



The New Full Disk H-alpha Telescope

*A short description and manual by Vasyl Yurchyshyn
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In December 2007 the Big Bear Solar Observatory obtained the first light with the new full disk H-alpha patrol telescope (Figure 1, above). The telescope is installed in a separate small dome on a Mead MAX mount. All elements of the optical layout are installed on a 75" long Linos X95 rail. The telescope and dome can be controlled remotely via VNC viewer. The optical layout of the telescope is presented in Figure 2.

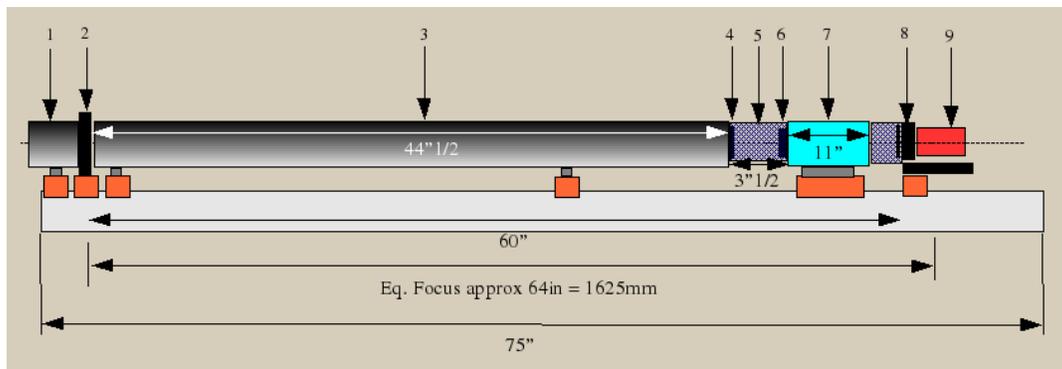


Figure 2. Optical layout of the New BBSO H-alpha patrol telescope.

The telescope is equipped with the dust cap assembly (Figure 2, 1) controlled via GALIL/W channel. The [Edmunds doublet](#) with a clear aperture of 98mm is used as an objective (2). The telescope's focal length of the objective is about 1625mm, which produces full disk solar images with an image scale of 1.005 arcsec per pixel. To minimize the scattered light leaking into the system, space between the objective (2) and the Infra-red (IR) filter (4) is sealed in an aluminum tube. The objective lens and the IR filter serve as entrance windows. Zeiss H-alpha Lyot Filter (7) is connected to the aluminum tube (3) with a Linos flexible bellow (120mm diameter). The H-alpha Lyot filter has a variable bandpass of 0.25Å or 0.5Å with a possibility to shift the bandpass within a 6Å range. The IR filter (4) and the H-alpha pre-filter (6) are installed inside the bellow. The pre-filter has a 10Å (?) bandwidth and it is mounted directly on the Lyot filter. Another Linos bellow connects the rear end of the Lyot filter to the camera mount (8). There

is a neutral density filter (NG11 2mm with 56% transmission) attached to the camera mount. The camera mount consists of a Linos rotational stage (100 steps per 1 deg) vertically positioned on a Linos parallel stage (1000 steps per 1 mm). The rotational stage is used to correct the Po angle and it is controlled via GALIL/Y channel. The parallel stage is used to focus the telescope and it is controlled via GALIL/X channel. Aluminum adapter rings are attached to the rotational stage and are used to mount the [JAI PULNIX TM4200GE camera](#) with Kodak [KAI4021](#) chip.

This camera is a miniature, high-resolution (4.2 megapixel), mono-chrome, progressive scan CCD camera with a frame rate up to 7 fps at a full 2048 x 2048 resolution. The high frame rate allows us to implement the image selection routine. This camera uses the Kodak KAI-4021 chip, which is a high-performance image sensor designed for a wide range of medical, scientific and machine vision applications. The 7.4 μm square pixels with micro lenses provide high sensitivity and the large full well capacity results in high 12-bit dynamic range. The vertical overflow drain structure provides anti blooming protection and enables electronic shuttering for precise exposure control. Other features include low dark current, negligible lag and low smear. The camera is connected to the control computer via GE link.

We have developed a data acquisition and telescope control software (see a screenshot in Figure 3), which allows for a remote operation of the patrol telescope with minimum involvement of the observing staff.

