



# Webcam & LPI Imaging



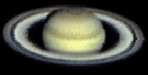
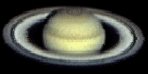
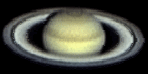
David Haworth

<http://www.stargazing.net/david>

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# Agenda

-  Camera Comparisons
-  Philips PCVC740K ToUcam
-  Meade Lunar Planetary Imager (LPI)

# Astroimaging Cameras Comparisons



**35mm Film**



**CCD**



**Digital SLR**



**Digicams**



**Webcams**



**LPI**



# Camera Comparisons

- 🪐 Exposure time
  - 🪐 Limiting factors
  - 🪐 Camera limitations
- 🪐 Field of view
  - 🪐 Optics focal length
  - 🪐 Camera sensor

# Exposure Limiting Factors

- 🪐 Light pollution
- 🪐 Seeing
- 🪐 Sky fog
  - 🪐 Twilight, moon & aurora
  - 🪐 Zodiacal light & gegenschein
  - 🪐 Sky glow

# Light Pollution at Camas, WA

30 Seconds Nikon D70 Image 18mm F/3.5



# Poor Seeing

Mars ToUcam





# Poor Seeing

## Moon ToUcam





# Average Seeing

## Mars ToUcam



# Good Seeing

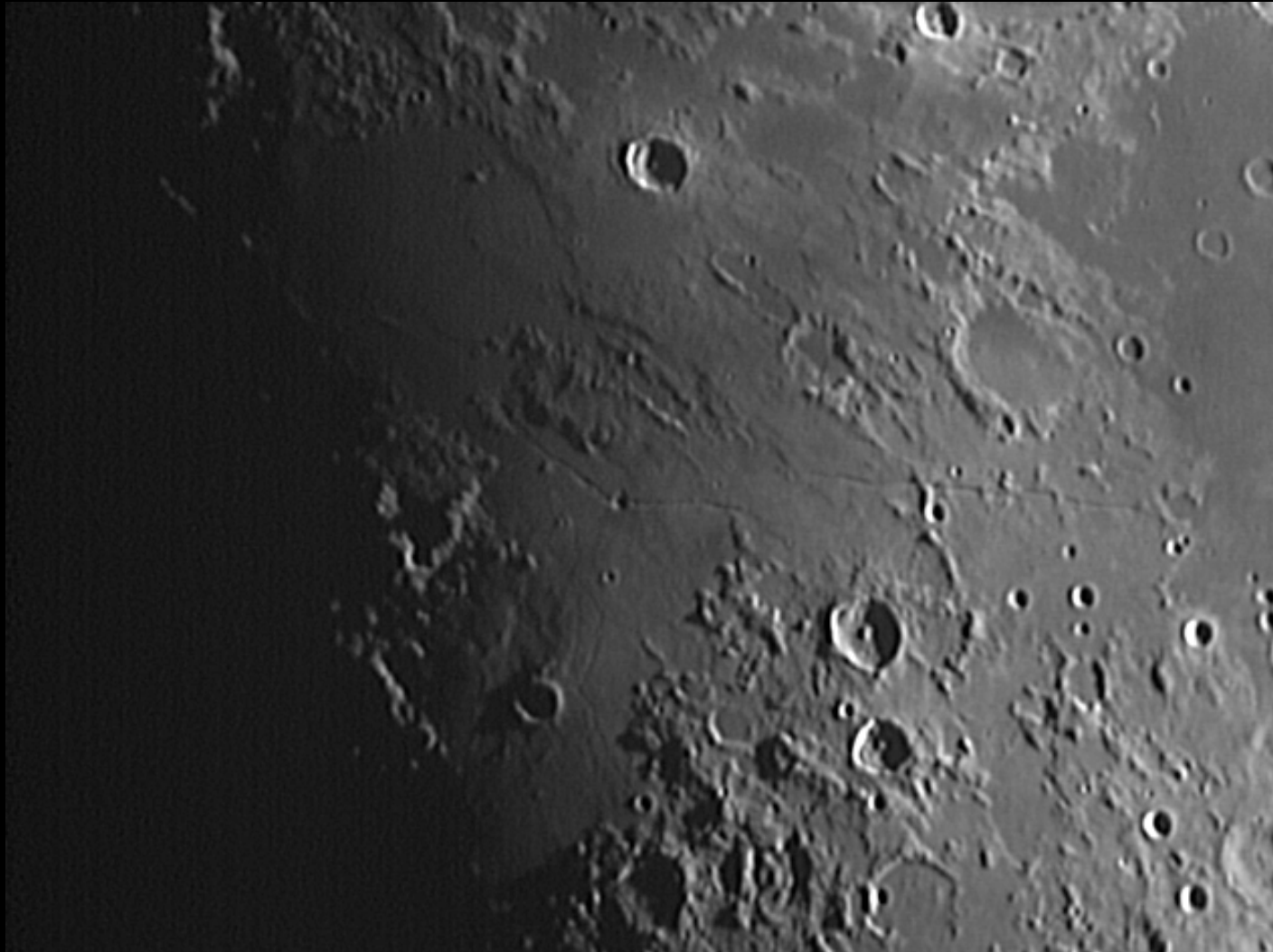
## Moon ToUcam





# Good Seeing Image Processed

## Moon ToUcam





# Very Good Seeing

## Saturn ToUcam



# Camera Exposure Times

## Film Cameras

Single  
Image  
Exposure  
Times

2.8h —  
17m —  
1.7m —  
10s —  
1s —  
.1s —  
.01s —  
.001s —

**Film Cameras**



**Limited by film reciprocity failure ~ 75 minutes**

# Camera Exposure Times

## CCD Cameras



Limited by electronic noise, cool CCDs ~ 40 minutes



# Camera Exposure Times

## Digital SLR Cameras



**Limited by electronic noise, digital SLRs ~ 5 minutes**

# Camera Exposure Times

## Digicams

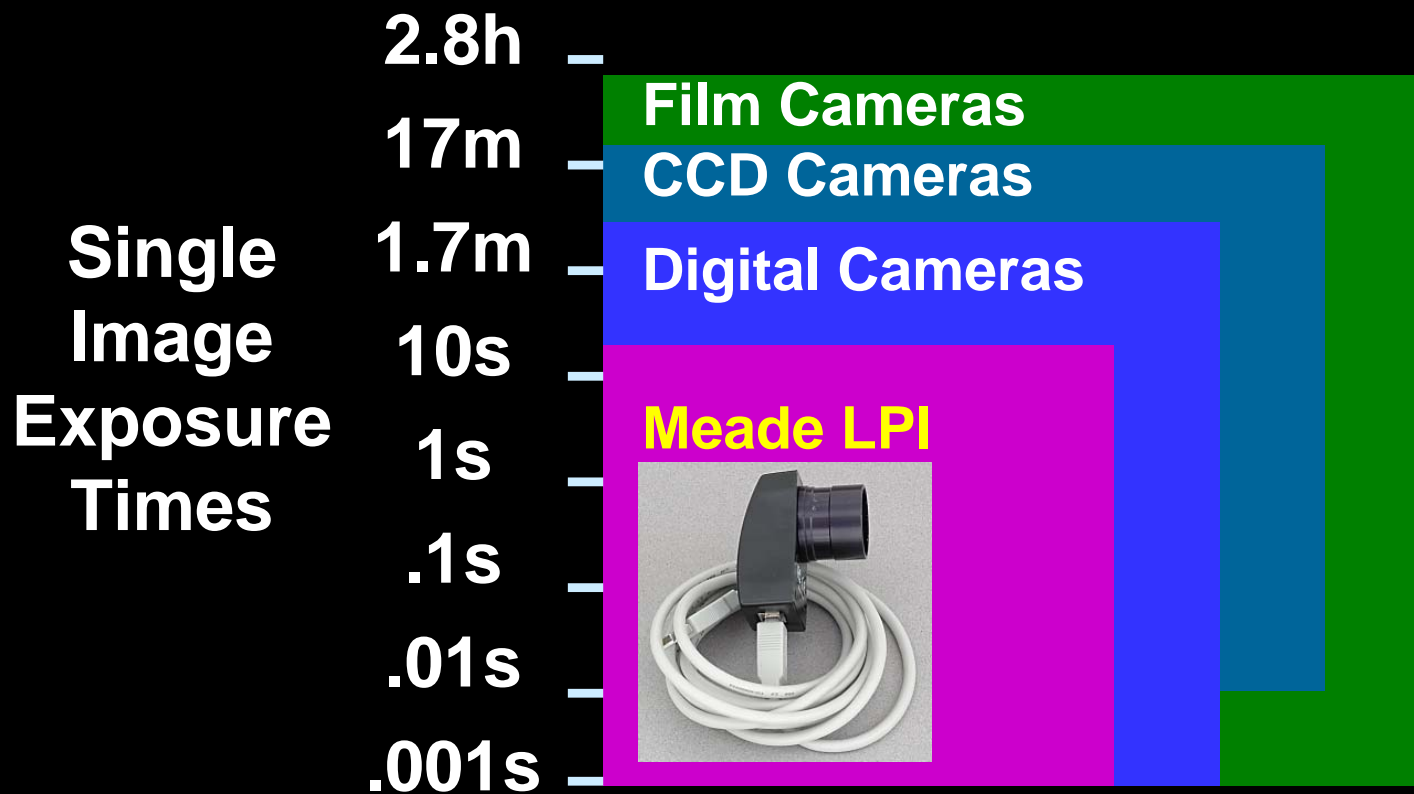


Limited by electronic noise

Digicams are typically more noisy than digital SLRs

# Camera Exposure Times

Meade Lunar Planetary Imager

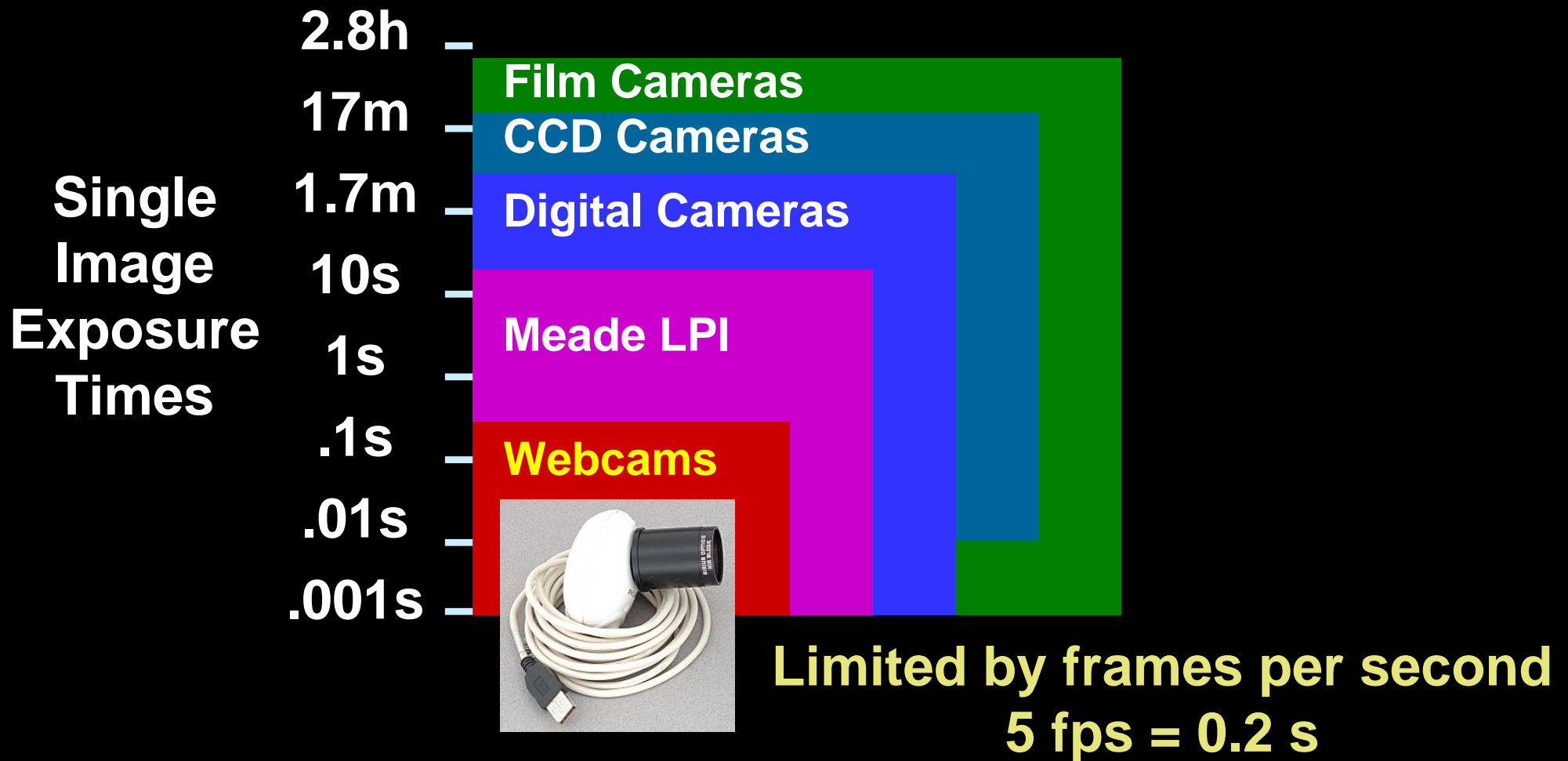


Limited by electronic noise & software limit of 16 s



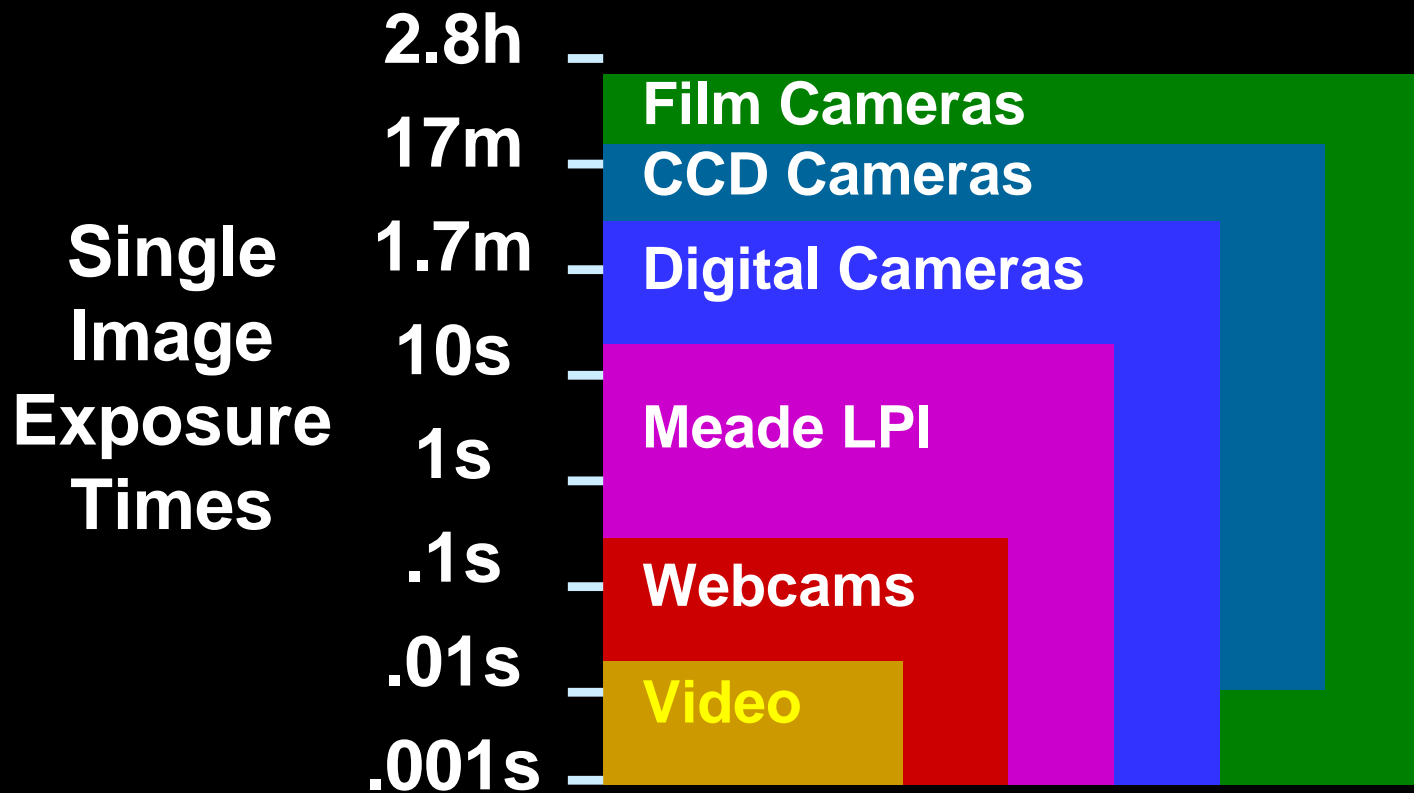
# Camera Exposure Times

## Webcams



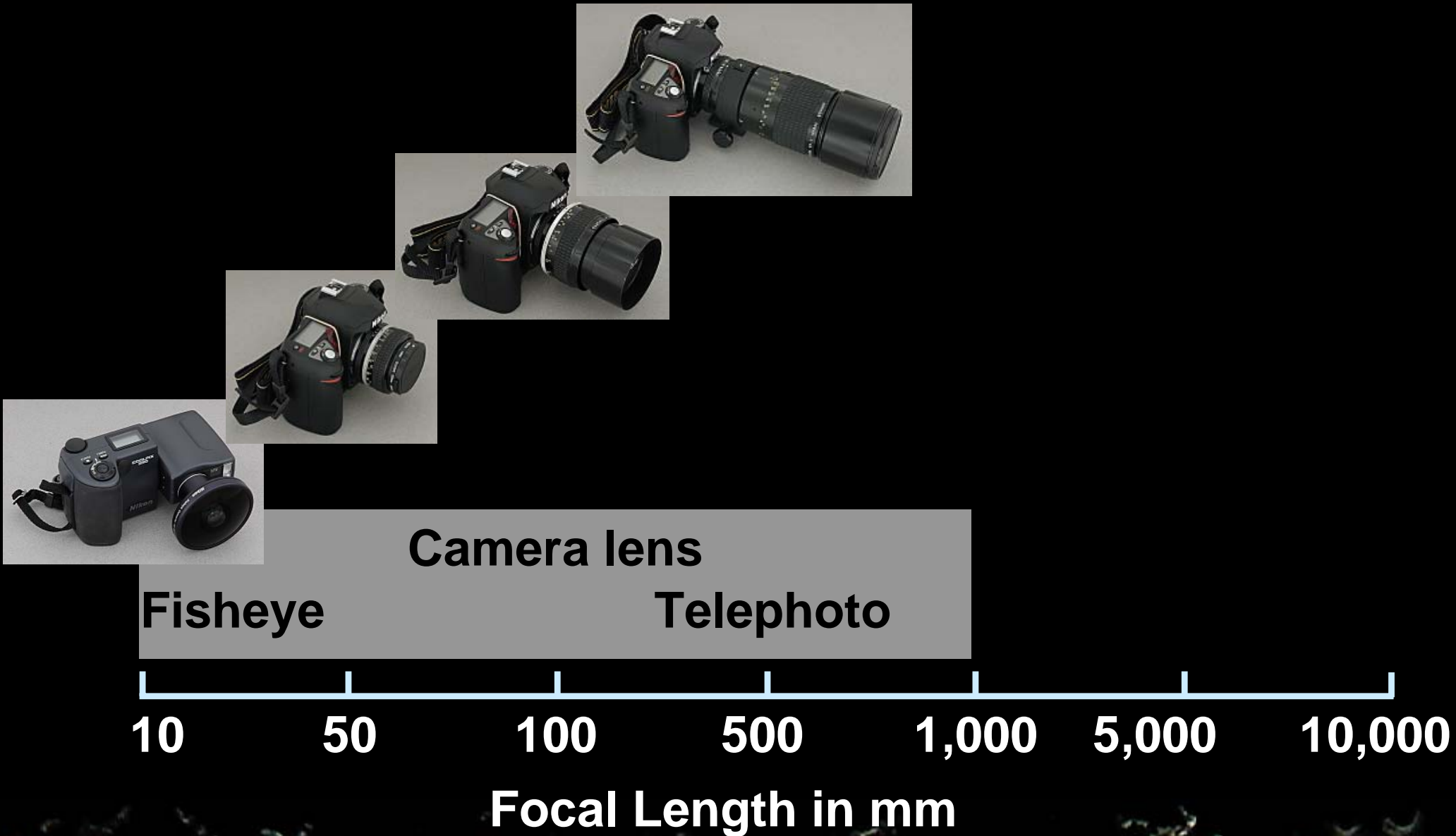
# Camera Exposure Times

## Video Cameras



Limited by video standards  $1/60 = 0.017$  sec

# Focal Length





# Focal Length

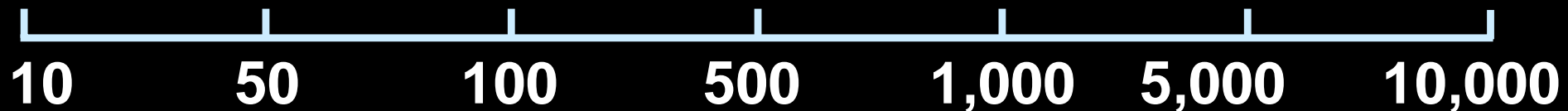


Telescopes

Camera lens

Fisheye

Telephoto



Focal Length in mm

# Focal Length



**Telescopes  
with barlow**

**Telescopes**

**Camera lens**

**Fisheye**

**Telephoto**

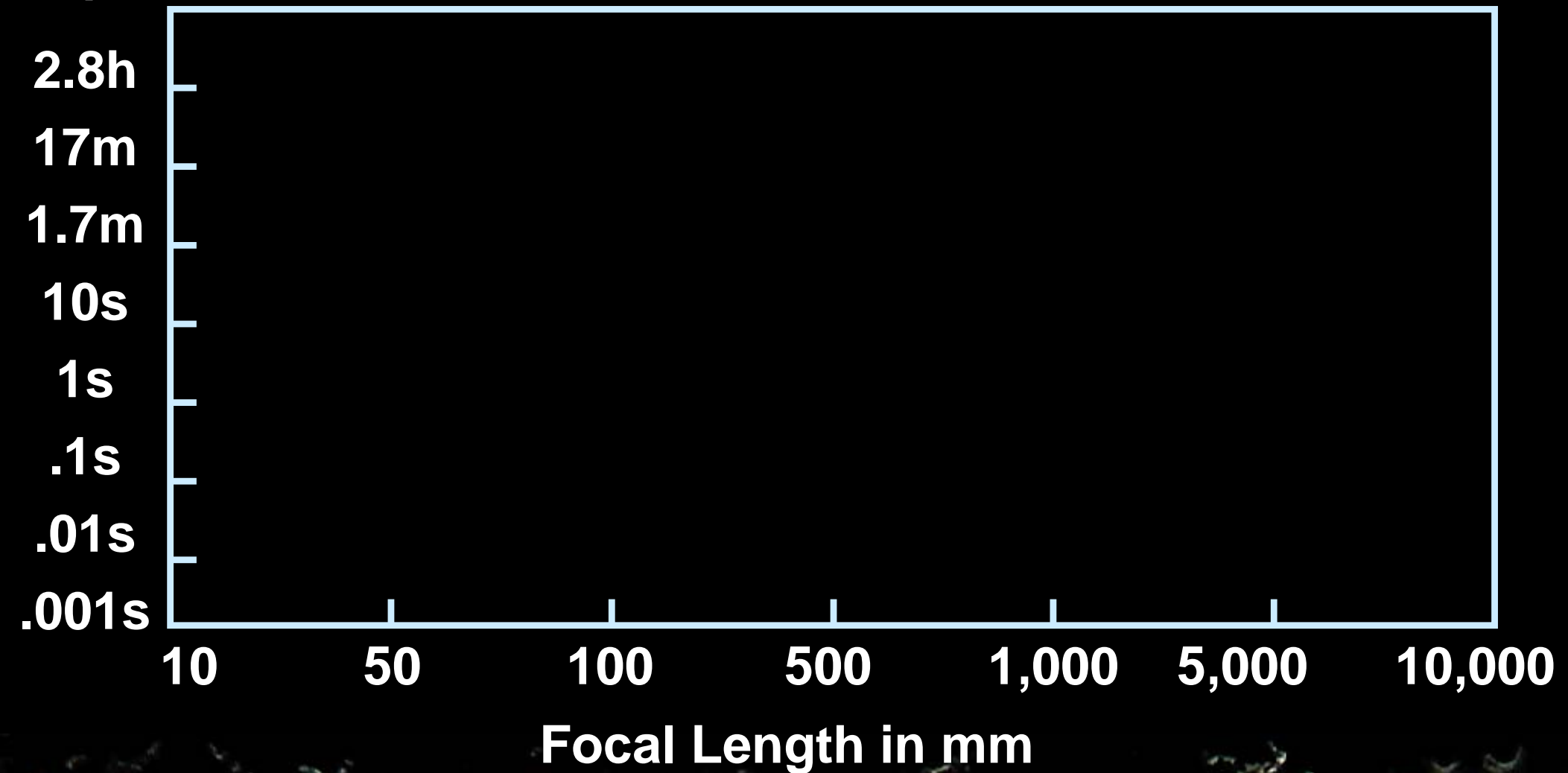
**10      50      100      500      1,000      5,000      10,000**

