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Development of nuclear power plant reactor monitoring by the neutrino method using the iDREAM detector

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In the 90s of the 20th century, scientists at the Kurchatov Institute experimentally proved that antineutrino spectrometers based on liquid scintillators can monitor the power of a nuclear reactor and the isotopic composition of burning fuel. These capabilities provide a complementary way of nuclear power plant reactor monitoring with respect to the standard methods in the framework of in-reactor control system. Moreover, such capability offers a promising tool for studying the dynamics of fuel burnout and changes in its isotopic composition in experimental industrial reactors of the 4th generation.
The iDREAM (industrial Detector of reactor antineutrinos for monitoring) experiment is aimed for precision spectrometry of reactor antineutrinos, studying so-called "reactor anomalies" and remote monitoring of nuclear reactors based on the characteristics of the antineutrino flux and spectrum, including for technical support of IAEA non-proliferation safeguards. In addition, since an industrial nuclear reactor is an exceptionally powerful source of gamma rays a nearby liquid scintillation detector allows us to study rare processes that go beyond the Standard Model.
The detector is a spectrometer based on liquid organic scintillator (LOS) where reactor antineutrinos are detected via inverse beta-decay reaction. The 1.1 m3 antineutrino target is filled with Gd-dopped linear alkylbenzene (LAB) based LOS. The original recipe and operational procedures ensured experimentally confirmed long term chemical stability and stability of the transparency and light yield. The detector is mounted at a distance of 19.5 m from the core center of the VVER-1000 reactor No. 3 of the Kalinin NPP with thermal power 3000 MW. The detector has been collecting data since 2022. Over several years of continuous data collection, the detector has shown a confident sensitivity to a drop in reactor power in the counting mode. Based on the data from the iDREAM neutrino detector, the daily energy output of the VVER-1000 industrial nuclear reactor was measured using the relative method. It is shown that the agreement between the results of measurements of energy output via neutrinos and data from in-reactor control systems reaches a value better than 1%.

Collaboration you are representing

iDREAM

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