Exoplanet observation in Taurus Hill Observatory and co-operation with Pulkovo Observatory

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25- 27th of April 2019, Helsinki, Finland

Taurus Hill Observatory is located in the eastern Finland in a small industrial town, Varkaus. Varkaus has about 20,000 inhabitants. The observatory is 30 km from the city center. The observatory site is completely without light pollution, expect sometimes there are very bright northern lights.

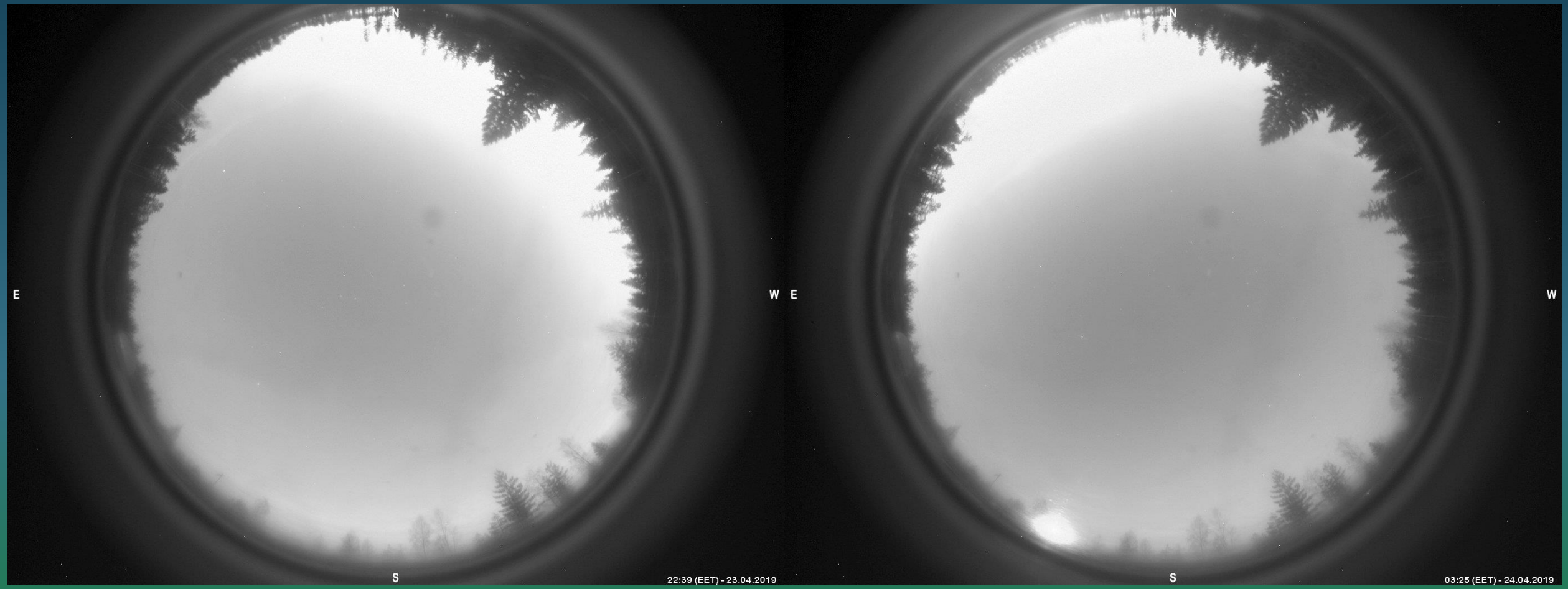
The observatory buildings: the main observatory was built in 2002 – 2003. The viewing platform next to it in the middle, was completed in 2016. Wheelchair access is also available. In the foreground there is the office building of the association. It also acts as a remote-control room for telescopes.
Below is the clubhouse and a hut for camping and a campfire site. Property management takes up a large part of the voluntary work time of the members.

What must be considered with the amateur observations?

The modest performance of the telescope. This limits the observation of the faint objects. The exoplanet objects must be brighter than 15 magnitudes. Usually only one telescope is in use though there are tens of interesting objects seen in the sky.
Finnish weather conditions: only about 30 completely clear nights a year in the winter season!
Lack of remote access to roof structures.
Absence of a broadband connection with enough line speed. Internet is disconnected several times a day. One gigabyte image data will easily become overnight.
The leisure time available for observations is very limited, “the daily work disturbs the hobby”.
Other association activities take a lot of time. The main task of the association is to organize public events.
Financial resources, the association does not get any financial support for basic activities and property management. For THO is needed about 8 000 euros a year. All the money is earned by members who work in the different volunteers.

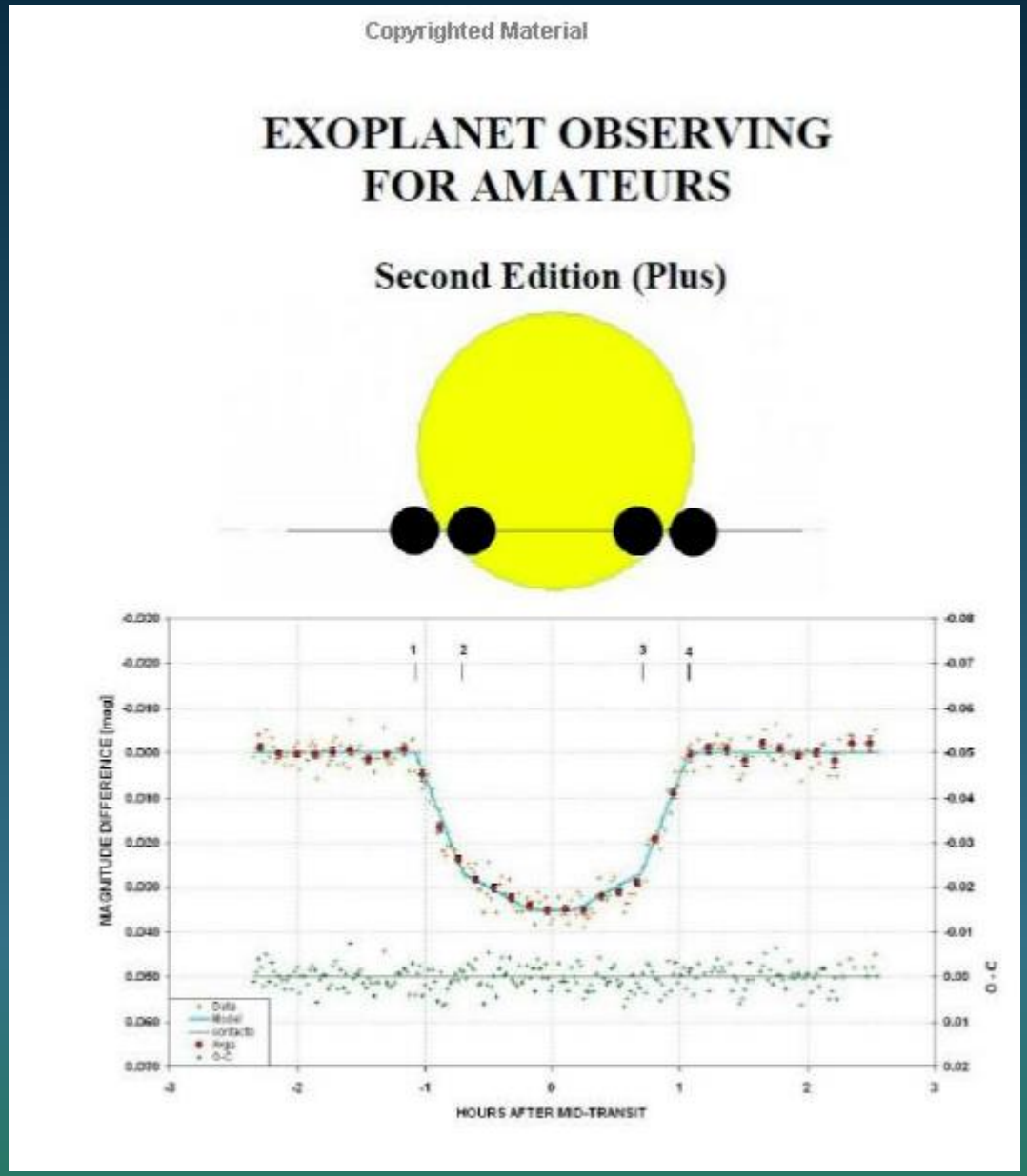
Typical light pollution of the northern sky.

