

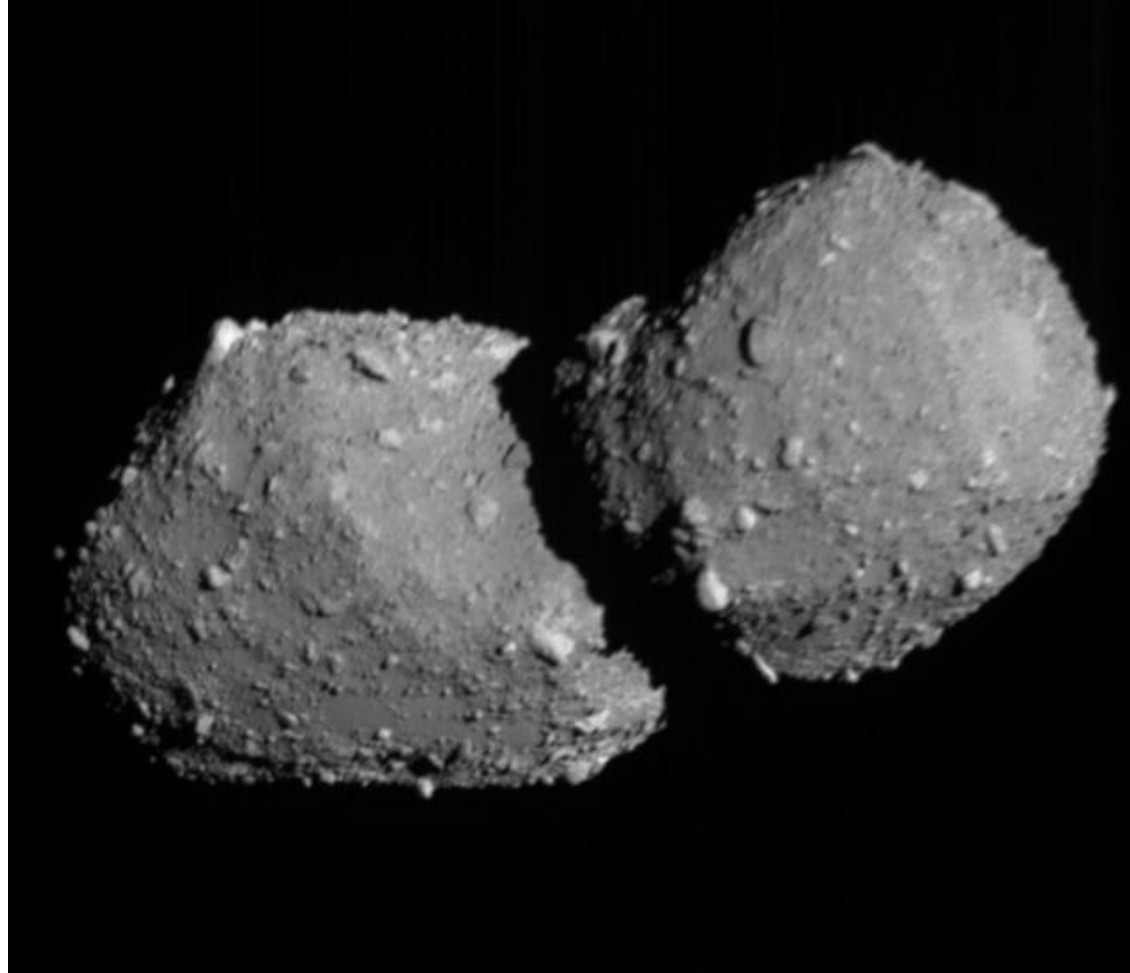
Occultation TYC4082-00763-1 by
asteroid (98943) 2001 CC21
(Torifune)

Miyoshi Ida (JOIN)

Hayabusa2

Successfully performed a flyby observation of 2001 CC21 (Torifune)

はやぶさ2 トリフネにフライバイ観測成功



To Ensure a Successful Flyby Observation

フライバイ観測を成功するために

- Improve the orbital accuracy of 2001 CC21
 - 2001 CC21の軌道精度を上げる
- Estimate the size of 2001 CC21
 - 2001 CC21の大きさを推定する



