

High resolution imaging of mutual events of the Jupiter moons.

Presented by John Sussenbach (NL) at ESOP XXXV, Guildford, UK on 2016 August 19-21

John Sussenbach and Willem Kivits



Triple shadow transit 12 October 2013

Ganymede

Io Europa

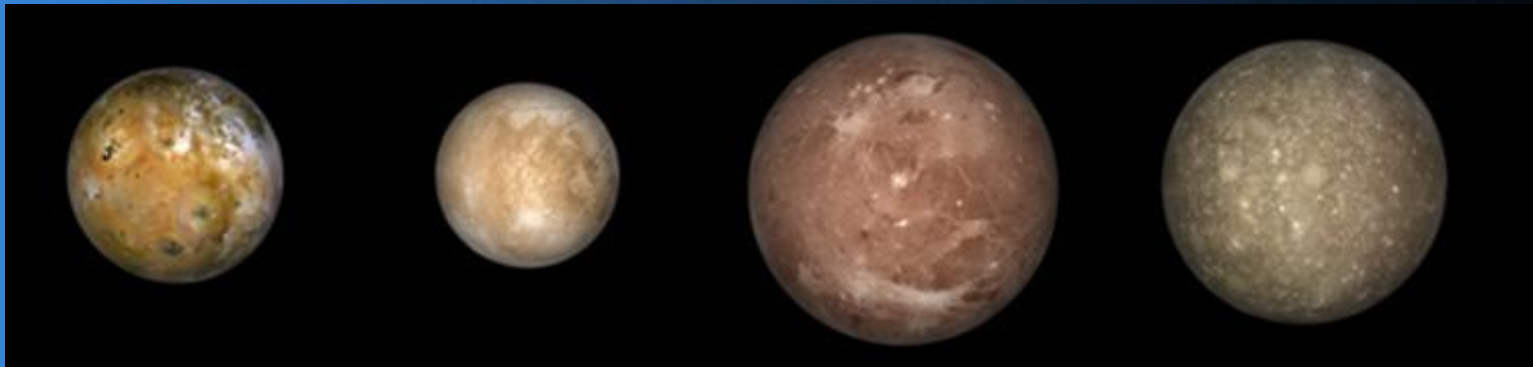


Every 5.93 years the Earth moves through the equatorial plane of Jupiter and its moons

This leads to mutual occultations and eclipses of these moons.



The Galilean moons



Io
1.15"

Europa
0.99"

Ganymede
1.67"

Callisto
1.52"

1. The observers



Willem Kivits: 20 inch Newtonian



John Sussenbach: C14

2. Procedures

Equipment

- *Telescopes:* C14 f/25 - f/40 (JS en WK)
Newtonian 20 inch (WK)
- *Camera's:* QHY5LII (CMOS)
DMK618 (Sony ICX618 chip)
- *IR filter:* 685 nm

Processing of the frames

- *centre with PIPP*

([https:// sites.google.com/site/astropipp](https://sites.google.com/site/astropipp))

- *preprocessing with Photoshop*

- *(hand selection)*

- *final processing with Autostakkert2! and Photoshop*

High resolution imaging of Ganymede



Resolution: 0.1"

3. Occultations



Conjunction of Ganymede and Europa 1 Januari 2015



01.26.24 UT
Minimal separation 0.03''

01.01.42 UT

01.09.06 UT

01.12.24 UT

01.16.26 UT

01.23.55 UT

01.26.24 UT

00.03.39 UT



00.04.40 UT



00.05.43 UT



00.06.46 UT



00.08.25 UT



00.09.29 UT



00.14.45 UT



Occultation of
Io by Callisto
7 January 2015

Occultation and eclipse of Ganymede by Io
12 February 2015 21.17.11 - 21.51.22 UT

