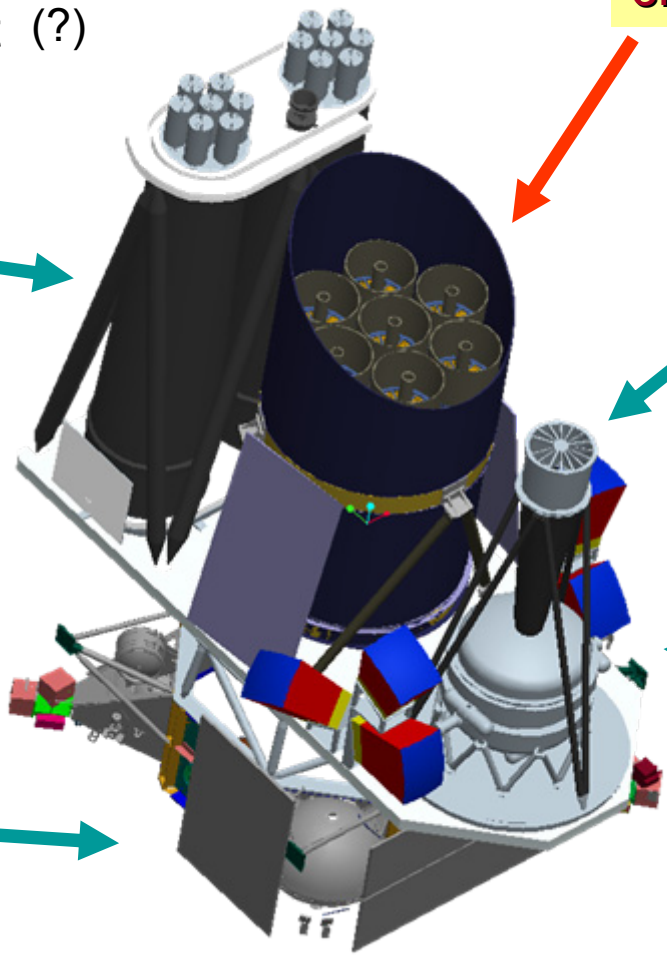
# eROSITA Calibration

# Spektr-Rentgen-Gamma (SRG)
# Спектр-рентген-гамма

to be launched in 2011
from Baikonur
into 600 km / 30° orbit (?)
with Soyuz-Fregat



eROSITA (D)

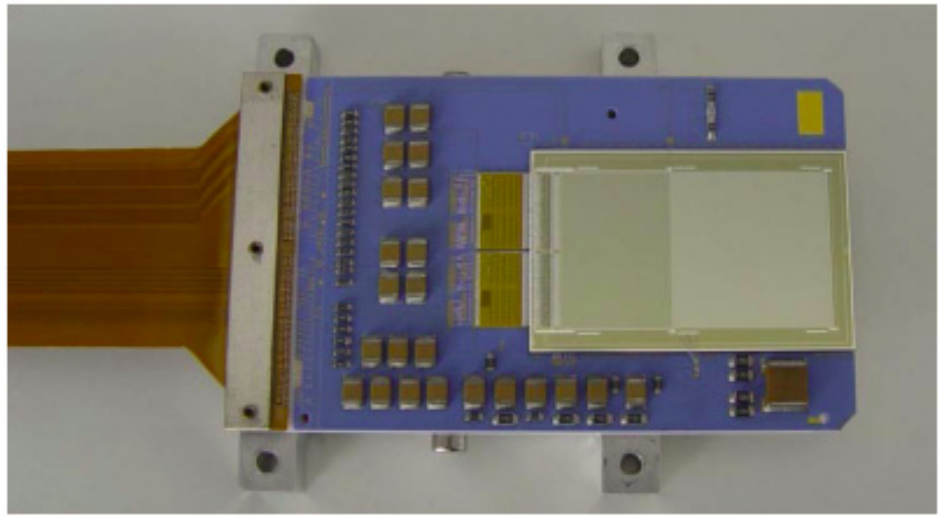
Calorimeter (NL,US,J)

ART-XC (Ru)

LWFT (UK)
"LOBSTER"

Spacecraft
"Navigator" (Ru)

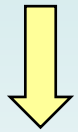
# eROSITA



## XMM-Newton vs. eROSITA detectors

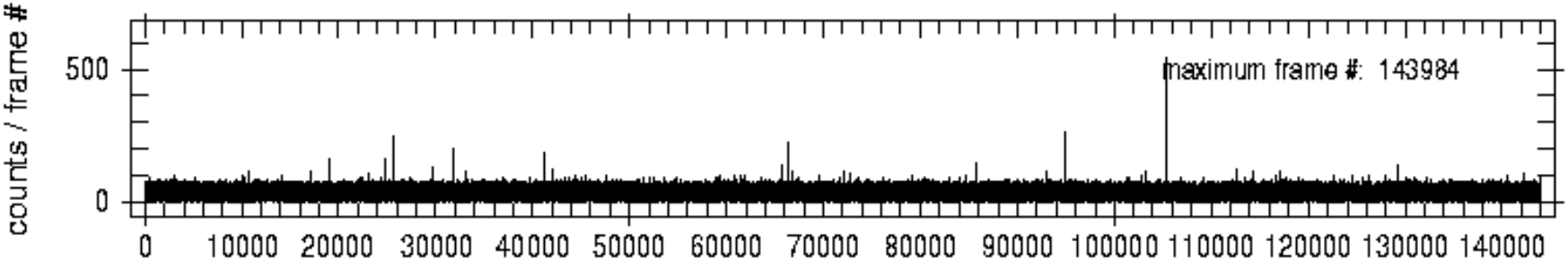
| Project | XMM-Newton PN detector | eROSITA detectors |
|---|---|---|
| CCD production | 1996-1998 | 2007-2008 |
| Sens. thickness | 300 µm | 450 µm (QE: E>7keV) |
| pixel size | 150 µm x 150 µm | 75 µm x 75 µm (split events) |
| CCD front side | bare gates | gates coated |
| image area | 35 $cm^2$ | 58 $cm^2$ |
| pixel process. rate: | 2.1 E6 pixel / s | 20.6 E6 pixel / s |
| el. noise (rms) | 5 $e^-$ | 2.5 $e^-$ (!) |
| CTI (6 keV) | 5E-4 | 3E-5 (!) ( CTI(t) ) |
| operating mode | full frame; OOT events: 6% | frame store; OOT: 4‰ (!) |
| #pixel transfers | 1-200 | 385-768 |
| Filter | choice: thin/medium/thick | on-chip |
| instr. background | several fluorescence lines | graded shield (B,C lines) |
| split events | mainly singles | mainly split events (up to 4 pix.) |
| E < 0.5 keV | poor spectroscopy | excellent spectroscopy (!) |

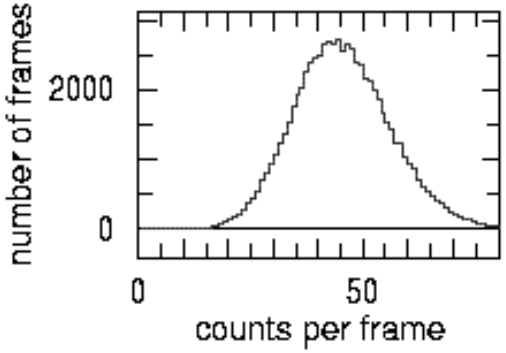
*eROSITA Ground Calibration*

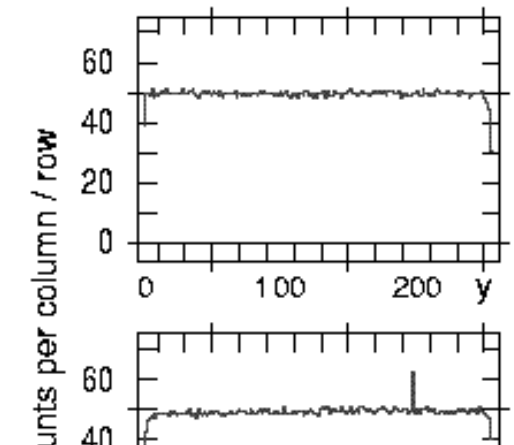


***TRoPIC Calibration***

# eROSITA / TRoPIC HK070622.015 raw data




y

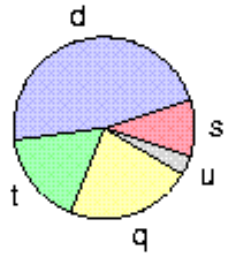
| | | | |
|---|---|---|---|
| 4.00 | 32.95 | 4.12 | D |
| 31.63 | 100 | 35.18 | T |
| 3.96 | 32.64 | 4.10 | Q |

| | | | |
|---|---|---|---|
| | 24.73 | | |
| 24.03 | 100 | 26.88 | D |
| | 24.36 | | |

| | | | |
|---|---|---|---|
| 22.84 | | 27.14 | |
| | 100 | | T |
| 22.94 | | 27.09 | |

| | | | |
|---|---|---|---|
| 24.74 | | 25.46 | |
| | 100 | | Q |
| 24.49 | | 25.31 | |

distribution of events




distribution of valid patterns


fraction of valid patterns


| | | | | | |
|---|---|---|---|---|---|
| s: | 325457 | 10.07 % | S: | 325457 | 22.48 % |
| d: | 1517672 | 46.98 % | D: | 758836 | 52.41 % |
| t: | 545964 | 16.90 % | T: | 181988 | 12.57 % |
| q: | 726644 | 22.49 % | Q: | 181661 | 12.55 % |
| u: | 114807 | 3.55 % | | (valid patterns only) | |
| Σ: | 3230544 | 100.0 % | Σ: | 1447942 | 100.0 % |

1 ——— 325457 (332698)
2 ——————— 758836 (769720)
3 ——— 184891 (186239)
4 ——— 194550 (196011)
5 · 1071 (1076)

# CTI

# CTI determination: Illustration of the Template Cross Correlation method (EPIC pn)

25 macro pixels,

20-29 singles
per macro pixel

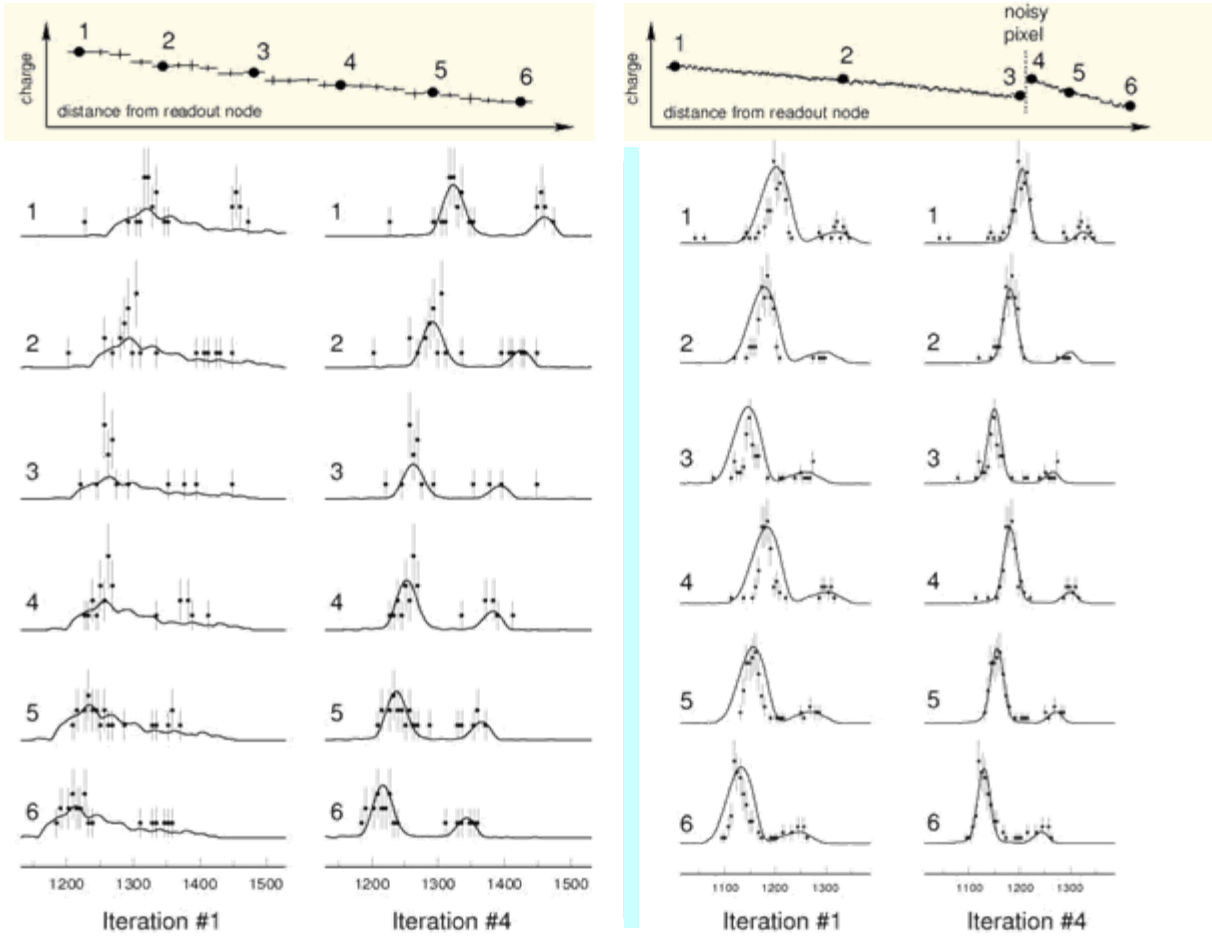
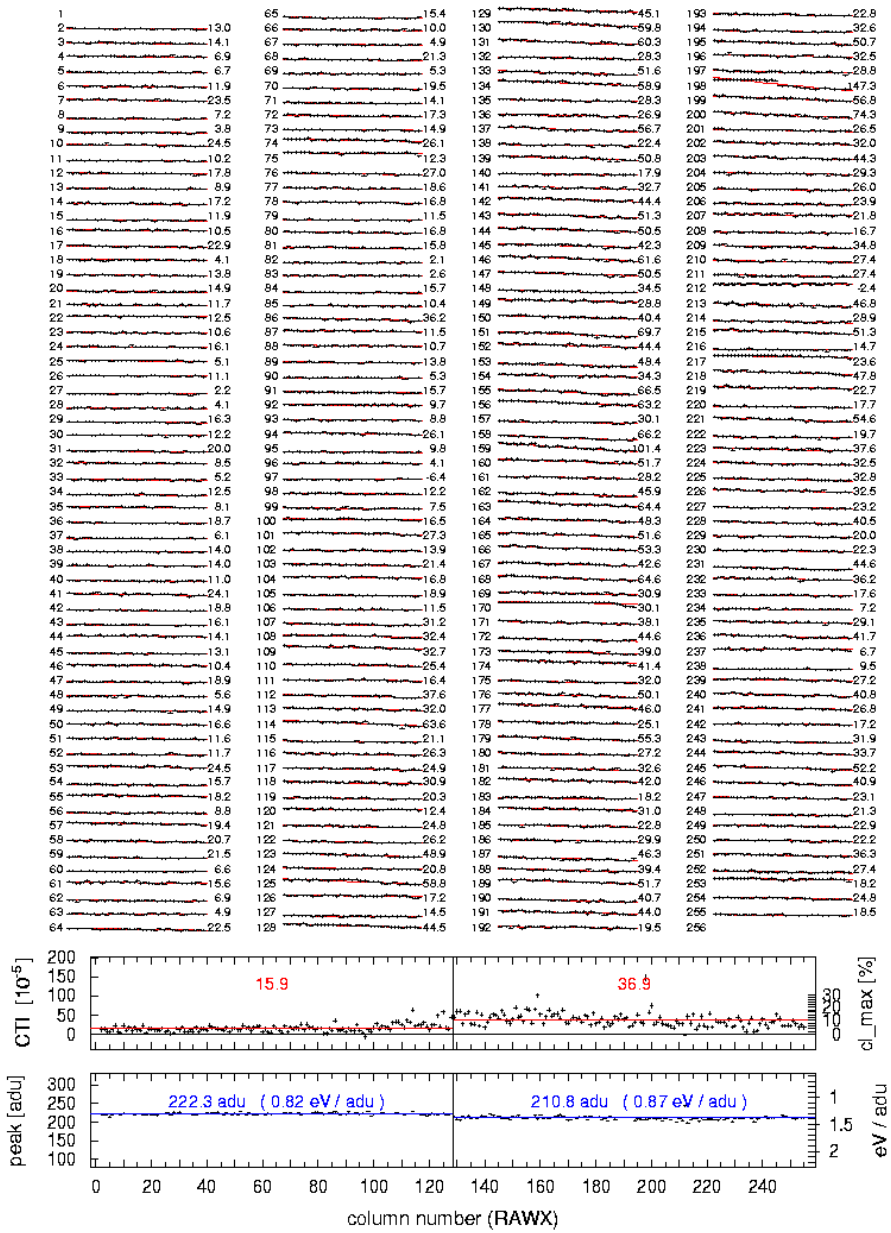


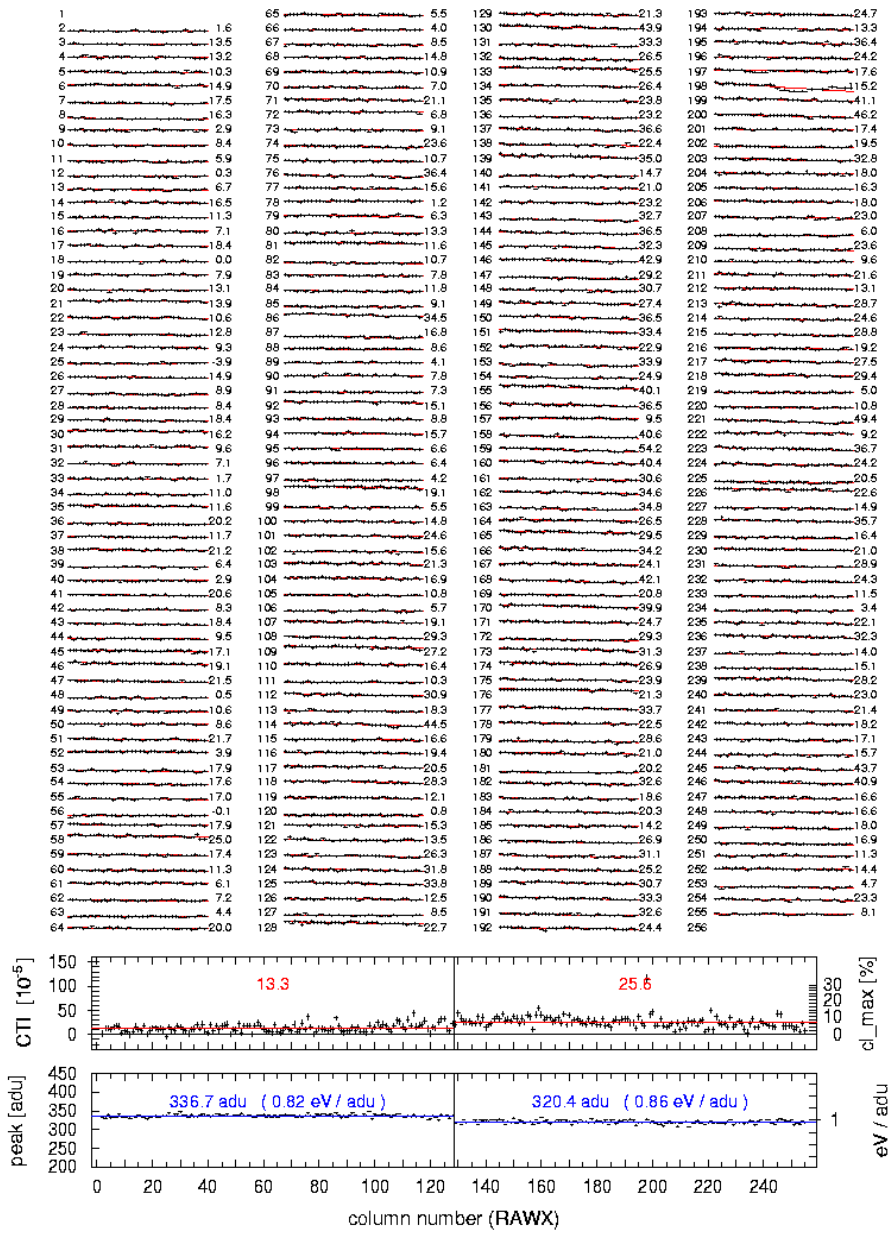

**Figure 9.** Illustration of the charge loss determination by the template cross correlation method, for the case of low (left) and high (right) statistical quality. In both cases the two columns show the results of template fits to spectra from selected macro pixels for the first (left) and last (right) iteration. The macro pixels are identified by filled circles in the resultant charge loss curves at top. In the case at left only 631 events were recorded within the whole CCD column, leaving only 20 – 29 events for each of the 25 macro pixels. At right, 17 864 events were available in total, sufficient for appling this technique to each individual pixel. Note how significantly the presence of a noisy pixel reduces the charge loss for events which were shifted across this pixel during readout. In both cases Mn–$K_\alpha$ and $K_\beta$ lines were analysed. (V9–74)

eROSITA / TRoPIC HK070704.979 0.183 keV CTI and gain

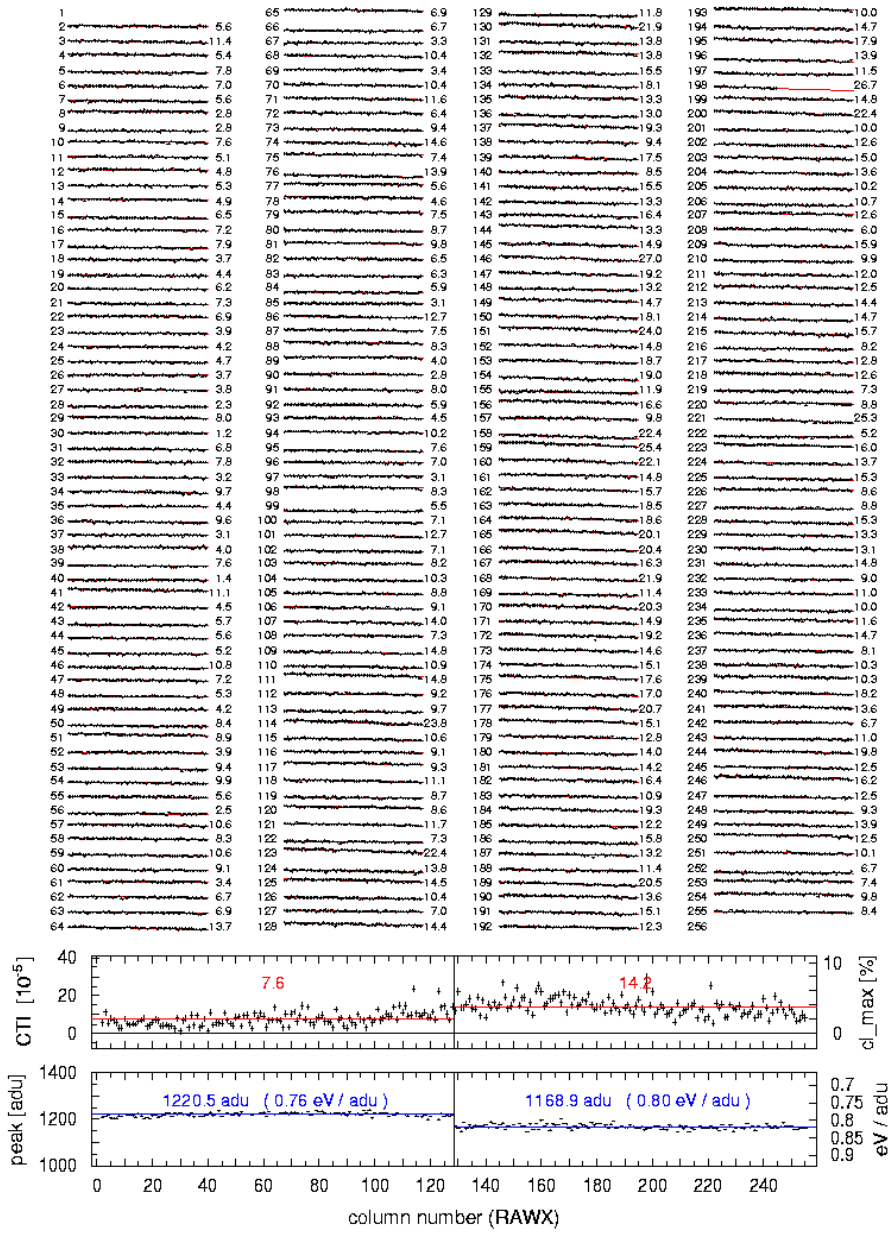





eROSITA / TRoPIC HK070705.913 0.277 keV CTI and gain

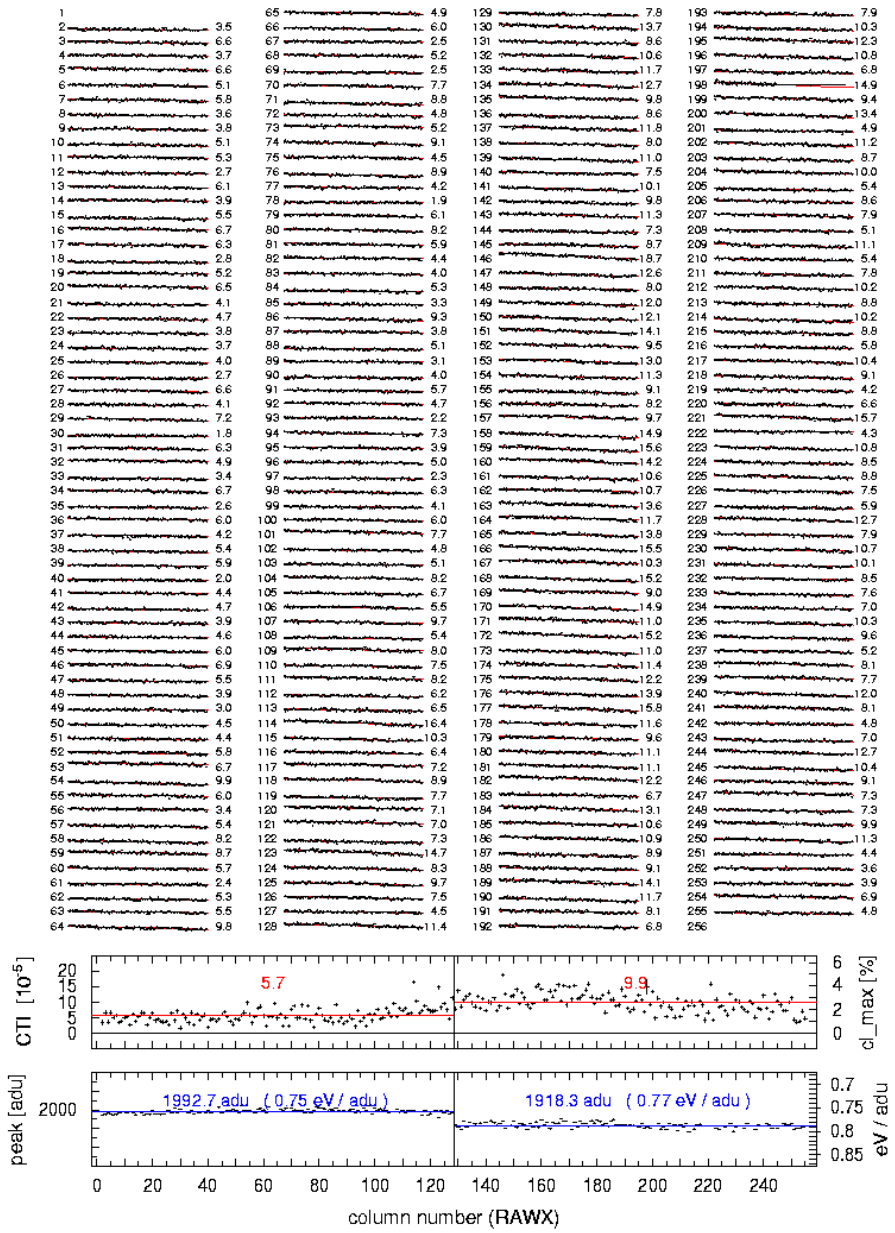


eROSITA / TRoPIC HK070621.017 0.930 keV CTI and gain

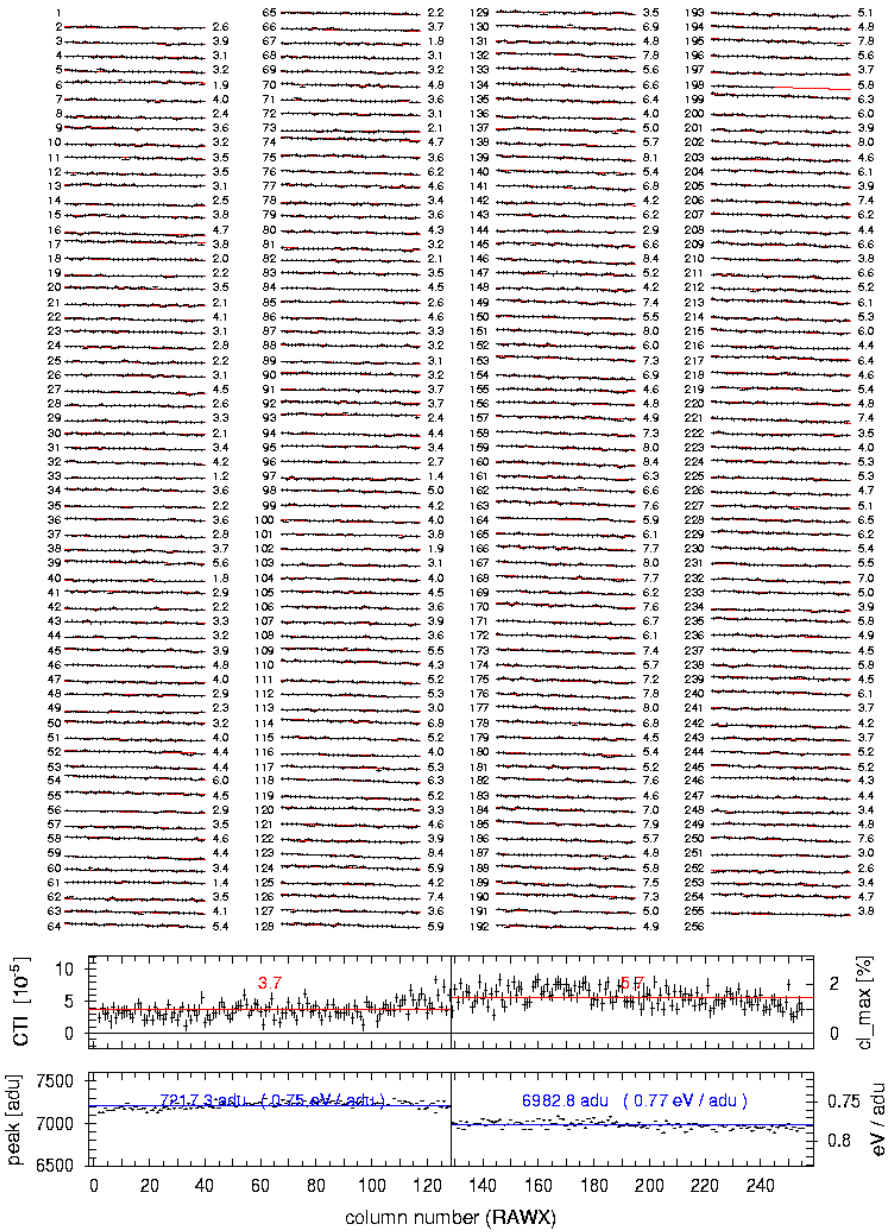





eROSITA / TRoPIC HK070622.005 1.486 keV CTI and gain

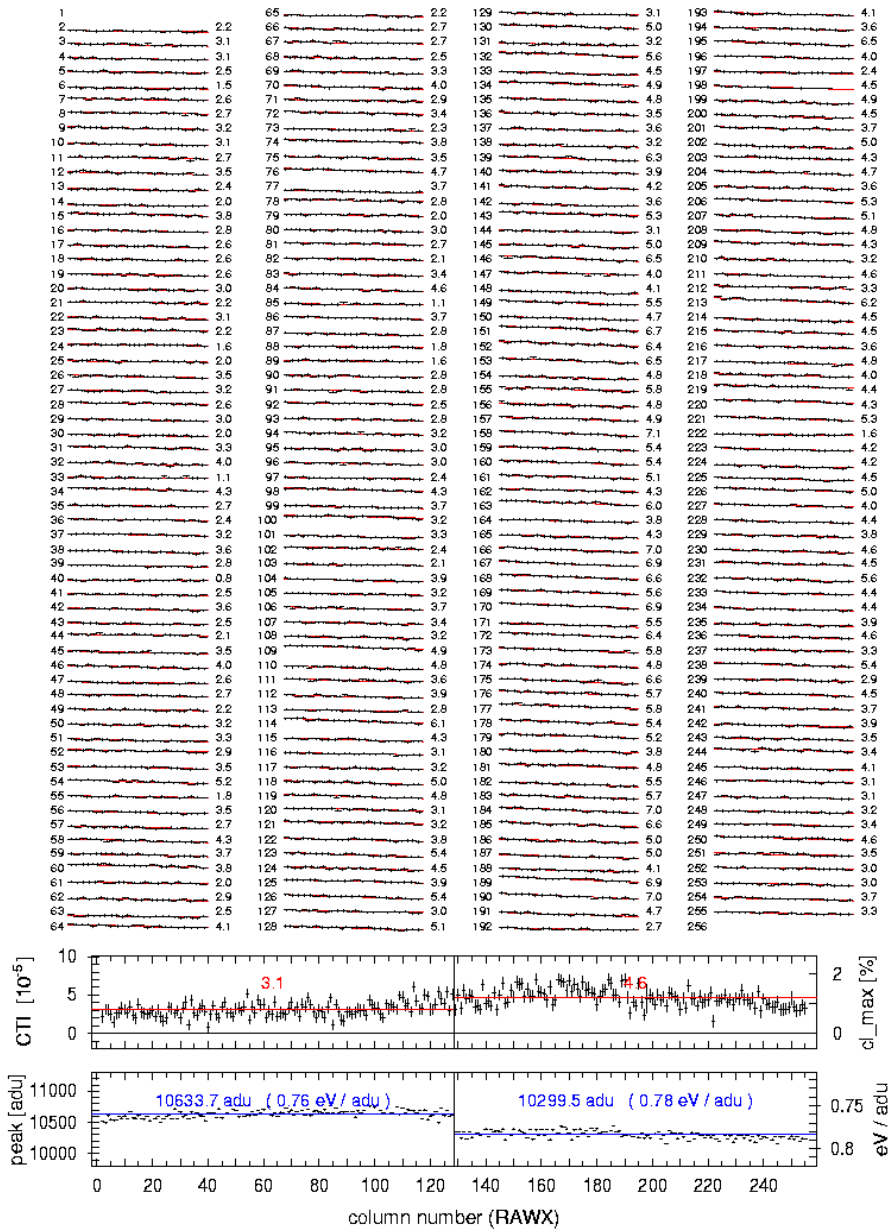


eROSITA / TRoPIC HK070622.012 5.410 keV CTI and gain



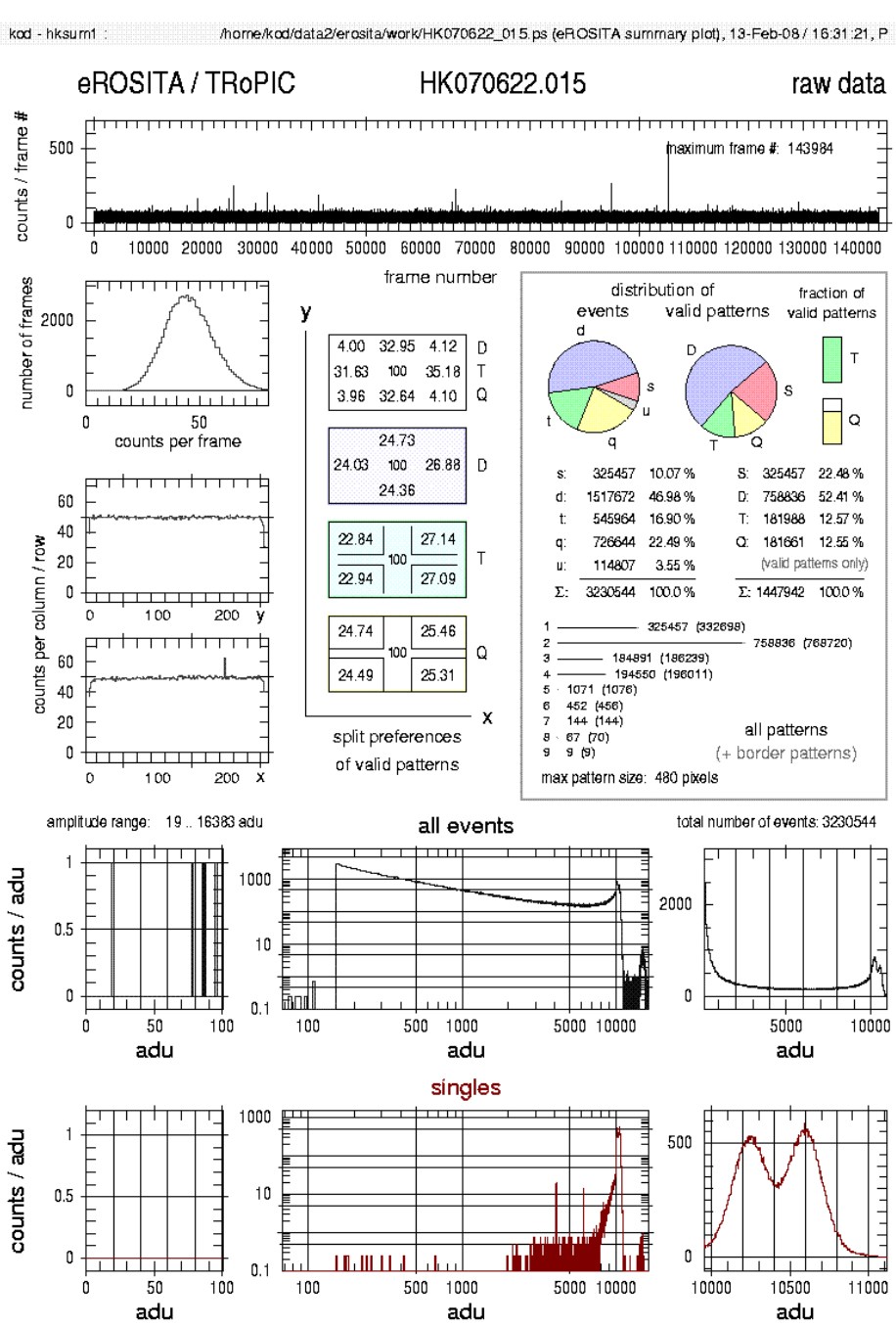



eROSITA / TRoPIC HK070622.015 8.040 keV CTI and gain



# CTI

dependence of the peak position on precursors




# Cu-K

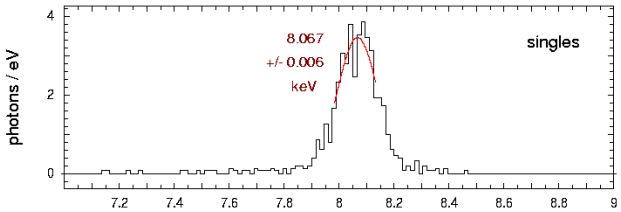
high trigger threshold

(~150 adu)

