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Pre-flight Calibration of LYRA, a Solar UV Radiometer on PROBA2 *(First Outline)*

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Abstract

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(The purpose of this paper is twofold: First, it is a standard tradition to publish a calibration paper for an instrument, in order to inform the scientists who will work with the data. Second, it is the "promised effort" - in return of the SCSL funding - to deliver a refereed paper, e.g., in A&A, Instrumental Section.)

1. Introduction

Purpose of LYRA, science, technology, BESSY campaigns, ...

Short description of planned data products and internet data bases, definition of calibration levels.

Which routines (see below) will do what, in which order? Explain logic of this order.

2. Steps of the Data Calibration Process

2.1. Raw Data

These "level 0" data [bytes], telemetry from the spacecraft, will not be public. Short description of telemetry format, unpacking, decompression, sorting, time stamping. Results are time-stamped data [counts] with information about commanded integration times, commanded LYRA head(s), ...
[Marie]

2.2. Exposure Time, Deadtime

Data entries that immediately follow a change in commanded integration time may have to be removed. Counts are divided by commanded integration time to receive frequencies. Results are time-stamped data [Hz], probably something like
hh:mm:ss.mmm Channel1 Channel2 Channel3 Channel4
plus header information like dd.mm.yyyy, commanded LYRA head, plus - if possible - housekeeping data, spacecraft position, pointing coordinates, ...

Value of read-out time, as given by producer, is 10.5807 microseconds. Describe effect on data observed in high cadence, and present deadtime correction formula (from LYRA Noise Distribution Report, IED 14 May 2007).

This could be made public as "level 1" data. It should be fixed and only be changed in case of telemetry errors that are discovered later on.

The following steps, on the other hand, lead to public "level 2" (or higher) data that is not fixed but subject to constant review due to growing experience.

2.3. Dark Current

Explain why dark current is handled at this stage, and not later: problems of VFC at very low frequencies.

Explain temperature influences.

Dark currents can either be estimated from pre-flight values, or they can regularly be observed on-board. Short description how this can be done, plans, routines, ... (closed doors? off-pointing?) Table of BESSY campaign values for 12 channels, preferably in [Hz] to avoid confusion about negative currents (e.g. as collected in LYRA Pulsed LED Tests Data Analysis, IED rev. 06 Mar 2007).

In case of dark current estimates, consider dependency on on-board temperature.

2.4. Voltage-Frequency-Converter

Short description of VFC function. Two parameters of linear dependence are regularly calculated/estimated and transmitted. Otherwise, pre-flight values may be used(?) The result of this correction is tension data [V].
[Silvio]

2.5. Resistance

Short technical description. Table of 12 values [Ohm]. Explain difference between gain resistor and (for some channels) amplifier. The result of this correction is current data [A].

2.6. Radiometric Model

2.6.1. Aperture Area

Short description of optical path, field of view. Value of precision aperture size is 7.06858e-06 m2; not subject to change.

2.6.2. Filter Transmittance

Short description of filters selected, and for what purpose. Start with executive summary, repeat reports.
[Ali]

2.6.3. Detector Responsivity and Flatfields

Short description of detectors selected, and for what purpose. Display 12 figures with combined filter-detector response vs. wavelength as measured in last BESSY campaign. Mention simulations on website.

Describe flatfields. Consider the fact that the test beam in the BESSY detector responsivity tests covered only a subset in the center of the detector (NI: 2.5 mm x 1.0 mm, GI: 1.5 mm x 1.5 mm). Table of 12 necessary correction parameters.
[Ali, Ingolf]

2.6.4. Linearity vs. Photon Flux

In the tests it could be shown that the responses are basically linear, at least in the expected signal area of interest. Either 12 figures, with relevant intervals marked, or table with fit parameters, quality.

2.6.5. Stability

Table with response time behavior and long-term drift. Possibilities to overcome these: Suggestion not to use certain channels for short observations, or - better - correction factors for start phase of these channels. Reaction to signal variation: Differences between early phase, i.e. directly after switch-on, and late phase, i.e. in saturation.

2.6.6. Purity

Describe problems resulting from lack of purity as calculated in radiometric model simulations, per channel. Give ways to estimate pure signal fraction (from LYRA Calibration Software Report, IED 25 Oct 2006, to be updated with new BESSY values and additional TIMED/SEE spectra); these methods will be subject to change due to in-flight experience, cross-calibration etc. Display 12 figures with solar flux signal vs. pure LYRA signal, as simulated; hopefully, the latter will rather stay constant.

The result of all these corrections is solar flux data in physical units [W m-2].

2.7. Monitoring

2.7.1. Degradation

Description of planned measurements to detect degradation by cross-calibration with LYRA channels and with other instruments (SWAP, EIT, SEM, TIMED/SEE, GOES, SUMER, ...?)

Description of LED tests, planned and already performed.

Mention tests of preflight aging.

2.7.2. Off-pointing

When pointing coordinates are transmitted from SWAP (or PROBA2?), the resulting signal increase or decrease can be calculated, and subsequently corrected, with the knowledge of the flatfield topology. Display 12 figures (or table? or only examples?) according to LYRA Flatfield Software, IED rev. 26 Apr 2007, and LYRA Detectors: Positions, Flatfields, Consequences, IED 20 Mar 2007. Pre-flight simulations will be tested and updated during the commissioning phase, in order to receive a correction table (+x% or -x% as function of pointing coordinates).

2.7.3. Orbit Variations

The variations of the Earth's orbit around 1 AU can be corrected by a simple factor depending on the day. Is a correction due to PROBA2's orbit around the Earth necessary (detectable)? - Variations due to periodic occultations (how often?) are another problem and lead to completely different observation routines, maybe a short description here.
[Marie]

3. Discussions and Conclusions

Once more, explain the differences in consistency: Level 1 data stay fixed, all higher levels are subject to growing experience and may regularly be updated. Importance of version date. Mention plans for calibration campaigns with other instruments.

Advantages and disadvantages of LYRA? No grating, no lenses, no mirrors to be considered. Straylight? Overall uncertainty? [Maybe %-values can already be given in the chapters above?]

Mention funding of SCSL by ISSI, Bern.

References

Hochedez et al., Adv Space Res 37, 303-312, 2006

Internal Reports (which?) as PDFs on website

...?