



**V International Alpic School for
Radiation Physics
&
International Conference on Beam and
Radiation Interaction and Applications
(ASRP-BRIA 2026)**

Book of Abstracts

Yerevan – Jermuk, Armenia

June 21 – 28, 2026

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Lectures

Resilient Stewardship: Radiation for the Preservation and Analysis of Cultural Heritage Objects

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As we gather for ASRP–BRIA 2026 in Yerevan, a city deeply rooted in ancient history, the role of beam–matter interactions in preserving our shared past becomes increasingly relevant. This talk explores the application of advanced radiation techniques—ranging from synchrotron radiation to X–ray fluorescence (XRF)—as essential tools for the non–destructive analysis and stabilization of archaeological artifacts.

We address the practical intersection of radiation physics and conservation, specifically looking at examples of how scientific techniques can bridge the gap between basic radiation physics and the tangible preservation of historical artifacts. The talk draws upon an earlier discussion held in February 2026 at the University of Oxford’s **History and Philosophy of Physics** (HAPP) Centre (Prof David Bradley | Radiation for the Preservation and Analysis of Cultural Heritage Objects | HAPP), the video containing the full recording of the St Cross College lecture, with that narrative now tailored to this more focused physics–based audience.

The preservation of cultural heritage objects is a race against time and environmental decay. While traditional conservation relies on chemical, environmental and other controlled interventions, the application of ionizing radiation offers a minimally–invasive, highly precise alternative for both analysis and stabilization. This presentation explores the dual role of radiation as both a diagnostic tool and a preservative agent. Examples encompass the efficacy of portable X–ray fluorescence (XRF) and other targeted tools, synchrotron–based techniques included, aiding in uncovering the elemental "fingerprints" of artifacts without compromising structural integrity. The talk also seeks to address a key application of radiation—specifically in the disinfection and consolidation of organic materials—providing a narrative that moves us from the laboratory to the museum floor. By integrating physics into the humanities, one can look to ensure that the "map" of our cultural history remains as resilient as the territory it describes.

In an era where regional logistics and preservation resources are under shifting pressures,

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these non-invasive, radiation-based methodologies offer a resilient framework for safeguarding the tangible records of human civilization, offering a path to protect organic and inorganic heritage without the need for imported chemical consolidants or invasive physical sampling. By leveraging the principles of radiation safety and dosimetry, we can provide heritage institutions with a robust framework for stewardship that remains viable even under fluctuating resource availability. The talk will conclude with a forward-looking perspective on how the ARPS community can contribute to global "heritage resilience" through the innovative application of radiation physics.

Key Thematic Elements:

- **Methodological Resilience:** The abstract emphasizes non-invasive techniques as a solution for conservation in environments where traditional resources may be limited.
- **Technical Continuity:** It links the foundational physics discussed in Oxford to the specific "Beam & Radiation Interaction" focus of the Armenian meeting.
- **Geographic Context:** By referencing the ancient history of the Caucasus, the text looks to anchor the scientific discussion in the local heritage of the host city.

Principles of LASER

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The physical principles underlying the operation of a LASER will be presented, along with the main modes in which it can operate and the salient characteristics of the radiation it emits. Finally, the different characteristics of LASERs used in controlled thermonuclear fusion experiments and those on particle acceleration in plasmas will be considered.

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Radiation Dose Reduction for Patients Undergoing Enhanced Contract CT Procedures

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Computed tomography (CT) is the primary source of ionizing radiation exposure to the general population and contributes approximately 75% of the total collective dose from medical radiological examinations. Patients receive higher radiation doses during contrast-enhanced CT procedures, such as angiography, compared with routine CT scans. The objective of this study was to estimate organ-specific and effective radiation doses during lower extremity CT angiography. A total of 111 patients (61.3% male and 38.7% female) underwent contrast-enhanced CT angiography. All examinations were performed using a 160-slice CT scanner at AMC Medical Center. The mean patient age (years) was 57.0 ± 20 (18–80). Patient radiation exposure was assessed using the volume CT dose index (CTDI_{vol}) and dose-length product (DLP), with mean values of 7.0 ± 2.0 (3.0–17.0) mGy and 3710 ± 125 (280–8370) mGy·cm, respectively. The mean effective dose per lower extremity CT angiography examination was 25 (1.70–50.0) mSv. The estimated average cancer risk was approximately one additional cancer incidence per 1,000 procedures. Patient doses in this study were higher than those reported in most previously published studies. Therefore, dose optimization strategies, including gonadal shielding when the primary beam is within 5 cm of the gonads, are strongly recommended. Reducing patient radiation dose remains a primary concern to minimize the probability of radiation-induced risks.

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X-ray Diffraction Study of the Surface Acoustic Waves in the YZ-cut of a LiNbO₃ Crystal

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YZ-cut of a LiNbO₃ crystal is the most commonly used in acoustoelectronics, as the propagation of surface acoustic waves (SAWs) in it is accompanied by autocollimation of the acoustic beam.

High-resolution X-ray diffraction measurements were performed at the RKFM optical beamline of the Kurchatov Synchrotron Radiation Source to study the propagation of a surface acoustic wave with a wavelength of $\Lambda=4\text{ }\mu\text{m}$ for both symmetric (reflection from (300) planes) and asymmetric diffraction (reflection from (054) planes). SAW has the elliptical polarization. In the case of symmetric reflection, only the normal component of the crystal lattice displacements affects the diffraction process, whereas in the case of asymmetric reflection, both the normal component and the longitudinal component of the crystal lattice displacements affect the diffraction process. Furthermore, during asymmetric diffraction from (054) planes, there is a significant increase in the number of diffraction satellites due to the decrease in the interplanar spacing. In this case, the ratio of the SAW amplitude to the interplanar spacing increases, which results in an increase in the number of diffraction satellites.

Furthermore, the process of SAW focusing on the surface of the YZ-cut of a LiNbO₃ crystal was investigated using X-ray topography. A special focusing interdigital transducer (IDT) was fabricated on the crystal surface for SAW focusing with at a distance of 10 mm. If the medium was isotropic, it would be possible to focus the SAW into a single point. The design of the focusing IDT took into account the dispersion of SAW velocities in different directions. However, due to differences in the electromechanical coupling coefficients and SAW amplitudes in different directions at a given focal length, focusing (different from the spot focusing) is clearly observed, in which a distinct interference pattern associated with the difference in SAW amplitudes is visible.

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Overview of Accelerator Based Activities in Armenia

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Armenia has a long-term experience in accelerator physics and accelerator-based activities since 60's of previous century. A short historical review over starting of activities in accelerator physics and experiments will be continued by the up-to-date information on the present spectrum of accelerator use. Target research directions for operating accelerators as Cyclon-18, LUE-75 and AREAL will be presented, then the perspective of AREAL accelerator present experimental program, as well as upgrade status and outlooks will be discussed. A short overview of CANDLE institute will be presented to point out existing infrastructure support for potential experimental programs.

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On Coherent Radiation of Charged Particles and the Possibility of Its Experimental Observation

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The coherent radiation of charged particles was investigated. Specifically, 3 cases are considered when the radiation intensity is proportional to 1) the square of the number of particles in a bunch, 2) the square of the number of bunches in a train, and 3) the square of the number of periods in the case of a periodic medium. The possibility of the simultaneous occurrence of these three cases, as well as the possibility of experimental observation of such situation are considered.

The conditions are clarified under which radiation amplification can be observed not only in the spectral-angular or in spectral distributions but also for the total radiated energy.

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Assessment of Occupational Radiation Exposure and Radiogenic Risk for Nuclear Medicine Personnel

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This study evaluated occupational radiation exposure among healthcare professionals working in nuclear medicine departments in Saudi Arabia over a six-year period. Thermoluminescent dosimeters (TLD) were used to quantify annual effective doses (Hp(10)) for a cohort of 32 workers, including nurses, nuclear medicine physicians, medical physicists, and technologists. The mean $\pm$ SD annual effective dose was 4.33 ± 8 mSv for nurses, 6.22 ± 4 mSv for technologists, 3.1 ± 2 mSv for medical physicists, and 5.71 mSv for physicians. The results indicate that technologists consistently received the highest radiation exposure due to their direct involvement in radiopharmaceutical handling and imaging procedures, whereas medical physicists experienced the lowest exposure. Overall, the occupational doses observed in this study were higher than those reported in the majority of previously published studies. Therefore, the development and implementation of dose reduction strategies, including improvements in the work environment, are essential to minimize annual effective doses.

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Archaeology and Physics. Latest Archaeological Discoveries in Armenia and the Study of Artifacts Using Physical Methods

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Ancient monuments attract people from almost every profession with their magical power. They have always drawn the curious to them. However, to understand the essence of archaeological sources, methods from the exact sciences—especially physics—are increasingly being applied. The connection between archaeology and physics lies in the application of precise physical methods to locate, date, and analyze ancient artifacts. Physics helps archaeologists “look” beneath the ground without excavations and determine the age of finds using isotope analysis. New physical research methods (radiocarbon, tomographic, X-ray fluorescence (XRF), and other types of analysis), which have increased the accuracy and depth of scientific investigations, are like a magic wand for explaining the ancient mysteries hidden within ancient artifacts. The analysis of materials using physical methods helps determine the composition of metals, ceramics, and stones. Interdisciplinary methods of comprehensive research reveal the secrets of ancient technologies, the scientific skills of those times, methods of artifact production, the connection between ancient mines and artifacts, and, at the same time, the trade and cultural ties of ancient societies and peoples. The latest research methods are transforming the humanities into an exact science.

Archaeological research conducted in the Republic of Armenia over the past few decades has led to remarkable discoveries that significantly expand—and at times even redefine—our understanding of ancient civilizations and the role of the Armenian Highlands in the history of the Ancient Near East. Among these discoveries, the following stand out: the oldest settlement with early Holocene stone architecture within the city limits of Yerevan—the Silikyan settlement; the oldest Eneolithic necropolis in Voskhat, where gold artifacts and evidence of iron use were found; the Shengavit settlement—a city with an ancient Eastern appearance; a large Early Bronze Age burial mound with clear signs of connections between the Yamnaya and Catacomb cultures of the Great Steppe; the earliest horse breeders and chariot makers in the Aragatsotn region at the turn of the 3rd–2nd millennia BCE; the forgotten kingdom and royal tombs of Verin–Naver and their connections to Elam; the necropolis of the northern capital of Teyshabain, where more than 250 burials from the Van Kingdom period have been excavated, as well as, likely, the tomb of the king’s governor, etc.

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Ultimately, physics helps archaeologists uncover deep layers of ancient artifacts, and archaeology—drawing on the findings of the exact sciences in its research—is reshaping our understanding of the ancient world, the role of individual civilizations and peoples in human development, and, ultimately, the very nature of humanity. This is one of the most promising fields of modern science, which is under close scrutiny in our joint research with physicists.

Artificial Intelligence Models in Medical Physics and Radiation Oncology Speaker

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Artificial Intelligence (AI) is rapidly transforming the field of medical physics and radiation oncology, offering new paradigms for data-driven, patient-specific decision-making. This presentation provides an overview of contemporary AI models—ranging from machine learning to deep learning architectures—and their integration into the radiotherapy workflow.

A particular focus is placed on AI-driven approaches for rapid and accurate dose calculation, treatment plan optimization, and image-based segmentation. These models have demonstrated significant potential in reducing computation times while maintaining or improving dosimetric accuracy, thereby enabling adaptive and personalized radiotherapy strategies. In addition, the role of AI in enhancing imaging modalities, predicting treatment outcomes, and supporting quality assurance processes is critically examined.

Despite these advances, important challenges remain, including model interpretability, data heterogeneity, regulatory considerations, and clinical validation. The talk will discuss current limitations and highlight emerging trends, such as hybrid physics-informed AI models and the integration of AI with novel radiotherapy devices and patient-specific systems.

Overall, this work aims to provide a comprehensive perspective on how AI models are reshaping medical physics practice, bridging the gap between technological innovation and clinical implementation, and ultimately contributing to improved patient outcomes in radiation oncology.

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X-ray Diagnostic Tools for Templates of Electronic Chips with a Topology of 1–30 nm

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The development of next-generation semiconductor technologies necessitates the use of modern methods for monitoring electronic circuit topology parameters, including critical dimensions, material homogeneity, and roughness. These challenges are particularly pressing in the fabrication of templates for high-aperture projection lithography in the extreme UV (EUV) and beyond (EUVL, BEUVL) ranges and the rapid inspection of the surfaces and layers of millions of memory chips written using image reduction and shifting [1].

Compared to SEM and AFM, a non-imaging indirect Short-Wave Scatterometry (SWS) method can simultaneously have a high spatial resolution (0.1–10 nm) and large fields of view (0.1–10 mm), which allows for rapid and reliable tracking of critical parameters of microcircuit topology and analysis of their homogeneity. Analysis of X-ray scattering intensity under normal and grazing incidence conditions using synchrotron or laboratory sources, including plasma-laser sources of coherent or partially coherent radiation, and solving the inverse scattering problem allows for the determination of the morphology of the analyzed structures and the composition of their materials with high accuracy and sub-second time resolution. SWS is a method of integral metrology that provides averaging of the electron density, critical dimensions, and roughness over a large observation spot in a specific projection. One of the most widely used metrology methods today, grazing small-angle X-ray scattering (GISAXS), is also related to SWS [2]. For the analysis of nanoscale objects with 3D topology, additional reference methods can be used, for example, X-ray or EUV ptychography [3].

The generally accepted approach to characterizing chips with various 3D element topologies uses single- and bi-periodic diffraction gratings with trapezoidal groove profiles, including multilayer ones, recorded in the process, with corresponding linear and angular dimensions and roughnesses. For the analysis of single-periodic gratings, primarily probe radiation incidence patterns along the grooves (conical diffraction) are used, while for bi-periodic gratings, a general 3D diffraction pattern described by two incidence angles and two polarization angles is used [4]. Using the exact or approximate solution of complex inverse problems on gratings, SWS is used to evaluate the quality (suitability) of a mask or chip (fragment) for further

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processing, as well as the potential for reducing Raman scattering and improving lithography quality.

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On the Structure of Massless Particles—Photons that Form Ionizing Radiation

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The paper studies the quantum motion of a photon in an arbitrary medium. Using the Yang–Mills equations for Abelian fields within the $SU(2) \times U(1)$ gauge symmetry, we derive a system of second–order partial differential equations for the photon's three–component wave function. For a homogeneous medium along the direction of motion, we obtain an equation for the full wave function that accounts for transverse dispersion. In particular, in a waveguide, the photon's state is shown to satisfy the equation of a two–dimensional quantum harmonic oscillator with variable frequency. The model is further extended to the case of a photon in a waveguide repeatedly scattered by two–level quantum dots, enabling processes of absorption and emission of entangled photon pairs. The work provides all necessary expressions for calculating expectation values of photon parameters, develops numerical algorithms, and presents test calculations with visualizations. It has been shown that in addition to frequency, spin and polarization, the photon has a spatial structure characterized by two quantum numbers, which plays a key role in processes involving photons. In conclusion, the photon — a fundamental particle central to astrophysics and cosmology — exhibits new properties directly relevant to space research, which we hope will provide fresh insights into the exploration of the Universe.

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Ultra–thin PTFE sheets for passive dosimetry under clinical linac photon and electron irradiation

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Polytetrafluoroethylene (PTFE) is a chemically stable, biocompatible polymer with near tissue–equivalent properties, making it a candidate material for passive radiation detection in medical applications. In this work, the radiation–induced optical response of ultra–thin (~75 µm) PTFE sheets is investigated under clinical linear accelerator irradiation, with emphasis on comparative behavior under megavoltage photon and electron beams. PTFE samples were irradiated using medical linac 6 MV photon beams over a clinically relevant dose range (0.1–10 Gy), with post–irradiation optical readout using photoluminescence (PL) / absorbance spectroscopy. The results demonstrate a clear dose–dependent increase in absorbance signal under photon irradiation, showing a sublinear response characterized by an approximately linear region at low doses (0.1–4 Gy) followed by a saturation at higher doses. This behavior is consistent with defect formation and recombination mechanisms in polymer systems. In contrast, irradiation under 6 MeV electron beams resulted in significantly weaker and less reproducible changes in optical response. The measured signal variations were found to be comparable to experimental uncertainty, preventing the establishment of a reliable dose–response relationship. This reduced sensitivity is likely attributed to differences in microscopic energy deposition, where localized electron track structures enhance recombination processes within the polymer matrix and reduce the efficiency of stable defect formation. The findings indicate that ultra–thin PTFE shows a stable

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and measurable response under therapeutic photon irradiation, while its application under electron beams is limited by low signal-to-noise ratio and radiation quality dependent effects. The results highlight the importance of energy deposition characteristics (e.g. LET), and radiation-induced molecular processes within polymer chains in the development of polymer-based radiation detectors, supporting further optimization of PTFE systems for radiation dosimetry applications.

