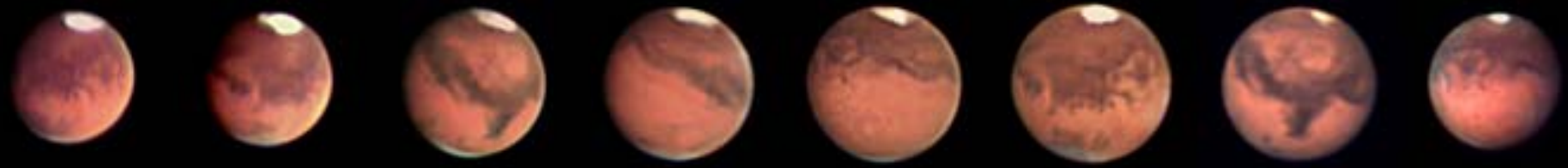
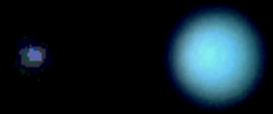
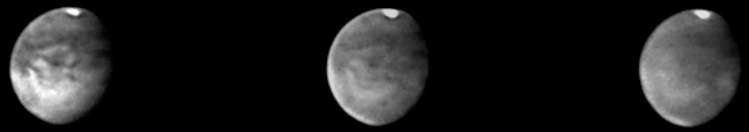


URANUS 11/02/03 02:24UT - 02:42UT RRGB Process 150 image Stack

GSC5808:88
Mag 11.24



3"



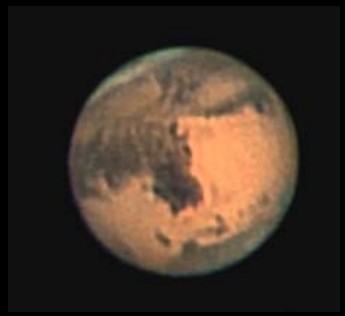
RED GREEN BLUE

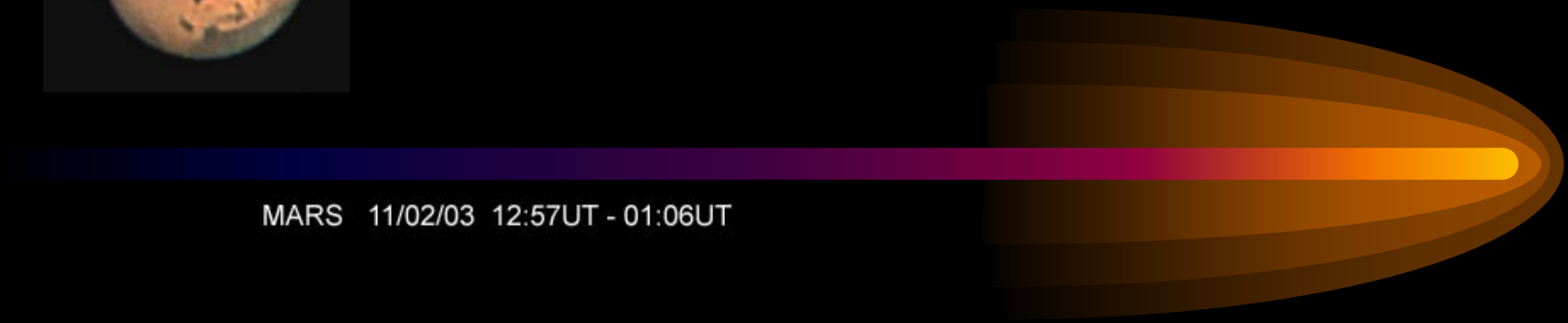
Magnitude 5.79 Diam 3.56"
Camera: ST7E Exp R .4, G .3, B .4 Temp -15°C C14, 0.08"/pixel (F66)

Imager: Larry Owens ltowens@comcast.net

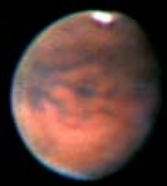
How to Image the Planets

Introduction to Digital Planetary Imaging and Processing





MARS 11/02/03 12:57UT - 01:06UT



CM: 100.6° Diam: 14.8" Mag: -1.2
C14 ST7E/CFW8 RGB Process 49 image stack F/33 0.16"/Pix

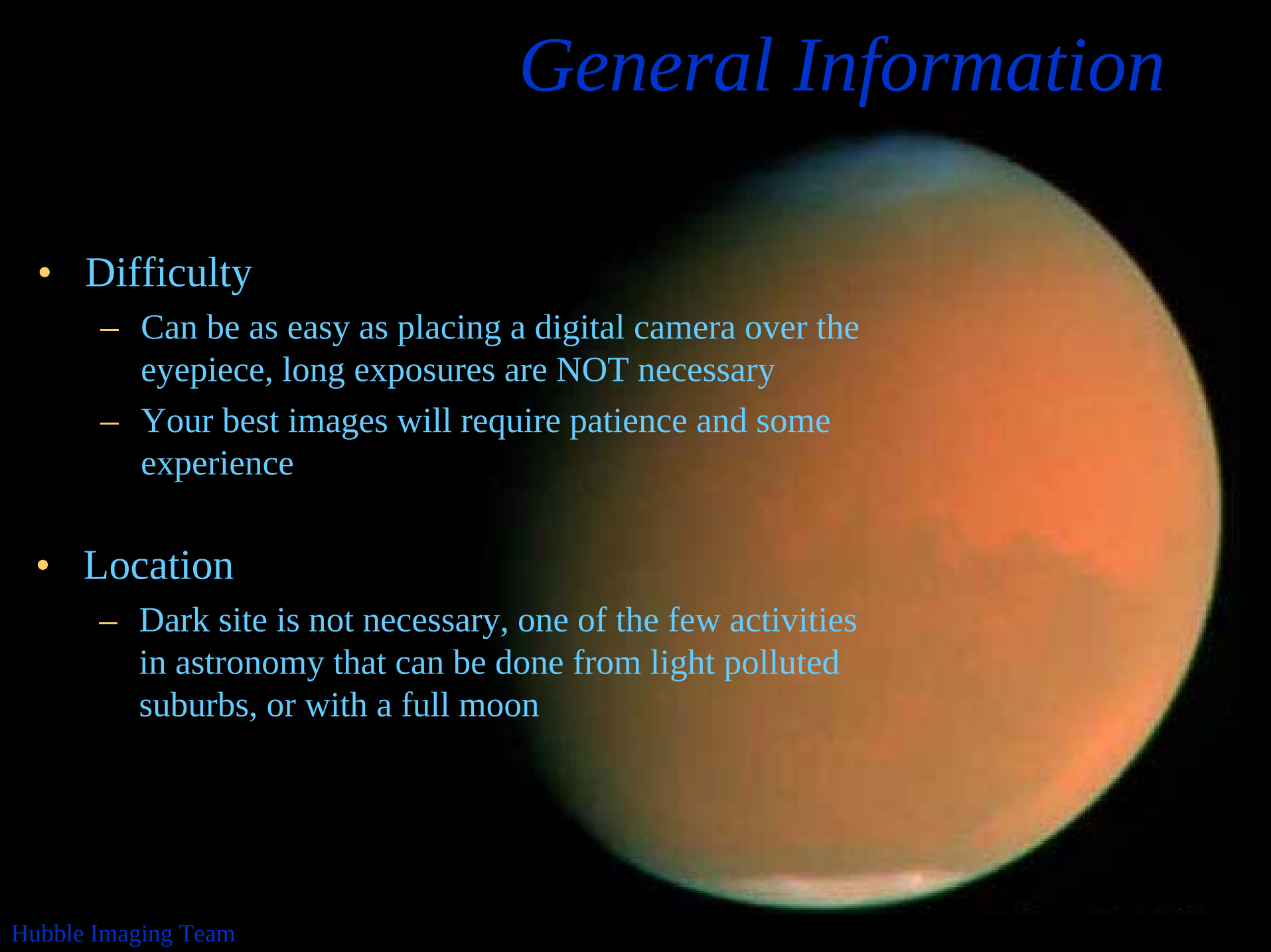
Imager: Larry Owens planetographer@comcast.net

