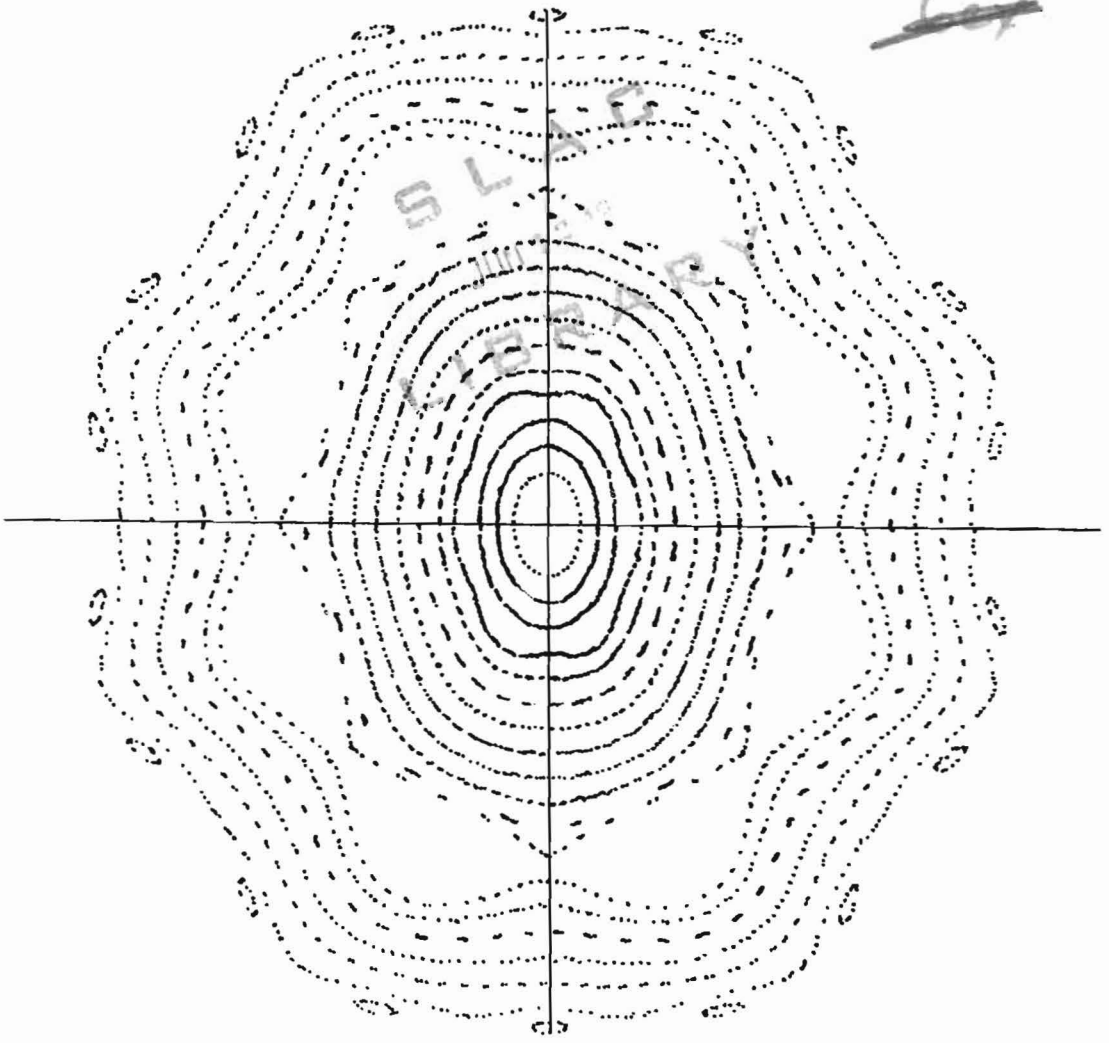
NALREP



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Monthly Report of the Fermi National Accelerator Laboratory

May 1975

Fermi National Accelerator Laboratory

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

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FERMILAB-75-5 0090.01

The Cover: Fermilab's beautiful future is illustrated by this phase diagram for a proton beam colliding with a very strong proton beam. This computer study of beam blow-up in POPAE, our proposed 1000-GeV storage rings, shows a stable beam with many benign resonances.

Operated by Universities Research Association Inc. under contract with the Energy Research and Development Administration

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THE SINGLE ARM SPECTROMETER

Data taking for Elastic Scattering #96, an experiment measuring the cross sections for pion-proton, kaon-proton, proton-proton, and antiproton-proton elastic and quasielastic scattering, was finished in February 1975. This marked the successful completion of the program undertaken by the Single Arm Spectrometer (SAS) collaboration to create a high energy, high resolution beam line and spectrometer system in the Meson Area, and to perform the commissioning experiment. The collaboration, consisting of nine laboratory and university groups, was organized in 1970 by Fermilab as a merger between those proposing or expressing interest in spectrometer measurements. The spectrometer design and initial physics objectives were studied and developed in workshop sessions which culminated in the proposal for Elastic Scattering #96. D. R. Ritson was appointed Spokesman for this collaborative effort.

