EUROFUSION_NCBJ_JET4 PROJECT FOR GAMMA-RAY DETECTORS IN PLASMA EXPERIMENTS

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Since 2012 NCBJ has been involved in work on gamma-ray diagnostics for plasmas. The main objective of our activity is participation in long term projects carried out at the Joint European Tokamak facility (JET), then to prepare detectors for the International Thermonuclear Experimental Reactor (ITER) as well as for the DEMOnstration Power Plant (DEMO), see www.euro-fusion.org. JET is the world's largest fusion reactor and the closest to ITER in design. The JET diameter is equal to 6 m and ITER will have a diameter of 12 m. Plasma volumes are 80 and 800 m^3 for JET and ITER, respectively. JET experiments are devoted to test plasma phenomena as well as materials and systems for ITER. At JET in a few years from now, a power-generating run with deuterium-tritium fuel is foreseen to sustain a fusion output of perhaps 20 MW for six or seven seconds. For ITER, it is expected to begin experiments in 2020 and to feed fusion fuel into the reactor not earlier than 2027. DEMO will be designed while ITER is running and it is hoped that it will begin operational in the 2030s and start to produce fusion power in the 2040s. Our short-term plans are connected with participation in projects and experiments at JET. In the years 2014-2017 we will participate in three of the JET4 Enhancement Projects. Taking part in JET enhancement projects is a good starting point for further collaboration within the European plasma community to join projects for ITER and DEMO.

In order to take full benefit from the deuterium-tritium (DT) campaign at the Joint European Tokamak (JET) planned for 2017, a number of diagnostic upgrades are necessary for fusion alpha particle measurements.

Members of the Nuclear Techniques & Equipment Department are participating in the development of detectors for different diagnostics at JET. Detector systems are based on scintillators and optimally matching photodetectors

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At JET the α particle diagnostics are based on the $^{9}Be(\alpha,n\gamma)^{12}C$ nuclear reaction occurring between confined α particles and beryllium impurity ions typically present

$$^{9}Be + \alpha \rightarrow \ ^{13}C \xrightarrow{n} {}^{12}C^{*} \xrightarrow{\gamma(4.44\ MeV)} {}^{12}C_{\ g.s.}$$

in the plasma. The 4.4 MeV gamma line is emitted in the reaction

Gamma ray diagnostics of magnetically confined plasmas provide information on runaway electrons (fast electrons that often appear during plasma disruptions), fusion products and other fast ions due to nuclear reactions on fuel ions or main plasma impurities such as carbon and beryllium.

Three different projects are currently being carried out by NCBJ within the JET4 Enhancements Projects: modernization of two detector systems at JET, the Gamma Camera (GCU) and Gamma Spectrometer (GSU) and building a new diagnostics, the Lost Alpha Gamma Rays Monitor (LRM).
In 2014 we concentrated on investigations to find the best detectors for gamma radiation measurements in high-temperature plasma in a strong magnetic field and intensive neutron and gamma fluxes. We studied both scintillator and photodetector properties for use in plasma experiments. Monte Carlo simulations are used to optimise detectors to measure gamma rays produced in reactions induced by alpha particles in tokamak experiments.

The current status of our activity is presented in more detail in subsequent articles of the NCBJ Annual Report 2014.

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