C14 f/25, QHY5LII camera and IR filter

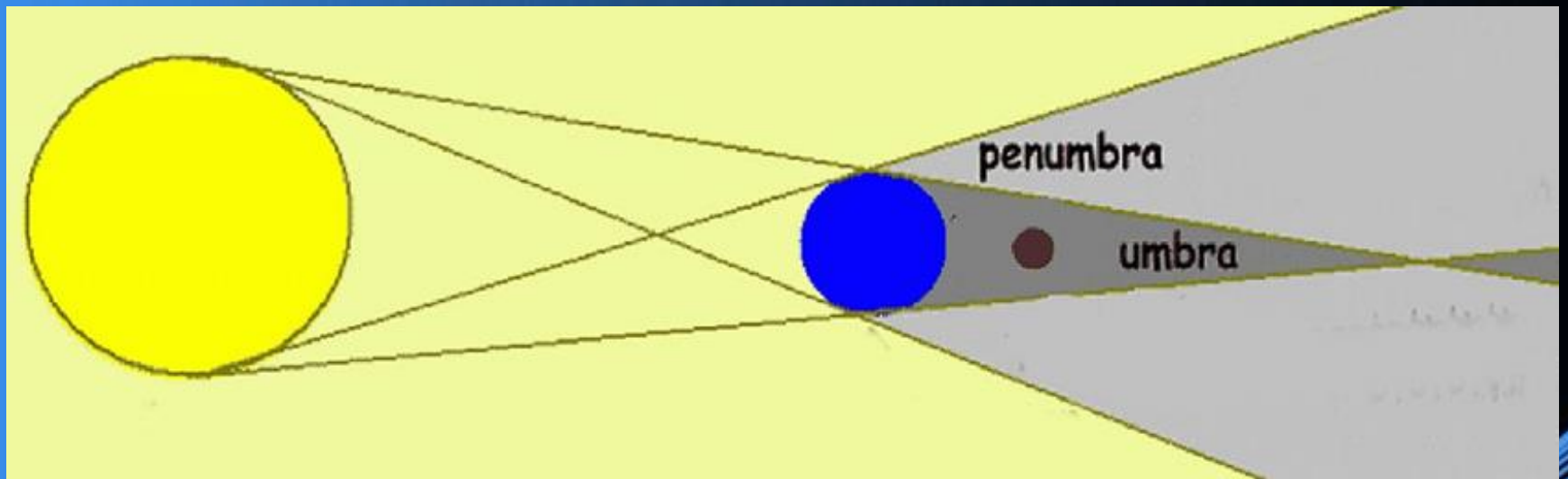
John Sussenbach

Occultation of Ganymede by Io 12 February 2015

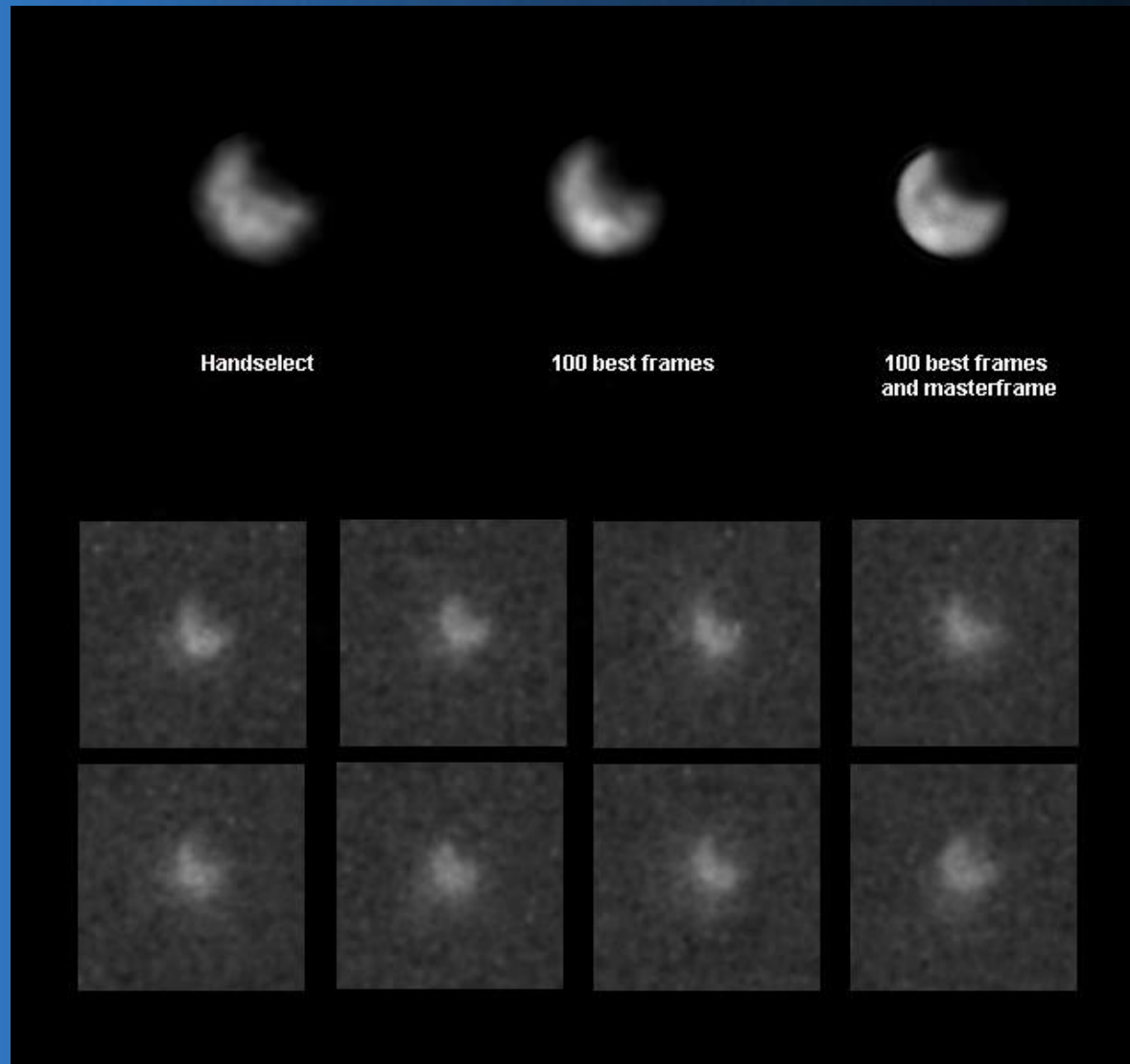
4.Eclipses



Umbra and penumbra



Selection procedure

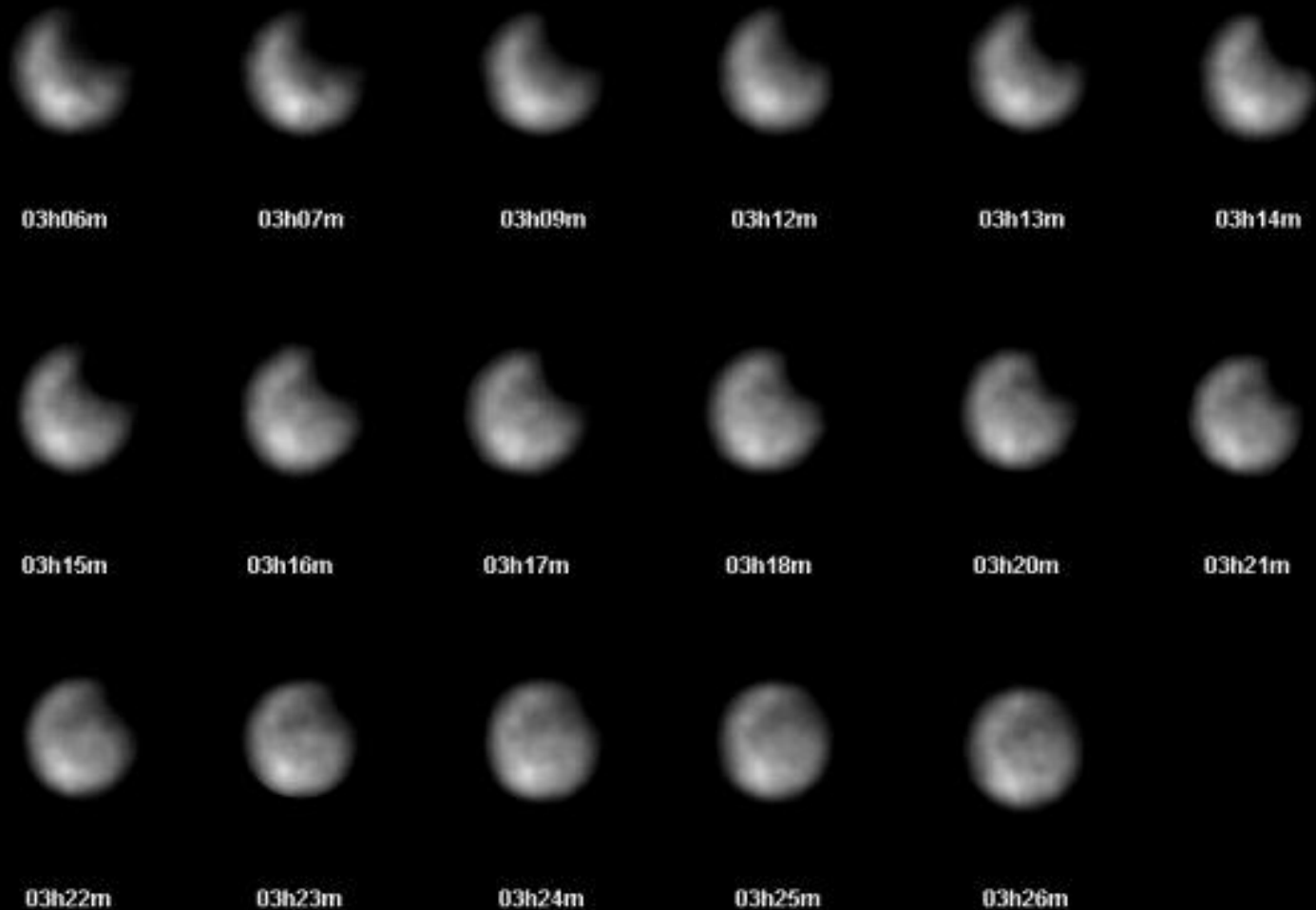


Eclipse of Callisto by Ganymede 25 November 2014

