Plasma Portraiture

Capturing images of fusion plasmas is no easy task because such plasmas can be 100 times denser than lead. However, x-rays that are bright enough and energetic enough can shine through the densest plasma to produce a "shadowgraph," just like a medical x-ray. Trident researchers recently implemented the Petawatt's x-ray-production technique to do just that—in order to take pictures of fusion plasmas; fusion-fuel compression, leading to the fuel's "ignition"; and hot, dense plasmas in general.

The researchers aim a short pulse at a metal wire with a diameter of 12 micrometers. The intense light quickly frees some of the electrons in the wire and accelerates them to energies of 100,000 or so electron volts. These energetic electrons then strike other electrons in close orbit around the metal's nuclei, "exciting" the orbiting electrons to move in larger orbits. The excited electrons quickly drop back to their original orbits, but they emit high-energy x-rays as they do.

The resulting x-ray burst can produce good x-ray photos of hot, dense plasmas. The burst is also brief enough—about as short as the light pulse—to freeze a swirling plasma's motion. Moreover, the x-rays are emitted from the end of the wire, so the source of the x-rays is about the size of the wire's diameter. This source size can capture details as small as 10 micrometers in an x-ray shadowgraph.

Other facilities around the world, including the University of Rochester's Omega-EP and the Z-R, a "z-pinch" plasma facility at Albuquerque's Sandia National Laboratories, are also using this technique to take pictures of hot, dense plasmas. NIF will use this same type of source.