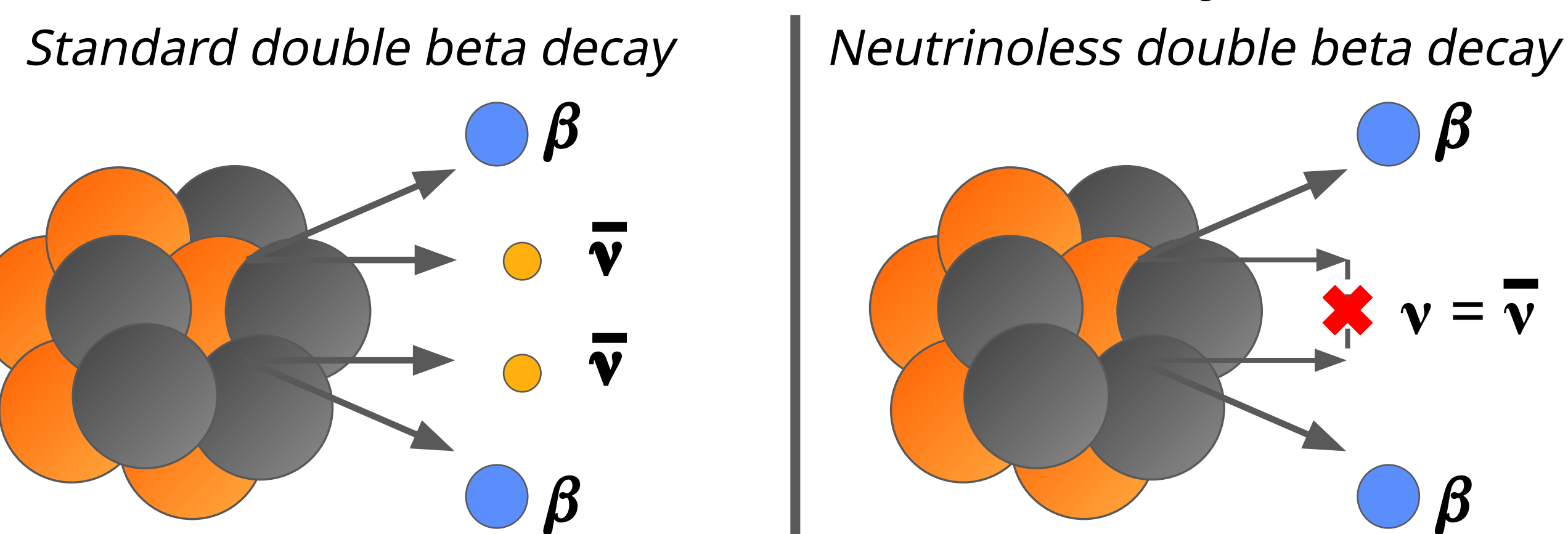


Latest Results from the CUORE Experiment

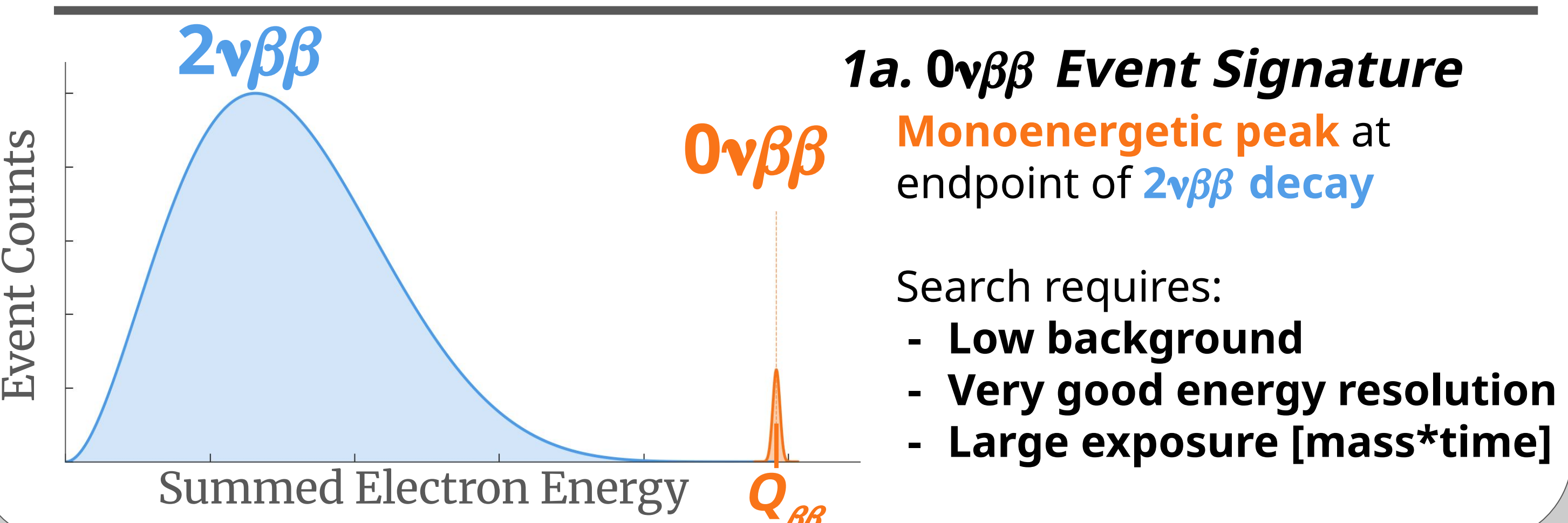


