Channeling 2024

Report of Contributions

https://agenda.infn.it/e/39892

Contribution ID: **2** Type: **oral**

Features of Radiation Generated by a Charged Particle Flying Through a Ball of Dispersive Material

Monday, 9 September 2024 17:30 (20 minutes)

The results of theoretical investigation of the spectral and angular distributions of the radiation generated by a charged particle crossing a ball of dispersive material in vacuum, are presented. Previously, in the case of a non-dispersive dielectric ball it was shown that strong peaks appear in the spectral distribution of the radiation intensity for certain values of the problem parameters. In this work we show that by choosing the dispersion law it is possible to achieve the generation of powerful radiation not in narrow bands, but over a fairly wide frequency range.

The work was partially supported by the Science Committee of RA, in the frames of the research project № 21AG-1C069.

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Presenter: Mr HARUTYUNYAN, Hayk (Institute of Applied Problems of Physics of NAS RA)

Session Classification: Radiation: Generation & Interaction

Contribution ID: **3** Type: **invited**

Radiation of surface polaritons by a charge circulating inside a dielectric cylindrical waveguide

Tuesday, 10 September 2024 11:15 (30 minutes)

We investigate the features of surface polaritons generated by a charged particle coaxially circulating inside a cylindrical waveguide immersed in a homogeneous medium. The corresponding surface waves are emitted on the eigenmodes of the cylindrical waveguide in the spectral range where the real parts of the dielectric permittivities for the cylinder and surrounding medium have opposite signs. The electric and magnetic fields are found by using the electromagnetic field Green tensor. The radiation fields are separated explicitly and the energy flux for the surface polaritons through the plane perpendicular to the waveguide axis is evaluated. We also discuss the radiation on the eigenmodes
corresponding to the guiding modes of the cylindrical waveguide.

Primary author: SAHARIAN, Aram (Yerevan State University, Yerevan, Armenia)

Co-authors: Prof. GRIGORYAN, L.Sh. (Institute of Applied Problems of Physics, NAS RA); Dr KHACHATRYAN, H.F. (Institute of Applied Problems of Physics, NAS RA)

Presenter: SAHARIAN, Aram (Yerevan State University, Yerevan, Armenia)

Session Classification: Radiation: Generation & Interaction

Contribution ID: **4** Type: **oral**

Few-particle intraband dipole transitions in strongly oblate asymmetric ellipsoid QD

Tuesday, 10 September 2024 17:30 (20 minutes)

The investigation methods of photon and ion channeling can give important information about the zone structure and the confinement potential character of the investigated quantum dots (QD). [1,2]. In particular, it is essential at the description of the physical processes in QDs with complicated geometry when the problem of quantum confinement of the particles is fundamentally important for the construction of a realistic Hamiltonian of the one-particle or many-particle system localized in QD. In the above-mentioned article [1] based on ion channeling methods through InAs QD there was an investigation of mechanical strain character. The possibility of the strain effect definition in QDs is discussed in the work [3]. It has been shown that in InGaAs/GaAs QDs the barrel-shaped lateral confinement leads to a larger spacing between higher excited states. As the shape of the lateral confinement is similar to the rectangular one for low-level states we can consider the model of QDs confinement potential in the frame of infinitely high QW approximation. The above-mentioned results allow us to consider the electron gas behavior in the ellipsoidal or lens-shape QDs in the scope of the infinite height rectangular quantum confinement potential model. While it can be shown that in the case of the strongly oblate ellipsoidal or lens-shape QDs with the circular cross-section, the in-plane motion in the perpendicular axial direction is confined with the two-dimensional circular oscillator potential [4]. In the proposed work the electron gas behavior in the strongly oblate ellipsoidal QD is discussed in the case when the cross-section is not circular but elliptic. The strong oblation condition of the QD, in that case, will imply that semiaxes a (along OX) and b (along OY) are much greater than semiaxis c (along the axial direction OZ).In the frame of the adiabatic approximation, it is shown that the electron gas is localized in the two-dimensional asymmetric oscillator well in the cross-section of QD. In the frame of the exact solvable Moshinsky model [5], there is given the analytical description of the electron gas behavior in the mentioned system and there is shown the possibility of the realization of the generalized Kohn theorem [6,7,8] in the considered system. The resonance frequencies of the long-wave radiation do not depend on the number of particles.

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Presenter: Prof. SARKISYAN, Hayk (Institute of Applied Problems of physics)

Session Classification: New Concepts

Contribution ID: **5** Type: **oral**

Polycapillary applications for tomographic studies

Thursday, 12 September 2024 17:10 (20 minutes)

First results on the use of polycapillary optical systems will be reported.

Primary authors: PEREZ, Alessandra (University of San Paolo); HAMPAI, Dariush (Istituto Nazionale di Fisica Nucleare); DABAGOV, Sultan (Istituto Nazionale di Fisica Nucleare)

Presenter: PEREZ, Alessandra (University of San Paolo)

Session Classification: Applications & X-rays

Contribution ID: **6** Type: **poster**

Influence of secondary electron emission on particle generation in a pyroelectric accelerator

Monday, 9 September 2024 18:30 (1 hour)

The concept of a pyroelectric accelerator entails a compact device that does not require an external high-voltage circuit or the use of hazardous materials. This enables the generation of an electron flow within a narrow energy range, which converges at a certain distance from the surface of the pyroelectric crystal when its temperature changes in a vacuum. Utilizing a target with a hole promotes the collimation of the electron flow to a specific energy level.

Nevertheless, secondary electron emission from the surfaces of the collimator target and the vacuum chamber strongly influences the dynamics of the electron flow. This limitation can hinder the increase in electron energy and trigger avalanche processes in the space between the crystal and the target. These processes have been studied both experimentally and through computer simulations. This discussion encompasses the mechanisms through which secondary electrons influence the primary electron flow from the crystal surface, as well as the stability of the pyroelectric accelerator.

The work was financially supported by a Program of the Ministry of Education and Science of the Russian Federation for higher education establishments, project No. FZWG-2020-0032 (2019-1569).

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Presenters: OLEINIK, Andrey (BelSU); KARATAEV, Pavel (Royal Holloway, Unviersity of London)

Session Classification: Poster Session 1

Contribution ID: **8** Type: **invited**

Application of PXR-based X-ray source using a Si(400) radiator in the 40-keV region

Thursday, 12 September 2024 16:00 (30 minutes)

The X-ray source based on parametric X-ray radiation (PXR) has been developed and employed for users studies at the Laboratory for Electron Beam Research and Application (LEBRA), Nihon University. The X-ray energy of the LEBRA-PXR source is limited to 34keV in the case of using Si(220) as a radiator. Samples containing elements heavier than cesium such as lanthanoid are difficult to treat for imaging because of the upper limit of the X-ray energy. Therefore, we decided to introduce Si(400) crystals into the LEBRA-PXR source in order to provide a PXR beam above 40keV for the investigation into fuel battery cells.

Primary author: Prof. HAYAKAWA, Yasushi (Laboratory for Electron Beam Research and Application (LEBRA), Nihon University)

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Presenter: Prof. HAYAKAWA, Yasushi (Laboratory for Electron Beam Research and Application (LEBRA), Nihon University)

Session Classification: Applications & X-rays

Contribution ID: **9** Type: **oral**

Mechanism of Self-Collimation and Weakening of Dechanneling During Realistic Channeling of Positive Ions in Crystals

Tuesday, 10 September 2024 09:50 (20 minutes)

The work considers the mechanism of self-controlled autocollimation of a beam of positive ions during their channeling in crystals, which can lead to a significant reduction in the angular dispersion of the ions beam. The autocollimation process is associated with elastic ion scattering and stepwise transfer of the transverse energy E_\perp of a channeled ion to groups N \approx \Lambda / 2 <d$_z$ > $ofcrystalatomsthatarelocalizedinregions\Lambda/2 = v_z/2\omegaofalternatingreflectionsoneachchannelwall.$

Primary author: VYSOTSKII, Vladimir (Kiev National Shevchenko Univ, Kiev, Ukraine)

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Presenter: VYSOTSKII, Vladimir (Kiev National Shevchenko Univ, Kiev, Ukraine)

Session Classification: Beams Interactions

Contribution ID: **10** Type: **not specified**

Controlled Channeling of Atom Electrons and Accompanying Nuclear Processes During the Orientational Action of a Polarized Laser Pulse on a Crystal

Tuesday, 10 September 2024 16:30 (20 minutes)

The work investigated the features of the formation and movement of a superdense flow of fast electrons, formed under the action of a polarized high-power laser pulse on the crystal surface, inside a crystal. It is shown that, at a certain orientation of the laser pulse, repeatedly planar channeling of these electrons occurs, with their energy reaching relativistic values.
The report also discusses the features of the interaction of periodically channeled electrons with crystal atoms and nuclei, including the excitation of nuclei, the creation of inversion of internal atom X-Ray states, and the process of inverse beta-decay of crystal nuclei.

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Presenter: VYSOTSKII, Vladimir (Taras Shevchenko National University of Kyiv)

Session Classification: New Concepts

Contribution ID: **11** Type: **not specified**

On the Possibility of Creating Sources of Induced Short-Wave Radiation Based on Channeling Electrons in an Optical Lattice

Monday, 9 September 2024 18:30 (1 hour)

The article discusses the prerequisites for the implementation of stimulated laser generation of short-wave (including X-ray) radiation based on a system of fast electrons channeled in a standing light wave. It is shown that considering all the features of the quantum states of such particles makes it possible to determine the conditions for implementing such short-wave lasers. To optimize such systems, it is necessary to use long hollow optical waveguides, inside which a high-current beam of relativistic electrons moves.

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Presenter: VYSOTSKII, Vladimir (Taras Shevchenko National University of Kyiv)

Session Classification: Poster Session 1

Contribution ID: **12** Type: **not specified**

Cherenkov Diffraction Radiation Studies at Diamond Light Source using a One Dimensional Beam Position Monitor

Monday, 9 September 2024 16:30 (20 minutes)

The following paper will display the fundamental ChDR studies which have been undertaken using the BPM prototype, presenting the design of the BPM itself whilst focusing on the process of optimising the maximum signal for 500 nm narrowband ChDR. Data acquisition for the examination of ChDR signal decay has stemmed from impact parameter scans where a particular assembly or beam parameter is altered, and the beam is moved transversely away from the prism. Exploration into the effect of altering ChDR parameters is considered alongside how the signal is impacted by prism rotation and examination of at which angle the detected ChDR signal is at a maximum. The vertical position at which the coupling between the emitted ChDR light and the fibre optic system is optimal has been determined, resulting in a maximum signal.
The broadband impact parameter and vertical measurements have been compared with their narrowband counterparts and presented.

Primary author: CLAPP, Alec (Royal Holloway University of London and Diamond Light Source)

Co-authors: Dr BOBB, Lorraine (Diamond Light Source); KARATAEV, Pavel (Royal Holloway, Unviersity of London)

Presenter: CLAPP, Alec (Royal Holloway University of London and Diamond Light Source)

Session Classification: Radiation: Generation & Interaction

Contribution ID: **13** Type: **not specified**

Radiation of surface polaritons by an annular beam coaxially enclosing a cylindrical waveguide

Tuesday, 10 September 2024 11:45 (20 minutes)

We investigate the radiation of surface polaritons by an annular beam that coaxially encloses a cylindrical waveguide. In the spectral range under consideration the real part of dielectric permittivity for the waveguide is negative. By using the Green tensor, the electric and magnetic fields are found inside and outside the waveguide. The contributions in the fields corresponding to surface polaritons are separated and the corresponding energy fluxes are evaluated in the exterior and interior regions. The energy losses are studied for general dispersion law of dielectric permittivity. The numerical examples are presented for the Drude model of dispersion.

The work was partially supported by the Higher Education and Science Committee of the Ministry of Education, Science, Culture and Sport RA in the frames of the research project 21AG-1C069 and the PhD support program 22AA-1C002.

Primary authors: SAHARIAN, Aram (Yerevan State University, Yerevan, Armenia); Dr KHACHATRYAN, Hrant (Institute of Applied Problems of Physics National Academy of Sciences of Armenia); GRIGORYAN, Levon (Institute of Applied Problems in Physics); KOTANJYAN, Vardazar

Presenter: KOTANJYAN, Vardazar

Session Classification: Radiation: Generation & Interaction

Contribution ID: **14** Type: **not specified**

Features of spontaneous short-wave radiation during channeling of weakly relativistic electrons in the main crystallographic planes of tetrafluoroaluminates

Thursday, 12 September 2024 09:30 (20 minutes)

In this work, the interaction potentials of electrons with the main crystallographic planes (100), (110), (101), (001) and (111) in crystals of tetrafluoroaluminates KAlF4, TlAlF4, RbAlF4 and NH4AlF4 were calculated. For beams of weakly relativistic electrons with Lorentz factors γ = 10, 20, 30 and with different angular dispersions, the features of spontaneous short-wave radiation were studied.

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Presenter: Ms STAKHOVA, Anastasia (Taras Shevchenko National University of Kyiv, Ukraine)

Session Classification: Radiation: Generation & Interaction

Contribution ID: **15** Type: **not specified**

Comparative analysis of X-ray CT images and the results of digital modeling of objects printed on a 3D printer

Thursday, 12 September 2024 17:50 (20 minutes)

Computed tomography (CT) is a widely used method that provides huge opportunities for imaging the internal structure of different samples without disturbing their structures. During a CT scan, X-rays pass through a sample and detectors measure the radiation intensity after their interaction with this sample. The images directly obtained during the X-ray CT scan are two-dimensional projections of a three-dimensional sample through which radiation has passed oriented at different angles to the irradiating beam. In classical tomography, a three-dimensional sample is represented as a series of thin layers with one pixel thickness. During the processing of the received data, it is assumed that the trajectory of the beam is a straight line, and the linear absorption of radiation in the material occurs:
$dI/I = \mu(x,y)dt$
The main mathematic models use inverse Radon transformation for the reconstruction of tomographic images from two-dimensional projections reconstructing the function $\mu(x,y)$. Three-dimensional reconstruction aims to restore the original $\mu(x,y)$ function of the sample under investigation and different mathematical algorithms can be used for that. It is important to use different complex-shaped samples to train and check the applicability of such algorithms. 3D printing allows the creation of complex samples that can be used for obtaining real CT images while models of these objects can be used for computer simulation of the results of CT experiments.
This study reports an ad-hoc algorithm for simulating tomography images of different 3D-printed samples and a comparison of these images to ones obtained in real CT experiments.

