Numerical results of ECH/ECCD in EAST discharge #62585@2.8s and 3.8s

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This note reports the results of numerical modeling of Electron Cyclotron Heating and Current Drive (ECH/ECCD) in EAST discharge #62585.

Figure 1 gives the launching geometry of Electron Cyclotron Wave (ECW) on EAST. The frequency of the ECW is 140GHz. The toroidal magnetic field in EAST is approximately given by $B_\phi = 4.160 \times 10^{-4} I_s / R$, where I_s is the current in a single turn of the TF coils, which in in the range from $8000A$ to $10000A$ for usual EAST discharges; The major radius R of the plasma region is in the range from $1.37m$ to $2.35m$. Using this and noting the electron cyclotron angular frequency is given by $\omega_c = B_\varphi e / m_e$ ($f_c = \omega_c / 2\pi$), we know that only the second harmonic cyclotron resonance can be realized by the 140GHz electromagnetic wave (including the small Dopper frequency shift $k_\parallel v_\parallel$ does not change this conlcusion).

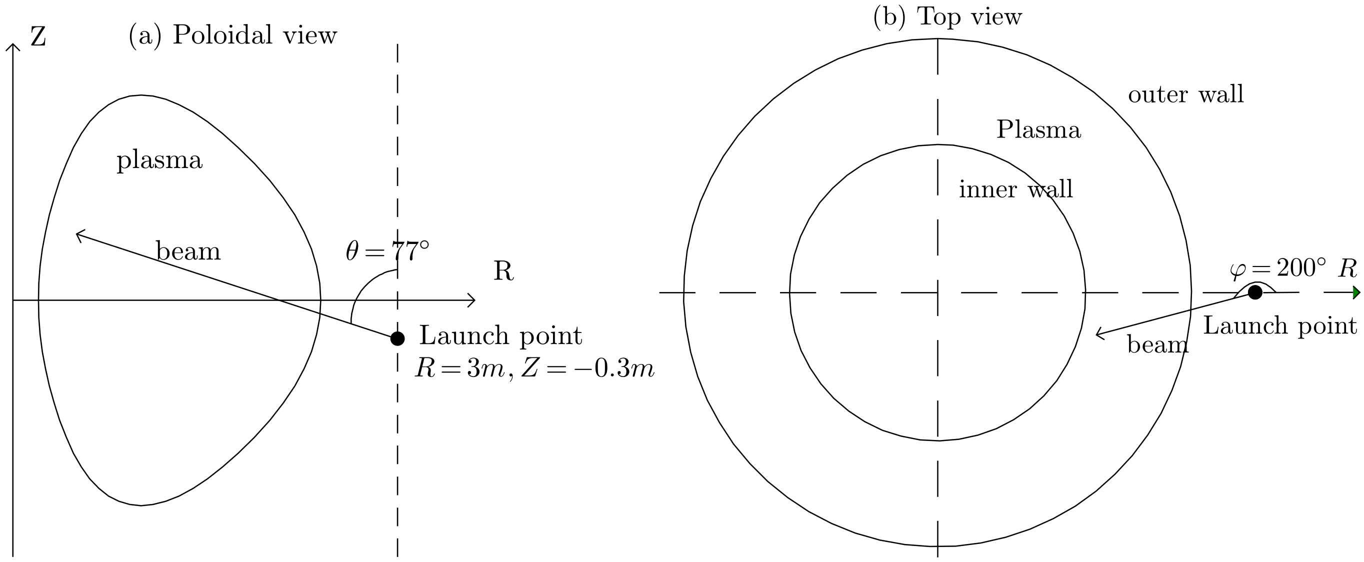

Figure 1. Poloidal view (a) and top view (b) of launching geometry of ECW on EAST. The location of the launching point is at ($R = 3m$, $Z = -0.3m$). The toroidal incident angle φ and poloidal angle θ are indicated on the figure ($\varphi = 200°$ and $\theta = 77°$ for EAST discharge #62585).