**Focal Length in mm**

# Exposure vs. Focal Length

Focal Ratio is third parameter

Exposure

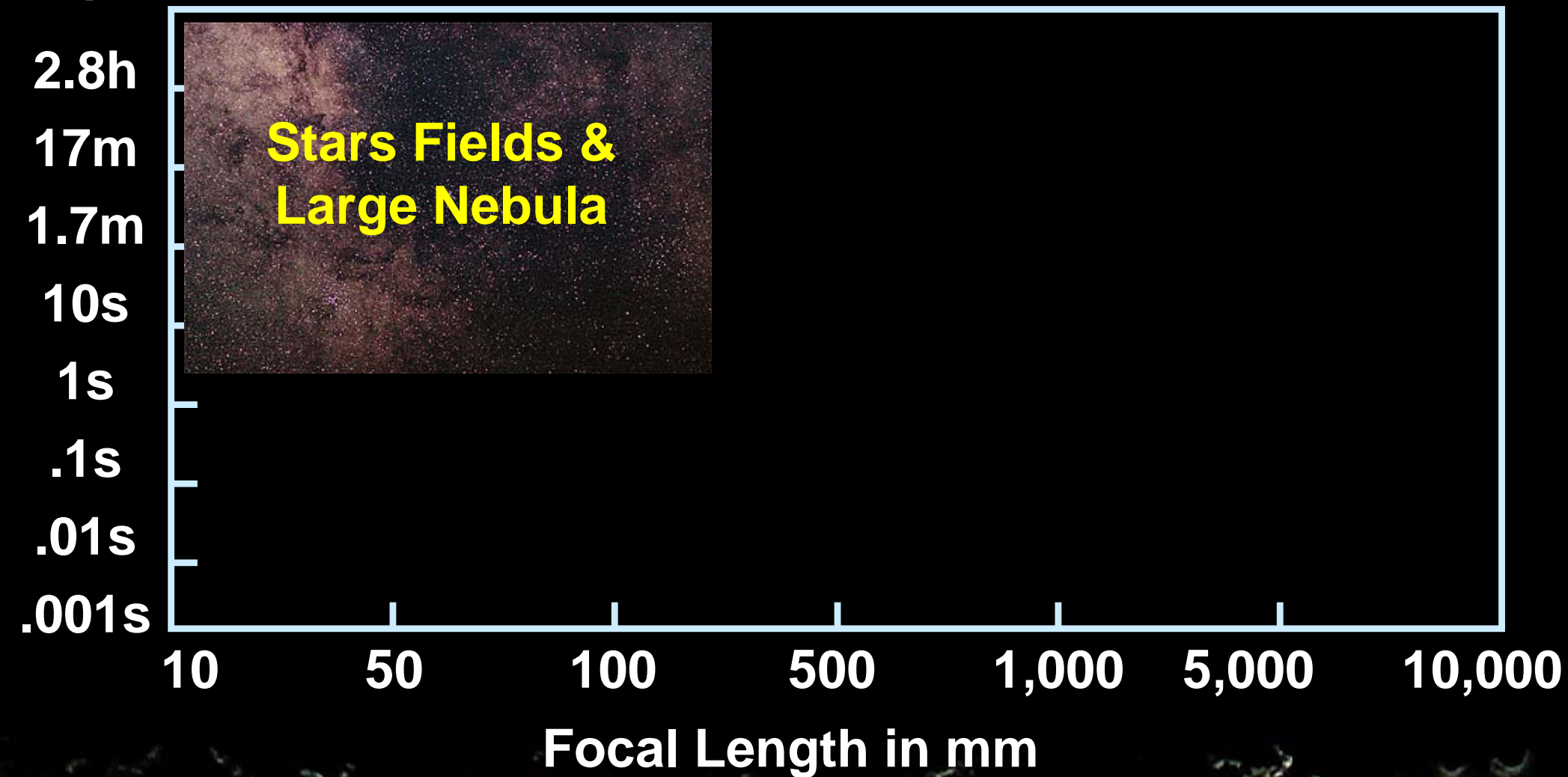




# Exposure vs. Focal Length

Focal Ratio is third parameter

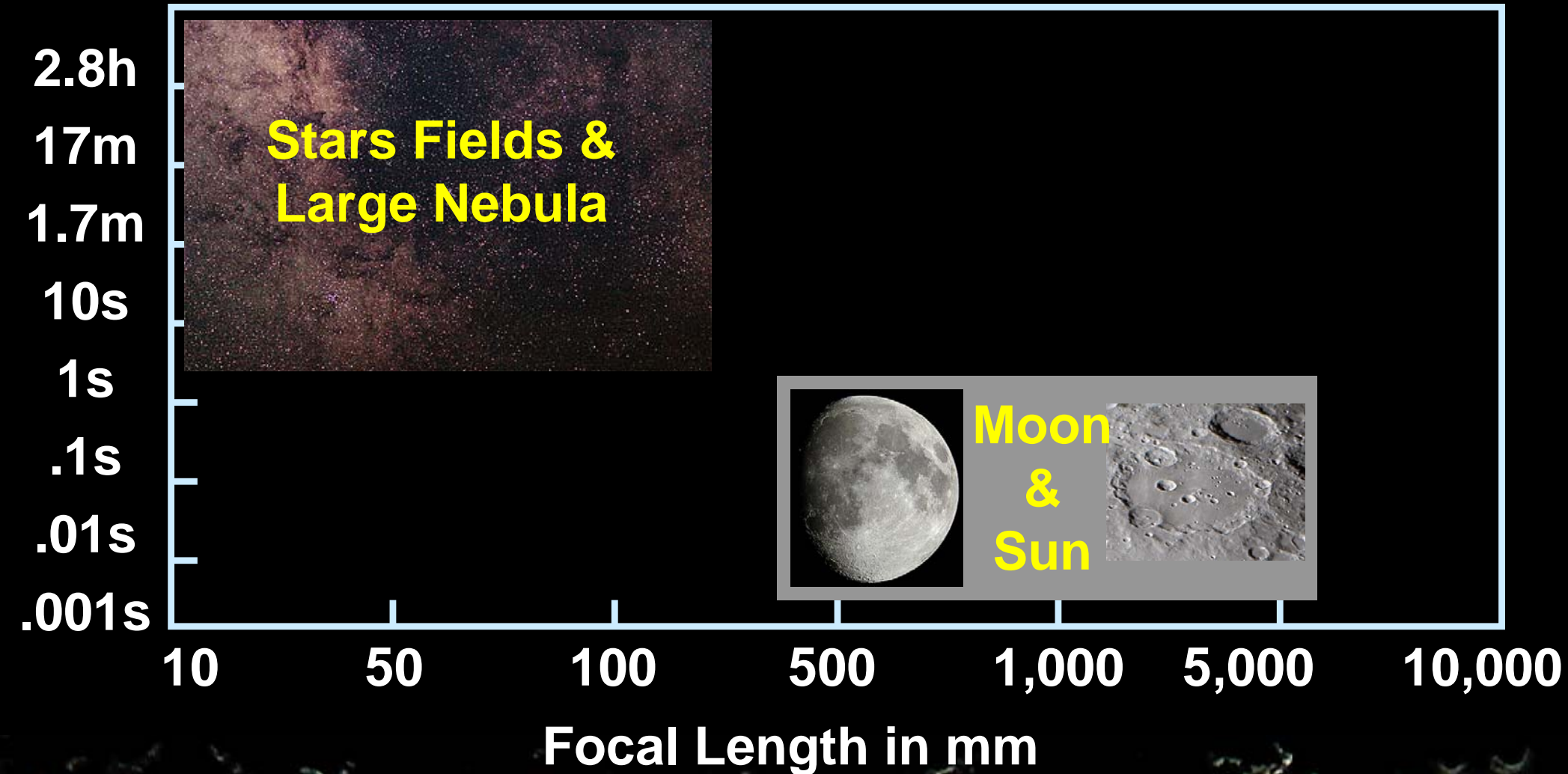
Exposure



# Exposure vs. Focal Length

Focal Ratio is third parameter

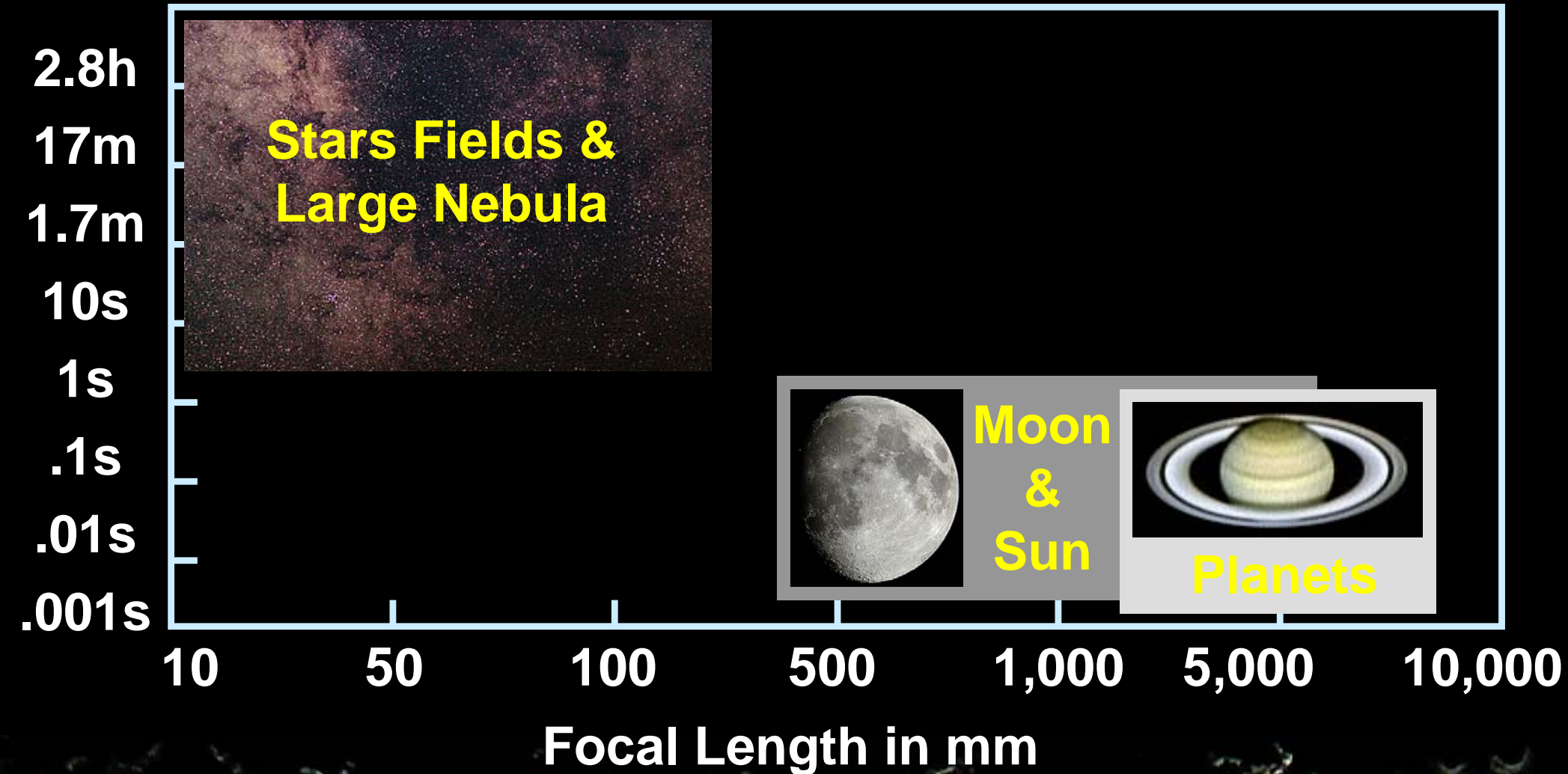
Exposure



# Exposure vs. Focal Length

Focal Ratio is third parameter

Exposure

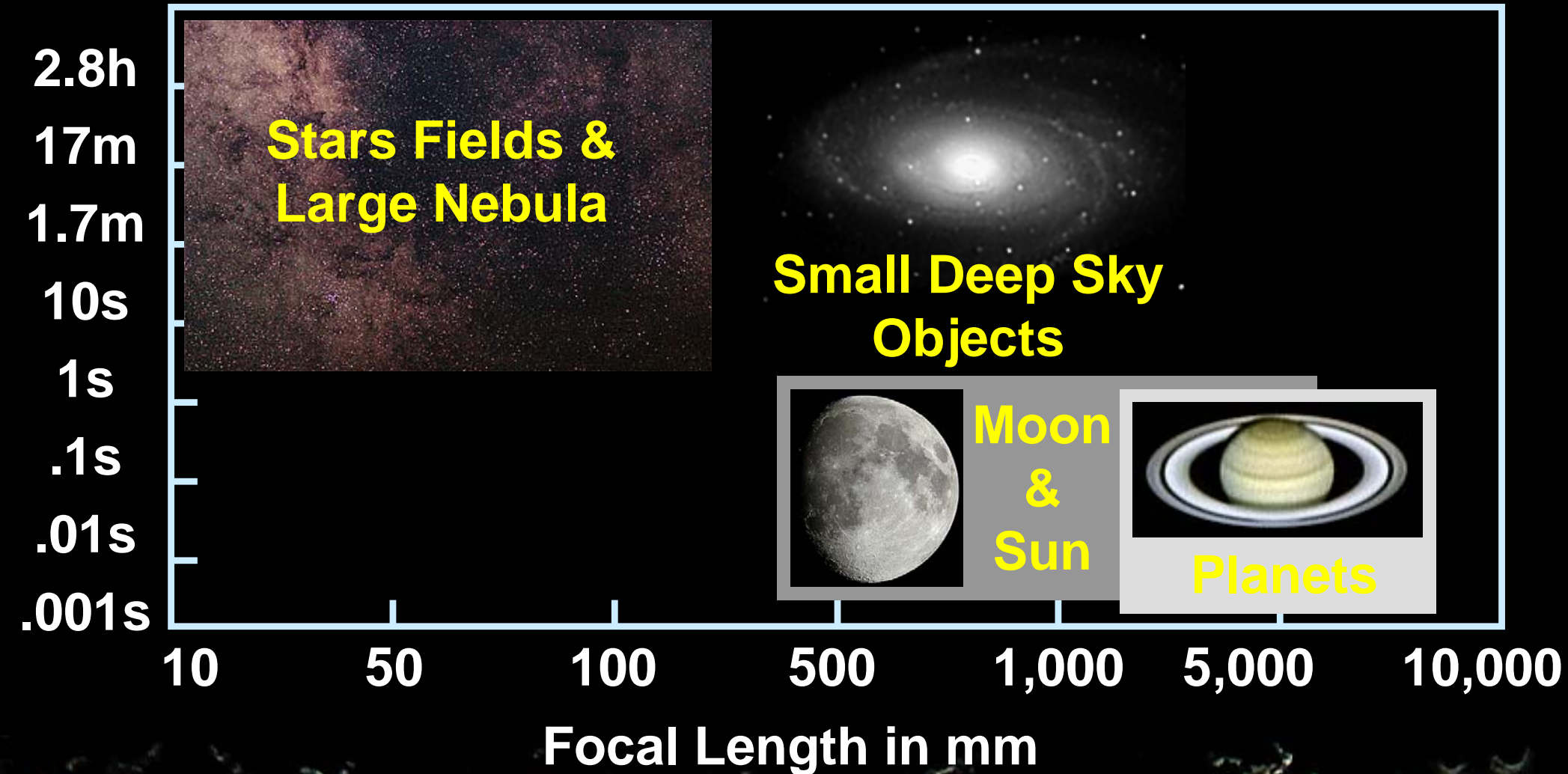




# Exposure vs. Focal Length

Focal Ratio is third parameter

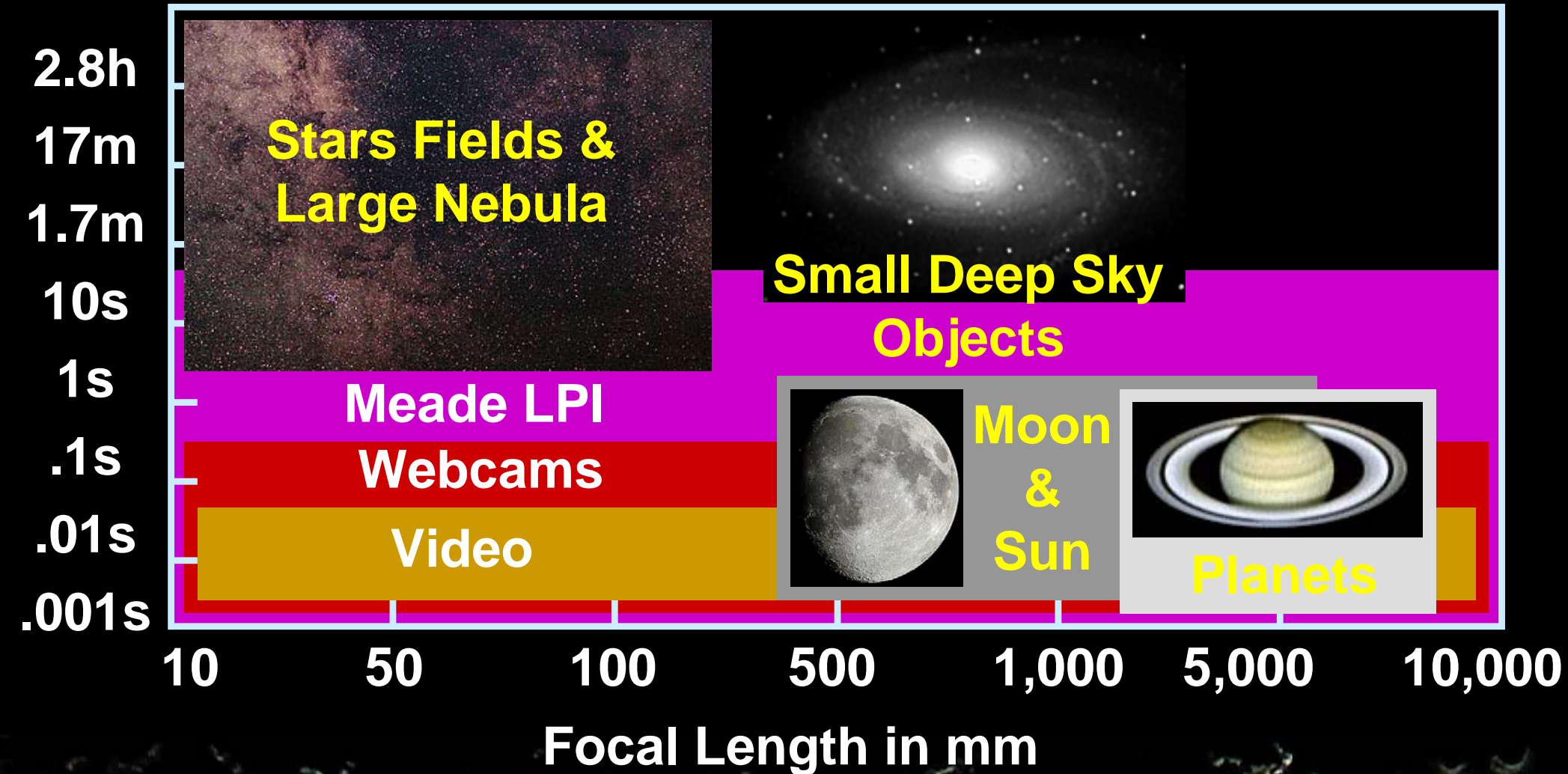
Exposure



# Exposure vs. Focal Length

Short Exposure Cameras

Exposure

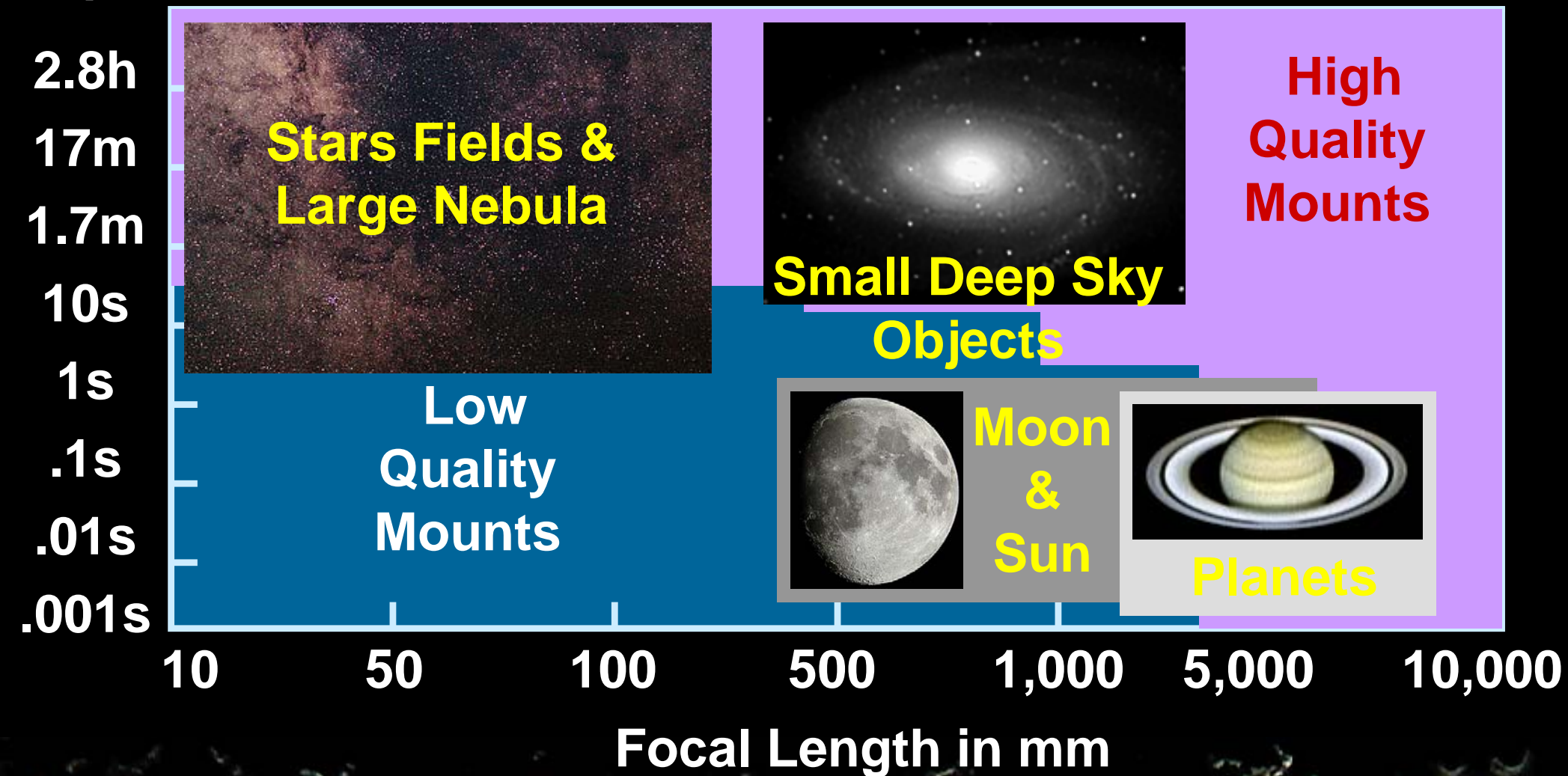




# Exposure vs. Focal Length

Mounts

Exposure





# Camera Comparisons

- 🪐 Field of view
- 🪐 Optics focal length
- 🪐 Camera sensor

# Cameras FOV Comparisons

## Using Orion 80mm Refractor 400mm Focal Length



**35mm Film**



**CCD**



**Digital SLR**



**Digicams**



**Webcams**



**LPI**

# 35mm Film FOV

Using Orion 80mm Refractor 400mm Focal Length



**35mm Film**  
**36mm x 24mm**

**Simulation image**  
**Moon is 3.6mm**





# Nikon D70 FOV

Using Orion 80mm Refractor 400mm Focal Length



**D70 Digital SLR**  
**3008 x 2000**  
**23.7mm x**  
**15.6mm**  
**Difficult to**  
**focus**

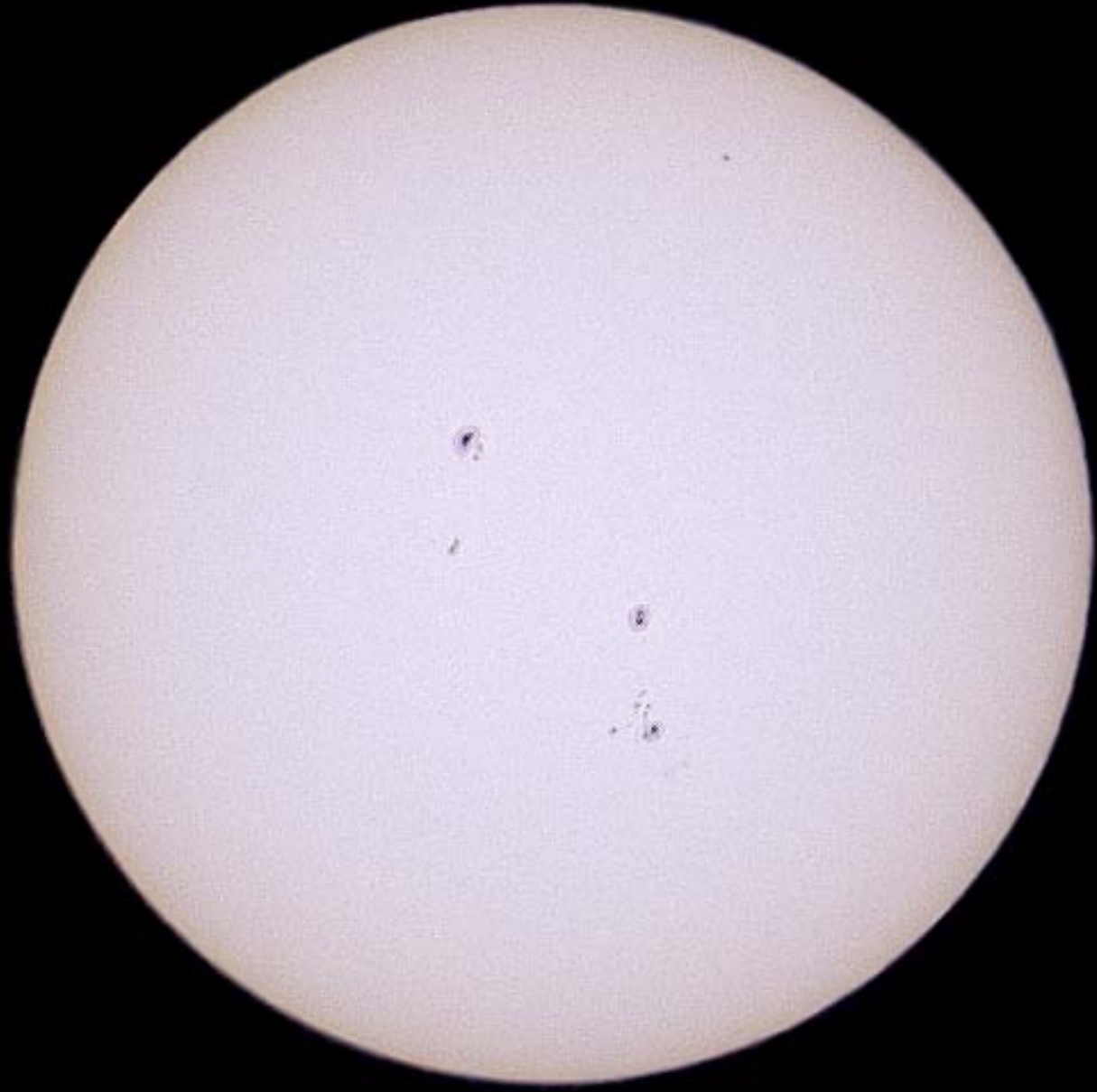


# Nikon D70 FOV

Using Orion 80mm Refractor 400mm Focal Length



**Digital SLR**  
**640 x 480**  
**crop**





# Nikon 990

Orion 80mm Refractor 400mm Focal Length



**Digicams**  
**Nikon 990**  
**afocal**  
**photography**  
**with eyepiece,**  
**Easy to focus**



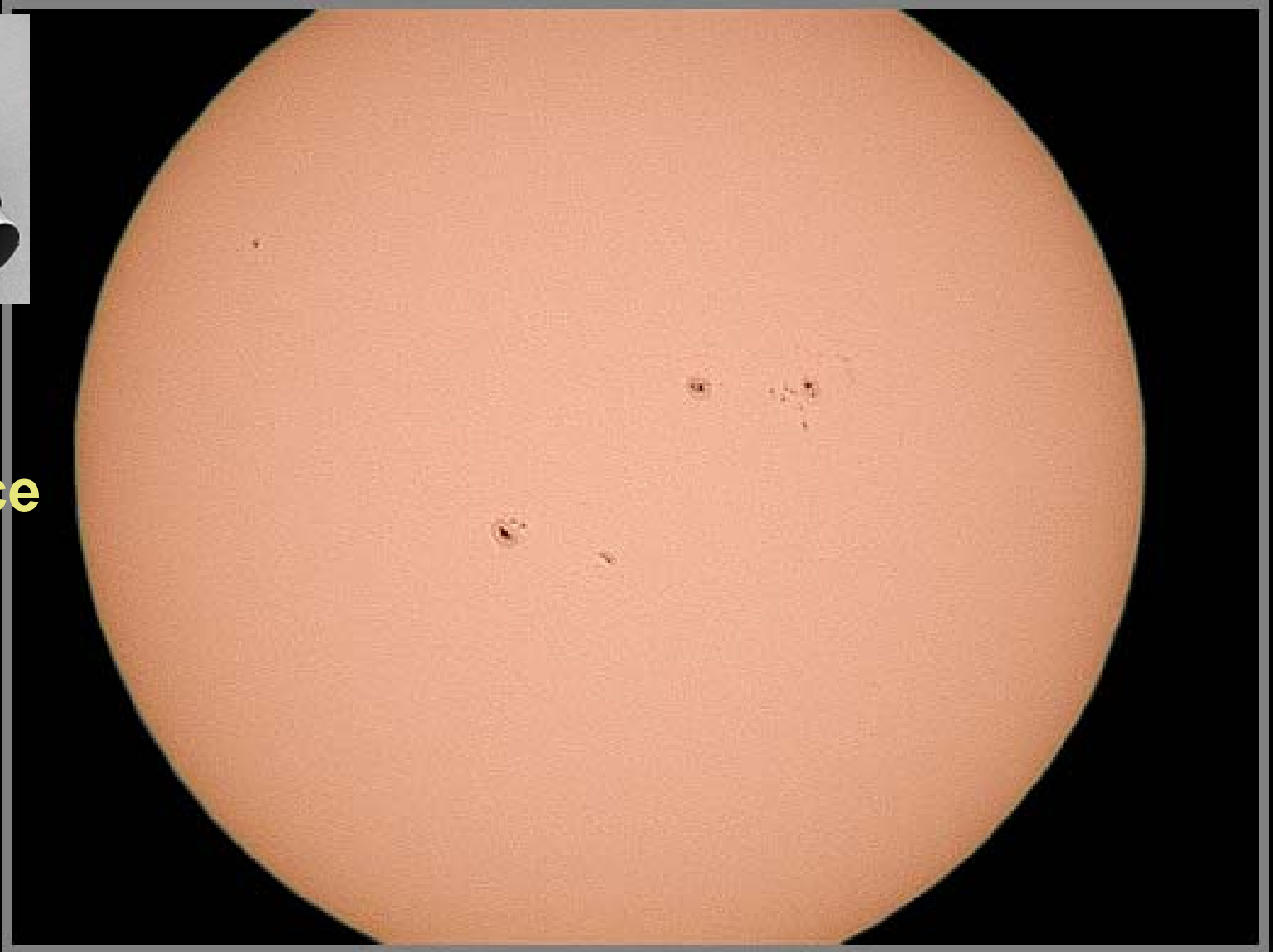


# Nikon 990 FOV

Using Orion 80mm Refractor 400mm Focal Length

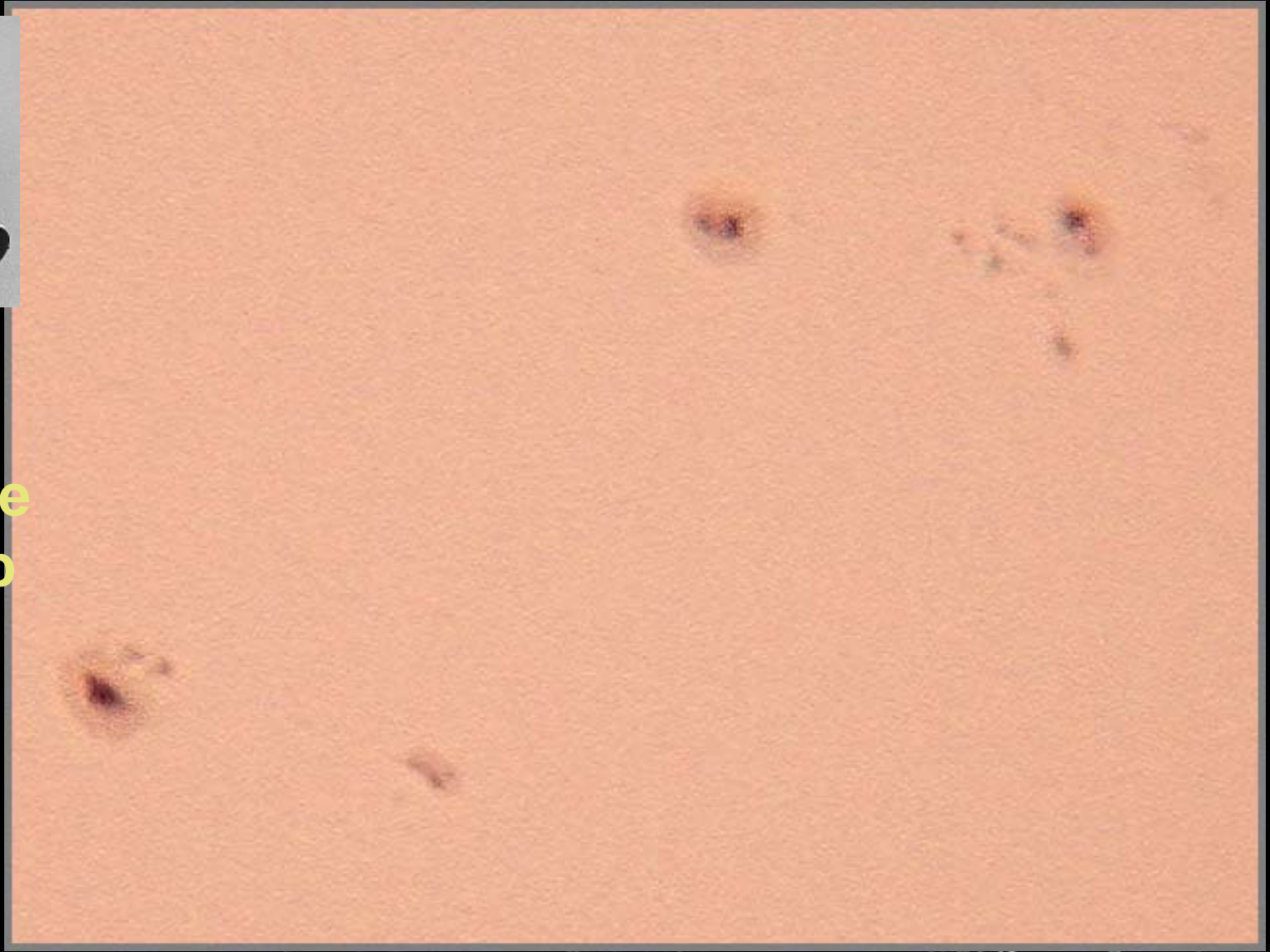


**Digicams**  
**Nikon 990**  
**14mm eyepiece**  
**2048 x 1536**



# Nikon 990 FOV

Using Orion 80mm Refractor 400mm Focal Length



**Digicams**  
**Nikon 990**  
**14mm eyepiece**  
**640 x 480 crop**



# SBIG ST237

Orion 80mm Refractor 400mm Focal Length



**SBIG ST237**

**Laptop**

**120 Vac or 12 Vdc**

**Slow downloading  
image to laptop**



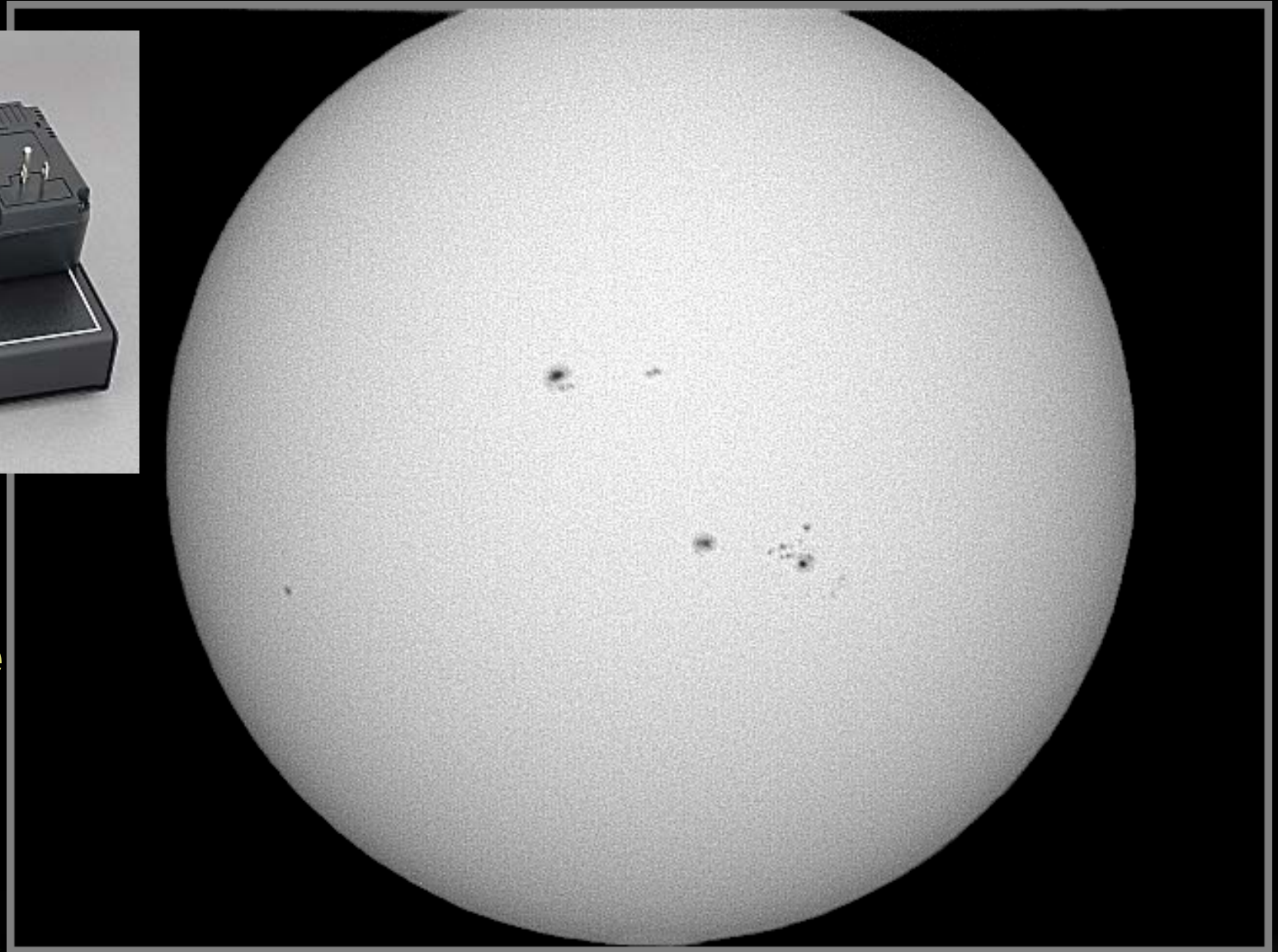


# ST237 FOV

Using Orion 80mm Refractor 400mm Focal Length



**CCD**  
**640 x 480**  
**monochrome**



# 740 ToUcam

Orion 80mm Refractor 400mm Focal Length



**ToUcam**  
**Laptop**  
**USB powered**  
**Fast focusing**  
**White case**  
**leaks light**





# 740 ToUcam FOV

Using Orion 80mm Refractor 400mm Focal Length



**ToUcam**  
**301 images**  
**stacked**  
**640 x 480**  
**632 x 477**  
**crop,**  
**Small FOV,**  
**Diagonal**  
**4.5mm**





# Meade LPI

Orion 80mm Refractor 400mm Focal Length



**Meade LPI  
Laptop  
USB powered**



# Meade LPI FOV

Using Orion 80mm Refractor 400mm Focal Length



**LPI**  
**640 x 480**





# ToUcam, LPI & BTC Cameras





# Webcam & LPI Imaging

	Cost	Availability	Time to use
740	\$93 + \$75 IRF \$20 Adp.	Not available, Replaced by 840	Less than 5 minutes
LPI	\$150	Sean's Astronomy Shop	Ready to use
BTC	\$20 + \$40 IRF \$7 Adp.	Fry's Electronics	A lot of work

# Webcam & LPI Imaging

	Advantages	Disadvantages
740	Good light sensitivity, Smallest pixels, ready to use adapters	Large AVI files, long image processing time
