# Education in Fusion

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OUTLINE:

- Short introduction of FNSPE, Czech Techn. Univ. in Prague.
- Physics and Technology of Thermonuclear Fusion – new curriculum at FNSPE.
- CSA - FUSENET.
- Tokamak GOLEM – educational device.

# Faculty of Nuclear Sciences and Physical Engineering

## Applied Sciences

- Mathematics
- Physics
- Languages
- Solid State Engineering
- Physical Electronics
- Material Sciences
- Dosimetry and Applications of Ionizing Radiation
- Nuclear Chemistry
- Nuclear Reactors
- Software Engineering in Economics

http://www.fjfi.cvut.cz

# Physics and Technology of Thermonuclear Fusion

ITER decision & COMPASS-D 2Prague → new curriculum at FNSPE CTU Prague

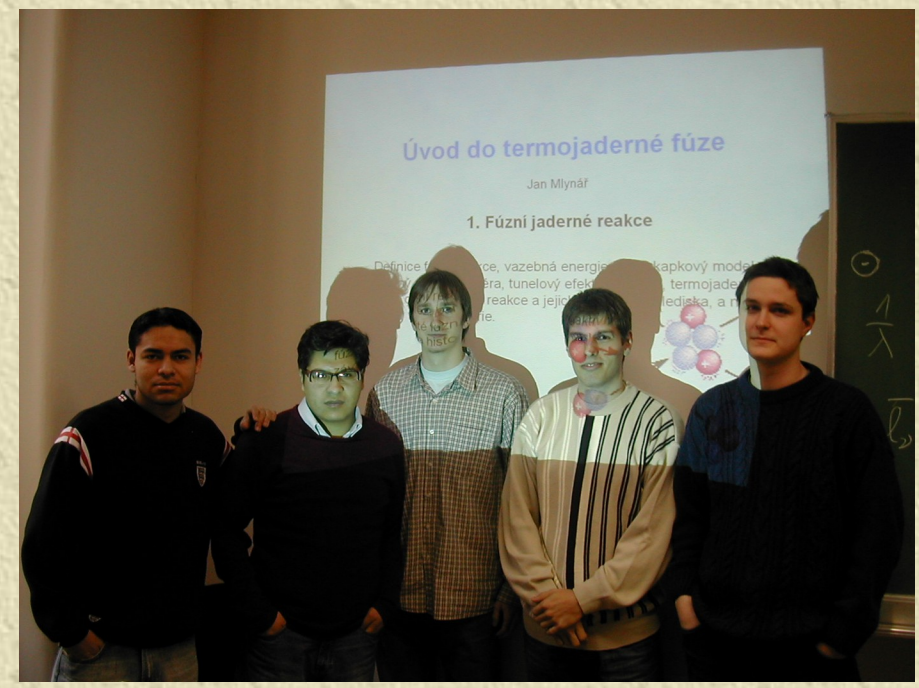
## Constraints (and Hopes)

- Compatibility with the Erasmus Mundus Fusion-EP (European MSc)
  *decided to act as if we were to be a member*
- Association EURATOM-IPP.CR as the key expert authority
  *here FNSPE already is a member*

# Principles and short-term planning

- 1 and 2 year of study are common for all physics students.
- The curriculum specializes in year 3 - introduction year, in Czech.
- Year 4 and 5 specialized in two streams:
  - Theory,
  - technology.
- year 3 (B.Sc.) opened in 2006.
- year 4 and 5 (M.Sc.) in 2007 and 2008.

- Michal Kazda – Erasmus Mundus
- Michal Kubič – Ph.D. in Cadarache



# FTTF – Master degree 1st. year *principal subjects*

**Winter term**

- Mathematical statistics.
- Quantum mechanics.
- Electrodynamics.
- Vacuum physics and technology / Transport phenomena.
- Nuclear physics.
- Bachelor work
- Languages

**Summer term**

- Numerical mathematics.
- Introduction to Fusion.
- Introduction to plasma physics.
- Introduction to power production.
- Bachelor work.
- Languages

# FTTF – Master degree 2nd. year *principal subjects*

**Winter term**

- Plasma theory.
- Physics of inertial fusion/Physics of tokamaks.
- Atomic and molecular physics.
- Structure and properties of materials.
- Plasma physics practica.
- Research work.

**Summer term**

- Plasma theory.
- Plasma diagnostics.
- Plasma modelling.
- Technology of thermonuclear devices.
- Theory of materials for nuclear devices.
- Plasma physics practica.
- Research work.

