NEXDOME OBSERVATORIES

DOME CONTROLLER

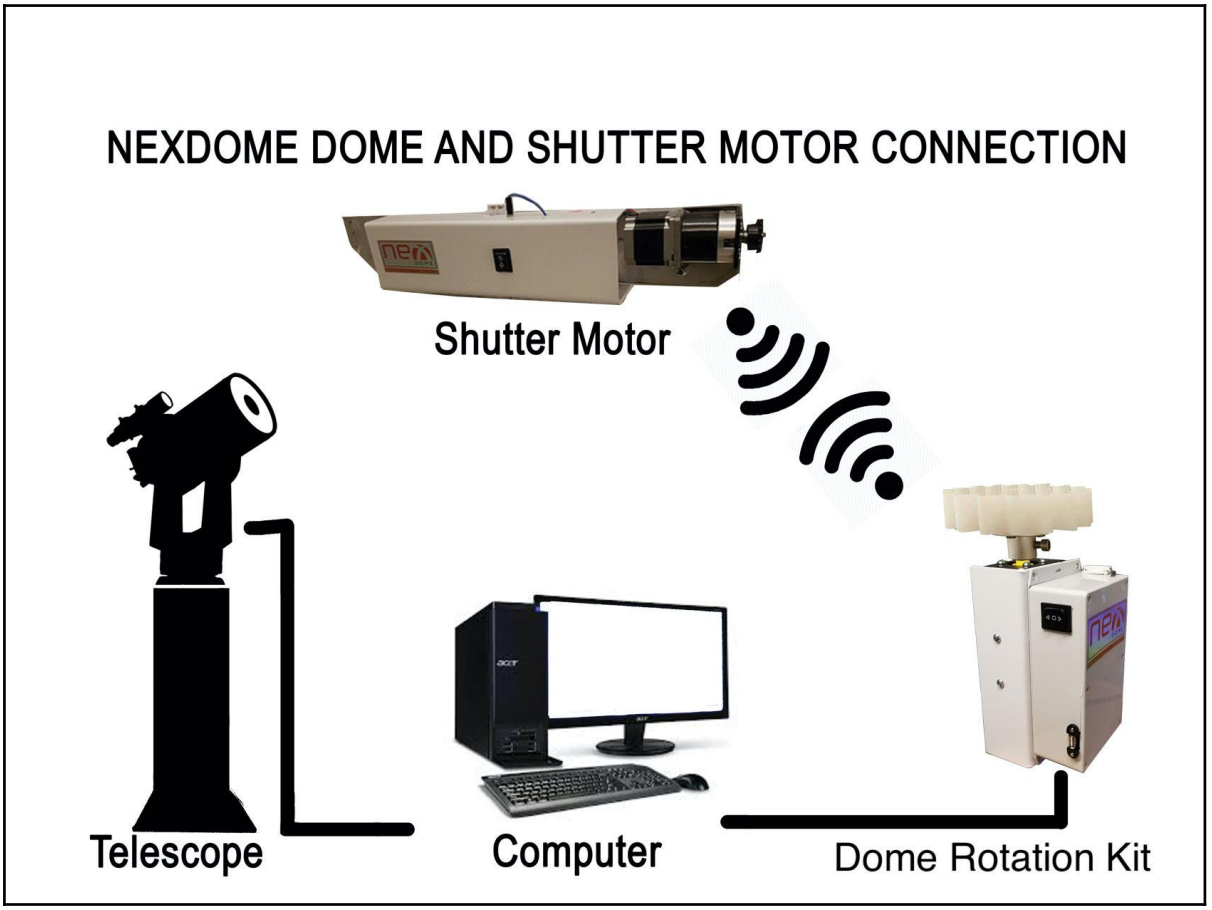
(BEAVER)

PCB controller designed and developed by **Lunatico Astronomia**

Introduction

Your ***Nexdome 2.2m Rotation Kit***, ***Rotation Kit with Rain Sensor*** and ***Shutter Kit*** comes with ready to use **NexDome Beaver** which is designed and developed in collaboration with **Lunatico Astronomia,** Spain.

How the system works



Dome Rotation Unit (with and without rain sensor versions): This unit is the main controlling unit that is connected to the observatory computer and rotates the dome in azimuth. The dome rotation unit also communicates with the (optional) Dome Shutter motor unit.

Shutter unit (optional): This unit opens and closes the dome shutters. The shutter unit is operated by battery and is connected to the dome rotation unit over wifi.

Initial Setup (Windows)

Dome Rotation Unit Setup

- Install software and drivers on the observatory computer.
- Connect via USB to the Dome Rotation Unit.
- Launch your dome controlling program. We are using ASCOM's Device Hub as the default dome controlling program here.

Note:

NexDome Beaver is compatible with Windows 7 and 10, both 32 and 64 bit versions.

Installing the ASCOM driver

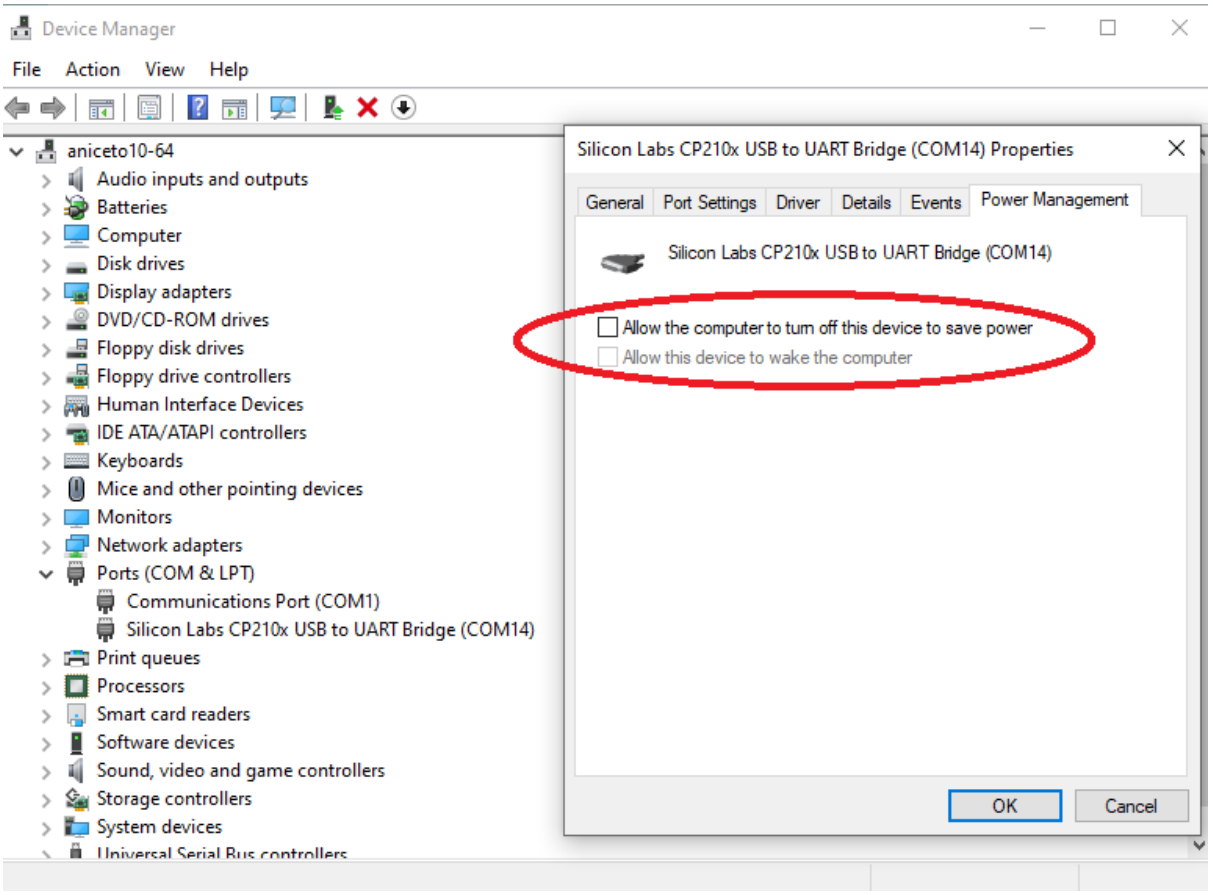
- If you haven't already, download and install the ASCOM platform: https://ascom-standards.org

