

PHEMU 2015 havaintokampanja

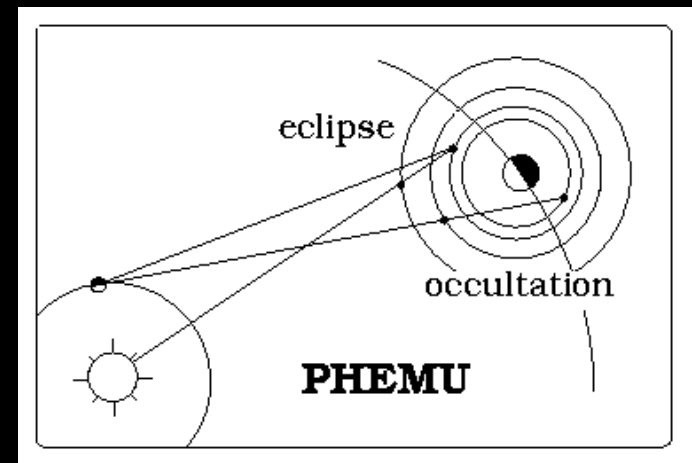


Arto Oksanen

Aurinkokuntatapaaminen
28.2.2015- Artjärvi

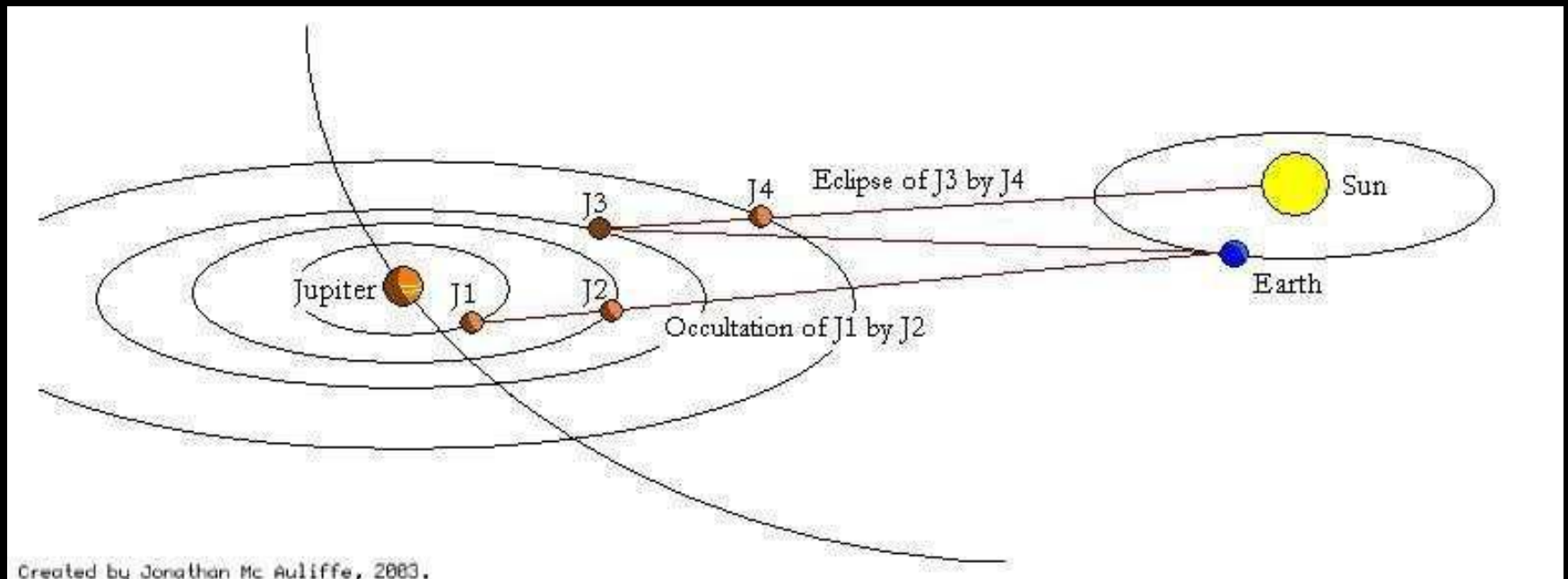
PHEMU2015 havaintokampanja

- * **In 2002-2003, the Earth and the Sun go through the common orbital plane of the galilean satellites of Jupiter. This occurs only every 6 years and allows the observation of mutual eclipses and occultations between the satellites.**
- * These observations were made during the last opportunities since 1973 until the former campaign of 1997 and they have led to interesting results well in astrometry (dynamics of the system) as in planetology (physics of the surfaces of the satellites) thanks to the large number of data obtained on a long interval of time.
- * Observations are easy to perform even with a small telescope (Galilean satellites have a magnitude about 5) and, in order to make them possible to the observers, we propose the information provided here.

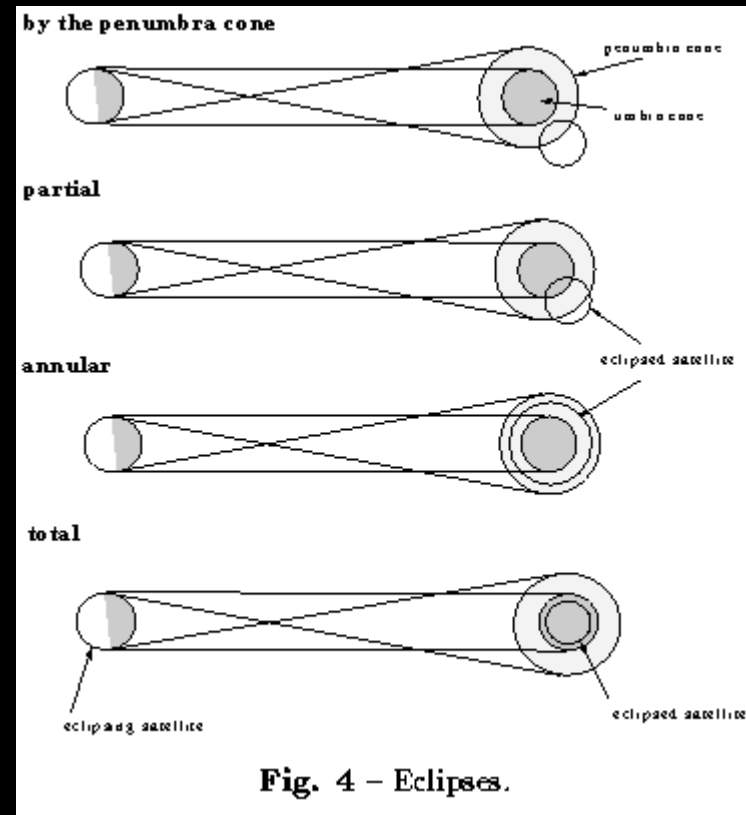
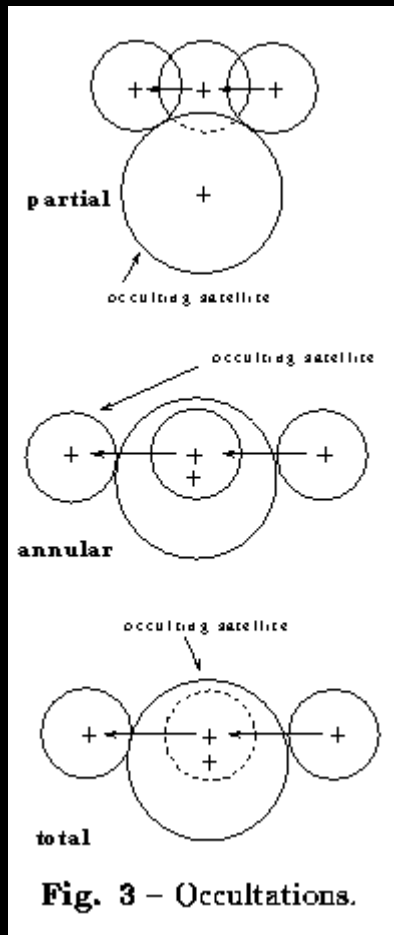


