

Status of the Y2L HPGe laboratory for low background measurements

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HPGe Detectors at Y2L

YangYang Underground Lab. (Y2L)

- The Y2L is located at a space provided by the Korea Hydro and Nuclear Power (KHNP) company.
- The Y2L is located in a tunnel where the vertical depth is about 700m.
- Rare events physics experiments such as COSINE(DM), AMoRE(0vDBD), and the low background HPGe facility are operating in Y2L.



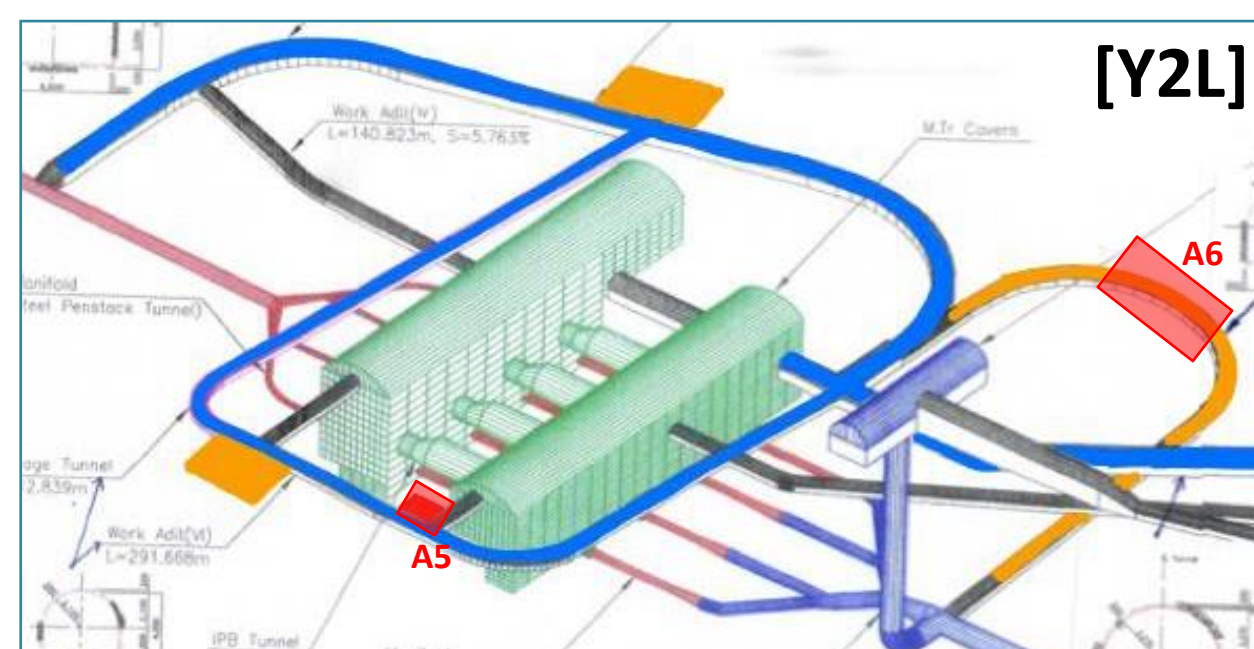
[Y2L Location]

HPGe Detectors at Y2L

- Two P-type HPGe detectors are running now.
- A well type HPGe detector is installed.
- A HPGe detector array in collaboration with CANBERRA are running now for Background measurement.

Detector Type	Location	Name	status
P type	Single detector	CC1	Running
Well type	Single detector	CC2	Running
P type	Detector Array w/ 14 detectors	ARRAY (temporary)	Running

[HPGe detector list in Y2L]



[A5/A6 room location]

