**Abstract**

The Levitated Dipole Experiment (LDX) will be the first experiment able to study high-beta plasma confined by a magnetic dipole with near classical energy confinement. LDX consists of three superconducting magnets and makes possible explorations of entirely new confinement concepts. We describe the LDX machine design and detail the fabrication status of the superconducting floating-coil, charging-coil, and levitation-coil. In addition, we summarize (1) our procedure to cool, to inductively charge, and to levitate the 1.3 MA floating coil, (2) our initial diagnostic set, and (3) our experimental and physics plans that answer the key questions of high-beta stability and confinement in the dipole fusion concept.

The Dipole Concept Originated by Seeking to Capture in the Laboratory the Physics of Nature’s High-Beta Plasma

The LDX Team is a Partnership of Plasma Scientists and Magnet Technology Experts

LDX required innovative engineering and design:
- High-field persistent Nb₃Sn coil with low mass and small size
- Innovative, lightweight cryostat with distributed supports having low-thermal conductivity
- Safe, relatively easy-to-operate cryogenics
- Large, inductive charging system designed for thousands of high-field cycling during daily charging and discharging
- Fusion’s first high-temperature superconducting magnet
- Levitation and stabilization system with distant, upper levitation coil

Factors in the LDX Design
- Overall size sufficiently large to allow for large magnetic flux expansion
- Highest possible field consistent with low weight
  - Use NbTi coil up to create high beta plasma (β ~ 30%)
  - Reduce effects from field errors and levitation fields
  - Use experience from previous levitation and separator experiments
  - Optimize cryogenics to simplify maintenance and operation

LDX Research Plan

Complete fabrication of the superconducting magnets
- The LDX project required the construction of an entirely new experimental facility that includes three superconducting magnets.

Today, our primary focus is to oversee completion of these magnet systems.

Establish safe and reliable operation
- Initial operation will include experiments with a supported dipole.
- Our launching apparatus (PPPL, CU, MIT) allows levitation while protecting the floating coil from loss of control or quench.

Physics studies include (1) understanding pressure profile effects on MHD stability, (2) electrostatic & magnetic stability, (3) transport and scaling.

LDX Superconducting Coil Manufacturing Status:

- **Floating Coil** (714 turns, Nb₃Sn, 5T, 1.3 MA turns)
  - Ability Engineering (South Holland, IL)
    - Floating coil has been completed and tested at full current and enclosed into high-pressure He vessel
    - Final assembly of outer cryostat is underway

- **Charging Coil** (8000 turns, NbTi, 5T, 4.2 MA turns)
  - SINTEZ/Science Technology Center (St. Petersburg, Russia)
    - Completed R&D tests of conductor, insulation, electromechanical properties
    - Coil winding underway
    - Manufacturing of cryostat scheduled

- ** Levitation Coil** (1310 turns, High Strength Bi-2223, 0.275 MA turns)
  - Everson Electric (Allentown, PA)
    - Conductor supplied by ASC
    - Joint and winding plan complete
    - Winding to begin next month

**The goal of the LDX experimental program is to investigate the possibility of steady-state, high beta dipole confinement with near classical energy confinement …for the first time!**

Floating Coil: Final Assembly

Charging Coil: Winding Underway

Levitation Coil: Fusion’s First HT Bi₂₂₂₃ Magnet

ECRH, Control, Basic Diagnostics On Schedule