EXPERIMENTAL EVALUATION OF A NEGATIVE ION SOURCE FOR A HEAVY ION FUSION NEGATIVE ION DRIVER*

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Negative halogen ions have recently been proposed as a possible alternative to positive ions for heavy ion fusion drivers because electron accumulation would not be a problem in the accelerator, and if desired, the beams could be photodetached to neutrals [1]. To test the ability to make suitable quality beams, an experiment was conducted at Lawrence Berkeley National Laboratory using chlorine in an RF-driven ion source. Without introducing any cesium (which is required to enhance negative ion production in hydrogen ion sources) a negative chlorine current density of 45 milliamperes per square centimeter was obtained under the same conditions that gave 53 milliamperes per square centimeter of positive chlorine, suggesting the presence of nearly as many negative ions as positive ions in the plasma near the extraction plane. The negative ion spectrum was 99.5% atomic chlorine ions, with only 0.5% molecular chlorine, and essentially no impurities. Although this experiment did not incorporate the type of electron suppression technology that is used in negative hydrogen beam extraction, the ratio of co-extracted electrons to negative chlorine ions was as low as 7 to 1, many times lower than the ratio of their mobilities, suggesting that few electrons are present in the near-extractor plasma. This, along with the near-equivalence of the positive and negative ion currents, suggests that the plasma in this region was mostly an ion-ion plasma. The negative chlorine current density was relatively insensitive to pressure, and scaled linearly with RF power. If this linear scaling continues to hold at higher RF powers, it should permit current densities of 100 milliamperes per square centimeter, sufficient for present heavy ion fusion injector concepts.

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1. L. R. Grisham, "Evaluation of Negative-Ion-Beam Driver Concepts for Heavy Ion Fusion," *Fusion Science and Technology* **43,** 191-199 (2003).