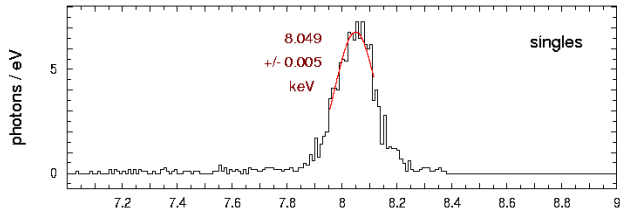
→ precursors 'significant'

3.0 million events

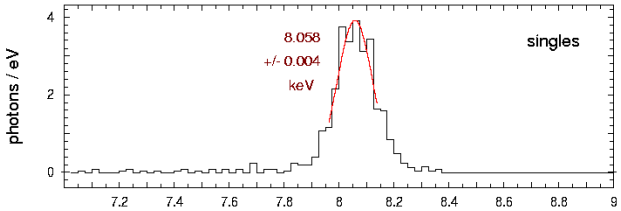
# HK070622.015 singles, x = 0..127



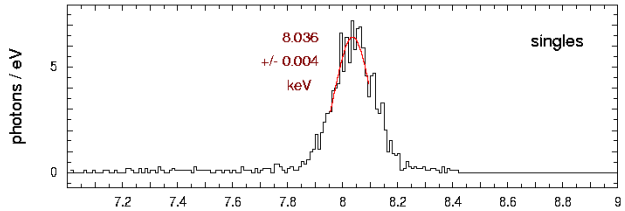

**1 .. 10 px**



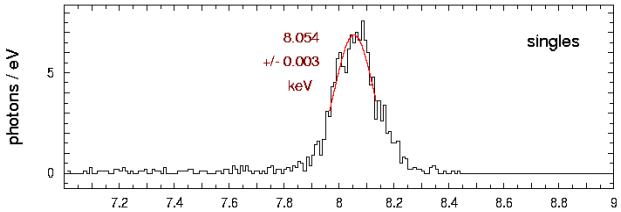

**91 .. 120 px**



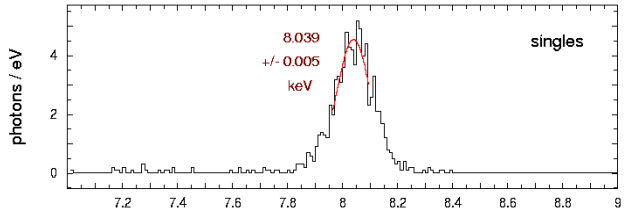

**11 .. 20 px**



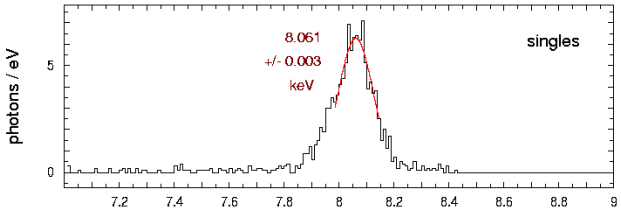

**121 .. 160 px**



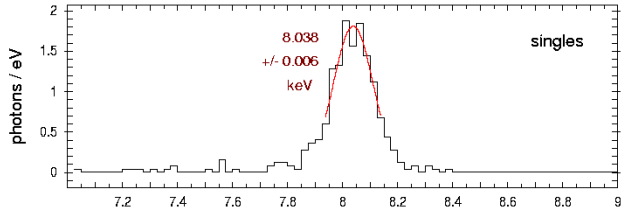

**21 .. 40 px**



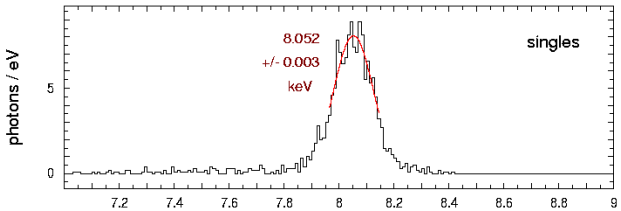

**161 .. 200 px**



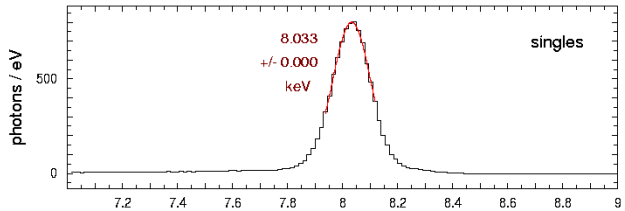

**41 .. 60 px**




**201 .. 256 px**



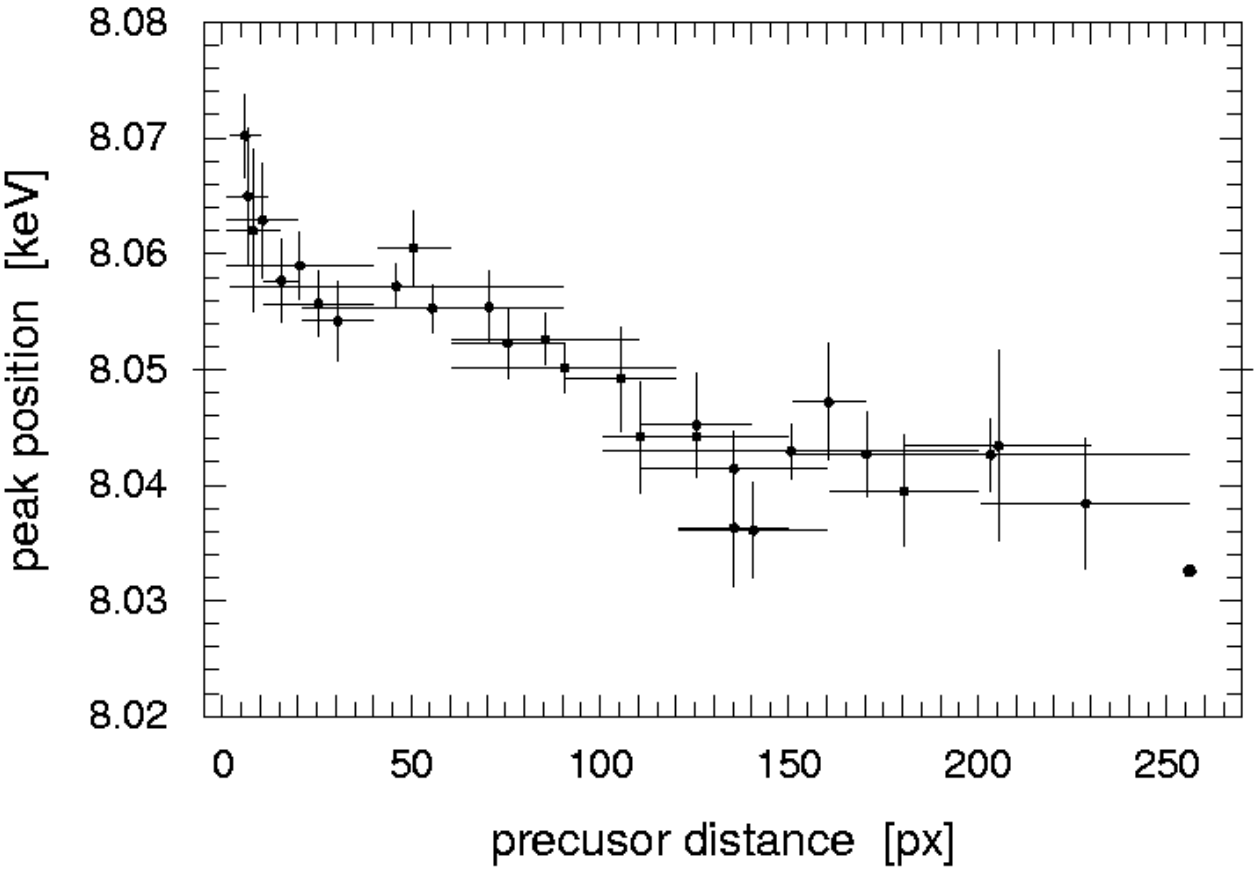

**61 .. 90 px**



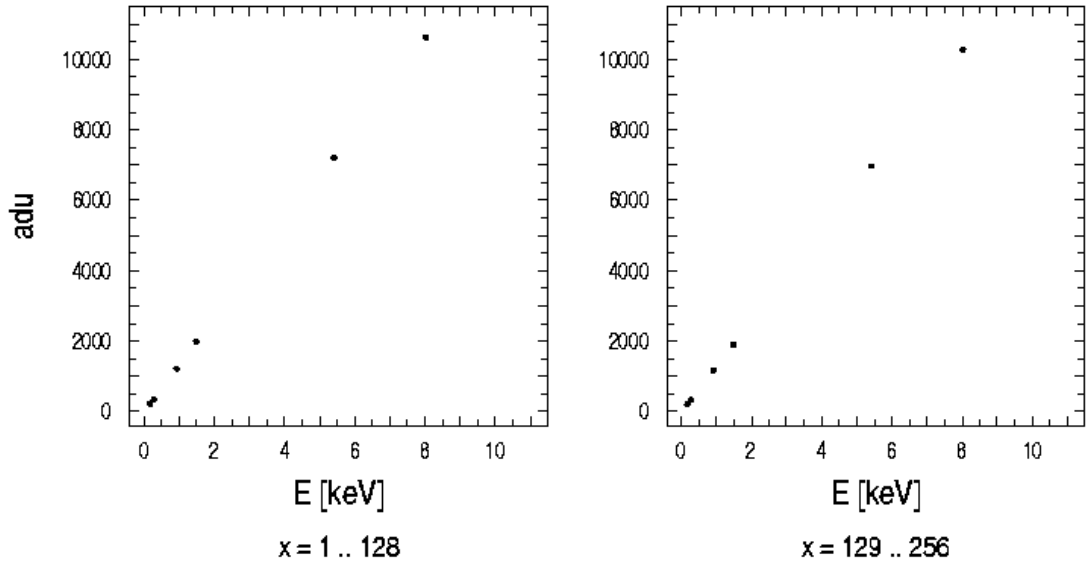

**first singles**

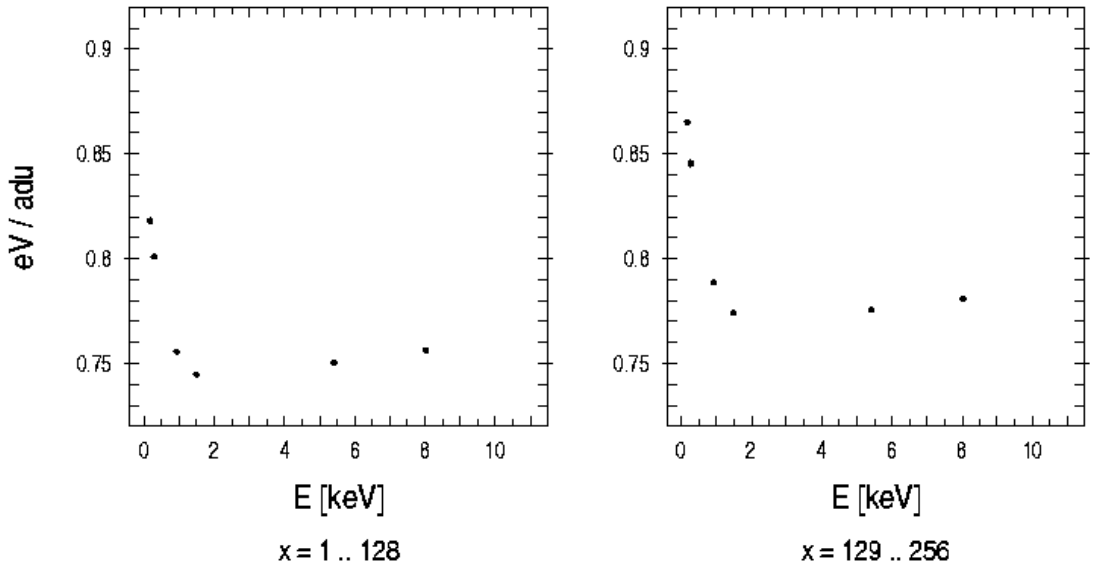
# HK070622.015

singles, x = 0..127



# Gain




input:

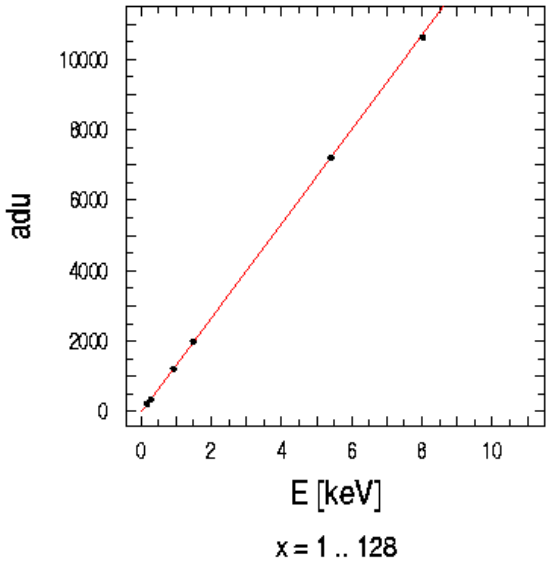
6 long flatfield exposures at

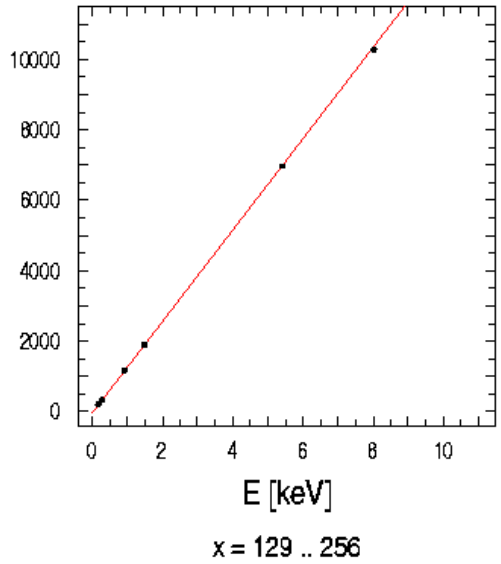
B-K, C-K, Cu-L, Al-K, Cr-K, Cu-K

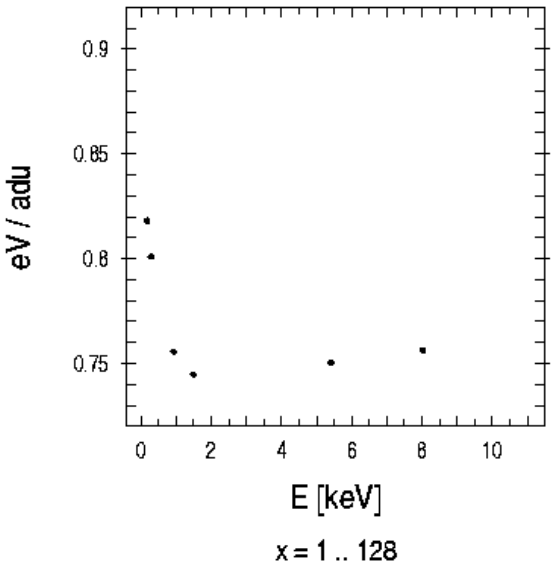
selection of all singles in the 20 CCD rows closest to the CAMEX

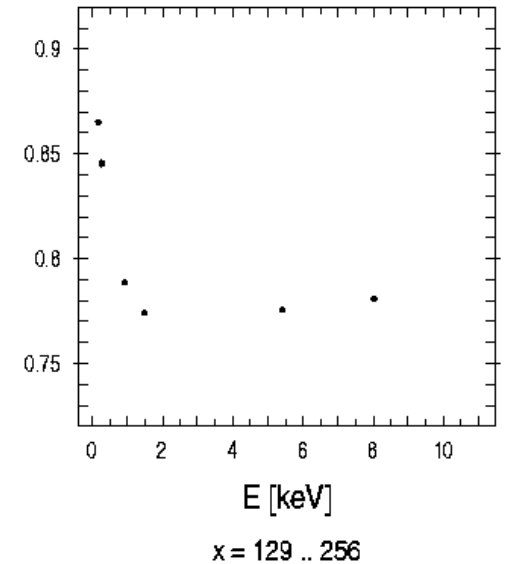
no corrections applied

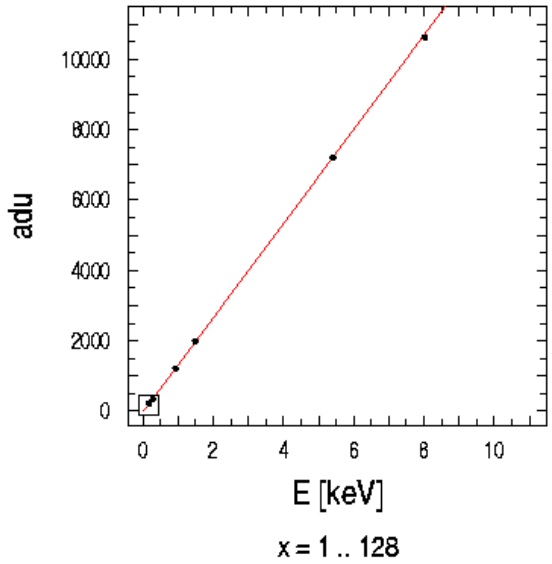
peak positions determined separately for CAMEX-1 and CAMEX-2

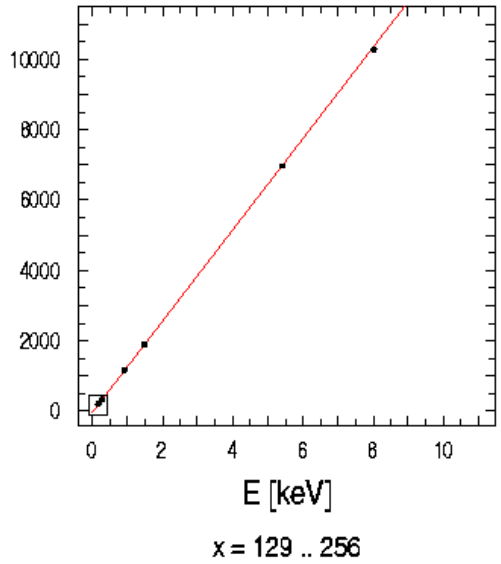

adu
10000
8000
6000
4000
2000
0
0
2
4
6
8
10
E [keV]
x = 1 .. 128

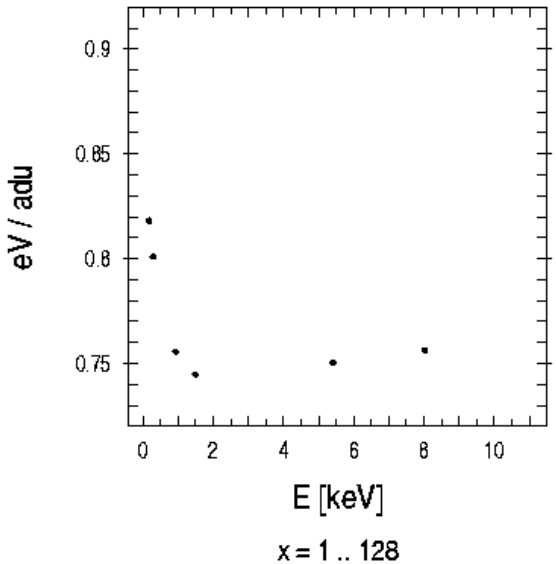

10000
8000
6000
4000
2000
0
0
2
4
6
8
10
E [keV]
x = 129 .. 256

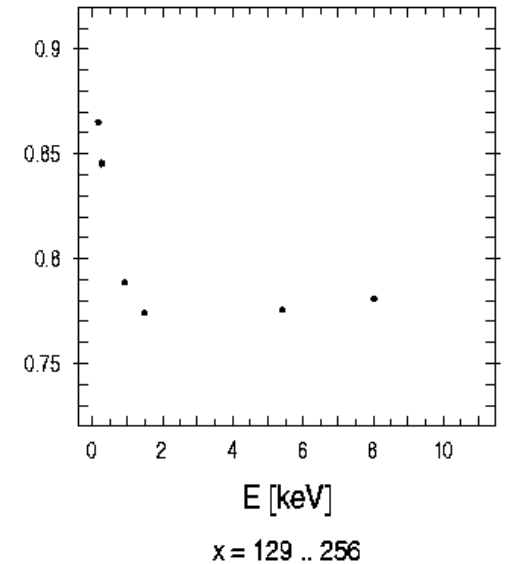

eV / adu
0.9
0.85
0.8
0.75
0
2
4
6
8
10
E [keV]
x = 1 .. 128

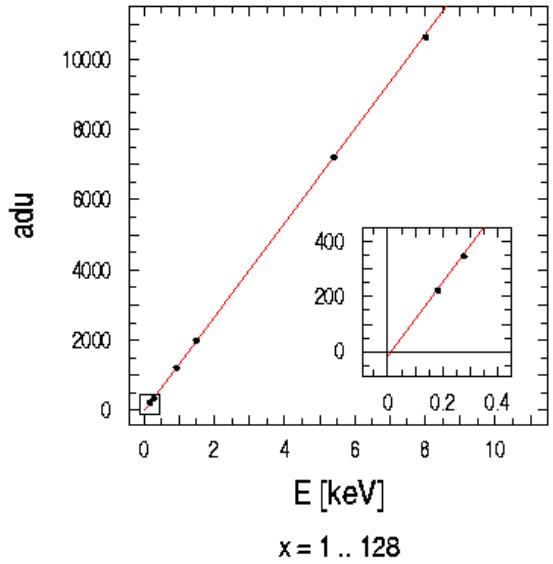

0.9
0.85
0.8
0.75
0
2
4
6
8
10
E [keV]
x = 129 .. 256

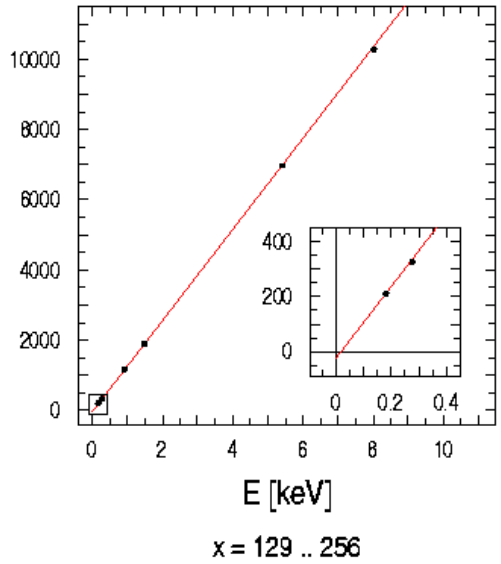

adu
10000
8000
6000
4000
2000
0
0
2
4
6
8
10
E [keV]
x = 1 .. 128


10000
8000
6000
4000
2000
0
0
2
4
6
8
10
E [keV]
x = 129 .. 256


eV / adu
0.9
0.85
0.8
0.75
0
2
4
6
8
10
E [keV]
x = 1 .. 128


0.9
0.85
0.8
0.75
0
2
4
6
8
10
E [keV]
x = 129 .. 256

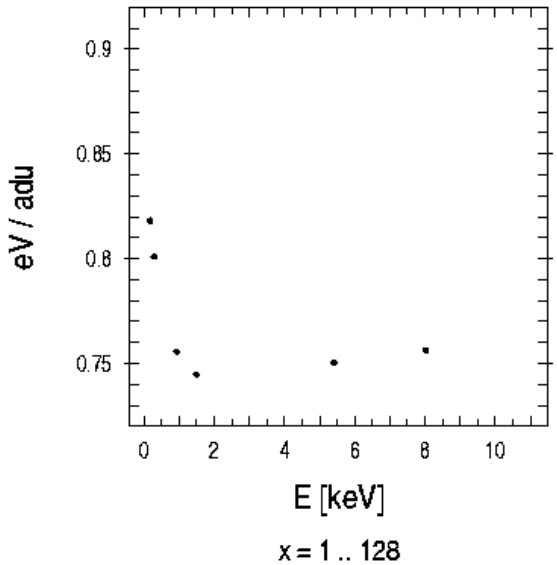


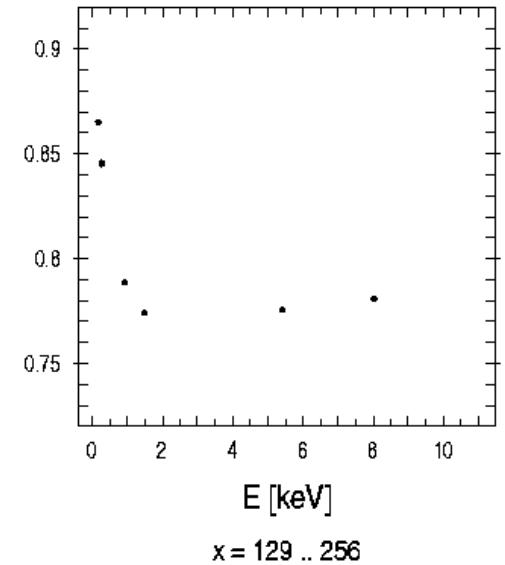



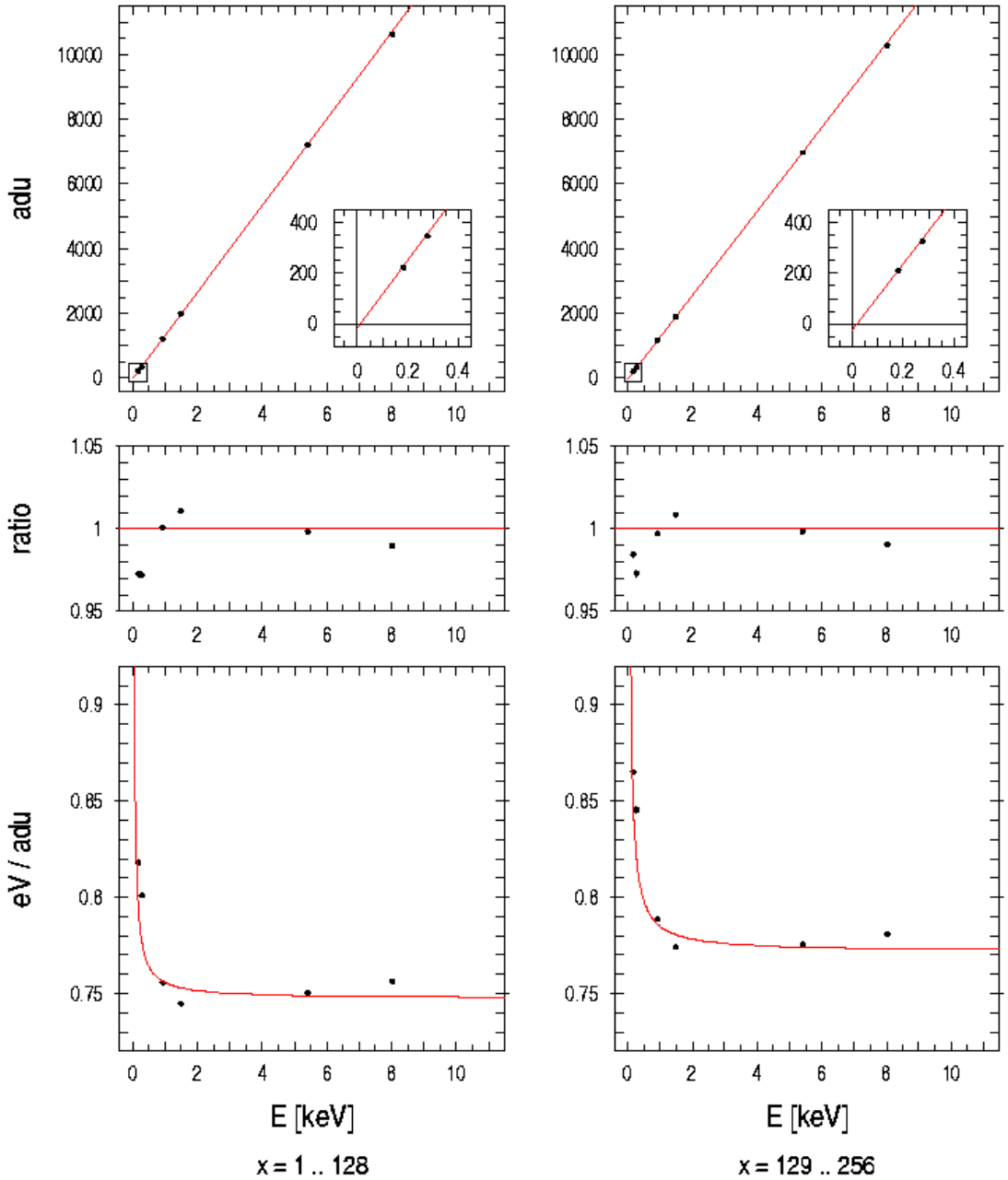

offset:

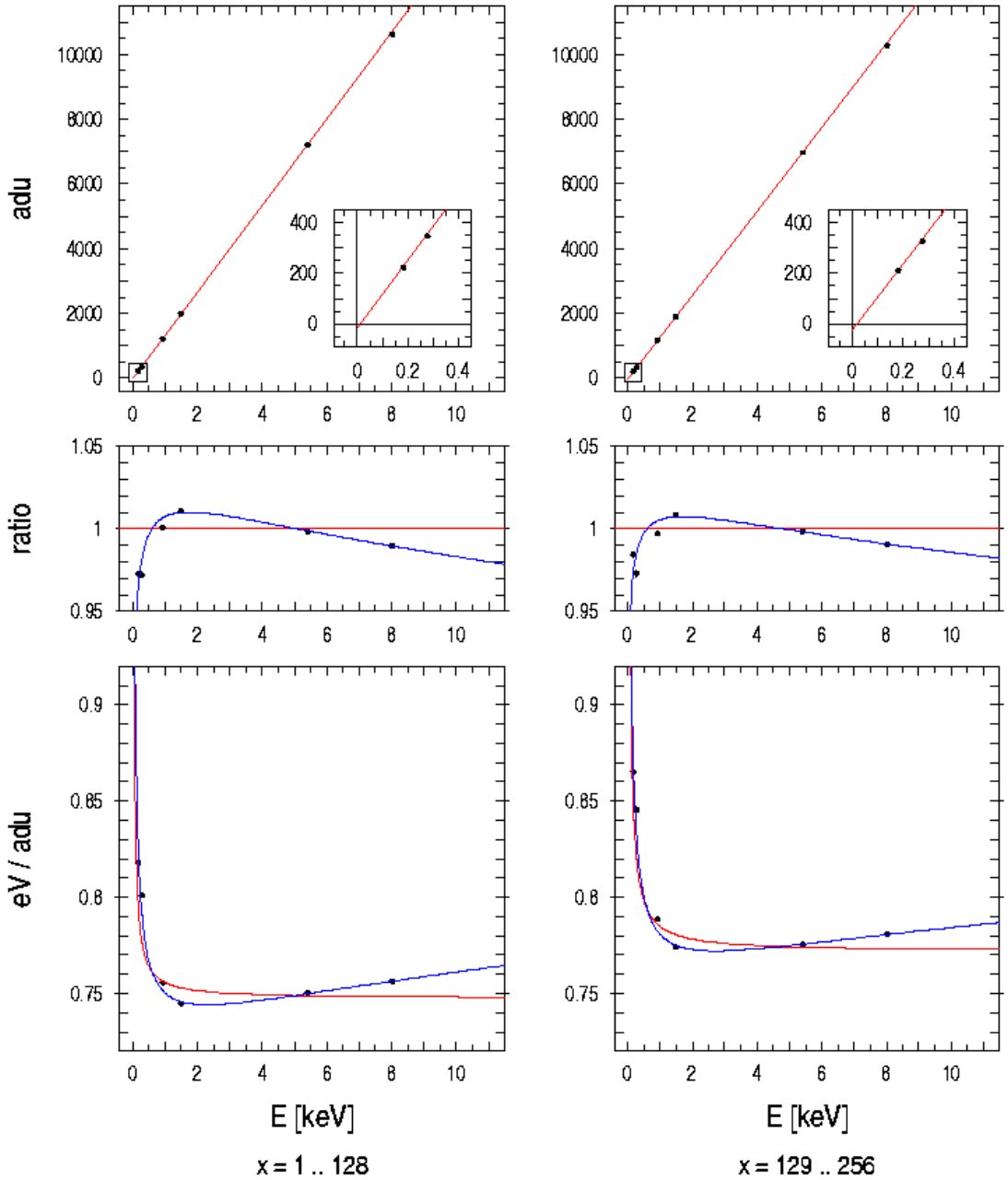
~ - 18 adu @ 0 eV

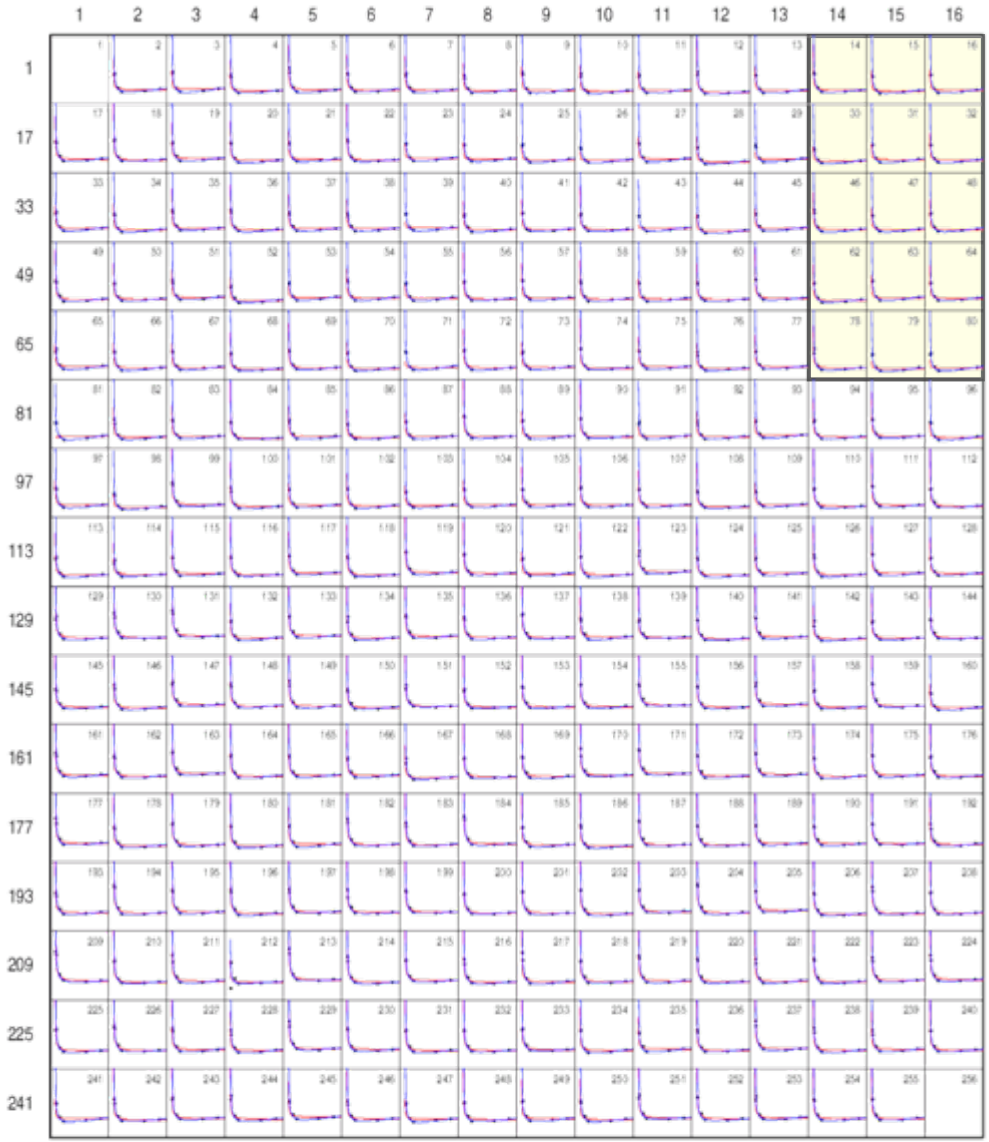
0 adu @ ~ 14 eV




adu
ratio
eV / adu
E [keV]
x = 1 .. 128
E [keV]
x = 129 .. 256


adu
ratio
eV / adu
E [keV]
x = 1 .. 128
E [keV]
x = 129 .. 256

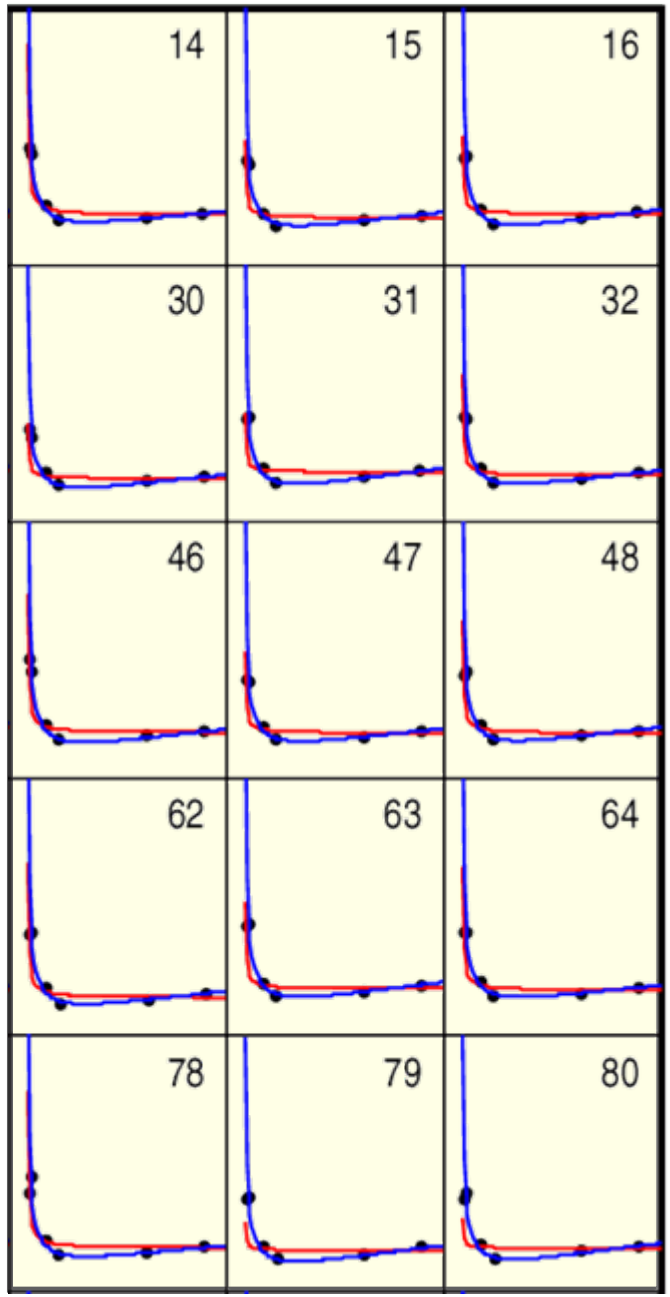


x axis: CTI corr amplitude (linear) , min : -1000 adu, max : 12000 adu

y axis: gain (linear) , min : 0.70 eV / adu , max : 1.00 eV / adu

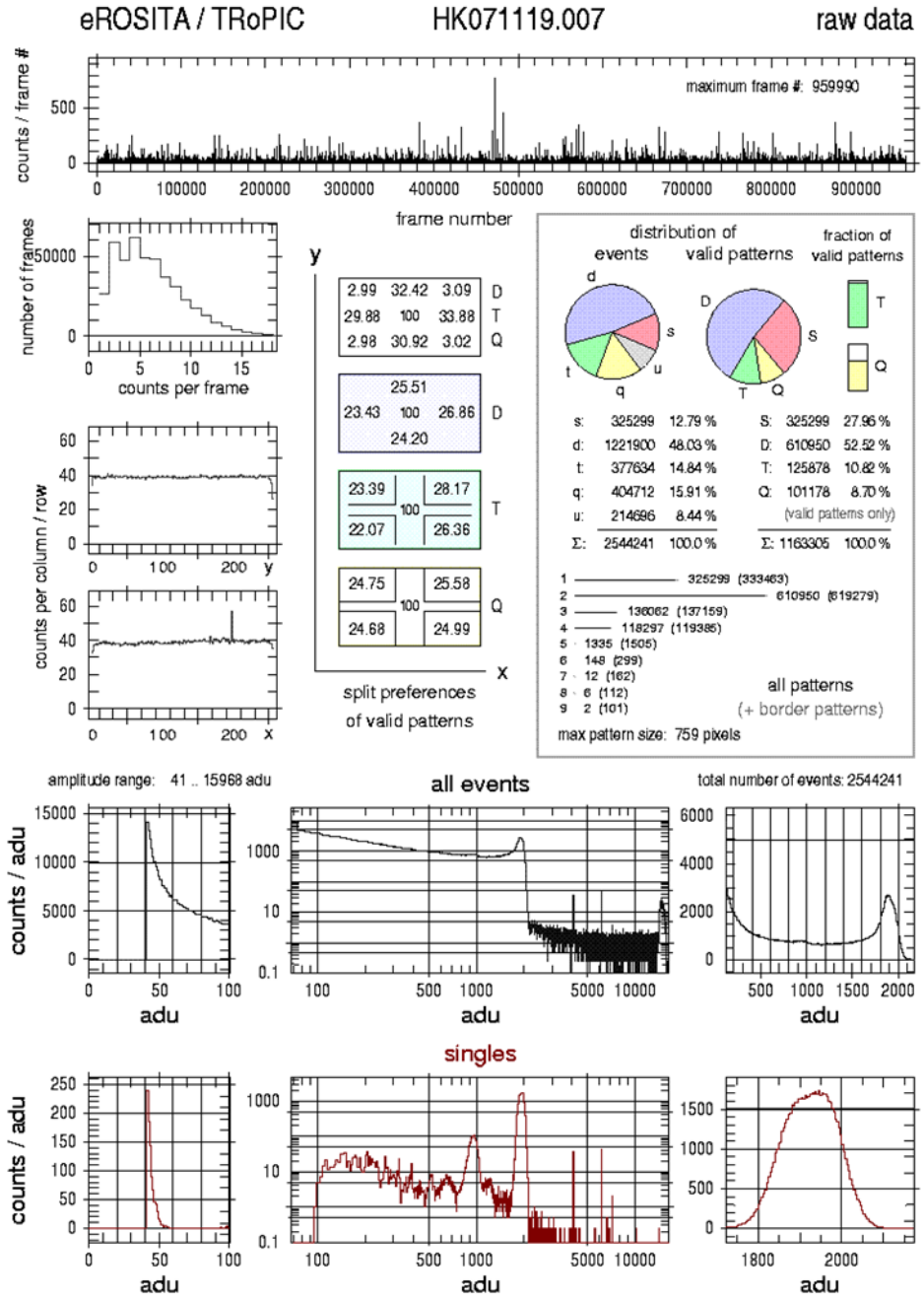
energies [keV] : 0.183 0.277 0.930 1.486 5.410 8.040

data files: HK070704.979 HK070705.913 HK070621.017 HK070622.005 HK070622.012 HK070622.015

