CoLiTecVS – new tool for automated reduction of photometric observations

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ABSTRACT. The capabilities of telescopes allow us to make the plotting of light curves a routine task. This one shifts the main attention of astronomer from the plotting to research. To achieve this goal, we developed a new tool for automated reduction of photometric observations, which includes the computational method for the brightness assessment of the investigated and comparison stars; brightness equalization of astronomical images using inverse median filter; light curve plotting and its processing using different tools.

Introduction

CoLiTec project created the universal system for the automatic data reduction – CoLiTecVS (Savanevych et al., 2015, 2018). This system allows astronomer creating the light curve of investigated variable star without manual data handling between processing steps.

CoLiTecVS workflow for the automatic data reduction

1. Calibration of the images by bias-frame, dark-frame and flat-field. Optionally the calibration by flat-field can be improved or completely substituted by inverse median filtration;
2. Identification of stars on the frames, plate solution and cross identification with astrometry catalogue;
3. Ensemble differential photometry using artificial comparison star constructed from weighted contribution of several selected constant stars;
4. Light curve construction for one selected object;
5. Archive the target data in the publicly available database ViViO. The process is fully automated and can be run online during the observations.
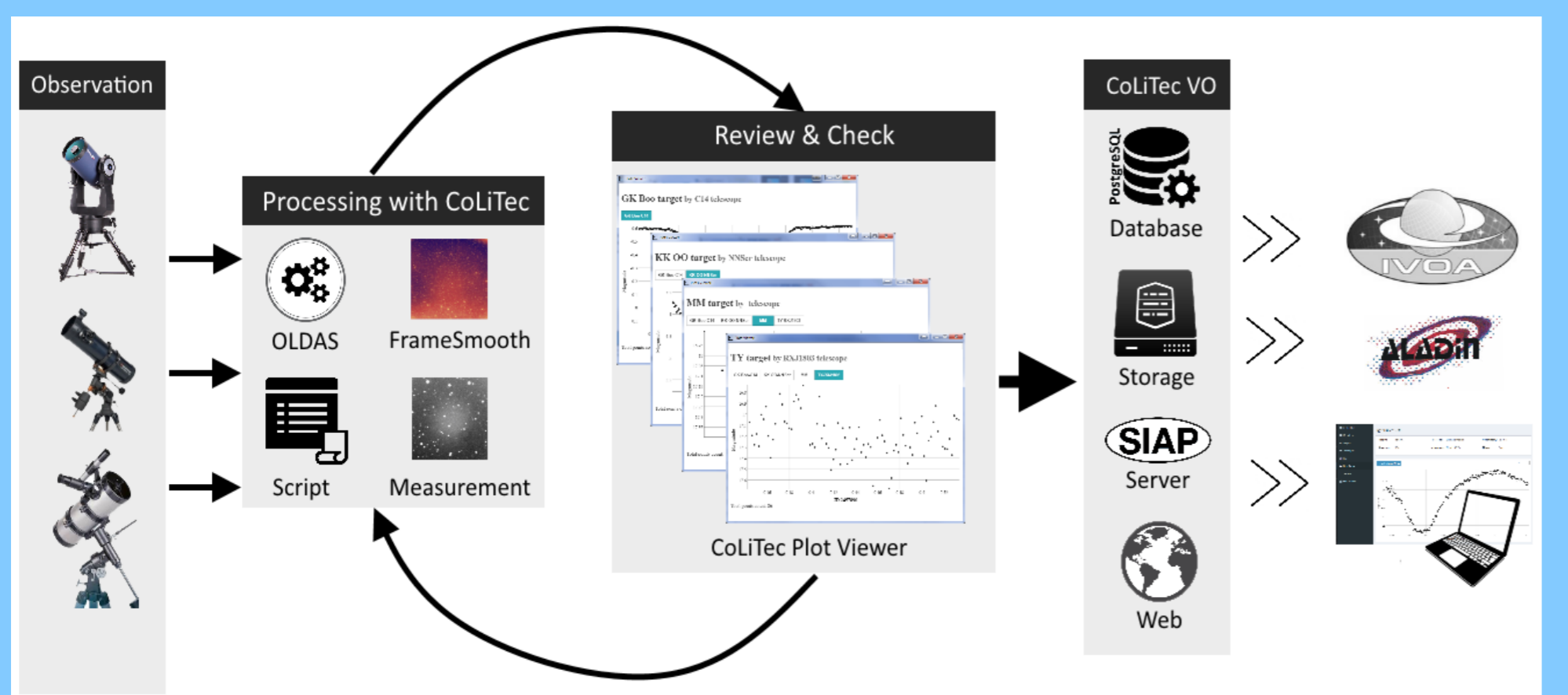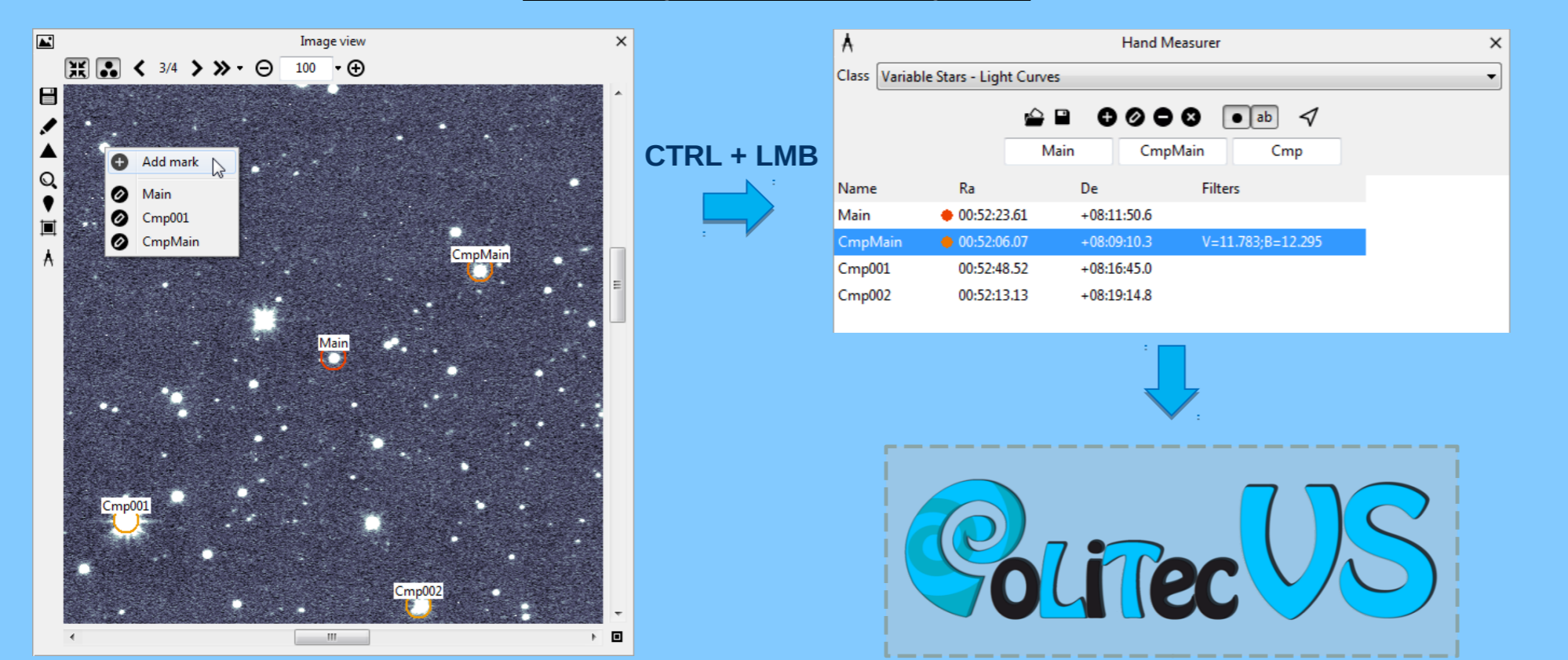

The detailed description of the program functionalities can be found in Savanevych et al. (2017)

Brightness equalization

Raw image   Classical calibration dark + flat   CoLiTecVS with inverse median filter

More about brightness equalization in Dubovský et al. (2017)

LookSky – the auxiliary tool

CTRL + LMB

➤ View opened series of frames
➤ Select investigated target and comparison stars
➤ Prepare a task-file for plotting the light curve. Will be used in the future in every reduction of given target.

