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A systematic study on the effects of Tl dopant contribution to quenching factor measurements in NaI crystals

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NaI(Tl) based scintillation detectors have become a staple in the field of direct dark matter searches, with the DAMA-LIBRA experiment being the standout for its reported observation which is in direct contrast with other results. In order to accurately calibrate the energies of WIMP-induced nuclear recoil signals and conclusively rule out the parameter space covered by DAMA/LIBRA, precise measurements of the quenching factor of the NaI crystals is essential for each of these experiments, as it is well established that electron recoils and nuclear recoils have dissimilar scintillation light yields.

In this study, we present first preliminary results of a systematic analysis that has been carried out by the COSINUS collaboration to measure the quenching factor values primarily in the low recoil energies of $1\text{-}30\text{keV}_{nr}$, in order to better understand the discrepancies/uncertainties reported by various experiments. Five ultra-pure NaI crystals, manufactured by the Shanghai Institute for Ceramics, each of which have varying Tl dopant concentrations, were irradiated with a mono-energetic neutron beam at the Triangle Universities National Laboratory, North Carolina, USA to study its impact on the quenching factor values in our desired recoil energy range.

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