Ultimate Orbit Tracker

Quick Start Guide

Ver 1.22

This software provides the traditional method of tracking satellites based on TLE files, as well as 16-bit recording capabilities for the main camera, automatic "guiding" of satellites for the main camera and guiding camera, seamless switching between main camera and guiding camera, and automatic exposure control for the main camera and guiding camera.

This software supports iOptron HAZ mounts and HAE mounts in AA mode.

System Configurations:

Configuration 1

- A supported iOptron HAZ or HAE (in AA mode) mount;
- A 120mm (30mm diameter, f/4) mini guidescope, with an iCAM462 guiding camera;
- A PlayerOne Apollo Mini camera (IMX429) as the main camera;
- A main telescope and other accessories.

This configuration is a preferred setup. It will track the satellites based on TLE files. This configuration can also provide seamless switching between the main camera and guiding camera for satellites "guiding", automatic exposure for the main camera and guiding camera, and recording capabilities for the main camera.

Configuration 2

- A supported iOptron HAZ or HAE (in AA mode) mount;
- A 120mm (30mm diameter, f/4) mini guidescope, with an iCAM462 guiding camera;
- Other fast response camera
- A main telescope and other accessories.

With this configuration, the system will track the satellites based on TLE files, as well as autoguide the satellites and automatic exposure control for the guide camera.

Configuration 3

- A supported iOptron HAZ or HAE (in AA mode) mount;
- Other equipment and accessories.

With this configuration, the mount can only provide the function of tracking the satellites based on TLE files. It can be used for traditional satellite imaging or wireless communication with the satellites (more equipment is needed).

Preparation before Imaging:

Here we use *Configuration 1* as an example for setup and operation.

1. Computer and software/driver needed:

    - Windows 10/11 64 bit system
    - A display with 1920X1080 DPI resolution
    - Ultimate Orbit Tracker software
    - PlayerOne Windows Camera Driver (from https://player-one-astronomy.com/service/software/)

- PlayerOne DirectShow Driver (from https://player-one-astronomy.com/service/software/)

2. Download software and drivers and install them.

3. Setup an OTA, main camera, guidescope, guide camera and other accessories onto a supported mount. Make sure that the logos of both the main camera and the guiding camera are facing up and parallel to the ground. This will ensure the X-Y axes of the cameras are aligned with the mount movement.

4. Focus the guide camera using a star, planet, or the moon.

5. Focus the main camera using a star, planet, or the moon.

6. The main camera and guide camera are parallel.

7. Update the system time accurately. It is recommended to use the free software *Dimension 4* (http://www.thinkman.com/dimension4/) to perform high-precision calibration and then synchronize the time to the mount via iOptron Commander.

8. Update the TLE file. The TLE file is located at *%localappdata%\UltimateOrbitTracker\TLE.txt.* The TLE data for each satellite consists of three lines. The first line is the name of the satellite. The second and third lines are satellite's orbits parameters. One may find the TLE file from websites such as **heavens-above** (*https://www.heavens-above.com/)*, or CelesTrak (*https://celestrak.org/*)

    Commonly photographed satellites include Hubble Space Telescope 20580, International Space Station 25544, and Tiangong Space Station 48274 are preloaded into the software and can be downloaded to your computer for adding/updating satellites.

    Note: The orbit of a satellite will be offset due to atmospheric drag even if it does not change its orbit actively. Therefore, it is strongly recommended to update the TLE data before each tracking, otherwise you may encounter the situation where the satellite cannot be found.

    To update the orbit data:

    (1) Go to *https://www.heavens-above.com/* *website*
    (2) Choose a satellite you want to observe, such as ISS. Click on it to open the page
    (3) Click on "Orbit" link
    (4) Copy the two line element into the TLE.txt file

9. Open the software and use a multi-mode GPS device such as a newer smartphone to get the longitude, latitude, and sea level, and then enter them correctly in the software settings. Note that the units for longitude and latitude are degrees plus decimals, not degrees, minutes, and seconds. The unit for sea level is meters. A device that supports multiple positioning systems such as GPS, BeiDou, and GLONASS has a better accuracy, same for a device that supports GPS L5 band.

10. Use the iOptron Commander or a hand controller to input the above location information into the mount.

11. Find a bright star. Ideally, choose a bright star near your transit route for easier syncing. You can use Heavens-Above website or SkySafari with updated TLE data to identify suitable stars.

