

Neutrinoless double beta decay results from CUORE-0 and status of the CUORE experiment



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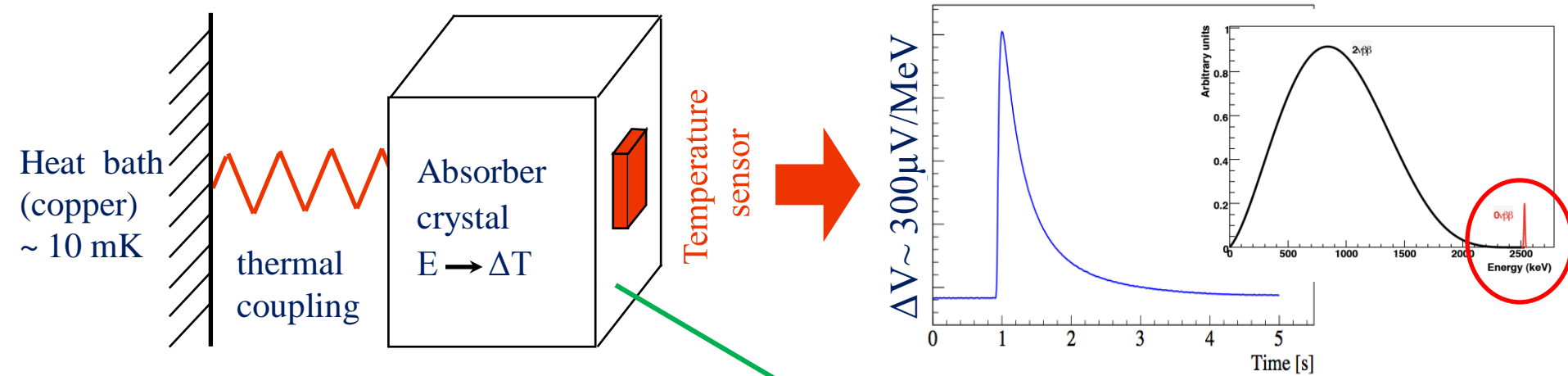


F. Terranova on behalf of the CUORE Collaboration



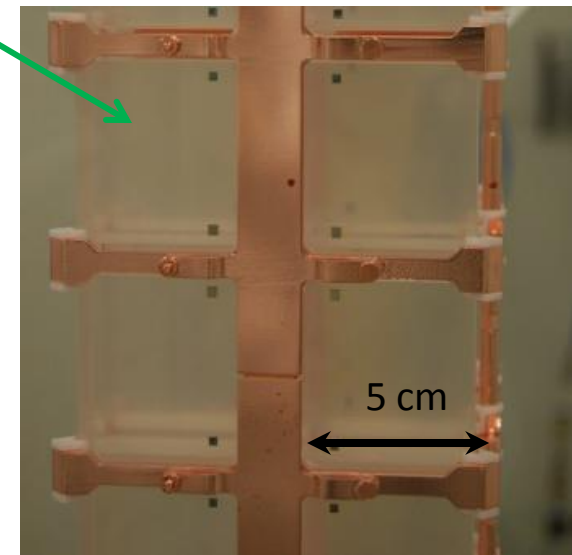
CUORE

The largest (741 kg total mass - 206 kg of ^{130}Te) and most ambitious (background ≈ 0.01 counts/keV/kg/y, $T_{1/2} = 9.5 \times 10^{25}$ y @ 90% C.L.) bolometric experiment to search for neutrino-less double beta decay.



