Latest results from the CUORE experiment

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on behalf of the CUORE collaboration

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European Nuclear Physics Conference 2025

The CUORE experiment

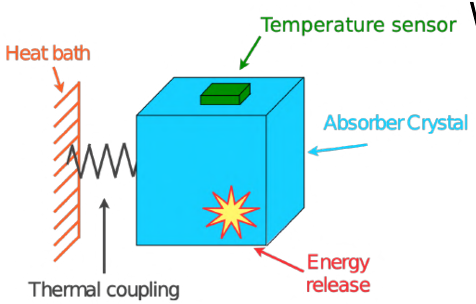
CUORE

Cryogenic Underground Observatory for Rare Events

Cryogenic experiment at tonne-scale,
utilising $^{(nat)}TeO_2$ cryogenic calorimeters operated at ~10 mK
Located at Laboratori Nazionali del Gran Sasso (Italy)

Search for rare events and for physics beyond the Standard Model

Main goal: search for 0νββ decay of ^{130}Te ($Q_{\beta\beta}$ = 2527.51 keV)



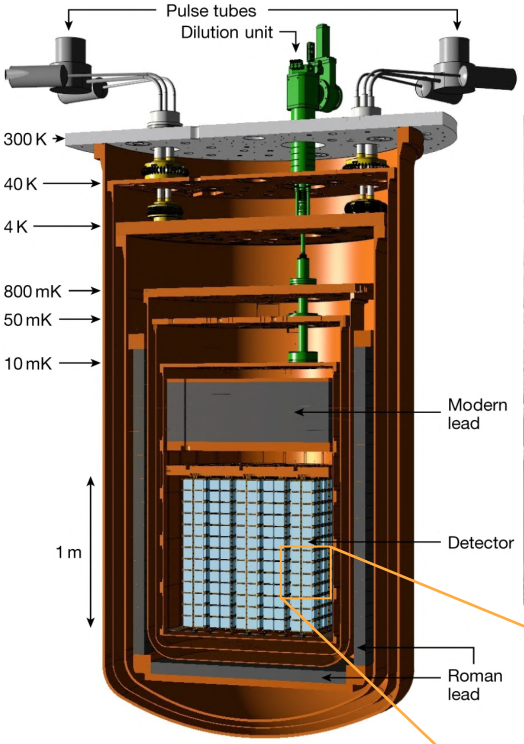
Why cryogenic calorimeters:

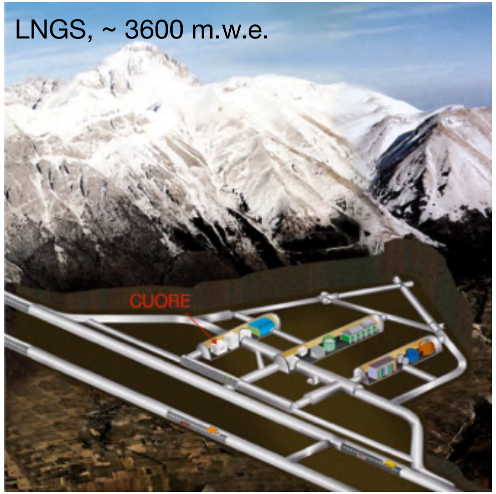
- E_{dep} converted into ΔT (phonons)
- Detector = ββ source
- Large calorimeters (~kg scale)
    - Sensitive from keV to MeV scale
    - Optimal energy resolution ~ 0.1%@MeV

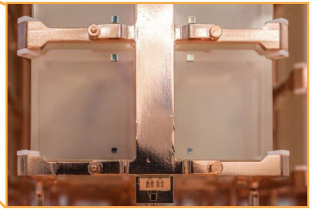
The CUORE challenge

Low temperature and low vibrations
988 TeO_2 detectors (~742 kg) operated as calorimeters at ~10 mK stable over time
- Multistage cryogen-free cryostat
- Mechanical vibration isolation: passive and active systems

Low background
- Deep underground location @LNGS
- Strict radio-purity controls on materials and assembly
- Passive shields from external and cryostat radioactivity
- Detector: high granularity and self-shielding

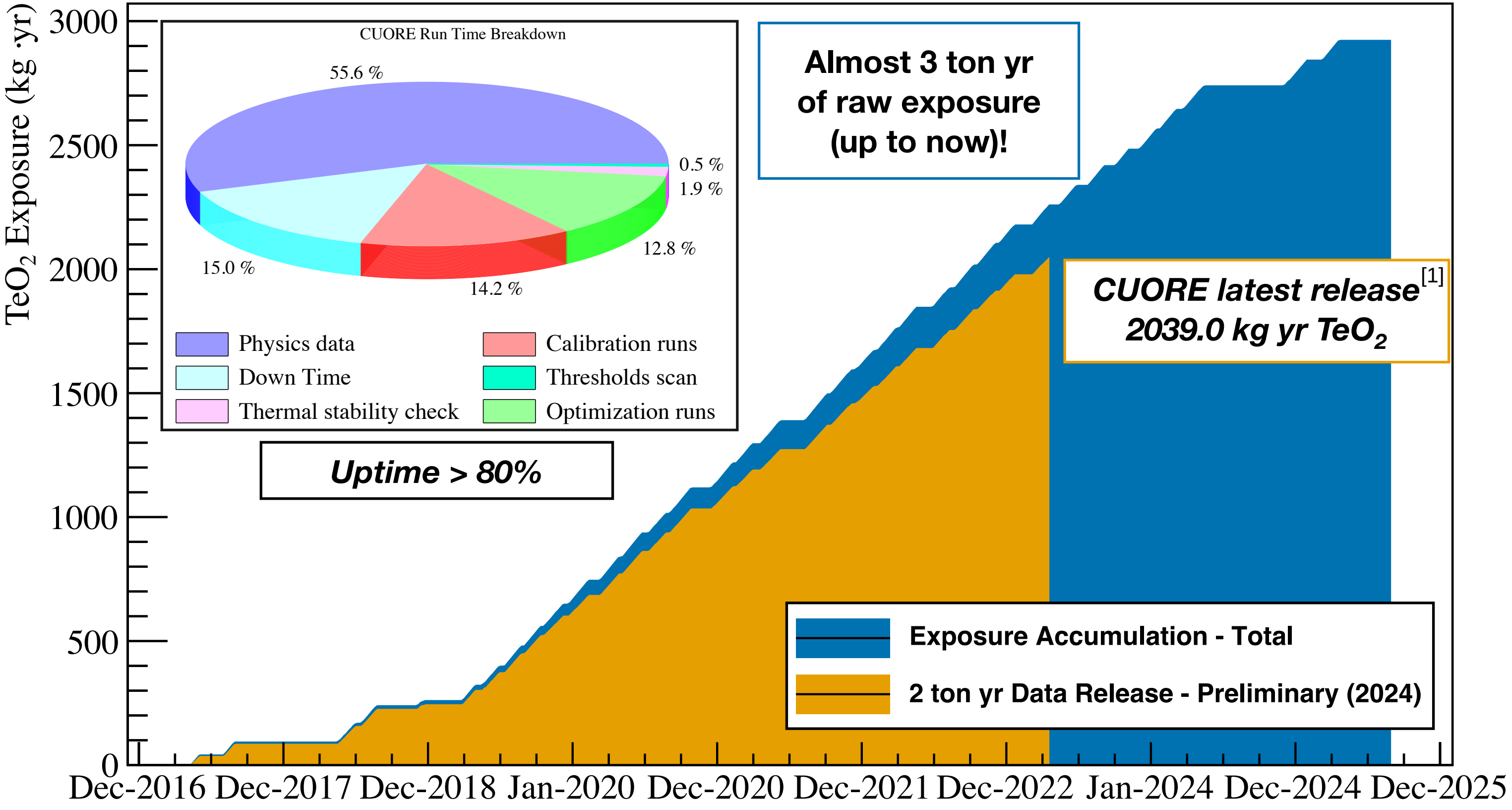






CUORE crystals

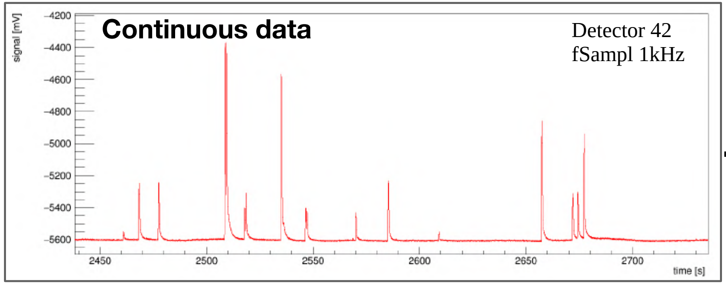
CUORE data-taking



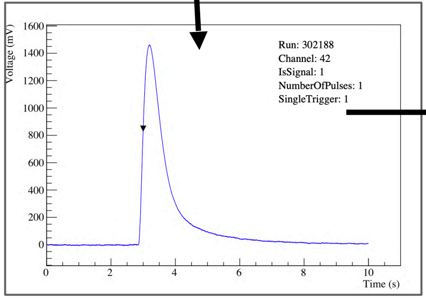
[1] CUORE Talk at TAUP2025, https://indico-cdex.ep.tsinghua.edu.cn/event/175/contributions/2287/

