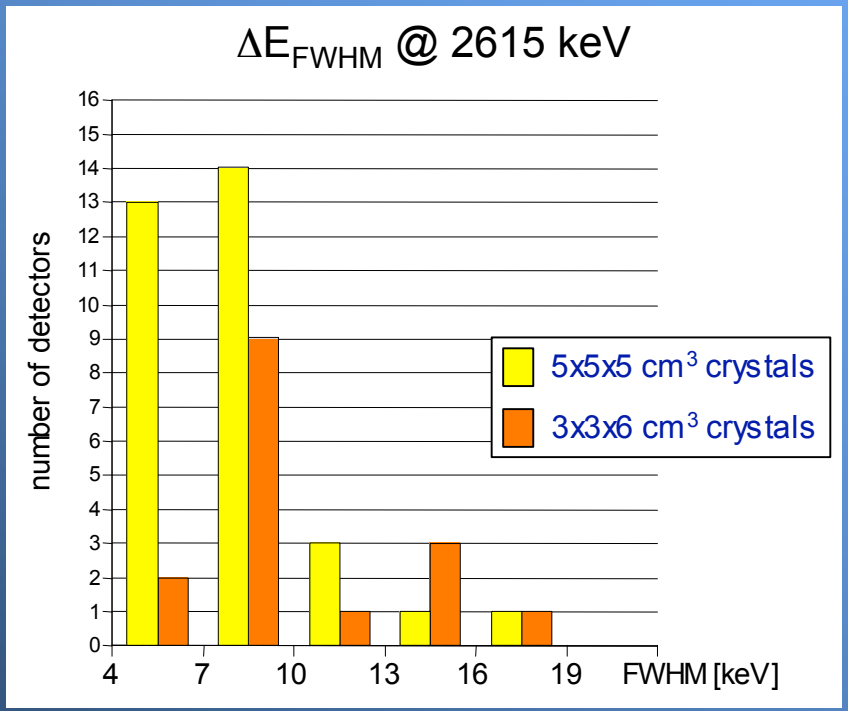
Detector performances

Some electrical connection were lost during the cooling of the tower, as a result 13 detectors cannot be read-out (until next warm up the cryostat)

