The first UCN counting from He-II spallation UCN source

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Neutrons whose energy is less than the Fermi potential of matter are completely reflected from the surface of the matter, which are defined as ultra cold neutrons (UCN). The unique property of UCN: UCN is confined in a bottled, is used for precision experiments on neutron electric-dipole-moment (EDM) and neutron β-decay, and experiments on quantum mechanics.

A new generation UCN source was constructed. The new UCN source uses a phonon excitation in superfluid helium (He-II) for UCN conversion from cold neutrons. Since a large phonon phase-space is used, the new method is free from the Liouville's theorem which limits the UCN density in the turbine source at Grenoble, which is the present most intense UCN source.

The UCN density is obtained by a product of production rate and storage time. The storage time is limited by up-scatterings upon phonon collision and wall collision in a UCN bottle. The up-scattering rate depends on temperatures of He-II and the UCN bottle. The temperature should be kept low, < 0.8 K for He-II. Therefore, small γ heating is essentially important to obtain high UCN density. Since the spallation neutron source has a larger n to γ ratio, we obtain a higher cold neutron flux, therefore a higher UCN production rate with small γ heating in the He-II compared with the reactor.

We used a spallation reaction of a lead target by a 400-MeV proton beam from the RCNP ring cyclotron for the neutron production. After 1- to 40-s proton beam impingement, neutrons were counted as a function of time. We observed a clear signal of the UCN production in the He-II bottle. We expect a great improvement in the UCN density compared with Grenoble.