

## Procedure for CO<sub>2</sub>ing the CHARA telescope mirrors

When the telescope mirrors for the CHARA telescopes become dirty with dust, pollen, or ash, the mirrors are cleaned by using compressed CO<sub>2</sub> from tanks.

The mirrors should be cleaned if the scopes have been used in windy conditions or if there is ash, dust or pollen in the air. The observing reports should be read each morning to see if pollen, ash, or other particulates have been mentioned. It is especially important to clean the mirrors if rainy or foggy weather or high humidity is coming which would react with the pollen or ash and stick to or damage the coatings. The mirrors should be CO<sub>2</sub>'d at the beginning of every month at minimum.

The CO<sub>2</sub> is stored and transported in tanks. There are two techniques for bringing tanks to the telescopes. One way is to fill several scuba tanks with CO<sub>2</sub> and take those in a backpack up to the domes. One scuba tank will do all 6 scopes if done lightly. The other way is to use the large tank in the truck with a long hose that can reach up to the tallest telescope domes.

The scuba tanks are kept in the SW corner of the old gray shed with the backpack and hose hanging on hooks on the wall. When full, the scuba tank will weigh around 22lbs. They will be marked with the weight so you can see that they were filled and have enough CO<sub>2</sub> to do the cleaning. When empty it will weigh 14.9lbs. Use the digital scale on the table in the old shed to weigh the tanks. Turn the scale on with the On/Off button. If the reading is not 0.00, hit the Tare button to zero it. Make sure the scale rests with all 4 feet on the ground. If anything touches the underside of the scale, it will display incorrectly. See pics below.



To fill the scuba tanks, take them with the digital scale and the fill hose which hangs on the end of the tool chest by the backpack and a crescent wrench to the loading bay 100" dome. Empty the scuba tank of its gas by opening the valve. Vent the gas slowly as it can come out with high pressure and it is very loud. The weight will go down to 14.9lbs or lower and the tank will get cold. Failure to vent the gas will prevent liquid CO<sub>2</sub> from entering the scuba tank. Unscrew the cap from the tall cylinder marked "in use".

Connect the fill hose to the valve of the cylinder using the end of the hose with the two ball valves and tighten with the crescent wrench. Make sure the ball valves are both closed. The other end will go on the scuba tank. Tighten the fitting onto the scuba tank with the wrench.

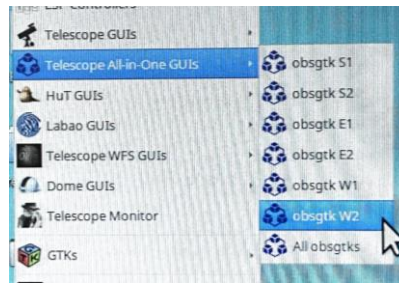
You can set the tank on a low table or cart to allow the scuba tank to be close to the tall cylinder's valve. You can also use wood blocks to raise it off the floor while sitting on the scale. If you zero out the scale weight with the wood blocks on it with the Tare button, the tank weight will be accurate. Open the filling cylinder's valve all the way and then open the ball valve nearer to the cylinder's valve. You will hear the CO<sub>2</sub> liquid transferring to the scuba tank and will see the weight rise on the scale. The weight should rise 7-8lbs over the empty weight. The colder the tank is, the more CO<sub>2</sub> will transfer when it is filled. When the weight stops rising, you can close the ball valve on the hose and the valve on the scuba tank. Open the other ball valve very slowly to vent the pressure in the hose and disconnect the hose from the scuba tank with the wrench. Fill the second tank in the same way if doing so. If not, close the valve tightly on the tall cylinder and open the closer ball valve to release the pressure at the valve. Remove the fill hose with the wrench and return the safety cap to the tall cylinder.

It is helpful to have 2 tanks, the scale and wrench when going out to the telescopes so you can monitor the usage and switch tanks if one no longer blows snow. When putting the tank in the backpack and after attaching the hose, make sure to open the valve before putting on the backpack. Use the metal clip to lock the backpack zipper closed. The orange clamp can be used to hold the wand after wrapping the hose around your upper body once or twice. See pics below.



