§68. Energy Confinement Scaling from the International Stellarator Database

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Regression analyses have been carried out for the international stellarator database which includes 859 discharges from the medium-sized helical devices ATF, CHS, Heiliotron E, W7-A and W7-AS. Recent results from enhanced confinement regime such as H mode and reheat mode are excluded from the database. Optimum fit of all devices is given by the following expression (International Stellarator Scaling 95, ISS95),

$$\tau_E^{ISS95} = 0.079 \times a^{2.21} R^{0.65} P_{tot}^{-0.59} \bar{n}_e^{0.51} B_t^{0.83} \iota_{2/3}^{0.40}$$

The units are: a and R in m, density in 10^{19}m^{-3}, power in megawatts, magnetic field in tesla and confinement time in seconds. This scaling satisfies Connor-Taylor-type theoretical constraints. No dependence of τ_E on the isotropic mass is indicated in the data set. No distinct difference between ECH and NBI can be diagnosed. Because of the different density ranges in the two heating methods, a possible difference might, however, be hidden in the density scaling properties. The density dependence of τ_E also turns to be more complicated than a simple power law. Figure 1 shows a comparison of all data together with ITER L mode database with the ISS95 expression. Although it is crucial to use the appropriate definition of a and ι in the comparison of stellarators and tokamaks, the ISS95 scaling describes tokamak data in L mode very well. In other words, also, the stellarator and the tokamak L mode are of comparable confinement quality. In Fig.1, the data of heliotron/torsatron devices and shearless stellarator have opposite offsets with respect to the ISS95 scaling. It should be noted that data stored in the database are primarily obtained in each standard operation. Operational modes with better confinement are obtained by means of intense wall conditioning and tailoring the magnetic geometry in each device. The ISS95 scaling should be recognized as an L-mode-like scaling. The ISS95 scaling is based on the selection of the iota-dependent scaling for heliotron/torsatron confinement. It was tested whether the choice of the radial position at which the ι value is taken influences the results. Regressions using ι at ρ = 1/3 or 1 do not, however, qualitatively change the results. If the iota-independent scaling is selected, the offsets reduces to a level similar to that when the LHD-scaling expression is used. The next generation experiments LHD and W7-X will allow to distinguished more clearly between the two scaling expression. The predicted operational regime in LHD is also illustrated in Fig.1, which suggests that the operational regime of LHD will be close to those of the present large tokamaks in L mode.

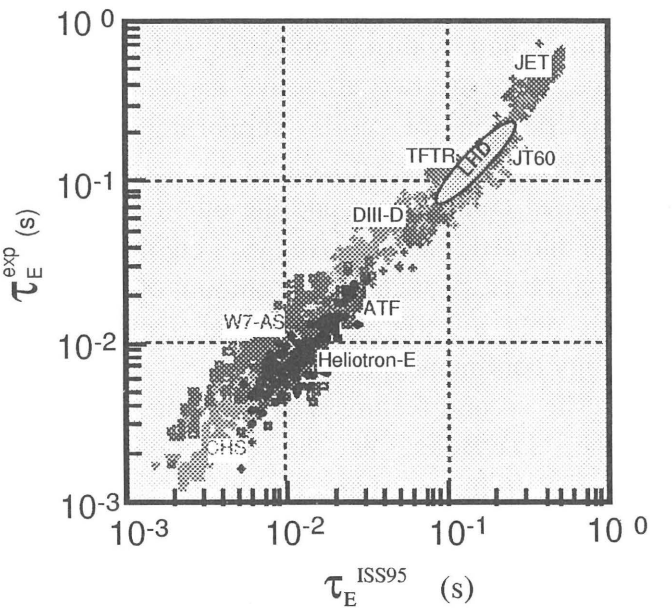

Fig.1 Comparison of energy confinement time obtained in experiments with the prediction from the ISS95 expression for the stellarator database and tokamaks from the ITER L mode database.