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Session Classification: Applications & X-rays

Contribution ID: **16** Type: **poster**

On a new method of diffraction microradiography of single crystals

Tuesday, 10 September 2024 18:35 (1 hour)

A new method of diffraction microradiography of single crystals has been proposed and implemented, based on increasing the resolution of X-ray topographic patterns. A special device has been developed, created, and tested that makes it possible to scan synchronously the slit for transmitting separate parts of the X-ray diffraction pattern and X-ray film with a predetermined speed ratio. The possibility of significantly increasing the resolution of X-ray diffraction patterns using the suggested new scanning method has been experimentally proven. It is shown that if individual parts of the diffracted beam are passed successively through a special narrow slit, which is synchronously scanned along with the X-ray film, we obtain a linear increase in topographic patterns. A proposed scheme for increasing the picture in parts, and a description and operating principle of the scanning device are also presented. A relationship between the ratio of the velocities of the slit and the X-ray film movement with the parameters of the scanning device and the sample (slit width, total thickness of thin crystals, thickness of a thick crystal, etc.) was revealed. The velocities of the reciprocating motion of the slit and the X-ray film were calculated. It has been experimentally proven that the scanning process does not introduce new information into the interference pattern, but only increases it, since these patterns in sectional topograms differ only in size in the scattering plane.
Keywords: X-ray interferometer, X-ray diffraction pattern, resolution, scanning, crystal.

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Session Classification: Poster session 2

Contribution ID: **17** Type: **not specified**

Monocapillary X-ray semilens application for imaging of fine details in macroscopic object

Tuesday, 10 September 2024 18:35 (1 hour)

The applied imaging task gains more and more interests during last few decades in very different scientific fields from medicine to material science. New advanced imaging techniques are continuously developed since the demands for their sensitivity (contrast and spatial resolutions) are constantly rising. It should be noted that the highest sensitivity are usually reached for specific techniques operating in conditions optimised for searching particular structures or elements in particular matrixes which are predetermined from a priori information about samples under investigation (particular location of details, materials of matrix and features, absorption parameters of different details of the sample etc.).

Polycapillary optics using for applied X-ray imaging tasks are widely announced in a number of studies [1]. These optical elements are usually used to enrich photon flux going through the sample, suppress scattered rays, and sometimes to modify spectral distribution of probe X-ray beam. As the channel size of these lenses are crucially lower than the sizes of pixels of available matrix X-ray detectors, imaging studies with them allows obtaining of averaged brightness of a several of capillaries in each particular pixel. In contrast, monocapillary X-ray optics (a bundle on single capillaries) with much higher capillaries size allows registration of X-ray signal from different part of capillary and potentially to obtain difference in X-ray response from parts of investigated samples corresponding to different part of capillaries. The technical difficulty in this case caused by the fact that big size of capillaries limits the maximal energy of X-ray channelling in the monocapillary lens/semilens by a few keV may prevent experimental studies with regular laboratory X-ray sources and in air conditions.

This study reports the first preliminary results on experimental imaging of gold grid made of 20 μm filament with 100 μm period using laboratory X-ray source and monocapilary lens.

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Primary authors: HAMPAI, Dariush (Istituto Nazionale di Fisica Nucleare); DABAGOV, Sultan (Istituto Nazionale di Fisica Nucleare); KOCHARYAN, Vahan (Institute of Applied Problems of Physics of NAS RA, 0014, Hr. Nersisyan str. 25, Yerevan, Armenia.); MARGARYAN, Vardan (Institute of Applied Problems of Physics NAS RA, 25 Hr. Nersisyan, Yerevan, 0014, Armenia); CHEREPENNIKOV, Yury

Presenter: CHEREPENNIKOV, Yury

Session Classification: Poster session 2

Contribution ID: **18** Type: **not specified**

Analysis of corundum crystals optical and ultraviolet transmittance after electron beam exposure

Thursday, 12 September 2024 17:30 (20 minutes)

Development of new materials and instrumentations for detection of charge particle beams and measuring their parameters are very topical in modern accelerator physics [1]. Cherenkov effect is well-known phenomenon that can be used for beam diagnosis. Commonly, diamond crystals is considered to be used as Cherenkov radiators for this purposes since this material has high resistance to radiation exposure. However, corundum crystals which are much cheaper also can be considered for beam diagnosis applications [2]. In previous study we demonstrated that corundum crystals provides high stability of their optical properties under electron irradiation [3]. This report continues investigations in changes of optical and ultraviolet transmittance of corundum crystals irradiated with high dose rate electron beams.

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Presenter: CHEREPENNIKOV, Yury

Session Classification: Applications & X-rays

Contribution ID: **19** Type: **poster**

Pion photoproduction on a deuteron at the VEPP-3 electron beam

Monday, 9 September 2024 18:30 (1 hour)

The pion photoproduction on nucleons and light nuclei is one of the main sources of information about their structure and electromagnetic properties. The ability to perform the experiments with polarized beam and/or target greatly increases the value of these reactions. The reason for this is that the study of various polarization observables reveals the mechanisms that cannot be seen and evaluated without using the polarized beam and/or target, since the contributions from small reaction amplitudes are strongly suppressed in unpolarized experiments.

The polarization observables include the components of tensor analyzing power of the pion photoproduction on a deuteron. In addition to their unique sensitivity to certain excitation mechanisms of nucleon resonances, these tensor observables can also manifest themselves in the study of dibaryon resonances. In contrast to theoretical studies, where the tensor polarization observables of the pion photoproduction on a deuteron have been studied for more than 40 years, there are quite a few experimental values for them. The reason is the difficulty to conduct the experiments in which a tensor-polarized deuterium target is used. A high degree of tensor polarization can be obtained only in the gaseous state, which corresponds to the target thickness 3-4 orders of magnitude smaller than in the solid state. Therefore, to perform an experimental study of tensor polarization observables, it is reasonable to use an internal tensor polarized target

At present, the internal target method is implemented only at the VEPP-3 storage ring in the Budker Institute of Nuclear Physics. The low thickness of the tensor-polarized gaseous deuterium target (1013 atoms/cm2) is compensated by the high electron beam current inside the VEPP-3 storage ring (~0.2 mA). In this paper, we present a review of the experimental works devoted to the study of the pion photoproduction on a tensor-polarized deuteron performed with the use of the VEPP-3 electron beam [1-4]. The connection between the electro- and photoreactions on the deuteron is described, and the methods for analyzing the experimental statistics and estimating the inseparable background with the use of the GEANT4 package and the GENBOS photoreaction generator [5] are presented.

This work was supported by the Ministry of Science and Higher Education of Russia (Contract No. FSWW-2023-0003).

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Presenter: CHEREPENNIKOV, Yury

Session Classification: Poster Session 1

Contribution ID: **20** Type: **poster**

Study of the evolution of populations of transverse energy levels during channeling of weakly relativistic positrons in hexagonal crystals

Monday, 9 September 2024 18:30 (1 hour)

In this work, as a result of the numerical solution of the system of kinetic equations for weakly relativistic positrons channeled both along the basal and prismatic planes and along the c-axes in the hexagonal crystals under study, the populations of quantum levels of transverse energy are found as a function of the longitudinal coordinate. The widths of levels and the probabilities of transitions between them are calculated within the framework of nonstationary perturbation theory by analogy with calculations carried out for electrons. Based on these data, the structures of radial profiles are calculated at various distances from the entrance to the channels, with the help of which the lengths of dechanneling can be determined.

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Presenter: MAKSYUTA, Mykola (Taras Shevchenko National University of Kyiv, Ukraine)

Session Classification: Poster Session 1

Contribution ID: **21** Type: **poster**

On the possibility of resonance capture of valence electrons by non-relativistic protons channeled in carbon nanotubes

Monday, 9 September 2024 18:30 (1 hour)

In the paper, calculations were made on resonance capture of valence electrons by non-relativistic protons channeled in carbon nanotubes. The probabilities of the formation of hydrogen atoms with such capture were calculated using the non-stationary perturbed theory. Ionization processes are also analyzed and it is shown that in a certain range of speeds a sufficiently high yield of neutral hydrogen atoms is achieved.

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Presenter: MAKSYUTA, Mykola (Taras Shevchenko National University of Kyiv, Ukraine)

Session Classification: Poster Session 1

Contribution ID: **22** Type: **not specified**

Investigating the relationship between Tip Effect and Field Emission in Vertically Aligned Carbon Nanotubes

Friday, 13 September 2024 09:30 (20 minutes)

Vertically aligned carbon nanotubes (VACNTs) are best candidate as emitters because of their high ordered structure, directional sensitivity and superior field emission performances. To understand the effective relation between field enhancement factor and surface morphology, we provide a protocol to quantitively characterize the topographic properties of nanotubes. After an efficient synthesis through thermal chemical vapor deposition, the surface of VACNTs were characterized via atomic force microscopy, from which we were able to quantify the distribution of radii of curvature using spectral analysis. By measuring field emission current, we have found a relation between the radius of curvature and field enhancement factor. This approach could be used as an efficient tool to predict the efficiency in field emission performances, just characterizing the surface topography of VACNTs.

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Presenter: CECCHINI, Luca (Istituto Nazionale di Fisica Nucleare)

Session Classification: Applications & X-rays

Contribution ID: **23** Type: **oral**

Footprint of Lienard–Wiechert field on a one-dimensional curve in space

On the basis of exact Lienar-Wichert equations a method is developed that determines parametric expressions of the electromagnetic field of a charged particle moving in vacuum on one-dimensional curve in space. Specific parameterization allows to overcome the problem of solving the retardation equation. We call the defined field on a one-dimensional curve the footprint of Lienard-Wiechert field, and the curve itself the footprint line. In this paper the method is applied to a charged particle moving along a helical trajectory. As one-dimensional curves, straight lines located differently with respect to the motion trajectory are chosen. Field domains with maximal amplitudes are identified and their motion with time is considered. It is shown that these domains are marked by the regions of the electric field line concentrations in space. Since the footprint line is given in an absolute manner, the fields of particles moving along different trajectories can be imprinted on it, i.e., the exact solutions of the electromagnetic fields from the particle beam can be determined.

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Session Classification: New Concepts

Contribution ID: **24** Type: **oral**

Development of methods for creating sensitive receivers for the detection of distant quasars

Thursday, 12 September 2024 10:30 (20 minutes)

There are not many more effective methods for researching the structure of the universe. However, there are opportunities that will allow to adjust some circumstances. First of all, there is an opportunity to determine the distribution of extragalactic sources with the help of quasar studies, to have more accurate data. Quasars being the brightest sources in the Universe, they can be observed at great distances. We need methods that will allow us to detect all quasars at certain distances. The absolute magnitudes of quasars are brighter than magnitude -23m, and observations are needed to detect all quasars at least at certain distances. To have complete data up to distances z=3-4, observations with sensitive telescopes are necessary. Quasars are rich in hydrogen, and with the help of hydrogen lines, spectral studies can be performed, even if only in one line, and the distance of a given quasar can be found. There are at least a few ranges where we can make observations and estimate distances. The first range is the infrared range, the second is optical, and the third is X-ray. Since quasars are rich in hydrogen, with the help of the Hα line, if you have sensitive receivers in the infrared range, you can observe weak quasars, with the help of Lα, you can get the necessary data in the optical range, when conducting studies in the X-ray range, you can use the channeling phenomenon as an amplifier and prepare a receiver in that range and have a sensitive a device that will allow to detect and measure the red shifts of distant quasars, to construct their distributions. This work is dedicated to the problem of having sensitive receivers in the specified ranges. If we can get a receiver that can detect quasars at red shifts of 3.4 and beyond, we can greatly improve our understanding of whether the Universe is homogeneous or inhomogeneous.

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Presenter: HOVHANNISYAN, Martik (Institute of Applied Problems of Physics NAS RA)

Session Classification: New Concepts

Contribution ID: **25** Type: **poster**

Completeness of the number of quasars surrounding the quasar 0851+20 as a sample for the detection of cosmic voids

Tuesday, 10 September 2024 18:35 (1 hour)

The distribution of quasars is quite a good indicator for studying the structure of the universe. The distribution of quasars around quasar 0851+20 gives grounds for asserting that if the number of quasars is complete and their distribution is homogeneous, then that part of the universe is homogeneous. In the distribution of extragalactic objects around quasar 0851+20, quasars show a more reliable result because quasars are more powerful sources and can be detected at greater distances. And the number of quasars found at certain distances is complete. With the help of this fact, it can be said that the distribution of quasars at these distances better reveals the structure of the universe. The work presents results that reveal the inhomogeneity of the structure of the Universe.

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Session Classification: Poster session 2

Contribution ID: **26** Type: **oral**

Observation of Coherent Cherenkov and Transition Radiation at the AREAL Accelerator

Thursday, 12 September 2024 09:50 (20 minutes)

The results of an experimental study of the spectral angular distribution of coherent transition and Cherenkov radiation in the sub–terahertz frequency range are presented. As targets, a thin silicon plate with an aluminium coating and a cylindrical Teflon resonator were used. The AREAL linear accelerator, with an energy of 3.6 MeV and located at the CANDLE Synchrotron Research Institute in Yerevan, served as the electron source. Radiation was recorded using SBD (Schottky Barrier Diode) detectors, designed for frequencies ranging from 33.5 to 50 GHz, 60 to 90 GHz, and 90 to 140 GHz. The obtained results were compared with previous experimental data and theoretical estimates. THz and sub-THz radiation generated by ultra relativistic charged particles can be used for development of intense sources of photons as well as for particle beam diagnostics.
The work was partially supported by the Science Committee of RA, in the frames of the research project № 21AG-1C069.

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Session Classification: Radiation: Generation & Interaction

Contribution ID: **27** Type: **poster**

Microtron M-5 at Tomsk Polytechnic University

Monday, 9 September 2024 18:30 (1 hour)

Accelerators of charged particles are powerful tools used in many fundamental researches and applied tasks. Compact accelerators are currently widely employed for pretesting and proof-of-principle experiments for MegaScience projects, as well as for applied purposes. In particular, electron accelerators allowing generating of few MeV beams are used for testing of different techniques of beam diagnostics, radiation exposure experiments etc. In this work, we present the detailed technical report of Microtron M-5 at Tomsk Polytechnic University after major upgrade, and scope and current status of experimental studies.

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Session Classification: Poster Session 1

Contribution ID: **28** Type: **oral**

Thermodynamic parameters of the electron gas in CdSe nanoplatelets

Tuesday, 10 September 2024 17:50 (20 minutes)

Semiconductor nanoplatelets (NPL) are quasi-two-dimensional systems occupying an intermediate position between quantum wells and quantum dots [1]. NPL is considered a promising area for the role of an elementary base for semiconductor devices of a new generation and various applications including ion channeling, sensing, green energetics, etc. [2-5].
The single-electron spectrum in NPL has a pronounced subband character when each level of axial quantization (Oz) is associated with a family of levels characterizing the state of the electron in the NPL cross-section plane [6-8]. In this regard, the movement of one particle within each subband is two-dimensional. NPL has several interesting physical characteristics [9-10]: electronic, optical, excitonic, etc.
If a several-particle electron gas is localized inside the NPL, it will exhibit statistical properties. At low densities and high temperatures of the electron gas, one can use Boltzmann statistics for an ideal gas. For the lower temperatures, we need to use Fermi –Dirac statistics.
The thermodynamic characteristics of weakly interacting electron gas in CdSe NPL are studied theoretically. Thermodynamic characteristics including free energy, entropy, and heat capacity are calculated in the framework of Boltzmann and Fermi –Dirac statistics. The main results are obtained in terms of the Ramanujan theta function. The dependencies of the entropy and heat capacity on the size of the NPL are determined.

