Richard, Diana, Maria Eleni

EPS Hands-on Workshop

September 30 to October 2

Summary presentation

Day 1

- Introduction of the event and its purpose and objectives

- Visit at CMS including guided tour

Talks at IdeaSquare from Markus Nordberg

- Technology and collaboration at CERN
- Introduction into IP
- Introduction to IdeaSquare and its projects
- Informal discussion about the topics covered in the talks

Day 1: Recap

What was the most valuable insight on Day 1 for you?

Day 2: Rapid prototyping – Egg challenge

- Day 2 started with an introduction of Markus Nordberg on protoyping and its importance for technology development

- After the introduction the participants were distributed into 5 groups to engage in the *egg challenge*, e.g. finding a way to protect an unboiled egg from crashing when dropped down from a given height using given resources.

The groups engaged in two rounds:

  - In round 1 only a very restricted list of resources was available (A4 paper, Masking tape, Cardboard, Wooden skewers, foam pieces). Drop height ~ 1.6. m
  - In round 2 the available resources were extended to additional materials and tools available within IdeaSquare. Drop height ~ 3.5 m

- In round 1 2 groups succeeded
- In round 2 all 5 groups succeeded

→ the increase of performance from round 1 to 2 underlines the importance and value of prototyping

(One key success may also have been that team members did not know each other before)

Day 2: Allocation of teams

- To distribute the workload of building up the experiments the participants were distributed in 5 groups

Experiment 1

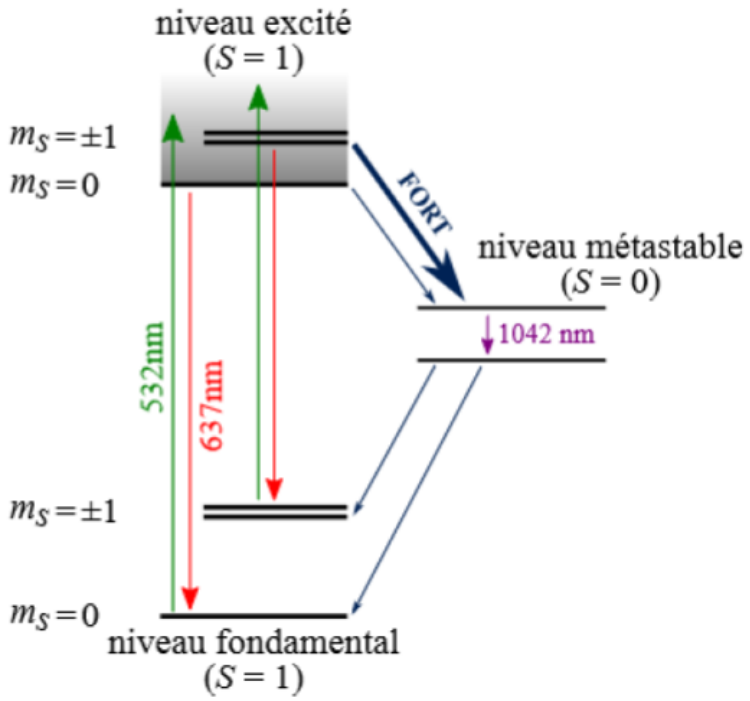
1. Software + data acquisition
2. Optics and interfacing
3. Electronics and connection
4. Mechanical setup
5. Synchronization of teams/Data compilation/Editing of final presentation

- To maximize the learning effect of the participants they were encouraged to join a team whoms tasks were outside their previous expertise.

- For experiment 2 the teams were slightly readjusted, but the structure with 5 teams was maintained.

Day 2: Quantum sensing experiment – Motivation

- NV- centers' electronic structure[7]

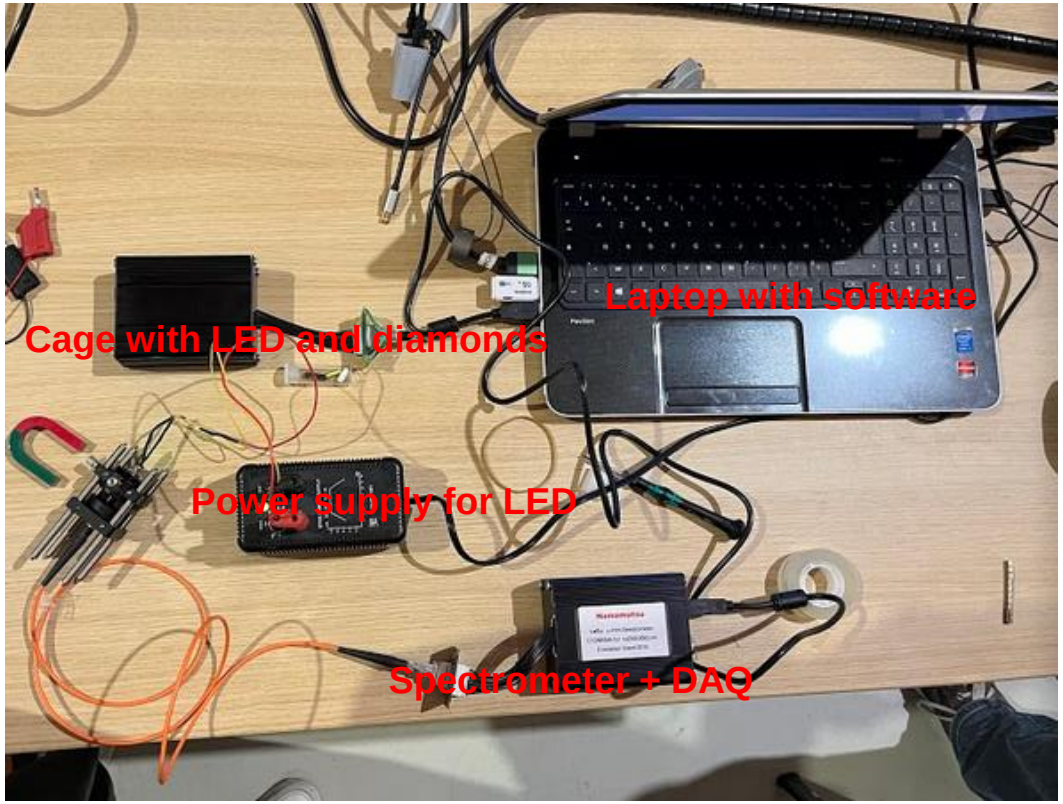


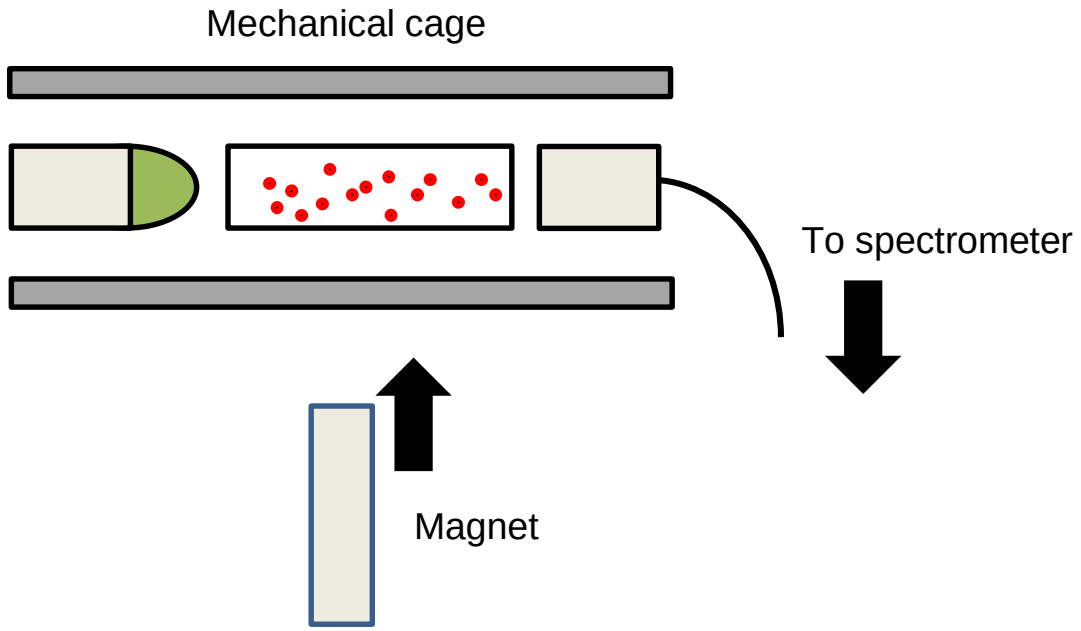
- The fluoresence of NV-centers is surpressed in the pressence of a magnetic field, since non-radiative transition become more probable.
- This allows to create simple and compact magnetic field sensors, with applications in e.g. engineering and medicine
- Following introductory talks from Jan Meijer and Stefan Kubsky the participants engaged in building a *proof-of-principle* quantum sensor.

