Mobility grant
The Extreme Light Infrastructure (ELI)
(4.09-15.09. 2023)

Dejan Karadžić

student Studijskog programa Fizika PMF, UCG

Experiment conducted by RD50 group from UCG

Beamtime awarded through 2nd ELI ERIC User joint call

- **Principal Investigator: Gordana Lastovicka-Medin**

- Funding agency: Ministry of Science and Technology Development, Montenegro

eli

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INVITATION LETTER

To whom it may concern

On behalf of the Department of Structural Dynamics I am pleased to invite Mr. Dejan Karadzic (student of the University of Montenegro) to ELI Beamlines Facility for a research stay from 04.09.2023 to 15.09.2023. His work will be focused on the Transient Current Technique (TCT) experiments and subsequent data analysis. These activities match well the research interest of our department and can result in fruitful scientific collaboration. The planned experiments will contribute in R&D of state-of-the-art detectors designed for high luminosity colliders.

The research plan of the visit is as follows:
1) Essential trainings (general safety, laser safety, cleanroom, TCT end-station)
2) Investigation of the Low Gain Avalanche Detectors (LGADs) under different fs laser induced charge generation conditions (various HV bias, laser power, temperature).
3) Data analysis and interpretation of the experimental results

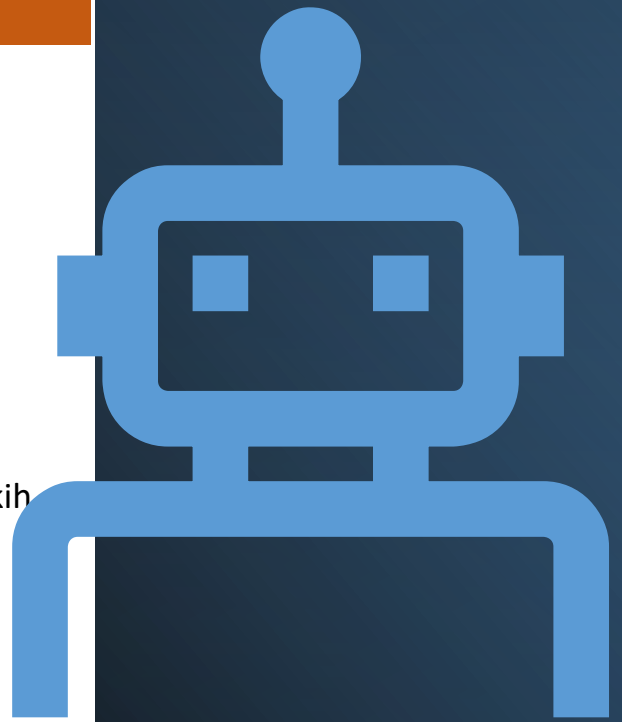
Dejan Karadzic will have access to all necessary laboratory equipment, including TCT end station and all related accessories (diagnostic equipment, software etc.). We will also gladly support him regarding the data analysis and interpretation of the results.
All the planned experiments, necessary trainings and related activities will be free of charge.
All travelling and accommodation costs will be solely covered by the participant.
Dejan Karadzic will work under supervision of Dr. Mateusz Rebarz who is a scientist responsible of TCT end station and related experiments.

Head of Department of Structural Dynamics
Dr. Jakob Andreasson

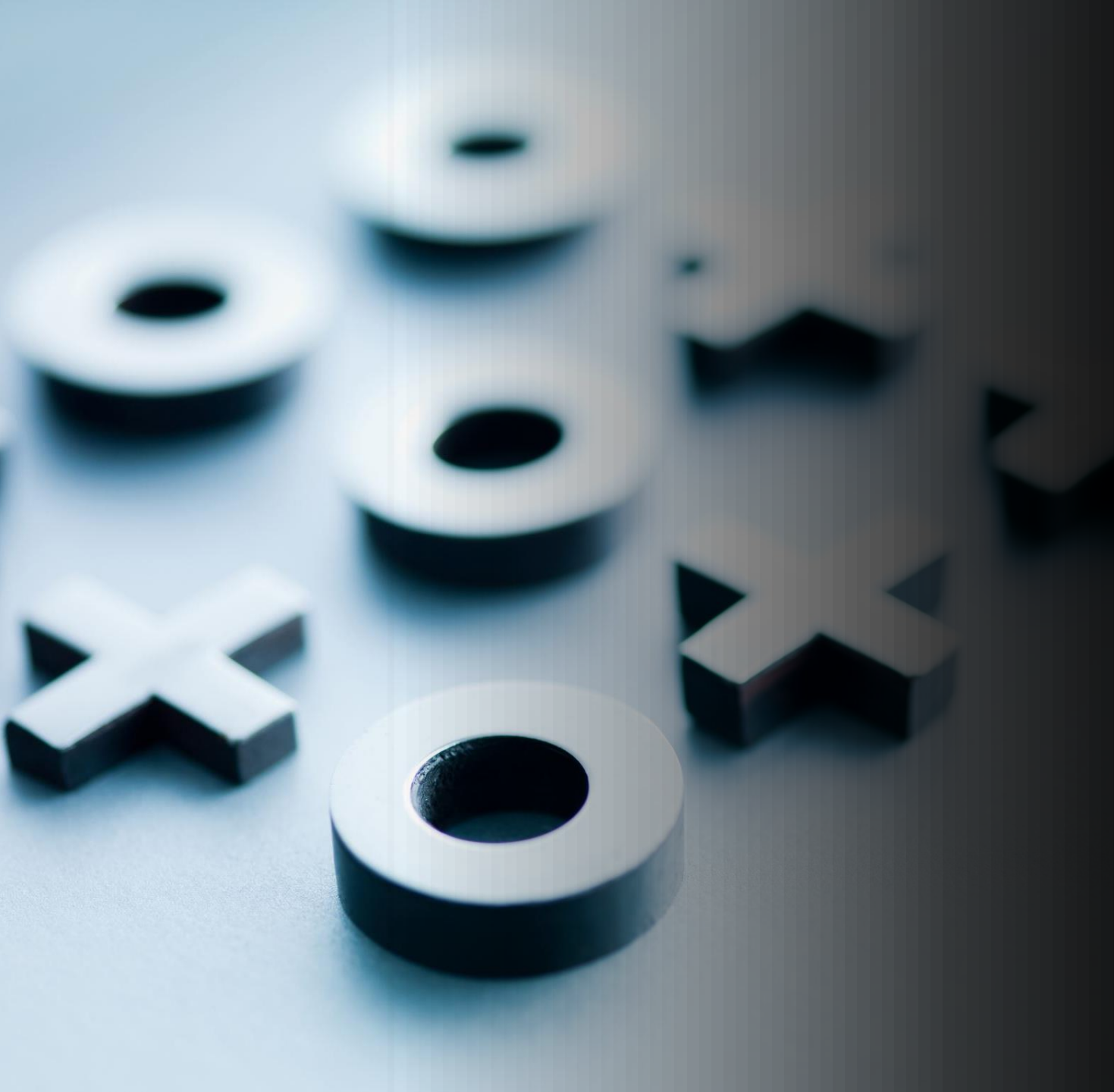
RESEARCH at ELI: R&D on Timing Detectors for CERN Experiments

