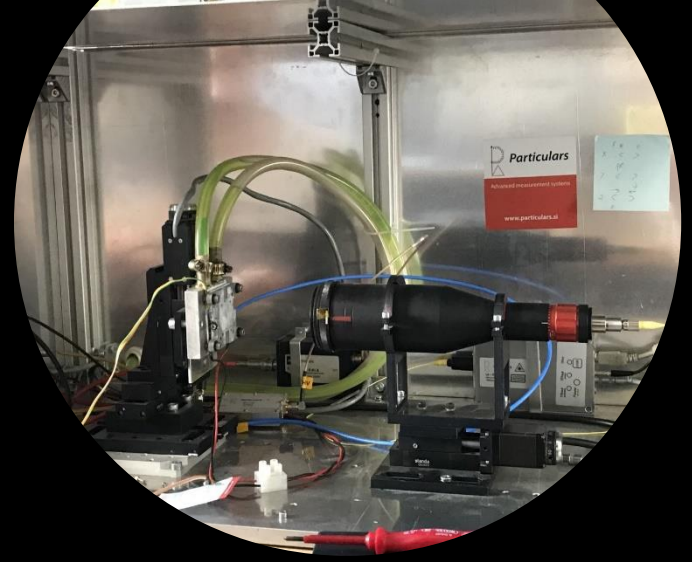
Training in instrumentation at the JSI and ELI Beamlines



Ivona Bozovic & Jovana Doknic

In collaboration with

Gordana Lastovicka-Medin, Mateusz Rebarz, Petja Skomin

Gregor Kramberger, Jiri Kroll

41th RD50 Collaboration Workshop, Sevilla, 28th of November – 2nd of December, 2022

Why do we think it is important to train young scientists at UoM

Investment in human capacity and resources.

How did we do it

By utilizing the potential that exists in research network we have already built:

MNE-JSI-ELI Beamlines

What were our targets

Training was not only in use of existing characterization tools but, importantly, in gaining skills in mounting set up.

Training on data taking, data acquisition, data processing, interpretation of results

AI in 4 weeks

One week at JSI

Three weeks at the ELI Beamlines

I part: JSI

The following slides show the training at the Institute „Jozef Stefan“ from 04.07. to 12.07. in Ljubljana, Slovenia.

First day

Arrival at the IJS and an introductory lecture on LGAD and the development of TCT.

A tour of the Institute's available laboratories together with an assigned mentor.

TCT Set up

One of the rooms of the F9 section (experimental physics department)

SECOND DAY

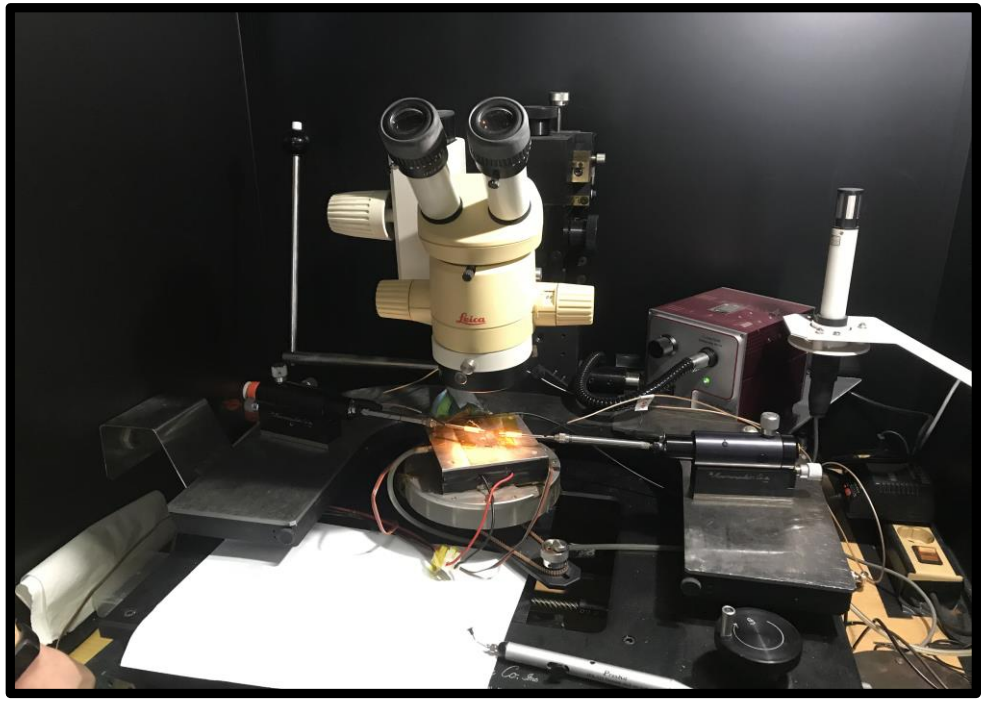
Lecture on the Higgs boson and its discovery (Additional education outside the main training).

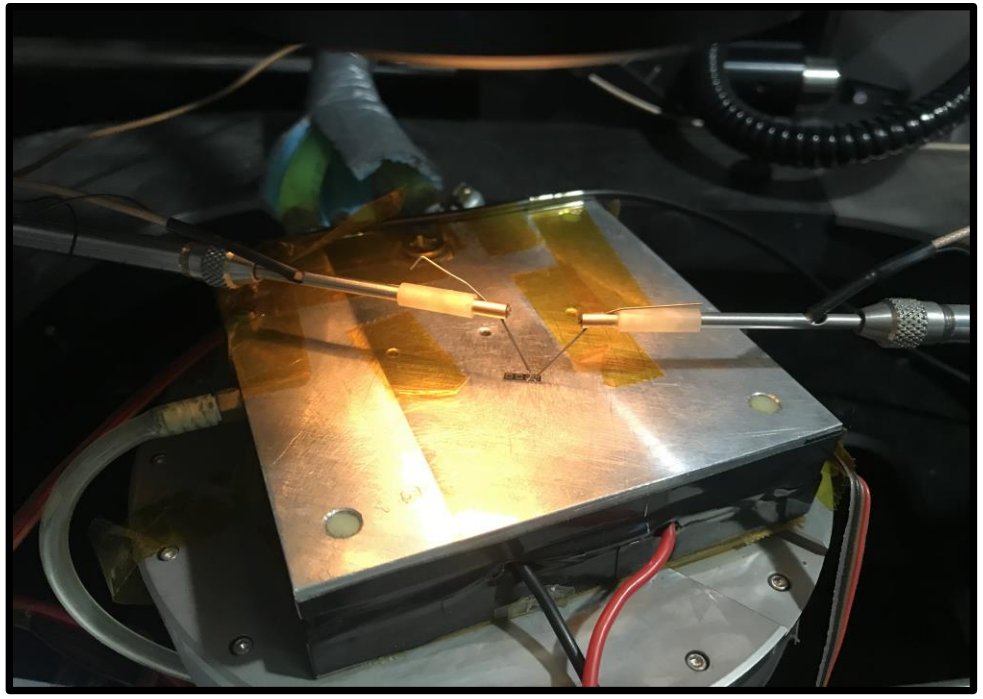
Return to study and practice in which we continued to analyze the TCT set up „Particulars“ together with the mentor (dr Gregor Kramberger).

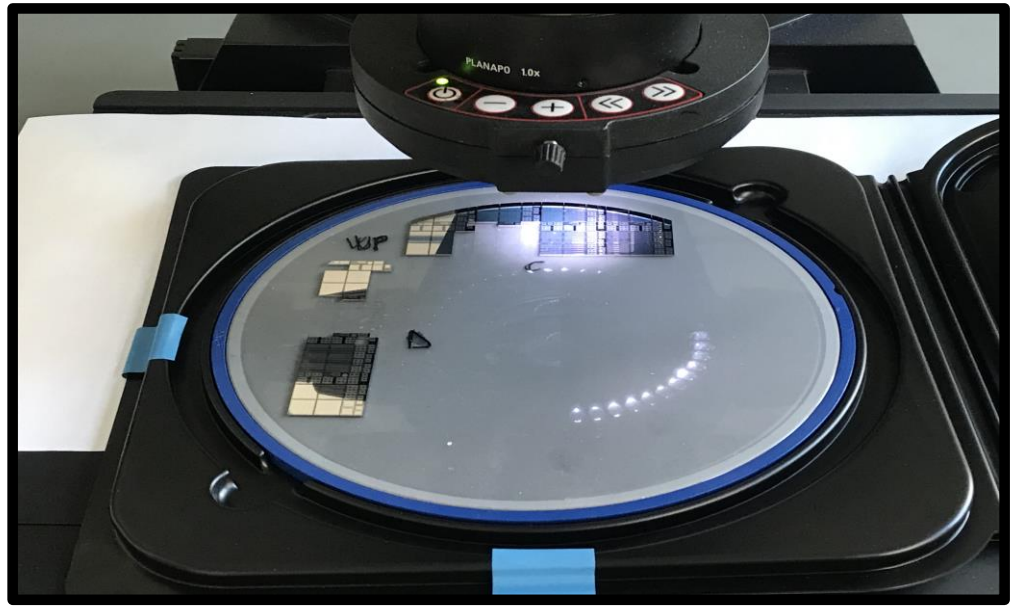
We started with Single Photon Absorption (SPA) mmeasurements in which we got acquainted with the software for analyzing them.

