PDC WP 334 600 : Science Flux Alerts

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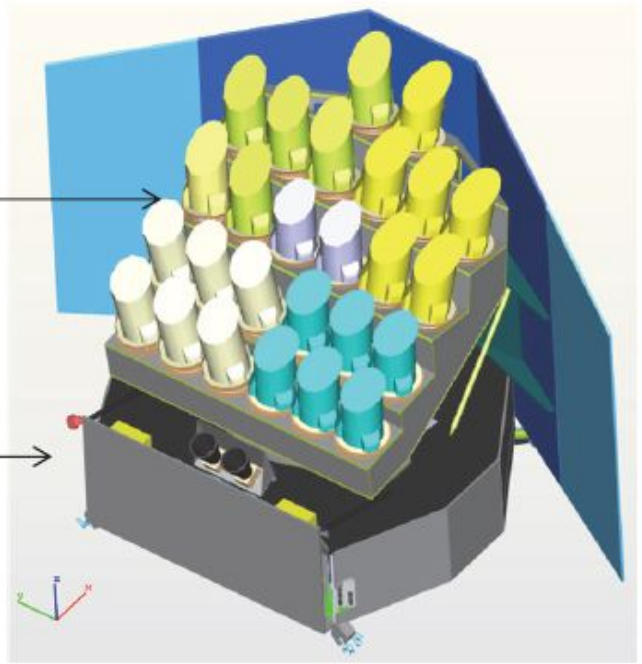
Highlight of the presentation

- Short overview of what would be the PLATO mission
- Sources of alerts vs what is already covered by the core-science
- Done so far : L0/L1 GDP URD, and Science Flux Alert DD
- Work which needs to be done now

PLAnetary **T**ransits and **O**scillations of stars (**PLATO**)
[mission adopted by ESA in June 2017]
plato [OHB and ESA signed the PLATO construction contract on 4 October 2018]

PLATO in a nutshell

- To obtain light curves of a few 100 000 stars to detect planetary transits and characterise the host star with asteroseismology
- Payload concept : 24 normal cameras (~500nm to ~1um), 4 groups of co-aligned telescopes
- Short stares (3 months) and long stares (up to 2 years) for light curves of 600 sec, 50 sec, 25 sec (imagettes) light curves for $V \gtrapprox 11$ - 16 mag stars
- 2 fast cameras, blue (~500nm to~665nm) and red (~670nm to ~1um), with sampling of 2.5 sec (imagettes)
- 104 CCDs (4 CCDs per camera) with 4510x4510 (18µm) pixels, ~15 arcsec/px
- 2232 deg2, with 4 groups of cameras respectively looking on 301 deg², 247 deg², 735 deg², and 949 deg²
- Targets observed in 6x6 pixel windows (i.e. 1.2 x 1.2 arcmin)
- Launch planned for end 2026 - going to L2



OHB Spacecraft design
PLATO Definition Study Report (Red Book)
ESA-SCI(2017)1

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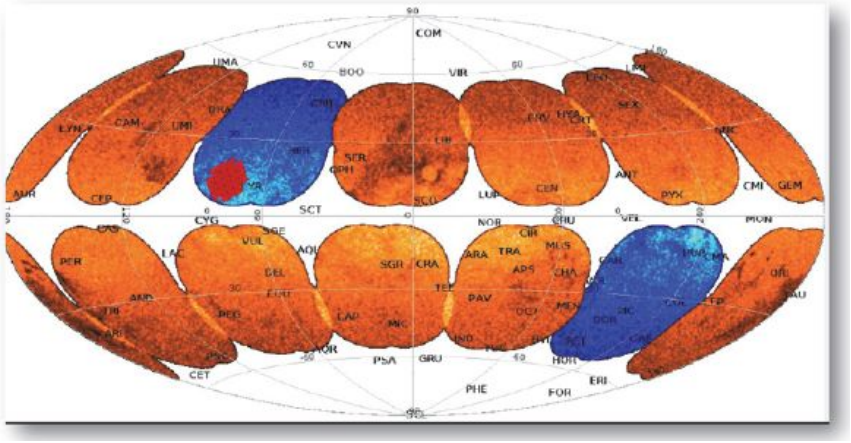