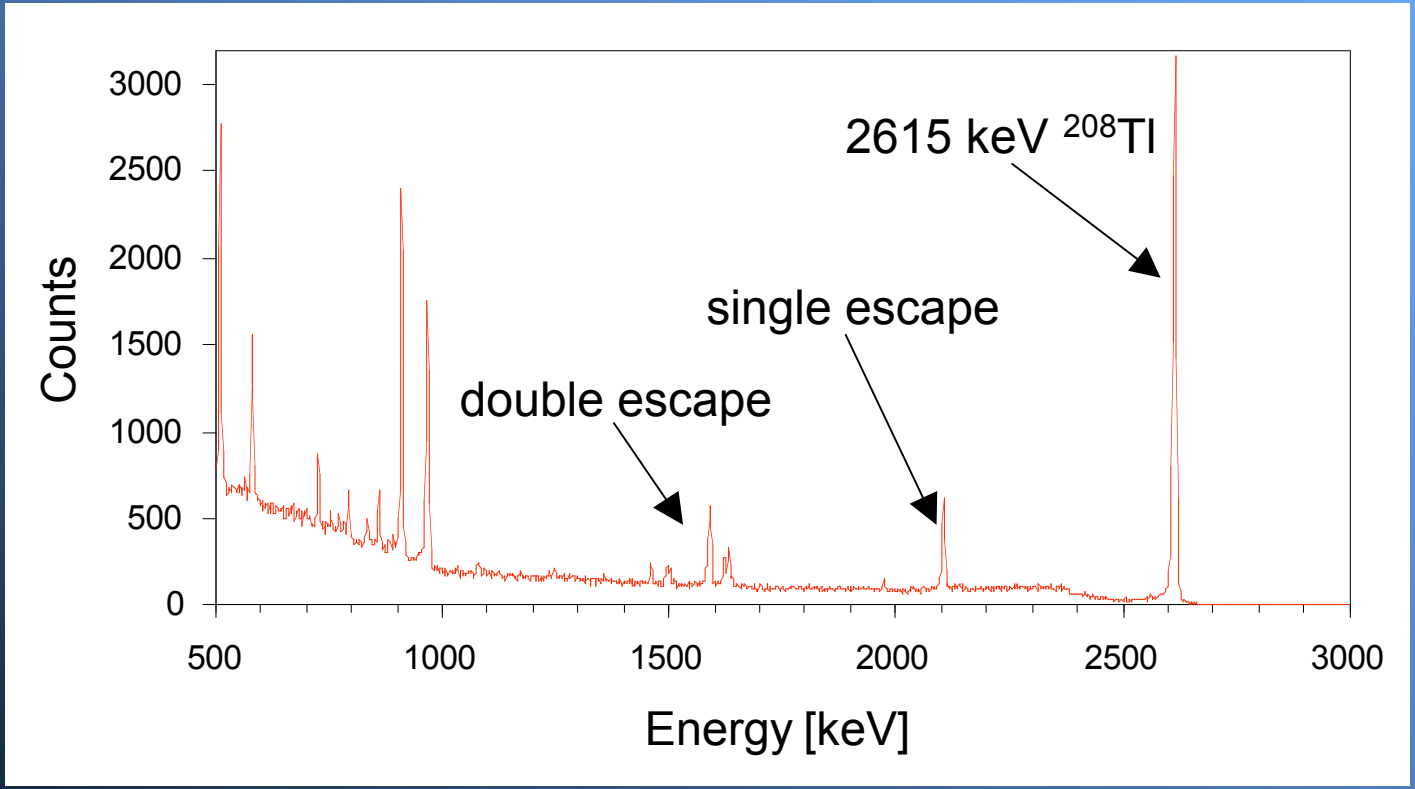


Average 5x5x5 cm^3 = 340 μV/MeV
Average 3x3x6 cm^3 = 440 μV/MeV

Average 5x5x5 cm^3 ~ 7 keV
Average 3x3x6 cm^3 ~ 9 keV



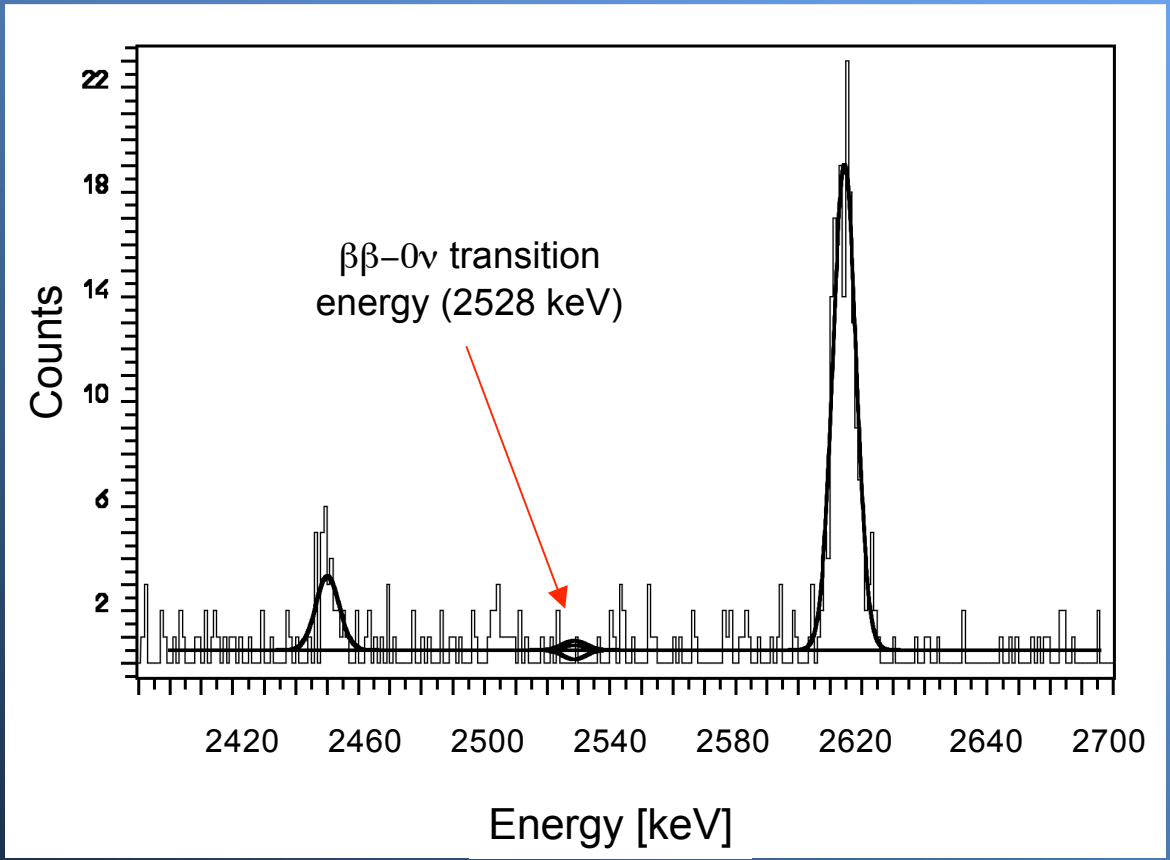
^{232}Th Calibration



Sum spectrum of all the 5x5x5 cm^3 detectors

ΔE_{FWHM} = 7 keV @ 2615 keV

Preliminary result on ^{130}Te ββ–0n decay



Total statistic ~ 2.3 kg × y

Anticoincidence background spectrum of the 5x5x5 cm^3 crystals around the **bb**-*0***n** *region*

