DOI: 10.34854/ICPAF.52.2025.1.1.003

PLASMA PHYSICS AND REACTOR TECHNOLOGIES DEVELOPING BY RUSSIAN SCIENTIFIC CENTERS THAT ARE ESSENTIALLY CONTRIBUTING TO THE ITER, TRT AND BEST FUSION PROJECTS *)

Krasilnikov A.V., Kashchuk Yu.A., Konovalov S.V.

Institution "Project center ITER", Moscow, Russia, <u>a.krasilnikov@iterrf.ru</u>

Cooperation of Rosatom and Russian academy of science research centers, state and privet technological companies are deeply involved in development of key scientific and technological problems of future fusion reactor creation in frame of fulfilment of RF obligations in the international ITER project. Entities of this cooperation actively participate in development and design of the Tokamak with Reactor Technologies (TRT) in Russia, started their involvement in research and technological cooperation on Chinese tokamaks EAST and BEST. ITER and BEST will be the quasistationary low temperature superconductive (LTS, Nb₃Sn and Nb-Ti) tokamaks with deuterium – tritium plasma and fusion power up to 500 (Q=10) and 200 MW (Q=5), respectively. TRT designing as quasistationary high temperature superconducting (HTS, REBCO), high magnetic field (8T) deuterium plasma tokamak with addition of the small amount of tritium. All these three machines will be full size plasma physics and engineering prototypes of future pure or hybrid (fusion-fission) reactor. Together they will contain so called technological platform of fusion reactor.

Creation of fusion reactor on the basis of tokamak still have several unresolved problems. Main of them are:

- experimental demonstration quasistationary fusion burn (creation of the stationary current, temperature, density profiles of the main plasma, creation of the optimized plasma parameter profiles on its periphery for diminishing of the plasma-wall interaction, including mitigation ELM instabilities. optimization of the divertor operation, disruption mitigation systems development);
- development of the quasistationary noninductive current drive;
- plasma technologies and materials development for effective first wall and divertor operation;
- development of the integrated methods of control;

Essential components and technologies of fusion reactor to be developed are:

- high temperature superconductive electromagnetic system;
- vacuum vessel (double layer and cooling);
- advanced first wall and divertor (W, B₄C, Li ...);
- auxiliary heating and current drive systems (0.5MeV D NBI, 230GHz ECRH, 60-80 MHz ICRH, ~1GHz helicons);
- breading and hybrid blanket modules;
- fusion reactor relevant diagnostics and control systems.

Existing activity in resolving main problems of fusion reactor creation, development its essential components and technologies and contribution to it of the cooperation of Russian scientific and technological centers and companies will be presenting in the paper on the basis their participation in ITER and TRT projects and potential contribution to BEST project in China. This leading by Rosatom fusion reactor cooperation in Russia first of all includes: "Project Center ITER", JSC NIIEFA, JSC NIKIET, JSC TVEL, NRC Kurchatov institute", JSC SRC RF TRINITI, PTI RAS, INP SB RAS, IAP RAS, MEPHI, JSC VNIIKP, JSC GKMP, Fusion-Center. In addition, the number of BEST/CRAFT (ASIPP, China) technologies (HTS and LTS superconductors, cryogenics, power supply systems, ICRH, robots etc.) could be efficiently applied at TRT with high economical effect.

Construction and experimental operation ITER, TRT and BEST, with the experience from other fusion projects of the ITER partners will provide the future successful creation of pure fusion and hybrid (fusion-fission) reactors.

The work was performed under the state contracts with Rosatom State Corporation dated 03/20/2024 No. H.4a.241.19.24.1024 and 04/17/2023 No H.4k.241.09.23.1060.

^{*)} abstracts of this report in Russian