Remotely operated robotic telescopes – the MicroObservatory Robotic Telescope Network.

Version 2 Originated 2021 February 23

Contents

1.0   Accessing the network
I must thank Martin Fowler for his considerable help with this project.

The network is operated by the [Harvard and Smithsonian Center for Astrophysics](#) and can be found [here](#) - Figure 1.1
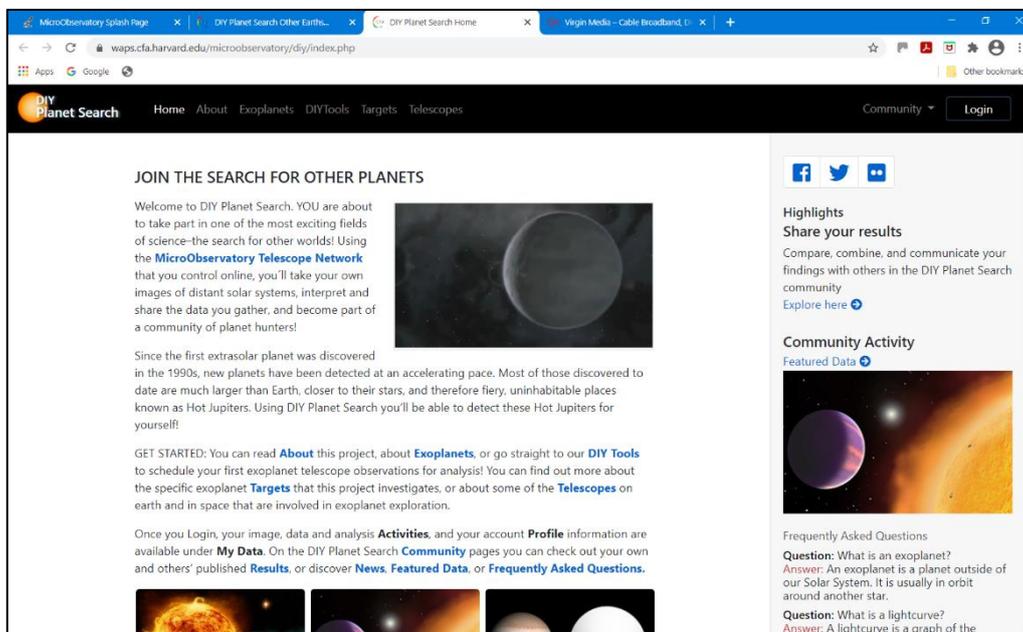
Figure 1.1. Log in/Register screen

2.0   Target selection
After logging in select DIY Tools on above page to arrive at the Schedule Target screen – Figure 2.1
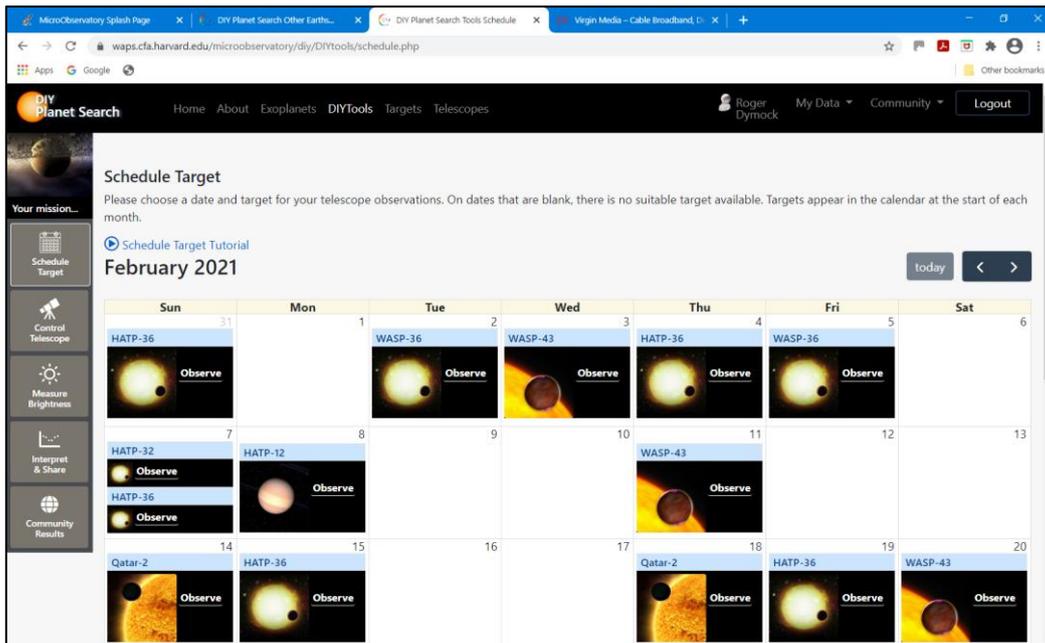
Figure 2.1. Schedule Targets

If you are participating in the ARIEL ExoClock project access the ExoClock Ephemerides page to choose a target which is shown there and on the MicoObservatory pages as shown in Figure 2.1. MicroObservatory data required when creating an ExoClock account is given in Section 5.

