Title

Golem tokamak for education and training
$\approx$ 5 years at the CTU, $\approx$ 4 years at service

Vojtěch Svoboda, et al. for IBA 2013

September 13, 2013

Outline

1 Introduction

2 Inventory 2012/2013

3 Forecast 2013/2014

Road to CTU, at the IPP (12.12.2007)

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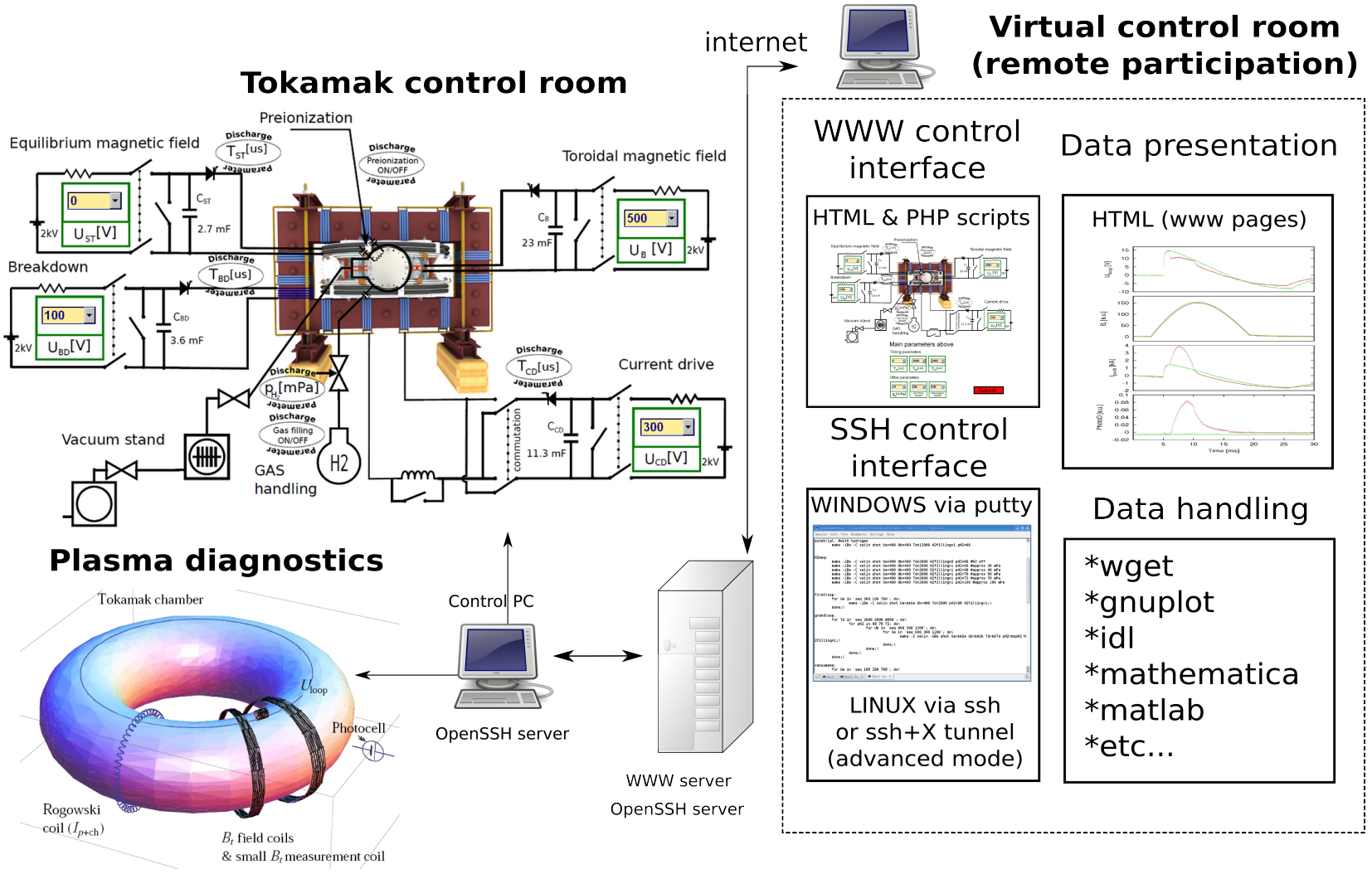
The smallest & oldest operational tokamak with the biggest control room in the world



Basic statistics up to 30.11.2012

Days from instalation: 1815.

