EFFECTS OF MAGNETIC GEOMETRY ON L-MODE AND H-MODE ENERGY TRANSPORT*

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The discharge geometry can influence energy confinement in a tokamak in several ways, even with fixed minor radius and aspect ratio. The first effect is the confinement increase from raising the volume – surface area ratio at fixed thermal conductivity. For a pure elongation (κ) scan, this effect scales like $\kappa/\sqrt{1+\kappa^2}$. The second effect is the increase in the effective minor radius of the plasma. For gyro-Bohm scaling (both neoclassical theory and electrostatic drift waves), this effect scales as κ^2. Bohm-like scaling should only scale with κ. All of the above discussion assumes fixed safety factor (q). However, empirical scalings are typically evaluated at fixed current (I).[1] Since q varies as $\sqrt{1+\kappa^2}$ and empirically $\chi \propto q^2$ plus a dependence on shear,[2] one expects an even more complex scaling in the case of fixed I.

These experiments seek to elucidate the roles of these varying effects during a change in κ. The DIII-D tokamak has a unique combination of shaping capability, high-power auxiliary heating, and transport diagnostics which allow experiments in L-mode and H-mode having κ variations in the range 1.17–2.0, spanning the range of burning plasma experiment designs. The scans are done at fixed normalized gyroradius, β, and collisionality. Holding these parameters constant is equivalent to fixed toroidal field, density, and temperature. To separate the effects of geometry and q, both constant I and constant q_{95} scans are performed.

The table below gives the measured κ scaling, reported as the exponent of a power law fit. Also shown for reference are the κ scalings from the ITER physics basis.[1] For the case of the constant q H-mode scan, a good match was not obtained, since the reduced power needed to match the temperature drops below the L-H power threshold. The reported number is a lower limit. A smaller scan will be carried out in the near future.

From the data, the conclusion is that the influence of geometry is much greater in H-mode than L-mode. This is not too surprising since the geometry change is largest in the high confinement H-mode pedestal and empirical H-mode scalings are gyro-Bohm. The H-mode scalings also favor the *ad hoc* geometry corrections in the Multimode model[3] over other general geometry calculations.[4]

	Constant I		Constant q	
	Exp.	ITER Database[1]	Exp.	ITER Database[1]
L-mode	0.34	0.64	1.32	3.22
H-mode	1.33	0.67–0.78	>3	2.3–2.72

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