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SPIDER in the roadmap of the ITER Neutral Beams

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To reach fusion conditions and control plasma configuration in ITER, the next step towards establishing nuclear fusion as viable energy source, suitable combination of additional heating and current drive systems is necessary. Among them, two Neutral Beam Injectors (NBI) will provide 33MW hydrogen/deuterium particles electrostatically accelerated to 1MeV; efficient gas-cell neutralisation at such beam energy requires negative ions, obtained by caesium-catalysed surface conversion of hydrogen/deuterium atoms in the ion source. ITER NBI requirements have never been simultaneously attained; so a Neutral Beam Test Facility (NBTF) was set up at Consorzio RFX (Italy). Experiments will verify continuous NBI operation for one hour, under stringent requirements for beam divergence (<7mrad) and aiming (within 2mrad). To study and optimise NBI performances, the NBTF includes two experiments: MITICA, full-scale NBI prototype with 1MeV particle energy; SPIDER, with 100keV particle energy, aiming at testing and optimising full-scale ion source. SPIDER will focus on source uniformity (~1.5m2 beam area), negative ion current density and beam optics. The SPIDER experiment, just entered into operation, will profit from strong numerical activities, simulating experimental scenarios, and refined diagnostic instruments, providing thorough plasma and beam characterisation.
The talk outlines the worldwide effort towards ITER NBI realisation. Coupling of radiofrequency to plasma, voltage holding with magnetic fields, distribution of caesium emitted from the evaporators will be addressed by SPIDER experimentation, supplemented by other small facilities specifically devoted to these issues. This talk will also outline the studies carried out in the ELISE facility (IPP-Garching, Germany), equipped with a half-size source, and in NIO1 at Consorzio RFX, which are supporting ITER NBI development. Concerning beam optics physics, specific issues are also addressed by joint experiments at QST and NIFS (Japan). Finally the talk will present the results of the first experiments in SPIDER, including the preliminary source plasma characterisation.

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