The tokamak Golem discharges

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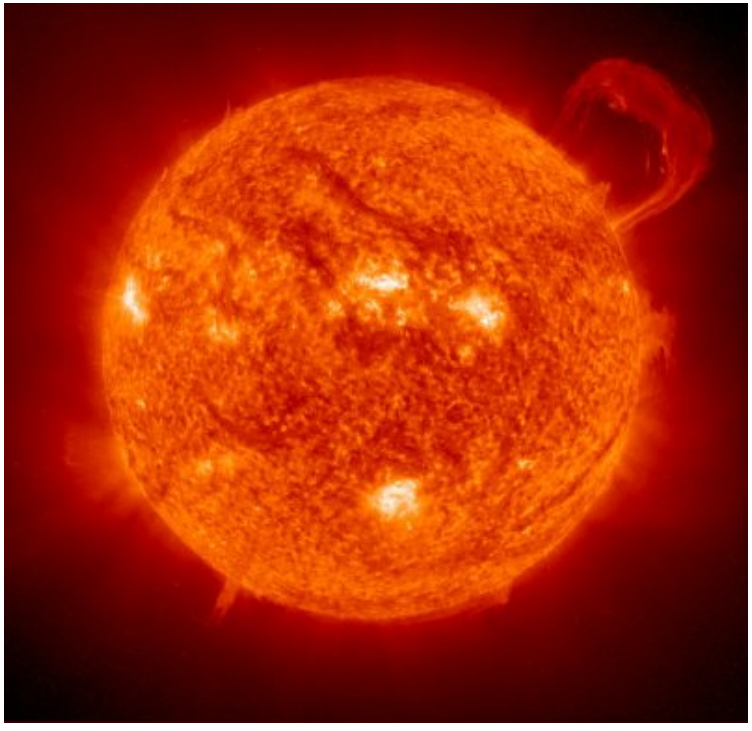
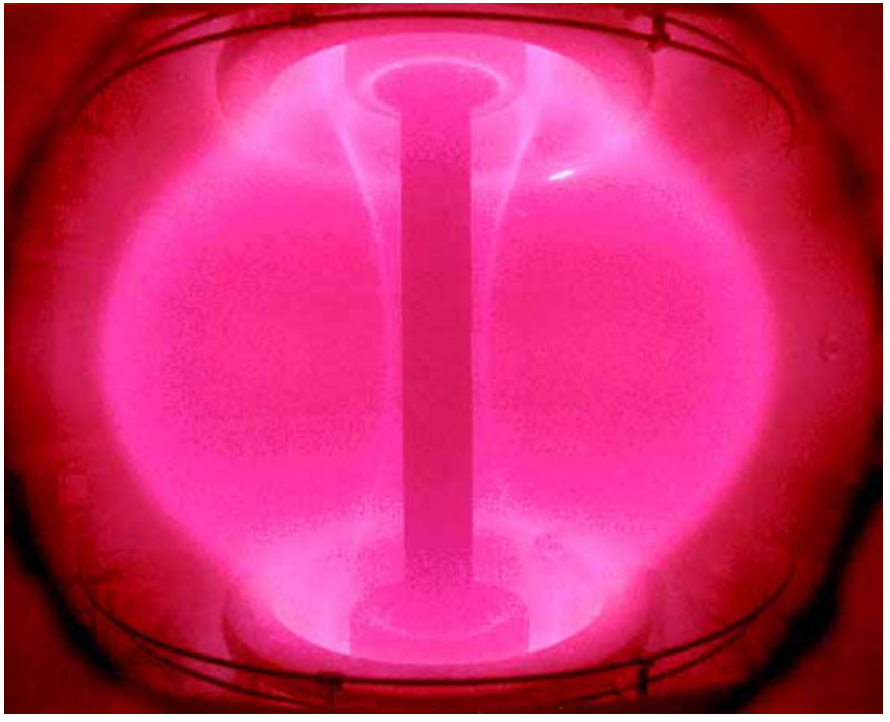
pro Žhavé výstřely 2011