# FTTF – Master degree 3rd. year *principal subjects*

**Winter term**

- Seminar FTTF

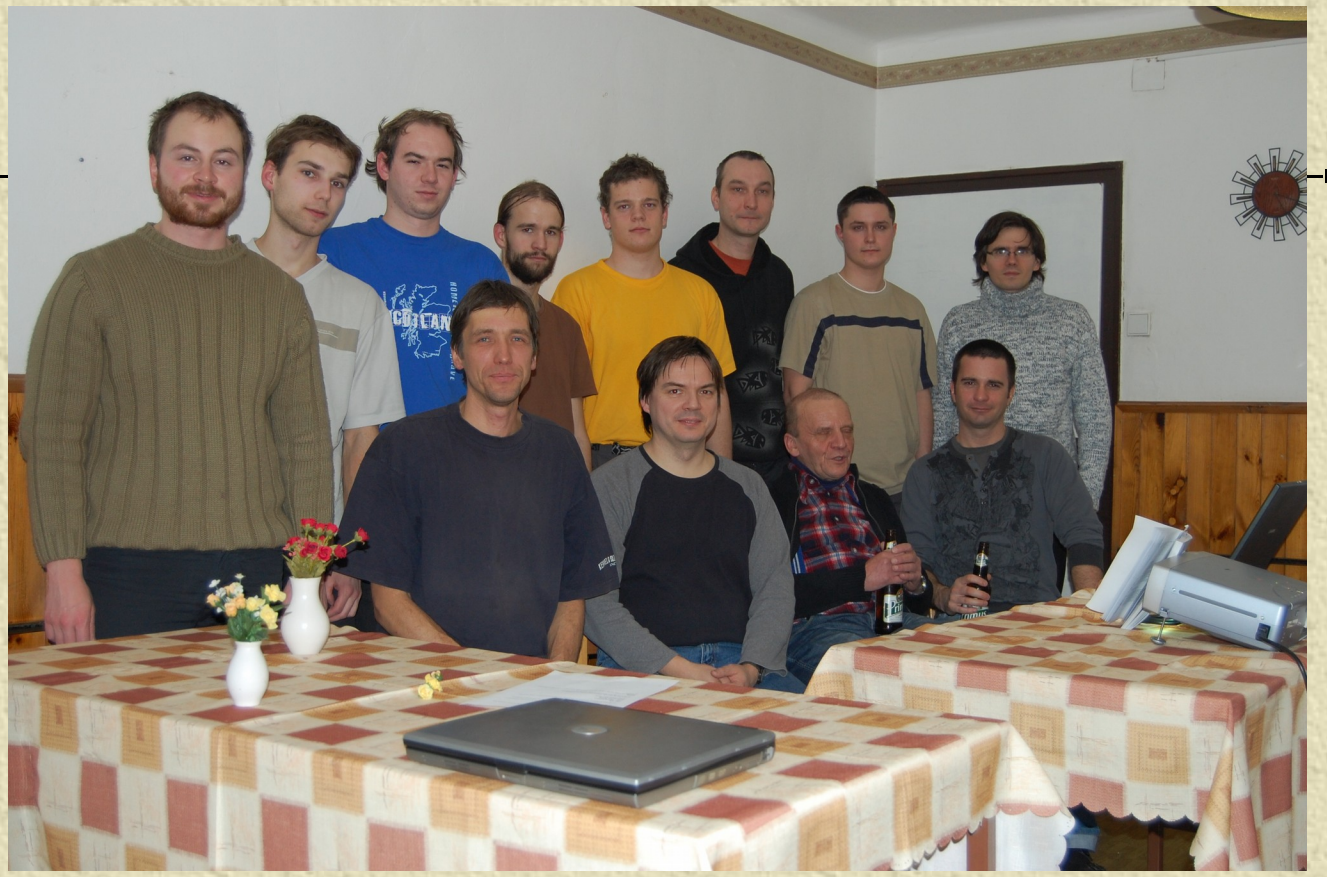
*(2008: prof. Oost, dr. Furno)*

- Non linear modelling.
- ITER.
- Pinches.
- Diploma thesis.

