

## Linearity of LYRA Channels For Expected Solar Variations

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The linear behavior of all LYRA channels was tested within the BESSY campaigns of 2006, cf. reports:

<http://solwww.oma.be/users/dammasch/RP-ROB-LYR-0132-GI-March2006.PDF> and

<http://solwww.oma.be/users/dammasch/RP-ROB-LYR-0132-NI-March2006.PDF>

After the expected performance of the LYRA channels was estimated with the help of sample spectra and the radiometric model, cf. report:

[http://solwww.oma.be/users/dammasch/IED\\_20080416\\_LYRA\\_Expected\\_Variations.pdf](http://solwww.oma.be/users/dammasch/IED_20080416_LYRA_Expected_Variations.pdf)

the question was raised whether the expected performance will take place in an interval in which the measurements suggest a linear behavior.

This was tested by using minimum and the maximum samples of solar spectra from the radiometric simulations. (*Remark:* These minima and maxima may be subject to change in the future, when new, i.e. recently calibrated samples from TIMED/SEE and SORCE will be used.) Naturally, the way to compare simulations and measurements is restricted: The BESSY linearity measurements were taken at some fixed wavelengths, while the simulations to calculate the expected LYRA performance were done with the nominal (usually broader) spectral intervals.

To make things comparable, the spectral flux (in  $W\ m^{-2}\ nm^{-1}$ ) from the minimal and maximal TIMED/SEE solar spectra at the measured wavelengths was multiplied with the area of the 3-mm precision hole ( $7.06858\ m^{-2}$ ) to receive the expected input power (in nW), and then multiplied with the responsivity (in  $A\ W^{-1}$ ) as chosen earlier (see below), to receive the expected LYRA signal (in nA). These values were compared to the values chosen for spectral power input during the BESSY campaigns, and the measured LYRA output. Slight differences come as no surprise, since the spectral responsivity values have been updated meanwhile, see report:

[http://solwww.oma.be/users/dammasch/IED\\_20080115\\_LYRA\\_Responsivity\\_Update.pdf](http://solwww.oma.be/users/dammasch/IED_20080115_LYRA_Responsivity_Update.pdf)

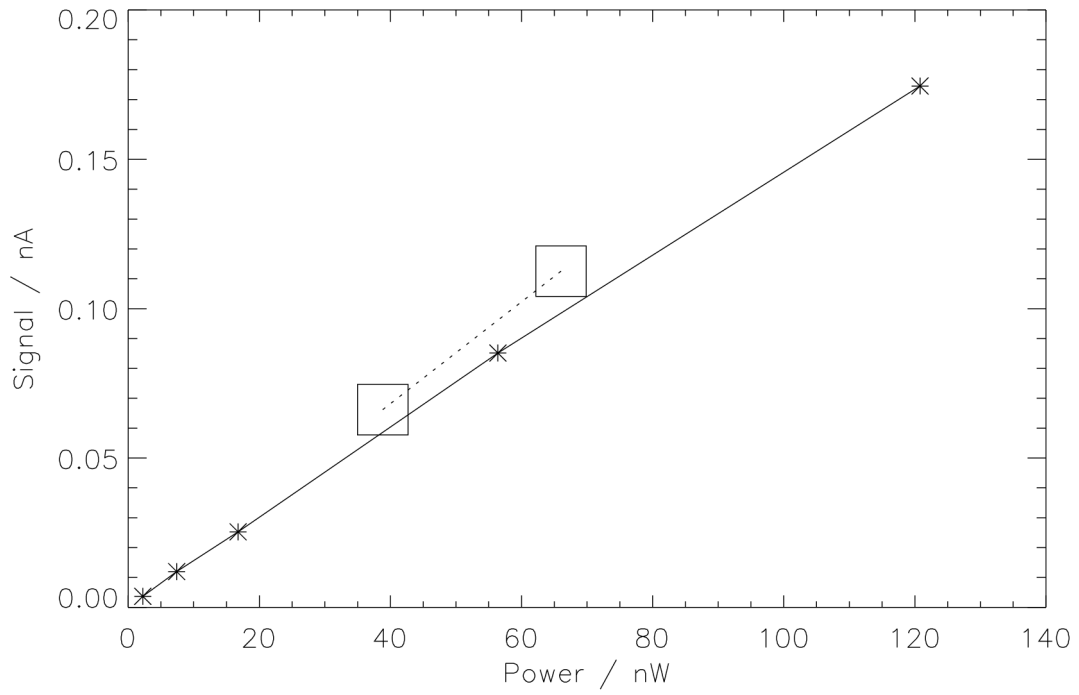
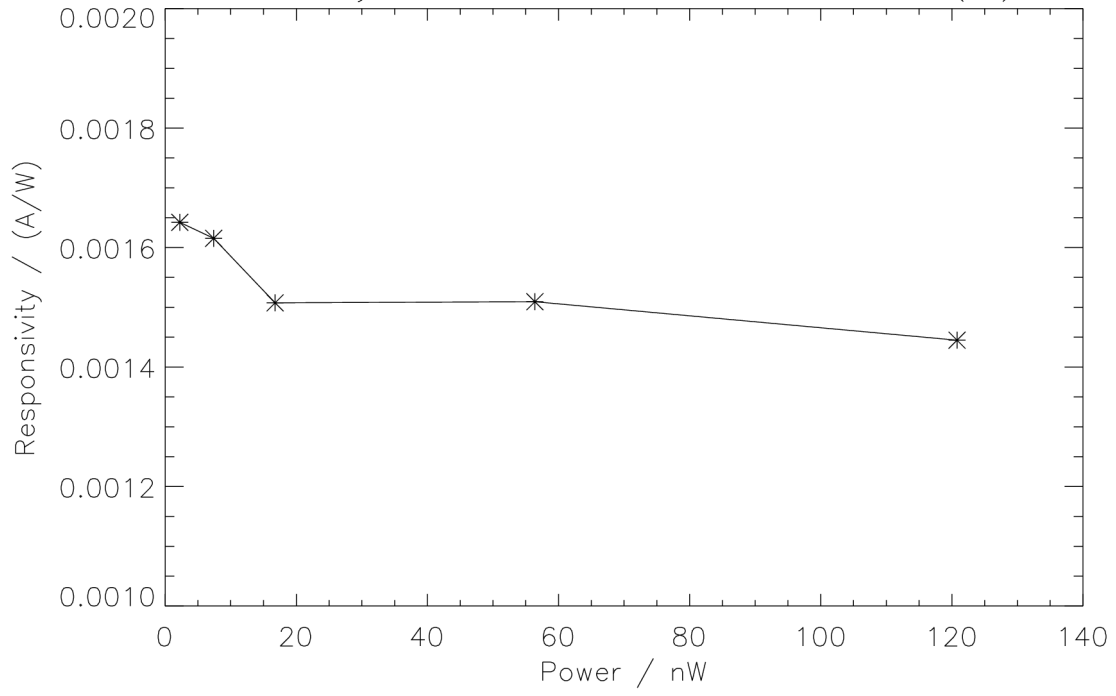
The following five images show responsivity vs. power (upper part) and signal vs. power (lower part) in a similar way as in the related campaign reports (see top of page). In addition, they show simulations (large squares) vs. measurements (asterisks) for LYRA head 1. (Heads 2 and 3 are still TBD, and head 1 is TBC after new spectral samples have been selected.) Channels 1 and 2 were measured within the NI campaign, channel 3 within NI as well as GI, and channel 4 within the GI campaign. The wavelengths chosen at BESSY represent a more or less important ratio of the total expected solar input; for more information see the table next page. The influence ratio is estimated as wavelength (e.g. 10 nm) purity divided by bandwidth (e.g. 1-20 nm) purity – separately for minimum and maximum samples – so it represents the importance of the wavelength chosen at BESSY for the nominal channel interval.

The (nonlinear) response of channel 1-3 (MSM11) as measured for the short wavelength (GI) is problematic insofar as it starts with a signal offset at zero power. This was already discussed in the related campaign report (see top of page). For simulation purposes, the value from the spectral responsivity measurement – obtained within the same campaign - was used, and trusted to deliver the correct expected output.