The observation time is possible from September to April. Now, at the end of April, there is enough twilight only between 11 pm and 3 am. Below are images of the Taurus Hill Allsky camera a few days ago at 10.30 pm and 03.30 am.

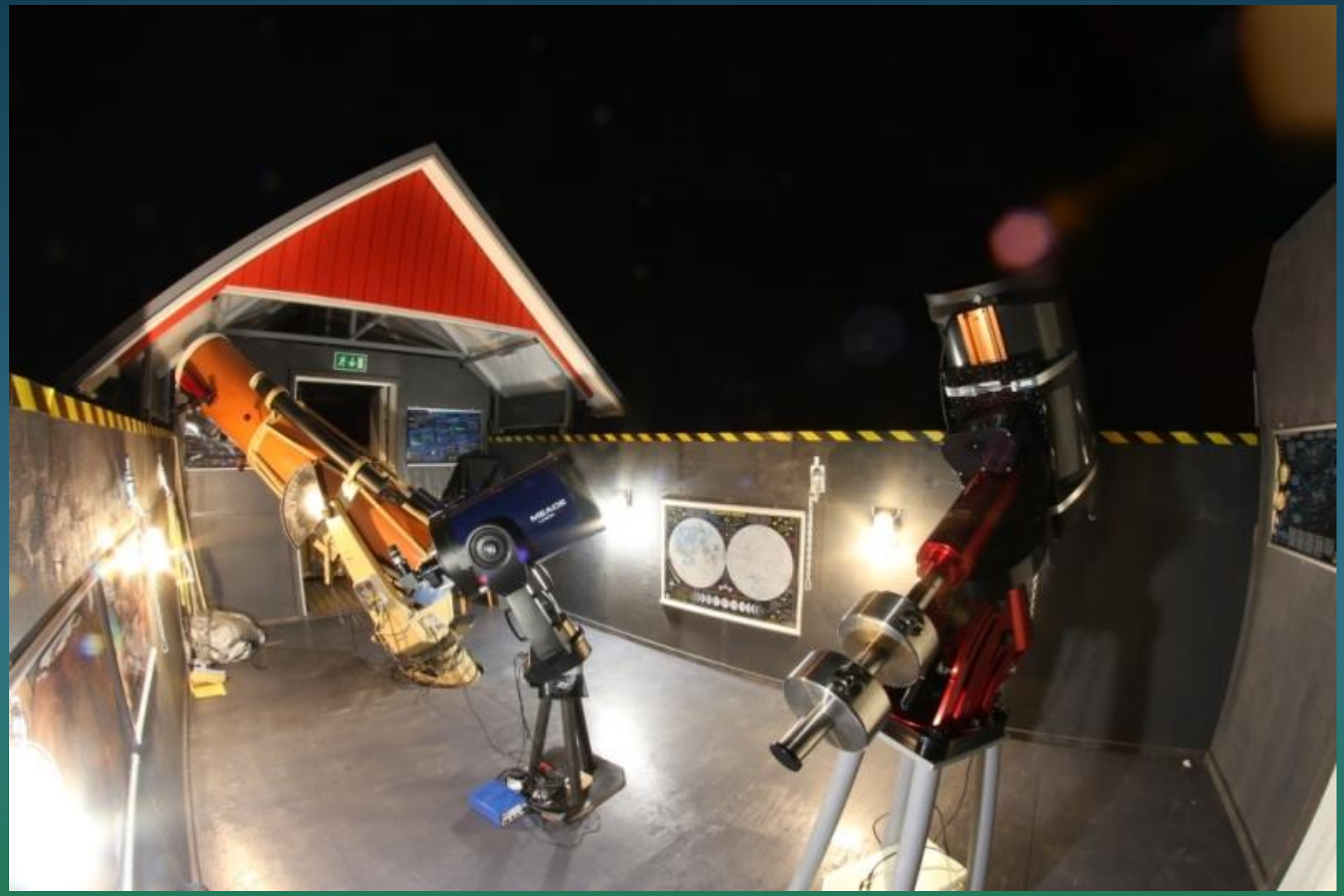


We have sent our observations to different universities, researchers and databases. Our almost 300 LC:s have been observed since 2006. About 120 have been sent to TRESCA. Normally, observations of many different objects are sent directly to the relevant research groups. In addition to the well-known exoplanets, there are many unsecured exoplanet observed.