Masterframes



Stacking 100 best frames (hand selection)



25 November 2014

Stacking best frames with 35% master frame



25 November 2014

Ganymedes eclipses Callisto 25 November 2014 (C14)



03.06 UT – 03.26 UT

5. Special effects around opposition (6 February 2015 19.00 h UT)

Eclipse of Ganymede by Jupiter
5 February 2015 23.07.07 - 23.15.27 UT

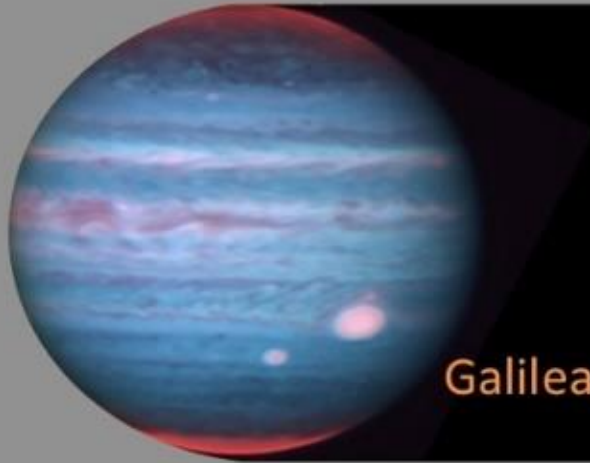
C14 f/20, IR filter and QHY5LII camera
John Sussenbach

Scattered sunlight on Ganymede

Sunlight is scattered by
Jovian haze

Sunlight

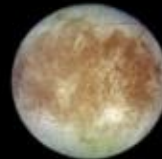
Satellites in Jovian shadow are
illuminated by scattered light