The target for 2021 February 25 is WASP-36 and the next step is to set up the observing run by clicking on 'Observe' for that object. This opens the Control the Telescope page – Figure 2.2.
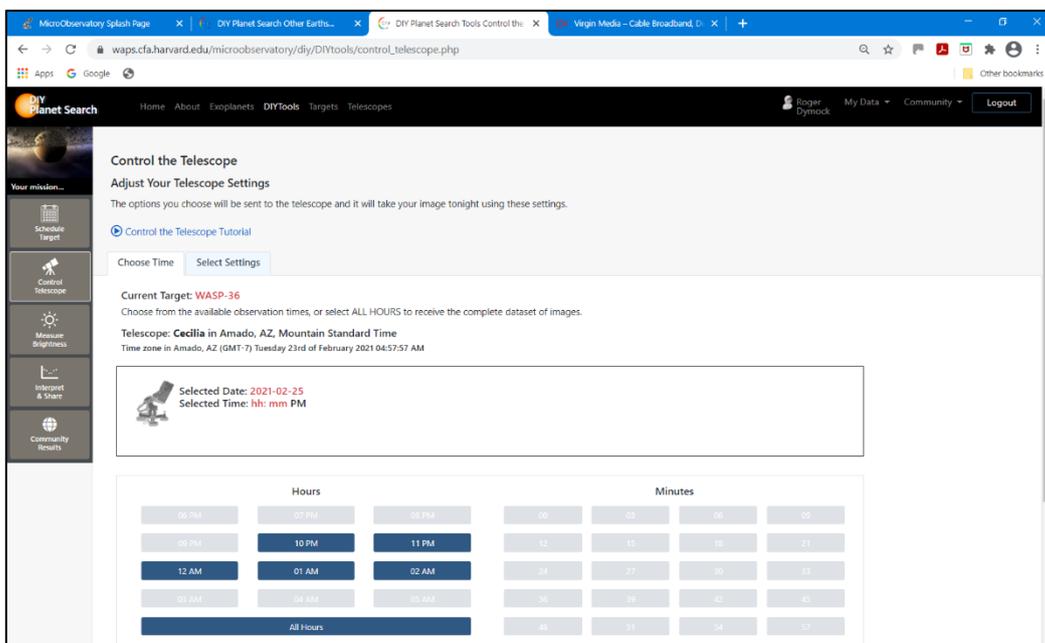
Figure 2.2. Control the Telescope

Under the 'Choose Time' tab select 'All Hours' which switches to the 'Select Settings' tab – Figure 2.3. Input the Exposure time as suggested (it may already be set to the appropriate value). There is only one filter - Clear
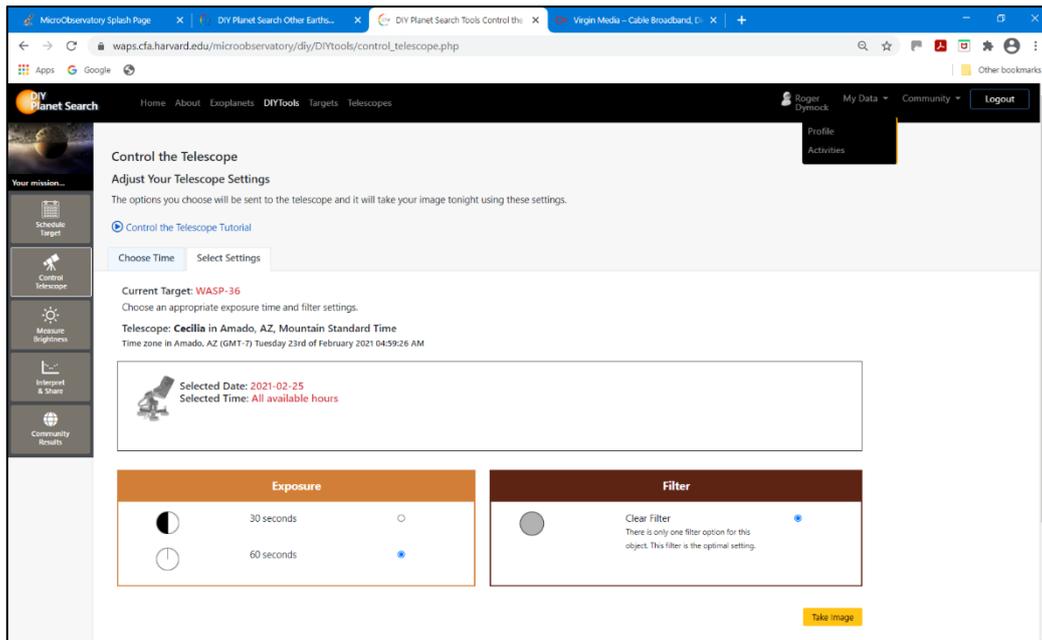
Figure 2.3. 'Select Settings' tab.

Clicking on 'Take Image' in the bottom right-hand corner of the screen displays the target and number of images – Figure 2.4.
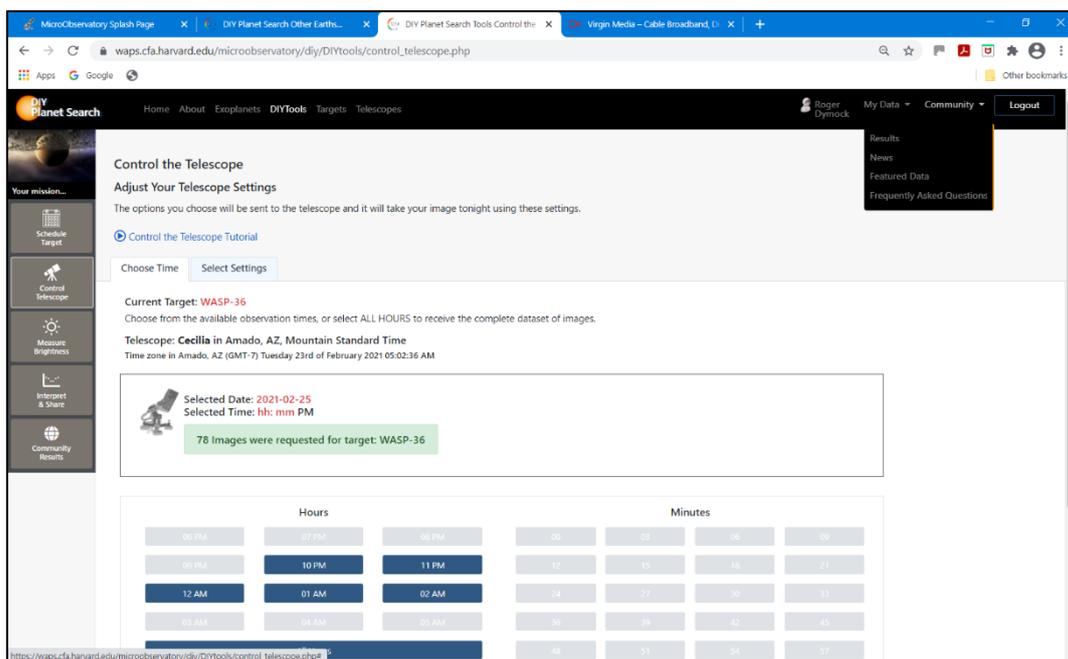
Figure 2.4. Target and images requested

