QHYCCD QHY 42 Camera : first evaluation and parameters measurements

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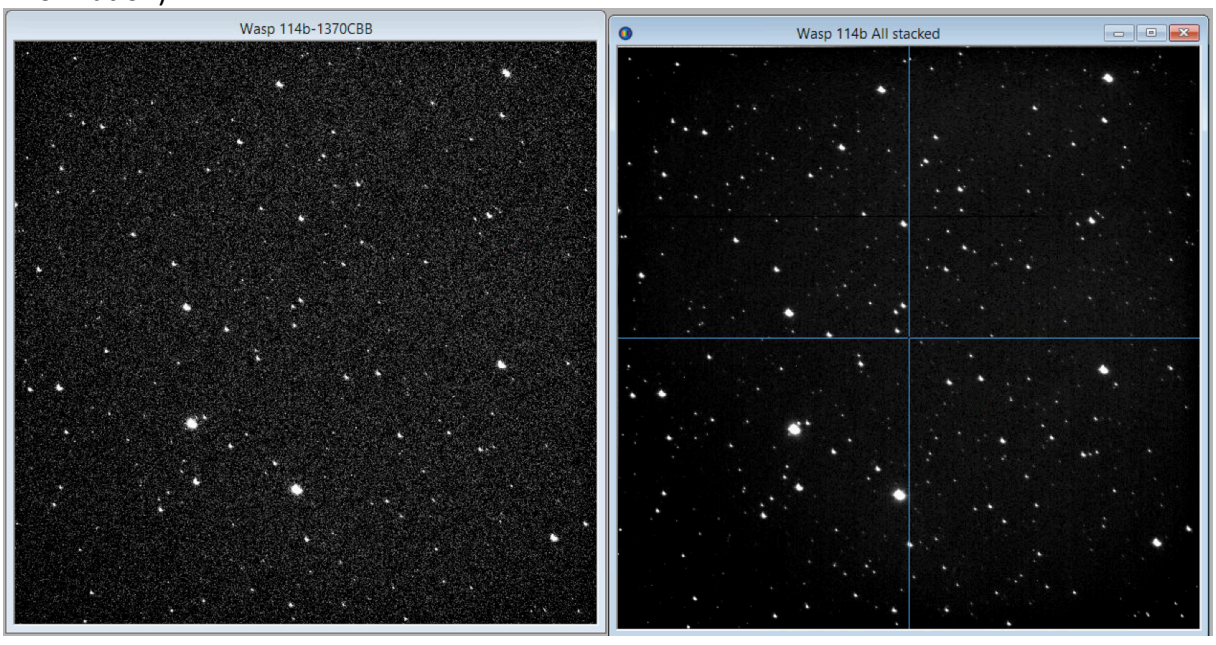
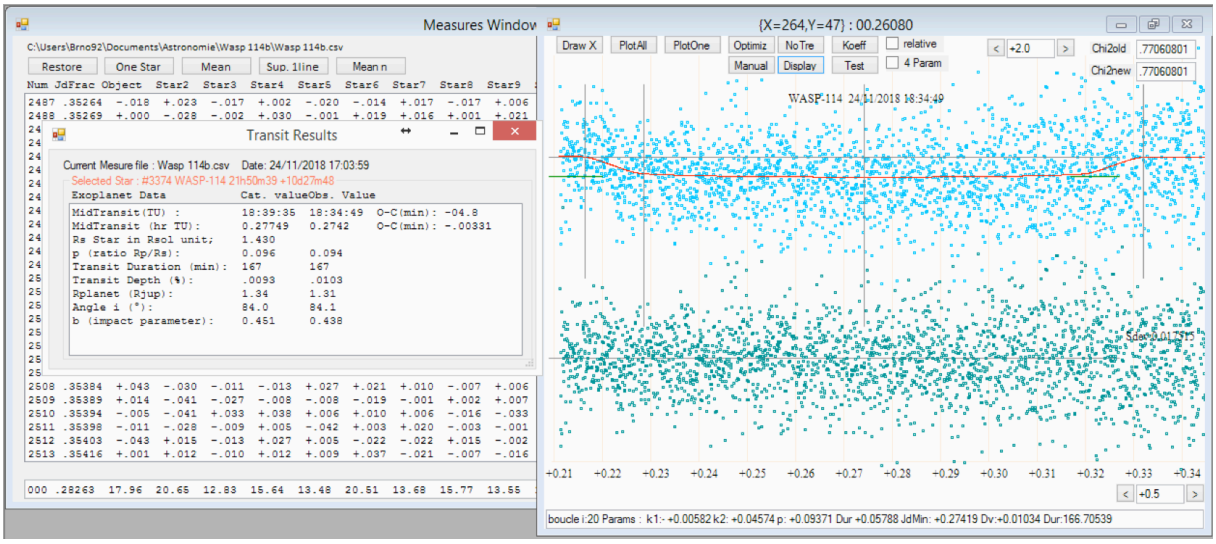
Part 3 : Exoplanet transit measurements with QHY 42 by QHYCCD

