Fermilab

April 1, 1982

Dr. Norman Gelfand
MS #105
FERMILAB

Dear Norm,

The purpose of this letter is to declare our intention to submit in the next few months a proposal for an experiment in the DØ intersection of the $p\bar{p}$ collider. The exact nature of such a proposal must necessarily depend on details which are not well known such as luminosity, detector building floor plan, near term capability of the Collider Detector Facility, etc. We will outline here some features of the proposed apparatus and physics program which we feel are subject to minimal change.

Detector. The heart of the apparatus is a non magnetic, segmented electromagnetic and hadron calorimeter. Most of the segments for the hadron calorimeter we intend to use are already built and are currently being used in E609. We intend to supplement these with additional hadron modules and incorporate a high resolution ($1.5\% + 1.5\%\sqrt{E}$) glass-scintillator electromagnetic shower detector such as that of E705.

The individual segments are readily stacked and can be deployed in a variety of ways to meet our experimental constraints. We envision stacking the segments in self-contained modules which can be moved by a 10 ton overhead crane. Two "arms" of the device could be placed together to cover the forward wall in the $\bar{p}$ direction from $\theta \approx 1^\circ$ to $\theta \approx 15^\circ$ for all azimuthal angles. Larger values of θ would be covered without the benefit of full azimuthal coverage by moving the arms with the overhead crane.

The calorimeter will be supplemented by a 4π charged multiplicity detector. This device is intended to give a measure of the charged multiplicity and information on the pseudorapidity distribution. It will consist of scintillators and/or wire chambers.

Physics Goals. With this equipment we expect to be able to address several physics problems:

1) Resonances and Large Masses. Hadronic decays of heavy particles with widths of several percent should be detectable. Electromagnetic decays of such particles can be observed for widths of a percent or less. Rejection of hadronic background in electromagnetic showers will be excellent because of the good hadronic and electromagnetic calorimetry. We expect Z^0 decays will be well matched to the detector capability.

2) Jet Physics. By moving the calorimeter arms one should be able to examine the angular distribution for constituent scattering over a wide range.

3) Cosmic Ray Physics. The 15^0 forward cone contains the results of most present day cosmic ray data. Binocular events, multiplicity behavior, charged/neutral ratios, and pseudo-rapidity distributions would be subjects of study.

Sincerely yours,

Albert Erwin,
University of Wisconsin

Brad Cox, Frank Turkot,
Fermilab

Walter Selove, Larry Cormell,
University of Pennsylvania

K. W. Lai,
University of Arizona

Tom Fields,
Argonne National Laboratory

June 7, 1982

Dr. Norman Gelfand
Second Floor, Central Lab
Fermi National Accelerator Laboratory
Batavia, Illinois

Dear Norm,

We present to you herewith 30 copies of an addendum to our letter of intent submitted to the PAC last April. We wish this to be considered in the June PAC Meeting. At this present time our design is still incomplete. Nevertheless, the design and development status of the equipment we propose to use is much further along than that of most of the existing proposals for DØ. However, a strong point of our apparatus is its flexibility, and we feel it will be better to define our objectives more precisely at a later time in a more complete proposal, especially in view of the fast moving developments at CERN.

To help with deliberations and especially with the layout of the DØ experimental area we are including some brief material on three subjects:

1. Description of the detector and possible floor plans.
2. Rough cost estimates.
3. Possible physics objectives.

Please keep us informed about the direction of the laboratory regarding DØ and let us know what else may be required.

Sincerely yours,

Albert Erwin,
University of Wisconsin

Brad Cox, Frank Turkot
Fermilab

Walter Selove, Larry Cormell,
University of Pennsylvania

Tom Fields,
Argonne National Laboratory

Attachment

Addendum to DØ Letter of Intent of April 1982

I. The Detector

The detector is non-magnetic and consists of two moveable calorimeters and a high precision vertex detector.

