conf-750811--8

LA-UR-76-717

TITLE: RECENT DEVELOPMENTS IN LINEAR THETA-PINCH RESEARCH: EXPERIMENT AND THEORY

AUTHOR(S): K. F. McKenna, R. R. Bartsch, R. J. Commisso, C. A. Ekdahl, K. B. Freese, R. F. Gribble, F. C. Jahoda, G. Miller, R. E. Siemon, J. U. Brackbill, J. P. Freidberg, S. P. Gary, H. R. Lewis, A. G. Sgro, L. Turner, and D. Winske

SUBMITTED TO: The IAEA Seventh International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Innsbruck, Austria, August 23-30, 1976.

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87544

An Affirmative Action/Equal Opportunity Employer

Recent Developments in Linear Theta-Pinch Research: Experiment and Theory*

K. F. McKenna, R. R. Bartsch, R. J. Commisso,
C. A. Ekdahl, K. B. Freese, R. F. Gribble,
F. C. Jahoda, G. Miller, R. E. Siemon, J. U. Brackbill,
J. P. Freidberg, S. P. Gary, H. R. Lewis, A. G. Sgro, L. Turner and D. Winske

Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87545 USA

High energy plasmas of fusion interest can be generated in linear theta pinches. However, end losses present a fundamental limitation on the plasma containment time. This paper discusses recent progress in end-loss and end-stoppering experiments and in the theoretical understanding of linear theta-pinch physics.

I. EXPERIMENTS

With the elimination of end losses as the ultimate objective, the following experiments have been carried out on the high-energy ($T_e + T_i$ = 3.2 keV, n_e = 1.5×10^{16} cm^{-3}), 5-m Scylla IV-P linear theta pinch: (1) [illegible] of the characteristic end-loss times, and the plasma flow [illegible] near theta-pinch coil ends, and (2) material end-plug experiments [illegible] to eliminate axial particle flow. The main result at present is the [illegible] increase in energy containment time [illegible] with [illegible] end plugs.

[illegible]

1. [illegible]

2. [illegible]

3. [illegible]

4. [illegible]

5. [illegible]

6. [illegible]

observed with the high-Z PN and SiO_2 plugs indicating that τ_E is dominated by plasma flow to the end plugs and z-dependent energy-loss processes.

3. The surface ablation profile of the quartz plugs is Gaussian with a radius about equal to the plasma column radius. Less than 1 μm of plug material was ablated per discharge and < 1% of the plasma energy is deposited on the plug surface per discharge.

4. A plasma ablation layer 1-2 cm thick develops on the plug surface ~ 1-2 μs after formation of the plasma column. For the all plugs the radial density profile within 2 cm of the plug surface is Gaussian. At axial positions > 2 cm, the profile becomes annular with the bulk of ablated material flowing [illegible] the outer edge of the main plasma column. For the LiD plugs, at positions [illegible] cm, the density profile is strongly peaked both along the plasma [illegible] axis and at the column outer edge.

II. THEORY

[illegible] Studies

[illegible]

agreement with experiment is obtained assuming conditions near complete end-shorting.

2. Magnetoacoustic heating of a collisionless pinch

Magnetoacoustic heating permits preferential ion heating when an appropriate dissipative mechanism exists. For a linear pinch, magnetoacoustic heating would not impose a limitation on end-stoppering schemes and may allow lower values of the induced RF electric field than are required when implosion heating is used alone. Magnetoacoustic heating also may be practical for reversed-field pinches.

Using two-fluid model, we have studied magnetoacoustic heating of a screw pinch in a collisionless plasma region theoretically, including the effects of finite ion gyroradius. Heating times and associated [illegible] are [illegible] alternative methods for controlled thermonuclear power using [illegible] thermal energy.

Work performed under the auspices of the U.S. Department of Energy.