NALREP

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Fermi National Accelerator Laboratory

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J. R. Sanford, Editor
N. Stiening, Assistant Editor

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THE COVER: Some members of the University of Hawaii-Lawrence Berkeley Laboratory collaboration (Experiment #155), which designed and built the External Muon Identifier (EMI). Pictured left to right are V. Peterson, J. Taylor, M. Stevenson, F. Harris, R. Cence, and S. Parker. The EMI, mounted on the outer shell of the 15-foot bubble chamber vacuum tank, aids in the interpretation of neutrino and antineutrino interactions. Preliminary results on the first EMI performance tests are reported on page 1.

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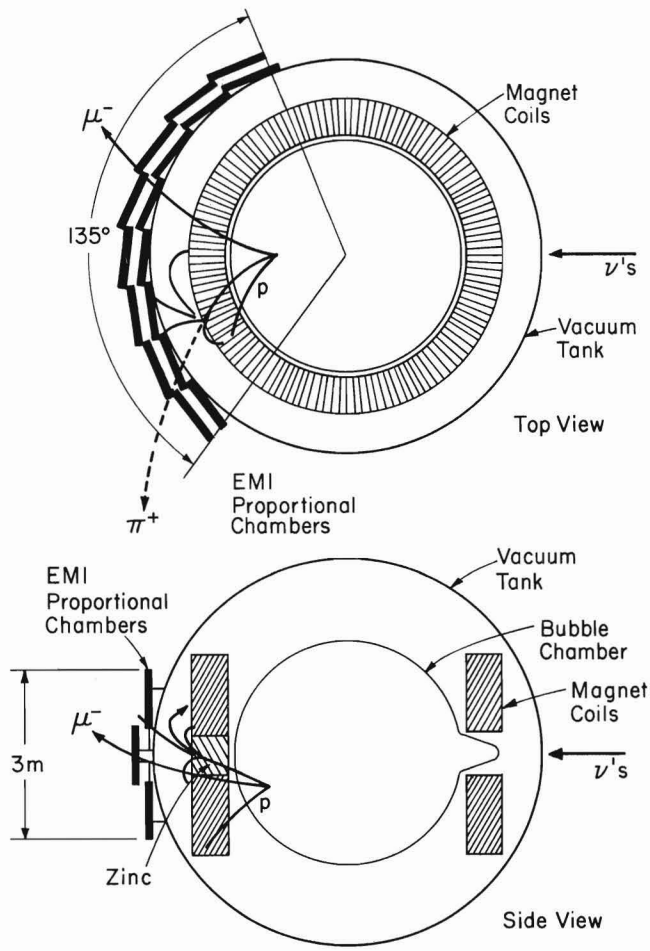
Dates to Remember

THE EXTERNAL MUON IDENTIFIER

During October and November, well over 100,000 pictures were successfully obtained in the Fermilab 15-foot bubble chamber. The large useful volume of the chamber (20 cubic meters), combined with the possibility of filling it with liquid hydrogen, deuterium, neon, or neon-hydrogen while exposing it to beams of neutrinos, antineutrinos, and hadrons, makes it one of the most powerful tools in high energy physics. Another device, the External Muon Identifier (EMI), which is attached to the outer shell of the vacuum tank and operated in conjunction with the chamber, aids in the interpretation of both neutrino and antineutrino interactions. The EMI is being developed and tested by a collaboration of physicists from the University of Hawaii and the Lawrence Berkeley Laboratory. It will eventually become a Fermilab facility.

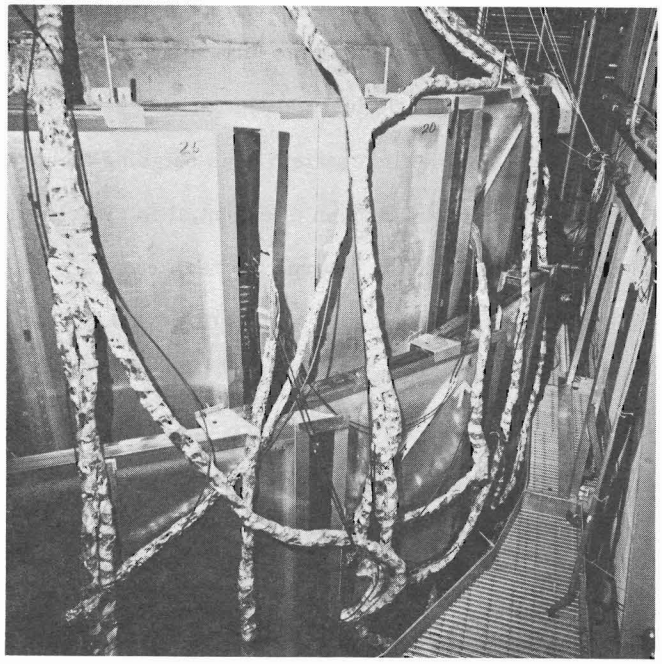
The EMI was originally conceived to aid in the study of neutrino interactions of the type: $\nu + p \rightarrow \mu^- +$ hadrons. In such interactions, the lepton changes from neutral (ν) to charged (μ^-) and delivers a "charged current" to the initial hadron, the proton. To analyze this type of event kinematically and compare it with theoretical models, the outgoing muon must be distinguished from the hadron tracks in the bubble chamber. Usually the highest-momentum track in the bubble chamber is that of the muon, but this need not be so when the neutrino charged current is probing most deeply the structure of the proton. In such instances, the lepton transfers most of its energy to the hadron system. The EMI provides positive information about which of the tracks is a muon in charged-current events.



A simulated neutrino interaction, $\nu + p \rightarrow \mu^- + p + \pi^+$, in the 15-foot bubble chamber. The μ^- produced passes easily through the superconducting magnet coils and hits the EMI plane along the trajectory observed in the chamber. The π^+ hadron interacts in the zinc between the magnet coils, and does not appear in the region expected by extrapolating its track to the EMI. The proportional chambers are mounted directly on the vacuum tank to maximize the solid-angle coverage.

Within the last two years considerable excitement has been generated by the discovery of a new class of neutrino interactions in which the lepton does not change its charge, but delivers a neutral current to the proton: $\nu + p \rightarrow \nu +$ hadrons. Here the final state has no outgoing muon. Because of this new discovery, muon identification is essential to clearly separate charged-current interactions from neutral-current ones.

Muon identification using the EMI makes use of the bubble chamber, the material in the superconducting magnet coils (with zinc added between and behind the coils), and a plane of multiwire proportional chamber detectors on the back of the vacuum tank. A simulated interaction is shown opposite. Interactions within the bubble chamber are located by scanning the film; then each track is carefully measured to determine its position and momentum. Using the known magnetic field, it is then possible to calculate the position of each track at the detector plane and to predict a circle in which the particle should be found if it is indeed a muon. The size of this circle depends upon measurement errors and multiple Coulomb scattering in the bubble chamber liquid, magnet coils, zinc, and vacuum tank walls. Hadrons undergo strong interactions in this material and will either be completely absorbed, scatter out of the multiple-Coulomb scattering circle, or produce hadron cascades. Thus they reveal their identity by producing no particles in the circle or many particles from the cascade in the region of the extrapolated track. Muons, which do not undergo strong interaction, will fall within the circle and thus be identified.



Multiwire proportional chambers mounted on the back of the 15-foot bubble chamber vacuum tank. The aluminum shielding boxes contain the chambers, delay lines, and amplifiers. An effort was made to keep the EMI chambers simple and inexpensive; they are made from picture frames of G10 fiberglass glued to the cathode planes which in turn are glued to a cardboard and mylar honeycomb stiffener. The chambers are overlapped to eliminate the possibility of missing particles.

The detector plane, shown above, is composed of 24 1-meter square proportional chambers stacked three high by eight wide, covering approximately 135° azimuthally. The magnet coils, which are primarily copper, are approximately 2.4 absorption lengths thick (about 36 cm). At present, three absorption lengths of zinc (totaling 15,000 lbs) have been stacked to fill voids in three portholes of the magnet support structure. Work is in progress to add an additional 100,000 lbs of zinc behind the coils to bring the absorber

thickness everywhere to three absorption lengths. This thickness is sufficient to eliminate approximately 96% of incident hadrons from a multiple Coulomb scattering circle large enough to contain 96% of incident muons. (Zinc was chosen because it is non-magnetic, reasonably dense, and relatively inexpensive.)

The geometric efficiency of the present EMI has been determined using a Monte Carlo calculation that assumes a simple parton model with quark-parton distributions within the proton in agreement with deep inelastic electron scattering. Assuming a broad-band neutrino beam such as one produced by 300-GeV protons on target and focused by two horns, the present EMI configuration should intercept 85% of the muons produced by the charged-current neutrino interactions in the bubble chamber.

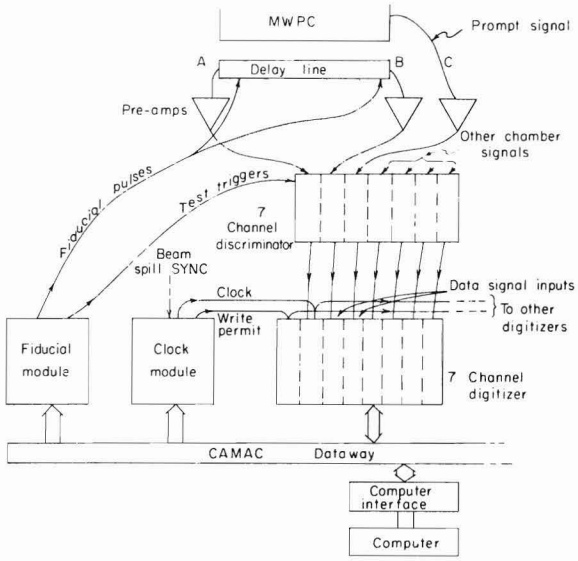
The proportional chambers and readout method used in the EMI system are unique. A test run at Berkeley several years ago impressed us with the work involved in operating only 200 channels of conventional one-amplifier-per-wire readout electronics and four small chambers. If the present EMI chambers were so constructed, 25,000 channels would be required to achieve the resolution desired. Instead, electromagnetic delay lines, first developed by V. Perez-Mendez of Berkeley, were used. In the EMI chamber, anode wires 20 μm in diameter, spaced 5 mm apart, are soldered to printed circuit strips on a sheet of mylar, which is then pressed against the delay line. The capacitative coupling is sufficient to transfer most of the pulse energy into the delay line. Several microseconds later, amplifiers at the ends of these lines pick up the pulses; the time difference gives the position, and the time

average (minus one-half the total delay line transit time) gives the event time. The ground current of the delay line is also tapped to provide the event time directly.

