

# ***Compton tail correction***

**Calibration : iterative (with pileup and low-energy tail)**

See Tatsuno's report on March 11, 2007

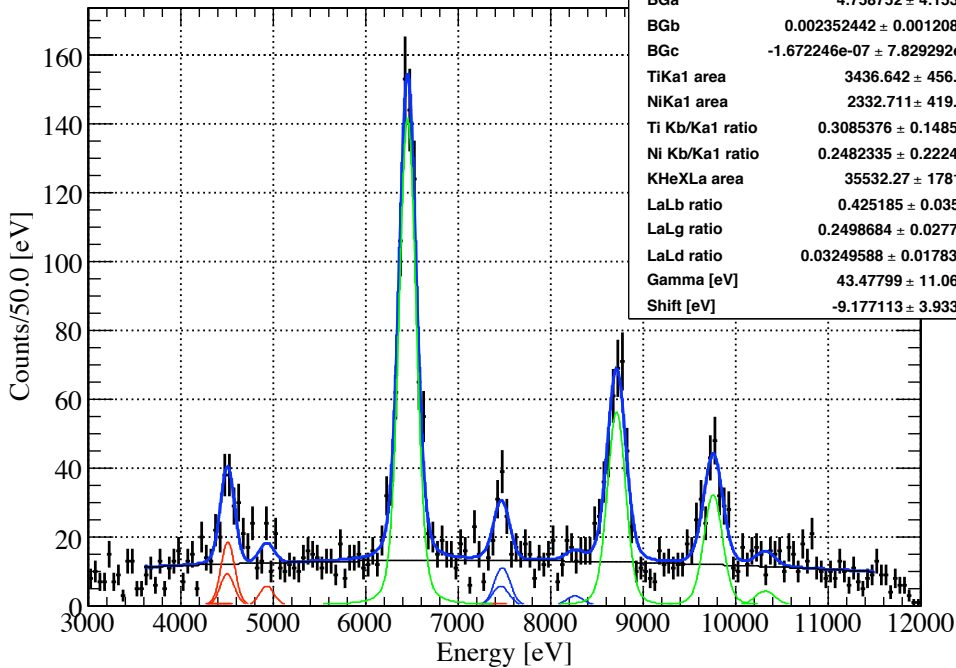
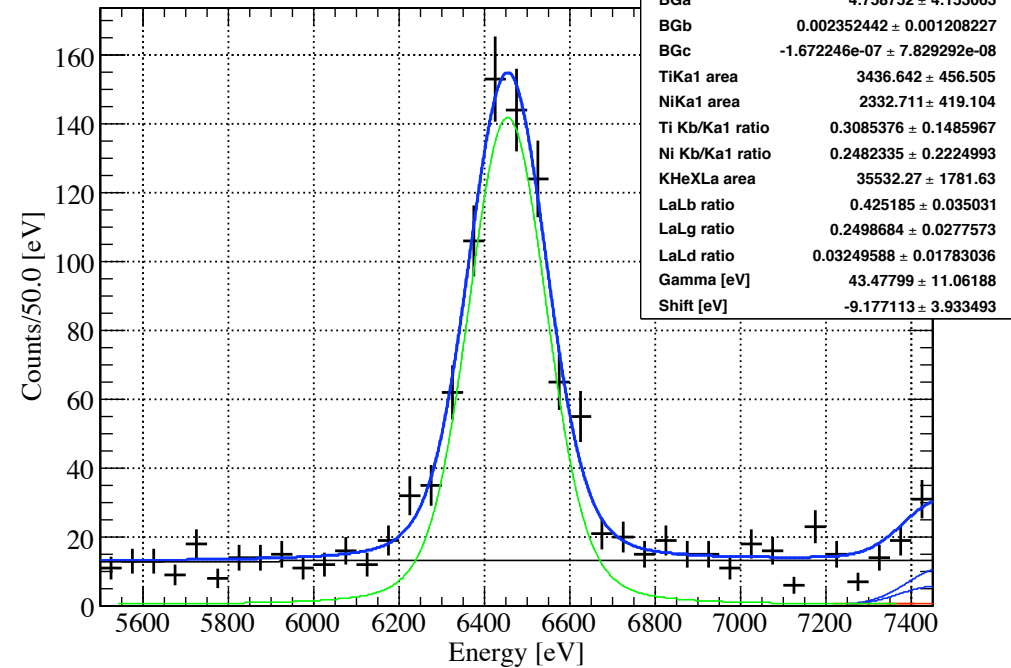
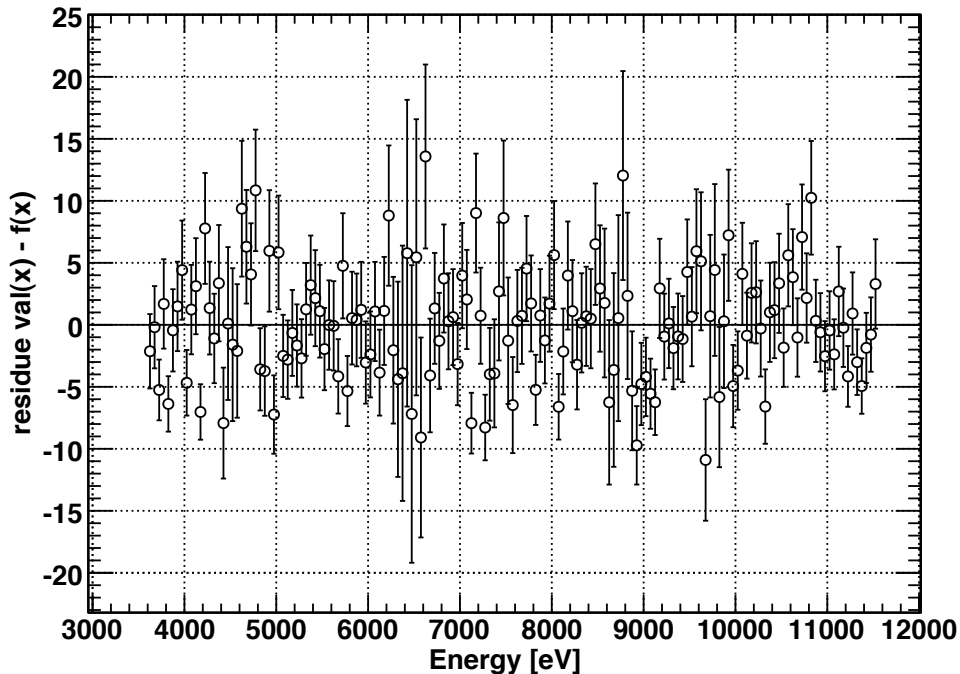
**Kstop selection :  $0.92 < k_{\text{stop}} \text{ ID function} < 1.1$**

See Okada-san's report on Oct 6, 2006

**Fiducial volume cuts :  $r < 110 \text{ mm AND } -65 \text{ mm} < z < 85 \text{ mm}$**

# 1. Pure Voigt profile fitting

First, let's fit the calibrated histogram  
without asymmetric functions

**Kstop 1st (no Compton, LEtail, pileup)****Kstop 1st (no Compton, LEtail, pileup)****fit residue**

**1st cycle no Compton tail,  
low-energy tail and pileup fit**

**Kstop selection and fiducial  
volume cuts were applied**

# 1st cycle no Compton tail, low-energy tail and pileup fit

FCN=912.02 FROM MINOS STATUS=SUCCESSFUL 3203 CALLS 3572 TOTAL  
EDM=1.45396e-08 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT NO.	PARAMETER NAME	VALUE	PARABOLIC ERROR	MINOS ERRORS	
				NEGATIVE	POSITIVE
1	BGa	4.75875e+00	4.05884e+00	-4.12101e+00	4.18512e+00
2	BGb	2.35244e-03	1.17984e-03	-1.21321e-03	1.20325e-03
3	BGc	-1.67225e-07	7.64689e-08	-7.80257e-08	7.85601e-08
4	Noise [eV]	5.62000e+01	fixed		
5	Fano	1.45000e-01	fixed		
6	TiKa1 area	3.43664e+03	4.56258e+02	-4.45690e+02	4.67319e+02
7	NiKa1 area	2.33271e+03	4.18232e+02	-4.08697e+02	4.29511e+02
8	Ti Kb/Ka1 ratio	3.08538e-01	1.44910e-01	-1.39856e-01	1.57337e-01
9	Ni Kb/Ka1 ratio	2.48234e-01	2.09530e-01	-2.12250e-01	2.32749e-01
10	KHeXLa area	3.55323e+04	1.77716e+03	-1.75647e+03	1.80679e+03
11	LaLb ratio	4.25185e-01	3.49669e-02	-3.40019e-02	3.60601e-02
12	LaLg ratio	2.49868e-01	2.77139e-02	-2.69258e-02	2.85888e-02
13	LaLd ratio	3.24959e-02	1.77813e-02	-1.72556e-02	1.84052e-02
14	Gamma [eV]	4.34780e+01	1.10200e+01	-1.08114e+01	1.13123e+01
15	Shift [eV]	-9.17711e+00	3.92919e+00	-3.93871e+00	3.92828e+00

Const Noise = 56.200 +- 0.000  
 KHeXLa Sigma = 82.002 +- 0.013  
 Fano = 0.145 +- 0.000  
 lalb\_ratio = 0.425 +- 0.035  
 lalg\_ratio = 0.250 +- 0.028  
 Gamma = 43.478 +- 11.062  
 Shift = -9.177 +- 3.933  
 Chisq/NDF = 205.512/145

**shift =  $-9.2 \pm 3.9$  eV**  
**width =  $43.5 \pm 11.1$  eV**

**consistent with Okada-san's results**  
**see report on Oct 6, 2006**

# 1st cycle no Compton tail, low-energy tail and pileup fit

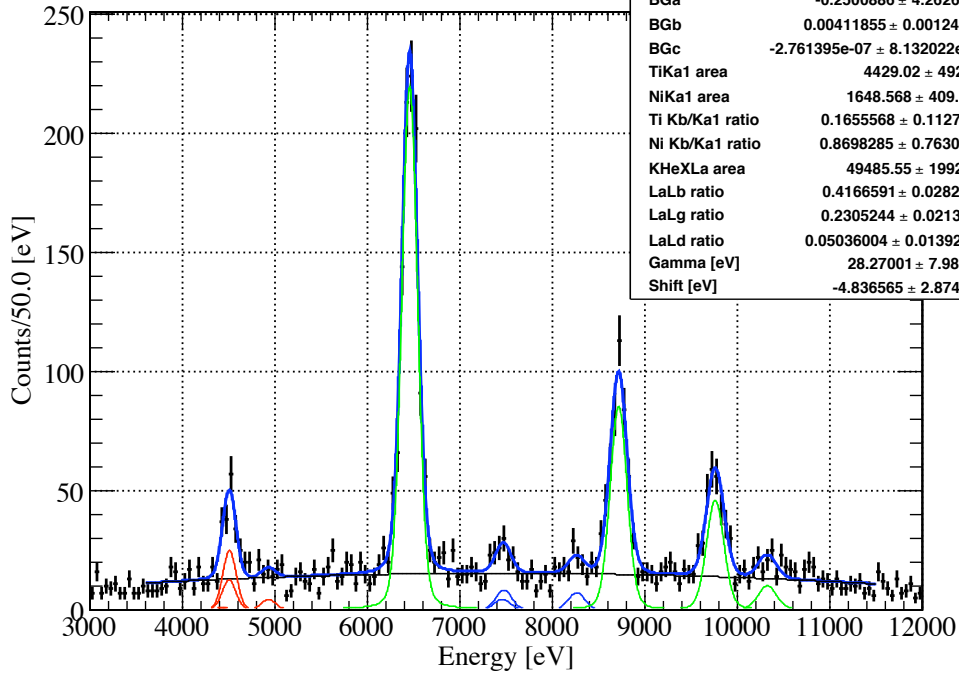
16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	0.00000e+00	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	5.65872e-02	fixed
24	Tail NiKa area factor	9.24735e-02	fixed
25	Tail slope Ka	1.89240e+00	fixed
26	Tail TiKb area factor	5.50000e-02	fixed
27	Tail NiKb area factor	9.30000e-02	fixed
28	Tail slope Kb	2.00000e+00	fixed
29	Tail La area factor	0.00000e+00	fixed
30	Tail Lb area factor	0.00000e+00	fixed
31	Tail Lg area factor	0.00000e+00	fixed
32	Tail Ld area factor	0.00000e+00	fixed
33	Tail slope L	1.89240e+00	fixed
34	Comp La shift	5.04600e+01	fixed
35	Comp La sigma	8.79800e+01	fixed
36	Comp La area	0.00000e+00	fixed
37	Comp La slope	8.75800e-01	fixed
38	Comp Lb shift	8.18100e+01	fixed
39	Comp Lb sigma	1.08568e+02	fixed
40	Comp Lb area	0.00000e+00	fixed
41	Comp Lb slope	1.22324e+00	fixed
42	Comp Lg shift	9.88300e+01	fixed
43	Comp Lg sigma	1.21491e+02	fixed
44	Comp Lg area	0.00000e+00	fixed
45	Comp Lg slope	1.33329e+00	fixed
46	Comp Ld shift	1.08500e+02	fixed
47	Comp Ld sigma	1.27516e+02	fixed
48	Comp Ld area	0.00000e+00	fixed
49	Comp Ld slope	1.45616e+00	fixed
50	Voigt r	4.00000e+00	fixed

**Pileup intensities were fixed at zero.**

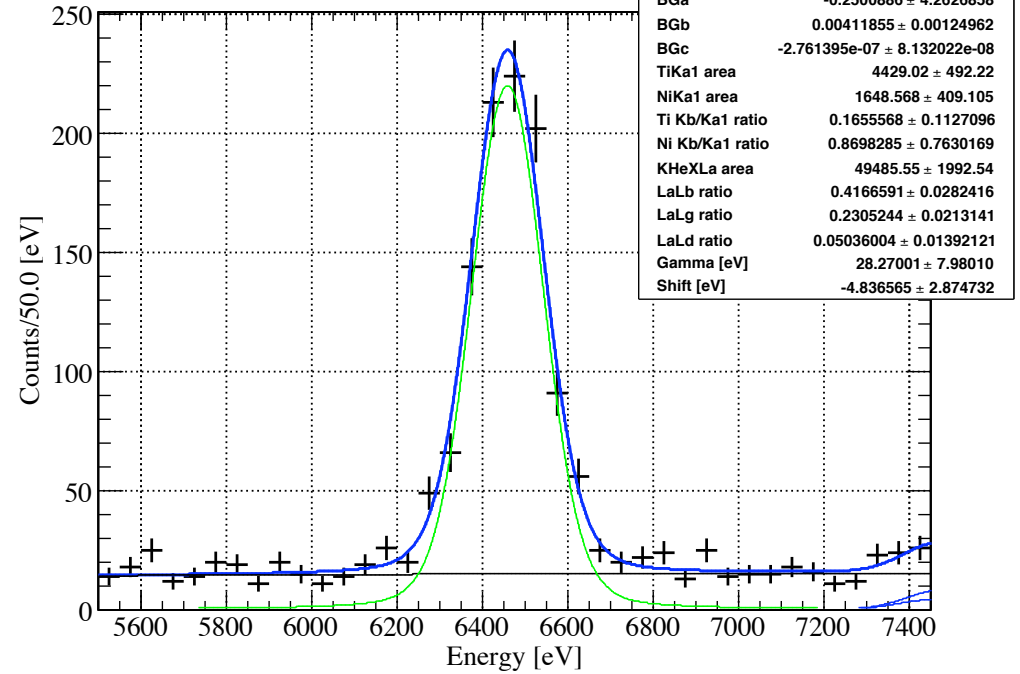
**Low-energy tail intensities were fixed at zero.**

