

ERSATZ EXPECTATIONS

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The enclosed figures show the results of Monte Carlo and other calculations on what we can expect for the November, 1985 SPS cruise with the "Ersatz" String Bottom Controller.

Fig. 1. Locations of optical and calibration modules to be used for the November cruise, in the "Webster W" configuration. The exact measured distances between modules are shown.

Fig. 2. Muon event rates as a function of depth for 6 PMT and 4 PMT configurations. In the latter case just the top 4 positions are used. The effective areas used in this plot were determined from the Monte Carlo and are 711 m^2 for 6 PMTs and 916 m^2 for 4 PMTs. The area for 5 PMTs, not shown in figure, is 785 m^2 . These all assume coincidence operation at the 1 p.e. level and the muon angular distribution at 4.5 km depth is integrated over; the dependence of effective area on depth is small. The angular resolution used is 10 ns and no cuts on overlap time (see below) were applied. Arrows on the right border show the expected false trigger rates for singles rates of 10^5 and 10^6 Hz and a 60 ns coincidence time window.

We see that the muon rate should be 1 per minute at DUMAND depth. False triggers will be no problem if the background is just K^+0 , unless we have only 4 PMTs working, and then only at the greatest depth. If the singles rates should prove higher, see the following figures.

Fig. 3. The signal-to-noise rate as a function of singles rate R_0 at 4.6 km (left axis) and 2.8 km (right axis). Again there are no cuts on overlap time. We see that we can get $S/N > 10$ with 5 PMTs for $R_0 < 10^{5.4} \text{ Hz}$ and for 6 PMTs with $R_0 < 10^{5.7} \text{ Hz}$ at 4.6 km.

Fig. 4. The definition of the overlap time τ . We note that it is 60 ns minus the difference between the leading edges of the latest and earliest pulses, $t_m - t_1$. Vertical tracks will ideally give exactly 60 ns overlap (see below).

Fig. 5. The integral false trigger rate is a function of overlap time. This is given, for N tubes, by $R_N = R_0^N [t_m - t_1]^{N-1}$. Thus it decreases with overlap time. We can try to reduce the background by, for example, limiting ourselves to those events with overlaps greater than 40 ns. The false rate in that case can be read off the graph for singles rates of 100 KHz and 1 MHz.

Fig. 6. The differential false trigger rate $dR_N/d\tau$, that is, the false trigger rates we would get if we plotted a histogram of event overlap times. The rates are shown in Hz per 10 ns interval.

Fig. 7. Overlap distributions for muon signal from the Monte Carlo runs:

(a) 6 PMTs, downward muons within 5.7° of zenith, with 0.1 ns time resolution. This shows how the overlap times are near 60 ns for downward tracks.

(b) 6 PMTs for muons with the angular distribution at 4.5 km, still 0.1 ns time resolution. This shows how overlap time distribution spreads out for muons away from vertical.

(c) What we should see: 6 PMTs, all muon angles, with time resolution a more realistic 10 ns. The distribution is spread out even further. It is clear that any cut which is used to significantly reduce the backgrounds [see Figs. 5 and 6] will greatly lower the signal. This does not appear to be a viable strategy for background reduction. However, the shape of the overlap distribution is quite different for signal and noise so that the observation of this distribution will be strong evidence that a signal has been seen.

(d) 4 PMTs, all muon angles, time resolution 10 ns. The distribution is slightly narrower than for 6 PMTs. The 5 PMT distribution looks pretty much like (c).

CONCLUSIONS

1. First priority: measure the singles rates. Then we will better know what to expect.
2. We should still have a good experiment with only 5 tubes operational, provided background rates are not too high. Four will be marginal, but probably still worth doing.
3. The muon event rate should be ~ 1 per min. at 4.5 km, ~ 10 per min. at 3 km.
4. A cut on overlap times will probably not help much in improving S/N in the presence of large backgrounds, but the overlap distribution for signal is quite different than for false triggered induced by background and so is a good indicator of the presence of signal.

