UCRL 9058

UNIVERSITY OF CALIFORNIA

Ernest O. Lawrence

Radiation Laboratory

BEVATRON OPERATION AND DEVELOPMENT. XXIII

AUGUST, SEPTEMBER, OCTOBER 1959

BERKELEY, CALIFORNIA

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TID-4500 (15th Ed.)

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BEVATRON OPERATION AND DEVELOPMENT. XXIII AUGUST, SEPTEMBER, OCTOBER 1959

Walter D. Hartsough

March 1960

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August, September, October 1959

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March 1960

ABSTRACT

An external proton beam was achieved this quarter. The properties of this beam were studied and several emulsion exposures were made.

A new secondary beam facility was completed at the north experimental area.

This quarter the following particle physics program was carried out: Bubble chambers were used to study p-$\bar{p}$ interactions and K^+ decay modes and interactions; counter experiments were done to determine the $\pi^{\pm}$ - nucleon total cross section, the decay modes of Σ^+ and Λ^o particles, π^+-p interactions, and $\theta_1 - \theta_2$ mass difference. Eighteen emulsion exposures to primary and secondary beams were made for seven external groups. Fifteen target bombardments were made in the primary proton beam for the Chemistry Department.

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EXPERIMENTAL FACILITIES

Quadrant-Mounted Targets

Table I lists the quadrant-mounted targets available during this quarter.

Lengthened Rapid-Beam-Ejector Pulse

(Glen Lambertson)

The pulsed magnet of the rapid beam ejector[1, 2, 3] was modified to lengthen by a factor of ten the beam pulse produced by this device; the new beam pulse is about 250 μsec long. The change was made to improve the efficiency of striking small-area targets (< 1 cm^2) and to reduce problems of particle counting during the pulse. The 250-μsec pulse was judged to be as long as bubble chamber operation would allow.

To produce the longer pulse, each turn of the original two-turn coil was replace with an 11-turn coil (See Fig. 1) of RG-17/AU cable with shield removed. The capacitor bank remains unchanged at 120 μf and the current pulse now rises to a maximum of 5500 amp in 500 μsec. With this lower peak current, the system operates with only one of the two originally installed ignitrons in series with the capacitor.

Operation of the rapid beam ejector has been simplified by the change to a longer, lower current pulse. Maintenance problems are few and performance and monitoring have improved greatly.

