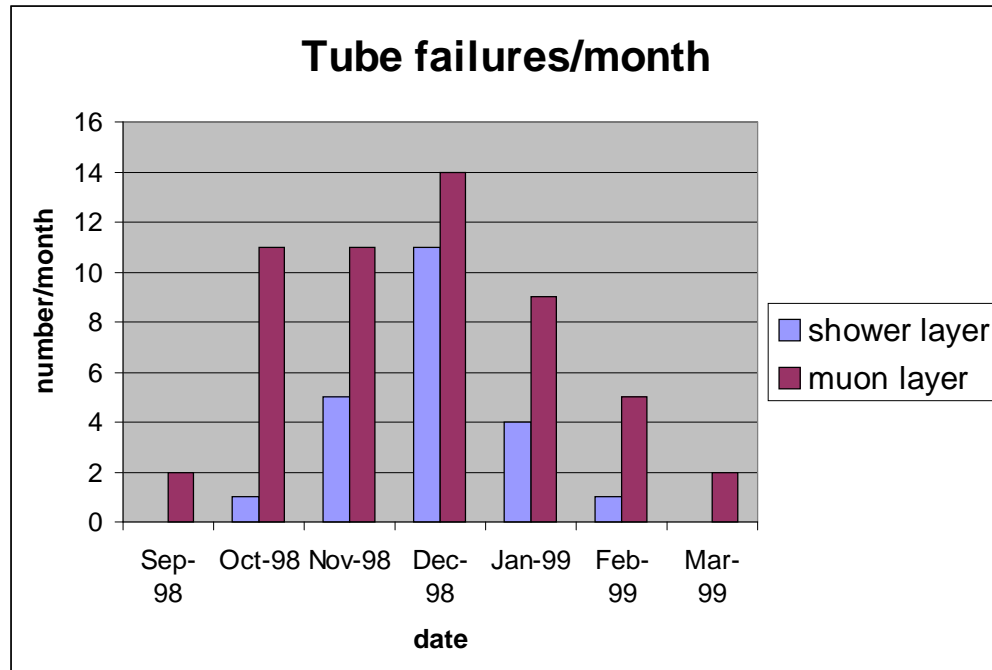


Milagro Tube Failures

I have spent some time trying to reconstruct what we know about PMT deaths. I have gone over the information in the log book as well as some of Diane's notes that I found in the counting house. Stephen and Diane did fairly complete maps of PMT impedances on 10/9, 11/5, 11/11, 12/30, and 1/25. In addition there are fairly complete entries of tube failures starting in mid-January. Consequently, I am able to determine the number of PMTs that died each month with fairly good confidence. There are two tubes (#129 and #694) for which that I can't determine the date of death. As points of reference I note that we installed 74 shower-layer tubes on October 7th, and the last 8 PMTs on October 23rd. We were certainly repairing muon-layer tubes in September and some shower-layer tubes in October – we do not have a decent record of this.

The plot below shows the number of PMT deaths per month for the muon layer and the shower layer.



There are a couple of things to note:

- There is a clear decrease in the number of tube failure rate since the first of the year. This is true for both the shower layer and the muon layer.
- The shower-layer death rate is much lower than the muon-layer rate. Remember that there are 450 shower-layer PMTs and only 286 muon-layer PMTs.
- We lost a fair number of shower-layer tubes in late December and January (just in time to skew our thinking at the collaboration meeting). We lost, at most, one shower-layer PMT since February 1st (this is tube # 129, who's date-of-death is unrecorded).

03/03/99

- We are still losing muon-layer tubes (note two in the fledgling month of March), but not at the rate in 1998.
- We have lost a total of 22 shower-layer tubes and 54 muon-layer tubes.

One suggestion made was that the reason for the high muon-layer deaths was that we reused Milagrito cables. It turns out that there are 19 muon-layer tubes with new cables (the same as used in the shower layer). Of these 19 tubes, 4 have died (21%) vs. a death-rate of 19% for the old cables. Thus the death of muon-layer tubes has nothing to do with reusing old cables.

As noted above, the death rate is ~4x higher for the muon layer than for the shower layer (20% vs. 5%). The shower layer (muon layer) PMTs are under ~1.65m (8.5 m) of water, a ratio of 5.2. Thus the death rate appears to go somewhat slower than the water pressure. This effect maybe even larger as the muon tubes have been under water longer than the shower tubes.

Conclusions

- 1) The rate of PMT deaths is decreasing for both the muon and shower layers. We may be approaching asymptopia.
- 2) The death rate is much higher for the muon layer (20% vs. 5%). This is somewhat slower than the ratio of water pressures on the two layers.
- 3) The data show that reusing old cables has no effect on the death rate.
- 4) One or two month's more data will be very helpful.