

Imaging the Moon, Planets & Sun with a Digital Camera



David Haworth, Copyright 2003



Scope

- 👁️ Digital Cameras with lens that do not remove

Lunar Imaging is a Good Starting Point

- 👁️ It is 2nd brightest object
 - 👁️ The Sun requires a expensive filter
- 👁️ Wide variety of equipment
 - 👁️ Camera Mounted on Tripod
 - 👁️ Telescope low, median and high resolution
- 👁️ Noticeable changes within hours
- 👁️ Very good learning for other imaging

Camera Mounted on Tripod

- ① Focus at infinity
- ① Vary the exposure times
- ① Vary the optical zoom
- ① Use self timer or
- ① Remote shutter



Camera Mounted on Tripod

2002.05.15 22:04

Camera Mounted on Tripod

· Jupiter

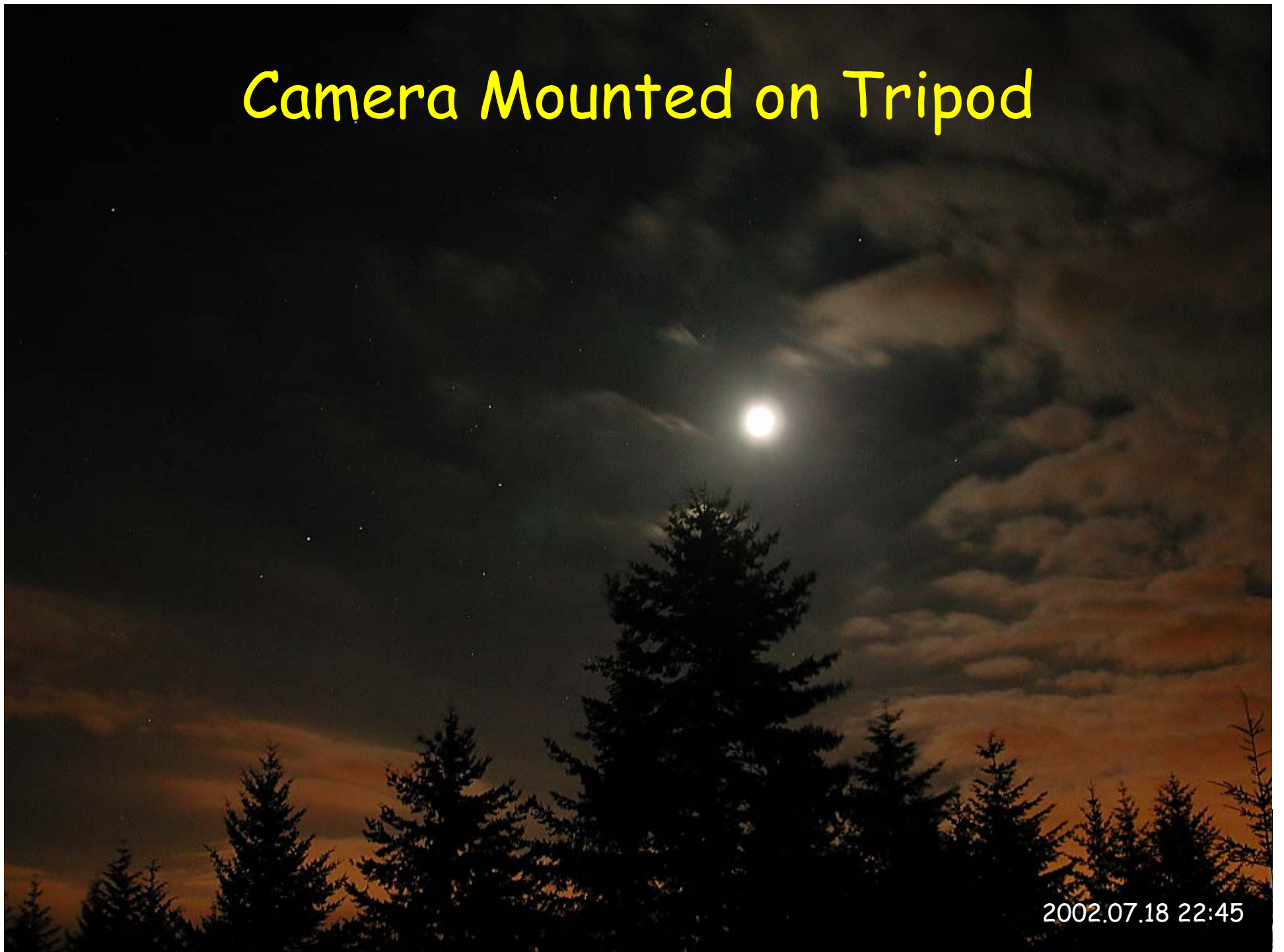
· Moon

· Venus

· Mars

2002.05.15 22:04

Camera Mounted on Tripod



2002.07.18 22:45

Camera Mounted on Tripod



Venus

Camera Mounted on Tripod

2x Telephoto Lens



Image 85 x 112 pixels
1/250 sec.



