High rate neutron and gamma ray spectroscopy of magnetic confinement fusion plasmas

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This lecture will address the recent development that has been carried out in the last few years for the forthcoming high power D and DT campaign. The focus is on the development of compact neutron and gamma-ray spectrometers which combine i) very high energy resolution; ii) MHz counting rate capabilities; iii) possibility of integration in multi sight-line camera configuration.

A new compact neutron spectrometer based on single crystal diamond detectors has been developed and installed at JET for measurements of the 14 MeV neutron spectrum. The neutron spectrometer is based on a matrix of 12 CVD Single-crystal Diamond pixels and features fast response and compact size. Measurements on a portable DT neutron generator have shown that neutron spectroscopy of the accelerated beam ions at unprecedented energy resolution (~1% at 14 MeV) is possible, which opens up new opportunities for diagnosing DT plasmas.

The talk will also illustrate the recent development of two new neutron spectrometers based on SiC and CLIC scintillator, for 14 MeV and 2.5 MeV neutrons, respectively. SiC offers an even higher resistance to neutron damage than diamonds while the CLIC scintillator opens new opportunities for 2.5 MeV neutron spectroscopy of D plasmas.

For what concerns gamma ray measurements, the JET gamma ray camera has been recently upgraded with the dual aim to improve the spectroscopic and rate capabilities of the detectors. A new compact spectrometers based on a LaBr3 scintillator coupled to Silicon Photomultiplier has been developed for gamma ray spectroscopy in the MeV energy range and at MHz counting rates. The upgraded system will reconstruct along 19 line of views into the plasma the spatial gamma ray emissivity from the plasma. This includes measurements of gamma rays produced by the interaction of fast ions with beryllium plasma impurities as well of the 4.5 MeV gamma rays from the reaction $^{9}Be(\alpha,n)^{12}C$.

Example of the roles of synthetic diagnostics for neutron and gamma ray spectroscopy of fusion plasmas will be given.