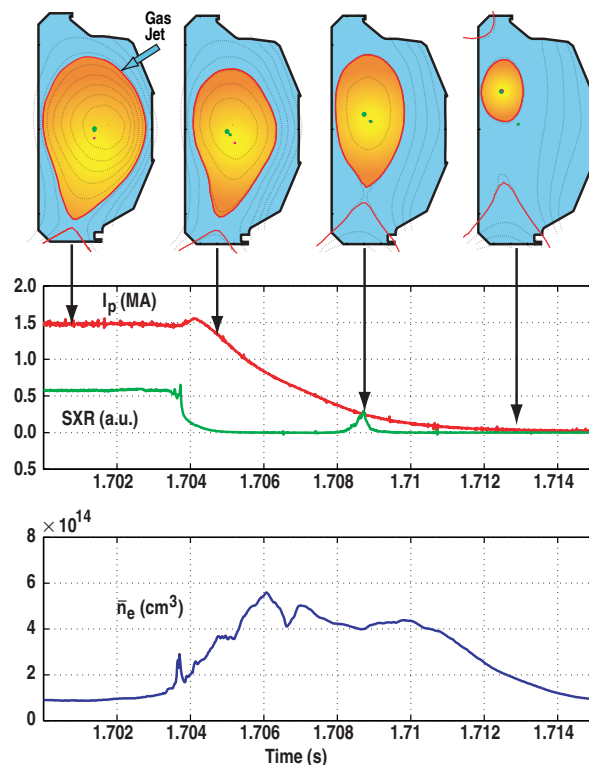


Controlled Plasma Termination With High Pressure Noble Gas Injection

Recent experiments at DIII-D National Fusion Facility have demonstrated a technique that rapidly terminates the plasma discharge without deleterious effects on the plasma containment device. This work was carried out by a collaborative team of scientists from University of California San Diego, Oak Ridge National Laboratory and General Atomics. These scientists used a high-pressure jet to inject the noble gas (neon or argon) into the plasma. The jet pressure exceeds the plasma pressure, with the result that it effectively penetrates to the central portion of the plasma in 1/1000th of a second, increasing the particle content of the plasma by a factor of 50. As a result, the plasma energy is then dissipated uniformly by ultraviolet radiation from the gas species, spreading the heat evenly over the wall area and avoiding local hot spots. The plasma cools quickly, leading to rapid decay of the plasma current while minimizing wall currents and mechanical stresses. More importantly, the impurity remains in a low charge state — that is, only one or two of the impurity's 10–18 electrons have been removed from the atoms. These electrons still bound in atoms slow down the ultra-high energy electrons (runaway electrons), reducing greatly or eliminating the rapid multiplication of these runaway electrons otherwise experienced in the rapid decay of hydrogenic plasma.

These results are very important for future tokamaks designed to produce fusion energy. Optimizing the tokamak for fusion energy production leads to operation of plasmas near fundamental pressure and current limits in the tokamak. When these limits are exceeded, an instability can cause a rapid loss of the energy contained in the plasma pressure and the confining magnetic field. During this rapid loss of energy the components inside the containment device are subject to damage by three effects: wall surface melting by the hot plasma particles, mechanical stresses from currents flowing in the wall, and the amplification of ultra-high energy electrons (runaway electrons) that can damage the vessel wall. These experiments indicate that by injecting high pressure gas into the plasma prior to reaching these limits, the plasma can be reliably terminated without the above deleterious effects.



Controlled plasma termination in DIII-D, induced by noble gas JET.