Post Saturation SASE FEL Dynamics and Short Pulse X-ray Generation

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Analytical and semi-analytical models of free-electron laser (FEL) dynamics have long provided valuable physical insight and practical tools for the design of self-amplified spontaneous emission and oscillator configurations. Logistic-type growth models and formulations based on Jacobi elliptic functions successfully capture the evolution from the small-signal regime to the onset of saturation. However, their applicability is typically limited to mild saturation and does not fully describe the complex dynamics occurring beyond this point. In this seminar, we describe an extension of these approaches by introducing a delayed logistic framework capable of incorporating memory effects and reproducing characteristic post-saturation features, including power oscillations and super-radiant evolution.

The FEL output characteristics are the result of a balance between different design parameters and their impact on the system and on the whole system dynamics. Their macroscopic consequences are an increase of the saturation length (implying an increase of the costs of the device), a reduction of the efficiency and on the harmonic generation mechanisms, on the spectral content and on the laser, pulse shaping and length.

Within this context, the dynamics of single spikes and of their qualities play a central role in the overall design strategy.

The emergence of attosecond X-ray free-electron lasers (XFELs) has opened new frontiers for probing ultrafast electronic dynamics on Ångström–attosecond scales. These sources rely on the generation of ultrashort, high-current spikes, where amplification occurs within a temporally localized lasing window. We develop a unified, scheme-independent description of this regime by linking the physics of short-pulse generation to post-saturation FEL dynamics. We show that the finite electron-beam length acts as a fundamental constraint governing both the achievable peak power and the minimum pulse duration, naturally connecting super-radiant emission to delayed nonlinear growth models.

The role of key electron-beam parameters—such as slice energy spread, emittance, energy chirp, transverse tilt, and undulator tapering—is analysed within this unified framework. Our results highlight intrinsic trade-offs between peak power, pulse compression, and single-

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spike stability, and provide general design criteria for optimizing phase-space manipulation in next-generation terawatt-class attosecond XFELs. This approach bridges traditional saturation models with modern ultrafast FEL operation, offering a compact and physically transparent description of FEL dynamics from startup to deep post-saturation.

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New Salts of Amino Acids, The Discovery of a New Class of Salts and their Possible Applications

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This lecture will provide an overview of the results of the authors who were awarded the “Prize of the National Academy of Sciences of Armenia–2025”.

- Salts of amino acids with simple, dimeric, trimeric and tetrameric cations
- Discovery of a new class of salts containing different amino acids
- Discovery of a new type of polymorphism
- A new effective remedy for the prevention and treatment of thyroid diseases
- New materials for solar energy conversion
- New pyroelectrics and ferroelectrics

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Contrast Media Utilization as a Radiation Dose Reduction Tool in Computed Tomography Procedures

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The medical imaging procedures that use ionizing radiation, especially computed tomography (CT), are associated with an increased radiation dose, which raises the lifetime risk of having cancer caused by radiation. Iodinated contrast media ($Z = 53$) increase X-ray attenuation, especially at lower photon energies, enhancing iodine attenuation and image contrast. This increased attenuation improves CNR, which can compensate for increased image noise associated with lower radiation dose settings. This study aims to conduct a multicenter analysis to evaluate the use of contrast media ($Z = 53$) as an effective tool for reducing radiation dose in CT scans. The data were collected at two hospitals: King Abdulaziz Hospital (KAH) and King Fahad Hospital (KFH). The patients' ages ranged from 19 to 87 years, weights ranged from 47 to 113 kg, and body mass index (BMI) ranged from 18 to 46 kg/m². The examinations were performed using multi-detector 128-slice computed tomography (MDCT) scanners. The CT urinary tract imaging protocol, including pre-injection, arterial, venous, and delayed phases, was applied. The tube voltage ranged from 90 to 140 kVp, with modified tube current (mAs). The slice thickness ranged between 1 and 3, with a pitch of 0.6. Contrast media (iodinated, 300 mgI/mL) was injected at a rate of 2.5–4 mL/min, followed by a saline flush. KAH showed higher mAs and DLP in most phases compared to KFH. This may be due to the use of dual-energy CT scanning at KFH, as mAs values at King Abdulaziz Hospital ranged from 6481 to 15569, with males having a higher average height than females. Similarly, DLP values were higher in males at the pre-arterial and pre-venous stages. In contrast, King Fahd Hospital showed greater variability in kVp and greater modulation in mAs per image, suggesting the need for more effective optimization of radiation techniques. As for CTDIvol values, they were generally similar but showed wider ranges at King Fahd Hospital, likely due to a greater variety of kVp settings. Both institutions, based on the data, demonstrated acceptable CT doses for contrast-enhanced Urography, but differences in protocol usage significantly affected the total patient dose. Contrast medium is an effective radiation dose optimization tool in CT scans, leading to improved diagnostic findings.

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Depth–Dose Peaks in Water Under Irradiation by Ultra–Intense Electron Beams

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Accurate characterization of energy deposition is critical for ultra–intense electron irradiations in advanced radiotherapy and microdosimetry. We investigate the impact of Coherent Stopping Power (CSP) on Very High Electron Energy (VHEE) beams under conditions where electron densities approach or exceed the threshold for collective interactions in matter. Using simulations of laser–plasma–accelerated and photoinjector–based electron bunches, we show that CSP can increase the deposited dose in water by up to 10\% in sub–millimeter beam waists, while remaining below 1—2\% for centimeter–scale beams or polymer dosimeters. CSP arises from collective electromagnetic excitations of the medium, which deposit energy without direct ionization, potentially altering the interpretation of dose at micrometer–to–millimeter scales. Our results highlight the importance of including CSP in dosimetric frameworks for ultra–short, high–density electron beams and suggest experimentally observable signatures, such as coherent Cherenkov emission. These findings are directly relevant for high–precision microdosimetry, cell–targeted studies, and ultra–high dose–rate (FLASH) radiotherapy applications by new–generation ultra–intense electron sources.

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Generation of Surface Polaritons on Cylindrical Interfaces by Charged Particle

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We discuss the radiation of surface polaritons that are localized at a cylindrical interface that separates two media with different electromagnetic properties. Charged particles are considered as radiation sources. Different types of trajectories are studied, including rectilinear motion parallel to the axis of the dielectric cylinder and circular motion around or inside the cylinder. The electromagnetic fields are investigated by using the Green dyadic for the geometry of a dielectric cylinder immersed in a homogeneous medium. The radiated energy in the form of surface polaritons is studied.

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Blackbody Radiation: A Calorimetric Measurement of the Stefan–Boltzmann Constant

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The properties of so-called blackbody radiation are essential for characterizing the ones of any radiating surface. Studies in this field are typically conducted using radiometric methods. This presentation will illustrate a calorimetric method for determining the Stefan–Boltzmann constant and the emissivity of metals at low temperatures, the latter property being of great interest in the design of spacecraft temperature control systems.

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Properties of Coherent Cherenkov Diffraction Radiation in Super–Radiant Regime

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Cherenkov Diffraction Radiation (ChDR), generated when a relativistic charged particle travels parallel to and close to a dielectric boundary, has attracted considerable research interest. As a type of polarization radiation, ChDR originates from the time–dependent polarization induced in the medium. Its characteristics are strongly influenced by beam parameters such as beam size, position, trajectory, energy, and bunch length.

Coherent ChDR occurs when the radiation wavelength is comparable to or exceeds the longitudinal bunch size. Under these conditions, the electrons emit radiation almost in phase, resulting in constructive interference and a substantial enhancement of the emitted field. Consequently, the radiation intensity scales with the square of the bunch charge, producing a significant increase in photon output, providing an opportunity to generate intense electromagnetic radiation beams in THz and sub–THz frequency ranges.

When coherent ChDR is emitted by a periodic sequence of bunches, the radiation fields from successive bunches interfere constructively, producing additional amplification at discrete

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frequencies defined by the accelerating RF frequency. This operating regime, referred to as super-radiant emission [1], enables the generation of highly monochromatic radiation lines [2], whose intensity is determined by the single-bunch length and monochromaticity is defined the beam train length.

In this report, we describe the main properties of super-radiant ChDR in the millimeter-wavelength range, based on experimental studies performed at the MT-25 Microtron in Dubna. We discuss the spatial distribution of the radiation in the pre-wave zone and present an analysis of the polarization properties of super-radiant spectral lines at different frequencies. In addition, we consider the potential application of this phenomenon for longitudinal diagnostics of short charged-particle beams.

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Optical Absorption and Photoionization of Coulomb Systems in Colloidal CdSe Nanoplatelets: A Brief Review

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In this paper, the phenomena of optical absorption and photoionization of exciton and impurity systems localized within colloidal CdSe nanoplatelets (NPLs) are theoretically and numerically investigated, taking into account the dielectric confinement effect. It is shown that reducing the dimensionality of the semiconductor and accounting for polarization effects at the NPL/environment interface significantly increase the binding energy of both excitons and impurities. In this regard, the influence of exciton effects on the nature of optical absorption in CdSe nanoplatelets is studied both in the absence of external fields and in the presence of an axial electric field. Mechanisms for controlling the threshold frequencies of exciton absorption are revealed, as well as the selection rules for optical transitions. Along with the optical absorption, the effect of a planar electric field on the photoionization cross-section of a donor impurity, localized at various regions across the plane of the nanoplatelet, is discussed. Finally, the influence of the direction of the planar electric field on the nature of impurity photoionization is examined.

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Abstracts

Application of X–ray Techniques to the Study of Metal Artifacts Recovered from Archaeological Excavations in Armenia

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X–ray analytical techniques are widely employed in the investigation of cultural heritage objects, particularly archaeological metal artifacts. Such studies play an important role in archaeometry, providing valuable information about the provenance, manufacturing technology, and conservation state of historical objects. In addition, non–destructive X–ray methods are especially attractive for the analysis of unique archaeological materials, since they minimize the risk of damage to valuable artifacts.

This report presents an overview of X–ray investigations of metal archaeological artifacts recovered from several archaeological sites in Armenia dating from the Chalcolithic period to the time of the Urartian Kingdom. The studied objects include bronze and other metal items discovered during excavations at sites corresponding to different historical and technological stages of the development of metallurgy in the region.

The investigations were carried out using a combination of X–ray analytical techniques, including X–ray fluorescence (XRF) analysis and X–ray imaging methods. The obtained results made it possible to identify characteristic compositional features of the investigated artifacts and to reveal differences associated with the use of various alloys and manufacturing approaches. The data also provide insight into ancient metal–processing techniques and contribute to the reconstruction of technological traditions in historical Armenia. In addition, the performed studies demonstrate the potential of modern X–ray analytical methods for non–destructive characterization of archaeological materials and for supporting conservation and restoration activities.

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Mammography Screening Outcome among Women Aged 40 and Above: A One-Year Retrospective Study in Saudi Arabia

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Breast cancer remains a leading cause of cancer-related morbidity and mortality among women worldwide. Early detection through mammography screening is critical to improving survival outcomes. The Breast Imaging Reporting and Data System (BI-RADS) provides a standardized framework for interpreting and reporting mammography results. Objective: This study aimed to evaluate the distribution of BI-RADS categories in a hospital-based breast cancer screening program for women aged 40 years and above at King Fahad Hospital over one year, and to compare findings with national and international data. Methods: A retrospective cross-sectional study was conducted using mammography records from January to December 2023. BI-RADS classifications were extracted from the radiology information system. Descriptive statistics were used to determine category distribution, and comparative analysis was performed against published studies from different countries. Results: A total of 2062 mammograms were analyzed. BI-RADS 2 (48.7%) and BIRADS 1 (32.3%) were the most frequent categories, while high-risk categories (BIRADS 4–6) represented only 2.5% of cases. The BI-RADS 0 recall rate was 10.6%. Seasonal and monthly variations were noted, with statistically significant differences in certain months. Comparison with regional and international studies showed broad alignment with programs in low- to moderate-incidence populations, though variations were observed in BI-RADS 3 and 0 proportions. Conclusion: The screening program demonstrated effective detection of benign and early-stage findings, with a low prevalence of high-risk categories. However, the moderate BI-RADS 0 rate highlights the need to improve image quality and reduce incomplete assessments. Strengthening follow-up protocols for high-risk findings and addressing operational variations may further enhance program performance.

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Structural Analysis of Novel Carbon–Aluminum Composites Under Mechanical Loading Using X–ray Microtomography

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Carbon–aluminum composites (CACs) are promising materials for the aviation and space industries, combining low weight with high strength and corrosion resistance. However, their practical application is limited by technological challenges, including the difficulty of impregnating carbon fibers with molten aluminum and the formation of brittle aluminum carbide at the phase interface. Despite many years of research and development, these composites have not yet achieved success due to persistent physicochemical and technological issues [1].

The formation of an optimal interface is key to the mechanical properties of CACs. To improve fracture toughness and strength, the fiber–matrix bond should be not maximized, but rather controlled at a low level. This can be achieved by optimizing thermal processing conditions and alloying the matrix, which suppresses the growth of brittle carbide phases.

In this study, X ray microtomography was used to examine the structure of pressed carbon–aluminum wire samples. Data segmentation enabled the identification of the aluminum matrix and carbon bundles, providing a basis for quantitative analysis and mathematical modeling of the mechanical properties of the composites. A numerical method for structural analysis of the samples was implemented. All projections of the samples were acquired using tomographs operated at the National Research Center "Kurchatov Institute" [2]. The CAC samples were obtained under the Russian Science Foundation project No. 22 79 10064 P.

This work was carried out as part of the state assignment of the National Research Center "Kurchatov Institute".

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A Specialized Resonator with Two Vibrating Wires for Monitoring Changes in The Structure of the Wire Material under the Influence of Ionizing Radiation

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In our previous work, we demonstrated that the natural frequency of the wire's oscillations responds sensitively to changes in the wire material's structure caused by proton beam irradiation, as well as to loads exceeding the elastic limit and short, high-power electrical pulses. To reliably determine these changes, it is essential to compare the frequencies of the wire used for measurements with those of a reference wire. In this work, a two-wire resonator has been developed in which both wires operate under equivalent thermal conditions, with the exception that one of the wires (the reference wire) is not subjected to the measured influence. A symmetrical magnetic system for the resonator has been designed and computed, which simultaneously serves as a mounting base for fastening the wires and as a massive thermal stabilizer. Initial experiments have been conducted using beams of ionizing radiation (protons and X-rays). The possibilities of using wires made of various materials, as well as materials that have passed special treatments, are considered.

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Geometric Resonance in an Open Dielectric Waveguide

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The formation patterns of secondary geometric resonances present in the impedance frequency distributions of a single–layer cylindrical waveguide with a thin dielectric wall are investigated. Their characteristic feature, as in the case of a two–layer metal–dielectric waveguide [1], is the independence of their location on the frequency axis from the waveguide's internal radius and the harmonic order. Also, as in a two–layer waveguide, the values of the corresponding resonant frequencies depend only on the optical thickness of the dielectric wall.

To identify the specific features of secondary resonance generation in the impedance of an open dielectric waveguide, a special algorithm for solving dispersion equations was developed, determining the transverse values of their eigenmodes.

A correspondence was established between the mechanisms by which secondary resonances influence the formation of wake functions in two–layer and single–layer waveguides. It is shown that the presence of secondary resonances (as in the case of a two–layer waveguide) is accompanied by the establishment of a regime of total internal reflection in the waveguide wall.

Studies establishing a correspondence between geometric resonances in two–layer metal–dielectric and single–layer open dielectric waveguides complement results establishing the general interchangeability (equivalence) of metal–dielectric and open dielectric waveguides [2] in problems related to accelerator physics.

