Degradation Estimation – Update

IED 20 Dec 2011, completed 11 Jan 2012

The first two figures at the bottom of this report show the uncalibrated signals for LYRA head 2 and head 3 versus time of open cover, in hours. Compared to previous reports,
http://solwww.oma.be/users/dammasch/IED_20101203_DegradationFit_Update.pdf
http://solwww.oma.be/users/dammasch/IED_20110519_LyraDegradationUpdate.pdf
data between May and December 2011 are added here. This is done in order to compare the effect of the first 150 hours of exposure between heads 2 and 3.

The next two figures show uncalibrated signals for LYRA head 2 and head 3 versus time after first light, in days (regardless if cover is open or closed). In this case, the dark currents have been removed. In channels 2-3, 2-4, and 3-3, the asterisks denote observations, while the black lines denote data corrected for solar variation. These corrections are performed by dividing by a normalized channel 3-4.

The last figure shows corrected observations (asterisks), fitted estimates (straight lines), and the original first light levels (dotted lines) of head 2 versus time after first light, in days. The difference between the original level and the estimated degradation is used to correct for degradation. This correction will be updated in the calibration software in the near future.

The LYRA calibration campaigns between May and December of 2011 were processed in order to get an improved degradation estimate for heads 2 and 3. (There are not much data for head 1). From the enclosed figures, it appears that the degradation of head 3 almost came to a halt in this period; April 2011 is marked in the first row of the second figure. Channels 1 and 2 seem to remain almost constant, whereas channels 3 and 4 are more dependent on solar variability, and actually increase.

In the second half of 2011, the cover of head 3 was opened longer than in the first 1.5 years taken together. While head 2 was degrading linearly in the first 5-6 days, head 3 apparently was not. Head 2 degradation happened in early 2010, head 3 degradation happened in short periods over two years. Please allow for some speculation:

So far, it was assumed that the degradation was caused by a dirt layer on the filters, and that this dirt layer was caused by outgassing material and polymerizing UV radiation. If this is really the case then there must be less outgassing material in the second half of 2011. One could ask, why is this so? And would it be a good advice to postpone the cover opening of UV channels' (like our channels 1, 2, 3 - not so much channel 4) for a longer while after launch?

The exact numbers of the degradation, dark currents removed:

```
ch2-1: from 492.0 to 2.0,  >99% loss
ch2-2: from 703.5 to 1.7,  >99% loss
ch2-3: from 16.6  to 1.8,   89% loss
ch2-4: from 37.5  to 27.0,  28% loss

ch3-1: from 920.0 to 700.0, 24% loss
ch3-2: from 545.5 to 408.6, 25% loss
ch3-3: from 273.6 to 180.0, 34%?loss
ch3-4: from 29.8 to 29.8,    0% loss
```

(All values in counts/ms; this was called “kHz” in earlier reports.)

Values for ch2-3, ch2-4, ch3-3 are fitted under the assumption that ch3-4 does not degrade, but instead reflects the real solar irradiance variation. (The observed values in the short-wavelength channels are actually rising because the Sun is more active in Dec 2011 than in Jan 2010.) The 34% loss for ch3-3 is probably too pessimistic, since ch3-3 cannot be expected to have the same amplitude of variability like ch3-4. Ch3-3 must still have a significant contribution >20nm that does not vary as much, while ch2-3, by now, probably does not have have this contribution any more.

It is not clear why the Zirconium ch*-4 should degrade at all, but maybe – while the flare sizes do not decrease - there are some lines (a little below 20nm ?) that are affected by the above-mentioned dirt layer on the filters. For the Aluminium ch*-3 this has to be the case, because it ranges up to 80nm, and this is probably exactly the part that has more or less

