CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

PlasmaLab@CTU – new facilities for diagnostics training

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FSNPE CTU Prague

Introduction

Double degree in fusion

- Full name: High temperature plasma physics and thermonuclear fusion
- Accreditation of double degree with the Gent University
- Launched in 2020

PlasmaLab@CTU

- Full name: High temperature plasma and fusion technology laboratory
- Aim: To build up a laboratory for education fusion physics and technology students in combination with the GOLEM tokamak development

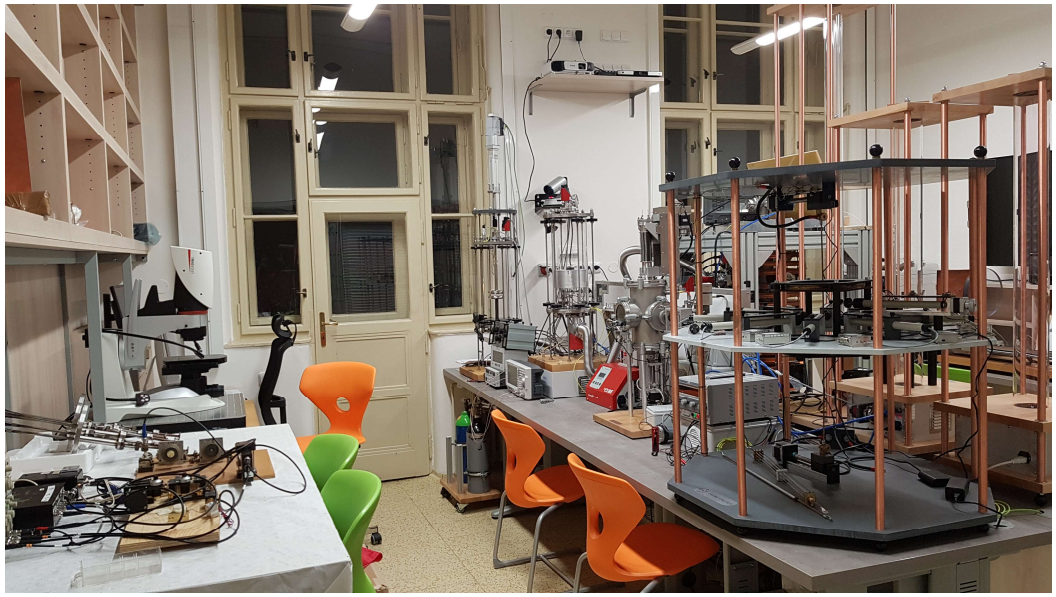
- Both the projects have support from the October 2017 till September 2022

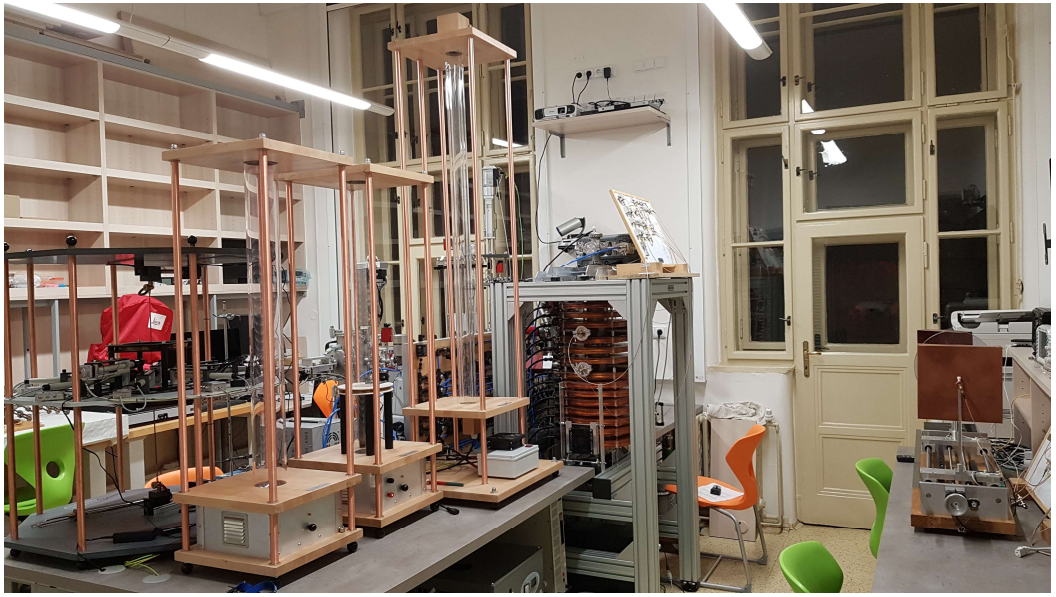
4 workspaces of PlasmaLab

- **Workspace 1 – Plasma**
  - Linear magnetic trap
  - Paschen curve
  - Discharge tubes
  - Resonance cavity
- **Workspace 2 – Magnetic and electric fields**
  - Magnetic stand
  - Electrostatic probes stand
  - Microwave interferometry
- **Workspace 3 – Optics**
  - Laser spectroscopy
  - Sonoluminescence
  - 3D microscope
- **Workspace 4 – GOLEM**
  - Modernization of feedback system, interferometry, stabilized sources, data acquisition system

PlasmaLab@CTU

- Basic experiments for fusion students
- Existing PlasmaLabs: Eindhoven (TU), Madison (Wisconsin University), Lisabon (IST), Gent (Gent University)