Operational days: $\approx$ 438.

Operational hours: $\approx$ 1954.

Actual shot No: #10417.

Shots with plasma: $\approx$ 7600.

Average plasma length: $\approx$ 7 ms.

Inventory cont.

Overal plasma length: $<$ **60 s.**

Bachelor thesis: **3 completed and 2 under construction.**

Diploma thesis: **1 completed and 1 under construction.**

Training courses: **SUMTRAIC day 5x, GOMTRAIC 2x, SCIWTRAIC 3x, FUMTRAIC 2x, HUNTRAIC 2x.**

Conferences: **EPS PPCF 4x, SOFT 2x, HTPD 1x.**

Excursions: **More then 70 excursions.**

Impact articles: **3x FUSENGDES, 1x RSI.**

Remote shots from abroad: $\approx$ **700**

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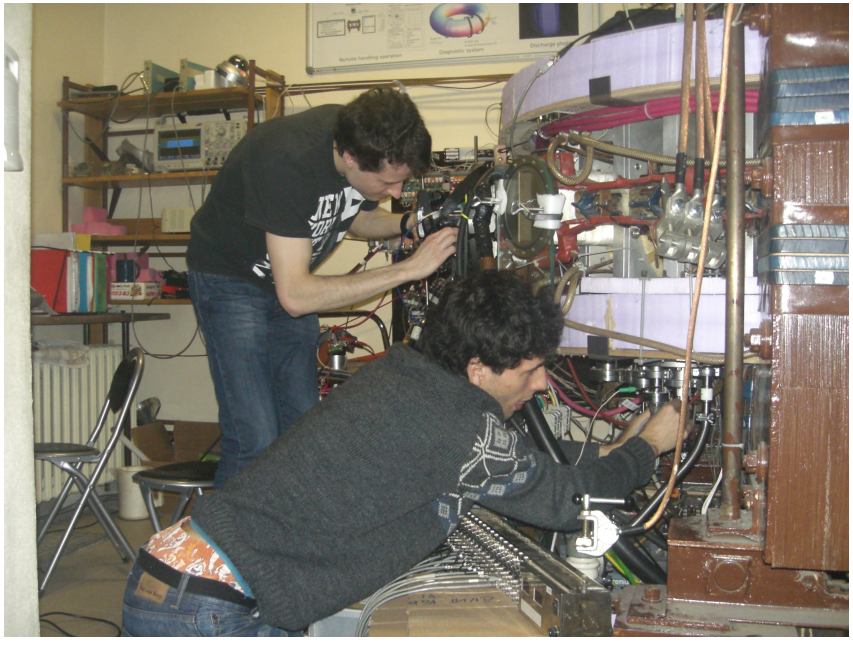
Forecast IBA, October 2012

- 10/12 Remote practica from Budapest II. .. OK
- 10/12 Remote demonstration from Trieste IAEA workshop. .. OK
- Bachelor and Diploma Thesis - cont. ... OK
- Excursions - cont. .. OK
- University of third age - cont. ... Finished
- The week of science - cont. ... OK
- GOMTRAIC II - spring 2013. ... OK
- SUMTRAIC 2013- cont. ... OK
- FUMTRAIC II - Feb. 2013. ... OK
- Remote practica.
- HTS (temporary slowed down), RF preionization .. OK, magnetic phenomena .. OK, probes measurements .. OK.

