

The tokamak GOLEM ...for fusion education
Education

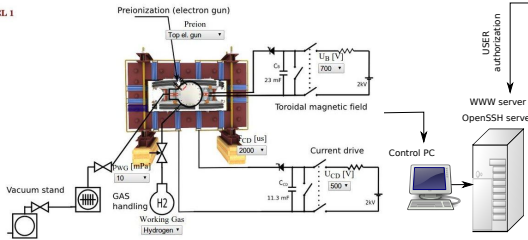
Vojtěch Svoboda
on behalf of the tokamak GOLEM team

July 29, 2017

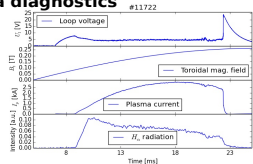
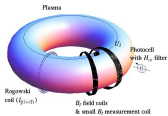
The global schematic overview of the GOLEM experiment

LEVEL 1

Tokamak technology setup



Basic plasma diagnostics



internet

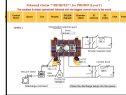
**Virtual control room
(remote participation)**

WWW control interface

Data presentation

HTML & PHP scripts

HTML (www pages)



SSH control interface

WINDOWS via putty

Data handling



- *wget
- *gnuplot
- *idl
- *mathematica
- *matlab
- *etc...

LINUX via ssh or ssh+X tunnel (advanced mode)

OpenSSH server

WWW server
OpenSSH server



Control PC

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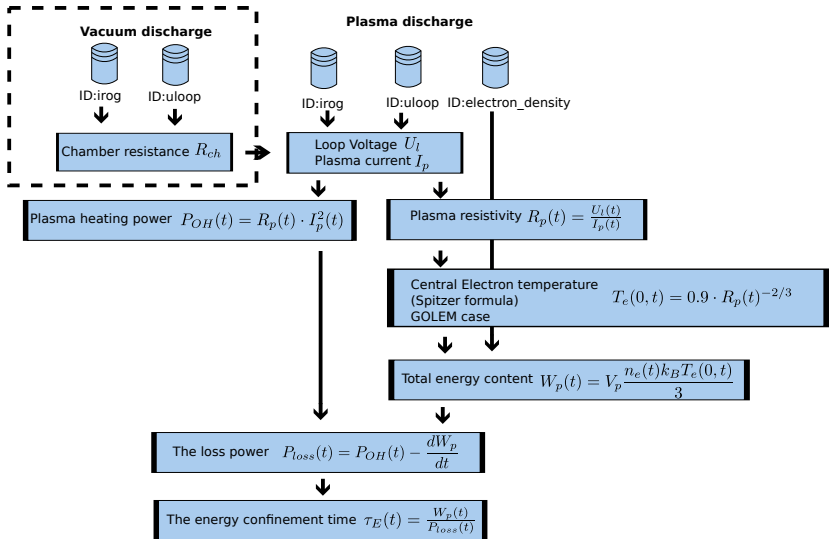
1 Hands on experiments

