



First Results from the Cuoricino Experiment



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on behalf of the CUORE collaboration:

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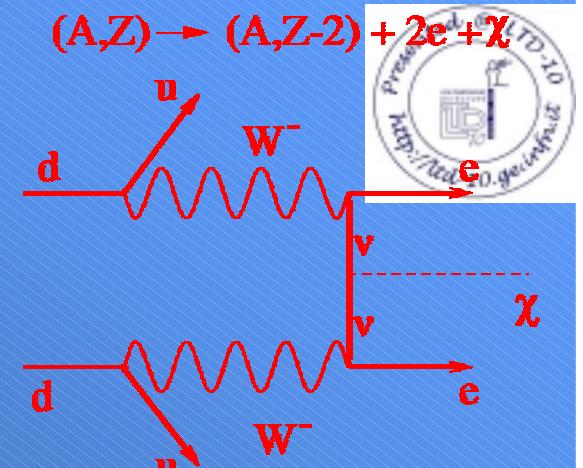
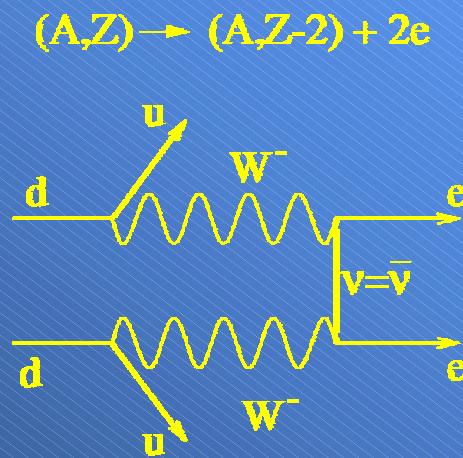
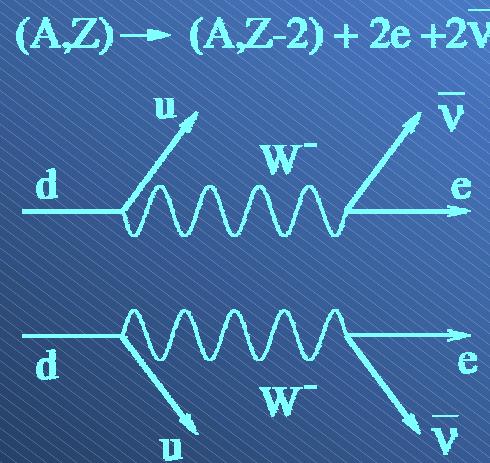
Dipartimento di Scienze Chimiche, Fisiche e Matematiche dell'Università dell'Insubria e Sezione di Milano dell' INFN, Como I-22100, Italy

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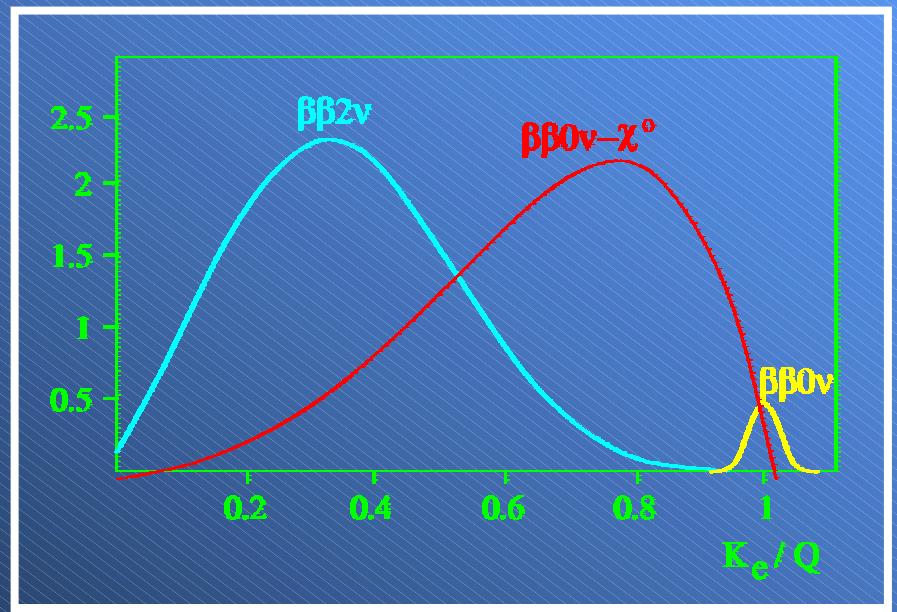


Double Beta Decay



Allowed in SM
observed in several nuclei with
 $\tau^{2\nu} \sim 10^{18} - 10^{21} \text{ y}$

- 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.



$$S^{0\nu} = \ln 2 N_A \times \frac{a}{A} \left(\frac{M \tau}{b \Gamma} \right)^{1/2} \times \epsilon \times B \times E$$

The diagram illustrates the factors contributing to the sensitivity of a neutrinoless double-beta decay experiment. The equation is:

$$S^{0\nu} = \ln 2 N_A \times \frac{a}{A} \left(\frac{M \tau}{b \Gamma} \right)^{1/2} \times \epsilon \times B \times E$$

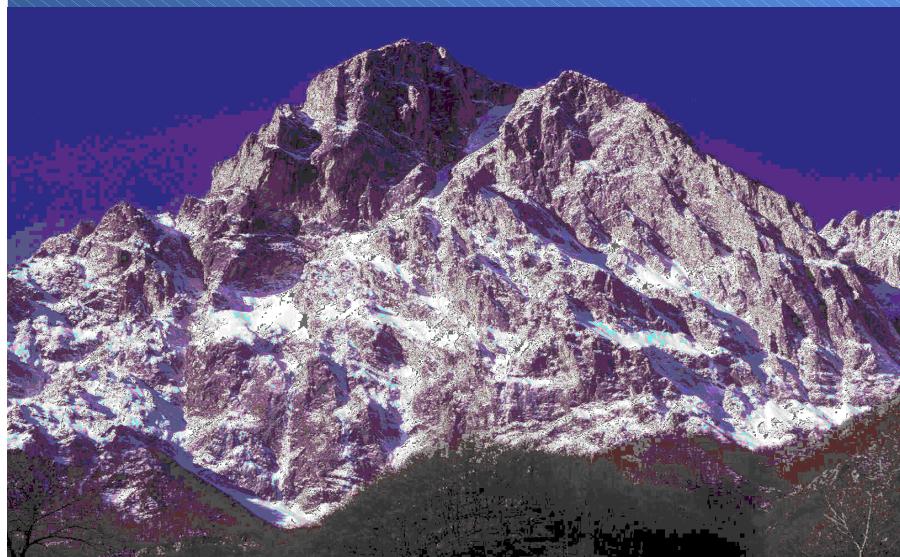
Where:

- Detector mass (kg)*: a / A
- Measurement Time (y)*: $(M \tau / b \Gamma)^{1/2}$
- Efficiency*: ϵ
- Energy resolution (keV)*: B
- Background (counts/keV/kg/y)*: E
- Isotopic abundance*: N_A
- Atomic mass*: A

A blue arrow points from the left towards the equation, indicating the overall result of the calculation.