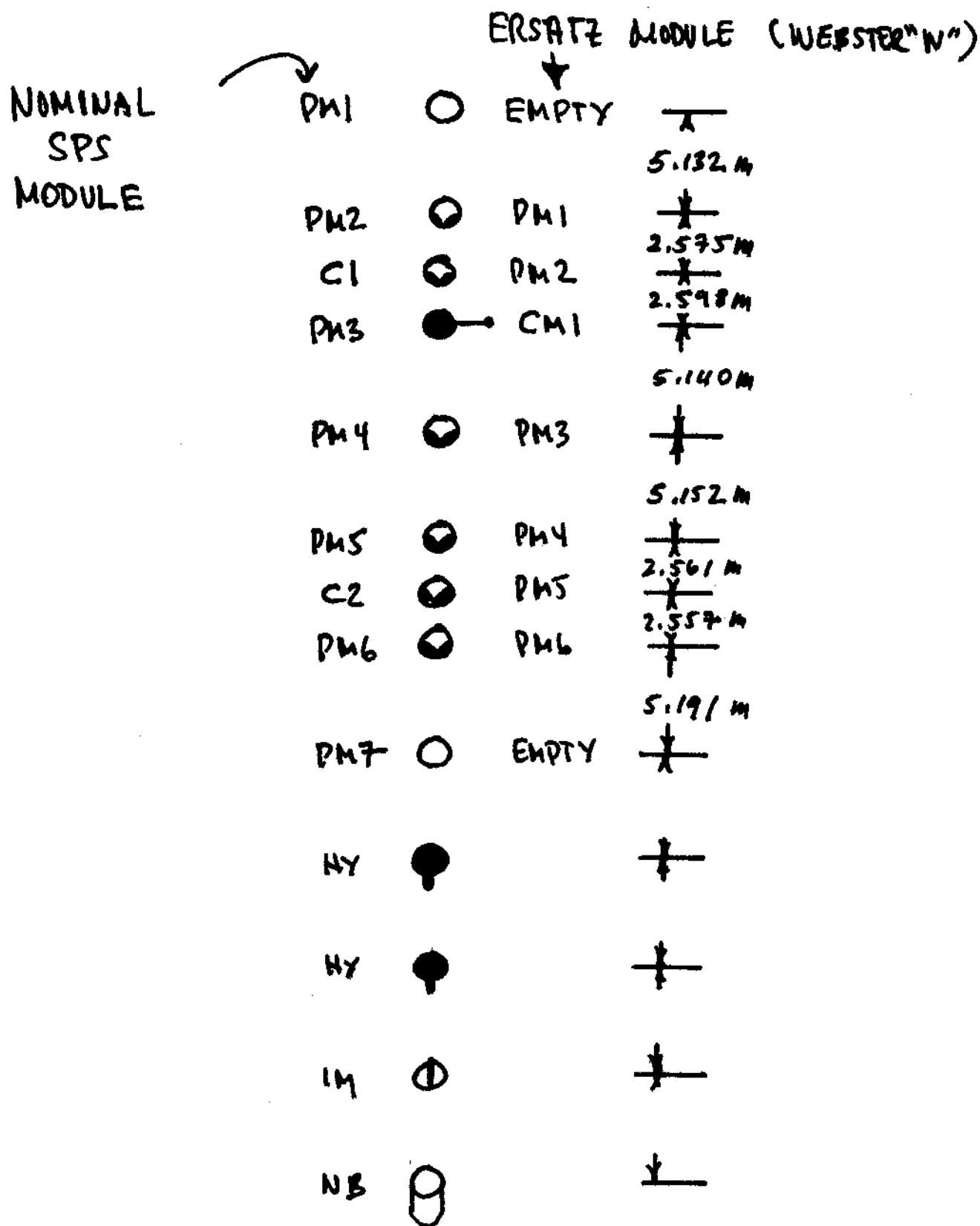
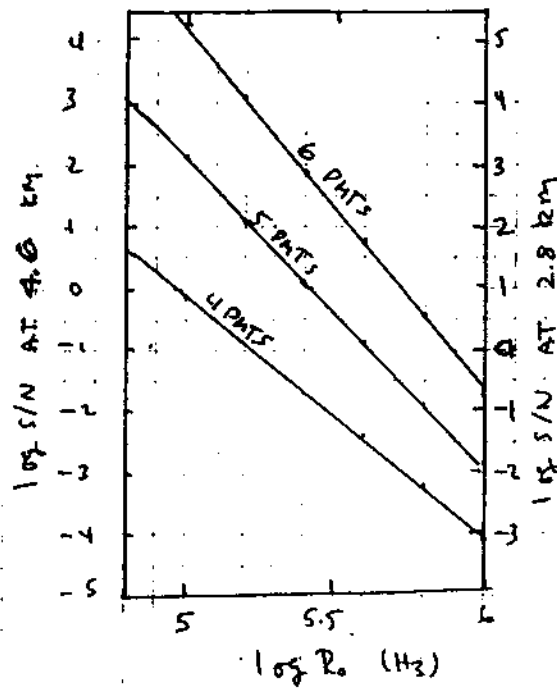