Bolometers:

- Outstanding energy resolution (0.2% FWHM – see below)
- High efficiency ($>80\%$ see below)
- Possible to study different candidates (different dielectric crystals)
- Scalable > 1 ton (see below)
- Modular (anti-coincidence)



CUORE

Cuoricino



2003-2008

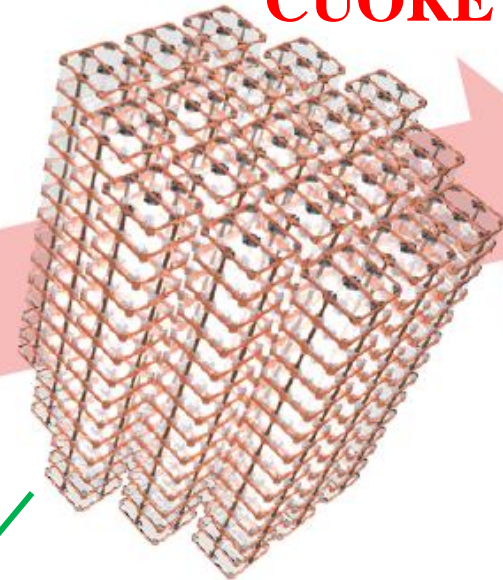
M = 11.3kg ^{130}Te

CUORE-0



2013- running

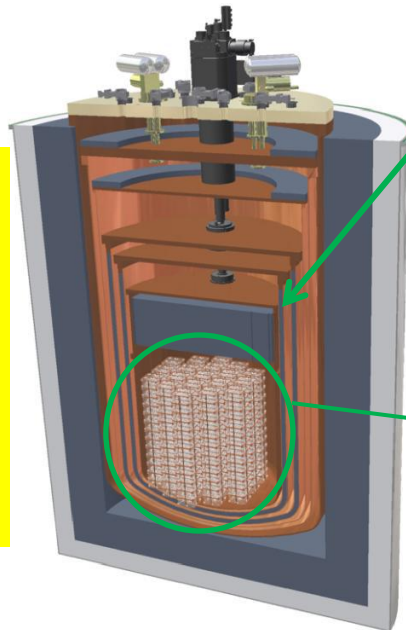
M = 10.9 kg ^{130}Te



2015-2020

M = 206 kg ^{130}Te

988 crystals
arranged in 19
towers
741 kg total mass
206 kg of ^{130}Te



LNGS - Italy



The challenges (and recent successes!) of CUORE

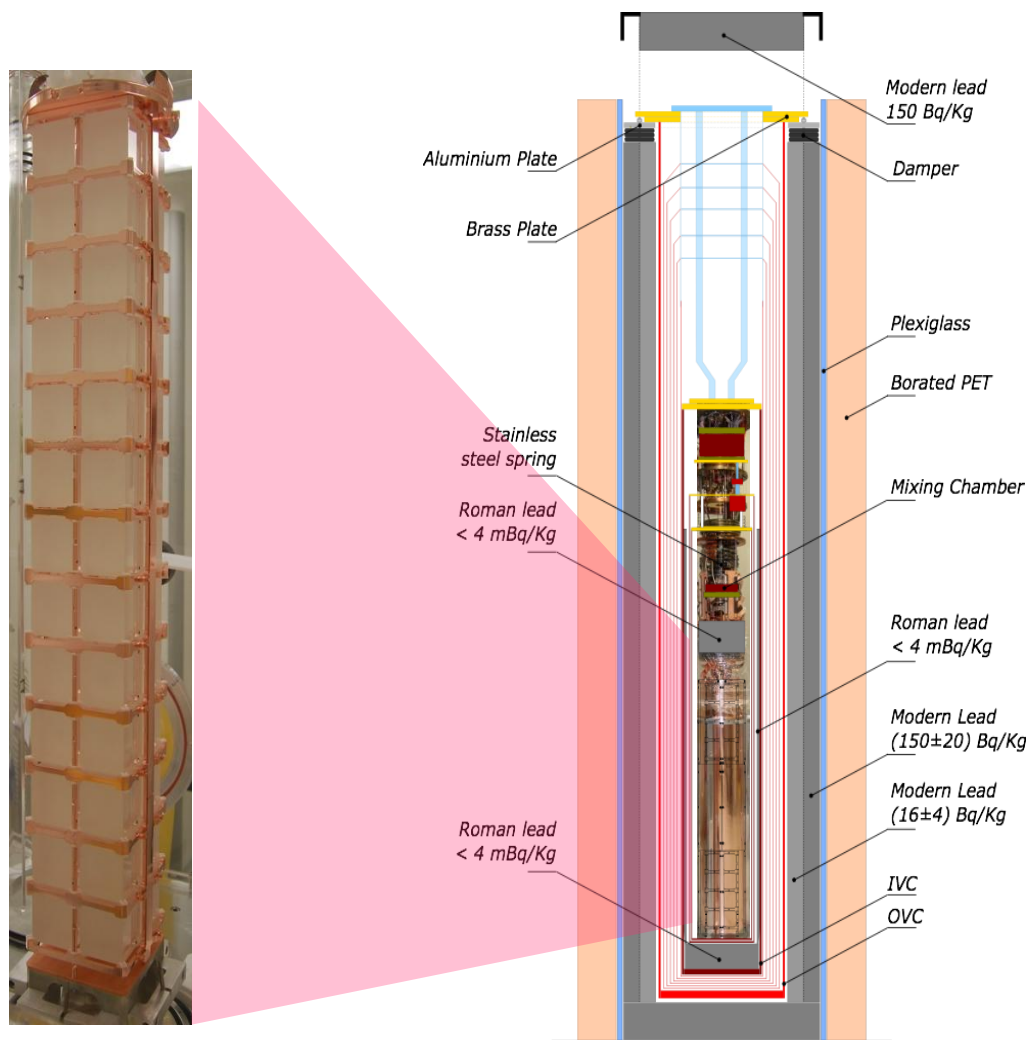
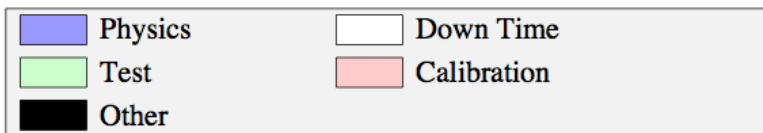
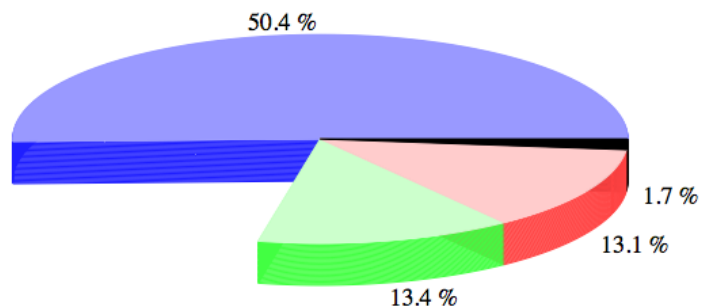
	Energy resolution	α continuum background	Cryogenics	γ background
Goal	5 keV FWHM	Significant reduction with respect to CUORICINO	~ 1 ton detector at $T = 10$ mK	Significant reduction with respect to CUORICINO
Methods	Thermistor and crystal quality. Noise mitigation	Strict radio-purity control protocols. New surface cleaning techniques	Custom pulse tube dilution refrigerator NEW!	Strict radio-purity control protocol Material selection for the cryostat Roman lead shields
Results	CUORE-0 NEW!	CUORE-0 NEW!	T=6 mK without thermal load Full integration by the end of the year Coming soon!	Start of detector operation by end of the year Coming soon!

CUORE-0

A single CUORE-like tower to test cleaning & assembly. As a matter of fact... a world-class experiment on $0\nu\beta\beta$ with ^{130}Te ☺

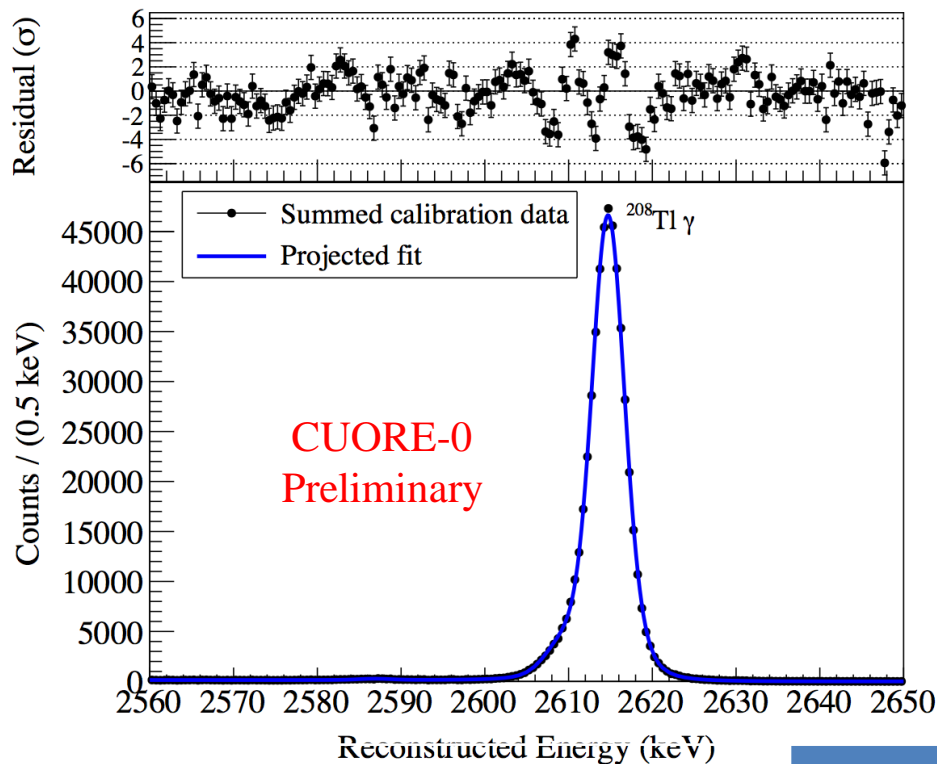
- TeO_2 : 39 kg
- ^{130}Te : ~11 kg (5×10^{25} nuclei)
- Total exposure: 35.2 kg·yr of TeO_2 (9.8 kg·yr of ^{130}Te)

CUORE-0 Dataset Run Time Breakdown

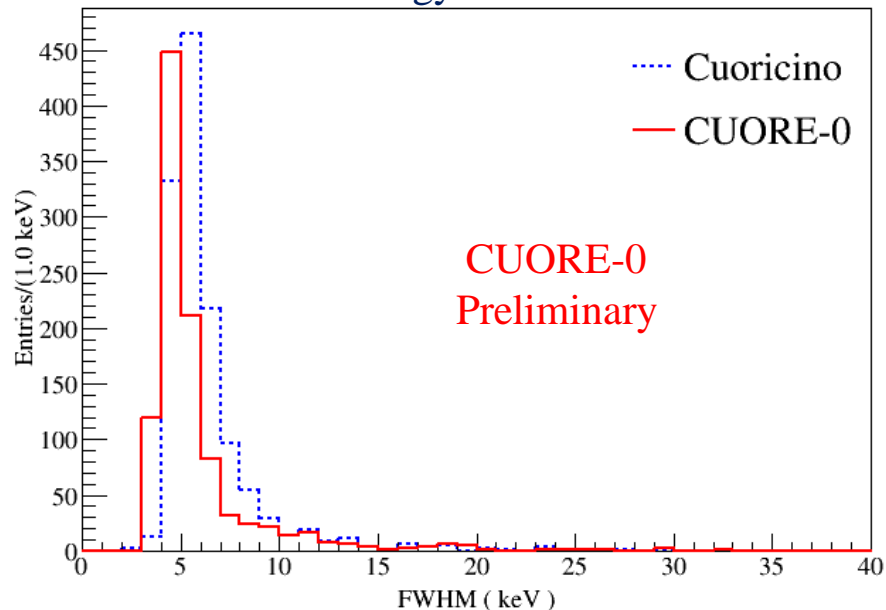


CUORE-0 – Calibration energy resolution

Total fit on the 2615 keV line



Distribution of energy resolution @ 2615 keV

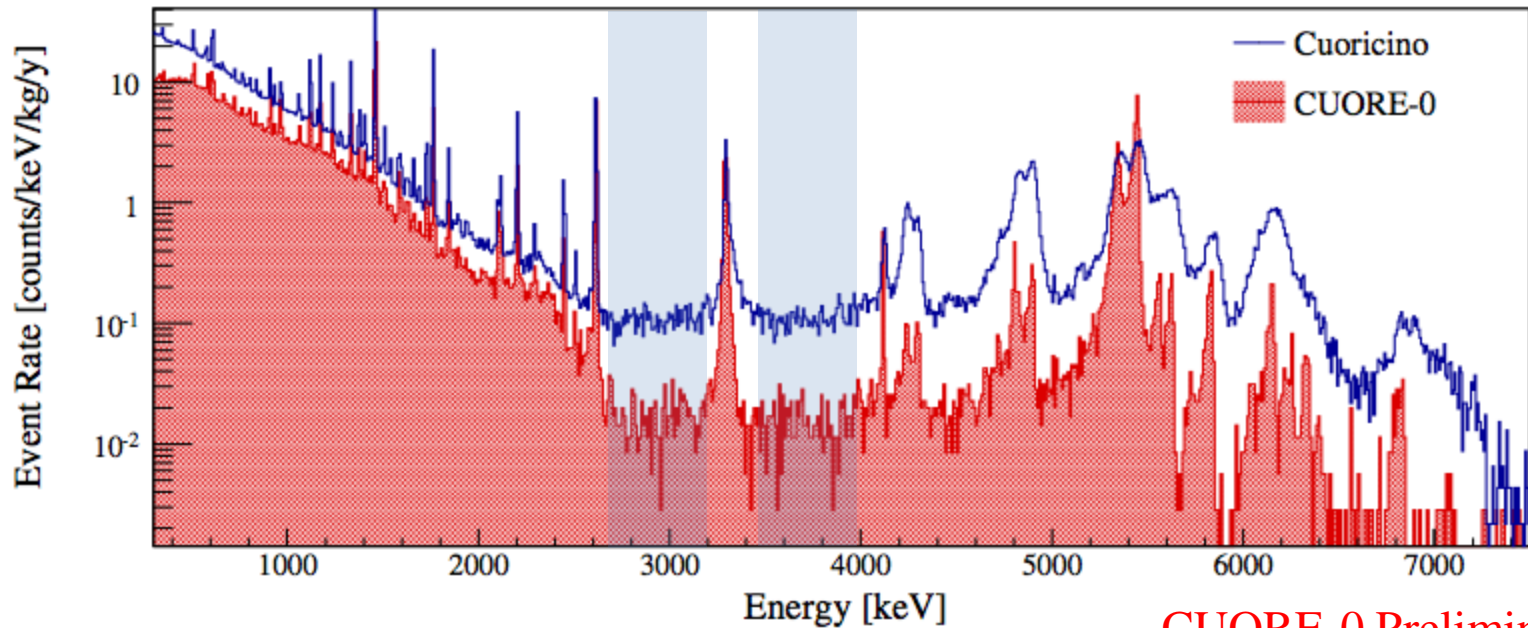


	Exposure-weighted harmonic mean FWHM	RMS of FWHM
Cuoricino	5.8 keV	2.1 keV
CUORE-0	4.9 keV	2.9 keV

The 5 keV resolution goal for CUORE has been reached

CUORE-0 – Background

Comparison of the total background spectrum in CUORE-0 and Cuoricino



CUORE-0 Preliminary

- a factor **~7 reduction** in the α continuum region
- γ 's from U chain reduced with radon control
- residual γ bkg in ROI from Th cryostat contaminations (negligible in CUORE)

	2.7-3.9 MeV [c/keV/kg/y]	efficiency [%]
Cuoricino	0.110 ± 0.001	83 ± 1
CUORE-0	0.016 ± 0.001	81 ± 1

The α background reduction goal for CUORE has been reached

Neutrino-less double beta decay results from CUORE-0

After selection cuts: 233 events in ROI [2470-2570 keV].

