XIX International Workshop on Neutrino Telescopes

Flash Talk session

γ Background Reduction in $0\nu\beta\beta$ Searches with Organic Compound Holder

"An acrylic assembly for low temperature detectors" to be submitted to EPJ-Plus
"Organic compounds for rare events physics" submitted to Nuovo Cimento C

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Organic compounds in Calorimetric $0\nu\beta\beta$ Searches with TeO_2

Neutrinoless double beta decay ($0\nu\beta\beta$) searches with TeO_2 thermal detectors

Required very low background (especially around the Q-value peak @ 2527 keV for ^{130}Te)

Main target: reduce the γ background in the Region Of Interest (ROI)

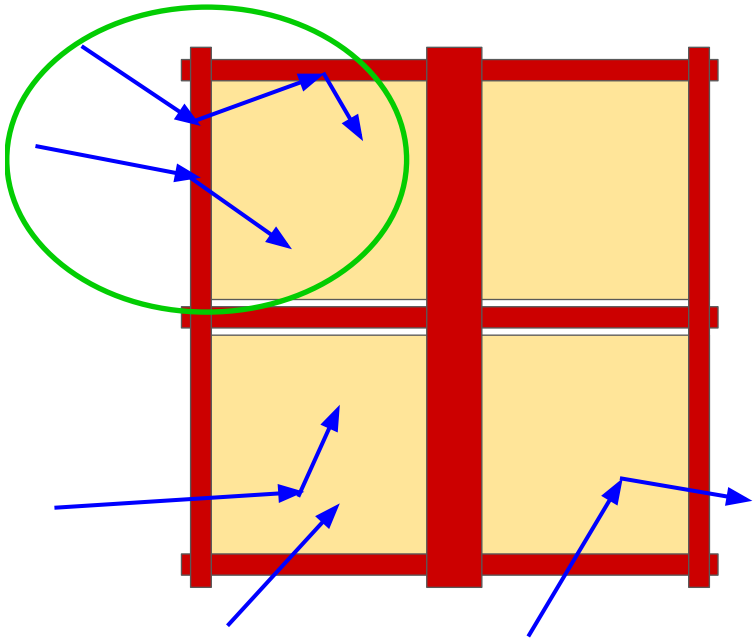
MAIN γ BACKGROUND SOURCE

Passive material with high Z and high ρ close to the detectors

+

2615 keV γ's from ^{208}Tl (^{232}Th chain) contained as contaminant

Background events due to **Compton scattering with the frame**



PROPOSAL

Detector holders made of Acrylic

- Reduced Compton scattering probability
- Possibility to employ the organic compound as scintillator
- 3D printed structures

