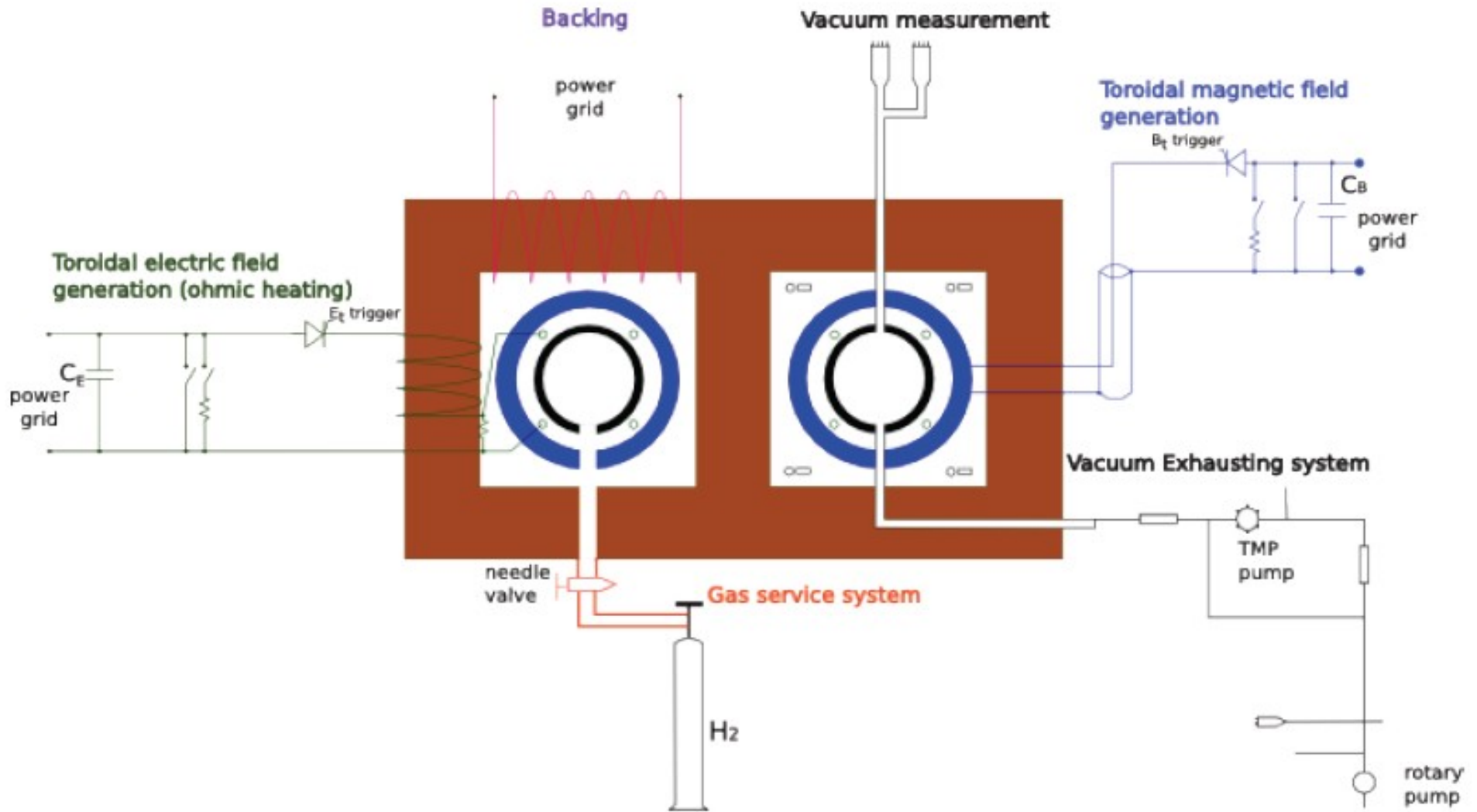# First experimental results from the GOLEM tokamak