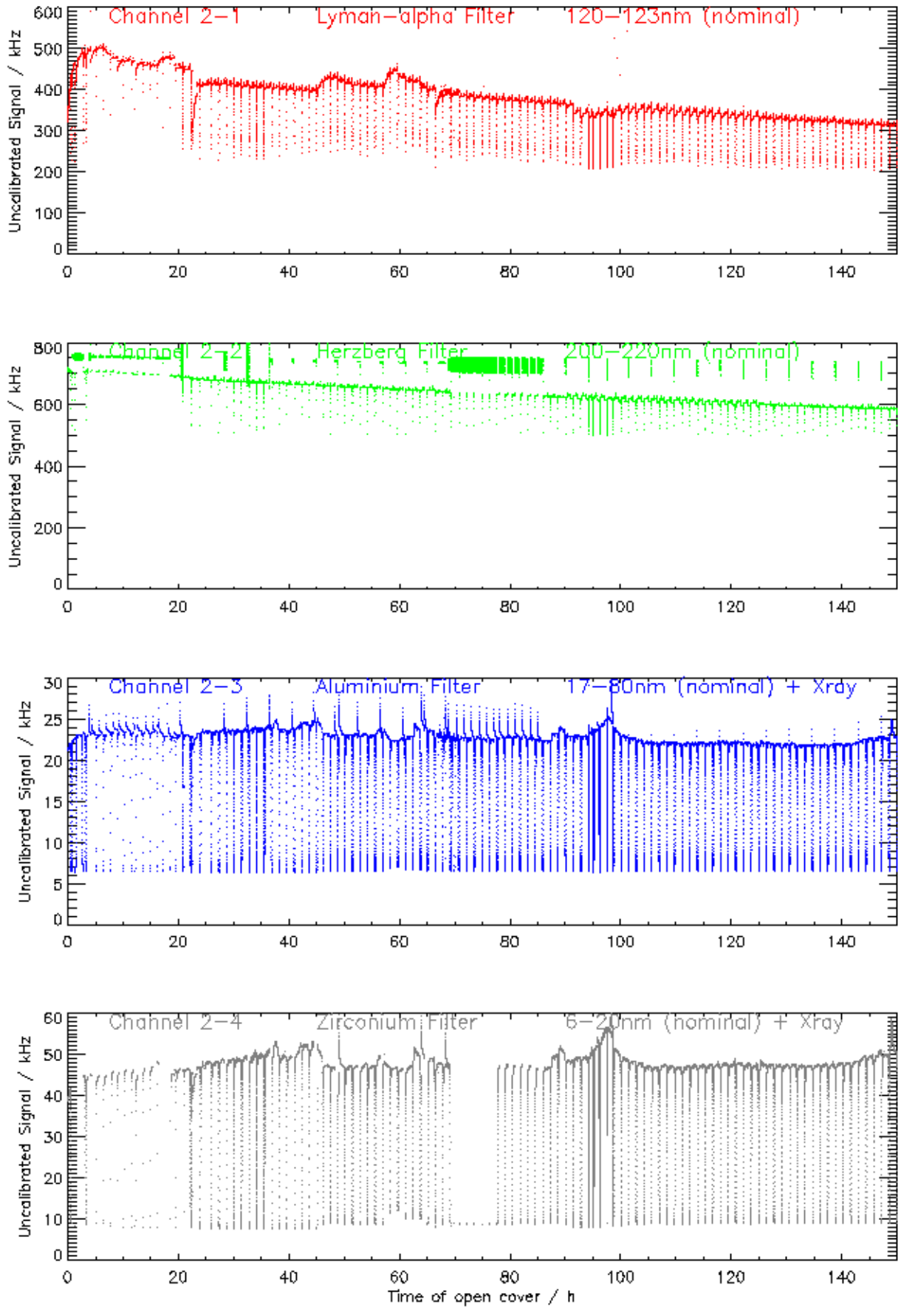
vanished in ch2-3, while the contribution below 20nm is still there.