Harnessing the Sun's (star's) energy



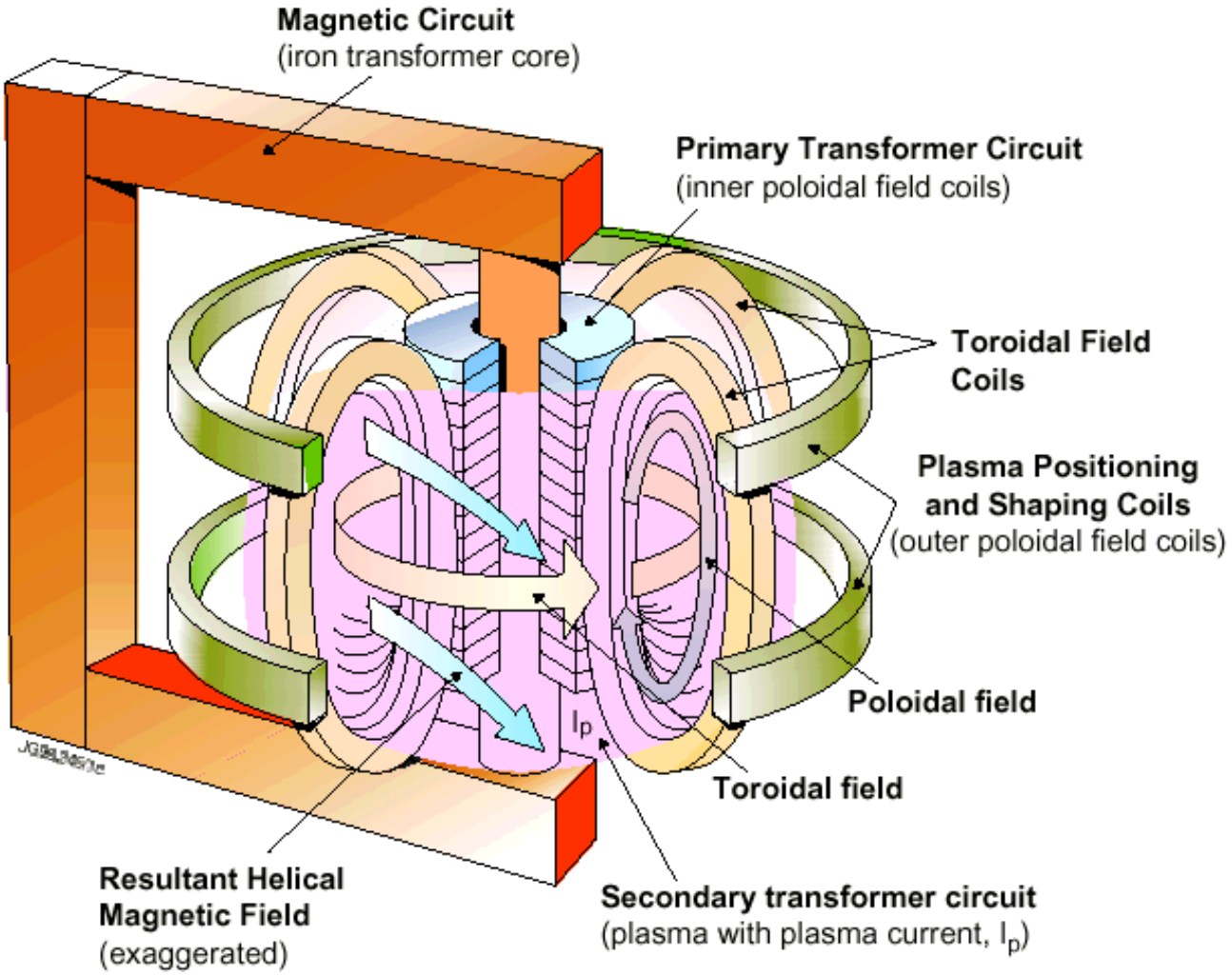


On the Earth the most feasible candidate:

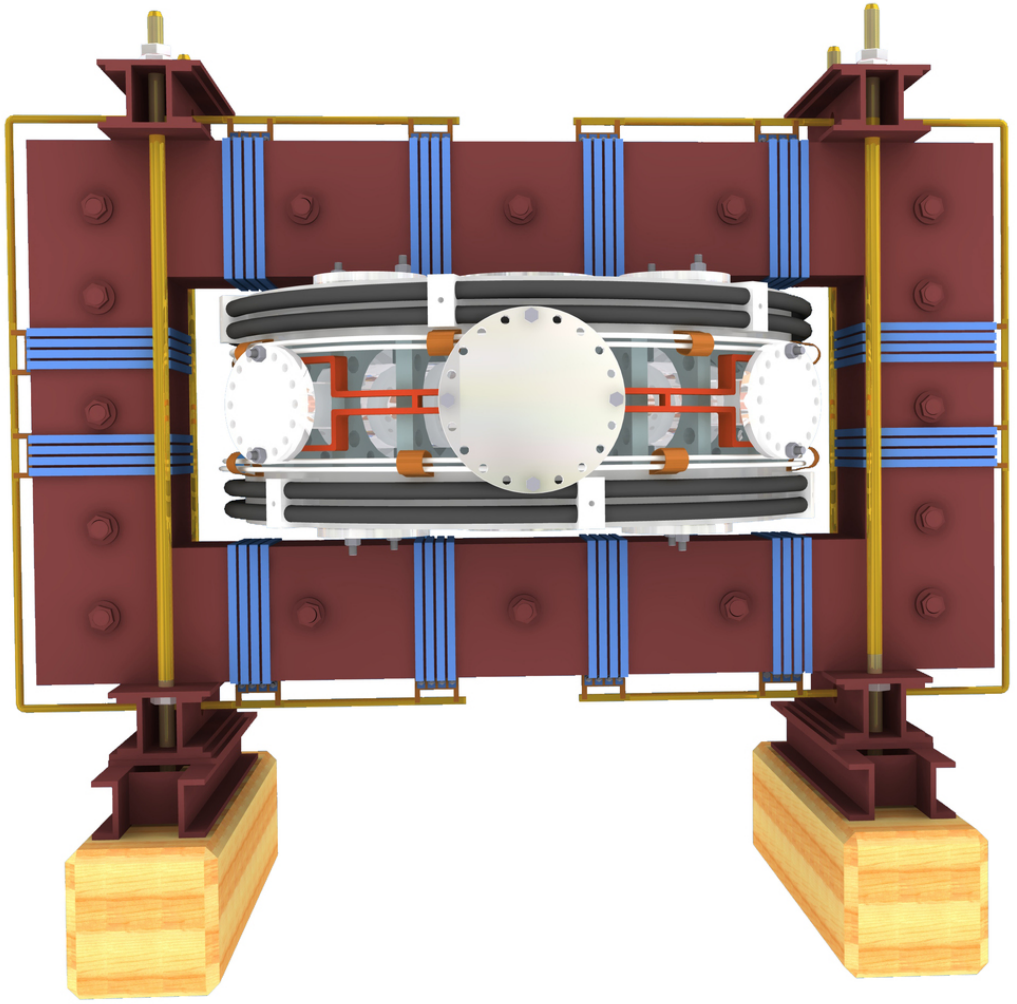
$$ {}^{2}_{1}\mathbf{D}_{(\mathbf{10keV})} + {}^{3}_{1}\mathbf{T}_{(\mathbf{10keV})} \Rightarrow {}^{4}_{2}\mathbf{He}_{(\mathbf{3.5MeV})} + \mathbf{n}_{(\mathbf{14.1MeV})} $$