GOMTRAIC 2013 - flagship of the project



- In-situ (PERFECT) and remote (NOT SO GOOD) part.
- 7 foreign students.
- 5 Czech students (remote and in-situ) and 1 Hungarian student **as tasks supervisors**.
- MHD, Tomography, HXR, Rake probe.
- Remote shots from Costa Rica, Mexico and India.

Technological achievements

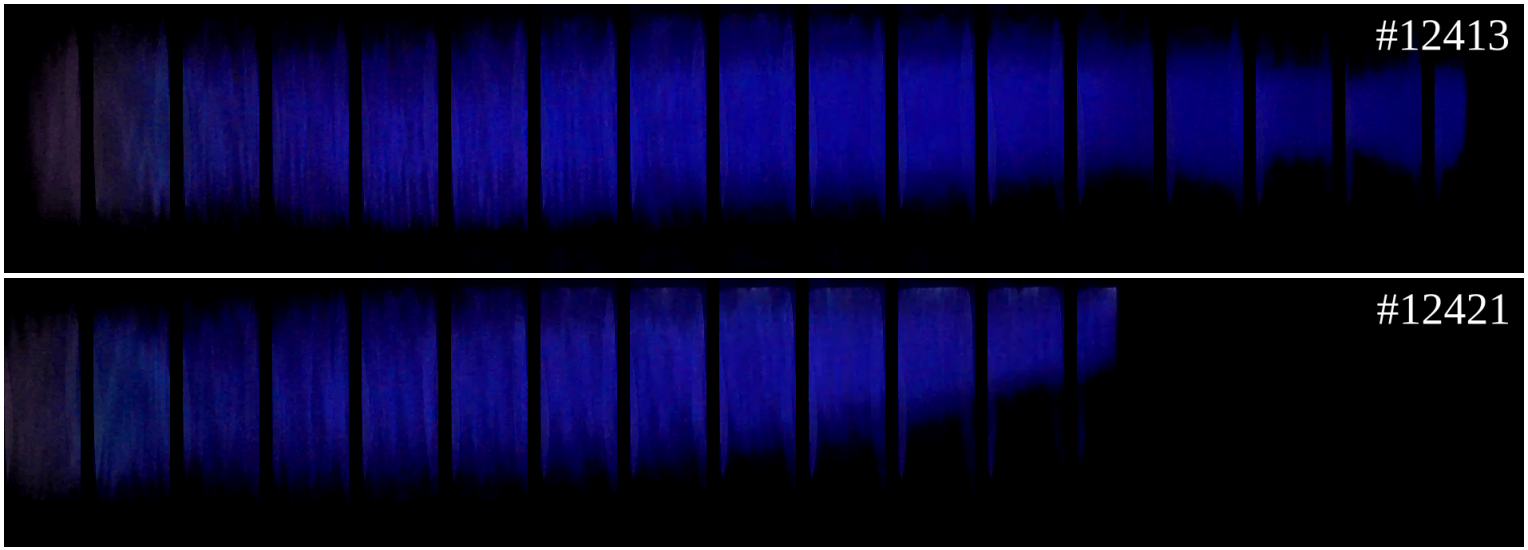
Reconstruction: from kludge to normal operation design