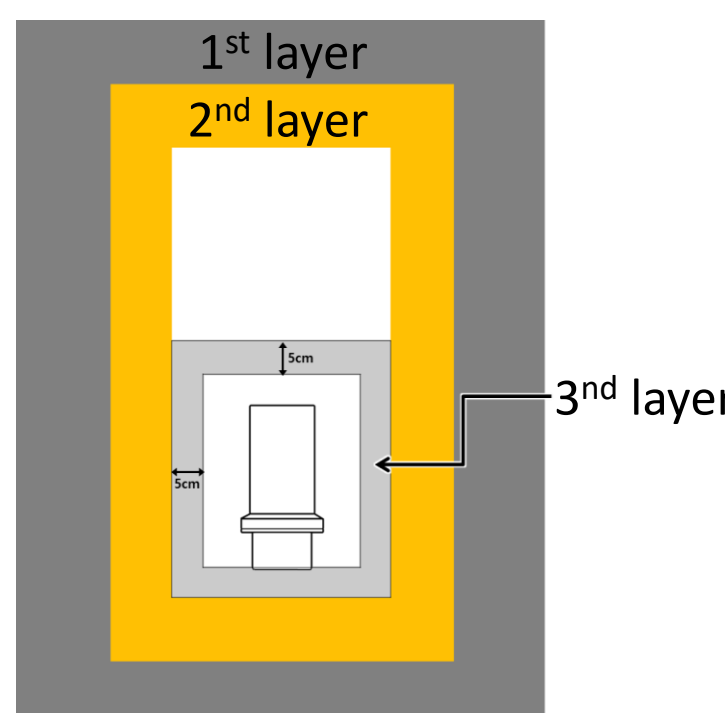
Overview : CC1 & CC2

CANCOAX1 : CC1

- CC1 is a P-type detector from CANBERRA and installed at Y2L/A6 in 2010. It's being used for radioactivity measurements of samples for other experiments.

- Shielding(Sh1v2) structure**

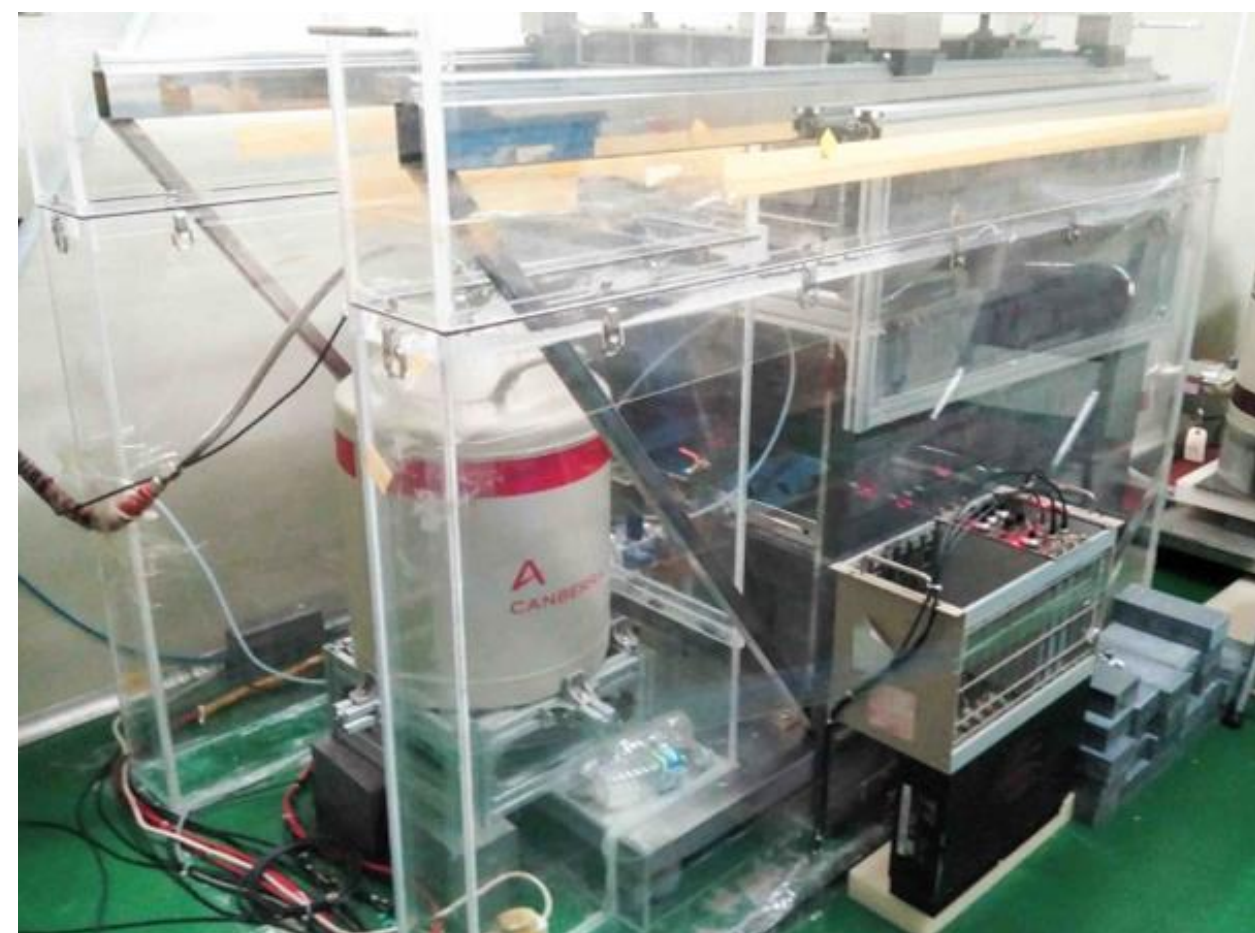
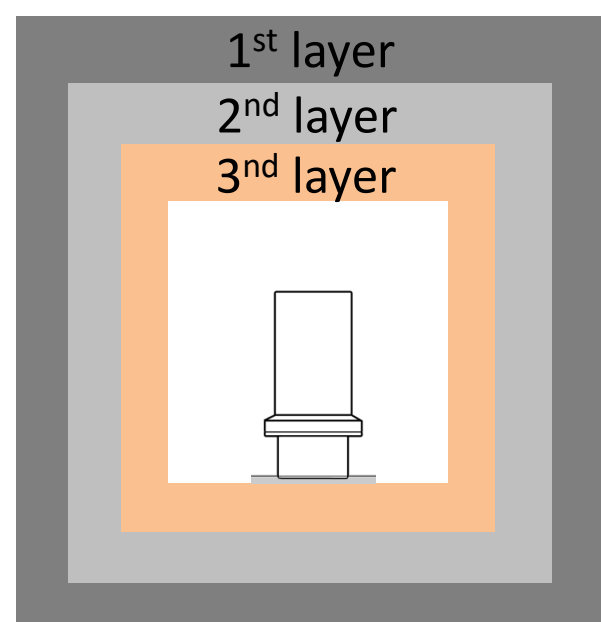
Sh1v2	material	Thickness
1 st layer	General lead	Top& bottom 10cm Side 15cm
2 nd layer	Copper	10cm
3 rd layer	Ancient lead	5cm