Introduction

After measuring intrinsic QHY42 parameters and had a quick look on “first lights” delivered by the QHY 42 Camera, this part 3 is devoted to exoplanet transit measurements.
My setup is an Officina Stellare RILA 400mm F5.2 telescope and an ASA Direct Drive DDM85.
As seen before, the QHY 42 is very sensitive, and the pixel full well is rapidly reached even on faint objects. The challenge here is to get a lot of short images and to examine which kind of results can be obtained in adding quite a lot of those short exposures images.
Usually, in photometry, you try to get long pose images (typically 1-2 minutes) to go to almost saturation of the max pixel (typically 40-50000 ADUs) to get the best Signal to noise ratio.
In this approach, instead of having typically 160 of 60 seconds images as usual, we have taken 2500 images of 4 seconds!
Our target is WASP 114b, where the star is 12.7 mag and we choose a pose length of 4 seconds (Gain= 7 - 0.45 e-/ADU), leading to a maximum pixel value of about 50 000 ADU (3100 “real” ADU, due to the 12 bits AD converter).
The 4 seconds image is quite poor due to the level of noise compared to the stars signal and a poor hazy sky. Moon was full, but rose up only in the middle of the transit. The sky plus the moon and the air mass became very bad at the end of the session.
On the left, a 4 second image and on the right 2500 4 seconds stacked image (just for information):