Report

1.-3. dana



- Dolazak na ELI. Trening obuka: general safety training, chemical safety training, clean room training, laser safety training. Obilazak zgrade.
- Upoznavanje sa laboratorijom E1 (experimental hall). Svo vrijeme obuke smo proveli u pomenutoj laboratoriji. Upoznavanje sa setup-om.
- Praktično iskustvo u izgradnji i podešavanju eksperimentalnih optičkih postavki za izvođenje eksperimenata sa tranzientnom strujom (TCT) na novoj generaciji detektora niskog pojačanja lavinskih struja (LGAD).
- Poznavanje savremenih femtosekundarnih laserskih sistema i najnovijih detektora čestica.
- Sticanje znanja iz oblasti čvrste stanice fizike i upotrebe elektronskih laboratorijskih instrumenata.
- Obuka o bezbednosti pri radu sa laserima.
- Obuka za rad u čistim prostorijama.
- Obuka o zaštiti od jonizujućeg zračenja.
- Iskustvo rada u visoko internacionalnom i interdisciplinarnom naučnom timu.
- Rad u laboratoriji sa najnovijim tehnikama razvoja inovativnih metoda.

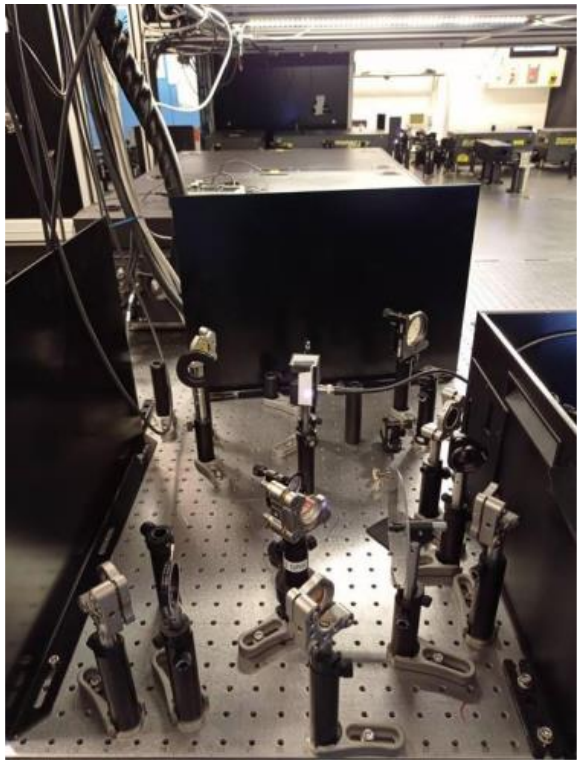


4.-12. dana

- Povezivanje setup-a, uz detaljno objašnjenje svih djelova i fizičkih procesa. Trening obuka upravljanja softwera na laptopu.
- Montiranje uzorka, njegovo pozicioniranje pomoću softwera i prva mjerenja.
- Nastavak treninga sa uzorkom, rađeno više mjerenja mijenjajući napon. Dobijanje prvih rezultata.
- Odlazak na Institut za Fiziku u Pragu. Praćenje procesa wire bondinga uzoraka
- Montiranje novog uzorka
- Mjerenja za LGAD W16 C1-V4-2TR i W16 C2-V2-2T su vršena za vrijednosti napona koje su se kretale od 60-140V
- SPA za nisku temperature -20, bez pojacivaca
- SPA za sobnu temperature bez pojacivaca
- Radjena su mjerenja za 0.2pJ, 0.5pJ, 1pJ, 2pJ, 5pJ mjenjajuci napon od 60-140V za svaki scan

Prostorija sa laserima E1 gdje se nalazi fs-laser TCT setup!