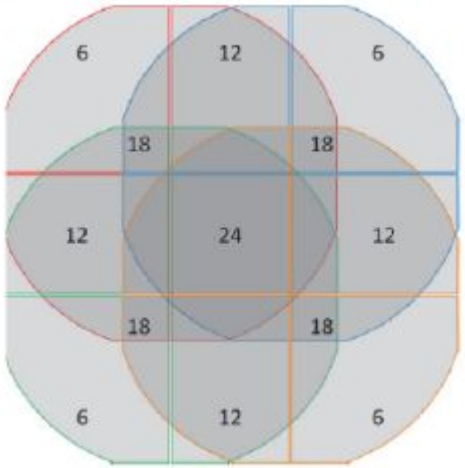

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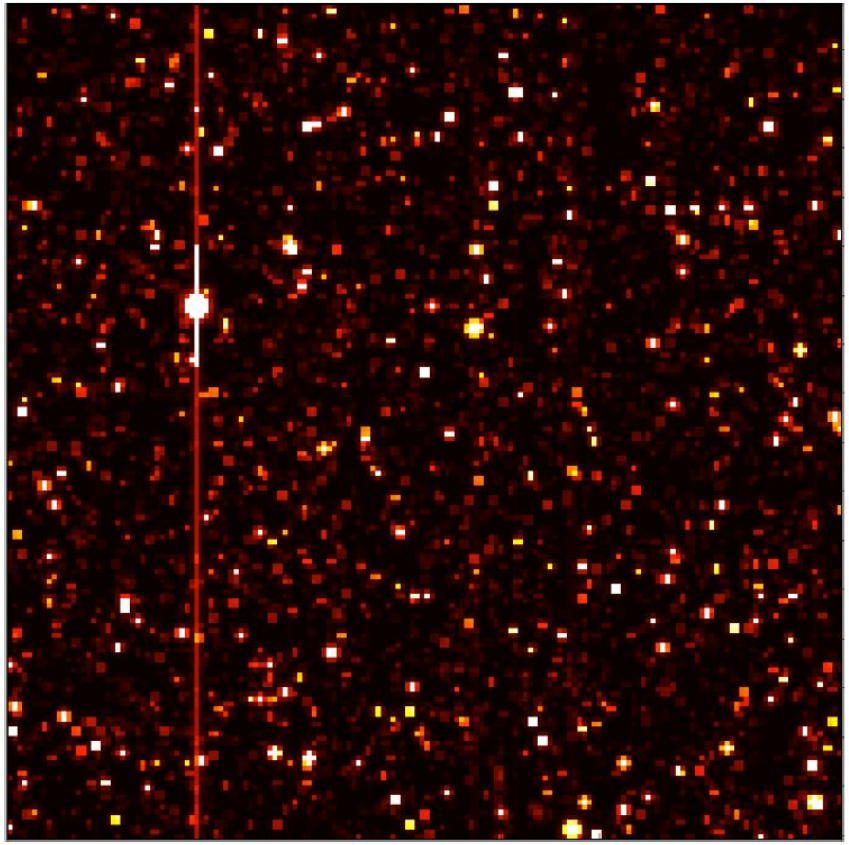

PLATOsim
Joris de Ridder, et al., KU Leuven

PLATO Definition Study Report (Red Book)
ESA-SCI(2017)1

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- To **goal** of the **W**ork **P**ackage **Science Flux Alerts** is to ***detect*** **astronomical transient**, ***and*** **to send** an ***alert*** about **a possible detection** of **rare events of scientific interest** for additional observations (e.g. optical spectroscopic observations for supernovae events), **considering their brevity and non-repeatability, while they are in progress**.

- For events related to the **core science of PLATO** (i.e. **planet-transiting** and **asteroseismology / stellar** events), an alert ***should be given*** with a **possible** change of sampling mode for the P5 sample (i.e. swap between 600 seconds light curves to 50 seconds sampling, or imagettes for 25 seconds sampling), although ***detection*** and ***analysis*** of such events are covered by other **W**orking **P**ackages (i.e. core science)

- No plans for taking data from **other missions**, and no plans of **doing follow up**, e.g. there is a Guest Observer program and ToO, but this is not part of the PLATO Science Flux Alert.

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PDC WP 334 600 – SCIENCE FLUX ALERTS

- The **Science Flux Alerts** will be a module in the L0/L1 pipeline, performed on-ground (after light curve averaging, detrending, outlier rejections, …)

- Developed at the **PDC** (**P**lato **D**ata Center), based at the **MPS** (**M**ax **P**lanck Institute for **S**olar System Research) in Göttingen, Germany

- There is a **W**orking **P**ackage, **WP16 Complementary Science**, in charge to exploit **PLATO** data for science excluding planet-transiting and asteroseismology. However, its goal is not to detect astronomical transient.

PDC WP 334 600 – SCIENCE FLUX ALERTS

The possible sources of alerts are, as PLATO targets or occurring in the background or foreground,

- For **planet-transiting** and **asteroseismology / stellar** events :
  - a. Planet transiting for sources in the P5 (lower priority) sample
  - b. Superflares
  - c. Pulsating eclipsing binaries
  - d. Hybrid pulsators

- For **non-planet-transiting** and **non-asteroseismology / stellar** events
  - a. Supernovae (e.g. KSN 2015K)
  - b. Gravitational Microlensing
  - c. Gamma-Ray Burst (optical) afterglow
  - d. Classical Novae
  - e. Dwarf Novae
  - f. Cataclysmic Variable
  - g. X-ray bursters (e.g. X-ray binaries)
  - h. AGN (e.g. blazar)
  - i. Stars with large and unpredicted light curve variability (e.g. LBV, Be, R Corona Borealis, FU Orionis)

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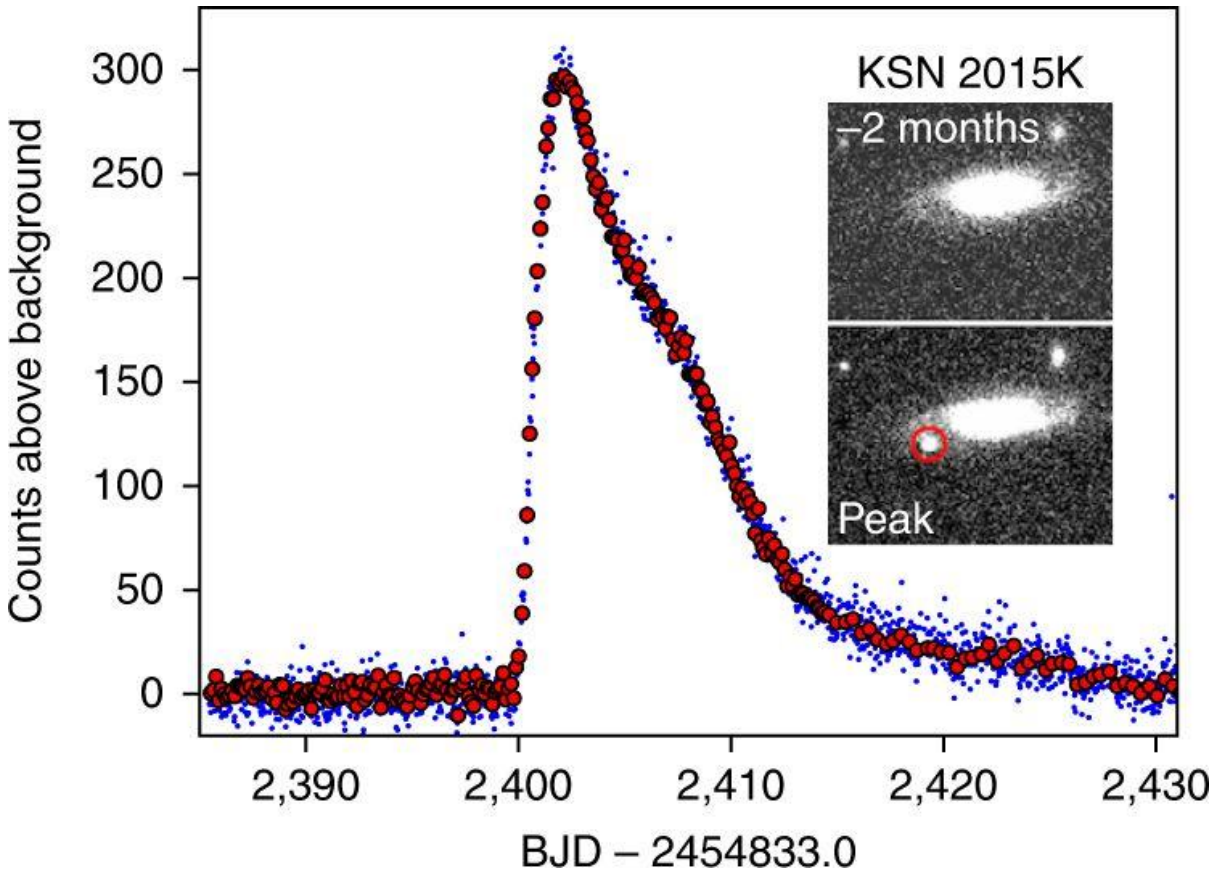
The possible sources of alerts are, as PLATO targets or occurring in the background or foreground,

- Other **unexpected or rare events** which **can, or cannot, be classified**,
  - a.) occultations by debris disks
  - b.) cometary material
  - c.) extrasolar ring system [e.g. J1407]
  - d.) asteroids (LoS of star in observing window)
  - e.) unclassified Galactic [e.g. KIC 8462852, aka the Tabby's Star, *observed* on 03.2011 and 02.2013 … reported in 2015]
  - f.) extraGalactic [e.g. SCP 06F6, with M_u ~ -23 mag] events.

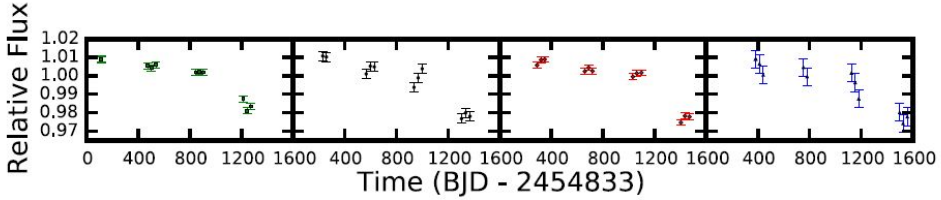
- Using the **fast camera** to spot **transient** which would have **variability in colours**, but **stable** light curve from the **normal camera**.

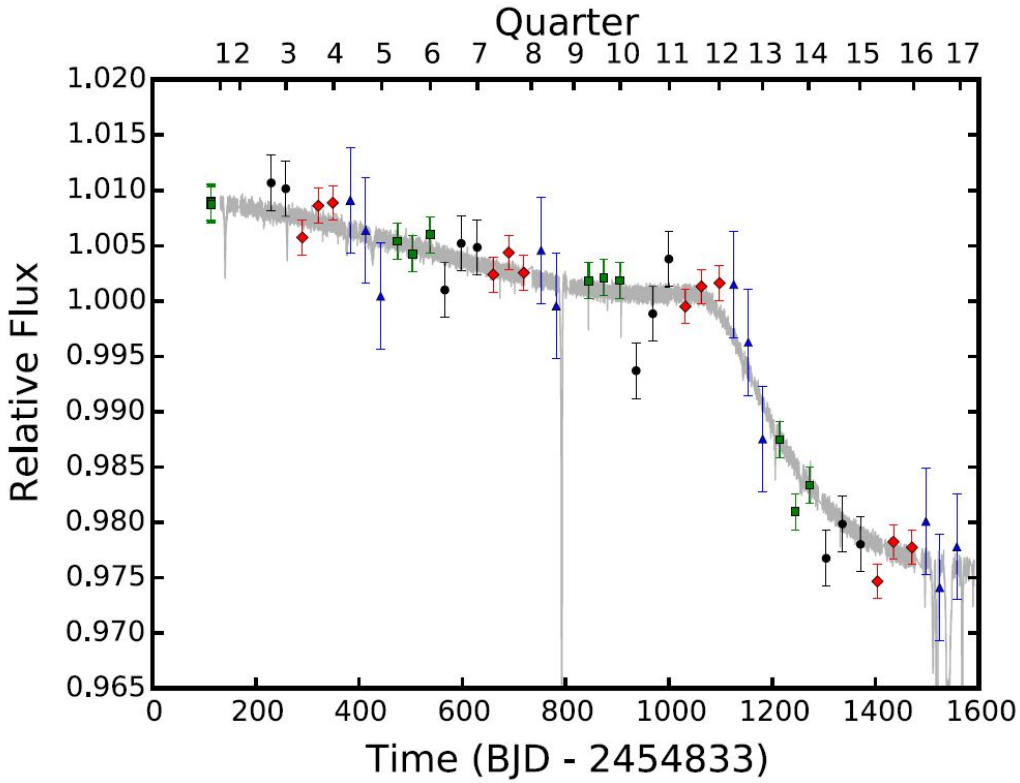
- *What else ?*

KSN 2015K and KIC 8462852 were noticed in light curves respectively **months** and **years after** the data was acquired, i.e. after they have occurred. It was therefore *too late to perform follow up observations* of these transients while they were in progress. This stress **the needs** of having algorithms developed **to triggered an alert** when astronomical transients are observed by PLATO.



K2 light curve of KSN 2015K (*blue dots* 30 min cadence, *red dots* 3 hrs median-value bins, Rest et al. 2018) … ***identified*** in February 2016 … but was ***observed*** on August 2015 (around peak). The two images are 60 s *i*-band DECam (4m, CTIO) from 7 July and 1 August 2015.





Light curve of KIC 8462852 (aka the Tabby's Star), variation *observed* on March 2011 and February 2013 … but *spotted* by **amateur** astronomer in 2015 (arXiv:1509.03622)

Work done so far

- L0/L1 GDP URD, which was submitted to DLR for the P/L PDR (Payload Preliminary Design Review) contains a requirement on Science Flux Alerts

Title **L0 and L1 Ground Data Processing User Requirement Document**

Subtitle Issued for the Payload Preliminary Design Review (P/L PDR).

Ref. **PLATO-MPSSR-PDC-RS-0003**
(known as PLATO-DLR-PL-RS-008 until 20-07-18)

Issue 2.0

Date 26-09-18

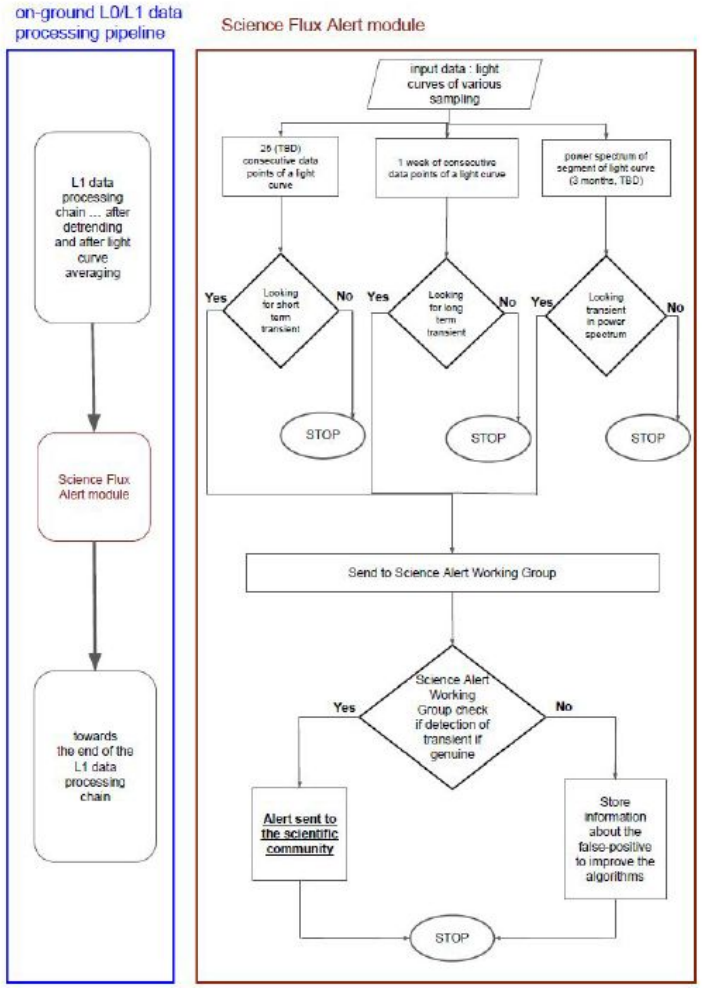
	Title:	**Science Flux Alert**
	Parent:	PSIRD-Devpt-DP-009
	Justif.:	Astronomical transients should be detected as soon as possible to allow follow up observations while they are in progress.
L0L1-PRL1-1080	The L1 data processing pipeline shall detect astronomical transients from the light curve, or from its power spectrum, and i) for **planet-transiting** and **asteroseismology events of scientific interest**, an **alert** should be given to allow for a **change of sampling** mode ii) for **non-planet-transiting** and **non-asteroseismology events**, an **alert** should be given about **a possible detection** of **rare events of scientific interest** for additional ground-based observations (e.g. optical spectroscopic observations for supernovae events), **considering their brevity and non-repeatability, while they are in progress** iii) shall allow different latencies for each type of alert	

Work done so far

- L0/L1 GDP URD, which was submitted to DLR for the P/L PDR (Payload Preliminary Design Review) contains a requirement on Science Flux Alerts
- Draft of DD on the Science Flux Alerts WP is circulating

plato	**PLATO DD on WP 334 600 Science Flux Alert**	MPS

PLATO Design Document on WP 334 600 Science Flux Alert



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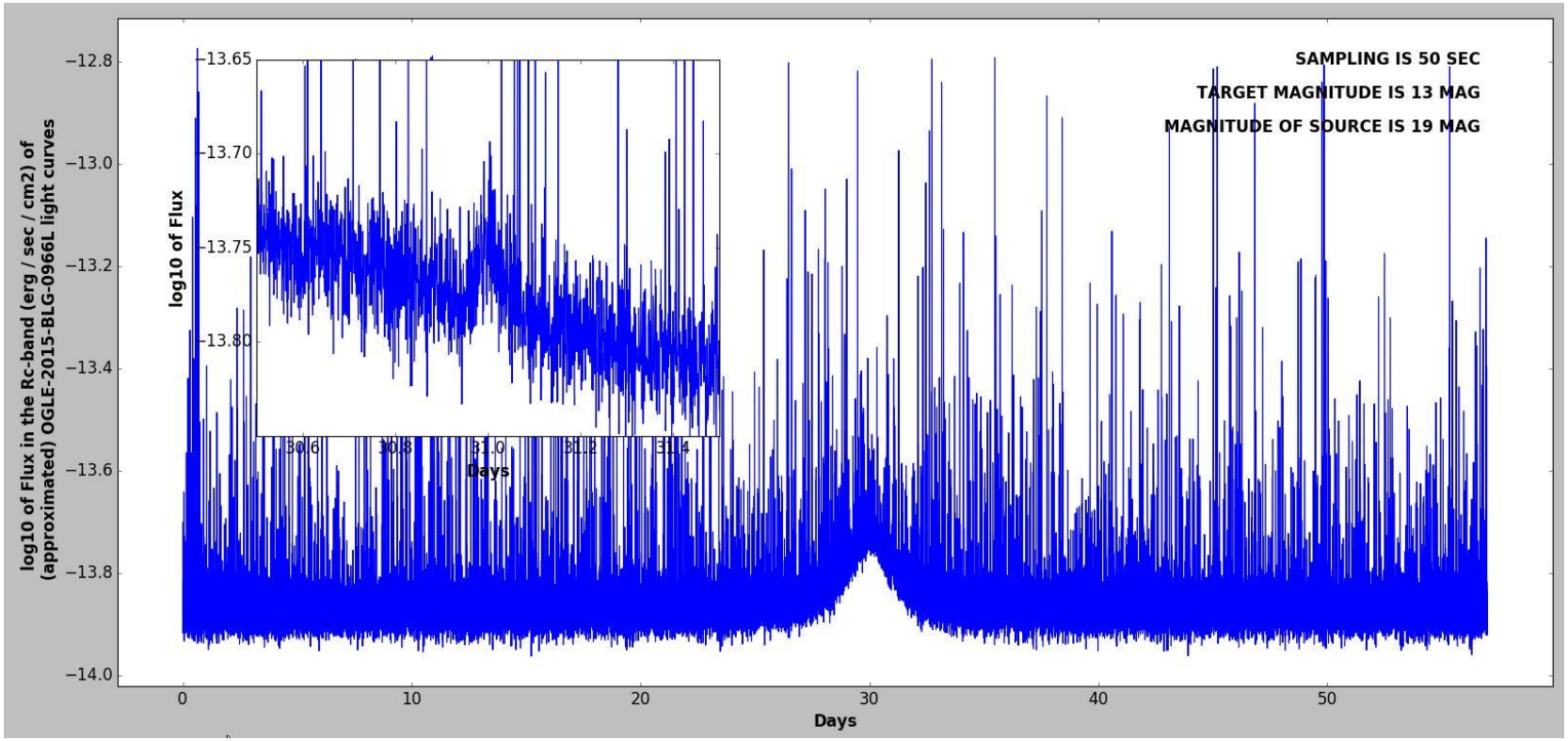
Work to be done within the next one or two years

- Incoming RIDs (i.e. Review Item Discrepancy) from the submission of the L0/L1 GDP URD for the PLATO P/L PDR, hopefully not concerning the requirement on the PLATO Science Flux Alerts
- Write down the ATBDs (Algorithm Theoretical Baseline Document) for the science flux alert module(s)
- Is there any existing documentation about the “GAIA alerts” detection algorithm?
- Simulation of astronomical transients for detection algorithms, previously using PIS (PLATO Imagettes Simulator), and ultimately using PLATOsim

Light curves using PIS
(PLATO Imagette Simulator, developed at LESIA, Obs. Paris)

