RF PLASMA SOURCE FOR HEAVY ION FUSION*

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We are developing high-current ion sources for Heavy Ion Fusion applications. Heavy ion driven inertial fusion requires beams of high brightness to deposit the necessary high energy in the target to obtain high gain. Our proposed RF plasma source starts with an array of high current density mini-beamlets (of a few mA each at ~100 mA/cm^2) that are kept separated from each other within a set of acceleration grids in order to minimize the space charge expansion. After they have gained sufficient kinetic energy (~1 MeV), the mini-beamlets will be allowed to merge together to form a high current beam (about 0.5 A) with low emittance. Simulations have been done to maximize the beam brightness within the physical constraints of the source.

We have performed a series of experiments on an RF plasma sources. A 80-kV 20-μs source has produced up to 5 mA of Ar^+ in a single beamlet. The emission current density was over 100 mA/cm for this case. We have measured the emittance of a beamlet, energy spread, and the fraction of ions in higher charge states. The plasma chamber has 26-cm inner diameter with multicusp permanent magnets to confine plasma. RF power (~11 MHz, >10 kW) is applied to the source via a 2-turn, 11-cm diameter antenna inside the chamber. We have tested a 80-kV 61-hole multi-beamlet array designed to produce a total current >200 mA. In these experiments the beamlets were not merged into a single beam. We are preparing hardware for a test of the extraction gap and first 4 Einzel Lens at the full gradient proposed for an injector. This experiment should produce a 0.5 A beam. The design of a full system with merged beamlets is also underway. It will be tested at one-quarter the normal gradient proposed for an injector. It should produce a low-emittance 40-mA beam. Details will be presented.

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