PSLS version 1.3 – release note

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The major improvement concerns the modeling of the residual systematic errors. While in the previous version 1.2, systematic errors were modeled on the basis of simulations made with PIS (PLATO Image Simulator) for a *single* camera (as in Samadi et al 2019, A&A), now they are derived from simulations made for **24 independent cameras and ~ 1,200 stars** ranging from P=8.25 to P=13.25.

The procedure used to derive the coefficients modeling the systematic errors (which are used by PSLS) is identical as in Samadi et al, except that they are now derived from simulations for 24 cameras and no longer with a signle one. In particular, as described in Samadi et al, raw light-curves are corrected for the star drift and mask updates using PSFs reconstructed on the basis of the microscanning technique. For this purpose microscanning simulations were generated for 24 independent cameras and for each simulated target.

The PIS simulations now include the Brighter Fatter Effect (BFE). The latter is modeled in a similar way as Guyonnet et al (2015, A&A), however for more details please refer to PLATO-LESIA-PDC-TN-0068 (i1.0). They also include a realistic IPRNU (Intra pixel Response Non-Uniformity) map as well as a realistic trap density map (the latter controls the amplitude of the CTI effect, relevant for *End Of Life* simulations) .

As in version 1.2, the systematic errors are built using a realistic field of view based on the Gaia DR2 catalogue. When systematic errors are enabled, PSLS picks from the systematic error parameters (a table stored in input file with the suffix .npy) the star with magnitude close to the magnitude specified by the user and with a drift amplitude in a given range (low: 0-0.4 px/90days, medium: 0.4-0.8 px/90days, and high: >0.8 pix/90days). Contrary to version 1.2, stars with different contamination ratios are no longer mixed together since for each target we have now simulations for 24 independent cameras[1].

Finally, our assumption concerning the star centroid error has been revisited. A systematic error of 0.03 pixel was so far assumed. However, the error of 0.03 pixel is what one expect for the 95th percentile. The centroid error is actually centred around zero and is Gaussian's like. Therefore, assuming systematically an error of 0.03 pixel is too pessimistic. Accordingly, the long-term drift and mask updates corrections were applied assuming a 1-sigma error of 0.01 pixel (hence 0.03 pixel for the 95th percentile). This substantially improves the residual systematic errors (for mask-based photometry, note that this does not concern PSF fitting based photometry).

All these new features are now integrated into PSLS and enable one to generate more realistic LCs for a long duration and for 24 independent cameras.
Here below some illustrations showing the residual LCs (systematic) generated for two quarters:

- figure 1: with mask update (representative for the P5 sample)
- figure 2: no mask update (representative for the P5 sample)

1 To mimic the systematic errors expected for different cameras, the previous version 1.2 randomly selected different targets (observed with the same camera). Accordingly, each individual residual light-curve corresponded to a star with a stellar contamination different to the other residual light-curves.

- figure 3: PSF fitting method (imagettes, representative for the P1 sample)

It should be noted that the correction of the effects induced the BFE, the Charge Transfer Inefficiency (CTI) and IPRNU is not yet introduced in these simulations. Finally, in the same way as done with the CoRoT and Kepler light-curves, it is also planned in the future to apply on the PLATO light-curves an empirical correction. Accordingly, all these corrections are expected to further reduce the level of the residual systematic errors.

The new package comes with the following new tables (containing the parameters modeling the systematic errors) :

- PLATO_systematics_[EOL|BOL]_V2.npy: systematic errors (aperture mask, P5 sample)
- PLATO_systematics_[EOL|BOL]_FixedMask_V2.npy: fixed aperture masks (P5 sample)
- PLATO_systematics_[EOL|BOL]_P1_V2.npy: systematic errors representative for the P1 sample (based on the PSF fitting method)

The tables are provided both for Begining Of Life (BOL) and End Of Life (EOL) conditions. To use these new tables set the parameter 'Systematics/Version' in the configuration file (YAML) to the value 2 . Older tables (version<2) are also provided.

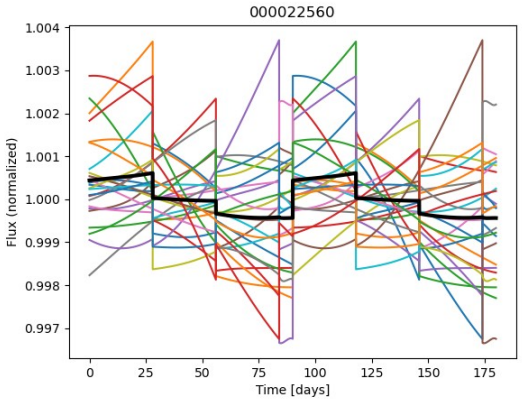

Illustration 1: individual residual light-curves (systematic errors) based on optimal binary masks (P5 sample) and with mask updates. The tick black line corresponds to the average over 24 cameras

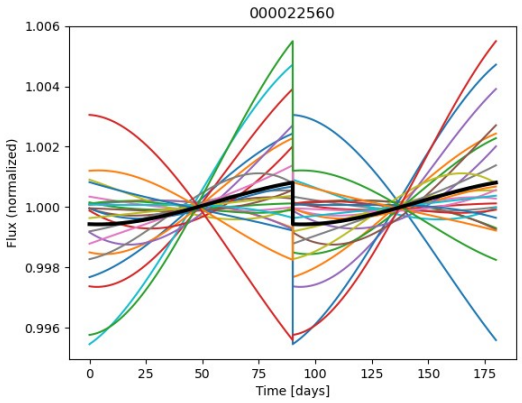

Illustration 2: individual residual light-curves (systematic errors) based on optimal binary masks (P5 sample) and with fixed mask. The tick black line corresponds to the average over 24 cameras

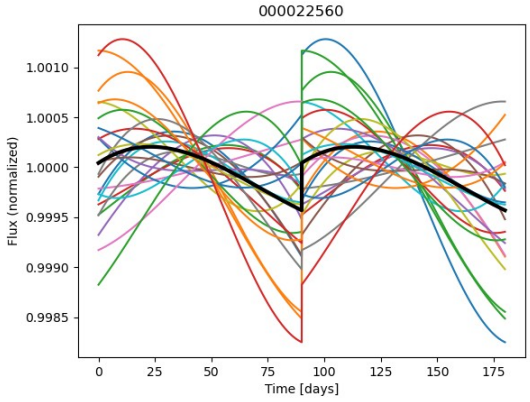

Illustration 3: individual residual light-curves (systematic errors) based on the PSF fitting method (P1 sample). The tick black line corresponds to the average over 24 cameras