The Process of Magnetic Reconnection Underlies Events in the Sun's Corona and Helps Drive Current in the National Spherical Torus Experiment

At the annual meeting of the Division of Plasma Physics of the Americal Physical Society being held in Quebec City, Canada, October 23–27, 2000, researchers will present some of the first physics results from the National Spherical Torus Experiment (NSTX), the new magnetic fusion device at the Princeton Plasma Physics Laboratory. It is called a "spherical torus" (ST) because the surface of the plasma in it is shaped like a sphere with a narrow hole through the center. To maintain plasma confinement in an ST and to help heat the plasma, a strong electric current, encircling the central hole, must be driven in the plasma. In December 1999, NSTX reached a primary design goal by operating with one million amperes of current induced in the plasma by a solenoid (a spool-shaped coil) passing through the central hole. In addition to this traditional way of driving the plasma current, the researchers are developing a new method for producing this current. Known as coaxial helicity injection (CHI), this technique involves injecting an electric current directly from coaxial circular electrodes inside the plasma chamber, in the presence of an applied magnetic field. A picture of the plasma inside NSTX during CHI is shown in Fig. 1. The magnetic field causes the injected current to wrap many times around central column in its passage between the electrodes, so the total current can be many times that injected, as shown in Fig. 2. The current loops formed during CHI have similarities to the coronal loops seen on the sun's outer surface during solar flares. Just as in the solar corona, these loops can become unstable and relax to a lower energy state through a process known as magnetic reconnection. In the case of the ST, this lower energy state is one in which some of the current flows on field lines which close on themselves inside the vessel to form a confined plasma core. Whereas the traditional technique of inducing the current with a solenoid can only produce brief bursts of plasma current in an ST, the CHI technique holds promise for helping them to operate continuously, as needed for a future fusion reactor. The NSTX experiments build on earlier work by Prof. Tom Jarboe and his team at the University of Washington in the Helicity Injected Torus (HIT).

Roger Raman (raman@aa.washington.edu), Dennis Mueller (dmueller@pppl.gov), and Dave Gates (dgates@pppl.gov) led the recent CHI experiments on NSTX.

Contact Martin Peng, NSTX Program Director (1-609-243-2305, mpeng@pppl.gov) for information concerning the research program on the NSTX.

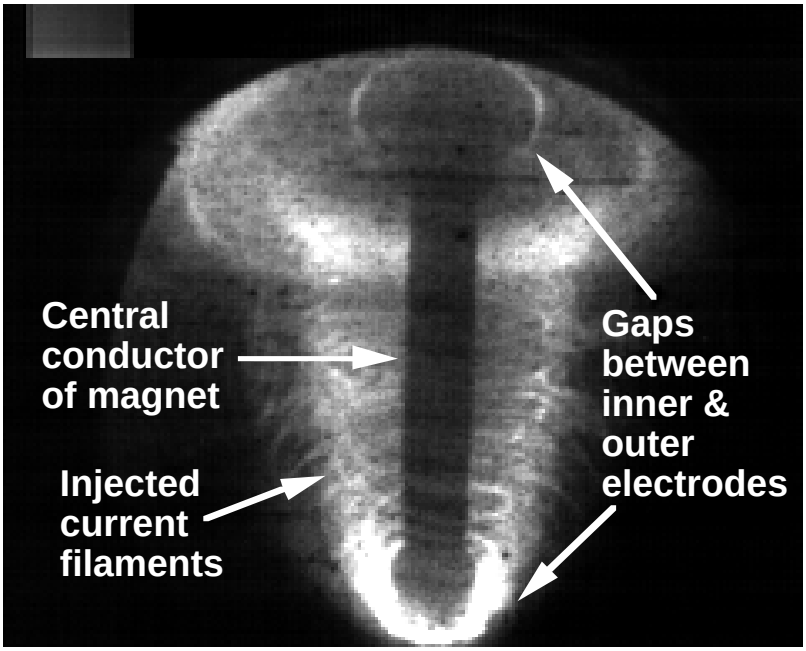

Fig. 1 Photograph with a fish-eye lens of a CHI plasma in NSTX showing filaments of current between the isolated inner and outer electrodes wrapping around the central conductor of the main electromagnet. The photograph was taken by Dr. Ricardo Maqueda of the Los Alamos National Laboratory.

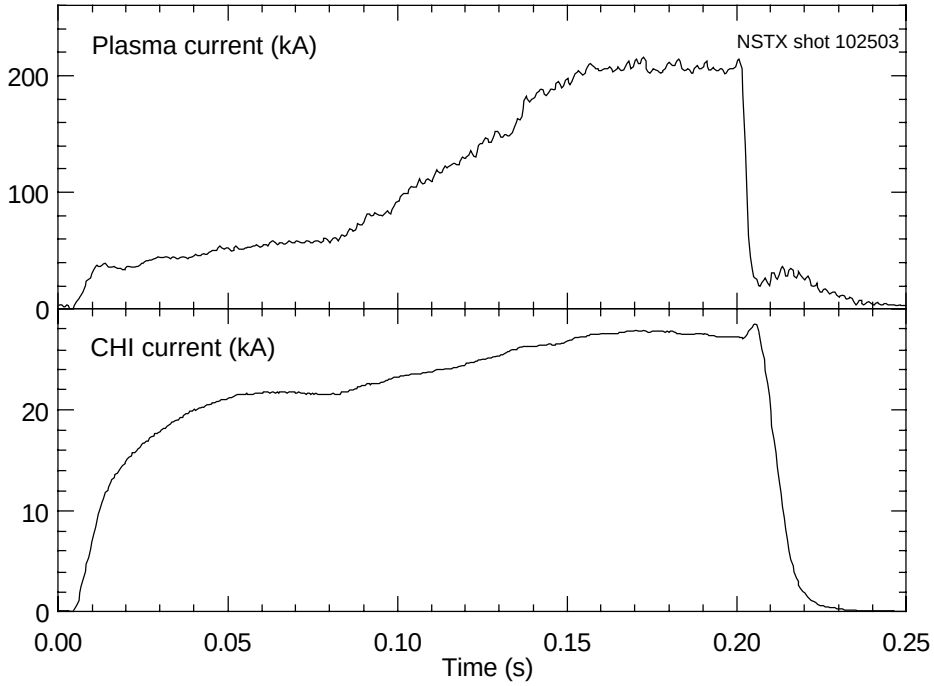

Fig. 2 Measurements of the injected CHI current and the total plasma current wrapping around the central conductor. The total plasma current reaches about 8 times the injected current.