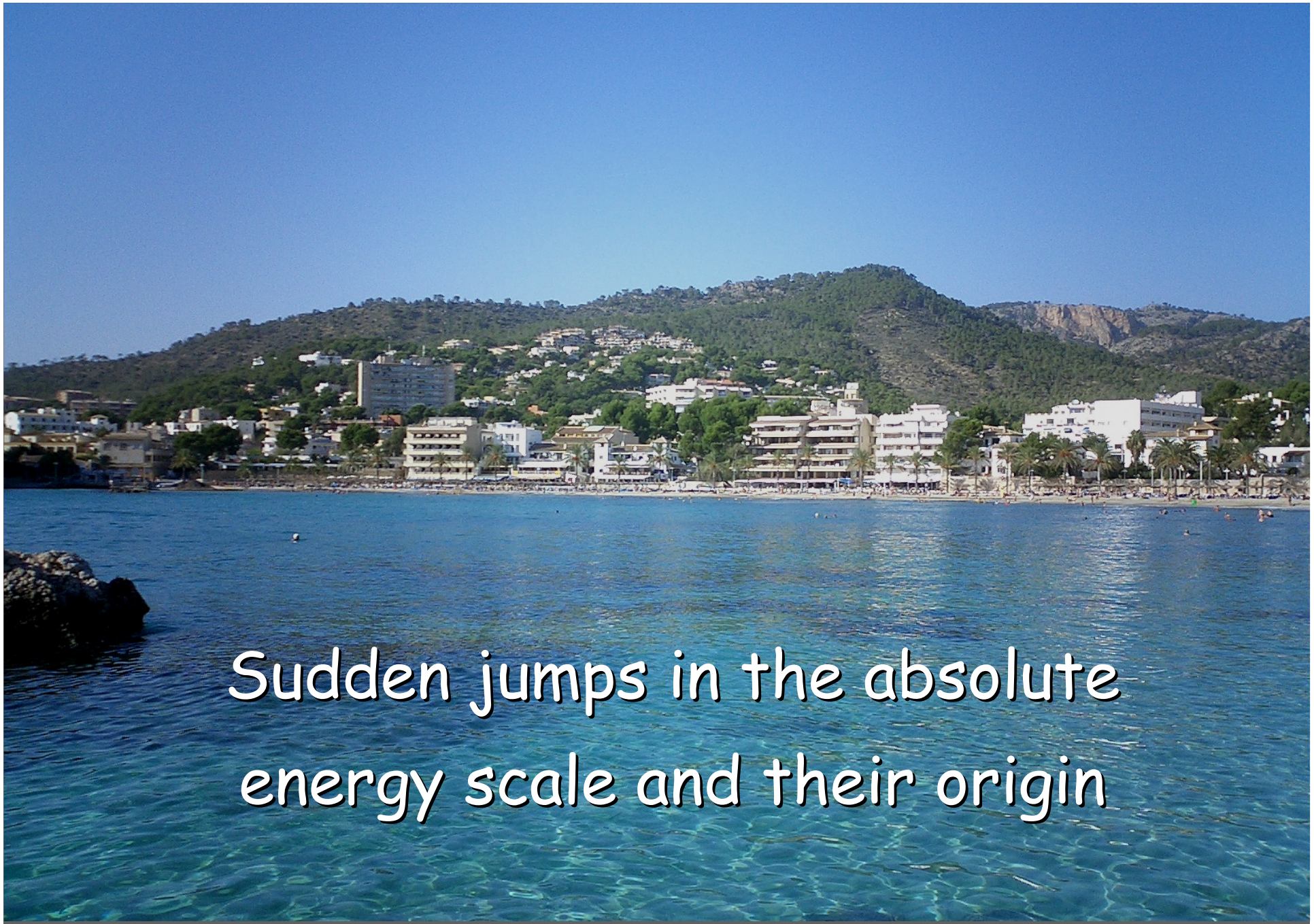
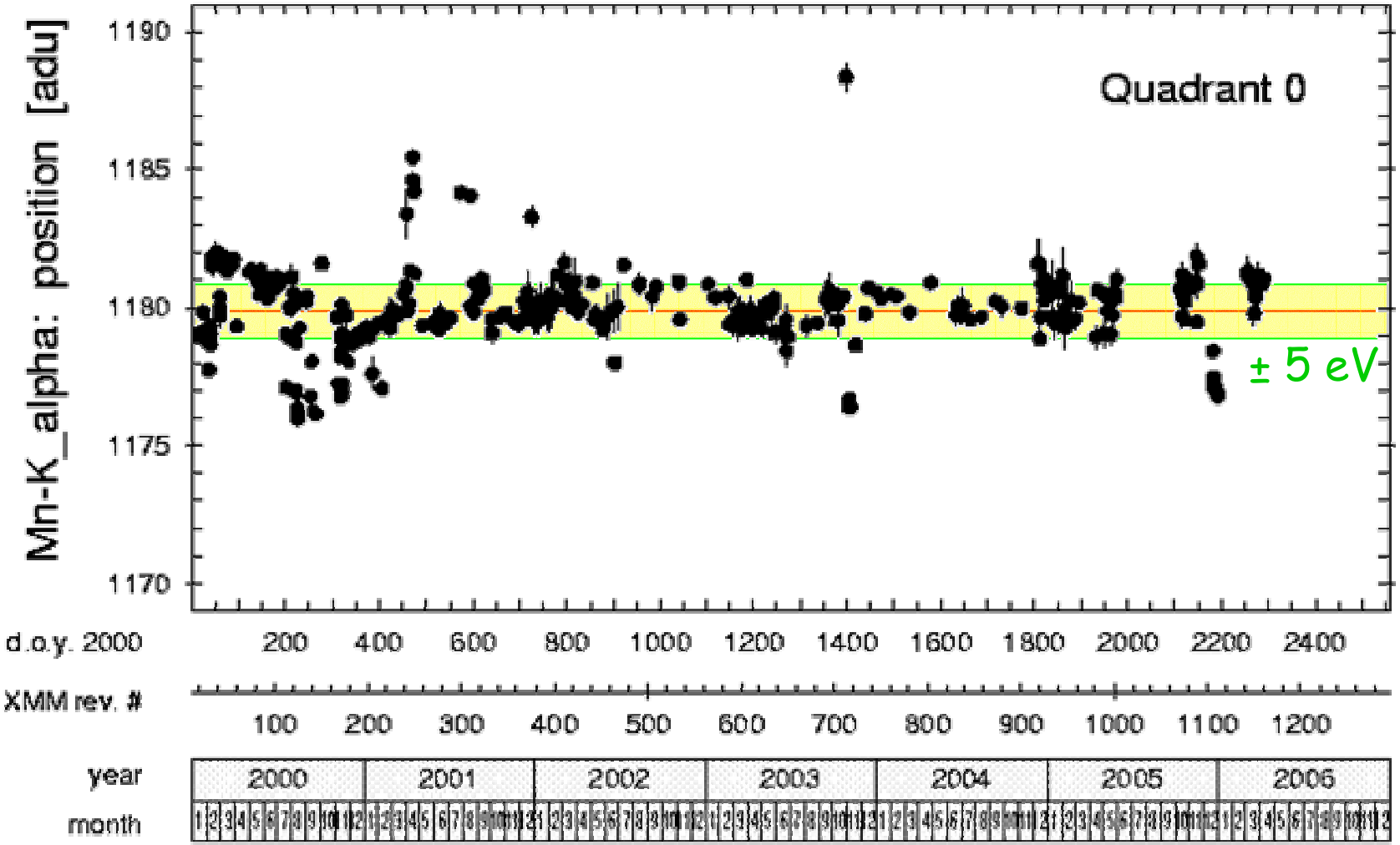


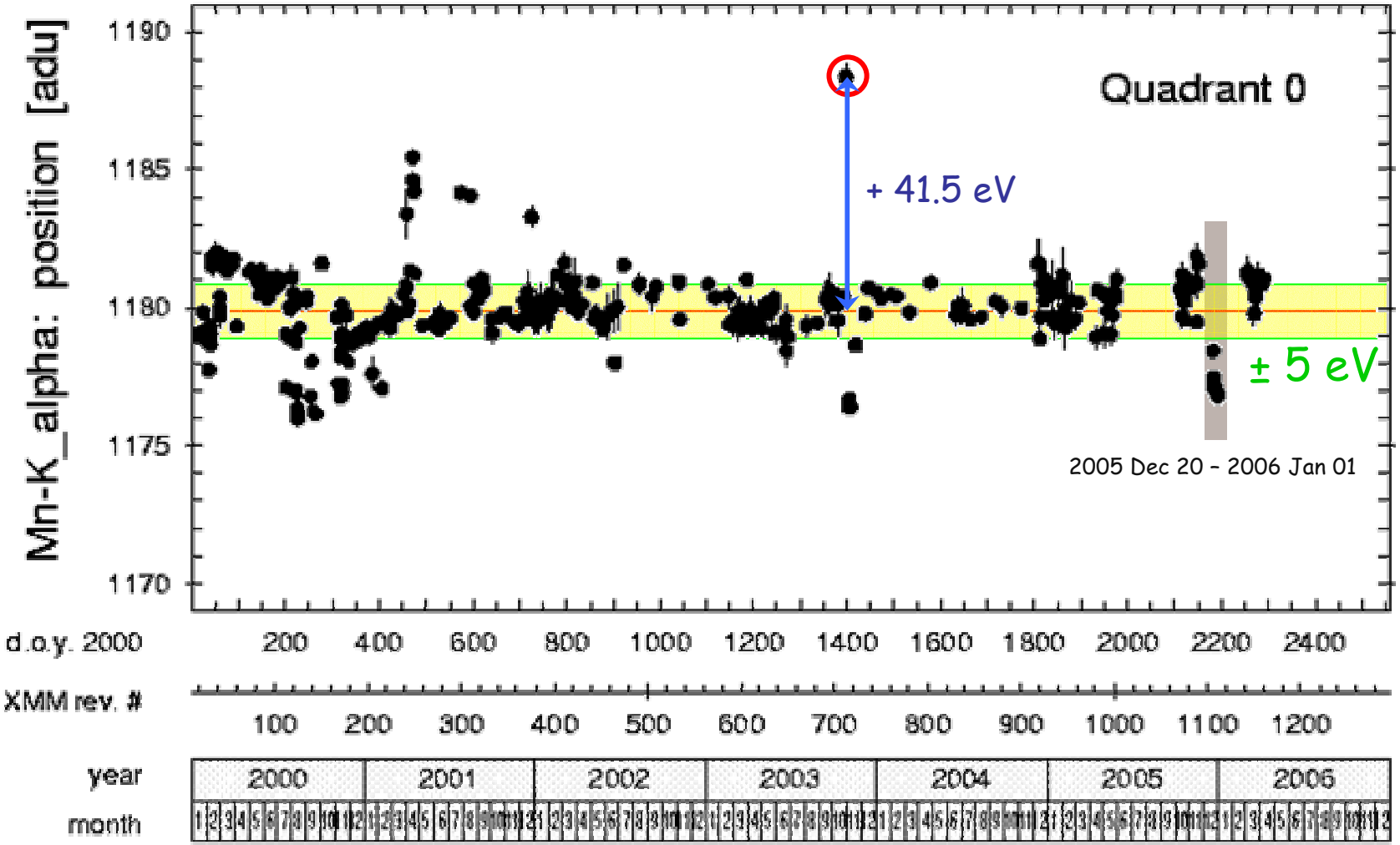
Sudden jumps in the absolute energy scale and their origin

FF Mn-K Pos Quadrant 0

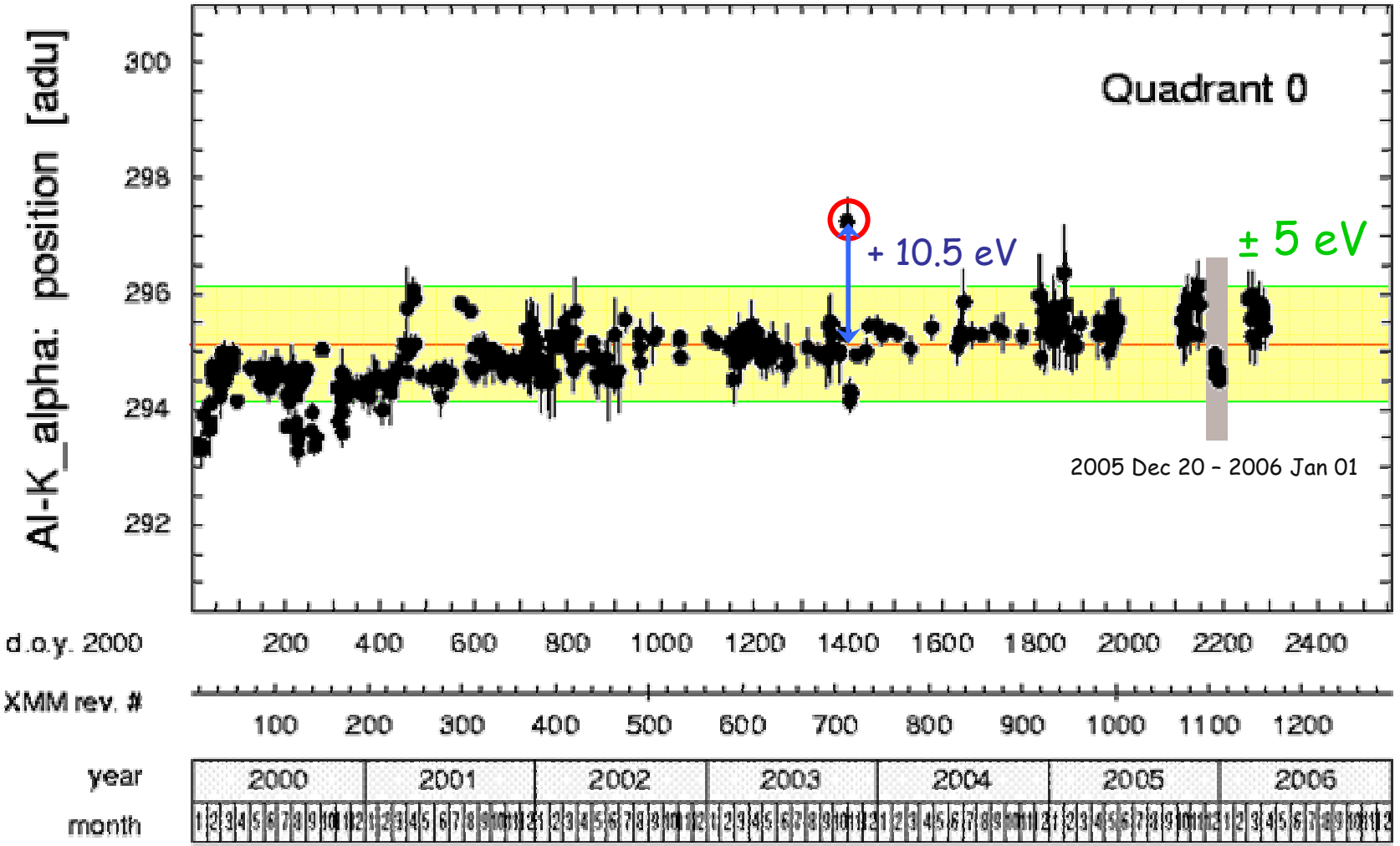


Effect of the particle background

FF Mn-K Pos Quadrant 0



FF AL-K Pos Quadrant 0

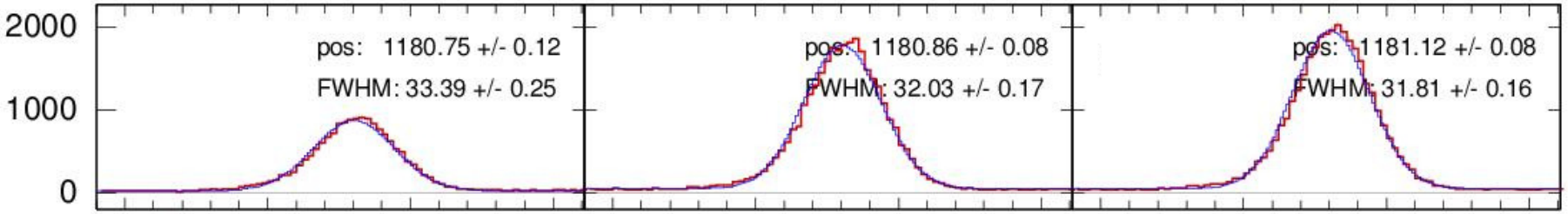


Al-K: 1.486 keV, +10.5 eV → +0.707%

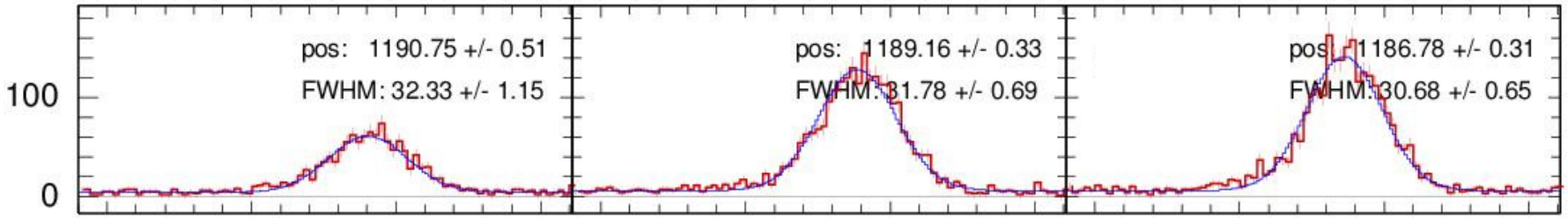
Mn-K: 5.894 keV, +41.5 eV → +0.704%

→ Change in the gain,
not in the offset

pn0709ff_705_0.fits low background first singles



pn0711ff_510_0.fits high background first singles



Energy resolution somewhat improved during high background

→ reduced charge loss noise → reduced charge loss

→ increased trap saturation

Energy shift occurs also for first singles

→ precursors 'invisible'

