



CUORE-0

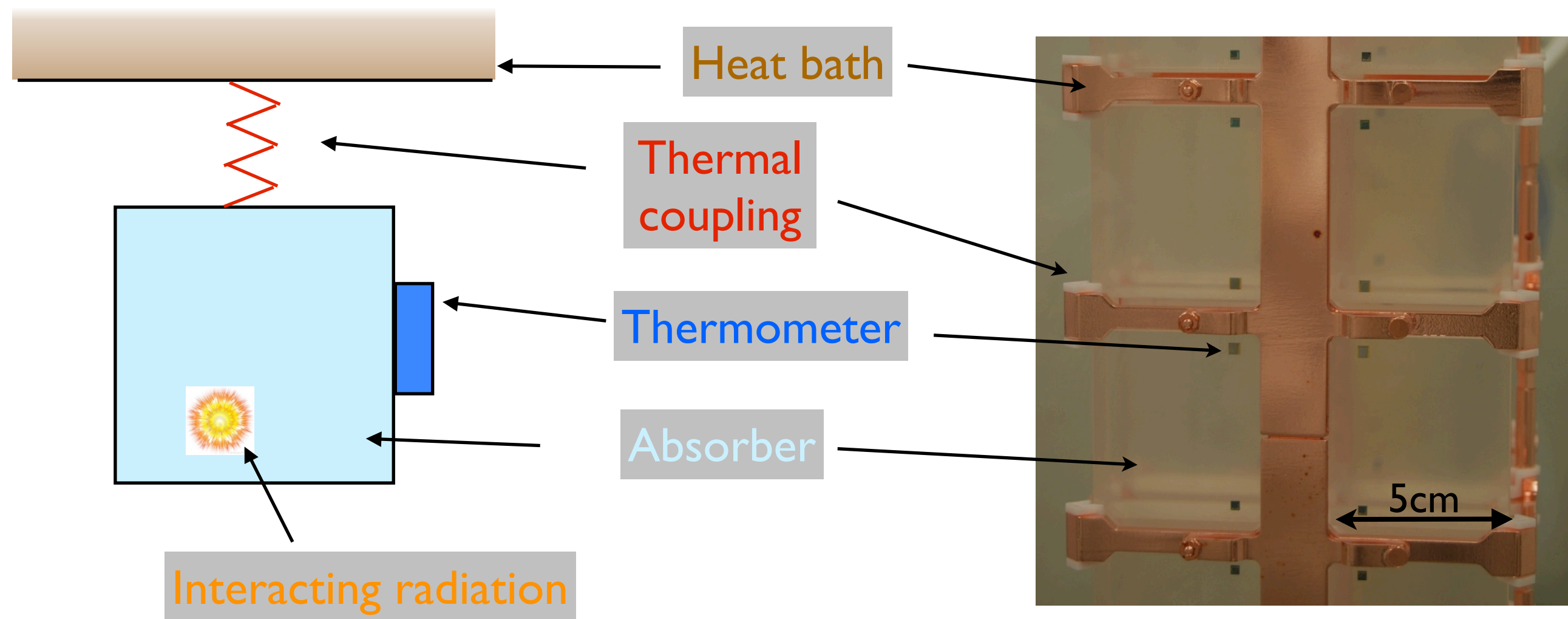
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October 29th, 2013
LNGS Scientific Committee

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- The lesson from Cuoricino
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 - First results on the background index

$0\nu\beta\beta$ search with TeO_2 bolometers

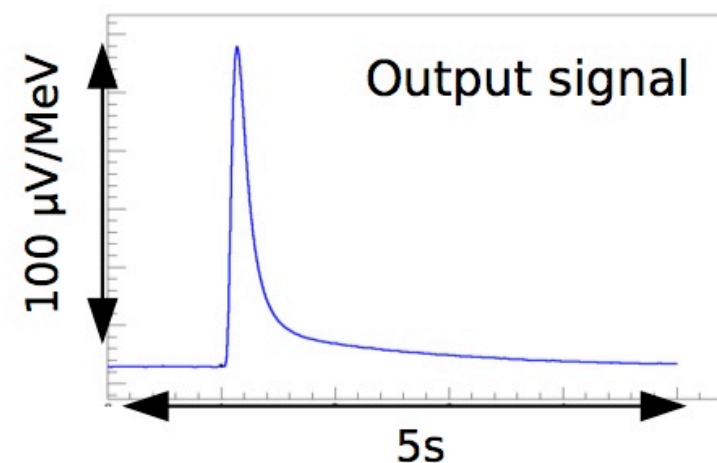


Absorber

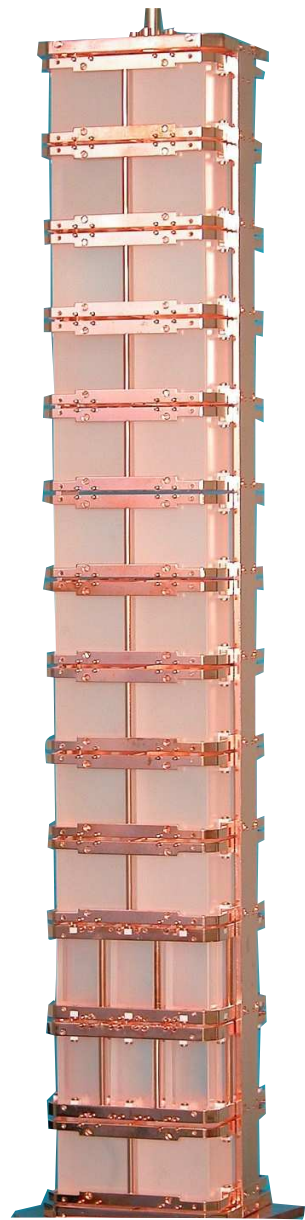
- Dimension: $5 \times 5 \times 5 \text{ cm}^3$
- $M \sim 0.75 \text{ kg}$
- $C \sim 10^{-9} \text{ J/K}$
- $\Delta T/\Delta E \sim 100 \text{ } \mu\text{K/MeV}$

Sensor

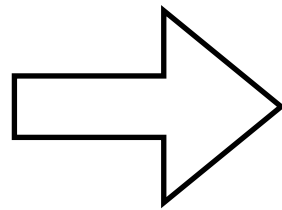
- $R = R_0 \exp[(T_0/T)^{1/2}]$
- $R \sim 100 \text{ M}\Omega$
- $\Delta R/\Delta E \sim 3 \text{ M}\Omega/\text{MeV}$



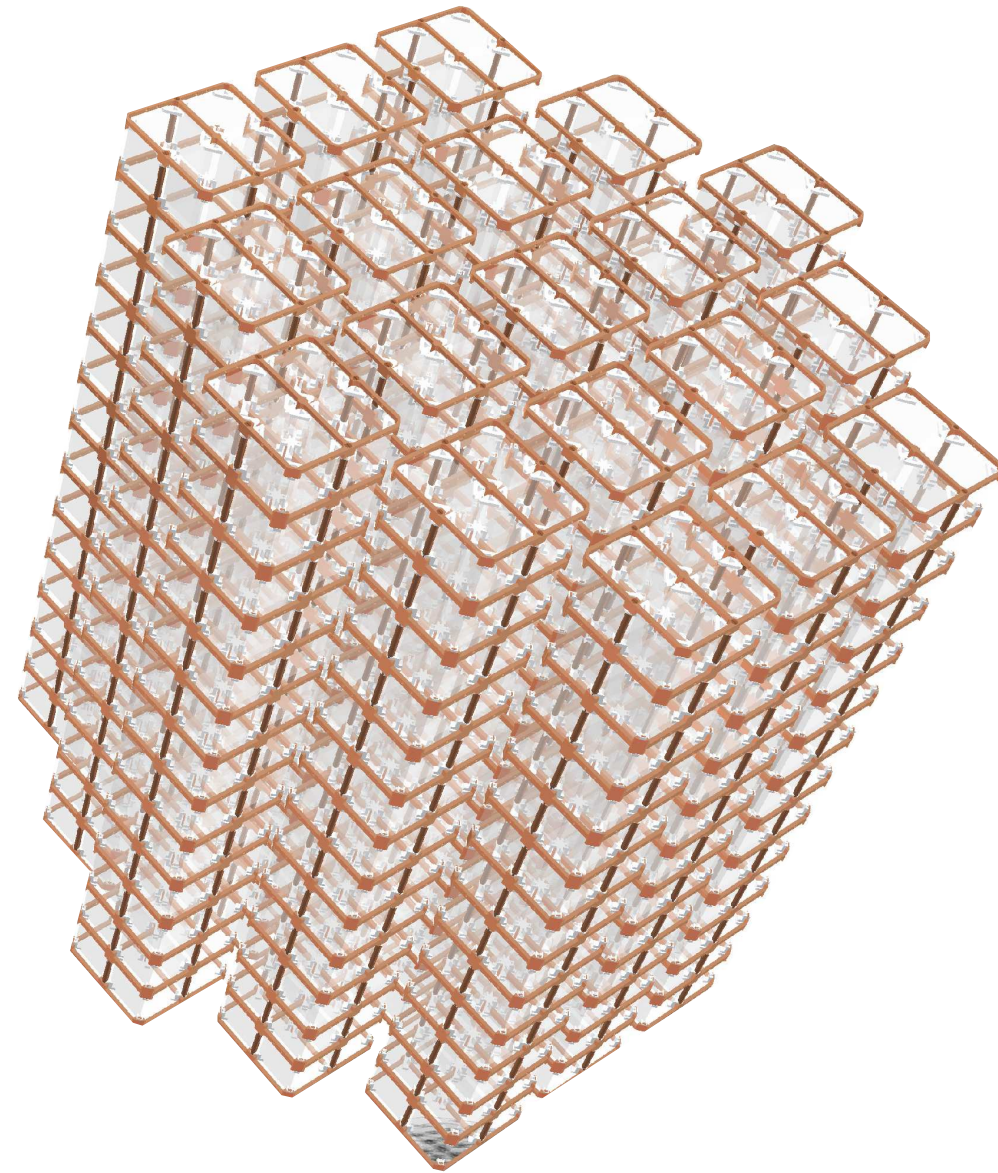
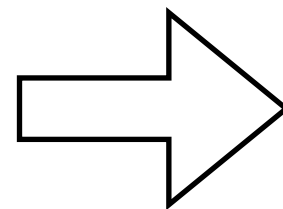
From Cuoricino to CUORE