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Session Classification: New Concepts

Contribution ID: **29** Type: **oral**

Radiation from a Charged Particle Rotating Around a Ball of a Dispersive Matter

Monday, 9 September 2024 17:50 (20 minutes)

The results of theoretical investigations of the spectral distributions of the radiation generated by an electron rotating around a ball of a dispersive matter, in vacuum, are presented. Previously, for non dispersive dielectric ball was shown that for certain values of the problem parameters, at certain harmonics, the electron may generate radiation field quanta exceeding in several dozens of times those generated by electron rotating in a continuous and transparent medium having the same real part of permittivity as the ball material (resonant radiation). In this work we show that by choosing the dispersion law it is possible to achieve the generation of "resonant"radiation simultaneously at several neighboring harmonics.

The work was partially supported by the Science Committee of RA, in the frames of the research project № 21AG-1C069.

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Session Classification: Radiation: Generation & Interaction

Contribution ID: **30** Type: **invited**

Possible Crystal Applications for FCC and Beyond

Monday, 9 September 2024 09:00 (30 minutes)

This presentation will first describe the status and plans of the ongoing Future Circular Collider (FCC) Feasibility Study, and then survey possible crystal and channeling applications for the FCC. The latter range from crystal-based positron production, over crystalline undulators, to crystal collimation. Finally, a long-term perspective is presented, where, in the far future, crystals or crystal-like structures could enable the construction of ultimate colliders.

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Session Classification: FCC & Channeling

Contribution ID: **31** Type: **poster**

SYLA accumulator ring status

Monday, 9 September 2024 18:30 (1 hour)

Two 4th generation synchrotron radiation sources will be in Russia soon. One of it is 3 GeV SKIF in Koltsovo and the another one is 6 GeV SYLA in Protvino (former SSRS-4 and USSR). Both were digned for equlibrium horizontal beam emittance is about 70 pm. The current activities on the SYLA project will be presented. As in most similar state-of-the-art facilities, electron beams will be injected into the SYLA storage synchrotron from a linear resonant accelerator with an energy of 6 GeV (top-off injection), which will also be a driver for the free electron laser. In order to obtain high beam lifetime as well as dynamic aperture, optimization of magnets and high order multipoles was performed.

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Session Classification: Poster Session 1

Contribution ID: **32** Type: **oral**

Geant4 implementation of inverse Compton scattering

Monday, 9 September 2024 16:50 (20 minutes)

Inverse Compton scattering [1, 2] is a promising instrument for engineering of a bright, compact and versatile X-ray source: with dimensions being significantly smaller, the brightness of this source is comparable with that of synchrotron radiation. Here we report on the creation of a new C++ module for inverse Compton scattering simulation and its implementation into Geant4 [3]. The module operates with a light target, which is virtual volume transparent for any particle and having properties of laser beam. The module allows simulation of laser and electron beams interaction under arbitrary angles, which can be of primary importance for reaching maximum luminosity of the radiation source [4]. We implemented it into Geant4 as a discrete physical process [5]. Such a form of integration makes it possible to combine new physical processes with those already built into Geant4 (for example, different types of scattering of both photons and primary particles), which significantly increases the quality of simulation. The direct simulation of inverse Compton scattering in Geant4 allowed us to create a model of a full-scale light source without using additional external programs. Comparison with other simulation programs and experiments shows that created physical module provides correct results.

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Session Classification: Radiation: Generation & Interaction

Contribution ID: **33** Type: **poster**

The Potential of Resonance Islands combined with Bent Crystals for Slow Extraction in Circular Hadron Accelerators

Monday, 9 September 2024 11:50 (15 minutes)

Recent advances in accelerator physics have expanded the array of techniques available for manipulating charged-particle beams. The successful implementation of adiabatic trapping and transport of beams in resonance islands at the CERN Proton Synchrotron has enabled multiturn extraction. The successful installation of bent crystals in the CERN Large Hadron Collider has enhanced the collimation system's cleaning performance, and in the CERN Super Proton Synchrotron it has helped reduce losses at the extraction septum during slow extraction. We explore the potential of utilising resonance islands and bent crystals together to develop an innovative method for slow extraction in circular hadron accelerators.

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Session Classification: FCC & Channeling

Contribution ID: **34** Type: **oral**

Microchannel Plate (MCP) Optical Device Characterization Using Synchrotron Radiation in the Soft X-Ray Domain

Thursday, 12 September 2024 16:50 (20 minutes)

Compact, efficient, and high-quality plasma wakefield-accelerated free electron lasers (FELs), betatron sources, and novel synchrotron radiation (SR) coherent sources are under development to meet the latest experimental and technological demands [1, 2]. All new sources need small, low-loss optical parts that can focus, condense, monochromatize, filter, and/or focus radiation, as well as change its polarization and phase [3]. Microchannel plates (MCPs) are compact diffractive optics capable of shaping intense beams of radiation and particles for a variety of applications in the UV and soft X-ray domains.

At these wavelengths, MCPs experience grazing incidence and total reflection from the surface, similar to capillary optics. An ordered array of typically cylindrical or rectangular channels is the typical pattern of these compact and thin optics, which have a flat or bent surface made of lead silicate glasses. A couple of MCPs, identical or different, rigidly linked in such a way that the incident radiation on the second MCP surface is the result of the diffracted radiation at the exit of the first MCP [4], represent a new type of metalens whose properties can be properly engineered. We recently proposed a new soft-x-ray/UV microscopy layout based on a confocal geometry using these types of meta-lenses suitable to be used with SR, FELs, betatrons and also conventional sources. Tests have been performed with synchrotron radiation at Elettra demonstrating the feasibility to image objects/samples placed inside the focal spot of bent MCPs.

In this contribution, we will present diffraction patterns generated by two MCPs assembled in a unique device in the transmission mode using radiation in the UV-soft X-ray domain at the CiPo beamline at Elettra [5]. Patterns collected at 92 eV and 480 eV, with the insertion device of the CiPo beamline working both in the wiggler and undulator modes, are presented. Working with the SR light at 480 eV, a condensed gaussian intensity distribution with a FWHM of 95 μm was observed, confirming the possibility of using this device as a SR condenser in this energy domain [6]. The analysis revealed that beam parameters and MCP configurations can be tuned to generate different patterns for different applications.

The results achieved also confirm that, similar to a multi-slit experiment, a MCP based device may provide fundamental information to probe the coherence degree of the SR source. Tests with different MCPs represent simple soft X-ray microscopy and imaging experiments in the framework of a full field transmission layout based on two compact, thin, and low-cost, low-weight MCPs.

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Session Classification: Applications & X-rays

Contribution ID: **35** Type: **oral**

Investigating the Impact of Metalloporphyrins on DNA Damage During Electron Beam Irradiation

Friday, 13 September 2024 10:10 (20 minutes)

Recent advancements in radiobiology focus on the effects of ionizing radiation on biological systems, with a critical emphasis on understanding how radiation impacts DNA, as structural breaks in DNA are a primary cause of cellular death. Enhancing the efficacy of cancer treatments by combining radiation therapy with other modalities, such as chemotherapy and phototherapy, can mitigate the side effects of radiation therapy.

This study investigates the effects of metalloporphyrins, specifically ZnTOEPyP4, used in photodynamic therapy on DNA damage during electron beam irradiation. The study explores DNA damage in both tumor and nearby healthy cells, which can lead to various human diseases. By combining radiation therapy with other cancer treatments, the approach to tumor treatment has significantly evolved.

In this research, structural changes in the DNA molecule were examined under electron beam irradiation at different doses (2 Gy, 4 Gy). The influence of ZnTOEPyP4 porphyrin on radiation-induced DNA damage was studied with varying relative concentrations of complexes (r = 0.01, 0.02, 0.04, where r = C_por./C_DNA). The study aimed to identify the potential potentiating effects of porphyrins on DNA damage, depending on the concentration of porphyrin and the radiation dose. The experiments utilized spectroscopy melting methods in a 10^-3 M NaCl buffer solution at pH 7.2. Results indicate that the presence of Zn porphyrin enhances radiation effects on DNA structure, leading to hydrogen bond breaks or double-strand breaks in the DNA molecule, depending on the electron beam irradiation dose.

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Session Classification: Applications & X-rays

Contribution ID: **36** Type: **oral**

FEL performance and tolerance studies of the EuPRAXIA@SPARC_LAB AQUA beamline

Monday, 9 September 2024 17:10 (20 minutes)

The AQUA beamline of the EuPRAXIA@SPARC_LAB free-electron laser facility is a SASE FEL designed to operate in the water window, in the 3-4 nm wavelength range. The electron beam driving this source is accelerated up to 1-1.2 GeV by an X-band normal conducting linear accelerator followed by a plasma wakefield acceleration stage.
The main radiator consists of an array of ten APPLE-X permanent magnet undulator modules, each 2 m long and with a period length of 18 mm.
An analysis of resistive wall wakefields and tolerances to magnetic field errors and misalignments is discussed, and their impact on the FEL performance is evaluated.

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Presenter: NGUYEN, Federico (ENEA)

Session Classification: Radiation: Generation & Interaction

Contribution ID: **37** Type: **oral**

Coherent Thomson backscattering and Cherenkov superluminal effect

Tuesday, 10 September 2024 12:45 (20 minutes)

Thomson backscattering of a laser beam on relativistic electrons is one of the most promising ways to generate bright quasi-monochromatic X-ray radiation. To achieve a high luminosity of such a source, it is possible to increase the intensity of the initial beams, but this will lead to nonlinear effects, which significantly degrade the radiation spectrum. Another approach is to optimize the geometry of collisions in order to maximize the beam interaction efficiency. In [1], we have derived an expression for the optimal geometry for the Thomson backscattering process by calculating the brightness for an arbitrary scenario. The cited article, however, does not take into account the effects of interference, which could potentially lead to considerably greater increase in intensity. Usually, implementation of coherent effects requires short beams with sizes smaller than the radiation length, which is challenging for the X-ray range. On the other hand, the luminosity approach used in [1] is not suitable for direct consideration of coherent effects.
In this work, we develop a theory describing the coherent luminosity of Thomson backscattering. We demonstrate that at certain angles of beam rotation, the "spot"of their geometric overlap moves with superluminal speed, resulting in the appearance of interference maxima in Cherenkov-like direction (see also [2]). It proves to be possible to keep two key issues: (i) to provide coincidence of superluminal Cherenkov peak with the direction of Thomson radiation, which leads to a sharp increase in the intensity of the backscattering; (ii) the laser front can be kept straight, while only the electron beam has been rotated. The latter is beneficial in terms of simplifying the laser system's setup. Interestingly, considering Cherenkov radiation in a vacuum we eliminate the effects of frequency dispersion typical of a medium. The direction of the cone is therefore determined solely by the ratio of the speed of light to that of the emitter.

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Session Classification: Radiation: Generation & Interaction

Contribution ID: **38** Type: **invited**

Laser and Particle Guiding in Plasmas at I-LUCE (INFN Laser indUCEd radiation production)

Thursday, 12 September 2024 11:15 (30 minutes)

The pursuit of compact, high-brightness particle and radiation sources has driven significant advancements in laser technology, emphasizing improved efficiency and repetition rates [1]. These developments have led to the emergence of a new generation of ultrafast high-power laser systems operating at high repetition rates worldwide.

In 2024, a new high-power laser facility called "I-LUCE" (INFN Laser indUced radiation acCEleration) will be established at INFN-LNS (Istituto Nazionale di Fisica Nucleare –Laboratori Nazionali del Sud) [2]. This facility's construction is funded by three projects under Italy's PNRR (Piano Nazionale di Ripresa e Resilienza) program: EuAPS (EuPRAXIA Advanced Photon Sources), Samothrace (SiciliAn MicronanOTecH Research And Innovation), and Anthem (AdvaNced Technologies for Human-centrEd Medicine).

The Ti:Sapphire laser at I-LUCE will have two outputs: a 50 TW beam line (25 fs, 25-30 mJ, 10 Hz) and a main beam line with a 350 TW laser (25 fs, 10 J, 2 Hz). I-LUCE will feature two distinct experimental areas, E1 and E2.

E1 will provide a globally unique setup that combines laser-generated plasmas with accelerated heavy ion beams from a Superconducting Cyclotron and a Tandem (already installed at LNS). This configuration will facilitate pioneering experiments in plasma physics, nuclear physics, and atomic physics. For moderate laser beam intensities (up to 50 TW), E1 will focus on nuclear fusion experiments and the study of stopping power in plasma.

In contrast, the E2 experimental room will specialize in proton and electron acceleration. It will include a specialized beamline designed to select, transport, and focus proton beams with energies ranging from 5-60 MeV, optimized for radiobiological experiments. Additionally, an electron beamline will be implemented to select beams with energies between 0.1-3 GeV. E2 will also enable independent experiments using intense laser beams to explore fields such as X-ray laser generation and neutron production.

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Session Classification: Laser/Plasma & Channeling

Contribution ID: **39** Type: **poster**

Features of Electron Bunch Formation in Radiofrequency Photoinjectors

Monday, 9 September 2024 18:30 (1 hour)

Radiofrequency (RF) photoinjectors are widely utilized to generate bright electron bunches for light sources. In RF photoinjectors, pico- and subpicosecond laser pulses meet the photocathode surface, resulting in photoemission. Although there are well-recommended models and approaches to describe photoemission in RF photoinjectors, some dark spots in understanding and theory-to-experiment inconsistencies still exist.

The brighter the electron bunch to be generated, the more detailed consideration of photoemission is needed. Electron bunch formation at the photocathode and its vicinity seems to be an especially crucial and sophisticated phenomenon. As laser pulses perturb the photocathode medium, a nonequilibrium conduction electron concentration, which evolution is described via the drift-diffusion equation, occurs. Electron concentration at the photocathode-vacuum contact not only defines photocurrent (longitudinal electron bunch profile), but also is defined by the one through the boundary condition in the respective drift-diffusion problem. Thus, photoemission is a self-consistent process worth investigating and describing with due attention. Also, it is of essence to account electron bunch not only influences the photocathode and its charge dynamics, but also on itself through space-charge forces, resulting in saturated photoemission.

In this research, recent results on developing a self-consistent model to describe bunch formation in RF photoinjectors are presented and briefly discussed.