→ precursors below lower threshold or in preceding frame(s)

The CTI during low and high background

rev 709, low background

Al-K

$CTI_{1-3} = (6.87 +/- 0.06) \cdot 10^{-4}$

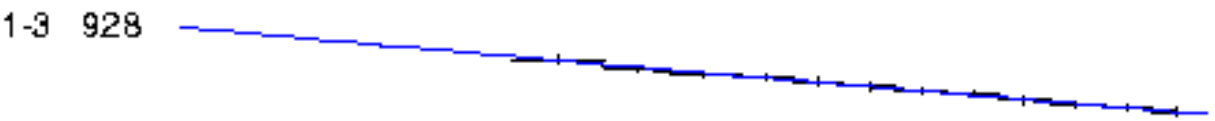
Mn-K

$CTI_{1-3} = (4.48 +/- 0.01) \cdot 10^{-4}$

→ decreased CTI during high background (Mn-K)

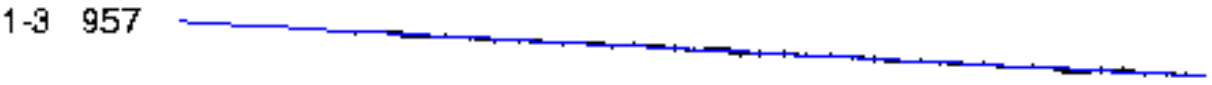
rev 711, high background

Al-K

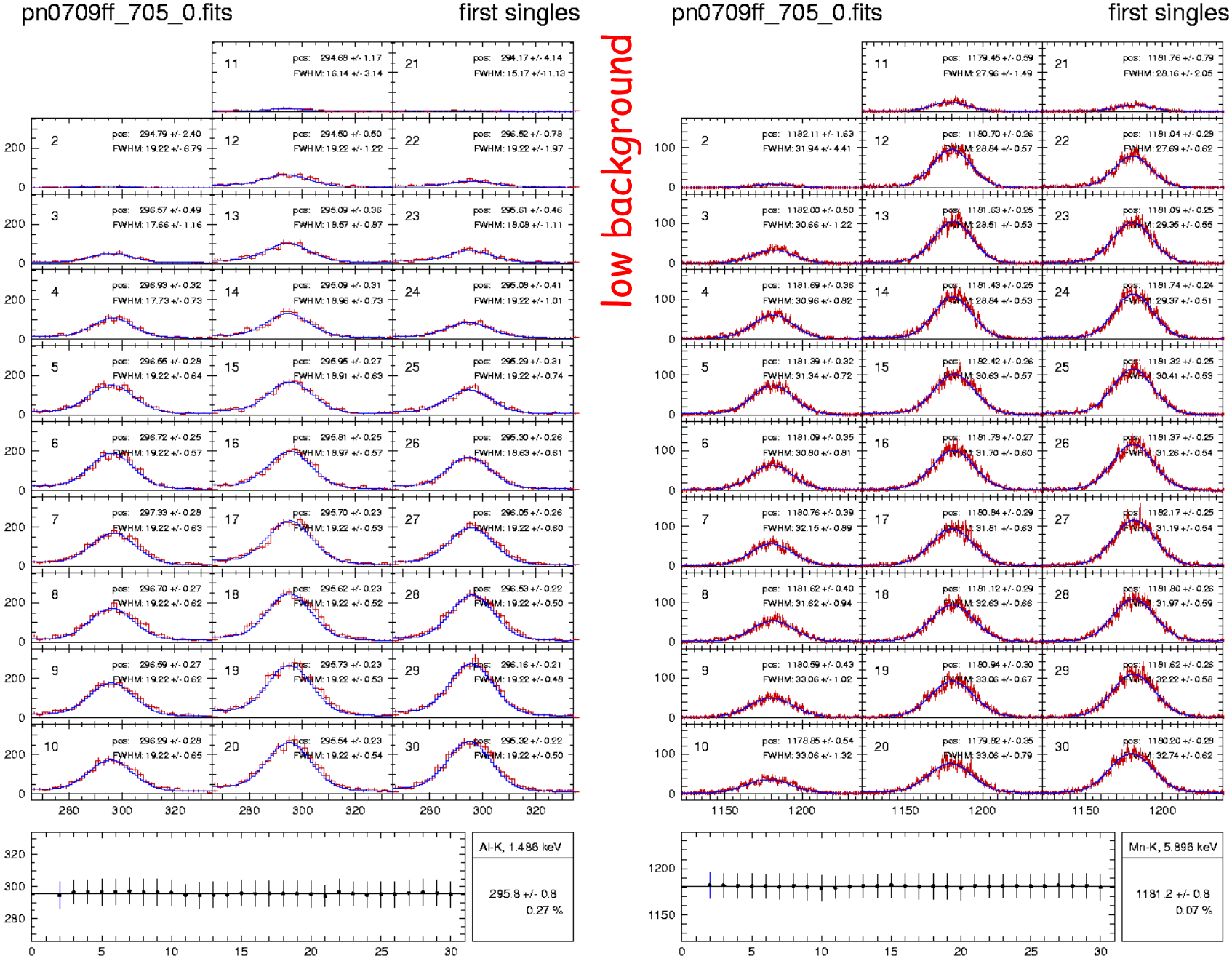


$CTI_{1-3} = (7.17 +/- 0.46) \cdot 10^{-4}$

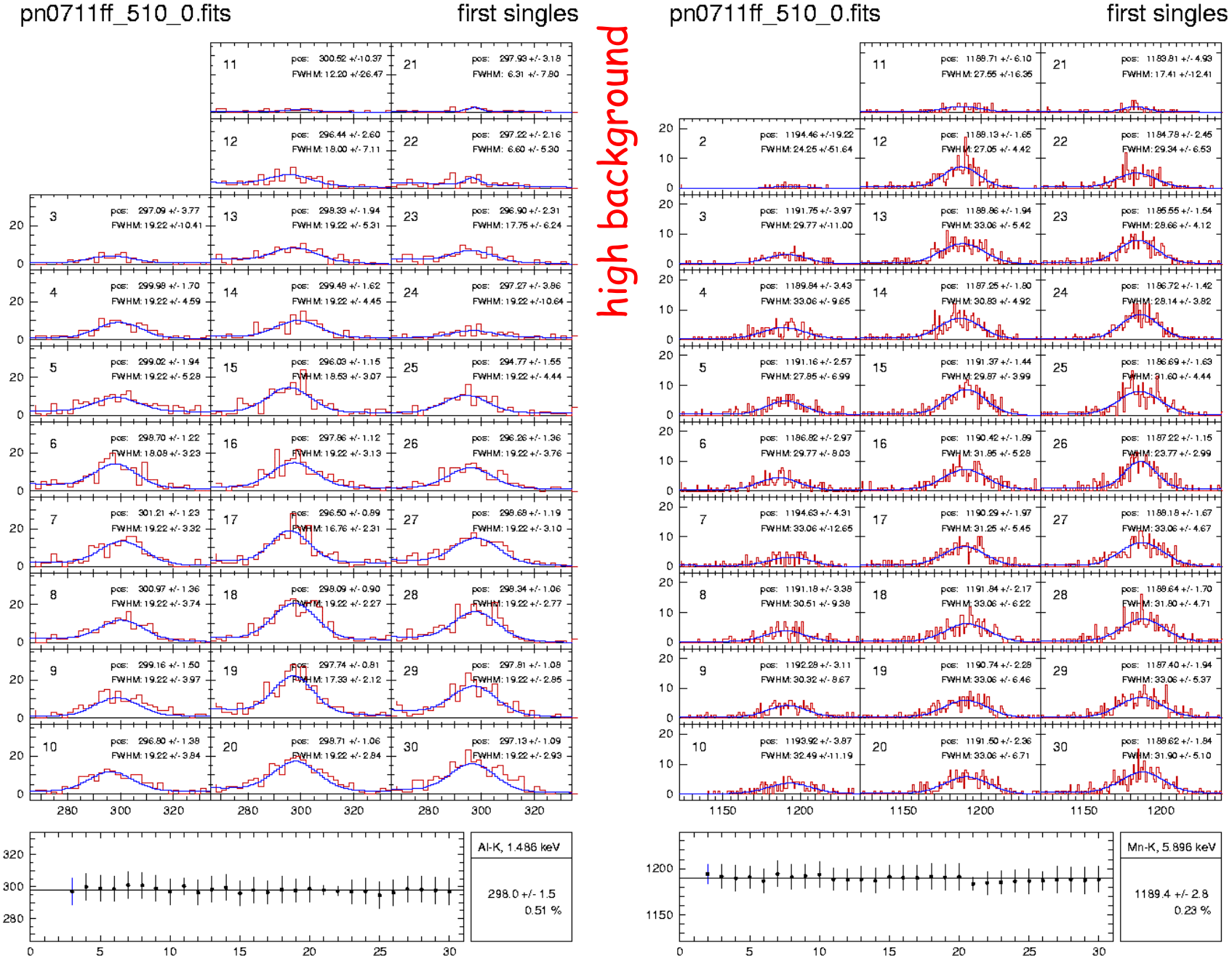
Mn-K



$CTI_{1-3} = (4.35 +/- 0.09) \cdot 10^{-4}$



EPIC pn: Jumps in the energy scale



EPIC pn: Jumps in the energy scale

→During episodes of high particle background the CTI is reduced.

→This is most likely caused by saturation of traps due to precursors.

→The charge of the precursors is below the 20 adu threshold and thus not available.

→The usual CTI correction cannot be used.

→ But there may be a correlation with the background flux which can be used for the correction..

Effect of the quadrant box temperature

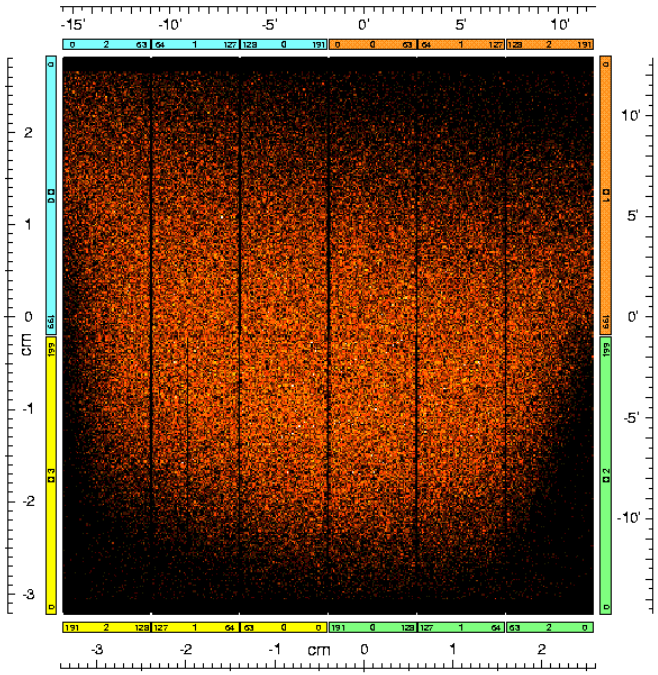
Gain/temperature correlation: earlier investigations

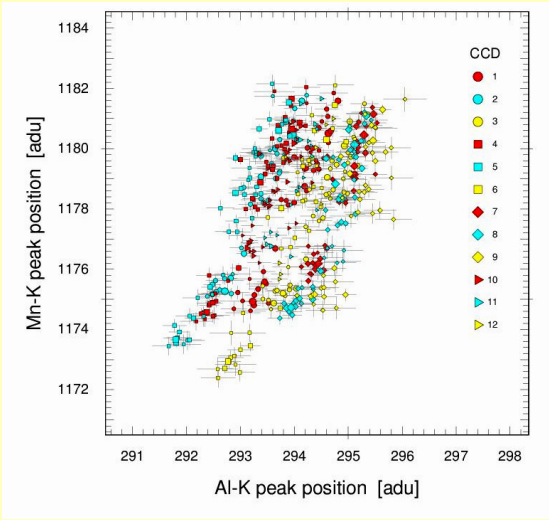
EPIC Calibration Operations Meeting

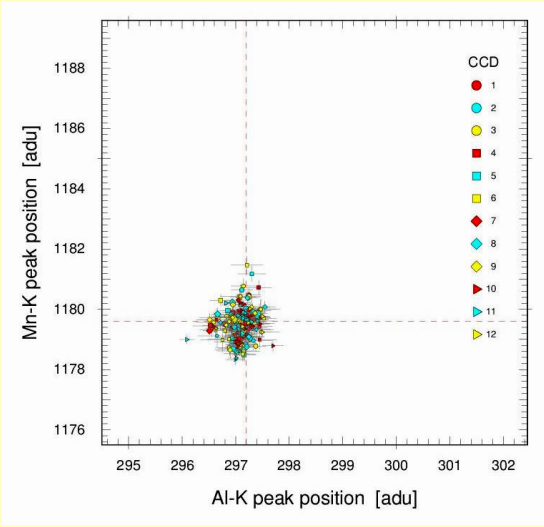
Leicester University
June 6 – 7, 2001

EPIC pn:
Gain/temperature correlation

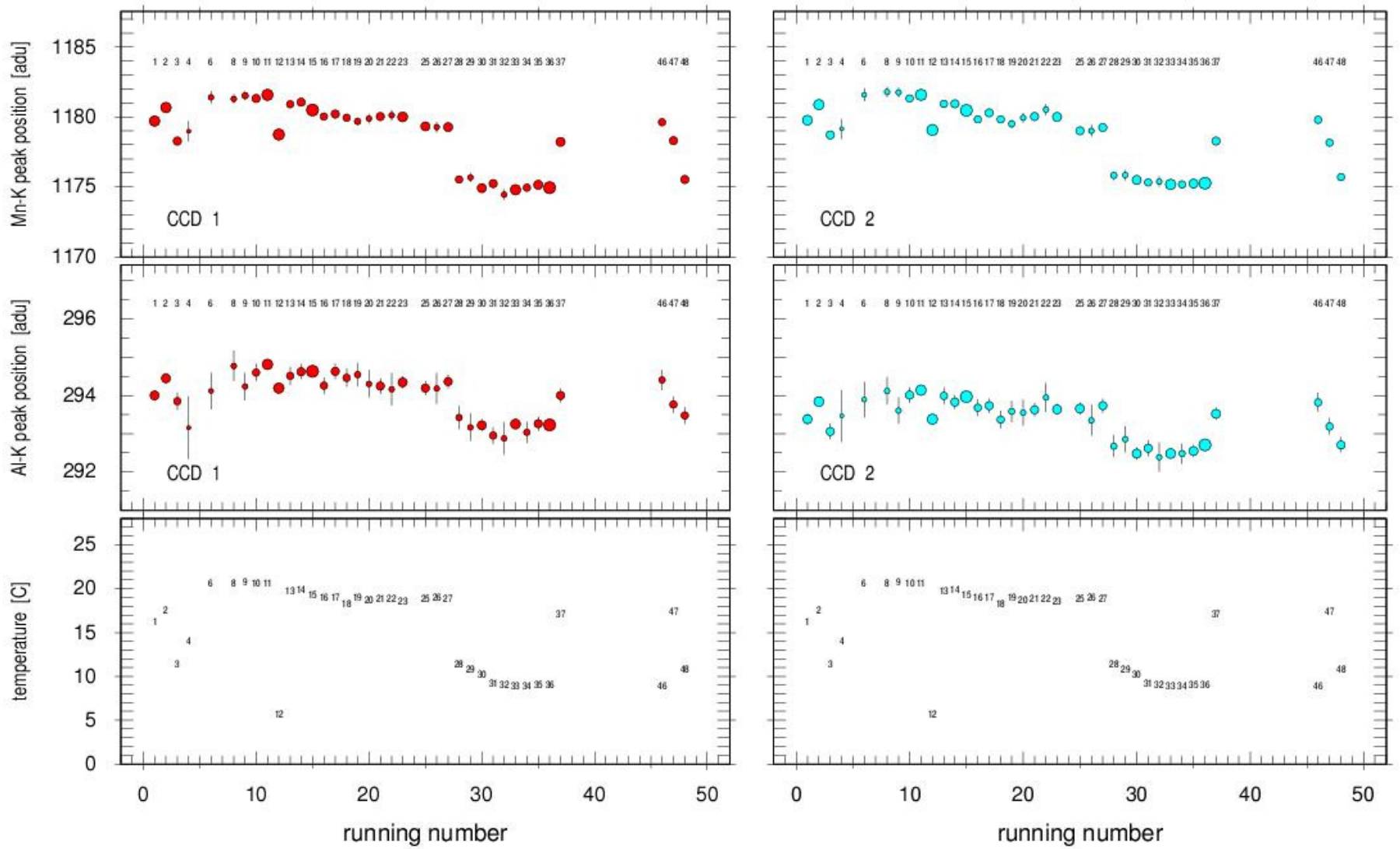
Konrad Dennerl
Max–Planck–Institut für extraterrestrische Physik
Giessenbachstraße
D–85748 Garching, Germany



