PDC WP 334 600 Science Flux Alerts : detection of transient astronomical events of scientific interest with PLATO

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ABSTRACT : The ESA mission PLAnetary Transits and Oscillations of stars (PLATO) is aiming at obtaining light curves of a few hundred thousand stars for detection of planetary transits and the characterisation of the host star with asteroseismology. It is likely that, during PLATO's lifetime, interesting events other than planetary transits or stellar oscillation will be detected, including supernovae, gamma-ray-burst, gravitational microlensing, stellar superflares, and other unexpected and unclassified transient events. The goal of the Science Flux Alerts is to detect and give an alert about a possible detection of one of these rare events, to trigger additional follow-up observations, considering their brevity and non-repeatability, while they are in progress.

GENERAL OBJECTIVES

- Science Flux Alerts will be implemented at Level 1 (L1) data processing level (i.e. calibrated PLATO observations corrected for instrumental effects), and will produce early flux alerts during L1 calibration

- For planet-transiting and asteroseismology events of scientific interest, an alert should be given to enable a possible change of on-board sampling mode (i.e. change cadence to 600 seconds, 50 seconds or 25 seconds)

- For other transients of scientific interest, an alert should be given about a possible detection of rare events of scientific interest for additional observations from other observatories, considering their brevity and non-repeatability, while they are in progress

SIMULATIONS OF EVENTS FOR SCIENCE FLUX ALERTS

The PLATO Imagette Simulator (P.I.S., developed by LESIA) was used to simulate a light curve for a 13 magnitude star observed by PLATO (which a magnitude representative of a meaningful fraction of PLATO targets), using a particle impact rate of 10 cm^{-2} sec^{-1}. The simulations are, from top to bottom,

1) Approximation of event OGLE-2015-BLG-0966L light curve (Street et al. 2016, $M_{lens}=0.38\pm0.04M_\odot$, $M_{planet}=21\pm2M_\oplus$)

2) A typical SNe Ia light curve (Li et al. 2010)

