THE TWO CONCEPTS OF MAGNETIC CONFINEMENT: TOKAMAK AND STELLARATOR

SIBYLLE GÜNTER

Max-Planck-Institut für Plasmaphysik, Garching and Greifswald, Germany
E-mail sibylle.guenter@ipp.mpg.de

Abstract. Nuclear fusion could contribute to the energy mix in the second half of this century. For a fusion reactor, matter has to be heated up to extremely high temperatures: more than 100 million degrees - about a factor of 10 hotter than the sun's core. At these temperatures, the material is fully ionized. The charged particles can be confined by magnetic fields, which are also able to provide the required efficient heat insulation. After more than 50 years of research, fusion has advanced to the decisive step on the way to a power plant: the international tokamak experiment ITER is designed to demonstrate the feasibility of net energy production from nuclear fusion reactions. In a joint enterprise by 7 partners (the EU, Japan, Russia, USA, China, the Korean Republic and India) - ITER is currently been built in Cadarache, France. With the Joint European Torus (JET) and the joint exploitation of the medium size tokamaks, the European fusion programme is well equipped to provide essential contributions to the preparation of ITER operation. The tokamak concept as realized in ITER is by far the most advanced confinement configuration. It however requires the continuous flow of an electric current in a donut-shaped plasma. In present devices, this plasma current is driven by a transformer and can therefore be maintained only over a certain time, which – in a reactor – could amount to several hours. A thermal storage would provide for continuity of the electric power production during the short time interval needed to recharge the transformer.

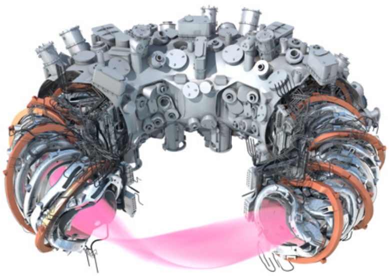

Figure: Sketch of the Wendelstein 7-X geometry.

An alternative to the tokamak is the stellarator, which needs a considerably more complex magnetic field configuration, but is intrinsically stationary without any need of external current drive. The complex magnetic field of a stellarator requires however careful optimization to ensure sufficiently good confinement properties. The first optimized stellarator of sufficient size to proof that the stellarator concept has the potential for a power plant, Wendelstein 7-X, has recently started operation in Greifswald, Germany. Wendelstein 7-X is a superconducting device with 50 non-planar coils, providing the magnetic confinement. In addition, 20 planar coils provide some flexibility of the magnetic field geometry (see figure).