Prospects for Core Helium And Related Measurements on ITER using Active Charge Exchange*

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The measurement of low-Z impurities, in particular He ash, in the core of ITER remains an outstanding diagnostic issue. The only credible candidate at present is active Charge Exchange Recombination Spectroscopy (CXRS) utilizing a Diagnostic Neutral Beam (DNB) optimized for the dual requirements of beam penetration and charge exchange cross section, resulting in beam energies of ~100 keV/amu[1]. Using the existing ITER parameter profile and equilibria data files and reasonable assumptions regarding viewing optics and DNB performance, we have employed a benchmarked multistep beam penetration code[2,3] to yield signal-to-noise estimates for possible core helium concentration measurements. These studies confirm the importance of precise determination of beam intensities via accurate modeling and independent measurement, as well as the need for beam modulation, in order to satisfy the stated measurement precisions needed for ITER. Comparable calculations have been done for an intense pulsed neutral beam based on ion diode technology, as well as other candidate He-CXRS wavelengths, to assess the relative advantages of these techniques. Finally, since any DNB-based diagnostic system actually deployed on ITER will likely be used for a variety of purposes, signal-to-noise calculations for the related active CXRS measurement of ion temperatures have also been performed and will be presented.

*Work supported by U.S. Department of Energy under Contract No. DE-AC03-89ER51114 and Grant No. DE-FG03-86ER53266.

[1]Minutes of the 6th Meeting of the ITER Diagnostic Expert Group and Technical Meeting, Naka, Japan, March 3–11, 1997.

[2]W. Mandl, Ph.D. Thesis, Univ. Munich, 1992.

[3]D.F. Finkenthal, Ph.D. Thesis, Univ. Cal. Berkeley, 1994.