

The tokamak GOLEM CAAS report #1
08/18-01/19

Vojtěch Svoboda
on behalf of the tokamak GOLEM team

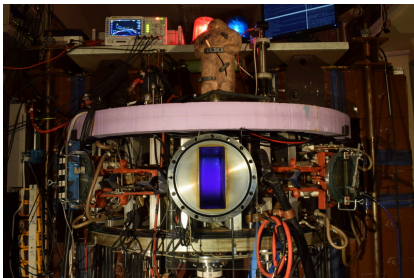
January 28, 2019

The PLASMA-C mission

- Díky unikátní výbojové opakovatelnosti 1 výstřel/minutu tokamaku GOLEM, budou měření RE se současnou časovou a prostorovou rozlišovací možností prováděna s dobrou statistikou s podporou další vhodné diagnostiky. Tato experimentální práce bude doplněna systematickým uchováváním souborů naměřených parametrů.
- Výzkum neutronů a rychlých iontů v tokamacích představuje další důležitou oblast se silně mezioborovým významem,..... Členové týmu se účastní společných evropských experimentů (MST a JET), včetně účasti na kampaních (kolem 6 ročně).
- Interpretace experimentálních výsledků získaných na PF-1000 z rekonexce magnetických silokřivek hrajících významnou roli při urychlení energetických iontů a elektronů jak v tokamakovém, laserovém tak v astrofyzikálním plazmatu.
- Závěry experimentální práce na GOLEMU a účasti na mezinárodní spolupráci budou diskutovány na konferencích a publikovány v

The GOLEM tokamak basic characteristics

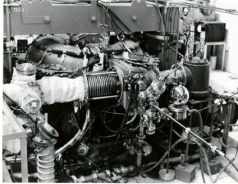
The grandfather of all tokamaks (ITER newslines 06/18)



- Vessel major radius: $R_0 = 0.4$ m
- Vessel minor radius: $r_0 = 0.1$ m
- Plasma minor radius: $a \approx 0.06$ m
- Toroidal magnetic field: $B_t < 0.5$ T
- Plasma current: $I_p < 8$ kA
- Electron density:
 $n_e \approx 0.2 - 3 \times 10^{19} \text{ m}^{-3}$
- Effective ion charge: $Z_{eff} \approx 2.5$
- Electron temperature: $T_e < 100$ eV
- Ion temperature: $T_i < 50$ eV
- Discharge duration: $\tau_p < 25$ ms
- (Electron) energy confinement time:
 $\tau_e \approx 50$ us

The GOLEM tokamak for education - historical background

Kurchatov Institute near Moscow,
Soviet Union
1960: **TM1-MH**



1974

Institute of Plasma Physics
Czech republic
CASTOR



2008

Czech Technical University Prague
Czech republic
GOLEM

Culham Centre for Fusion Energy
Great Britain
1989: **COMPASS-D**



2006

COMPASS



GOLEM

... somewhere, in the ancient cellars of Prague,

there is hidden indeed "infernal" power. Yet it is the very power of celestial stars themselves. Calmly dormant, awaiting mankind to discover the magic key, to use this power for their benefit...

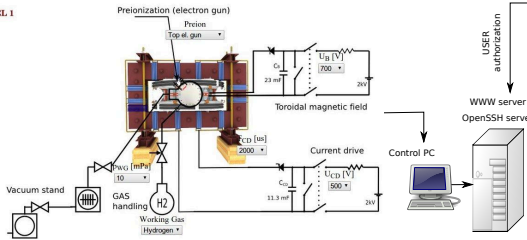


At the end of the 16th century, in the times when the Czech lands were ruled by Emperor Rudolf II, in Prague, there were Rabbi Judah Loew, well known alchemist, thinker, scholar, writer and inventor of the legendary GOLEM - a clay creature inspired with the Universe power that pursued his master's command after being brought to life with a shem, . Golem is not perceived as a symbol of evil, but rather as a symbol of power which might be useful but is very challenging to handle. To learn more of the Golem legend, see e.g. [Wikipedia/Golem](https://en.wikipedia.org/wiki/Golem).