Remote control

- Philosophy of PlasmaLab@CTU: remotely controlled as much as possible
- GOLEM is fully controlled
- Control via Internet GUI
- Each experiment has it’s own Raspberry Pi
- Master Raspberry Pi: software, switches on other Raspberries
- Some devices go directly to the Internet (oscilloscopes, spectral analyzer, gauges via controller…)
- Some devices controlled via Arduinos (step motors)
- Some parts manually controlled (cylinders, changing of parts…)

Students

- For all levels of students from High School up to doctoral
  - So far: MSc lab works, newly Bc lab works
  - Bc thesis completed, one ongoing
  - High School student (Global Talent Mentoring)
  - Many more at GOLEM (from Highs School up to PhD)
- Remote courses
  - Distance schooling
  - Global Talent Mentoring
  - Open to schools and international students
  - GOLEM – long list of remote measurements, schools, campaigns

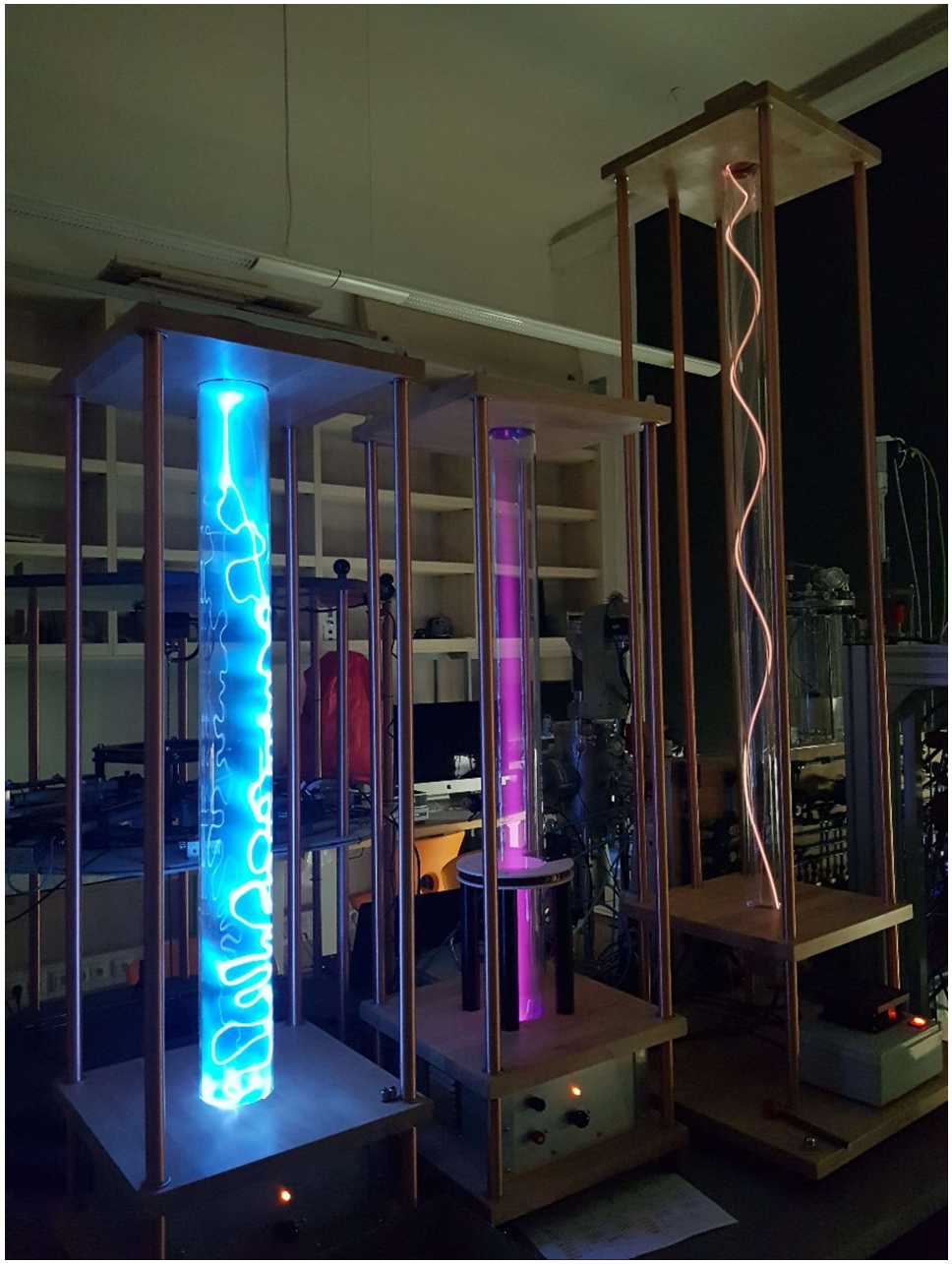
Linear magnetic trap

- Waves propagation in plasma across and along the magnetic field
- Fusion relevance: wave heating, wave access and wave diagnostics: ICRH, ECRH, ECE, reflectometry etc.

