LYRA degredation status after ~4500 days

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This report is based on earlier reports, for explanations see here:
https://www.sidc.be/users/dammasch/IED_20201124_Degrad4000.pdf
https://www.sidc.be/users/dammasch/IED_20180223_LyraStatus3000.pdf
It uses recent calibration campaigns between Sep 2020 and Mar 2022.

These additional campaign values are based on the latest estimates of dark currents, see here:
https://www.sidc.be/users/dammasch/IED_20220502_DarkCurrents2022.pdf

Altogether, the report uses up to 246 campaigns (beginning in Jan 2010) where units 1, 2, and 3 were observing in parallel. With the help of these observations, the degradation development of all three units was estimated with polynomial and other functions. For this purpose the short-wavelength channels (*-3 and *-4) were corrected for solar activity.

Values up to day #5000 are extrapolated. It is assumed that all channels of unit 2 and the long-wavelength channels of unit 3 will not change any more. - The previous estimate of ch2-4 may have been a bit too pessimistic.

First Light day #1 is 06 Jan 2020, day #4452 is 15 Mar 2022, i.e. the last campaign used here. The following table shows the current estimated degradation of the quiet-Sun signal ("baseline") between these days: Values before and after are in counts/ms, percentages show what is left from the original signal at First Light.

ch1-1	1300.0 -> 439.0	34%
ch1-2	613.4 -> 238.0	39%
ch1-3	17.2 -> 4.8	28%
ch1-4	30.3 -> 16.8	55%
ch2-1	492.0 -> (2.5)	<1%
ch2-2	703.5 -> (1.5)	<1%
ch2-3	16.6 -> 0.1	<1%
ch2-4	37.5 -> 4.0	11%
ch3-1	920.0 -> 467.0	51%
ch3-3	545.5 -> 2.0	<1%
ch3-3	273.6 -> 16.6	6%
ch3-4	30.0 -> 10.9	36%

The figures on the following three pages show the development for units 1, 2, and 3.

Other than earlier degradation reports, this report will also discuss the development of the active-region signal, and the development of the flare signal. Since different spectral intervals are responsible for these signals, their degradation is expected to be different than the degradation of the baseline.

