Field-Aligned ICRF Antenna Design for EAST*

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To obtain long-pulse, high performance plasmas, the heating, current and flow drive actuators will need to be efficient, compatible with plasma facing materials, and reliable. Efficient operation requires both optimized coupling and maximizing coupled power. The former requires detailed knowledge of the SOL (Scrape-off Layer) density profile and the latter requires operating at relatively high power density. Long pulse lengths will exacerbate even small interactions between actuators and the plasma periphery. For reliable long pulse operation, high voltage and power handling capabilities significantly beyond 'short pulse' operation are required. For ion cyclotron range of frequency (ICRF), a number of physics and technological challenges remain for steady state, toroidal devices. Among the most critical is maintaining good coupling and maximizing the coupled power through plasma variations including edge localized modes (ELMs) and confinement transitions. As pulse length increases, enhanced localized heat loads associated with antenna operation can challenge antenna integrity. In addition, ICRF impurity sources and contamination need to be minimized to enable effective plasma heating.

Here, we report on a four strap field aligned (FA) antenna design for the EAST tokamak. A FA antenna is an antenna where the current straps and antenna side enclosure are perpendicular to the total magnetic field while the Faraday screen rods are parallel to the total magnetic field. In C-Mod, a FA antenna has been shown to be inherently load tolerant which allows for robust coupled power to plasma. Furthermore, the RF enhanced heat flux and antenna impurity source were nearly eliminated. For both L and H-mode discharges, the core impurity contamination is 20-30% lower but not eliminated. The emerging physics understanding is that the local RF impurity sources and RF enhanced heat flux is reduced due to the geometric alignment of the FA antenna while impurity contamination is a result of far field sheaths. An important aspect of antenna design is to identify a core absorption scenario that is characterized by strong single pass absorption for a broad range of target discharges. To maximize power coupling, the antenna spectrum needs to balance the $k_{||}$ needed for strong single pass absorption and high coupling efficiency through evanescent layer. The latest design for a FA four strap adapted to EAST device will be presented.

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