Helicon normal modes in radially non-uniform plasma

Ph. Guittienne[1], R. Karimov[2], I. Furno[3]

[1] *Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland*

Helicon discharges are often seen as a bit mysterious, and indeed, they exhibit many experimental behaviors that are difficult to explain, such as abrupt plasma density jumps, hysteresis, and "blue core" formation, to name only a few. A large part of the difficulties in modelling helicon plasmas arises from the fact that simple analytical approaches, relying on approximations such as constant plasma density or collisionless plasma, fail to provide an accurate description of helicon wave physics. We developed a semi-analytical approach allowing the determination of helicon modes in a collisional plasma column of arbitrary radial density profile. The influence of density gradients on the modes propagation, and more particularly on their energy deposition patterns, can then be investigated, notably showing that sharp density drops at the plasma column edge lead to dominant edge localized power deposition, while for gently radially varying plasma profiles an axially peaked power deposition is expected. In the former case, the rapid damping of Trivelpiece-Gould (TG) components of the wave at the plasma edge is clearly responsible for the observed energy deposition profile. As the density profile sharpness is reduced, such as for bell shaped plasma, the TG components of the modes become less predominant, up to the point where Helicon (H) components define the power deposition pattern. In addition, this modes study also clearly shows that dominant H modes are expected to be much less axially damped than dominant TG modes. As a consequence, TG modes can very well dominantly contribute to the energy deposition in the source region, and almost not downstream in the plasma column.