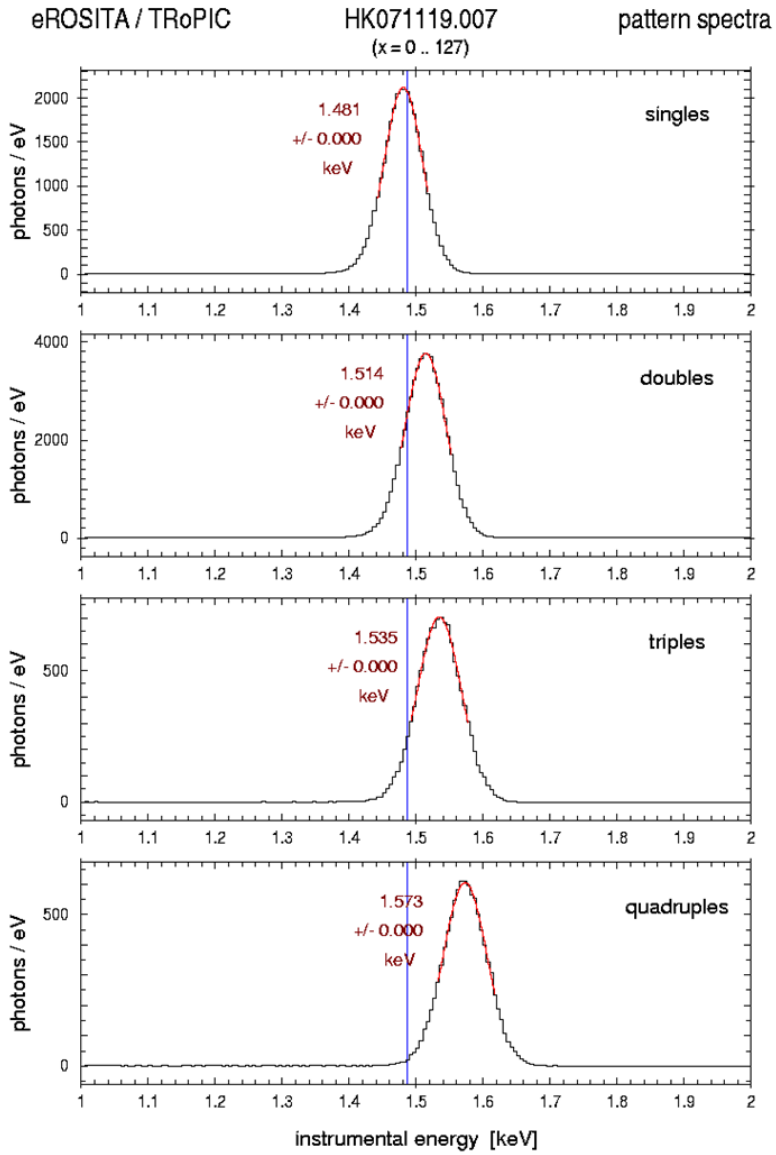


# Application of the cti and gain correction derived for singles

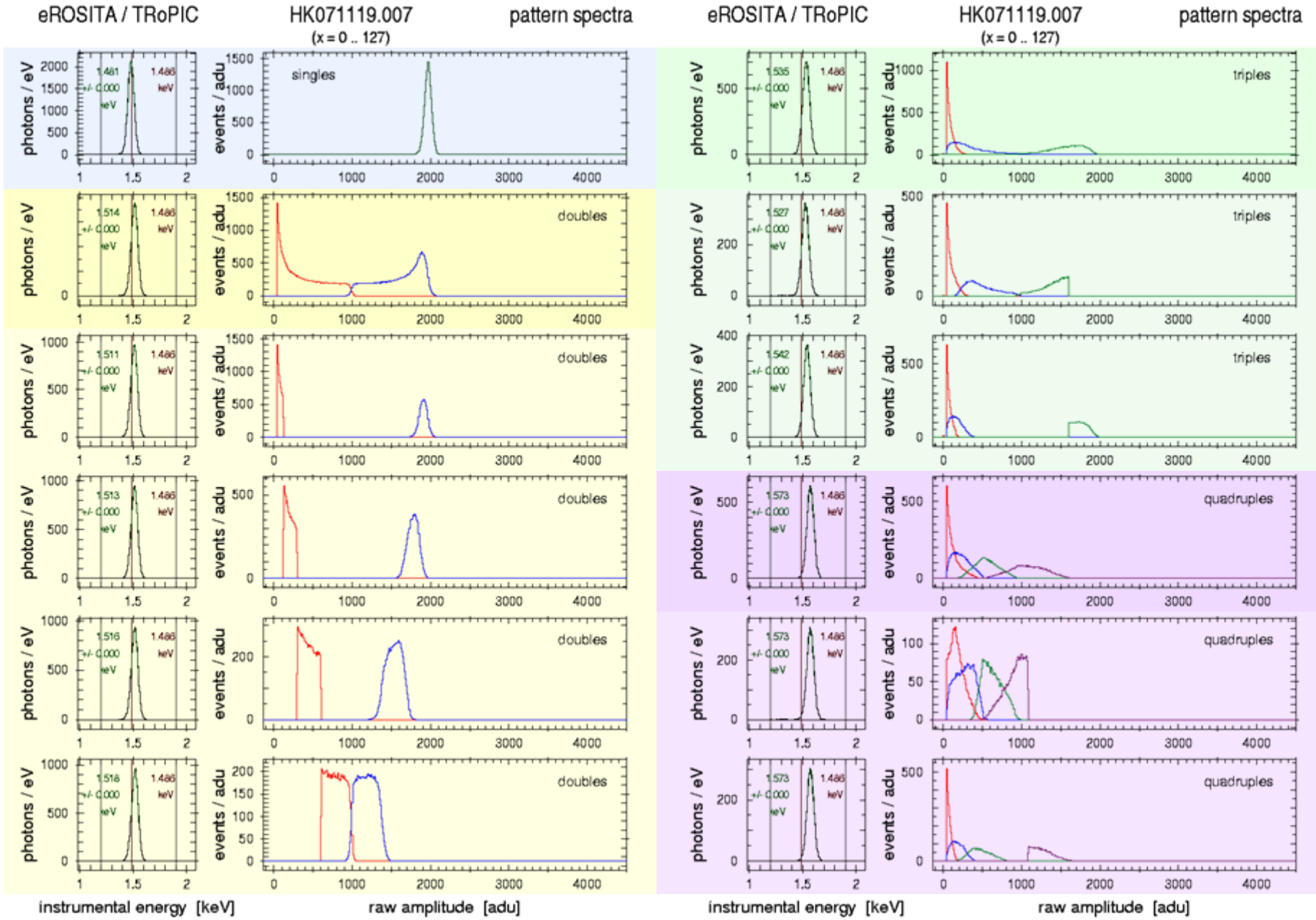
**Al-K (1.486 keV)**



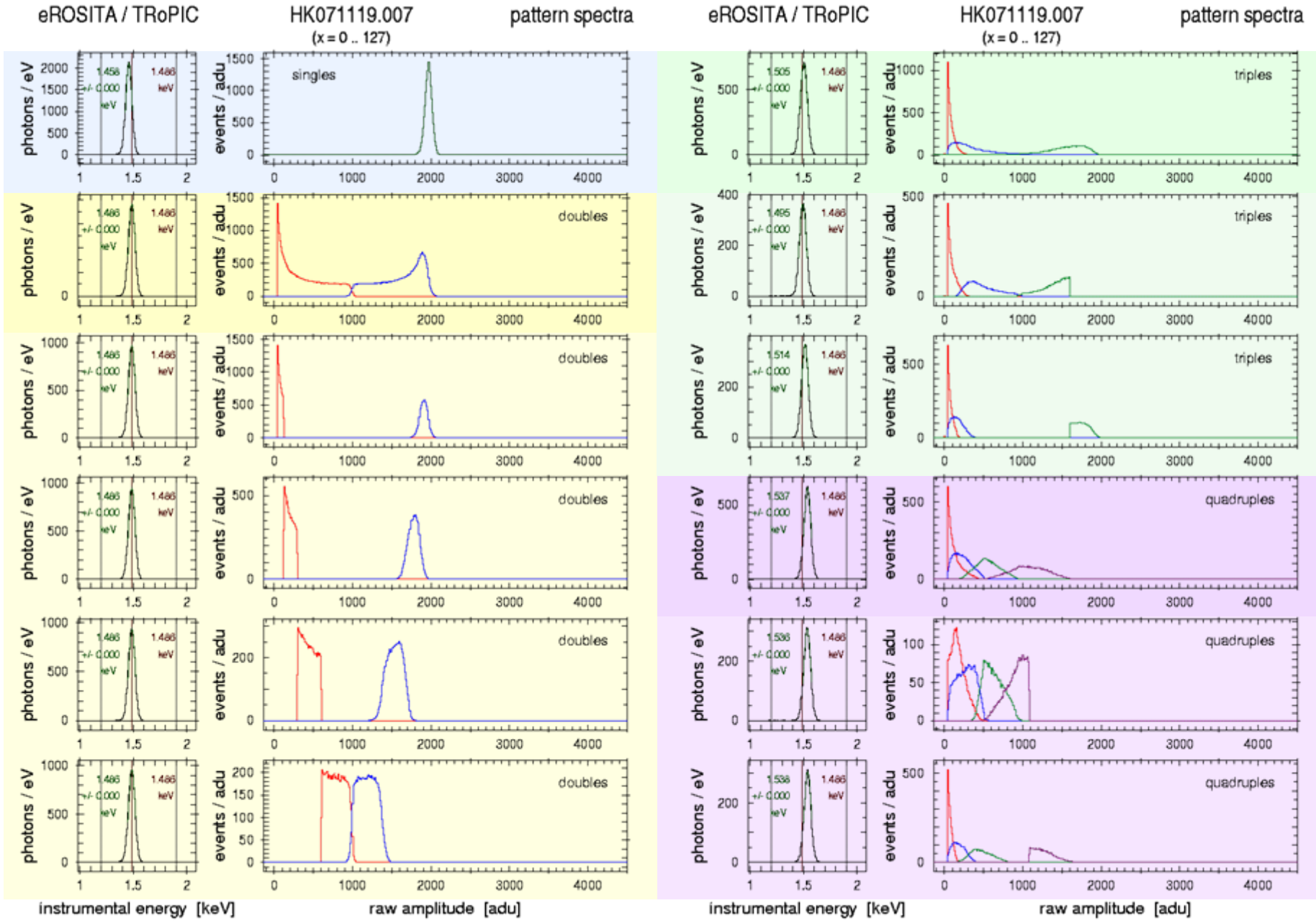

HK071119.007 **Al-K** monochromator,
NLL=0A00 (10s), SPLT=0028 (40a)



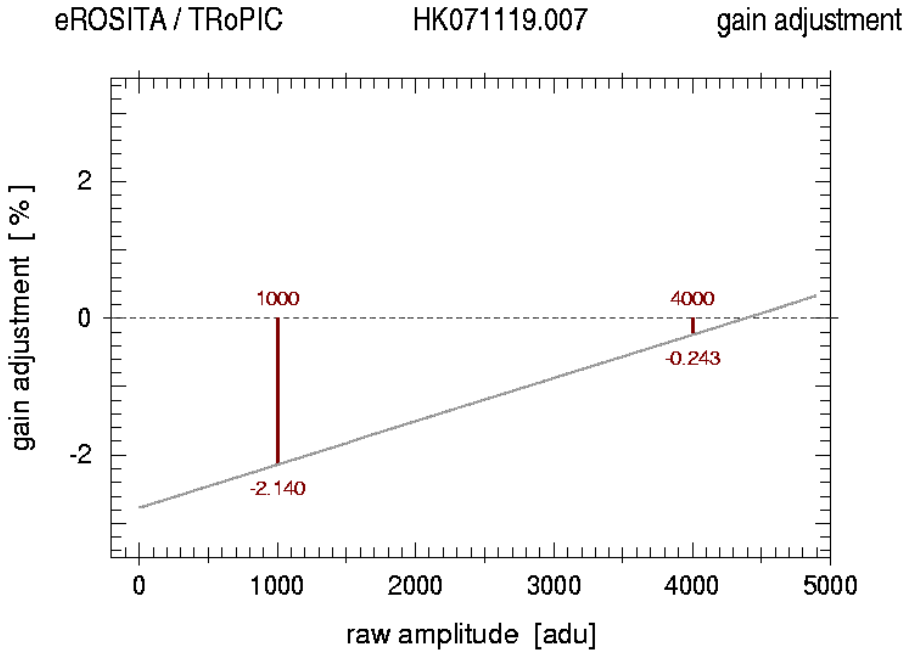
# Al-K

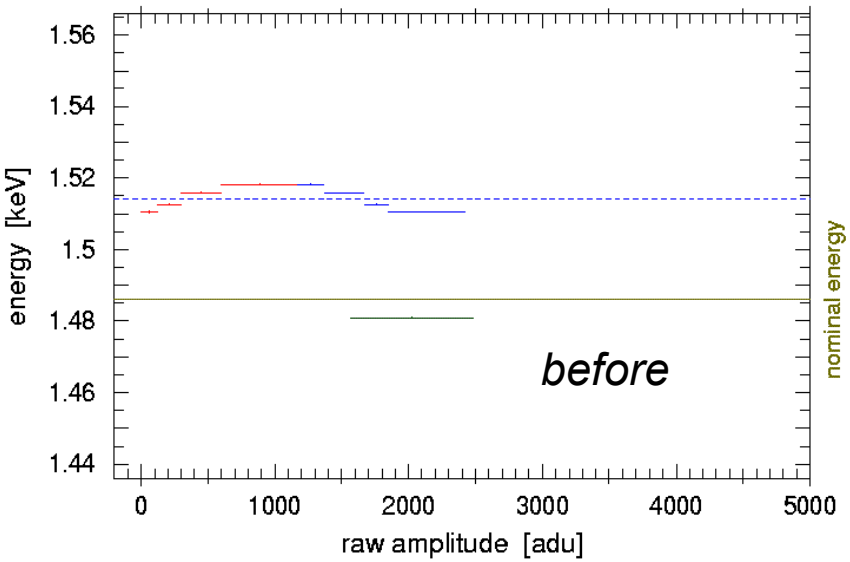

eROSITA / TRoPIC
HK071119.007
(x = 0 .. 127)
pattern spectra
singles
doubles
triples
quadruples
photons / eV
events / adu
instrumental energy [keV]
raw amplitude [adu]

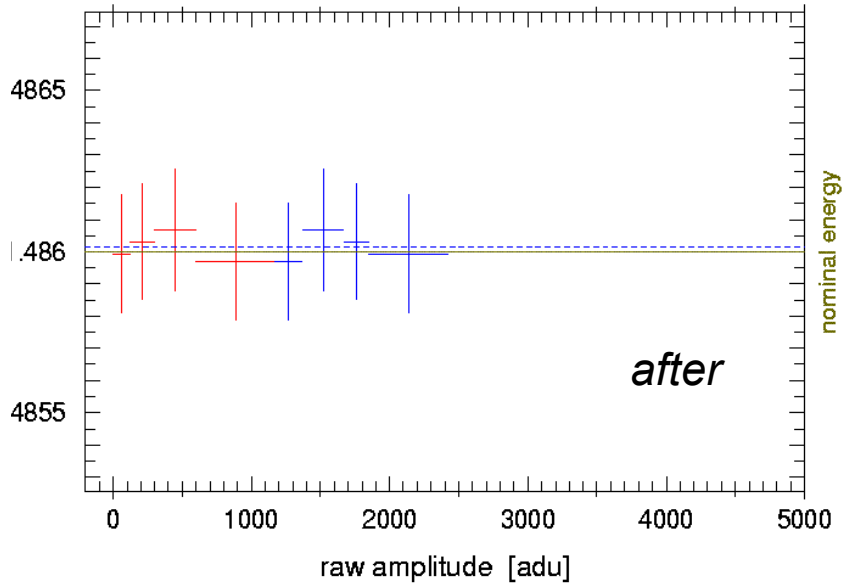
# Al-K


eROSITA / TRoPIC
HK071119.007
(x = 0 .. 127)
pattern spectra
singles
doubles
triples
quadruples
photons / eV
events / adu
instrumental energy [keV]
raw amplitude [adu]

Al-K (1.486 keV):
gain adjustment for doubles



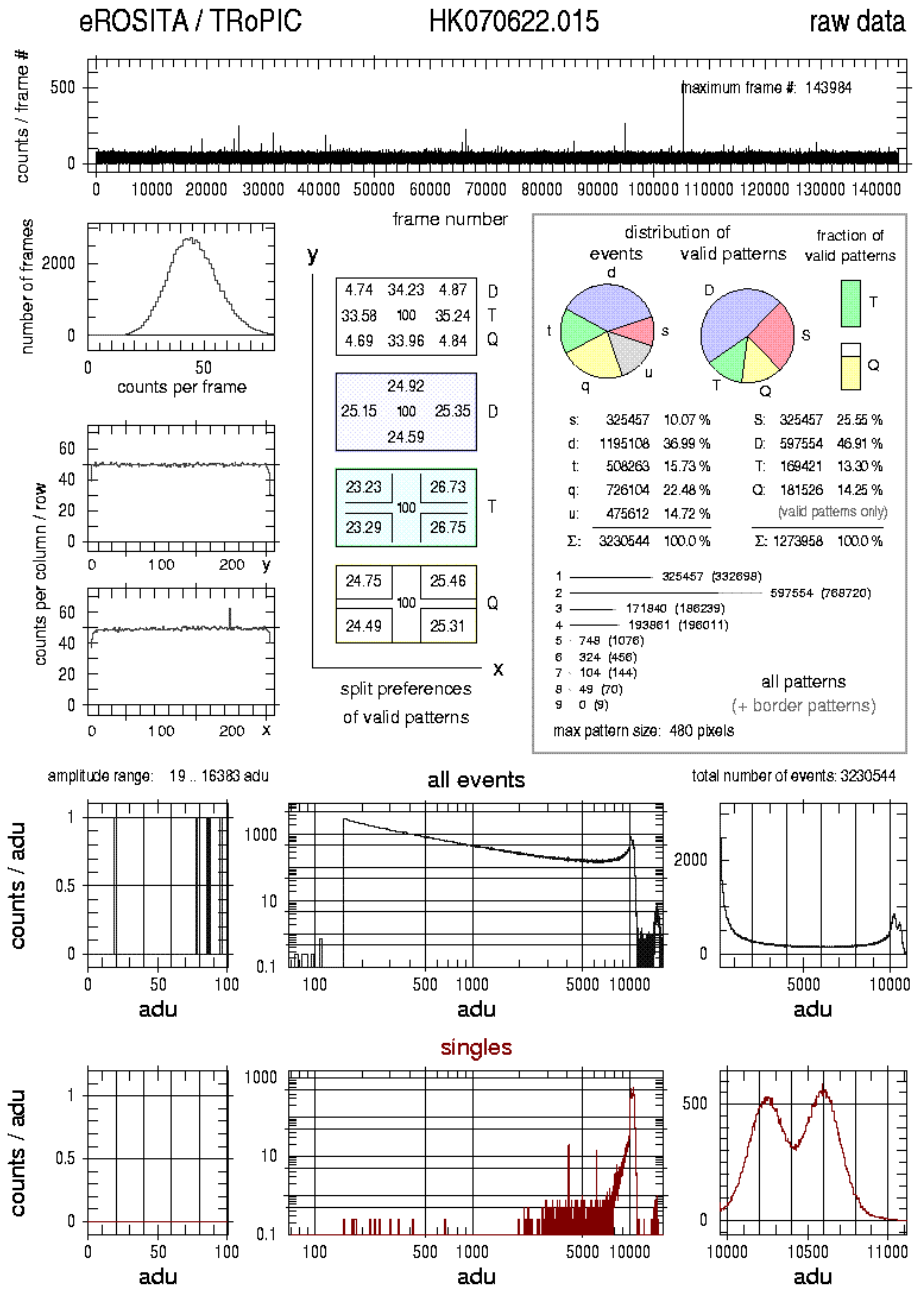
# Application of the cti and gain correction derived for singles

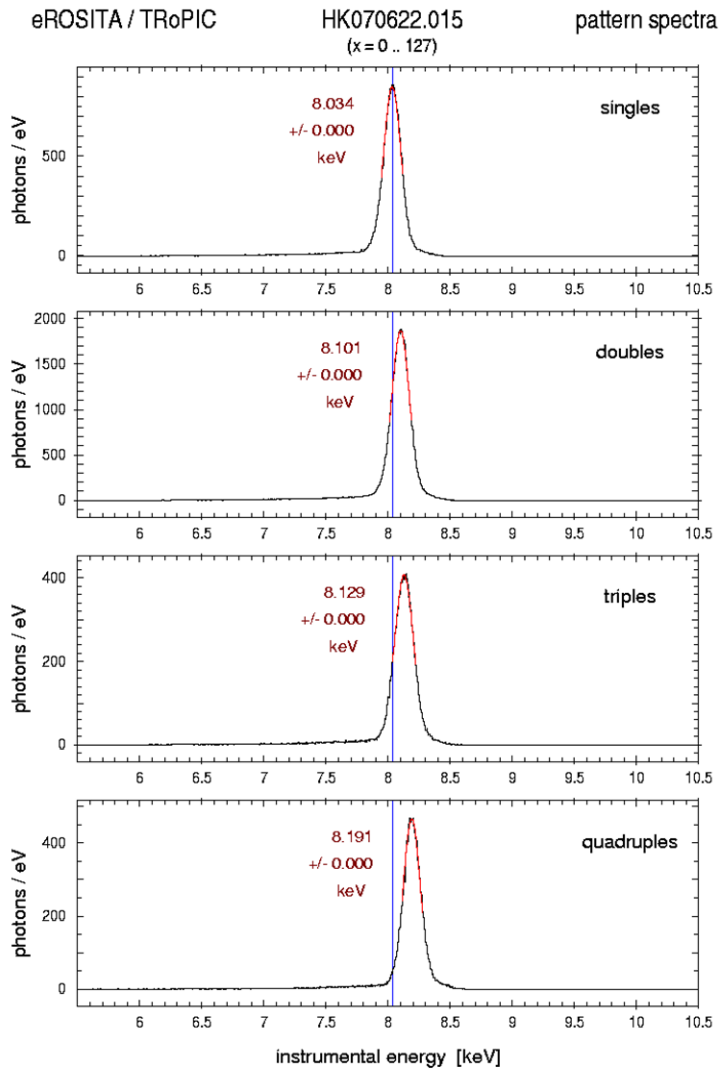
**Cu-K (8.040 keV)**

# Cu-K

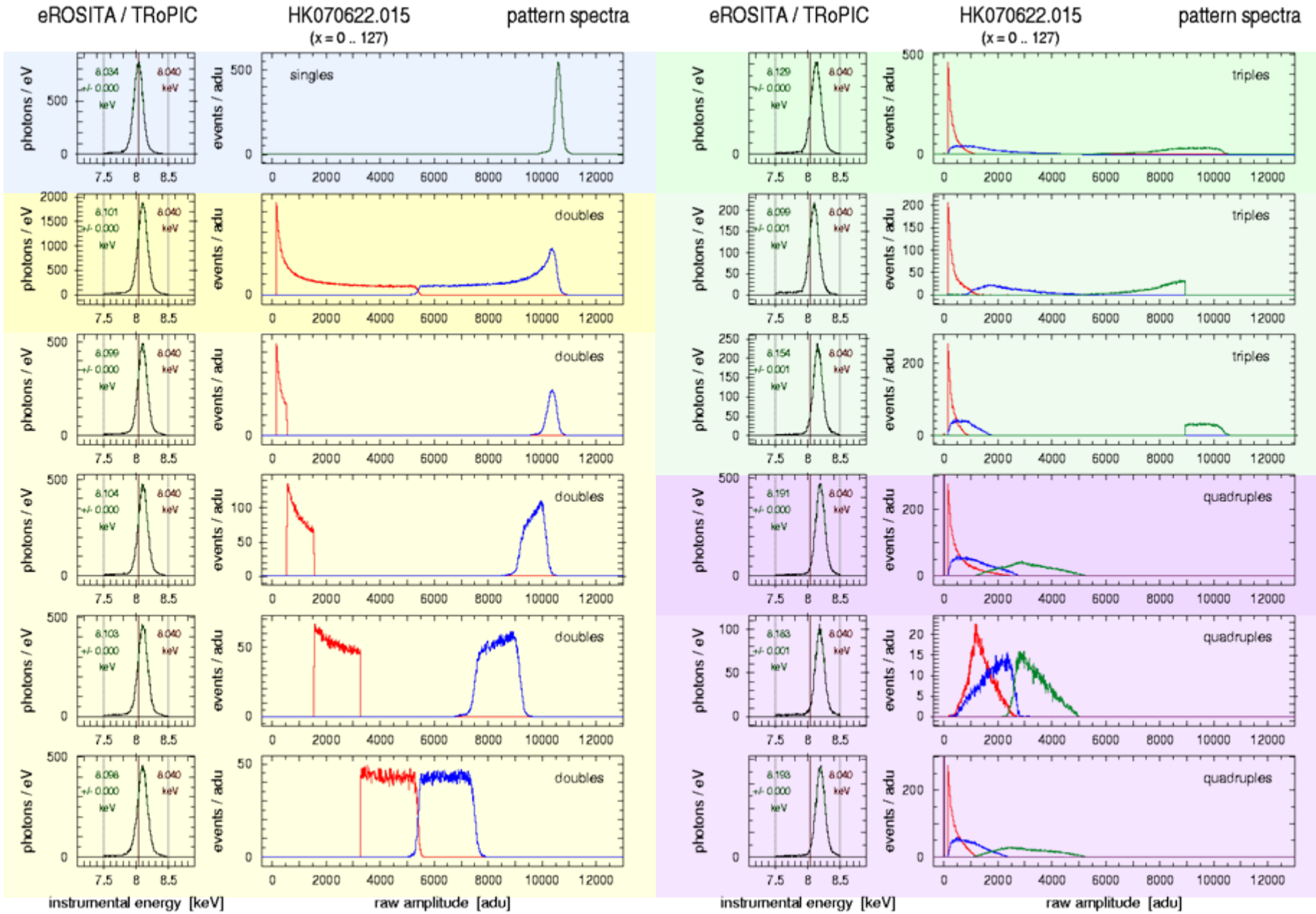
high threshold (~130 adu)

→ overcorrection of doubles not due to noise collection

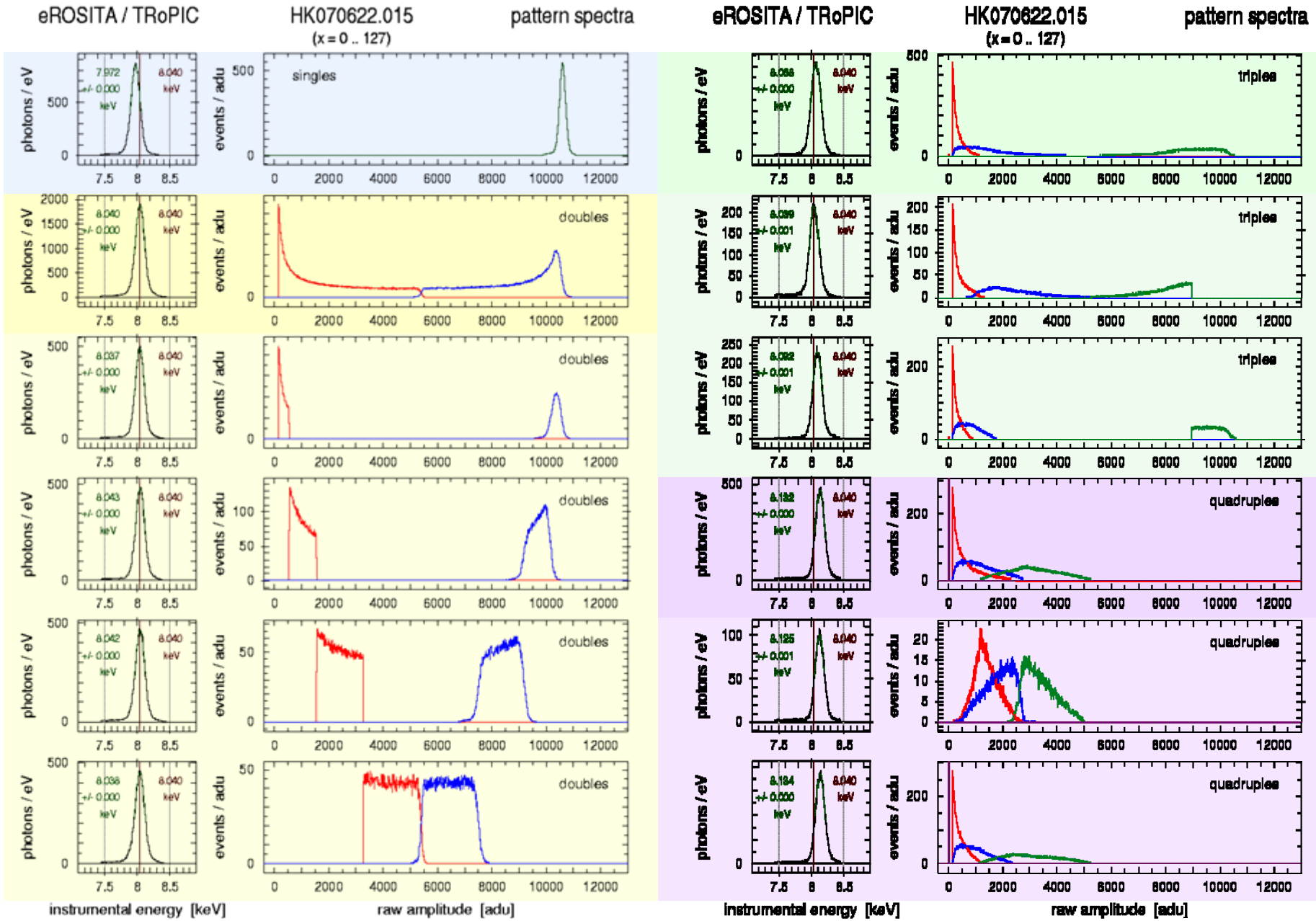


# Cu-K

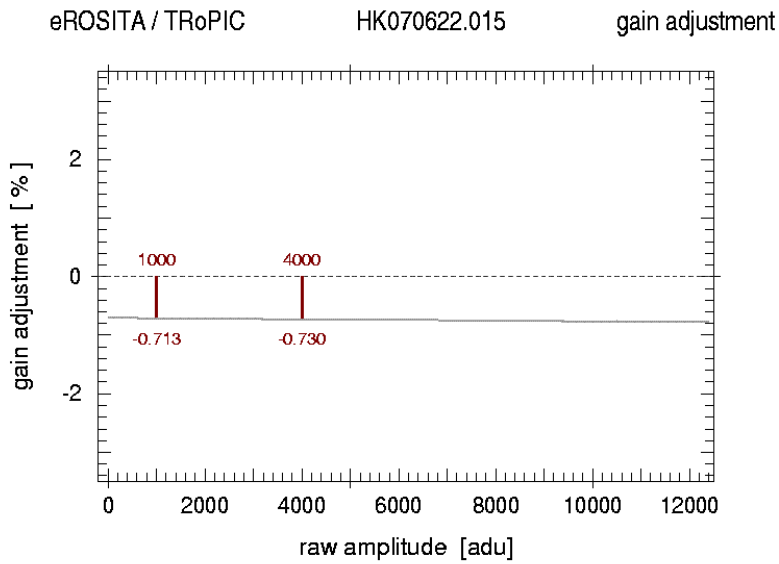

eROSITA / TRoPIC
HK070622.015
(x = 0 .. 127)
pattern spectra
singles
doubles
triples
quadruples
photons / eV
events / adu
instrumental energy [keV]
raw amplitude [adu]

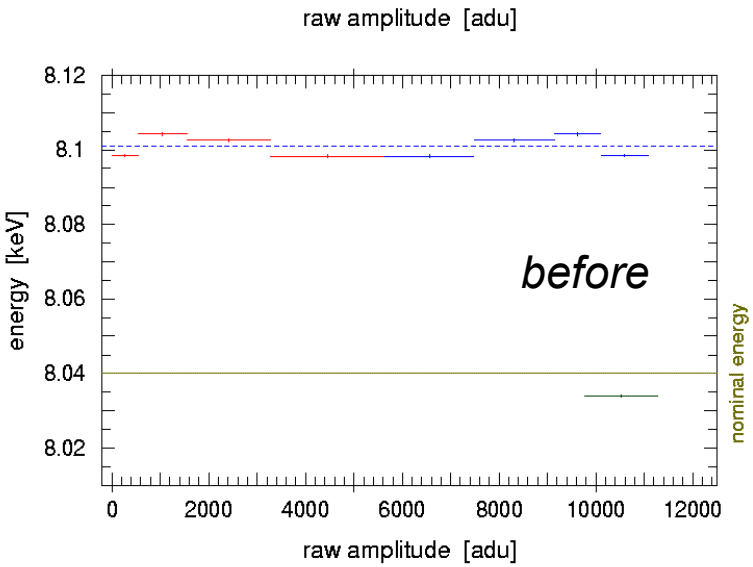
# Cu-K

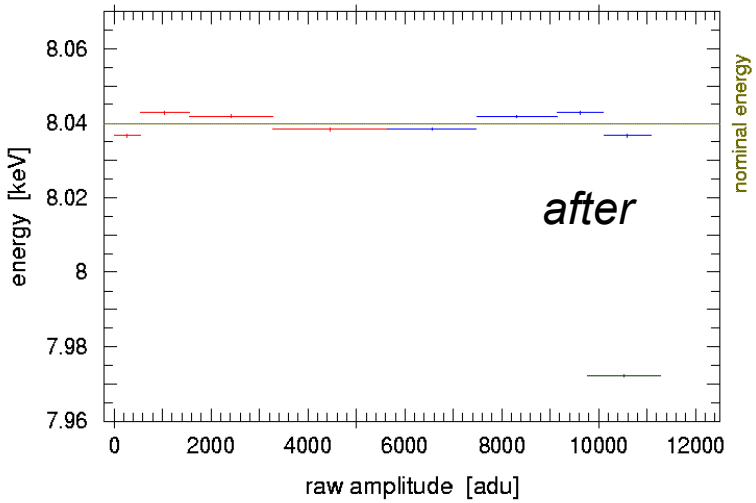

eROSITA / TRoPIC
HK070622.015
(x = 0 .. 127)
pattern spectra
singles
doubles
triples
quadruples
photons / eV
events / adu
instrumental energy [keV]
raw amplitude [adu]