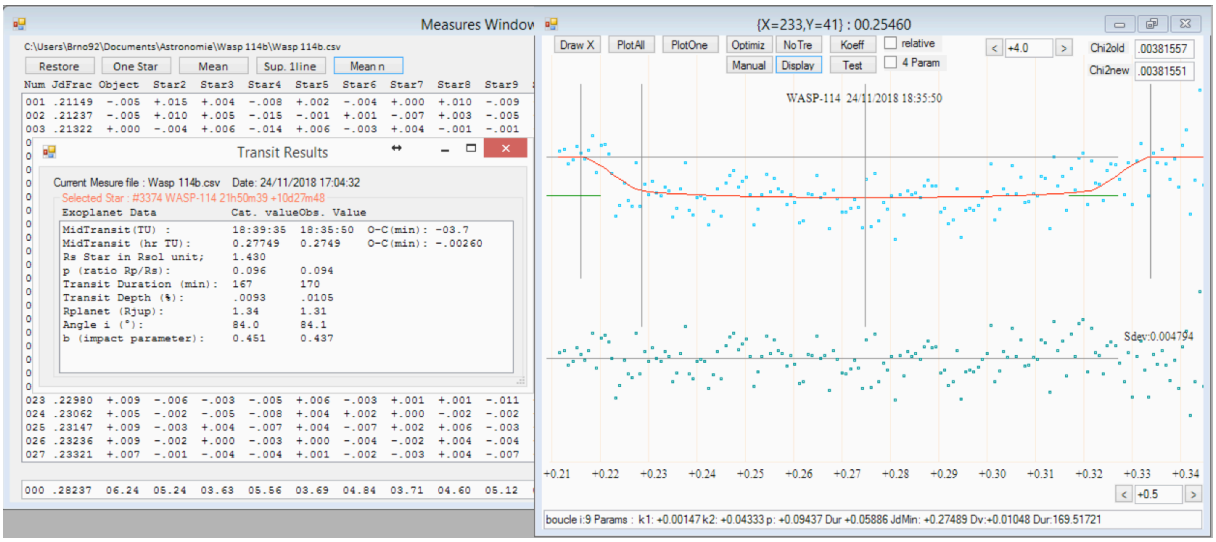


The first analysis is to run the regression algorithm on the 2500 successive images: as expected, the points are highly dispersed, but the curve fitting is anyhow found by the algorithm and gives surprisingly good results:



Standard deviation is quite high (17 mmag) but acquisition rate is also high (4.9 data per minute).

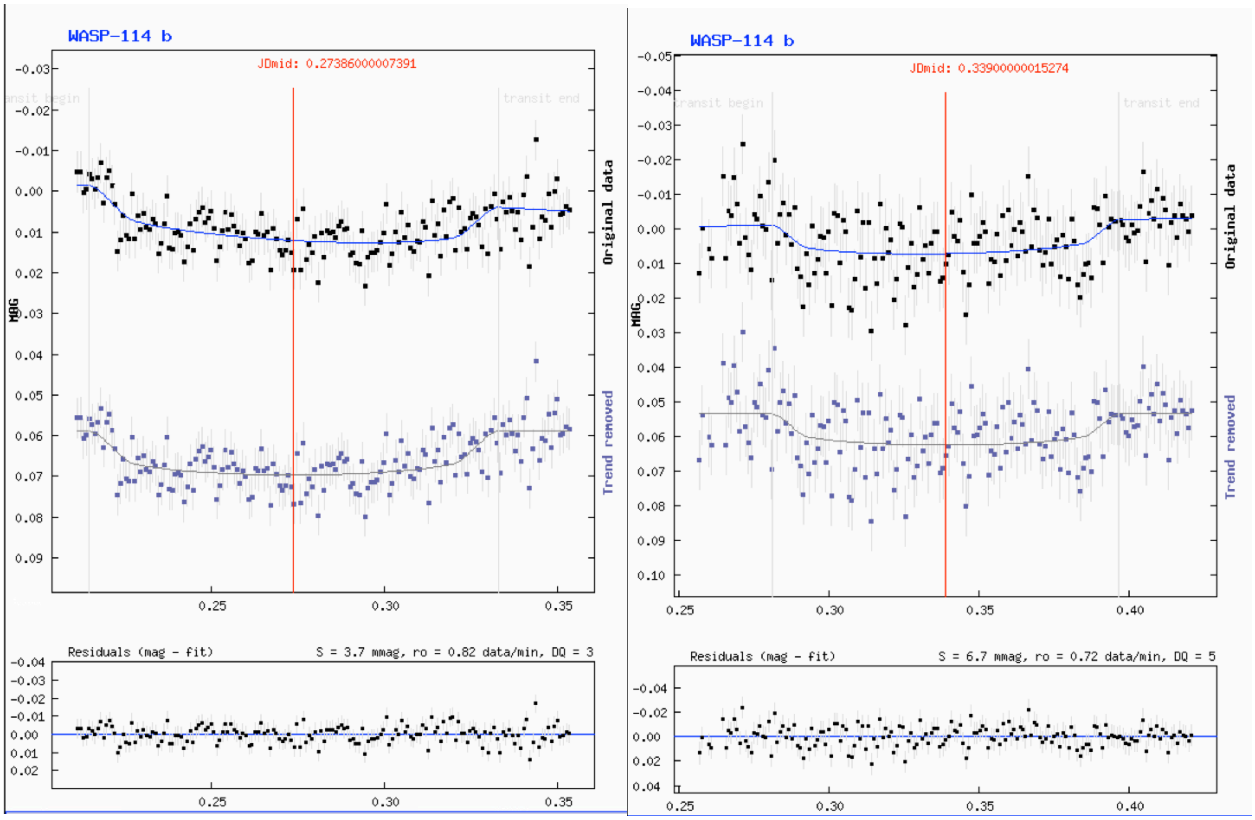
Now, if we take the mean of 15 consecutive measures, the standard deviation becomes much better 4.8 mmag and a data acquisition rate falling to 0.82 data per minute:



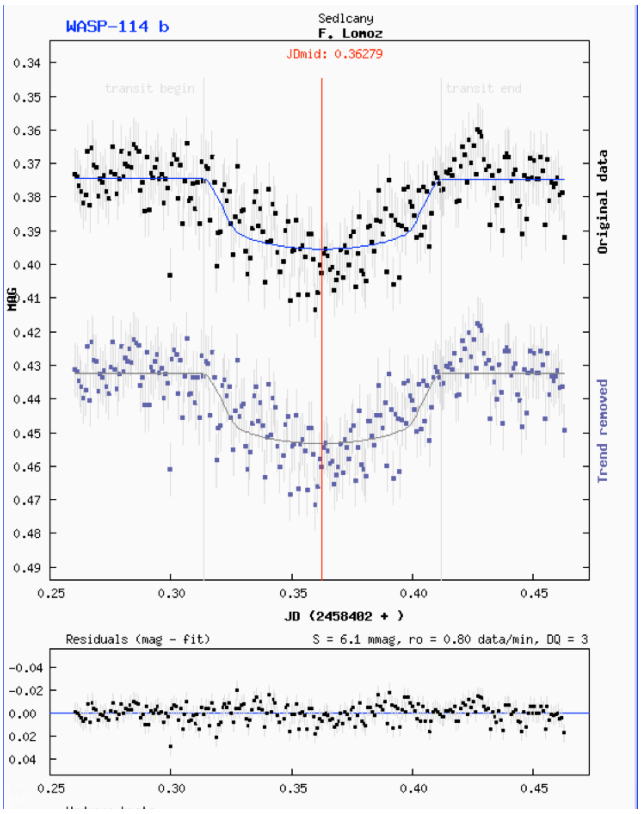
Comparison with other measures

It is interesting to compare this set of 2500 measures to other more traditional (long exposures) measures.

