The ITER ECH FS Launcher design for an optimized Physics Performance

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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]. In order to deposit current predominately inside the island, a narrow current deposition profile is required, along with a wide steering range to access all relevant flux surfaces over the wide spectra of possible ITER plasma equilibria. The ITER launcher design uses a front steering (FS) mirror that provides optimum focusing for NTM stabilisation and the possibility for a wide steering range. Two FS launcher designs are under consideration: an NTM launcher [2] 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 ECH system for ITER [3].

In either design, the launcher is capable of injecting up to 16MW per port (eight beams of up to 2.0MW) using a two mirror system (1 focusing and 1 steering) for focusing and redirecting the beam towards either the q=3/2 or 2 flux surfaces for all envisioned plasma equilibria. The launcher provides adequate focusing capabilities to insure a large margin of safety for NTM stabilisation efficiency ($\eta_{NTM}=j_{CD}/j_{BS}$), $1.8< \eta_{NTM} <3.5$ depending on the scenario and flux surface.

The best allocation of the four ports with respect to design safety and physics application are discussed. For example, the two steering mirrors in each port can be spread apart for an increased scanning range ($0.45 \leq \rho_\psi \leq 0.95$), while reducing the steering mirror rotation minimising the induced stresses and prolonging the operational lifetime of the mechanism. At least 16 of the 24 beams can be applied to any given flux surface in the extended scanning range by partitioning the power between the two steering mirrors. Note that the steering mechanism uses a frictionless system [4], flexure pivots replace traditional bearings and a gas pneumatic actuator replaces mechanical feeds. Preliminary engineering analyses indicate that the FS launcher can comply with the ITER requirements.

Details of the FS launcher design and possible options available with the corresponding implications on the ECH physics performance will be discussed.

References

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