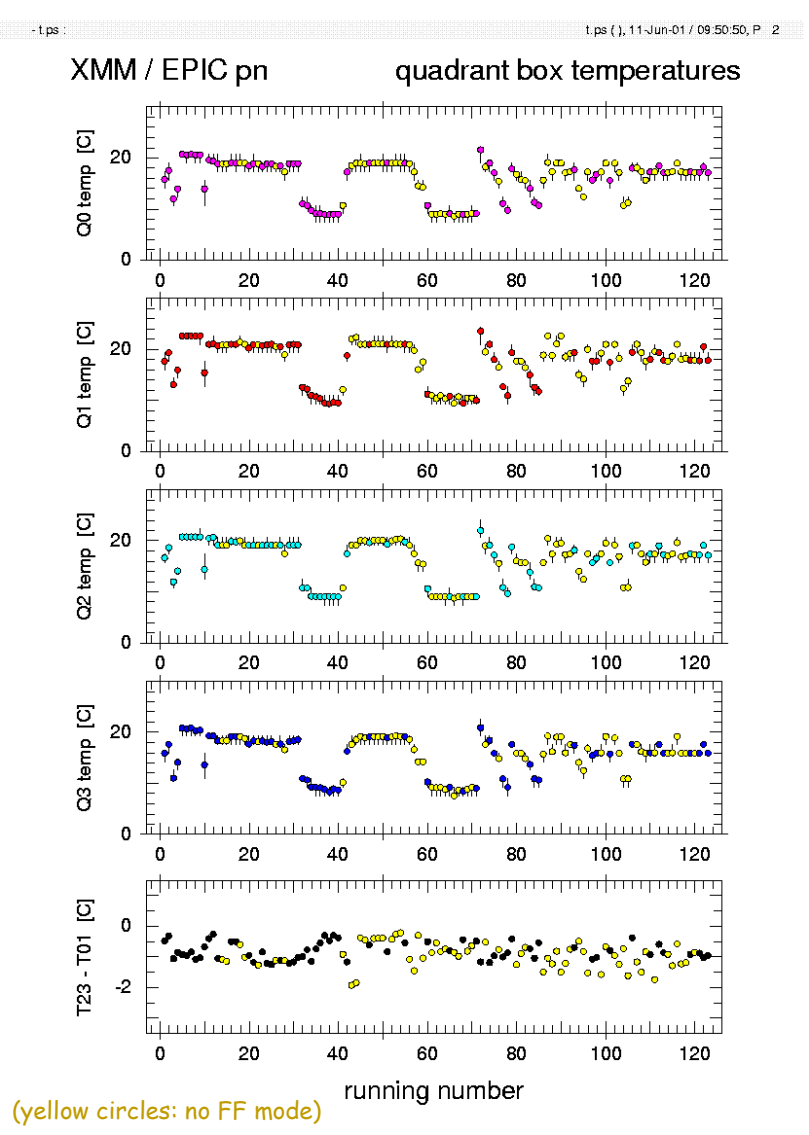




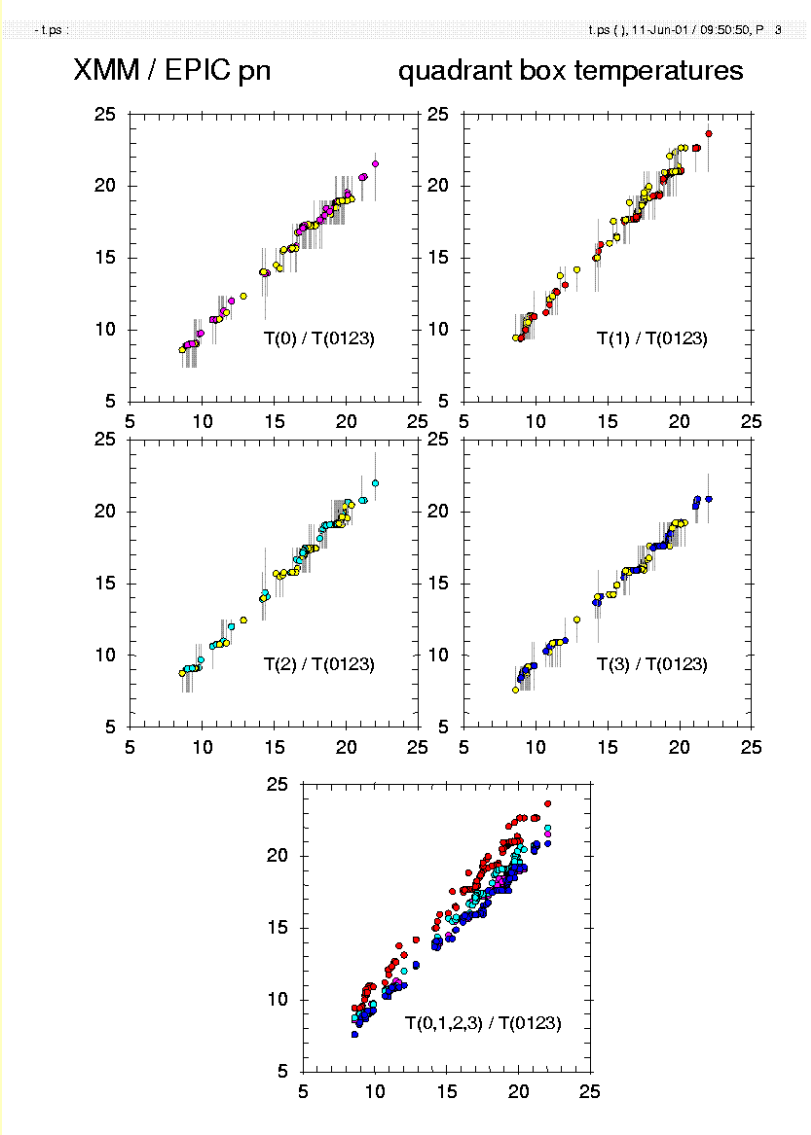
Mn-K_α & Al-K position and quadrant box temperature



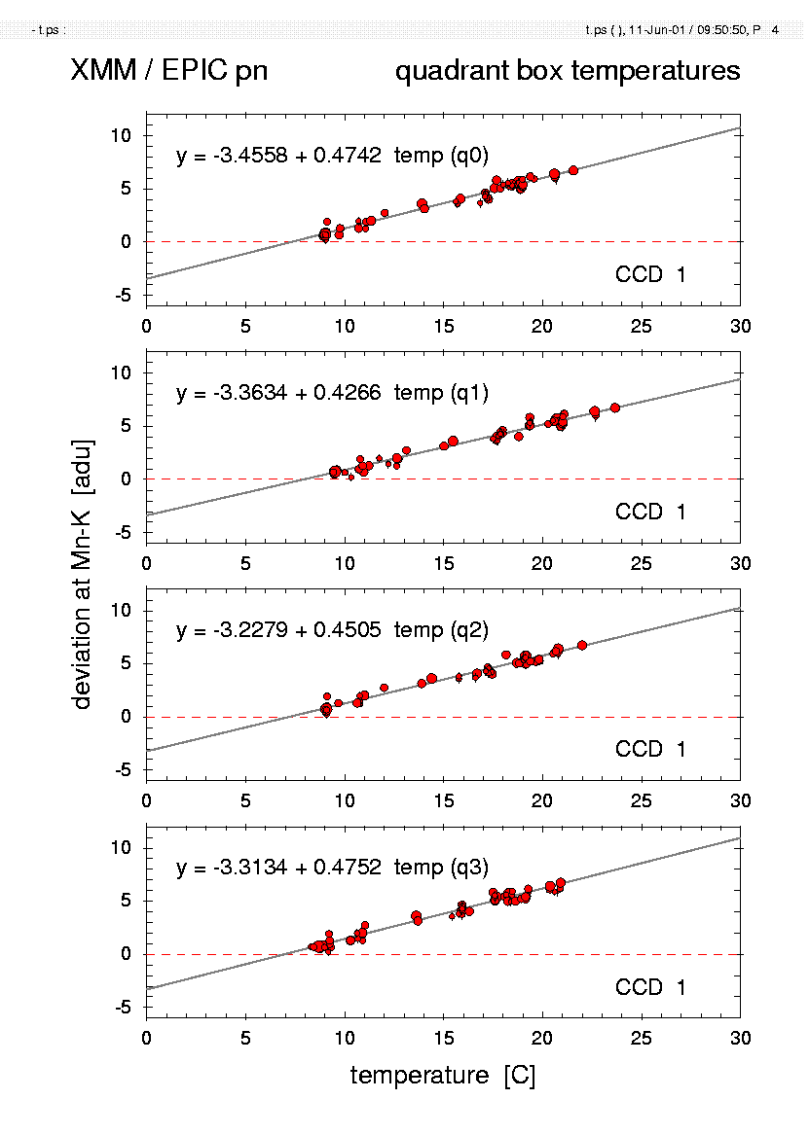
Quadrant box temperatures

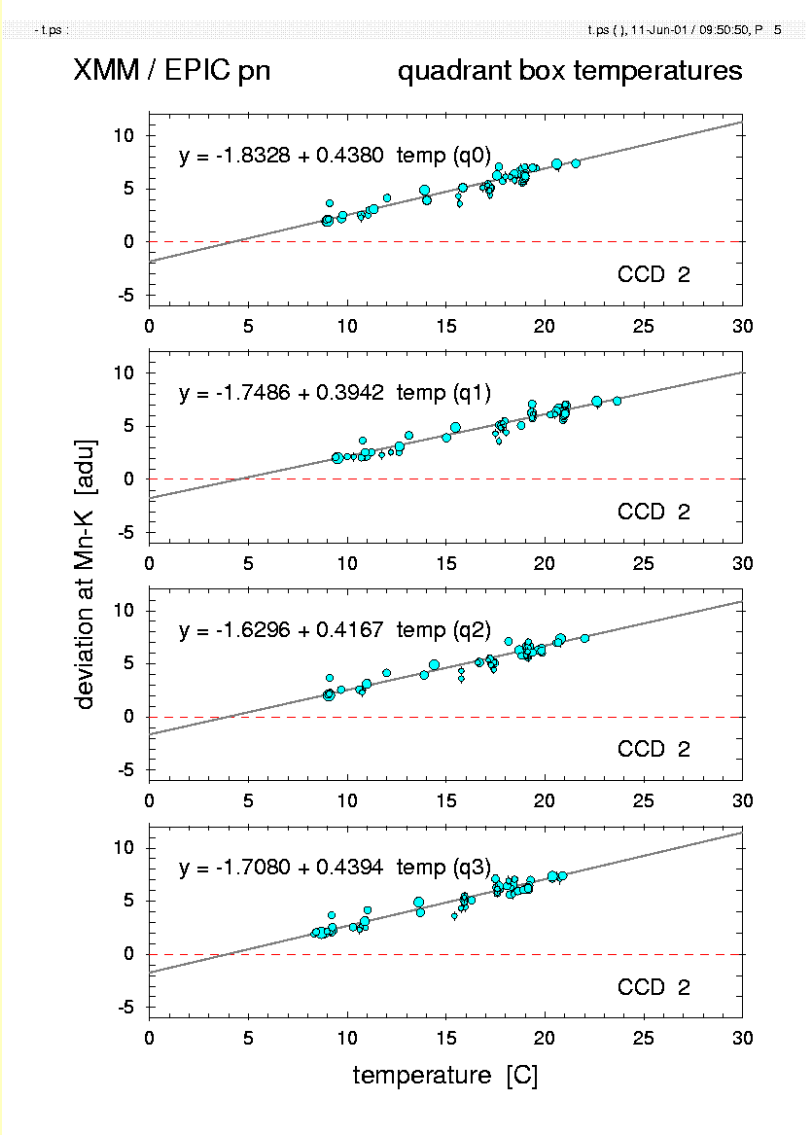


(yellow circles: no FF mode)

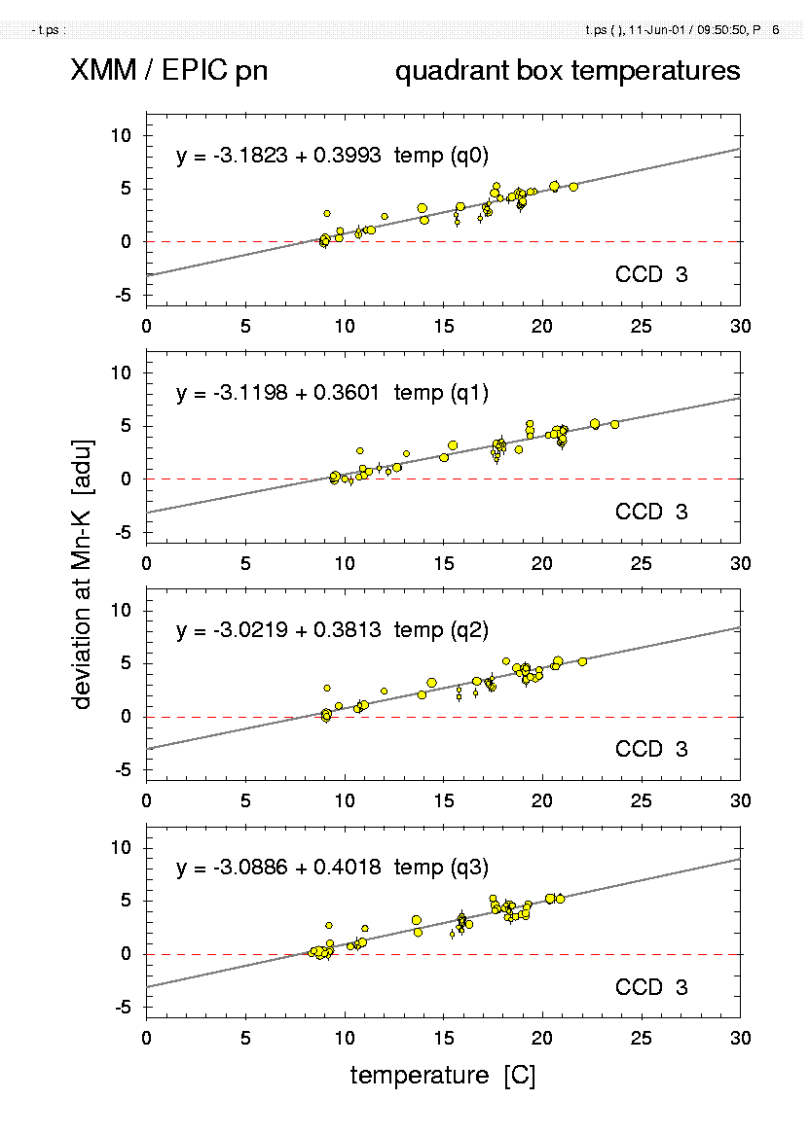


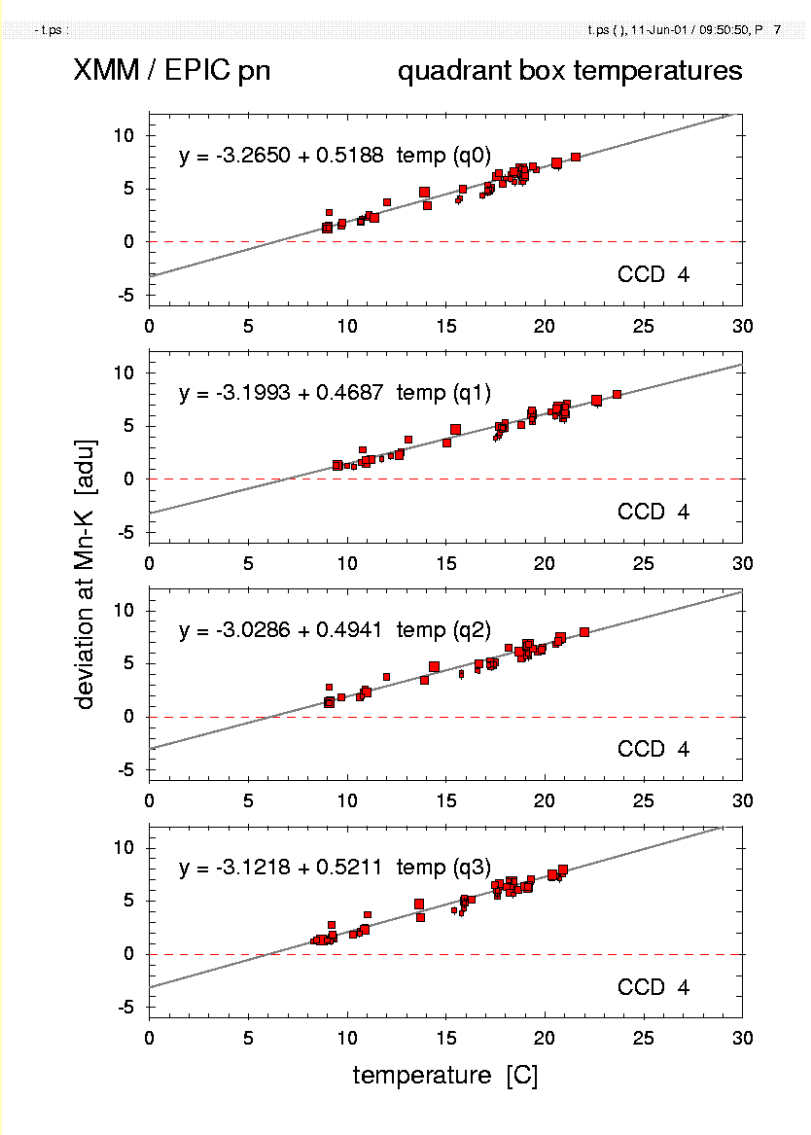
Mn-K_α position vs. temperature: CCD 1 & 2