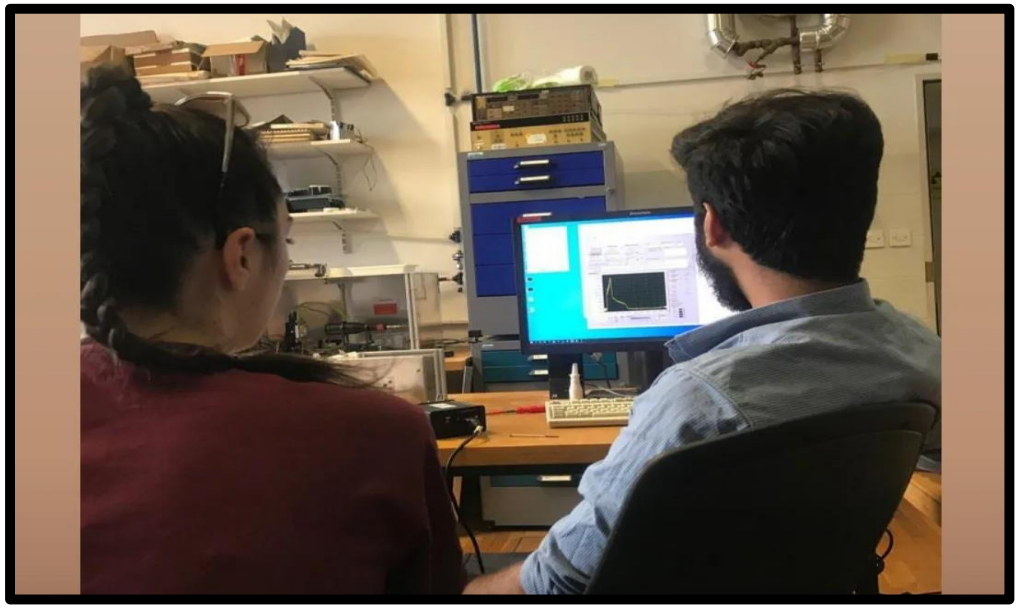
DAY 3 AND 4

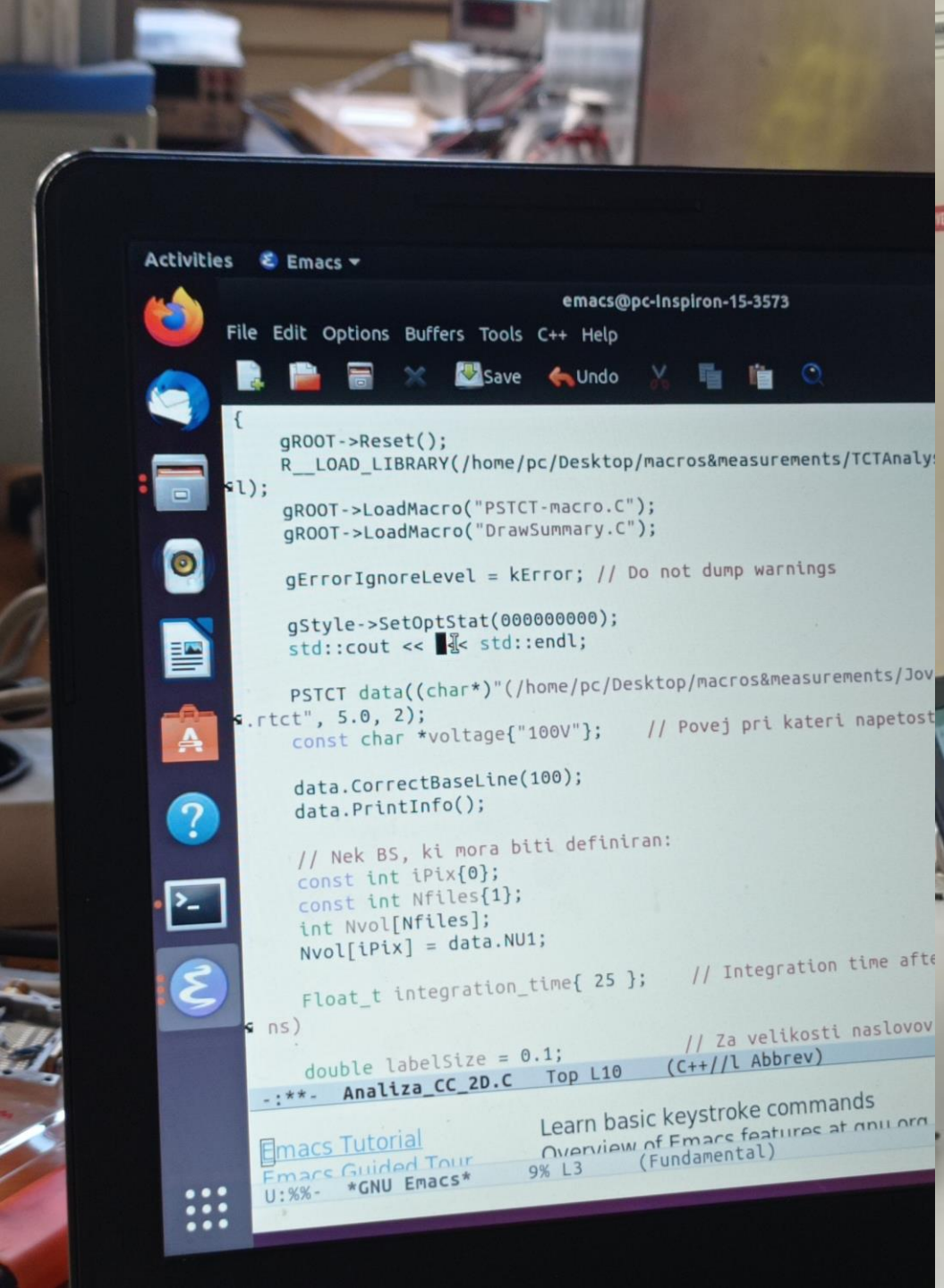
We got the opportunity to explore instrumentation and software at the lab for development and characterization of silicon detectors at the JSI.


Leica




PLANAPO 1.0x





DAY 5

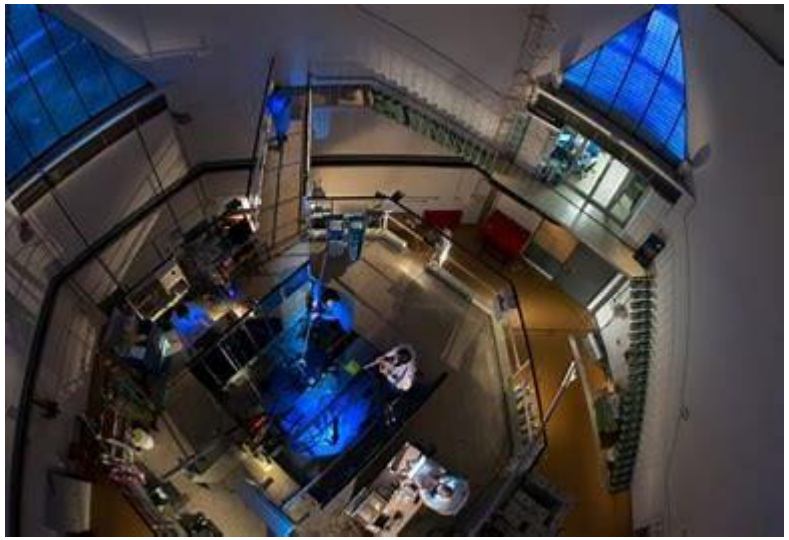
Lectures about the program ‘ROOT’

Introductory lecture, installation of the program on our computer, learning the basic principles and concepts, analyzing the codes that we use for our measurements.

