Study of the PSR B1259-63 2014 periastron passage
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γ-ray-loud binary (GRLB) systems are a newly identified class of X-ray binaries in which interaction of an outflow from the compact object (black hole or neutron star) with the wind and radiation emitted by a companion star leads to the production of very-high energy (VHE) γ-ray emission. Five such systems PSR B1259-63, LS 5039, LS I+61 303, HESS J0632+057 and 1FGL J1018-5859, have been firmly detected as persistent or regularly variable TeV γ-ray emitters (see Dubus (2013) for a review and references therein).

PSR B1259-63 is the only GRLB system in which we are sure about the nature of the compact object. In this system a 48 ms radio pulsar is in a highly eccentric 3.4 year orbit with a Be star LS 2883. This system is known to be highly variable on an orbital time scale in radio (Johnston et al. 2005, and references therein), X-ray (Chernyakova et al. 2009, and references therein), and TeV (Aharonian et al. 2005) energy ranges. The orbital multi-wavelength variability pattern is determined by the details of the interaction of relativistic pulsar wind with a strongly anisotropic wind of the companion Be star, composed of a fast, rarefied polar wind and a slow, dense equatorial decretion disk. The disk of the Be star in the PSR B1259-63 system is believed to be titled with respect to the orbital plane. The line of intersection of the disc plane and the orbital plane is oriented at $\sim 90^{\circ}$ with respect to the major axis of the binary orbit (Wang et al. 2004) and the pulsar passes through the disk two times per orbit.

In the 2010 the PSR B1259-63 periastron passage was for the first time monitored in GeV energy range by Fermi. While during the periastron itself the observed GeV emission was at the level predicted by the IC model(Neronov & Chernyakova 2008), a month after the periastron passage absolutely unpredicted month-long GeV flare was observed (Tam et al. 2011; Abdo et al. 2011). During the GeV flare, PSR B1259-63 was characterized by an extremely high conversion efficiency of pulsar spin-down power into gamma-ray emission. No similar excesses has been observed at any other wavelength. The physical origin of the flare is still under debate.

Optical observations of 2010 gave a hint that the flare could be related to the disruption of the Be star disk (Chernyakova et al. 2014). But at that time it was only an indication, as the flare happened to be during the gap in optical monitoring. For the periastron of 2014 we have organised an extensive multiwavelength campaign aiming to have more information on the processes taking place in the system, and especially around the time of the GeV flare. Our continuous monitoring of the source allowed the immediate detection of the start of GeV flaring activity, reported in Malyshev et al. (2014).

During my stay in Dublin I was working together with Dr. Chernyakova on the analysis and interpretation of the data collected during our multiwavelenth campaign. We have found out that (see Fig. 1):

- In 2015 Fermi flare happened approximately at the same orbital phase as in 2010.
- The 2014 GeV flare exhibits a similar average flux level and spectral shape with the 2010 flare, but shows different flux evolution.
- Dense coverage of Swift observations after the periastron passage allowed for the first time to observe second rise of the flux in details, and to find out that the second X-ray peak is almost twice as high as the first one, similar to the behaviour commonly observed in radio.
- Optical observations shows rapid change of the width of the Hα line at the moment of GeV flare in agreement with the model of Chernyakova et al. (2014).

Currently we are preparing a paper describing all our findings and plan to submit it to MNRAS in early 2015.

