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Progress on the Los Alamos High-Density Field Reversed Configuration Experiment

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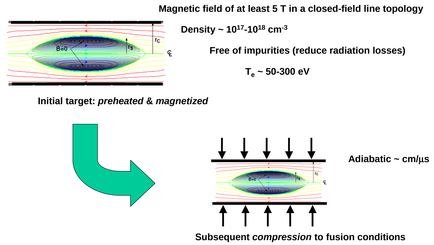
Introduction

Abstract

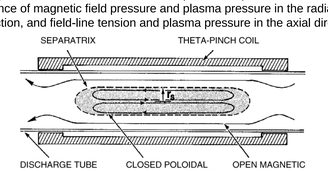
We present the status of the LANL high-density Field Reversed Configuration (FRC). This FRC will be the target plasma for *Magnetized Target Fusion* (MTF) experiments; heating it by compressing it inside an imploding flux conserver should allow access to fusion conditions. We present our current experimental setup to study the pre-ionization ,formation, and translation phases of the FRC. Diagnosing of this plasma is challenging due to the short timescales, high energy densities, high magnetic fields, and restricted access. Our goal is an FRC with n~10^{17} cm^{-3}, T~100-300 eV, B~5 T, and a lifetime of 10-20 µs. According to previous experience, the pre-ionization (PI) process is crucial for good FRC formation. We will ionize the gas in the initial pre-ionization experiments by impressing a rapidly oscillating (~300 kHz) axial magnetic field over a slower-timescale magnetic bias field of comparable magnitude. This occurs just prior to the theta pinch coil magnetic field reversal. This is a much (10 x) larger field that radially contracts and forms the closed field lines for the FRC.

MTF: Magnetized Target Fusion



Field Reversed Configuration

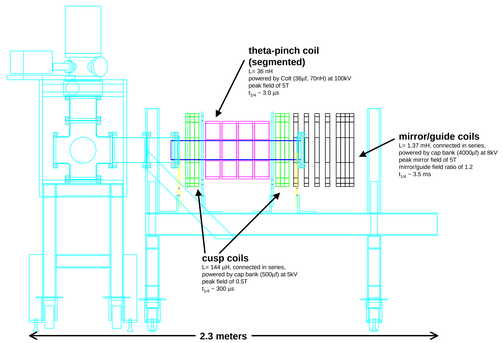
The FRC is an elongated compact toroid that is formed without toroidal field. The FRC consists of a closed-field-line torus inside a separatrix and an open-field-line *sheath* outside the separatrix. Equilibrium in a FRC is a balance of magnetic field pressure and plasma pressure in the radial direction, and field-line tension and plasma pressure in the axial direction.



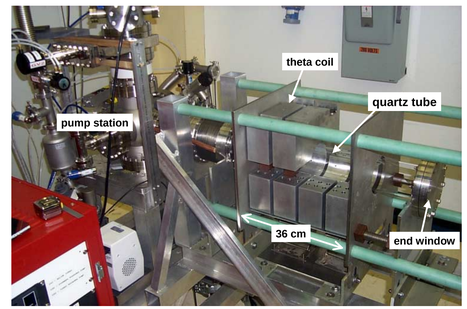
FRC geometry showing separatrix radius and flux-conserving boundary.

Experimental Setup

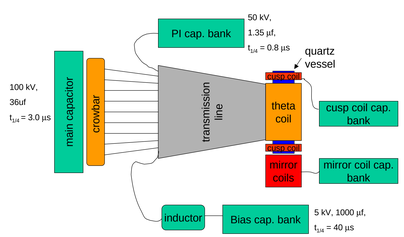
Experimental Setup - Side View



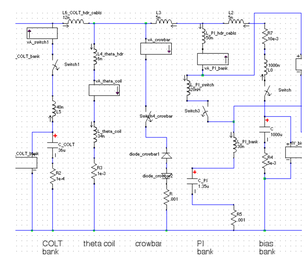
Assembly of Experiment



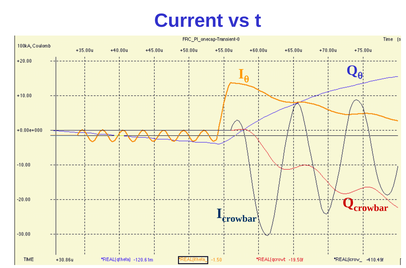
Block Diagram



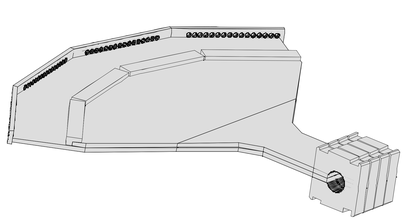
Electrical Circuit



Current vs t



Transmission Line



Pre-ionization Experiment

Method

- ring theta-pinch coil ringing
- overlap bias field
- frequency: ~300kHz

Goals

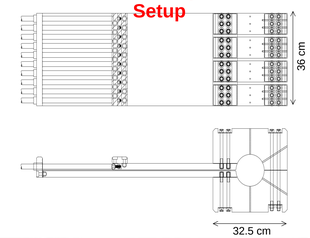
- > 50% ionization
- low level of impurities

Diagnosing Pre-ionization

Qualitative diagnostics:
1. Watch plasma glow (fast-framing photography)

Quantitative diagnostics:
1. Interferometry (side-on and end-on)
2. Studying electrical pulse shapes (variation of load inductance)

Pre-ionization Experimental Setup



View of Pre-Ionization Setup

Bias Bank / Inductor

Mirror/Cusp Field Pancake Coil

Summary / Future Directions

After achieving pre-ionization goals, two clearly defined phases will follow

Phase 1: FRC formation suitable for compression -- in situ characterization

FRC Goal Parameters:	Principal diagnostics planned:
- density n ~ 10^{17} cm^{-3}	Excluded flux B-probe array
- temperature T_e ~ T_i ~ 300 eV	Interferometry
	Thomson scattering
- lifetime τ_E > 10 µs	Bolometry
	Optical Spectroscopy

Phase 2: FRC Translation into liner via conical theta pinch

FRC inside liner:	Principal diagnostics planned:
- liner r_{wall} = 5 cm	B probe array
- plasma r_s ~ 3 cm	Bolometry
- plasma l_s = 30 cm	Interferometry
	Spectroscopy