Install NexDome Beaver program

- Download and install the Beaver software and ASCOM drivers, available from https://lunaticoastro.com/beaver/current/Beaver-Install.exe
- Download and install the Beaver USB drivers, available from https://lunaticoastro.com/beaver/CP210x_Universal_Windows_Driver.zip
- Connect your computer to the Dome Rotation Unit with the provided USB cable.
- Turn on your Dome Rotation Unit.

Windows will detect a new device and install the drivers automatically.

Use the windows device manager to find out what COM port has been assigned - this number will always be the same for your dome rotation unit, and we'll need it later to configure the connection. Also, at this moment, disable the power savings feature of the USB port.



Shutter Unit setup

Turn on the shutter unit power switch. Wait about 30 seconds for the shutter unit to be found by the Dome Rotation Unit.

NOTE;

*** If the shutter is not closed, it will try to close automatically. This is normal.**

**** If you don't have a shutter unit, please check the *Configuration* section.**

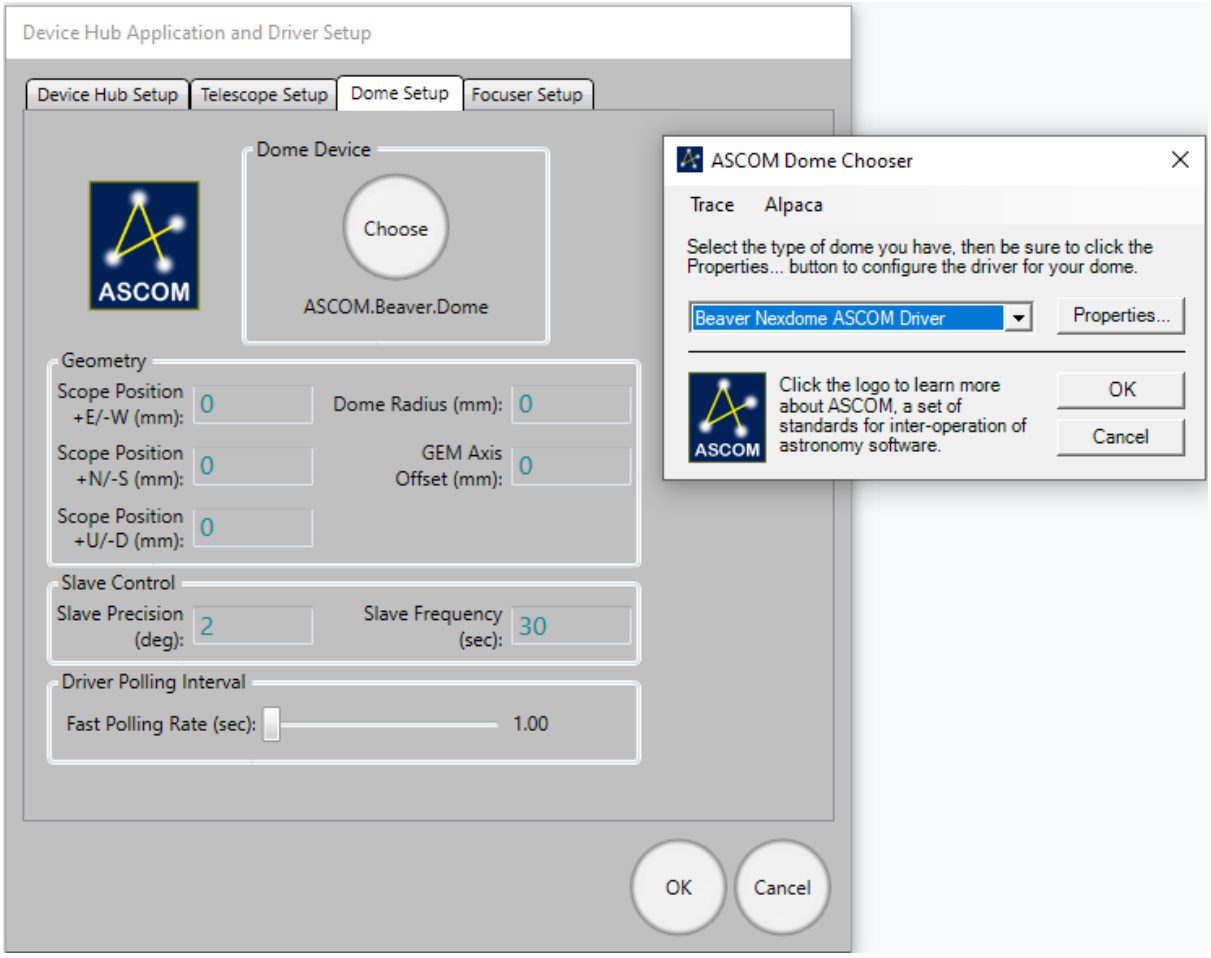
Synching and Configuring the Dome and Shutter Units

- Launch your dome controlling program (ASCOM Device Hub)

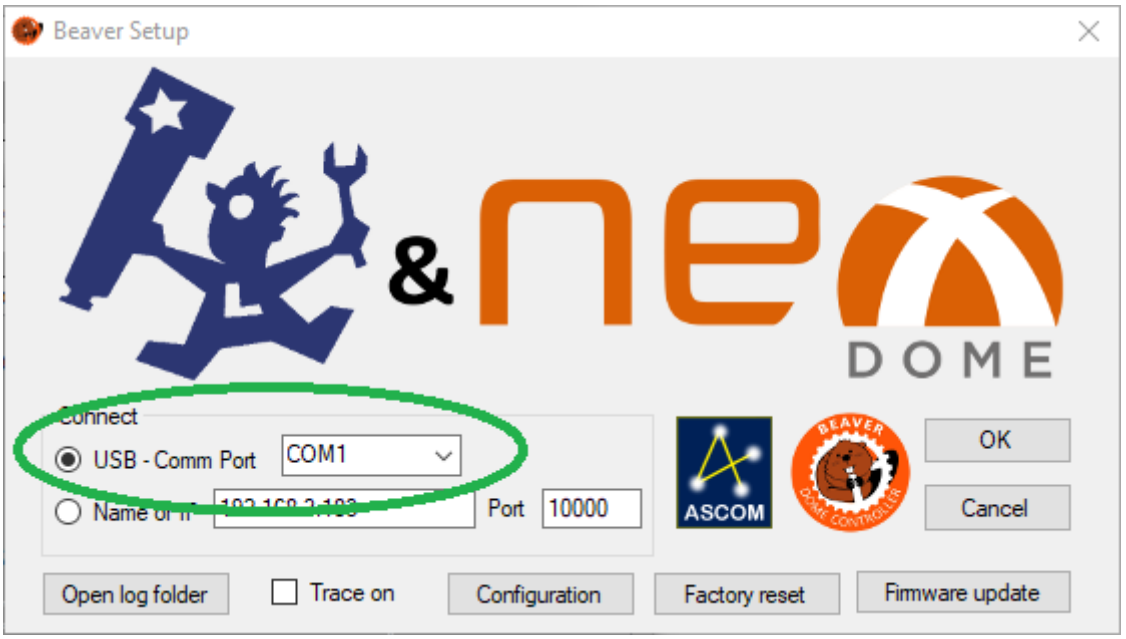
Note:

Some programs, such as Voyager, Sequence generator, etc, include their own dome to telescope slaving. It is up to you to choose the software to synchronize both elements. We'll use the ASCOM device hub here for reference.

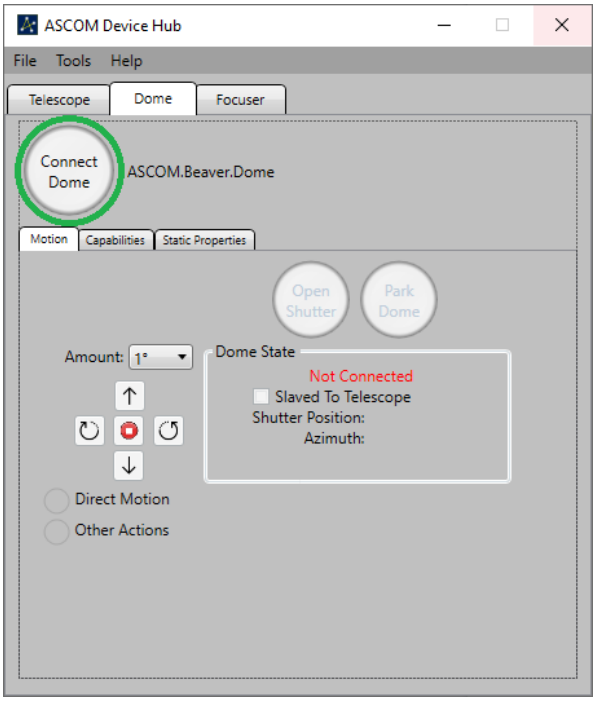
Run the ASCOM Device Hub from the ASCOM menu (start menu -> ASCOM platform 6), select menu "**Tools->setup**, select the **Dome Setup** tab. Select **Beaver Nexdome ASCOM drive**r. Click on **Properties**.



By clicking on **Properties**, the **NexDome Beaver Setup** window will open. From the **USB - Comm Port** drop down menu, select the port number associated with the dome rotation unit USB port connection identified earlier in Device Manager.



Click **OK** on this window.
Click **OK** on the ASCOM **Device Hub Dome Setup** window.
Select **Dome** tab on the **ASCOM Device Hub** window
Click **Connect Dome**.

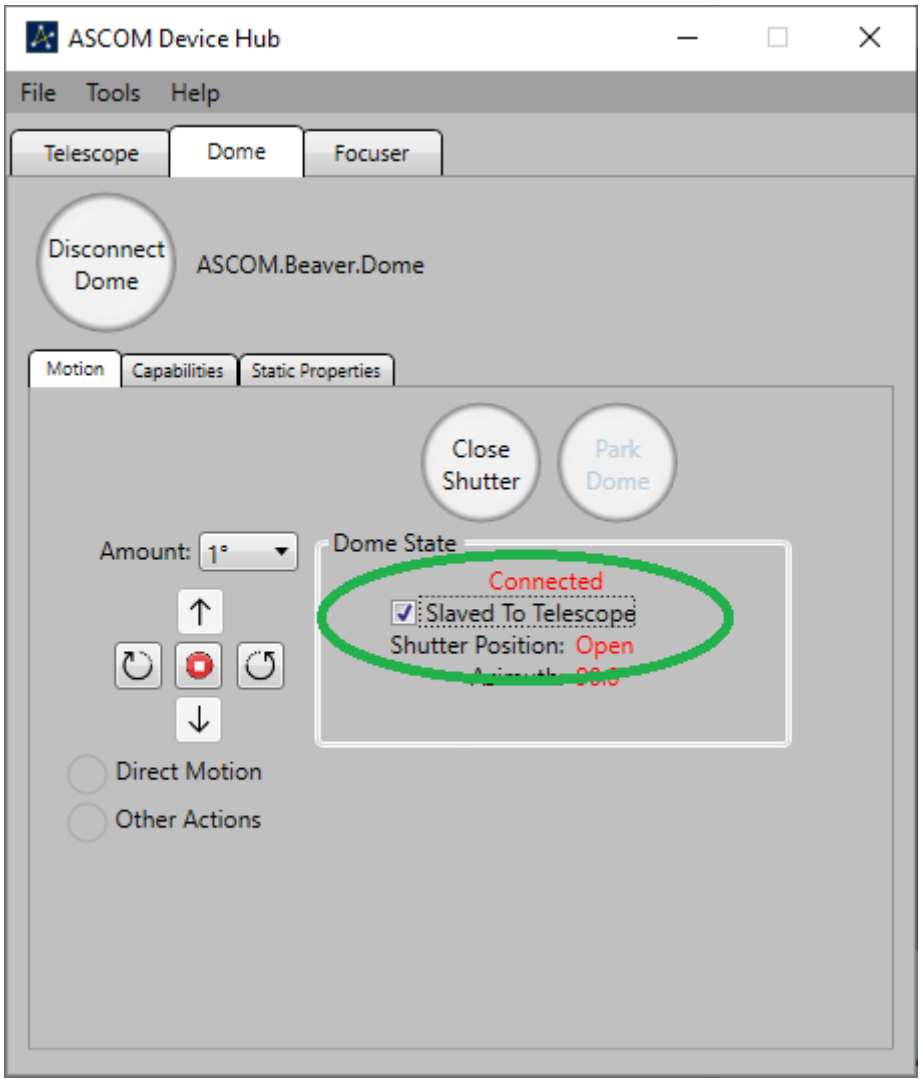


You can now control your dome via any ASCOM compatible Windows software.