**Compton tail intensities were fixed at zero.**

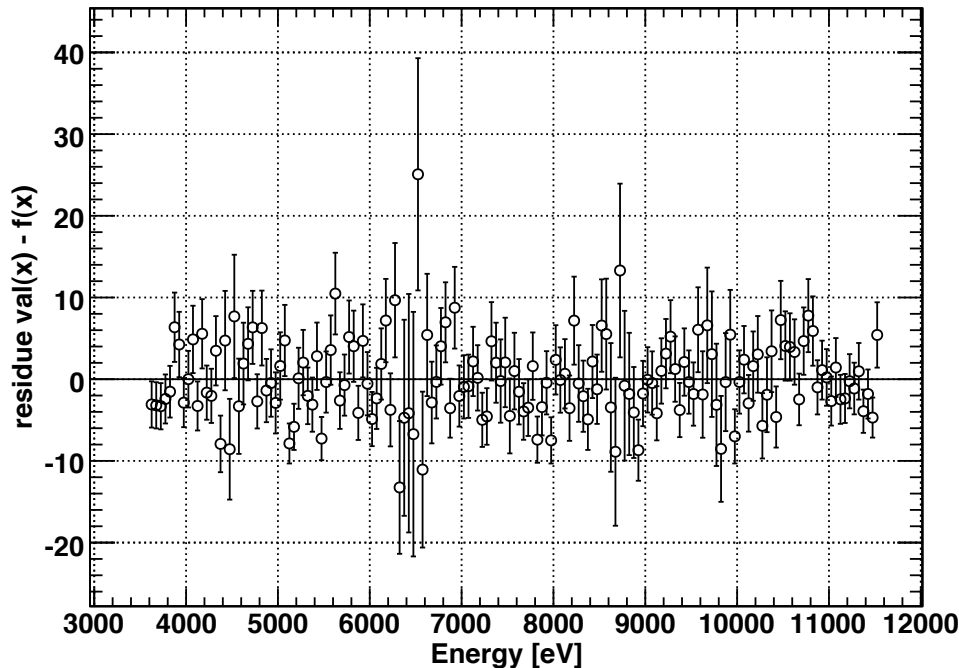
**Kstop 2nd (no Compton, LEtail, pileup)**



**Kstop 2nd (no Compton, LEtail, pileup)**



**fit residue**



**2nd cycle no Compton tail,  
low-energy tail and pileup fit**

**Kstop selection and fiducial  
volume cuts were applied**

# 2nd cycle no Compton tail, low-energy tail and pileup fit

FCN=913.203 FROM MINOS		STATUS=PROBLEMS		3154 CALLS		3519 TOTAL	
		EDM=4.92204e-08		STRATEGY= 1		ERROR MATRIX ACCURATE	
EXT PARAMETER		PARABOLIC		MINOS ERRORS			
NO.	NAME	VALUE	ERROR	NEGATIVE	POSITIVE		
1	BGa	-2.50089e-01	4.12991e+00	-4.22951e+00	4.29586e+00		
2	BGb	4.11855e-03	1.20990e-03	-1.25497e-03	1.24428e-03		
3	BGc	-2.76140e-07	7.87813e-08	-8.10286e-08	8.16118e-08		
4	Noise [eV]	5.45000e+01	fixed				
5	Fano	1.28000e-01	fixed				
6	TiKa1 area	4.42902e+03	4.91936e+02	-4.81291e+02	5.03144e+02		
7	NiKa1 area	1.64857e+03	4.11902e+02	-3.94421e+02	4.23789e+02		
8	Ti Kb/Ka1 ratio	1.65557e-01	1.10344e-01	-1.07612e-01	1.17808e-01		
9	Ni Kb/Ka1 ratio	8.69828e-01	7.63017e-01	-3.46942e-01	at limit		
10	KHeXLa area	4.94856e+04	1.98679e+03	-1.96902e+03	2.01605e+03		
11	LaLb ratio	4.16659e-01	2.82036e-02	-2.75377e-02	2.89456e-02		
12	LaLg ratio	2.30524e-01	2.12909e-02	-2.07553e-02	2.18729e-02		
13	LaLd ratio	5.03600e-02	1.39020e-02	-1.34973e-02	1.43452e-02		
14	Gamma [eV]	2.82700e+01	7.93725e+00	-7.82101e+00	8.13918e+00		
15	Shift [eV]	-4.83656e+00	2.87260e+00	-2.87552e+00	2.87394e+00		

Const Noise = 54.500 +- 0.000  
KHeXLa Sigma = 78.232 +- 0.009  
Fano = 0.128 +- 0.000  
lalb\_ratio = 0.417 +- 0.028  
lalg\_ratio = 0.231 +- 0.021  
Gamma = 28.270 +- 7.980  
Shift = -4.837 +- 2.875  
Chisq/NDF = 171.817/145

**shift =  $-4.8 \pm 2.9$  eV**  
**width =  $28.3 \pm 8.0$  eV**

**consistent with Okada-san's results**  
**see report on Oct 6, 2006**

# 2nd cycle no Compton tail, low-energy tail and pileup fit

16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	0.00000e+00	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	5.65872e-02	fixed
24	Tail NiKa area factor	9.24735e-02	fixed
25	Tail slope Ka	1.89240e+00	fixed
26	Tail TiKb area factor	5.50000e-02	fixed
27	Tail NiKb area factor	9.30000e-02	fixed
28	Tail slope Kb	2.00000e+00	fixed
29	Tail La area factor	0.00000e+00	fixed
30	Tail Lb area factor	0.00000e+00	fixed
31	Tail Lg area factor	0.00000e+00	fixed
32	Tail Ld area factor	0.00000e+00	fixed
33	Tail slope L	1.89240e+00	fixed
34	Comp La shift	5.04600e+01	fixed
35	Comp La sigma	8.79800e+01	fixed
36	Comp La area	0.00000e+00	fixed
37	Comp La slope	8.75800e-01	fixed
38	Comp Lb shift	8.18100e+01	fixed
39	Comp Lb sigma	1.08568e+02	fixed
40	Comp Lb area	0.00000e+00	fixed
41	Comp Lb slope	1.22324e+00	fixed
42	Comp Lg shift	9.88300e+01	fixed
43	Comp Lg sigma	1.21491e+02	fixed
44	Comp Lg area	0.00000e+00	fixed
45	Comp Lg slope	1.33329e+00	fixed
46	Comp Ld shift	1.08500e+02	fixed
47	Comp Ld sigma	1.27516e+02	fixed
48	Comp Ld area	0.00000e+00	fixed
49	Comp Ld slope	1.45616e+00	fixed
50	Voigt r	4.00000e+00	fixed

**Pileup intensities were fixed at zero.**

**Low-energy tail intensities were fixed at zero.**

**Compton tail intensities were fixed at zero.**



→ We got a non-zero shift and a large width.

1st cycle

$$\text{shift} = -9.2 \pm 3.9 \text{ eV}$$

$$\text{width} = 43.5 \pm 11.1 \text{ eV}$$

2nd cycle

$$\text{shift} = -4.8 \pm 2.9 \text{ eV}$$

$$\text{width} = 28.3 \pm 8.0 \text{ eV}$$

**However we must consider  
“Compton tail,” low-energy tail and pileup.**

These tails are added with fixing their parameters.

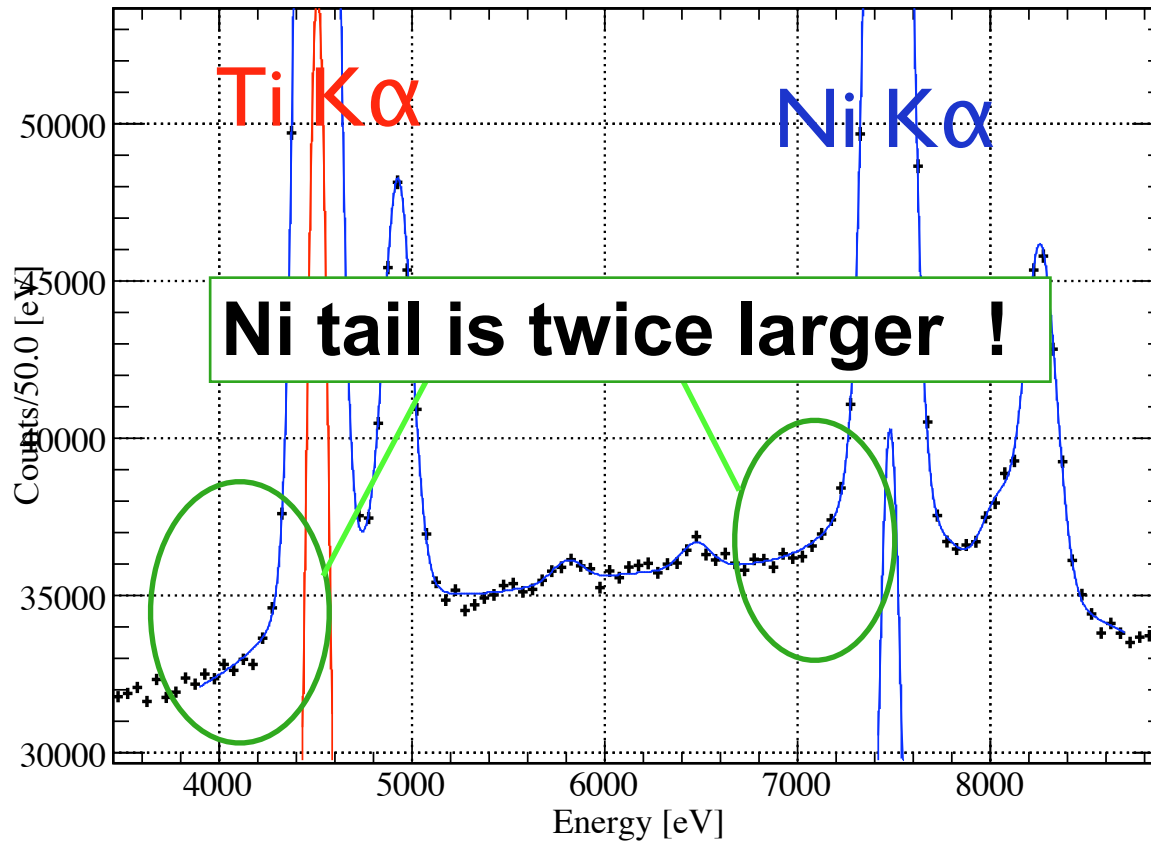
**Compton tail : GEANT simulation**

**Low-energy tail : Self-trigger (TiK $\alpha$  and NiK $\alpha$ )**

**Pileup : Self trigger and Flash ADC**

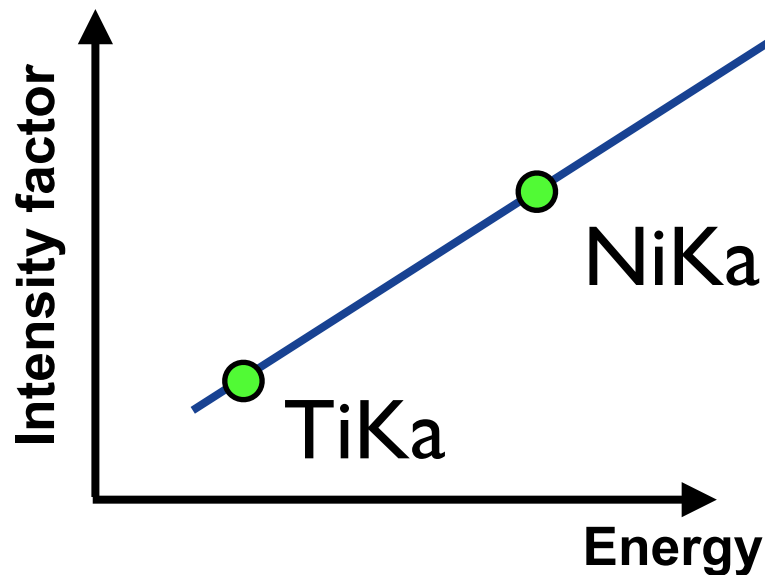
# PROBLEM

Intensity of the low-energy tail depends on the energy.

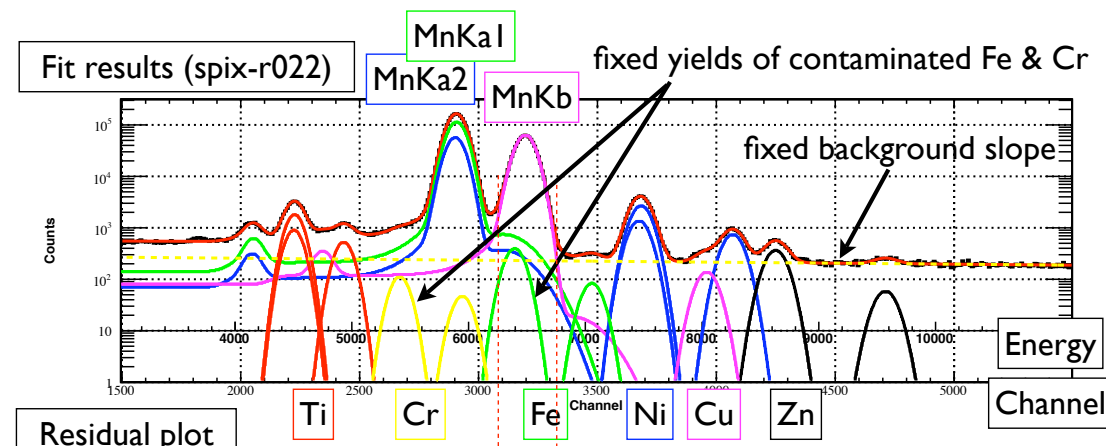


# How estimate the intensity of the KHeX tail ?

Linear approximation  
(by Ishiwatari-san)



Can we use the PSI data  
or other test measurements ?



