

Electromagnetic and mechanical analysis of alternative magnetic divertor configurations for DEMO

R. Ambrosino^(a,b), U. Bonavolontà^(b), A. Castaldo^(b), G. Di Gironimo^(a,b), D. Marzullo^(b), S. Merriman^(c), F. Militello^(c), H. Reimerdes^(d)

^(a) University of Naples Federico II, via Claudio 21, I-80125, Napoli, Italy

^(b) CREATE-ENEA, via Claudio 21, I-80125, Napoli, Italy

^(c) CCFE, Culham Science Centre, Abingdon OX14 3DB, United Kingdom

^(d) Ecole Polytechnique Federale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH-1015 Lausanne, Switzerland

ABSTRACT

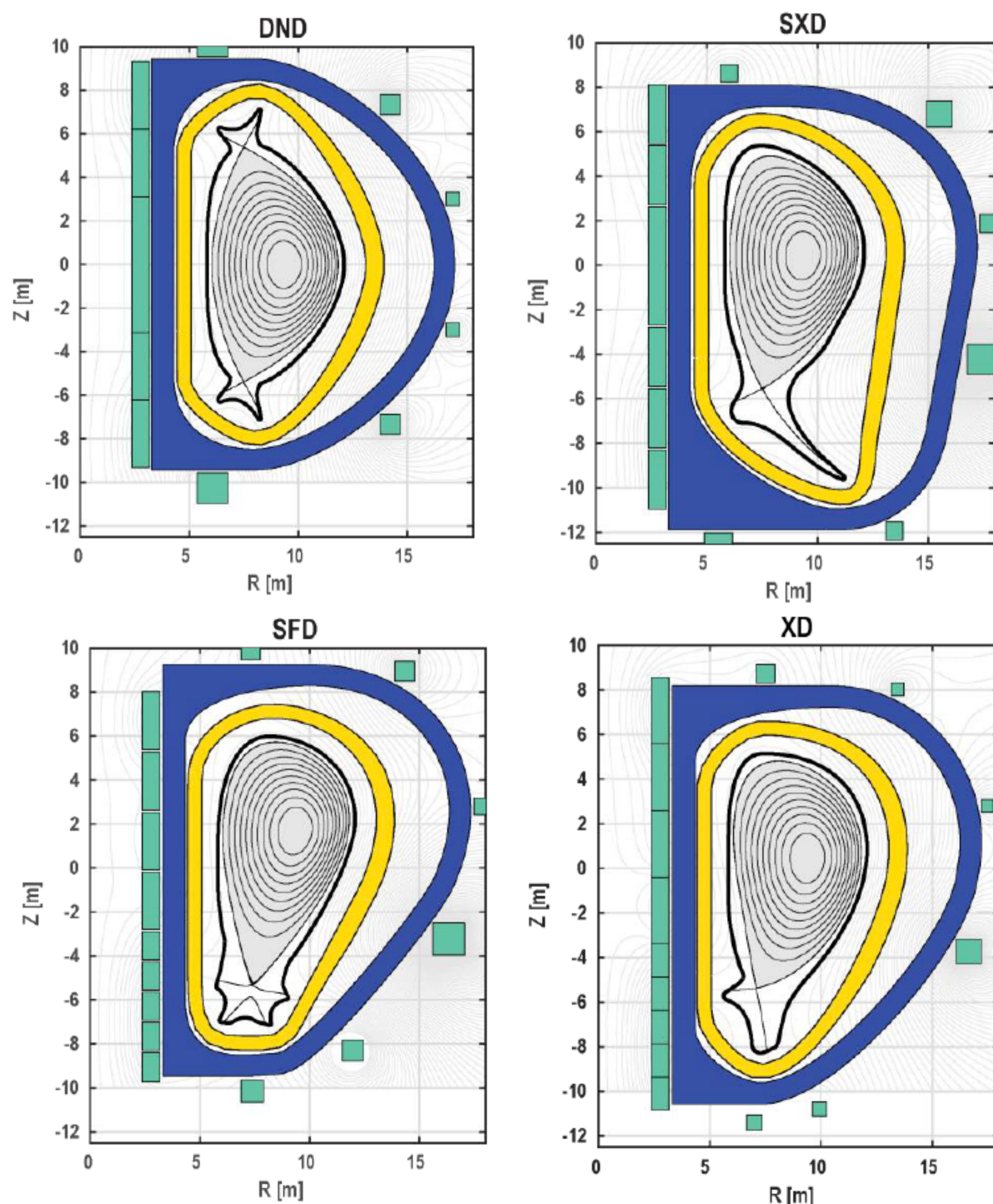
The European roadmap to the realisation of fusion energy has identified a number of technological and scientific challenges towards the development of a DEMO reactor. Mission 2 'Heat-exhaust systems' includes the investigation of alternative divertor configurations such as the Double Null, Snowflake, X and Super-X divertors as a reliable solution for the power exhaust problem.

In this paper, an electromagnetic and mechanical analysis of DEMO alternative configurations is presented. Moreover, a controllability analysis of the plasma configuration is tackled in terms of plasma vertical stability and shape sensitivity respect to a prescribed set of disturbances.

