

5-th Gamow International Conference in Odessa:
"Astrophysics and Cosmology after Gamow: progress and perspectives"
and

The XV-th G. Gamow's Odessa Astronomical Summer Conference-School, 16-23
August, 2015, Odessa, Ukraine

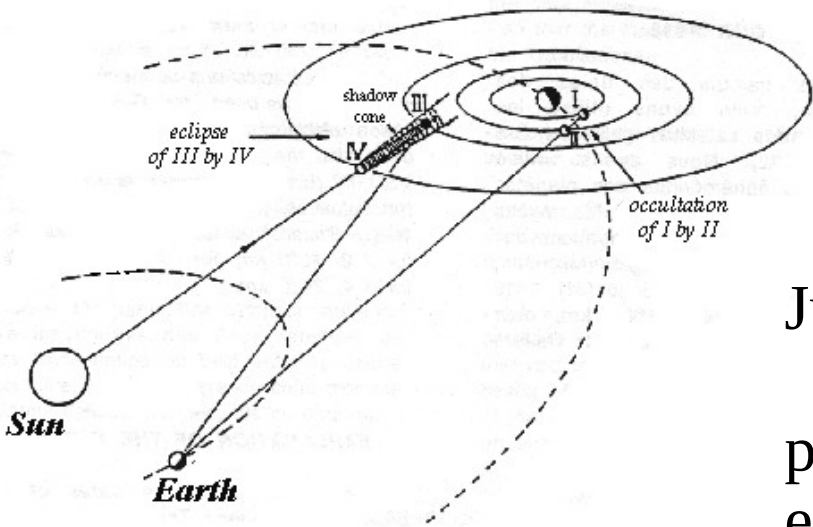
The results of observations of mutual phenomena of the Galilean satellites of Jupiter in 2009 and 2015 in Nikolaev Astronomical Observatory

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Plan

- Mutual events in Jovian satellites system
- Instruments and software for observations
- Mutual events of 2009 and 2015 seasons
in RI NAO
- Conclusions

Jupiter mutual events

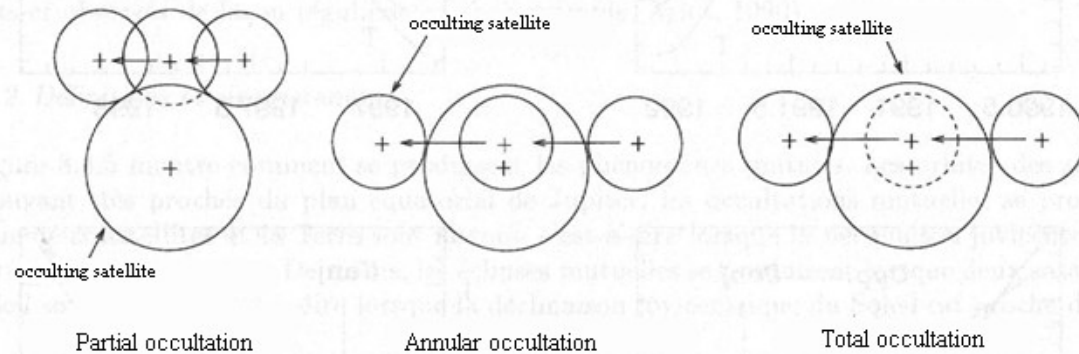


The mutual event is an eclipse or occultation in a satellites system

The mutual events of the Galilean satellites of Jupiter occur for a 12-month period every 6 years.

The Jovian system looked like a clock more perfect than the ones existing at that time and the eclipses were easy to observe.

The search of small gravitational or non-gravitational effects, not yet put into evidence, and for the study of the problems related to the resonances.



Instruments for observations



Nikolaev Astronomical observatory Telescope MCT

(Latitude: $46^{\circ} 58' 18''$ N Longitude: $31^{\circ} 58' 29''$ E)

$D = 0.115$ m

$F = 2.0$ m

CCD camera WAT-902H

Active Pixels 752×582

Pixel size $8.6 \mu\text{m} \times 8.3 \mu\text{m}$

FOV $11.2' \times 8.3'$



- UTC time moment is synchronized by GPS.
- The frequency of taking images is **25 per sec.**
- The filter **RG19** near to Cousins was used.

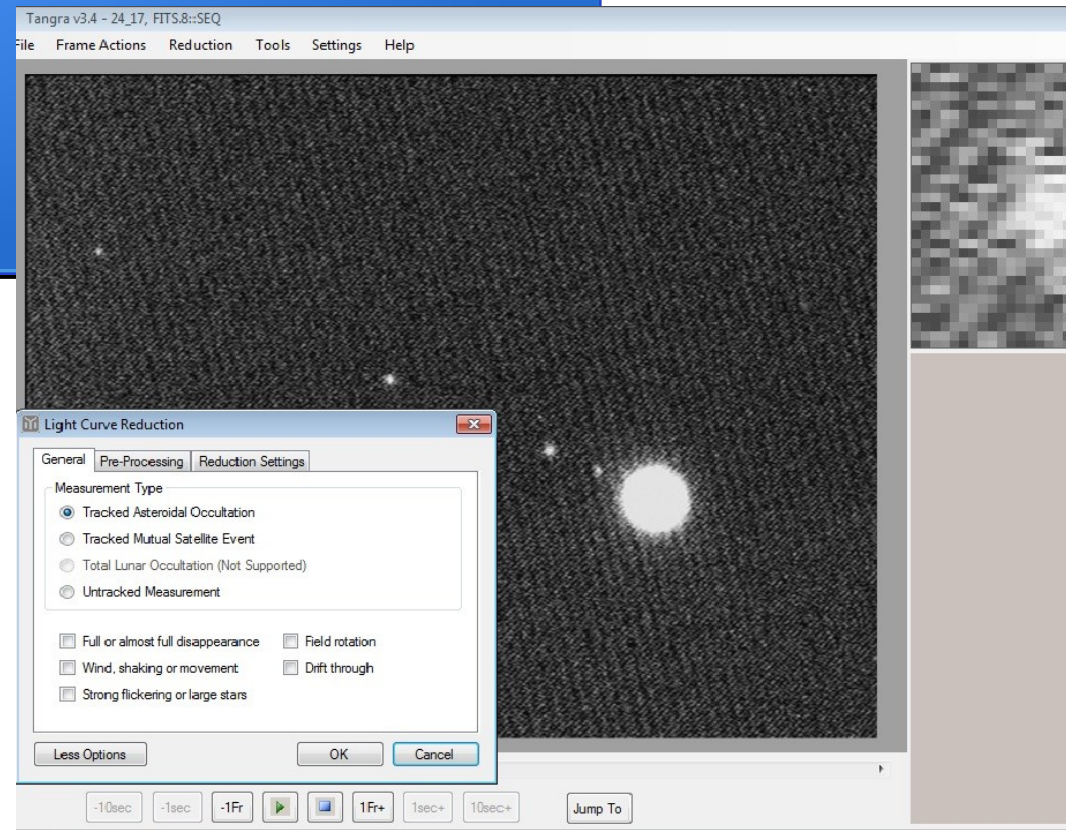
Software for observations

Tangra v3.4

(developed by Hristo Pavlov)

Features

- automatic processing of sequence of Fit-images;
- produce masters bias, dark, flat field;
- choice of different type of observations (eclipse, occultation);
- choice of different methods of measuring flux and background;
- convenient report file for future analysis;
- possibility to improve measurements by binning and normalising.