From Okada-san's report on Jan 9, 2007

*Now I used the linear approximation for KHeX tails.*

## 2. Voigt + asymmetric functions fitting

**Compton tail : GEANT simulation**

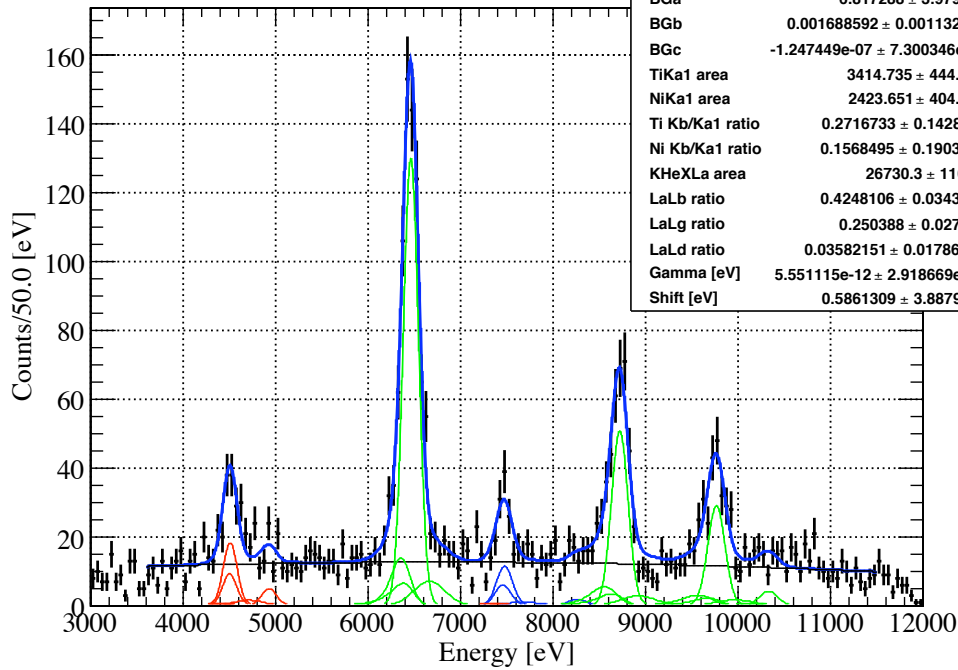
**Low-energy tail : Self-trigger (TiK $\alpha$  and NiK $\alpha$ )**

Function : 
$$T(i, E_{jk}) = \frac{Gain}{2\beta\sigma_{jk}} e^{\frac{E_i - E_{jk}}{\beta\sigma_{jk}} + \frac{1}{2\beta^2}} \operatorname{erfc} \left( \frac{E_i - E_{jk}}{\sqrt{2}\sigma_{jk}} + \frac{1}{\sqrt{2}\beta} \right)$$

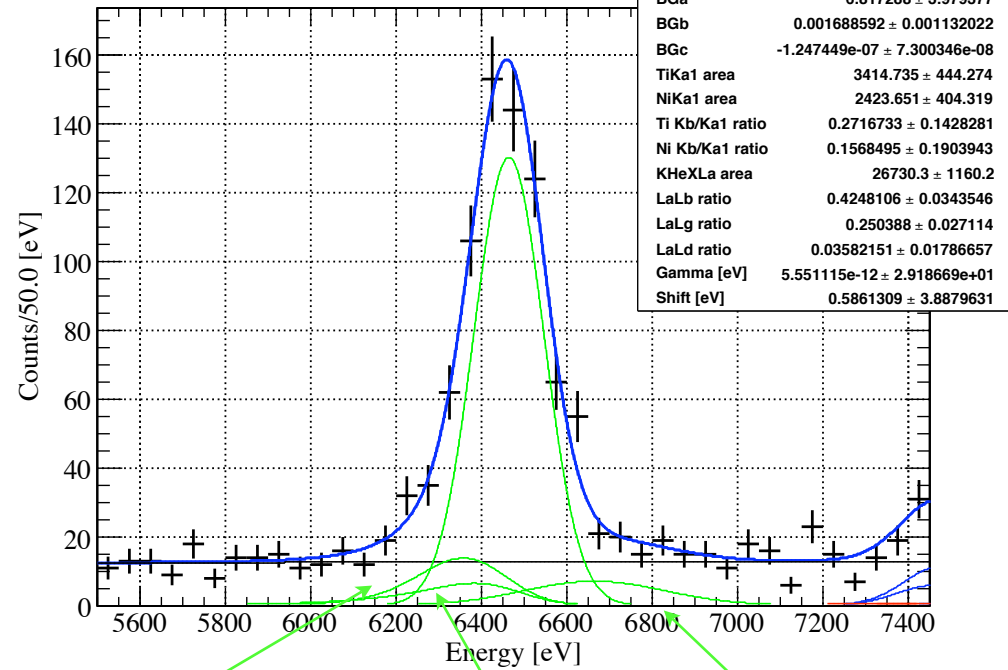
**Pileup : Self trigger and Flash ADC**

Function : pure Gaussian

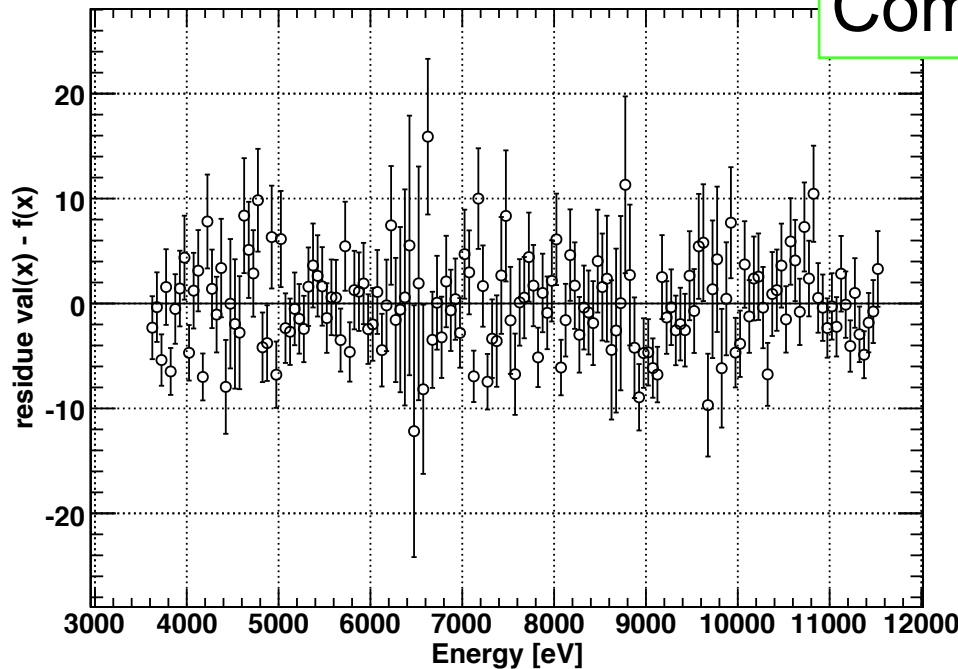
**Kstop 1st**



**Kstop 1st**



**fit residue**



Compton tail

Low-energy tail

Pileup

**1st cycle**  
**(with Compton tail, low-energy tail and pileup)**

**Kstop selection and fiducial volume cuts were applied**

# 1st cycle

(with Compton tail, low-energy tail and pileup)

```
FCN=907.667 FROM MINOS      STATUS=SUCCESSFUL  4257 CALLS      4693 TOTAL
      EDM=1.75338e-07      STRATEGY= 1      ERROR MATRIX ACCURATE
EXT PARAMETER              PARABOLIC              MINOS ERRORS
NO.  NAME      VALUE      ERROR      NEGATIVE      POSITIVE
  1  BGa      6.81729e+00  3.85756e+00 -3.92933e+00  4.02943e+00
  2  BGb      1.68859e-03  1.09295e-03 -1.14558e-03  1.11846e-03
  3  BGc     -1.24745e-07  7.05300e-08 -7.21897e-08  7.38172e-08
  4  Noise [eV] 5.62000e+01  fixed
  5  Fano      1.45000e-01  fixed
  6  TiKa1 area 3.41474e+03  4.43844e+02 -4.34095e+02  4.54452e+02
  7  NiKa1 area 2.42365e+03  4.03462e+02 -3.94363e+02  4.14275e+02
  8  Ti Kb/Ka1 ratio 2.71673e-01  1.39328e-01 -1.34461e-01  1.51195e-01
  9  Ni Kb/Ka1 ratio 1.56849e-01  1.90394e-01 at limit      2.10464e-01
10  KHeXLa area 2.67303e+04  1.13805e+03 -1.12600e+03  1.19444e+03
11  LaLb ratio 4.24811e-01  3.42949e-02 -3.33344e-02  3.53748e-02
12  LaLg ratio 2.50388e-01  2.70721e-02 -2.63023e-02  2.79250e-02
13  LaLd ratio 3.58215e-02  1.78201e-02 -1.73048e-02  1.84283e-02
14  Gamma [eV] 5.55112e-12  2.91867e+01 at limit      8.81920e+00
      WARNING - - ABOVE PARAMETER IS AT LIMIT.
15  Shift [eV] 5.86131e-01  3.88371e+00 -3.88837e+00  3.88756e+00
```

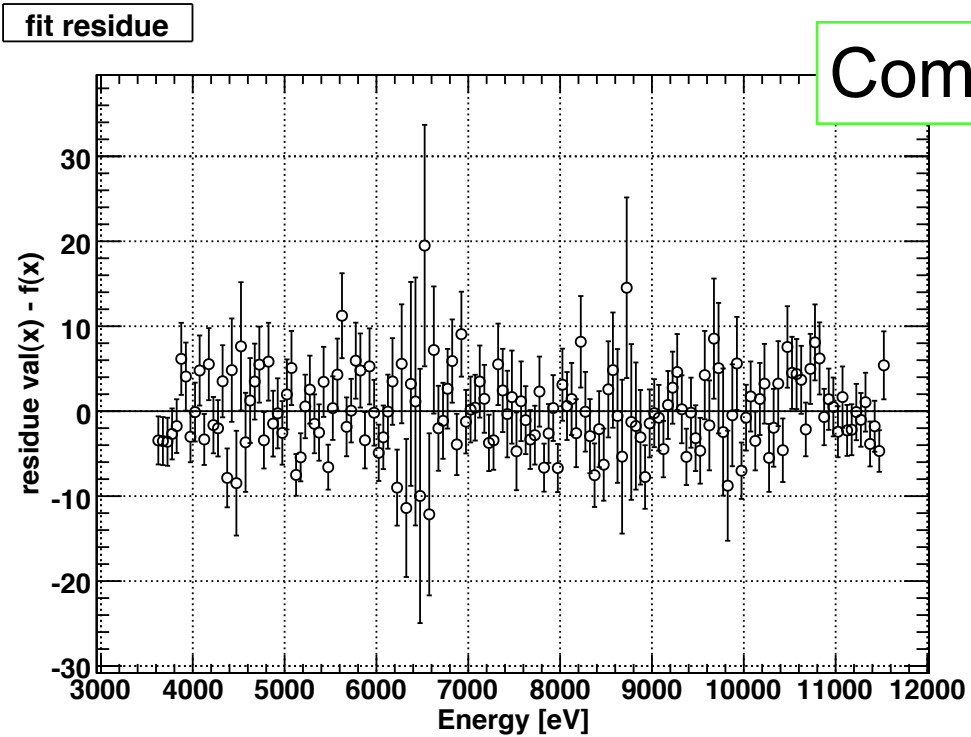
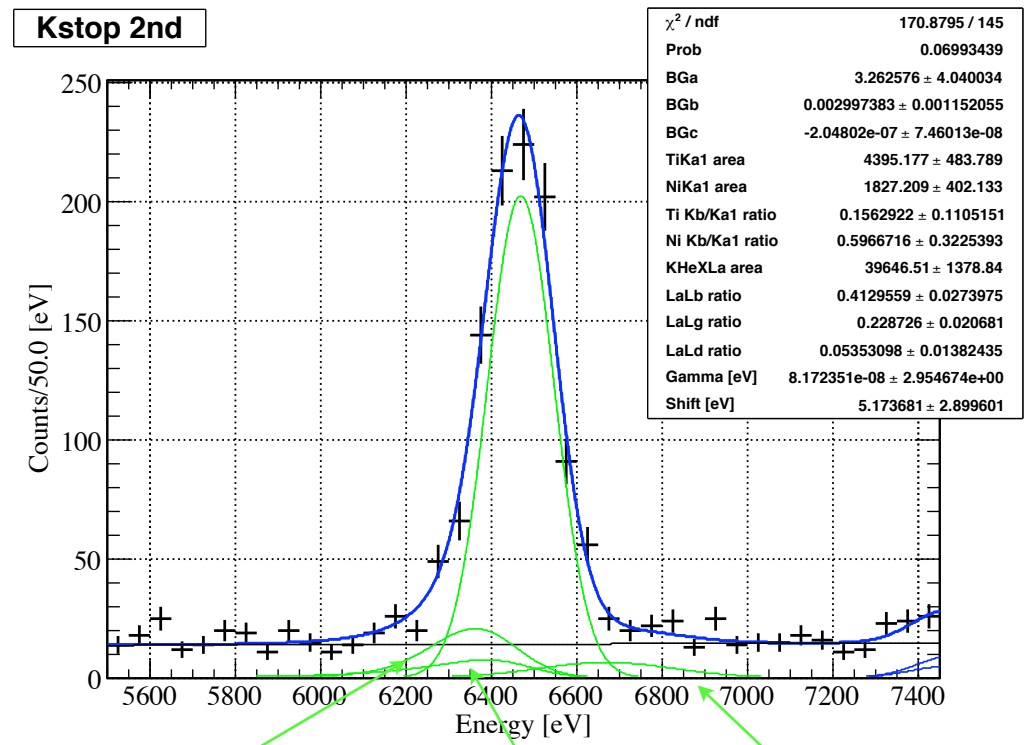
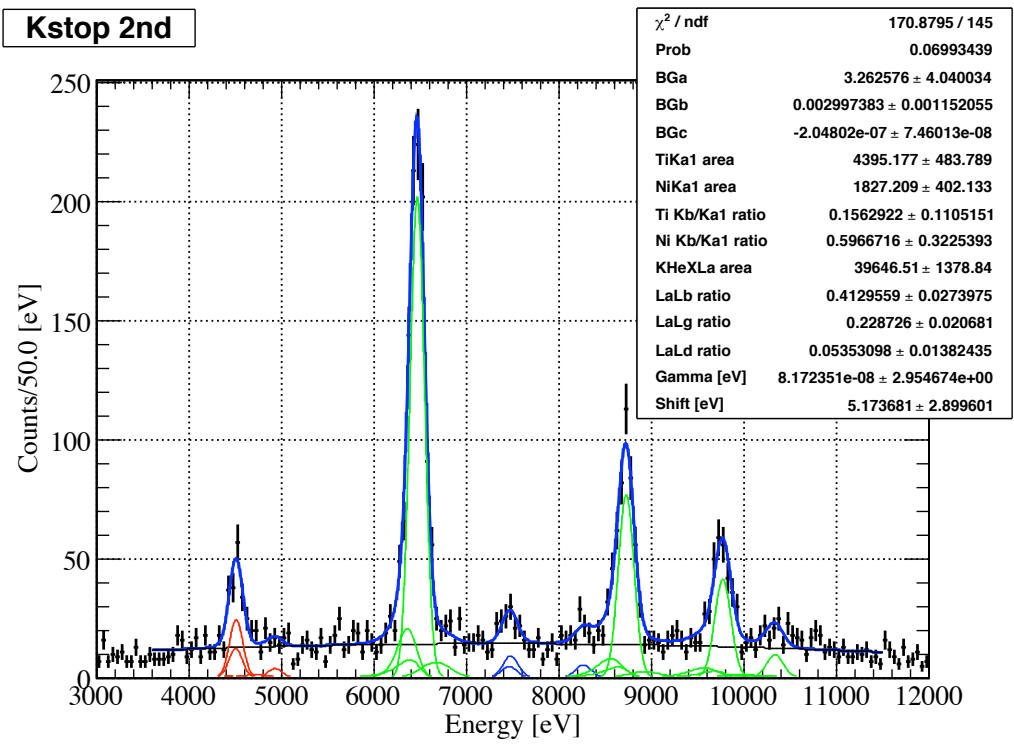
```
Const Noise = 56.200 +- 0.000
KHeXLa Sigma = 82.035 +- 0.013
Fano = 0.145 +- 0.000
lalb_ratio = 0.425 +- 0.034
lalg_ratio = 0.250 +- 0.027
Gamma = 0.000 +- 29.187
Shift = 0.586 +- 3.888
Chisq/NDF = 197.390/145
```