A. Calorimeters. Each calorimeter consists of an electromagnetic part followed by a hadronic part.

1) The electromagnetic calorimeter consists primarily of glass scintillator blocks. Samples of these have been tested and shown capable of energy resolution $\Delta E/E \leq 1.1/\sqrt{E} + 1.6\%$. We believe the constant term can be decreased to approximately 1% with better shower containment than was possible in the test set up.[1] The glass blocks are 20 radiation lengths long and are preceded by 3.5 radiation lengths of scintillator glass preconverter. The preconverter is followed by scintillation hodoscopes to optimize the spatial resolution for single photons and electrons and to maximize the two photon resolving power.

[1] To be published in IEEE proceedings, Fall 1982.

A detector of this type is scheduled to run in Tevatron experiment E-705 before the collider is commissioned.

2) The hadronic calorimeter is constructed with modules of steel and acrylic scintillator slabs. These modules are arranged in towers that point to the beam intersection region and are approximately aligned with corresponding glass scintillator blocks of the electromagnetic layer. The modules are mounted in groups sealed in light-tight boxes that are strong enough to permit handling by a 20 ton overhead crane. 70% of one hadronic calorimeter we plan to use is already constructed and was used in E-609. Resolution in that experiment was approximately $\Delta E/E = 0.70/\sqrt{E}$.

B. 4π-Vertex Detector. The primary function of the vertex detector is to reconstruct the charged particle trajectories and to locate accurately the vertex of the main event. It will also produce a measure of event multiplicity by sampling the charged multiplicity. In addition the accuracy should be sufficient in many cases to identify particles with lifetimes in excess of 10^{-13} seconds. 1500 sense wires with 6 mm spacing surround the intersection region. A barrel construction with end cap planes allows one to reconstruct vertices using charged particles that exit the beam pipe in the neighborhood of the intersection region.

C. <u>Possible Floor Plans.</u> Because of its modular construction the detector can (with a modest amount of advance preparation) be made to accommodate beam pipes and a variety of experimental objectives. A possible floor plan is shown in Fig. 1. One calorimeter is threaded by the beam pipes. A single tower is removed for each pipe, and each layer of calorimeter is constructed in 2 halves. Figure 2A is also a sketch representing this same floor plan. Figures 2B and Fig. 2C show two other floor plans which could be used with different physics objectives in mind.

For floor plan 2A the percentage of azimuthal angle covered at each polar angle θ is plotted in Fig. 3. This particular arrangement is especially good for examining "cosmic ray" physics (θ less than 15°). It should also be useful in studying diffractive production of baryon/meson pairs formed from heavy quark-antiquark pairs provided they decay predominantly into hadronic and charged leptonic jets.

Parameters describing the floor plan of Fig. 2A are as follows:

a) Front wall calorimeter

$\Delta\theta = \pm 23°$ (centered at $\theta = 0°$)
$\Delta\Omega = 0.35$ sr
184 hadron towers

b) Side wall calorimeter

$\Delta\theta = \pm 30°$ (centered at $\theta = 56°$)
$\Delta\Omega = 0.75$ sr.
192 hadron towers

II. Rough Cost Estimates

A. Hadron Calorimeters

Additions to old calorimeter	$ 200K
New hadron calorimeter	1,400K

B. Electromagnetic Calorimeters

Glass scintillator (450-6" blocks)	1,350K
Phototubes, electronics, etc.	450K

C. Vertex Detector (1500 wires)	200K
	$3,600K

One might expect ~ $1,000K of this will be funded through groups outside Fermilab over a period of 2 years.

III. Physics Objectives

The device described here has several unique features which will probably determine how it must be used.

A. It has a very fine grained tower structure--equivalent to a 4π detector with over 5,000 towers.

B. The electromagnetic energy resolution is the best that can be had at present. It is sufficient in fact to check the expected $Z°$ width if it couples only to known flavors. If it couples to heavier, as yet unknown flavors (e.g., $Z° \to \nu\bar{\nu}$), then this device should be able to detect it in a width measurement.

Rates are such that if luminosity is $\sim 10^{30}$, one could expect 600 events with $Z^{\circ} \rightarrow e^{+}e^{-}$ in three months of running with floor plan 2B. A detailed Monte Carlo must be done to obtain a more reliable number.