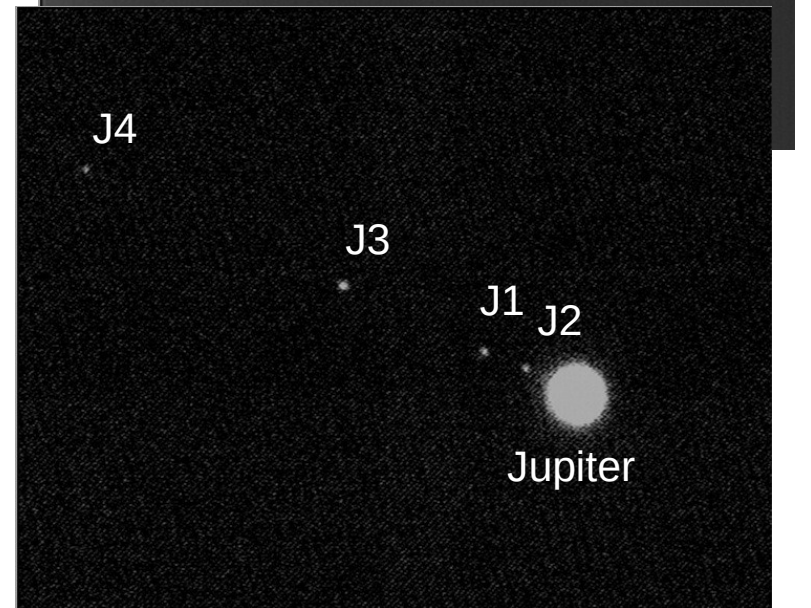
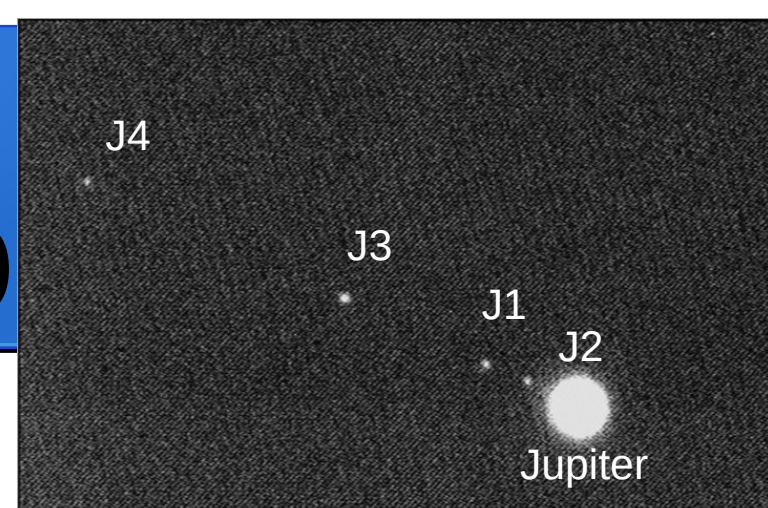