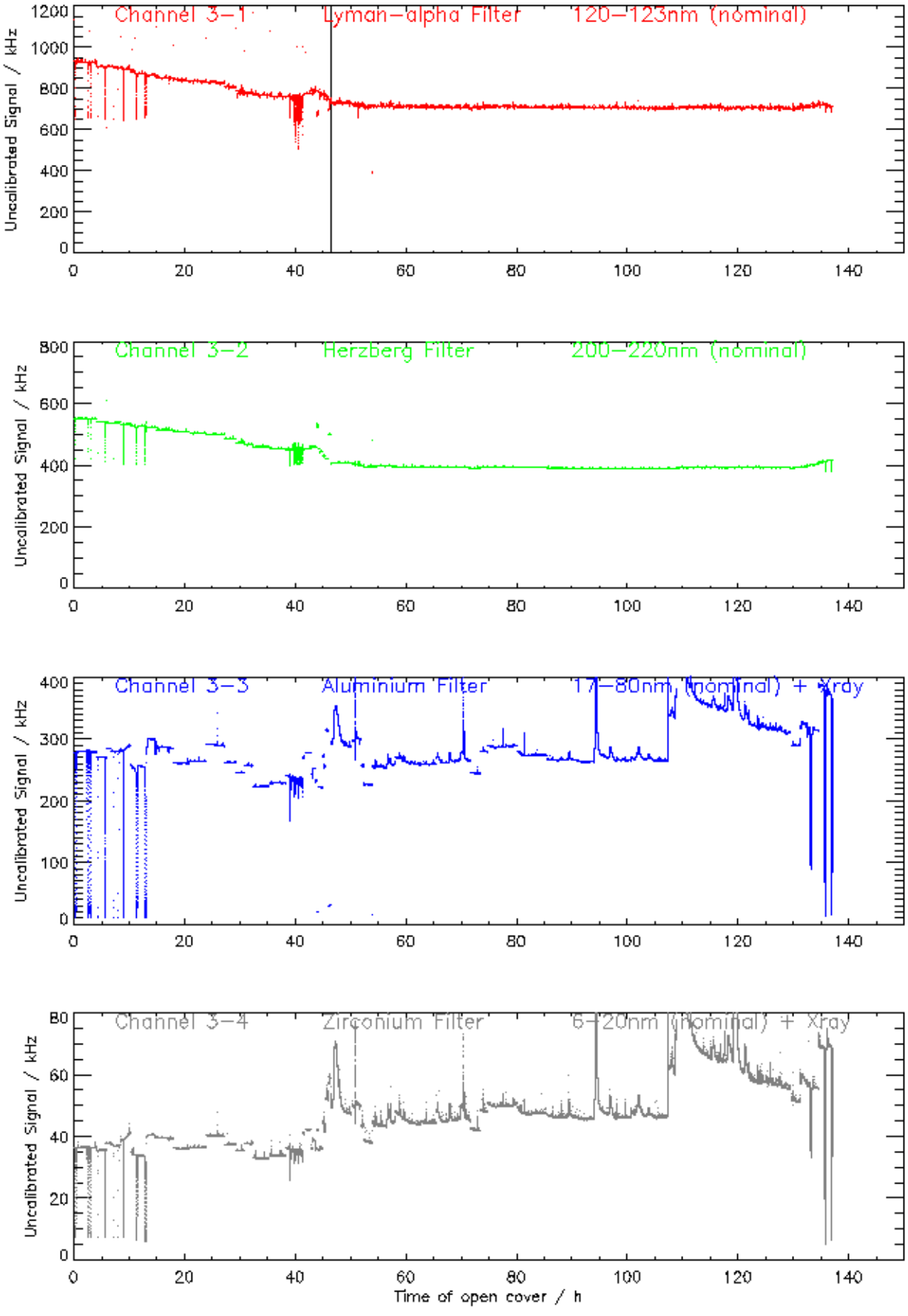
Did the degradation slow down in April 2011 or earlier? Considering the two plots below, where irradiance (minus dark current) is shown vs. day and not vs. time of open cover - which makes a difference for Head 3 - then it appears that the degradation already slowed down around day 100.