2 Remote experiments

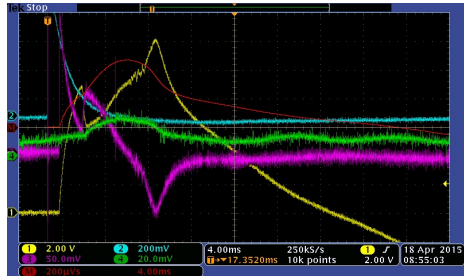
3 Virtual model

4 Appendix

Towards Energy confinement time τ_E



Hands on tokamak GOLEM

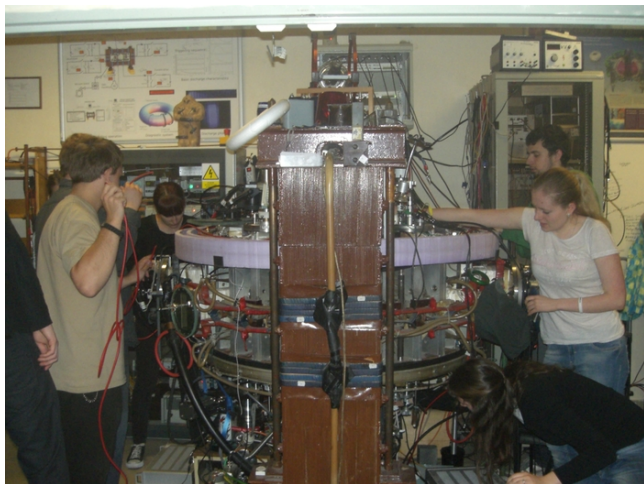


On site tokamak GOLEM controll



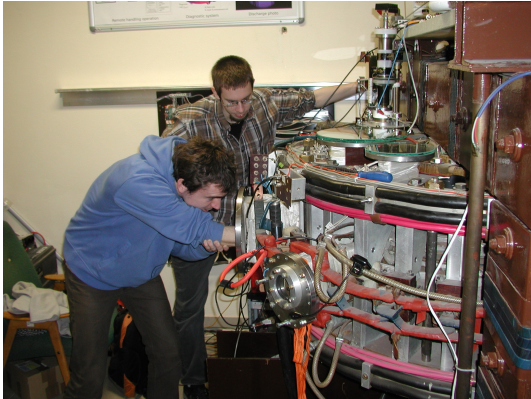
- Summer Training Course 2009-2015,2017
- Erasmus Mundus Training Course 2013-2015
- Science week 2010-2017
- Nucleus Day 2014

Hands on tokamak



- Laboratory Practice for Basic course of Physics 15,16,17
- Golem Training course 13

Bachelor & Master thesis made @ tokamak GOLEM



- **Bachelor thesis:** Magnetic field configurations and their measurement, Interactive model, Plasma flow velocity measurements using Mach probe arrays, Virtual model, Bolometric measurements, Breakdown studies, Vertical plasma stabilization.
- **Master thesis:** Microwave interferometry, Remote operation of the vertical plasma stabilization, Measurements of magnetic fields.

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2 Remote experiments

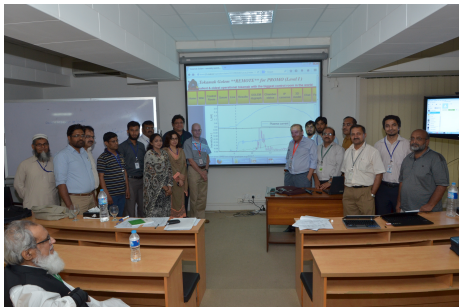
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Remote control

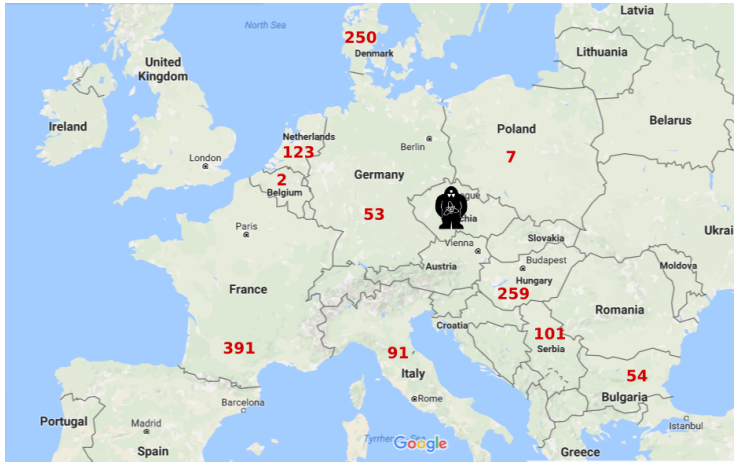


Remote controll - inventory



- Ghent University 09; TU Eindhoven 11,15,16,17; Bochum University 13; Garching 13; Lemvig High School 14; TU Kobehaven 14,15; University of Belgrade 15,16; BUTE Budapest 10,12-16; Instituto Tecnologico Costa Rica 10; University of Padova 14,16; TU Torino 16.
- French Training Course & EM 12-14,16; Bangkok 16.
- Workshops Kiten 14,16; Observatorium Valasske Mezirici 14; Islamabad 14.
- Global Tokamak Experiment 10.