The individuals who participated in the designing and building of the SAS and in Elastic Scattering #96 included:

From Argonne National Laboratory: D. S. Ayres, R. Diebold, G. J. Maclay
From Brown University: D. Cutts, R. E. Lanou, L. J. Levinson, J. T. Massimo
From CERN: J. Litt, R. Meunier
From Cornell University: B. Gittelman, E. Loh, M. Sogard
From Fermilab: A. E. Brenner, D. Carey, J. E. Elias, G. Mikenberg
From Instituto di Fisica, Bari, Italy: E. N. Anelli, C. DeMarzo, P. Lavopa, G. Maggi, F. Posa, G. Selvaggi, P. Spinelli, F. Walner
From Massachusetts Institute of Technology: D. Barton, J. Butler, J. Fines, J. I. Friedman, H. W. Kendall, B. Nelson, L. Rosenson, R. Verdier
From Northeastern University: B. Gottshalk
From Stanford University: R. L. Anderson, K. Brown, D. Gustavson, D. R. Ritson, G. A. Weitsch.

The milestone dates in the development of the M6 beam line and the SAS installation can be summarized briefly as follows:

Approval of Elastic Scattering #96 proposal	December 1970
Signing of experimental agreement	November 1971
Completion of M6 beam line through the second focus	April 1973
First beam delivered through M6 beam line and the SAS installation	October 1973
Installation of hydrogen targets, beam dump, and scattering angle bends, M6 and SAS completed	February 1974
Start of Elastic Scattering #96 data taking	April 1974
Completion of data taking	February 1975

As one indication of the size and scope of the installation, the beam and spectrometer complex in the Meson Area extends over 1970 feet from the production target to the final muon detection counter. The SAS itself is housed in a narrow enclosure which extends 500 feet north of the Meson Detector Building, while the M6 beam line lies in the tunnel beneath the earth berm of the Meson Area muon shield. Only the experimenters' liquid hydrogen target, the beam stop, and the scattering angle magnet system are located in the Detector Building. The beam and spectrometer system contains 62 magnets: 28 quadrupoles, 19 main-ring dipoles, 13 vernier dipoles, and 2 sextupoles. The particle detection apparatus includes 144 scintillation counters, 16 planes of multiwire proportional counters, and 7 high pressure gas Cerenkov counters, as well as over 50 miles of coaxial cable. The system is operated by two computer systems, the Meson Area MAC-16 system which controls the beam line, and an on-line PDP-11 system which records data and monitors the particle detection instrumentation.

Some of the design criteria imposed for the M6 secondary beam, namely the requirements for high resolution, high flux, and very small halo,

were intended to provide a suitable beam for spectrometer operation. The final beam configuration has three stages with two intermediate foci. Each stage has point-to-parallel-to-point optics with the bends situated in the parallel regions to maximize the momentum resolution. This technique meets the design criteria, and also simplifies most of the tuning adjustments, making possible noninteractive, noniterative tuning procedures.

A schematic representation of the first stage of the M6 beam is shown below. Except for the initial septum magnets, it depicts the optics for any of the three stages. In the first stage, the secondary particle production angle with respect to the incident extracted proton beam, is established by fixed collimators, the angular acceptances are defined by the f-stop variable collimators, and the momentum bite is imposed by the momentum stop collimator at the first focus. At the first focus the beam spot is very small vertically, but highly dispersed horizontally.

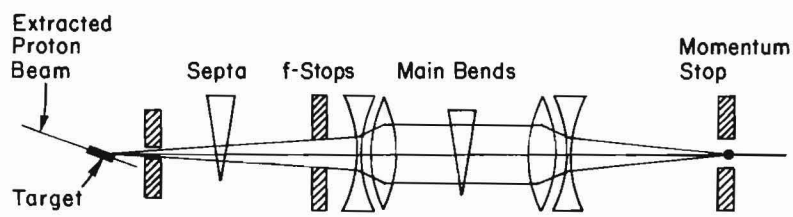


Diagram of the first stage of the M6 secondary beam in the Meson Area. Maximum values for the acceptance are $\Delta\theta = \pm 0.56$ mrad, $\Delta\phi = \pm 0.76$ mrad, and $\Delta P/P = \pm 0.60\%$. Horizontal and vertical magnifications are 1.7 and 2.7, respectively, and the divergence is 6.33 cm/%.

The second stage of the M6 beam serves mainly as a filter to remove the halo produced in the first-stage collimators. At the second focus, a 30-element scintillation counter array provides a determination of the momentum of each particle.

In the third stage, the dispersed beam is momentum-recombined and focused onto the hydrogen target as a point spot. In addition to the second-focus momentum hodoscope, the third stage of the M6 beam is instrumented with hole counters for halo suppression, trigger counters for event selection, two pairs of X-Y hodoscopes for tagging incident particle trajectories, and three gas Cerenkov counters for particle identification. A diagram of this stage is shown below.

