§6. Systematic Validation Study Based on Experiment Database Through Extension of Integrated Transport Analysis Suites for LHD and Toroidal Plasmas

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The integrated transport analysis suite, TASK3D-a (its first version: a01, its calculation flow is shown at the upper part of Fig. 1), has been developed and applied mainly to NBI-heated LHD plasmas [1]. Recently, further extension has been conducted such as including ECH ray-tracing codes (TRAVIS [2] and LHDGauss [3]) and the module for creating ascii files to be registered onto the International Stellarator-Heliotron Confinement Database [4,5]. Inclusion of ECH ray-tracing code can significantly enhance systematic energy transport analysis of ECH- (and NBI-) heated LHD plasmas, for which previously stand-alone ECH absorption calculations has been performed such as reported in Ref. [6]. Further extensions for physics analyses such as on the plasma flow, Alfven eigenmodes, energetic particles, and others, have been progressing.

(Below, sole responsibility of the first author, M.Yokoyama) Accumulation of TASK3D-a analyses results has led to the attempt at deducing functional fittings for radial profiles of the electron and ion heat diffusivities (χ_e and χ_i) with local parameters [7]. Such deduced fitting expressions can be directly implemented into the predictive modelling, so that the transport model assumption (like a Gyro-Bohm) is no longer required. This approach may be considered to be the most relevant ("validated") to the existing experiment database, because it is based on experimental data. Figure 2 shows comparison of $\chi_i/[T_i/(eB)]$ values between TASK3D-a analysis-database and the predicted values by obtained functional fitting. Around 3000 data points, corresponding in a wide range of T_i and radial positions, are reasonably aligned on the diagonal line in Fig. 2. An important statistical measure of the goodness of the model is the ratio R^2 of the variation explained by the model to the total variation. The obtained value is R^2=0.84, which is a relatively high value. The value of the root-mean-square-error (RMSE) is 0.27. Further application of TASK3D-a in a wider range of LHD plasmas and the resulting increase of analysis database will be performed in this direction. It should be emphasized that this approach is comprehensive for any other combinations of integrated transport analysis suits and fusion experiments.

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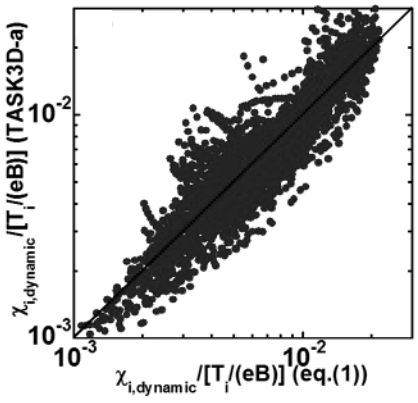

Fig. 2: The comparison of $\chi_i/[T_i/(eB)]$ values between TASK3D-a analysis-database and the regression results.

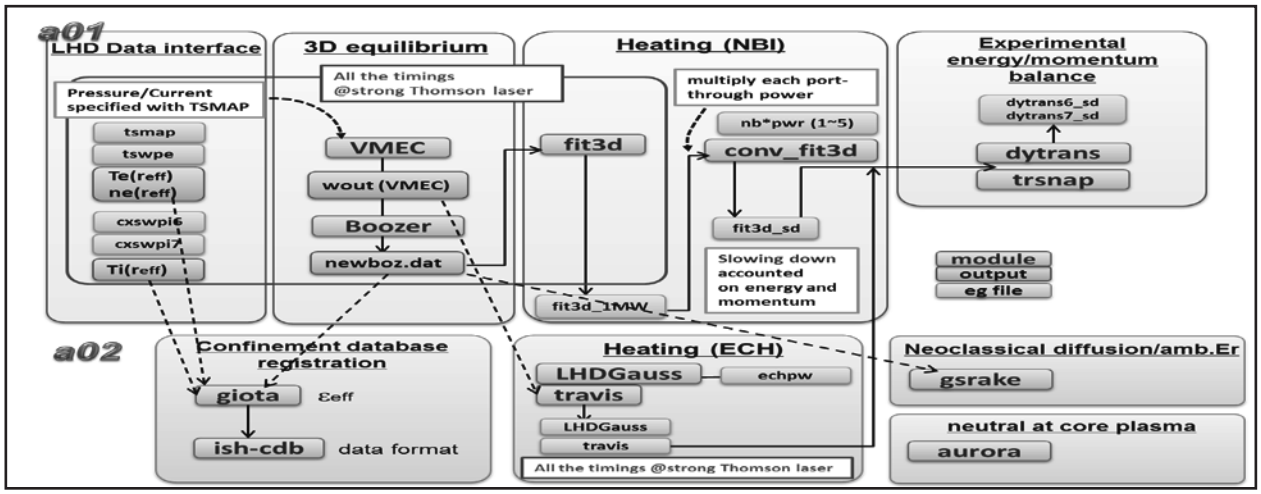

Fig.1: Calculation flows in TASK3D-a01 (upper part) and a02 (being extended).