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NEW N3 BEAMLINE DESIGN

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A new N3 beam has been designed for the Neutrino Area, with the secondary target in the vicinity of Enclosure 103. With the installation of a portion of the Tevatron Shield[1], the present N3/N5 beamlines cannot be maintained because they lie inside the Shield. The Tevatron Shield is a six foot steel rod centered on the N0 beamline. It begins in Enclosure 100 and extends downstream about 150 meters. The N7 beamline has been redesigned to move it outside the Shield, and bring the primary proton beam to a target just downstream of Enclosure 103 (See TM-937). The new N3 beamline is shown schematically in figure 1, with new construction shown in the hatched areas.

The basic concept of the new N3 design is due to an experimenter on E597, Dr. W. Neale of the Cavendish Laboratory, Cambridge University. The goal of the new design is to provide enriched beams for Experiments 565/570 and Experiment 597, and at the same time provide the alternative of using the existing N5 beams to calibrate the 15' Bubble Chamber and the neutrino detectors in Lab E and Lab C. The existing N5 beamline will use the new N3 frontend together with all existing downstream magnets and enclosures. The N5 magnets in Enclosure 105 will be moved slightly to correct for the new target position and angle, otherwise the line remains unchanged.

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[1]Mori, S., "Muon Shield for the Tevatron at Fermilab", TM-790, May 17, 1978.

In the new N7 beam, the primary proton beam strikes the target at 30.9 mrad horizontally (with respect to N0) and down 3.4 mrad vertically. The new N3 line views the target at a production angle of 3 mrad horizontally and zero degrees vertically. A narrow aperture EPB dipole follows the target making an up bend of 3.4 mrad. Its purpose is to (1) restrict the momentum bite of the secondary beam entering Enclosure 105, (2) to kill as many wide angle/low momentum secondaries as possible, (3) in conjunction with the pre-target vertical bend to aim many of the decayed muons into the ground, and (4) to sweep out the charged particles for the $\bar{p}$ beam required by Experiment 597. Limiting the momentum bite into Enclosure 105 minimizes the interference between this beam and experiments in the Wonder Building. Killing as many secondaries as possible, near the target and aiming many of the muons into the ground, minimizes the amount of shielding necessary for radiation protection.

The new N3 follows the present trajectory, using most of the existing beampipes and enclosures. The section that is different occurs between Enclosure 105 and Enclosure 108. A horizontal bend of about 6.5 mrad east is added between the two existing quadrupoles in Enclosure 105 to disperse the beam for momentum selection in Enclosure 106'. In addition to momentum collimators, Enclosure 106' contains one horizontal field lens, one vertical field lens, and a west bend of about 14 mrad. This is followed by Enclosure 108' (Enclosure 108 plus a south extension) which bends about 7.5 mrad east, matching it into the existing downstream pipes and enclosures. Enclosure 108' also contains a quadrupole doublet which makes undispersed horizontal and vertical foci about 35 meters upstream of Enclosure 112. Collimators at the undispersed foci are used by Experiment 597 to define the target. Enclosures 112 and 114 are

are used without change. The present 106 Cerenkov counter is moved downstream of Enclosure 114. The second Cerenkov counter is made by removing the "head" presently in Enclosure 108, and installing it in Enclosure 112. A final quadrupole is placed on Pad 116 to make the beam small horizontally and big vertically as it enters the 30" Bubble Chamber.

Since the new beam must accomodate a wide range of conditions for the various experiments, three tunes are listed in Table I (dipole strengths are given in kilogauss, quadrupole strengths in kilogauss/inch). For comparison all tunes are listed at 100 Gev/c, although in reality, the experiments will be using tunes scaled for their particular momentum. Most of the running for the approved experiments is at 100 and 200 Gev/c, however, there are short runs at 360 and 400 Gev/c.

Tune 1 is for Experiment 597 and maximizes the acceptance for $\bar{p}$ at 100 Gev/c. Tune 2 is for Experiments 565/570. They use two differential Cerenkov counters to tag pions, kaons, and protons. Tune 2 has a parallel section between Enclosure 108' and Enclosure 112 for one Cerenkov counter, and a region of small angles ($<$ 0.25 mrad RMS half-width) downstream of Enclosure 114 for the second Cerenkov.