Observations of mutual events in NAO

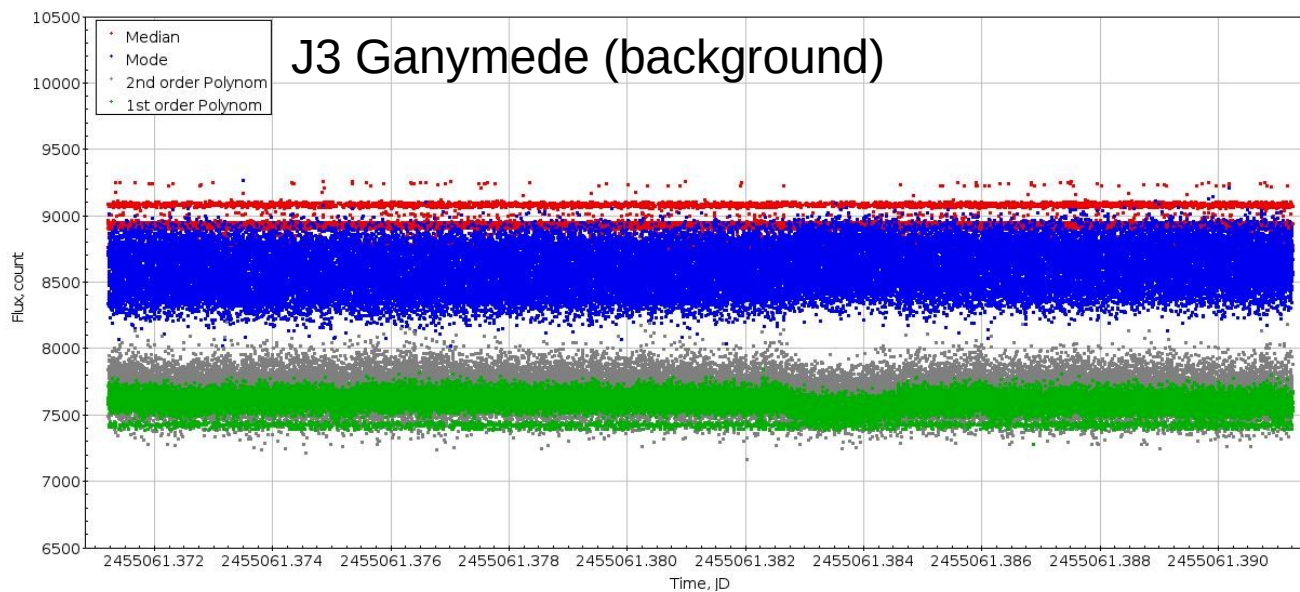
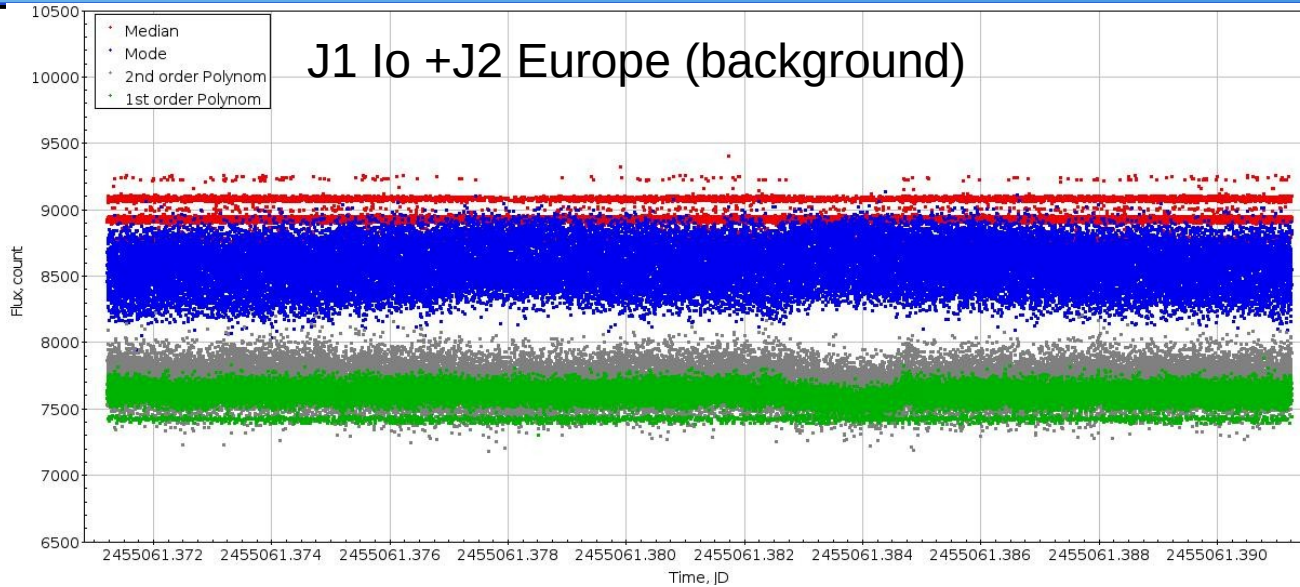
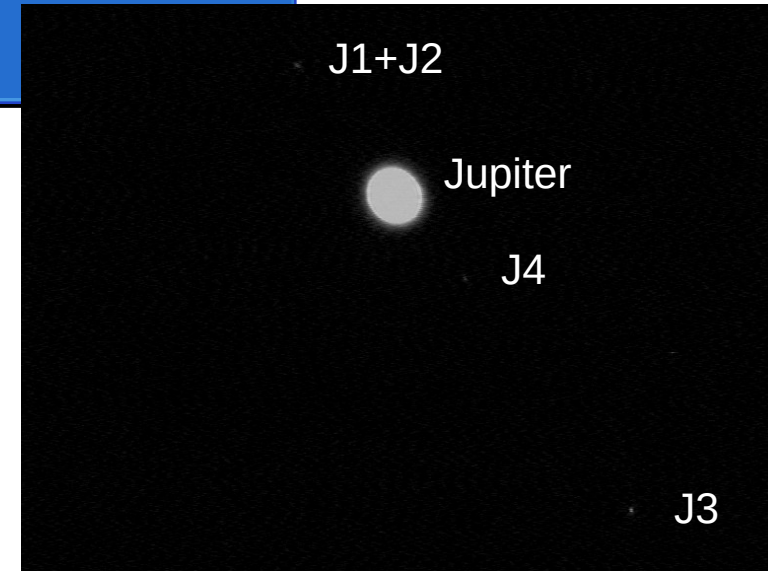
The observations of 10 mutual events obtained in RI NAO for 9 nights at 2009 season. Because of bad weather only for 5 events were constructed reliable lightcurves.

For 2014-15 season only 5 nights observations carried out for 5 mutual events. After reducing and analyzing only 2 reliable lightcurves were conducted.

The data set for light curves have been sent in the IMCCE (Institute de Mecanique et de calcul des ephemerides, France) that coordinates the PHEMU campaigns.

