Applied Physics

Wednesday, 11.09.2024, Room ETF C 1

Time	ID	**Applied Physics I: Physics Applied to Medicine** *Chair: Leonid Rivkin, PSI Villigen*
17:00	**201**	**Advanced X-ray imaging: from the nanoscale at synchrotrons to clinical applications in hospitals** *Marco Stampanoni, Paul Scherrer Institut* Imaging leverages significantly on the unique properties of synchrotron radiation, in particular with the recent introduction of 4th generation facilities. In this lecture, I will showcase some of the latest results, including ptychographic nanoimaging and time-resolved tomographic microscopy and discuss related challenges. I will further elaborate on how some of the tools originally designed for machine diagnostics purposes have developed into powerful, potentially game-changing instruments with a clinical impact, specifically for breast and lung imaging. The talk has been conceived to provide an “easy-entry” into the fascinating world of modern X-ray imaging.
17:30	**202**	**Isotopes for diagnostics and therapy of cancer** *Roger Schibli, Robert Eichler, Cristina Mueller, Nicholas Philip van der Meulen Paul Scherrer Institute* Radioactive compounds are important role in the diagnosis and treatment of cancer. Accelerator facilities are used to produce diagnostic radionuclides (β+ and γ-emitters). Most therapeutic nuclides are produced via neutron irradiation. The production route via nuclear spallation reaction after bombardment with high-energy protons is an innovative way of producing medically interesting radionuclides but is underdeveloped. We will present the concept TATTOOS (”Targeted Alpha Therapy using Terbium and Other Oncological Solutions”) proposed by PSI together with the UZH/USZ. With TATTOOS we will produce isotopically and radiochemically pure radionuclides for medical purposes using the world’s most powerful proton accelerator HIPA at PSI.
18:00	**203**	**Proton therapy developments at PSI** *Anthony Lomax, Centre for Proton Therapy (CPT), PSI and Department of Physics, ETH* Proton therapy is already becoming a mature approach to treating cancers using radiation, whereby their physical characteristics (the Bragg peak) allow for much improved sculpting of the delivered radiation dose to the tumour than conventional radiotherapy using high energy photons. Nevertheless, many technical improvements can still be made, many of which are being pursued at CPT. Main current areas of research are 1) adaptive therapy, 2) FLASH irradiations, 3) On-line imaging of PET activation and 4) biological outcomes analysis, all of which will be explained in more detail during this presentation.
18:30	**204**	**FLASH therapy** *David Meer, Paul Scherrer Institut* In biological experiments for radiotherapy, irradiation at ultra-high dose rates demonstrated a protective effect on the healthy tissue. The so-called FLASH effect, originally explored with electrons, is now being studied with other beams such as protons. The presentation will discuss the experience of upgrading a proton beamline for FLASH experiments at the Center for Proton Therapy. It includes the technical changes to the beam line hardware, challenges in dosimetry and different beam delivery options. Results of first biological experiments will be reported as well as the implementation of a randomized FLASH study for first animal patients.
18:45	~~**205**~~	*cancelled*

