Synergy Study of the Equatorial and Upper Port ITER ECH Launchers for an Enhanced Physics Performance

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The ITER ECH heating and current drive system consists of 24MW at 170GHz, which can be directed to either the equatorial or upper port launching antennas (launchers) depending on the desired physics application. The equatorial launcher[1] (EL) uses a front steering mirror to sweep the beam in the toroidal plane providing co-ECCD over the range of $0 \leq \rho_\psi \leq 0.65$, while the upper launcher[2] also using a front steering mirror sweeps the beam in a poloidal plane providing co-ECCD over the range of $0.64 \leq \rho_\psi \leq 0.93$[3]. The present requirements for physics applications are very imbalanced between the two launcher systems, with the UL devoted to stabilising the neoclassical tearing modes while the EL has to satisfy all other physics applications inside of $\rho_\psi \leq 0.6$, including control of the sawteeth, assisting in current profile control, on and off-axis current drive and heating, etc. None of the beams launched from the EL can access the entire range due to geometrical and refraction effects[4] In the region of $\rho_\psi > 0.45$, the current deposition profile (j_{CD}) is rapidly decreasing, such that the EL may not be able to control the sawteeth in this region.

Modifying the scanning range of both launchers, seeking a synergy between the two systems, can enhance the physics capabilities of both launcher systems, also allowing to exploit further the specific characteristics of the two launchers: very localised CD for the UL vs. higher CD efficiency for the EL. The scanning range of the UL can be increased to access the region from $0.45 \leq \rho_\psi \leq 0.95$, and used for applications such as control of the sawteeth, NTMs, FIR and ELMs, all of which require a relatively high j_{CD} and narrow deposition width (w_{CD}). This would relax the steering range requirements of the EL reducing the required access range to $0 \leq \rho_\psi < 0.5$, providing adequate flexibility to modify the launcher design in such a way that all beams access the entire range. The EL could then be optimized for physics applications that require more bulk current drive (such as current profile tailoring for hybrid scenarios) and central heating. In addition, there is the possibility to modify one of the three steering mirror assembly (8 beams) such that counter-ECCD could be provided over the same range.

The options available for modifying the two launcher designs for an enhanced ITER ECH physics programme will be presented. In addition, preliminary beam tracing analysis of the modified launcher designs along with a global analysis of EC H&CD capability in ITER for the overall physics programme will be discussed.

References

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