Instead of building additional sets of wire planes or chambers to measure the orthogonal and 45° (redundancy) coordinates, the two cathode planes are made of printed-circuit strips, which are brought out to three additional delay lines and amplifiers. Thus, a thousand would-be amplifiers are reduced to seven, and the entire system needs fewer channels than that used several years ago. The channels are more complex, of course, and the event-handling rate is limited, but it has proven adequate for the experiment.

The arrival times of the delay-line pulses are digitized using a system designed by F. Kirsten of Berkeley. Up to 16 digitizations per delay line amplifier may be stored in the fast memory of a CAMAC digitizer module during the beam spill and read into the computer when the spill is over. The system is shown on page 7.

The on-line computer system performs the usual tasks of reading out the digitizer data, writing the data to tape, and testing the readout electronics. In addition, the computer automatically monitors cosmic-ray tracks between beam spills and checks the performance of the proportional chambers. Experimenters may interrupt the monitoring at any time to make displays of chamber efficiency and uniformity also using cosmic-ray tracks. Using this system, the computer is kept busy all the time, as are the experimenters -- even when there is no beam!

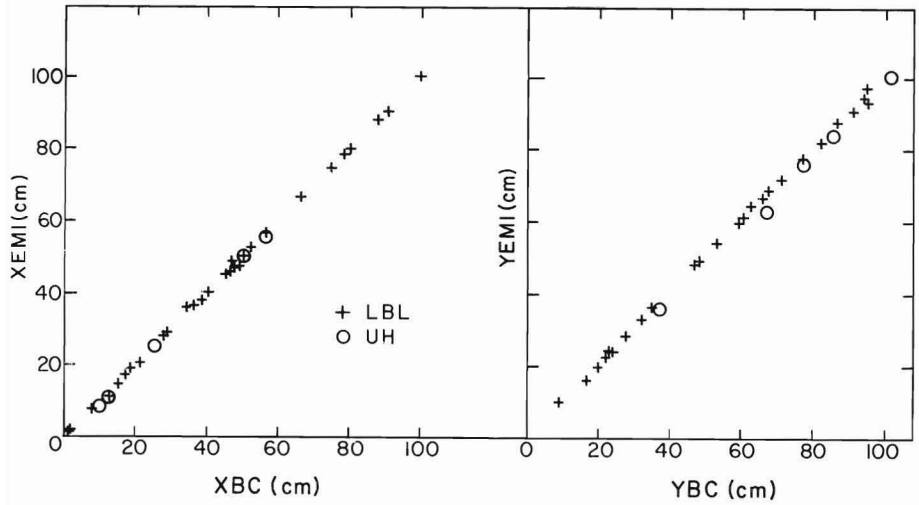


Proportional chamber readout system. A clock is started at the beginning of the beam spill, and the same 28-MHz pulse train is scaled by all seven channel digitizers. Amplifier pulses feed into a seven-channel zero-crossing discriminator, which accurately determines the center of each pulse. Whenever a pulse is received from a discriminator channel, the present scaler contents are strobed into the digitizer memory.

The EMI has recorded proportional chamber data whenever the bubble chamber has operated, taking exposures with various neutrino and hadron beams incident. These data are being used to test and calibrate the system to determine:

--The muon identification efficiency, using known muons.
--Hadron rejection, using low-energy secondary beams.
--The performance of the EMI for the actual event topologies found in neutrino and antineutrino reactions.

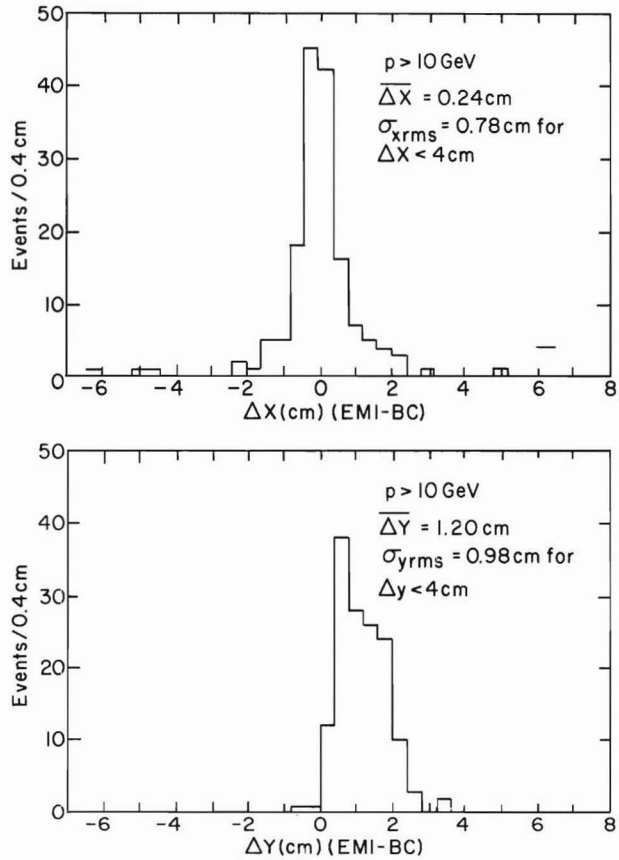
Although this program is by no means complete, the initial results are very promising.



