PL172

Neutron source VITA: from an idea to a clinic and fundamental knowledge

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A compact neutron source has been proposed and created at the Budker Institute of Nuclear Physics to obtain a neutron beam that largely meets the BNCT requirements. The source comprises an original design tandem accelerator (Vacuum Insulated Tandem Accelerator), a solid lithium target, and a beam shaping assembly. The accelerator is used to provide a dc proton/deuteron beam. The ion beam energy can be varied within a range of 0.6–2.3 MeV, keeping a high-energy stability of 0.1%. The beam current can also be varied in a wide range (from 1 pA to 10 mA) with a high current stability (0.4%). The unique capabilities of the facility allow: i) to generate an epithermal neutron flux with characteristics suitable for BNCT; ii) to generate thermal neutrons for determining the impurity content by the activation analysis, in particular, in ceramic samples developed for ITER; iii) to obtain a diagnostic neutron beam of an epithermal energy range without the presence of fast and thermal neutrons in it for boron imaging; iv) to generate a powerful flux of fast neutrons for radiation testing of optical fibers for CERN; v) to form a bright source of monochromatic γ-rays with an energy of 478 keV for measuring the ^{7}Li(p,p'γ)^{7}Li cross-section and the contribution of the fast neutron dose and the ^{14}N(n,p)^{14}C reaction dose to the absorbed dose during BNCT, vi) to generate 9.17 MeV γ-rays with the ^{13}C target for detecting explosives; vii) to study the energy and angular characteristics of the ^{11}B(p,α)αα reaction. The neutron source served as a prototype for the facility created for a clinic in Xiamen (China) and the facilities being created for the CNAO in Pavia (Italy) and the Oncology Center in Moscow (Russia). The report describes the features of the facility, the results of its application, and plans for future research.

Keywords:
charged particle accelerator, neutron target