Importance of Environmental Radiation Measurements in Radiation Safety Report

[a]Korea Heavy-ion Medical Accelerator Project
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Outlines

- Introduction
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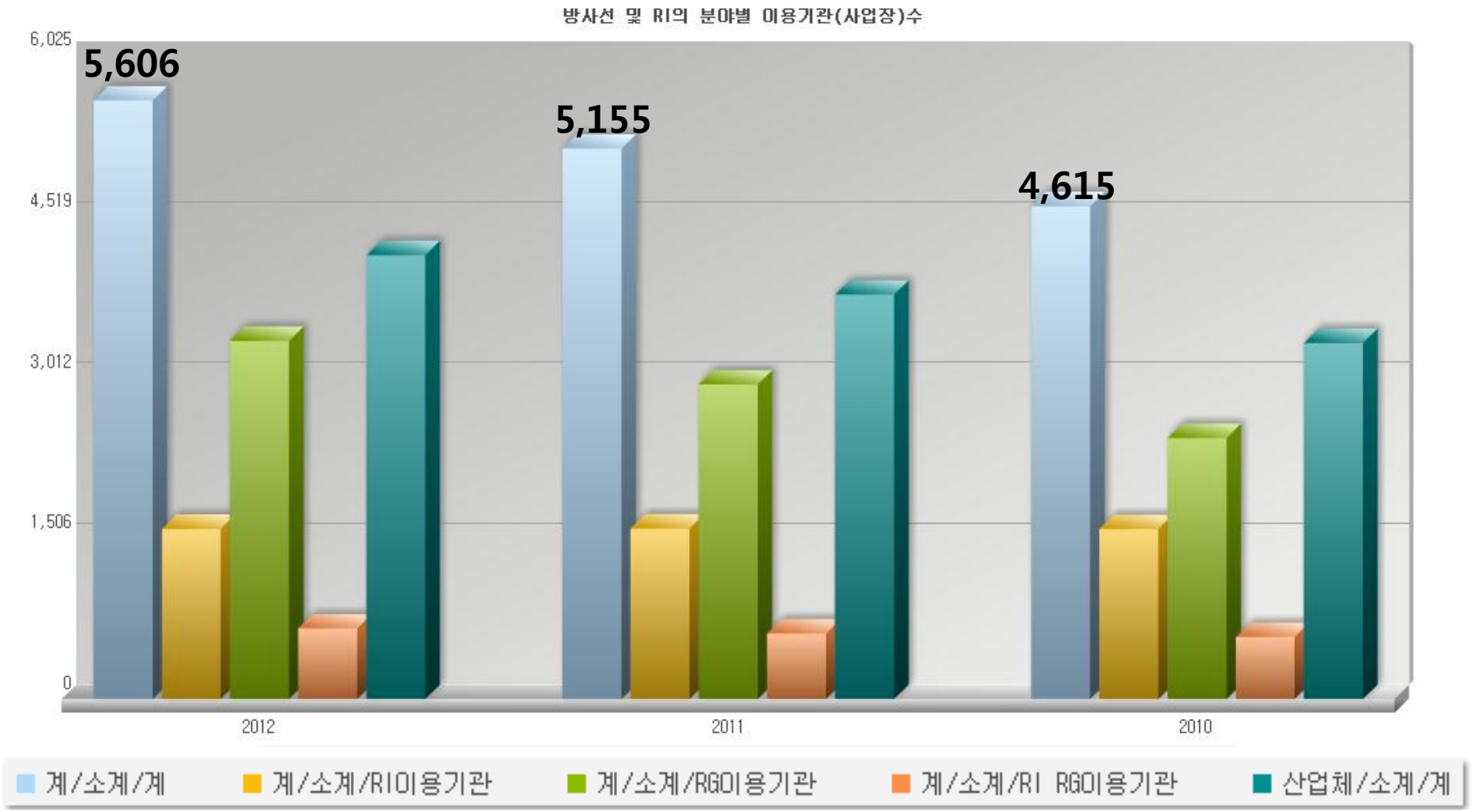
- Results
- Conclusions

