SSVT 2025 will be dedicated to the possibilities of cutting-edge research in new research infrastructures in the Czech Republic

(Presentation of lectures in English for advanced users, doctoral students and employees of research companies)

SSVT 2025

“New capacities of top notch research in the Czech Republic”

2. 6. – 5. 6. 2025
Hotel Jitřenka in Konstantinovy Lázně

Tuesday 3. 6. 2025, morning

1) ***Ing. Filip Křížek, Ph.D. -*** projects Terafit and CzechNanoLab

Institute of Physics of the Czech Academy of Sciences, Division of Solid State Physics, Department of Spintronics and Nanoelectronics, Prague

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The Queen of Vacuum Chambers and the Doors She Opens

I will briefly introduce Molecular Beam Epitaxy, which is the leading technique for growth of ultra-pure materials in ultra-high vacuum. I will place this unique technique into the context of research of material systems designed for applications in quantum information processing. Finally, I will share some of the research experiences that MBE has enabled me to explore throughout my career.

2) ***Ing. Kateřina Pachnerová Brabcová, Ph.D.*** – project ResHum

Nuclear Physics Institute of the Czech Academy of Sciences, Department of Radiation Dosimetry, Husinec - Řež

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Radiocarbon dating: From early settlements to illegal ivory

Radiocarbon dating is a key tool in archaeology and Quaternary Earth sciences, as it is one of the few methods that allows for absolute age determination. The Czech Radiocarbon Laboratory (CRL) at the Nuclear Physics Institute of the CAS operates state-of-the-art infrastructure for its research, including Accelerator Mass Spectrometry (AMS), the only facility of its kind in the Czech Republic. The MILEA AMS system enables precise and robust measurements of radiocarbon and other difficult-to-measure radionuclides. CRL's research spans a broad chronological spectrum, providing new insights into various periods of human history—from early human settlement in Central Europe, through Neolithic subsistence strategies and the Iron Age, to the Middle Ages. In addition, CRL also addresses contemporary challenges, such as dating ivory to support efforts in combating illegal wildlife trade.

Tuesday 3. 6. 2025, afternoon

3) ***Ing. Michal Urbánek, Ph.D. -*** project CzechNanoLab

CEITEC Brno University of Technology, Purkyňova 123, 612 00 Brno

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New materials and characterisation techniques for magnonic applications

Magnonics is the field of science that studies the physical properties of spin waves and uses them for data processing. Scalability down to atomic dimensions, operation in the GHz to THz frequency range, exploitation of pronounced nonlinear and non-reciprocal phenomena, compatibility with CMOS are just a few of the many advantages offered by magnons. In this talk I will introduce the basic concepts of magnonics, discuss the current devices and computational concepts, and the most common materials and characterisation techniques used in this field. I will also present our recent results in the development of magnetic (meta)materials for magnonic applications and in the development of characterisation techniques suitable for probing magnons, such as propagating spin wave spectroscopy and Brillouin light scattering spectroscopy and microscopy.

4) ***Jakub Dostálek Ph.D.,*** *Barbora Špačková, Scott Nicholas Lynn, Hana Lísalová* – project SenDiSo

Institute of Physics of the Czech Academy of Sciences, Division of Optics, Department of Optical and Biophysical Systems, Prague

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Plasmonics for single biomolecule analysis

Detection and interaction analysis of chemical and biological species have become essential in numerous fields important to modern human society including health sector (biomarker-based diseases diagnosis and development of therapeutic drugs), environmental monitoring (analysis of pollutants), and safety (detection of harmful pathogens). There will be discussed recent advances in optical spectroscopy and microscopy – based techniques that, when combined with micro/nanofluidic devices and functional biointerfaces, allow for the analysis of biomolecules with unpreceded accuracy. In particular, there will be given a focus to topics embraced by the OPJAK project Sensors and Detectors for Future Information Society that are spanning from plasmonic biosensor technologies for single molecule detection assays, plasmonic substrates for vibrational spectroscopy – based fingerprinting of target analytes, nano-optics for label-free single molecule imaging, and development of advanced antifouling biofunctional coatings. The paper will introduce metallic nanostructures that are tailored for nanoscale manipulation with light in plasmon-enhanced fluorescence and surface-enhanced Raman spectroscopy and there will be as well discussed recently emerged optical scattering techniques for rapid single molecule tracking in nanochannels. The opportunities brought by the ability to detect target molecular species at ultimate single molecule level in complex biological fluids will be addressed and the necessity of using dedicated coatings for mitigation of unspecific sorption will be highlighted.