From LoicToraille: Utilisation de centres NV comme capteurs de champs magnétiques à haute pression dans des cellules à enclumes de diamant. Physique [physics]. Université Paris Saclay (COmUE), 2019. Français. NNT: 2019SACLN056. tel-02429177v2; https://tel.archives-ouvertes.fr/tel-02429177v2

Day 2: Quantum sensing experiment – Experimental setup

Picture by Diana Craete

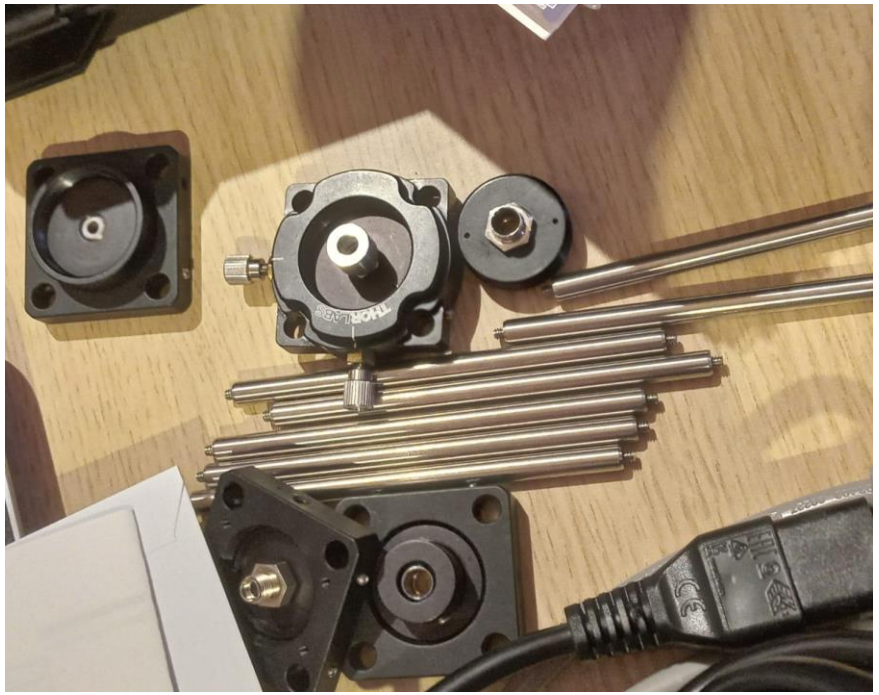




Two different combinations of spectrometer and optical fiber were tested.

Day 2: Construction of the mechanical cage

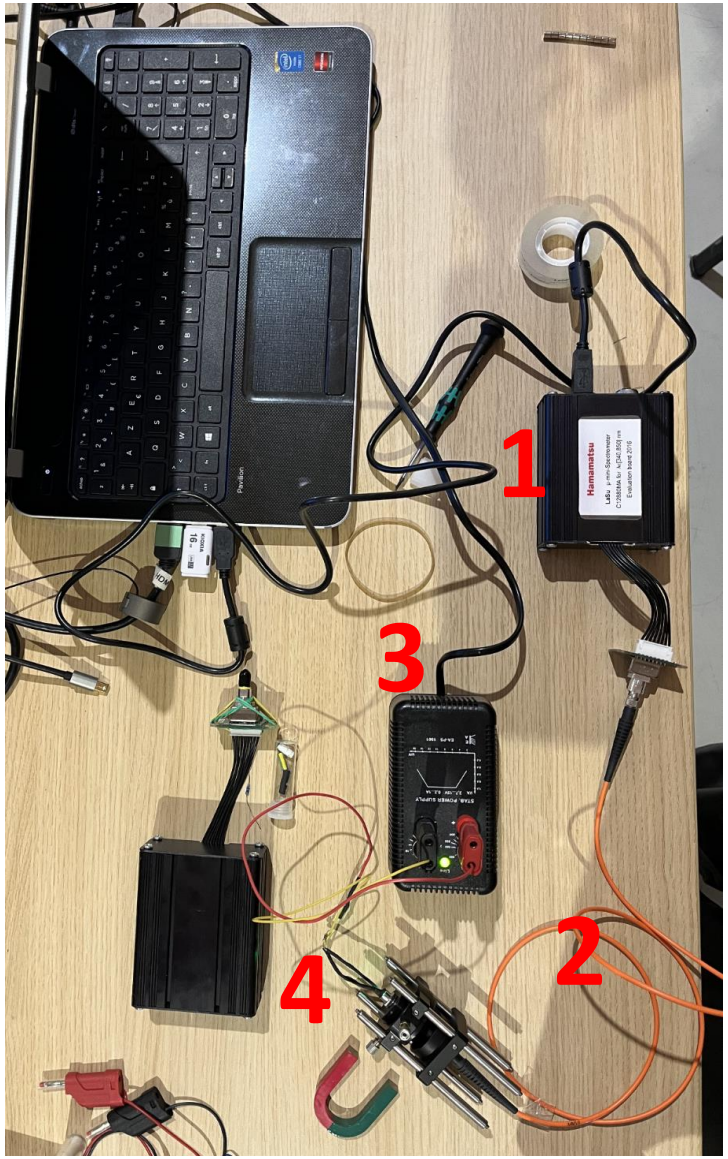
Material: Cage mechanical elements



Pictures by Diana Craete

Final structure

Day 2: Quantum sensing experiment – Results configuration 1



Picture by Diana Craete

STEPS

1. Connect spectrometer (1) to laptop.
2. Open the program (ThorLabs).
3. Connect the voltage supply to the leaser
4. Setup the green laser (4) and aimed it right to the hole of the optical fiber (2).
5. Plugged the one edge of the optical fiber (2) to the laptop, and the other one to the spectrometer (1).

Day 2: Quantum sensing experiment – Results configuration 2

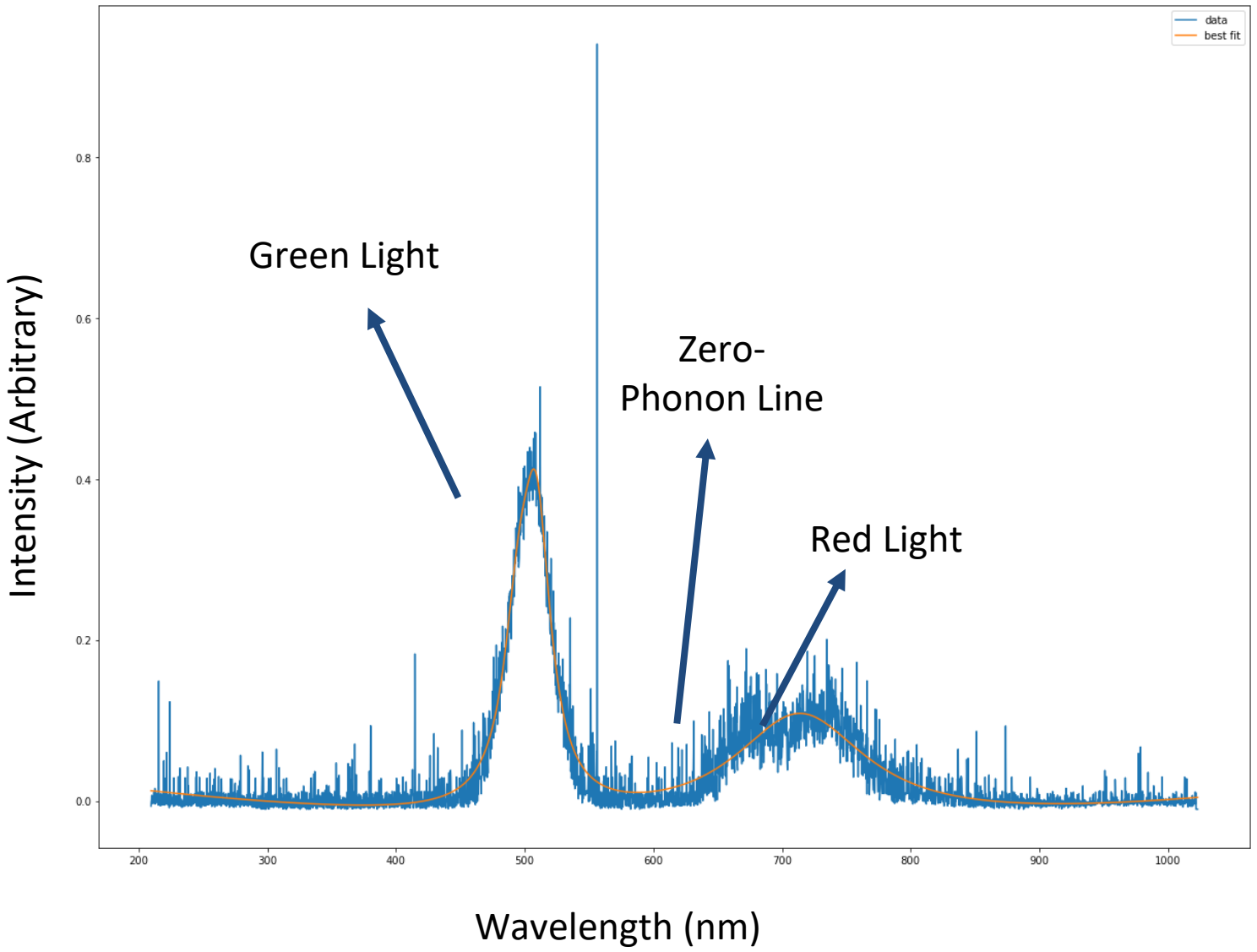
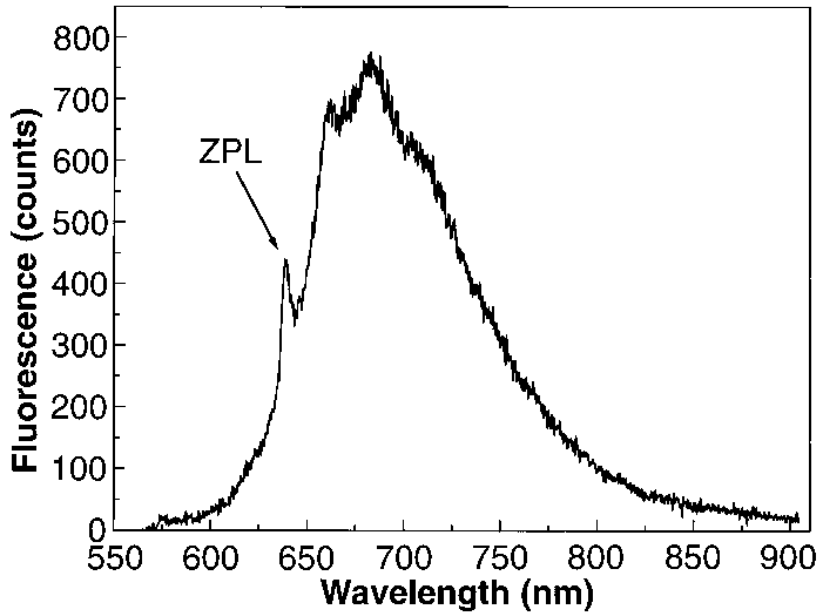
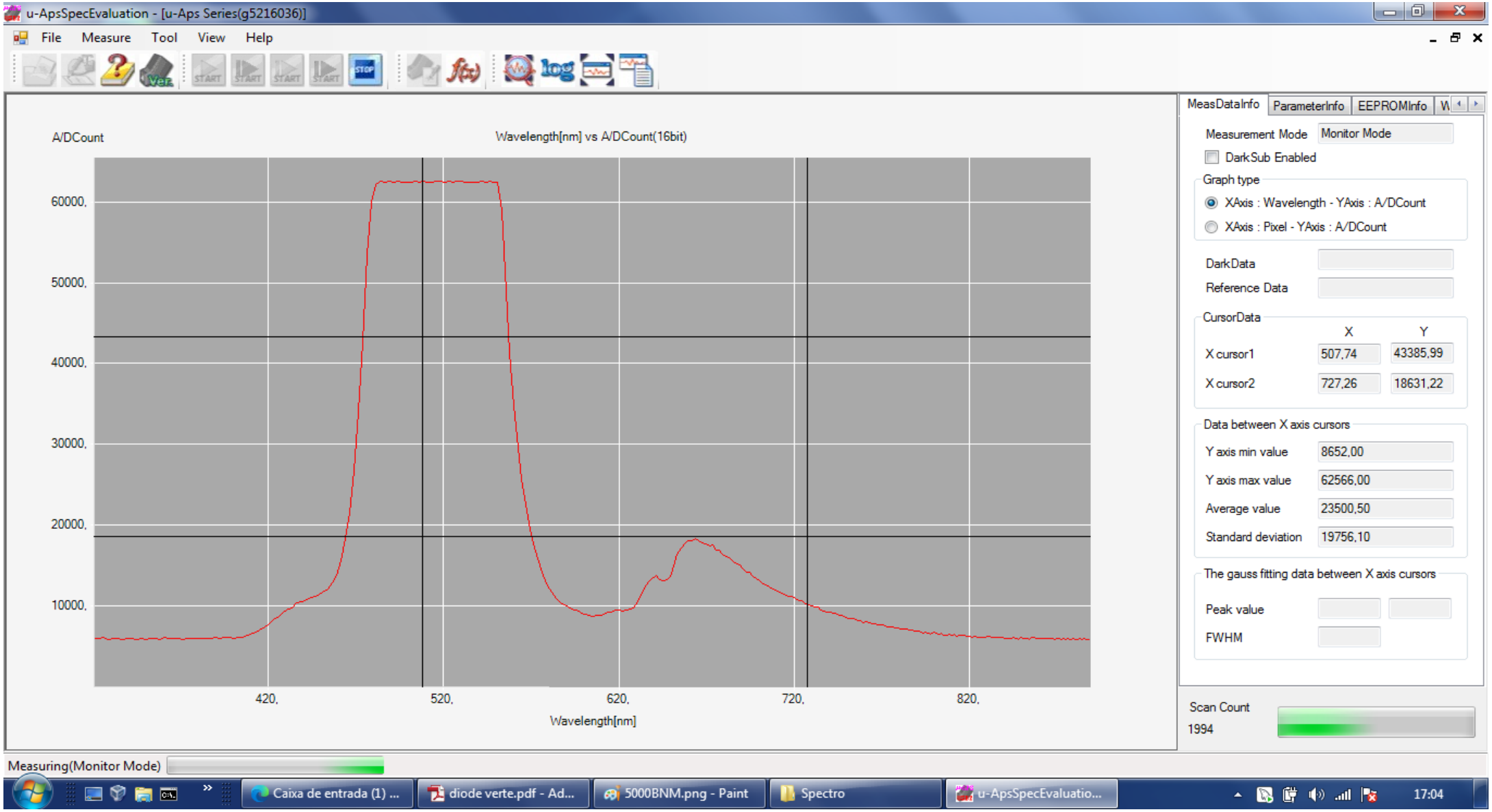