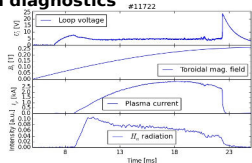
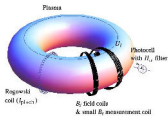
The global schematic overview of the GOLEM experiment

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

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

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

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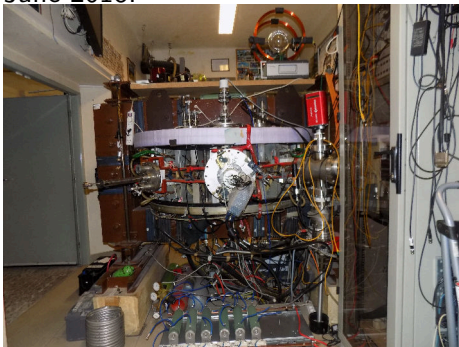
2 Diagnostics

3 Production

4 Input/Output

Reconstruction

June 2018:



October 2018:

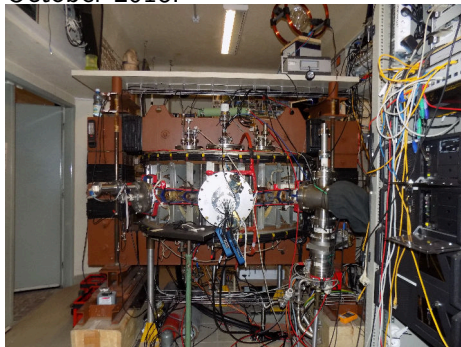


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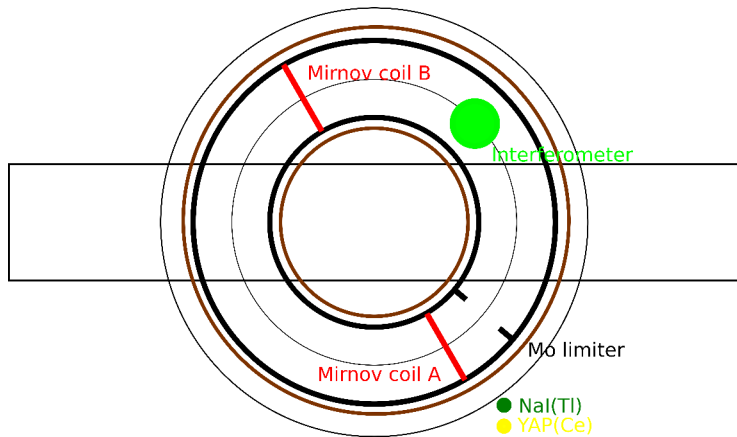
1 Tokamak GOLEM Regime

2 Diagnostics

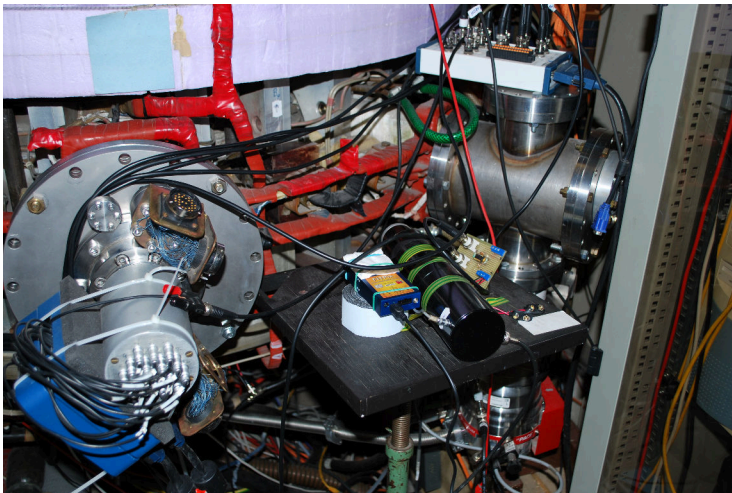
3 Production

4 Input/Output

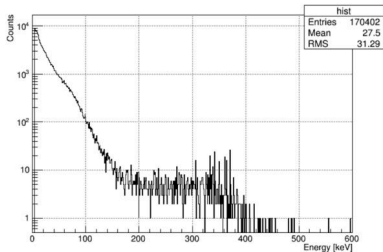
REs current Experimental setup



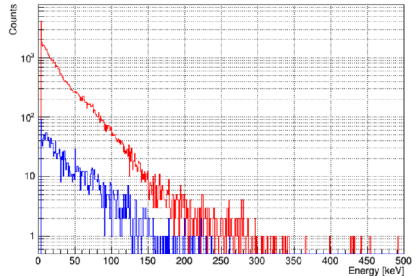
V. Linhart: Medipix probe to HXR (REs) studies