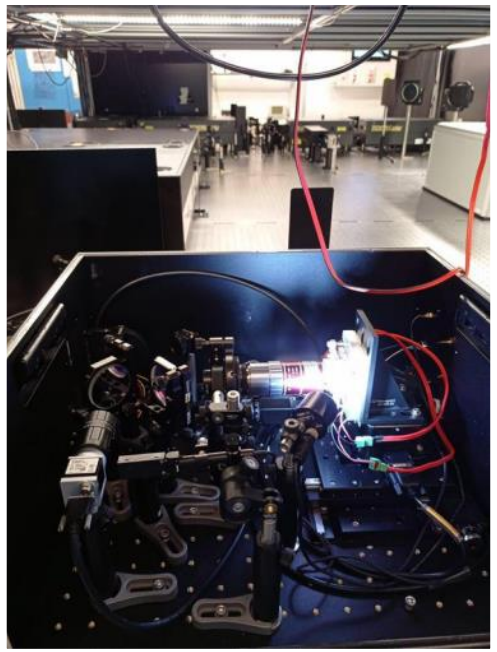
Postavka eksperimenta

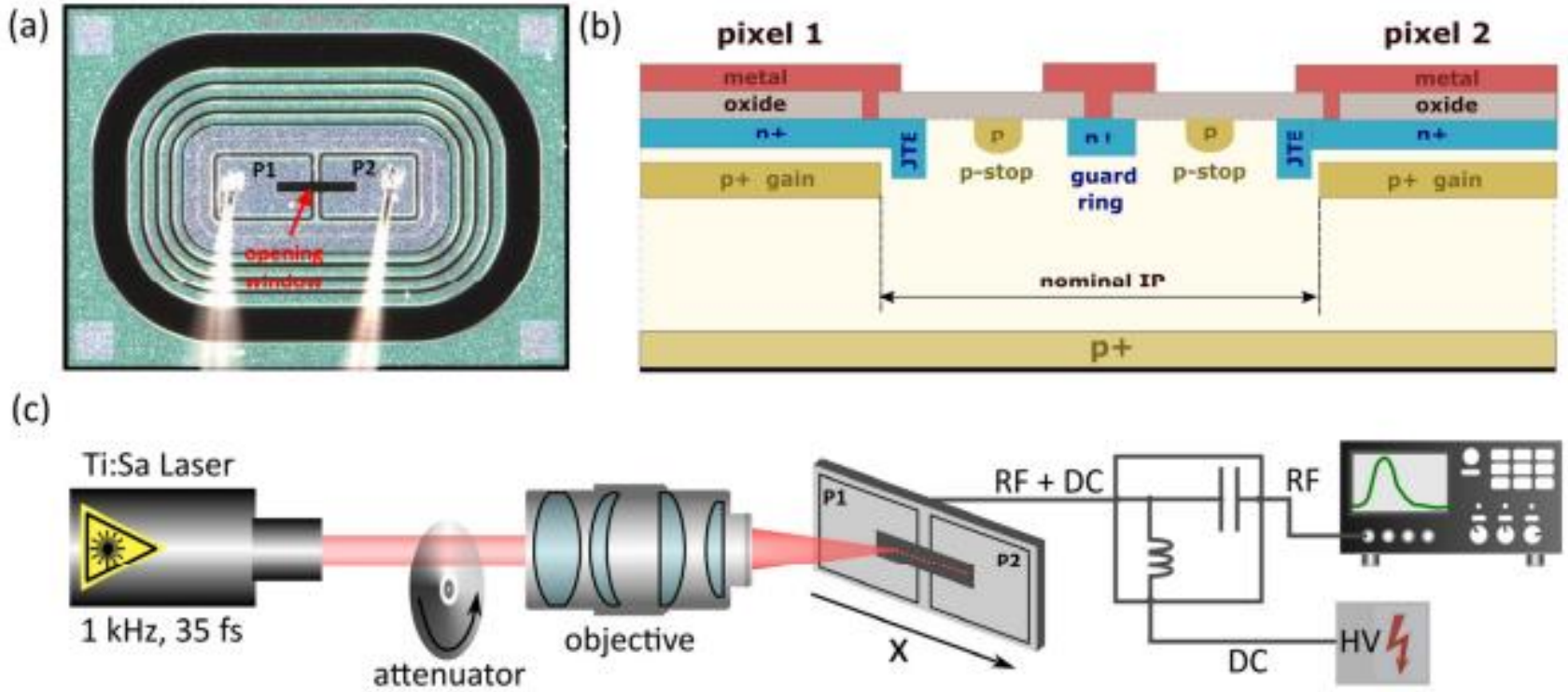


Experimentalna tehnika: tehnika tranzientnih struja (TCT)

- ✓ ultrabrzi I ultrakratki laserski pulsevi (800 nm, 60 fs, 1 KHz) se koriste da se genertisu parovi elektrona i supljina unutar medjupiksell oblasti I unutar piksela a onda se za svaku tacki iliminacije racuna integrisano naelektrisanje I crta profil naelektrisanja po segmentiranom LGAD-u..