The CUORE data production chain

From single detectors waveform data stream



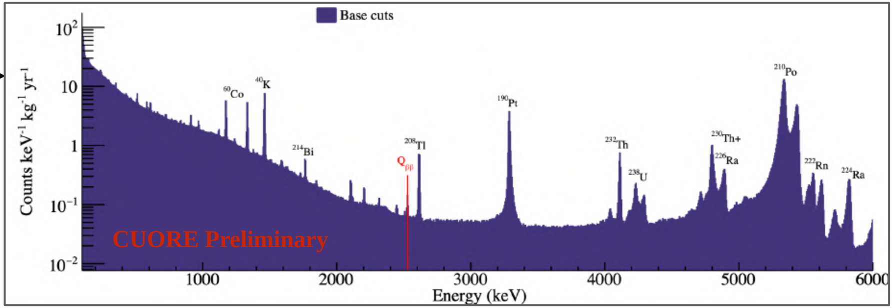
Denoising → Optimum trigger



Event: physics pulse

Optimum Filter → Gain Correction → Energy Calibration → Coincidences → PCA

To a cumulative energy spectrum

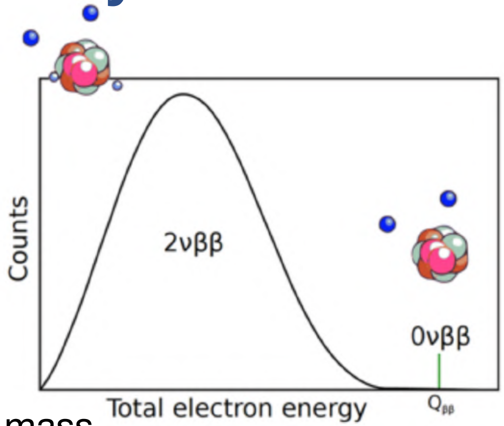


CUORE physics analyses: 0νββ ^{130}Te decay search

- Beyond Standard Model process (ΔL = 2)

$$(A, Z) \longrightarrow (A, Z+2) + 2e^-$$

- Not yet observed: $T^{1/2}_{0\nu\beta\beta} > 10^{22\text{-}26}$ yr



Impacts of a potential observation of **0νββ decay**:

- Existence of Lepton Number violating processes
- Presence of a Majorana term for the neutrino mass, $m_{\beta\beta}$

From the 0νββ decay rate it is possible to infer the effective ν mass

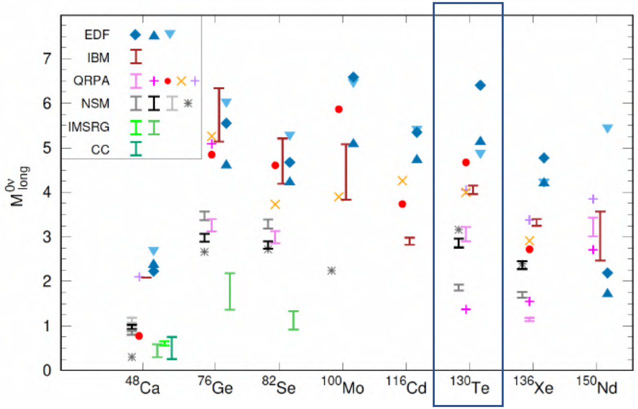
$$\frac{1}{T^{0\nu}_{1/2}} \propto G(Q_{\beta\beta}, Z)|M_{nucl}|^2|m_{\beta\beta}|^2$$

Phase space integral $G(Q_{\beta\beta},Z) \sim Q_{\beta\beta}^5$

Nuclear matrix element (NME)

Effective neutrino mass term

Rev. Mod. Phys. **95**, 025002; https://doi.org/10.1103/RevModPhys.95.025002



Key role of **NME and its uncertainties** for a precise **inference of the effective neutrino mass.** Strong connection with nuclear physics efforts into improving the nuclear models for multiple isotopes

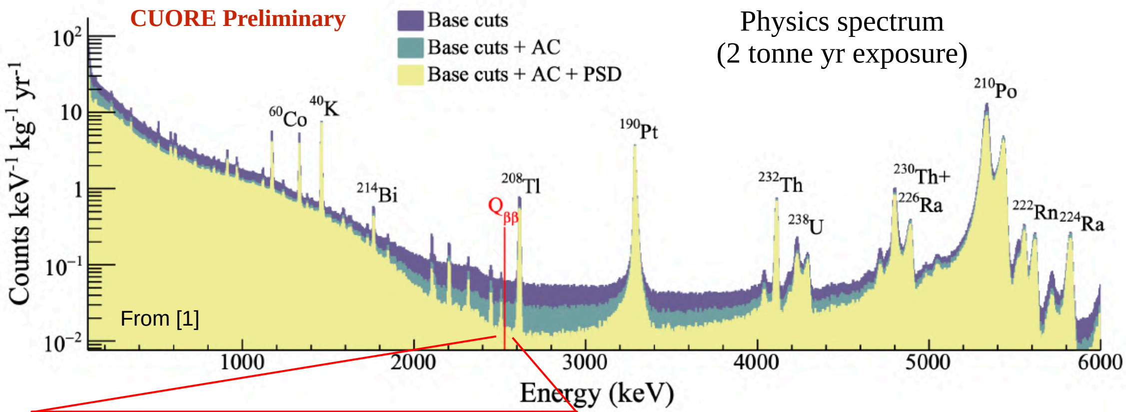
CUORE physics analyses: 0νββ ^{130}Te decay search

2 ton yr data release

Data from May 2017 to April 2023

Total exposure for 0νββ decay search:

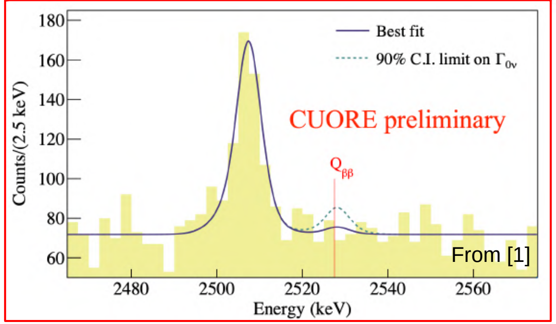
2039.0 kg yr TeO_2, 567.0 kg yr ^{130}Te



Quality cuts for **0νββ search**:

- BaseCuts (trigger, energy reconstruction, pileup rejection)
- Anti-coincidence, AC (only single crystal events)
- Pulse shape discrimination, PSD (only particle-like pulses)

Total efficiency 93.4(2)%



No evidence of signal at $Q_{\beta\beta}$ in ROI

Average background index in the ROI
$(1.42\,^{+0.03}_{-0.02}) \times 10^{-2}$ cts/(keV kg yr)

Pending publication

CUORE physics analyses: $0\nu\beta\beta$ ^{130}Te decay search

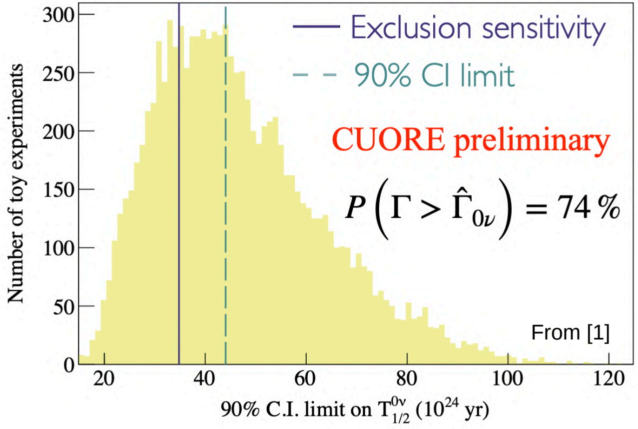
2 ton yr data release

Bayesian fit of the data in the ROI

Lower limit on ^{130}Te $0\nu\beta\beta$ half life:

$T_{0\nu}^{1/2}$ (^{130}Te) > 3.5 x 10^{25} yr (90%C.I.)