Cu-K (8.040 keV):

gain adjustment for doubles



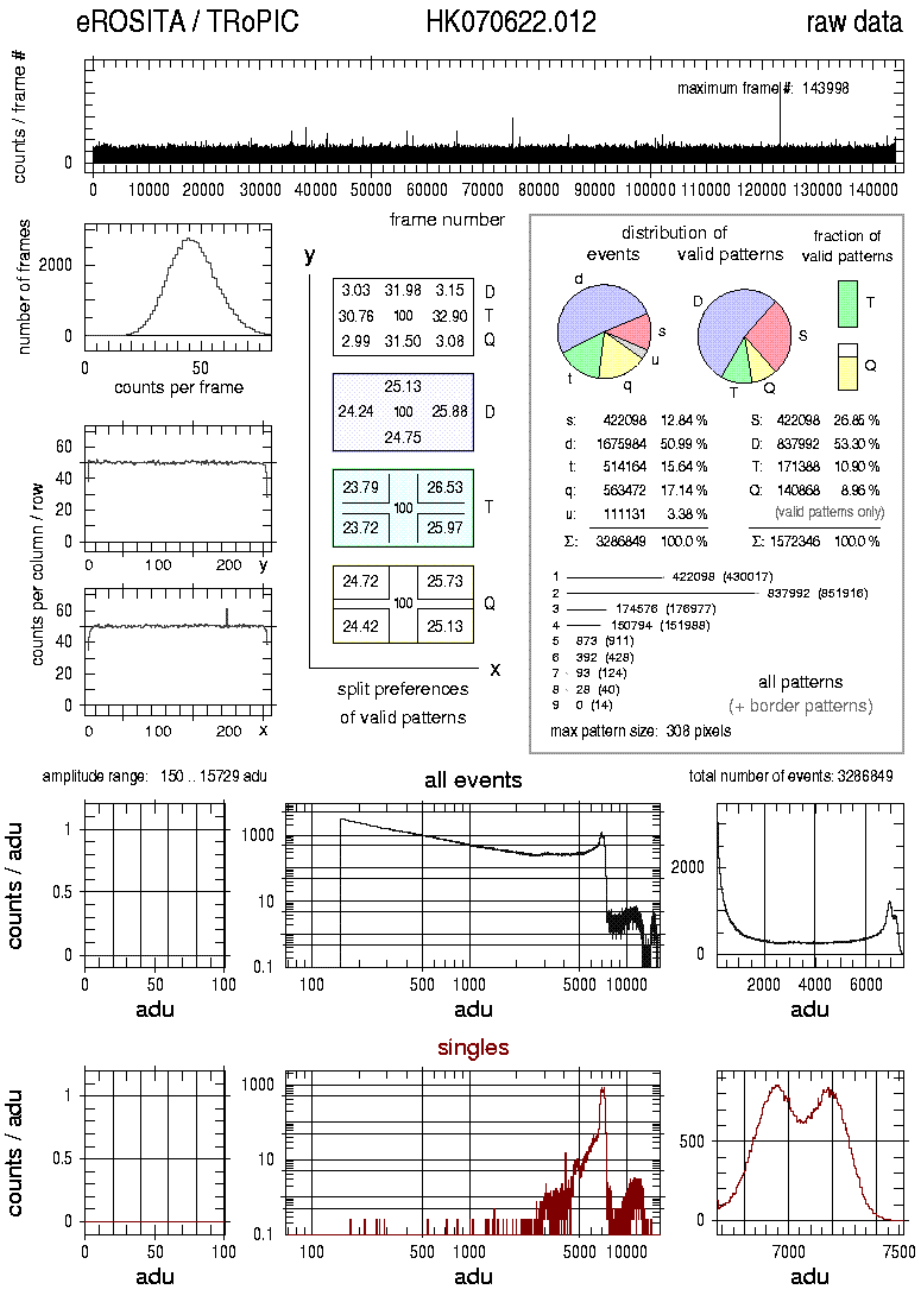



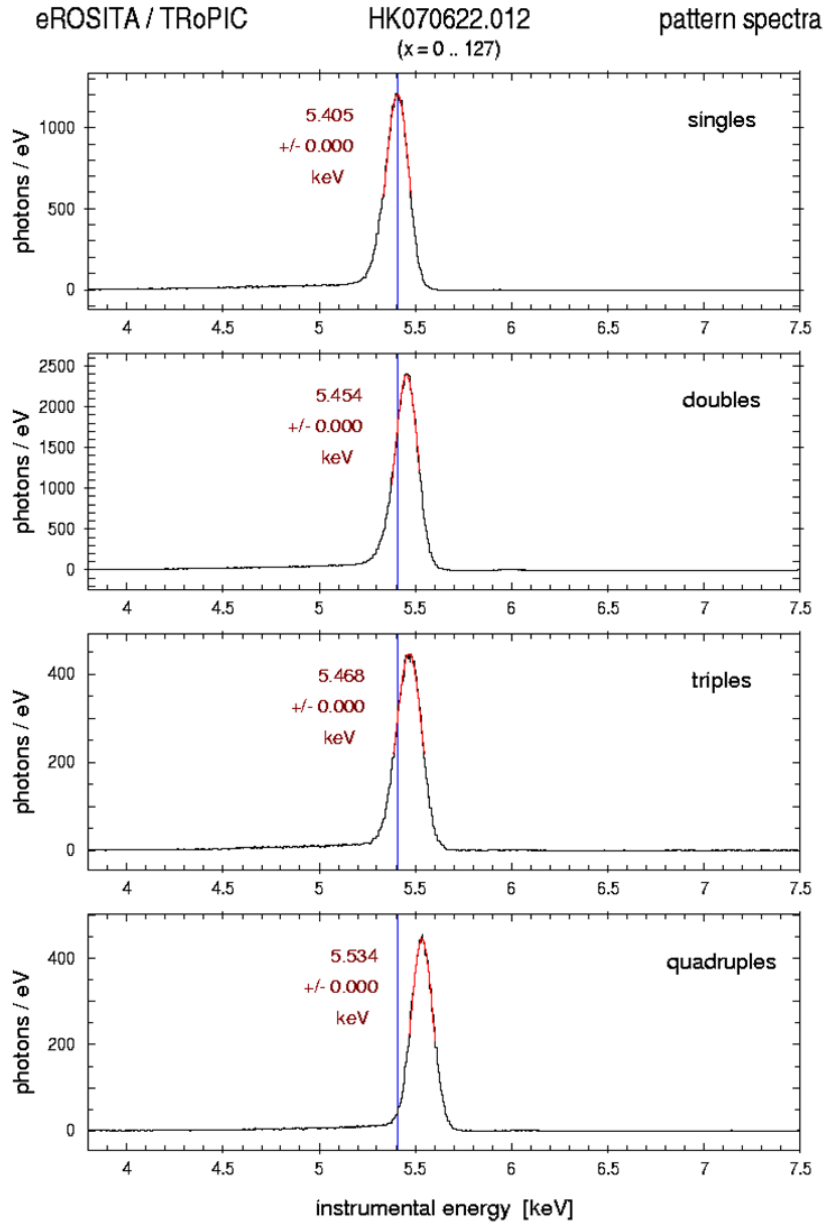



# Application of the cti and gain correction derived for singles

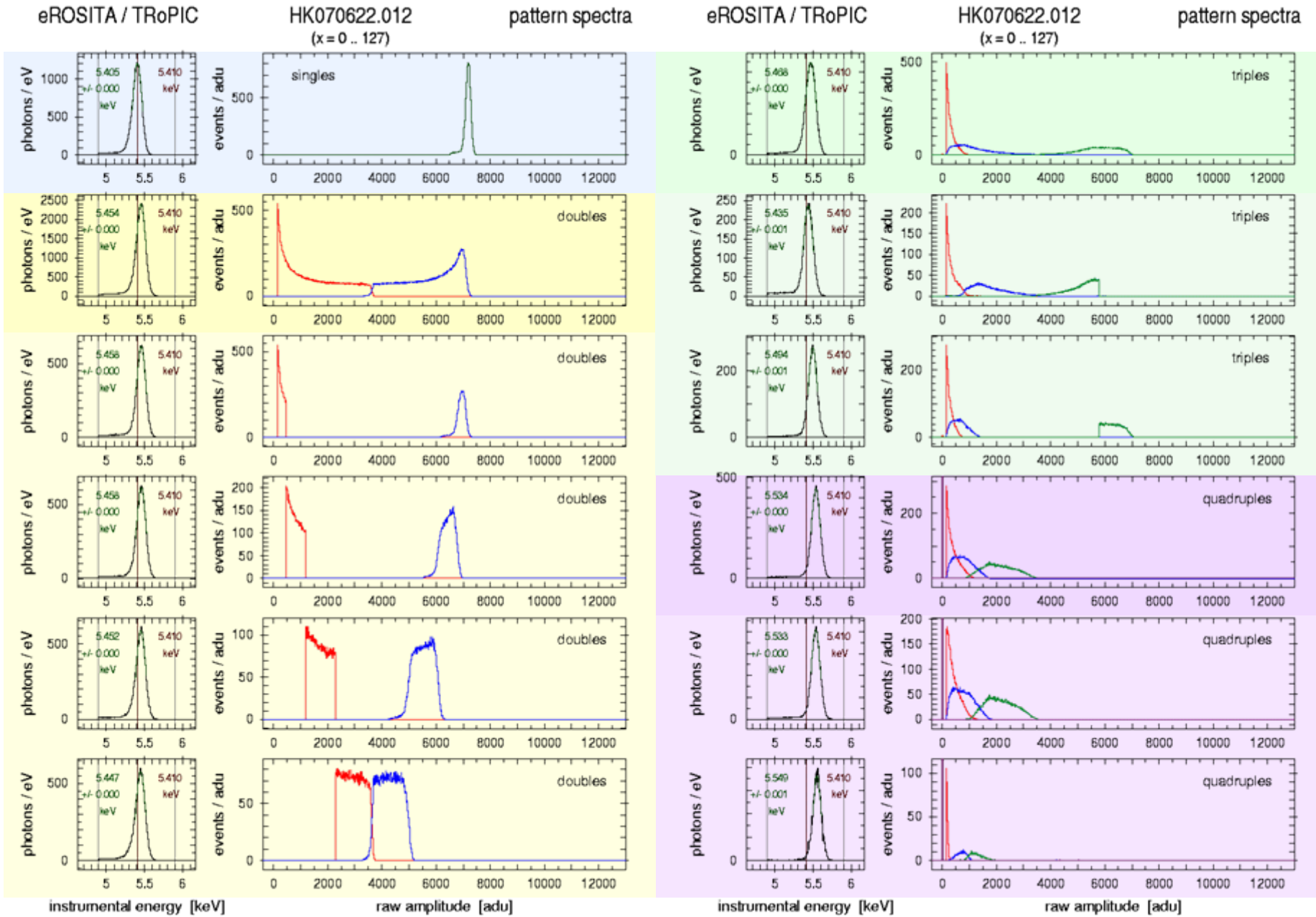
**Cr-K (5.410 keV)**

# Cr-K

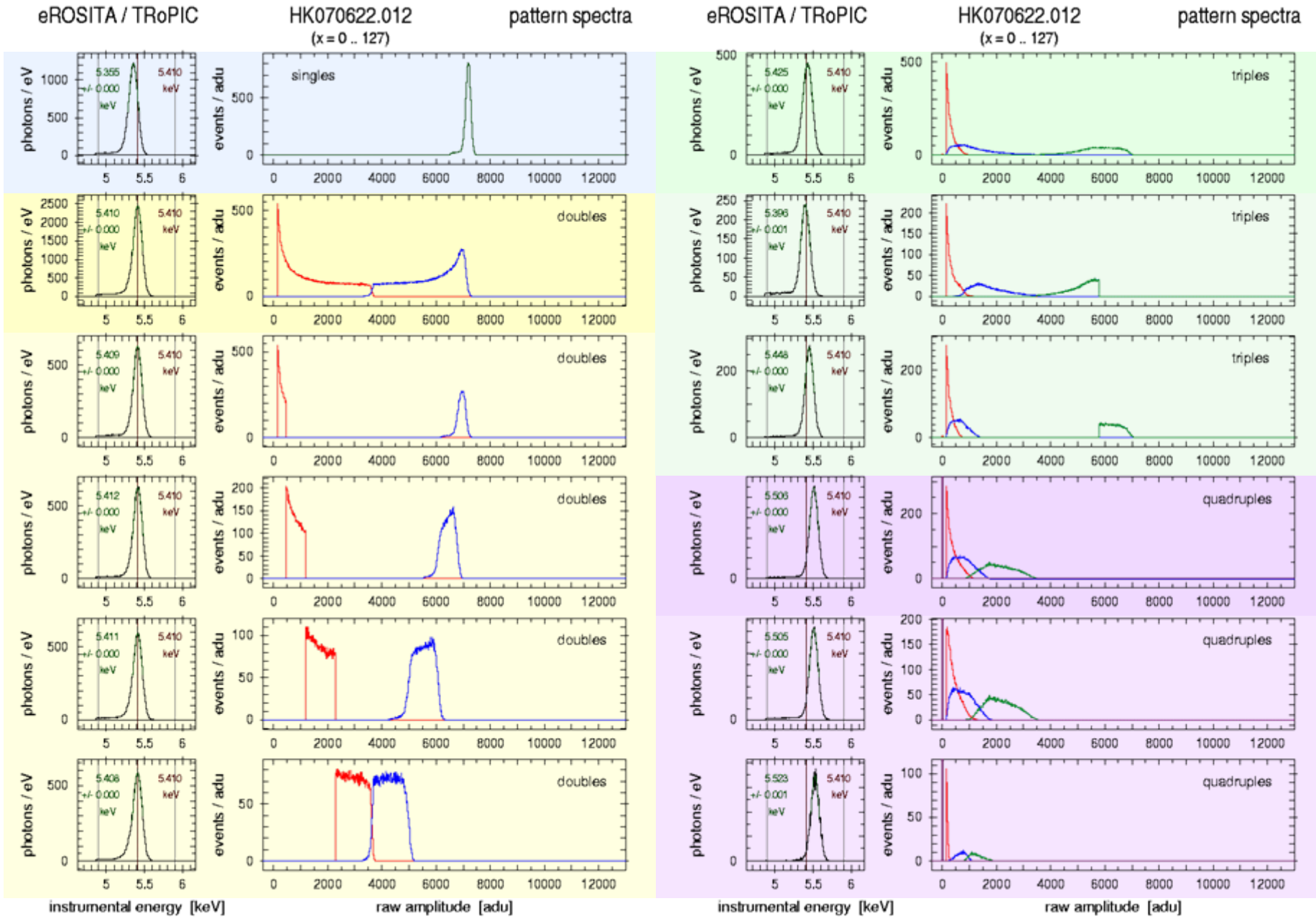

eROSITA / TRoPIC
HK070622.012
raw data
counts / frame #
maximum frame #: 143998
frame number
number of frames
counts per frame
counts per column / row
split preferences
of valid patterns
distribution of events
fraction of valid patterns
all patterns
(+ border patterns)
max pattern size: 308 pixels
amplitude range: 150 .. 15729 adu
all events
total number of events: 3286849
counts / adu
adu
singles


eROSITA / TRoPIC
HK070622.012
(x = 0 .. 127)
pattern spectra
photons / eV
5.405
+/- 0.000
keV
singles
5.454
+/- 0.000
keV
doubles
5.468
+/- 0.000
keV
triples
5.534
+/- 0.000
keV
quadruples
instrumental energy [keV]

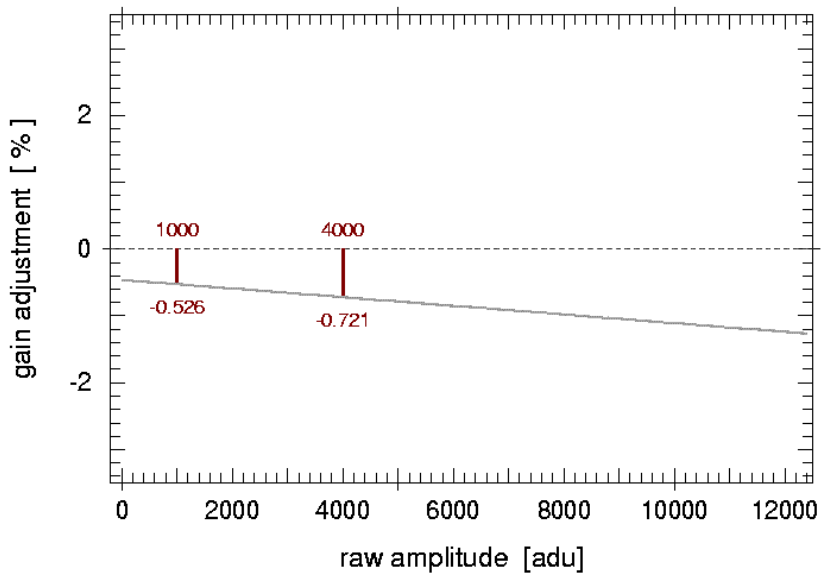
# Cr-K

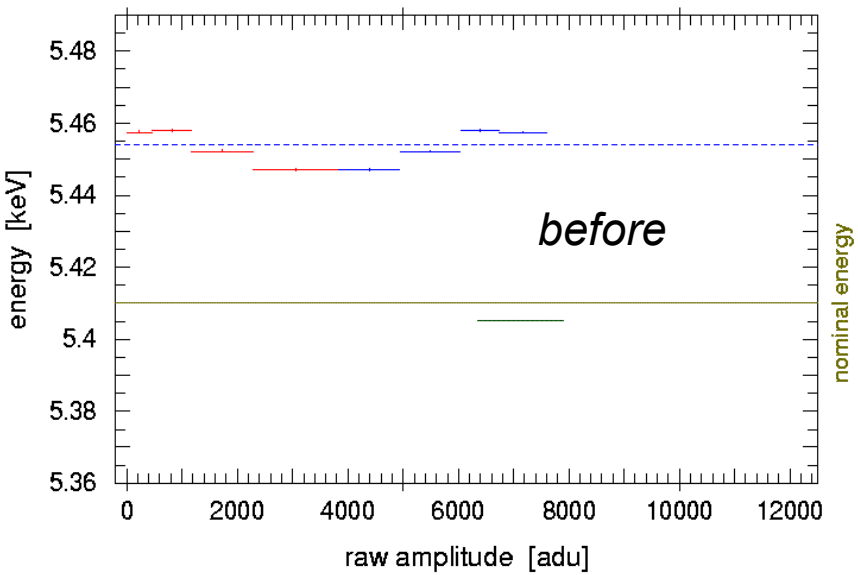

eROSITA / TRoPIC
HK070622.012
(x = 0 .. 127)
pattern spectra
singles
doubles
triples
quadruples
photons / eV
events / adu
instrumental energy [keV]
raw amplitude [adu]

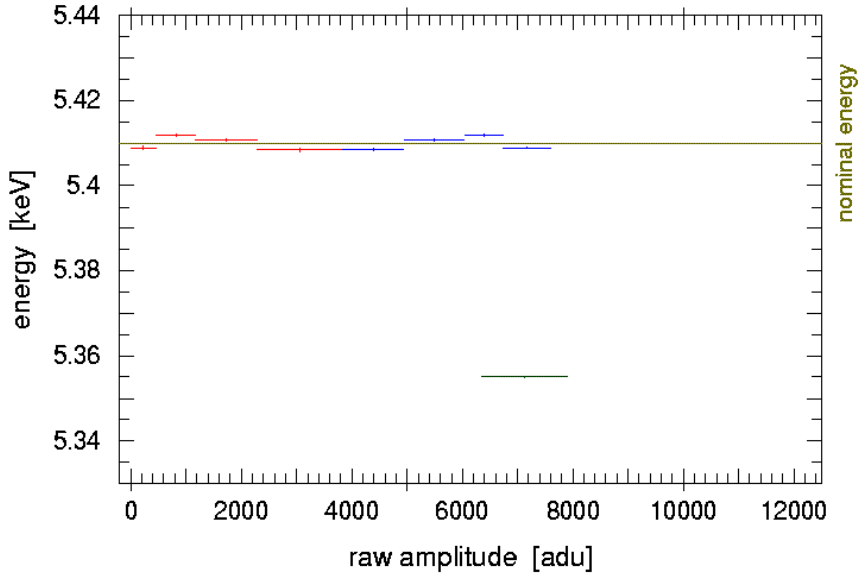
# Cr-K

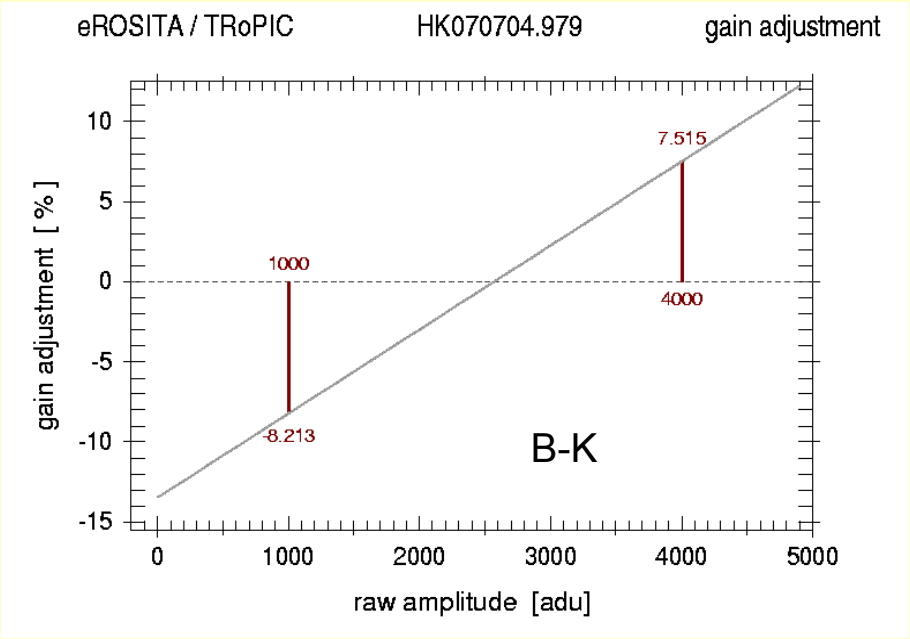

eROSITA / TRoPIC
HK070622.012
(x = 0 .. 127)
pattern spectra
singles
doubles
triples
quadruples
photons / eV
events / adu
instrumental energy [keV]
raw amplitude [adu]

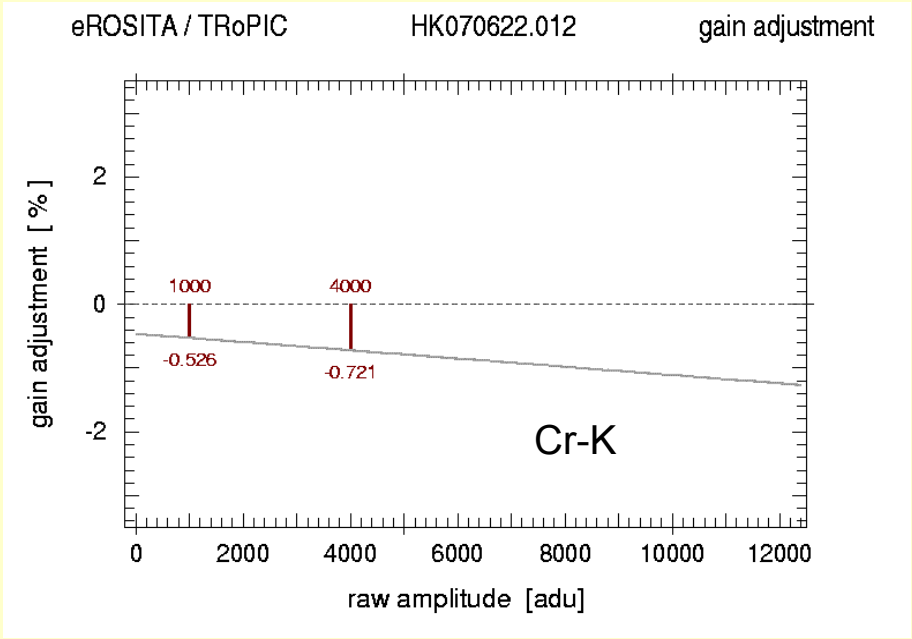
Cr-K (5.410 keV):
gain adjustment for doubles

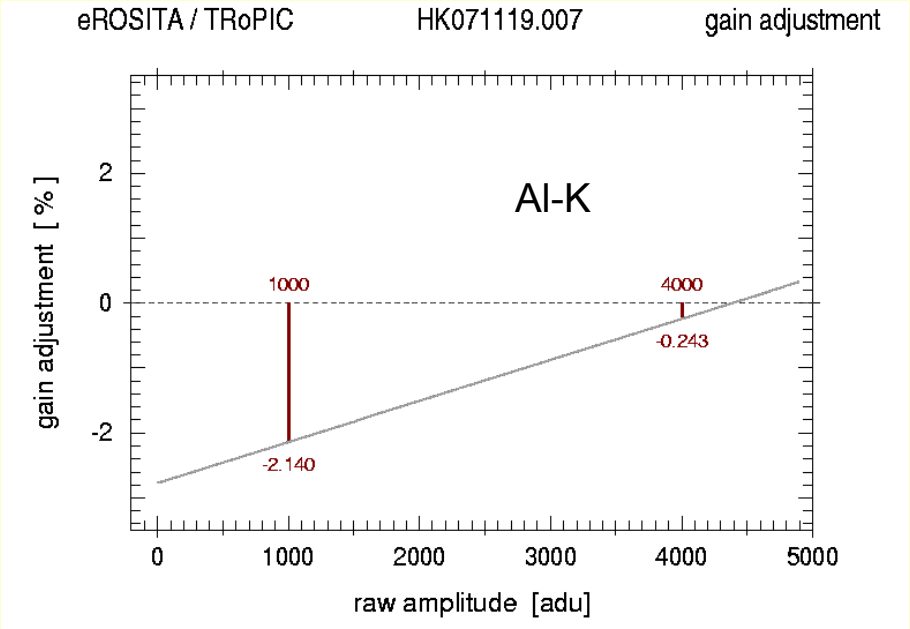


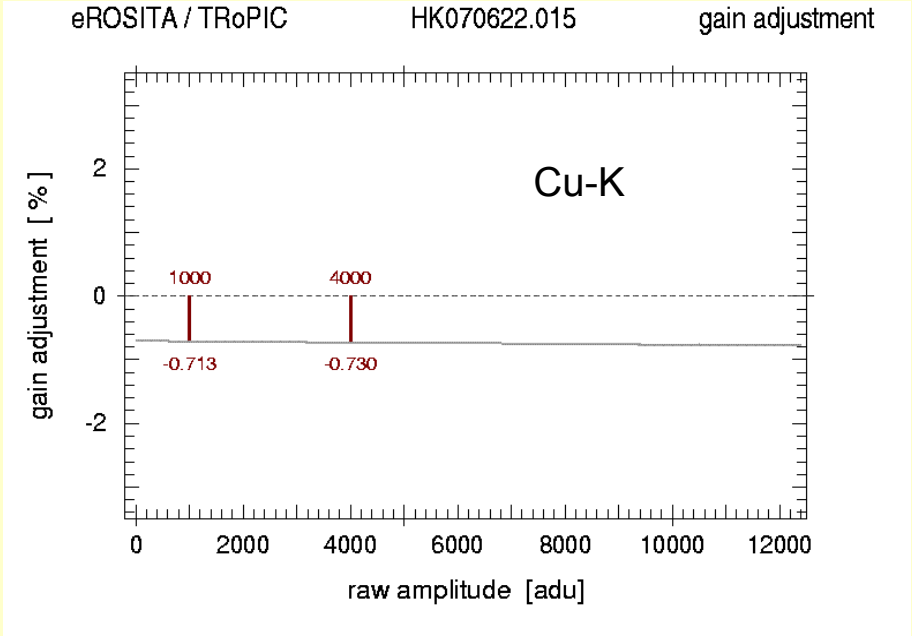




eROSITA / TRoPIC
HK070704.979
gain adjustment
gain adjustment [ % ]
raw amplitude [adu]
7.515
1000
4000
-8.213
B-K


eROSITA / TRoPIC
HK070622.012
gain adjustment
gain adjustment [ % ]
raw amplitude [adu]
1000
4000
-0.526
-0.721
Cr-K


eROSITA / TRoPIC
HK071119.007
gain adjustment
gain adjustment [ % ]
raw amplitude [adu]
1000
4000
-0.243
-2.140
Al-K


eROSITA / TRoPIC
HK070622.015
gain adjustment
gain adjustment [ % ]
raw amplitude [adu]
1000
4000
-0.713
-0.730
Cu-K

# eROSITA/TRoPIC Gain Correction

→ Patterns cannot be corrected by any gain(E) function which is applied to their components individually, even if this function is made dependend on (x,y) and the pattern type.

→ If correction for singles is applied, then patterns become overcorrected, with the amount of overcorrection monotonically increasing with pattern size

What is the reason ?

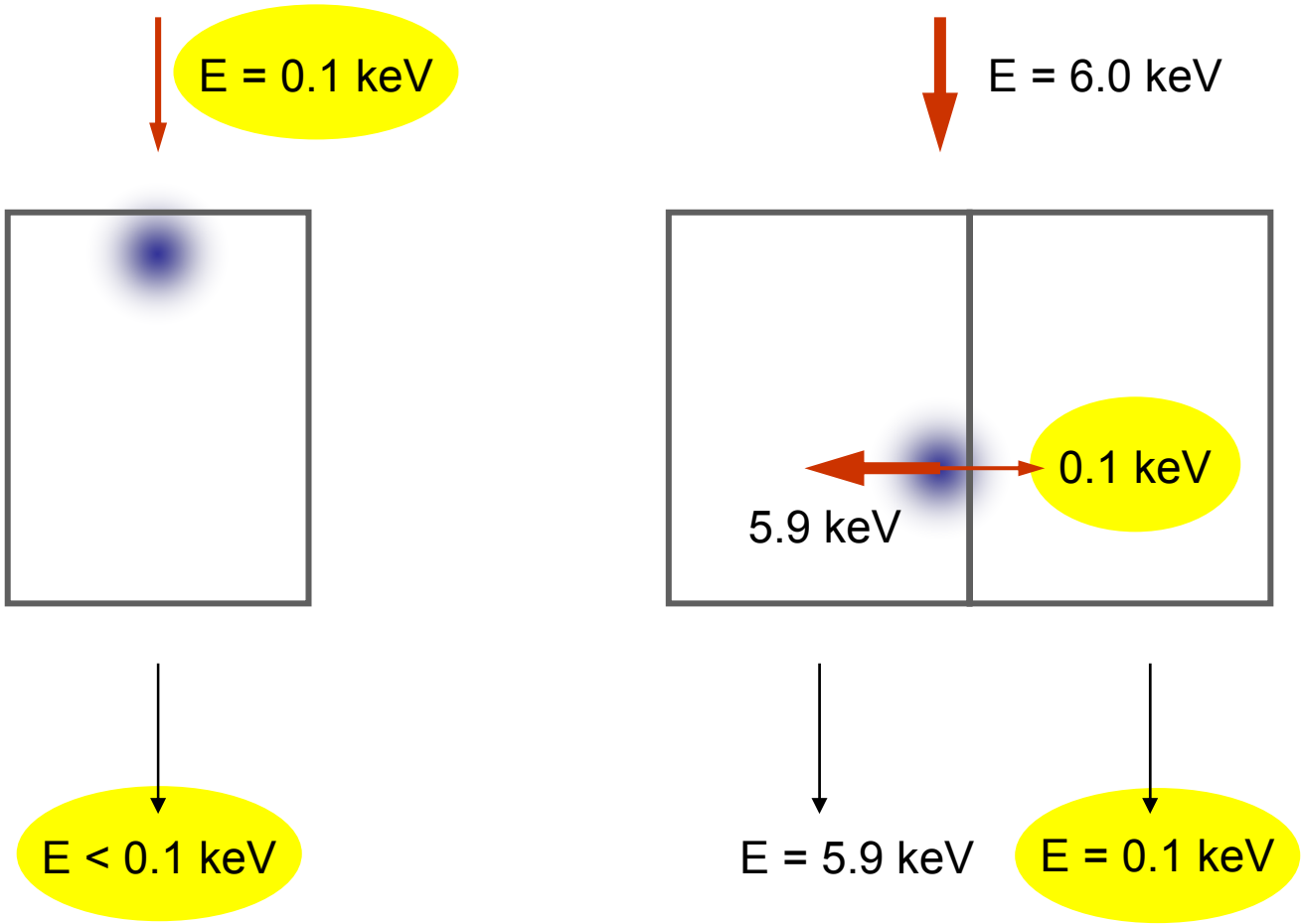
- *why offset ?*
- *why overcorrection for patterns ?*

# eROSITA/TRoPIC Gain Correction

- *why offset ?*
- *why overcorrection for patterns ?*

- nonlinear amplification ?
- offset calculation ?
- common mode ?
- pileup with noise ?
- frame store ?
- partial events ?

# Charge Loss due to Partial Events



# eROSITA/TRoPIC Gain Correction

- *why offset ?*
- *why overcorrection for patterns ?*

- nonlinear amplification ?
- offset calculation ?
- common mode ?
- pileup with noise ?
- frame store ?
- partial events ?
- threshold !

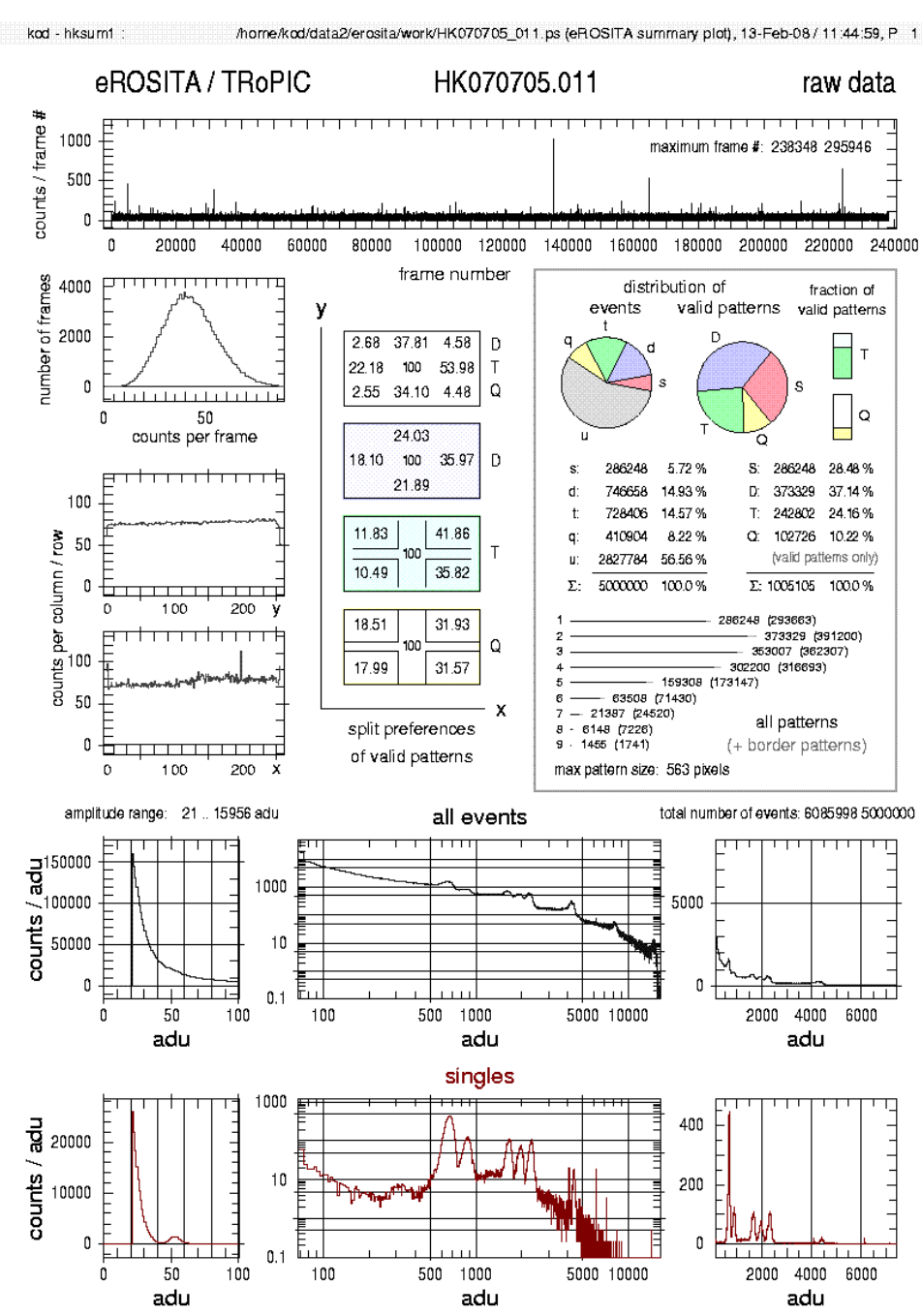
# Low Energy Threshold

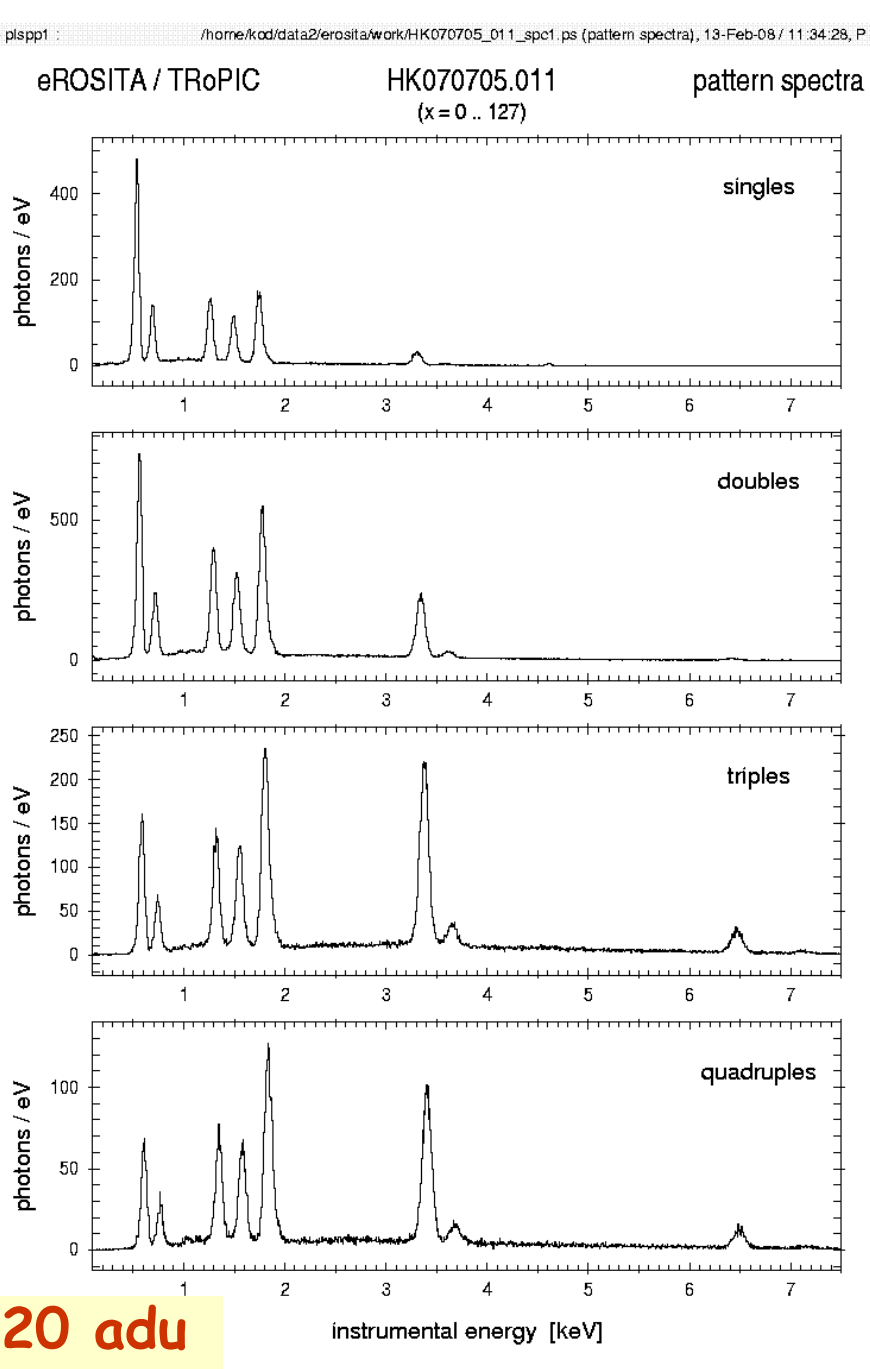
General consequences

data corrected with gain derived from singles

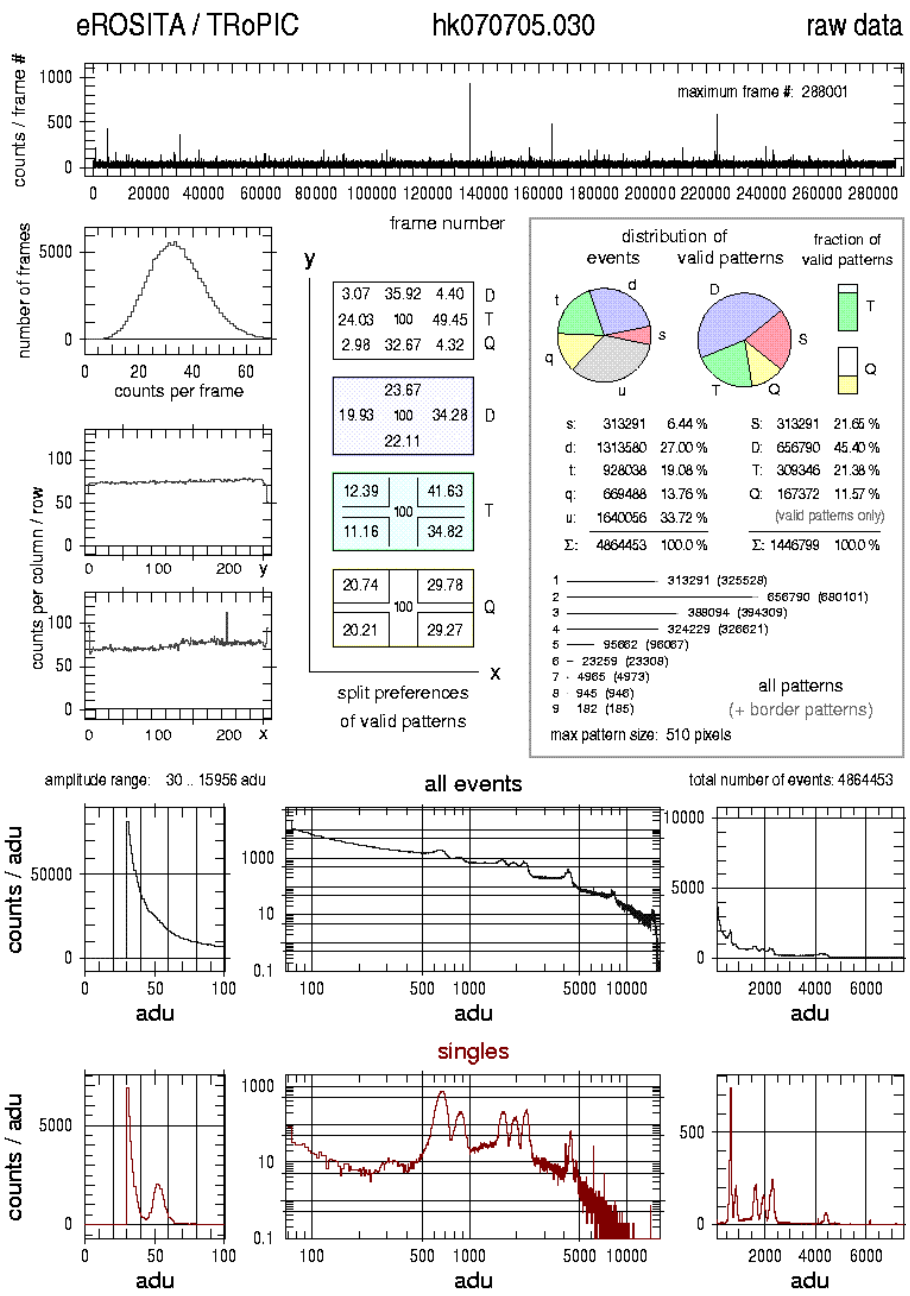
data set: HK070705.011  Macor, 15 kV, 4.2 V, EPIC-Filter, 5 Sigma, 20 adu