**Summer term**

- Seminar FTTF.
- Physics and human cognition.
- Diploma thesis**.**

# Winter school Marianska 2009



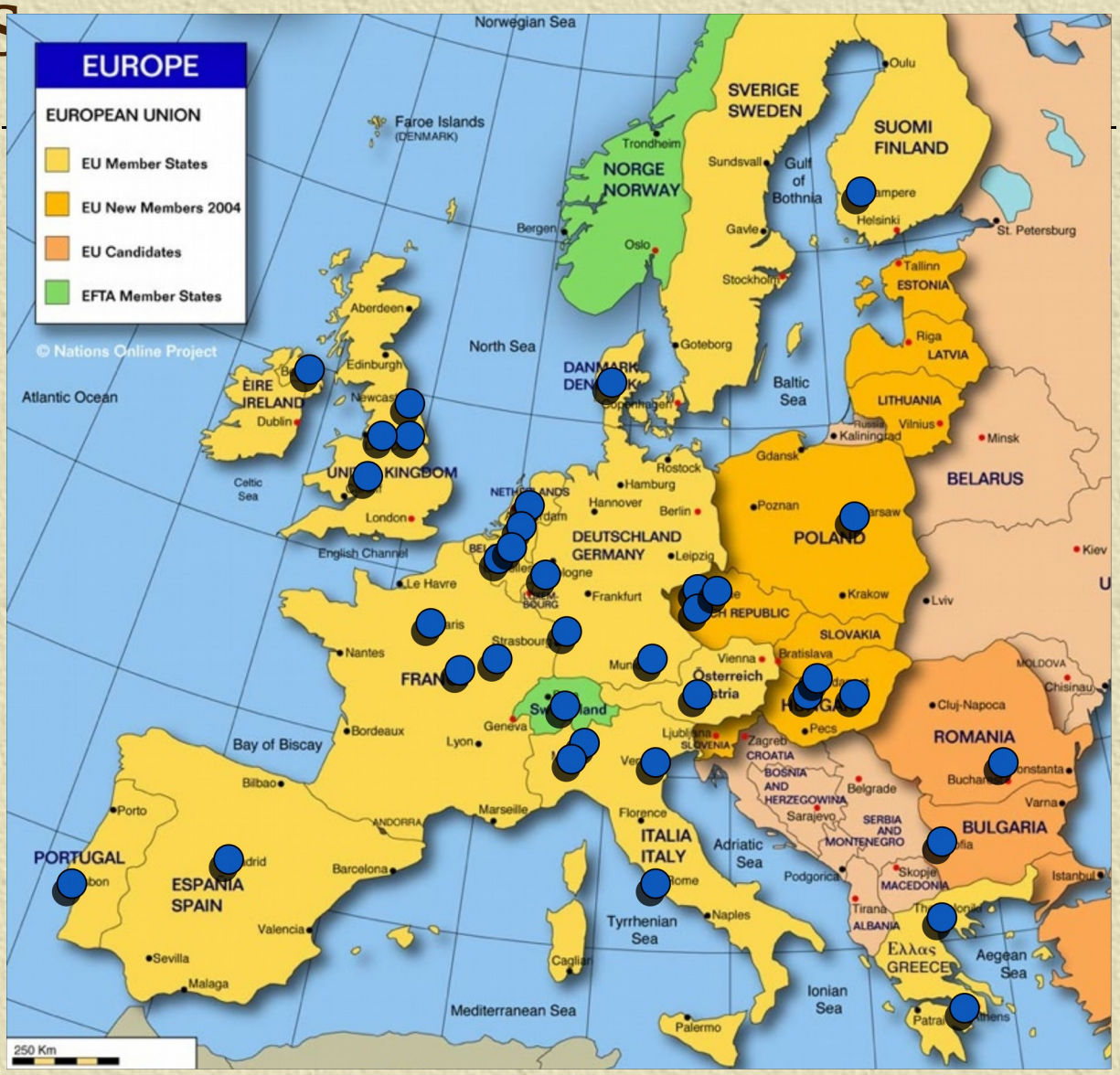
- Presentations of students.
- Invited lectures.
- Social programme.

# FUSENET a European Fusion Education Network

- Goal: establishment of a European Fusion Education Network (FUSENET) for education in fusion science and technology, as part of a comprehensive package of coordination actions, in order to increase, enhance, and broaden fusion training and education activities in Europe.
- Contribution European Commission: 2 Million Euro.
- Duration: 4 years.
- Start of the project: 1st October 2008.