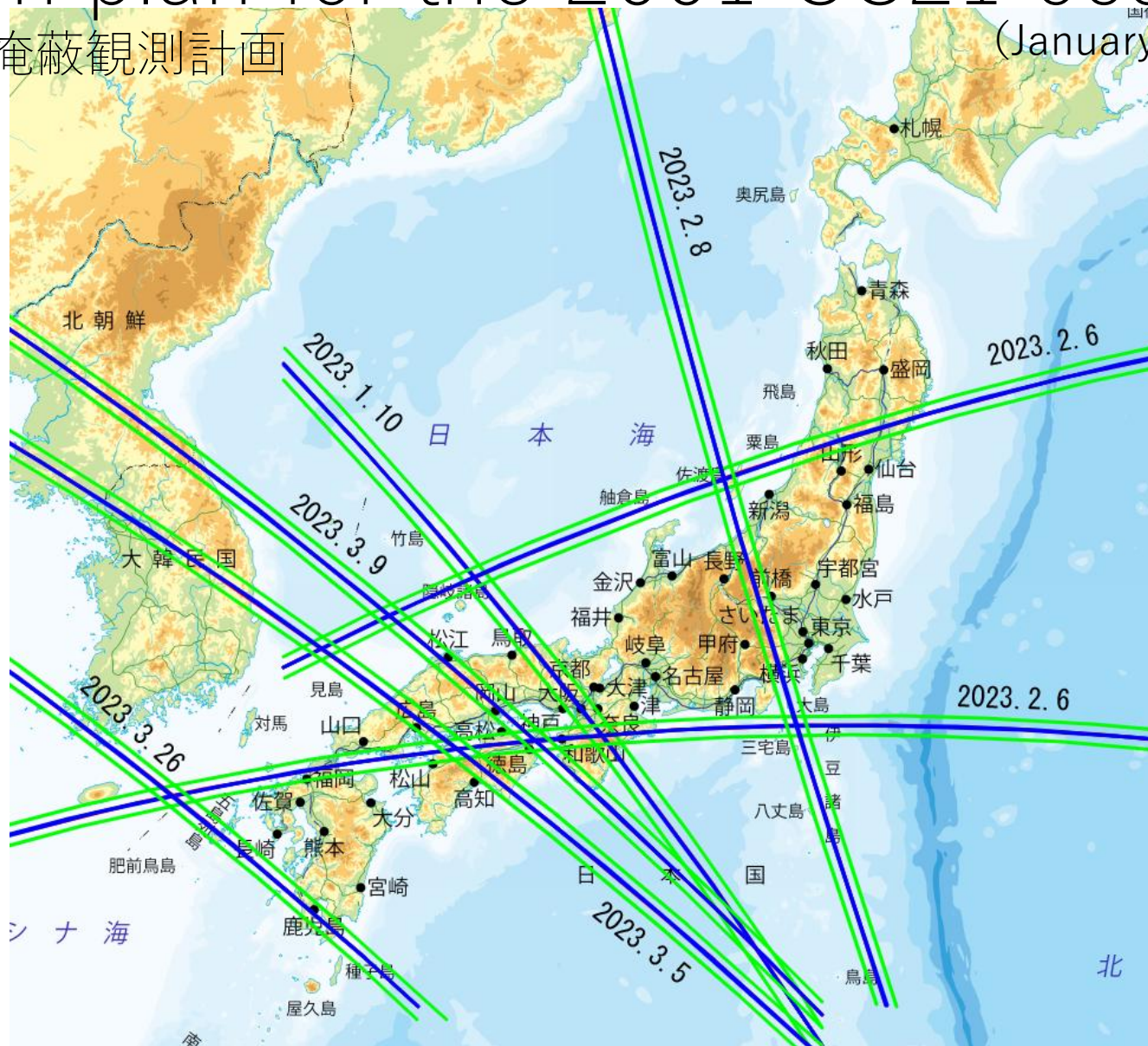
Occultation observation of 2001 CC21

2001 CC21による掩蔽観測

Observation plan for the 2001 CC21 occultation

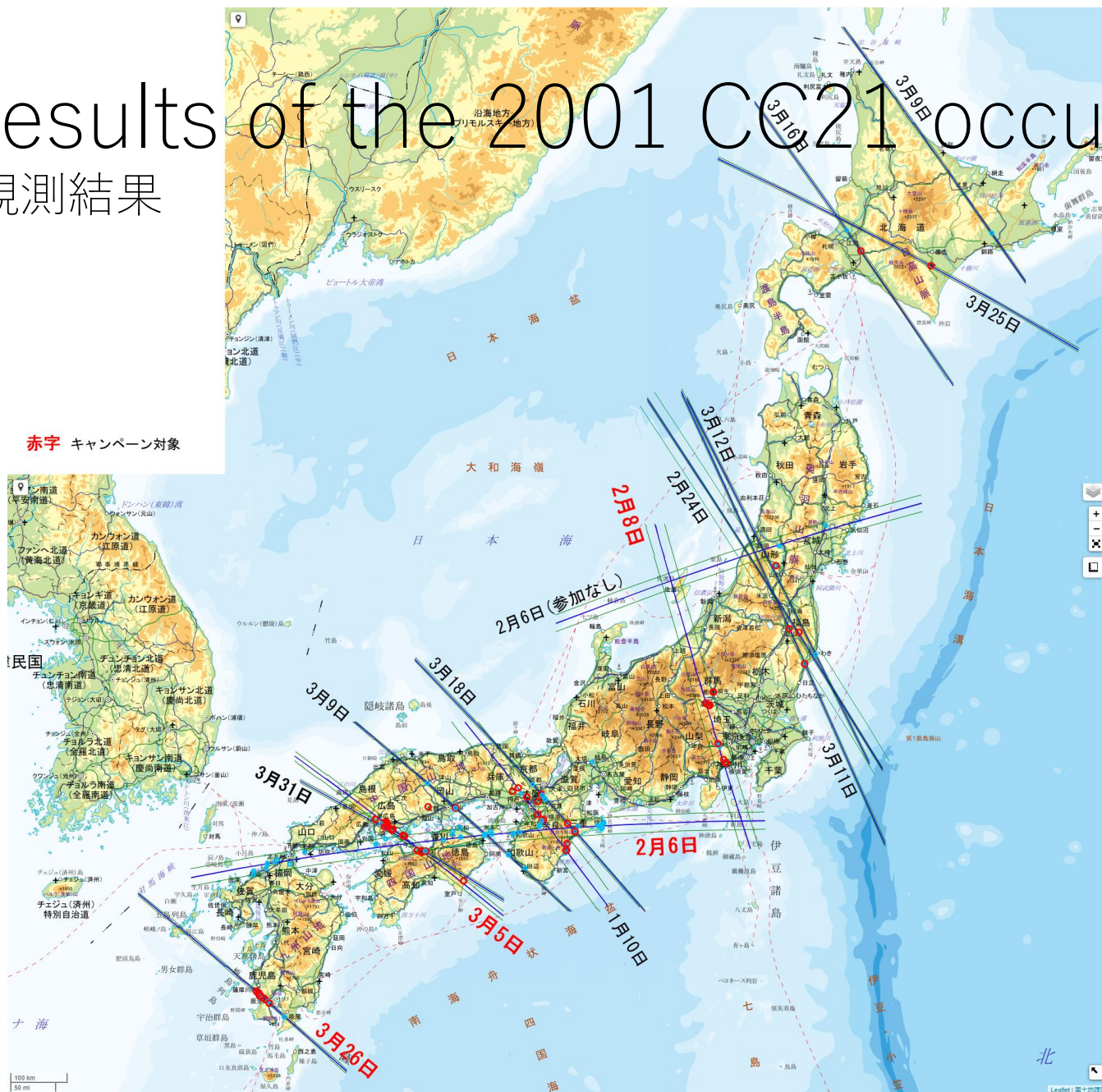
2001 CC21による掩蔽観測計画

(January-March 2023)



Observation results of the 2001 CC21 occultation

2001 CC21による掩蔽観測結果



List of Stellar Occultation Observations of 2001 C21 (January-March 2023)

date (UT)	Target star	magnitude	region	Number of observation sites	Dimming	No dimming	Observation established	Observation failed
1/10	UCAC4 604-046164	11.9	Kinki	13	0	10	10	3
* 2/6	HIP 41805	7.7	Kinki, Northern Kyushu	42	0	0	0	42
* 2/8	TYC 3799-00311-1	9.3	Tokai, Kanto, Hokuriku	14	0	12	12	2
2/24	UCAC4 764-036151	13.1	Tohoku	1	0	1	1	0
* 3/5	TYC 4082-00763-1	10.1	Shikoku, Chugoku	20	1	18	19	1
3/9	UCAC4 756-031031	11.4	Chugoku, Southern Kinki	12	0	3	3	9
3/9	UCAC4 756-031018	12.6	Northern Hokkaido	1	0	0	0	1
3/11	UCAC4 752-032169	12.6	Tohoku	4	0	3	3	1
3/12	UCAC4 750-030445	12.5	Tohoku	2	0	0	0	2
3/16	UCAC4 741-029905	12.9	Hokkaido	2	0	1	1	1
3/18	UCAC4 735-029482	12.1	Kinki	13	0	5	5	8
3/25	UCAC4 710-018777	12.6	Hokkaido	1	0	1	1	0
* 3/26	HIP 10366(=6Per)	5.1	Southern Kyushu	18	0	13	13	5
3/31	UCAC4 682-009893	10.7	Shikoku, Chugoku	3	0	2	2	1
total				146	1	69	70	76

List of Stellar Occultation Observations of 2001 C21 (January-March 2023)

I went on three expeditions.遠征しました				region	Number of observation sites	Dimming	No dimming	Observation established	Observation failed
→ 1/10	UCAC4 604-046164	11.9	Kinki		13	0	10	10	3
* 2/6	HIP 41805	7.7	Kinki, Northern Kyushu		42	0	0	0	42
* 2/8	TYC 3799-00311-1	9.3	Tokai, Kanto, Hokuriku		14	0	12	12	2
2/24	UCAC4 764-036151	13.1	Tohoku		1	0	1	1	0
→ * 3/5	TYC 4082-00763-1	10.1	Shikoku, Chugoku		20	1	18	19	1
3/9	UCAC4 756-031031	11.4	Chugoku, Southern Kinki		12	0	3	3	9
3/9	UCAC4 756-031018	12.6	Northern Hokkaido		1	0	0	0	1
3/11	UCAC4 752-032169	12.6	Tohoku		4	0	3	3	1
3/12	UCAC4 750-030445	12.5	Tohoku		2	0	0	0	2
3/16	UCAC4 741-029905	12.9	Hokkaido		2	0	1	1	1
→ 3/18	UCAC4 735-029482	12.1	Kinki		13	0	5	5	8
3/25	UCAC4 710-018777	12.6	Hokkaido		1	0	1	1	0
* 3/26	HIP 10366(=6Per)	5.1	Southern Kyushu		18	0	13	13	5
3/31	UCAC4 682-009893	10.7	Shikoku, Chugoku		3	0	2	2	1
total					146	1	69	70	76

List of Stellar Occultation Observations of 2001 C21 (January-March 2023)

date (UT)	Target star	magnitude	region	Number of observation sites	Dimming	No dimming	Observation established	Observation failed
1/10	UCAC4 604-046164	11.9	Kinki	13	0	10	10	3
* 2/6	HIP 41805	7.7	Kinki, Northern Kyushu	42	0	0	0	42
		9.3	Tokai, Kanto, Hokuriku	14	0	12	12	2
		13.1	Tohoku	1	0	1	1	0
* 3/5	TYC 4082-00763-1	10.1	Shikoku, Chugoku	20	1	18	19	1
3/9	UCAC4 756-031031	11.4	Chugoku, Southern Kinki	12	0	3	3	9
3/9	UCAC4 756-031018	12.6	Northern Hokkaido	1	0	0	0	1
3/11	UCAC4 752-032169	12.6	Tohoku	4	0	3	3	1
3/12	UCAC4 750-030445	12.5	Tohoku	2	0	0	0	2
3/16	UCAC4 741-029905	12.9	Hokkaido	2	0	1	1	1
3/18	UCAC4 735-029482	12.1	Kinki	13	0	5	5	8
3/25	UCAC4 710-018777	12.6	Hokkaido	1	0	1	1	0
* 3/26	HIP 10366(=6Per)	5.1	Southern Kyushu	18	0	13	13	5
3/31	UCAC4 682-009893	10.7	Shikoku, Chugoku	3	0	2	2	1
total				146	1	69	70	76

I captured the dimming.
減光を捉える



Covering zone and observation points on March 5, 2023



Covering zone and observation points on March 5, 2023



- 1460 m west of the prediction center
- センターから1460m西

Observation equipment 観測機材



- Shooting data 撮影のデータ
- Telescope Non-automatic equatorial mount
- Aperture: 20cm Type: SCT F=2.1
- Using 6.3 and 3.3 reducers
- CMOS camera ZWO ASI290MM
- Output Format=AVI file
- Binning=2
- Capture Area=1440x500
- Colour Space=MONO8
- Turbo USB=100
- Gain=340
- Exposure=0.0256秒
- Brightness=38
- [Time keep] VK-172とHACSTIP-GPS

Preparing Materials for Observation

観測資料の作成

(98943) 2001 CC21 8th TYC 4082-00763-1 を探す

観測時刻: 3月5日 21h45m59s ±0.2秒 日時分

最大観測時間: 0.2秒

星光度: 7.1等

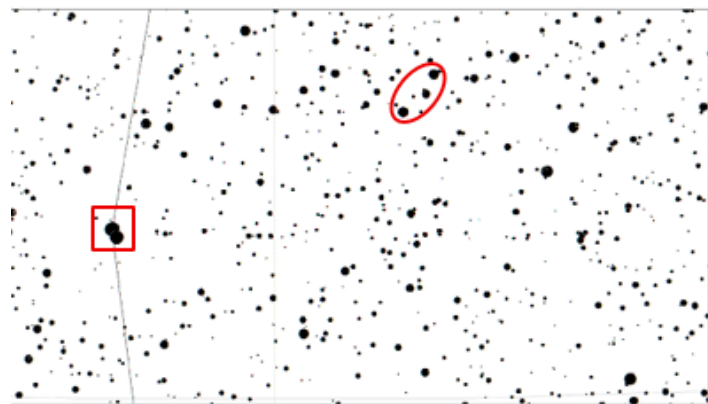
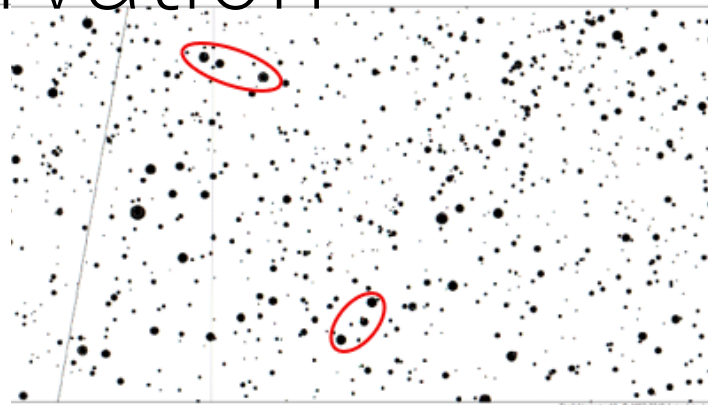
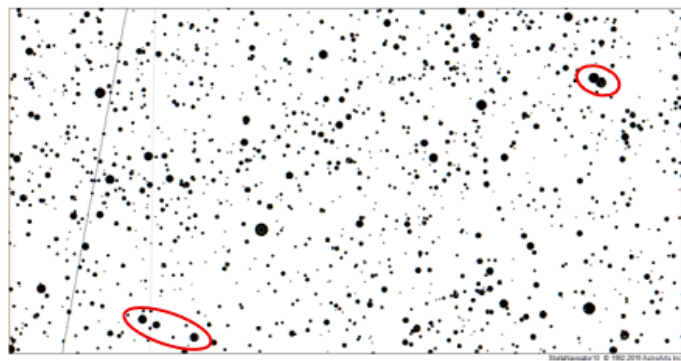
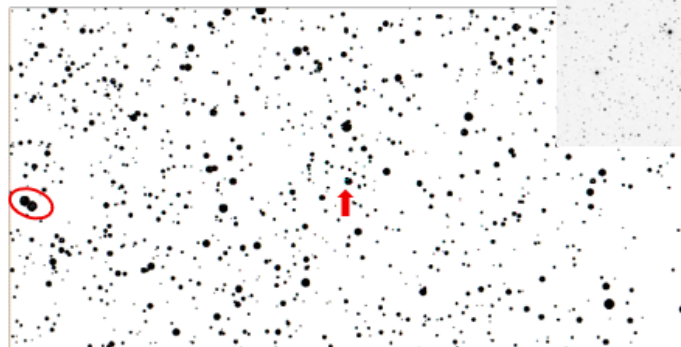
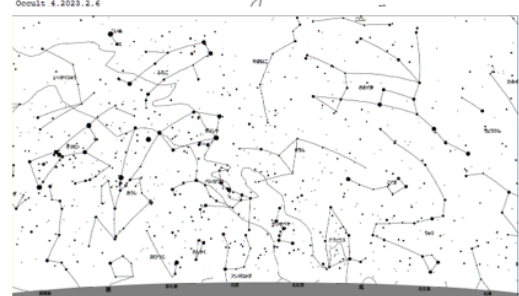
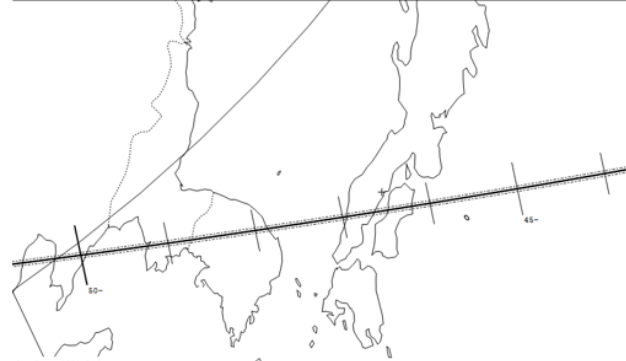
合成等級: 10.1等

恒星の光度: 10.1等

小惑星光度: 等

恒星の高度: h44° 32' 太陽: 47° 月: 67° ? rank7th

98943 2001 CC21 occults TYC 4082-00763-1 on 2023 Mar 5 from 12h 38m to 13h 29m UT
Star: (Dia = 0.1 mas) Duration: Max = 0.15 secs Asteroid: Dia = 17.2
W: 1.1; M: 10.7; R: 9.3 Dia = 0.28 secs, Iuse = 0.024 secs Dia = 0.39 to 10km, 6.2 mas
RA = 4 40 34.661 (astrometric) Mag Drop: 7.1 (100%) 7.4 (100%)
Dec = 42 15 39.510 Parallax red: 327" Hourly SRA = -21.286
Top Date: 4 42 42, 42 18 38 Moon: Dist = 47", illum = 96% JPL201:2023-Feb-12, Known errors
Prediction of 2023 Feb 13 Error 16.3 x 47.7 mas for RA 511" Dec = -31.38"



