# SINGLE PASS COLLIDER MEMO CN-

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TITLE: SYNCHROTRON RADIATION SHIELDING FOR SLC ALCOVE ELECTRONICS

The question has been raised concerning where to put lead shielding to reduce the synchrotron ra iation dose to the electronics in the alcoves. Assuming th the alcoves are not near a collimator, the dominant radiation so ice is synchrotron radiation. Previous calculations indicate that a one centimeter thick lead door on the alcove would provide sufficient shielding. It was proposed that a one half inch thick le d door be used (the next available thickness). The door would be roughly 36 square ft and weigh 1150 lbs. The alternative would be to shield the transport line, i.e., the open side of the magnets and the gaps between the magnets.

We have done some further calculations concerning the possibilities of shielding the transport lines instead of the alcove. The point of contention in previous discussions is whether synchrotron radiation propagates as "gas" down the tunnel or whether it is attenuated rapidly.

As a first approximation we used the MORSE Monte Carlo Code. The input was a single photon energy bin covering 300-450 keV. The code simulated the SLC tunnel (but straight). Point sources were placed at positions along the transport line and, a detector was placed 30 cm from the farther wall. This is pessimistic since any recession of the electronics into the alcove would discriminate against small angle scattering of the photons and large angle scattering requires more scattering events, hence more attenuation of the photons takes place before they reach the alcove. The results are shown in Fig. 1. Both total dose and scattered dose are shown as a function of the distance along the tunnel to a point source. Also shown is an inverse distance squared function normalized at 5 meters. We should remember that in the real SLC case, the dose rate contribution will drop off even faster with distance since the magnets provide shielding in the forward direction. In fact, at about 25 meters, the magnets completely shield any direct radiation.

To confirm these calculations, we made measurements in the 2/3 take-off point tunnel using a 137Cs source. Although, the energy is somewhat higher (660 keV), one would expect to see no drastic change in scattering over this energy range. The scattered dose was measured with lead blocking the direct beam. The results, along with the MORSE results are plotted in Fig. 2,

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normalized at 5 meters. As can be seen, the agreement is excellent. The scattered dose could only be measured out to a distance of 20 meters because of the interference of some nearby radioactive components.

What we need to know is at what distance the contribution to the alcove dose becomes negligible. We have approximated a line source by integrating Fig. 1 and have plotted the result in Fig. 3. Shielding plans were to reduce the dose rate to about 2% by using a 1 cm thick lead shield (1/2 inch is the next available thickness). If the transport line is shielded out to 15 meters in each direction with a 1/2 inch thick lead shield, then the contribution from the unshielded areas would be less than 2%. If we use a 1.5 inch wide strip of lead along the open face of the magnet and assume 1 square ft in addition for each gap we need a total of 24.3 square ft. i.e.

2 x 15 m x 3.28 ft/m x 1.5/12 = 12.3 square ft

12 magnet gaps x 1 square ft = 12 square ft

total = 24.3 square ft

This shielding proposal is probably very conservative because:

a) the magnet shielding in the direction along the transport is not taken into account.

b) the recession into the alcove helps.

We propose going only 10 m in each direction with the shielding initially, requiring about 18 square ft of lead. Measurements during the first year would indicate the need for further shielding.

It seems that this solution must be cheaper than building the heavy alcove doors with some kind of mechanical assistance to open and close them. In addition, the general area near each alcove will have a reduced dose rate and this is the area where cables and wires will be concentrated.

It can be questioned as to whether this will help in light of the high energy radiation due to general beam loss along the transport line. In CN-230 Jenkins calculated that the dose rate at 29.3 meters from a collimator absorbing 10 kW, decreased to equal that from synchrotron radiation. In unpublished calculations made at the same time as CN-230, Jenkins found that a collimator would have to be 245 meters from the alcove to keep the dose to the electronics down to the desired level. These calculations are geometry dependent and Jenkins has assumed no shielding from the magnets or from the alcove. It is clear that the electronics should be recessed into the alcoves as much as possible.

