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First evaluation of gamma-ray emission from alpha-boron reactions in the ITER tokamak with a tungsten wall

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Obtaining experimental information on the properties of alpha particles, such as their energies and spatial profile, is quite challenging. One of the methods currently planned for the ITER tokamak is *gamma-ray spectroscopy*.

Until 2023, alpha particle measurements via gamma-ray spectroscopy relied on nuclear reactions between alpha particles and ^{9}Be impurities. However, since ITER will feature a fully tungsten first wall conditioned with natural boron instead of a ^{9}Be wall, new approaches are needed.
Boron will be injected to condition the wall and support plasma operations, but no experiment has yet studied boron-based reactions to derive alpha particles information in tokamaks.

This work makes a first contribution to this problem by computing the alpha-boron gamma-ray emission expected at ITER including a first
calculation of the background.
The calculation focuses on the RGRS (Radial Gamma Ray Spectrometer) diagnostic, which consists of three gamma-ray spectrometers observing the plasma through three co-planar, collimated and radial lines of sight.
The numerical evaluations performed in this work are based on simulations of ITER plasma scenarios stored in the IMAS database.
Starting from the density, emission and temperature profiles of the particles in a DT plasma discharge, quantities of interest were derived to predict the signal expected from the $^{10}B(\alpha, p\,\gamma)^{13}C$ reaction. From these data, it was possible to implement scenarios with different fuel composition (D^3He) and different thermal equilibrium (supra-thermal scenarios) to study the alpha particle measurement capability of RGRS under a range of conditions.

In order to assess the RGRS performance in a DT/D^3He plasma scenario, specific Monte Carlo simulations were conducted. These took into account the geometrical and structural aspects of the tokamak and the diagnostics under consideration, together with the expected amount of neutron and photon fluxes.

First calculation results of the radiation background expected at the detector position were also included in the model. We find that gamma-ray measurements are possible with a time resolution of the order of the alpha particle slowing down time for most of the detectors. We also identify the radiation background at the detector as the main
factor that determines the feasibility of the measurements.

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