12. To ensure accurate results, it is important to set the main lens focal length correctly in the settings of this software. This focal length includes the final focal length after any extension lenses or reduction lenses are used. For example, if you are using a C11HD with a 2x extension lens, the final focal length is 2800mm * 2 = 5600mm. This value also affects the distance of the fine-tuning buttons in the lower right corner of the main interface.

13. Correctly set the maximum exposure time in the settings of this software. This value determines the longest exposure time that the software will use when automatically adjusting the exposure. in the main camera. A longer exposure can result in a smaller gain in the same image, which can lead to a bright image with a wider dynamic range and lower noise. However, a longer exposure time may also introduce some trailing in the final image.

14. Correctly set the minimum expected exposure time in the settings of this software. This value determines the shortest exposure time that the software will use when automatically adjusting the exposure for a bright target. In this case, the software will first try to reduce the exposure time to the minimum value while keeping the gain at the maximum value. If this is not enough to avoid overexposure, the software will then reduce the gain instead. This will result in a lower-noise image with a wider dynamic range.

15. Correctly set the recording folder in the software settings. Make sure that the target folder has enough space and write speed to accommodate the large amount of data generated by the recording process. The maximum continuous write speed during recording can reach 390 MB/s, which means that 32.4 GB of data can be written in one minute. A complete satellite transit may require several tens of GB to 200 GB of hard drive space. Recording to a mechanical hard drive with insufficient write speed outside the cache or insufficient write speed may result in serious frame drops.

Start Taking the Image

1. Set up the system. Connect the mount and cameras to the computer.

2. Power on the mount. Wait the mount performing self-calibration. Use **MENU=>Zero Position => Goto Zero Position** to send the mount to Zero Position. Or set up the mount manually.

3. Go to a star near the path that the satellite will pass by and align/sync the mount.

4. Click on **UltimateOrbitTracker** program icon on desktop . Ignore the error message related to the settings, if this is your first time launching the application. You'll need to enter them later.
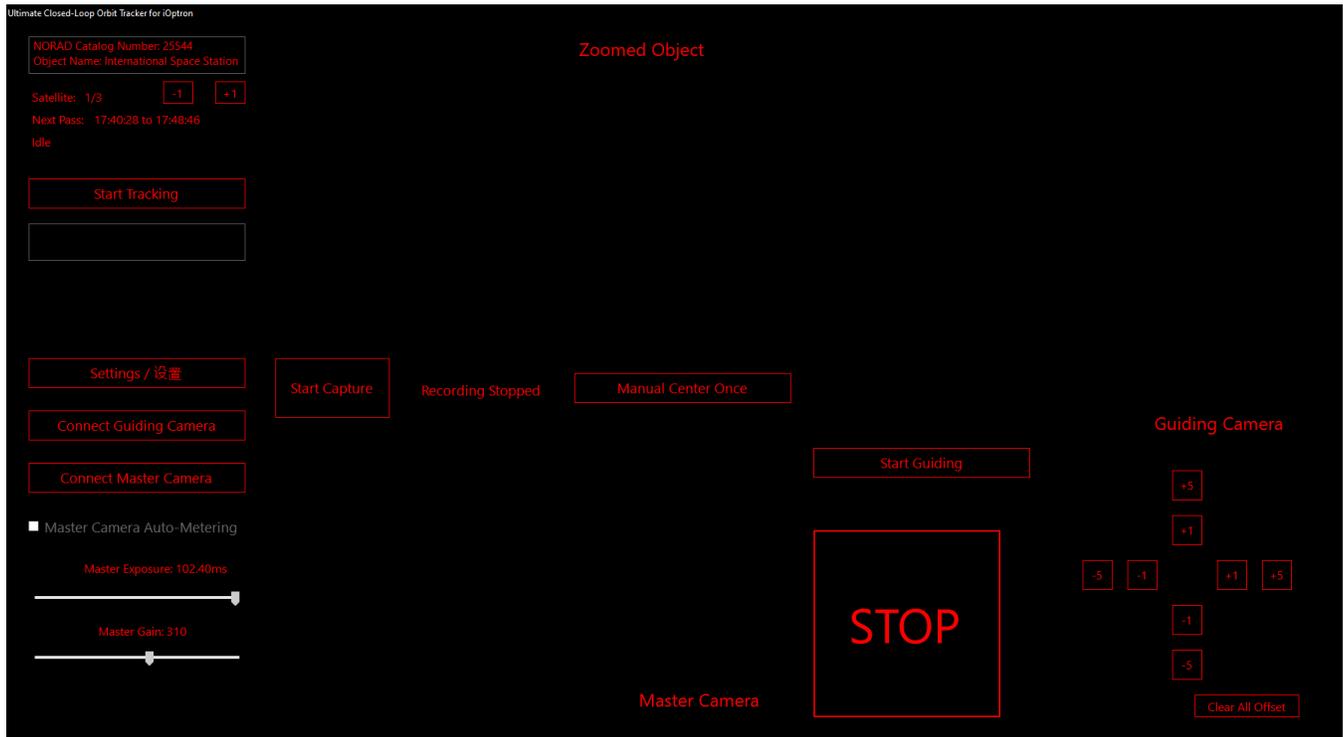