Michael Tristan Hurst on behalf of the CUORE Collaboration - Neutrino 2026

1. Neutrinoless double beta decay ($0\nu\beta\beta$)

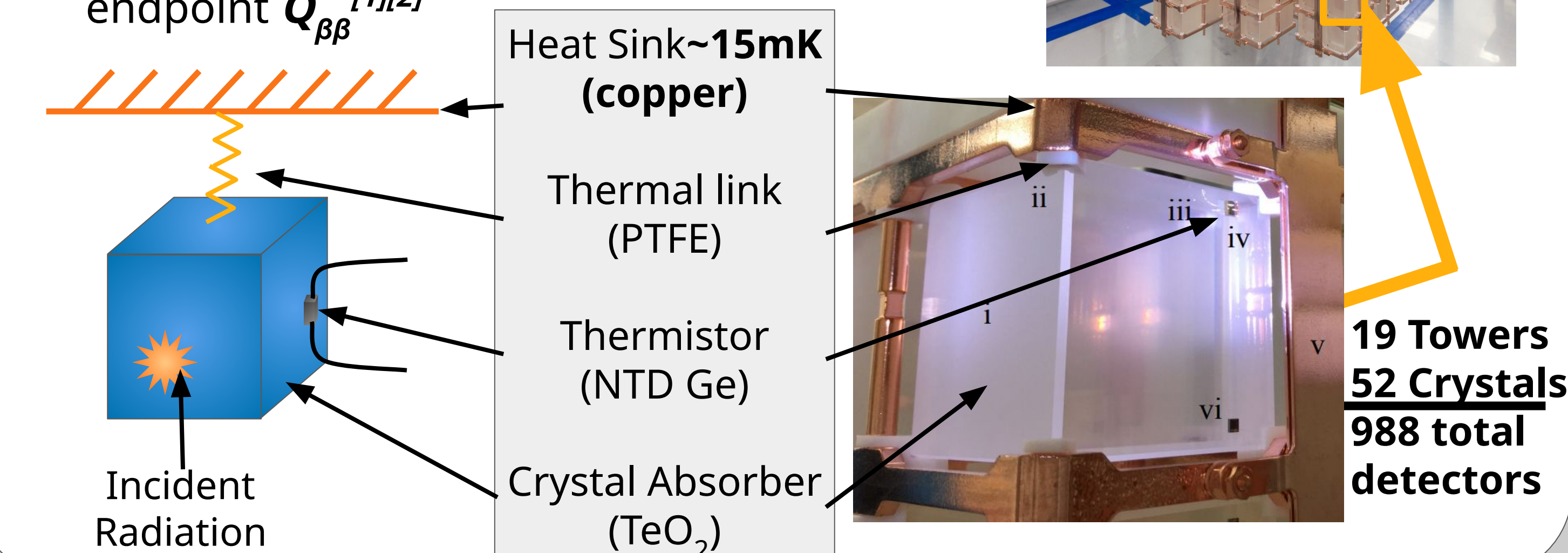
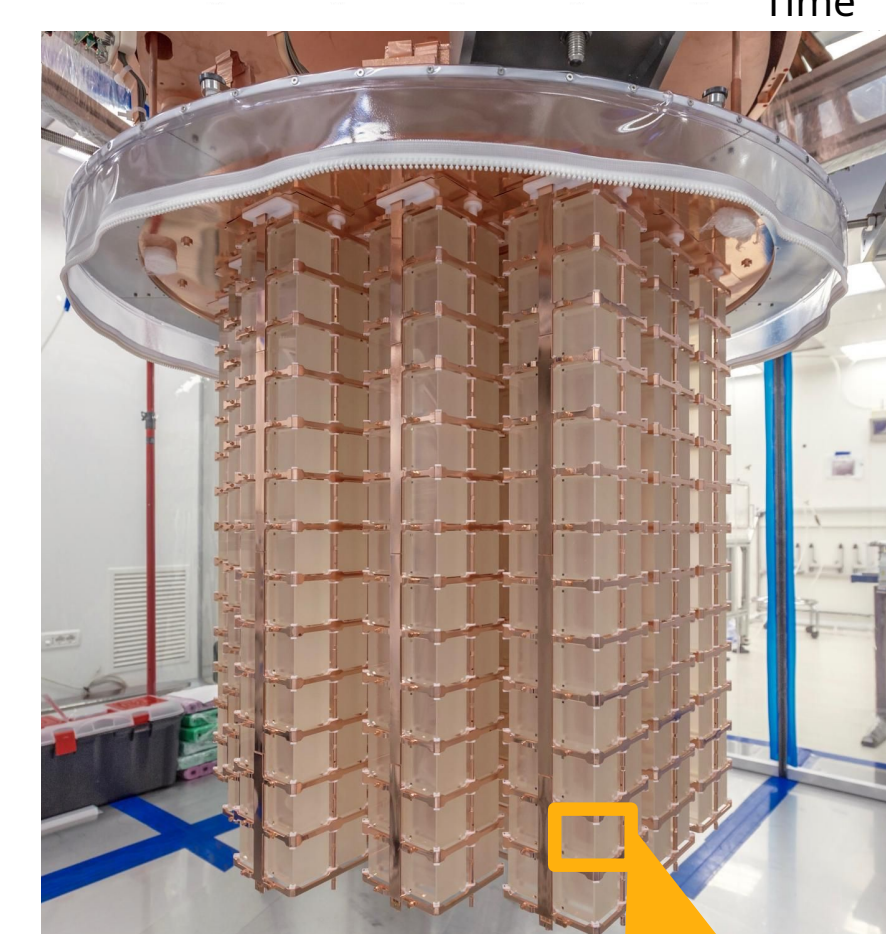
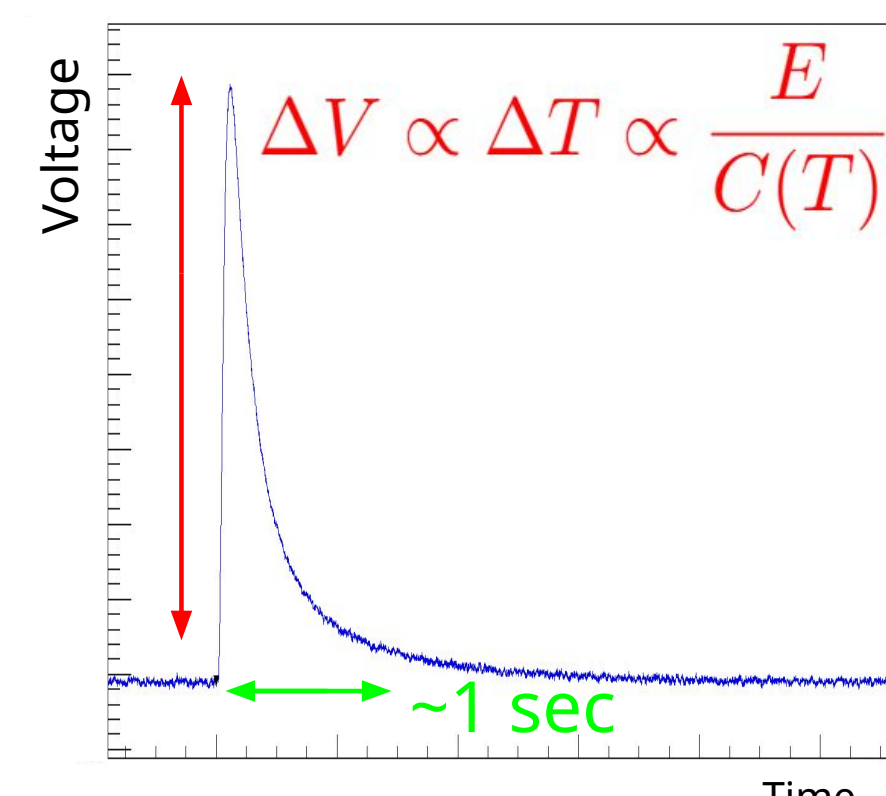