Figure 1: Measurements with magnetic field applied

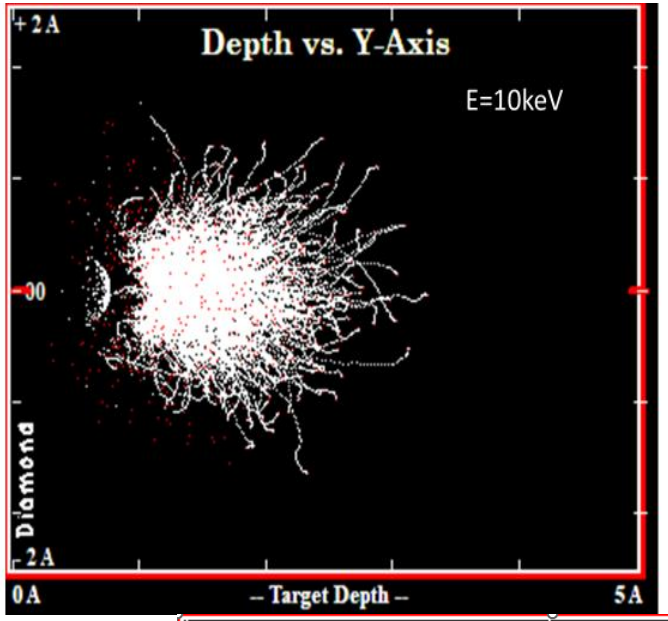
Figure 2: Theoretical plot.

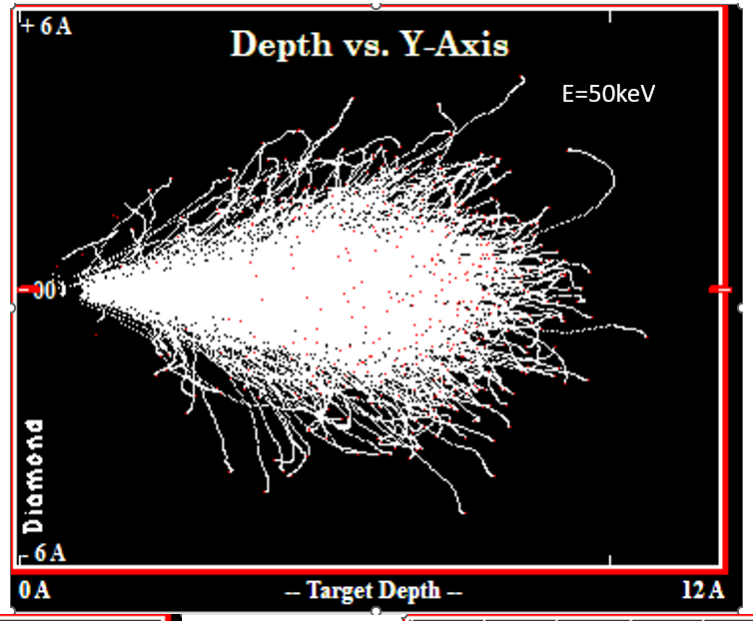


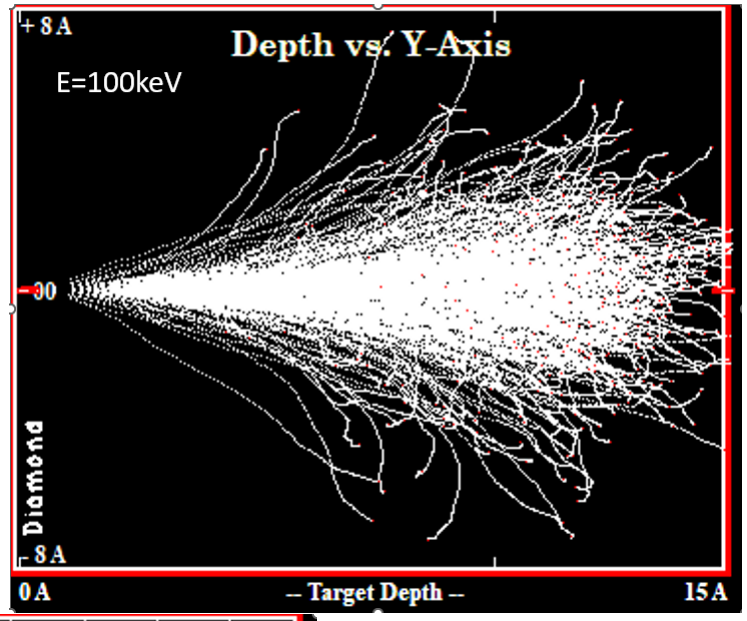
Day 2: Second spectrometer

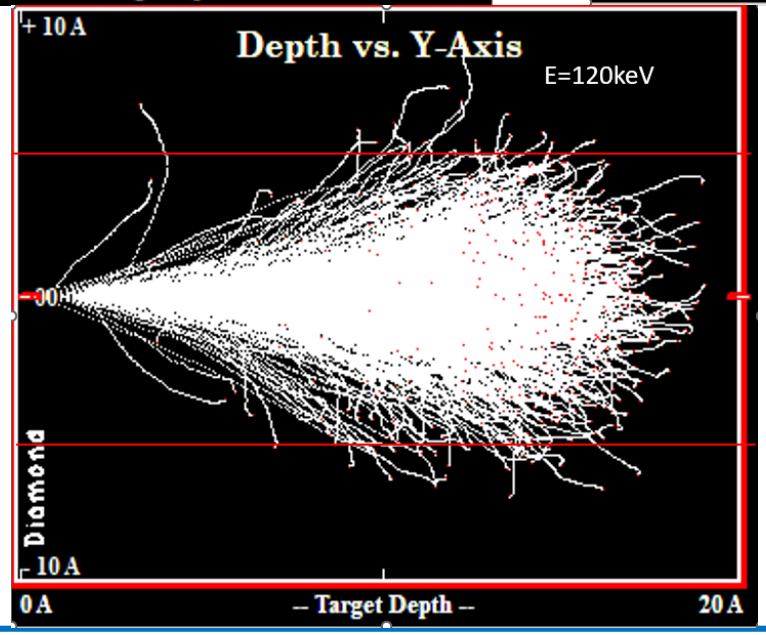


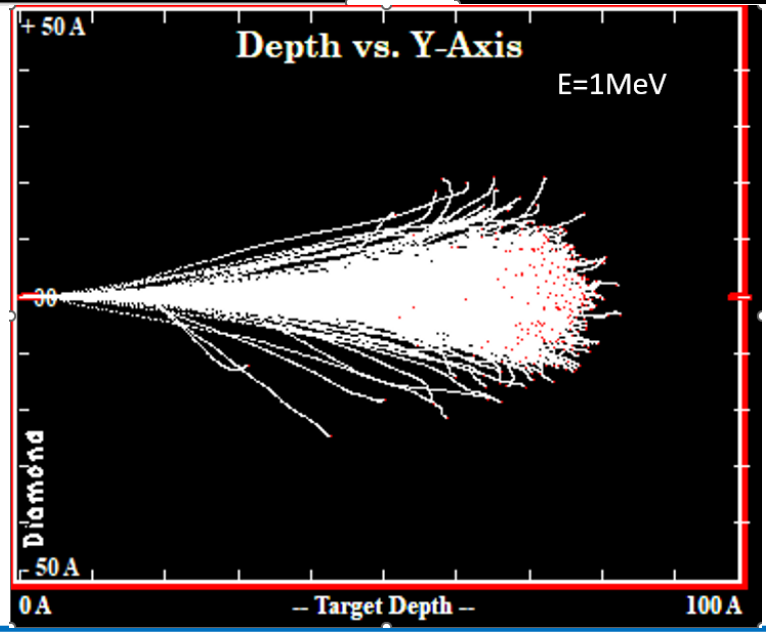
Day 2: Quantum sensing experiment – Simulation results (given by team 3)



