On the energy confinement time in Spherical Tokamaks: implications for the design of pilot plants and fusion reactors

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Experiments on NSTX and MAST [1, 2] have shown the thermal energy confinement time in spherical tokmaks, $\tau_{E,\mathrm{th}}$, to have a stronger toroidal field and weaker plasma current dependence than in conventional large aspect ratio tokamaks. However, these scalings were derived for single machines, both of which are similarly sized. Consequently, the NSTX and MAST experimental scaling laws do not include a size dependence, and so cannot be used to extrapolate the performance of future differently sized spherical tokamaks. In this talk we use physics-based arguments [3], primarily that the dominant core transport is Gyro-Bohm like, to extend the scalings to include a size dependence. Assuming that confinement follows this new scaling we consider the implications for ST pilot plants and reactors, by exploring the conditions necessary for high fusion gain at the minimum fusion power and toroidal field for a range of differently sized STs.

References

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