Timepix3 detector - preliminary results

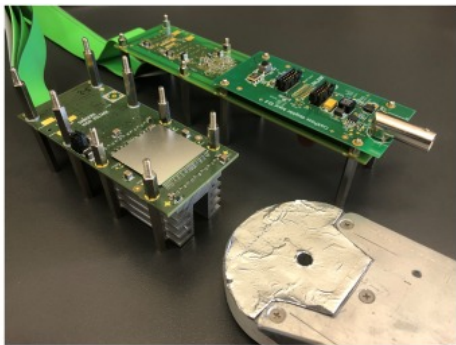


Recorded spectrum in Golem discharge # 27758 → maximum energy of RE around 500 keV?



Spectra recorded in forward and backward directions e. g. in current (blue) and co-current (red) directions → correlation with favourable direction of motion of REs

Strip detector

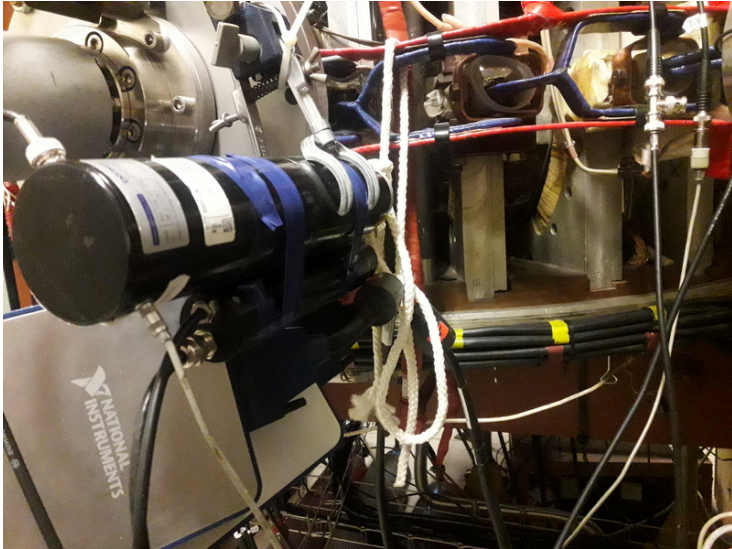


(a) Medipix2 detector with CoaXPress readout and lead pinhole, used during RE related COMPASS campaigns.

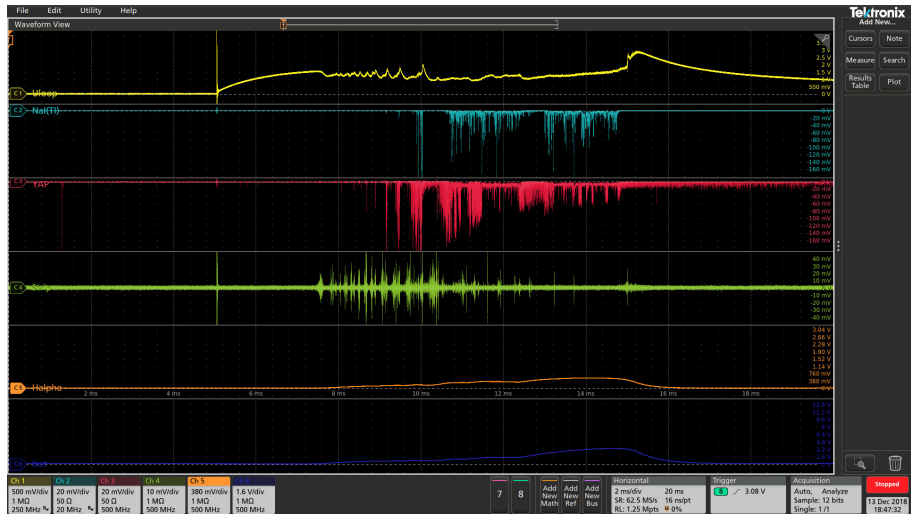


(b) PH32 detector attached to a radial manipulator, used during RE related GOLEM campaigns.