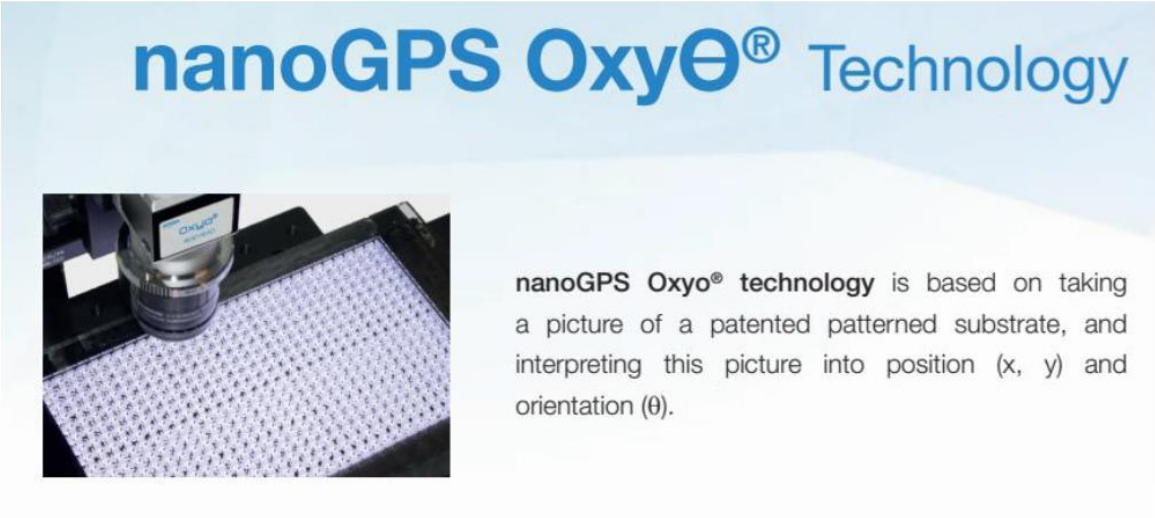








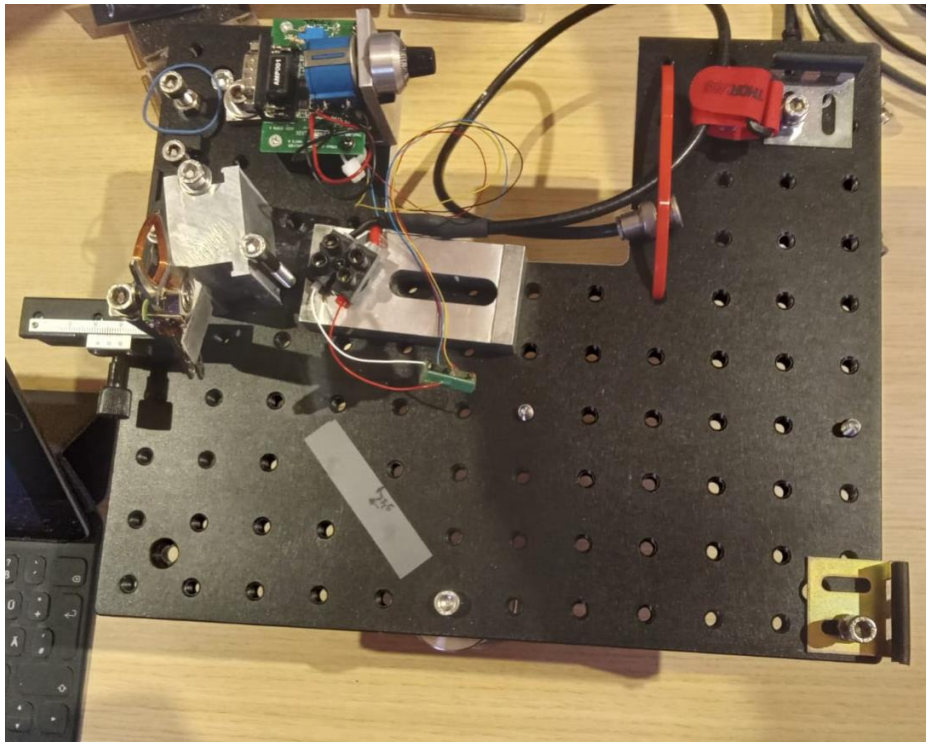
Day 2: nm-positioning experiment - Motivation

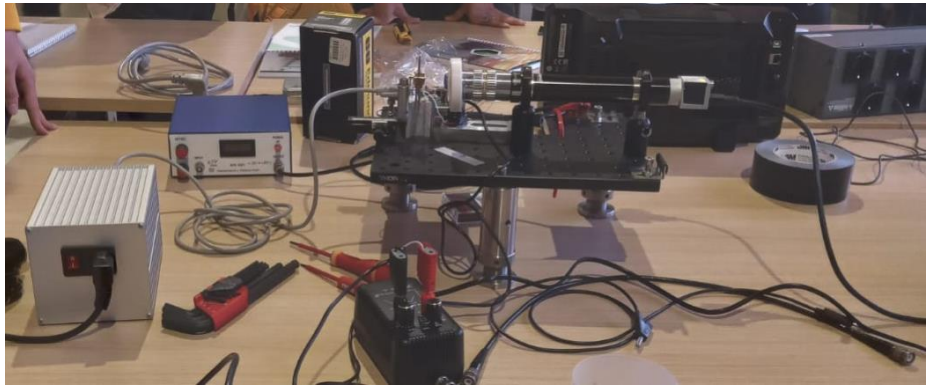


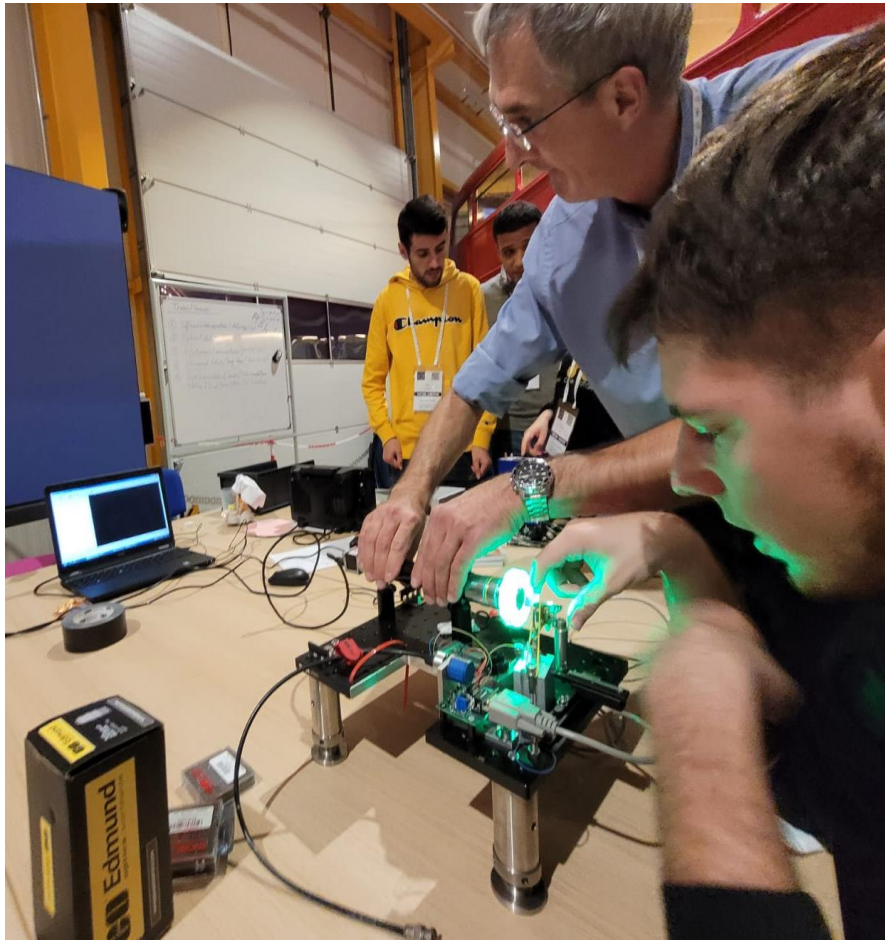
Introduced in a ZOOM talk by Olivier Acher from Horiba

- nm-level positioning is of importance for many different fields of research and technology
- In this experiment a modern positioning technique (OXYO from HORIBA) was set up and its performance compared against that of a strain gauge
- Additionally thermal drifts and thermal loads in the systems were qualitatively analyzed