Cuoricino
2003-2008
~11kg ^{130}Te



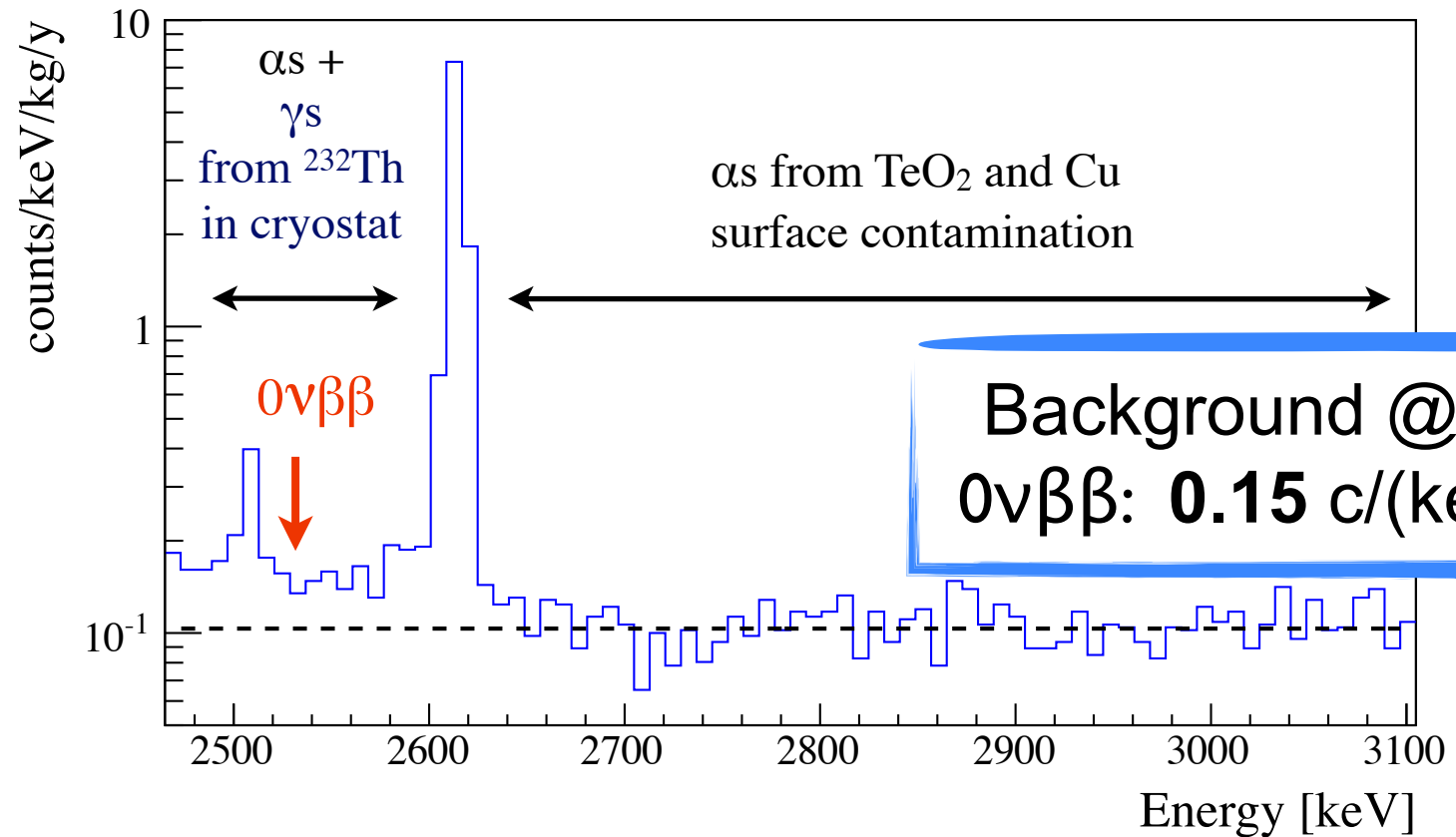
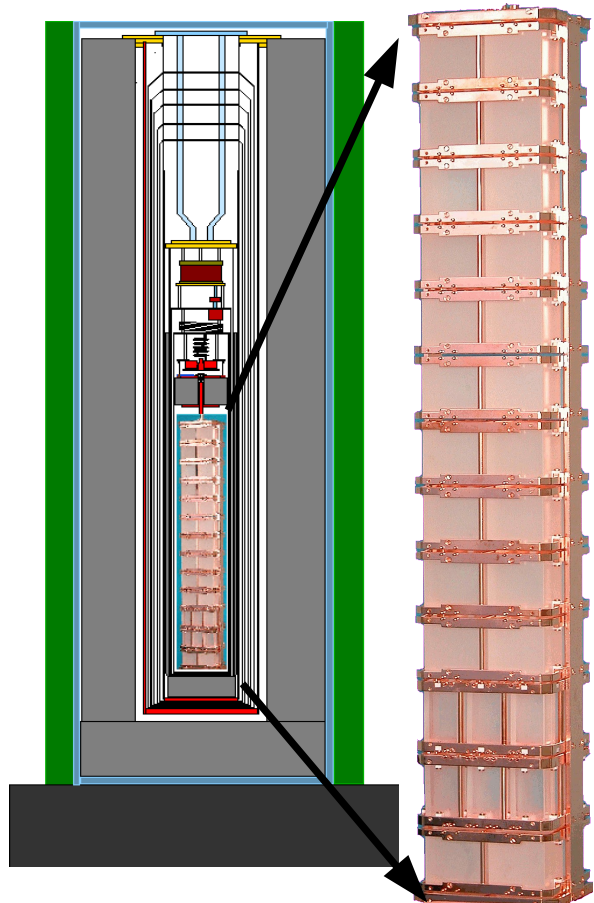
CUORE-0
2013-...
~11kg ^{130}Te



CUORE
2015-2019
~200kg ^{130}Te

The lesson from Cuoricino

62 TeO₂ crystals
TeO₂: 40.7 kg

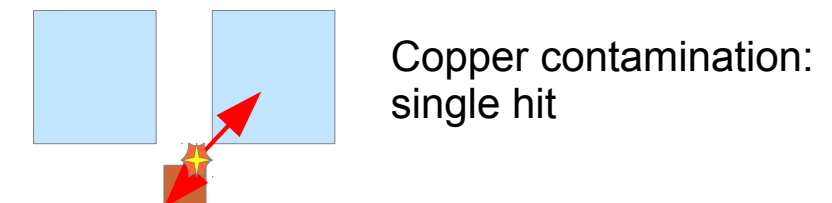
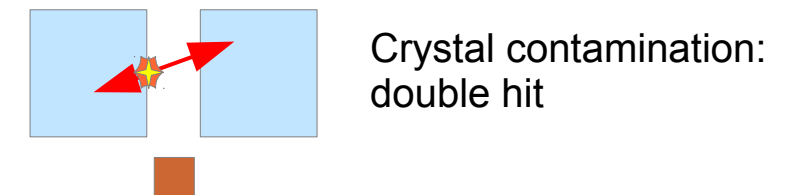


Main background contributions at $Q_{\beta\beta}$:

✓ ²³²Th contaminations in cryostat shield: (30±10%)

✓ Degraded **alphas** from crystal surfaces (10±5%)

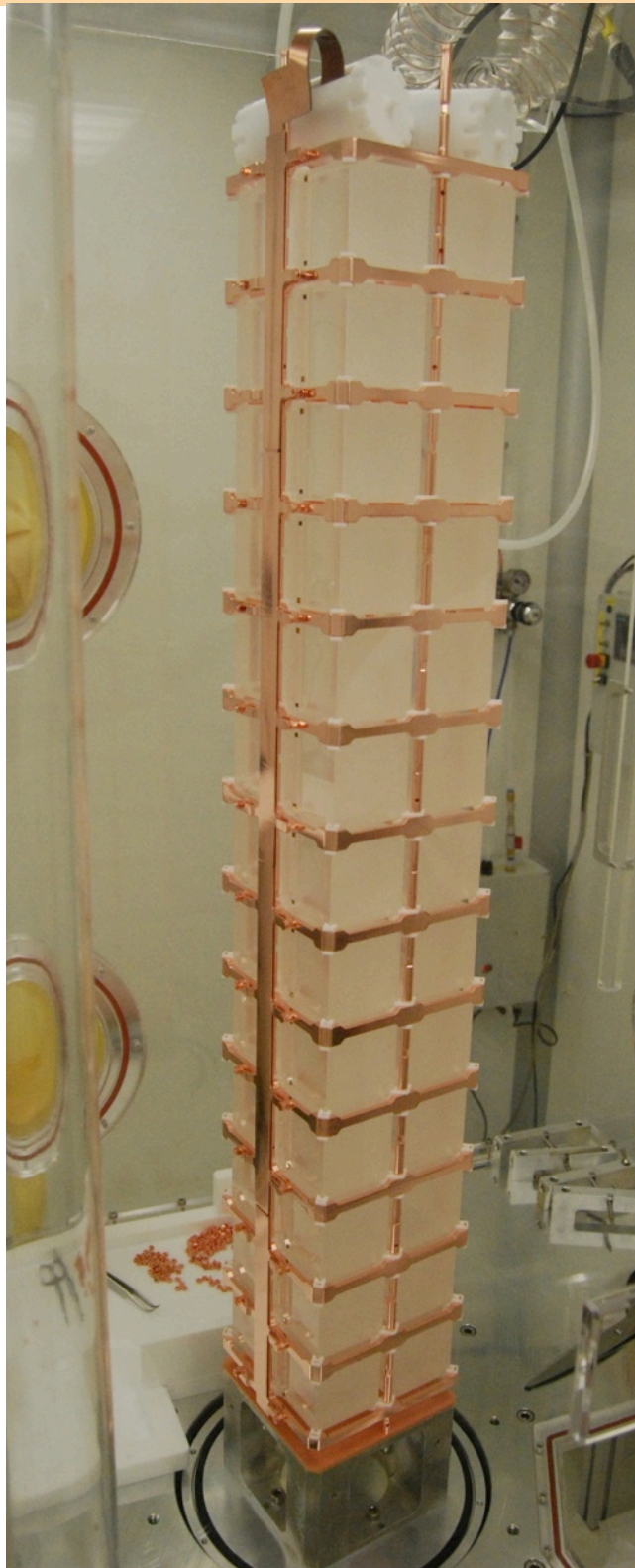
✓ Degraded **alphas** from Cu holders surfaces (50±20%)