Alternative magnetic configurations

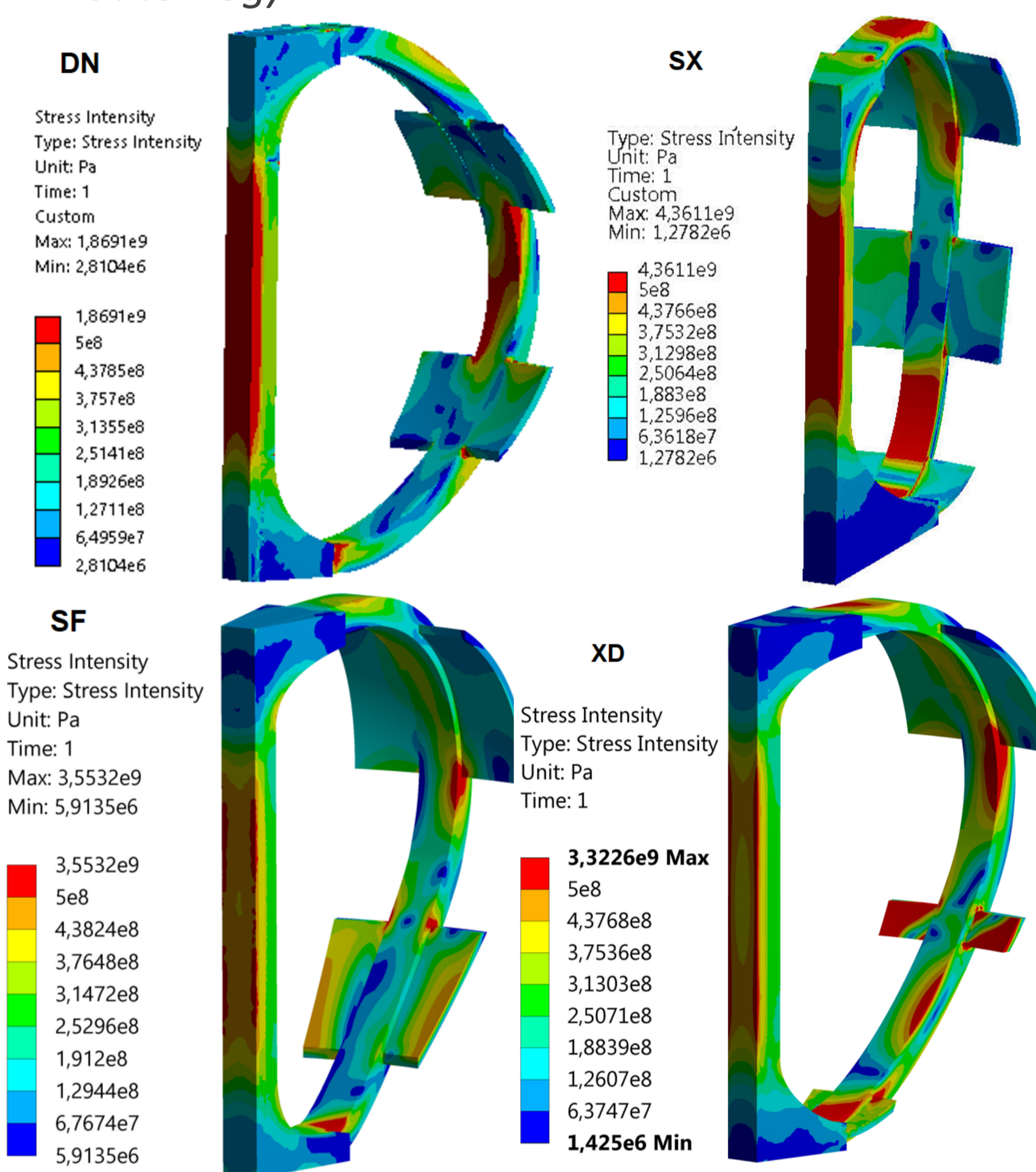
The alternative configurations are designed at a major radius of $R = 8.94\text{m}$, aspect ratio $AR = 3.1$ and plasma current parameters $I_{p1} = 19.07\text{MA}$, $\beta_p = 1.14$ and $l_i = 0.8$ (DEMO single null 2017 baseline parameters).

The PF coils systems of the SN, DN and SX configurations are composed of 11 independent coils while for the XD and the SF a redundant segmentation of the central solenoid has been imposed to increase the flat top flux swing.



TF structural analysis

- Structural calculations were carried out to assess potential failure of the TF coils.
- Stress linearization used to assess the failure points ($Pm < Sm$; $Pm + Pb < 1.5Sm$; $Sm = 667\text{ MPa}$ for the Inner leg; $Sm = 500\text{ MPa}$ for the outer leg).



- All configurations fail, but stress concentration can be probably removed in most cases
- The DN configuration presents mechanical behavior and stresses similar to the standard SN configuration
- Intercoil structures and fillets not yet optimized in agreement with the remote maintenance constraints

- Remote maintenance of the divertor is still an open problem for ACs

Sensitivity analysis

A minor disruption and a big ELM were simulated imposing:

- Minor disruption $\Delta l_i = -0.1$, $\Delta \beta_{p01} = -0.1$
- Big ELM $\Delta l_i = +0.1$, $\Delta \beta_{p01} = -0.1$