C. As demonstrated in E-609 the solid angle for the two calorimeters is adequate for studying parton scattering with two jets. For much smaller solid angles the "Fermi momentum" of the partons makes it too unlikely to detect both jets. Floor plans such as 2C could study back-to-back parton scattering.

D. The high resolution vertex detector offers the opportunity for observing high multiplicity anomalies which might be associated with phase changes of nuclear matter, and the electromagnetic detector could simultaneously observe the expected increase in photon yield.

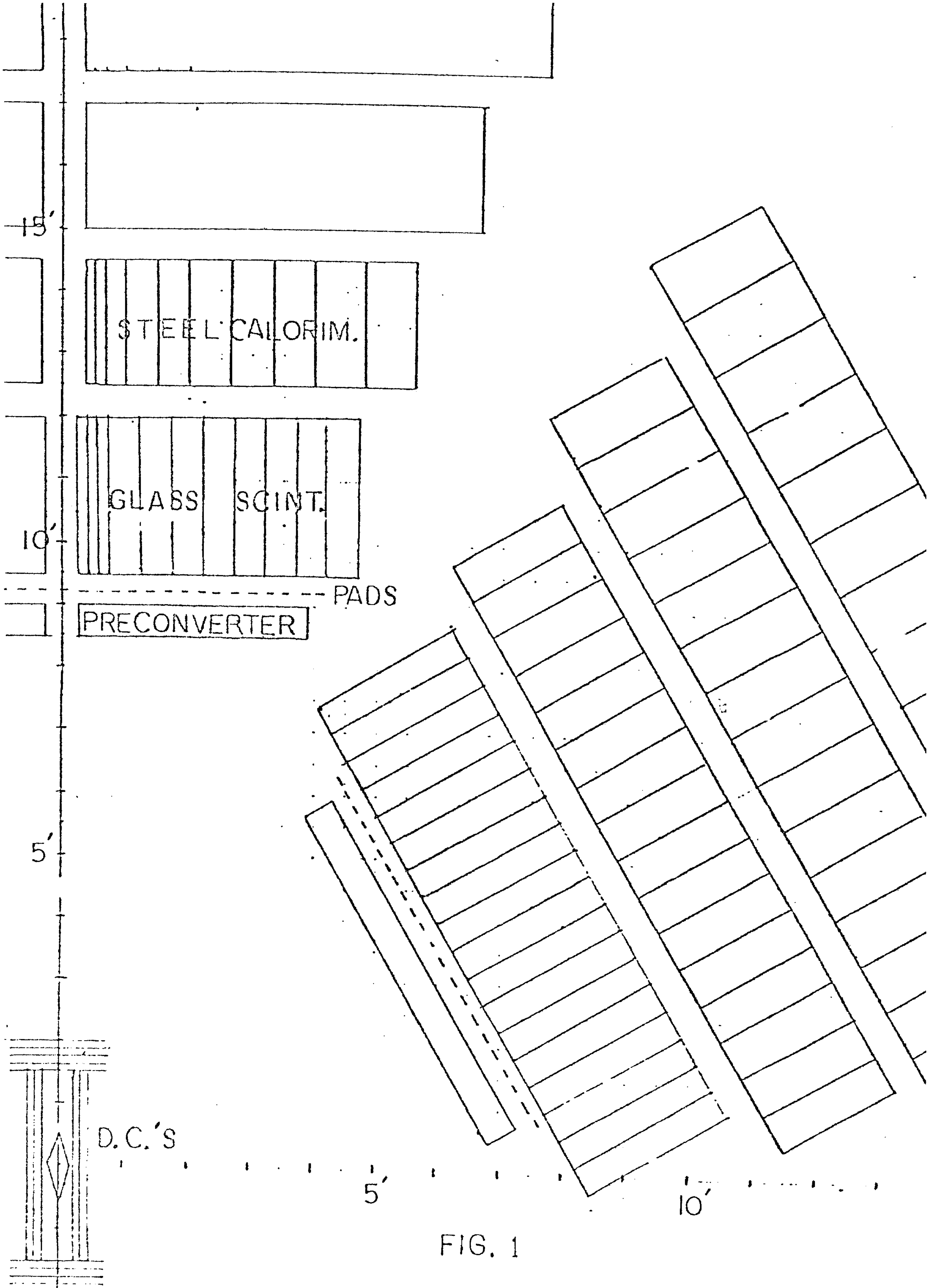
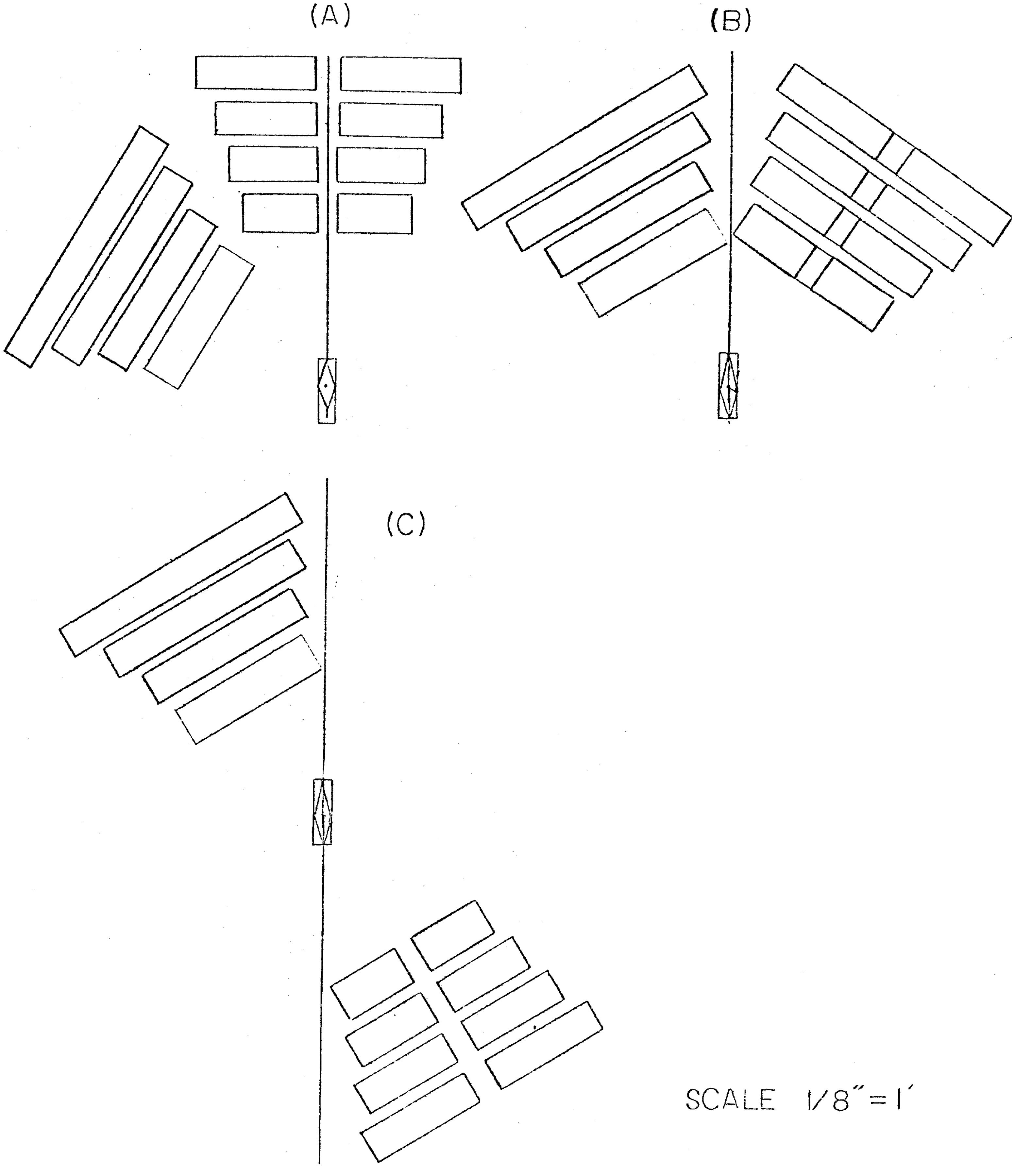


