

title

## Educational activities @ the tokamak GOLEM

Vojtěch Svoboda

# Outline

1 2009

2 2010

3 2011

4 2012

5 2013

6 2014

7 2015

8 2016

# 08/09: SUMTRAIC #1

Summer Training Course, Prague, Czech Republic. Introductory session, more than 100 discharges performed by 17 students from 7 European countries.



# 12/09: a demo for Ghent university

GENT : Sint-Michielsbrug over de Leie  
GAND : Le Pont Saint-Michel et La Lys  
GHENT : The Saint-Michaels Bridge - The "Lys"

Dear Voijtor,  
Thank you very much for the FOLEM performance!

John Ort

CAMILLE  
Gregory  
Monta  
Klaas  
Mathias  
Tom  
Thank you!  
Frederik  
Bert  
Romain

Flavia  
Jonas  
Pieter  
Sebastien  
Bert  
Sven  
Celine  
Tyler  
Yves  
Olivier  
Lore  
Sam

Jelle  
Kevin  
Thomas  
Frédéric  
Kim  
Tine  
Ethe



# Outline

1 2009

**2 2010**

3 2011

4 2012

5 2013

6 2014

7 2015

8 2016

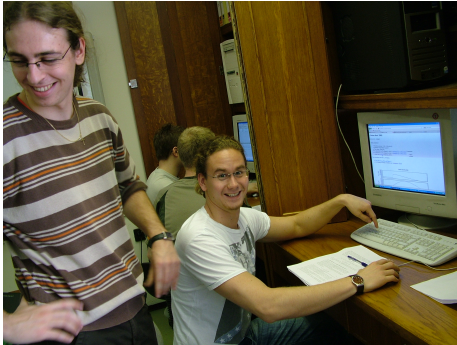
## 08/10: SUMTRAIC #2

Summer Training Course, Prague, Czech Republic. Introductory session, more than 100 discharges performed by participants from European countries.



## 03/10: HUNTRAIC #1

Hungarian Training Course for BTE Budapest. Introductory session, more than 70 discharges performed by 3 students.



Andras Karman, Gergely Klujber, Mate Ferenczy and Peter Nemetvarga :

First of all, we would like to express our gratitude for this remarkable opportunity. To perform a remote measurement on a tokamak, and to be

# 03/10: a Budapest postcard

Dear Vojtěch and  
GOLEM team!

Operating GOLEM  
from Budapest was fun,  
and we are hoping to  
do it - on a larger scale -  
in the future!

Best wishes,  
Gergő Póhal

**BROS UNIVERSAL** Bt. H-3516 Miskolc, Pesti u. 106.  
Tel.: 70/314-45-81, e-mail: brosuniversal@chello.hu



TOKAMAK GOLEM

Břehová 7.

Praha 1

CZ-115 19

CZECH REPUBLIC



## 08/10: First over sea remote from Costa Rica

participant:

Running the first touch from the Instituto Tecnológico de Costa Rica. The interface is accessible and works very well. I look forward to having my students run a session and analyse the data, and collaborate in developing this excellent project. Thank you for providing such a wonderful opportunity.

Luis D. Jimenez:

I would like to thank you for your hard work and for letting us run an experiment on GOLEM. I hope we can repeat the experience soon. It was a very tasty bit of science on the making.

Laura Barillas Mora:

I am very glad to write you on behalf of the students of the Plasma Physics Group of the Costa Rica Institute of Technology, PlasmaTEC. Thank you for letting us make some plasma shots last June 15th. from

## 12/10: Global Tokamak Experiment

In a special event called the Global Tokamak Experiment using a web based system, in over 4 hours 38 participants from 10 different countries carried out 83 plasma discharges. Due to the global nature of this experiment a security access keys (also referred to as tokens) were distributed to limit the usage of the tokamak. A login based system identified between participants, and experiment manager. Thus the machine was based in the Czech Republic, the experiment manager in the UK, and the participants in many other countries.

*It was great! .. Many thanks to Billy for the excellent site design and to Vojtech Svoboda and his team for the interesting experiment. I hope that it will ever happen again. I and another student has already been discussed the results of shots yesterday the whole evening and today, a good idea to make the discussion more global=D.*

*GTE participant*

# 12/10: ITER news hit #1



the way to new energy

china eu india japan korea russia usa

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## ITER Newsline

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## News in Brief

38th International Conference on Plasma Science (ICOPS) - Second Announcement

15th International Conference on Fusion Reactor Materials (ICFRM-15)

## Links

"InterFaces"

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"ITER on Facebook"

"ITER on YouTube"

## Conferences

# iter newsline

## Launch of the world's first global tokamak experiment

Culham Centre for Fusion Energy (CCFE) PhD student Billy Huang has set up a website for the world's first global tokamak experiment, which began today. The project allows anyone in the world with a physics background and internet access to apply to have a go at running shots on the GOLEM tokamak in Prague, a machine that has been made remotely operable by Tokamak Engineer Dr Vojtech Svoboda and his team.

"The Tokamak Global Experiment is an innovative project that gives participants the opportunity to change real parameters on a real machine, from anywhere in the world," said Billy Huang (pictured right). "Our goal with this project is to get people participating and interested in fusion research around the globe."

