# Innovation on ITER Neutron diagnostics towards DEMO

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Neutron measurement is one of the major diagnostic methods on ITER, and it will be one of few plasma measurement tools on DEMO. Its principal role on ITER is to allow evaluation of fusion output, indicating how close the ITER plasma approaches the ultimate goal of a self-sustained nuclear fusion reactor. Tests of various types of candidate blanket will be carried out on ITER, and the neutron fluence on the first wall is an inevitable key parameter for these experiments.

In addition, neutron diagnostics supply a variety of both spatially and time-resolved information to facilitate our understanding of physics, especially with regard to the behaviours of energetic particle, the ion temperature, the fuel isotope ratio ($n_T/n_D$), $\alpha$-particle confinement, and so on. The time-resolved neutron emission profile is essential to study the energy and particle transport of ITER plasma.

To date, 9 sub-systems have been considered: a radial neutron camera, a vertical neutron camera, in-vessel neutron flux monitors, ex-vessel neutron flux monitors, neutron and gamma spectrometers, neutron activation systems, and lost alpha detectors. Some of which are well designed and are now ready for construction, but most of them have components to be developed or to be tested. Innovative development of diagnostic components, such as a high-resolution neutron spectrometer, robust compact neutron detectors, effective neutron shields for gamma-ray detection, so on are needed.

Parameters mentioned above often cannot be determined by a single measurement system, but require a combination of two or more systems. For example, the fusion output, which should be measured by time-resolved emission monitors well-calibrated onsite with high accuracy and high reliability, will be cross-checked using several detectors. Moreover, the integral of the neutron rate from a shot is checked by the total yield, as measured by the activation system.

Absolute calibration of these systems is required. It is suggested to use two sources in combination: a $^{252}$Cf source and a 14 MeV neutron generator. The sources would need to be rotated on many different toroidal axes in the ITER vessel. Detail study by MCNP calculations on the self-shadow effect of the sources, the source energy effect, accuracy against the profile change, etc. is necessary to obtain an accurate calibration factor.

References

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