**shift =  $0.6 \pm 3.9$  eV**  
**width =  $0 + 8.8$  eV**

16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	1.07228e-01	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	5.65872e-02	fixed
24	Tail NiKa area factor	9.24735e-02	fixed
25	Tail slope Ka	1.89240e+00	fixed
26	Tail TiKb area factor	5.50000e-02	fixed
27	Tail NiKb area factor	9.30000e-02	fixed
28	Tail slope Kb	2.00000e+00	fixed
29	Tail La area factor	8.02085e-02	fixed
30	Tail Lb area factor	1.07529e-01	fixed
31	Tail Lg area factor	1.20167e-01	fixed
32	Tail Ld area factor	1.26976e-01	fixed
33	Tail slope L	1.89240e+00	fixed
34	Comp La shift	5.04600e+01	fixed
35	Comp La sigma	8.79800e+01	fixed
36	Comp La area	1.38406e-01	fixed
37	Comp La slope	8.75800e-01	fixed
38	Comp Lb shift	8.18100e+01	fixed
39	Comp Lb sigma	1.08568e+02	fixed
40	Comp Lb area	1.74475e-01	fixed
41	Comp Lb slope	1.22324e+00	fixed
42	Comp Lg shift	9.88300e+01	fixed
43	Comp Lg sigma	1.21491e+02	fixed
44	Comp Lg area	1.86872e-01	fixed
45	Comp Lg slope	1.33329e+00	fixed
46	Comp Ld shift	1.08500e+02	fixed
47	Comp Ld sigma	1.27516e+02	fixed
48	Comp Ld area	1.91088e-01	fixed
49	Comp Ld slope	1.45616e+00	fixed
50	Voigt r	4.00000e+00	fixed

# 1st cycle

(with Compton tail, low-energy tail and pileup)



Compton tail      Low-energy tail      Pileup

**2nd cycle**  
**(with Compton tail, low-energy tail and pileup)**

**Kstop selection and fiducial volume cuts were applied**



# 2nd cycle

(with Compton tail, low-energy tail and pileup)

```
FCN=913.866 FROM MINOS      STATUS=SUCCESSFUL  3505 CALLS      3975 TOTAL
                        EDM=3.19626e-07  STRATEGY= 1      ERROR MATRIX ACCURATE
EXT PARAMETER              PARABOLIC              MINOS ERRORS
NO.  NAME      VALUE      ERROR      NEGATIVE      POSITIVE
  1  BGa       3.26258e+00  2.92961e+00 -4.00300e+00  4.07707e+00
  2  BGb       2.99738e-03  8.21802e-04 -1.15791e-03  1.14620e-03
  3  BGc      -2.04802e-07  5.34900e-08 -7.42825e-08  7.49202e-08
  4  Noise [eV] 5.45000e+01  fixed
  5  Fano      1.28000e-01  fixed
  6  TiKa1 area 4.39518e+03  4.81796e+02 -4.73223e+02  4.94356e+02
  7  NiKa1 area 1.82721e+03  3.95105e+02 -3.91702e+02  4.12564e+02
  8  Ti Kb/Ka1 ratio 1.56292e-01  1.08172e-01 -1.05380e-01  1.15650e-01
  9  Ni Kb/Ka1 ratio 5.96672e-01  2.93128e-01 -2.92312e-01  3.52766e-01
 10  KHeXLa area 3.96465e+04  1.37354e+03 -1.36496e+03  1.39272e+03
 11  LaLb ratio 4.12956e-01  2.73285e-02 -2.67221e-02  2.80728e-02
 12  LaLg ratio 2.28726e-01  2.06434e-02 -2.01516e-02  2.12100e-02
 13  LaLd ratio 5.35310e-02  1.38046e-02 -1.34199e-02  1.42289e-02
 14  Gamma [eV] 8.17235e-08  2.95467e+00  at limit      2.63570e+00
                        WARNING - - ABOVE PARAMETER IS AT LIMIT.
 15  Shift [eV] 5.17368e+00  2.89787e+00 -2.89832e+00  2.90088e+00
```

```
Const Noise = 54.500 +- 0.000
KHeXLa Sigma = 78.263 +- 0.009
Fano         = 0.128 +- 0.000
lalb_ratio  = 0.413 +- 0.027
lalg_ratio  = 0.229 +- 0.021
Gamma       = 0.000 +- 2.955
Shift       = 5.174 +- 2.900
Chisq/NDF   = 170.880/145
```

**shift =  $5.2 \pm 2.9$  eV**  
**width =  $0 + 2.6$  eV**

16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	6.29851e-02	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	3.41463e-02	fixed
24	Tail NiKa area factor	8.01144e-02	fixed
25	Tail slope Ka	2.18047e+00	fixed
26	Tail TiKb area factor	3.40000e-02	fixed
27	Tail NiKb area factor	8.00000e-02	fixed
28	Tail slope Kb	2.50000e+00	fixed
29	Tail La area factor	6.44037e-02	fixed
30	Tail Lb area factor	9.93990e-02	fixed
31	Tail Lg area factor	1.15588e-01	fixed
32	Tail Ld area factor	1.24309e-01	fixed
33	Tail slope L	2.18047e+00	fixed
34	Comp La shift	5.23100e+01	fixed
35	Comp La sigma	8.60284e+01	fixed
36	Comp La area	1.37001e-01	fixed
37	Comp La slope	8.83081e-01	fixed
38	Comp Lb shift	8.31000e+01	fixed
39	Comp Lb sigma	1.07792e+02	fixed
40	Comp Lb area	1.74774e-01	fixed
41	Comp Lb slope	1.20151e+00	fixed
42	Comp Lg shift	1.05740e+02	fixed
43	Comp Lg sigma	1.20631e+02	fixed
44	Comp Lg area	1.86762e-01	fixed
45	Comp Lg slope	1.29132e+00	fixed
46	Comp Ld shift	1.07100e+02	fixed
47	Comp Ld sigma	1.25054e+02	fixed
48	Comp Ld area	1.90864e-01	fixed
49	Comp Ld slope	1.47932e+00	fixed
50	Voigt r	4.00000e+00	fixed

## 2nd cycle

(with Compton tail, low-energy tail and pileup)

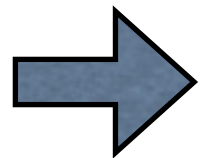
- The shift was corrected  $\sim +10$  eV
- Zero-width was gotten !

1st cycle

shift =  $0.6 \pm 3.9$  eV  
width =  $0 + 8.8$  eV

2nd cycle

shift =  $5.2 \pm 2.9$  eV  
width =  $0 + 2.6$  eV



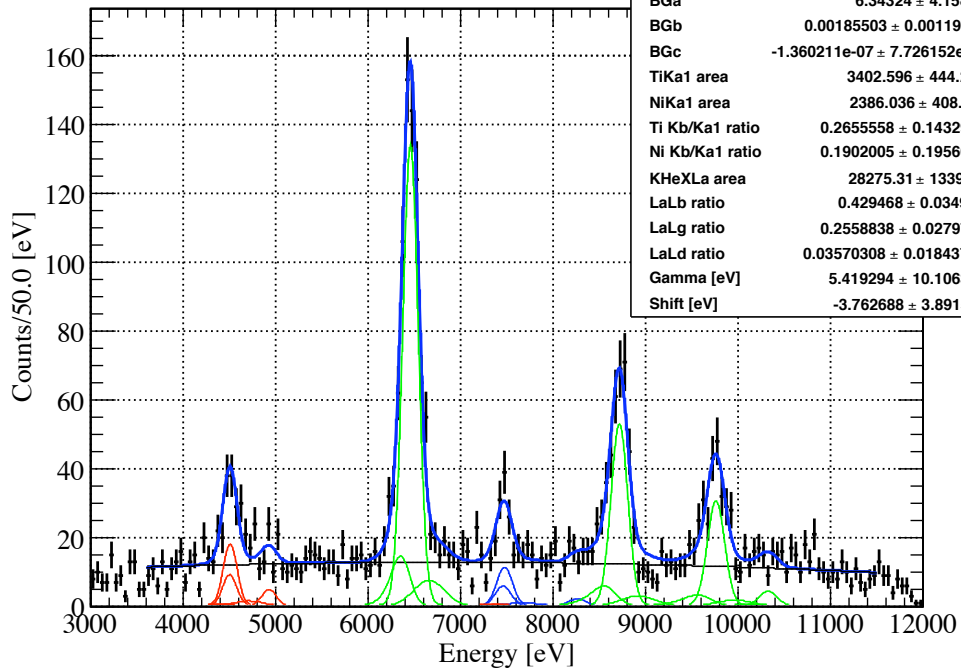
**Compare the tails ON/OFF fitting**

Next : no low-energy tail fit

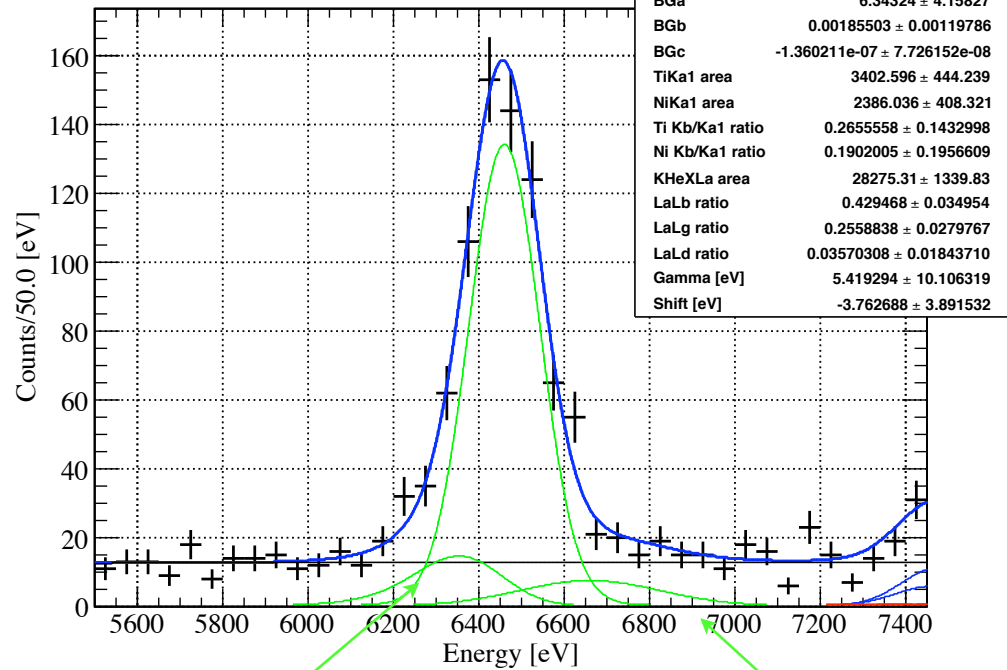
If we ignore the low-energy tail ....

**No low-energy tail fitting**

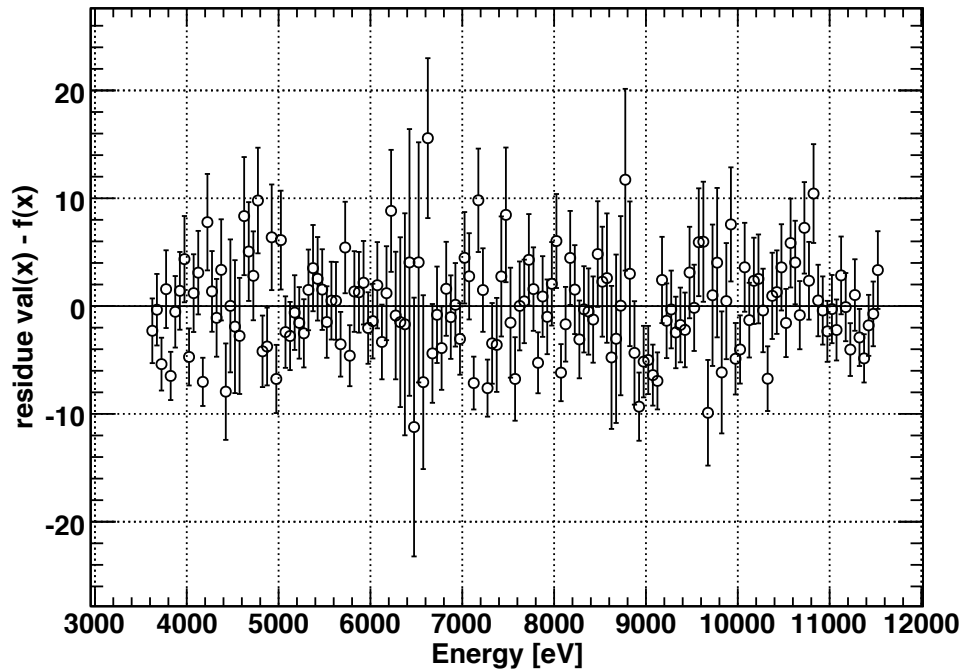
**Kstop 1st (no low-energy tail)**



**Kstop 1st (no low-energy tail)**



**fit residue**



Compton tail

Pileup

**1st cycle no low-energy tail fit  
(with Compton tail and pileup)**

**Kstop selection and fiducial  
volume cuts were applied**

# 1st cycle no low-energy tail fit (with Compton tail and pileup)

FCN=909.686 FROM MINOS STATUS=SUCCESSFUL 3328 CALLS 3692 TOTAL  
EDM=4.05923e-08 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT NO.	PARAMETER NAME	VALUE	PARABOLIC ERROR	MINOS ERRORS	
				NEGATIVE	POSITIVE
1	BGa	6.34324e+00	4.02909e+00	-4.12376e+00	4.19279e+00
2	BGb	1.85503e-03	1.15998e-03	-1.20303e-03	1.19268e-03
3	BGc	-1.36021e-07	7.48697e-08	-7.69987e-08	7.75243e-08
4	Noise [eV]	5.62000e+01	fixed		
5	Fano	1.45000e-01	fixed		
6	TiKa1 area	3.40260e+03	4.43845e+02	-4.34045e+02	4.54432e+02
7	NiKa1 area	2.38604e+03	4.07108e+02	-3.98378e+02	4.18263e+02
8	Ti Kb/Ka1 ratio	2.65556e-01	1.39731e-01	-1.35036e-01	1.51563e-01
9	Ni Kb/Ka1 ratio	1.90200e-01	1.95661e-01	at limit	2.15779e-01
10	KHeXLa area	2.82753e+04	1.33666e+03	-1.32288e+03	1.35679e+03
11	LaLb ratio	4.29468e-01	3.48873e-02	-3.39310e-02	3.59763e-02
12	LaLg ratio	2.55884e-01	2.79288e-02	-2.71555e-02	2.87978e-02
13	LaLd ratio	3.57031e-02	1.83873e-02	-1.78430e-02	1.90312e-02
14	Gamma [eV]	5.41929e+00	1.01063e+01	at limit	1.04059e+01
15	Shift [eV]	-3.76269e+00	3.88651e+00	-3.89374e+00	3.88932e+00

Const Noise = 56.200 +- 0.000  
 KHeXLa Sigma = 82.021 +- 0.013  
 Fano = 0.145 +- 0.000  
 lalb\_ratio = 0.429 +- 0.035  
 lalg\_ratio = 0.256 +- 0.028  
 Gamma = 5.419 +- 10.106  
 Shift = -3.763 +- 3.892  
 Chisq/NDF = 200.954/145