The use of radiations in health and industry



출처 : 미래창조과학부, 방사선및방사성동위원소이용실태조사

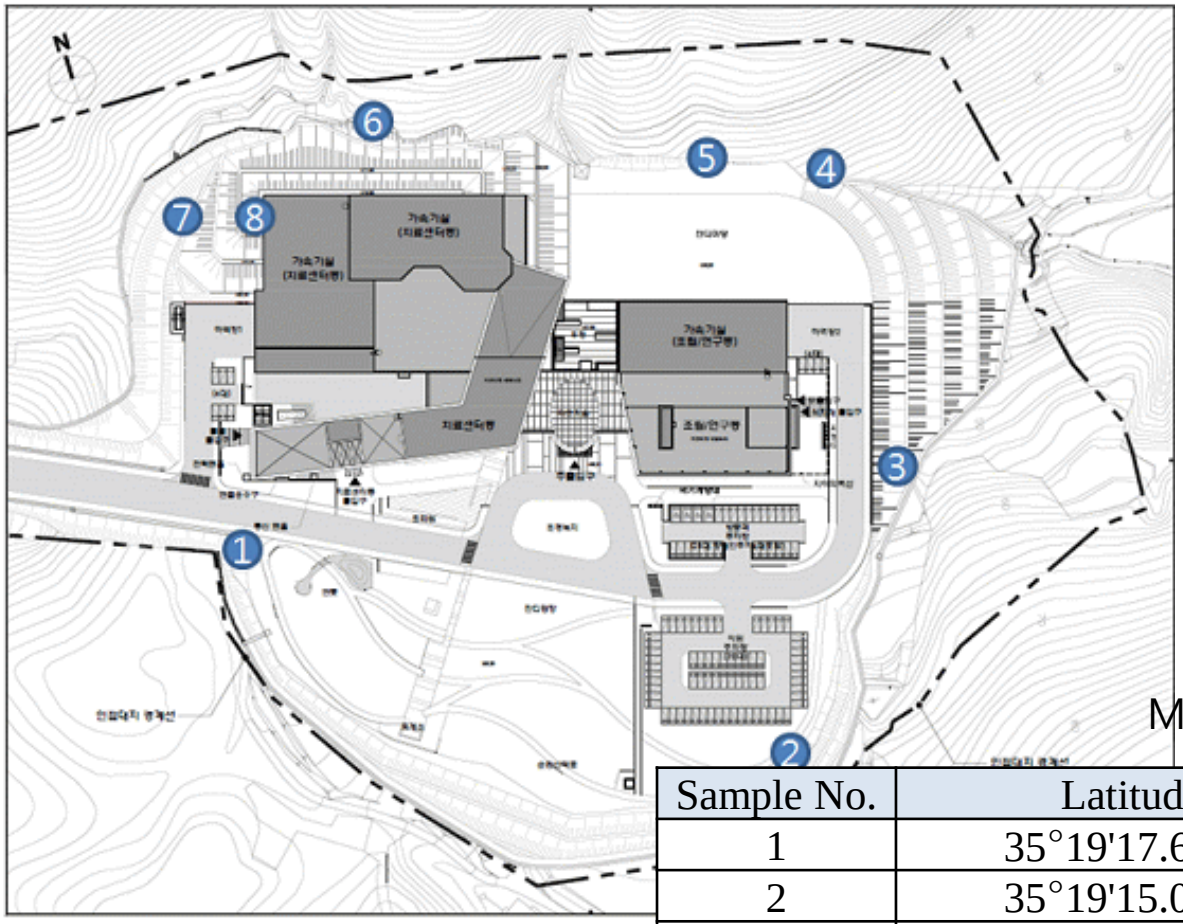
Annual natural radiation

- The dose rate limit for a public place is 1mSv/yr.
- UNSCEAR has estimated the annual natural background dose rate of 2.4 mSv/yr in worldwide average.
- Actually, the typical range varies from 1 to 10 mSv/yr.