$\longrightarrow$ Confine & Heat && Diagnose $\longleftarrow$

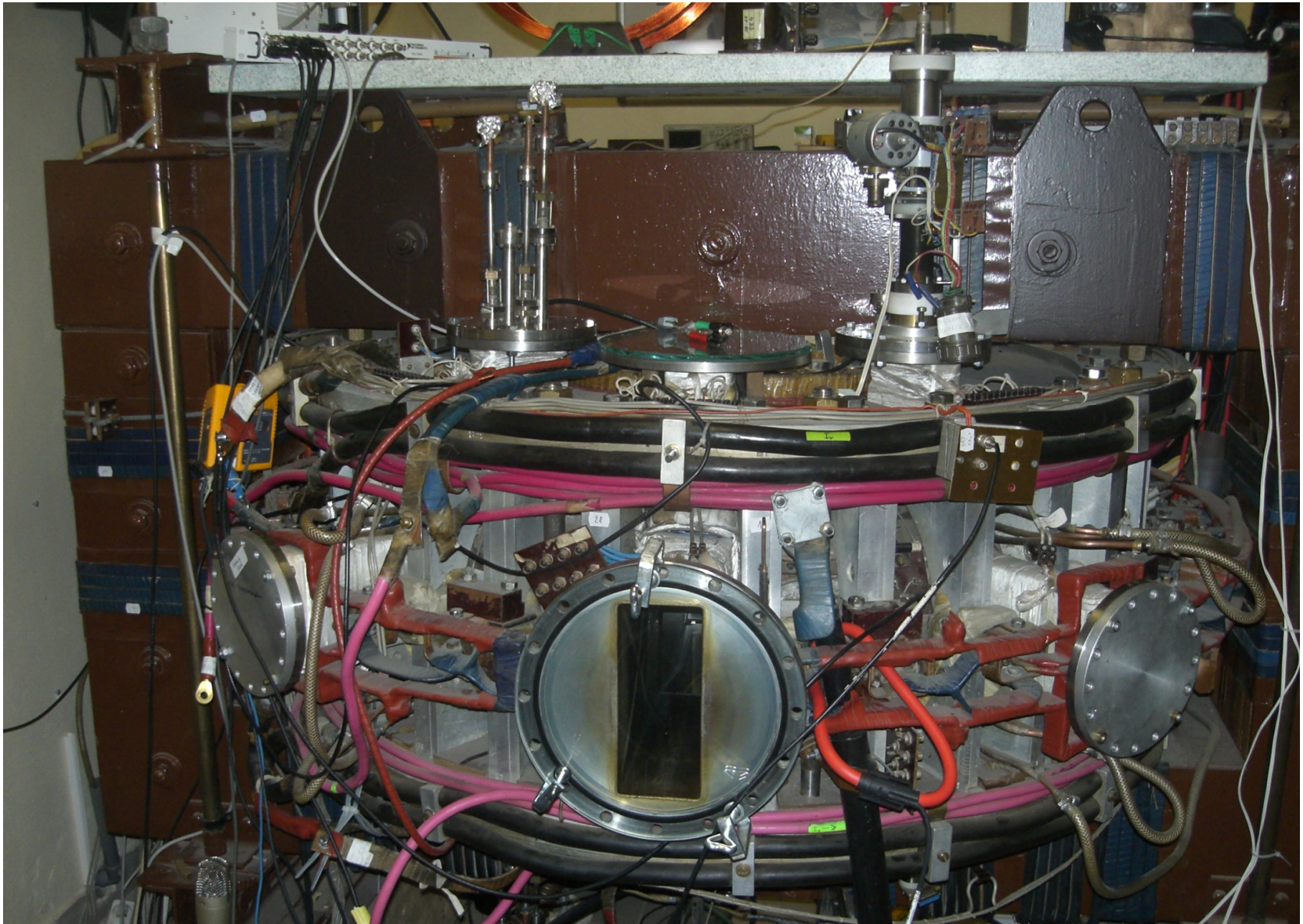
Magnetic confinement - Tokamak



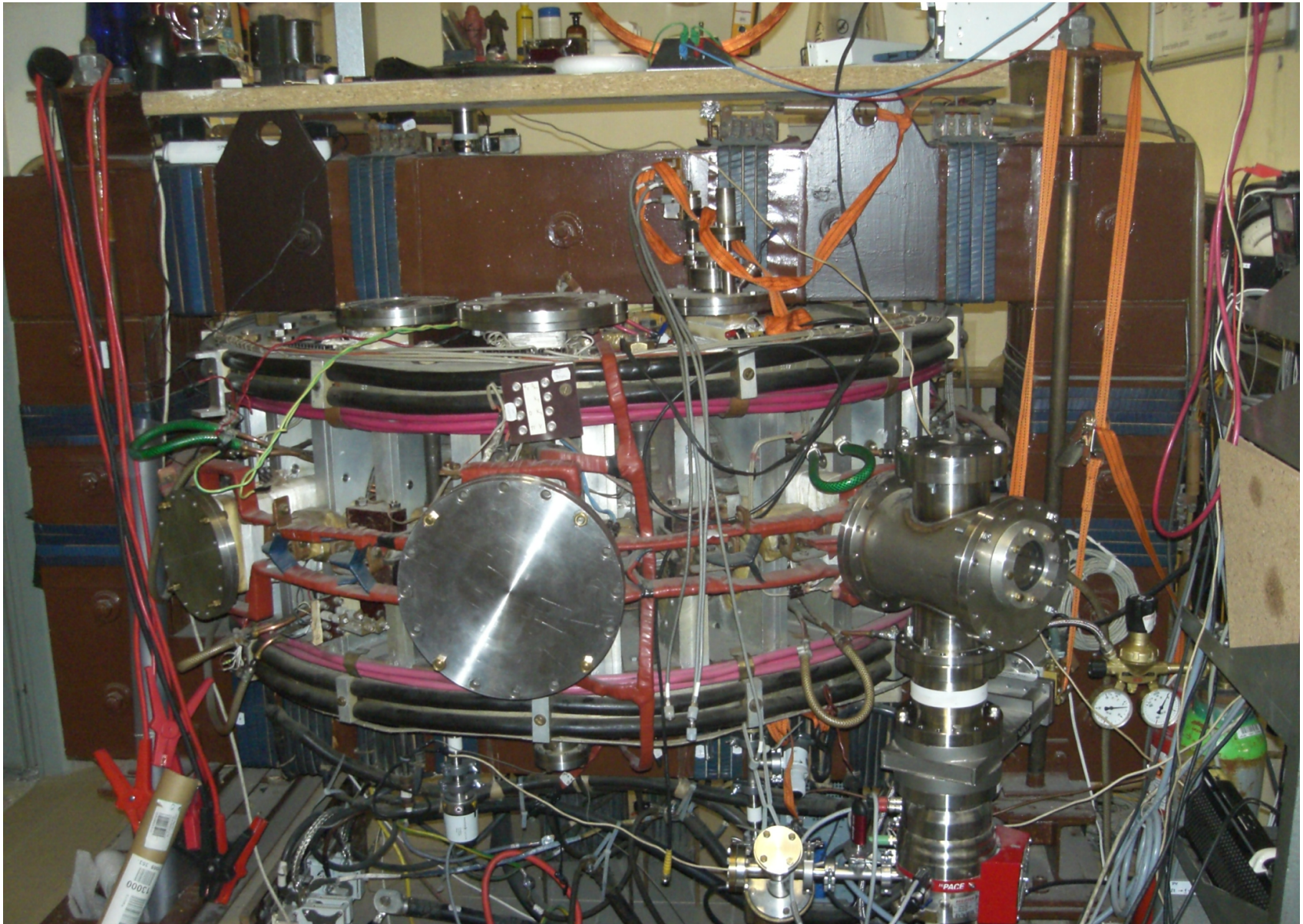
The Golem tokamak