LPI	Real-time image processing, good color balance, electronic eyepiece	Less light sensitive, software crashes
BTC	Very low cost	No gain control, Not recommended

# ToUcam Imaging

🪐 Advantages

🪐 Disadvantages

🪐 Hardware

🪐 Software





## USB PC-camera PCVC740K

### Full Video Power

#### • High sensitivity CCD sensor

Record high quality VGA video even at light levels below 1 Lux.

#### • 60 fps flickerfree video

High update rate gives true natural motion sensation.

#### • Megapixel still pictures

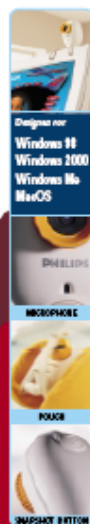
Philips' technologies make your snapshots sharp as a knife in 1280x960 resolution.

#### • Built-in microphone

Digital USB microphone immune to ticks, clicks and hum of your computer.

#### • Remote voice control

Create snapshot by voice command.



Let's make things better.



PHILIPS

## USB PC-camera



### Video Power

Philips' solution for video performance at your desktop.

With the ToUcam range, Philips sets the pace for how PC video cameras should look and perform in the future. Each camera in the ToUcam range has highly integrated components built into a really cute, compact bird-shaped housing. Everything about the ToUcam PRO is performance. From its high quality video, versatile design with travel pouch, to the flawless operation, the ToUcam PRO has it all. Obviously at a quality you'd expect from a 'A' brand company.

### High Performance

• Sensitivity - Many times the scenes you record are not made in ideal lighting conditions as created in studios. Then you will appreciate this PC-camera's excellent ability to adjust to merely any lighting condition, ranging from candles to bright sun-light.  
• Framerate - Streaming video consists of a sequence of frames. The more frames, the more fluent the perception of movement.

With 60 frames per second you are assured of an optimum refresh rate for the human eye.

• Resolution - A digital image consists of a large set of pixels. The more pixels, the more details you can recognize in the images. The ToUcam PRO delivers video in as many as 307,200 pixels. Still images are built up with over 1 million pixels.

### Voice controlled snapshot

• There's no longer a need to push a button to make a snapshot, just smile and say "cheese". The camera will pick up this command and execute the snapshot function.

### Easy travel pouch

• While on the move you can take your camera anywhere. The pouch included with the ToUcam PRO protects it while transporting.

### Technical specifications ToUcam PRO - PCVC740K

Packaging content  
ToUcam PRO PC-camera ✓  
Quick install guide ✓  
Installation CD-ROM ✓  
Attachment base ✓  
Easy travel pouch ✓

#### Included Applications for Microsoft Windows

Application	Name	By
• Web cam + broadcast	Spotlite	Microsoft
• Video conferencing	NadMeeting 3.01	Microsoft
• Video mail	VideoLink Mail 4.0	Smith-Micro
• Image capture	Photo Explorer 6.0	Ulead
• Image album	Photo Explorer 6.0	Ulead
• Image editing	Photo Express 2.0	Ulead
• Video capture	V-recorder	Philips
• Game I	Vball	Reality Fusion
• Game II	Karate	Reality Fusion
• Screensaver game I	Bounce-It 2	Reality Fusion
• Screensaver game II	Pop the Bubbles 2	Reality Fusion
• Internet update tool	Vdownload	Philips
• Configuration check	Vcheck	Philips
• Application launcher	Vcunge	Philips