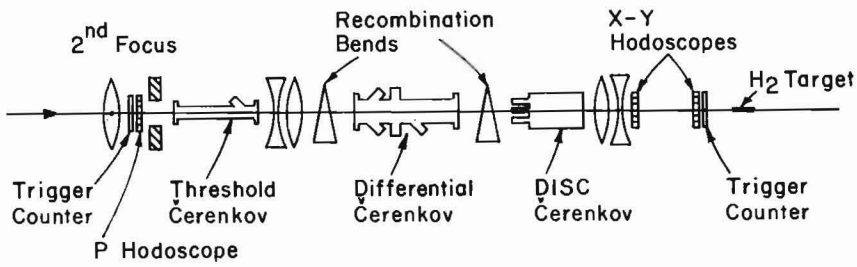


Diagram of the third stage of the M6 beam, including particle identification, trajectory, and momentum tagging instrumentation.

Since the SAS is placed at 0° to the M6 beam line and does not pivot about the third beam focus to vary the scattering angle, it can be considered essentially as the fourth stage of the M6 beam. From this perspective, the SAS is a point-to-parallel-to-point beam stage with quadrupole triplet lens systems instrumented as both a particle production and a particle tagging stage. A diagram showing the SAS components is shown on page 5.

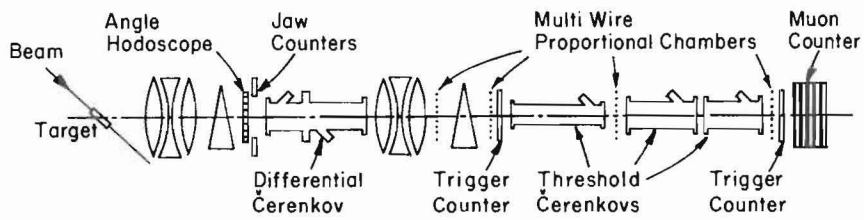
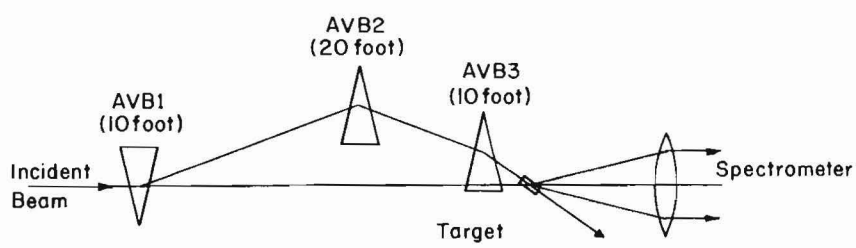


Diagram of the SAS instrumentation.

For interactions in the liquid hydrogen target at the third focus, the angle between the incident beam and the SAS is varied by magnetic deflection of the incident beam. A system of three main-ring bending magnets just upstream of the target is used to pitch the incident beam in the vertical plane as shown below. The last two magnets are supported by adjustable jack stands, remotely operable, which keep them centered on the beam axis as the angle is varied. The height of the trigger counter and the X-Y hodoscope located between the last two pitching magnets is also remotely adjustable, while the hydrogen target simply pivots about its center to track beam-angle variations.



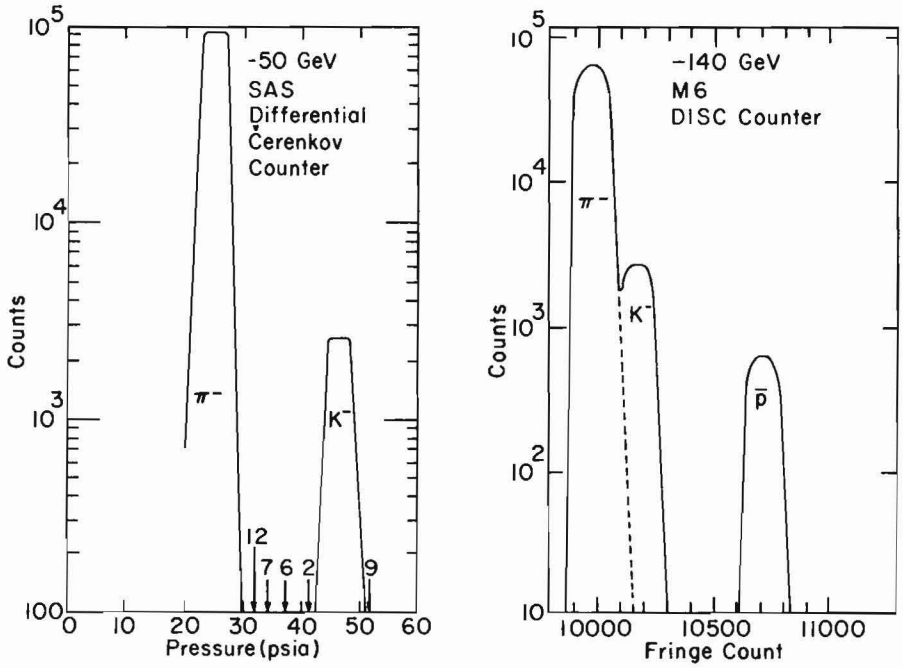
Variation of the SAS scattering angle by magnetic deflection of the incident beam.

