DOI: 10.34854/ICPAF.51.2024.1.1.001

FEC-2023 CONFERENCE: ENGINEERING AND PHYSICAL CHALLENGES OF CONTROLLED NUCLEAR FUSION *)

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The 29th IAEA Conference FEC-2023 was held in London in October 2023. At the conference the results of research obtained over the past two years on the most essential issues of thermonuclear fusion were presented.

The results of the DT campaign on the largest operating tokamak, JET (EUROfusion), were presented by Dr. C. Maggi. In the experiments, a record thermonuclear energy was obtained – 59 MJ in 5 s in tritium-enriched plasma (nT/nD ratio was 85/15). In the report the choice of isotope ratio to achieve the record results was justified.

The JET is replaced by the JT-60SA tokamak, built within the framework of European-Japanese cooperation. Pros of the JT-60SA: larger size than JET, superconducting magnetic system allowing long discharges. Cons: BT = 2.25 T is almost half that of JET, it is impossible to work with tritium, which narrows the possibilities of experiments. During testing, defects in the magnetic system were identified, the elimination of which delayed the launch by 2.5 years.

The state of work on the construction of the ITER reactor was reported by its director P. Barabaschi. Currently, 80% of the work required to launch the tokamak has been completed. The launch is significantly delayed due to the Covid-19 pandemic, non-conformities found after the manufacture of the vacuum chamber, and the need to test superconducting magnetic coils. Ways to minimize delays are presented.

Dr. G. Federici presented an analysis of the effect of increasing the magnetic field on the size of the E-DEMO reactor. It is shown that an increase in BT does not lead to a decrease in the size of the tokamak due to an increase in the supporting structure size. The prospects for using configurations with a small aspect ratio are discussed. Due to the delay of ITER, concerns arose that the intended licensing of DEMO reactor blanket materials would not be completed in a timely manner. EUROfusion considers it necessary to construct a Volumetric Neutron Source (VNS) for licensing.

The most ambitious project presented at the conference was the SPARC tokamak project based on a high-temperature superconductor with BT = 12.2 T, in which it is planned to achieve Q > 1. The private company CFS, together with the Massachusetts Institute of Technology, intend to launch the SPARC in 2025, and to build a commercial reactor ARC with electric power of 400 MW in 30-th.

It is worth noting the achievement of quasi-stationary discharges: fully non-inductively driven current for 1000 s and a 400-second H-mode on the Chinese EAST tokamak, as well as a 400-second discharge with improved confinement on the Korean KSTAR tokamak. The audience was greatly interested in the results obtained on the Globus-M2 (G.S. Kurskiev, RF) and ST40 (St. McNamara, UK) spherical tokamaks, which demonstrated the possibility of achieving subthermonuclear temperatures in compact devices.

Dr. A. Park presented a report on achieving “physical” ignition at the National Ignition Facility (Livermore National Lab). In the best experiment, thermonuclear energy of 3.88 MJ was obtained with the input laser energy of 2.04 MJ.

Two trends in the progress of thermonuclear research were clearly seen at the conference. The first of these is the “explosive” increase in the number of private companies offering fast tracks to the creation of low-power reactors or involved in solving technical issues of controlled nuclear fusion. The second trend is the evident increase in a quality of the scientific results and the growth of research activity in Asian countries, first of all, in China and in Japan and Korea as well.

The author’s participation in the FEC-2023 conference was supported by the FP #3 CP DTTS.

*) abstracts of this report in Russian