ECRH beam Optics optimization for ITER upper port launcher

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The purpose of the ITER electron cyclotron resonance heating (ECRH) upper port launcher is to stabilize the neoclassical tearing mode (NTM) by driving currents (co-ECCD) locally inside either the q=3/2 or 2 island [1]. The efficiency in stabilizing the NTM is evaluated by the ratio of the peak driven current divided by the local bootstrrap current ($\eta_{NTM}=j_{CD}/j_{BS}$), thus favoring a narrow deposition profile. The mm-wave optical design has been optimized to provide the narrowest j_{CD} over the region NTMs are expected to occur in the plasma cross section. Two sets of mirrors (focusing and steering) are used for decoupling the focusing and steering aspects of the launcher.

The limitations to the optical system are due to spatial restrictions of the narrow width of the blanket shield module. In addition, part of this space is reserved for the steering mechanism [2]. The space is optimized by supperimposing 4 beams on each mirror, this maximizes the beam spot size (~64mm) on the focusing mirror, which results in a narrow beam waist (~19mm) focused far into the plasma (~1.5m) [3].

The designed ECRH launcher has 8 beams (4 beams × 2 vertical rows). The four beams forming one row which are injected into the plasma from a single steering mirror should have the same deposition location in order to have the optimum η_{NTM}. However, the relative angles between four beams need to be either slightly divergent or convergent depending on the desired deposition location, implying some spatial spreading of the four deposition profiles. The relative angles between the beams can be controlled by modifying the focusing mirror curvature in the toroidal direction, which is also used to compress the beam assembly onto the steering mechanism. Optimizing the beam spreading and spacing on the steering mirror induces an astigmatism in the output beam that modifies the beam focusing (between +5% to −10% depending on the deposition location). The optimization procedures will be discussed along with the resulting η_{NTM} performance.

Two FS launcher designs are under consideration: an NTM launcher [3] providing access over the region in which the NTMs are expected to occur ($0.64 \leq \rho_\psi \leq 0.93$), and an Extended Physics (EP) launcher increasing the access range ($0.45 \leq \rho_\psi \leq 0.95$) seeking a synergy with the equatorial launcher for an enhanced ECRH system for ITER [4]. The above optimization procedure will be described for both designs, in addition to other variations in the optical layout for enhanced physic performance.

References

[1] H. Zohm *et al.*, Journal of Physics: Conference Series 25 (2005) 234-242.
[2] R. Chavan *et al.*, Journal of Physics: Conference Series 25 (2005) 151-157.
[3] M. Henderson *et al.*, Journal of Physics: Conference Series 25 (2005) 143-150.
[4] M. Henderson *et al.*, *Synergy study of the Equatorial and Upper port ITER ECH Launchers for an enhanced Physics Performance*, this conference.