Larry Owens

General Information

Hubble Imaging Team

General Information



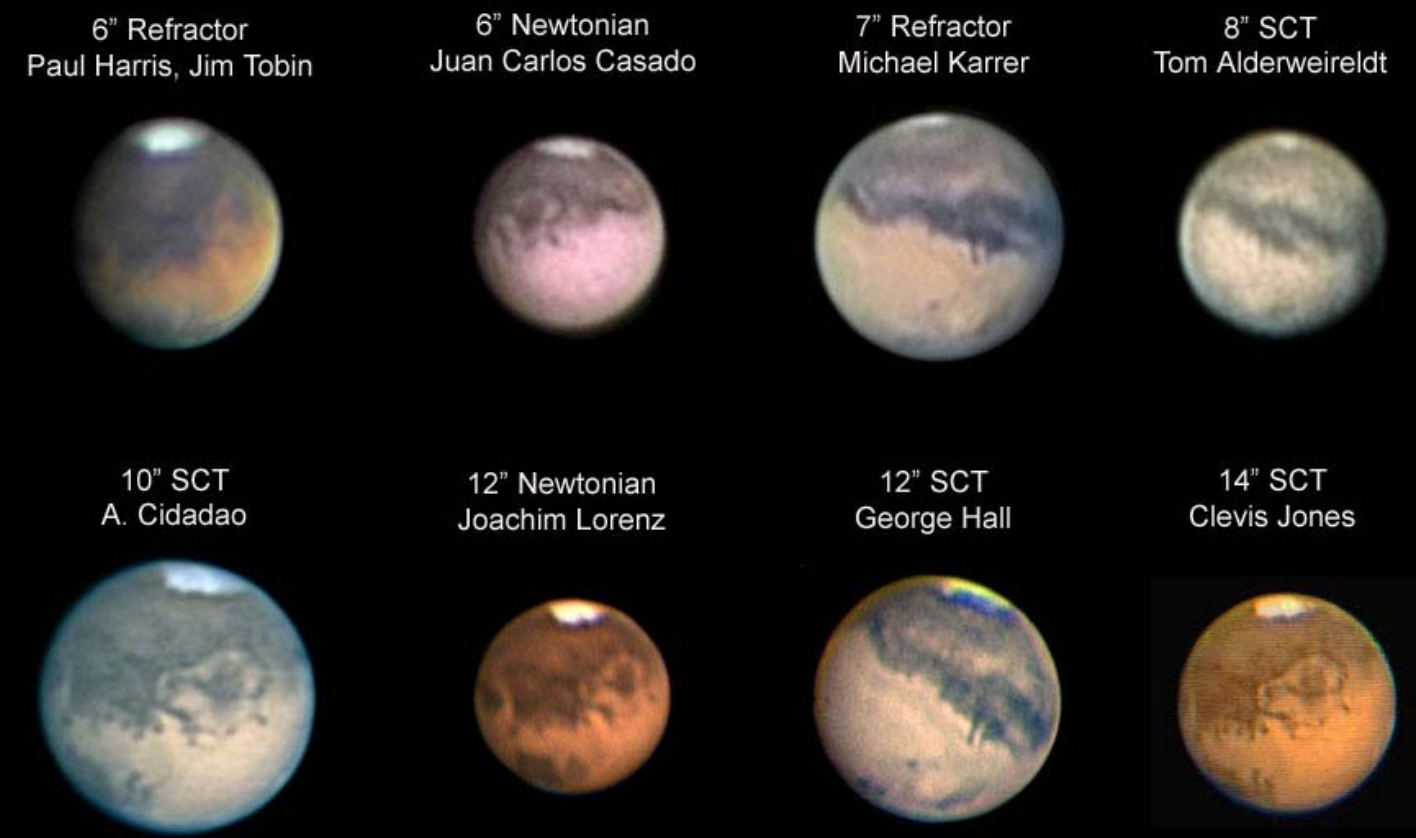
- Difficulty
  - Can be as easy as placing a digital camera over the eyepiece, long exposures are NOT necessary
  - Your best images will require patience and some experience
- Location
  - Dark site is not necessary, one of the few activities in astronomy that can be done from light polluted suburbs, or with a full moon

General Information

- Equipment
  - Practically any digital camera, web cams, CCD
  - Modest telescope on a reasonably sturdy mount
- Digital Image Processing
  - Take the time to learn how to stack and enhance your images

General Information

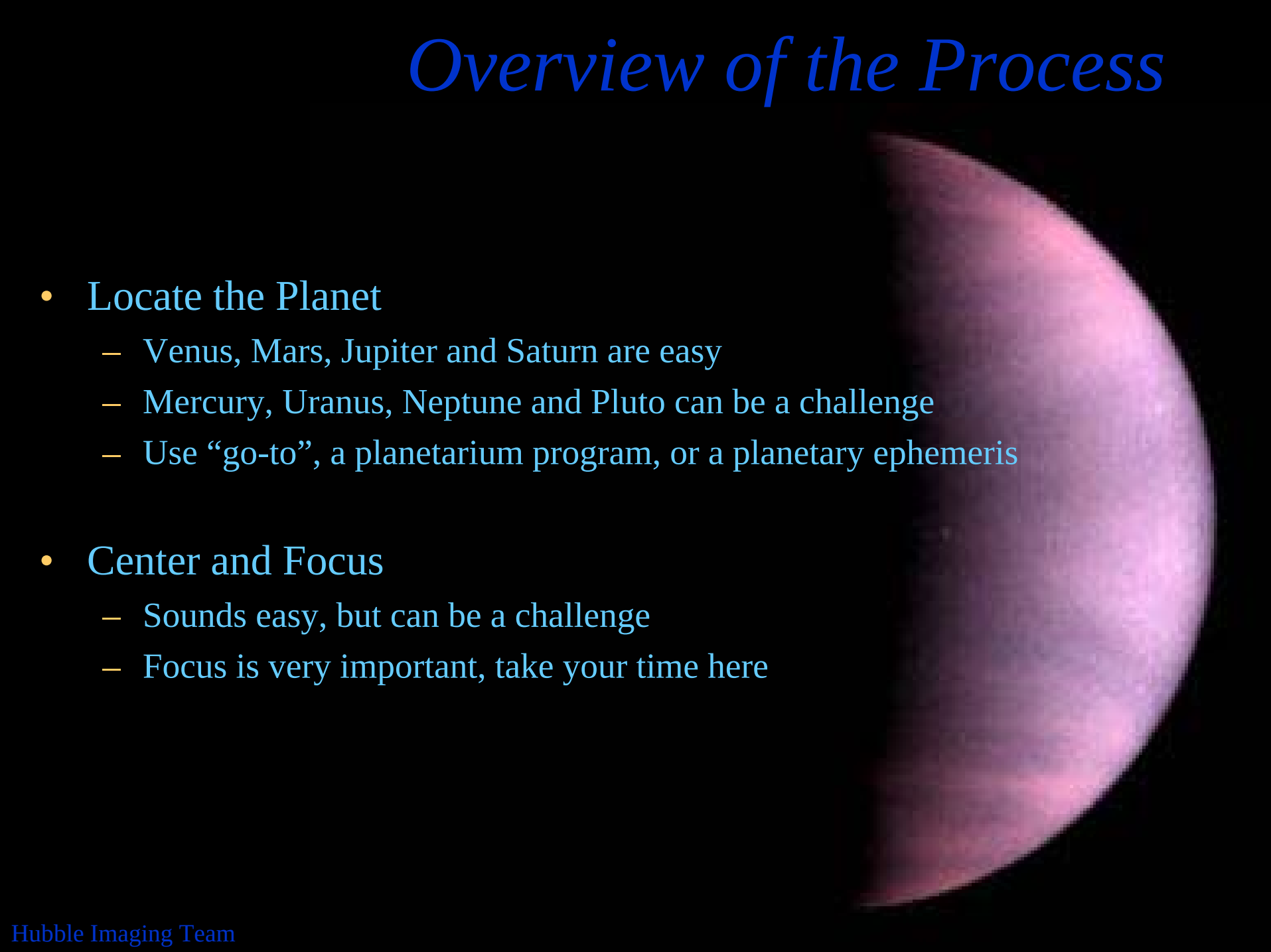
- What to Expect
  - Results depend on atmospheric conditions, equipment and your skill