CANCOAX2 : CC2

- CC2 is a P-type detector from CANBERRA and installed at Y2L/A6 in 2016. It has the same purpose as the CC1.
- Shielding(Sh2v2) structure**

Sh2v2	material	Thickness
1 st layer	General lead	10 cm
2 nd layer	Goslar lead	10 cm
3 rd layer	Copper	10 cm



▲ [Detector CC2 & shield Sh2v2 Structure]

◀ [Detector CC1 & shield Sh1v2 Structure]

Background level : CC1 & CC2

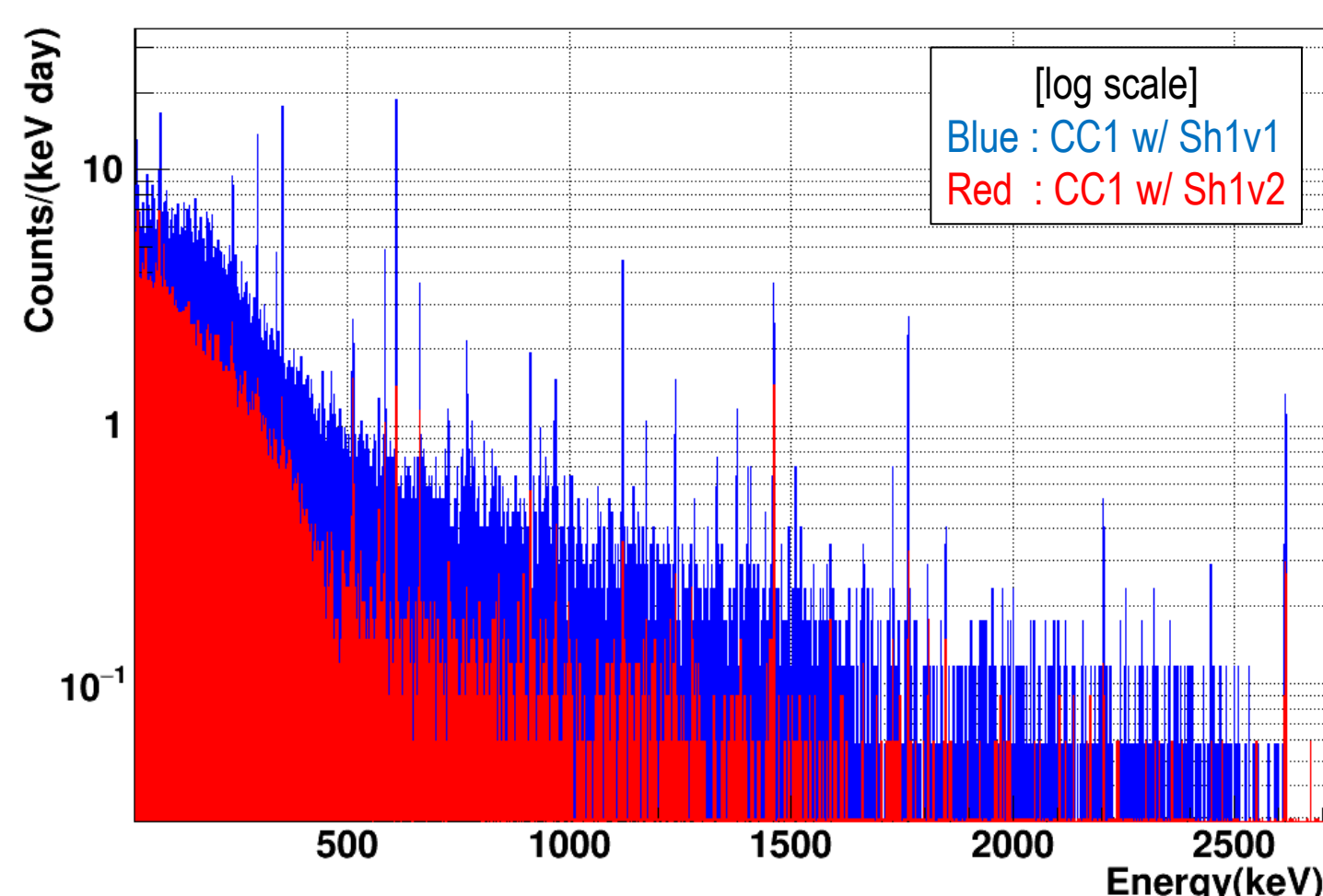