$$T_{1/2} > 2.8 \cdot 10^{24} \text{ y}$$

$$m_{\beta\beta} < 0.3 \div 0.7 \text{ eV}$$

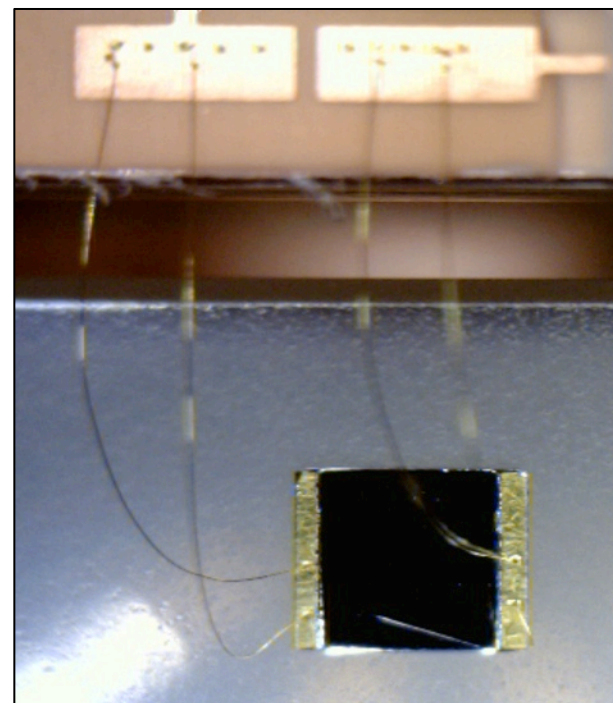
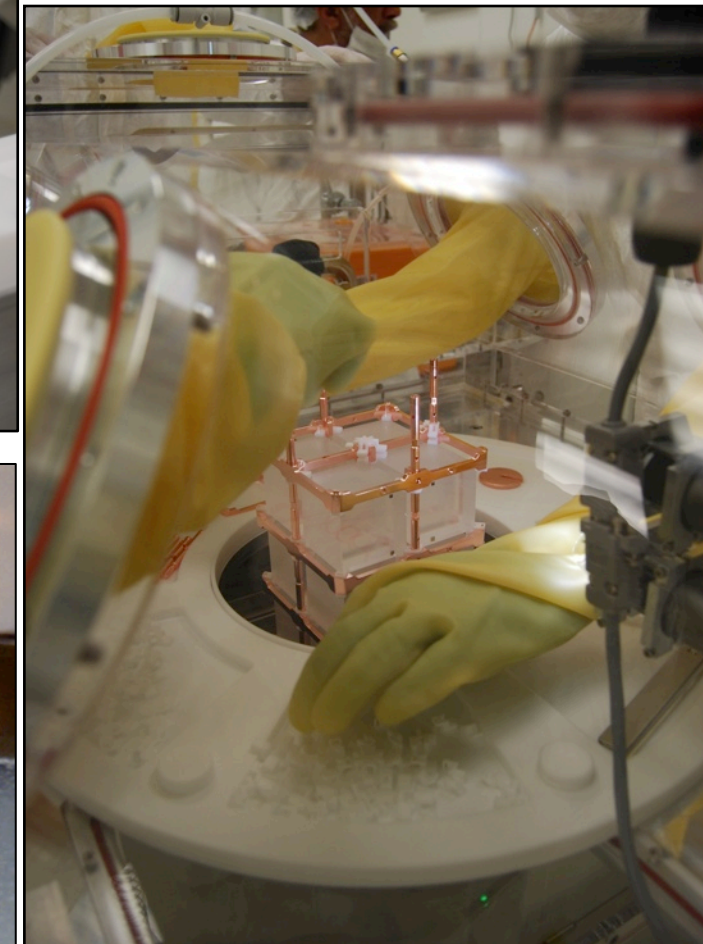
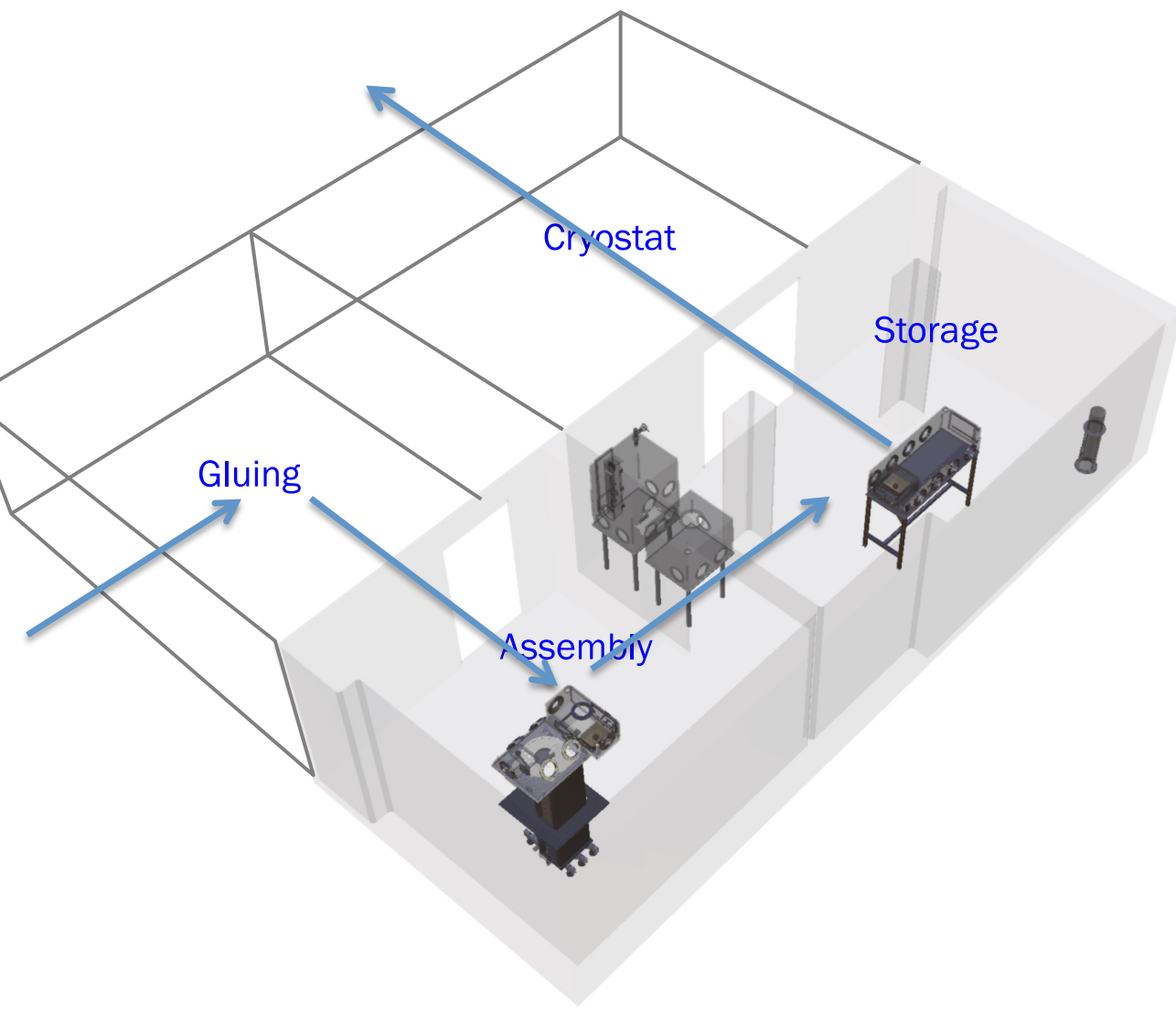
CUORE-0



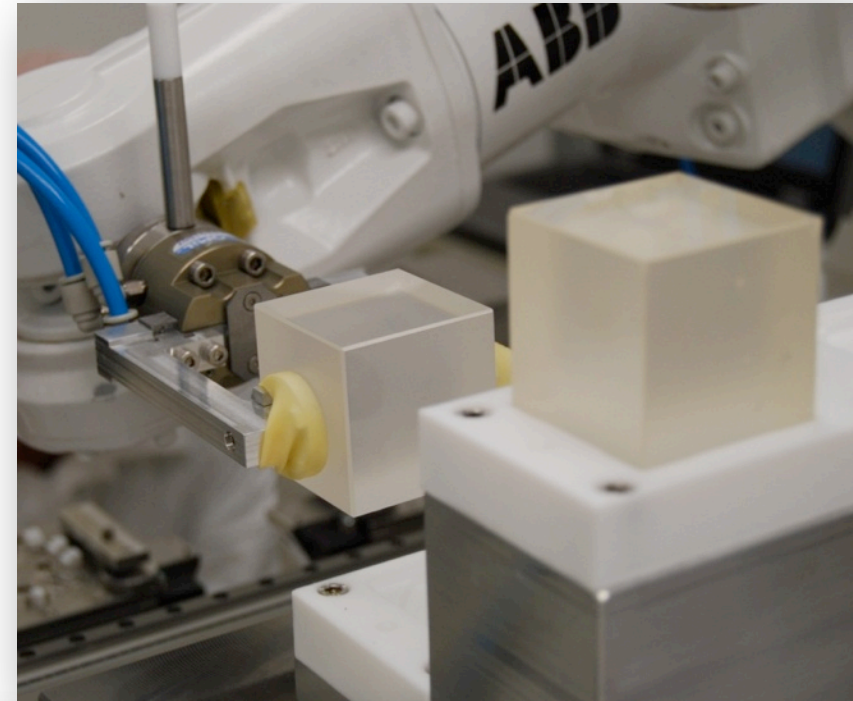
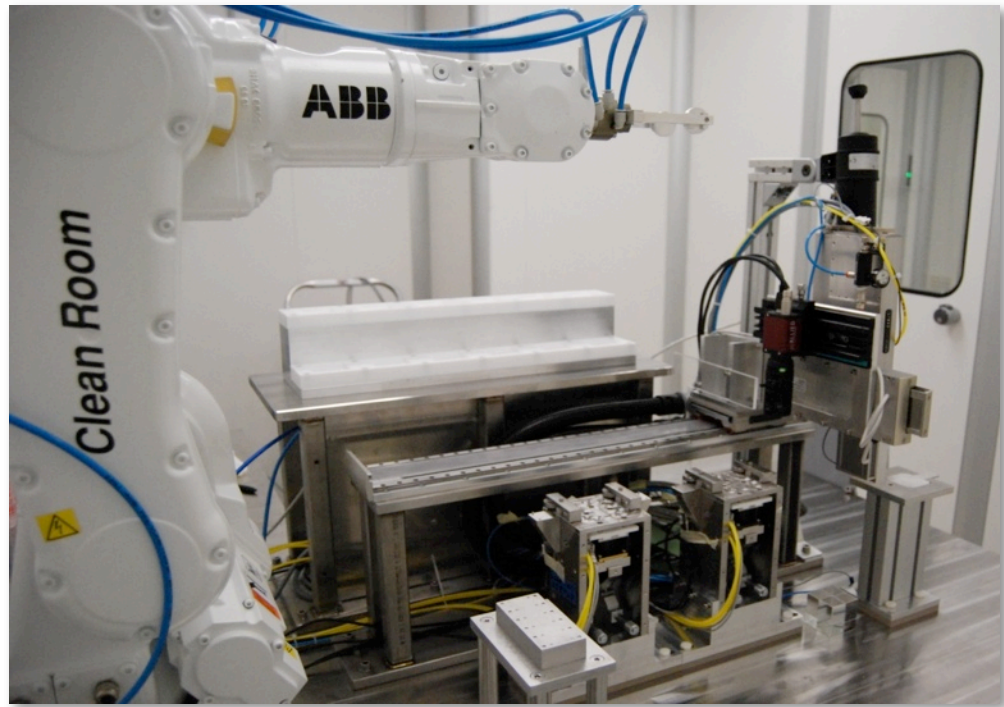
- CUORE-0 is a single CUORE tower
- **Goal:** test the new cleaning and assembly procedures
 - 52 x 750g TeO₂ bolometers
 - 39kg of TeO₂
 - 11kg of ¹³⁰Te
 - 13 floors of 4 crystals each
- It is operating in the same cryostat as Cuoricino
- The γ background coming from cryostat shield is the same. **CUORE-0 is a test of the α background reduction**

CUORE-0 construction

CUORE-0 assembly was performed in the new CUORE clean room, testing and debugging all procedures that will be adopted in the CUORE construction



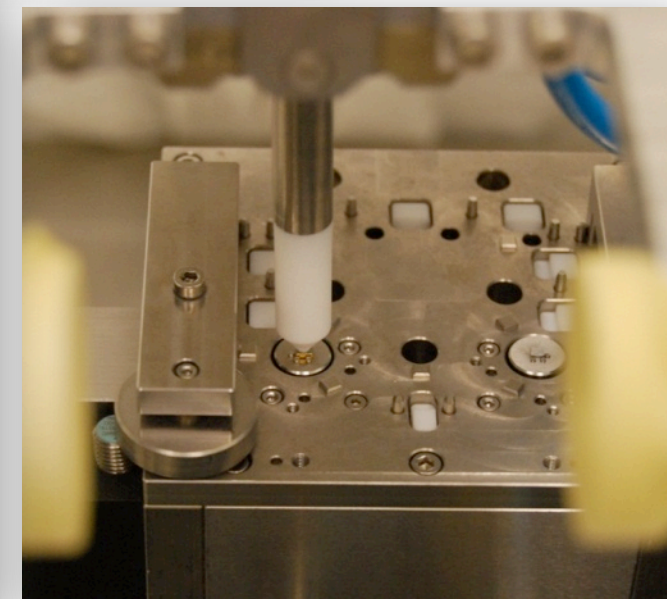
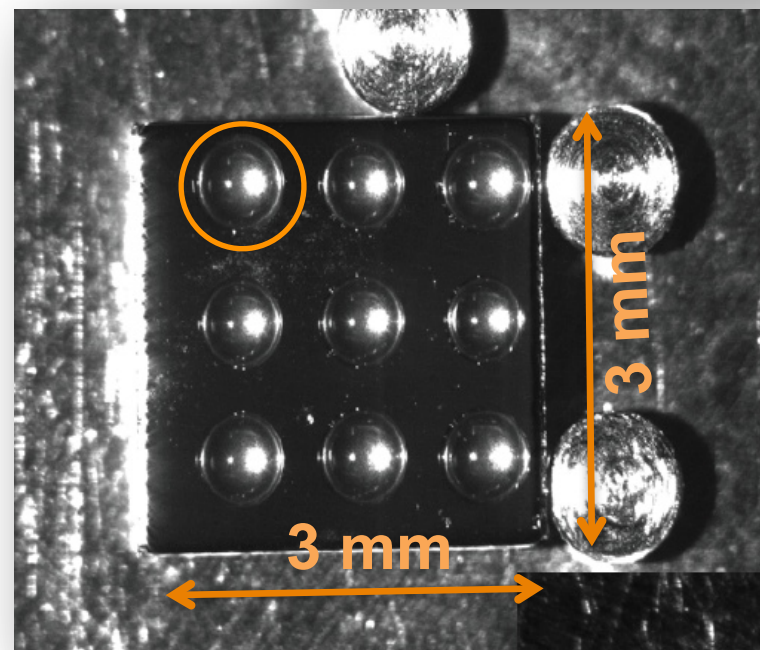
CUORE-0: sensors coupling



