

Initial Performance Evaluation of an Automated System for ^{177}Lu Removal from Patient Urine Following ^{177}Lu -DOTATATE Therapy

Kimiteru Ito¹, Keiichi Hirano², Atsushi Shishido¹, Yasuko Kikuchi², Shigemi Seri², Yuichiro Sugawara²

¹Department of Diagnostic Radiology, National Cancer Center Hospital, Tokyo, Japan. ²AMS Kikaku Co.,Ltd., , Tokyo, Japan.

Background

- ^{177}Lu -DOTATATE therapy administers >7 GBq per cycle; a substantial fraction is excreted in urine, generating significant radioactive waste at the point of care.
- Safe on-site management of this radioactive waste is essential for radiation safety compliance.
- A novel automated column-based system removes ^{177}Lu from patient urine at the point of care. (Figure 1)
- This study reports the initial performance evaluation of this system.

Methods

- Urine from 12 patients treated with ^{177}Lu -DOTATATE at National Cancer Center Hospital was processed (Test 1–2: parameter exploration; Cases 1–10: performance evaluation).
- Urine was automatically passed through adsorbent-filled columns to capture ^{177}Lu .
- Parameters varied:
 - **Flow rate:** 5 or 10 mL/min
 - **Number of columns:** one to three in series
 - **Column design:** (1) straight-sided layered → (2) constricted layered → (3) constricted with homogeneous mixed-adsorbent
- Removal efficiency = % reduction in ^{177}Lu activity (pre- vs. post-processing, decay-corrected).
- SPECT imaging assessed ^{177}Lu distribution within columns.

Results

- Parameter exploration (Test 1–2): Flow rate of 10 mL/min yielded 79.46% removal. Optimized conditions (5 mL/min) adopted for Cases 1–10.
- All cases achieved $\geq 97.9\%$ removal (Figure 2), regardless of urine volume (1,527–4,174 g) or tumor type. Optimized mixed-adsorbent configuration achieved up to 99.98% (Cases 6–8).
- SPECT imaging (Figure 3, Cases 5 & 6): Layered packing showed focal ^{177}Lu accumulation in the lower segment, indicating uneven adsorbent contact and incomplete removal (97.97%). In contrast, the Mixed packing achieved uniform ^{177}Lu distribution throughout the column, confirming full adsorbent utilization and explaining the superior removal efficiency (99.64%).
- Single-column protocol (Cases 9–10) achieved 98.63–98.97%, demonstrating feasibility for simplified clinical workflow.
- Removal rates consistently exceeded 97.9% across all patient urine volumes and tumor types.