$$\tau_{1/2}^{0\nu} \geq 5.0 \cdot 10^{23}\, y \,(90\%\, CL)$$

$$\langle m_\nu \rangle \leq 0.7 - 1.7\, eV\, *\quad (90\%\ CL)$$

* Dependent on the value for the nuclear matrix elements

Cryogenic Underground Observatory for Rare Events

Array of 1000 detectors:

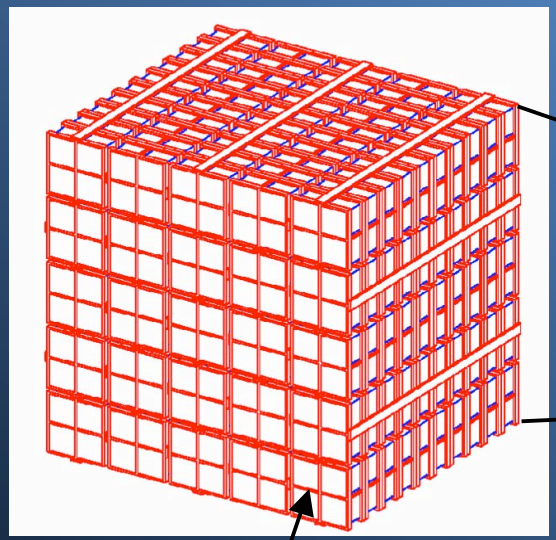
25 towers - 10 modules/tower

4 detectors/module

→ M = 0.79 ton di TeO_2

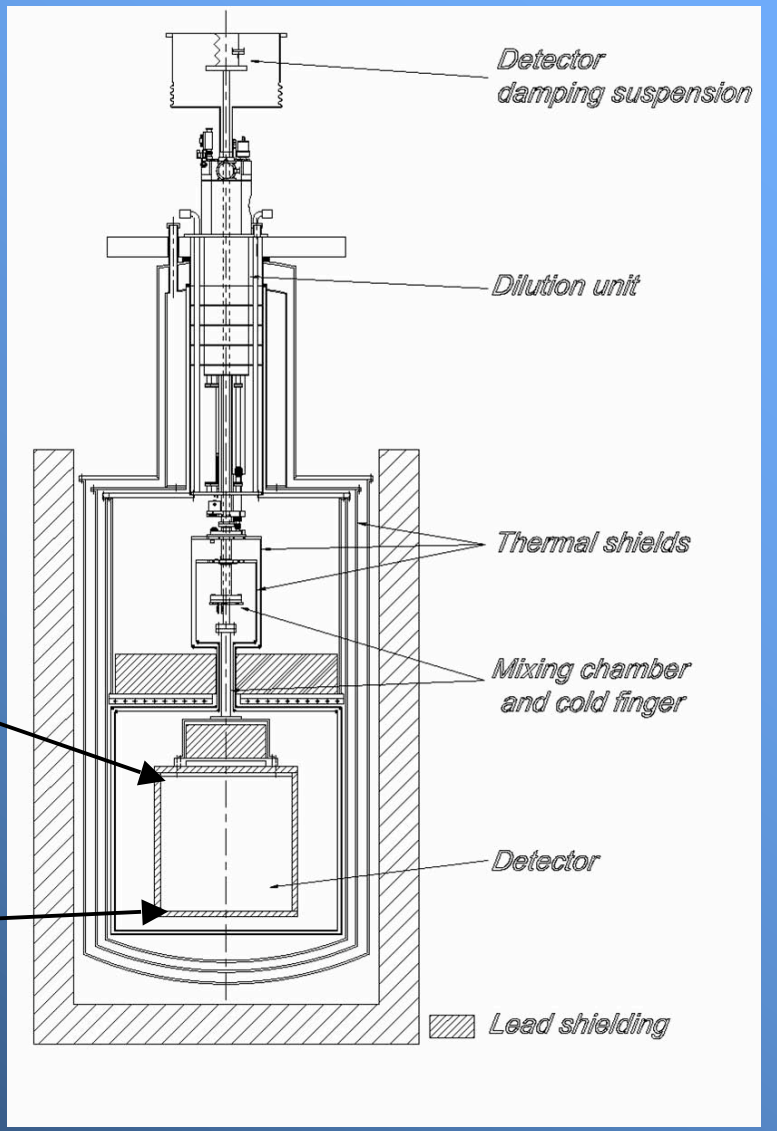
Sensitivity DDB-0ν *(ext. background 1 c/keV ton a)*