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Session Classification: Poster Session 1

Contribution ID: **40** Type: **not specified**

Form-factor of hollow electron beams in Smith-Purcell radiation

Tuesday, 10 September 2024 18:35 (1 hour)

Hollow electron beams are actively studied now in view of their usage for high-intensity beam collimation at the Large Hadron Collider in CERN [1, 2]. Besides, the intensively studied today beams with non-zero orbital angular momentum (OAM) are also hollow. Usually hollow beams with OAM are described by Gaussian-Laguerre or Bessel functions. Yet, as a first step, the ring-shaped constant or Gaussian functions can also describe hollow beams. In our earlier paper [3] we have shown that properties of transition radiation are very close for solid and hollow Gaussian beams. It means that transition radiation is not the best tool for diagnostics of such beams.
Here we study Smith-Purcell radiation as a more promising type of radiation due to its sensitivity to the transverse properties of the beam. We report the theory of Smith-Purcell effect, generated by electrons from a metasurface, for which the theory can be constructed without additional problems [4, 5]. We consider the two-layer structure of the hollow beam with the current density is constant inside each layer. This is because the computer simulation of hollow beam dynamics performed in [6] has showed that the hollow electron beam obtain such structure. We demonstrate that the form-factor for the layered beam strongly differs from that for the solid beam, and based on that we propose a practical scheme for diagnostics of the internal structure of hollow beams.

The research is supported by the Foundation for the Advancement of Theoretical Physics and Mathematics BASIS, Project No. 23-1-3-2-1.

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Session Classification: Poster session 2

Contribution ID: **42** Type: **invited**

Implementing Capillary Design for Reliable VHEE Beam Delivery

Thursday, 12 September 2024 13:05 (30 minutes)

Very High Energy Electron (VHEE) radiotherapy is gaining attention for its potential to revolutionize cancer treatment [1]. VHEE employs high-energy electrons (~250 MeV) accelerated to extremely high speeds, which are precisely targeted at deep-seated tumors. This method offers significant penetration and optimal dose distribution, effectively targeting tumors while sparing healthy tissues. The precision of VHEE supports high dose-rate irradiation, promising improved treatment outcomes and fewer side effects. However, the widespread adoption of VHEE is currently limited by the availability of hospital-scale accelerators, a challenge being addressed by advancements in high-gradient laser-plasma accelerators (LPAs) [2].

Our proposed method focuses on accelerating electrons using lasers in capillary discharge [3] at I-LUCE (INFN-Laser indUCEd radiation production), a new laser facility in Catania, Italy. We are designing a capillary system there for generating electrons optimized for dual FLASH/VHEE modes. Different capillary geometries (length, diameter, channel shape) will be studied to enhance high-quality electron beam production.

Capillaries demonstrate exceptional capability in producing high-quality electron beams with precise energy control, despite requiring meticulous laser focusing and a complex setup. They effectively guide and confine laser pulses and plasmas over extended distances, facilitating higher acceleration gradients and superior control over beam emittance. The use of capillaries for e-LPAs holds particular promise for VHEE applications within the Laser Wakefield Acceleration (LWFA) scheme, enabling energies and fluxes reaching several GeV to be achieved [4]. Therefore, by leveraging the I-LUCE laser's characteristics—50-350 TW power, 1-7 J energy, 23-150 fs pulse duration, 10^17-10^19 W/cm^2 intensity, and 1-10 Hz repetition rate—along with a plasma density of 10^17-10^19 cm^(-3), we can produce electron beams with energies ranging from 0.1 to 3 GeV. These beams will have a charge of 30-400 pC and contain 10^8-10^9particles per pulse.

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Session Classification: Laser/Plasma & Channeling

Contribution ID: **43** Type: **oral**

Radiation pressure driven collisionless shock ion acceleration at Brookhaven National Laboratories

Monday, 9 September 2024 12:50 (15 minutes)

Laser-plasma ion acceleration is a well established field of research, with several mechanisms being exploited to produce particle beams with high energy and short bunch lengths.
One of these techniques is radiation pressure acceleration (RPA), which turns into collisionless shock acceleration (CSA) when thermal effects become relavant.

Scaling laws show that both the vector potential of the laser, and the critical density of the plasma scale favorably with the laser wavelength. These considerations make the long wavelength ($9.2\mu m$) and high power ($a_0 > 1$) CO_2 laser at the Brookhaven National Laboratories the ideal choice for exploring and pushing the boundaries of radiation pressure acceleration using gaseous targets.

The work carried out by the Imperial College group at BNL has demonstrated steady ion production, albeit with low energy, in the scenario where the laser's main pulse interacts with a the gas jet from a supersonic conical nozzle. Clear channelling of the laser through the hydrogen plasma was observed experimentally, using an ultra short Ti-Sapphire optical probe, and in PIC simulations with very good agreement between the results.

Significant gains in the ion energies were obtained when employing the laser's pre-pulse to shape the target and form spherical blast waves. This approach consistently produced ∼1MeV monoenergetic ion beams. The results are backed by PIC simulations which give insights on collisionless shock acceleration dynamics. New targetry is being developed to achieve high density gradients in the target without relying on the volatile pre-pulse.

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Session Classification: FCC & Channeling

Contribution ID: **44** Type: **oral**

First studies of crystal collimation for the FCC-ee

Monday, 9 September 2024 09:35 (15 minutes)

The Future Circular electron-positron Collider (FCC-ee) is being designed to reach energy and luminosity frontiers for lepton colliders. This requires managing very high-intensity lepton beams, with stored beam energies up to 17.5 MJ. Therefore, a beam collimation system is essential for safely disposing of unavoidable beam losses. Unique challenges for the collimation system design need to be addressed, and the exploitation of channelling of charged particles in a bent crystal-assisted collimation scheme is being explored as a possible solution. This paper presents the first studies to assess the feasibility of implementing such a collimation scheme in the FCC-ee.

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Session Classification: FCC & Channeling

Contribution ID: **45** Type: **poster**

Influence of Crystals Mosaic Structure on the Characteristics of Fast Electrons Radiation

Monday, 9 September 2024 18:30 (1 hour)

It is known that the mosaic nature of the crystal significantly affects the characteristics of the radiation of fast electrons, and the degree of this influence depends on the radiation mechanism. The intensity of radiation at the Bragg angle increases sharply due to the additional contribution of diffracted real photons of transition and bremsstrahlung radiation [1], peaks in the spectra of coherent bremsstrahlung radiation and radiation during channeling, on the contrary, become less intense, and their width increases [2].
The effect of crystal mosaic on the movement of electrons has not yet been studied. Measurements of the Θ-scans of the soft component of the radiation of relativistic electrons in mosaic crystals of pyrolytic graphite showed that the position of the maxima due to the "volumetric capture" of electrons in the planar channeling mode coincides with the observation angle, as for perfect crystals [3], but the dependence amplitudes depending on the viewing angle are not described by the theory of multiple scattering.
Measurements of the total radiation energy at a fixed solid angle for several observation angles confirmed the presence of features in the angular distribution of electrons in mosaic crystals, up to the manifestation of an analogue of the "focusing"effect. The possible reason for the observed effects is discussed.

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Session Classification: Poster Session 1

Contribution ID: **46** Type: **oral**

Current activities on the 4th generation synchrotron source SYLA of the National Research Center "Kurchatov Institute"

Thursday, 12 September 2024 16:30 (20 minutes)

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Session Classification: Applications & X-rays

Contribution ID: **47** Type: **oral**

Mechanisms of destruction of MWCNTs of various diameters under ion irradiation

Friday, 13 September 2024 09:50 (20 minutes)

Previously, in experiments with irradiation of multi-walled carbon nanotubes, it was shown that nanotubes with a smaller number of layers are destroyed more strongly than thicker-walled nanotubes at the same irradiation fluences with He+ ions [1]. In this work, the ion-induced destruction of MWCNTs was modeled using the classical molecular dynamics method using the LAMMPS code [2] and AIREBO-M potentials [3], as well as taking into account electronic braking.

The model considered 5 different MWCNT diameters. As a result of the simulation, approaches to explaining the mechanisms of different behavior of thin-walled and thick-walled nanotubes under the same irradiation conditions are discussed.
The research is carried out using the equipment of the shared research facilities of HPC computing resources at Lomonosov Moscow State University [4].
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Session Classification: Applications & X-rays

Contribution ID: **48** Type: **oral**

Can microscopic structure of matter affect X-ray polarization radiation?

Monday, 9 September 2024 18:30 (1 hour)

When a fast charged particle induces polarization currents in a medium, these currents become a source of polarization radiation. Polarization radiation Vavilov-Cherenkov, transition, Smith-Purcell and other radiations. Although polarization radiation has a microscopic nature, its microscopic description is not well developed.

Here we present the preliminary results of microscopic theory of X-ray polarization radiation. The theory is based on multipole decomposition of an atom's polarization current and a procedure of averaging radiation from individual atoms over the entire matter. Well-known formulas for solid and gas Cherenkov and transition radiation are obtained in the limiting cases. To describe the structure of matter, we use the correlation function. We find that, for highly porous polymers and sol-gel aggregates, the known expressions for Cherenkov and transition radiation are not applicable. We also discuss the microscopic theory in terms of the local field effects.

The study was partially supported by the Ministry of Science and Higher Education of the Russian Federation, Projects No. FZWG-2020-0032 (2019-1569) and No. FSWU-2023-0075.

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Session Classification: Poster Session 1

Contribution ID: **49** Type: **oral**

First-principles calculations of channeling of low-energy ions in SWCNTs and the effect of many-particle interactions

Wednesday, 11 September 2024 10:50 (20 minutes)

Previously, calculations showed that the channeling of low-energy ions in SWCNTs leads to the emergence of many-particle interactions, which leads to the establishment of a special regime of particle motion in the SWCNT channel, similar to gliding [1]. In this work, using TD-DFT [2] and ab initio molecular dynamics [3] methods, a similar mechanism was considered, taking into account many-particle interactions from first principles.

The model is based on the PBE functionality; the STO-3G and 6-31G basis sets were used.
The research is carried out using the equipment of the shared research facilities of HPC computing resources at Lomonosov Moscow State University [4].

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Session Classification: Beams Interactions

Contribution ID: **50** Type: **oral**

Novel Approach to Positron Production for the FCC-ee Using Lattice Coherent Effects in Oriented Crystals

Monday, 9 September 2024 09:55 (15 minutes)

The high-luminosity requirement in future lepton colliders imposes a need for a high-intensity positron source. In the conventional scheme, positron beams are obtained by bremsstrahlung and electron-positron pair through the interaction between a high-energy electron beam and a high-Z amorphous target. In the conventional positron generation system, one way to increase positron intensity is by boosting the incident electron beam power. However, the target's allowable heat load and thermo-mechanical stresses severely limit the beam power of the incident electrons. To overcome these limitations, an innovative approach using lattice coherent effects in oriented crystals appears promising.
Two configurations were investigated in application to the Future Circular Collider (FCC-ee) positron injector as alternatives to the conventional scheme. One configuration splits the production into two stages: a thin crystal as a radiator followed by an amorphous target for positron production. The other configuration uses a single thick crystal that simultaneously acts as a radiator and converter. Simulations were conducted from the positron production phase to the entrance of the damping ring to estimate the accepted positron yield. The results show significant advantages of the crystal-based positron source: thinner targets than the conventional scheme, resulting in lower deposited power, achieve a comparable accepted positron yield.

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Session Classification: FCC & Channeling

Contribution ID: **51** Type: **oral**

Quantum mechanical estimation of dielectric constant values in dielectric materials in a special state with negative dielectric constant

Friday, 13 September 2024 12:05 (20 minutes)

In the proposed model for the anomalous (with negative values for dielectric constant) region of consideration with the assumption of the formation of dipole-domain cells (DDC) in the substance, the state of the substance is characterized by the parameter of the degree of dominant orientational ordering DDC. In the model approximation, matter is considered as a continuous homogeneous medium consisting of weakly interacting identical quantum particles DDC. The frequency dependence of the dielectric constant ε(ω) in the anomalous incommensurate phase in a certain temperature range is considered. At the same time, the microstate of a substance is defined as a superposition of microstates DDC with a corresponding set of natural frequencies. The theory of small perturbations is applied, assuming that the interaction of DDC with an external field is sufficiently weak. In the dipole approximation, the Schrodinger equation is solved to find the wave function DDC with subsequent quantum mechanical assessment of the contribution of a certain microstate to the degree of oscillation in the measured quantity ε(ω) in resonant interaction DDC with an external field. The state with maximum orientational ordering DDC in the dominant direction with the most expected negative value for ε is considered. The Bi2/3Cu3Ti4O12 is considered with specific symmetry and parameters of the elementary cell.

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Session Classification: New Concepts

Contribution ID: **52** Type: **poster**

Shaped Cherenkov radiators for increasing of light collection

Tuesday, 10 September 2024 18:35 (1 hour)

Here we report on the results of computer simulations of a calorimeter system for charged particle detection based on Cherenkov radiators with a profiled end-face. We performed simulations in the Geant4 package [1], which is the leading simulation toolkit in high-energy physics, accelerator physics, medical physics, and space studies. We demonstrate that profiled end-faces of Cherenkov radiators provide increase in the light output from a radiator depending on the radiation frequency and the shape of the end-face. In addition, by giving a special shape to end-faces, one can focus Cherenkov light at a certain distance from the calorimeter station. This makes it possible to move the readout electronics from the radiation hazard area and to decrease noise caused by unwanted interaction of particles with it. Such calorimeter type can be used for increasing the quality of the upcoming muon experiment - Mu2e [2, 3].

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Session Classification: Poster session 2

Contribution ID: **53** Type: **oral**

Smith-Purcell radiation of vortex electrons from a metasurface

Tuesday, 10 September 2024 18:35 (1 hour)

We present the theory of interaction between a metasurface and an electron with non-zero orbital angular momentum (OAM). The metasurface consists of meta-atoms –subwavelength particles – located at the nods of 2D lattice with periods comparable to the wavelength of radiation. Previously we constructed the theory of SPR from such a metasurface for an electron with zero OAM [1, 2]. We discuss the influence of the magnetic momentum of the vortex electron [3] and extend the theory for meta-atoms, made of material with high permeability. Inside such meta-atoms the external field of the free electron excites internal currents so that the magnetic momentum of each meta-atom might be as large as its dipole momentum. The efficiency of interaction between the metasurface and the electron increases with increasing OAM of the electron. Taking into account that OAM can reach 10^3, the effect can be observed experimentally. The results are compared with those for the conventional grating [4].

