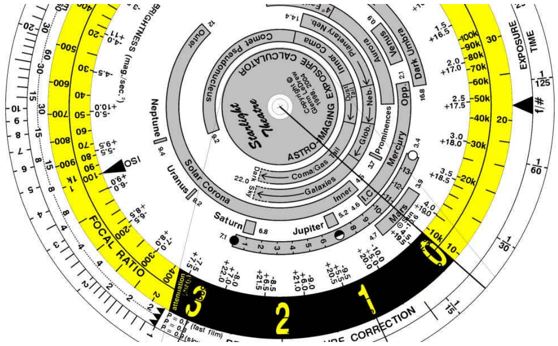
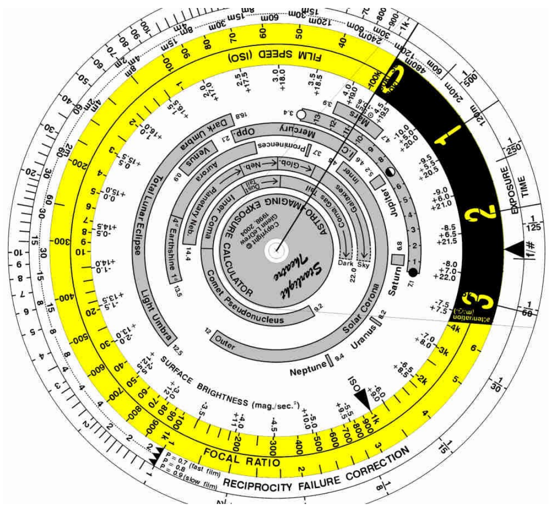
WHIZ WHEEL - Astro-imaging Exposure Calculator

This tutorial extends our instruction booklet on the use of the Whiz Wheel Exposure Calculator.

Mars



Let us determine the optimal exposure for Mars. For this example let's start with a telescope using eyepiece projection on relatively fine grain film (ISO 100). Lets say the projection optics result in an effective focal ratio of 22. Because Mars is an extended object, the actual aperture does not matter. However, a larger aperture at the same focal ratio will result in a larger image on the film.

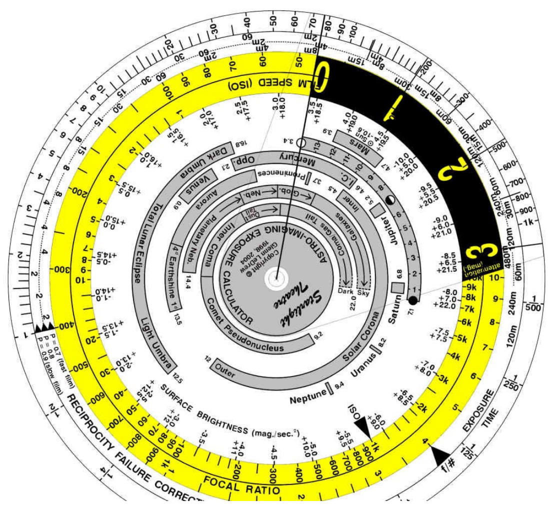


Mars has a narrow range of surface brightness (3.9 to 4.7 mag./sec.^{2}) and results in a calculated exposure ranging from 1/30 seconds to 1/15 seconds. This exposure is relatively slow, but it is long enough to permit a manual shutter over the front of the telescope that will minimize the vibration due to a camera's shutter. To take the picture, cover (but do not touch) the aperture of the telescope with a dark card, open the camera shutter for a few seconds (to allow the shutter induced vibrations to dampen out), very quickly wave the card out away from the aperture, then back again. Then close the camera shutter.

Unfortunately if the atmospheric seeing is not very good, the image will be constantly moving. A much faster exposure time is needed to freeze this motion. This may be done in two ways: use faster film or more sensitive detector or use a shorter focal ratio. A shorter focal ratio will also result in a smaller image. Let us see what will result with an ISO 1000 film (or effective ISO for a detector) and a focal ratio of 10.

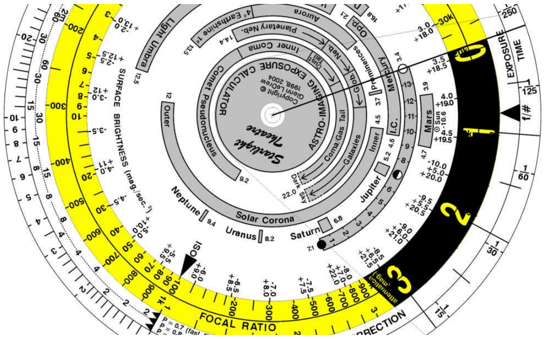
The new exposure is about 1/1000 second at the end of the exposure scale. But if you need to, you may extrapolate to shorter exposures. Remember that the shutter of your electronic camera may not be able to move this fast, requiring you to stop-down your telescope aperture or use eyepiece projection to bring the exposure into a practical range.

Moon



The Moon is very difficult to image because of the range in local surface brightness. The Calculator only gives the average brightness over the Moon's apparent disk. If you try to image the full Moon using ISO 1000 film at f/4, we get a bizarre exposure of 75 seconds (?). Actually, this is beyond the 1/1000-second limit. More correctly, it is 75/1000 x 1/1000 = 75 millionths of a second. Film and detectors behave differently at such short exposures. Film suffers a form of reciprocity failure and no commercial electronic detectors and film cameras have effective shutter speeds this fast.