"Simulation" of light curves of selected transient, **if** they are occurring in (or in the vicinity of) a window (i.e. 1.2 x 1.2 arcmin) where PLATO is observing a **V~13 magnitude star :**

OGLE alert for OGLE-2015-BLG-0966 was issued on 11 May 2015 (Street et al. 2016)



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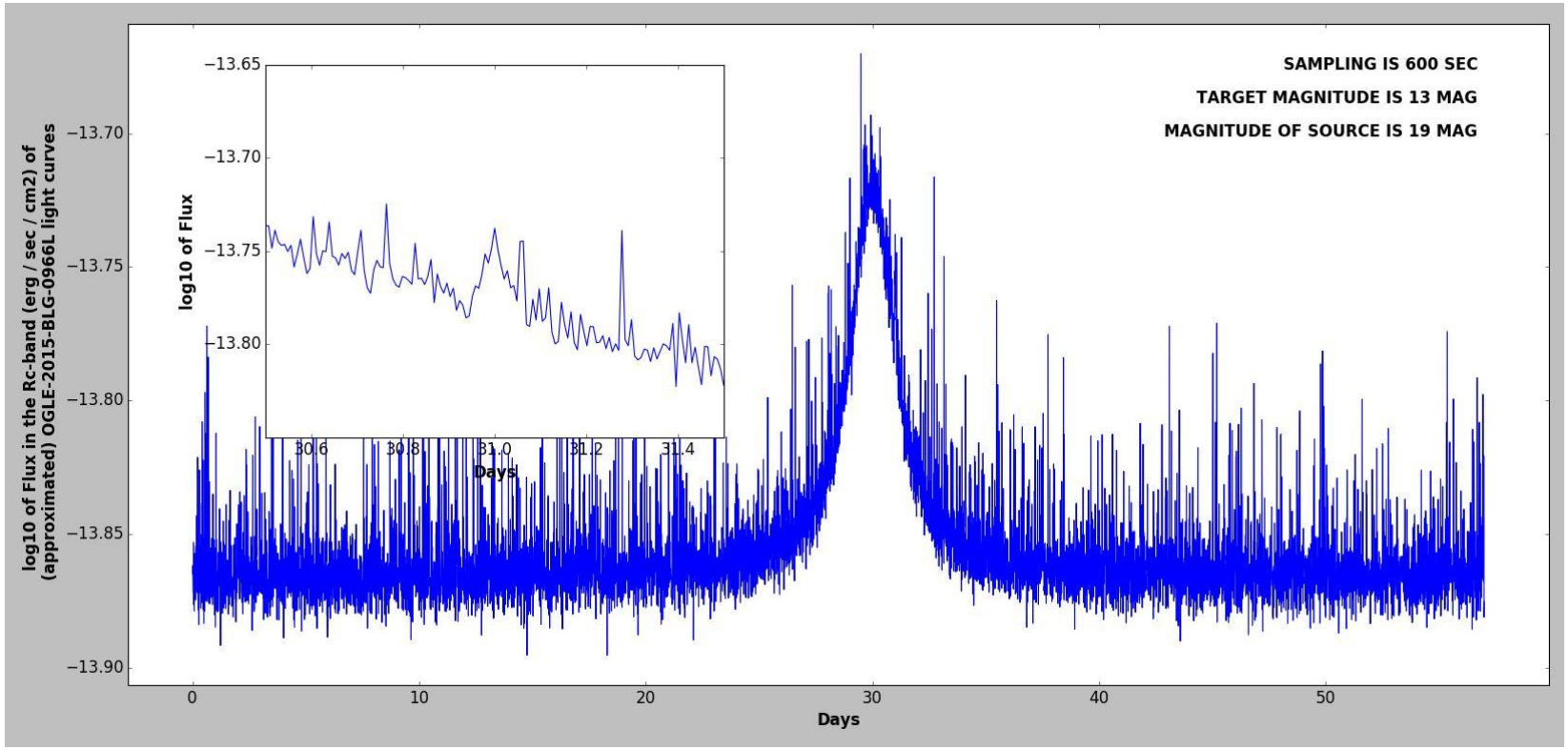

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- Preparing detection algorithms (1) based on previous experience, and (2) using PLATOsim simulations

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Thank you !

Questions ?