3) GRB 081203A optical afterglow light curve (Kann et al. 2010)
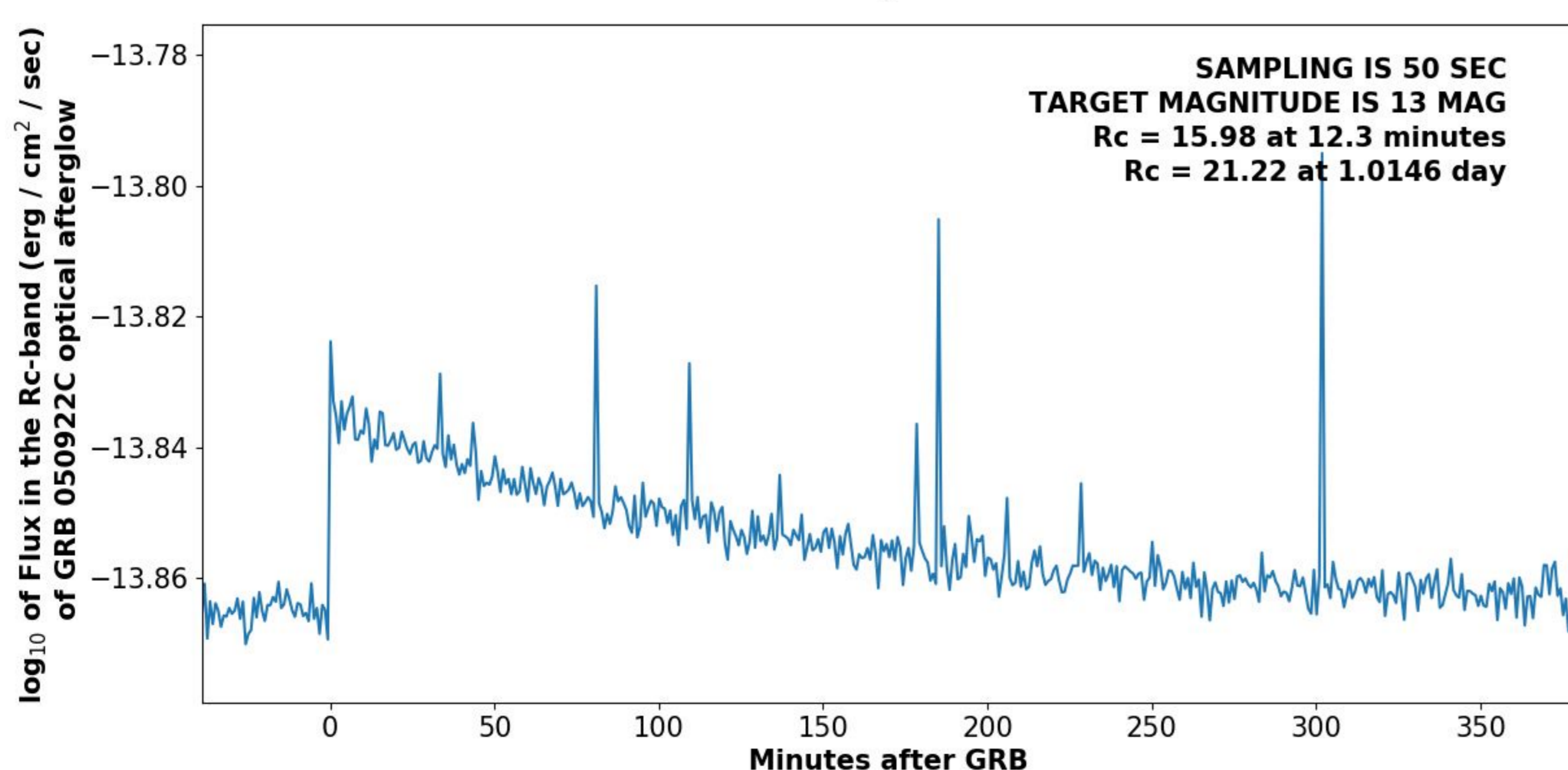