Preparing Materials for Observation

観測資料の作成

(98943) 2001 CC21 対 TYC 4082-00763-1 を探す

観測時刻: 3月5日 21h45m50s $\pm$ 2秒 日時分

最大観測時間: 0.2秒

星光度: 7.1等

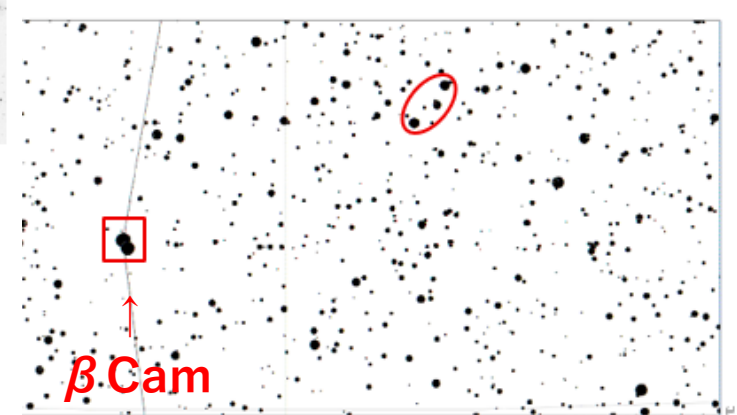
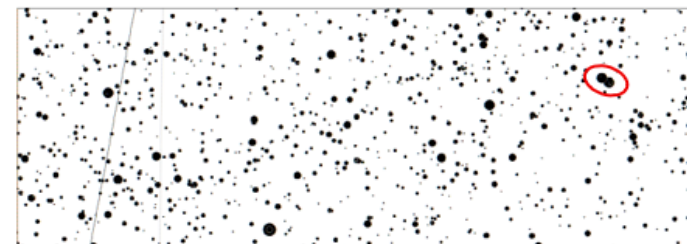
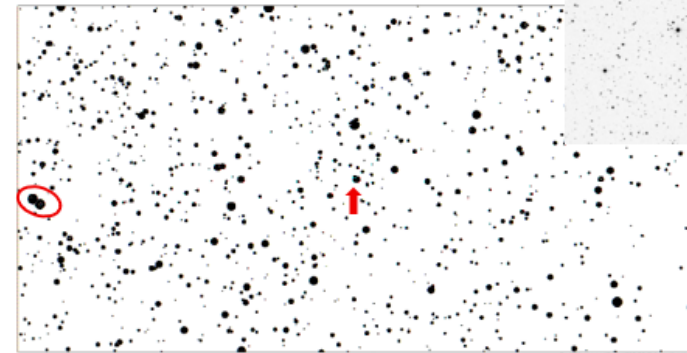
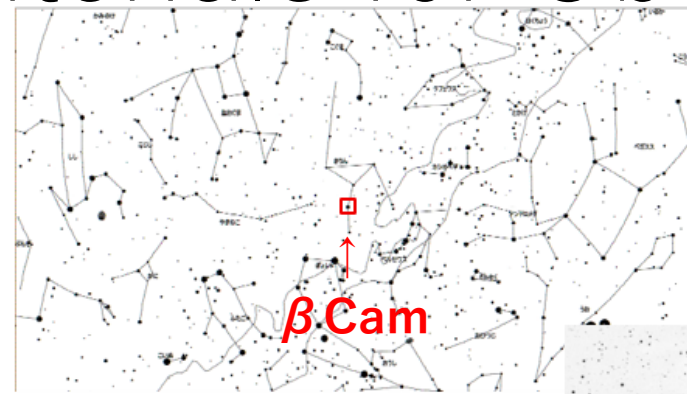
合成等級: 10.1等

恒星の光度: 10.1等

小惑星光度: 等

恒星の座標: h44° 32' 太陽 47° 月 67° ? rank7

98943 2001 CC21 occults TYC 4082-00763-1 on 2023 Mar 5 from 12h 38m to 13h 29m UT
Star: (Dia = 0.1 mas) Duration: Max = 0.15 sec Asteroid: Dia = 17.2
W 10.1; RA 10.7; Dec 9.3 RA = 4 40 36.661 (astrometric) RA = 0.28 sec, Dia = 0.24 sec Dia = 0.39 arcsec, 6.2 mas
RA = 4 40 36.661 (astrometric) Mag Disp: 7.1 (100%), 7.4 (100%) Parallax red. 327
Dec = 42 15 39.510 Sun: Dist = 391 Hourly SRA = -21.246
Top Date: 4 42 42, 42 18 38 Moon: Dist = 477, illum = 96% Dec = -31.387
Prediction of 2023 Feb 13 JPL201:2023-Feb-13, Known errors
Reliable 2.1 (Beverly, Dugger)



Prepare a star chart showing the path from a nearby bright star to the target star
近くの明るい星から目的星までの星図を準備

Preparing Materials for Observation

観測資料の作成

(98943) 2001 CC21 对 TYC 4082-00763-1 を隠す

観測時刻: 3月5日 21h45m50s +/-2秒 日時分

最大観測時間: 0.2秒

星光度: 7.1等

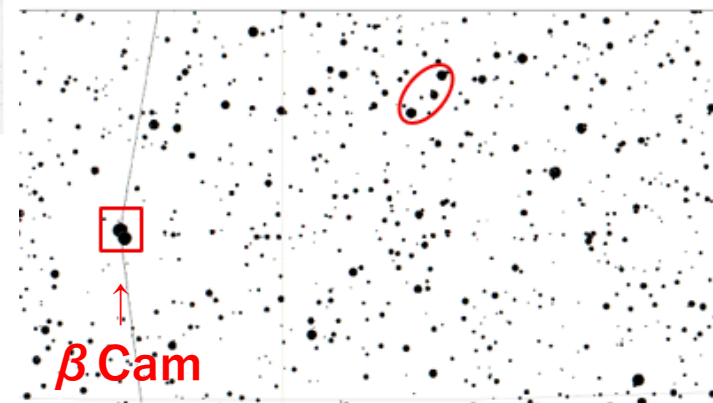
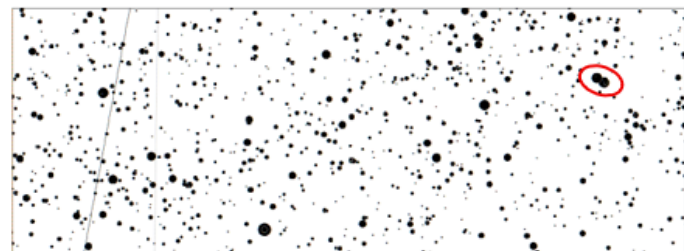
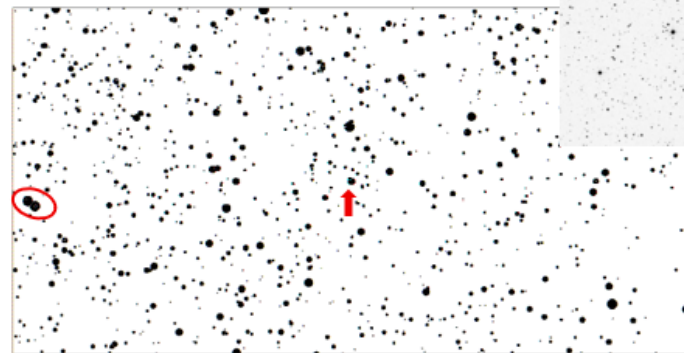
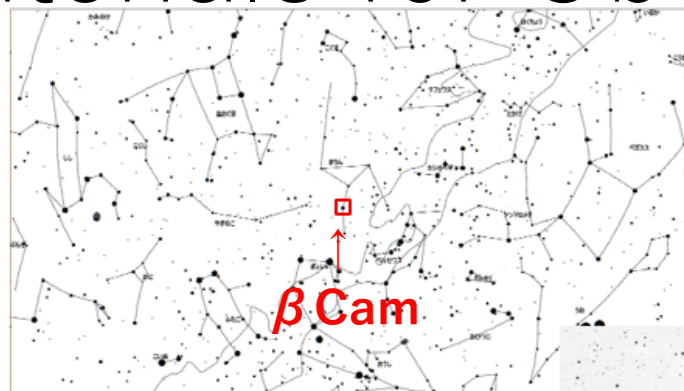
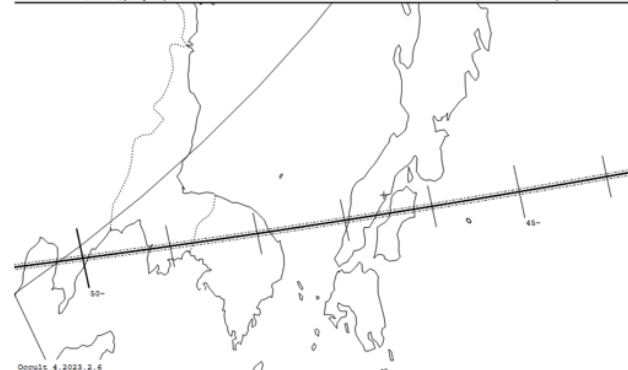
合成等級: 10.1等