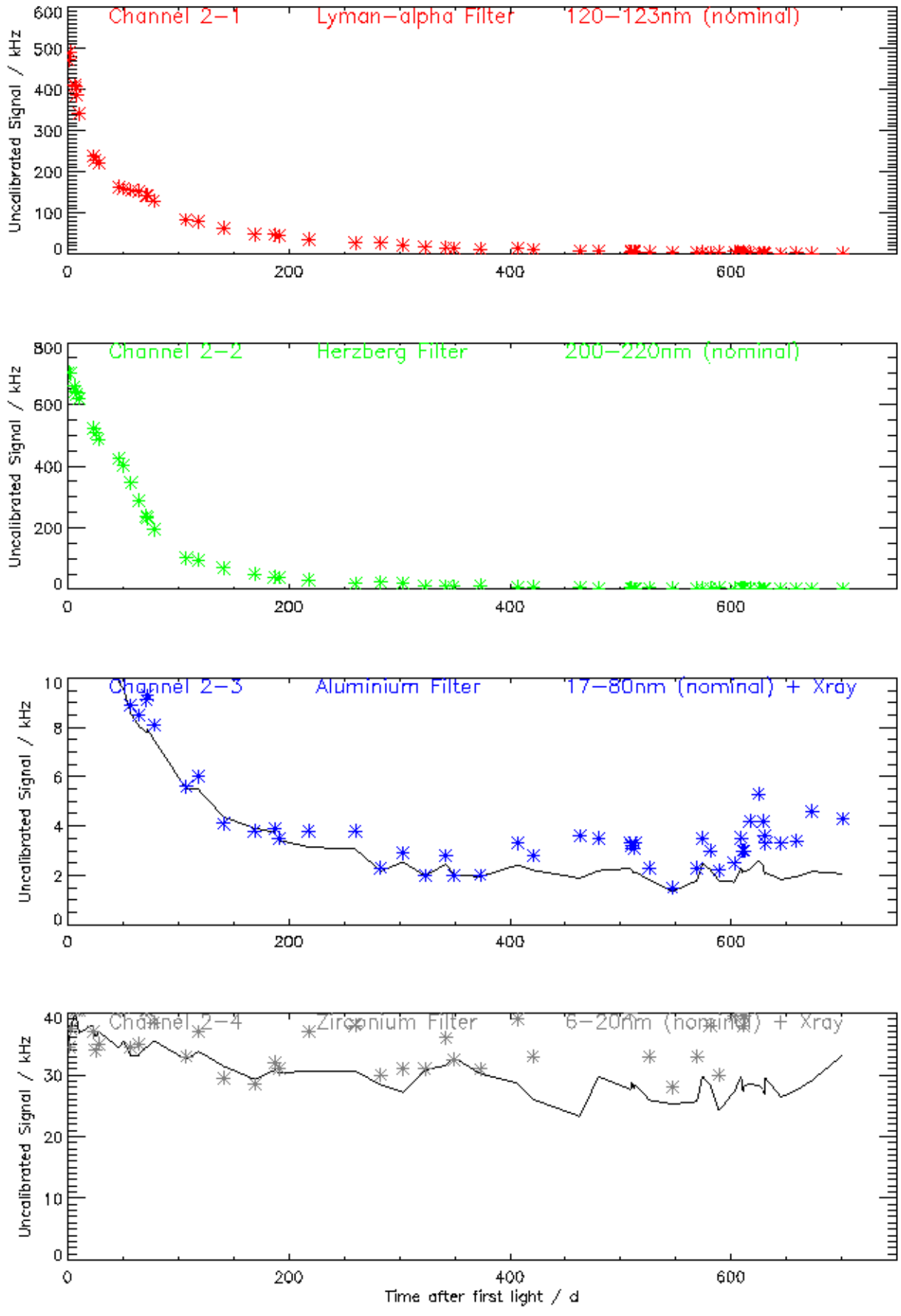
The plots also show that the difference in degradation is not caused by differences in dark currents - these are subtracted here. And in addition: The dark currents only play a minor role in the current values of head 3. Finally, the dark current of ch3-2 is even constant, i.e. temperature-independent.