Camera Mounted on Tripod



Camera Mounted on Tripod



Venus

Tips

- ① Lens converts
 - ① Manual focus distances are not correct
- ① Remote release cable
 - ① Improves productivity

Imaging with Telescopes

Orion Short Tube



Orion Argonaut



Orion Short Tube Telescope

- 👁️ Achromatic refractor
- 👁️ 80mm aperture
- 👁️ 400mm focal length
- 👁️ f/5 f-ratio
- 👁️ Orion SVD mount



Orion Argonaut Telescope

- 👁️ Maksutov-Cassegrain
- 👁️ 150mm aperture
- 👁️ 1800mm focal length
- 👁️ f/12 f-ratio
- 👁️ Orion EQ-3 Mount

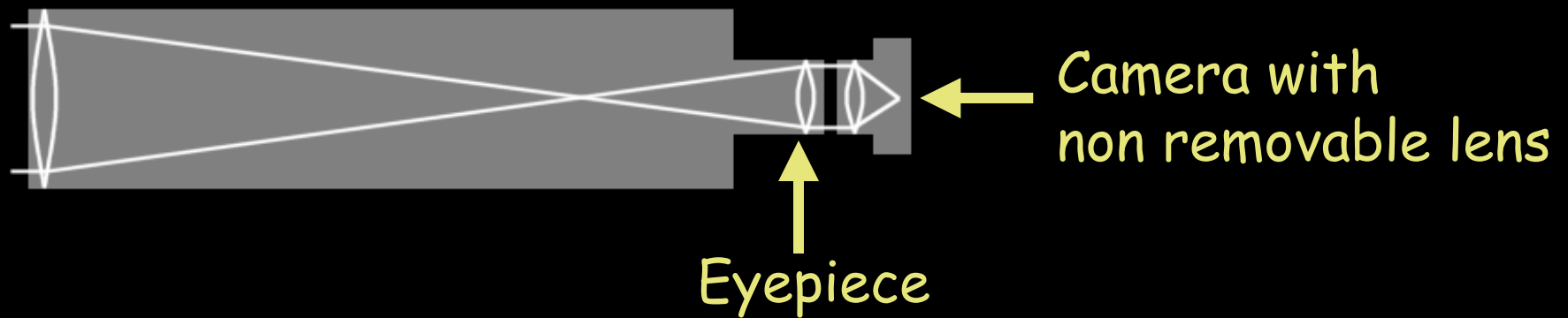


Tip: Use Vibration Suppression Pads



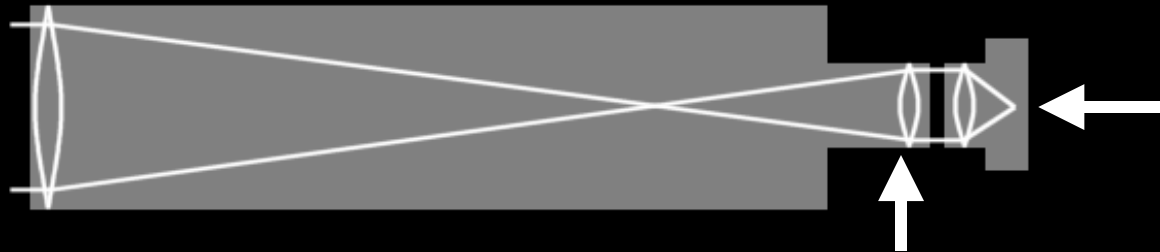
Afocal Coupling

Camera is aimed into the eyepiece



Afocal Coupling

Basic Formulas



F_c = Camera focal length

D = Telescope aperture

F_{ep} = Eyepiece focal length

F_t = Telescope focal length

f_t = Telescope focal ratio = F_t / D

Magnification = F_t / F_{ep}

Projection Magnification = F_c / F_{ep}

Effective Focal Length = $F_t \times$ Projection Magnification

Effective f -ratio = $f_t \times$ Projection Magnification

Projection Magnification = F_c / F_{ep}

E_p	$F_c = 8.2 \text{ mm}$	$F_c = 23.4 \text{ mm}$
mm	M	M
9.5	0.86	2.46
10	0.82	2.34
14	0.59	1.67
18	0.46	1.30
20	0.41	1.17
24	0.34	0.98
26	0.32	0.90

