The Tearing Stability of High-$\beta_N$ Discharges is Directly Linked to the Ideal MHD Stability Boundary

F. TURCO, Columbia U., T.C. LUCE, A.D. TURNBULL, GA, D. BRENAN, Princeton U. — High-$\beta_N$ scenarios in tokamaks are limited by tearing modes (TM) above the no-wall $\beta_N$ limit. It has been shown that the calculated classical stability index $\Delta'$ has a pole at the $\beta_N$ ideal-wall limit, due to the proximity to the 1/1 internal kink limit, destabilizing a $m/n=3/2$ or $=2/1$ TM. New modeling of several experimental DIII D equilibria shows that this feature is common to all the types of scenarios, e.g. with $q_{min}\gg 1$ (no 1/1 internal kink), without a conducting wall, and with a wall in contact with the plasma surface. Systematic changes to the plasma current density and pressure profiles show that the $\Delta'$ trends with $\beta_N$ for all the equilibria have a sharp increase at $\sim 90\%$ of the ideal (no-wall, with-wall, without vacuum) limit, independently from the proximity to the $q=1$ surface. In this $\beta_N$ range, small perturbations in the ideal MHD boundary will cause large changes in the tearing stability. This effect may overwhelm the attempts to stabilize the TMs, e.g. with broad or direct ECCD injection.

$^1$Work supported by the US Department of Energy under DE-FG02-04ER54761, DE-FC02-04ER54698, and DE-AC02-09CH11466

W. Solomon
Princeton Plasma Physics Laboratory

Date submitted: 15 Jul 2013
Electronic form version 1.4