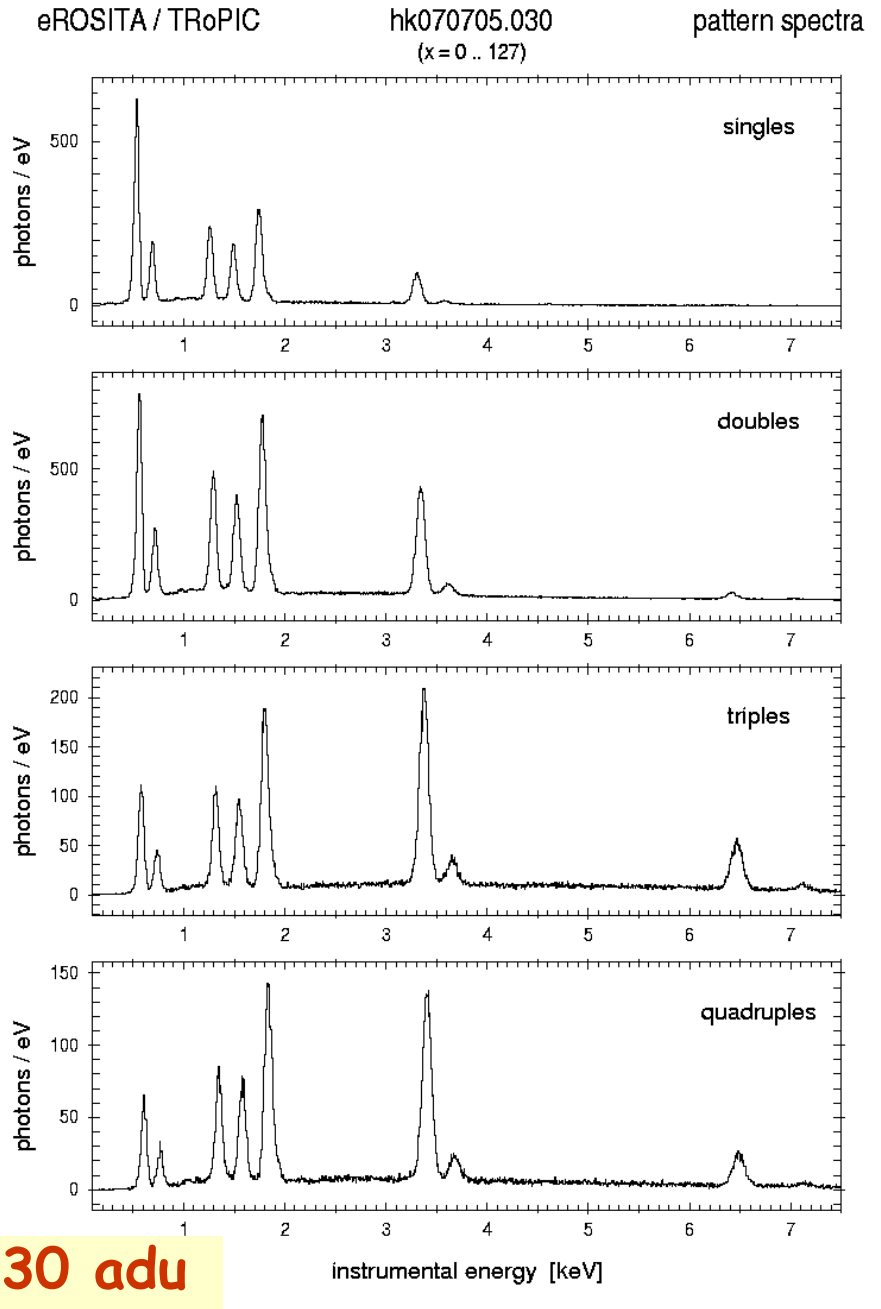
6.1 million events


eROSITA / TRoPIC
HK070705.011
raw data
maximum frame #: 238348 295946
counts / frame #
frame number
number of frames
counts per frame
counts per column / row
distribution of events
valid patterns
fraction of valid patterns
split preferences of valid patterns
all patterns
(+ border patterns)
max pattern size: 563 pixels
amplitude range: 21 .. 15956 adu
all events
total number of events: 6085998 5000000
counts / adu
adu
singles

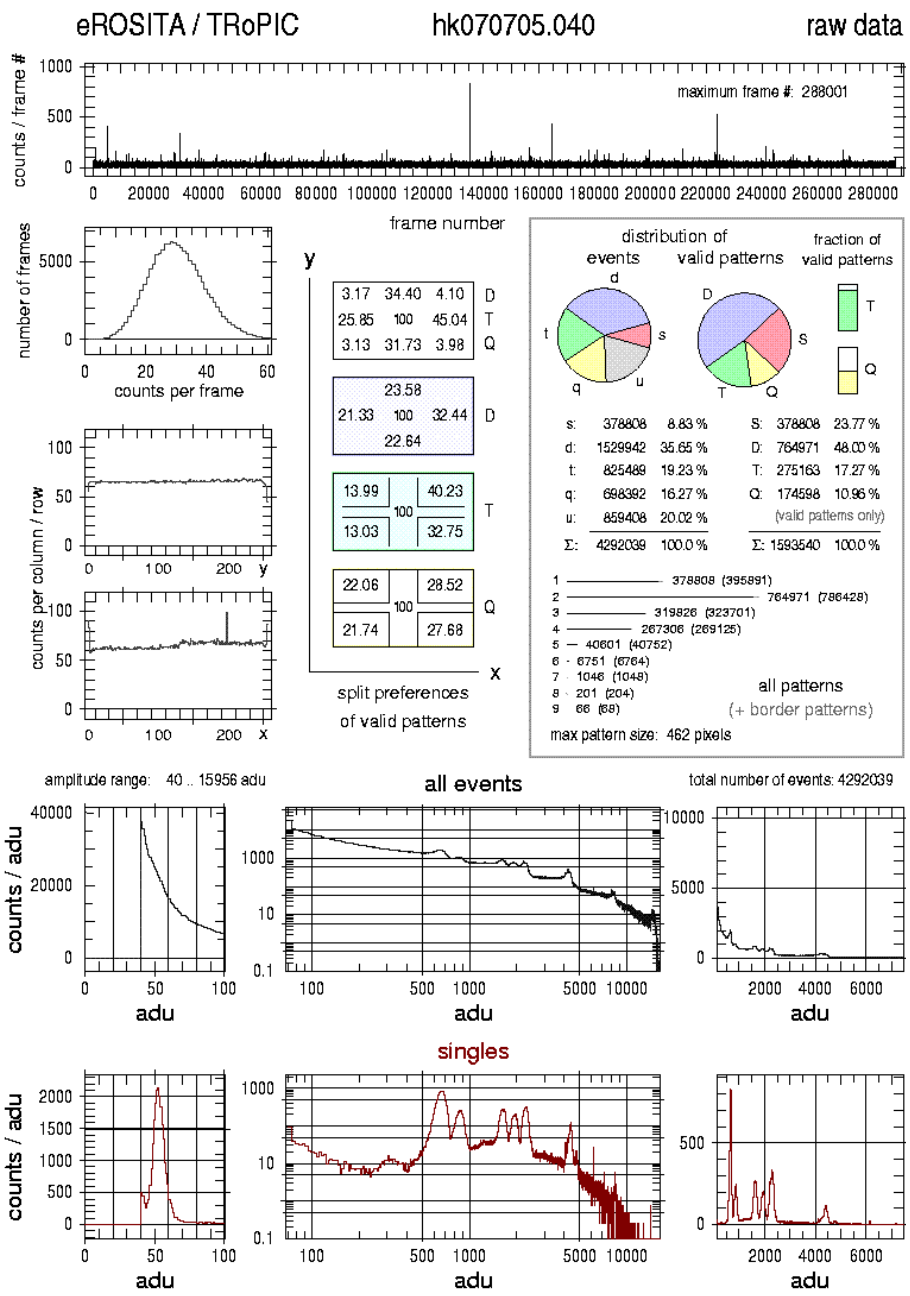

eROSITA / TRoPIC
HK070705.011
pattern spectra
(x = 0 .. 127)
singles
doubles
triples
quadruples
photons / eV
instrumental energy [keV]

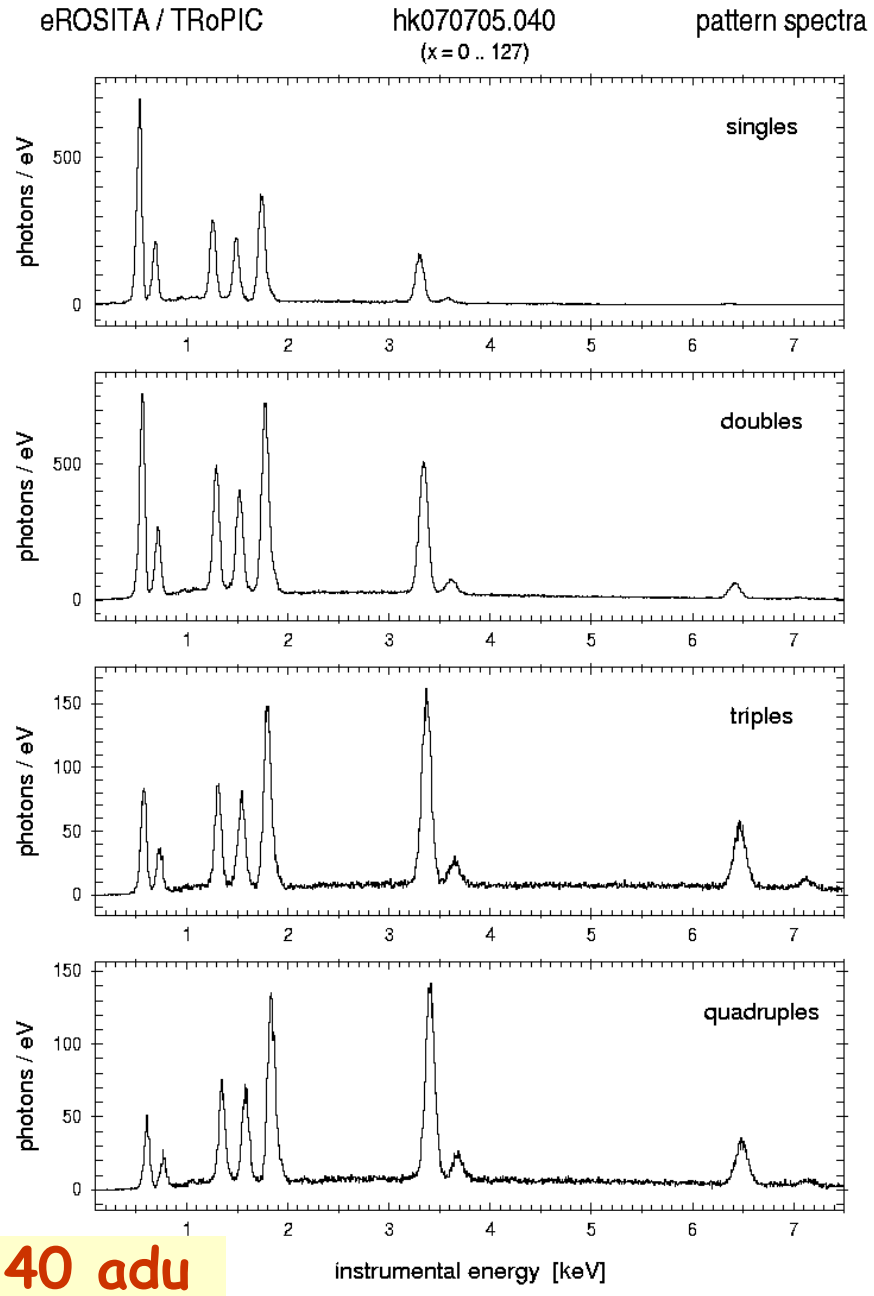
**20 adu**


eROSITA / TRoPIC
hk070705.030
raw data
counts / frame #
maximum frame #: 288001
frame number
number of frames
counts per frame
counts per column / row
split preferences
of valid patterns
distribution of events
valid patterns
fraction of valid patterns
all patterns
(+ border patterns)
max pattern size: 510 pixels
amplitude range: 30 .. 15956 adu
all events
total number of events: 4864453
counts / adu
adu
singles

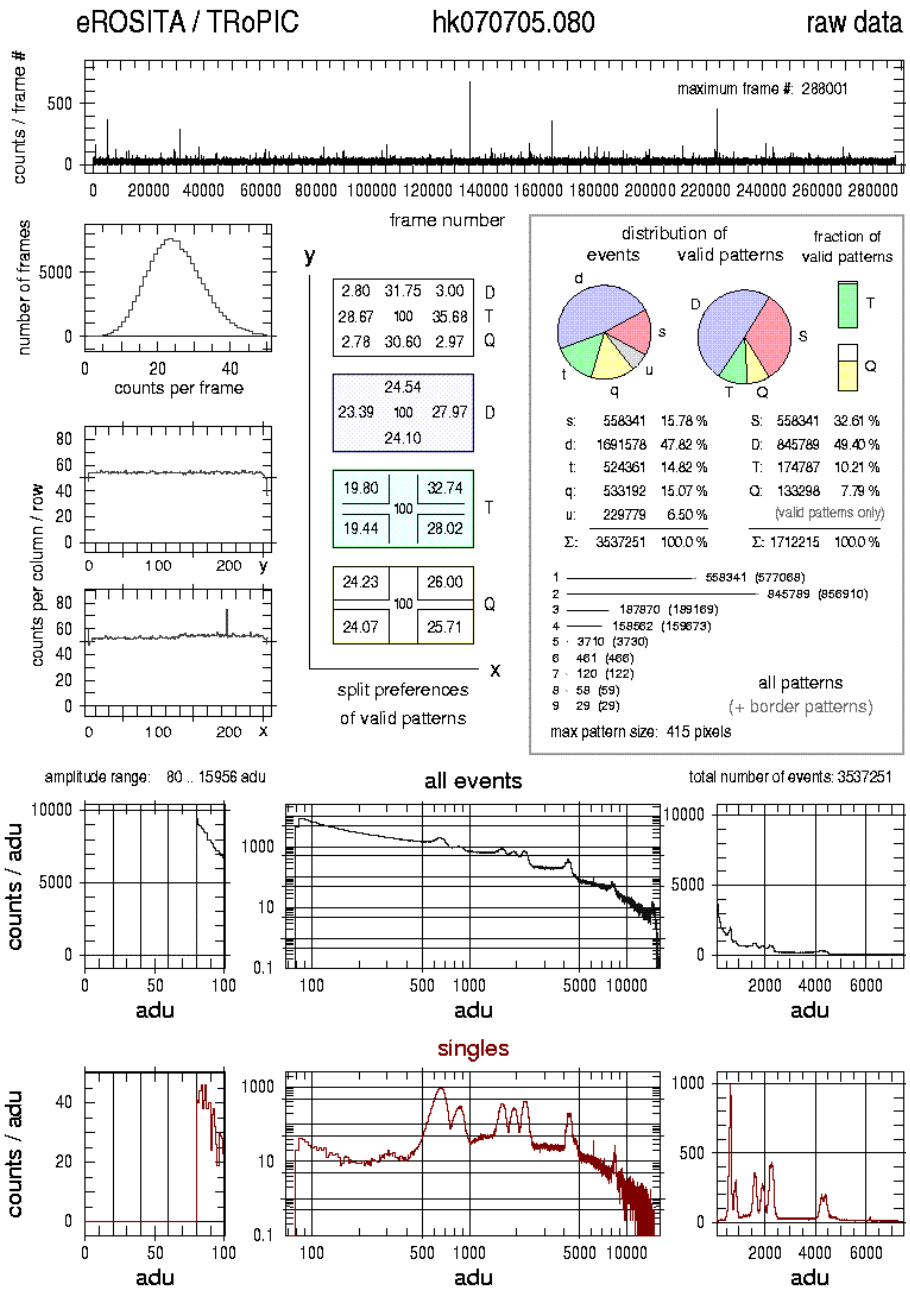

eROSITA / TRoPIC
hk070705.030
(x = 0 .. 127)
pattern spectra
photons / eV
singles
doubles
triples
quadruples
instrumental energy [keV]

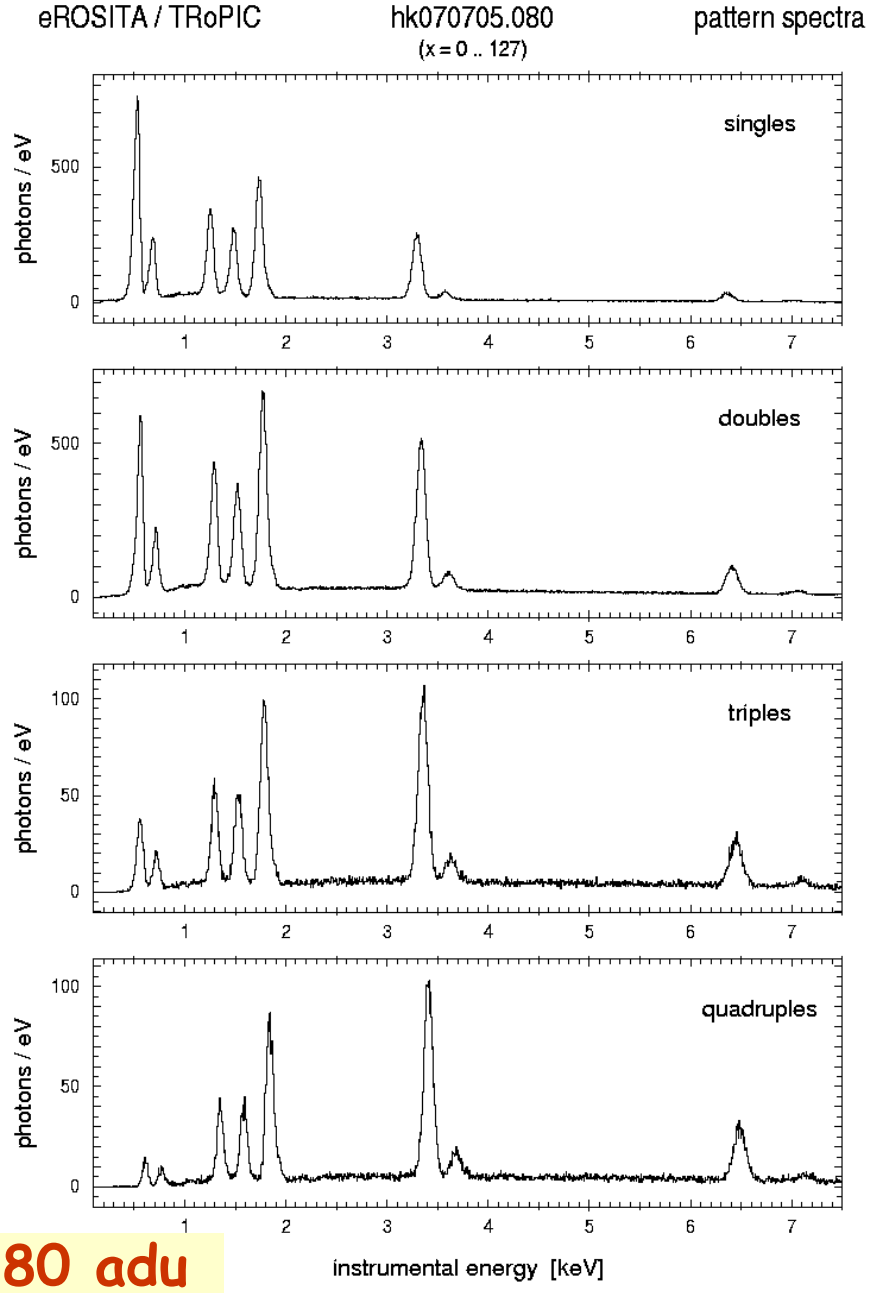
**30 adu**


eROSITA / TRoPIC
hk070705.040
raw data
counts / frame #
maximum frame #: 288001
frame number
number of frames
counts per frame
counts per column / row
distribution of events
distribution of valid patterns
fraction of valid patterns
split preferences of valid patterns
all patterns (+ border patterns)
max pattern size: 462 pixels
amplitude range: 40 .. 15956 adu
all events
total number of events: 4292039
counts / adu
adu
singles

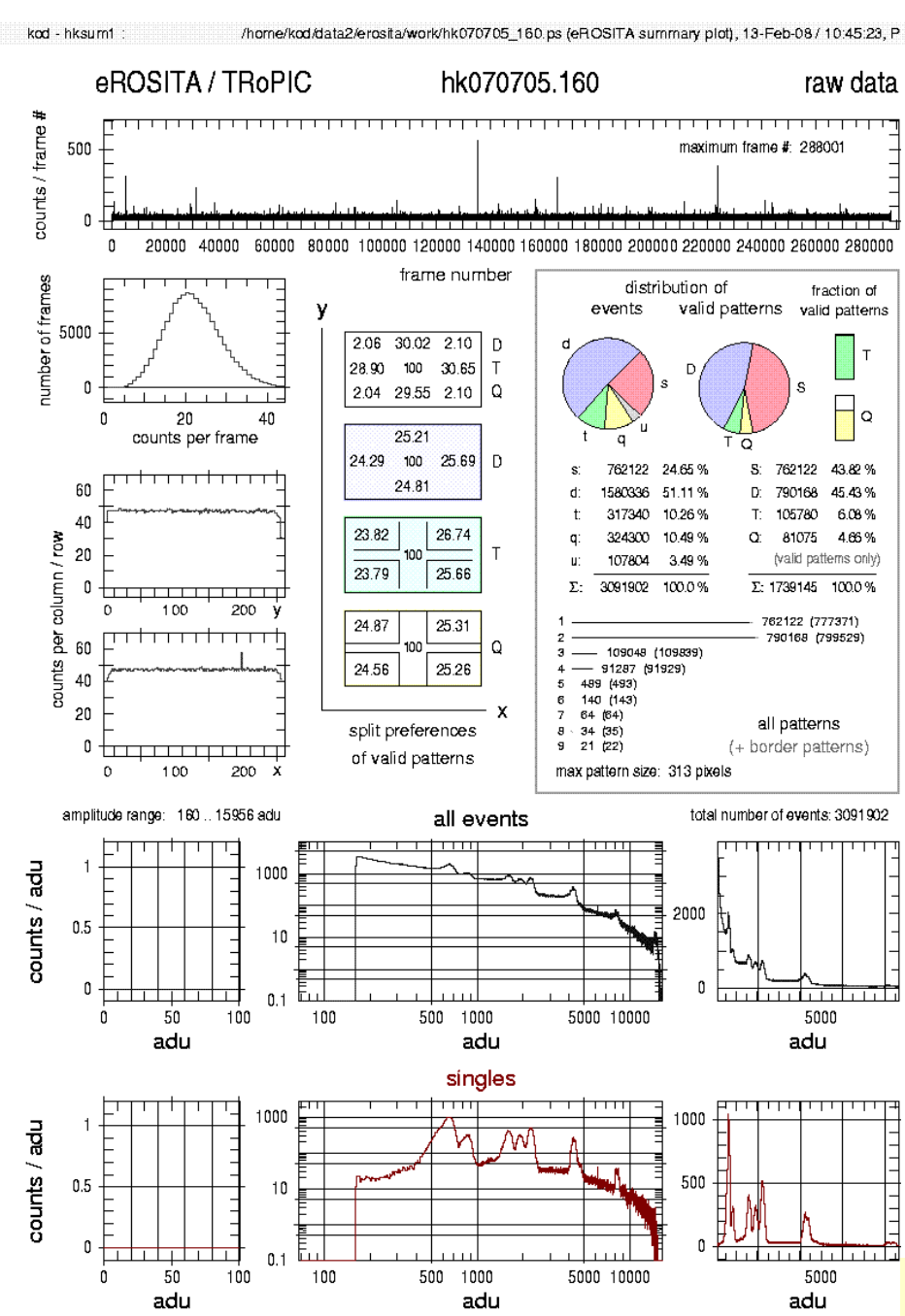

eROSITA / TRoPIC
hk070705.040
(x = 0 .. 127)
pattern spectra
photons / eV
singles
doubles
triples
quadruples
instrumental energy [keV]

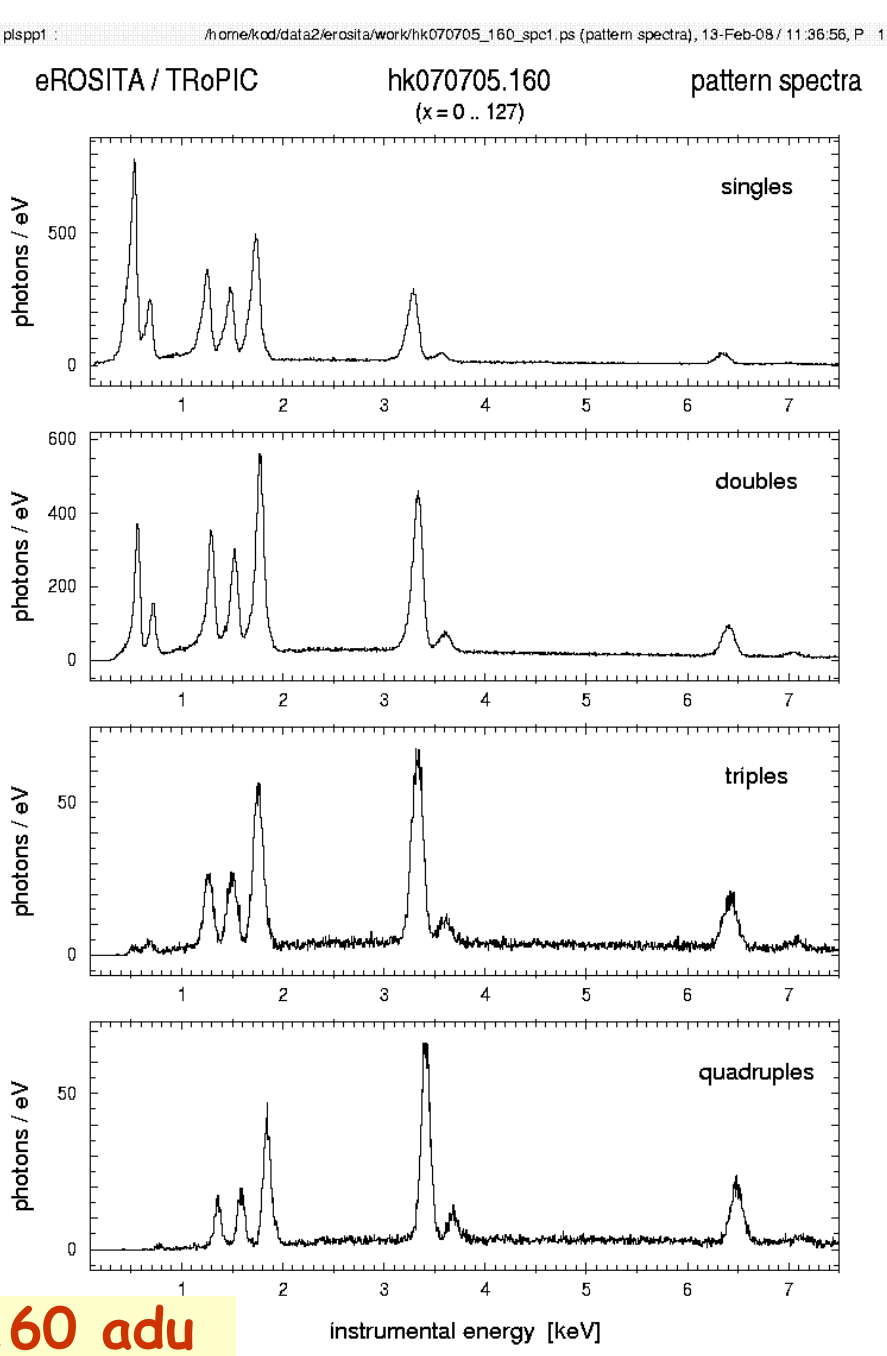
**40 adu**


eROSITA / TRoPIC
hk070705.080
raw data
counts / frame #
maximum frame #: 288001
frame number
number of frames
counts per frame
counts per column / row
split preferences
of valid patterns
distribution of events
valid patterns
fraction of valid patterns
all patterns
(+ border patterns)
max pattern size: 415 pixels
amplitude range: 80 .. 15956 adu
all events
total number of events: 3537251
counts / adu
adu
singles

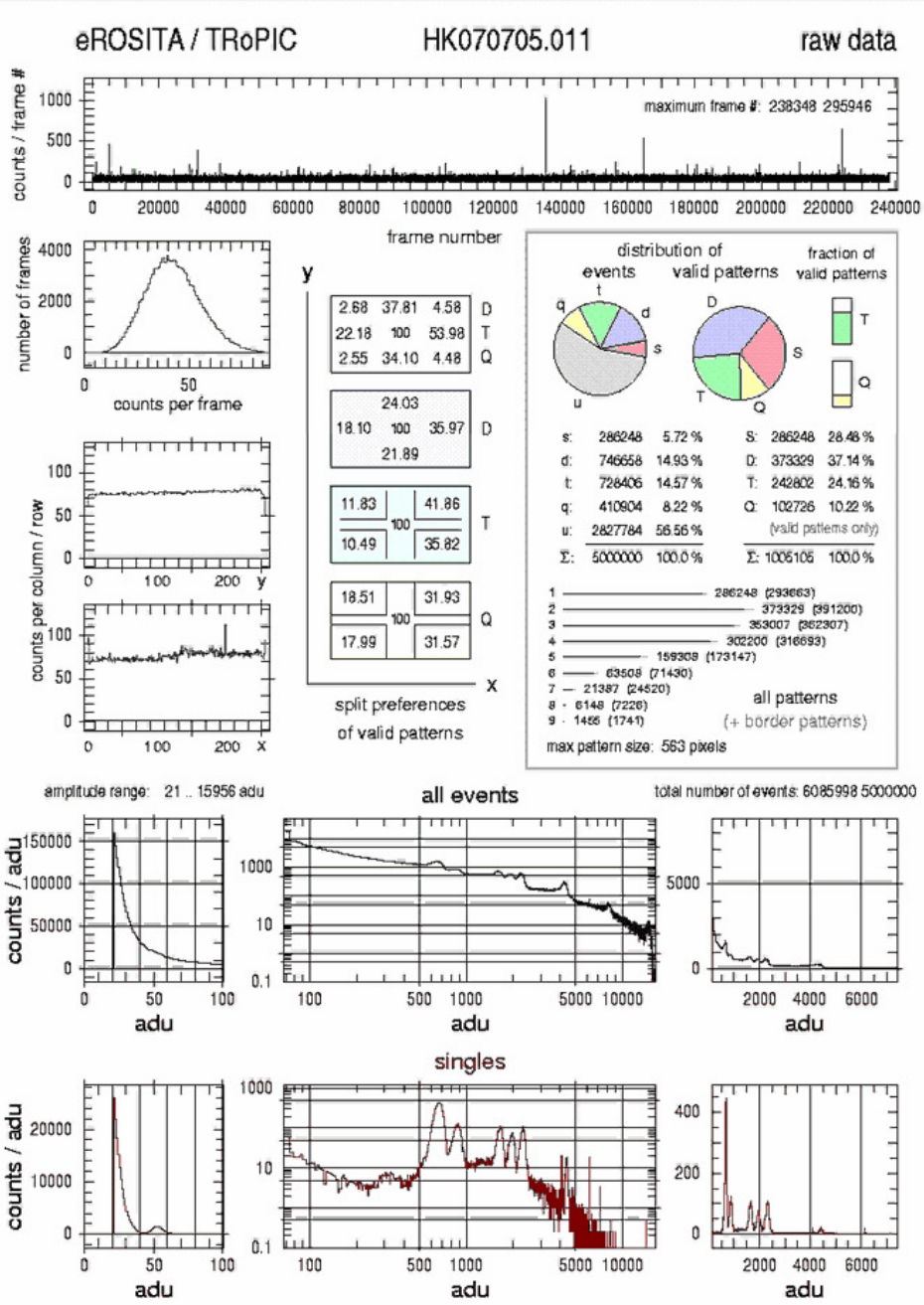

eROSITA / TRoPIC
hk070705.080
(x = 0 .. 127)
pattern spectra
singles
doubles
triples
quadruples
photons / eV
instrumental energy [keV]