Sh1 : Shielding of CC1

- Sh1v1** : Sh1 was composed of only 1st layer(Copper) and 2nd layer(General lead) until August 2014. Background Net count rate was about 0.023Hz (@50-3000keV).
- Sh1v2** : 3rd layer(Ancient lead) was added to reduce the background level from November 2014. Background Net count rate is about 0.0075Hz (@50-3000keV).

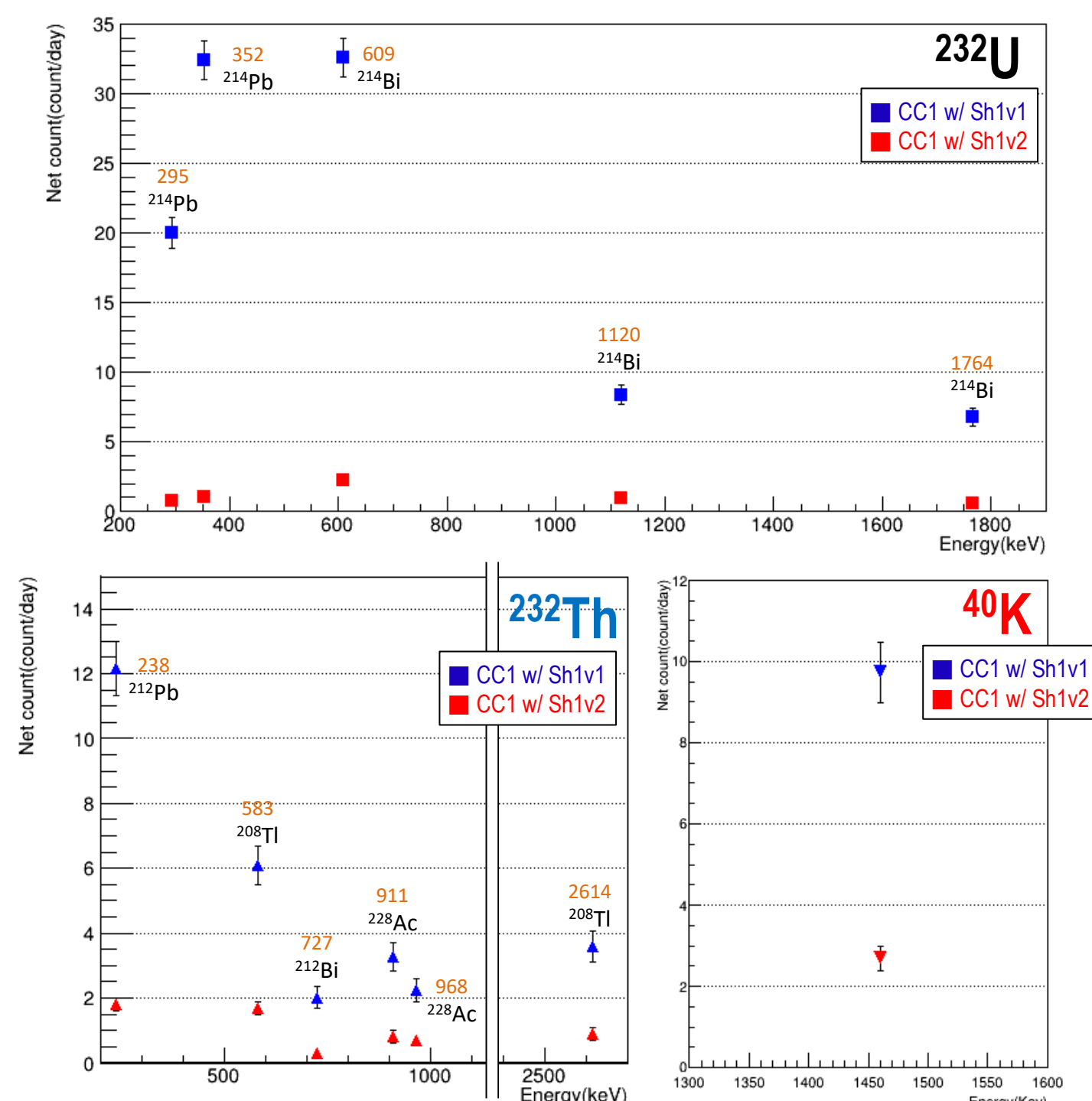
- Background Net count rate (@50-3000keV)**

