FUSION TECHNOLOGIES: FROM ITER TO NEXT STEP EXPERIMENTS

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Тоkamak (**ТО**роидальная; **КА**мера **МА**гнитная **К**атушка (in Russian)) conсept was proposed by soviet scientists I.E. Tamm and A.D. Sakharov. First researches at tokamaks were performed in Kurchatov Institute in 1951–1973 under L.A. Artsimovich leadership. L.A. Artsimovich and V.D. Shafranov have proposed the elongated tokamak with poloidal divertor in 1972. First superconducting tokamaks Т-7 (NbTi) and Т-15 (Nb3Sn) were created also in Kurchatov institute. In 1985 E.P. Velikhov has proposed to create the ITER Project, which construction is carried out today with full speed by seven partners.

Majority of the ITER systems and firstly vacuum vessel and superconducting electromagnetic system (EMS) (NbTi poloidal coils, Nb3Sn toroidal coils and center solenoid, high temperature superconducting (HTSC) current leads) are at the stage of industrial manufacture now. In addition to low temperature superconductors (LTSC) Nb3Sn and NbTi ITER partners are planning to use the REBCO HTSC at the next (after ITER) step of fusion plant EMS creation (DEMO (EU), Helical Fusion Reactor (Japan) and ARC (USA)). ITER first wall and divertor are manufactured from Ве and W, respectively. Nevertheless, advanced magnetic topologies and liquid lithium are actively considering for projects of next step divertors. Respective researches are carrying out at modern tokamaks and are planning in nearest experiments at Т-15МD, NSTX, DDT and others.

Gyrotrons (170 GHz, 20 MW), ion cyclotron range of frequancy antennas (40–55 MHz, 20 MW) and heating beam injectors with gas stripping cells (0.7–1 MeV, 33 MW) are manufacturing for ITER additional heating. Creation of 230 GHz gyrotrons, traveling wave antennas that will provide off-axis current generation using helicons at frequency ~600 MHz and neutral beam injectors with optical or plasma striping cell were started for next step experiments.

More than 30 methods and systems of equipment of plasma diagnostics are developing and will be used and ubgraded during ITER experiments. Majority of created methods and in particular those that will demonstrate long operation in radiation fluxes will be further used in fusion reactor. This statement fully respects to robots, plasma control systems (plasma profile control, desruption matigation system and others) and remote participation in experimets.

Several concepts of experimental brider blankets will be studied in ITER. But the number of ITER partners consider the possibility to create hybrid «fusion–fission» reactor as next step device and for this reason are developing blankets with fissile materials. These blankets should provide decission of such nuclear fission technology problems as fuel manufacture and minor actinid materials transmutation.