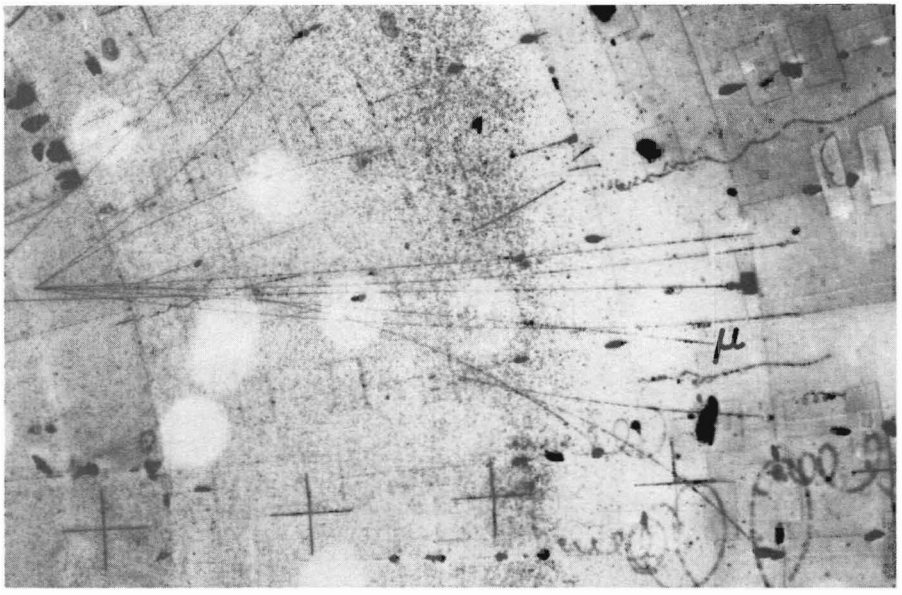
Measured EMI coordinates versus coordinates predicted by bubble-chamber measurements for a sample of known muons in a typical EMI chamber. Points should lie along a straight line passing through the origin with a slope of one if the chamber positions and delay-line velocities have been determined correctly. Fitted slopes and intercepts are respectively, 1.0 and -0.09 cm for X (horizontal), and 0.986 and 1.36 cm for Y (vertical) for this proportional chamber.

In general, the number of particles (hits) recorded in the proportional chambers during neutrino running is quite low and easily handled by the data acquisition system. During the July-August run with neutrinos generated by 300-GeV protons on target and a single focusing horn, an average of one hit per proportional chamber was found in a typical pulse of 6×10^{12} protons on target.

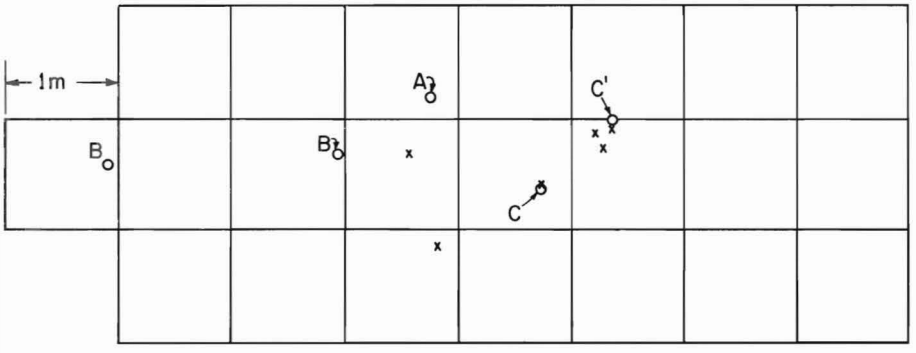
Another important calibration is obtained from a select subsample of the charged particles entering the bubble chamber during neutrino running.



Histograms of the difference between the predicted and observed X and Y coordinates for known muons for all EMI chambers. The net displacement of 1 cm in the Y coordinate probably results from an error in the survey. These measurements will be used to correct the survey. The rms deviation expected due to multiple scattering alone is approximately 5 mm.



A neutrino interaction in the liquid hydrogen of the 15-foot bubble chamber. There are three negatively charged tracks and four positively charged ones. All but the lowest-momentum positive track extrapolated to hit the EMI plane. (Photograph courtesy of the 15' Neutrino #45 group.)



Extrapolated track positions (X) and observed hits (O) in the EMI for the seven-prong event shown above. The EMI chambers are shown flattened out. The hit labeled C is only 8 mm from the highest momentum negative track, well within the expected error circle. The time-coincident hit C' is 7 cm from the nearest extrapolated track, indicating that it is a hadron. Hits A and B occurred at times unrelated to the C and C' hits. The EMI thus identified the highest momentum negative track (-12.5 GeV) as the muon for this event.

This sample may be used to test both the efficiency and spatial reconstruction accuracy of the system. By carefully examining the data, one finds that 96% of a sample of 320 such tracks strike the EMI within 10 cm of the position predicted from the bubble-chamber measurements. This preliminary result implies a muon detection efficiency of 98% after correcting for the hadron contamination (2% of the subsample). Muon events are also useful in determining the locations of the proportional chambers, and the results obtained will be used to refine the original survey. Some of the muon data are shown in the figures on pages 8 and 9.

