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Beam loss monitoring in NanoTerasu storage ring with active neutron dosimeter

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A compact 3 GeV synchrotron light source (NanoTerasu) has been in operation at Tohoku University's new Aobayama campus in Japan since April 2024. NanoTerasu provides both soft and hard x-rays from insertion devices installed in the 3 GeV storage ring [1,2]. At present 10 of the 28 beamlines designed are available; the remaining 18 beam lines will be installed in the future. The storage ring is operated with a storage electron current of ~100 mA by a top-up mode injection for the maximum design value of 413 mA. In the accelerator commissioning, beam loss information of the storage ring is important not only for beam tuning, but also for radiation safety. We have measured secondary neutrons generated by electron beam loss to obtain information on the position, timing and amount of electron beam loss. Secondary neutrons produced by photonuclear reactions have a peak energy around 2 MeV and more isotropic than secondary photons emitted in the interaction between a high-energy electron and materials. The neutron dose in the accelerator tunnel attenuates simply with distance from the beam loss position regardless of the direction of electron beam. On the other hand, secondary photons as a bremsstrahlung have a strong forward peaking; the photon dose depends on not only distance from the beam loss position but also the direction of electron beam. We used a semiconductor-type active personal radiation dosimeter DMC3000 coupled with neutron module to measure neutron dose inside accelerator tunnels. The dosimeter was put in the NanoTerasu storage ring tunnel and continuously measure gamma and neutrons dose during accelerator operation.

We present some examples of dose distribution in the storage ring tunnel and an optical hatch during the accelerator commissioning.

[1] A. Takeuchi et al., "Estimation of Absorbed Dose due to Gas Bremsstrahlung Based on Residual Gas in Electron Storage Rings", Nucl. Sci. Eng. vol. 2, issue 2, 2024

[2] H. Matsuda et al., "Shielding design of NanoTerasu for gas bremsstrahlung and photonuclear reaction", J. Nucl. Sci. Technol., vol. 61, issue2, 2024

Scientific Topic 1

Source terms, new accelerator facilities and related topics

Scientific Topic 2

Scientific Topic 3

Scientific Topic 4

Shielding and dosimetry

Scientific Topic 5

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Session Classification: Session 1 - Source terms, new accelerator facilities and related topics

Track Classification: Source terms, new accelerator facilities and related topics