Synching and Configuring Telescope with Dome

Setup the telescope driver, with the same process mentioned above for the dome. Select menu **Tools->setup**. Select **Telescope setup.** Select your telescope model. Click **OK.**

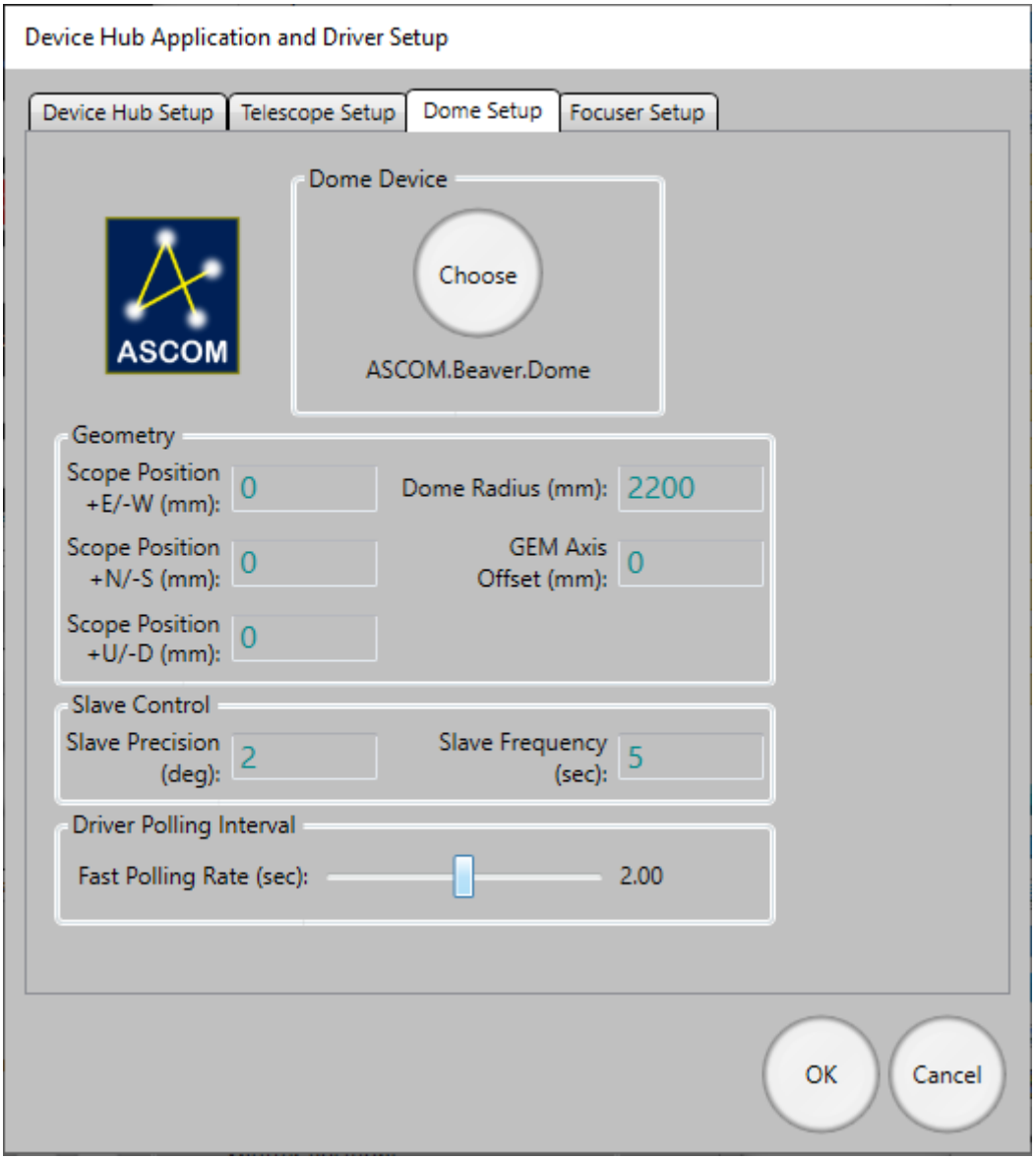
To slave the dome to your telescope, Check the **Slaved To Telescope option** box**.**



Your dome will be following the telescope from now on!

It may be a good idea to test your system now; check the shutter operation, the rotation buttons also operate correctly, etc. In case of problems refer to the troubleshooting section.

If everything is ok, disconnect the dome from the **ASCOM Device Hub** and go to the **Dome Setup** page for more dome geometry and other configurations.

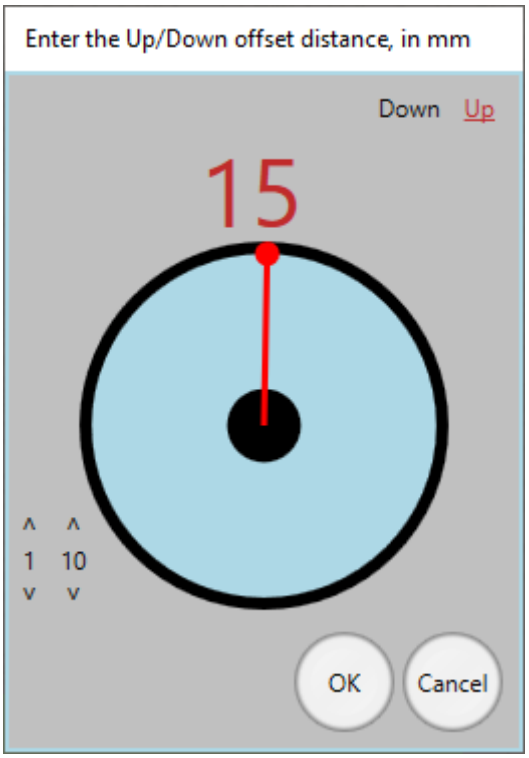


Unless our telescope rotation center is perfectly centered on the dome, and using a fork mount, we need the software to correct for that misalignment of the axis.

We can do so in the geometry section, specifying the values for each misalignment:

- **E/W**: for the typical pier at the center of the dome, this value will be 0.
- **N/S**: same, if the mount is a GEM, there will be some north displacement (south if at the southern hemisphere) - the bigger the farther from the equator (see diagram).
- **Up/Down**: again, telescope rotation point from centre of the dome sphere.

For each value, we'll see a window to adjust it:



Other geometry values:

- **Dome radius**: 2200mm
- **GEM axis offset**: length of the distance from the RA axis to the center of the telescope. Fork mounts, this will be 0.