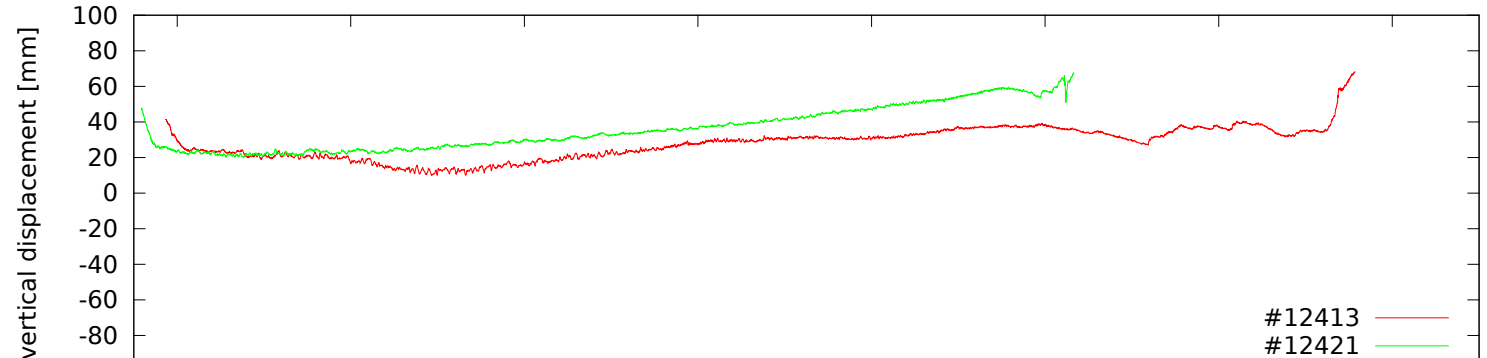
HW, control and web presentation SW (python), database oriented analysis (SQL), WIKI (gitit).

- Vertical stabilization.
- Plasma breakdown with 2.45 GHz MW launcher.
- Bottom and top preionization gunn instalation (breakdown studies).

