MEASUREMENT AND VERIFICATION OF Z_{eff} RADIAL PROFILES USING CHARGE EXCHANGE RECOMBINATION SPECTROSCOPY ON DIII–D

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Charge exchange recombination (CER) spectroscopy in the visible spectrum is used to measure the radial ion density distribution of impurities in the core plasma of DIII–D. The radial profile of the effective ionic charge, $Z_{eff}(r)$, is subsequently calculated from the impurity densities and the plasma's electron density. The CER measured radial distributions rely on a calculated neutral beam attenuation radial profile, which are confirmed by independent measurement. This technique, which determines the neutral beam's deuterium density by coupling measured beam D_α emissions with a time-dependent collisional radiative calculation, will be described. The CER derived absolute density/concentrations of carbon are verified by comparisons with the spectrometrically measured core plasma's visible bremsstrahlung emission, which is proportional to Z_{eff}. Conversely, the seeded neon concentration is overestimated by a factor of 1.7 by CER. This correction is shown to be caused by the enhanced direct capture into the upper level of the measured visible neon transition (Ne X n = 11 to 10, 5249 A) from excited (n = 2) beam atoms. Due to several problems, including line radiation contamination of the diagnostic's spectral region, the standard $Z_{eff}(r)$ derived from inversion of line integrated visible bremsstrahlung emissions does not provide reliable profiles, but rather a measure of the average impurity content. Z_{eff} profiles are found to vary considerably in shape and magnitude over different operational regimes, confirming the need for accurate profiles.