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Scheme of the tokamak

Diagnostics available

- **Loop voltage** measurement

  - *Single loop of wire along the vacuum vessel*

- **Plasma (and vessel) current** measurement

  - *Rogowski coil around the vacuum vessel*

- **Toroidal magnetic field** measurement

  - *A small coil located on the vacuum vessel under the toroidal field coils*

- **Visible plasma radiation** measurement

  - *A photocell observing the glass tokamak port*
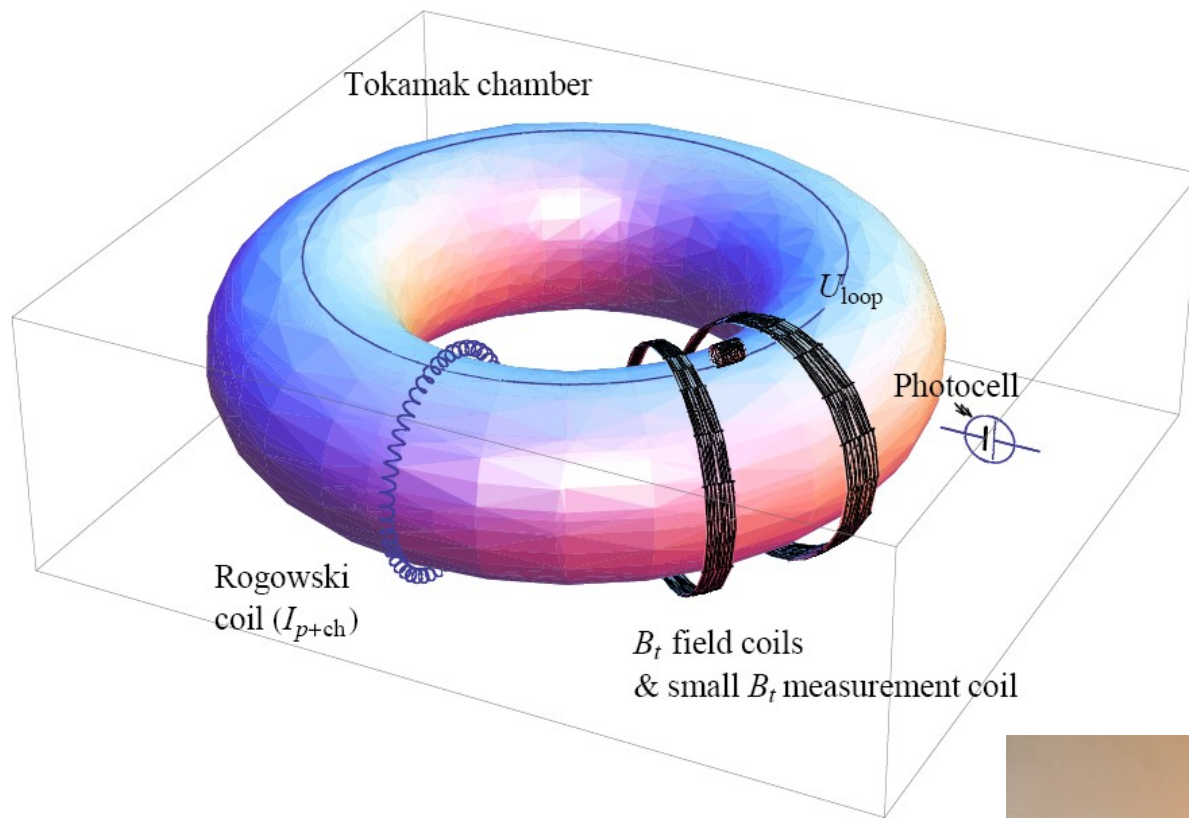
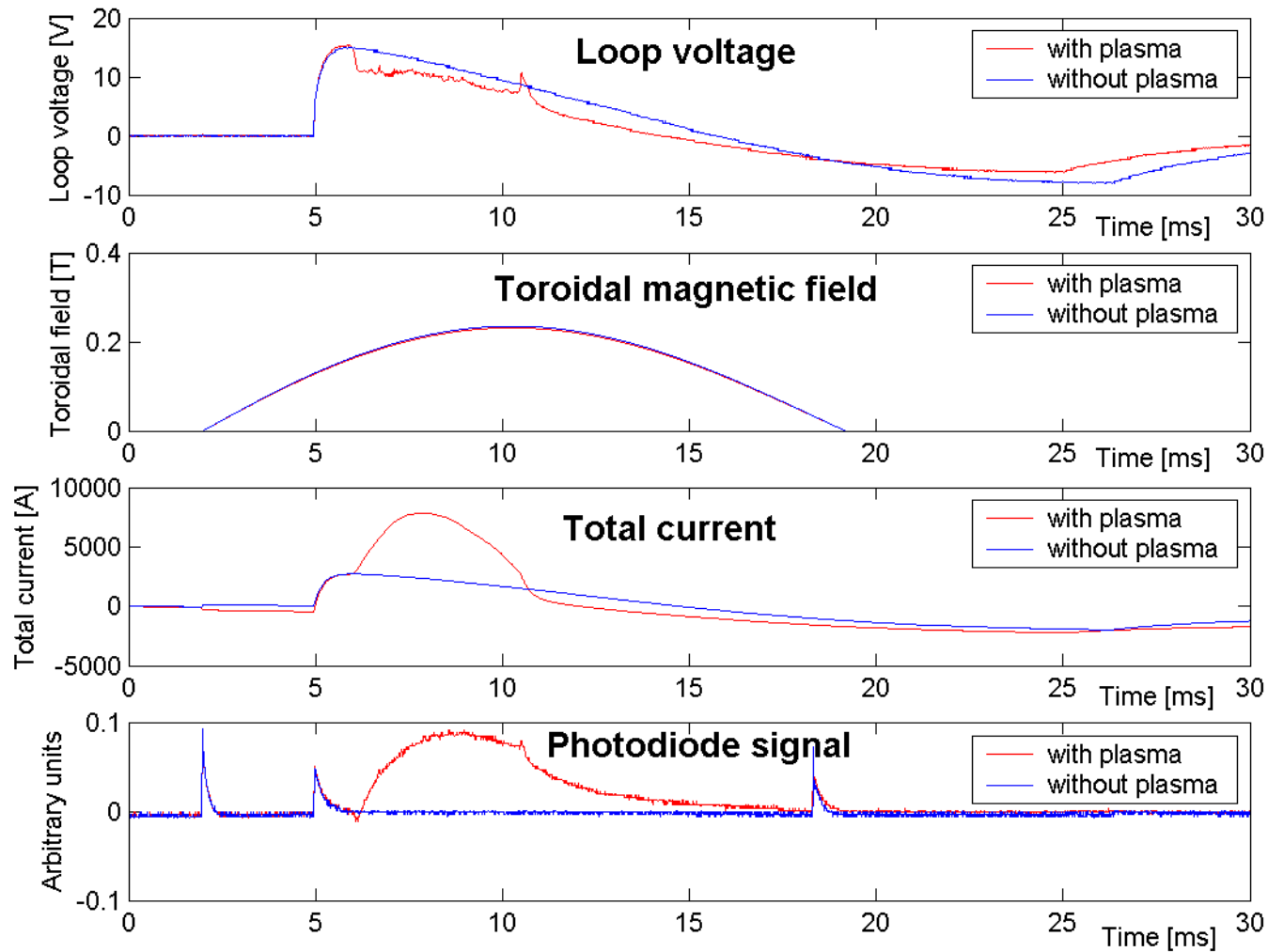| Major radius	0.4 m
Minor radius	0.1 m
Minor radius (limiter)	0.085 m