恒星の光度: 10.1等

小惑星光度

恒星の高度: h44° 32' 太陽: 47° 月: 67° rank7

98943 2001 CC21 occults TYC 4082-00763-1 on 2023 Mar 5 from 12h 38m to 13h 29m UT
Star: (Dia = 0.1 mas) Duration: Max = 0.15 secs Asteroid: Dia = 17.2
W: 10.1; N: 10.7; E: 9.3 km = 0.28 secs, loss = 0.024 secs Mag Drop: 7.1 [100%], 7.4 [100%]
RA = 4 40 36.661 (astrometric) Parallax red. 32" Hourly SRA = -21.24s
Dec = 42 15 39.810 Sun: Dist = 93° Error 16.3 s 47.7 mas on RA 54" JPL201:2023-Feb-12, Known errors
[of Date: 4 42 42, 42 18 38] Prediction of 2023 Feb 12
Reliable 2.1 (Beverly, Dugger)



Use the naked eye to locate a nearby bright star
眼視にて近くの明るい星を導入

Preparing Materials for Observation

観測資料の作成

(98943) 2001 CC21 8th TYC 4082-00763-1 を探す

観測時刻: 3月5日 21h45m50s ±0.2秒 日時分

最大観測時間: 0.2秒

星光度: 7.1等

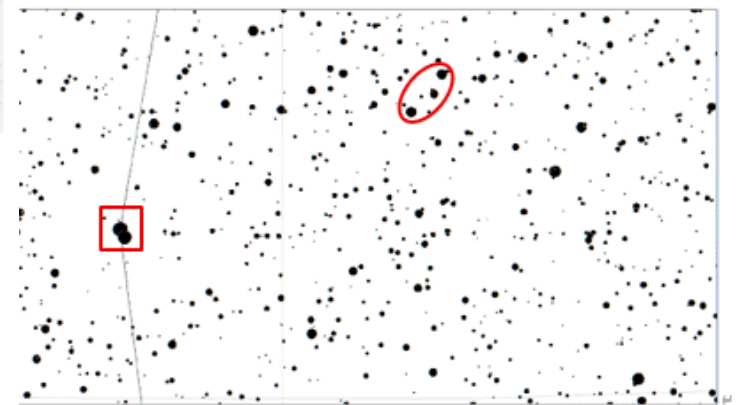
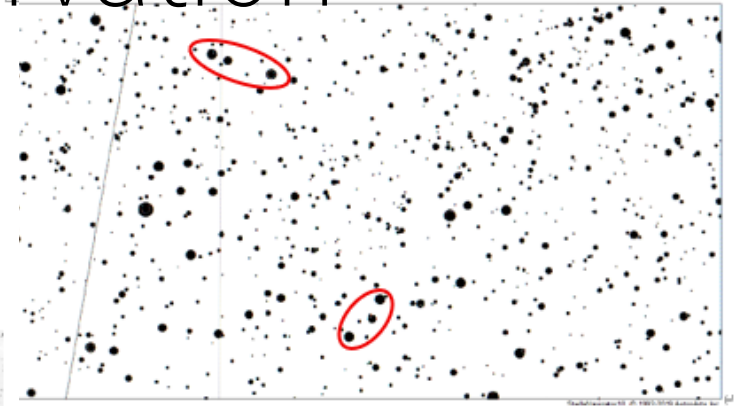
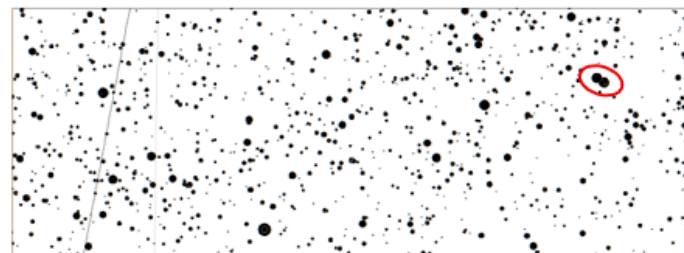
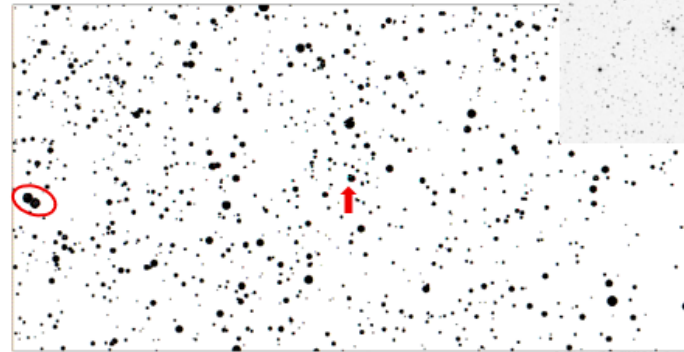
合成等級: 10.1等

恒星の光度: 10.1等

小惑星光度: 等

恒星の高度: h44° 32' 太陽: 47° 月: 67° ? rank7th

98943 2001 CC21 occults TYC 4082-00763-1 on 2023 Mar 5 from 12h 38m to 13h 29m UT
Star: (Dia = 0.1 mas) Duration: Max = 0.15 sec Asteroid: Dia = 17.2
W: 1.1; N: 10.7; E: 9.3 km = 0.28 sec, loss = 0.024 sec Mag Drop: 7.5 [100%], 7.4 [100%]
RA = 4 40 36.661 (astronomic) Parallax red. 32" Hourly SRA = -21.246
Dec = 42 15 39.610 Sun: Dist = 93° Moon: Dist = 67°, illum = 96% GCR = -31.58°
Top Date: 4 42 42, 42 18 38 Prediction of 2023 Feb 13 JPL201:2023-Feb-13, Known errors
Reliable 2.1 (Beverly, Dugroc)

