Measurements on the GOLEM tokamak

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1. Aim of the experiment:

The measurements performed on the GOLEM tokamak fall into four categories:

1. Determination of vacuum chamber parameters (first 5 shots)
2. Study of plasma breakdown (5th – 35th shots)
3. Estimation of main plasma parameters (36th – 61st shots)
4. Attempt to achieve low q, safety parameters(62nd – 66th shots)

2. Introduction

Due to the high energy that can be harnessed via thermonuclear fusion, two devices have been conceived to confine high temperature plasmas, these are tokamaks and stellerators.

A tokamak is device that generates a magnetic field to provide confinement for high temperature plasma. The magnetic field is generated by the superposition of a toroidal magnetic field generated by external field coils and the poloidal magnetic field by a strong toroidal plasma current induced by the central solenoid.

This way the magnetic field lines are winding helically around the torus surface. These are called magnetic surfaces. The tokamaks magnetic field consists of such nested magnetic surfaces. The q safety parameter describes each magnetic surface, being the number of toroidal turns necessary for the field line to reach its starting poloidal position. For tokamaks with large aspect ratio it can be approximated the following:

$$q(r,t) = \frac{r}{R}\frac{B_t(t)}{B_p(r,t)} \tag{1}$$

Where R is the major radius, r the minor radius.

Regarding the energy balance of a tokamak, another important quantity is the energy confinement time, which can be defined as the characteristic time of energy loss.

$$\tau_e = \frac{W_{pl}}{P_{loss}} \tag{2}$$

Where W_{pl} is the total plasma energy, P_{loss} is the power lost.

The Lawson criteria is a threshold for self-sustained thermonuclear fusion plasma burn at optimum temperature (25keV). Thus the reaching of high energy confinement time and higher density is of central interest in tokamak research.

$$n\tau_e > 10^{20}\ sm^{-3} \tag{3}$$

3. The GOLEM tokamak

Parameters of the GOLEM tokamak(Fig.1):

- Major radius at the magnetic axis: $R = 0.4m$
- Minor radius: $r = 0.1m$
- Radial position of the limiter: $a = 0.085m$

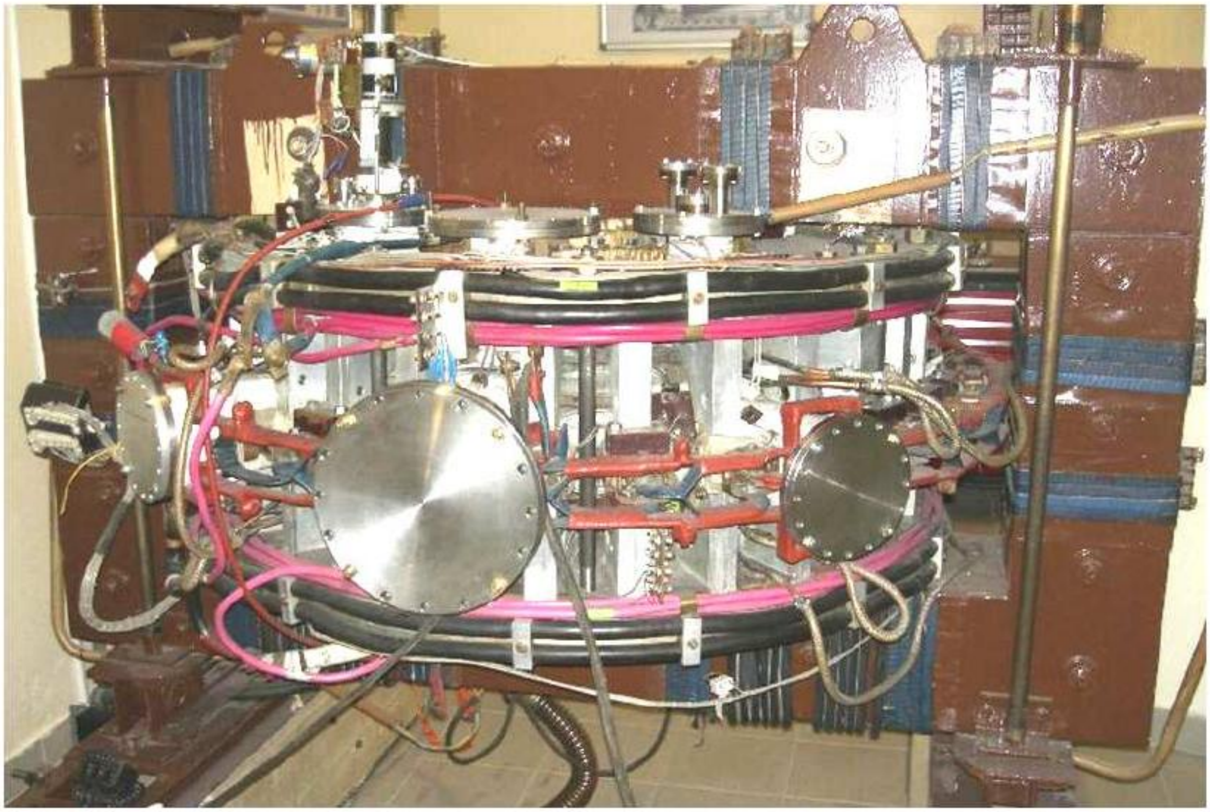

Figure 1: GOLEM Tokamak

The GOLEM tokamak is equipped with full remote control capability, the parameters which are to be set remotely follow:

- Torroidal magnetic field through the voltage of the toroidal field capacitor bank(U_B), range: 400-1400V
- Toroidal electric field(E_t) through the capacitor bank for the current drive(U_E=U_{CD}) range: 100-600V
- The time delay between the triggers of the toroidal magnetic field and the current drive(T_{CD}), range: 0-20000μs

- Hydrogen gas pressure(pH2), range: 0-100mPa
- Preionization ON/OFF

Diagnostics that can be accessed online:

- Time resolved measurement of loop voltage (U_l).
- Time resolved measurement of total toroidal current by Rogowski coil (I_t).
- Time resolved toroidal magnetic field by coil measurement (B_t).
- Time resolved measurement of plasma radiation by photodiode.
- Vacuum chamber pressure (p_{ch}).
- The temperature of the vacuum vessel chamber (T_{ch}).

All recorded data and settings can be accessed online for each shot. The root directory being:

http://golem.fjfi.cvut.cz/operation/shots/<shotnumber>

4. Measurements and evaluation

Primary real time communication to the local support (Dr. Vojtech Svoboda) is through Skype instant messaging. View skype log in appendix.

First step of measurements was the correction for the DC bias. With a 1MHz sampling rate and the measurements start at 5ms there are 5000 samples for background noise. The algorithm for the correction of bias is averaging the data points from the background samples and subtracting it from the measured value.

This bias correction has to be calculated separately in each shot.