TCT setup





LGAD

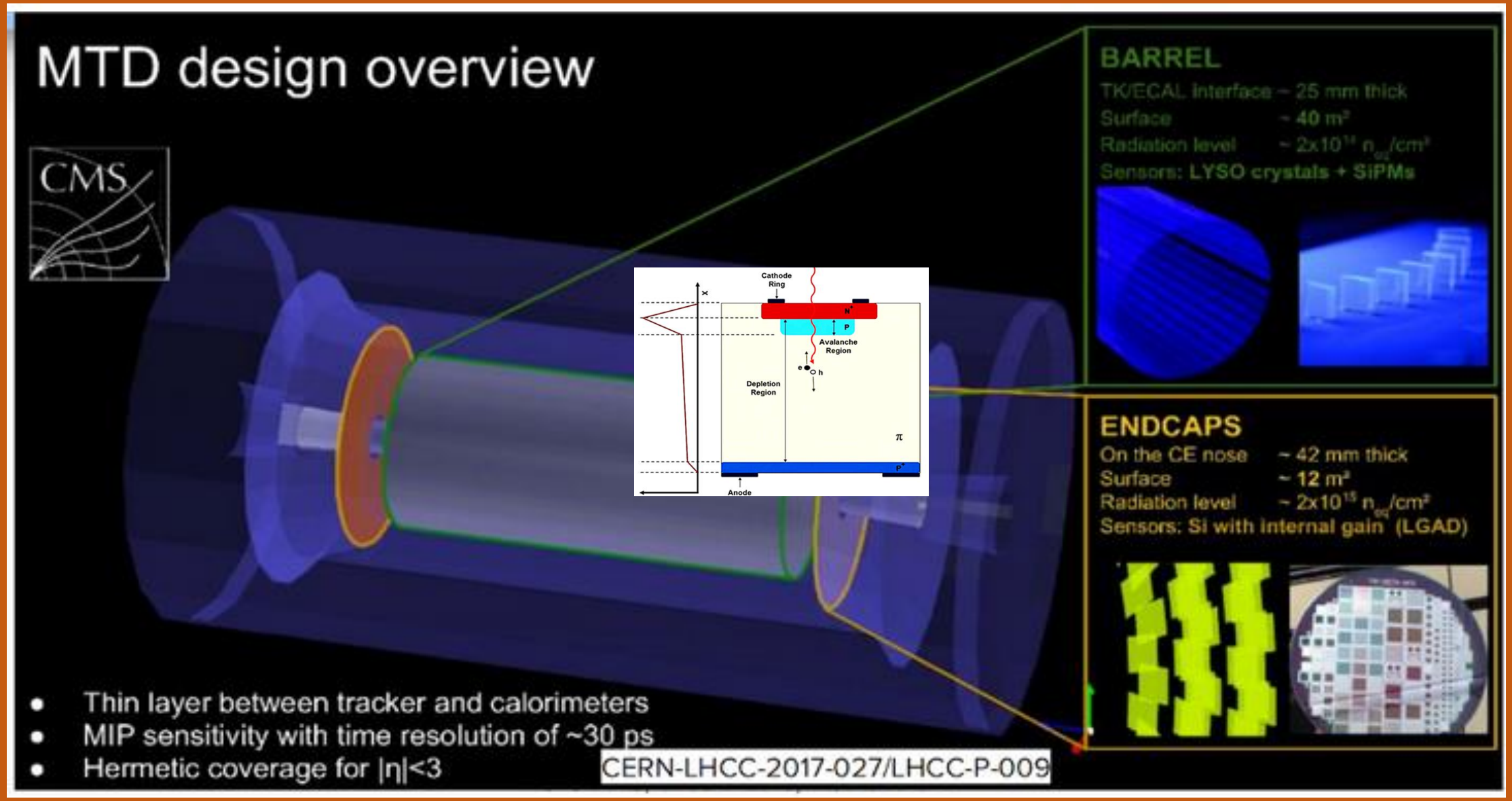
TCT set-up

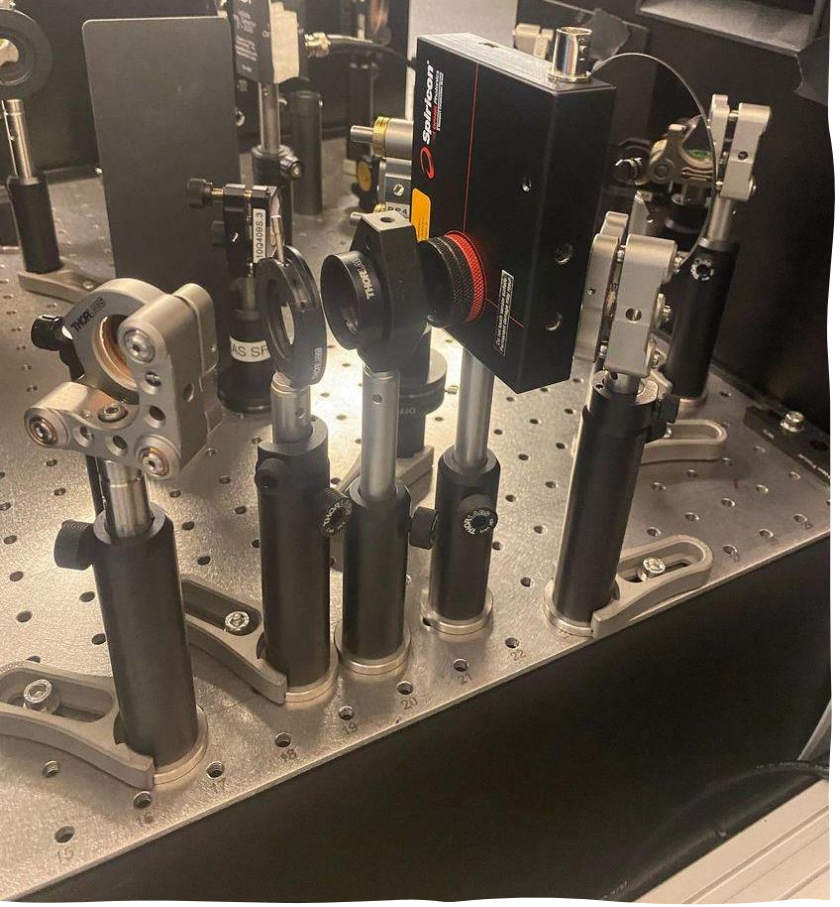
Shema eksperimenta

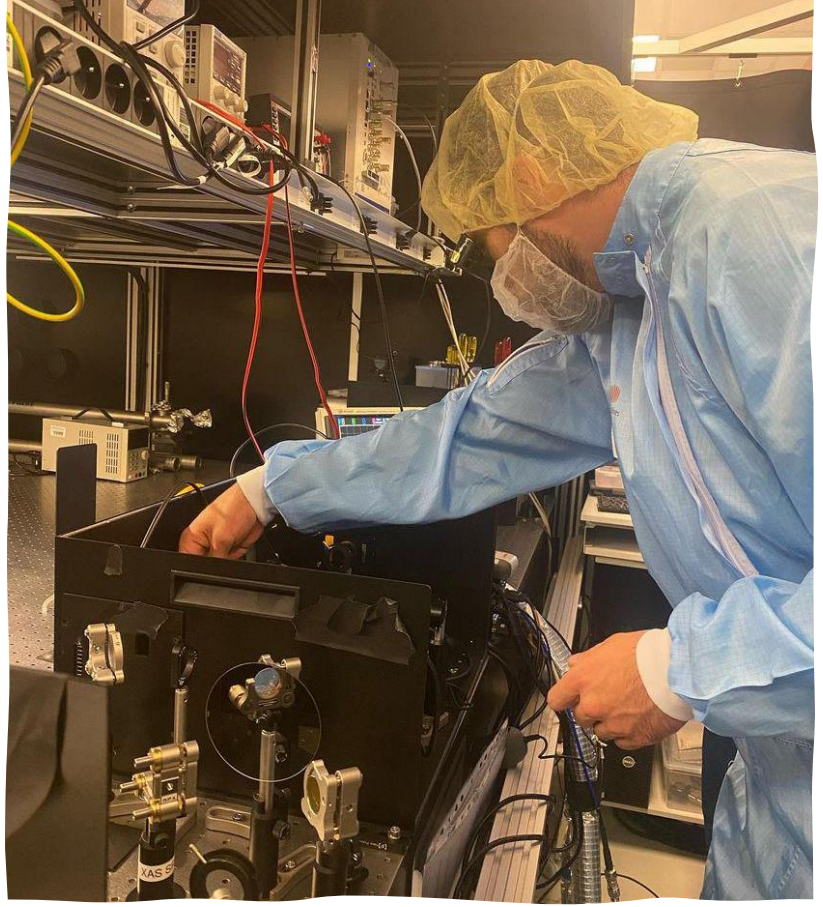
Figure (a) Top view of a Type 10 LGAD prototype (2 × 1 pixel) with opening window. (b) Simplified visualization of the cross-section of the interpad region with two p-stops and guard ring. (c) Scheme of experimental configuration of TCT setup for charge-space scanning.

