Development of a One-Meter Plasma Source for Heavy Ion Beam Charge Neutralization*

Philip C. Efthimion, Erik P. Gilson, Larry Grisham and Ronald C. Davidson
Plasma Physics Laboratory
Princeton University, Princeton, New Jersey, 08543 USA

Simon Yu and B. Grant Logan
Lawrence Berkeley National Laboratory
University of California, Berkeley, California, 94720 USA

Highly ionized plasmas are being employed as a medium for charge neutralizing heavy ion beams in order to focus to a small spot size. Calculations suggest that plasma at a density of 1 - 100 times the ion beam density and at a length ~ 0.1-1.0 m would be suitable for achieving a high level of charge neutralization. An electron cyclotron resonance (ECR) source was constructed at the Princeton Plasma Physics Laboratory (PPPL) in support of the joint Neutralized Transport Experiment (NTX) at the Lawrence Berkeley National Laboratory (LBNL) to study ion beam neutralization. Pulsed operation of the source enabled operation at pressures in the 10^{-6} Torr range with plasma densities of 10^{11} cm^{-3}. Near 100% ionization was achieved. The source was integrated with the NTX facility and used in the plasma neutralization experiments. The plasma was approximately 10 cm in length in the direction of the beam propagation, but future experiments require a source 1m long. The present ECR source does not easily scale to that length. Consequently, large-volume plasma sources based upon ferroelectric ceramics are being considered.[1] These sources have the advantage of being able to increase the length of the plasma and operate at low neutral pressures. The source will utilize the ferroelectric ceramic $BaTiO_3$ to form a metal plasma. A 1 m long section of the drift tube inner surface of NTX will be covered with the ceramic. A high voltage (~ 1-5 kV) is applied between the drift tube and the front surface of the ceramic by placing a wire grid on the front surface. A current density of ~ 0.5 A/cm^2 is required. Pulsed plasma densities of 10^{12} cm^{-3} and neutral pressures ~ 10^{-6} Torr are expected. A test stand to produce a 20 cm long plasma in a drift tube is being constructed and will be tested before a 1 m long source is developed. Experimental results from the source development are presented.

[1] A. Dunaevsky, Bull. Am Phys. Soc. **48,** No. 7, 294 (2003).

*Research supported by Department of Energy Contract No. DE-AC02-76-CH-03073.