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Publication Date

1961-06-14

UNIVERSITY OF
CALIFORNIA

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*Radiation
Laboratory*

BEVATRON OPERATION AND DEVELOPMENT. XXIX
February through April 1961

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UCRL-9721
UC-28 Particle-Accelerators
and High-Voltage Machines
TID-4500 (16th Ed.)

UNIVERSITY OF CALIFORNIA
Lawrence Radiation Laboratory
Berkeley, California
Contract No. W-7405-eng-48

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Walter D. Hartsough

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Printed in USA. Price 50 cents. Available from the
Office of Technical Services
U. S. Department of Commerce
Washington 25, D.C.

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*Preceding Quarterly Reports: UCRL-9671, UCRL-9546.

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ABSTRACT

The Bevatron operated 84% of the scheduled operating time this quarter. The machine was shut off 12% of the scheduled operating time because of component failure and 4% at the request of the user. Four resident laboratory research groups and six groups from outside institutions conducted experiments in π - and K-meson beams. Bubble chambers, counter techniques, and spark chambers were used.

A program to modernize the Bevatron has been approved and is in the early stages of accomplishment. The objective of this program is to make the Bevatron a more useful experimental facility.

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IMPROVEMENT PROGRAM

During this past year authorization was granted for a \$9,600,000 Bevatron Improvement Program. The intent of this program is to modernize the Bevatron with particular emphasis on making it a more useful experimental facility. In general, the objectives are to improve the control flexibility and the reliability of the machine; to increase the beam intensity; to adequately shield the machine for a beam intensity of 10^{13} protons per pulse; and to provide increased experimental facilities. To achieve these objectives the following major areas of updating and/or modification are included in the program:

1. A new injection system will be built that includes an entirely new ion gun, an 18-Mev strong-focusing linear accelerator, and an achromatic inflection system. This injector will have an output of from fifty to one hundred times that of the present unit.
2. The Bevatron will be enveloped within a concrete shield. The thicknesses of this enclosure will be ten feet for the wall and seven feet for the roof. Suitable beam slots and access labyrinths will be provided.
3. Beam control system: The shielding project requires relocation of much of the radio-frequency equipment. It is intended that advantage be taken of this enforced move and of the time afforded by the shielding shutdown to eliminate many of the difficulties with the present system. In addition, a number of improvements are contemplated that will improve the productivity, flexibility, and reliability of the accelerator. Among these are improved radial beam-position monitoring, a radial beam-position feedback system, a flat-topped magnet pulse for long beam spills, and a system that will allow a second rapid-beam-ejector pulse during an acceleration cycle.
4. Motor generator sets: The flywheels and flywheel shafts will be replaced.

5. Experimental facilities: Included in this phase of the program are plans for an external beam; additional secondary beam ports; further development of remotely positioned gap-mounted targets; modifications to the building to increase the experimental area; and an increase in the number of auxiliary magnets, spectrometers, power supplies, and power-distribution facilities.

At the present time we are engaged in the early phases of most of the above projects.

OPERATION

The machine operation record for this quarter is presented in Fig. 1 and Tables I and II. The Bevatron was shut down on February 1 for three days to allow an experimental-setup change.

On March 28, following several ignitron faults, operation was suspended to permit investigation of the cause of a vibration alarm on the No. 1 bearing of the east generator. Careful checks of the generator were made, including visual, ultrasonic, and magnetic-particle inspections. The machine was then observed during operation at various reduced speeds. These checks failed to disclose a source of excessive vibration or any abnormal behavior. Operation resumed on March 29.

Subsequently it was observed that when field excitation is removed from the generator and the machine is unloaded (this occurs following an ignitron fault) the generator oscillates about a new magnetic center. In the case of the east generator, the amplitude of this axial oscillation was sufficient to cause the shoulder on the shaft to strike the thrust collar on the No. 1 bearing. This produced a large-amplitude vibration in the bearing pedestal.

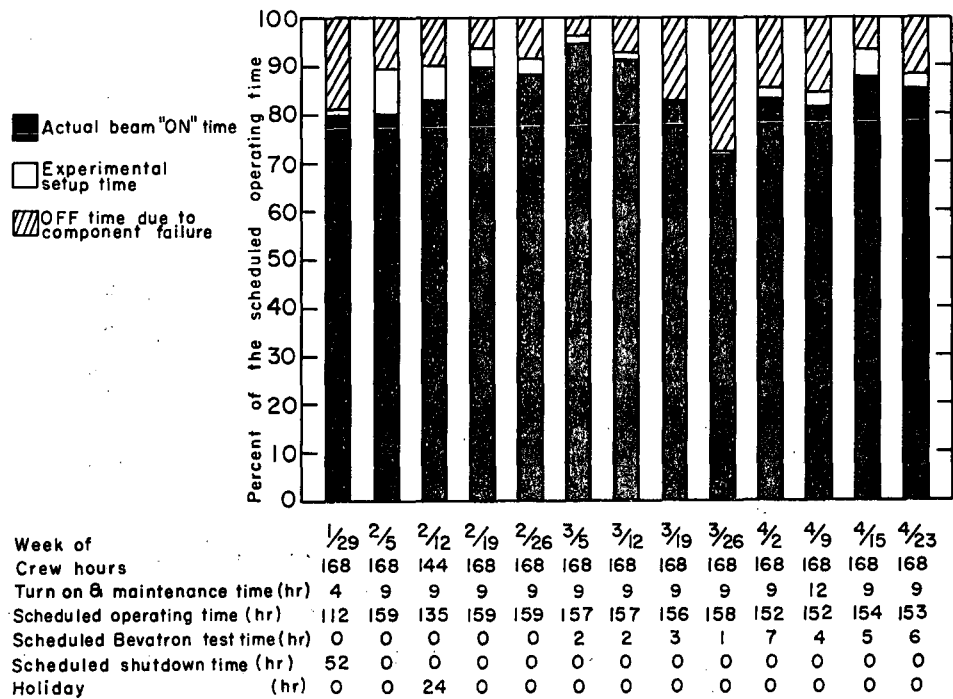
During the period of shutdown mentioned above, the Bevatron was at air for one day for maintenance and for installation of a target.

RESEARCH

The experimental research program for January 1961 is summarized in Table III. Table IV lists the experiments done this quarter.

MAGNET POWER SUPPLY

The magnet pulse record appears in Table V.



MU-24047

Fig. 1. Bevatron operating schedule, February through April 1961.

Table I. Beam record

Week of (1961)	Number of 8-hour shifts	Total integrated beam (10^{15} protons)
Jan. 29 - Feb. 4	13	8.6
Feb. 5 - 11	21	9.9
Feb. 12 - 18	18	10.0
Feb. 19 - 25	20	15.5
Feb. 26 - Mar. 4	21	17.0
Mar. 5 - 11	21	17.8
Mar. 12 - 18	21	17.1
Mar. 19 - 25	21	15.0
Mar. 26 - April 1	21	11.0
April 2 - 8	21	12.0
April 9 - 15	21	11.6
April 16 - 22	21	14.0
April 23 - 29	21	13.0 ^a

Maximum beam amplitude at full energy	=	3×10^{11} protons per pulse
Maximum injected beam	=	600 μ a
Average beam per 8-hour shift	=	1.3×10^{15} protons

^aDuring a portion of this week, at the request of the user, the machine was run at reduced beam levels.

Table II. Analysis of the total lost beam time due to component failure (%)

Month (1961)	Injector	Magnet power supply	rf accelerating system	other
Feb.	25	14	11	50
March	35	45	3	17
April	52	24	4	20

Table III. Summary of bevatron experimental research program, January 1961

Group	Start of experiment	End of experiment	Experiment	Beam time		Pulse sched- ule	Primary or secondary experiment
				(12-hour periods)	(hours)		
<u>Internal Groups</u>							
Alvarez	4-22-60	in progress	$\pi^\pm$ interactions in hydrogen and deuterium using the 72-in. hydrogen bubble chamber (0.9 to 1.6 Bev/c).	217 38	2163 436	1:1 1:2	P
Alvarez	8-9-60	1-24-61	K^- interactions in hydrogen and deuterium using the 15-in. hydrogen bubble chamber (740 Mev/c).	119 34	1279 330	1:1 1:2	P
Lofgren	12-7-60	1-31-61	K^+ -p and K^+ -n total cross sections and elastic scattering (1 to 3 Bev/c)	22 10	248 106	1:1 1:1	P S
Lofgren	1-27-61	1-31-61	π^+ -p scattering, measurement of angular distribution. (1.5, 2.0, 2.5 Bev/c)	3	25	1:1	S
Seaborg	Chemistry target bombardments (3) in the internal proton beam,						
<u>External Groups</u>							
Institution and Experimenter							
Univ. Chicago Northwestern U. Levi Setti	1-14-61	1-23-61	Emulsion exposure (800-Mev/c K^-). Study of production of hyperfragments.	9	106	1:1	P
Duke University Block	1-27-61	in progress	Study of K^- interactions in a helium bubble chamber (740 Mev/c).	3	25	1:1	P