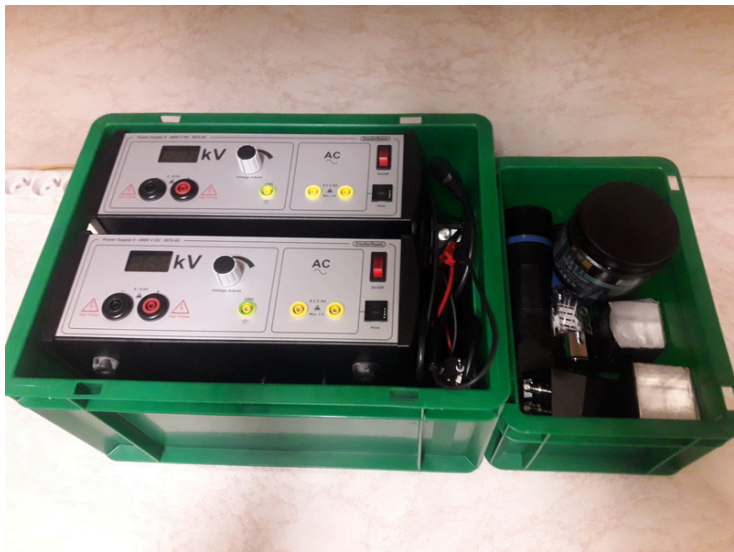
YAP and NaI(Tl)



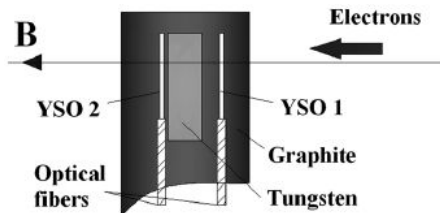
YAP & NaI(Tl) & Strip @ #28873



Plastic Scintillators to be installed



Future plans: RE direct probe (Textor inspiration)



- Probe consist from: scintillating crystals (YSO-Y₂SiO₅:Ce), optical fibres, photomultipliers,
- 5 mm thick graphite housing, second scintillator behind 8 mm of tungsten
- Graphite housing shields from ambient light and low energy particles (electrons: $\lesssim 2.5$ MeV)

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1 Postdoc : Pravesh Dhyani

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Pravesh Dhyani

at 13.89 · PhD (Physics)

Follow

Overview Contributions Info Reputation Research Interests

Introduction

Pravesh Dhyani currently works at the Department of Physics, Ulsan National Institute of Science and Technology. Pravesh does research in Plasma Physics. Their current project is 'Aditya tokamak operation and control.'

Skills and expertise (7)

View all

Numerical Simulation Plasma Plasma Physics Magnetohydrodynamics

Affiliation

Ulsan National Institute of Science and Technology

Location
Ulsan, South Korea

Department
Department of Physics

Position
Post Doctoral Researcher



12

Research Items

1,306

Reads

18

Citations

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Top co-authors (50)

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Investigation of runaway electrons at Golem

7th Meeting on Runaway Electron Modeling

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L. Novotný¹, V. Linhart¹

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² Institute of Plasma Physics, Czech Academy of Sciences, Prague



Operational domain on the GOLEM tokamak in hydrogen plasmas

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Abstract. A series of discharges in Hydrogen were performed in two experimental sessions in different tokamak vessel configurations. The vessel was not conditioned before the first session, while inductive heating of the vessel and cleaning glow discharge were applied before the second session. Experimental results from both sessions are compared, and optimum operational conditions for the majority of key plasma parameters are determined. It is found that plasma performance with a properly conditioned vessel is significantly better, as expected. In particular, a noticeable increase of discharge duration, and of the electron temperature is observed.

Keywords: tokamak, plasma, operation domains.

Acknowledgements: