

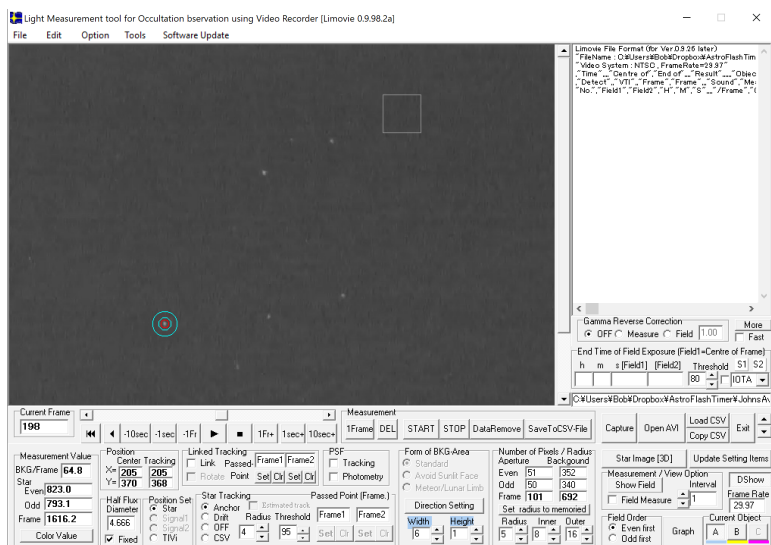
Using Limovie to process
'flash timed' occultation videos
using the Astro Flash Timer (AFT) iPhone app or
the Occult Flash Timer (OFT) Android phone app

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Overview of process:

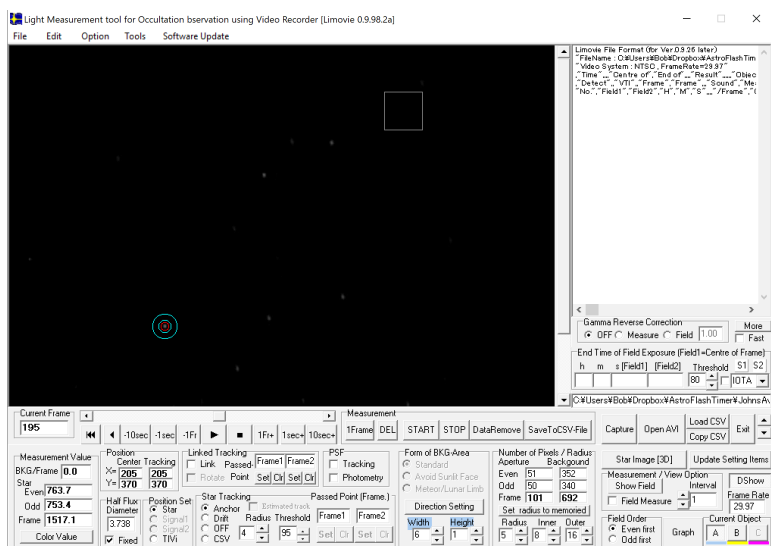
1. Prior to the occultation and with the camera set at **the gain and integration level to be used** for the observation, adjust the intensity of the phone LED so that the camera image is not saturated by the flash. This is a critical step to obtaining accurate timing using flash timing. Adding some layers of red tail-light tape and/or pinholes in aluminum foil over the LED can help achieve this.
2. Make sure to set the camera to a gamma of 1.0. Accurate flash-timing utilizes sub-frame calculations (time interpolation based on intermediate intensity values at transitions) which in turn require a linear camera pixel response.
3. Prepare/clear the AFT/OFT log.
4. Begin recording the occultation, then emit a 4 second flash into the optical path of the telescope. (The 4 second time is recommended to ease later processing of the light curve by *pyote*.)
5. After the occultation, emit another 4 second flash into the telescope optical path.
6. Terminate the recording and preserve the log of the two flash times. (Suggestion: email the log to yourself, an available feature in AFT.)
7. When processing the video in Limovie, two apertures will be used: a standard aperture around the occulted star and a large rectangular aperture to detect the goal-post flashes that bracket the occultation. A dual light curve csv file will be produced. One light curve contains the timing information from the goal-post flashes. The other light curve is the occultation to be timed.
8. Process the csv file using *pyote* which has had some recent features added to make it easy to process such files.