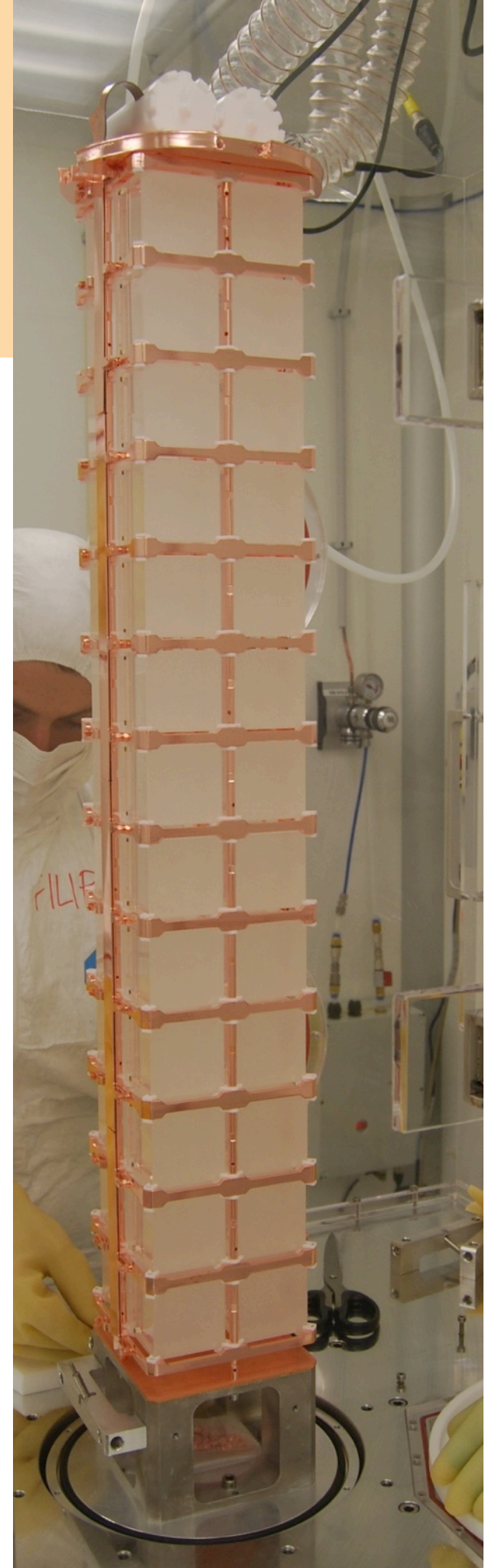
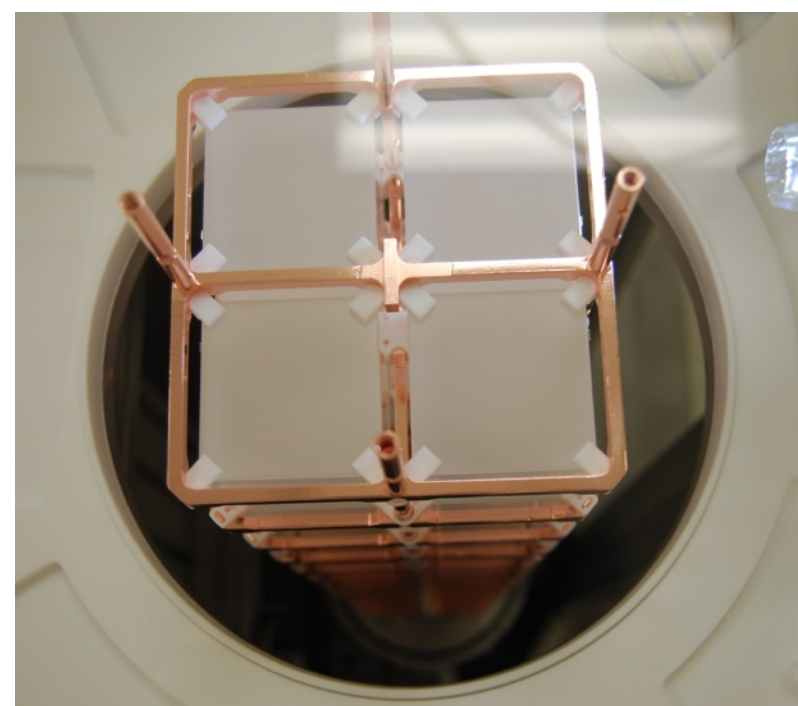
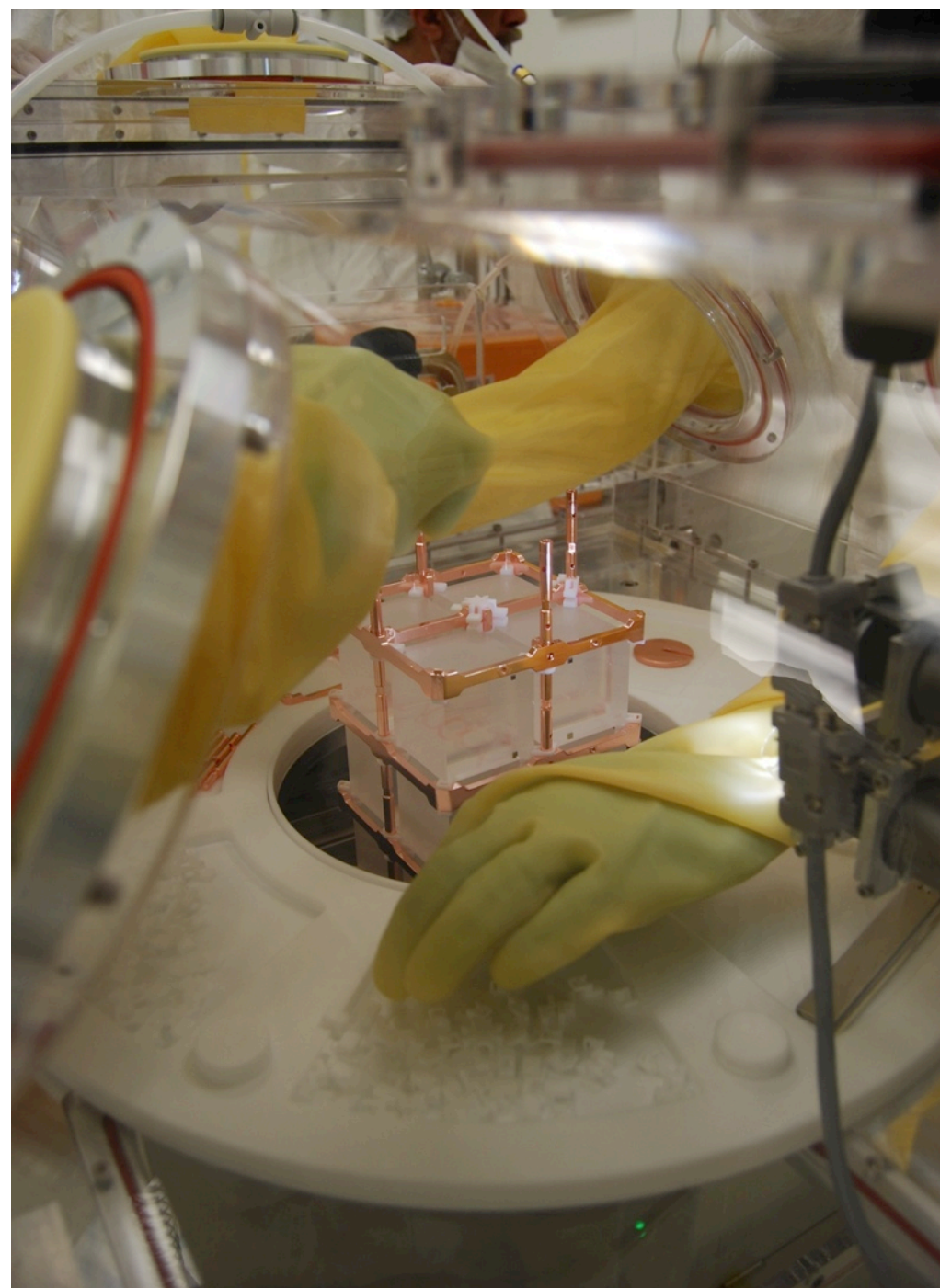
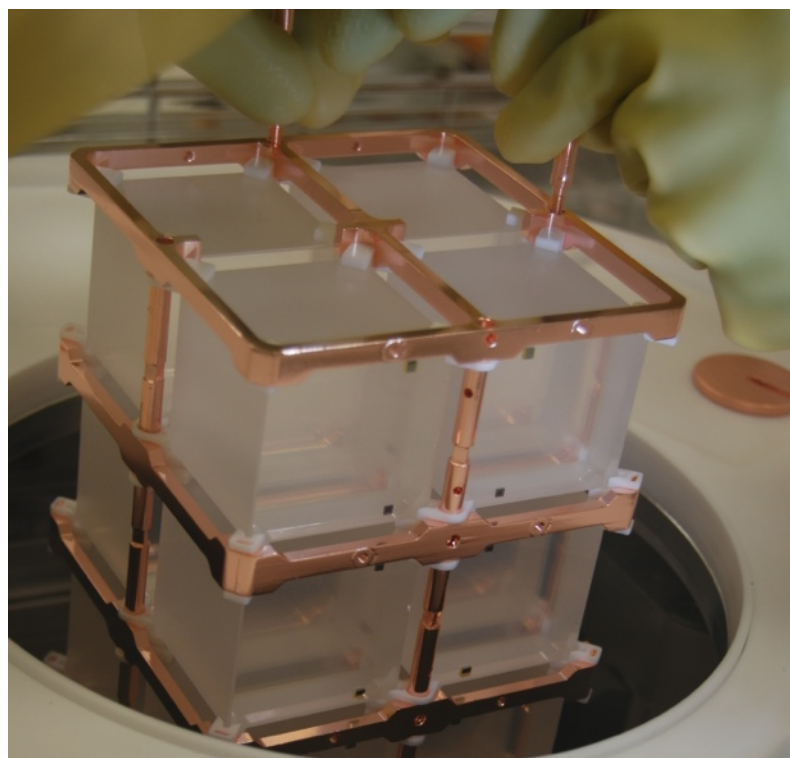
The detector performances (e.g. energy resolution) are driven by the sensor-to-crystal coupling (**glue spots**).

Features:

- new semi-automatic system
- highly-reproducible
- minimize radioactive recontamination.