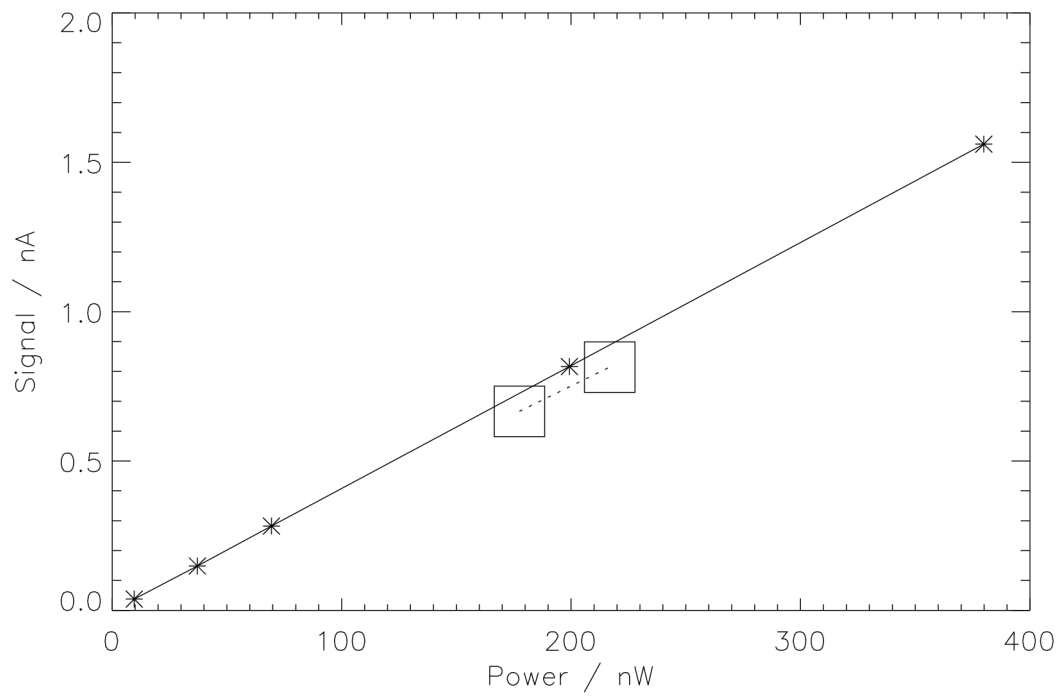
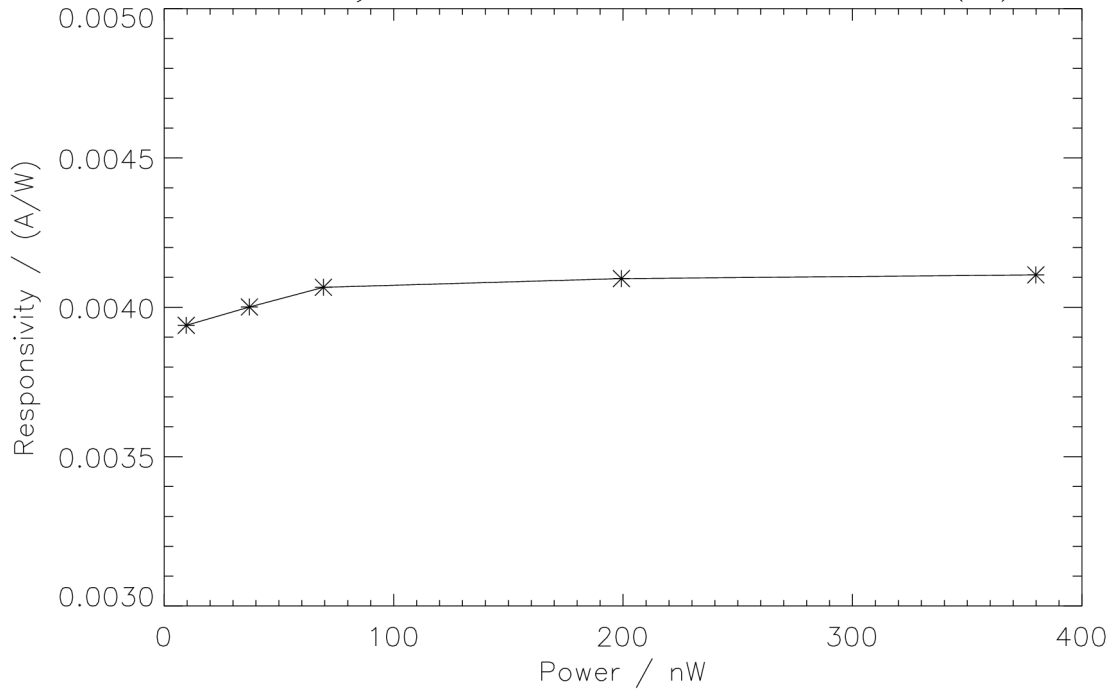
The figures for channels 1 and 2 appear on a linear scale, the figures for channels 3 and 4 appear on a log-log scale due to the larger variability in short-wavelength intervals. As a result, channels 1-1, 1-2, and 1-4 appear to be linear in the intervals of solar input to be expected. Results for channel 1-3 (NI) do not appear to be representative, because the spectral responsivity of LYRA is relatively low around 50 nm; nevertheless, the result appears to be a linear extension of the measured values. The best one can say about the channel 1-3 measurements from the GI campaign is that it appears to converge slowly towards the otherwise measured spectral responsivity factor.

LYRA channel			nominal	at BESSY	rel. infl. (min-max)
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1-1	Ly XN	+ MSM12	~121.5nm	121nm(NI)	97% - 97%
1-2	Herzberg	+ PIN10	200-220nm	210nm(NI)	7.5% - 7.5%
1-3	Aluminium	+ MSM11	17-80nm	50nm(NI)	0.06% - 0.04%
1-3	Aluminium	+ MSM11	17-80nm	18nm(GI)	13.5% - 15.1%
1-4	Zr (300nm)	+ AXUV20D	1-20nm	10nm(GI)	10.7% - 5.2%

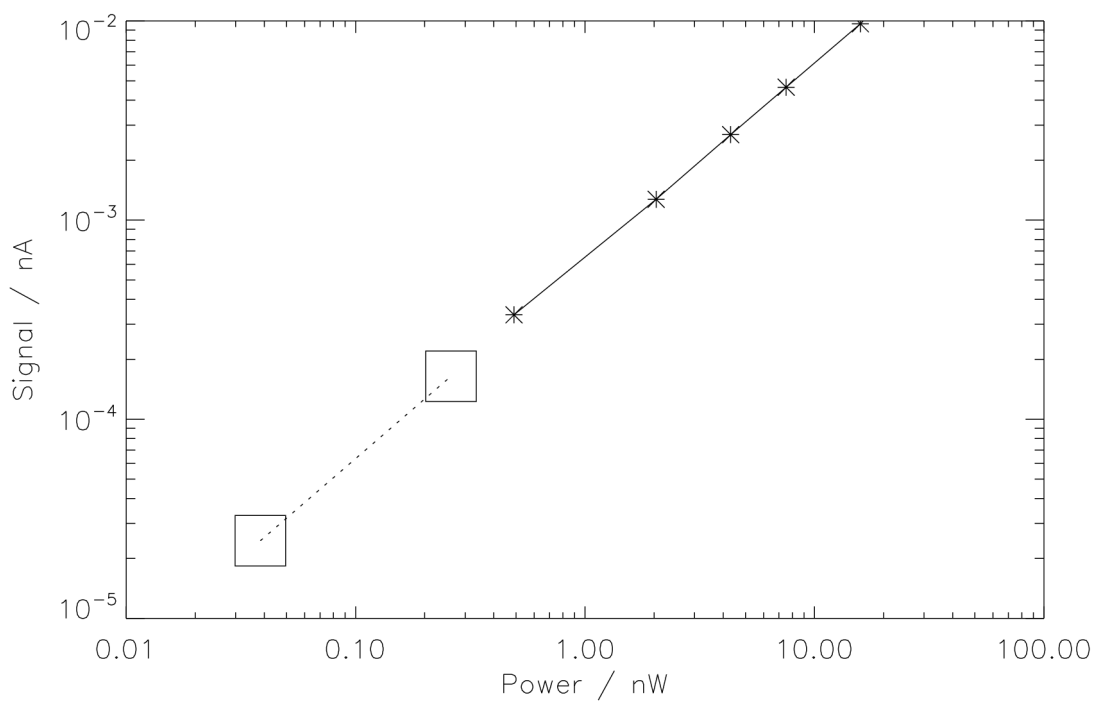
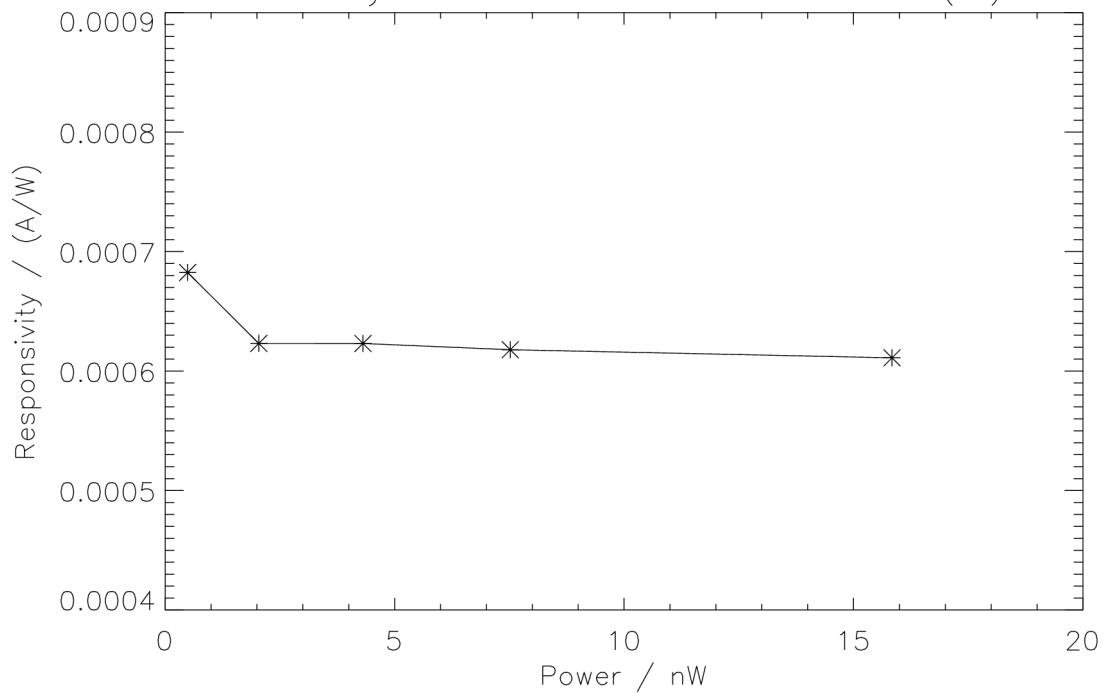
Linearity: LYRA Channel 1-1 @ 121 nm (NI)



