November 29, 2005

Progress report of LHeII Target for E570

Shigeru Ishimoto, Masami Iio

LHeII Target was cooled twice from the week of November 14 to last weekend.

< Set up >　Refer to Fig. 1.

① 8 SDDs were attached to disk and installed into the cryostat.

② The pipe, which includes the ^{55}Fe-checking source for calibration of the SDDs, was assembled in the cryostat.

③ The cables of power supply of SDDs and thermometers that were connected with 4 down-stream ports were moved to the 4 up-stream ports.

(Setup of a previous test　He consumption : -7.5 %/h)

④ Target cell was attached in order to measure consumption of helium without removing CFRP vacuum vessel.

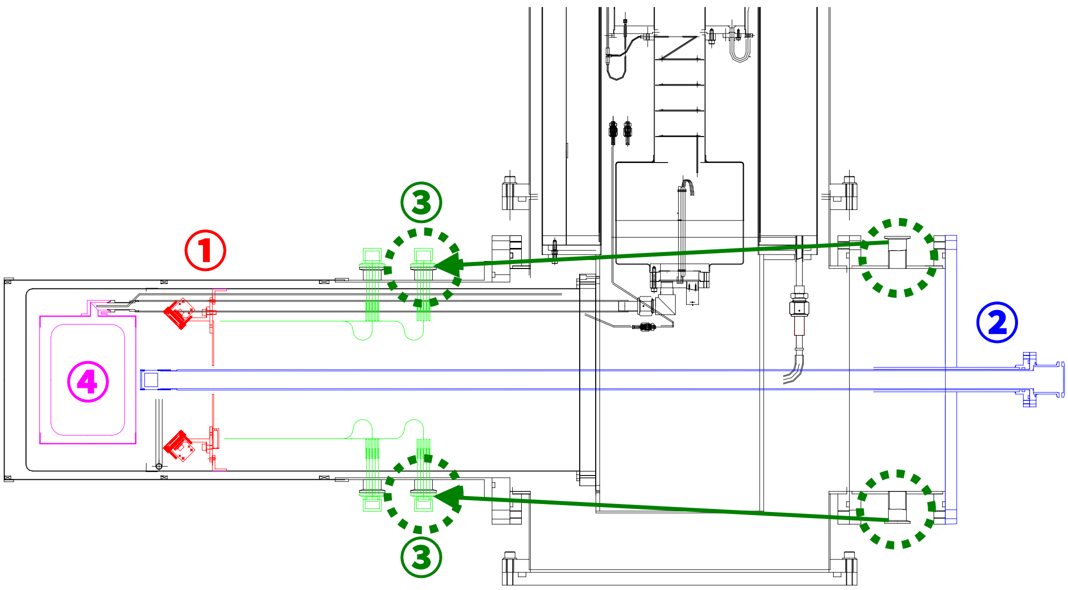

Fig. 1. Setup for SDD calibration test

< Condition of SDD calibration test >

- N_2 Buffer was filled with Liq. N_2.
- 4K Buffer was filled with He gas
- The inside of 1K parts was vacuum.

< Thermal stability during SDD calibration test >

The thermal stability of SDD No.6 is shown in the following Fig. 2- 7.

- Temperature change like a burst was observed but the thermal oscillation at the E570 beam time disappeared