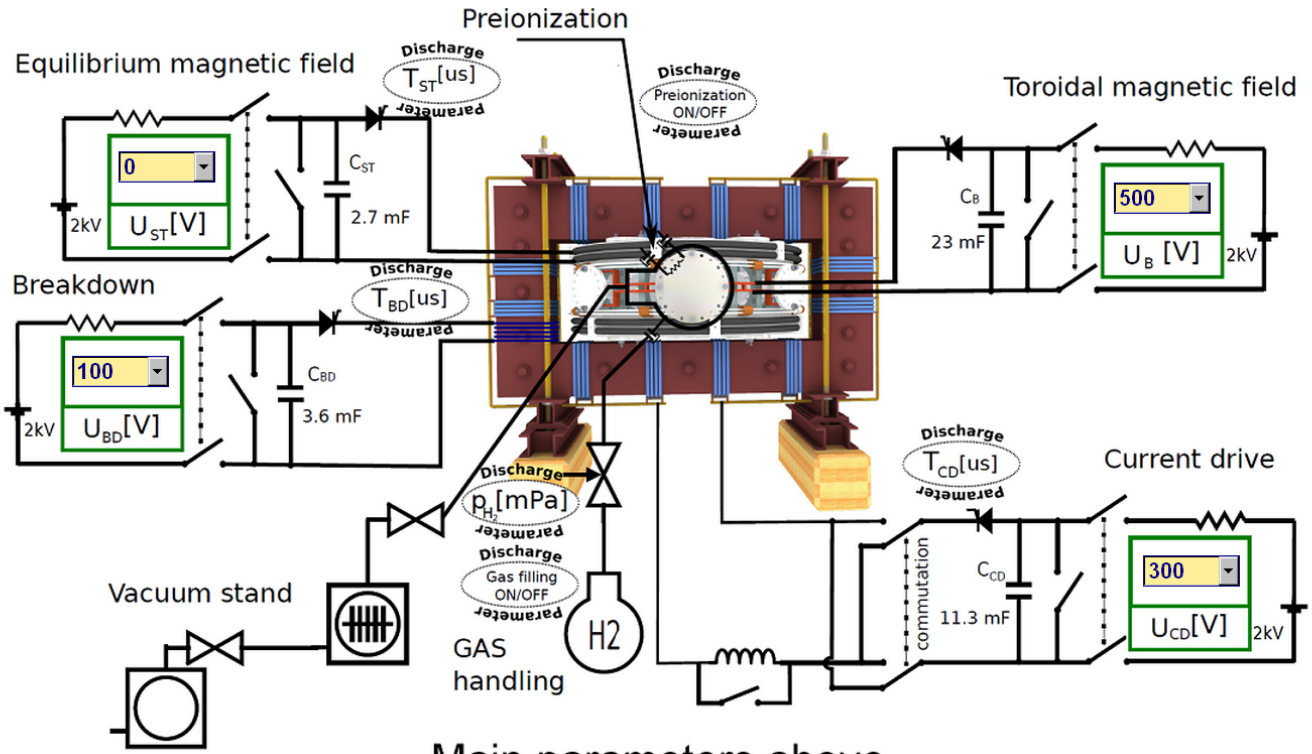
The Golem tokamak - South view



The Golem tokamak - North view



Engineering scheme of the GOLEM tokamak



Main parameters above

Timing parameters