Tasks

1) *Find the minimum values of adjustable parameters still to achieve plasma discharge*

2) *Find regimes with most distant values of the edge safety factor, compute the safety factor*

adjustable:

- Voltage of the capacitors for the electric field (primary circuit of the transformer) <700V
- Voltage of the capacitors for the toroidal magnetic field <1000V
- Pressure of H_2
- Time delay of electric against the magnetic field <10ms

Typical GOLEM shot

Task 1. (find minimum config with plasma)

- Crude estimate only (capacitors are not charged accurately to the preset voltage)

- Only 2 parameters shifted (voltage of capacitors for the E and B field)

  Results:

  ➢ 350-400V needed for the magnetic field capacitors

  ➢ 370-400V needed for the electric field capacitors

Task 2. (Safety factor)

FORMULAS USED :

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

Safety factor (circular plasma)

$$B_p(r) = \mu_0 \circ \frac{I_{pl}}{(2\pi r)}$$

Poloidal magnetic field (circular plasma)

$$B_t = \frac{\mu_0 N}{2\pi R} \circ C U \circ \frac{\beta^2 + \omega_0^2}{\omega_0} \circ e^{-\beta t} \circ \sin(\omega_0 t)$$

Toroidal magnetic field (from the RLC circuit)

$$\beta = \frac{1}{2} \circ \frac{R}{L_{tot}} \qquad \omega_0 = \sqrt{\frac{1}{L_{tot} C} - \frac{1}{4} \circ \frac{R^2}{L_{tot}^2}}$$

$$I_{vessel} \approx U_{loop} / R_{vessel} \qquad R_{vessel} = 0.49 \, m\Omega$$

Vessel current, vessel resistivity
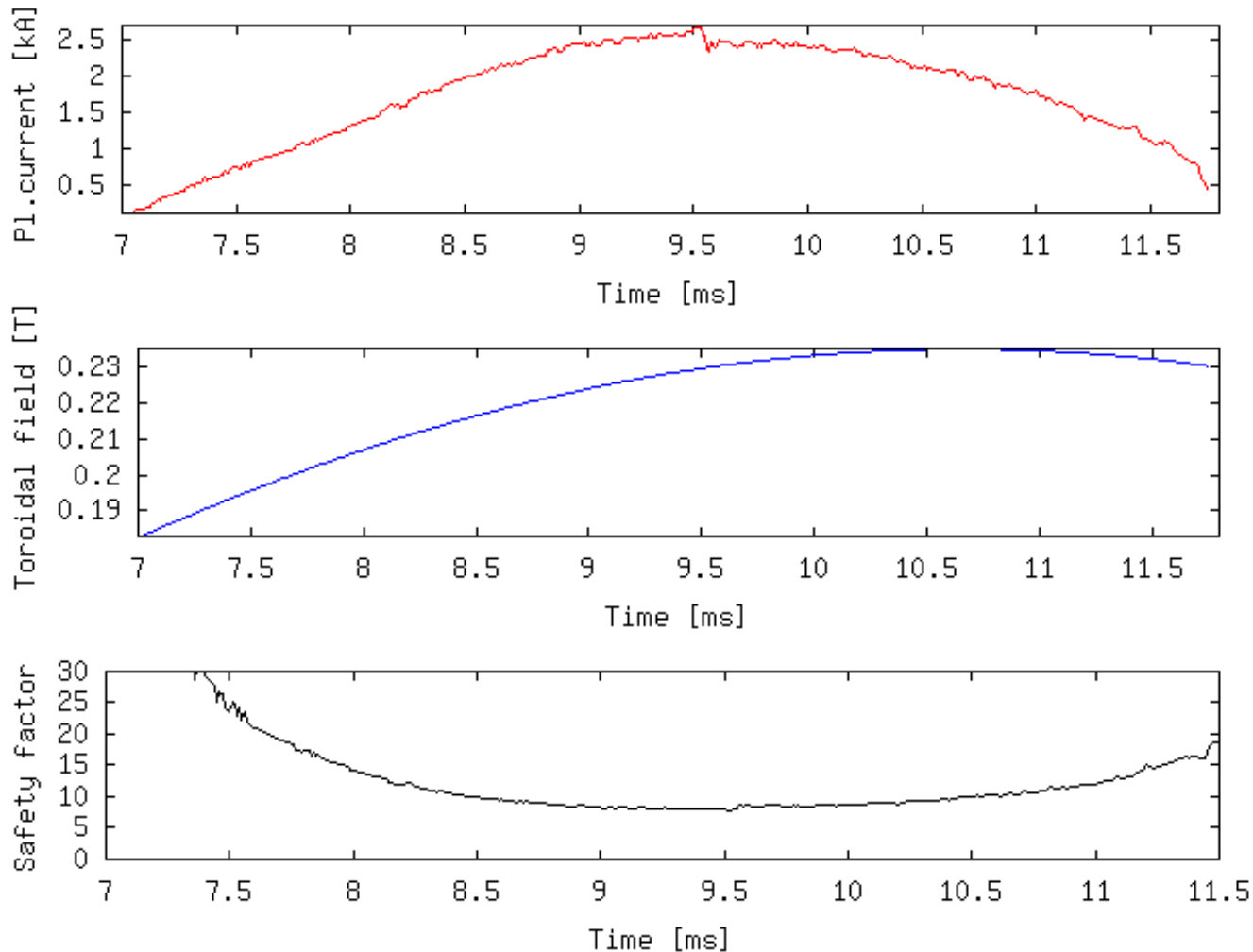
$$I_{pl} = I_{tot} - I_{vessel}$$
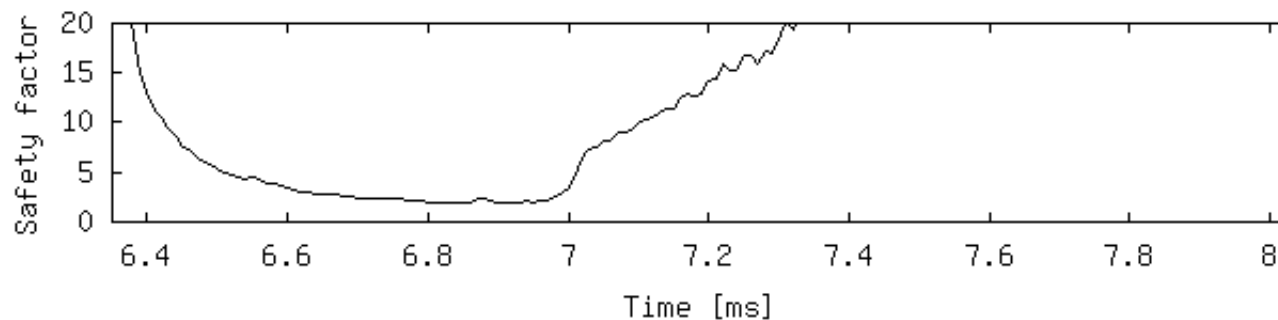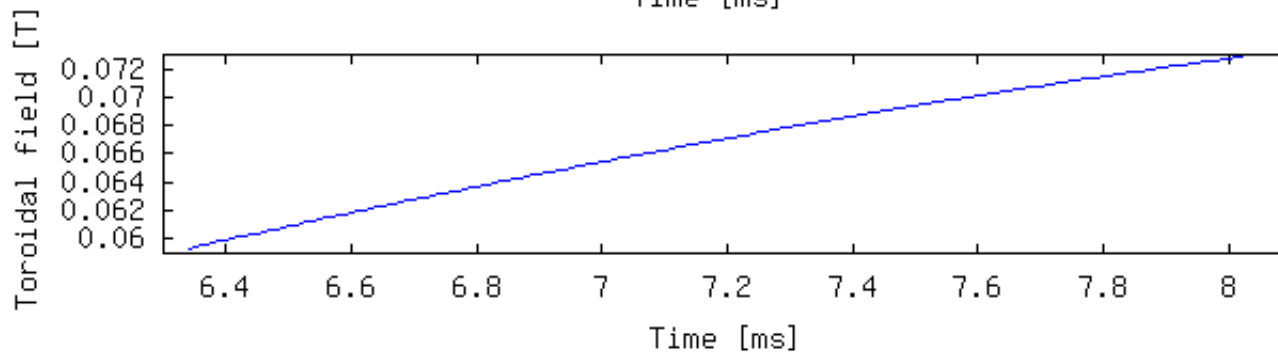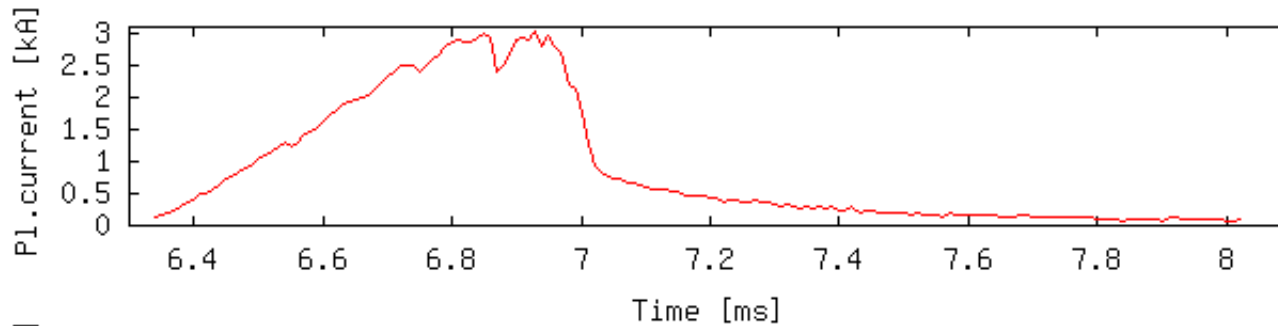
Plasma current

Task 2. (Safety factor)

a) HIGH Q REGIME (high mag.field, low current)

U_{Et}	377V
U_{Bt}	1024V
B_t	0.28T
Discharge length	4.8ms
Chamber pressure	$1.8*10^{-2}$Pa
Plasma resistivity	1.35mΩ
Max. I_P	2.66kA

Task 2. (Safety factor)

a) LOW Q REGIME (low mag.field, high current)

U_{Et}	761V
U_{Bt}	347V
B_t	96mT
Discharge length	0.7ms
Chamber pressure	$1.9*10^{-2}$Pa
Plasma resistivity	4.39mΩ
Max. I_P	3.02kA

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The end