DAY 6

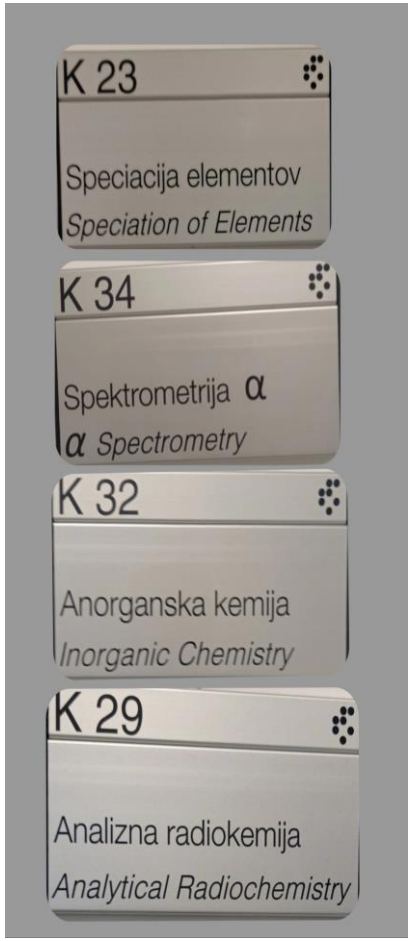
REACTOR „TRIGA“ in Ljubljana

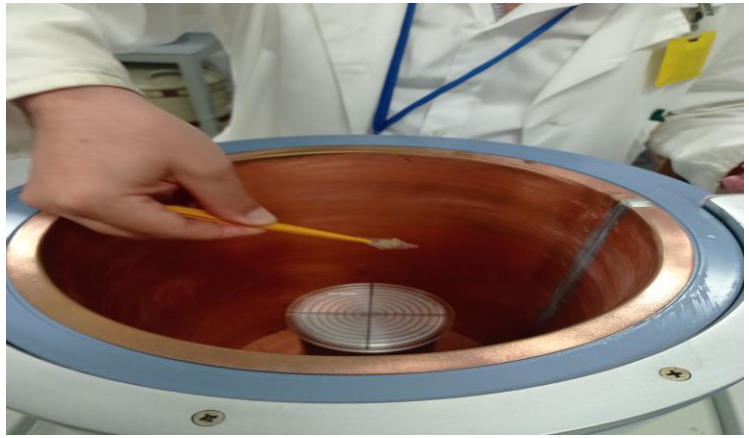
Highlight of the day

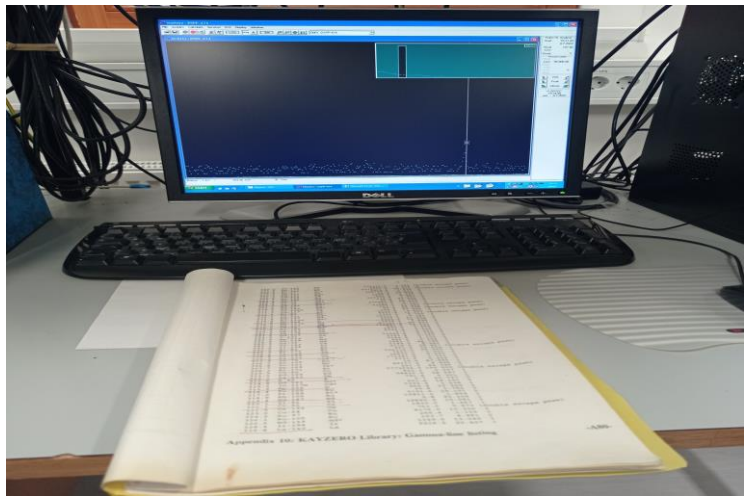


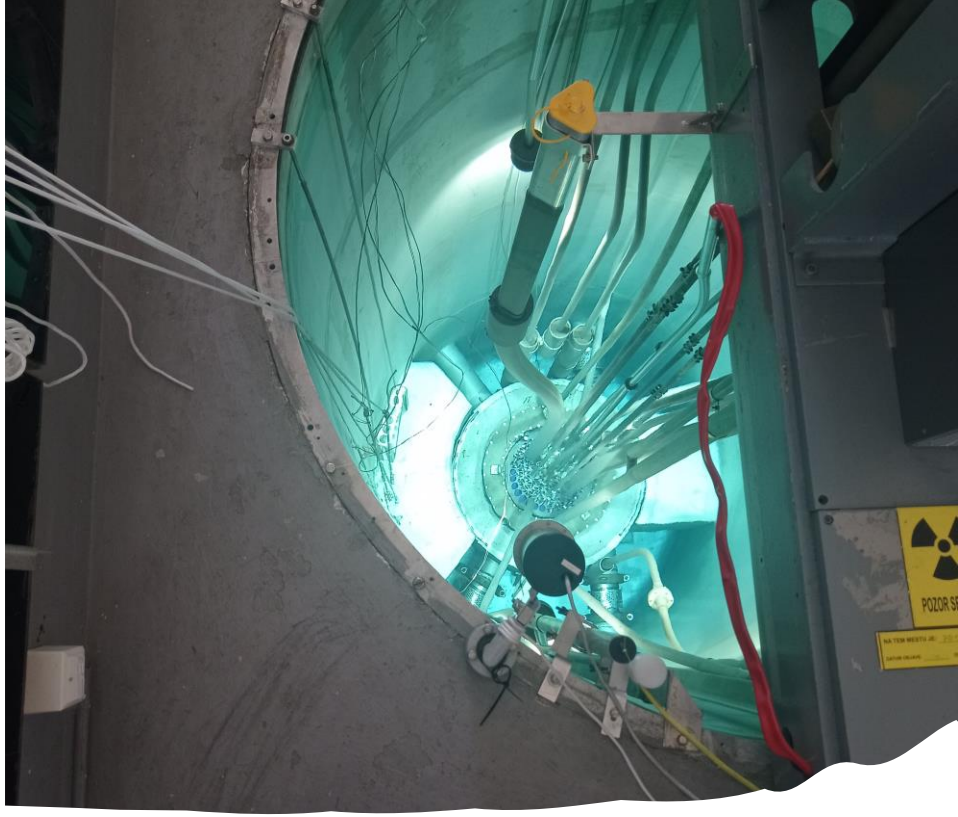
- We had the opportunity to visit more laboratories of the Institute in another department- the IJS Reactor Center.
- That day we got another mentor: Dr Radojko Jacimovic who performed three spectroscopic experiments with us, and then we toured the Reactor where we met Dr Anze Jazbec who explained to us how nuclear reactor works and all the physical processes that take place.
- Chernobyl accident was reconstructed in front of our eyes !

Here we show the experiment with the professor Jacimovic and some photos taken during our visit to laboratories at O2 (Chemistry of enviroment)

