Advancements of neutron and γ-ray diagnostics for fusion device and perspectives for ITER

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The main goal of the next thermonuclear fusion experiments, such as ITER, is the realization of a burning plasma in which deuterium and tritium ions are confined in thermal equilibrium at temperatures between 10 and 20 keV. The DT fusion reaction produces an alpha particle and a neutron plus a residual 17.6 MeV. The alphas, being charged, remain confined and contribute to the self-sustainment of the plasma. By measuring the 4.45 MeV gamma rays emitted by the reaction $^{9}Be(\alpha,n)^{12}C$, it is possible to gain a deeper understanding of fast ion physics in fusion plasmas that will help toward the realization of an ignited plasma. Gamma-ray spectroscopy has proven to be a valuable probe of the fast ion dynamics and, in particular, at JET, has provided diagnostic information on fast ion effects during Ion Cyclotron Resonance Heating [1]. For what concerns Neutron Emission Spectroscopy, by measuring the 2.5 MeV or 14 MeV neutron spectrum in D and DT plasmas, respectively, it has shown to be a powerful method to infer ion temperature and distinguish between thermal and suprathermal ions, the latter created by external heating [2,3].

This talk is focused on the recent developments of gamma-ray and neutron diagnostics. Diamond and Silicon Carbide Detectors have been demonstrated as a promising high energy neutron diagnostic for high rate (1 MHz) and high energy resolution (<2%) measurements [4]. Their compact size, fast response time and capability to withstand high neutron fluences make them relevant as neutron diagnostics in future fusion machines. Recent developments in the multiple-line-of-sight gamma-ray spectrometer proposed to measure fusion alpha particle profiles in ITER will be presented.

[1] M. Tardocchi et al, *Phys. Rev. Letters* 107 (2011) 205002

[2] M. Tardocchi et al, *Nuclear Fusion* 42 (2002) 1273

[3] M. Nocente, *Rev. Sci. Instrum.* 86, 103501 (2015).

[4] C. Cazzaniga et al., *Rev. Sci. Instrum* 11E101 (2014)