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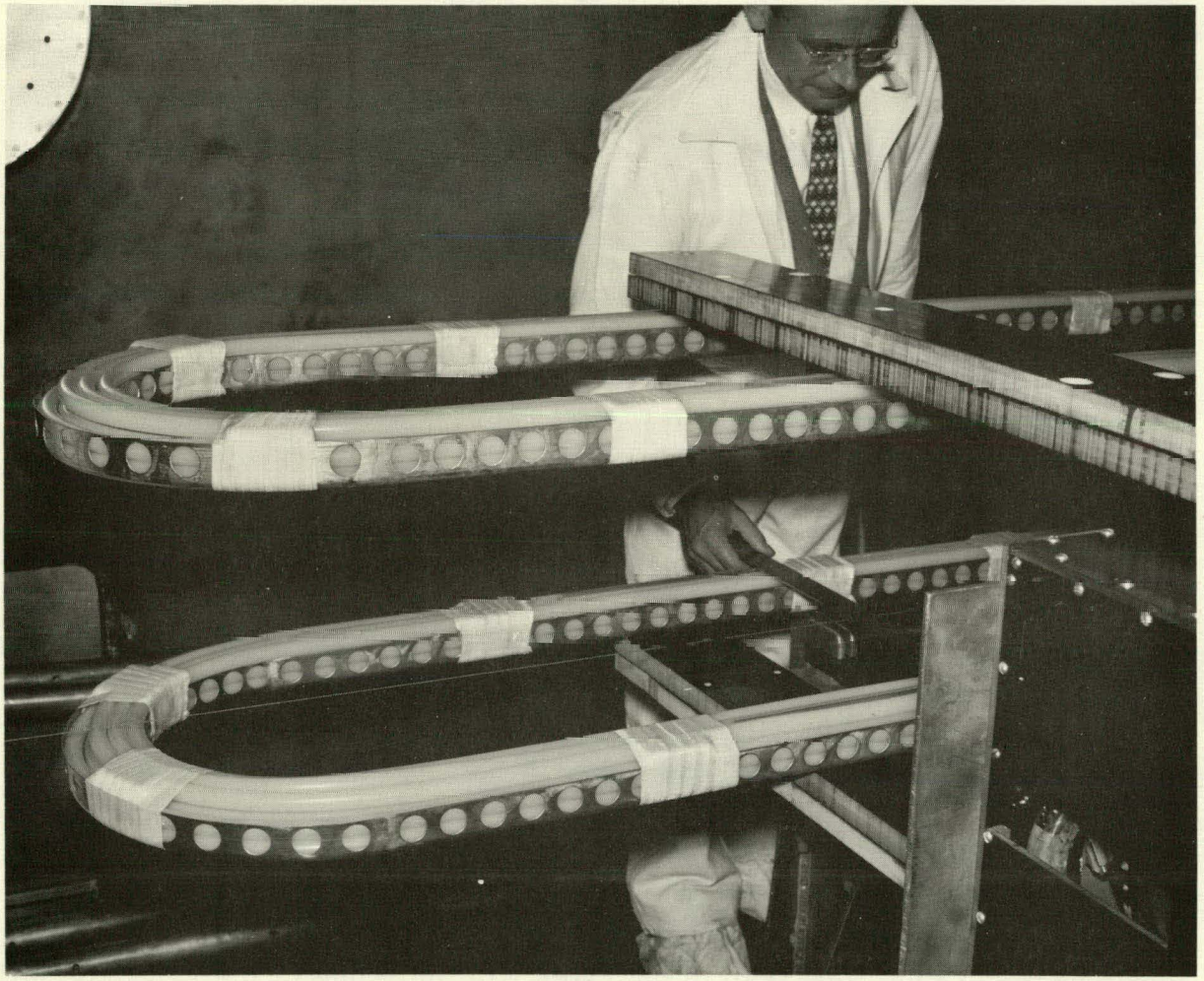
[1] Bevatron Operation and Development. XV. UCRL-8114, Jan. 1958.

[2] Bevatron Operation and Development. XVII, UCRL-8334, June 1958.

[3] Charles G. Dols, The Electrical System of the Bevatron Rapid Beam Ejector (Beam Kicker). UCRL-8346, July 1958.



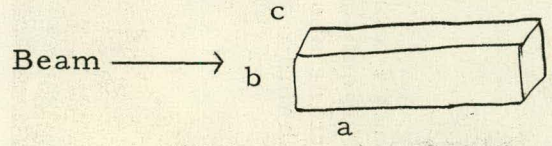
ZN-2397

Fig. 1. New rapid beam ejector coils during installation in the south straight section.

TABLE I

Quadrant-mounted targets, August 6, 1959 to end of quarter

Quadrant	Azimuthal location (Ref: entrance end of quadrant) (deg min)		Radial location: Outer-radius edge of target (in.)	Radial location: Outer-radius edge of lip (in.)	Target material	Target size a x b x c (in.)
III	19	36	599-3/8	599-1/2	Aluminum	5 × 1/8 × 1/2
III	19	36	599-5/16	599-7/16	Aluminum	5 × 1/8 × 1/2
III	22	21	599-3/8	599-1/2	Aluminum	5 × 1/8 × 1/2
III	23	38	*596 596-1/16	*596-1/8 596-3/16	Aluminum	5 × 1/8 × 1/2
III	23	38	*596 595-3/8	*596-1/8 595-1/2	Aluminum	5 × 1/8 × 1/2
III	72	29	*597-3/4 597-13/16	*598-1/8 598-3/16	Copper	3 1/2 × 1/2 × 1/2
III	72	36	*597-3/4 597-13/16	*598-1/8 598-3/16	Copper	3 1/2 × 1/2 × 1/2
III	75	30	599-1/2	599-3/4	Graphite	2 35/64 × 1 × 4
III	76	08	599-1/2	599-3/4	Graphite	2 35/64 × 1 × 4
IV	16	23	599-5/16	599-9/16	Graphite	2 35/64 × 1 × 4
IV	17	01	599-7/16	599-11/16	Graphite	2 35/64 × 1 × 4



*September 15, 1959 to end of quarter

New Secondary-Particle Beam Facility at the North Straight Section

Figure 2 is a simplified schematic of a new secondary-particle beam facility at the north experimental area. Target and beam port (vacuum extension and vacuum gate valve) are shown. Also shown is an arrangement of collimators, bending and focusing magnets, and separators to produce an analyzed secondary-particle beam.