- Sh1v1 : about 0.023Hz (17.1 day)

- Sh1v2 : about 0.0075Hz (33.3 day)



▲ CC1 Background spectrum comparison



[238U, 40K, and 232Th levels in the CC1]

Isotopes	Peak (keV)	Net count (count/day)	
		CC1 Sh1v1	CC1 Sh1v2
²³⁸ U	²¹⁴ Pb 352	32.4±1.4	1.0±0.2
	295	20.0±1.1	1.0±0.2
	²¹⁴ Bi 609	32.6±1.4	2.1±0.3
	1764	6.7±0.6	0.6±0.1
²¹⁴ Bi	1120	8.4±0.7	0.9±0.2
	⁴⁰ K 1460	9.7±0.7	2.7±0.3

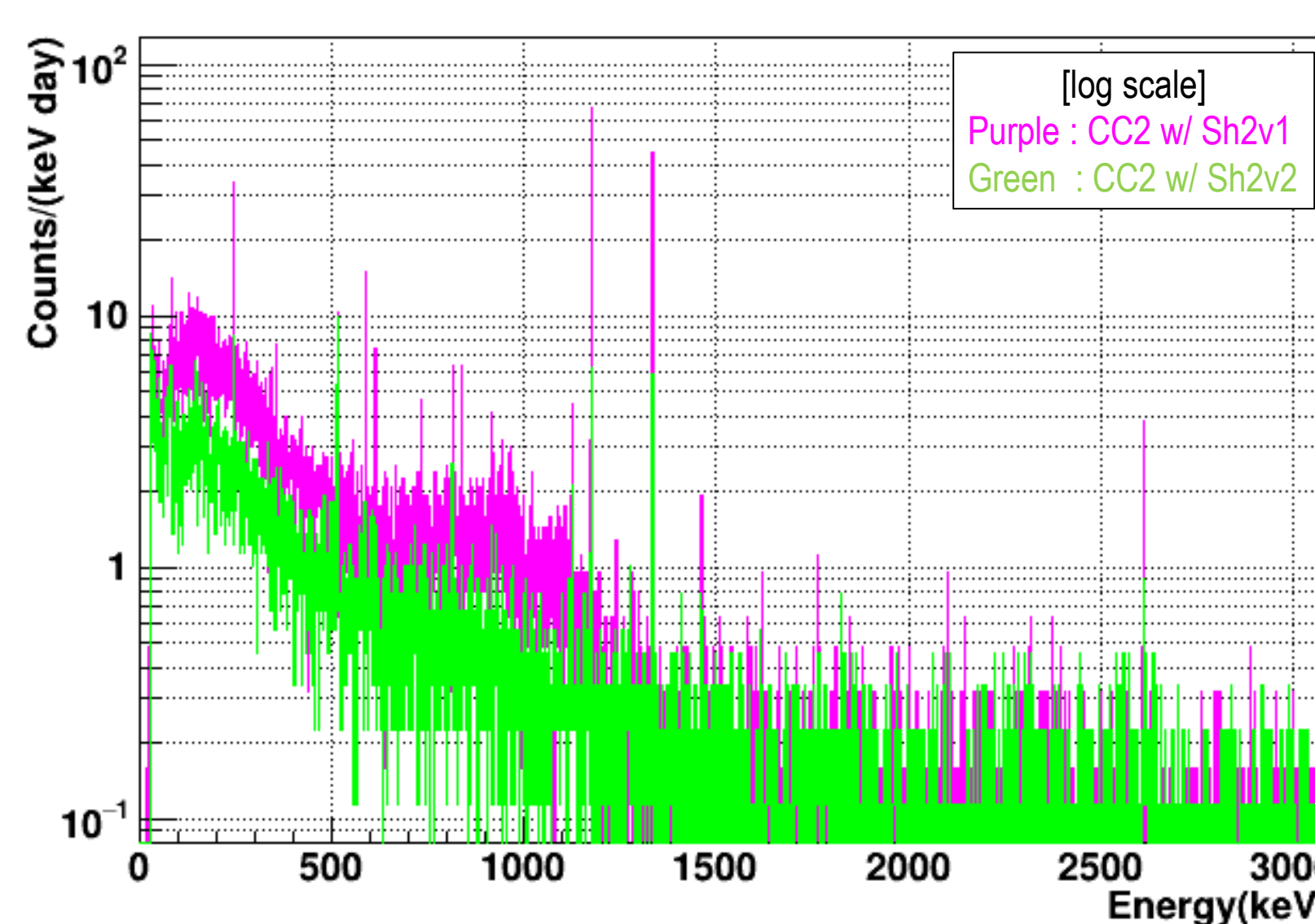
[CC1 Background levels (mBq/kg)]

