Technological platforms of ITER and TRT for fusion energy development

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The tokamak plasma configuration was invented and researches at several first tokamaks were started in “Kurchatov institute” at the beginning of 1950-th. More than 200 tokamaks were constructed in scientific and technology developed countries up to now. 11 and 17 MW of fusion power were produced at TFTR (USA) and JET (EU) in 1994 and 1997, respectively. In 1986 following proposal of the Soviet Union design of the International Thermonuclear Experimental Reactor ITER having project value of fusion power of 500 MW was started. At the moment all ITER systems including 25 of RF responsibility are manufacturing in scientific centers and industrial plants of 7 ITER Partners and ITER machine assembling is in progress.

ITER fusion technologic platform includes: water cooling vacuum vessal, Be first wall,
W divertor, Nb3Sn and Nb-Ti coils of the electromagnetic system, 1 MeV and 16 MW neutral beam injectors, 40-55 MHz and 20MW ion cyclotron heating system, 170 GHz and 1 MW gyrotrons, highest power cryopumps and cryogenic system, tritium breading experimental blanket modules, reactor relevant diagnostics, control systems and remote handling systems and IT technologies. ITER project created would-wide fusion industry.

In frame of the ITER project in Russia were created: manufacture of superconductors (JSC «TVEL», JSC «ChMZ», JSC VNIIKP, JSC “Bochvar institute”, IPHE, NRC «Kurchatov institute», JSC «Efremov institute”, JSC «SNSC»); technologies and semi-industrial plants for first wall in divertor manufacture (JSC “Efremov institute” and JSC “Dollezhal institute”); experimental benches and technologies to perform first wall and divertor components tests (JSC “Efremov institute”, JSC “Dollezhal institute”, and JSC SRC RF TRINITI); gyrotrons (invented and successfully manufacturing in IAP RAS and JSC “Gykom”**);** port-plugs (INP SB RAS) and Port plug test facilities (JSC «GKMP»); methods and equipment for plasma diagnostics (NRC «Kurchatov institute», “Ioffe institute” INP SB RAS, Institution “Project center ITER”, “Fusion-center”, JSC SRC RF TRINITI).

In accordance with Joint Implementation Agreement for creation of the ITER organization Russian Federation have right for free licenses for application in national fusion program for all technology created in frame of ITER project and also information about world fusion industry. But ITER technologic platform does not include all technologies required for fusion reactor creation, namely Li first wall, methods of noninductive plasma current generation, HTSC coils, radiation hardness test technologies of reactor components, etc.

To provide successful creation of fusion reactor in Russia it is necessary to arrange efficient participation of Russian scientists and specialists in ITER construction and experiments in 2025-2045 and to create in Russia experimental scientific-technological basis (technological platform) – Tokamak with Reactor Technologies (TRT) – prototype of the plasma part of hybrid (fusion-fission) reactor. Main technical decisions and technologies that could be created by Russian scientific centers and industrial companies today were integrated in TRT conceptual design [1].

References

1. A.V. Krasilnikov, S.V. Konovalov, E.N. Bondarchuck, et al., Plasma Phys. Rep. 47, 1092-1106 (2021). Russian text in Fizyka Plasmy, 2021, Vol.47, №.11, pp. 970-985.