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Transverse Profile Measurements of Low–Intensity Electron Beam Using an Optical–Fibre Scanner: Comparison with Optical Transition Radiation

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We report on vacuum testing of an optical–fibre scanner for measuring transverse profiles and divergence of low–intensity electron beams at the microtron TPU (5.7 MeV). The measurements were performed with a beam charge of 100 pC using two fibre materials of identical thickness (1 mm): PMMA (polymethyl methacrylate, also known as Plexiglas or organic glass) and a scintillating optical fibre. Unlike traditional methods, where light trapped in the fibre is recorded at its end, we detect emission from the fibre region intersected by the beam, perpendicular to the fibre axis. This radiation is attributed to luminescence of the fibre material.

Transverse beam profiles and divergence angles obtained with the fibre scanner are compared against optical transition radiation data, which serves as an independent reference method. The divergence is determined by analysing beam size variations at three measurement points separated by a known drift distance – a standard technique in beam diagnostics.

The optical–fibre scanner demonstrates high potential for diagnostics of low–intensity beams in accelerators with high electromagnetic or radiation interference. Its ability to provide both transverse profile and divergence data makes it particularly valuable for beam tuning and optimization in modern accelerator facilities, especially in environments where conventional methods (wire scanners, luminescent screens) face significant limitations.

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Establishing Diagnostic Reference Levels for Radiation Dose Optimization in Adult and Pediatric CT Imaging at King Salman Hospital

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Computed Tomography (CT) is one of the most widely used imaging modalities, but it also significantly contributes to patient radiation exposure. Establishing Institutional Diagnostic Reference Levels (IDRLs) is a crucial step toward optimizing radiation dose and enhancing patient safety. This proposal aims to assess radiation doses in adult CT imaging at King Salman Hospital and develop IDRLs that reflect local clinical practices while aligning with international guidelines.

Methods: A retrospective study will analyze dose data from adult CT scans performed at King Salman Hospital. Data will be collected from standard protocols, including CT scans of the Brain, Chest, Abdomen, and Pelvis. Key dose metrics such as CTDI_{vol} (mGy), DLP (mGy·cm), and effective dose (mSv) will be extracted from dose reports. Descriptive statistics will be used to determine the median, 25th percentile, and 75th percentile values. IDRLs will be proposed at the 75th percentile following guidelines from the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA).

Results: Preliminary analysis indicates variability in radiation doses across different CT protocols. Initial findings show that doses for CT Abdomen and Pelvis are higher than published national and international benchmarks, whereas CT Brain examinations generally fall within acceptable ranges. These differences highlight opportunities for dose optimization and protocol review.

Conclusions: Establishing IDRLs at King Salman Hospital will support evidence-based dose management, improve radiation protection, and promote adherence to international best practices. The results of this study will provide a framework for ongoing monitoring, staff training, and protocol optimization, ensuring safer CT imaging for adult patients.

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From Dose to Risk: Assessing Radiation Exposure and Lifetime Cancer Risk in 128–Slice CT

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Background: CT pulmonary angiography (CTPA) is a highly effective diagnostic tool for detecting pulmonary embolism. However, its increasing use raises concerns regarding patient radiation exposure and cancer risk.

Methods: This study evaluated the radiation dose and lifetime cancer risk associated with CT pulmonary angiography (CTPA) performed at a major university hospital. DoseWatch was used to extract dose metrics from 246 adult patients, and CT–Expo 2.5 was used to calculate the effective dose. Although CTPA is a highly effective diagnostic tool, concerns persist regarding its increasing use and associated radiation exposure.

Results: The volume CT dose index, dose length product and effective dose values in this cohort were all below the UK diagnostic reference levels, indicating that the current protocols are generally well optimized. Although these are relatively low doses, age– and sex–specific lifetime cancer risk estimates revealed a measurable excess risk, particularly among younger and female patients.

Conclusions: The findings show that CTPA practices conform to international dose benchmarks, but continuous dose optimisation is still needed, particularly for radiosensitive populations. These results support the refinement of local protocols and contribute to national dose audit data for future DRL settings.

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Dosimetry for BNCT: Experience on Accelerator Based Neutron Source VITA

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Accelerator based neutron source was proposed, developed and now is intensively using for boron–neutron capture therapy (BNCT), – binary method for the treatment of malignant tumors, and BNCT research related topics, such as testing boron agents for BNCT and developing and implementing methods for dosimetry in BNCT.

Nowadays, important task in BNCT is to provide a methodology for direct measurement of all BNCT–related radiation doses – γ –ray dose from accelerator and neutrongenerating targets, thermal neutron or “nitrogen” dose from nuclear reaction $^{14}\text{N}(\text{n},\text{p})^{14}\text{C}$, fast neutron dose from nuclear reaction $^1\text{H}(\text{n},\text{n})^1\text{H}$, “hydrogen” dose from nuclear reaction $^1\text{H}(\text{n},\gamma)^2\text{H}$ and “boron” dose from nuclear “BNCT” reaction $^{10}\text{B}(\text{n},\alpha)^7\text{Li}$. The most important reaction is last one, in BNCT it called “useful”.

In BNCT laboratory of Budker Institute of Nuclear Physics there were proposed and implemented several methods for BNCT dosimetry. First is the “cell dosimeter”, when the sum of “nitrogen” and “hydrogen” doses are measuring as the difference in γ –ray doses during irradiation of cell cultures with two different types of ionizing radiation (γ –radiation and mixed neutron and γ –radiation) for achieve equal survival. Next method is prompt γ –ray spectroscopy, when γ –rays from BNCT reaction with 478 keV energy, born in 94% of cases, are detecting by high–sensitivity γ –ray spectrometer. Additional method is using compact neutron detector, based on polystyrene scintillators with and without boron. Difference of signals is proportional to a “boron” dose. Also we use fricke dosimetry, based on oxidizing ferrous ions (Fe^{2+}) to ferric ions (Fe^{3+}) in an acidic aqueous solution. The amount of produced Fe^{3+} ions proportional to a total dose absorbed.

Paper presents status of developing and implementing methods for BNCT dosimetry on accelerator based neutron source VITA.

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Optical Electron Beam Diagnostics at the Novosibirsk FEL

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We present an overview of recent and upcoming enhancements to the optical electron beam diagnostics stations at the Novosibirsk Free Electron Laser (FEL) facility. These diagnostic stations are designed to measure key beam parameters, including beam energy spread, length and emittance, at the third FEL of Novosibirsk FEL. Currently, the stations for measuring electron beam energy spread and undulator radiation spectrum are in the commissioning phase, with initial results already obtained. The new optical diagnostics are essential for the precise tuning of the magnet system used in electron outcoupling experiments. This paper provides a comprehensive overview of the new diagnostic systems, discusses the preliminary measurement results of beam parameters, and outlines the experiments planned for the near future.

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Comparative Study of Surface Effects Induced by Argon Ion Irradiation in Fused Quartz

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Single-crystal silicon and silicon dioxide remain the primary materials for high-precision mirrors and other components of X-ray and extreme ultraviolet (EUV) optics. A key feature of these elements is the stringent requirement to maintain their complex geometrical shape and high surface smoothness. One of the approaches to reducing surface roughness and shaping substrates for various X-ray optical elements is ion beam etching. However, ion treatment also significantly alters the composition and density of the near-surface layer, which may adversely affect subsequent stages of element fabrication.

In this work, structural damage in the near-surface layer of SiO₂ after ion irradiation and its influence on the angular dependence of the reflectivity $R(\theta)$ are investigated using X-ray reflectometry (XRR) and grazing-incidence small-angle scattering (1D GISAXS). The methodology is based on comparing experimental $R(\theta)$ curves with theoretical calculations. A model-independent approach [2] was employed to reconstruct the sample structure.

The samples were irradiated with accelerated argon ions at an energy of 1 keV and a current density of 0.39 mA/cm² using an ion beam etching setup described in detail in [3]. The irradiation doses were 1.24×10^{17} , 1.24×10^{18} , and 1.24×10^{19} ions/cm². The experimental study was carried out using a diffractometer setup with a mobile source-detector system, equipped with an X-ray tube with a copper anode, a Si(220) monochromator ($\lambda = 1.5405 \pm 0.1$ Å), a three-slit collimation system, angular encoders (inductive resolvers), a scintillation detector SCSD4 (Radicon), and a linear detector Mythen2 (Dectris).

A change in the electron density profile of the near-surface layer of fused quartz as a function of depth due to argon ion bombardment was observed. To interpret the results, numerical

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simulations of ion depth distribution in the substrate were performed using two methods: Monte Carlo and classical molecular dynamics. The simulated data explain the presence of two peaks in the depth distribution of argon ions concentration.

This work was carried out within the framework of the state assignment of NRC “Kurchatov Institute” for the X-ray studies and under Agreement No. 075–15–2025–458 with the Ministry of Science and Higher Education of the Russian Federation for the experimental data analysis.

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Solution of the Klein–Gordon Equation in External Yang–Mills Gauge Field

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Exact solutions of the Klein–Gordon equation in an external non–Abelian gauge field with an $SU(N)$ symmetry group have been obtained. The external field is a solution of the Yang–Mills equations and describes a plane wave on the light cone. The obtained solutions form a complete set and can be used in the procedure of canonical quantization of scalar fields.

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Features of Radiation from a Charge in Coaxial Helical Motion Around a Cylindrical Waveguide Field

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We investigate the radiation emitted by a charged particle moving along a helical orbit around a dielectric cylinder immersed in a homogeneous medium. Formulae are derived for the electromagnetic potentials, electric and magnetic fields, and for the spectral–angular distribution of the radiation in the exterior medium. It is shown that under the Cherenkov condition for the dielectric permittivity of the cylinder and the velocity of the particle’s image on the cylinder surface, strong, narrow peaks appear in the angular distribution for the number of quanta radiated on a given harmonic. At these peaks, the radiated energy exceeds the corresponding quantity for a homogeneous medium by several dozen times. Analytic estimates are given for the heights and widths of these peaks. The results of numerical calculations of the angular distribution of the radiated quanta are presented. The conditions for surface–type mode generation are also discussed. The dispersion relation and the results of numerical evaluations of the energy losses on these modes are presented.

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Radiation of Twisted Photons in Elliptical Three-Frequency Undulators

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Photons with orbital angular momentum are an effective tool for investigating rotational degrees of freedom in quantum systems [1]. In this work, we theoretically investigate the generation of such photons in three-frequency elliptical undulators, which serve as a bright source of photons in composite twisted states – linear superpositions of modes with definite projections of the total angular momentum (TAM), amplitudes, relative phases, and polarizations.

Based on the general formalism developed in [2], we obtain simplified expressions for the radiation amplitude and establish selection rules for TAM projections [3]. When the frequency ratio is rational, the radiation spectrum becomes equidistant and is described by a principal quantum number, while the allowed TAM values for a fixed harmonic also form an equidistant structure. Explicit expressions for the amplitudes and relative phases of the composite state modes are derived. The parameters of composite states can be predictably controlled by adjusting the multifrequency helical undulator parameters. In particular, the phases of three arbitrary modes admissible by selection rules in the composite state with definite energy can be made arbitrary by tuning the phases of one-frequency undulators comprising the three-frequency one. Numerical studies confirm theoretical conclusions regarding resonance development and control of composite photon states.

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Real–Time Tracking of Glass Samples Irradiated by Electron Beam of 5 MeV Accelerator AREAL

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A real–time tracking facility has been developed and built for samples irradiated by a 5 MeV electron beam from the AREAL accelerator. Online monitoring of the samples in the irradiation process is facilitated by a 1/2.7–inch CMOS camera with a spectral range covering the visible and near–infrared spectrum. Glass plates of different shapes and compositions are used as samples. The facility also enables the monitoring of samples made of different materials.

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Electron Transport Phenomena in Films with Surface Roughness

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A theory of galvanic and thermomagnetic phenomena in thin films with an isotropic energy spectrum is developed, taking into account electron scattering by film surface roughness. Expressions for the components of galvanic and thermomagnetic tensors in films with rough surfaces were found in the presence of a magnetic field perpendicular to the film plane, an electric field, and a temperature gradient in the film plane.

The kinetic coefficients obtained in this study provide information on the mechanisms of both surface and volume scattering and the characteristics of surface defects. Measuring the kinetic coefficients and analyzing them using the obtained formulas, along with modern experimental research methods, can provide more complete information on surface defects and their influence on film properties.

These formulas are used to estimate the film surface roughness dimensions using experimental data on magnetoresistance and the Hall coefficient.

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Prospects for an Intense Monochromatic X-ray Source Based on Diffraction of Transition Radiation in Crystals with a Temperature Gradient

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Nowadays, X-ray radiation is widely used for imaging and probing the internal structure of materials in advanced medical and biological applications owing to its high penetration capability and its interactions with matter through absorption, diffraction, reflection, and scattering. For many analytical techniques, monochromatic X-ray radiation is of particular importance, as it enables the acquisition of highly informative data.

In this report, we propose a novel approach that combines a multilayer Teflon radiator with a quartz crystal under temperature gradient to produce an intense spectral line formed by the diffraction of TR together with PXR. The radiation generated by an electron beam with energies ranging from 0.8 to 4.4 GeV was investigated at the DESY II TestBeam facility. A set of radiators with Teflon layer thicknesses ranging from 20 to 200 μm and a fixed air gap of 800 μm was used in the experiments. X-ray detection was performed using an AMPTEK X-123SDD spectrometer equipped with a silicon drift detector.

The experimental results show that the maximum value of the radiation yield in the reflected monochromatic line from multilayer targets is achieved for a single-layer thickness of 20 μm accounting target self-absorption. Stack of Teflon targets (120 Teflon layers of 20 μm thickness, separated by 800 μm gaps) with 4.4 GeV electron beam resulted to a reflected monochromatic X-ray yield of 3.5×10^{-4} photons per electron, with a spectral width of 300 eV. These results indicate that proposed approach to develop alternative sources of monochromatic X-ray radiation is highly promising.

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Peculiarities of X-ray Transition Radiation Generation in a Periodic Teflon Radiators

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Radiation emitted by relativistic charged particles traversing natural or artificial periodic structures has been extensively studied in recent decades. It has been shown that, in such media, well-known processes – including parametric X-ray radiation, transition radiation (TR), and Cherenkov radiation – can exhibit interference effects that significantly modify their properties. In particular, the use of multilayer radiators enables the generation of intense TR beams with a broad spectrum in the X-ray range.

In this report, we investigate the parameters of TR generated in multilayer Teflon radiators of various designs. The experiments were carried out at the DESY II TestBeam facility using an electron beam with energies in the range of 0.8 – 4.4 GeV. A set of radiators with Teflon layer thicknesses ranging from 20 to 200 μm and a fixed air gap of 800 μm was employed. X-ray detection was performed using an AMPTEK X-123SDD spectrometer equipped with a silicon drift detector.

The experimental results show that variations in the thickness of single layer lead to a redistribution of intensity in the TR spectrum and, under certain conditions, to the formation of additional peak. As the thickness of a single layer increases, the spectral maximum shifts toward higher energies. Furthermore, an increase in the electron beam energy results in a significant enhancement of the TR yield.

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Feasibility of 3D–Printed Targets for Coherent Cherenkov Diffraction Radiation Generation

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Polarization radiation is widely used for the diagnostic of charged particle beams due to its high sensitivity to various parameters, such as beam shape, bunch length, energy, and angular distribution. Special attention is given to coherent radiation, which occurs when the wavelength of the generated radiation is comparable to or exceeds the length of a single electron bunch. At most modern accelerator facilities, such as linear accelerators and synchrotrons, the conditions for coherence are satisfied, allowing this phenomenon to be effectively used for real–time beam parameter monitoring.

