# Studies of Neutral Particle Assimilation During Massive Argon Gas Injection in DIII-D*

E.M. Hollmann,[1] T.C. Jernigan,[2] L.R. Baylor,[2] J.A. Boedo,[1] S.K. Combs,[2] T.E. Evans,[3] M. Groth,[4] D.A. Humphreys,[3] P.B. Parks,[3] D.L. Rudakov,[1] H.A. Scott,[4] E.J. Strait,[3] J.C. Wesley,[3] W.P. West,[3] D.G. Whyte,[5] and J. Yu[1]

[1]*University of California-San Diego, La Jolla, California 92093, USA*
[2]*Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*
[3]*General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA*
[4]*Lawrence Livermore National Laboratory, Livermore, California 94550, USA*
[5]*Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA*

Shutdown of discharges using massive gas injection (MGI) is a promising technique for reducing tokamak wall damage during disruptions.[1] However, runaway electron (RE) generation is an outstanding concern. Collisional suppression of RE during the current quench (CQ) requires large total electron densities ($n_{crit} \approx 10^{16}$ cm$^{-3}$ in DIII-D). In an attempt to achieve this density using MGI, a new large-orifice ($D = 2$ cm) gas valve was used (compared with the $D = 0.4$ cm valve used previously). This valve delivered 6000 torr$\cdot\ell$ of argon into the vacuum chamber in a pulse of about 10 ms duration (at the chamber). The injected neutrals, assuming full assimilation by the plasma, are sufficient to achieve the desired density $\gamma_{crit} \equiv n_{e,tot}/n_{crit} > 1$. However, $\gamma_{crit}$ is found to be about 0.01 during the CQ. $\gamma_{crit}$ is estimated by matching observed thermal and current decay rates with KPRAD and CRETIN modeling. Several factors contribute to the low value of $\gamma_{crit}$. The finite rise time of neutral flow causes the plasma shut down to occur before the bulk of the impurities arrive, with more than 90% arriving after the CQ is over. Also, a majority of the argon neutrals are stopped at the plasma edge and spread sideways into the vacuum region instead of being ionized. This has been observed over a wide range of target plasmas and is consistent with calculations of jet stopping.[2] The results suggest that achieving $\gamma_{crit} > 1$ may be difficult in DIII-D using the MGI technique. Present modeling suggests a less than linear increase in $\gamma_{crit}$ as the valve size (or number) is increased. This prediction will be tested in 2007 experiments.

[1]D.G. Whyte, T.C. Jernigan, D.A. Humphreys, et al., J. Nucl. Mater. **313**, 1239 (2003).

[2]P.B. Parks, "Deceleration and stopping of broad gas jets injected into plasmas," to be submitted to Phys. Rev. Lett.

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