Stability and repeatability of the pitching magnet settings, as well as the beam and spectrometer momentum settings, is continuously monitored with magnetic field probes located in 3-foot long monitor magnets. These magnets are connected in series with the appropriate beam line and SAS magnet elements. In addition, scattering measurements are made symmetrically using the pitching magnets to deflect the beam both up and down in order to eliminate the systematic effect of any angle offset between the beam and the spectrometer.

A set of gas Cerenkov counters in both the SAS and the third stage of the M6 beam line provides complete tagging of particle type (pion, kaon, or nucleon) on an event-by-event basis for incident and outgoing particles separately. In principle, data on nine different reactions can be taken simultaneously, although in practice the relative rates for some of the reactions are extremely small. Electrons and muons in the beam are not tagged event by event, but may be measured separately when necessary using a lead-scintillator sandwich shower counter and a muon range counter. Typical lepton fluxes at +70 GeV/c are 0.6% positrons and 1.6% muons.

In the beam line, the threshold counter, the differential counter, and the DISC counter are nominally pressurized to respond to pions, nucleons, and kaons, respectively. The SAS is equipped with three threshold counters and a differential counter which is normally set to respond to nucleons. Two strategies for pion-kaon separation have been used in Elastic Scattering #96. For energies less than 150 GeV/c the longest of the threshold counters was set for pions and the two shorter counters were pressurized to respond to

both kaons and pions. A kaon event triggered two of the counters while a pion event triggered all three, providing the signature. At higher energies, when the efficiency of the threshold counters for pions becomes a problem, all three counters were set for pions to regain high detection efficiency, and the signal from the antimirror in the differential counter was used as the pion-plus-kaon trigger. Good rejection ratios ($>10^4$) were realized for the kaon trigger at all energies using these techniques. Typical pressure curves for two of the differential counters are shown below.



Typical Cerenkov pressure curves for the SAS differential counter and the M6 beam line DISC counter taken during Elastic Scattering #96 running.

Information about the trajectory and momentum of scattered particles is provided by ten multiwire proportional chambers located at four places

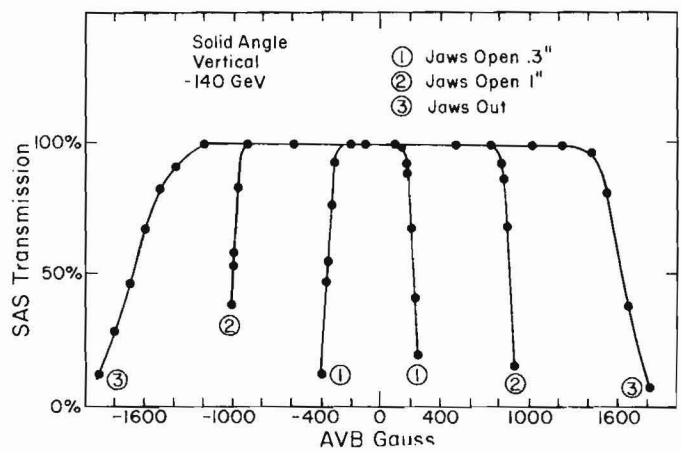
along the SAS and by a vertical-angle scintillator hodoscope situated in the focal plane of the front quadrupole lens system. Four remotely adjustable jaw counters establish the horizontal and vertical angle bites separately, and two trigger counters select events. At the downstream end of the SAS, a lead-scintillator sandwich shower counter identifies electrons, and twelve interaction-lengths of iron interspersed with scintillation counters identify muons.

An on-line PDP-11 computer system serves both to record data directly onto magnetic tape for later off-line analysis, and to monitor the M6-SAS instrumentation and detectors in detail throughout the course of a measurement. Using the straight-through beam, on-line determinations of basic parameters such as efficiency, focal quality, and resolution are readily obtainable.

The fact that the incident beam can be sent directly down the spectrometer at 0° greatly facilitates calibrating the SAS. By varying the appropriate beam or spectrometer parameters, the calibration constants can be measured directly. For example, the dispersion coefficient at the momentum focus can be determined by varying the current in the SAS magnet elements with the incident beam momentum spread set at a small value, 0.05%. Absolute calibration of the momentum is provided by the DISC counter to about 0.1%, as the index of refraction of the counter gas is determined continuously with a laser interferometer.

Measurements of the solid-angle coefficients can also be made directly using the scattering angle pitching magnet system. If the final lens system

in M6 is turned off, the beam incident on the SAS is parallel, and will be brought to a point focus in the focal plane of the SAS front lens system where the jaw counters are located. Varying the angle of the incident beam with the pitching magnets causes the image to sweep across the plane of the jaw counters, thus providing a direct determination of the solid-angle coefficient. An example of this procedure is shown below.