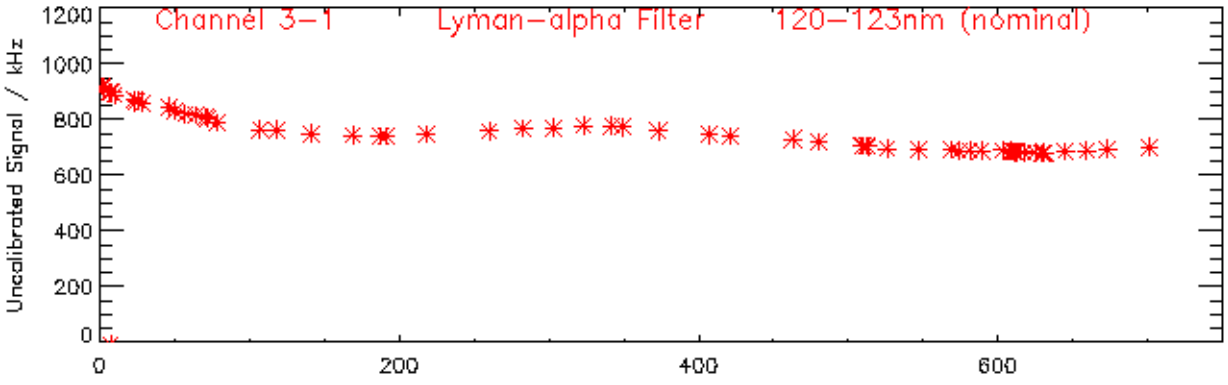
The downward peaks in the beginning of the curve are parts of occultations within the month of Jan 2010. They do not have any meaning concerning degradation.

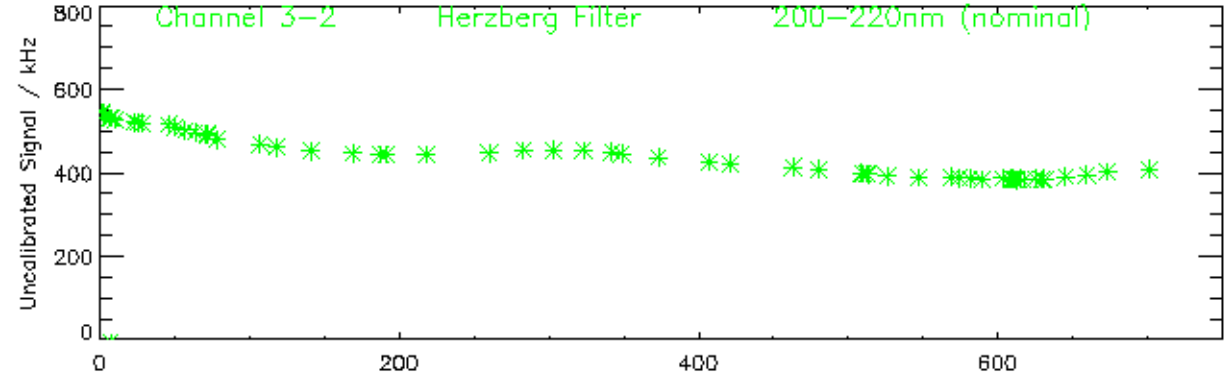
Apparently, solar variability can be observed in Lyman-alpha ch3-1 and Herzberg ch3-2, at least one would not expect these channels to recover. Since beginning of October 2011, their values increased from approx 690 to 700 counts/ms (ch3-1) and from 390 to 408 counts/ms (ch3-2). Again, dark currents are subtracted, and the dark current of ch3-2 is constant anyway. Please remember that ch3-1 has a large contribution from non-UV, maybe that is why the variation is smaller than in ch3-2.