Jupiter



Io



Europa



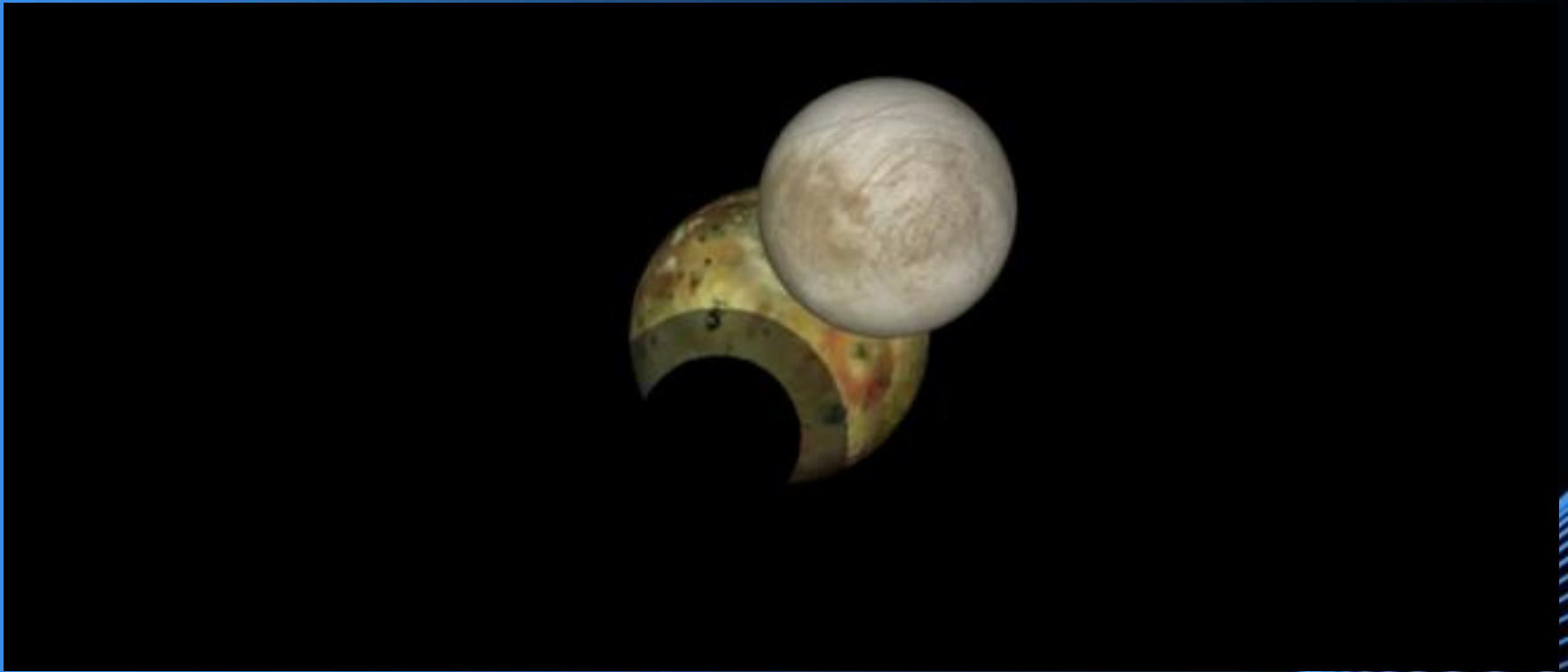
Ganymede



Callisto

Galilean satellites in Jovian shadow

Europa occults and eclipses Io 7 February 2015



Opposition on
6 February 2015 19.00 h UT



21h52.4m



21h53.5m



21h54.5m



21h55.5m



21h56.5m



21h57.6m



21h58.7m



21h59.7m



22h00.7m



22h01.8m



22h02.8m

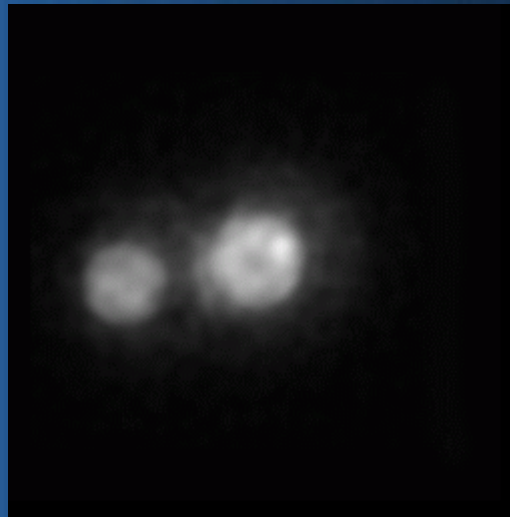


22h03.8m