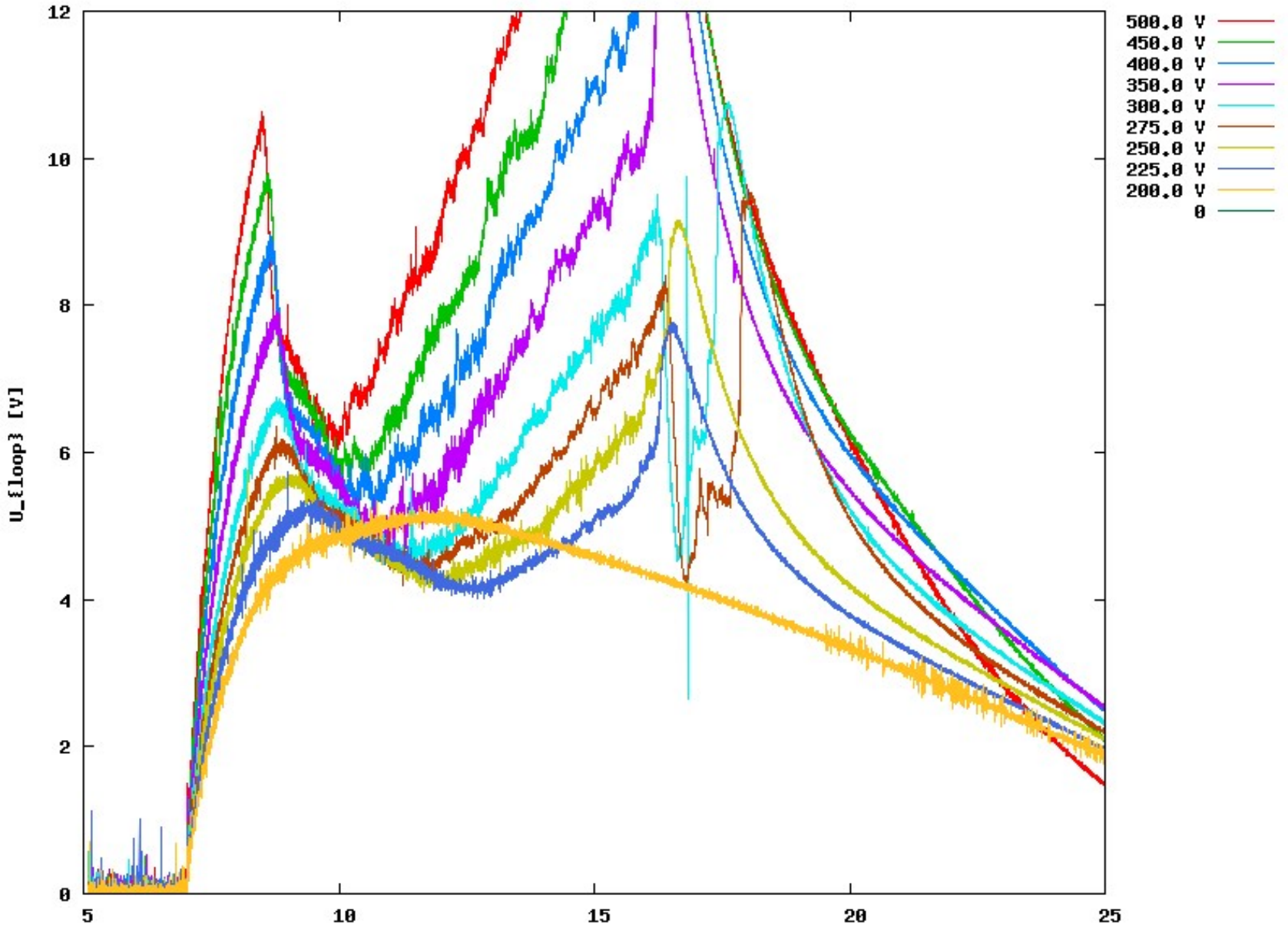
Vertical plasma stabilization

4 Mirnov coils at poloidal angles. Computer with real-time OS for calculating the plasma position with a frequency of 50 kHz. Voltage source driven by the computer controls a current in a poloidal coils. The prolongation of the plasma life was over 2 ms.