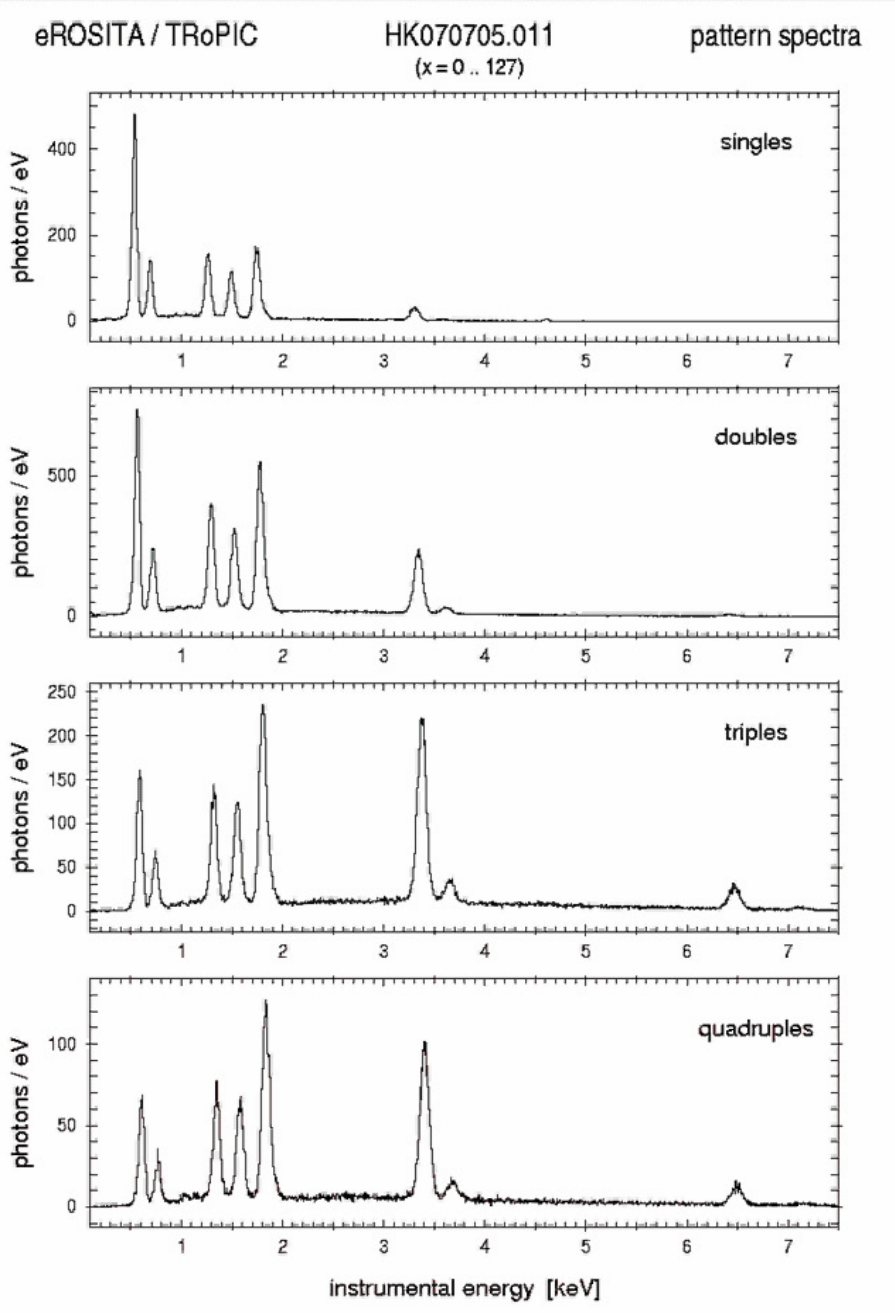
80 adu


kod - hksum1 : /home/kod/data2/erosita/work/hk070705_160.ps (eROSITA summary plot), 13-Feb-08 / 10:45:23, P
eROSITA / TRoPIC
hk070705.160
raw data
counts / frame #
maximum frame #: 288001
frame number
number of frames
counts per frame
counts per column / row
distribution of events
valid patterns
fraction of valid patterns
split preferences of valid patterns
all patterns
(+ border patterns)
max pattern size: 313 pixels
amplitude range: 160 .. 15956 adu
all events
total number of events: 3091902
counts / adu
adu
singles


kod - plspp1 : /home/kod/data2/erosita/work/hk070705_160_spc1.ps (pattern spectra), 13-Feb-08 / 11:36:56, P 1
eROSITA / TRoPIC
hk070705.160
(x = 0 .. 127)
pattern spectra
photons / eV
singles
doubles
triples
quadruples
instrumental energy [keV]

**160 adu**


kod - hksum1 : /home/kod/data2/erosita/work/HK070705_011.ps (eROSITA summary plot), 13-Feb-08 / 11:44:59, P 1
eROSITA / TRoPIC
HK070705.011
raw data
counts / frame #
maximum frame #: 238348 295946
frame number
number of frames
counts per frame
counts per column / row
y
x
split preferences
of valid patterns
distribution of events
fraction of valid patterns
all patterns
(+ border patterns)
max pattern size: 563 pixels
amplitude range: 21 .. 15956 adu
all events
total number of events: 6085998 5000000
counts / adu
adu
singles


- plspp1 : /home/kod/data2/erosita/work/HK070705_011_spc1.ps (pattern spectra), 13-Feb-08 / 11:34:28, P 1
eROSITA / TRoPIC
HK070705.011
(x = 0 .. 127)
pattern spectra
singles
doubles
triples
quadruples
photons / eV
instrumental energy [keV]

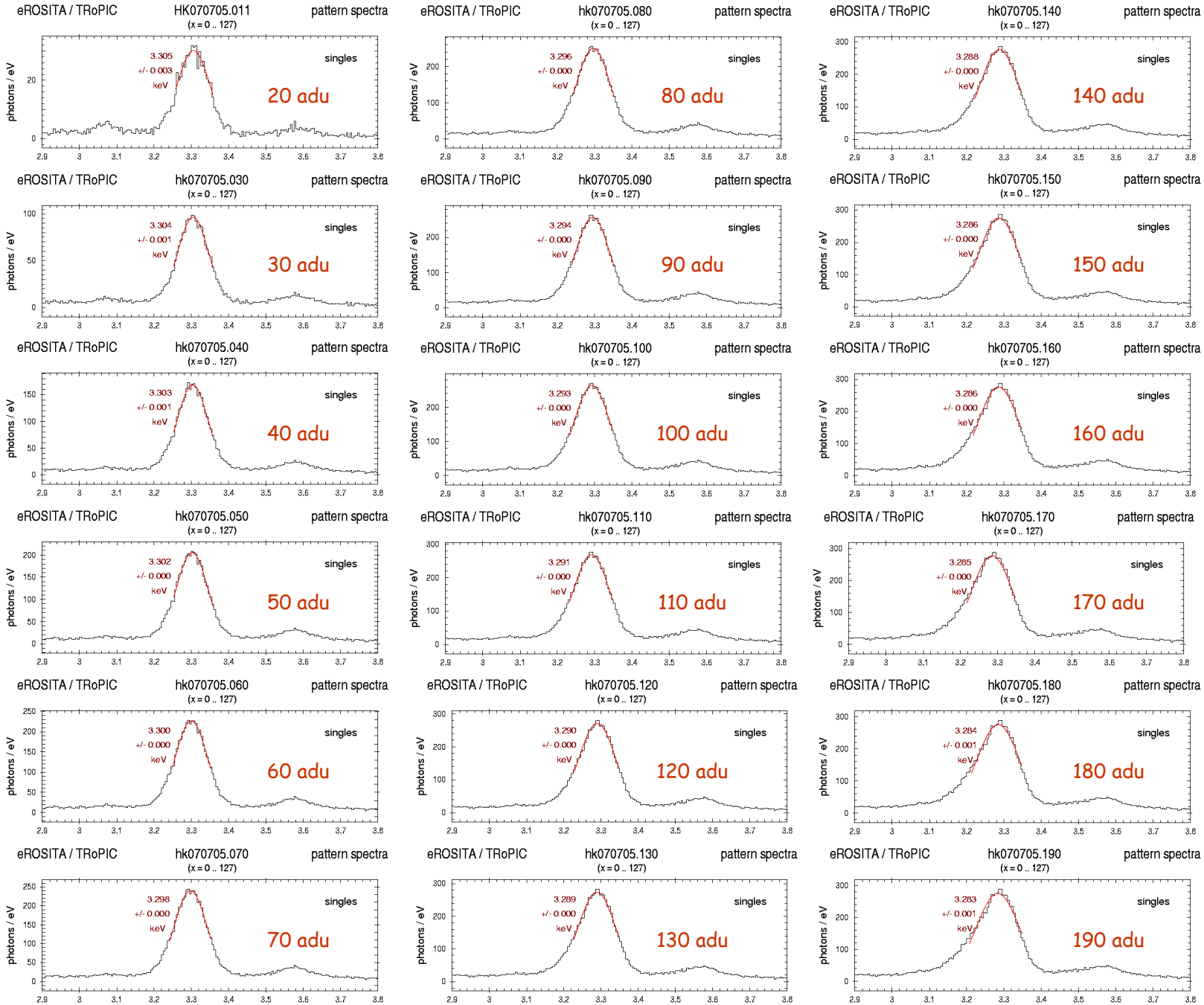
# Low Energy Threshold

Dependence of the peak position derived from singles
on the low energy threshold

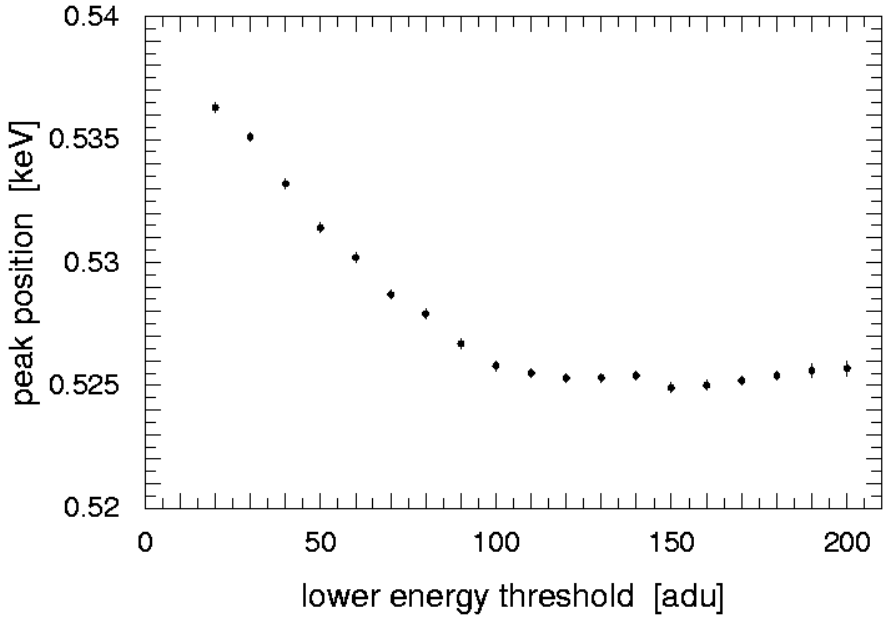
data corrected with gain derived from singles

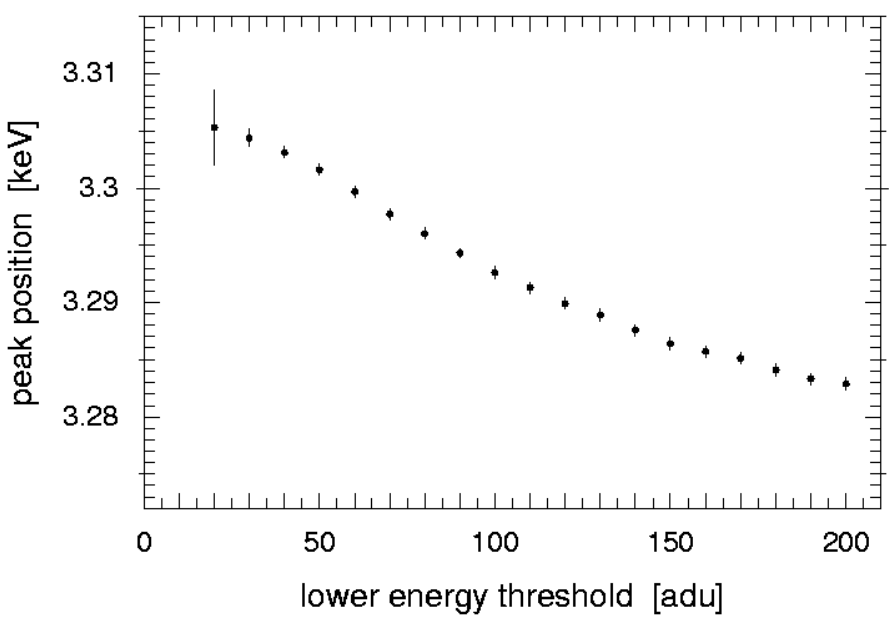
data set: HK070705.011  Macor, 15 kV, 4.2 V, EPIC-Filter, 5 Sigma, 20 adu

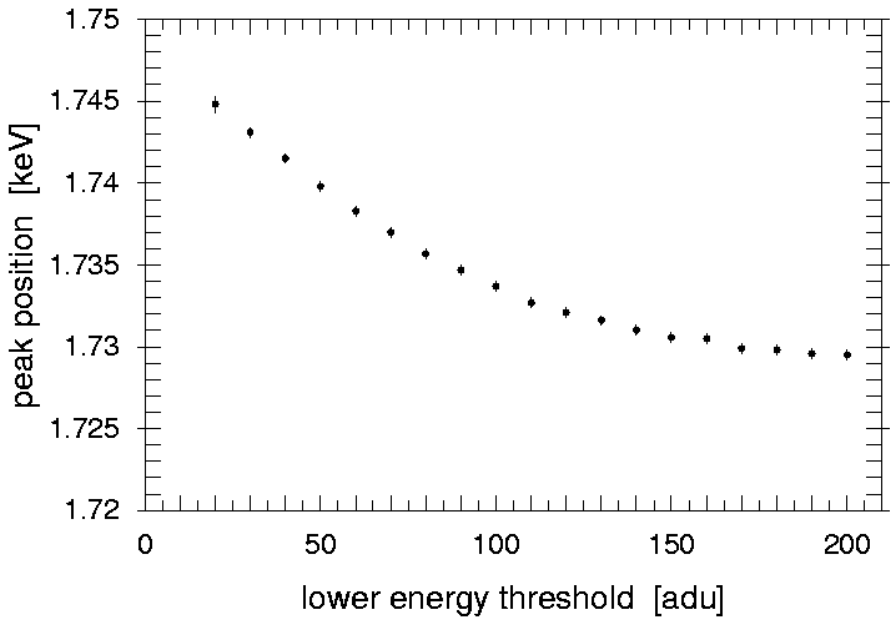
6.1 million events

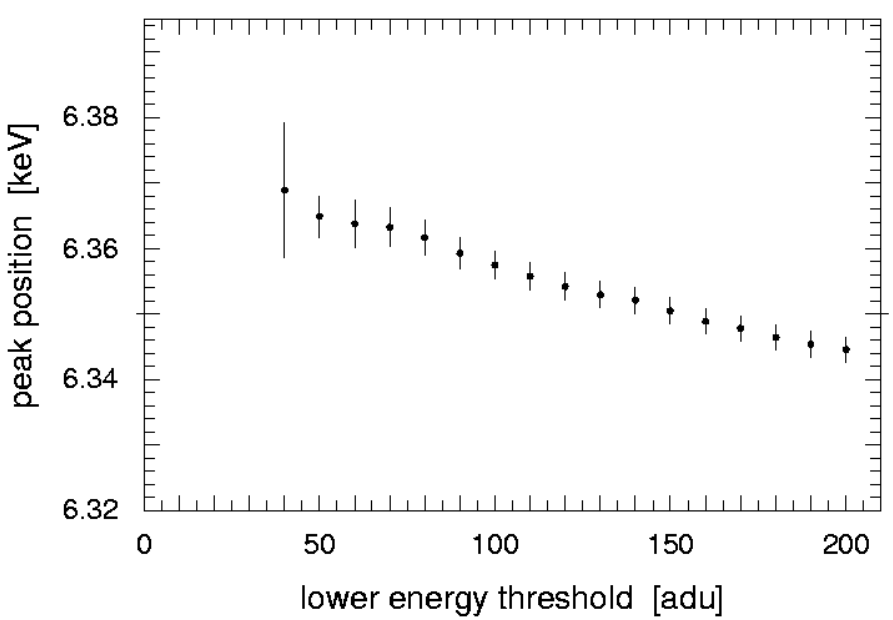

eROSITA / TRoPIC HK070705.011 pattern spectra
(x = 0 .. 127)
3.305
+/- 0.003
keV
singles
20 adu
eROSITA / TRoPIC hk070705.080 pattern spectra
(x = 0 .. 127)
3.296
+/- 0.000
keV
singles
80 adu
eROSITA / TRoPIC hk070705.140 pattern spectra
(x = 0 .. 127)
3.288
+/- 0.000
keV
singles
140 adu
eROSITA / TRoPIC hk070705.030 pattern spectra
(x = 0 .. 127)
3.304
+/- 0.001
keV
singles
30 adu
eROSITA / TRoPIC hk070705.090 pattern spectra
(x = 0 .. 127)
3.294
+/- 0.000
keV
singles
90 adu
eROSITA / TRoPIC hk070705.150 pattern spectra
(x = 0 .. 127)
3.286
+/- 0.000
keV
singles
150 adu
eROSITA / TRoPIC hk070705.040 pattern spectra
(x = 0 .. 127)
3.303
+/- 0.001
keV
singles
40 adu
eROSITA / TRoPIC hk070705.100 pattern spectra
(x = 0 .. 127)
3.293
+/- 0.000
keV
singles
100 adu
eROSITA / TRoPIC hk070705.160 pattern spectra
(x = 0 .. 127)
3.286
+/- 0.000
keV
singles
160 adu
eROSITA / TRoPIC hk070705.050 pattern spectra
(x = 0 .. 127)
3.302
+/- 0.000
keV
singles
50 adu
eROSITA / TRoPIC hk070705.110 pattern spectra
(x = 0 .. 127)
3.291
+/- 0.000
keV
singles
110 adu
eROSITA / TRoPIC hk070705.170 pattern spectra
(x = 0 .. 127)
3.285
+/- 0.000
keV
singles
170 adu
eROSITA / TRoPIC hk070705.060 pattern spectra
(x = 0 .. 127)
3.300
+/- 0.000
keV
singles
60 adu
eROSITA / TRoPIC hk070705.120 pattern spectra
(x = 0 .. 127)
3.290
+/- 0.000
keV
singles
120 adu
eROSITA / TRoPIC hk070705.180 pattern spectra
(x = 0 .. 127)
3.284
+/- 0.001
keV
singles
180 adu
eROSITA / TRoPIC hk070705.070 pattern spectra
(x = 0 .. 127)
3.298
+/- 0.000
keV
singles
70 adu
eROSITA / TRoPIC hk070705.130 pattern spectra
(x = 0 .. 127)
3.289
+/- 0.000
keV
singles
130 adu
eROSITA / TRoPIC hk070705.190 pattern spectra
(x = 0 .. 127)
3.283
+/- 0.001
keV
singles
190 adu
photons / eV

# HK070705.011

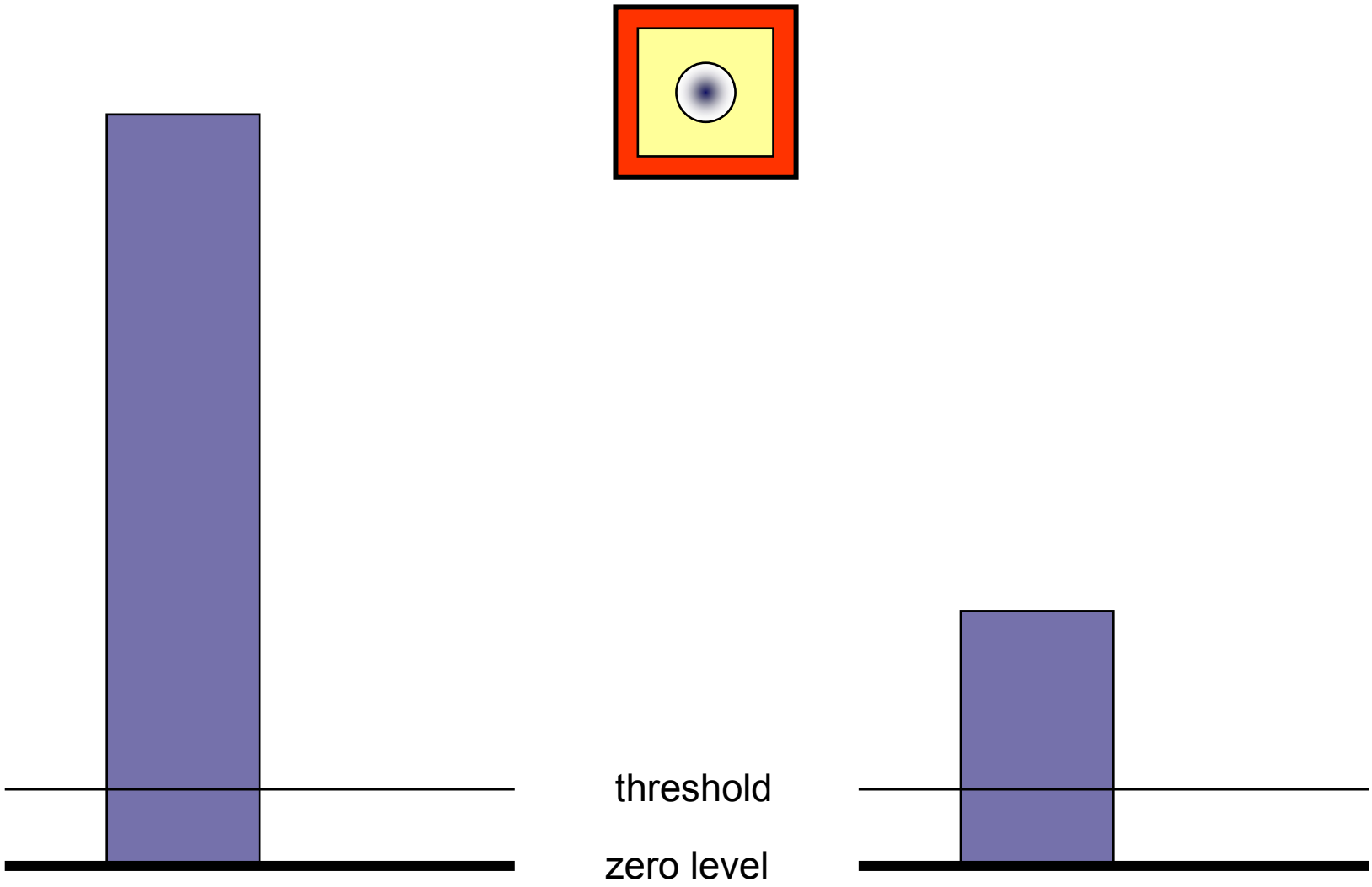


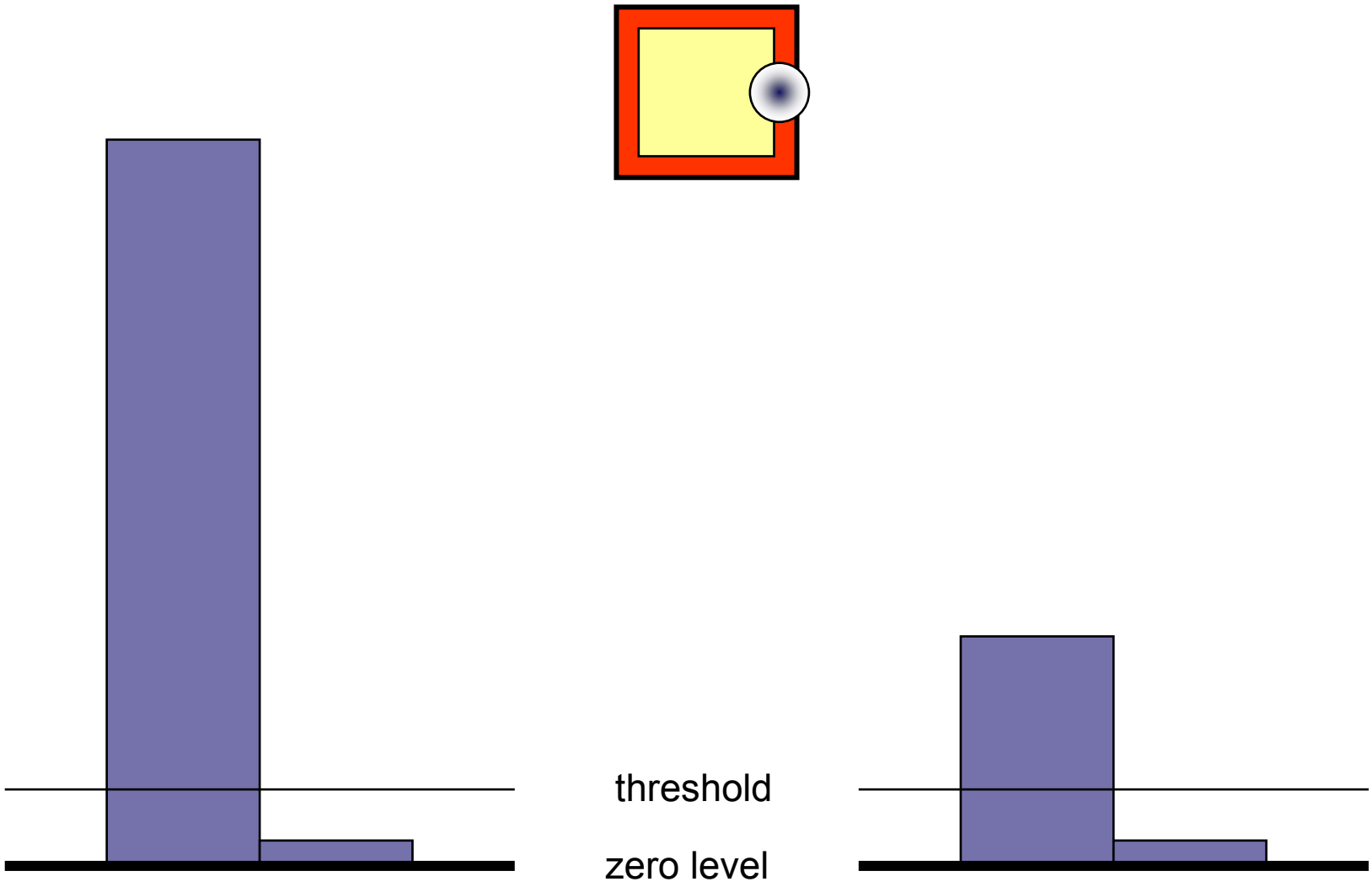



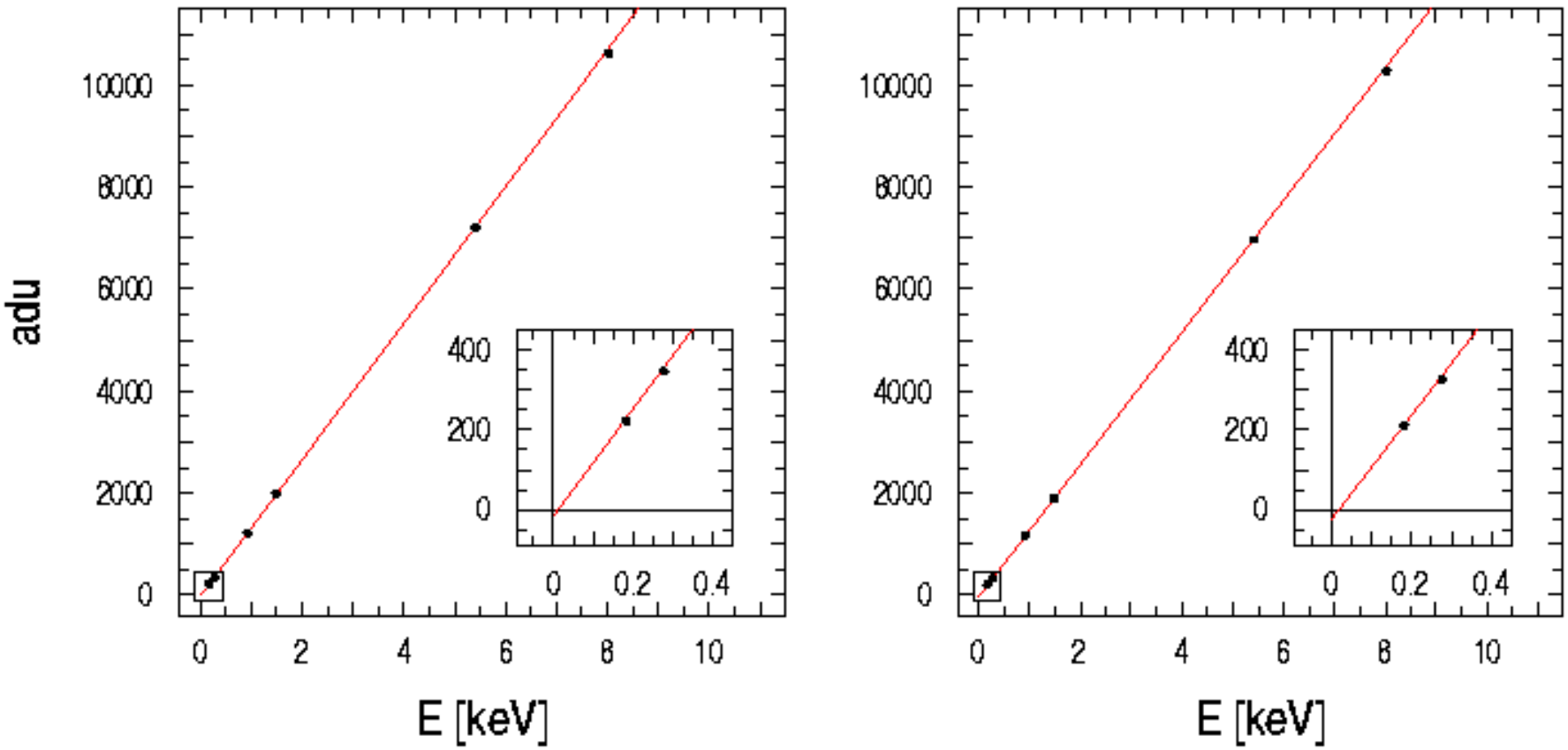
# Threshold Induced Charge Loss



# Threshold Induced Charge Loss



# eROSITA/TRoPIC Gain Correction

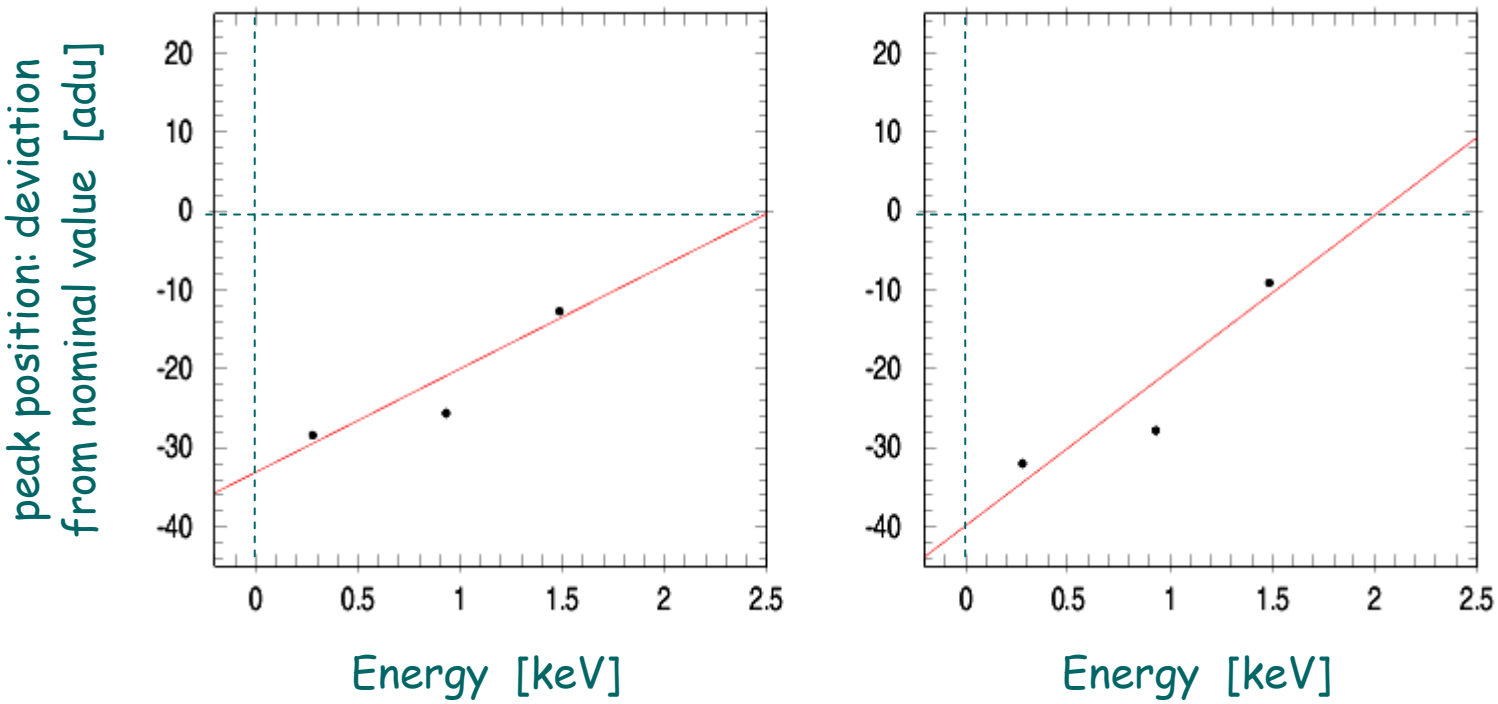



offset:

~ - 18 adu @ 0 eV

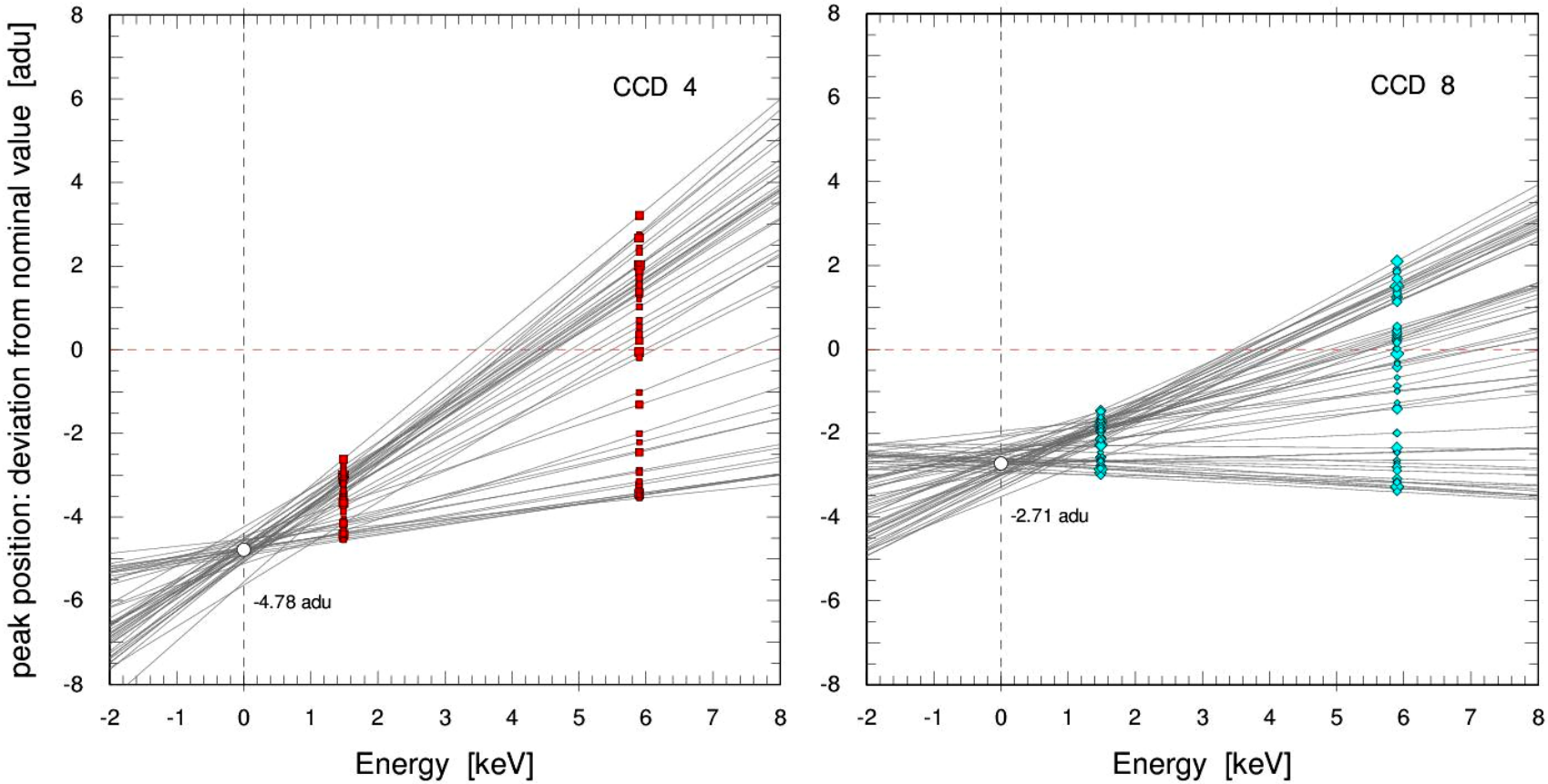
0 adu @ ~ 14 eV

# eROSITA / TRoPIC calibration

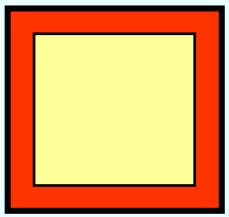


# XMM-Newton / EPIC pn

## deviations of the Al-K and Mn-$K_\alpha$ positions

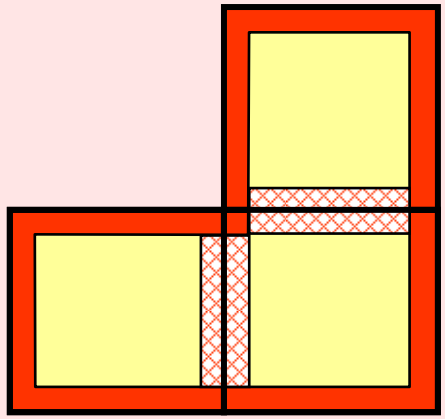


# Patterns, Borders, and Threshold Induced Charge Loss



**Single:**

4 borders

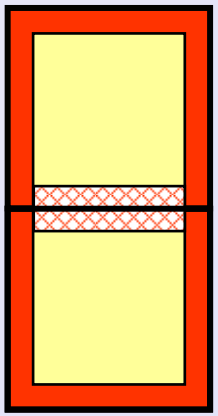


**Triple:**

8 borders

3 singles: 12 borders

→ border filling factor: 8/12

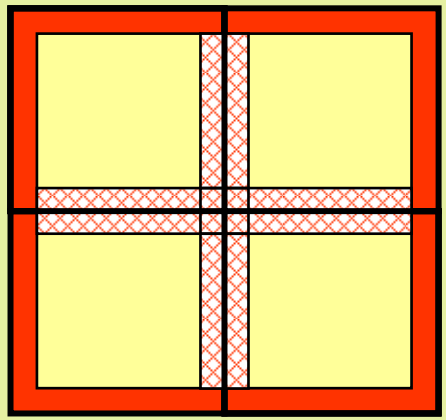


**Double:**

6 borders

2 singles: 8 borders

→ border filling factor: 6/8



**Quadruple:**

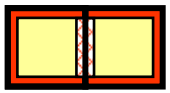
8 borders

4 singles: 16 borders

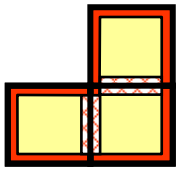
→ border filling factor: 8/16

# Patterns, Borders, and Threshold Induced Charge Loss

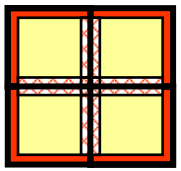
**Single:** 4 borders
correction for 4 borders
✓