### Representation of the photometric observations in CoLiTecVS
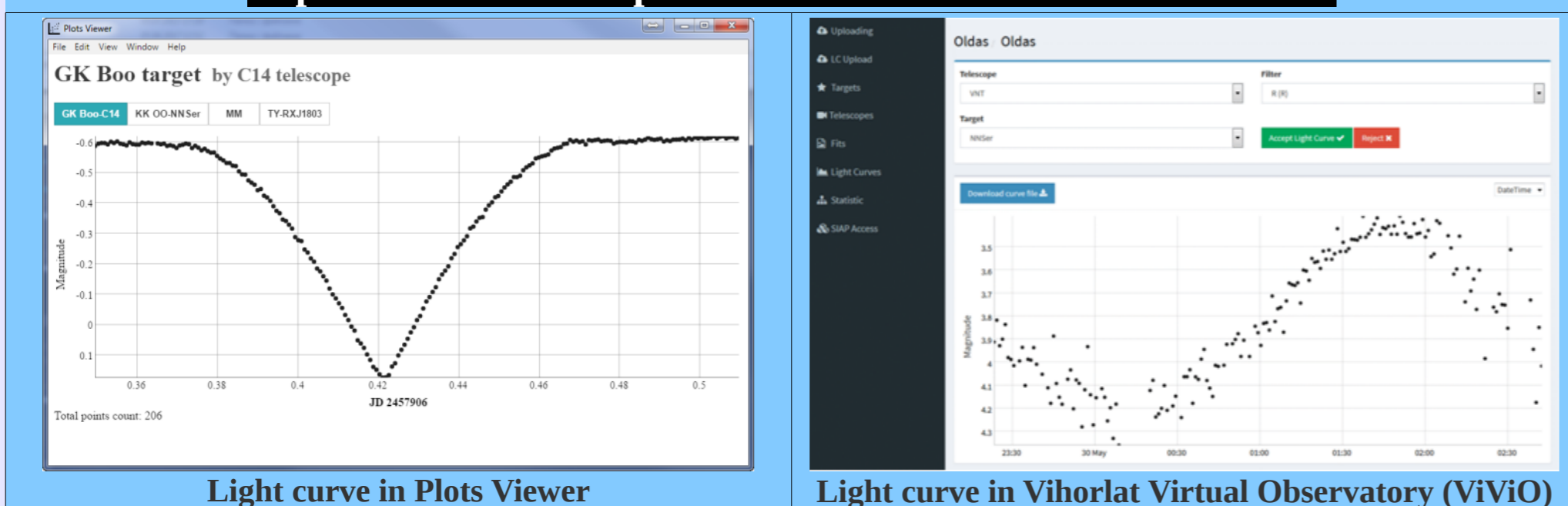
Light curve in Plots Viewer   Light curve in Vihorlat Virtual Observatory (ViViO)

Website: http://www.neoastrosoft.com/colitecvs_en/

Testing on real images

We have performed several tests to ensure the reliability of produced data. We have analyzed archival images taken on the Astronomical Observatory on Kolonica Saddle (Kudzej and Dubovsky, 2010) with several instruments. First we have investigated the possible influence of non-linearity of median filtering on the photometry results. We didn't find measurable influence. Contrary – the background brightness equalization by inverse median filter usually provides better results than classical flat-field calibration. The photometry of constant stars obtained by CoLiTecVS was compared with values obtained by the conventional reduction process, i. e. calibration and photometry performed with Muniwin (Motl, 2009) software and subsequently the ensemble photometry using MCV software (Kim et al., 2004).