Overview of the Process

Hubble Imaging Team

Overview of the Process

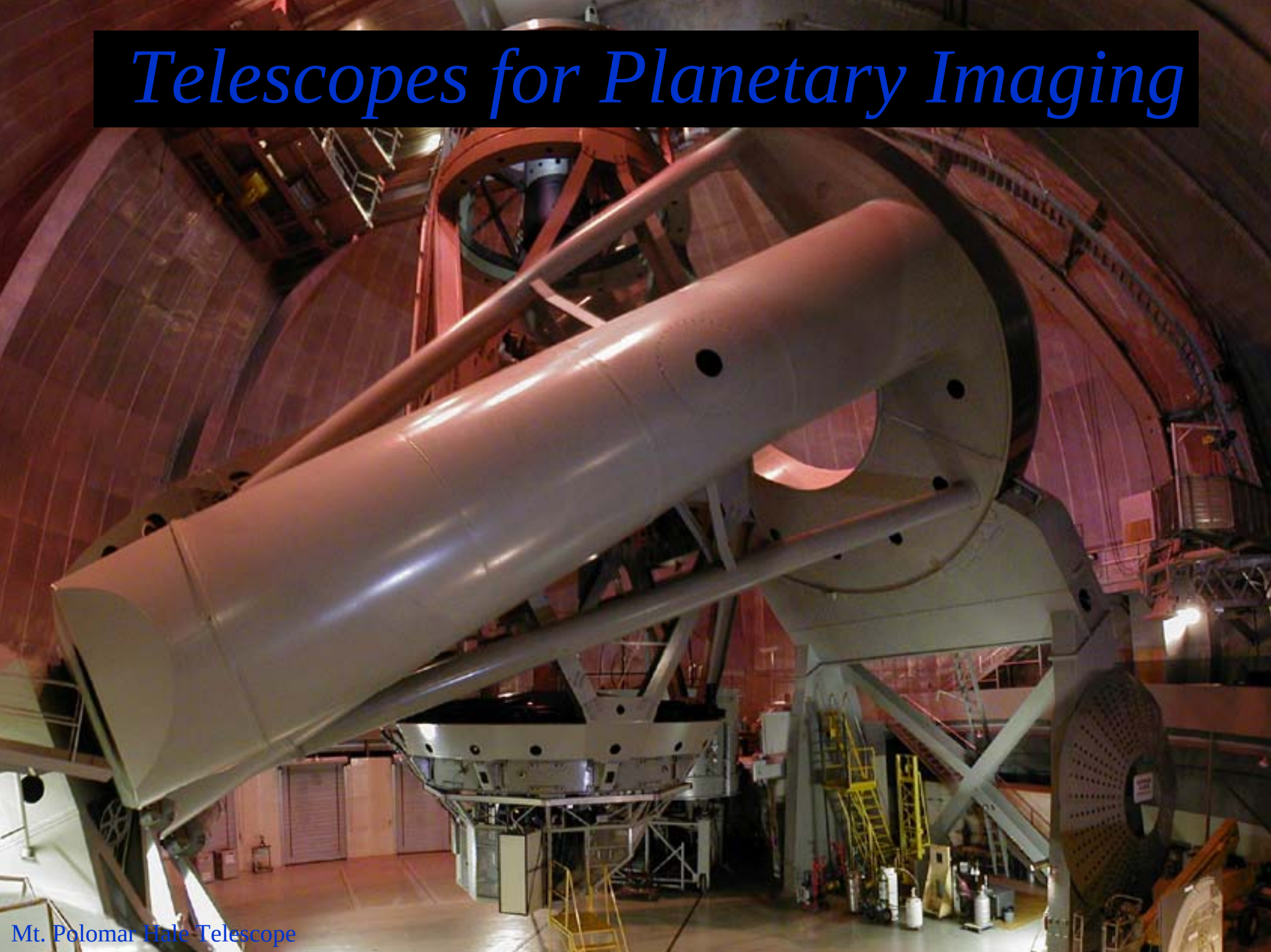


- Locate the Planet
  - Venus, Mars, Jupiter and Saturn are easy
  - Mercury, Uranus, Neptune and Pluto can be a challenge
  - Use “go-to”, a planetarium program, or a planetary ephemeris
- Center and Focus
  - Sounds easy, but can be a challenge
  - Focus is very important, take your time here

Overview of the Process

- Take a Series of Images
  - Take as many as possible in the time available (planetary rotation, stacking)
- Stack and Enhance the Image
  - Image stacking reduces noise and allows the imager to extract more detail

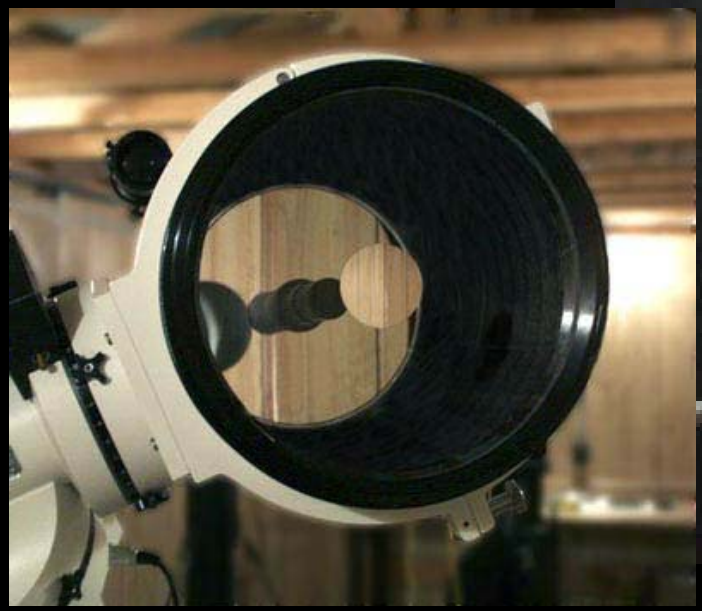
Telescopes for Planetary Imaging



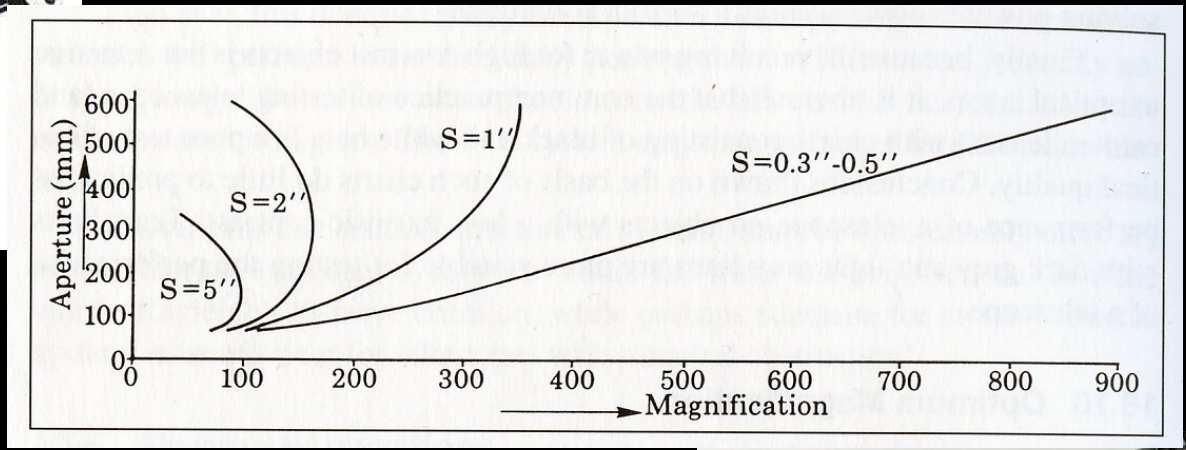
Mt. Polomar Hale Telescope

Telescopes for Planetary Imaging
Best Optics

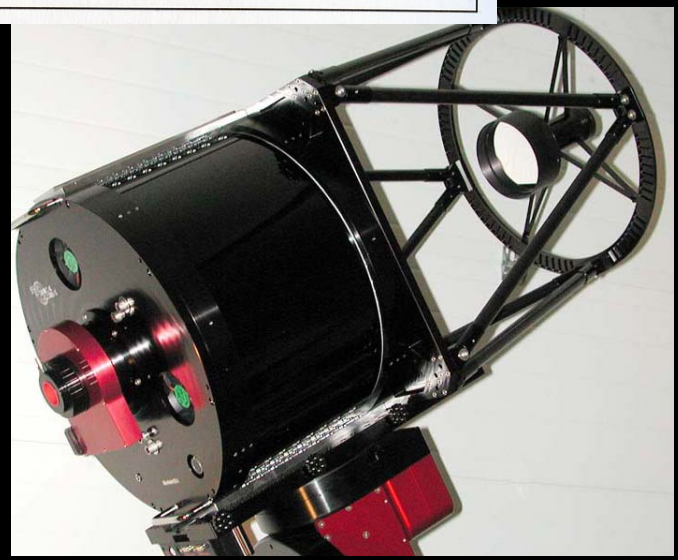
- Long Focus Systems (Best Case)
  - Provide higher magnification
  - Simpler optical train to get the power you need
  - End result is *usually* a sharper planetary image