• Camera settings	V-property	Philips
• PDF reader	Acrobat Reader 4.05	Acrobat

#### Included Applications for Apple Macintosh

• Video mail	BTv
• Webcam	Oculus
• Video conference	Net
• Video capture	Quicktime

#### Packaging Information

H x W x D	285 x 160 x 88 mm
Packaging weight	431g.

#### Product Specification

Optical Sensor	1/4" CCD
Video Resolution	640 x 480 pixels (VGA)
Snapshot resolution	1280 x 960 pixels (Megapixel)
Min Illumination	< 1 Lux
Auto white balance	2500 - 7500 K
Integrated lens	6mm f2.0 H33°
Max framerate	60 fps
Color depth	24 bits

Audio	
Micro Sensitivity	75 - 105dB
Micro frequency range	150Hz - 10kHz

#### Controls

Full automatic control	✓
Video format	✓
Framerate	✓
Brightness	✓
Gamma	✓
Saturation	✓
Contrast	✓
White balance	✓
Exposure	✓
Recording volume	✓

Characteristics	
H x W x D	69 x 48 x 48 mm
Weight	110 g
Cable length	2.95 m
Built-in snapshot button	✓
Built-in microphone	✓
Monitor and LCD mounting attachment base	✓
Easy travel Pouch	✓

Power	
In operation	1.2 W

#### Minimum system requirement

Microsoft Windows	Apple Macintosh
Windows 98, 2000, Me	Apple Mac OS 9.0
Intel Pentium II or AMD K6-2	Mac Rev A - D
32 MB RAM	32 MB RAM
50 MB free HDD	50 MB free HDD
1 free USB port	1 free USB port
CD- or DVD-ROM drive	CD- or DVD-ROM drive
Audio playback capability	Audio playback capability
64K color display	64K color display
Internet connection	Internet connection

<http://www.pcstuff.philips.com>

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3112 165 63381

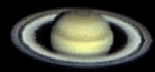
Let's make things better.



PHILIPS

# ToUcam PRO Advantages

Philips PCVC740K ToUcam PRO



< 1 lux illumination sensitivity

	PCVC720K ToUcam XS	PCVC730K ToUcam Fun	PCVC740K ToUcam Pro
Sensor	CMOS	CMOS	CCD
Pixels	352 (H) x 288 (V)	640 (H) x 480 (V)	640 (H) x 480 (V)
Still image resolution	640 (H) x 480 (V)	800 (H) x 600 (V)	1280 (H) x 960 (V)
Illumination	< 10 lux	< 5 lux	< 1 lux
Integrated lens	F2.0	F2.0	F2.0

# ToUcam PRO Advantages

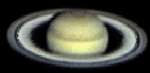
Philips PCVC740K ToUcam PRO

- 🪐 Good for bright objects
  - 🪐 Moon, Sun & Planets
- 🪐 Acquire many images very quickly
- 🪐 Simple & quick to use
- 🪐 Low cost if you have a laptop with USB
- 🪐 No external power is needed



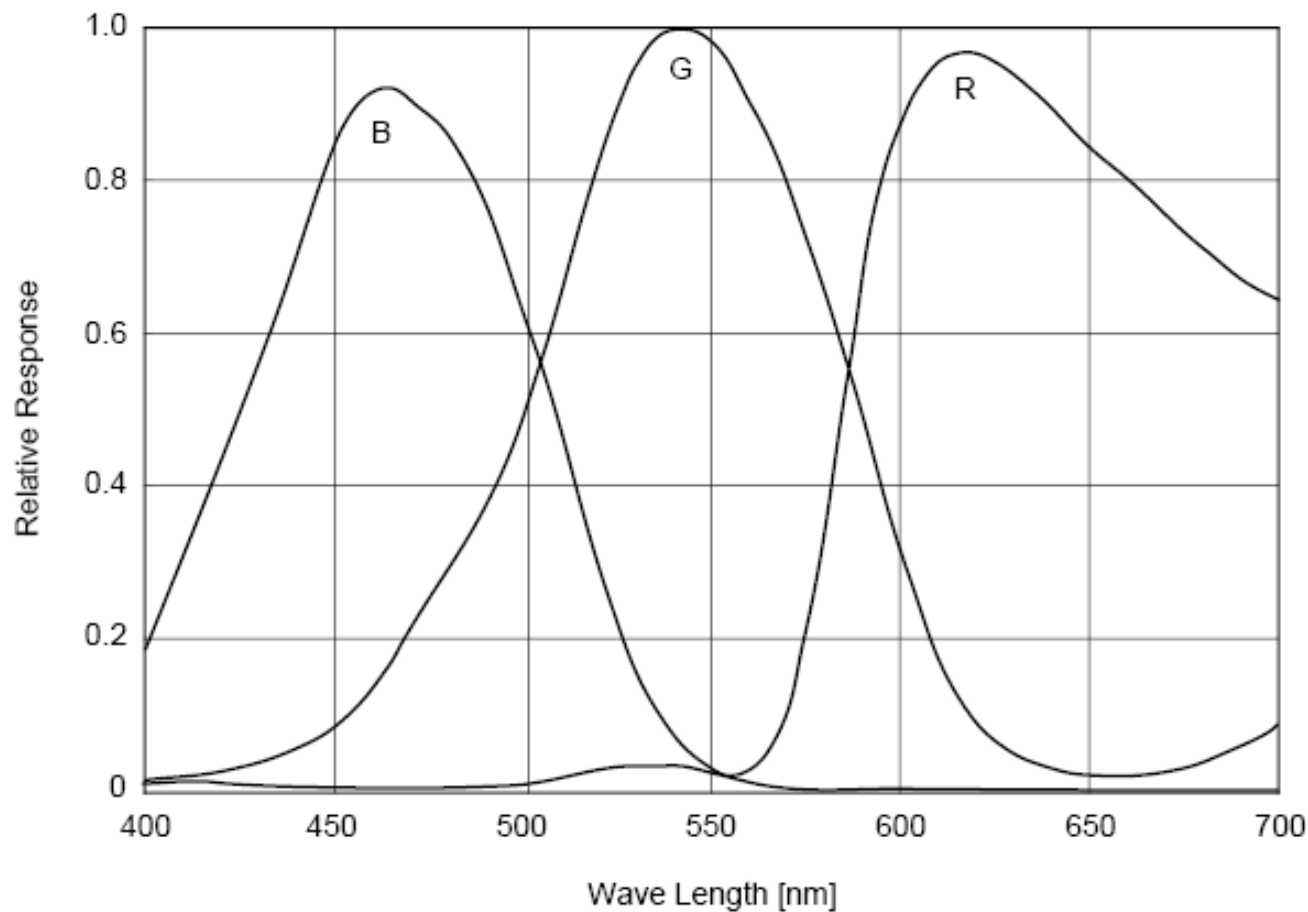
# ToUcam PRO Advantages

Philips PCVC740K ToUcam PRO



## Balanced color sensitivity

**Spectral Sensitivity Characteristics** (excludes lens characteristics and light source characteristics)



# ToUcam PRO Advantages

Philips PCVC740K ToUcam PRO

- 🪐 Small square pixel size  $5.6\mu\text{m}$
- 🪐 Single shot color
- 🪐 Progressive scan
- 🪐 Antiblooming characteristics
- 🪐 Small & light weight
- 🪐 Continuous variable-speed electronic shutter

# ToUcam Imaging

🪐 Advantages

🪐 Disadvantages

🪐 Hardware

🪐 Software





# ToUcam PRO Disadvantages

Philips PCVC740K ToUcam PRO

- 🪐 Not good for deep sky objects
- 🪐 Limited to short exposures
  - 🪐 Typical max 1/25 sec.
  - 🪐 Special max 1/5 sec. mode
- 🪐 640x480 size

# ToUcam PRO Disadvantages

Philips PCVC740K ToUcam PRO

- ☾ Typically images are noisy
- ☾ AVI compression
- ☾ Dropped frames
- ☾ Light leaks through white plastic case when solar imaging
- ☾ Hard disk is filled quickly
  - ☾ 140 sec. = 620 MB AVI file