- $0\nu\beta\beta$ is a hypothesized **BSM Physics** process
- If observed, would establish neutrinos as **Majorana fermions**, showing they are their own antiparticle
- **Lepton-number violating process**, could help explain Matter-Antimatter Asymmetry in the universe
- Decay process sensitive to **effective Majorana mass** of ν , $m_{\beta\beta}$



2. CUORE Experiment

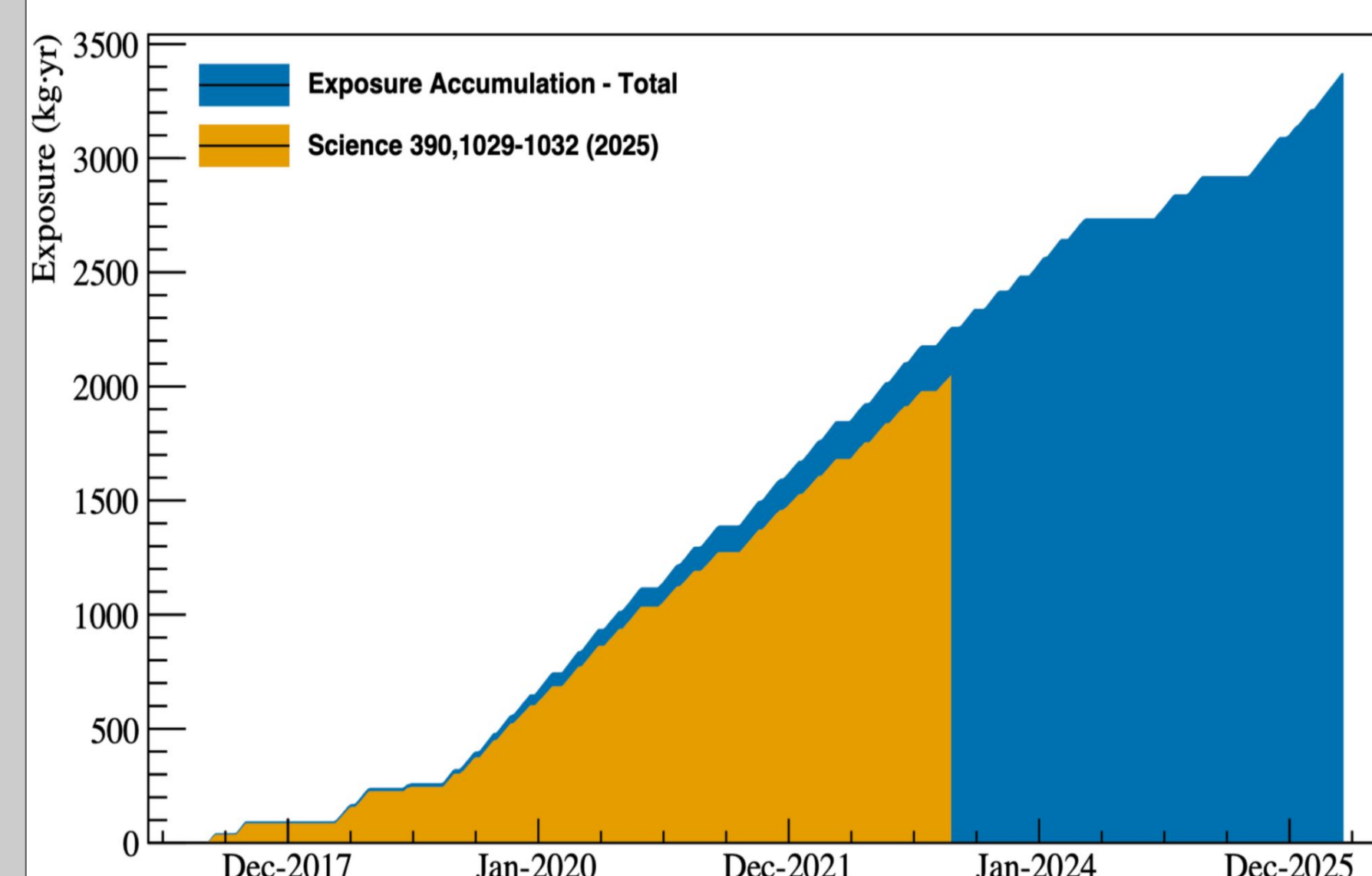
- **Cryogenic Underground Observatory for Rare Events** ~1400 m underground at LNGS in Italy (~3600 m.w.e.)
- ~ 10^6 reduction in atmospheric muons^[6]
- Multilayer passive shielding
 - **Roman Lead** low background material to mitigate ^{210}Pb long half-life impact
 - Modern Lead for complete shielding
 - Borated-Polyethylene Neutron Shielding
- Array of **988 TeO_2 Crystals** as cryogenic calorimeters; both source and detector
- Entire array kept at ~15mK
- Excellent energy resolution, $\Delta E/E = 0.3\%$ at endpoint $Q_{\beta\beta}$ ^{[1][2]}