Telescopes for Planetary Imaging
Best Optics



- Optical Size Considerations (Aperture)
  - Top quality smaller aperture refractors (great for unsteady skies)
  - Large aperture Cassegrain systems (8”-16”)
  - 11” and higher optics require very steady skies
    - 14”-16” is probably the largest to use in average stability



Telescopes for Planetary Imaging
Best Mounts

- Equatorial Mounts are Best if Stacking
  - Little or no field rotation to deal with
  - Low periodic error mount when using high magnification
  - Hand controller for guiding out errors or drift

Telescopes for Planetary Imaging
Best Mounts

- Computerized Alt Azimuth or Tracking Dob
  - OK for quick single non-stacked exposures
  - Can stack but more trouble because of field rotation
  - Add an equatorial platform or wedge for best results

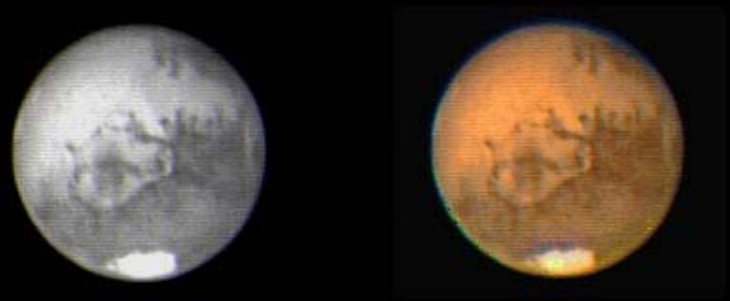
Cameras for Planetary Imaging

SBIG, Inc

Cameras for Planetary Imaging
Web Cam's

- General Information
  - Most economical way to image the planets
  - Best to remove supplied lens
  - Best to use a UV/IR blocking filter
  - Many color Web Cam's are suitable
  - Most can use ready-made 1.25" adapters
  - May be difficult to keep CCD clean

- Phillips TouCam
  - Very popular among planetary imagers
  - Sensitive color CCD
  - Sells for $139 with 1.25" nose piece



Luminance Color

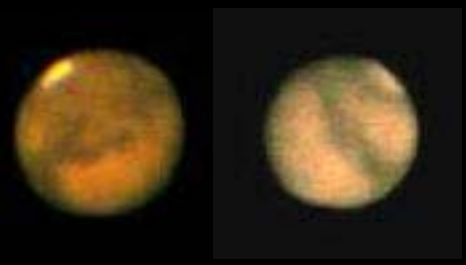
NOTES: Image taken from Bahia Honda State Park in the Florida Keys. Stability was average with winds gusting to 20mph. The image is a stack of 239 frames processed with RegiStax and Photo Shop. Planetary data from Mars Priviewer II version 2.01.

Date:	08/26/03	Optics:	C14 SCT
Time:	05:52UT	F/Ratio:	F/25
CM:	72.8°	Camera:	Quickcam VC
DE:	-18.83°	CCD Tmp:	Not Reg
Diam:	25.07"	Exposure:	Auto
Mag:	-2.87	Filters:	None
Phase:	99.78%	Process:	Frame Stacking

Imager: Clevis Jones

Cameras for Planetary Imaging
Digital Land Cameras

- General Information
  - Dual purpose - can take pictures OF and through your telescope
  - Laptops not required
  - Best to have a remote or cable release
  - Some digital cameras even work well for deep sky astrophotography



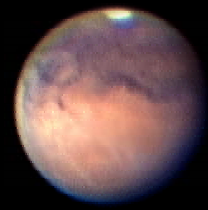
2 meg Canon Digital Camera
6” refractor without motor drive
Imager: Drew Sorenson

- Two Types
  - Fixed lens digital cameras
    - Required to use camera lens
  - Digital SLR
    - More expensive, may cause jitter
  - Telescope adapters available for all types

Cameras for Planetary Imaging
CCD Cameras

- Two Basic Methods
  - CCD with color chip - using the same basic process used with web cams and digital cameras
  - Monochrome CCD with color filter wheels - RGB or LRGB process

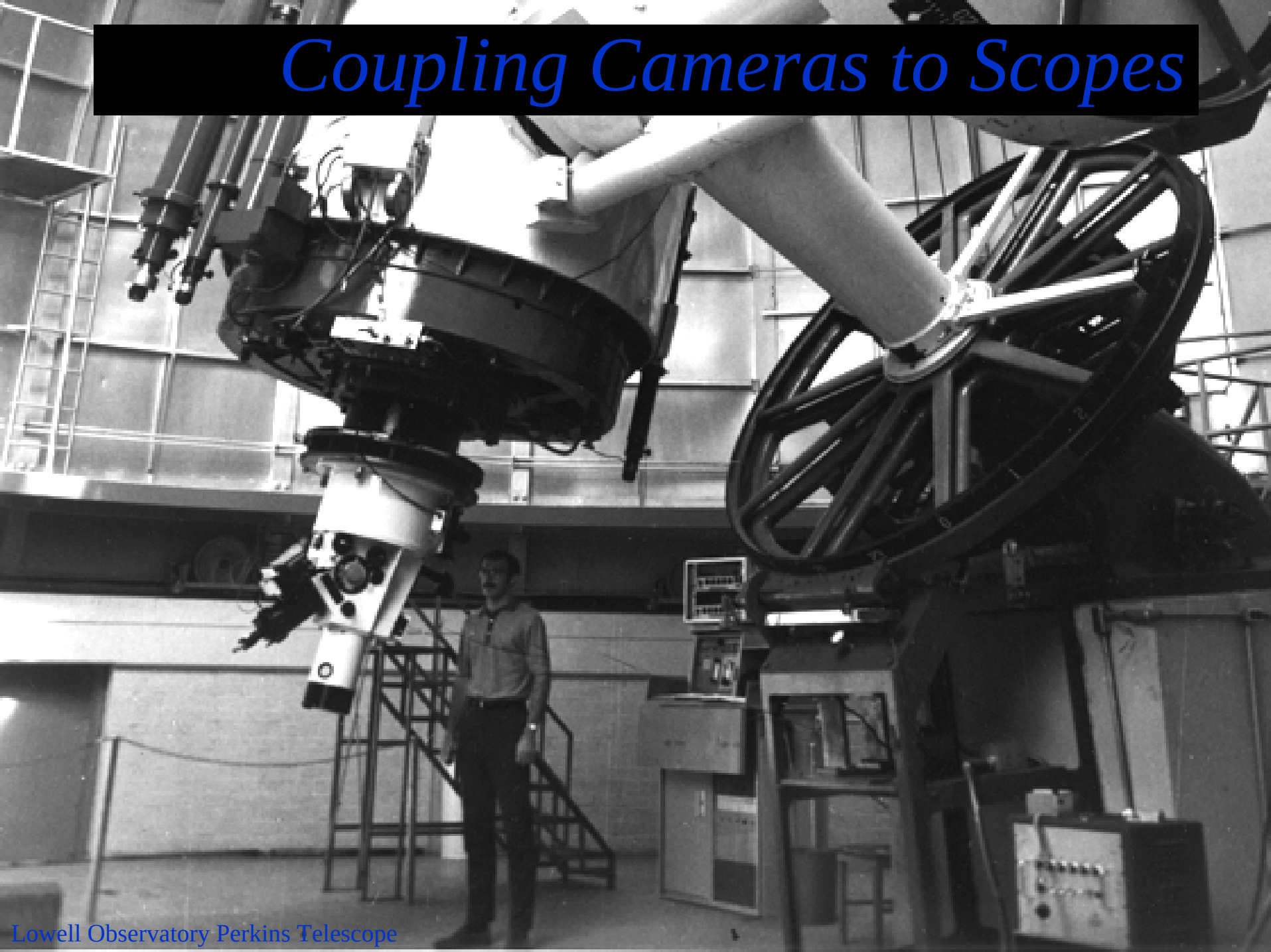
RGB



TouCam Color

- RGB/LRGB Color Method
  - Take black and white images through filters
  - Combine images to make color by computer
  - Better color depth, more processing options
  - The way the professionals do it - but it is definitely the hard way