This work aims to assess the feasibility of using three–dimensional (3D) printing for the generation of coherent polarization radiation, specifically Cherenkov diffraction radiation, which is produced when a charged particle passes along the boundary of a dielectric medium. In previous studies [1], the Cherenkov diffraction radiation method was shown to be a promising tool for

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addressing current diagnostic challenges in modern accelerators, owing to its non-invasive nature, high sensitivity, and real-time monitoring capability. Application of 3D printing allows to create targets for Cherenkov diffraction radiation generation with complex geometries and precisely controlled dielectric properties. However, 3D printing technique, as fused filament fabrication, has certain characteristics that may affect the performance of such targets. Therefore, the objective of this study is to evaluate the required quality of a 3D–printed target for the generation of coherent Cherenkov diffraction radiation. The angular distribution of the electromagnetic-radiation intensity produced by high-energy electrons of the MT-25 microtron (Dubna, Russia) passing near the 3D–printed PLA–plastic (polylactide) prism was constructed for the various harmonics.

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Dose-Dependent Effects of AgTOEPyP4 Metalloporphyrin on X-ray-Induced DNA Damage

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The synergistic interaction between porphyrins and ionizing radiation offers a promising avenue for enhancing tumor cell killing while potentially protecting healthy tissue. This study investigates the dose- and concentration-dependent influence of the cationic metalloporphyrin AgTOEPyP4 on X-ray-induced DNA damage, with the aim of identifying optimal conditions for therapeutic application.

DNA stability was assessed using the thermal denaturation method, monitored by UV-Vis spectrophotometry (Agilent Cary 3500 Multizone) at a heating rate of 1°C/min in 10⁻³ M NaCl (pH 7.0). Experiments were performed at X-ray doses of 2 Gy and 4 Gy, and at three porphyrin-to-DNA molar ratios ($r = C_{\text{Porph}}/C_{\text{DNA}} = 0.01, 0.02, \text{ and } 0.04$). The melting temperature (T_m) and melting interval (ΔT) were used as quantitative indicators of double-helix integrity and radiation-induced strand breakage.

Irradiation of bare DNA produced a marked decrease in T_m (49.3°C) and a broadening of ΔT , consistent with the induction of single- and double-strand breaks and global structural destabilization. Strikingly, the presence of AgTOEPyP4 reversed these effects in a concentration-dependent manner: at a 2 Gy dose, T_m increased to 59.8°C and 63.6°C at $r = 0.02$ and $r = 0.04$, respectively, demonstrating a significant radioprotective effect. Importantly, the balance between radioprotective and radiosensitizing behavior was found to depend critically on the combination of porphyrin concentration and applied dose, suggesting a tunable, dual-mode mechanism of action.

These findings provide quantitative insight into the molecular interactions governing porphyrin-DNA complex stability under ionizing radiation, and highlight the potential of metalloporphyrins as concentration- and dose-programmable agents in radiation-based cancer therapy.

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Quantifying Cumulative Doses to Organs at Risk (OARs) from kVCBCT in Prostate IGRT

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This study aimed to quantify the cumulative absorbed dose delivered to pelvic organs at risk (OARs) from kilovoltage cone-beam computed tomography (kV-CBCT) during image-guided radiation therapy (IGRT) for prostate cancer.

Methods and Materials

A retrospective analysis was conducted on a 105-patient cohort treated with a Varian OBI system. To model the 125 kV source (equipped with a half-fan bowtie filter), we utilized the EGSnrc/BEAMnrc Monte Carlo toolkit, generating a phase space file of 3×10^9 particles. Patient 3D phantom geometries were generated directly from each patient's planning CT. We used EGSnrc/DOSXYZnrc to simulate image acquisition and generate 3D dose distributions to quantify the absorbed doses in OARs.

Results

Mean cumulative absorbed doses were 4238.40 mGy (right femoral head), 4092.16 mGy (left femoral head), 3720.23 mGy (bladder), 3197.2 mGy (rectum), 2156.30 mGy (penile bulb), and 2122.29 mGy (bowel). Bladder and rectum doses were high due to their complete inclusion within the imaging field. The high femoral head doses occurred because of the predominant photoelectric effect in bone tissue at kV energy levels. The total number of CBCT scans per patient was the most critical factor driving cumulative dose variation. Cumulative imaging doses exceeded the AAPM TG-180 recommended 5% therapeutic threshold in 68% and 64% of cases for the right and left femoral heads, respectively, as well as 51% for the bladder and 11–28.5% for other OARs. These contributions should be integrated into treatment planning.

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Effective Dose to Patients in Interventional Cardiology: Multicenter Study in Sudan

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Interventional cardiology procedures are essential for diagnosing and managing cardiovascular diseases but involve significant patient exposure to ionizing radiation. Effective dose (ED) is a key metric for estimating stochastic risk and enabling comparisons across procedures. Data from Sudan on patient ED remain limited.

Objective: To estimate patient effective dose during common interventional cardiology procedures in Sudan and compare results with international benchmarks. **Methods:** A multicenter retrospective study was conducted in six hospitals in Khartoum State, Sudan. Data from 3,354 patients undergoing coronary angiography (CA), percutaneous coronary intervention (PCI), combined CA+PCI, pacemaker implantation, and percutaneous transvenous mitral commissurotomy (PTMC) were analyzed. Kerma–area product (KAP) and fluoroscopy time (FT) were extracted from DICOM headers. ED was estimated using procedure–specific KAP–to–ED conversion coefficients based on UNSCEAR and ICRP recommendations.

Results: Median ED values were: CA (2.82–5.44 mSv), PCI (12.84–27.70 mSv), CA+PCI (24.59–50.59 mSv), and pacemaker implantation (3.09–10.87 mSv). Mean ED values were 4.93 mSv (CA), 20.95 mSv (PCI), 39.85 mSv (CA+PCI), and 9.92 mSv (pacemaker). Conversion coefficients were consistent with international data; however, notable inter–hospital variability was observed, reflecting differences in operator practice, procedural complexity, and imaging protocols.

Conclusion: Patient ED in Sudanese interventional cardiology procedures is comparable to international levels. However, variability across centers highlights opportunities for optimization. Establishing national diagnostic reference levels (DRLs), implementing routine dose audits, and enhancing operator training are recommended to improve radiation protection and patient safety.

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Experimental Study of Cherenkov Diffraction Radiation Generated by a Conical Dielectric Target on the MT–25 Microtron Electron Beam

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Cherenkov diffraction radiation (ChDR) is generated when short bunches of charged particles with relativistic energies pass near dielectric targets, due to the interaction of the particles' Coulomb field with these targets. ChDR is promising for use as a means of non-disturbing diagnostics of high-energy particle beams [1–2], as well as for generating radiation in the terahertz and sub-terahertz ranges [3].

In [4], the possibility of generating a ChDR on a conical target in the "spotlight" mode, i.e., with the highest possible directivity for a given geometry, was theoretically predicted. A pronounced narrow peak of the ChDR is formed in the wave zone, the maximum of which is observed at a small angle relative to the charge trajectory, with this angle depending only on the geometric dimensions of the target. The intensity of the ChDR in this case is the highest possible.

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Thus, the described configuration appears optimal for creating terahertz and sub-terahertz sources based on a ChDR.

This paper presents the first results of the experimental implementation of the spotlight effect for a ChDR on the MT-25 microtron beam [5]. Based on the theory from [4], a theoretical calculation of the parameters of a conical target corresponding to the parameters of this experimental setup was performed. A cooled absorber was developed for beam absorption, the parameters of which were calculated using Geant4. A series of simulations of ChDR generation in a calculated target using the developed absorber was conducted using COMSOL Multiphysics. The experimental study was conducted on Channel 2 of the MT-25 microtron using a 16 MeV electron beam with an average beam current of 1.5 μ A and a pulse repetition rate of 100 Hz. A dielectric cone with a central hole, 3D-printed from PLA, was used as the target. This paper will describe the theoretical basis of the experiment, the simulation results, the details of the experimental setup, and preliminary experimental data.

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Multi–Angle Beam Profile Reconstruction Using Cylindrical Ionization Chambers for High–Energy Beam Diagnostics

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Precise beam diagnostics is a fundamental requirement in modern high–energy physics, particularly for optimizing the performance of accelerator complexes used in collider experiments, synchrotron radiation sources, and free–electron lasers. Among the most critical parameters to characterize is the transverse intensity distribution of the beam. A promising approach to obtain beam profiles is multi–angle scanning, which allows to reconstruct the transverse distribution from a set of projection measurements [1].

To implement this method for high–energy electron beam diagnostics, we propose using an array of cylindrical ionization chambers. These detectors are particularly well–suited for such applications due to their mechanical robustness, high radiation tolerance, and ability to operate over a wide dynamic range of beam intensities.

In earlier work [1], a four-channel ionization-chamber system validated for the transverse beam profile determination by the multi-angle scanning method. The results showed that increasing the number of the detectors improve quality of reconstruction. Consequently, the detector was upgraded: the anode tube diameter was changed from 3 mm to 2 mm and the channel count increased from 4 to 16. This enhancement provides far greater resolution for high-energy electron beam diagnostics and enables detailed beam shape reconstruction. The experiment at the MT-25 microtron (Dubna, Russia) confirmed that a 2 mm diameter chamber array with 5 mm spacing maintains excellent linearity and low background current, ensuring rapid, accurate transverse intensity distribution of the electron beam measurement.

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Improvement of Detection Limits in Gamma Spectroscopy for Radioactivity Analysis in Thermal Waters Using Monte Carlo Simulation

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The accurate assessment of natural radioactivity in thermal waters is often limited by low activity concentrations and the sensitivity of detection systems. Improving detection limits is therefore essential for reliable environmental monitoring and radiological evaluation.

In this study, sixteen thermal water samples were collected from various hot spring sources in eastern Algeria. The analysis focuses on naturally occurring radionuclides, including potassium-40 (K-40), uranium-235 (U-235), uranium-238 series (such as Ra-226, Pb-214, and Pb-210), and thorium-232 series radionuclides. Measurements are planned using a high-purity germanium (HPGe) detector due to its high resolution and efficiency in gamma-ray spectroscopy.

To enhance the detection performance, a Monte Carlo simulation approach is being developed using the MCNP code. The simulation model aims to optimize the detector geometry, sample configuration, and measurement conditions in order to reduce background effects and improve minimum detectable activity (MDA).

This work is currently in progress, with simulation results expected to guide future experimental measurements and the integration of complementary techniques such as LIBS. The proposed methodology contributes to improving the sensitivity and reliability of radioactivity analysis in environmental water samples.

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From First Experiments to Brighter Sources: Nonlinear Compton Scattering, Harmonics, and Control Strategies

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Nonlinear Compton scattering in collisions of relativistic electron beams with intense laser pulses offers a promising route toward compact tunable X-ray and gamma-ray sources. As the laser intensity increases, the radiation spectrum is expected to depart from the linear regime through several characteristic effects, including redshift and broadening of the main spectral line, an increase in photon yield, and the emergence of higher harmonics. These signatures provide a natural basis for identifying the onset of nonlinearity and for developing strategies to improve source performance.

In this contribution, we discuss ideas for first proof-of-principle experiments aimed at observing robust manifestations of nonlinear Compton scattering under realistic conditions. Particular attention is paid to experimentally accessible observables such as total photon yield, spectral shift, spectral width, and harmonic content. Among these, higher harmonics are especially attractive as clear signatures of nonlinear interaction, while the evolution of the fundamental line can provide complementary information on the transition from the linear to the nonlinear regime.

We also outline physical approaches for improving source brightness and spectral properties. These include increasing the effective interaction strength, optimizing pulse duration and envelope shape, using controlled chirp to mitigate nonlinear spectral broadening, and employing structured pulse sequences such as pulse stacking. Together, these ideas define a practical path from the first observation of nonlinear signatures toward brighter and better controlled photon sources based on nonlinear Compton scattering.

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On Coherent Radiation from Pair of Electron Bunches Moving Along the Waveguide Axis, Filled with Periodic Medium

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We investigate the radiation from a pair of electron bunches moving along the cylindrical waveguide axis, assuming that the waveguide is partially loaded by a medium with periodic dielectric permittivity. The results of numerical calculations are presented in the special case of layered medium consisting of a finite number (2–4) of dielectric plates separated by vacuum gaps. We show that under certain conditions on the problem parameters the quasi-coherent radiation generated inside the plates is self-amplified at certain waveguide modes. The possibility of observing this phenomenon at the AREAL accelerator is discussed, and a preliminary experimental setup is presented.

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On the Possibility of Using Corundum to Create Sensitive VUV, UV and IR Detectors

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The energy, spectral and temporal characteristics of corundum ($\alpha\text{-Al}_2\text{O}_3$) with various activators in different optical regions were studied. The elements that can be part of optically active crystals and those elements that can create new exciton–photon interactions leading to new transitions and energy transformation were determined. The percentage of impurities in these crystals and the percentage of this mixture at which the maximum conversion of optical radiation will occur were determined, absorption and luminescence spectra were obtained. Luminescence measurements were carried out at several constant frequencies of corundum irradiation and at different orientations of the crystal. Luminescence is the most important characteristic of crystals in the development of optical converters. The studies of these crystals led to the conclusion that corundum can be used as a photoconverter not only in the UV range, but also for creating sensitive detectors in the VUV and IR wavelength ranges. To modify the electrophysical properties of the single crystal, corundum was irradiated with accelerated ions of various elements to create active elements with precisely specified dimensions in the crystal.

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Deposition Using Pulsed Arc Discharge

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There are materials that are difficult to deposit using thermal methods due to their high operating temperatures, as well as materials that exhibit low efficiency in magnetron sputtering. In such cases, an arc discharge can be used to evaporate the material. Typically, a direct current arc discharge is employed and maintained for a relatively long duration. Evaporation from the overheated arc crater produces a large flux of high-energy particles, which leads to strong clustering of the evaporated material. In the present experiments, an arc discharge was used in a pulsed mode, switched on for a short period—just long enough for the arc crater to begin forming—after which it was turned off. This made it possible to control the degree of clustering. The results of the study are presented.

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Next-Generation Hybrid Military Aircraft

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In the context of the rapid development of military technologies, the creation of next-generation aviation systems that combine high efficiency, mobility, and reduced energy consumption has become increasingly important. One of the most promising areas of modern aerospace engineering is the development of hybrid military aircraft that integrate conventional engines with electric and hybrid-electric propulsion systems. This technology aims to improve combat capabilities while reducing fuel consumption, noise levels, and thermal visibility.

Next-generation hybrid military aircraft can be used for reconnaissance missions, cargo transportation, and combat operations requiring increased stealth capabilities. The use of electric components reduces the acoustic signature of aircraft, which is especially important for unmanned missions and special operations. In addition, the integration of artificial intelligence and autonomous control systems improves navigation accuracy and operational efficiency.

Current research focuses on Vertical Take-Off and Landing (VTOL) technologies, hybrid-electric engines, high-capacity batteries, and alternative energy sources such as hydrogen fuel cells. These innovations expand operational range and reduce dependence on traditional aviation fuel. Leading aerospace and defense companies (Archer Aviation, Anduril Industries) are actively investing in the development of such systems, considering them the future of military aviation.

Despite their advantages, hybrid military aircraft still face technical and economic challenges, including battery limitations and high production costs. Nevertheless, continued technological progress creates new opportunities for the development of more efficient and intelligent aviation systems.

Thus, hybrid military aircraft represent an important stage in the evolution of aviation technology and may significantly influence the future of modern armed forces.

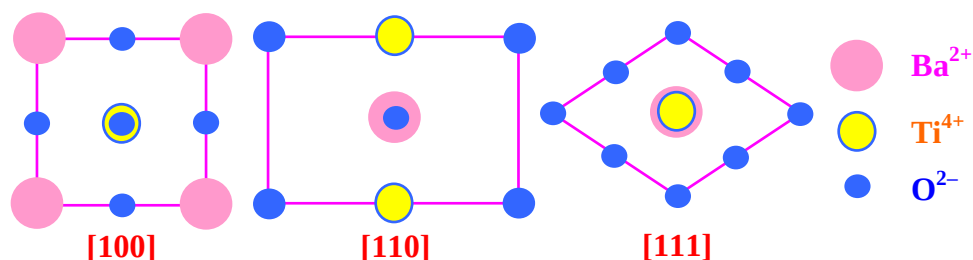
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Features of Channeling and Spontaneous Radiation of Relativistic Electrons along the Main Crystallographic Axes of Barium Titanate Crystal in the Cubic Phase

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The paper presents the results of a study of the spectral distributions of spontaneous radiation arising from the channeling of relativistic electrons along the main crystallographic axes [100], [110], and [111] of barium titanate, for example, at a temperature of 500°K, when this crystal is in the cubic phase. The analysis was carried out using a methodology similar to that in Ref. [1]. The figure shows two-dimensional cells constructed from projections of these axes onto planes perpendicular to them (illustrated are the cases in which the centers of these cells coincide with axes containing two types of ions; the [110] axes, consisting only of O^{2-} ions, are depicted by larger circles, since their density is twice as high as in the other cases)



From this figure it can be seen that the spectral distributions of spontaneous radiation are formed by partial contributions of potentials from individual axes in the following proportions: $Ba^{2+} : (Ti^{4+} + O^{2-}) : 2O^{2-}$ for the [100] axes; $(Ba^{2+} + O^{2-}) : Ti^{4+} : O^{2-}$ for the [110] axes; $(Ba^{2+} + Ti^{4+}) : 3O^{2-}$ for the [111] axes. Detailed calculations show that, during the channeling of relativistic electrons along these axes, spectra of spontaneous radiation arise which, as in the planar cases (see Ref. [1]), are more intense than those in conventionally used crystals with a diamond structure.