Frequentist limit: $T_{1/2} > 3.4 \cdot 10^{25}$ yr (90% C.L.)



Limit on the effective neutrino mass, assuming light Majorana-neutrino exchange:

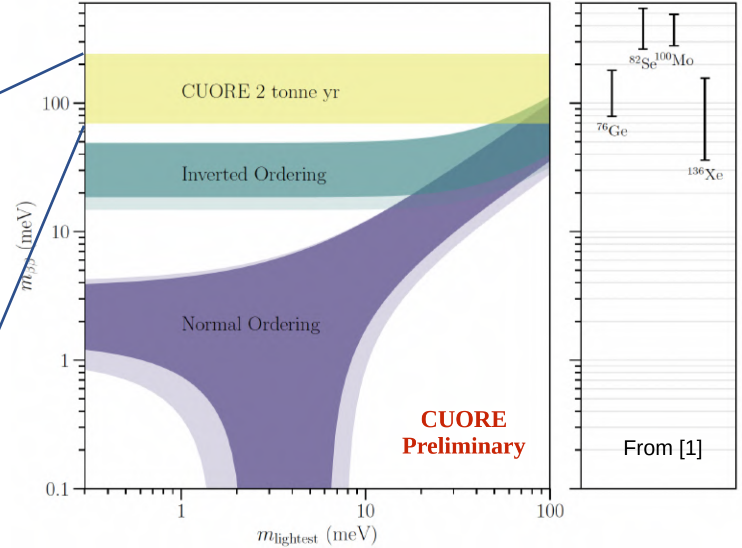
$m_{\beta\beta}$ < 70-250 meV

NME ^{130}Te

(3.9, 6.4)

Nuclear models considered: QRPA, ISM, IBM, NREDF

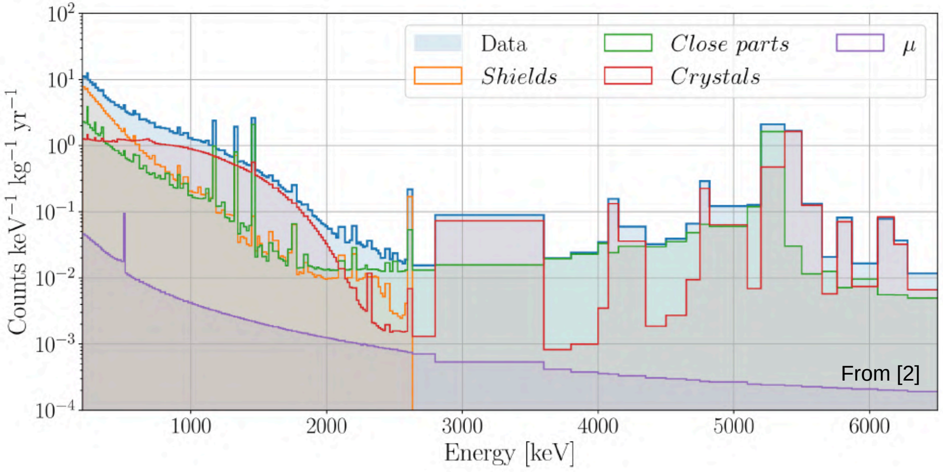
Pending publication

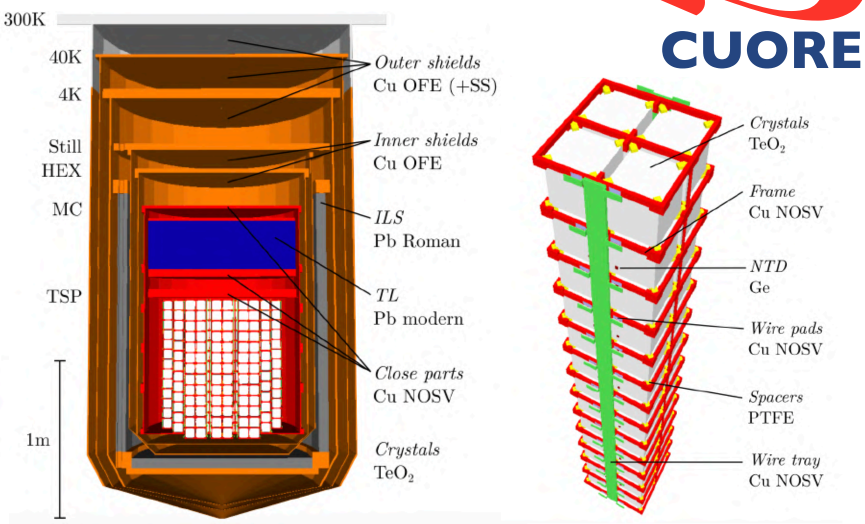


CUORE physics analyses: background model

Reconstruction of the CUORE physics spectrum

- GEANT4 simulation + measured detector response function to produce expected spectra
- Multiple background sources simulated (data-driven), **Bayesian MCMC fit**
- Exploit coincidences & detector self-shielding to constrain location of sources





Total exposure for BM analysis: 1038.4 kg yr

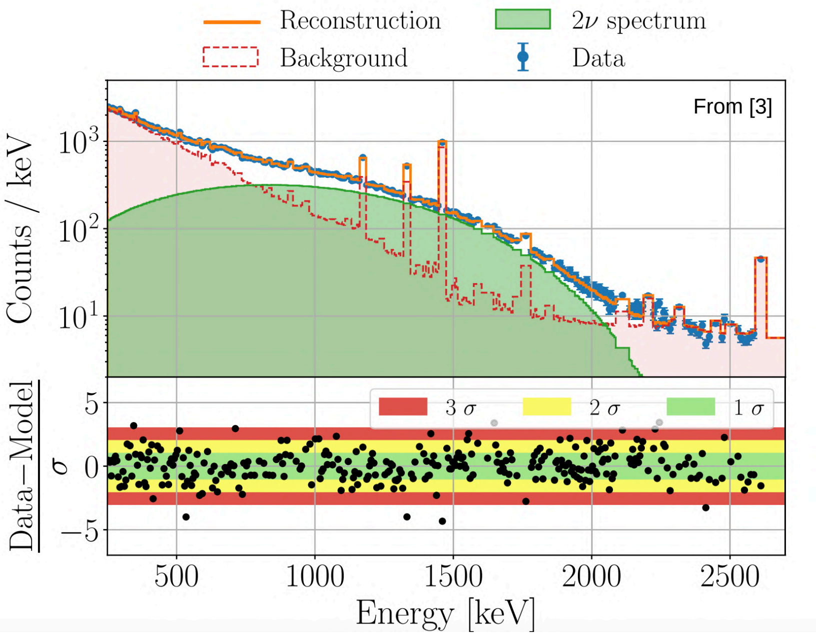
- Sensitivity levels down to 10 nBq kg^{-1} and 0.1 nBq cm^{-2} for bulk and surface contamination
- Main contributions to ROI BI: degraded α particles (~90%), multi-Compton of γs and cosmic muons

[2] Adams D. et al. (CUORE collaboration), Phys. Rev. D 110, 052003 (2024), https://doi.org/10.1103/PhysRevD.110.052003

CUORE physics analyses: $2\nu\beta\beta$ ^{130}Te decay measurement

CUORE

^{130}Te $2\nu\beta\beta$ decay: dominant component of the observed single-site physics spectrum between ~ 1 to 2 MeV

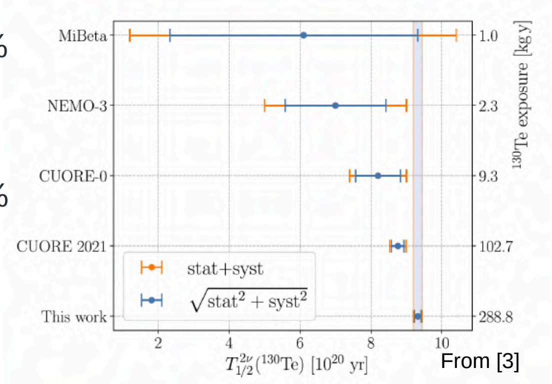


→ **Precise $2\nu\beta\beta$ half-life measurement**

Choice of the nuclear model
Single-state dominance (SSD), with leading contribution from 1^+ state of intermediate nucleus
- Selected as reference
- Preferred to higher-state dominance (HSD) model

$T_{2\nu}^{1/2}$ (^{130}Te) = [9.32 $^{+0.05}_{-0.04}$(stat) $^{+0.07}_{-0.07}$(syst)] x 10^{20} yr

- Statistical uncertainty ~0.5%
- Contribution from nuisance parameters ~0.01%
- Multiple sources of systematic uncertainties < 1%



From [3]

[3] Adams D. Et al. (CUORE collaboration), Phys. Rev. Lett. 135, 082501 (2025), https://doi.org/10.1103/jdhf-hn4l

CUORE physics analyses: $2\nu\beta\beta$ ^{130}Te decay measurement

CUORE

Study of $2\nu\beta\beta$ spectral shape

Use of **improved formalism** for $2\nu\beta\beta$ half-life.