19:00	**206**	**In-vivo range verification of proton therapy treatment with the PETITION PET scanner** *Keegan McNamara [1], Marina Béguin [2], Günther Dissertori [2], Judith Flock [2], Cristian Fuentes [2], Antony Lomax [1], Shubhangi Makkar [1], Christian Ritzer [2], Carla Winterhalter [1]* *[1] Paul Scherrer Institute, Center for Proton Therapy* *[2] ETH Zurich, Department of Physics* Validation of the range of protons delivered during proton therapy is important to ensure that there is no overdosage of healthy tissue or underdosage of the tumour. Positron emission tomography can image isotopes, e.g. ^{15}O and ^{11}C, produced by nuclear interactions of the protons within the patient, giving a surrogate for delivered dose. The PETITION PET detector has been developed for in-vivo range verification. Using a rotating open-ring design, equivalently a fixed design with a movable upright patient couch, for in-beam and post-irradiation imaging of the patient we show the ability to detect anatomical changes within the patient, as well as induced shifts of < 2 mm, without interruption to clinical workflows.
19:15	**207**	**PETITION PET scanner for biological adaptation of the proton treatment plan** *Shubhangi Makkar [1], Marina Béguin [2], Günther Dissertori [2], Judith Flock [2], Cristian Fuentes [2], Jan Hrbacek [1], Keegan McNamara [1], Christian Ritzer [2], Damien C. Weber [1], Antony Lomax [1], Carla Winterhalter [1]* *[1] Center for Proton Therapy, Paul Scherrer Institute* *[2] Department of Physics, ETH Zürich* A positron emission tomography (PET) scanner has been developed within the PETITION collaboration, for online adaptation and verification purposes in proton therapy. It can be used for biological adaptation of the treatment plan by imaging hypoxia daily on-the-table. Hypoxic cells within the tumours are radio-resistant and not accounting for it can result in a suboptimal treatment. A retrospective treatment planning study was performed in this context to first translate voxel-wise PET intensities into equivalent proton doses and thereby into an adapted treatment plan. This indicated a median improved tumour control probability of 10% amongst the cohort of ten patients without any significant increase in proton dose to the healthy organs.
19:30	**208**	**POSiCS a handable gamma-camera for radio-guided surgery** *Cyril Alispach, Domenico Della Volpe, Aramis Raiola, Universitè de Genève* At the frontier between research and innovation, POSiCS is a project aiming to build a scalable and handable gamma-camera for Radio-Guided Surgeries. Targeting the imaging of lymph nodes for biopsies in the context of breast cancer and cutaneous melanoma, the camera aims at reducing the invasiveness of the surgical procedure while improving the surgery success probability. The camera is based on an innovative position-sensitive SiPM with reduced number of channels over a large area. We use Deep Neural Networks to enhance the resolution of the gamma-camera yielding an increase in the number of distinguishable regions by a factor 10. The device performances and its use-case will be presented.

19:45	**209**	**Advantages and drawbacks of a back-scattering Mueller polarimetric setup comparing with surface imaging one** *Vladislav Stefanov, Bhanu Pratap Singh, Andre Stefanov,* *Institute of Applied Physics, University of Bern* Mueller polarimetry is a strong experimental tool for characterizing the optical properties of samples. Nowadays, polarimetry-based devices represent one of the most promising directions for recognizing various types of a cancer during surgical procedures for example. While polarimetric reflection surface imaging is popular, we focus on the back-scattering setup, where the light penetrates deeply into highly scattering media. This enables the study of the internal structure of a sample rather than just its surface, making it useful for cases beyond histological analysis. In the presentation we will discuss the advantages and drawbacks of each setup's configuration based on the experimental study of a human brain sample.
20:00		***END***

Thursday, 12.09.2024, Room ETZ E 7

Time	ID	Applied Physics II: Applied Physics & Plasma Physics (combined session) *Chair: Laurie Porte, EPFL*
17:00	**211**	**Analysis of natural disruptions on JET with JOREK** *Lili Edes, Jonathan Graves, Mengdi Kong, Swiss Plasma Center, EPFL* Tokamak disruptions pose significant challenges in fusion research. Although it has been widely accepted that natural disruptions are caused by the growth of tearing or neoclassical tearing modes[1], studies have shown that the finite resistivity of the wall can have a significant effect on the thermal loss of the plasma[2]. This study investigates the chain of events leading to disruptions, focusing on the role of tearing modes and their dependence on wall resistivity. JOREK-STARWALL[3] simulations are being conducted based on a JET discharge in which natural disruption was observed. These simulations serve to benchmark previous studies based on M3D simulations and to conduct further analysis of Resistive Wall Tearing Modes.
17:15	**212**	**MHD simulations of runaway electron avalanche in ITER mitigated disruptions** *Chizhou Wang [1], Javier Artola [2], Vinodh Bandaru [3], Jonathan Graves [1], Matthias Hoelzl [4], Mengdi Kong [1], Eric Nardon* *[1] Swiss Plasma Center, EPFL, [2] ITER Organiation, [3] Indian Institute of Technology Guwahati, [4] Max Planck Institute for Plasma Physics* The avalanche of high-energy runaway electrons (RE) during ITER disruptions could potentially generate several MA's of RE current which might damage the plasma-facing components. Previous studies have suggested that avoiding the formation of such a large RE current would be difficult. However, before their quantity increases to a large value, some REs might be lost due to the scraping-off of the flux surfaces on the wall during the plasma's vertical displacement or the magnetic stochasticity from the growth of MHD instabilities. In our work, this process is simulated with the JOREK code, using a reduced MHD model self-consistently coupled to a RE fluid description.

