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COMPARISON OF HALO PREDICTIONS WITH EXPERIMENTAL MEASUREMENTS OF OFFSITE MUONS ARISING FROM 275 GeV/c MUON LINE OPERATIONS

Craig D. Moore

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I. INTRODUCTION

Muon line operations in the Neutrino Area produce stray beams of halo muons (TM-497). The purpose of this note is to present a comparison between measurements of the halo intensity at various location along the beam line and predictions of HALO (a Monte Carlo computer program to calculate muon halo). Experiment E-319 presented an opportunity to make a clean set of measurements of halo beams since this experiment does not use the Chicago cyclotron magnet. When the cyclotron magnet is on the experimental situation is complicated by the return leg of the cyclotron magnet (TM-497).

II. DESCRIPTION OF HALO

HALO is a CERN computer program written by C. Iselin which uses the Monte Carlo method to calculate halo in muon beams. The program is based on ideas contained in Turtle, written by D. Carey, and another program originally written by T. Yamanouchi. For the purposes of this note only the first part of the muon line (first dog leg) was modeled. This approximation was made

originally to simply get the program working in a simplified version. Since, as is shown below, we obtain reasonable results with just this portion of the beam line we shall present these results. Other approximations made are:

1. bare target
2. no quads
3. preliminary parametrization of field in bending magnets.

We are able to obtain XY (coordinates perpendicular to the beam line) plots of the halo beam at various Z (distance along beam line) locations. Using these plots we are able to obtain muons/cm^2 in the same manner that the experimental results were obtained.

III. EXPERIMENTAL RESULTS

The experimental results were obtained using the MERL (a mobile environmental monitoring station). This monitoring station is equipped with two 8" x 8" scintillation paddles with the associated fast electronics. The MERL also is equipped with a telemetry system which receives the NO SEM. Table I presents the Z positions of the measurements along with peak intensities and peak locations (Y = perpendicular distance from the muon line positions in Enclosure 101). Table I also presents the squared ratio of the distances from E-101 with Z E-103 as the start. Comparing these ratios with the ratios of the MERL readings (normalized) to the

E-103 readings is one piece of evidence that the halo beam is coming from E-101. Another indication that E-101 is the source is the rough constancy of the Y/Z ratios. Hence our parametrizations of the muon line which extends up through E-101 should be a reasonable approximation.

IV. COMPARISON OF HALO TO EXPERIMENTAL RESULTS

We made experimental measurements at the four locations indicated in Table I. The results are presented in Figure I in units of muons/(cm^2 10^{12}inc proton). The dots are the measurements and the line is drawn to guide the eye. Also shown in the Figure 1 are the HALO results (the histograms are the HALO results). A point to be stressed is that there is no normalization factor, i.e., the HALO results are absolute numbers. The widths and peak heights are reproduced quite nicely. However, there is a systematic shift in position, i.e., HALO consistently predicts a peak position at approximately 29 milliradians and the experimental distributions are further west.

V. CONCLUSION

The main purpose of this note is to show that HALO does predict halo beams that compare quite well in absolute intensity, position and width with experimental measurements. The reason for demonstrating this is to indicate that HALO does have the ability to make correct predictions about future runs using the muon line. (In fact this was done for the 275 GeV/c run

TABLE I.

Location	Z	Z-ZE-101	Y	Y/Z	MERL/10^{12}	MERL/MERL E-103	$\left(Z \frac{E\text{-}103}{Z}\right)^2_{101}$
E-101	105370						
E-103	106065	695	21	.030	4816	1.	1.
Muon Lab	106679	1309	40	.030	1280	.27	.28
Lab A	108500	3130	106	.034	208	.043	.049
Site	116474	11004	347	.032	205	.0042	.0040

to indicate how quickly the experimental measurements should be made.) Future improvements that need to be made include:

1. production spectrum modified to include the effect of target train
2. better field maps for dipoles
3. inclusions of quads
4. inclusion of second part of the beam line
5. inclusion of the cyclotron magnet

After these improvements have been made studies can be conducted to indicate the potential problems at 1000 GeV/c main ring operation. These will be used, for example, to indicate the proper placement of bending magnets which would bend the halo beams into the earth.