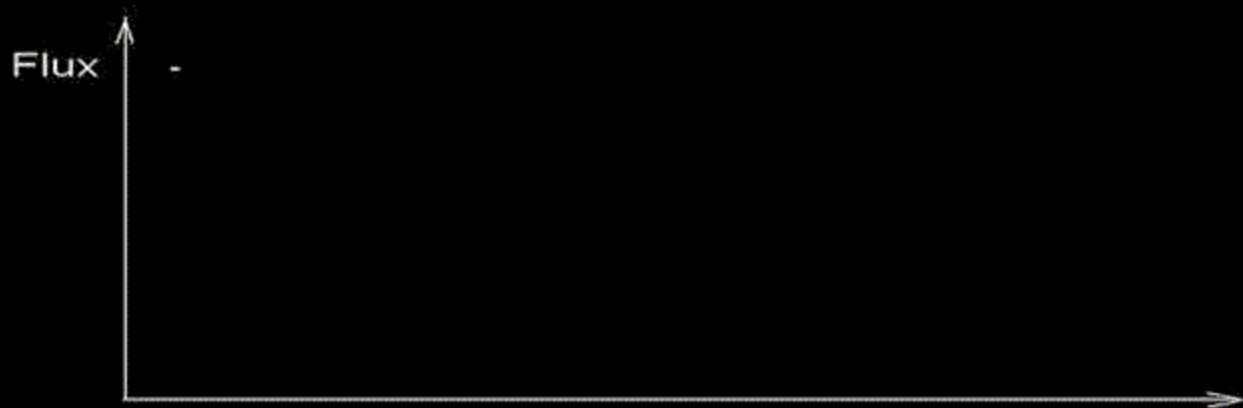
Havaintogeometria

- ★ Kuuden vuoden välein Jupiterin suurten kuiden radat ovat Maan suuntaan
- ★ Kuiden kesken tapahtuu suuri määrä pimennyksiä ja ylikulkuja



Pimennykset (E) ja ylikulut (O)



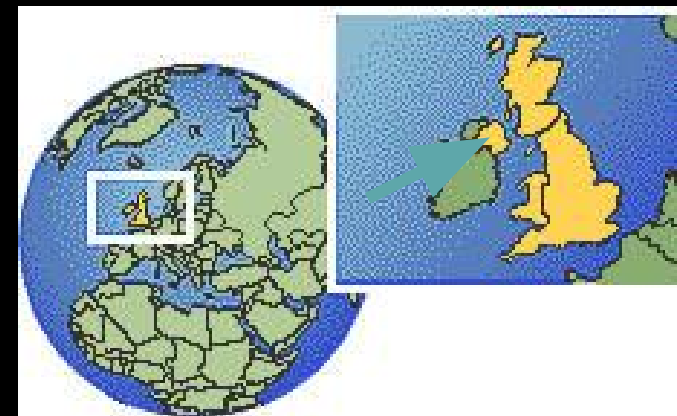


Havainnot vuonna 2003

- * **105 phenomena were observable at Nyrola Observatory**
 - * **Sun elevation < -10.0 deg.**
 - * **Jupiter elevation > 10.0 deg.**
 - * **distance to the planet > 1.0 planetary radii**
 - * **magnitude drop > 0.010**

International Pro-am collaboration

- * A. Oksanen
 - * havainnot
- * A. Christou (Armagh Observatory, Northern Ireland)
 - * kalibrointi
 - * fotometria
- * IMCCE (Paris Obs, France)
 - * koordinointi
 - * lopullinen analyysi



Havainnot 2003

- * CCD-kuvat lyhyellä valotusajalla V-suotimella
- * 40 cm Meade LX200 + SBIG ST8XE
- * Tarkka aikareferenssi (Nyrölään ntp-palvelin, GPS)
- * Lyhytkestoisia ilmiöitä (muutamia minuutteja)
- * Helppo löytää



Havaitut tapahtumat 2003

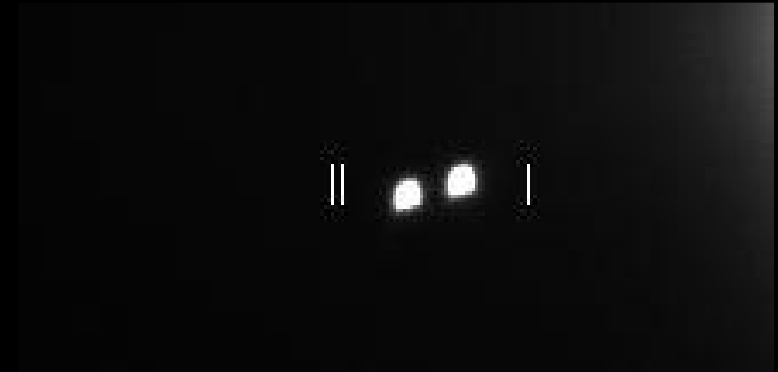
<u>DATE</u>	<u>TYPE</u>	<u>OBS.</u>	<u>START</u>	<u>OBS. END</u>	<u>SAMPLES</u>	<u>EXPTIME</u>	<u>FILTER</u>	<u>OBS.</u>
30/12/02	2 ECL	1	20:30:08	20:59:02	144 (154)	5.0	V	I/II
30/12/02	4 OCC	3	21:06:32	21:36:21	180	1.0+5.0	V	III+IV/I
06/01/03	2 ECL	1	23:24:08	23:49:04	400	0.5	C	I/II
14/01/03	2 ECL	1	02:19:47	02:53:34	523 (537)	0.5	C	I/II
16/01/03	4 OCC	2	23:46:32*	01:05:27	502 (604)	1.0	V	IV+II/III
19/02/03	4 OCC	1	20:19:29	20:41:30	282	1.0	V	IV+I/III
19/02/03	4 ECL	1	22:00:25	22:27:47	448	1.0	V	I/III
15/03/03	3 ECL	4	21:47:40	22:32:30	579 (599)	1.0+2.0	R	IV/III
17/03/03	1 ECL	3	18:09:20	18:40:14	560	1.0	V	III/I
20/03/03	1 OCC	2	23:46:04	00:00:00	201	1.0	V	I+II/III
25/03/03	1 ECL	3	19:58:18	20:20:41	250 (420)	0.5	V	III+II/I
25/03/03	2 OCC	3	20:37:18	20:56:16	353	0.5	V	III+II/I
25/03/03	2 ECL	3	23:58:35*	00:20:21	305 (326)	1.0	V	III/II
<u>11/04/03</u>	<u>3 ECL</u>	<u>2</u>	<u>20:53:23</u>	<u>21:11:15</u>	<u>261</u>	<u>1.0</u>	<u>V</u>	<u>II/III</u>