17:30	**213**	**Kinetic simulations of the magnetized plasma-wall boundary layer in fusion devices** *Nicole Vadot [1], S. Zeegers [2], Alessandro Geraldini [1], Stephan Brunner [1]* *[1] École Polytechnique Fédérale de Lausanne, [2] Eindhoven University of Technology* Considering conditions relevant to magnetic fusion plasmas, a code is being developed for solving in a kinetic framework the steady state solution of the plasma-wall boundary layer, comprising both the collisionless magnetic presheath and the Debye sheath. For a given electrostatic potential profile, discretized on a finite element basis, the ion density in each element is calculated by summing the contributions of a set of particle trajectories whose initial conditions are sampled from a given incoming distribution function. An iterative scheme is used to correct the electrostatic potential profile until Poisson's equation is satisfied, thus bypassing a computationally expensive time evolution. The code currently assumes a Boltzmann distribution of electrons, and generalization towards kinetic electrons is being developed. Initially written in C+OpenMP [S. Zeegers, master thesis, Eindhoven Univ. of Tech.], the code is being rewritten in Chapel, a modern task and node-parallel programming language.
17:45	**214**	**Turbulence-inclusive Modelling of Electron-Cyclotron Wave-Plasma Dynamics in Tokamaks** *Ewout Devlaminck [1], Jean Cazabonne [2], Stefano Coda [1], Joan Decker [1], Omar Maj [3], Emanuele Poli [3]* *[1] Swiss Plasma Center, EPFL, [2] CEA Cadarache, [3] Max Planck Institute for Plasma Physics* Electron-cyclotron waves are widely used for plasma heating and current drive in tokamaks. The possibility of very localised deposition renders them appealing for instability mitigation and tailored control. However, previous work1 indicates that simulations overlooking turbulence effects tend to significantly overestimate the method's efficiency. The discrepancy with experimental results is believed to stem from two effects2: microwave beam broadening due to turbulent plasma density fluctuations and wave-enhanced turbulent transport of suprathermal electrons. This project aims to couple two codes, WKBeam3 and LUKE4, to simulate both effects simultaneously for the first time, yielding a comprehensive understanding of the combined dynamics. Experimental validation at the TCV tokamak is also envisioned.
18:00	**215**	**Sub-micrometric hollow channels in bulk fused silica** *Pasquale Barbato [1], Rebeca Martínez Vázquez [2], Roberto Osellame [2]* *[1] Paul Scherrer Institut, [2] CNR - IFN* Ultrafast lasers are outstanding tools for glass processing. When focused inside a transparent substrate, a train of femtosecond pulses can be absorbed via non-linear interactions resulting in a permanent modification of the sample. In this work, we show how an extremely focused femtosecond laser beam followed by wet chemical etching can be used to create sub-micrometric channels in fused silica, realizing three-dimensional hollow structures in bulk material with an unprecedent resolution.
18:15	**216**	**Detection of land mines and unexploded ordnance** *Yves Marc Acremann, Robert Früh, Joel Rehmann, Yiming Li, Matthias Röllin, Francisco Carrion Ruiz, Andreas Vaterlaus, ETH Zürich* Land mines and unexploded ordnance (UXO) are a wide-spread humanitarian problem in former war zones. Different techniques are used for the detection, but a main problem is the high false positive rate. For the detection of UXO we developed portable electromagnetic induction spectrometer, which is able to distinguish the size of metal objects in the ground. At low frequencies of less than 1 kHz the skin depth in metals is in the range of centimeters and allows for distinguishing small metal fragments from UXO. Further perspectives of UXO and land mine detection will be discussed.
18:30		***END***
19:00		***Transfer to Dinner***
19:30		***Conference Dinner***

ID	Applied Physics Poster
231	**Calibration of reflection and back-scattering Mueller Polarimetric setups** *Bhanu Pratap Singh, Vladislav Stefanov, Andre Stefanov, Institute of Applied Physics, University of Bern* Mueller Polarimetry is a technique that can differentiate areas with distinct optical structures, such as tumorous and healthy tissue, or identify complex optical structures like fiber orientation in the brain. The well-established calibration methods of Mueller Polarimetric setups in transmission cannot be straightforwardly applied to reflection or back-scattering configurations. In our presentation, we provide a brief overview of the development of Mueller Polarimetric setups, and we demonstrate the implementation of a calibration procedure utilizing a novel configuration of reference samples. This approach enhances accuracy compared to standard methods, as demonstrated in our results.