5. When a mount connecting window displayed, select the **Auto Detection** or a **COM** port that the mount is assigned, to connect the mount.
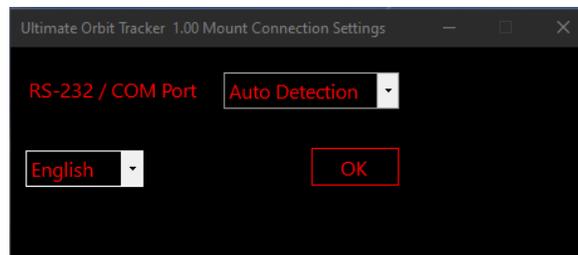

If there is a connection issue or the mount is not supported by the software, an error message will be displayed.
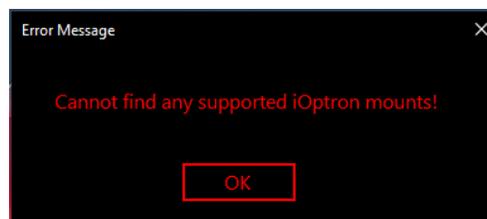
A full satellite tracking screen will be displayed when the software connected to a mount successfully.
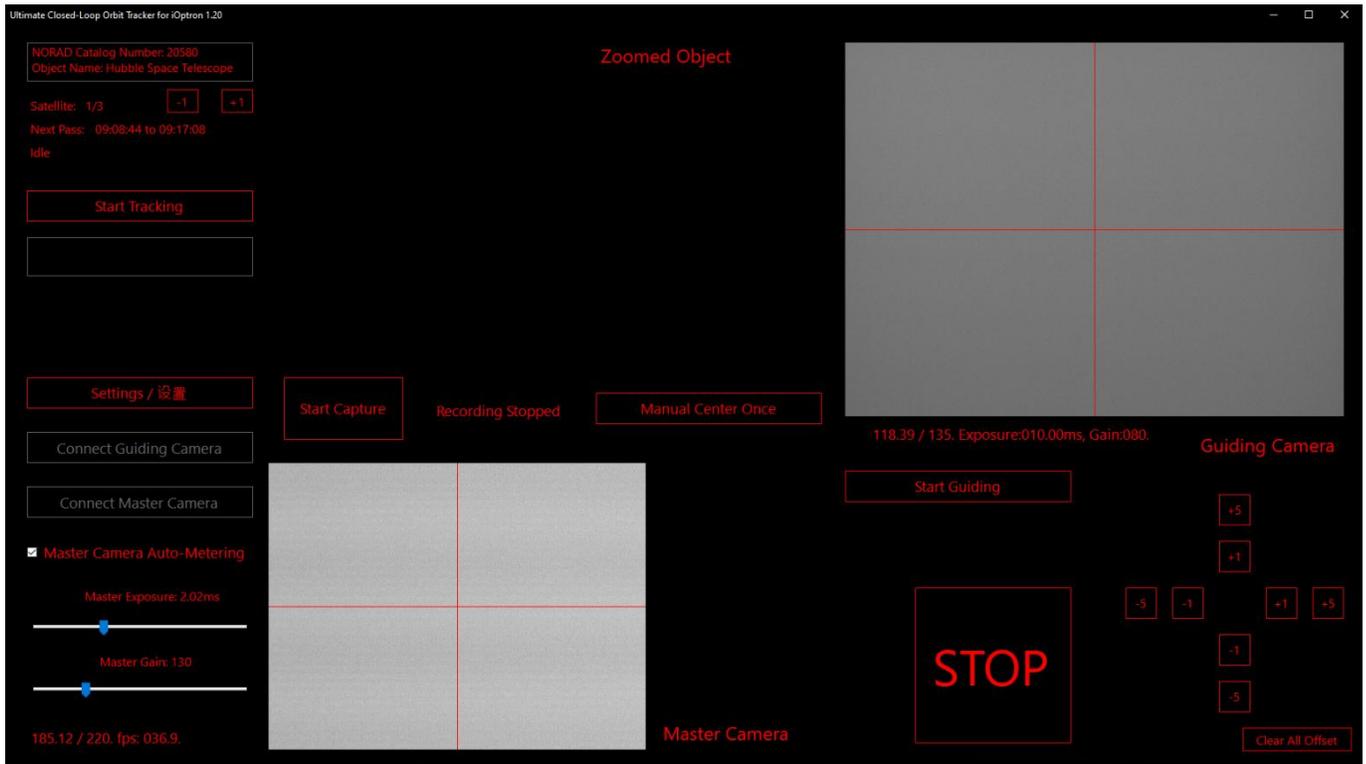