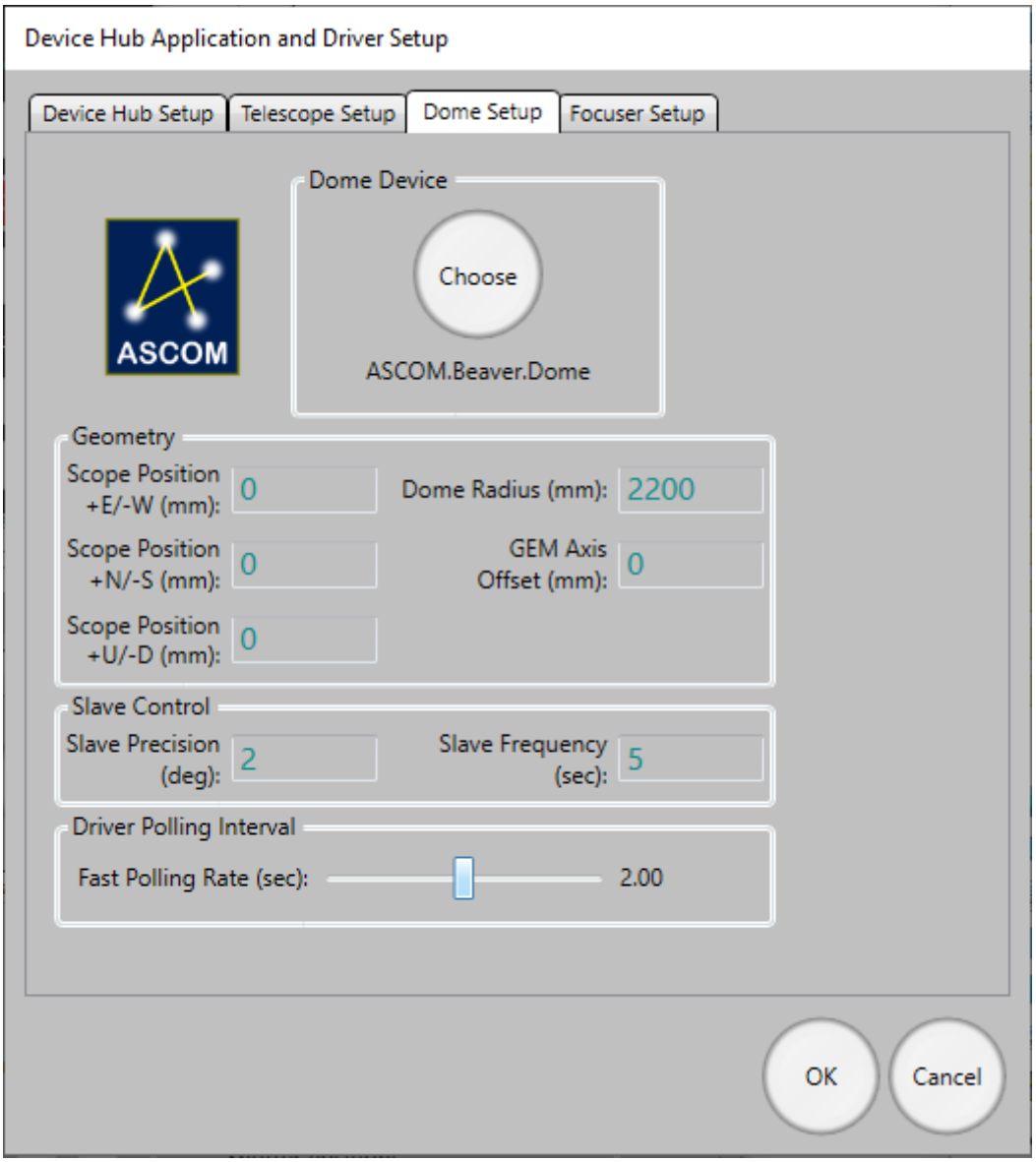
The remaining configuration parameters:

- **Slave precision**: what is our margin of error; the bigger the telescope aperture, the smaller, as we need all the incoming light to reach the telescope objective.
- **Slave frequency**: how often the alignment will be checked.
- **Polling rate**: how often the device hub will contact your Beaver

… for these 3 parameters, the values shown (2º, 5 seconds, 2 seconds) are fine for most cases.

Configuring Scope-Dome Synchronization

In order to synchronize with a telescope, you must provide information about the telescope geometry and how it is positioned within the dome.



The computations required for scope-dome synchronization are nontrivial and somewhat sensitive to small input errors. Therefore, to get accurate scope-dome synchronization across the whole sky, your geometry settings must be as accurate and precise as possible.

The meaning of each setting will be explained in detail, but first a note about origins.

Scope Position Offset is the amount by which your telescope's centre of rotation is offset from the center of the dome's rotation. It is important to understand where the telescope's center of rotation is located. This is not necessarily over the center of the pier; it is the intersection between the polar (right ascension) axis and the declination axis. In the following examples, the center of rotation is circled in green.

Note: the point of interest is inside a solid object! This makes measuring somewhat tricky, but it is important to be as precise as possible when taking measurements. You may need to use some ingenuity to obtain your measurements. For example, one can measure to the edge of the axis and then add the axis radius.

Similarly, the center of rotation of your dome is an imaginary point in space. This can be found by dropping a plumb line from the centre of the roof and then taking the point along

that line that is level with the top of the dome walls. This point, the dome center of rotation, is the origin for all of your geometry measurements.

Geometry Measurements Explained

The **N/S** and **E/W** and **Up/Down** parameters are how much the mount intersection point is off from the centre of rotation of the dome. The best way to measure this is often by taking differences. First identify the four cardinal points (North, East, South, West) around the dome rim. Remember that North is true north, not magnetic north. You may wish to mark these points for future reference. Then measure from the intersection point of the telescope to the north point on the dome rim, to the south point, to the east point and to the west point.

Your offset **N/S** is then your measured distance south minus measured distance north. This will be positive if the intersection is offset to the north and negative if offset to the south.

Ø **N/S Offset** = Measured Distance South – Measured Distance North

Similarly, your **E/W** offset is measured distance to west minus measured distance to east

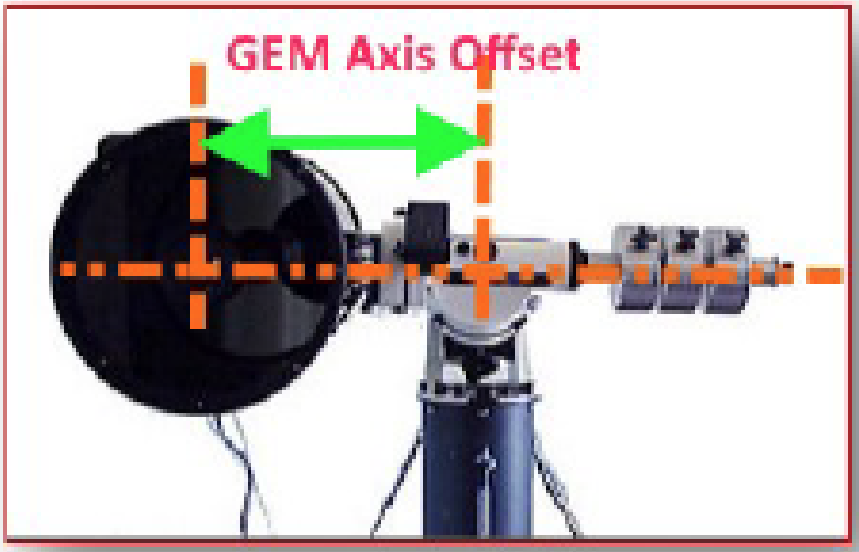
Ø **E/W Offset** = Measured Distance West – Measured Distance East

The **Up/Down** distance is the height of the mount intersection above the dome rim. Positive means the mount intersection is above the rim, negative means it is below the rim. One way to measure this would be to put both the declination axle and the telescope tube perfectly horizontal (using a spirit level) and then measure the height above the floor of the centre of the telescope tube, or the counterweight shaft.