Selecting 'My Data/Activities' at the top of the page opens the page shown in Figure 2.5.
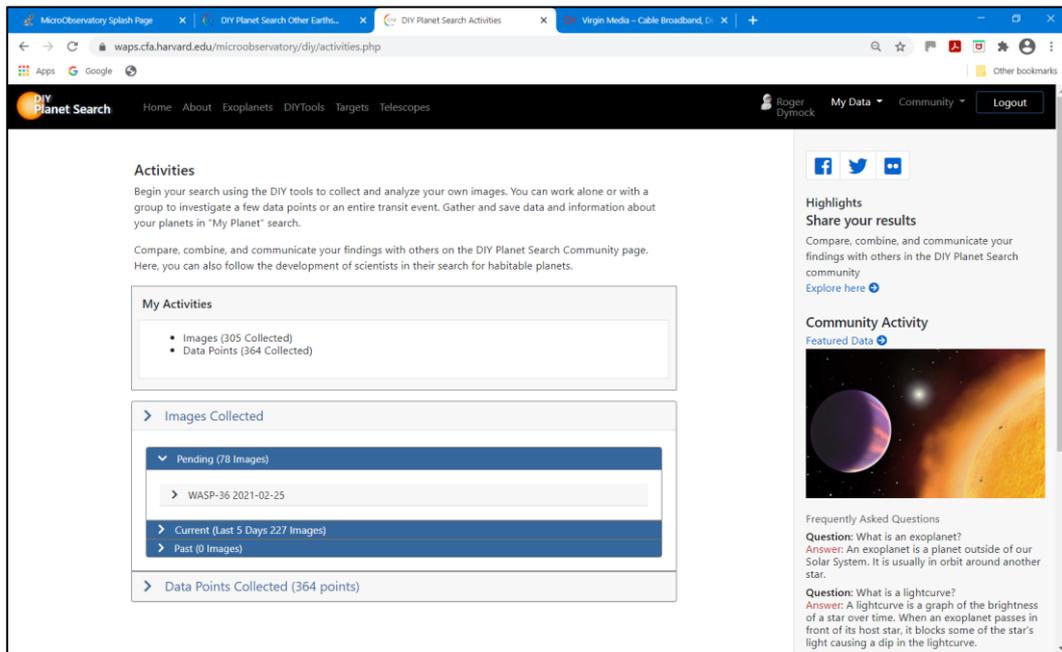
Figure 2.5. Activities.

The scheduled WASP-36 images are shown under Pending. Images previously obtained are listed under 'Current (Last 5 days…)' or (Past…) - WASP-43b in Figure 2.6.
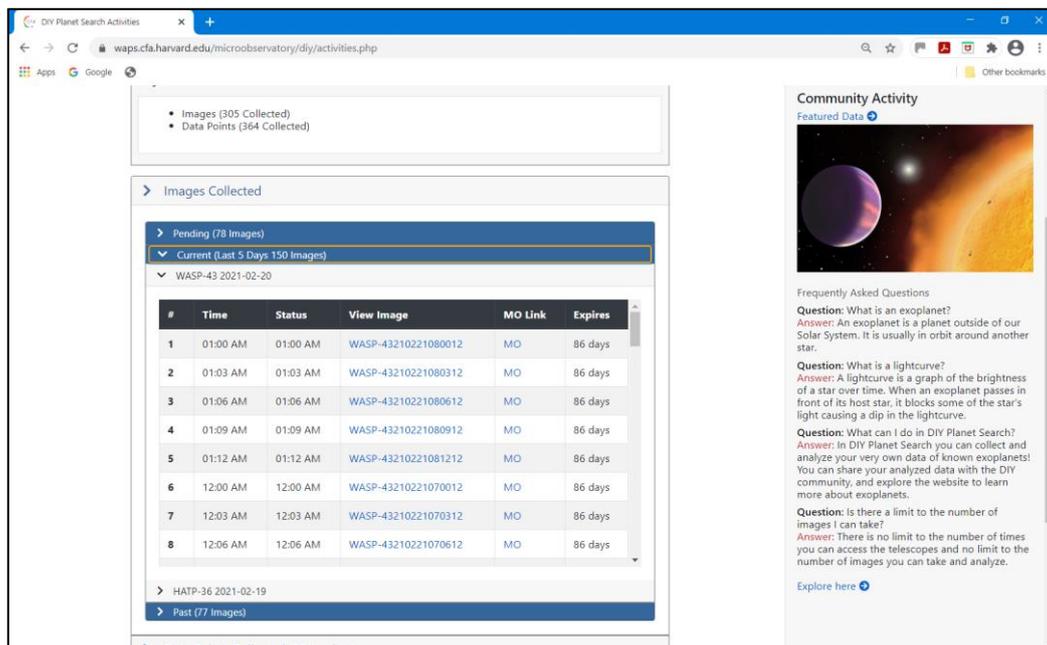
Figure 2.6. (Partial) list of images of Wasp-43b obtained on 2021 Feb 21

