Exploring the impact of Mediterranean Storms on CUORE mK-calorimetric experiment

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Poster #77

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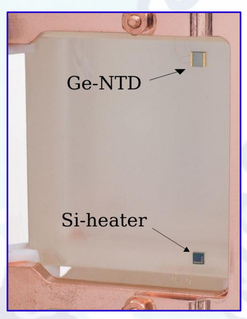
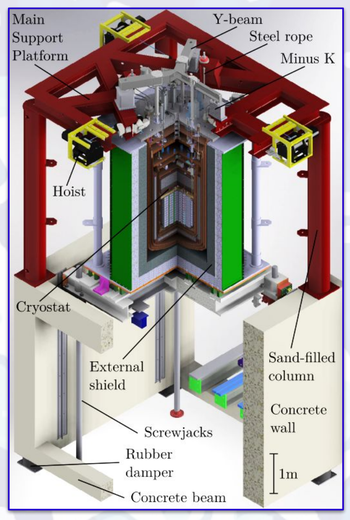
1. CUORE experiment

- CUORE searches for $0\nu\beta\beta$ decay of ^{130}Te:
  - ultra-rare process:
    $T_{1/2}^{0\nu}(^{130}\text{Te}) > 3.8 \cdot 10^{25}$ yr (90% C.I.);
  - leptogenesis ($\Delta L = 2$), Majorana $\nu \equiv \bar{\nu}$.

- CUORE experiment @ LNGS (Italy):
  - 988 low-T calorimeters at T ~ 11-15 mK;
  - TeO_2 crystals + Ge-NTD thermistors.





- Frequency band of CUORE thermal pulses: ~ 0-5 Hz

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  identify and characterize sources of low-ν noise to improve noise-reduction techniques and detectors energy resolution ΔE.

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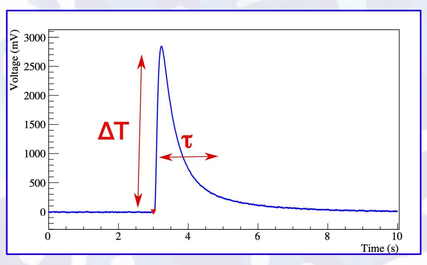
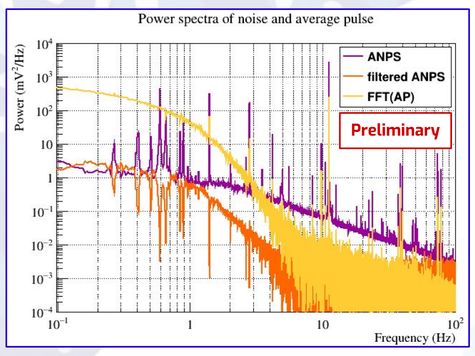
  potential worsening of $0\nu\beta\beta$ decay sensitivity:

$$S^{0\nu} \propto \sqrt{\frac{M\,T}{\Delta E\,B}}$$

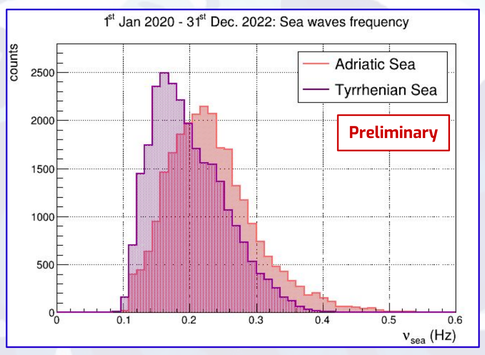


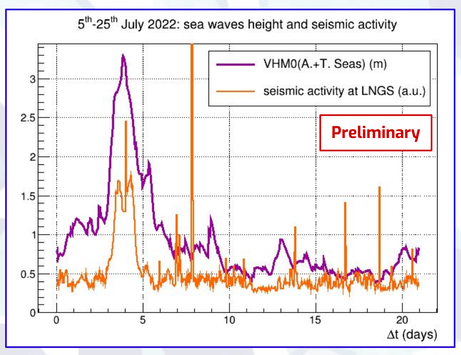


2. Multi-device approach

- Marine microseisms:
  - faint seisms due to sea waves motion and marine storms;
  - $0.1 \lesssim \nu_{sea} \lesssim 0.5$ Hz in Adriatic and Tyrrhenian Seas.