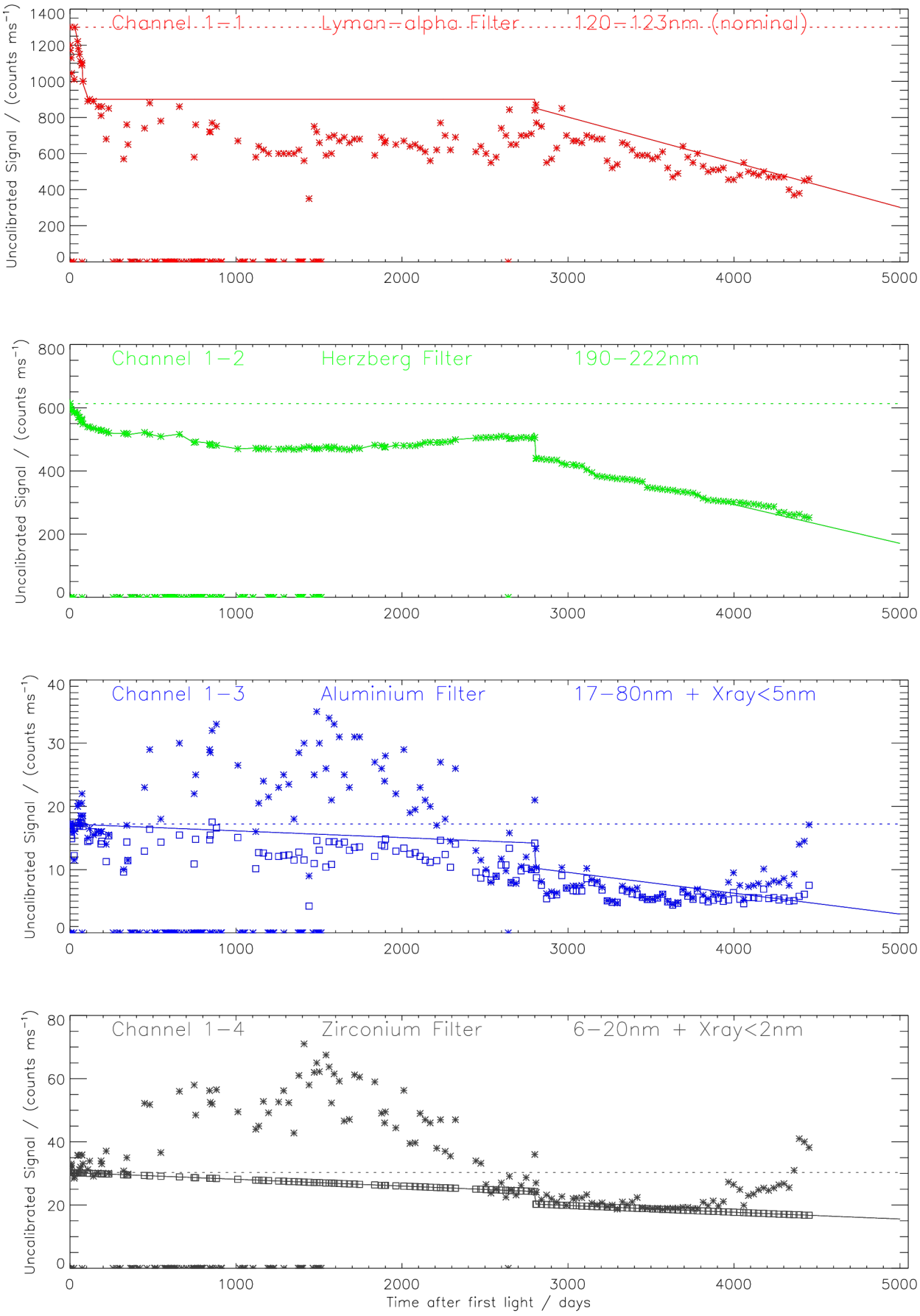

Figure 1: Baseline degradation of LYRA unit 1

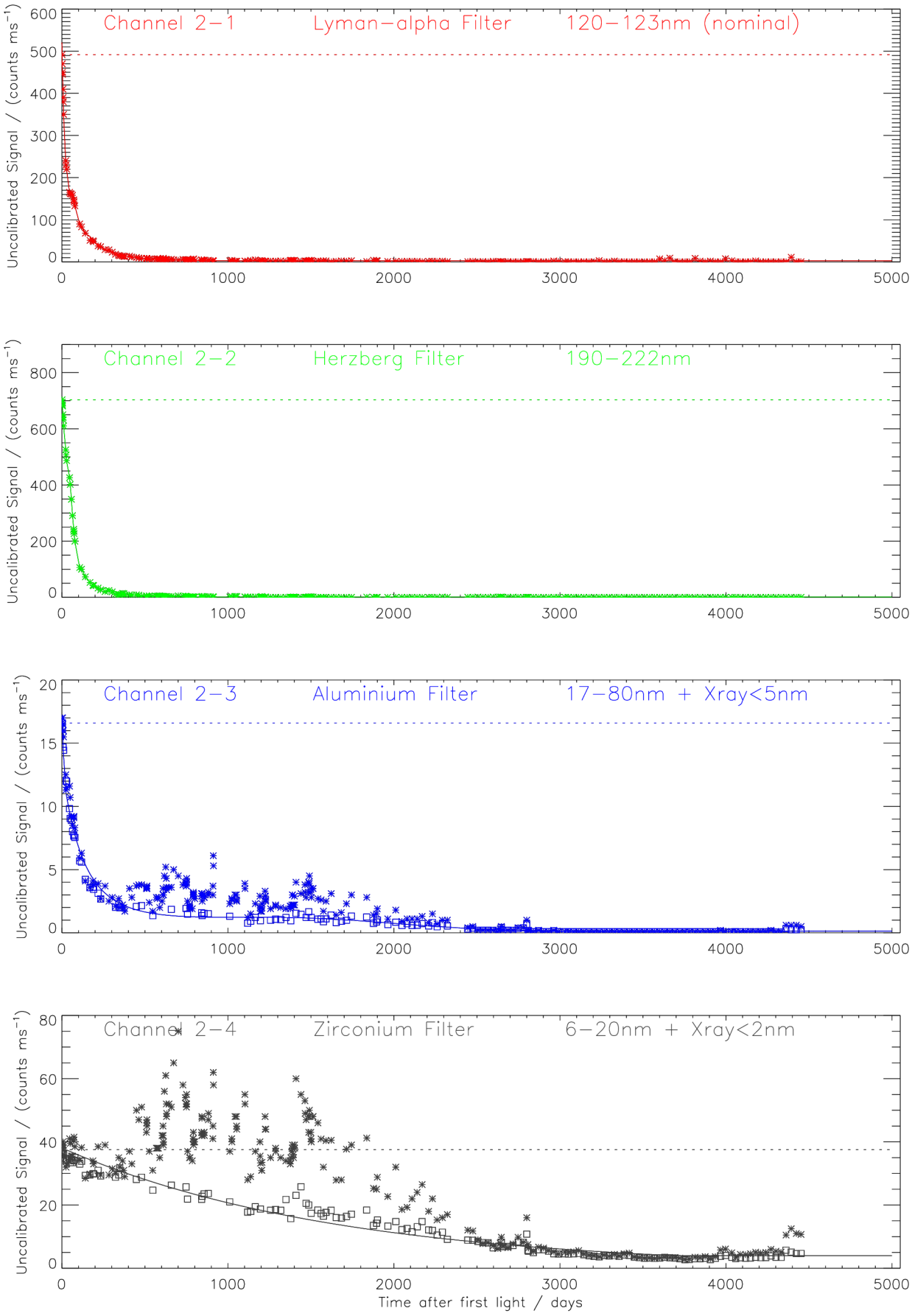

Figure 2: Baseline degradation of LYRA unit 2

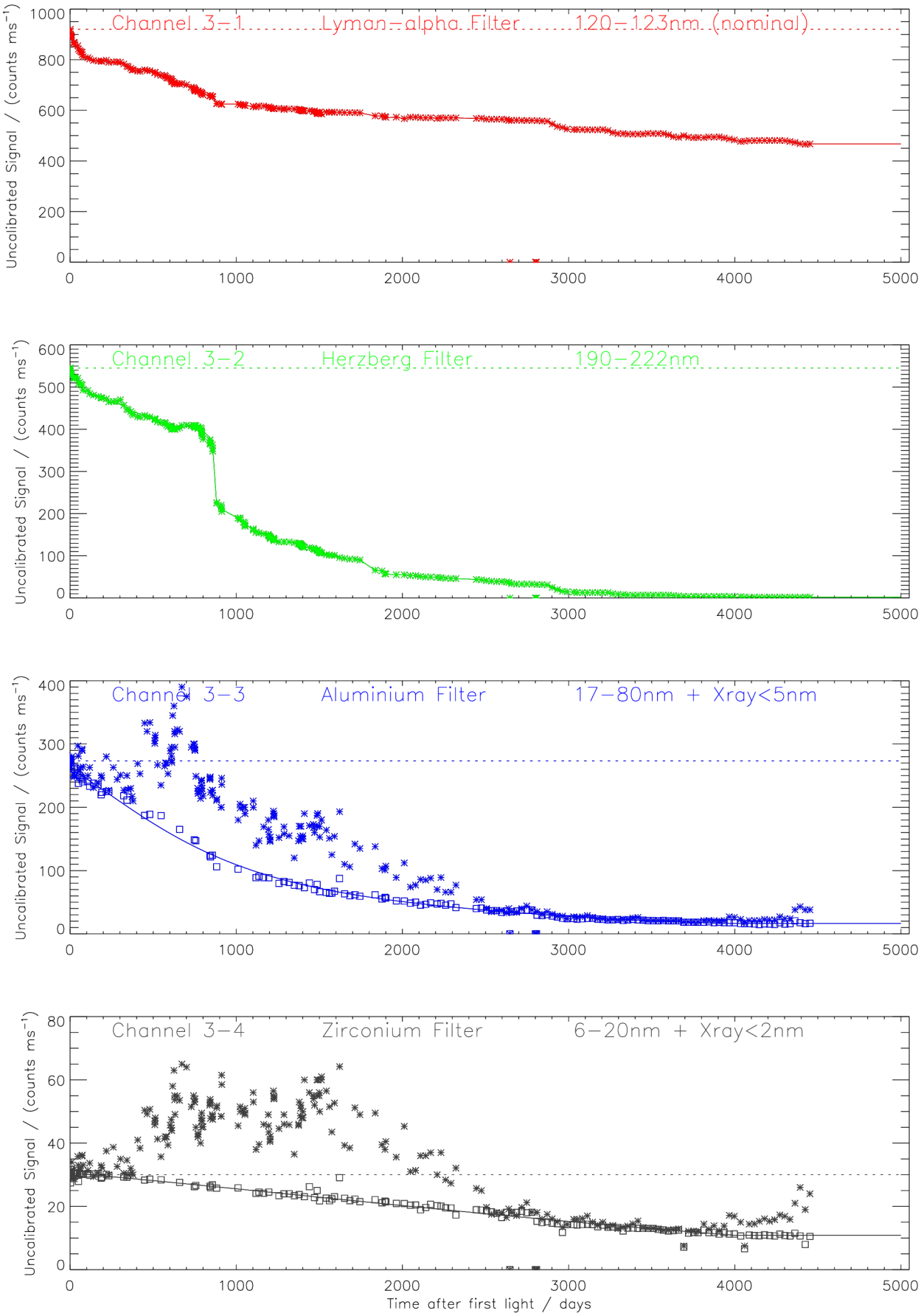

Figure 3: Baseline degradation of LYRA unit 3

Degradation of the active region signal.

The figures on the following two pages show the normalized irradiances for channels *-3 and channels *-4 for the various campaigns. Normalized means: The estimated degradation is added to the observed irradiances, and then all values are divided by the First Light value. Ch3-3 is a bit problematic, because of its long saturation time, which is usually longer than the campaign time. Some campaigns did not include unit 1, these appear around zero.