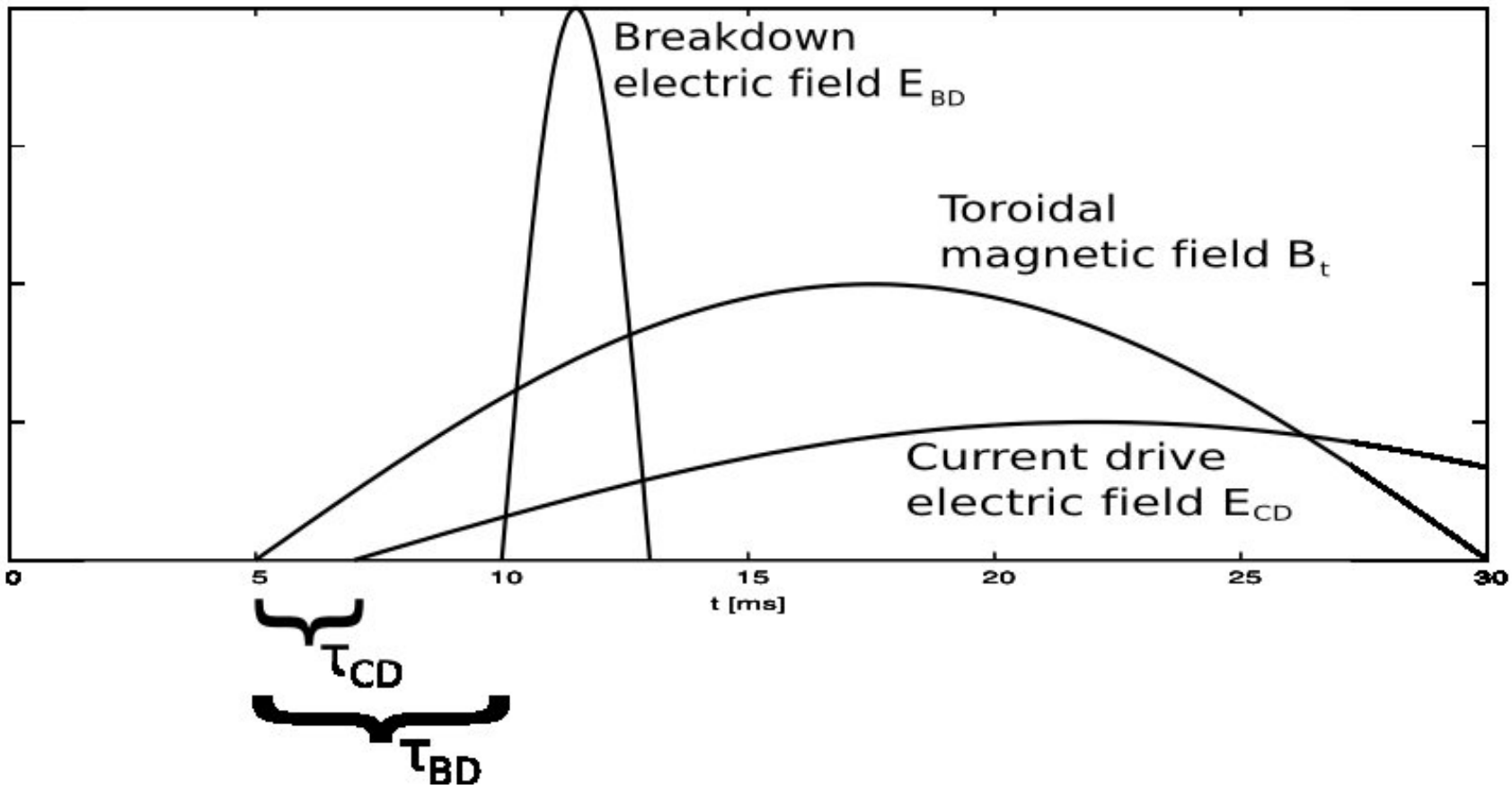
0	3000	2000
T_{ST}[us]	T_{BD}[us]	T_{CD}[us]

Other parameters

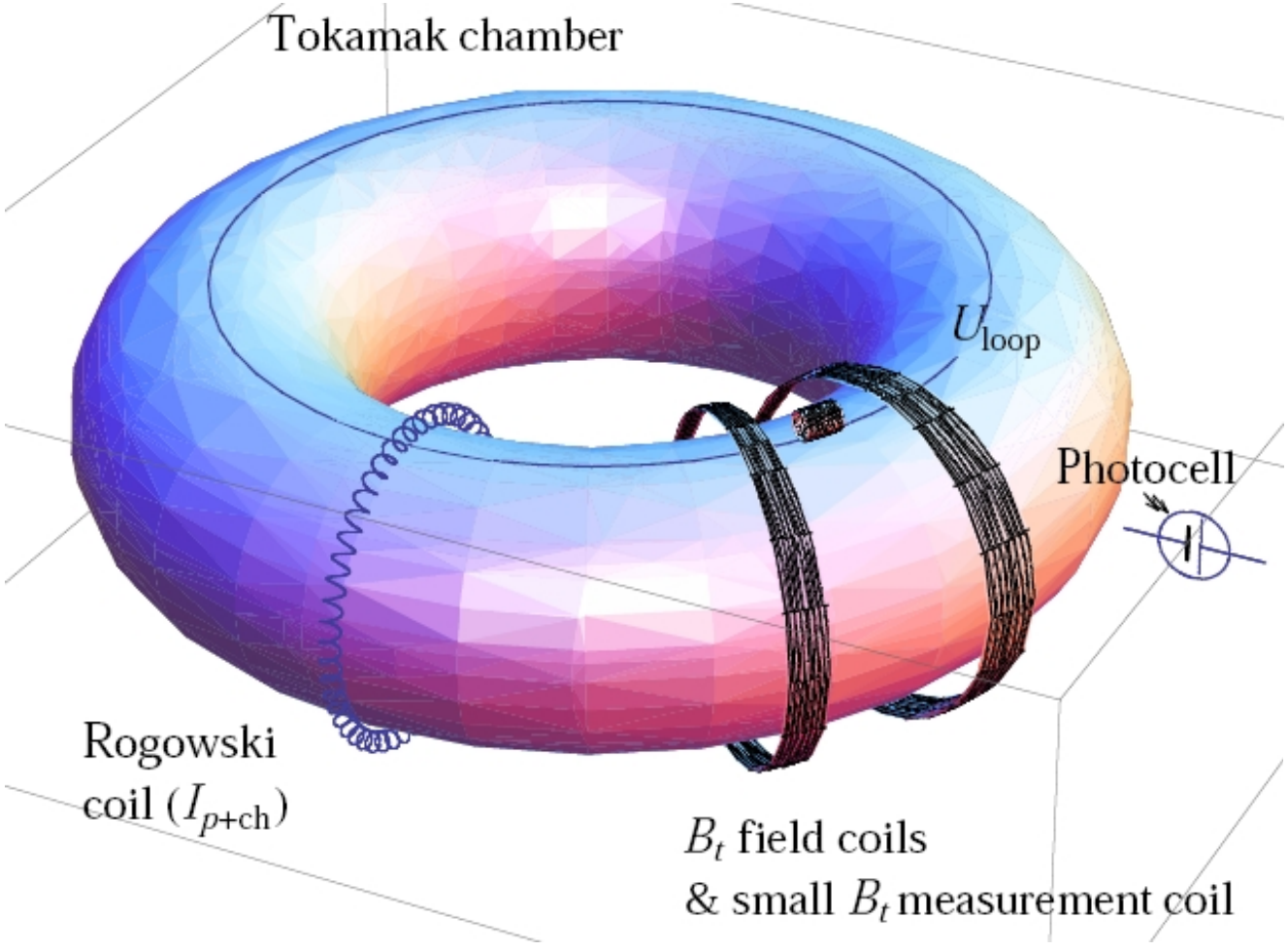
20	ON	ON
p_{H_2}[mPa]	Gas filling ON/OFF	Preionization ON/OFF