GOLEM is one of the oldest tokamaks in the world, originating from Russia. Although not nearly as large as JET, GOLEM still produces small amounts of fusion energy and is used as an educational device.

Promotion of this initiative, which is run in conjunction with the Institute of Plasma Physics of the Czech Republic and the Czech Technical University, is mainly targeted at university level physics students, but

03 Dec, 2010 - #156

[view printable version](#)

[<< return to Newsline #156](#)

[Fusion World](#)



# Outline

1 2009

2 2010

**3 2011**

4 2012

5 2013

6 2014

7 2015

8 2016

# 06/11: The Science week @Nuclear Faculty, CTU #1

3 groups performed more than 50 discharges.



## 08/11: SUMTRAIC #3

Summer Training Course, Prague, Czech Republic. Introductory session, more than 100 discharges performed by participants from European countries.



11/11: remote from Eindhoven

# Outline

1 2009

2 2010

3 2011

**4 2012**

5 2013

6 2014

7 2015

8 2016



# LC NEWSLINE

THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

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CURRENT ISSUE  
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## Timely Technical Review

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Barry Barish | 12 January 2012



*The GOLEM Tokamak at the Czech Technical University.  
Image: FNSPE*

While in Prague, I also was invited to give a special general lecture at the Czech Technical University and while there was given a tour of the **GOLEM Tokamak**. This tokamak – a device that confines plasma in a toroidal shape – has an exceptional history. It was constructed in 1960 in Moscow under the name TM-1 as one of the first tokamaks built and is now the oldest tokamak in operation in the world. It serves as part of the fusion science programme as a learning device in a field that is now building the very large international project ITER, a step towards eventually creating fusion energy. An interesting feature of the GOLEM setup is that it is used remotely as a teaching instrument through their website.

# 10/12: Joint ICTP-IAEA College on Plasma Physics @Trieste

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**International Centre  
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## Support

[smr2369@ictp.it](mailto:smr2369@ictp.it)

## Introduction to remote experiments on the GOLEM tokamak

### Place

Location: Trieste - Italy

Date: 2 Oct 11:20 - 12:20

[Timetable](#) | [Contribution List](#)

Tue 02/10

[Print](#) [Full screen](#) [Filter](#)

11:00

### Introduction to remote experiments on the GOLEM tokamak JAN STOCKEL

12:00

Leonardo da Vinci Building Main Lecture Hall, Trieste - Italy

11:20 - 12:20

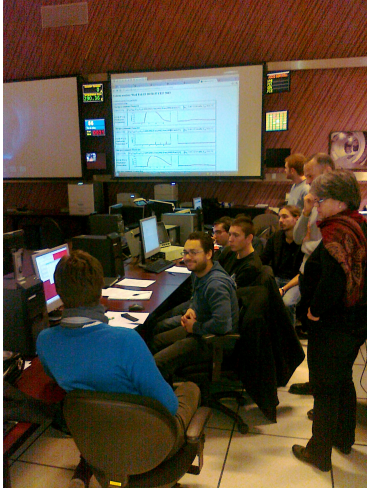
[PDF](#) | [iCal](#)

## Organizers

Directors: S. Mahajan, Z.  
Yoshida, R. Kamendje  
(IAEA), D. Gomez-Local  
Organiser: J. Niemela

# 02/12: FUMTRAIC - French fusion masters training course #1

a whole week event in Cadarache



*I just wanted to thank you for coming in Cadarache to introduce us to the amazing work you've done with the GOLEM*



the way to new energy

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"Limitless Power"

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"Worldwide Fusion Links"

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Conferences

18 May - 22 May, 2015

Plasma Facing Materials & Components for fusion applications

Aix-en-Provence, France

20 May - 22 May, 2015

EST-Energy 2015  
Karlsruhe, Germany

31 May - 04 Jun, 2015

Symposium on Fusion

## iter newsline

### Students command 100 plasma pulses, remotely

-Remy Guirlet, CEA

Participants in the French Master's in Fusion Science program have been hard at work since early February at the nearby IRFM (Institut de Recherche sur la Fusion Magnétique), participating in hands-on workshops and attending specialized lectures on magnetic fusion (see Newsline 208).

For the 2012 edition of this annual intensive program a new hands-on project was proposed: taking control—remotely—of the Czech tokamak GOLEM.

The GOLEM Tokamak, formerly CASTOR, was re-installed in 2009 at the Czech Technical University (CTU) in Prague by Dr. V. Svoboda and his students. The Czech team has implemented a reliable and user-friendly interface with the tokamak control and data acquisition systems, allowing graduate and post-graduate students to become acquainted with the operation of a small tokamak and to propose and perform experiments.

Under the supervision of Dr. Svoboda, GOLEM was (almost) exclusively in the students' hands for one week. More than 100 plasma pulses were performed. By groups of two or three, students studied plasma parameters' roles on performance and worked to optimize parameters to achieve the longest plasma. They also investigated conditioning techniques, ion mass number effects, and energy confinement time. Following data analysis and questioning, students presented the scientific results of their experiments at the end of their hands-on session.

