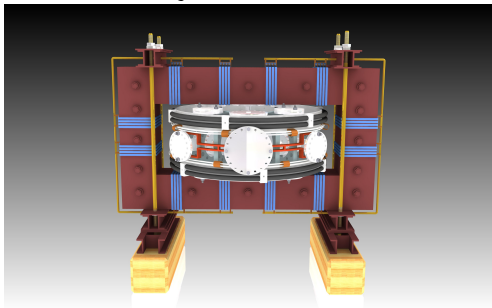


Mariánská 2012

Vojtěch Svoboda



Outline of the talk

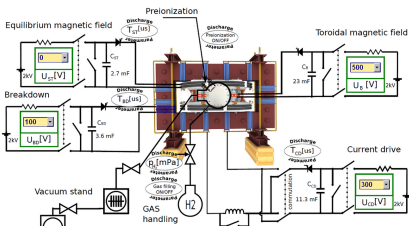
- 1 Introduction
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- 8 From the gallery
- 9 Forecast 2012

Outline

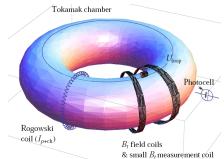
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Unique remote operation capability

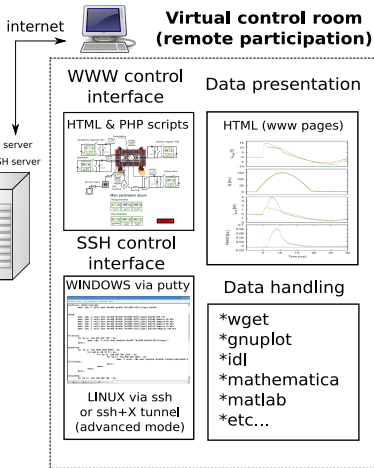
Tokamak control room



Plasma diagnostics



Virtual control room (remote participation)





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Multi-mode remote participation on the GOLEM tokamak

V. Svoboda^{a,*}, B. Huang^{d,e}, J. Mlynář^{a,b}, G.I. Pokol^c, J. Stöckel^b, G. Vondrášek^a

^a Faculty of Nuclear Sciences and Physical Engineering CTU Prague, CZ-115 19, Czech Republic

^b Institute of Plasma Physics AS CR, CZ-182 21 Prague, Czech Republic

^c Institute of Nuclear Techniques, Budapest University of Technology and Economics, Association EURATOM-HAS, H-1111 Budapest, Hungary

^d Culham Centre for Fusion Energy, OX14 3DB, Abingdon, Oxfordshire, United Kingdom

^e Department of Physics, University of Durham, South Road, Durham DH1 3LE, United Kingdom

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ABSTRACT

The GOLEM tokamak (formerly CASTOR) at Czech Technical University is demonstrated as an educational tokamak device for domestic and foreign students. Remote participation of several foreign universities (in Hungary, Belgium, Poland and Costa Rica) has been successfully performed. A unique feature of the GOLEM device is functionality which enables complete remote participation and control, solely through Internet access. Basic remote control is possible either in online mode via WWW/SSH interface or offline mode using batch processing code. Discharge parameters are set in each case to configure the tokamak for a plasma discharge. Using the X11 protocol it is possible to control in an advanced mode many technological aspects of the tokamak operation, including: i) vacuum pump initialization, ii) chamber baking, iii) charging of power supplies, iv) plasma discharge scenario, v) data acquisition system.