3.0   On-line analysis

On the 'DIY Tools screen, Figure 3,1 Select 'Measure Brightness' – Figure 3.1 to bring up the screen of that name – Figure 3.2.
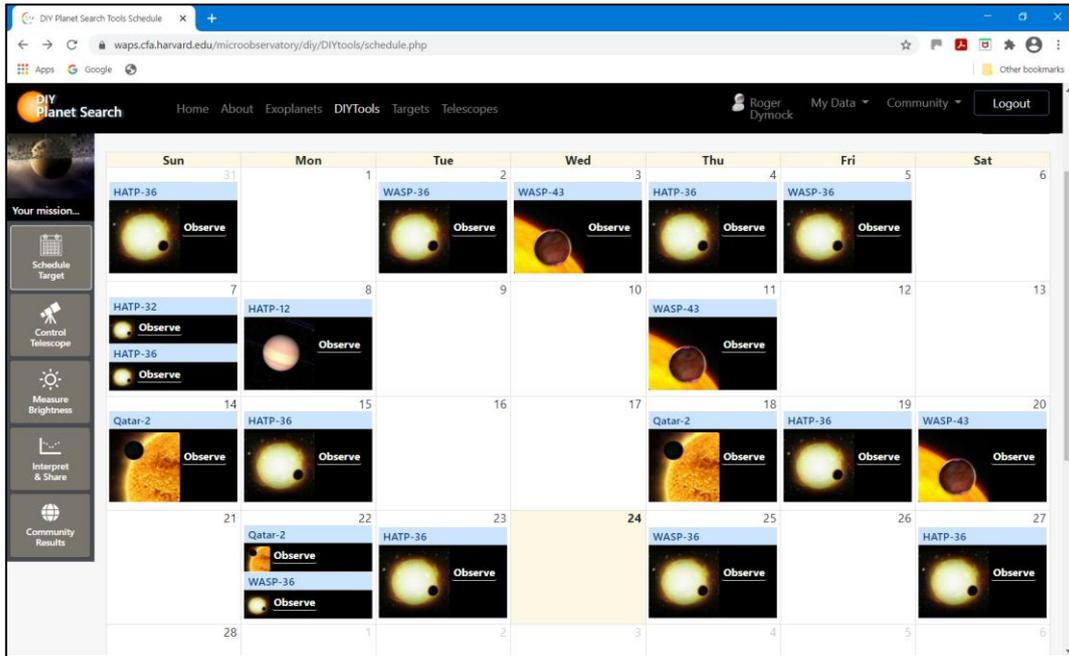
It is recommended that you watch the three tutorials before proceeding with brightness measurements.　　　Figure 3.1. DIY Tools screen

Click on 'My Requests' and select the first image in the list (not the Darks) – Figure 3.2
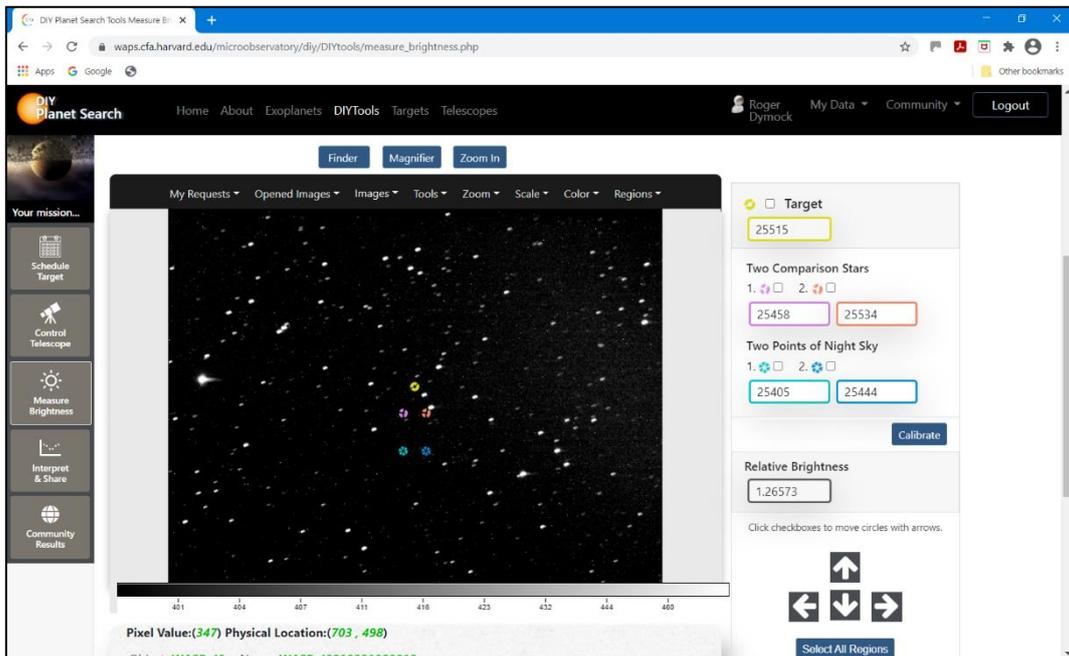
Figure 3.2. Measure Brightness screen