CUORE is the world's first bolometric $0\nu\beta\beta$ experiment to reach tonne-year exposure scale. Multi-year cryogenic stability enabled the most stringent limit on the $0\nu\beta\beta$ decay of ^{130}Te yet achieved. The successful long-term operation of CUORE in stable conditions demonstrates that bolometric arrays at tonne-scale are a **mature technology**, providing the foundation for next-generation rare event searches for $0\nu\beta\beta$ and other rare processes.

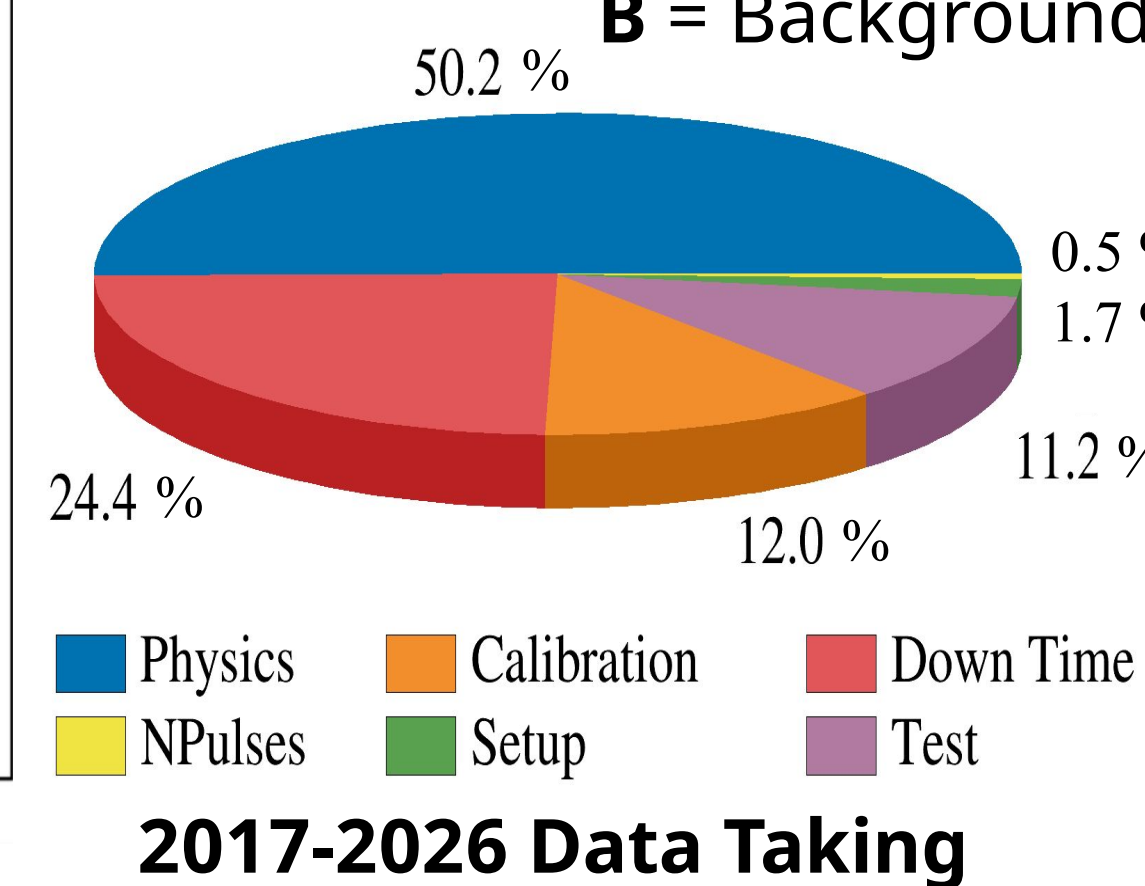
3. CUORE Data Taking

- **Stable Cryogenic Conditions**
- **9 Years of Data taking**