Orion Short Tube F = 400mm, $f = 5$

Ep	Zoon Out		Zoon In	
mm	F mm	f -ratio	F mm	f -ratio
9.5	345	4.3	985	12.3
10	328	4.1	936	11.7
14	234	2.9	669	8.4
18	182	2.3	520	6.5
20	164	2.1	468	5.9
24	137	1.7	390	4.9
26	126	1.6	360	4.5



Orion Argonaut F = 1800mm, $f = 12$

Ep	Zoon Out		Zoon In	
	F mm	f -ratio	F mm	f -ratio
9.5	1554	10.4	4434	29.6
10	1476	9.8	4212	28.1
14	1054	7.0	3009	20.1
18	820	5.5	2340	15.6
20	738	4.9	2106	14.0
24	615	4.1	1755	11.7
26	568	3.8	1620	10.8



Afocal Coupling

- 👁️ Camera is aimed into the eyepiece
 - 👁️ Hold the camera over the eyepiece
 - 👁️ Set camera on tripod next to telescope
 - 👁️ Use bracket attached to eyepiece
 - 👁️ Use camera adapter
 - 👁️ Use eyepiece with adapter

Afocal Coupling



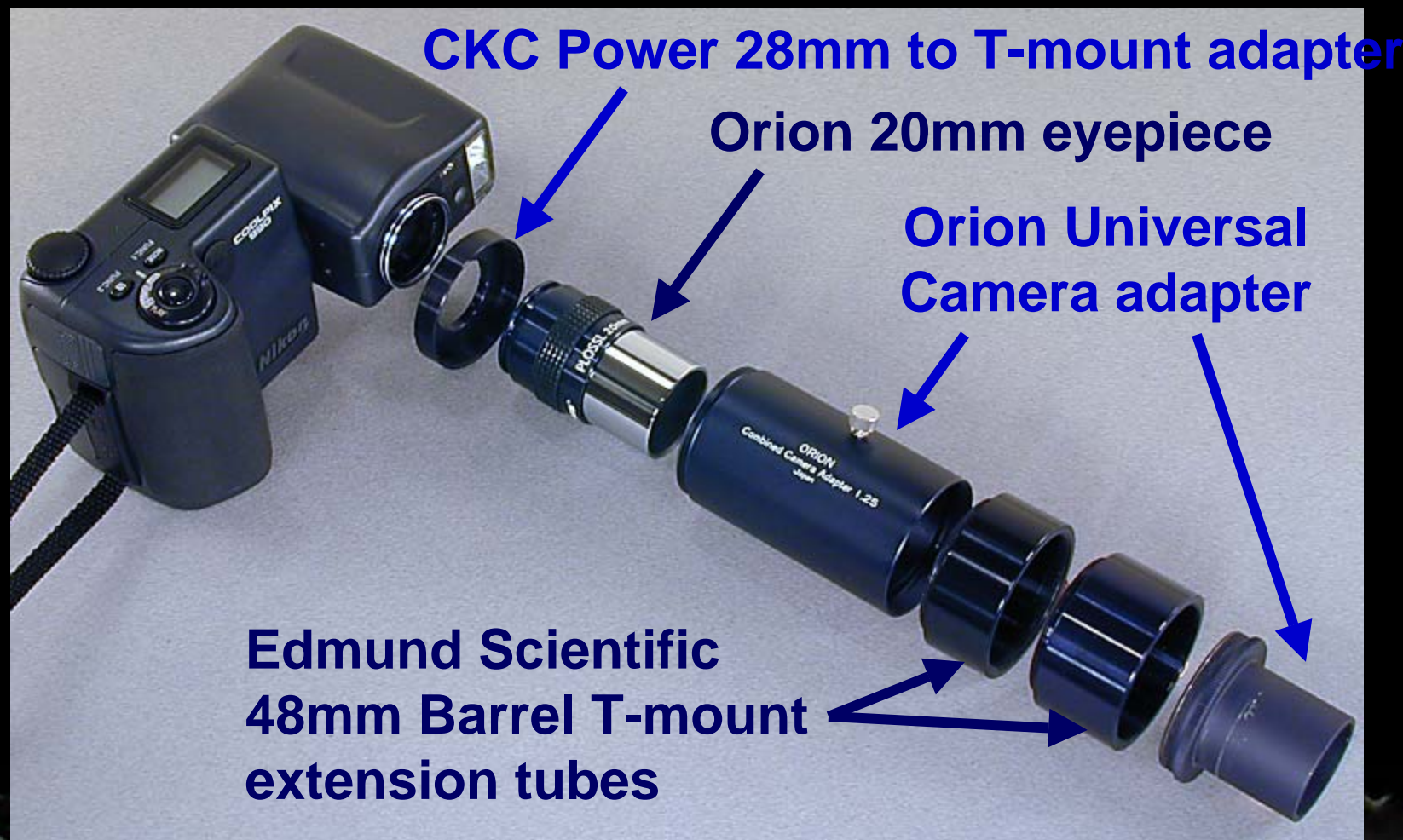
Afocal Coupling

Afocal Camera Adapter



Nikon 990 Camera

Afocal Camera Adapter



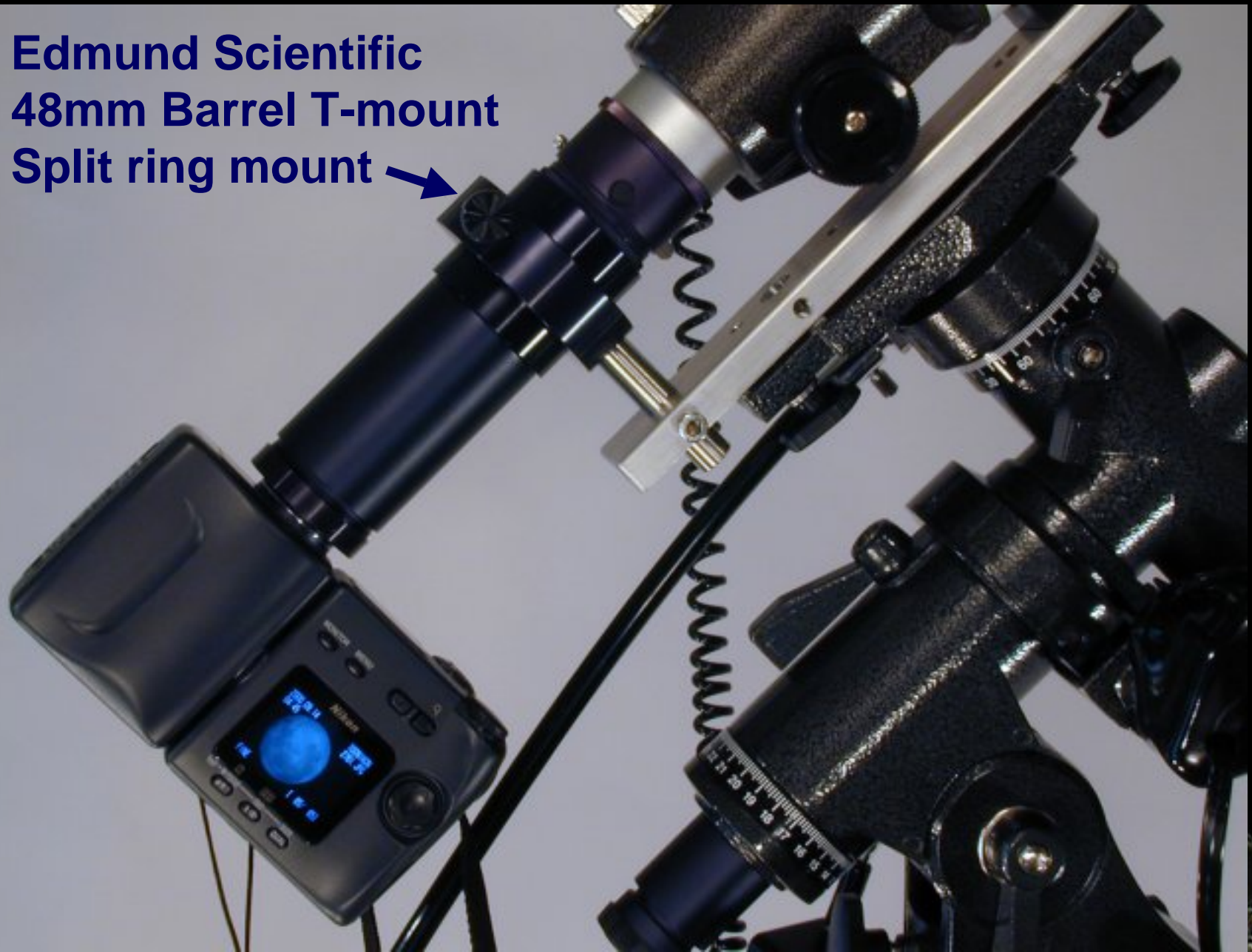
Nikon 990 Camera

Afocal Camera Adapter



Afocal Coupling Telescope Mounting

Edmund Scientific
48mm Barrel T-mount
Split ring mount →



Afocal Coupling

Eyepieces with Adapter or Threads



Nikon 990 Camera

Afocal Eyepiece with Adapter



Nikon 990 Camera

Afocal Eyepieces with 28mm Threads



24mm
Eyepiece

18mm
Eyepiece

Nikon 990 Camera

Afocal Eyepiece with 28mm Threads



Nikon 990 Camera

Afocal Eyepiece with 28mm Threads



Nikon 990 Camera

Afocal Eyepiece with 28mm Threads



Vignetting when Zoom Out



Imaging Setup

- Polar alignment
- Power
- Camera
- Dew heater



Tip: Cool Down

👁️ Plan for cool down time



Nikon Camera Settings

- Manual mode
- Manual focus at infinity
- White balance: sunny
- Image sharpening: high
- Aperture wide open

Tip: Use Lowest ISO Setting

- Take test images
 - At different ISO settings
- More noise at higher ISO settings
 - 200 and 400