A portion of the accelerating electrode had to be removed in order to provide an unobstructed beam path. This is indicated by a broken line in the drawing.

Figure 2 shows an experimental arrangement in which the Bevatron vacuum extends through the second bending magnet. There is, however, an interlocked vacuum gate valve between the Bevatron and the first bending magnet to isolate the Bevatron from loss of vacuum in the analysis system.

SHUTDOWNS

Four shutdowns occurred this quarter: the scheduled shutdowns on August 4 and September 14 were for maintenance and installation of new equipment; unscheduled shutdowns occured on August 10, to remove a beam aperture obstruction, and on October 2 for removal of a beam-clipper mechanism that had failed in service.

MAGNET POWER SUPPLY

The magnet pulsing and fault record appears in Table II.

OPERATION

The operation history of the Bevatron is summarized in Fig. 3 and 4. Operation at present is scheduled 24 hours per day, 7 days per week. The exceptions to this are two 4-hour shutdown periods each week for maintenance and, generally, a 1- or 2-week shutdown each quarter for machine modifications and installation of new equipment.

Tables III and IV and Fig. 5 present the operation record of the Bevatron during this quarter.

RESEARCH

The research activity, this period, is summarized in Table V.

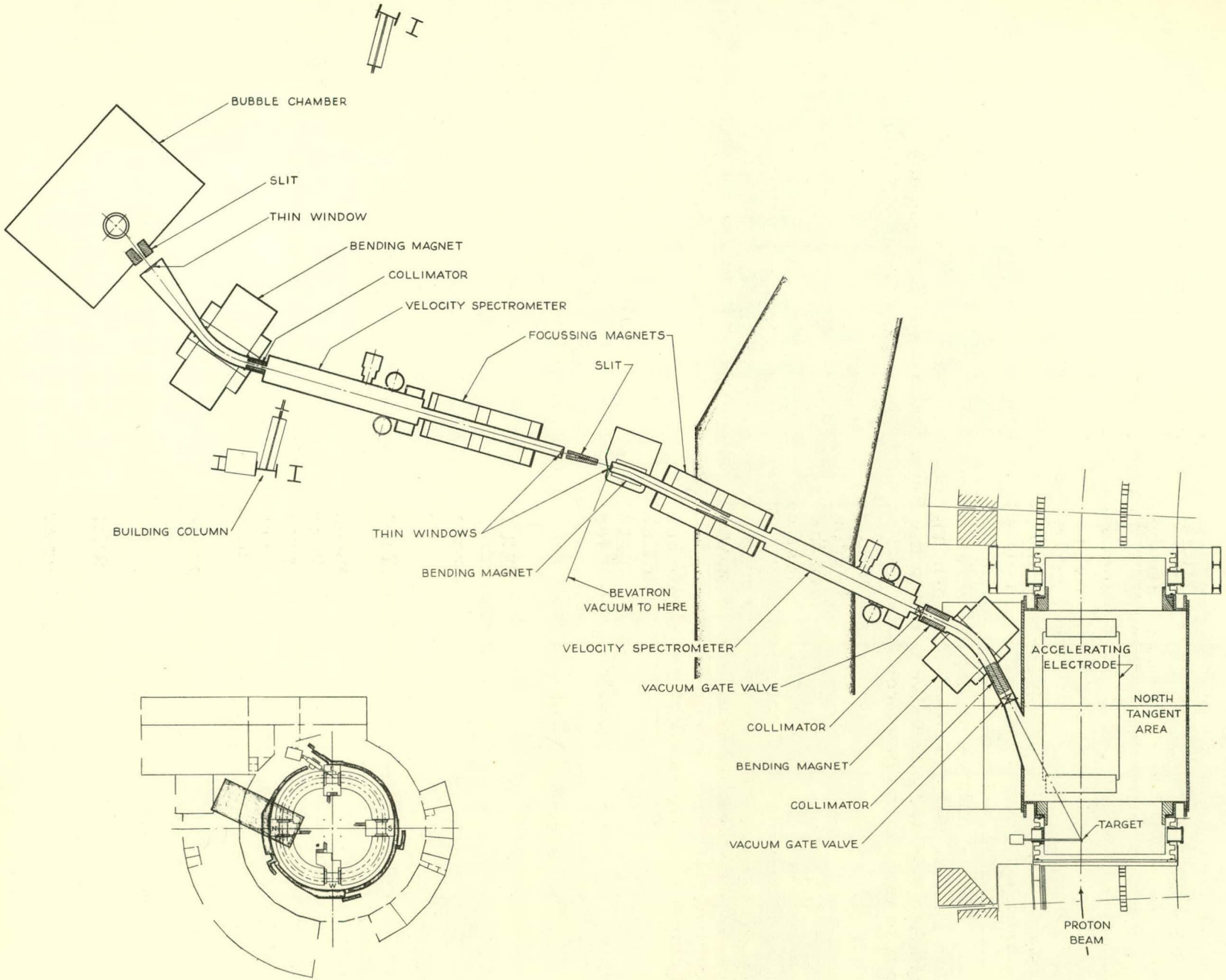


Fig. 2. New experimental facility at the north straight section. Shown also is a typical experimental arrangement.

Table II

Ignitron fault rate

MONTH	5 to 6 pulses per minute						7 to 9 pulses per minute						10 to 17 pulses per minute					
	1500 to 6000 amp			6100 to 9000 amp			1500 to 6000 amp			6100 to 9000 amp			1500 to 6000 amp			6100 to 9000 amp		
	Pulses	Faults	P/F	Pulses	Faults	P/F	Pulses	Faults	P/F	Pulses	Faults	P/F	Pulses	Faults	P/F	Pulses	Faults	P/F
1957																		
June	1144		144	12799	23	550	1744	1	1744	36648	80	458	17929	9	1992			