4.1 Determination of vacuum chamber parameters

The point of vacuum shots is to determine the inductance and the resistance of the vacuum vessel. Due to the fact that if no plasma is formed in the vacuum vessel the current runs through it, by measuring this current. Using the model of an LR circuit, we denote U_l the loop voltage, I_{tot} the chamber current, R_{ch} chamber resistance and L_{ch} chamber inductivity.

$$U_l = R_{ch} I_{tot}(t) + L_{ch} \frac{dI_{tot}}{dt} \tag{4}$$

Having measuredU_l, I_{tot} and $\frac{dI_{tot}}{dt}$ determining the chamber resistance and inductivity becomes quite easy, especially if we take in consideration that the time derivate of the total current is very steep and the current itself is close to 0 in the moment of switching on the toroidal electric field (see Fig.2), equation (4) becomes:

$$U_l = L_{ch} \frac{dI_{tot}}{dt} \tag{5}$$

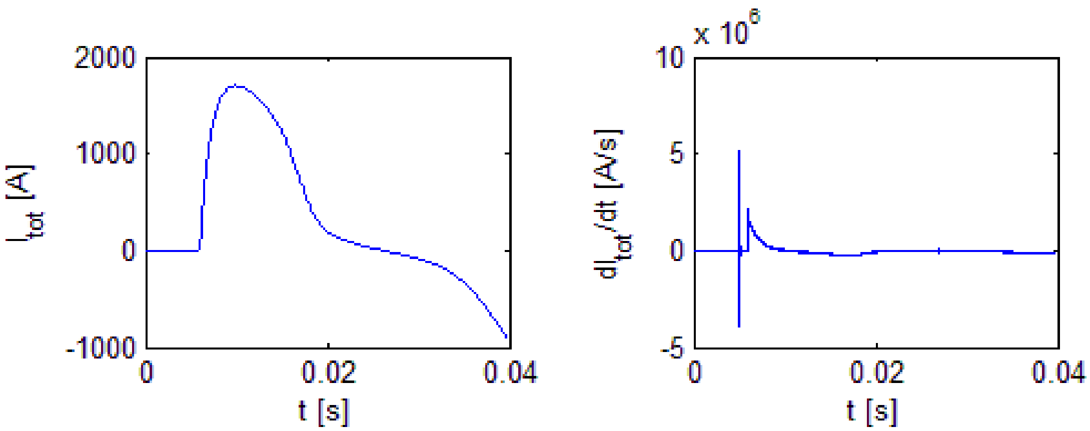

Figure 2: Chamber current and Current time derivate time dependency

At the flat top of the current curve we notice that the time derivate is close to zero thus equation (4) becomes:

$$U_l = R_{ch} I_{tot}(t) \tag{6}$$

Using this approach the R_{ch} chamber resistance and L_{ch} chamber inductivity are calculated easily. We performed these calculations on 5 vacuum shot, aver ageing the result (see table 1). These values will be important in further calculations.

Shot Number	L(H) × 10^{-7}	R(Ω) × 10^{-3}
9955	6.75	9.53
9956	7.03	9.50
9957	4.03	9.70
9958	6.81	9.56
9959	6.85	9.51
Average	6.29	9.56

Table 1: Chamber resistance and inductivity

4.2 Plasma Breakdown

After calculating the chamber parameters the second task was to fill the chamber with H_2 and search for the parameters at which plasma breakdown would occur and to establish a line separating breakdown and non – breakdown.

Firstly the H_2 gas inlet did not provide the planed gas pressure, having grater errors in domains of small gas pressures, as well as in case of drastic changes in pressure. If shots were planned consecutively at the same plasma pressure then the planned value would deviate only by 1-2% from the planned value.

Shot Number	Plasma	U_B(V)	U_{CD}(V)	T_{CD}(µs)	P_{H2} Planned(mPa)	P_{H2} Actual(mPa)
9960	1	600	500	1000	10	11.12
9961	1	600	500	1000	6	6.36
9962	1	600	500	1000	4	4.29
9963	1	600	500	1000	2	2.61
9964	1	600	500	1000	1	1.81
9965	1	600	300	1000	10	3.94
9966	0	600	200	1000	10	7.01
9967	0	600	100	1000	10	8.48
9968	1	600	300	1000	6	8.35
9969	1	600	300	1000	6	4.49
9970	1	600	300	1000	8	5.84
9971	1	600	300	1000	4	6
9972	1	600	300	1000	2	2.72
9973	0	600	300	1000	1	1.89
9974	0	600	200	1000	16	7.78
9975	0	600	200	1000	20	17.03
9976	0	600	200	1000	24	22.8
9977	0	600	200	1000	30	28.99
9978	0	600	200	1000	35	34.01
9979	0	600	200	1000	40	39.15
9980	0	600	200	1000	60	59.19
9981	0	600	200	1000	80	79.39
9982	0	600	200	1000	95	94.62
9983	0	1000	200	1000	95	91.77
9984	0	600	300	1000	2	0.08
9985	0	600	300	1000	1	0.09
9986	0	600	300	1000	4	0.12
9987	0	600	300	1000	6	0.54
9988	1	600	300	1000	10	2.6
9989	1	600	300	1000	16	10.12

Table 2: Break down parameters

The H_2 gas that was introduced into the plasma was pre-ionized. Our approach was the following: the first shot 9960 at a voltage of 500V and a gas pressure of 10 mPa resulted in plasma, thus we kept the voltage constant and steadily decreasing the pressure. This approach did not yield any non-breakdown shot due to high voltage. Keeping the pressure at 10mPa and decreasing the voltage resulted the first non-breakdown event at 200V (shot nr. 9966). The following shots were focused on investigating low densities at a loop voltage of 300V and the entire density spectrum at a loop voltage of 200V.

Our findings were the following: In a steady magnetic field no breakdown event had occurred at a loop voltage of 200V or beneath or at 300 volts if the gas density is below 2mPa (see Table 2 and Fig.3) we concluded that the breakdown event occurred at 300V.

