

USE OF ACCELERATORS FOR RESEARCH AND TRAINING IN THE UNIVERSITY ENVIRONMENT

S.H. PARK¹, J. BAHNG¹, B.S. LEE², C.S. PARK¹, E.-S. KIM¹

¹ Korea University Sejong campus, Sejong, Korea

² Korea Basic Science Institute, Daejeon, Korea

Department of Accelerator Science in Korea University Sejong is dedicated to Graduate school curriculum including research and development in the field of accelerator science. Since 2017, compact accelerators are under construction or commissioning for the test and training. First, ECR ion source operating at ~2.45 GHz has been reconstructed for ion mass spectroscopy and/or accelerator-based neutron source. 2 mA of Ar ion at 30 kV of extracting voltage was generated with 0.1% stability for more than 1 hour. Ion beam deflected 90° at an analysing magnet will be accelerated higher energy by an accelerating tube, followed by the second analysing magnet for ion mass spectroscopy. The second beamline deflected 45° at the analysing magnet will be placed with a RFQ, a beam optics for expanding beam size, a Be converter, and a Moderator. The RFQ system is designed for 2.5 MeV deuteron or ~3 MeV proton [1] and the design of the target for neutron generation is under way. Main purpose is to develop the more compact and effective neutron source for medical applications.

Secondly, an electrostatic ion accelerator for ion implantation is operational. It consists of a Duoplasmatron for high-current ion beam, an accelerating tube for 150 keV of proton, a diagnostic box, a gate valve and a sample chamber. The doublet optics should be installed next to the gating valve for beam focusing and/or shaping at the sample stage.

The third one is high-power THz free electron laser (FEL) system based on microtron [2], which is in preparation for commissioning. The electron beam can be accelerated from 4 MeV to 7 MeV by adjusting the number of turns before extracted to straight beamline. The extracted electron beam is deflected 90° using three dipoles and the beam optics is optimized to minimize the dispersion effect at the entrance of undulator for FEL. The hybrid-type helical undulator is tuned the deflection parameter K using biased current source instead of changing the gap. The resonator is waveguide mode in vertical direction and free propagating mode in horizontal direction. High power THz is outcoupled in transmissive way. To suppress the diffractive effect a Quartz crystal lens is used for vacuum window. The macro-pulse duration is about 4 μsec having lots of 30 ps micro-pulses separated by 356 ps High power. The macro-pulse is typically operated at 1~3 Hz repetition rate. THz light source is good for R&Ds on a single-shot imaging, a security inspection, THz resonance spectroscopy, and so on. Due to intrinsic property of FEL lasing scheme, the linewidth of THz is less than 10^{-3} . To improve the spectral resolution for fingering of a rotational or vibrational mode of a certain atom or molecule, the linewidth should be reduced further. The Michelson interferometric mode selection system combined the parallel plate waveguide is a candidate in THz spectral range. These compact accelerators are good for training and useful for related applications.

We also have plans to reassemble 50 MeV microtron used as an injector in BESSY and install 50 MeV, sub-ps pulsed electron linac transferred from Pohang Accelerator Laboratory (PAL, Pohang). Fs electron linac is consisted of a photocathode gun, two S-band NC RF accelerators, two chicanes for the pulse compression and the coherent transition radiation (CTR) in THz range. This system will be used for the performance proof-testing of developed equipment and instruments for 4GSR. In near future the central control system will be built for operation and user service.

As for education and training, there is a prototype of RF coupler pair at 325 MHz which was designed, manufactured, and tested [3]. A longitudinal gradient bending magnet in hybrid type and its precise magnetic measurement system is under development. All systems and R&D activities in Department of Accelerator Science will be great resources for the education and training in the world. Beside the regular curriculum in Graduate school, the intensive education and training program has been routinely held for beginners, graduate-level, or personnel in research institutes and/or industries. Asian school for SC RF cavity and Cryogenic system is scheduled if Corvid-19 situation is even out.

REFERENCES

- [1] Bahng, J., Lee, B.-S., Kim, E.-S., Park, S.H., Park, H.-K., “Design of compact accelerator system for high flux accelerator- based neutron source”, Rev. Sci. Instrum. 91, 023323 (2020)
- [2] Jeong, Y.U., Miginsky, S., Gudkov, B., Lee, K., Mun, J., Shim, G., Bae, B., Kim, H.W., Jang, K.-H., Park, S., Park, S.H., and Vinokurov, N., “Waveguide-mode Terahertz Free Electron Lasers driven by Magnetron-based Microtrons”, IEEE transactions on nuclear science VOL. 63, NO. 2, p.898 – 905 (2016)
- [3] Yoon, J., Park, J.S., Bahng, J., Kim, K.-R., Park, S.H., Kako, E., Kim, E.-S., “Development of the antenna adjustable power coupler for 325 MHz superconducting cavities”, Nuclear Inst. and Methods in Physics Research, A 1010, 165484 (2021)