# OEDGE Modeling of the DIII-D H-mode $^{13}CH_4$ Puffing Experiment*

J.D. Elder[1], A.G. McLean[1], P.C. Stangeby[1], S.L. Allen[2], J.A. Boedo[3], B.D. Bray[4], N.H. Brooks[4], M.E. Fenstermacher[2], M. Groth[2], D. Reiter[5], D.L. Rudakov[3], W.R. Wampler[6], J.G. Watkins[6], W.P. West[4], and D.G. Whyte[7]

[1]*University of Toronto Institute for Aerospace Studies, 4925 Dufferin St., Toronto, Canada, M3H 5T6*
[2]*Lawrence Livermore National Laboratory, Livermore, California, 94550 USA*
[3]*University of California-San Diego, La Jolla, California, 92093 USA*
[4]*General Atomics, San Diego, California 92186-5608, USA*
[5]*Institüt für Plasmaphysik, Forschungszentrum, Jülich, Germany*
[6]*Sandia National Laboratories, Albuquerque, New Mexico, 87185, USA*
[7]*University of Wisconsin, Madison, Wisconsin, 53706 USA*

A trace gas puffing experiment was performed on DIII-D where $^{13}$C methane was injected into ITER-like partially detached ELMy H-mode plasmas. The injection was toroidally symmetric through the upper pumping plenum at a rate of 18.8 Torr-ℓ/s from 2500 ms to 4500 ms during constant plasma conditions for each discharge. The puffing was repeated over a series of 18 consecutive identical discharges. These 18 discharges were preceded by a series of similar discharges using $^{12}$C methane puffing, some with sweeping of the strike points, to better characterize the plasma and to obtain a comprehensive set of diagnostic measurements. These measurements included spectroscopy (multi-chord divertor spectrometer, MDS), fixed Langmuir probes in the divertor target, divertor and core/edge Thomson scattering, reciprocating probes, toroidal camera spectroscopic images, CER spectroscopy, IRTV and bolometry. Immediately after the $^{13}$C puff experiment, DIII-D was vented to air and 64 tiles were removed for surface analysis. The quantity of $^{13}$C on each of these tiles was measured.

A background plasma solution is determined by combining the diagnostic measurements with "onion-skin" modeling using the OEDGE code. This plasma solution is used to calculate the sources and transport of the $^{13}$C in the vessel. The sources include both the initial puff as well as the erosion of the deposited $^{13}$C layers as a result of the ongoing plasma exposure. The code is used to model the final deposition of the $^{13}$C after 18 discharges. The dependency of this deposition on the flow pattern in the main scrape-off layer (SOL) is evaluated. These SOL flows include specified parallel flows as well as a specified radial outward drift (with respect to major radius). A radial drift transports $^{13}$C resulting from methane breakup at the edge of the plasma towards the separatrix. Imposition of such a drift is motivated by the need to transport the $^{13}$C farther into the plasma in order to model the experimentally measured deposition. Similar radial drifts were also imposed by Ref. [1] in the Edge2D code as being needed in order to replicate the measured JET parallel flows. The calculated $^{13}$C deposition pattern is compared to the experimental results from the surface analysis of the tiles.

In order to model this experiment, the methane breakup model in DIVIMP was enhanced by integrating the latest reaction data from the compilation of Janev and Reiter and by the addition of an enhanced model for the methane fragment reaction kinetics based on this data. In addition, code was added to allow the imposition of radial outward drifts on the individual particle motion.

[1] Kirnev, *et al.,* J. Nucl. Mater. **337–339**, 271 (2005).

*Work supported by the U.S. Department of Energy under W-7405-ENG-48, DE-FC02-04ER54698, DE-FG02-04ER54758, DE-AC04-94AL85000, and DE-FG02-04ER54762.