Physics and Control of ELMing H–mode Negative-Central-Shear Advanced Tokamak ITER Scenario Based on Experimental Profiles from DIII-D

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Abstract. Key DIII–D Advanced Tokamak (AT) experimental and modeling results are applied to examine the physics and control issues for ITER to operate in a negative central shear (NCS) AT scenario. The effects of a finite edge pressure pedestal and current density are included based on the DIII-D experimental profiles. Ideal and resistive stability analyses demonstrate that feedback control of resistive wall modes by rotational drive or flux conserving intelligent coils is crucial for these AT configurations to operate at attractive β_N values in the range of 3.0–3.5. Vertical stability and halo current analyses show that reliable disruption mitigation is essential and mitigation control using an impurity gas can significantly reduce the local mechanical stress to an acceptable level. Core transport and turbulence analyses indicate that control of the rotational shear profile is essential to reduce the pedestal temperature requirement necessary for high β. Consideration of edge stability and core transport suggests that a sufficiently wide pedestal is necessary for the projected fusion performance. Heat flux analyses indicate that with core-only radiation enhancement the outboard

peak divertor heat load is near the design limit of 10 MW/m^2. Detached operation may be necessary to reduce the heat flux to a more manageable level. Evaluation of the ITER pulse length using a local step response approach indicates that the 3000 s ITER long-pulse scenario is likely both necessary and sufficient for demonstration of local current profile control.