Tip: Use Lowest ISO Setting



SHUTTER : 1/125sec
SENSITIVITY : ISO400



SHUTTER : 1/60sec
SENSITIVITY : ISO200



SHUTTER : 1/30sec
SENSITIVITY : ISO100

Tip: Use Lowest ISO Setting



SHUTTER : 1/125sec
SENSITIVITY : ISO400



SHUTTER : 1/60sec
SENSITIVITY : ISO200



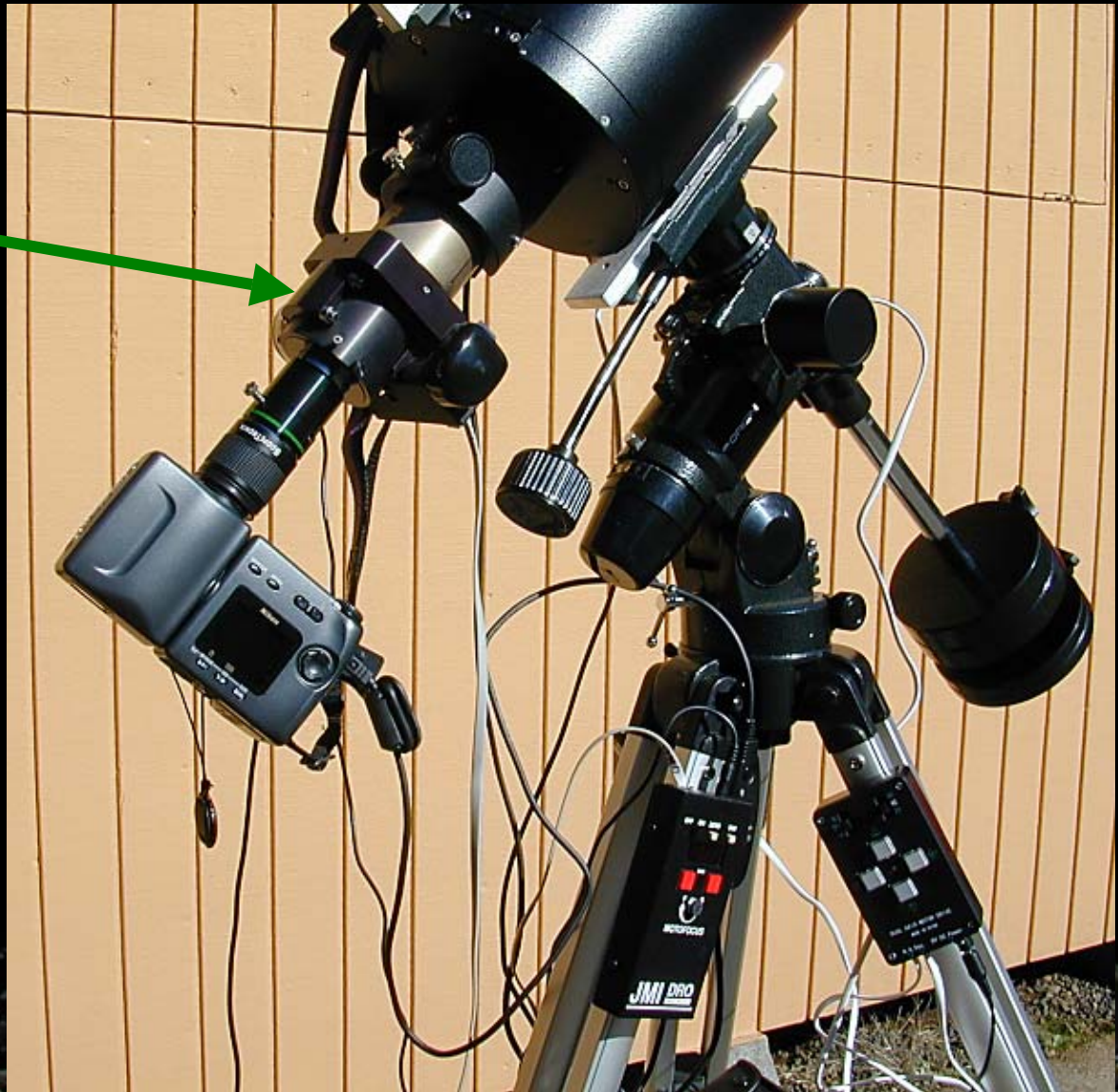
SHUTTER : 1/30sec
SENSITIVITY : ISO100

Focusing

- 👁️ Manual focus at infinity
- 👁️ Image sharpening: high
- 👁️ Maximum digital zoom