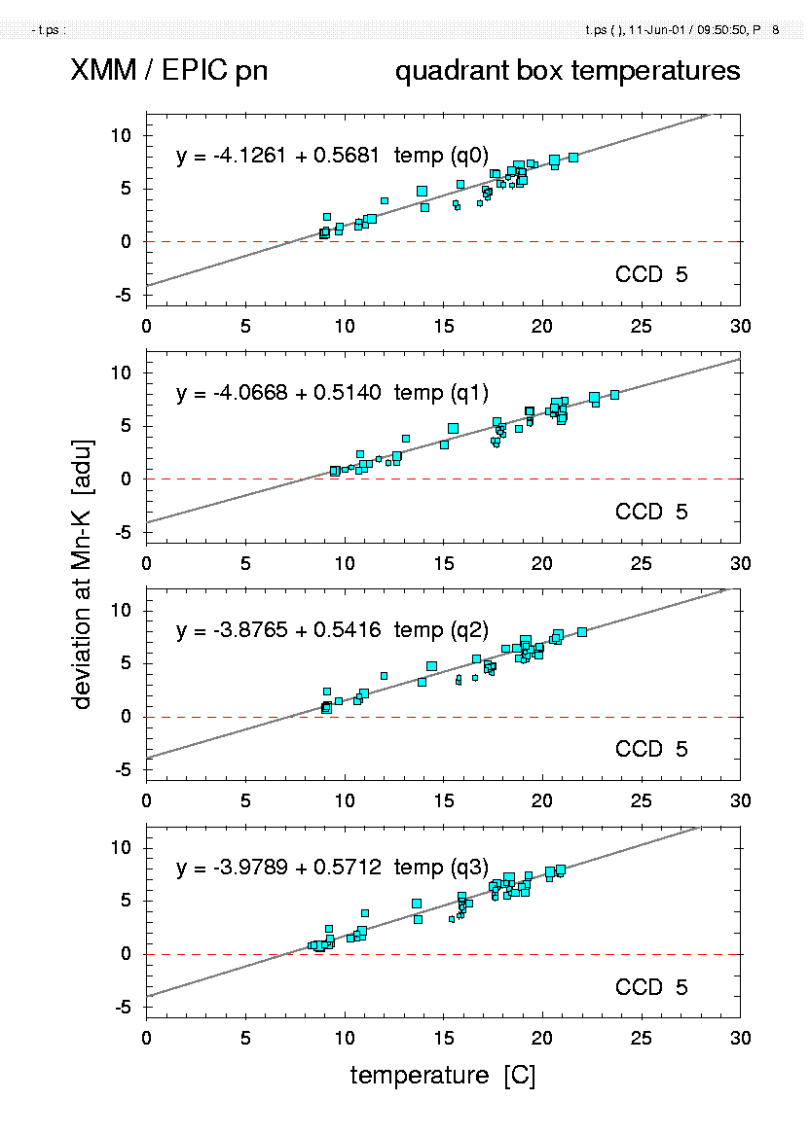


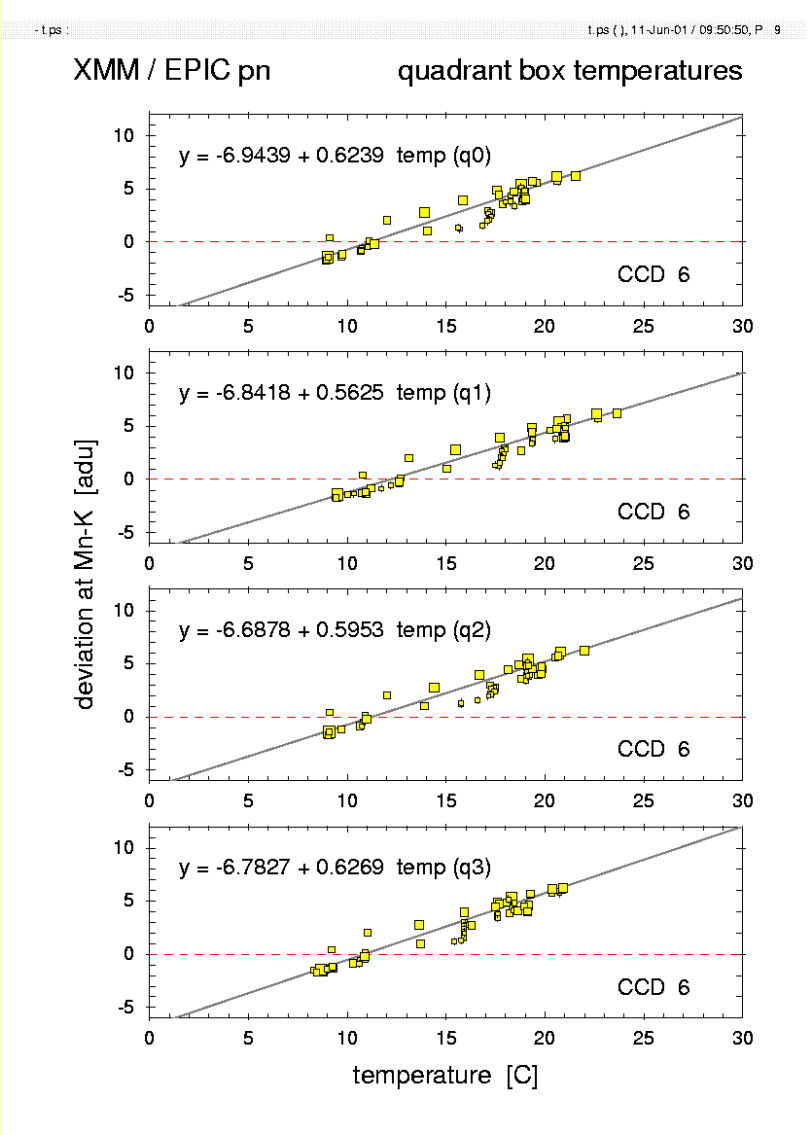
Mn-K_α position vs. temperature: CCD 3 & 4



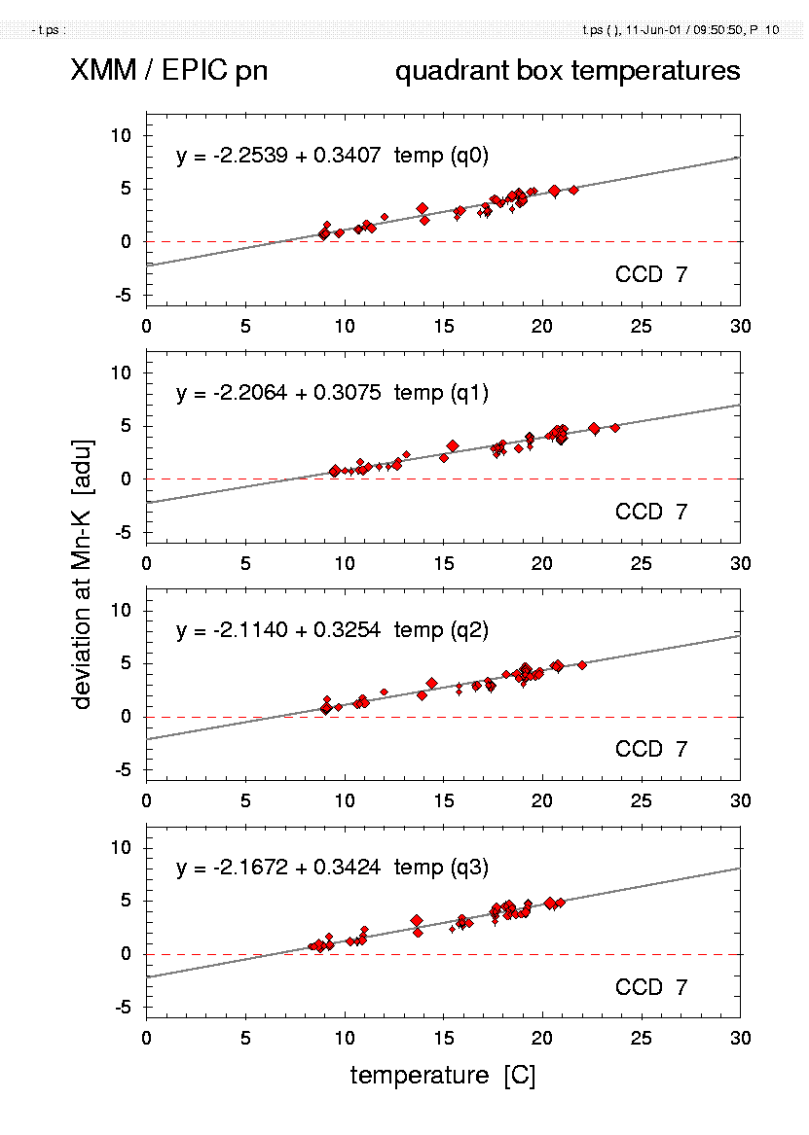


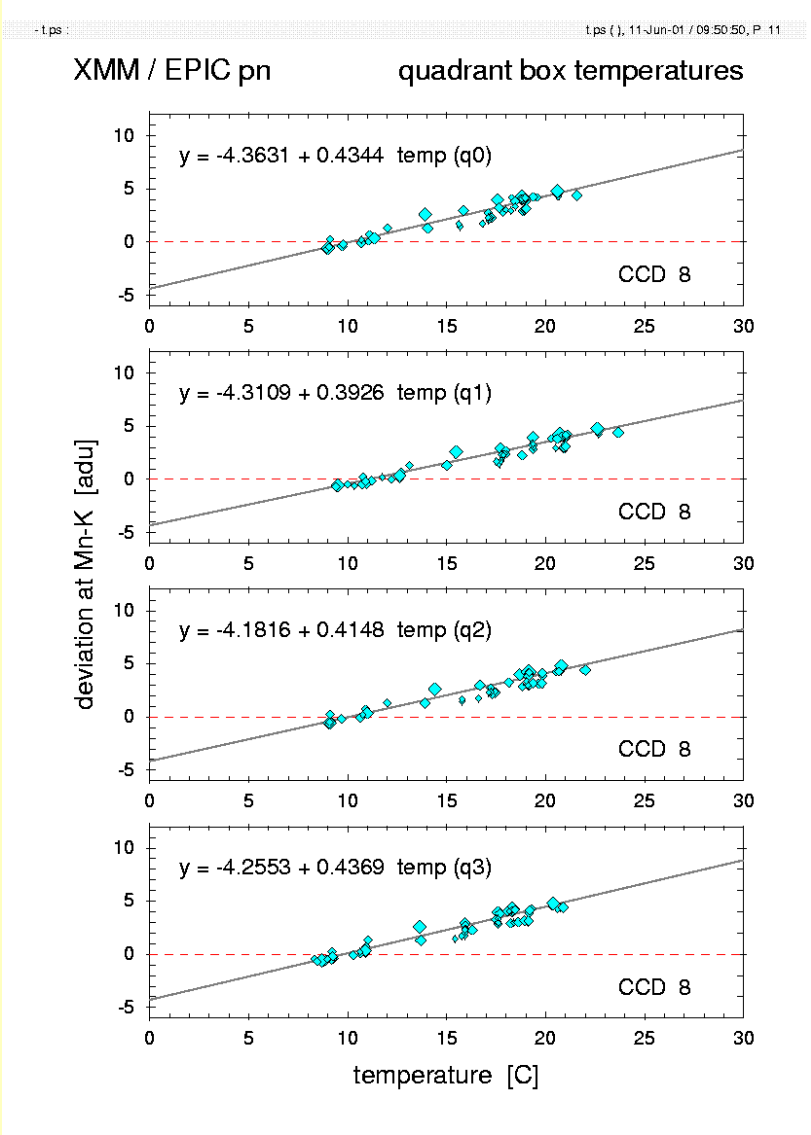
Mn-K_α position vs. temperature: CCD 5 & 6



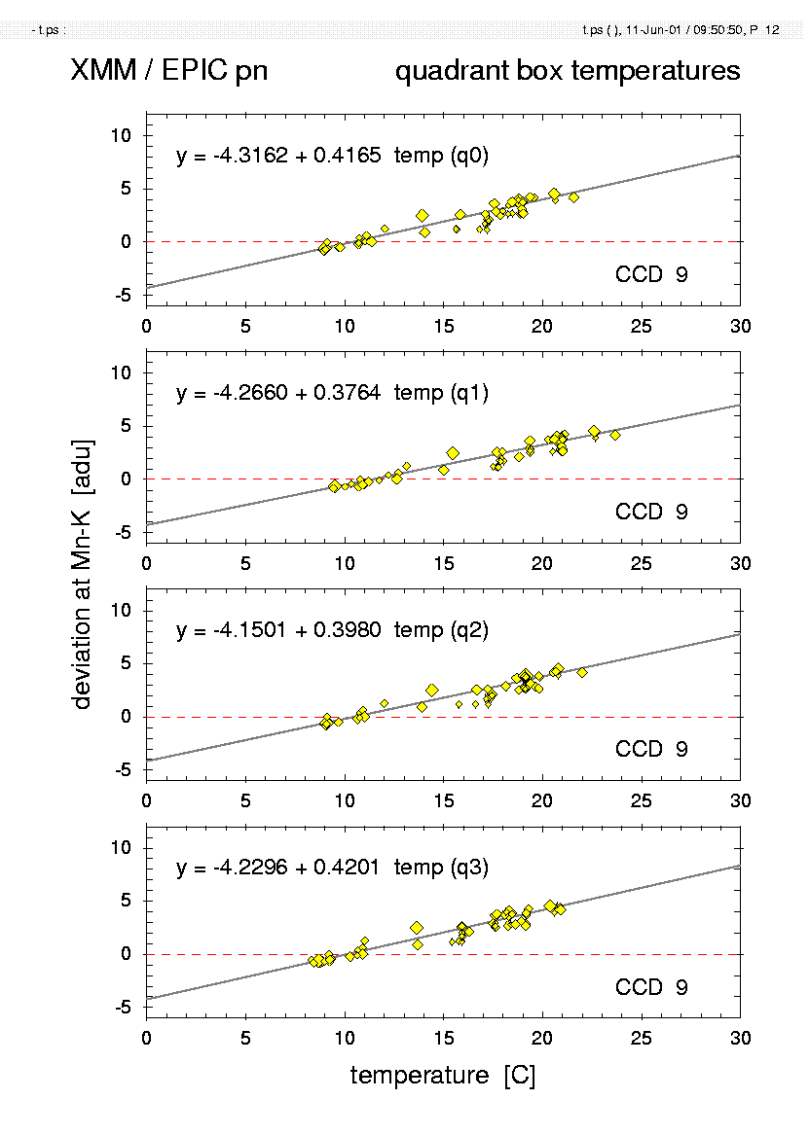


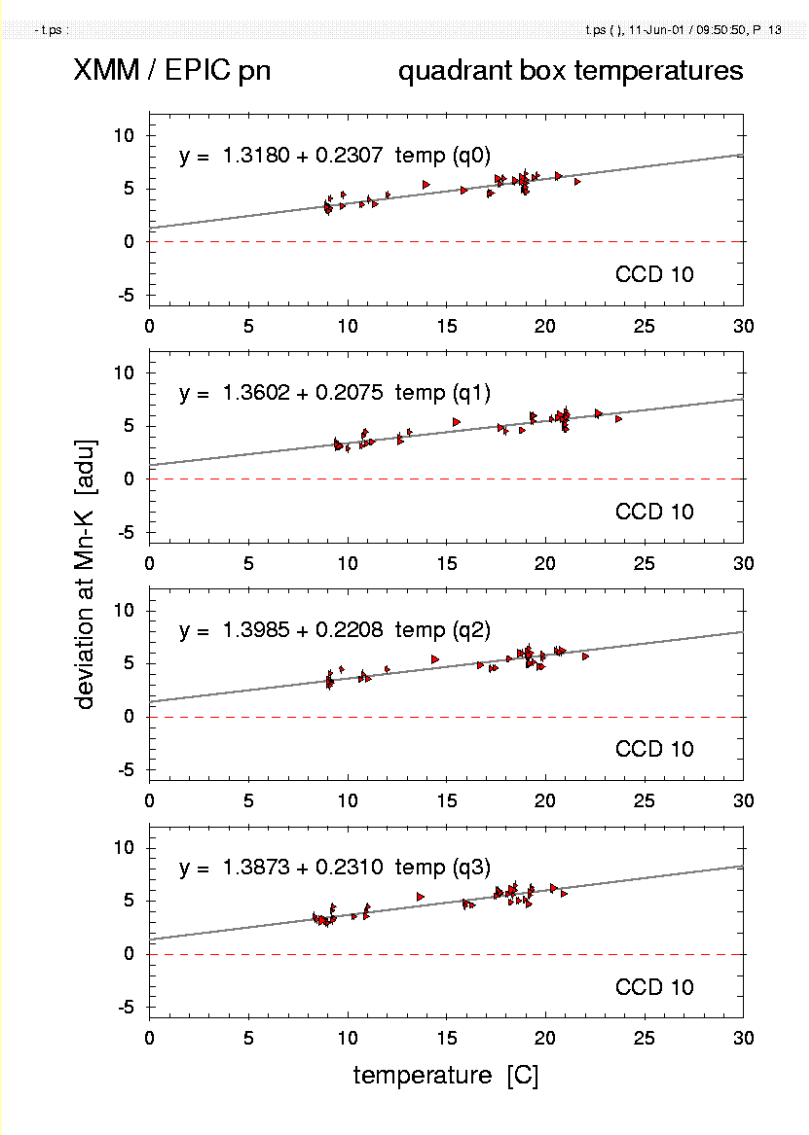
Mn-K_α position vs. temperature: CCD 7 & 8