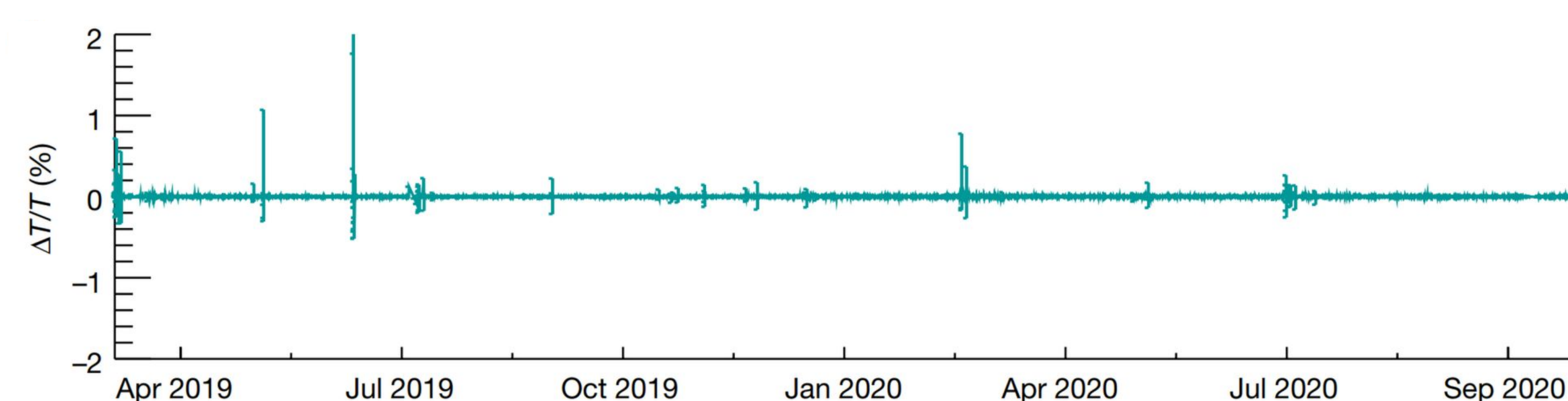


$$S^{0\nu} \propto \epsilon \sqrt{\frac{M \cdot t}{\Delta E \cdot B}}$$

$S^{0\nu}$ = Sensitivity to 0ν Decay
 ϵ = Efficiency of Detection
 M = Mass
 t = Time of measurement
 ΔE = Avg Energy Resolution
 B = Background



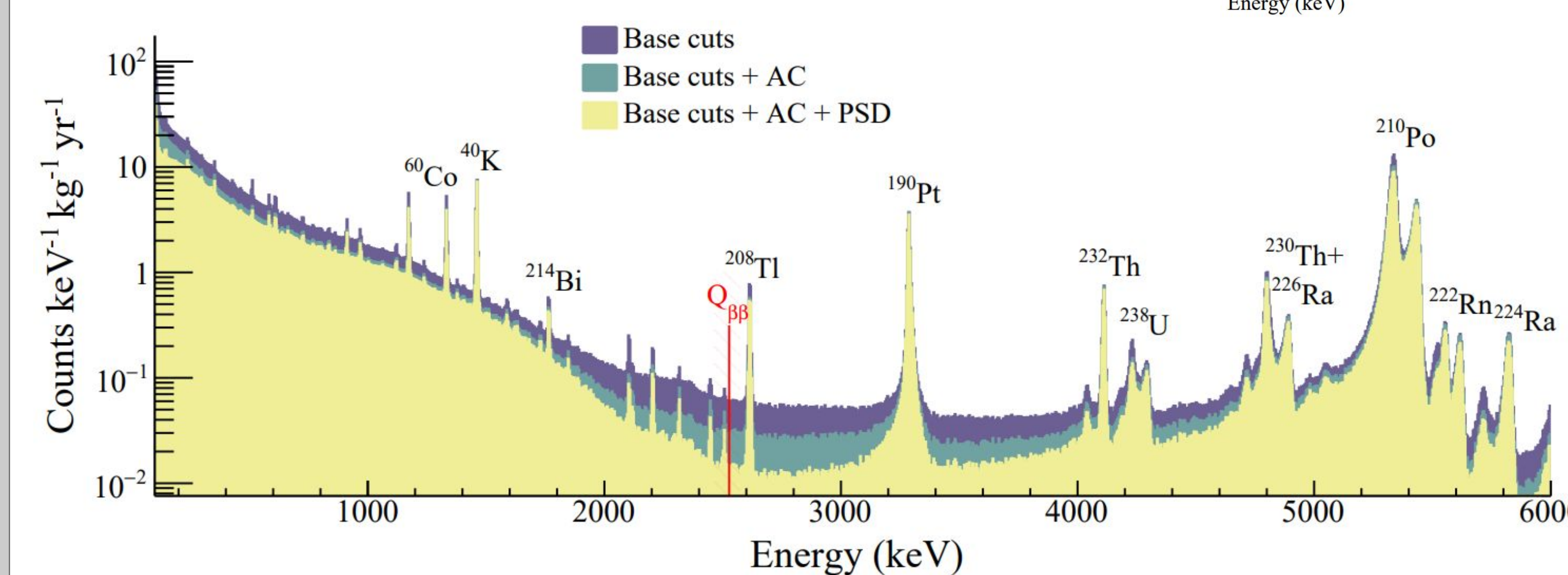
CUORE 2TY ΔE FWHM @ $Q_{\beta\beta} = 7.310(24) \text{ keV}^{[1]}$
Background Rate ROI = $1.42^{+0.03}_{-0.02} \times 10^{-2} \text{ cts/keV/kg/yr}^{[1]}$
Total Efficiency = 93.4(18)%^[1]
 (Combined Reconstruction, Anti-coincidence, Pulse Shape Discrimination, and Containment Efficiencies)