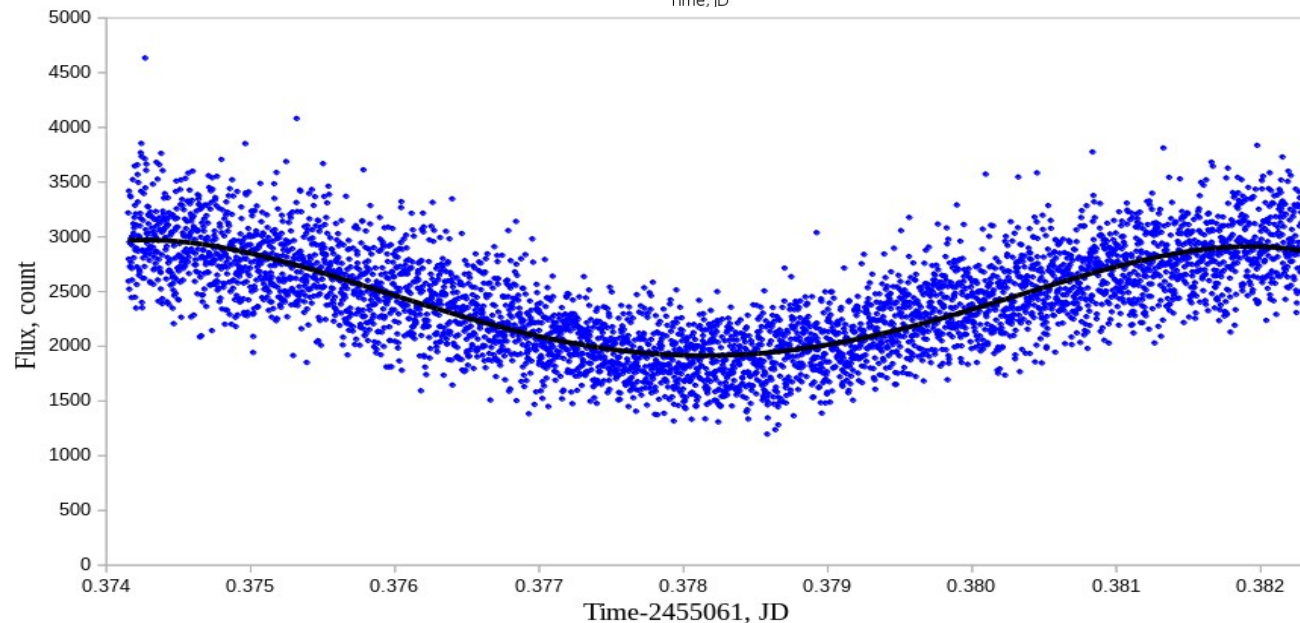
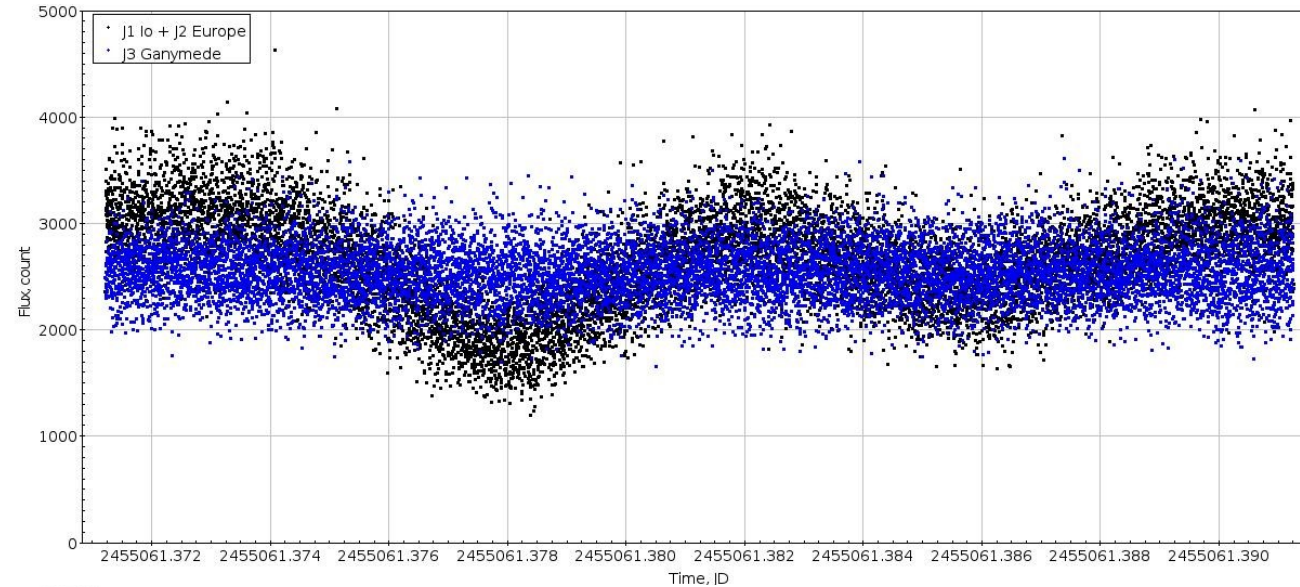


Mutual event of 17.08.2009



	J2 Europe		J3 Ganymede	
	Mean	rms	Mean	rms
Mode	8581.7	160.9	8598.6	164.6
Median	8932.7	77.5	8920.4	75.6
2nd order Polinom	7685.9	122.5	7665.7	120.3
1st order Polinom	7604.1	63.9	7590	63.4

Mutual event of 17.08.2009



**J1 Io occults
J2 Europe**

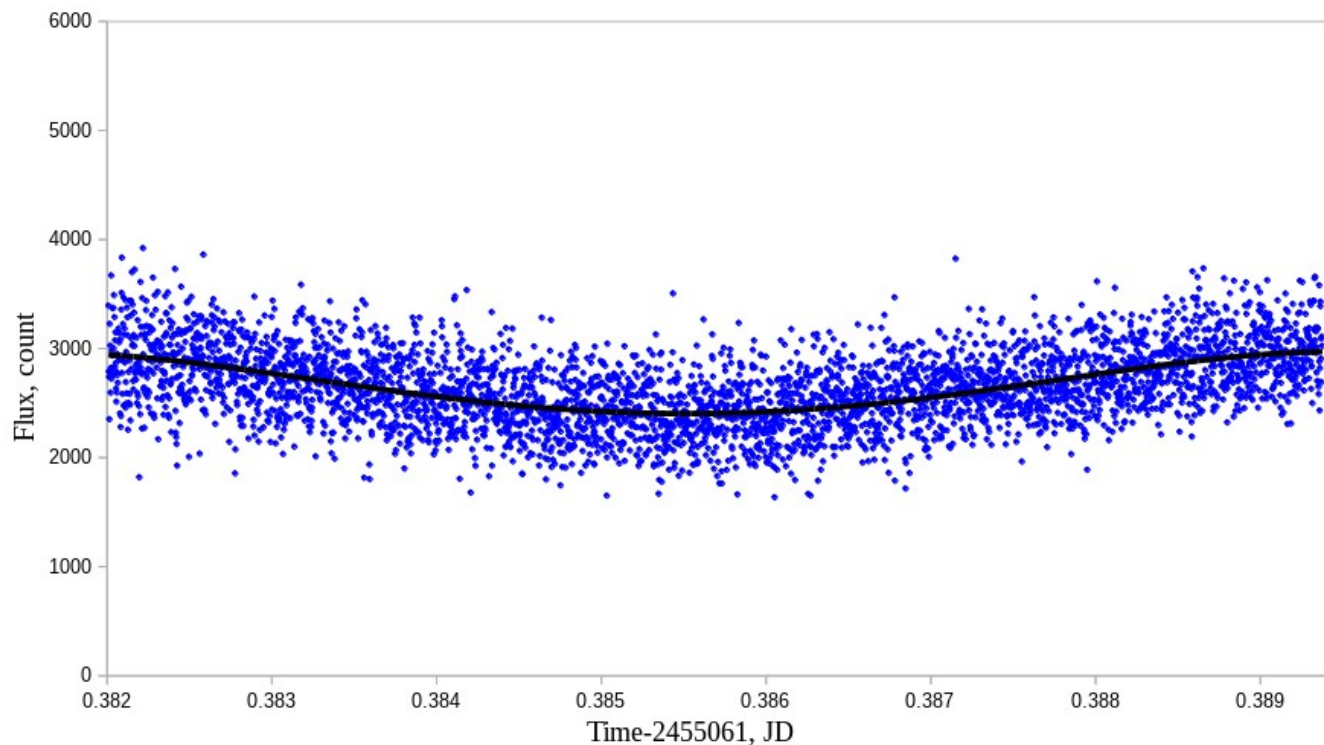
**Prediction
by IMCCE:**

Begin - 20:57:55
End - 21:10:37
 Δm - 0.624

Our estimations:

Begin - 20:58:40
End - 21:09:41
Maximum
phases - 21:04:15
 Δm - 0.55

Mutual event of 17.08.2009 (continue)



J1 Io eclipses
J2 Europe

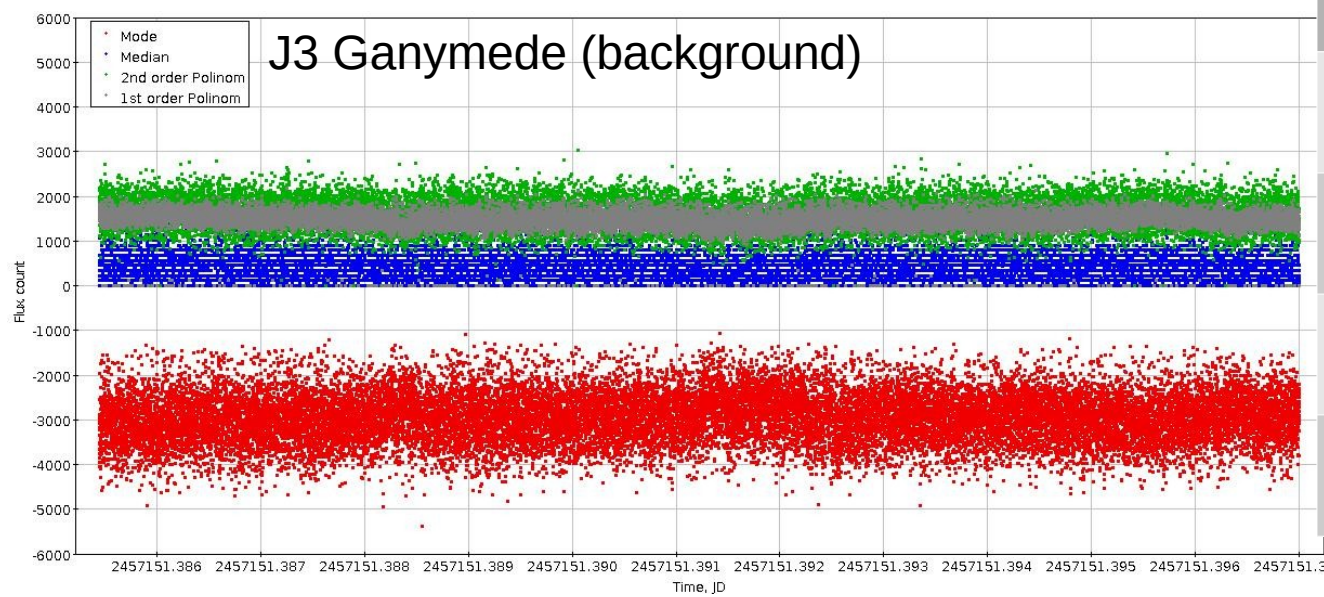
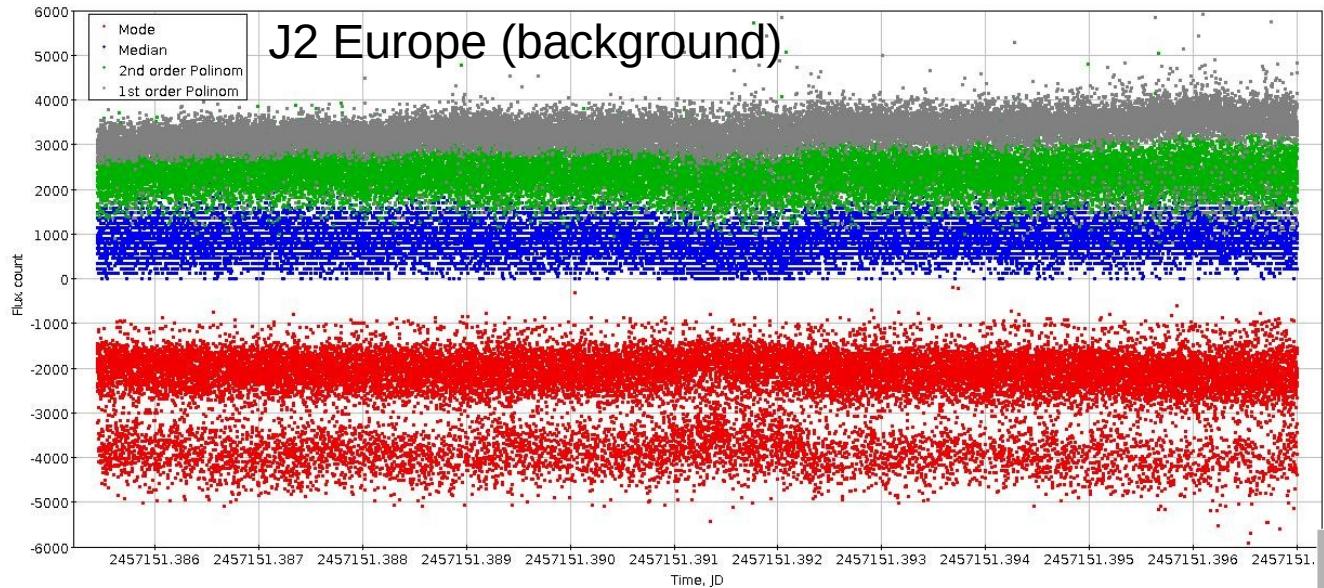
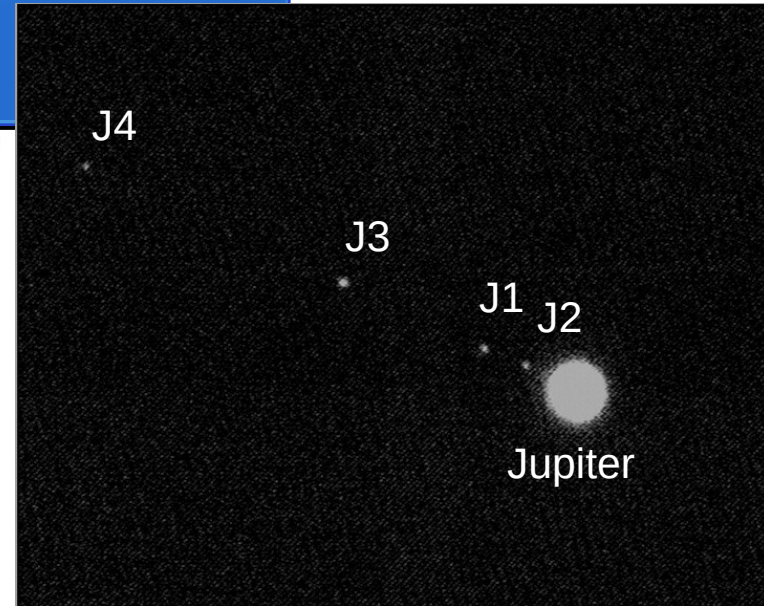
**Prediction
by IMCCE:**