Taylor expansion over lepton energies, introducing **nuclear model refinements**:
→ Addition of subleading nuclear matrix elements
→ Spectral shapes and relative strengths of the Taylor-expanded terms offer **constraints on intermediate states and on $g_{eff,A}$**

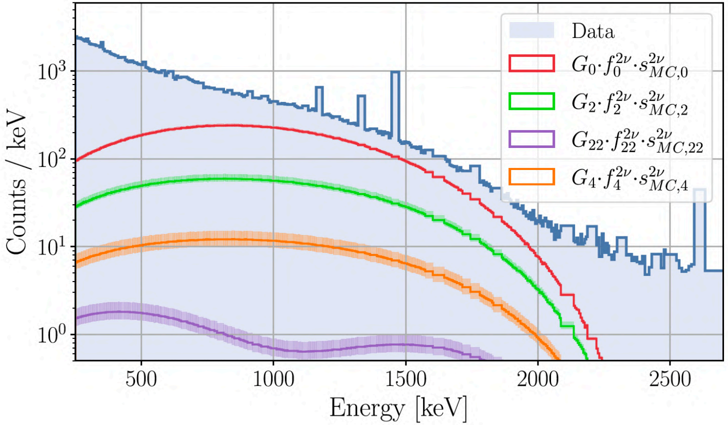
$$[T^{2\nu}_{1/2}]^{-1} = (g_{\rm A}^{\rm eff})^4 |M^{2\nu}_{\rm GT-1}|^2 \Big\{ G_0 + \xi_{31} G_2 + \frac{1}{3}(\xi_{31})^2 G_{22} + \left[\frac{1}{3}(\xi_{31})^2 + \xi_{51}\right] G_4 + \frac{1}{3}\xi_{31}\xi_{51} G_{42} + \frac{2}{3}\xi_{31}\xi_{51} G_6 \Big\},$$

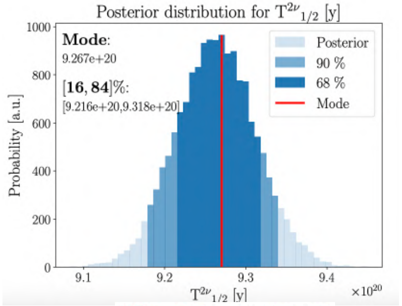
CUORE Supplemental Material

Data reconstruction with multiple shape components for $2\nu\beta\beta$.

Good fit to CUORE data.

SSD model slightly favoured, half-life consistent < 1σ





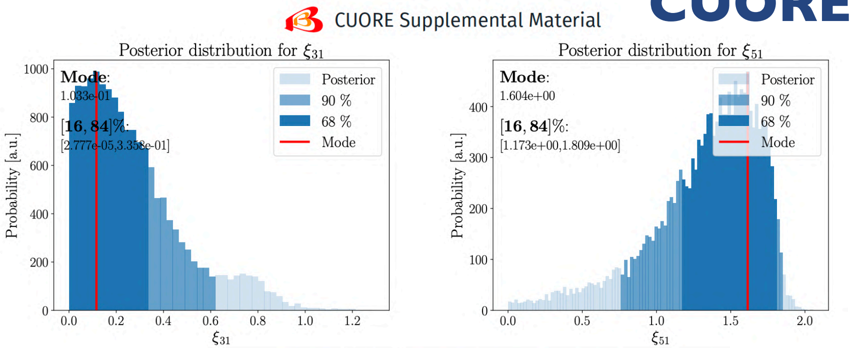
CUORE Supplemental Material

CUORE physics analyses: 2νββ ^{130}Te decay measurement

CUORE

2νββ spectrum fit with improved formalism: results

Considerations on nuclear models (pnQRPA, ISM):
- ξ_{31} consistent with 0. Meets theoretical predictions
- Non zero ξ_{51}
  - Rules out HSD model
  - Far from the expectations. Hp: incomplete theoretical description of the decay, such as minor effects not yet included or potential BSM physics

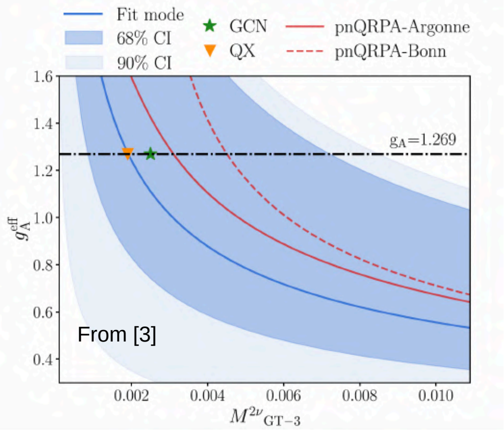


First-ever information from ^{130}Te on $g_{A,eff}$

- Mode confirming quenching of g_A
- Good match with theoretical models
- Relatively high uncertainty

$$g_A^{\mathrm{eff}} = \left[\frac{\left[T_{1/2}^{2\nu\beta\beta}\right]^{-1} \cdot \xi_{31}^2}{M_{GT-3}^2 \cdot G} \right]^{1/4}$$

where $G = G_0 + \xi_{31} G_2 + \xi_{31}^2 G_{22}/3 + (\xi_{31}^2/3 + \xi_{51}) G_4.$

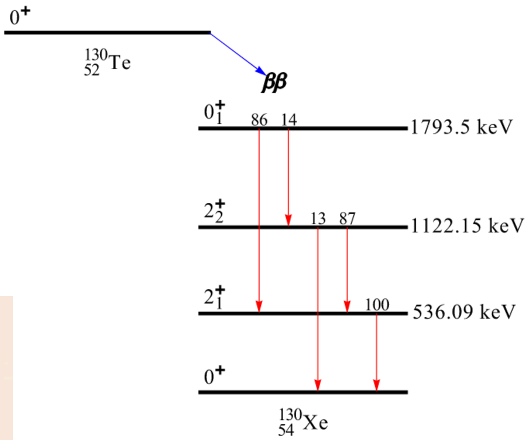


Synergy between spectral studies from rare decays and nuclear physics

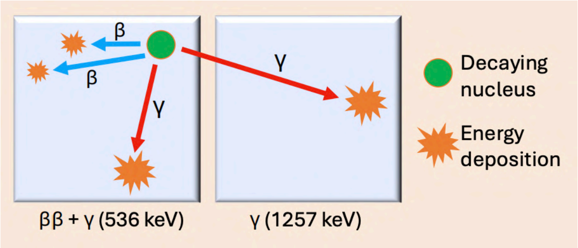
[3] Adams D. Et al. (CUORE collaboration), Phys. Rev. Lett. 135, 082501 (2025), https://doi.org/10.1103/jdhf-hn4l

CUORE physics analyses: ββ ^{130}Te decay to excited states

- 2νββ decay to the 0^+ excited state observed in ^{100}Mo and ^{150}Nd, with half lives of the order of few 10^{20} yr
- 2νββ (and 0νββ) decay of ^{130}Te to the first 0^+ excited state of ^{130}Xe not yet measured.
  $(T_{2\nu,0+}^{1/2})_{th} = (7.2 - 5630) \times 10^{23}$ yr (QRPA, NSM)



Signature of the decay:
Cascade of de-excitation γs in coincidence with βs
- multi-site signatures
- background reduction



Input from nuclear physics for ^{130}Xe excited states modelling and transition probability

- First CUORE search on 372.5 kg yr TeO_2
No evidence of signal.
$T_{0\nu,0+}^{1/2} > 5.9 \times 10^{24}$ yr (90% C.I.)
$T_{2\nu,0+}^{1/2} > 1.3 \times 10^{24}$ yr (90% C.I.)