The [Master des Sciences de la Fusion](#) is a collaborative training program sponsored by major French institutions of higher education (Aix-Marseille, Bordeaux, Nancy and Paris-Sud Universities, Ecole Polytechnique and CEA-INSTN). Next year's February gathering is expected to draw 40 students. Including students from the pan-European [Erasmus Mundus Master](#)

08 Mar, 2012 - #213

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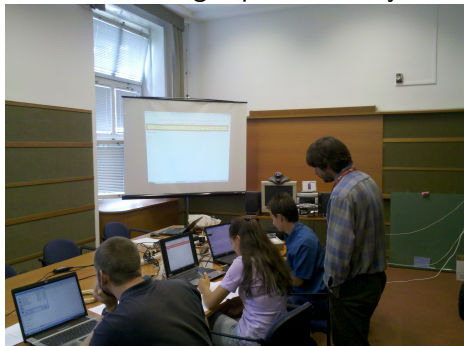
Fusion World



Putting theoretical knowledge to the test and "driving" a real machine.

## 05/12: HUNTRAIC #2

Hungarian Training Course for BTE Budapest. Introductory session, more than 90 discharges performed by 3 students.



Annamária Kéri, Máté Halász, Márton Horváth:

Dear Vojtech, We would like to kindly thank you for the opportunity and your assistance during our laboratory exercise. We learned much about the basics of fusion technology, with special attention to tokamak devices, and

# 02-05/12: GOMTRAIC (GOLEM training course) #1

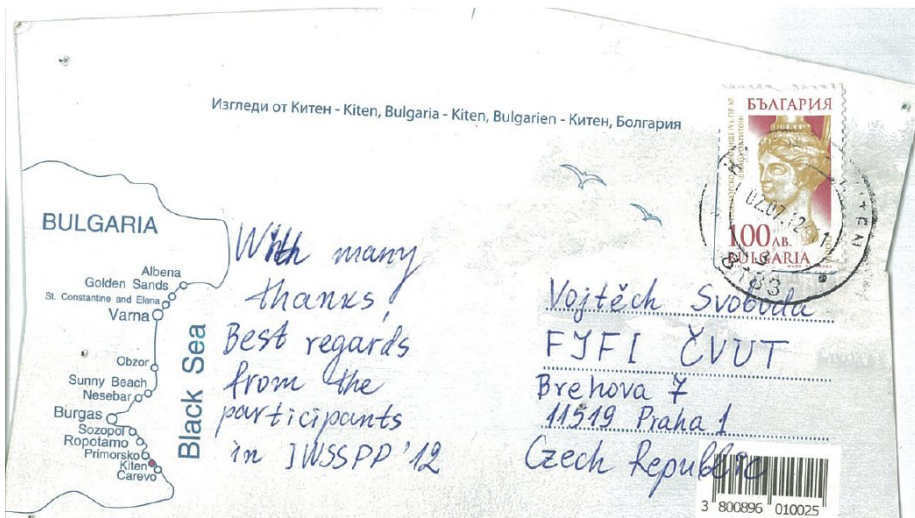


participant:

... It was wonderful experience for me to do experiment under your guidance. I thank you, the GOLEM team again for yesterday's rack probe experiments. We will thoroughly analyse the shots. ...

# 06/12: the 5th International Workshop and Summer School on Plasma Physics. Kiten, Bulgaria

Introductory session, more than 80 discharges performed by 21 students from 5 European countries.



## 08/12: SUMTRAIC #4

participant:

Experimentation regarding the optimization of operating parameter was good. Data analysis on the basis of set parameters provide opportunity explore the magnetic fusion physics.



# Outline

1 2009

2 2010

3 2011

4 2012

**5 2013**

6 2014

7 2015

8 2016

## 02/13: Remote from Cadarache #2



# 05/13: GOMTRAC #2





[RUB](#) - [Physik](#) - [Fakultät](#)

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SCHÜLER\*INNEN

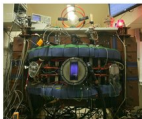
## Aktuelle News und Meldungen

Aus dem Bereich Physik und Astronomie

Ältere Meldungen finden Sie im [News-Archiv](#).

### 15.07.2013: Studierende der Vorlesung „Einführung in die Plasmaphysik“ steuern den Tokamak GOLEM in Prag

Im Sommersemester 2013 hat Prof. Dr. Jan Benedikt den Studierende der Vorlesung „Einführung in die Plasmaphysik“ ermöglicht, das Plasma-Experiment GOLEM an der Universität in Prag von Bochum aus zu steuern.



[english version](#)

Im Sommersemester 2013 hat Prof. Dr. Jan Benedikt den Studierende der Vorlesung „Einführung in die Plasmaphysik“ ermöglicht, das Plasma-Experiment GOLEM an der Tschechischen Technischen Universität in Prag (CTU) von Bochum aus zu steuern und mehr über dessen Funktionsprinzip zu lernen. Zuerst fand eine „Begehung“ des Institutes und dessen Räumlichkeiten als 3D Modell statt. Dort kann der Tokamak virtuell in seine Einzelteile zerlegt und betrachtet



# 07/13: a postcard from Bochum

Schöne Grüße aus Bochum

**PRIORITY**  
PRIORITAIRE / LUFTPOST

BRIEF  
mb  
13-7 13



Christoph  
Jakob  
Christopher  
Simon  
Carsten  
Paschal  
Thomas  
Pica  
Theresa  
Katharina  
Fabian  
Jan  
Lars  
Fabian

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Vojtěch Svoboda  
KPFJFI ČVUT  
Břehová 7  
115 19, Praha 1  
Tschechische Rep.

