14 MeV Calibration of JET neutron detectors

Jan Dankowski[a], P. Batistoni[b], S. Popovichev[c], A. Cufar[d], Z. Ghani[c], L.Giacomelli[e], S. Jednorog[f], A. Klix[f], S. Lilley[b], E. Laszynska[f], S. Loreti[c], L. Packer[b], A. Peacock[g], M. Pillon[b], R. Price[c], M. Rebai[i], D. Rigamonti[i], N. Roberts[i], M. Tardocchi[e], D. Thomas[i] and JET contributors[1]

[a]*The Henryk Niewodniczański Institute of Nuclear Physics PAN, Kraków, Poland*
EUROfusion Consortium, Culham Science Centre, Abingdon, Oxon, OX14 3DB, UK
[b]*ENEA, Department of Fusion and Nuclear Safety Technology, I-00044 Frascati (Rome), Italy*
[c]*CCFE, Culham Science Centre, Abingdon, Oxon, OX14 3DB, UK*
[d]*Reactor Physics Division, Jo˘zef Stefan Institute, Jamova cesta 39, SI-1000 Ljubljana, Slovenia*
[e]*Istituto di Fisica del Plasma "P. Caldirola", CNR, Milano, Italy*
[f]*Institute of Plasma Physics and Laser Microfusion, Hery 23, 01-497 Warsaw, Poland*
[k]*Karlsruhe Institute of Technology, D-76344 Eggenstein-Leopoldshafen, Karlsruhe, German*
[i]*Dipartimento di Fisica "G. Occhialini", Università degli Studi di Milano-Bicocca, Milano, Italy*

In conjunction with the planned in 2019 deuterium-tritium experimental campaign at JET tokamak, a calibration of the JET neutron monitors at 14 MeV neutron energy is needed. For this purpose two compact D-T neutron generators (NGs) were purchased from VNIIA, Russia. The NGs have been fully characterised and calibrated prior to the in-vessel calibration of the JET monitors. The goal of this report is to show the results of the measurements performed using different types of neutron detectors which allowed us to obtain the neutron emission rate and the anisotropy of the neutron generator, i.e., the neutron flux and energy spectrum dependence on emission angle, and to derive the absolute emission rate in 4π sr. The use of high resolution CVD diamond spectrometers made it possible to resolve the complex features of the neutron energy spectra resulting from the mixed D/T beam ions reacting with the D/T nuclei present in the neutron generator target. The instability of the neutron source, several monitoring detectors were attached to it to continuously monitor the neutron emission rate during the in-vessel calibration. CVD diamond detectors and activation foils, have been calibrated in terms of n/counts within ±5% total uncertainty. A neutron source routine has been developed, able to produce the neutron spectra resulting from all possible reactions occurring with the D/T ions in the beam impinging on the Ti D/T target. The neutron energy spectra calculated by combining the source routine with a MCNP model of the neutron generator have been validated by the measurements. These fully characterized neutron generators have been used recently to perform the accurate calibration of two JET neutron systems, namely fission chambers and activation system. NGs were deployed inside the vacuum vessel by means of the existing remote handling system (RH), The report will also present preliminary results of this in-vessel calibration.