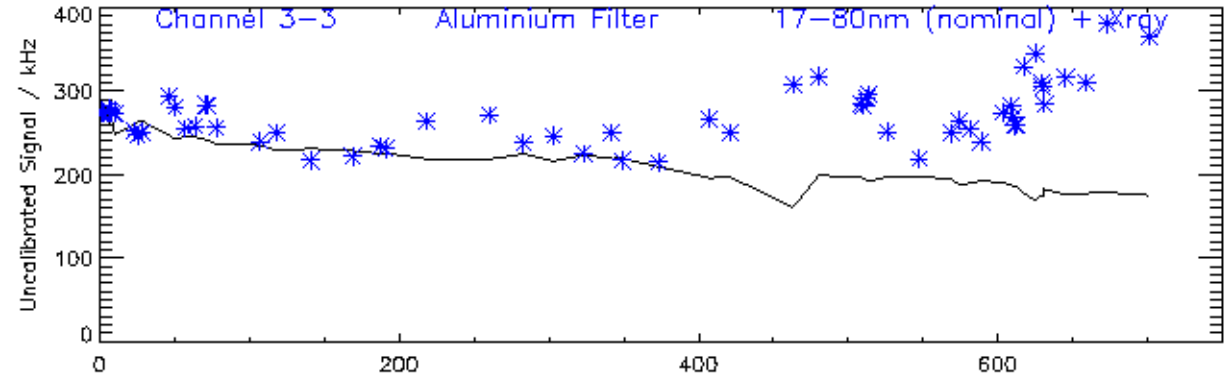

Channel 2-1
Lyman-alpha Filter
120-123nm (nominal)
Channel 2-2
Herzberg Filter
200-220nm (nominal)
Channel 2-3
Aluminium Filter
17-80nm (nominal) + Xray
Channel 2-4
Zirconium Filter
6-20nm (nominal) + Xray
Uncalibrated Signal / kHz
Time of open cover / h

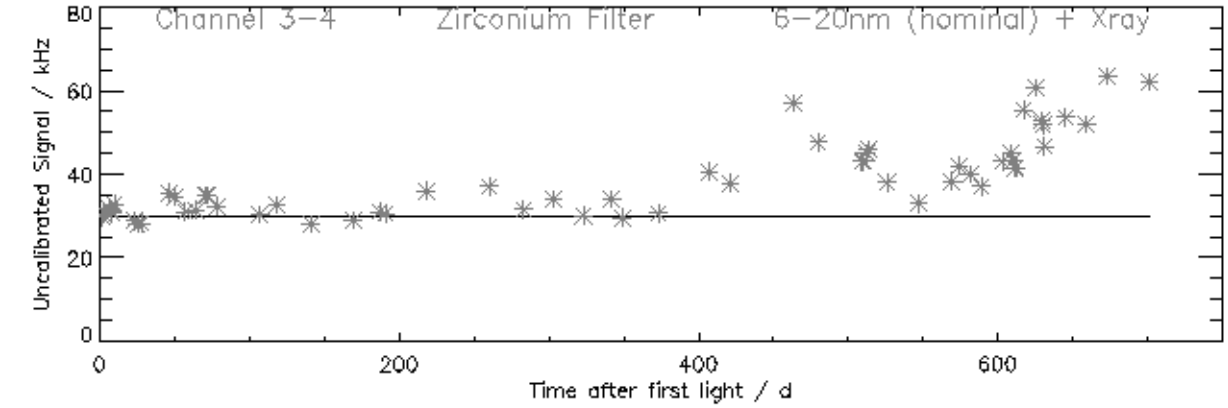

Channel 3-1 Lyman-alpha Filter 120-123nm (nominal)
Channel 3-2 Herzberg Filter 200-220nm (nominal)
Channel 3-3 Aluminium Filter 17-80nm (nominal) + Xray
Channel 3-4 Zirconium Filter 6-20nm (nominal) + Xray
Uncalibrated Signal / kHz
Time of open cover / h