Table IV. Summary of bevatron experimental research program, February through April 1961

Group	Start of experiment	End of experiment	Experiment	Beam time		Pulse schedule	Primary or secondary experiment
				(12-hour periods)	(hours)		
<u>Internal Groups</u>							
Alvarez	4-22-60	in progress	$\pi^{\pm}$ interactions in hydrogen and deuterium using the 72-in. hydrogen bubble chamber (0.9 to 1.6 Bev/c).	268 50	2732 548	1:1 1:2	P
Segrè	2-5-61	in progress	$\pi - \pi$ scattering (280-Mev/c to 2.25-Bev/c π^{-}).	55	475	1:1	P
Barkas	3-9-61	3-15-61	Emulsion exposure (740-Mev/c $10 K^{-}$).		87	1:1	P
Lofgren	3-16-61	4-23-61	Spark-chamber tests in a π -meson beam.	--	14	1:1	S
Lofgren	4-21-61	in progress	Study of Σ , Λ decay polarization using spark chambers (1-Bev/c π^{+}).	5	69	1:1	P
Perlman	Chemistry target bombardment (1) in the internal proton beam.						
<u>External Groups</u>							
Institution and Experimenter							
Duke Univ. Block	1-27-61	4-10-61	K^{-} interactions in a helium bubble chamber (740 Mev/c).	65 ^a	636 ^a	1:1	P
U. Tennessee King	3-16-61	3-16-61	Emulsion exposure (740-Mev/c K^{-}).	--	1-1/2	1:1	P
U. Stockholm Ekspong	4-12-61	4-13-61	Emulsion exposure (700-Mev/c K^{-}).	2	30	1:1	P
Univ. Miami Perlmutter	4-13-61	4-15-61	Emulsion exposure (700-Mev/c K^{-}).	1	14	1:1	P
Tufts Univ. Schneps	4-15-61	4-15-61	Emulsion exposure (700-Mev/c K^{-}).	2	18	1:1	P
Oxford Univ. Wilkinson	4-16-61	4-20-61	Emulsion exposure (700-Mev/c K^{-}).	9	88	1:1	P

^aThis experiment was done on a 1:1 and 1:2 pulse basis. The beam-time record, however, represents the equivalent of 1:1 pulse operation.

ACKNOWLEDGMENTS

Edward J. Lofgren is the Bevatron Group Leader; William A. Wenzel is the Alternate Group Leader. Walter D. Hartsough, with Glen R. Lambertson and Wendell Olson assisting, is in charge of Bevatron operation. The operating crew supervisors are Duward Cagle, Frank Correll, Ross Nemetz, and Glenn White. The following are crew members: Robert Allison, G. Stanley Boyle, Robert Brokloff, Ashton Brown, Gary Burg, Norris Cash, Ferdinand Dagenais, Raleigh Ellisen, Robert Gisser, William Kendall, William Lee, Wayne Logan, David Loucks, Kenneth Morgan, and Joseph Smith. Many support and development projects were carried out by crew members. In addition, the following were responsible for special projects: Robert Anderson, Trancuilo Canton, Warren Chupp, Bruce Cork, Kenneth Crebbin, Rudin Johnson, Leroy Kerth, Glen Lambertson, Fred Lothrop, Robert Richter, William Wenzel, Emery Zajec, and Theodore Zipf. Engineering groups were headed by Edward Hartwig, Electrical Engineering; Clarence Harris, Electrical Coordination; and William Salsig, Mechanical Engineering. Donald Milberger was in charge of the Electrical Maintenance Group.

This work was done under the auspices of the U.S. Atomic Energy Commission.

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