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BEVATRON OPERATION AND DEVELOPMENT. 50

April through June 1966

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*Preceding Quarterly Reports: UCRL-16809, UCRL-16741

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Robert W. Brokloff and Kenneth C. Crebbin

Lawrence Radiation Laboratory
University of California
Berkeley, California

November 17, 1966

ABSTRACT

The beam was on for experimenters 85.7% of the scheduled operating time. During this quarter, the Bevatron accelerated 1.80×10^{18} protons. The external-proton-beam extraction efficiency for short spills (200 to 500 μ sec) was doubled (from 15% to 30%) by using an outer-radius "lipless" target. We discovered that the cranes above the Bevatron magnet caused a local perturbation in the magnetic field near peak field. This perturbation was sufficient to cause tracking changes and beam loss in some modes of operation.

I. MACHINE OPERATION AND EXPERIMENTAL PROGRAM

The Bevatron operations record is shown in Fig. 1. The beam was on 85.7% of the scheduled operating time. During this quarter, the Bevatron accelerated 1.80×10^{18} protons. The beam was off 7.3% of the time because of equipment failure and 7.0% of the time for experimental setup, tuning, and routine checks.

The operating modes of the Bevatron this quarter was essentially the same as reported previously.¹ The Bevatron was scheduled to run 158.75 periods this quarter. It actually operated 151.75 periods, during which we logged 241 periods of experimental time for prime users and 188 periods for parasitic users. The Lofgren experiment (No. 48) and the University of Michigan-UCLA experiment (No. 43A) were both set up at the third focus of the external proton beam. They both used the long spill (800 msec) at 5.3 BeV, but could not be run simultaneously because of background problems. The separation between the two secondary-beam channels was insufficient to allow stopping the primary proton beam in a position such that the background was low in both secondary-beam channels simultaneously. A summary of the experimental program is shown in Table I.