Then subtract the height of the dome rim (1350 mm from the schematic drawings) to give your up/down offset.

Ø **Up/Down Offset** = Counterweight Shaft Height Above Floor – Height of Dome Rim **Dome radius** we can read off the schematic drawings, approximately 1025 mm.

The final measurement is the "**GEM axis offset**", which is the distance from the intersection point to the centre of the telescope tube.



Again, this is a tricky one because it's in the middle of a solid object. This may be best approached by measuring from the intersection point to the top of the saddle plate, then from the saddle plate to the centre of the telescope tube (or, measure the diameter of the tube and divide by 2 to get radius). Then add those two together:

Ø **GEM axis offset** = Intersection to Saddle Plate + tube radius

Try to be as accurate as you can in all the measurements, tricky though it is, as the accuracy will affect how well synchronization works. You probably need to be accurate to _at least_ 1 cm and _ideally_ 1mm. It is worth taking a bit of time to get accurate results and hopefully you will only need to do it once.

Safety measures

The system includes several advanced safety measures:

- up to 2 rain / weather sensors can be connected, with a normally open relay (such as the Hydreon RG9 or 11 rain detector and Lunatico's CloudWatcher)

  In case of rain or bad weather, the system will automatically close the shutter.

- the shutter battery level is monitored

  If the battery installed in the shutter unit reaches a certain (user programmable) threshold, the shutter will close automatically, and the dome will rotate to the charging position

- the shutter open and close limit switches are also checked

  If they fail to activate or deactivate when they should, the system will stop and issue a warning

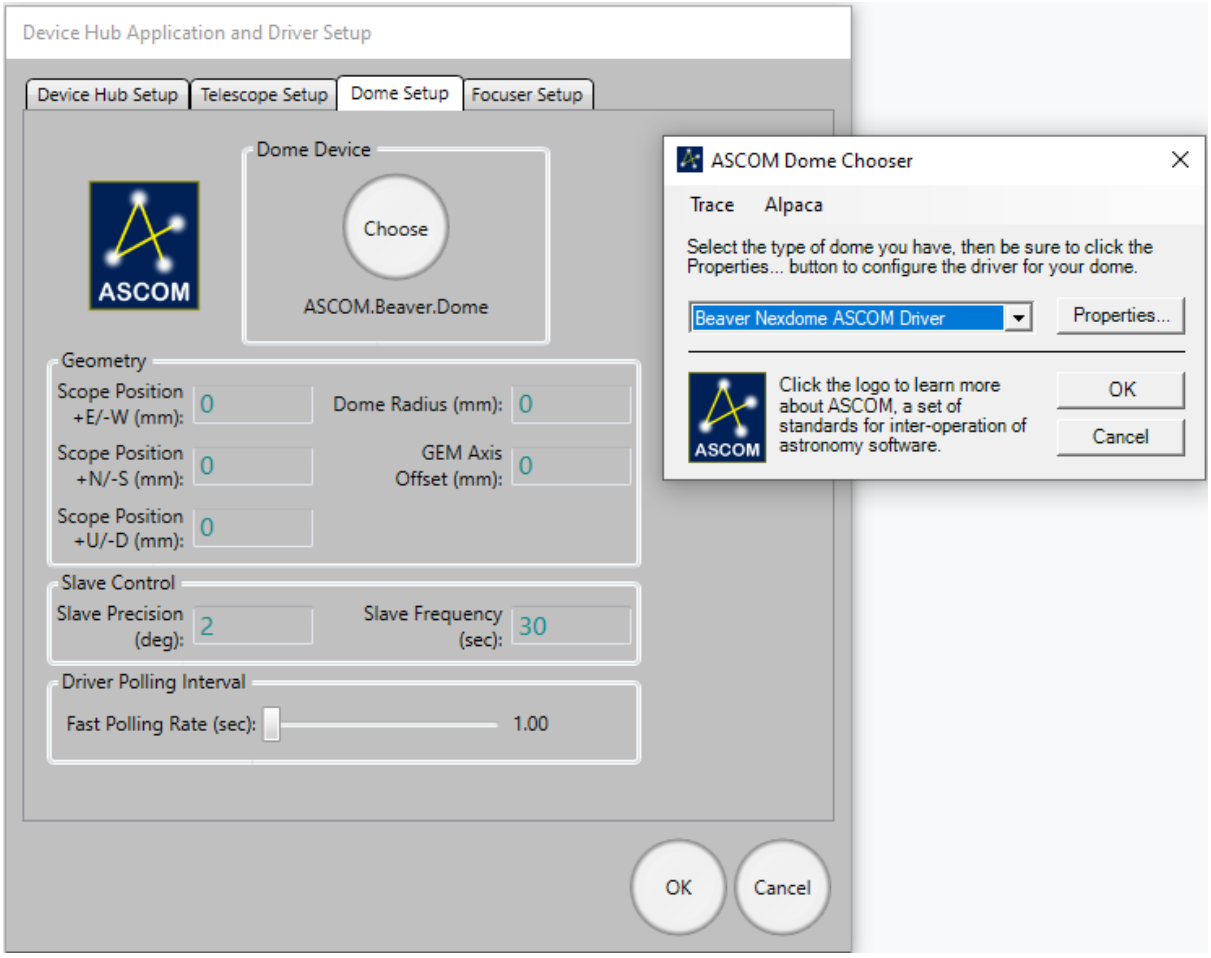
- the rotation home sensor

  Similarly, if the home sensor is not found after what should be a complete revolution, the system will stop and warn