- Multi-device approach to correlate data from:
  - **Copernicus (E.U. Earth Observation space programme)**: identify storms, evaluate sea waves amplitude (VHM0);
  - **seismometers** at LNGS and on top of CUORE: correlate increase of seismic noise at LNGS with storms;
  - **CUORE low-temperature calorimeters.**





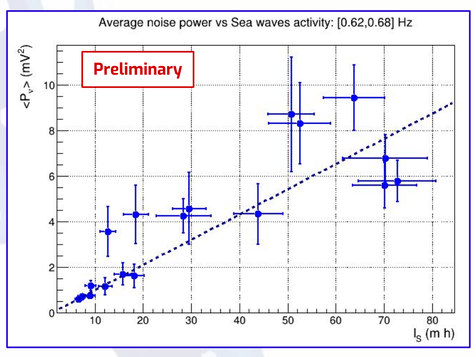
3. Impact of storms on CUORE

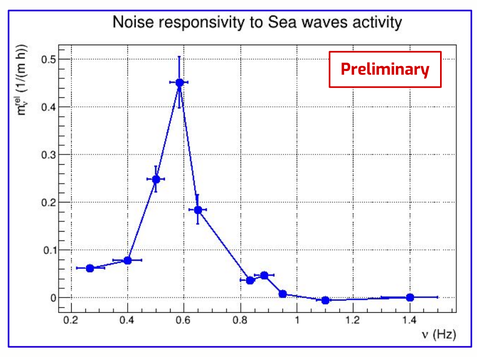
3.1 Time correlations between storms and low-ν noise

- Power of a noise ν-component:
  $P_\nu = \int_{\nu_1}^{\nu_2} ANPS(\nu)d\nu$
- Noise power ratio: $R_\nu = \frac{P_{i,\nu}}{P_{ref,\nu}}$
  - sub-Hz noise increases during Mediterranean storm outbreak.

3.2 Correlation between sea activity and low-ν noise

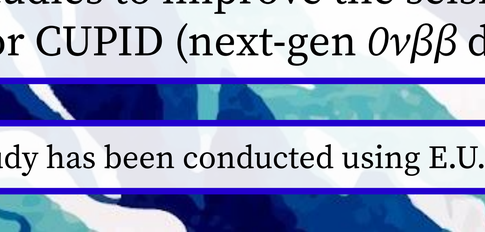
- Sea waves activity: $I_S = \int_{t_i}^{t_f} [VHM0_A(t) + VHM0_T(t)]dt$
- CUORE low-ν noise is linearly correlated to sea activity:
  - angular coefficient $m_\nu^{rel} = \frac{m_\nu}{min(<P_\nu>)}$ quantifies the responsivity of noise to changes of sea activity;
  - maximum responsivity at $\nu \sim 0.6$ Hz ➡ ➡ resonant mode of CUORE infrastructure.

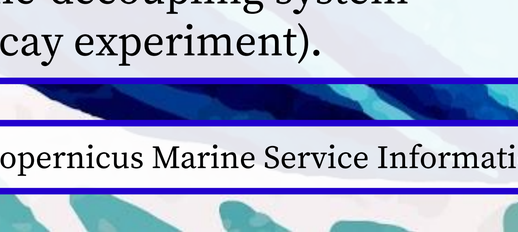




3.3 Seasonal modulation of CUORE baseline resolution

- CUORE $FWHM_{baseline}$ is linearly correlated to sea activity.
- The **seasonal modulation of Med. Sea activity reflects into seasonal modulation of CUORE $FWHM_{baseline}$** (1 yr period).





4. Next steps

- Ongoing analysis:
  - assess the impact on low-energy threshold;
  - assess the impact on γ-peaks energy resolution;
  - structural tests to mitigate microseismic noise in CUORE

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  studies to improve the seismic-decoupling system for CUPID (next-gen $0\nu\beta\beta$ decay experiment).

This study has been conducted using E.U. Copernicus Marine Service Information.