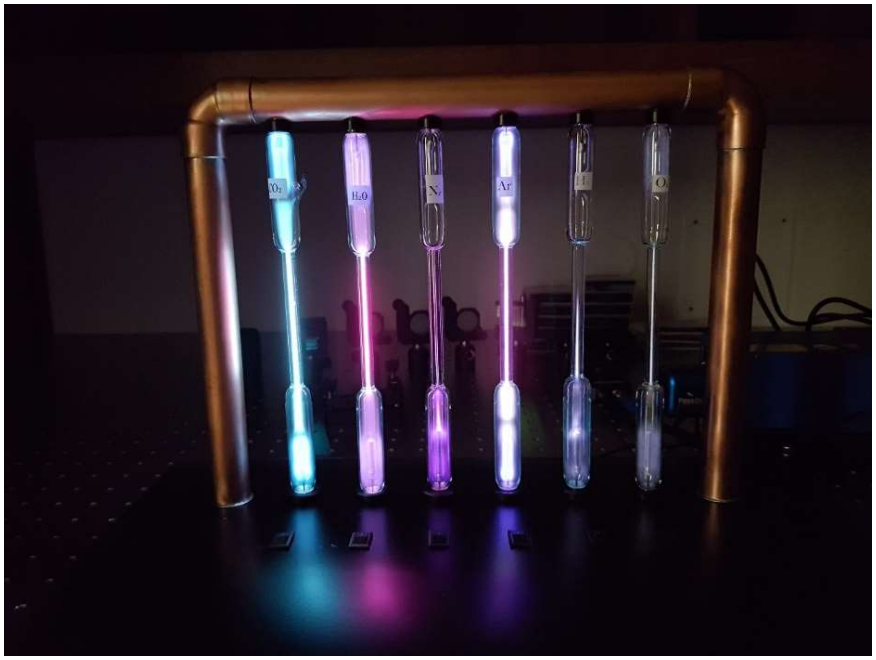
Paschen curve

- Breakdown measurement in various gases
- Fusion relevance: break-down, plasma start-up

Discharge tubes



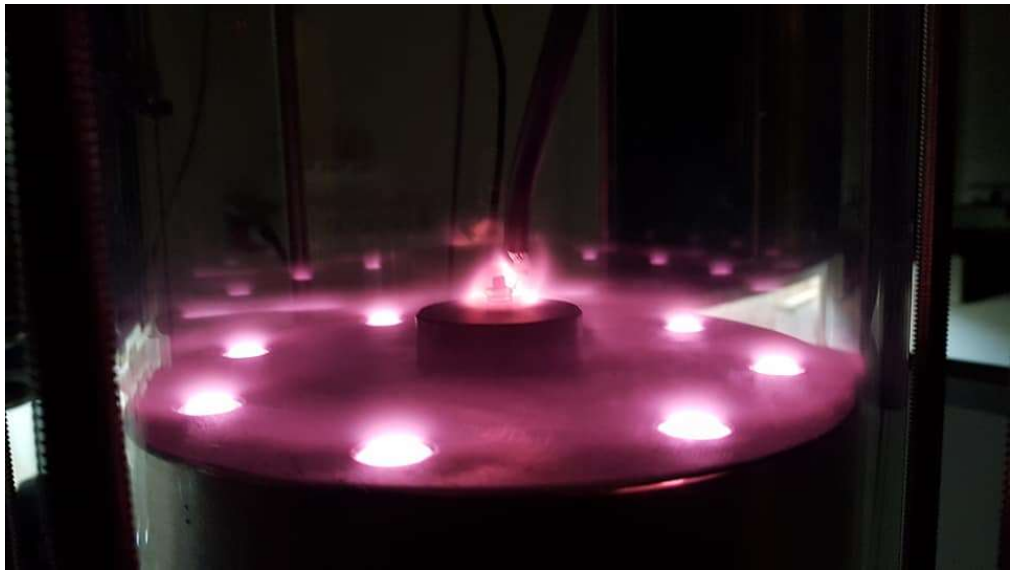
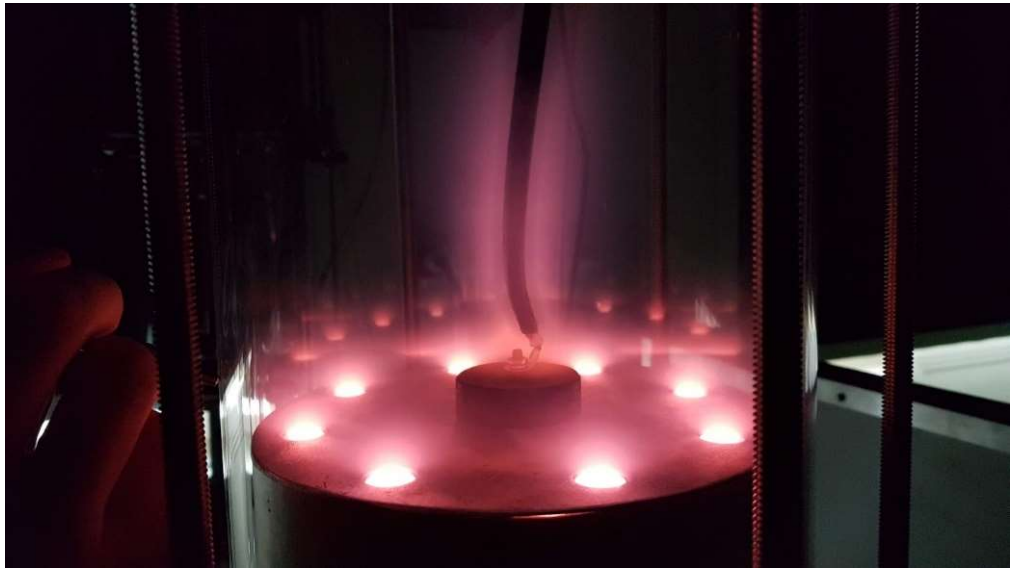
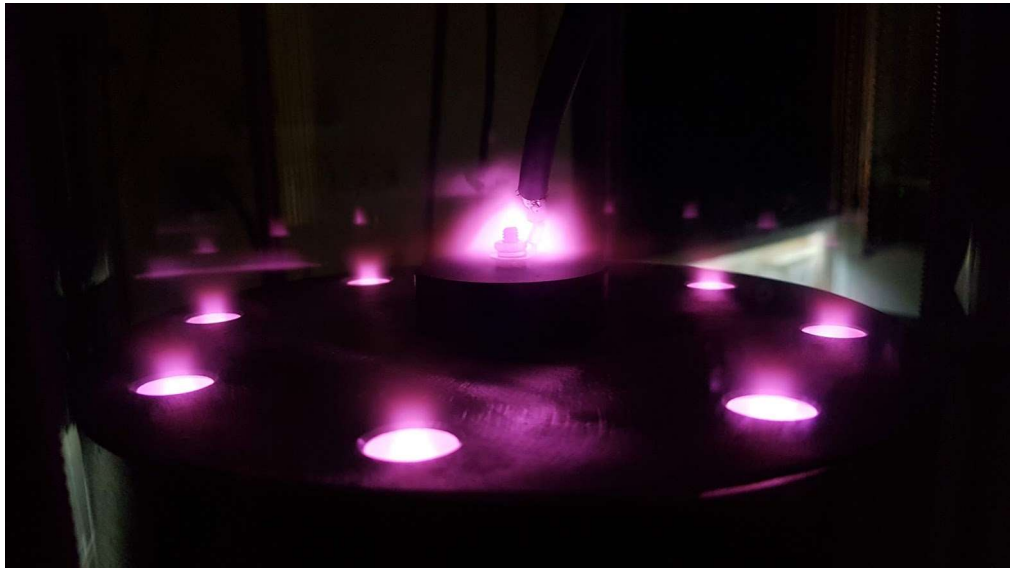
- Tube with pressure and gas control
- Spiral tube
- Iodine tube
- Fusion Relevance: Optics measurements, PR



