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Monte Carlo simulation of the pulse height spectra produced in diamond detectors by quasi-monoenergetic neutrons. Comparison with experimental data

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The accurate simulation of fusion neutronics experiments is required for the development of the techniques aiming at monitoring the neutron flux and performing spectral analyses in the forthcoming ITER reactor. The interplay between experimental activity and simulation is the mean for proving and generalising the assumptions on ITER neutronics until it will be built. The work is carried out in view of the possible use of diamond detectors as high resolution neutron spectrometer for ITER project. The characteristics of such diamond based neutron spectrometers, like the carbon nuclear data, the electronics and the response pulse height spectra, need to be precisely assessed.
In the summer 2011 a team from the Frascati Neutron Generator (FNG-ENEA Fusione, Rome, Italy) performed a set of measurements with several diamond detectors at the Van der Graaff laboratory at the Institute for Reference Material and Measurements (IRMM, Geel, Belgium) in collaboration with the VdG team in order to determine the response functions of diamond detector to quasi monoenergetic neutrons in the energy range 8-20 MeV. Source neutrons were produced by accelerating deuterons onto solid targets containing deuterium or tritium.
The energy spectrum of the source neutrons (indeed, they are never monoenergetic because of target effects) are simulated with an ad-hoc source routine, which is to compile within the MCNPX or MCNP5 distribution. It is possible to develop computational models that reasonably include any contribution to an experimental neutron source from deuteron-deuteron or deuteron-triton reactions.
The front end of the simulation involves a detector routine (TALLYX, also to compile within an MCNP source distribution) that reproduces the measured pulse height spectrum. It is triggered upon interaction of a neutron (generated and transported inside MCNP) with carbon. The C-12 nuclear data are those from ENDF/B-VII.0, TENDL-2009, ENSDF and spare literature to include: elastic, inelastic, (n,a), (n,p) (n,d) reaction channels. The high resolution of the diamond detectors underpins the validation of the evaluated cross sections above 10 MeV and consequently some sets of measurements have been performed with this purpose.
The high quality of the available measurements allowed the definitive validation of the computational tools, especially the detector routine, which might be adopted for the perspective activities related with the ITER project.

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