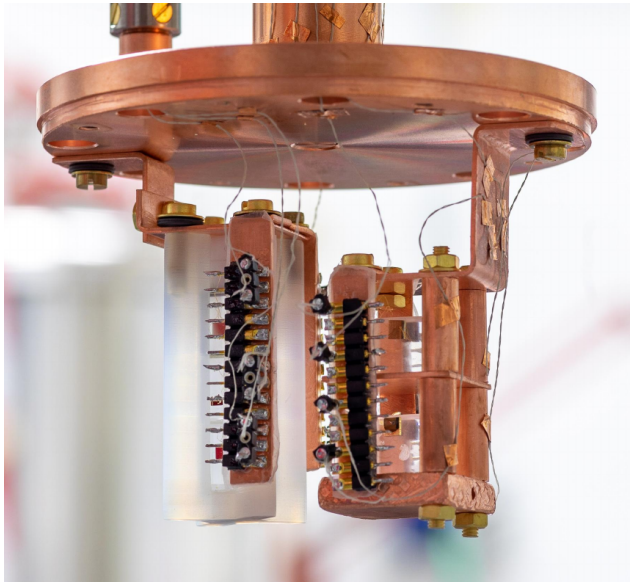
STABILITY

Very good baseline stability over 50 hrs run, same as channels from copper tower

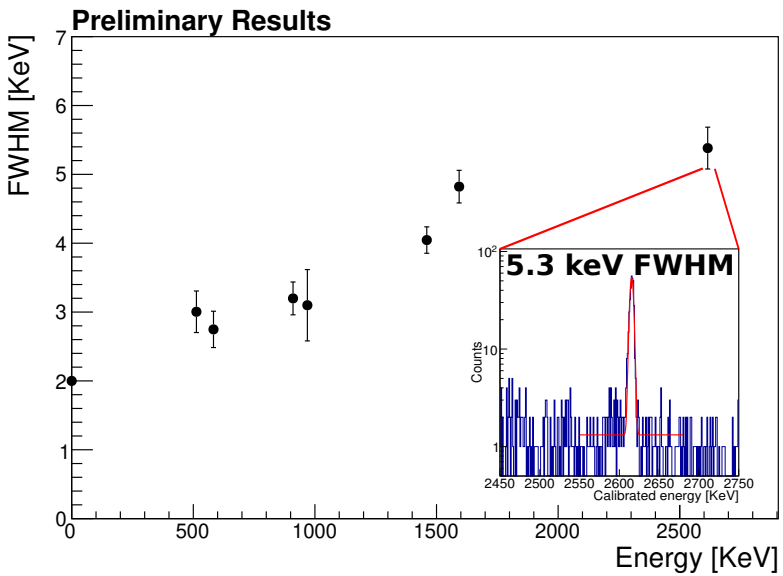
SIGNAL SHAPE

Faster pulses from acrylic holder when working at the optimal point (slightly higher temperature wrt copper)

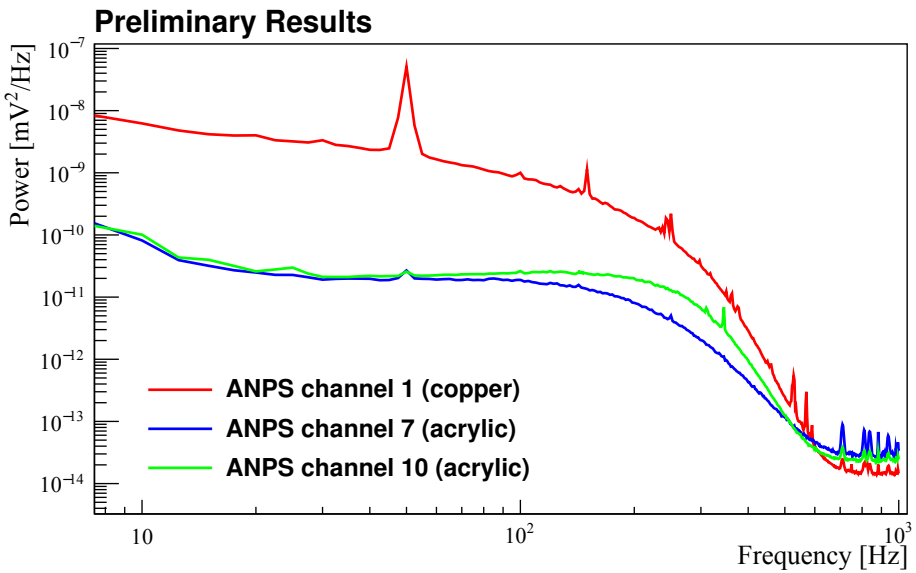
Useful to reduce pile-up



ACRYLIC RESOLUTION



NOISE PROPERTIES



Data acquisition

↓

Data analysis and spectrum reconstruction

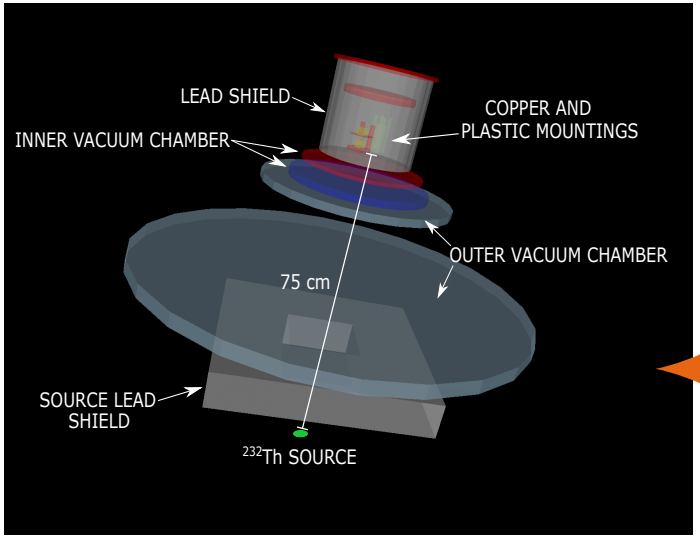
↓

2615 keV region fit (normalize exposure)

