

## **DEVELOPMENT OF EXTENDING THE BEAM PULSE LENGTH OF DIII-D NEUTRAL BEAM SYSTEM**

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The DIII-D fusion research tokamak utilizes seven neutral beam ion sources for plasma heating and current drive. These ion sources and the neutral beam system have performed with high availability and reliability since 1987. A strong focus of the ongoing research program is the achievement and investigation of high performance discharges with fully noninductive current drive with pulse lengths longer than the resistive time. As such, extending the beam pulse length without lowering the beam power is one of the goals for the next 5 years. Currently, the deuterium beam pulse length of our ion sources operated at 80 keV is limited to 3 seconds due to the heat handling capability of some beamline internal components that are used to collimate the beam or to protect other beamline components from being damaged by residual (un-neutralized) energetic ions. A systematic study based on actual heating of beamline internal components has been performed to develop a plan for extending the beam pulse length to 10 seconds. The beam pulse limitation for each beamline internal component was obtained by extrapolating temperature rises of thermocouples embedded in the beamline internal components. The study determined that the pole shield of the residual ion-bending magnet is the component that limits the beam pulse length to 3 seconds for 80 keV beam operation. Beam pulse length at 80 keV can be doubled with the upgrade of the magnet pole shield alone. Temperature rise measurements also showed that the stainless steel drift duct (the section connecting beamline and tokamak vessel) will be able to handle the heat from the re-ionized neutral particles. In addition to beamline internal components, long pulse beam operation of ion sources and other beam subsystems need to be operationally confirmed. Tests have shown ion source, liquid nitrogen and helium cryopumps, control system, cooling systems, and power supply system operated flawlessly at beam energy of 60 keV for 10 seconds. This gives us confidence that the current DIII-D neutral beam system could operate at least twice the current beam pulse length after upgrade of the magnet pole shield. The status and schedule for the full upgrade to 10 seconds will be presented.

This work was supported by the US Department of Energy under DE-FC02-04ER54698.