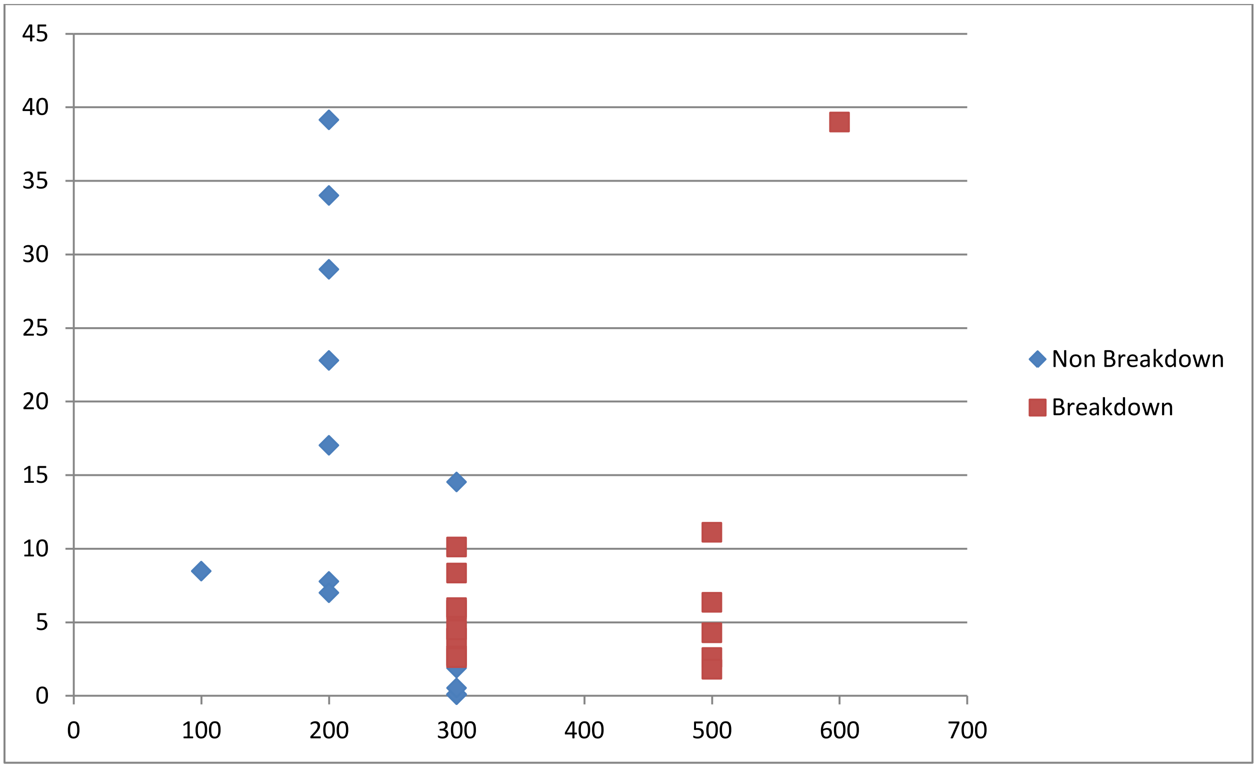

Figure 3: Plasma Breakdown x label U_{CD}*(V) and y label* p_{H2}*(mPa)*

4.3 Plasma Current

In the latter part of the experiment we studied the effect certain parameters have on the plasma, as well as achieving high values for plasma temperature, energy confinement time and calculating plasma parameters.

The first task was to determine the plasma current and resistance. This problem is similarly solved as the determination of the chamber resistance and inductivity. The tokamak is described as a parallel LR circuit, one branch modeling the chamber current, the other the plasma current. The following equations can be applied to this system:

$$U_l = R_{ch}I_{ch}(t) + L_{ch}\frac{dI_{ch}}{dt} \quad (7)$$

$$U_l = R_{pl}I_{pl}(t) + L_{pl}\frac{dI_{pl}}{dt} \quad (8)$$

$$I_{tot}(t) = I_{ch}(t) + I_{pl}(t) \quad (9)$$

The chamber parameters are already determined in section 4.1. The plasma inductance is considered $0(L_{pl} \approx 0H)$. Integrating equation (7) and combining with (9) the plasma current is determined. To calculate the plasma resistance we used equation (8) with the above specified condition. Fig.4 and 5 present shots 10002 and 10004 which has the lowest R_{max} recorded, as well as I_{plmax}.

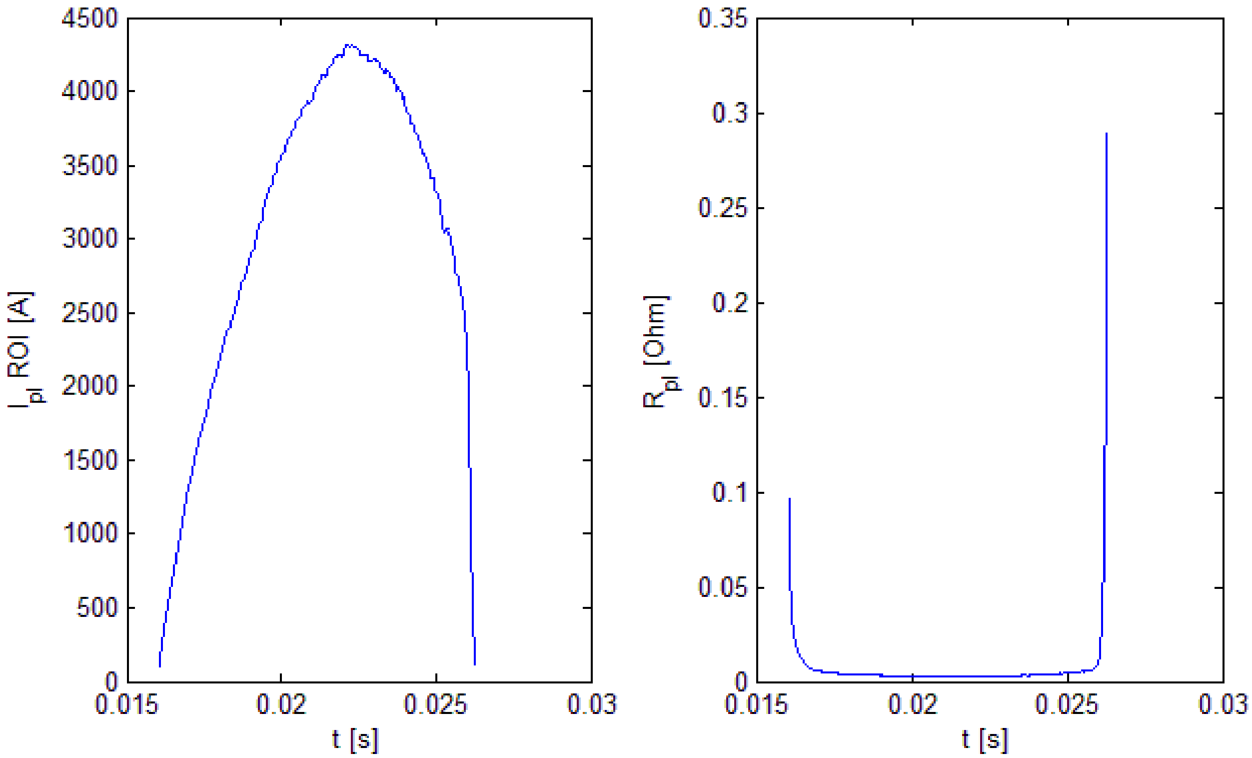

Figure 4: Shot 10002, Current and resistance time dependency

Compare shots 10007-9 and 10001-2 with 10004-6 the plasma resistance increases in weaker magnetic fields, if the plasma pressure and the particle density can be considered constant. Plasma resistance is temperature dependent, thus has high values at break down and at the end of measurement.