Resonance cavity

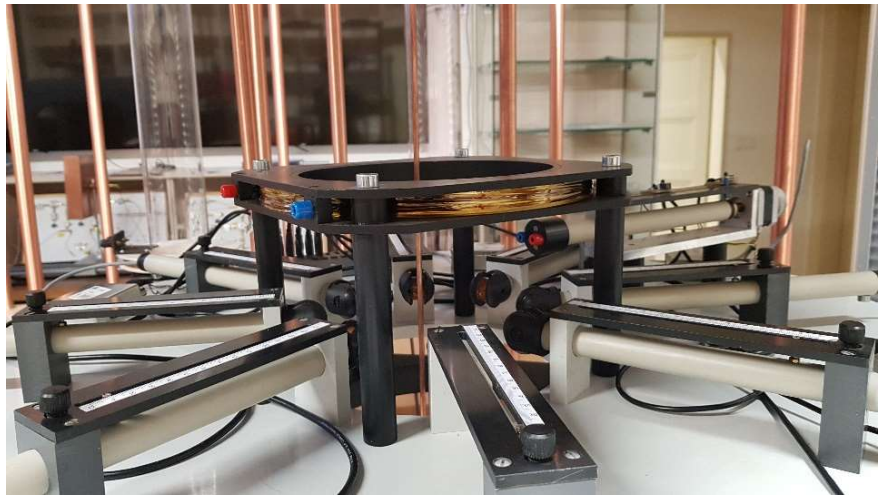
- Study of microwave resonator: estimation of resonance spectra
- Study of plasma – microwaves interaction: density estimation from the cavity resonance
- Fusion Relevance: Microwaves (ECRH) are a prime heating tool for fusion plasmas