Europa occults and eclipses Io 7 February 2015



AS2! stack



100 best handpicked



100 best + 35% master

6. Different types of eclipses

Europa eclipses Io
2015-02-22

C14 f/33
QHY5LII
685nm LP

Winjupos



Io



02h44m UT

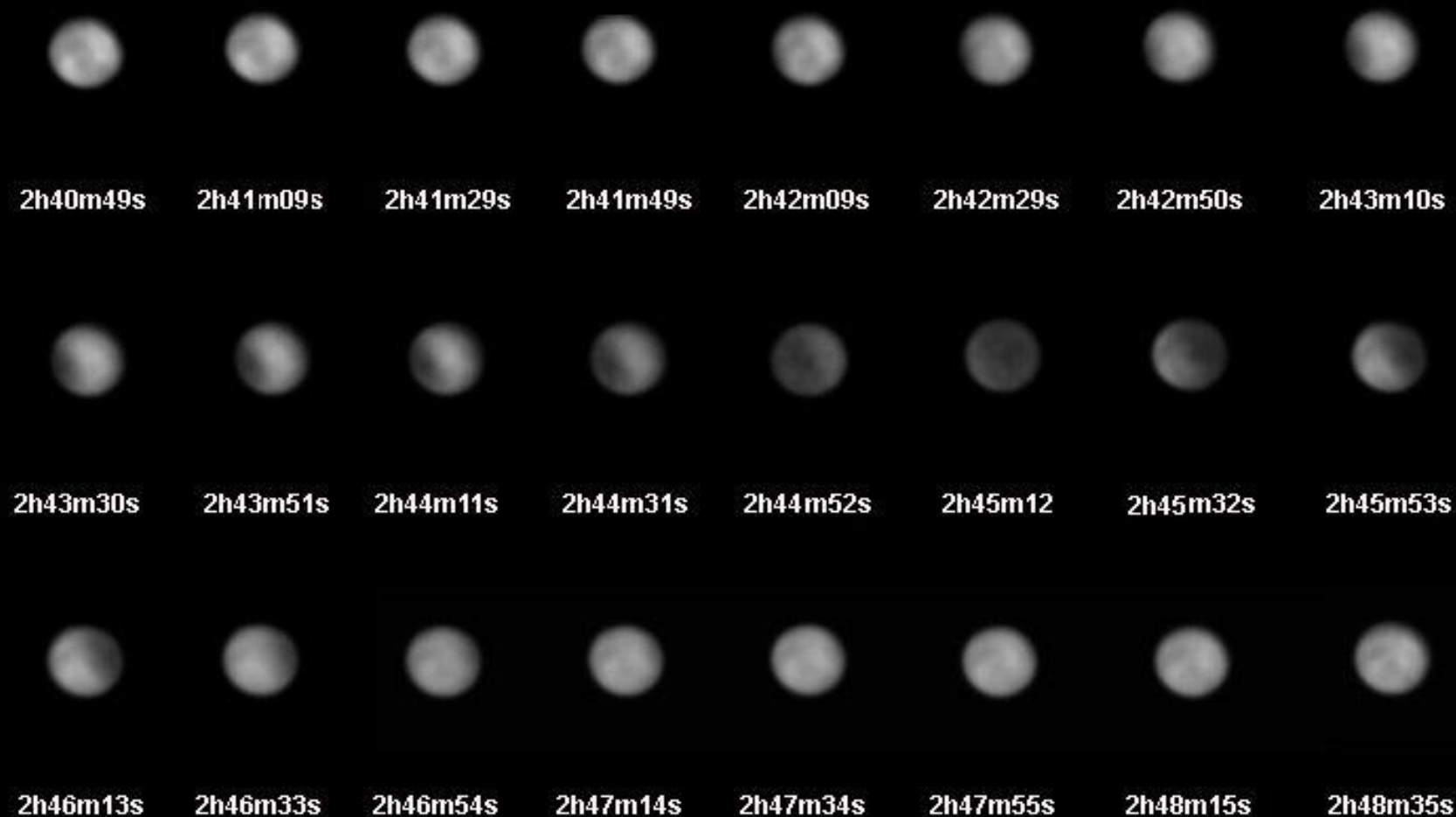
02h45m UT

02h46m UT

Willem Kivits
Siebengewald
Netherlands

Europa eclipses Io 22 February 2015

Europa eclipses Io 20150222



22 February 2015 02.40.49 UT - 02.48.35 UT North up
