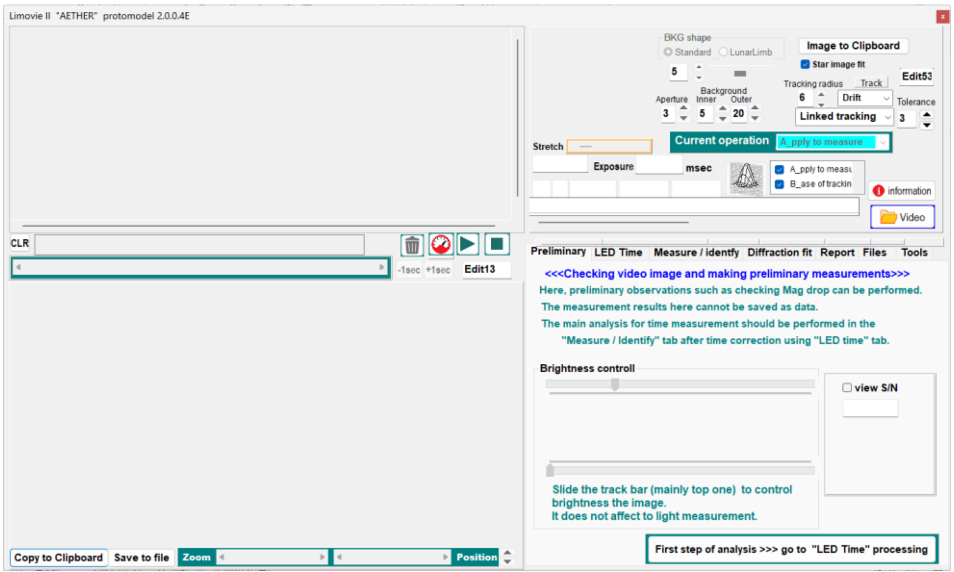
Limovie II User's Manual

2025 Dec. 30 Rev. 1.4

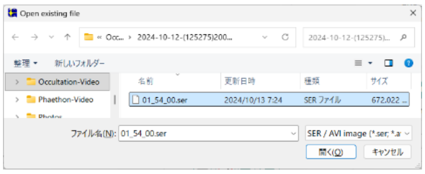
Thank you for downloading Limovie II. This software can perform a series of tasks: [1] measuring light curves from videos observing occultations, [2] determining the event time by comparing them with diffraction simulation curve, and [3] creating reports to send to IOTA/EA Regional Coordinators. Users do not need to save the results to some files and transfer them for other software during whole analysis.

1. Overview

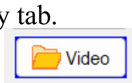


Limovie has four fundamental area: [1] Video image (left-top), [2] Photometric region control items(right-top), [3] Display graph (left bottom), [4] Seven tabs for series processing of analysis and making report (right-bottom). Most of the work is done by manipulating the tab area. From observation to report creation, proceed by operating the tabs from left to right in order.

2. On observation or preliminary of measurement

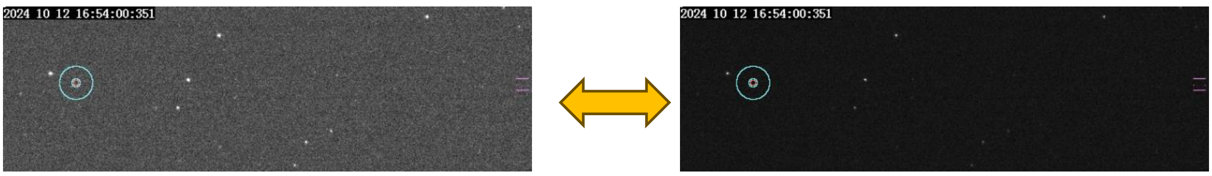


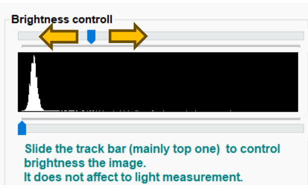
1st. Open the Preliminary tab.

2nd. Click Video button  (on photometric region control area) .

"Loading file" dialog will open. Select the video file (.ser or .avi) .

3rd. Video image of first frame will be displayed. Control their brightness with track bar on Preliminary tab.



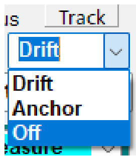


Visual inspection of recorded images

Play back video

The video can be found the scene with the scroll bar  , and be played back with play  button. However, the playback speed does not equal to video recorded. This is because frames are read one by one from the file for measurement. Playback speed varies depending on the computational load of the measurement process. This will be discussed later in the “photometry” section.

When the blue photometric region drifts and becomes bothersome, either click on a bright star other than the target star to keep it track. Or, set Tracking mode to Off. In that case, remember to switch back to Drift mode when you perform measurements later.



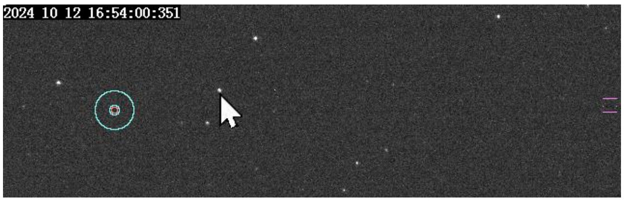
S/N check

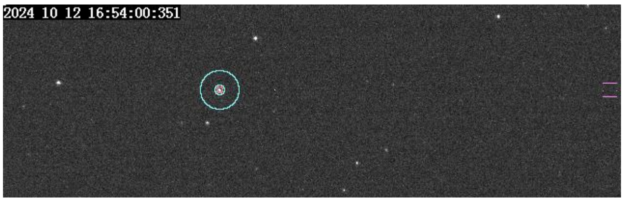
To obtain better occultation observation videos, high S/N recording is essential. IOTA/EA recommends an S/N (1/standard deviation of noise) of 4 or higher. If the S/N is 2.5 or lower, reports will not be accepted except in rare cases where multiple observations were obtained. It is important to perform preliminary (test) video recording before the actual event and check the signal-to-noise ratio. At the observation site, after test recording, load the video file and perform a preliminary measurement.

Preliminary measurement

1st. If necessary, use the scroll bar to advance to the position in the video it should be check.

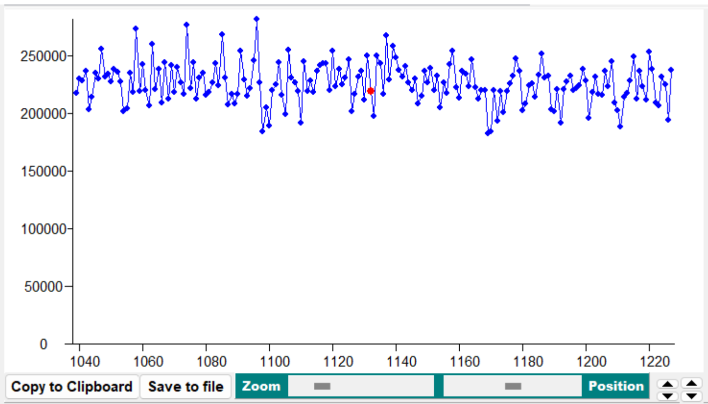
2nd. Left Click the target star. Photometric region (color concentric circles) will be set.