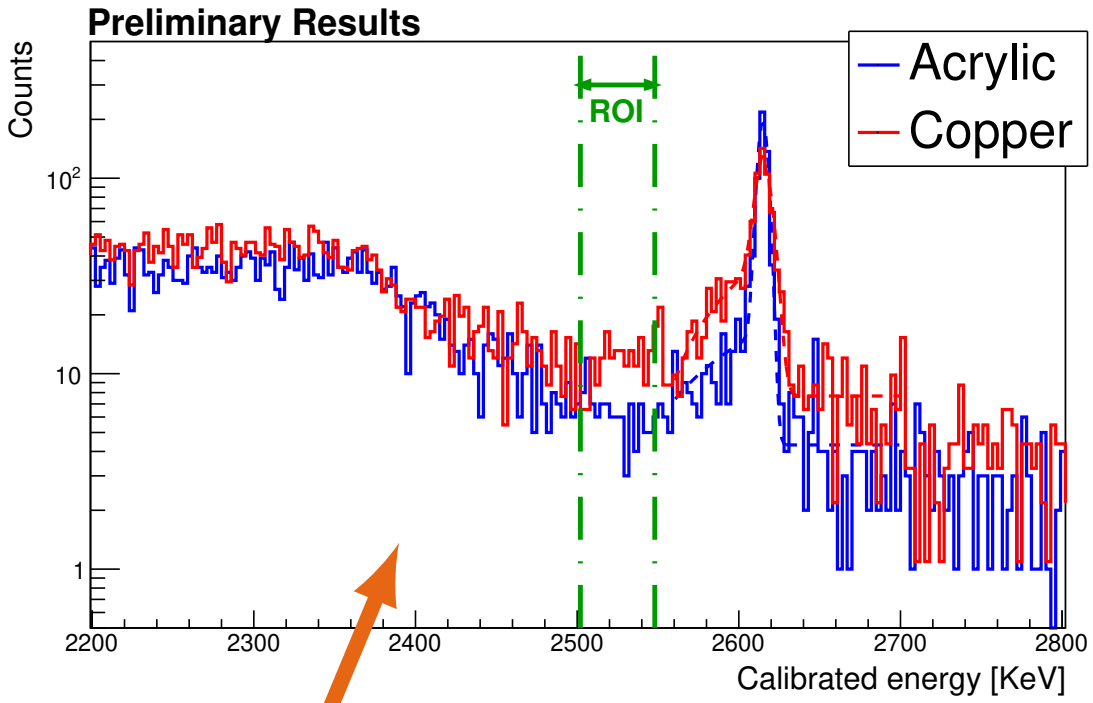
↓

Background determination

Setup Monte Carlo simulation



SPECTRA COMPARISON

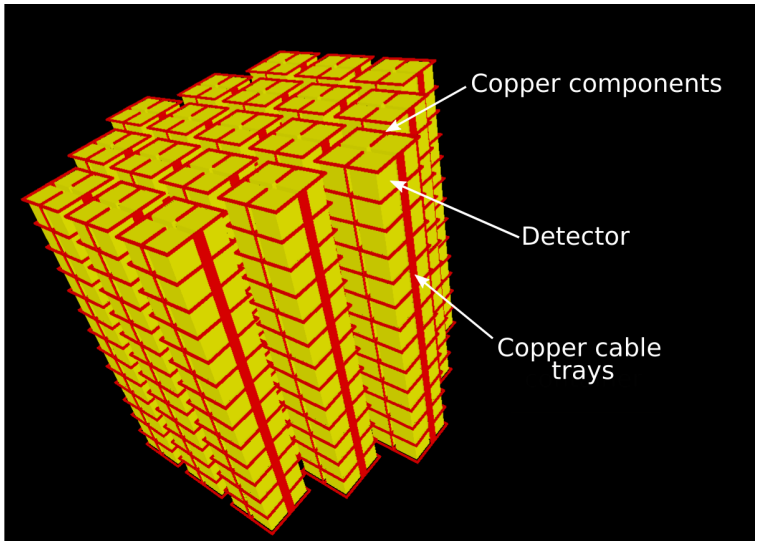


FINAL RESULTS

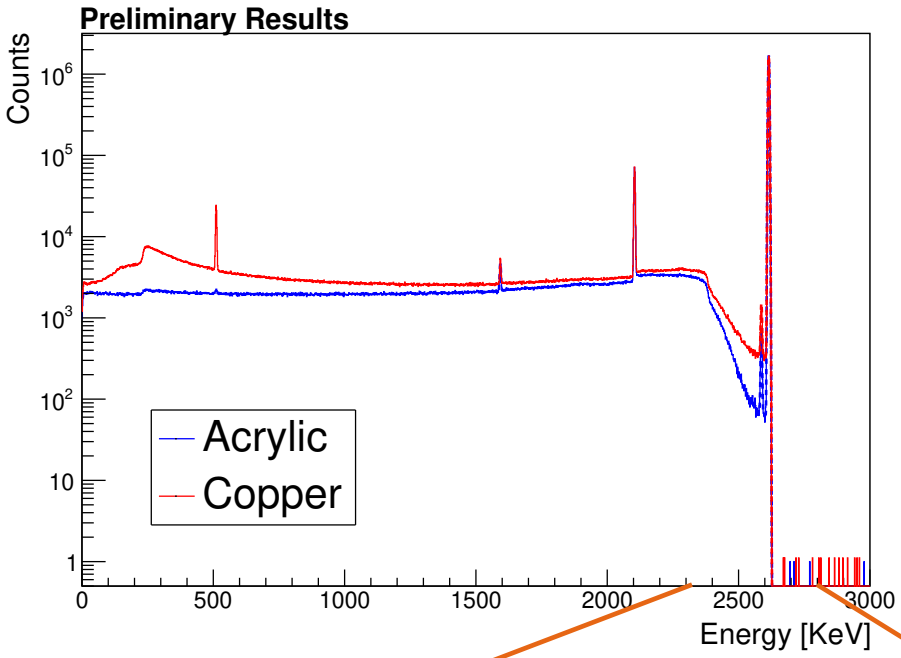
Data type	Holder material	ROI background [counts]
Experimental	Acrylic	109 ± 10
	Copper	204 ± 23
Monte Carlo	Acrylic	251 ± 16
	Copper	321 ± 30

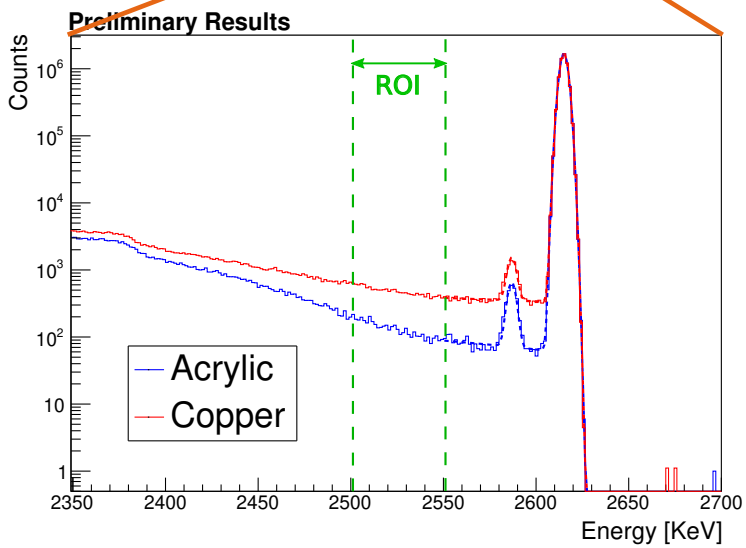
ROI background in acrylic lower @ $3.8\,\sigma$

Simulation of a larger structure (the CUORE experiment) in order to **consider more realistic setup of interest**



GENERATION OF 2615 keV γ AS CORE CONTAMINATION





FINAL RESULTS

Simulation	Tower	ROI bkg	Reduction Factor
External γ's	Acrylic	173 ± 13	$4.7^{+0.5}_{-0.6}$
	Copper	808 ± 30	
Frame contamination γ's	Acrylic	3116 ± 55	$5.0^{+0.1}_{-0.2}$
	Copper	15608 ± 139	

Acrylic characterization @ Milano-Bicocca

- No issues encountered during the cool-down;
- Good mechanical properties for acrylic at milli-Kelvin scale;
- Good energy resolution (5 keV @ 2615 keV), same as detectors in copper holder;
- Acrylic noise not degradated and comparable to the copper one;
- At the same heat sink temperature, faster pulses for acrylic;
- In acrylic, the ROI γ background is lower than the one in copper $3.8\,\sigma$, compatible with Monte Carlo simulations (1.2σ).

Acrylic replacement in CUORE

- ROI γ background reduction of a factor 4.7 for photons out of the innermost structure;
- ROI γ background reduction of a factor 5 for photons produced as core contamination in the holder.

Perspectives

- Possibility to use acrylic as scintillator, increasing the background rejection power.

Thanks for the attention!

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