Stability analysis of low-n modes for the Divertor Tokamak Test facility Single Null Scenario

V. Fusco[1], G. Vlad[1], G. Fogaccia[1], E. Giovannozzi[1]

ENEA, FSN, C. R. Frascati, Via E. Fermi 45, 00044 Frascati (Roma), Italy

Stability analysis is considered to be of fundamental importance to allow operation of plasma fusion devices and prevent bad confinement with consequent loss of plasma performance and/or plasma wall damages. For these reasons a careful analysis of the plasma stability properties for the DTT (Divertor Tokamak Test) machine [1] is undergoing. DTT is a new facility, under construction in Frascati, Italy, whose aim is to design and test a divertor able to face the problems of thermal loads and power exhaust. In this work the SN (single null) scenario proposed for DTT is studied [2]; our attention is focused on low-n stability for both ideal and resistive plasmas. Such analysis is part of a process where different codes follow each other in a consistent chain; so, equilibrium analysis, which precedes stability, follows the results of electromagnetic analyses (CREATE-NL, [3]) and transport analyses (JETTO, [4]). The code used to study the equilibrium is CHEASE [5], a high-resolution fixed boundary code that solves the Grad-Shafranov equation in toroidal geometry, assuming static MHD equilibria and axisymmetry. MARS [6] is the stability code used. It solves full MHD linear, resistive equations and can also consider a vacuum zone between the plasma last closed surface and a perfectly conducting wall, which is conformal to the plasma last closed magnetic surface. First the reference scenario is carefully analyzed; in this framework, the relevant parameters are the safety factor on axis, q_0=0.7, and at the edge, $q_{95\%}$=2.8, the q=1, located around s≈0.64 (being s the poloidal radial like coordinate), the β=1.9, defined as $2\mu_0\langle p\rangle/B_0$, being p the pressure averaged on the plasma volume and B_0 the on axis magnetic field, the pressure peaking approximately equal to 4. Studies with ideally conducting wall placed at infinity as well as at finite distance have been considered. Moreover β and safety factor profiles have been varied to perform a sensitivity study. The analysis reveals, for the reference scenario, an unstable internal kink (m,n)=(1,1), and infernal modes localized around the low shear and high pressure gradient zone. No external modes were observed unless main quantities, such as the safety factor or the β parameter, are strongly varied.

[1] R. Martone, R. Albanese, F. Crisanti, A. Pizzuto, P. Martin. “DTT Divertor Tokamak Test facility Interim Design Report, ENEA (ISBN 978-88-8286-378-4), April 2019 ("Green Book")” https://www.dtt-dms.enea.it/share/s/avvglhVQT2aSkSgV9vuEtw. [2] Casiraghi et al, Nucl.Fusion 61, 2021, 116068. [3] R. Albanese et al., Fusion Engineering and Design 96–97 (2015) 664–667.[4] Cenacchi G. and Taroni A. 1988 ENEA-RT-TIB 88-5 ENEA. [5] H. Lütjens, et al., 97, Issue 3, 1996, Pages 219-260. [6] A. Bondeson, G. Vlad, and H. Lütjens. Physics of Fluids, B4:1889–1900, 1992.