- Current search with 2039 kg yr TeO_2 based on CUORE Background Model
Sensitivity $S_{2\nu,0+}^{1/2} = 3.7 \times 10^{24}$ yr

In progress!

[4] Adams D. et al. (CUORE collaboration), Eur. Phys. J. C (2021) 81:567 https://doi.org/10.1140/epjc/s10052-021-09317-z
CUORE excited states search Poster at TAUP 2025, https://indico-cdex.ep.tsinghua.edu.cn/event/175/contributions/2269/

CUORE physics analyses

Decays of other Te isotopes

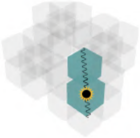
^{120}Te 0νβ^{+}EC decay

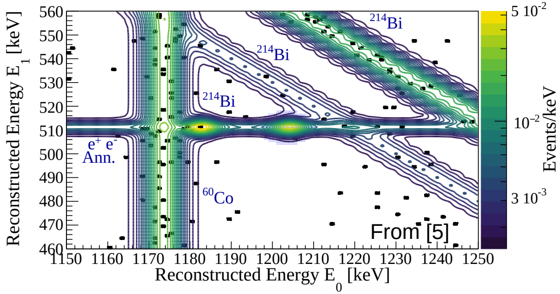
$Q_{\beta\beta}$= 1714.8 keV, natural abundance: 0.09%

Clear signature from e+e- annihilation and ^{120}Sn de-excitation via X-ray/Auger electrons emission

$T_{0\nu}^{1/2}$ (^{120}Te) > 2.9 × 10^{22} yr (90%C.I.)

M2 (β^{+} + X + γ_{511}, γ_{511}) : (1203.8, 511) keV



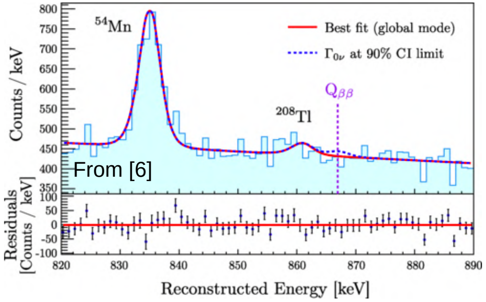


^{128}Te 0νββ decay

$Q_{\beta\beta}$= 866.7 keV, natural abundance: 31.74%

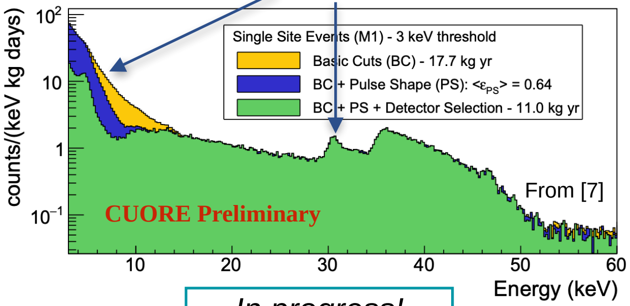
$T_{0\nu}^{1/2}$ (^{128}Te) > 3.6 × 10^{24} yr (90%C.I.)

Improved limit of over a factor 30 wrt to previous direct search results, and exceeded the results from geochemical experiments



Low energy spectrum

- Specific low-energy variables & event-level cuts to optimise sensitivity at keV-scale
- Investigation of spectral features potentially related to **^{121}Te,^{123}Te,^{125m}Te decays** (not yet measured)



In progress!

[5] Adams D. *et al.* (CUORE Collaboration), Phys. Rev. C 105, 065504 (2022), https://doi.org/10.1103/PhysRevC.105.065504

[6] Adams D. *et al.* (CUORE Collaboration), Phys. Rev. Lett. 129, 222501 (2022), https://doi.org/10.1103/PhysRevLett.129.222501

[7] Adams D. et al (CUORE collaboration), https://arxiv.org/abs/2505.23955 (Submitted to PRD)

CUORE: what's next

CUORE Phase-I (current)

Continue data taking until meeting goal
~ 3 ton yr TeO_2
(1 ton yr ^{130}Te)

Estimate end of data taking in mid-2026

Large statistics to perform high sensitivity searches in several channels (ββ decay, dark matter, exotic phenomena, …)

CUORE Phase-II

Upgrade of the cryogenic system to improve cooling power and reduce vibrational noise

Plan to resume data-taking in 2027

Lower thresholds high sensitivity low energy studies (axions, WIMPS, …)

CUPID (CUORE Upgrade with Particle Identification)

Scintillating cryogenic calorimeters to overcome CUORE-sensitivity-limiting α background

- ββ decay candidate:
  ^{130}Te (2527 keV) → ^{100}Mo (3034 keV)
- 1596 $Li_2{}^{100}MoO_4$ scintillating crystals paired with Ge-light detectors
- Bkg goal in ROI ~ 10^{-4} cts/(keV kg yr)
- Same cryogenic infrastructure

Conclusions

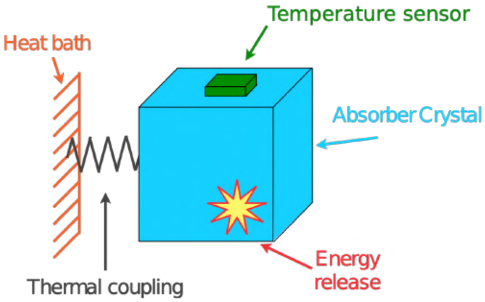
- CUORE demonstrates the feasibility of a tonne-scale experiment employing cryogenic calorimeters at ~10 mK, for the search of the $0\nu\beta\beta$ decay and rare events
- CUORE data-taking is proceeding with > 80% uptime. A raw exposure of almost 3 ton yr achieved as of today!
- CUORE has a rich science program of searches for rare decays of different Te isotopes, low energy studies and multi-crystal studies.
- The CUORE rare decays searches and results have strong synergies with the nuclear physics community
- CUORE paves the road to the CUPID project (CUORE Upgrade with Particle IDentification) for next generation tonne-scale cryogenic calorimeters for $0\nu\beta\beta$ decay and rare event searches

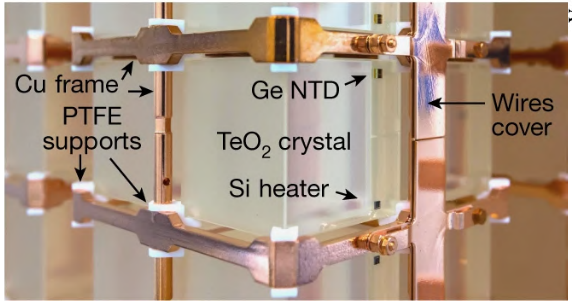
Thank you on behalf of the CUORE Collaboration

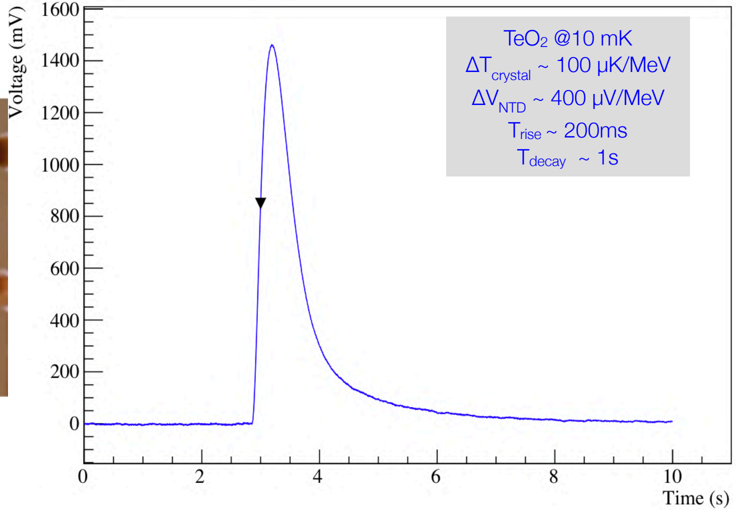
Backup

0νββ searches with cryogenic calorimeters: how

Cryogenic calorimeters
Conversion of energy deposit into phonons, measuring the heating of the crystal/absorber, which has to be operated at ~10 mK.