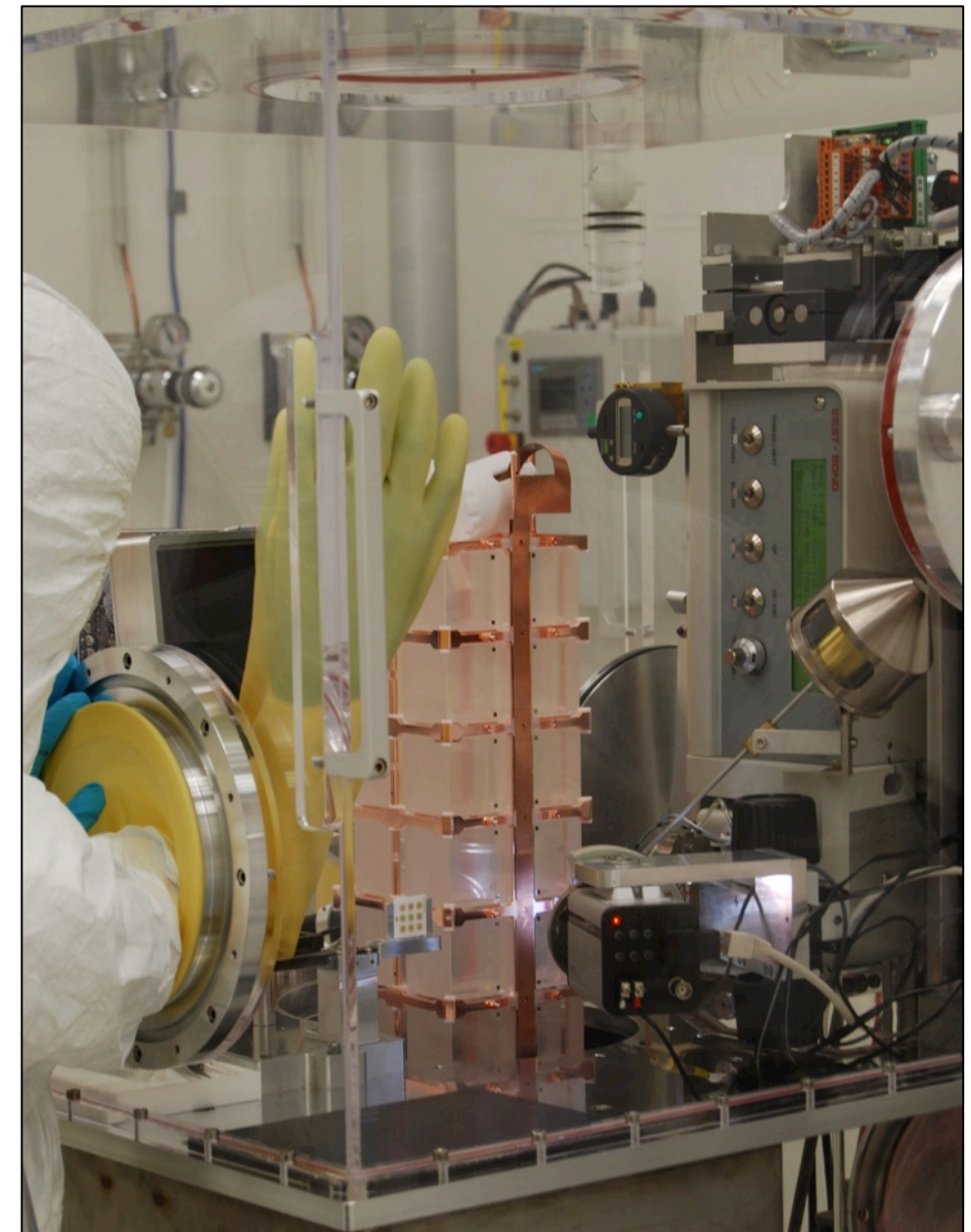
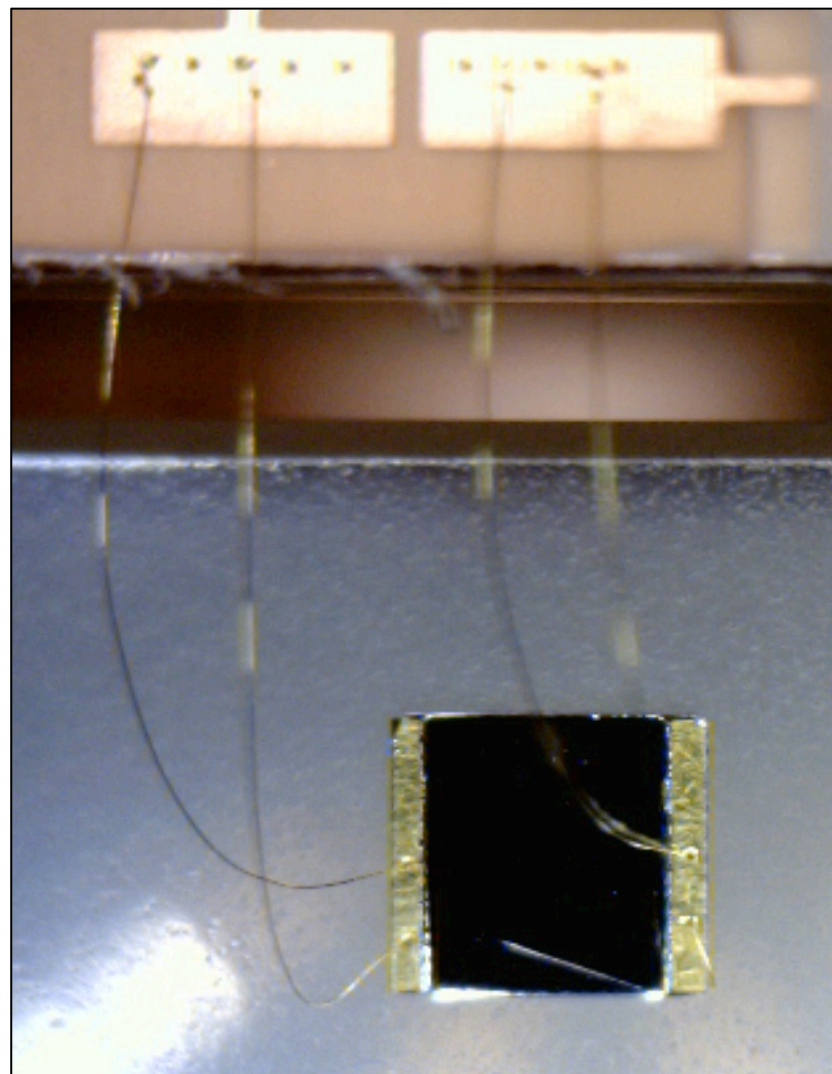
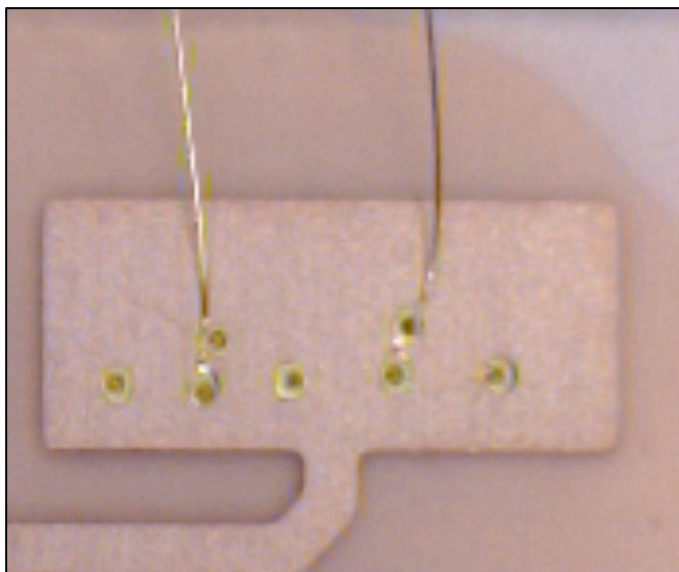
The tower assembly



