NSTX
National Spherical Torus Experiment • PROGRAM HIGHLIGHTS
APRIL 2002

Favorable Initial Results on Plasma Stability and Containment in the Spherical Torus

The National Spherical Torus Experiment (NSTX) has recently produced two results that have confirmed the potential of the spherical torus magnetic "bottle" to contain hot plasmas with properties favorable for developing fusion energy.

First, on February 26, the NSTX obtained a very high ratio (β_T) of the plasma pressure to that of the applied magnetic pressure, 31.5%. The currents in the magnetic ring coils around the plasma were arranged to produce a nearly spherical plasma shape, which improved the overall plasma stability (Figure 1). Part of this effort involved careful adjustment of the shape and position of two of the large ring coils. Energetic neutral atoms, injected to heat the plasma to high pressure, spin the plasma at high speed. The careful shaping and the plasma spin are predicted by theory to aid in the attainment of high pressure. The β_T value exceeded the initial calculations of 25% on which the proposal for NSTX was based and for which a research goal was set for September 2002.

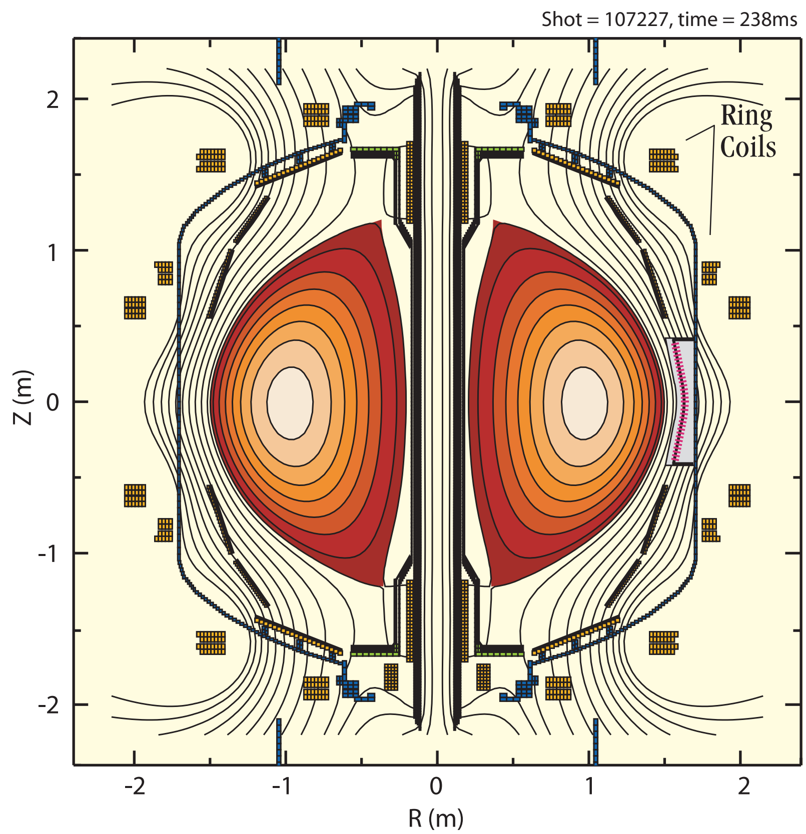

Figure 1. Magnetic fields from the ring coils surrounding the plasma are tailored to create plasmas of very nearly spherical shape in NSTX.