More exciting was the first look at actual neutrino events. The first useful one is shown on page 10, along with an analysis using the additional data provided by the EMI system. Analyses of neutrino events are just beginning, and much work remains to be done in analyzing muon and hadron events, but thus far, the performance of the EMI is very promising.

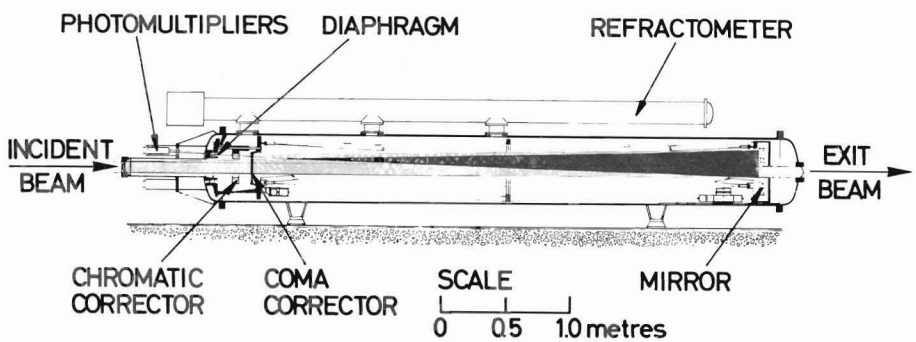
Reported by F. Harris, J. Marriner,
S. Parker, and M. Stevenson

Participants in 15' EMI Test #155, the collaboration which designed and built the EMI include R. Cence, F. Harris, S. Parker, M. Peters, V. Peterson, V. Stenger, and D. Yount from the University of Hawaii; and A. Barbaro-Galtieri, J. Marriner, G. Lynch, F. Solmitz, and M. Stevenson of Lawrence Berkeley Laboratory.

THE DISC CERENKOV COUNTER FROM CERN IS USED AT FERMILAB

A high resolution differential Cerenkov counter was installed in the M6 beam line in the Meson Area for use by Single-Arm Spectrometer #96 and Coulomb Elastic Scattering #69 experiments. The counter was designed and built at CERN and brought to Fermilab at the end of 1973. It is now fully operational and routinely identifying the beam particles with high precision.

A cross section through the counter is shown below. Beam particles enter from the left and traverse its 5-meter length before leaving the counter. The Cerenkov light is emitted by the high energy charged particles passing through helium gas in the pressure vessel of the counter. The light rays are produced along the length of the counter at an angle to the direction of the particle dependent upon the particle's velocity and the index of refraction of the helium gas. A precision-ground concave mirror at the end of the counter reflects the light back and focuses the rays produced at a definite angle to a corresponding circle or ring, with a radius proportional



Vertical section through the CERN-Fermilab DISC Cerenkov counter.

to the angle. At the focal plane of the rings there is a diaphragm with an annular aperture. The light which passes through it is detected by eight high-quality photomultipliers. Fast electronic circuits are used to determine how many of the photomultipliers have responded to the light. By varying the pressure of the helium gas, the index of refraction is varied and the light is made to pass through the aperture for a chosen velocity and not for other velocities. Since the beam particles have been selected to be a definite momentum, particles of different mass can be identified by their velocities.

The velocity resolution of the counter and its ability to separate particles depends upon the sharpness of the ring image of the Cerenkov light. Three main effects can broaden the light distribution:

--The multiple scattering of a particle on its way through the gas in the counter

--The chromatic dispersion of the produced light due to the variation of the index of refraction of the gas with the wave length of the emitted light

--The geometric aberrations of the focusing optical system

The first effects can be reduced with proper choice of the gas filling the counter. Helium is the best choice, but nitrogen or air can be used in some instances. The second effect is suppressed by a special optical element added to the focusing mirror. Similarly, high quality optical components can take care of the third effect. There is a single lens of fused silica which corrects mainly for aberration and a triplet lens of sodium chloride and fused silica elements which corrects for chromatic aberrations. The latter lens is remotely adjustable in position along the counter axis to obtain the best focus of the ring image for a given particle

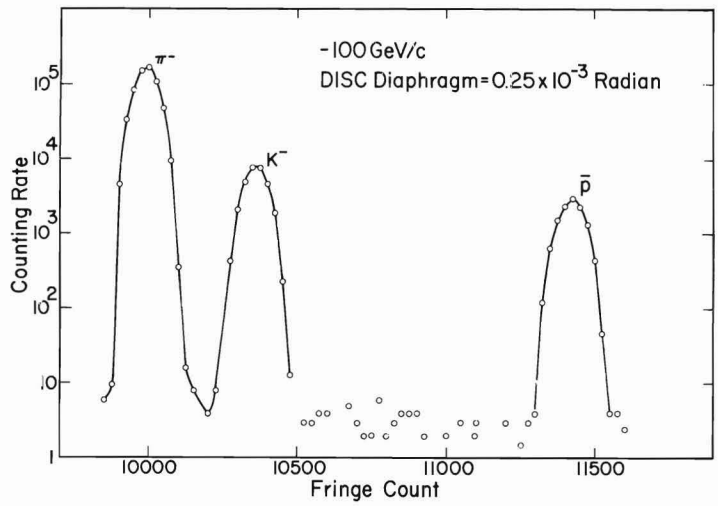
velocity. The optical elements are supported on a rigid framework inside the pressure vessel. This framework can be remotely adjusted to align the optical axis along the axis of the high energy beam, removing any need for precise positioning of the counter barrel in the beam.