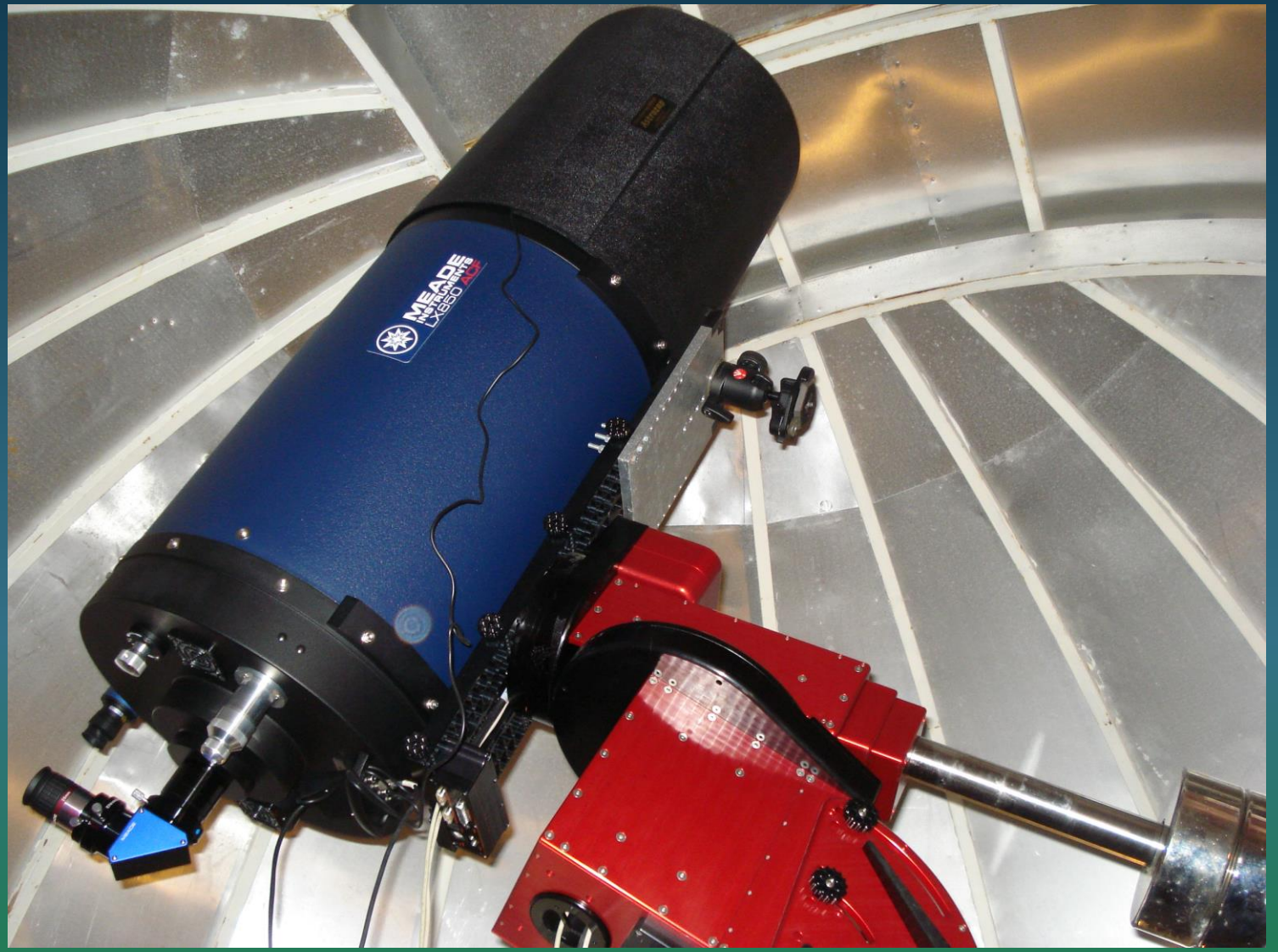
Our contacts:
Prof. Gregory Laughlin, Santa Cruz, CA
2006 - 2007
Amateur astronomer Bruce Gary, Hereford (G95), AZ
2007 - 2009
TRESCA
2009 -
Prof. Sergio Messina, Catania, Italy
2013 - 2014
Prof. Eugene Sokov, Pulkovo (St. Petersburg), Russia
2013 -
Amateur astronomer Paul Benni, Acton, MA
2017 -



The viewing platform: the equipments are Celestron 14", Meade 12" and Newton 14.5". Celestron is on the Paramount MEII (TheSkyX sofware) and it has SBIG ST-8XME CCD camera with Johnson / Bessell photometric filters.

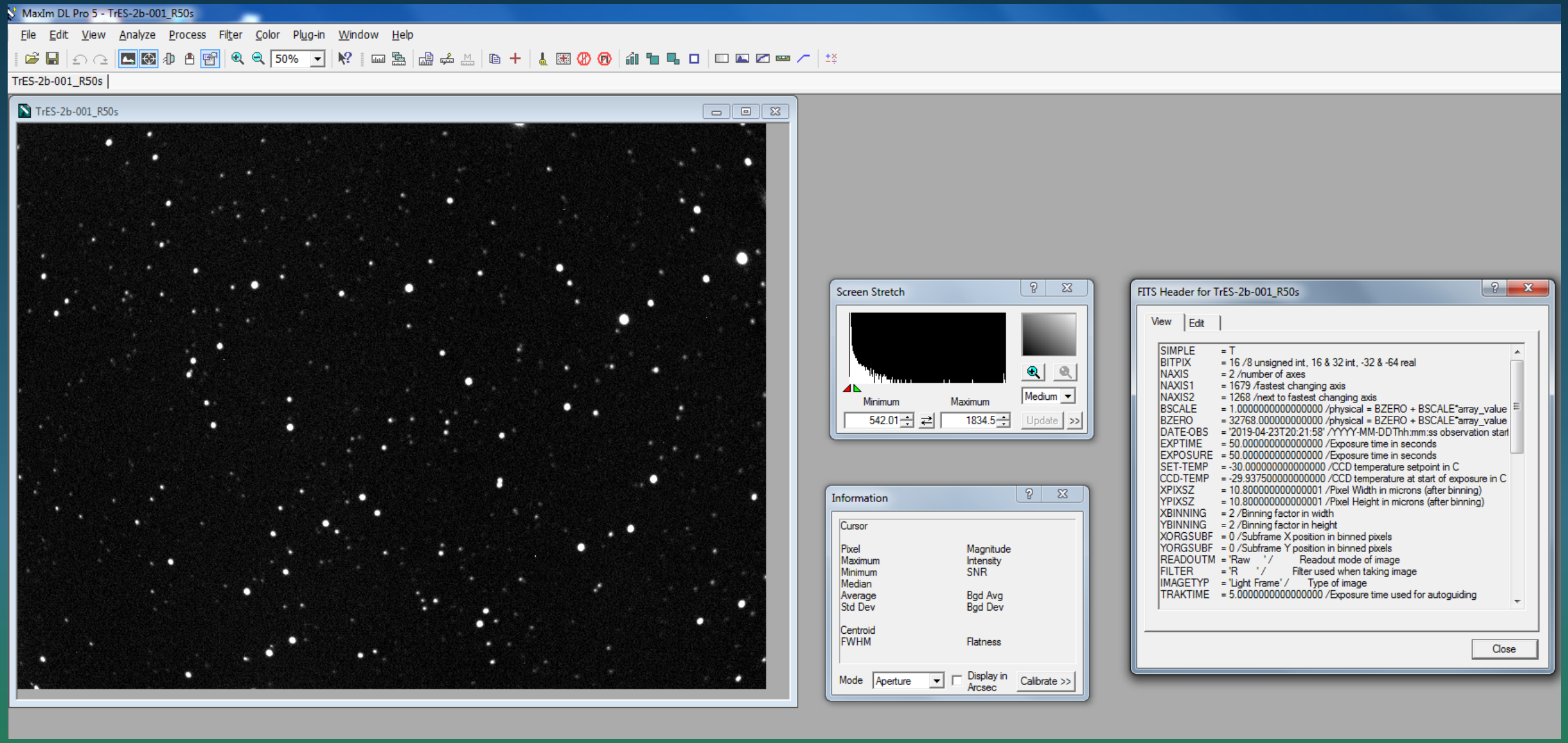


The main device of Taurus Hill Observatory is Meade16”ACF on the Paramount ME (TheSky5 software). It has SBIG STT-8300M CCD camera.

