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## Determination of Ionization Yields for Recoil Nuclei in Argon

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Two-phase (liquid–gas) argon detectors exhibit good sensitivity to relatively low recoil-nucleus energies ( $\sim 1$  keV) — which is precisely why they have found widespread application in nuclear physics and astrophysics experiments. Scaling up to active masses of tens of tonnes opens up another area for them — WIMP searches. Reconstruction of the recoil-nucleus energy from the detector signal is impossible without knowledge of the ionization yield, i.e. the ratio of the number of electrons emitted from the liquid into the gas to the recoil-nucleus energy. Ionization yields are most conveniently measured using neutrons that mimic WIMPs.

Work on measuring argon ionization yields with a two-phase detector is underway at the Budker Institute of Nuclear Physics. The recoil-nucleus energy of 120 keV obtained in earlier measurements with a 2.45 MeV neutron beam from a D–D reaction-based neutron generator [1] was relatively high; moreover, the accumulated statistics were insufficient to achieve the required accuracy. A solution was found in the use of the VITA accelerator-based neutron source at BINP SB RAS, employed for the development of boron neutron capture therapy (BNCT) techniques [2, 3]: it made it possible both to increase the statistics and to move to lower recoil-nucleus energies. For two series of test measurements, a scintillation detector based on a stilbene single crystal and a photomultiplier tube was used instead of the two-phase detector. This made it possible to determine the detection thresholds of the neutron detectors and the quenching factors of the stilbene crystals. Agreement with the experiment was also demonstrated by Monte Carlo simulations of the energy spectra of scattered neutrons.

The next phase of the experiment is currently being prepared: the light collection of the two-phase detector is to be increased, and the detector itself is to be placed in the bunker of the VITA accelerator-based neutron source. The light collection is planned to be improved by coating the entire surface of the detector with the wavelength shifter tetraphenylbutadiene (TPB). A series of studies has already been carried out, in which the re-emission efficiency of TPB was measured and aging effects were investigated. The sensitivity to optical scintillation signals is expected to be enhanced by installing an additional photodetector array of silicon photomultipliers (SiPMs) ArrayC-60035-4P-BGA. For these SiPMs, the gain, the cross-talk probability, and the dark noise count rate at cryogenic temperature have been measured.

References 1. A. E. Bondar et al., Siberian Physical Journal 12, 3 (2017). 2. С. Ю. Таскаев. Ускорительный источник нейтронов VITA. М.: ФИЗМАТЛИТ, 2024. 248 с. 3. S. Taskaev et al. VITA accelerator neutron sources: status and research results. Preprint 202605.0884 (2026).

**Primary author(s) :** BAKULEV, Mikhail (MSU Physics Faculty); Prof. BONDAR, A. (Budker Institute of Nuclear Physics, Novosibirsk State University); Mr. OLEJNIKOV, V. (Budker Institute of Nuclear Physics, Novosibirsk State University, ); GROMOV, Maxim (SINP MSU); Mr. LIZUNOV, A. (Budker Institute of Nuclear Physics, Novosibirsk State University); Mr. MIHEEV, T. (Budker Institute of Nuclear Physics, Novosibirsk State University); Mr. NOSOV, V. (Budker Institute of Nuclear Physics, Novosibirsk State University); Mr. SOKOLOV, A. (Budker Institute of Nuclear Physics, Novosibirsk State University); Mr. STARTSEV, N. (Novosibirsk State University); Mr. CHASHCHIN, S. (Lomonosov Moscow State University (Skobeltsyn Institute of Nuclear Physics)); CHEPURNOV, Alexander (Skobeltsyn Institute of Nuclear Physics, Moscow State University); Mr. BYKOV, T. (Budker Institute of Nuclear Physics, Novosibirsk State University); Mr. KASATOV, D. (Budker Institute of Nuclear Physics,

Novosibirsk State University); Ms. SOKOLOVA, E. (Budker Institute of Nuclear Physics, Novosibirsk State University); Prof. TASKAEV, S. (Budker Institute of Nuclear Physics, Novosibirsk State University, Joint Institute for Nuclear Research)

**Presenter(s) :** BAKULEV, Mikhail (MSU Physics Faculty)

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