Day 2: Mechanical setup



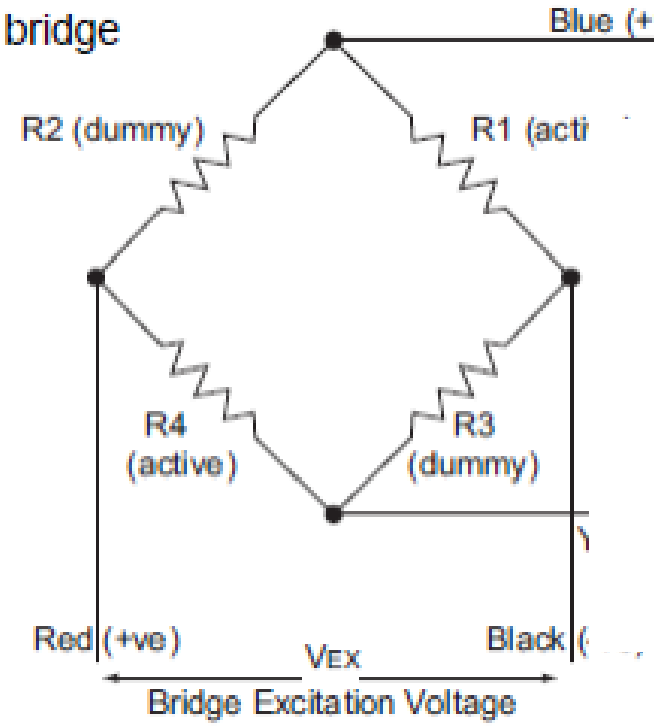




Pictures by Diana Craete

Day 2: Electronics team

V_0 = Output voltage of full bridge
V_{EX} = Excitation voltage

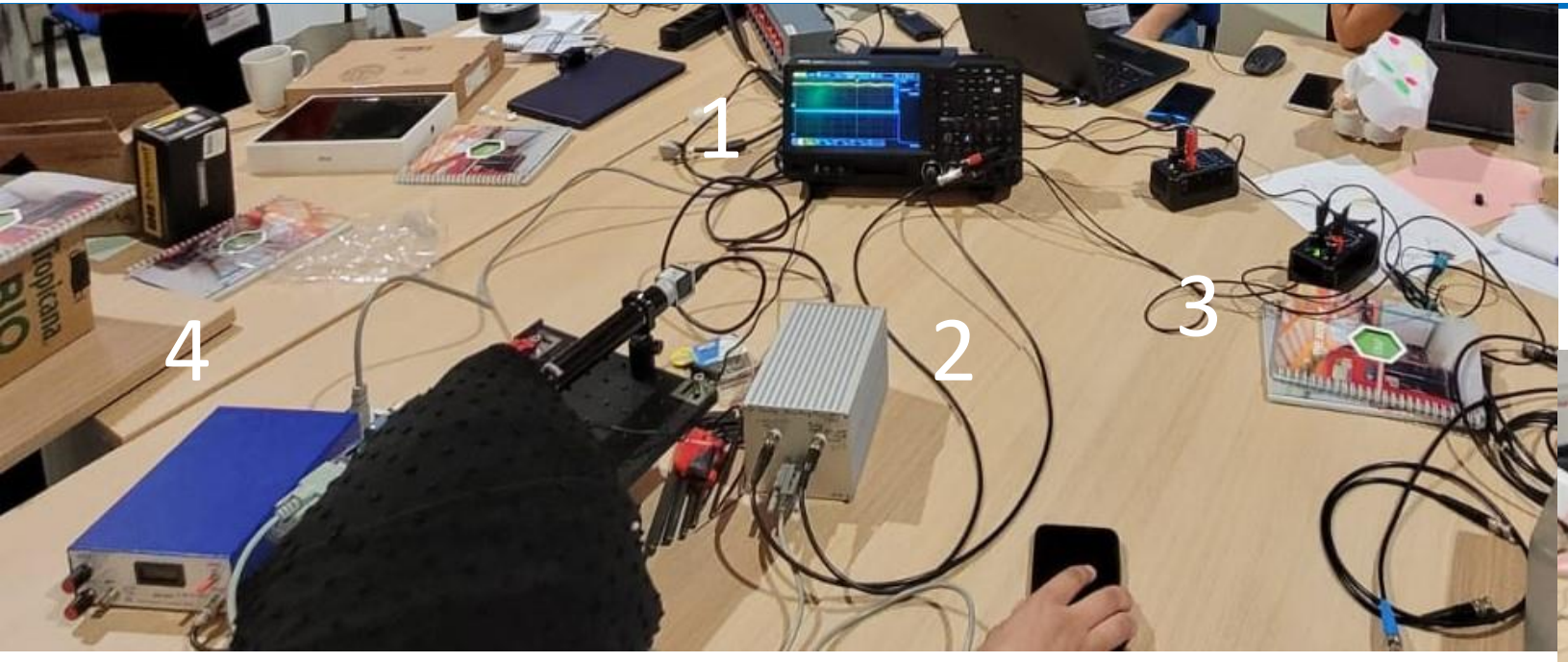


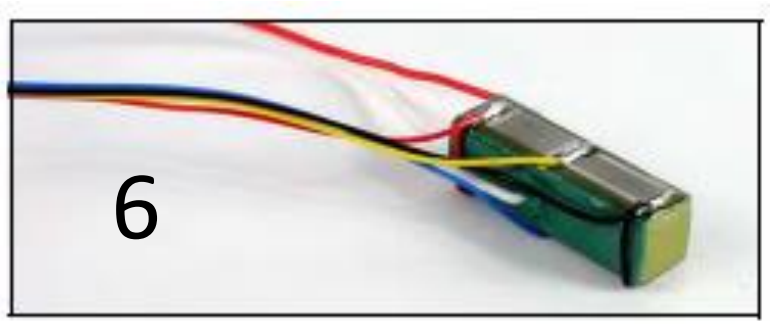
$$G = 1 + \frac{50k\Omega}{R_G}$$

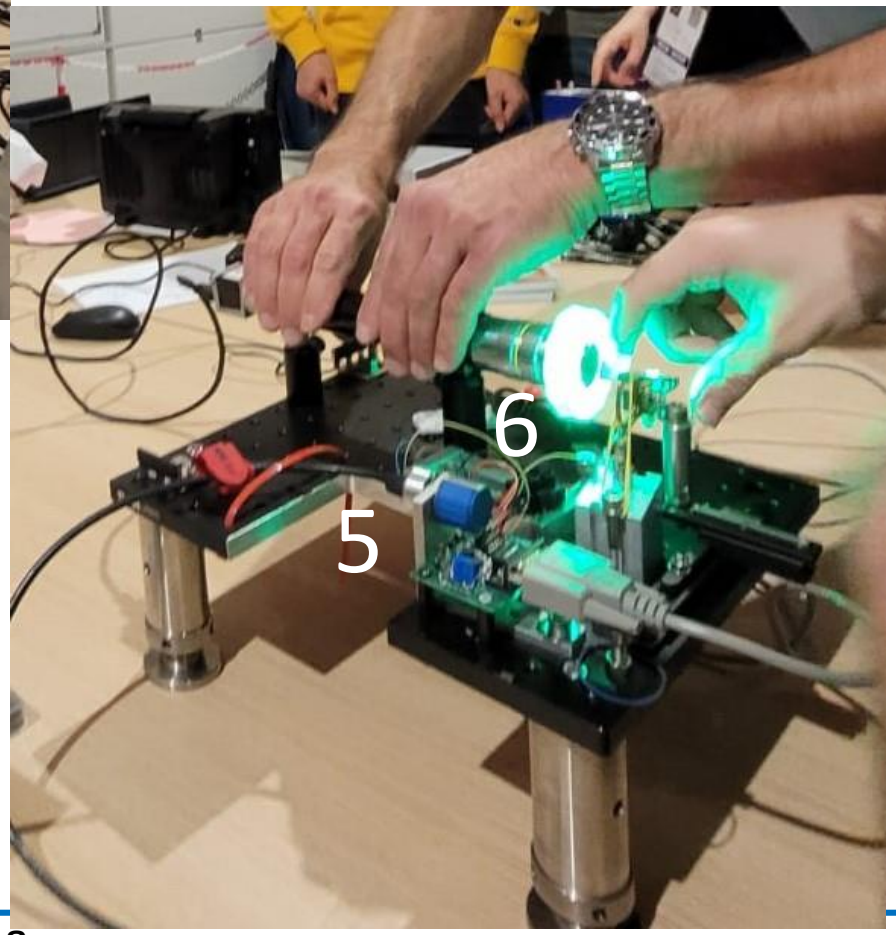
Where:

$$R_G = \frac{VR1 \times R3}{VR1 + R3}$$

Day 2: Mechanical setup - details



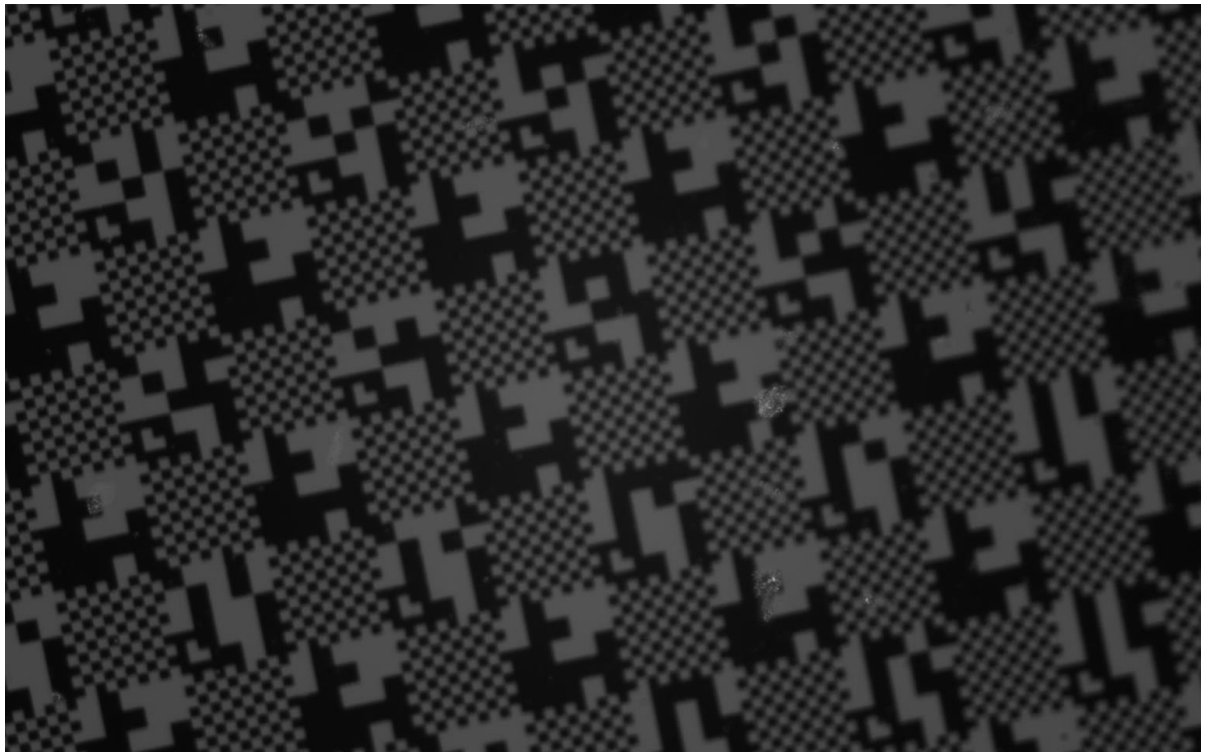




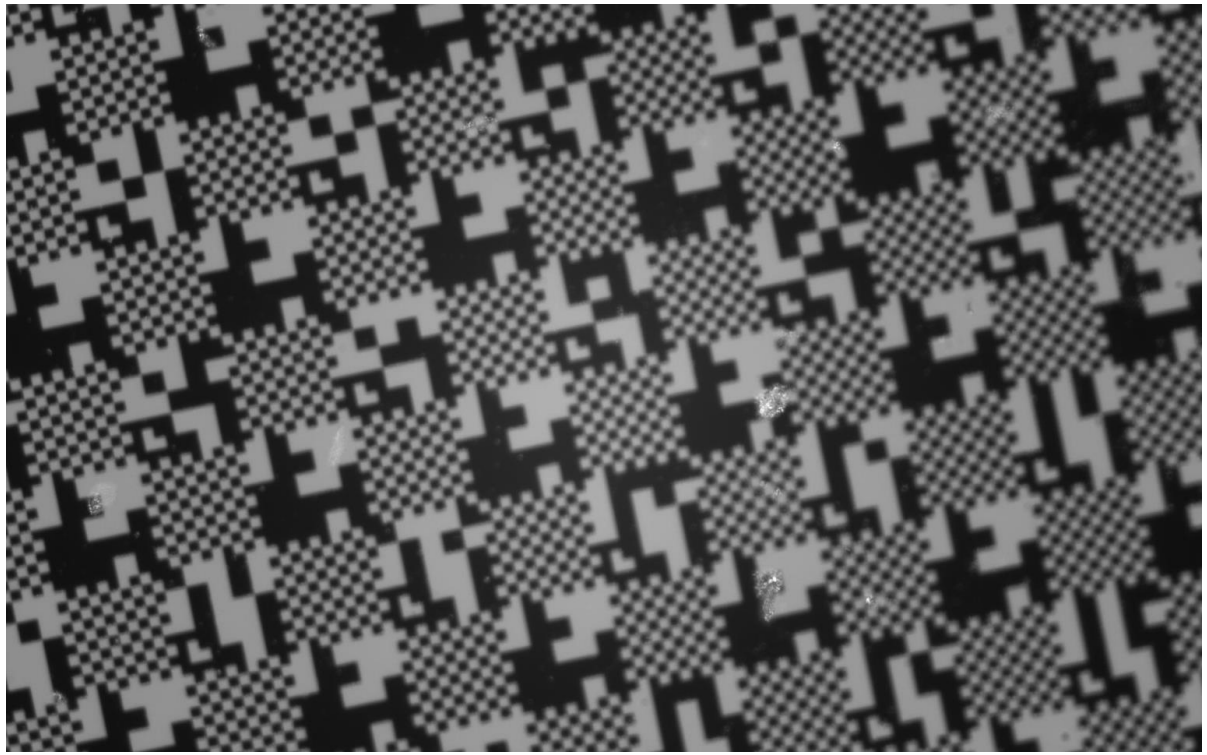
Pictures by Diana Craete

1- Oscilloscope
2-Wheatstone bridge and power supply for the OpAmp +-15V
3-Power supply for 4.5V max
4-Power supply for the piezo 0-150V
5-Potentiometer for gain selection
6-Piezoelectric pillar