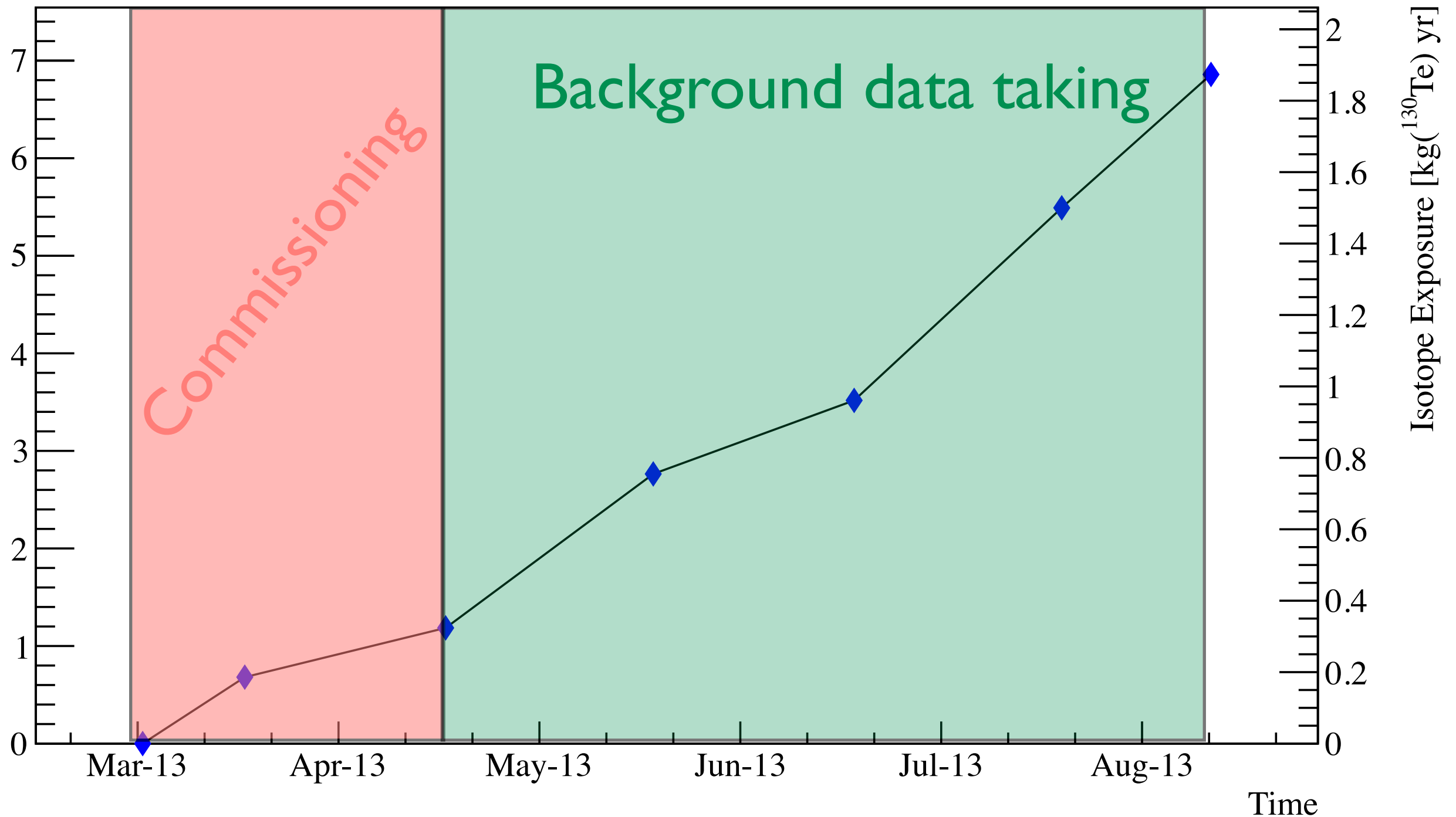
CUORE-0: wiring connection

The 3 steps of the bonding

1. Gold balls on the Cu pads
2. Wires bonding
3. Reinforcing the bonding



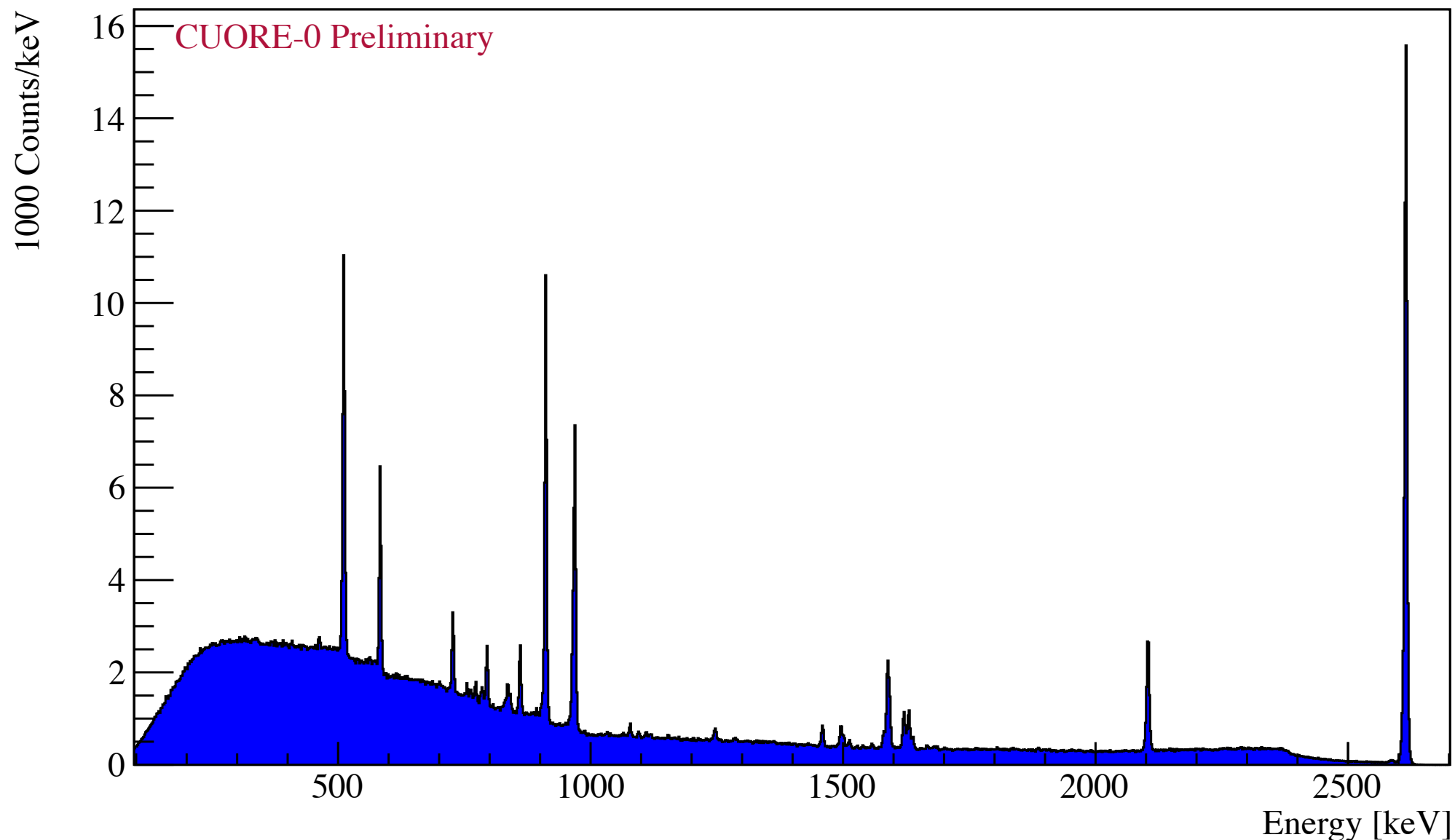
CUORE-0 exposure



CUORE0 energy calibration

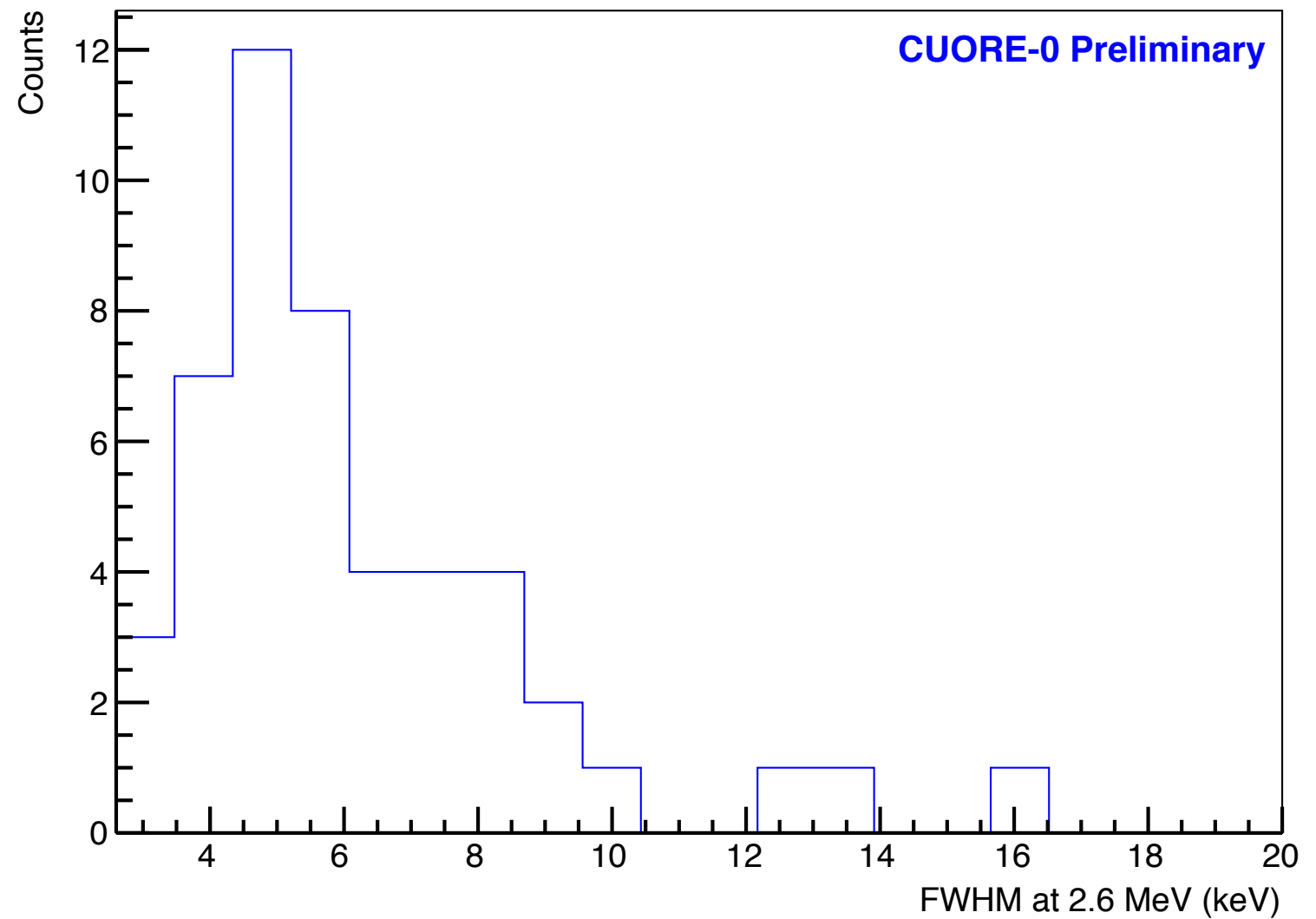
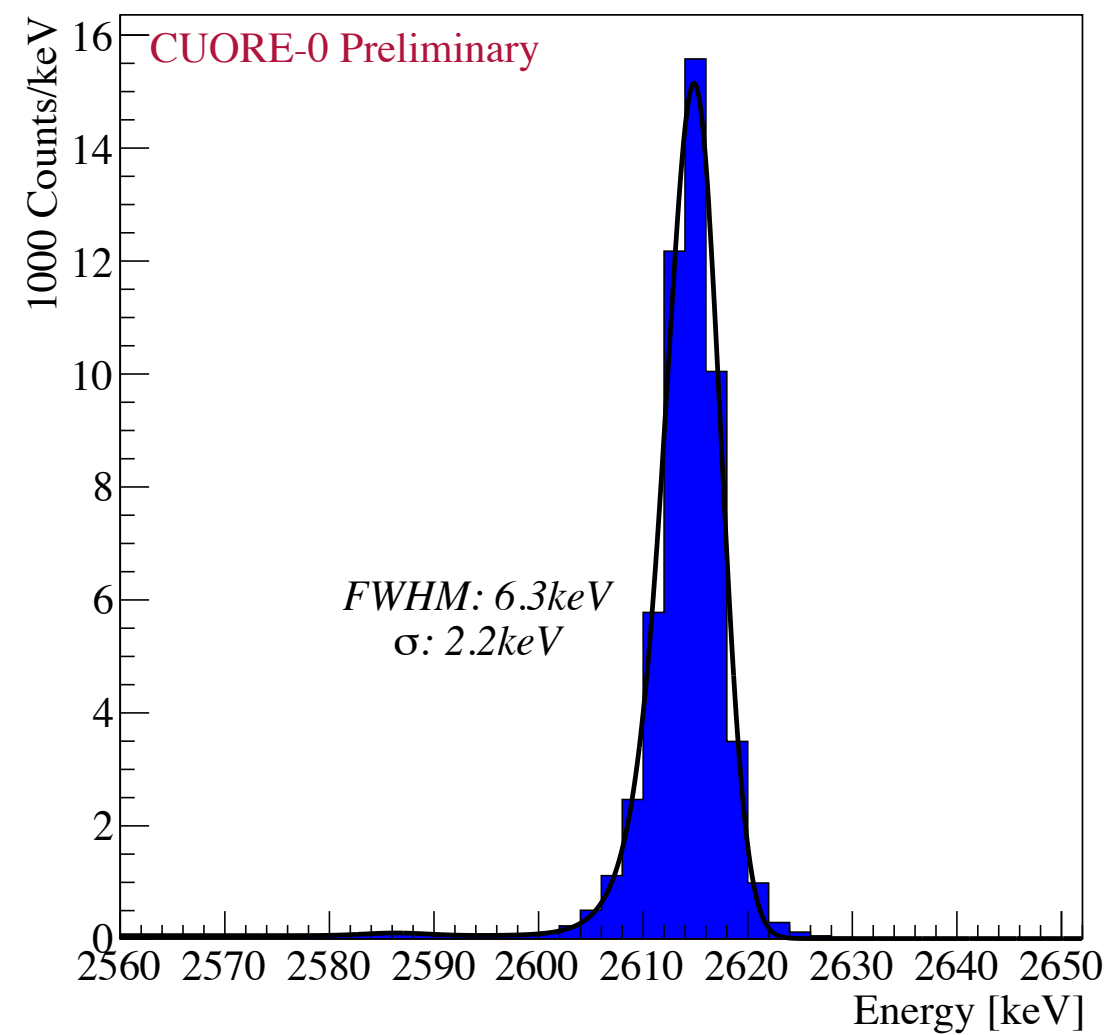
The calibration is performed with a ^{232}Th source placed outside the cryostat, inside the external lead shield

Sum of energy spectrum of 49 channels

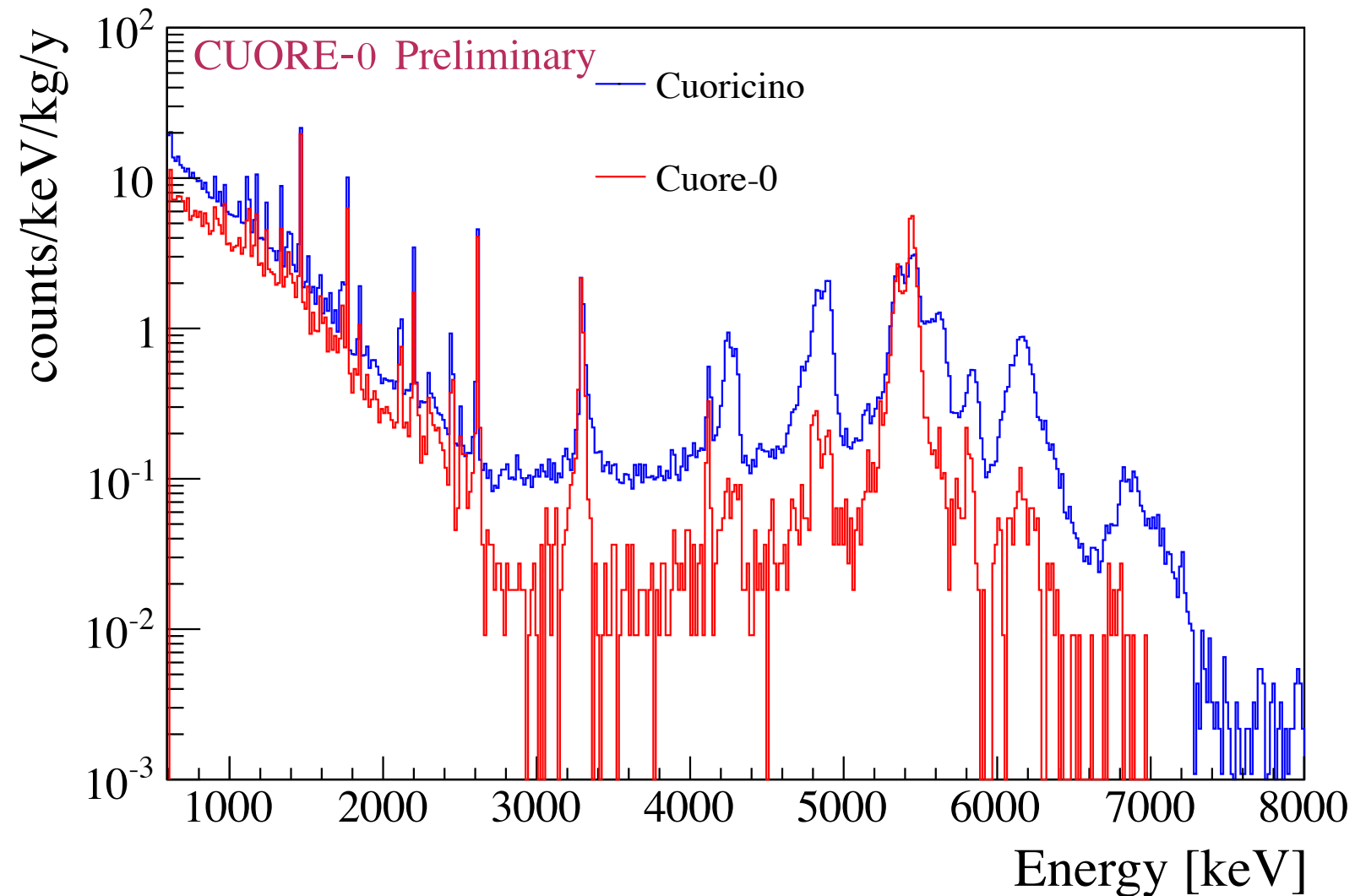


Energy resolution

Energy resolution evaluated at 2615 keV (^{208}Tl)

