Ultracold Neutron Source for Research in Fundamental Physics at the PIK Reactor

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In 2020, a Federal Program was implemented for creating experimental facilities for the PIK reactor. One of the main facilities to be constructed within this Program is a new superfluid helium based UCN source for research in fundamental physics [1]. The projected UCN density in the chambers of a neutron EDM spectrometer connected to the source by a UCN guide is expected to be 200 cm^{-3} [2].

This UCN source will be installed on the thermal neutron beam channel GEK-4 with its inner diameter of 220 mm. Our plan is to create a 1-meter-wide aperture in the outer PIK biological shielding. This hole is large enough to host the entire UCN source, with a graphite reflector, a liquid deuterium pre-moderator and the superfluid helium converter, everything included in an outer vacuum vessel. The thermal neutron flux density in the convertor is expected to be 6.6×10^{10} $cm^{-2}s^{-1}$.

UCN source manufacturing is at the final stage right now: all the elements of the entire UCN source part and the technological complex have already been manufactured. More than 40 m^3 of isotopically pure helium-4 with a helium-3 content below 10^{-8} was produced. Work is underway to assemble the entire complex at PNPI for cryogenic testing and confirm the operating parameters of the facility.

In general, a broad research program is planned. The UCN guide system has been designed to feed up to four experimental facilities. At the start of its operation, it is planned to equip the UCN source with experimental setups already available at PNPI: an nEDM spectrometer and two neutron lifetime experiments, one with a gravitational and one with a magnetic trap.

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Keywords: ultracold neutron, PIK reactor, superfluid helium, neutron EDM

References

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