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Remote demonstration from Invited lecture

Remote Engineering and Virtual Instrumentation, Brasov 2011



Thomas Todd (TNT)



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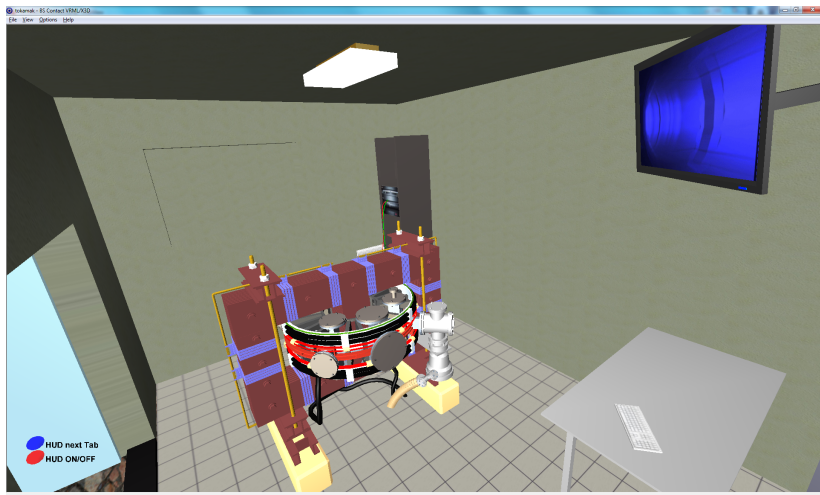
The GOLEM tokamak virtual model

An interactive 3D virtual model (VRML language) of both the tokamak hall and infrastructure room has been created.

The virtual model offers several ways to explore:

- To visit all rooms and corridors around the tokamak
- To learn components of the TOKAMAK by clicking on various virtual parts.
- To visualize processes inside the tokamak.
- To control selected processes of the real tokamak via web browser.

