CUORE is a ton-scale underground bolometer array of 988 TeO₂ cubic crystals operated at the INFN Gran Sasso National Laboratories (LNGS) with the main aim of searching for the neutrinoless double beta decay (DBD) of 130Te and other rare processes. The crystals are arranged in 19 towers placed in a custom built dilution refrigerator able to cool down and keep the detector at the stable temperature of ~10 mK.

The energy released by particle interactions in the crystal cause a temperature rise. Neutron Transmutation Doped Ge thermistors transform the temperature pulses induced by particles into voltage pulses. They are biased to the temperature pulses induced by transmutation Doped Ge thermistors the crystal cause a temperature rise. Neutron absorption of neutrons in the target material results in the production of 140Te and subsequent ββ decay.

The CUORE cryostat

The CUORE cryostat is made of 6 nested copper vessels thermalized at decreasing temperatures. The cooling power is provided by a dilution unit and 5 Pulse Tube (PT) Cryocoolers:

- custom adapted PT415-RM (Cryomech)
- cooling power: 1.2 W @ 4.2 K and 32 W @ 45 K for each PT
- 0.7 Hz rotating valve alternatively connects high/low pressure sides of a compressor to optimize the amplitude evaluation, hence the energy resolution.

The length W of the waveforms limits the resolution of the Discrete Fourier Transform (DFT) to \( \Delta \theta = 1/W \sim 0.1 \text{ Hz} \). A sample of noise events with a 100 s window were used to investigate sub-structures of the Noise Power Spectrum (NPS, Fig. 4).

The CUORE data analysis relies on 10 s waveforms around each trigger position. Each waveform is processed with an Optimum Filter to optimize the amplitude evaluation, hence the energy resolution. The expected average improvement in the resolution of the Discrete Fourier Transform (DFT) to \( \Delta \theta = 1/W \sim 0.1 \text{ Hz} \).

The notch filter is effective just on noise events, despite a transient response that grows as the inverse of the removed bandwidth. When applied to thermal pulses, ringing is observed and the filtered pulse is distorted.

We are interested in removing the low frequency components, because there our signal lies: 0 < f < 5 Hz. We would like to achieve:

- very precise removal of noise peaks in order to minimize the loss of signal components
- accurate estimation of the bandwidth and frequency of each noise source
- minimal deformation of the original pulse

We implemented a time domain notch filter:

\[ y[n] = \sum_{i=1}^{2} a_i y[n - i] + \sum_{i=2}^{2} b_i y[n - i] \]

where \( y[n] \) is the n-th sample of the filtered output signal, \( x[n] \) is the corresponding sample of the input signal, \( a_i \) and \( b_i \) are constant coefficients that define the filter response.

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