6. Click on **Settings** to "**Set Location**", "**Master OTA and Camera Settings**", and choose a "**Recording Folder**". Click on "**Change**" to enter the settings and click on "**Confirm**" to save the changes.
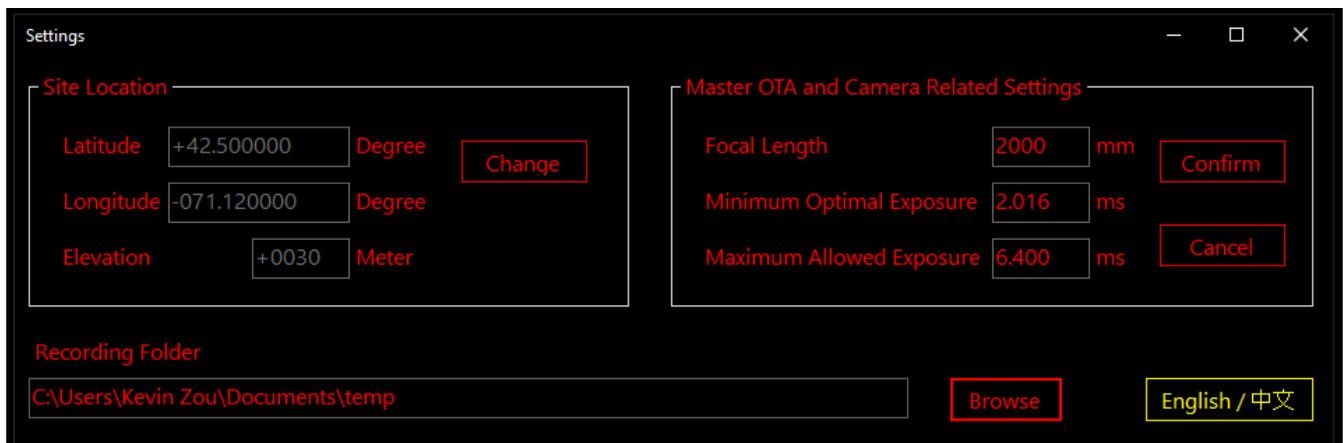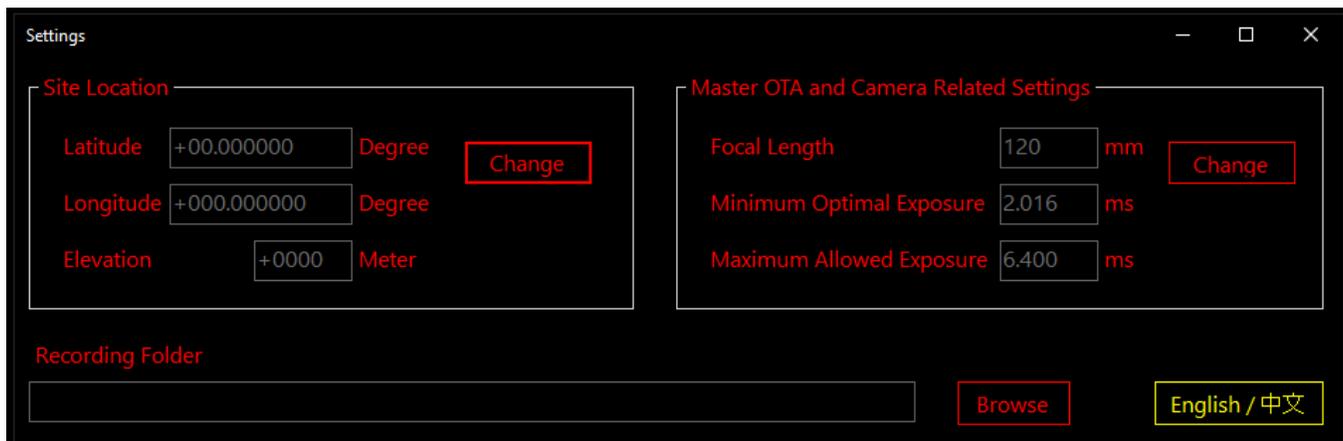
7. Click "**Connect Guide Camera**" and "**Connect Main Camera**" on the left side of the main interface to confirm that the guide camera and main camera are both displayed correctly.

