Contribution ID: **21** Type: **not specified**

VERDI detector benchmark experiment at the ENEA 14 MeV Frascati Neutron Generator

Tuesday, 18 September 2018 17:00 (20 minutes)

For future fusion plants, such as DEMO, there is a great need for detectors capable to accurately monitor neutrons under the harsh conditions imposed by fusion environment. In particular, detectors required in Test Blanket Modules must be capable to accurately measure neutron fluence under high and variable neutron count rates, high gamma background, high temperature and high and variable magnetic fields. The Novel Neutron Detector for Fusion (VERDI) project aims to develop a detector which will provide a robust approach for neutron detection in fusion plants. The detector comprises a composite low activation matrix compound capsule containing a defined concentration of added metallic elements. The neutron fluence and energy spectrum will be inferred by analysis of the multiple gamma lines produced by the activation of the metallic elements. The key innovation lies in the use of the composite ceramic capsule which is capable to withstand the extreme environment of a fusion plant. In this work, the candidate metallic elements for the VERDI detector are defined. FISPACT-II radionuclide inventory code was used in order to simulate irradiations under fusion relevant neutron spectra and calculate induced activities and their evolution in time. A benchmark experiment was performed at the ENEA Frascati Neutron Generator to demonstrate the feasibility of VERDI detectors to measure neutron fluence under a reference fusion-relevant field. A number of prototype VERDI detectors was fabricated, tested out of field and irradiated under DT neutrons (14 MeV). Gamma-ray measurements were performed aiming in the detection of both short-lived and long-lived product isotopes. The results in terms of realized reactions and induced activities were compared to the respective calculated data using the FISPACT-II code and a very good agreement was observed. In the next level of development, VERDI detectors will be tested under real fusion conditions at JET Long Term Irradiation System.

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Session Classification: O2.B

Track Classification: Diagnostics