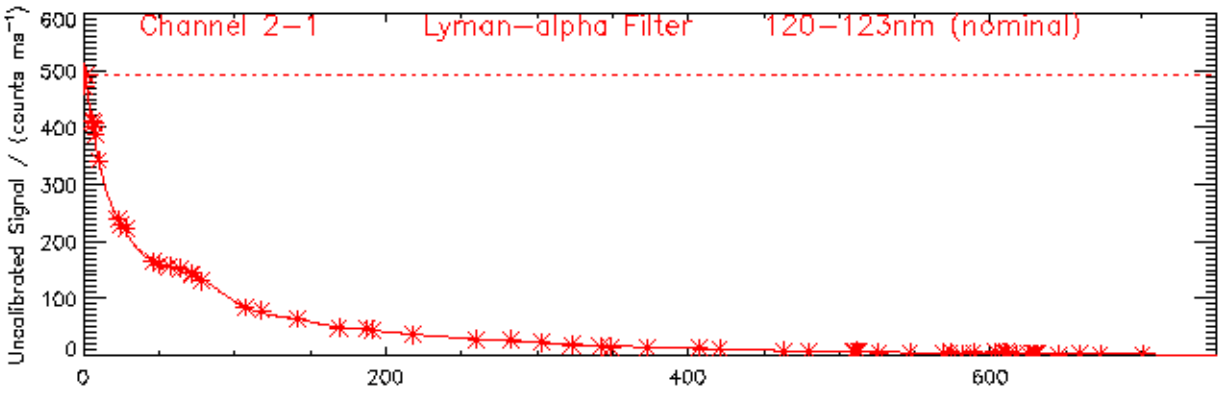

Channel 2-1 Lyman-alpha Filter 120-123nm (nominal)
Uncalibrated Signal / kHz
Channel 2-2 Herzberg Filter 200-220nm (nominal)
Uncalibrated Signal / kHz
Channel 2-3 Aluminium Filter 17-80nm (nominal) + Xray
Uncalibrated Signal / kHz
Channel 2-4 Zirconium Filter 6-20nm (nominal) + Xray
Uncalibrated Signal / kHz
Time after first light / d

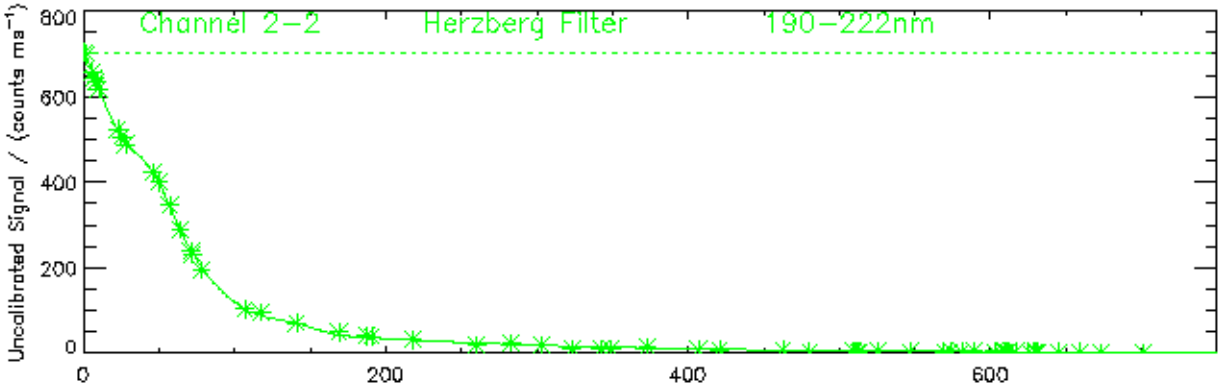

Channel 3-1
Lyman-alpha Filter
120-123nm (nominal)
Uncalibrated Signal / kHz
0
200
400
600
800
1000
1200

