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UCRL-9220
Particle Accelerators
TID-4500 (15th Ed)

UNIVERSITY OF CALIFORNIA
Lawrence Radiation Laboratory
Berkeley, California
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BEVATRON OPERATION AND DEVELOPMENT. XXIV
November, December 1959, January 1960

Walter D. Hartsough

May 25, 1960

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BEVATRON OPERATION AND DEVELOPMENT. XXIV

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*Preceding Quarterly Reports: UCRL-9058, UCRL-9011

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ABSTRACT

Study of particle interactions was continued this quarter. Bubble chambers, counting systems, and nuclear emulsions were used to investigate the interactions of π^\pm , μ^- , and K^+ mesons. Two primary experiments conducted during this period were made by groups visiting this Laboratory. Nuclear emulsion stacks were exposed for ten outside groups — five exposures to a π^- beam and five to a K^+ beam.

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EXPERIMENTAL FACILITIES

Quadrant-Mounted Targets

Table I lists the quadrant-mounted targets installed during the latter part of this quarter.

Beam Position Programming

A recently published UCRL report* describes a three-channel computer (transistorized, relay-operated) that synthesizes a time-dependent program for radial position control of the Bevatron beam. The system allows all the useful aperture of the Bevatron to be used at any time during the acceleration or deceleration cycle. Different beam-position programs for different magnet pulses are possible as well as more than one program during a given pulse. This system is currently in use at the Bevatron.

MAGNET POWER SUPPLY

The magnet record appears in Table II.

SHUTDOWNS

Only one shutdown occurred this period — a scheduled shutdown December 22 for maintenance and installation of targets.

* Harry G. Heard, Arbitrary Control of the Radial Position of the Internal Beam of the Bevatron, UCRL-9006, Jan. 1960.

Table I

Quadrant-Mounted Targets,
December 22, 1959 to end of Quarter

Quadrant	Azimuthal Location (Ref: entrance end of quadrant) (deg. min)		Radial location		Target material	Target Size a × b × c (in.)
			Outer-radius edge of target (in.)	Outer-radius edge of lip (in.)		
II	76	52	599-13/16	600-1/16	Stainless Steel	2 × 1/2 × 1/2
II	77	08	599-11/16	599-15/16	Stainless Steel	2 × 1/2 × 1/2
II	80	23	601-1/4	601-1/2	Stainless Steel	2 × 1/2 × 1/2
II	80	39	601-1/4	601-1/2	Stainless Steel	2 × 1/2 × 1/2
III	19	36 (up)	599-3/8	599-1/2	Aluminum	5 × 1/8 × 1/2
III	19	36 (dn.)	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 (up)	596	596-1/8	Aluminum	5 × 1/8 × 1/2
III	23	38 (dn.)	596	596-1/8	Aluminum	5 × 1/8 × 1/2
III	72	29	597-3/4	598-1/8	Copper	3-1/2 × 1/2 × 1/2
III	72	36	597-3/4	598-1/8	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

Beam

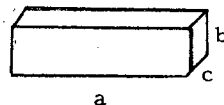
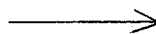