C14 f/25, QHY5LII camera and IR filter

John Sussenbach

Io eclipses Europa 22 February 2015

Occultation of Io by Europa

22 February 2015 02:40:49 - 02:48:35 UT

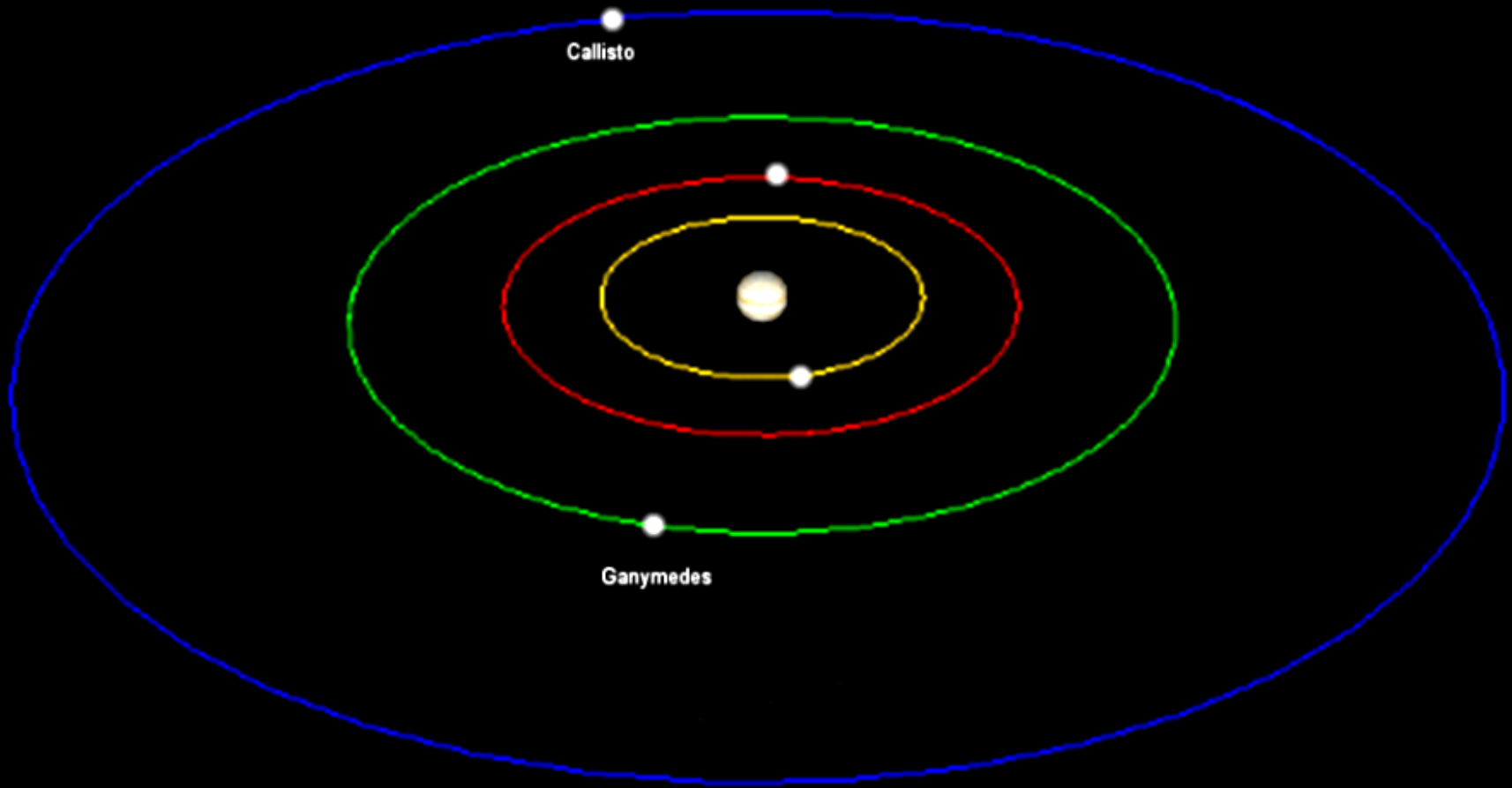
C14 f/25, QHY5LII camera and IR filter

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Ganymede eclipses Callisto 2 February 2015 (1)



Ganymede eclipses Callisto 2 February 2015(2)



