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A concept of neutrino scintillation detector with threshold below 1 keV

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A modular SrI2(Eu) scintillation ultra-low energy threshold neutrino detector is being developed in INR RAS to research low energy neutrinos produced in radioactive isotope decays and also reactor neutrinos. Proposed layer structure of the detector allows to easily scale it depending on the task. Each layer will consist of 16 modules, each comprising 4 scintillation crystals. Readout of each crystal is done by a SiPM matrix. In this work, performance of SrI2(Eu) scintillation detectors will be discussed. The light yield of SrI2(Eu) scintillator can reach up to 120 p.e./keV. SiPMs with high photon detection efficiency (PDE) of around 50% can be used to lower the threshold down to ˜100 eV. SrI2(Eu) emission spectrum aligns well with SiPM maximum PDE. It will be shown that Dark Current Rate (DCR), which is the main disadvantage of utilizing SiPMs for low threshold measurements, is suppressed at temperatures below -60℃. DCR of several SiPM matrixes was tested in a broad temperature range for various operating voltages. The measurements show satisfactory light yield of tested SrI2(Eu) scintillation detector prototypes. Preliminary results of scintillation detectors confirm the ability to detect recoil electrons with energy below 1 keV. A developed coincidence scheme and single electron counting regime should allow to decrease noise rate and to detect events with the discussed threshold of 100 eV.

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