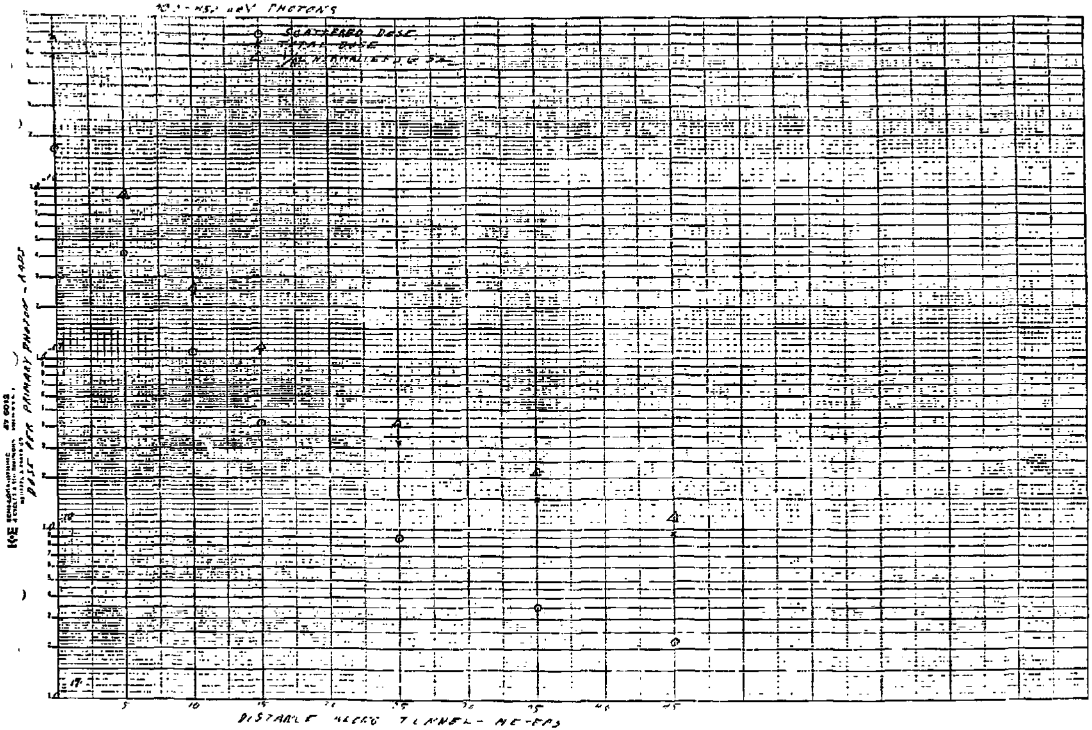


FIG. 1

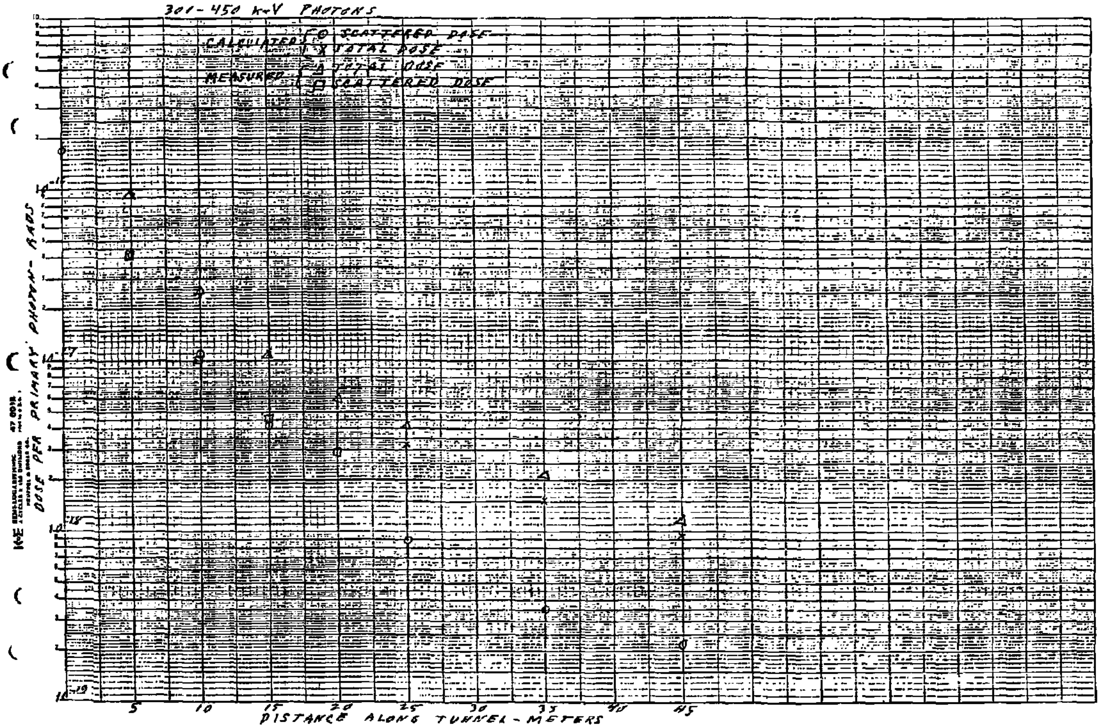
301-450 keV PHOTONS
CALCULATED
O SCATTERED DOSE
X TOTAL DOSE
MEASURED
Δ TOTAL DOSE
□ SCATTERED DOSE
DOSE PER PRIMARY PHOTON - RADS
5
10
15
20
25
30
35
40
45
DISTANCE ALONG TUNNEL - METERS

FIG. 2

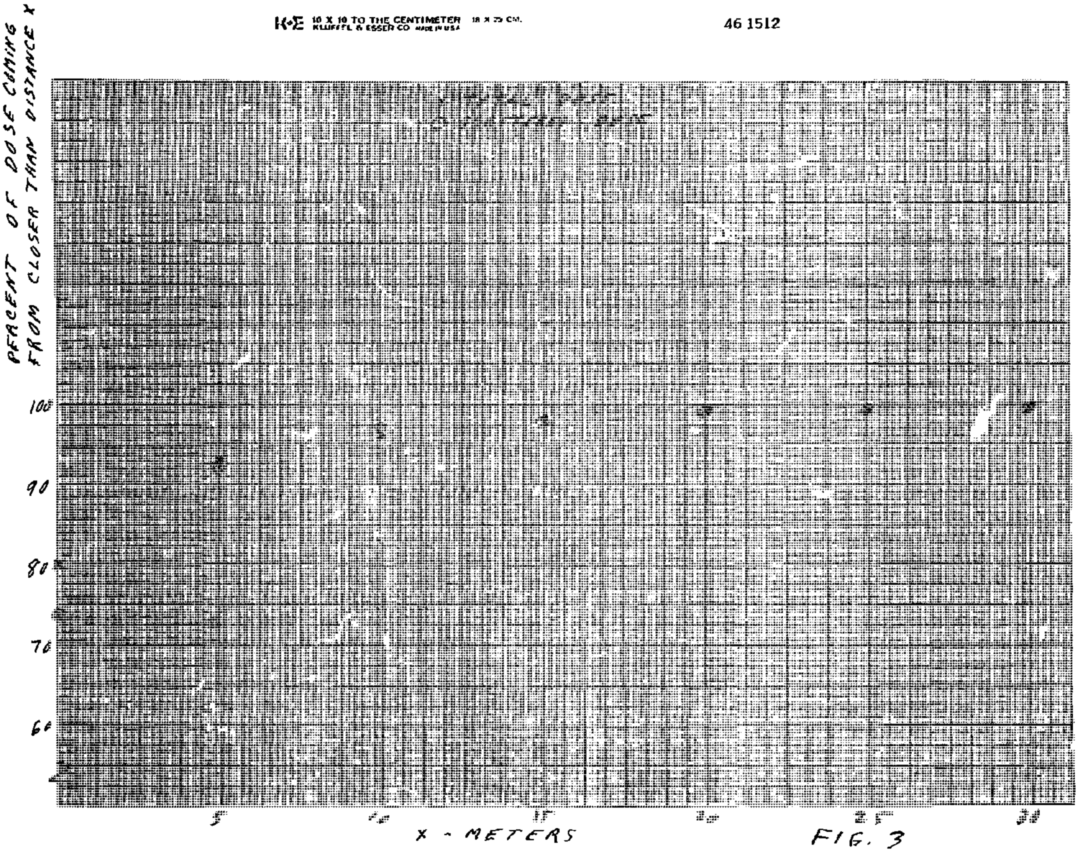
K+E 10 X 10 TO THE CENTIMETER 18 X 25 CM.
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1512
PERCENT OF DOSE COMING
FROM CLOSER THAN DISTANCE X
100
90
80
70
60
5
15
25
30
X - METERS

FIG. 3