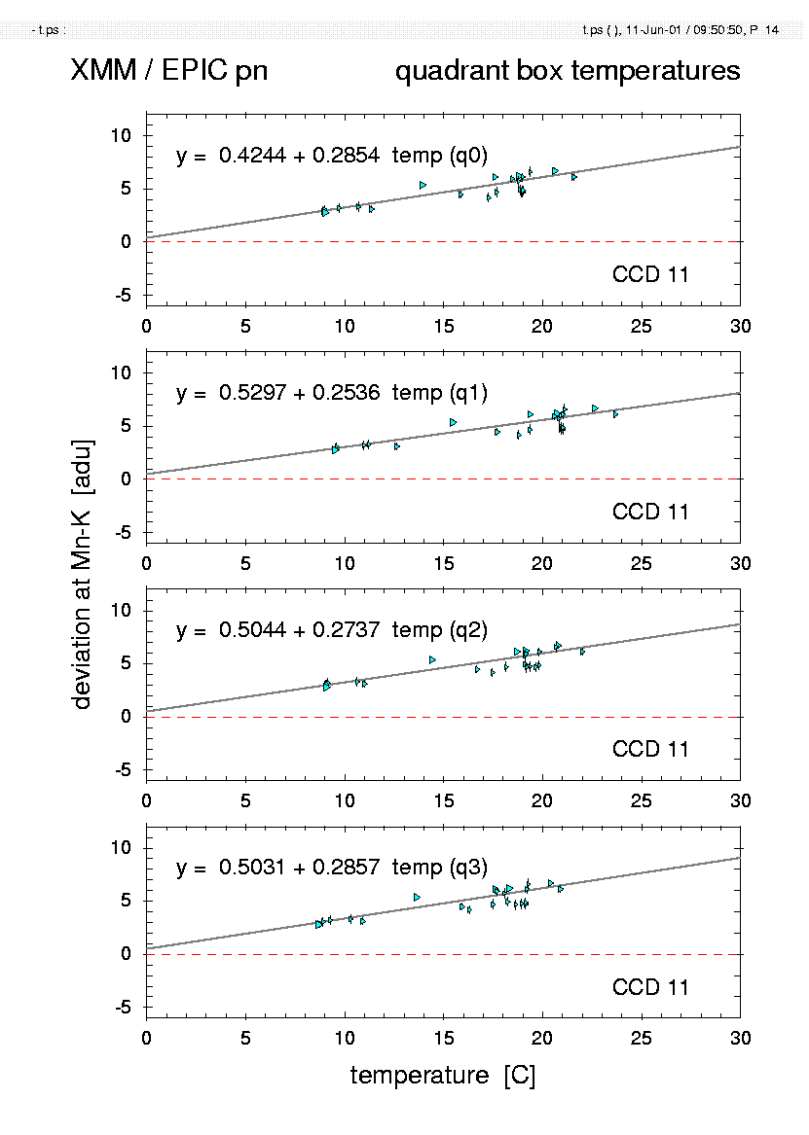


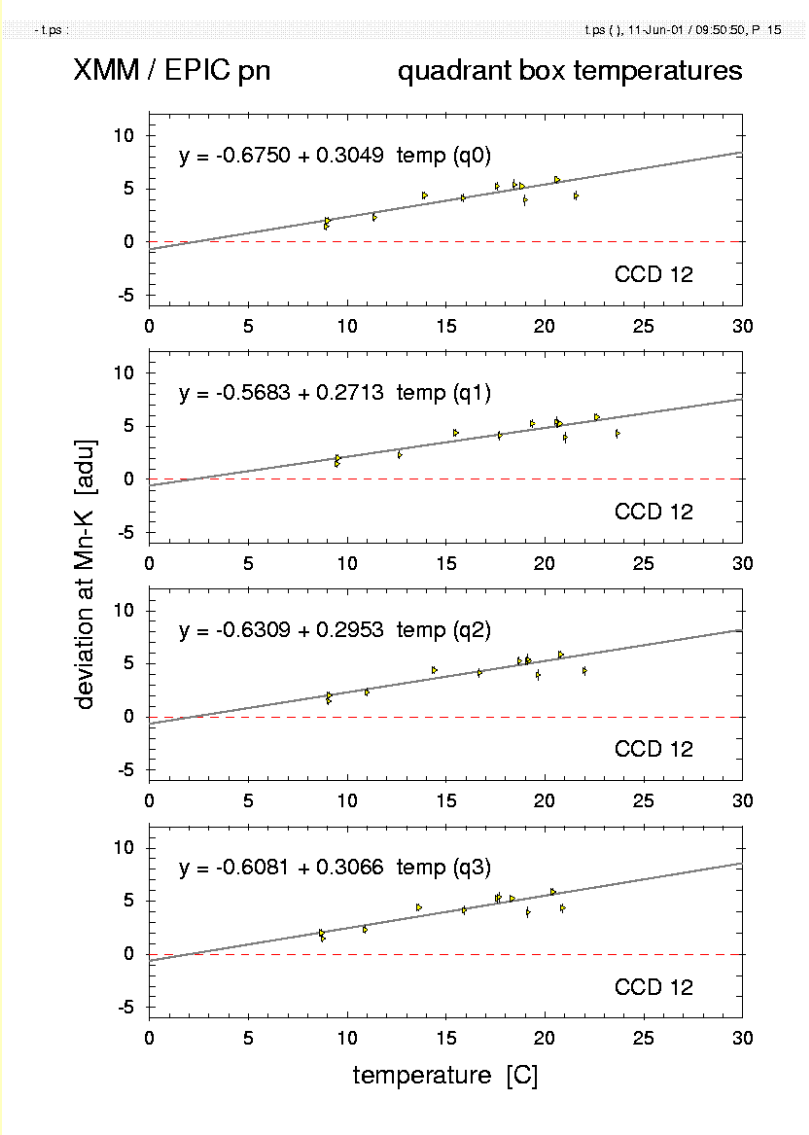
Mn-K_α position vs. temperature: CCD 9 & 10



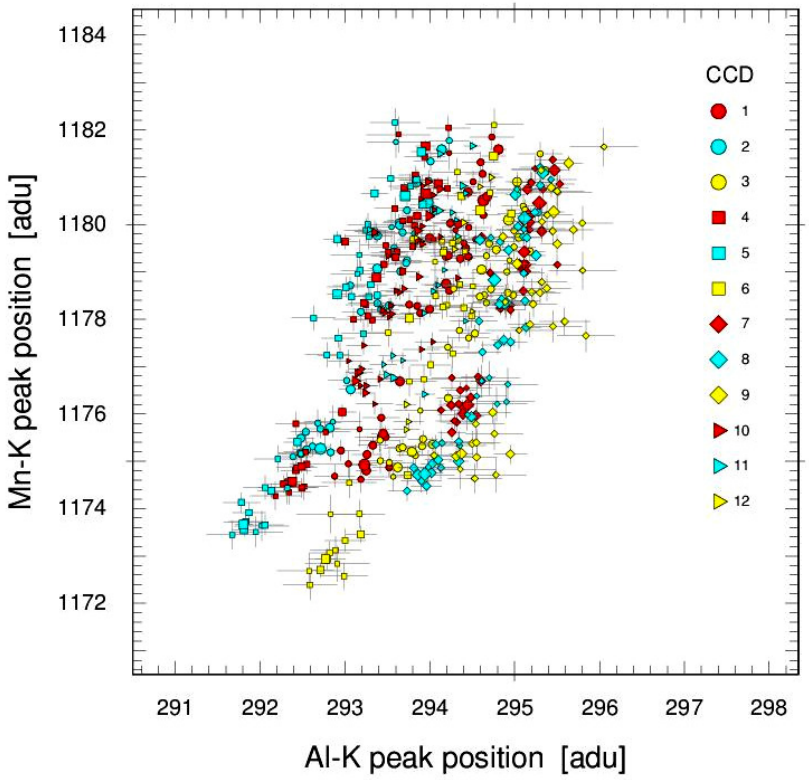


Mn-K_α position vs. temperature: CCD 11 & 12

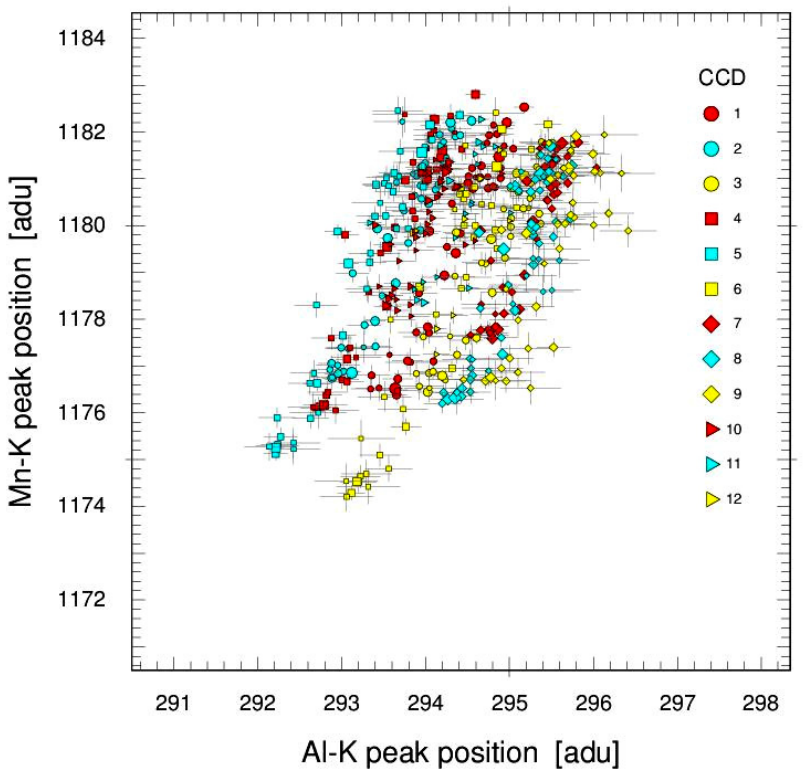




Mn-K_α position vs. Al-K position

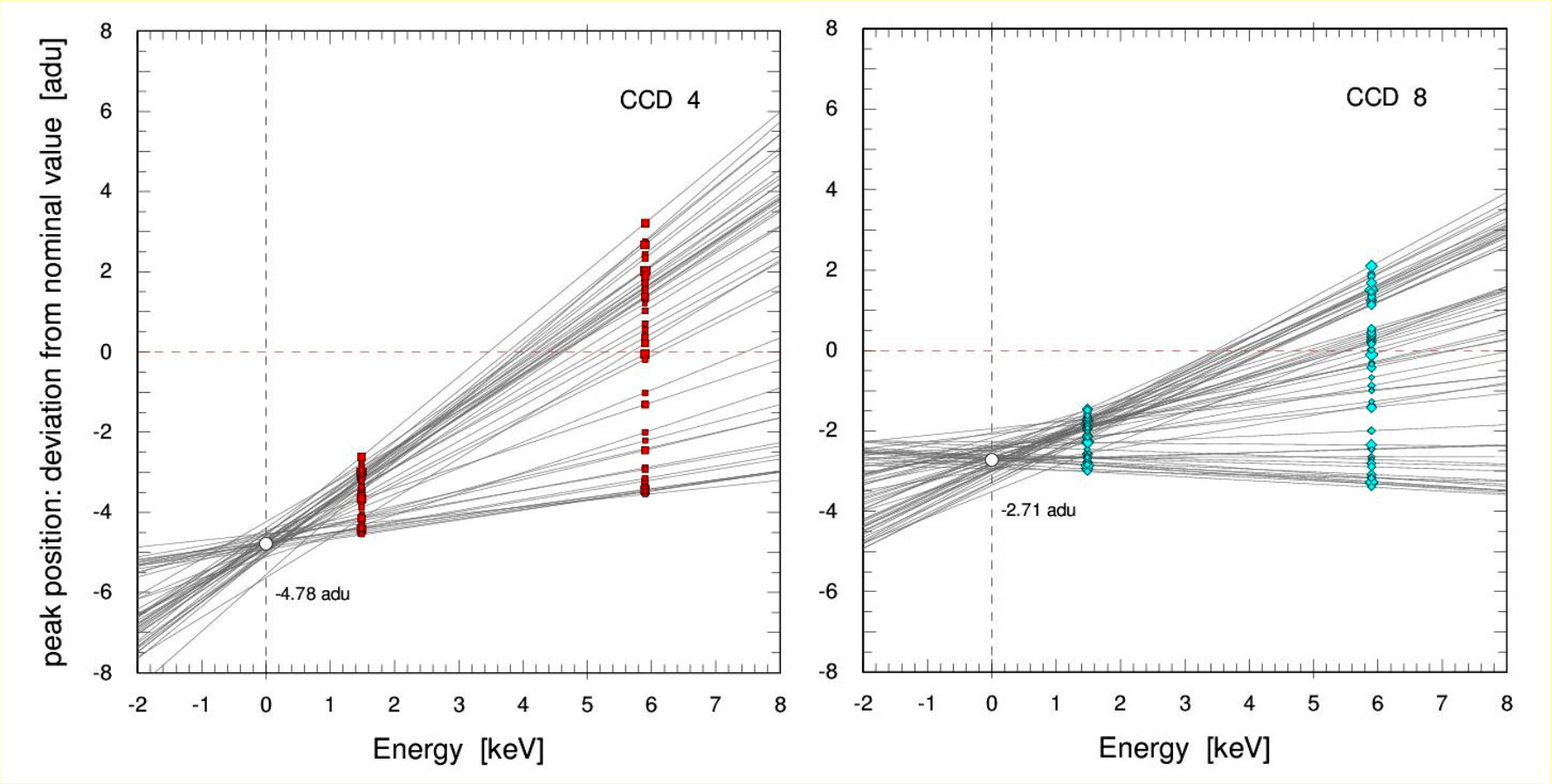


Peak positions Mn-K_α vs. Al-K for 476 data points obtained in 44 observations from XMM rev. 023 – 202.

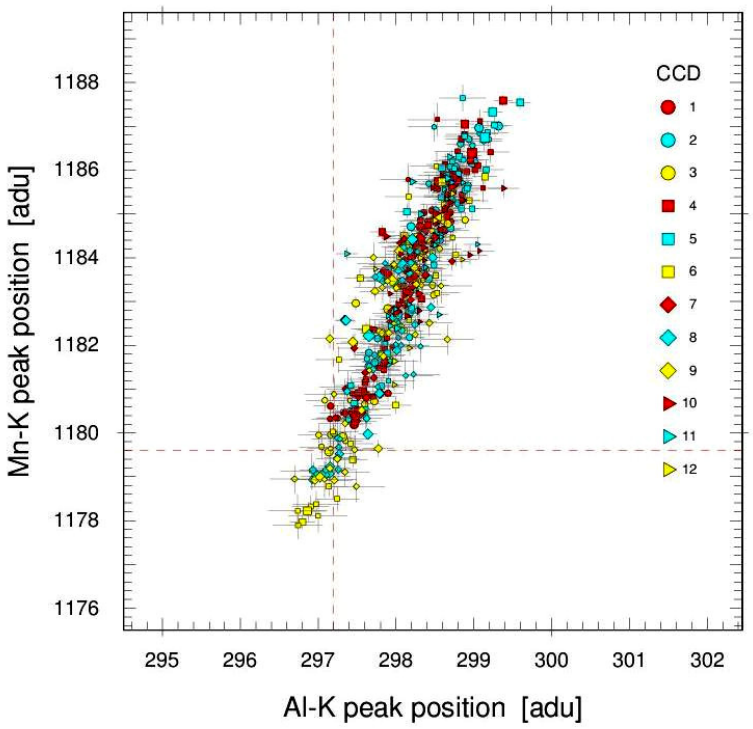


Peak positions Mn-K_α vs. Al-K for 476 data points obtained in 44 observations from XMM rev. 023 – 202, after correcting for a mean CTI change of $+0.59 \cdot 10^{-7}/d$.

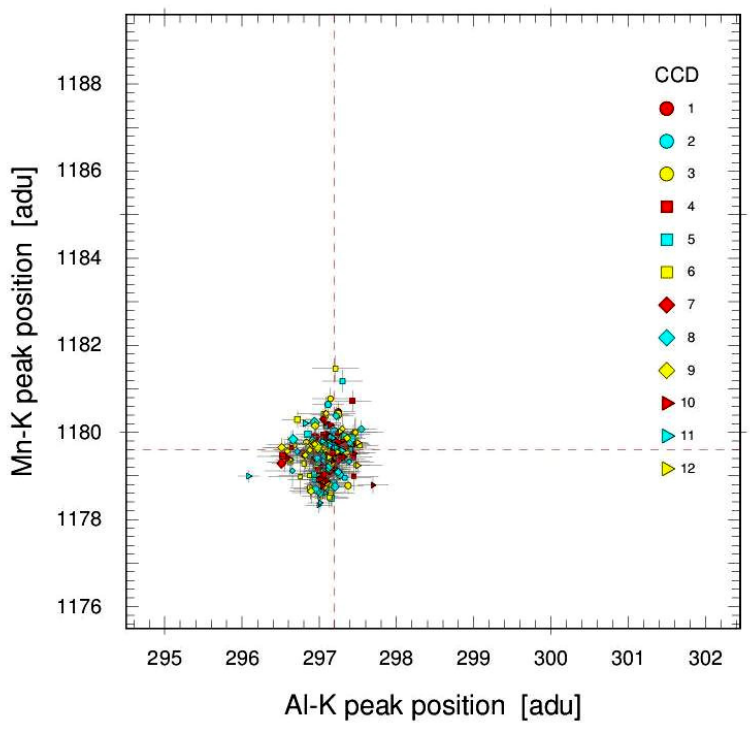
Deviations of the Al-K and Mn-K_α positions



Mn-K_α position vs. Al-K position

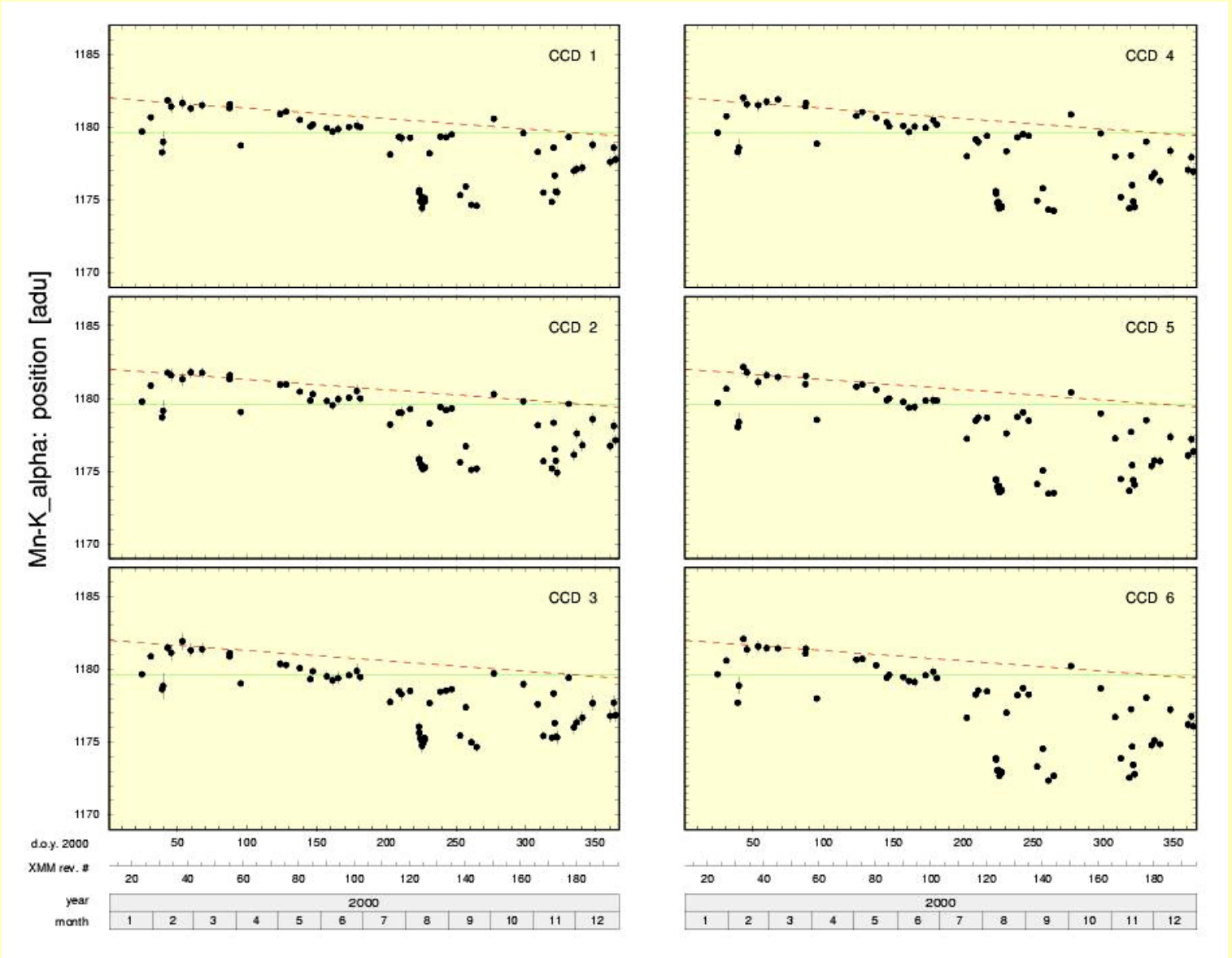


Peak positions Mn-K_α vs. Al-K for 476 data points obtained in 44 observations from XMM rev. 023 – 202, after correcting for a mean CTI change of $+0.59 \cdot 10^{-7}/d$, and adding a constant offset for each CCD, with a value between 2.25 – 5.19 adu. The dashed lines mark the nominal peak positions.