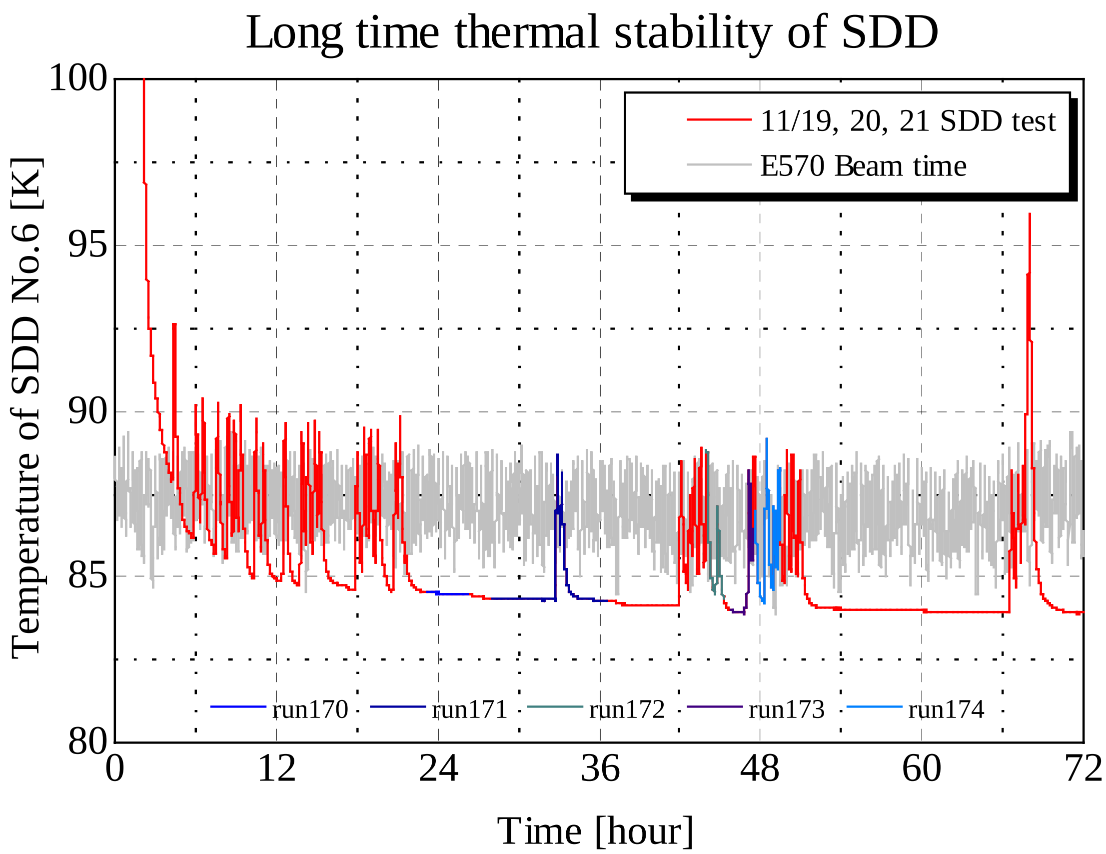

Fig. 2. Thermal stability

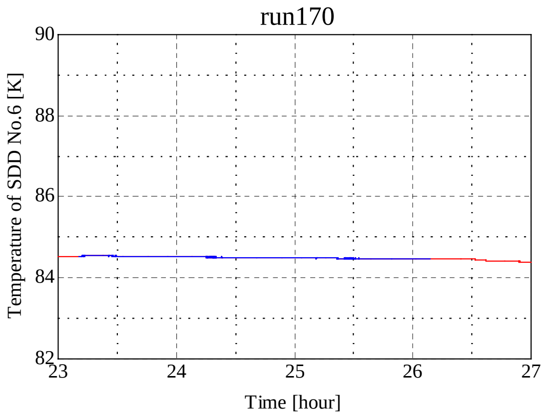

Fig. 3. run170

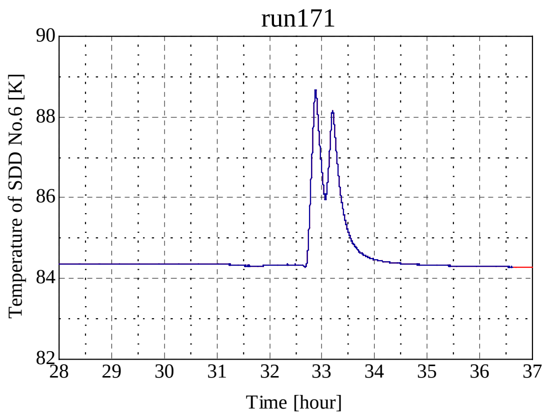

Fig. 4. run171

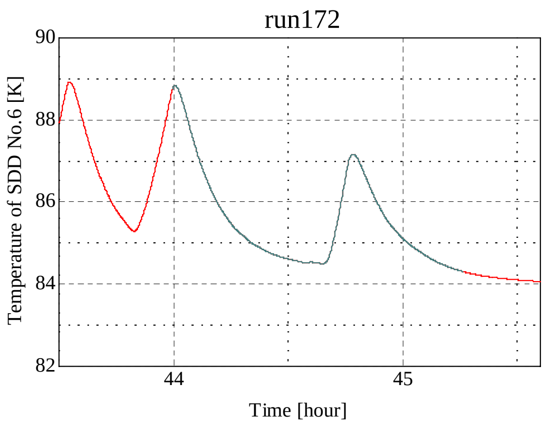

Fig. 5. run172

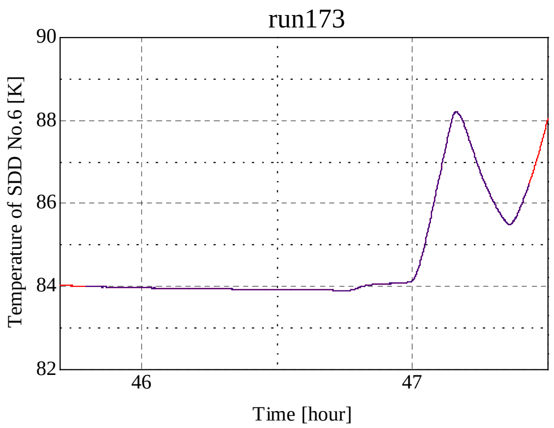

Fig. 6. run173

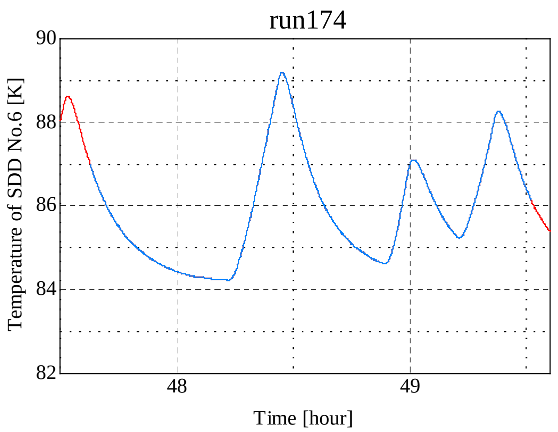

Fig. 7. run174

< He consumption test >

The target warmed up to room temperature after the SDD test, the [55]Fe pipe was pulled out, and it was cooled down again to measure the He consumption.

< The test result >

- **The thermal stability of SDD No.6 by He cooling is shown in the following Fig. 8, 9.**

➔ The burst disappeared and Temperature of SDD was 82.9±0.2 K.

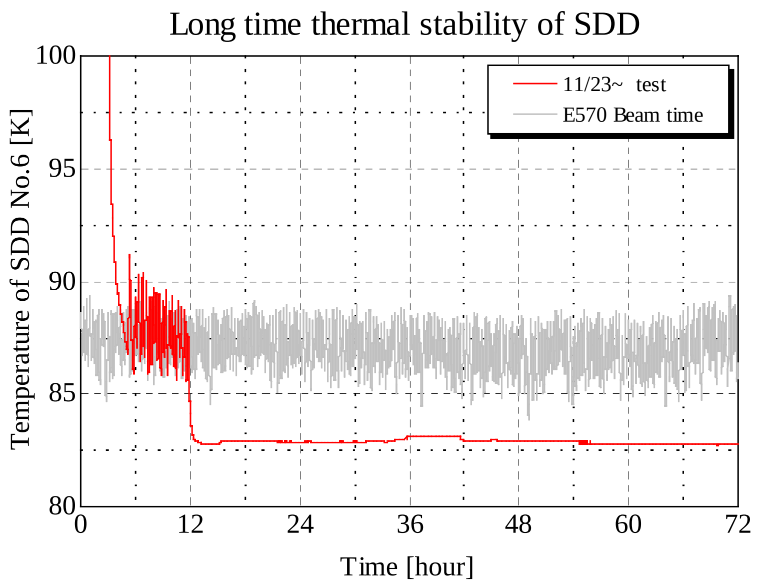

Fig. 8. Thermal stability by He cooling

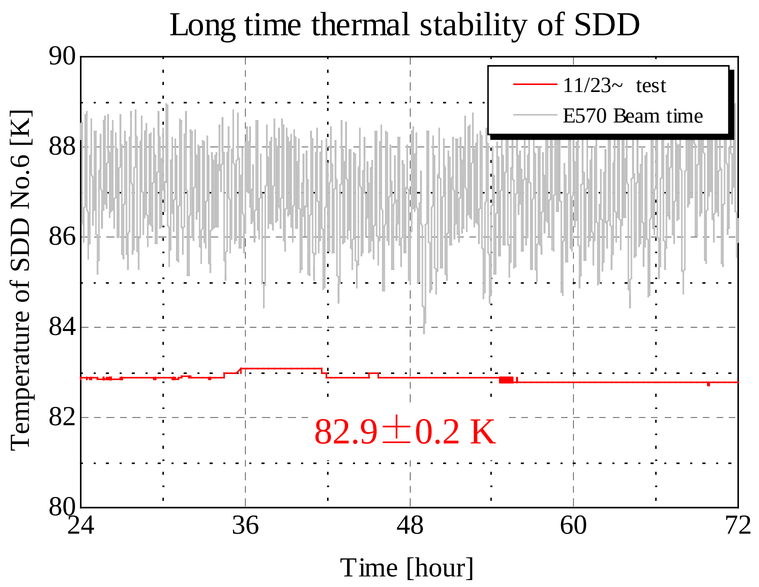

Fig. 9. Thermal stability by He cooling

- Result of He consumption is shown in the Fig. 10, 11, 12

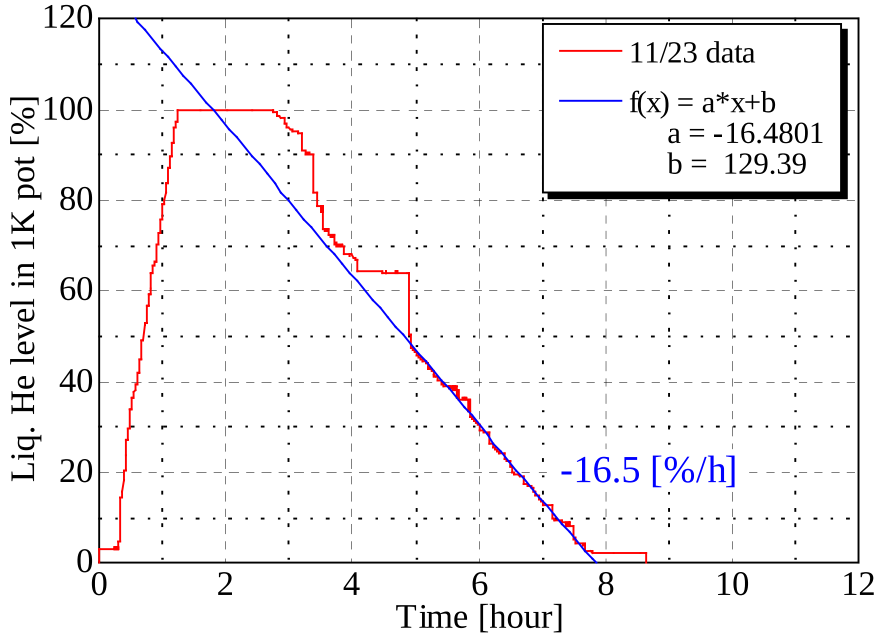

Fig. 10. Result of 1st He consumption test

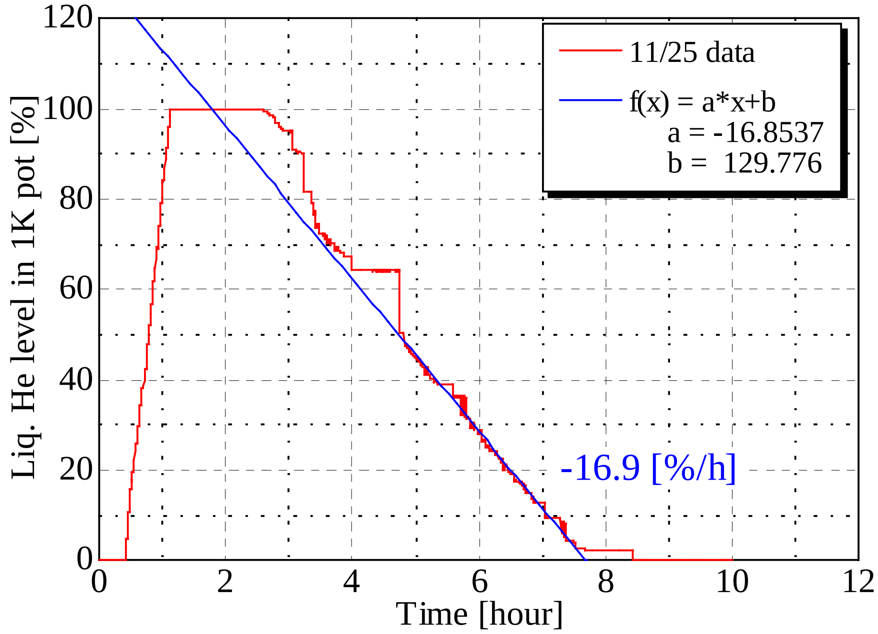

Fig. 11. Result of 2nd He consumption test

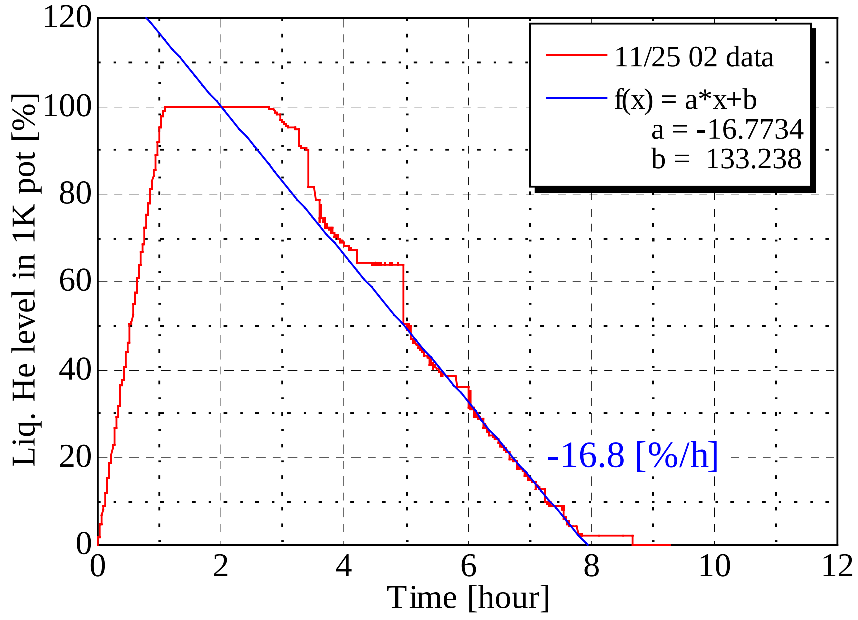

Fig. 12. Result of 3rd He consumption test

1st test (Fig. 10) : -16.5 [%/h]
2nd test (Fig. 11) : -16.9 [%/h] <= SDD H.V. of SDD was "ON"
3rd test (Fig. 12) : -16.8 [%/h]
(~-13 [%/h] <= E570beam time)

➔ Consumption of a helium increased!!!

- **Is the heat input from the hole for attaching a ^{55}Fe pipe large?**
- **As for the He consumption increase, the contact to SDD Disk or R.T. of the cables of cell heater is considered to be the cause.**

< The future plan to next test >

We will test once more on the condition that the following,

- **The down - stream hole for attaching a ^{55}Fe pipe is closed**
- **Cables of cell heater remove**

If there is no improvement, it will return to a E570 beam time setup.

ADC calibration

Hideyuki Tatsuno

2005.11.29 (Tue)

1 Introduction

At the E570 first cycle experiment the ADCs have some odd-even effect. Odd-even effect is a strange binning problem of TKO PH-ADC at 2^x ch or $2^y + 2^z$ ch. Due to this effect, the raw spectrum have some systematic error which is significant for the KHeX shift determinantion. This effect can be seen by measuring the differential non linearity (DNL). Measuring the DNL is very important to estimate the systematic error and to correct ADC ch digitization.
And the integral non linearity (INL) is also measured. INL is very sensitive to the pulser's non linearity. But it's difficult to estimate the pulser's non linearity, so there is a limit to measure and discuss the INL.

2 Differential non linearity

Differential non linearity is defined as the maximum and minimum difference between the step width and the perfect width of any output step. Step means the interval of input analog voltage for 1 output code (*ex.* 000 to 001). Non linearity produces quatization steps with varying widths. All steps should be 1, but some are narrower or wider.

2.1 Measurement

For this time measurement, BNC ramp generator (model:LG-1) and BNC pulse generator (model:PB-4) which are borrowed from SMI are used. The ramp generator output is Figure 1.

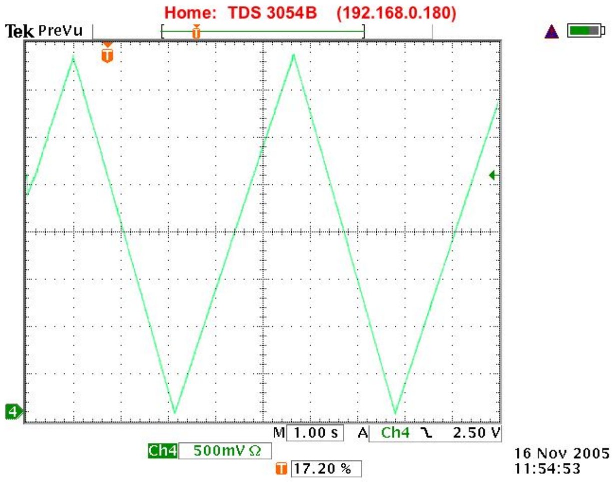

Figure 1: BNC ramp generator output. The period is 5 sec. The slope of up and down are some how different.

This time the period was 5 sec to take a picture by an oscilloscope, for actual measurement the period was 50 sec which is enough for the pulse generator to generate continuous gaussian shape pulse. This ramp generator has different slopes for up and down. But it doesn't influence the DNL measurement. And this ramp generator has some negative output like Figure 2.

This negative output is reflected on the pulse generator output. Figure 3 is the pulse generator output. The ramp generator negative output corresponds to the negative shaped pulse.

The pulse generator has some offset $\sim$ 4 mV, this is adjustable but we forgot to do. These negative pulse and some offset are reflected on the raw histogram of ADC. Figure 4 is typical raw histograms of ADC. The right figure is the zoom up of the left one. The offset and negative effects can be seen. The left side figure has some slope which is due to the pulse generator's non linearity. This slope was seen also in the previous Berti's report.

To estimate the DNL, three steps are needed. First cut the region of negative and offset effects 0-500 ch and overflowed region, second fit the histogram by linear line, finally cal-

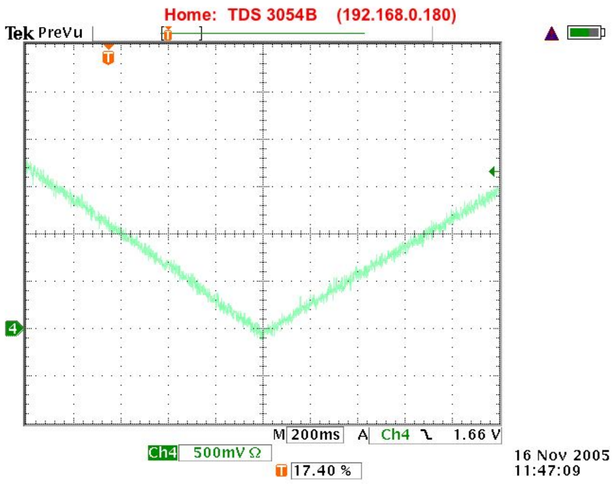

Figure 2: Zoom upped the ramp generator output. The period is 5 sec. A little negative region exist.

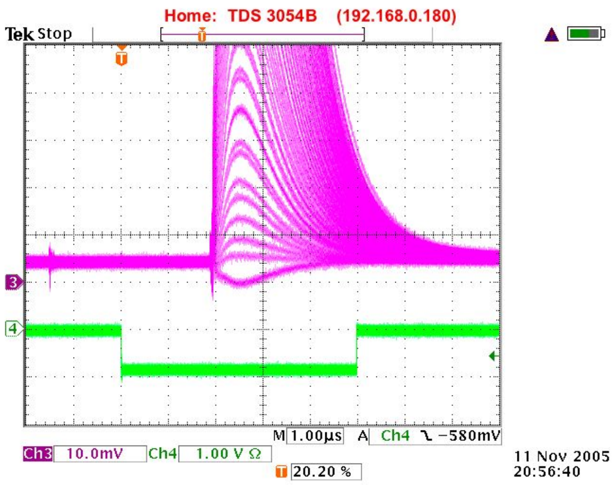

Figure 3: BNC pulse generator output. The input is ramp generator's out. The period is 5 sec. Some negative region and offset can be seen.

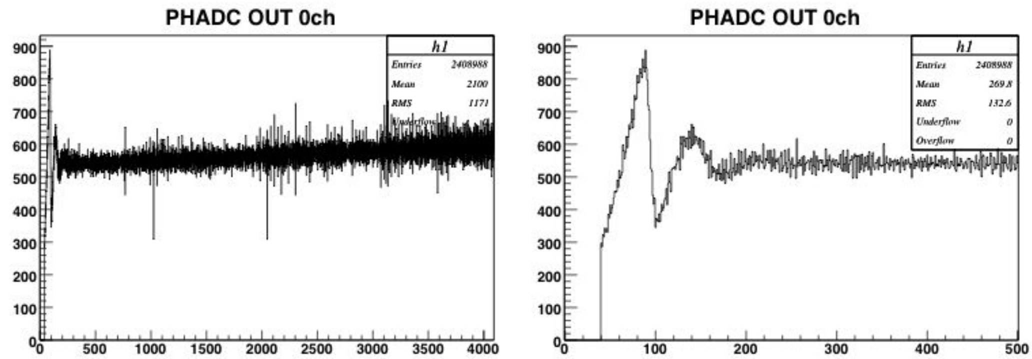

Figure 4: Typical DNL histograms. The right figure is a zoom up of the left one. The left side figure has some slope. In the right one, some spike structure can be seen. To fit the slope, need to cut the spike region.

culate the residue of raw data and the fit result. Figure 5 is a typical step of estimation of DNL.

The result of 8 channels (0 to 7 ch) for actual experiment is Figure 6.The average is $\underline{5.2310 \pm 0.0243\ \%}$.

This DNL is too huge! This huge DNL is due to the frequently odd even effect. Especially at 1024 and 2048 ch, extraordinary odd even effect exists. And more, 16 channels or 32 channels interval are large effects like Figure 7.

To reduce this odd even effect, what we can do is randomizing the ADC ch. Adding ran() - 0.5 or (ran() - 0.5)$\times$2 is some how effective which was reported by Hayano-san (mail 11/3). But even it can't omit the effect. We expect the TKO Wilkinson ADC...

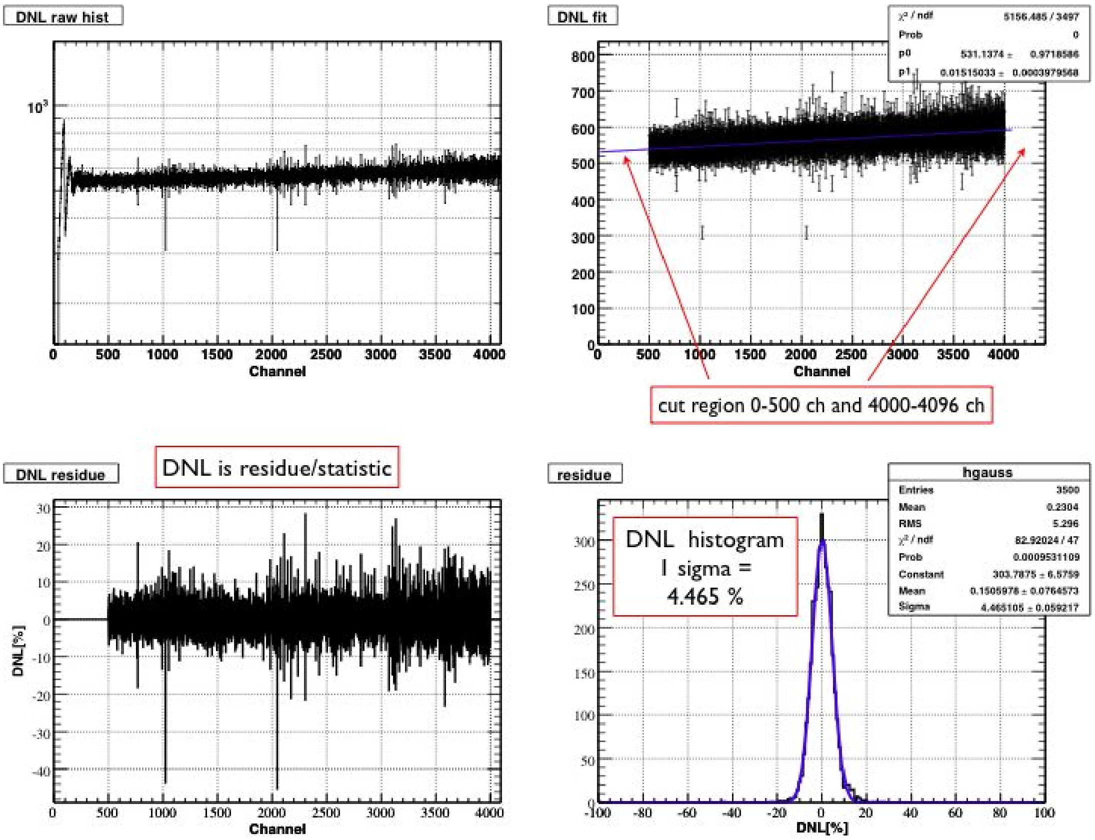

Figure 5: Three steps of DNL estimation. First cut the region of negative and offset effects 0-500 ch and overflowed region, second fit the histogram by linear line, finally calculate the residue of raw data and the fit result.

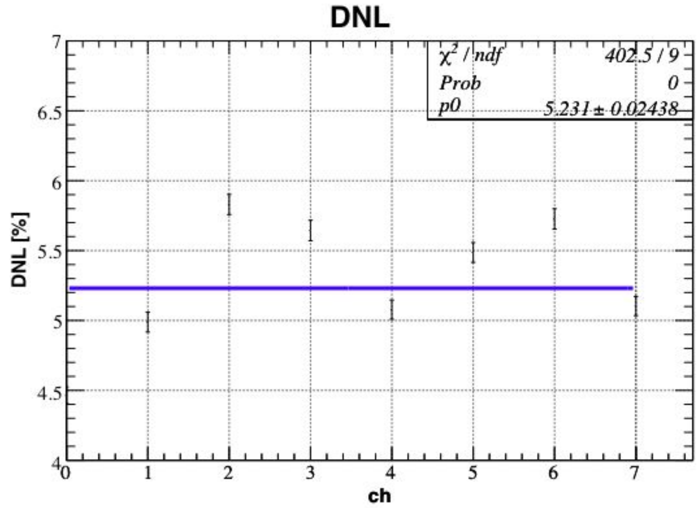

Figure 6: 8 ch DNL results. This average is 5.2310 ± 0.0243 %.

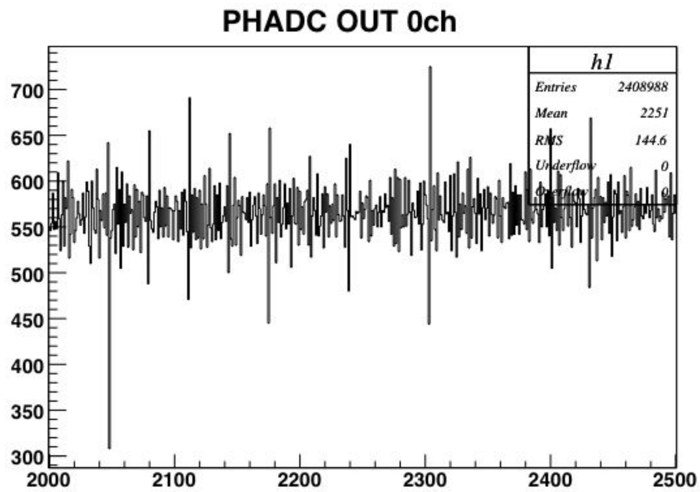

Figure 7: Typical odd even effects. Some extraordinary effect can be seen at 2048 ch and with 16 or 32 ch interval.

3 Integral non linearity

Integral non linearity is defined as the maximum vertical difference between the actual and the perfect curve. INL can be interpreted as a sum of DNLs. INL influences the calibration peaks mean directly, so its measurement is very important for estimation of the systematic error. But the measurement is difficult, because the analog input needs precise linearity. Unfortunately the BNC pulser's linearity is suspicious, so only the limit can be determined.

3.1 Measurement

This time also the BNC pulse generator was used. The typical generated pulse is like Figure 8.

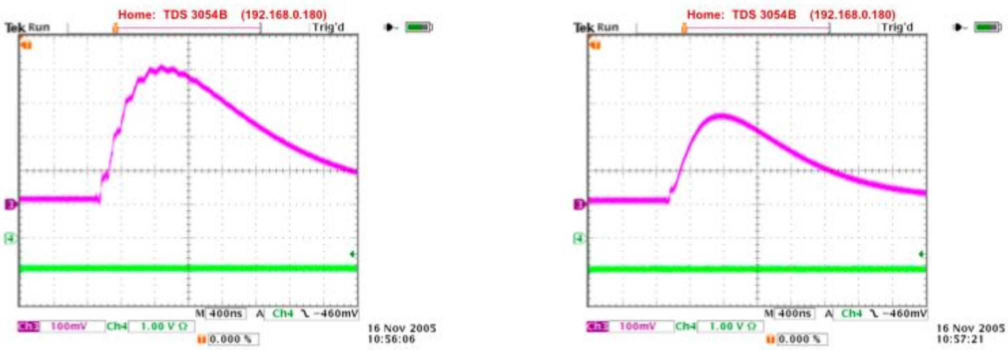

Figure 8: Typical BNC pulse generator output. The left figure is not attenuated pulse, the right one is 2 times attenuated pulse.

The left figure is not attenuated pulse, the right one is 2 times attenuated pulse. Clearly the left figure has some strange edge structure. On the other hand the attenuated pulse doesn't have it. This is because the measurement was done by attenuated pulse.

The pulse generator has four dials to tune the pulse height. Outmost dial number is 0 to 9, so we can change the pulse height 10 times. INL was measured by this dial change, in other words measured ten points of ADC channel.

The input voltage, pulse height accuracy is most important for INL. The pulse height is measured by a digital oscilloscope. The digital oscilloscope converts an analog input to a digital signal by like flash ADC, so already at this point some non linearity can exist. For this reason, we can say only the upper limit of the integral non linearity.

Before the result, look back on the previous INL measurement. According to previous report (2005/9/15), the ADC have about 35 ch INL. This is too huge. Then we checked it by the same method, and reached the same result and found the reason of the huge INL (Figure 9).

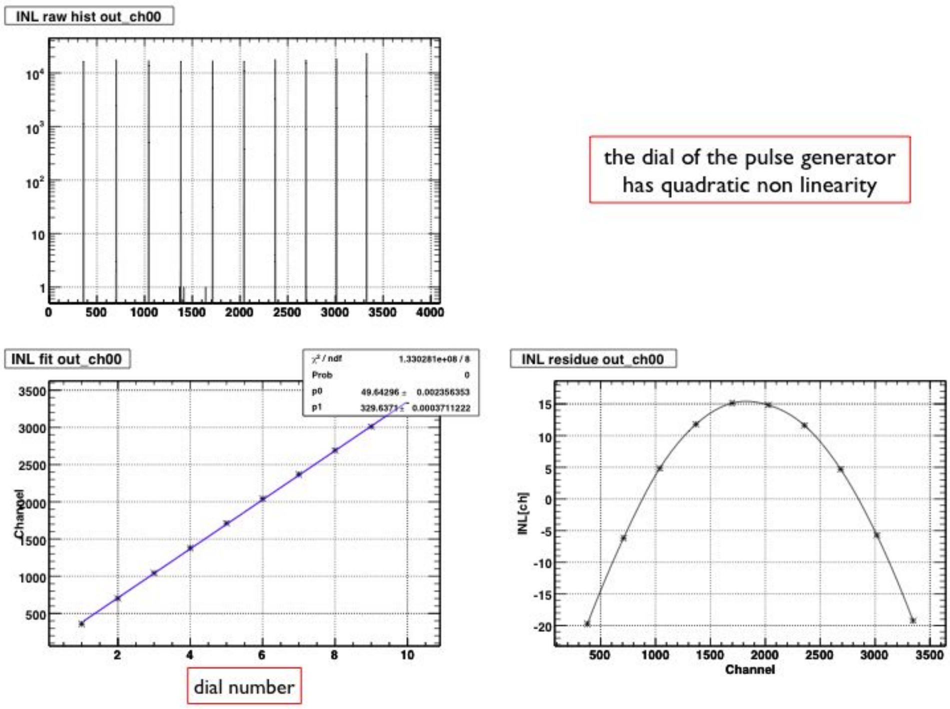

Figure 9: Reconstruction of previous INL measurement. The dial of the pulser has quadratic non linearity.

The reason is that the pulse generator has quadratic non linearity. Because this non linearity is very large, the ADC INL is hidden. To see the ADC INL, more precise input voltage measurement is needed. But it is difficult, so we measured it by oscilloscope. Unfortunately the oscilloscope has some line width. This line width becomes the pulse height error, so it is not so accurate. Even so, the ADC INL like result can be seen in Figure 10.

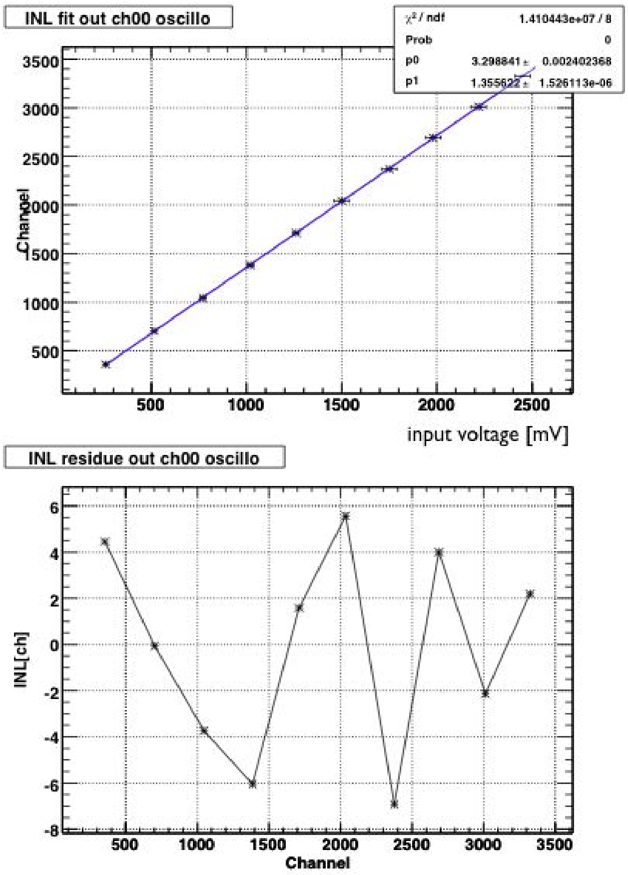

Figure 10: INL of ADC. The input voltage is measured by digital oscilloscope, so it is not enough for estimation of INL and the systematic error.

But this maybe also over estimation. We need more precise physical calibration peaks or accurate pulse generators for the measurement of INL.

4 Pulser for ADC gain monitor

We borrowed an ORTEC pulse generator from Tamura-san. In the last preparation report (mail), this pulser had strange high frequency noise. But recently that noise has disappeared, so we can use it for ADC gain monitor.

For checking the long time stability of the pulser and ADC system, 11 hours data was recorded, and compared with a short time data. Figure 11 is the result.

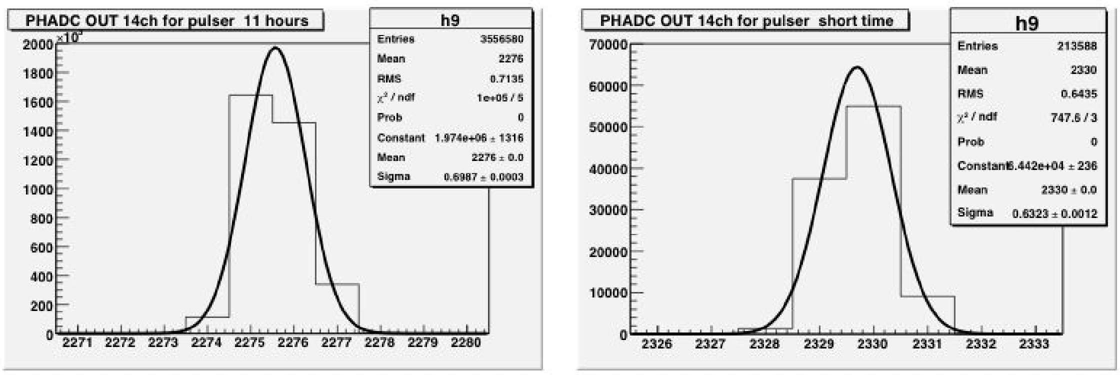

Figure 11: The comparing of long time and short time pulser output measurement. Left is 11 hours data, right is short time (a few minutes) data.

The left side 11 hours fit result looks wider than the right side short time one. But this can be occurred by INL, DNL or the input voltage error. So we can't conclude only by this whether the system has the long time stability. Even so this pulser can be used as an ADC gain monitor.

E570 meeting report

2005/11/29 S.Okada

1 ^{55}Fe source calibration for new SDDs

Last week we have performed ^{55}Fe source calibration for new five SDDs and three SDDs which have worked well in E570 first cycle. At this moment, seven SDDs is working well and one SDD (port #1) could not work due to bad connection of Ring X voltage line.

We took both data with and without preamp cover. The fit results are shown in Figure 2 (w/o preamp cover) and Figure 3 (w/ preamp cover). The Gaussian width (FWHM) at Mn $K_{\alpha 1}$ is listed in Table 1. The width was not drastically changed before and after covering preamp box. Though the resolution of SDD #2 and #5 which had been working well in the last beam time was not good, we confirmed that the newly orderd SDDs are working well and having good resolution. The SDD operation temperature in this measurement was about 85K. (see Iio-san's report)

Fitting results			
SDD#		FWHM [eV] @ Mn $K_{\alpha 1}$ (SDD calib. run #)	
		w/o preamp cover	w/ preamp cover
#1	(new)	-	-
#2	(original)	218.60 ± 0.41 (run#171)	217.95 ± 0.92 (run#174)
#3	(new)	198.66 ± 0.35 (run#171)	197.45 ± 0.62 (run#174)
#4	(original)	181.75 ± 0.41 (run#170)	184.54 ± 0.84 (run#173)
#5	(original)	217.65 ± 0.55 (run#170)	220.90 ± 0.85 (run#173)
#6	(new)	198.95 ± 0.27 (run#171)	188.50 ± 0.52 (run#174)
#7	(new)	191.43 ± 0.30 (run#171)	189.30 ± 0.68 (run#174)
#8	(new)	187.18 ± 0.57 (run#170)	194.47 ± 0.59 (run#173)

For the fitting method, I referred to

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‘‘Simulations of Si(Li) x-ray detector response’’,
 X-ray spectrom. 2001;30:230-241
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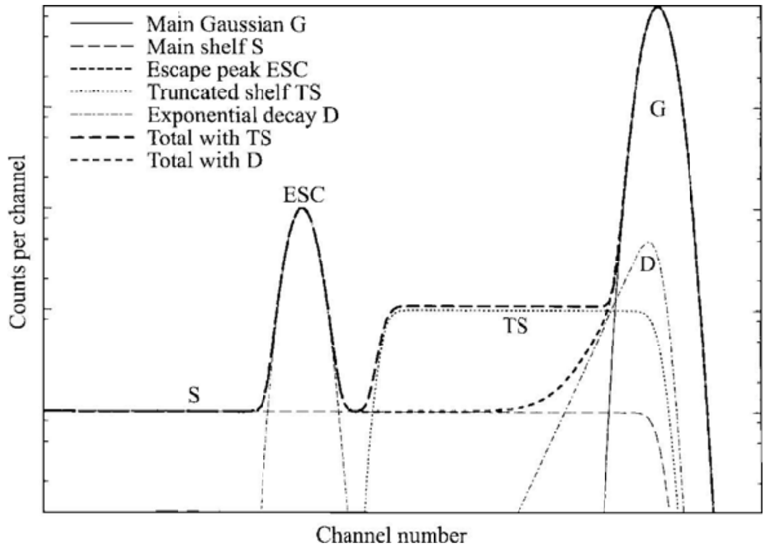

Figure 1: Typically encountered line shape described in empirical terms.

$$
\begin{aligned}
\text{Gaussian primary peak : } G(i) &= H_G \exp\left[\frac{-(i-i_0)^2}{2\sigma^2}\right] \\
\text{Shelf : } S(i) &= \frac{1}{2}\, H_S \operatorname{erfc}\left(\frac{i-i_0}{\sigma\sqrt{2}}\right) \\
\text{Truncated Shelf : } TS(i) &= \frac{1}{2}\, H_{TS} \left[\operatorname{erfc}\left(\frac{i-i_0}{\sigma\sqrt{2}}\right) - \operatorname{erfc}\left(\frac{i-i_T}{\sigma\sqrt{2}}\right)\right] \\
\text{Exponential-like feature : } D(i) &= \frac{1}{2}\, H_D \exp\left(\frac{i-i_0}{\beta}\right) \times \operatorname{erfc}\left(\frac{i-i_0}{\sigma\sqrt{2}} + \frac{\sigma}{\beta\sqrt{2}}\right)
\end{aligned}
$$

$\mathbf{i}$: channel number

$\mathbf{i}_0$: the centroid channel corresponding to the incident photon energy E_0

$\mathbf{i}_T$: the inflection point of lower extremity of the truncated shelf is equivalent to energy 0.4 E_0 to 0.85 E_0.

σ : the standard deviation of the Gaussian component

β : the slope of the exponential feature

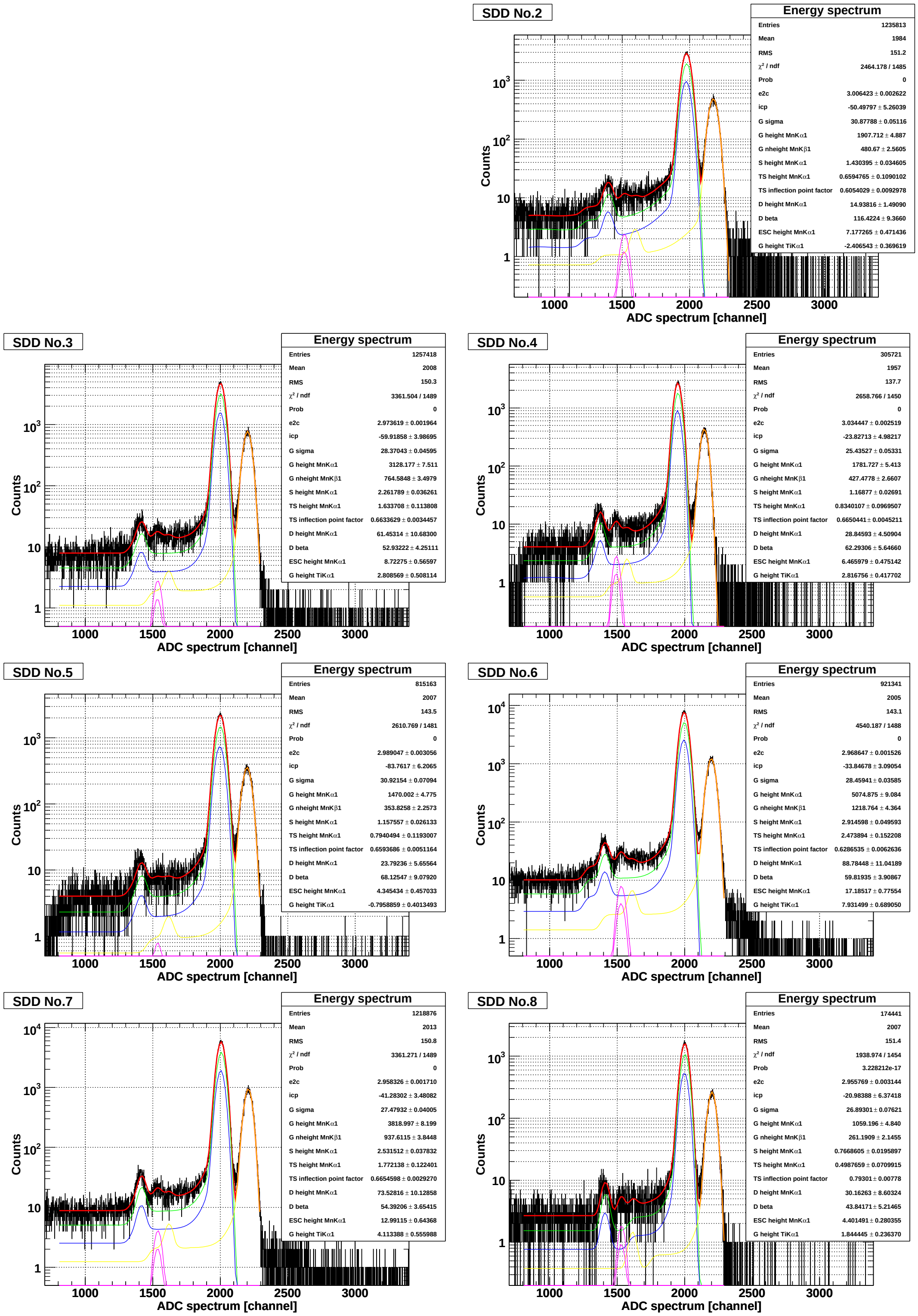

Figure 2: Fitting results of ^{55}Fe source calib. without preamp cover : SDD calibration run # 170 (for SDD # 4, 5, 8) and run # 171 (for SDD # 2, 3, 6, 7)