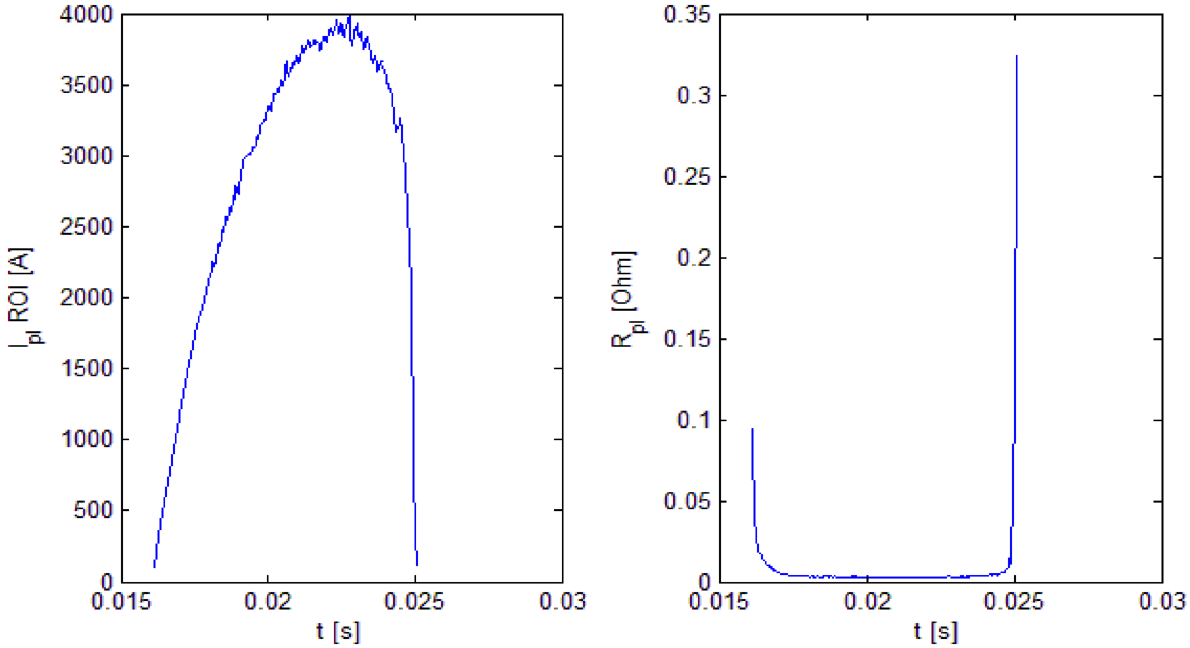

Figure 5: Shot 10004, Current and resistance time dependency

4.4 <u>Plasma heating power</u>

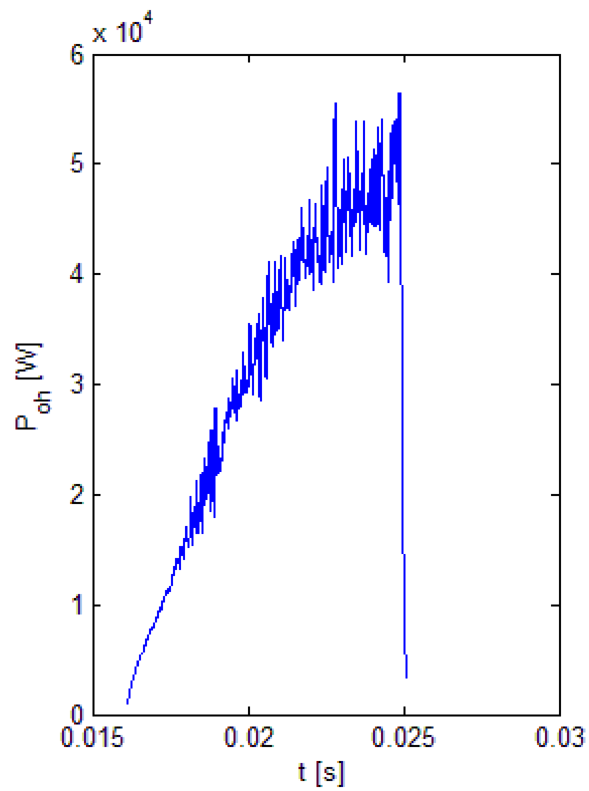

Figure 6: Shot 10004, Heating Power time dependency

In case of the GOLEM tokamak the only heating mechanism is the ohmic heating of the plasma, the medium being a conductor with finite resistivity.

$$P_{OH}(t) = R_{pl}(t) I_{pl}(t)^2 \qquad (10)$$

In which expression $R_{pl}(t)$ is the plasma resistance and $I_{pl}(t)$ the plasma current. The maximum value achieved was 55940W in shot nr. 10004 (Fig. 6).

4.5 Central electron temperature

Central electron temperature can be calculated using the Spitzer formula:

$$T_{e0}(t) = \left(\frac{R}{a^2}\frac{8Z_{eff}}{1544}\frac{1}{R_{pl}(t)}\right)^{2/3} \quad (11)$$

In which $T_{e0}(t)$ is the central electron temperature in electron –volts, $R_{pl}(t)$ is the plasma resistance, R the major radius and a the radial position of the limiter. Summing up the shots we have performed it is clear that increase in loop voltage will increase the temperature, in the meanwhile the electron temperature registers an increase if the average plasma density drops.

At constant values, except magnetic field intensity, the plasma central temperature is at it's height when the magnetic field is medium. Fig. 7 presents shot 10009, which has the highest recorded value for T_{e0} 49.55 eV, equivalent for 574780K.

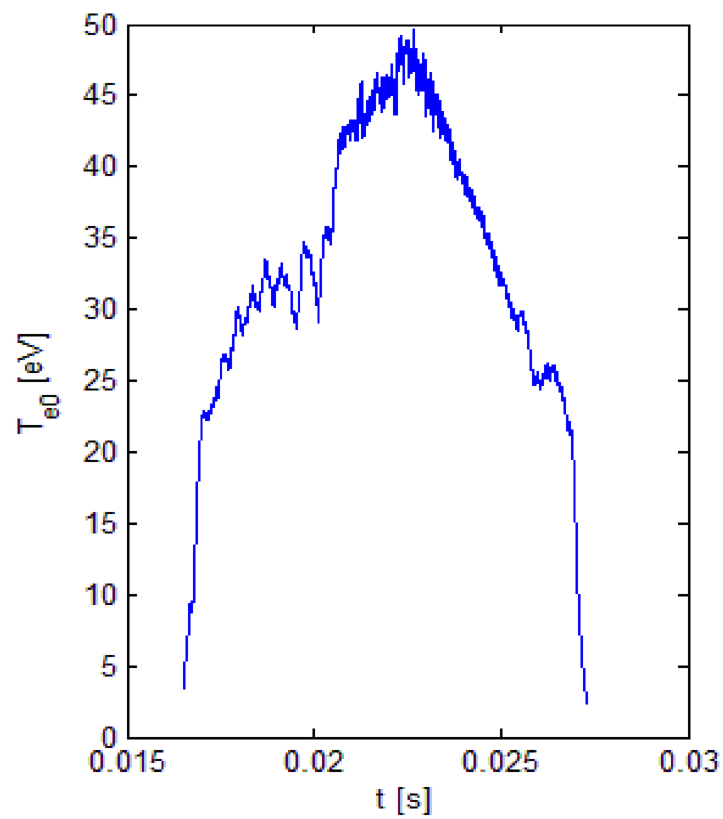

Figure 7: Shot 10004, Heating Power time dependency

4.6 Electron Density

Due to the fact that the GOLEM tokamak has no equipment to measure electron density, this value is deduced from the ideal gas laws. The average density is assumed to be constant, although is a rough estimate due to plasma wall interaction and the fact that the gas inside GOLEM is not fully ionized.