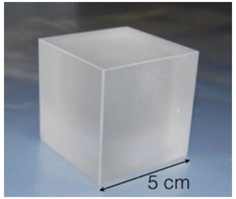
CUORE detectors and thermal pulse

Crystals with masses of ~ tens-hundreds g read by high impedance thermistors are slow detectors (~1ms-1s), still suitable for rare event physics searches

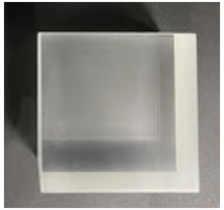
0νββ searches with cryogenic calorimeters: why

- ββ source embedded into the detector: high detection efficiency, ε~1
- Wide choice of absorber materials: possibility to exploit many ββ candidates
- Crystals of masses ~ 0.5kg with reproducible radio purity levels and detector performance: large active mass, up to ton-scale
- High energy resolution detectors (FWHM/E ~ 0.1-0.3% at $Q_{\beta\beta}$): measurement of the sum energy of the two emitted electrons
- Particle ID possibile for scintillating crystals: α background rejection
- Large dynamics: from keV to MeV

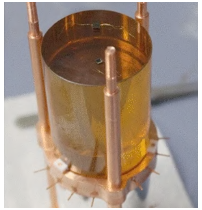
TeO_2 - ^{130}Te

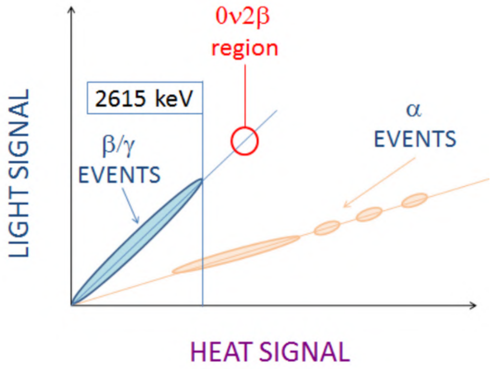


Li_2MoO_4 - ^{100}Mo



ZnSe - ^{82}Se



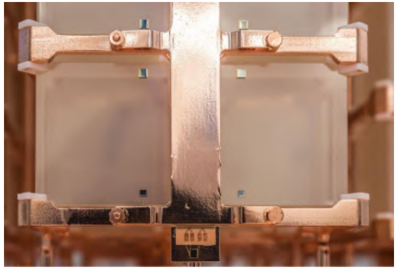


0νββ searches with cryogenic calorimeters: where are we?

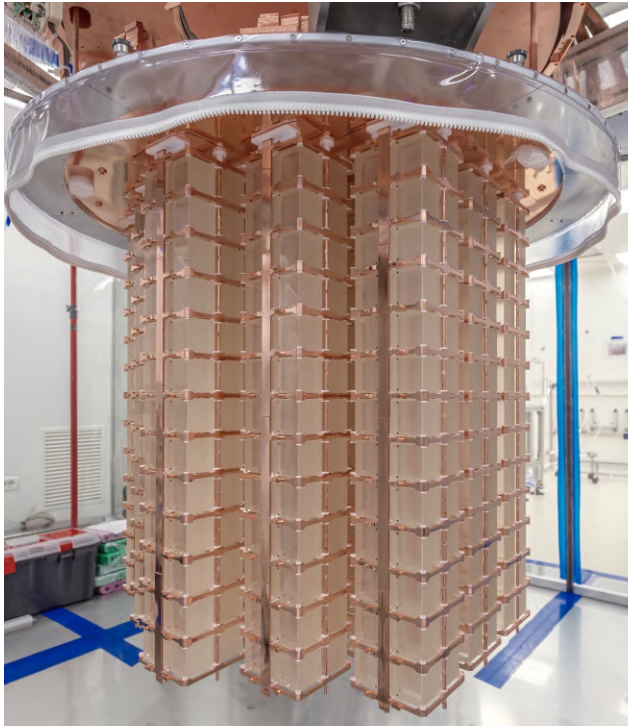
CUORE (2017-ongoing) @LNGS

CUORE 1TY - Nature (2022)

CUORE



TeO₂

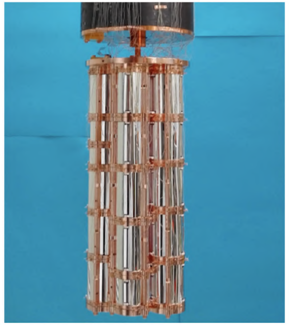


CUORE demonstrated the feasibility of a **tonne-scale experiment** employing cryogenic calorimeters, for the search of the 0νββ decay and rare events

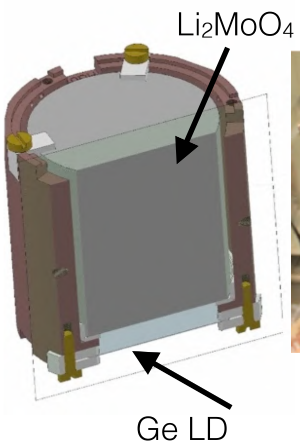
Talk CUORE results @ TAUP2025

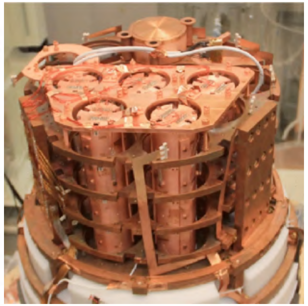
0νββ searches with cryogenic calorimeters: where are we?

CUPID-0 (2017-2020)
@LNGS



CUPID-Mo (2019-2021)
@Modane





CUPID-0 and CUPID-Mo demonstrated that the **technology of scintillating calorimeters** is mature to be implemented on large scale

The path towards CUPID

CUPID: CUORE Upgrade with Particle Identification

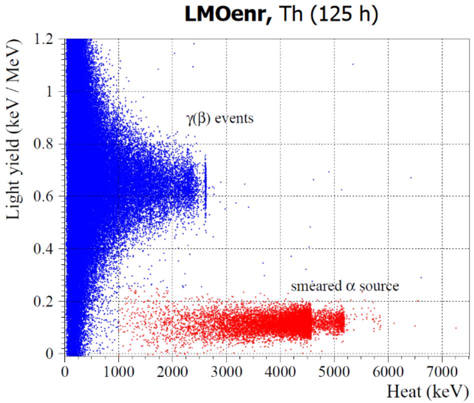
Exploit ^{100}Mo as ββ candidate

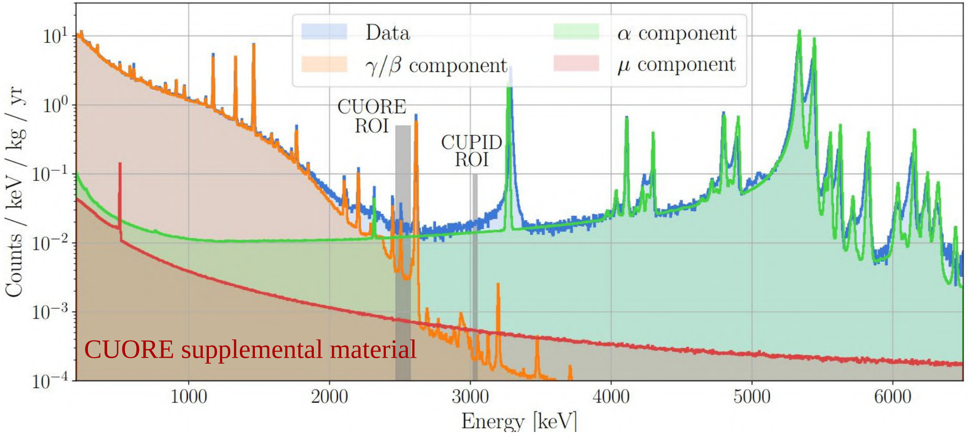
→ Utilise Li_2MoO_4 **scintillating crystals** for particle ID: high reduction of α background

→ Higher Q-value ($Q_{\beta\beta}$ = 3034 keV), most β/γ backgrounds reduced

→ Better phase space ad NME compared to ^{130}Te

CUORE background in the ^{100}Mo region, once α and μ are removed, is close to 10^{-4} cts/(keV kg yr)





CUORE Bkg Model - PRD (2024)