* in these cases the dataset was truncated by removing data points before midnight in order to facilitate plotting. The actual data files contain the full dataset.

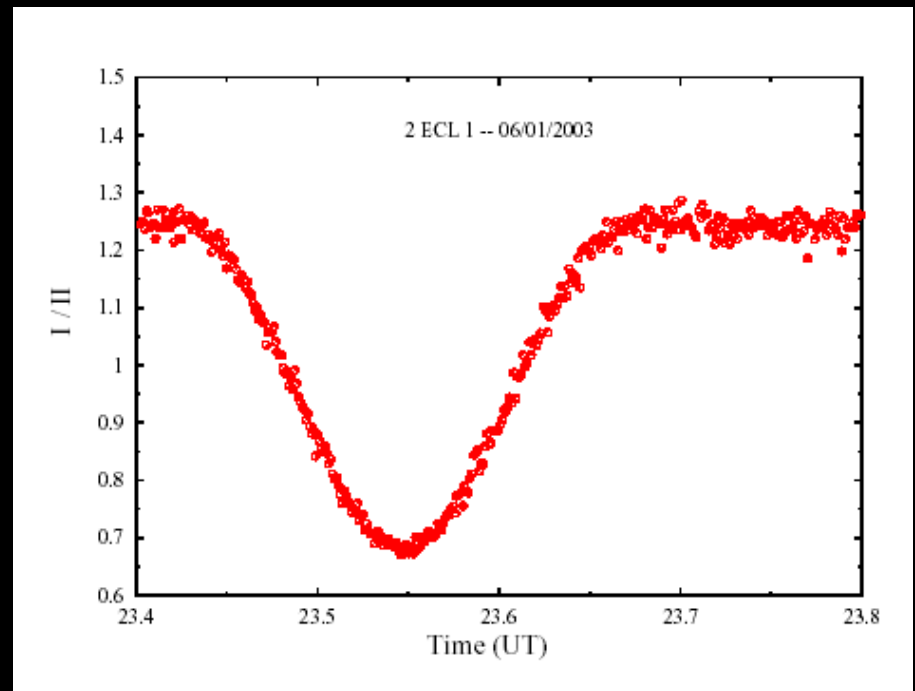
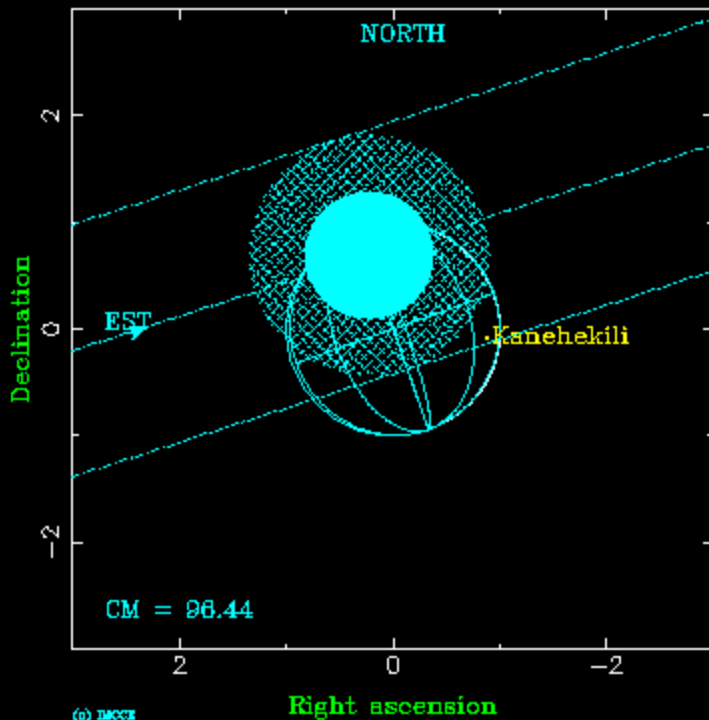
Fotometria: dr. Christou