T^{5y} ~6.6 10^{26} y $\langle m_\nu \rangle$ ~ 15 - 40 meV

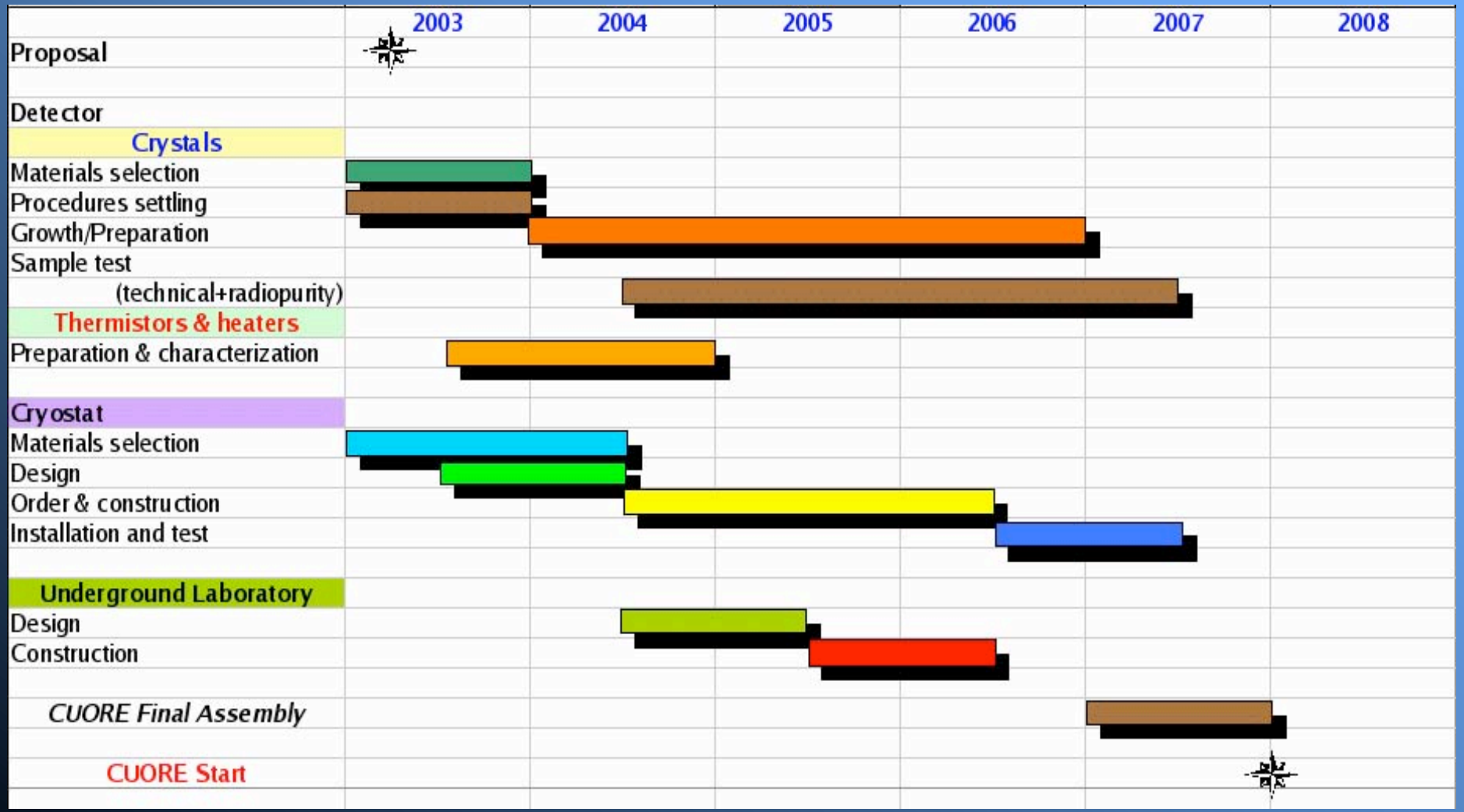


70 cm

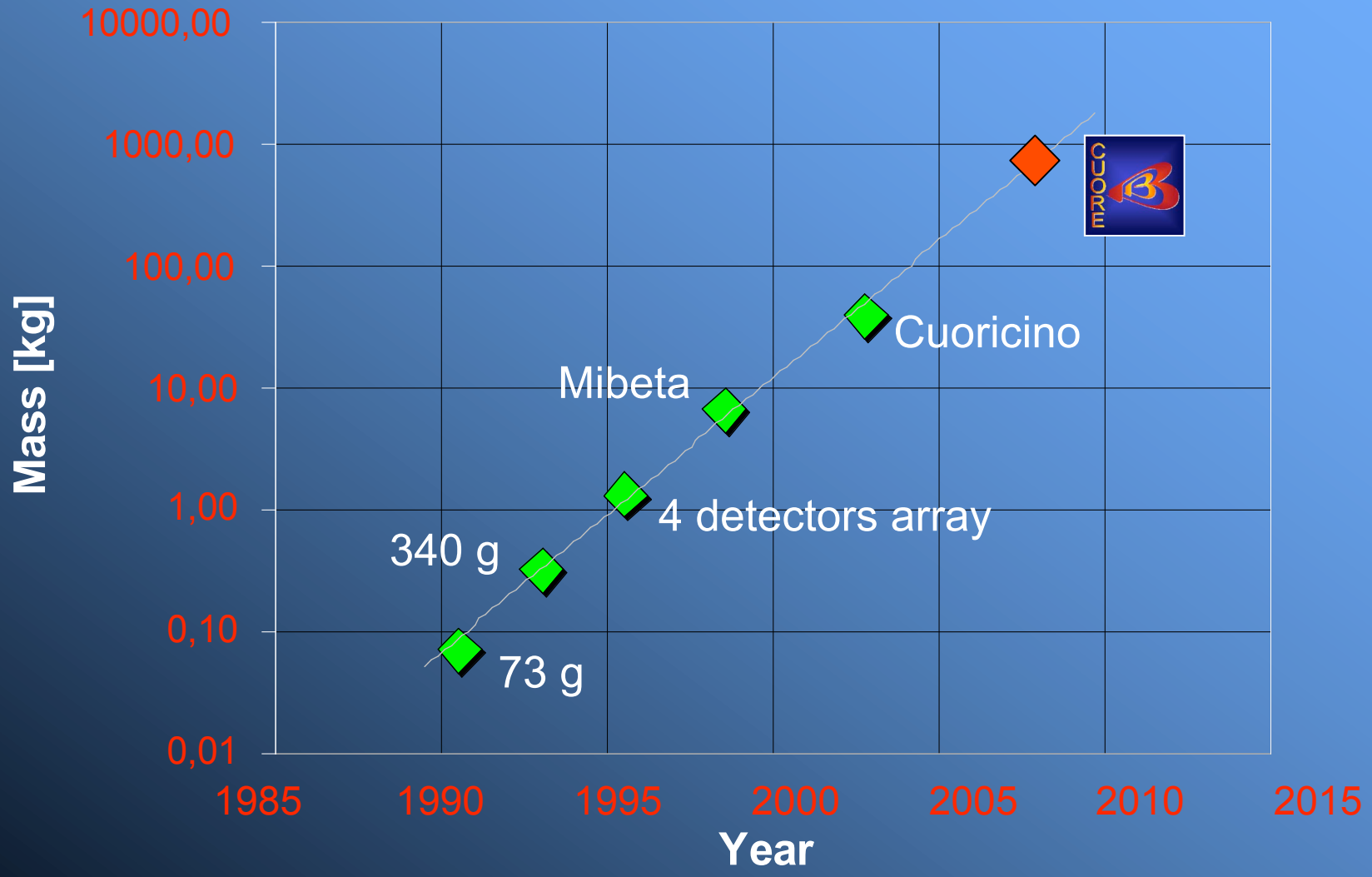
25 towers CUORICINO-like



Temptative CUORE schedule



Moore's Law


10000,00
1000,00
100,00
10,00
1,00
0,10
0,01
Mass [kg]
1985
1990
1995
2000
2005
2010
2015
Year
73 g
340 g
4 detectors array
Mibeta
Cuoricino
CUORE