INSTITUTE OF PLASMA PHYSICS OF THE CZECH ACADEMY OF SCIENCES

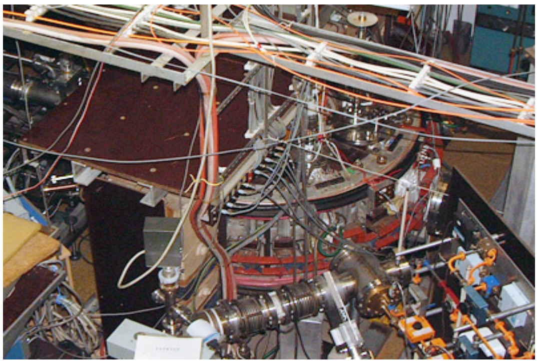
The Academy of Sciences of the Czech rebublic - ASCR

History of the CASTOR Tokamak

The **CASTOR** (**C**zech **A**cademy of **S**ciences **TOR**us), in the period 1977-1984 was named TM-1-MH, facility was a tokamak with a circular plasma cross section, which was operated in the Institute of Plasma Physics of the CAS from 1977 to 2006. The tokamak was built in early 1960s in Moscow under a name TM-1 (tokamak malyj = a small tokamak) and indeed it was one of the first working tokamaks ever. In 1975 the machine was donated to our Institute, where its operation started under name TM-1-MH (Microwave Heating). Its major refurbishment, including installation of a new vacuum chamber and a feed-back system of the plasma position, enabling several times prolongation of the discharge length and at the same time the name of the device has been changed to CASTOR in 1985. Research on tokamak CASTOR was undertaken until the end of 2006 when the operation was discontinued due to the installation of the new facility tokamak COMPASS. The tokamak CASTOR was then transported to the Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University, where it serves under a new name GOLEM for education of students in the new curricullum Physics and Technology of the termonuclear fusion.

The last closed magnetic surface in this tokamak is defined by a poloidal limiter made from molybdenum. The working gas is hydrogen. The power source for the toroidal magnetic field coils was based on 1 MJ condensor bank. A delay LC line with the energy of several tens of kJ generates and heats the plasma. The plasma position is stabilized by a magnetic field feedback system.

The CASTOR Tokamak in 2004

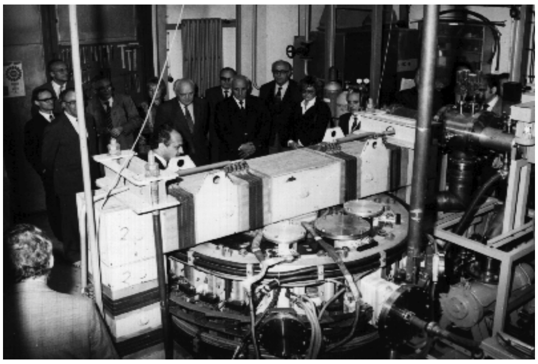


The main components of the tokamak CASTOR:

- Vacuum chamber and coils for toroidal, poloidal and vertical magnetic fields, condensor banks as the power source
- Vacuum pumping system (with turbomolecular pumps and forepumps) including the pressure gauges and a piezoelectric valve for fuelling (H, He)
- System for the cleaning of the vacuum vessel inner wall (baking of the vessel, glow discharge)
- Feedback system for the plasma position stabilisation in real time
- System for additional plasma heating and non-inductive current drive via the lower-hybrid electromagnetic wave (2 x 40 kW at 1,25 GHz)
- Set of basic diagnostics for measurements of the main plasma parameters
- System of automatic acquisition of the experimental data (56 channels with sampling frequency 100 kHz, 80 channels of fast acquisition with sampling frequency 1 MHz)

The main parameters of the tokamak CASTOR:

• major radius	R= 0.4 m
• minor radius	a= 0.085 nebo 0.060 m
• toroidal magnetic field	$B_t < 1.5$ T
• plasma current	$I_{p < 25\ kA}$
• pulse length	t < 50 ms
• plasma density	n_e= 0.2-3.0*10^{19} m^{-3}
• electron temperature	$T_e(0) < 200$ eV
• ion temperature	$T_i(0) < 100$ eV



Diagnostic systems:

The tokamak CASTOR was equipped with several unique diagnostic systems which allowed for detailed studies of physical processes in its plasmas:

- VUV spectrometer of the Seya-Namioka type with high spatial resolution
- XUV spectrometer with the dispersion elements based on multi-layer mirrors
- Bolometer array for measurements of radiation losses
- Microwave interferometer for the plasma density measurements working on the frequency 70 GHz
- Energy spectrum analyser of fast neutral atoms
- Radiometer of electromagnetic radiation in frequency ranges 17-27 GHz and 27-40 GHz
- Microwave reflectometer at 29, 33, and 35 GHz
- Langmuir probe arrays for edge plasma monitoring both in radial and poloidal directions
- Advanced probes for measurements of ion and electron temperatures, plasma potential and flows in the plasma edge
- Frequency modulated microwave interferometer at 70 GHz frequency
- RF probes (capable of measurements up to 10 GHz) for characterisation of the lower-hybrid wave and its interaction with plasma in front of the RF antenna
- Arrays of magnetic probes (coils) for magnetic turbulence measurements

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