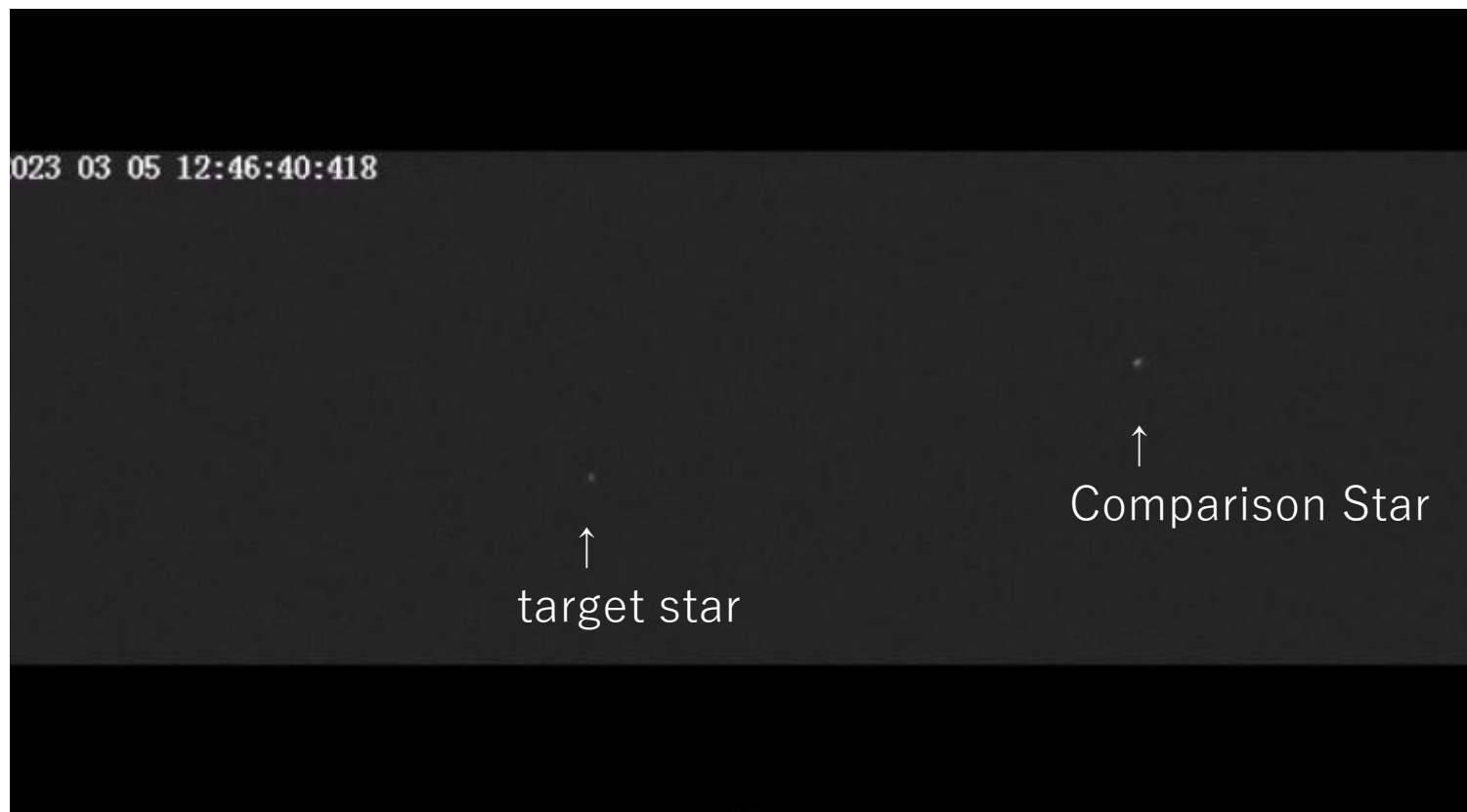


Align the telescope with the target star using the fine-tuning knob while referring to the star chart and the computer monitor.
星図とパソコンモニターを見ながら微調整ハンドルで目的星を導入