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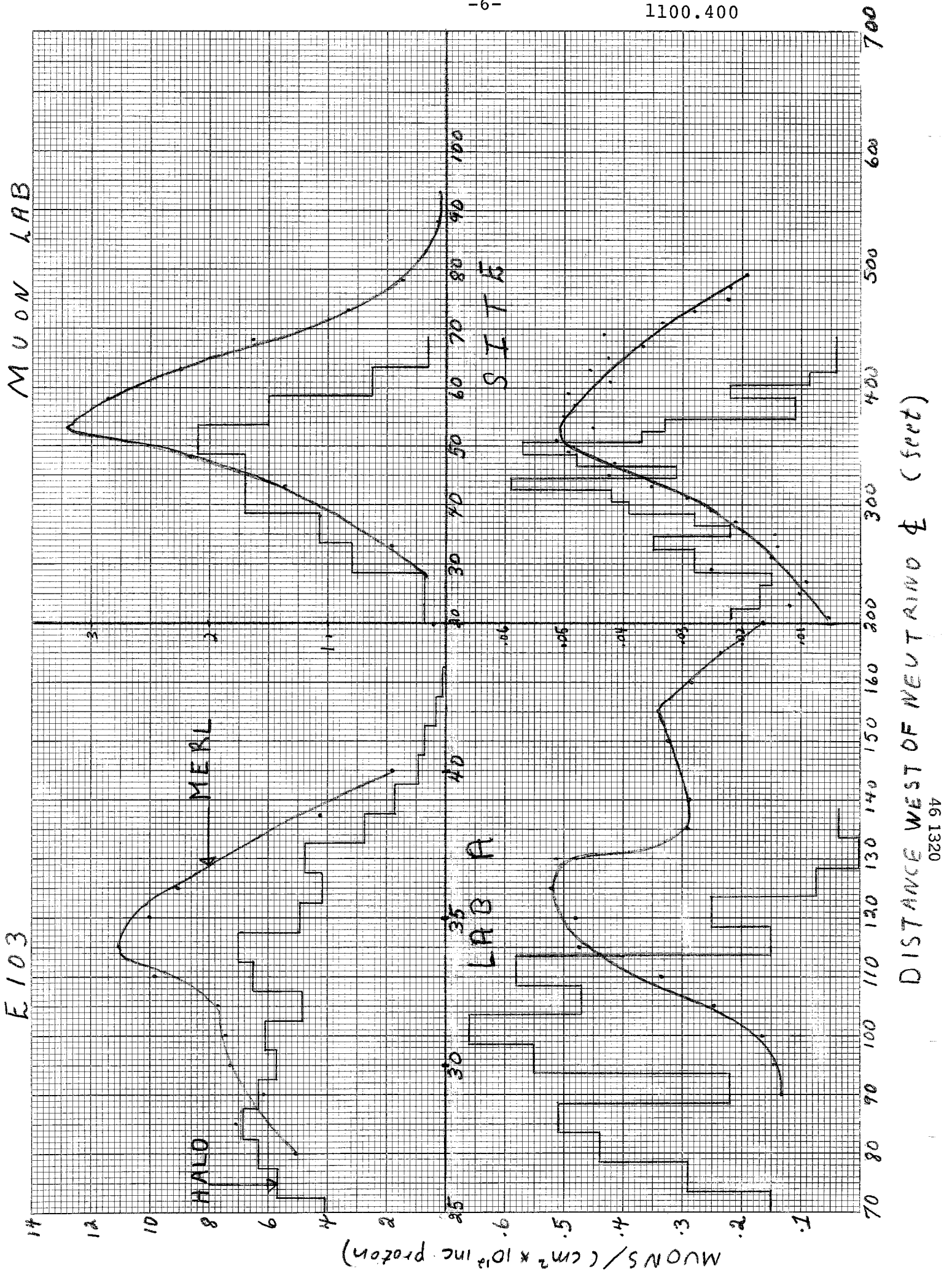
MUON LAB
E103
MERL
HALO
LARA
SITE
MUONS/(cm² × 10¹⁴ inc. proton)
DISTANCE WEST OF NEUTRINO ⊕ (feet)
46 1320