Position the Target and Comparison star circles as explained in Tutorial 2 – Find your star. You can Zoom to accurately position the circles – Figure 3.3.
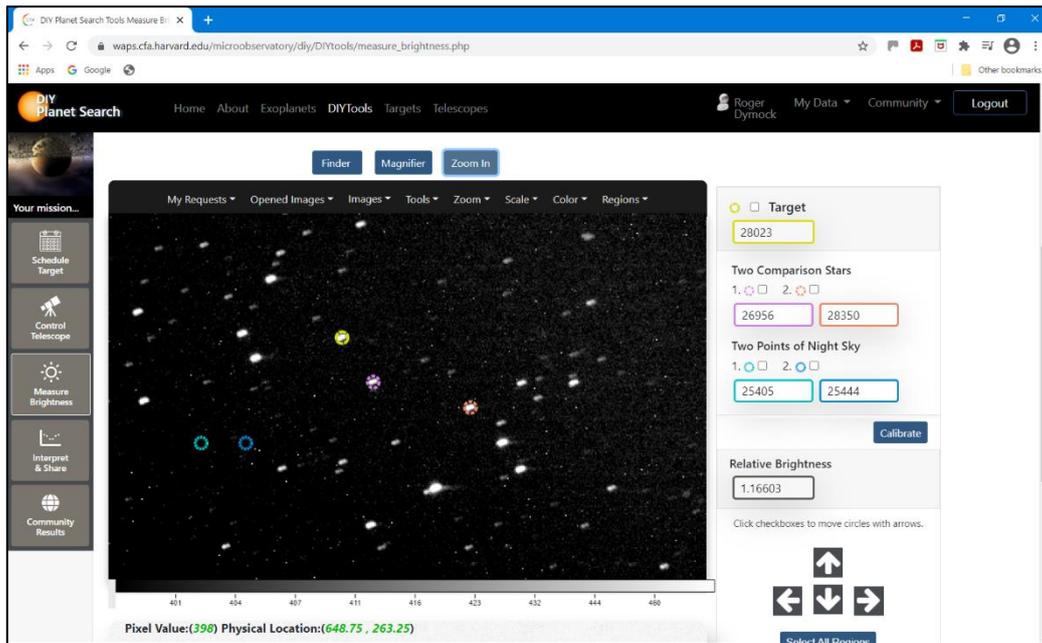
Figure 3.3. Zoom In feature to position measurement circles

Place the remaining two circles near the target star in regions clear of other stars – use the Magnifier to verify this is so.

Open a Dark image from the 'My Requests' list for the object being measured – this will be used to calibrate the images, return to the list and open the first image.

You may need to reposition the circles for each image so use a combination of Zoom and the Move arrows at bottom right to do this. To move all five circles at the same time, tick each box above the objects on the right of the screen.

Return to the 'My Requests' list and select the next image, Zoom In and position as required, 'Calibrate' and then 'Calculate and Record'.

Repeat until all images have been analysed.

Measurements can be viewed under the 'View Data' tab – Figure 3.4
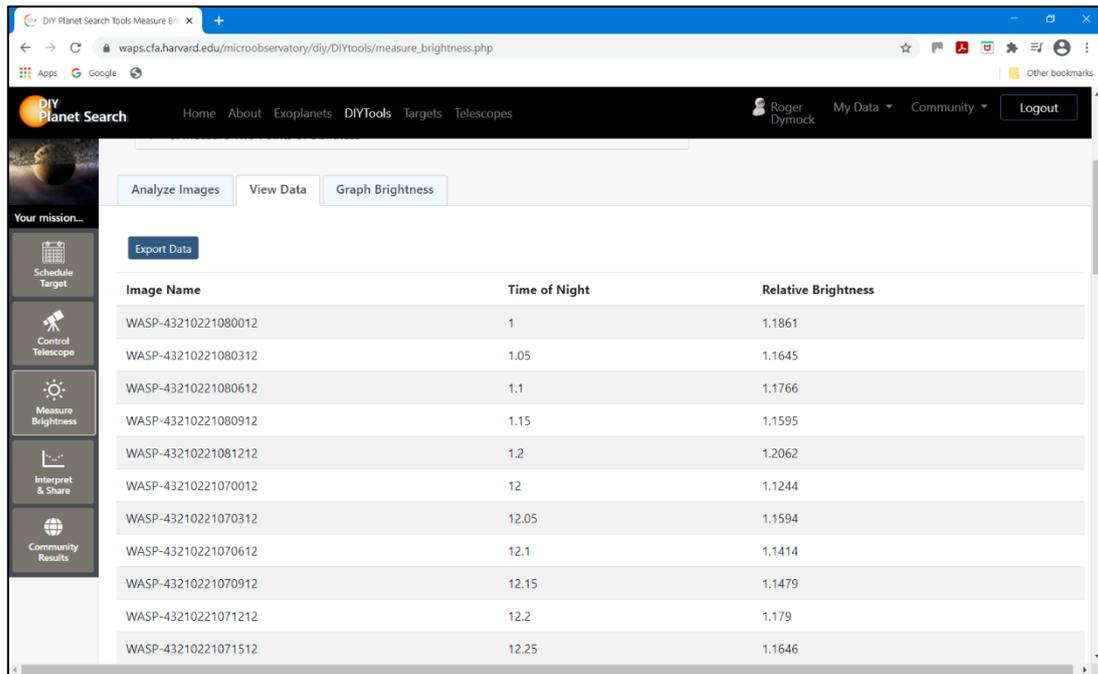
Figure 3.5. WASP-43b (partial) data