Begin	-	21:08:39
End	-	21:22:26
Δm	-	0.436

Our estimations:

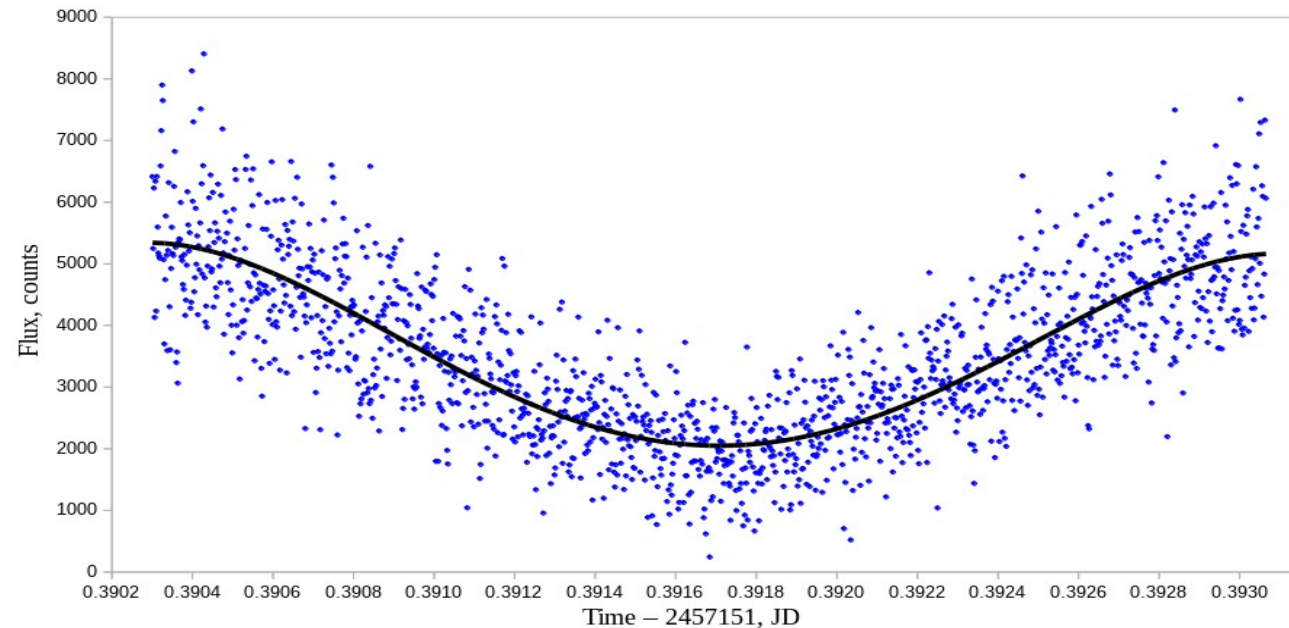
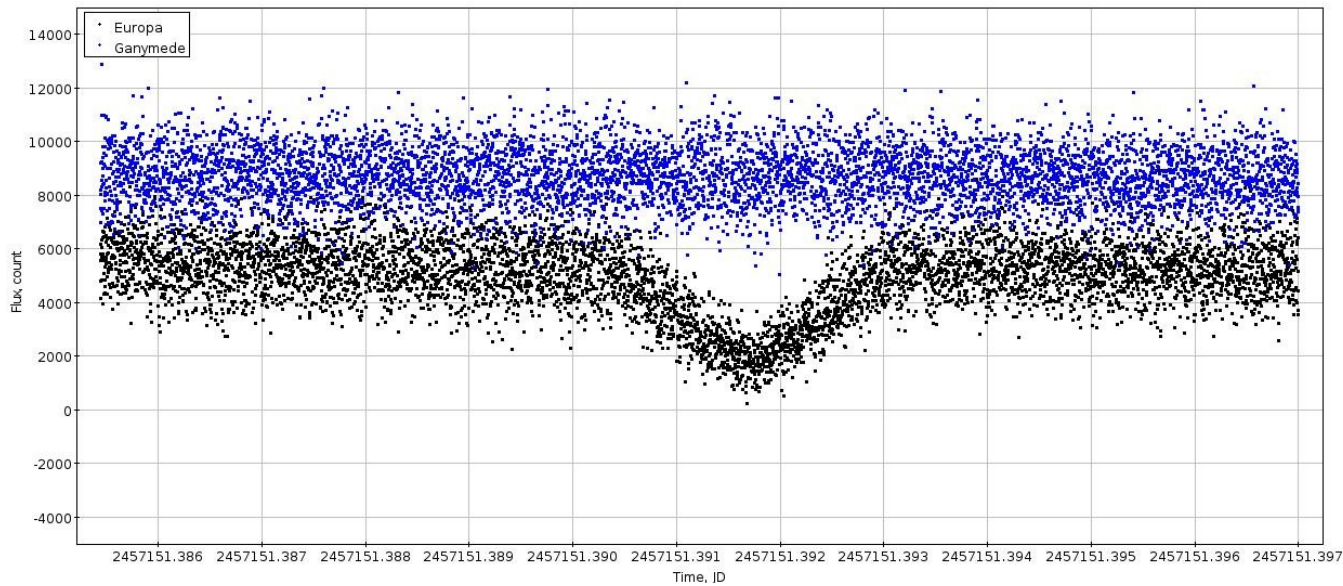
Begin	-	21:09:47
End	-	21:21:8
Maximum phases	-	21:15:27
Δm	-	0.27

Mutual event of 08.05.2015



	J2 Europe		J3 Ganymede	
	Mean	rms	Mean	rms
Mode	-2495.8	876.2	-2946.1	544.5
Median	884.1	338.7	350.6	296.8
2nd order Polinom	2377.9	404.6	1575.9	320.3
1st order Polinom	3296.1	381.8	1456.5	225.2