Resonance cavity

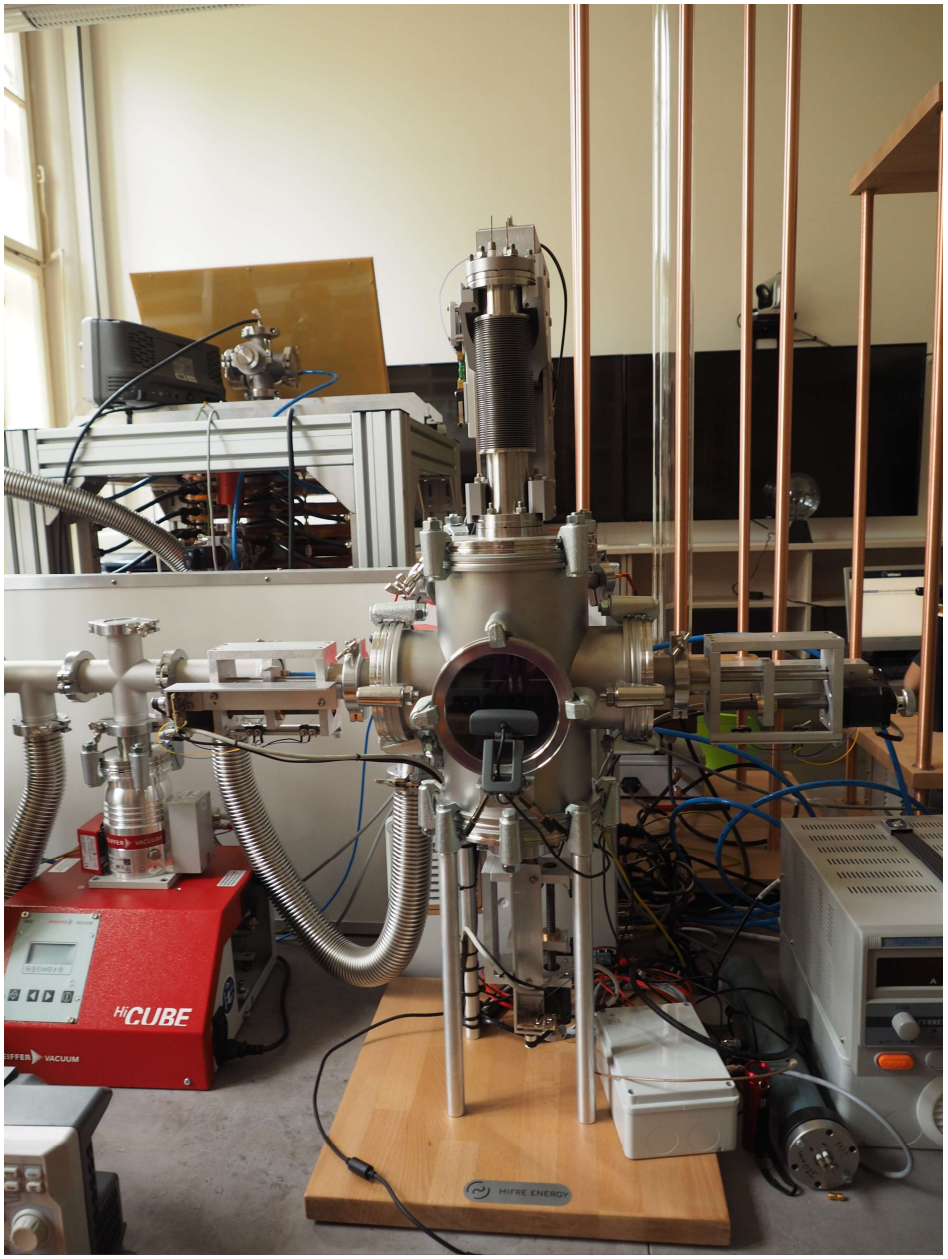





Magnetic stand

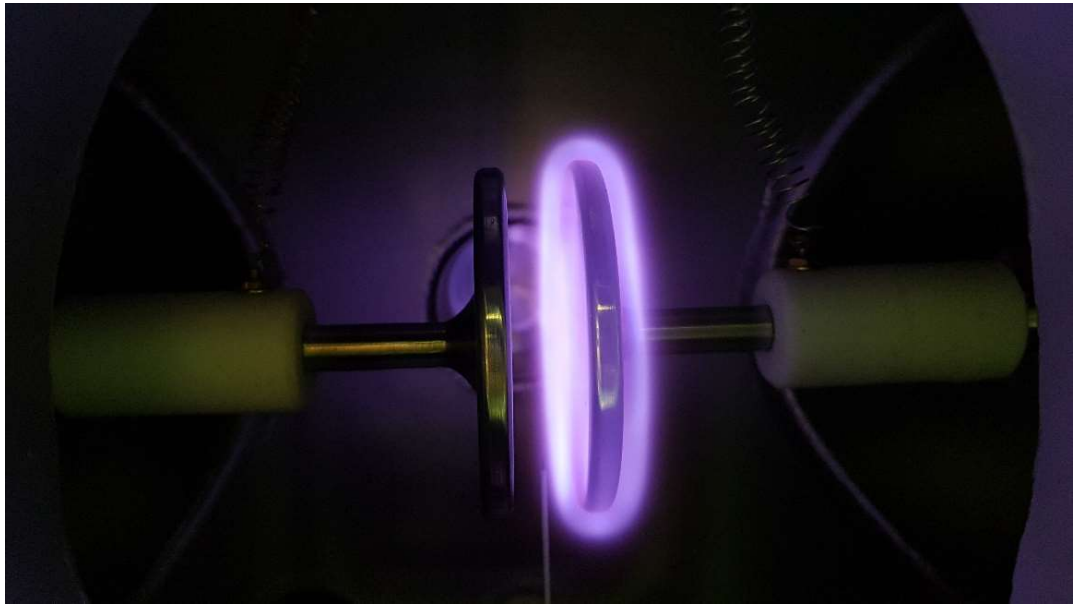
- Preparation for measurements with coils, feedback system
- Measurements of magnetic field around a wire (“plasma”)
- Fusion relevance: Standard diagnostic for measurement of current or magnetic field, feed back