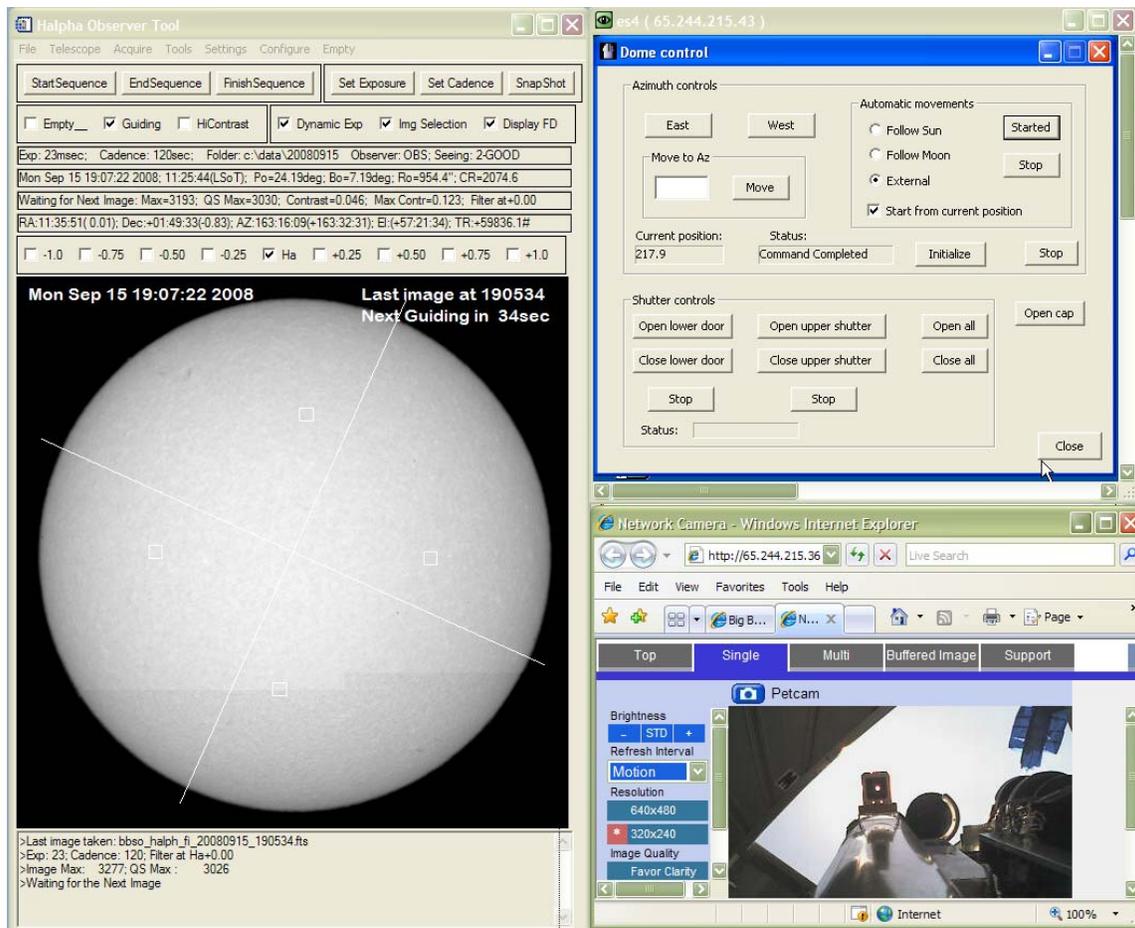


Figure 3. Screenshot of BBSO Halpha patrol telescope control software. This software allows to remotely control and operate the telescope and dome with minimum involvement of BBSO staff.

Short manual

There are two control computers that are involved in Halpha observations: i) *ES4* - Windows operated Dell desktop computer - controls dome movement and ii) *Halpha* - Windows operating Dell notebook - controls the telescope, mount and data acquisition. They both use the same keyboard, mouse and monitor that are connected via a KVM switch. To switch between them, press twice "Scroll Lock" and "1" to use *Halpha* and press twice "Scroll Lock" and "2" to use *ES4*. Note that beep sounds after you press "Scroll Lock" twice.

To Start Observations

- 1) Turn on the mount
- 2) Turn on the monitor
- 3) Switch to *ES4*
- 4) Start "Dome Control" application
- 5) In "Dome 'Control" click on the "Initialize" button
- 6) In "Dome 'Control" open the shutter (lower door may stay closed from mid-Marcg till mid September)
- 7) In "Dome 'Control" select "External" and Click on "Start" button
- 8) Switch to *Halpha*
- 9) *Open UltraVNC and connect to *ES4*. Passowrd: telbbb. Resize the window (see Fig. 3). This connection is only needed to have ready access to dome controls;
- 10) Make sure that the parallel port switch is in Halpha position.
- 11) Start IE and connect to Ha petcam (in bookmarks). This will allow you to monitor the telescope pointing. This web cam is installed on the Halpha telescope
- 12) Start IDL
- 13) Type in command "obs_tool", press "ENTER"
- 14) Select "telescope"->"Open Dust Cap"
- 15) Select "Telescope"->"Set Po"
- 16) Select "Telescope"->"Find Sun"; Mount begins to move. The sun should appear in the field of view. If yes, then go to step 19, otherwise do 17 and 18.
- 17) After the pointing is done, if the sun will not appear in the field of view you'll be asked to select the appropriate mount position (i.e., before noon or after noon) and press "Done". Mount move control window will then appear.
- 18) Press buttons to point the telescope at the sun. When the solar disk is entirely in the field of view, press "Done". You may also switch between mount speeds "center" (faster) and "guide" slower. Note! We move the mount not the sun. I.e., when "WEST" button is pressed the telescope move to the west, the sun moves to the EAST.
- 19) Select "Acquire"->"Data". A live image will appear. 4 small boxes indicate the area used to measure image contrast; Crosshair indicates the position of the earth NS axis and equator. When moving the mount the sun will shift along these lines!
- 20) Check "Guiding" box to start guiding
- 21) Press "StartSequence" to start taking data and make a corresponding entry in the BBSO observer's logs.
- 22) Take flat field data and post images.
- 23) To pause observations (saving images) Click "End Sequence".
- 24) To stop observations and exit, click "Finish Sequence" and then select
- 25) "File"->"Exit" to exit