Tunes 1 and 2 are designed to have a large acceptance for relatively large sources. In Experiment 597 the large source is due to $\bar{\Lambda}^0$ decay from which one obtains the $\bar{p}$. In Experiments 565/570 the large source is due to multiple scattering the beam through a polyethylene filter, used to enrich the natural kaon fraction. (A portion of the enrichment also comes from accepting particles produced at large angles.)

Scaling up either tune 1 or tune 2 to 400 Gev/c means adding more quadrupoles. Tune 3 is a high energy tune which uses no additional magnets, but does sacrifice total acceptance. At high energies the beam is essentially either all pions (negative beam) or all protons (positive beam), and thus no filtering is done. As a result the beamline looks at a small source, which partially compensates for the decreased angular acceptance. The flux will be adequate because there will be no filtering and if necessary, the production angle can be made small. At high energies the experiments also want as small a horizontal spot at the 30" Bubble Chamber as is possible. Tune 3 accomplishes this by making the magnification small at the Bubble Chamber. For comparison, the Sine-like rays for each tune is shown in figure 2.

References

1. Lach, J. and Pruss, S., "Hadron Beams in the Neutrino Area", TM-285, January 25, 1971.
2. Neale, W. W., "Enriched Particle Beams for the Bubble Chambers at the Fermi National Accelerator Laboratory", FN-259, June 24, 1974.
3. Stefanski, R., "400 Gev Proton Transport to a Modified Neutrino Area", TM-937, February 1980.