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Study of the Transformation of Functional Properties of Materials Under the Influence of Pulsed Radiation Irradiation by Electrons and Ions with Dose

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The project is aimed at a comprehensive experimental and theoretical study of exchange interactions, magnetotransport phenomena, spin and phase transitions in magnetic semiconductors, including complex cobalt oxides. These compounds demonstrate a wide range of physical phenomena, such as spin crossover, giant magnetoresistance, dielectric–metal transition, orbital ordering, ferroelectric and magnetoelectric effects, as well as structural phase transitions [1–3]. The study of these phenomena is one of the leading areas of modern condensed matter physics, both fundamental and applied, although the microscopic mechanisms of formation of the properties of complex cobalt compounds remain insufficiently studied. The unique functional properties of these compounds are associated with the ability to change the spin states of cobalt ions (Co⁴⁺, Co³⁺ and Co²⁺) due to small changes in thermodynamic parameters (temperature, pressure, magnetic field, pulsed electron irradiation). An additional degree of spin freedom creates differences in the mechanisms for the implementation of these phenomena compared to other transition metal oxides. Modification of the structure and magneto–transport properties of ferro– and antiferromagnetic materials will be carried out using pulsed ions Xe²⁶⁺ irradiation on the NICA accelerator complex at the irradiation station of the SOCHI with an energy 3.2 MeV/nucleon with intensities at 10⁷ particles/sec, pulse duration of 4 μs.

Note that pulse duration corresponds to the time scale of switching of domain walls, which play a decisive role in changing magneto–transport properties.

Pulsed electron irradiation includes a whole range of effects: ionizing radiation, electron

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concentration affecting spin states, temperature, dynamic pressure and electromagnetic pulse. These effects will be studied separately under pulsed action of a strong magnetic field from 20 to 150 Tl, which will allow more correctly identifying the contribution of each of them to the transformation of magnetotransport properties and conducting a comparative analysis with changes in temperature and external pressure.

Preliminary results show that irradiation leads to structural and magnetotransport transformation in the studied compounds, including isotropization of the crystal structure and transition to the ferromagnetic phase. However, the effect of irradiation parameters on metastability remains unclear.

Research methods include X-ray and neutron diffraction for analyzing the long-range order of the crystal and magnetic structure, EXAFS spectroscopy, X-ray magnetic circular dichroism (XMCD) for studying the short-range order of the crystal and magnetic structure of the 3d-valence states of cobalt. All methods will be used in a wide range of temperatures and pressures.

Theoretical data analysis is aimed at clarifying the microscopic mechanisms of the phenomena under study. Since the systems under consideration belong to the class of strongly correlated ones, the density functional theory will be used taking into account the Coulomb interaction and many-particle effects within the framework of the dynamic mean field theory (DFT+DMFT). The results of the research will reveal the relationship between lattice, electron and magnetic degrees of freedom, which will open up opportunities for controlling their physical and chemical properties and creating new functional materials for use in terahertz and subterahertz generators based on the excitation of spin oscillations by spin current [1–3].

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Transport–Equation Formalism for Low–Charge Ultrashort Electron Bunches: Photocurrent Profiles from Copper and Cesium Telluride Photocathodes

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High–quality electron bunches are now essential to fundamental science, from advanced light sources to ultrafast electron diffraction (UED) and microscopy (UEM). Electron bunches with low transverse emittance and charges ranging from tens of fC to hundreds of pC are typically generated via radiofrequency (RF) photoguns.

Photoemission, a key process in RF photoguns, determines initial bunch quality and parameters (bunch length, RMS size). For low–charge subpicosecond bunches — of particular interest for ultrafast imaging — the emission often occurs in the linear regime, where the photocurrent scales directly with the laser pulse energy. Classical photoemission models (such as Fowler–DuBridge or the three–step) may not adequately describe the temporal structure of the bunch in this regime, and a more transparent analytical framework is needed.

In this work, we analytically derive photocurrent profiles from copper and cesium telluride cathodes within the linear photoemission regime. Using a transport–equation formalism, we obtain the dependence of bunch charge on laser energy and the temporal structure of the emitted current. The obtained expressions for quantum efficiency and photocurrent profiles are in good agreement with available experimental data for both copper and cesium telluride photocathodes, providing a fast analytical alternative for predicting photocathode performance in the low–charge regime relevant to ultrafast electron imaging techniques.

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On Development of Scientific Justified Quantitative and Qualitative Requirements for the Proposed Earthquake Early Warning Integrated Territorial System for Armenia and its Optimal Warning Algorithm

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Armenia is located in one of the most seismically active regions of the Alpine–Himalayan seismic belt and has experienced several destructive earthquakes, including the catastrophic 1988 event that caused severe human and economic losses. Despite the above and significant advances in seismic monitoring and hazard assessment, the country still lacks an operational earthquake early warning system (EEWS) capable of providing rapid alerts to critical infrastructure and the population.

This study presents a comprehensive conceptual design and feasibility analysis of a territorial integrated Earthquake Early Warning System tailored for the seismotectonic conditions and infrastructural characteristics of Armenia. The research aims to assess the suitability and adaptability of existing EEWS concepts and algorithms for Armenian conditions, and to develop a scientifically justified and systemized quantitative and qualitative requirements on proposed Armenian national territorial integrated EEWS and its architecture and EEW algorithms capable of providing timely early alerts for densely populated urban areas and critically important infrastructural and other objects.

The study analyzes the seismotectonic framework of Armenia, major seismic sources,

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historical earthquake impacts, and spatial relationships between hazardous faults and high-risk target areas. A comparative evaluation of existing EEW Systems and EEW methodologies—including on-site, regional, hybrid, and ML/AI-based algorithms—is performed in order to identify the most suitable approaches for implementation in Armenia.

Based on these analyses, the paper proposes scientifically justified quantitative and qualitative requirements for the technical, operational, and maintenance characteristics of the Proposed Armenian EEWS, including requirements for its conceptual architecture, optimal EEW algorithms, configurations of seismic networks, real-time data processing systems, magnitude estimation accuracy, and warning dissemination mechanisms. Special attention is given to the requirements enabling the effective protection of critically important objects and early warning for urban population centers.

Generation of Cherenkov Diffraction Radiation from Moderately Relativistic two Subsequent Bunches in Teflon Radiator

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Narrowband Cherenkov radiation in the millimeter-wave and sub-terahertz frequency ranges has attracted considerable attention as a compact and tunable source of coherent electromagnetic radiation. In particular, radiation in the 30–50 GHz range can be generated when relativistic electron beams propagate through dielectric structures under conditions satisfying the Cherenkov criterion. Compared with broadband emission mechanisms, narrowband Cherenkov sources provide enhanced spectral selectivity, making them attractive for high-resolution spectroscopy, imaging, diagnostics, and accelerator-based applications.

In this work, experimental studies were carried out to investigate the spectral properties of coherent Cherenkov radiation from a cylindrical Teflon radiator produced by two subsequent electron bunches at the AREAL accelerator. The influence of the inter-bunch delay on the coherent radiation intensity was examined for delays ranging from 1 to 41 ps. Radiation detection was performed using a narrowband Schottky barrier diode detector coupled to a waveguide-fed pyramidal horn antenna operating in the 33–50 GHz frequency range. The spectral characteristics of the emitted radiation were analysed using a measurement setup incorporating a Martin–Puplett interferometer. The obtained experimental results show good agreement with theoretical expectations.

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X-ray Characterization, Optical and Nonlinear Optical Properties of α -LiIO₃ Crystals with L-Valine Additive

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This study reports on the growth and comprehensive characterization of pure and L-Valine amino acid-modified α - LiIO₃ single crystals, with an emphasis on structural features and nonlinear optical properties. High-quality nonlinear optical (NLO) α - LiIO₃ crystals from pure aqueous solution and α - LiIO₃ crystals from an aqueous solution containing L-Valine amino acid (5 mol%) were grown using the slow- evaporation method under controlled conditions. Structural analysis using single-crystal and powder X-ray diffraction indicates that the L-Valine additive is incorporated predominantly as defect centers or interstitial inclusions. Infrared spectroscopy further confirms the incorporation of functional groups characteristic of L-Valine into the α - LiIO₃ crystal.

Optical studies demonstrated improved transmittance in the visible region for α - LiIO₃:L - Val crystals and a significant reduction of the band gap attributed to the formation of additive-induced electronic states.

Notably, second-harmonic generation (SHG) efficiency increased for α - LiIO₃:L - Val crystal compared to pure α - LiIO₃. The observed enhancement is associated with modified electron density distribution and defect-mediated polarization effects.

The combined X-ray, spectroscopic, and SHG analyses demonstrate that amino acid additives provide an effective route for enhancement of optical and nonlinear optical properties in α - LiIO₃ crystals, making them promising candidates for photonic and optoelectronic applications.

This work was carried out within the framework of the project No. 25RG-2F039, provided by the Higher Education and Science Committee of the MESCS Republic of Armenia.

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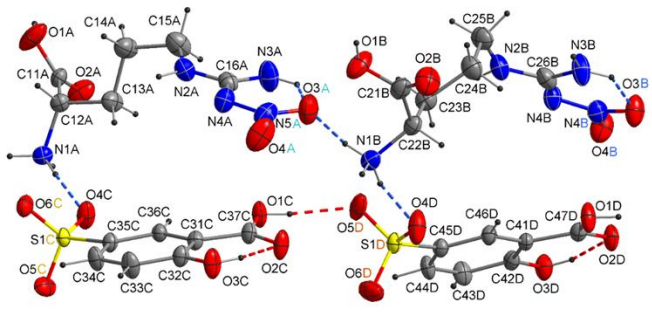
The Study of L–Nitroargininium 5–Sulfosalicylate Crystals

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The subject of the present study is L–nitroargininium 5–sulfosalicylate (L–NNA·5–SSA) crystal. The thermal properties, vibrational spectra, UV–Vis transmittance spectrum, Vickers hardness and second harmonic generation activity were experimental studied. The crystal and molecular structure of crystal was determined by the single–crystal X–ray diffraction method. L–nitroarginine exists as a monocation (L–NNA⁺) in the nitrimine form. The experimental and optimized lattice parameters of the crystal structure of L–NNA·5–SSA (space group P212121) is presented in Table. The optimized unit cell volume was reduced by 6.24% for L–NNA·5–SSA. The bands originating from the orbital electrons of oxygen (O), nitrogen (N) and carbon (C) are responsible for the formation of energy gaps of about 2.9 eV for L–NNA·SSA. High–quality bulk crystals were grown. They exhibit dielectric and nonlinear optical properties.

Experimental and theoretical lattice parameters and asymmetric part of the unit cell of L–NNA·5–SSA crystal.			
Lattice parameters	Exp.	Theor.	
a (Å)	13.26100	12.99463	
b (Å)	15.38600	14.84202	
c (Å)	17.83200	17.68802	
$\alpha = \beta = \gamma$ (°)	90	90	
Volume (Å ³)	3638.3(3)	3411.4(3)	

The research was supported by the Higher Education and Science Committee of MESCS RA (Research project № 24WS–1C022).

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Vickers Microhardness Analysis and Optical Studies of Pure and L-Alanine Assisted α -LiIO₃ Single Crystals Using Hays–Kendall and PSR Models

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Pure and L-alanine (L-Ala) assisted lithium iodate (α -LiIO₃) single crystals were successfully grown from aqueous solution by the slow evaporation technique. The present work focuses on the comparative investigation of the mechanical and optical properties of pure and L-Ala-assisted α -LiIO₃ crystals, which are promising nonlinear optical materials for photonic and optoelectronic applications. Vickers microhardness measurements were carried out at different applied loads to evaluate the load-dependent mechanical response of the grown crystals. The experimental data were analyzed using the Hays–Kendall approach and the Proportional Specimen Resistance (PSR) model to determine the characteristic hardness parameters and indentation behavior. The results reveal noticeable variations in microhardness and resistance parameters between pure and amino acid-assisted crystals, indicating the influence of the growth environment and defect formation on the mechanical stability of α -LiIO₃. Optical investigations show that, despite the observed modifications in hardness behavior, the optical response is predominantly governed by defect-related localized electronic states. These defect states contribute to changing optical absorption and a narrowing of the optical band gap in α -LiIO₃:L-Ala crystals. Overall, the results confirm that L-Ala-assisted growth is an effective approach for tuning the functional properties of α -LiIO₃ single crystals for advanced photonic and optoelectronic device applications.

The research was supported by the Higher Education and Science Committee of MESCS RA (Research project № 25RG–2F039).

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Numerical Modelling of Twisted Radiation of Relativistic Electrons from a Spiral Target

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As recent studies have shown, radiation with orbital angular momentum – commonly referred to as twisted radiation – has the potential to become a new tool in research, owing to the additional degree of freedom provided by the orbital angular momentum [1]. This type of radiation and the additional degree of freedom it offers can provide valuable additional information about the interactions of photons, electrons and neutrons with materials. At Tomsk Polytechnic University, a new scheme for generating twisted radiation using relativistic electron beams and a spiral target, which acts as a radiation source, has been proposed.

This paper presents the results of computer simulations of radiation of relativistic electrons from a spiral target, including such radiation properties as angular distributions of radiation intensity, phase patterns of the radiation, Stokes' parameters, and the spectral distribution of the radiation according to the topological charges of the orbital angular momentum.

This research was supported by the Russian Ministry of Science and Higher Education, project No. FSWW–2026–0046.

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Study of the Quasar 0827+24 and the Distribution of Quasars Located Within a Conical Section of Radius 6° Around It

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The quasar 0827+24 is located more than 30° above the plane of the Galaxy. Radiation coming from its surroundings is only weakly absorbed by the Galaxy, and therefore the reliability of the obtained observational data is fairly high. Spectral studies of the quasar show that:

1. In the radio range, the spectrum is extremely flat ($\alpha \approx 0$, $F \sim \nu^\alpha$), which supports the idea that quasar 0827+24 is relatively young, a characteristic typical of quasars.
2. At frequencies higher than the radio range, the spectrum declines more rapidly, which can be explained by the fact that the quasar loses its energy faster at high frequencies.

The histogram of quasar distribution shows that the maximum number of quasars is found around $z \approx 1.5$. This is natural, since detecting more distant quasars is more difficult, while the actual number of nearby quasars is smaller. The histogram also indicates that in the interval $z = 2.4-3$, the number of quasars is lower than in the interval $z = 3-3.4$. Around $z = 2-3$, a deficit in the number of quasars is observed everywhere, making it more likely that we are indeed dealing with a smaller population of quasars in this range.

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Study of the Quasar 1637+57 and about the Distribution of Quasars Within a Cone of 6° Radius Around It

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The quasar 1637+57 has been studied over a very wide range of the electromagnetic spectrum. Particularly interesting are the data obtained in the radio range, according to which the radio spectral index is close to 0, which is typical for quasars. For the majority of the 11 quasars studied by us, the spectral indices are also close to that of our quasar (Figure 1).

Within a region of 6° radius around the quasar 1637+57, only 129 quasars have been identified, which is on average about 10 times fewer than in other studied regions. This is rather unusual, especially considering the galactic latitude of about 40° , where the absorption caused by the Galaxy is expected to be very small. The shape of the histogram as a function of redshift z is shown in Figure 2, and the small number of quasars does not exhibit any noticeable dependence on distance.

