Tokamak GOLEM for fusion education - chapter 17: magnetic islands, disruption prediction, diamagnetic measurement, spectroscopy, transport barrier, ion temperature measurement

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Tokamak GOLEM serves as an educational tokamak at the Czech Technical University in Prague. It is the world's oldest operational tokamak. Its unique remote-control interface enables hands-on training for students not only at CTU, but also internationally. This contribution presents the latest students' projects on the tokamak GOLEM. This is the first part of two contributions on this subject.

A neural network–based approach to **magnetic island detection** is under development, employing two-dimensional correlation maps of Mirnov coil signals as inputs for image-based pattern recognition. CQER-IQ (UK) is working with GOLEM data to evaluate an information-theoretic approach for systematic **pre-termination prediction** and subsequent experimental validation of preventative measures, using Mirnov coil diagnostics as a primary signal source.

Diamagnetic measurements using a pair of coaxial loops on the GOLEM tokamak are being developed together with automated analysis software for time-resolved estimates of plasma stored energy.

A **spectroscopic study** has been performed on the GOLEM tokamak, inspecting the influence of impurities on the formation of a spontaneous electron temperature gradient, under different plasma current and density conditions. A **fast spectroscopy diagnostic** with sub-millisecond time resolution was developed to investigate spontaneous transport barrier formation in helium plasmas.

An **improved electric probe-head** had been installed, consisting of two Langmuir probes and two Ball-pen probes. It operates in floating, biased, and swept regimes, allowing local transport studies in the plasma edge. Following the installation of the probe and repair of the vacuum vessel, the transport barrier was confirmed to remain present. MHD activity preceding the barrier phase was then analyzed, and the observed activity is most consistent with magnetic islands. Spectroscopic measurements show strong Cl II emission alongside C III and N II, with possible He II emission, suggesting higher temperatures.

Using a swept ball-pen probe, **ion temperature was measured with an ultrafast temporal resolution of 5 µs** and analyzed with an improved program designed for universal application across various tokamaks (GOLEM, ASDEX Upgrade, and COMPASS) and potentially the Wendelstein 7-X stellarator.