Tip: Electric Focuser

JMI NGF-S
DRO Focuser



Steps to a Good Sharp Exposure

Everything is Dependent on Seeing Conditions

Image Sharpness

Image Exposure

Exposure Time

Camera Zoom

Eyepiece

Telescope

Seeing



Poor Seeing



Good Seeing, No Image Processing



Good Seeing, Image Sharpen



F mm	<i>f</i> -ratio
2340	15.6

Exposure

Over
Exposed

1/8 sec

1/4 sec

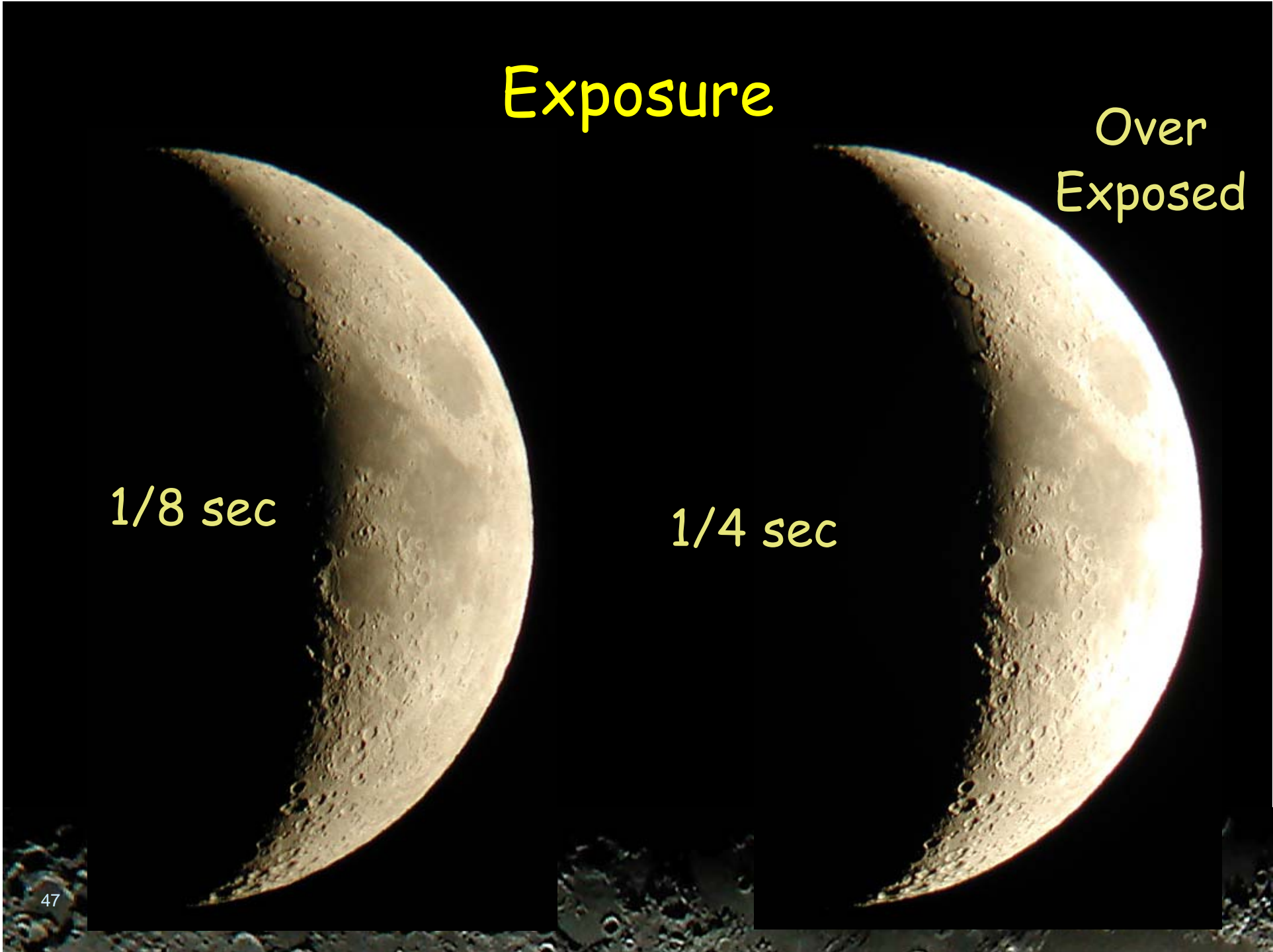


Image Exposure

👁️ Take one image & check histogram



8 sec Image Exposure Problems



Achromatic Refractor
False Color



Camera Noise



Lens Flair

Shutter Release

- ① Shutter-release button
- ① Self-timer
- ① Shutter Release Controller