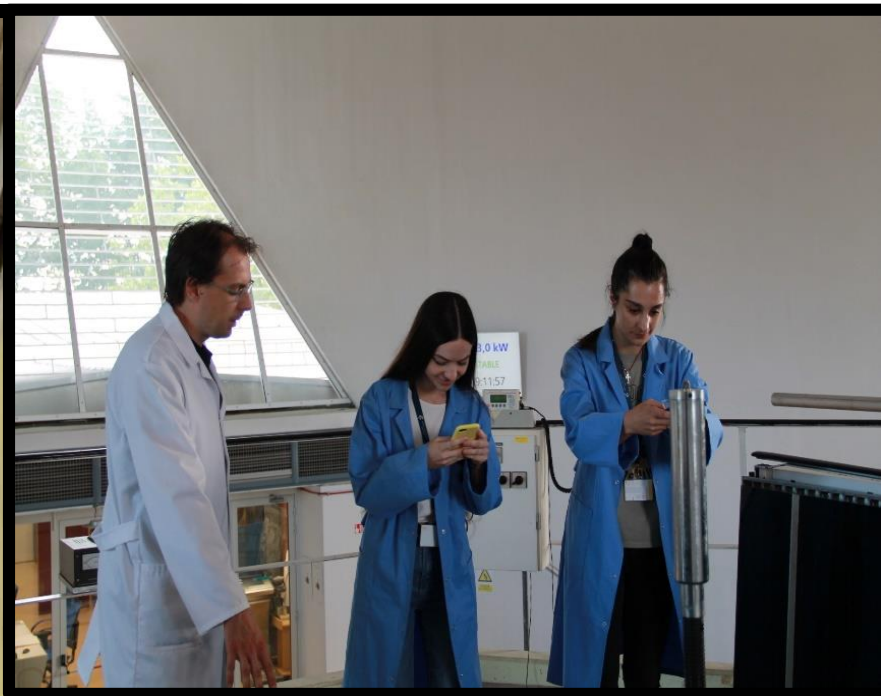


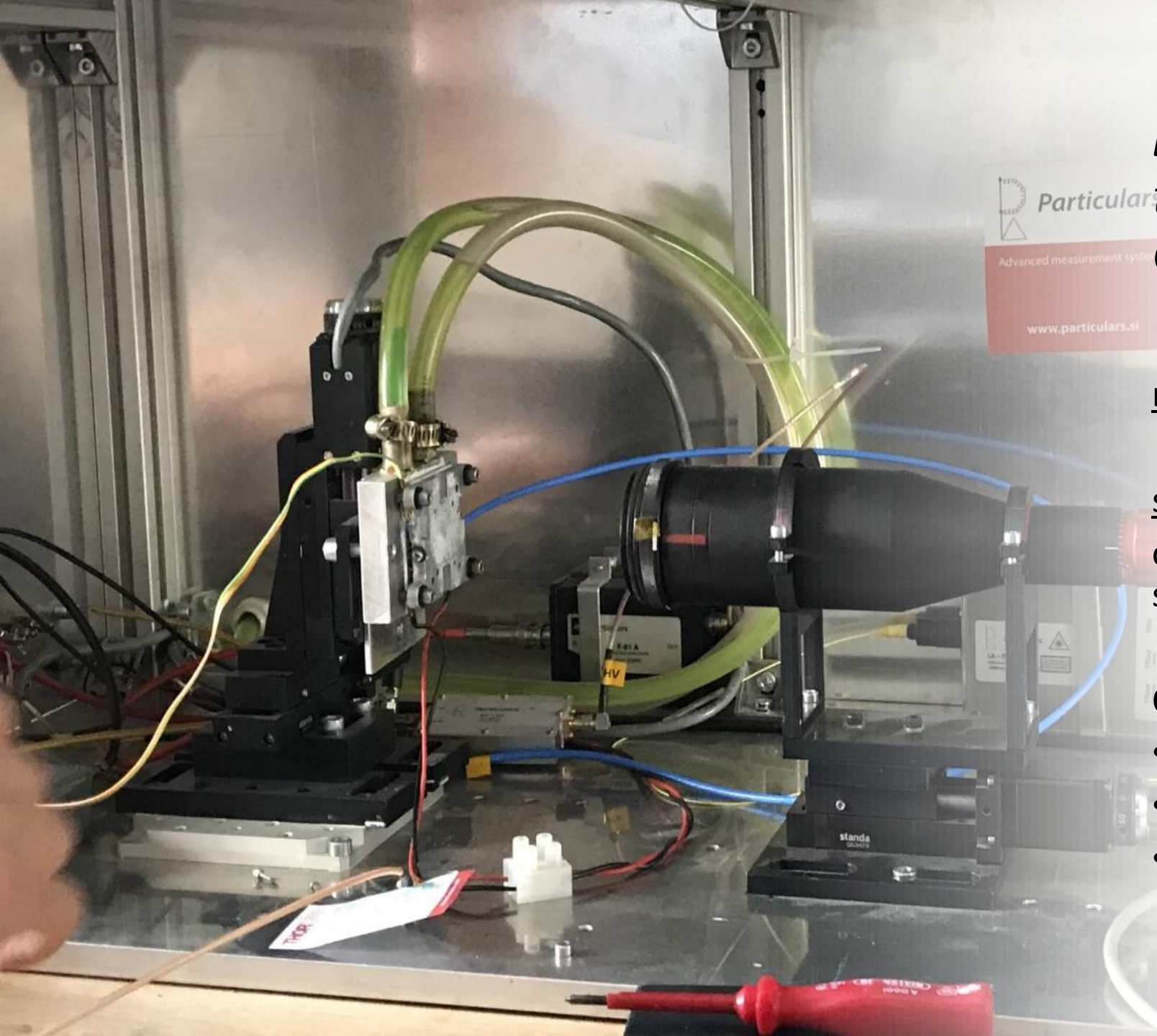






Reactor





Back to F9 and TCT *and training supervised by Gregor Kramberger.*

method: TOP TCT

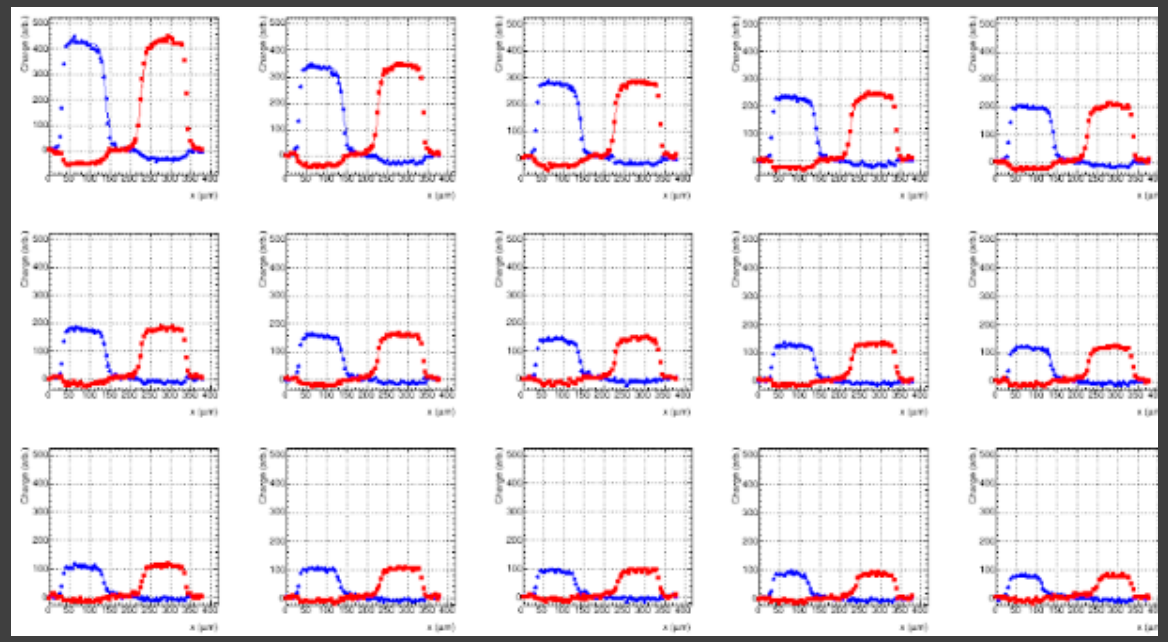
sensor: UFSD 1X2-T9-GR3_0

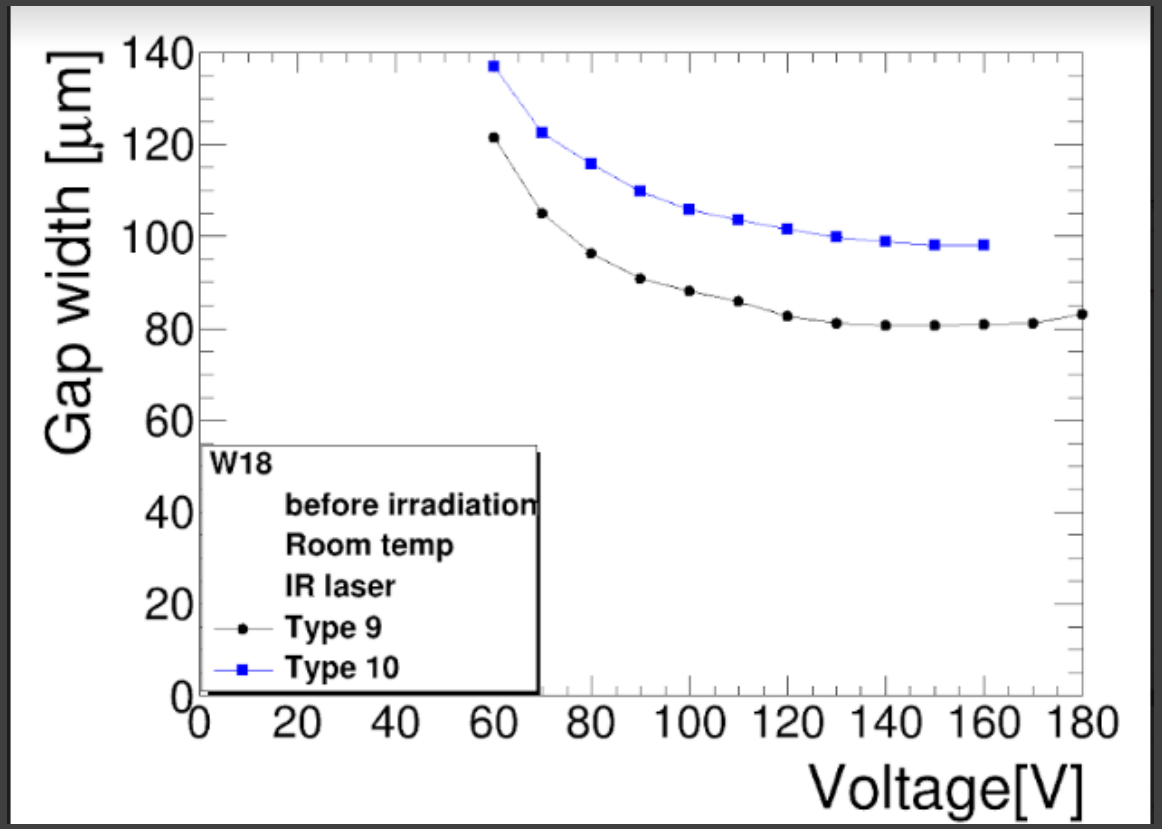
characteristics: NON Irradiated sample

OUR MEASURMENTS:

- CV and IV caracteristics
- CCE characteristics
- IP vs voltage

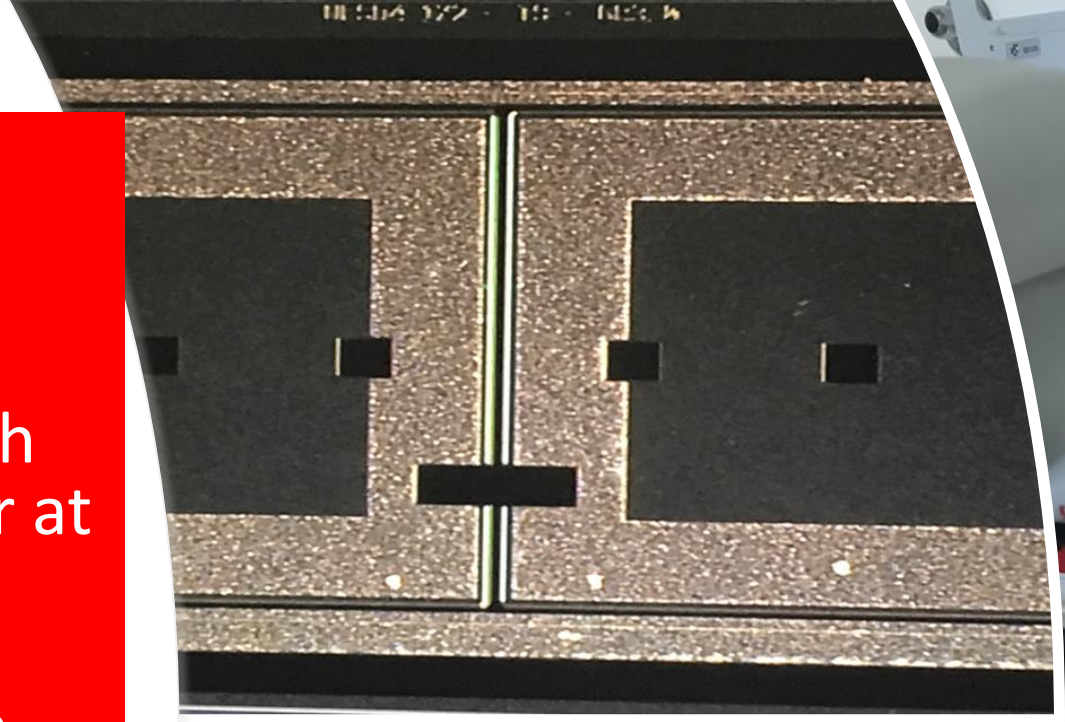
Our measuremnts (extracted example)

