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Towards a new generation of high power high efficiency neutral beam heating system for the future fusion reactors

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Since the signature of the ITER treaty in 2006, a new research programme targeting the emergence of a new generation of Neutral Beam (NB) systems for future fusion reactors has been underway at CEA, several academic laboratories in France and EPFL (Switzerland). To provide plasma heating and current drive, the NB system specifications are very demanding: a very high level of neutral power (up to 150 MW) and energy (1 MeV), including high wall-plug efficiency (η > 60%), high availability and reliability. To meet these specifications, a novel NB concept based on the photo-detachment of the energetic negative ion beam is under study. The keystone of this new concept is the achievement of a photo-neutralizer where a high power photon flux (˜3 MW) generated within a Fabry Perot cavity will overlap, cross and partially photo-detach a narrow and tall "blade-like"negative ion beam accelerated to high energy (1 MeV). It will be shown that such a photoneutralization based NB system would have the capability to provide several tens of MW of D0 per beam line with a wall-plug efficiency higher than 70%. The talk will describe the injector concept and the main achievements in 2016; in particular, to provide a blade-like ion beam, a first Helicon plasma jet of 1.8 meter long in hydrogen with a density ne˜5 1017 m-3 has been achieved at EPFL. At the LAC laboratory, a reduced scale photoneutralization experiment has demonstrated 50% photoneutralization in continuous wave on a 1.2 keV H- beam under 10 kW photon power stored in an optical cavity.

Eligible for student paper award?

No

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