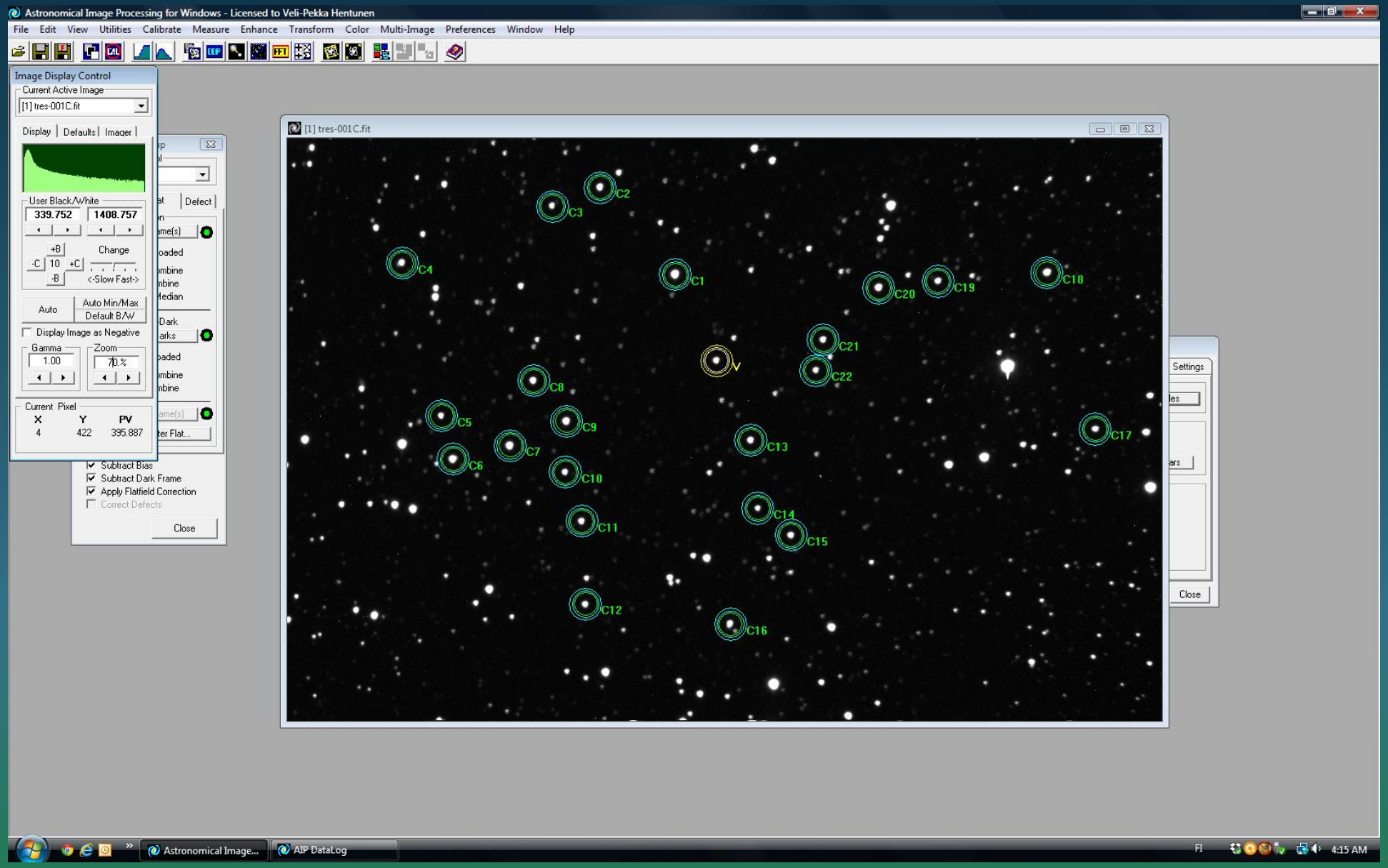


Here I am installing SBIG ST-8XME CCD camera to the Meade telescope with Mr. Markku Nissinen. With him I have done for example supernova searching and brightness measurements, gamma ray burst OA observations and asteroid light curve measurements.