The formula used follows:

$$n_{avr} = \frac{2p_{ch}}{k_B T_{ch}} \tag{12}$$

4.7 Plasma Energy

The total energy can be easily calculated using ideal gas laws, but the quantity will be uncertain due to the uncertainty in the measurement of the electron density.

$$W_{pl} = V \frac{n_{avr} k_B T_{e0}(t)}{3} \tag{13}$$

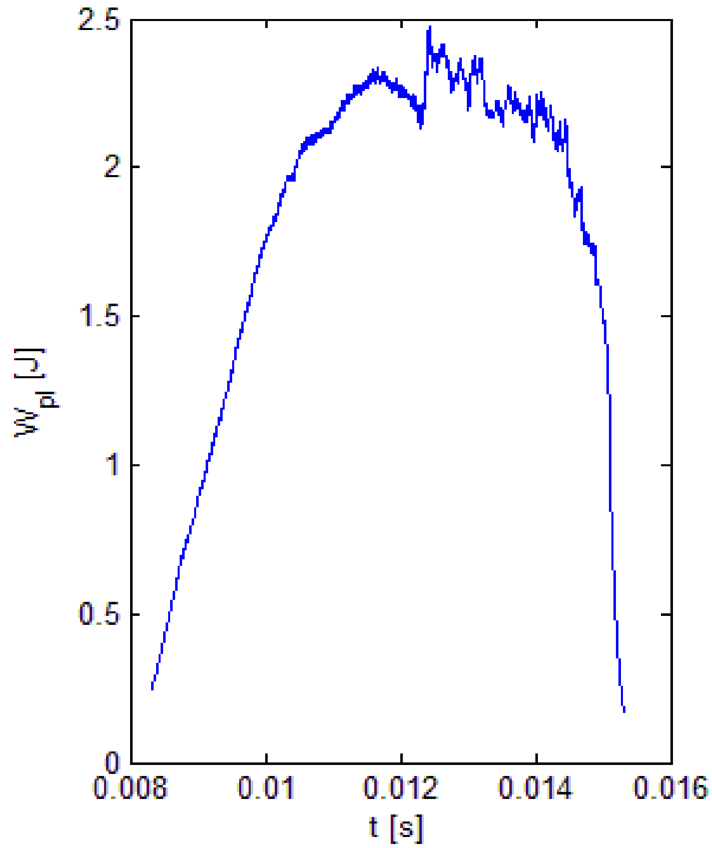

Figure 8: presents the maximum energy in shot 9996.

4.8 Energy Confinement time

Having calculated the plasma energy chapter 4.7 and the plasma heating power chapter 4.4 the energy confinement time can be derived the following:

$$P_{loss}(t) = P_{OH}(t) - \frac{dW_{pl}}{dt} \quad (14)$$

Thus resulting in:

$$\tau_e = \frac{W_{pl}}{P_{loss}}$$

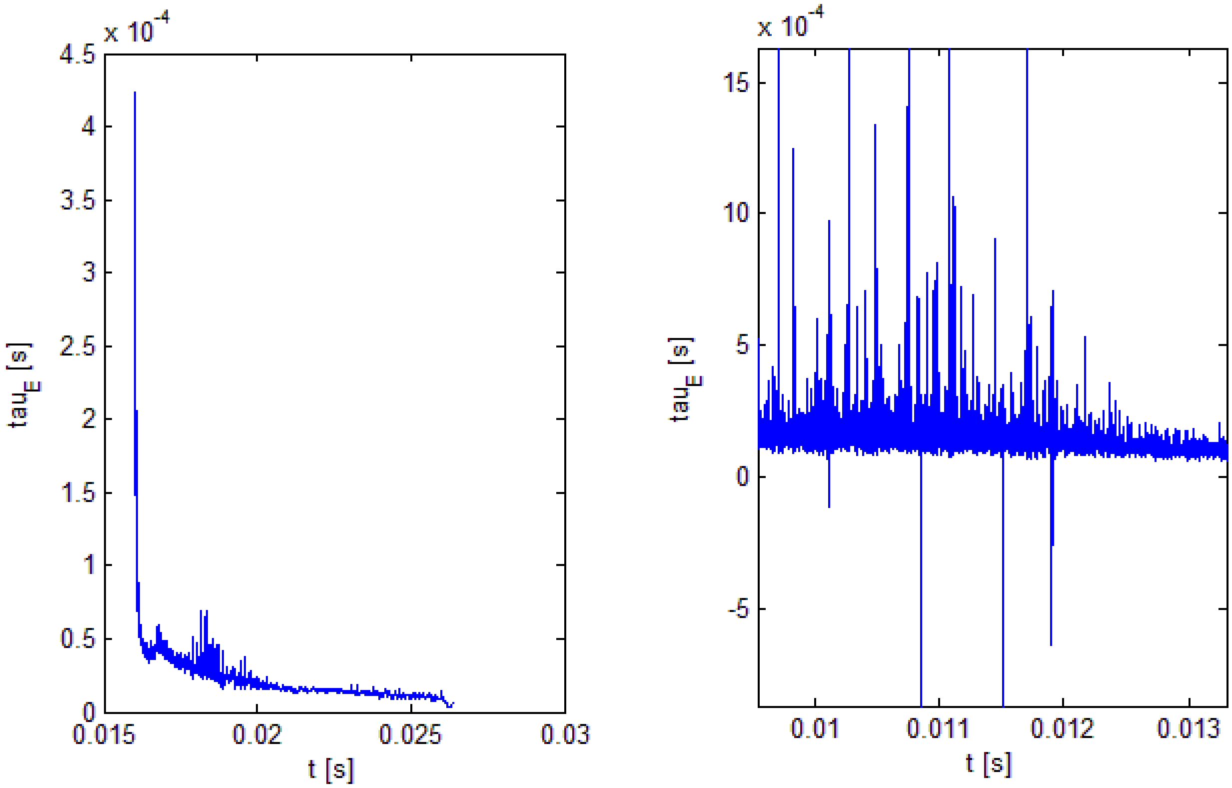

Figure 9: Left low energy confinement time

Right high energy confinement time

The aim would be to increase the energy confinement time by increasing the plasma energy, higher densities, plasma temperatures.

