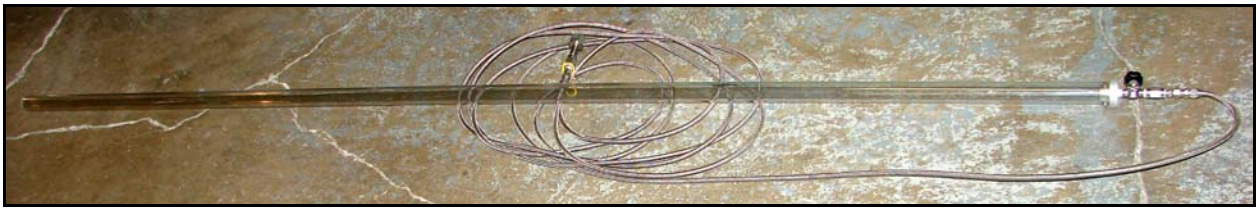
Jerry Martin's Co_2 Snow Apparatus

Introduction: Jerry Martin fashioned this Co_2 snow optics cleaning device similar to the ones that he built at McDonald Observatory. We made changes to fit our particular needs and I believe improved upon the design.

The principal at work with this apparatus is the sublimation of the liquid Co_2 passing through the orifice and flashing to a solid forming snowflakes of Co_2 ice (dry ice). These snowflakes shower over the optic surface with some force knocking the dirt loose from the surface and dragging it down and off the optic surface while leaving no cleaning residue.



Building: We designed a long 8 ft. wand for cleaning the hard to reach 120″ primary and a much shorter version for the easily assessable optics. They are light in weight and relatively inexpensive to build. All items listed except the machined aluminum orifice body can be purchased at McMaster –Carr.

The picture above shows from left to right the hose adapter, coupling, needle valve, and the orifice body. The wand and braided hose have been removed.

The materials needed are as follows:

- 1½″ Polycarbonate tubing with 1¼″ inside diameter. Length to fit your needs.
- Stainless steel needle valve.
- Stainless steel braided flexible hose – length as needed.
- Stainless steel Co_2 fittings for cylinder connection.
- Inline filter – optional.

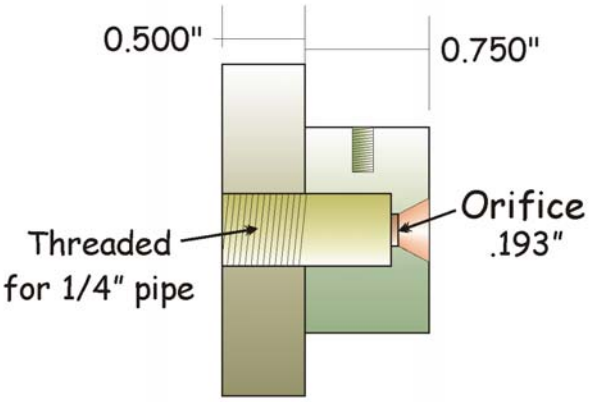
- Aluminum orifice body machined to specs. Stainless steel would also be a good alternative though more difficult to machine and more expensive.
- Stainless steel hose fittings
- Stainless steel couplings.
- Co_2 cylinder with eductor tube (for liquid delivery from cylinder).

The reasons that we use polycarbonate tubing for the wand are as follows:

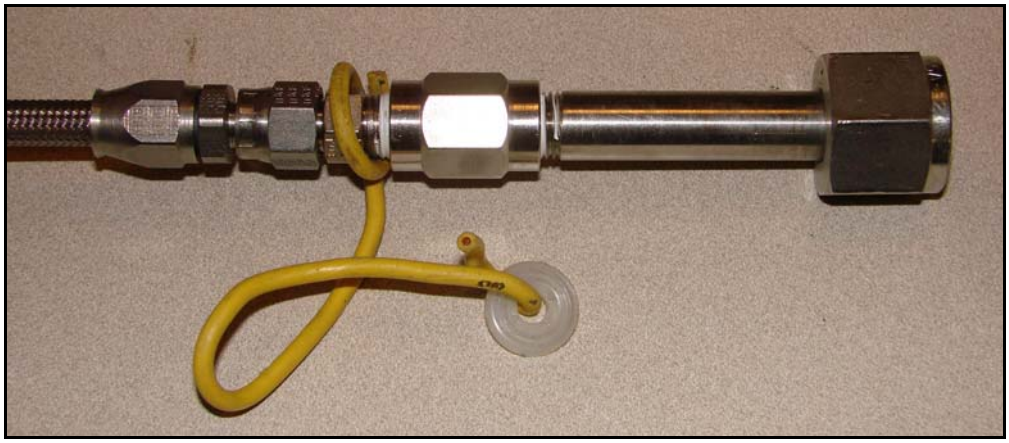
- We tried the much cheaper acrylic tubing and had it shatter with just small impacts and when cooled with Co_2 it becomes extremely brittle.
- Polycarbonate is very impact resistant. It takes a real beating to even crack the polycarbonate tube and it is much more resistant to cryogenic brittleness. The extra cost is worthwhile.

We use stainless steel fittings because we don't want corrosion forming inside the fittings and then contaminating the snow therefore contaminating the optic coating. Condensation also forms externally on all cold surfaces of the apparatus so stainless steel is highly recommended.