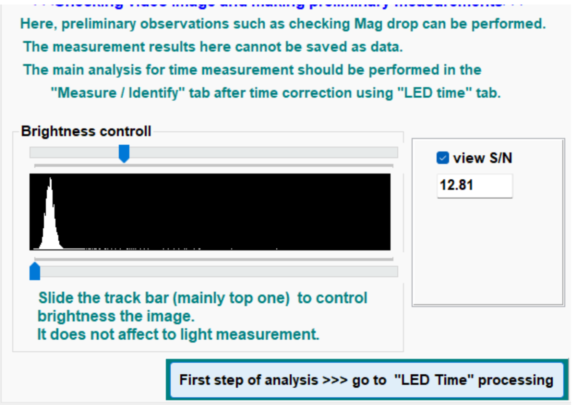




3rd. Start measurement with  (speed meter icon) button, and stop it with  button.

A relative light intensity graph will be displayed.

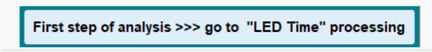




4th. Check the “view S/N” checkbox, the S/N ratio is displayed.

In this example, a fairly good video was captured. Normally, the S/N ratio would be lower. Use this value as a reference when determining the frame exposure time. Note that in cases of shallow light decreasing, the S/N ratio will be lower than this value.

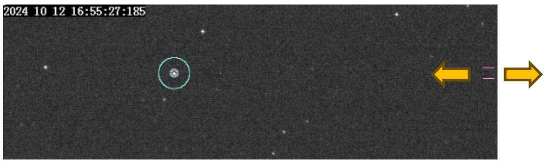
3. Check/register dropped frames, and obtain accurate frame time

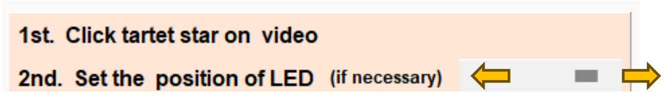
The observation video occasionally exhibits frame drops. It is important to be aware of these sections. Furthermore, except for cameras with built-in GPS, the timestamps on the frames indicate the processing time of the capture software and exhibit some degree of fluctuation. This function automatically processes, registers, and corrects these timestamps and frame drops. Click 

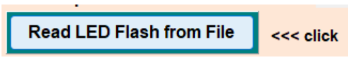
button at right bottom of main window.

1st. Click the target star to set photometric region on the target star.

2nd. Set horizontal position of LED photometric region (magenta rectangle). It should avoid any star or hot pixel.



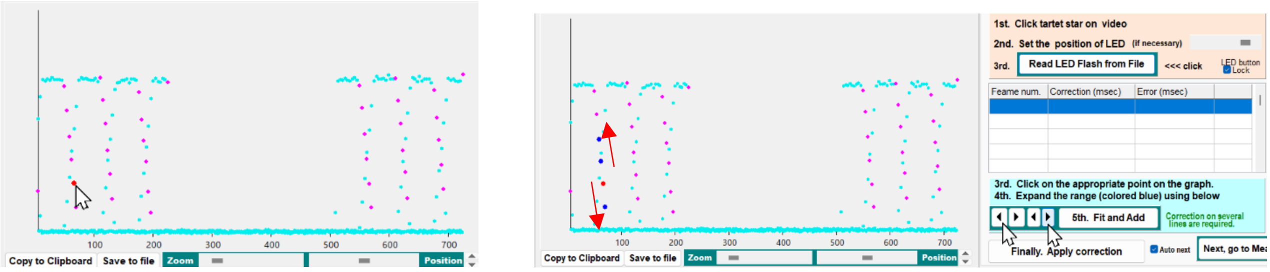


3rd. Click 

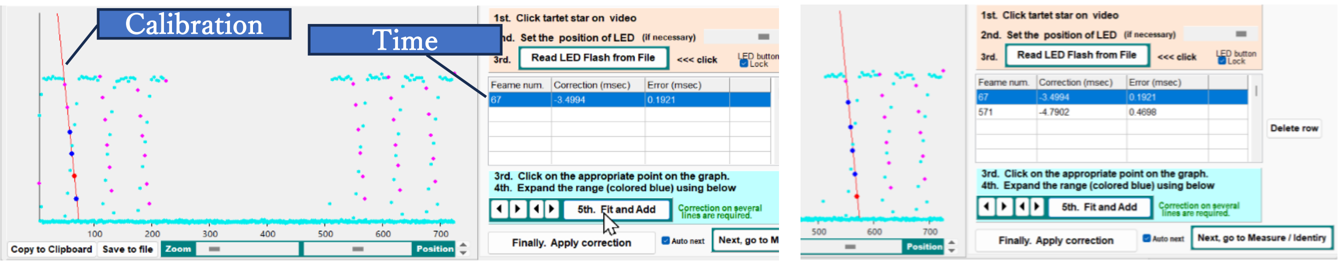
button. Wait several seconds.. 

[Case of non-integer frame rate video with 1PPS LED flash.]

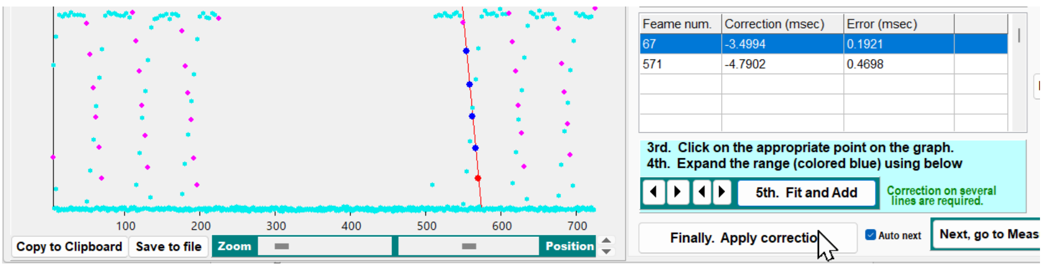
4th. Click magenta dot, and Stretch blue dot area with Up-Down buttons

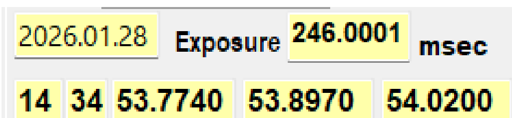


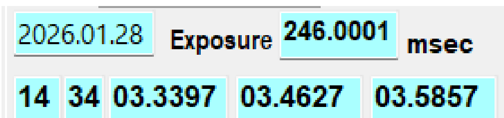
5th. Click "Fit and Add" button. The time correction data is registered to list. Perform this at two or more line.



6th. Click "Finally Apply correction" button, then the time on whole frames will be corrected. Color of time area turn to light blue. It indicates the time is precisely corrected.







In most cases, the "delay" in the display time caused by capture software is around 5-10 milliseconds. For a 100-millisecond frame exposure time, this amounts to 5-10%. If the S/N ratio on the light curve is 10 or higher, indicating a good observation, the impact of this delay becomes non-negligible. Naturally, if the frame exposure time is around 20 milliseconds, the effect will be significant. Therefore, correction using LEDs becomes essential. On the other hand, when the frame exposure time exceeds 200 milliseconds, the impact of capture delay becomes only 2-3%, a level that can be safely ignored. Does this mean LEDs are unnecessary? Not at all. This is because the frame exposure time is often determined while viewing the video image during the observation. Hesitation in deciding whether to light the LED at that moment results in missing the observation opportunity. By always performing LED correction, you establish a routine that reliably handles every possible scenario.

[Case of integer frame rate video with 1PPS LED flash.]