Selecting the 'Graph Brightness' tab displays the transit curve – Figure 3.6. The reduction in brightness can be discerned between approximately 11 and 12 hours (Arizona time).
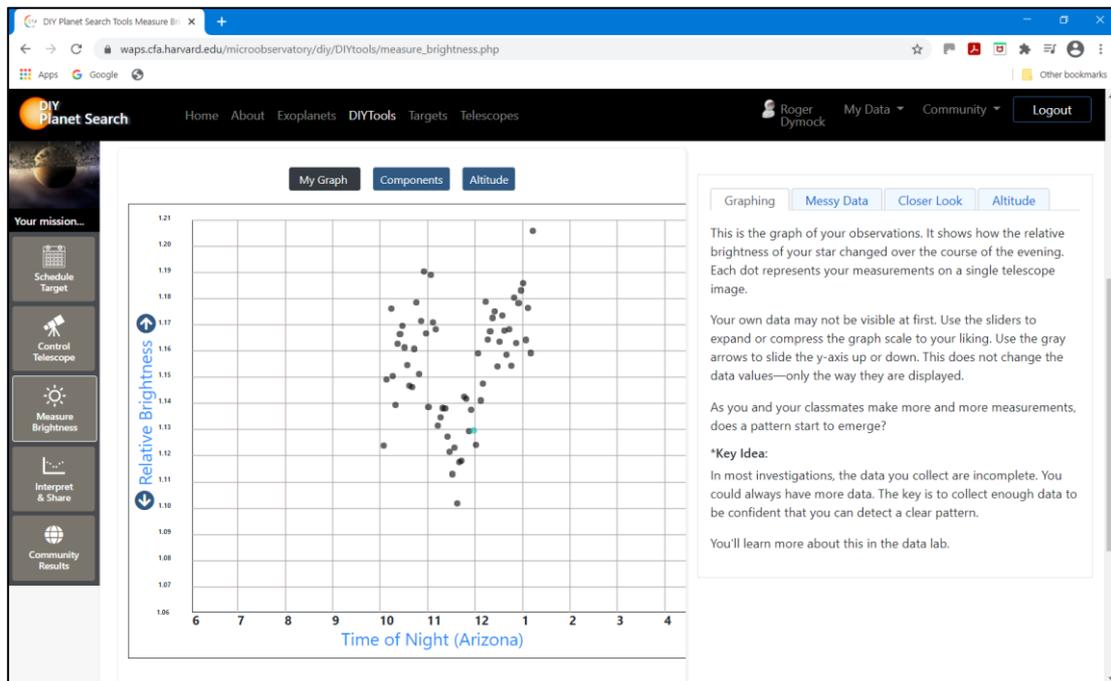
Figure 3.6. Transit light curve

To overlay your results with a reference graph and predicted transit time, select 'Interpret and Share', choose the star in the box 'Data you analyzed', 'View Reference Graph' and 'View Predicted Transit' – Figure 3.7.
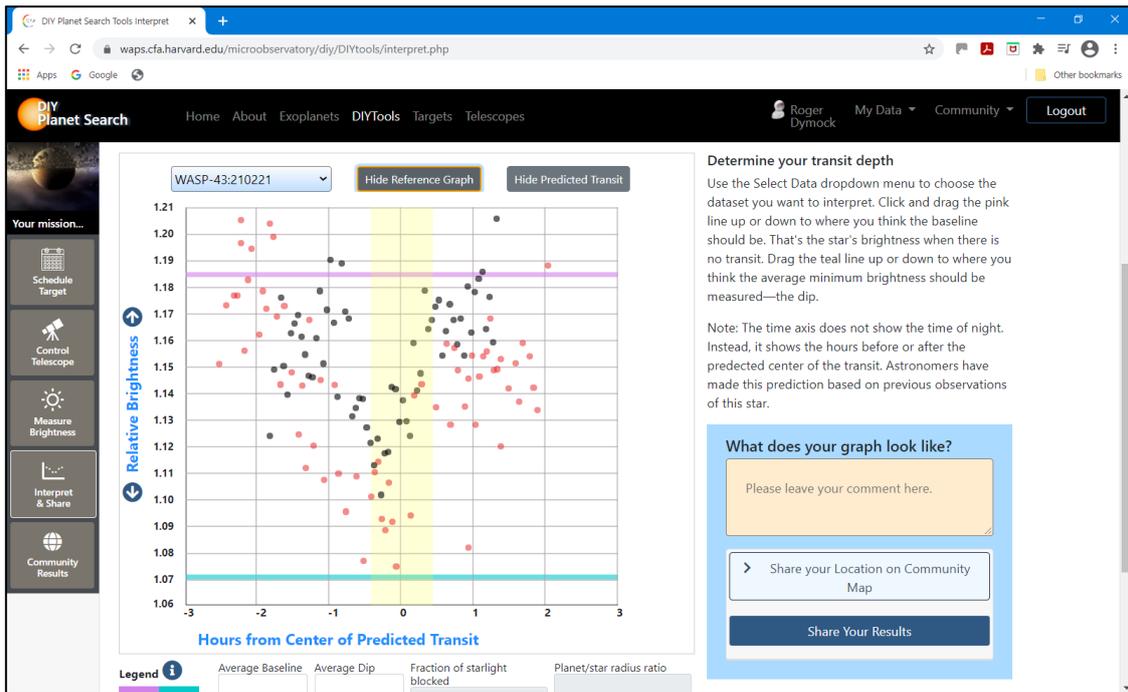
Figure 3.7. Results plus Reference Graph and Predicted Transit.

4.0   Downloading images and dark frames (for off-line analysis)

4.1   Downloading images

There are time consuming (4.1.1) and somewhat less time consuming (4.1.2) methods. For the former a strong wrist is required as this requires a considerable number of mouse clicks!!! My thanks to Martin Fowler for his advice as on the latter.

4.1.1   The time-consuming method

Images should be available within three days. Select 'My Data/Activities' at the top of the page to open the page shown in Figure 2.6. Select the images you wish to download from the Current or Past lists.

