Understanding the Power Dependence of the Pedestal*

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The pressure at the top of the edge transport barrier (or "pedestal height") strongly impacts fusion performance. Predicting the pedestal height in future devices such as ITER remains an important challenge for plasma theory. One aspect of predicting the pedestal height that has a particularly strong impact on fusion reactor performance is the dependence of pedestal height on input power. A weak but significant average positive correlation between input power and pedestal height has been observed in empirical database studies, though this dependence is absent in some regimes. Here we attempt to understand both the average dependence and variation in particular cases via detailed studies of MHD constraints on the pedestal, and consideration of transport physics.

It has been established that the edge pedestal height in standard ELMing H-mode is generally constrained by intermediate wavelength MHD instability, as posited by the peeling-ballooning model [1-2]. While the MHD constraint itself does not have an explicit power dependence, it can in fact correlate to power, via at least three mechanisms: 1) Pedestal width: the MHD constraint on the pedestal height is dependent (though not linearly dependent because the stability constraint is non-local [2]) on transport and source characteristics that determine the shape of the profiles in the edge barrier region (often referred to as the "pedestal width"), and the pedestal width may have a power dependence. 2) Shafranov shift: the MHD constraint, particularly for strongly shaped plasmas, depends strongly on the Shafranov shift, a non-local quantity which in turn depends on core profiles which have a power dependence. 3) Kink/peeling constraint: At low collisionality, the MHD constraint is due to current driven kink/peeling modes, which are weakly stabilized by increasing pressure gradient, hence the pedestal gradients can increase with power in this regime without immediately exceeding the MHD constraint.

Here we quantify these mechanisms, validate against experiment, and explore implications for future devices.

[1] P.B. Snyder, H.R. Wilson, et al., Phys. Plasmas **9** (2002) 2037.
[2] P.B. Snyder, H.R. Wilson, et al., Plasma Phys. Control. Fusion **46** (2004) A131.

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