Wednesday 4. 6. 2025, morning

5) ***Dr. Daniele Margarone*** **-** project ELI

ELI Beamlines Facility, Extreme Light Infrastructure ERIC, Dolní Břežany, Czech Republic

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Contribution to high-performance Laser Science at the Extreme Light Infrastructure (ELI)

The Extreme Light Infrastructure (ELI) is a research facility that provides a wide range of scientists with access to the largest and most diverse set of high-performance laser systems in the world [https://eli-laser.eu]. Lasers are used to study the fundamentals of interaction between matter and ultra-high-intensity, ultra-fast light pulses, including plasma physics and relativistic acceleration of electrons and ions, or drive secondary sources of ultra-short, high-intensity beams of light or particles which are used for imaging, diffraction and fast spectroscopic studies of materials and biological systems.

Such technology is also developed to explore potential applications in laser-driven compact accelerators that could provide alternatives to current central facilities for synchrotron radiation and ion/neutron beams on a scale that could be located more readily in university departments, industrial laboratories or hospitals.

ELI operates as a single multi-site organisation with complementary facilities: (i) the ELI Attosecond Light Pulse Source (ALPS) facility in Hungary for the exploration of ultra-fast processes with uniquely high time resolution [https://www.eli-alps.hu]; (ii) the high-energy ELI Beamlines facility in the Czech Republic, with a particular emphasis on high peak laser intensity and delivery of secondary sources [https://eli-beams.eu]; and (iii) the Nuclear Physics (NP) facility in Romania for the combination of ultra-intense lasers with brilliant gamma-ray beams [https://www.eli-np.ro].

A particular feature and potential strength of ELI is the complementarity of the facilities, allowing for the support of a particularly wide range of multidisciplinary science and enabling the co-development of new, enabling technology – for example in laser optics, diagnostics or targets for the generation of secondary sources. The three ELI Facilities have been available to user access based on peer-reviewed excellence through open calls for proposals since 2022 and have attracted scientists across the globe requesting access (~360 proposals) to approximately 40 different instruments.

An overview of the current instruments offered by ELI, designed to support a wide range of scientific disciplines and research methodologies, will be given along with highlights of recent user experiments and planned commissioning and R&D activities.

6) ***RNDr. Filip Křížek, Ph.D.*** - *project Forte*

*Nuclear Physics Institute of the Czech Academy of Sciences, Department of Heavy Ion Physics, Husinec - **Řež***

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FORTE prestissimo

The FORTE project interconnects the research carried out in the Czech Republic in particle physics, astro-particle physics, cosmology and gravitation. These fields are key to understanding the principles underlying our universe and determining its past and future evolution. In the talk, we will illustrate the research being carried out within the FORTE project at the high energy physics experiments at CERN, where we study fundamental interactions and extreme states of matter; then we will discuss how we hunt for elusive neutrinos; and finally, we will see how astro-particle physicists measure cosmic rays whose energy exceeds by many orders of magnitude the capabilities of existing man-made accelerators.

7) ***prof. RNDr. Jana Kalbačová Vejpravová, Ph.D.*** – *project AMULET*

Faculty of Mathematics and Physics, Charles University, Department of Condensed Matter Physics, Prague

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AMULETs – next-generation advanced materials

The development of materials with tailored properties and their seamless integration into functional structures is a cornerstone of modern materials science. The AMULET project advances this field through high-impact, interdisciplinary research with globally significant implications. To achieve this, the AMULET consortium brings together expertise across all critical aspects of complex material engineering and advanced multiscale materials. The project's innovative approach is based on multiscale engineering, combining experimental and theoretical research with the development and production of application-specific materials (AMULETs). These materials undergo precise subnanometer-scale modifications to create universal functional building blocks, which are then non-destructively integrated into multidimensional architectures. This strategy enables the design of next-generation materials with tailored properties and broad application potential. The talk will summarize key aspects of the AMULET research strategy and the most significant achieved results.

8) ***prof. Ing. Hanuš Seiner, Ph.D. DSc.*** – *project Ferrmion*

Institute of Thermomechanics of the Czech Academy of Sciences, Department of Ultrasonic Methods, Prague

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Functionalities of Ferroic Materials: from Mathematics to 3D APT

The talk will introduce the FerrMion project, the main aim of which is to develop tools for transferring unique functional behaviours of ferroic solids onto engineering and application levels. The project encompasses a broad range of scientific disciplines, ranging from the calculus of variation to additive manufacturing. A big emphasize in the project is put on bridging between various spatial and temporal scales, both in experiments and in theory. The finest spatial scale in ferroics is the atomistic one, treated theoretically by first-principles and molecular dynamics simulations; obtaining relevant experimental data for such purposes requires an imaging technique with a comparable resolution. For this reason, the project has an ambition to build and operate a 3D atom probe tomography (3D APT) facility in Prague, the first of its kind in the former Central and Eastern Europe.