July	72		72	5012	11	456	1372	2	686	48854	70	6979	33027	35	945	106896	124	878
August	2711	5	542	7463	14	533	536	1	536	81217	89	912	20918	5	4183	89439	53	1686
September	959	2	479	5674	10	567	1053	3	351	22926	40	573	11644	18	647	98469	97	1015
October				1335	5	267	1124			129138	114	3133	14070	4	3515	22967	25	918
November							2419	4	605	117513	124	948	23379	4	5695	56409	50	1128
December				359						4082	3	1360	11855			167868	175	1530
1958																		
January	1842	0	1842	2423	2	1212	305	0	305	14974	12	1248	16435	4	4109	170844	106	1612
February	3189	4	172	2146	2	1071	736	0	736	83637	85	984	6937	10	694	77452	82	944
March	1408	2	704	638	3	233	1215	0		75304	72	1061	13101	3	4367	165124	94	1754
April	751	0	751	888	0	888	188	0	188	600	0	600	11006	4	3501	163052	43	3559
May	10340	2	5170	-	0	-	10337	8	1292	-	0	-	216	0	-	-	0	-
June	53897	34	1585	-	0	-	232988	111	2099	-	0	-	479	0	479	-	0	-
July	6498	0	6498	759	0	759	8873	4	2218	2922	0	0	110652	35	3161	79836	51	1565
August	13	0	-	10381	8	1297	-	-	-	-	-	-	95616	8	11952	230,139	40	5753
September	-	-	-	1990	-	-	-	-	-	3649	-	-	14803	-	-	276,169	41	-
October	-	-	-										9249			238,340	43	5520
November	3931	-	-	1619	1	-	91	-	-	2769	-	-	9500	-	-	278,548	26	-
December				361	-	-	-	-	-	-	-	-	3371	-	-	151,642	9	-
1959																		
January	-	-	-	320	-	-	1515	-	-	1146	-	-	7621	-	-	301420	44	-
February	-	-	-	630	-	-	-	-	-	-	-	-	38215	3	12738	267220	32	8351
March	1012	-	-	6601	-	-	457	-	-	723	-	-	7518	1	7518	235053	41	5733
April	41	-	-	1475	-	-	110	-	-	67300	8	8412	36938	5	7387	227555	39	5834
May	8	-	-	521	-	-	-	-	-	-	-	-	175419	9	19491	168489	19	8446
June	569	-	-	24	-	-	-	-	-	1044	-	-	9492	-	-	257940	12	15173
July	-	-	-	-	-	-	-	-	-	27144	2	13572	9086	-	-	363273	28	12974
August	3314	3	1105	762	-	-	208	-	-	369	-	-	6099	-	-	339849	33	10298
September	1352	-	-	981	-	-	-	-	-	2348	-	-	4405	2	2202	296763	35	8479
October	2547	2	1247	82	-	-	637	1	637	499	-	-	4262	2	4631	368385	56	6578