The marked intervals show Mar 2011 and Mar 2022, both at a comparable phase of solar cycle 24 and 25, i.e. fifteen months after the assumed solar minimum, respectively.

The following table shows the normalized irradiances above 1.0 (which represents the solar minimum level) before and after. The percentages show what remained from the active region signal, assuming that the first unit 1 value represents 100% for all ch*-3 and all ch*-4:

ch1-3	0.72 -> 0.72	100% -> 100%
ch2-3	0.11 -> 0.02	15% -> 3%
ch3-3	0.55 -> 0.08	76% -> 11%
ch1-4	0.75 -> 0.74	100% -> 99%
ch2-4	0.56 -> 0.18	75% -> 24%
ch3-4	0.73 -> 0.44	97% -> 59%

This means that the response to active regions practically has not changed in unit 1 during the 11-year solar cycle. In unit 3, the response had already somewhat diminished in Mar 2011 and more so in Mar 2022, but more significantly for channel 3 than for channel 4. The same development, but quantitatively more serious, can be observed in unit 2, which was constantly exposed. But in all cases, the loss of response is less dramatic than for the baseline.

The reason for this behaviour is: Unit 2 was longer exposed than unit 3, which in turn was longer exposed than unit 1. The longer wavelength intervals degrade faster than the shorter wavelength intervals, thus channels *-1 and *-2 are stronger affected than channels *-3, which are stronger affected than channels *-4.

The response of the short-wavelenth channels to solar activity can be seen on the following two pages.