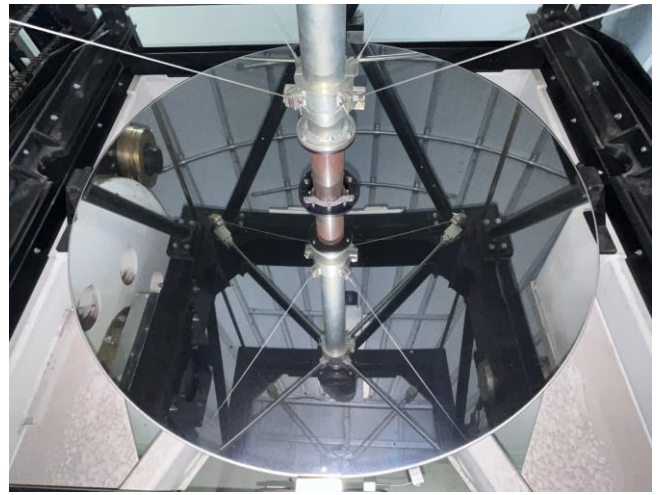
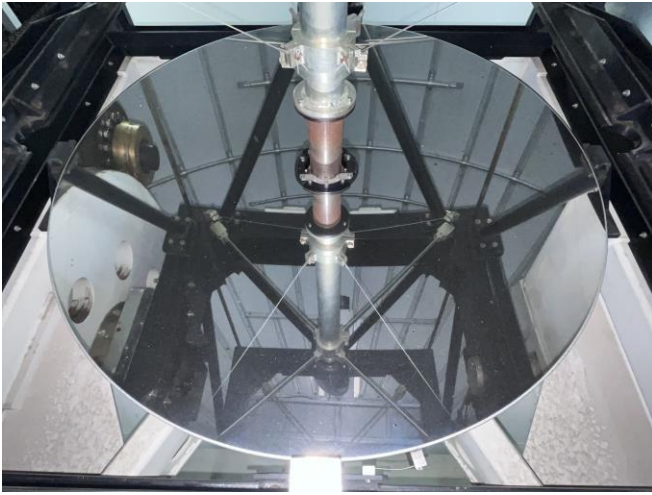
At the telescopes, if using the scuba tank and backpack, you will need to turn your body to get up the stairs and through the hatch to the observing floor. It is a tight squeeze through the hatch, but keeping the scuba tank and backpack towards the corner of the hatch will allow you to make it through. When you get to the telescope, go to the computer and turn on the monitor with the power button on the lower right. Use the obsgtk (Telescope-All-in-One GUI) or the Telescope GUI from the blue CHARA menu to open and close the covers. Open the M1, M3, M5, and beacon flat covers on the Control tab of the obsgtk. See pics below.



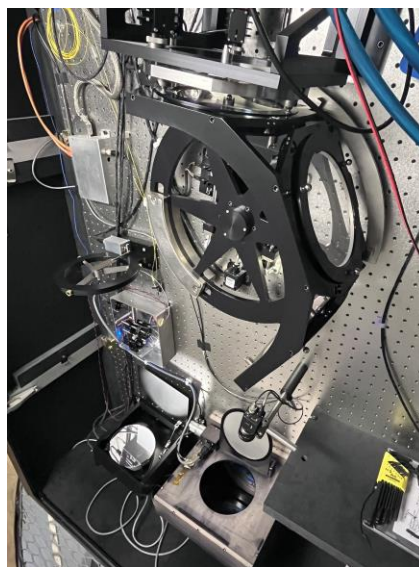


Use the 7 foot step ladder to give you access to the M3 mirror which is the highest one you will need to reach. You can clean the M3 mirror while the M1 cover is opening. It is the slowest to open and close so always do that first. Check the M3 mirror and support to be sure there is nothing that can fall from the M3 down to the M1 mirror. The nozzle should spray visible  $\text{CO}_2$  snow if operating correctly and under sufficient pressure. Lightly wave the nozzle over the entire surface of the mirrors at a shallow angle to knock the particulates off. Do not blast the mirrors directly downward or without moving the wand and make sure not to touch the mirror surface. Pics below show the M3 and M1 mirrors before and after cleaning. Note the dust has been removed and the contrast has increased.





After cleaning the M1 and M3 mirrors, close those mirror covers and open the AO box by removing the door on the side of the box and lifting the curtain with the chain hanging inside the box. The chain with the connecting link is the one to pull down to open the curtain. Do not turn the curtain in the opposite direction or the mechanism can be damaged, and the curtain can get jammed. If it does not move freely, do not force it and ask Norm or Craig for help. You can lift the bottom of the curtain as you open it to lessen the strain on the chain and gears. Open it until it is above the height of the carousel and dichroics. Clean the 3 dichroics, beacon flat and M5 mirror to remove the particulates. See pic below. The carousel with the 3 dichroics is the black mechanism above center. The M5 mirror is in the gray box at bottom center and the beacon flat is on the bottom left of the AO box.



Use the small step stool to allow you to reach the dichroic from above. Do not clean the ACQ camera or WFS camera mirrors in the upper right of the box. When you are done, close the covers for the M1, M3,

M5 and beacon flat from the computer and be sure they do close. Close the curtain and replace the door on the side of the AO box. Put the ladder back up on the hook. Make sure the floor area is clear of any obstructions that could impede the rotation of the telescope. Make sure to close the hatch when you leave.

Prepared by Norm Vargas May 13, 2025