Totals

Number of faults

1957	Number of pulses	Arc-backs	Arc-throughs	P/F
June	70,264	6	117	562
July	195,233	29	247	707
August	202,284	29	138	1211
September	140,725	47	123	828
October	168,634	80	68	1139
November	199,720	67	115	1097
December	184,164	41	137	1055
1958				
January	206,823	31	93	1668
February	174,093	74	107	951
March	265,790	22	152	1476
April	187,155	13	31	5987
May	20,893	6	4	2089
June	287,364	23	122	1981
July	209,540	38	52	2320
August	336,149	12	44	6003
September	296,611	16	25	7234
October	246,583	23	20	5734
November	296,458	11	16	10979
December	155,374	5	4	17,263
1959				
January	312022	11	33	7091
February	306065	8	27	8745
March	53362	19	33	6032
April	336936	15	37	6479
May	318922	9	19	11390
June	269069	7	10	15827
July	399503	7	23	13317
August	350601	4	32	9739
September	305829	14	23	8266
October	388382	20	48	6253

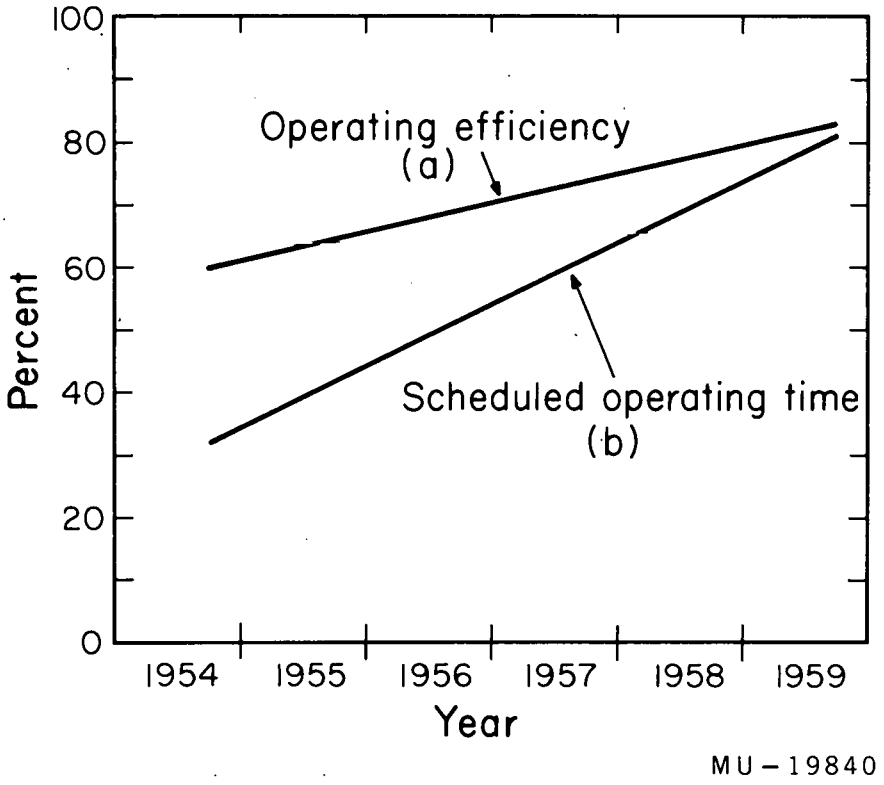


Fig. 3. Operating Record

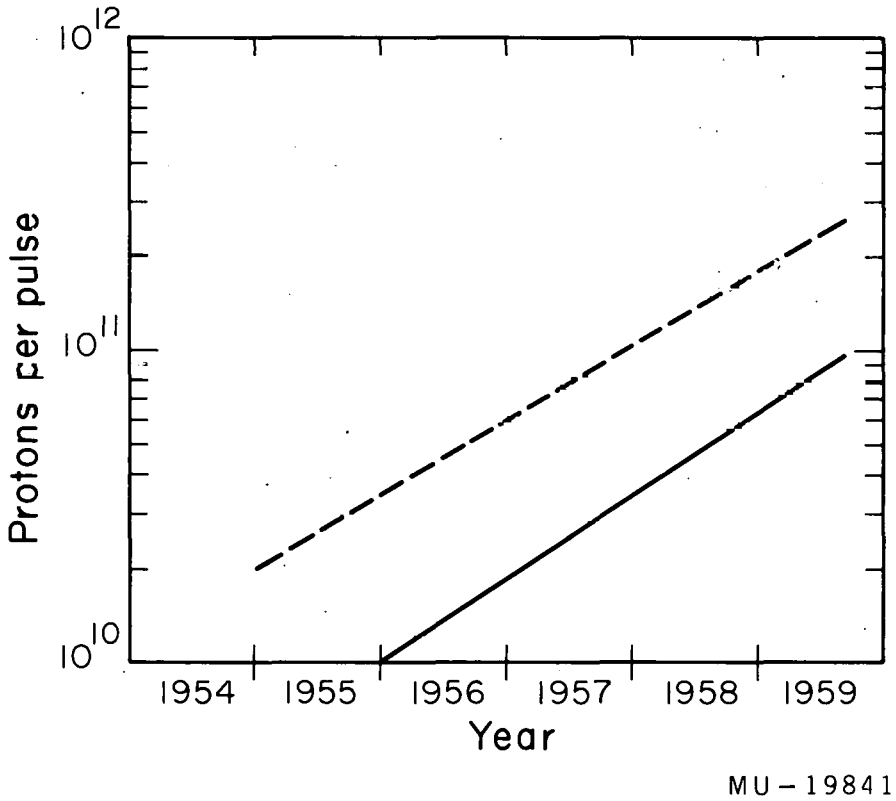


Fig. 4. Beam Record

TABLE III

Analysis of the total beam time lost because of component failure (percent)

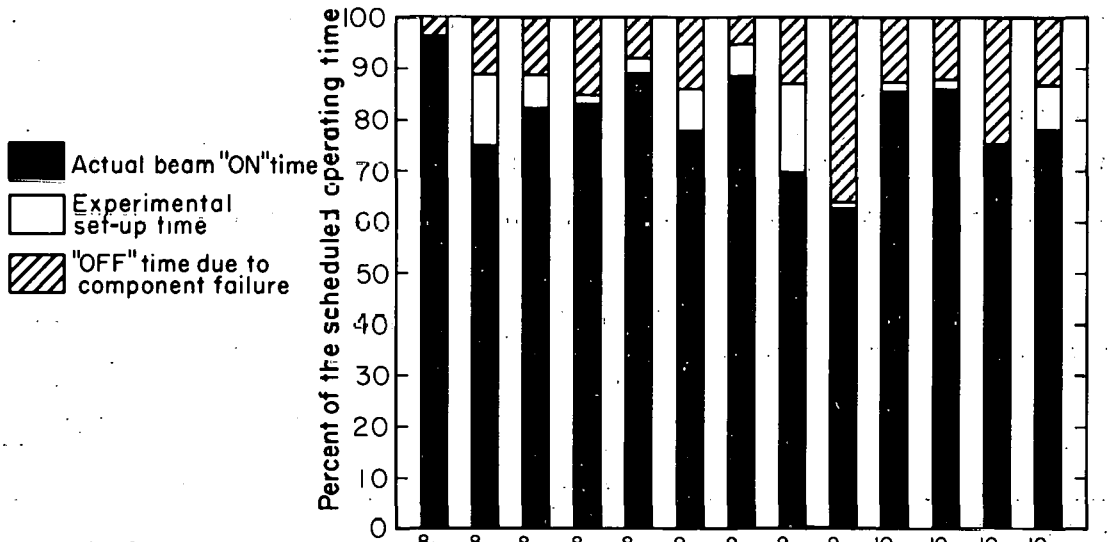
Month, 1959	Injector	Magnet Power Supply	rf Accelerating System	Other
August	21	14	9	56
September	19	27	7	47
October	45	37	2	16