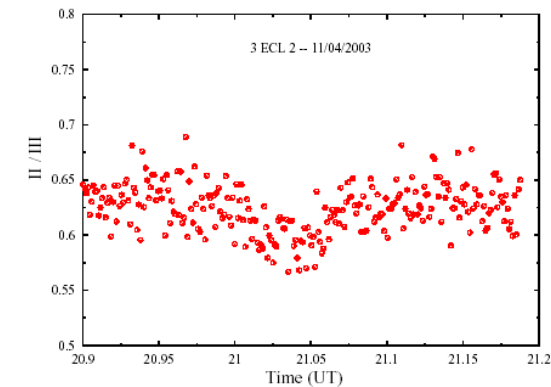
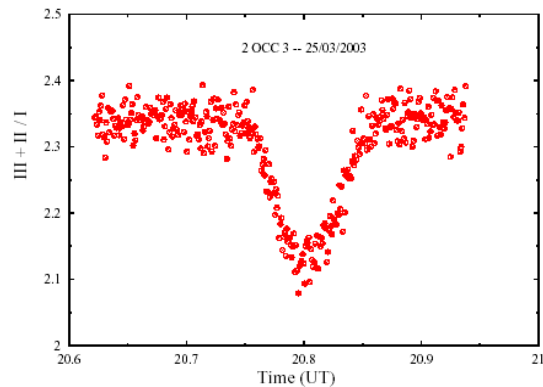
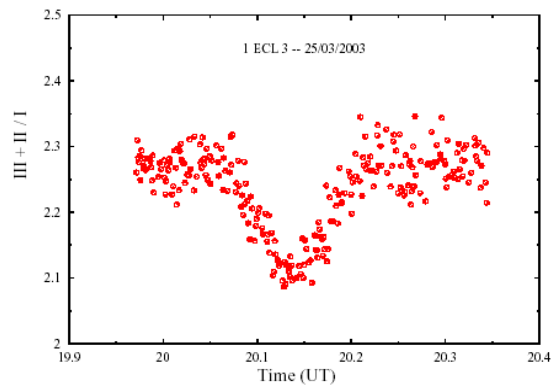
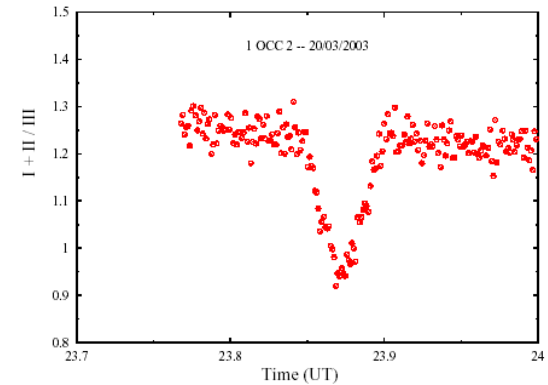
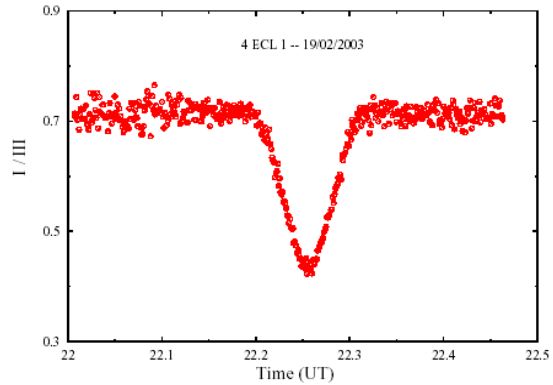
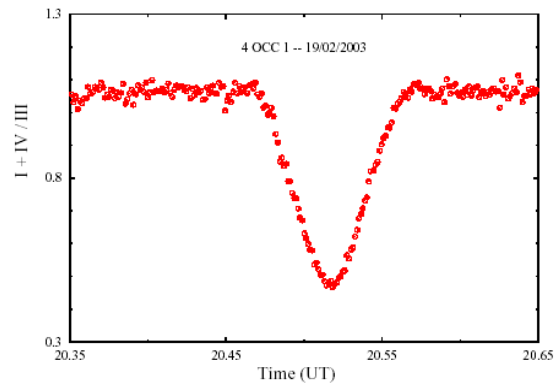
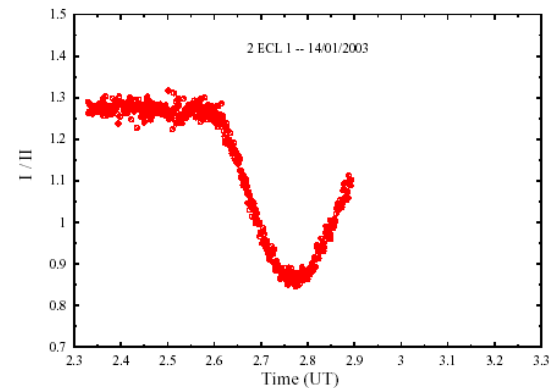
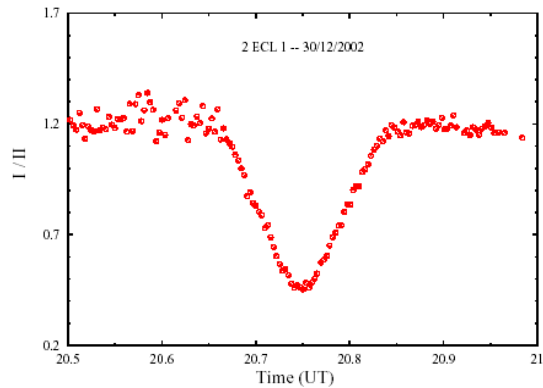
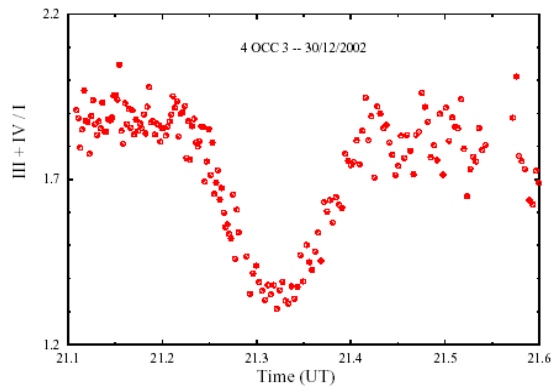
- * Aperature photometry with IDL
- * Relative flux of
 - * eclipsed moon vs. eclipsing moon
 - * occulting moon + occulted moon vs. third moon
- * Moons move during events
- * Photometry data given to IMCCE

Europe ecl. Io Jan 6, 2003



Europe ecl. Io on 1/6/2003





The PHEMU03 catalogue of observations of the mutual phenomena of the Galilean satellites of Jupiter[★]