In this device, the optical aberrations have been reduced to the unavoidable limit set by the diffraction of light. The corresponding velocity resolution for the DISC (Differential Isochronous Self-Collimating) Cerenkov counter is about 5×10^{-7} of the speed of light. This accurate determination, coupled with the known masses of beam particles, gives an independent calibration of the average momentum of the M6 beam, of 0.1% accuracy. The nominal +140 GeV/c setting of the beam elements has been determined to provide a true momentum of +138.0±0.1 GeV/c, using the separation between the proton and deuteron mass in this case.

Studies of the fast electronics circuitry have shown that an electronic counting efficiency of about 80% can be reached if an eight-fold coincidence among the phototube outputs is required. If six (or more) of the eight are required, the efficiency is close to 100%.

In order to search for and detect known particles, the counting rate is recorded as the function of the pressure of the gas. A typical pressure curve obtained in a negatively charged beam of 100 GeV/c momentum using a diaphragm aperture size of 0.25 mrad is shown on page 15.

A mass spectrum taken from π^- to $\overline{D}$ at 100 GeV/c is displayed on page 16. A threshold counter set on pions was used to depress the background, probably associated with pion interactions upstream of the DISC.



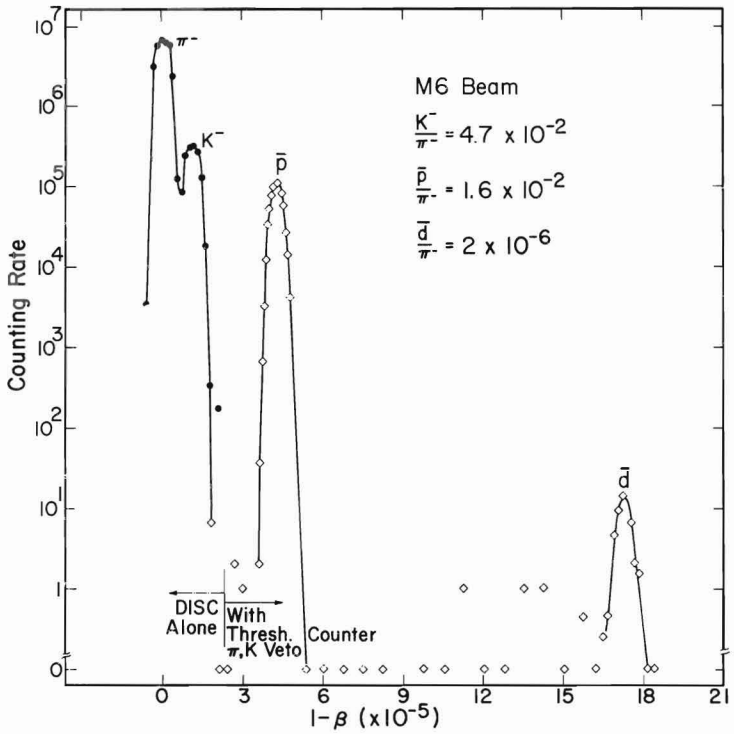
The DISC counting rate as a function of pressure or index of refraction shows the presence of negatively charged pions, kaons, and antiprotons.

The particle ratios for these data are listed on the figure.

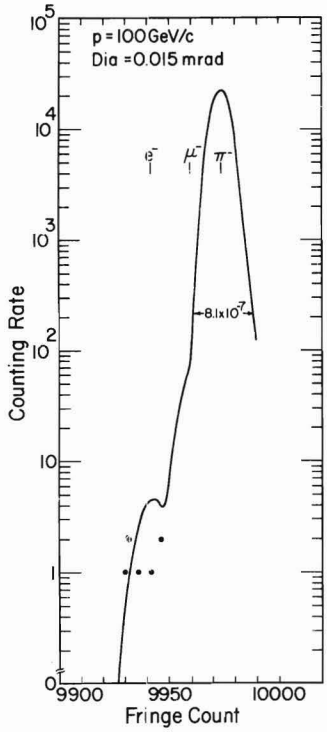
The ultimate velocity resolution of the counter was investigated by studying the shape of the pion peak for small sizes of the aperture of the diaphragm. On page 17, the resolution curve is shown for the diaphragm set to 0.015 mrad. The full width of this curve at 1% of the peak value is equivalent to $\Delta\beta = 7.5\times10^{-7}$, which agrees very well with the expected resolution at 100 GeV/c.

Even without taking into account the reduction by a factor of five of the multiple scattering contribution at 500 GeV/c, this curve shows that at 500 GeV/c, kaons would be separated from pions with a rejection ratio against the pions of better than 100 to 1.

The DISC Cerenkov counter successfully achieved its design



A mass search reveals only the expected known particles in a negatively charged 100-GeV/c beam. Notice the one-part-per-million of antideuterium present in the beam.



The resolution of the DISC is tested by setting a small diaphragm opening and measuring the width of the counting rate curve as the pressure is varied. The positions of negative electrons, muons, and pions are indicated. Their velocities differ by only one part per million.

performance values and is now being used for identification of charged particles over the wide range of particle masses and energies available at Fermilab.