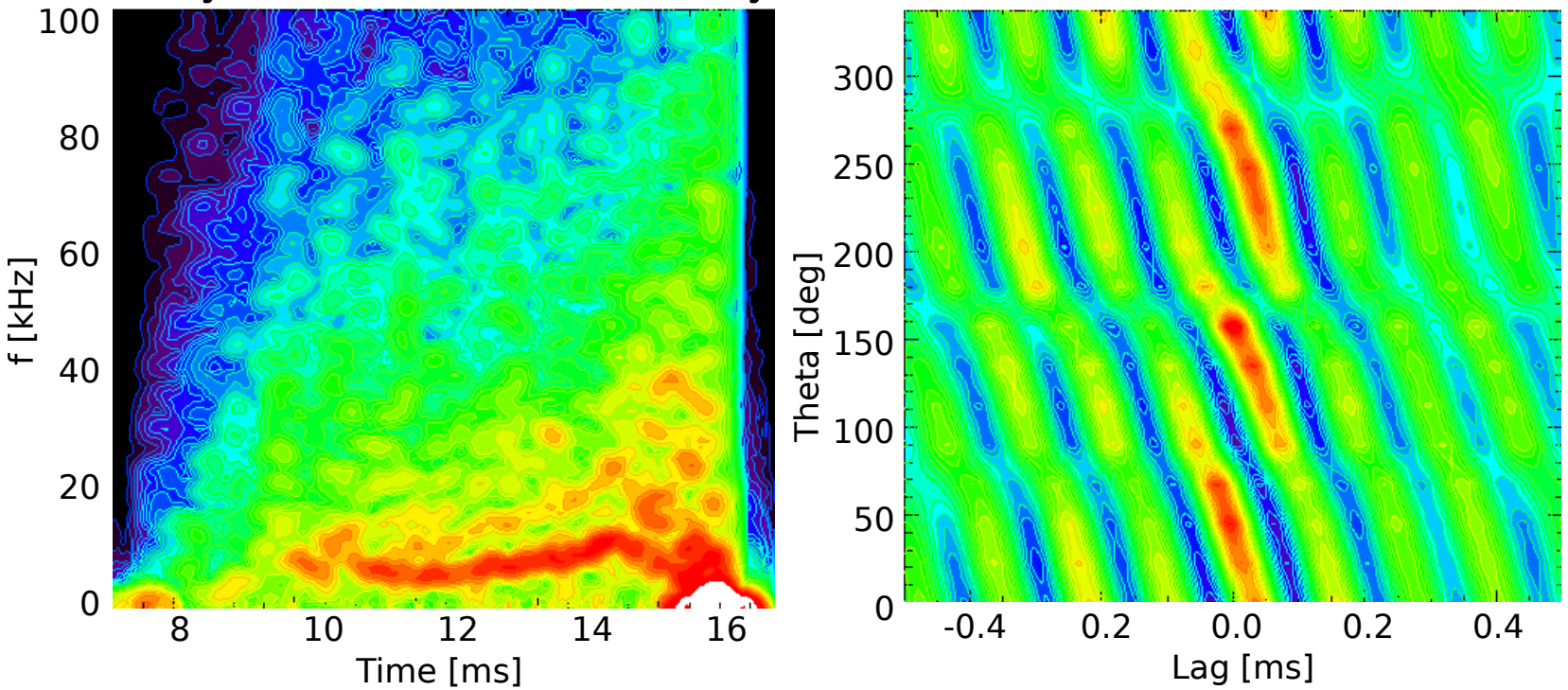


Breakdown otimization with the 2.45 GHz MW launcher



Focused topics: MHD studies

Array of 16 Mirnov coils has been instaled. Magnetic islands detected at low q regime of tokamak $m = 3$ magnetic island – shown by cross-correlation analysis of $14 - 15$ ms interval



Spectrogram of B_θ perturbations detected by a Mirnov coil located on $\theta = \pi/2$, Cross-correlation coefficients of B_θ perturbation signal on an array of 16 Mirnov coils. Reference coil chosen on $\theta = \pi/2$

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Forecast 2013/2014

- Prague Museum Night (tomorrow).
- 5 high school students in the GOLEM team.
- FUMTRAIC III, GOMTRAIC III, SCIWTRAIC IV, HUNTRAIC III, SUMTRAIC day at GOLEM VI.
- IAEA joint experiment.
- Bacheelor thesis IV, V.
- Diploma thesis II.

Technological plans and chalenges

- HW, SW, Wiki reconstruction cont.
- Both E_{CD} orientation.
- Both B_t orientation.
- Breakdown optimization cont.
- Plasma time length prolongation from 20 to 30 ms
- Horizontal stabilization.
- Firing rate $\approx$ 1 RPM.

Plans: Poloidal asymmmetries in particle flux in the SOL (R.Pitts at.al. Journal of Nuclear Materials, 1990.)