**shift =  $-3.8 \pm 3.9$  eV**  
**width =  $5 + 10^{-?}$  eV**

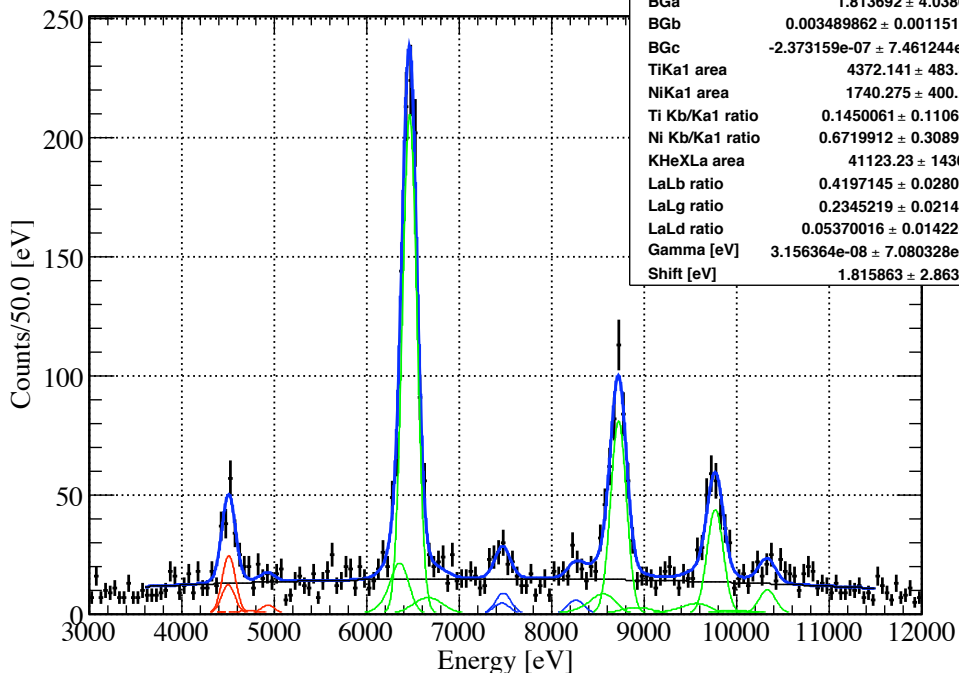
# 1st cycle no low-energy tail fit (with Compton tail and pileup)

16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	1.07228e-01	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	5.65872e-02	fixed
24	Tail NiKa area factor	9.24735e-02	fixed
25	Tail slope Ka	1.89240e+00	fixed
26	Tail TiKb area factor	5.50000e-02	fixed
27	Tail NiKb area factor	9.30000e-02	fixed
28	Tail slope Kb	2.00000e+00	fixed
29	Tail La area factor	0.00000e+00	fixed
30	Tail Lb area factor	0.00000e+00	fixed
31	Tail Lg area factor	0.00000e+00	fixed
32	Tail Ld area factor	0.00000e+00	fixed
33	Tail slope L	1.89240e+00	fixed
34	Comp La shift	5.04600e+01	fixed
35	Comp La sigma	8.79800e+01	fixed
36	Comp La area	1.38406e-01	fixed
37	Comp La slope	8.75800e-01	fixed
38	Comp Lb shift	8.18100e+01	fixed
39	Comp Lb sigma	1.08568e+02	fixed
40	Comp Lb area	1.74475e-01	fixed
41	Comp Lb slope	1.22324e+00	fixed
42	Comp Lg shift	9.88300e+01	fixed
43	Comp Lg sigma	1.21491e+02	fixed
44	Comp Lg area	1.86872e-01	fixed
45	Comp Lg slope	1.33329e+00	fixed
46	Comp Ld shift	1.08500e+02	fixed
47	Comp Ld sigma	1.27516e+02	fixed
48	Comp Ld area	1.91088e-01	fixed
49	Comp Ld slope	1.45616e+00	fixed
50	Voigt r	4.00000e+00	fixed



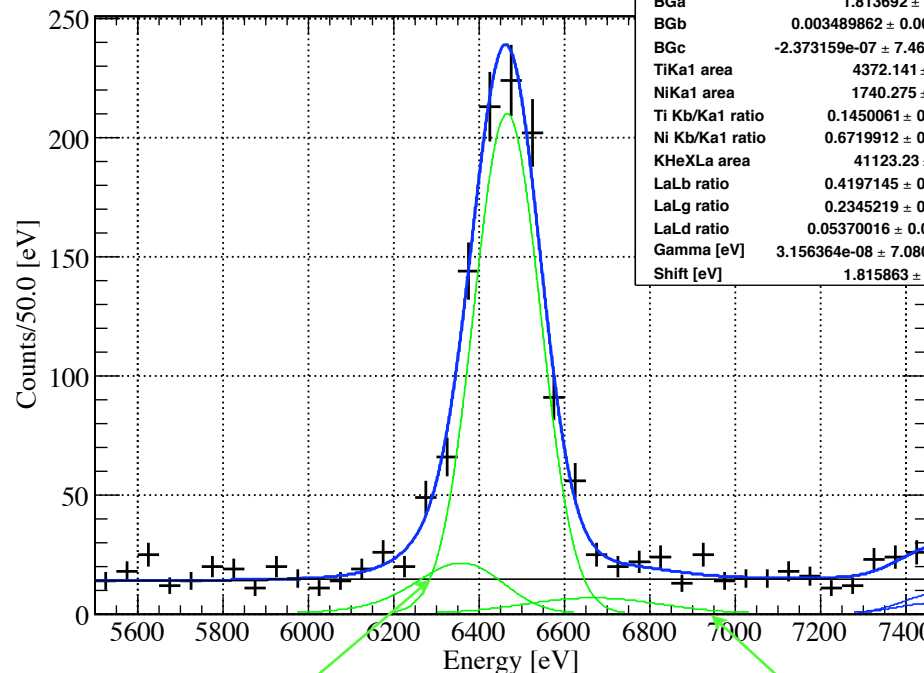
**Low-energy tail intensities  
were fixed at zero.**

Kstop 2nd (no low-energy tail)



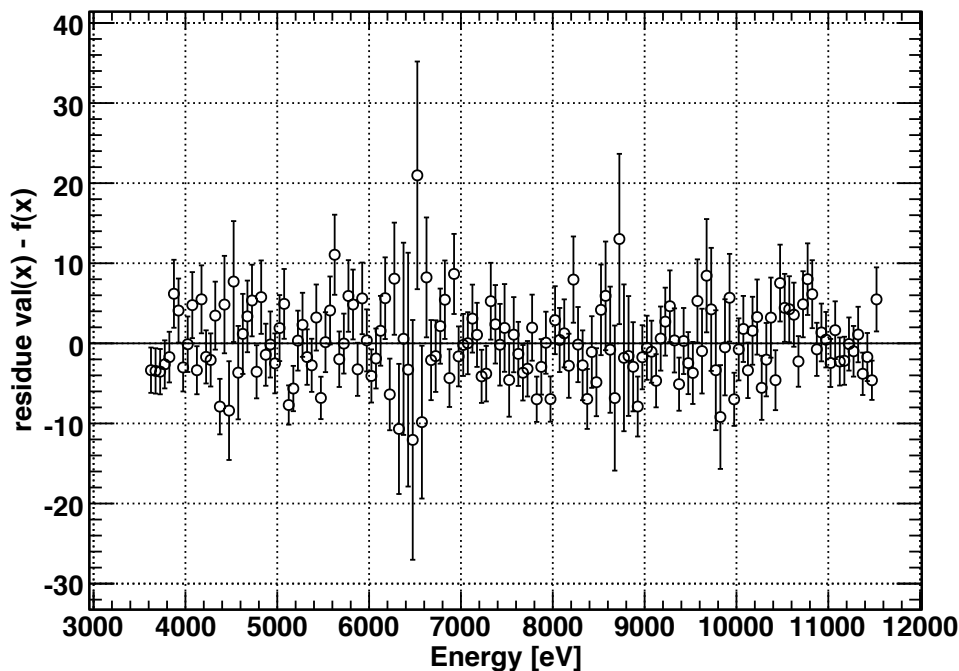
$\chi^2 / \text{ndf}$	168.6354 / 145
Prob	0.08729411
BGa	1.813692 ± 4.038624
BGb	0.003489862 ± 0.001151865
BGc	-2.373159e-07 ± 7.461244e-08
TiKa1 area	4372.141 ± 483.388
NiKa1 area	1740.275 ± 400.257
Ti Kb/Ka1 ratio	0.1450061 ± 0.1106864
Ni Kb/Ka1 ratio	0.6719912 ± 0.3089998
KHeXLa area	41123.23 ± 1436.81
LaLb ratio	0.4197145 ± 0.0280906
LaLg ratio	0.2345219 ± 0.0214089
LaLd ratio	0.05370016 ± 0.01422095
Gamma [eV]	3.156364e-08 ± 7.080328e+00
Shift [eV]	1.815863 ± 2.863616

Kstop 2nd (no low-energy tail)



$\chi^2 / \text{ndf}$	168.6354 / 145
Prob	0.08729411
BGa	1.813692 ± 4.038624
BGb	0.003489862 ± 0.001151865
BGc	-2.373159e-07 ± 7.461244e-08
TiKa1 area	4372.141 ± 483.388
NiKa1 area	1740.275 ± 400.257
Ti Kb/Ka1 ratio	0.1450061 ± 0.1106864
Ni Kb/Ka1 ratio	0.6719912 ± 0.3089998
KHeXLa area	41123.23 ± 1436.81
LaLb ratio	0.4197145 ± 0.0280906
LaLg ratio	0.2345219 ± 0.0214089
LaLd ratio	0.05370016 ± 0.01422095
Gamma [eV]	3.156364e-08 ± 7.080328e+00
Shift [eV]	1.815863 ± 2.863616

fit residue



Compton tail

Pileup

**2nd cycle no low-energy tail fit  
(with Compton tail and pileup)**

**Kstop selection and fiducial  
volume cuts were applied**



# 2nd cycle no low-energy tail fit (with Compton tail and pileup)

FCN=911.502 FROM MINOS STATUS=PROBLEMS 3033 CALLS 3476 TOTAL  
EDM=2.977e-07 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT NO.	PARAMETER NAME	VALUE	PARABOLIC ERROR	MINOS ERRORS	
				NEGATIVE	POSITIVE
1	BGa	1.81369e+00	3.93725e+00	-4.00227e+00	4.07498e+00
2	BGb	3.48986e-03	1.12239e-03	-1.15765e-03	1.14608e-03
3	BGc	-2.37316e-07	7.27471e-08	-7.42990e-08	7.49259e-08
4	Noise [eV]	5.45000e+01	fixed		
5	Fano	1.28000e-01	fixed		
6	TiKa1 area	4.37214e+03	4.83047e+02	-4.72841e+02	4.93935e+02
7	NiKa1 area	1.74028e+03	3.99465e+02	-3.89863e+02	4.10651e+02
8	Ti Kb/Ka1 ratio	1.45006e-01	1.08238e-01	-1.05646e-01	1.15727e-01
9	Ni Kb/Ka1 ratio	6.71991e-01	3.09000e-01	-3.09795e-01	at limit
10	KHeXLa area	4.11232e+04	1.43616e+03	-1.42301e+03	1.45061e+03
11	LaLb ratio	4.19714e-01	2.80568e-02	-2.73806e-02	2.88006e-02
12	LaLg ratio	2.34522e-01	2.13867e-02	-2.08473e-02	2.19704e-02
13	LaLd ratio	5.37002e-02	1.42017e-02	-1.37945e-02	1.46474e-02
14	Gamma [eV]	3.15636e-08	7.08033e+00	at limit	4.56376e+00
			WARNING -	- ABOVE PARAMETER IS AT LIMIT.	
15	Shift [eV]	1.81586e+00	2.86164e+00	-2.86277e+00	2.86446e+00

Const Noise = 54.500 +- 0.000  
 KHeXLa Sigma = 78.253 +- 0.009  
 Fano = 0.128 +- 0.000  
 lalb\_ratio = 0.420 +- 0.028  
 lalg\_ratio = 0.235 +- 0.021  
 Gamma = 0.000 +- 7.080  
 Shift = 1.816 +- 2.864  
 Chisq/NDF = 168.635/145

**shift =  $1.8 \pm 2.9$  eV**  
**width =  $0 + 4.6 - ?$  eV**

# 2nd cycle no low-energy tail fit (with Compton tail and pileup)

16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	6.29851e-02	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	3.41463e-02	fixed
24	Tail NiKa area factor	8.01144e-02	fixed
25	Tail slope Ka	2.18047e+00	fixed
26	Tail TiKb area factor	3.40000e-02	fixed
27	Tail NiKb area factor	8.00000e-02	fixed
28	Tail slope Kb	2.50000e+00	fixed
29	Tail La area factor	0.00000e+00	fixed
30	Tail Lb area factor	0.00000e+00	fixed
31	Tail Lg area factor	0.00000e+00	fixed
32	Tail Ld area factor	0.00000e+00	fixed
33	Tail slope L	2.18047e+00	fixed
34	Comp La shift	5.23100e+01	fixed
35	Comp La sigma	8.60284e+01	fixed
36	Comp La area	1.37001e-01	fixed
37	Comp La slope	8.83081e-01	fixed
38	Comp Lb shift	8.31000e+01	fixed
39	Comp Lb sigma	1.07792e+02	fixed
40	Comp Lb area	1.74774e-01	fixed
41	Comp Lb slope	1.20151e+00	fixed
42	Comp Lg shift	1.05740e+02	fixed
43	Comp Lg sigma	1.20631e+02	fixed
44	Comp Lg area	1.86762e-01	fixed
45	Comp Lg slope	1.29132e+00	fixed
46	Comp Ld shift	1.07100e+02	fixed
47	Comp Ld sigma	1.25054e+02	fixed
48	Comp Ld area	1.90864e-01	fixed
49	Comp Ld slope	1.47932e+00	fixed
50	Voigt r	4.00000e+00	fixed



**Low-energy tail intensities  
were fixed at zero.**

## Full tails fit

1st cycle

shift =  $0.6 \pm 3.9$  eV  
width =  $0 + 8.8$  eV

2nd cycle

shift =  $5.2 \pm 2.9$  eV  
width =  $0 + 2.6$  eV

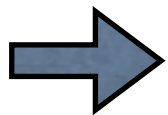
## No low-energy tail fit

1st cycle

shift =  $-3.8 \pm 3.9$  eV  
width =  $5 + 10$  eV

2nd cycle

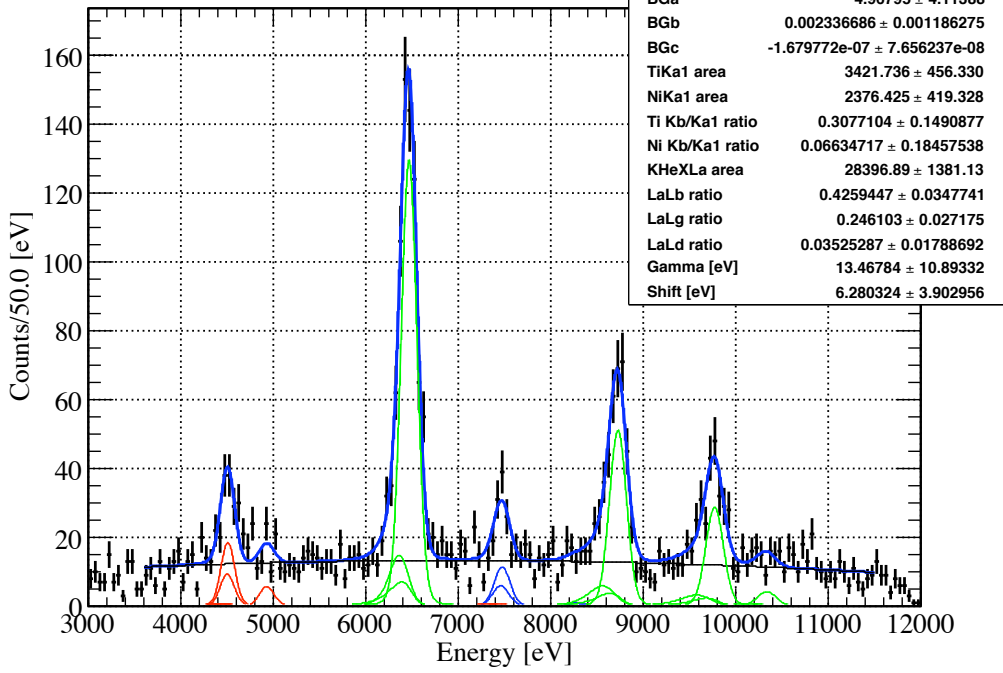
shift =  $1.8 \pm 2.9$  eV  
width =  $0 + 4.6$  eV