Below is a picture of what your camera image should look like with the phone flash on. There is a gentle wash of light that is clearly not saturating the pixels in the image --- the M67 star field remains visible during the flash.



The above picture also shows the two apertures that will be used for producing a dual trace light curve. The star aperture is placed over the star to be occulted. The rectangular aperture can be placed at any convenient position (unless your camera has a rolling-shutter --- see addendum for the procedure to use in this case) and may include stars, but try to avoid them, particularly if any are saturated. Note: a strong high SNR signal will be obtained from the rectangular aperture even with what appears to be a not very bright flash: 2601 pixels are included in a 51 x 51 aperture and so large sums with low noise are typically obtained.

Below is a picture with the LED off ---



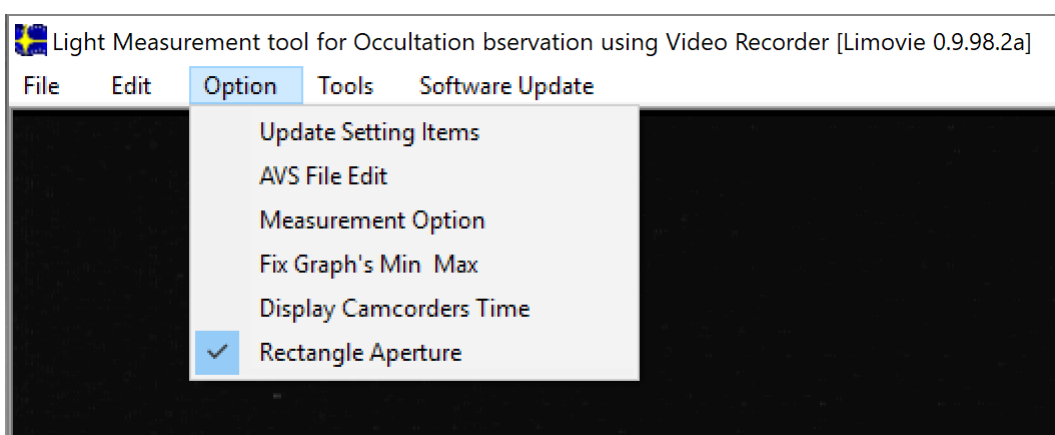
The examples shown above are from a test performed by John Grismore (the author of the AFT app). He used an 8 inch Meade LX2000GPS SCT with a Watec 910HX. The gentle, non-saturating flash intensity was achieved in this case by a combination of multiple layers of red tail-light tape over the iPhone LED and inclining the iPhone at a 30 degree angle with respect to the scope optical axis (90 degrees would be straight into the telescope). This is clearly an effective technique, but other means can be used as well.

The use of the rectangular aperture in Limovie is probably not familiar to users of this program and successful use of this feature involves some trickery. There are three things a user needs to know:

1. Where in the GUI does one go to activate the activate the rectangular aperture.
2. How does one adjust the size of the rectangular aperture (tricky because when first opened, a rectangular aperture cannot be resized).
3. How does one set the background level for a rectangular aperture (background subtraction is built into the usual star apertures, but is un-obvious for the rectangular aperture).

We'll address these issues one at a time.