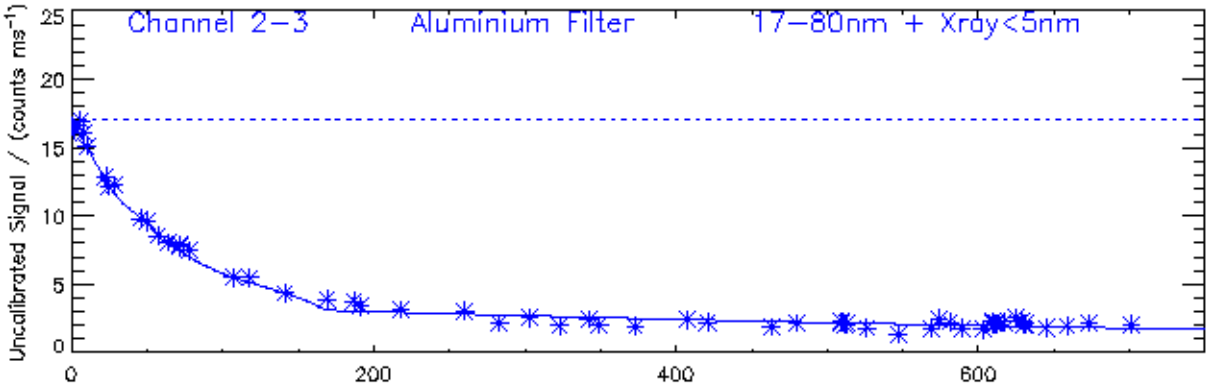

Channel 3-2
Herzberg Filter
200-220nm (nominal)
Uncalibrated Signal / kHz
0
200
400
600
800

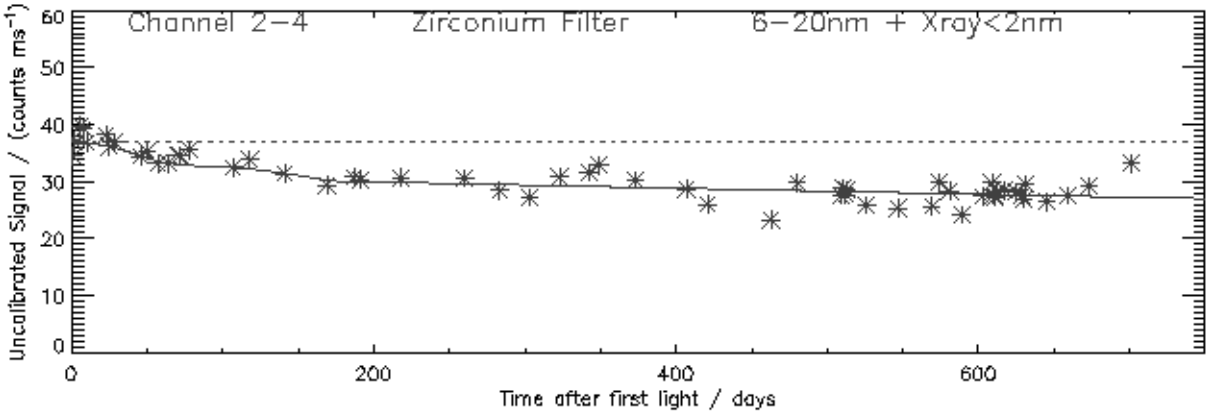

Channel 3-3
Aluminium Filter
17-80nm (nominal) + Xray
Uncalibrated Signal / kHz
0
100
200
300
400


Channel 3-4
Zirconium Filter
6-20nm (nominal) + Xray
Uncalibrated Signal / kHz
0
20
40
60
80
0
200
400
600
Time after first light / d


Channel 2-1
Lyman-alpha Filter
120-123nm (nominal)
Uncalibrated Signal / (counts ms^{-1})
0
100
200
300
400
500
600
0
200
400
600


Channel 2-2
Herzberg Filter
190-222nm
Uncalibrated Signal / (counts ms^{-1})
0
200
400
600
800
0
200
400
600


Channel 2-3
Aluminium Filter
17-80nm + Xray<5nm
Uncalibrated Signal / (counts ms^{-1})
0
5
10
15
20
25
0
200
400
600


Channel 2-4
Zirconium Filter
6-20nm + Xray<2nm
Uncalibrated Signal / (counts ms^{-1})
0
10
20
30
40
50
60
0
200
400
600
Time after first light / days