4.9 q = 2 Disruption

The task is to plan a plasma in which would function with a q = 2 safety factor, in which case plasma instabilities resonant to the q = 2 surface cause discharge terminating disruptions to occur.

$$q(a,t) = \frac{a^2}{R}\frac{B_t(t)\pi}{\mu_0 I_{pl}(t)} \tag{15}$$

Can be derived from the following expression:

S
$$B_p(a,t) = \frac{\mu_0}{2\pi}\frac{I_{pl}(t)}{a}$$

To achieve q = 2 one must decrease the toroidal magnetic field and increase the plasma current. To achieve even greater magnetic fields we tried to increase T_{CD} to its maximum still the lowest safety factor we have achieved was q = 3(Fig.10: Hugill diagram).

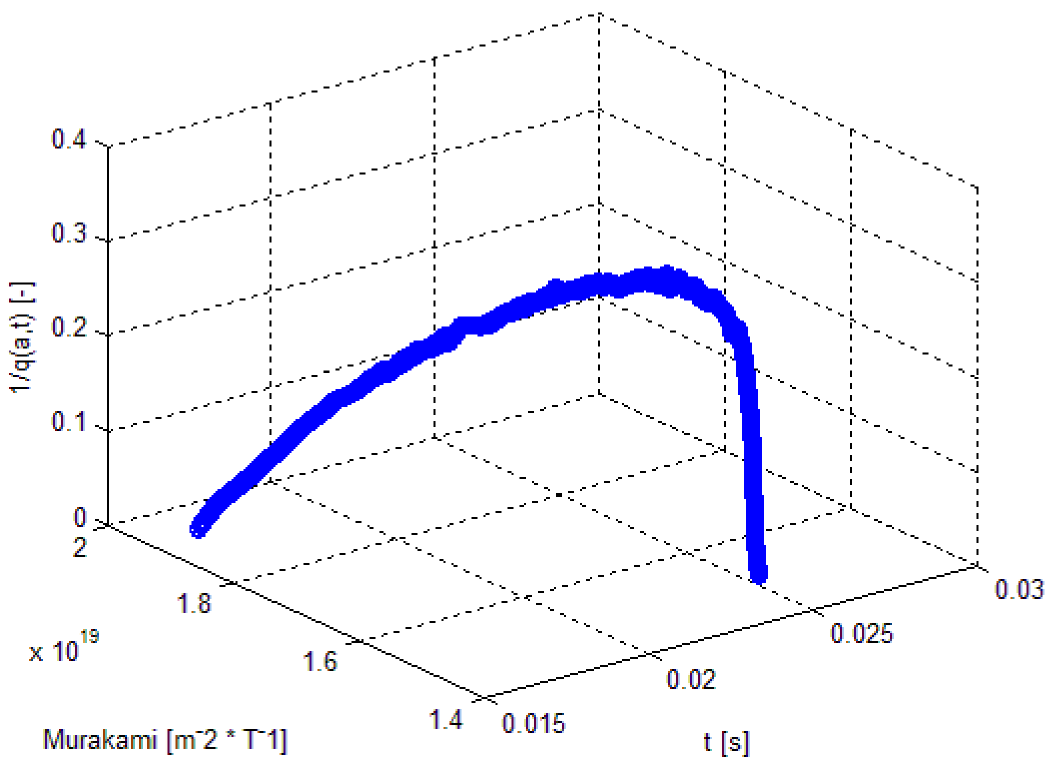

Figure 10: Hugill diagram for shot 10004

5. Conclusions

The purpose of this measurement was to familiarize ourselves with a tokamak and learn the basics of its functions.

First part of the experiment served as familiarization with the device.

Second part of the experiment served to learn how to create plasma, distinction between break down event and non breakdown.

Third part served to understanding and experimenting with certain plasma parameters.

APPENDIX

Table 3: Plasma parameters

Shot Number	Rpmax[Ohm]	Ipmax[A]	Temax[eV]	τe[s]	Poh max[W]	Wpl max[J]	n avrg	q min
9960	0.0375	2159	32.29	8.54E-05	24110	0.8250	6.05E+18	5.10
9961	0.0389	2472	35.51	6.49E-05	27650	0.5620	3.77E+18	4.75
9962	0.0444	2624	36.48	4.42E-05	28310	0.4231	2.80E+18	4.61
9963	0.0498	2748	36.24	5.18E-05	29970	0.3125	1.99E+18	4.74
9964	0.0467	2838	40.02	4.16E-05	30520	0.2711	1.60E+18	4.57
9965	0.0487	1747	42.19	9.59E-05	11140	0.4824	2.61E+18	7.88
9968	0.0249	1578	38.71	1.22E-04	10230	0.7660	4.72E+18	8.65
9969	0.0254	1804	43.22	2.99E-04	12210	0.5212	2.86E+18	7.77
9970	0.0263	1742	43.3	1.36E-05	11640	0.6407	3.51E+18	7.93
9971	0.0207	1798	43.5	9.62E-05	11940	0.6578	3.59E+18	7.87
9972	0.0259	1888	47.76	4.70E-05	12020	0.4033	2.00E+18	7.78
9988	0.0253	1842	45.78	3.80E-04	12180	0.3643	1.88E+18	7.65
9989	0.233	1066	27.46	8.70E-05	6919	0.6394	5.52E+18	13.20
9991	0.054	3351	40.15	9.21E-05	44770	1.6320	9.67E+18	4.37
9992	0.0553	3321	39.73	1.30E-04	43850	1.6450	9.82E+18	4.90
9993	0.0424	2897	36.2	1.70E-04	38140	1.4650	9.60E+18	7.90
9994	0.0393	1886	25.5	1.39E-04	24890	2.0130	1.97E+19	12.97
9995	0.0511	2123	27.11	1.69E-04	27790	2.2400	1.96E+19	7.67
9996	0.0647	2426	30.07	1.15E-04	31160	2.4760	1.95E+19	5.75
9998	0.0329	1838	23.08	7.20E-05	23970	1.8930	1.94E+19	20.29
9999	0.0288	1509	20.43	1.20E-04	19260	2.5050	2.94E+19	25.03
10001	0.0409	2781	32.12	2.45E-05	35750	0.6223	4.50E+18	13.50

10002	0.0719	4316	45.4	2.98E-05	55990	0.9103	4.79E+18	4.47
10003	0.0135	975	25.75	7.88E-04	5663	0.5200	4.77E+18	39.85
10004	0.0786	3938	45.3	1.80E-05	55940	0.9178	4.88E+18	3.01
10005	0.0733	4272	47.33	2.04E-05	55070	0.9402	4.75E+18	3.63
10006	0.0491	4043	47.44	2.87E-05	50580	0.9774	4.82E+18	6.68
10007	0.072	4358	46.88	3.10E-05	56420	0.6968	3.44E+18	3.60
10008	0.0778	4382	48.1	1.19E-05	53740	0.3837	1.89E+18	3.59
10009	0.0547	4081	49.55	1.05E-05	46090	0.3192	1.55E+18	7.59
10017	0.0696	4501	48.33	2.09E-05	56940	0.4748	2.38E+00	4.36
10018	0.0446	1496	28.07	6.39E-05	24330	0.4547	3.79E+18	4.48
10020	0.0425	1459	27.37	6.85E-05	17960	0.5490	4.77E+18	2.78
10021	0.0252	1538	27.88	6.39E-05	23490	0.5849	4.97E+18	3.20

