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Development of the low-energy nuclear physics in Russia and project of the Universal Compton Radiation Source

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Development of the low-energy nuclear physics in Russia is discussed with special emphasis on the project of the Universal Compton Radiation Source (UCRS).

The construction of the UCRS accelerator complex was proposed as one of the first large-scale scientific project of the Russian National Center of Physics and Mathematics (Sarov) [1]. The construction started in the beginning of 2026 and the commissioning is planned for 2031. The complex consists of two electron accelerators with maximum energies $E_e = 120$ MeV (120 MeV LINAC) and $E_e = 2.0$ GeV (200 MeV LINAC + booster synchrotron) and two storage rings operational in the energy ranges $E_e \sim 70-120$ MeV and $E_e \sim 0.5-2.0$ GeV. The (quasi)monochromatic gamma and X-ray quanta are generated by the inverse Compton scattering of laser photons with $E_{ph} \sim 0.1-3.3$ eV by relativistic electrons. Energy of generated photons E_γ continuously covers the range from 10 keV to 1.5 GeV providing a broad scientific universalism of the complex.

The main research objectives of the complex are the fundamental problems of nuclear photonics in the energy range $E_\gamma \sim 0.5 - 60$ MeV [2]: photonuclear reactions, photofission, nuclear spectroscopy, high-precision study of the regions of giant dipole resonance and pygmy dipole resonance, reactions relevant to nuclear astrophysics, etc. X-ray radiation with $E_\gamma \sim 10 - 700$ keV is planned to be used for materials science, non-destructive testing and biology. The availability of high-energy gammas with $E_\gamma \sim 60 - 1500$ MeV opens scientific opportunities in the field of hadron photonics and high-energy nuclear physics (Compton scattering on nucleons and nuclear matter, meson degrees of freedom in nuclear matter, etc.). Electron bunches with a maximum energy up to $E_e \sim 2$ GeV can be used for generation of intense ultrashort pulses of gamma radiation for studies of fast processes, and in combination with the planned terawatt laser for research in the field of high-energy density physics (e.g. nonlinear electrodynamics, etc.).

[1] https://ncphm.ru/science/infrastructure/megascience/iki

[2] L.V. Grigorenko et al., Scientific program of INOK – Compton source of the monochromatic gamma-quanta at NCPhM, FIZMAT 3-4 (2023) 121-259 (in Russian) [https://fizmat-journal.ru/issues/2023/3].

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