SUMTRAIC at GOLEM

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http://golem.fjfi.cvut.cz/sumtraic

1 Tokamak GOLEM

GOLEM is a small size tokamak with the circular poloidal cross-section. Main parameters are:

- Major radius of the vacuum vessel $R = 0.4$ m.
- Minor radius of the vacuum vessel $r = 0.1$ m.
- Radius of poloidal limiter $a = 0.085$ m.

Principal engineering scheme (see fig 1) has five principal parts:

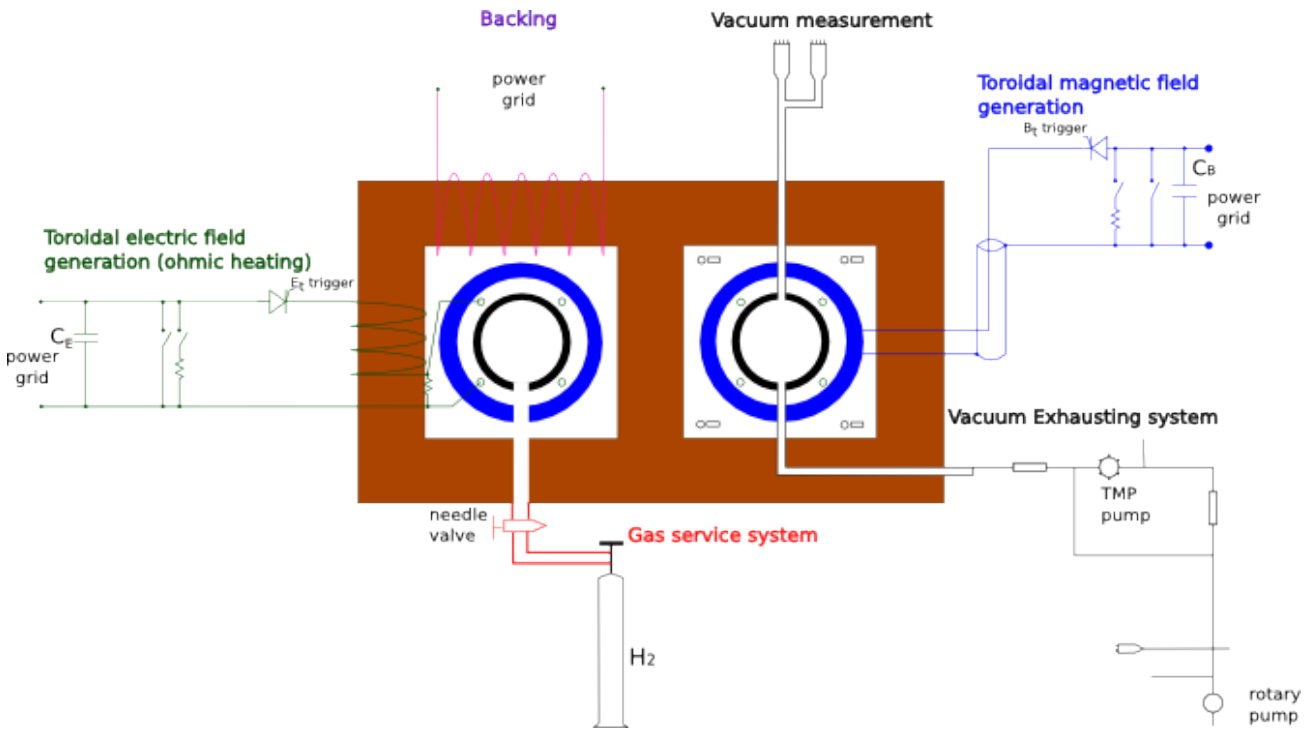

Figure 1: Principal engineering scheme of the tokamak

- B_t toroidal magnetic field generation circuit (blue color) with the aim to confine the plasma, consisting of a set of capacitors with the total capacity $C_B = 10.8$ mF charged up to $U_{C_B} = 2$ kV, which is triggered by PC controlled thyristor into a set of 28 magnetic field coils, altogether having inductance $L_B = 2.76$ mH. This LC circuit together with the thyristor produce one harmonic current pulse in the coils which generates the required toroidal magnetic field B_t.

- E_t toroidal electric field generation circuit (green color) with the aim to generate, heat the plasma and to drive the plasma current, consisting of a set of capacitors with the total capacity $C_E = 3.6$ mF charged up to $U_{C_E} = 600$ V, which is triggered by PC controlled thyristor into a primary winding of the transformer. This LC circuit generate through the time changing magnetic flux in the transformer core the appropriate toroidal electric field E_t which firstly generate and consequently heat the plasma. E_t generates current both in plasma and in the tokamak chamber, which resistance $R_{chamber} \approx 10\ m\Omega$
- Vacuum system, consisting of a rotary vacuum pump, valves, a turbomolecular pump and a measurement system, alltogether aiming to reach the preassure $\approx 5 \cdot 10^{-4}$ Pa.
- Gas handling system providing hydrogen with working preassure $\approx 5 \cdot 10^{-2}$ Pa.
- Backing system, which serves to clean the tokamak chamber.

2 Available diagnostics

At the moment, the GOLEM tokamak is equipped by following diagnostics

- A single loop around the transformer core measures the loop voltage U_{loop}.
- A Rogowski coil, surrounding the tokamak chamber measures the sum of the plasma and chamber current I_{p+ch}.
- A small pick-up coil placed on the tokamak chamber measures the toroidal magnetic field B_t.
- A photocell facing a glass port of the tokamak measures the plasma radiation in the visible part of the spectra.