# ToUcam Imaging

🪐 Advantages

🪐 Disadvantages

🪐 Hardware

🪐 Software





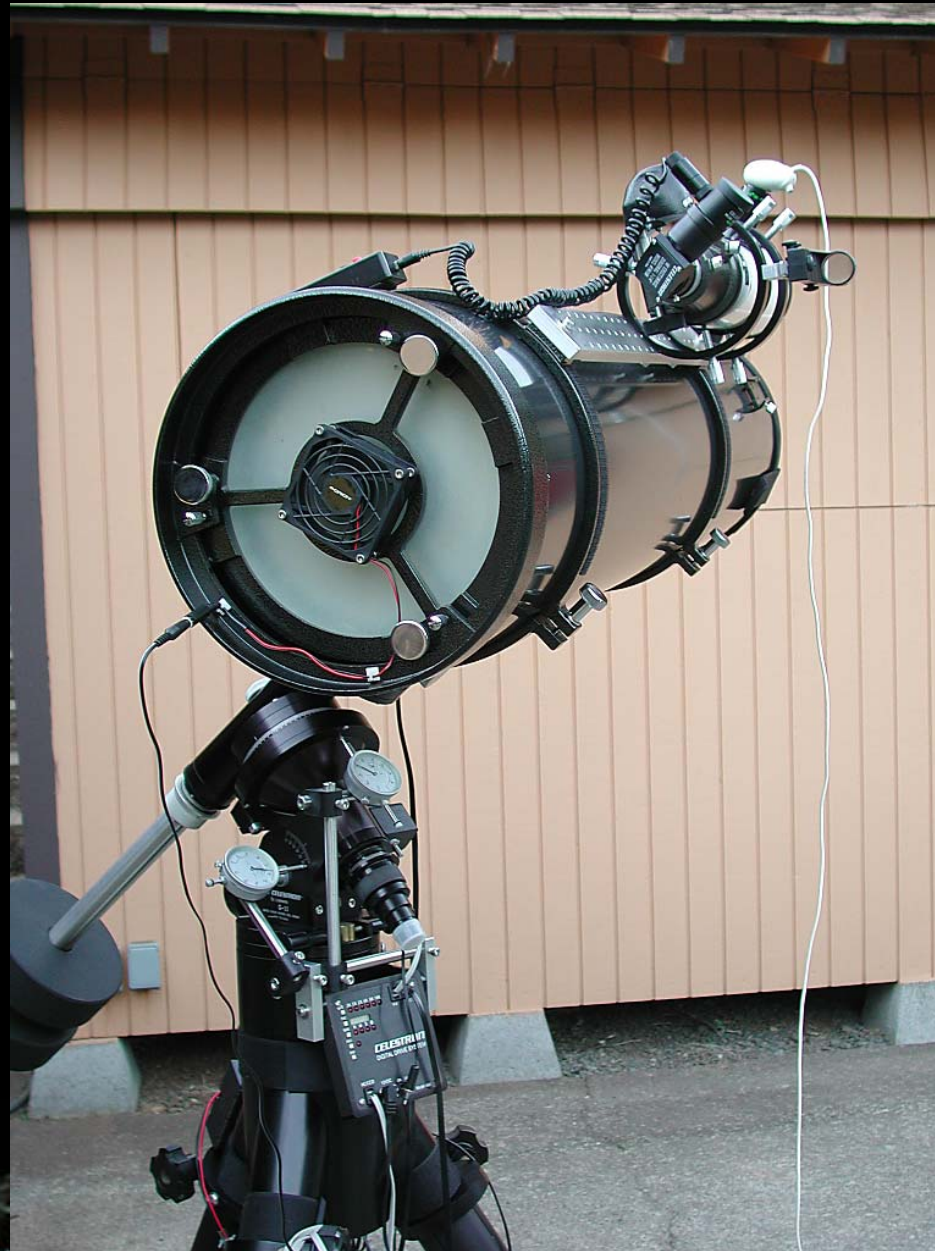
# Orion Atlas 10 Reflector on G-11

254 mm aperture, f/4.7 focal ratio, 1200 mm focal length





# Cooling the Mirror Before Imaging



# Focusing

## Diffraction Focusing





# Beta Lyra Double Star 46"

## Diffraction Focusing





# Finding the Planet

## Cross Hairs Eyepiece



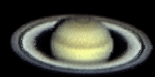


# Solar Imaging

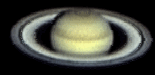




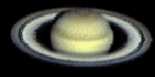
# ToUcam Imaging



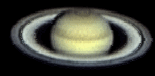
Advantages



Disadvantages



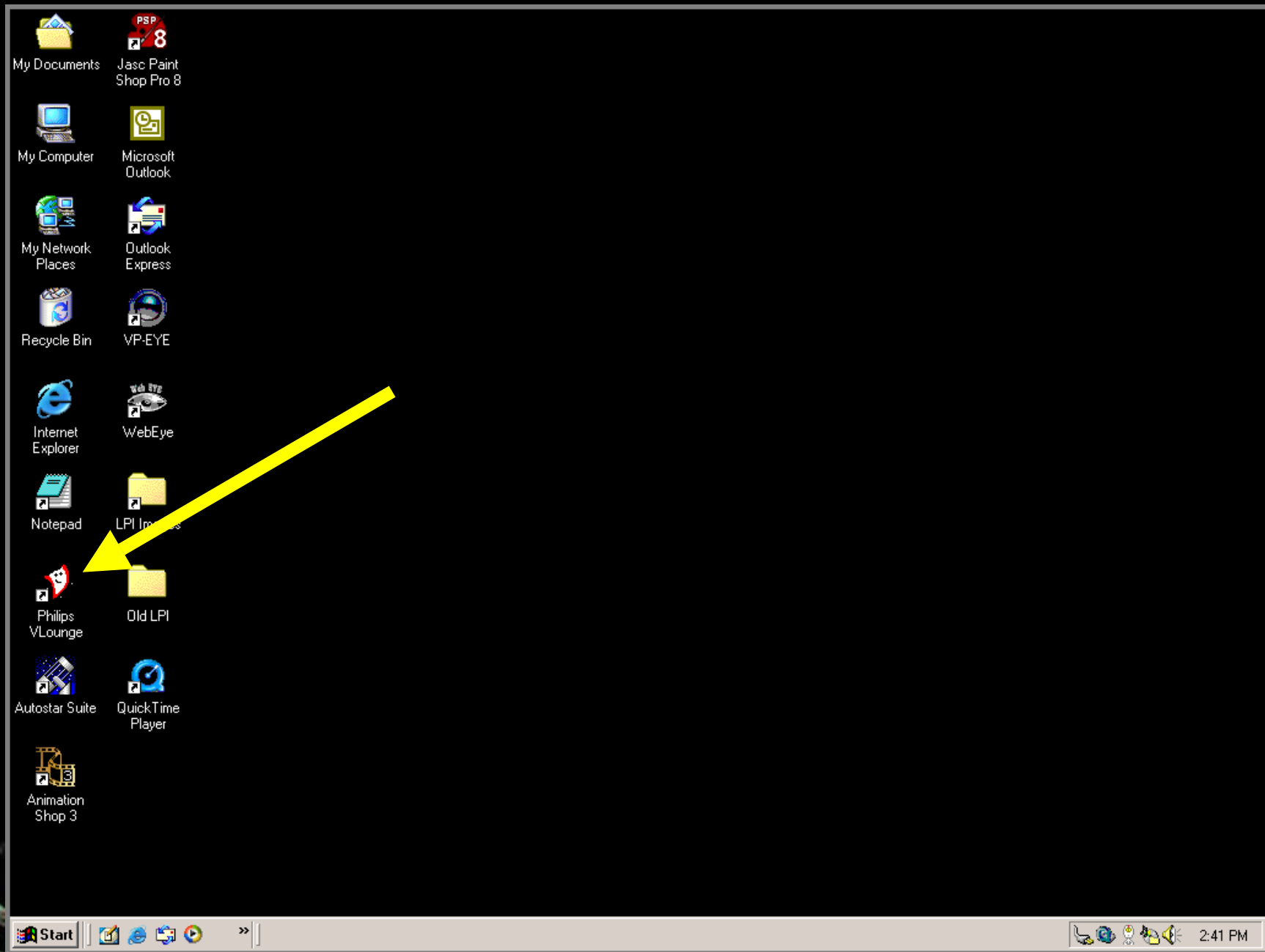
Hardware



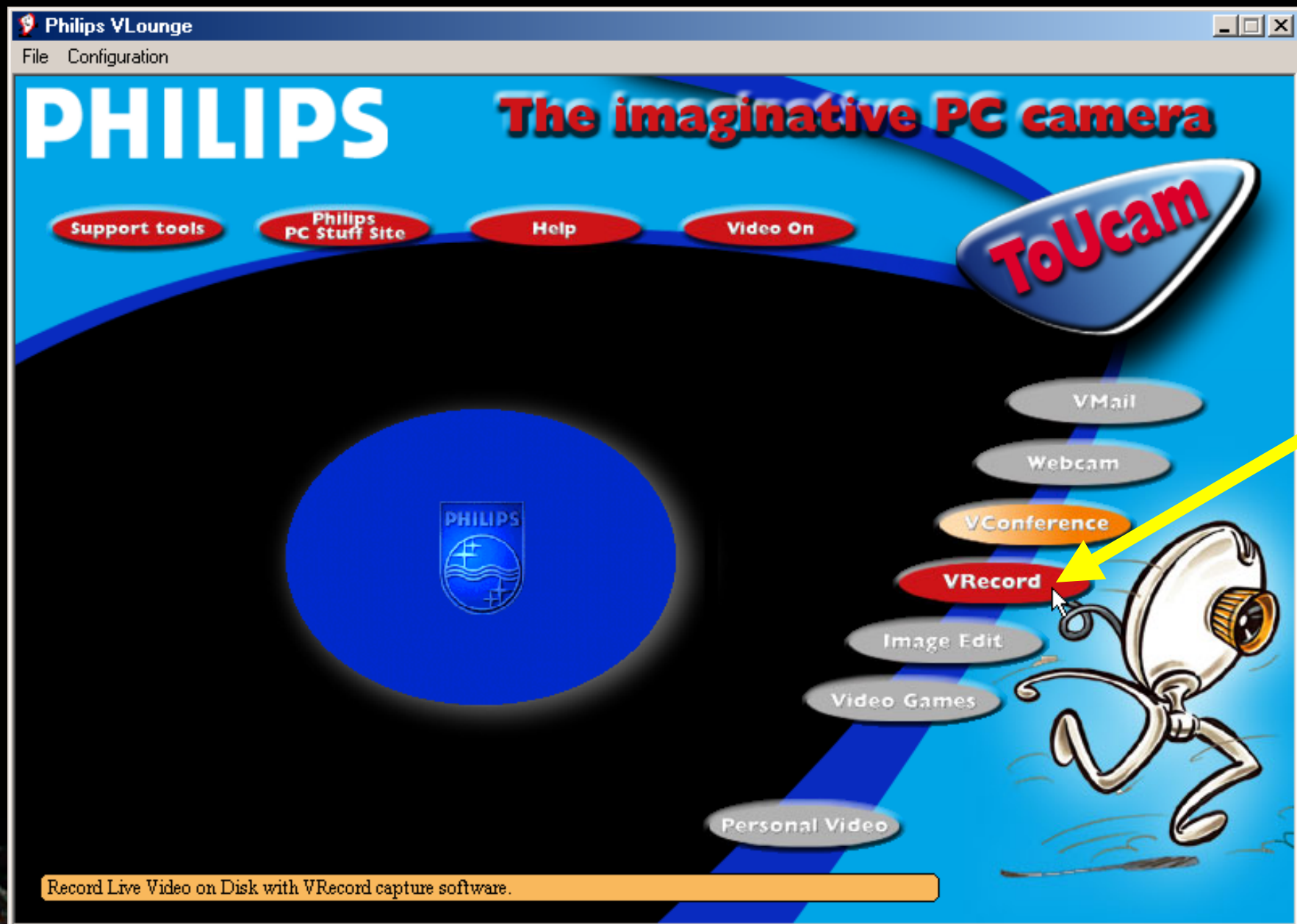
Software



# ToUcam VLounge

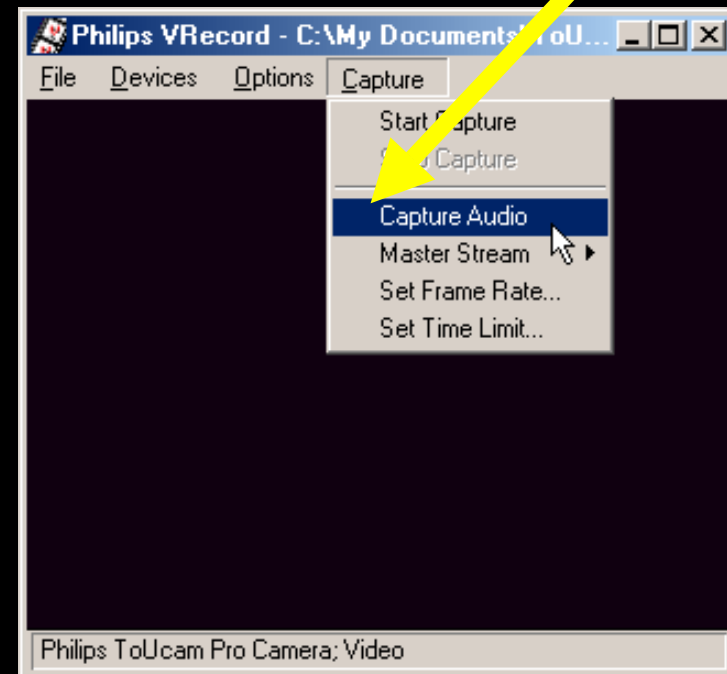
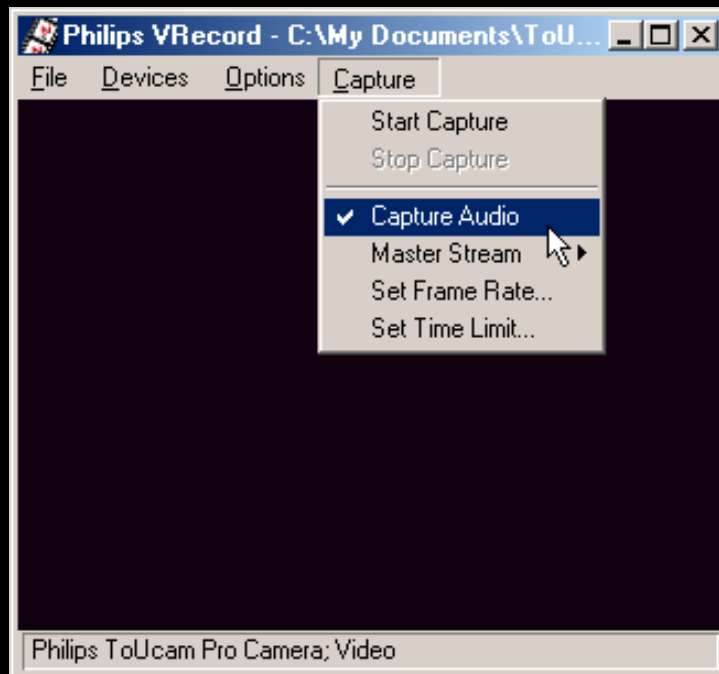


# ToUcam VLounge

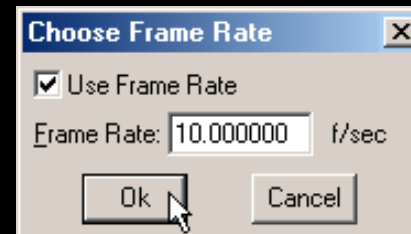
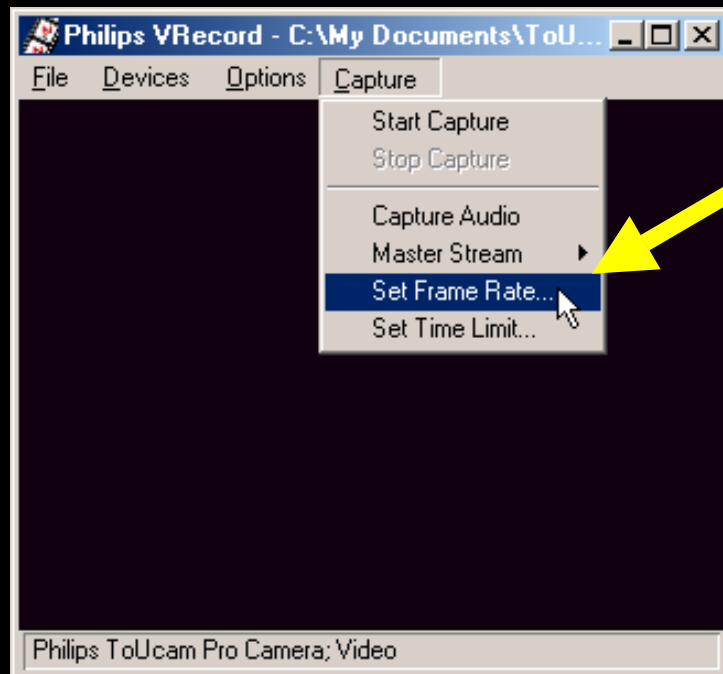




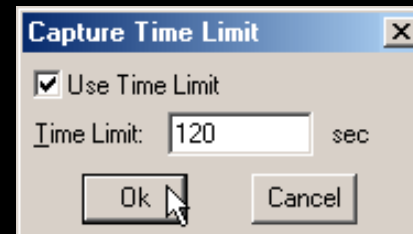
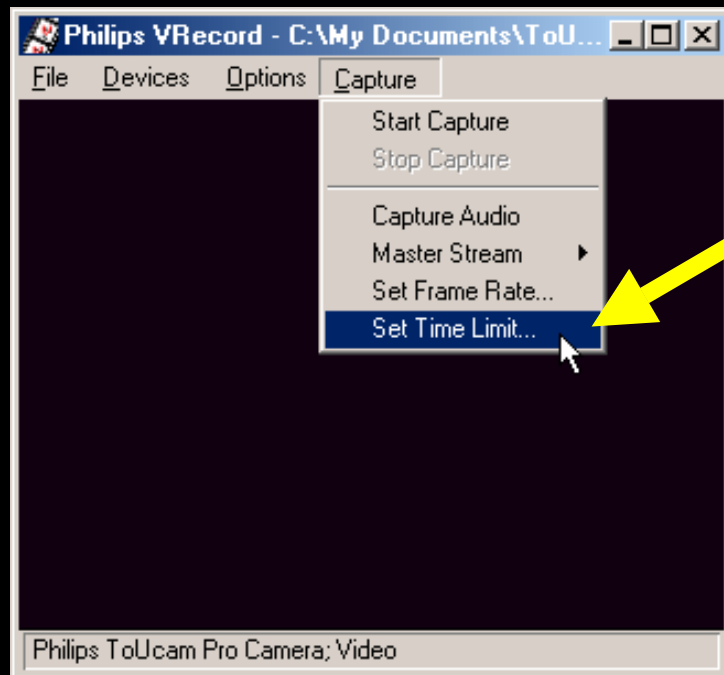
# ToUcam VRecord