Environmental Radiation Measurements

- The back ground radiation measurement is necessary in pre-construction phase for the new heavy-ion medical accelerator facility.
- Moreover, this information is useful for the environmental control of the continuing operation of the radiation facility and the final decommissioning phase.
- Besides, a big nuclear power plant site is located within the range of about 4 km from our accelerator facility.
- This fact is enough to draw attention of artificial radionuclide.

Measurement points & sampling sites



Measurement date : 5/22/2014

Sample No.	Latitude	Longitude
1	35°19'17.65"N	129°14'50.53"E
2	35°19'15.05"N	129°14'55.47"E
3	35°19'17.35"N	129°14'57.79"E
4	35°19'20.33"N	129°14'57.56"E
5	35°19'20.69"N	129°14'56.57"E
6	35°19'21.79"N	129°14'52.99"E
7	35°19'21.28"N	129°14'49.72"E
8	35°19'21.15"N	129°14'50.63"E

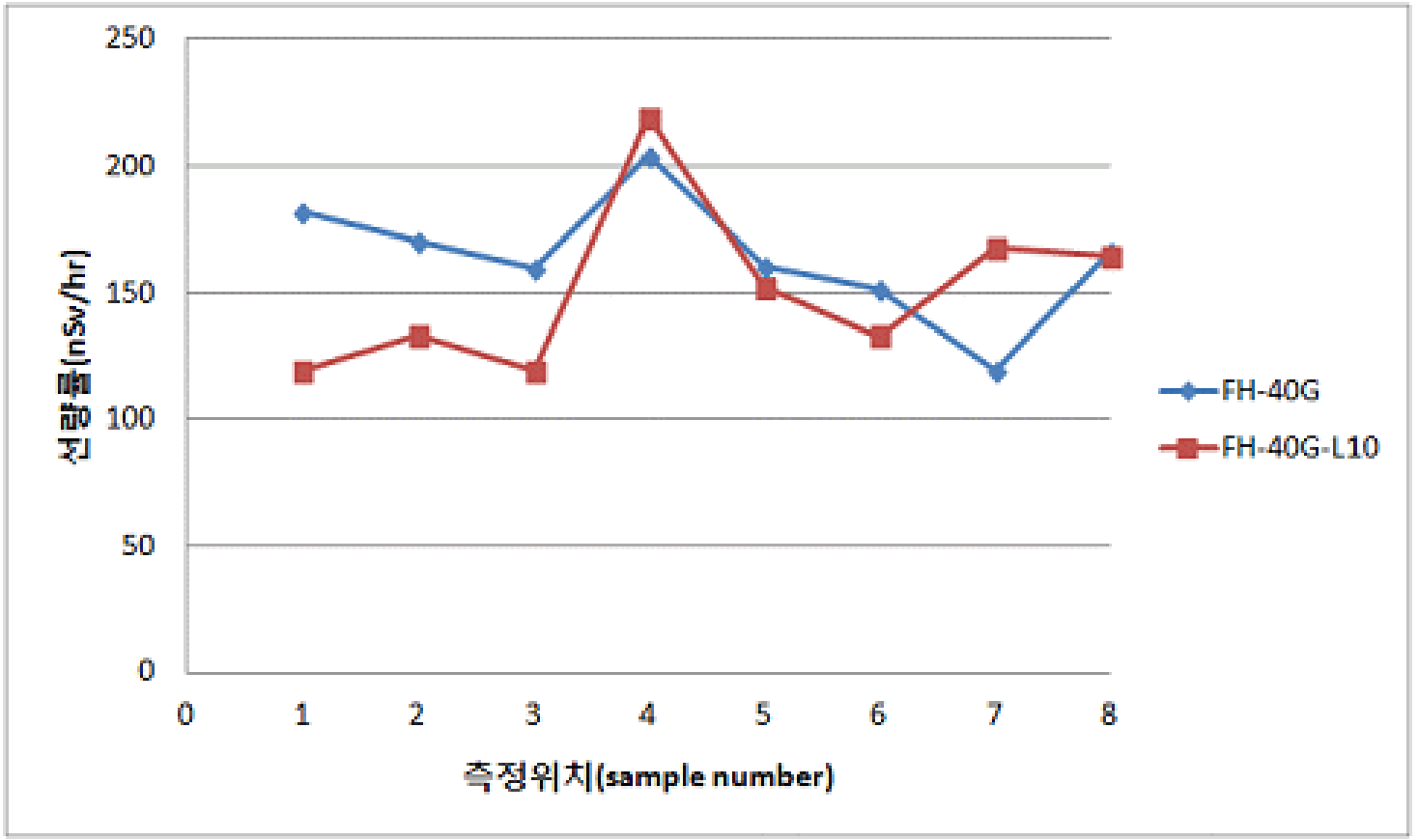
Background radiation measurement on the ground