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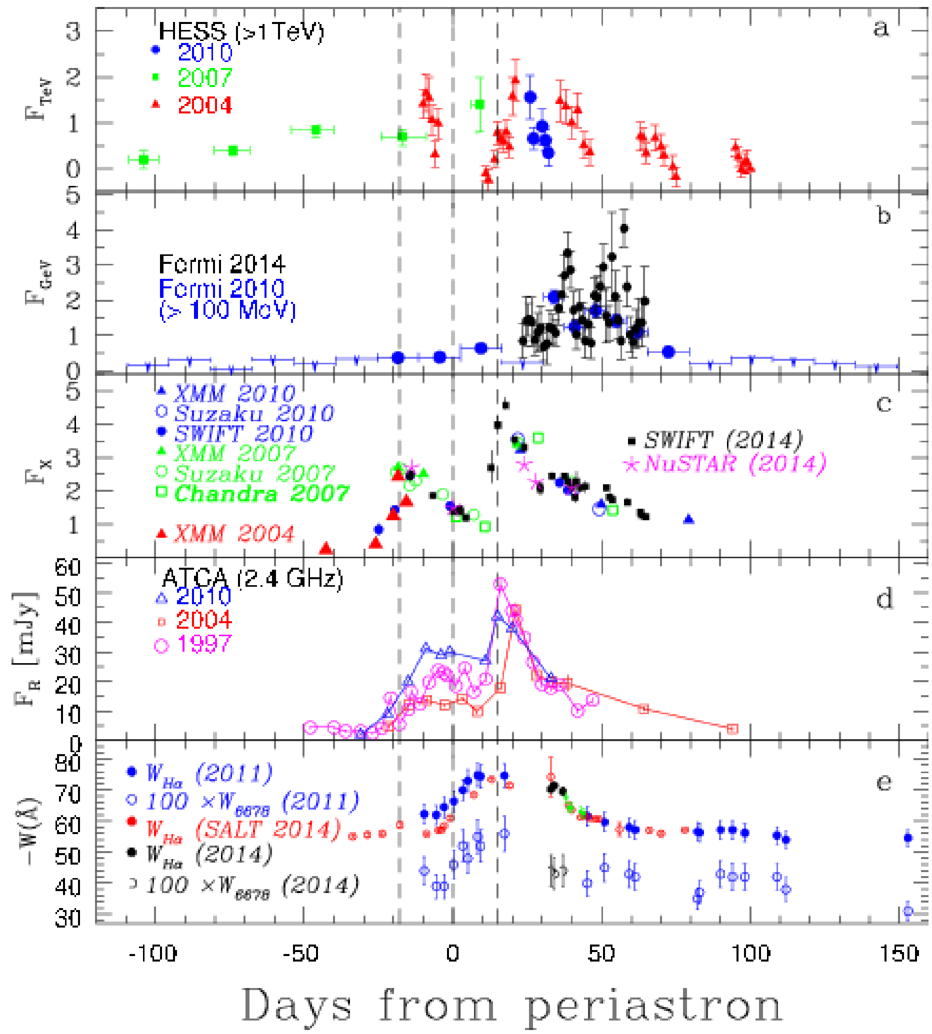

Fig. 1: Orbital light curves of PSR B1259-63 around periastron for several passages. *Panel a*: observations by H.E.S.S. in the $E > 1$ TeV energy range for the 2004, 2007, and 2010 periastron passages (Aharonian et al. 2005, 2009; H.E.S.S. Collaboration et al. 2013). Flux is given in 10^{-12} cm^{-2} s^{-1}. *Panel b*: *Fermi*-LAT flux measurements in the $E > 100$ MeV energy range for the 2010 and 2014 periastron passages. Flux is given in 10^{-6} cm^{-2} s^{-1}. *Panel c*: X-ray fluxes from 2014 (this work) and three last periastron passages (Abdo et al. 2011; Chernyakova et al. 2009). Flux is given in 10^{-11} erg cm^{-2} s^{-1}. The typical error of the X-ray data is smaller than the size of the symbols. *Panel d*: Radio (2.4 GHz) flux densities measured at ATCA for the 2010, 2004 and 1997 periastron passages (Abdo et al. 2011; Johnston et al. 2005, 1999). Dashed lines correspond to the periastron and to the moments of disappearence (last detection) and reappearence (first detection) of the pulsed emission. *Panel e*: Evolution of the equivalent widths of Hα (filled circles) and He I λ6678 (open circles). W_{6678} is shown multipled by a factor of 100 for easier comparison to $W_{\mathrm{H}\alpha}$.