Remote discharges over the Czech borders



+ IN ~ 10, + PK ~ 70, + OTHERS ~ 100

$\Sigma(09/12-02/17) \sim 1500$

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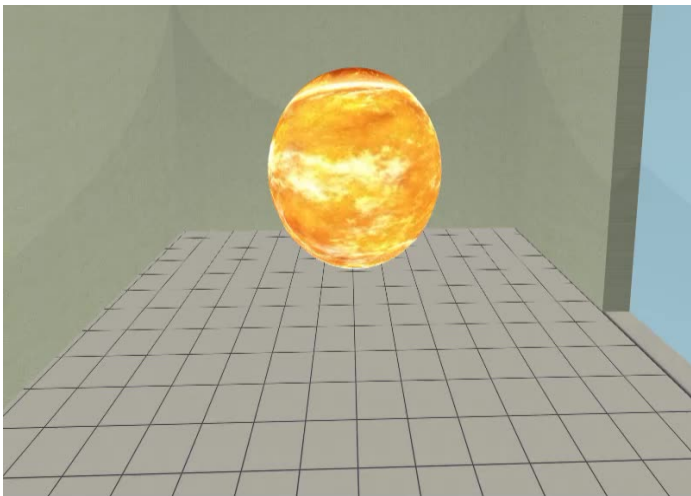
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2 Remote experiments

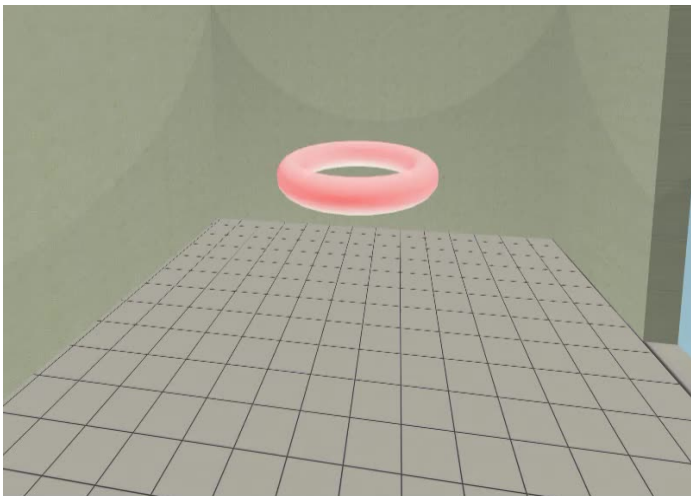
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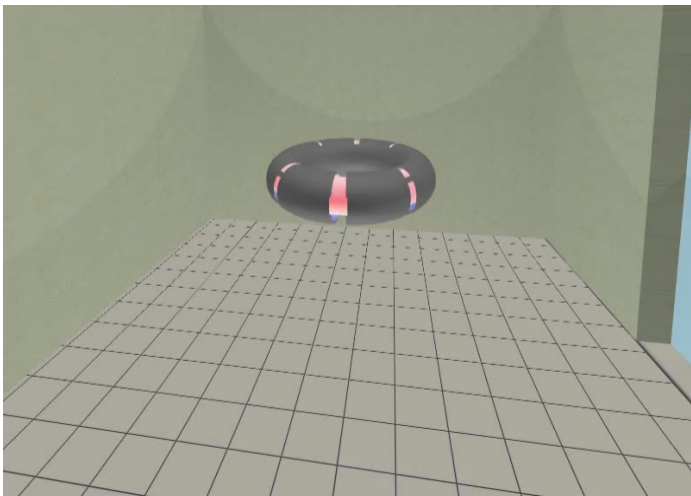
The technology to conquer: make a μ Sun on the Earth



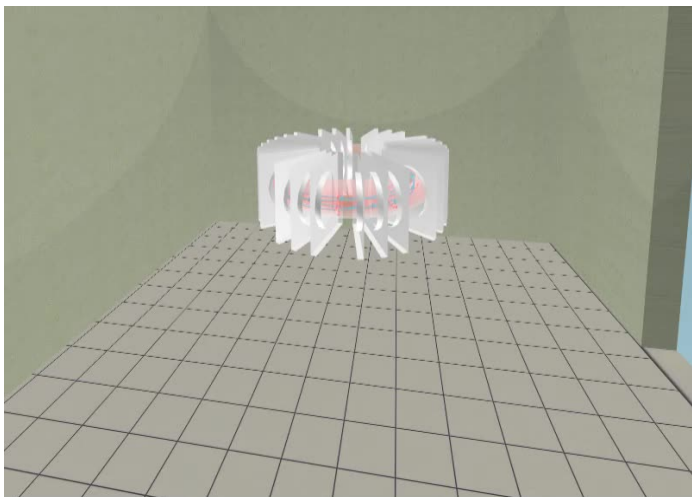
Magnetic confinement requires the toroidal geometry