Sh2 : Shielding of CC2

- Sh2v1** : Background level of CC2 with Sh2v1 at the beginning (May 2016) was huge compared with the CC1. Especially very high levels of Cobalt peaks were found and it is suspected that the movement parts of the Sh2v1 include stainless steel.
- Sh2v2** : The layer structure is the same as the Sh2v1 but some movement parts were changed in August 2016.
- Background Net count rate (@50-3000keV)**

- Sh2v1 : about 0.040Hz (6.3 day)

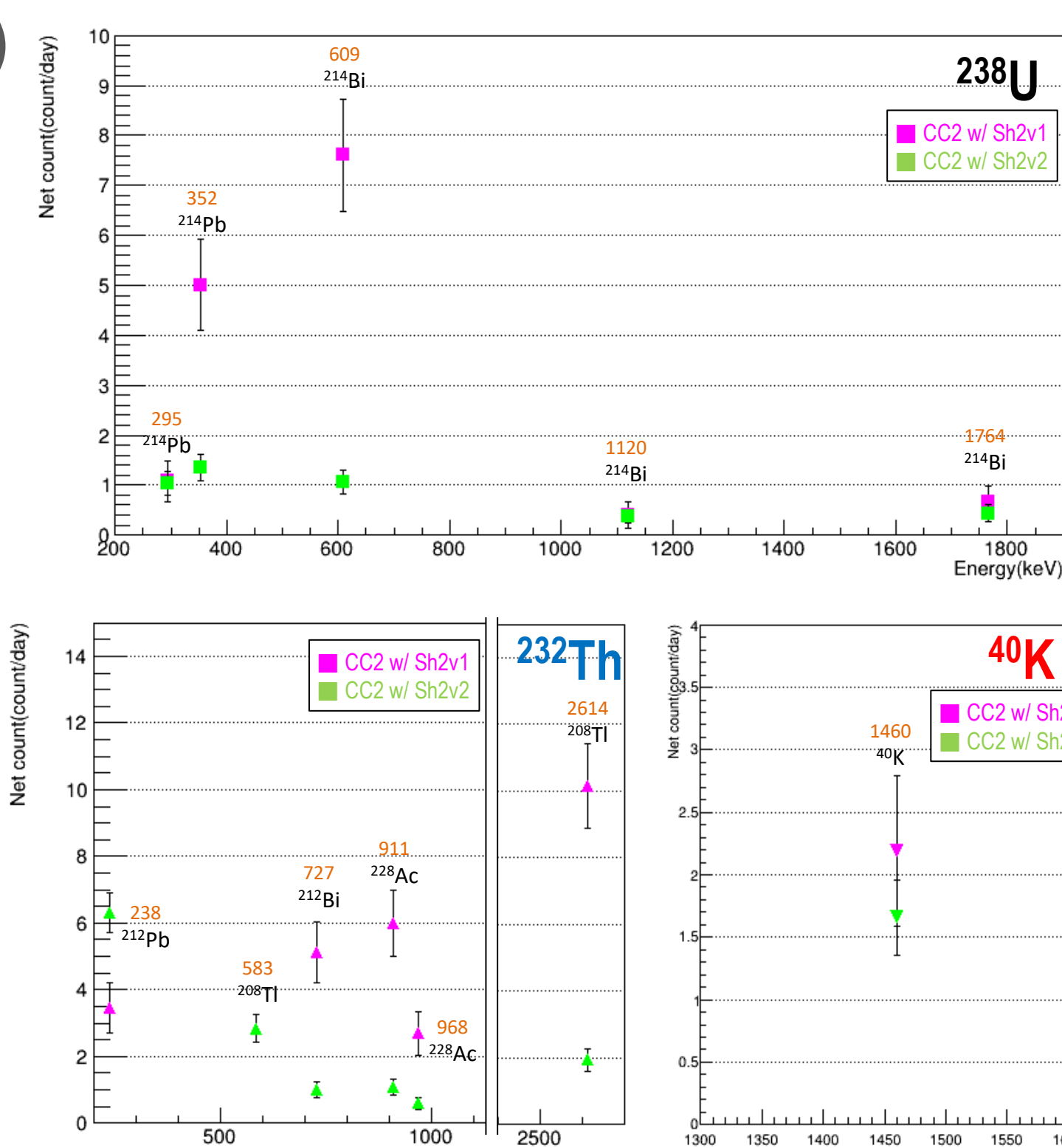
- Sh2v2 : about 0.018Hz (18.0 day)