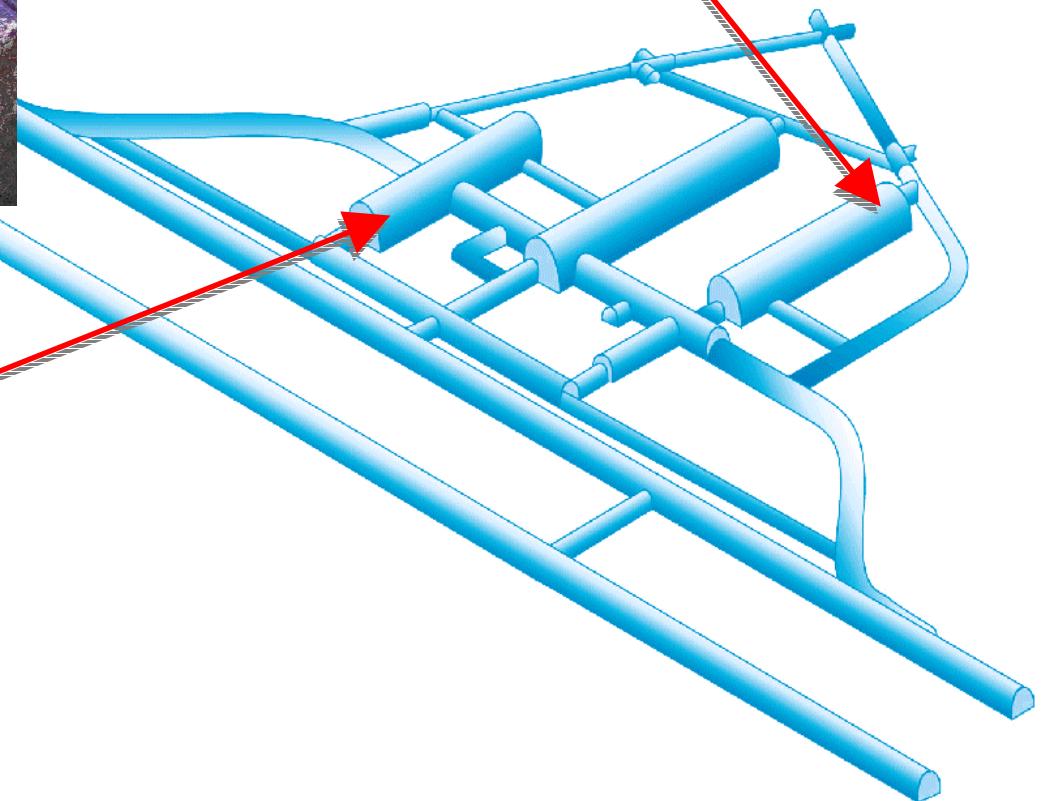


CUORE @ LNGS



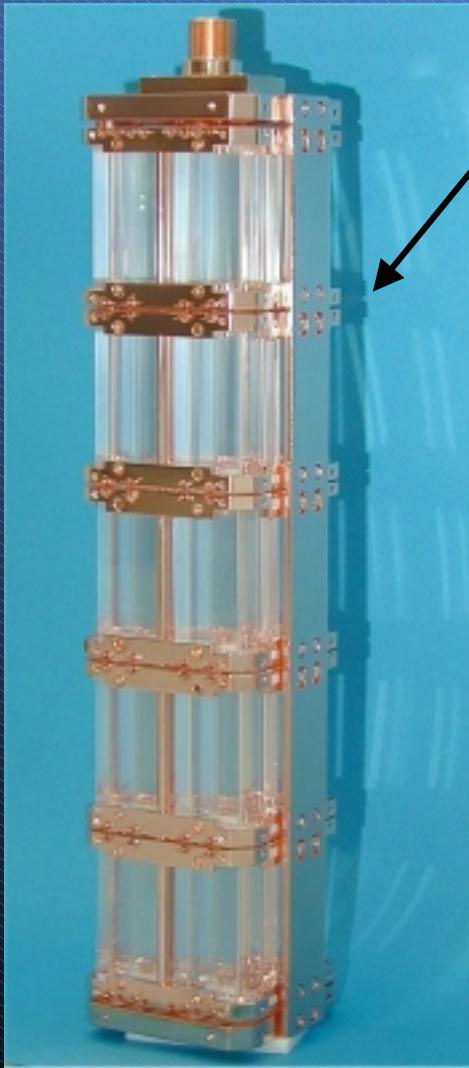
Cuoricino (Hall A)

CUORE R&D (Hall C)





Mibeta (^{130}Te)

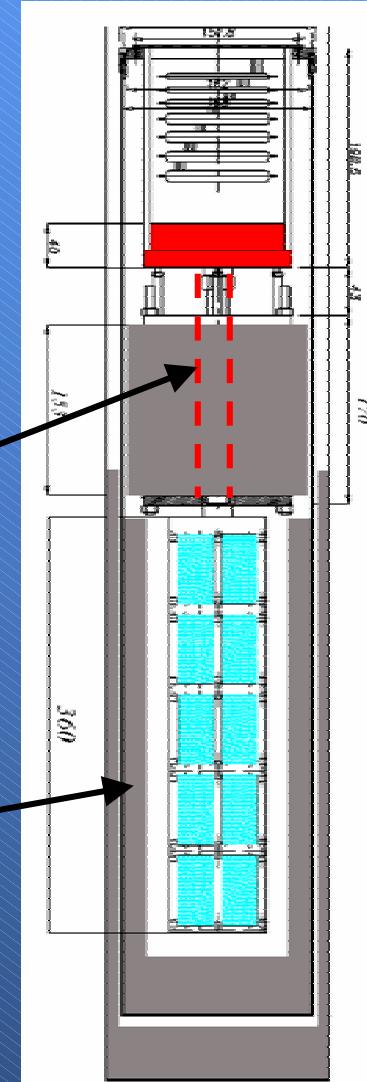


5 modules, 4 detectors each,
arranged in a tower-like
structure (6.8 kg)