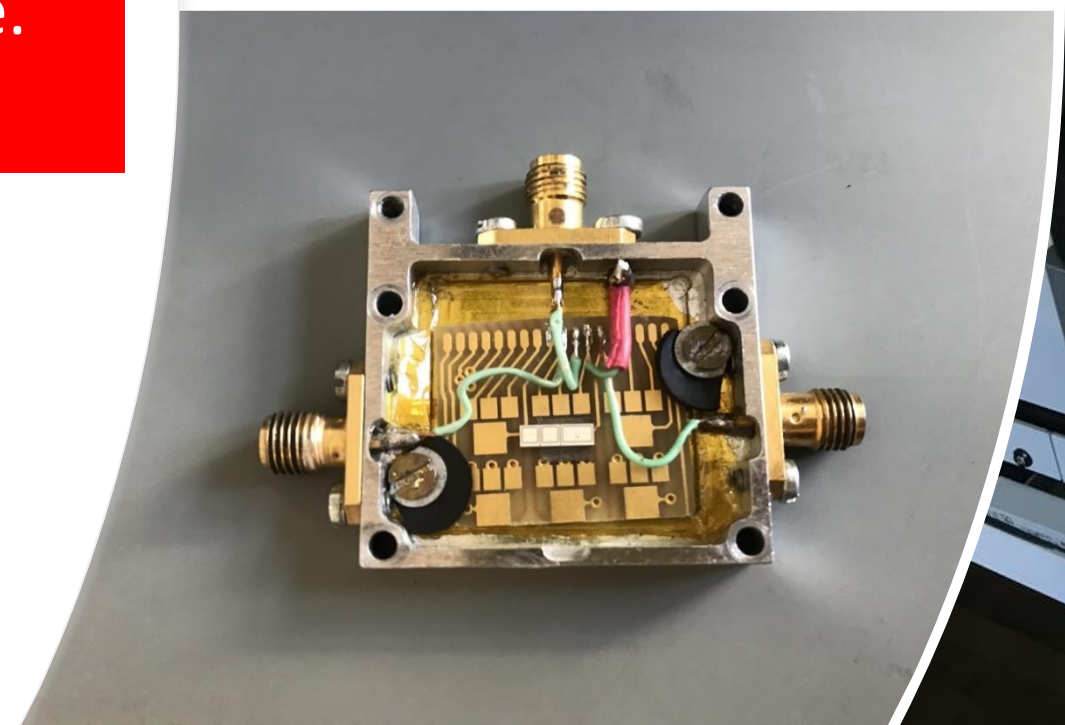


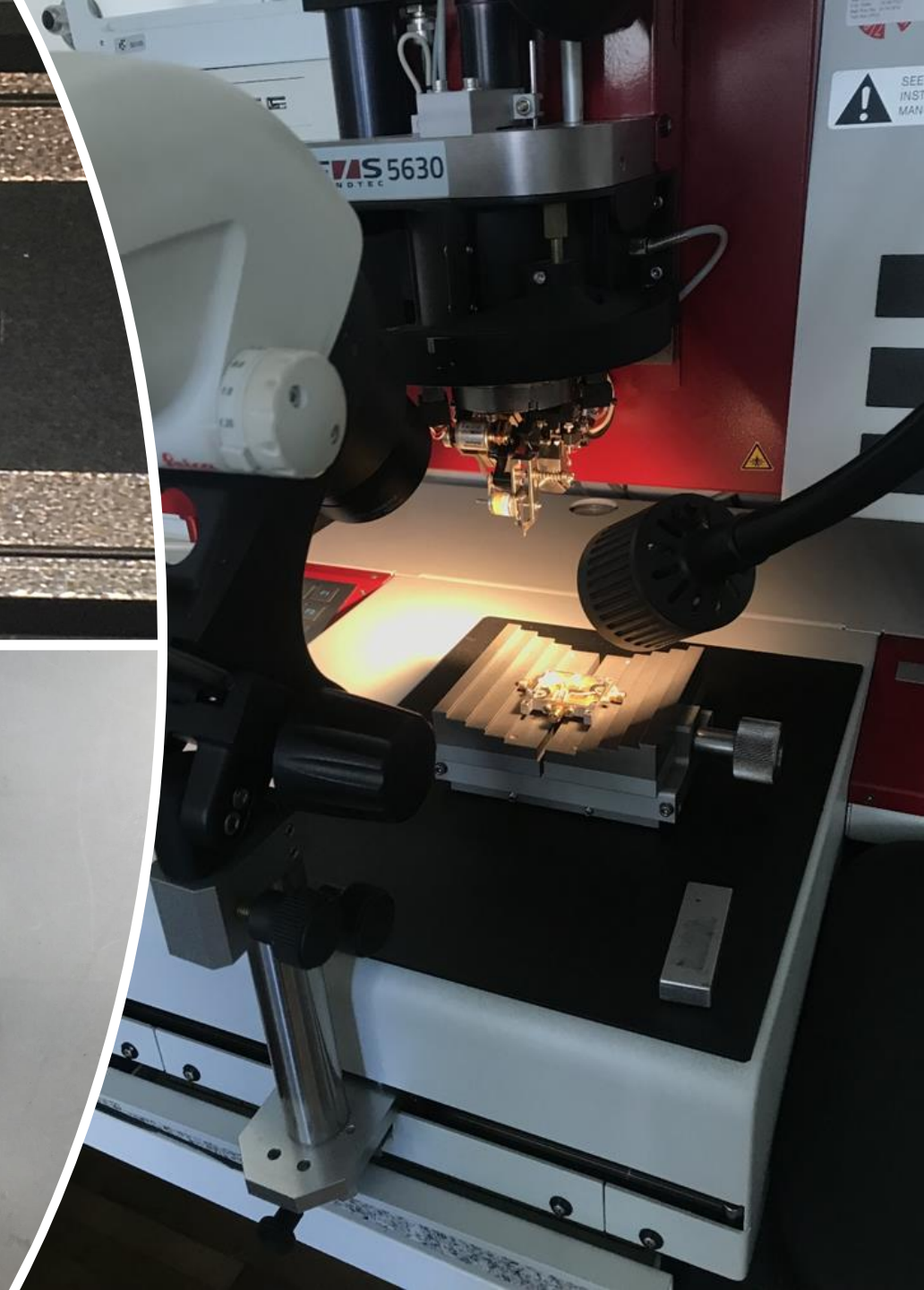


Our Interpad distance measurements on UFSD W18 Type 9 and Type 10 (supervised with Petja)

The training in Slovenia was introductory course into more complex training and research we did 2 weeks later at the International Research center ELI Beamlines in Prague.



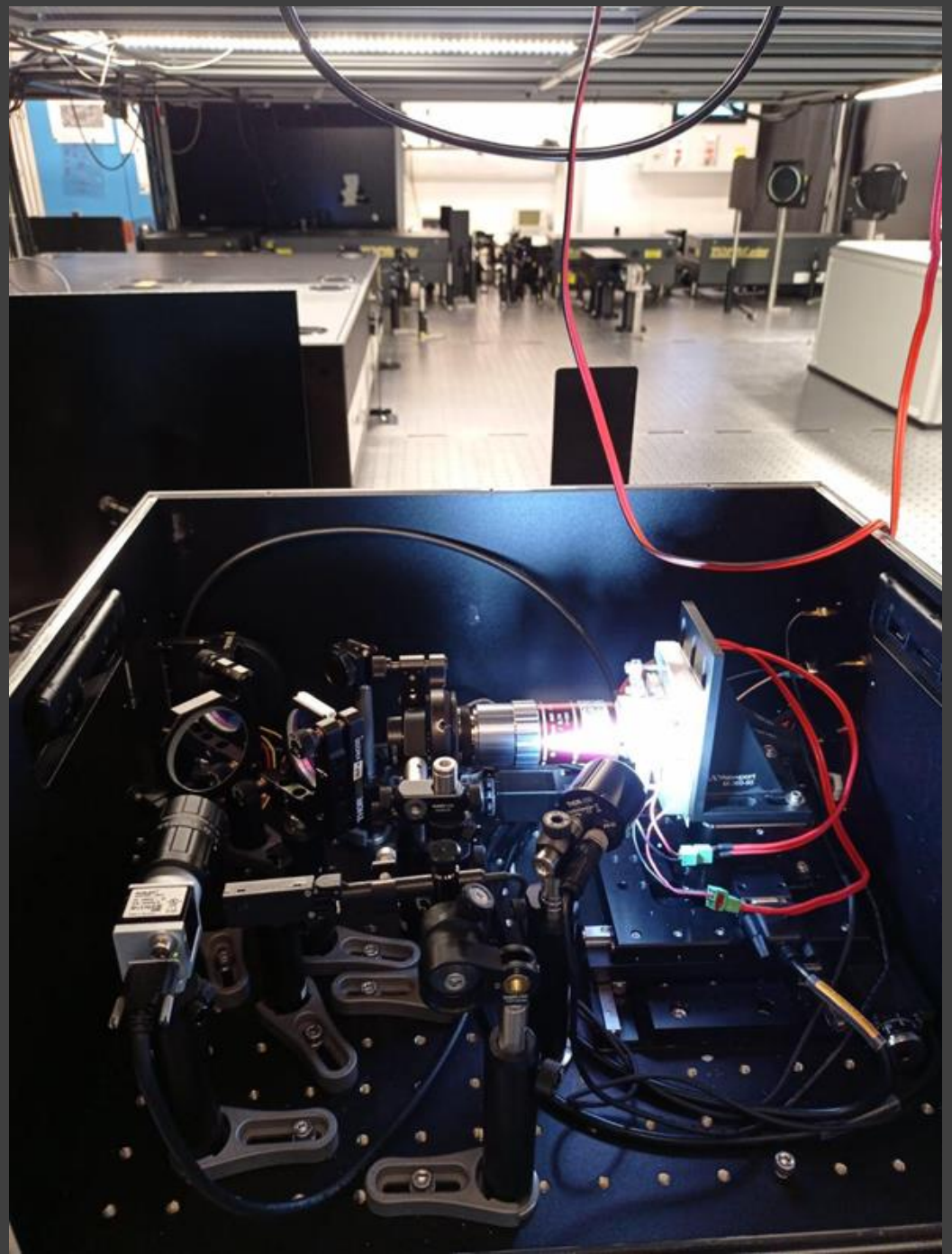




II part training

ELI Beamlines

This is the LASER HALL -E1 where out set up was placed



This is the TCT set up we exploited.

And here is image taken in the control room E1 with images of us in the control room.

- Before going to the Laser Hall, it is necessary to pass the Clean Room. Clean Room is a room that guarantees that dust and microorganisms that could affect the outcome of the measurement will not be brought into the laboratory. When we provide optimal (sterile) conditions, we move to the Control Room. The Control Room ensures that only persons with the necessary identification enter the Laser Hall. We enter the laboratory after the sound signal when the sign (LASER ON) is on the board, which ensures our safety and the safety of the people already in the laboratory.

Jovana DOKNIĆ

Ivona BOŽOVIĆ

Training by days:

Designed by Mateusz Rebarz and prof. G. Medin

- 25.07: Arrival to ELI. First trainings:
  - ✓ general safety training,
  - ✓ chemical safety training,
  - ✓ clean room training,
  - ✓ laser safety training.
  - ✓ tour of the building.
- 26.07: Training at the experimental hall (E1).
  - ✓ TCT-SPA Setup overview.
- 27.07: Training at the experimental hall (E1).
  - ✓ The set up was dismounted and we had to built it from the scratch!
  - ✓ Connecting all parts of the setup, with a detailed explanation of functionality of each part with detailed description of physical processes following the laser interaction with sensor.
  - ✓ Software management and data acquisition training on a laptop.
- 28.07: Training at the experimental hall (E1).
  - ➢ Positioning of the Device under test (DUT) , using the specially developed software and taking the first measurements.
- 29.07: Continuation of training with a test sample,
  - ✓ several measurements were made by changing the voltage. Getting the first results.
  - ✓ 1.08: Training in the use of software for processing the obtained data. Installing the software on our computers and training on how to analyze data we took in our measurements.
  - ✓ Preparation of sensor A9; its inspection using advanced microscope; obtaining a magnified and clear image of the sensor using a microscope.
- 2.08: Training continued:
  - ✓ Sensor placement, positioning using computer software.
  - ✓ Measurements were made at room temperature for 0.2 pJ and 5 pJ for a z scan.
  - ✓ Using the computer, we changed the voltage values.
  - ✓ Five measurements were made in the interval from 50V to 230V for 0.2pJ, and four in the interval from 100V to 230V for 5pJ.
  - ✓ We controlled the signal using an oscilloscope.

3.08. Since sensor was an irradiated sample, we used a cooling system. We did the same measurements at a temperature of -21˚C.

(During our stay in Prague there was 9th International Conference. Frontiers of Quantum and Mesocopic Thermodynamics 2022. and Mateusz invited us with his colleagues from ELI to join them at the Concert of classical music!)

4.08. Departure to the Institute of Physics in Prague.

- ✓ Monitoring of the wire bonding process of the samples sent from the Jožef Stefan Institute in Ljubljana.

5.08. **Introduction to TPA setup.**

8.08. Independent installation of sample (HPK p2). Depth scan for voltage values from 100V to 400V. These measurements lasted about 3 hours on average for one voltage value. In the breaks between voltage changes, we processed previous data in our office.