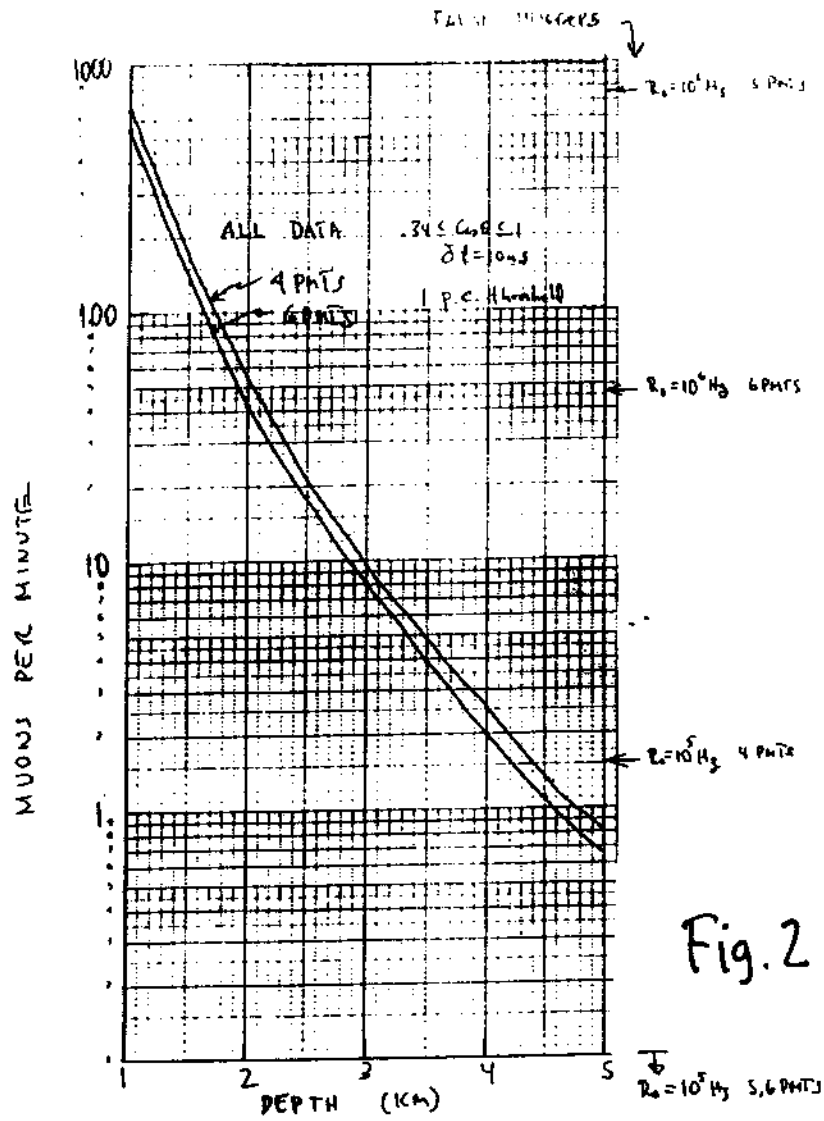