# Partners

36 partners
18 countries
22
Universities
14 Euratom
Associations



# Proposal 09/2007 & Kick off 11/2008 meetings in Prague

# Czech contribution to FUSENET WPs

- **WP5:** Development and coordination of international fusion courses such as summer courses and specialised courses *(SUMTRAIC - IPP).*
- **WP7:** Increasing the access to existing fusion-related experiments and infrastructure for teaching purposes, and the development of new teaching hardware *(plasma physics practica, WP7 management - IPP)*.
- **WP8:** Identify existing master level educational material and develop plan for topquality master-level text on fusion technology *(new textbook - FNSPE).*
- **WP9:** Development of multimedia teaching materials *(empirical tokamak GOLEM model, WP9 management –FNSPE + multimedia development - CUNI).*
- **WP10:** Funding of organization and coordination of joint educational activities in support of European Doctorate and Master level education *(mobility of sudents - FNSPE + CUNI).*

# Education - we offer

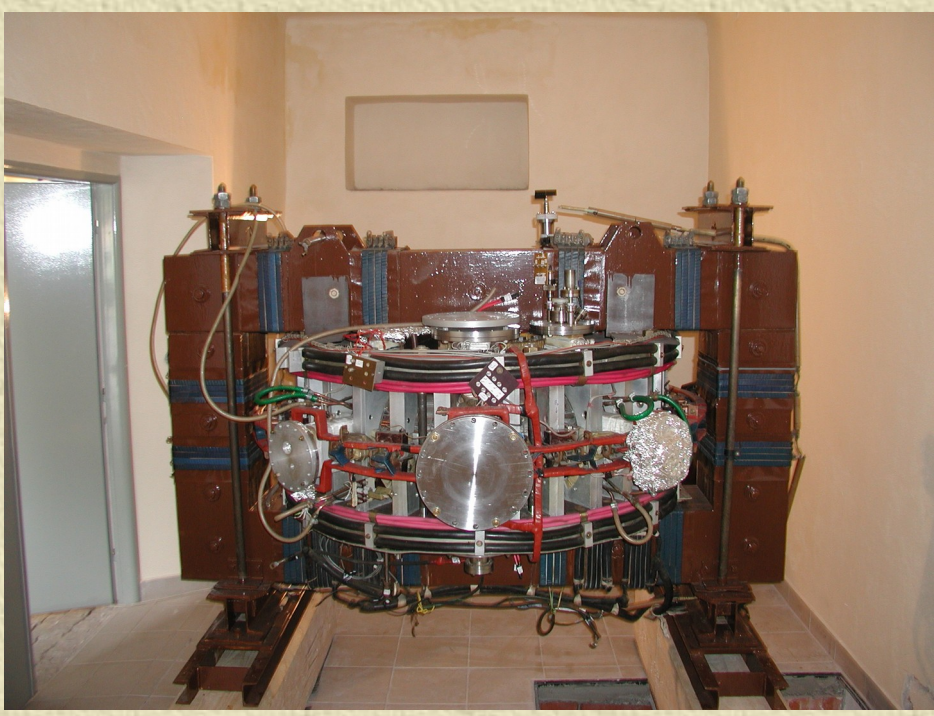
- Flexibility to accomodate our programme to support collaboration.
- Networking.
- Access to experimental labs for plasma science: Materials, Nuclear reactor, COMPASS, Corona discharge, PALS, tokamak GOLEM.
- SUMTRAIC – summer training school.

# Education - we look for ..

- Mobility of students and teachers.
- Access to experimental equipment specialized for fusion education.
- Fusion education coordination between universities, like FUSION-EP.
- Information exchange on fusion matters.

# Tokamak GOLEM

- 1960 -1974 **TM1-MH** Kurchatov Institute of Atomic Energy, Moscow.
- 1977-2007 **CASTOR** Institute of plasma physics, Czech Academy of Sciences.
- 2008 **GOLEM** educational device at FNSPE, Czech Technical University.



# GOLEM - Milestones

- Routine operation of tokamak.
- Design of experimental practica:
- ✓ Elementary diagnostics.
- ✓ Probe measurements.
- ✓ Bolometric field for radiation losses.
- ✓ Interferometer in 4 mm zone.
- ✓ System for magnetic field measurement by Hall probes.
- ✓ X-ray diagnostics.

# Future

- Tokamak GOLEM.
- Ph.D. (collaboration with Charles University)
- Mobility of teachers.
- English language?

# Summary

- Physics and Technology of Thermonuclear Fusion – new curriculum at FNSPE.
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# Discussion?

- Priorities?
- Public order?
- Future programme of tokamak GOLEM?