Ahoj Vojto, teď posílám  
slibený pohled. Akce měla  
veliké úspěchy! Honza



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Deutschland ist schön – wir zeigen es!

# 10/13: a demo for PhD students in Garching

Schöne Grüße aus München  
Stadtpanorama mit Alpenkette

THANK YOU FOR THE REMOTE  
SESSION!

Andra Hvalbyrd

Patriot

Many <sup>Diach</sup> Thanks!  
Visary

Pietro Rotter

Davidson

Christina



Briefzentrum

**PRIORITY**  
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VOSTĚCH SVOBODA

BŘEHOVÁ 7

110 00 PRAHA 1

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Foto: H. P. Welte

Deutschland ist schön – wir zeigen es!



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# 12/13: EMTRAIC #1 (Erasmus Mundus Training course)

DEAR VOJTECH SVOBODA,  
Thank you very  
much for having us  
at Golem. It was a  
pleasure. We will  
recommend the online  
control room to others.  
Best wishes,  
Steph  
Thomas



Agencija ProVis - Nova stereometrija dolgoram vrtionum, 1615; © www.AgencijaProVis.cz

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*IFA TRAINNA Florent*

# Outline

1 2009

2 2010

3 2011

4 2012

5 2013

**6 2014**

7 2015

8 2016



## 02/14: Remote from Cadarache #3



# 02-05/14: the GOLEM serves as practice lab in the basic course of physics @CTU

## Vysokoteplotní plazma na tokamaku GOLEM

Skupina tokamaku GOLEM

Verze: 20. března 2014

### 1 Pomůcky

Zařízení pro generaci a udržení vysokoteplotního plazmatu - tokamak GOLEM, pracovní plyn - vodík,  $T_i$  cívka,  $B_z$  cívka, Rogovského pásek, fotodioda,  $H_\alpha$  filtr, měřela vakua, datový sběr, osciloskop Tektronix.

### 2 Teoretický úvod

Nutno na začátku zdůraznit, že následující výklad je velmi strohou zkratkou fyzikálně-technologické problematiky zvládnutí řízené termojaderné fáze v obdobích s magnetickým uchráněním - tokamacích - v posuzovaných podmínkách.

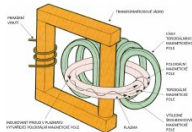
#### 2.1 Plazma

Plazma je kvazineutrální plyn vzniklý ionizací atomů neutrálního plynu. Skládá se tedy ze dvou hlavních složek, elektronů a iontů. Většina iontů pochází z pracovního plynu, např. vodíku. V reálném plazmatu je přítomné také malé, ale nezanedbatelné množství nečistot, jako je dusík, kyslík anebo uhlík. Vlastnosti plazmatu se v mnoha ohledech liší od klasického plynu, především kvůli rozdílnému typu interakcí. Zatímco v klasickém plynu dochází spravidla k lokálním srážkám pouze dvou částic, jednotlivé části plazmatu spolu v tokamaku interagují prostřednictvím dalekodosahových magnetických a elektrických polí, takže na každou částici najednou působí velké množství jiných částic na vzdálenosti řádově až metry. Kvazineutrálnost se rozumí, že makroskopický náboj plazmatu je nulový, a kolektivní chování považujeme na reakci plazmatu na přítomnost elektromagnetických polí jako celek. Důsledkem tohoto chování jsou uzákladní vlastnosti plazmatu, z nichž mnohá je stále ne úplně pochopena a jsou součástí intenzivního vědeckého výzkumu.

#### 2.2 Tokamak

Hlavním cílem řádného výzkumu je vytvoření a udržení vysokoteplotního plazmatu. Mělo by zde docházet k jaderné fúzi, a obsažení lehkých jader na tezi za uvolnění velkého množství energie přeměnou jaderých vazebných síl. Takové zařízení by mohlo v budoucnu sloužit jako prakticky nevyčerpatelný, bezpečný a co do odpadu téměř neškodný zdroj energie pro lidstvo. Technologické řešení tohoto úkolu vyžaduje splnění několika nesnadných úkolů:

1. Zahřátí paliva na požadovanou teplotu řádově několika stupňů Celsia, což je dosaženo aplikací ohmického ohřevu, ohřevu elektromagnetickými vlnami a vhodně frekvencí a také vstříknutím svazků velmi rychlých neutrálních částic.
2. Zahřátí kontaktů takto horlé látky (plazmatu) se stěnou reaktoru, což je dosaženo vhodnou konfigurací komory a tvary magnetického pole.



Obrázek 1: Základní schéma tokamaku. Převzato z [4].

Typickým zařízením na generaci a studium vysokoteplotního plazmatu je tokamak (Obr. 1). Jde o transformátor, jehož jediným sekundárním závitem (nukleáru) je vysokoteplotní - a tedy dobře vodivé - plazma. Plazma je uzavřeno ve vakuové nádobě tvaru toroidu, na které je navinuta cívka vytvářející pesterňové (toroidální) magnetické pole. Základní princip fungování tokamaku je založen na aplikaci Maxwellových rovnic v integrálním tvaru, viz např. Štol [13].

