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FTP/4-6: Development of Magnetic Fusion Neutron Sources and Fusion-Fission Hybrid Systems in Russia

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Development of tokamak based fusion neutron sources and fusion-fission hybrids for nuclear fuel production and nuclear waste transmutation has been initiated in Russia to accelerate implementation of modern magnetic fusion technologies.
Various devices realizing intense DT fusion from 1 MW up to 100 MW have been considered and passed the pre-conceptual design level. Those include conventional, advanced and spherical tokamaks, helical systems and mirror machines. The nuclear fuel production and transmutations are addressed both for U-Pu and Th-U fuel cycles with different types of coolers and nuclear fuels.
For tokamaks with beam driven plasma at Q=0.2-1 it is possible to reach neutron loadings higher than 0.2 MW/m2 having the external wall area from 10 to 50 m2 and fusion power from 1 to 10 MW. Tokamaks with unshielded coils, copper or beryllium, have simplest design and lowest cost. The upgrading program of Globus-M tokamak has been initiated in Russia. It will be helpful for decision making about future ST-devises. Conventional tokamaks with shielded coils were considered having Cu, HTSC and LTSC conductors. All tokamaks have problems with steady state operation, heating and current drive are as well as with plasma FW and divertor loadings, ELMs and disruptions.
The ignition conditions Q > 30 for plasma are planned to study within IGNITOR project. Reaching the 100 MW fusion power for a few seconds in the magnetic field of 13 T at plasma current 11 MA is the major goal. The conceptual design of the machine is completed and construction has started in Italy. The site for the device will be provided by TRINITI. Design of the FNS on mirror machine at Novosibirsk has shown possibility to reach 2 MW/m2 neutron loadings at 2 m2 area. Certain benefits may be provided by quasi-axisymmetric helical systems, which are disruption-free, are less sensitive to current drive requirements and have potential characteristics competitive with conventional and AT tokamaks.
The most promising applications for FNS and FFHS are pure neutron production at thermal neutron flux higher than 10E15 n/cm2s, nuclear fuel production in continuous molten salt cycles, especially in Th-U one. Within next years Russia plans to complete the engineering design of several FNS options, to make a choice and to begin construction of a demonstration FNS with fusion power up to 10 MW.

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