

Modeling plasma-wall interactions in IGNITOR

F. Subba¹ and R. Zanino¹

¹ *Dipartimento di Energetica, Politecnico, Corso Duca degli Abruzzi 24, 10129 Torino, Italy*

Abstract

We study the problem of modeling a first-wall/limiter plasma, i.e., with the magnetic separatrix tangent to a solid wall acting like the limiter. A first wall/limiter will be used in IGNITOR to distribute the power extracted from the plasma over the largest possible surface, reducing the thermal loads on the solid plasma-facing components. In IGNITOR this system should allow handling large volumetric power densities without damaging the wall.

The physics of limiter plasmas near the tangency point is in many respects unclear. Due to their relatively large Larmor radius, more ions than electrons hit the wall when the magnetic field inclination becomes sufficiently low. In such situations, the solid wall should not develop a negative electrostatic sheath. A theory of the sheath in such conditions in a tokamak environment is not as known as for the corresponding standard case.

The tangency point in a limiter plasma poses to the modeler also problems related to the particular geometrical configuration. The most common codes used to simulate a tokamak Scrape-off Layer implement the Finite Volume method on a quadrilateral structured mesh. This choice proves to be simple and reliable for many applications, e.g. divertor tokamaks. However, due to the strong anisotropy in the plasma transport properties, a sufficient numerical accuracy can be guaranteed only if the computational grid is aligned with the magnetic surfaces. It is hard to respect this constraint with a structured quadrilateral mesh near the tangency point. Some attempts to solve this problem have led in the past at applying the Finite Element method to modeling tokamak plasmas, and at exploring the use of adaptive grid techniques. But at present such techniques are not yet as consolidated as the more traditional tools.

Here we apply the B2-solps5.0 code to an IGNITOR plasma with $B_T = 13T$ and $I_p = 11MA$, using a grid purposely designed to fit the singularity at the tangency point. We test the B2-solps5.0 code on this grid, and discuss its numerical performance and convergence properties. The results, in particular the power load distribution on the limiter, are compared with the predictions of simplified Scrape-off Layer models, to assess their range of validity and possible usefulness for the first-wall/limiter design.