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Status of the High-Current Electron-Beam Ion Source Charge Breeder for the Facility for Rare-Isotope Beams

The Reaccelerator (ReA) of the Facility for Rare-Isotope Beams (FRIB) employs an Electron-Beam Ion Trap (EBIT) as a charge breeder to reaccelerate rare-isotope beams to several MeV/u. The ReA EBIT uses a Pierce-type electron gun with its cathode partially immersed in the fringe field of a 4-T superconducting solenoid. A barium-impregnated tungsten dispenser cathode is used to produce an electron current of 300 –600 mA, corresponding to an electron current density of 170 –340 A/cm² in the ion trap region. The maximum trap capacity of the ReA EBIT is 10¹⁰ elementary charges. However, this is insufficient to handle high RIB rates, which are expected to exceed to 10¹⁰ particles/s in some case. In order to accept such rates, a High Current Electron-Beam Ion Source (HCEBIS) has been built and is now being commissioned. The HCEBIS is based on main components of the former Test-EBIS at Brookhaven National Laboratory. The HCEBIS electron beam is launched from a 9.2-mm lanthanum hexaboride convex cathode immersed in a 0.1-T axial magnetic field from a room-temperature coil and adiabatically compressed into the 4-T field of a superconducting solenoid. An electron-beam current of 1 A with a 50% duty cycle has been produced. More than 2 A was obtained for short duty cycles. An upgrade to increase the electron-beam current of up to 4 A in the future will allow for a maximum trap capacity of 2.4×10¹¹ elementary charges. This paper presents the status of the HCEBIS, including the results of the electron-beam commissioning and systematic studies.

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