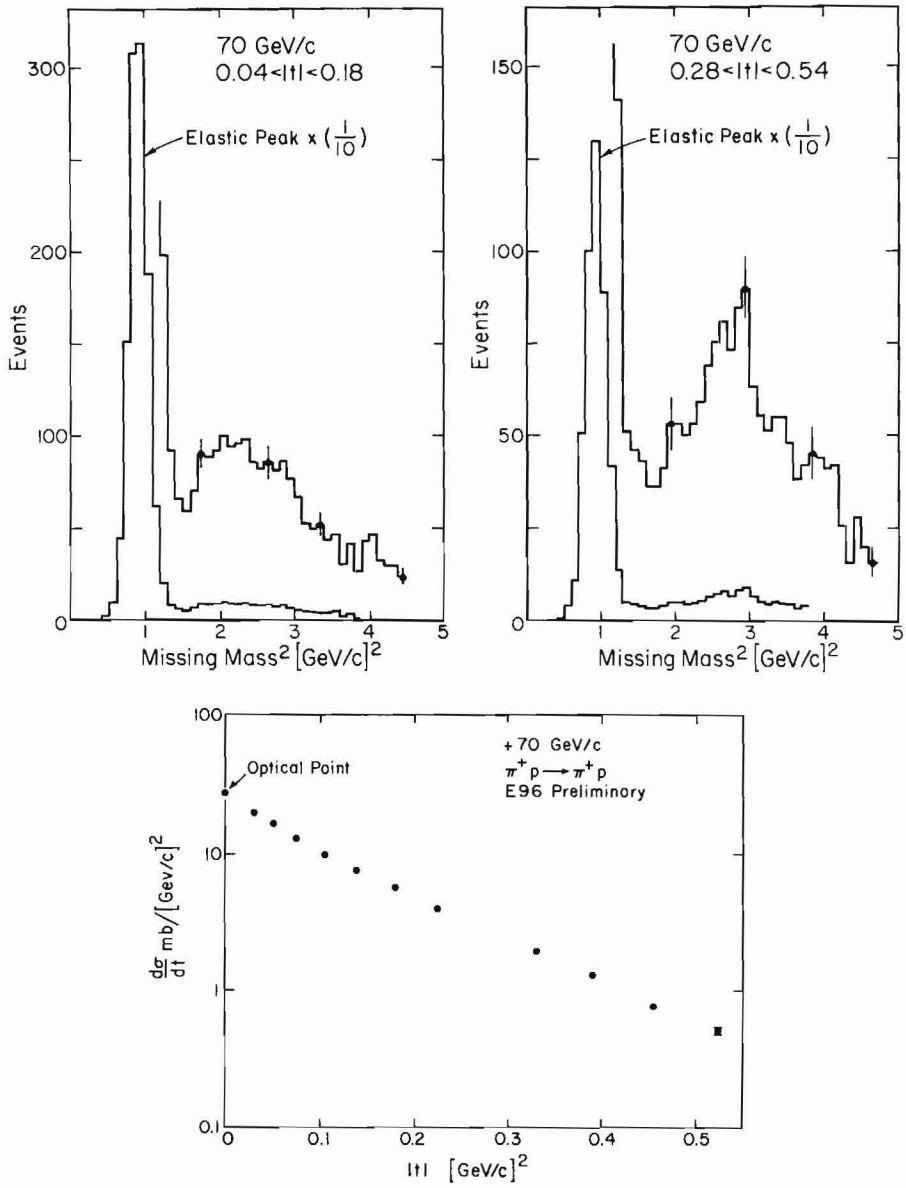
Curves of 0°-SAS transmission through the aperture-defining jaw counters for three settings of the jaws (0.305 inch, 1.000 inch, and fully open) as a function of the incident beam angle measured in field strength of the pitching magnets. The ratio of the FWHM for curves 1 and 2, 570 G/1860 G = 0.306 compared with the ratio of the jaw openings, 0.305, is a check on the measurement. Curve 3 shows the physical aperture of the SAS as defined by the magnets when the counter jaws are fully open.

The present performance of the M6 beam and spectrometer installation compared with the objectives listed in the original proposal for Elastic Scattering #96 can be summarized as follows:

Parameter	Design	Actual
Momentum resolution at 200 GeV/c	0.032%	0.07%
Solid-angle acceptance		
At 200 GeV/c	8.5 μster	5 μster
At 60 GeV/c	20 μster	12 μster
Momentum acceptance	4%	4.5%
Momentum dispersion	3 cm/%	3.7 cm/%
Angular resolution	0.1 mrad	0.1 mrad
Maximum momentum	200 GeV/c	175 GeV/c

The momentum resolution has been found to be limited by power supply regulation, chromaticity of the second beam focus, and multiple scattering effects. The present resolution studies indicate that performance at the design level could be realized by adding sextupole magnets in the second beam stage and improving power supply regulation. Multiple scattering effects would still limit the resolution at energies below 100 GeV. Decreasing the solid angle to 5 μster was a compromise made to gain a larger acceptance of particles from the target. This is important at large angles where the apparent size of the target (source of the SAS flux) is determined not by the incident beam size, but by the effective target height (the target length times the scattering angle). It is possible to increase the solid angle of the SAS, but only by trade-off compromises involving the limits on other variables such as momentum resolution, projected target height, or maximum momentum.