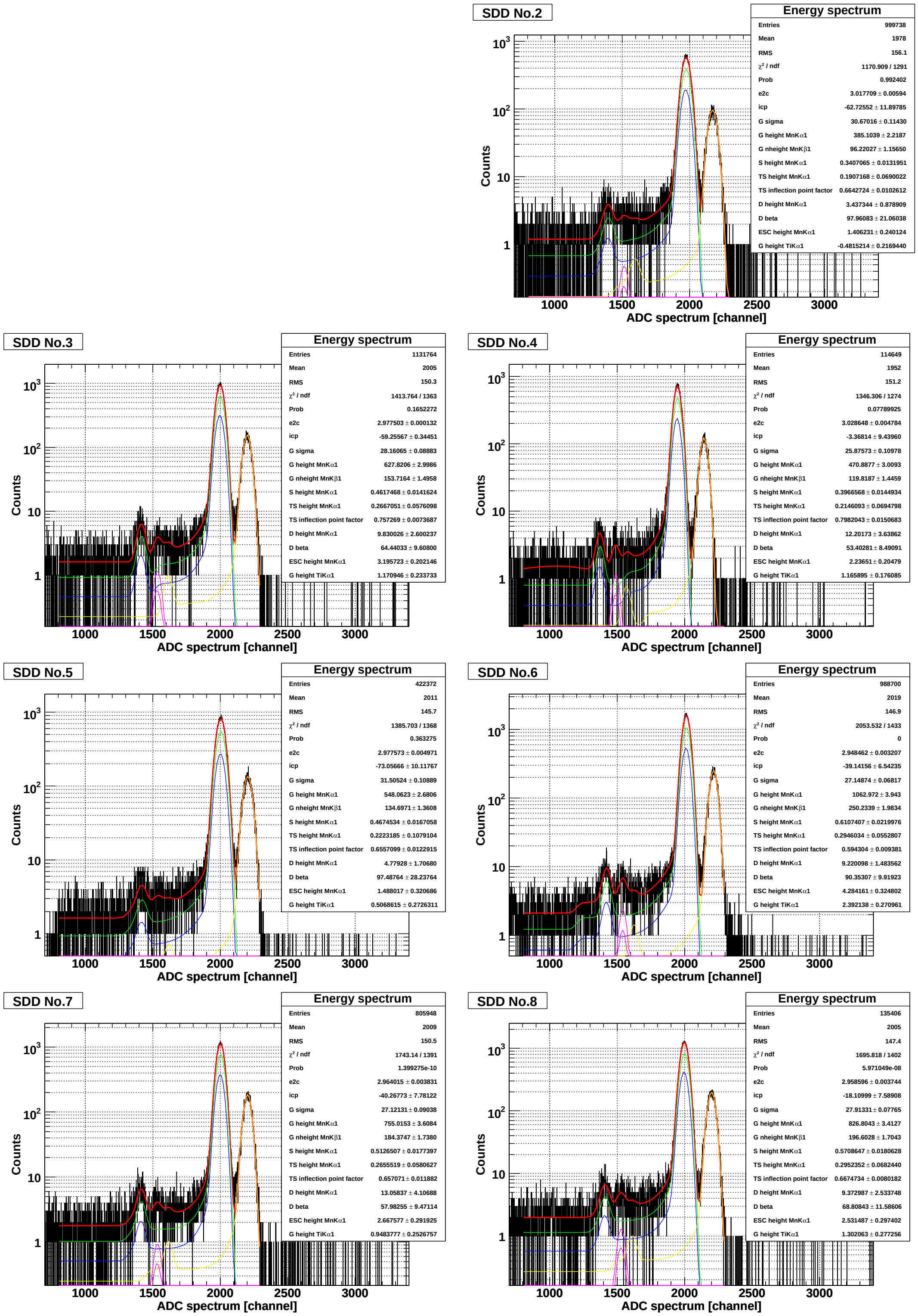

Figure 3: Fitting results of ^{55}Fe source calib. without preamp cover : SDD calibration run # 173 (for SDD # 4, 5, 8) and run # 174 (for SDD # 2, 3, 6, 7)

2 Summary of the present status of our all SDDs

Yesterday Matsuda-san reported that two SDDs repaired by KETEK (SDD#3 and #6) were delivered to RAL. He will bring them to Japan on December 7.

The SDD#6 had a broken ceramics. That was fixed and the bonding was tested but it remained at a worse energy resolution. It seems the detector itself has suffered some damage, but they are not sure what kind of damage exactly and have no chance to repair it further.

The present SDD status are summarized in Table 1.

SDD#	port#	S/N	Repairing	Status	Notes	Ownership
#1	-	V2-8-5.3	re-bonding	○ (repaired)	(very low rate signal)	RIKEN
#2	#2*	V2-8-5.4	re-bonding	○	working well	RIKEN
#3	-	V2-8-3.4	replaced FET	○ (repaired)	(bad resolution)	RIKEN
#4	-	V2-7-4.2	broken	×	dead	RIKEN
#5	#5*	V2-9-5.4	-	○	working well	RIKEN
#6	-	V2-7-4.4	re-bonding	△	ceramic board cracking	SMI
#7	-	V2-9-3.3	re-bonding	○ (repaired)	ceramic board cracking	SMI
#8	-	V2-8-4.3	re-bonding	○ (repaired)	(strange signal shape)	SMI
#9	#4*	V2-7-5.4	-	○	working well	SMI
#10	#1	V2-6-3.2	-	○	newly ordered	RIKEN
#11	#3	V2-6-4.2	-	○	newly ordered	RIKEN
#12	#6	V2-6-4.3	-	○	newly ordered	RIKEN
#13	#7	V2-6-5.2	-	○	newly ordered	RIKEN
#14	#8	V2-6-5.3	-	○	newly ordered	RIKEN

Table 1: Summary of the present status of our all SDDs

* : Original port location.

3 Preparation status

```
>> SDD
   + 7/8 SDDs are alive.
   + 1 dead SDD's voltage is unstable.
   + this week, planning one more calibration test.
   + the goal is all SDDs alive.

>> Cables and Modules
  + for 8 ch cables are set.
  + (upper veto) * (reset veto) logic are added
     to remove the veto through cross talk.

>> DC Separator
  + started tuning from 11/25 (Fri.), now smoothly upped about 200V.
```

```
>> Beam Time Schedule
  + 41 shifts available
```

4 Things to do

```
>> Cables and Modules
  + 3rd crate TKO power supply has over current problem.
    --> must fix and ensure two healthy slots
        for one more REF scaler and Wilkinson ADC.
  + 3rd SMP has strange problem if it is at the edge of the SMPs,
    but if it is in the middle of the SMPs, it works correctly.
  + Wilkinson type ADC will be delivered on December 5. --> operation check.

>> DC Separator
  + Separator shift from this week ?

>> T2 PMT Replacement
  + replace T2 with new PMTs <-- when?

>> Cosmic ray calibration
  + when starts?
```

5 Topic for discussion (making dicisions)

```
>> workshop
 --> Vienna Workshop : Dec. 21-22, 2005, Vienna
     (http://www.oeaw.ac.at/smi/ambs2005.htm)
 --> Kyoto Workshop : Feb. 20-22, 2006, YITP, Kyoto University
     (http://www.phys.nara-wu.ac.jp/~pnphys/nuclth/HFD06/)
 --> JPS : Mar. 27-30, 2005, Ehime/Matsuyama
     (http://wwwsoc.nii.ac.jp/jps/jps/bbs/meetings.html)
  ex) 3 talks : 1.detector(Tatsuno), 2.cryostat(Iio), 3.physics(Okada)
                - 1st talk include motivation
                - 3rd talk include preliminary results.

>> shift assignment

>> Run schedule of E570
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