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Radiation shielding analysis for synchrotron radiation beamlines of 4th generation storage ring in Korea

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The 4th generation storage ring (4th GSR) facility has been planned and launched in Korea since July 2021. Storage ring circumference is 799.297 m and is composed of 28 symmetrical cells with a beam emittance of 62 pm.rad. The stored electron energy and current are 4 GeV and 400 mA, respectively. The facility includes a 200-MeV linac, a booster ring, and a storage ring (SR). Both SR and booster ring are located in the same tunnel.
In previous work, the bulk shielding calculations were performed [1]. In this work, the FLUKA Monte Carlo code was employed to calculate the equivalent dose rates generated from Gas Bremsstrahlung (GB) and synchrotron radiation throughout the beamlines based on the current design conditions. GB which is produced by electron beam interaction with residual gases in the vacuum chambers in the SR is a source of high-energy radiation that penetrates the beamlines. The GB generates electromagnetic shower in beamline components and produces neutrons via photonuclear reactions, exposing high radiation doses so that it needs to be shielded properly. The injection efficiency into SR was assumed as 90%. Calculations were performed to optimize the wall thicknesses of optical and experimental hutches. A permanent dipole magnet was also considered in the front-end beamline components as a safety magnet. The safety magnet deflects all primary particles in case of any accidental situation. The dose rate was calculated around the beamline for an accidental scenario to confirm the safety magnet's role in the beamline. The appropriate shielding criteria were determined based on the Nuclear Safety Act in Korea and the ALARA principle. These simulations will provide an overall radiological framework for shielding the beamlines of the 4th GSR in Korea.

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[1] N. S. Jung, Radiation Shielding Evaluation of 4th Generation Storage Ring in Korea, 11th International Workshop on Radiation Safety at Synchrotron Radiation Sources (RadSynch23), ESRF, Grenoble, France 30 May-2 June (2023).

Scientific Topic 1

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