PLM-2 PLASMA device FOR FULL-SCALE TESTS OF FUSIon reactor MATERIALS WITH STATIONARY MEGAWATT LOADS: PROJECT PARAMETERS

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For the design and construction of thermonuclear fusion reactors (ITER, FNS, DEMO), full-scale testing of materials, mock-ups and prototypes of the wall and divertor is required. The available technologies for testing by beam loads are not sufficient for these purposes, despite the fact that they provide a powerful total heat flux to the materials. It is extremely important to ensure adequate conditions of plasma load on materials. For such purposes, a linear magnetic trap PLM-2 device is designed for stationary hours-long plasma confinement with parameters capable of providing the relevant reactor plasma loads on materials:

– longitudinal magnetic field is 0.25 T, section of a magnetic field up to 2.5 T;

– diameter of the plasma is 3.5–10 cm;

– discharge duration: stationary, up to 500 minutes or more;

– plasma electron density is up to 1019–1020 m–3;

– the energy of ions in the flow to the target is 1–300 eV;

– ion flux on the target ~1023–1025 m–2 s–1;

– stationary thermal load to the target material - more than 10 MW m–2;

– stationary plasma flux is similar to a thermonuclear reactor in the steady state discharge;

– cooling of wall and target modules - stationary, testing of modules with water, two-phase combined-cycle, liquid metal cooling;

– ICR plasma heating 0.5–27 MHz, use of helicon antennas;

– a module with powerful beam heat loads on a target - up to 2 GW/m2 with a duration of up to
1 ms with a frequency of up to 20 Hz (similar to extreme loads at ELMs and disruptions in a diverter of a fusion reactor);

– the “detached” mode, an analogue of the closed tokamak divertor mode;

– liquid metal (LM) wall elements / limiters of lithium, tin and others;

– technology of plasma control and turbulent heating of plasma by electrodes under voltage;

– the tested materials are tungsten, molybdenum, steels, graphite, lithium, tin, tantalum, nickel, titanium, iridium, platinum, iron, copper, composite alloys.

The PLM-2 device has no analogues in Russia, with parameters similar to the most powerful device in the world, like MAGNUM-PSI (European Union), will be built on the basis of the existing PLM device (NRU “MPEI”) [2].

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References

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2. Budaev V.P. e a. VANT ser. Thermoyadernyi sintez, 40, 3, 23 (2017).