NEW N3 SCHEMATIC

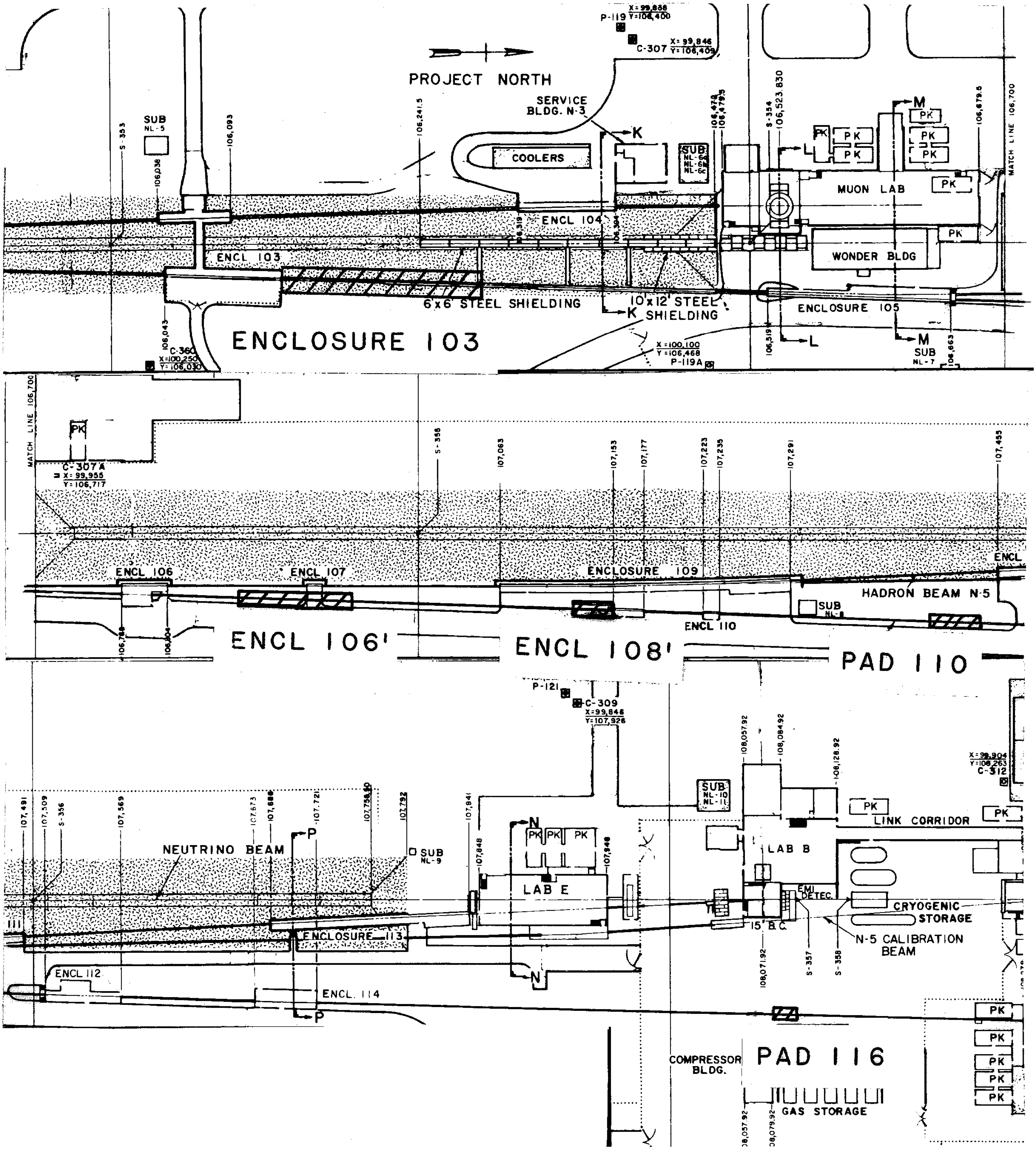

FIGURE 1

TABLE I

Element	Z Center	Magnet Type	Name	Tune 1 100 Gev	Tune 2 100 Gev	Tune 3 100 Gev
Target	6175.0	--	3T	--	--	--
Dipole	6182.0	EPB	3B03T	--	--	--
H Collimator	6222.5	--	3C03H	--	--	--
Quadrupole	6234.0	3Q120	3D03	-2.55282	2.28140	OFF
V Collimator	6266.4	--	3C03V	--	--	--
Quadrupole	6277.9	3Q120	3F03	1.47707	-1.58465	OFF
Quadrupole	6596.5	3Q84	3D05	-0.89618	1.25889	-1.53816
Dipole	6611.6	B-2	3E05	3.55000	3.55000	3.55000
Quadrupole	6643.5	3Q84	3F05	1.17959	-0.95049	1.63917
Quadrupole	6862.7	3Q120	3D06	-1.40000	OFF	OFF
Dipole	6879.2	B-2	3W06-1	-3.87500	-3.87500	-3.87500
Quadrupole	6894.2	3Q60	3F06	2.10000	OFF	OFF
H Collimator	6904.2	--	3C06H	--	--	--
V Collimator	6915.7	--	3C06V	--	--	--
Dipole	6932.2	B-1	3W06-2	-3.87500	-3.87500	-3.87500
Kicker	7117.6	--	3K08	--	--	--
Quadrupole	7125.1	3Q84	3D08-1	-1.12060	-0.84449	1.05867
Quadrupole	7133.6	3Q84	3D08-2	-1.12060	-0.84449	1.05867
Dipole	7148.6	B-2	3E08	4.20000	4.20000	4.20000
Quadrupole	7163.6	3Q84	3F08-1	1.08536	0.71033	-0.97552
Quadrupole	7172.1	3Q84	3F08-2	1.08536	0.71033	-0.97552
Quadrupole	7405.5	3Q60	3D10	-1.20000	OFF	OFF
V Collimator	7417.0	--	3C10V	--	--	--
H Collimator	7428.5	--	3C10H	--	--	--
Dipole	7521.6	EPB	3W12	-3.72200	-3.72200	-3.72200
Dipole	7544.3	EPB	3U12	3.72200	3.72200	3.72200
Quadrupole	7562.5	4Q120	3F12	0.89825	0.31786	0.68832
Quadrupole	7692.3	3Q60	3D14	-1.35656	-1.64247	-0.63319
Dipole	7701.3	EPB	3W14-1	-3.01000	-3.01000	-3.01000
Dipole	7712.9	EPB	3W14-2	-3.01000	-3.01000	-3.01000
Quadrupole	8076.2	4Q120	3F16	0.57280	0.54623	0.56006