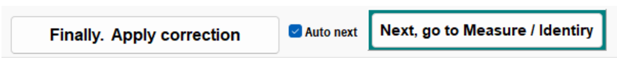
Methods using non-integer frame rates enable extremely high-precision time correction by utilizing the fact that LED brightness changes at fixed intervals between frames.

In contrast, with integer frame rates, there is no change in LED brightness. Therefore, Limovie does not utilize this for time correction. In such cases, you may proceed to the next task without clicking the magenta dot, leaving the time display area yellow. If correction is necessary due to this, consult your IOTA/EA coordinator.

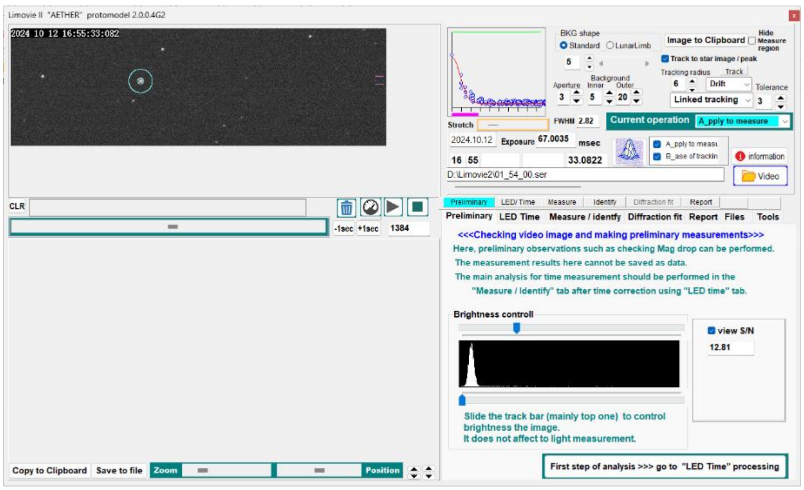
[Case of Built in GPS camera.]

For cameras with built-in GPS, the timestamp records the time when exposure ends or begins. Therefore, no time value correction is necessary. However, frame drop checking is required. This can be done by clicking the "Read LED flash from file" button. It is important that the time display frame is highlighted in yellow.

4. Measurement ~Obtaining a light curve~



If "Auto next" check box is checked then the Tab changes automatically licking by clicking "Apply correction" button. When "Auto next" button is not checked, The tab is changed with "Next go to Measure / Identify" button.



The Tab at left bottom will be changed to Measure / Identify. On this tub, capable following three processes.

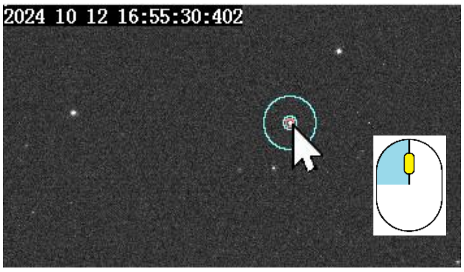
1. Measure and make light curve.
2. Read various elements for making diffraction simulation and for making report from xml prediction file.
3. Make dat format light curve for report to IOTA.

Light measurement

Measure the light change of target star with some comparison stars, and then make light curves.

[Set photometric region to target star]

Click the target star on video image. The photometric region will be centered on the star.

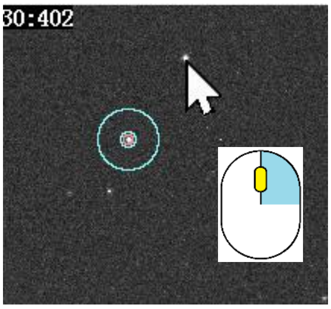


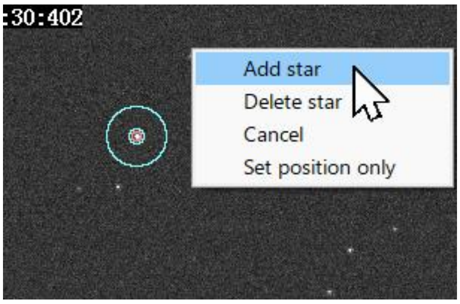
For bright target stars, photometry using a single star can yield accurate measurement results. However, even bright stars may become obscured and dim, causing tracking to fail and the photometry area to drift away from the star's position. Therefore, even for bright stars, it is better to use a tracking reference star as described below.

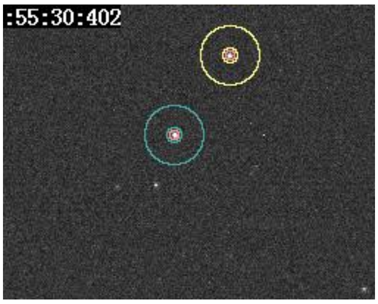
[Set a tracking reference star]

Tracking reference star should be a bright enough star. If there are no stars brighter than the target star within the image, a slightly dimmer star is acceptable. Furthermore, to perform the absorption correction due to clouds described later, it is preferable to select a star as close as possible to the target star.

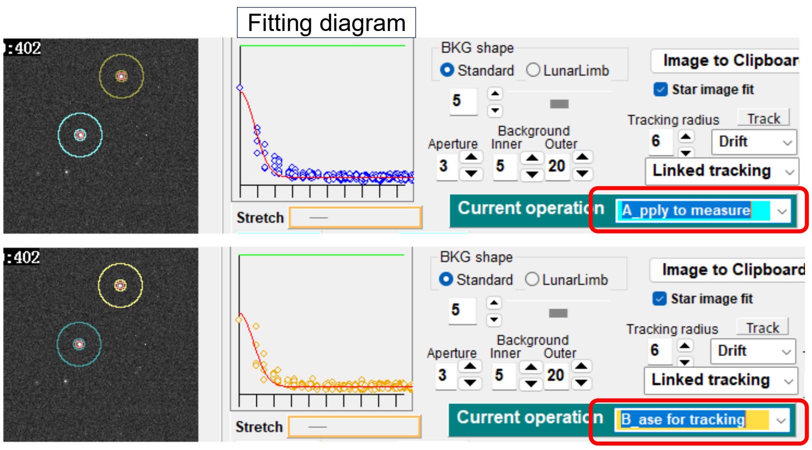
To add other comparison star, right click the star, and select "Add star". The more photometric regions for more stars can be set with this way.







The photometric region settings (such as aperture size, background size, and background region shape) can be modified to appropriate values or shapes. To do so, the photometric region must be highlight displayed.



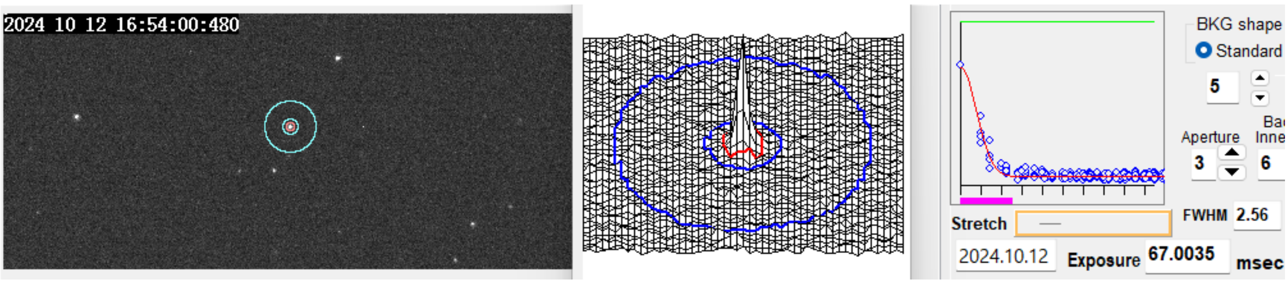
The photometric region (target / comparison star) can be switched using the Current operation combo box. This operation can also be performed by placing the mouse cursor over the combo box and scrolling the mouse wheel.