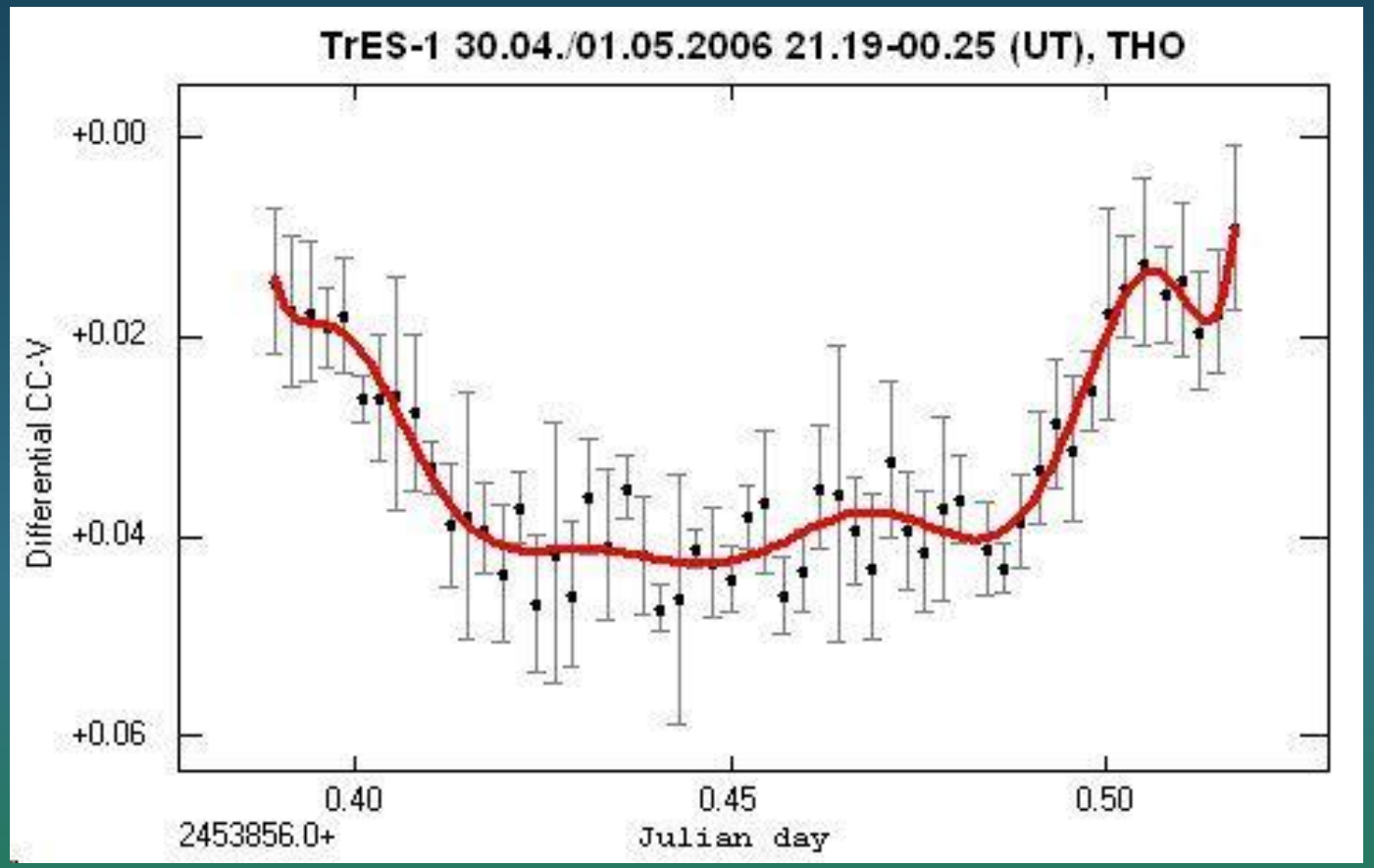
We use for imaging MaxIm DL 6 software. Images are also calibrated with this program.



Photometric measurements are made using the AIP4WinV2 program.



Here is the first exoplanet observation of Taurus Hill Observatory: TrES-1b. It was done at the 30th of April in 2006. The observation was sent to Prof. Gregory Laughlin. After that moment the co-operation with the before-mentioned partners began to start gradually.
Fortunately at that time, the transit occurred at the darkest time of the night. So the whole light curve of the transit could be measured.



Here is a TTV targets list of Pulkovo Observatory. The list is about five years old and we haven't got an update for it. In the past couple of years, co-operation has been very limited. Only occasionally observation requests have come from Pulkovo.

In the category Extra-high priority mentioned TrES-5b is the main target of the our co-operation. We have made the most observations just for this target, totally about 20 times.

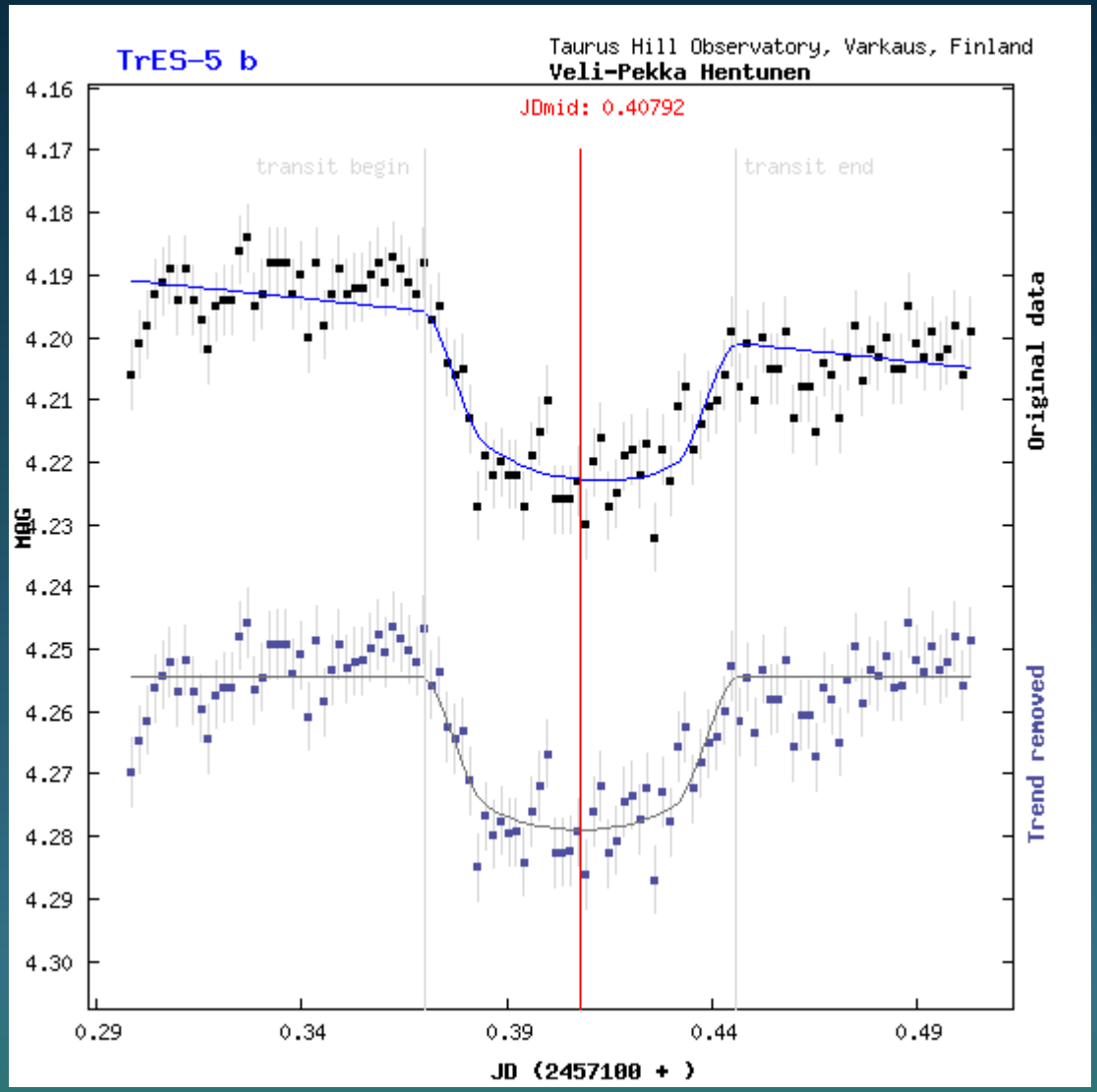
Extrasolar systems with possible TTV signals:

Extra-high priority	High priority	Secondary priority	Third priority
TrES-5b	HAT-P-37b	HAT-P-3b	HAT-P-10b/WASP-11b
Qatar-1b	HAT-P-30b/WASP-51b	HAT-P-13b	WASP-13b
WASP-4b	Corot-1b	HAT-P-19b	HAT-P-16b
WASP-52b	WASP-12b	OGLE-TR-56b	Kepler-17b
Kelt-1b	Kelt-3b	OGLE-TR-113b	Qatar-2b
HAT-P-25b	Corot-8b	WASP-6b	WASP-48b
HAT-P-22b	WASP-3b	XO-5b	HAT-P-15b
WASP-17b	WASP-19b	WASP-50b	WASP-64b
GJ 3470b	HAT-P-27/WASP-40b	HAT-P-28b	WASP-98b
HD 80606b	TrES-2b	HAT-P-17b	
	GJ 436b	HAT-P-23b	
	WASP-58b	WASP-16b	
	WASP-46b	WASP-23b	
	WASP-21b		

Here is a typical light curve from TrES-5b. The star is quite faint about 13.6 magnitude. So its exposure time is usually 120 seconds with a photometric R filter.

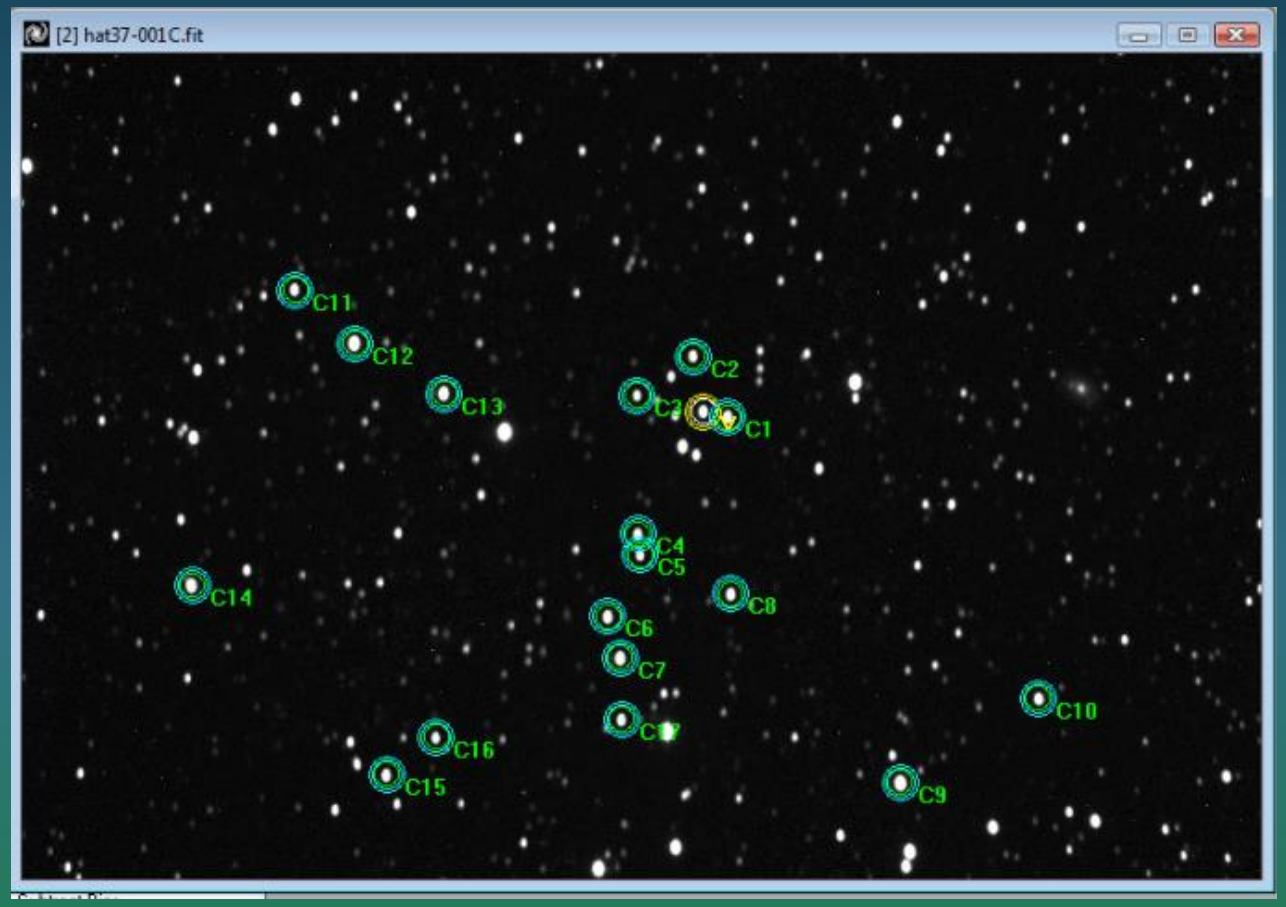
From these numerous observations made by different partners in 2016 and 2017 Eugene Sokov's research group found a regular variation (TTV). On the basis of this evidence it was calculated that the star had also another planet, TrES-5c. It is about Neptune's mass object that circulates with 1: 2 resonance compared to the TrES-5b planet.

The publication is "*Transit timing analysis of the exoplanet TrES-5 b. Possible existence of the exoplanet TrES-5 c.*" *and it was* released in Monthly Notices of the Royal Astronomical Society, Volume 480, Issue 1, October 2018, Pages 291-301.

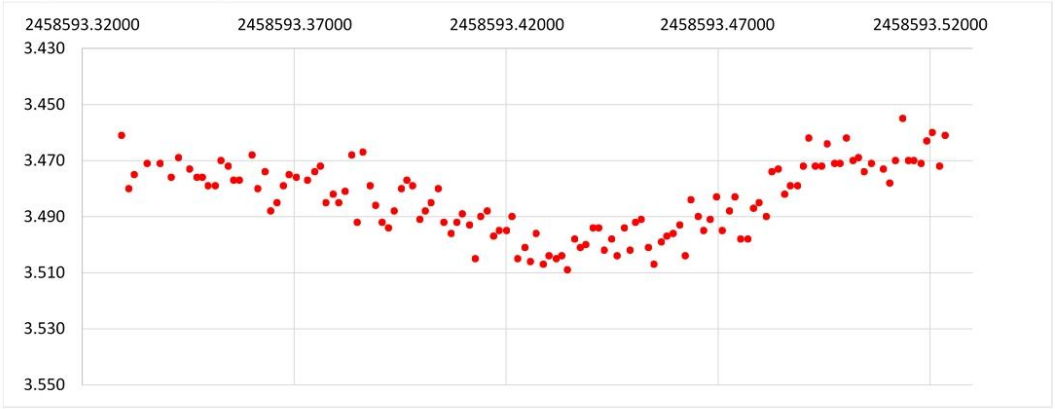


In many observable targets there is a matter of attention:

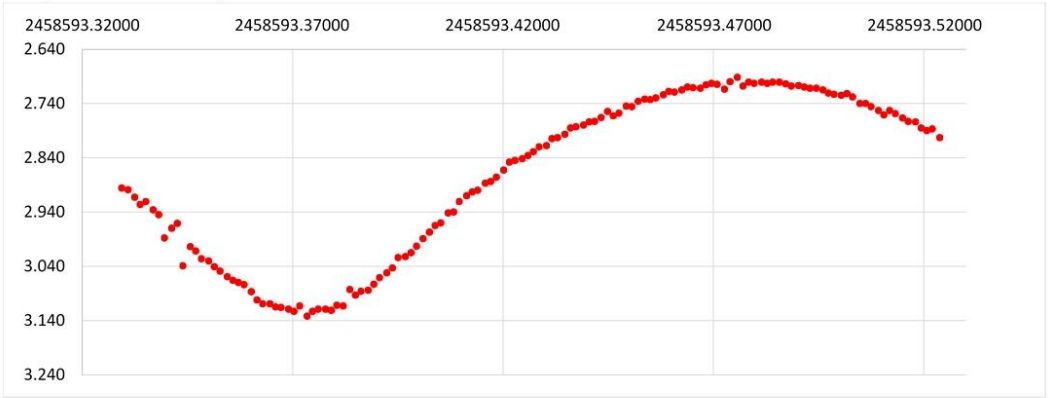
There is a variable star in the same field as the target. Like this one in the HAT-P-37b image field. This light curve has been measured a week ago.



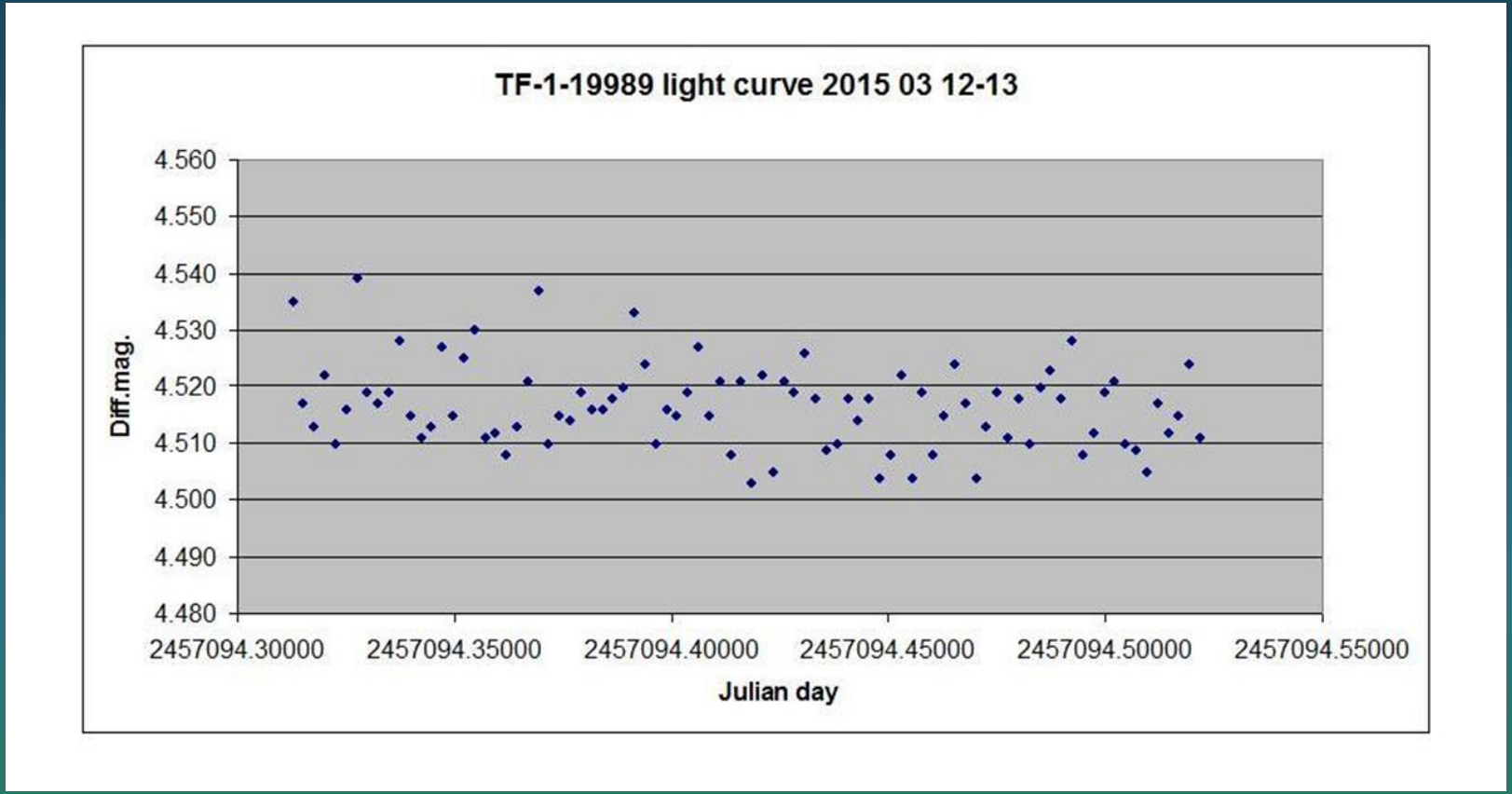
HAT-P-37b
THO, 2019.04.19-20
C-14, Paramount MEII, ST-8XME