To further illustrate the performance of the SAS thus far, typical results from Elastic Scattering #96 are presented on page 11. Both the "raw" missing mass data from the on-line results and the corresponding cross sections determined by detailed off-line analysis are included. The momentum resolution is adequate to separate elastic from inelastic events at both t-ranges shown.



Missing mass squared spectra at +70 GeV/c for elastic and near elastic scattering in two t-ranges, 0.04 to 0.18 (upper left) and 0.28 to 0.54 (upper right), and the pion-proton elastic cross section (lower) from the same data. In the lower figure, the fine mesh scattering angle information has been combined into larger bins to increase the statistical accuracy of individual points and clarify the graphic presentation.

In conclusion, the M6-SAS complex has been constructed and developed to the level at which high-resolution high-precision physics measurements have been successfully carried out on a time scale that is quite early in the life of an accelerator laboratory. Second-generation experiments being prepared for the SAS facility, Associated Production #99 and Inclusive Scattering #118 in particular, contain challenging aspects which will test the momentum resolution power and the Cerenkov rejection power even more strongly than did Elastic Scattering #96.

Reported by J. E. Elias

NOTES AND ANNOUNCEMENTS

APPOINTMENTS . . .

J. Ritchie Orr has been appointed an Assistant Director of the Laboratory, and has joined the Directorate. A major portion of his time will be devoted to problems linking the Directorate to the three technical divisions of the Laboratory--Accelerator, Research, Administrative--and to problems which straddle two or more divisions.

Drasko Jovanovic has joined the Research Division as an Assistant Head.

NEW HOURS . . .

The Users Center, which offers a variety of activities, is now open from 5:00 p. m. to midnight, Monday through Friday. It is closed on weekends.

FACILITY UTILIZATION SUMMARY--APRIL 1975

During the first three weeks of April the Fermilab research program continued in all experimental areas, with the accelerator operating at 300 GeV. In that time, beam was delivered for 287 of the 389 hours actually scheduled for high energy physics research. A three-week shutdown for maintenance and development work began on April 21. Originally, this shutdown had been planned so that the repaired 100-MW main-ring pulse transformer could be reinstalled at the substation. However, delays in the repair work and finally an internal short to ground which developed during high voltage testing of the transformer led to the cancellation of that portion of the accelerator improvement program. The shutdown took place as planned so that the rebuilding of the proton beam elements to the Meson Area could be completed.

In the first two days of the shutdown, booster studies (with the goal of higher energy operation) were performed on the day shift and main ring and power supply studies took place at night. Magnet regulation and rf voltage problems limited the maximum operating energy of the booster to 8.5 GeV. On April 23, the main site power load was switched to the Giese Road backup substation to permit maintenance of the 345-kV switchgear, while contractor work began on the replacement of all damaged main-ring electrical feeder cables and the connection of switchgear terminations for a planned future superconducting transmission line. Accelerator maintenance and development projects which were underway at the end of April included installation of the new left bend magnet line to upgrade the Meson Area to 400-GeV operating

capability, major additions and improvements in both the booster and main-ring rf systems, improvements in the injection and extraction systems for the booster (to enable higher intensity operation), improvements in the 200-MeV transport system, a general upgrading of the main-ring magnet system, and consolidation of the main control room operating console arrangement.

During the three-week period devoted to the high energy physics research program, twelve experimental groups used the beam available in the Meson Area. Pion Dissociation # 86A, Form Factor # 216, Photon Inclusive # 268, Beam Dump # 108, Particle Search # 366, K^0 Regeneration # 82, and Elastic Scattering # 69A were all taking data, while Muon Search # 335, Particle Search # 330, and Hadron Jets # 260 were setting up, testing equipment, and taking preliminary data during the brief periods of time they used beam. Test Hadron Jets # 246 was engaged in detector module calibrations throughout most of this period, and Nuclear Chemistry # 81A parasitically exposed four more targets in the primary proton beam in Meshall. During the shutdown period, major alterations were made in the M2 beam line in preparation for a new generation of experiments; equipment installation work went on in the beam tunnels and other secondary beam lines as well.