Experimental data from these diagnostics are digitized by the sampling frequency 100 kHz and stored by PC.

3 Proposed laboratory experiments

- Start to charge capacitor sets both the U_E and U_B up to 600 V with the p_{H_2} preassure at $\approx 2 \cdot 10^{-2}$ Pa and time delay $\tau_{BE} \approx 2$ ms beetween U_B thyristor trigger and U_E thyristor trigger. Find the minimumvalues of $U_E, U_B, p_{H_2}, \tau_{BE}$ parameters to get the plasma discharge.
- The safety factor q (see e.g. [2, J. Brotánková Ph.D.]) describes a helicity of a resulting magnetic field in the tokamak as a superposition of a toroidal B_t and poloidal B_p magnetic field components. In the first approximation for the GOLEM like tokamaks, it can be expressed as:

$$q(r) = \frac{r}{R}\frac{B_t}{B_p(r)}.$$

  Measure the safety factor and find two regimes (by changing $U_E, U_B, p_{H_2}, \tau_{BE}$) with the most different values of the safety factor.

References

[1] WWW's Tokamak GOLEM at FNSPE CTU Prague. http://golem.fjfi.cvut.cz. [Online; accessed 15-Sept-2009].

[2] Jana Brotánková. *Study of high temperature plasma in tokamak-like experimental devices.* PhD thesis, Charles University, 2009. (*Available at http://golem.fjfi.cvut.cz).*

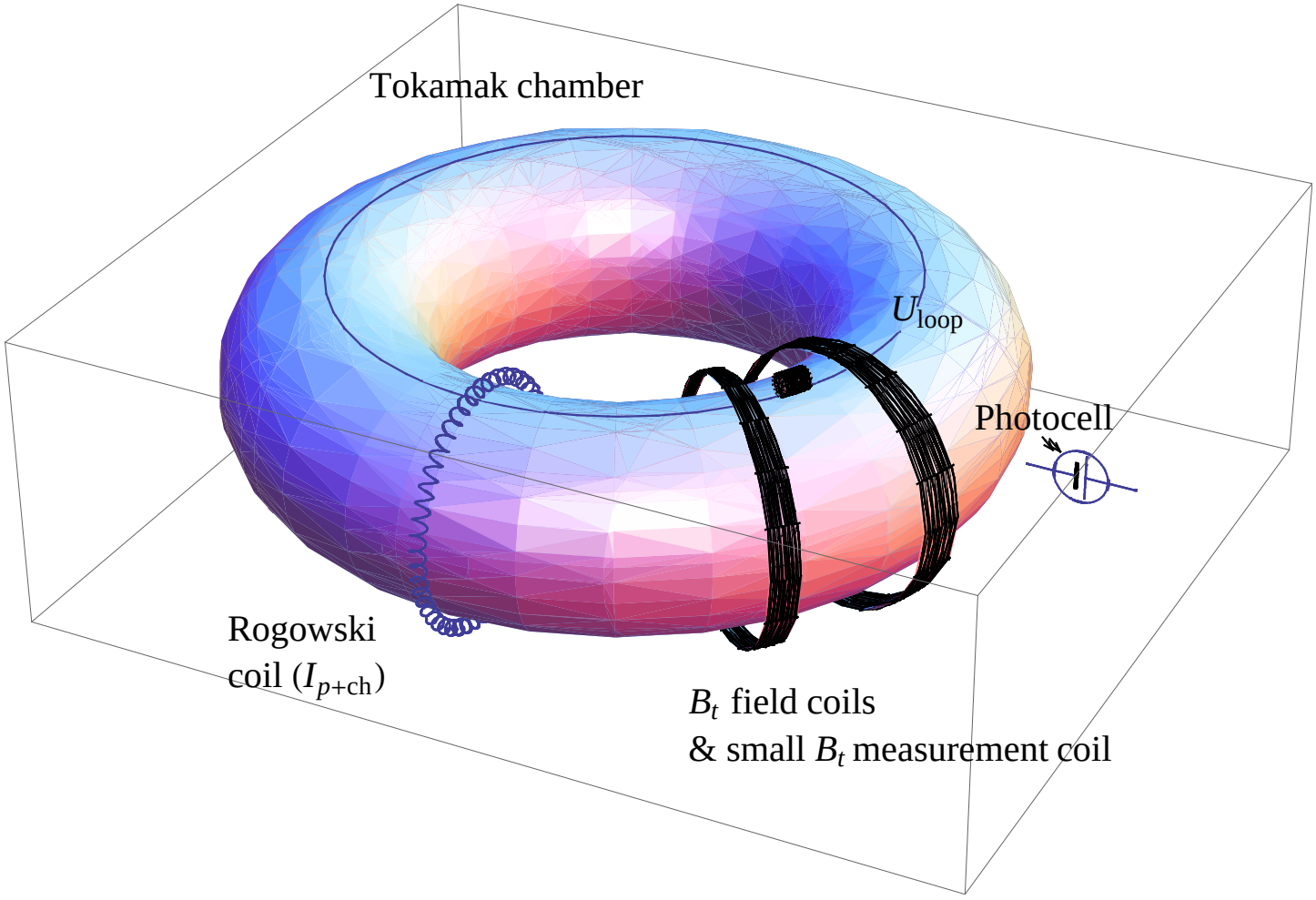

Figure 2: Diagnostic system of the tokamak GOLEM