Figures 2 gives the power deposition profile, driven current profile, poloidal view of ECW ray, and top view of ECW ray in EAST discharge #62585 at 2.8s. In this discharge, ECW power of approximate 500kW is injected into the plasma with the toroidal incident angle $\varphi = 200°$ and poloidal angle $\theta = 77°$. Similar results are given in Fig. 3 for the same discharge at 3.8s. These results are calculated by Jiale Chen using the version 1.8 of Toray_ga ray tracing code in the OMFIT framework. Pure extraordinary (X) mode is assumed in the calculation. The results indicate that the ECW power is mainly deposited at the radial location $\rho \approx 0.25$ with expansion width $\Delta\rho \approx 0.2$. The total current driven by ECW is about 5kA, which is negligible compared to the total plasma current (600kA). However the local driven current density is relatively large. The peak value of the local driven current density is $75\text{kA} / m^3$, which appears at $\rho \approx 0.25$.

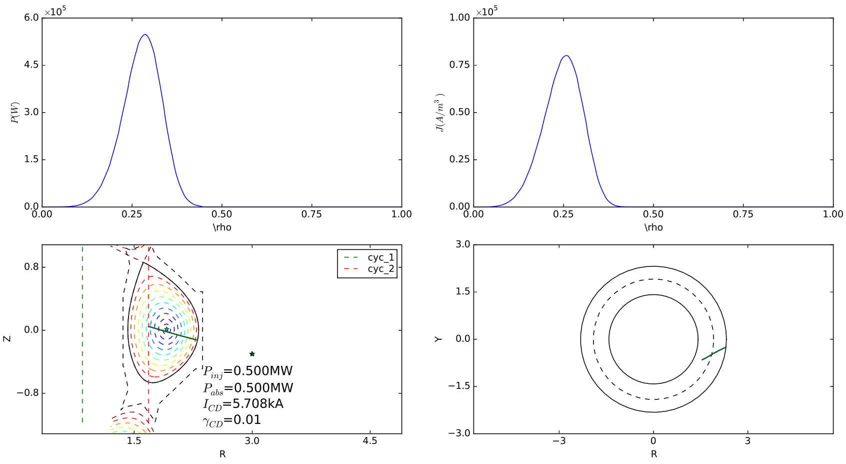

Figure 2. Power deposition profile (upper left), driven current profile (upper right), poloidal view of ECW ray (lower left), and top view of ECW ray (lower right) for EAST discharge #62585 at 2.8s. Pure extraordinary (X) mode is assumed in the calculation. The first and second harmonics resonance layers of the X mode are indicated on the lower-left graph. The effective charge of ions is chosen as $Z_{\rm eff} = 2.1$ in this calculation. The current drive model used is the fifth mode specified in Toray code.

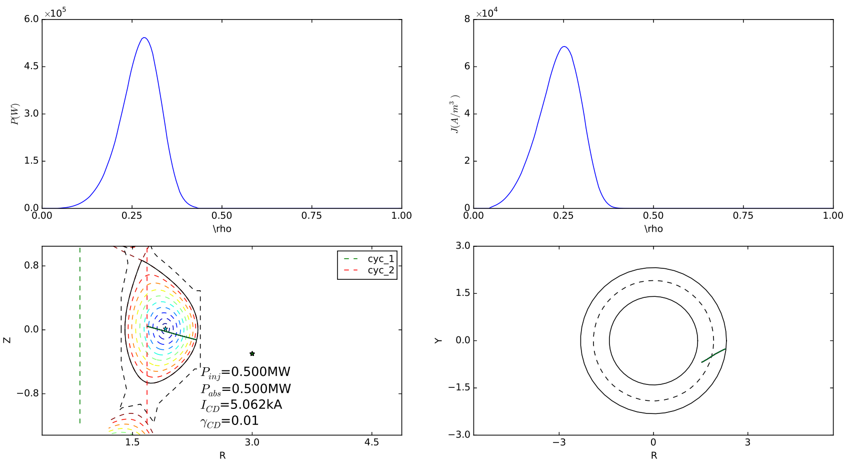

Figure 3. Power deposition profile (upper left), driven current profile (upper right), poloidal view of ECW ray (lower left), and top view of ECW ray (lower right) for EAST discharge #62585 at 3.8s. Pure extraordinary (X) mode is assumed in the calculation. The first and second harmonics resonance layers of the X mode are indicated on the lower-left graph. The effective charge of ions is chosen as $Z_{\rm eff} = 2.1$ in this calculation. The current drive model used is the fifth mode specified in Toray code.