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Experimental Study on Single Electron Storage in 2024

Y. Asai[a], M. Shimada[b,c], H. Miyauchi[b,c] and M. Katoh[c,d]

[a]Graduate School of Advanced Science and Engineering Hiroshima University, 1-3-1 Kagamiyama Higashi-Hiroshima 739-8526, Japan
[b]High Energy Accelerator Research Organization (KEK), 1-1 Oho Tsukuba 305-0801, Japan
[c]Research Institute for Synchrotron Radiation Science, Hiroshima University, 2-313 Kagamiyama Higashi-Hiroshima 739-0046
[d]UVSOR Synchrotron Facility, 38 Nishigo-Naka Myodaiji Okazaki 444-8585, Japan

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We have started single-electron storage [1] experiments at UVSOR-III since 2021 with the aim of conducting fundamental research on electromagnetic radiation. At BL1U, we extracted undulator light in the UV region at a wavelength of 355 nm into the atmosphere and observed its intensity using a photomultiplier tube. By using appropriate band-pass filters to reduce background light and a beam scraper to decrease the electron beam intensity, we succeeded in observing a step-function-like intensity change [1] under a small number of electron storage conditions with a good SN ratio, confirming single-electron storage.

In the fiscal year 2022, we advanced the sophistication and labor-saving of single electron storage technology and began experiments to observe synchrotron radiation from single electrons. As a result, we successfully confirmed that the undulator radiation from a single electron follows a Poisson distribution, with the number of emitted photons per pass being much less than one, which is consistent with the theoretical calculations based on classical electrodynamics [2]. In addition, we also observed the photon statistics from numerous electrons of the order of 10^8 and the results are also consistent with Poisson statistics. Additionally, as part of the beam dynamics research related to single electron storage, we investigated the relationship between the insertion depth of the beam scraper, and the beam lifetime. The results suggest that the lifetime weakly depends on the insertion depth when it is a few hundred microns from the beam center but strongly depends on it when it is closer. We speculate that the gas-scattering lifetime is dominant in the former region but the quantum one in the latter.

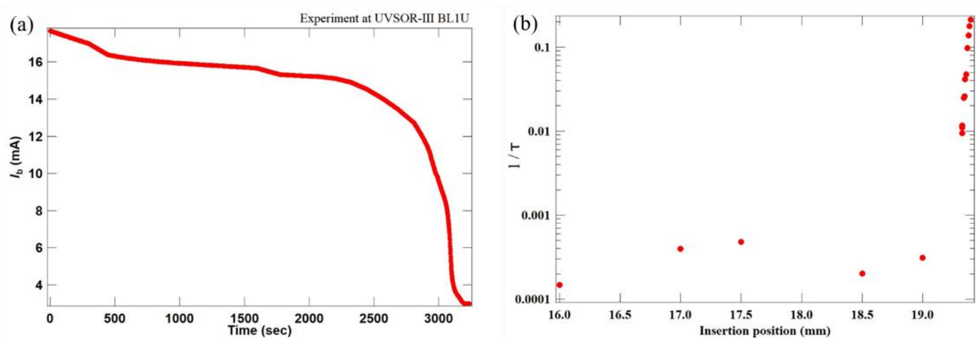

FIGURE 1. Relationship between beam scraper insertion position and beam lifetime

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