FEATURE ARTICLE

Shoot the 'Never Again' Transit of Venus 2012

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Interested in capturing the Venus transit? Here are a few tips.

"THERE is always a next time," so goes the saying. But not with this event – the Transit of Venus, or ToV. After this ToV of 6th June 2012, no one living on this Earth today can expect to get it ever again in his lifetime. There will not be another ToV for the next 115 years or until 2117 (December 10/11).

Only three ToVs have taken place after Nicephore Niepce produced the world's first known photograph in 1825 – 9th December 1874, 6th December 1882 and 8th June 2004. While photographic initiatives in the first two episodes remained entirely confined within the abode of the rich and famous or hard-core academicians, ToV 2004 became the first one to have motivated worldwide efforts to capture the event in the photographic lens. But, despite the presence of digital cameras then, it was largely film-based expensive shooting by people of special interest groups.

Eight years down the line, the mass penetration of digital cameras has opened a much larger vista for everyone to try to shoot this 'never again' event.

As it Appears

The small, dark, black, round body of Venus first appears at the edge of the Sun as just a near unperceivable dent. This outer to outer contact between these two circular bodies is called Contact 1 or C1. In a couple of minutes, the entire planet enters into the boundary of the solar disc with a contact of the outer edge of Venus with the inner edge of the solar disc. This is C2.

After attaining the Greatest Transit (GT) and traversing the entire solar disc, the planet once again touches the edge of the solar disc on the opposite side at C3 and finally comes out of the face of the Sun at C4 signaling an end to the Transit.

For a photographer, C2 and C3 of a transit are the most appealing and rewarding.

Visibility

ToV is normally an over six-hour event that is visible from almost half of the Earth's surface. This time, location wise, the visibility stretches both sides of the International date line and time wise, both 5th and 6th June. The global visibility chart gives an overall idea (Figure 3). But for India, the Sun will rise above the eastern horizon on the morning of 6th June after these two initial contacts. So, C3 remains the only option for us here to shoot the edge-to-edge phase. Naturally, this critical 'Now or Never' situation deserves a much better photographic preparation to shoot the ToV.

We will keep this discussion mostly confined to the digital arena, as not many film-based analog cameras are likely to get into action this time. There are two basic ways to shoot ToV:

1. Directly through a telelens, telescope, spotscope or binocular attached to a camera.
2. Indirectly, by forming an image of the Sun through a scope and shooting the image.

While the first one gives better quality of image, it demands a good solar filter and extreme levels of precaution. Since the object to shoot, the Sun, is almost 100,000 times brighter than the normal mid sunny day terrestrial view, it demands extreme levels of precaution. Even a small gap may cause large irreversible damage to your equipments and eyes.

The second procedure, on the other hand, is comparatively easy to handle with no need of solar filters but, of course, it comes at the cost of image quality.

In order to bring down the solar brightness within the acceptable limit we need to cut it down to 1/1,00,000th or 1 x 10 to the power of Minus 5. Technically speaking, we need to see the Sun through a D5 filter.

Sunlight contains a wide spectrum of light waves including ultraviolet (below 400 Angstrom wavelength), visible light (from 400 to around 700 Angstrom wavelength) and infrared (above 700 Angstrom wavelength). Our D5 filter needs to be capable of cutting down this entire spectrum. Items like used X-ray plates, smoked glass, films, magnetic disc of floppy discs, CD ROMs, are not at all safe. A chart prepared by Dr. B.R. Chou, Professor of Optometry at the University of Waterloo for NASA Solar Eclipse Bulletins (Figure 1) depicts the Spectral Response Curve or attenuating capability of different filters at different wavelengths.

Professional quality solar filters, manufactured by putting a thin layer of aluminum on optical grade acetate sheets, are the safest ones. These filters are available with specialized shops even in India, but are expensive.

As the chart suggests, the safety factor of a stack of two sheets of fully exposed, then overdeveloped and fixed 120-format B/W silver based negative film does come within the acceptable limit. Welder's Glass (W14) can also be a good alternative. The stacked film gives a grayish image of the Sun while it is greenish and silvery with Welder's Glass and aluminum based filters respectively.