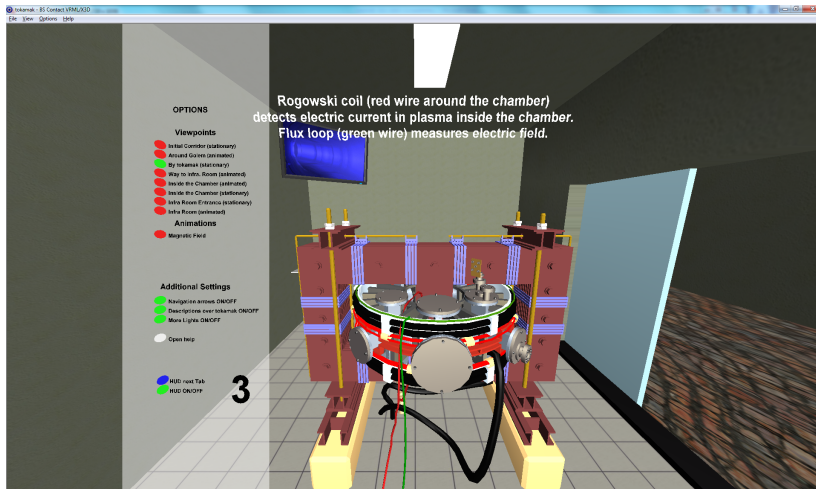
The GOLEM tokamak virtual model - Entry



The GOLEM tokamak virtual model - Power infrastructure

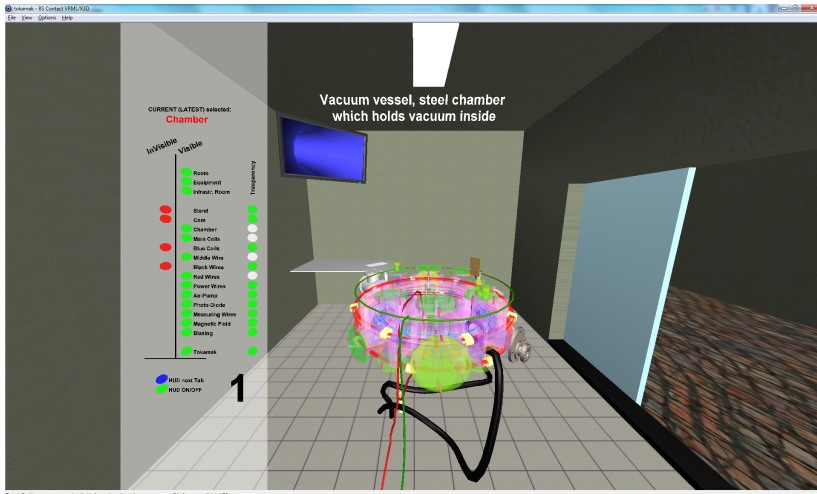


The GOLEM tokamak virtual model - Outer view

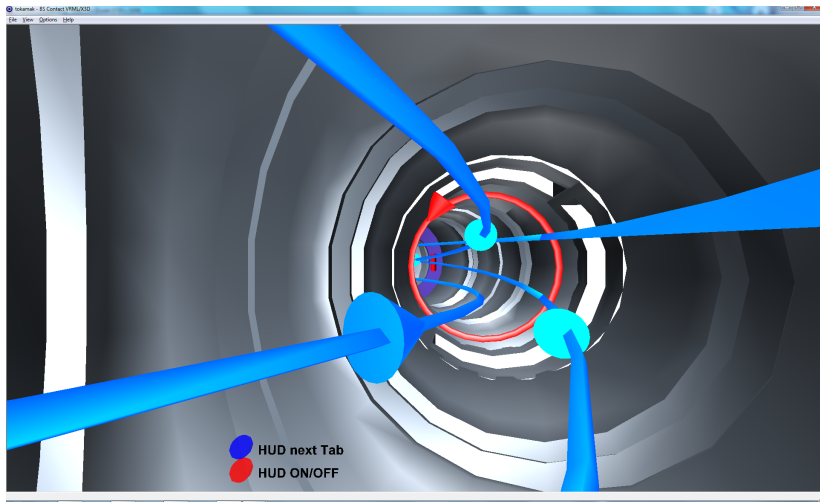


Touch Do You want to open detailed information about the diagnostics? Left mouse click is YES

The GOLEM tokamak virtual model - Inner view



The GOLEM tokamak virtual model - Chamber



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The GOLEM tokamak **virtual** Control Room - level I

Location Edit View Bookmarks Tools Settings Help

http://golem.fjfi.cvut.cz/voperation/tasks/PROMO/1212GOLEM/Level_I/exp.php

Tokamak Golem ****VIRTUAL**** for GOLEM (Level I)

Home Control Room Queue Live Results Manual

LEVEL 1

Preionization (electron gun)

Preion ON

U_B [V] 600 2kV

23 mF

Toroidal magnetic field

t_{CD} [us] 1000

Current drive

U_{CD} [V] 500 2kV

11.3 mF

P_{H_2} [mPa] 20

Vacuum stand

GAS handling

H₂

The GOLEM tokamak **virtual** Control Room - level II

Location Edit View Bookmarks Tools Settings Help

http://golem.fjfi.cvut.cz/voperation/tasks/PROMO/1212GOLEM/Level_II/exp.php

Tokamak Golem ****VIRTUAL**** for GOLEM (Level II)

Home Control Room Queue Live Results Manual

LEVEL 2

Preionization (electron gun)
Preion ON

Breakdown
 U_{BD} [V] 100 2kV
 C_{BD} 3.6 mF
 T_{BD} [us] 4000

Toroidal magnetic field
 C_s 23 mF
 U_B [V] 600 2kV

Current drive
 C_{CD} 11.3 mF
 U_{CD} [V] 500 2kV
 T_{CD} [us] 3000

Vacuum stand
 P_{H_2} [mPa] 20
GAS handling H₂

The GOLEM tokamak real Control Room

Location Edit View Bookmarks Tools Settings Help

http://golem.fjfi.cvut.cz/roperation/tasks/PROMO/1212GOLEM/Level_1/exp.php

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

Home Control Room Queue Live Results Manual

LEVEL 1

Preionization (electron gun)