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8. Select a satellite you want to track from the list in the upper left corner using the +1 and -1 buttons. Click "**Start Tracking**". If the satellite has not yet transited, the mount will pre-aim in the direction of the upcoming rise. It will stop waiting after it arrives. If the satellite is already in transit, the mount will start tracking directly.

9. When the satellite enters the field of view of the guidescope, press the "**Center Once Manually**" button, or use the buttons in the lower right corner to fine-tune the satellite to enter the field of view of the main camera. When the satellite frame in the main camera turns green, click "**Start Guiding Target**". The program will automatically execute the satellite "guiding". You can also check the "**Automatic Exposure**" of the main camera on the left side. The program will automatically adjust the camera parameters according to the target brightness and the preset values in the settings. The upper part of the main interface will display a magnified image of the satellite. You can fine-tune the focus of the telescope based on this image. Click "**Start Recording**" to record the raw data of the main camera in 16-bit SER format for later processing with other software.

Additional Notes:

- The initial TLE only include three major space objects. You need to enter the new satellites manually. The file should be updated regularly, as the orbits of satellites can be affected by atmospheric drag.
- The main camera should be focused on a bright star or other object before starting the tracking process.
- The exposure time and gain should be adjusted as needed to obtain the desired image quality.
- The recording folder should have enough space and write speed to accommodate the large amount of data generated by the recording process.
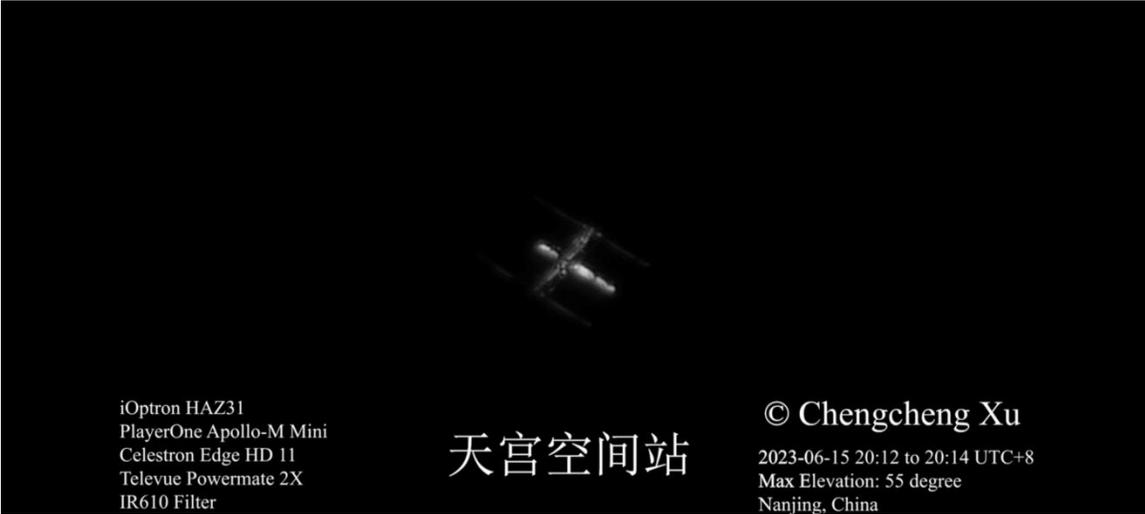
Possible Limitation:

When a near-Earth satellite crosses at a high angle, the mount may temporarily lose track when the altitude is about 80 degrees or higher. When the satellite's angle decreases, the mount will catch up again.
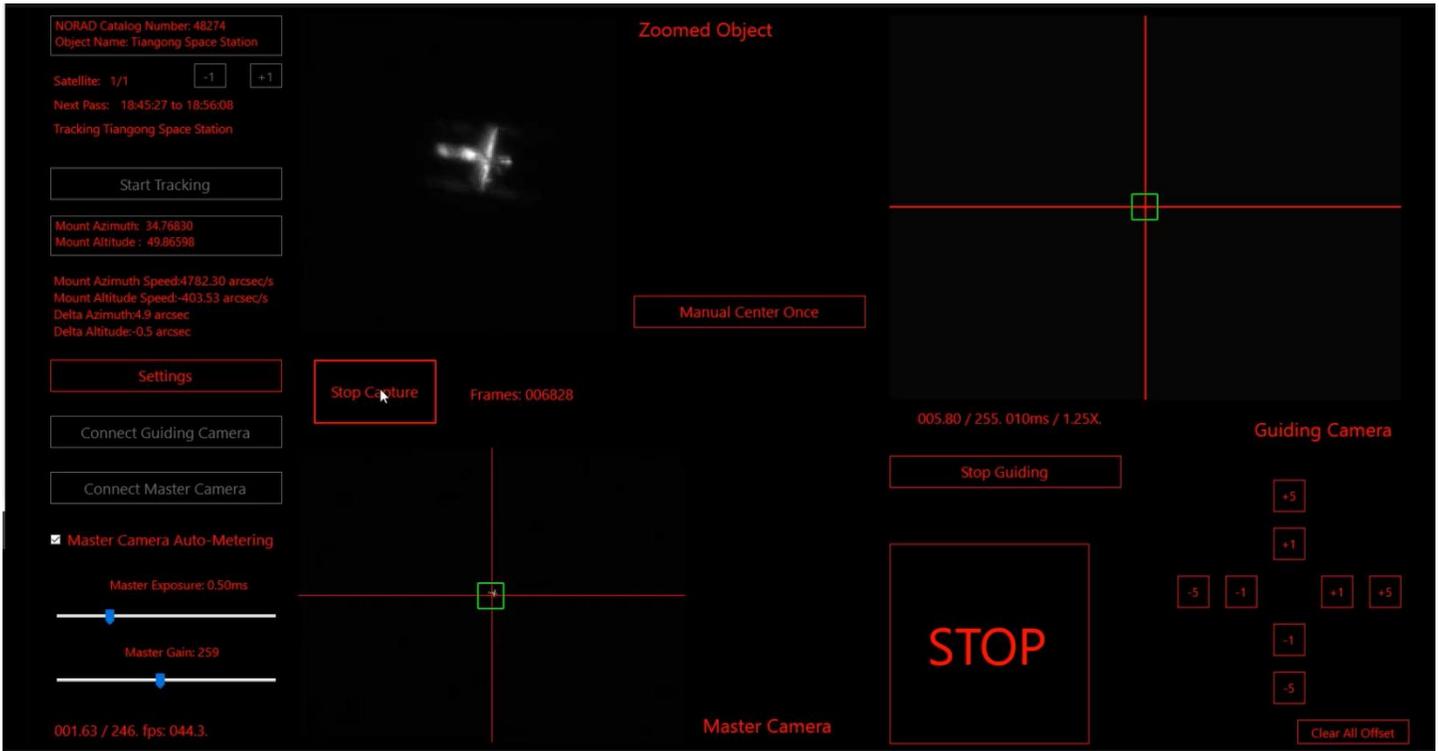
Active control screen

International Space Station (TLE 25544)

iOptron HAZ31
PlayerOne Apollo-M Mini
Celestron Edge HD 11
Televue Powermate 2X
IR610 Filter

天宫空间站

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2023-06-15 20:12 to 20:14 UTC+8
Max Elevation: 55 degree
Nanjing, China

Tiangon Space Station (TLE 48274)