Therefore, it may be assumed that outside the Galaxy, in this particular direction, there exists an absorbing medium that prevents the observation of the full quasar population. Another possibility is that the number of quasars in this region is intrinsically small; however, this explanation appears less probable. The number of other extragalactic objects is also low in this region, and thus our assumption about the existence of an absorbing medium may be reasonably well justified. If such an absorbing medium does exist, then it becomes impossible to draw reliable conclusions about the large-scale structure of the Universe in that direction. Consequently, it is necessary to verify the existence or absence of such an absorbing medium.

To overcome the difficulties in studying the structure of the Universe in this region, both analytical studies and observations with sensitive telescopes are required. Observations with

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highly sensitive instruments are beyond our current capabilities, whereas the analytical investigations will be presented in our work.

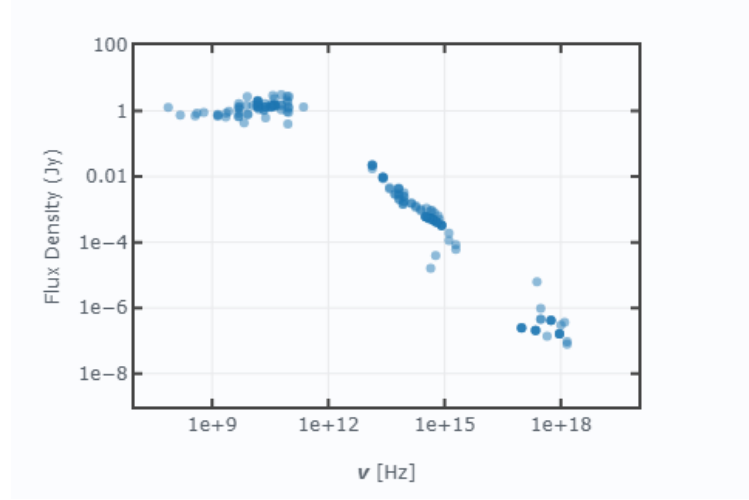


Fig. 1. Dependence of Flux Density on Frequency (log–log scale).

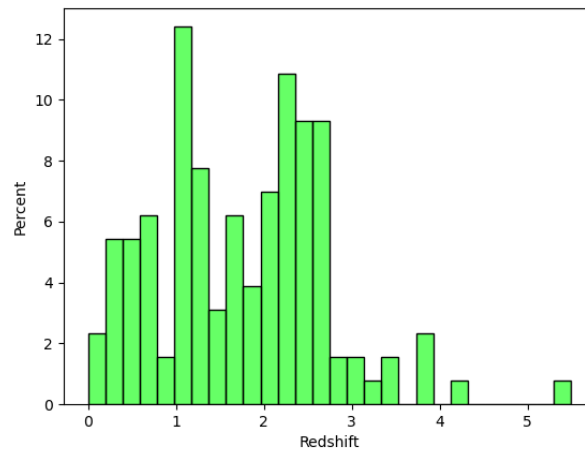


Fig. 2. Histogram of quasar distribution by redshifts in percentages.

Study of the Distribution of Extragalactic Sources Around the Quasar 1641+39 Within a Radius of 6 Degrees

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The quasar 1641+39 is a relatively nearby and fairly bright source. In the blue band, it has exhibited variability with a very large amplitude, changing between magnitudes 14.7 and 17.7. Variability is a common phenomenon for quasars; however, a variation of 3 magnitudes is a rather rare event. Taking this variability into account, spectral studies produce the following picture (Fig. 1). From Fig. 1 it can be seen that there is some variability even in the radio range. The spectral index is close to 0.4, which represents a fairly steep spectrum for quasars, although the variability does not allow the spectral index to be estimated accurately.

The quasar 1641+39 is a very active and highly compact source, while the spectral index suggests that it is embedded within a larger-scale radio source. In the region surrounding the quasar within a radius of 6 degrees, the number of quasars is 1973 which is relatively high, and the redshift histogram shows that the maximum number is concentrated in the range $z = 1.5-2$. A detailed study of the histogram makes it possible to conclude that this distribution pattern supports the idea that the quasars are distributed uniformly within the 6-degree-radius region. The relatively small number of detected quasars at low redshifts is due to the scarcity of nearby quasars, while at high redshifts the smaller number is mainly caused by the difficulty of detecting them.

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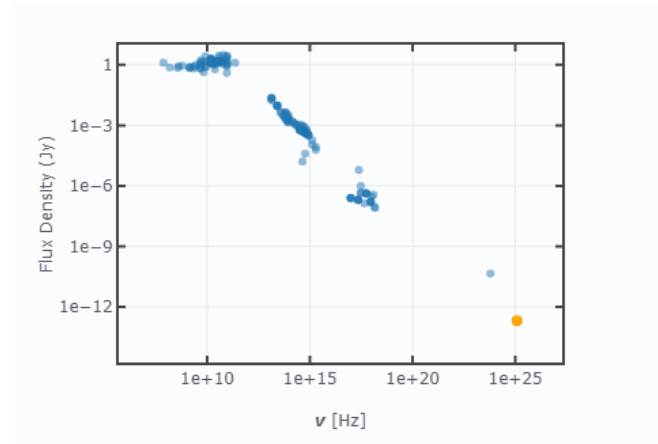


Fig. 1. Dependence of Flux Density on Frequency (log–log scale).

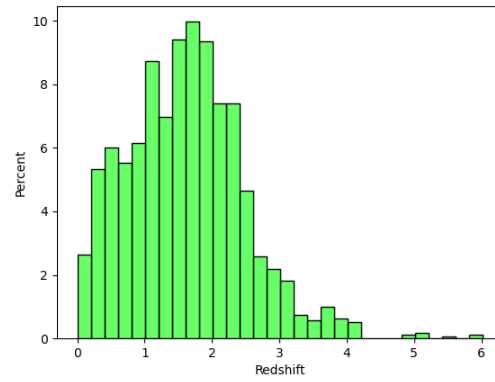


Fig. 2. Histogram of quasar distribution by redshifts in percentages.

Review of Current Dosimetric Methods Used for Skin Dose Estimation in Interventional Radiology

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Background:

Interventional radiology (IR) procedures involve significant localized radiation, which can cause deterministic skin effects. Precise estimation of the peak skin dose (PSD) is crucial for patient safety, dose optimization, and follow-up. However, directly measuring the PSD is challenging because of the dynamic beam geometry and patient variability.

Objective:

This review assesses the current dosimetric methodologies employed for estimating skin dose in interventional radiology, emphasizing their underlying principles, benefits, limitations, and clinical applicability.

Methods:

A narrative review of the contemporary literature and international guidelines was conducted, focusing on commonly used dosimetric approaches in fluoroscopically guided procedures. The methods were categorized into system-reported dose metrics, direct skin dosimetry, dose reconstruction techniques, and computational modeling.

Results:

Metrics displayed by fluoroscopy systems, particularly the cumulative air kerma at the interventional reference point (Ka,r) and the kerma-area product (KAP), are extensively utilized for real-time monitoring and ensuring adherence to regulatory standards. Although these indicators are practical, they only provide indirect estimates of the peak skin dose (PSD). Direct dosimetry methods, such as thermoluminescent dosimeters (TLDs), optically stimulated luminescence (OSL), metal-oxide semiconductor field-effect transistors (MOSFETs), and radiochromic films, provide enhanced local accuracy but are constrained by placement uncertainties and workflow restrictions. Advanced dose reconstruction techniques employing

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Radiation Dose Structured Reports (RDSR) and system geometry facilitate patient-specific skin dose mapping and yield more reliable PSD estimations. Monte Carlo-based simulations further improve accuracy; however, they are predominantly restricted to research environments due to their computational and operational complexity.

Conclusion:

The current practice in interventional radiology dosimetry is evolving from a dependence on surrogate console metrics to the adoption of integrated geometry-based dose-tracking systems. Although cumulative air kerma continues to serve as a practical screening tool, real-time skin dose mapping has emerged as the most promising method for precise peak skin dose estimation and prevention of radiation-induced skin injury. The ongoing incorporation of advanced modeling techniques into clinical workflows is anticipated to enhance patient dose management.

Molten Salt Fueled and Fast–Neutron Reactors (MSFR), Development and Demonstration

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Currently, there is no viable alternative to the operation of nuclear power plants in Armenia. It is essential to implement a facility designed with inherent safety and highly reliable protection systems, ensuring stable defense against nuclear events, accidental explosions, and seismic shocks. Small Modular Reactors (SMRs) offer a promising solution to these challenges.

SMRs are advanced nuclear reactors with a capacity of up to 300 MW per unit. They can be factory–assembled and transported to the site, offering a flexible solution for power generation. Within this framework, Molten Salt Fast Reactors (MSFRs) represent a prospective type of SMR. They combine the advantages of a fast neutron spectrum with liquid fuel, offering potential for enhanced inherent safety, superior fuel utilization, and a reduction in the volume of long–lived nuclear waste.

While characterized by high operational safety goals, advanced SMRs—including MSFR configurations—require comprehensive research regarding risk factors and operational cost optimization. A primary technological bottleneck in the MSFR fuel cycle is the requirement for high purity Lithium–7 to maintain a favorable neutron economy and minimize tritium generation. To address this chemical engineering barrier, an innovative technical approach is introduced to handle the complex problem of the Lithium–7 isotope.

Furthermore, to validate these advancements and comprehensively test all operational features under real–world conditions, the construction of a 40 MWe demonstration unit is suggested. This presentation addresses these issues and proposes concrete recommendations for their resolution.

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Radiation Induced Defect Dynamics and Functionalization in TiO₂ and CuO Nanostructures: Exploiting Oxygen Vacancies for Sensing in Harsh Radiation Environments

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Ionizing radiation exposure in outer space, nuclear reactor, and particle accelerators induces electronic defects leading to functional deterioration in standard semiconductor electronic components. Recent studies indicate that nanostructured metal oxide semiconductors, such as titanium dioxide (TiO₂) and copper oxide (CuO), may serve as reliable materials in such harsh environments due to their ability to engineer defect concentrations. This review highlights the physics behind radiation-induced defect creation mainly oxygen vacancies (V_O) in TiO₂ and CuO nanomaterials under exposure to X-rays and energetic electrons, and the impact of such defects on enhancing the material performance in radiation detection applications. Radiation induced defects cause significant variations in optical and photoelectric properties in TiO₂, creating shallow donor states and mid gap levels, affecting optical absorption, photoluminescence intensity, and electrical conductivity. The effect of the synthesis method, morphology, and surface chemistry on defect generation, migration, and annealing behavior are discussed. In addition, radiation induced changes in oxidation state and crystal lattice deformation in CuO result in pronounced conductivity variation, providing opportunities for radiation detection through electronic dosimetry approaches. Comparison of radiation effects in less stable metal oxide materials, such as ZrO₂, will be used to highlight radiation hardness strategies. Future outlooks include heterostructure development, in situ radiation experiments, and defect engineering methods to create adaptive materials for hostile conditions. The study offers a basic insight into the functionality of radiation defects in metal oxides nanoparticles, which aids in creating future sensing devices resistant to radiation.

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Inverter–Free Solar Charging

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This project proposes an innovative direct DC–to–DC charging system for electric vehicles that eliminates the need for traditional inverters and complex power converters. The system achieves the required charging voltage by using a dynamic switching mechanism that adjusts the number of solar panels connected in series based on real–time solar intensity. By bypassing multiple energy conversion stages and simplifying the electrical path, this approach significantly increases overall energy efficiency and reduces hardware costs. The project also includes several other innovative approaches aimed at further improving the system’s efficiency.

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Remote Control Ball

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This work introduces a remotely controlled ball designed for movement on various surfaces. This mechanical version of the device utilizes an integrated microcontroller and a wireless control system via Bluetooth or Wi-Fi. A specialized control algorithm has been developed to maintain balance and ensure smooth directional changes. While experimental results demonstrate the current system's efficiency, development is also underway for advanced hydraulic and magnetic versions of the platform. The device is designed for education, research, entertainment, and the advancement of small-scale robotics.

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Investigation of Cristal Imperfections with Multiple Four–Crystal X–ray Interferometers

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A double four–crystal X–ray interferometer has been developed and tested, and moiré patterns have been obtained with it. On the basis of this interferometer, a new method for studying imperfections in crystalline materials has been proposed. It is shown that double X–ray interferometers make it possible to describe more completely the stress field in crystals caused by defects and to reveal fine structures of interference patterns that represent images of these defects. It has been experimentally demonstrated that moiré topographic patterns obtained using a double X–ray interferometer depend on the orientation of the reflecting planes relative to the defect (dislocation). It is shown that multiple X–ray interferometers make it possible to simultaneously observe images of various structural imperfections. A new method of stereometric topography has been proposed for the purpose of detecting defects in single crystals.

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Application of Dispersion Relations to the Problem of Calculating the Radiation Field of a Particle Moving Along a Helical Trajectory in a Multilayer Cylindrical Waveguide

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A new approach to solving the problem of the radiation field of a particle moving along a helical trajectory in a cylindrical waveguide with a multilayer wall is proposed. The solution for forced electromagnetic oscillations (caused by charges and currents generated by the particle's motion) in the waveguide's interior is represented as a superposition of elementary solutions of inhomogeneous Helmholtz equations containing uncertain transverse eigenvalues. The latter are determined from the dispersion relations for the same elementary inhomogeneous modes of the multilayer waveguide. As a result, frequency distributions of the expansion weight coefficients for an arbitrary mode are determined, each characterized by pronounced resonances describing forward and backward radiation, respectively.

One advantage of the resulting solution is the ability to fill the waveguide's interior with an arbitrary dispersive medium (e.g., plasma), which may expand the scope of application of the structure. Another advantage is the visual form of the solution, which represents the direct transformation of the charge's own field under the influence of the multilayer structure surrounding the charge's trajectory.

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Investigation of Smith–Purcell Radiation from High–Energy Electrons in both Air and a Dielectric Medium

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Smith–Purcell radiation, emitted when a charged particle passes near a periodic metallic structure [1, 2] has attracted attention in past few decades. It offers particular promise for beam parameter reconstruction, including bunch length and transverse profile. On the other hand it is a source of monochromatic radiation that can be used for in various areas of material science. However, the practical application of Smith–Purcell radiation has traditionally been limited by the fabricating precision periodic targets.

In this work, we experimentally demonstrate the generation of Smith–Purcell radiation from high–energy electrons using two types of targets. First, measurements were performed with a freestanding metallic grating (the air–backed geometry) to establish a baseline for Smith–Purcell radiation. Second, we employed a 3D–printed dielectric lens equipped with the metallic strips to provide the necessary periodic boundary conditions (the dielectric–backed geometry). The measurements were carried out using a high–energy electron beam of the MT-25 microtron

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(Dubna, Russia), and the emitted radiation from both configurations was characterized in terms of its spectral and angular properties.

A study of the effect's properties revealed that the Smith-Purcell radiation peaks of the first order are detected at angles that shift toward larger values with increasing frequency. As the Smith-Purcell radiation frequency increases, a narrowing of the amplitude distributions at half-maximum is observed, while a decrease in the area and amplitude of the detected peaks is observed. The measured Smith–Purcell radiation observation angles agree with theoretical predictions within an 1° accuracy.

We thank FLAP Collaboration for in-kind contribution and discussing the results.

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Coherent Cherenkov Diffraction Radiation as a Source of Circularly Polarized THz Radiation

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In recent years, interest has grown in the study of chiral biological objects composed of helical components with a predominant right-handed (or left-handed) twist. These studies rely on circularly polarized (CP) radiation, typically available in the optical range (via lasers) or X-ray range (via undulators). Despite the widespread use of THz radiation in medicine and biology, the problem of creating a source of circularly polarized radiation in this range remains unresolved.

In this work, we propose and theoretically analyze Cherenkov diffraction radiation (ChDR) as a novel mechanism for generating CP THz beams. The process involves a short electron bunch (energy ~ 20 MeV, duration ~ 1 ps) traveling in vacuum along the face of a prismatic dielectric radiator. The prism apex angle is optimized to minimize losses during radiation extraction from the dielectric into vacuum. Polarization characteristics, calculated using the polarization current model, show a high degree of circular polarization for radiation emitted outside the plane of symmetry perpendicular to the prism face along which the electrons travel. Angular selection of the ChDR makes it possible to achieve 90% circular polarization in the range of 0.1–0.5 THz.

