§6. Extended International Stellarator Confinement Database and a Provisional Scaling of Energy Confinement Time

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Emerging new experiments as well as findings of improved modes have motivated revision of the international stellarator confinement database (ISCDB). The web page of ISCDB is jointly hosted by NIFS and Max-Planck-Institut für Plasmaphysik and available at http://iscdb.nifs.ac.jp/ and http://www.ipp.mpg.de/ISS.

More than 2500 data from a variety of stellarators, i.e., ATF, W7-A, W7-AS, Heliotron E, CHS, LHD, TJ-II and Helioton J have been compiled in the database. The largest device, LHD has extended the parameter regime to substantially lower normalized gyro radii and collisionality regimes which are 3-10× closer to the reactor regimes than those of the mid-size devices. Data from the flexible heliac TJ-II allows us to investigate the rotational transform ι dependence over a much larger variation than is available in the other experiments, which shows a unequivocal positive dependence on ι.

A simple regression analysis of the entire data using the same parameters as in ISS95[1] results in an unusual expression with a very strong gyro-Bohm nature and a negative dependence on ι. Data inspection and experience from inter-machine studies suggest necessity to introduce a magnetic configuration dependent parameter in order to supplement the set of regression parameters and resolve this seemingly contradictory result. A deterministic parameter characterizing the magnetic configuration has not been identified yet, so an enhancement factor on ISS95 is used to describe the magnetic configuration effect. One renormalization factor is defined by the averaged value of experimental enhancement factors for each configuration. Iteration of a regression analysis of data normalized by these factors tends to converge into

$$\tau_E^{ISS04v3} = 0.148 a^{2.33} R^{0.64} P^{-0.61} \bar{n}_e^{0.55} B^{0.85} \iota_{2/3}^{0.41}.$$

This scaling expression is similar to ISS95 and gives a much better fitting. Resultant normalization factor for subsets f_{ren} is shown in Fig.1.

It is reasonable to suppose that this renormalization factor is attributed to specific properties of the helical field structure of the devices. One possible leading parameter is an effective helical ripple, ε_{eff} although there exist other potential configuration factors. Figure 2 shows the correlation of ε_{eff} with the enhancement of confinement times with respect to the unified scaling law ISS04v3. The upper envelope resembles an $\varepsilon_{eff}^{-0.4}$ dependence, however, detailed studies on ε_{eff} behaviour are required as the data indicate, e.g. large scattering of W7-AS data.

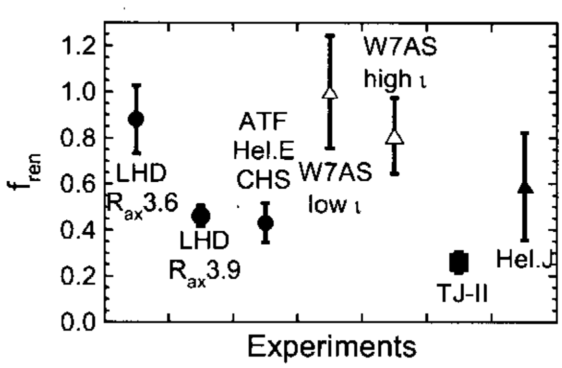

Fig.1 Renormalization factors for configurations.

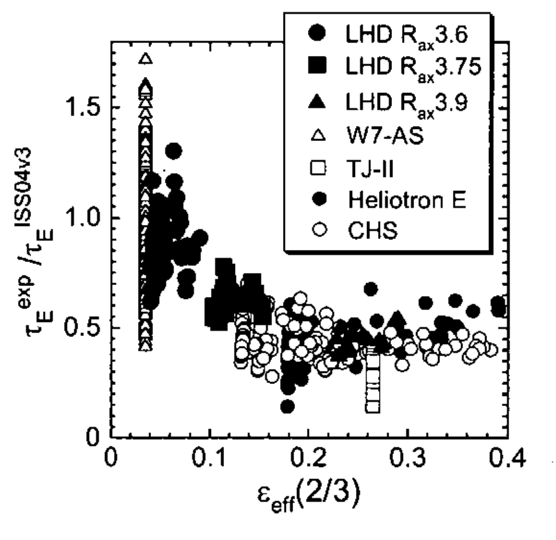

Fig.2 Confinement enhancement factors on ISS04v3 as a function of ε_{eff} at r/a=2/3.

Reference
1) Stroth, U., Nucl. Fusion 36 (1996) 1063.