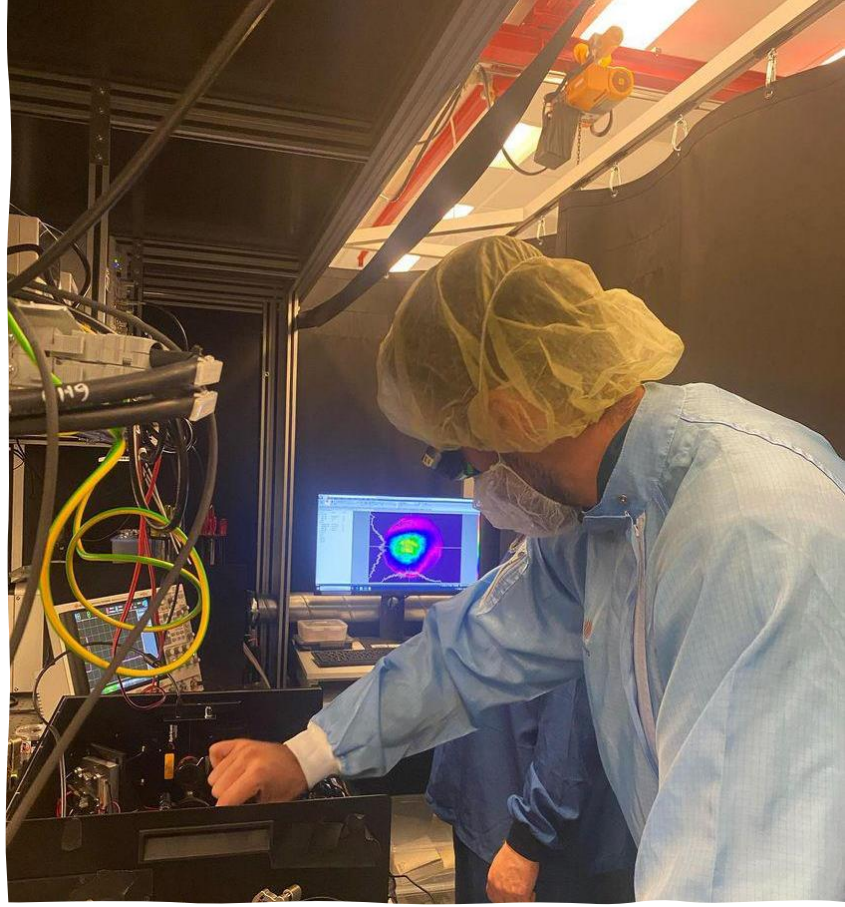
Laštovička-Medin, Gordana, et al. "Exploring the Interpad Gap Region in Ultra-Fast Silicon Detectors: Insights into Isolation Structure and Electric Field Effects on Charge Multiplication." *Sensors* 23.15 (2023): 6746.

LGAD for CMS


MTD design overview
CMS
BARREL
TK/ECAL interface ~ 25 mm thick
Surface ~ 40 m²
Radiation level ~ 2x10¹⁴ n_eq/cm²
Sensors: LYSO crystals + SiPMs
Cathode Ring
N+
P
Avalanche Region
e
h
Depletion Region
π
P+
Anode
ENDCAPS
On the CE nose ~ 42 mm thick
Surface ~ 12 m²
Radiation level ~ 2x10¹⁵ n_eq/cm²
Sensors: Si with internal gain (LGAD)
• Thin layer between tracker and calorimeters
• MIP sensitivity with time resolution of ~30 ps
• Hermetic coverage for |η|<3
CERN-LHCC-2017-027/LHCC-P-009