The exact size of the orifice body is not critical. It must be machined to fit inside the 1½″ polycarbonate tube. We know that an orifice of .193″ or a #10 drill size works very well at making snow. There is enough pressure to push the snow through the long 8 ft. tube we use for the 120″.

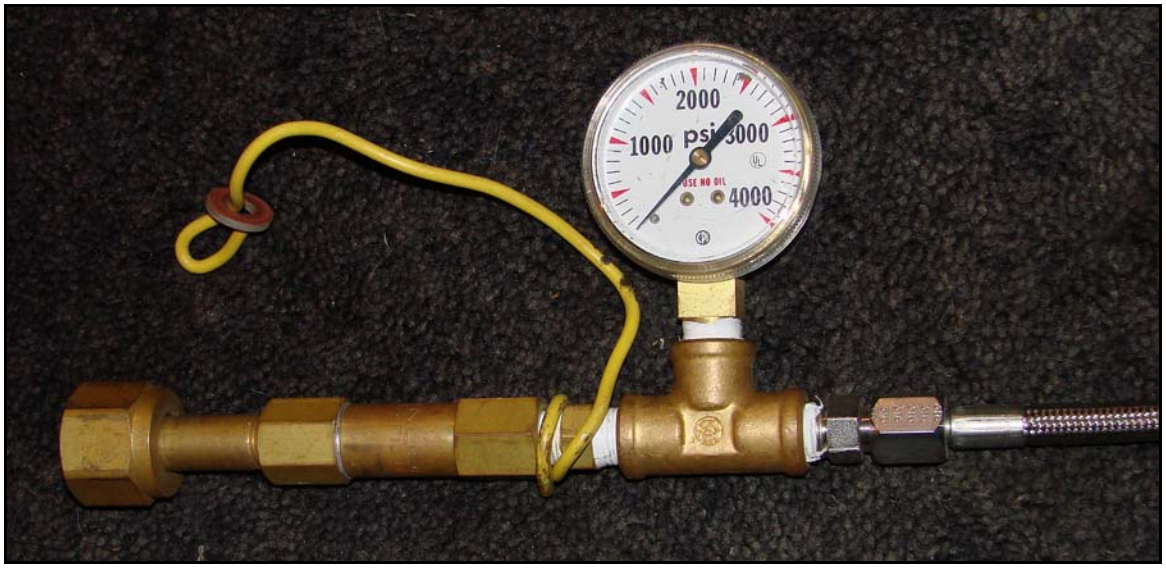


Aluminum Orifice Body Detail



The previous picture shows from left to right the braided hose, hose adapter, coupling, and the Co_2 tank adapter. No regulator is used with the Co_2 cylinder. The adapter is connected directly to the tank using full cylinder pressure. Be sure to place the seal washer (temporarily held by the yellow wire) between the adapter seal face and cylinder when attaching the apparatus to the cylinder.

Above is the short wand model. Over time we still got small cracks around the screw holes. When you drill the attachment holes in the wand make them larger than needed to allow for expansion and contraction and leave the screws a little loose.



This is our first model with inline filter, pressure gauge, and brass fittings. The gauge is not necessary and this particular gauge is rated for much higher pressures than needed. Pressure in a Co_2 cylinder is a little over 600 psi.

Safety: Always secure the Co_2 cylinder properly. Cryogenic gloves must be worn while the apparatus is in use because of the extreme cold produced by the sublimation of Co_2. Safety glasses or face shield must be used. Do not use in an enclosed area without proper ventilation and monitoring. Asphyxiation and death may result. Below is a picture of one of our cryo safety stations. We have three at the 120" and one at the 40".

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Use: This is the setup we use for most cleanings. A cylinder chained into a cylinder cart with the cylinder valve cap in place until ready to use.

- Remove cylinder cap.
- Attach the cylinder fitting end to the cylinder valve after inserting the seal washer.
- Put on cryo gloves and eye protection.
- Close wand needle valve.
- Open cylinder valve fully.
- Check for leaks.
- Aim the wand towards the optic and open the needle valve.
- The optics are best cleaned in a vertical orientation and from top to bottom so the snow hits the optic surface and gravity takes the snow flakes and the dirt down and off the optic and the flakes sublimate to a gas leaving no residue on the optic.
- It is best to do the cleaning on a low humidity day so water will not condense on the optic surface.
- Co_2 snow is very cold (dry ice) and if the wand is not kept moving, a cold area will form on the optic surface allowing water condensate to form. The water condensate will upon contact with the Co_2 form carbonic acid that will etch coatings.

Cleaning gone bad: The Crossley primary is one optic that had its coating ruined with carbonic acid. We cleaned it in place by opening the side panels on the telescope tube. When we were done cleaning we shut the panels and left. It was a cold wet winter day when we closed the panels on the telescope and the space between the mirror cover and optic surface was full of Co_2 gas. Sometime after cleaning, the mirror surface reached the dew point and condensation formed on the mirror. The Co_2 trapped in the space reacted with the beads of dew on the optic surface and under every bead of dew the coating was completely dissolved away. It was so bad we had to do an emergency coating. In hindsight we should have left the side panels open for a while so the Co_2 had a chance to escape and we should have waited for fair weather with low humidity.

This picture shows the apparatus connected and under pressure.

This picture shows the Co_2 snow apparatus in operation. Note the flakes of snow in the right of the picture.