- **The gamma dose rate on the ground was measured with two portable FH40G survey meters.**

	FH-40G	FH-40G-L10
Energy range	36keV~1.3MeV 10nSv/hr~1Sv/hr	30keV~4.4MeV 10nSv/hr ~100mSv/hr
Calibration factor (300uSv/hr)	1.10	1.07
Calibration date	2014.4.11	2014.4.14

Background radiation measurement on the ground

- The range of gamma dose rate on ground varies from 118 to 219 nSv/hr, which is 1.5 times higher than the public annual dose limit (1mSv/yr ≒ 114.2 nSv/hr).



Background radiation measurement in soil

- Surface soil samples were collected at the chosen surfaces, each about 2 kg per sample within 5 m radius and the depth of about 0 ~ 5 cm.
- Pre-preparation of the soil sample for the measurement of radioactive isotopes was followed by the definition of ISO 18589-2.
- After preprocessing, soil sample of about 1kg was filled in Marinelli beaker(1,000 ml).
- Measurement time was about 80,000 sec with two HPGe semiconductor detectors.

Background radiation measurement in soil

* HPGe semiconductor detector model

	GR1520	GC2518
Relative efficiency	15 %	25 %
Resolution	1.33 MeV ~2.0 keV	1.33 MeV ~2.0 keV
Uncertainty	6 %	5.7 %
Calibration date	2013.07.12	2013.07.12

* Measurement information of soil samples

Sample No.	Sampling date	Mass(g)	Measured date
1	2014-05-22, 13:55	1257.47	2014-06-03, 17:41
2	2014-05-22, 14:08	1190.38	2014-06-03, 17:45
3	2014-05-22, 14:13	1291.29	2014-06-05, 15:10
4	2014-05-22, 14:25	1075.43	2014-06-05, 15:15
5	2014-05-22, 14:31	1179.36	2014-06-06, 13:42
6	2014-05-22, 14:40	1025.36	2014-06-06, 13:47
7	2014-05-22, 14:49	999.83	2014-06-07, 20:31
8	2014-05-22, 15:06	1158.19	2014-06-07, 20:35