Preion ON

Vacuum stand

GAS handling

P_{H_2} [mPa] 20

H_2

Toroidal magnetic field

C_b 23 mF

U_B [V] 600 2kV

Current drive

C_{cd} 11.3 mF

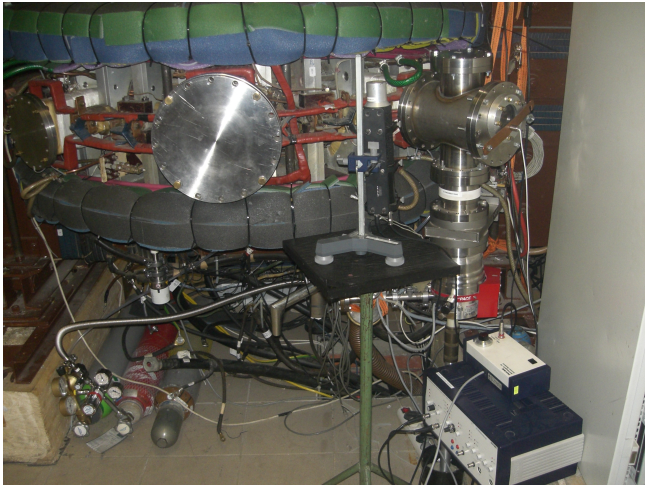
U_{CD} [V] 500 2kV

I_{CD} [us] 1000

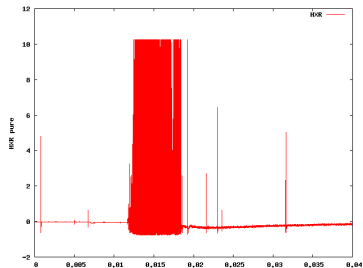
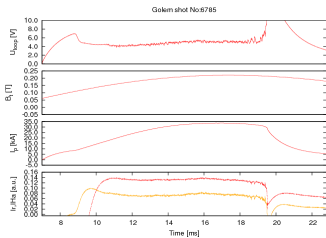
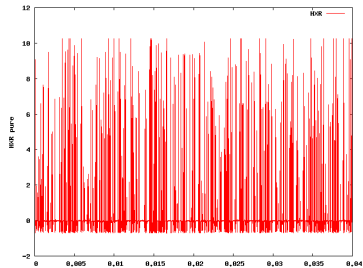
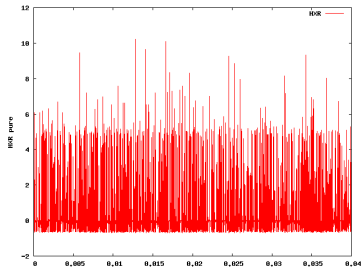
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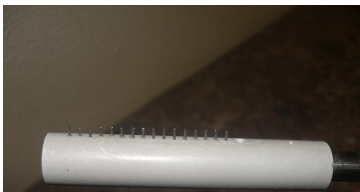
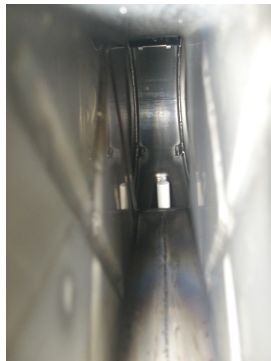
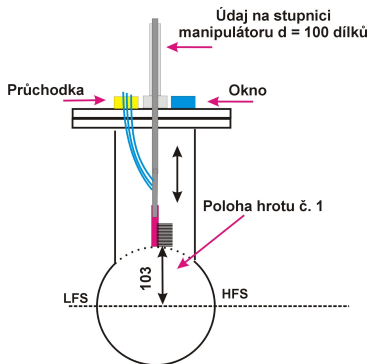
HXR (Lenka Kocmanová) (6780-6787)



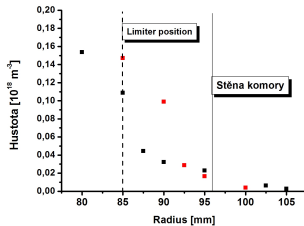
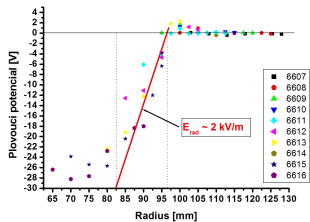
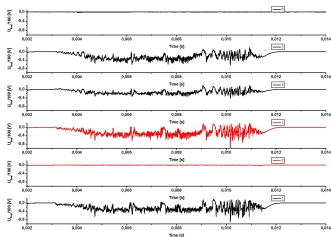
HXR (Lenka Kocmanová) (6780-6787)



