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A Compact Multi-Beamlets High Current Injector for HIF Drivers

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For heavy ion beam driven inertial fusion (HIF), a driver-scale injector requires multiple beams with each beam carrying a current of about 0.5 - 1.0 A. Due to the significant space charge force in heavy ion beams, an effective way to create a high-current bright beam is by merging many high-current-density (~ 100 mA/cm^2) beamlets. Using curved electrodes in the pre-accelerator, an array of converging beamlets can produce a beam with the envelope radius, convergence, and ellipticity matched to an electrostatic quadrupole (ESQ) channel. Computer simulation studies have shown how the beamlets merge with emittance growth. Nevertheless, the final merged beam still has an acceptable emittance and therefore good beam brightness [1]. The size of a driver-scale injector system using this approach will be several times smaller than the one designed using traditional single large-aperture beams, so the success of this experiment has significant economical and technical impacts on the architecture of HIF drivers.

We have previously demonstrated the extraction of high current density beamlets from an RF-driven argon plasma source [2]. At present we are running a proof-of-principle experiment that merges 119 beamlets into an ESQ channel at beam energy up to 400 keV. The experiment is scheduled to complete in April 2005. Beam diagnostics include Faraday cup, beam imaging using scintillators, and projectional emittance using slit-scanners. Initial experimental results have already shown qualitative agreement with computer simulation. More quantitative comparison will be done in the coming months, and these results will be presented at the conference.

References

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