DEVELOPMENT AND TESTING OF A FAST NEUTRONS DETECTOR UNIT FOR THE ITER UPPER NEUTRON CAMERA

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Vertical Neutron Camera (VNC [1]) is a subsystem of ITER neutron diagnostics intended for measurement of neutron yield in the poloidal plasma section of tokamak. The VNC diagnostics will measure the time resolved neutron emission profile for both DD and DT ITER plasmas, providing the evaluation of the fusion power density, α-source density, neutron and α-source emissivity profile, ion temperature profile, fusion power and total neutron flux and others parameters. VNC has to provide measurement of neutron fluxes in the range 105—1011 cm-2sec-1. VNC consists of two parts: upper VNC, located in the upper port #18, and lower VNC located in the lower port #14. Upper VNC contains 6 collimators and Lower VNC contains 5 collimators. Fast Neutron Detection Unit (FNDU) is located at the end of every collimator to measure neutron fluxes.

Neutron analysis of Upper VNC performance has been carried out. Ration signal/background was shown to be lower than expected. Calculations showed that neutron fluxes in the Upper VNC are by one order of magnitude higher than in the Lower VNC. This fact has defined the Upper VNC design: sensitivities of Upper VNC FNDU detectors are to be less by one order of magnitude than for the Lower VNC.

Taking into account the results of neutron analysis a new FNDU for Upper VNC has been developed. Its dimensions are: length 310 mm and diameter 66 mm. One double-electrode fission chamber and two diamond detectors with different sensitivities are the main parts of FNDU. Electrodes with uranium layer with surface density 0.26 mg/sq. cm. are used. In the first electrode system there are 15 plates with double-side uranium layer and 2 plates with one-side layers. In the second electrode system there are 5 electrodes with double-side and 2 electrodes with one-side uranium layers.

In the developed FNDU the signal is pinned through metalloceramic insulators, located on the one flange of the detector unit. Fission chamber located in the hermitic housing, which volume is pre-pumped and filled by gas mixture. Fission chamber is electrically isolated from the housing by ceramic rings. Diamond detectors contain one sensitive element with different dimensions.

Tests were performed in the testing facility of NIITFA: seismic stability, steadiness to sinusoidal vibration, strength to single shocks, steadiness to atmosphere pressure, strength to thermocycling, check for influence of elevated operating temperature of the environment. Tests of tentative samples on the neutron generator were carried out at SRC RF TRINITI

References

1. V.N. Amosov, S,A. Meshchaninov, N.B.Rodionov. Prikladnaya Fizika, №4, 2011, pp. 104-108.