In the Neutrino Area, the program was focused on neutrino and anti-neutrino experiments using the 15-foot bubble chamber filled with a 21% neon, balance hydrogen, mixture. Installation of the two-horn trainload and repairs to the main beam dump were completed during the first several days of the month. This was followed by a few days of beam and chamber tuneup before

a 50,000-picture run with one-turn extraction began for Experiment #28A. The horn polarity was then changed and ceramic beam plugs installed, after which the system was operated until the shutdown and some 27,000 additional pictures were accumulated for Experiment #180. Particle Search #369 used low intensity slow spill throughout this period for initial setup and test work in the Muon Laboratory, by tuning the muon beam for hadrons, first from the horn target and later, during the antineutrino run, from a target in the bypass beam. The Neutrino #310 group operated parasitically in this beam to test their "gamma catchers," while Neutrino #1A collected data parasitically to bubble-chamber operation, particularly during the antineutrino running. During the first week of the major shutdown, the 15-foot bubble chamber was pulsed and measurements of vibration amplitudes and frequencies were made in an attempt to analyze and understand several abnormal operating characteristics observed during the operation with the neon-hydrogen mixture. Work on the horn target was deferred to permit radiation cooldown.

There was activity in all three Proton Area beam lines during April. Installation of all components for the triple-splitting station was completed on April 4; on that evening a three-way split beam was monitored and recorded in the Proton East, Central, and West beam lines in Enclosure H. During the following two and one-half weeks, Di-Lepton #288 used the beam in Proton Central to set up and test counters and other apparatus, while the electron beam produced in the Proton East target area was tuned and transported into the Tagged Photon Laboratory so that equipment could be checked and tuned up. The triple splitting station was operated again in the 12 hours

just prior to the major shutdown, and beam was transported through the new quadrupole enclosures and into the Proton West target area as a test, while beam was maintained into the other two lines. Work during the shutdown was devoted primarily to installing additional experimental equipment in the Proton East and Central areas, while outside contractors continued construction work on the Proton West quadrupole enclosures.

In the Internal Target Area, Particle Search # 363 took data for one week early in April, using the upstream rotating filament target. The remainder of the running time was available for background tests and preliminary data taking with the hydrogen gas jet by the Proton-Nucleon Inelastic # 317 group. As in previous months, this work was restricted to evening and weekend shifts because of the construction work at C-Zero associated with the building of the recoil room. After suspension of accelerator studies on April 23, work was immediately begun to break through the outside wall of the main-ring tunnel in order to complete construction of the transition area connecting the Main Ring and the new room for the Internal Target Area.

The summary of facility utilization for the month of April is on pages 18 and 19.

I. Summary of Accelerator Operations

		Hours	
A.	Accelerator use for physics research		
	Accelerator physics research	38	
	High energy physics research	287	
	Research during other use	(54)	
	Subtotal		325
B.	Other activities		
	Accelerator setup and tuning to experimental areas	7	
	Scheduled interruption	279	
	Unscheduled interruption	109	
	Subtotal		395
C.	Unmanned time		0
	Total		720

II. Summaries of High Energy Physics Research Use

		No. of Expts.	Hours	Results
A.	Counter experiments	19	1910	
B.	Bubble chamber experiments	2	161	78,198 pictures
C.	Emulsion experiments	0	-	
D.	Special target experiments	1		4 targets
E.	Test experiments	0		
F.	Engineering studies and tests	4	130	1162 pictures
G.	Other beam use	-	53	Beam tuning
		26	2254	

III. Number of Protons Accelerated and Delivered ($\times 10^{18}$)

			Protons
A.	Beam accelerated in Main Ring	Total	1.25
B.	Beam delivered to experimental areas		
	Meson Area		0.46
	Neutrino Area		
	Main beam		0.63
	Bubble chamber beam (estimated)		0.01
	Proton Area		0.01
		Total	1.11

IV. Beam Utilization by Experiment

	Hours	
A. Meson Area		
Elastic Scattering # 69A	182.4	
Nuclear Chemistry # 81A	-	4 targets
K^0 Regeneration # 82	195.7	
Pion Dissociation # 86A	67.9	
Beam Dump # 108	107.0	
Form Factor # 216	165.8	
Test Hadron Jets # 246	87.6	Tests
Hadron Jets # 260	33.4	
Photon Inclusive # 268	164.8	
Neutron Dissociation # 305	6.3	
Particle Search # 330	40.2	
Muon Search # 335	18.3	
Particle Search # 366	268.0	
B. Neutrino Area		
15' ν/H_2 & Ne # 28A	99.1	50,455 pictures
15' $\bar{\nu}/H_2$ & Ne # 180	62.5	27,743 pictures
Neutrino # 1A	71.3	
Tachyon Monopole Search # 202	-	Cosmic ray running
Neutrino # 310	19.0	Tests
Particle Search # 369	158.0	Tests
C. Proton Area		
Di-Lepton # 288	137.3	
D. Internal Target		
Proton-Nucleon Inelastic # 317	133.4	
Particle Search # 363	53.2	
Total	2071.2	

MANUSCRIPTS AND NOTES PREPARED DURING MARCH AND APRIL 1975

Copies of preprints with Fermilab publication numbers can be obtained from the Publications Office or Theoretical Physics Department, 3rd floor east, Central Laboratory. Copies of all articles listed are on the reference shelf in the Fermilab Library.