J.-E. Arlot¹, W. Thuillot¹, C. Ruatti¹, A. Ahmad², A. Amossé⁴⁷, P. Anbazhagan⁵⁰, M. Andreyev⁵, A. Antov¹², M. Appakutty⁵⁰, D. Asher², S. Aubry¹, N. Baron¹, N. Bassiere¹, M. Berthe³, R. Bogdanovski¹², F. Bosq²⁵, E. Bredner⁶, D. Buettner⁷, M. Buromsky⁴⁰, S. Cammarata²⁷, R. Casas⁸, G. D. Chis⁹, A. A. Christou², J.-P. Coquerel⁴⁴, R. Corlan¹⁰, C. Cremaschini¹¹, D. Crussaire²⁶, J. Cuypers³², M. Dennefeld⁴⁶, P. Descamps¹, A. Devyatkin²², D. Dimitrov¹², T. N. Dorokhova¹³, N. I. Dorokhov¹³, G. Dourneau²⁵, M. Dueñas^{14,51}, A. Dumitrescu¹⁰, N. Emelianov⁴³, D. Ferrara²⁷, D. Fiel¹⁵, A. Fienga¹, T. Flatres³⁹, S. Foglia¹¹, J. Garlitz¹⁶, J. Gerbos¹⁷, R. Gilbert¹, R. M. D. Goncalves¹⁸, D. Gonzáles^{14,51}, S. Yu. Gorda¹⁹, D. L. Gorshanov²², M. W. Hansen⁴¹, M. Harrington², T. R. Irmambetova²⁰, Y. Ito²¹, V. Ivanova¹², I. S. Izmailov²², M. Yu. Khovritchev²², E. V. Khrutskaya²², J. Kieken²⁵, T. P. Kiseleva²², K. Kuppuswamy⁵⁰, V. Lainey¹, M. Lavyssié²³, P. Lazzarotti²⁴, J.-F. Le Campion²⁵, E. Lellouch²⁶, Z. L. Li⁴², E. Lo Savio²⁷, M. Lou^{14,51}, E. Magny⁴⁴, J. Manek²⁸, W. Marinello¹¹, G. Marino²⁷, J. P. McAuliffe², M. Michelli¹¹, D. Moldovan⁹, S. Montagnac⁴⁴, V. Moorthy⁵⁰, O. Nickel²⁹, J. M. Nier⁴⁴, T. Noel³⁰, B. Noyelles^{1,3}, A. Oksanen³¹, D. Parrat⁴⁴, T. Pauwels³², Q. Y. Peng³³, G. Pizzetti¹¹, V. Priban³⁸, B. Ramachandran², N. Rambaux^{1,25}, M. Rapaport²⁵, P. Rapavy¹⁷, G. Rau⁴⁴, J.-J. Sacré³⁹, P. V. Sada³⁴, F. Salvaggio²⁷, P. Sarlin⁴⁴, C. Sciuto²⁷, G. Selvakumar⁵⁰, A. Sergeev⁵, M. Sidorov²², S. Sorescu¹⁰, S. A. Spampinato¹¹, I. Stellmacher¹, E. Trunkovsky⁴³, V. Tejfel³⁵, V. Tudose¹⁰, V. Turcu⁹, I. Ugarte², P. Vantyghem⁴⁵, R. Vasundhara⁴, J. Vaubaillon¹, C. Velu⁵⁰, A. K. Venkataramana⁵⁰, J. Vidal-Sáinz^{14,51}, A. Vienne^{1,3}, J. Vilar³⁶, P. Vingerhoets⁴⁹, and W. Vollman³⁷

(Affiliations can be found after the references)

Received 19 June 2008 / Accepted 23 September 2008

ABSTRACT

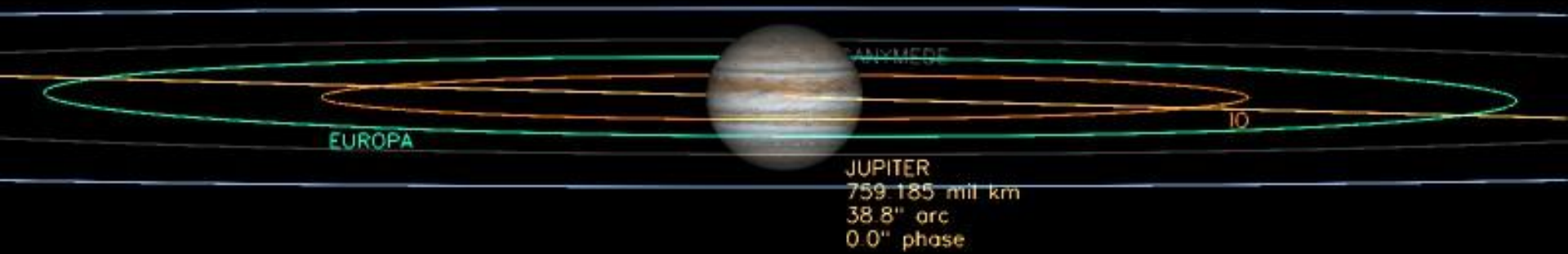
Context. In 2003, the Sun and the Earth passed through both the equatorial plane of Jupiter and therefore the orbital planes of its main satellites.
Aims. During this period, mutual eclipses and occultations were observed and we present the data collected.
Methods. Light curves of mutual eclipses and occultations were recorded by the observers of the international campaign PHEMU03 organized by the Institut de mécanique céleste, Paris, France.
Results. We completed 377 observations of 118 mutual events from 42 sites and the corresponding data are presented in this paper. For each observation, information about the telescope, receptor, site, and observational conditions are provided.
Conclusions. This paper gathers all data and indicates a first estimate of its precision. This catalogue of these rare events should constitute an improved basis for accurate astrometric data useful in the development of dynamical models.

Key words. astrometry – eclipses – occultations – planets and satellites: individual: Jupiter

PHEMU 2014-2015

Planeetta	Jupiter
Oppositio	6.2.2015
Konjunktio	Kesäkuu 2014 ja elokuu 2015
Aurinko planeetan ekvaattoritasossa	5.2.2015
Maa planeetan ekvaattoritasossa	8.11.2014, 10.4.2015 ja 5.5.2015
Planeetan deklinaatio	+22 to +20 astetta

