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BNCT ECR Discharge Chamber Low SWR Design and Beam Experiments

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Boron Neutron Capture Therapy (BNCT) is an emerging treatment in nuclear medicine and radiation therapy, offering precise cancer cell targeting while sparing healthy tissue. The discharge chamber, a critical component of the BNCT ECR ion source, significantly impacts ion source performance and beam quality. This article details the design of the second BNCT accelerator ECR ion source (BNCT02 ECR) at the Institute of High Energy Physics, Chinese Academy of Sciences. It explores two design schemes for the discharge chamber：a cylindrical discharge chamber and a square discharge chamber on geometric structure, magnetic field configuration, and ridge waveguide design to achieve a low standing wave ratio (SWR). These improvements address discharge instability caused by sensitive ceramic block positioning, enhancing beam intensity, stability, and arc ignition success. Beam experiments validated the design. The BNCT system at Dongguan People's Hospital has operated efficiently since 2024, achieving a target beam power of ~28 kW, an operational rate >95%, and cumulative runtimes of 6,694 hours for the ion source and 7,073 hours for the power source. A single neutron target has accumulated 5,160 milliampere-hours, with a peak daily target time exceeding 110 milliampere-hours. BNCT02's neutron flux density meets IAEA clinical standards.

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