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NUCLEUS - Exploring coherent neutrino-nucleus scattering with cryogenic detectors

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The NUCLEUS experiment aims for the detection of coherent neutrino-nucleus scattering at a nuclear power reactor with gram-scale, ultra-low threshold cryogenic detectors. This technology leads to a miniaturization of neutrino detectors and allows to probe physics beyond the Standard Model of Particle Physics.

We present results from a 0.5g prototype detector, operated above ground, which reached an energy threshold for nuclear recoils of below 20eV. This sensitivity is achieved with tungsten transition edge sensors which are operating at temperatures of ~15mK and are mainly sensitive to non-thermal phonons. These small recoil energies become accessible for the first time with this technology, which allows collecting large-statistics neutrino event samples with a moderate detector mass. A first-phase cryogenic detector array with a total mass of 10g enables a 5-sigma observation of coherent scattering within several weeks.

We identified a suitable experimental site at the CHOOZ nuclear power plant and show muon and neutron background measurements performed there. The operation of a NUCLEUS cryogenic detector array at such a site requires highly-efficient background suppression.

NUCLEUS plans to use an innovative technique consisting of separate cryogenic anti-coincidence detectors against surface backgrounds and penetrating (gamma-, neutron-) radiation. We present first results from prototypes of these veto detectors and their operation in coincidence with a NUCLEUS target detector.

Furthermore, I will present details on a planned extensive R&D program towards a NUCLEUS phase 2 detector array with a total mass of 1kg. Issues that need to be addressed are the TES fabrication reproducibility, detector mass production and readout multiplexing.

The NUCLEUS experiment has been fully funded and we are currently preparing the first-phase cryogenic detector which is scheduled to be commissioned in 2021 at the CHOOZ nuclear power plant.

Less than 5 years of experience since completion of Ph.D

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Student (Ph.D., M.Sc. or B.Sc.)

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