With this change, the fitting diagram will also display information about the selected star.

[Detail setting for photometric regions elements]

Limovie II uses aperture metering. While it also performs PSF metering internally, due to its susceptibility to atmospheric turbulence based on Limovie ver.1's metering performance, PSF results (indicated by red curve on star image graph) are not output as metering values in Limovie II. PSF results are utilized for star tracking.

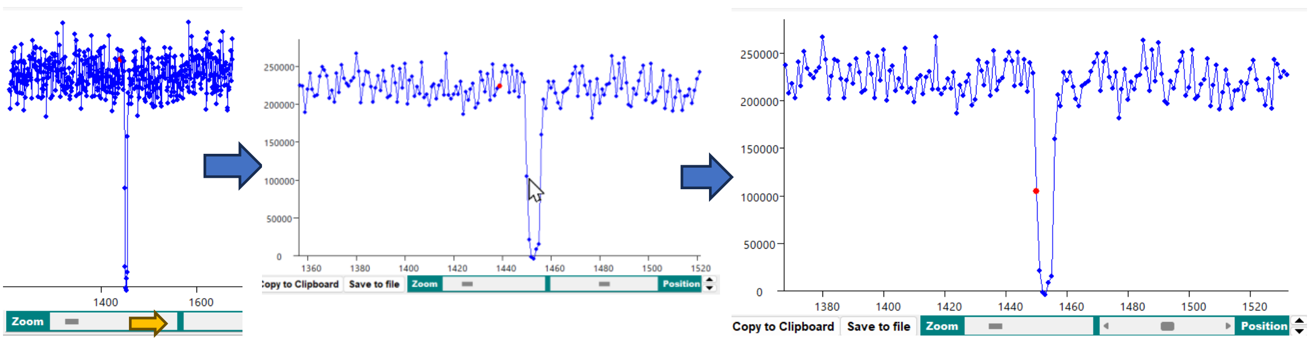
1st. Check star image and measurement region.



FWHM value is displayed under the aperture radius. And also, a magenta horizontal bar on bottom of star image graph. The length of this magenta horizontal bar represents the FWHM value, which varies from frame to frame. Press the play button to start the video. Read the average FWHM from the scale or displayed value, then set the Aperture radius to achieve good photometry. You can also observe this process in the 3D graph. (For 3D graphs, refer to the Appendix.)

2nd. Measurement and draw graph

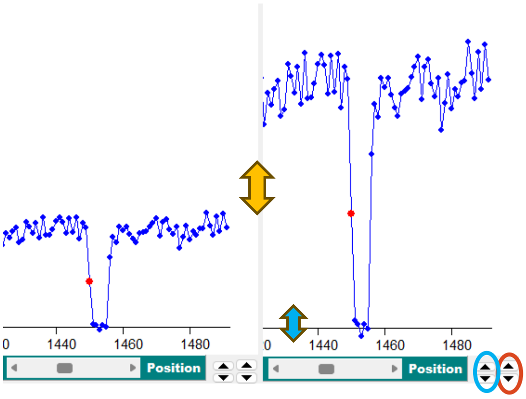
When click [button] button is, photometry starts. Next, it can be stopped with [button] button, then a graph of light curve will be displayed.



3rd. Changing the horizontal and vertical scaling factor / position

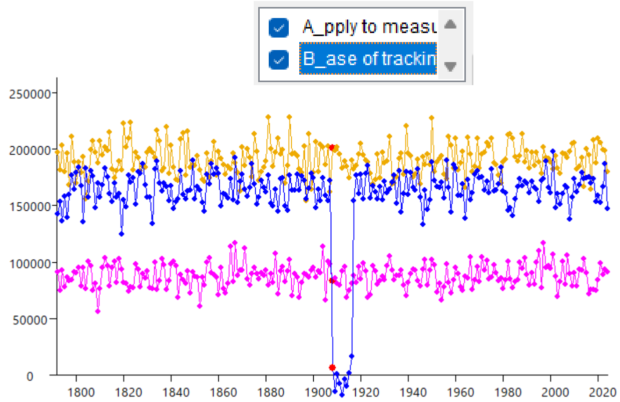
Initially the graph has very small horizontal width. This is to make it easy to see the overall changes at a glance.

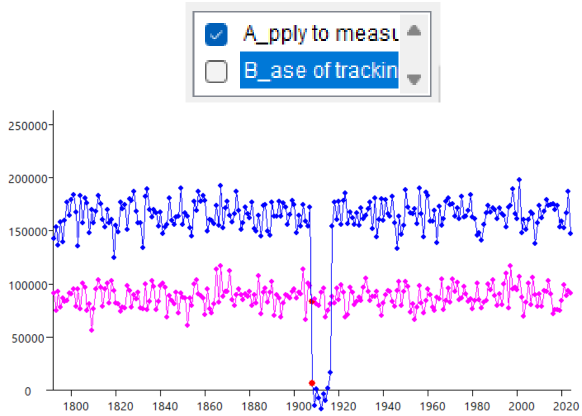
It can be stretched by Zoom slide bar. When clicking any dot, the clicked point is centered automatically.



The horizontal position can be change with position slide bar.

The graph height is adjusted to match the brightest star among all measured stars. If it appears too high or too low, the graph height can be adjusted using the **up/down button** in the bottom-right corner of the graph. Likewise, the height of the X-axis can be adjusted using the **up/down button** on the left.





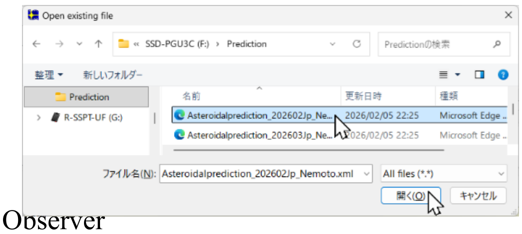
When photometrically measuring multiple stars, the display of each light curve can be toggled using the list box.

5. Identify the phenomenon and register observer / observation site

Reads the parameters required for diffraction simulation calculations and the information needed for reporting from OCCULT's forecast XML file. Observer names and observation sites are also registered here.

