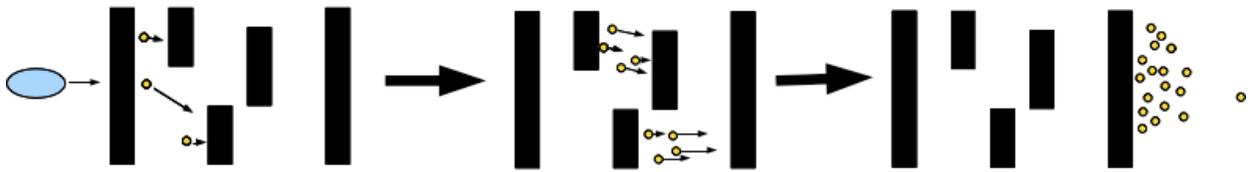
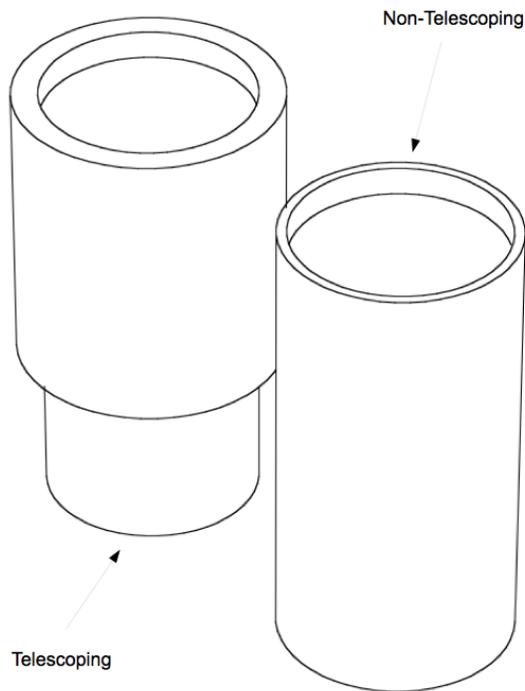


Photomultiplier Tubes (PMTs)

Photomultiplier tubes (abbreviated as PMTs) are the most important piece of the detector and also the most difficult piece to test and work with. To understand the PMT is to understand the entire detector. Photomultipliers work through a method of signal gain to create a strong signal from a small incident. When a cosmic ray intersects with the block of scintillator, a burst of photons is released into the detector. When one of these photons enters the PMT, it collides with a plate that releases electrons into the tube. These electrons collide with more plates, and eventually an avalanche of electrons is created as a signal. A diagram is shown below.



In CROP you will be exposed to two different types of photomultiplier tubes: telescoping and non-telescoping.



Telescoping Tubes

The telescoping tubes were donated by a project that completed its run. These tubes were brought to CROP from Utah, and require extensive testing to see how well they work. An illustration of one of these PMTs is below



Some of these tubes do not work at all, others may need to be repaired before they can function, but what is true of all of them is that they need to be cleaned. Light enters the tube through its base which is placed in contact with a polished block of scintillator. Therefore having the glass surface on the base of the PMT as transparent as possible creates a more optimal path for the light to travel through. The bottoms of the PMTs often have large amounts of glue stuck to them. Acetone provides a method of dissolving the glue, and alcohol removes other oils and dirt. Once you have cleaned the bottom, use the alcohol to clean the top too

If you are working with a “new” batch of the telescoping PMT’s you will notice that they have gray power cables. To this day I have no idea how the previous project got away with using these cables because they begin to break down at 600V. The PMT’s run at 1300V-1800V. Due to the fact that our project lacks the magical ability to not burn through the cable, we have to replace them. In the lab you will find standard high voltage cables (in my day it was red). Replacing the cables for these PMT’s is not very difficult. One simply removes the outer casing of the red HV cable, unbraids the copper wire, strips the plastic surrounding the inner HV wire, and solders them to the PMT. Copper wire goes in the place marked 0V, inner HV wire goes to place marked HV. Cover them with electrical tape to insulate the electricity.

Non-Telescoping Tubes

We have different PMTs from a company called “Electron Tubes.” These PMTs have higher efficiencies, higher thresholds, and operate at a higher voltage. When running a threshold scan on these PMTs you will have to use a higher voltage than the recommended 1350 volts the “Efficiency Testing” chapter suggests. It is not uncommon for them to run at their peak efficiency at around 1800V. There are a couple things that need to be mentioned when dealing with these new PMTs. First and foremost is that you may need to place them in their tubes to begin with. To do this you slide them into a cardboard tube that has been cut into sections. You then have to caulk the top, outer edge of the PMT to make it light tight. However, this alone is not enough to seal light out of the tube. There is a gap between the top circuit board and the cardboard tube. You either have to put special high resistance caulk to seal it, which is purchased through Dr. Kelty at the electronics shop, or place a cap on the top of the PMT that is light tight. After you put the PMT in its tube, you now have the task of wiring it.

