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Current Status of Research and Development in the Radiation Equipment Fab.

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1. Introduction

The Radiation Equipment Fab. supports the development of core technologies such as radiation detector and radiation generator, as well as the development of application devices utilizing them since operation in 2017. It also supports the fostering of small and medium-sized company through research equipment services and technical support to industry, academia, and research institutes. The radiation equipment Fab. has compound semiconductor single crystal growth technology for radiation detection, ionization chamber and semiconductor sensor technology. Is also has high energy X-ray generator development technology based on electron accelerator technology. The Radiation Equipment Fab. has developed a domestic standard container inspection system and established a research institute. It is currently preparing to develop an imaging system for the export of the developed container inspection system overseas. In this paper, developments currently being conducted in radiation equipment Fab. are addressed.

2. Radiation Equipment currently under development at the radiation equipment FAB.

2.1 Development of a 3D radiation composite detection system(Compton Camera)

3D radiation composite detection is equipment that visualizes the presence of radioactive contamination and the location of the contamination source in real time and can quickly process the contamination source.

The radiation equipment fab designed a portable radiation composite detection equipment and a radiation composite detection algorithm. The portable radiation composite detection equipment consists of a detector sensor module, a data acquisition system, a collimator mask, and a laser scanner. The detector sensor module was constructed using a pixel-type CZT module (M400 from H3D (US)) that shows an energy resolution of 1.1% at 662 keV. The data acquisition system can communicate via Ethernet and can simultaneously list and record the reaction location and energy. The collimator was designed considering the image field of view, radiation teaming performance, focal length, and dose estimation accuracy.

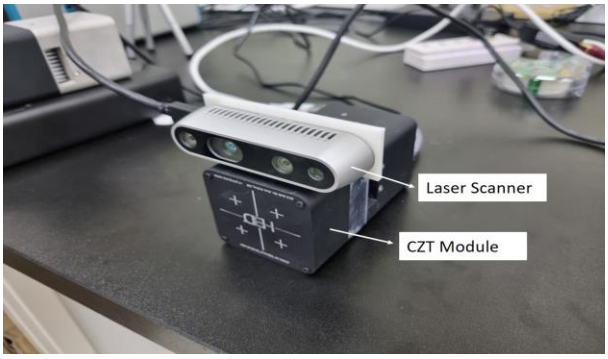

Fig 1. A developed Compton camera

For the composite detection image, an image reconstruction algorithm, an image alignment algorithm, a nuclide analysis algorithm, and a dose estimation algorithm were developed. For the low-energy gamma-ray image reconstruction, a cross-correlation-based decoding algorithm was used using a coded aperture.

Table 1. Specifications of a Compton Camera

Contents		Performance
Radiation Detection	Acquisition Time	10s @ 0.1 μSv/h @ Cs-137
	Imaging Time	40s @ 0.1 μSv/h @ Cs-137
	Resolution	1.5% @ Cs-137
	Energy Range	0.06 ~ 3.0 MeV
Position Detection	Viewing angle	360°
	Resolution	> 30°
Identification	Nuclide	> 2
Dose Measurement error		20%

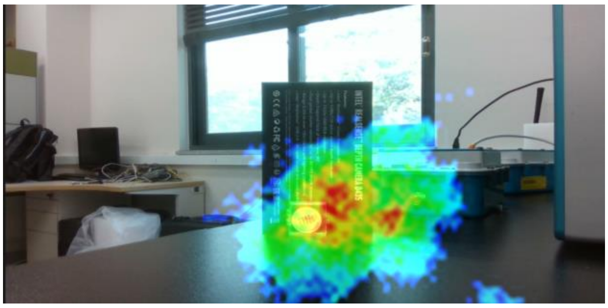
Figure 2. 3D radiation and visual imaging for Cs-137 by using the developed system

2.2 Development of an electron accelerator for stinky odor treatment

A mobile stinky odor treatment integrated system is being developed using a variable output electron accelerator. The stinky odor treatment technology using electron beams is a technology that removes odors by controlling the output of an electron beam accelerator using an olfactory sensor. The odor treatment technology automatically controls the output of an electron beam accelerator to the optimal decomposition dose for each type and concentration of livestock odor detected in real time by an olfactory sensor, thereby economically treating odors and minimizing electron beam decomposition byproducts. A small high-output variable electron accelerator develops and optimizes a variable 400 keV small generator.

