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Study of a single line of sight gamma ray diagnostics for measurements of the absolute gamma ray emission from JET

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The fusion power produced in a DT thermonuclear reactor is currently determined by measuring the absolute 14 MeV neutron yield of the main T(D,n)α fusion reaction. Measurements of 17 MeV gamma rays born from the much less probable $T(D,\gamma)^5He$ reaction (branching ratio of ~10^{-5}) have been proposed as an alternative independent method to validate the neutron counting method and also to fulfill the requests of the nuclear regulator for licensing ITER DT operations. However, the development of absolute 17 MeV gamma-ray emission measurements entails a number of requirements, such as: i) knowledge of the 17 MeV gamma-ray to 14 MeV neutron emission branching ratio; ii) the simulation of the gamma ray transport from the extended plasma source to the gamma ray detectors; iii) a careful determination of the absolute efficiency of previously calibrated gamma ray spectrometers.

In this work, we have studied the possibility to infer the global gamma ray emission rate from measurements made with a 3"x6" $LaBr_3$ spectrometer (named KM6T) installed at the end of a collimated tangential line of sight at the JET tokamak. The relation between the line integrated emission and the total emission from the JET tokamak has been investigated numerically for a range of 17 MeV gamma emission profiles expected in DT discharges. Results show that 17 MeV gamma ray fluxes at the end of the KM6T line of sight have a weak dependence (less than 10%) on the plasma profile and can therefore be used to infer the total emission from the plasma. A validation of the method using neutron measurements from D plasmas is also presented.