The CUPID Experiment

CUPID: CUORE Upgrade with Particle Identification

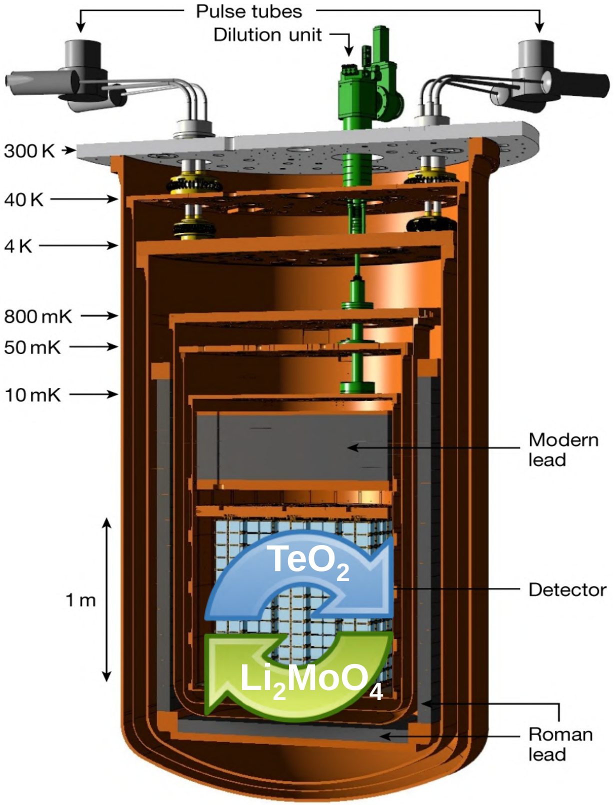
Replace CUORE TeO_2 detector with an array of $Li_2{}^{100}MoO_4$ scintillating crystals

New detector array:

- 1596 Li_2MoO_4 scintillating crystals (280 g each)
- 1700 light detectors → scintillation signal read-out
- Mo enrichment > 95% in ^{100}Mo

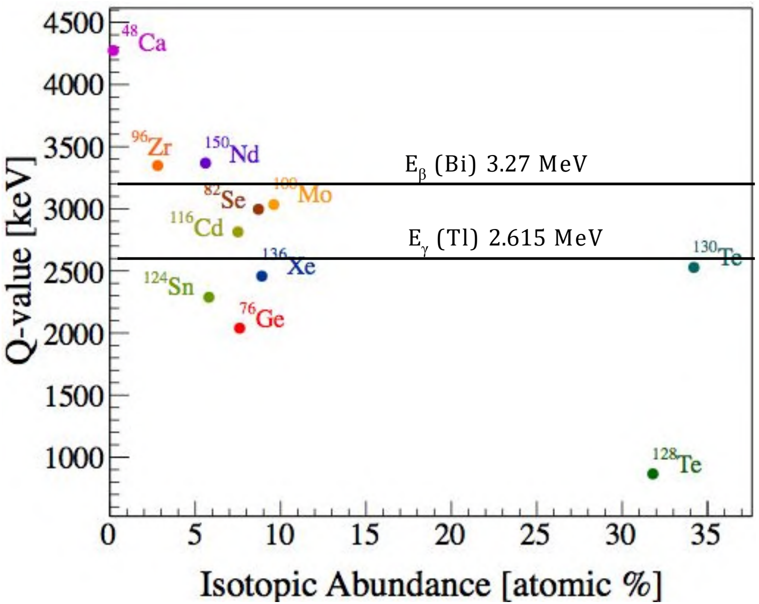
Additional needs:

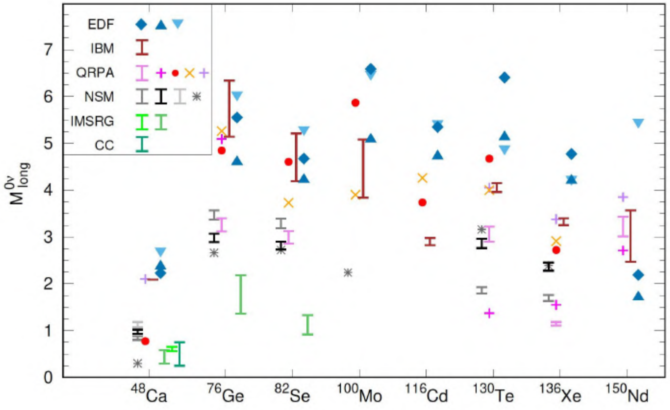
- Upgrade the CUORE cryostat for a ~1600 double read-out array
- Improve external n-shield & add a µ-veto



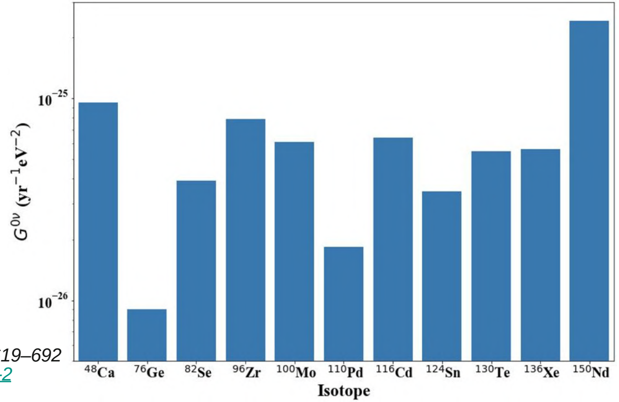
https://arxiv.org/pdf/2503.02894 (Accepted for publication by EPJC)

0νββ searches: candidate isotopes





Rev. Mod. Phys. **95**, 025002; https://doi.org/10.1103/RevModPhys.95.025002

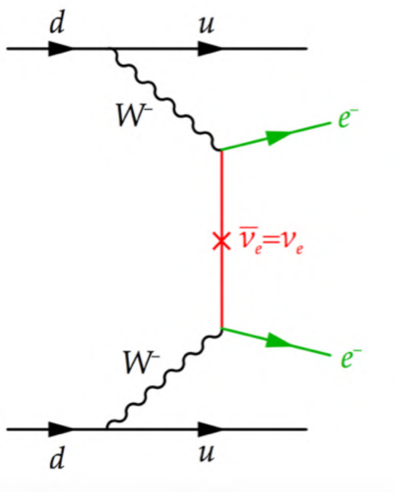


La Rivista del Nuovo Cimento (2023) 46:619–692
https://doi.org/10.1007/s40766-023-00049-2

0νββ decay and inference on neutrino mass

The standard neutrinoless double-beta decay mechanism: light Majorana neutrino exchange

The parent nucleus emits a pair of virtual W bosons. The W exchange a Majorana neutrino to produce the outgoing electrons. The exchanged neutrino can be seen as emitted (in association with an electron) with almost total positive helicity. For a massive Majorana neutrino, it has a small, O(m/E), negative helicity component which is absorbed in the other vertex by the Standard Model electroweak current.



From the decay rate it is possible to infer the effective neutrino mass

$$\frac{1}{T^{0\nu}_{1/2}} \propto G(Q_{\beta\beta}, Z)|M_{nucl}|^2|m_{\beta\beta}|^2$$

Phase space integral $G(Q_{\beta\beta},Z) \sim Q_{\beta\beta}^5$

Nuclear matrix element (NME)

Effective neutrino mass term

0νββ decay and inference on neutrino mass

CUORE

The standard neutrinoless double-beta decay mechanism: light Majorana neutrino exchange

$$\frac{1}{T^{0\nu}_{1/2}} \propto G(Q_{\beta\beta}, Z)|M_{nucl}|^2|m_{\beta\beta}|^2$$

Effective neutrino mass term $|m_{\beta\beta}|^2$

Neutrino mass matrix Mν can be decomposed as $M_\nu = U\ \mathrm{diag}(m_1{,}m_2{,}m_3)\ U^t$

where $m_i>0$ are the masses of the neutrinos and U is the PMNS mixing matrix.

Define the effective Majorana mass $m_{\beta\beta}$ where ϕ_i are called Majorana phases and cannot be probed by oscillation experiments.

$$m_{\beta\beta} = \left| \sum_{i=1}^{3} |U^2_{ei}|\ e^{i\varphi_i}\ m_i \right|$$

$m_{\beta\beta}$ is the ee-element of the mass matrix $|(M_\nu)_{ee}|$

0νββ is directly connected to neutrino oscillations phenomenology, and that it also provides direct information on the absolute neutrino mass scale, as cosmology and decay experiments do.