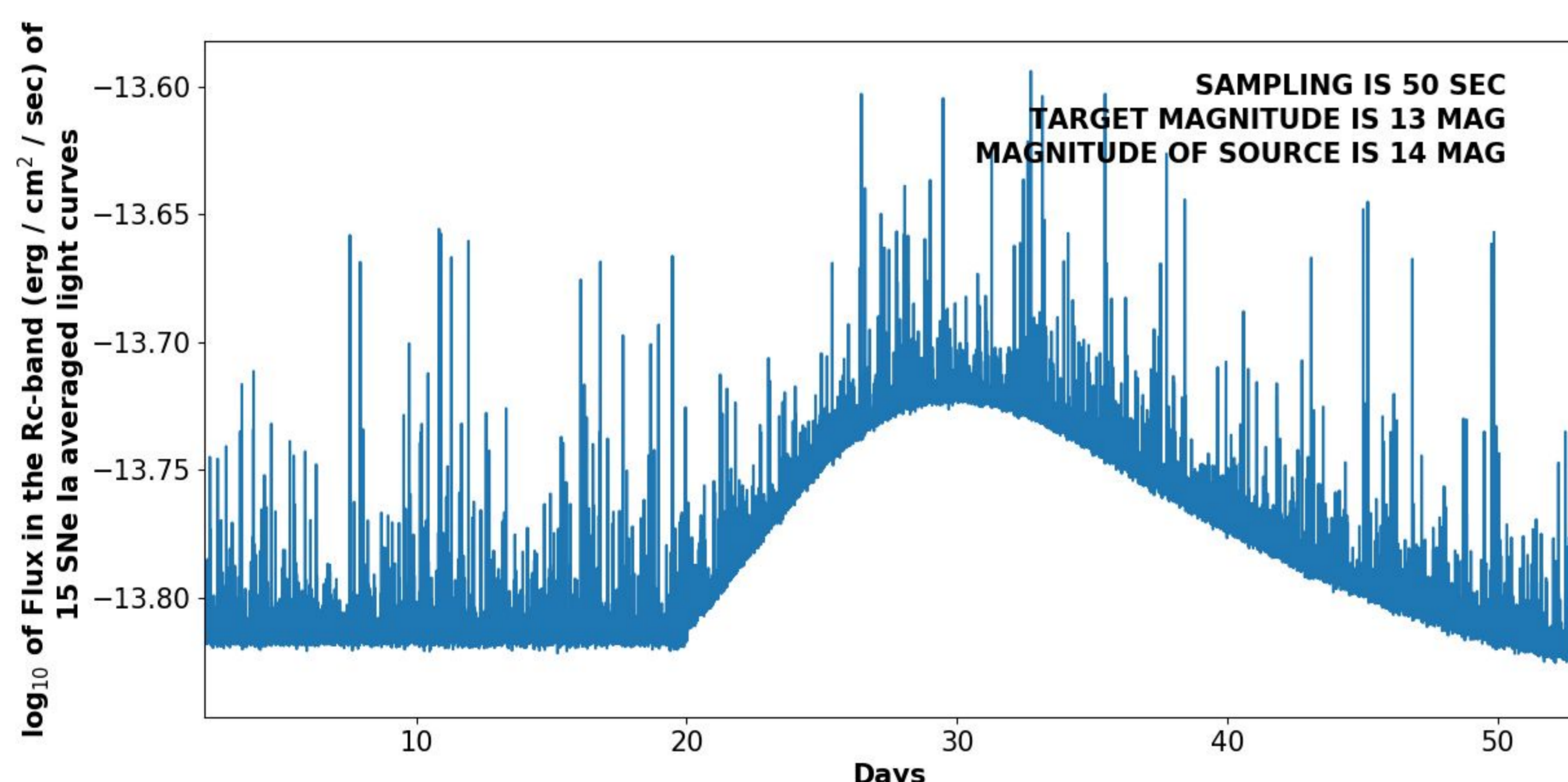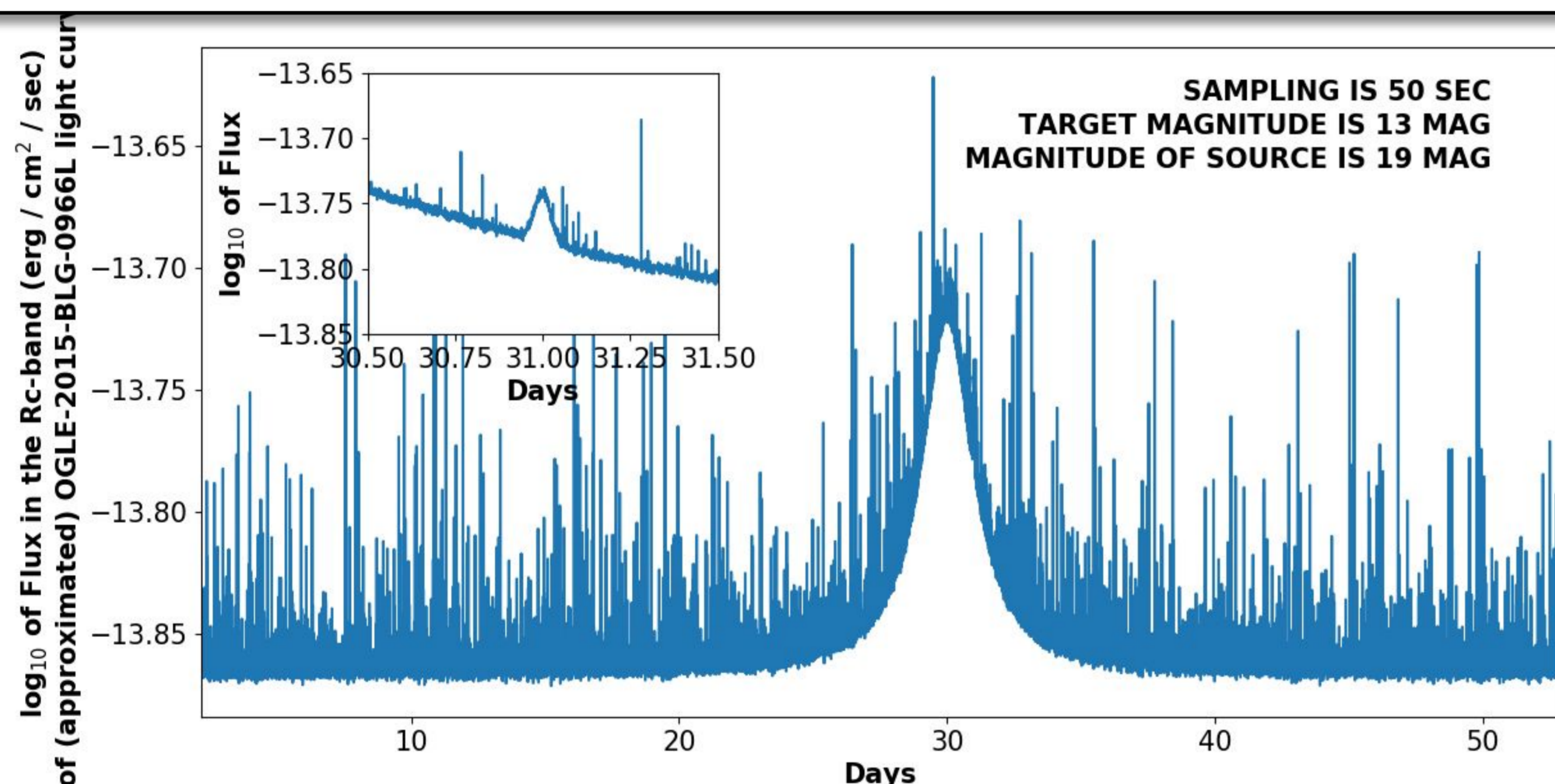
SCIENCE FLUX ALERTS WORK PACKAGE

