David Gregocki

Research interests

- Laser-driven plasma-based electron accelerators
- Particle-in-cell simulations of laser-plasma interaction

Education

Academic Qualifications

Master's degree in Nuclear and Particle Physics **2021-2023**

- *Faculty of Nuclear Sciences and Physical Engineering,*
  Czech Technical University in Prague, Czech Republic

Master's thesis
Transition of electron beams between vacuum and plasma in the external injection into a laser wakefield accelerator
Supervisor: Ing. Miroslav Krůs, Ph.D.
Consultant: Ing. Dominika Mašlárová

Subjects included

Quantum Field Theory	Detector Systems and Data Acquisition
Quantum Chromodynamics	Quantum Many-Body Problem in the Theory of Atomic Nuclei
Fundamentals of Electroweak Theory	Matrix Lie Group Representations
Accelerators	Physics behind Standard Model
Statistical Data Analysis	Special Practicum
Modern Detectors	Seminar on Quark-Gluon Plasma

Final exam (June 6th, 2023): Particle Physics, Experimental Methods, Accelerators

Bachelor's degree in Experimental Nuclear and Particle Physics **2017–2021**

- *Faculty of Nuclear Sciences and Physical Engineering,*
  Czech Technical University in Prague, Czech Republic

Bachelor's thesis
Characterisation of plasma waves generated by intense laser pulses
Supervisor: Ing. Dominika Mašlárová
Consultant: Ing. Miroslav Krůs, Ph.D.

Subjects included

Calculus	Basics of Programming	Numerical Methods
Linear Algebra	Experimental physics	Waves, Optics and Atomic Physics
Mechanics	General Chemistry	Thermodynamics and Statistical Physics
Electricity and Magnetism	Experimental Laboratory	Theoretical Physics
Heat and Molecular Physics	Selected Topics in Mathematics	Subatomic Physics
Quantum Mechanics	The Equations of Mathematical Physics	Interaction of Ionisation Radiation
Detectors and Principles of Detection	Special Theory of Relativity	

Final exam (Sep 3rd, 2021): Subatomic Physics, Thermodynamics and Statistical Physics

- **Gymnasium of Michala Miloslava Hodžu** **2013–2017**
  M. M. Hodžu 860/9, Liptovský Mikuláš

  Graguaded with honors
  School principal's award for representing the school in math competitions throughout the course of study.
  Final exam (May 25th, 2017): Mathematics, Physics, English, Slovak language and literature

Conference presentations

- Gregocki D., Mašlárová D., Krus M. Transition of electron beams between vacuum and plasma in the external injection into a laser wakefield accelerator. Poster presentation at SPIE Optics + Optoelectronics, April 24-28, 2023, Prague, Czech Republic.

Publications

- David Gregocki, Dominika Maslarova, and Miroslav Krus "Transition of electron beams between vacuum and plasma in the external injection into a laser wakefield accelerator", Proc. SPIE 12579, Laser Acceleration of Electrons, Protons, and Ions VII, 1257909 (8 June 2023); https://doi.org/10.1117/12.2665683

Notable Projects

- **Research Project:**
  External injection of electron beams into a laser wakefield accelerator
  Supervisor: Ing. Dominika Mašlárová
  Consultant: Ing. Miroslav Krůs, Ph.D.

  Abstract: The largest accelerating fields that are achievable by conventional accelerators are in the order of 100 MV/m. This limit is inherent to the way conventional accelerators work. The state-of-art generation of high-intensity laser pulses enables the construction of a particle accelerator with very high field gradients. Such accelerators are compact and have very efficient acceleration compared to the conventional types of accelerators. Laser wakefield acceleration, namely, has proven its potential of accelerating electron bunches, reaching accelerating gradients up to hundreds of GV/m. Nonetheless, current experiments demonstrating laser wakefield acceleration suffer from the lack of control or large shot-to-shot fluctuations. This is partially because the injection of electrons into the accelerating structure and their subsequent acceleration are inherently coupled in all of the traditional schemes. These schemes are based on nonlinear dynamics, such as wavebreaking, and injecting electrons from the plasma background itself. Therefore, there is a growing interest in the mechanism where electron bunches are injected from a different accelerator, so that the injection can be controlled more effectively. In the frame of this work, we have performed 2D particle-in-cell simulations using the Smilei code. Several values of laser intensity and initial electron beam energy were analyzed. An optimal set of parameters, with 100% trapping efficiency and low energy spread, has been proposed.
- **Participation in R&D projects:**
  Investigation of advanced techniques for laser-driven plasma-based accelerators

  From 2021 to 2023 I have been a team member of a working group of scientists and students at the Department of Physics at the Faculty of Nuclear Sciences and Physical Engineering that perform research and development of compact laser-driven accelerators. This group covered several currently progressive fields in plasma accelerator research, from numerical simulations over ultrashort bunch generation and diagnostics development to plasma accelerator technology. It was a three-year project titled "Investigation of advanced techniques for laser-driven plasma-based accelerators" supported by the Student Grant Competition of the Czech Technical University; grant no.: SGS22/180/OHK4/3T/14. My research project, together with my master's thesis, were part of this project and supported by the same grant.

Technical and Personal skills

- **Programming Languages:** Python, C++
- **Software:** Matlab, ROOT, Arduino, LTspice, LabVIEW, CCD VideoCom
- **Operating system:** Microsoft Windows 10, Linux
- **Languages:** Slovak-native, English-fluent, German-intermediate

Interests and extra-curricular activity

- In June 2023, I participated at VědaFest, the largest outdoor popular educational event in the Czech Republic, in order to popularize science, especially the physics of lasers.
- Since November 2022, I have been a member of SPIE Student Chapter CTU, a group formed in 2016. Its main focus is to organize regular meetings and other events for the public, primary and secondary schools with the support of the SPIE organization.
- For the year 2022, I have been awarded merit scholarships based on outstanding achievement in academics.