9.08. Continued work with HPK2.

10.08. Sensor placement. Measurements for TI LGAD W11 A4 were made for voltage values ranging from 50V to 230V. Z scan and trench scan were performed.

110.8. Continued work with TI LGAD W11 A4. After completing the measurement and data processing, we attended a lecture by Shudhashil Bharthuar, a member of the RD50 community. The lecture discussed LGAD and different types of sensors.

12.08. Summarizing the obtained results and a short training in the use of another data processing software. A short demonstration of plasma creation.

It is important to note that from the second week we work independently, starting with setting up the sample, positioning and changing the conditions (voltage) and using the cooling system.

We worked independently, but under the supervision of mentor Mateusz.

We also processed the data independently on our computers using software installed by our mentor and using Origin.

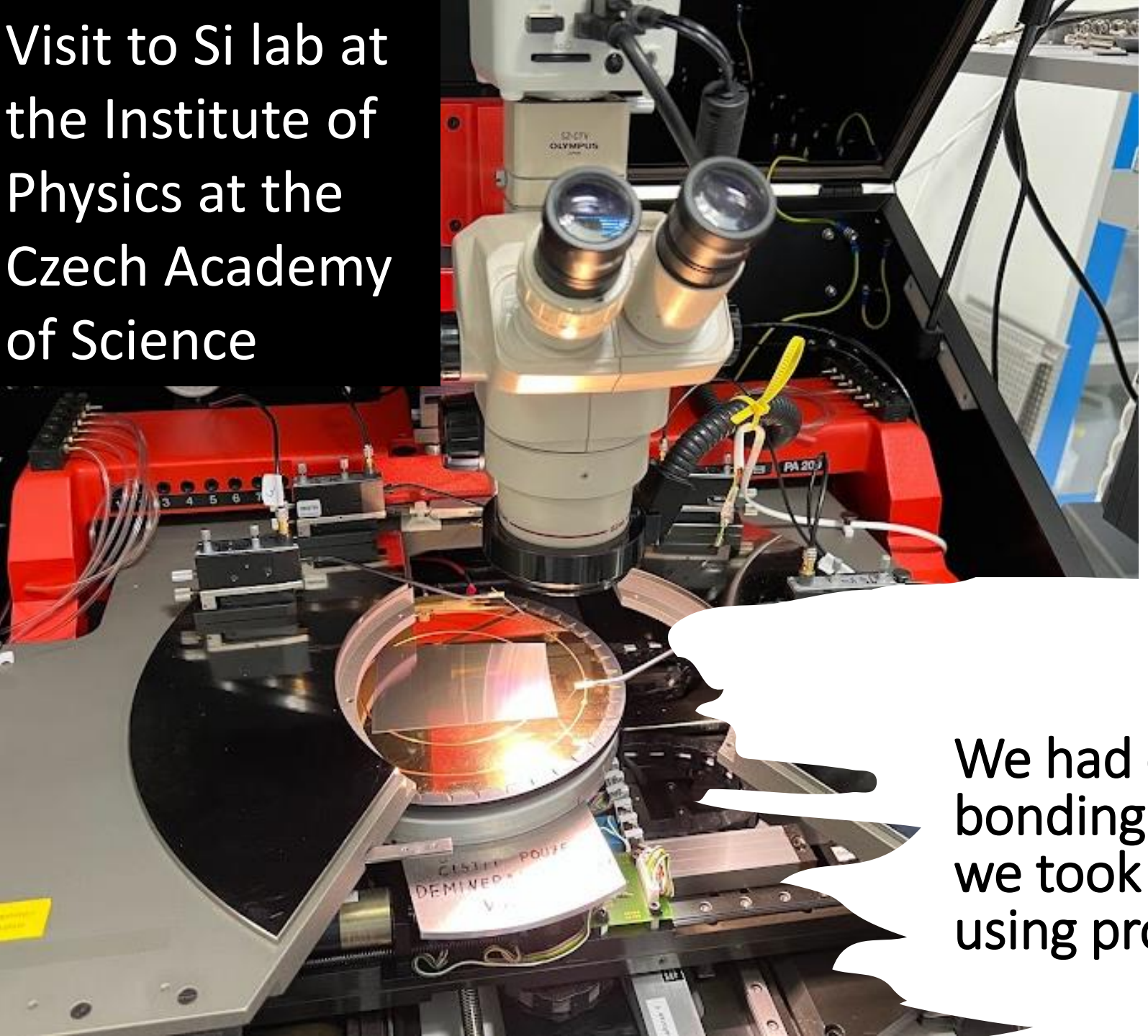
The most challenging task

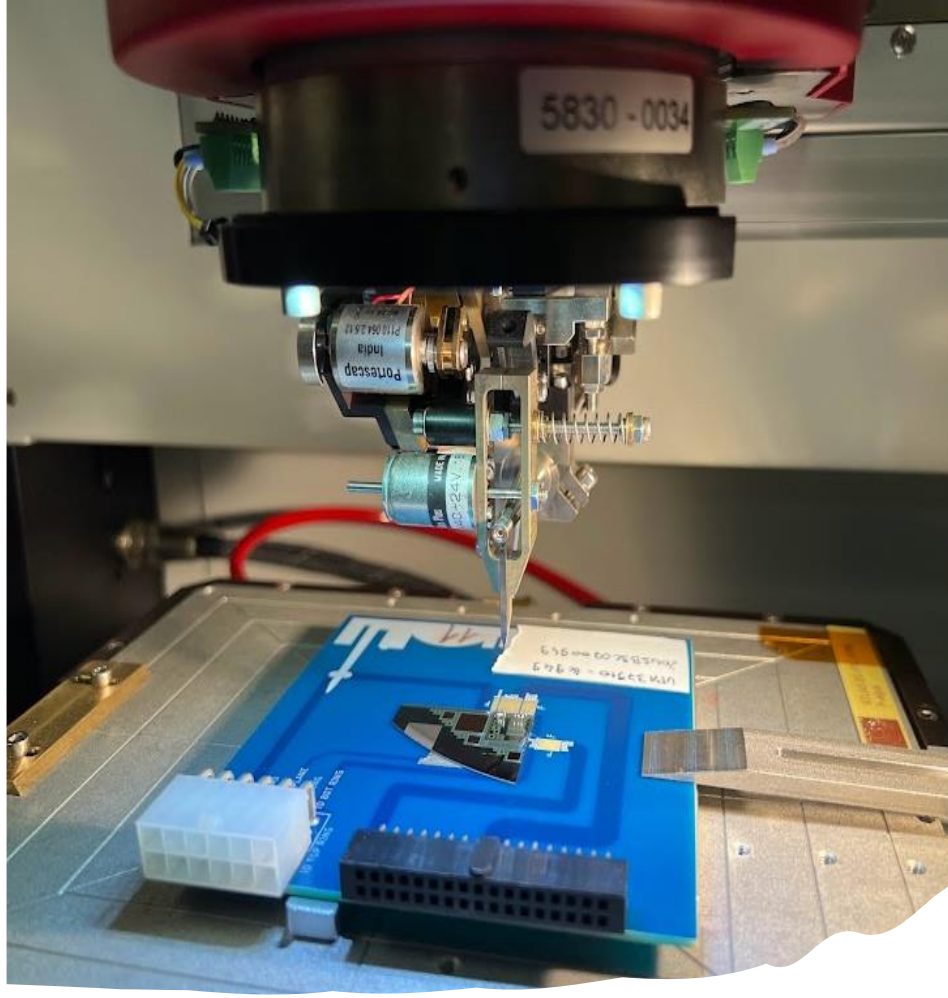
- The most challenging task was when we have been asked to mounted TCT by our self (including TPA)!

  For that purpose Mateusz sacrificed existing set up. He generously dismounted it for the sake of his teaching . We did all from the scratch, focusing beam, positioning, connecting all parts, calibrating, testing…

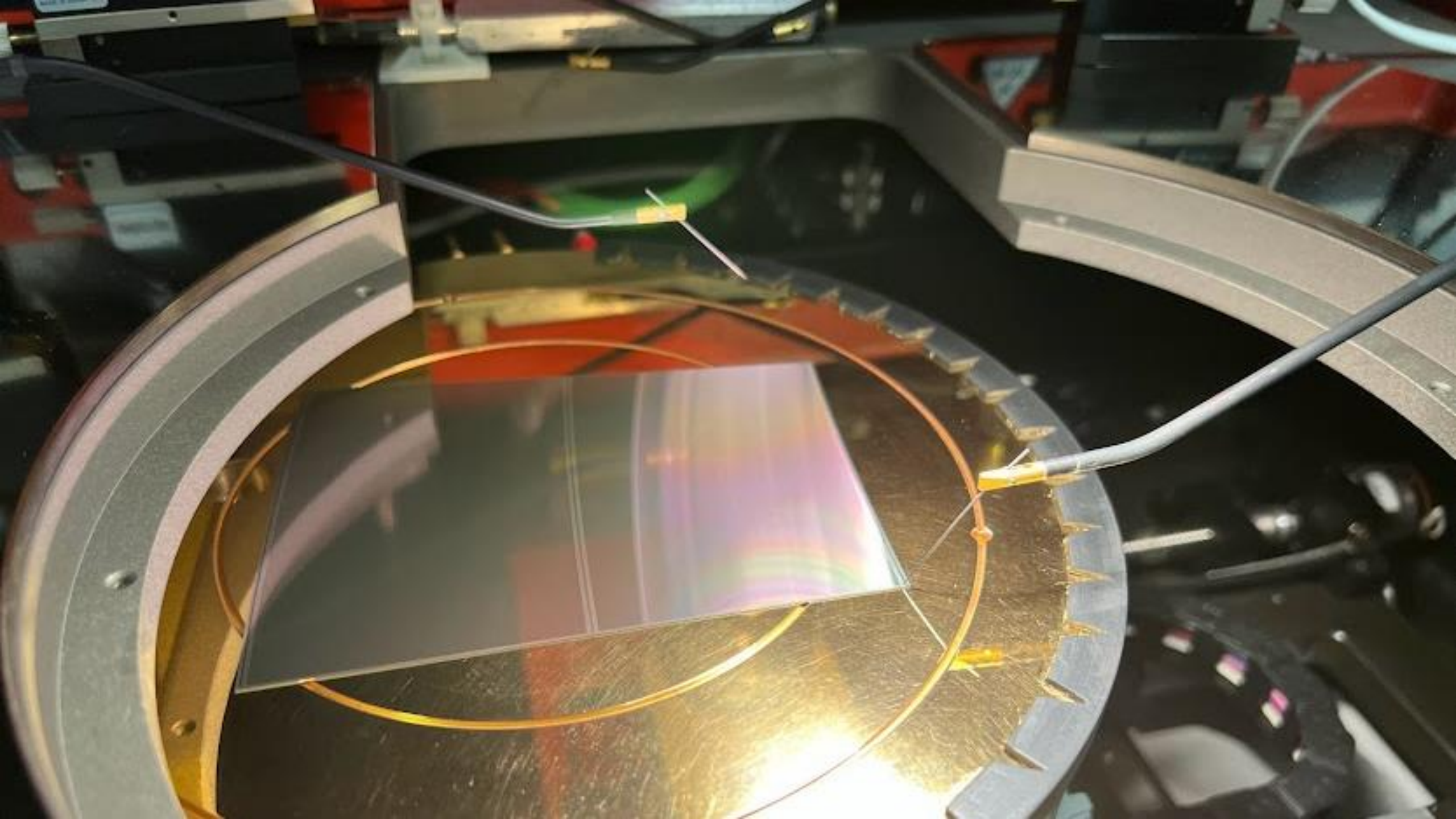
- At the end we were the most proud student in the world! And our mentor was proud on us.
- Then we did independently IP measurements!