Table 2: General measures

Shot Number	Plasma	Ub[V]	Ucd[V]	Tcd[us]	H2[mPa]	H2 Actual[mPa]	Actual P[mPa]	Pch[mPa]
9955	0	600	500	1000	0	0.01	1.47	1.46
9956	0	600	600	1000	0	0	1.43	1.43
9957	0	600	100	1000	0	0	1.43	1.43
9958	0	400	100	1000	0	0	1.43	1.43
9959	0	700	400	1000	0	0.03	1.45	1.42
9960	1	600	500	1000	10	11.12	12.55	1.43
9961	1	600	500	1000	6	6.36	7.82	1.46
9962	1	600	500	1000	4	4.29	5.8	1.51
9963	1	600	500	1000	2	2.61	4.14	1.53
9964	1	600	500	1000	1	1.81	3.32	1.51
9965	1	600	300	1000	10	3.94	5.41	1.47
9966	0	600	200	1000	10	7.01	8.48	1.47
9967	0	600	100	1000	10	8.48	9.93	1.45
9968	1	600	300	1000	6	8.35	9.78	1.43
9969	1	600	300	1000	6	4.49	5.94	1.45
9970	1	600	300	1000	8	5.84	7.27	1.43
9971	1	600	300	1000	4	6	7.44	1.44
9972	1	600	300	1000	2	2.72	4.15	1.43
9973	0	600	300	1000	1	1.89	3.31	1.42
9974	0	600	200	1000	16	7.78	9.19	1.41
9975	0	600	200	1000	20	17.03	18.42	1.39
9976	0	600	200	1000	24	22.8	24.18	1.38
9977	0	600	200	1000	30	28.99	30.33	1.34
9978	0	600	200	1000	35	34.01	35.37	1.36

9979	0	600	200	1000	40	39.15	40.45	1.3
9980	0	600	200	1000	60	59.19	60.53	1.34
9981	0	600	200	1000	80	79.39	80.72	1.33
9982	0	600	200	1000	95	94.62	95.94	1.32
9983	0	1000	200	1000	95	91.77	93.04	1.27
9984	0	600	300	1000	2	0.08	1.37	1.29
9985	0	600	300	1000	1	0.09	1.33	1.24
9986	0	600	300	1000	4	0.12	1.4	1.28
9987	0	600	300	1000	6	0.54	1.84	1.3
9988	1	600	300	1000	10	2.6	3.91	1.31
9989	1	600	300	1000	16	10.12	11.44	1.32
9990	0	600	300	1000	16	14.54	15.86	1.32
9991	1	700	600	1000	20	18.74	20.04	1.3
9992	1	800	600	1000	20	18.98	20.35	1.37
9993	1	1200	600	1000	20	18.5	19.89	1.39
9994	1	1200	600	1000	40	39.66	40.92	1.26
9995	1	800	600	1000	40	39.18	40.61	1.43
9996	1	600	600	1000	40	39	40.45	1.45
9997	0	200	600	1000	40	41.23	42.68	1.45
9998	1	1000	600	10000	40	38.98	40.3	1.32
9999	1	1000	600	10000	60	59.74	60.99	1.25
10001	1	1000	600	10000	10	8.26	9.52	1.26
10002	1	500	600	10000	10	8.65	9.93	1.28
10003	1	1000	300	10000	10	8.6	9.89	1.29
10004	1	300	600	10000	10	8.89	10.12	1.23
10005	1	400	600	10000	10	8.61	9.85	1.24
10006	1	700	600	10000	10	8.73	10	1.27
10007	1	400	600	10000	2	5.88	7.14	1.26
10008	1	400	600	10000	2	2.7	3.92	1.22
10009	1	800	600	10000	2	1.99	3.22	1.23
10010	0	300	300	10000	2	1.21	2.45	1.24
10011	0	300	350	10000	2	1	2.26	1.26
10012	0	300	400	10000	2	0.81	2.06	1.25
10013	0	300	450	10000	2	0.82	2.06	1.24
10014	0	400	450	10000	2	0.82	2.06	1.24
10015	0	500	450	10000	2	0.8	2.05	1.25
10016	0	500	600	10000	4	1.11	2.35	1.24
10017	1	500	600	10000	10	3.7	4.94	1.24
10018	1	200	600	10000	10	6.63	7.85	1.22
10019	0	300	600	500	10	7.86	9.09	1.23
10020	1	300	600	1000	10	8.67	9.89	1.22
10021	1	400	600	1000	10	9.09	10.31	1.22

Skype log 1.10.2012

[9:34:17] *** Horváth László added NTI Hallgató ***

[9:35:30] Tokamak GOLEM: Hi nti.hallgato, Gergo, are yoyu there?

[9:35:41] NTI Hallgató: Hi Vojtech, we are here.

[9:35:48] Tokamak GOLEM: Very good

[9:35:56] Tokamak GOLEM: So best regards from Prague

[9:36:07] Tokamak GOLEM: Here is your interface

[9:36:09] Tokamak GOLEM: http://golem.fjfi.cvut.cz/current/

[9:36:28] NTI Hallgató: we could connect and we also saw you on IP cameras.

[9:36:51] NTI Hallgató: can I pass the communication to the students to begin the exercise?

[9:37:04] Tokamak GOLEM: Yes

[9:37:32] NTI Hallgató: Then by for now. Just tell the students if you need me!

[9:37:44] Tokamak GOLEM: OK

[9:39:27] NTI Hallgató: Hello

[9:39:37] NTI Hallgató: my name is Ors

[9:39:38] Tokamak GOLEM: Hello, best regards from Prague

[9:39:45] NTI Hallgató: thank you

[9:39:58] Tokamak GOLEM: Hi Ors, how many studets are there?

[9:40:09] NTI Hallgató: we are a group of 4

[9:40:32] Tokamak GOLEM: Fine, best regards to all of them

[9:40:41] NTI Hallgató: i will tell them

[9:40:53] NTI Hallgató: so for starters

[9:41:03] NTI Hallgató: we would do the 5 vacuum shots

[9:42:54] Tokamak GOLEM: OK, so try to make your first vacuum shot .. and then wait

[9:44:12] Tokamak GOLEM: For beginning I recommend to ask for my permisson for every shot. Thank you. Then I will let you go on without my approval

[9:44:13] NTI Hallgató: we have started it

[9:44:25] Tokamak GOLEM: OK, capacitors are charged

[9:44:42] Tokamak GOLEM: sorry ..charging..

