Radiation Safety and Shielding Analysis of MARUSYA Facility for Relativistic Ion Beam Experiments

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A series of relativistic nuclear physics experiments is planned at the Nuclotron facility of the Laboratory of High Energy Physics (LHEP), Joint Institute for Nuclear Research (JINR). As part of the applied research program, the MARUSYA experimental setup will be utilized. MARUSYA is a magnetic spectrometer, whose magneto-optical system includes dipole magnets SP-12a, SP-57, SP-40, and quadrupole lenses 1K100 and ML-17. The experimental area must comply with strict radiation safety standards. This study presents a preliminary assessment of radiation hazards and an evaluation of the existing shielding. The first stage involves analyzing different beam-target combinations to identify the most critical radiation scenario. Planned targets include materials such as C, Al, Cu, and Pb, with densities up to 8 g/cm^2. Proton beams with energies up to 10 GeV and ion beams of Li, C, and Ar with energies up to 4.5 AGeV will be used. The proton beam intensity is expected to reach 5×10^{10} particles per pulse, and for Ar ions from 1×10^{3} to 1×10^{10} particles per pulse. Pulse durations may reach 6 seconds with a repetition period of up to 12 seconds, corresponding to average beam intensities of 2.5×10^{10} p/s for protons and 5×10^{9} ions/s for Ar. These parameters form the basis for dose rate evaluations. Residual activation of targets and air activation are also taken into account in the shielding evaluation.