# ToUcam VRecord

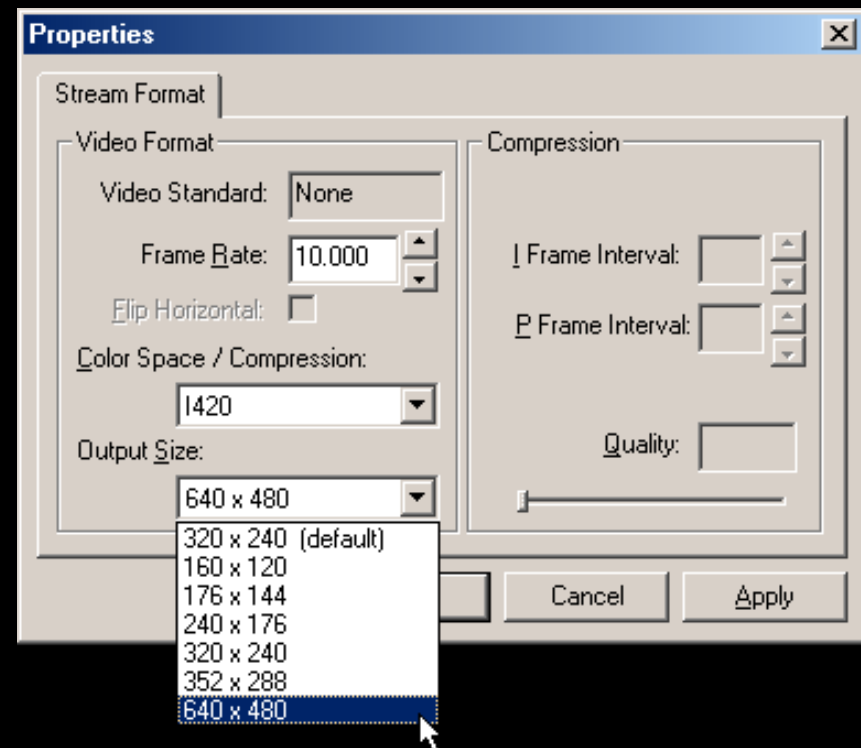


# ToUcam VRecord

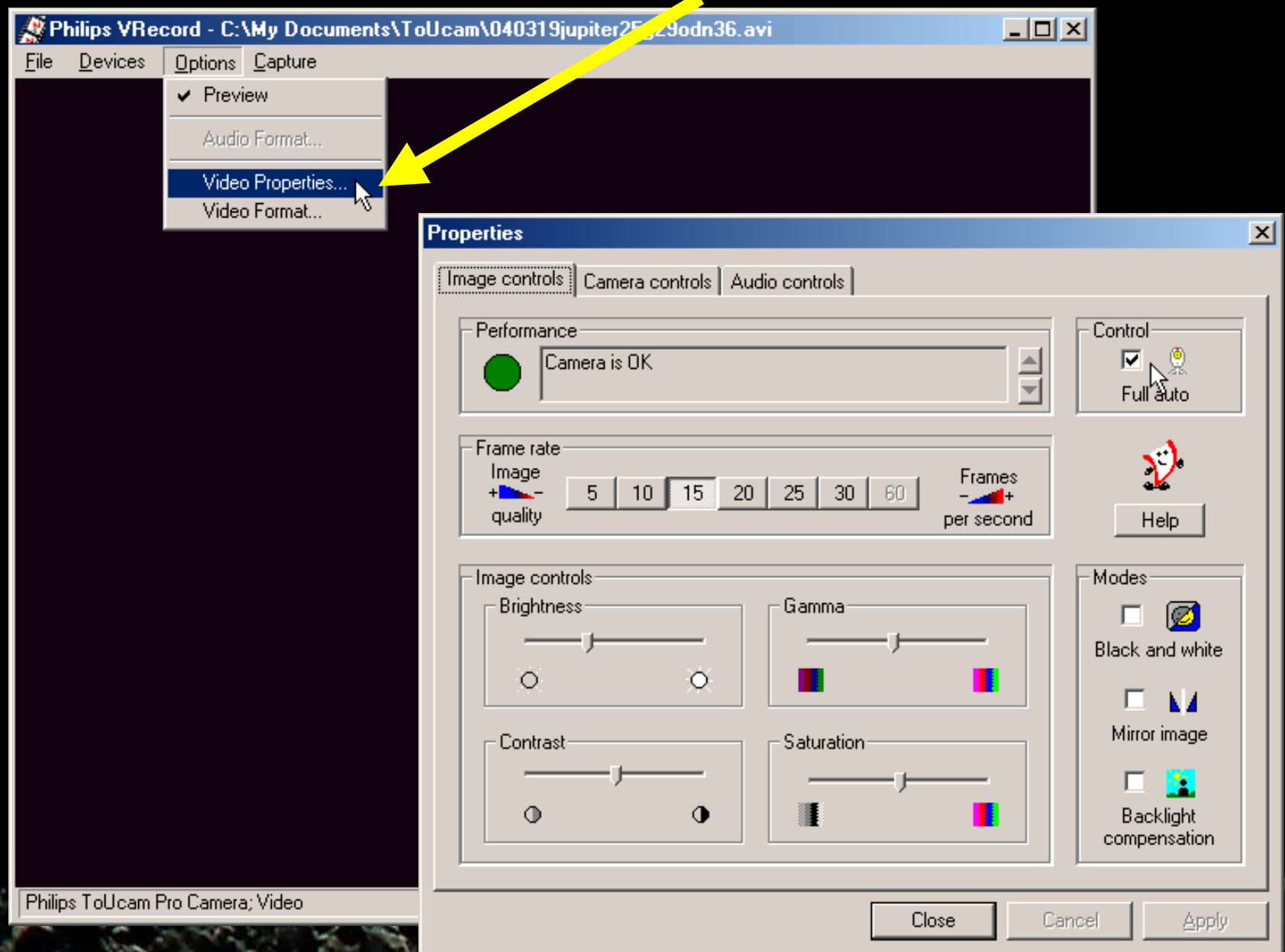




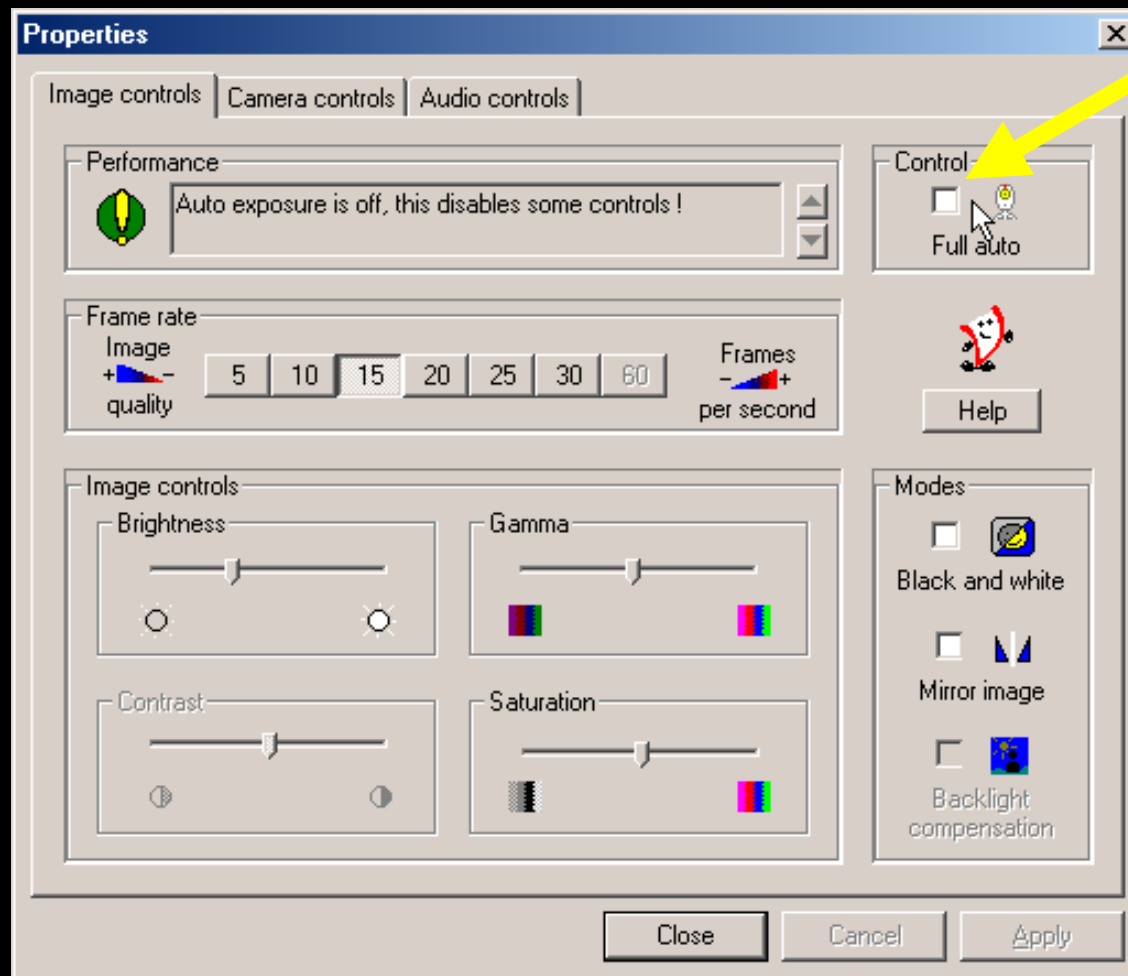
# ToUcam VRecord



# ToUcam VRecord

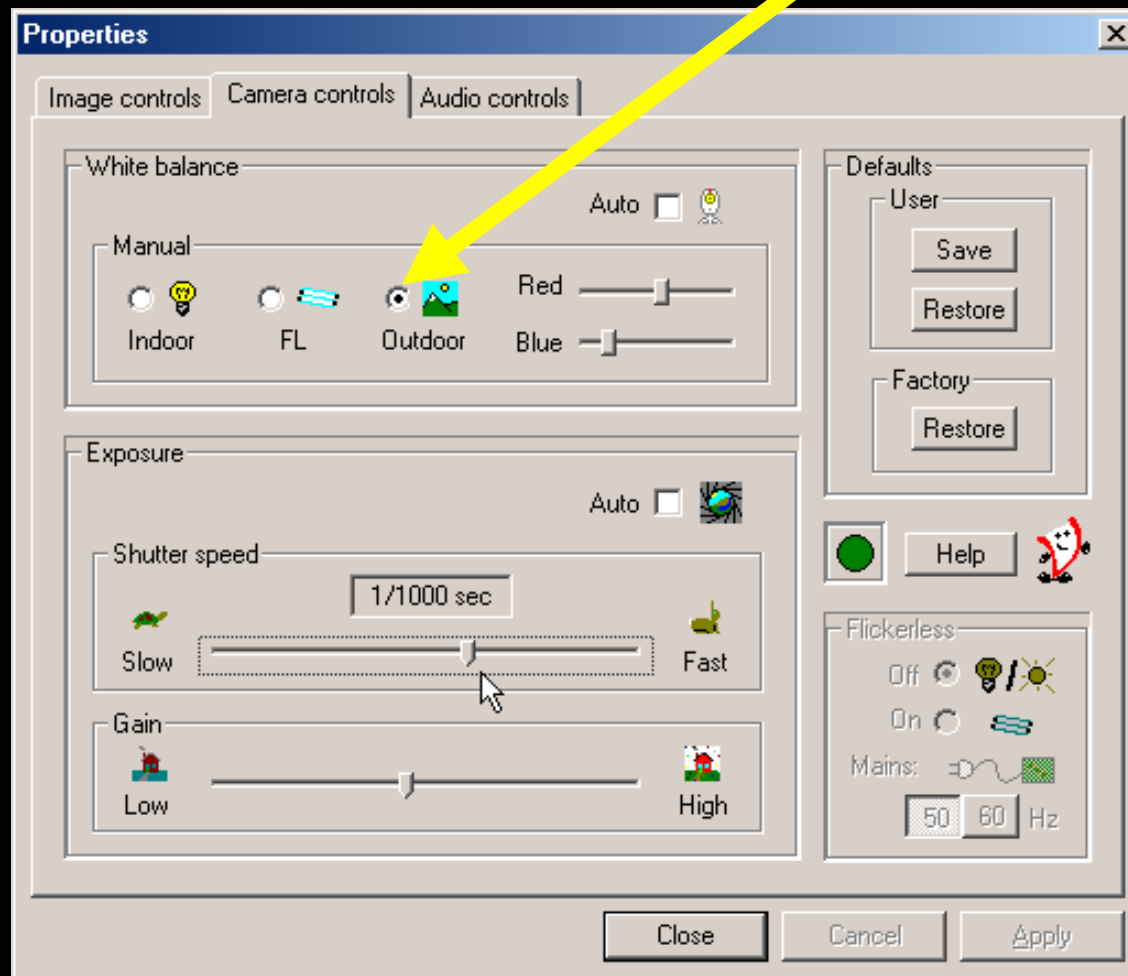


# ToUcam VRecord

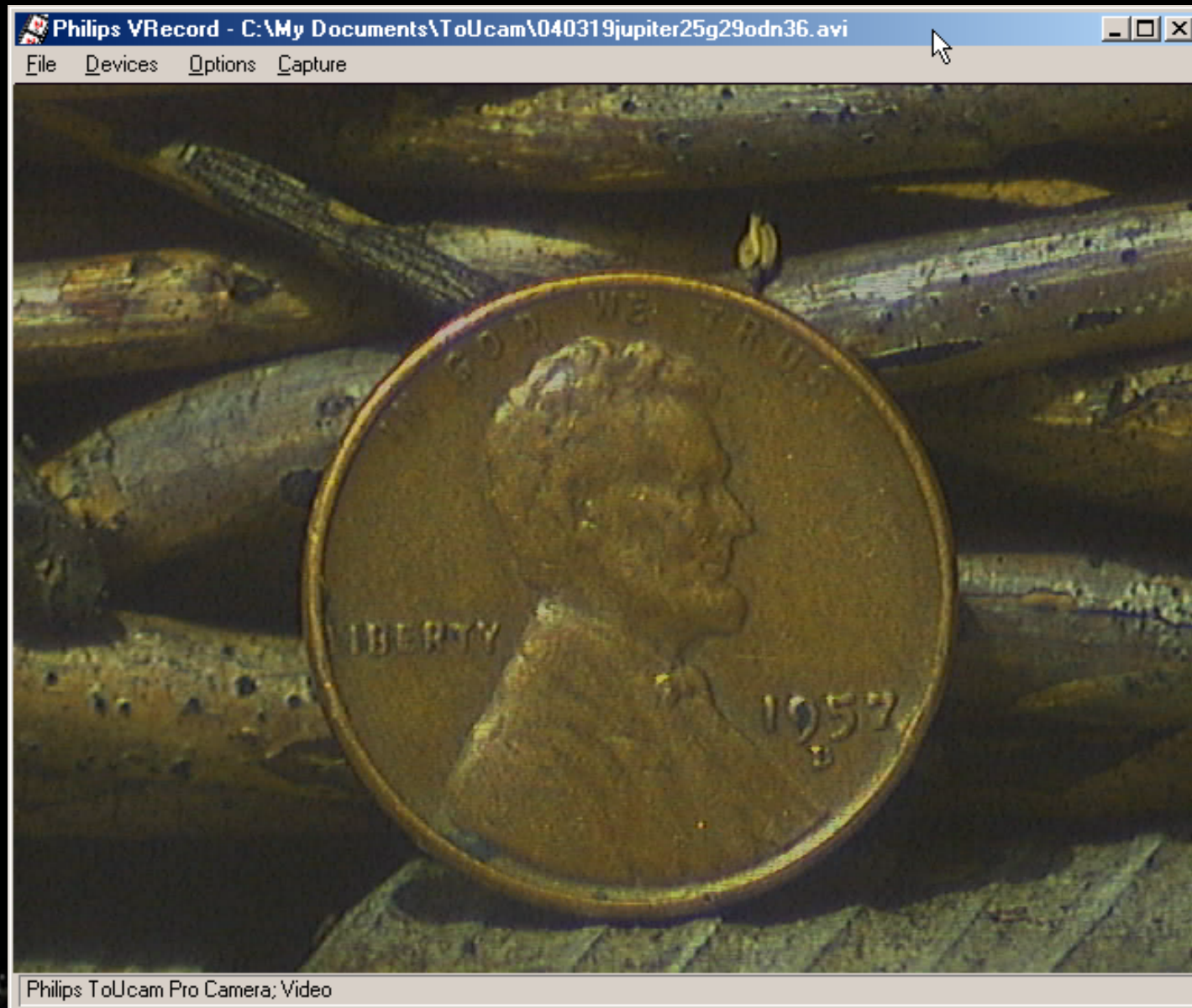




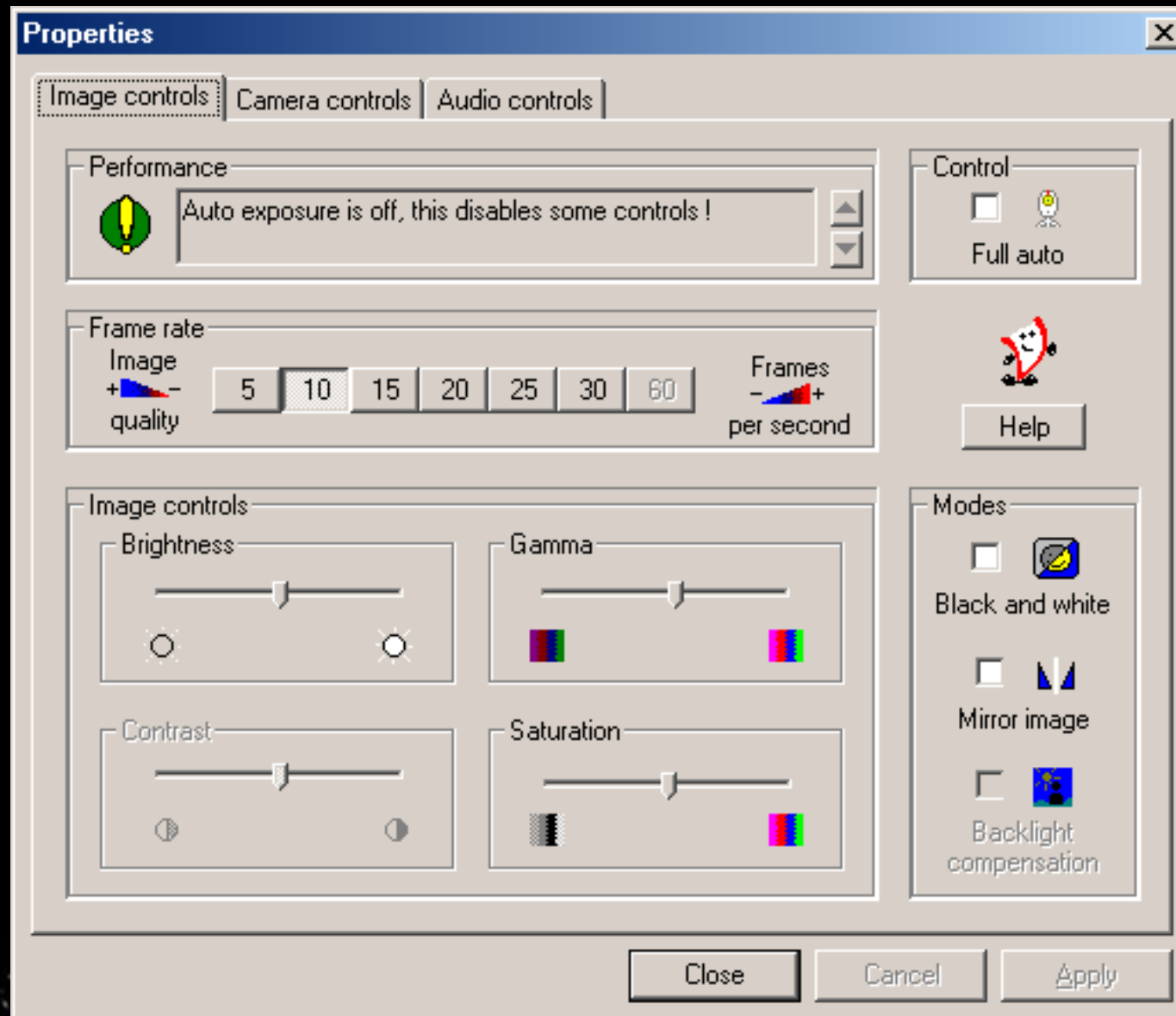
# ToUcam VRecord



# ToUcam VRecord

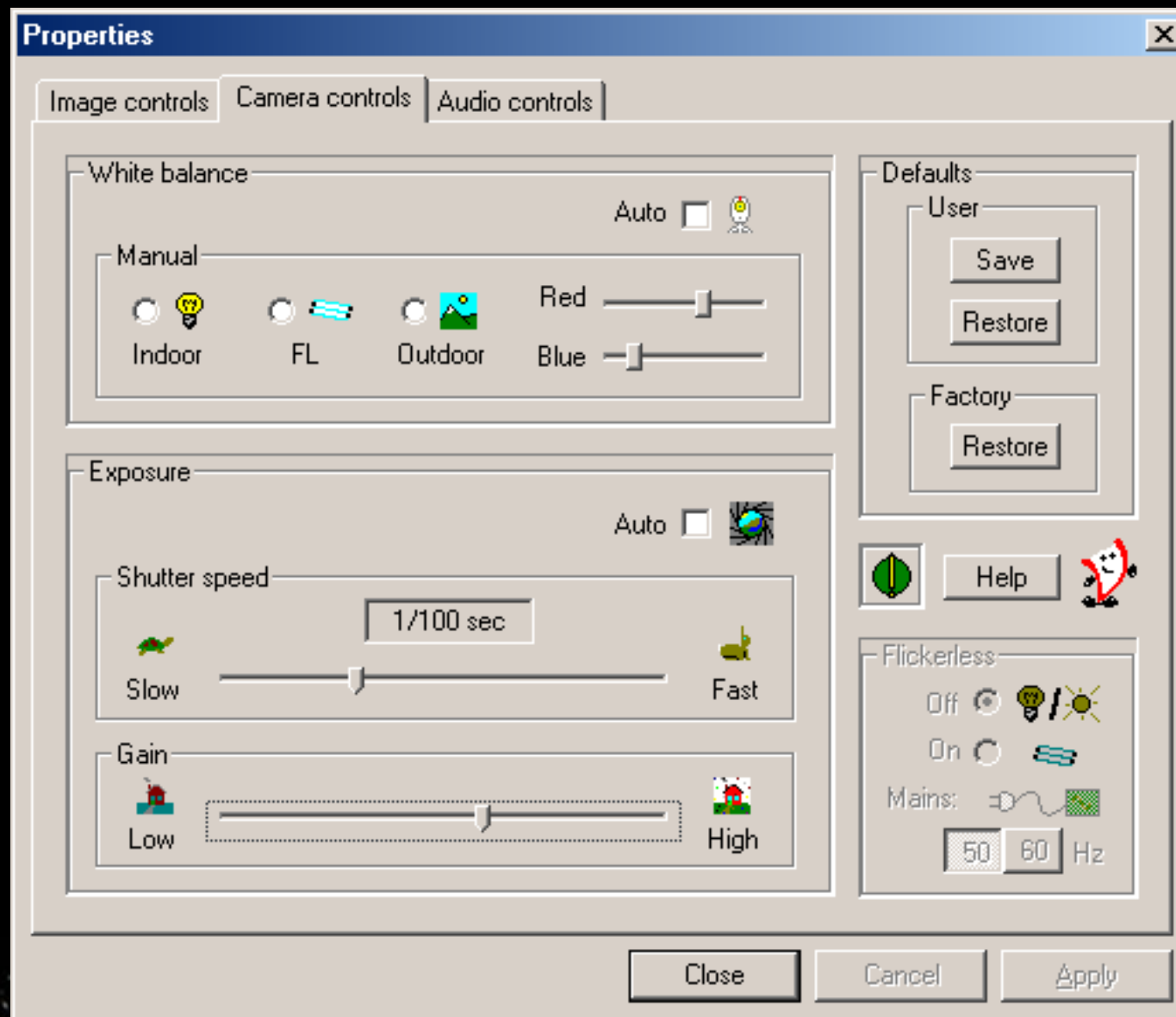


# ToUcam VRecord





# ToUcam VRecord



# Saturn 1/19/2004

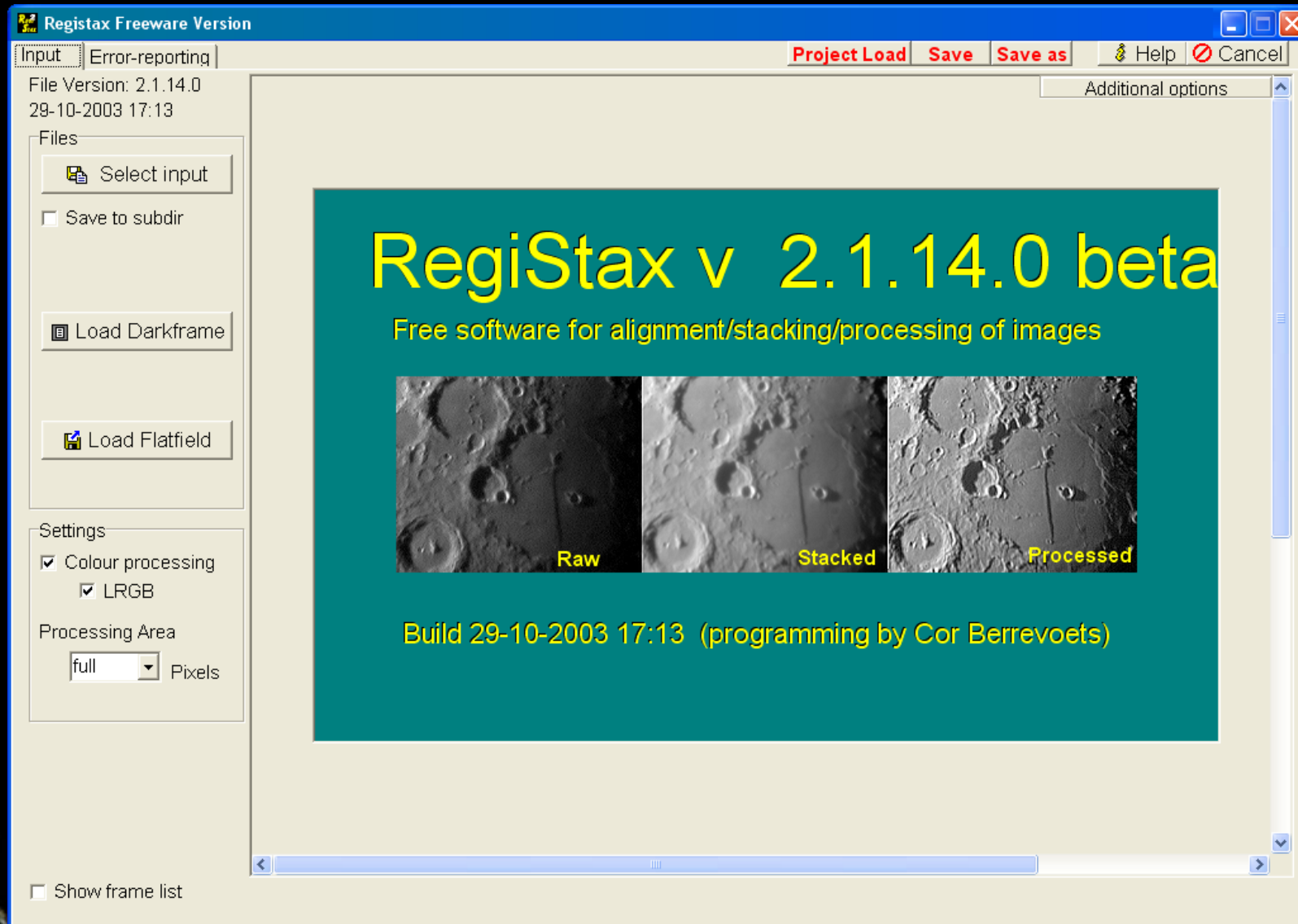
Orion Atlas 10 Reflector on G-11

Tele Vue 5x Powermate (effective  $>f/23.5$ ,  $>6000$  mm)



# Cor Berrevoets RegiStax

<http://aberrator.astronomy.net/registax/>





# Saturn 1/19/2004

RegiStax: 1024 Images Stacked a 2x



# Saturn 1/19/2004

RegiStax: 1024 Images Stacked a 2x  
Wavelet, Gamma, Brightness Processed



# Saturn 1/19/2004

RegiStax: 1024 Images Stacked a 2x

Wavelet, Gamma, Brightness Processed

Photoshop: Unmask Sharpen, Color Balance, Resize to 1x





# Saturn 1/19/2004

RegiStax: 1024 Images Stacked a 2x

Wavelet, Gamma, Brightness Processed

Photoshop: Unmask Sharpen, Color Balance, Resize to 1x

Resize to 0.5x, Unmask Sharpen,



# Orion Atlas 10 Reflector on G-11

Tele Vue 5x Powermate (effective  $>f/23.5$ ,  $>6000$  mm)



# Double Epsilon in Lyra 2.4"

Orion Atlas 10 (Focal Length 1200mm)



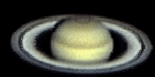


# Albireo Double Star 34.4"

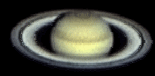
Celestron CG-11 (Focal Length 2800mm)



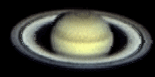
# Meade Lunar Planetary Imager (LPI)



Advantages



Disadvantages



Software

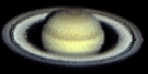
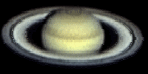
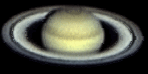
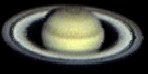
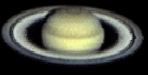
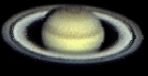


# Meade LPI Advantages

- 🪐 Good for bright objects
  - 🪐 Moon, Sun & Planets
- 🪐 Real-time image processing
  - 🪐 Electronic eyepiece
  - 🪐 Selecting, stacking and sharpening
- 🪐 Acquire many images quickly
- 🪐 Simple & quick to use
- 🪐 Low cost if you have a laptop with USB
- 🪐 No external power is needed



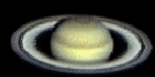
# Meade LPI Advantages

-  Small square pixel size
-  Single shot color
-  No compression
-  Antiblooming characteristics
-  Small & light weight
-  Variable-speed electronic shutter

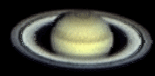
# Meade LPI Advantages

- 🪐 .001 to 16 seconds exposure
  - 🪐 Some deep sky objects are possible
- 🪐 Color balance is better than the 740 on Jupiter
- 🪐 Save images in different formats

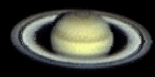
# Meade Lunar Planetary Imager (LPI)



Advantages



Disadvantages

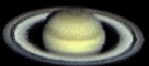
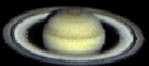
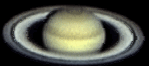
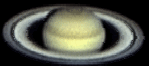
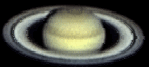


Software

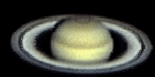




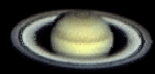
# Meade LPI Disadvantages

-  Less sensitive to light than 740
-  No solar image stacking
-  No color balance
-  Software crashes
-  640x480 size

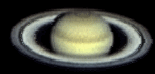
# Meade Lunar Planetary Imager (LPI)