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Session Classification: Poster session 2

Contribution ID: **54** Type: **poster**

Calculation of the Orbital Angular Momentum of Axial Channeling Radiation from Relativistic Electrons in Thin Si Crystal

The twisted photon is a state of a free electromagnetic field with the certain energy, longitudinal projection of the momentum, projection of the total angular momentum and helicity. Various schemes of production of the twisted photons have been proposed recently. The undulators [1-5] and free electron lasers [6-8] are used in these schemes. High energy twisted photons can also be generated by particles channeled in aligned crystals [9-11].
Channeling radiation of plane wave photons is well studied and finds various applications. The photon energy of the radiation lies in MeV spectral range. Planar channeling radiation has several ad-vantages over other types of radiation such as the narrow spectrum and focus. In [9] we calculated the OAM per one photon generated by planar and axial channeled electrons as function of the angle between momen-tum of the incidence electron and the plane or axis of the channeling. In the work [11] we described planar channeling radiation from electrons in terms of twisted photons. The energy spectrum of twisted photons and the projection of the total angular momentum per photon were calculated. We revealed the oscillations of the projection versus the photon energy. The distance between the maxima was about 25-30 keV.
In this work, we plan to continue the calculation of the OAM in the case of axial channeling and check whether the periodical dependence remains intact or disappears

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Contribution ID: **55** Type: **poster**

On the Feasibility of Employing a Territorial Anti-Seismic Early Warning and Protection System in Armenia

Tuesday, 10 September 2024 18:35 (1 hour)

As international experience shows, advances in modern science and technology in designing and introducing earthquake early warning systems (EEWS) in many countries significantly improved the effectiveness and feasibility of short-term early warnings of upcoming earthquake shakes and the use of territorial EEWSs. Despite the universal recognition of the EEWSs' efficacy in many countries and their encouraging experience, no territorial EEWS has yet been designed and implemented in the Republic of Armenia (RA), though we have painful statistics on the large human and material losses caused by previous devastating earthquakes, the country's high seismic activity, and risks, as well as the lowest seismic resistance of many objects.

The study of the EEWSs' international experience and the seismic situation in the RA shows that the design, development, and implementation of the country-wade integrated system of early warning of the population about upcoming earthquake shakes and preliminary anti-seismic protection of important objects is an important, realistic and feasible issue for the improvement of the RA seismic safety.

On the other side, the comparative analyses of the characteristics of the RA territory and the distribution of seismic sources and the network of seismic stations with the EEWSs' different working principles, algorithms, and architectures show that none of the on-site (local) or regional (network) early warning algorithms and EEWS architectures used can be applied in the proposed Armenian EEWS, due to which we started to develop a combined algorithm and architecture for the EEWS effective operation.

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Presenter: Dr MKHITARYAN, Samvel (Institute of applied problems of Physics NAS RA)

Session Classification: Poster session 2

Contribution ID: **56** Type: **poster**

Identification of material by X-ray fluorescence analysis with a pyroelectric X-ray generator

Tuesday, 10 September 2024 18:35 (1 hour)

Development of advanced intense and reliable sources of charged particle beams is a direction within accelerator physics on its own right. By changing the temperature of Lithium Tantalate (LiTaO3) single crystal at moderate vacuum conditions leads to generation of strong electric field. The uncompensated polarization during the heating or cooling of the crystal causes the ejection of electrons from the dielectric layer on the surface of the crystal. The electrons ejected either from the crystal or from the target (depending on polarity) are accelerated and gain energy of up to a 100 keV. The energy of these electrons can be determined by measuring the energy spectrum of the X rays that resulted from the electron interactions with the target. The conception of a pyroelectric accelerator enabled us to develop compact (portable) electron source, which does not require an external high-voltage and the use of hazardous materials.

Here we present studies of features of electron flux in pyroelectric accelerator depending on the Influence of temperature variation. It is revealed that employing only the electron beam enables the successful acquisition of quantitative information regarding the sample content through pyroelectric driven PD-PIXE analysis. These findings set the stage for the development of a compact and versatile apparatus for elemental analysis of materials based on the pyroelectric source.

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Session Classification: Poster session 2

Contribution ID: **57** Type: **oral**

Cherenkov radiation from transparent plate for beam diagnostics

Tuesday, 10 September 2024 12:05 (20 minutes)

The report presents the measurement results of the characteristics of optical Cherenkov radiation (ChR) in comparison with traditional transition radiation (TR). The experiment was carried out using an electron beam from the LINAC200 accelerator with an energy of 18 MeV. The radiation was detected at an angle of 90 degrees relative to the electron beam using the TAMRON lens with a focal length of 18 –400 mm and the CCD camera (QHY533C, 3003X3003 pixels with size 3.76 mcm). As TR and ChR targets we used an aluminized silicon wafer and a corundum plate (0.5 mm thick). When focusing "on target", the dimensions of the "light footprint"of a collimated electron beam with a diameter of 5 mm on both targets were measured.

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Presenter: KARATAEV, Pavel (Royal Holloway, Unviersity of London)

Session Classification: Radiation: Generation & Interaction

Contribution ID: **58** Type: **poster**

111In medical isotope production via different accelerator types

Tuesday, 10 September 2024 18:35 (1 hour)

The radionuclide 111In is one of the widely used radionuclides in diagnostic nuclear medicine. Research on its production has been carried out since the second half of the last century. For commercial purposes, 111In is produced in proton or alpha particle induced reactions on cadmium or silver targets [1, 2]. However, in recent years, various activation methods have been proposed to obtain it. In this review, we analyze the routes to obtain 111In, comparing our experimental results with published data. The analysis presented in this review will be useful for selecting the appropriate nuclear reaction to produce high purity 111In for applications.
In our experiments, we investigated nuclear reactions on enriched tin targets induced by protons and photons, based on availability of compact medical cyclotron and linear electron accelerator in Yerevan.
The stack of enriched (63.2%) 114Sn foils was irradiated using 18 MeV proton beam provided by cyclotron IBA Cyclone18/18 [3]. Cross-sections of the 114Sn(p,α)111In reaction using the stacked-foil activation technique were measured. This method allows us to calculate cross sections for several energies under the same conditions in a single irradiation.
The enriched (92.6%) 112Sn target was irradiated at the linear electron accelerator LUE-75 of A. Alikhanian National Science Laboratory at the bremsstrahlung endpoint energy Eγmax = 55 MeV. The cross section per equivalent quantum for reaction 112Sn(γ,x)111In, have been measured via the method of activation and off-line γ-ray spectrometric technique [4].
The cross sections of the 111Cd(p,n)111In reactions have been measured repeatedly and have large cross-sections at the maximum of the excitation function [2]. But the excitation function of 114Sn(p,α)111In has been measured for the first time in Ref. [3]. Comparison of experimental data confirmed that the probability of 111In formation in the case of proton-nucleus reactions on the 114Sn target is lower than in the 111Cd(p,n)111In [5].
The experimental data showed that the yield of 111In in the 112Sn(γ,x) reaction is significantly lower than in case of using proton-nuclear reactions on cadmium, but is comparable to other reactions for producing 111In [2]. Our research allows us to conclude that it is possible to use the photonuclear method for the production of 111In if the proton beam is not available. An important point is the low activity of impurities in the final product, and in the case of photonuclear production, radioactive impurities are short-lived and their amount becomes insignificant a day after irradiation.

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Session Classification: Poster session 2

Contribution ID: **59** Type: **oral**

Experiments of particle guiding and radiation in laser-plasma channels

Thursday, 12 September 2024 12:05 (20 minutes)

Plasma acceleration is a novel technique for a large variety of applications, including radiation sources of new generation. X-ray sources based on betatron radiation from plasma accelerators hold promise as compact, innovative and highly accessible solutions for radiation users. The key feature that makes these sources unique, lies in the shortness of the pulses delivered, falling in the femtosecond range and paving the way for ultrafast photon science in the X-ray range.
In this work, temporal characterizations of the betatron radiation pulses emitted by electron bunches undergoing acceleration and guiding in plasma channels is shown.

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Presenter: CURCIO, Alessandro (Istituto Nazionale di Fisica Nucleare)

Session Classification: Laser/Plasma & Channeling

Contribution ID: **60** Type: **oral**

Intense laser pulses propagation in overdense plasmas

Thursday, 12 September 2024 11:45 (20 minutes)

The propagation of electromagnetic waves in plasmas is allowed up to a maximum density (critical density) at which the pulsation of the wave W equals the plasma frequency Wp. However, at high intensities some phenomena arise which allow electromagnetic radiation to penetrate regions of the plasma at density higher than the critical one. Some of these phenomena will be presented here.

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Presenter: GIULIETTI, Danilo

Session Classification: Laser/Plasma & Channeling

Contribution ID: **61** Type: **oral**

Peculiarities of twisted photon generation in the ondulator

Monday, 9 September 2024 18:30 (1 hour)

In this work, we consider results of numerical modeling of the evolution of radiation power and the orbital angular momentum per photon as a function of the length of the undulator. The orbital angular momentum of radiation is investigated when the axis of the detector does not coincide with the axis of the undulator, as well as in the case of radiation of twisted photons at a small angle of departure relative to the axis of the undulator.

Primary authors: BOGDANOV, Oleg (LNF&TPU); BRAGIN, Sergey

Presenter: BRAGIN, Sergey

Session Classification: Poster Session 1

Contribution ID: **62** Type: **poster**

Radiation from Electrons Channeled in the System of Fan-Oriented Half-Wavelength Crystals

Monday, 9 September 2024 18:30 (1 hour)

When a charged particle penetrating through the half-wavelength crystals (HWC) it experiences a half of the channeling oscillation. The crystal planes deflect the beam, i.e. mirror-reflection of the beam. The mirror-reflection phenomenon for 2 MeV protons in a half-wavelength Si crystal has been previously proved [1]. At relativistic energies, the mirroring effect was observed for 400 GeV protons at CERN-SPS [2]. The existence of the mirroring effect for negative charged particles at HWC channeling was experimentally demonstrated at the SAGA-LS for 255 MeV electrons [3-5].
In the work [6] the angular distributions and trajectories of relativistic ions channeled in the system of fan-oriented Si and W HWCs are numerislly calculated. Simulations revealed that trajectories has a specific shape in the form of arc.
In this study, we present the numerical calculations of the channeling radiations from relativistic electrons in a such system fan-oriented HWCs.

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Presenter: BOGDANOV, Oleg (LNF&TPU)

Session Classification: Poster Session 1

Contribution ID: **63** Type: **oral**

G4ChannelingFastSimModel and G4BaierKatkov model for the FCC-ee crystal-based positron source

Monday, 9 September 2024 10:15 (15 minutes)

Simulation of a crystal-based positron source requires sophisticated modeling of the trajectories of electrons and positrons in a heavy crystalline material, such as a tungsten crystal. This also includes accounting for their multi-photon radiation and ionization energy losses. The models [1-3] for charged particle motion in an averaged atomic potential, as well as their radiation using the Baier-Katkov method [4], have been implemented into the Geant4 simulation toolkit [5] within the G4ChannelingFastSimModel [6] and G4BaierKatkov models, respectively. These models have been released in Geant4 version 11.2. Our recent updates will be included in the next Geant4 release later this year.

We provide a detailed description of the model, its performance, and its functionality, and we compare our simulation results with experimental data [7].

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Presenter: SYTOV, Alexei (Istituto Nazionale di Fisica Nucleare, Sezione di Ferrara)

Session Classification: FCC & Channeling

Contribution ID: **64** Type: **oral**

Full simulations of beam dynamics of crystal-based extraction from the DESY II Booster Synchrotron using BDSim simulation code boosted with G4ChannelingFastSimModel

Tuesday, 10 September 2024 10:30 (20 minutes)

In order to perform full simulations of crystal-based extraction from an accelerator, a combination of simulation codes for beam dynamics in an accelerator and channeling physics in crystals is required. Our solution exploits the Beam Delivery Simulation (BDSIM) [1], an extensive library that contains thick lens accelerator tracking routines and a wide variety of accelerator components and magnets. BDSIM utilizes the Geant4 toolkit [2] to simulate both the transport of particles in an accelerator and their interactions with accelerator materials. Additionally, BDSIM provides an easy way to implement new accelerator components through a user interface. We have utilized this interface to create a bent crystal as a new component and integrated Geant4 version 11.2.1, which includes the G4ChannelingFastSimModel [3], to incorporate channeling physics into this crystal.

We have developed a complete BDSIM simulation model of the DESY II Booster Synchrotron to simulate the crystal-based extraction process of 6 GeV electrons using BDSIM combined with G4ChannelingFastSimModel. We simulate the setup [4] that has already been published and compare the simulation results. We also discuss the feasibility of conducting the first proof-of-principle experiment.

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Session Classification: Beams Interactions

Contribution ID: **65** Type: **poster**

ESR Study of New Dynamic Processes in Liquid and Frozen States of the Oriented Liquid Crystal Systems

Tuesday, 10 September 2024 18:35 (1 hour)

Nematic single crystals (NLC) find wide application in creating various optical devices, where the functioning is based on effects related to the change in orientation of the optical axis or the disruption of optical homogeneity of the crystal in electric, magnetic, and acoustic fields. The development of fundamentally new indicator devices based on electro-optic effects in LCs simul¬taneously imposes new requirements on their physicochemical properties. The study aimed to obtain numerical values of such dynamic parameters, as orientation relaxation time and ordering, which would offer new technical solutions that would expand the field of practical applications of LC.

The mobility (rotatory diffusion) and ordering of molecules were investigated by the electron spin resonance (ESR) tech¬nique with the help of a spin probe. ESR measurements were carried out in the temperature range of -270C - +700C, which is far beyond LC⟶Crystal transition point. Uniformly oriented samples were obtained by the application of a sufficiently strong magnetic field ~ 3000 G. ESR measurements were carried out on a radio spectrometer PЭ-1301 in a microwave region of 9 GHz. The magnetic parameters we-re measured with an accuracy of ⊠0,4 G. The accuracy of temperature measurements was ±0,1oC. Our analysis of the ESR spectra was based on the well-developed spin relaxation theory [1-3].

It was determined that, depending on the LC system, the rotatory diffusion correlation time (changes in the same way as the rotational anisotropy. In the investigated LC systems in the liquid state, were found. In a frozen LC system, depending on the particular molecular structure of the system's components, the high molecular mobility of was managed to obtain. It has been shown that such high mobility of molecules, extending far beyond the LC⟶Crystal transition point, is caused by the structural features of the components' molecules, which increase system polarity and alter the activation energy for the rotational motion of molecules.

We note that the results on the mobility and ordering in binary systems of NLCs in the solid state were obtained by us for the first time. These findings have both fundamental and practical significance. Currently, NLCs in the solid state are finding practical applications in thermoelectric memory displays, as anisotropic solid optical mediums such as compensators, prisms, optically active plates, etc. Studying the physicochemical properties of such liquid crystalline medium will allow us to improve their operational characteristics.

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Session Classification: Poster session 2

Contribution ID: **66** Type: **oral**

Study of a positron source for FCC-ee based on oriented crystals - Setup optimization and experimental measurements

Monday, 9 September 2024 10:35 (15 minutes)

Positron sources are key elements for future lepton colliders, such as FCC-ee. In order to generate high intensity and low emittance positron beams, two alternative approaches based on oriented crystals have been proposed with respect to the conventional method, which relies on the electron into positron conversion in a thick amorphous target [1,2]. In this contribution, we present the optimization of the crystal-based positron source for FCC-ee. The study was carried out through detailed simulations of the positron production in crystals (Geant4) and the tracking inside the positron injector (RF-track). Also, we present the results of some experiments to demonstrate the photon and positron production enhancement achievable with oriented tungsten crystals. The setup of these experiments was simulated in Geant4 taking advantage of our novel G4ChannelingFastSimModel [3] and G4BaierKatkov models. The excellent agreement obtained between experimental and simulation results validate our simulation approach to the positron production for FCC-ee.