Visit to Si lab at the Institute of Physics at the Czech Academy of Science

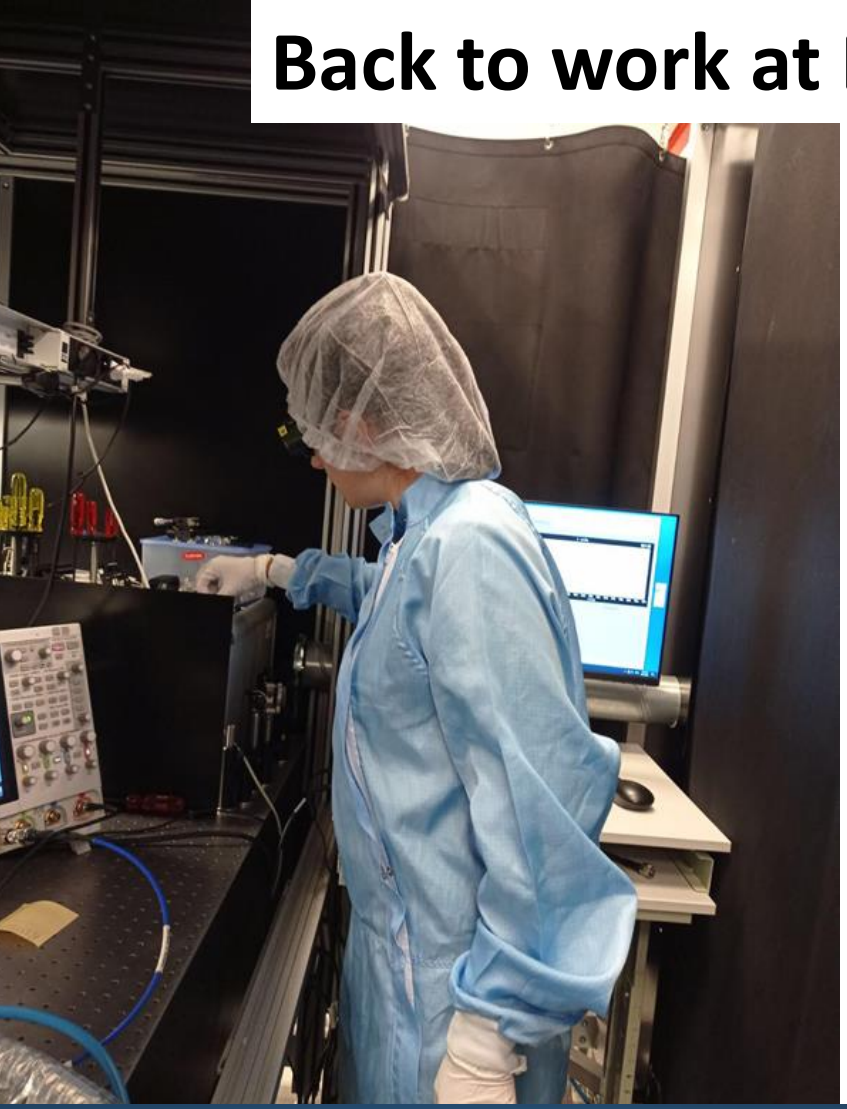


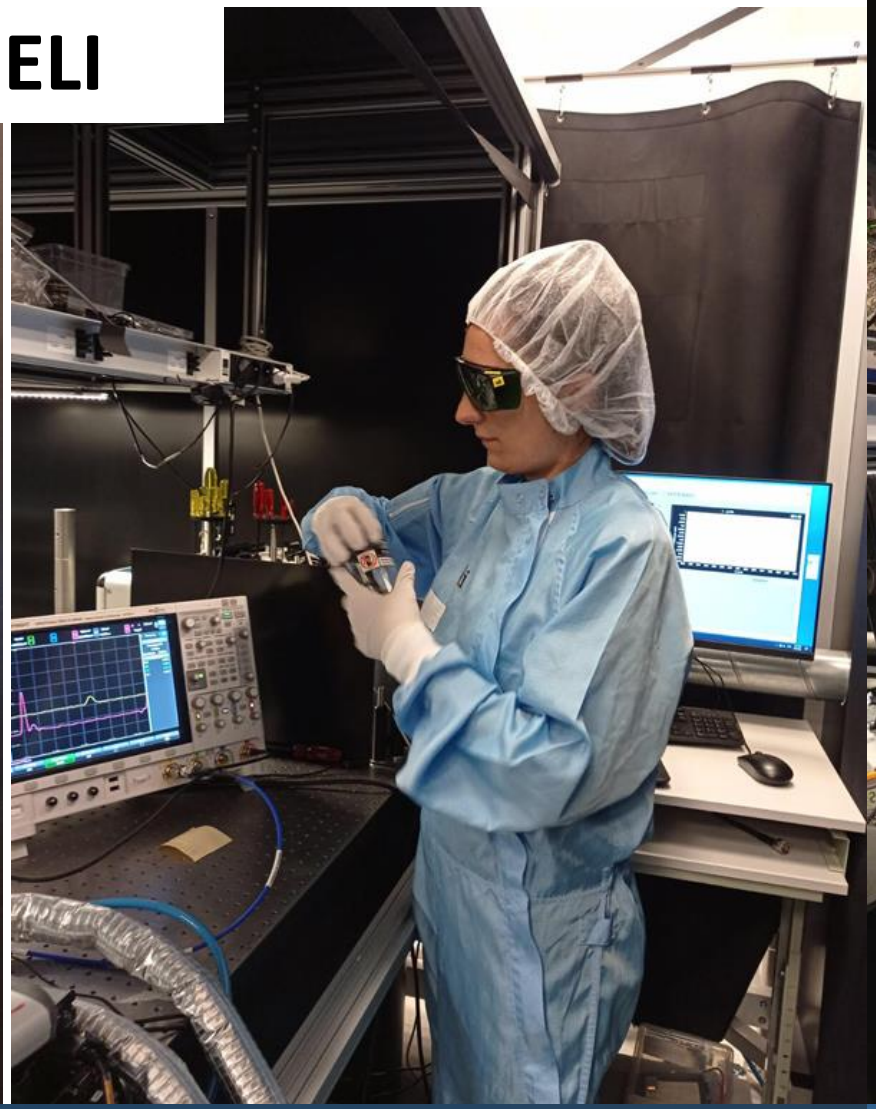


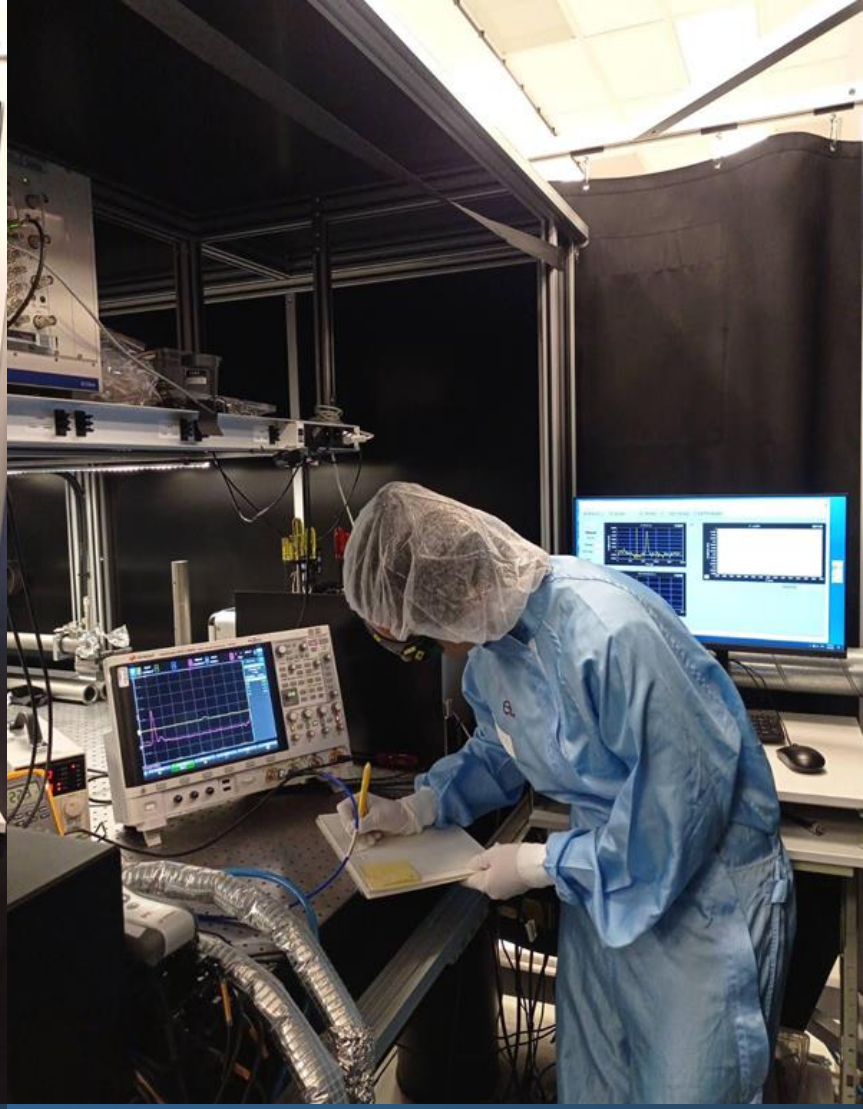
We had chance to observe the wire bonding performed by Jiri Kroll and we took part in IV measurements using probe station.



