Passive Crystal Antineutrino Detectors for Nuclear Safeguards

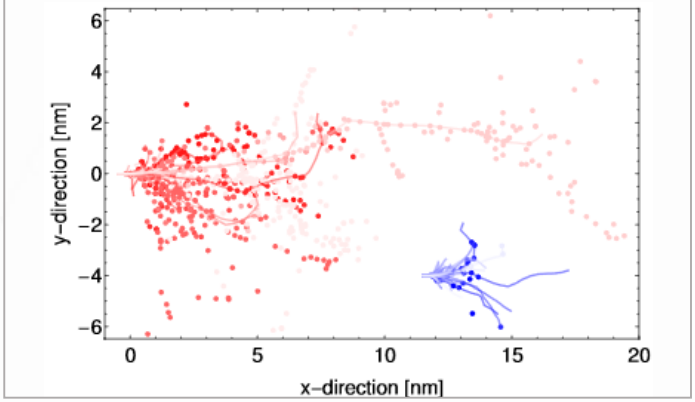
VTIP 21-124: "Passive Low-energy Nuclear Recoil Detection with Color Centers"

THE CHALLENGE

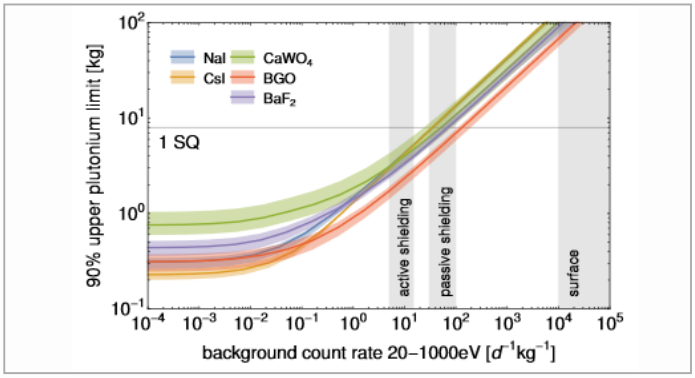
As the use of nuclear energy becomes more prevalent in the 21st century, finding novel methods of detecting radiation for personal dosimetry and non-proliferation applications have become increasingly important.

OUR SOLUTION

The Huber lab at Virginia tech has developed a class of nuclear detectors based on low-energy nuclear recoil events. These detectors utilize crystal defects (i.e. color centers) which can be detected using confocal microscopy. The detectors are passive, operate at room temperature, inexpensive, and robust. Additional advantages to this technology include immunity from cyber attacks and spoofing. The detectors can be tailored to a broad range of applications including thermal neutron detection, personal dosimetry, and nuclear non-proliferation safeguards to monitor reactor power and put limits on plutonium production.



Shown is the overlay of 50 typical cosmic ray neutron (red) and reactor coherent elastic neutrino nucleus scattering events blue in NaI. Vacancies are marked by disks and tracks created by the primary recoil are marked by a line.



Shown is the 90% CL limit upper bound on the amount of produced plutonium for a reactor which is shut down as a function of the neutron background rate. The detector size is 100 g, the distance is 20 m and the data taking period is 90 days. The different curves are for different materials, as specified in the legend, and the width of the band is due to a±20% variation of threshold damage energy. The black horizontal line indicates 8 kg of plutonium, the so-called significant quantity (SQ).

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