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3. A. Sytov et al. JKPS (2023) 83:132–139.

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Session Classification: FCC & Channeling

Contribution ID: **67** Type: **not specified**

Truncated Coulomb potential for planar channeling

Wednesday, 11 September 2024 10:10 (20 minutes)

It is shown that if the screening function of an atomic potential may be described within the Thomas-Fermi approximation, the corresponding continuous potential for planar channeling to a good accuracy reduces to a truncated Coulomb potential. The sum of two displaced Coulomb potentials also accurately approximates thermal continuous potentials for (110) Si, Ge, W and (111) Ge oriented crystals not too close to atomic planes. Such a possibility can be used to simplify description of channeled and quasichanneled particle motions. For illustration, we derive closed-form expressions for classical particle channeling periods, quantum energy levels, and the tunneling probability for a negatively charged particle in the field of a single atomic plane. Simple scaling laws in dependencies of those quantities on the atomic number Z arise in this case.

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Session Classification: Beams Interactions

Contribution ID: **68** Type: **oral**

Ultra-high acceleration gradient using structured nanomaterials

Thursday, 12 September 2024 10:10 (20 minutes)

Solid-state plasma wakefield acceleration has recently garnered attention as a viable alternative for achieving unprecedented ultra-high acceleration gradients on the order of 1 TV/m or beyond [1, 2]. In this context, recent advancements in nanofabrication techniques [3] have opened up the possibility of creating structured plasmas with inhomogeneous properties. For instance, the utilization of carbon nanotube (CNT) bundles and multi-layer graphene [4] holds great potential for generating stable plasmas with electron densities reaching as high as 10^24 cm^-3, i.e., orders of magnitude higher than conventional gaseous plasmas. As part of a new collaborative effort called NanoAcc (Application of Nanostructures in Accelerator Physics), we have conducted Particle-In-Cell (PIC) simulations to investigate both laser-driven and beam-driven excitation of pre-ionized targets utilizing CNT arrays. Our results confirm the attainment of wakefields at the TV/m scale. Additionally, we have observed phenomena such as self-injection, sub-femtosecond bunch formation, and the acceleration of electrons within micrometre-scale targets, leading to kinetic energies of approximately 10 MeV. These findings open up promising possibilities for manipulating charged particle beams, thereby shaping the future of compact accelerator design and radiation sources. Furthermore, solid-state plasmas offer a high degree of tunability in extracting relevant bunch parameters through effective control over the target structure. In this article, we present an overview of the studies conducted thus far by the NanoAcc collaboration, and discuss future experimental plans as well as potential applications.

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Presenter: SYTOV, Alexei (Istituto Nazionale di Fisica Nucleare, Sezione di Ferrara; Korea Institute of Science and Technology Information)

Session Classification: New Concepts

Contribution ID: **69** Type: **not specified**

Observation of X-Ray Transition Radiation from Relativistic Electrons Passing a Stack of Plates

Tuesday, 10 September 2024 12:25 (20 minutes)

The results of experimental observations of X-ray transition radiation (with energies ranging from 10 to 200 keV) from a stack of thin aluminum foils (10-20 μm thick), separated by layers of either Teflon or air (50-100 μm thick), are presented. The experiment was conducted using the electron beam of the DESY Test Beam Facility at energies of 1.0 and 2.4 GeV. The spectral-angular distribution of radiation from electrons passing perpendicularly through the target was investigated. Additionally, the case where the angle of incidence on the target varied by about one degree from the normal axis was studied. The obtained results are compared with previous experimental data and theoretical estimates.

The measurements leading to these results have been performed at the Test Beam Facility at DESY Hamburg (Germany), a member of the Helmholtz Association (HGF). The research received funding from the European Union's Horizon Europe research and innovation programme under grant agreement no. 101057511.

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Session Classification: Radiation: Generation & Interaction

Contribution ID: **70** Type: **oral**

Multiple scattering,volume capture and volume reflection of positive charged particles in bent single crystals

Tuesday, 10 September 2024 10:10 (20 minutes)

An analytical model for the volume capture of high-energy positive particles into planar (111) channels of a silicon single crystal is proposed. Under the assumption that the cause of particle capture is multiple scattering, the capture probability is found. Channeling of trapped particles is also considered. Comparison of calculations with experiment is performed. Results of the study will be useful in the realization of multicrystal devices for collimation and extraction of beams on modern and future accelerators.

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Presenter: Dr MAISHEEV, Vladimir (IHEP, Protvino, Russia)

Session Classification: Beams Interactions

Contribution ID: **71** Type: **poster**

Observation of Coherent Transition Radiation in Super-radiant Regime and its Application for Longitudinal Diagnostics

Monday, 9 September 2024 18:30 (1 hour)

Coherent TR (CTR) is generated when the radiation wavelength is comparable to or longer than the bunch length. In that case, all particles emit radiation more or less in phase, and the radiation intensity is proportional to a square of the number of particles in a bunch. However, if we have a sequence of bunches (a train) separated by a fixed distance from one another, the radiation is generated in a so called super-radiant regime. In that case the coherent radiation generated by individual bunches interfere. The radiation spectrum, in this case, is no longer continuous, but represents a set of very narrow lines separated by the bunch sequence frequency, which is proportional (if not equal to) the accelerating (RF) frequency. The width of those lines depends on the number of bunches in the train. For example, for 7000 bunches the relative monochromaticity can reach 10^{-4} - 10^{-7} depending of which radiation harmonic is observed. With modern interferometer based Fourier Transform spectrometers or gratings it is not possible to achieve sufficient resolution to precisely measure those lines.

In this report we will present CTR measurements in super-radiant regime using a horn antenna and a spectrum analyser at MT-25 microtron in Dubna. The measurement system enabled us to precisely resolve several radiation harmonics. We will demonstrate how RF frequency shifts during the acceleration and evaluate the single electron bunch length from the extracted spectrum.

Primary authors: KUBANKIN, Alexander (Belgorod National Research University); BALDIN, Anton (Joint Institute for Nuclear Research); Mr KLENIN, Artemiy (Belgorod State National Research University, 85 Pobedy str., Belgorod 308015, Russia); KIDANOVA, Ekaterina (Belgorod State National Research University, 85 Pobedy str., Belgorod 308015, Russia); Mrs BUSHMINA, Elizaveta (Joint Institute for Nuclear Research); KISHIN, Ivan (Belgorod State National Research University, 85 Pobedy str., Belgorod 308015, Russia); NOZDRIN, Mikhail (Joint Institute for Nuclear Research); KARATAEV, Pavel (Royal Holloway, Unviersity of London); STUCHEBROV, Sergei (Tomsk Polytechnic University); Mr ALEXEEV, Sergey (Joint Institute for Nuclear Research); KOCHARYAN, Vahan (Institute of Applied Problems of Physics of NAS RA, 0014, Hr. Nersisyan str. 25, Yerevan, Armenia.); MARGARYAN, Vardan (Institute of Applied Problems of Physics of NAS RA, 0014, Hr. Nersisyan str. 25, Yerevan, Armenia); BLEKO, Vitold (National Research Tomsk Polytechnic University)

Presenter: KARATAEV, Pavel (Royal Holloway, Unviersity of London)

Session Classification: Poster Session 1

Contribution ID: **72** Type: **oral**

Experimental Investigation of Coherent Cherenkov Diffraction Radiation in Super-radiant Regime

Monday, 9 September 2024 16:00 (30 minutes)

Recent years have witnessed an intense investigations of Cherenkov diffraction radiation (ChDR) appearing when a fast charged particle moves in the vicinity of and parallel to a dielectric interface. This is a member of polarization radiation family, because the radiation arises as a result of dynamic polarization of a medium. The ChDR properties are sensitive to various beam parameters including beam size, position, direction, beam energy, and bunch length. Coherent ChDR is generated in the wavelength range longer than or comparable to the longitudinal size of the bunch. In this case all electrons emit radiation more or less in phase stimulating each other's emission. The radiation intensity is proportional to a square of bunch charge resulting in an enormous increase in the number of photons.

In this report we shall demonstrate generation of intense ultra-monochromatic ChDR radiation in mm-wavelength range at MT-25 microtron in Dubna. The experimental results and analysis will be presented. The influence of the longitudinal beam parameters on the radiation monochromaticity and spectral shape will be presented.

Primary authors: KUBANKIN, Alexander (Belgorod National Research University); BALDIN, Anton (Joint Institute for Nuclear Research); KLENIN, Artemiy (Belgorod State National Research University, 85 Pobedy str., Belgorod 308015, Russia); KIDANOVA, Ekaterina (Belgorod State National Research University, 85 Pobedy str., Belgorod 308015, Russia); BUSHMINA, Elizaveta (Joint Institute for Nuclear Research); KISHIN, Ivan (Belgorod State National Research University, 85 Pobedy str., Belgorod 308015, Russia); NOZDRIN, Mikhail (Joint Institute for Nuclear Research); KARATAEV, Pavel (Royal Holloway, Unviersity of London); STUCHEBROV, Sergei (Tomsk Polytechnic University); ALEXEEV, Sergey (Joint Institute for Nuclear Research); KOCHARYAN, Vahan (Institute of Applied Problems of Physics of NAS RA, 0014, Hr. Nersisyan str. 25, Yerevan, Armenia.); MARGARYAN, Vardan (Institute of Applied Problems of Physics of NAS RA, 0014, Hr. Nersisyan str. 25, Yerevan, Armenia); BLEKO, Vitold (National Research Tomsk Polytechnic University)

Presenter: KARATAEV, Pavel (Royal Holloway, Unviersity of London)

Session Classification: Radiation: Generation & Interaction

Contribution ID: **73** Type: **oral**

On the shape stability of angular distributions of the channeled protons.

Wednesday, 11 September 2024 10:30 (20 minutes)

We have devised an experiment to reveal structures in angular distributions of axially channeled protons that are the most resistant to distortions caused by the multiple scattering with crystal electrons that, in the limiting process, erase all structures and produce a featureless Gaussian distribution. The origin of the observed shape stability was linked to the shape constancy of certain closed curves in the scattering angle plane, quantified by the distribution of the number of times each curve travels around the coordinate origin.

Primary author: COSIC, Marko

Co-authors: Dr PEROVIC, Srdjan (Vinča Institute of Nuclea Sciences); Dr SIKETIĆ, Zdravko; Dr JAKŠIĆ, Milko (Institute Ruđer Bošković,); Dr VIĆENTIJEVIĆ, Milan (Institute Ruđer Bošković,)

Presenter: COSIC, Marko

Session Classification: Beams Interactions

Contribution ID: **74** Type: **oral**

DE BROGLIE WAVE AND LONGITUDINAL DENSITY EFFECT

Friday, 13 September 2024 10:30 (20 minutes)

A.V. Shchagin1,2,*, G. Kube1

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Abstract
The de Broglie wave characterizing a relativistic particle moving in a medium and X-ray radiation emitted in the medium by the relativistic charged particle are considered. Phase and group velocities of both, de Broglie and electromagnetic waves are compared. The criterion for the appearance of the Ter-Mikaelian longitudinal density effect (dielectric suppression effect) is formulated in terms of phase and group velocities.
This project has received funding through the MSCA4Ukraine project #1233244, which is funded by the European Union.

Primary author: SHCHAGIN, Alexander (DESY)

Co-author: Dr KUBE, Gero

Presenter: SHCHAGIN, Alexander (DESY)

Session Classification: Applications & X-rays

Contribution ID: **75** Type: **oral**

DOPPLER EFFECT IN A MEDIUM IN THE X-RAY RANGE

Friday, 13 September 2024 12:25 (20 minutes)

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Abstract
The Doppler effect in X-ray range emitted by a relativistic oscillator in a medium or by a relativistic charged particle moving in a periodical medium is considered. The radiation can be emitted, for instance, due to mechanisms of parametric X-ray radiation, coherent bremsstrahlung, undulator radiation in a crystalline undulator, transition radiation from a stack of foils. The splitting of the Doppler frequency emitted in the X-ray range that arises due to the influence of the medium is shown and discussed.
This project has received funding through the MSCA4Ukraine project #1233244, which is funded by the European Union.

Primary authors: SHCHAGIN, Alexander (DESY); Dr KUBE, Gero

Presenter: SHCHAGIN, Alexander (DESY)

Session Classification: New Concepts

Contribution ID: **76** Type: **oral**

VOLUME REFLECTION CRYSTALLINE UNDULATOR

Tuesday, 10 September 2024 16:50 (20 minutes)

A.V. Shchagin1,2,*, G. Kube1, A.P. Potylitsyn3, S.A. Strokov1

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Abstract
Two schemes of the crystalline undulator, based on the volume reflection effect of ultra-relativistic charged particles from bent crystallographic planes, are discussed. For the first time, analytical expressions have been derived for several key properties of the volume reflection undulator: the undulator parameter, the undulator equations, the set of emitted undulator frequencies, the angular range for the emission of undulator radiation, and the energy threshold required for the operation of such a volume reflection undulator. The influence of the density effect on the yield of the undulator radiation from a crystalline undulator and possible applications of the volume reflection undulator for transmutation of nuclear waste are discussed.
This project has received funding through the MSCA4Ukraine project ION-LOSS #1233244, which is funded by the European Union.

Primary authors: SHCHAGIN, Alexander (DESY); Dr KUBE, Gero; Prof. POTYLITSYN, Alexander; Dr STROKOV, Sergey

Presenter: SHCHAGIN, Alexander (DESY)

Session Classification: New Concepts

Contribution ID: **77** Type: **oral**

First operational use of crystal collimation at the Large Hadron Collider (LHC) with high intensity and high energy heavy-ion beams

Monday, 9 September 2024 11:15 (30 minutes)

An important upgrade program has been deployed for the collimation system of the Large Hadron Collider (LHC) for lead-ion beams, which will achieve their high-luminosity target intensity upgrade during LHC Run 3 (2022-2025). While certain effects like e-cloud, beam-beam interactions, impedance, injection, and dump protection are mitigated with ion beams, halo collimation poses an increasing challenge compared to the operation with
proton beams. This is because the conventional multi-stage collimation system is about two orders of magnitude less efficient for ion beams compared to proton beams. Ion fragments scattered from the collimators in the betatron cleaning insertion pose a risk of quenching cold dipole magnets downstream, potentially limiting performance. Planar channeling in bent crystals has been proven effective for high-energy heavy ions and is now considered the baseline solution for collimation in the High-Luminosity LHC (HL-LHC) era. This paper provides an overview of a first milestone achieved in 2023, where crystal-assisted collimation was used operationally along the entire LHC heavy-ion run.