Every detector was a TeO_2
crystal $3 \times 3 \times 6 \text{ cm}^3$ (340 g)

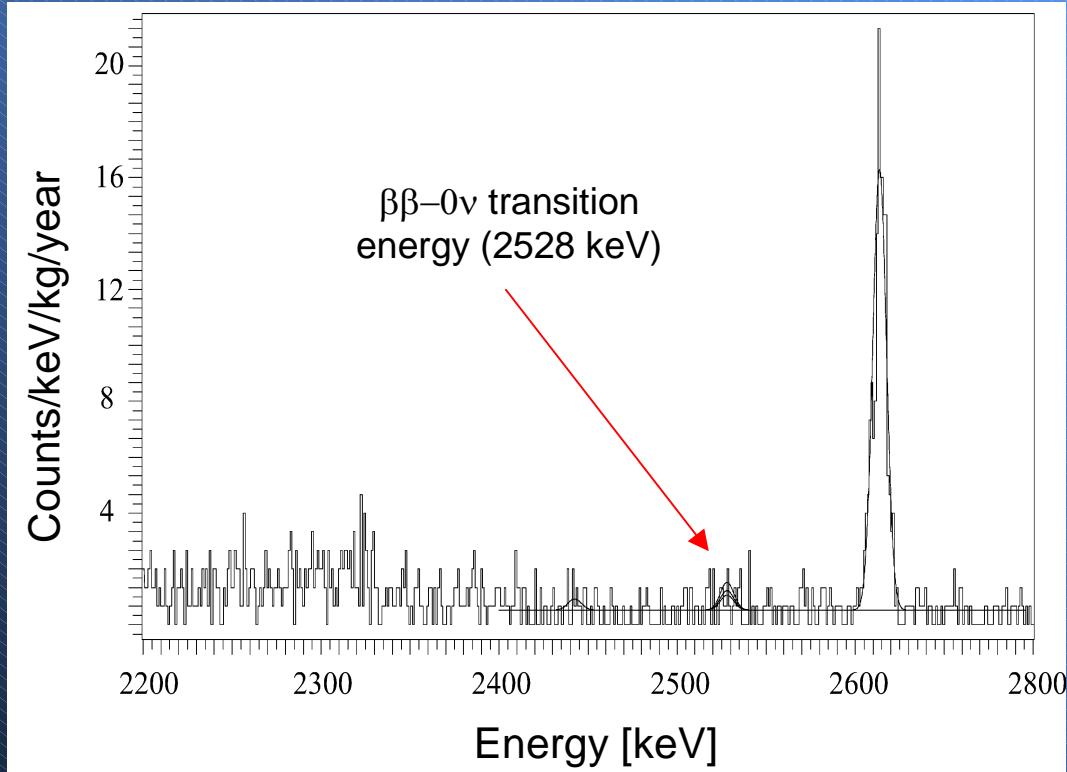
Cold finger: $\sim 7 \text{ mK}$

The tower was surrounded
by a Roman lead inner shield





Mibeta Results



Total statistic $\sim 4.3 \text{ kg} \times \text{y.}$

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

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



$$\langle m_\nu \rangle \leq 1.1 - 2.6 \text{ eV}^* \quad (90\% \text{ CL})$$

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

* Dependent on the value for the nuclear matrix elements

The 790 g detectors

R&D on new detectors 5x5x5 cm³ of TeO₂ (790 g)

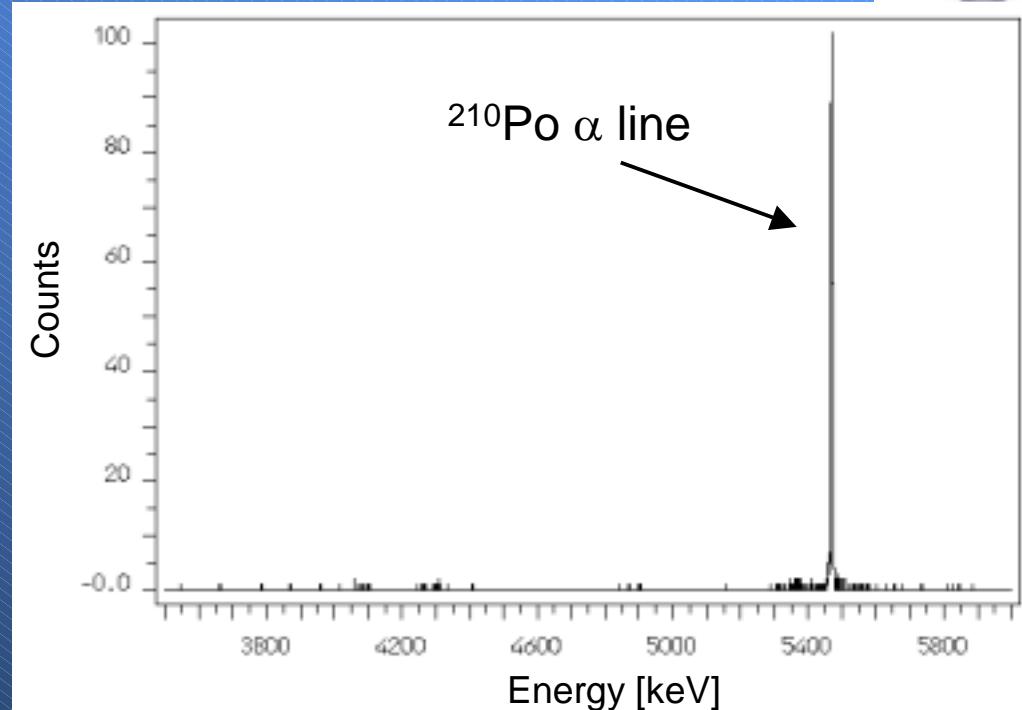


The best 790 g detector:

- 1.5 keV FWHM @ 0.351 MeV
- 2.4 keV FWHM @ 0.911 MeV
- 3.8 keV FWHM @ 2.615 MeV
- 4.2 keV FWHM @ 5.407 MeV