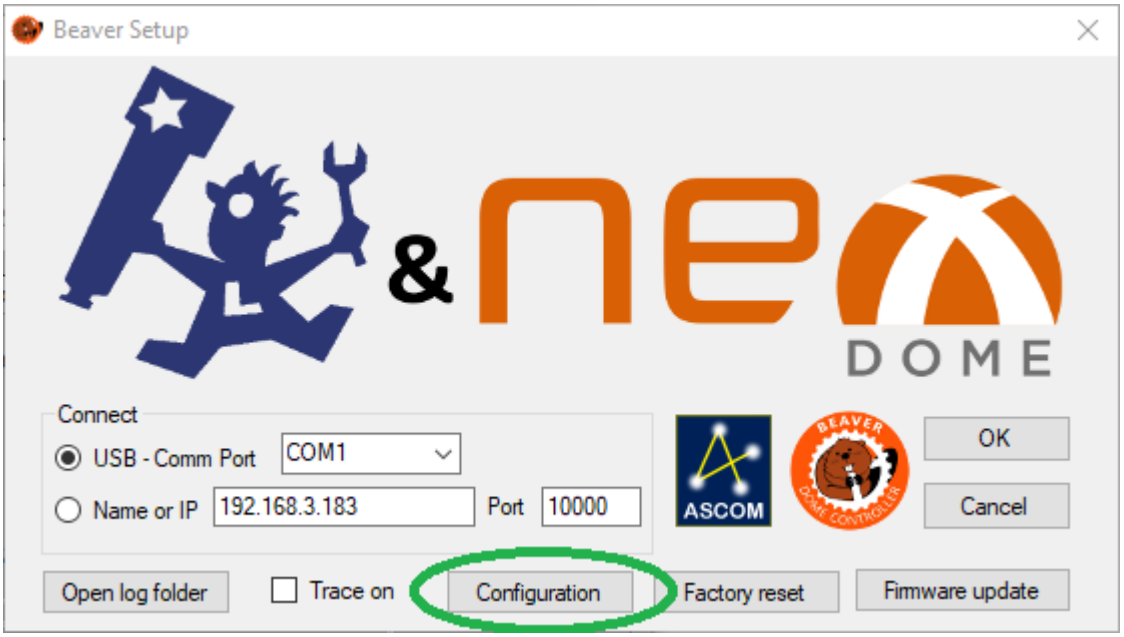
NexDome Beaver Advance Configuration

The NexDome Beaver default settings cover most observatory setups. However if you like to change these settings or preferences, follow the instructions here.

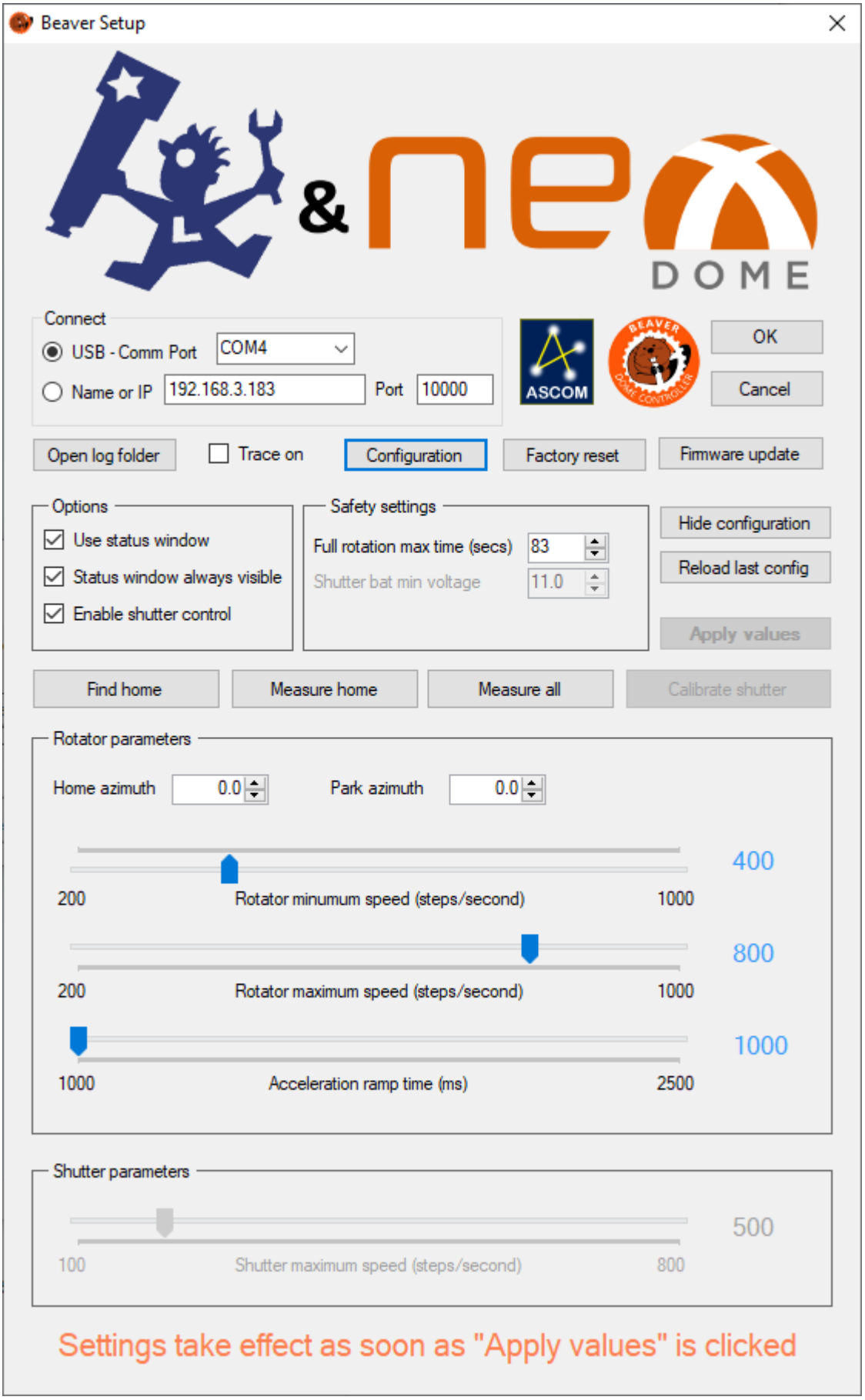
Click on **Properties** on **ASCOM Device Hub Setup** > **Dome Setup** window.



This will open the **Beaver Setup** window.

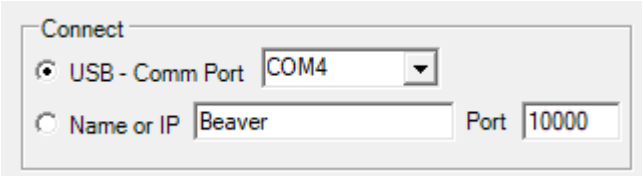


Click on **Configuration.**

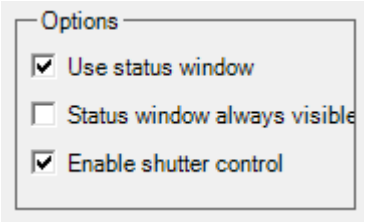

Beaver Setup
&
DOME
Connect
USB - Comm Port
COM4
Name or IP
192.168.3.183
Port
10000
ASCOM
OK
Cancel
Open log folder
Trace on
Configuration
Factory reset
Firmware update
Options
Use status window
Status window always visible
Enable shutter control
Safety settings
Full rotation max time (secs)
83
Shutter bat min voltage
11.0
Hide configuration
Reload last config
Apply values
Find home
Measure home
Measure all
Calibrate shutter
Rotator parameters
Home azimuth
0.0
Park azimuth
0.0
400
200
Rotator minumum speed (steps/second)
1000
800
200
Rotator maximum speed (steps/second)
1000
1000
1000
Acceleration ramp time (ms)
2500
Shutter parameters
500
100
Shutter maximum speed (steps/second)
800
Settings take effect as soon as "Apply values" is clicked

Connect

Shows how beaver is connected to your observatory computer.