Various people have expressed interest on Science Flux Alerts activities throughout the consortium. The activities related to Science Flux Alerts are consolidated in a single PDC work package at L1 processing level : PDC WP 334 600 Science Flux Alerts. Roles and responsibilities still need to be defined.

POSSIBLE SOURCES OF ALERTS

- Planet-transiting and asteroseismology / stellar events :
  - Planet transiting
  - Pulsating eclipsing binaries
  - Superflares
  - Hybrid pulsators

- Non-planet-transiting and non-asteroseismology / stellar events :
  - Supernovae
  - Gravitational Microlensing
  - Gamma-Ray Burst
  - Classical Novae
  - X-Ray bursters (e.g. X-Ray binaries)
  - Active Galactic Nucleus (e.g. blazar)

- Other unexpected events which can, or cannot, be classified :
  - Variability in the light curves which results from occultations by debris disks, cometary material, or extrasolar ring system (e.g. J1407, Mamajek et al. 2012)
  - Asteroids passing in the line of sight of an observing window
  - Other unclassified events, such as
    - KIC 8462852, also known as the Tabby's Star (Montet and Simon 2016)
    - SCP 06F6, with M_U ~ 23 mag (Barbary et al. 2008)

EVENT REPORTING

- When the detection of an event (candidate) occurs, the PLATO Science Working Team and the Science Flux Alerts work package will be informed.

- Sanity check to confirm if genuine (e.g. stellar superflares detected instead of outliers)

- When a planet-transiting or asteroseismology / stellar event is detected, possible change of on-board sampling mode (i.e. change the cadence to 600 seconds, 50 seconds or 25 seconds).

- When a non-planet-transiting or non-asteroseismology / stellar event is detected, an alert can be send to the community for follow-up observations which are not possible with PLATO (e.g. optical spectroscopy follow-up of supernovae, radio observation follow-up of a gamma-ray burst), considering their brevity and non-repeatability, while they are in progress. It is possible to chose the recipient of the alerts.
  - *IVOA* (International Virtual Observatory Alliance) *Sky Event Reporting*
  - *Gamma-ray Coordinates Network*

TRANSIENT OBSERVATIONS BY PREVIOUS MISSIONS

The Kepler spacecraft was able to detect a Supernovae of type II-P (Garnavich et al. 2016). Kepler also monitored a known blazar for ~1.6 years (Mohan et al. 2016). Ongoing work is being done to search for gravitational microlensing events in the Kepler field (Hoffman & Rowe 2015).

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