Optimization of the Main Parts of the New Pulsed Nuclear Reactor NEPTUNE

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A new pulsed high flux nuclear reactor is currently being developed within the Frank Laboratory of Neutron Physics (FLNP) to replace the current IBR-2M reactor after the end of its service life. One of the proposed options is the NEPTUNE reactor (average power of 12–15 MW, pulse duration of 210 μs and an average neutron flux of 1.6×10^{14} n/cm^2/s and at the peak power of 3.8×10^{17} n/cm^2/s), which will use fuel based on the isotope Np-237 for the first time.

Np-237 is a threshold isotope with a fission threshold of 0.4 MeV, lower than the fission threshold of uranium-238 of 2 MeV. This gives it a greater advantage in terms of the possibility of using as the new nuclear fuel in pulsed reactors to obtain a short neutron pulses, have a low background power between pulses and use a new, more effective reactivity modulator and control rods based on neutron moderation (also for the first time in fast reactors).

The report and presentation will explain the principle of operation of the reactor, its most important properties and some of the features that were discovered during the developing stage, while presenting proposed solutions:

- illustrate the possibility of partially using high enriched uranium (90% U-235 enrichment) or low-enriched uranium (with U-235 enrichment less than 20%) fuel with the possibility of using anew stationary reflector around the reactor core to enhancing the safety parameters of the reactor by increasing the generation life time of the neutron;
- a new proposal for a reactivity modulator will be presented in order to reduce the thermal load on the titanium hydrate material to increase its service life;
- also review the results of comparing the use of three materials, namely liquid para hydrogen, solid methane, and mesitylene, at temperatures of 20 K, in order to increase the percentage of cold neutrons extracted in the neutron channels.