Then, on March 26, the NSTX produced plasmas in the High-Confinement-Mode (H-mode) lasting essentially the full duration of the pre-programmed period of constant plasma current. Special techniques were applied to reduce gas recycling from the wall and thus permit easier formation of the barrier against heat loss at the edge. The edge barrier is a key characteristic of the H-mode (Figure 2). The

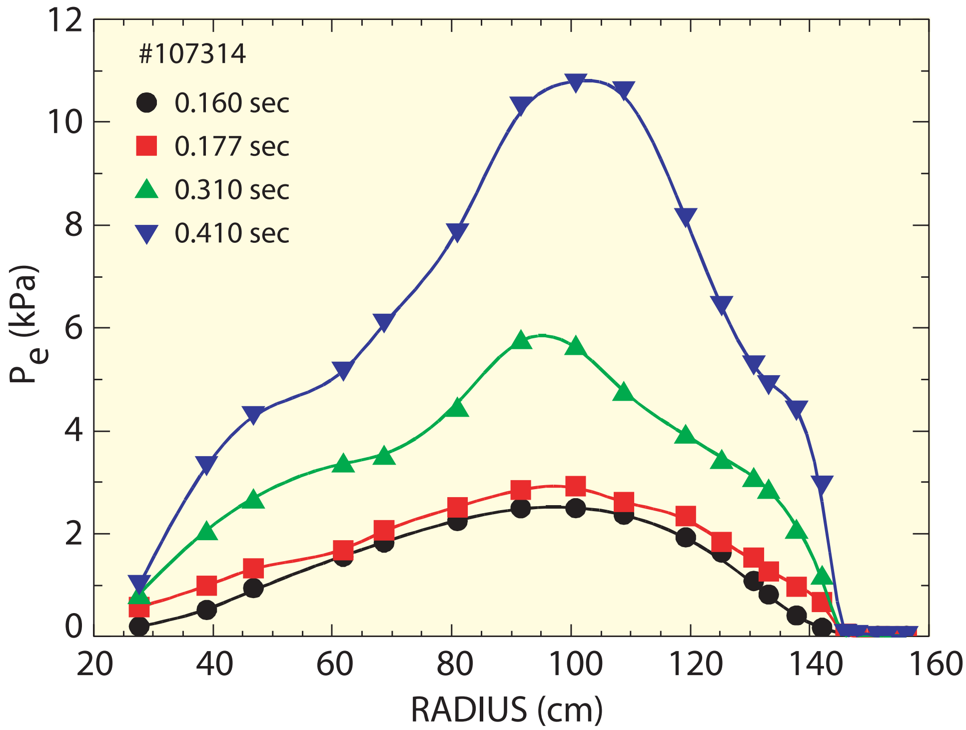

Figure 2. Laser scattering measurements of plasma electron energy density (pressure) as a function of the major radius from the center of the NSTX device just before the H-mode (0.160s) and through the H-mode (0.177s – 0.410s). A strong thermal barrier against energy loss at time = 0.410 s is indicated by the very steep gradient near the outer plasma edge between Radius = 140 – 145 cm.

plasma energy was contained for about 1.3 times the duration projected from the H-mode plasma database developed from studies in many tokamak fusion experiments.

Future NSTX research in these areas will focus on combining high stability with strong barriers against heat loss to produce plasmas of higher performance, and on sustaining such plasmas for a longer duration.

About NSTX

NSTX is a national magnetic fusion experimental facility, located at the U.S. Department of Energy's Princeton Plasma Physics Laboratory, to test the physics principles of the innovative Spherical Torus (ST) confinement concept. The ST concept promises new opportunities for exciting scientific discoveries toward an optimized confinement system and an affordable energy development path. The NSTX National Research and Facility Operations Teams have produced exceptional results since the start of experimentation in September 1999 and continue striving to improve in expertise and capability to produce high-quality scientific results and excellent plasma performance.

NSTX Program participants include scientists from: Princeton Plasma Physics Laboratory; Oak Ridge National Laboratory; University of Washington; Columbia University; General Atomics; Johns Hopkins University; Los Alamos National Laboratory; Nova Photonics; Lawrence Livermore National Laboratory; University of California - San Diego; University of California - Davis; University of California - Los Angeles; Massachusetts Institute of Technology; University of California - Irvine; Sandia National Laboratory; Princeton Scientific Instruments; CompX; Lodestar; New York University; University of Maryland; and Dartmouth University.

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