Mutual event of 08.05.2015



J1 Io eclipses
J2 Europe

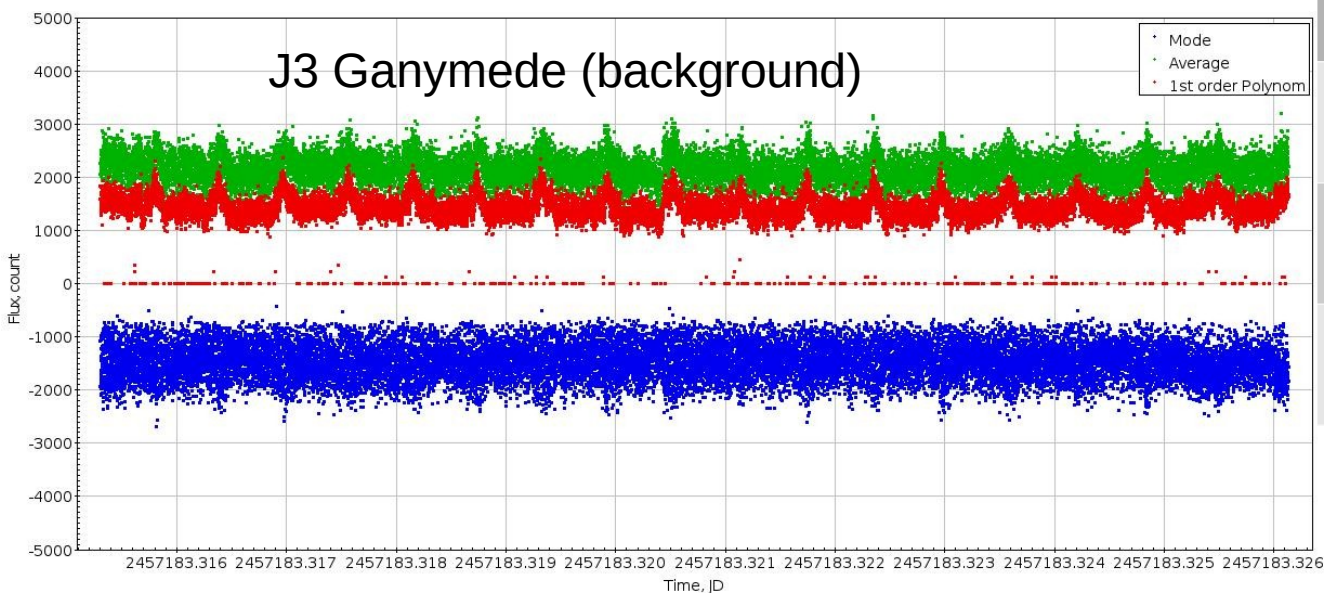
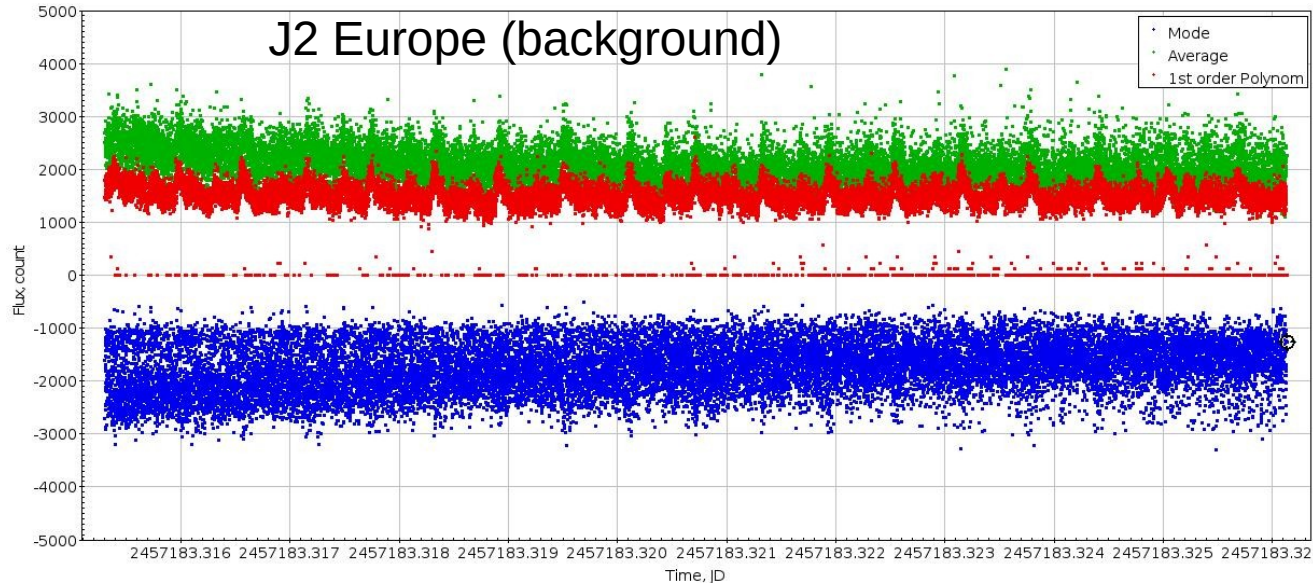
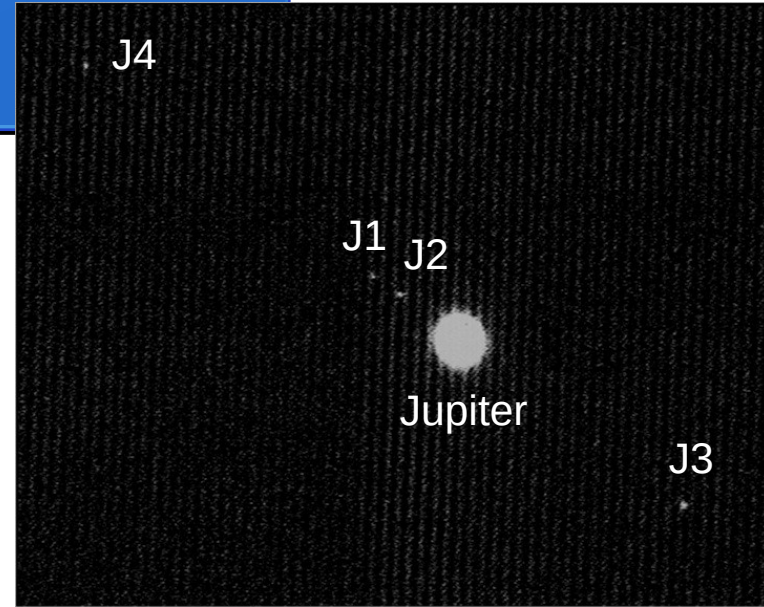
**Prediction
by IMCCE:**

Begin - 21:21:26
End - 21:26:53
 Δm - 0.572

Our estimations:

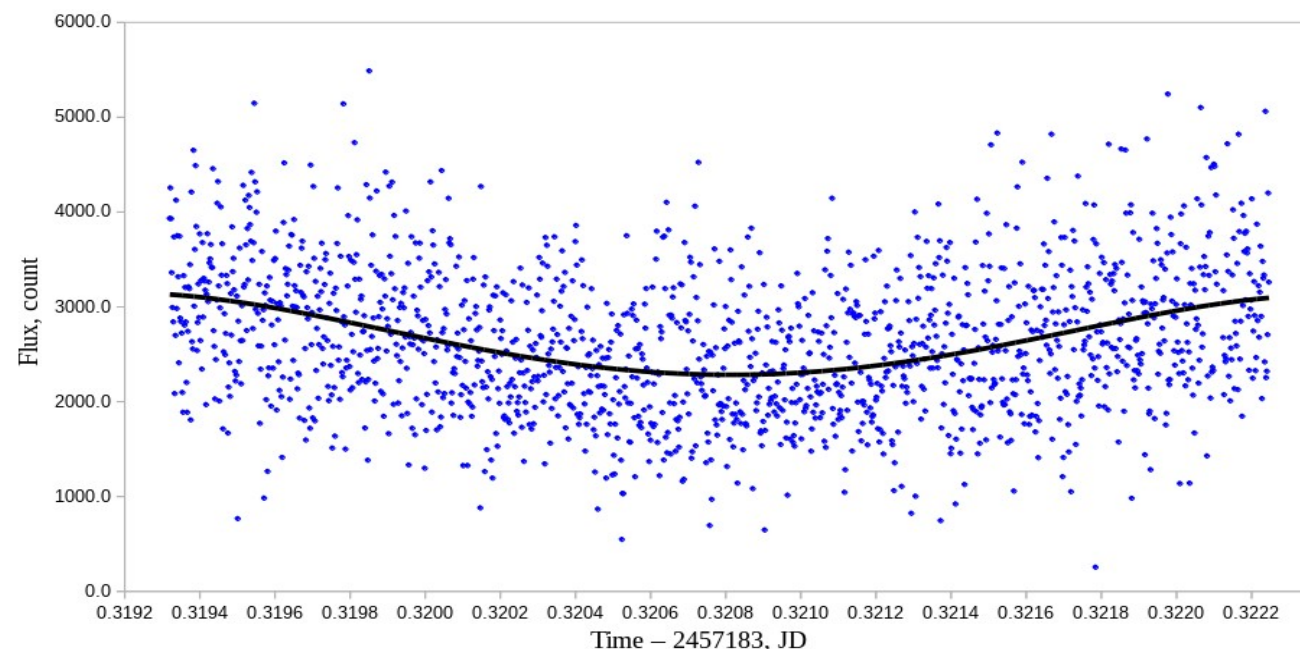
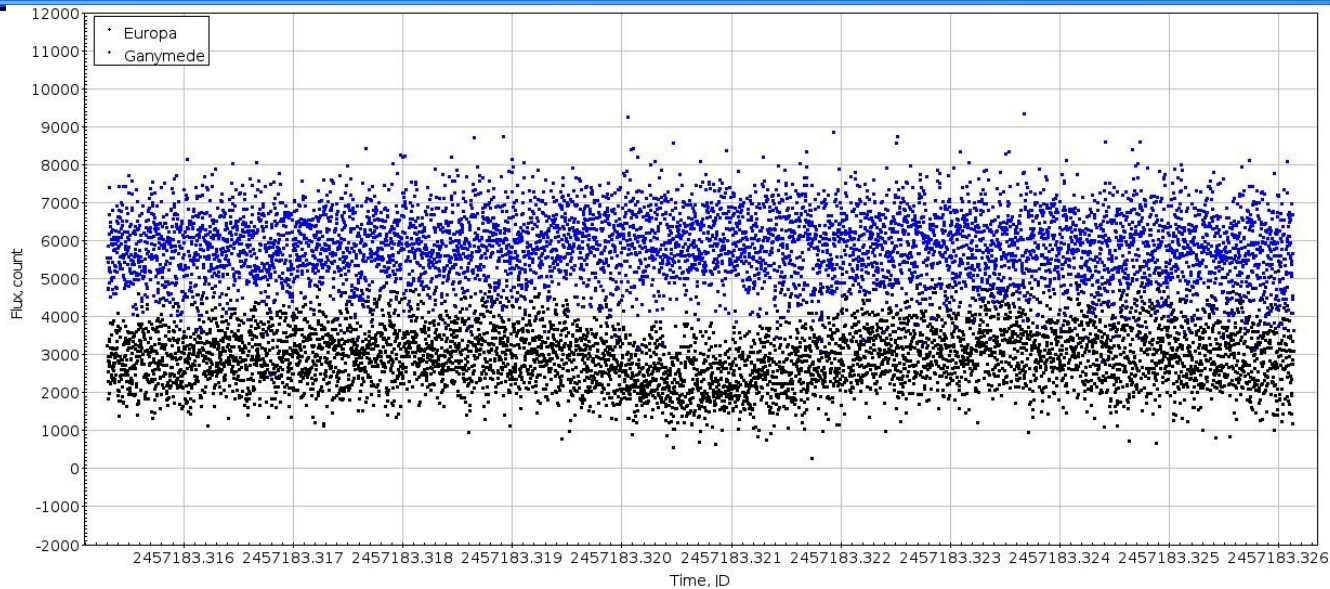
Begin - 21:22:01
End - 21:26:03
Maximum
phases - 21:24:04

Mutual event of 06.09.2015



	J2 Europe		J3 Ganymede	
	Mean	rms	Mean	rms
Mode	-1733.5	453.0	-1470.9	327.2
Average	2082.5	326.9	2159.7	249.1
1st order Polinom	1450.5	347.1	1413.4	251.1

Mutual event of 09.06.2015



J1 Io eclipses
J2 Europe

**Prediction
by IMCCE:**

Begin - 19:39:10
End - 19:44:54
 Δm - 0.307

Our estimations:

Begin - 19:39:35
End - 19:44:11
Maximum
phases - 19:41:54
 Δm - 0.37

Conclusions

The photometric observations of the mutual events in the Jovian satellites system were carried out at RI Nikolaev Astronomical Observatory in 2009 and 2015 observation seasons.

The relative photometry was performed and five reliable lightcurves for mutual events in 2009 season and two lightcurves in 2015 were obtained. The moments of the beginning, end, maximum phases of events and the magnitude drop at maximum phase were estimated.

The comparison of the obtained time moments from our observations with the ephemeris calculated by IMCCE (Institute de Mecanique et de calcul des ephemerides, France) shows differences about 0.5 – 1 minute.

The results of observations have been sent to the IMCCE that coordinates the PHEMU campaigns.