(the best α spectrometer ever realized)

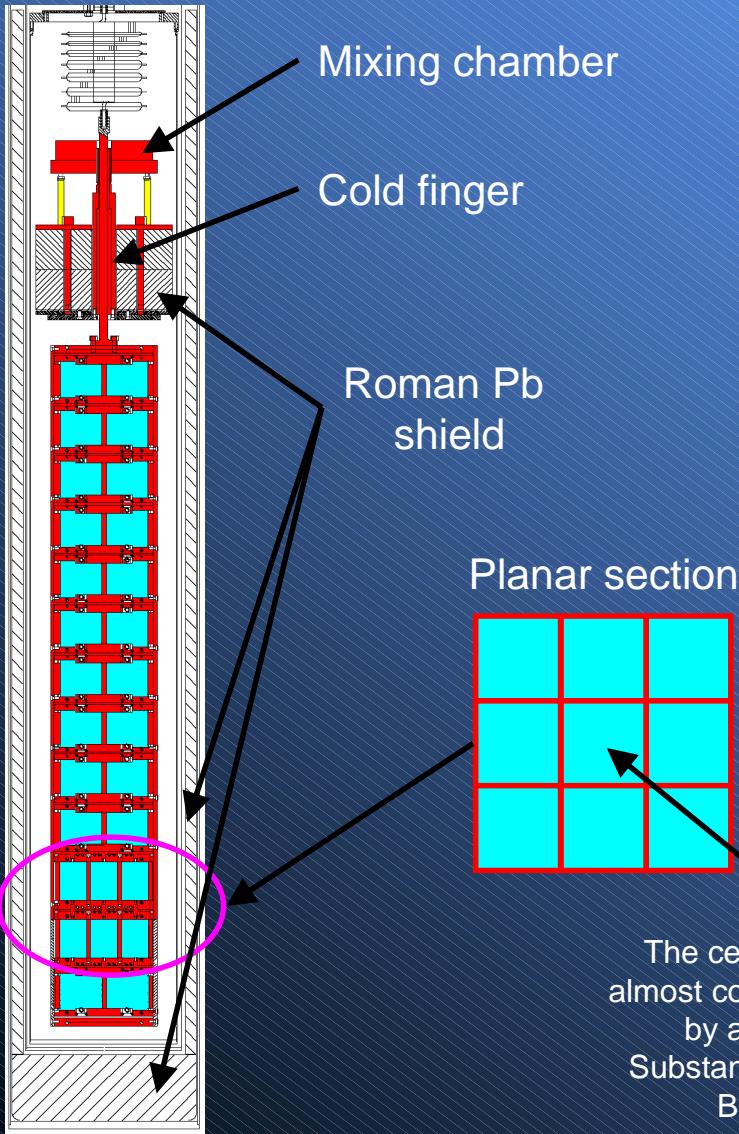
A.Alessandrello et al, NIM A440 (2000) 397-402



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



Cuoricino



11 modules
4 detectors each
Dimension: $5 \times 5 \times 5$ cm 3
Mass: 790 g

2 modules
9 detectors each,
Dimension: $3 \times 3 \times 6$ cm 3
Mass: 330 g

Total mass
40.7 kg

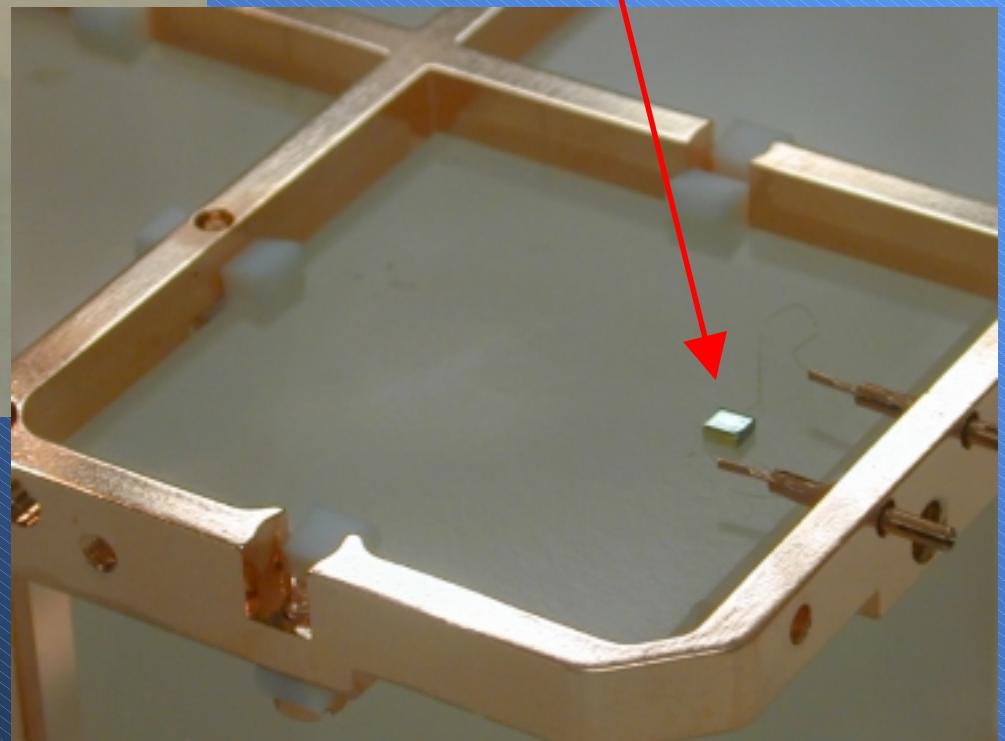
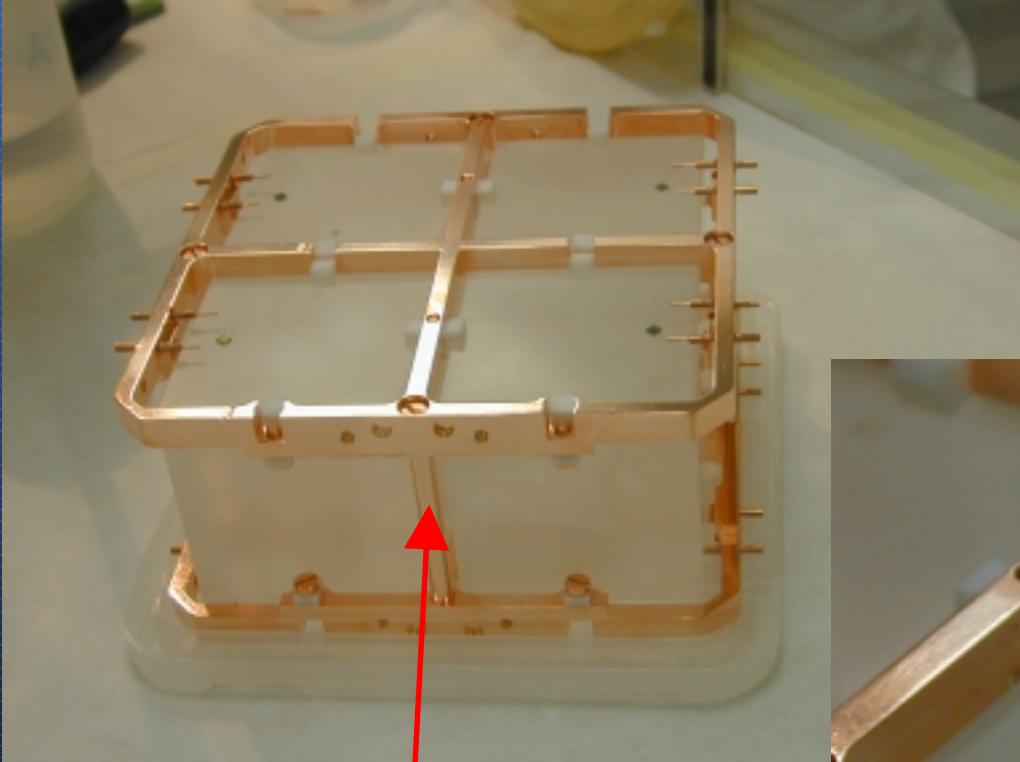
Detectors assembling