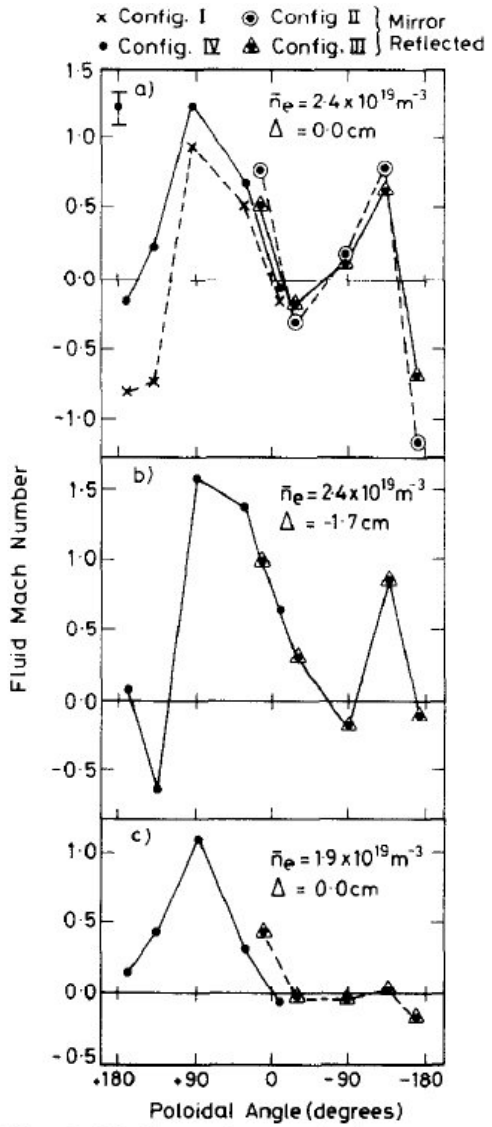
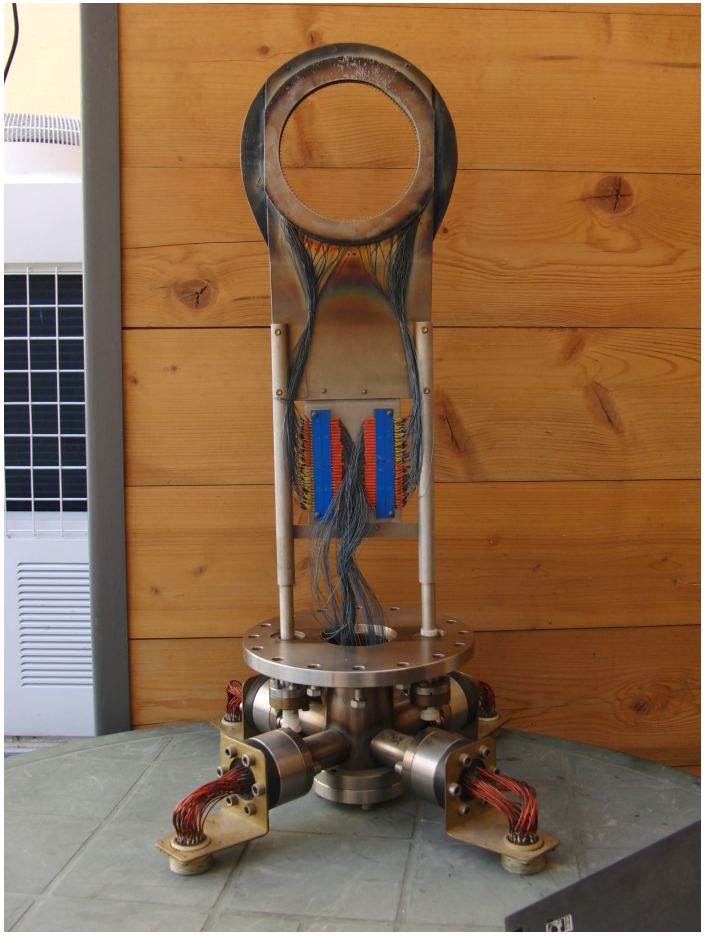


Fig. 5. Full poloidal distribution of Mach number. (a) $\bar{n}_e = 2.4 \times 10^{19}$ m^{-3}, $\Delta = 0.0$ cm, (b) $\bar{n}_e = 2.4 \times 10^{19}$ m^{-3}, $\Delta = -1.7$ cm, (c) $\bar{n}_e = 1.9 \times 10^{19}$ m^{-3}, $\Delta = 0.0$ cm.



Acknowledgement

Acknowledgement

The financial support by FUSENET, MSM 6840770039, MSM 6840770014 and A1581, SGS SGS11/131/OHK4/2T/14 is acknowledged.

Special thanks to the GOLEM team (students, teachers, technicians)

Edita Bromova, Zdenek Cespiro, Ivan Duran, Vladimir Fuchs, **Ondrej Grover**, Pavel Hacek, Billy Huang, Igor Jex, Michal Kazda, Jindrich Kocman, Martin Kubic, Ondrej Kudlacek, Petr Liska, **Tomas Markovic**, Jan Mlynar, **Michal Odstrcil**, Tomas Odstrcil, Ondrej Pluhar, Gergo Pokol, Ondrej Sebek, Michal Smid, **Gabriel Vondrasek**, Frantisek Zacek, and Jiri Zara.

GOLEM?