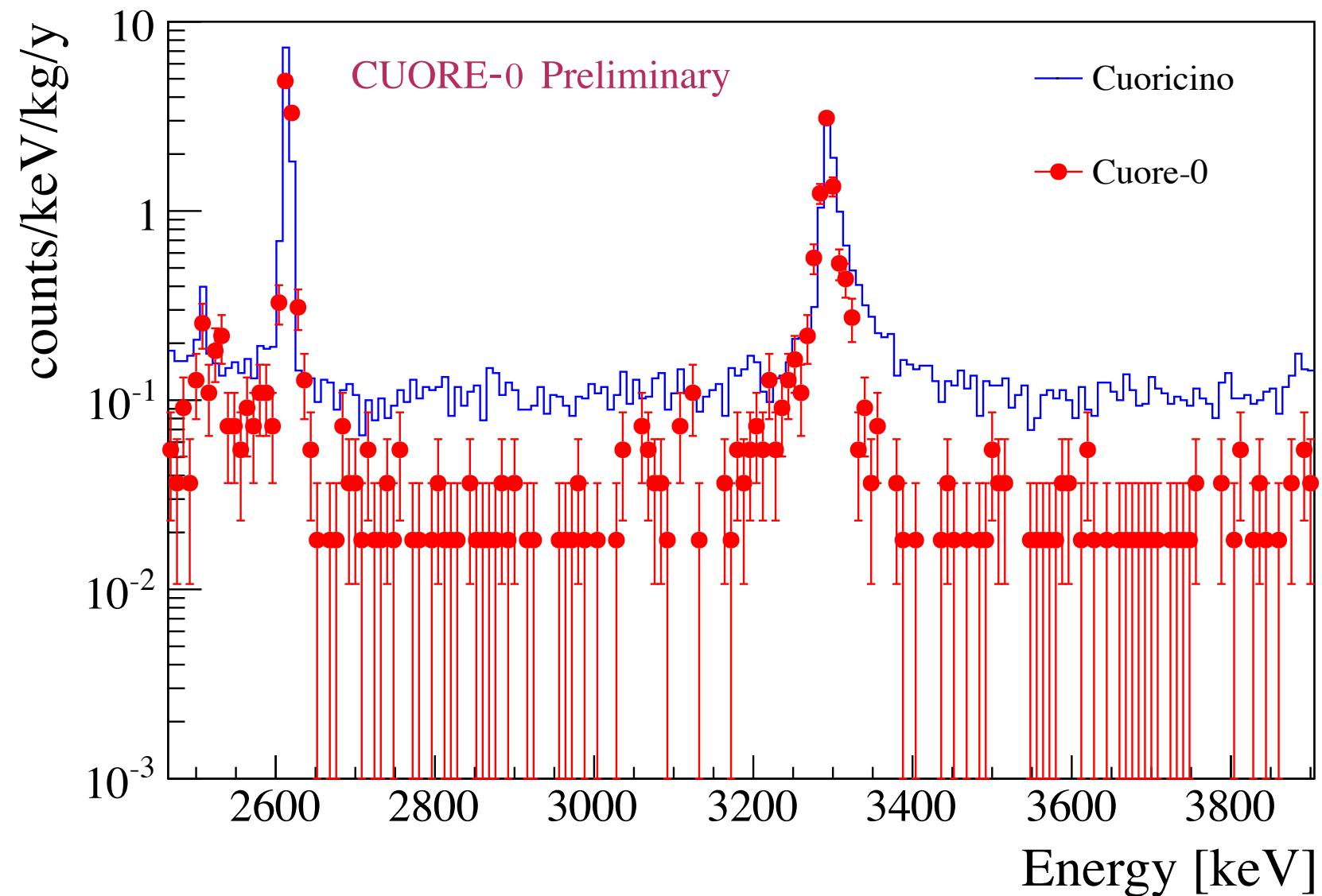


Cuoricino VS CUORE-0



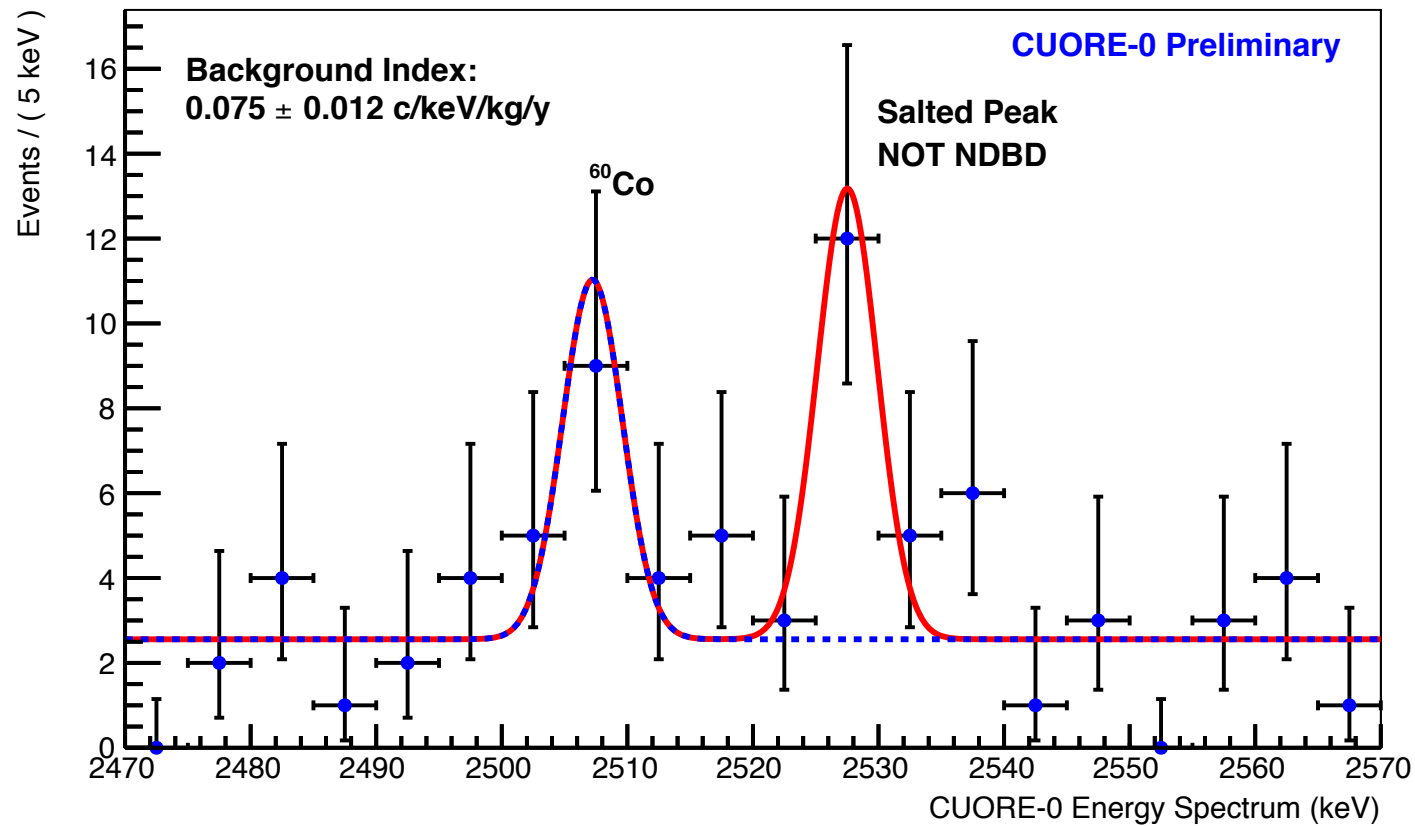
- ^{238}U and ^{232}Th α lines are reduced due to new surface cleaning protocols
- ^{232}Th γ lines are not reduced (the cryostat is the same)

α flat background

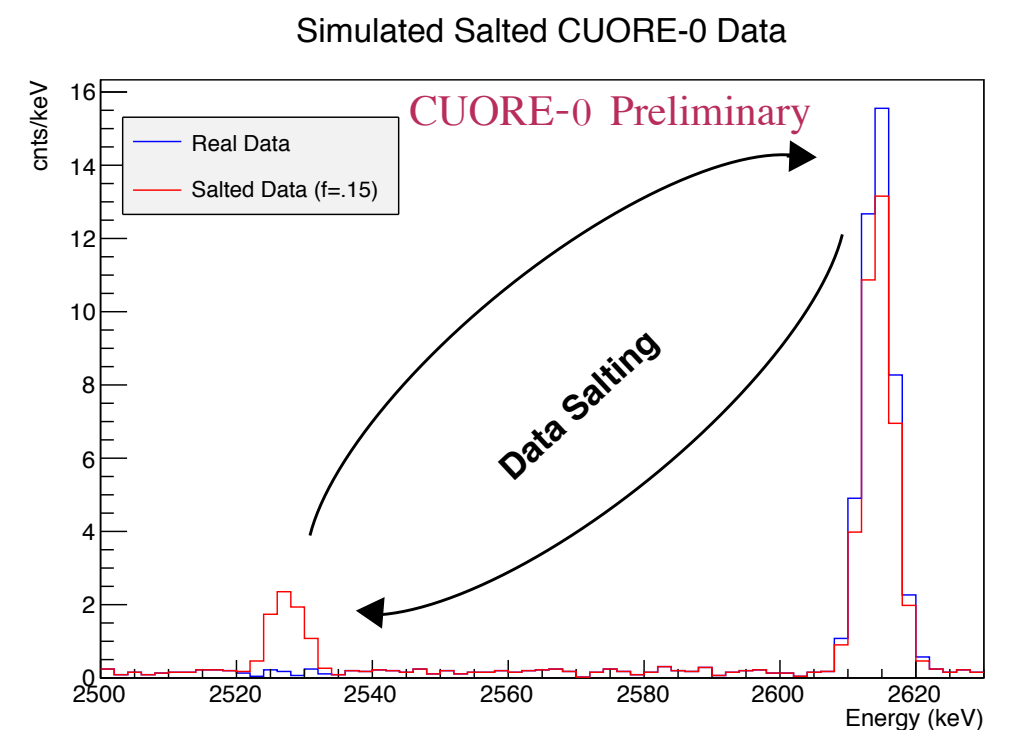


	Avg. flat bkg. [counts/keV/kg/y]		signal eff. [%] (detector+cuts)
	$0\nu\beta\beta$ region	2700-3900 keV	
CUORICINO	0.153 ± 0.006	0.110 ± 0.001	83 ± 1
CUORE-0	0.074 ± 0.012	0.019 ± 0.002	78 ± 1

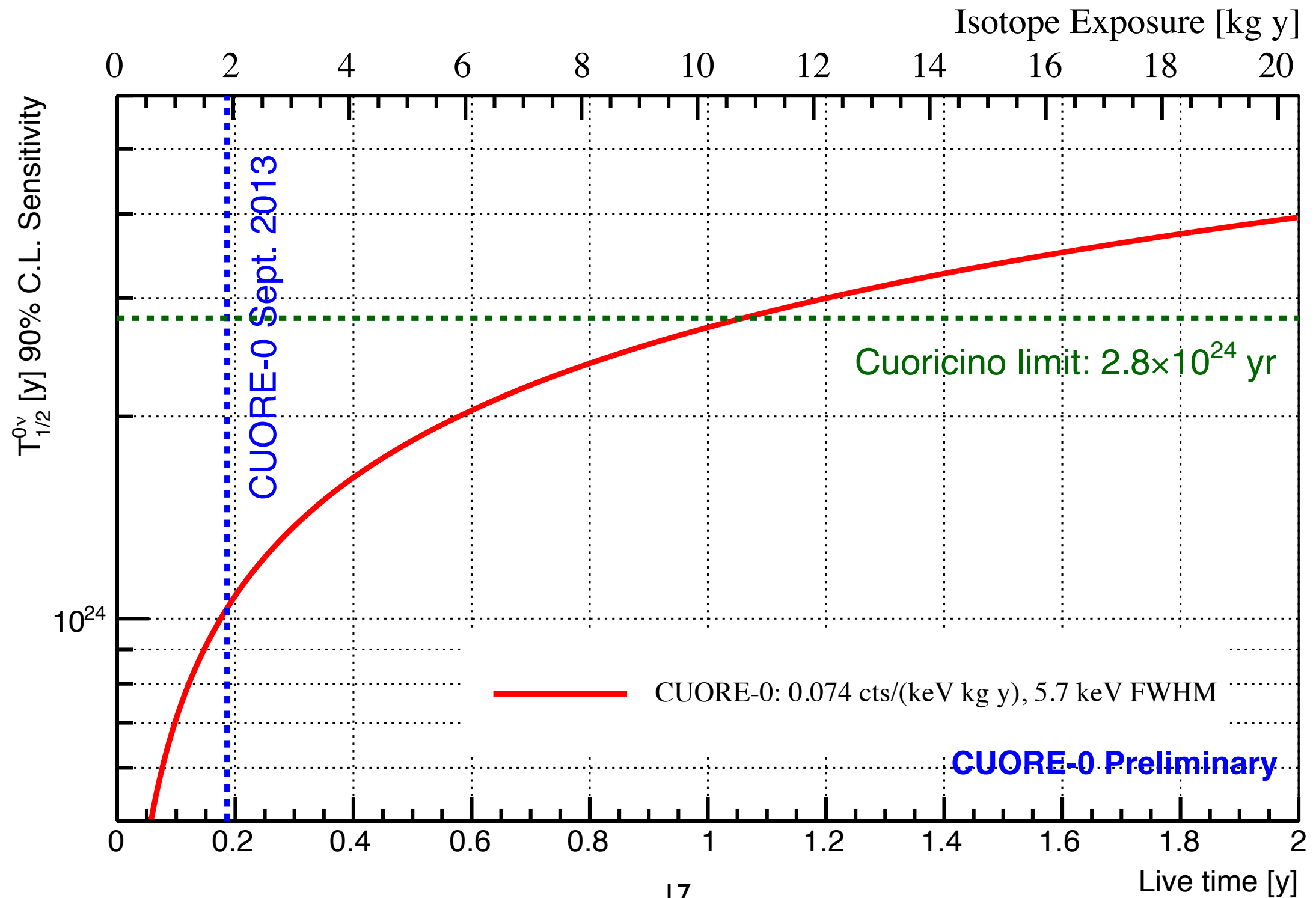
$0\nu\beta\beta$ ROI (blinded)



Exchange a small (and blinded) fraction of ^{208}Tl events (2.6 MeV) with events in the $0\nu\beta\beta$ region, producing a **fake peak**



CUORE-0 sensitivity



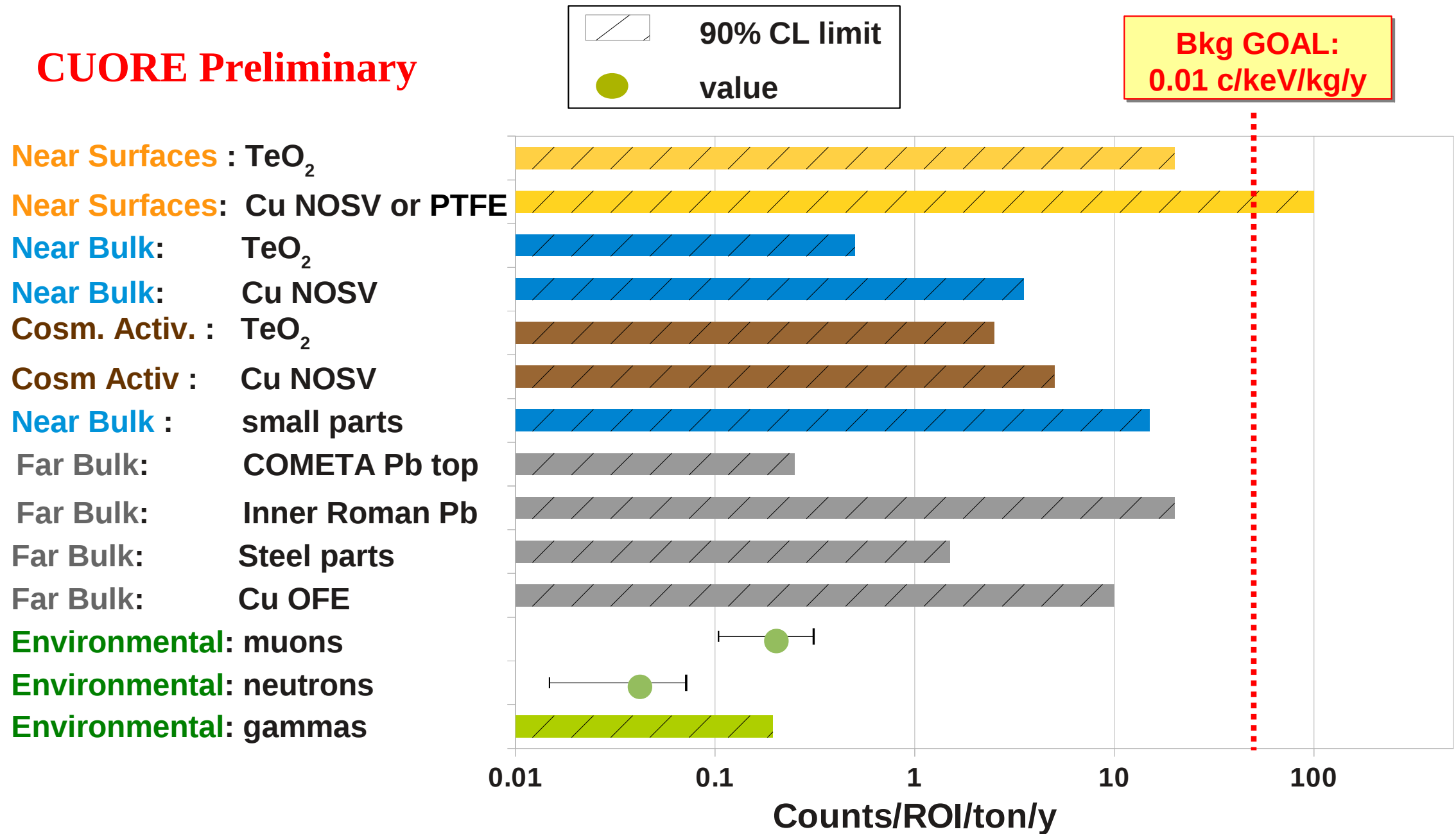
Conclusions

- After many problems related to the old Cuoricino cryostat (installed in HallA since 1989), the CUORE-0 detector is now in the data taking phase
- The preliminary information on the detector performance and background are promising:
 - **the background from surface contamination is x6 times smaller than Cuoricino**
- According to the performance, with a background of 0.074 ± 0.012 counts/keV/kg/y in the ROI, CUORE-0 will overtake the Cuoricino sensitivity in about one year of data taking.
- The detector is providing important information for CUORE:
 - the CUORE assembly and the cleaning techniques have been validated

Back-up

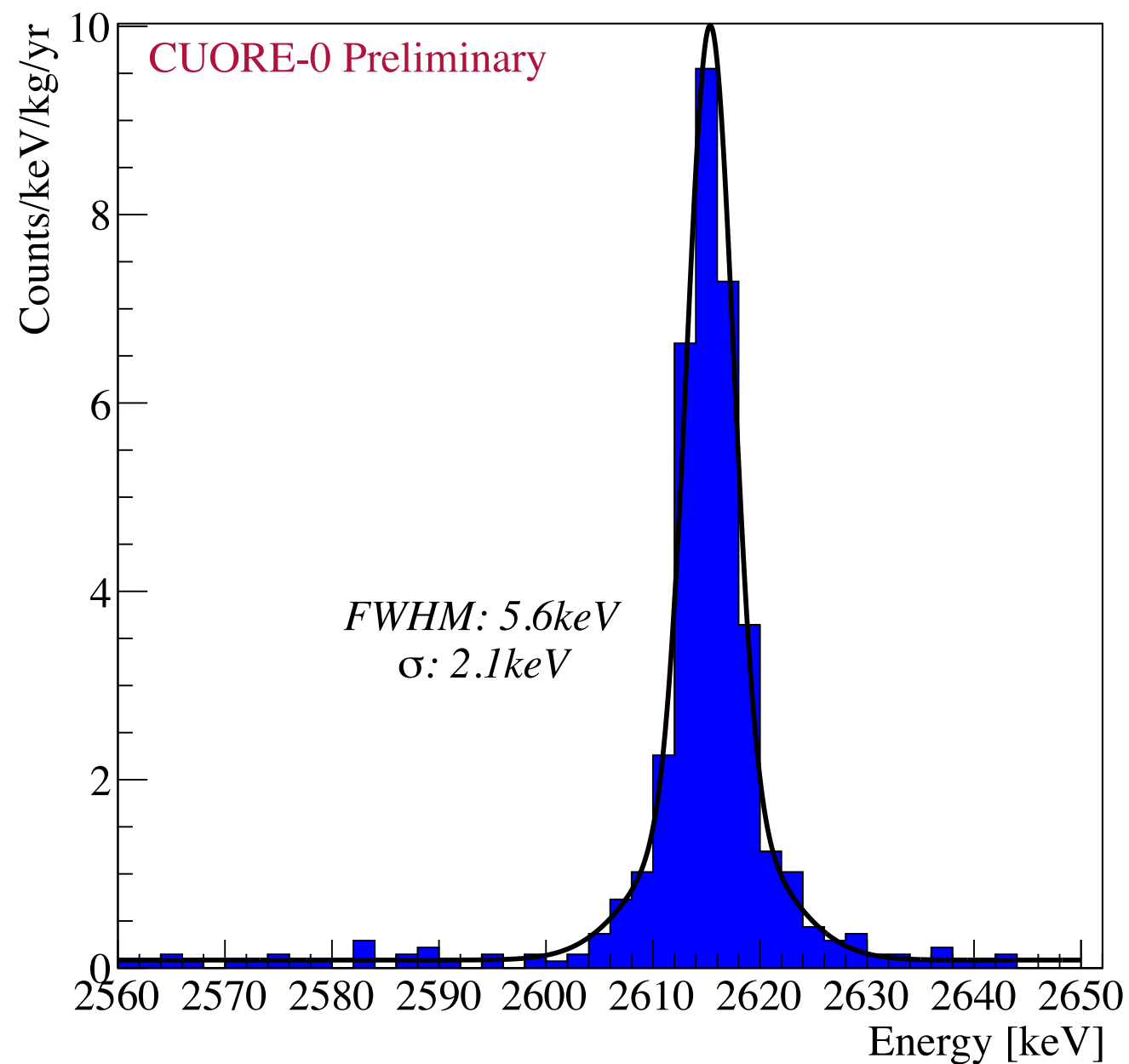
Background budget

CUORE Preliminary



Energy resolution on bkg runs

CUORE-0 Background Spectrum



**Sum of energy spectrum
in background runs of 49
channels @ 2615keV**