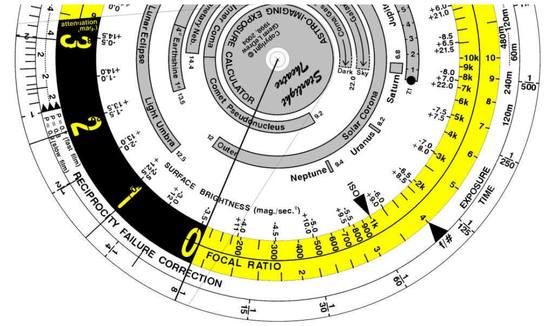
A better image results with a more balanced set of parameters. Try, ISO 100 at f/10.



This gives an exposure of about 1/250 second and is much more reasonable. At first and last quarter, the range in brightness can be more than factor of two between the bright highlands and the darker mare, or from near the limb (where the Sun would be high in the lunar sky) to the terminator with long shadows. Depending on your needs, you may have to start with the calculated exposure and experiment to get the best exposure for your purpose.

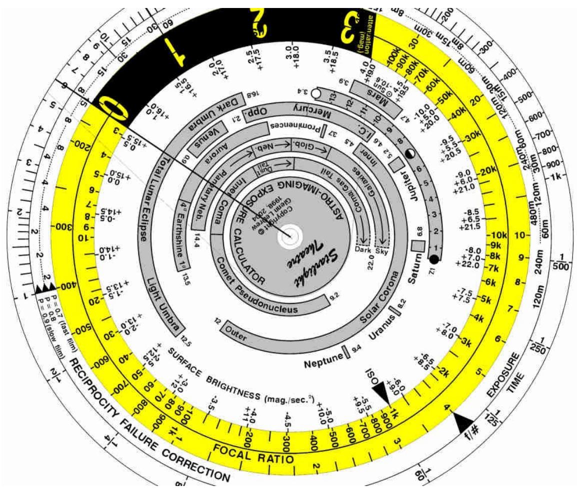
Comets

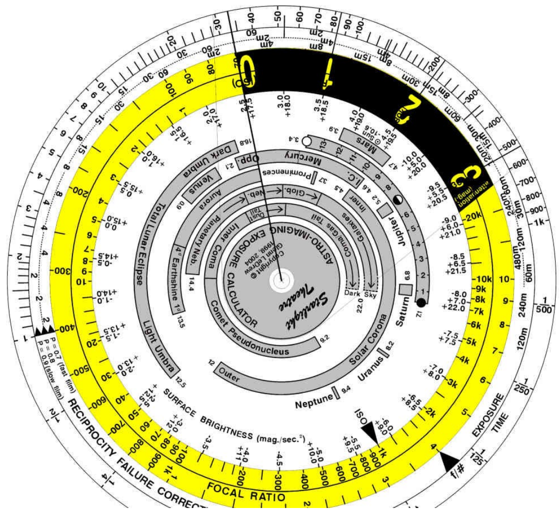
The surface brightness of a comet can range from about 9.2 mag. / sec.^{2} to the dark sky limit of 22 mag./sec.^{2}. How does the calculator handle this range of exposure?



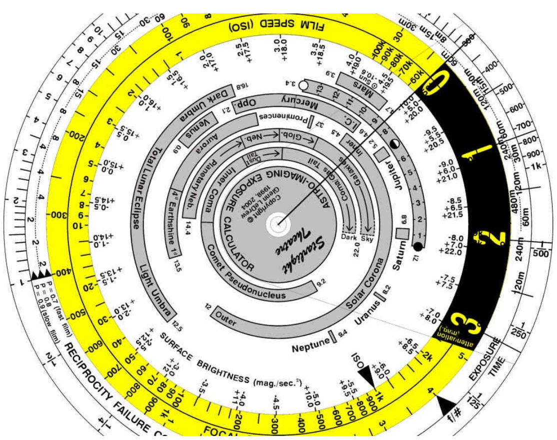
Lets start with the pseudo nucleus. It resembles a “star” on the comet’s head. This is not the actual nucleus; it is much too small and dark to be seen. Rather, it is the scattered light from the dense cloud of gas rising from the actual nucleus. At f/4 and with a detector with an effective ISO 1000 or equivalent film, the initial exposure would be only about 1/8 second. But this image will only show a featureless dot.

To image the inner coma requires an exposure of about 6 seconds. For film, this requires a correction for reciprocity failure, or about 15 seconds. This shows the benefit of electronic imaging because for these detectors, reciprocity failure is negligible. Slower speed film (lower ISO) suffer less reciprocity failure





The dust tail will need an exposure of 33 seconds or almost 3 minutes if film is used. The gas tail will need about 300 seconds (5 minutes) to be properly exposed (about 60 minutes for film).



For the above-mentioned focal ratio and detector speed, the calculator “runs out” of exposure at a surface brightness of about +21.2 mag./sec.^{2}. You can however extrapolate using the cursor’s attenuation scale. Note that 2.5 magnitudes = 10x in brightness. This will take you from 1,000 seconds to 2,100 seconds (35 minutes) for 22 mag./sec.^{2} at the sky fog limit. These exposures will change with a different f-ratio or effective ISO of your detector or film.

Summary

The Whiz Wheel does not let you blindly calculate exposures. Use your judgement. A nonsense exposure usually means your section of focal ratio and effective ISO are not compatible with good imaging practice. So, you should review your set up.

Good Imaging.

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