Electrostatic probes stand

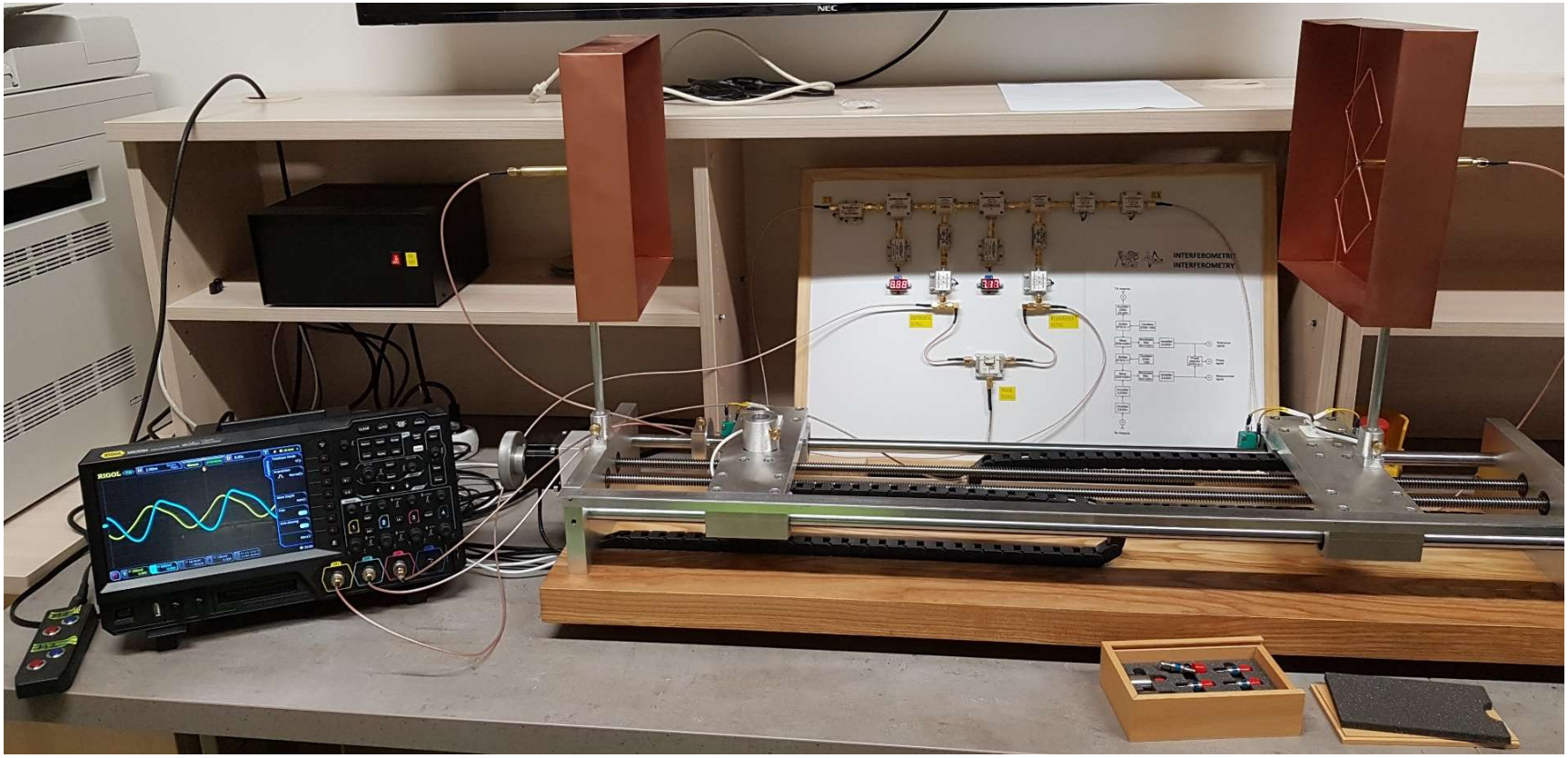


- Langmuir probes, emissive probe – basics
- Test bed for probe designs
- Fusion relevance: Basic measurements in edge/SOL of fusion plasma



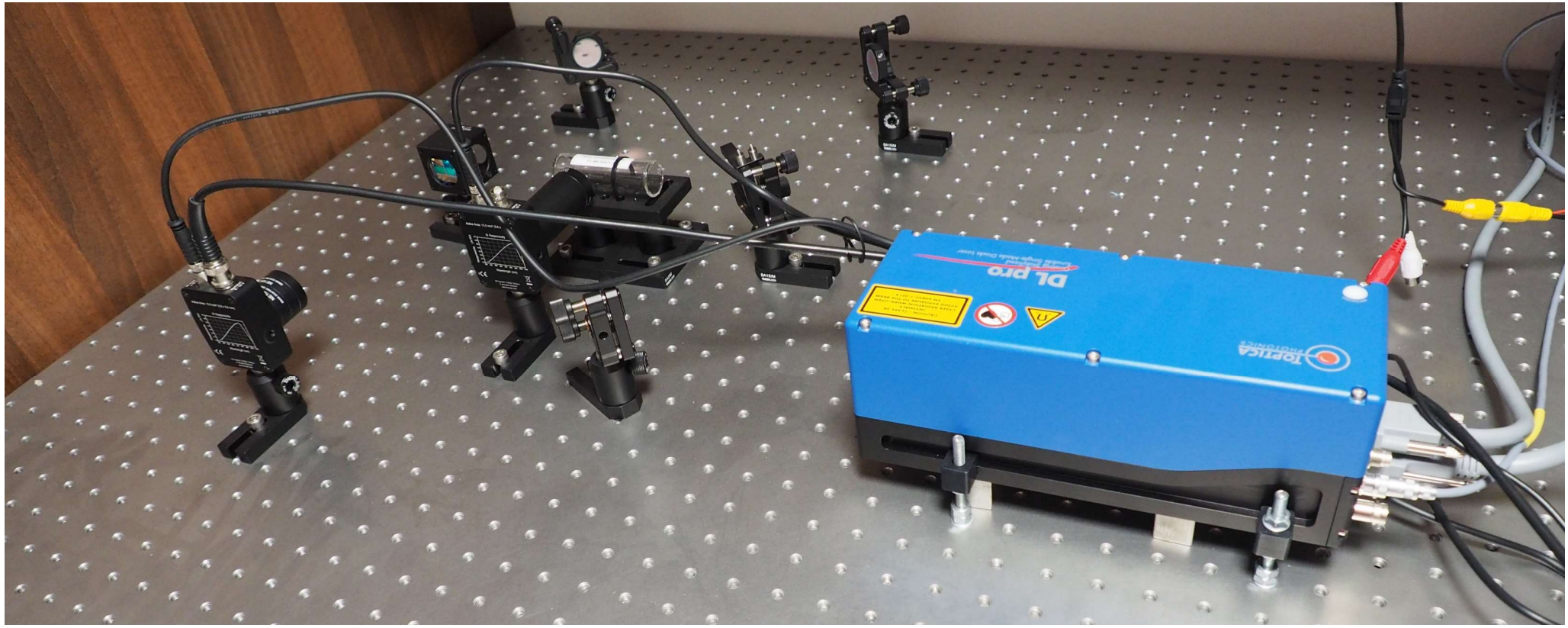
Microwave interferometry

- Interferometry principle, microwaves propagation, tuning of microwave device
- Fusion relevance: Interferometers are key diagnostics for plasma density measurements