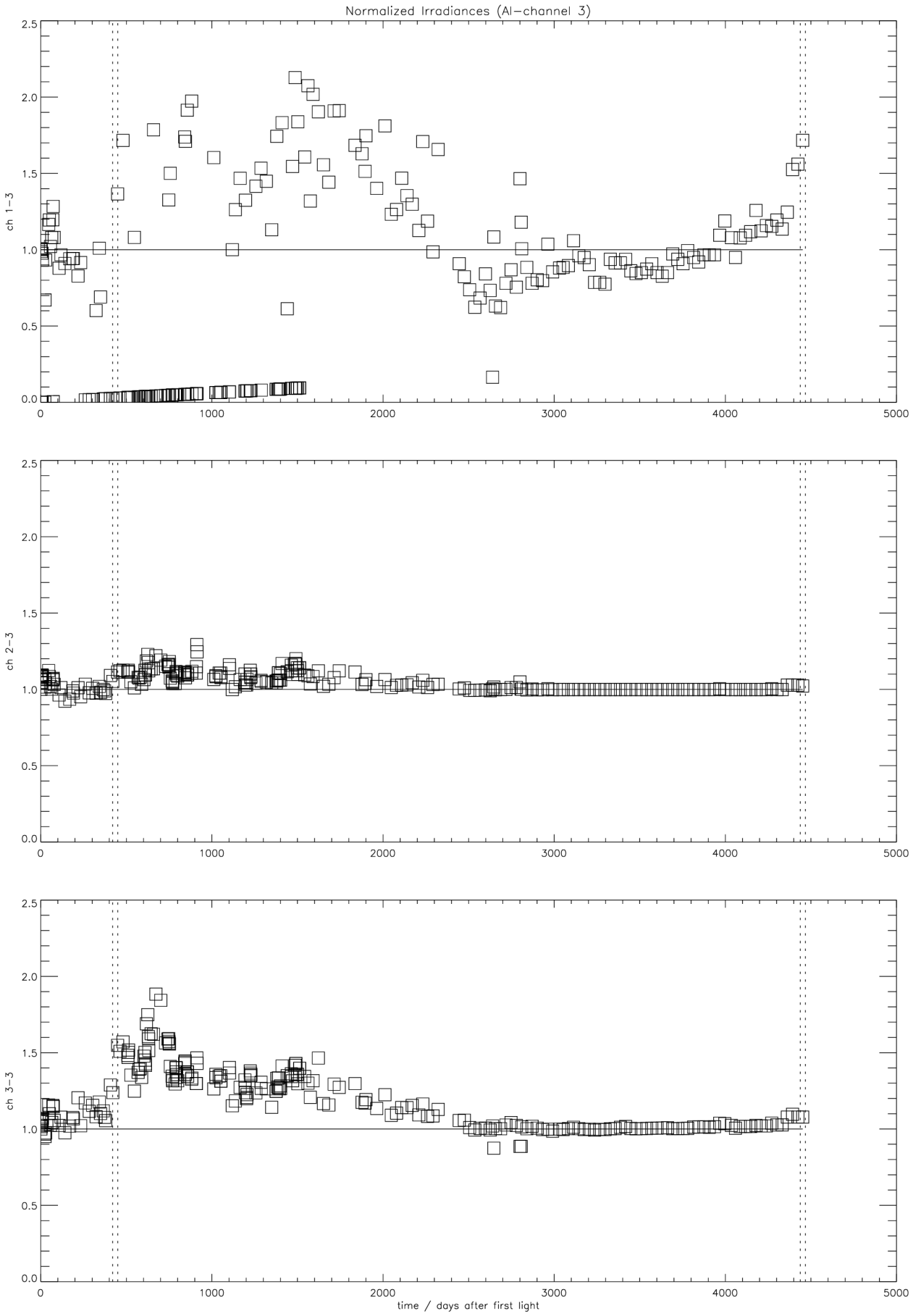

Figure 4: Response of channels *-3 to solar activity

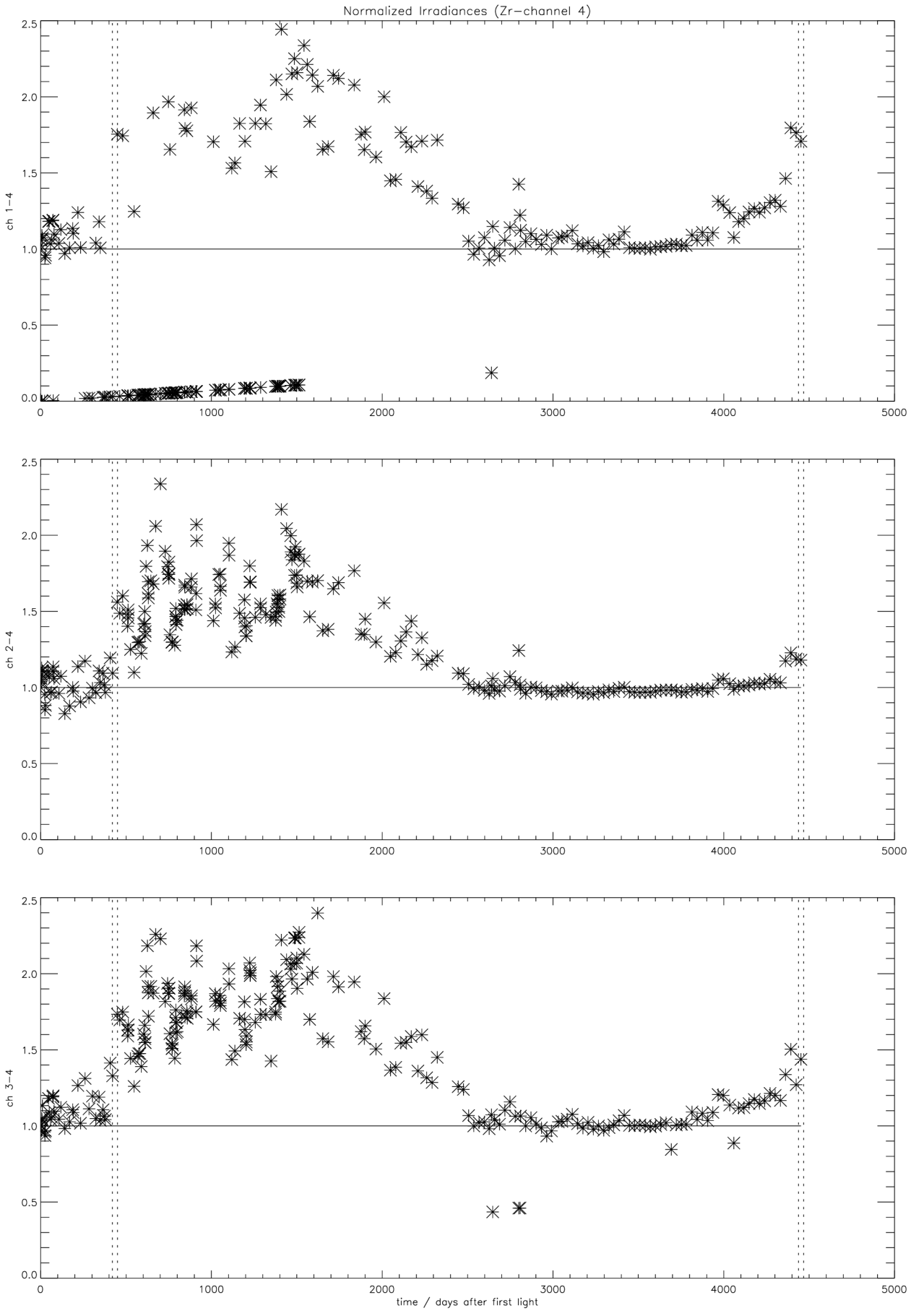

Figure 5: Response of channels *-4 to solar activity

Degradation of the flare response

Some work has already been done on this topic, see here:
https://www.sidc.be/users/dammasch/IED_20190730_FlareStrength.pdf
This includes the development of unit 2 until 2019, as well as some 2017 and 2019 campaigns with unit 1 and 3.

[Rest: TBD]