Coupling Cameras to Scopes



Lowell Observatory Perkins Telescope

Coupling Cameras to Scopes
Camera Adapters

- Hold it and shoot
  - Nothing required but a steady hand and a good focus
  - Hold camera over eyepiece and hope for the best

- Camera Holders
  - Clamps to eyepiece and holds camera in position (need bulb or remote)

Coupling Cameras to Scopes
Camera Adapters

- Digital Camera Filter Thread Adapters
  - Adapter fits filter threads on camera
  - Connects to standard adapters (“T” Thread) or special eyepieces
- 1.25” adapters for Web Cams
  - Replaces lens with adapter (Need UV/IR block filter)

Coupling Cameras to Scopes
Optical Coupling

- Eyepiece Projection
  - Can be used with fixed lens cameras
  - For high power projections directly in to removable lens cameras

- Barlow Lens
  - Multiplies focal length of telescope
  - Extensions can increase the effective focal length
  - For projecting directly in to removable lens cameras, web cams or CCD cameras

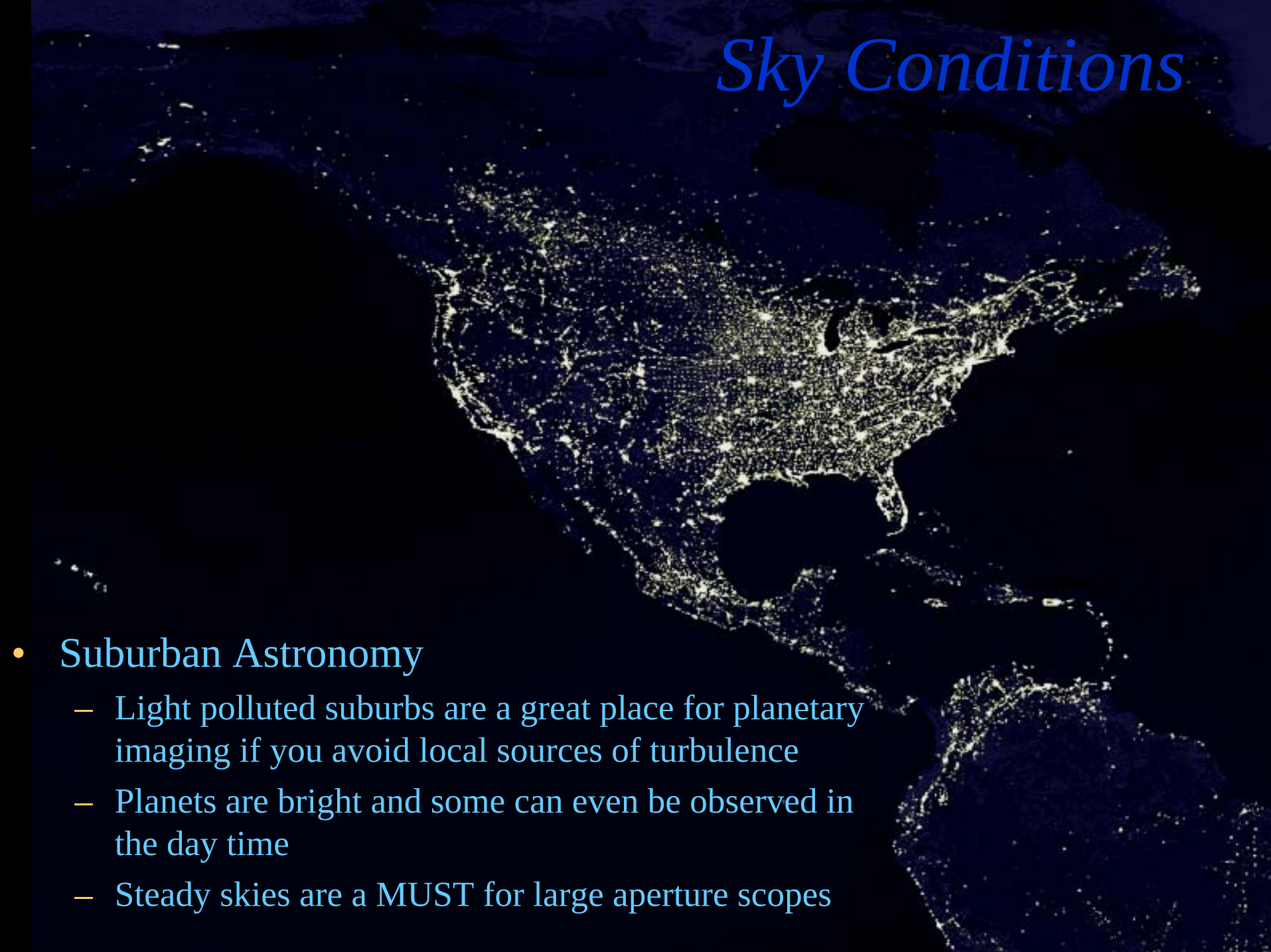
Coupling Cameras to Scopes Accessories

- Crayford Focuser
  - No image shift with SCT's (Important at high magnification)
  - Motorized focuser lets you adjust focus without shaking the scope
  - Allows you to sit at your laptop and perform fine focus adjustments

Sky Conditions

Brasstown Bald, Clevis Jones

Sky Conditions



- Suburban Astronomy
  - Light polluted suburbs are a great place for planetary imaging if you avoid local sources of turbulence
  - Planets are bright and some can even be observed in the day time
  - Steady skies are a MUST for large aperture scopes

Sky Conditions

- Watch out for Sources of Local Air Turbulence
  - Dew heaters up too high
  - Concrete, asphalt, furnace discharges, chimneys, pine trees
  - Open field on a raised platform is best

Sky Conditions

V..... < 0.4"

IV..... ~ 0.4-0.9"

III..... ~ 1.0-2.0"

II..... ~ 3.0-4.0"

I..... > 4"

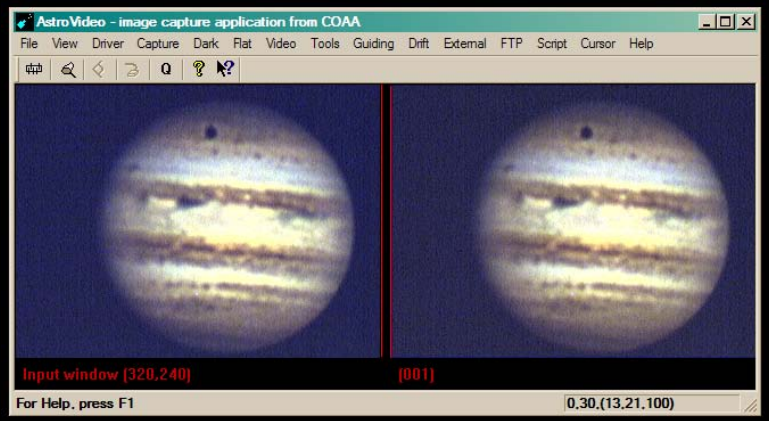
- Best Seeing
  - Typically after midnight and in the middle of a high pressure dome
  - Check the Clear Sky Clock and set your Clear Sky Alarm Clock

Image Acquisition Software

Third Quarter Moon
Larry Owens

Image Acquisition Software

- Webcams
  - AstroVideo
    - Can select number of frames to capture
    - Exposure control, Frames/sec
    - Save to AVI or FITS
    - Apply “Flats” and “Dark Frames”
  - Webcam Software
    - Typically not the best choice but will get the job done
- CCD Cams
    - MaximDL
    - CCDSoft
      - Both allow automatic filter selection
      - Chip cooling management
      - Exposure control
      - Darks and Flats