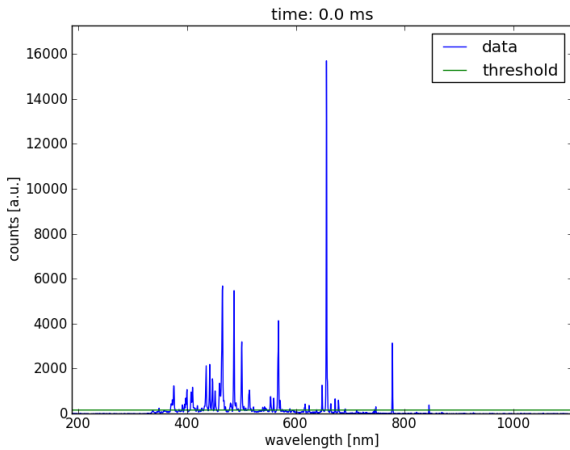
Rake probe (2012)



Rake probe (2012) - results



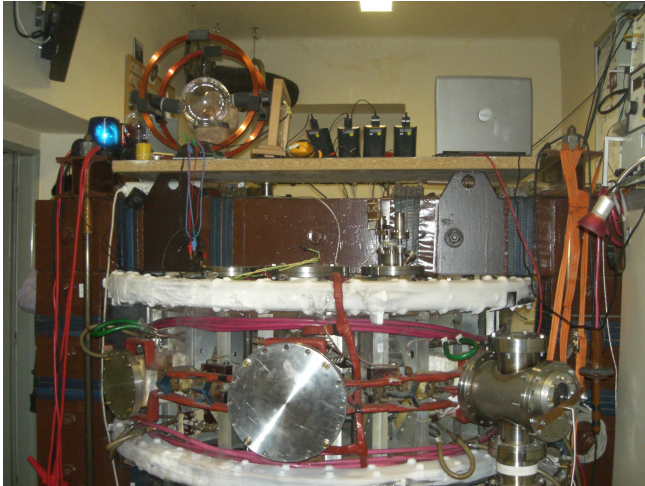
Spectra



Outline

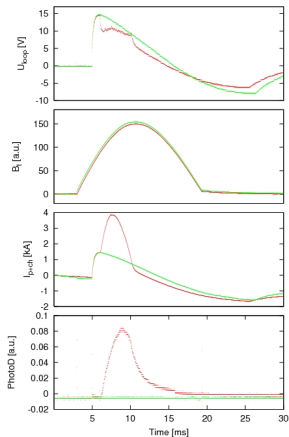
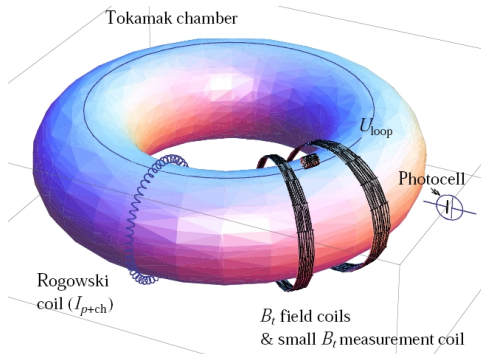
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HTS



video

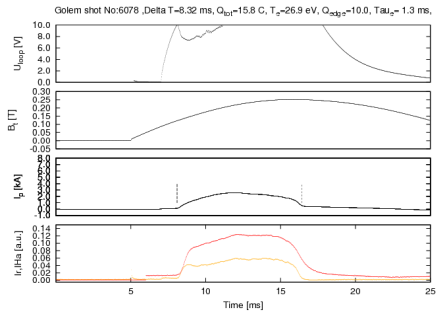
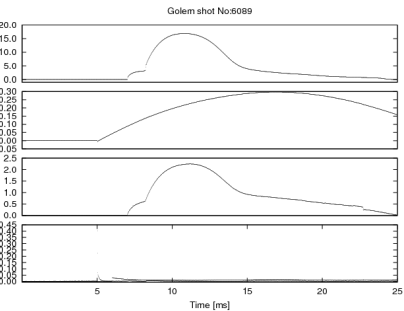
Basic plasma diagnostics in tokamak GOLEM



Data Acquisition System based on:



Hunt for quenches



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Path to science



High school students at scientific projects

- Ondrej Grover: Interferometry measurements.
- Adam Shindlery: Probes diagnostics.
- Ondrej Vrba: Radiation diagnostics.