To Take Flat Field Data and Post Daily Images

- 1) In the observation mode, Select "Acquire"->"Flat Field". The mount will point the telescope at different areas on the sun and a series of 16 displaced full disk images will be taken.
- 2) When done, the telescope will be centered at the sun and observations will resume.
- 3) Generate the flat field image and other flat field corrected images for daily update. Select "Tools"->"Make Flat Image". The program will be busy for about 1 min. When it is finished, two 512x512 windows will be displayed on the right side of the screen.
- 4) Inspect the images. If the image in the lower right window is uniform then the flat field data are acceptable.
- 5) Select "Tools"->"Accept Fulldisk". The two windows will close and daily images will be transferred to the BBSO web server. Normal observations will resume.
- 6) We do it twice a day. At the beginning of the observing run and after the German flip in.
- 7) If the observations began in the afternoon the flat field data is taken only once.

German Flip

Near local solar noon the mount should be flipped. Watch the screen. Close to 12:00LoST (telescope and sun azimuth are close to 180 deg) the observations will be paused, the mount will be put to sleep and the computer will ask permission to do the flip. Unless otherwise instructed, click "Yes". The mount will flip (move) during approximately 10 min time interval. Normal observations should automatically resume once the flip is finished.

Buttons

"Start Sequence" - start taking data with the preset exp time and cadence

"EndSequence" - stop taking data; switch from observing to live mode

"Finish Sequence" - leave the live image mode, ready to exit the program.

To return to observations, select "Acquire"->"Data"

"Set Exposure" - set exposure (also can be done thru "Settings"->"Set Exposure")

"Set Cadence" - set cadence (also can be done thru "Settings"->"Set Cadence")

"Snapshot" - takes a single image when the button is pressed

Selections

(o / v means unchecked/checked on launch)

o empty

o Guiding

o HiContrast - when checked, the program will save a hi contrast image, whether in live or observing mode

v Dynamic Exp - when checked the exp time will be adjusted automatically so that the quiet sun brightness is between 3100 and 3200. Max dynamic exp is 250 ms.

NOTE: when taking flat field images the expose is not adjusted.

v Img Selection - when checked, 20 images are taken in about 6.5 sec and the one with the highest contrast is best is saved.

v Display FD - when checked, the full disk is displayed. When unchecked, the program will ask to click on the solar area you want to view in full resolution. To return to FD mode, simply check the box again.

Status Lines

First Line displays exp. time, cadence; data folder and observer

Second line displays date and time; solar Po and Bo; Solar radius; and Carrington rotation number

Third line displays various current information such image stats; regime (guiding, waiting); filter position

Filter Position Selector – check appropriate boxes to observe at desired wavelengths. One image will be taken at each filter position. The cadence between those images will be as previously set.

Menu Bar

"File"->"Open Fits" to peak saved fits files and view them;

"File"->"Exit" to exit

"Telescope"->"Open Dust Cap" - to open the dust cap

"Telescope"->"Set Po" - to set Po angle

"Telescope"->"Find Sun" - to point telescope to the sun

"Telescope"->"Fine Pointing" - mount control

"Telescope"->"Focus" - to focus the telescope

"Telescope"->"Park Scope"

"Telescope"->"Close Dust Cup" - to close the dust cap

Select "Acquire" to

"Acquire"->"Flat Field" - takes shifted images for flat fielding

"Acquire"->"Data" - turn on the live and observing mode

Select "Setting" to set:

- exp. time - default is 22 ms, will automatically adjust if Dyn. Exposure is checked
- cadence - default is 120 sec;
- observer - default is "OBS";
- data folder - default is c:\data\YYYYMMDD
- seeing - default is 2-Good
- mount position - is automatically set when the program starts
- Update time - will allow update time of windows system

Select "Configure" and

"Filter Configs" to indicate desired wavelengths and how many images should be taken at each position.