# 03/14: Demo for Lemvig high school

Lemvig Kirke

Greeting from Lemvig!

Kristen Pedersen  
Charlotte Callisen

Pearl S. Dreyberg

Paul Oles

Pammar G. Harvat

Sigrid Hoff

Sarah Tolderlund

Astrid Mogensen

Kristina Lund

Maike Nielsen

Christina Villumsen

Nikolaj Kristiansen  
Pernille Højstov

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FOTO: Robert Trojborg - LE 8

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Danmark



14.00  
DANMARK

Tolkamak GOLEM

Brehova 7

115 19 Prague 1

Czech Republic



# 04/14: The Nucleus Day in cooperation with the Research Centre Rez, Czech Republic

DEN S JÁDREM 2014 » DEN S JÁDREM 2013 »

Hledat



O AKCI REPORTY » VZOROVÝ PROJEKT FOTOGALERIE KE STAŽENÍ KONTAKT PŘIHLÁŠKA

Reporty > 2. den DsJ > Jaderná fúze – 2. Report

## Jaderná fúze - 2. Report

**Report** ze dne: 2. 4. 2014

**Skupina:** Jaderná fúze

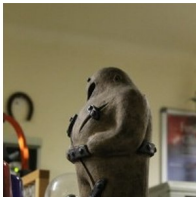
**Téma:** Experimenty na tokamaku GOLEM

*(změření základních fyzikálních parametrů popisujících plazma)*

**Zpracoval:** Petr Novotný

Ve středu 2. 4. 2014 jsme se šli opět podívat na Fakultu Jadernou a Fyzikálně Inženýrskou, kde jsme začali aktivně provádět „pokusy“ na TOKAMAKU GOLEM. Tokamak je od ostatních tokamaků odlišný především svou „kapesní“ velikostí, dále je pro něj charakteristický talisman – keramický Golem, který se tradičně před každým pokusem „zapaluje“.

Před zahájením pokusů jsme si vyslechli přednášku na téma bezpečnosti práce a následně jsme se seznámili se základními operacemi, které se na tokamaku Golem provádějí. Zjistili jsme, jak se



### PŘIHLÁŠENÍ

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# 04/14: Workshop at Observatorium Valašské Meziříčí



# 06/14: Remote from Kiten workshop #1

**6<sup>th</sup> International Workshop  
&  
Summer School  
on Plasma Physics**

30 June - 6 July 2014  
Kiten, Bulgaria

**Topics:**

- \*Fusion Plasma and Materials
- \*Plasma Modelling and Fundamentals
- \*Plasma Sources, Diagnostics and Technology

**Organised by:**

**University of Sofia**

**Co-organisers:**

**PLASMER Foundation**

**Workshops:**

- \*Remote **GOLEM** operation  
Czech Technical University, Prague
- \***Plasmas for Sustainable Environment**  
Institute of Plasmas and Nuclear Fusion, Lisbon, Portugal

# 06/14: The Science week @Nuclear Faculty, CTU #4



# 08/14: International Nathiagali Summer College @Islamabad





## SUMTRAIC 2014 Prague

*12th International Summer Training Course  
on Experimental Plasma Physics*



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### MEASUREMENT

The only summer school where you can see how the different diagnostic systems work in a real tokamak; and integrate your new theoretical knowledge and programming practice into plasma physics measurements!

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		<b>Morning (9:00-13:30)</b>	<b>Afternoon (15:00-18:30)</b>
24.8.	Sunday	Arrival-accommodation	
25.8.	Monday	Introductory lectures	Tour around COMPASS
26.8.	Tuesday	Discussion with supervisors	COMPASS Experiment 1.
27.8.	Wednesday	GOLEM Experiment	GOLEM Experiment
28.8.	Thursday	Data processing	COMPASS Experiment 2.
29.8.	Friday	Data processing	Data processing
30.8.	Saturday		
31.8.	Sunday		
1.9.	Monday	Data processing	COMPASS Experiment 3.
2.9.	Tuesday	Data processing	COMPASS Experiment 4.
3.9.	Wednesday	COMPASS Experiment 5.	COMPASS Experiment 6.

# 09/14: The night of scientists #1



# 10/14: HUNTRAIC #4



# 12/14: PhD session from Padova

Padova  
Vedute di Padova

THANK YOU FOR THE  
REMOTE SESSION!

Nisarg Patel — *visay*

*Pathejy*

*Abhishek Senthil*

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*Shekhar P. B. B.*

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## 12/14: EMTRAIIC #2

Katja Melnik:

This is a small letter to say you a big THANK YOU for an interesting excursion at Golem Tokamak! It is a great work you do - "doing a science with a human face". Many thanks again!!!

Li Fan, participant:

Thank you so much for yesterday's experiment and it is really a nice and interesting experience for me, it's like working with my own Tokamak which is really fancy. And I think it is definitely a good training opportunity for students who just start his or her fusion study and get a close, better understanding of the basics. And last, I hope the students in my country, China, will also have the chance to get close to GOLEM, I will definitely tell them my experience here when I am back in China.