GSC 3553-845
THO, 2019.04.19-20
C-14, Paramount MEII, ST-8XME

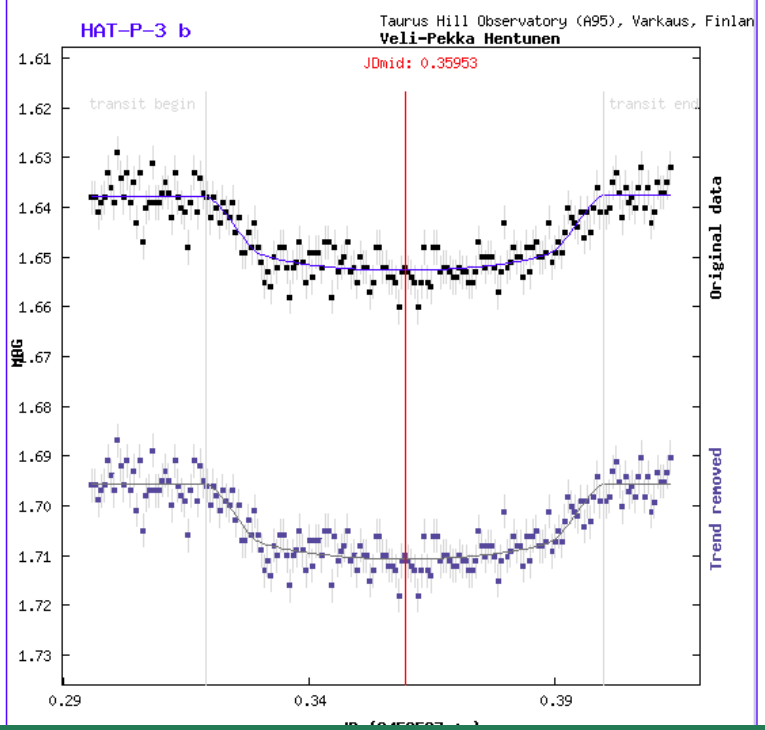


This is one of the most exciting moment in the exoplanet hunting. There is sometimes a request to make a light curve measurement of a new exoplanet candidate. But so far, the results of light curve measurement has been like this one. There is no evidence of a new exoplanet. So, unfortunately any exoplanet has not yet been found with this method.

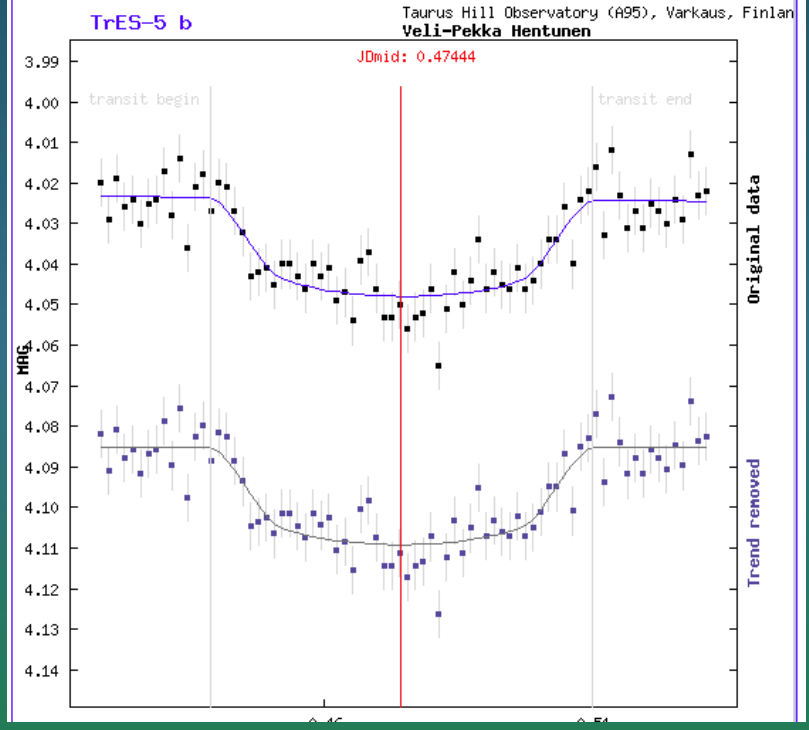


Last week on Tuesday I had nothing else to do. So, I observed three known exoplanets in the same night. It was still possible before the bright summer period. Here are the light curves sent to TRESCA.

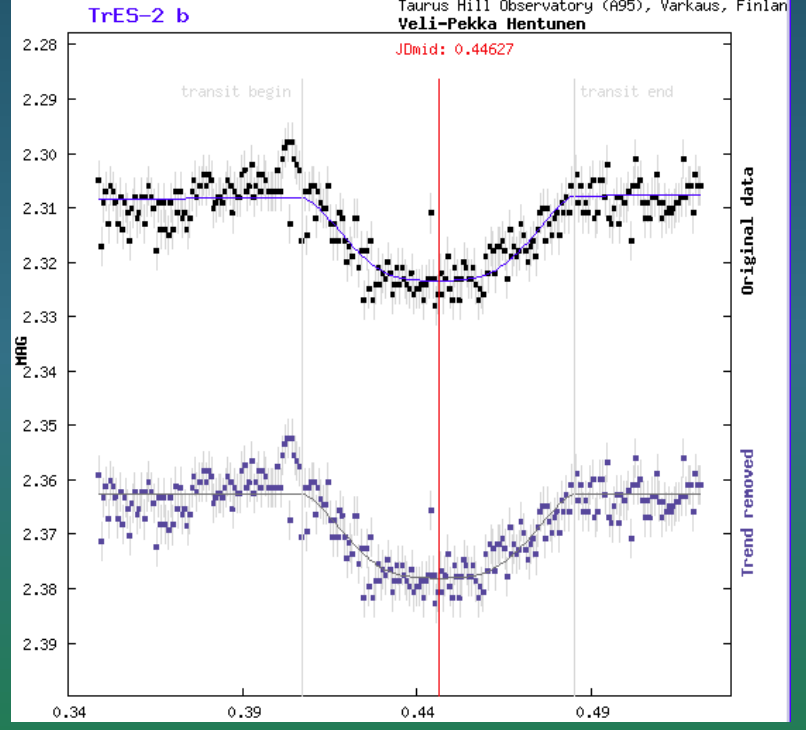
Exoplanet: HAT-P-3 b
observer: Veli-Pekka Hentunen
Post address: Mielikinkuja 28, 78850 Varkaus, Finland
E-mail: veli-pekka.hentunen@kassiopeia.net
Station: Taurus Hill Observatory (A95), Varkaus, Finland
Geographic location: east longitude: **28°** | north latitude: **62°**
Instrument: C-14, Paramount MEII, ST-8XME
Photometric filter: U B V R I Clear
Notes / conditions: 50 sec exposures, 5 comparison stars
Already published in:



Exoplanet: TrES-5 b
observer: Veli-Pekka Hentunen
Post address: Mielikinkuja 28, 78850 Varkaus, Finland
E-mail: veli-pekka.hentunen@kassiopeia.net
Station: Taurus Hill Observatory (A95), Varkaus, Finland
Geographic location: east longitude: **28°** | north latitude: **62°**
Instrument: C-14, Paramount MEII, ST-8XME
Photometric filter: U B V R I Clear
Notes / conditions: 120 sec exposures, 11 comparison stars
Already published in:



Exoplanet: TrES-2 b
observer: Veli-Pekka Hentunen
Post address: Mielikinkuja 28, 78850 Varkaus, Finland
E-mail: veli-pekka.hentunen@kassiopeia.net
Station: Taurus Hill Observatory (A95), Varkaus, Finland
Geographic location: east longitude: **28°** | north latitude: **62°**
Instrument: Meade16"ACF, Paramount ME, STT-8300M
Photometric filter: U B V R I Clear
Notes / conditions: 50 sec exposures, 10 comparison stars
Already published in:



Thank you!