Reported by J. Litt, R. Meunier, and S. Ecklund

FACILITY UTILIZATION SUMMARY -- NOVEMBER 1974

During November, the major emphasis of the experimental program was placed on neutrino research. The 15-foot bubble chamber, the External Muon Identifier apparatus, and the combined spark-chamber, calorimeter, and magnet array of the Neutrino #1A group were all employed to investigate interactions produced using the horn-focused neutrino beam. The major portion of the 300-GeV proton beam was fast-extracted and directed onto the wide-band horn target train for this work. Several continuing problems with electrical breakdown on the horn resulted in only a single horn working at an operating efficiency of about 70% over the month. Research continued at much lower priority in the Meson and Proton Areas, with 10 to 15% of the accelerated beam provided in the slow-spill mode.

Compared with October, the accelerator operated with slightly improved reliability (72%) and at a higher integrated accelerated proton intensity, although still short of the standards set during September. A major fraction of the difficulties occurred during the long Thanksgiving weekend. Some important discoveries were made at mid-month in establishing a relationship between present rf system parameters and the beam instabilities observed at high accelerated beam intensities in the main ring. Further studies of these phenomena should uncover a means for achieving higher accelerated and extracted beam intensities.

In the Neutrino Area, the users of the 15-foot bubble chamber filled with liquid hydrogen, 15' Neutrino #45A, EMI Test #155, and Antineutrino #31A were each scheduled for successive periods of running. Among them

a total of over 93,000 pictures were collected in November. In addition, p-p @ 300 GeV #343, running as a backup experiment, collected some 6,800 pictures during two intervals when the horn was not operational. The EMI #155 group ran parasitically during the #45A and #31A runs, while the Neutrino #1A group took data behind the bubble chamber whenever neutrino/antineutrino running was in progress. About 10^{18} protons were delivered on target for the neutrino program. This same beam was available to the Monopole #76 group which uses the horn target for their investigations. Other groups that used the beam for short periods included Super Heavy Elements #285 and Long Lived Particles #115; some time was also devoted to Engineering Run #234, to further engineering studies by the 15-foot bubble chamber operations group, and to some tests using the muon beam. Tachyon Monopole #202 continued to collect cosmic-ray data using the bubble chamber fringe field.

The Meson Area program involved thirteen experimental groups. Elastic Scattering #7, Elastic Scattering #69A, and Neutron Backward #12 collected data while Neutral Hyperon #8 and Photon Inclusive #268 essentially completed setup work and began to take preliminary data. Test runs were carried out by Photoproduction #87A, Super-Heavy Elements #147, Detector Development #229 and #261, and Di-Muon #337, while Hadron Jets #260 made use of beam for setting up and checking out equipment. Beam Dump #108 made two exposures on each of two targets and Nuclear Chemistry #81A exposed an additional four targets during the month. A major dislocation in the program occurred on November 8 when four septum magnets at the

upstream end of the M1 beam line overheated due to lack of cooling water; this failure shut down the beam line. The magnets were removed on November 14 and a single spare magnet from the M6 beam installed, permitting the operation of M1 at 50 GeV/c for Elastic Scattering #7 for the remainder of the month.

Two experiments and one engineering run comprised the research activity in the Proton Area during November. The group conducting the electron/photon beam tests in the Proton-East Area completed a successful run on the 11th. By the time the studies were concluded a beam of electrons had been transported into the Tagged Photon Laboratory at energies up to a maximum of 225 GeV. Work then immediately began in P-East to reinstall and put into operation the equipment and experimental apparatus for Photoproduction #87A. This work was completed in less than two weeks, permitting the experimenters to begin taking data on both photon and neutron production events during the last week of the month. Meanwhile in Proton Center, the Lepton #70 group collected data throughout November on electron, kaon, and muon production with their spectrometer arm set at 50 mrad.

Because of several helium cold-leaks in the gas jet target, it was not possible to carry out the tests planned for the p-N Inelastic #317 experiment in the Internal Target Area. Testing was therefore limited to short periods during which one of the rotating targets was used. Repairs of the leaks were continuing at the end of the month. On November 27, ground was broken for a new experimental area enclosure adjacent to the main-ring tunnel at C-0.

The Accelerator Utilization Summary for November is as follows:

I. Summary of Accelerator Operations

		Hours	
A. Accelerator use for physics research			
Accelerator physics research		55	
High energy physics research		440	
Research during other use		(47)	
	Subtotal		495
B. Other activities			
Accelerator setup and tuning to experimental areas		10	
Scheduled interruption		44	
Unscheduled interruption		171	
	Subtotal		225
C. Unmanned time		0	0
	Total		720

II. Summaries of High Energy Physics Research Use

	# of Expts.	Hours	Results
A. Counter experiments	12	2236	
B. Bubble chamber experiments	3	187	86,100 pictures
C. Emulsion experiments	1	2	Tests
D. Special target experiments	4	284	10 targets
E. Test experiments	5	388	16,690 pictures
F. Engineering studies and tests	3	164	346 pictures
G. Other beam use	-	32	
	28	3293	