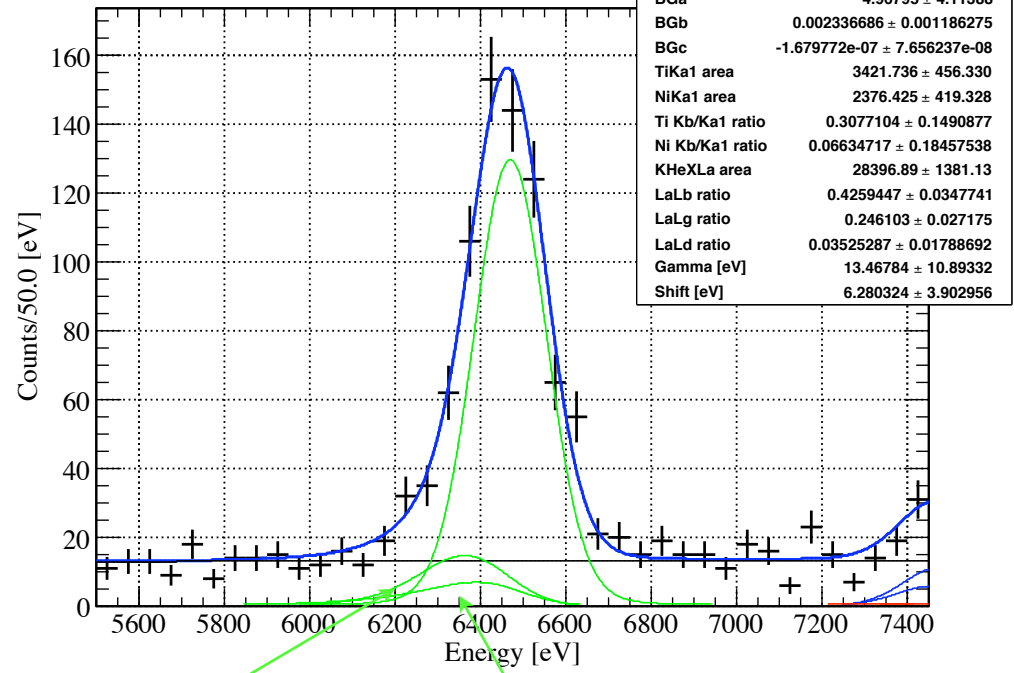
**Low-energy tail does not influence the width**  
**The shift was corrected  $\sim +4$  eV by the LE tail**

**No pileup fitting**

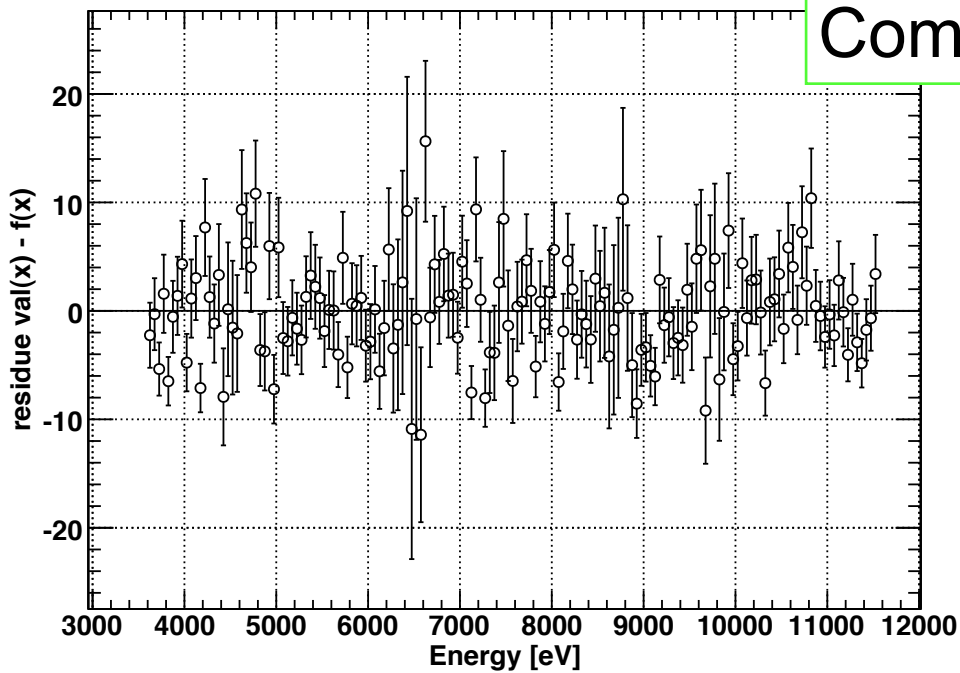
**Kstop 1st (no pileup)**



**Kstop 1st (no pileup)**



**fit residue**



Compton tail

Low-energy tail

**1st cycle no pileup fit  
(with Compton tail and low-energy tail)**

**Kstop selection and fiducial volume cuts were applied**

# 1st cycle no pileup fit

(with Compton tail  
and low-energy tail)

FCN=909.517 FROM MINOS STATUS=SUCCESSFUL 3808 CALLS 4207 TOTAL  
EDM=9.50677e-10 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT	PARAMETER	PARABOLIC	MINOS ERRORS		
NO.	NAME	VALUE	ERROR	NEGATIVE	POSITIVE
1	BGa	4.96795e+00	3.36826e+00	-4.08059e+00	4.14717e+00
2	BGb	2.33669e-03	9.62597e-04	-1.19128e-03	1.18127e-03
3	BGc	-1.67977e-07	6.22737e-08	-7.62853e-08	7.68395e-08
4	Noise [eV]	5.62000e+01	fixed		
5	Fano	1.45000e-01	fixed		
6	TiKa1 area	3.42174e+03	4.55057e+02	-4.45538e+02	4.67121e+02
7	NiKa1 area	2.37643e+03	4.13933e+02	-4.08894e+02	4.29763e+02
8	Ti Kb/Ka1 ratio	3.07710e-01	1.45371e-01	-1.40300e-01	1.57875e-01
9	Ni Kb/Ka1 ratio	6.63472e-02	1.84575e-01	at limit	2.18643e-01
10	KHeXLa area	2.83969e+04	1.36307e+03	-1.36222e+03	1.40004e+03
11	LaLb ratio	4.25945e-01	3.46692e-02	-3.37452e-02	3.58029e-02
12	LaLg ratio	2.46103e-01	2.71002e-02	-2.63738e-02	2.79755e-02
13	LaLd ratio	3.52529e-02	1.78362e-02	-1.73328e-02	1.84410e-02
14	Gamma [eV]	1.34678e+01	1.06406e+01	-1.05991e+01	1.11875e+01
15	Shift [eV]	6.28032e+00	3.89683e+00	-3.89375e+00	3.91216e+00

Const Noise = 56.200 +- 0.000  
KHeXLa Sigma = 82.055 +- 0.013  
Fano = 0.145 +- 0.000  
lalb\_ratio = 0.426 +- 0.035  
lalg\_ratio = 0.246 +- 0.027  
Gamma = 13.468 +- 10.893  
Shift = 6.280 +- 3.903  
Chisq/NDF = 199.855/145

shift =  $6.3 \pm 3.9$  eV  
width =  $13.5 \pm 10.9$  eV

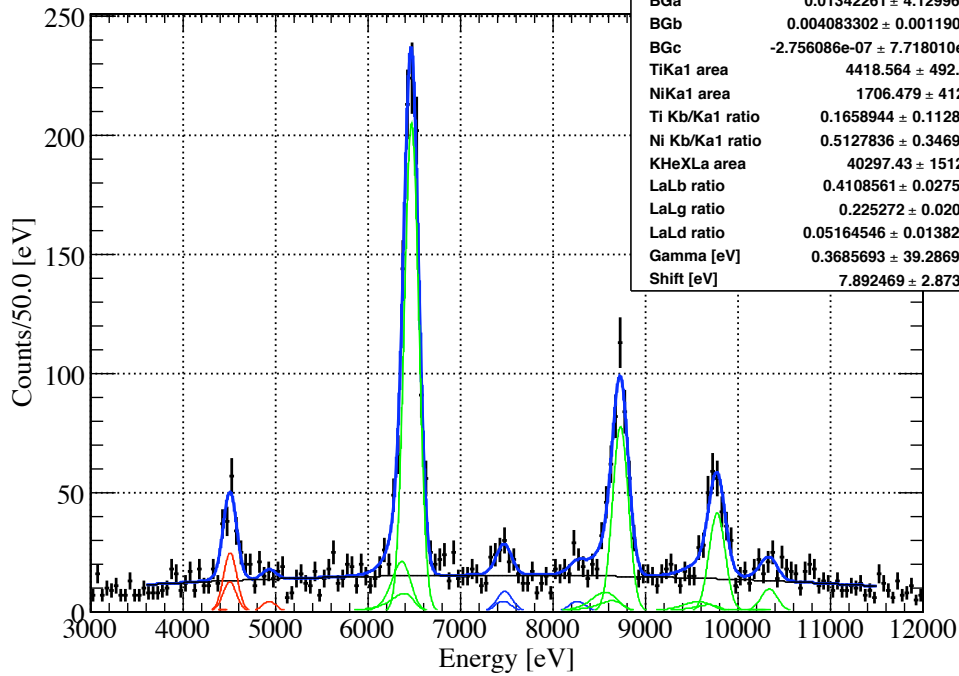
16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	0.00000e+00	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	5.65872e-02	fixed
24	Tail NiKa area factor	9.24735e-02	fixed
25	Tail slope Ka	1.89240e+00	fixed
26	Tail TiKb area factor	5.50000e-02	fixed
27	Tail NiKb area factor	9.30000e-02	fixed
28	Tail slope Kb	2.00000e+00	fixed
29	Tail La area factor	8.02085e-02	fixed
30	Tail Lb area factor	1.07529e-01	fixed
31	Tail Lg area factor	1.20167e-01	fixed
32	Tail Ld area factor	1.26976e-01	fixed
33	Tail slope L	1.89240e+00	fixed
34	Comp La shift	5.04600e+01	fixed
35	Comp La sigma	8.79800e+01	fixed
36	Comp La area	1.38406e-01	fixed
37	Comp La slope	8.75800e-01	fixed
38	Comp Lb shift	8.18100e+01	fixed
39	Comp Lb sigma	1.08568e+02	fixed
40	Comp Lb area	1.74475e-01	fixed
41	Comp Lb slope	1.22324e+00	fixed
42	Comp Lg shift	9.88300e+01	fixed
43	Comp Lg sigma	1.21491e+02	fixed
44	Comp Lg area	1.86872e-01	fixed
45	Comp Lg slope	1.33329e+00	fixed
46	Comp Ld shift	1.08500e+02	fixed
47	Comp Ld sigma	1.27516e+02	fixed
48	Comp Ld area	1.91088e-01	fixed
49	Comp Ld slope	1.45616e+00	fixed
50	Voigt r	4.00000e+00	fixed

**1st cycle no pileup fit**

**(with Compton tail  
and low-energy tail)**

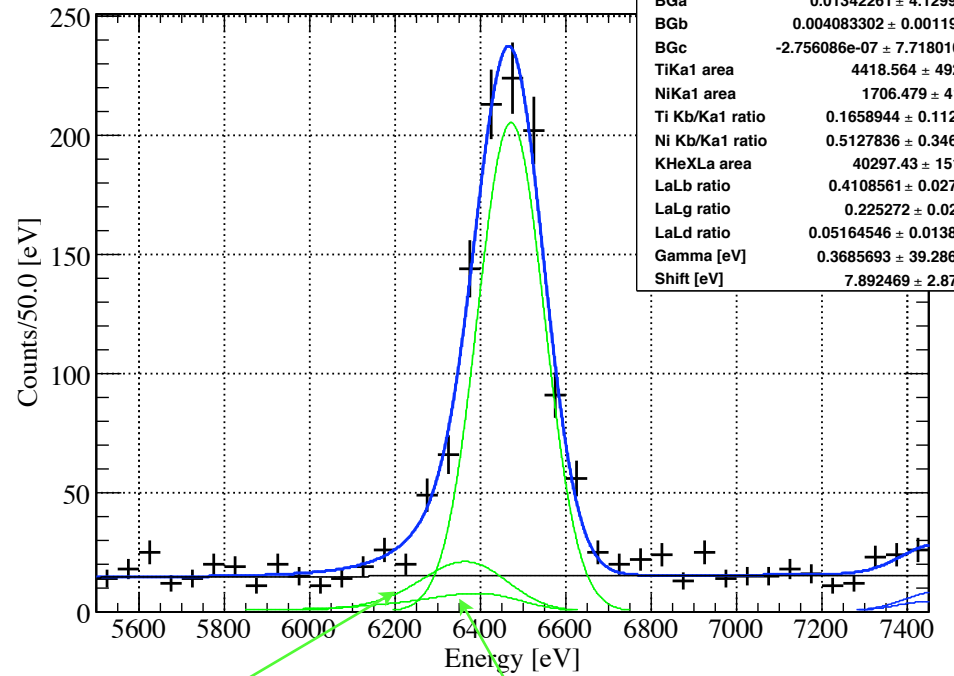
**Pileup intensities were  
fixed at zero.**

**Kstop 2nd (no pileup)**



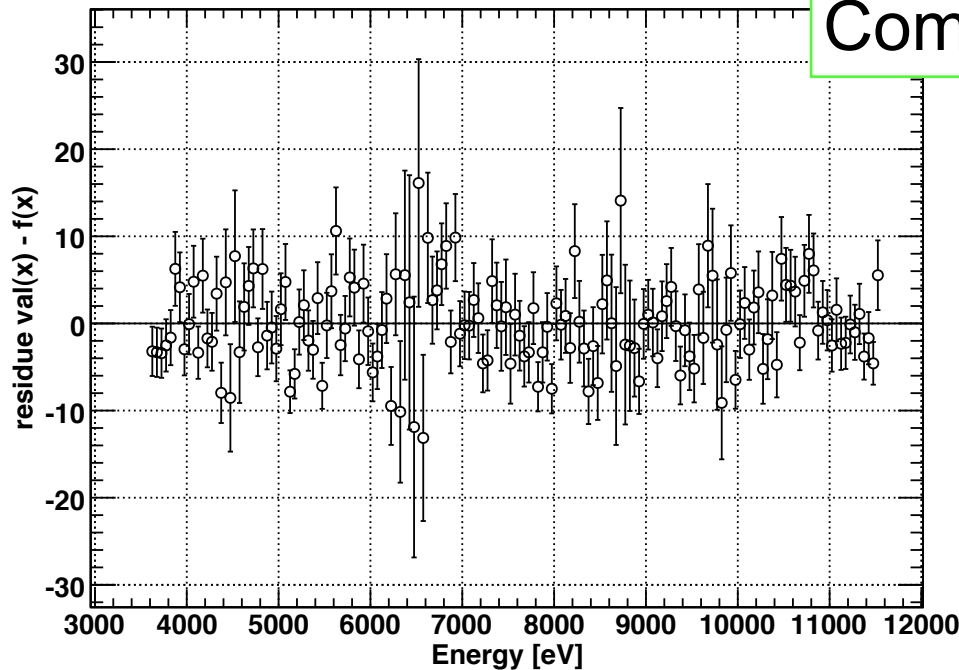
$\chi^2 / \text{ndf}$	180.2212 / 145
Prob	0.02502355
BGa	0.01342261 ± 4.12996149
BGb	0.004083302 ± 0.001190594
BGc	-2.756086e-07 ± 7.718010e-08
TiKa1 area	4418.564 ± 492.127
NiKa1 area	1706.479 ± 412.27
Ti Kb/Ka1 ratio	0.1658944 ± 0.1128674
Ni Kb/Ka1 ratio	0.5127836 ± 0.3469826
KHeXLa area	40297.43 ± 1512.50
LaLb ratio	0.4108561 ± 0.0275945
LaLg ratio	0.225272 ± 0.020830
LaLd ratio	0.05164546 ± 0.01382389
Gamma [eV]	0.3685693 ± 39.2869492
Shift [eV]	7.892469 ± 2.873439