**Double:** 6 borders
but: correction for 8 borders
→ overcorrection: -6/8 + 8/8 = +2/8 = +0.25



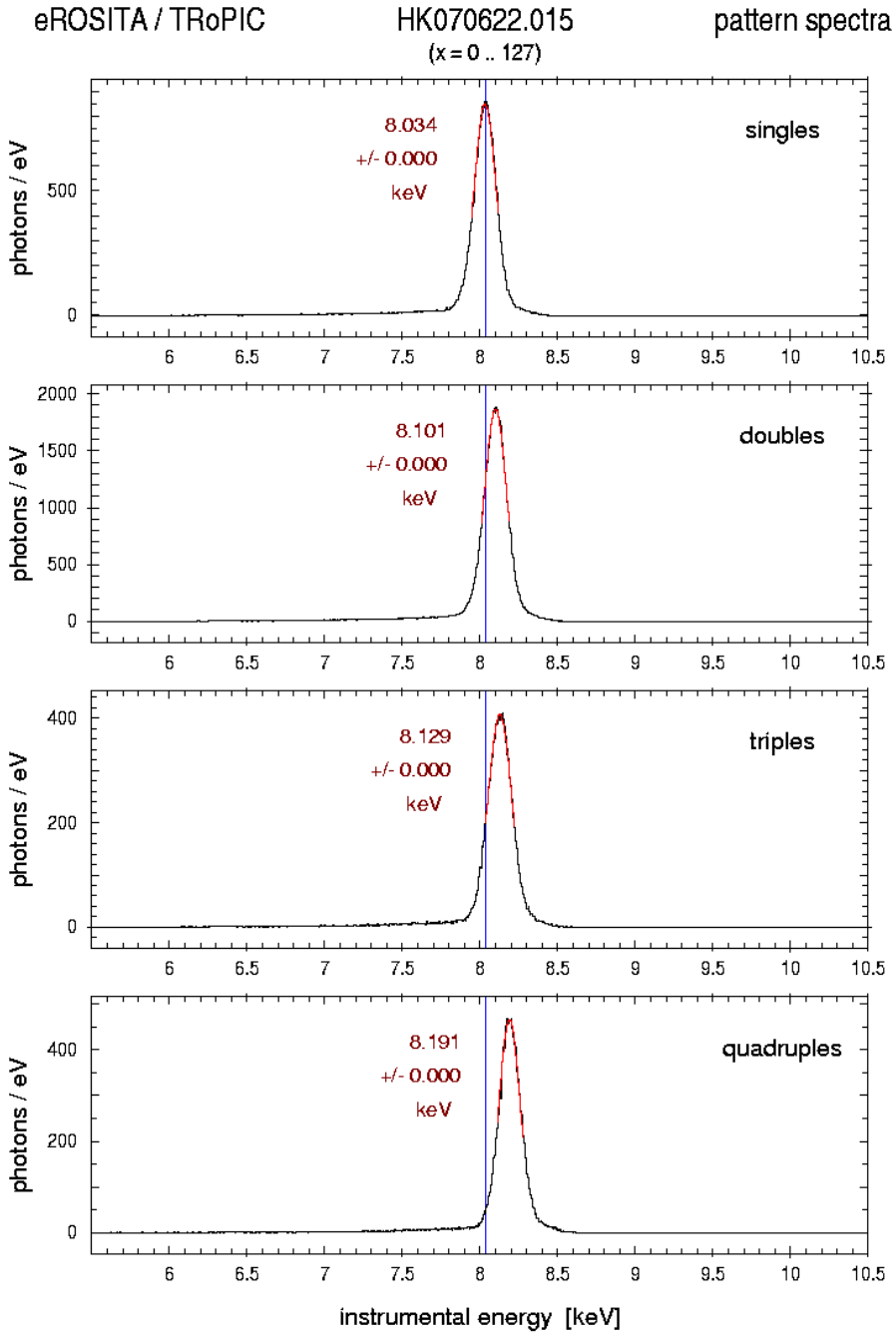
**Triple:** 8 borders
but: correction for 12 borders
→ overcorrection: -8/12 + 12/12 = +4/12 = +0.33



**Quadruple:** 8 borders
but: correction for 16 borders
→ overcorrection: -8/16 + 16/16 = +8/16 = +0.50

**→ predicted overcorrections:**

**d : t : q = 3 : 4 : 6**




## Cu-K:

doubles: +67 eV

triples: +95 eV

quadruples: +157 eV

**measured:**

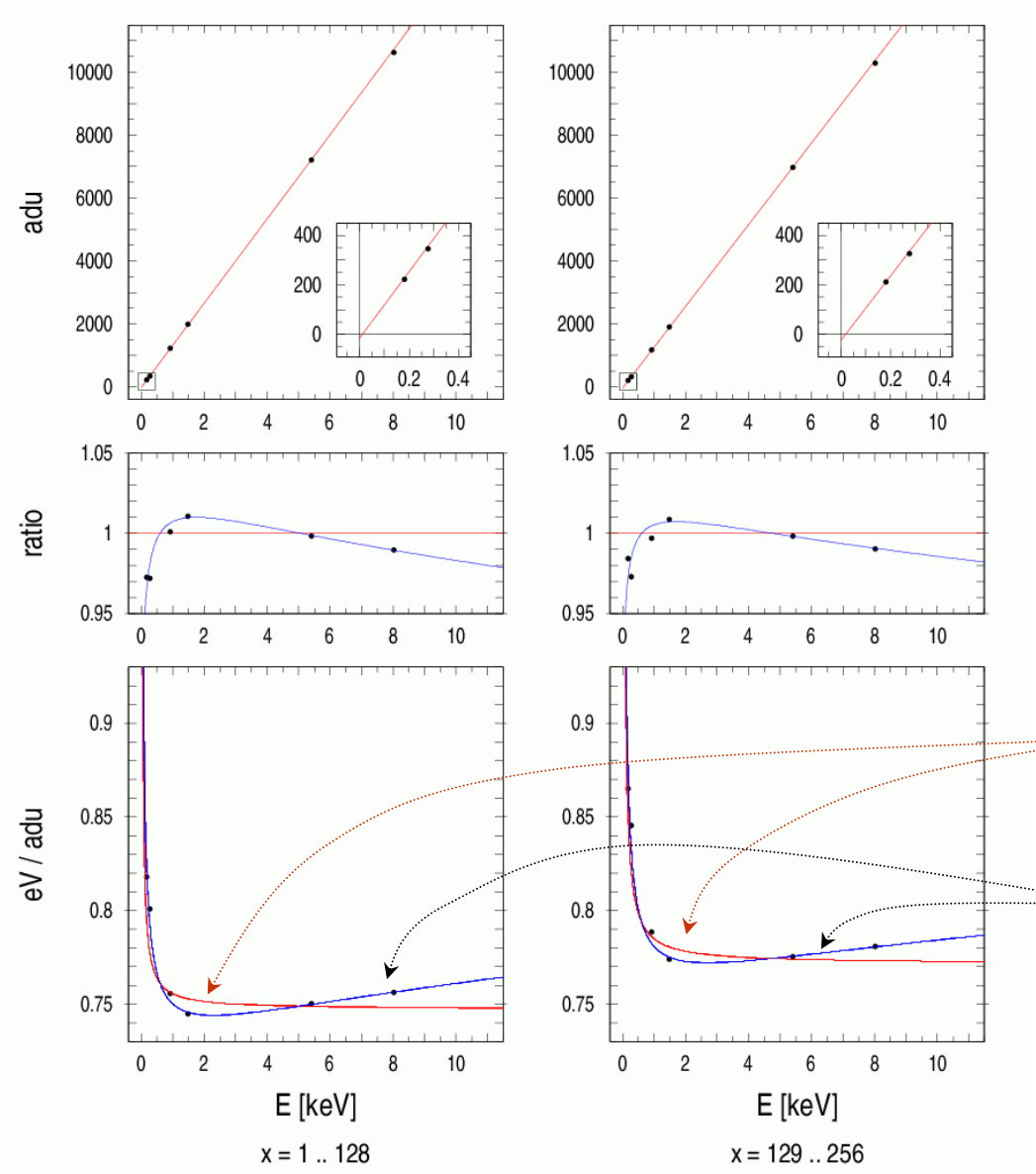
d : t : q = 2.6 : 3.6 : 6.0

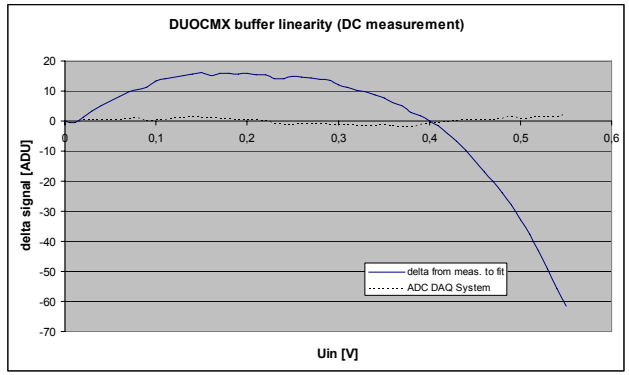
**predicted:**

d : t : q = 3 : 4 : 6

ratios somewhat different for lower energies: partial event effect ?

# eROSITA / TRoPIC calibration




nonlinear "electronic" gain

"cutoff" gain

"cutoff" gain + "electronic" gain

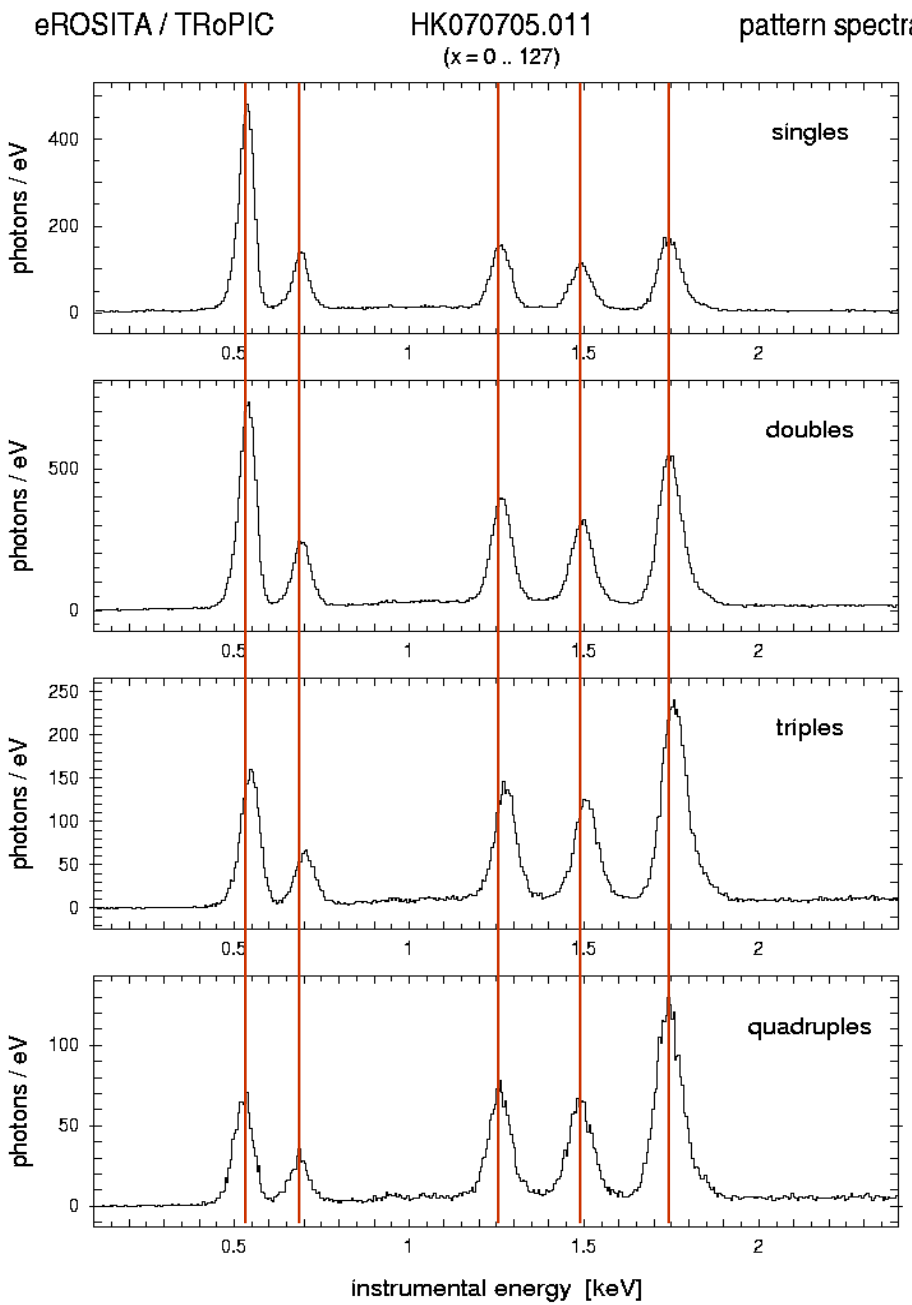
# eROSITA/TRoPIC Gain Correction

Implications for the gain correction algorithm for pn CCDs:

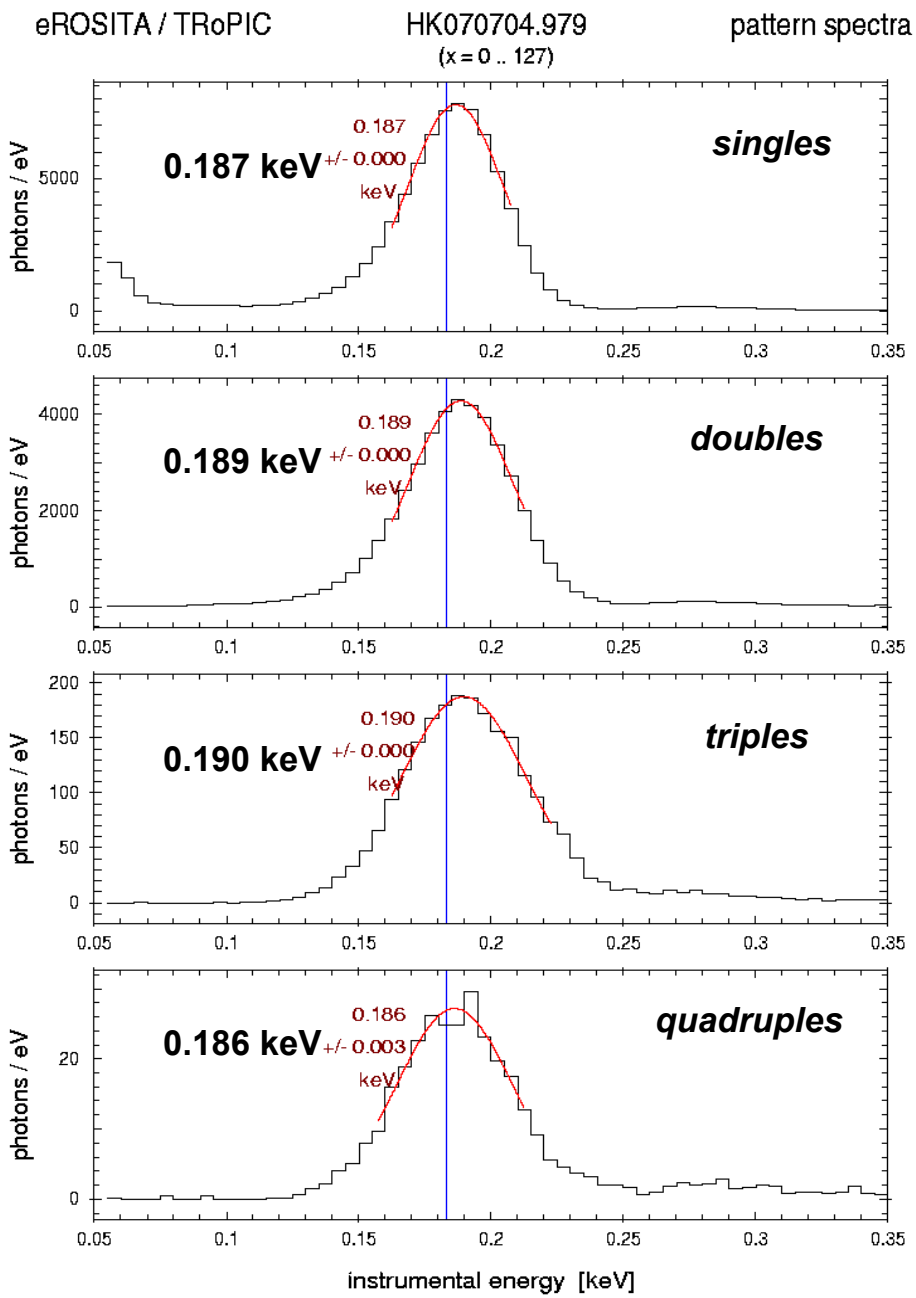
1. apply first the "electronic" gain correction to all events (i.e., singles and pattern components)
2. recombine the events to photons
3. apply then the "cutoff" gain correction (depending on energy and pattern size) to all photons in order to recover the lost charge and to linearize/adjust the energy scale

→ first results:

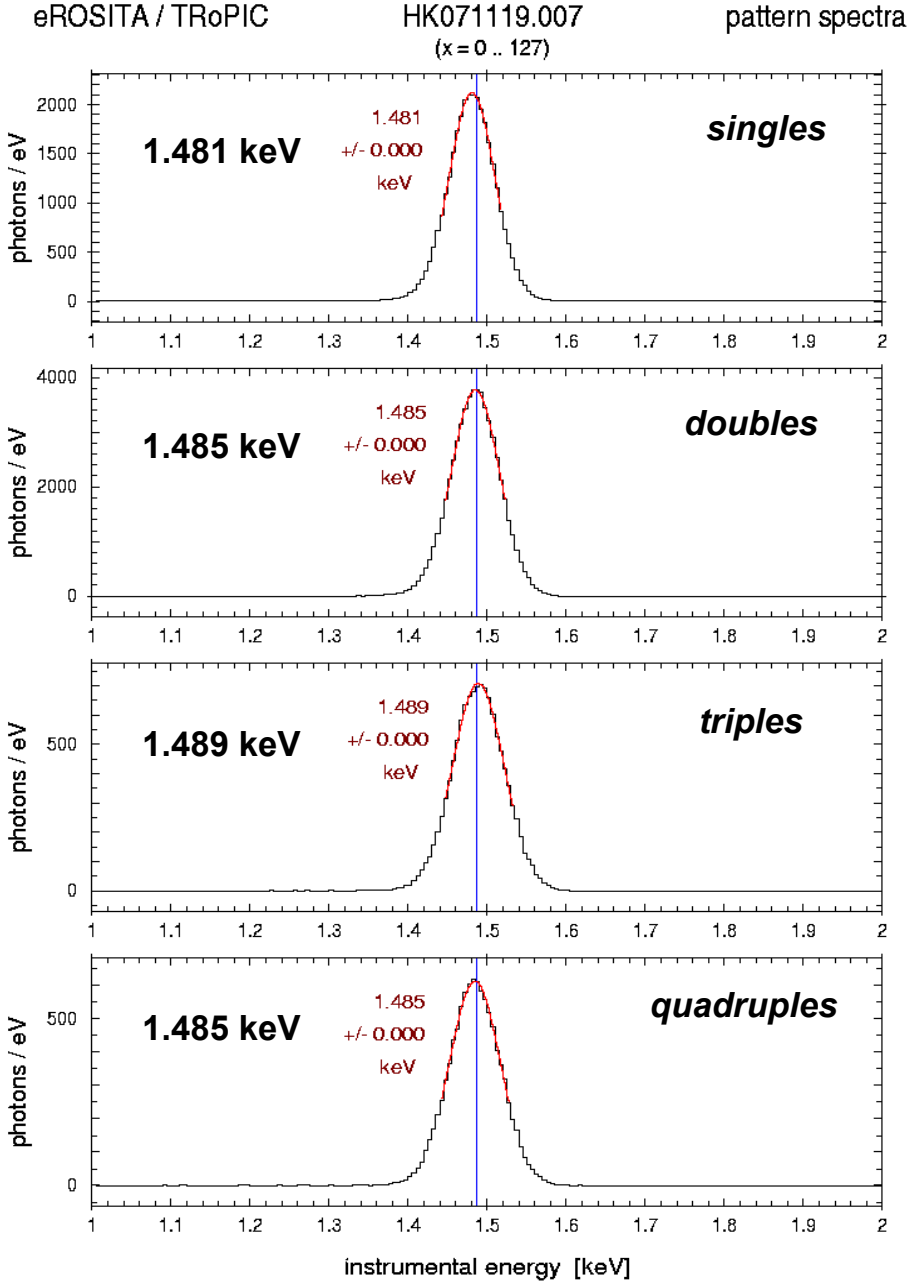
# Macor



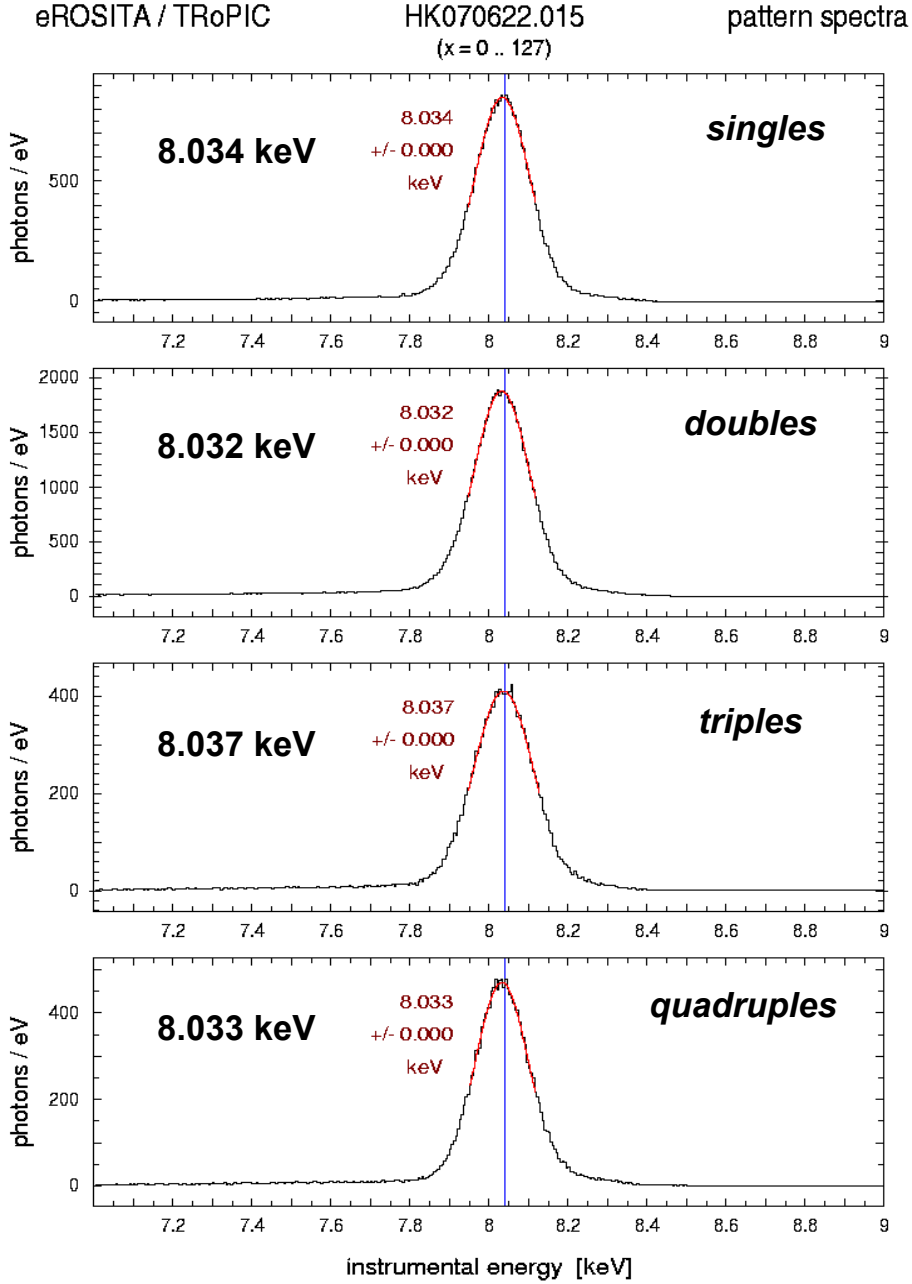

# B-K (0.183 keV)



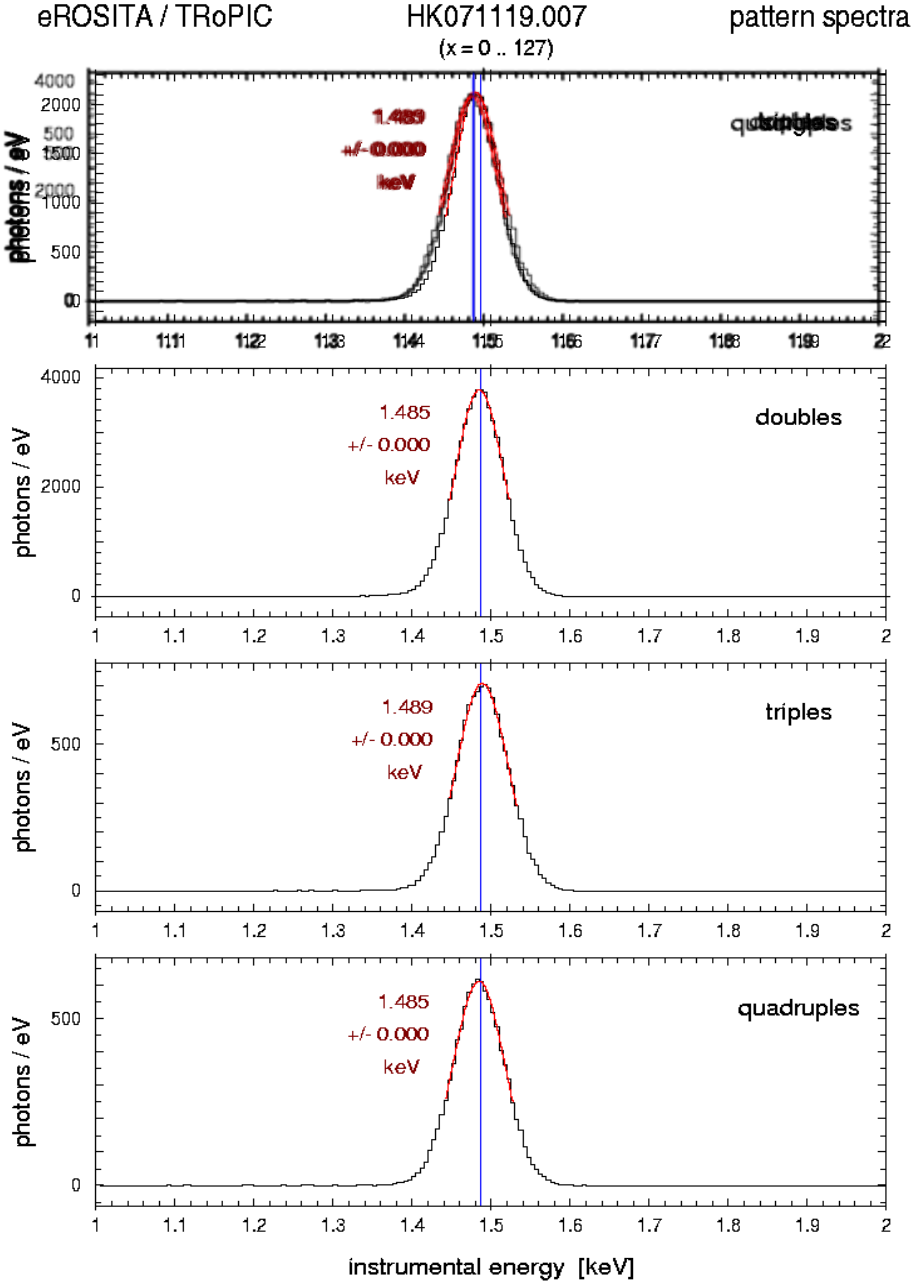
## Al-K (1.486 keV)



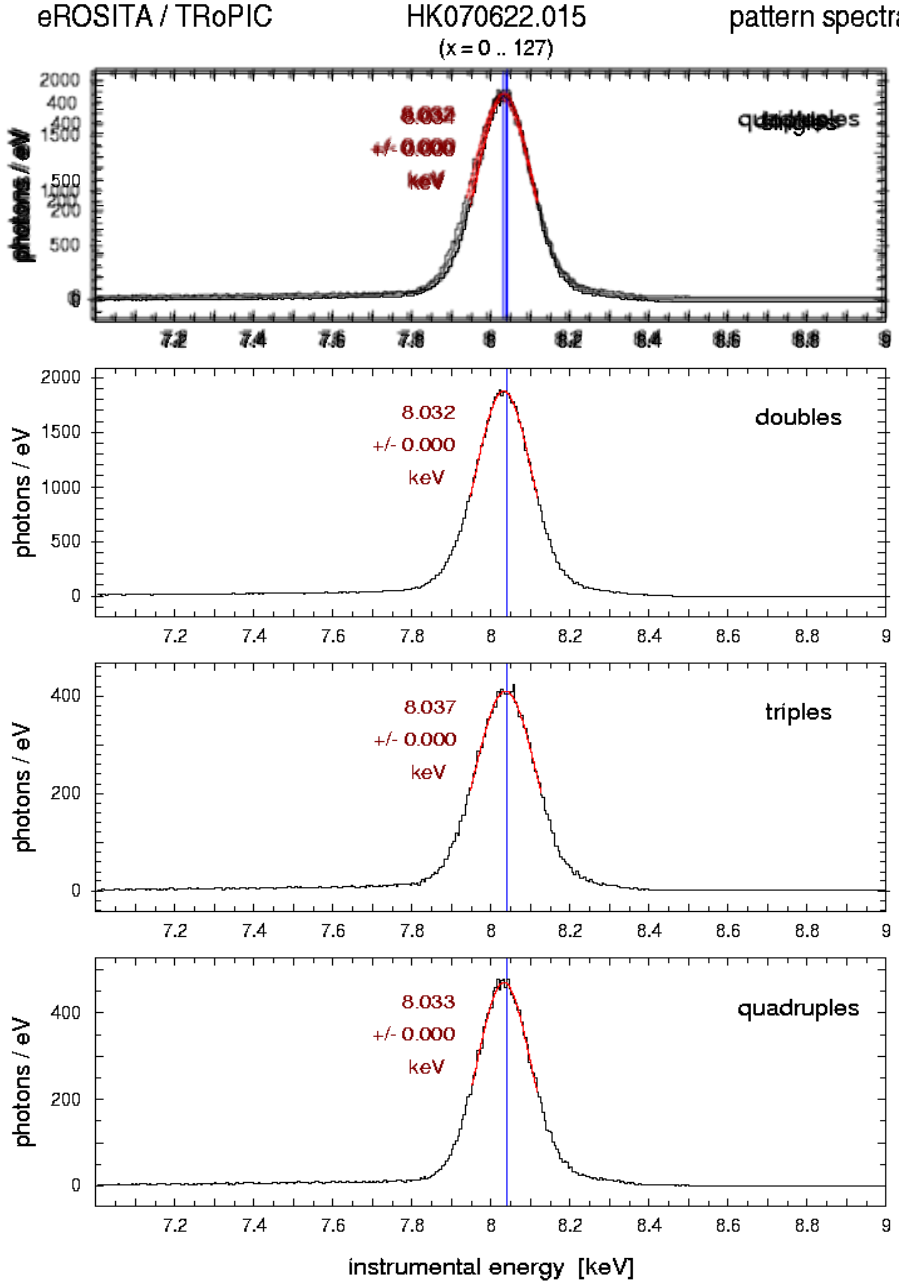

## Cu-K (8.040 keV)



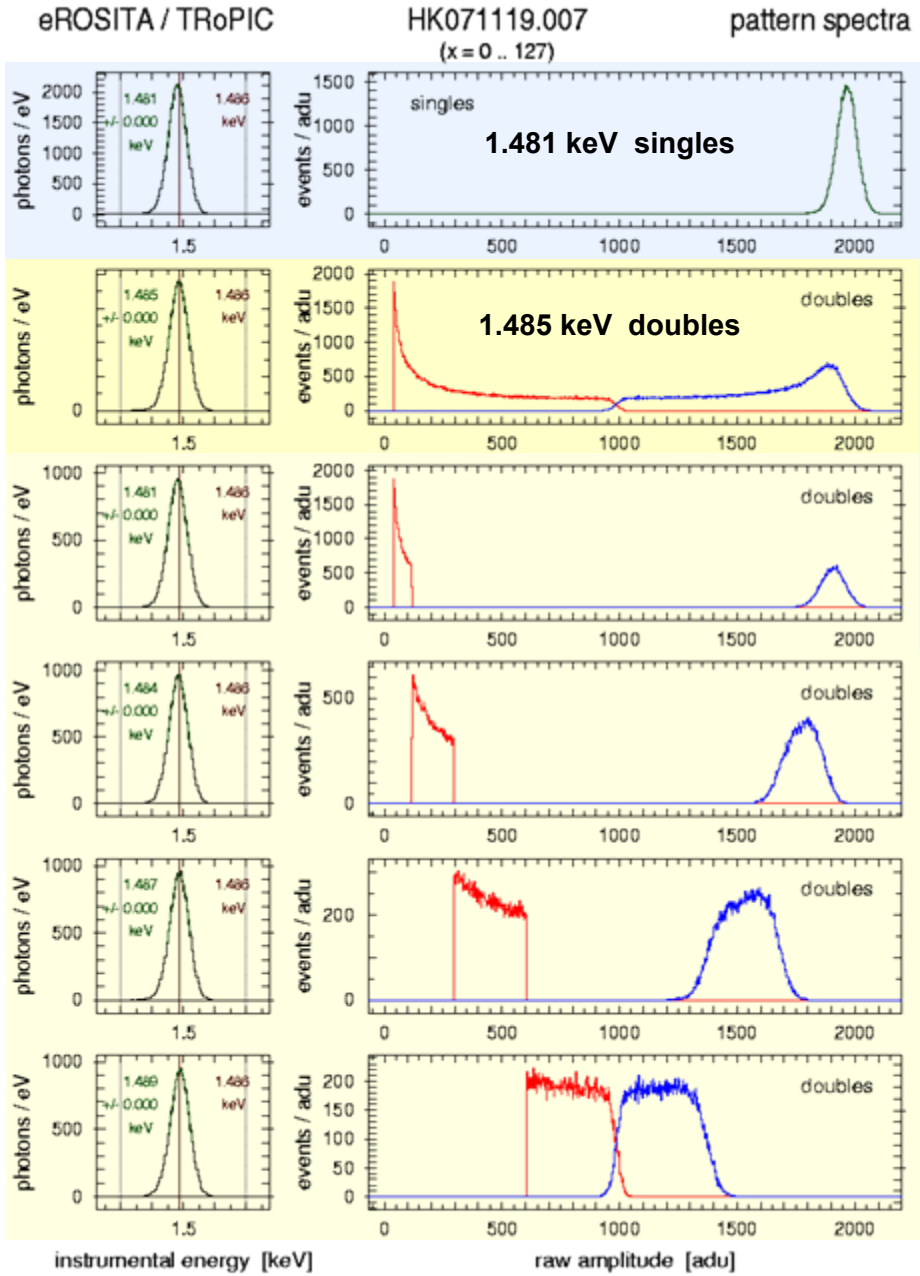
# Al-K (1.486 keV)

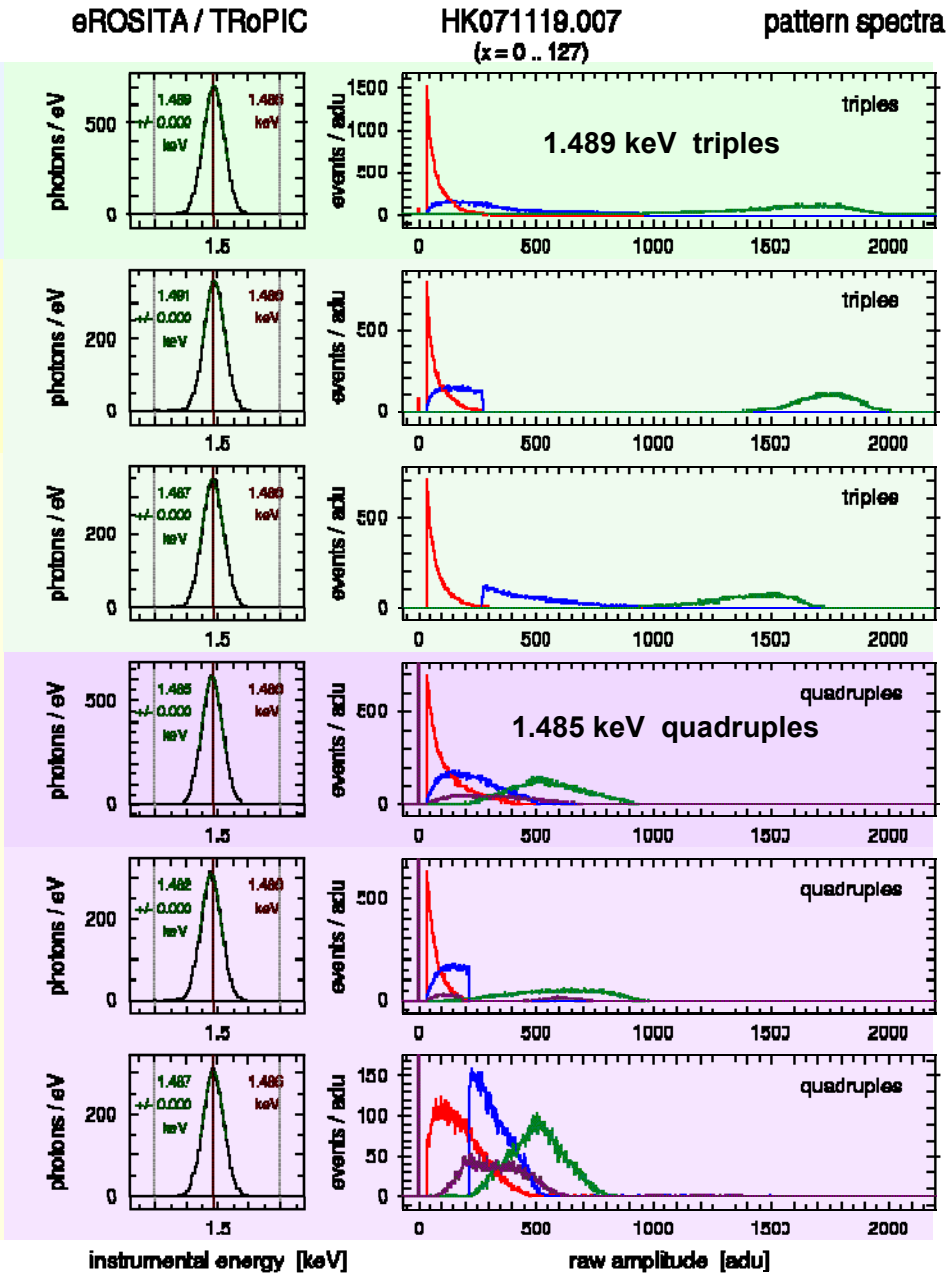


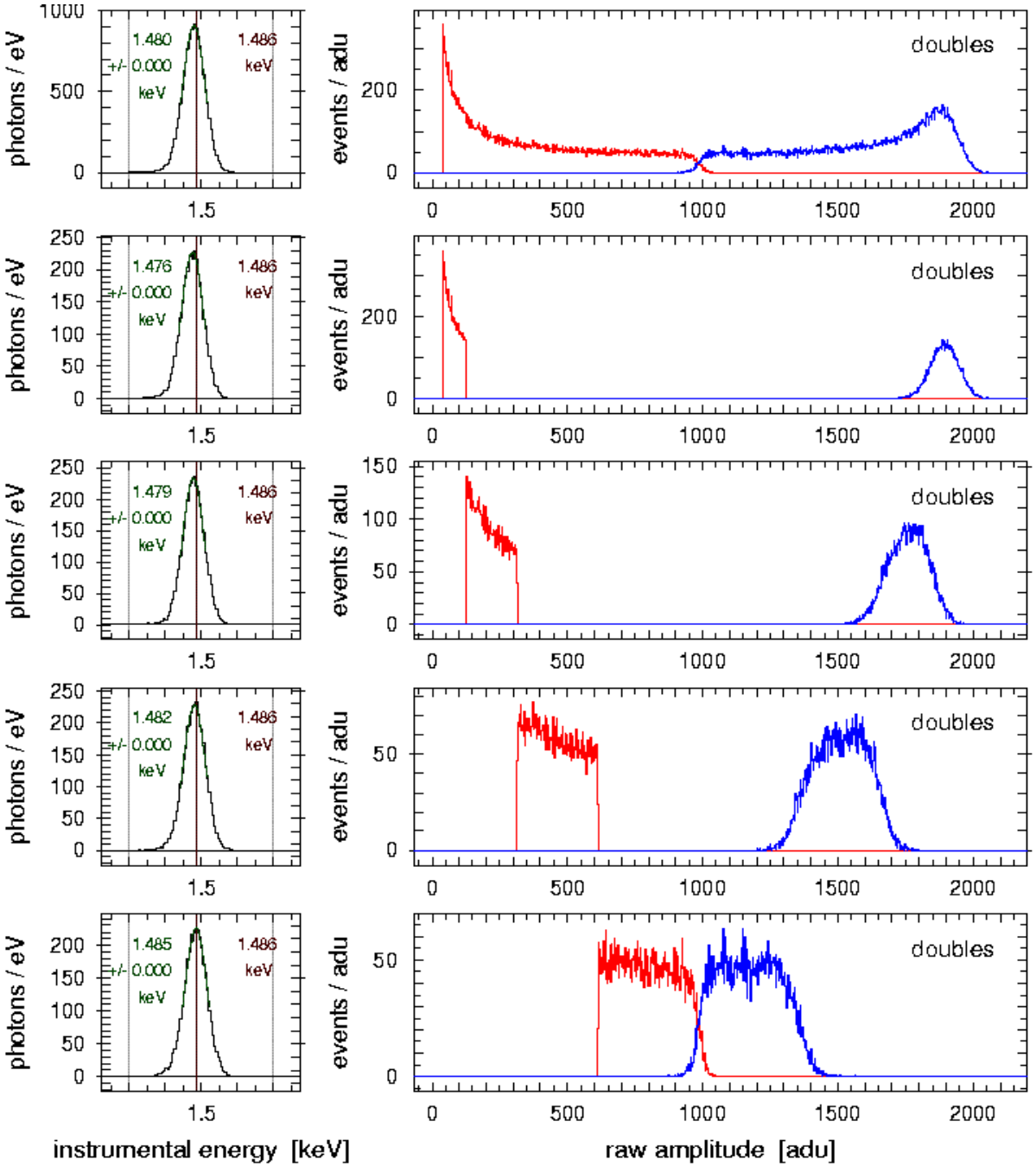

# Cu-K (8.040 keV)



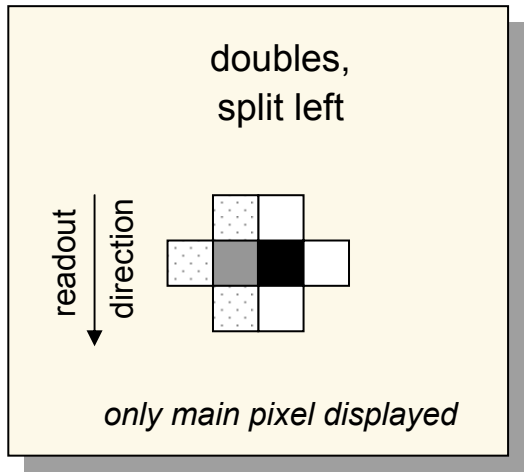
# Al-K (1.486 keV)


eROSITA / TRoPIC
HK071119.007
(x = 0 .. 127)
pattern spectra
photons / eV
events / adu
singles
1.481 keV singles
doubles
1.485 keV doubles
1.484 keV doubles
1.487 keV doubles
1.489 keV doubles
instrumental energy [keV]
raw amplitude [adu]


eROSITA / TRoPIC
HK071119.007
(x = 0 .. 127)
pattern spectra
photons / eV
events / adu
triples
1.489 keV triples
triples
triples
quadruples
1.485 keV quadruples
quadruples
quadruples
instrumental energy [keV]
raw amplitude [adu]

