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High-intensity highly charged ion beam production by superconducting ECR ion sources at IMP

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Accelerator facility for rare isotope beam production requests high power primary ion beam which actually very much depends on performance of the front-end ion source. Superconducting ECR ion source with higher magnetic fields and higher microwave frequency is the most straight forward path to achieve high beam intensity and high charge state in the past years. SECRAL is a superconducting-magnet-based ECRIS (Electron Cyclotron Resonance Ion Source) for the production of intense highly-charged heavy ion beams. It is one of the best performing ECRISs worldwide and the first superconducting ECRIS built with an innovative magnet to generate a high strength Minimum-B field for operation with heating microwaves up to 24-28 GHz. SECRAL has so far produced a good number of CW (Continuous Wave) intensity records of highly-charged ion beams, in which the beam intensities of 40Ar^{12-14+} , 86Kr^{18+} , 129Xe^{26+} have exceeded 1 eMA for the first time by an ion source. SECRAL source has run into operation to deliver highly charged ion beams for HIRFL accelerator for more than 9 years and total beam time more than 30000 hours, which has demonstrated its excellent stability and reliability. SECRAL-II, an upgraded version of SECRAL, was built successfully in less than 3 years, and has recently been commissioned at full power of a 28 GHz gyrotron and three frequency heating (28+45+18 GHz). New record beam intensities for highly charged ion production have been achieved by SECRAL-II, such as $620\text{e}\mu\text{A } 40\text{Ar}^{16+}$, $15\text{e}\mu\text{A } 40\text{Ar}^{18+}$, $53\text{e}\mu\text{A } 129\text{Xe}^{38+}$ and $17\text{e}\mu\text{A } 129\text{Xe}^{42+}$. A 45 GHz superconducting ECR ion source FECR (a first Fourth generation ECR ion source) is being built at IMP. FECR will be the world first Nb₃Sn superconducting-magnet-based ECR ion source with 6.5 Tesla axial mirror field, 3.5 Tesla sextupole field on the plasma chamber inner wall and 20 kW@45 GHz microwave coupling system. This talk will focus on high-intensity highly- charged ion beam production by SECRAL and SECRAL-II at 24-28 GHz and technical design of 45 GHz FECR, which demonstrates a technical path for highly charged ion beam production from 24-28 GHz SECRAL to 45 GHz FECR.

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