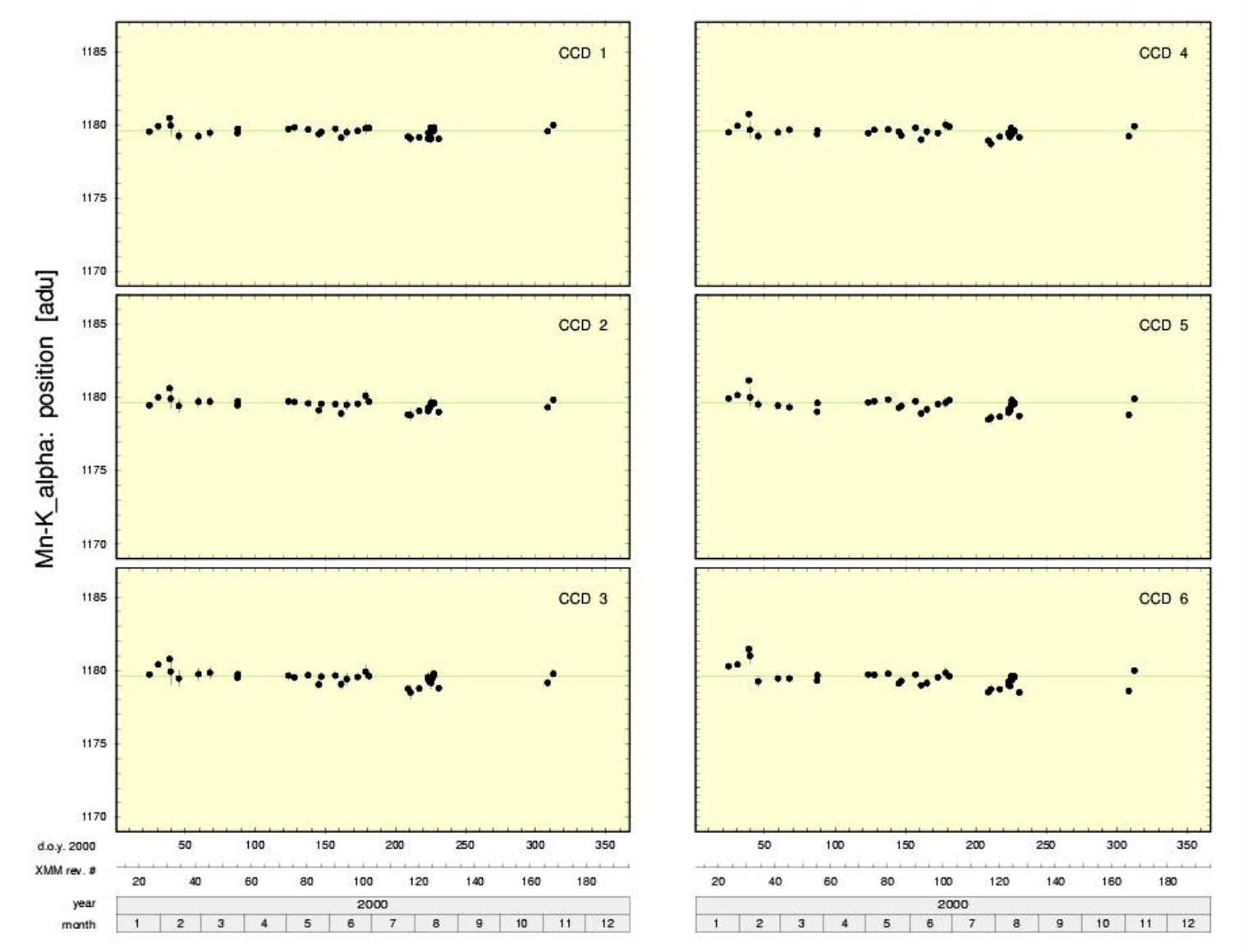


Peak positions Mn-K_α vs. Al-K , after correcting for a mean CTI change of $+0.59 \cdot 10^{-7}/d$, adding a constant offset for each CCD, with a value between 2.25 – 5.19 adu, and scaling the gain with the temperature. The dashed lines mark the nominal peak positions.

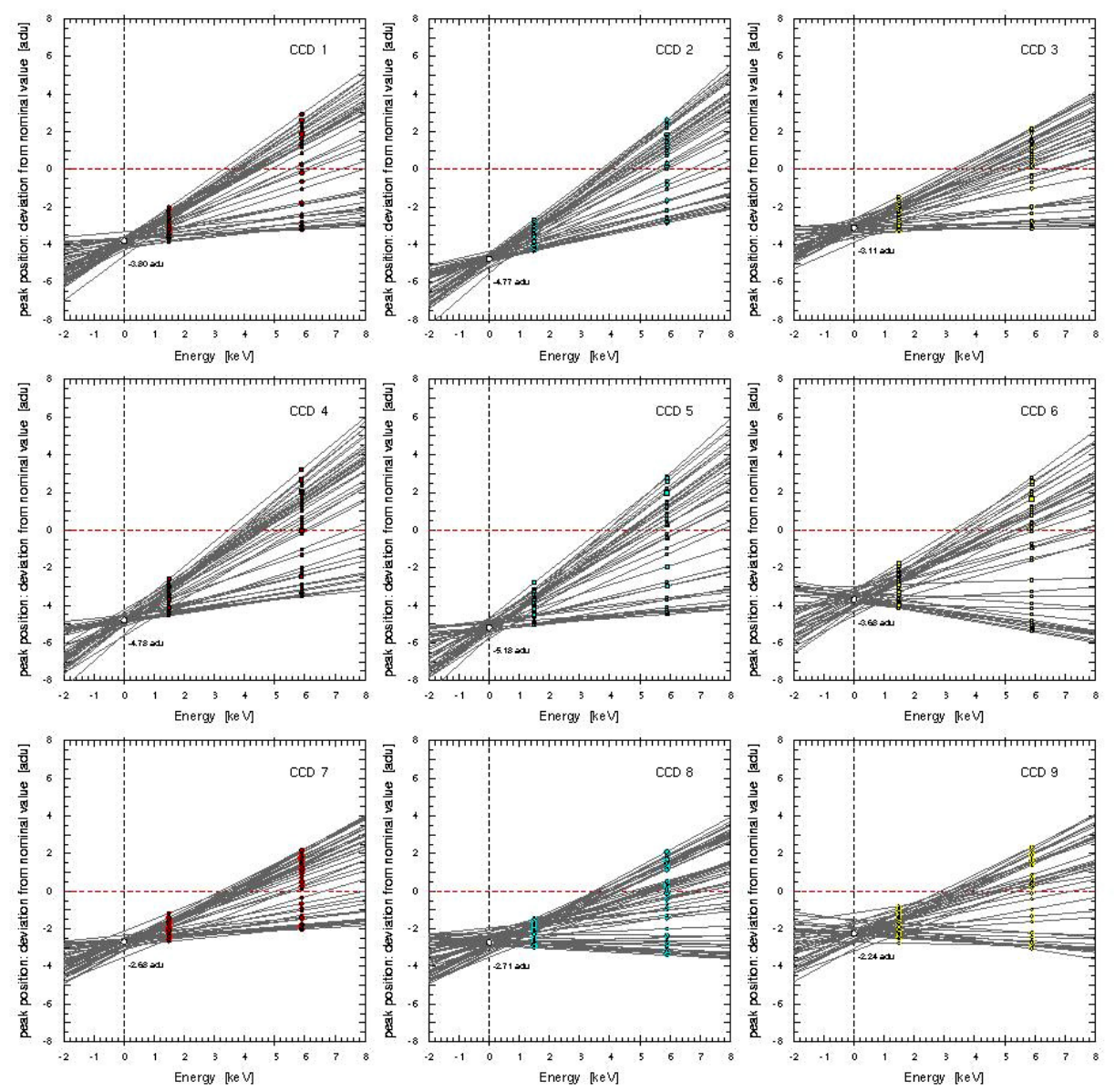
Mn-K_α positions (after gain and CTI correction)



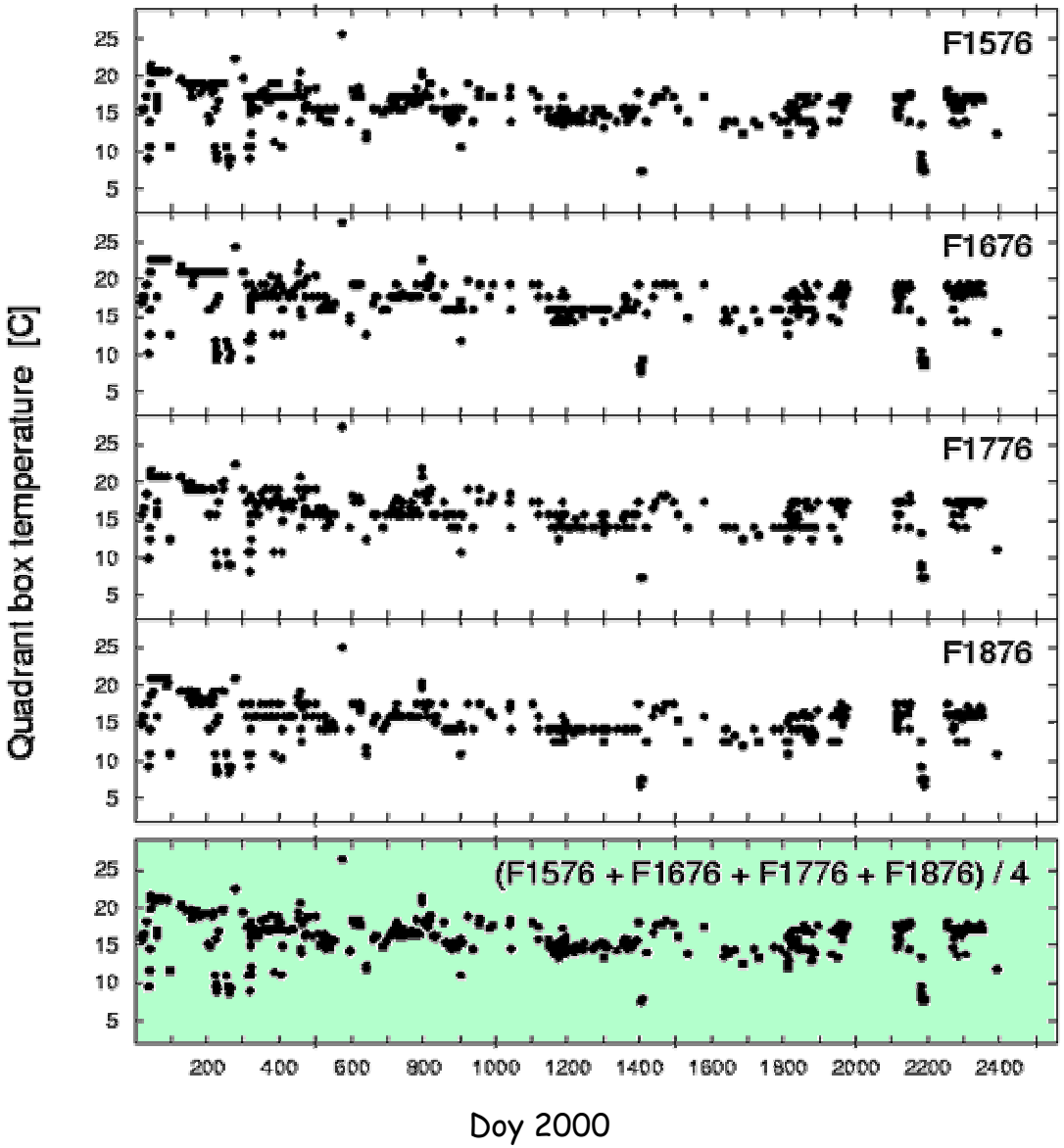
Mn-K_α positions after temperature (and dCTI/dt) correction

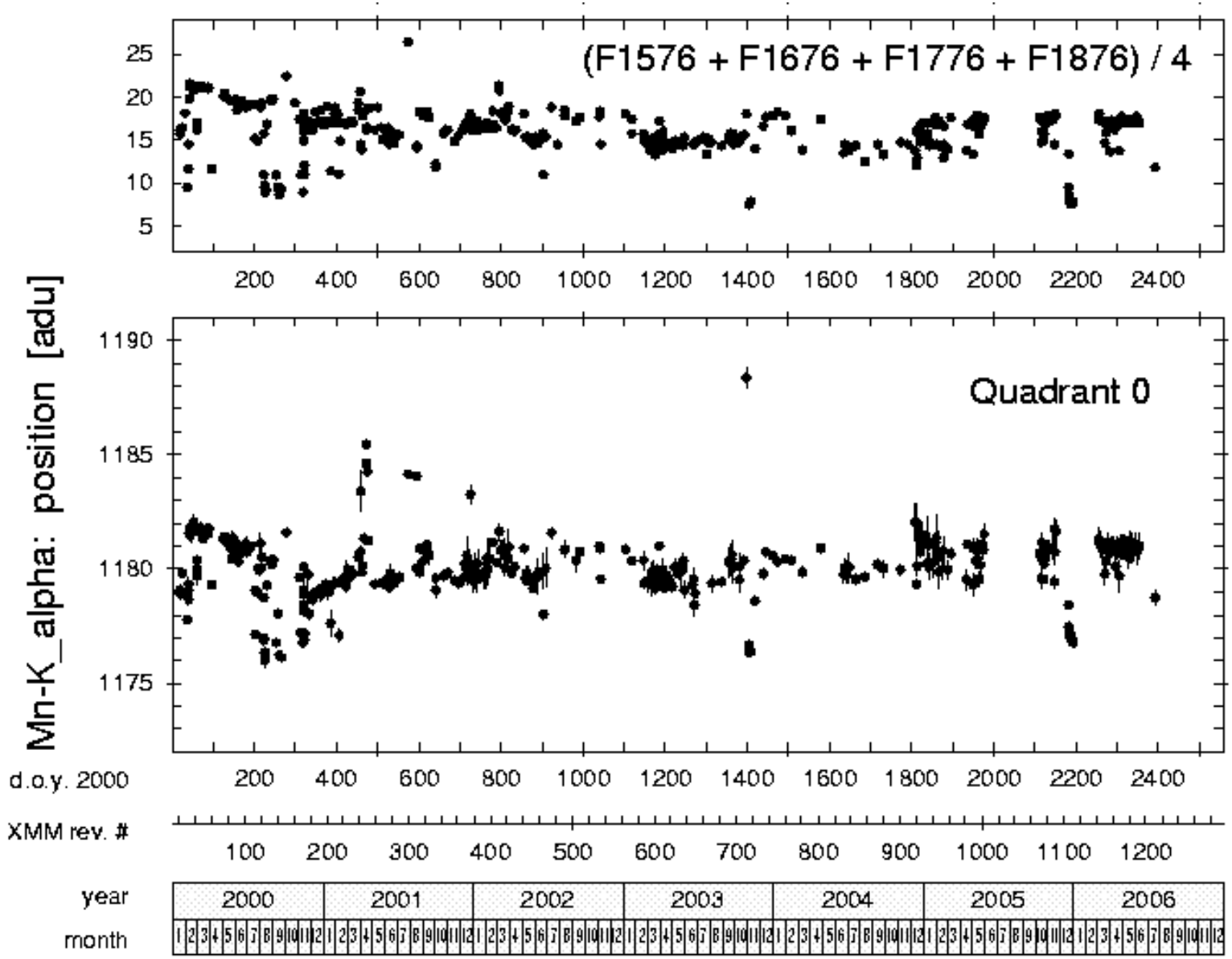


"CCD offsets"