Table II
Ignitron fault rate

MONTH	5 to 6 pulses per minute						7 to 9 pulses per minute						10 to 17 pulses per minute						Totals					
	1500 to 6000 amp			6100 to 9000 amp			1500 to 6000 amp			6100 to 9000 amp			1500 to 6000 amp			6100 to 9000 amp			Number of pulses	Number of Arc-backs	Number of Arc-throughs	P/F		
	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	1,144		144	12,799	23	550	1,744	1	1,744	36,648	80	458	17,929	9	1,992					70,264	6	117	562	
July	72		72	5,012	11	456	1,372	2	686	48,854	70	6,979	33,027	35	945	106,896	124	878	195,233	29	247	707		
August	2,711	5	542	7,463	14	533	536	1	536	81,217	89	912	20,918	5	4,183	89,439	53	1,686	202,284	29	138	1,211		
September	959	2	479	5,674	10	567	1,053	3	351	22,926	40	573	11,644	18	647	98,469	97	1,015	140,725	47	123	828		
October	-	-	-	1,335	5	267	1,124	-	-	129,138	114	3,133	14,070	4	3,515	22,967	25	918	168,634	80	68	1,139		
November	-	-	-	-	-	-	2,419	4	605	117,513	124	948	23,379	4	5,695	56,409	50	1,128	199,720	67	115	1,097		
December	-	-	-	359	-	-	-	-	-	4,082	3	1,360	11,855	-	-	167,868	175	1,530	184,164	41	137	1,055		
1958																								
January	1,842	0	1,842	2,423	2	1,212	305	0	305	14,974	12	1,248	16,435	4	4,109	170,844	106	1,612	206,823	31	93	1,668		
February	3,189	4	172	2,146	2	1,071	736	0	736	83,637	85	984	6,937	10	694	77,452	82	944	174,093	74	107	951		
March	1,408	2	704	638	3	233	1,215	0	-	75,304	72	1,061	13,101	3	4,367	165,124	94	1,754	265,790	22	152	1,476		
April	751	0	751	888	0	888	188	0	188	6,000	0	600	14,006	4	3,501	153,052	43	3,559	187,155	13	34	3,982		
May	10,340	2	5,170	-	0	-	10,337	8	1,292	-	0	-	216	0	-	-	0	-	20,893	6	4	2,089		
June	53,897	34	1,585	-	0	-	232,988	111	2,099	-	0	-	479	0	479	-	0	-	287,364	23	122	1,981		
July	6,498	0	6,498	759	0	759	8,873	4	2,218	2,922	0	0	110,652	35	3,161	79,836	51	1,565	209,540	38	52	2,320		
August	13	0	-	10,381	8	1,297	-	-	-	-	-	-	95,616	8	11,952	230,139	40	5,753	336,149	12	44	6,003		
September	-	-	-	1,990	-	-	-	-	-	3,649	-	-	14,803	-	-	276,169	41	-	296,611	16	25	7,234		
October	-	-	-	-	-	-	-	-	-	-	-	-	9,249	-	-	237,340	43	5,520	246,583	23	20	5,734		
November	3,931	-	-	1,619	1	-	91	-	-	2,769	-	-	9,500	-	-	278,548	26	-	296,458	11	16	10,979		
December	-	-	-	361	-	-	-	-	-	-	-	-	3,371	-	-	151,642	9	-	155,374	5	4	17,263		
1959																								
January	-	-	-	320	-	-	1,515	-	-	1,146	-	-	7,621	-	-	301,420	44	-	312,022	11	33	7,091		
February	-	-	-	630	-	-	-	-	-	-	-	-	38,215	3	12,738	267,220	32	8,351	306,065	8	27	8,745		
March	-	-	-	6,601	-	-	457	-	-	723	-	-	7,518	1	7,518	235,053	41	5,733	53,362	9	33	6,032		
April	1,012	-	-	1,475	-	-	110	-	-	67,300	8	8,412	36,938	5	7,387	227,555	39	5,834	336,936	15	37	6,479		
May	41	-	-	521	-	-	-	-	-	-	-	-	175,419	9	19,491	168,489	19	8,446	318,922	9	19	11,390		
June	569	-	-	24	-	-	-	-	-	1,044	-	-	9,492	-	-	257,940	12	15,173	269,069	7	10	15,827		
July	-	-	-	-	-	-	-	-	-	27,144	2	13,572	9,086	-	-	363,273	28	12,974	399,503	7	23	13,317		
August	3,314	3	1,105	762	-	-	208	-	-	369	-	-	6,099	-	-	339,849	33	10,298	350,601	4	32	9,739		
September	1,352	-	-	981	-	-	-	-	-	2,348	-	-	4,405	2	2,202	296,763	35	8,479	305,829	14	23	8,266		
October	2,547	2	1,247	82	-	-	637	1	637	499	-	-	9,262	2	4,631	368,385	56	6,578	381,412	20	41	6,253		
November	-	-	-	9	-	-	-	-	-	11	-	-	6,326	-	-	377,884	57	6,631	384,230	7	50	6,741		
December	1,069	-	-	2,599	6	433	456	-	-	894	4	223	6,025	2	3,012	280,425	45	6,232	291,468	20	37	5,113		
1960																								
January	4,809	-	-	2,289	2	1,145	510	1	510	701	-	-	5,254	2	2,627	368,039	68	5,412	381,602	23	50	5,227		

OPERATION

Bevatron operation is summarized in Tables III and IV and Fig.

1.

RESEARCH

Table V lists the research activity for this quarter.

Table III

Beam record		
Week of	Number of 8-hour shifts	Total integrated beam (10^{15} protons)
Nov. 1-7	15	7.2
Nov. 8-14	20	7.4
Nov. 15-21	21	13.0
Nov. 22-28	14	8.2
Nov. 29-Dec. 5	20	10.6
Dec. 6-12	20	13.0
Dec. 13-19	19	9.6
Dec. 20-26	5	2.3
Dec. 27-Jan. 2	---	---
Jan. 3-9	20	8.7
Jan. 10-16	21	13.9
Jan. 17-23	21	16.3
Jan. 24-30	16 ^a	11.3