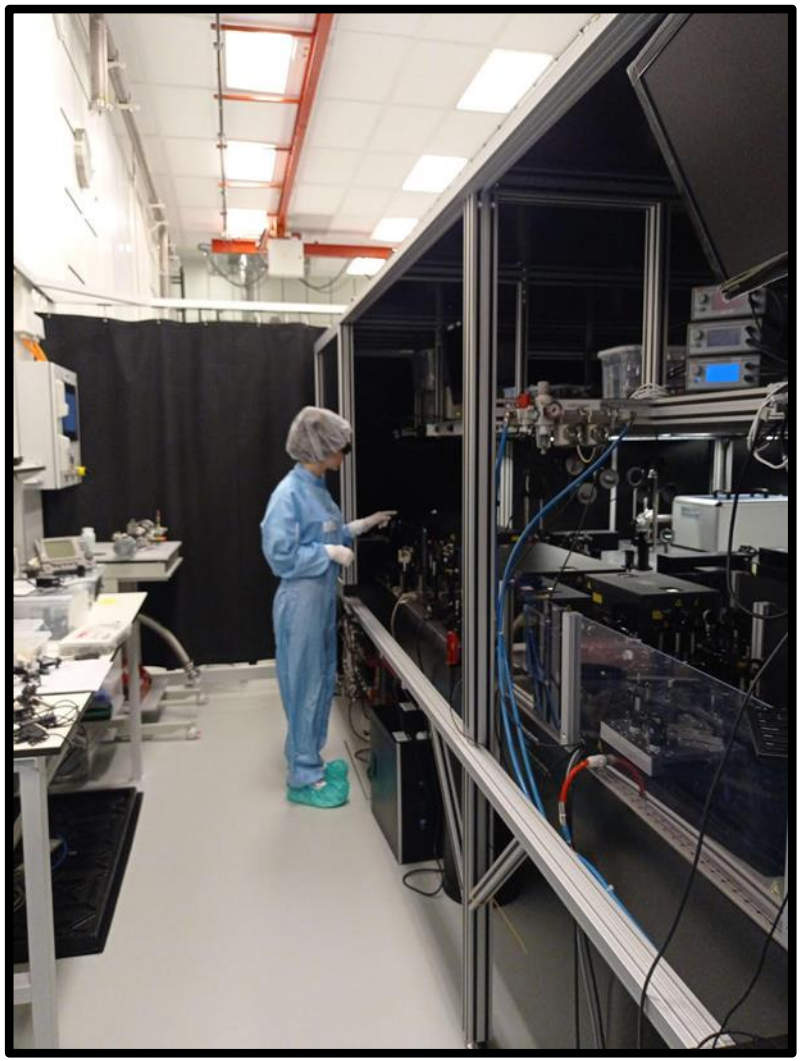
Back to work at ELI

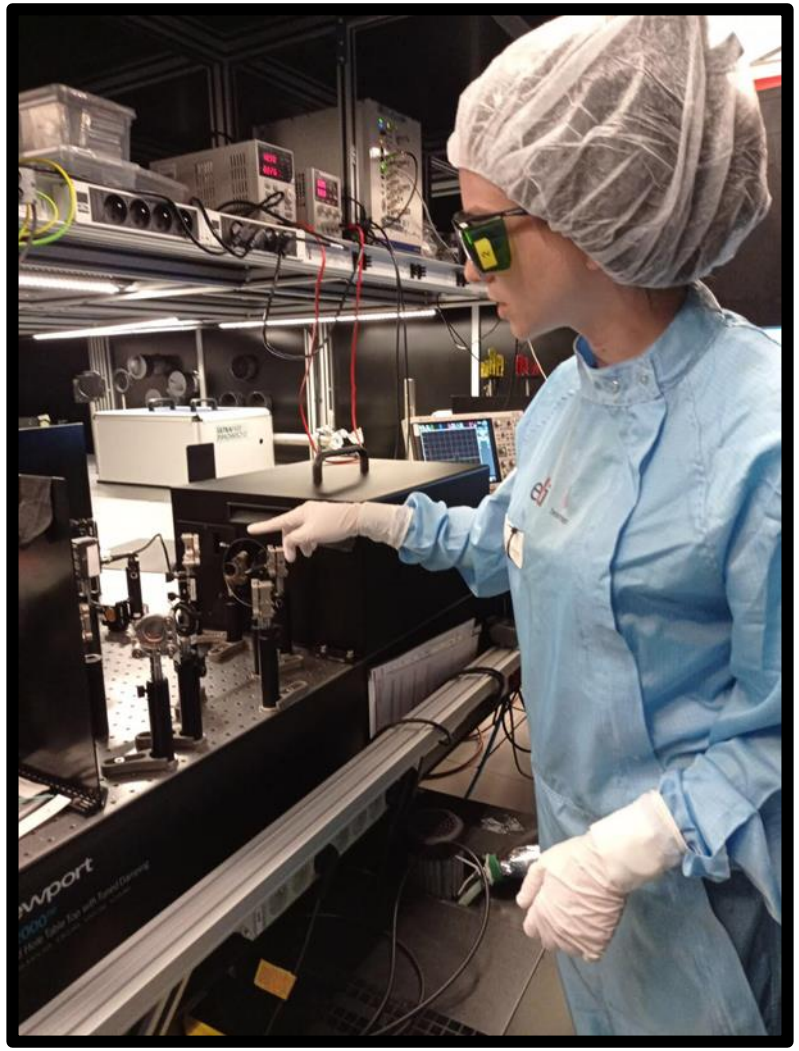




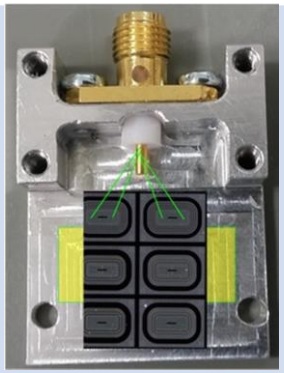
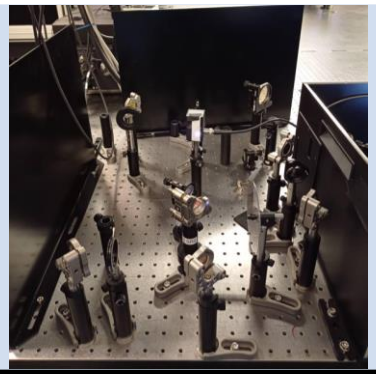
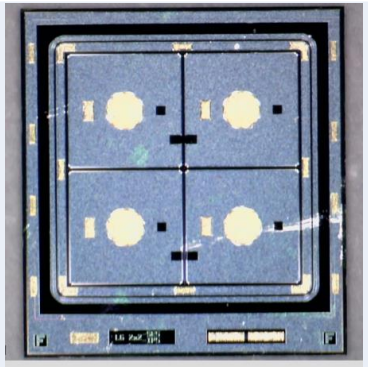
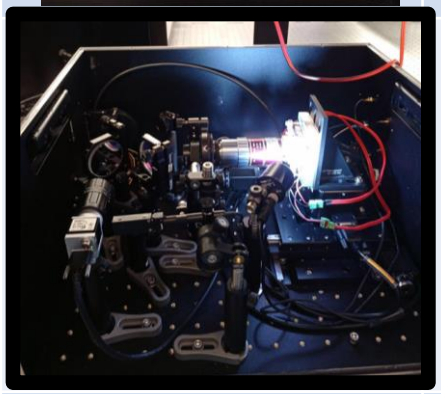
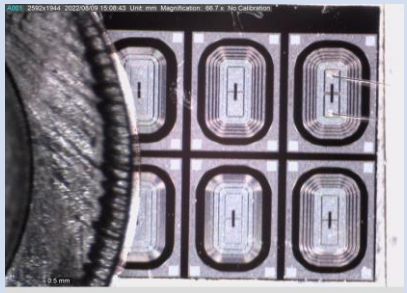


Jovana Doknić





Ivona Božović

Senzor	Slika	Set-up	Metod
A9			**ROOM TEMPERATURE:** • 0,2 pJ (50-230)V • 5 pJ (100-230)V **Using the chiller (-21˚C)** • 0,2 pJ (50-230)V • 5 pJ (100-230)V
HPK2			100-400V
A4 W11			MEASURING TRENCH SCAN for: 50-230V

Summary

- The training that lasts for 4 weeks have been designed for us, 2 students from University of Montenegro: one week at JSI, and 3 weeks at ELI Beamlines.
- The largest difference between training at the JSI and at the ELI Beamlines was that at JSI we were instructed how to apply TCT technique, (ps –laser, SPA) while at the ELI Beamlines we wee thought how to mount it. All by ourselves!
- We owe a great deal of gratitude to Mateuzs Rebarz, who worked with us and selflessly tried to teach us as much as possible in this short period. We say "the short" period, because we had in total of four weeks (a week in Ljubljana and three in Prague) to master and learn material that we had not encountered before at the University of Montenegro. On the other hand, the knowledge we acquired at the university helped us a lot to understand the physics that was hidden behind the "experiment" itself.
- It was a great honor to collaborate with and learn from scientists and work in laboratories like those at ELI. As part of the training, we had the opportunity to communicate with other students and learn about different cultures (Pakistan, India, Mexico, Japan...). It is important to emphasize that all the participants were master's and doctoral students, except for us, which was an incentive for us to work even harder.
- We would like to take this opportunity to express our gratitude to Professor Medin, who trusted us and made it possible for us to have this incredible experience for every student.

- We are just students of final BSc years, and it is awesome to be part of this very kind and supportive community!

Thank you.