Options

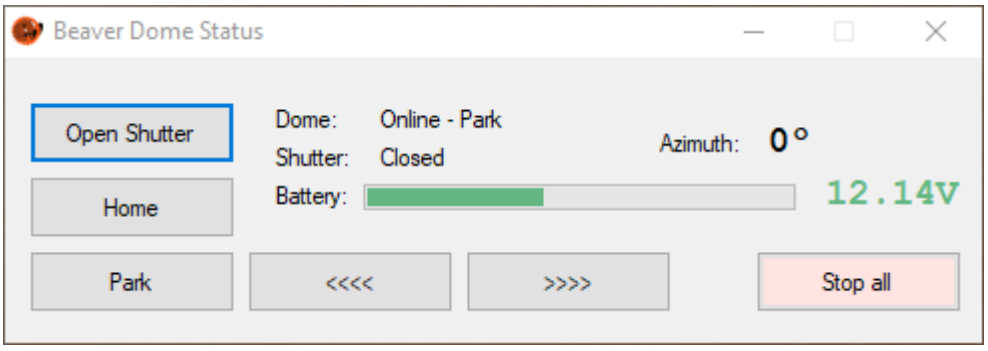


Use Status Window: (see below) this status Window displays some information and controls. If active, it will pop up on your screen every time the Beaver is active.

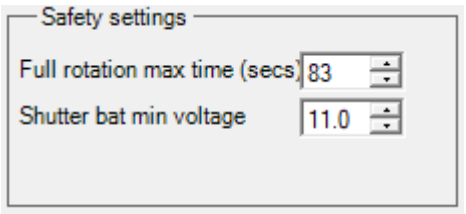
Status Window Always Visible: Keeps the Status windows always visible, that is, on top of other windows.

Enable Shutter Control: Select this option only if you have a NexDome Shutter Unit also installed.

Beaver Dome Status Window



Safety settings



Full rotation max time (secs): this is the maximum amount of time the dome can be rotating with no home sensor detection. If exceeded, the system will stop and signal an error.

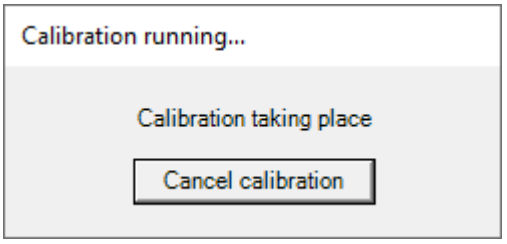
Shutter min voltage: By setting the voltage in this field the shutter will automatically close (at a slow speed, to make sure it has enough torque) when the battery voltage falls below this voltage setting. The dome moves to park position to recharge the battery on the shutter unit.

Calibrations

Find Home: will move the dome to the home position, and check the sensor is active.
Measure Home: will rotate the dome until the home sensor is found, and then carefully measure its size, so in the future accurate synchronization can be made.
Measure All: apart from measuring home, it will later perform a full rotation until the same point is reached again.

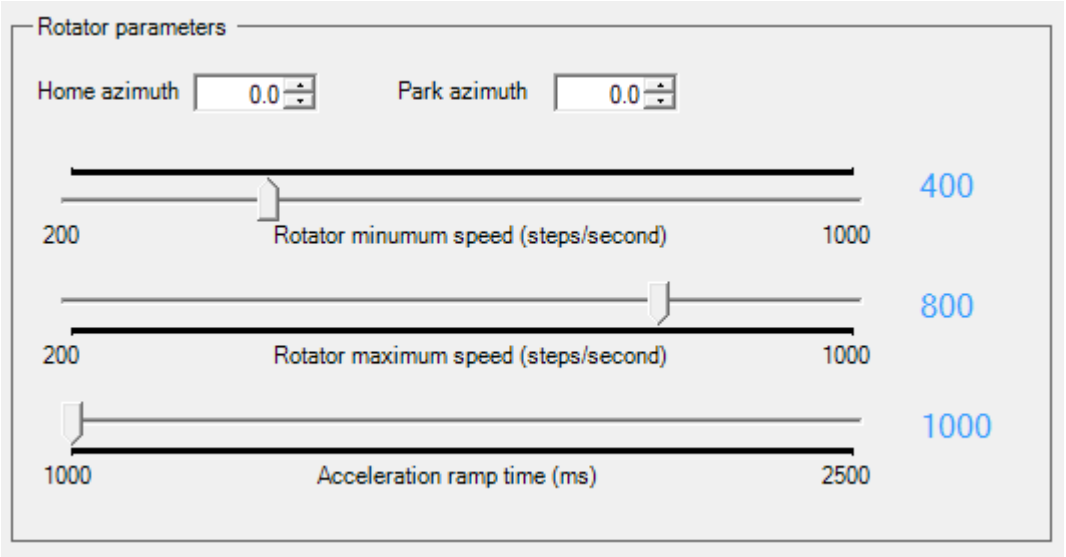
Calibrate Shutter: similarly, this operation will open and close the shutter, measuring the distance. Not really necessary unless the shutter fails to work correctly.

At least once “Measure all” should be executed - it will find the home sensor, measure it carefully, then perform a full rotation and center on the home sensor. Once done, if the dome rotates smoothly, it will be very precise, and will re-synchronize itself every time it finds the home switch.

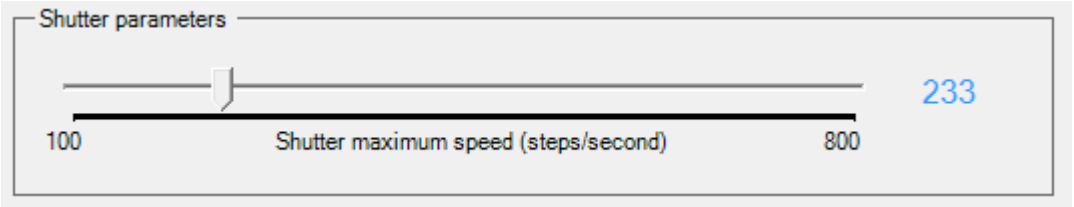


You can cancel the calibration at any moment.

Rotation parameters



Shutter parameters



The remaining few buttons will:

- open the log folder, if needed for troubleshooting (in case of problems, it is recommended to activate “Trace on”, for more information).
- start the firmware update process (you can directly download the firmware file or, if there’s no internet connection, you can bring the file manually from other computer)

  please note: once the firmware is updated in the rotation unit, it will automatically update the firmware in the shutter unit. ***Once updated, the shutter will reboot - and that will imply closing the shutter if not already closed.***

- accept or cancel changes as expected. Some values (most) are stored in the Beaver itself, you’ll notice by the “Apply values” button becoming active. You’ll also be warned before discarding any changes.

For isolated observatories, this setup is perfectly valid and operative. The rotation unit and the shutter unit will automatically identify themselves, and start operating together.

For places where there is a group of domes, for example, this may be a tad dangerous (as one rotation unit could pair with a shutter from another dome) - so there are many options to configure your devices to work in any circumstances.