Architecture, Implementation, and First Performance Results of a Neutron Beam System for Accelerator BNCT

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Accelerator-based boron neutron capture therapy (BNCT) requires simple, reliable, and cost effective sources of neutron beams. Proton-lithium reaction at proton energies of about 2.5MeV generates neutrons with energy spectrum favorable for BNCT. This range of proton energies is optimal for electrostatic accelerators. Modern technologies of electrostatic accelerators make it possible to achieve the targeted performance and meet the requirements of reliability, simplicity, and cost.

The tandem type of electrostatic accelerators is particularly attractive for the Neutron Beam System (NBS) for accelerator BNCT. The principle of operation of tandem accelerators makes it possible to reduce the accelerating voltage by a factor of two, and to place the ion injector at the ground potential. The first implementation of an experimental tandem accelerator for BNCT NBS was developed at the Budker Institute of Nuclear Physics (BINP), which has partnered with TAE Technologies to commercialize the technology by increasing the nominal proton beam energy and current to clinically relevant levels.

In order to boost the proton beam parameters, the architecture of the tandem accelerator underwent substantial improvements, including the replacement of the Cs-based negative ion source with a Cs-free alternative. Introduction of a pre-accelerator, together with advanced beam optics, helped to resolve long-standing issues with current limitation and beam stability in the tandem. The design of the high voltage power supply was improved to achieve high reliability. The adaptive high energy beam line provides high uniformity of the beam rastering on the solid lithium target.

The first commercial NBS system from this partnership underwent testing at BINP before beginning installation at its permanent location. First operations of the NBS have proved the architecture concept. At present, the system is in its final commissioning stage with operational parameters meeting or exceeding the design specifications.