Primary authors: MAZZOLARI, Andrea (INFN); ABRAMOV, Andrey (CERN); LECHNER, Anton (CERN); LINDSTROM, Bjorn (CERN); MIRARCHI, Daniele (CERN); MATHESON, Eloise (CERN); RICCI, Gianmarco (CERN); POTOINE, Jean-Baptiste (CERN); DEWHURST, Kay (CERN); BANDIERA, Laura (INFN); ESPOSITO, Luigi (CERN); CALVIANI, Marco (CERN); D'ANDREA, Marco (CERN); ROMAGNONI, Marco (INFN); DI CASTRO, Mario (CERN); TAMISARI, Melissa (INFN); ABERLE, Oliver (CERN); HERMES, Pascal (CERN); DEMASSIEUX, Quentin (CERN); SEIDENBINDER, Regis (CERN); BRUCE, Roderik (CERN); CAI, Rongrong (CERN); SOLIS, Santiago (CERN); GILARDONI, Simone (CERN); REDAELLI, Stefano (CERN); GUIDI, Vincenzo (INFN); RODIN, Volodymyr (CERN); IVANOV, Yuri; GAVRIKOV, Yury

Presenter: MIRARCHI, Daniele (CERN)

Session Classification: FCC & Channeling

Contribution ID: **78** Type: **oral**

Novel Hardware Setup for Astrophysics and Cosmology at INFN-LNF

Friday, 13 September 2024 11:45 (20 minutes)

Permanent Staff Personnel and Associated Personnel of INFN-LNF are setting up the local Astrophysics and Cosmology Team (ACT). The INFN-LNF ACT joined in 2023 the initial development phases of one of the forthcoming next-generation cosmology space-borne probes. The INFN-LNF ACT constituted an Integrated Test Facility (ITF), which is being instrumented in a dedicated space and will also make use of pre-existing INFN-LNF infrastructures. In the present contribution, the activities of commissioning and setup of the so-called 'pocket' cryostat are described, and, the possibility of improving the detection ability of the sensors of interest are briefly discussed.

Primary author: PORCELLI, Luca (Istituto Nazionale di Fisica Nucleare)

Co-authors: DABAGOV, Sultan (Istituto Nazionale di Fisica Nucleare); DELLE MONACHE, Giovanni Ottavio (Istituto Nazionale di Fisica Nucleare); HAMPAI, Dariush (Istituto Nazionale di Fisica Nucleare); MODESTINO, Giuseppina (Istituto Nazionale di Fisica Nucleare); Prof. SAVAGLIO, Sandra (University of Calabria)

Presenter: PORCELLI, Luca (Istituto Nazionale di Fisica Nucleare)

Session Classification: New Concepts

Contribution ID: **79** Type: **oral**

Innovations and developments in Ge gamma undulators with Pulse Laser Melting

Thursday, 12 September 2024 12:25 (20 minutes)

Crystalline based undulators are breakthrough devices for the development of novel gamma-ray Light Sources (LS). These devices, operating at photon energies from 100 keV up to GeV, represent a new approach for gamma ray production. Taking advantage of the channelling phenomena, it is possible to expose of an oriented crystal (linear, bent or periodically bent) to the relativistic particles beams. Ultra relativistic beams can be confined within the atomic channels formed by crystalline planes and forced to follow the periodic trajectory imposed by the bent curvature of the crystal with consequent emission of brilliant and directional light.
This study is focused on the possibility to induce strain in semiconductor monocrystalline materials with extremely precision with the pulse laser melting (PLM) process in order to control the bending requirement for these devices.
This particular technique has recently been succeeded to induce strain in Ge/Si monocrystal semiconductors due to the possibility to realize surface stressor layers by introducing a high concentration of impurity atoms within the first few hundred nanometers, well above the equilibrium solid solubility in these materials.
In this work we describe the main results we obtain for the highest strain and curvature on Ge samples (with Sb dopant) by variation of some laser annealing work parameters (energy, number of pulses, amount of impurity atoms on the coated surface) for different crystallographic directions.
The structure of the layer was studied by X-ray diffraction and Raman spectroscopy while curvature by surface profilometry.
Furthermore, we will show first results of undulator prototypes realized by combination of UV maskless lithography and PLM process.
These prototypes, with different pattern of stressor layers geometry in order to optimize the homogeneity and harmonicity of the curvature of the inner part of the crystal, will be characterized by Raman Spectroscopy and electrical AFM measurements.

Primary author: VALZANI, Davide (Istituto Nazionale di Fisica Nucleare)

Co-authors: CARRARO, Chiara (Istituto Nazionale di Fisica Nucleare); DE SALVADOR, Davide (Padova University; INFN-LNL); Prof. NAPOLITANI, Enrico (University of Padua); Dr SGARBOSSA, Francesco (University of Padova & INFN Legnaro National Lab.); MAGGIONI, Gianluigi (Istituto Nazionale di Fisica Nucleare); BERTOLDO, Stefano (University of Padua; LNL-INFN)

Presenter: VALZANI, Davide (Istituto Nazionale di Fisica Nucleare)

Session Classification: Laser/Plasma & Channeling

Contribution ID: **80** Type: **invited**

Planar channeling of 855 MeV electrons in a boron-doped (110) diamond undulator - a case study

Tuesday, 10 September 2024 16:00 (30 minutes)

A 4-period diamond undulator with a thickness of 20 μm was produced with the method of Chemical Vapour Deposition (CVC), applying boron doping, on a straight diamond crystal with an effective thickness of 165.5 μm. A planar (110) channeling experiment was performed with the 855 MeV electron beam of the Mainz Microtron MAMI accelerator facility to observe the expected undulator peak. The search was guided by simulation calculations on a personal computer. However, an undulator peak was not observed. Implications for the prepared undulator structure are discussed.

Primary author: Prof. BACKE, Hartmut

Co-authors: Dr KLAG, Pascal; Dr CALISTE, Thu Nhi Tran; Dr LAUTH, Werner

Presenter: Prof. BACKE, Hartmut

Session Classification: New Concepts

Contribution ID: **81** Type: **poster**

Cherenkov diffraction radiation generated by 3D printed plastic samples

Tuesday, 10 September 2024 18:35 (1 hour)

In this study, a series of experimental samples were produced using the fused filament fabrication technique. The set comprised dielectric wafers printed from a variety of polymers, including polyethylene terephthalate glycol (PETG), polylactide (PLA), acrylonitrile butadiene styrene (ABS), high impact polystyrene (HIPS), styrene-acrylonitrile (SAN) and PLA with differing concentrations of impurities, including copper, bronze, carbon and wood fibre powder. A terahertz laser was applied to measure the refractive index and absorption plus reflection coefficient. Based on the data obtained, the most optimal materials were selected, from which test samples with a special geometry were manufactured for the ChDR generation.

A series of experiments was conducted at the MT-25 microtron in Dubna to investigate the generation of ChDR in the created samples when the electron beam passed parallel to their surface. Subsequently, the super-radiant spectrum of the generated radiation on several harmonic lines was investigated using a spectrum analyser. The data obtained were compared with the ChDR generated under identical conditions by a Teflon radiator manufactured by standard milling from cast material.

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Presenter: KARATAEV, Pavel (Royal Holloway, Unviersity of London)

Session Classification: Poster session 2

Contribution ID: **82** Type: **oral**

TWOCRYST: A proof-of-principle machine test for a double-crystal fixed-target experiment at the LHC

Monday, 9 September 2024 12:10 (15 minutes)

As part of the Physics Beyond Colliders (PBC) study at CERN, the feasibility of using the Large Hadron Collider (LHC) for in-vacuum Fixed-Target (FT) experiments has been investigated. Bent crystals offer unique opportunities in this context due to their proven capability for advanced high-energy beam manipulations. In the so-called double-crystal setup, a first crystal deflects particles from the beam halo onto an in-vacuum target. A second crystal, positioned just downstream, deflects charged particles created in the target, inducing precession of short-lived baryons that cannot be measured using conventional magnets. The second crystal must induce a deflection of several mrad over a few cm. To demonstrate the feasibility of this complex scheme in the LHC conditions, and to evaluate the performance with beam in the multi-TeV energy range, a proof-of-principle setup named TWOCRYST, is planned for installation in the LHC and for operation in 2025. This paper presents the status of TWOCRYST and the studies planned in scope of the project.

Primary authors: MIRARCHI, Daniele (CERN); HERMES, Pascal (CERN); REDAELLI, Stefano

Presenter: REDAELLI, Stefano

Session Classification: FCC & Channeling

Contribution ID: **83** Type: **poster**

Influence of crystal curvature on the angular distribution of channeled particles

Monday, 9 September 2024 18:30 (1 hour)

The quantum mechanical problem of the angular distribution of particles at the exit from a curved crystal is considered. Preliminary results have shown that the addition of a some perturbation to the average atomic potential leads to a deformation of the angular distribution function of channeled particles at the exit from a bent crystal. But the angular distribution function of channeled particles is still symmetrical with respect to the angle of rotation determined by the bending of the crystal. At the same time, channeled particles can leave the channel due to scattering by a perturbation of effective potential. Due to the presence of particles scattered by the perturbation of effective potential at angles exceeding the critical angle in the total function of angular distribution appears some asymmetry with respect to the rotation angle.

Primary author: DIK, Alexey (Lebedev Physical Institute of Russian Academy of Science)

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Presenter: DIK, Alexey (Lebedev Physical Institute of Russian Academy of Science)

Session Classification: Poster Session 1

Contribution ID: **84** Type: **not specified**

Electromagnetic processes in strong crystalline fields: Toward a high-performance calorimeter for future HEP experiments

Thursday, 12 September 2024 09:00 (30 minutes)

high-energy physics and astrophysics, yet their crystalline structure and lattice orientation are often overlooked in detector design. However, the electromagnetic field experienced by particles impinging on a crystal at small angles relative to a lattice axis can significantly influence interaction mechanisms. Specifically, for electrons or photons with energies of O(10 GeV) or higher striking a high-Z crystal at angles of a few mrad, the strong field regime is reached. In this regime, bremsstrahlung and pair production cross sections are enhanced compared to the Bethe-Heitler model, which applies to amorphous or randomly oriented materials. The SF-induced enhancement accelerates the development of the electromagnetic shower.

The OREO (ORiEnted Calorimeter) team is thoroughly investigating these effects, aiming to develop innovative calorimeters with higher energy resolution, improved photon detection efficiency, and better particle identification capabilities due to the relative enhancement of electromagnetic interactions over hadronic ones. Additionally, such a detector could achieve the same resolution as current models with reduced thickness. Here, we provide an overview of the lattice effects that drive the shower boost and discuss the current status of developing a functional calorimeter prototype. An oriented-crystal calorimeter could be transformative for both accelerator fixed-target experiments and satellite-based γ-ray observatories.

Primary author: BANDIERA, LAURA (Istituto Nazionale di Fisica Nucleare)

Presenter: BANDIERA, LAURA (Istituto Nazionale di Fisica Nucleare)

Session Classification: Radiation: Generation & Interaction

Contribution ID: **85** Type: **poster**

Development of numerical model for simulation dose distribution in Gd-based neutron-capture radiation therapy sessions

Tuesday, 10 September 2024 18:35 (1 hour)

Particle and radiation beams are widely used for cancer therapy. In last decades neutron sources are becoming more and more popular for medical applications. One of the most advanced technique for cancer treatment is neutron-capture therapy (NCT). In this technique, a particular element with high cross-section of neutron initiated nuclear reaction is accumulated in a tumour and irradiated by epithermal neutrons that causes radiation directly in its volume. This approach leads to powerful energy release in the tumor with less irradiation in healthy tissues. Currently 10B is considered as the most suitable element for this technique since it emitts after nuclear reaction alpha particle, which further absorb in very short range [1]. However, other elements, such as 156Gd and 158Gd, potentially may be used for NCT. These elements have much higher cross-section that potentially allows decreasing requirements for neutron beam intensity and, consequently, using wider range of neutron facilities. However, Gd emits electrons and high energy gamma quanta after neutron initiated nuclear reaction that can cause high radiation exposure of healthy organs and tissues [2]. In this study we propose Monte-Carlo simulation based numerical model for calculation of dose distribution in Gd-based neutron-capture radiation therapy sessions.

This work is supported by the Russian Science Foundation, project No. 23-19-00614.

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2. Issa F., Loppolo J. A., Boron and Gadolinium neutron capture therapy. –Sydney: Elsevier, 2013. –24 p.

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Presenter: CHEREPENNIKOV, Yury

Session Classification: Poster session 2

Contribution ID: **86** Type: **oral**

Positron Beam Steering via Planar Channeling and Volume Reflection with Silicon Crystals at MAMI

Tuesday, 10 September 2024 09:30 (20 minutes)

Using a 530 MeV positron beam from the Mainz Microtron MAMI and a bent silicon crystal, we successfully manipulated positron trajectories through planar channeling and volume reflection. This experiment revealed detailed structures in the angular distribution of channeled charged particles within bent crystal planes. Our findings align with simulations, enhancing our understanding of interactions between charged beams and bent crystals. This research advances methodologies for slow extraction in GeV range circular accelerators. Additionally, it contributes to the development of advanced x-ray sources via channeling in periodically bent crystals, demonstrating significant progress in the field.

Acknowledgments:
This work was supported by the European Commission through the Horizon Europe EICPathfinder TECHNO-CLS (G.A. 1016458).

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Presenter: NEGRELLO, Riccardo (Istituto Nazionale di Fisica Nucleare)

Session Classification: Beams Interactions

Contribution ID: **87** Type: **poster**

Gain coefficient of stimulated radiation in a system of two undulators

Tuesday, 10 September 2024 18:35 (1 hour)

A formula for the spectral distribution of intensity of radiation from a system of gap-separated spiral undulators is derived. It is found that the form of spontaneous radiation line is changing, viz., it narrows, if the gap between the undulators increases. As the gain factor of the stimulated radiation depends on the derivative of the form of the line, then, as shown in this work, at least in the linear mode the gain factor may be increased by means of the undulator system.

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Presenter: Dr SHAMAMYAN, Anahit (Military Academy after Vazgen Sargsyan MoD RA)

Session Classification: Poster session 2

Contribution ID: **88** Type: **oral**

Crystal assisted steering of muon collider beam

Monday, 9 September 2024 12:30 (15 minutes)

The Muon Collider is an ambitious proposal to push the boundaries of high-energy physics beyond current limitations. By exploiting for the first time unstable fundamental particles such as muons, this collider combines the precision of electron/positron collider and the higher energy reach of hadron colliders.
Bent crystal had proven great utility for manipulation of ultrarelativistic beams in accelerators, such as beam extraction in U70, spin precession in Tevratron and beam collimation in LHC. In this contribution we investigate the potential of silicon and germanium bent crystals for steering 1.5 - 5 TeV muons, as first step for their potential integration in the future design of the muon collider. This study involves comparing the efficiency of various mechanisms for deflecting muons using bent crystals of both planar and axial orientation.