Testing the possible influence of non-linearity of median filtering on the photometry results
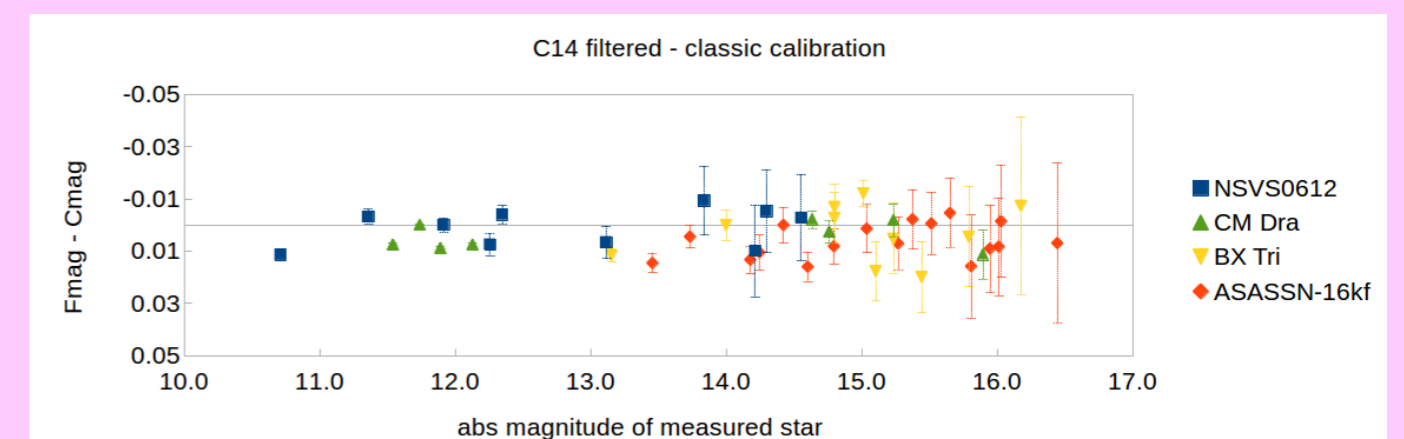

Differences between photometry on images calibrated in classical way (Cmag) and images calibrated by inverse median filter (Fmag). Only images well calibrated by classical master-flat were selected. Both methods are equivalent in this situation.