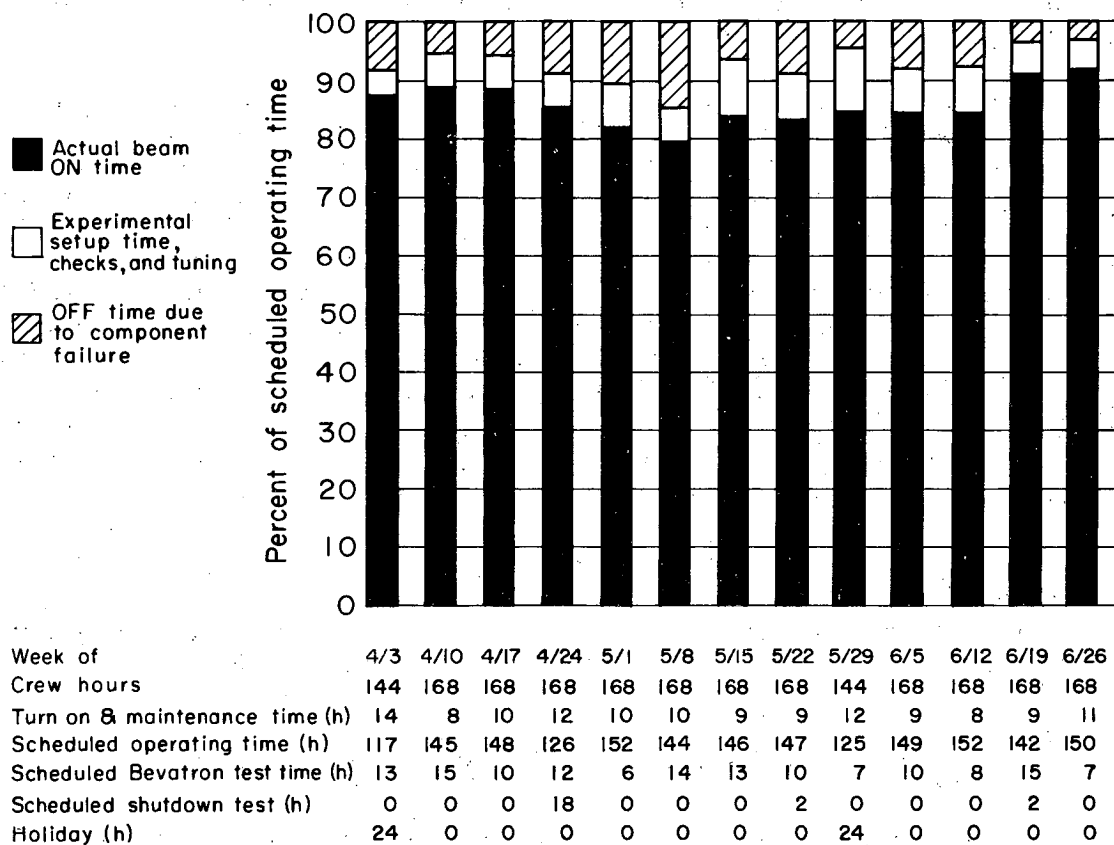
II. SHUTDOWN

The Bevatron was shutdown for two 24-hour periods this quarter: an administrative holiday on April 8 and Memorial Day, May 30.

III. BEVATRON DEVELOPMENT AND STUDIES

Some development periods were devoted to beam tracking and extraction of the external proton beam during the "mezzanine"² operation of the magnet pulse. Some time was devoted to studies of computer control of the injector system, which will be covered in more detail in the next quarterly report.

External-proton-beam extraction-efficiency studies continued. The extraction efficiency for short spills (200 to 500 used) was doubled (from 15% to 30%) by using an outer-radius "lipless" target to eliminate the normal radial-position sweep at the first extraction magnet when an inner radius target and lip is used. This position sweep is caused by the combination of orbit perturbation and energy damping in going through a "lip". The "lip" is necessary on an inner radius target for beam extraction. At present this mode of extraction is not compatible with our long-spill extraction system, so we have not been able to use it operationally. These studies will continue.



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Fig. 1. Bevatron operating schedule.

