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Fast magnetization of a high-to-low-beta plasma beam

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Authors
Song, J. J
Wessel, F. J
Yur, G.
et al.

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A Microwave Generated Plasma for Ion Implantation Studies

Philip F. Keebler and J. Reece Roth

UTK Plasma Science Laboratory
Department of Electrical and Computer Engineering
University of Tennessee
Knoxville, Tennessee 37996-2100

Industrially acceptable methods of plasma ion implantation not only require an efficient means of switching the negative high-voltage pulses, but also require an energy efficient plasma generation system. To do this, a non-magnetized microwave generated plasma was designed and is being built. Pictured below is the block diagram. The power source is from a Model PPS-2.5 AS 2500-W, 2.45 GHz Varian (Eimac) microwave power pack with a WR-340 waveguide port. Both the forward and reflected power is measured with a Model EW3-DPM3S Varian power meter. A Model EW3-HH Varian HH tuner (power matching device) is included for impedance matching. Next, a Model GS315 Gerling RMS step transition, which steps WR-340 (S band) waveguide to WR-284 waveguide, is included since there are many more microwave components available in the WR-284 size. Next, a standard EH tuner is included which is used for most of the matching since the plasma is a changing load. Then, an isolator is included to minimize the reflected power back on the source if the plasma extinguishes. "I" in the diagram denotes the microwave vacuum interface constructed from fused quartz including an E-probe launcher. The cavity resonator includes several ports: sample holder port (SHP), Langmuir probe port (LPP), mass spectrometer port (MS), vacuum port (VP), gas feed port (GFP), and ion gauge port (IGP). The cavity was designed such that several TE modes (other than the dominant mode) will be set up in the resonator to give a quasi uniform field distribution so that the plasma can have an approximately uniform number density. The surface of the cavity resonator will have many permanent magnets fixed to it to help confine the plasma.

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3P3-14

Fast Magnetization of a Low to High Beta Plasma Beam

F. J. Vessel, J. H. Song, and V. Postker
University of California, Irvine
and
C. Yur and H. U. Rahman
IGPP, University of California, Riverside

We have studied the magnetization of a high-beta hydrogen-plasma beam injected into a vacuum transverse magnetic field (8 x plasma energy density/magnetic field energy density > 1). Normal parameters were: T_e < 5 eV, n_e < 3 x 10^{13} cm^{-3}, v_0 < 7 x 10^6 cm/s, t_{pulse} < 70 us, B_z < 300 G. Plasma beam characteristics were measured for a wide beam, a/b_a < 35, and a downstream distance, x < 300 b_a, where a is the beam radius, x is the downstream distance, and b_a is the ion pyroradius. We observe a brief initial state of diamagnetic propagation followed by F < B (magnetized) propagation; F < B propagation is accompanied by beam compression transverse to B with such as much as a factor of four increase in density and a slight drift of the beam in the direction of the ion Lorentz force. At high fields, R = 200-300 G, the observed magnetic field diffusion time is much faster than calculated from classical Spitzer conductivity and is more of the order of the diffusion time based on Hall conductivity.

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3P3-15

Preliminary Considerations and Experiments to Obtain Higher Brightness of Pulsed Ion Beams With bunch

Tokyo Institute of Technology, Department of Energy Sciences, The Graduate School at Nagatsuta, Nagatsuta 4259, Nidori-ku, Yokohama, Kanagawa, 227 Japan

One of the still-important issues of the intense pulsed ion beams for inertial confinement fusion compared with the lasers is to get the higher ion beam brightness with all kinds of considerable efforts. So that, we tried preliminary considerations and experiments in this direction with the method of beam bunching. Although almost all of getting the higher beam brightness are based on the geometrical focusing of the beams extracted from concave anode surfaces until now, it is hoped to bunch the beams during the beam transport to get still higher brightness of the beams. So that, we adopted the following methods to gather the fundamental data to prepare the future experiments of beam bunchings.

To bunch the beams, we need (1) focusing type ion diodes without turn on delay times, (2) large current channels to transport focused ion beams and (3) pulsed power generators to supply high voltage to the ion diodes which is suitable for the beam bunching. In these regards, we operated a pulsed ion source with a so called active anode, and we designed a small channel to be assembled together with our cryogenic ion diode. Then we also measured the particle distributions within the ion diode which had large effects on the characteristics of the beam focusing and the beam transport.

To extract ion beams without turn-on delay times and to exclude the disturbances by the neutral...