2013



2014



2015



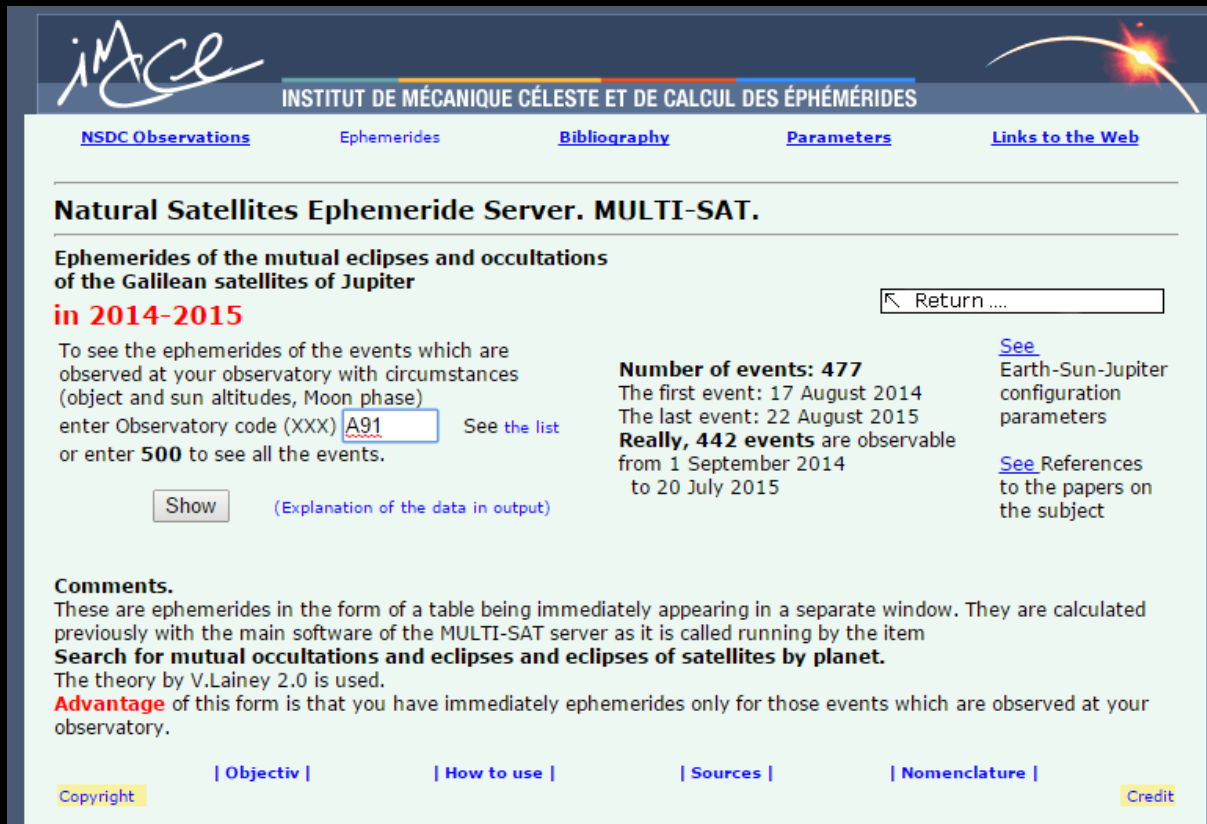
2016



Ennusteet havaintopaikalle

Tapahtumia yhteensä: 477 (17 August 2014 - 22 August 2015)

Työkalu ennusteille: http://www.imcce.fr/hosted_sites/saimirror/nsszph515he.htm



imcce INSTITUT DE MÉCANIQUE CÉLESTE ET DE CALCUL DES ÉPHÉMÉRIDES

[NSDC Observations](#) [Ephemerides](#) [Bibliography](#) [Parameters](#) [Links to the Web](#)

Natural Satellites Ephemeride Server. MULTI-SAT.

Ephemerides of the mutual eclipses and occultations of the Galilean satellites of Jupiter in 2014-2015

To see the ephemerides of the events which are observed at your observatory with circumstances (object and sun altitudes, Moon phase) enter Observatory code (XXX) See the list or enter **500** to see all the events.

(Explanation of the data in output)

Number of events: 477
The first event: 17 August 2014
The last event: 22 August 2015
Really, 442 events are observable from 1 September 2014 to 20 July 2015

[See](#) Earth-Sun-Jupiter configuration parameters
[See](#) References to the papers on the subject

Comments.

These are ephemerides in the form of a table being immediately appearing in a separate window. They are calculated previously with the main software of the MULTI-SAT server as it is called running by the item **Search for mutual occultations and eclipses and eclipses of satellites by planet.** The theory by V.Lainey 2.0 is used.
Advantage of this form is that you have immediately ephemerides only for those events which are observed at your observatory.

[| Objectiv |](#) [| How to use |](#) [| Sources |](#) [| Nomenclature |](#)

Copyright Credit

Ennusteet Hankasalmelle (A91)

Planet: Jupiter (DE405)

Planet

Observatory N: A91 - Hankasalmi Observatory

Timescale: UTC

Mean equator and equinox of J2000. ICRF.

Mutual events of satellites:

Date	begin: h	m	s	end: h	m	s	Type	Dur(m)	Impact	m	Δm	limb(")	dist(")	Planet($^{\circ}$)	Sun($^{\circ}$)	Moon phase
2015	3	1	4 9 33	4	15	42	201	6.1	0.015	4.6	0.586	97.25	:	6.316	-8.743	0.724
2015	3	1	5 1 36	5	8	34	2E1	7.0	0.076	4.6	0.896	89.08	19.98 :	1.101	-2.681	0.726
2015	3	2	18 43 12	18	48	9	302	5.0	0.546	4.3	0.243	49.01	:	40.660	-21.827	0.821
2015	3	2	20 22 5	20	29	52	3E2	7.8	0.257	4.3	0.465	73.01	45.51 :	45.145	-30.508	0.825
2015	3	3	4 5 32	4	10	60	301	5.5	0.028	4.2	0.567	20.41	:	5.877	-8.496	0.845
2015	3	4	17 12 2	17	18	1	201	6.0	0.075	4.6	0.586	95.37	:	33.299	-11.092	0.937
2015	3	4	18 11 7	18	17	53	2E1	6.8	0.146	4.6	0.849	85.64	22.91 :	38.875	-17.768	0.939
2015	3	6	0 19 43	0	21	22	102	1.7	0.898	4.6	0.021	21.94	:	30.185	-29.919	0.980
2015	3	6	1 14 13	1	18	21	1E2	4.1	0.518	4.6	0.357	7.59	31.61 :	24.002	-25.748	0.978
2015	3	6	4 50 28	4	58	7	103	7.7	0.082	4.2	0.360	88.49	:	0.262	-2.148	0.970
2015	3	7	14 53 38	15	3	51	2E4	10.2	0.280	4.9	0.533	156.85	75.57 :	19.194	5.703	0.887
2015	3	8	15 37 17	16	2	29	3E4	25.2	0.310	4.5	0.337	352.94	56.23 :	24.824	1.175	0.824
2015	3	9	14 20 32	14	24	52	1E2	4.3	0.458	4.6	0.428	8.10	34.63 :	16.373	9.829	0.766
2015	3	9	21 30 53	21	35	12	302	4.3	0.692	4.4	0.135	55.43	:	43.356	-31.415	0.747
2015	3	9	23 35 29	23	43	37	3E2	8.1	0.036	4.4	0.465	84.57	55.42 :	33.170	-30.714	0.742
2015	3	11	19 17 54	19	23	32	201	5.6	0.183	4.6	0.496	91.25	:	44.821	-22.181	0.626

Taulukon sisältö

Explanations to the table of the ephemerides of the mutual occultations and eclipses of the natural satellites.

Date begin: h m s - moment of the start of event.

end: h m s - moment of the end of event.

Type - type of the event is given in the form "nEm" or "nOm" where n is the number of eclipsing or occulting satellite, m is the number of eclipsed or occulted one. "E" denotes an eclipse and "O" denotes an occultation.

Dur(m) - expected duration of the event in minutes.

Impact - impact factor which is equal to zero if the event is a central passage of satellite through the shadow or through the apparent disk of another satellite. Impact factor is equal to unit in the case of a grazing event.

m - combined magnitude of the pair of satellites in the event.

Δm - expected maximum drop of the combined magnitude.

limb(") - angular apparent distance of the occulted or eclipsed satellite from the limb of the planet (in arcseconds).

dist(") - angular apparent distance of the eclipsed satellite from the eclipsing one (in arcseconds).