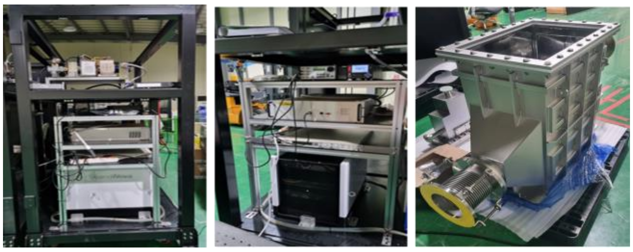

Figure 3. Developed electron accelerator power(left), control unit(middle), electron beam gas reactor(right)

After connecting the ion pump and applying high voltage to check for vacuum leakage, the vacuum was confirmed to be up to 4×10^{-7} Torr, and the vacuum was confirmed to be maintained after a period of time. The cooling line was configured to divide the individual devices into three groups so that the cooling water is divided, and when the individual devices were connected to the cooling water pipe and the cooler was operated, it was confirmed that the cooling water set temperature was normally maintained without any leakage at all connection parts at the fixed cooling water pressure (2~3 kPa). As a result of the test operation of the power system, it was confirmed that power was normally supplied to the modulator and electron gun power supply without arcing in the high voltage cables and terminals, and the equipment was confirmed to operate stably without any special abnormalities during the test operation for several hours. However, since long-term operation is required for odor removal, additional long-term stability tests of the equipment are required. It was confirmed with an oscilloscope that high-power high-frequency pulses and high-voltage pulses were generated from the modulator and the electron gun power supply, and it was necessary to modify the electron gun body structure to extract a large amount of electrons stably from the electron gun and increase the incidence rate into the accelerator tube. The insulation of the high-voltage wire section was reinforced to prevent high-voltage arcing during operation

Table 2. Specifications of a mobile electron accelerator and a system

Classification	Contents	Performance
Electron accelerator	Electron energy	500 keV
	Electron average current	1 mA (Max. 3 mA)
	Type	Pulse high frequency
	Frequency	2,998 MHz
	Waveguide	WR-284
	Shield	Self-shieling
Mobile vehicle	Dimension	6 m (L), 2.5 m(W), 3.4 m (H)
	Weight	6 ton
	Others	Air suspension, Landing gear, Air conditioner

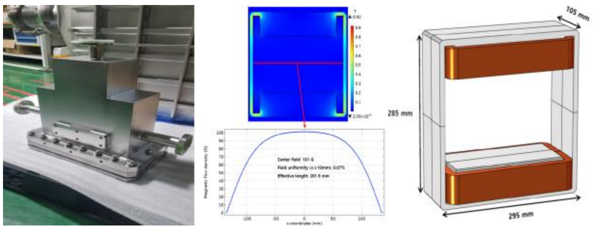

Figure 4. Developed electron beam scanhorn(left), simulation of magnetic field of bipolar magnet(middle), designed bipolar magnet(right)

3. Radiation Equipment Fab. Center

Key Infrastructures of the Radiation Equipment Fab. Center are a crystal growth facility, a semiconductor fabrication process facility, an evaluation facility and a high energy X-ray & fast neutron facility. Currently development drifts of the Fab. are system integration for NDT, safety, and security, etc.

Figure 4 shows the main facilities of the radiation equipment fab.

Figure 4. Crystal growth facility (upper left), semiconductor processing facility (upper right), 9 MeV(lower left) and 15 MeV test facility