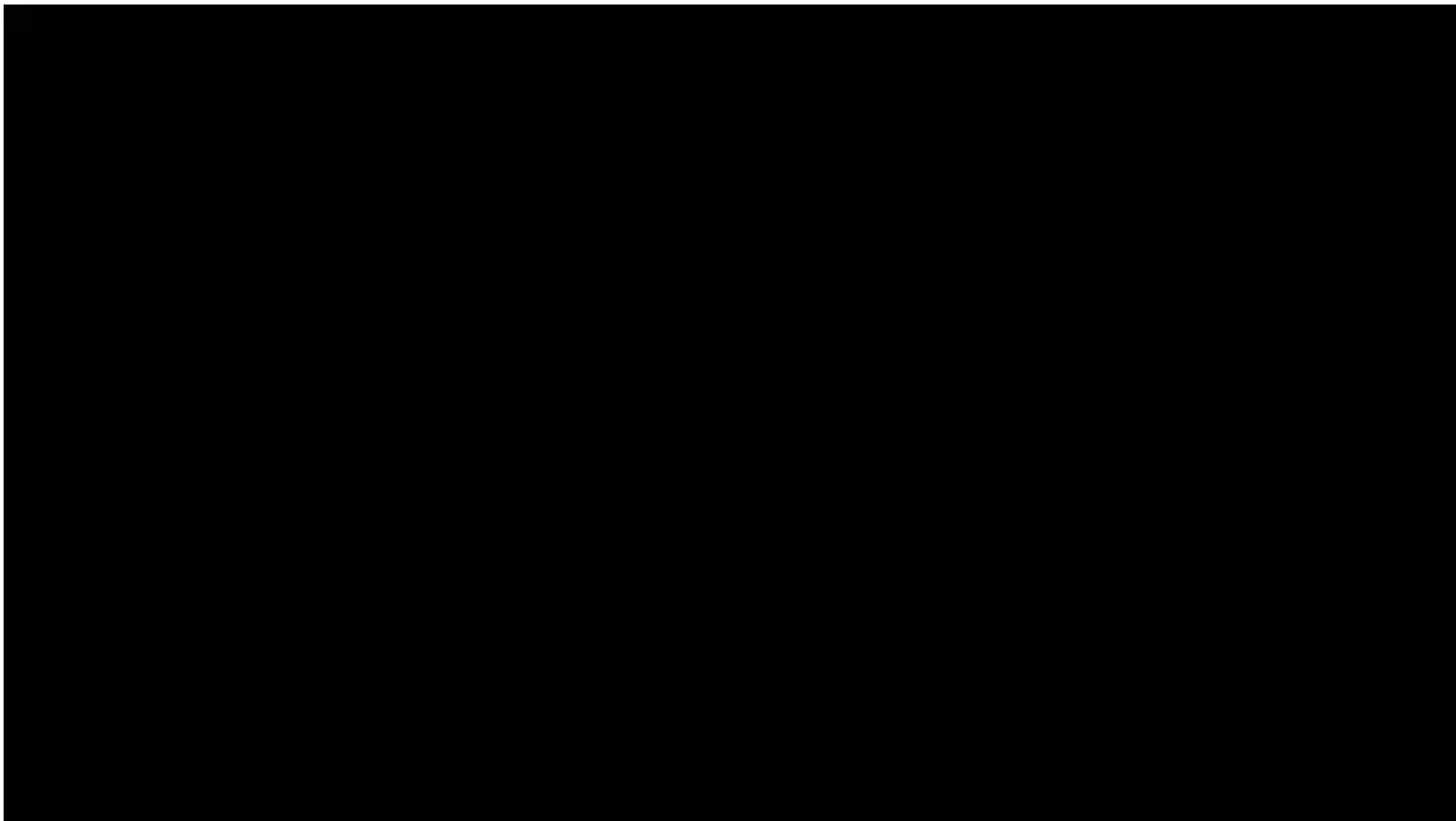
Observation video 観測動画

2023年3月5日
小惑星
(98943)2002CC21
による掩蔽

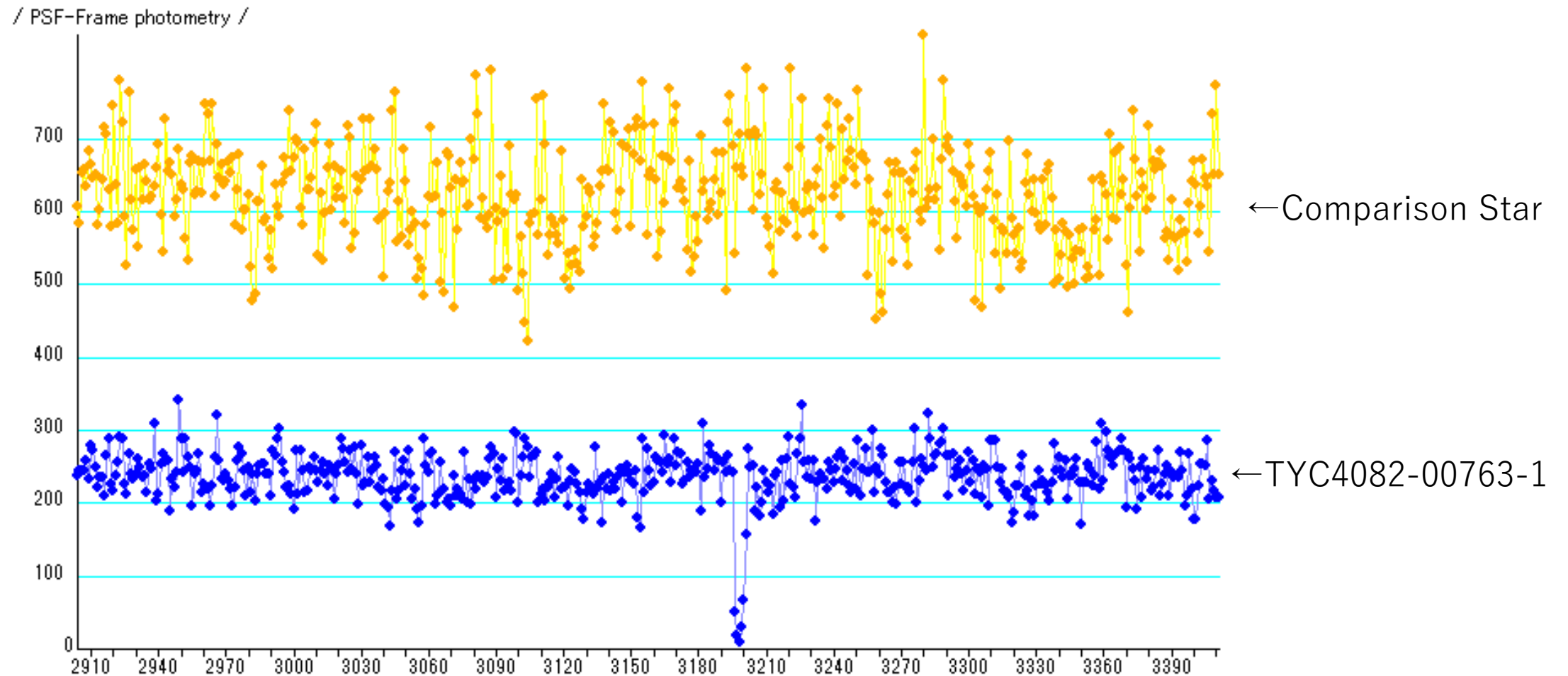
Observation video 観測動画



Observation video 観測動画



Observation results 観測結果

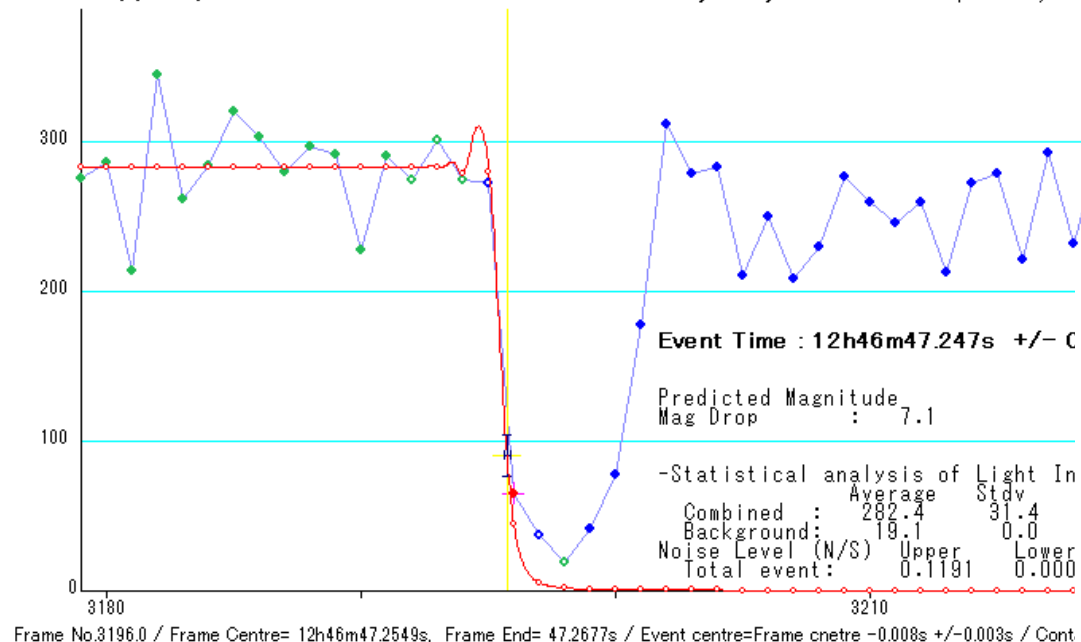


Light curve obtained from observations

Observation results

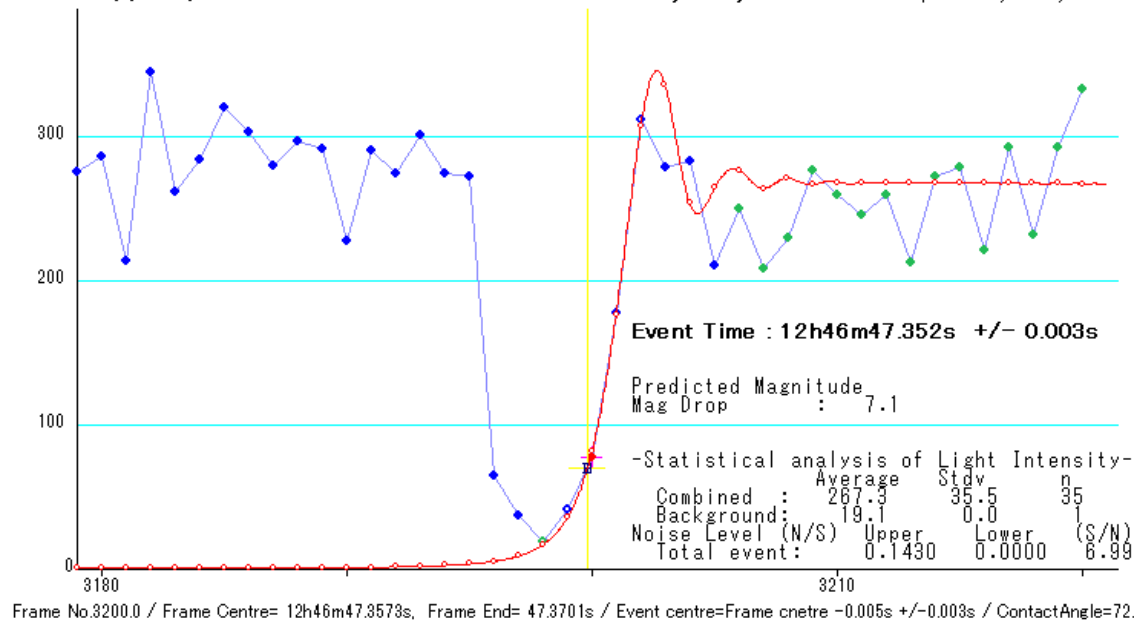
観測結果

2023 Mar 5; (98943) 2001 CC21 occults TYC 4082-00763-1 Observed by K. Miyashita / PSF-Frame photometry / Object: Dista



Covering time: 0.105 seconds

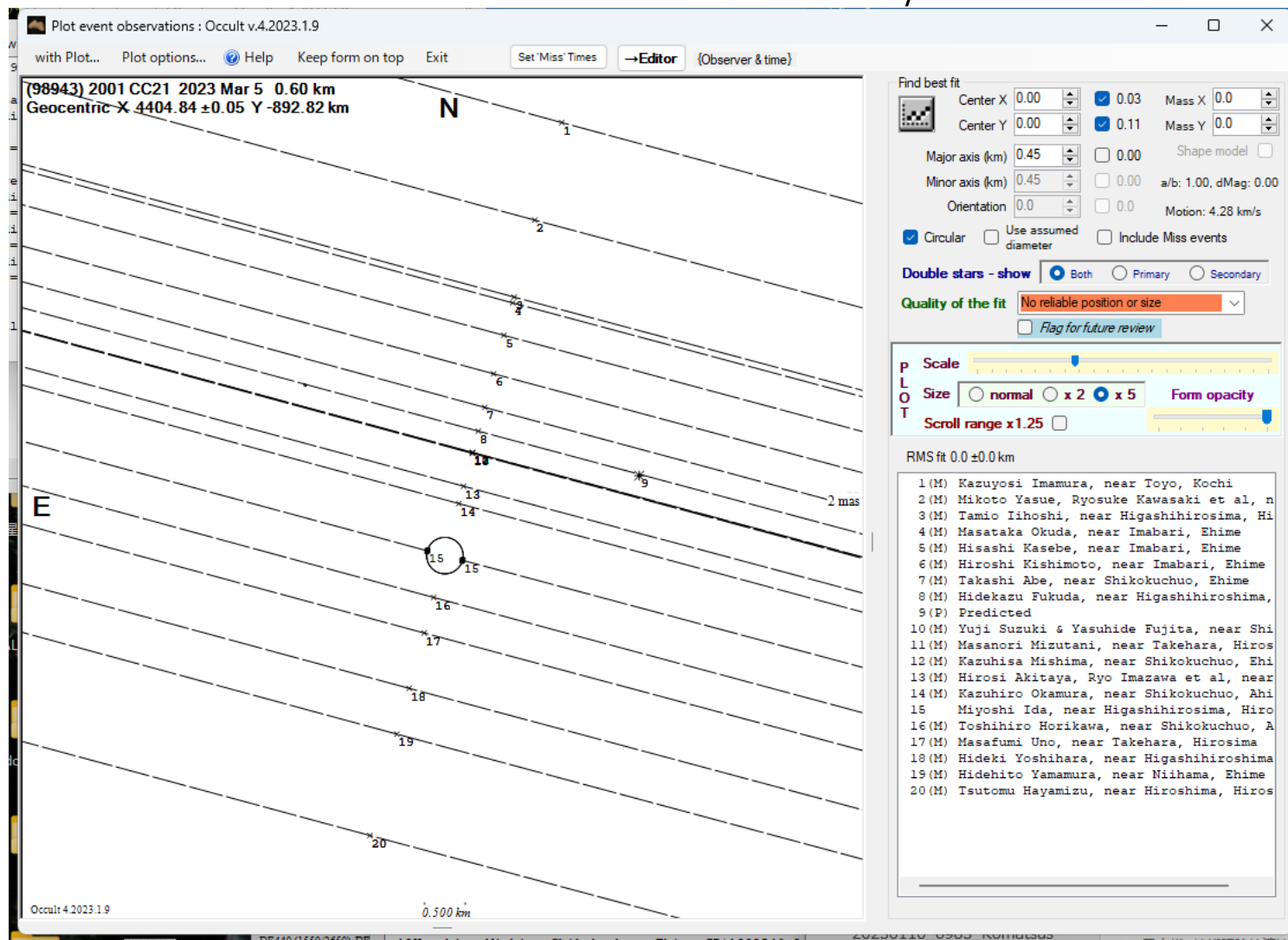
2023 Mar 5; (98943) 2001 CC21 occults TYC 4082-00763-1 Observed by K. Miyashita / PSF-Frame photometry / Object: Dista