Planet(°) - elevation of the planet above the horizon (in degrees).

Sun(°) - angular apparent depth of the Sun under the horizon (in degrees).

Moon phase - Moon phase (0.0 for new Moon, 1.000 for full Moon).

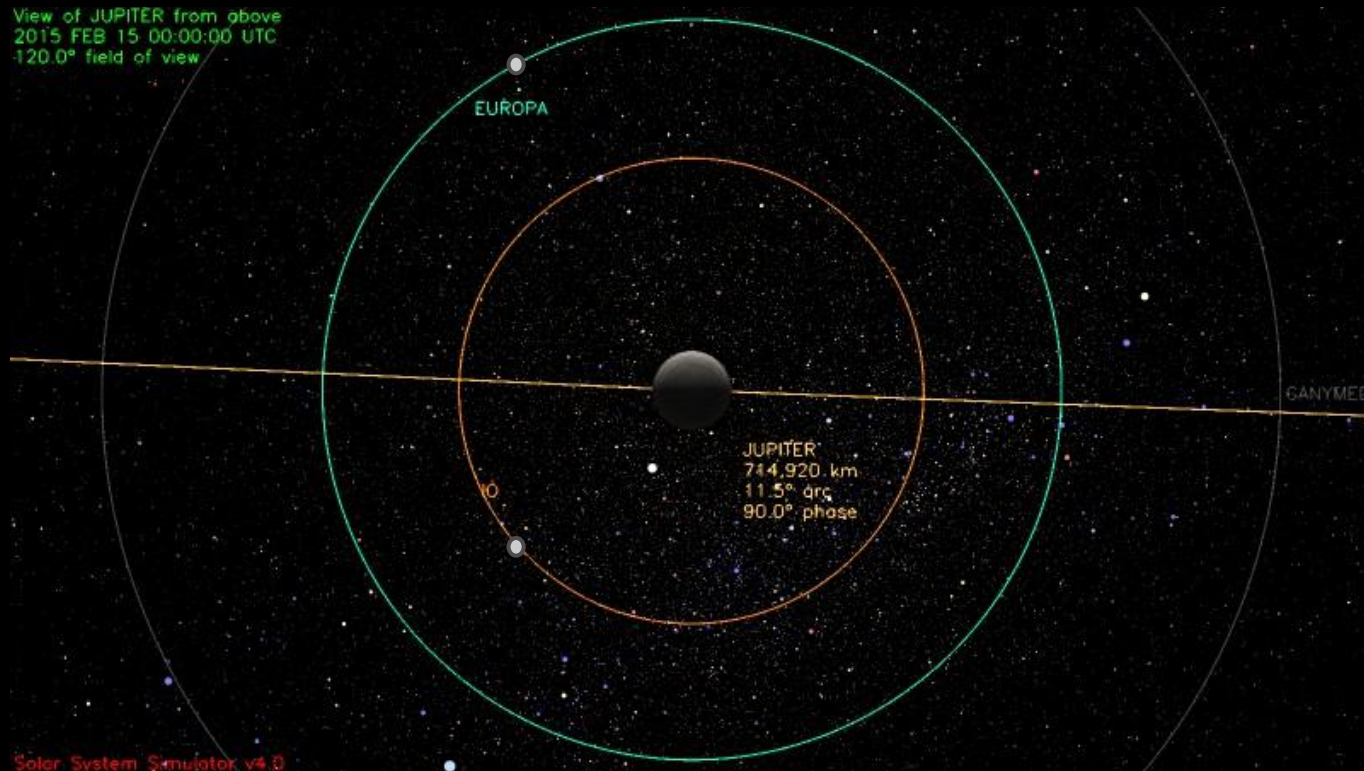
Parhaat tapahtumat

Date	begin: h m s	end: h m s	Type	Dur minutes	Impact arcsec	mag	flux drop	limb(")	sat(")
2015 03 01	04 09 33	4 15 42	201	6.1	0.015	4.6	0.586	97.25	:
2015 03 01	05 01 36	5 8 34	2E1	7.0	0.076	4.6	0.896	89.08	19.98 :
2015 03 02	20 22 05	20 29 52	3E2	7.8	0.257	4.3	0.465	73.01	45.51 :
2015 03 04	17 12 02	17 18 1	201	6.0	0.075	4.6	0.586	95.37	:
2015 03 04	18 11 07	18 17 53	2E1	6.8	0.146	4.6	0.849	85.64	22.91 :
2015 03 06	04 50 28	4 58 7	103	7.7	0.082	4.2	0.360	88.49	:
2015 03 06	06 34 59	6 45 57	1E3	11.0	0.017	4.2	0.977	67.81	35.76 :
2015 03 07	11 21 10	11 28 41	204	7.5	0.036	4.9	0.211	125.69	:
2015 03 07	14 53 38	15 3 51	2E4	10.2	0.280	4.9	0.533	156.85	75.57 :
2015 03 08	06 15 01	6 20 50	201	5.8	0.131	4.6	0.545	93.33	:
2015 03 08	07 20 43	7 27 15	2E1	6.5	0.198	4.6	0.770	82.03	25.76 :
2015 03 08	09 26 39	9 49 55	304	23.3	0.293	4.5	0.231	308.45	:
2015 03 08	15 37 17	16 2 29	3E4	25.2	0.310	4.5	0.337	352.94	56.23 :
2015 03 09	21 30 53	21 35 12	302	4.3	0.692	4.4	0.135	55.43	:
2015 03 09	23 35 29	23 43 37	3E2	8.1	0.036	4.4	0.465	84.57	55.42 :
2015 03 11	19 17 54	19 23 32	201	5.6	0.183	4.6	0.496	91.25	:
2015 03 11	20 29 50	20 36 10	2E1	6.3	0.251	4.6	0.688	78.40	28.49 :
2015 03 13	07 31 06	7 39 35	103	8.5	0.208	4.3	0.354	95.21	:
2015 03 13	09 52 14	10 5 52	1E3	13.6	0.100	4.3	0.836	67.70	39.13 :
2015 03 14	07 50 07	8 10 14	1E3	20.1	0.097	4.3	0.805	141.97	36.37 :
2015 03 14	12 19 55	12 27 15	2E3	7.3	0.730	4.4	0.123	183.65	47.30 :
2015 03 15	08 21 18	8 26 44	201	5.4	0.249	4.6	0.434	89.04	

<http://www.imcce.fr/phemu/selected-phemu15.txt>

Selected events occurring at more than 50 arcsec from the limb of Jupiter with a flux drop larger than 5%.