Laser spectroscopy

- Emission and absorption spectrum in Rb vapors, Doppler shift in the spectrum in the line
- Fusion relevance: Advanced techniques for density and temperature measurements in plasmas, like LIF

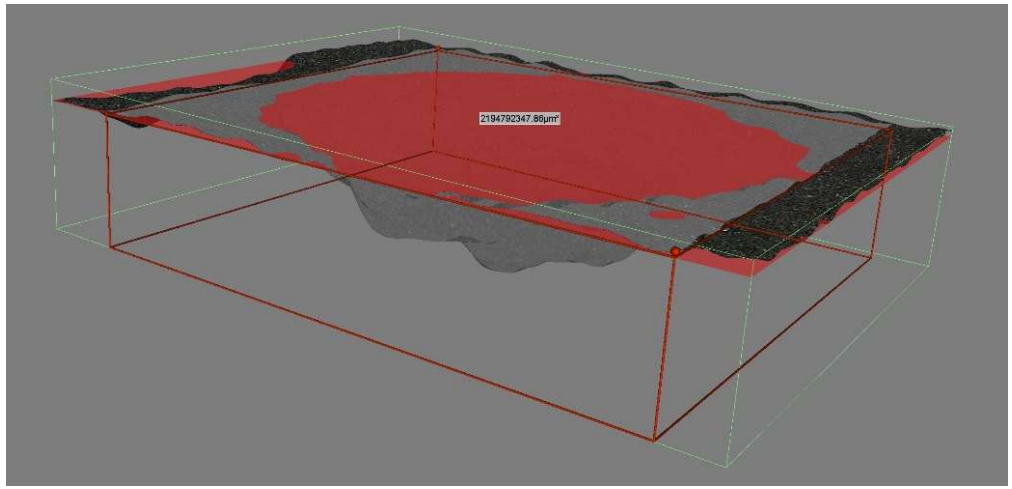


Sonoluminescence

- Sonoluminescence generation
- Temperature in the bubbles is about 10e5 K (10 eV)
- Fusion relevance: optical measurements of high temperatures, bubble fusion

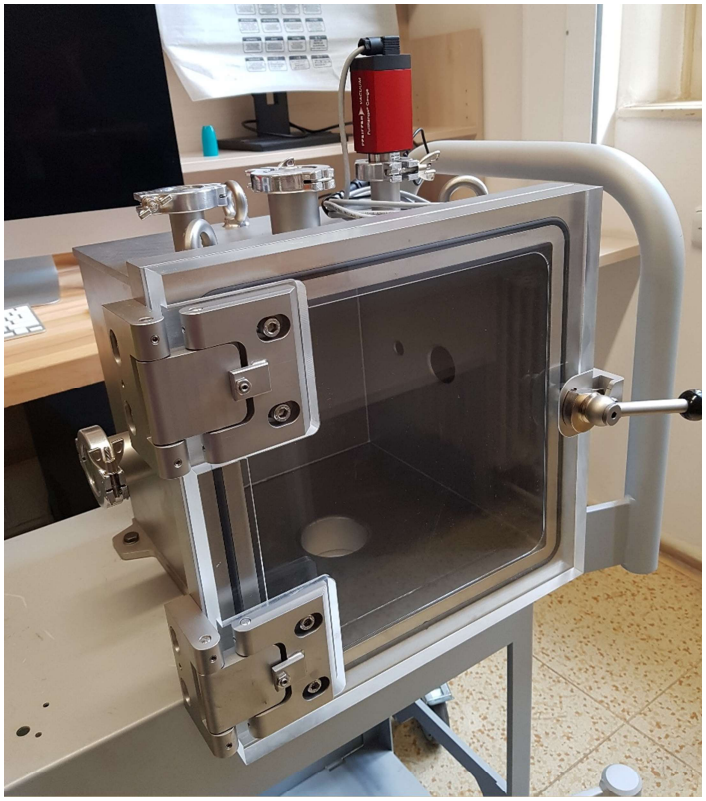
3D microscope

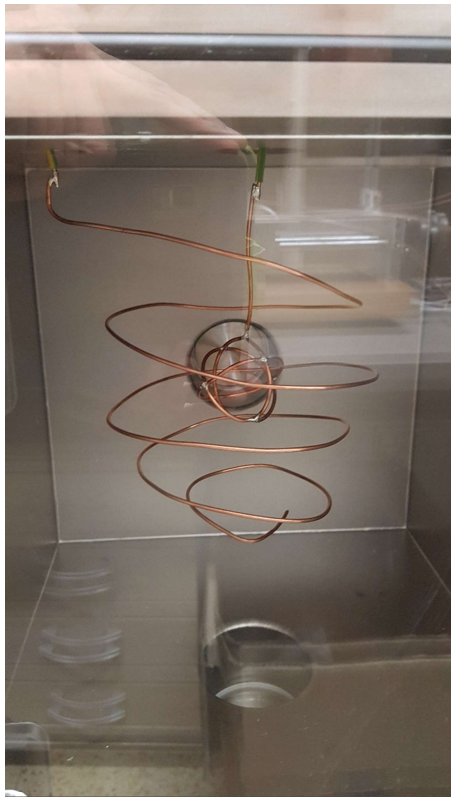
- Digital PC controlled 3D microscope
- Study of plasma-wall interaction
- 3D is reached by scanning
- 3D reconstruction, measurement of distances, depths, volumes etc.