Submit

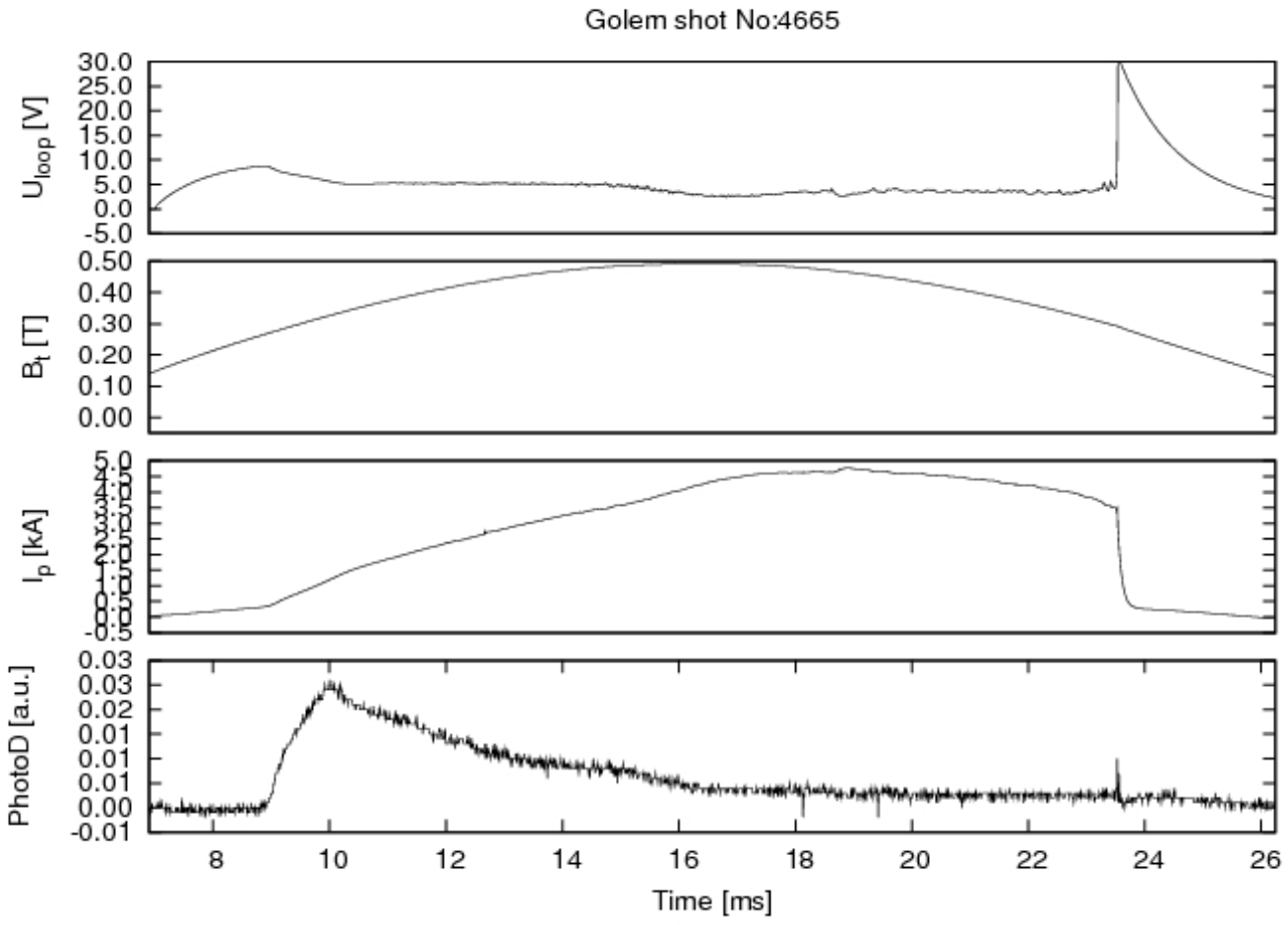
Triggering sequence



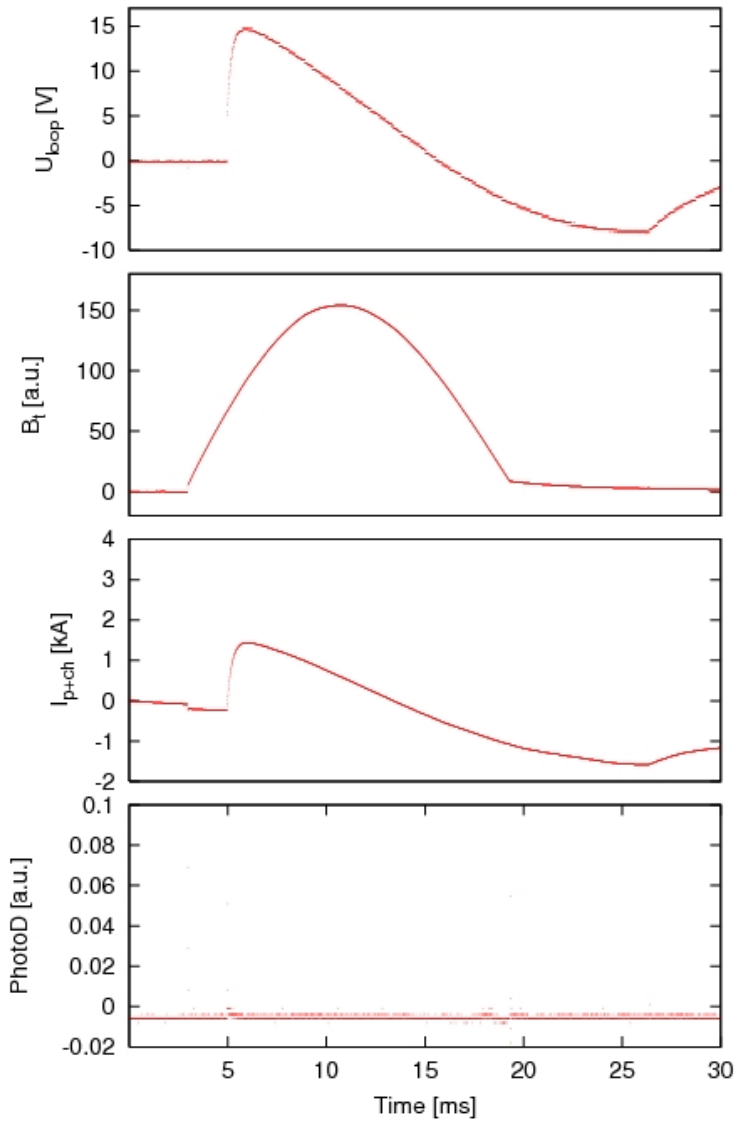
Basic plasma diagnostics in tokamak GOLEM