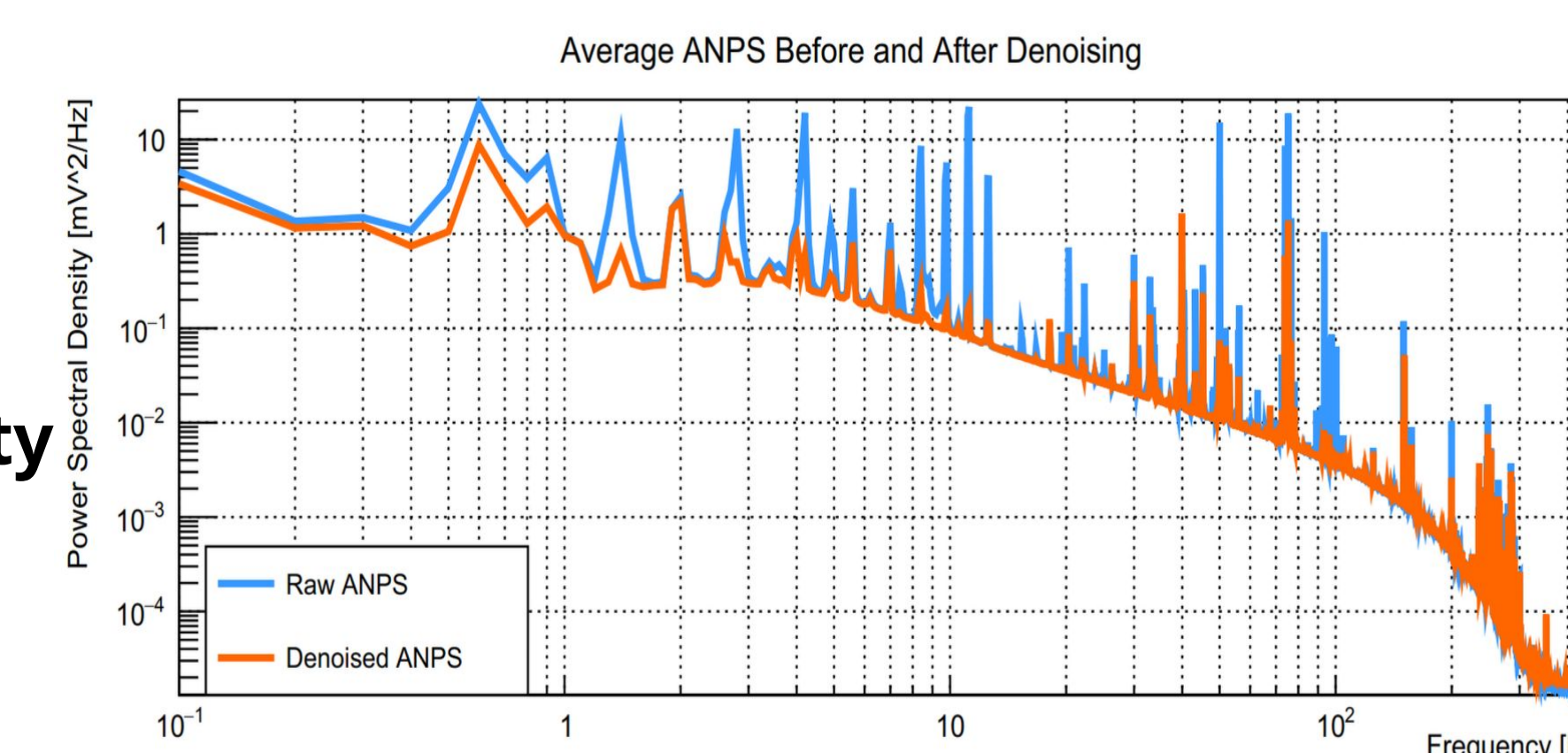
Temperature variation over a year of continuous data taking at $T_{\text{base}} = 12\text{mK}^{[2]}$