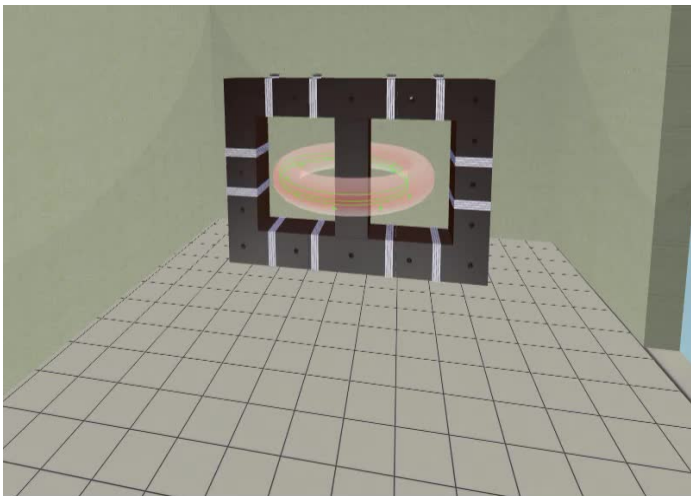
The thermonuclear reaction takes place in the chamber



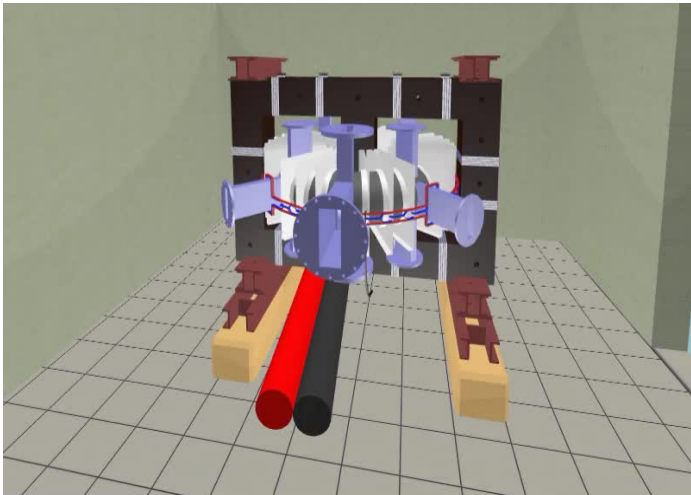
Toroidal magnetic field coils secure the plasma confinement



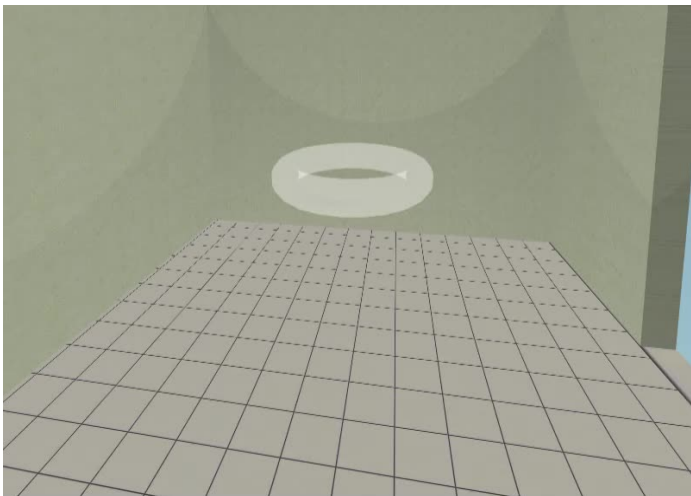
Transformer secures the plasma creation and heating