All the operations done in
nitrogen atmosphere



Cuoricino module

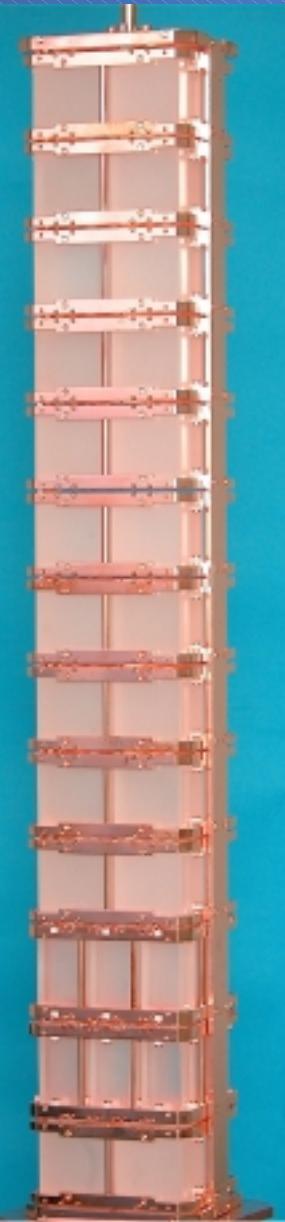




Tower assembling



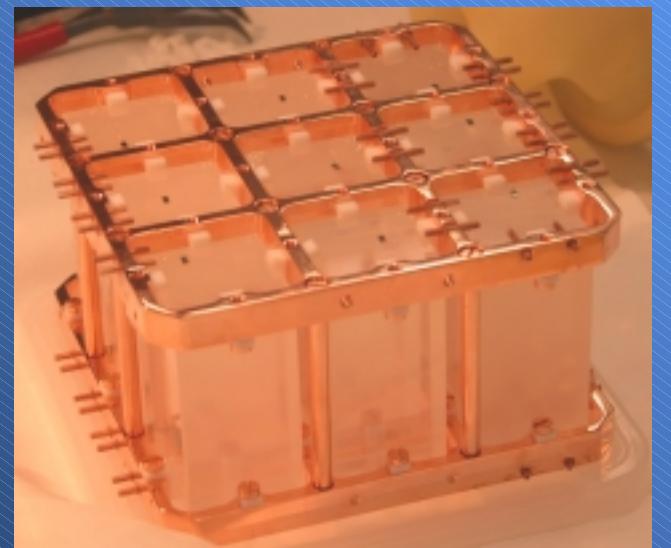
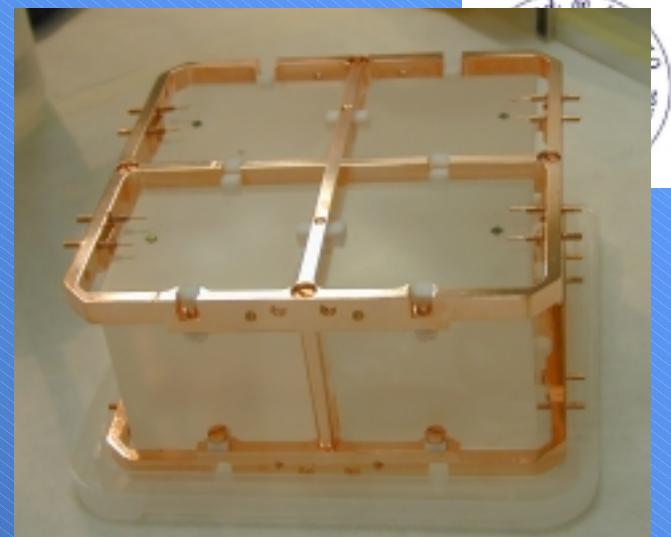
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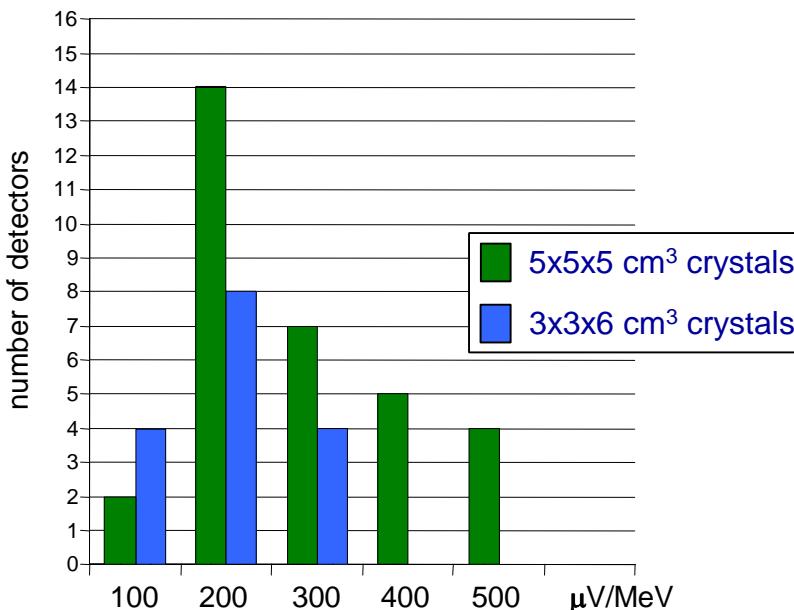