Day 2: Calibration

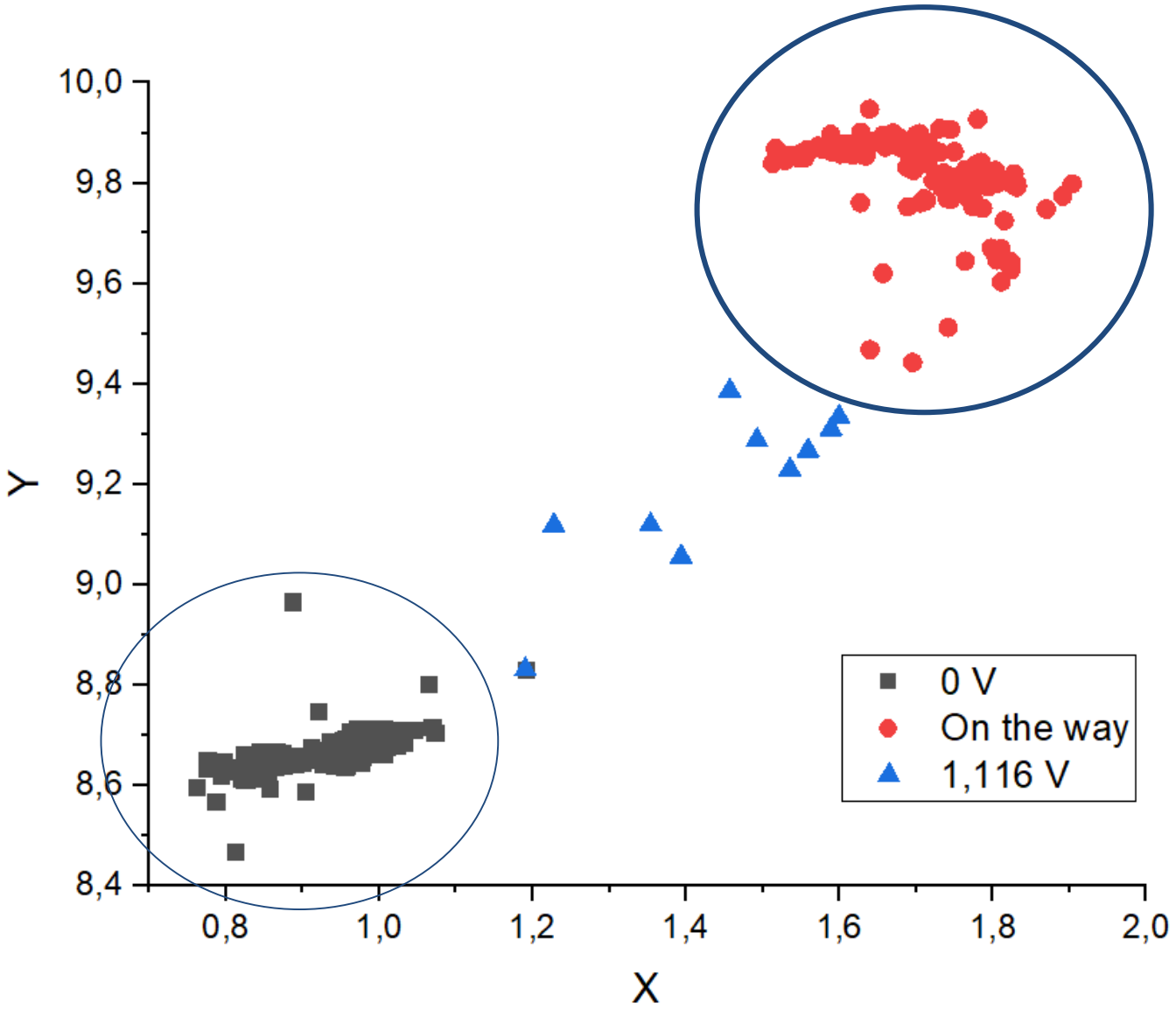


ET = 5000



ET = 10000

Day 2: Calibration and comparison



0 nm → 110.74 nm

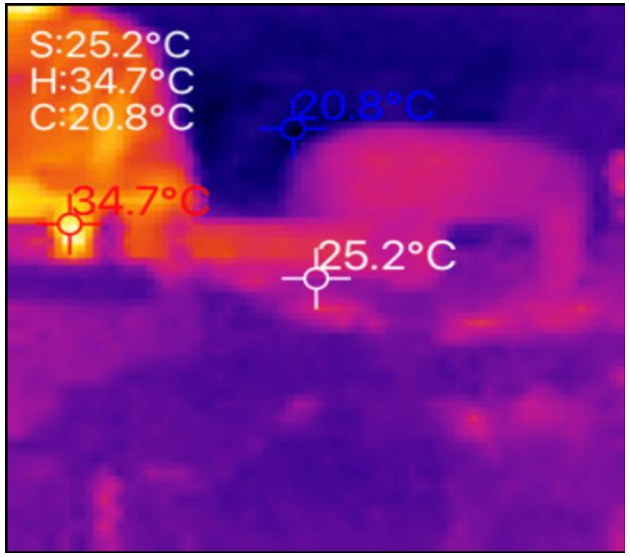
0 V → 1.116 V

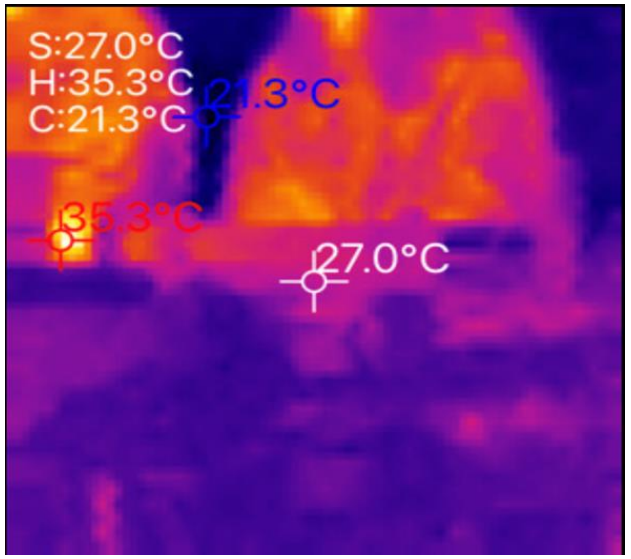
99.229 nm/V

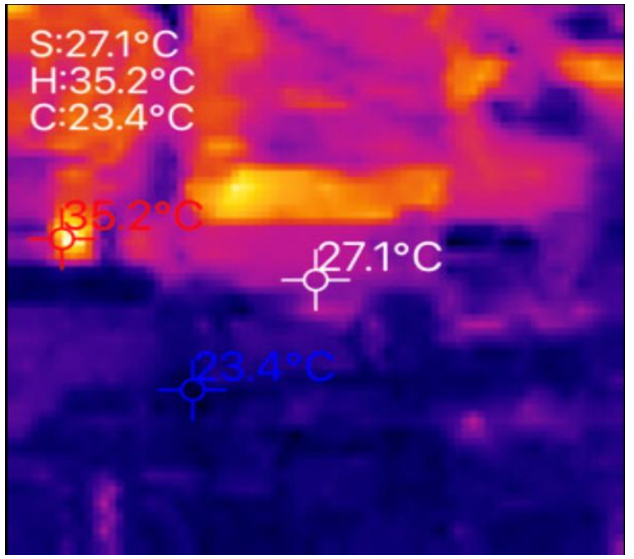
≈

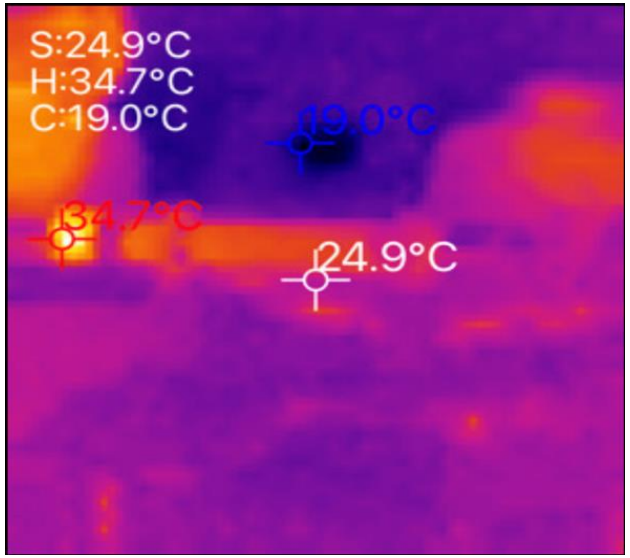
100 nm/V

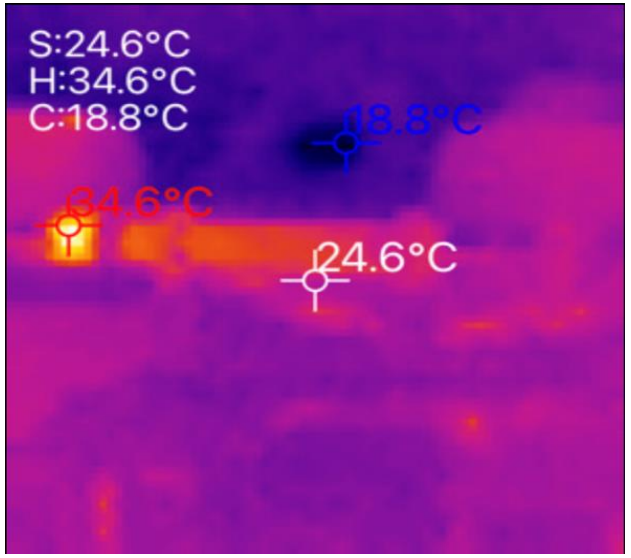
Day 2: Results thermal images (without “critical” points)

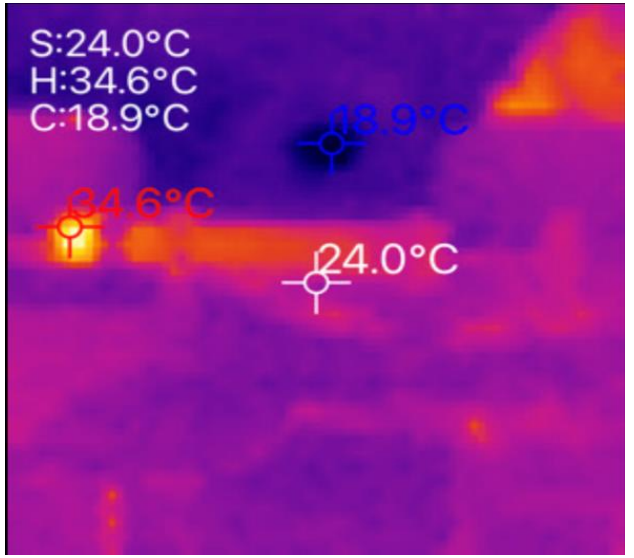




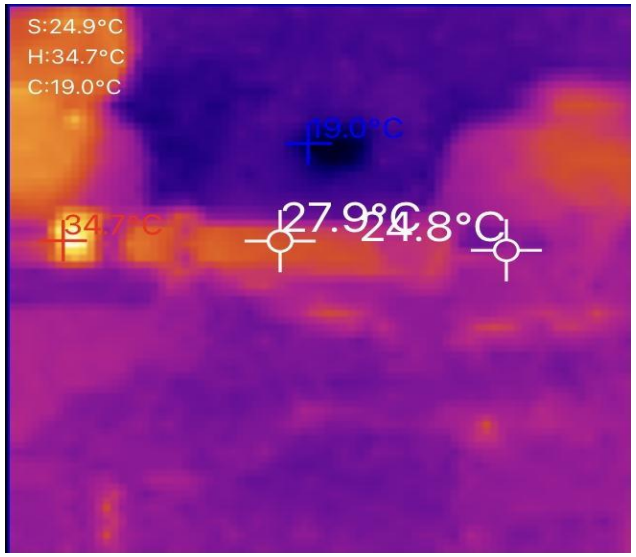


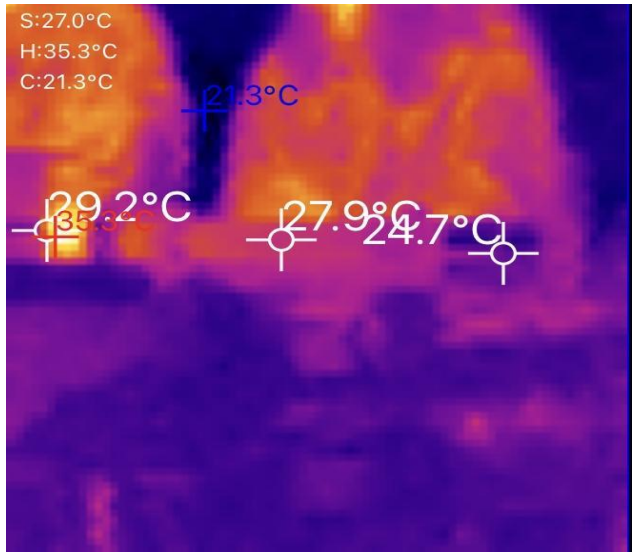


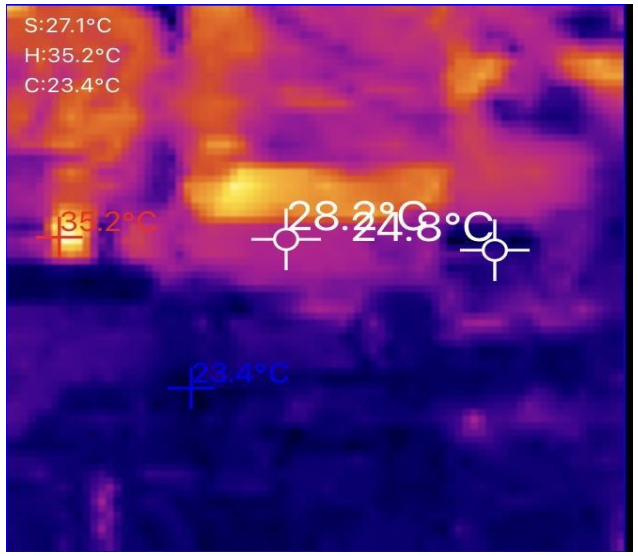


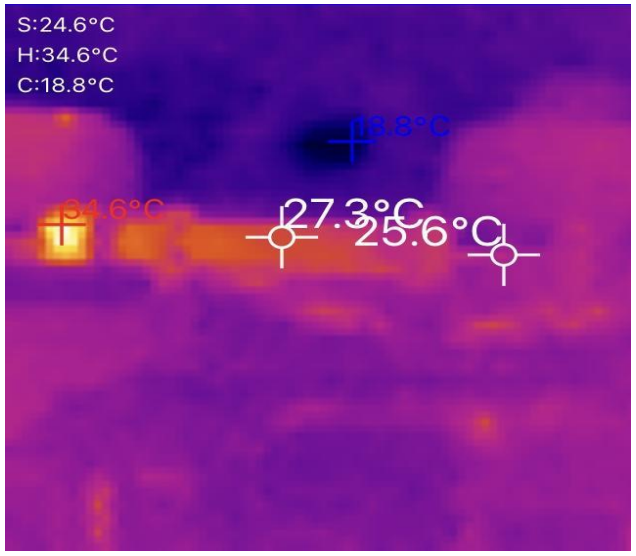


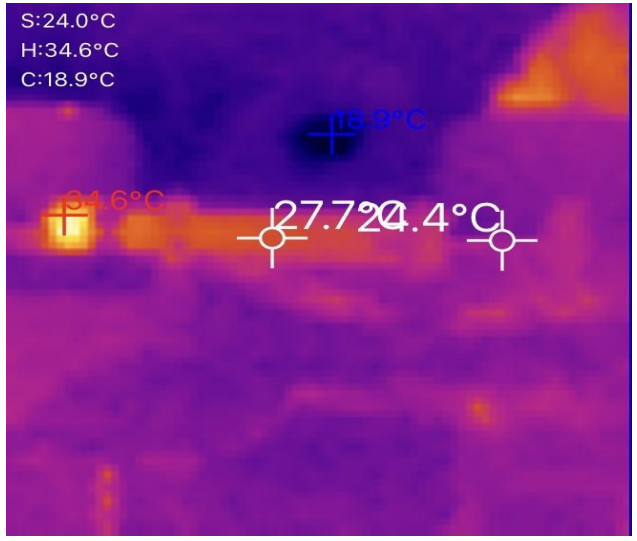
Day 2: Results thermal images (with “critical” points)