Select an image by clicking on 'MO' in the 'MO Link' column which links to the page shown in Figure 4.1.1.
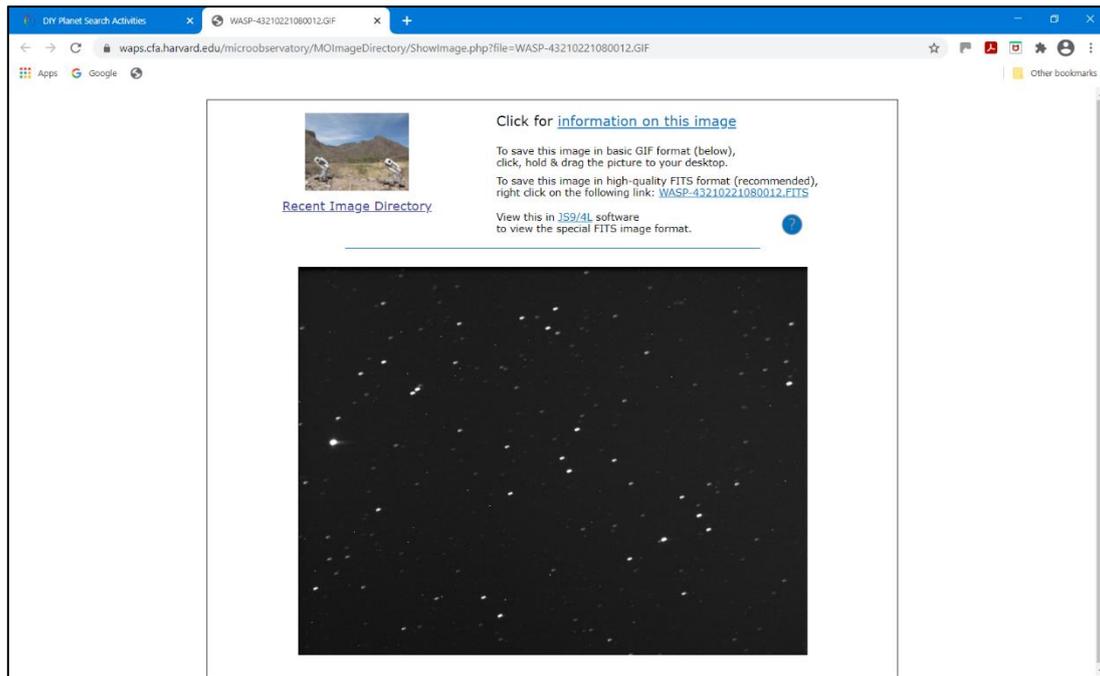
Figure 4.1.1. Image for download

As stated on the page download the image by right-clicking on the link and then 'Save link as…' in the pop-up window. Next Image does not work so you will need to return to the list shown in Figure 4.2 by closing the window shown in Figure 4.3.

Now all you have to do is repeat the above sequence for each image you wish to download. Any marked with an X in the 'Status' column can be ignored.

To download dark frames see below.

4.1.2. The less time-consuming method
A list of images and dark frames can be found at (http://mo-www.cfa.harvard.edu/MicroObservatoryLegacy/ControlCenter/index.html) – Figure 4.1.4
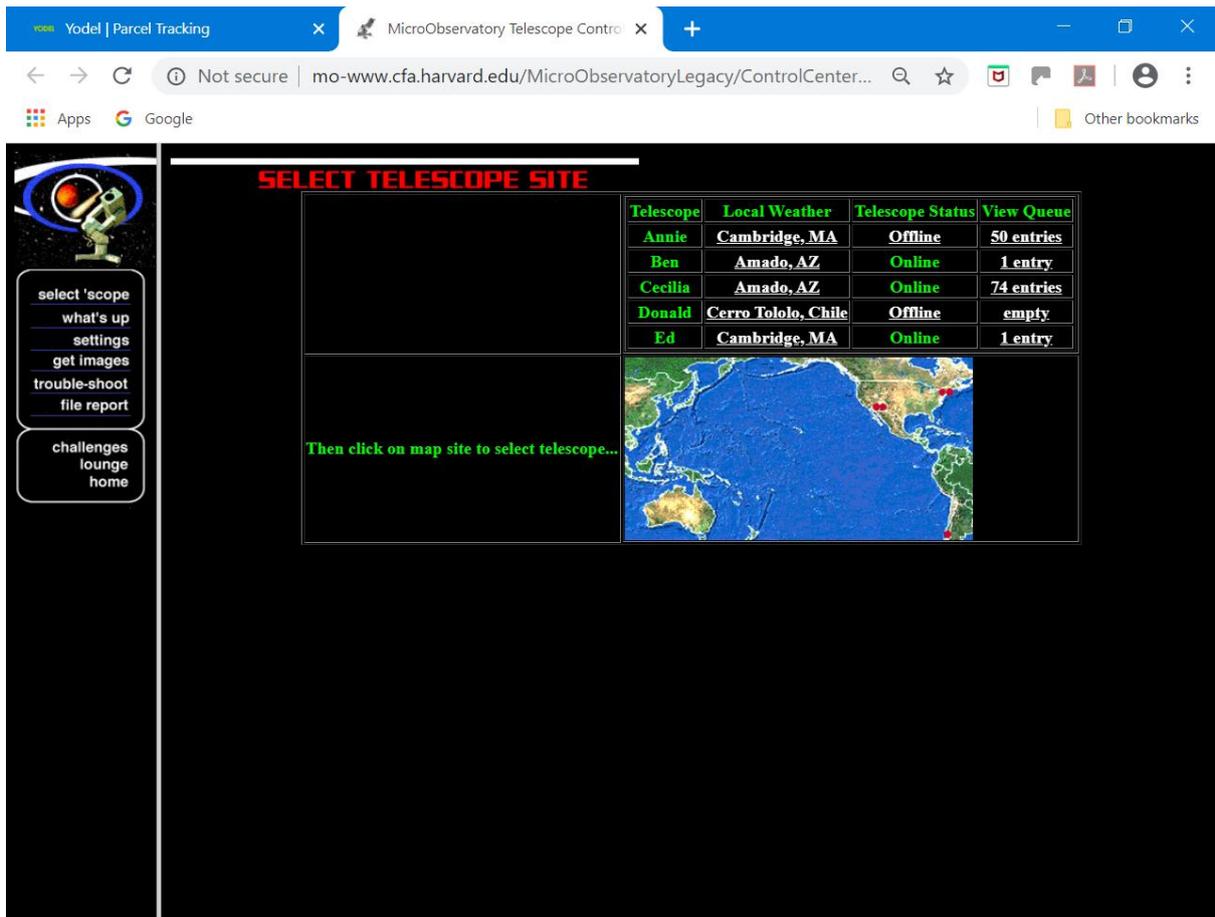
Figure 4.1.4 Control center

To obtain your images select 'get images' from the list on the left of the page and scroll down to the required images and date. In this example HAT-P-36b – Figure 4.1.5. Note that the exoplanet images are interspersed with the others taken on that night.