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Presenter: ROMAGNONI, Marco (Istituto Nazionale di Fisica Nucleare)

Session Classification: FCC & Channeling

Contribution ID: **89** Type: **poster**

Line shape of soft photon radiation generated at zero angle in an undulator with a dispersive medium

Tuesday, 10 September 2024 18:35 (1 hour)

Unlike in a vacuum undulator, an undulator containing a dispersive medium forms a line shape of soft photons. The energy of these photons is determined by the oscillation frequency of an ultra-relativistic charged particle and the plasma frequency of the medium, when the energy of the particle greatly exceeds the threshold energy for radiation formation. The line shape of the spontaneous radiation of soft photons at zero angle, as well as their number, has been obtained. The directed beams of coherently radiated soft photons by microbunches of charged particles may find significant practical applications.

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Presenter: Dr GEVORGYAN, Hayk (Alikhanyan National Laboratory (Yerevan Physics Institute))

Session Classification: Poster session 2

Contribution ID: **90** Type: **invited**

Enhancing Planar Channeling Efficiency: Final Results from the GALORE Project

Wednesday, 11 September 2024 09:00 (30 minutes)

The efficiency of planar channeling for positive particles is limited by nuclear scattering when particles approach too close to the nuclei within the atomic planes. To mitigate this effect, a solution was proposed in 2007 [1], involving the creation of an optimized interruption in the crystal lattice at a strategic position before nuclear dechanneling can occur. Implementing this solution presents a significant technological challenge, which had remained for years unresolved.
In this talk, we present the final results achieved by the recently concluded GALORE project. Utilizing techniques developed for silicon microelectronics, we fabricated a silicon bent crystal with a micro-trench designed to enhance channeling efficiency. This new prototype was tested at CERN's SPS H8 beamline using a 180 GeV/c hadronic beam, marking the first measurement of increased channeling efficiency.

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Acknowledgement
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Session Classification: Beams Interactions

Contribution ID: **91** Type: **poster**

A Novel Python Tool for Analyzing Geant4 Simulations: Enhancing Understanding of Particle Channeling in Crystals

Monday, 9 September 2024 18:30 (1 hour)

We present a novel Python tool for the analysis of Geant4 simulations that enhances our understanding of coherent phenomena occurring during the interaction of charged particles with crystal planes. This tool compares the total energy of particles with the potential energy inside crystal channels, enabling a complete examination of coherent effects. By tracking and tagging the dynamics of each simulation step, it provides deeper insights into how different phenomena contribute to both radiation and particle deflection. Applicable to both curved and straight crystals, this tool can play a key role in improving crystal-based extraction methods and the development of gamma-ray sources using crystals.

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Session Classification: Poster Session 1

Contribution ID: **92** Type: **invited**

A POSITRON BEAMLINE FOR CHANNELING EXPERIMENTS AT MAMI

Tuesday, 10 September 2024 09:00 (30 minutes)

A new high-quality positron 530 MeV beam has been installed at the Institute for Nuclear Physics of the University of Mainz using the features of the MAMI accelerator. Positrons are created by pair conversion of bremsstrahlung, produced by a focused 855 MeV electron beam of MAMI in a 10 μm thick tungsten self converter target, and energy selected by an outside open electron beamline bending magnet. Magnetic focusing elements in between are designed to prepare in a well shielded chamber a low divergence positron beam.
The properties of the positron beam line such as the positron rate, the beam spot size and the divergence of the positron beam will be discussed. First channeling experiments with Silicon crystals will be presented.

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Session Classification: Beams Interactions

Contribution ID: **93** Type: **oral**

Silicon Crystalline Undulator Based On Silicon Nitride Stressor Layer Patterning: Design and Building from TECHNO-CLS Project

Tuesday, 10 September 2024 17:10 (20 minutes)

Current limitations in the field of undulators include the inability of state-of-the-art magnetic undulators to achieve periods shorter than a few centimeters. To overcome these limitations, Crystalline Undulators (CUs) consist of periodically bent crystals [1] in which channeled electrons or positrons follow the bending of the crystalline planes must be developed. These CUs aim to generate intense and monochromatic sources of hard X and γ electromagnetic radiation with energies from 100 keV to GeV [2,3].
In this work, we present a novel approach exploiting silicon nitride stressor layer to produce short period CUs. We report the results of finite element method (FEM) analysis of CUs and the evaluation of the optimal geometric parameters for the undulator, revealing detailed 3D deformation and the related emitted radiation spectrum. Additionally, dynamic simulations were conducted using the relativistic atomistic molecular dynamics approach implemented in MBN Explorer [4]. We fabricated first prototypes of CUs using advanced silicon microelectronics techniques, facing significant challenges from an experimental manufacturing perspective.

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Presenter: MALAGUTTI, Lorenzo (Istituto Nazionale di Fisica Nucleare)

Session Classification: New Concepts

Contribution ID: **94** Type: **oral**

Bent crystals for spin precession experiment at LHC

Wednesday, 11 September 2024 09:30 (20 minutes)

Bent crystals, through channeling effects, can induce coherent deflection of charged particles, making them invaluable tools for controlling particle beams. This research focuses on the fabrication, of bent crystals tailored for spin precession studies at the LHC.

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Presenter: MAZZOLARI, Andrea (Istituto Nazionale di Fisica Nucleare)

Session Classification: Beams Interactions

Contribution ID: **95** Type: **poster**

Coherent radiation of modulated positron bunch formed in crystalline undulator

Tuesday, 10 September 2024 18:35 (1 hour)

The problem of coherent X-ray radiation formed in crystalline undulator (CU) by positron bunch with modulated density is solved. The CU parameters are calculated, the choice of which provides coherent radiation of the positron bunch (with parameters of LCLS) modulated in the SASE FEL process. If modulation depth is not too small, then an X-ray photon beam is formed, more powerful and monochromatic than in the case of SASE FEL. This approach can be used in the experiment for determination of this important parameter, viz., the modulation depth.

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Session Classification: Poster session 2

Contribution ID: **96** Type: **oral**

Beam superimposition with bent crystals

Wednesday, 11 September 2024 09:50 (20 minutes)

Bent crystal have been widely used to deflect high energy particles in the last decades and the precise knowledge of their properties has been crucial for their deployment in particle accelerator complex. Based on a time-reversal approach to the channeling effect, the UA9 collaboration is investigating the possibility to merge two particle beam impinging with specific angles on a bent crystal. This process would be an intriguing way to increase the luminosity of particle beams through beam superimposition, overcoming limitations due to Liouville's theorem. An experimental setup and preliminary tests carried out at the CERN SPS facility to prove this concept will be presented.

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Session Classification: Beams Interactions

Contribution ID: **97** Type: **invited**

Carbon nanostructure for particle physics, the Ptolemy experiment

Friday, 13 September 2024 09:00 (30 minutes)

Neutrinos produced in an early stage of the Big Bang are believed to pervade the Universe.
The Ptolemy project is studying novel experimental techniques to observe this relic cosmological background neutrinos and to eventually study their flux and compare it with cosmological models.
This requires to face challenges in material technologies as tritium storage on nanostructure and detection of low energy electrons with cryogenic micro-calorimeters.
The current status and outlook of the project is presented with particular emphasis to the use of graphene and oriented carbon nanotubes.

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Presenter: CAVOTO, Gianluca (Istituto Nazionale di Fisica Nucleare)

Session Classification: Applications & X-rays

Contribution ID: **98** Type: **invited**

Status and prospects for the Mu2e experiment at Fermilab

Monday, 9 September 2024 13:10 (30 minutes)

The Mu2e experiment at Fermilab will search for the coherent, neutrino-less conversion of negative muons into electrons in the coulomb field of Al nuclei. This is one of the clearest Charged Lepton Flavour Violating processes for exploring New Physics in the Intensity Frontier of Particle Physics. Observation of this process, by identifying the monoenergetic electron at ~105 MeV, would be an unambiguous signal of physics beyond the Standard Model (BSM).
Mu2e aims to improve previous sensitivity on the conversion rate by four orders of magnitude, reaching a single event sensitivity of 3x10−17. To achieve this goal, the experiment needs to provide the highest intensity pulsed muon beam in the world, with up to 1010 stopped muon/sec. This is achieved using the Fermilab proton beam and the design and realization of a unique 25 m long solenoidal system. Reducing beam losses in the slow extraction region indicates also the needs of bent crystals for shadowing.
The conversion electron will broad set of BSM models and to probe mass scales up to 104 TeV/c2, not allows to explore a achievable to any current (or planned) high energy collider be identified by a high-resolution straw tracker, with better than 180 keV momentum precision and a fast CsI crystal calorimeter. Both detectors are inserted in the last solenoid section, just behind the Al Stopping Target. Large part of the solenoids is covered by a Cosmic Ray Veto to identify
fake candidates produced by cosmic rays.
We expect to complete the experiment construction in 2025, start commissioning in the pit in 2026 and start data taking with beam at beginning of 2027. In this talk, we report the details of the experimental layout, the construction status of the magnetic system and detectors and present the reach of the first physics run.

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Session Classification: FCC & Channeling

Contribution ID: **99** Type: **invited**

XCT - from Synchrotron to Desktop Applications

Friday, 13 September 2024 11:15 (30 minutes)

X-ray Computed Tomography (XCT) is a nondestructive technique to reconstruct and visualize inner features within solid objects as digital informations. An XCT image is typically called a slice, as it corresponds to what the object being scanned would look like if it were sliced open along the plane transverse to the rotation axis. Actually, the best resolution achieved is through X-ray beams by Synchrotron Radiation Laboratories (SRL); however, the high quality and performing SRL have restricted access to exper- imental campaigns because of a few and highly expensive plants worldwide-dislocated, friendly-available, busy beamlines with poor duty cycles and dedicated instrumentation managed by specialists not always available in the research groups. These are part of the motivations inducing people towards X-ray sources suitable for table-top experiments. By this reason, while SRL-based μXCT combines sub-micrometer resolution with a high signal-to-noise ratio (contrast), recent advances in desktop μXCT devices have achieved comparable results with benefits in availability and user-friendliness.
In this work, we will shown our significant results obtained in XLab Frascati (INFN- LNF) through our new μXCT facility in comparison with several groups involved in μXCT desktop R&D and in SRL facilities.
Acknoledgments - the authors would like to acknowledge the work done by our col- leagues Dr. G. Cappuccio, Dr. A.M.M.M. Perez, E. Capitolo and G. Papalino for their contribution in our common researches.

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Session Classification: New Concepts

Contribution ID: **100** Type: **oral**

Compton backscattering sources, high intensity lasers and non-linear QED phenomenology

Thursday, 12 September 2024 12:45 (20 minutes)

The development of intense laser sources and of accelerators, capable of providing medium energy high quality electron beams (e-b), has paved the way to the construction of X-ray sources, with significantly large brightness. Even though, the best performing X-ray beams are those provided by Synchrotron or FEL devices, the CBS's (Compton Backscattered Source) are becoming effective competitors in terms of versatility, easier maintenance and construction costs.
The turning point, determining the construction of lasers with intensities exceeding 10^20W/cm^2, has been the use of the Compression Pulse Amplification (CPA) technique, we are reporting the laser intensity evolution during the last decades. It is possible to conclude that the capabilities of this technology are sufficient to reach regions where copious photon backscattered fluxes and brightness can be reached, along with the possibility of observing effects where non-linear QED effects can be observed.
We make a general discussion on the physical aspects of high intensity laser and high energy electrons. We discuss the possibility of observing non-linear effects characterizing X-Ray Compton backscattering sources and multi-photon scattering processes (including pair productions and genuine QED effects associated with quantum vacuum engineering, like pair production).
We comment on the combined effects between high intensity laser and high energy electrons to "simulate"strong field effects like those associated with the Schwinger-Sauter critical field.

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Session Classification: Laser/Plasma & Channeling

Contribution ID: **103** Type: **poster**

Development and first measurement results of a 3.5-cells S-band RF gun with a photocathode for the SYLA synchrotron complex

Monday, 9 September 2024 18:30 (1 hour)

Currently, NRC «Kurchatov Institute» jointly with partners is developing the 4th generation synchrotron radiation source SYLA (Synchrotron + Laser) with an energy of
6 GeV [1]. This facility will consist of a source based on a storage ring and a free electron laser (FEL). As one of the options, an RF gun with a photocathode will be used to generate short high-brightness electron bunches for the FEL. The gun structure consists of 3.5 π-mode standing wave accelerating cells at operating frequency of 2800 MHz with a coaxial RF coupler.

Previously, beam dynamics simulation, optimization of electrodynamic characteristics and thermal processes analysis were performed [2,3]. At this point, the fabrication of the RF gun has been completed.

The report presents the results of measurements of the experimental sample (the operating frequency, the axis electric field, Q factor).

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Session Classification: Poster Session 1

Contribution ID: **104** Type: **not specified**

CHANNELING 2024: CLOSING

Friday, 13 September 2024 13:10 (30 minutes)

Presenter: DABAGOV, Sultan (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **105** Type: **invited**

New Light on Leonardo (and on Leonardo and Light)

Sunday, 8 September 2024 17:00 (1 hour)

Leonardo da Vinci, considered the prototype of universal man, is one of the best-known figures in the history of humanity on a global level. His pictorial works have become the most famous icons in the collective imagination: Mona Lisa, the Last Supper, the Salvator Mundi. People think we already know everything about him: but is that really the case? This report will present some of the most important discoveries of recent years, which have completely changed the way we interpret Leonardo's life and work. And it will add some information on one of the most fascinating aspects of his research, still little known: the enormous interest that Leonardo had in light, between theoretical knowledge and empirical experience.

Primary author: Prof. VECCE, Carlo (Università di Napoli L'Orientale)

Presenter: Prof. VECCE, Carlo (Università di Napoli L'Orientale)

Session Classification: Channeling Primer

Contribution ID: **106** Type: **poster**

The European Plasma Research Accelerator with eXcellence In Applications (EuPRAXIA) Advanced Photon Sources (EuAPS) Betatron Radiation Source: Status Update and Photon Science Perspectives

Tuesday, 10 September 2024 18:35 (1 hour)

The EuPRAXIA EU project is leading advancements in particle accelerator research and photon source development through innovative plasma acceleration techniques. The EuAPS project, led by INFN in collaboration with CNR and the University of Tor Vergata, focuses on utilizing laser wakefield acceleration to create a betatron ra- diation source at the INFN Frascati National Laboratory. This radiation, produced by oscillating charged particles, combines the peak brilliance of synchrotron radia- tion with the pulse duration of FEL radiation, offering a broad spectrum for various experimental applications.

The EuAPS source aims to deliver tens of femtosecond X-ray pulses in the 1 to 10 keV range, enabling ultrafast methodologies in imaging and X-ray spectroscopy. Be- tatron radiation is advantageous due to its reduced costs and compact size, providing access to research facilities comparable to synchrotrons and FELs.

At the Laboratori Nazionali di Frascati (INFN - LNF), the pilot experiment will focus on X-ray phase contrast imaging and tomography, with plans for more ad- vanced experiments like X-ray Absorption Spectroscopy (XAS) in both static and time-resolved modes. The design of a dedicated beamline and experimental station is critical for the success of future experiments at the LNF.

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Session Classification: Poster session 2