Detector performances



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)

Pulse height (normalized to 1 kg of TeO₂)



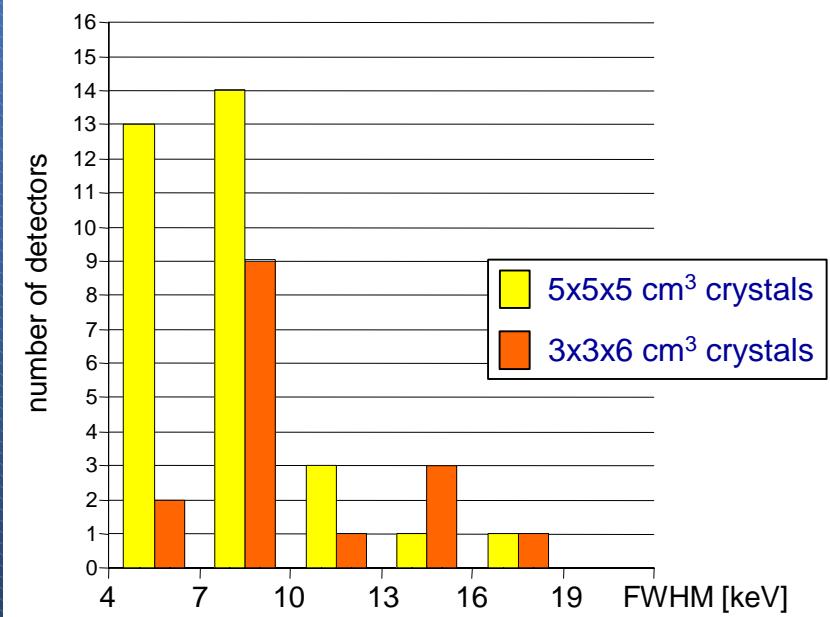
Average 5x5x5 cm³ = 340 μV/MeV

Average 3x3x6 cm³ = 440 μV/MeV

Average 5x5x5 cm³ ~ 7 keV

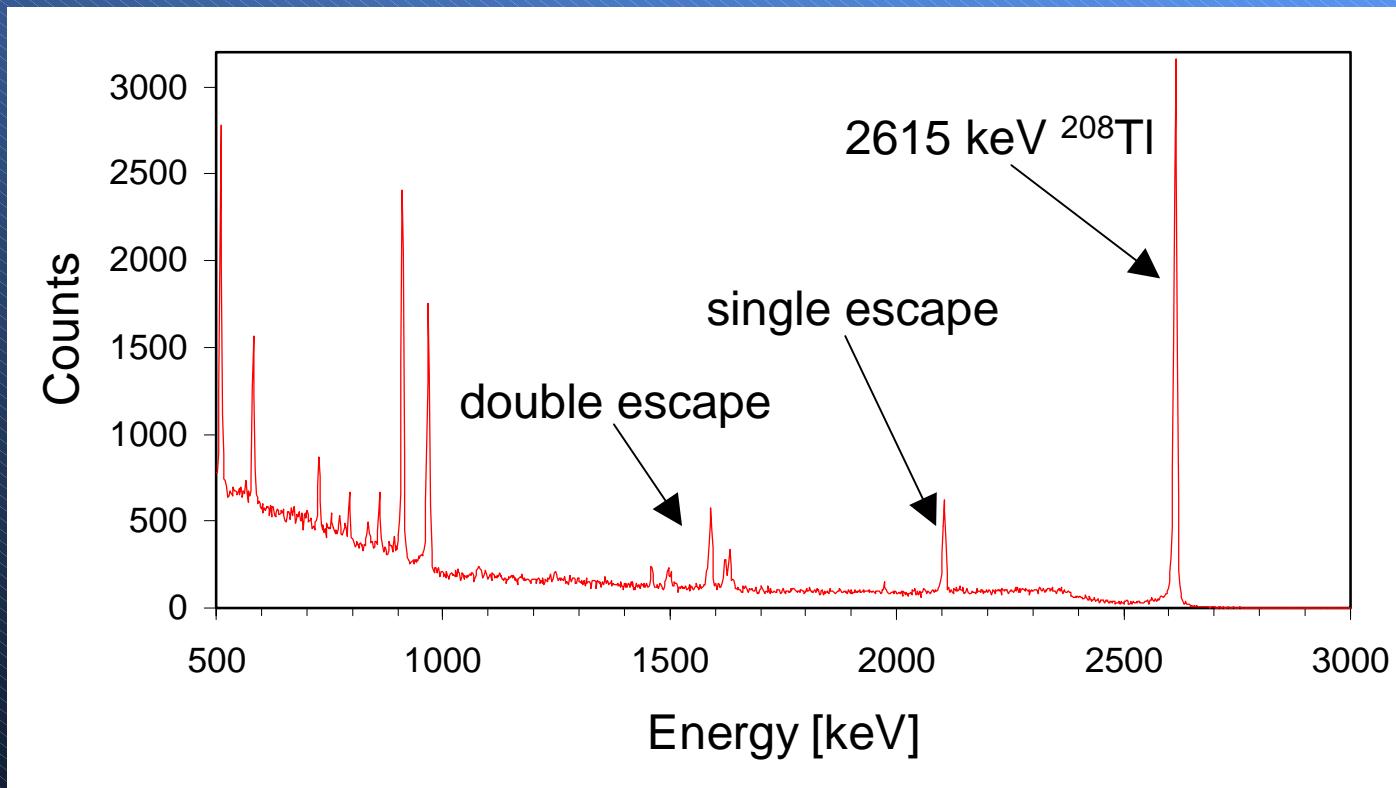
Average 3x3x6 cm³ ~ 9 keV

ΔE_{FWHM} @ 2615 keV





^{232}Th Calibration

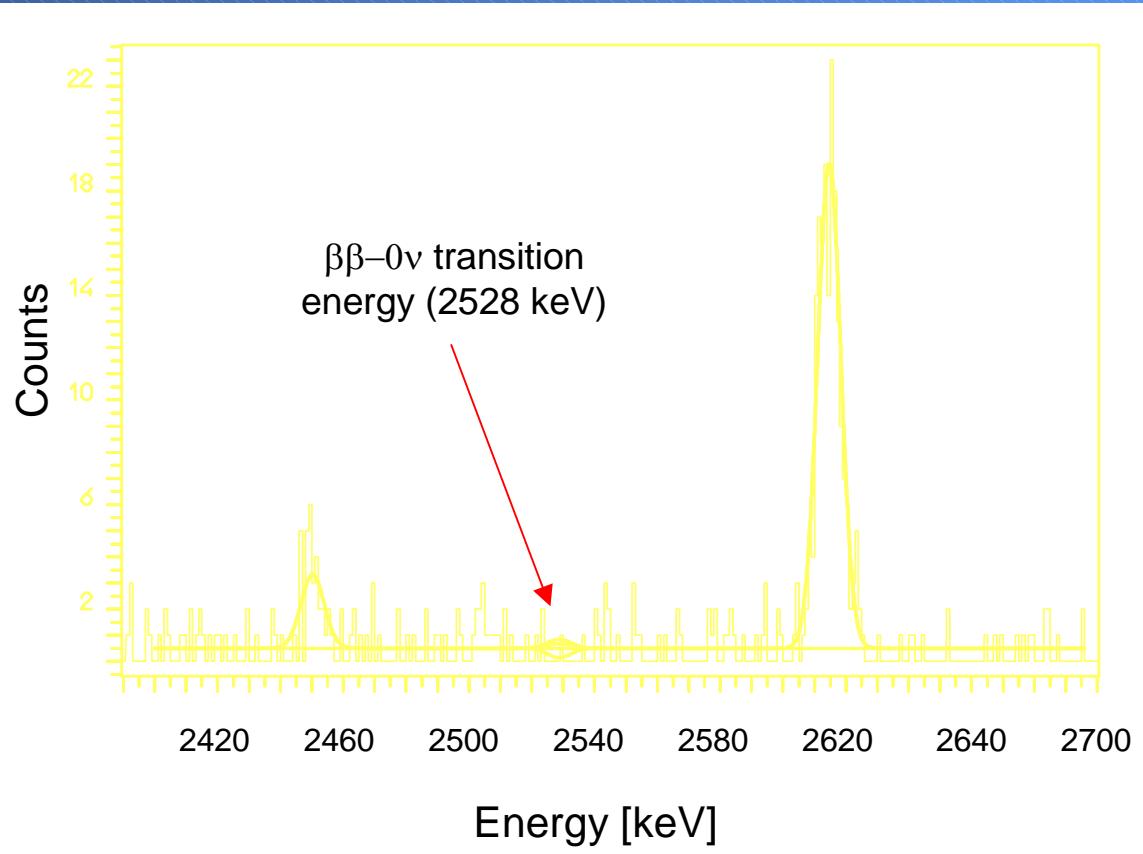


Sum spectrum of
all the $5 \times 5 \times 5 \text{ cm}^3$
detectors

$$\Delta E_{\text{FWHM}} = 7 \text{ keV} @ 2615 \text{ keV}$$



Preliminary result on ^{130}Te $\beta\beta-0n$ decay



Total statistic $\sim 2.3 \text{ kg} \times \text{y}$

Anticoincidence background spectrum of the $5 \times 5 \times 5 \text{ cm}^3$ crystals around the $\text{bb}-0n$ region

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



$$\langle m_\nu \rangle \leq 0.7 - 1.7 \text{ eV}^* \quad (90\% \text{ CL})$$

* Dependent on the value for the nuclear matrix elements



Cryogenic Underground Observatory for Rare Events

Array of 1000 detectors:

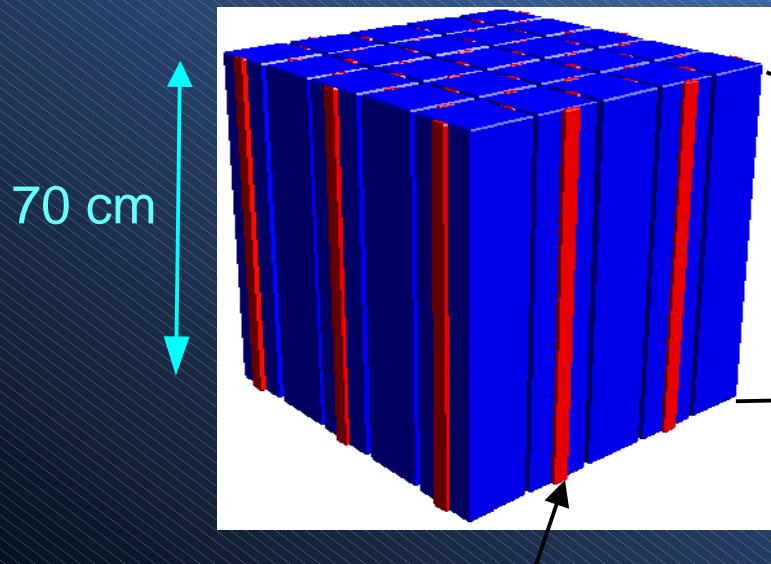
25 towers - 10 modules/tower

4 detectors/module

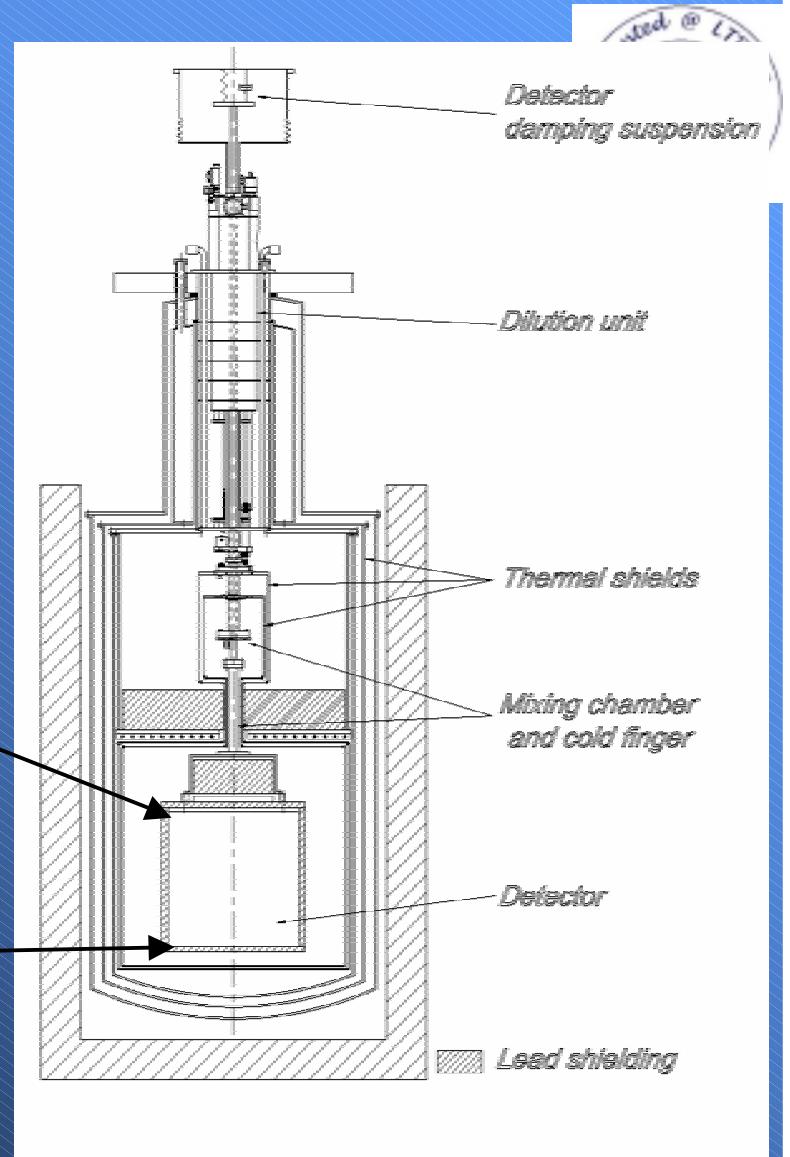
→ $M = 0.79 \text{ ton}$ di TeO_2

Sensitivity DDB-0v (*ext. background 1 c/keV ton y*)

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

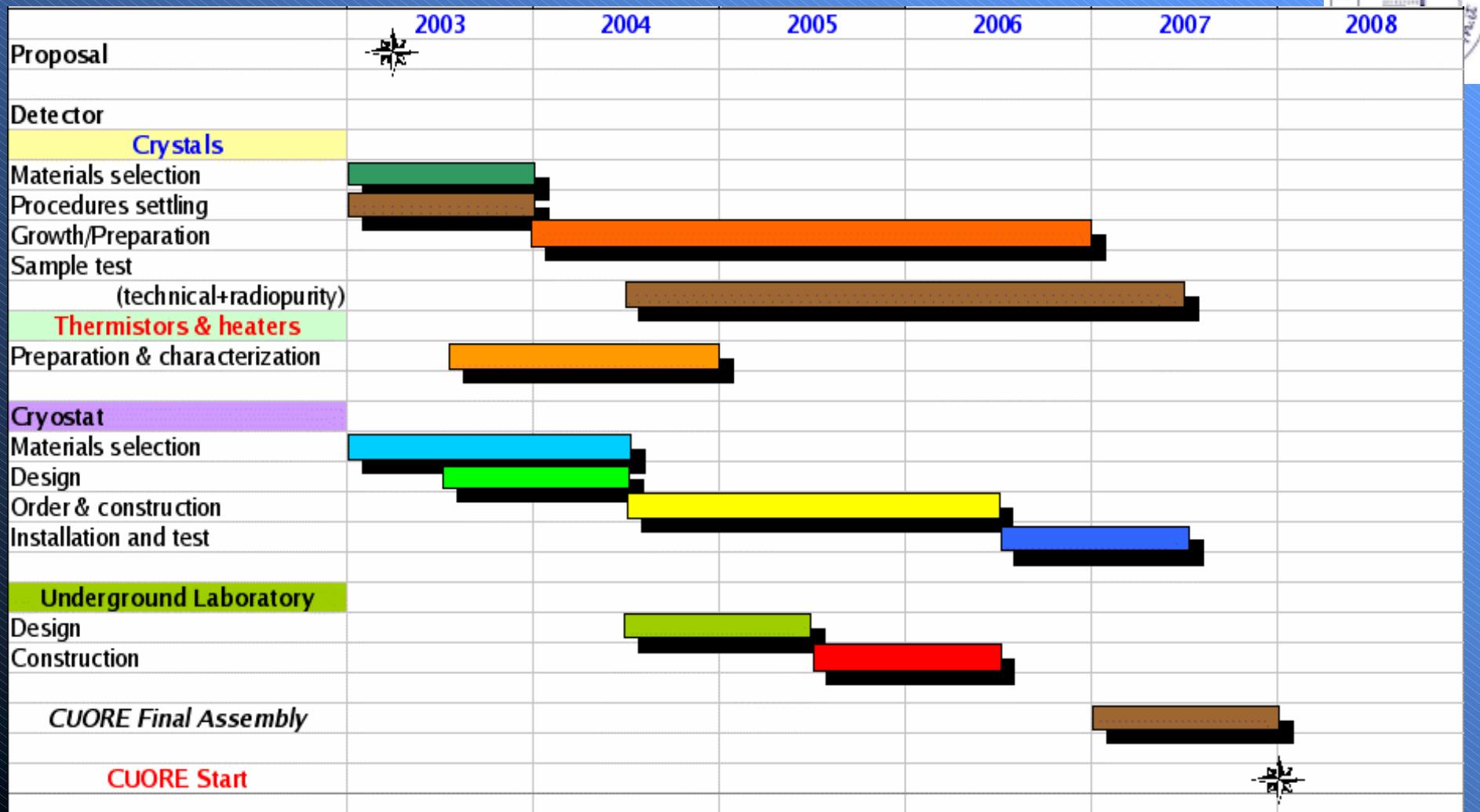


25 towers CUORICINO-like





Temptative CUORE schedule





Moore's Law