Distance 2.9 million km

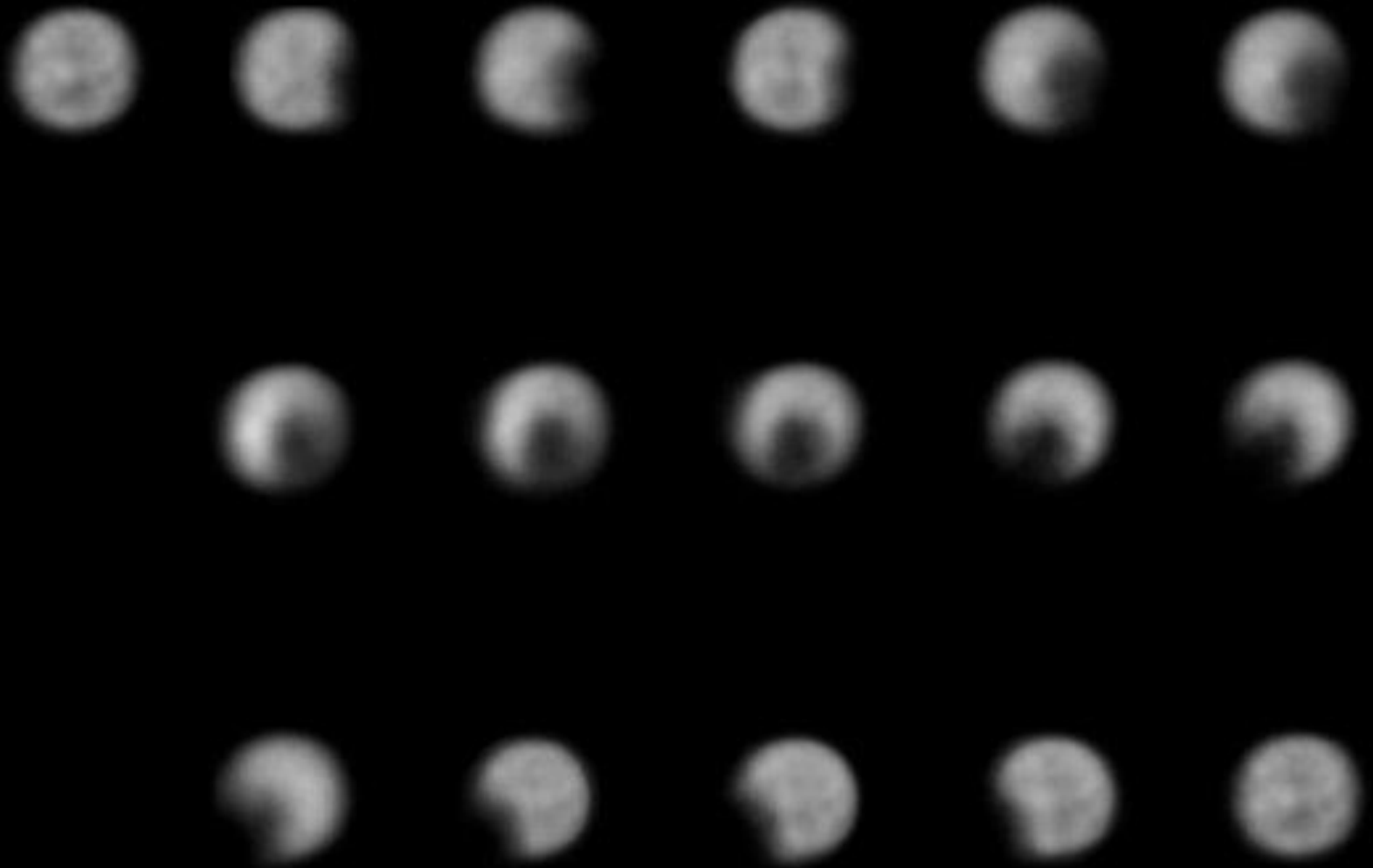
Europa eclipses Io 11-3-2015 WK



Io eclipses Ganymede 12-2-2015 WK

Io eclipses Ganymede 13 March 2015 WK

23.15-23.43 UT



Io eclipses Ganymede 13 March 2015 WK



Next opportunity in 2021!

Io eclipses Europa



Europa

23 May 2021 21.09 UT

**Unfortunately, Jupiter will be in Sagittarius.
In NL only 20 degrees above the horizon!**



Willem Kivits

18 October 1951 - 23 February 2016
Siebengewald (NL)