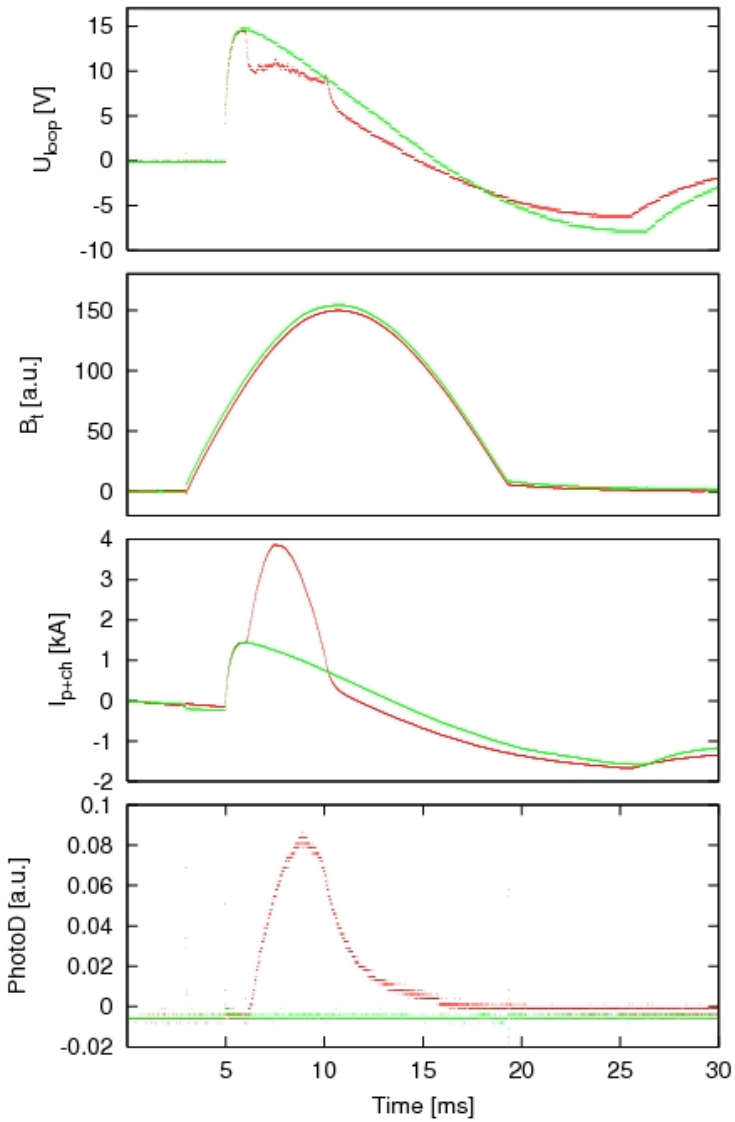
Golem discharge



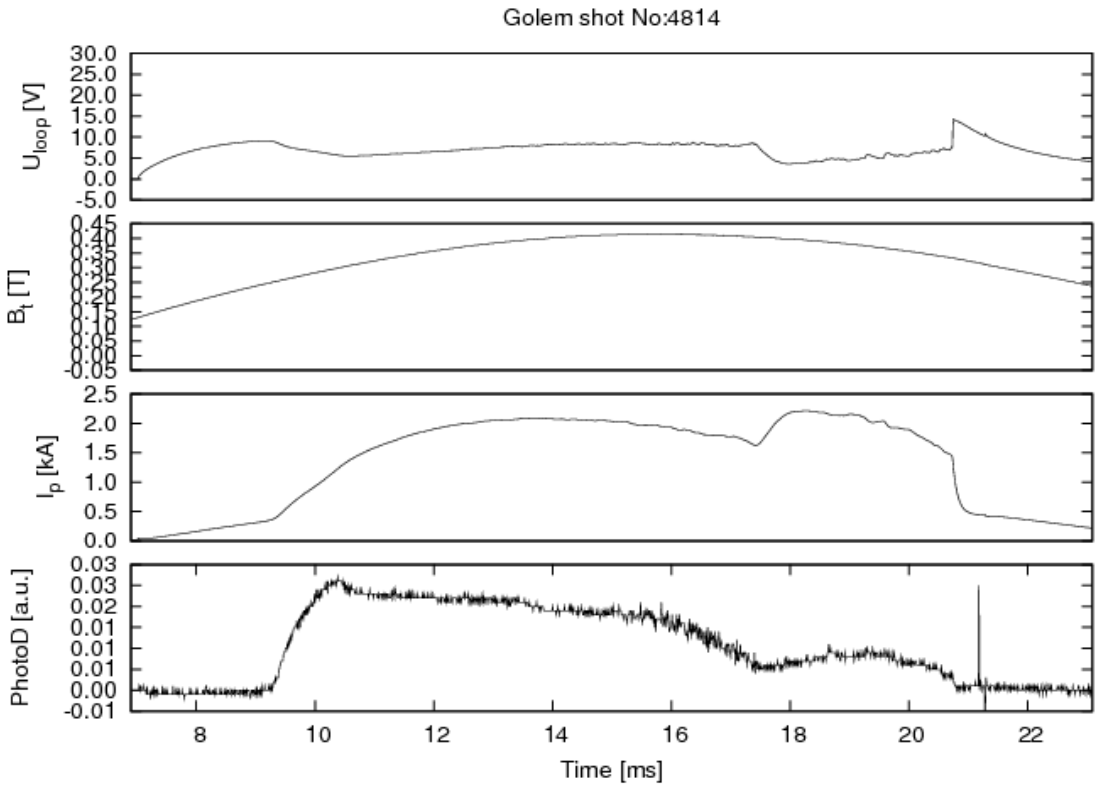
DAS without working gas (no discharge)