Rev. Mod. Phys. **95**, 025002;
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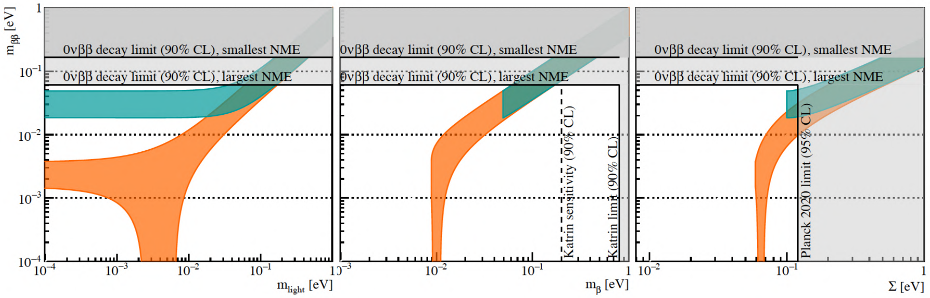


0νββ decay and inference on neutrino mass

The standard neutrinoless double-beta decay mechanism: light Majorana neutrino exchange

$$\frac{1}{T_{1/2}^{0\nu}} \propto G(Q_{\beta\beta}, Z)|M_{nucl}|^2|m_{\beta\beta}|^2$$

Nuclear Matrix Elements

Factoring out the hadron coupling gA wrt to just the **nuclear many-body part** and to light neutrino exchange

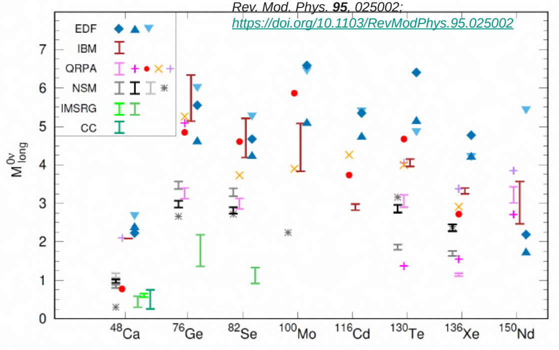
$$|M_{nucl}|^2 = g_A^4|M_{light}^{0\nu}|^2$$

All nuclear methods used to study 0νββ decay make a significant effort to describe with high quality the structure of the initial and final nuclei and the relative long and short-term interactions among nucleons.
Models: *Shell model, QRPA, EDF theory, IBM, Ab-initio methods*

$$M_{light}^{0\nu} = M_{long}^{0\nu} + M_{short}^{0\nu}$$

The variation of the NME about a factor three for a given isotope, highlights the uncertainties introduced by the approximate solutions of the nuclear many-body problem.

Current strong effort to improve the nuclear models for multiple isotopes ai quantify the NMEs theoretical uncertainties



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0νββ decay and inference on neutrino mass

CUORE

The standard neutrinoless double-beta decay mechanism: light Majorana neutrino exchange

$$\frac{1}{T_{1/2}^{0\nu}} \propto G(Q_{\beta\beta}, Z)|M_{nucl}|^2|m_{\beta\beta}|^2$$

Nuclear Matrix Elements

Factoring out the **hadron coupling gA** wrt to just the nuclear many-body part and to light neutrino exchange

$$|M_{nucl}|^2 = g_A^4|M_{light}^{0\nu}|^2$$

The “gA quenching" is a potential source of uncertainty in 0νββ-decay NMEs.
Most calculations systematically overestimate β-decay Gamow–Teller matrix elements. This implies the need of a correction, by quenching the value of the axial coupling g_A ($g_A' = q\ g_A$ with q ~0.7-0.8).

Very recently decay β-decay has been studied with the ab initio methods. These calculations suggest that the overprediction of matrix elements is more likely related to the GT β-decay operator than to gA.

CUORE physics analyses: 0νββ ^{130}Te decay search

Model	M0v	SRC	Reference	Link	Authors
QRPA-Jy (pnQRPA)	4.00	CD-Bonn	PRC 91, 024613 (2015)	http://journals.aps.org/prc/abstract/10.1103/PhysRevC.91.024613	Suhonen, Hyvärinen
NREDF	6.405	(shape+pair)	PRL 111, 142501 (2013)	http://dx.doi.org/10.1103/PhysRevLett.111.142501	Vaquero, Rodriguez
	5.13	(shape)			
ISM	1.79	Argonne	PRC C 93, 024308 (2016)	http://dx.doi.org/10.1103/PhysRevC.93.024308	Horoi, Neacsu
	1.93	CD-Bonn			
ISM	2.76	Argonne	J. Phys. G 45, 014003 (2018)	https://doi.org/10.1088/1361-6471/aa9bd4	Menéndez
	2.96	CD-Bonn			
QRPA	3.939	Arg. (t_1/2)	PRC 98, 064325 (2018)	https://doi.org/10.1103/PhysRevC.98.064325	Šimkovic, Smetana, Vogel
	4.673	Arg. (SU4)			
QRPA deformed	2.9	Argonne	PRC 97, 045503 (2018)	https://doi.org/10.1103/PhysRevC.97.045503	Fang, Faessler, Šimkovic
	3.22	CD-Bonn			
ISM	3.16	(effective op.)	PRC 101, 044315 (2020)	https://doi.org/10.1103/PhysRevC.101.044315	Coraggio, Gargano, Itaco, Mancino, Nowacki
	3.27	(bare operator)			
IBM-2	4.154	Arg. (pos. M_T)	PRD 102, 095016 (2020)	https://doi.org/10.1103/PhysRevD.102.095016	Deppisch, Graf, Iachello, Kotila
CDFT	4.89	Argonne	PRC 95, 024305 (2017)	https://doi.org/10.1103/PhysRevC.95.024305	Song, Yao, Ring, Meng

G0v (1E-15)	error	Reference	Link	Authors
14.22	0.9954	PRC 85, 034316 (2012)	http://dx.doi.org/10.1103/PhysRevC.85.034316	Iachello, Kotila
14.1		PRC 88, 037303 (2013)	http://dx.doi.org/10.1103/PhysRevC.88.037303	Stoica, Mirea
14.2547		PRC 92, 055502 (2015)	http://dx.doi.org/10.1103/PhysRevC.92.055502	Stefanik, Dvornicky
14.24		Front. Phys. 7, 12 (2019)	https://doi.org/10.3389/fphy.2019.00012	Stoica, Mirea

NMEs and Phase space factors for ^{130}Te

CUORE physics analyses: 2νββ ^{130}Te decay measurement

2νββ spectrum fit with improved formalism: results

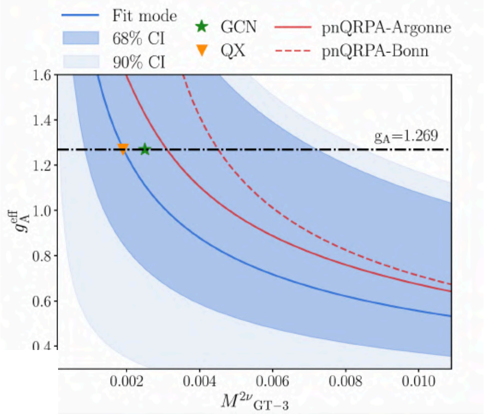
First-ever information from ^{130}Te on g_A

- Relatively high uncertainty
- Smaller S/N wrt to similar studies on ^{100}Mo and ^{136}Xe
- Advanced background model + high collected statistics
- Mode confirming quenching of gA
- Good match with theoretical models

$$g_A^{\mathrm{eff}} = \left[\frac{\left[T_{1/2}^{2\nu\beta\beta}\right]^{-1} \cdot \xi_{31}^2}{M_{GT-3}^2 \cdot G} \right]^{1/4}$$

where $G = G_0 + \xi_{31} G_2 + \xi_{31}^2 G_{22}/3 + (\xi_{31}^2/3 + \xi_{51}) G_4.$

$g_{A,\mathrm{eff}}$ effective value of axial coupling constant in nuclear medium



- CUORE data. For each Markov-chain MC step of the fit and for $M_{2\nu,GT-3}$ in the range 0–0.01, we obtain a posterior distribution for $g_{\mathrm{eff},A}$, from which we extract 68% CI and 90% CI.
Predictions from two nuclear models, ISM and pnQRPA. ISM has two different interactions, QX (g_A = 0.76) and GCN5082 (g_A =0.48)
- g_A free neutron value of 1.269