The Cube

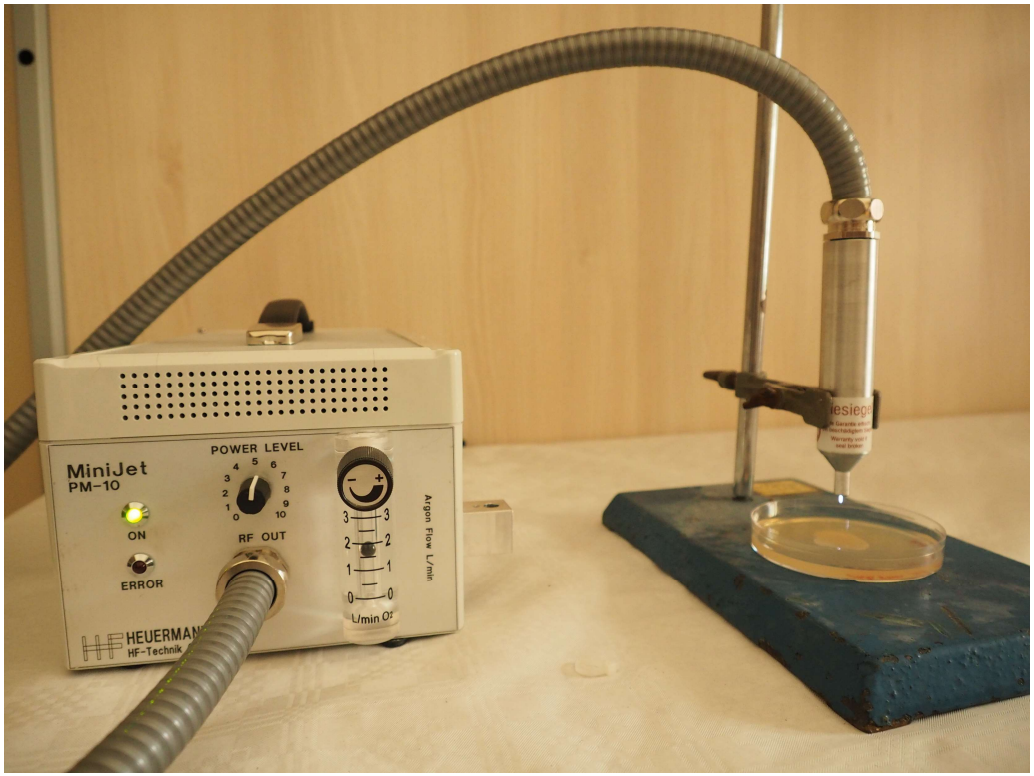
- Universal recipient
- Test bed for experiments – seminars, liquid metals etc.

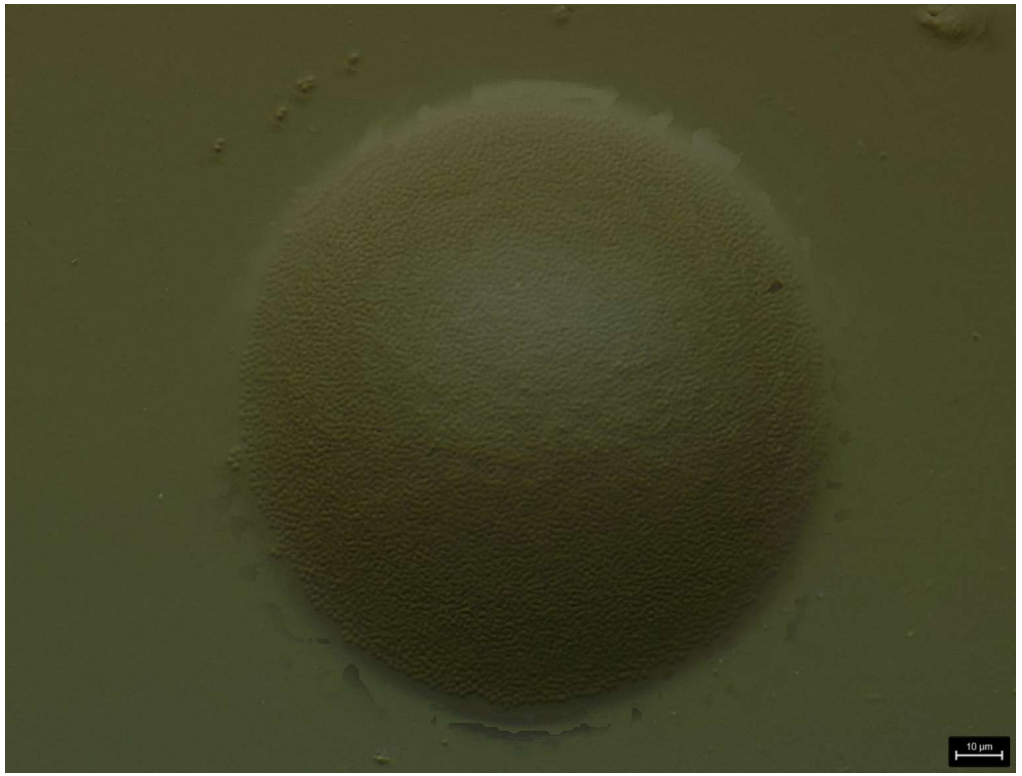




Plasma Mini Jet

- 10 W, Argon, 40 deg.C
- Surface conditioning
- Plasma treating of bacterial structures (cooperation with the Chemical University)





GOLEM

GOLEM

- New poloidal field coils and primary winding coils – last year, finished
- New control system electronics is being finalized

Conclusions

- FSNPE CTU is doing the complete University education, all the 3 degrees (Bc, MSc, PhD) – in fusion physics and technology
- We work on being available for international students by international collaborations
- PlasmaLab@CTU is a lab for all levels of students, from High School
- Remote laboratory work

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Master Event

- Online conference for MSc students
- 5th – 6th October
- Organized by FuseNet
- Registration: www.fusenet.eu
- One day for scientists (6th), one day for engineers (5th)