# Outline

1 2009

2 2010

3 2011

4 2012

5 2013

6 2014

**7 2015**

8 2016

# 01/15: remote for TU Denmark #1



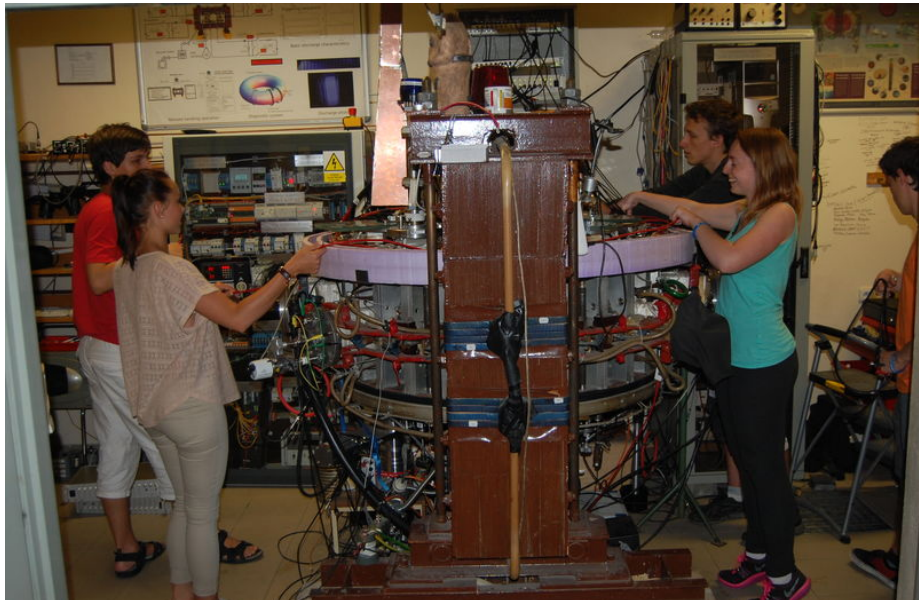
## 01/15: Overall Feedback

Remy Guirlet, FUMTRAIC 2012,2013,2014 supervisor:

The events you organise with students are a very good training for them. On our side, we have always had enthusiastic comments from our master students. Moreover, the GOLEM project is right in our objectives of giving the students the opportunity to operate an 'understandable' tokamak.



# 06/15: The Science week @Nuclear Faculty, CTU #5



## 09/15: The night of scientists #2



## 09/15: Remote training course for Grenoble university



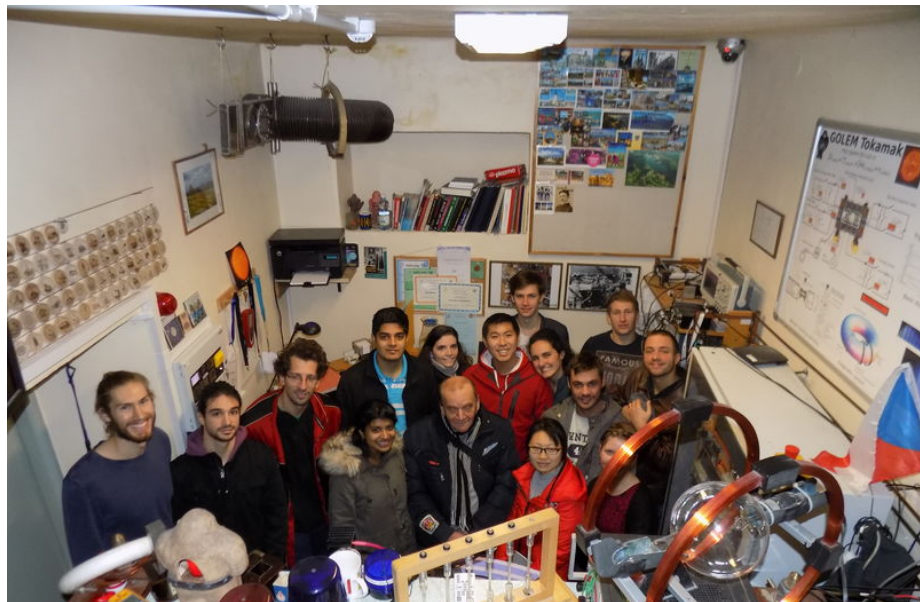
# 10/15: Plasma workshop for Belgrade University #1



# 11/15: Tokamak GOLEM for FUSENET PhD event



# 12/15: Erasmus Mundus Training course #3



# 12/15: Remote training course for Eindhoven university Master classes



# 12/15: A letter from Roger Jasper

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Dear Vojtech,

Please find here the fee we have to pay to be able to make real fusion science with our students!  
As judged from their enthusiasms (maybe you can read that from their faces in the enclosed pictures), this is a very good investment!



# Outline

1 2009

2 2010

3 2011

4 2012

5 2013

6 2014

7 2015

**8 2016**

# 01/16: remote for TU Denmark #2



# 02/16: Training course for Erasmus Mundus European Master

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## Energy Balance for Ohmic Plasmas on Golem

Mathieu Debongnie, Ekaterina Matveeva

February 23, 2016

### Abstract

This paper reports the results of an investigation on global energy balance on tokamak Golem[1]. Measurements of interferometer diagnostics, rogowski coil, loop voltage are analysed to calculate power losses and energy confinement time. Discharges with various plasma densities and electron temperatures are compared.

