Sensitivity of DNFM fission chambers to neutron spectrum on ITER AT DIFFERENT ISOTOPIC PURITIES OF URANIUM-238 [[1]](#footnote-1)\*)

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Diagnostics "Divertor neutron flux monitor" (DNFM) is designed to determine neutron yield and fusion power of ITER plasma [1] in a wide dynamic range of measurements. The time resolution of diagnostics is 1 ms. The required relative measurement error for DT plasma is 10% and for DD plasma - 20%. Ionization fission chambers (FC) with different isotopic composition and mass of the fissile material (235U and 238U) will be used as detectors of ionizing radiation. FCs with 238U are particularly sensitive to high energy neutrons (> 1 MeV). To minimize the impact on thermal neutron measurements in these detectors it is planned to use 238U with an isotopic purity of 99.9999%. During ITER operation, 239th isotope of plutonium is generated in these FCs, which leads to changes in sensitivity of the detectors up to 8% [2]. Changing the sensitivity of the FCs will make an additional error in measurement. Also, such a high degree of 238U content leads to an increase in the cost of DNFM detectors manufacturing.

The work investigated the change in sensitivity of the DNFM FCs with 238U for the entire period of the ITER operation. Four variants of uranium purity differing in mass fraction of 238U were considered: high purity (99,9999%), intermediate purity (99,9%), depleted (99,8%) and natural (99,26%).

Based on the analysis of the calculations results we can conclude that a decrease in the isotopic purity of 238U in the FCs leads to a decrease in the dependence of measurements sensitivity to the 239Pu production, because the decrease in the mass fraction of 238U increases the contribution of scattered neutrons to the fission reaction rate of uranium due to a corresponding increase in the mass fraction of 235U. In the considered variants the amount of gained 239Pu practically does not depend on the 238U content.

The use of depleted uranium or intermediate purity uranium does not require significant changes of the design of the DNFM FCs, because the sensitivity changes do not exceed 17% relatively pure uranium (when a technological error of uranium spraying on the FCs ~ 20%). Depleted uranium application will significantly reduce the cost of FCs manufacturing.

The use of natural uranium is also possible. It should be noted that the sensitivity of the FCs with natural uranium is significantly higher than that of the FCs with high pure uranium. The sensitivity of the FCs affects the value of the possible dynamic measurement range. To preserve the value of the DNFM system measurement rang, it is necessary to reduce the mass of the FCs with natural uranium by ~1.5 times relative to the mass of FCs with high-purity uranium.

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References

1. Yu.A. Kaschuck, et al., "Divertor Neutron Flux Monitor: Conceptual Design and Calibration", AIP Conf. Proc. 988, 303 (2008).
2. D.V. Portnov et al., "Radiation and transport analysis of the ITER "DNFM" Neutron Diagnostics Detectors characteristics", XLVII International Zvenigorod conference on the plasma physics and controlled thermonuclear synthesis, March 16-20, 2020.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/E/ru/HE-Kovalev.docx) [↑](#footnote-ref-1)