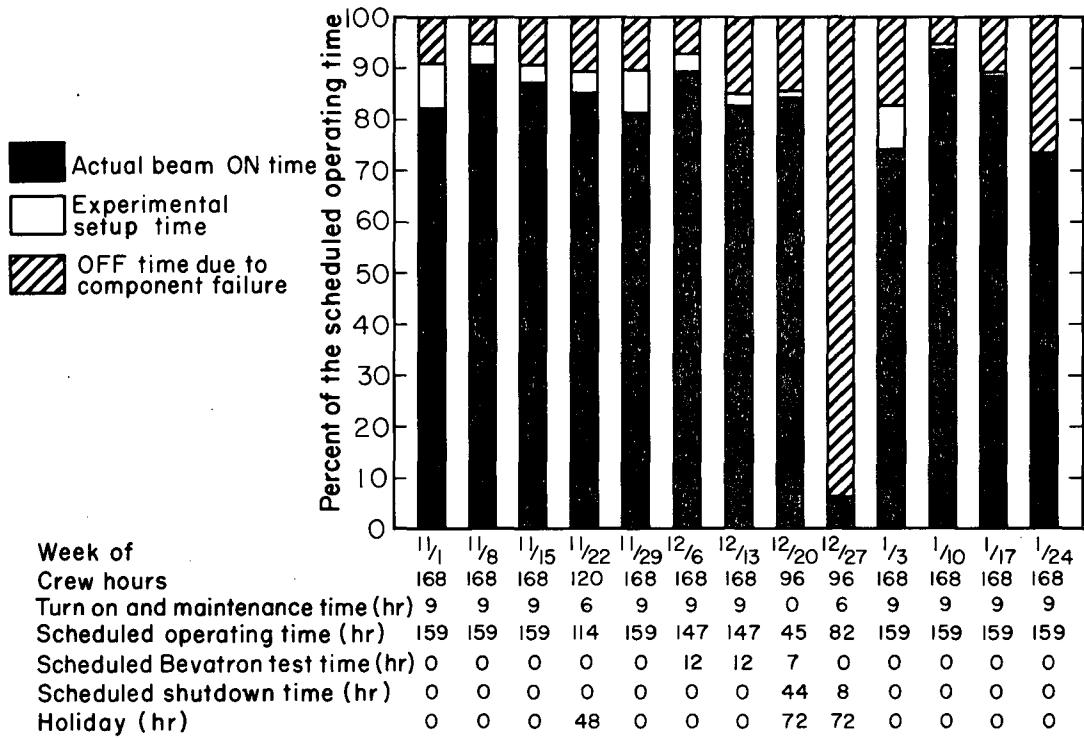
Maximum beam amplitude at full energy = 3.1×10^{11} protons per pulse
 Maximum injected beam = 600 microamperes
 Average beam per 8-hour shift = 5.3×10^{14} protons

^aBeam amplitude was reduced at the request of the experimental group.

Table IV

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

Month	Injector	Magnet power supply	Radio-frequency accelerating system	other
November 1959	32	29	5	34
December 1959	12	58	6	24
January 1960	31	61	2	6



MU-20515

Fig. 1. BEVATRON OPERATING SCHEDULE
November, December 1959, January 1960

Table V

Bevatron experimental research program
November, December 1959, January 1960

INTERNAL GROUPS

Group and Experimenters	Experiment
Alvarez: Gow, Stevenson, Watt	Test of the 72-inch hydrogen bubble chamber, using a pion beam
Barkas: Nichols Nichols	Investigation of 3.5-Bev/c π^- - meson interactions in emulsions Determination of the scattering of 2-Bev/c μ^- mesons in iron, using emulsions
Lofgren and UCRL Group: G. Goldhaber, S. Goldhaber, Stork, Ticho	Investigation of K^+ -meson interactions in hydrogen and deuterium, using the 72-inch hydrogen bubble chamber (220- to 875 Mev/c K^+)
Powell: Birge, Shonle	π^- -p scattering at 730 Mev/c, using the 15-inch hydrogen bubble chamber
Segrè: Lach, Lander, Steiner, Wiegand	Investigation of the interaction $\pi^- + p \rightarrow \Sigma^+ + K^+$, using counters (900- to 1200-Mev/c π^+ beam)

EXTERNAL GROUPS

Institution and Experimenters	Experiment
Princeton University: Fitch, Perkins, Pirove	Study of $\theta_1 - \theta_2$ mass difference, counters
Beloit College, Wisconsin: Fuller	Chemistry bombardment: Al, Sb foils bombarded in the 6.2-Bev proton beam (5.9×10^{13} p $^+$)
University of Washington: Masek	Study of 2-Bev/c μ^- - meson scattering, using counters and emulsions (3.5-Bev/c π^- - meson beam)

Table V (Con't)

Bevatron experimental research program
November, December 1959, January 1960

EXTERNAL GROUPS

Institution and Experimenters	Experiment
Tata Institute, Bombay, India Biswas	Emulsion exposures in the 3.5-Bev/c π^- beam
University of Wisconsin Fry, Groves	
University of Tennessee King, Childers	
University of Washington Masek	
Tufts Institute Schneps	
N. R. L., Washington, D. C. Glaser	Emulsion exposures in the K^+ -meson beam (the 700-Mev/c K^+ beam was degraded to 350 Mev/c)
Max Planck Institute of Physics, Munich, Germany Gottstein	
Oxford University, England Mulvey	
Stevens Institute of Technology Taylor	
University of Ottawa, Canada Van Heerden	

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