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"The High Intensity Challenge for Electron Cyclotron Resonance Ion Sources."

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Research in nuclear physics with heavy ions continues to drive the development of Electron Cyclotron Resonance (ECR) ion sources to both higher charge states and greater intensities. Already, the beam intensities from ECR ion sources have reached the 1 emA level for beams such as O^{6+} and Ar^{8+}. However, the production of mA level beams from heavier, higher charge state beams presents significant challenges. The first challenge is to generate and confine a sufficiently dense plasma with a very low neutral density and high electron temperature to produce the needed ions. Fortunately, the density of the high charge state ECR plasmas scales roughly with the square of the microwave frequency, provided the magnetic field is scaled linearly with frequency and $B_{confinement}$~2 B_{ecr} is maintained. At 28 GHz, the optimum confining fields are about 2 T which can only be produced with superconducting magnets. The second challenge is to produce the high intensity beams from solid feeds and this requires specialized ovens located close to the hot electron plasma. The third challenge is to efficiently extract and transport the intense beams without degrading the emittance. Traditionally ECR sources have operated in the 10 to 20 kV range but at these voltages the space charge forces cause beam losses when the total extracted currents are many mA. The two main approaches are to operate at higher extraction voltage and to separate the desired charge state from the others extracted as early in the beam transport as possible. In this paper we will review the current performance of high field high frequency ECR ion sources such as RIKEN-18 GHz ECR, SERSE and Phoenix, describe other ion sources under now under construction such as the superconducting source VENUS at Berkeley and discuss progress on the beam transport issues.

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