E570 meeting report　　16/June/2006　H.Tatsuno

Systematic error of the centroid of X-ray peaks from adding histograms with gain drifts correction

There are some gain drifts in a cycle of E570 experiment,
so about 8-12 runs are packed as a unit of a data set.
As a gain of a data set isn't same as the gain of other data set,
a histogram isn't same also.

When all histograms are added to get the final result after
channel to energy conversion, it is not clear that the centroid
of a X-ray peak is same as the energy used as calibration.
In this report, it is checked by a simulation using two pure
Gaussians as Ti and Ni Kα1 peaks.

1. Two pure Gaussians (simulation)

10000 events
for 1 Gaussian

Simulation : pure gaussians (Ti and Ni)

histogram id

hpg1	
Entries	20000
Mean	1941
RMS	490
Underflow	0
Overflow	0

Ti

Ni

$\sigma = 25$ ch

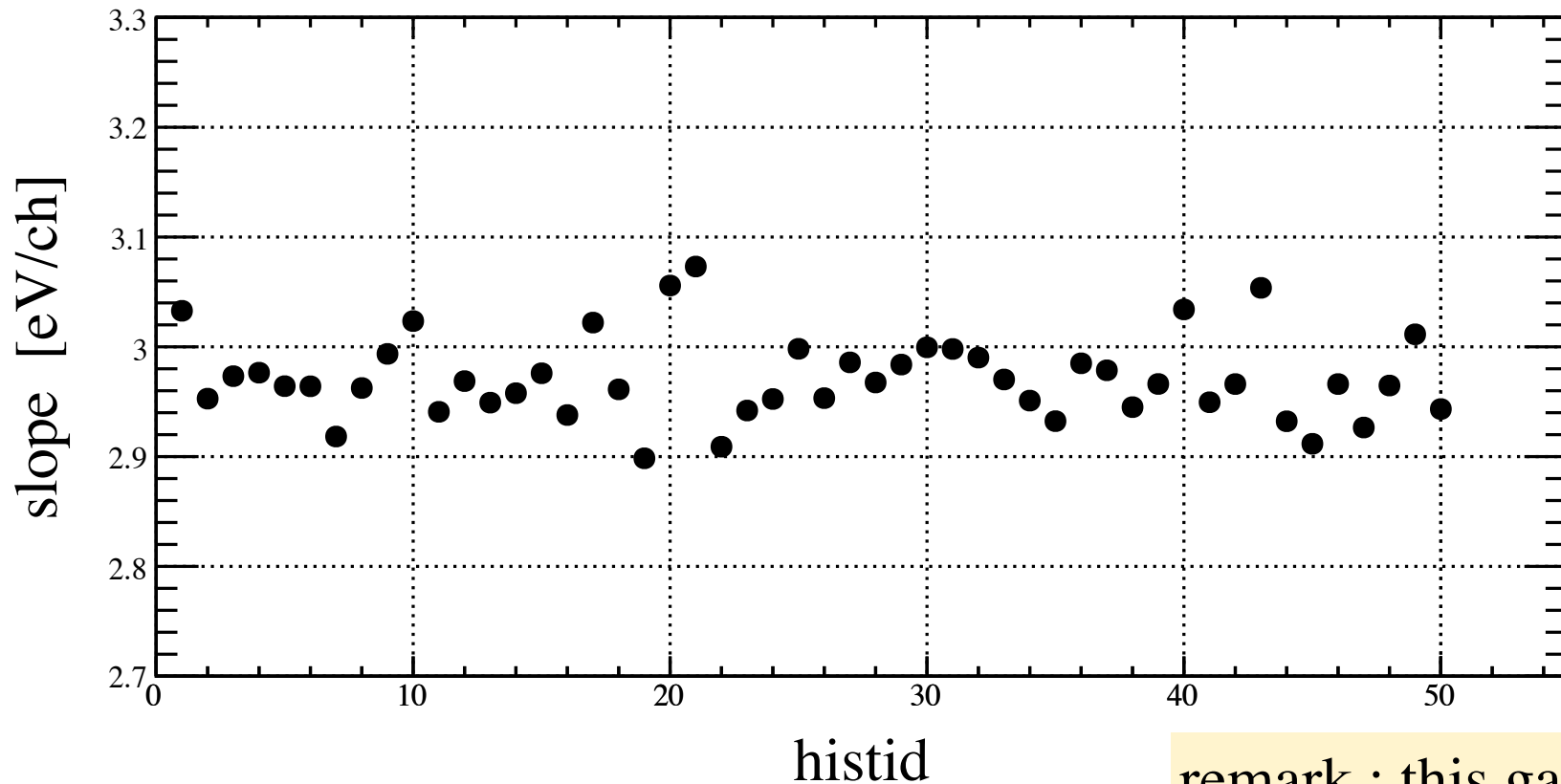$\sigma = 30$ ch
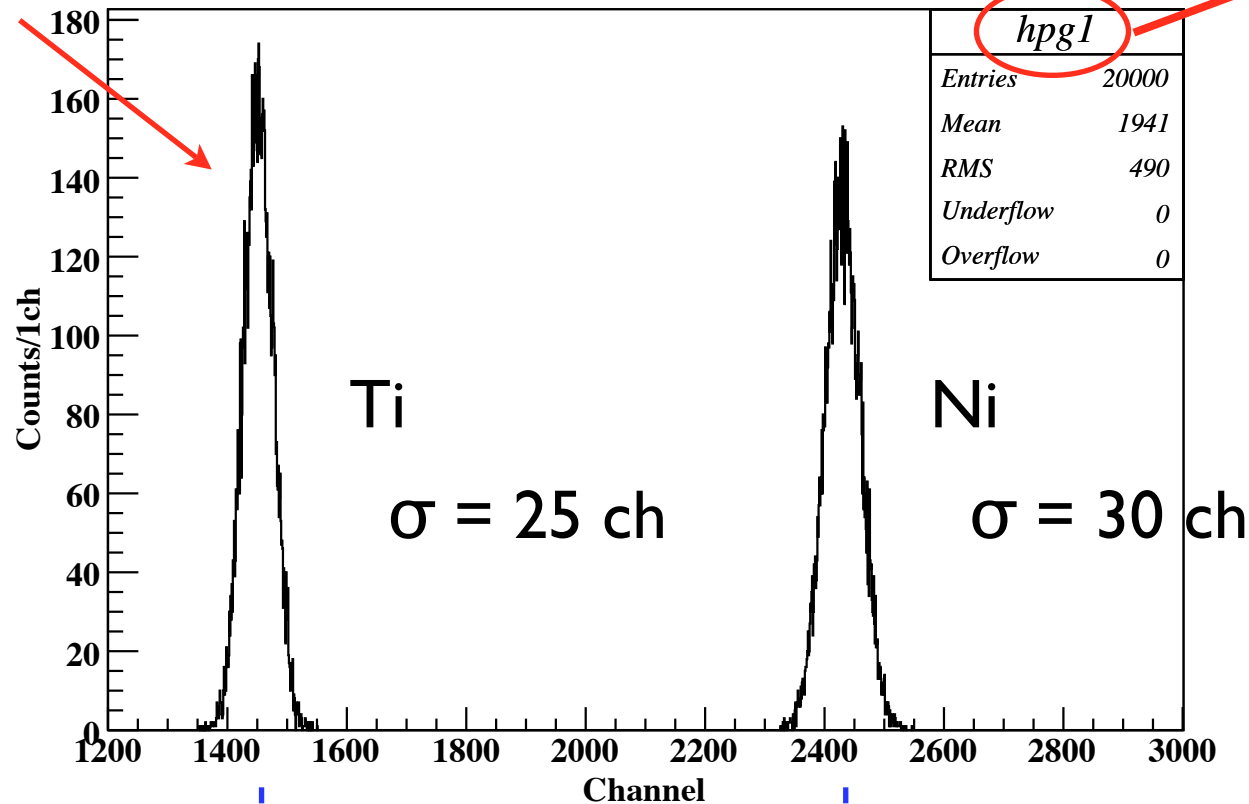
meanTi = RandGaus(1450,10)   meanNi = RandGaus(2450,10)

the mean of Gaussians change with the histogram id
as a Gaussian distribution ($\sigma = 10$ ch).

2. Gain drift simulation

slope = (E(NiKa1) - E(TiKa1)) / (meanNi - meanTi)

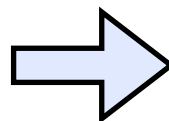E(NiKa1) = 7478.15 eV,   E(TiKa1) = 4510.84 eV

Simulation : ev/ch

histid

remark : this gain drift is
over estimation.

3. Fitting added histograms with gain drifts correction
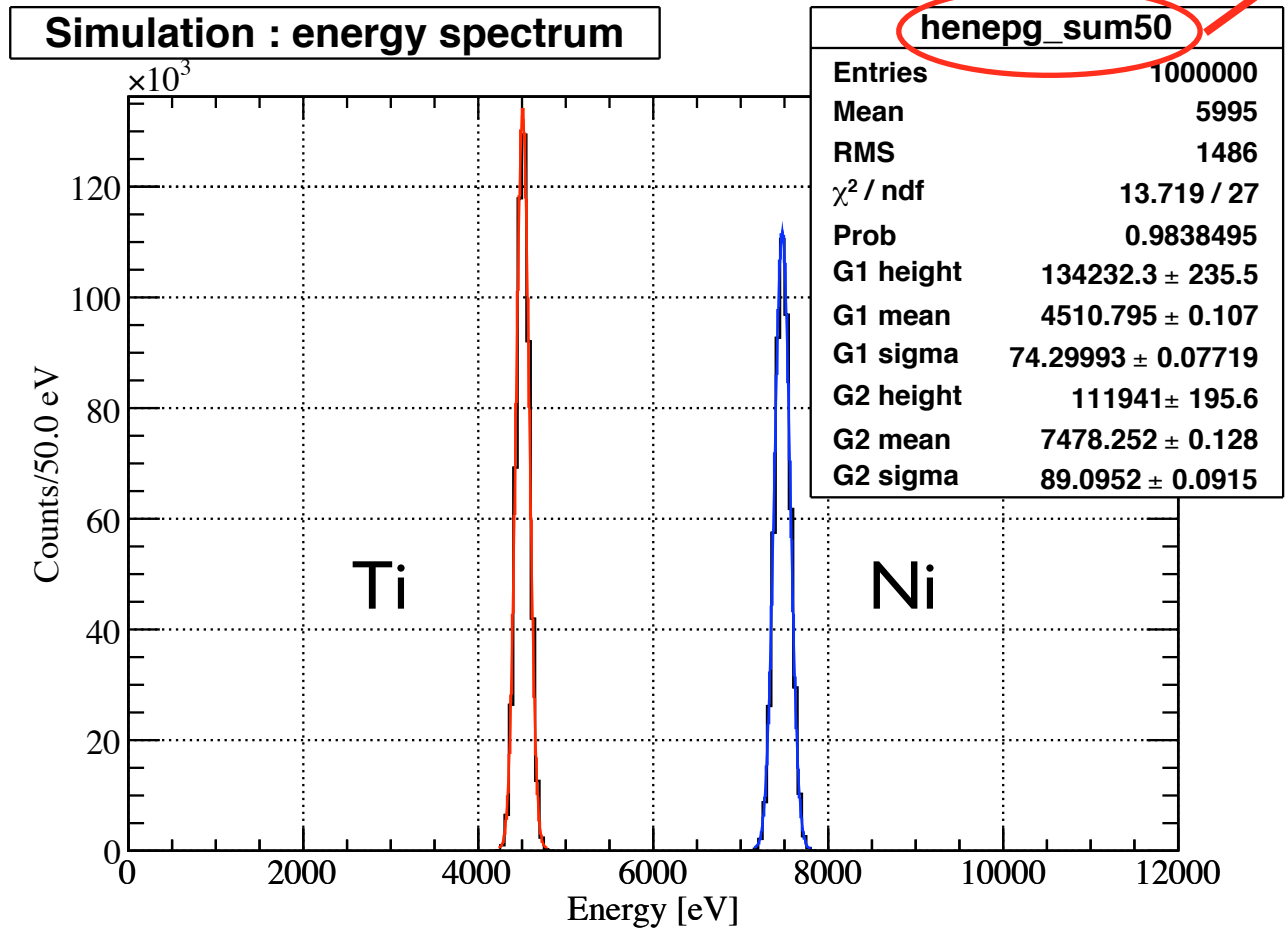
the number of added histograms

Simulation : energy spectrum

henepg_sum50	
Entries	1000000
Mean	5995
RMS	1486
χ^2 / ndf	13.719 / 27
Prob	0.9838495
G1 height	134232.3 ± 235.5
G1 mean	4510.795 ± 0.107
G1 sigma	74.29993 ± 0.07719
G2 height	111941 ± 195.6
G2 mean	7478.252 ± 0.128
G2 sigma	89.0952 ± 0.0915

Ti   Ni

Counts/50.0 eV

Energy [eV]

Get the mean of Gaussians ⟹ Compare the mean with the energy used as calibration

4. Fit results

number of hist	TiKa1 [eV]	NiKa1 [eV]
10	4510.80 ± 0.24	7477.70 ± 0.29
30	4510.85 ± 0.14	7478.00 ± 0.20
50	4510.80 ± 0.11	7478.25 ± 0.13
70	4510.80 ± 0.11	7478.25 ± 0.13
100	4510.86 ± 0.08	7478.09 ± 0.09

calibrated values : E(TiKa1) = 4510.84 eV, E(NiKa1) = 7478.15 eV

we can conclude "systematic error << statistical error"
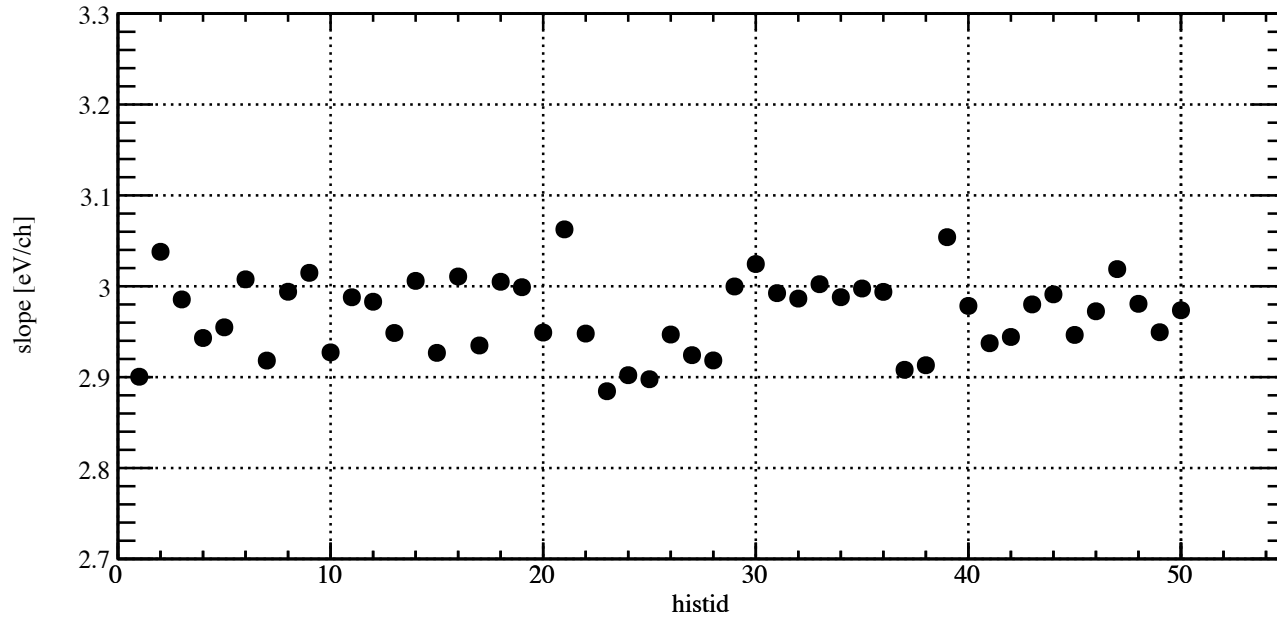
low statistic test (1)
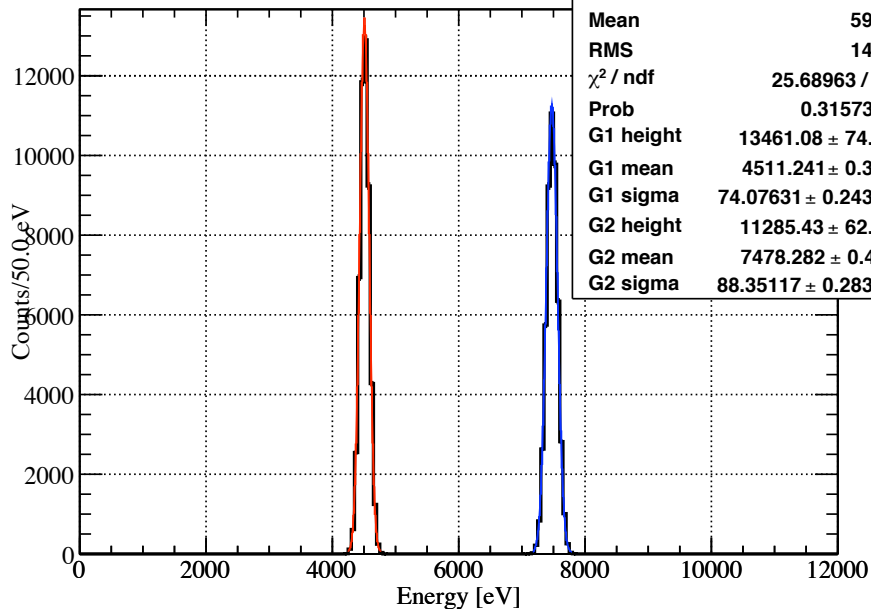

1000 events for 1 Gaussian

pure gaussian

Ti σ = 25 ch

Ni σ = 30 ch

hpg1	
Entries	2000
Mean	1950
RMS	513.1
Underflow	0
Overflow	0
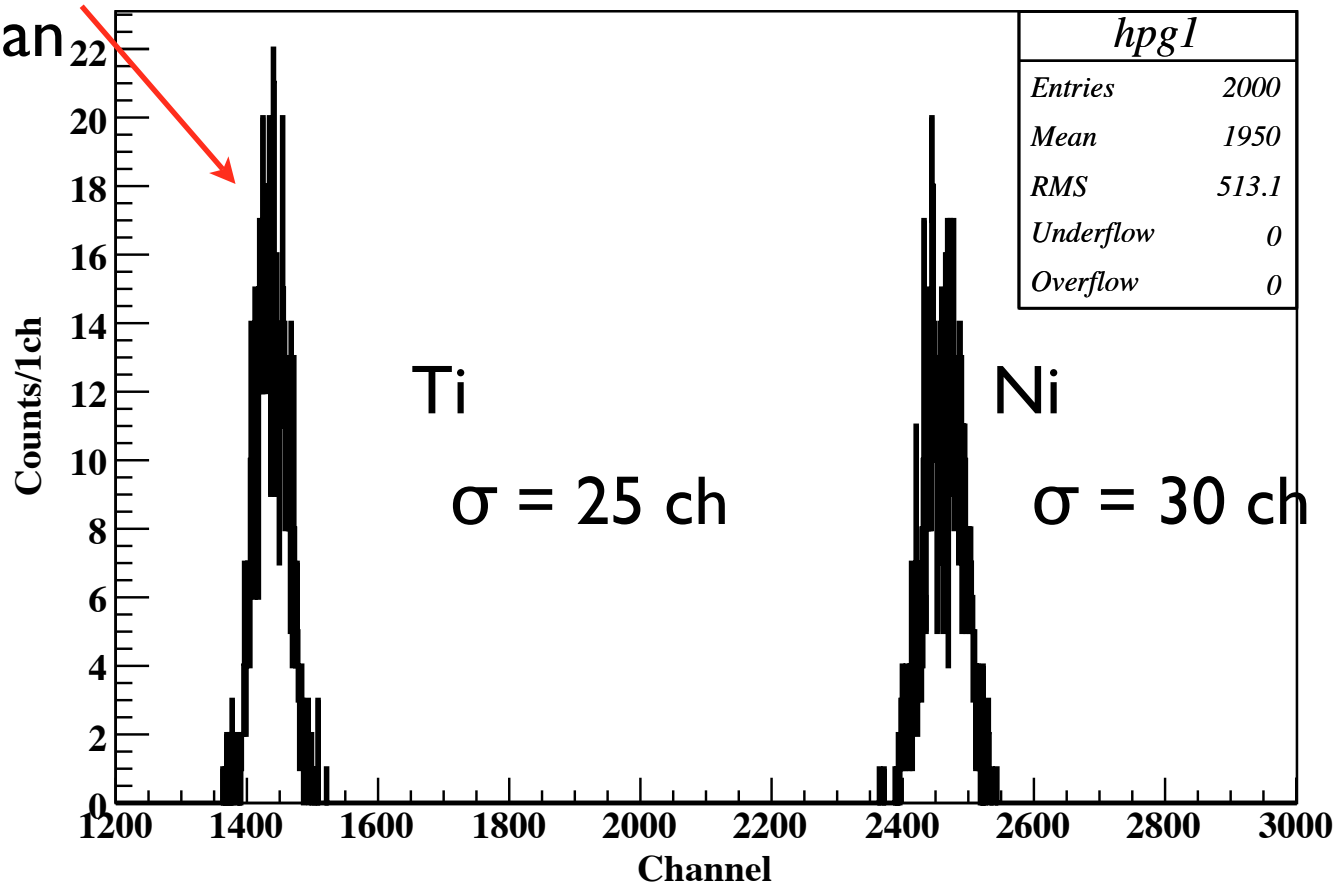
the number of histograms is 50.

low statistic test (2)

Simulation : ev/ch

Simulation : energy spectrum

henepg_sum50	
Entries	100000
Mean	5995
RMS	1486
χ^2 / ndf	25.68963 / 23
Prob	0.3157352
G1 height	13461.08 ± 74.69
G1 mean	4511.241 ± 0.338
G1 sigma	74.07631 ± 0.24324
G2 height	11285.43 ± 62.16
G2 mean	7478.282 ± 0.401
G2 sigma	88.35117 ± 0.28398

TiKa1 = 4511.24 ± 0.34 eV
NiKa1 = 7478.28 ± 0.40 eV

if the statistics is changed as 1/10 times, the centroid of X-rays are not changed .

Summary

The systematic error from adding the histograms with gain drifts correction is estimated by simulation using two pure Gaussians as Ti and Ni $K\alpha 1$ X-rays.

The systematic error is smaller than the statistical error enough to neglect it.