Best value fit of the $0\nu\beta\beta$ decay rate: $\Gamma_{0\nu} = 0.01 \pm 0.12(\text{stat.}) \pm 0.01(\text{syst.}) \times 10^{-24} \text{ yr}^{-1}$

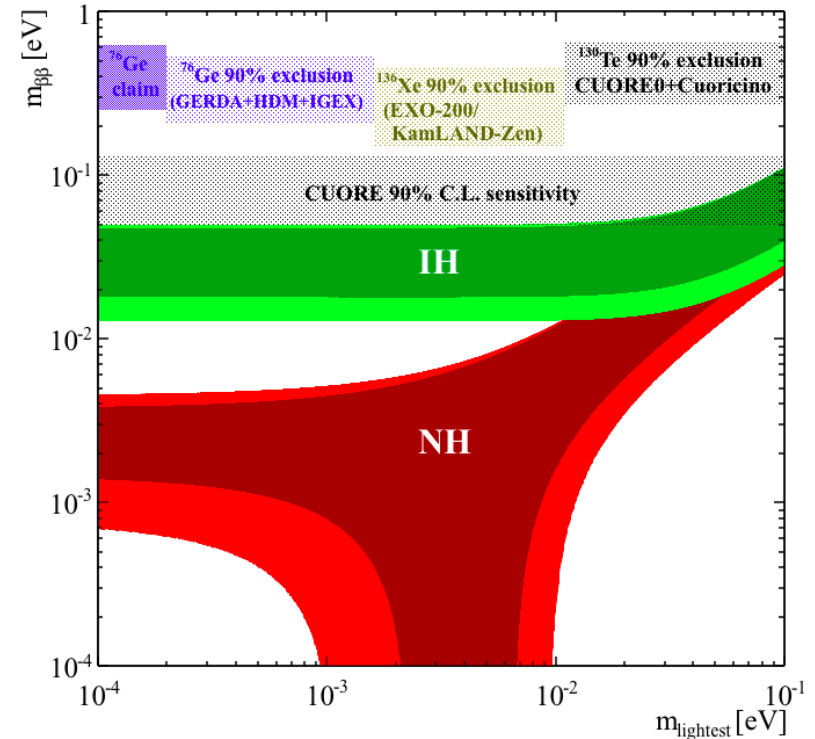
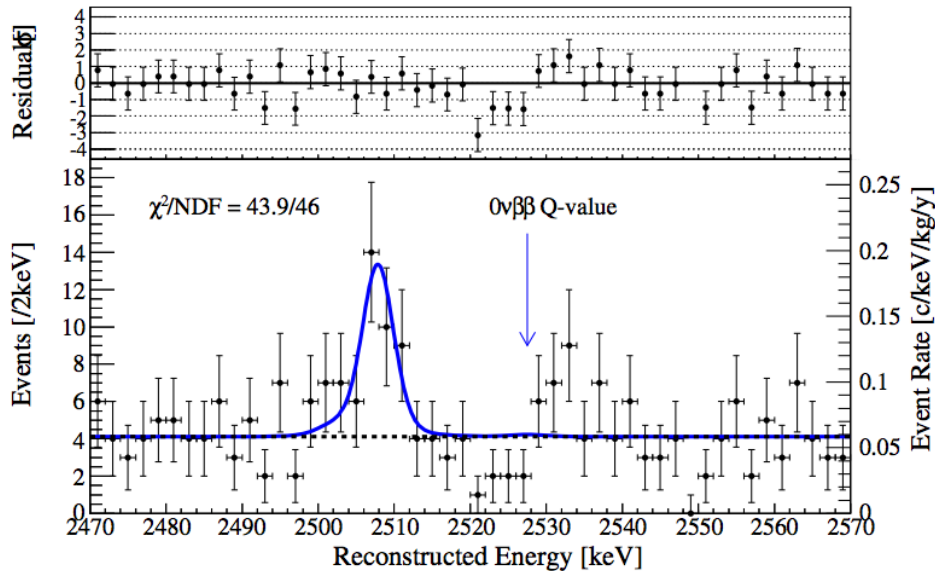
Background index in ROI: $0.058 \pm 0.004(\text{stat.}) \pm 0.002(\text{syst.}) \text{ c/keV/kg/y}$

