

Operation of the GOLEM tokamak at the PhD event

Adapted from Belgrade training course October 2015. Special acknowledge to Milos Vlainic, author of the original document.

General Information:

Web of GOLEM: <http://golem.fjfi.cvut.cz>

Access to GOLEM database: <http://golem.fjfi.cvut.cz/shots/0/> (shows the last executed shot)

GOLEM Operation for Dummies:

Step 1: go to the link <http://golem.fjfi.cvut.cz/PhDevent> .

Step 2: click on '**Master Demo**', now you get (note the burning GOLEM sign on the top left :D):

Tokamak Golem **REMOTE for Belgrade (Level I)**
The smallest & oldest operational tokamak with the biggest control room in the world

Home Wiki **Control Room** Queue Results GOLEM dygraph IP cameras 3D model Chat Level I

Welcome to the GOLEM remote control room

Link to current event: <http://golem.fjfi.cvut.cz/ahm>

This is the real remote control room for the tokamak GOLEM, where you can configure your own discharges and put them into the queue. The discharge setups are processed based on agreement with the [tokamak GOLEM operator team](#).

Feel free to setup your discharge in the **CONTROL ROOM**, choose your choices in the **QUEUE**. The actual discharge is processed in the **LIVE** window and then have a look at the output in the **RESULTS** table. You can also use the **GOLPLOT** interface for comparing results from different discharges.

For an even more realistic experience you may want to watch the live feed from the **IP CAMERAS**, observe the status of the **CHAMBER** or **CHAT** with the operator team in the bottom window.

Currently two levels of remote operation are available:

- Level I (Basic: Gas management; Toroidal magnetic field; Current drive; Preionization)
- Level II (= Breakdown operation) - not available

Whenever you'll feel lost, please consult the [WIKI](#).

Before you start to operate this tokamak, you may want to see the tokamak and the infrastructure room in the [3D VIRTUAL MODEL](#).

Enjoy. Please feel free to send comments on this control room to the operator or use the [FEEDBACK](#) form.

Vojtech Svoboda for the GOLEM team.

Step 3: finally you got to the '**Control Room**', getting:

Tokamak Golem **REMOTE for Belgrade (Level I)**
The smallest & oldest operational tokamak with the biggest control room in the world

Home Wiki Control Room Queue Results GOLEM dygraph IP cameras 3D model Chat Level I

LEVEL I

Preionization (electron gun)
Preion OFF

Toroidal magnetic field
 $U_B [V]$ 600
23 mF

Current drive
 $I_{CD} [A]$ 1000
 $U_{CD} [V]$ 500
11.3 mF

Vacuum stand
GAS handling
Working Gas
Hydrogen

Discharge comment

Place the discharge setup into the queue

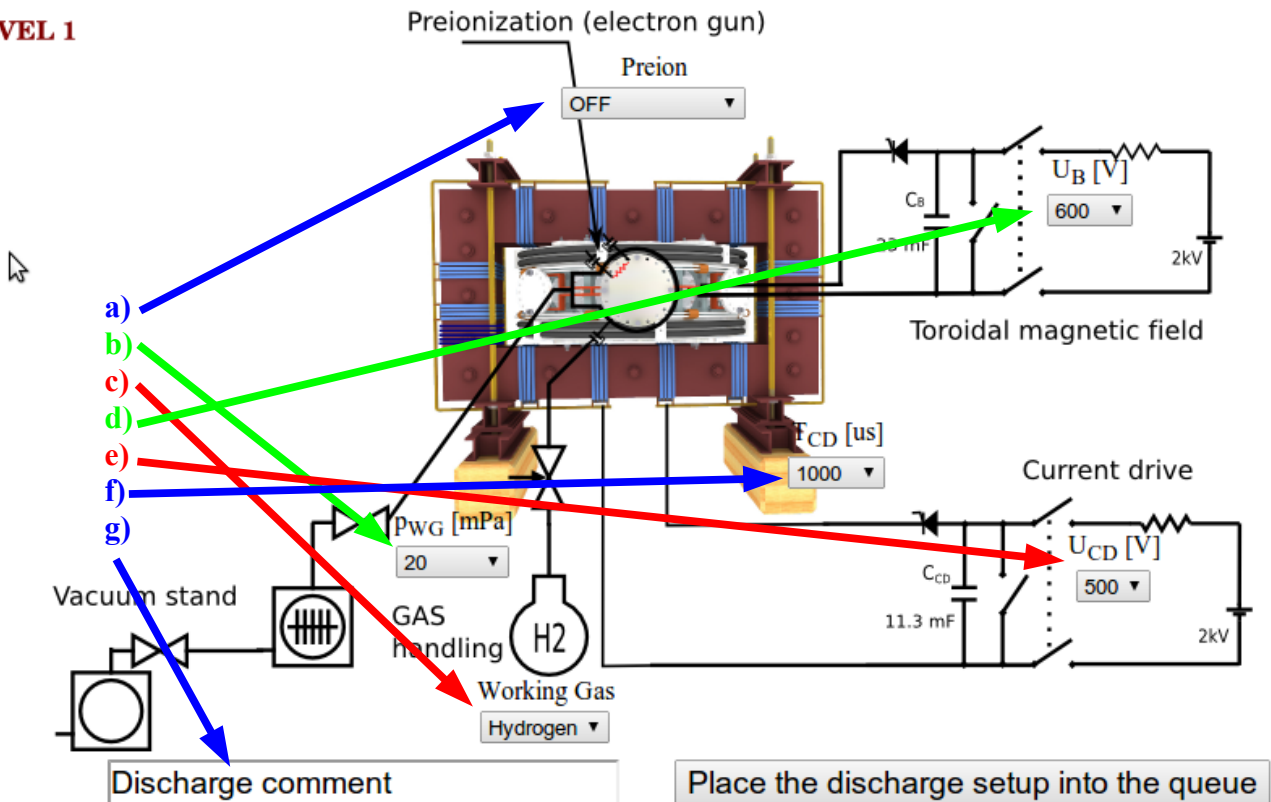
ZOOMED Control Room:

*Tokamak Golem **REMOTE** for Belgrade (Level I)*

The smallest & oldest operational tokamak with the biggest control room in the world



LEVEL 1



Step 4: WHAT CAN BE MODIFIED (letters are connected with the ones on the figure above)?

a) Preion = Preionization → {OFF (default), Top el. gun, ECRH assisted}:

Choosing type of preionization. Even though Option 'OFF' is a default, use 'Top el. gun', as this one you assure that there will be breakdown to initiate ionization of gas for creating plasma!!! Option 'ECRH assisted' is not functioning at the moment! While it is possible to create plasma with 'OFF', it is a gambling and could be a waste of discharge – thus time! ;)

b) p_{WG} [mPa] = Pressure in the vacuum vessel before the discharge → {from 1 to 100 with some steps, with 20 as default}:

Even though 20 mPa is default, pressure should be set to lower as possible. Unfortunately, there is some leak in GOLEM vessel does weeks, so there is background pressure of 11 mPa. Hence, putting under this value is nonsense. Anyway, there is plasma even with this relatively high pressure – which is enough for the current purposes! Moreover, real pressure is usually not 20 as requested, but something like 15-16 – thus better than requested ;)

c) Working Gas → {Hydrogen (default), Helium}:

Simply setting the the working gas – both are available, but maybe better to stay with the H due to the leakage...

d) U_B [V] = Voltage going through the capacitor charging the toroidal field (TF) coils → {from 50 to 1100 with step of 50 V, where 600 is default}:

This defines the strength of the toroidal magnetic field B_{tor} – higher U_B , higher B_{tor} :)

e) U_{CD} [V] = Voltage going through the capacitor charging the central solenoid → {from 50 to 700 with step of 50 V, where 500 is default}:

This defines the strength of the plasma current I_p – higher U_{CD} , higher I_p :)

f) T_{CD} [μ s] = Delay time of the central solenoid charging relative to TF coils → {from 500 to 20000 with step of 500, where 1000 is default}:

This defines delay time when the central solenoid will start to be charged relative to the starting time of charging the toroidal field coils (which is always 5 ms!!!). Higher this time, higher is the B_{tor} at the breakdown – to have maximum B_{tor} at the breakdown T_{CD} has to be set on 19000!!!

g) **DISCHARGE COMMENT:**

DO NOT FORGET ABOUT THIS ONE!!! It is very very important to write down why or what are you doing in this discharge!!! It is good for making difference after the experiments – so maybe write your name or something funny to make the discharge even more special ;)

Step 5: Give a discharge to a execution waiting list, by pressing the 'Place the discharge setup into the queue', after that you check is your discharge in the 'Queue':

Tokamak Golem **REMOTE for Belgrade (Level I)**
The smallest & oldest operational tokamak with the biggest control room in the world

LEVEL 1

Discharge comment

Place the discharge setup into the queue

One then gets this:

Where you should see all discharges in the queue and there statuses! Note that now there are none, as I did not do this PrintScreen when we really doing the experiments :D
 Anyway, once you check that there is a discharge for you – you go to the '**IP cameras**', where the live streaming of the GOLEM tokamak hall is shown (if the operation is done remotely, of course). There are two screens – one camera shows you the room with tokamak, where first blue rotating beacon light will sign the start of the discharge process and finally red rotating beacon light presents that there is only 10 s until the discharge and everybody (if anybody is still in the room) should leave the room immediately; second camera is inside the tokamak and you will see the 'Top electron gun' for preionization (if set ON) and after some time a strong flash – which is the discharge!!!
 After some time you can finally go to the '**Results**' and check what is there:

[Link to current session](#)

Identification	Submitted	U _B [V]	U _{cd} [V]	T _{cd} [us]	H ₂ [mPa]	Preion. [on/off]	Plasma [s]	Shot No	Global ShotNo	Comment
Belgrade	2015-10-01 18:08:34	1100	700	20000	->(20)	1		6777	19907	shot for Honza - all max
Belgrade	2015-10-01 18:04:32	600	650	20000	->(20)	1		6776	19906	Largest Btor with Large OH
Belgrade	2015-10-01 17:59:30	600	500	1000	->(20)	0		6775	19905	Tcd = 10ms / breakdown at max Btor
Belgrade	2015-10-01 17:58:55	600	500	10000	->(20)	1		6774	19904	Discharge comment
Belgrade	2015-10-01 17:50:52	600	600	0	->(20)	1		6773	19903	repeat previous for DAQ test
Belgrade	2015-10-01 17:41:43	600	600	0	->(20)	1		6772	19902	Zero delay - Tcd=0
Belgrade	2015-10-01 17:37:31	700	500	2000	->(20)	1		6771	19901	Higher Btor
Belgrade	2015-10-01 17:22:47	600	500	1000	->(20)	1		6770	19900	Milos playing with Honza

Here you can click on the discharge number ('Global ShotNo') and see the data!!! You all see here the shots Stockel and Milos did ;)