[CC2 Background spectrum comparison]

Isotopes	Peak (keV)	Net count (count/day)	
		CC2 Sh2v1	CC2 Sh2v2
²³⁸ U	²¹⁴ Pb 352	5.0±0.9	1.4±0.3
	295	1.1±0.4	1.0±1.2
	²¹⁴ Bi 609	7.6±1.1	1.1±1.2
	1764	0.7±0.3	0.4±0.2
²¹⁴ Bi	1120	0.4±0.3	0.4±0.1
	⁴⁰ K 1460	2.2±0.6	1.7±0.3

Isotopes	Peak (keV)	Net count (count/day)	
		CC1 Sh1v1	CC1 Sh1v2
²³² Th	²²⁸ Ac 911	3.3±0.4	0.8±0.2
	968	2.3±0.4	0.7±0.1
	²¹² Pb 238	12.2±0.8	1.8±0.2
	²¹² Bi 727	2.0±0.3	0.3±0.1
²⁰⁸ Tl	2614	3.6±0.5	0.9±0.2
	583	6.1±0.6	1.7±0.2

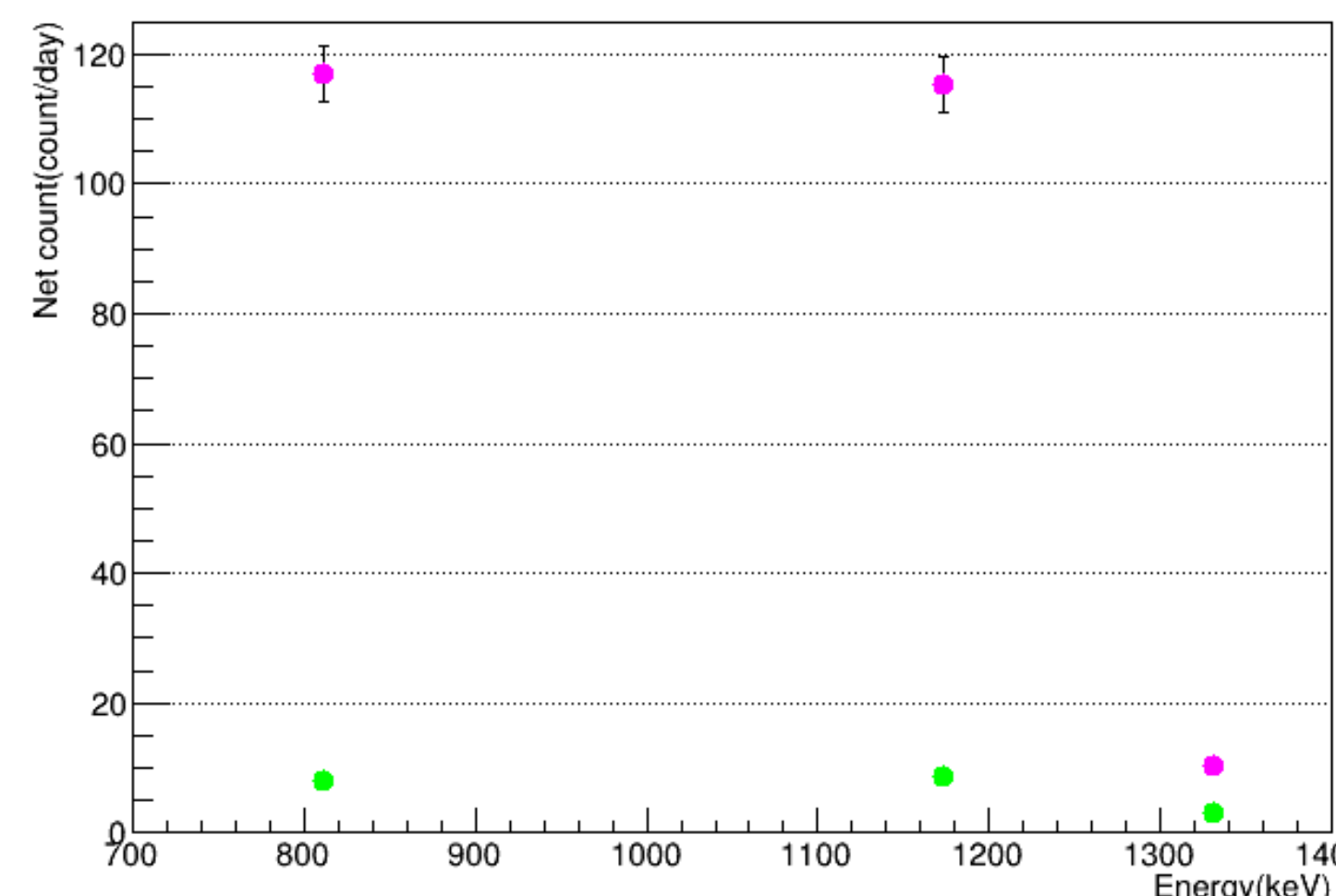


[238U, 40K, and 232Th level of CC2]

Isotopes	Peak (keV)	Net count (count/day)	
		CC2 Sh2v1	CC2 Sh2v2
²³² Th	²²⁸ Ac 911	6.0±1.0	1.1±0.3
	968	2.7±0.7	0.6±0.2
	²¹² Pb 238	3.5±0.7	0.8±0.2
	²¹² Bi 727	5.1±0.9	1.0±0.3
²⁰⁸ Tl	2614	10.2±1.3	1.9±0.4
	583	25.8±2.0	2.8±0.2

[CC2 Background levels (mBq/kg)]

- Cobalt levels**



Isotopes	Peak (keV)	Net count (count/day)	
		CC2 Sh2v1	CC2 Sh2v2
⁶⁰ Co	1173	117.0±4.4	8.1±0.8
	1332	115.4±4.4	8.8±0.8
⁵⁸ Co	811	10.2±1.3	3.0±0.5

[CC2 Cobalt levels (mBq/kg)]

Summary & Plan

- We have 3 single detectors and 1 array detector in Y2L. CC1 and CC2 are running for material screening now, and an ARRAY is running for background measurement. A WELL is installed and will be running soon after a few tests.