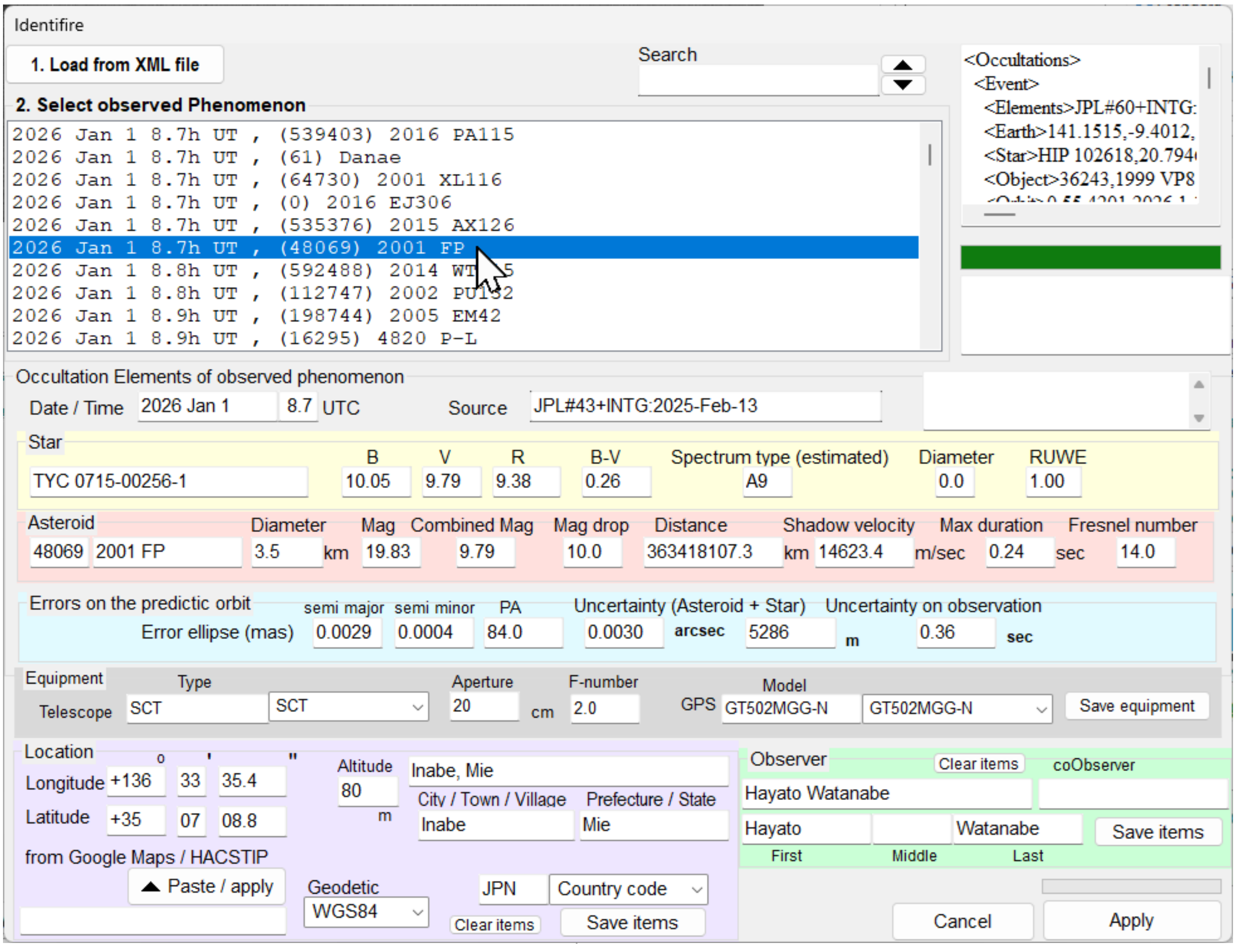
1st. Click “Read Asteroid / Star information and Set Observer / Site” button

2nd. Select xml prediction file >> Open



3rd. Select the observed phenomenon Register Equipment, Site, Observer

[If the prediction list contains only one entry, simply input the relevant information.]



[Case of the XML contains several prediction lists]

Click the corresponding phenomenon will populate the information in each field.

[When XML contains a very large number of phenomenon lists]

When predicting phenomena occurring over a wide observation area and over a long period, the list may contain a very large number of events. In such cases, loading the XML file may take 10 seconds or longer. To locate the target asteroid in the list, search using its number or part of its name as a keyword. Since the same asteroid may be listed for different dates or times, use the Search button to display candidates sequentially, then click the row for the relevant event to select.

4th. Input observer's name, location of observation, equipment

Enter the observer's name in the First, Middle, and Last name fields respectively.

Enter the observation location names in the "Municipality" and "State" fields, respectively.

It is a simple way to input location data.

4-1. Click the Latitude, Longitude data of Google Maps.

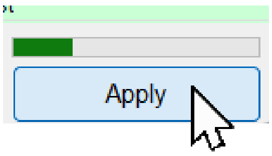
4-2. Click Paste/apply button. Longitude, latitude data will set automatically.

Altitude data cannot be auto-set. Input the data obtained from appropriate source (e. g. GSI maps).

For the equipment, select or enter the appropriate items for each category.

Each setting can be saved and registered in the config file. However, regarding observation locations, only those using fixed observation points should save and register them.

Apply the loaded/input data to subsequent processing.



Click the Apply button. When clicking the button, the program will take several seconds to calculate the star's limb darkening before closing the Identify window.

6. Make .dat light curve file

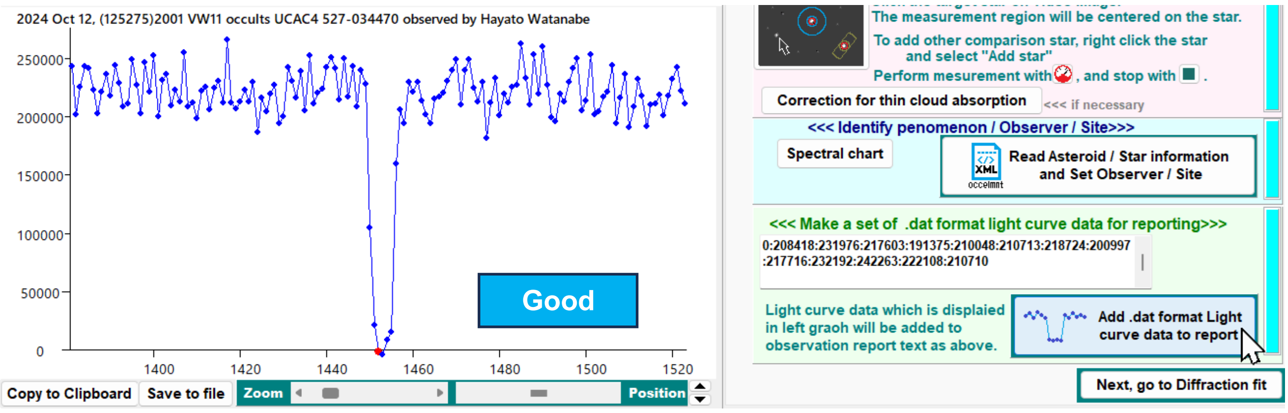
IOTA collects light curve data as .dat files (text data). See below example.