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Neutron Generation and Thermal Analysis of Thin–Film Lithiumbased Targets Under Pulsed Proton Beam Irradiation

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This work presents the results of numerical simulations of neutron generation via the ${}^7\text{Li}(p,n){}^7\text{Be}$ reaction in thin–film lithium–based targets irradiated by a pulsed proton beam, as well as an analysis of the evolution of the temperature field within the target material. The effects of beam parameters such as pulse duration, current magnitude, pulse repetition frequency, and the magnitude and shape of the accelerating voltage on the energy spectrum and angular spectrum of the emitted neutron flux are investigated. The thickness of the neutron–generating layer is optimized taking into account the beam energy spectrum. The calculations are carried out for targets made of metallic lithium (Li), lithium fluoride (LiF), and lithium oxide (Li₂O), including those with a sealing protective titanium coating. The spatial distribution of energy deposition and the dynamics of the temperature field are simulated taking into account the thermophysical properties of the materials for various pulsed proton beam parameters. It is shown that the energy deposition profiles differ significantly for different neutron–generating layers, which imposes constraints on the achievable neutron flux parameters. The obtained results provide quantitative recommendations for the selection of pulsed proton beam parameters and the design of target configurations for the development of a high–intensity pulsed neutron source.

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Analysis of Electron Beam Images on the Glass Plates for the Beam Transverse Profiles

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This study investigates the combination of glass plate irradiation and digital processing of electron beam images to improve the characterization of electron beam transverse profiles and absorbed doses distribution in irradiation experiments. The proposed approach deals with limitations of traditional techniques, namely the absence of real time feedback and insufficient spatial resolution. By integrating glass plate irradiation with advanced digital processing methods, this technique enables high resolution mapping of dose distribution and provides precise and controlled irradiation for improved processing of matter.

This research explores the integration of glass plate irradiation and electron beam image digital processing to enhance the characterization of electron beam profiles and absorbed dose transverse distribution in materials and biological tissues irradiation experiments.

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About a New Method and Device for Continuous Visible Recording of Low-Frequency Signals with Electronic Digital Step Sweeping

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The quasar 0827+24 is located more than 30° above the plane of the Galaxy. Radiation coming from its surroundings is only weakly absorbed by the Galaxy, and therefore the reliability of the obtained observational data is fairly high. Spectral studies of the quasar show that:

1. In the radio range, the spectrum is extremely flat ($\alpha \approx 0$, $F \sim \nu\alpha$), which supports the idea that quasar 0827+24 is relatively young, a characteristic typical of quasars.
2. At frequencies higher than the radio range, the spectrum declines more rapidly, which can be explained by the fact that the quasar loses its energy faster at high frequencies.

The histogram of quasar distribution shows that the maximum number of quasars is found around $z \approx 1.5$. This is natural, since detecting more distant quasars is more difficult, while the actual number of nearby quasars is smaller. The histogram also indicates that in the interval $z = 2.4-3$, the number of quasars is lower than in the interval $z = 3-3.4$. Around $z = 2-3$, a deficit in the number of quasars is observed everywhere, making it more likely that we are indeed dealing with a smaller population of quasars in this range.

The histogram of quasar 0827+24 alone is not sufficient to guarantee the reliability of the obtained result; however, comparison with other objects makes this result more convincing.

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The Spectral Line Shape of Stimulated Radiation Generated in an Optical Klystron at Zero Angle and the Corresponding Number of Radiated Photons

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When an electron bunch interacts with spontaneously radiated photons, the number of these photons increases due to stimulated radiation, which is associated with a violation of detailed balance. Since the gain coefficient is proportional to the derivative of the spontaneous radiation line shape, it increases with the optical klystron parameter (the distance between the undulators), as the spontaneous radiation spectrum becomes narrower due to interference of radiation fields generated in the individual undulators. However, an optimal value of this parameter exists.

Using the expression for the spontaneous emission line shape, a gain coefficient for stimulated radiation, $g(\mathbf{z}, \mathbf{s})$, per unit propagation length of the electron bunch is derived. Naturally, this coefficient depends both on the radiation frequency and on the optical klystron parameter.

An analytical expression for the gain coefficient is obtained, which exhibits a power-law dependence on $1 + g(\mathbf{z}, \mathbf{s})$, with the exponent given by the undulator length l . The peak frequency of the stimulated radiation spectrum is determined, and the spectral line shape is found to be asymmetric: it varies more rapidly in the low-frequency (soft) region than in the high-frequency (hard) region.

An expression for the number of stimulated photons is derived. The case where the optical klystron and electron bunch parameters match those used in XFEL process is considered. It is shown that a significant enhancement occurs in the water-window spectral region, which is important for practical applications.

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Radiation Technologies and Behavior Management

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The aim of this research is to study the importance of the interconnection between Radiation Technologies and Behavior Management, that intersects particularly within specialized settings, focusing on optimizing safety, ensuring staff compliance with radiation protection standards, and improving outcomes. Key approaches include the application of behavioral models to enhance radiation protection compliance, the integration of technology-driven simulation for training purposes, and the use of interventions to manage anxiety and movement.

The study revealed that the intersection of technology and behavior is based on cooperation and anxiety reduction to ensure precision. The investigation revealed the key crosspoints and techniques which are Behavioral Safety Models (ALARA), Theory of Planned Behavior (TPB), Behavior Management in Radiation Therapy, Incident Learning Systems, Advanced Imaging and Communication, Social Cognitive Theory.

The safety, security and proportionality of theoretical models such as the Belief Model (BM), the Social Cognitive Theory (SCT), the Haddon Matrix (human, material and environment) are under analysis. Tools for Radiology Behavioral Management are identified, studied and presented as followings: Psychometric Screening Tools; Communication Frameworks; SPIKES; NURSE for naming, understanding, respecting, supporting, exploring; ADAPT for discussing prognosis and expectations; Digital Intervention Technology (BIT) Models, Play-based Appointments. The Technology-Driven Behavioral Tools such as Technology Acceptance Model (TAM), and Biofeedback and AR are also study targets.

As radiation requires high precision and is needed to stay perfectly still without physical distress, and to manage the behavior of involuntary movements and psychological the specially developed guidelines should be in use. Virtual and Augmented reality (VR/AR) environments are used to practice the sounds and sights of the equipments before the actual session, significantly reducing the need for sedation. Key drivers for Behavior Change-Management include training and education, safety culture and leadership, client education.

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Experimental Imaging of Fine Structures in Macroscopic Objects Using Monocapillary X-ray Optics

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Advanced imaging techniques have attracted growing interest in recent decades in fields ranging from medicine to materials science. Their continuous development is driven by increasing demands for higher sensitivity, improved contrast, and better spatial resolution. The highest performance is often achieved using methods optimized for detecting specific structures or elements in well-characterized matrices based on prior information about the investigated object.

Polycapillary X-ray optics are widely used in applied imaging to increase the photon flux transmitted through a sample, suppress scattered radiation, and modify the spectral composition of the probing beam. Because the diameters of individual capillaries are much smaller than detector pixel sizes, the recorded signal represents an average over many capillaries within each pixel. In contrast, monocapillary X-ray optics consisting of larger individual capillaries can provide spatial variations of the X-ray signal corresponding to different regions of the sample. However, the relatively large capillary diameters restrict efficient X-ray channeling to energies of only a few keV, complicating experiments under atmospheric conditions with conventional laboratory X-ray sources.

In this work, experimental imaging of a gold grid with a filament thickness of 20 μm and a period of 100 μm was performed using a laboratory X-ray source combined with a monocapillary lens. The results demonstrate enhanced contrast near capillary boundaries that is explained by small-angle X-ray scattering effects in such structures.

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X-ray Diffraction Study of Deformation Fields Induced by Temperature Gradient in Single Crystals

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As is known, the correct choice of the deviation function is very important in order to obtain a certain intensity, spectral and spatial distribution in the diffracted beams formed as a result of X-ray diffraction in deformed crystals. To describe the deviation function, it is sufficient to provide the dependence of the bending radius and interplanar distances of the reflecting atomic planes on the coordinate.

In this paper, the deviation function of the deformation field in a crystal caused by an external temperature gradient was investigated using the narrow collimated polychromatic beam X-ray diffraction method.

A rectangular parallelepiped plate made of an X-cut quartz single crystal was used one of the edges (heated) of which was parallel to the reflecting planes ($10\bar{1}0$). To determine the deformation field formed in the sample at different temperature distributions, topograms of the cross-section of the beam reflected from $(10\bar{1}0)$ reflecting atomic planes in Laue diffraction geometry at different distances from the sample were recorded using a coordinate detector with a resolution of 55 μm . To provide different temperature distributions in a crystal, a special device was prepared, allowing to move the thin heating spiral, parallel to the lateral surface of the sample.

As a result, the average values of the bending radius and interplanar distance of the reflecting atomic planes in the direction of beam propagation in the single crystal were determined for different positions of the heater. It was shown that the spectral width of the reflected beam and the spatial distribution of the spectrum in the beam strongly depend on the position of the heater.

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Features of Spectral–Angular Distribution of Radiation by a Train of Electron Bunches Passing Through the Center of a Conductive Ball

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The spectral and angular distributions of radiation generated by a rectilinearly and uniformly moving charged particle, or a train of bunches of charged particles, is studied. It is assumed that the particle bunches pass through the center of a ball made of conductive composite material. This work is based on the exact analytic solutions of Maxwell's equations. A generalized Drude–Lorentz–Sommerfeld formula is used for the dielectric function of the ball material in the numerical analysis. Peaks in the emission spectrum of particles at certain 'resonant frequencies' with wavelengths of approximately the ball's radius are shown to be possible. This effect occurs as a result of the constructive superposition of electromagnetic field oscillations generated by a charged particle at the ball's surface, which is accompanied by intense radiation. These peaks disappear if the ball is replaced by a plane–parallel plate made of the same material with a thickness equal to the ball's diameter.

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Using Catastrophe Theory in Experimental Research

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The article discusses the use of catastrophe theory for:

1. Determining the number of independent (control) parameters required in a given experiment
2. Determining singular points at which phase transitions are possible
3. Determining the type of phase transition
4. Providing a qualitative description of nonlinear processes containing third and fourth degree derivatives.

A method for constructing equations of catastrophe from experimental curves is presented.

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Control of Modulational Instability During Thin Film Deposition Using an Acoustoplasma Magnetron

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Acoustoplasma magnetrons (APMs) represent a unique class of devices designed for the precision control of plasma processes. Unlike classical systems, APMs combine the properties of magnetron and glow discharges, allowing them to be utilized across a wide spectrum of applications. One of the most promising areas for APM application is the deposition of thin films.

A distinctive feature of the APM is the ability to control the influence of modulational instability. By adjusting discharge parameters—such as buffer gas pressure, current, voltage, and system geometry—it is possible to modify the perturbation spectrum and the degree of its amplification. This allows for either the suppression of modulational instability to achieve maximum coating uniformity or, conversely, its utilization for the formation of structured materials, specifically porous and gradient structures.

This capability transforms the APM into a technological tool that enables the management of material properties at the micro– and nano–levels. The ability to perform deposition and selective etching processes within a single technological cycle facilitates the production of smooth and dense films, making this methodology indispensable for creating components in modern micro– and optoelectronics.

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Optical Phase Detection in Microwave Light Rangefinder

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In the process of adjusting and setting up optical telescopes and short-wave radio antennas, when checking the straightness of the axes of large-sized hollow cylindrical products, as well as in large-scale mechanical engineering and aircraft engineering, it is necessary to measure broken lines in arbitrary planes. For this purpose, a light rangefinder and a reflector are installed, as in conventional measurements, at the beginning and end of the lines, and at the points of its break, rotary deflecting mirrors are installed. On broken lines, the operation of the compensatory light rangefinder is disrupted. In this regard, it is proposed to use amplitude-modulated light, the phase detection of which is carried out by the reference optical channel. Moreover, phase detection is carried out independently of the processes occurring in the cathode chamber of the photoelectron multiplier.

It has been shown that when the voltage on the light modulator crystal is sharply reduced, and the light modulation characteristic becomes linear, the position of the minima of the observed signal becomes sharply narrowed, which makes it possible to build high-precision light rangefinders for measuring broken lines.

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Comparative Analysis of Symmetric and Asymmetric X-ray Reflection in Quartz Single Crystals under a Temperature Gradient

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In the present work, the results of an experimental investigation and comparative analysis of symmetric and asymmetric reflection of X-ray radiation in quartz single crystals (X-cut) in Laue geometry under the presence of a temperature gradient are presented. The temperature gradient was created perpendicular to the crystal surface normal and, in the symmetric and asymmetric cases, respectively, along the normal and at the asymmetry angle relative to the reflecting atomic planes, and was controlled within specified limits. The investigations were carried out for symmetric and asymmetric reflections (asymmetry angle $\varphi = 47^\circ$) from the $(10\bar{1}1)$ planes of quartz crystals with a thickness of 1.5 mm.

Diffraction topograms were recorded at three different distances from the crystal, which made it possible to trace the evolution of the spatial intensity distribution of the reflected beam and to determine the focal distances for symmetric and asymmetric reflections at different values of the temperature gradient.

The experimental results demonstrated that, with increasing temperature gradient, the intensity of the reflected X-ray beam increases significantly, while the focal point shifts closer to the crystal.

It is shown that the focal distance depends both on the diffraction geometry and on the magnitude of the temperature gradient.

Comparative analysis revealed that, under identical temperature-gradient conditions, the focal distance of the X-ray radiation in the case of symmetric reflection is smaller than that in the asymmetric reflection geometry.

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Comparative Analysis of Potential Energy Surfaces of Systems $\text{C}_2\text{H}_4 + \text{HO}_2$ and $\text{C}_2\text{H}_4 + \text{CH}_3\text{O}_2$

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HO_2 radicals play a key role in atmospheric chemistry and chain reactions of oxidation and combustion. A comparative analysis of the main reaction pathways of interaction in the reaction systems $\text{C}_2\text{H}_4 + \text{HO}_2$ and $\text{C}_2\text{H}_4 + \text{CH}_3\text{O}_2$ was performed using quantum chemical calculations.

The energy parameters for the aforementioned reactions were defined, the reactants, products, intermediates, and transition states were identified, and the activation energies (E_a) and enthalpies (ΔH) of these reactions were calculated. The results of studies conducted using the hybrid M062X/6–31+G(d,p) method of density functional theory indicate that similar reactions in both systems have approximately equal E_a and ΔH . However, reactions leading to the formation of peroxide radicals $\text{C}_2\text{H}_5\text{O}_2$ and $\text{C}_3\text{H}_7\text{O}_2$ have different values for E_a – 9.2 and 40.5 kcal/mol, respectively. The differences in activation energies for these reactions can be explained by the fact that different types of bonds with different energies are involved in the breaking and forming processes. The O–C bond in the methylperoxyl radical is slightly stronger than the O–H bond in the hydroperoxyl radical.

The subsequent reaction pathways of the adducts $\text{RC}_2\text{H}_4\text{O}_2$ and $\text{C}_2\text{H}_4\text{O}_2\text{R}$ were also studied. In both systems, the energetic pathways for the formation of such practically significant products as acetaldehyde CH_3CHO and ethylene oxide $\text{C}_2\text{H}_4\text{O}$ were determined.

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The Study of L–Arginine Dichloride Crystal

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The subject of the present study is L–arginine dichloride (L–Arg·2HCl) crystal. The thermal properties, vibrational spectra and second harmonic generation activity were studied. The crystal and molecular structure of L–Arg·2HCl crystal was determined by the single–crystal X–ray diffraction method at 295K. This crystallize in the monoclinic (P21) system. Unit cell parameters: $a=7.4907(15)$ Å, $b=20.092(4)$ Å, $c=12.101(2)$ Å, $\alpha=\gamma=90^\circ$, $\beta=99.35(3)^\circ$, $Z=6$, $D_c=1.370$ g/cm³, $V=1797.0(6)$ Å³. The asymmetric part of the unit cell of L–Arg·2HCl contains crystallographically independent three L–argininium (2+) cations and six Cl[–] anions (3L–Arg²⁺·6Cl[–]). The layers of arginine cations are formed in the bc plane, and these layers are connected through Cl[–] anions, forming strong hydrogen bonds. In [1] were divided the interactions of the guanidyl group with carboxylate and phosphate anions into four types, and only one of the 25 studied compounds were encountered a Type D interaction. In the L–Arg·2HCl structure, the interaction between the anion and the guanidyl group is very similar to the Type D. The bulk crystals were grown. They exhibit nonlinear optical properties.