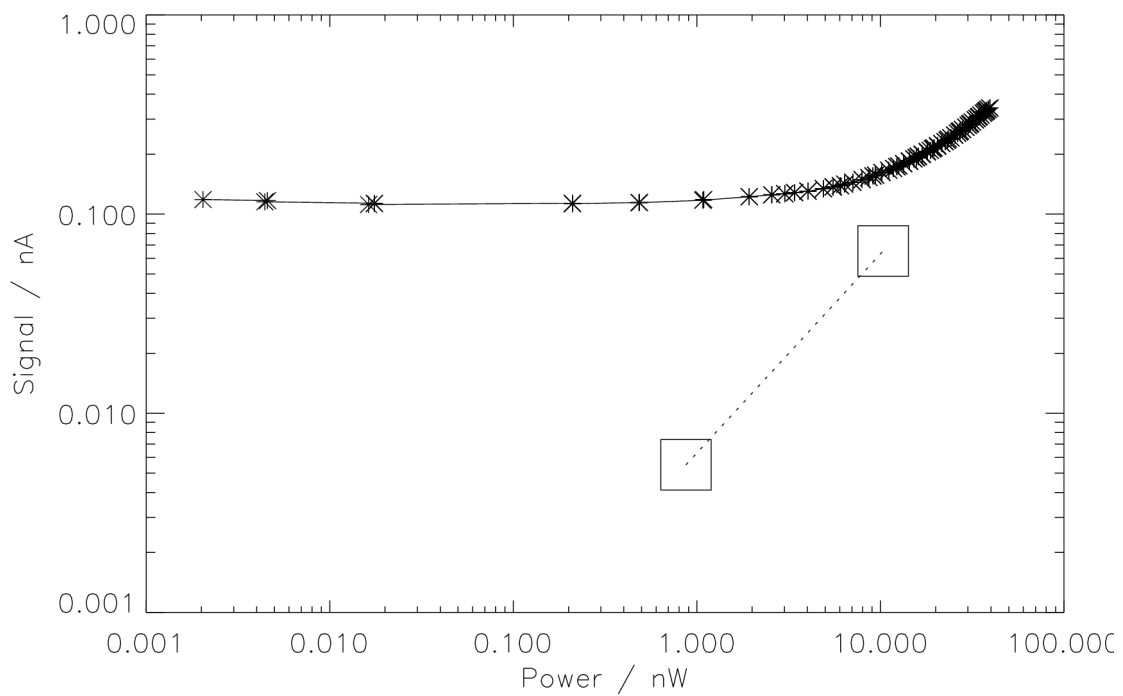
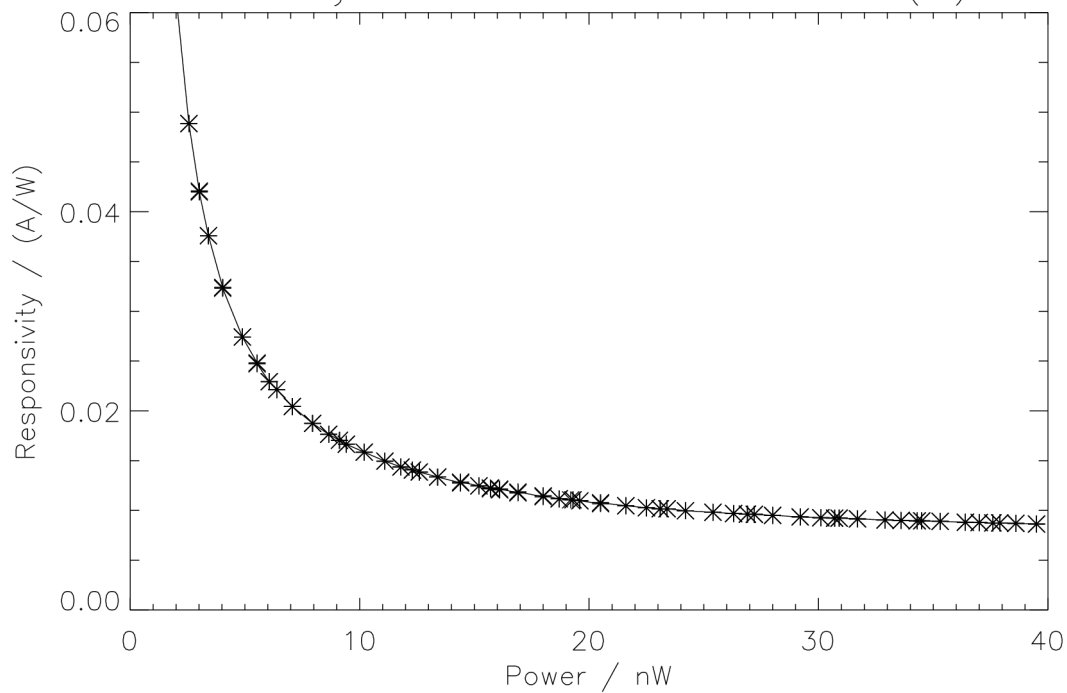
Linearity: LYRA Channel 1-2 @ 210 nm (NI)



Linearity: LYRA Channel 1-3 @ 50 nm (NI)



Linearity: LYRA Channel 1-3 @ 18 nm (GI)



Linearity: LYRA Channel 1-4 @ 10 nm (GI)