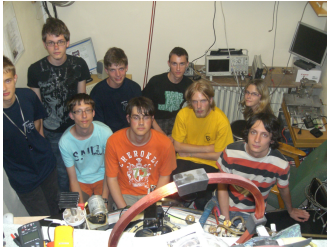
Summer Training School on Plasma Physics SUMTRAIC 2011



Bachelor thesis

- BT 2011 - DT 2012: Jindrich Kocman. Plasma position stabilization on Tokamak GOLEM
- BT 2010 - DT 2012: Tomas Markovic. Magnetic Field Configurations and Their Measurement on Tokamak GOLEM
- BT 2011: Ondrej Pluhar. Interactive model of tokamak GOLEM.
- DT 2013?: Lenka Kocmanova: HXR
- BT 2012 at FEI: Milan Hjek & Adam Fiedler: Virtual model, cont.

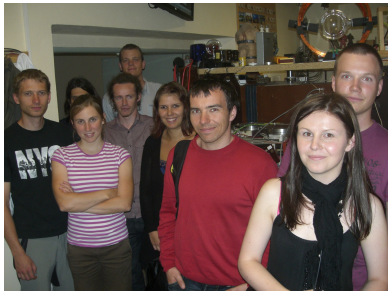
The week of Science



Microprojects

- Dynamic Stabilization of the Plasma Position in the Tokamak GOLEM.
- Plasma Position Detection with the Fast Camera on the Tokamak GOLEM.
- Learning Algorithms on the tokamak GOLEM.
- Vertical Plasma Position Detection with the Mirnov Coils.

Excursions ≈ 20



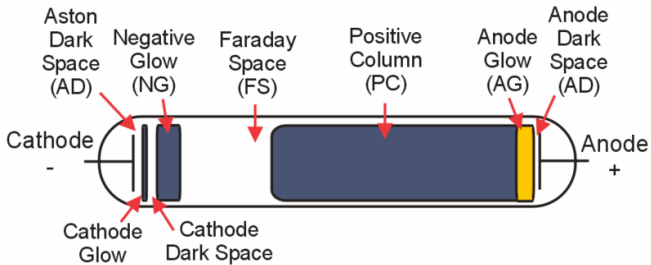
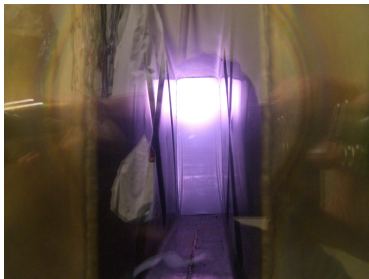
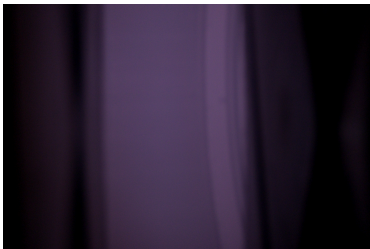
University of the 3rd age



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Glow discharge ..



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- Virtual model (2 new FEI students):
 - New components ... DAS, Control panel, Working gas management, plasma.
 - Connection to GOLEM wiki.
 - New dynamic components: Discharge process, pre/post discharge process.
 - **Automated Virtual Guide of the Tokamak.**
- He: alternative working gas
- HTS cont.

Acknowledgement

Acknowledgement

The financial support by FUSENET, MSM 6840770039, MSM 6840770014 and A1581 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, Adam Sindlery, Michal Smid, Gabriel Vondrasek, Frantisek Zacek, and Jiri Zara.

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