Conceptual Design of Confined Alpha Particle Diagnostic System for ITER Using an Energetic He^0 Beam

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Confinement of alpha particles produced by D-T reaction in a thermonuclear plasma is one of the most important issues to sustain the burning plasma on ITER. To measure the velocity distributions of the alpha particles in the plasma, neutralization of a beam probe of energetic helium neutrals produced from the auto-detached from negative helium (He^-) ions is proposed to be the most promising. A conceptual design of confined alpha particle diagnostic system using the energetic neutral helium (He^0) beam has been examined for ITER. The system consists of a high-brightness positive helium (He^+) ion source, an alkali-metal vapour cell to produce He^- ions by double charge exchange, a magnetic deflection type ion separator with a stigmatic beam focusing, an electrostatic pre-accelerator, a radio-frequency quadrupole (RFQ) accelerator, a long-free-flight beam transport line and a neutralized alpha particle detector. For ITER, the He^- beam current of 100 mA order at the beam energy about 2 MeV is required to fulfill the signal detection with enough S/N ratio. The ion beam production and acceleration devices are designed to be installed behind the third neutral beam (NB) heating system. The accelerated He^- beam is injected into the beam transport line of the NB heating system and the auto-neutralized He^0 beam is produced during the long beam injection line into the fusion reactor. The detection system for the neutralized alpha particles is designed to be installed in one of the diagnostic port plugs.