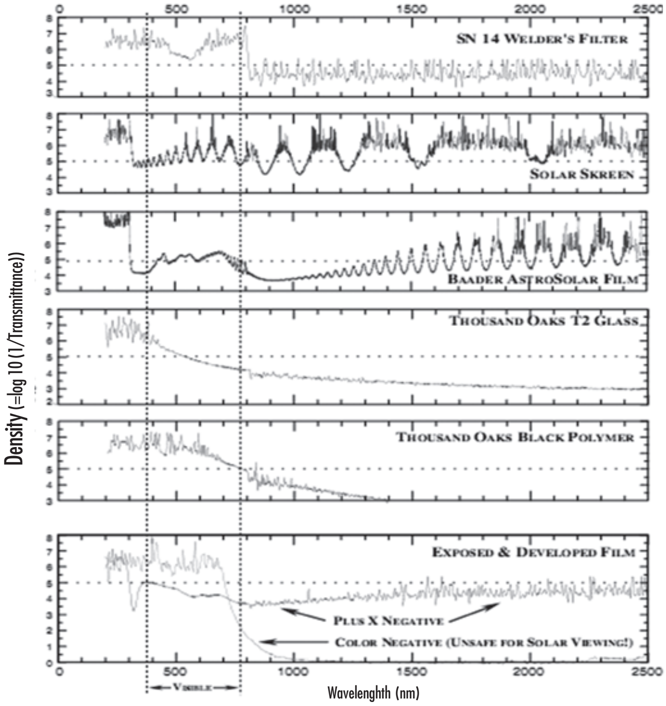

Fig. 1. Spectral Response Curve of filters

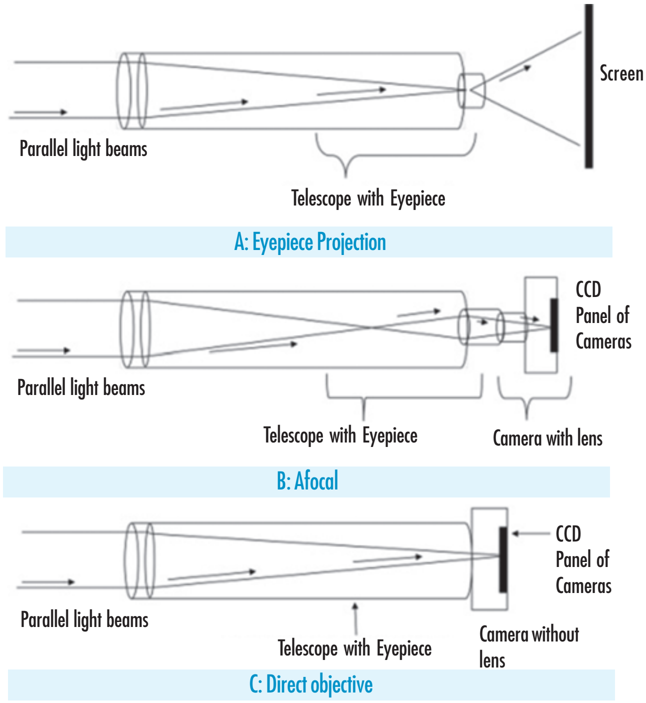

Fig. 2. A. Eyepiece projection. B. Afocal. C. Direct objective.

Image Size and Resolution

The Sun covers just 0.5 degree (0.5 x 60 x 60 = 1800 second) of our vision against our total vision of around 170 degree. In other words, its angular size can be called 0.5 degree. The size of the solar disc in an image with any particular lens can be determined with a simple equation:

F/110 = D (in mm).

Here **F**= Focal length of lens; **D** = Diameter of the image of solar disc on image making CCD/CMOS panel of camera.

Digital cameras come with different physical and megapixel sizes of panels (Figure 4). The size of the final solar image on screen or print is highly dependent on these factors.

We can use the following equation to calculate the diameter of the solar disc image in print or screen:

D x M = I

Here **M** = Ratio of the size of print needed and size of image making panel of camera and **I** = Diameter of Solar disc image in print or screen in mm.

The size of the image on the computer monitor screen (at 100% viewing) will depend on monitor resolution too. The following equation comes in handy to calculate this:

I = (C x D)/ U.

Here **C** = Number of pixel per mm in the image making panel, and **U** = Number of image making units per mm on screen.

Let us take an example here:

You have a Nikon D7000 camera (sensor size 23.6 x 15.7 mm having 4928 X 3264 pixels or 16 megapixel) fitted with a lens of 300 focal length. Print size needed 153 mm x 102 mm or 6" x 4".

Thus, D = 300/110 or 2.73 mm and M = 102 mm/15.7 mm or 6.5.

So, I = 2.73 x 6.5 or 17.75 mm in 153mm x 102 mm or 6" x 4" print.

Now, for the size of image on the screen: Usual CRT monitors come with 72 image-making units per inch or 72/25.4 = 2.83 units per mm while a usual LCD monitor comes with 96 similar units per inch or 96/25.4= 3.77 units per mm.

So, U for CRT is 2.83 and- U for LCD is 3.77.

C for D7000 = 4928/23.6 = 208.8.

Thus,

I in a CRT monitor will be (208.8 x 2.73)/ 2.83 = 201 mm and

I in a LCD monitor will be (208.8 x 2.73)/ 3.77 = 151 mm.

All these are for the Sun. But what about Venus? Due to continuously changing distance between Earth and Venus, the apparent angular size of the planet keeps on changing to the eyes of an observer from Earth. On the Transit day, size of Venus will be 57.8" or around 1/30th of the Sun. So, in our example, Venus will appear on a CRT monitor with a size of 201/30 = 6.7mm.

These equations will apply for analogue cameras too. To utilize these for

SUGGESTED SHUTTER SPEED (IN SECONDS) AT DIFFERENT ISO AND APERTURE (F/RATIO) SETTING

	ISO 200	ISO 400	ISO 800	ISO1600
f/4.5	1/2000	1/1000	1/500	1/250
f/5.6	1/1000	1/500	1/250	1/125
f/8	1/500	1/250	1/125	1/250
f/11	1/250	1/125	1/250	1/500
f/16	1/125	1/250	1/500	1/1000

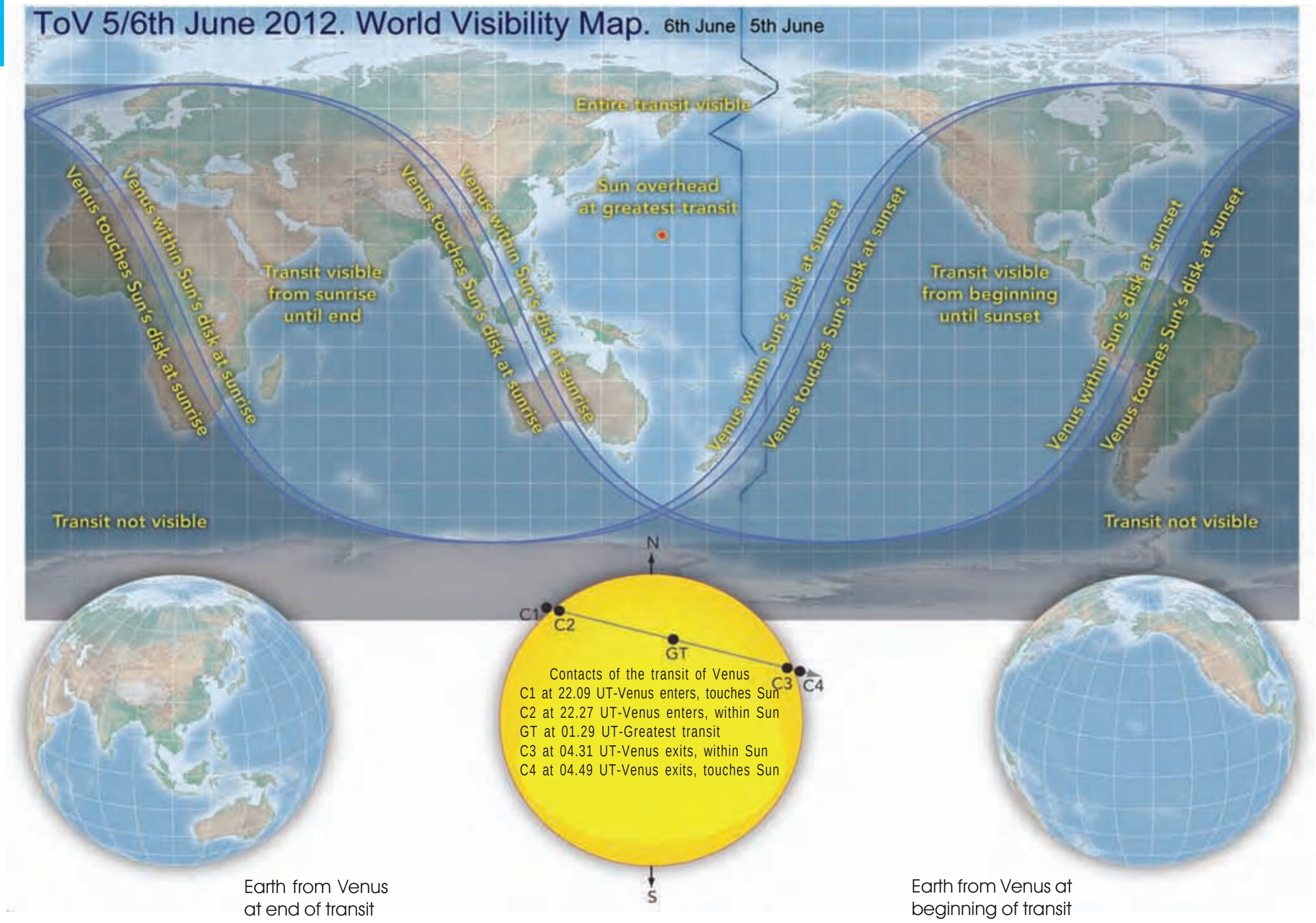

Fig. 3. Worldwide visibility

any compact digital, one needs to find out the actual value of **F** and **C** with the help of its detailed specification normally given in user manuals.

Resolving Strength of a System

In ToV, the main challenge for a photographer is capturing a well resolved, pitch dark, uniform and sharp round shaped miniscule Venus over the face of the bright Sun. At C2 and C3, dark Venus shows a Black Drop effect too. It is an appearance of spillage of black from the Venusian body on the brightly illuminating solar disc (Figure 6). We can definitely have a large sized image of all these even with a tiny pocket-sized camera with high zoom configuration of say 10X.

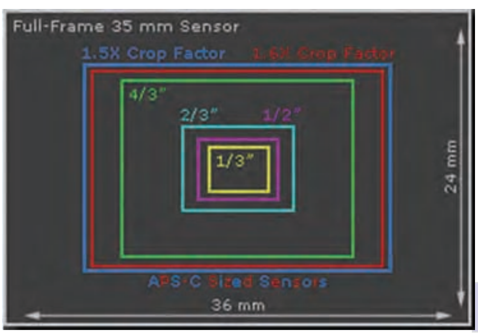

Fig. 4. Different CCD/CMOS panel dimensions

But these compacts with physically small sized lenses and small image-making panels are not likely to produce a very well resolved image of Venus or noise-free overall output.

Direct Shooting using Binocular, Spotscope or small Telescope

Attaching compacts or even SLRs as the imaging device with a Binocular or Spotscope or small Telescope is a good idea to ensure high magnification as well as better-resolved images. Experienced users can use a properly Sun-filtered telescope directly as the lens for SLR cameras, without using the eyepiece in telescope and lens in camera. It is known as Direct Objective arrangement (Figure 2).

But compacts or SLRs with their lens can be used indirectly in afocal arrangement (Figure 2) that can produce excellent results with terrific magnification. First put the Sun Filter on the mouth of the Binocular or Spotscope. Fix the scope on a stand. Target the Sun and look through the eyepiece. Focus the Sun as best as possible. In case you use spectacles, do not put it off while focusing. Now, take the camera, go to manual shutter speed, aperture and focus control. Set focus at infinite distance and set the camera behind eyepiece of the telescope or binocular. You will find reasonably sharp image of the Sun on your LCD panel. With zooming in or off in the camera, the image size on LCD panel will vary.

Get set to a size of solar disc, not much large, not too small. A solar disc diameter of around 2/3rd of the LCD panel is a good balance. Now, adjust exposure and click. If your model does not support manual override, let it be in auto. It will consider the image being shot inside the telescope or binocular as at infinite distance and adjust its focus accordingly.

The chart on page 16 suggests a few baseline exposure settings applicable for both Afocal and Direct Objective shooting of ToV while using D5 Sun filter in front of the lens.

This chart may not be useful for Afocal system, as the actual effective aperture of the whole system will depend on the

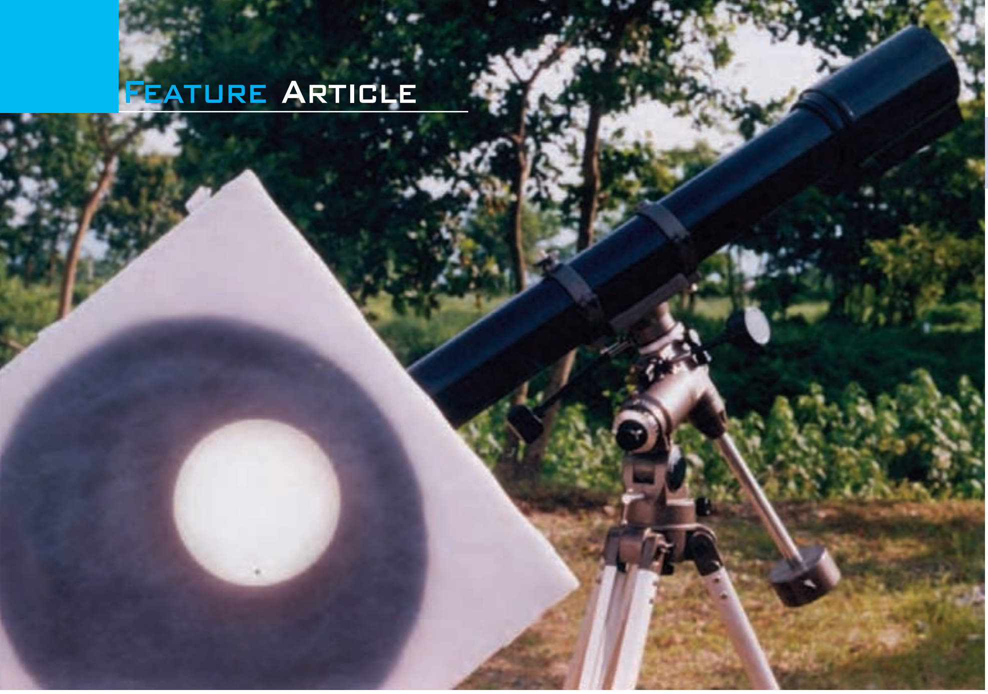

Fig 5. Eyepiece projection. Back projection of ToV 2004 inside a sealed projection funnel. (Picture: Debasis Sarkar)

Fig 6. Black drop effect. ToV 2004. (Picture: Debasis Sarkar)

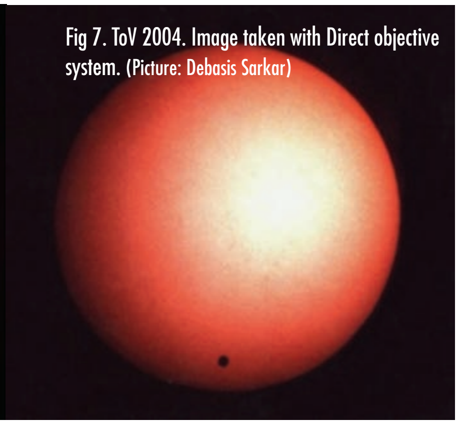

Fig 7. ToV 2004. Image taken with Direct objective system. (Picture: Debasis Sarkar)

actual focal length and objective diameter of the scope or binocular used. Trial and error is the best method.

In both Direct Objective or Afocal system, care must be taken to ensure as low as possible leakage of lights between the gaps of telescope, lens or camera. The best possible alignment of all the instruments, and as stable as possible holding of these is very important.

Indirect Method

The best indirect method is eyepiece projection. Here the image formed by a Telescope or Binocular's (which is technically a combination of two small telescopes) primary objective (the front lens in case of refracting telescopes or primary mirror in case of reflecting telescopes) is projected through the eyepiece on a screen.

Fix your Telescope or Binocular on a stand (use one side of a Binocular only, keeping the other closed), target towards the Sun and let the bright image get projected on a screen. It can be a front projection on open screen, or a back projection inside a specially built projection box or projection funnel with its entire inside painted matte black (Figure 5). While any wrinkle free white paper can be a good screen for front projection, tracing papers used in engineering drawings are good as back projection screen. The closed and back projection will offer much higher contrast of image. Shoot the image on screen with any camera just like photographing a usual terrestrial view.

In eyepiece projection, sun filter is not used in front of lens. So, extreme care must be taken always to allow the bright image of the Sun to come out of the system to fall on the screen instead of falling inside the instrument body and heating its internal parts.

Points to Remember

- Keep a black cloth to cover yourself and your camera monitor. Viewing LCD panel of camera under broad daylight is a real nightmare.

- The Earth always keeps moving. Thus Sun will keep changing its position in the sky. So, the gadgets will need careful and frequent re-orientations.

- Experienced users may avoid using cemented lens elements containing eyepiece like Kellner, Plossl or Nagler class. High heat inside eyepiece may damage the cementing of expensive elements. Rather, use simple and economical Huygen or Ramsden type eyepieces with no cemented elements.

- Use approved and certified Sun goggles to look at the Sun directly. The goggle should be used over the usual spectacles. But not all can resolve Venus well without a Telescope or Binocular.

- Use a good tripod.
- Take adequate precaution to keep the Sun filter absolutely scratch free.
- No leakage of direct sunlight within camera by-passing the filter should be allowed.
- Fix the filter in such a manner that it can be easily removed and reattached if needed.
- Use ISO 200 or 400 setting to ensure low noise in image.
- Make an eye goggle with the solar filter you are using or buy a prebuilt one. Use it while looking towards the Sun.
- In case of any major technical trouble with your camera, just do not get too involved in fixing it. Simply leave it and 'record' the ToV with your best cameras, your eyes – of course, with proper precaution.

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