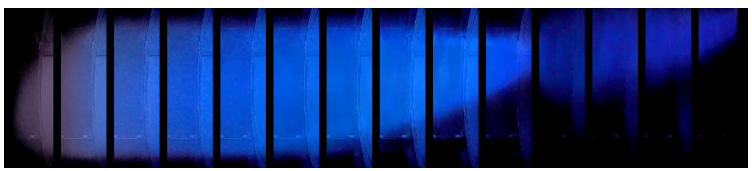
DAS plasma discharge with working gas



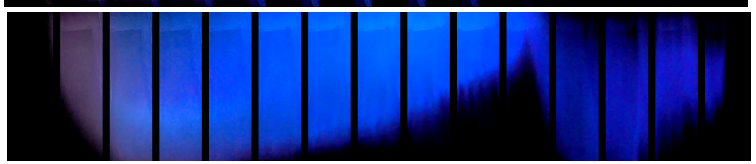
Fast camera



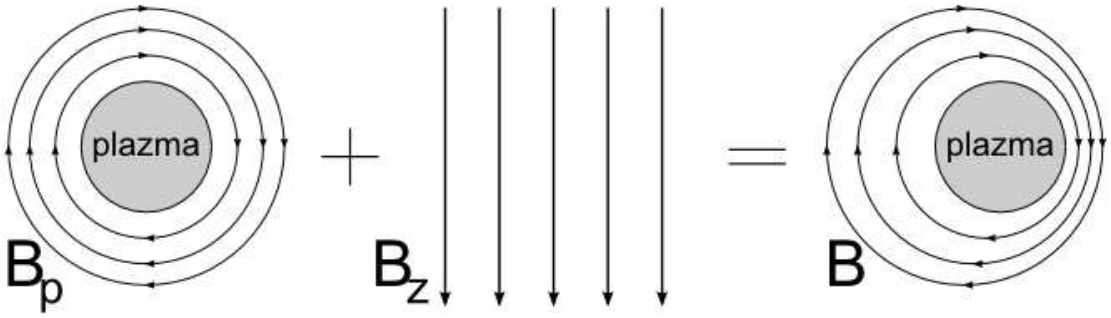
TOP view:

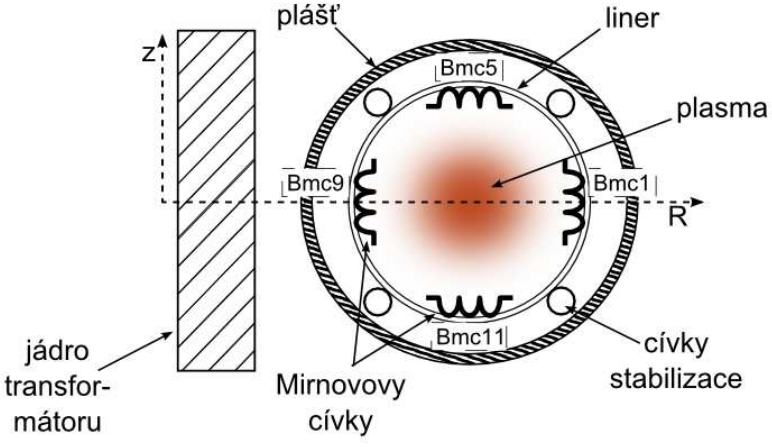


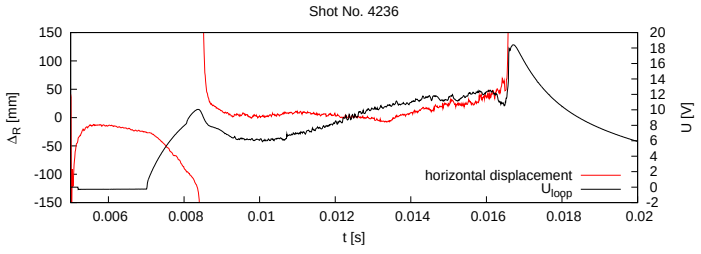
SIDE view:



Plasma Position using Mirnov Coils







Central electron temperature estimation I [1]

The current density of plasma is

$$j = E \cdot \sigma \tag{1}$$

where σ is the specific conductivity of plasma given by

$$\sigma(r) = 1.544 \cdot 10^3 \cdot \frac{T_e(r)^{3/2}}{Z_{eff}}, \qquad [\Omega^{-1}\mathrm{m}^{-1}, \mathrm{eV}] \tag{2}$$

and the electric field E is assumed constant in the poloidal cross-section:

$$E = \frac{U_{loop}}{2\pi R}. \tag{3}$$

Plasma current is obtained by integrating current density over the plasma column:

$$I_{pl} = \int_0^a E \cdot \sigma(r) 2\pi r dr. \tag{4}$$

Central electron temperature estimation II [1]

For the electron temperature, we assume a polynomial profile

$$T_e(r) = T_e(0)\left(1 - \frac{r^2}{a^2}\right)^{\alpha} \tag{5}$$

where a is the minor radius and $T_e(0)$ is the central electron temperature. Substitution gives us the formula for the central electron temperature

$$T_e(0) = \left(\frac{R}{a^2}\frac{8 \cdot Z_{eff}}{1.544 \cdot 10^3}\right)^{2/3} \cdot \left(\frac{I_{pl}}{U_{loop}}\right)^{2/3}. \tag{6}$$

For the CASTOR/GOLEM tokamak geometry with $a = 78$ mm :

$$T_e(0) = 89.8 \cdot \left(\frac{I_{pl}\ [kA]}{U_{loop}}\right)^{2/3} \approx 230\ eV. \tag{7}$$

The effective ion charge is assumed as $Z_{eff} = 2.5$.

Tokamak Marianska 2011

References I

Brotankova, J.
Study of high temperature plasma in tokamak-like experimental devices.
PhD. thesis 2009.