**Kstop 2nd (no pileup)**



$\chi^2 / \text{ndf}$	180.2212 / 145
Prob	0.02502355
BGa	0.01342261 ± 4.12996149
BGb	0.004083302 ± 0.001190594
BGc	-2.756086e-07 ± 7.718010e-08
TiKa1 area	4418.564 ± 492.127
NiKa1 area	1706.479 ± 412.27
Ti Kb/Ka1 ratio	0.1658944 ± 0.1128674
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KHeXLa area	40297.43 ± 1512.50
LaLb ratio	0.4108561 ± 0.0275945
LaLg ratio	0.225272 ± 0.020830
LaLd ratio	0.05164546 ± 0.01382389
Gamma [eV]	0.3685693 ± 39.2869492
Shift [eV]	7.892469 ± 2.873439

**fit residue**



Compton tail

Low-energy tail

**2nd cycle no pileup fit  
(with Compton tail and low-energy tail)**

**Kstop selection and fiducial volume cuts were applied**



# 2nd cycle no pileup fit

(with Compton tail  
and low-energy tail)

FCN=921.266 FROM MINOS STATUS=PROBLEMS 5724 CALLS 6153 TOTAL  
EDM=4.38618e-08 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT NO.	PARAMETER NAME	VALUE	PARABOLIC ERROR	MINOS NEGATIVE	MINOS POSITIVE
1	BGa	1.34226e-02	2.98192e+00	-4.00666e+00	4.25326e+00
2	BGb	4.08330e-03	8.54037e-04	-1.23116e-03	1.15003e-03
3	BGc	-2.75609e-07	5.56449e-08	-7.46132e-08	7.97470e-08
4	Noise [eV]	5.45000e+01	fixed		
5	Fano	1.28000e-01	fixed		
6	TiKa1 area	4.41856e+03	4.90822e+02	-4.81202e+02	5.03052e+02
7	NiKa1 area	1.70648e+03	4.05545e+02	-4.00209e+02	4.24338e+02
8	Ti Kb/Ka1 ratio	1.65894e-01	1.10584e-01	-1.07721e-01	1.18014e-01
9	Ni Kb/Ka1 ratio	5.12784e-01	3.11241e-01	-3.15834e-01	3.78131e-01
10	KHeXLa area	4.02974e+04	1.57666e+03	-1.42943e+03	1.59558e+03
11	LaLb ratio	4.10856e-01	2.75945e-02		2.83657e-02
12	LaLg ratio	2.25272e-01	2.07820e-02	-2.02924e-02	2.13680e-02
13	LaLd ratio	5.16455e-02	1.38217e-02	-1.34081e-02	1.42397e-02
14	Gamma [eV]	3.68569e-01	3.92869e+01	at limit	7.84162e+00
15	Shift [eV]	7.89247e+00	2.87285e+00	-2.86591e+00	2.88097e+00

Const Noise = 54.500 +- 0.000  
KHeXLa Sigma = 78.272 +- 0.009  
Fano = 0.128 +- 0.000  
lalb\_ratio = 0.411 +- 0.028  
lalg\_ratio = 0.225 +- 0.021  
Gamma = 0.369 +- 39.287  
Shift = 7.892 +- 2.873  
Chisq/NDF = 180.221/145

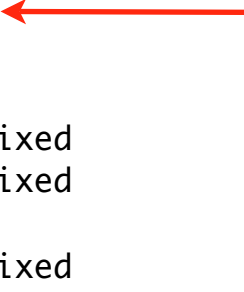
**shift =  $7.9 \pm 2.9$  eV**  
**width =  $0.4 + 8.0 - ?$  eV**

16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	0.00000e+00	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	3.41463e-02	fixed
24	Tail NiKa area factor	8.01144e-02	fixed
25	Tail slope Ka	2.18047e+00	fixed
26	Tail TiKb area factor	3.40000e-02	fixed
27	Tail NiKb area factor	8.00000e-02	fixed
28	Tail slope Kb	2.50000e+00	fixed
29	Tail La area factor	6.44037e-02	fixed
30	Tail Lb area factor	9.93990e-02	fixed
31	Tail Lg area factor	1.15588e-01	fixed
32	Tail Ld area factor	1.24309e-01	fixed
33	Tail slope L	2.18047e+00	fixed
34	Comp La shift	5.23100e+01	fixed
35	Comp La sigma	8.60284e+01	fixed
36	Comp La area	1.37001e-01	fixed
37	Comp La slope	8.83081e-01	fixed
38	Comp Lb shift	8.31000e+01	fixed
39	Comp Lb sigma	1.07792e+02	fixed
40	Comp Lb area	1.74774e-01	fixed
41	Comp Lb slope	1.20151e+00	fixed
42	Comp Lg shift	1.05740e+02	fixed
43	Comp Lg sigma	1.20631e+02	fixed
44	Comp Lg area	1.86762e-01	fixed
45	Comp Lg slope	1.29132e+00	fixed
46	Comp Ld shift	1.07100e+02	fixed
47	Comp Ld sigma	1.25054e+02	fixed
48	Comp Ld area	1.90864e-01	fixed
49	Comp Ld slope	1.47932e+00	fixed
50	Voigt r	4.00000e+00	fixed

## 2nd cycle no pileup fit

(with Compton tail  
and low-energy tail)

Pileup intensities were  
fixed at zero.



## Full tails fit

1st cycle

shift =  $0.6 \pm 3.9$  eV  
width =  $0 + 8.8$  eV

2nd cycle

shift =  $5.2 \pm 2.9$  eV  
width =  $0 + 2.6$  eV

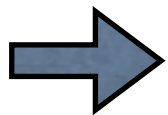
## No pileup fit

1st cycle

shift =  $6.3 \pm 3.9$  eV  
width =  $13.5 \pm 10.9$  eV

2nd cycle

shift =  $7.9 \pm 2.9$  eV  
width =  $0.4 + 8.0$  eV

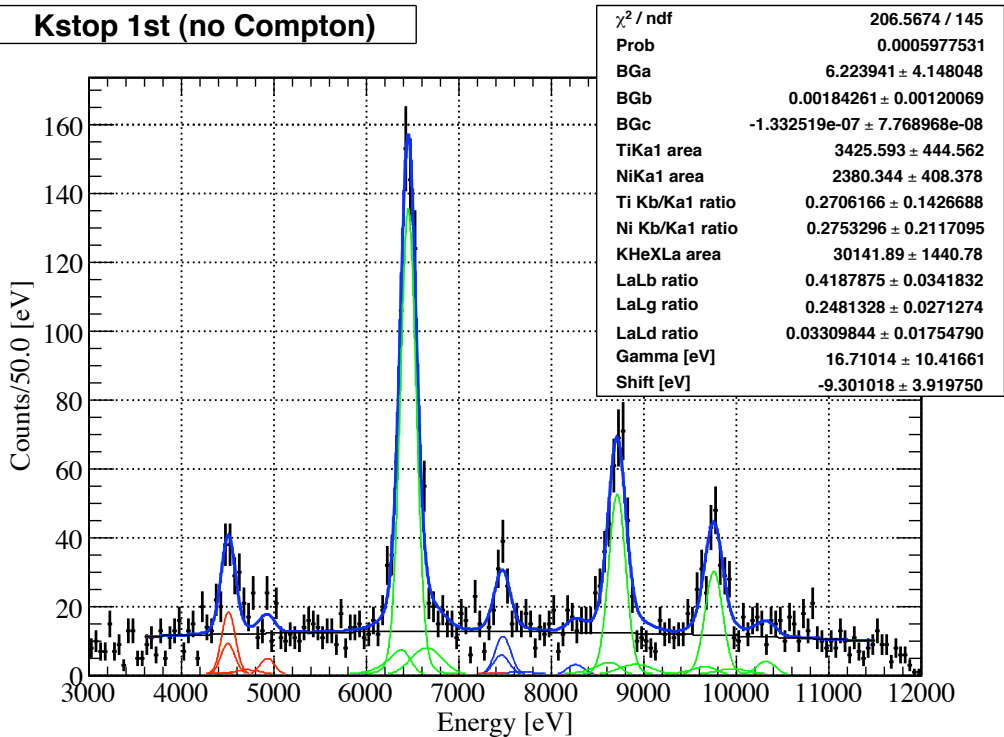


**Different corrections between 1st and 2nd cycles**

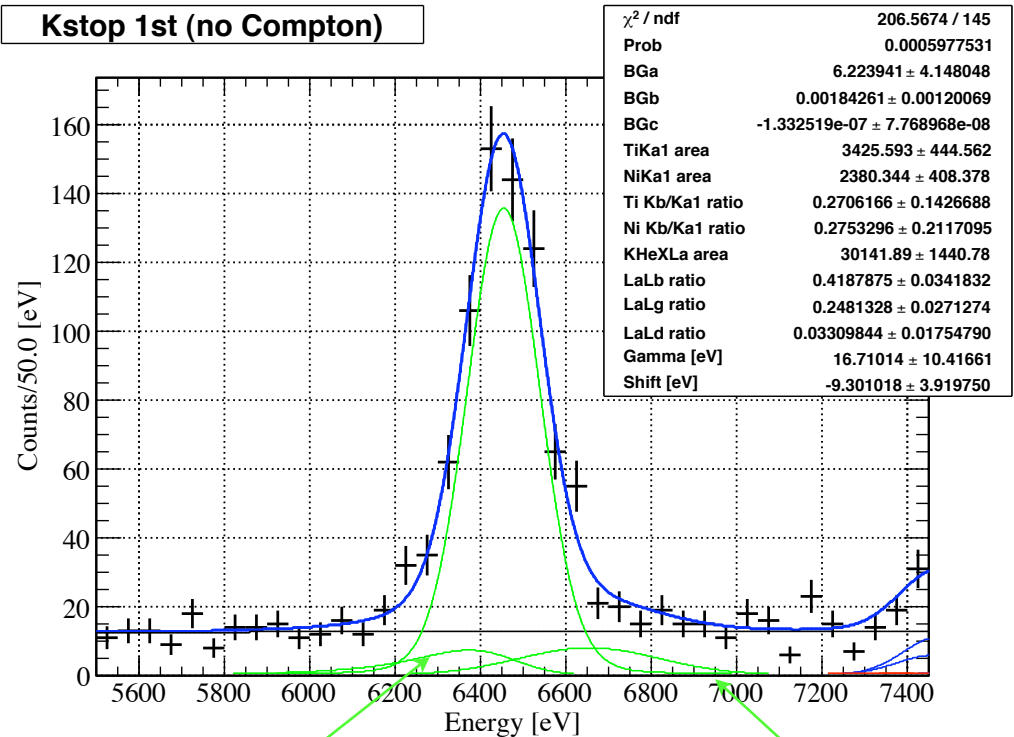
**The shift was corrected  $\sim -3$  eV ? by the pileup**

**No Compton tail fitting**

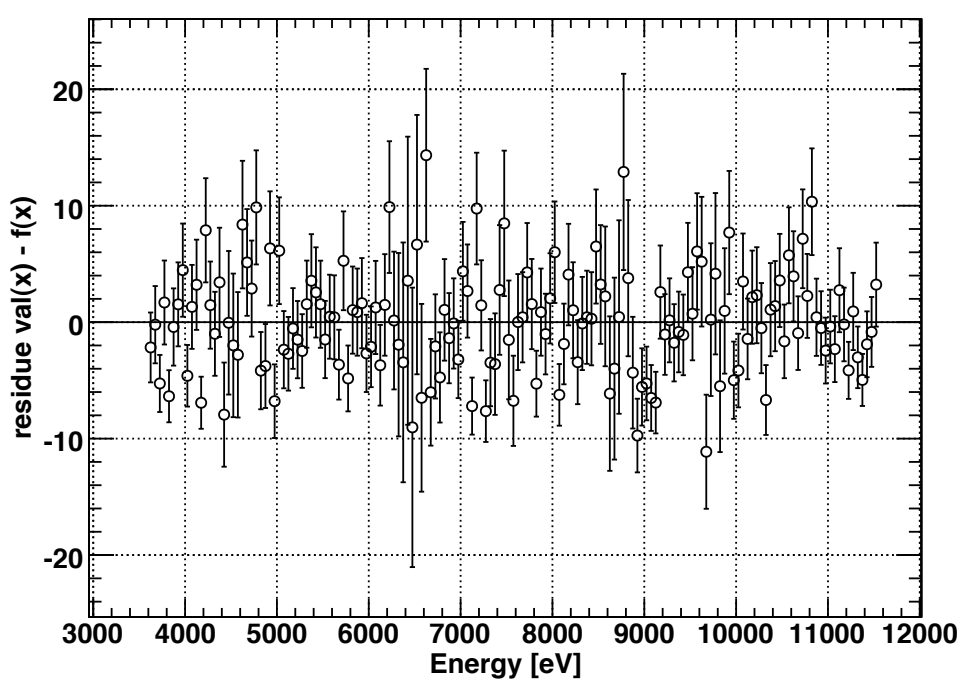
**Kstop 1st (no Compton)**



**Kstop 1st (no Compton)**



**fit residue**



Low-energy tail

Pileup

**1st cycle no Compton tail fit  
(with pileup and low-energy tail)**

**Kstop selection and fiducial  
volume cuts were applied**

# 1st cycle no Compton tail fit (with pileup and low-energy tail)

FCN=914.088 FROM MINOS STATUS=SUCCESSFUL 3100 CALLS 3472 TOTAL  
EDM=3.65151e-09 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT NO.	PARAMETER NAME	VALUE	PARABOLIC ERROR	MINOS ERRORS	
				NEGATIVE	POSITIVE
1	BGa	6.22394e+00	4.04684e+00	-4.11450e+00	4.18159e+00
2	BGb	1.84261e-03	1.17034e-03	-1.20571e-03	1.19567e-03
3	BGc	-1.33252e-07	7.57440e-08	-7.74287e-08	7.79507e-08
4	Noise [eV]	5.62000e+01	fixed		
5	Fano	1.45000e-01	fixed		
6	TiKa1 area	3.42559e+03	4.44289e+02	-4.34388e+02	4.54736e+02
7	NiKa1 area	2.38034e+03	4.07347e+02	-3.98455e+02	4.18300e+02
8	Ti Kb/Ka1 ratio	2.70617e-01	1.39178e-01	-1.34400e-01	1.50938e-01
9	Ni Kb/Ka1 ratio	2.75330e-01	2.00973e-01	-2.01871e-01	2.21548e-01
10	KHeXLa area	3.01419e+04	1.43747e+03	-1.42247e+03	1.45908e+03
11	LaLb ratio	4.18787e-01	3.41220e-02	-3.31855e-02	3.51809e-02
12	LaLg ratio	2.48133e-01	2.70852e-02	-2.63250e-02	2.79298e-02
13	LaLd ratio	3.30984e-02	1.75016e-02	-1.69819e-02	1.81139e-02
14	Gamma [eV]	1.67101e+01	1.03740e+01	-1.01615e+01	1.06718e+01
15	Shift [eV]	-9.30102e+00	3.91433e+00	-3.92655e+00	3.91295e+00