Advantages



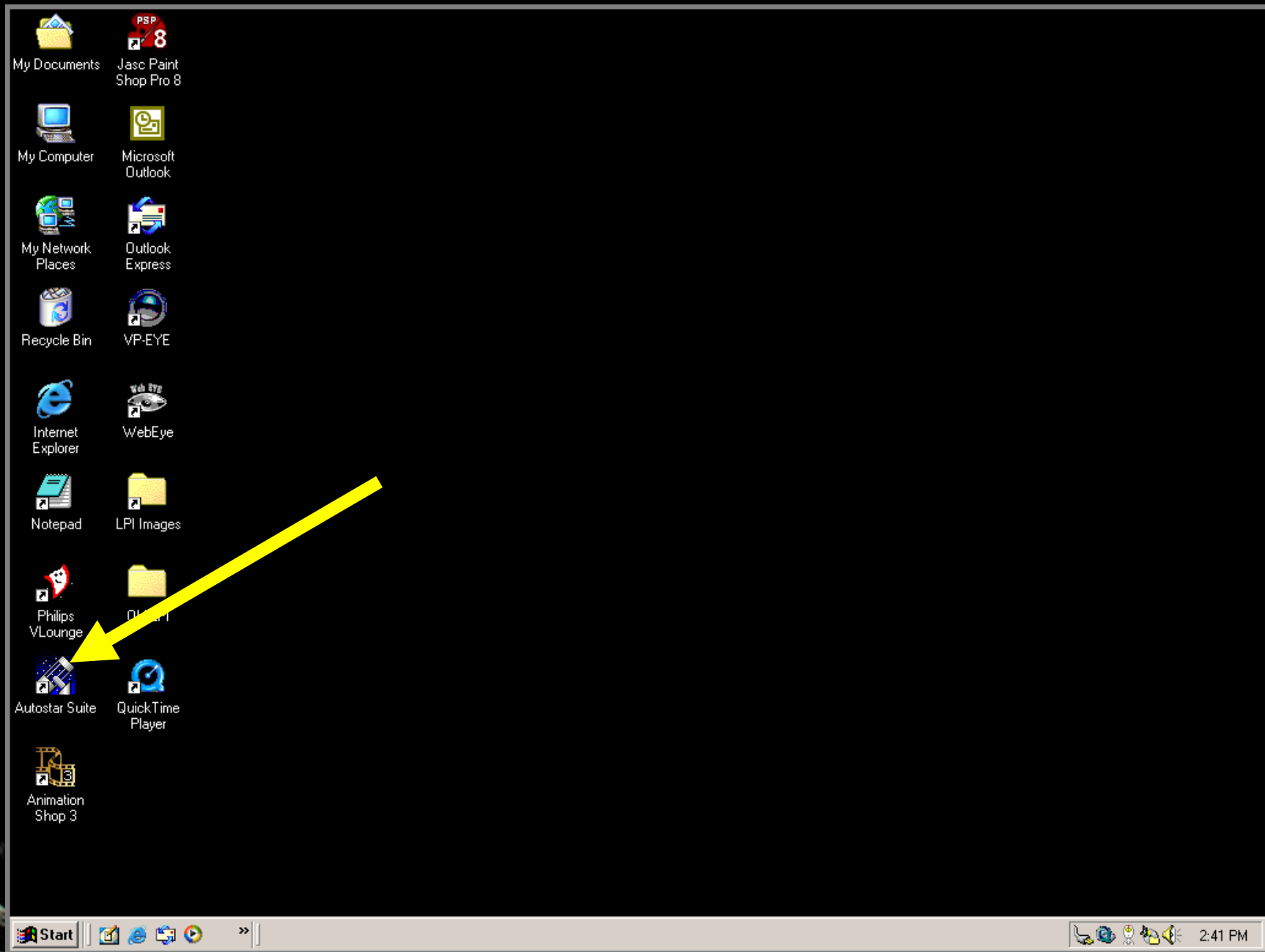
Disadvantages



Software

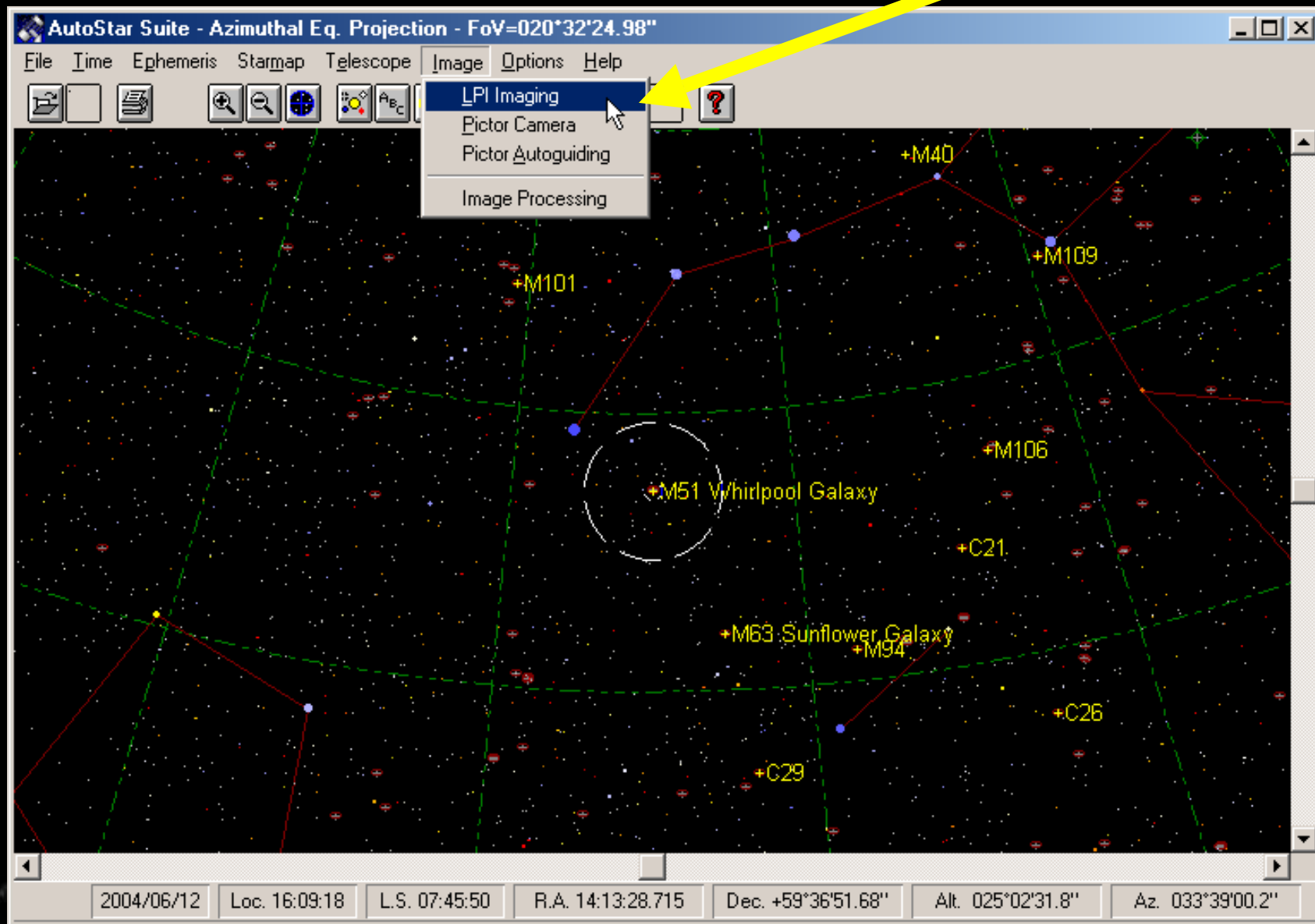


# Meade LPI Autostar Suite

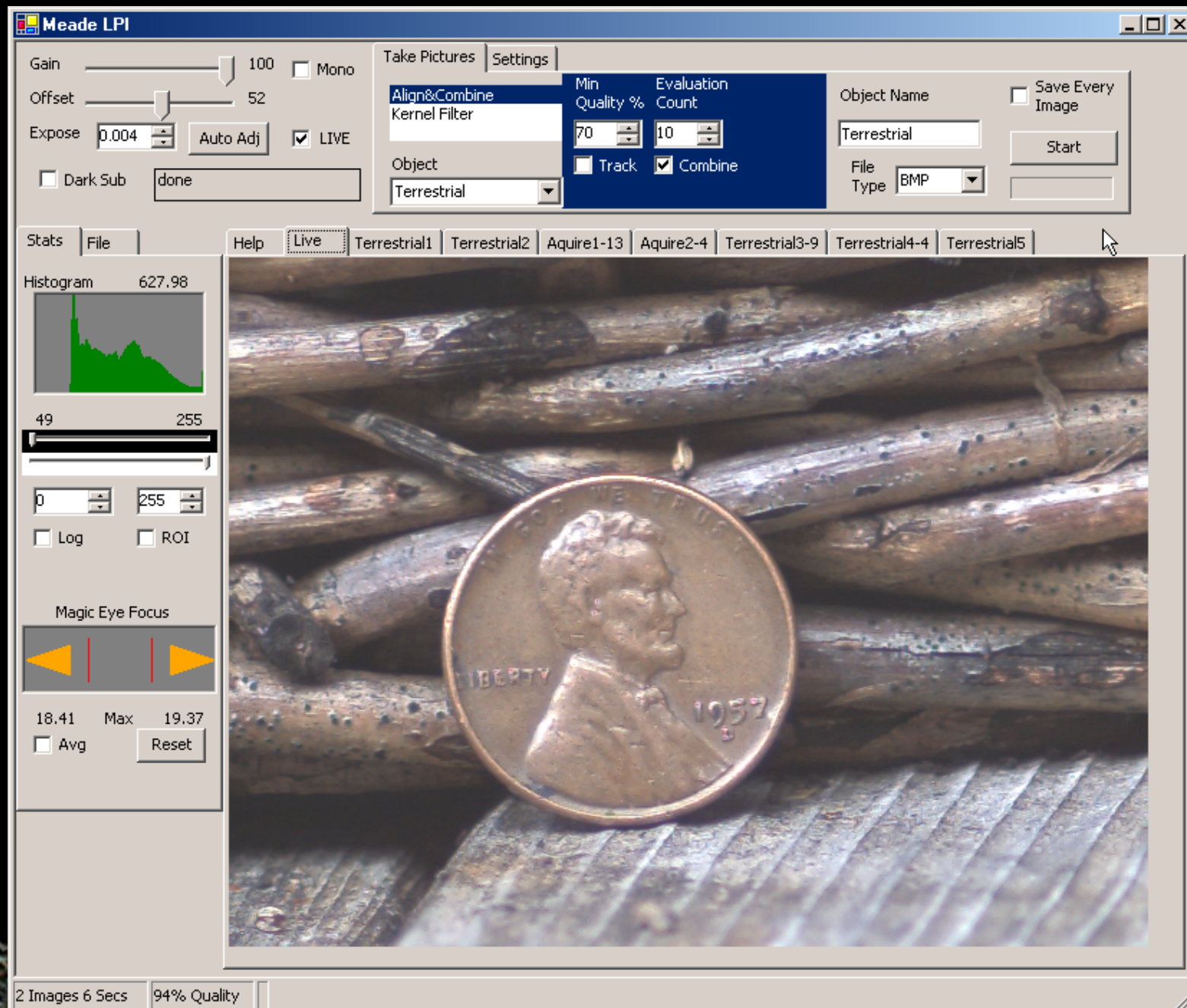




# Meade LPI Imaging

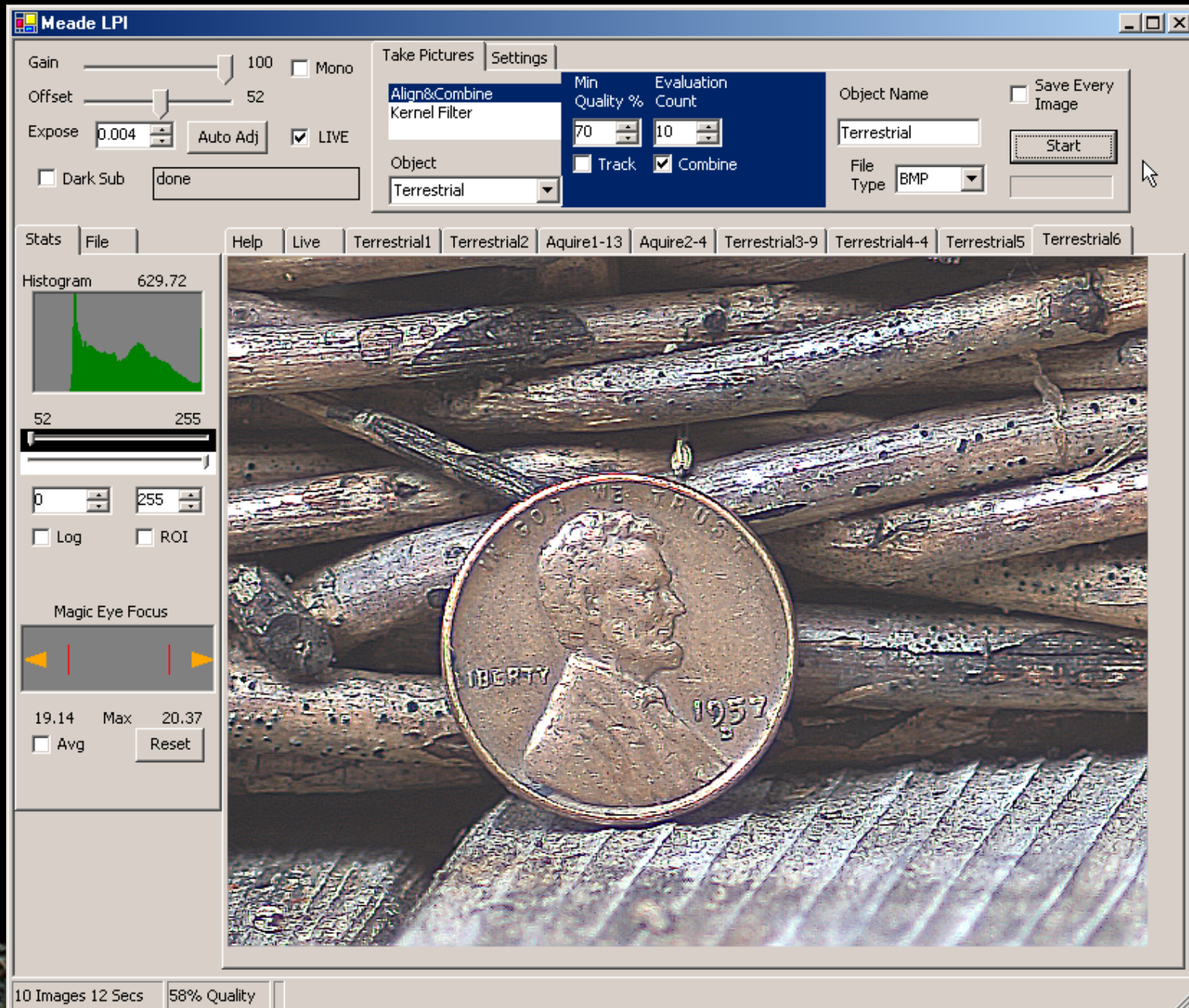


# Meade LPI Imaging





# LPI Real-time Image Processing





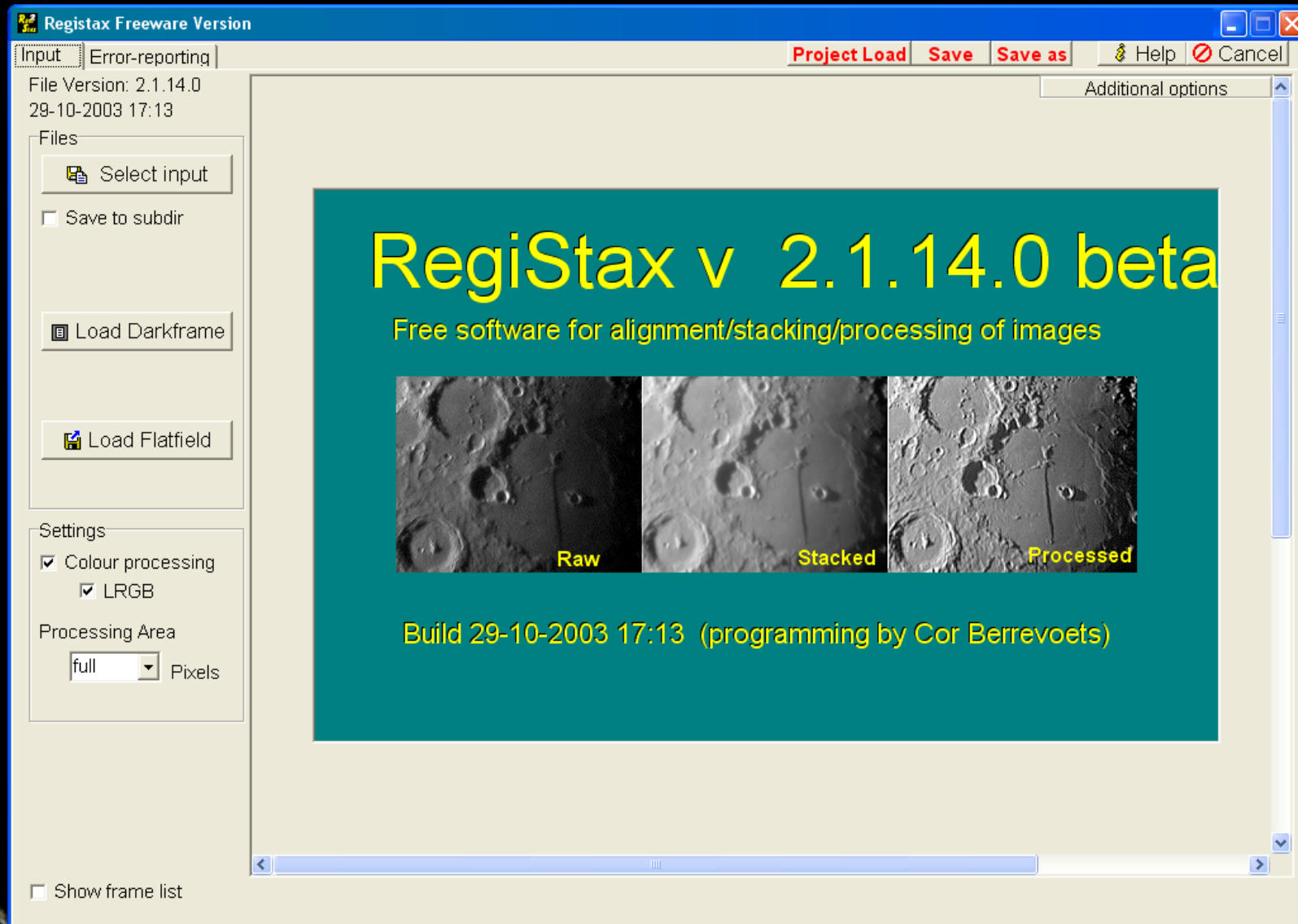
# Moon 5/1/2004

Orion Argonaut™ 150mm Maksutov-Cassegrain on EQ-3  
Tele Vue 2x Barlow (effective  $>f/24$ ,  $>3600$  mm)



# Cor Berrevoets RegiStax

<http://aberrator.astronomy.net/registax/>





# Moon 5/1/2004

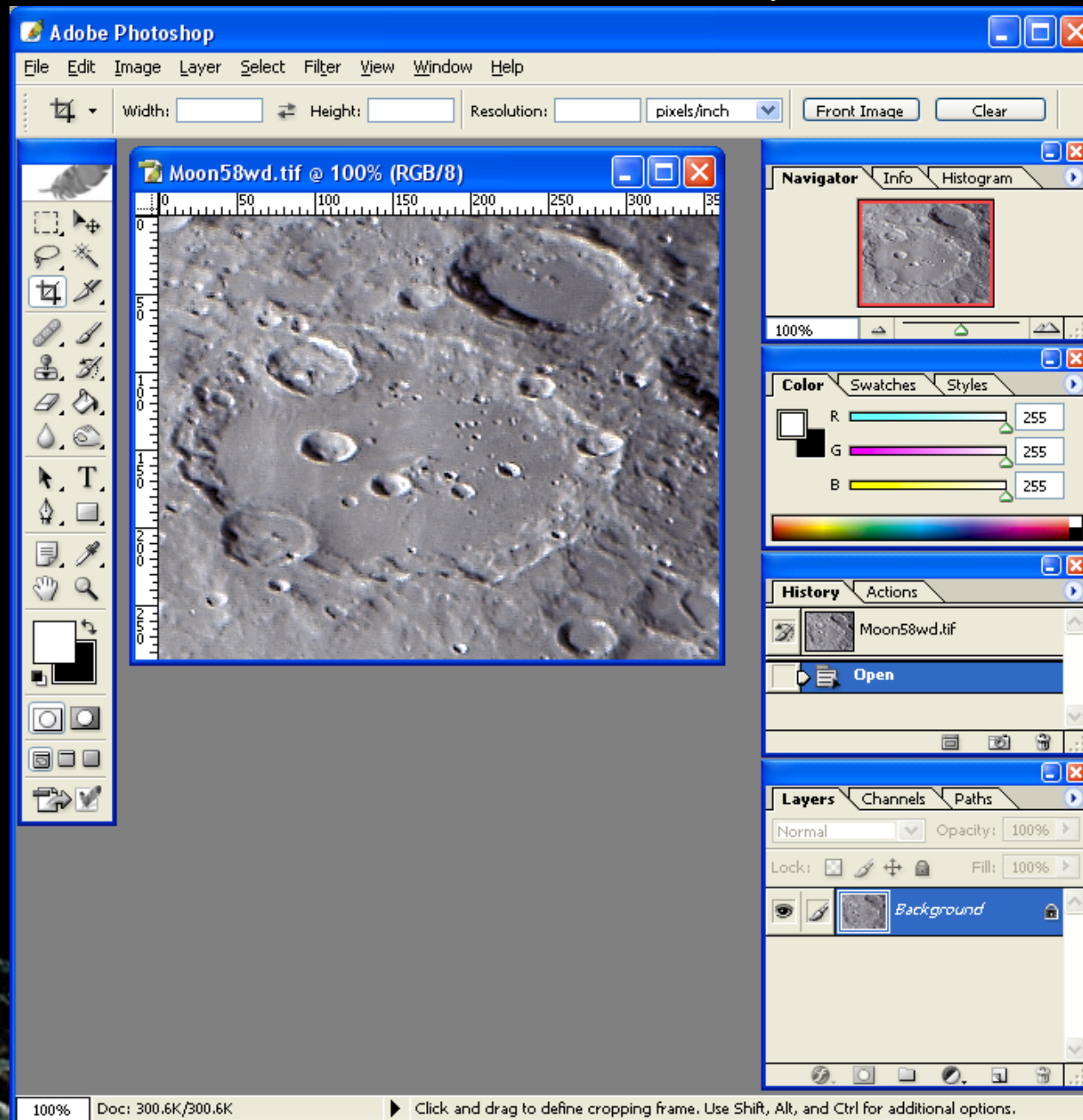
Registax Version 2.1.14.0 beta, wavelett processed





# Image Processing

## Adobe Photoshop



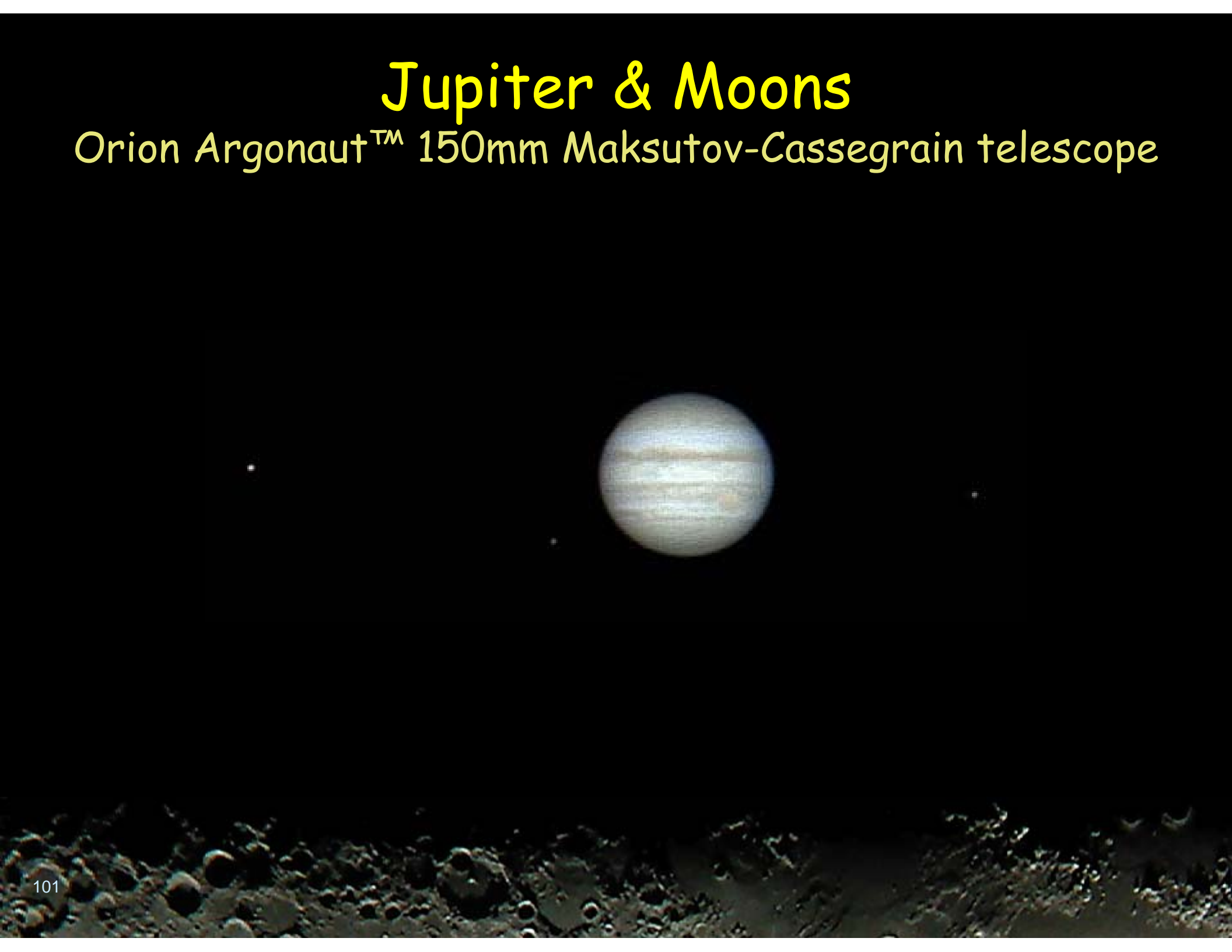
# Moon Clavius Craterlets 5/1/2004

Photoshop Version CS, unsharp mask, levels, and crop



# Jupiter & Moons

Orion Argonaut™ 150mm Maksutov-Cassegrain telescope





# CCD Astroimaging Information

[www.stargazing.net/david/](http://www.stargazing.net/david/)

## CCD Astroimaging Information

From Observational Astronomy Web Site by David Haworth  
<http://www.stargazing.net/david/>

### CCD Astroimaging Books

- *A Practical Guide to CCD Astronomy*, Patrick Martinez and Alain Klotz, 243 pages
  - A guide to choosing and using CCD cameras for amateur astronomers
- *Amateur Telescope Making*, Stephen F. Tonkin
  - Chapter 14 is on building and using a Cookbook CCD Camera by Al Kelly, 14 pages
- *The Art and Science of CCD Astronomy*, David Ratledge, 162 pages, <http://www.astrovid.com/CCDBOOKS.HTM>
  - 12 chapters by different authors about their CCD experiences.
- *Astronomical Equipment for Amateurs*, Martin Mobberley
  - Chapter 8 is on electronic imaging, 43 pages
- *Astrophotography for the Amateur*, 2<sup>nd</sup> Ed., Michael A. Covington
  - Chapter 12 is on Computer Image Enhancement, 26 pages & Chapter 13 is on CCD Imaging, 16 pages
- *CCD Astronomy Construction and Use of an Astronomical CCD Camera*, Christian Buil, 321 pages
  - An intermediate to advanced understanding of CCD camera design, operation and imaging processing.
  - <http://www.willbell.com/ccd/ccd4.htm> or <http://www.astrovid.com/CCDBOOKS.HTM>
- *The CCD Camera Cookbook*, Richard Berry, Vesikko Kauto & John Munger, 176 pages
  - This book shows you how to build your own CCD camera.
  - <http://www.willbell.com/ccd/ccd5.htm>
- *Choosing and Using a CCD Camera*, Richard Berry, 96 pages
  - Book includes Quikpix software for PCs
  - <http://www.willbell.com/ccd/ccd6.htm>
- *Deep Space CCD Atlas: North (264 pages) and South* books by John Vickers P.O.B. 1292 Duxbury, MA 02331
  - A good reference of CCD images to verify your objects
- *Electronic Imaging in Astronomy - Detectors and Instrumentation*, Ian S. McLean, 472 pages
  - CCDs and other imaging devices used in professional observatories
- *FOSTER CCD Imaging Series*, Software Bisque, 107 pages, <http://www.bisque.com/>
  - Covers the fundamental requirements for obtaining good CCD images.
- *The Handbook of Astronomical Image Processing*, Richard Berry & James Burnell, 640 pages
  - A very good book on image processing & it includes *Astronomical Image Processing for Windows* (AIP4WIN)
  - Willmann-Bell, Inc. <http://www.willbell.com/aip/index.htm>
- *Handbook of CCD Astronomy*, Steve B. Howell, 164 pages, Cambridge University Press
  - Good intermediate introduction to CCD imaging.
- *Introduction to Astronomical Image Processing*, Richard Berry, 96 pages
  - A beginners' guide to CCD image enhancement for PCs and basics on CCD imaging processing, includes Astronomical Image Processing (AIP245) software
  - <http://www.willbell.com/ccd/ccd7.htm>
- *The New CCD Astronomy*, Ron Wodaski, 476 pages
  - A very good book to start learning about CCD astronomy
  - <http://www.newastro.com/newastro/default.asp>
- *Splendors of the Universe: A Practical Guide to Photographing the Night Sky*, Terence Dickinson, Jack Newton, Terence Dickinson
  - Covers various aspects of astrophotography including CCD imaging
  - Part 4: More Power to You, 17 pages
- *Video Astronomy*, Steve Massey, Thomas A. Dobbins & Eric J. Douglass, 200 pages
  - A beginners' guide to using video
  - Sky Publishing Corp., <http://skyandtelescope.com/>

### Book Stores

- Large astronomy book vendor: Willmann-Bell, Inc. <http://www.willbell.com/ccd/index.htm>
- Amazon.com book store online search, <http://www.amazon.com/>
- Powell's a local Portland book store with online search, <http://www.powells.com/>

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