Results of Background radiation measurement in soil

Nuclide	Half life	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5		Sample 6		Sample 7		Sample 8	
		Activity(Bq/kg-dry) (Uncertainty)	MDA (Bq/kg)	Activity(Bq/kg-dry) (Uncertainty)	MDA (Bq/kg)	Activity(Bq/kg-dry) (Uncertainty)	MDA (Bq/kg)	Activity(Bq/kg-dry) (Uncertainty)	MDA (Bq/kg)	Activity(Bq/kg-dry) (Uncertainty)	MDA (Bq/kg)	Activity(Bq/kg-dry) (Uncertainty)	MDA (Bq/kg)	Activity(Bq/kg-dry) (Uncertainty)	MDA (Bq/kg)	Activity(Bq/kg-dry) (Uncertainty)	MDA (Bq/kg)
Be-7	53.44 d	16.30456 (1.355124E-03)	-	12.24042 (9.984700E-04)	-	14.01279 (1.187141E-03)	-	10.51452 (1.101251E-03)	-	30.69803 (1.544614E-03)	-	**35.82879** (1.619362E-03)	-	11.63729 (1.383376E-03)	-	21.75921 (1.467847E-03)	-
K-40	1.27E9 y	614.13190 (1.214799E-02)	4.79	513.59880 (1.055404E-02)	6.08	729.84090 (1.423818E-02)	4.43	793.53520 (1.600697E-02)	7.49	823.75610 (1.605766E-02)	5.31	**937.72050** (1.879968E-02)	7.78	417.68120 (8.780368E-03)	5.53	847.89620 (1.700635E-02)	7.61
Mn-54	312.5 d	0.58842 (6.189977E-05)	-	< MDA* (8.625428E-05)	0.28	0.60363 (6.215921E-05)	-	0.83831 (5.342989E-05)	0.34	0.69142 (7.035185E-05)	-	0.87469 (5.624219E-05)	0.35	0.47333 (5.914958E-05)	-	**1.51536** (6.590370E-05)	0.34
Co-60	5.27 y	-	-	-	-	0.49668 (1.287678E-04)	0.41	-	-	< MDA* (1.597608E-04)	0.52	-	-	-	-	-	-
Zr-95	63.98 d	-	-	-	-	-	-	0.78481 (9.394518E-05)	-	0.78452 (1.255909E-04)	-	0.61254 (1.003154E-04)	-	-	-	**1.54505** (1.213804E-04)	-
Sb-122	2.73 d	-	-	4.60650 (2.409675E-03)	-	20.04257 (5.413356E-03)	-	18.41139 (3.780525E-03)	-	19.67090 (6.517788E-03)	-	-	-	-	-	**70.89524** (1.021996E-02)	-
Sb-126	12.4 d	0.71515 (9.563008E-05)	-	0.43471 (6.326950E-05)	-	0.82966 (1.135539E-04)	-	0.73482 (9.356252E-05)	-	1.09859 (1.417887E-04)	-	0.58252 (9.557261E-05)	-	0.94663 (1.283475E-04)	-	**1.32683** (1.764038E-04)	-
Cs-137	30.0 y	0.63755 (6.289057E-05)	0.29	0.21931 (3.719517E-05)	-	0.73172 (6.762429E-05)	0.31	0.42280 (4.885323E-05)	-	0.75430 (7.580820E-05)	0.37	0.18544 (4.563734E-05)	-	**1.49427** (8.617208E-05)	0.32	-	-
Bi-211	2.14 m	-	-	-	-	-	-	5.50209 (1.143283E-03)	-	-	-	5.35230 (1.180792E-03)	-	-	-	**6.53033** (1.334763E-03)	-
Bi-212	60.55 m	18.67181 (8.919486E-04)	-	15.07754 (7.819661E-04)	-	23.41238 (1.158072E-03)	-	28.76426 (1.069618E-03)	-	24.25444 (1.186006E-03)	-	27.38813 (1.122814E-03)	-	18.73281 (9.652869E-04)	-	**53.13027** (1.030298E-03)	-
Pb-212	10.64 h	23.86567 (3.930252E-04)	-	23.55246 (3.065948E-04)	-	41.97434 (5.357455E-04)	-	40.34064 (4.980758E-04)	-	22.29898 (4.538225E-04)	-	43.0328 (5.311034E-04)	-	31.39742 (4.419870E-04)	-	**80.58892** (8.798031E-04)	-
Bi-214	19.9 m	22.62337 (3.818665E-04)	0.91	15.03776 (2.744788E-04)	-	25.89208 (4.204181E-04)	0.99	27.35979 (3.923445E-04)	-	29.19656 (4.724473E-04)	1.00	27.23029 (4.208846E-04)	-	22.42827 (4.246610E-04)	1.04	**42.74020** (5.127621E-04)	-
Pb-214	26.8 m	22.45296 (3.248294E-04)	0.94	17.55763 (2.177624E-04)	-	29.46038 (3.715399E-04)	0.97	29.71704 (3.792466E-04)	-	28.51122 (4.045661E-04)	1.08	30.86794 (3.991621E-04)	-	25.68126 (3.539789E-04)	1.02	47.52035 (5.431786E-04)	-
Rn-219	3.96 s	3.56978 (5.805422E-04)	-	1.71034 (7.889443E-04)	-	4.08847 (6.525121E-04)	-	2.17782 (4.613870E-04)	-	5.11388 (7.046471E-04)	-	2.60697 (1.028168E-03)	-	4.04218 (6.330651E-04)	-	3.75941 (1.272262E-03)	-
Ra-226	1600 y	-	-	-	-	-	-	-	-	84.12763 (3.609464E-03)	-	-	-	-	-	-	-
Ac-228	6.13 h	32.11418 (3.816273E-04)	-	25.67725 (3.461567E-04)	-	40.71807 (4.064091E-04)	-	43.35238 (3.982933E-04)	-	39.92885 (4.674417E-04)	-	46.43836 (4.704221E-04)	-	31.81183 (4.430920E-04)	-	86.30300 (6.446281E-04)	-
Th-231	25.52 h	2.90830 (1.931060E-04)	-	8.15890 (5.423614E-04)	-	4.08180 (3.504959E-04)	-	13.11601 (7.143757E-04)	-	3.40243 (2.339151E-04)	-	15.75796 (7.769898E-04)	-	6.02028 (4.428268E-04)	-	21.83365 (8.788326E-04)	-
Pa-234	6.70 h	-	-	1.51106 (2.695784E-04)	-	0.54414 (8.058321E-05)	-	2.09226 (1.533212E-04)	-	1.15682 (1.695050E-04)	-	3.33176 (3.882538E-04)	-	-	-	3.68902 (1.845448E-04)	-
Pa-234M	1.17 m	46.81908 (2.277478E-02)	-	-	-	63.23374 (2.397467E-02)	-	46.15681 (1.310819E-02)	-	-	-	37.60111 (1.250162E-02)	-	85.37330 (2.191750E-02)	-	34.09559 (1.595875E-02)	-
U-235	7.03E8 y	3.29008 (2.465588E-04)	-	2.95220 (1.599025E-04)	-	4.66790 (2.015679E-04)	-	5.00297 (2.016363E-04)	-	-	-	4.83571 (2.045630E-04)	-	4.59232 (2.011812E-04)	-	7.17032 (2.373267E-04)	-