III. Number of Protons Accelerated and Delivered ($\times 10^{17}$)

		Protons @ 300 GeV
A. Beam accelerated in main ring	Total	18.51
B. Beam delivered to experimental areas		
Meson Area		4.70
Neutrino Area		
Main beam		11.46
Bubble chamber beam (estimated)		0.14
Proton Area		0.35
	Total	16.65

IV. Beam Utilization by Experiment

	Hours	
A. Meson Area		
Elastic Scattering #7	297.8	
Neutral Hyperon #8	269.5	
Neutron Backward #12	399.2	
Elastic Scattering #69A	287.0	
Nuclear Chemistry #81A	-	4 targets
Photoproduction #87A Tests	30.2	
Beam Dump #108	3.2	4 targets
Hadron Jets #260	124.9	
Super-Heavy Elements #147	1.7	
Detector Development #229	14.3	
Detector Development #261	134.5	
Photon Inclusive #268	111.0	
Di-Muon Proposal #337 Tests	3.1	
B. Neutrino Area		
Neutrino #1A	278.4	$\int p = 8.7\times10^{17}$
15' Antineutrino/H_2 #31A	42.8	26,117 pictures
15' Neutrino/H_2 #45A	119.4	53,207 pictures
Monopole #76	278.4	1 target
Long-Lived Particles #115	5.5	
Tachyon Monopole #202	-	Cosmic-ray running
15' p-p @ 300 GeV #343	25.2	6,776 pictures
15' EMI Tests #155	195.3	13,999 pictures
15' Engineering Run #234	10.4	2,691 pictures
Super-Heavy Elements #285 Tests	1.9	1 target
C. Proton Area		
Lepton #70	370.6	
Photoproduction #87A/Di-Muon #358	88.6	
D. Internal Target Area		
p-N Inelastic #317	3.1	
	3096.0	

PROPOSALS RECEIVED DURING OCTOBER AND NOVEMBER 1974

No.	Title	Submitted By
340	The Electron-Photon Cascade Shower in Lead Absorber	S. Dake
341	Interactions of π^+ Mesons and Protons in a Hydrogen-Neon Mixture	W. Ko
342	Proposal to Study Neutral Pion Production in 200 GeV/c $\pi^- p$ Interactions in the 15-Foot Bubble Chamber with a Track-Sensitive Target	V. P. Kenney
343	Proposal to Study Neutral Particle Production in 250 GeV pp Interactions in the Fermilab 15-Foot Bubble Chamber	R. Engelmann
344	Proposal to Survey Central Collisions in the Reaction $\bar{p} + p \rightarrow$ Mesons between 30 and 60 GeV/c in the 30-In. Hydrogen Bubble Chamber at NAL	L. Gutay
345	Proposal to Study Multiparticle Production in 100 GeV/c Antiproton-Deuterium Interactions with the NAL 30-Inch Bubble Chamber	G. Ekspong
346	Search for Heavy, Shortlived Particles	G. Ekspong
347	Proposal to Measure the Elastic Scattering of Hadrons at Large Momentum Transfer	J. K. Walker
348	Proposal to Study Scattering of Muons from Protons and Deuterons at Momentum Transfers Up to $q^2 = 150 (\mathrm{GeV}/c)^2$	R. Wilson
349	Proposal for a Program of Muon Scattering at High Intensity	T. B. W. Kirk
350	A Proposal to Study π^0 and η Inclusive Production with Incident π^- in the Triple Regge Region	R. Kenney
351	K^0 Regeneration at the Highest FNAL Energies	S. H. Aronson
352	Proposal to Study Neutral Current Neutrino and Anti-Neutrino Interactions in the 15-Foot Bubble Chamber Using the EMI	M. L. Stevenson

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354	A Survey for Exotic Particles in the M1 Beam	T. Kycia
355	Measurement of Total ν, $\bar{\nu}$ Cross Sections at High Energies	B. Barish
356	Studies of Deep Inelastic Differential Distributions at High Energies for ν, $\bar{\nu}$ Beams	B. Barish
357	A Proposal to Search for Charmed Particles and Measurements of Two-Particle Inclusive Cross Sections at Large $P_{\perp}$	D. Meyer
358	Dimuon Production by Neutrons	W. Lee
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361	Precision Measurement of $\Lambda \rightarrow e^- \nu p$ Decay Parameters	R. March
362	Interaction of 200-400 GeV Pions with Emulsion Nuclei	P. Jain
363	A Proposal to Search for Charmed Particle Production Near Threshold	S. Olsen
364	A Proposal to Search for Charmed Particles Originating from the Interactions of 400 GeV/c Protons in Emulsion Nuclei	J. Sacton
365	A Proposal to Search for the Production of Charmed Mesons in πp Interactions	D. Garelick
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January 6, 1975	Computer Users Meeting, 4 p.m. in the Auditorium
January 17, 1975	Future Muon Program Workshop (see NALREP September and October issues for details).
January 25, 1975	Fermilab Art Series: Fine Arts Quartet. Tickets available in Guest Office.
February 20, 1975	Deadline for receipt of material to be considered at the spring meeting of the Fermilab Program Advisory Committee.
March 20-22, 1975	Spring meeting of the Fermilab Program Advisory Committee.
March 21, 1975	Fermilab Art Series: An Evening of Dance. Tickets available in Guest Office.
March 30, 1975	Requests for summer housing should be received in the Housing Office.