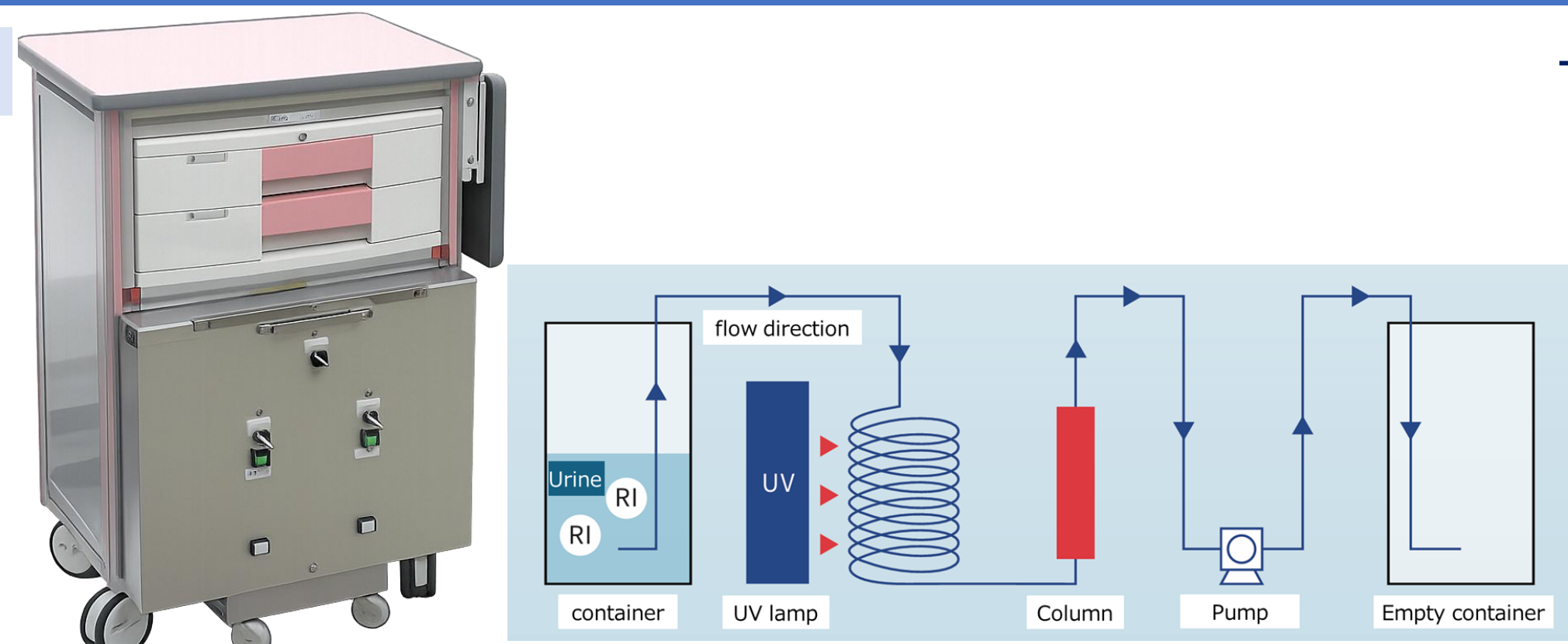


Figure 1. Overview of the Automated ^{177}Lu Removal System and Processing Schematic

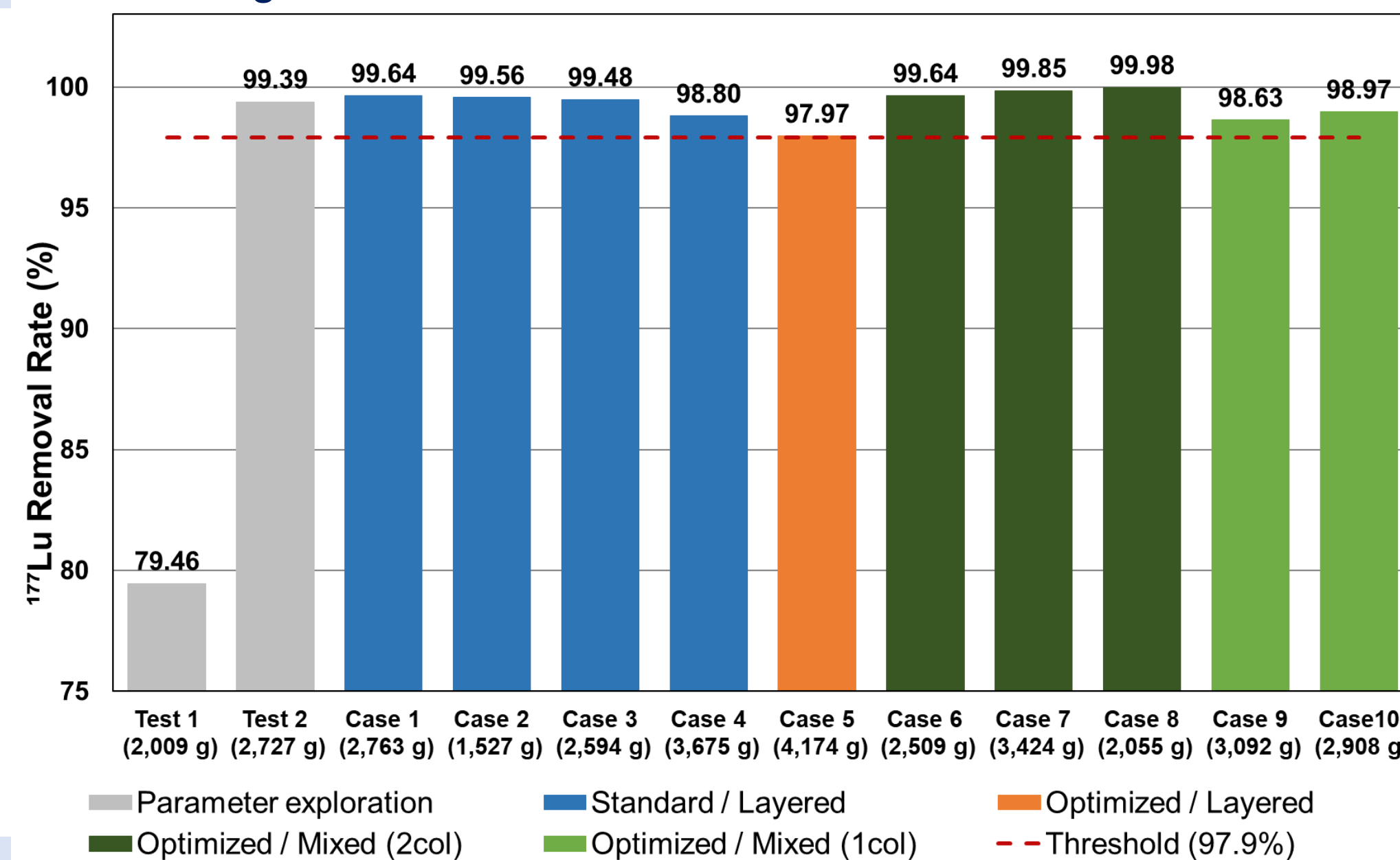


Figure 2. ^{177}Lu Removal Rate by Column Configuration (Cases 1–10; urine volume shown in parentheses)