Background radiation measurement in soil

- If the measured value is below MDA(Minimum Detectable Activity) value, it is designated as MDA.
- ^{137}Cs were detected in all samples of about 0.18 ~ 1.50Bq/kg-dry, except for the sample number 8. The detection of this artificial isotope was assumed due to radioactive fallout from the past nuclear bomb experiments and the long time effect of Fukushima accident in Japan.
- ^{60}Co was detected at sample number 3, about 0.50Bq/kg-dry. ^{54}Mn was detected in all samples, 0.47 ~ 1.52Bq/kg-dry except sample number 2. The detection of ^{60}Co and ^{54}Mn can be explained by the nearby Kori nuclear power plant.
- Typical natural radionuclide ^{40}K was also detected in all samples, about 417 ~ 938 Bq/kg-dry which lies in the range reported by the Korea Institute of Nuclear Safety.

Conclusions

- Nuclear safety act (104) requires background radiation measurement only for a nuclear power plant facilities.
- We also measured the background environmental radiation for the KHIMA facility.
- Effective dose rate on the ground was about 1.5 times higher than the annual dose limit for a public area, 1mSv/yr.
- For the artificial radioactive isotopes, we observed ^{137}Cs, ^{60}Co, and ^{54}Mn. ^{137}Cs is unusual because this can frequently be observed in the area of the nuclear bomb experiments. Thus, we carefully guess that it is due to the radioactive fallout from nuclear bomb experiments or the long time effect of Fukushima accident in Japan.
- Our facility is already affected by the other nearby or far away facilities and our measurements prove to be very useful for the relative estimation of the effect done only by the KHIMA facility.

KIRAMS

Thank You

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