**Golem, Power Balance**

### 1 Introduction

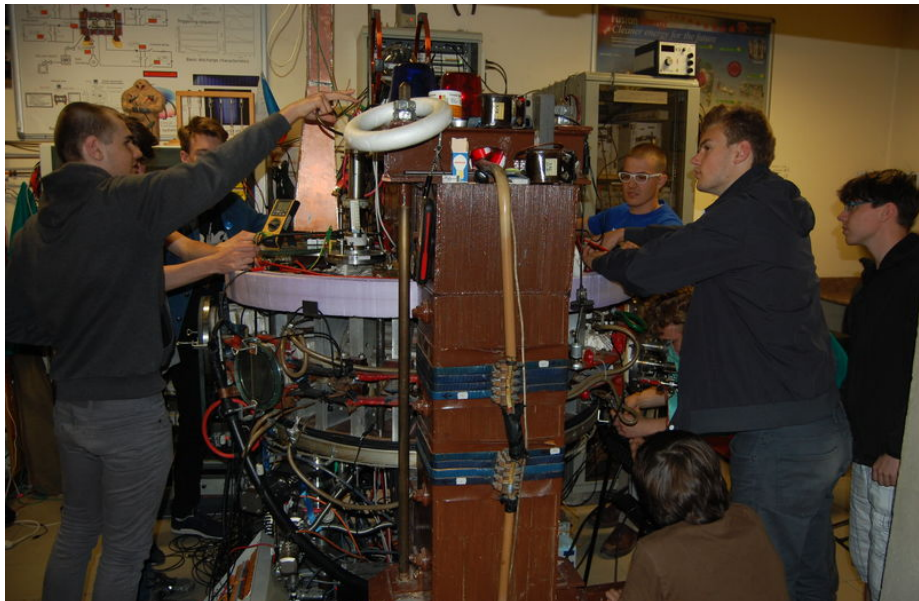
To evaluate the impact of the radiation loss, two different assumptions can be compared. The first hypothesis is that the radiation power and

A tokamak plasma is subjected to power loss

05/16: tokamak GOLEM operated by 7 years old boy  
(under supervision of dr. Stockel)



# 06/16: The Science week @Nuclear Faculty, CTU #6



## 06/16: Remote from Kiten workshop #2



## 07/16: Support letter from EUROfusion programme manager office

of fusion research has indicated that for the expected future increase in staffing needs it is important to strengthen the educational activities in the field.

The EUROfusion consortium has taken note of the systematic and successful efforts of the FNSPE CTU in the field of education of future fusion experts, with a significant impact on the European level. Remote experiments on the GOLEM tokamak in Prague are in the curriculum of several European summer schools in the field. Last year, FNSPE organised in Prague the successful FuseNet PhD event for 130 doctoral students in nuclear fusion coming from across whole Europe. This event was possible thanks to a grant from EUROfusion. Many former students of FNSPE continue their careers in fusion either in their own country (e.g. on the COMPASS tokamak) or abroad, while foreign students (e.g. from Serbia) have developed expertise and enthusiasm in fusion research at FNSPE and IPP Prague.

Prof.dr. A.J.H. (Tony) Donné (Programme manager EUROfusion)

09/16: ITER DG Mr. Bernard Bigot (right) visiting the tokamak GOLEM





# 09/16: The night of scientists #3



# 09/16: Tokamak GOLEM presented in the occasion of the Prince of Monaco visit at ITER



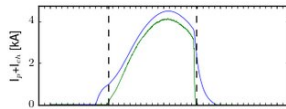
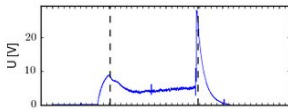
# 09/16: Gaudeamus Fair @ Brno



# 09/16: Remote training course for Budapest university #6

20/11/2016

Working gas: H  
 Preionization: Upper el. gun  
 Status: OK  
 Plasma: True



$\Delta t=15.5$  ms,  $\langle I_p \rangle=3.41$  kA,  $U_{BD}=8.8$  V,  $\langle U_p \rangle=4.51$  V,  $T_e=47.5$  eV,  $P_{OH}=15.40$  kW,  $Q_{ed}=3.5$

**Shot: 22316 Task: TrainingCourses/HUNTRAIC/September2016**

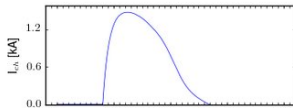
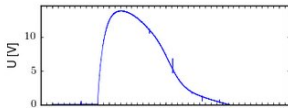
**Comment: Group1 - Ucd500\_P10**

**Tags: 'breakdown failure', 'el preionization', 'Vacuum'**

(None, datetime.date(2016, 9, 15)) (None, datetime.date(2016, 9, 15)) (None, datetime.date(2016, 9, 15))  
 $(U_B, U_{BD}, U_{CD}) = (800(5.0$  ms),  $0(5.0$  ms),  $500(8.0$  ms)) [V]

