NEUTRAL BEAM DEPLOYMENT ON DEMO AND ITS INFLUENCE ON DESIGN

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A number of power plant studies have produced a range of operating conditions for a DEMO device, from steady state to pulsed plasma operation. Each variant places different demands on the heating and current drive systems determined by the purpose for which the system is deployed. These demands influence not only the power requirement but also the number and size of individual power units and the pulse length. This paper considers these requirements with reference to the deployment of the neutral beam (NB) system and discusses the influence imposed on R&D.

An initial optimisation study for the geometry of the NB system has been undertaken to identify those aspects of operation and design that are priority R&D issues. The high power(~240MW), high duty cycle (~80%) requirement of the steady state device is most demanding and plasma profile control imposes a lower limit on the number of individual NB units commensurate with the degree of power modulation required. Adopting a nominal NB power unit of 9MW, gas neutralizer and 70% transmission (equivalent to 7mrad divergence in ITER), their number and clustering can be optimised to reduce the total port injection area whilst balancing the problem of packing high voltage modules. Additional factors, such as improved beam current density, neutralization efficiency and transmission can also be included to indicate the best R&D route to optimisation.

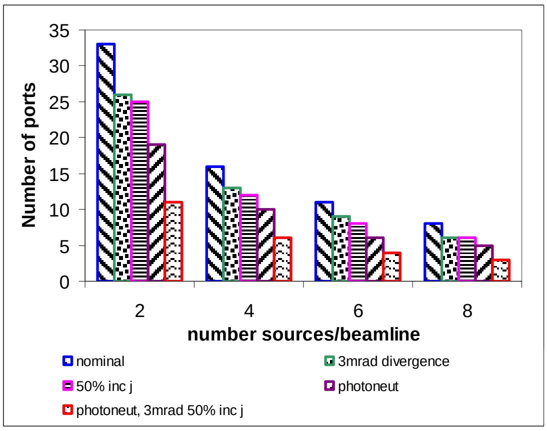

Figure 1 Impact of beam development strategies on injection ports.

Figure 1 shows the ports required as a function of unit packing density; the effects of various NB development strategies, reducing the divergence, increasing the current density and introducing the photoneutralizer, are shown. The figure reveals the following points: (i) there is little gain in striving for high packing density, (ii) improving transmission by reducing the divergence (or eliminating direct interception) is as advantageous as a 50% increase in current density and possibly easier to achieve, (iii) the photoneutralizer reduces the port requirement by two, (iv) truly significant improvement requires a combination of all three strategies. The number of injection ports is of particular concern as these interrupt the breeder blanket; it is shown that the total port area represents less than 1% of the blanket surface area. Additional R&D requirements resulting from the long NB pulse length emerge from the study e.g. caesium consumption of 24kg/yr and the need to cool peripheral structures subject to low heat flux over long periods.

For the pulsed DEMO the development of technologically complex neutralizers may not be attractive, given the modest influence of NB on plant efficiency but achieving reliable and repeatable operation for 1% duty cycles is a challenge. Thus by considering the differing deployment of NB on DEMO devices, the R&D can be prioritized and realistic compromises identified.

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