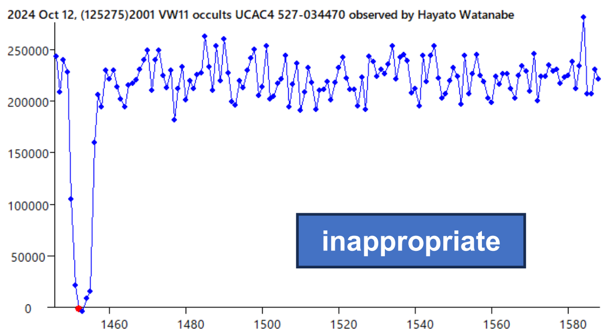
```
Date: 2025-12-26 14:18:51.43: 57.12: 170
Star: 0: 0: 0: 0: 0-0-0: 494-054622
Observer: +133:57:26.5: +34:17:10: 36: Toshihiro Horikawa
Object: Asteroid: 1584: Fuji
Values:2114:2473:2331:2060:2378:2115:2161:2141:2314:2620:2264:2496:2525:2615:2359:2
405:2536:2428:2820:1954:2005:2023:2470:2659:2491:2491:2594:2203:2144:2364:2134:1698
:2253:2002:2427:2606:2933:2120:2200:2810:2140:2096:1673:1962:2469:2279:1985:2319:23
90:2198:2229:2523:2065:2123:2429:1781:3013:2635:2681:2563:2657:2349:2267:1977:2535:
2167:2279:2495:2305:2552:2811:2440:2465:2018:2219:2358:2159:2357:2728:2517:1679:329
1:2431:2632:2358:2138:2760:2372:2570:2465:2588:2637:2770:2166:2126:2589:2610:2517:3
062:2157:2523:2156:2009:2782:2420:2617:2505:2564:2137:2231:2272:2109:2886:2642:2416
:2618:2211:2911:2473:2123:2497:2346:2749:2545:2590:2430:2184:2208:2067:2340:1970:25
77:2004:2474:2218:2326:2434:2164:2591:1979:2473:2436:2585:2033:2110:2221:2006:2208:
1927:1873:1843:2076:2520:2137:2128:2589:2022:1996:2737:2514:2478:2535:2156:2543:225
4:2447:2628:1960:2824:2718
```

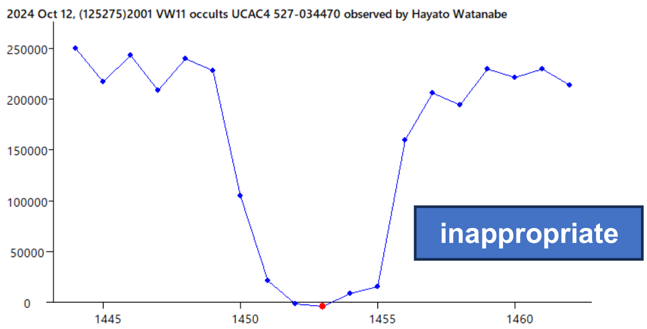
Click 

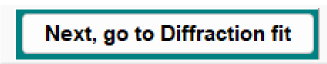
button.

For this reporting data, light curves are required that include a sufficient length before and after the event, not just the event itself. Before clicking the Create button, position of the occultation-induced drop at the center and display the graph with the proportions shown in the figure. This graph will be saved directly as data in the data box, and it will be added to email report text.







After completing the above steps, click 

button to move to the tab for determining the time of occultation.

7. Determining the time of occultation

Overview for the function of the “fitting Diffraction simulation”

Limovie creates diffraction simulations assuming the celestial body's edge is straight, and the body can be considered a semi-infinite plane. This is useful for determining the apparent time of relatively large asteroids with a Fresnel number of 10 or greater. It can also provide a rough estimate of the apparent time for bodies with a Fresnel number between 1 and 10.

The calculated diffraction curve cannot be directly compared to the light curve. This is because the actual phenomenon (even assuming no noise) is an integral of the variation over the frame exposure time. For comparison, a curve (shown as the red curve in the graph) must be created by incrementally shifting the timing of the frame exposure relative to the diffraction light variation and integrating it. The timing that best matches the observed light curve must then be identified as the phenomenon time. Limovie's fitting is performed in this manner.

The generated simulation curve has the same time axis (horizontal axis) as the observed video. The vertical axis (light intensity value), however, is constructed such that the value when unmasked is 1.0 and when masked is 0.0. Therefore, it is necessary to match the brightness during masking and unmasking to the light curve obtained from the observation. Since the observed light curve contains atmospheric fluctuations and sensor readout noise, these values are averaged, and the simulation curve values are adjusted to match them.

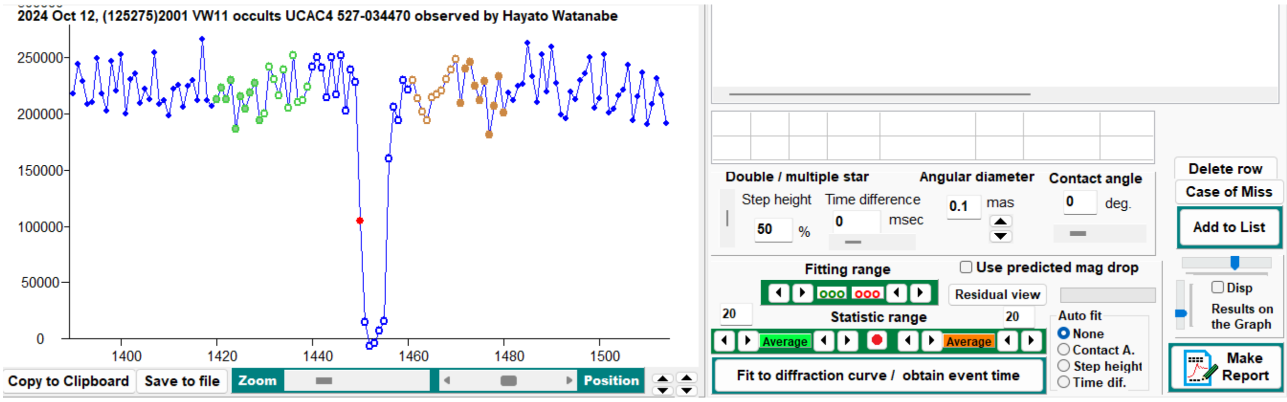
The green or orange areas on the screen are used to calculate these averages and standard deviations. By default, 20 points are used for this purpose. However, for the un-occulted (bright) portion, the setting must be adjusted to use 30 or more points, ideally 60 or more. Conversely, for the occulted dark portion, fewer points may suffice since the light drop can be very brief. Nevertheless, ensure the setting captures the sufficiently dark portion, excluding intermediate values.

The observation light curve and simulation are performed using only the areas within the white circles. This is called the “Fit range”. This range only needs to include a few points around the moment the disappearance or reappearance. [Note: This white circle (fit range) is independent of the peripheral color. The peripheral color indicates that it is both within the fit range and part of the static range.]

Except in cases of grazing occultation or when the Fresnel number is 10 or less, the mutual influence of diffraction phenomena on disappearance and reappearance can be considered negligible. Furthermore, since the contact angle typically differs between D and R due to topography, it is only natural that D and R should be fitted separately.

Limovie’s diffraction fit function perform fitting to disappearance and to appearance individually.

Below figure is the first display of this function (tab).