$p_{H_2}=0.21 \rightarrow 10.06$  mPa

Working gas: H  
 Preionization: Upper el. gun  
 Status: OK  
 Plasma: False



**Shot: 22315 Task: TrainingCourses/HUNTRAIC/September2016**

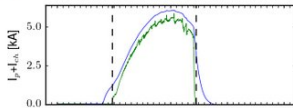
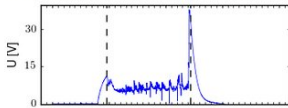
**Comment: Group1 - Ucd500\_P12**

**Tags: 'el preionization', 'spectrometer', 'hydrogen\_plasma', 'hot\_plasma', 'density estimated', 'long shot', 'Plasma', 'disruption', 'low Q'**

(None, datetime.date(2016, 9, 15)) (None, datetime.date(2016, 9, 15)) (None, datetime.date(2016, 9, 15))  
 $(U_B, U_{BD}, U_{CD}) = (800(5.0$  ms),  $0(5.0$  ms),  $500(8.0$  ms)) [V]

$p_{H_2}=0.22 \rightarrow 12.10$  mPa

Working gas: H  
 Preionization: Upper el. gun  
 Status: OK  
 Plasma: True



$\Delta t=14.8$  ms,  $\langle I_p \rangle=4.69$  kA,  $U_{BD}=11.0$  V,  $\langle U_p \rangle=6.30$  V,  $T_e=47.0$  eV,  $P_{OH}=29.56$  kW,  $Q_{ed}=2.4$

**Shot: 22314 Task: TrainingCourses/HUNTRAIC/September2016**

**Comment: Group1 - Ucd500\_P14**

**Tags: 'el preionization', 'hydrogen\_plasma', 'hot\_plasma', 'density estimated', 'long shot', 'Plasma', 'disruption', 'low Q'**

(None, datetime.date(2016, 9, 15)) (None, datetime.date(2016, 9, 15)) (None, datetime.date(2016, 9, 15))  
 $(U_B, U_{BD}, U_{CD}) = (800(5.0$  ms),  $0(5.0$  ms),  $500(8.0$  ms)) [V]

$p_{H_2}=0.22 \rightarrow 13.99$  mPa

## 10/16: Plasma workshop for Belgrade University #2



# 11/16: Remote workshop for Eindhoven university



# 11/16: Report of the 19th Meeting of the International Board of Advisors of IPP.CR

Education is expected to decide on possible support for these two FNSPE projects at the beginning of 2017.

The training activities on COMPASS/GOLEM (EMTRAIC, GOLEM, FUMTRAIC, SUMTRAIC, HUNTRAIC, and GOMTRAIC) are continued. The modern IT tools at GOLEM offer a very good way to attract students, even if the actual tokamak hardware is quite aged. These activities are unique and strongly appreciated within the EU fusion community, and offer hands-on experience for young researchers on tokamak operation which is hardly possible on larger devices. Therefore, IBA strongly recommends the maintenance of these activities (also on the larger COMPASS-U) in parallel with the present level of outreach.














## 11/16: Remote training course for Torino politecnico








# 12/16: Demonstration for Padova University

## Recent

-  Emilio Martines
-  Fabio Subba
-  toon.weyens
-  Roger Jaspers
-  Echo / Sound Tes...
-  live:vodouch99
-  Martin Matusu
-  argonaut\_2012
-  NTI Hallgat6, Ge...
-  Gerg6 Pokol
-  Plamena Marinova
-  silver.ice
-  JanStockel

[9:34:29 AM] **emilio martines**: IT WORKS

[9:34:30 AM] ... thx

[9:37:24 AM] **Tokamak GOLEM**: 12 ms! 5kA! Very good!

[9:47:51 AM] **Emilio Martines**: the confinement time calculations uses the interferometer density measurement?

[9:48:02 AM] **Tokamak GOLEM**: yes

[9:48:08 AM] **Emilio Martines**: ok, so it is unreliable

[9:48:21 AM] **Tokamak GOLEM**: yes ..

[9:48:21 AM] **Emilio Martines**: because of 2pi shift

[9:48:24 AM] ... ok

[9:48:52 AM] **Tokamak GOLEM**: Maybe you should wait for discharge without 2pi problem

[9:53:02 AM] ... 16 ms!

[9:53:20 AM] ... Without 2 pi shift!!

[10:00:48 AM] ... vacuum shots, is that what you intend?

[10:01:08 AM] **Emilio Martines**: no, I was trying to achieve very low  $I_p$ , but probably Vloop is too low

[10:01:12 AM] ... I was just commenting on this

[10:01:36 AM] **Tokamak GOLEM**: 200 V for  $U_{CD}$  is really to low

[10:01:39 AM] **Emilio Martines**: ok

[10:01:46 AM] ... how much should I put? 300?

[10:01:53 AM] **Tokamak GOLEM**: at least

[10:01:56 AM] **Emilio Martines**: ok

[10:02:43 AM] ... this is the last one, then we stop

[10:02:58 AM] **Tokamak GOLEM**: really last one?

[10:03:14 AM] **Emilio Martines**: well, let's see how it goes

[10:04:34 AM] ... any idea why it ended so quickly?

[10:04:49 AM] ... density too high?