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Neutronics pre-analysis and the status of neutron spectrum unfolding for the development of VERDI

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In future fusion power plants, such as DEMO, D-T neutron emission is predicted to exceed 1e21 neutrons/second. Accurately monitoring neutron energies and intensities will be the primary method for estimating fusion power, and calculating key parameters, including the tritium breeding ratio and nuclear heating. The Novel Neutron Detector for Fusion (VERDI) project, implemented under the EUROFusion Enabling Research 2017 program, aims to develop a novel neutron detector, capable of withstanding the harsh environment of a future fusion power plant. The VERDI detector is based on the foil activation technique, which relies neutron spectrum unfolding methods to process the convolution of gamma-ray measurement and detector response function and infer the neutron energy spectrum. A benchmark experiment has already been performed at the Frascati Neutron Generator, at ENEA, details of this experiment are provided in another submission. In this paper, experimental results from the Frascati Neutron Generator have been applied to neutron spectrum unfolding techniques. Calculations performed using MCNP and FISPACT-II were successful in predicting the gamma-spectroscopy peaks, and the initial use of MAXED has provided a neutron energy spectrum in good agreement with expectations. Results from the benchmark experiment have shown that careful treatment of (n,gamma) reactions are needed for neutron spectrum unfolding to obtain physically realistic solutions at low energy. The application of the VERDI detector is now being extended to JET to explore behaviour in both short-term and long-term experiments. This paper will focus on the pre-analysis calculations that have been performed in preparation for upcoming experiments during the JET D-D campaign. The status of neutron spectrum unfolding will also be discussed in this overview, along with plans for the development of neutron spectrum unfolding.

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