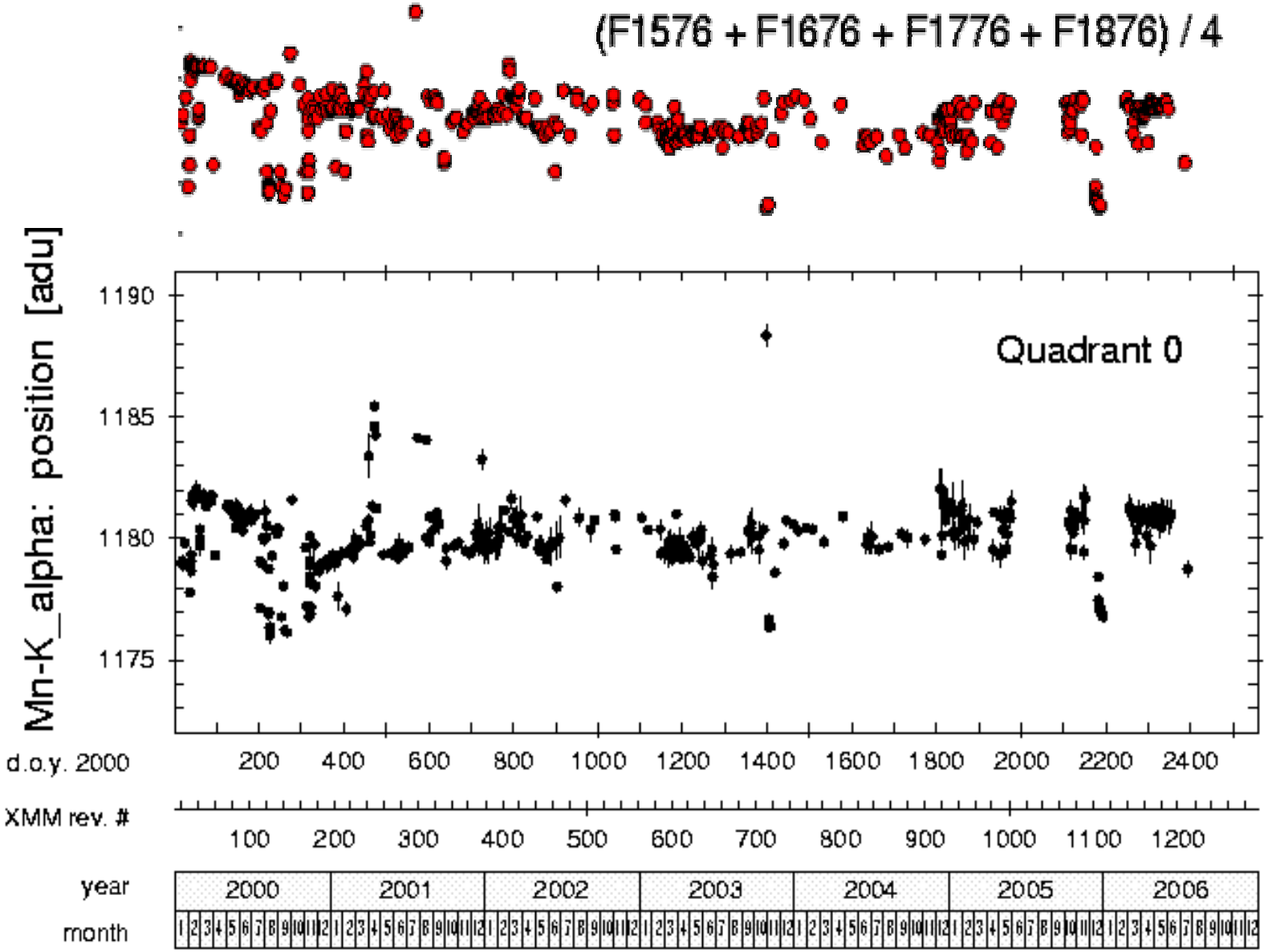

CCD 1
CCD 2
CCD 3
CCD 4
CCD 5
CCD 6
CCD 7
CCD 8
CCD 9
peak position: deviation from nominal value [adu]
Energy [keV]
-3.80 adu
-4.77 adu
-3.11 adu
-4.78 adu
-5.18 adu
-3.68 adu
-2.68 adu
-2.71 adu
-2.24 adu