Const Noise = 56.200 +- 0.000  
KHeXLa Sigma = 82.002 +- 0.013  
Fano = 0.145 +- 0.000  
lalb\_ratio = 0.419 +- 0.034  
lalg\_ratio = 0.248 +- 0.027  
Gamma = 16.710 +- 10.417  
Shift = -9.301 +- 3.920  
Chisq/NDF = 206.567/145

**shift =  $-9.3 \pm 3.9$  eV**  
**width =  $16.7 \pm 10.4$  eV**

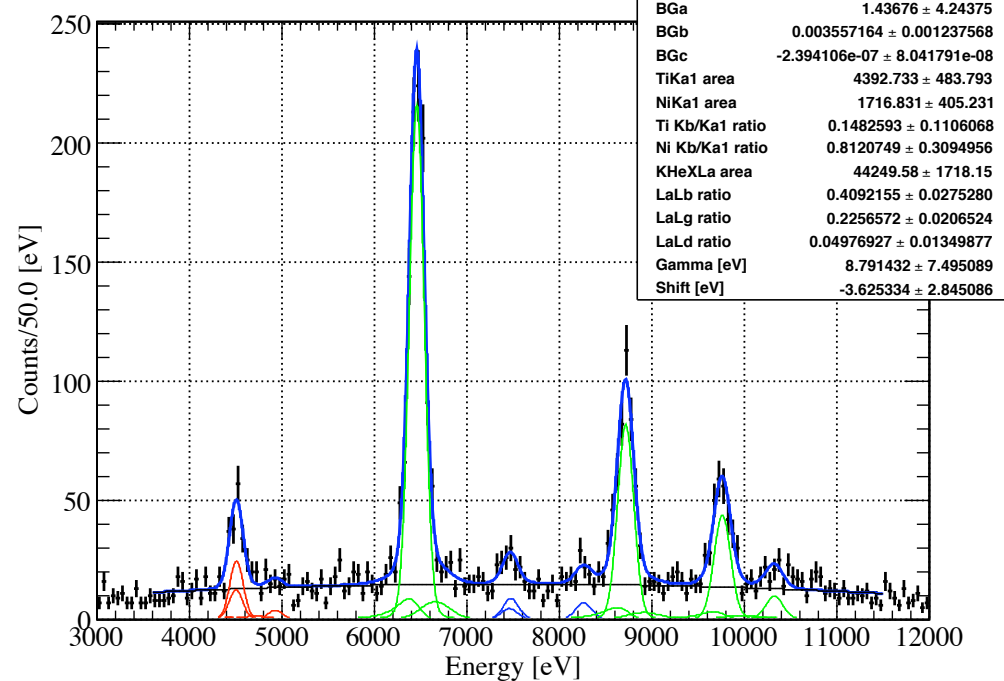
# 1st cycle no Compton tail fit (with pileup and low-energy tail)

16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	1.07228e-01	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	5.65872e-02	fixed
24	Tail NiKa area factor	9.24735e-02	fixed
25	Tail slope Ka	1.89240e+00	fixed
26	Tail TiKb area factor	5.50000e-02	fixed
27	Tail NiKb area factor	9.30000e-02	fixed
28	Tail slope Kb	2.00000e+00	fixed
29	Tail La area factor	8.02085e-02	fixed
30	Tail Lb area factor	1.07529e-01	fixed
31	Tail Lg area factor	1.20167e-01	fixed
32	Tail Ld area factor	1.26976e-01	fixed
33	Tail slope L	1.89240e+00	fixed
34	Comp La shift	5.04600e+01	fixed
35	Comp La sigma	8.79800e+01	fixed
36	Comp La area	0.00000e+00	fixed
37	Comp La slope	8.75800e-01	fixed
38	Comp Lb shift	8.18100e+01	fixed
39	Comp Lb sigma	1.08568e+02	fixed
40	Comp Lb area	0.00000e+00	fixed
41	Comp Lb slope	1.22324e+00	fixed
42	Comp Lg shift	9.88300e+01	fixed
43	Comp Lg sigma	1.21491e+02	fixed
44	Comp Lg area	0.00000e+00	fixed
45	Comp Lg slope	1.33329e+00	fixed
46	Comp Ld shift	1.08500e+02	fixed
47	Comp Ld sigma	1.27516e+02	fixed
48	Comp Ld area	0.00000e+00	fixed
49	Comp Ld slope	1.45616e+00	fixed
50	Voigt r	4.00000e+00	fixed

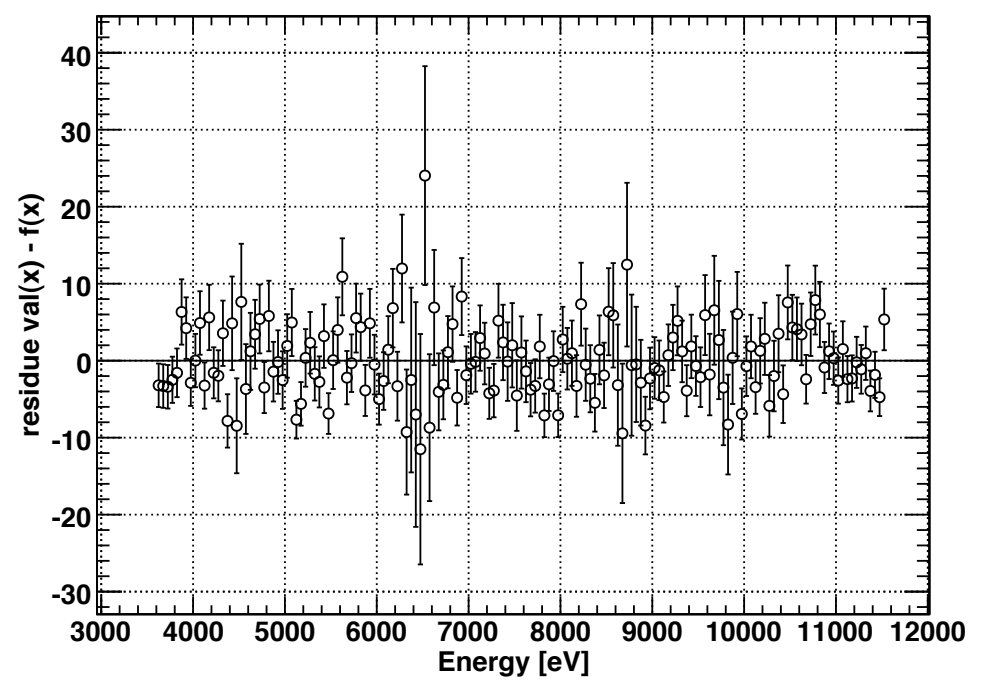
Compton tail intensities  
were fixed at zero.



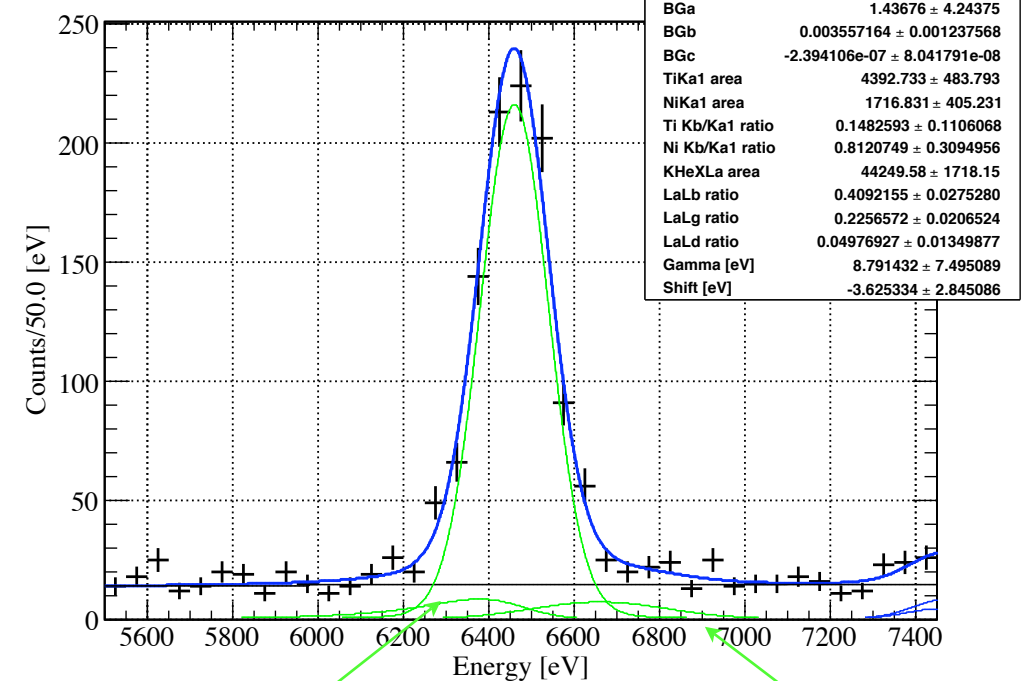
**Kstop 2nd (no Compton)**



**fit residue**



**Kstop 2nd (no Compton)**



Low-energy tail

Pileup

**2nd cycle no Compton tail fit  
(with pileup and low-energy tail)**

**Kstop selection and fiducial  
volume cuts were applied**



# 2nd cycle no Compton tail fit (with pileup and low-energy tail)

FCN=910.592 FROM MINOS STATUS=PROBLEMS 3252 CALLS 3625 TOTAL  
EDM=3.83738e-08 STRATEGY= 1 ERROR MATRIX ACCURATE

EXT NO.	PARAMETER NAME	VALUE	PARABOLIC ERROR	MINOS ERRORS	
				NEGATIVE	POSITIVE
1	BGa	1.43676e+00	3.93055e+00	-4.21003e+00	4.27746e+00
2	BGb	3.55716e-03	1.14374e-03	-1.24277e-03	1.23237e-03
3	BGc	-2.39411e-07	7.44119e-08	-8.01413e-08	8.06945e-08
4	Noise [eV]	5.45000e+01	fixed		
5	Fano	1.28000e-01	fixed		
6	TiKa1 area	4.39273e+03	4.83284e+02	-4.73216e+02	4.94369e+02
7	NiKa1 area	1.71683e+03	4.02425e+02	-3.94878e+02	4.15583e+02
8	Ti Kb/Ka1 ratio	1.48259e-01	1.08207e-01	-1.05582e-01	1.15631e-01
9	Ni Kb/Ka1 ratio	8.12075e-01	3.09496e-01	-3.23662e-01	at limit
10	KHeXLa area	4.42496e+04	1.70922e+03	-1.69932e+03	1.73698e+03
11	LaLb ratio	4.09216e-01	2.74813e-02	-2.68461e-02	2.82100e-02
12	LaLg ratio	2.25657e-01	2.06255e-02	-2.01152e-02	2.11895e-02
13	LaLd ratio	4.97693e-02	1.34807e-02	-1.30888e-02	1.39088e-02
14	Gamma [eV]	8.79143e+00	7.42396e+00	-7.33762e+00	7.65256e+00
15	Shift [eV]	-3.62533e+00	2.84472e+00	-2.84546e+00	2.84472e+00

Const Noise = 54.500 +- 0.000  
 KHeXLa Sigma = 78.236 +- 0.009  
 Fano = 0.128 +- 0.000  
 lalb\_ratio = 0.409 +- 0.028  
 lalg\_ratio = 0.226 +- 0.021  
 Gamma = 8.791 +- 7.495  
 Shift = -3.625 +- 2.845  
 Chisq/NDF = 167.459/145

**shift =  $-3.6 \pm 2.8$  eV**  
**width =  $8.8 \pm 7.5$  eV**

# 2nd cycle no Compton tail fit (with pileup and low-energy tail)

16	TiKa1 mean [eV]	4.51084e+03	fixed
17	NiKa1 mean [eV]	7.47815e+03	fixed
18	TiKb1 mean [eV]	4.93181e+03	fixed
19	NiKb1 mean [eV]	8.26466e+03	fixed
20	Pile area factor	6.29851e-02	fixed
21	Pile shift [eV]	2.00000e+02	fixed
22	Pile sigma factor	2.00000e+00	fixed
23	Tail TiKa area factor	3.41463e-02	fixed
24	Tail NiKa area factor	8.01144e-02	fixed
25	Tail slope Ka	2.18047e+00	fixed
26	Tail TiKb area factor	3.40000e-02	fixed
27	Tail NiKb area factor	8.00000e-02	fixed
28	Tail slope Kb	2.50000e+00	fixed
29	Tail La area factor	6.44037e-02	fixed
30	Tail Lb area factor	9.93990e-02	fixed
31	Tail Lg area factor	1.15588e-01	fixed
32	Tail Ld area factor	1.24309e-01	fixed
33	Tail slope L	2.18047e+00	fixed
34	Comp La shift	5.23100e+01	fixed
35	Comp La sigma	8.60284e+01	fixed
36	Comp La area	0.00000e+00	fixed
37	Comp La slope	8.83081e-01	fixed
38	Comp Lb shift	8.31000e+01	fixed
39	Comp Lb sigma	1.07792e+02	fixed
40	Comp Lb area	0.00000e+00	fixed
41	Comp Lb slope	1.20151e+00	fixed
42	Comp Lg shift	1.05740e+02	fixed
43	Comp Lg sigma	1.20631e+02	fixed
44	Comp Lg area	0.00000e+00	fixed
45	Comp Lg slope	1.29132e+00	fixed
46	Comp Ld shift	1.07100e+02	fixed
47	Comp Ld sigma	1.25054e+02	fixed
48	Comp Ld area	0.00000e+00	fixed
49	Comp Ld slope	1.47932e+00	fixed
50	Voigt r	4.00000e+00	fixed

Compton tail intensities  
were fixed at zero.



## Full tails fit

1st cycle

shift =  $0.6 \pm 3.9$  eV  
width =  $0 + 8.8$  eV

2nd cycle

shift =  $5.2 \pm 2.9$  eV  
width =  $0 + 2.6$  eV

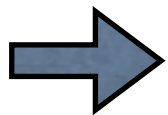
## No Compton tail fit

1st cycle

shift =  $-9.3 \pm 3.9$  eV  
width =  $16.7 \pm 10.4$  eV

2nd cycle

shift =  $-3.6 \pm 2.8$  eV  
width =  $8.8 \pm 7.5$  eV



**Centroid of the width was shifted from zero to ~10 eV  
The shift was corrected ~+9 eV by the Compton tail**

*← These results were expected by simple simulations !*

# Summary

**Compton tail correction was done. As a result,**

1st cycle  
shift =  $0.6 \pm 3.9$  eV  
width =  $0 + 8.8$  eV

2nd cycle  
shift =  $5.2 \pm 2.9$  eV  
width =  $0 + 2.6$  eV

almost zero-shift and zero-width

## Corrections

- Low-energy tail* → **Low-energy tail does not influence the width  
The shift was corrected  $\sim +4$  eV**
- pileup* → **Different corrections between 1st and 2nd cycles  
The shift was corrected  $\sim -3$  eV ?**
- Compton tail* → **Centroid of the width was shifted  
from zero to  $\sim 10$  eV  
The shift was corrected  $\sim +9$  eV  
by the Compton tail**

# Next

## ▶ How fix the $K\beta$ tail intensity ?

→ Feedback from the PSI data

→ re-calibration

**The  $K\beta$  tail conflicts with the pileup Gaussian.**

**Since the pileup is one of the main corrections, we should be careful to decide the pileup intensity.**

**Flash ADC data are not yet usable fully!**

▶ **Systematics error estimation**

▶ **Publish a letter paper**