CUORE-0 90% C.L. lower limit from profile likelihood:

$$T_{1/2}^{0\nu} > 2.7 \cdot 10^{24} \text{ yr}$$

CUORE-0 results combined with the existing 19.75 kg·yr of ^{130}Te exposure from Cuoricino

$$T_{1/2}^{0\nu} > 4.0 \cdot 10^{24} \text{ yr}$$



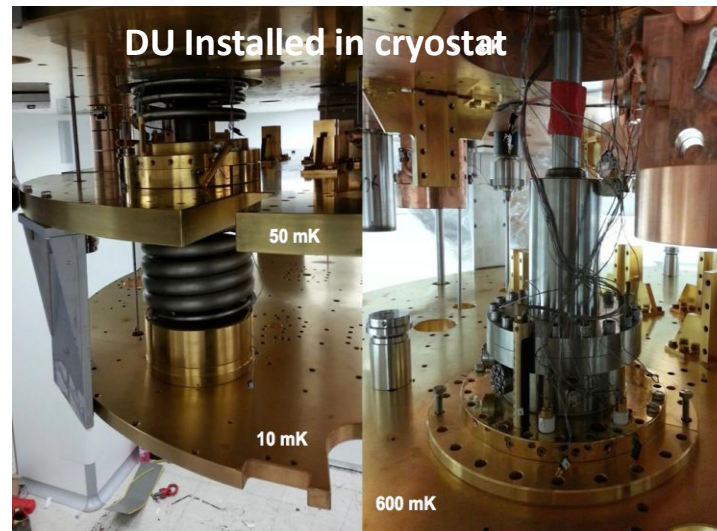
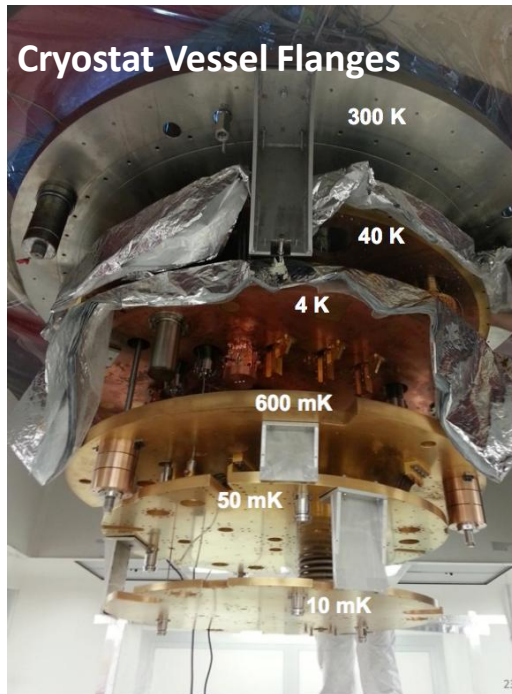
CUORE is just around the corner: detectors



All 19 CUORE towers have been completed and are ready to be installed

CUORE is just around the corner: cryostat

- Cryostat assembled, passed 4K (pulse tubes) commissioning tests
- **6 mK temperature reached during the commissioning runs** with the pulse tubes + Dilution Unit
- Final integration run (with all systems but the detectors) is ongoing



The CUORE experiment will start operation by end 2015

Conclusion

It has been a very special year for CUORE!

- ✓ We released the first CUORE-0 results, which are very encouraging in view of CUORE:
 - Characteristic energy resolution: 4.9 keV
 - α background 7 times smaller than CUORICINO
- ✓ CUORE-0 provides the best world limit on neutrino-less double beta decay in ^{130}Te
 - $T_{0\nu} > 2.7 \times 10^{24}$ y (standalone)
 - $T_{0\nu} > 4.0 \times 10^{24}$ y (combined CUORE-0+CUORICINO)
- ✓ The construction of CUORE is close to the end:
 - All 19 detector towers built and ready to be installed
 - Cryostat reached 6 mK in commissioning runs
 - Full integration runs are ongoing
- ✓ Start of the operation of CUORE is expected by the end of the year