Experimental Physics

A. Benvenuti et al. Experiment #1A	Simply Focused Neutrino Beams (FERMILAB-Conf-75/30-EXP; submitted to the International Colloquium of the CNRS on "Neutrino Physics at High Energy," Paris, France, March 18-20, 1975)
B. Aubert et al. Experiment #1A	Hadron Production at 0.8 Mrad by 300 GeV Protons Incident on a Thick Aluminum Target (FERMILAB-Conf-75/31-EXP; submitted to the International Colloquium of the CNRS on "Neutrino Physics at High Energy," Paris, France, March 18-20, 1975)
V. E. Barnes et al. Experiment #2B	K^+p Interactions at 100 GeV Using a Hybrid Bubble Chamber-Spark Chamber System and a Tagged Beam (Submitted to Phys. Rev. Letters)
B. Y. Oh et al. Experiment #2B	Two Particle Correlations in the Central Region of pp and π^-p Interactions at 100-300 GeV/c (Submitted to Physics Letters B)
W. Morris et al. Experiment #2B	Study of the Energy and Charged Multiplicity Dependence of Inclusive π^- Production in π^-p Interactions Up to Fermilab Energies (Submitted to Physics Letters B)
P. H. Eberhard et al. Experiment #3	Improvements of a Magnetic Monopole Detector (Submitted to Review of Scientific Instruments)
V. Bartenev et al. Experiment #36	The Total Elastic Proton-Proton Cross Section from 9 to 300 GeV/c [Submitted to Yad. Fiz. (Sov. J. Nucl. Phys.)]
D. C. Carey et al. Experiment #63	Evidence for Radial Scaling in a New Kinematic Range (FERMILAB-Pub-75/20-EXP; submitted to Phys. Rev. Letters)
Y. W. Yu et al. Experiment #81A	Nuclear Reactions of ^{238}U with 300- and 11.5-GeV Protons: Formation of Nuclides in the A-110-140 Mass Region (Submitted to Phys. ReV. C)

J. Knauer et al. Experiment #87	Photoproduction of Narrow Resonances (Submitted to Phys. Rev. Letters)
B. Knapp et al. Experiment #87	Dimuon Production by Neutrons (Submitted to Phys. Rev. Letters)
C. Bromberg et al. Experiment #'s 138 and 252	The Charge Structure of Multiparticle Final States in pp Collisions at 102 and 400 GeV/c (Submitted to Phys. Rev.)
K. Niu et al. Experiment #156	X-Particle Production in 205 GeV/c Proton Interactions
M. I. Tretyakova et al. Experiment #183	Interactions of 200 GeV/c Protons with Emulsion Nuclei. Charged Particle Multiplicities
D. Bintinger et al. Experiment #184	A Limit on the Production Cross Section for Massive Leptons (Submitted to Phys. Rev. Letters)
L. C. L. Yuan Experiment #229	Some New Developments on Transition Radiation Detectors for High-Energy Particles (Invited talk at the ESRO Workshop, Frascati, Italy)
L. C. L. Yuan et al. Experiment #229	Observation of Transition Radiation from Pions at 100-250 GeV (Submitted to Phys. Rev. Letters)
L. C. L. Yuan et al. Experiment #229	Transition Radiation from Electrons at 50 GeV (Submitted to Phys. Rev. Letters)
J. P. DeBrion et al. Experiment #252	Production of $\Delta(1236)$ in pp Collisions at High Energies (Submitted to Phys. Rev. Letters)
C. Bromberg et al. Experiment #252	The Charge Structure of Multiparticle Final States in pp Collisions at 102 and 400 GeV/c (Submitted to Physical Review)
P. L. Jain et al. Experiment #255	A High Energy Test of Quantum Electrodynamics (Submitted to Physical Review)

Theoretical Physics

M. B. Einhorn and C. Quigg	Nonleptonic Decays of Charmed Mesons: Implications for e^+e^- Annihilation (FERMILAB-Pub-75/21-THY; submitted to Phys. Rev.)
S-J. Chang et al.	Chiral Confinement: An Exact Solution of the Massive Thirring Model (FERMILAB-Pub-75/22-THY; submitted to Phys. Rev.)

General

K. C. Seino	Low Drift Instrumentation Amplifier--IC Amplifier? Modular Amplifier? Build One with Op Amps? (Submitted to Electronics)

Physics Notes

A. F. Greene et al. FN-273	A Survey of the Fermilab Research Program

DATES TO REMEMBER

June 14, 1975	Fermilab Auditorium Arts Series: The Edwardians. Tickets available in Guest Office.
June 21-27, 1975	Summer meeting of the Fermilab Program Advisory Committee.
July 1, 1975	Requests for fall housing accommodations, including dormitory rooms and family residences, should be received in the Housing Office.