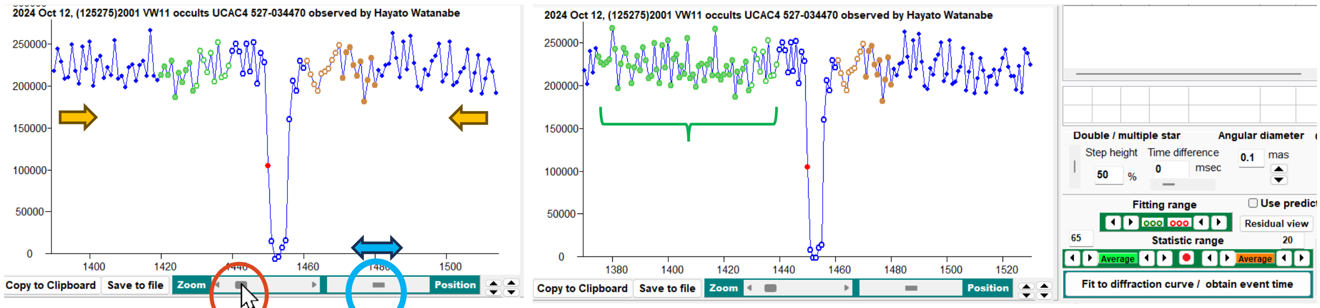


Diffraction function ~fitting procedure and operation~

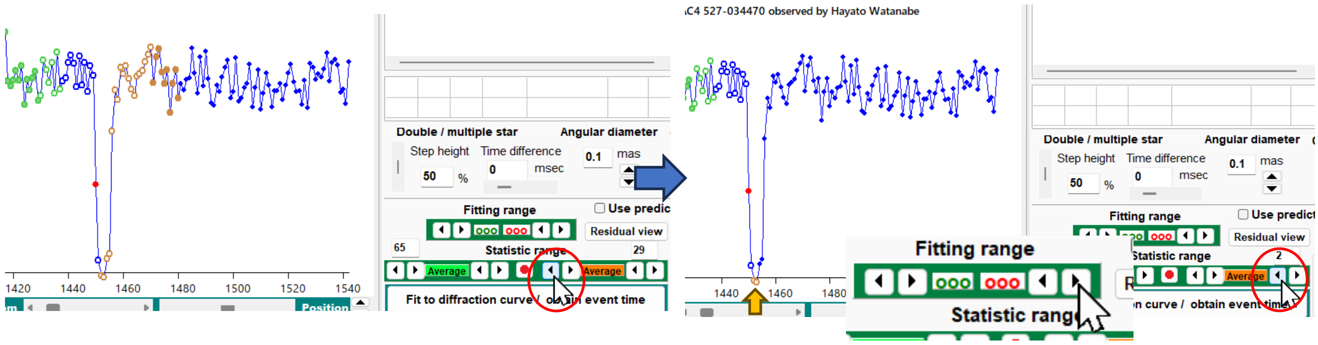
When the screen from the previous page appears, proceed with the fitting using the following steps. The basic The basic sequence of operations is to first set the statistical range, then set the fit range, and finally perform the fit using the Fit Diffraction Curve button.

[For disappearance]

1st. Set statistic range.



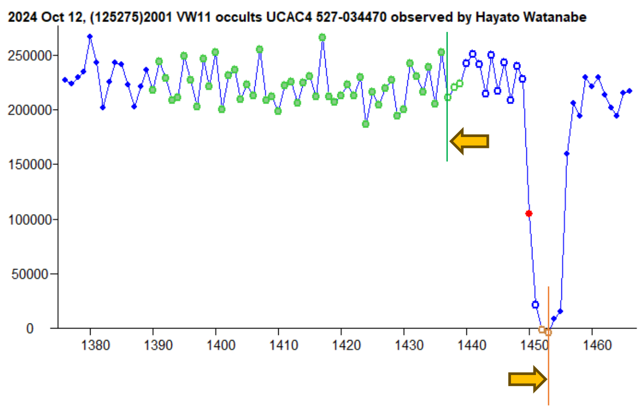
At first, reduce the horizontal zoom level of the graph to see a wider range. Next expand green dot area with left triangle button. The number of green dots is displayed above the left-right triangle button. It is recommended that the number is 60 or larger.



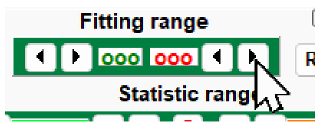
Next, Set orange statistic range with two left-right triangle buttons.

When a short drop as this example, the statistic area should be set to complete occulted dots. For light curves with a broad base, the statistical area for the light drop period can be set more widely. On the other hand, if the light drop occurred in only one frame, it may have been significantly shorter than the frame exposure time. To investigate this, check the "Use predicted mag drop" box and then perform the fitting described later.

2nd. Set fitting range



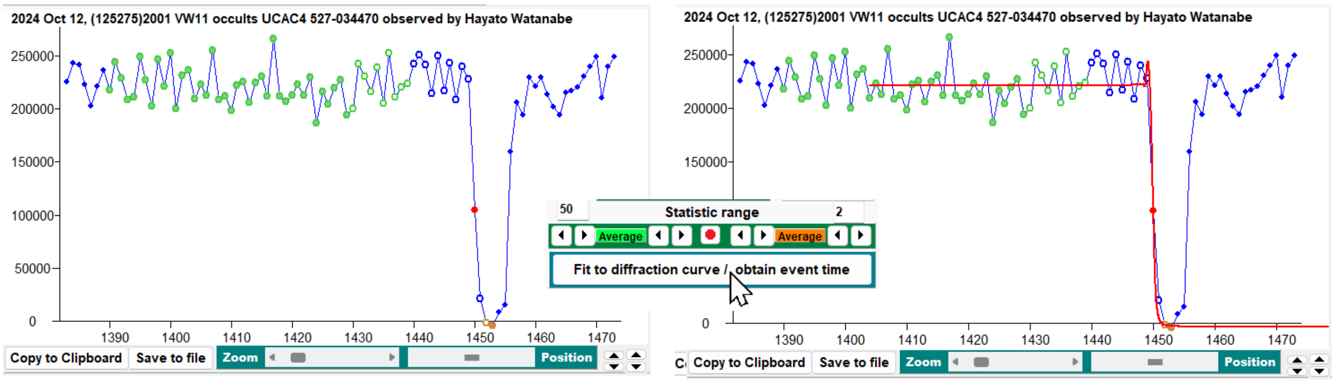
Fitting range can be change with fitting range control.



In spite of the statistic range is separated left and right, the fitting range is continuous. The selected point (red filled circle) is included in the fitting range.

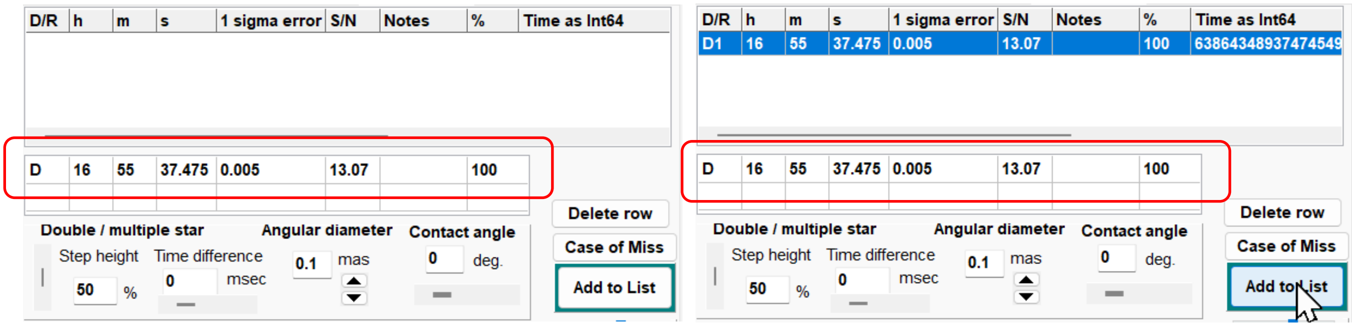
The fitting range should ideally span 10 to 20 points on either side of the moment the phenomenon occurs (the selection point, marked in red). However, securing more points has little effect on the measurement results. This is because, when compared to the diffraction simulation curve, the section where the light intensity changes abruptly has the greatest impact on the fit, while the influence of other sections at the desired time is largely negligible.