Testing the correctness of the background flattening on images with strong scattered light
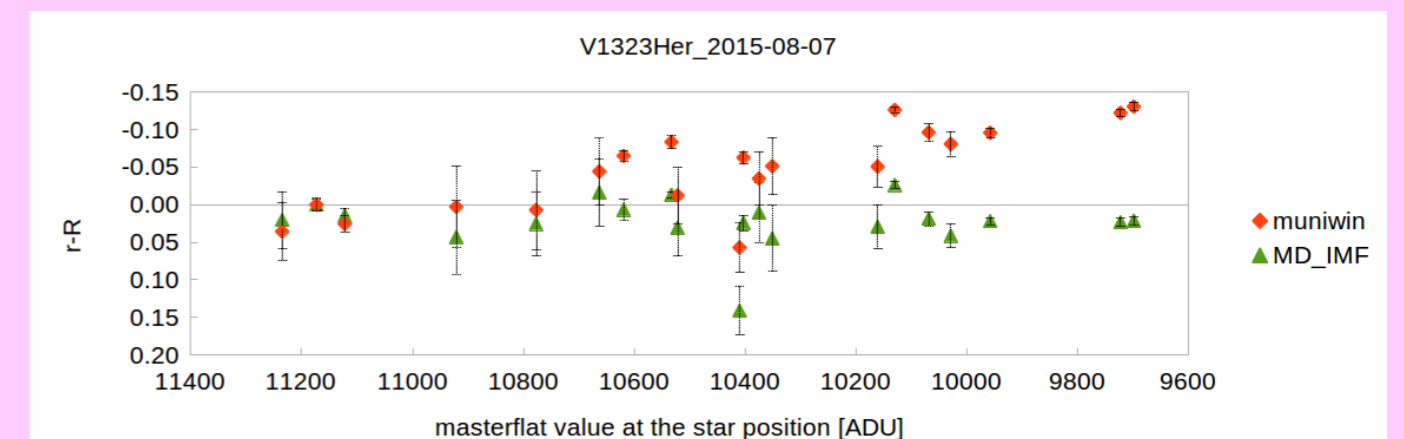
V1323 Her field stars measurements. R – standard values from Henden's photometry, r – measured values, 'muniwin' – classical procedure, 'MD_IMF' – master dark calibration and equalization by CoLiTecVS without master-flat.
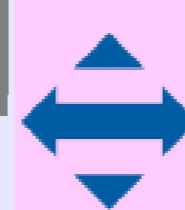
Comparison of photometry results of constant stars
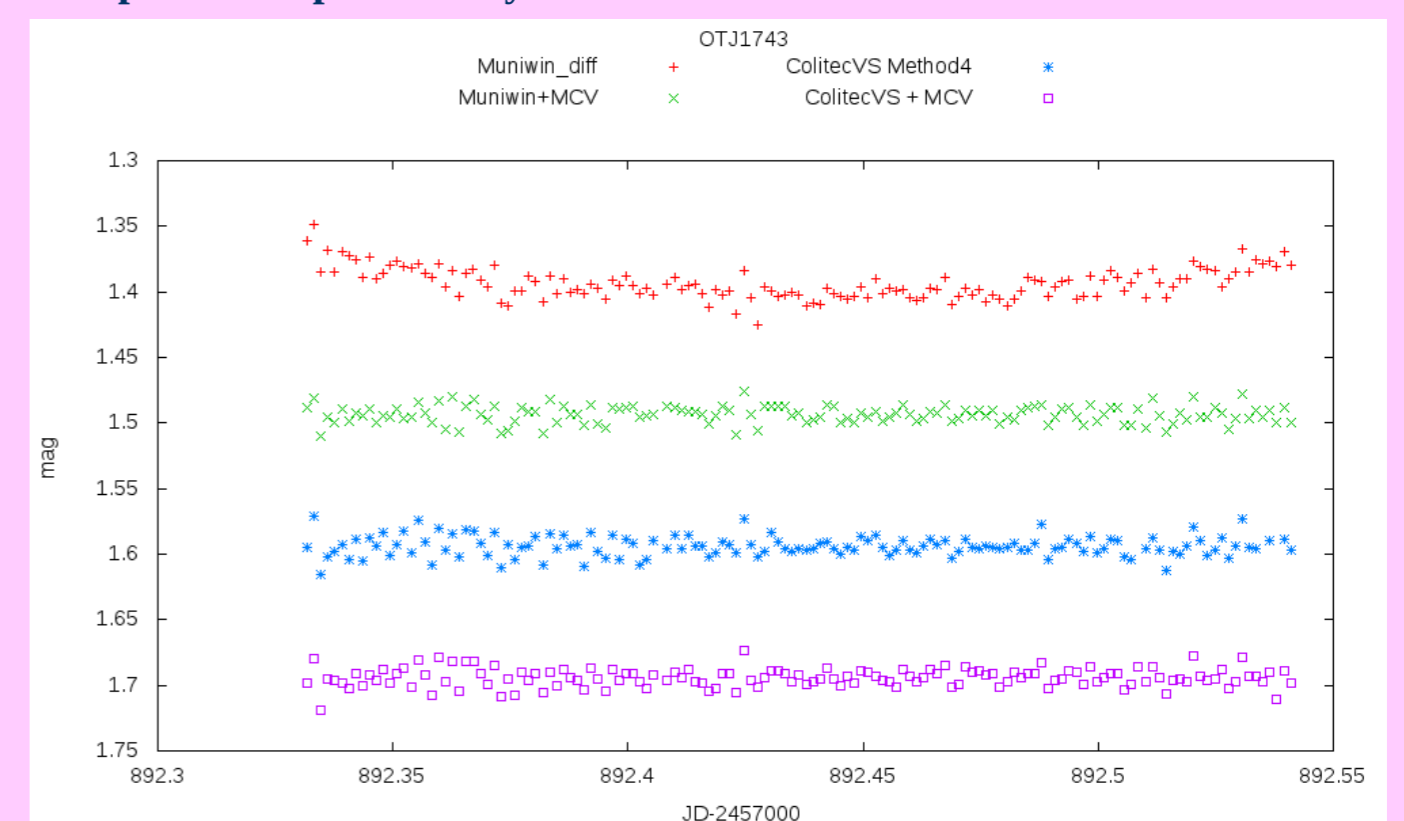
	mean	σ
Muniwin differential photometry 1 comparison star	1.3935	0.0118
Muniwin instr. values + MCV ensemble photometry	1.3935	0.0067
CoLiTecVS ensemble photometry fully automated	1.3939	0.0078
CoLiTecVS instr. values + MCV ensemble photometry	1.3941	0.0070

The disadvantage of single comparison star is clearly visible. The trend with parabola shape is caused by extinction. The rest of the light curves are practically equal. So the CoLiTecVS can replace the conventional reduction process with the same precision and accuracy. If the user don't trust the automatic process completely, he has still the option to take instrumental output of CoLiTecVS and play with MCV.

References

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