15.2.2015 102 (00:03 UT) & 1E2 (00:24 UT)

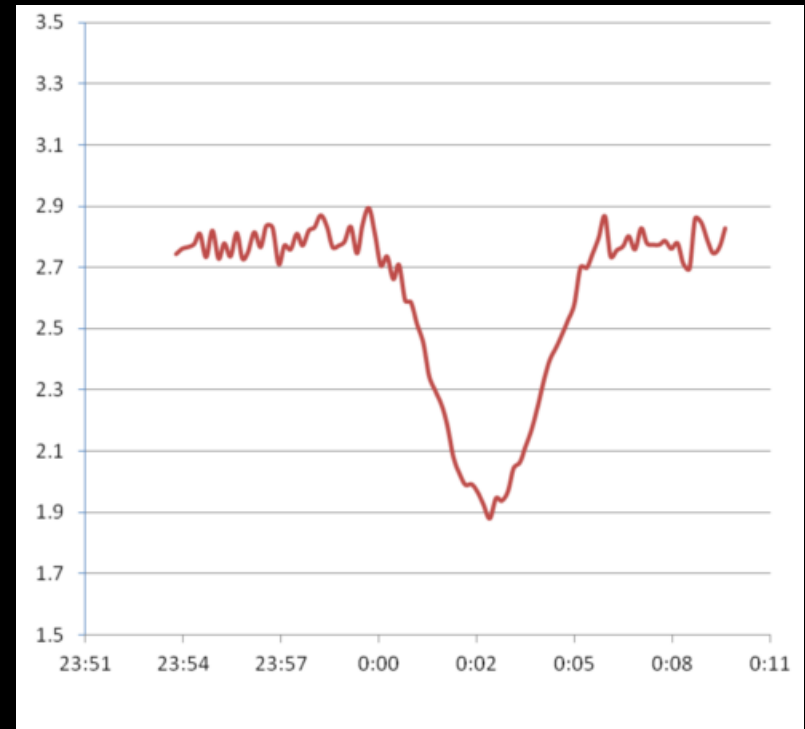
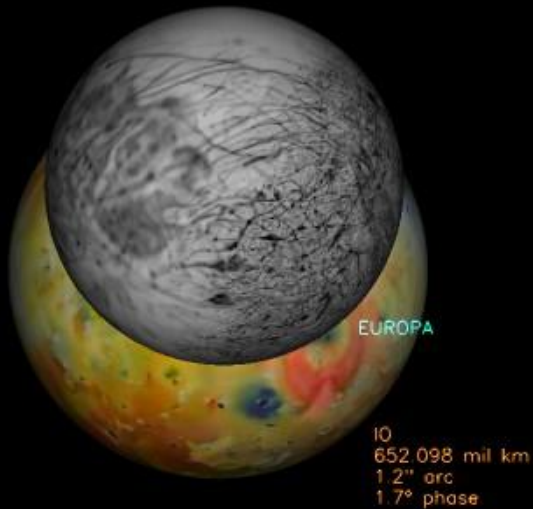




https://www.youtube.com/watch?v=lzyNg6Rt_NA

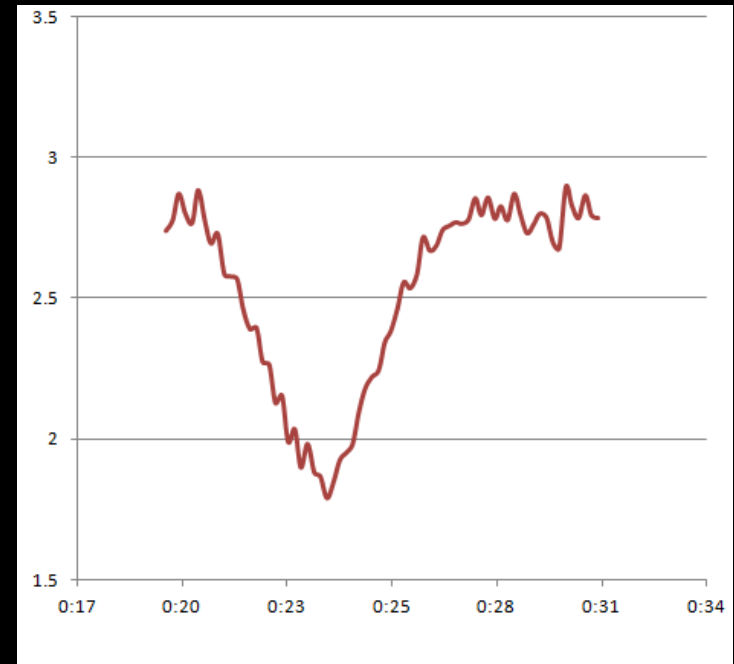
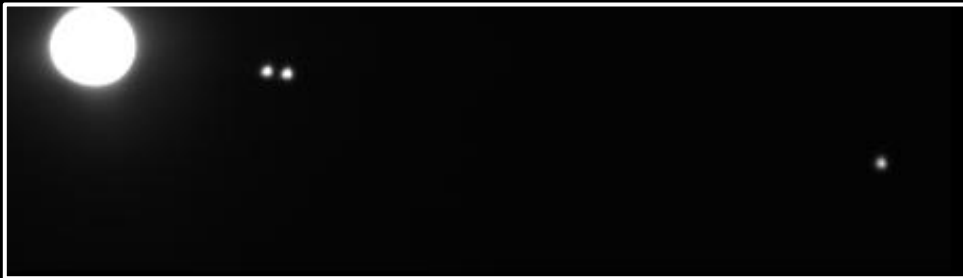
Europe ocl. Io 15.2.2015

Date	begin: h	m	s	end: h	m	s	Type	Dur minutes	Impact arcsec	mag	flux drop	distance to limb(")	sat(")
2015 02 14	23	59	46	0	6	26	201	6.7	0.215	4.5	0.466	103.67	:



Europe ecl. Io 15.2.2015

Date	begin: h	m	s	end: h	m	s	Type	Dur minutes	Impact arcsec	mag	flux drop	distance to limb(")	sat(")
2015 02 15	00	20	03	0	27	51	2E1	7.8	0.130	4.5	0.849	101.18	7.94 :



Haasteita ja vaatimuksia

- ★ Sää !
 - ★ vain pieni osa tapahtumista on havaittavissa
- ★ Kuiden kirkkaus
 - ★ lyhyt valotusaika -> skintillaatio -> kohina
- ★ Ajoitus
 - ★ FITS aikaleimat (1s?)
 - ★ suljinviive (0.2s?)
 - ★ NTP palvelimen tarkkuus (0.1s?)
 - ★ Windows (0.1s?)
- ★ Fotometria
 - ★ Jupiter
 - ★ Kohdistus
 - ★ Suuri määrä kuvia



Kysymyksiä?



Arto Oksanen

tel: +358-40-5659438

arto.oksanen@jkl Sirius.fi

<http://www.ursa.fi/sirius>