TABLE IV

Beam Record

Week of	Number of 8-hour shifts	Total integrated beam (10^{15} protons)
August 2-8	13	8×10^{15}
9-15	Unscheduled shutdown, Bevatron tests and low-beam- level experiments.	
16-22	17	8×10^{15}
23-29	20	9×10^{15}
August 30-Sept. 5	21	12×10^{15}
Sept. 6-12	16	8×10^{15}
13-19	4	2×10^{15}
20-26	14	2×10^{15}
Sept. 27-Oct. 3	21	5×10^{15}
October 4-10	21	7×10^{15}
11-17	18	7×10^{15}
18-24	21	10×10^{15}
25-31	14	6×10^{15}

Average beam per 8-hour shift = 4×10^{14} protons



Week of	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	9/27	10/4	10/11	10/18	10/25
Crew hours	168	168	168	168	168	144	168	168	168	168	168	168	168
Turn on and maintenance time (hr)	0	10	9	9	9	5	0	9	9	9	9	9	9
Scheduled operating time (hr)	76	81	159	159	159	139	28	154	159	147	135	159	159
Scheduled Bevatron test time (hr)	0	65	0	0	0	0	0	0	0	0	24	0	0
Scheduled shutdown time (hr)	92	12	0	0	0	0	140	5	0	12	0	0	0
Holiday (hr)	0	0	0	0	0	24	0	0	0	0	0	0	0

MU-19839

Fig. 5. BEVATRON OPERATING SCHEDULE
Aug. Sept. Oct. 1959

TABLE V

Bevatron experimental research program
August, September, October 1959

INTERNAL GROUPS

Group and experimenters	Experiment
Alvarez: Eberhard, Kalbfleisch, Parker, Poierier, Stevenson	p-$\bar{p}$ interactions in the 72-in bubble chamber; 1.7-Bev/c separated and focused $\bar{p}$ beam
Miller, Murray Gow, Stevenson, Watt	Septum separator tests Development tests on the 72-in. bubble chamber; 2-Bev/c π^- beam
Barkas	Emulsion stacks exposed in the external 6.2-Bev p beam
Glaser: Brown, Kadyk, Roe	Study of the decay modes of K^+ mesons, using a xenon bubble chamber; 700-Mev/c K^+
Helmholz: Devlin, Perez-Mendez	Measurement of the $\pi^\pm$ -nucleon total cross sections; 0.6- to 1.5-Bev/c $\pi^\pm$
Helmholz-Moyer: Atkinson, Hess, Perez-Mendez	Measurement of the attenuation mean free path of 5-Bev neutrons in various materials
Lofgren: G. Goldhaber, S. Goldhaber, Stork, Ticho	Study of K^+ interactions in H_2 and D_2, using the 15-in. liquid hydrogen bubble chamber
Cool, Cor, Cronin, Kerth, Wenzel	Study of the asymmetry in the decay of Σ^+, Λ^0 particles; 1.13-Bev/c $^+$ beam
Chupp, Hartsough, Lambertson, Richter	Study of the location, direction, and divergence of the xternal proton beam at the recently installed west straight section beam aperture
Segrè: Lander, Lach, Steiner, Wiegand	Measurement of the cross section for the interaction $\pi^+ + p \rightarrow \Sigma^+ + K^+$; 1.03- to 1.33-Bev/c π^+
Seaborg: Alexander	U, Al target bombardment; 6.2 Bev. 1.4×10^{13} p^+ 6.2 Bev. 6.3×10^{13} p

Table V (continued)

INTERNAL GROUPS

Group and experiments	Experiment
Benioff	CeO_2, polystyrene, Al target bombardment;
	2.2 Bev. 3.2×10^{14} p^+;
	2.2 Bev. 2.8×10^{14} p^+;
	5.7 Bev. 1.4×10^{14} p^+;
	5.7 Bev. 1.4×10^{14} p^+;
	CeO_2, polystyrene, Zn, Al target bombardment;
	2.2 Bev. 1×10^{14} p^+;
	5.7 Bev. 2.3×10^{14} p^+.
	Semicarbazide, Al target bombardment:
	5.7 Bev. 1.2×10^{13} p^+;
	5.7 Bev. 5×10^{11} p^+
Markowitz	Zn, Al target bombardment;
	6.2 Bev. 4×10^{13} p^+;
	6.2 Bev. 5×10^{12} p^+
Reeder	Al, Zn, Fe target bombardment;
	4.0 Bev. 5×10^{14} p^+;
	5.7 Bev. 4.8×10^{13} p^+
	Al, Zn target bombardment;
	4.0 Bev. 1.2×10^{14} p^+

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