FIG. 1

FIG. 2



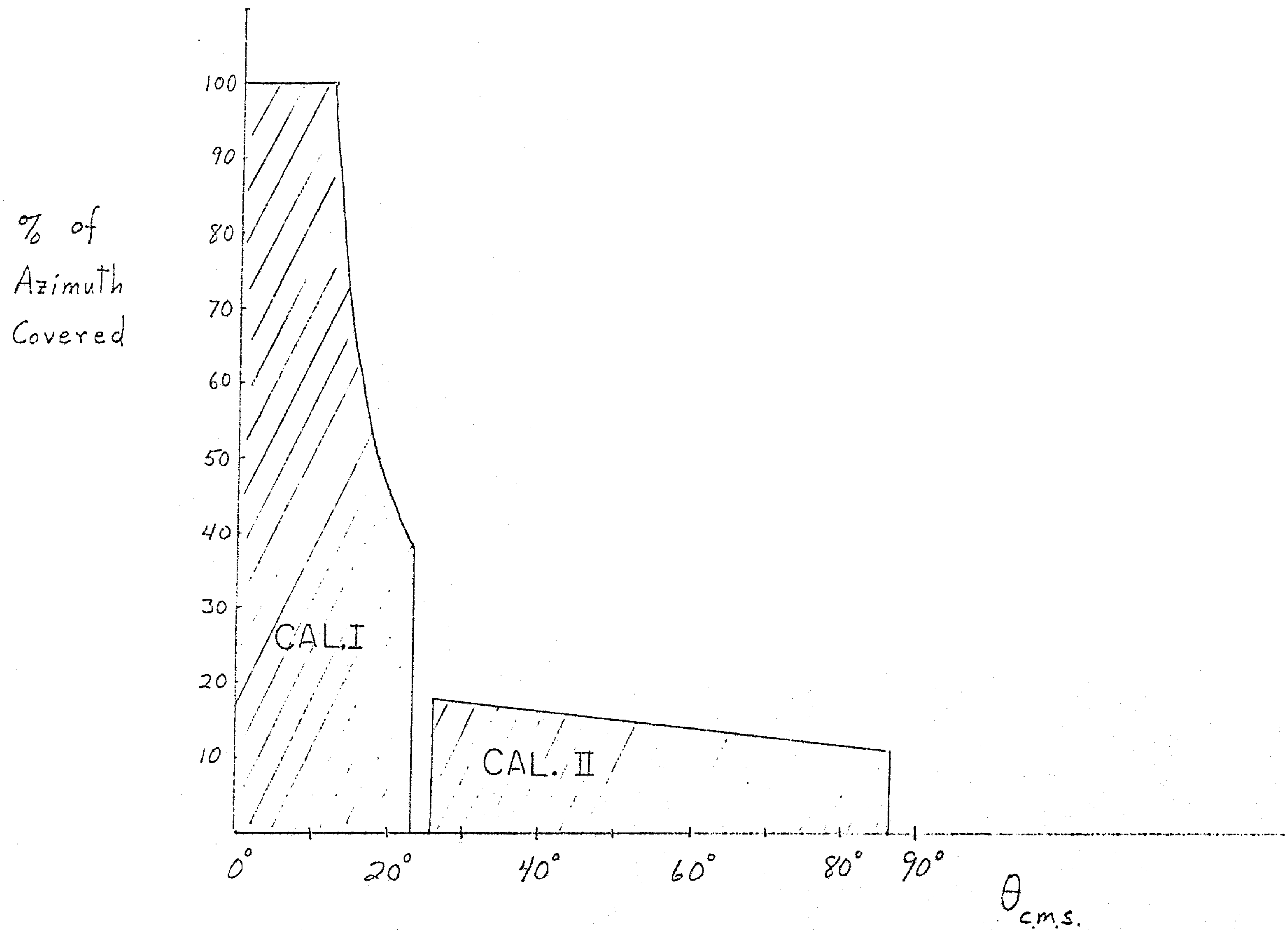

% of
Azimuth
Covered
100
90
80
70
60
50
40
30
20
10
CAL.I
CAL. II
0°
20°
40°
60°
80°
90°
$\theta_{c.m.s.}$

FIG. 3