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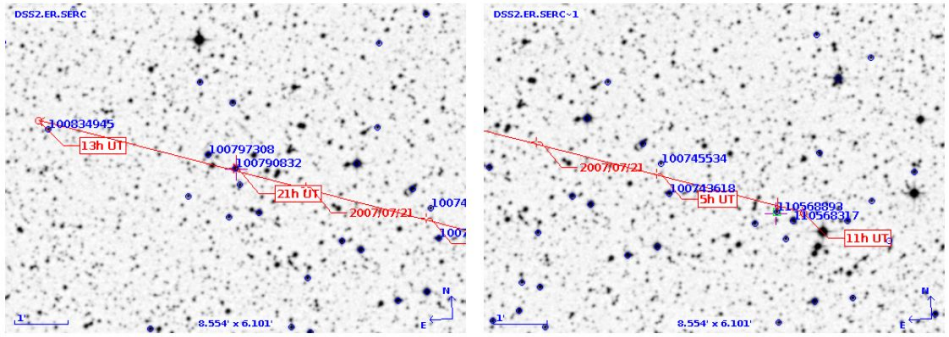
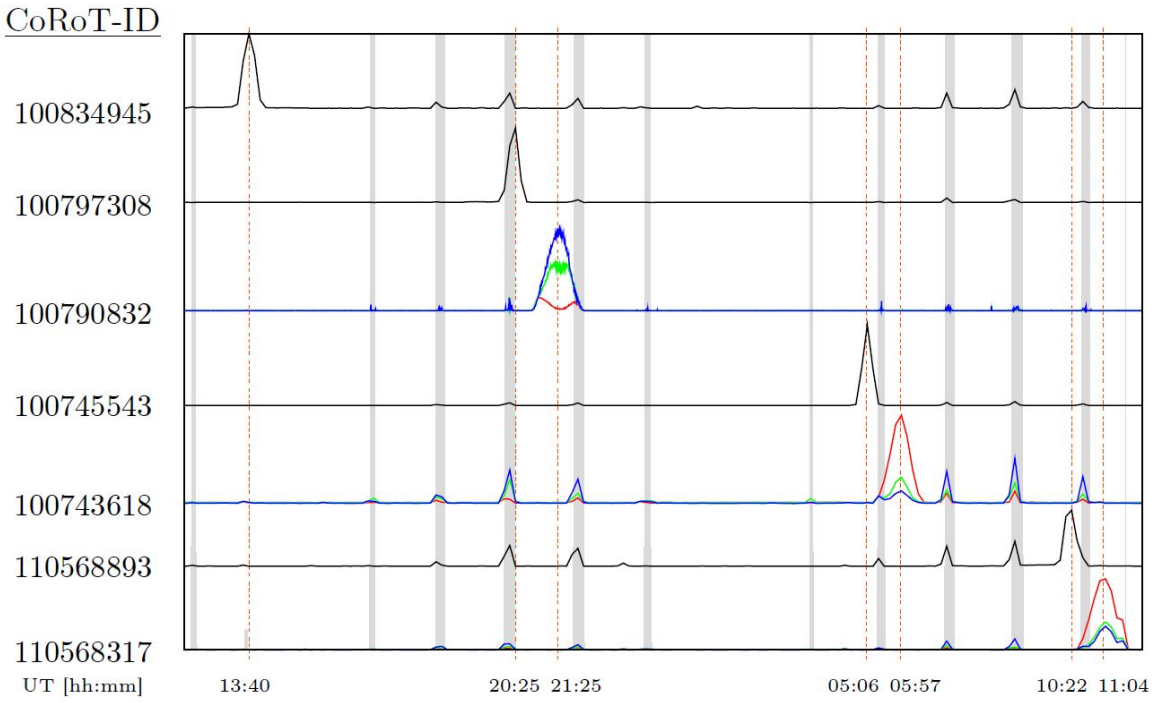
Additional material





Top two panels.: ESO DSS2 plates showing CoRoT targets (blue) and the trajectory of **Asteroid 137 Meliboea** (red solid line) starting on 20 July 2007 (left panel) until 21 July 2007 (right panel) with UTC time. *Lower panel.:* Light curves of several CoRoT targets (CoRoT-ID on the Y axis) versus UTC time (X axis). The horizontal dashed line indicates when the asteroids 137 Meliboea crossed the line of sight of the corresponding CoRoT targets. Taken from "Analyse von Flares mit Hilfe von CoRoT-Lichtkurven" (Alexander Drabent, Diplomarbeit, Friedrich-Schiller-Universität Jena, Physikalisch-Astronomische Fakultät 2012), Figure 5.7 (top panels) and Figure 5.8 (lower panel).