- ① Shutter Release Software with PC

Remote Release Cable

👁️ Nikon MC-EU1 Remote Cord



Shutter Release Controller

👁️ DigiSnap 2000

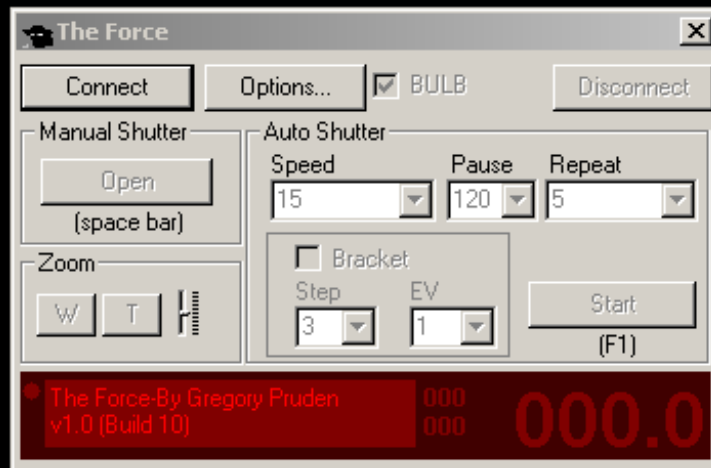
👁️ <http://www.harbortronics.com/digimain.htm>



Shutter Release Software

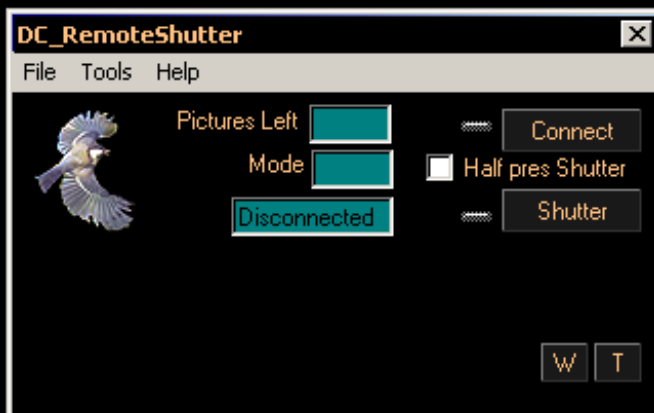
👁 The Force

👁 <http://velatron.com/dca/TheForce/>



Shutter Release Software

- ① Digital-Camera.dk
- ① <http://www.digital-camera.dk/>



Partial Solar Eclipse Movie



June 10, 2002
Partial Solar Eclipse
David Haworth



Partial Solar Eclipse Movie

- 👁 June 10, 2002
- 👁 130 images @ 1 minute apart
 - 👁 17:00 to 19:08
- 👁 Nikon 990 Digital Camera
- 👁 Orion 80mm Short Tube refractor