Fig. 1



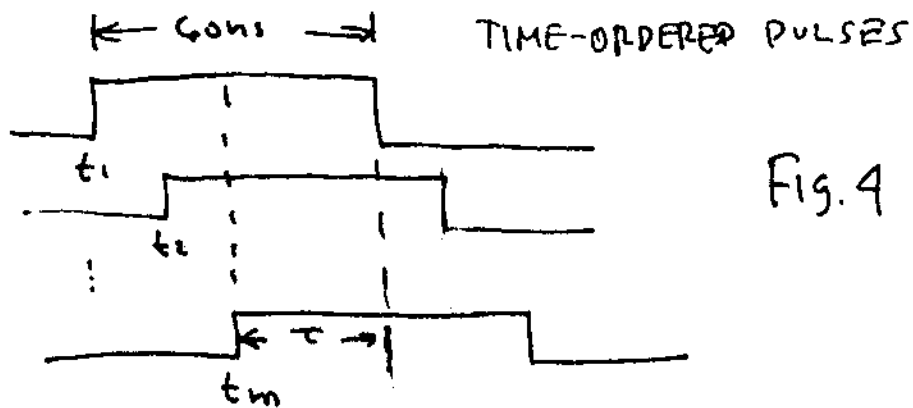


Fig. 4

$$\text{OVERLAP TIME} = 60 - (t_m - t_1) \equiv \tau$$

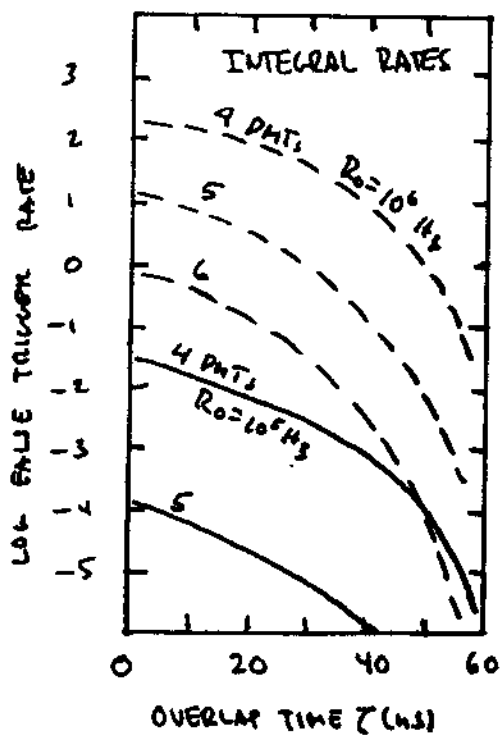


Fig. 5

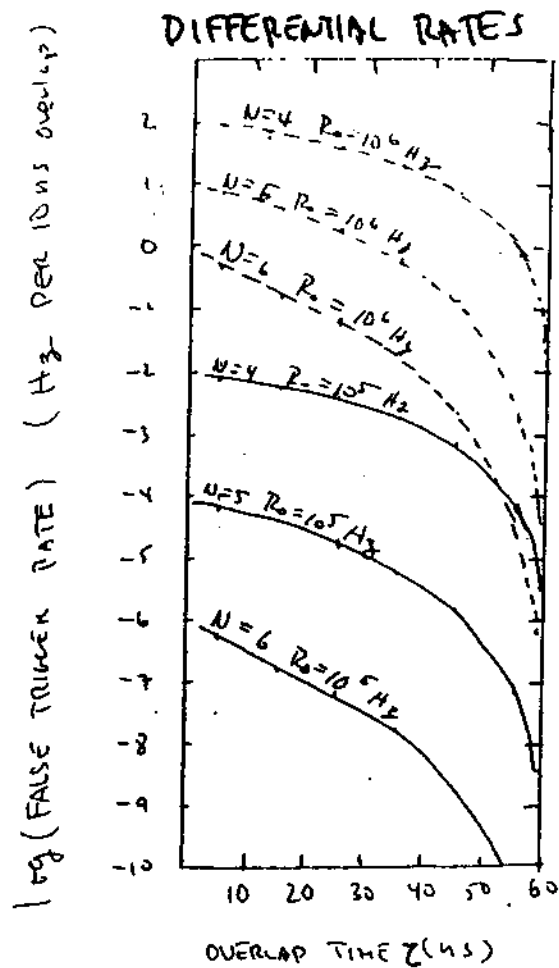


Fig. 6

