An ECRH system for JET: A Feasibility Study

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ITER relies heavily on the use of Electron Cyclotron Resonance Heating (ECRH) for current profile tailoring and Neoclassical Tearing Mode (NTM) control. To allow JET to fulfil its mission in preparing ITER operation, the installation of an ECRH system on JET would be highly desirable and therefore a study has investigated the feasibility of installing such a system on JET. Technology assessment has proceeding hand in hand with physics calculations to converge on a system proposal which can be implemented in a reasonable time without compromising performance while giving priority to the use of ITER technology. The principal goals of such a system are: Current drive at large minor radii for NTM stabilisation, current drive at intermediate radii for current profile tailoring and sawtooth control and central electron heating to equilibrate electron and ion temperatures in high performance discharges. The main technical parameters provided by the physics studies are the system frequency(ies), the required power and the toroidal and poloidal injection ranges. Comparing a dual frequency system (113/150GHz) ideal for toroidal fields below 2.7T and above 3.2T with a 170GHz system adapted for fields of 2.7-3.3T, the 170GHz option was found to be most appropriate for the operation planned in JET. This choice has the added benefit of using - and hence testing - gyrotrons and many other components developed for ITER. As 10MW in the plasma was found to be the minimum to fulfil all the physics requirements, a plant consisting of twelve 1 MW gyrotrons is proposed. An antenna allowing toroidal and poloidal steering over a wide range is being designed, using the ITER upper launcher steering mechanism for real time poloidal steering. The study has identified the most convenient position for the antenna and made recommendations on plant location and transmission line routing. Issues related to tritium containment have led to a design using two single disc ITER windows in each transmission line. Various power supply options and the extent to which existing JET power supplies can be used have been evaluated. Finally the study has produced a plan showing that such a system can be operational in about 5 years from the time that the decision to proceed is taken. The cost and required manpower associated with implementing such a system on JET have also been estimated.