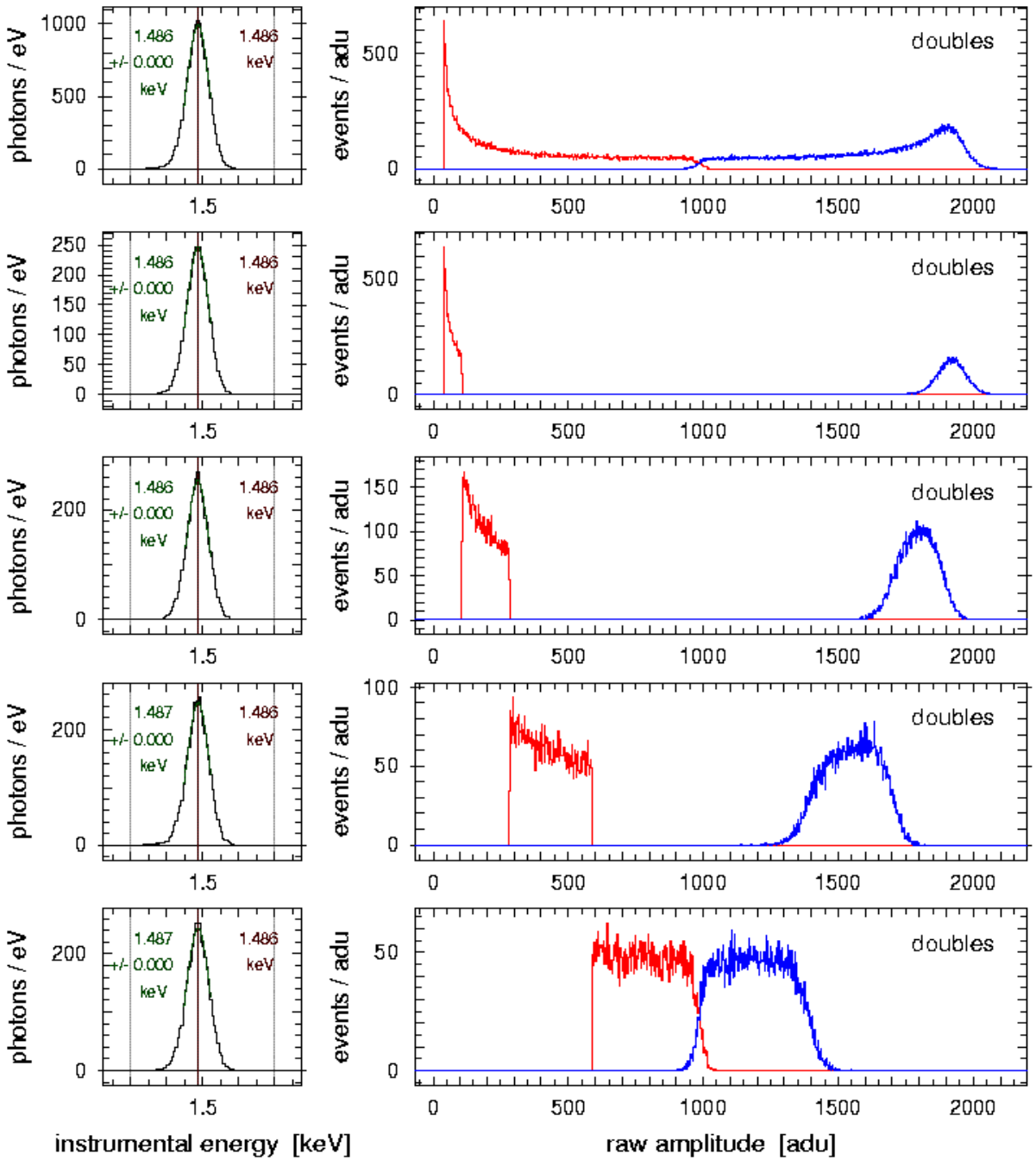



**Al-K**

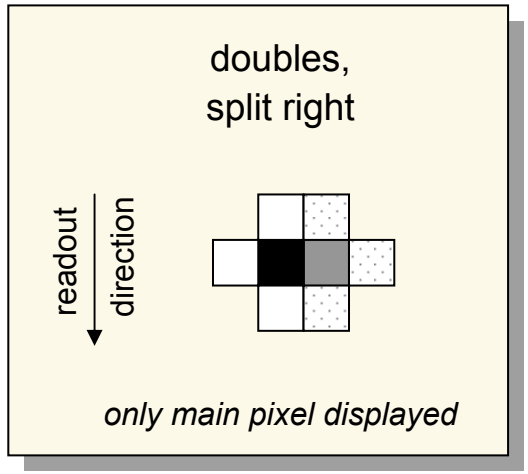



1.480 keV

(- 6 eV)

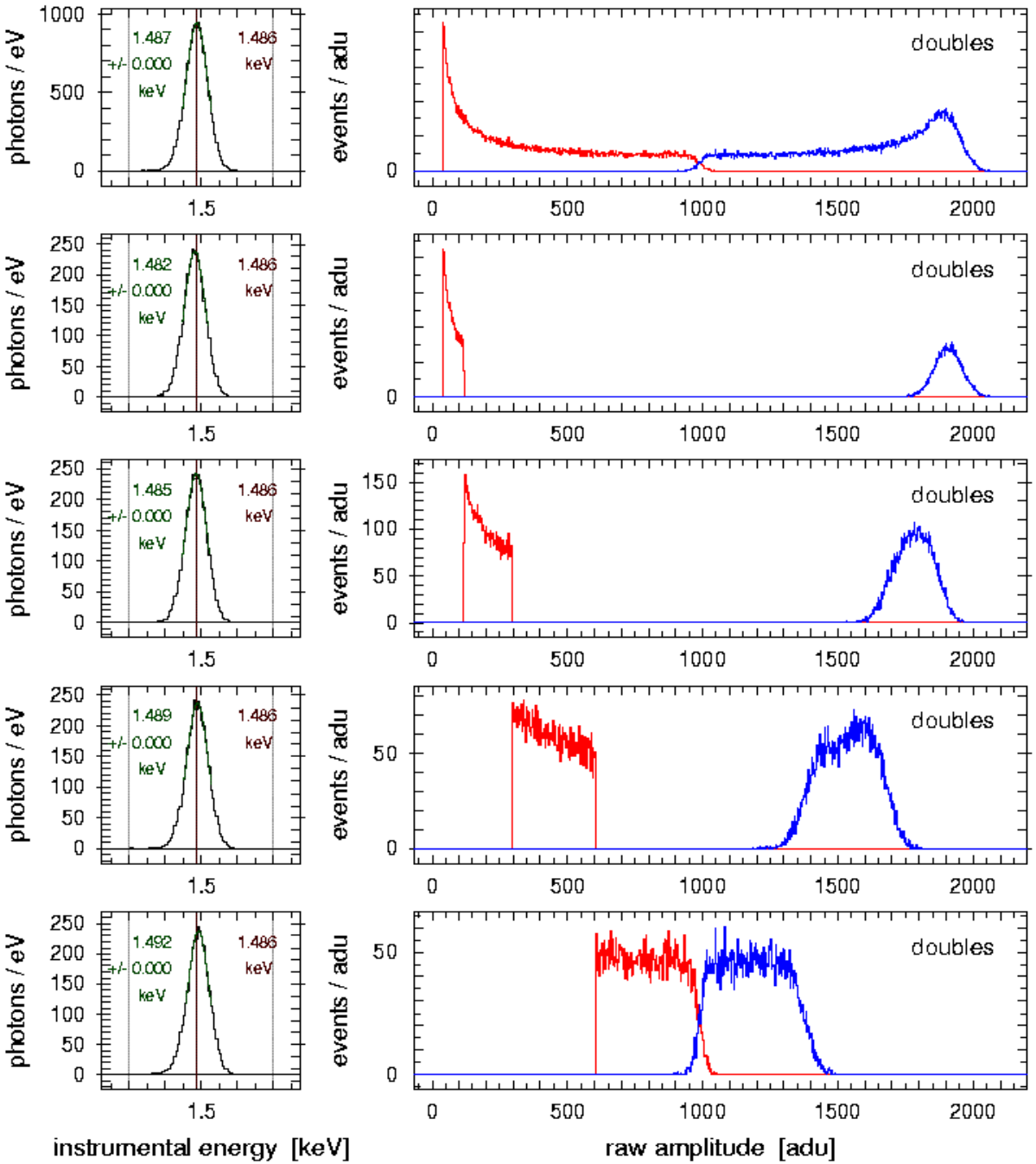



## Al-K




1.486 keV

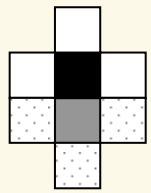
(+ 0 eV)




**Al-K**

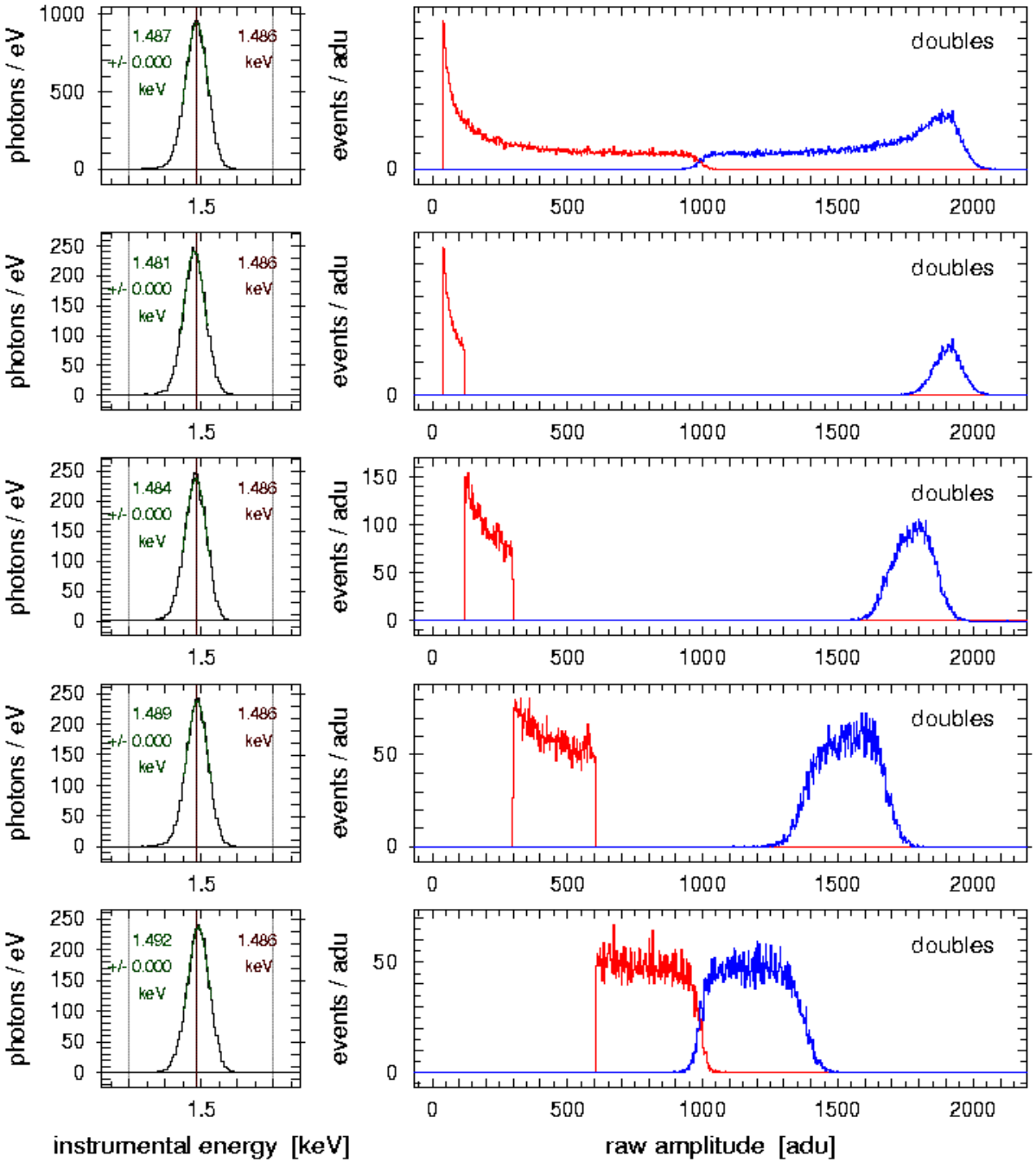
doubles,
split forward

readout direction

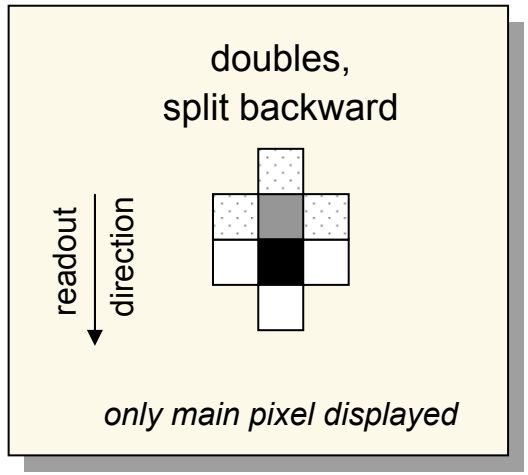


*only main pixel displayed*

1.487 keV
(+1 eV)

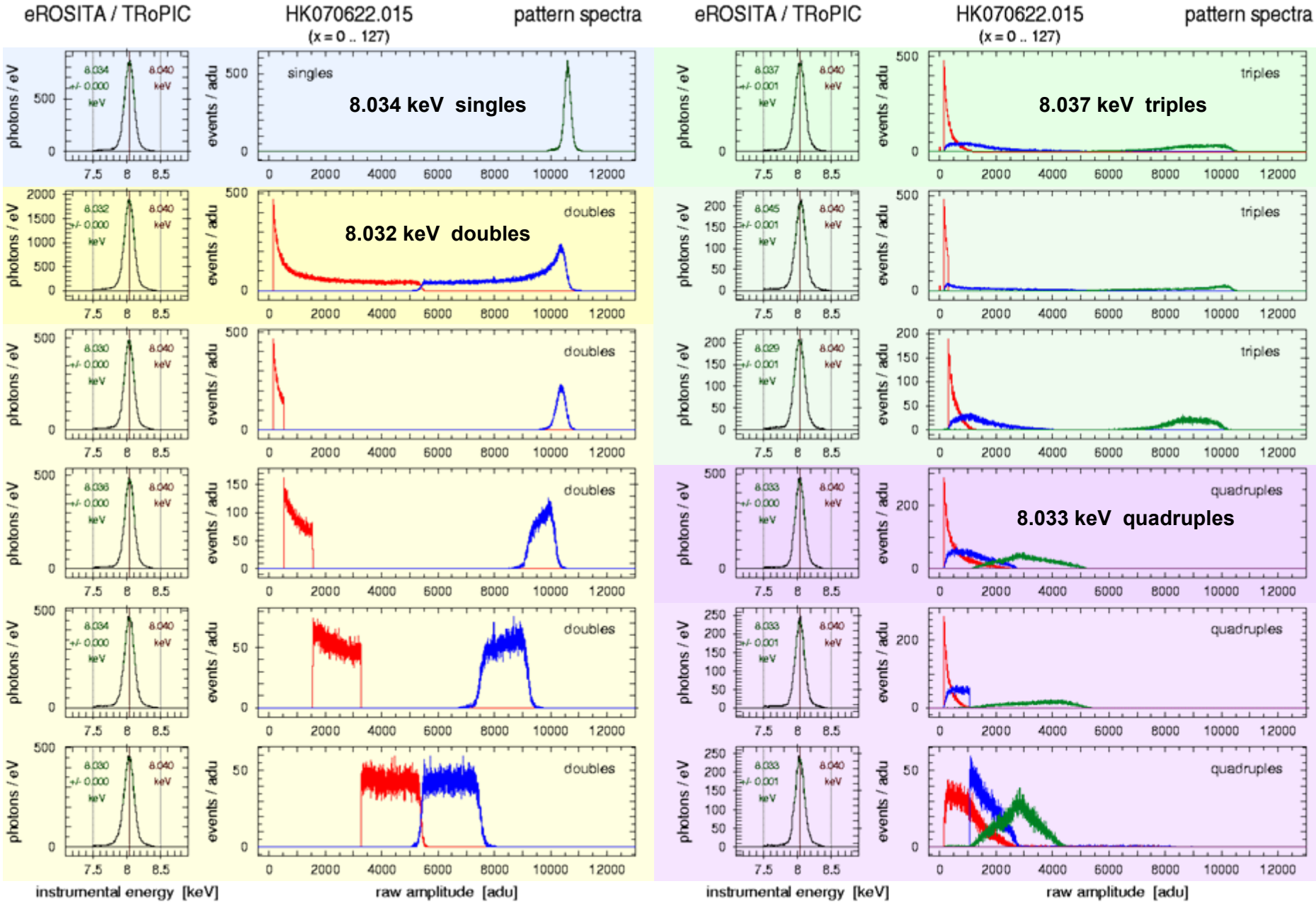


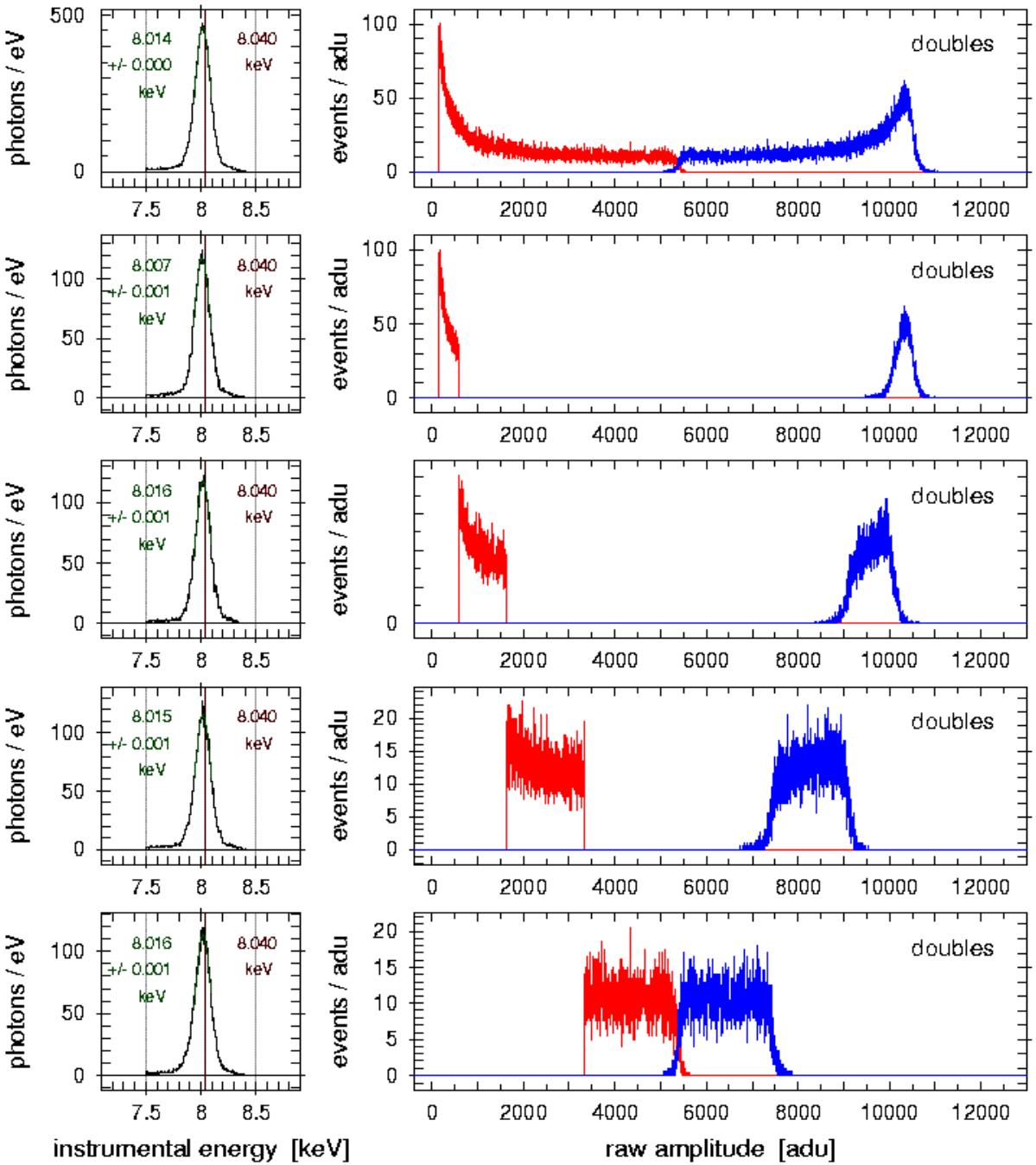

## Al-K



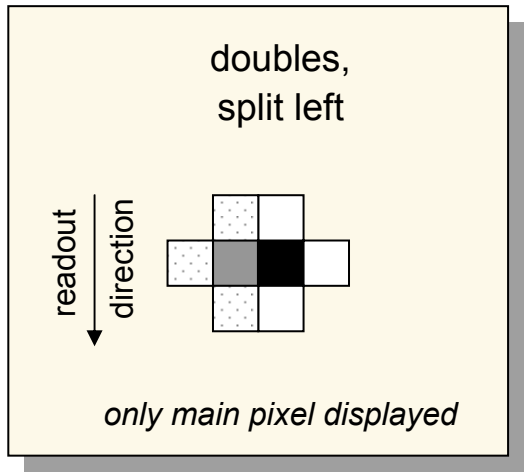

1.487 keV
(+1 eV)

# Cu-K


eROSITA / TRoPIC
HK070622.015
(x = 0 .. 127)
pattern spectra
eROSITA / TRoPIC
HK070622.015
(x = 0 .. 127)
pattern spectra
photons / eV
events / adu
8.034 +/- 0.000 keV
8.040 keV
singles
8.034 keV singles
8.037 +/- 0.001 keV
triples
8.037 keV triples
8.032 +/- 0.000 keV
doubles
8.032 keV doubles
8.045 +/- 0.001 keV
triples
8.030 +/- 0.000 keV
doubles
8.029 +/- 0.001 keV
triples
8.036 +/- 0.000 keV
doubles
8.033 +/- 0.000 keV
quadruples
8.033 keV quadruples
8.034 +/- 0.000 keV
doubles
8.033 +/- 0.001 keV
quadruples
8.030 +/- 0.000 keV
doubles
8.033 +/- 0.001 keV
quadruples
instrumental energy [keV]
raw amplitude [adu]
instrumental energy [keV]
raw amplitude [adu]

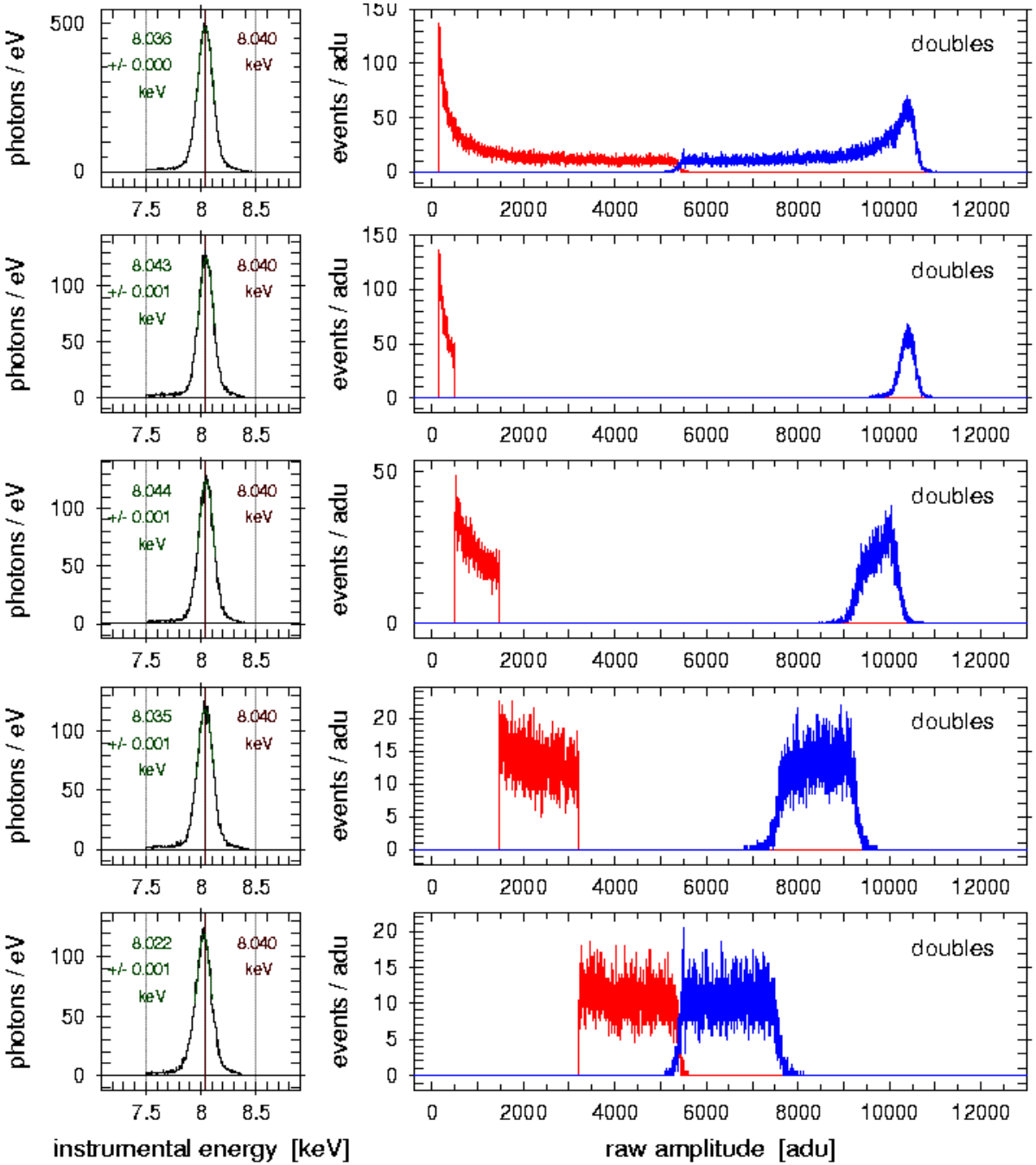



**Cu-K**




8.014 keV

(-26 eV)



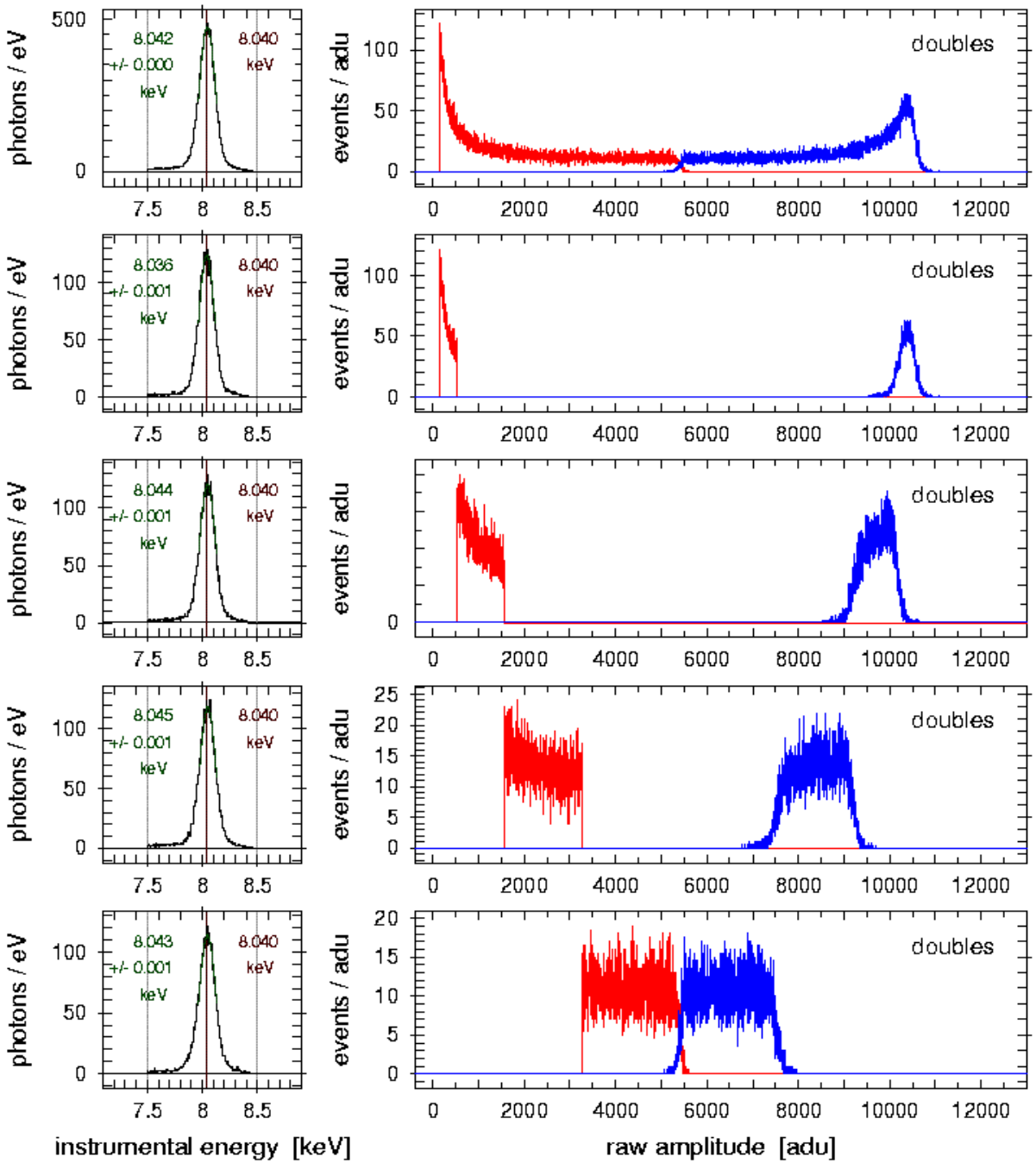

**Cu-K**

doubles,
split right

readout direction

*only main pixel displayed*

8.036 keV
(-4 eV)



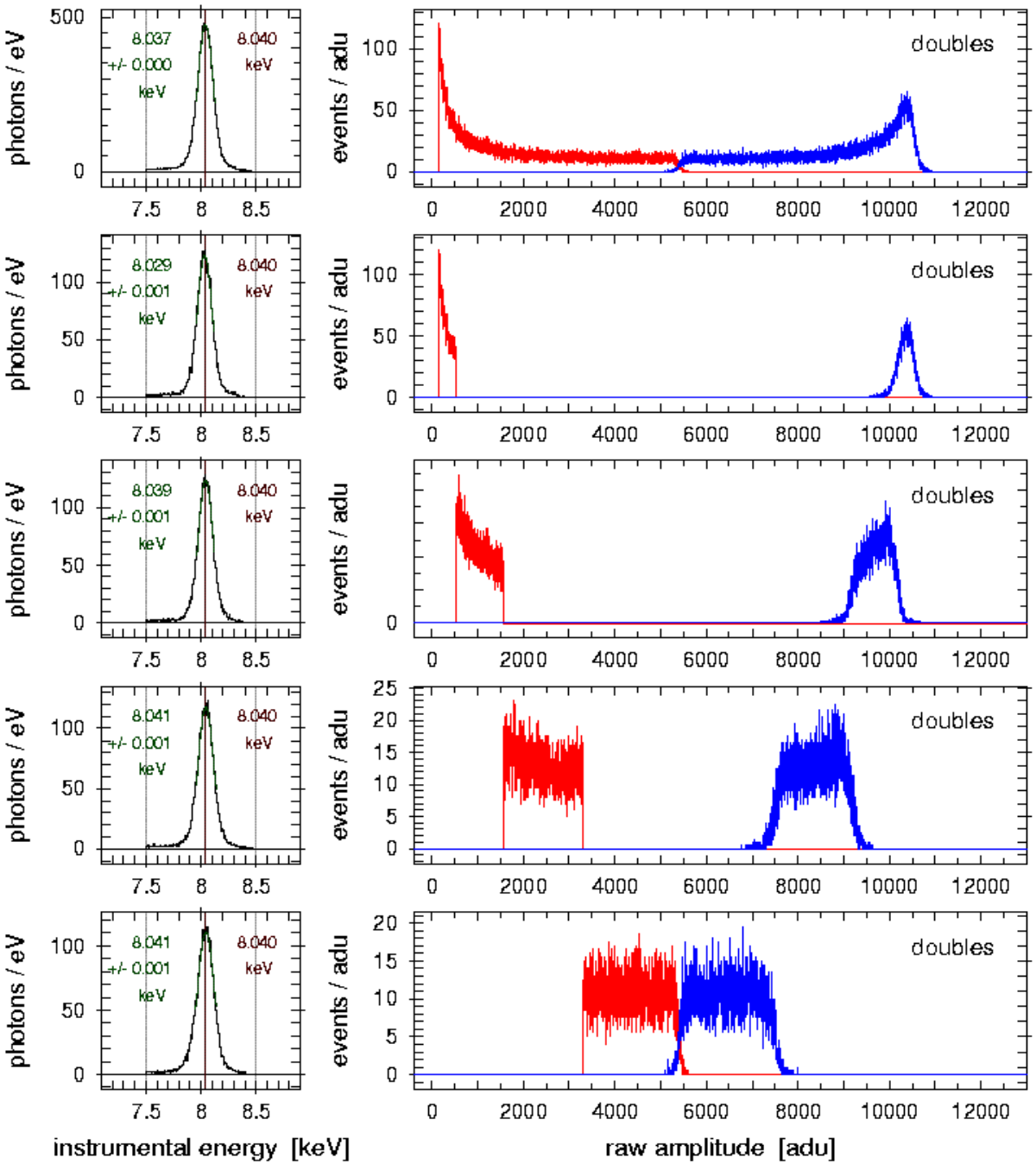

## Cu-K

doubles,
split forward

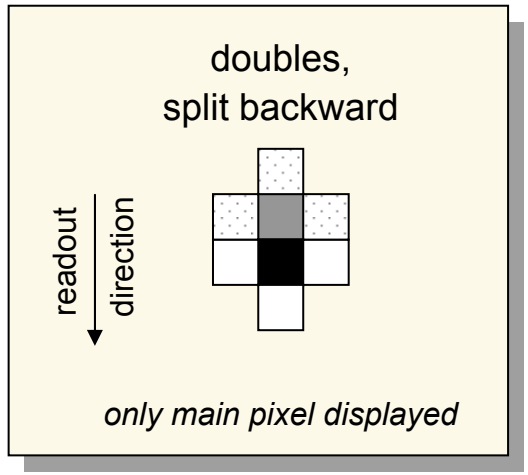
readout direction

*only main pixel displayed*

8.042 keV
(+2 eV)




## Cu-K




8.037 keV

(-3 eV)