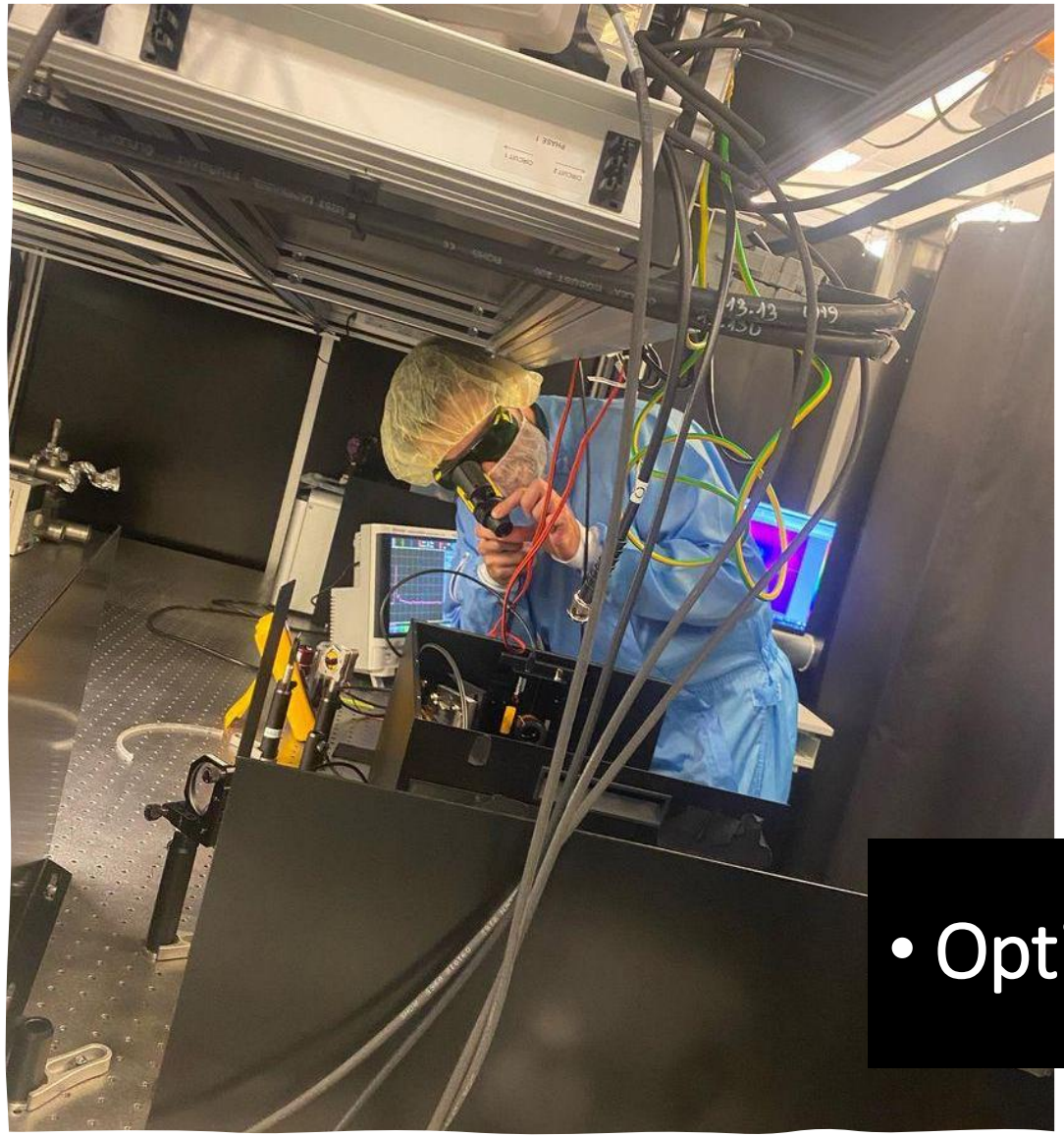




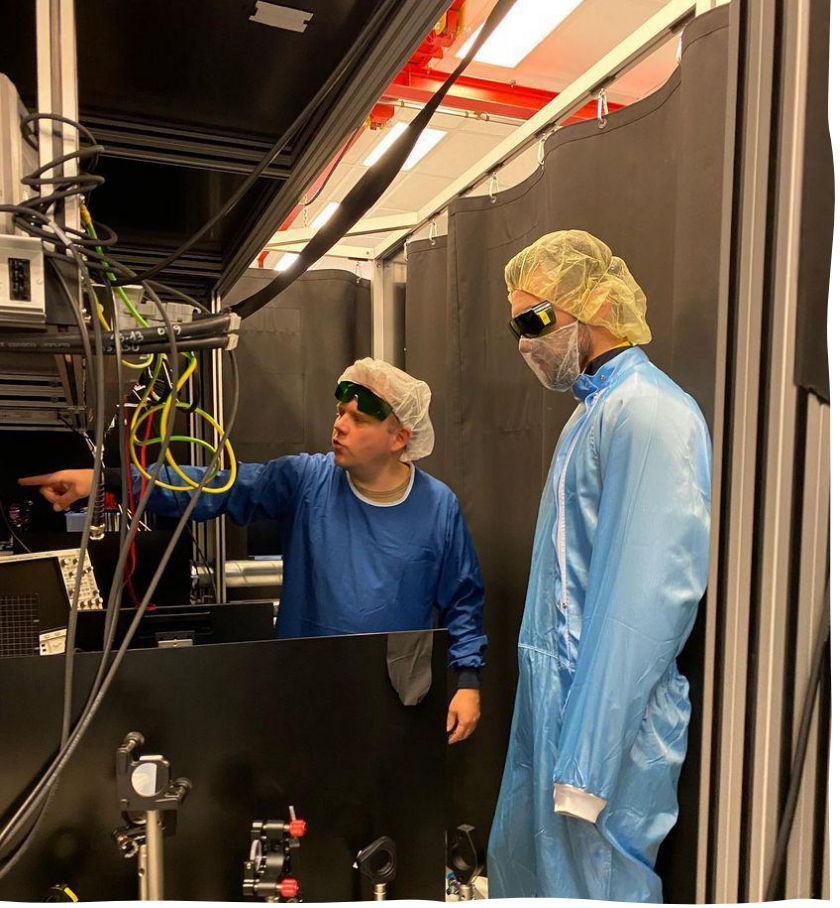


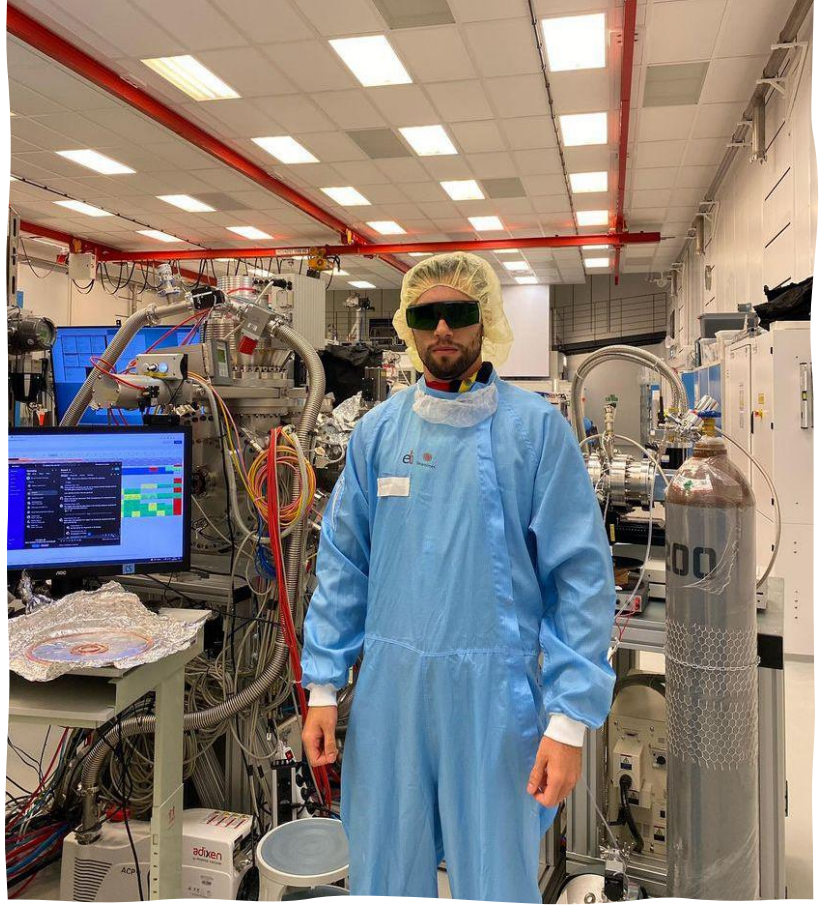
Podešavanje lasera,

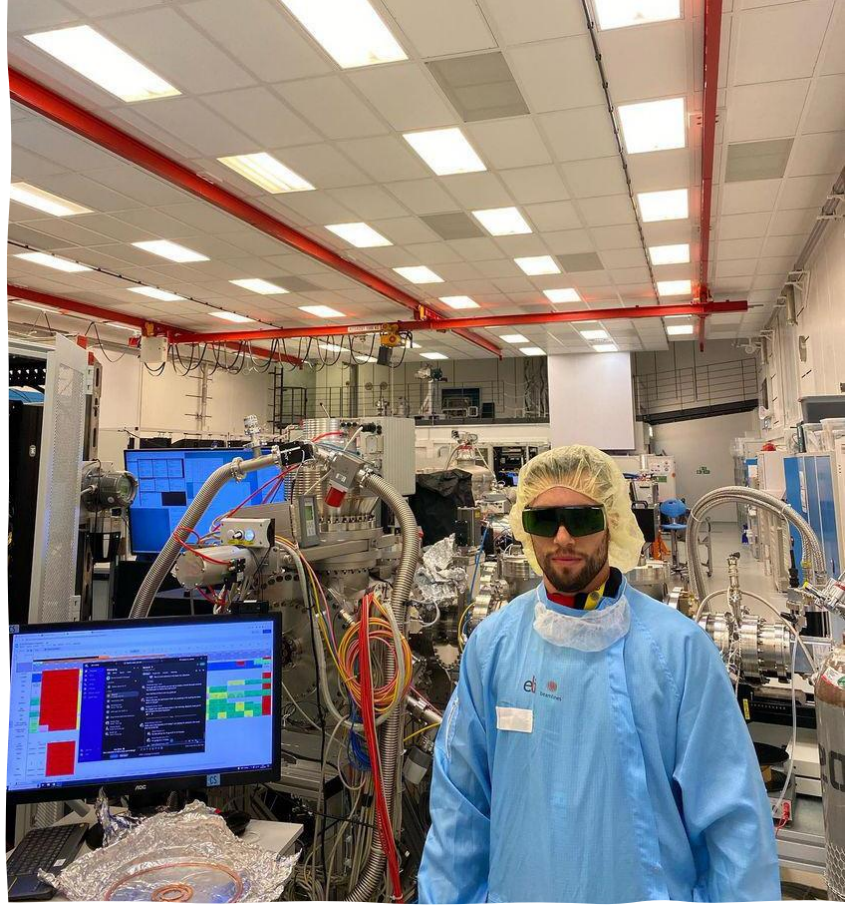
Centriranje, fokusiranje lasera



- Optimizacija, “alignment”

