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ITR/P5-38: Analysis of Current Profile Measurement Capability on ITER

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In this study, the CUPID (Current Profile Identification) code is applied for the first time to assess (1) the accuracy of q profile measurement utilizing both the poloidal polarimeter and motional Stark effect (MSE) diagnostic, (2) influence of the tilted heating neutral beam (HNB) for the q profile measurement, and (3) the accuracy of q profile measurement during the start-up phase. CUPID determines a current profile consistent with the measurement data from the poloidal polarimeter, MSE, the position and shape of the last closed flux surface, the total plasma current and the electron density and temperature measured by Thomson scattering. We added random errors to the input data and ran CUPID 40 times in order to obtain the cumulative distribution function (CDF) of the maximum error of the identified q-value. The measurement data of the poloidal polarimeter are orientation, theta, and ellipticity angle, epsilon, of the polarization state of the probe laser beam. The measurement data of MSE is pitch angle, gamma. We estimate the maximum error (evaluated as the error of the q-value when the value of CDF equals to 0.954) of q-identification with varying standard deviation of theta, epsilon, and gamma (sigma(t), sigma(e), and sigma(g)) and several conditions of HNB. The analysis results suggest that at least one of sigma(t) or sigma(g) with 0.1 degree or less is needed to satisfy the required accuracy of q (10 %) at start-of-burn phase of S2 and S4. The error of q profile measurement by the poloidal polarimeter and MSE with the off-axis HNB is not significantly different from that by the poloidal polarimeter and MSE with the on-axis HNB. Therefore, even though the information around the magnetic axis lacks, MSE with the off-axis HNB is informative for the q-profile identification. It is recommended that both sigma(t) and sigma(g) are 0.1 degree or less to keep redundancy in diagnostics. The analysis results of the start-up phase suggest that the accuracy of q identified by only the poloidal polarimeter could be less than 10 % when sigma(t) is less than 0.1 degree

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