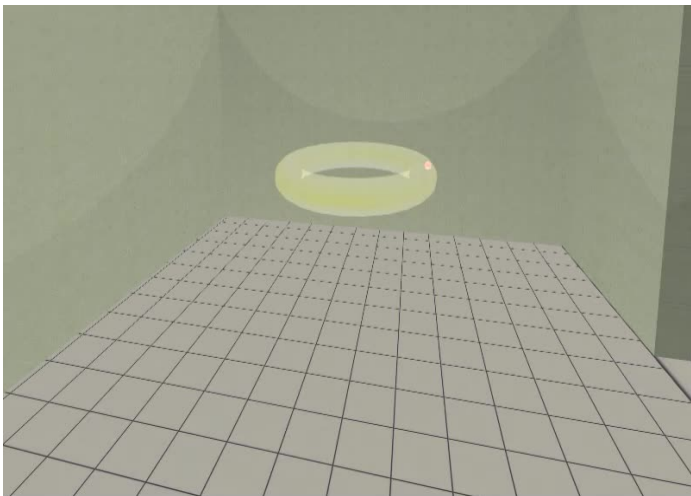
The final technology altogether



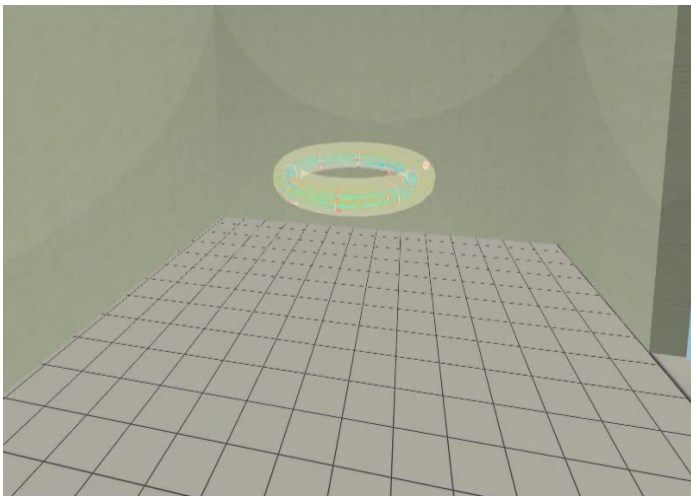
Introduce the working gas (Hydrogen x Helium)



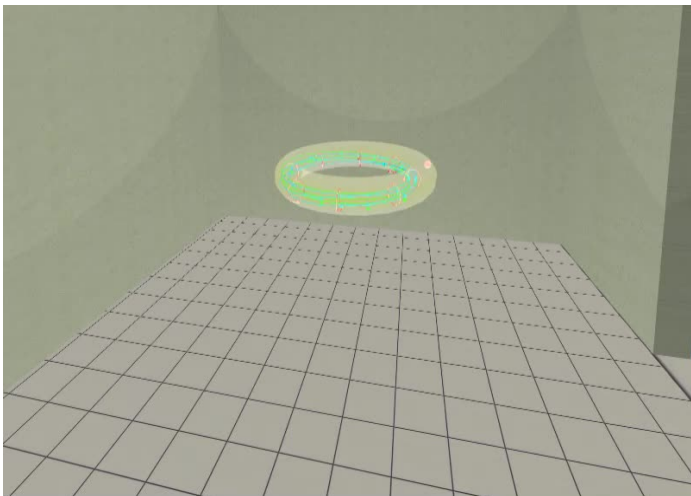
Switch on the preionization



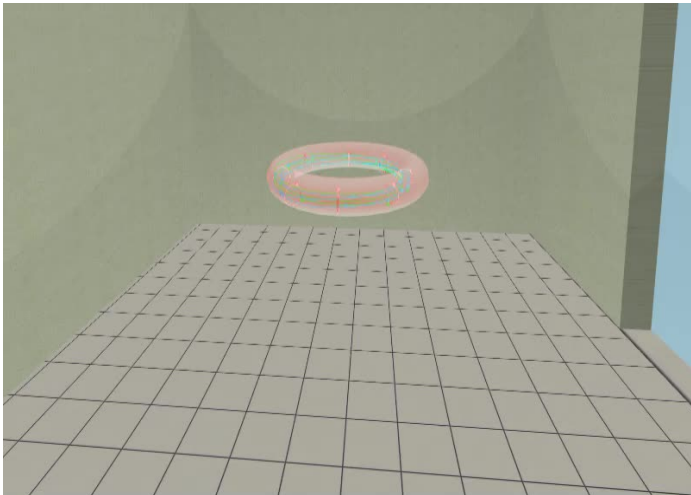
Introduce the magnetic field



Introduce the electric field



Plasma ..



The tokamak COMPASS with NBI



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References I

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References II



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