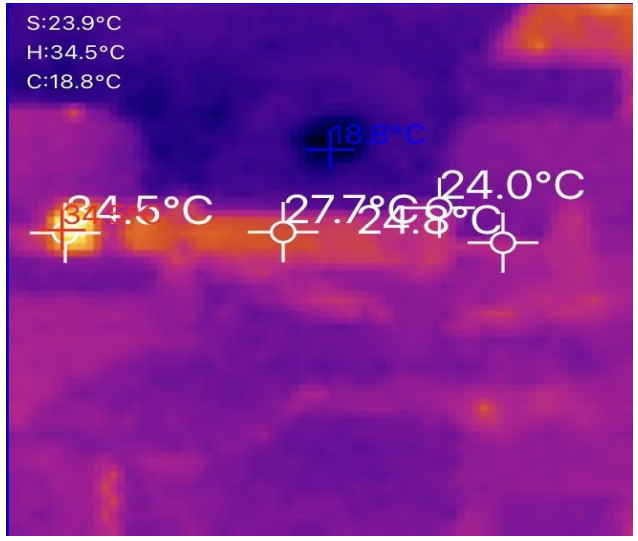




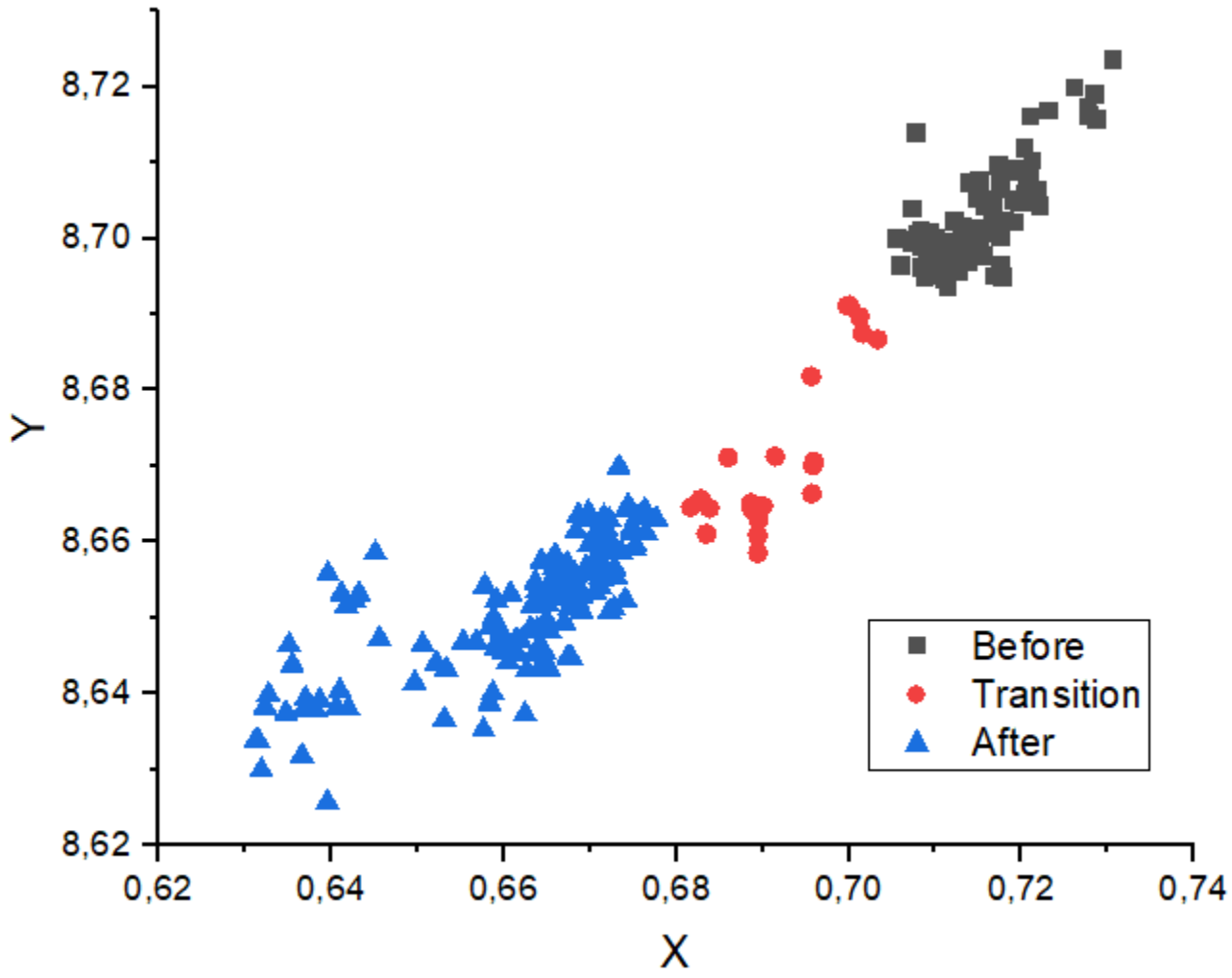




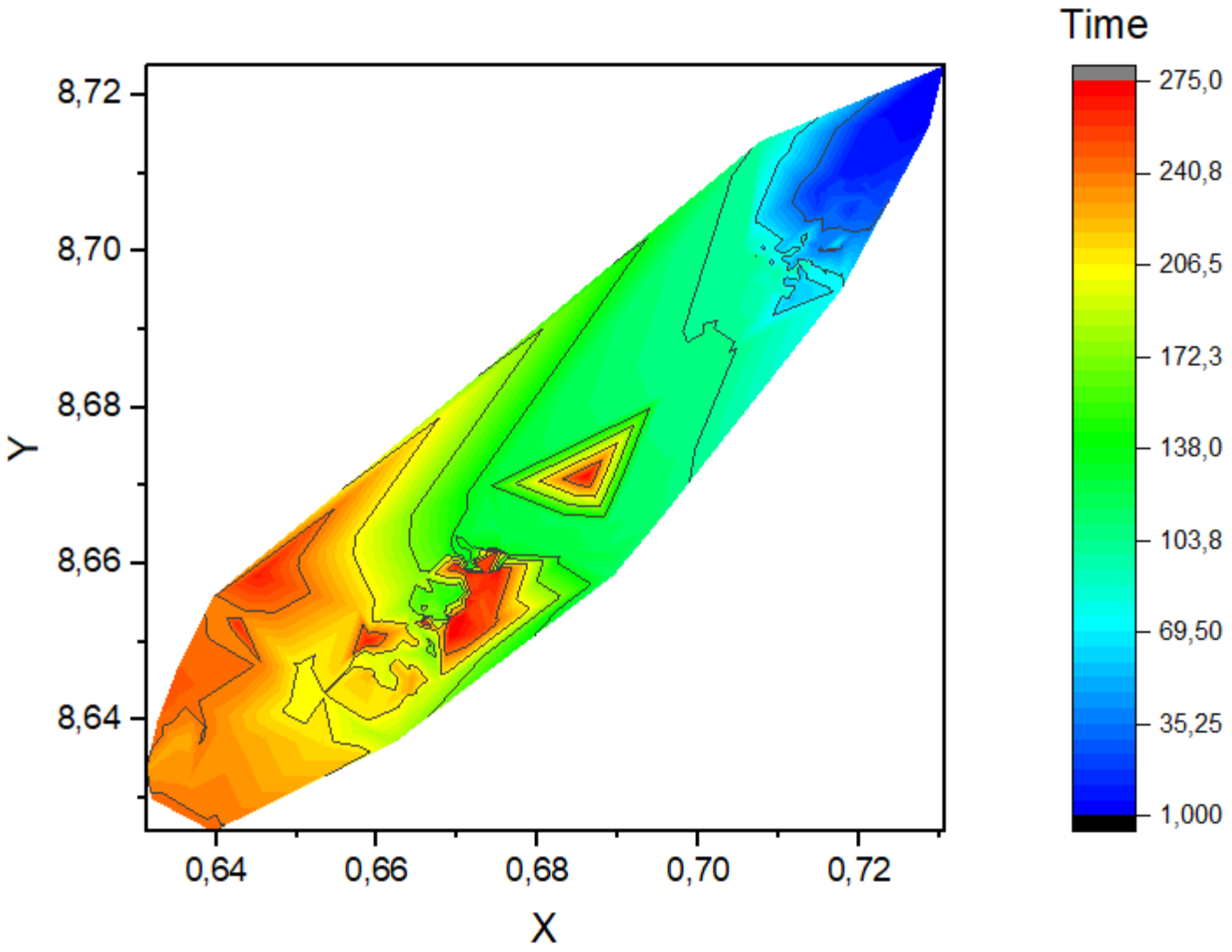




Day 2: Results thermal drifts



Day 2: Results thermal drifts



0.6 °C

550 nm

Problems the teams encountered

What were the problems you encountered?

Summary of the workshop

What did you like most?

What will you take from the workshop?