3rd. Diffraction fitting



Click “Fit to diffraction curve / obtain event time” button. Most fit simulation line has been obtained, and it indicates the Event time.

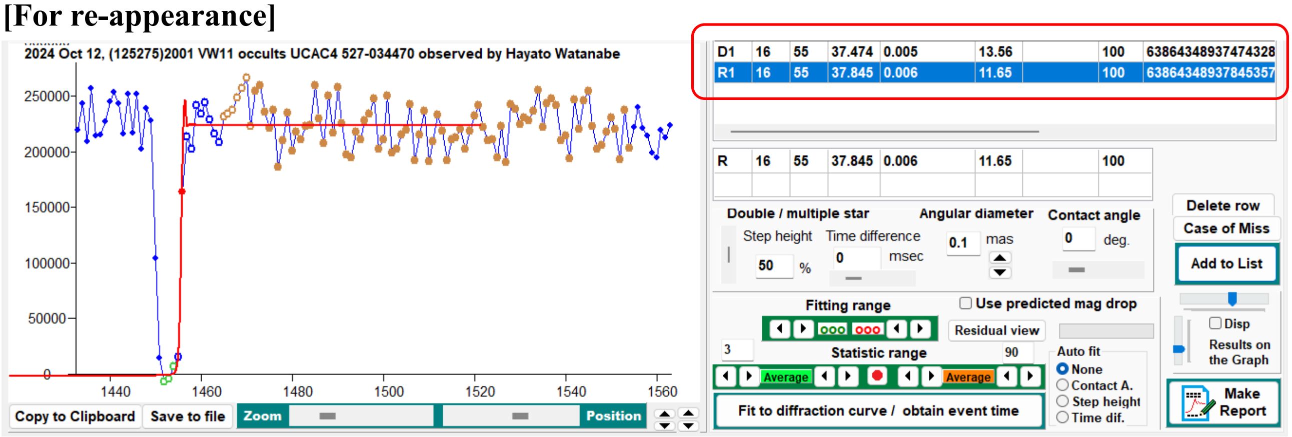
Finally, register the event time



The event time obtained from fitting is displayed on the middle area as a candidate. To ensure the event time, click “Add to List” button. The time is entered into the list on the top.

If you make a mistake during this operation, click the incorrect entry in the list to highlight it, then press the Delete button to remove it.

[For re-appearance]

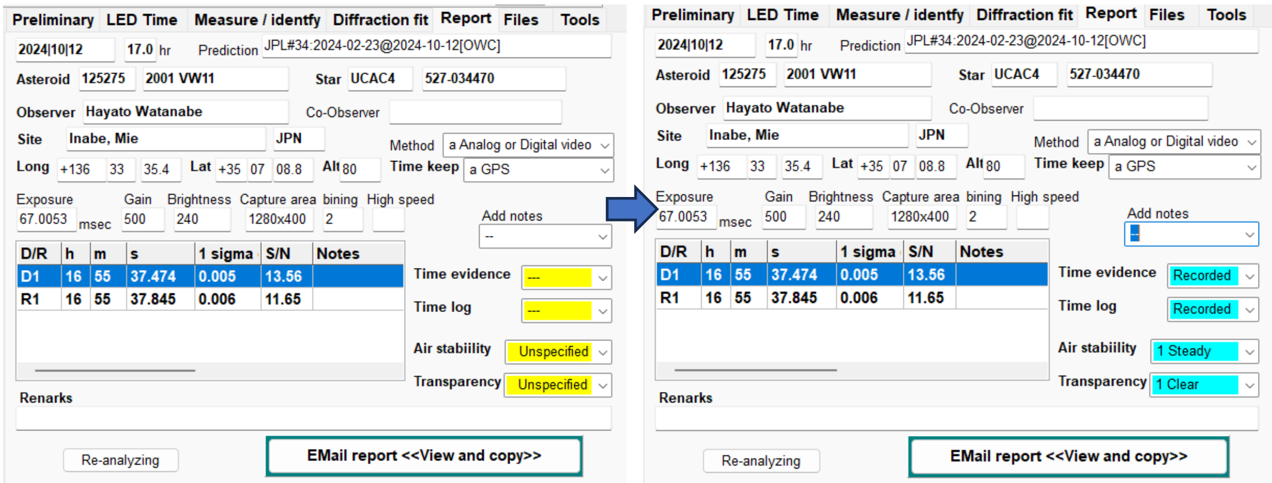


Reappearance is handled in the same manner as Disappearance.

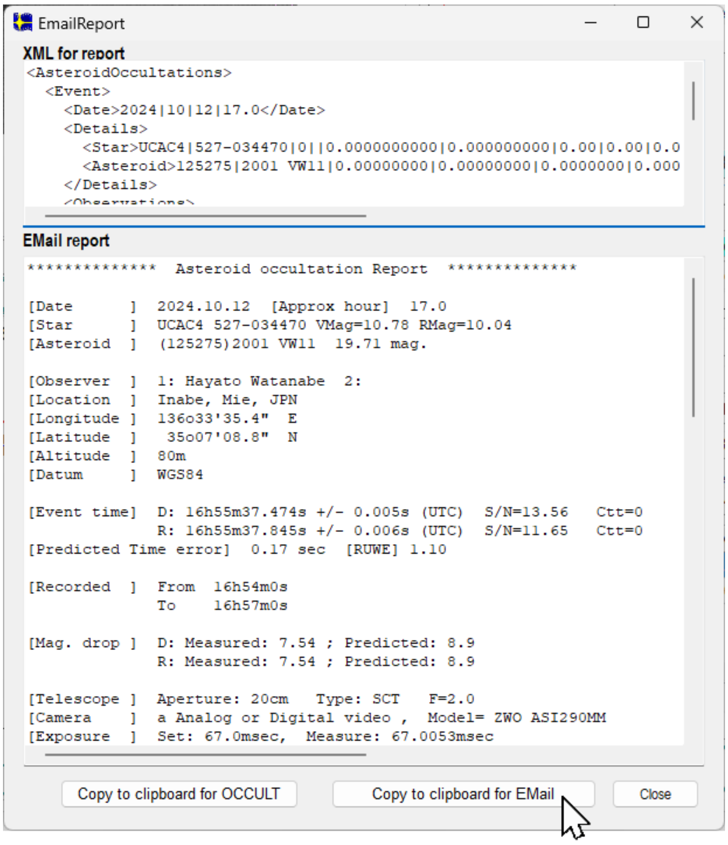
This registers the occurrence times for D and R in the table. However, the number of time rows must be a multiple of 2. This is because the XML file for reporting requires times to be handled as pairs of D and R. In the case of double stars, D, R, or both may have two occurrence times; this is described in the Appendix.

Make report (for IOTA/EA)

Currently, reports of observations to IOTA/EA are submitted via email. Limovie can automatically generate the report format. Click the [Make Report] button to open the Report Creation tab.



There aren't many input fields here. This is because nearly all the information has already been entered on the Identify screen. Select the field displayed in yellow, then click the [EMail report <<View and copy>>] button.



The "Email Report" window will appear.

Check & read the Email report field, then click [Copy to clipboard for EMail] button.

Next, open your email tool and paste the report you copied earlier from the clipboard into the body. That completes the report preparation.

Great job on the analysis work.