4. Recent CUORE Results

Using **over 2 tonne-years** of TeO_2 exposure, CUORE set most stringent limit on $0\nu\beta\beta$ decay half-life in ^{130}Te ever measured over $T_{1/2} > 3.5 \times 10^{25} \text{ yrs}$ & $m_{\beta\beta} < 70\text{-}250 \text{ meV}^{[1]}$



- **CUORE** sensitive to environmental conditions
 - Earthquakes, Storms, Seawave Microseisms
- Seasonal variations lead to estimated **~4.3% sensitivity loss** between best/worst energy resolution^[4]
- Mitigated by offline active noise cancellation, or **denoising** algorithm^{[11][4]}



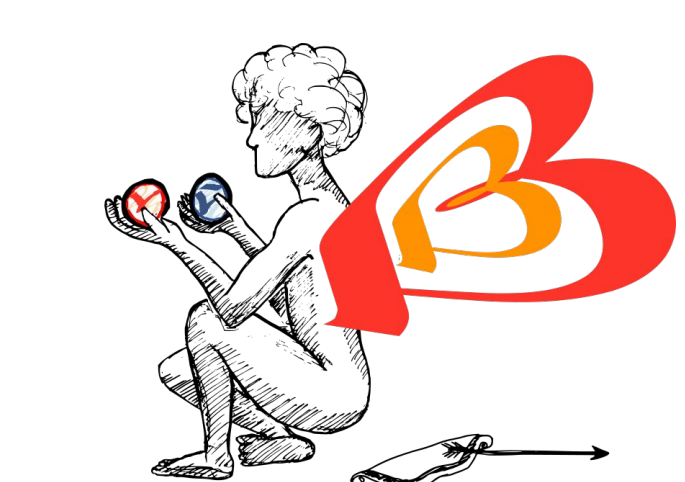
5. CUORE into the Future

CUORE 3 tonne-year of TeO_2 collection now complete
 Cryogenic Upgrade of Cryostat Planned:

- Improved Cooling Power and Vibrational Decoupling

Cryogenic expertise and infrastructure from **CUORE** will support the **CUPID Experiment** (CUORE Upgrade with Particle Identification)

- Next generation $0\nu\beta\beta$ experiment using ^{100}Mo will improve $S^{0\nu}$ by an order of magnitude^[5]



CUPID 3σ Plan^[5]:
 $S^{0\nu} - 1 \times 10^{27} \text{ yr}$
 $m_{\beta\beta} - 12\text{-}21 \text{ meV}$

6. Want to know more? CUORE and CUPID Posters

- #291 : Event topology in energy reconstruction in CUORE, Aaron Chizhik
- #326 : End-to-End Data Analysis Methods of CUORE, Krystal Alfonso
- #294 : Search for Baryon Number Violation with CUORE, Vivek Sharma
- #111 : Search WIMP Annual Modulation in CUORE, Rebecca Kowalski
- #303 : Multiplicity-2 Analysis in CUORE and CUPID Experiment, Tong Zhu
- #307 : The CUPID $0\nu\beta\beta$ Experiment, Hawraa Khalife
- #032 : Simulation of CUPID sensitivity to solar neutrinos, Ruoxi Wang
- #149 : Towards CUPID-1T: microwave multiplexing, Stefano Ghislandi
- #209 : Reduction of cosmogenic backgrounds in CUPID, Penny Slocum
- #312 : NTL Light Detectors for the CUPID Experiment, Andrea Giuliani
- #339 : Frequency multiplexed TES LDs in CUPID, Vladyslav Berest
- #269 : CUPID-1ton: Exploring Normal Ordering, Pranava Teja Surukuchi