Limovie ver. 0.9.9.5A(Aqua)5i7Bによる解析

Sky plane projections of 2001 C21 stellar occultation event of March 5, 2023

整約結果



「DOUSHITE (Diffracted Occultation's United Simulator for Highly Informative Transient Explorations) :ドウシテ」 Ko Arimatsu (NAOJ)

- Size of the 2001 C21 (Torifune)
- トリフネの大きさ
- Longest axis: approximately 840 m, Shortest axis:
approximately 310 m
- 長径およそ840 m、短径およそ310 m

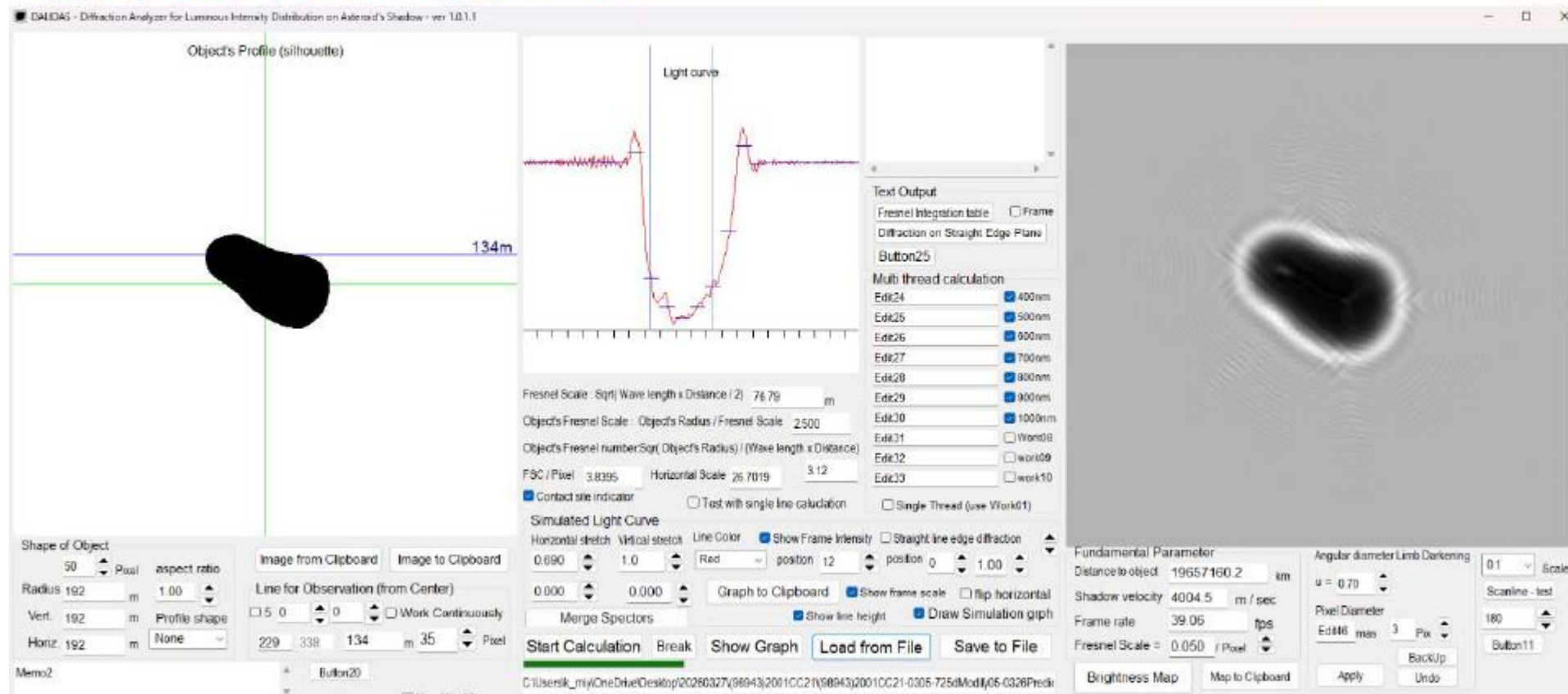
Analysis by Mr. Miyashita

宮下氏による解析

Shape estimation

形状の推定

観測されたライトカーブを満たすモデル



Hayabusa2

Successfully performed a flyby observation of 2001 CC21 (Torifune)

はやぶさ2 トリフネにフライバイ観測成功