- CC1

CC1 is the first P-type HPGe detector in Y2L. Sh1v1 is the first shielding of CC1 with general lead and copper and its background level was 0.023Hz (@50-3000keV). Sh1v2 is the improved shielding from sh1v1 with ancient leads. The background level of CC1 with Sh1v2 is 0.0075Hz (@50-3000keV). ²³⁸U level is greatly decreased by factors of 10~30. ²³²Th level is reduced by factors of 2~6, and ⁴⁰K also reduced by a factor of about 3.

- CC2

CC2 is the second P-type HPGe detector in Y2L. Sh2v1 is the first shielding of CC2 with general lead, Goslar lead, and copper. Background level of CC2 with Sh2v1 was higher than expected, and Co activity was especially very high. Sh2v2 is a modified shielding in August 2016. After the shield improvement, the background level of CC2 is reduced from 0.040Hz(Sh2v1) to 0.018Hz(Sh2v2). ²³²Th level is reduced by factors of 3~6 and several peaks of ²³⁸U are removed. ⁶⁰Co peaks are also reduced by a factor about 14 but still remained at about 8mBq/kg.

- Plan

- ✓ We will study the background of the CC2 in Sh2v2 for reduction of Cobalt activity.
- ✓ The ARRAY will be used for rare decay study, so It needs an ultra low background. The measurement and study of the ARRAY background are ongoing.