Quadrant box temperatures



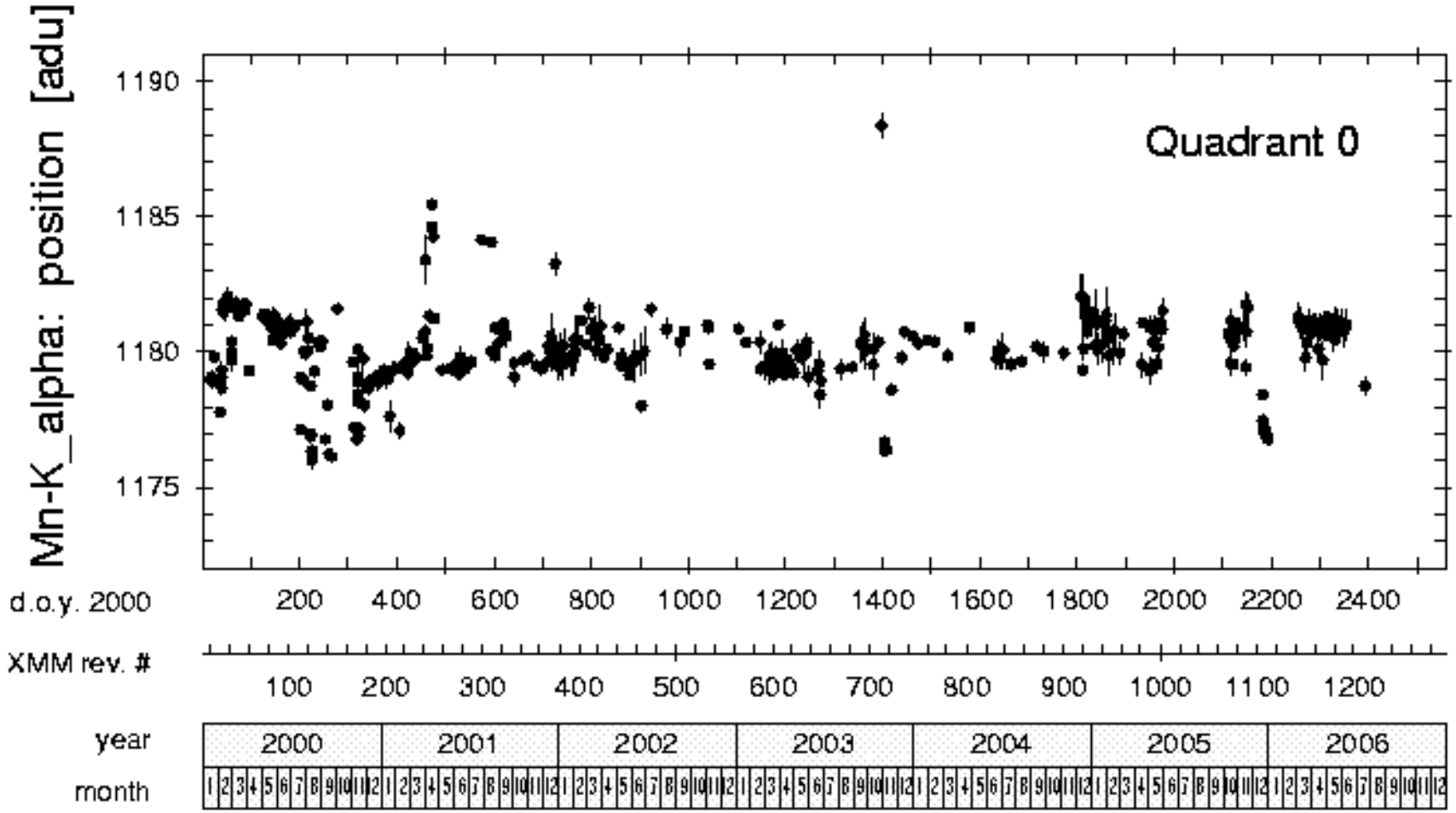


EPIC pn: Jumps in the energy scale

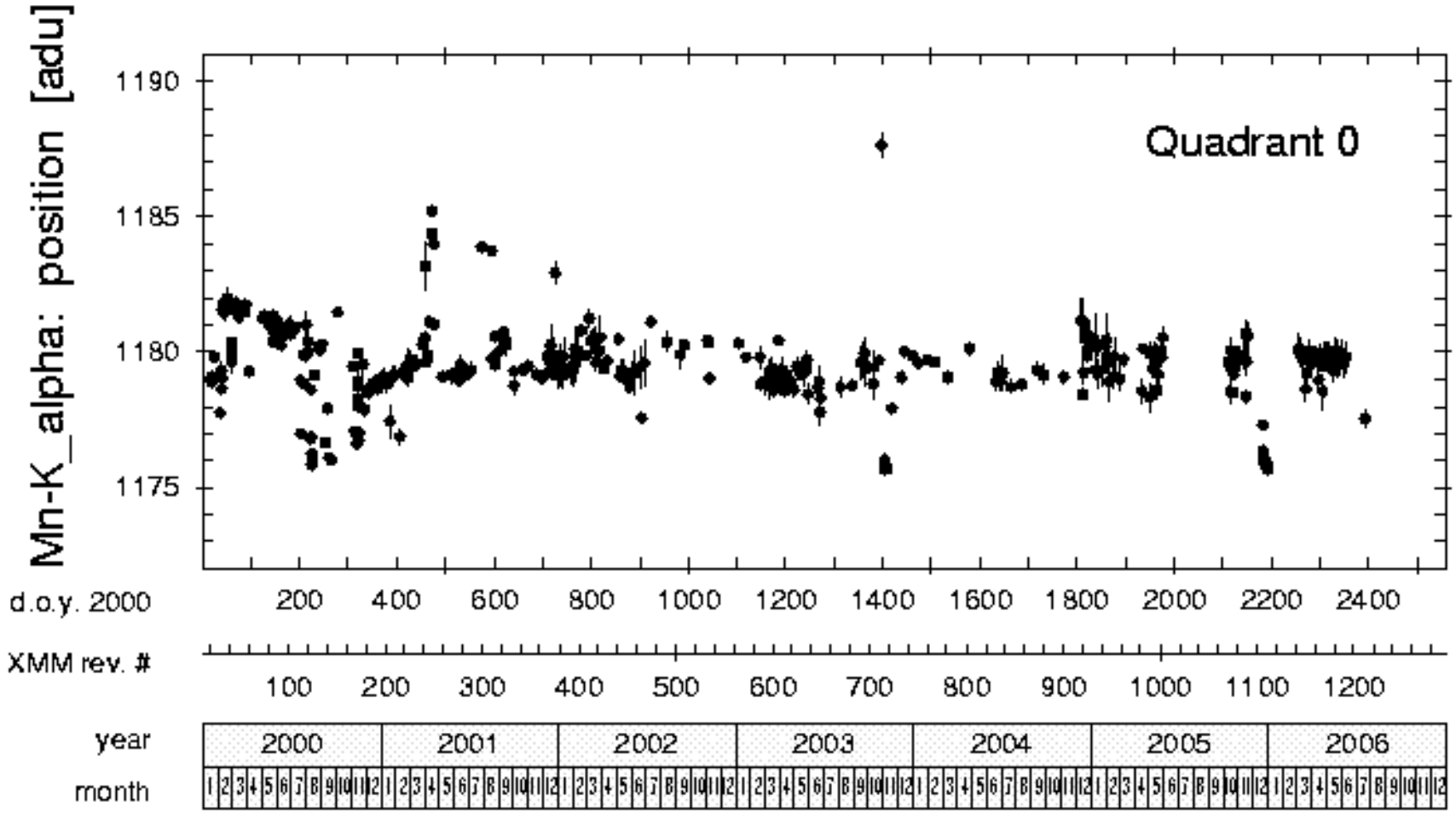


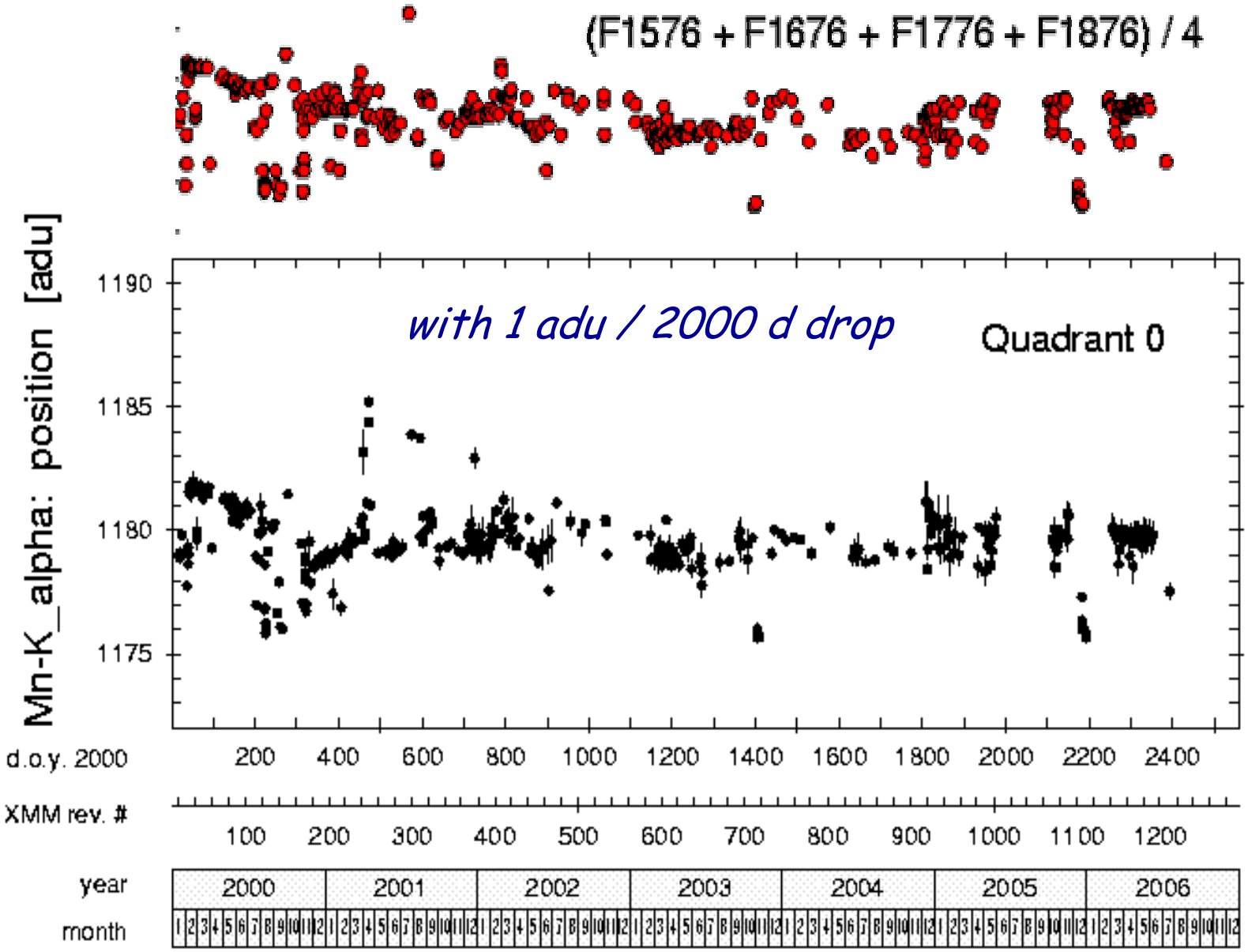
EPIC pn: Jumps in the energy scale

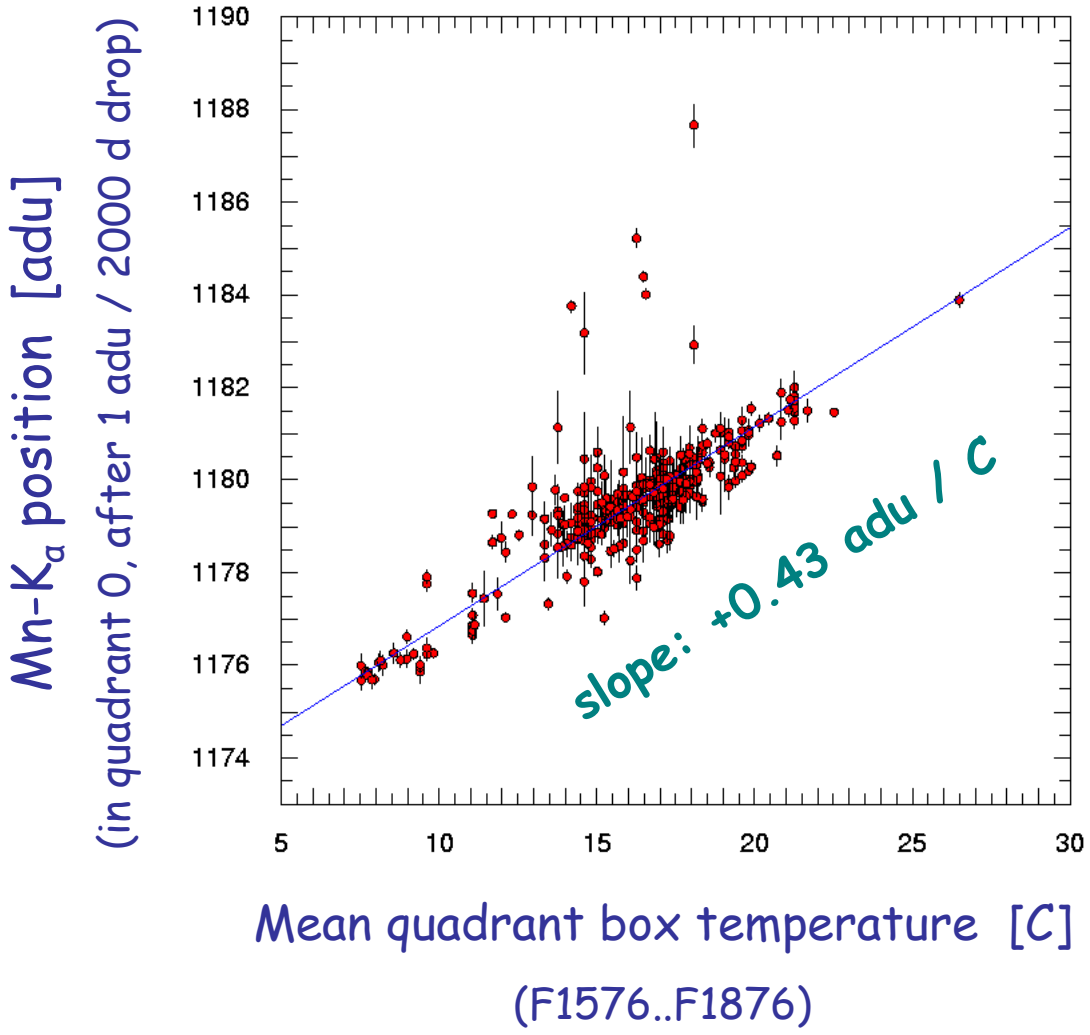
Standard correction



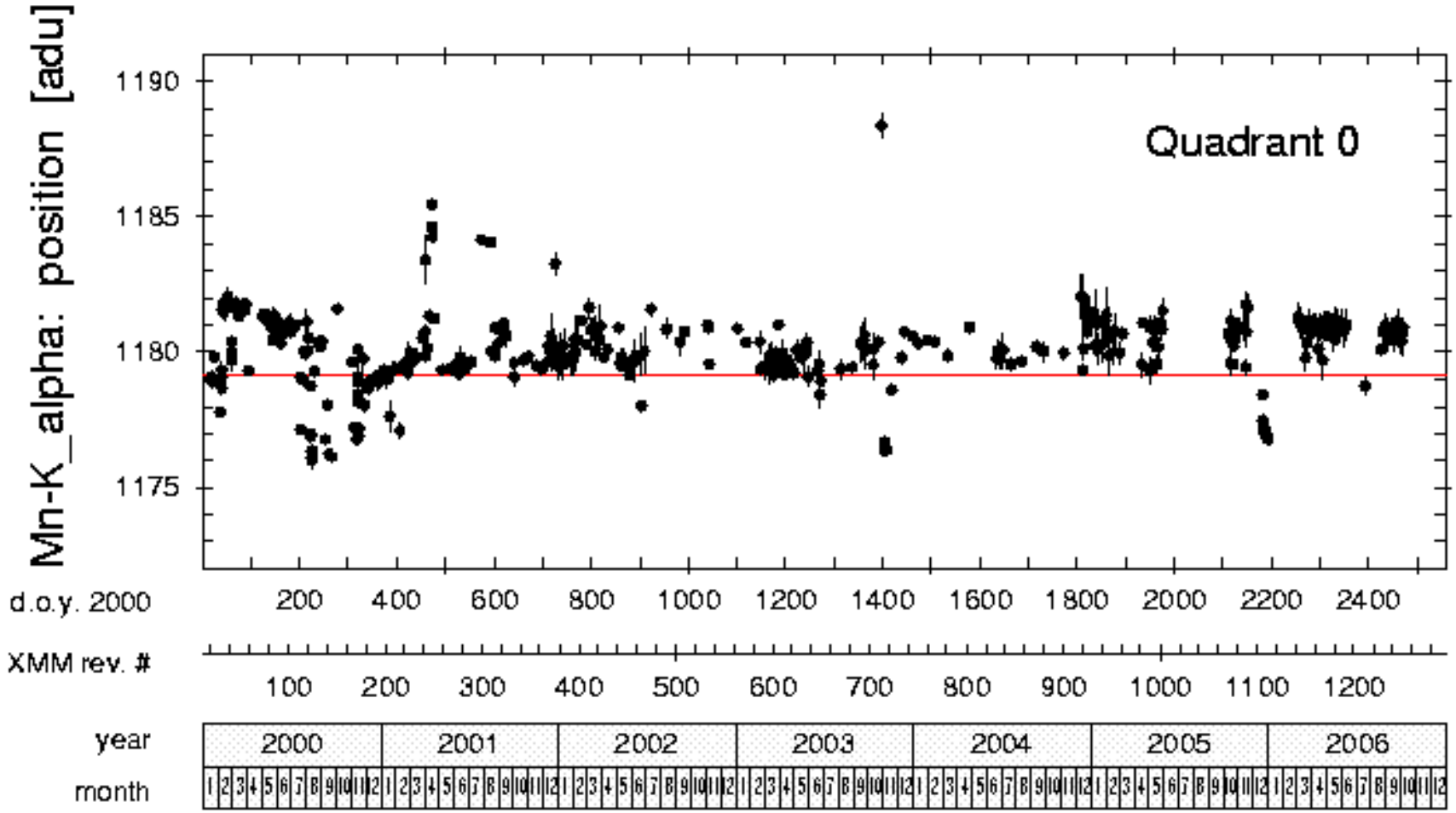
with 1 adu / 2000 d drop



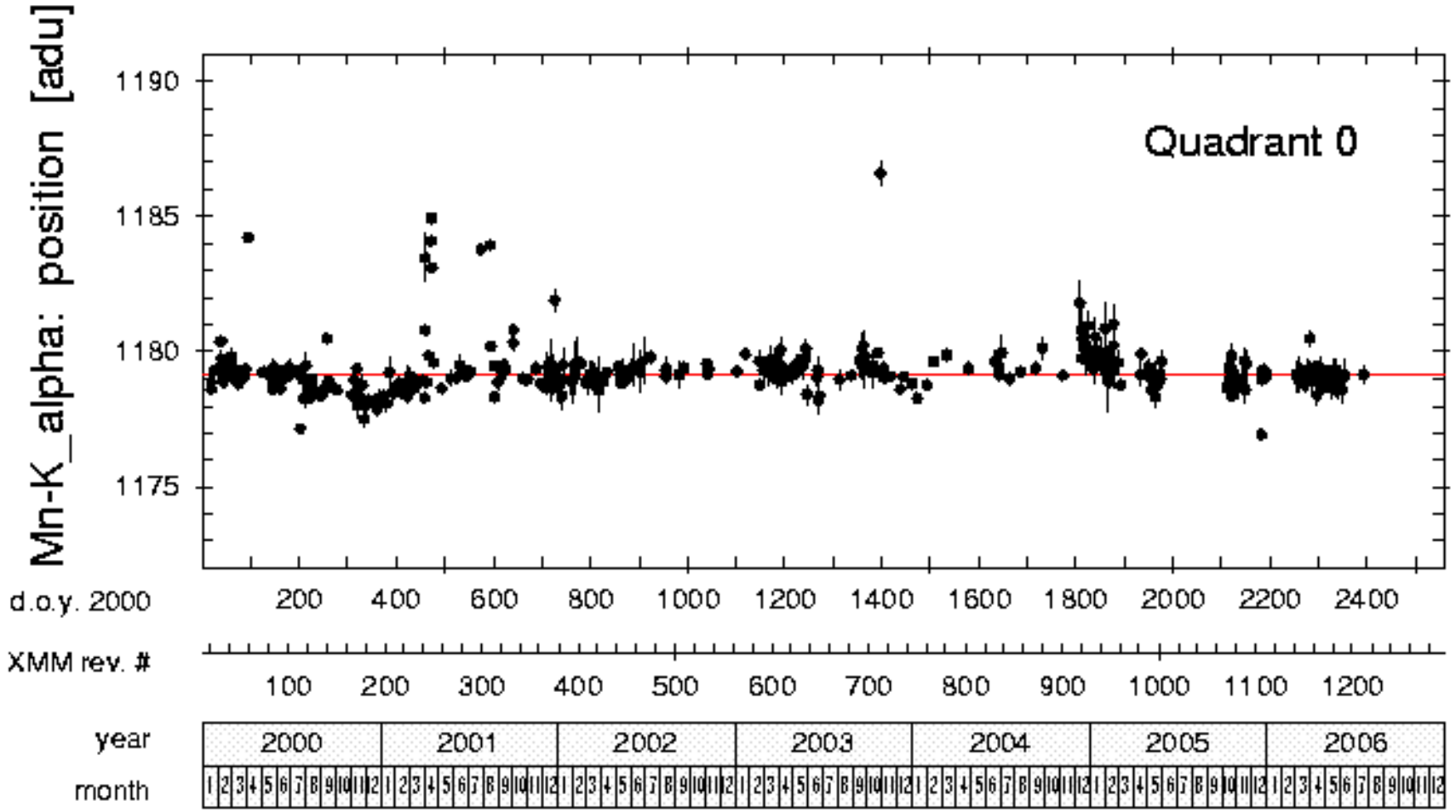

(F1576 + F1676 + F1776 + F1876) / 4
with 1 adu / 2000 d drop
Quadrant 0
Mn-K_alpha: position [adu]
1190
1185
1180
1175
d.o.y. 2000
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
XMM rev. #
100
200
300
400
500
600
700
800
900
1000
1100
1200
year
2000
2001
2002
2003
2004
2005
2006
month


Mn-Kα position [adu]
(in quadrant 0, after 1 adu / 2000 d drop)
1190
1188
1186
1184
1182
1180
1178
1176
1174
5
10
15
20
25
30
slope: +0.43 adu / C
Mean quadrant box temperature [C]
(F1576..F1876)

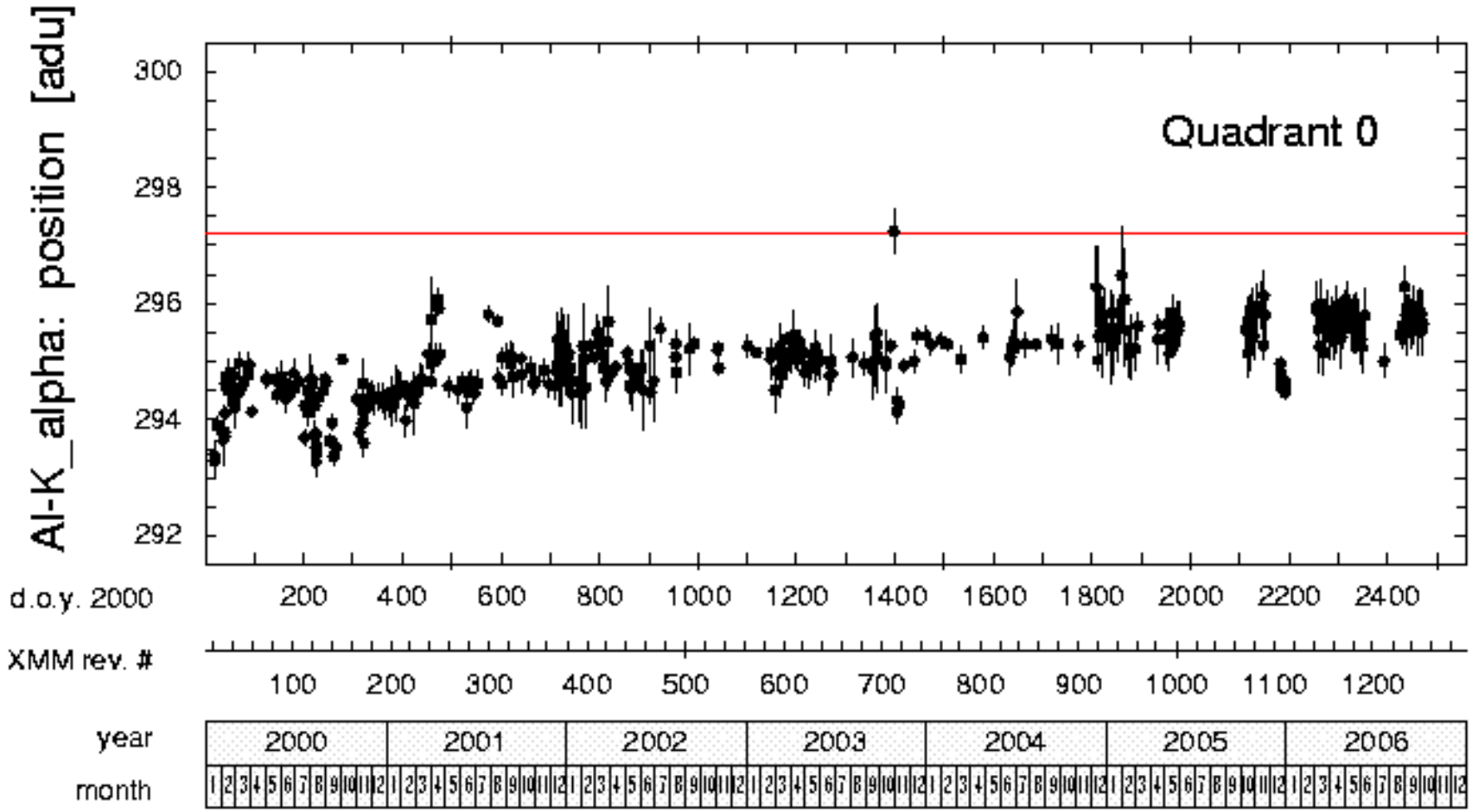
standard correction



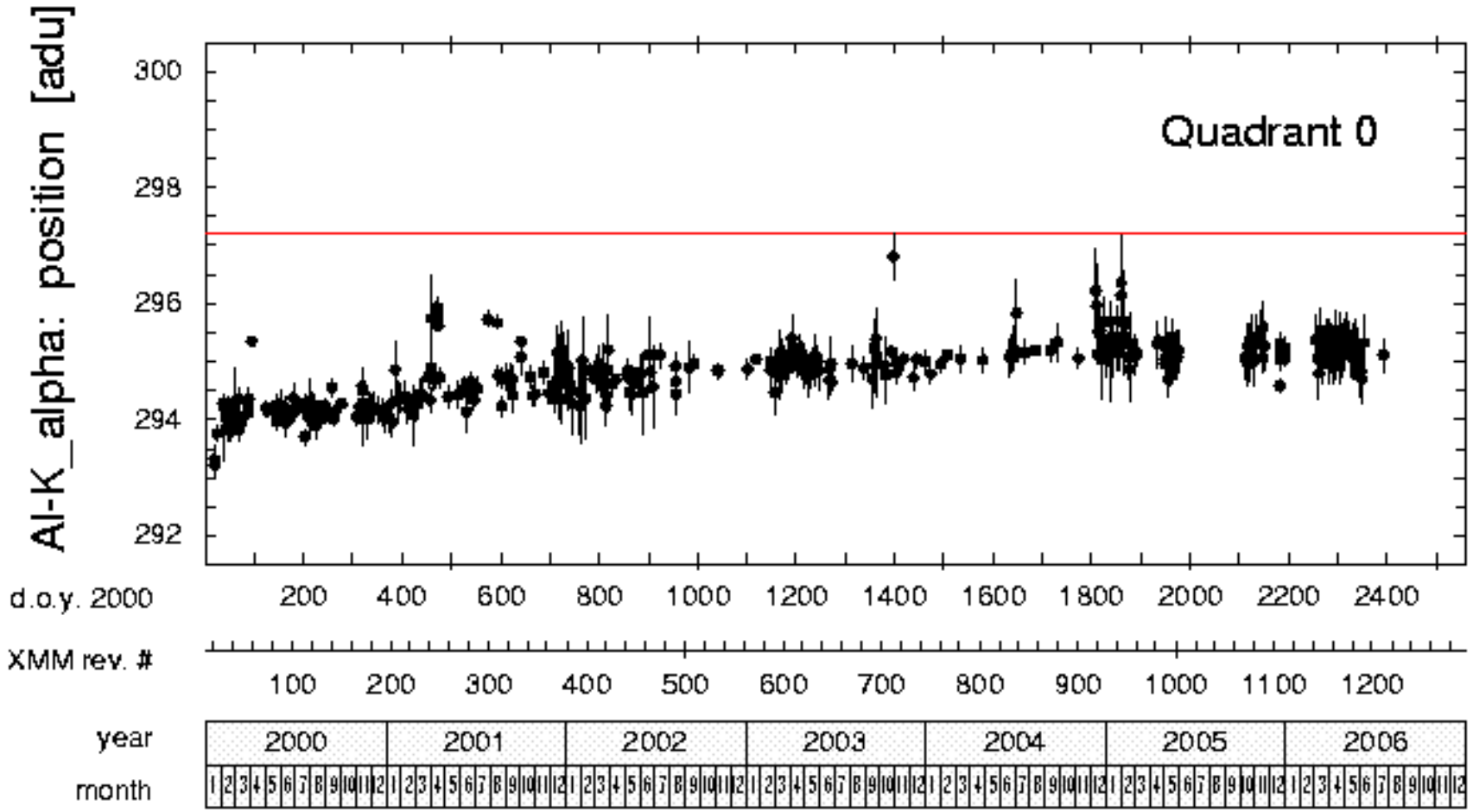
after temperature.. correction



standard correction



after temperature.. correction



Multiply all energies with a factor F:

$$F = (1 - A(t) - B(T_q)) \, C$$

$$A = 4.24 * 10^{-7} \, (t-t_0)/[d]$$

$$B = 3.65 * 10^{-4} \, T_q/[^{o}C]$$

$$C = 1.0057$$

t_0 : 2000-Jan-01

T_q: mean of T(F1576)..T(F1876)

EPIC Calibration Meeting, Mallorca

EPIC pn: Jumps in the energy scale

K. Dennerl, 2006 October 26