Figure 4.1.5. Image list

Unfortunately the images till have to be downloaded one at a time but the number of mouse clicks required is much reduced.

To download images;
- click on the icon in the FITS image column
- save to the required folder
- click on the next image and etc.

To review images before download
- click on the icon in the Image File name column to bring up the image shown in
  Figure 4.1.6
- click on the image name at top right
- save to your desired folder
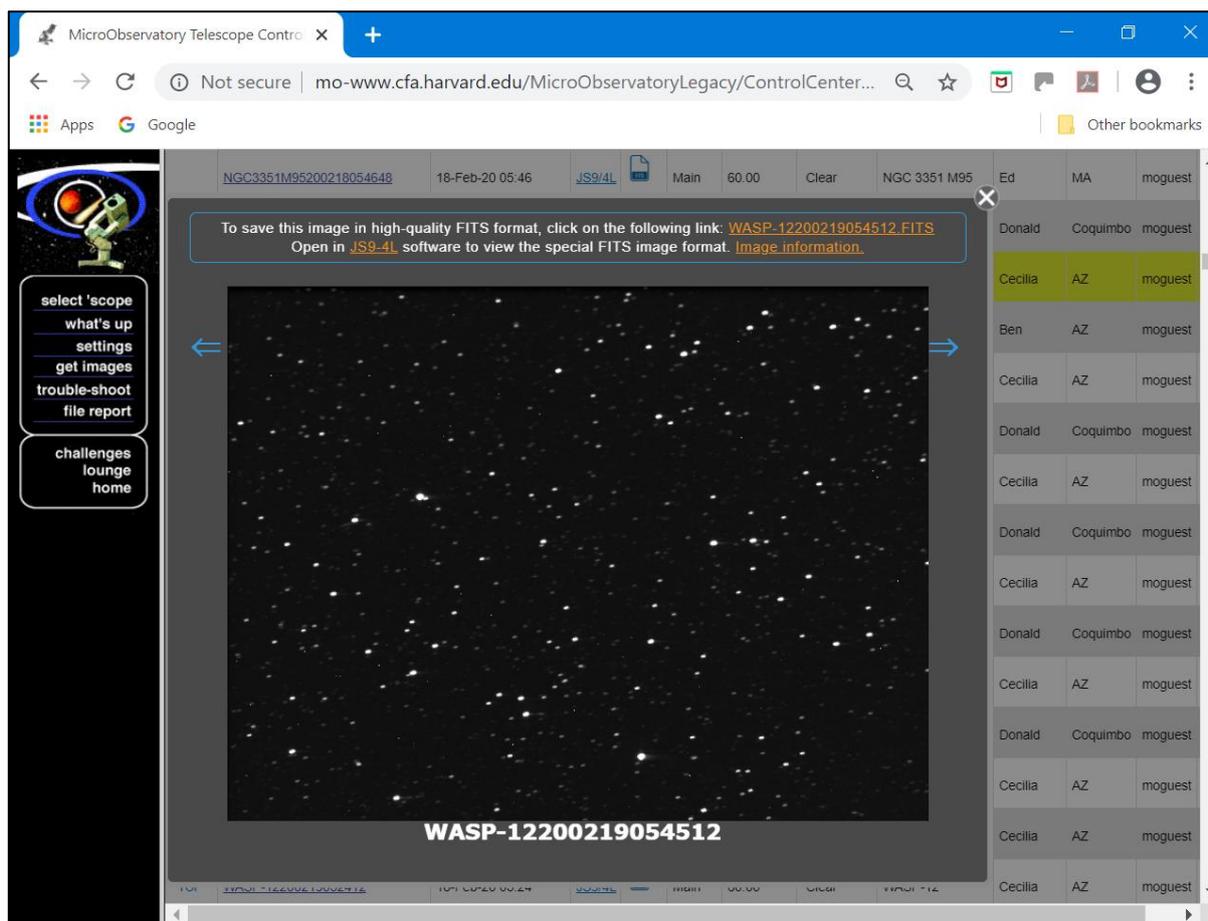
Figure 4.1.6. FITS image

To download dark frames;
- scroll up/down around the date of your images
- select five dark frames ensuring they have the same exposure times as your images and are
  listed as 'Opaque
- click on the icon in the FITS image column
- save to the required folder
- click on the next image and etc.

For ARIEL ExoClock participants please use the HOPS software – see appendices A and B at
https://britastro.org/sites/default/files/ARIEL%20Space%20Mission%20V2.pdf

5.0   MicroObservatory data
Telescope

Name;	Cecilia
Type;	5.25", f/3.6, 152mm Maksutov reflector
Focal length	550 mm (Note 1)
Camera;	KAF 1402ME, 1317x1035 binned 2x2 to 650 x 500 pixels
ADUs	12 bit CCD therefore max ADU is 4096 (Note 2)
Pixel size	6.8x6.8 microns binned 2x2 to 13.6x13.6 microns
Plate scale	5.17"/pixel
Image size	56' wide x 43' high
Filter;	Clear

Note 1   FL set to 542mm using Astrometrica
Note 2   Image FITS header states 16 bit as 12 bit is not a valid
parameter

Location
Whipple Observatory;   Lat 31.68N (+31 40 48N), Long -110.88 (110.88, 110 52 48W)
Time Zone;   -7