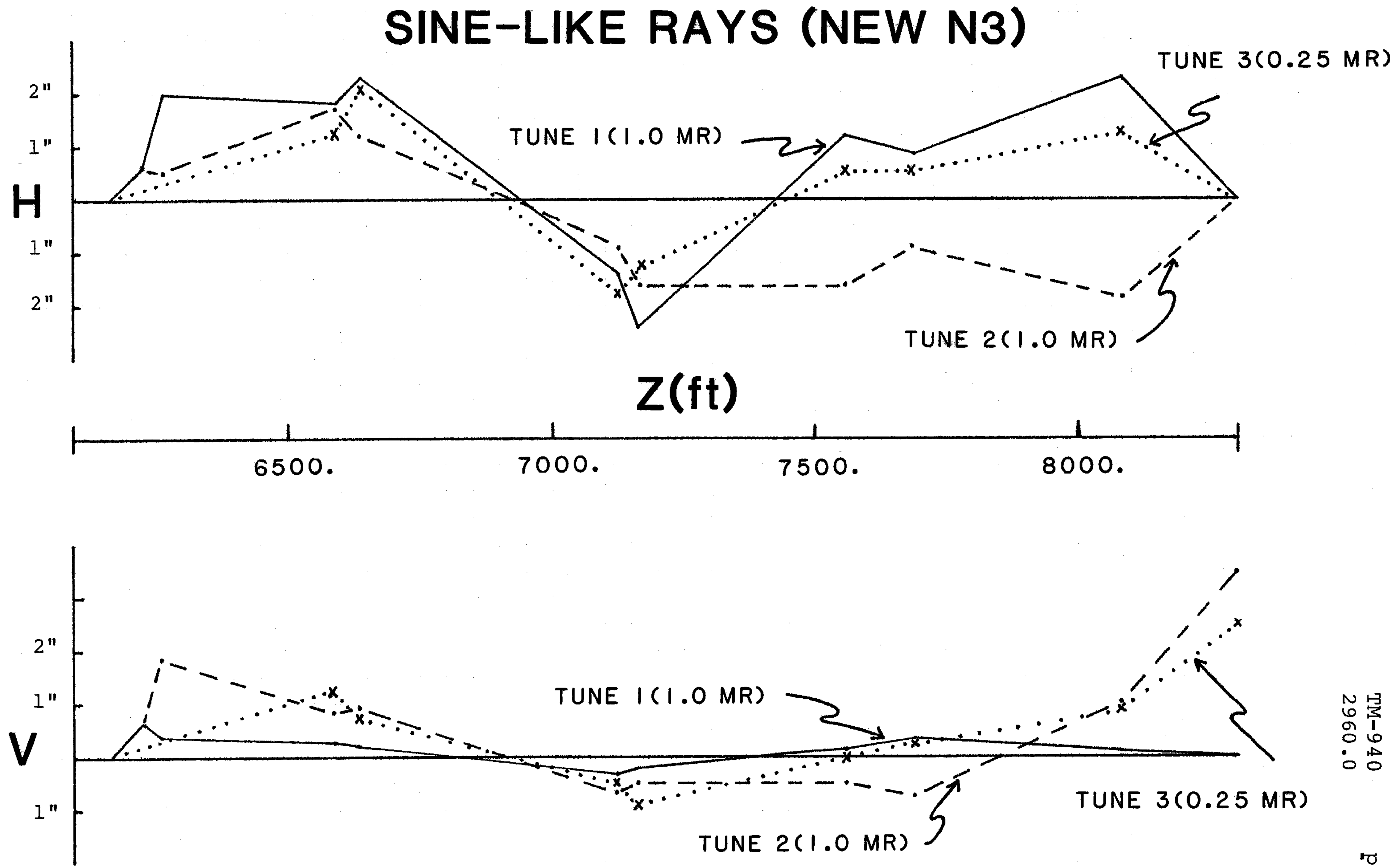
SINE-LIKE RAYS (NEW N3)
H
V
2"
1"
TUNE 1(1.0 MR)
TUNE 2(1.0 MR)
TUNE 3(0.25 MR)
Z(ft)
6500.
7000.
7500.
8000.

FIGURE 2