[9:44:46] NTI Hallgató: ok

[9:45:08] NTI Hallgató: so that i wont make any mistake

[9:45:30] NTI Hallgató: are we good to go?

[9:46:46] Tokamak GOLEM: I do not understand .."good to go"

[9:47:03] NTI Hallgató: i mean that the procedure has started

[9:47:19] NTI Hallgató: we have entered the second set of parameters

[9:47:33] NTI Hallgató: can we initiate?

[9:47:36] Tokamak GOLEM: So it was shot 9955, can you see results?

[9:47:47] NTI Hallgató: yes i can

[9:48:05] NTI Hallgató: thank you

[9:48:45] Tokamak GOLEM: OK, so proceed to the next shot, you can make all vacuum shots now

[9:48:57] NTI Hallgató: ok i will initiate now

[9:49:17] NTI Hallgató: started

[9:49:27] Tokamak GOLEM: OK, charging

[9:49:44] Tokamak GOLEM: Can you hear the sound from tokamak room?

[9:49:57] NTI Hallgató: i do not have any sound

[9:50:15] NTI Hallgató: but i can see the room

[9:50:52] Tokamak GOLEM: The room IP camera has a microphone, so you can try to hear the sound from the operation

[9:54:57] NTI Hallgató: can we proceed to third shot?

[9:55:20] Tokamak GOLEM: Yes, you can now make all vacuum shots planned

[9:55:38] NTI Hallgató: ok

[9:56:16] NTI Hallgató: the i will place all setup in the queue for vaccum

[9:56:36] Tokamak GOLEM: OK

[10:00:37] Tokamak GOLEM: I have a request, could you please report immediately any problem you encounter during the operation? I mean especially everything concernig the www interface

[10:00:51] NTI Hallgató: of course

[10:00:55] NTI Hallgató: so far so good

[10:02:19] NTI Hallgató: when we'll do the plasma shots, more precisely when we'll fill the tokamak with gas would it be more advantageous for us to gradually incerease the H2 pressure

[10:03:14] NTI Hallgató: we are done with vacuum

[10:04:14] Tokamak GOLEM: OK, let us start with plasma trial, you can configure it and run it

[10:04:38] NTI Hallgató: we have our first config. can i proceed?

[10:04:44] Tokamak GOLEM: yes

[10:07:39] Tokamak GOLEM: Plasma! congratulations

[10:07:47] NTI Hallgató: thank you

[10:08:02] Tokamak GOLEM: Have you seen the flash with the chamber IP cam

[10:08:19] NTI Hallgató: of course

[10:08:29] NTI Hallgató: can we proceed to next?

[10:08:41] Tokamak GOLEM: Very good. Go ahead

[10:11:44] NTI Hallgató: can i plan the next 4-5 shots in advance?

[10:11:58] Tokamak GOLEM: Yes, You can now make shots without my approval

[10:12:04] NTI Hallgató: ok

[10:12:36] NTI Hallgató: we will be carefull not to break anything:P

[10:13:16] Tokamak GOLEM: Very good, could you please make a photo of controll room with students and possibly teacher and send it to me?

[10:13:31] NTI Hallgató: of course

[10:17:31] NTI Hallgató: i have heard that you can not buy any alcohol in Prague

[10:17:48] NTI Hallgató: is there still prohibition?

[10:18:30] Tokamak GOLEM: Prohibition has been canceled partially last thursday

[10:19:51] Tokamak GOLEM: And it was only for more then 20% of alcohol. Othervise our government cannot survive

[10:20:08] NTI Hallgató: yes i imagine so

[10:20:31] NTI Hallgató: well anyway good that it passed

[10:25:10] NTI Hallgató: no plasma this time?

[10:25:21] Tokamak GOLEM: Is absolutely everything OK? Please report any problem. Thanks. (Gergo, thank you in advance, I hope that everything you reported from last session is now OK, is it? And waiting for the same report after today's session)

[10:26:21] Tokamak GOLEM: Probably toroidal electric field to low to breakdown the plasma

[10:26:40] NTI Hallgató: that is good

[10:27:42] NTI Hallgató: right now we are searching for the borderline between breakdown and non breakdown

[10:28:19] Tokamak GOLEM: Very good. Good luck..

[10:28:30] NTI Hallgató: thank you

[11:22:21] Tokamak GOLEM: Hi, everything OK? Have you tried "Chamber status" button?

[11:23:43] NTI Hallgató: no but i will

[11:26:28] NTI Hallgató: in the last couple of shots the actual plasma pressure was considerably lower than the parameters we have asked for

[11:29:02] Tokamak GOLEM: Please note, that the operation with the working gas is a bit tricky. And you should always check if it succedeed. If not, you should repeat the shot with same parameters. You can expect better performance from shot to shot if you you leave the same pressure value. The worst behaviour is when you make a huge difference in the presure setup

[11:29:51] NTI Hallgató: thank you

[11:29:58] NTI Hallgató: i will do so

[11:42:33] Tokamak GOLEM: Plese stop it for a moment. I've got a SW problem.

[11:43:34] NTI Hallgató: good

[11:43:50] NTI Hallgató: but you have to cancel them

[11:44:21] NTI Hallgató: i have already enqueued

[11:44:25] NTI Hallgató: one more

[11:44:40] Tokamak GOLEM: OK

[11:48:07] Tokamak GOLEM: Now it is OK, continuing .. you can go on again .. without my approval

[11:48:31] NTI Hallgató: ok

[11:55:00] NTI Hallgató: Hi, is everything allright?

[11:55:57] Tokamak GOLEM: Problems with fast cameras. You can continue, I guess you do not need them too much.

[11:56:10] NTI Hallgató: not

[12:58:11] Tokamak GOLEM: Please, specify better discharge comment. It is good for remembering the aim you have at the trigger moment ..

[12:59:01] NTI Hallgató: I am writing all discharges on paper in my own log

[13:01:30] Tokamak GOLEM: Still I believe it is worth to make a note here

[13:01:41] NTI Hallgató: i will

[13:10:46] Tokamak GOLEM: Everything OK?

[13:16:27] NTI Hallgató: yes it is okű

[13:16:40] NTI Hallgató: just thinking for our last shots

[13:17:03] Tokamak GOLEM: OK

[13:33:21] NTI Hallgató: I think we have finished for today

[13:33:32] NTI Hallgató: Thank you for your help

[13:33:46] NTI Hallgató: Regards from Budapest

[13:36:15] Tokamak GOLEM: OK, I will appreciate if you find a time to complete "feedback form", see menu. And price for the session is a postcard from the Town of measurement to Tokamak GOLEM, Brehova 7, Prague 1, CR. Thank you in advance. Best regards from Prague, hope you have enjoyed the session.VS for the GOLEM

[13:37:06] NTI Hallgató: I will, have nice afternoon bye

[13:37:17] Tokamak GOLEM: bye