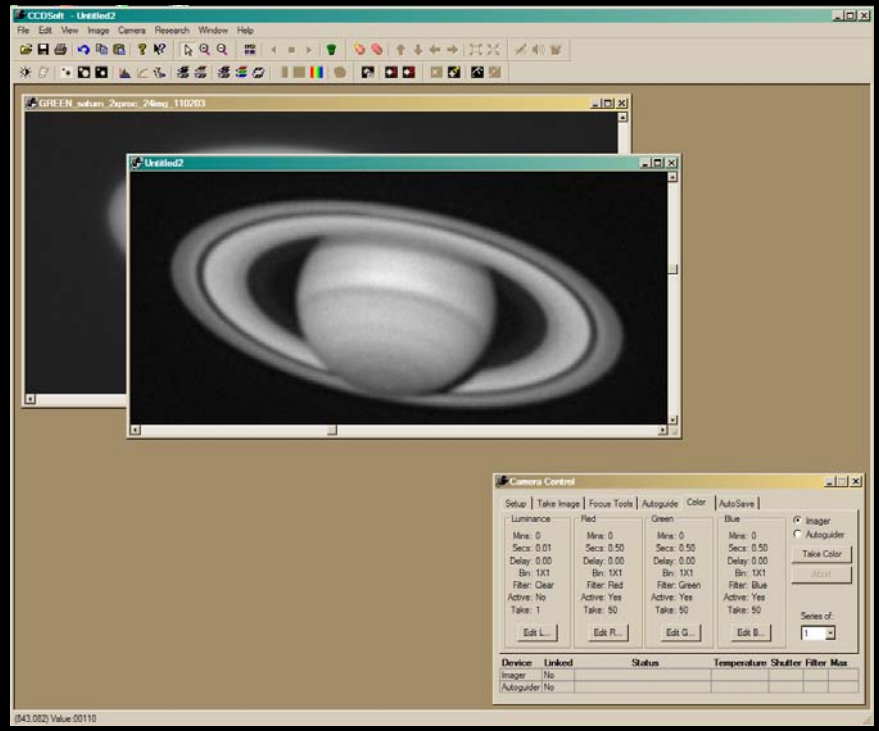
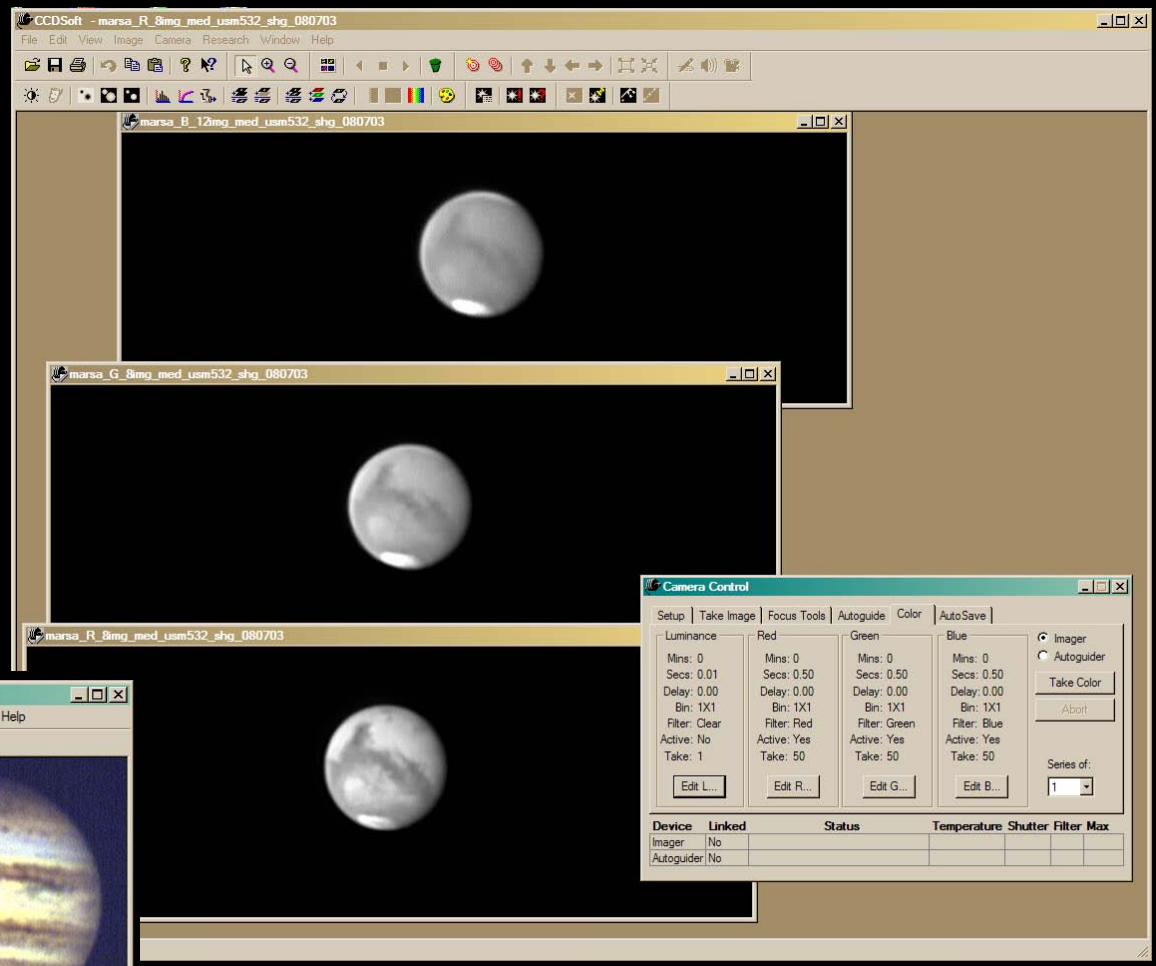


