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BEAM ENERGY DEPOSITION IN THE MAGNET POLE SHIELD REGION OF THE DIII-D NEUTRAL BEAM INJECTORS*

H.K. Chiu, C. Hu,[†] B.G. Scoville, R.M. Hong
General Atomics, P.O. Box 85608, MS 34-224, San Diego, CA 92186-5608
[†]Institute of Plasma Physics Chinese Academy of Sciences, Hefei Anhui, P. R. China
chiuhk@fusion.gat.com

A neutral beam injector at DIII–D is comprised of an ion source, a gas filled neutralizer cell, an ion dump operated in conjunction with a sweeping magnet, along with other components for beam shaping and diagnostics. Energetic deuterium ions are formed when deuterium ions are extracted from the arc chamber and accelerated by the accelerator of the ion source. Colliding these energetic deuterium ions with the deuterium gas in the gas-filled neutralizer cell produces a beam of energetic deuterium neutrals and residual deuterium ions. The residual deuterium ions are removed from the beam by applying the magnetic field produced by the sweeping magnet to the beam; steering the ions to an ion dump out of the beam path, permitting the neutral particles of the beam to proceed into the DIII–D torus. The region that could be affected by the steering magnet's field is framed by copper panels called pole shields. These pole shields protect the magnet from the energetic ions. The pole shields are water-cooled, and water flow calorimetry is available to measure energy deposition onto them.

Damage to the pole shields can result from a catastrophic event where a large energy deposition occurs over a short time, or can be the result of cyclic stress fracture induced by repeated energy depositions over a long period of time. The energy deposition on the pole shields is dependent on the beam optics and the magnetic field between the pole shields.

Tools for calculating beam profile as a function of beam position and optics and for calculating ion trajectories were developed. Using these tools, the theoretical energy deposition to the pole shields for a series of beam optics and steering magnetic fields were calculated. Comparison to water flow calorimetry data was made. The results of these calculations and an operating window for the ion source to prevent pole shield damage are detailed.

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