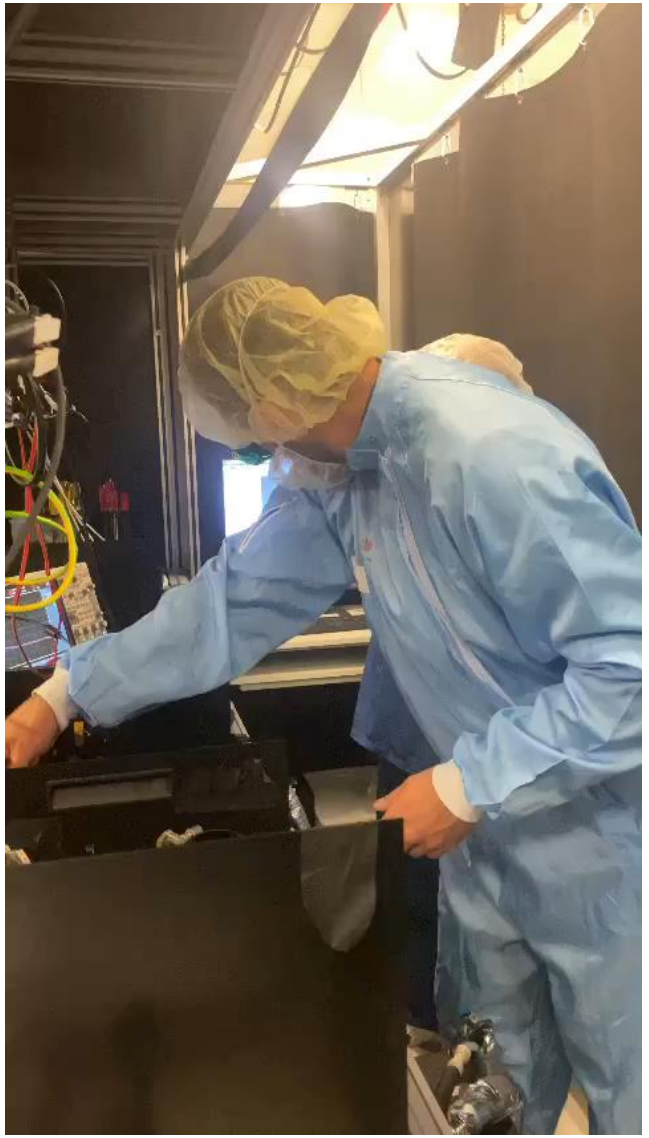


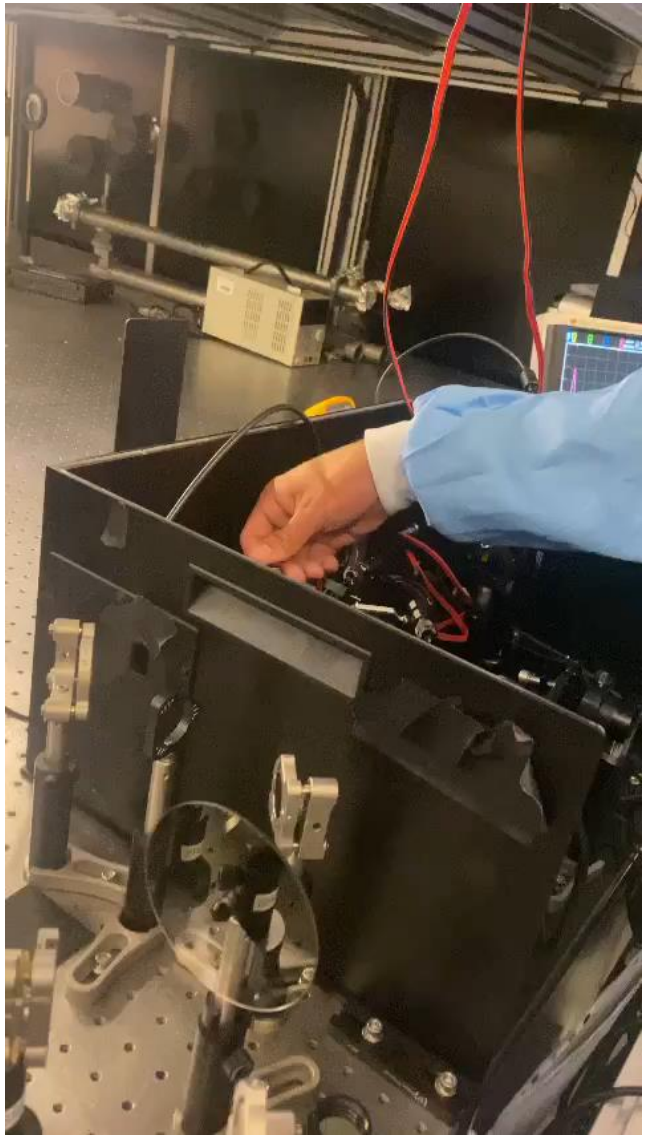




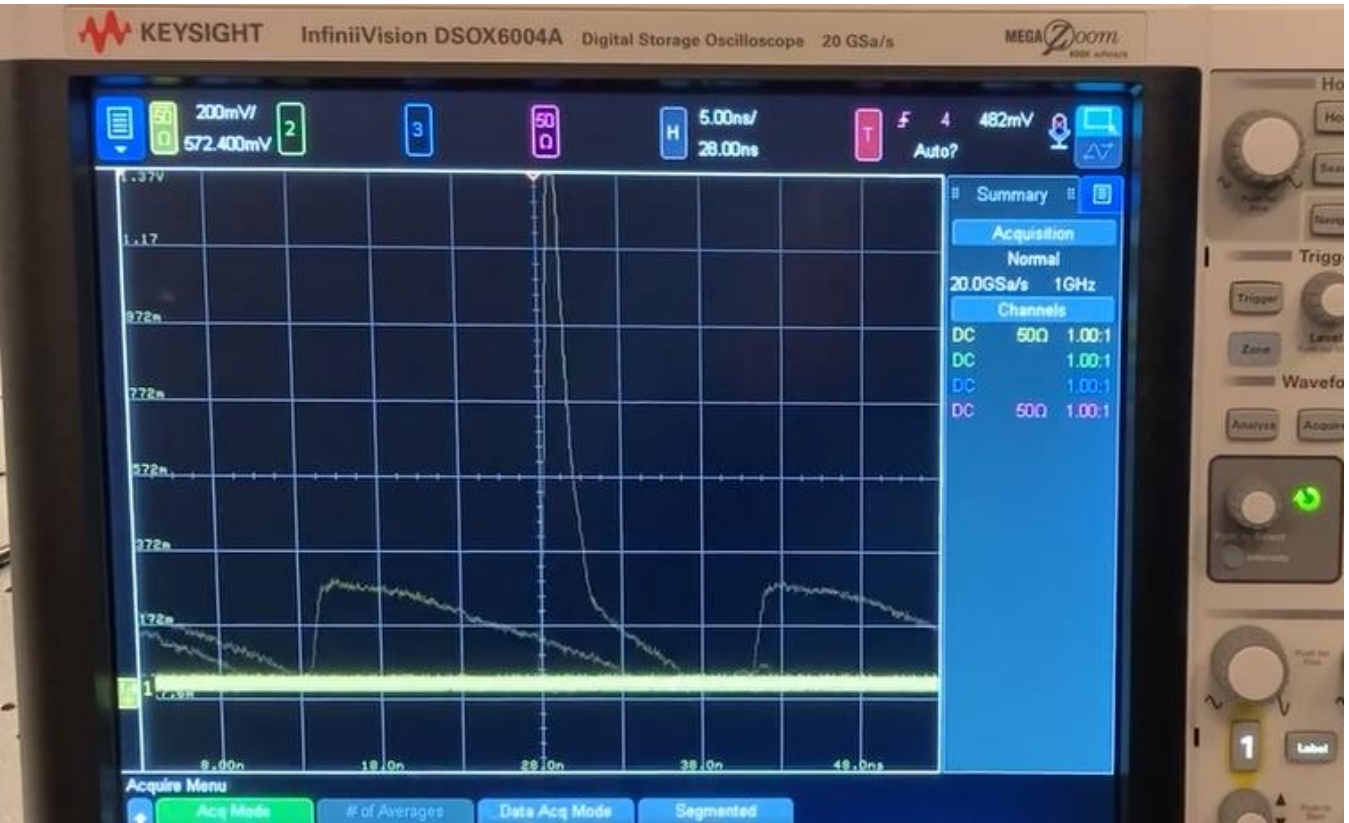
