Fast Ion Transport Studies in DIII-D High β_N Steady State Scenarios*

C.T. Holcomb, Lawrence Livermore National Laboratory

DIII-D research is identifying paths to optimize energetic particle (EP) transport in high β_N steady state tokamak scenarios. Operation with q_{min} >2 is predicted to achieve high β_N, confinement, and bootstrap fraction. However DIII-D experiments have shown that Alfvén eigenmodes (AE) and correlated EP transport can limit the performance of some q_{min} >2 plasmas. Enhanced EP transport occurs in plasmas with q_{min}=2–2.5, q_{95}=5-7, and relatively long slowing down time. Strong AEs are present, the confinement factor H_{89}=1.6–1.8 and β_N is limited to ~3 by the available power. These observations are consistent with EP transport models having a critical gradient in β_f. However, adjusting the parameters can recover classical EP confinement or improve thermal confinement so that H_{89}>2. One example is a scenario with β_P and β_N ≈3.2, q_{min} >3 and q_{95}≈11 developed to test control of long pulse, high heat flux operation on devices like EAST. This has an internal transport barrier at ρ≈0.7, bootstrap fraction > 75%, density limit fraction ≈1, and H_{89}≥2. In these cases AE activity and EP transport is very dynamic - it varies between classical and anomalous from shot to shot and within shots. Thus these plasmas are close to a threshold for enhanced EP transport. This may be governed by a combination of a relatively low $\nabla\beta_{fast}$ due to good thermal confinement and lower beam power, short slowing down time, and possibly changes to the *q*-profile. Another example is scenarios with q_{min} ≈1.1. These typically have classical EP confinement and good thermal confinement. Thus by using its flexible parameters and profile control tools DIII-D is comparing a wide range of steady state scenarios to identify the key physics setting EP transport.

*Work supported by the US Department of Energy under DE-AC52-07NA27344, SC-G903402, DE-FC02-04ER54698, and DE-AC02-09CH11466.