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Radiation–Hardened Materials for Electronics and Sensing: A Review of Hybrid Coordination Systems and Metal–Oxide Nanostructures

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As a result of growing radiation risks in spacecraft, nuclear installations, and high–energy physics experiments, there is an ever–growing need for radiation–tolerant functional materials for electronic and sensing devices. Traditional silicon electronics degrade upon prolonged exposure to ionizing radiation due to accumulation of defects and carrier trapping. Hence, alternative approaches for radiation–tolerant devices are urgently sought. In this review, recent progress in the development of radiation–resistant materials specifically metal–organic frameworks (MOFs), hybrid coordination polymers (HCPs), and wide–bandgap metal–oxide nanostructures is critically assessed. The structural evolution, coordination bond stability, and radiation–induced defect formation pathways in MOFs and HCPs are analyzed, with particular attention to radiolytic linker degradation, metal–node integrity, and the emergence of functional defect centers. For wide–bandgap metal oxides, including TiO₂, CuO, and ZrO₂, the mechanisms governing oxygen vacancy formation under ionizing radiation, phase transformation behavior, and dose–dependent electronic structure modulation are examined in depth. The role of material architecture dimensionality, interface density, and hybrid coordination networks in determining radiation tolerance and defect self–healing capacity is systematically discussed. Potential applications of these material platforms in radiation–tolerant electronics, optical dosimetry, and next–generation sensing devices are evaluated, along with their comparative advantages over conventional silicon–based technologies. Current challenges in long–term radiation stability, defect engineering precision, and device integration scalability are outlined, and future research directions including AI–guided materials discovery and hybrid MOF–oxide architectures are proposed. This review underscores the strategic importance of coordination chemistry and defect engineering paradigms in building the next generation of radiation–hardened functional systems.

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Energy Assignment in Stacked–Foil Activation Experiments for Proton–Induced Reactions on Enriched Tin Isotopes

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The present study focuses on the experimental determination of excitation functions for proton–induced nuclear reactions on enriched tin isotopes up to 18 MeV. These data are important for the development of production routes for medically relevant radionuclides and for the validation of nuclear reaction models. Irradiations were performed at the Yerevan Radioisotope Production Center using the IBA Cyclone 18/18 cyclotron and the stacked–foil activation technique. The produced radionuclides were identified and quantified by high–resolution γ –ray spectrometry, and reaction cross sections were determined from the measured activities.

Particular attention was devoted to the determination of proton energies in individual foils. Due to continuous energy degradation within the stack, measured cross sections correspond to energy–averaged quantities. Proton transport and energy–loss processes were simulated using the SRIM and PHITS codes to obtain proton energy distributions and to calculate mean and effective energies for each foil. The calculated energies were verified using well–established copper monitor reactions and the recommended IAEA monitor cross–section data.

Good agreement between calculated and experimentally derived energies confirmed the reliability of the methodology and allowed the actual proton beam energy to be estimated at approximately 18.1 MeV. Excitation functions for several reactions on enriched tin isotopes were measured and compared with available experimental data and theoretical calculations. While satisfactory agreement was observed for some reaction channels, significant discrepancies were found for reactions involving complex particle emission.

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On Noninvasive Information Extraction from Objects with Variable Entropy

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We have recently demonstrated both theoretically and experimentally [1,2] that the quantum vacuum, in the limit of statistical equilibrium in three-dimensional space, forms an energy lattice composed of massless spin-1 Bose particles, which we call hions. Our extensive experimental studies have shown that material objects, particularly those undergoing continuous active processes (such as biological tissues), create inhomogeneities in the spin distribution of hions in the surrounding 3D space. This region is referred to as a quantum halo. These spin inhomogeneities measurably alter the refractive index of the vacuum near the object. It has been experimentally proven that even small biological tissues, at a distance of 3–4 centimeters, can change the vacuum's refractive index sufficiently to be detected. A low-power laser beam (410 nm wavelength, 5 mW) passing through this region, after undergoing Fraunhofer diffraction through a slit, shows clear changes in the diffraction pattern. These changes are reliably registered by measuring light intensity with CCD matrices in different diffraction zones. A similar effect has also been observed with remote exposure to various liquids. With appropriate statistical analysis, this effect can serve as a reliable, non-invasive method for obtaining comprehensive information about the entropy of the studied objects. This approach is particularly promising for real-time (online) biomedical analysis and diagnostics.

This novel technique opens new possibilities for non-invasive, real-time monitoring of living biological systems, potentially enabling early detection of pathological changes through alterations in tissue entropy without direct contact or sample preparation.

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Non–Destructive Testing of Concrete Structures: From Theory to Practice

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Traditional methods for inspecting reinforced concrete elements often require partial destruction of the material or opening up the structure. In this regard, non–destructive testing methods are becoming increasingly widespread, as they allow the internal condition of a structure to be assessed without compromising its integrity.

The application of X–ray and neutron tomography for non–destructive evaluation of concrete and reinforced concrete structures has been studied.

It is shown that the exponential attenuation model of radiation, described by the Bouguer–Lambert–Beer law, enables quantitative assessment of the material condition and the detection of internal defects such as voids, cracks, cavities, damage to the reinforcement protective layer, and zones of increased moisture.

Linear attenuation coefficients for the main components of concrete mixtures are presented, and their application in the interpretation of tomographic images is discussed. The combined use of X–ray and neutron methods provides a comprehensive analysis of structural condition, taking into account both density and moisture content of the material. This makes it possible to carry out reliable engineering assessments without destroying concrete elements.

The practical significance of the work lies in the ability to plan the repair and strengthening of structures, as well as to justify engineering decisions aimed at improving durability and load–bearing capacity.

The results can be used to develop effective inspection methods, assess technical condition, and predict the service life of construction facilities.

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Comparative Analysis of Neural Surrogate Architectures for Acoustic Wave Propagation in Heterogeneous Media

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The study presents a comparative analysis of three scientific machine learning architectures, Physics-Informed Neural Networks (PINNs), Fourier Neural Operators (FNO), and Deep Operator Networks (DeepONet), applied as surrogate models for acoustic wave propagation in heterogeneous media. Traditional numerical solvers such as FDTD and FEM are computationally prohibitive in multi-query scenarios, and neural surrogates have demonstrated orders-of-magnitude inference speedup. However, the three architectures encode wave physics through fundamentally different mechanisms, resulting in distinct performance characteristics that have not been systematically compared.

The analysis evaluates reported results across problem categories of increasing complexity (homogeneous and layered media, heterogeneous velocity fields, and scattering-dominated domains) and compares the architectures on prediction accuracy, computational cost, data efficiency, noise robustness, and frequency-dependent performance. The spectral bias problem, the systematic underrepresentation of high-frequency wave content, is examined as the principal shared limitation, with each architecture offering partial mitigation through its structural properties: PDE-constrained optimization in PINNs, spectral convolution in FNO, and branch-trunk decomposition in DeepONet.

The analysis demonstrates that the three architectures occupy complementary niches: PINNs for inverse problems and data-scarce settings, FNO for high-throughput forward simulation on regular domains, and DeepONet for geometrically flexible and noise-tolerant applications. Current gaps, specifically the absence of standardized acoustic benchmarks and the neglect of uncertainty quantification, are identified as priorities for advancing the field.

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Investigation of Interaction of Various Types of Bentonite with Radioactive Materials

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In this paper the bentonite interaction with radioactive materials has been studied: particularly, as a natural enterosorbent for radioactive waste; characteristics and radiation absorption; effectiveness lied in cation exchange capacity.

Bentonite clay is scientifically proven to bind to and remove certain radioactive isotopes from the body and the environment. The bentonite carries a negative charge that attracts and binds positively charged radioactive particles, which are then excreted. But it does not absorb radiation like a sponge soaking. In this research 30 articles are filtered among 280 published scientific articles to focus on relevant, high-quality studies on the effects of bentonite.

Studies have shown that bentonite is highly effective at removing isotopes like Cesium-137 (Cs-137), Uranium and Thorium from liquids. Bentonite is highly effective as a physical barrier to block external radiation. It is often used in nuclear waste management as a self-sealing backfill for storage tanks and has been found to be more effective than other clays at attenuating gamma rays. Bentonite is a negatively charged clay mineral that attracts positive ions, allowing it to bind to radioactive elements such as Uranium, and Strontium, and it can bind and remove up to 98% of Cs-137 from contaminated wastewater. In environmental and industrial cases, it is used to treat radioactive wastewater. Bentonite can also act as an enterosorbent, binding to toxins and heavy metals in the digestive tract to prevent them from being absorbed into the bloodstream. On the skin or as a physical barrier, bentonite can provide a level of shielding against low-energy gamma radiation. It has also been used in experimental sunscreens to absorb UV light. Bentonite removes the physical radioactive particles that emit radiation; it cannot undo the damage already caused by the radiation itself at the cellular level. While its ability to bind toxins is documented in animal studies, clinical research on its effectiveness for radiation detoxification in humans is still limited.

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Cherenkov Diffraction Radiation: Theory and Key Experimental Results from Tomsk Polytechnic University

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Cherenkov radiation across different spectral ranges is now an important tool for investigations in experimental radiation physics, charged particle beam diagnostics, nuclear energy and astrophysics. Since the early 2000s, renewed interest in this phenomenon has emerged, driven by advances in metamaterials and photonic crystals – artificial structures with tailored, nontrivial electromagnetic properties that enable substantial modification of radiation characteristics.

This report presents a theoretical and experimental study of a specific mechanism – Cherenkov diffraction radiation (ChDR) – conducted at Tomsk Polytechnic University over the past two decades. The research focuses on radiation arising when a moderately relativistic charged particle flies near a finite-sized dielectric radiator, under the condition that the distance between the particle's trajectory and the radiator is comparable to the effective radius of the Coulomb field of the passing charge. The physical mechanism is based on dynamic polarization of the electron shells of the radiator's atoms induced by the charge's field.

We investigated ChDR process in GHz and sub-THz range using 6.1 MeV electron beam of the TPU microtron, but the developed theoretical model allows modelling of ChDR characteristics with photon energies down to soft X-rays.

The work demonstrates practical applications of Cherenkov diffraction radiation for non-perturbing diagnostics of charged particle beams at modern accelerators and for generation of quasi-monochromatic radiation in the GHz and THz frequency ranges.

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Discussion of the Technical Requirements for X–ray Detectors Used to Register Faint Objects in Universe

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As a result of the study of a number of galaxies, quasars and extragalactic sources around them, the need to record weaker energies arises, especially for observing their spectral lines. This is necessary for observing distant objects and estimating their distances. Determining the distances of objects using redshifts becomes important, which in turn is possible only in the X–ray range. The problem is that in the X–ray range, in the range of redshift values of 1–10, no other type of telescope is required.

In this regard, we have set a task to study the possibility of increasing the angular and energy sensitivity of sensors of telescopes operating in the X–ray range by studying possible new methods for creating more sensitive sensors.

The main goal of this work is to define such technical requirements for X–ray telescopes that will allow observing faint objects in the distant universe that are invisible to current telescopes.

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On the Possibility of Synchronizing of Multiple Wave Sources by Forming a Diffraction Pattern with Principal Maxima for their Jointly Generated Field

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We investigate a field-mediated mechanism for synchronizing multiple wave sources based on the formation of their joint diffraction pattern during the scattering of fields generated by individual sources by a single system of secondary sources. In a scalar formulation, we consider an ensemble of primary emitters, each of which experiences field scattering in the principal maxima mode: the source geometry is chosen such that each is located in the region of the maximum of the diffracted field generated by the others. We discuss the need to analyze the phase relationships between field oscillations in the regions of the maxima and source oscillations, as well as so-called source-synchronized return maxima (i.e., maxima arising in the region of the sources themselves). We demonstrate that the realization of a joint diffraction pattern with return-synchronized maxima leads to the emergence of a synchronization effect between the primary and secondary field sources.

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Repetitive Patient Exposure in Medical Imaging: Cumulative Dose, Risk, and Optimization Strategies

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Background: Repetitive patient exposure from CT, fluoroscopy, and interventional imaging is rising globally. Cumulative doses in heavily imaged cohorts can exceed 100 mSv (PET/CT mean ~79 mSv, range 6–399 mSv), raising stochastic cancer concerns despite clear diagnostic benefit.

Objective: To synthesise current evidence on cumulative patient exposure and integrate the authors' multi-year dosimetric programme covering CT, CT angiography, paediatric imaging, and interventional procedures

Methods: Structured narrative review of CT DIvol, DLP, KAP, organ doses, in Saudi Arabia, benchmarked against international recommendations.

Results: CT angiography delivered effective doses of 5.0–16.5 mSv with LAR cancer risk of 0.02–0.08 % per scan. Paediatric CT in Sudan showed 3–5-fold inter-centre CT DIvol variability, several protocols exceeding international reference levels. Cath-lab patients received mean KAP of 26,052 mGy·cm². Hysterosalpingography and cystourethrography optimisation reduced patient dose by up to 40; iterative reconstruction reduced CT dose by 30–60 % without diagnostic loss. Digital dose registries reduced repeat imaging rates by 15–25%.

Conclusion: Although per-examination doses lie within international ranges, substantial inter-centre variability and elevated cumulative doses persist in heavily imaged subgroups. Patient-centred imaging-personalised pathways, dose registries, AI decision support, and harmonised regional DRLs is needed to maintain ALARA while preserving diagnostic efficacy.

Keywords: cumulative radiation dose; computed tomography; interventional radiology; paediatric imaging; iterative reconstruction; diagnostic reference levels.

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Occupational Radiation Exposure in Medical Imaging and Industry: Current Challenges, Dosimetry Advances and Risk Optimization

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Background: Occupational radiation exposure remains a significant concern across diagnostic and interventional medical imaging, nuclear medicine, radiotherapy, and industrial applications of ionising radiation. Despite technological advances and tightened regulatory frameworks, radiation workers continue to accrue cumulative doses that may translate into stochastic and, less commonly, deterministic health effects, with substantial inter-individual and inter-institutional variability indicating that current protection programmes are not yet uniformly optimized

Methods: occupational dose metrics Hp(10), Hp(0.07), and/or Hp(3), eye-lens and extremity doses, were measured using TLD-100 thermoluminescent and Al₂O₃:C optically stimulated luminescence (OSL) dosimeters cross-calibrated against secondary standards. Findings were appraised narratively against the 20 mSv·y⁻¹ whole-body and 20 mSv·y⁻¹ eye-lens limits.

Results: In a tertiary interventional radiology department, mean annual personal dose equivalents measured by TLD-100 were Hp(10) = 4.6 ± 7.0 mSv and Hp(0.07) = 5.1 ± 7.3 mSv (range 0.1–25.5 mSv), with 16 % of staff exceeding the 20 mSv annual limit. In cardiac catheterization laboratories, OSL-measured personal dose equivalents averaged 1.11 ± 0.21 mSv for cardiologists, 0.84 ± 0.11 mSv for nurses, and 0.68 ± 0.014 mSv for radiographers. Nuclear medicine and PET/CT department personnel mean annual whole-body doses of 0.72, 0.94, 0.51 and 0.16 mSv for technologists, nurses, medical physicists and NM physicians, respectively, all below international limits but with nurses identified as the priority group for further optimisation

Conclusion: Average occupational doses in well-resourced centres lie below international limits, but a small yet clinically important fraction of staff particularly in interventional radiology and cardiology continues to exceed the 20 mSv·y⁻¹ threshold, while nurses in nuclear medicine emerge as a consistent priority group.

Keywords: occupational radiation exposure; personal dosimetry; thermoluminescent dosimeters; optically stimulated luminescence; interventional radiology; nuclear medicine.

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