- Kontrolisanje parametara lasera

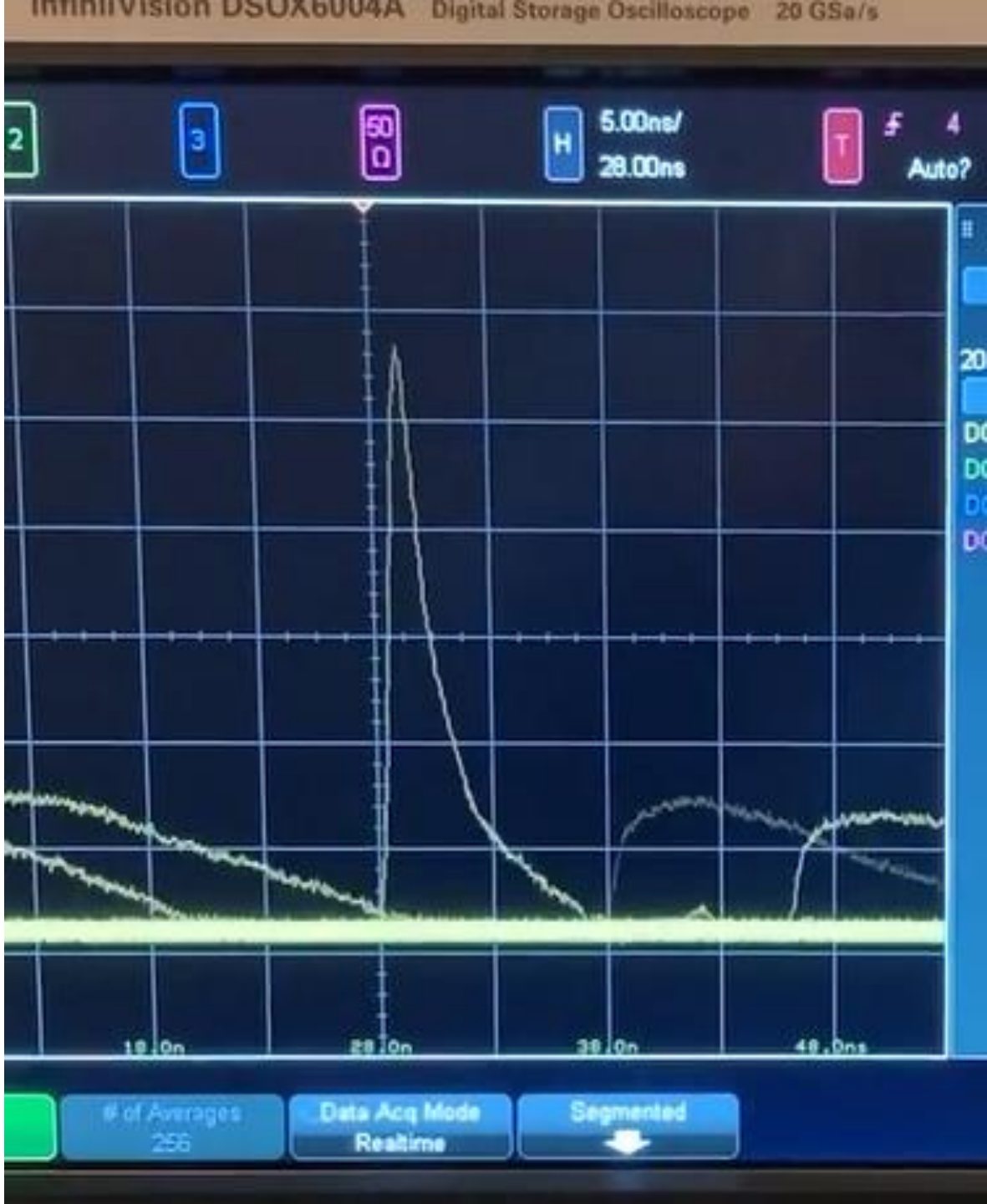
(video)





Data Analysis





Next step: Publishing!

Thank you ☺