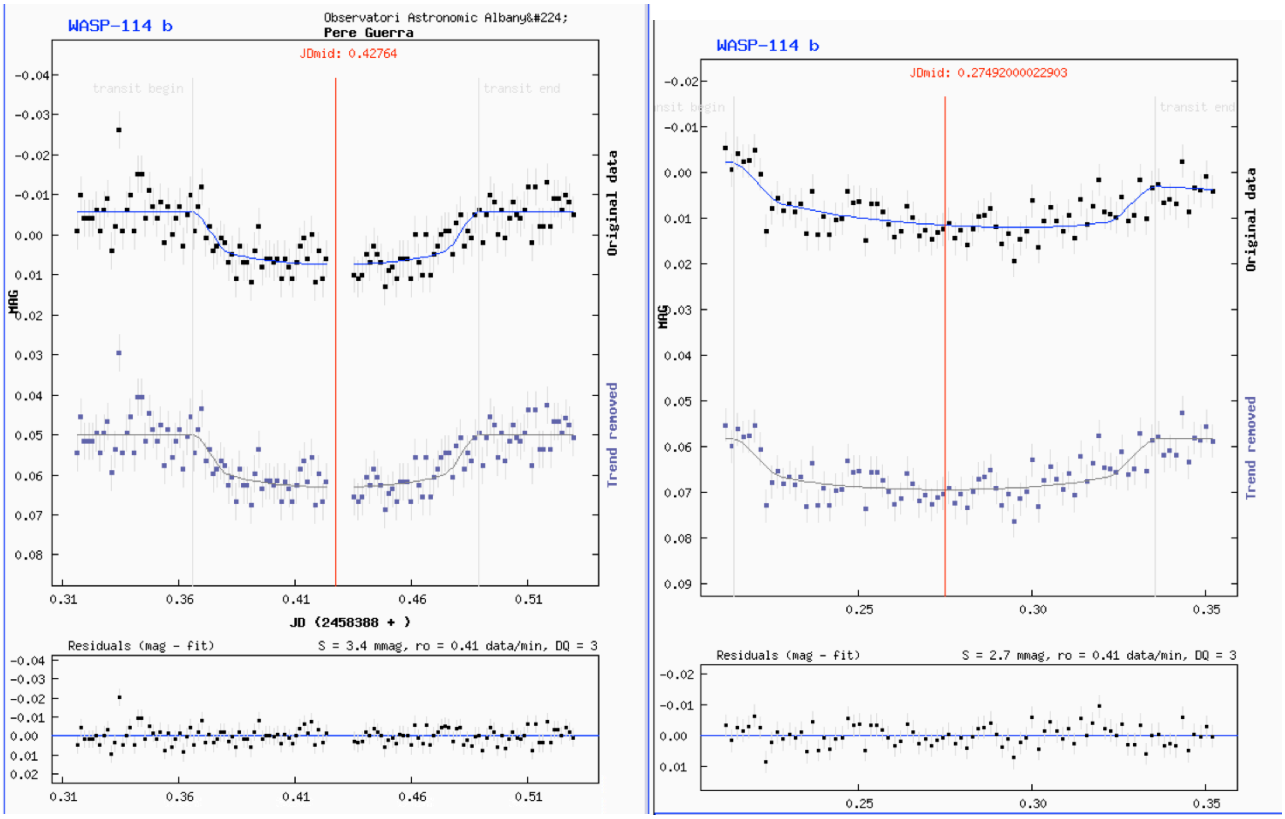
On the left, QHY42 15x4 sec November 24, 2018 and on the right a set of 60 seconds measures made on the same set-up but with a FLI 11002 camera (2016-10-09) : the improvement realized by the very sensitive QHY42 is very impressive with a S indicator dropping from 6.7 mmag to 3.7 mmag (ETD site) :



Another set of measures made by F. Lomoz (2018-10-11 on the right under) with a Newton 300/1200+ST2000XM (60 seconds poses) gives about the same precision as the upper right one.



Another comparison can be made with Pere Guerra (2018-09-27, 16" Meade ACF F8 Moravian G4-9000) (on the right) with our measures with QHY42 but stacked to 120 seconds to compare both results (on the right) :



Once again, the measures with the QHY 42 is better than those with the Moravian G4-9000 equipment with a comparable set-up.

Conclusion

The QHY 42 camera from QHYCCD with a very high QE and a broad spectrum in the near IR is perfectly indicated to exoplanet transit measurement by aperture photometry. Its high gain and limited full well implies to take many short exposures images (which is possible thanks to the very low read noise), and to take the mean of set of images to give equivalent results to usual long pose approach.

It has been demonstrated that this approach (taking the mean of short images- typically 15 x 4 seconds images), rather than a unique 60 seconds images allows to take all the benefit given by this very sensitive camera, without loosing any precision by taking the mean of measurements.

Compared to the FLI 11002 on the same set up, the QHY 42 camera has allowed to reduce the standard deviation of the fitting curve from 8.4 to 4.8 mmag on 60 seconds images.

The draw back is the necessity to take a large number of images (2500 instead of 160), which requires more disk space and computing power. But it is also easier to get rid of poor images (satellite for instance).