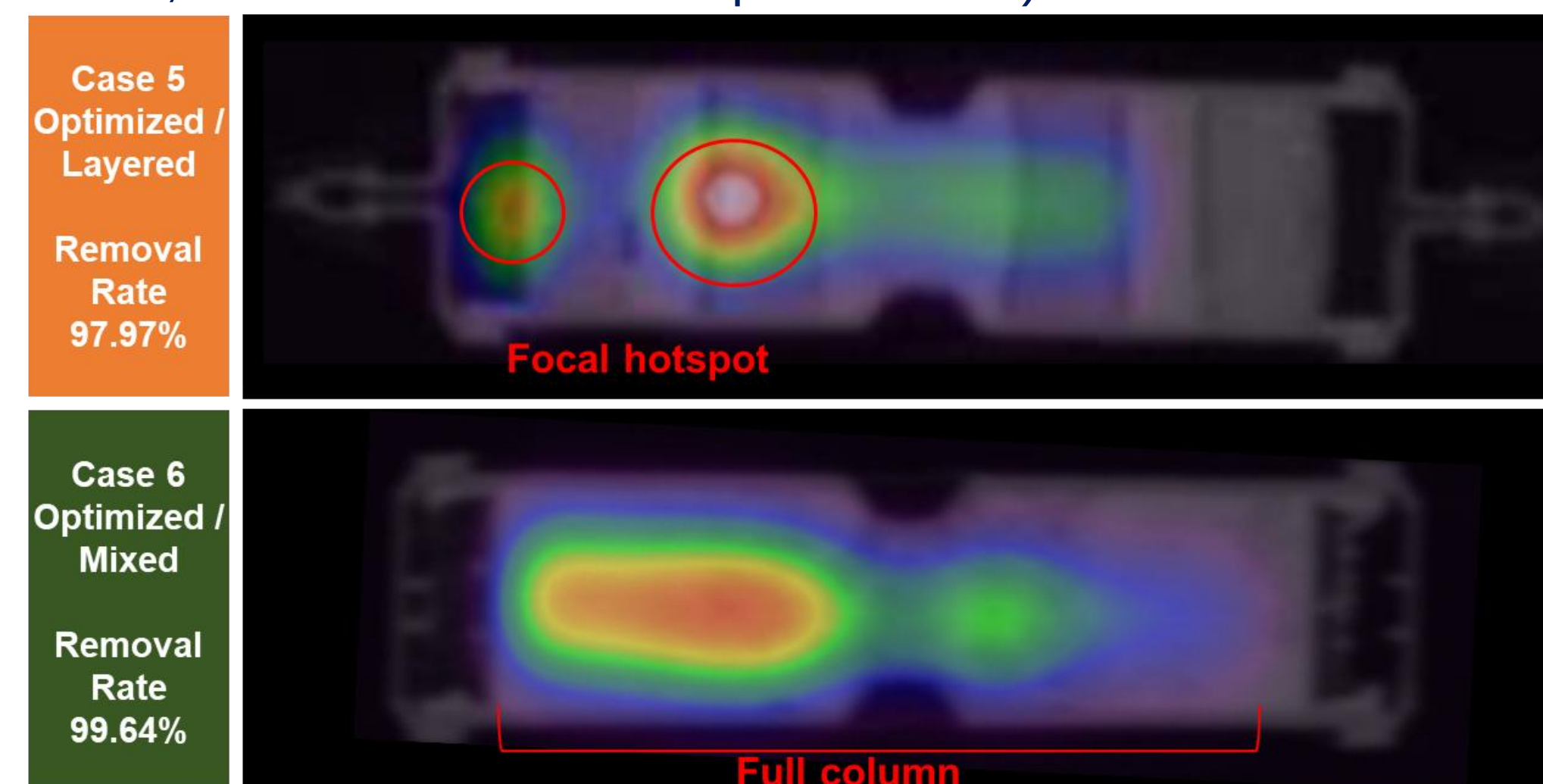


Figure 3. SPECT Imaging of ^{177}Lu Distribution: Non-uniform (Case 5, Standard / Layered) vs. Uniform (Case 6, Optimized / Mixed)

Table 1. Patient Characteristics and ^{177}Lu Removal Performance by Column Configuration

Case	Age	Sex	Primary Tumor	Urine Vol. (g)	Flow Rate (mL/min)	Column Configuration	^{177}Lu Pre (MBq)	^{177}Lu Post (MBq)	Removal Rate (%)
Test 1	68	Male	Pancreas	2,009	10	Standard / Layered	3871	795.19	79.46%
Test 2	45	Male	Pancreas	2,727	10	Standard / Layered	4146	25.38	99.39%
Case 1	47	Female	Pancreas	2,763	5	Standard / Layered	5189	18.66	99.64%
Case 2	65	Female	Pancreas	1,527	5	Standard / Layered	771	3.37	99.56%
Case 3	48	Male	Rectum	2,594	5	Standard / Layered	4475	23.14	99.48%
Case 4	57	Male	Pancreas	3,675	5	Standard / Layered	3964	47.44	98.80%
Case 5	48	Male	Rectum	4,174	5	Optimized / Layered	3595	72.98	97.97%
Case 6	58	Male	Rectum	2,509	5	Optimized / Mixed (2col)	2501	8.95	99.64%
Case 7	68	Female	Pancreas	3,424	5	Optimized / Mixed (2col)	4362	6.75	99.85%
Case 8	59	Female	Paranasal sinus	2,055	5	Optimized / Mixed (2col)	3774	0.95	99.98%
Case 9	63	Female	Pancreas	3,092	5	Optimized / Mixed (1col)	4430	60.70	98.63%
Case10	61	Female	Pancreas	2,908	5	Optimized / Mixed (1col)	2658	27.31	98.97%

Parameter exploration Standard / Layered Optimized / Layered Optimized / Mixed (2col) Optimized / Mixed (1col)

Conclusions

- An automated column-based system achieves consistent ^{177}Lu removal $\geq 97.9\%$, regardless of urine volume or tumor type, meeting institutional radiation safety requirements.
- SPECT imaging mechanistically confirms that homogeneous packing maximizes adsorbent utilization and removal efficiency.
- Both dual- and single-column protocols are feasible, enabling flexible clinical implementation at the point of care.

Contact: Kimiteru Ito, MD, PhD, kimito@ncc.go.jp