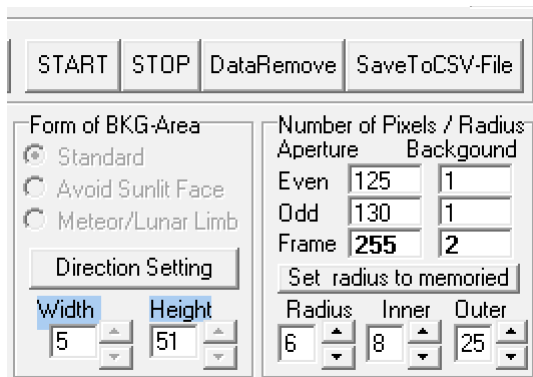
1: Where in the GUI does one go to activate the activate the rectangular aperture.



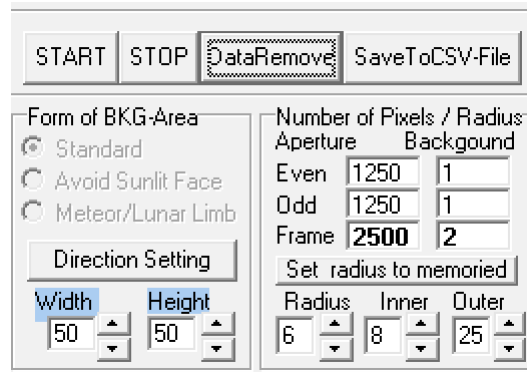
Click on **Option|Rectangular Aperture** to activate the rectangular aperture.

2: How does one adjust the size of the rectangular aperture (tricky because when first opened, a rectangular aperture cannot be resized).

When a rectangular aperture is first activated, it appears at a default size of Width 5 and Height 51 and, while there are spinner controls for adjusting the size, they will be grayed out (inactive) as seen below:



The trick to activating the Width/Height spinners is to click the **START** button, then quickly click the **STOP** button, then click **DataRemove** and confirm that you do want the data deleted. After that sequence, the display will change to:



and I changed the dimensions of the rectangular aperture to 50 x 50 by clicking on the spinner controls to show that they were in effect.

3: How does one set the background level for a rectangular aperture (background subtraction is built into the usual star apertures, but is un-obvious for the rectangular aperture)

The background value that Limovie uses when reporting rectangular aperture sums is obtained from whatever the aperture sum was *when the aperture size was last changed or the aperture repositioned*. That value will be subtracted from all subsequent readings as the video is processed. Note that while the estimation of background values for regular star apertures is dynamically determined (and so may change at each frame), that does not happen for rectangular apertures: a constant value is used with the value for that constant set by the aperture sum when last the aperture size was changed/positioned. This has not seen to be a problem to date, but could be an issue if a recording with a significant change in background intensity with time is processed.

Given the above, the procedure to use in Limovie is this:

1. Run the video and position it to a few seconds before the first flash.
2. Position a regular star aperture over the star that will be occulted.
3. Right click in the image and click on **Object Star Add**. The aperture added will be a regular star aperture. We change that to rectangular in the next step.
4. Change to a rectangular aperture (click **Option | Rectangular Aperture**). Now the star aperture added in the above step changes to a rectangular aperture.
5. Activate the Width/Height spinner controls for the rectangular aperture by performing the **START-STOP-DataRemove** magic click sequence.
6. You may need to position your video again as it will have been changed by step 5 unless you were very fast.
7. Position the rectangular aperture where you want it (preferably some starless area) and set its Width and Height to 51 x 51 (except for rolling-shutter cameras). Note that this procedure also sets the background value that Limovie will use in reporting aperture sums for this aperture.
8. Proceed as you would normally to produce the csv light curves file.

Continue to the companion tutorial on using **pyote** to analyze flash timed videos. There you will find an example of the goal-post timing process applied to an artificial occultation.

Addendum: special instructions for rolling-shutter cameras

If the camera being used for the video recording has a rolling-shutter, the start-of-exposure time is different for each successive line in the video. Because of this, it is necessary to align the rectangular aperture that measures the goal-post flashes with the target star y-position and make the aperture short and wide instead of square. An example is shown below:

