A Beginner's Guide to Imaging the Moon

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Telescopes

There are hundreds of choices of telescopes. Refractors provide excellent optics and are usually heavy. Reflectors provide good optics, are large, and require frequent calibration. Catadioptric telescopes are lighter in weight and provide good optics. The larger the aperture, the more light a telescope gathers. The moon is very bright and doesn't require gathering a lot of light. The focal length will determine the size of the object that is projected onto the eyepiece or camera sensor. Some telescopes with long focal lengths will fill the sensor too much and may require a focal reducer. Others won't fill it enough. This article will show various telescopes and focal lengths. One may also choose to use a camera telephoto lens in place of a telescope. There is far more to discuss than this article covers. Photo simulations were derived from the software "Stallarium," which is available free for Mac or PC.

Mounts/Tripods

There are two basic types of mounts, equatorial and alt azimuth (altitude azimuth). Equatorial mounts align with Polaris and follow the path of the stars. Alt azimuth mounts have an up and down and side to side movement. Then, there are computerized mounts that automatically follow the path of the planets and stars. The moon moves somewhat quickly. A computerized mount will follow the moon's path automatically. The moon is about 1/2 degree in diameter and moves 1/2 degree, in about 2 minutes. As a general rule, the moon can be photographed for about 2 seconds before the moon's movement becomes a problem.

Cameras

There are three basic types of cameras. There is the 35 mm DSLR or mirrorless type with either an APS-C (15 mm x 22.5 mm) sensor or full frame (24 mm x 36 mm) sensor. When using a DSLR, the mirror up function should be used to minimize camera shake, a function that is not required on mirrorless cameras. There are also astronomy dedicated video cameras that require a computer to use. Computers are useful when stacking images is required for deep space objects. The moon can be photographed with a single image. Full frame cameras are more expensive than APS-C cameras. When imaging the moon, is the wide field of view obtained from a full frame camera necessary? See the simulations and judge. Also having a camera with an articulating view screen is important for astrophotography.

Exposure

Use a remote switch to prevent camera shaking.
Set the camera for manual focus and exposure.
Use magnified view to fine focus the telescope.
Set the ISO to 200.
Set the shutter speed to 1/125 or 1/250 seconds. This may need to be adjusted faster or slower depending upon the brightness of the moon. A full moon is brighter than a quarter moon.

Focal Multipliers and Focal Reducers

Barlow Lenses multiply the focal length of a telescope. A Barlow lens of 2x indicates using a Barlow lens between the telescope and camera to multiply the focal length by a factor of 2. Often a camera may not have enough “back focus” to use a Barlow lens with a camera. Therefore, they are not recommended in this article.

A focal reducer of f/6.3 indicates using a focal reducer lens between the telescope and camera to reduce the focal length by a factor of 0.63. However, for the telescopes shown herein, the factor is actually f/6.9. Focal reducers also correct and flatten the optics.

Stellarium Simulations

All simulations were done at a field of view of 5.5 degrees using Stellarium software.

Full Frame vs APS-C Sensor Cameras

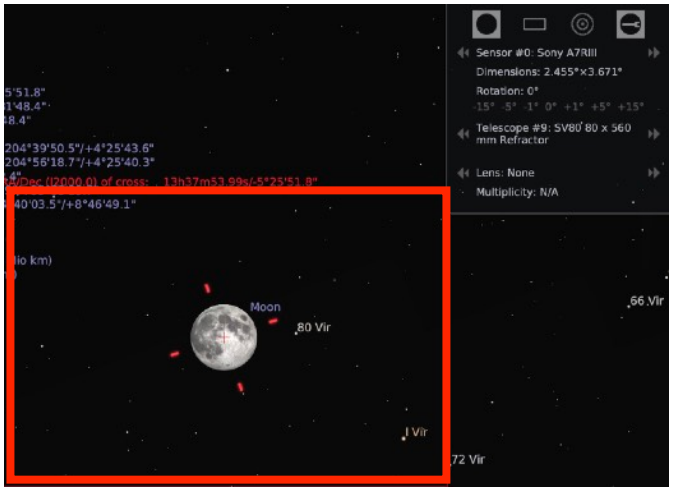
As seen below, the moon somewhat fills the image plane of the APS-C sensor. The image plane is much larger with the full frame sensor. In this case, the wider field of view of the full frame sensor may be considered a waste of space and money.

600 mm Camera Lens, APS-C Camera
15 mm x 22.5 mm sensor

600 mm Camera Lens, Full Frame Camera
24 mm x 36 mm sensor

Telescopes and Lenses at Various Focal Lengths

SV80 Refractor, 80 mm x 560 mm, APS-C



SV80 Refractor, 80 mm x 560 mm, Full Frame

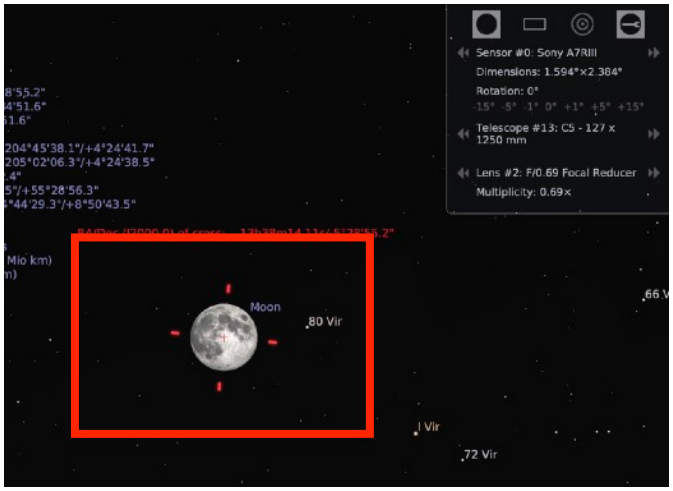
SV102 Refractor, 102 mm x 714 mm, APS-C

SV102 Refractor, 102 mm x 714 mm, Full F.

C5 Cassegrain, 127 mm x 1250 mm, APS-C

C5 Cassegrain, 127 mm x 1250 mm, Full F.

C5, 127 mm x 1250 mm with 0.69 reducer, APS-C

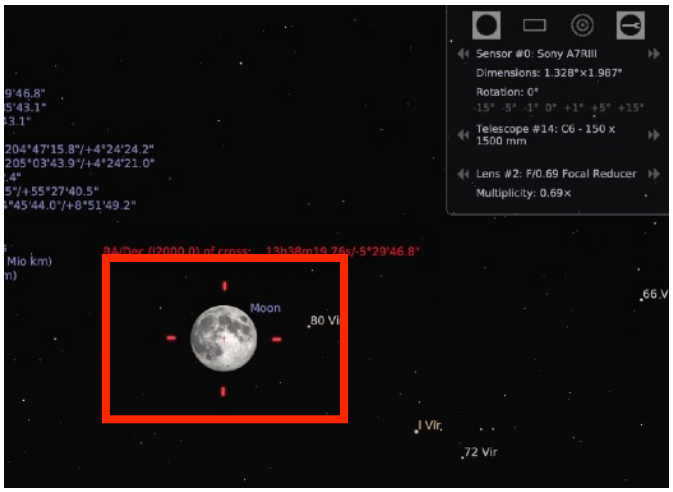


C5, 127 mm x 1250 mm with 0.69 reducer, Full F.

C6 Cassegrain, 150 mm x 1500 mm, APS-C

C6 Cassegrain, 150 mm x 1500 mm, Full F.

C6, 150 mm x 1500 mm with 0.69 reducer, APS-C



C6, 150 mm x 1500 mm with 0.69 reducer, Full F.

C8 Cassegrain, 203 mm x 2032 APS-C

C8 Cassegrain, 203 mm x 2032 Full Frame

C8, 203 mm x 2032 mm with 0.69 reducer, APS-C.

C8, 203 mm x 2032 mm with 0.69 reducer, Full F.

Comments

The C5 and C6 telescopes without a reducer and the C8 with a reducer fit the frame. However, the moon moves at a somewhat fast rate. It could be out of the frame by the time the camera is focused. A slightly larger field is needed to capture the moon. Too small a telescope or lens will result in significant cropping and enlarging, which results in a loss of resolution.

There are three primary factors in choosing a telescope: function, price, and weight. There are far more choices for telescopes and cameras than are shown here. For this article, the C6 telescope with the f/6.3 focal reducer and alt azimuth tripod was chosen. Their specifications are listed below. The Stellarvue 102 Access (refractor) is a second choice, albeit almost twice the price of the C6. Refractor telescopes usually provide better optics with a higher weight and cost of Cassegrain telescopes. Other telescopes can work equally as well.

Resources - Celestron C6 Setup

Celestron C6-A-XLT CG-5, 6" f/10 Schmidt-Cassegrain Telescope (OTA)
6" (150 mm) Schmidt-Cassegrain OTA
1500 mm Focal Length, f/10 Focal Ratio
StarBright XLT Optical Coating System
Optical Tube Weight: 10 lbs
List price: $650

Vixen Porta II Mount Tall plus
Adjustable height: 40 to 67 inches
Mount Weight: 15 lb including tripod
Load Capacity: 20 lbs
List Price: $540

Sony Alpha a6300 Mirrorless Digital Camera
24.2 MP DX-Format CMOS Sensor
23.5 x 15.6 mm sensor size
Max Resolution 6000 x 4000
Pixel width = 23.5 / 6000 = 0.0039 = 3.9 microns
Pixel height = 15.6 / 4000 = 0.0039 - 3.9 microns
14.3 oz. (0.89 pounds)
List Price: $750

Fotodiox Lens Mount Adapter, T /T2-Mount Lens to Sony E-Series Camera
Item model number: 11-T-Mount-NEX
List Price: $14

Celestron T-Adapter with SCT 5, 6, 8 with 9.25, 11, 14, Black (93633-A)
Item model number: 93633-A
List Price: $27

Celestron f/6.3 Reducer Corrector for C Series Telescopes
Item model number: 94175
List Price: $150

Vello ShutterBoss II Timer Remote Switch for Sony Multi-Terminal
Item model number: RC-S2II
List Price: $50

Resources - Stellarvue SV102 Access Setup

Stellarvue SV102 Access - 102 mm Super ED Refractor with 2.5" SV Focuser
Aperture: 102 mm (4”)
Focal Length: 714 mm
OTA Weight: 9.2 lb
List price: $1,100

Vixen Porta II Mount Tall plus
Adjustable height: 40 to 67 inches
Mount Weight: 15 lb including tripod
Load Capacity: 20 lbs
List Price: $540

Sony Alpha a6300 Mirrorless Digital Camera
24.2 MP DX-Format CMOS Sensor
23.5 x 15.6 mm sensor size
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Item model number: RC-S2II
List Price: $50

Tele Vue 2" Camera Adapter
Item model number: ACM-2000
List Price: $53

Celestron C6 with Vixen Porta II Tall Mount

Celestron C6 with Camera Adapter, Reducer, and Camera

First Quarter Moon with the Stellarvue SV80 Access Refractor Telescope

Further Technical Information

For further technical information, see the book “Introduction to Astronomy and Photography” By Dr. John A. Allocca at Amazon.com