Image Acquisition Software

- Acquisition Demo
  - AstroVideo
    - TouCam Pro
  - CCDSoft
    - SBIG ST7e



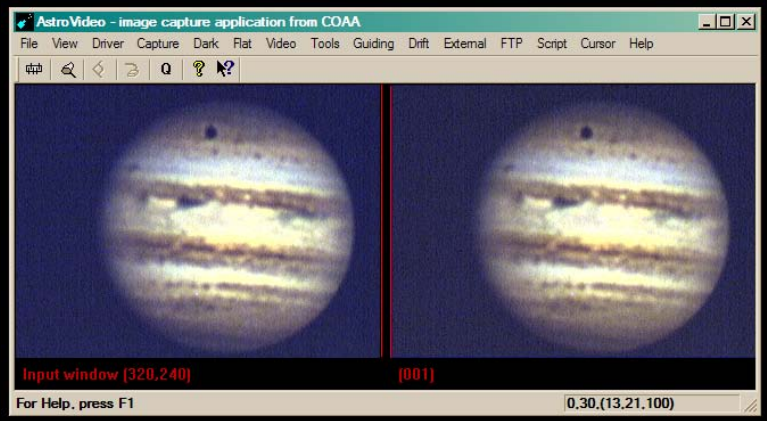
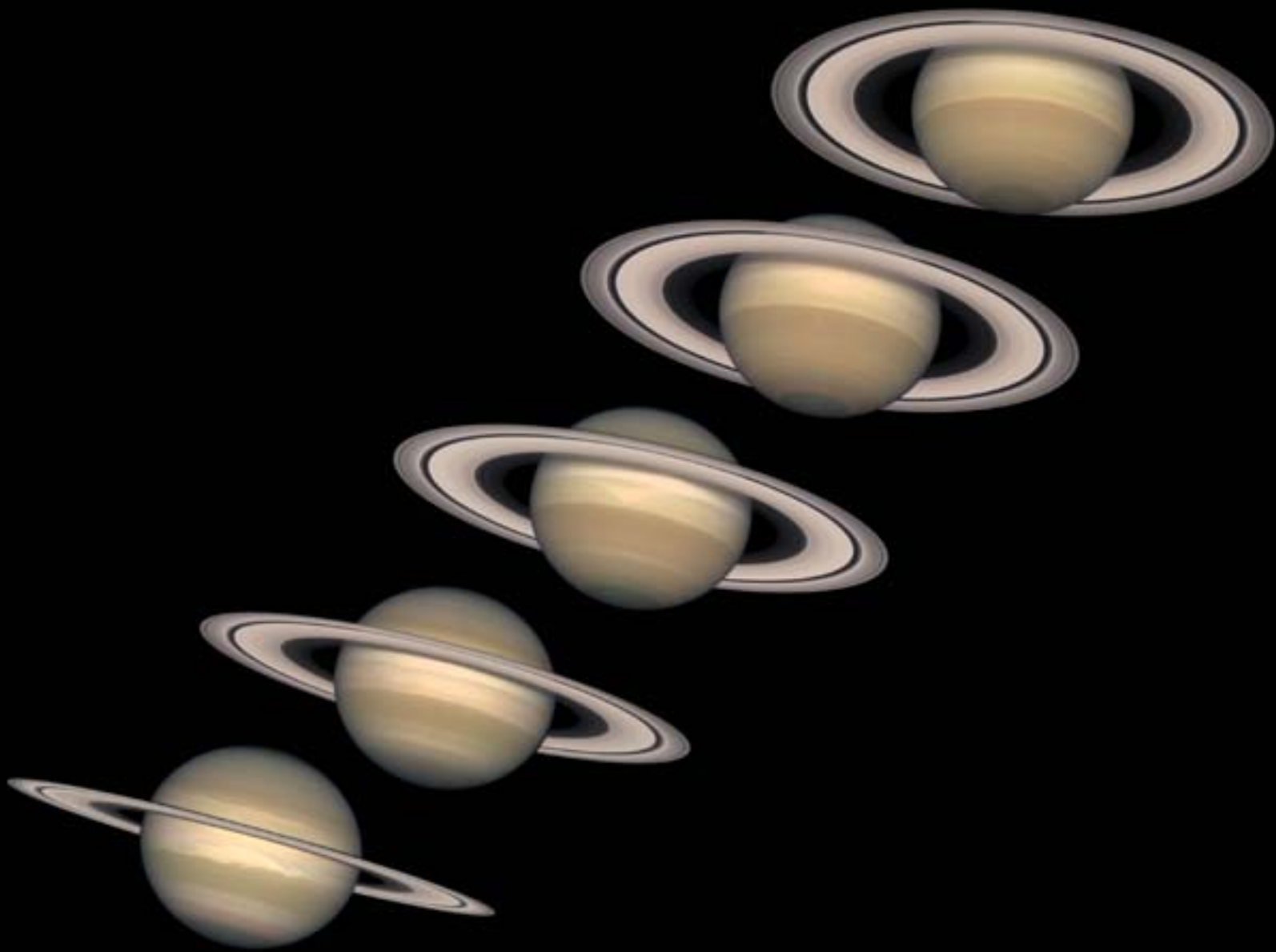
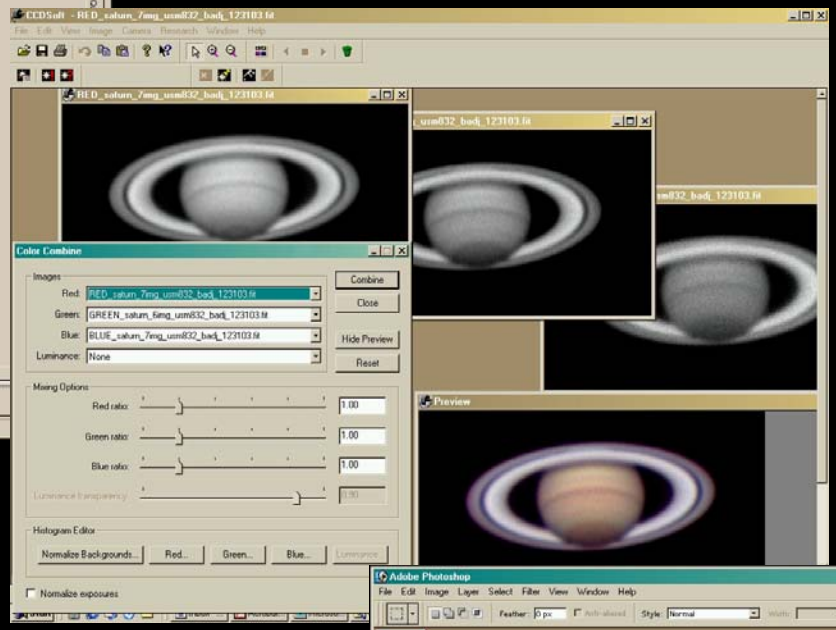


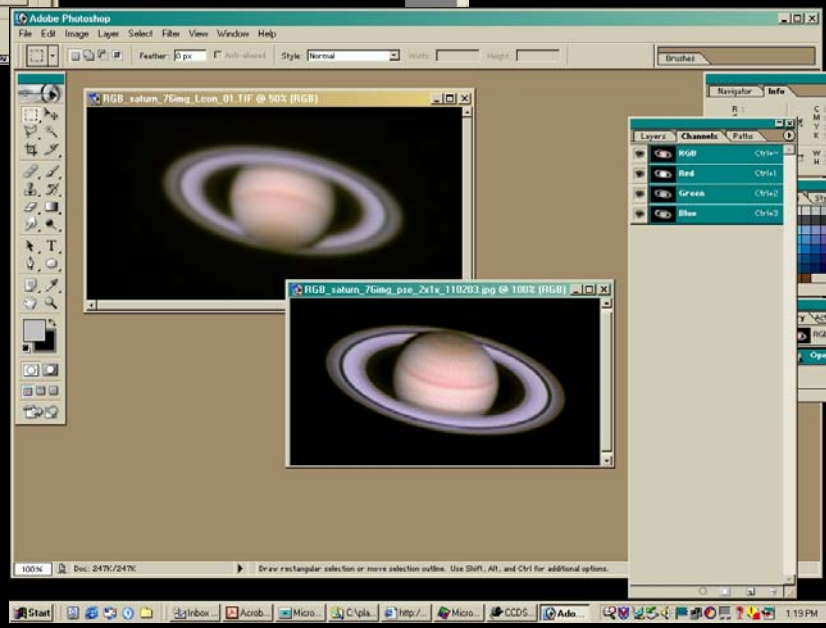
Image Processing



Hubble Imaging Team

Image Processing



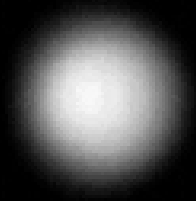


- Basic Process
  - Stacking
    - Many images stacked reduces noise
  - Color combining
    - From black and white to color
  - Enhancing
    - Fuzzy raw images become sharp and colorful