Partial Solar Eclipse Movie Steps

- ① Convert JPG image files to BMP
 - ① IrfranView
- ① Align
 - ① MaxIm DL
- ① Resize from 2048 x 1536 to 640 x 480
 - ① IrfranView

Partial Solar Eclipse Movie Steps

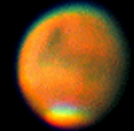
- ① Sharpen
 - ① IrfranView
- ① Histogram adjust
 - ① Paint Shop Pro
- ① Create Windows Media Video WMV file
 - ① Windows XP Move Maker 2

Partial Solar Eclipse Movie

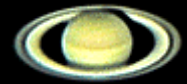


Planets

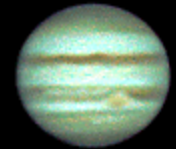
 Real Small



 Requires high magnification



 Stacking is must



Planet Stacking

One image

Best Image

Worst Image

Stacked Images

Best Image

2 Stacked

4 Stacked

8 Stacked

16 Stacked

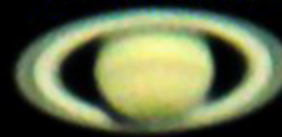
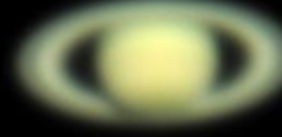
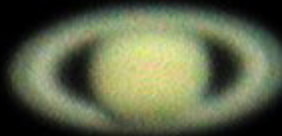
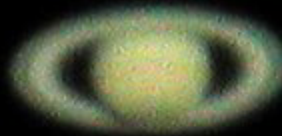
22 Stacked

32 Stacked

64 Stacked

88 Stacked

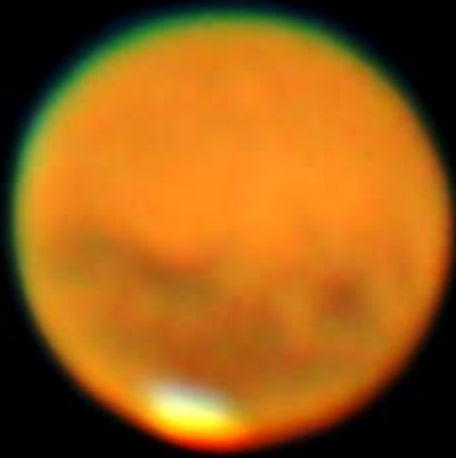
22 Stacked & Processed



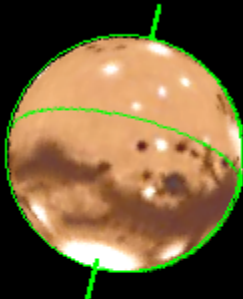
OSP 2003 Mars

Wednesday August 27, 3:11 am

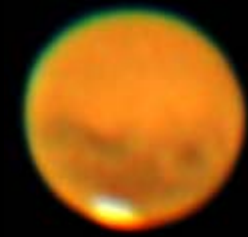
 29 Stacked Images 1/125 sec



CM=124.70 DE=-18.81



Central Meridian [deg]:	124.7000
Declination of Earth [deg]:	-18.8000
P.A. of axis [deg]:	346.1800
Diameter [arcsec]:	25.0800
Phase:	0.9981
Magnitude:	-2.8700
Celestial North at top	
Celestial East at left	



OSP 2003 Mars

👁️ Nikon 990

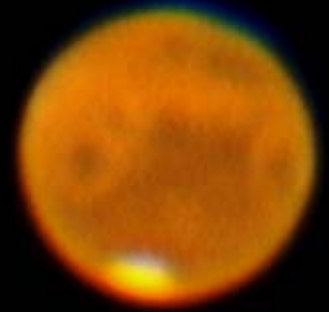
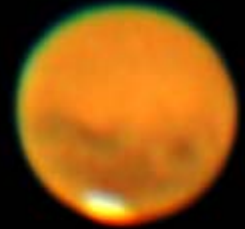
👁️ 29 Stacked Images 1/125 sec

👁️ Wednesday August 27, 3:11 am

👁️ ToUcam webcam

👁️ 660 Stacked Images 1/125 sec

👁️ Thursday August 28, 11:10 pm



More Information

- 👁️ Will post presentation & references on website by end of September
- 👁️ <http://www.stargazing.net/david>