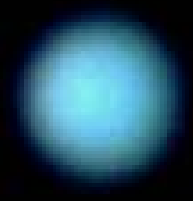
Image Processing

URANUS

Raw Image



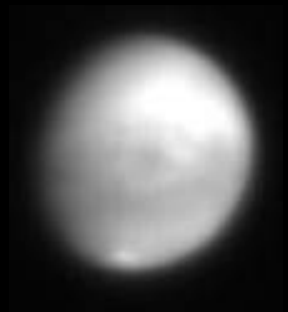
45 image Stack



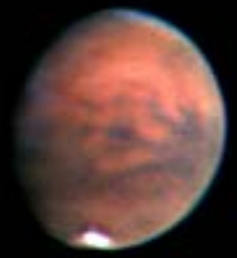
Final Color Image

MARS

Raw Image



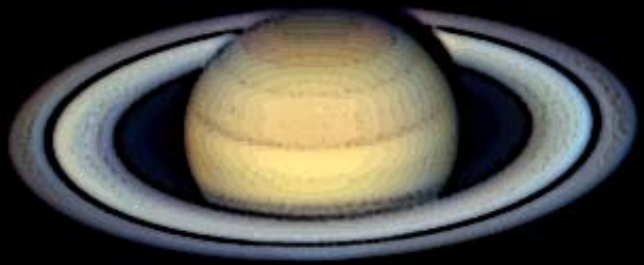
17 Image Stack



Final Color Image

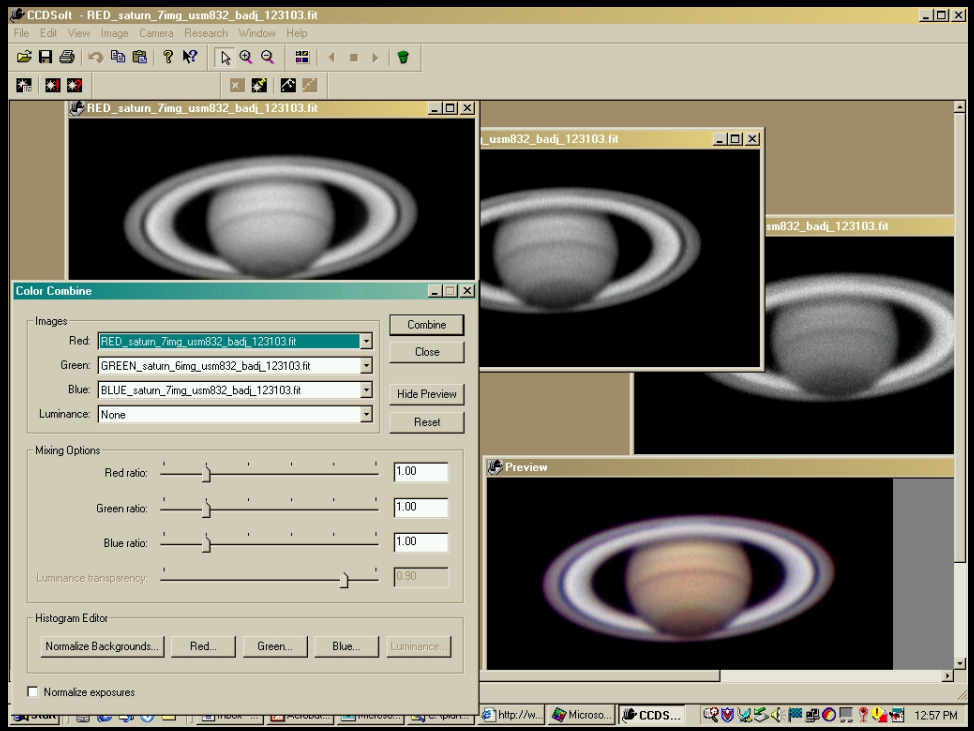
- Stacking
  - Take large number of raw images, or take a movie (AVI's)
  - Carefully align each image using software
  - Perform the stack process
    - Basically averages the data from each frame
    - Result is a single very low noise image that can be aggressively enhanced

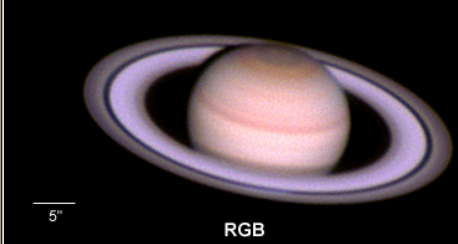
Image Processing

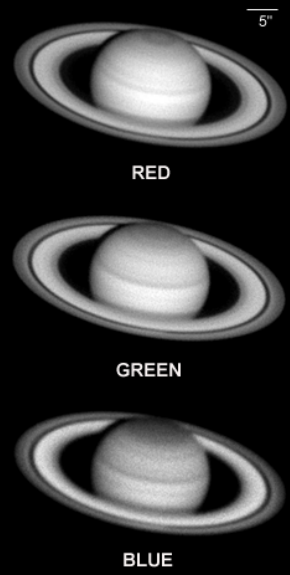


- Image Bit Depth and Bits per Pixel
  - 8 b/p = 256 shades/p
    - Color has RGB so bit depth = 24 or 16.7 million colors
    - **.bmp** and **.jpg** file formats are 8 b/p bit depth of 24
  - 16 b/p = 65,536 shades/p
    - Color has RGB so bit depth = 48 or 281 trillion colors
    - **.tif** and **.fit** file formats are 16 b/p or bit depth of 48
  - Stacking can increase the Bit Depth of your image
    - Save stacked images as **.tif** or **.fit** to keep the advantage
  - Enhance images in 16 bit as much as possible (some software has only limited support)

Image Processing







Date:	11/02/03
Time (Start):	08:40UT
Time (End):	09:10UT
Diam:	19.4"
Mag:	-0.1
Phase:	99.8%
CM I, II, III:	185.6°, 177.2°, 221.2°

Optics:	C14 SCT
Sec/Pixel:	.148" (F/35)
Camera:	ST7E
CCD Temp:	-20°C
Exposure:	R .1, G .1, B .2
Filters:	CFW8/RGB
Process:	Autodark, no flat

NOTES: Image taken from Alpharetta, GA. Clear Sky Clock indicated seeing to be "Excellent" and this seemed to be true though there were intermittent periods of instability. The RGB is a stack of 76 images, R 28, G 24, B 24. Processed with CCDSoft, MaximDL and PhotoShop. Planetary data from WIMP Ephemeris v-5.4.

Imager: Larry Owens *ltowens@comcast.net*

- Color Combining
  - Black and White images taken through color filters are combined creating a full color image

Image Processing

- Enhancing
  - The final stacked color image is probably not what you had hoped for
  - Involves color correcting, sharpening, brightness/contrast adjustments
  - The process is like painting a picture, you take turns with each feature, enhancing here and there until you're satisfied with the image
  - Work with images in a 16 bit format such as .TIF or .FIT as much as possible. PhotoShop CS allows use of more tools on 16 bit images compared to PhotoShop 7.0 or PhotoShop Elements
  - Most often used features in PhotoShop
    - Levels
    - Curves
    - Color Balance
    - Brightness/Contrast
    - Hue/Saturation
    - Gaussian Blur
    - Unsharp Mask
    - Polygon Tool

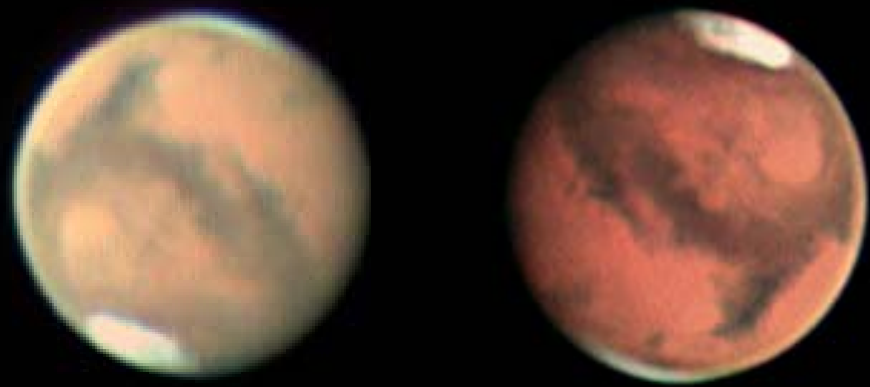


Image Processing

- Software
  - Webcam Image Acquisition
    - AstroVideo http://www.ip.pt/coaa/astrovideo.htm
  - CCD Camera Image Acquisition
    - CCDSoft by Software Bisque
    - MaximDL by Diffraction Limited
  - Stacking, Color Combining
    - CCDSoft by Software Bisque
    - MaximDL by Diffraction Limited
    - RegiStax http://aberrator.astronomy.net/registax/
  - Image Enhancement
    - PhotoShop 7.0 or CS by Adobe
    - PhotoShop Elements by Adobe

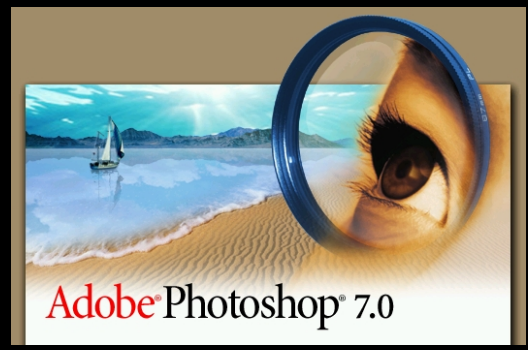


Image Processing

- Image Processing Demo
  - Stacking/Enhancing
    - RegiStax 3.0
    - PhotoShop CS
  - Color Combining
    - CCDSoft