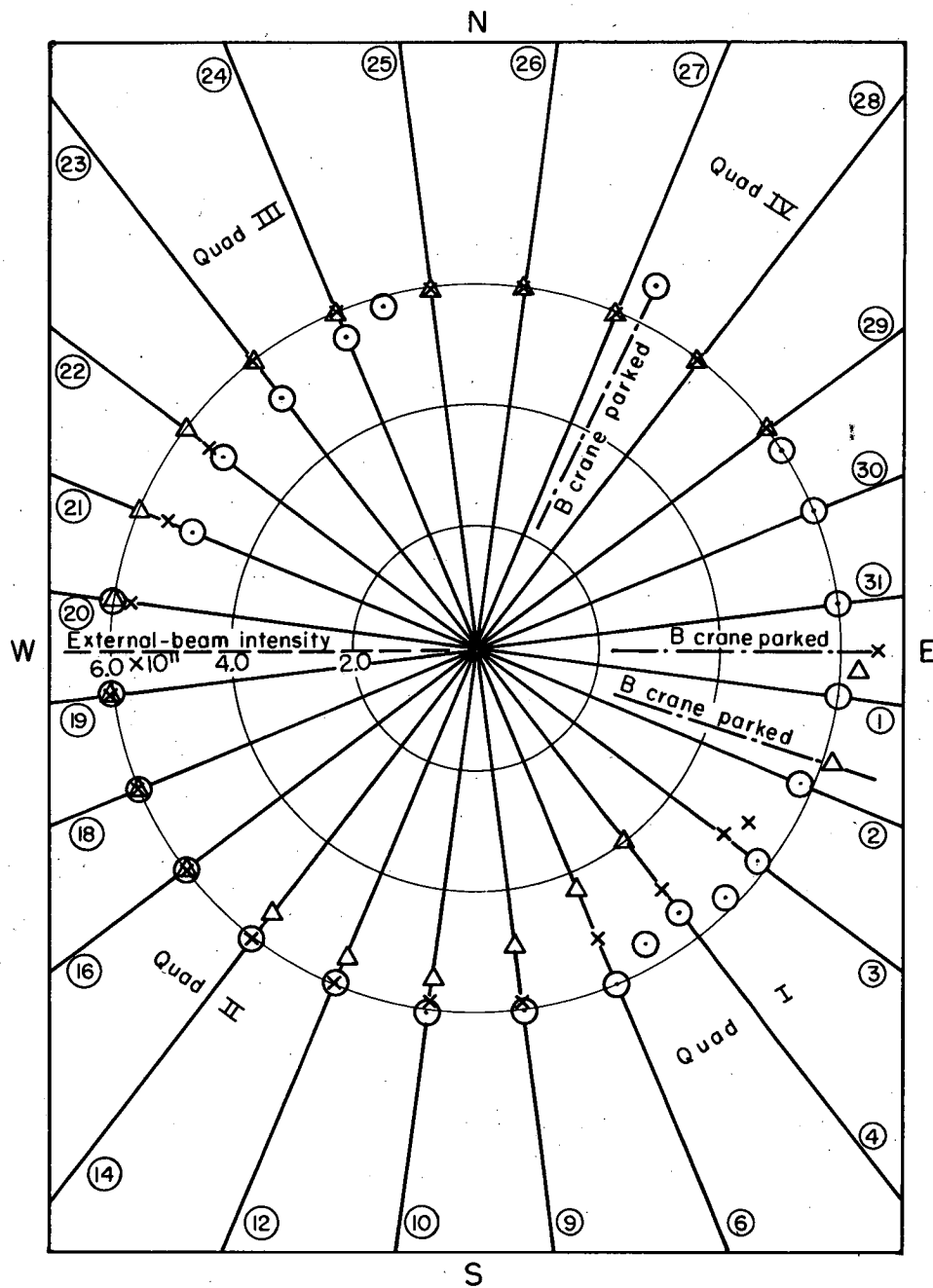
Table I. Summary of Bevatron experimental research progress, April through June 1966.

Groups	Run	Dates		Experiment	Beam time				Primary or secondary experiment
		Start	End		This quarter April-June	From start through June 1966	Pulse schedules		
		12-hour periods	Hours		12-hour periods	Hours			
Internal groups									
Alvarez-Murray	39	8/5/65	6/27/66	K^0 - K^0 interference using 25-in. bubble chamber	77	898	204	2160	1:1 P
Segrè-Chamberlain-Stiening	40	9/2/65	In progress	Polarization of K_3 decays	26	284	115	1280	1:1 P
Loftgren-Cork-Wenzel	48	9/16/65	In progress	Diboson mass spectra	25	318	29	371	1:1 S
		5/26/66	In progress		4	34	4	34	1:1 P
*Moyer-Helmholz-Parker	47A	1/28/66	In progress	Neutral decay Rate $K_L^0 \rightarrow 2\pi$	30	397	42	536	1:1 S
		5/19/66	In progress		4	37	4	37	1:1 P
Alvarez-Pripstein	66	2/8/66	6/1/66	d-d interactions	10	108	10	108	1:1 S
		4/19/66	6/29/66	in 72-in. bubble chamber	54	558	54	558	1:1 P
External groups									
† Alvarez-Purdue-Illinois	45	5/7/65	In progress	μ -p interactions in 72-in. bubble chamber	44	436	75	878	1:1 P
Masek-U. of Wash.	50	3/18/66	In progress	Magnetic moment of Ξ cascade particles	84	848	85	879	1:1 S
		5/20/66	In progress		5	54	5	54	1:1 P
Longo-Holland-U. of Mich. - UCLA	43	4/7/66	In progress	K^0 decays	36	421	36	421	1:1 S
		5/24/66	In progress		25	290	25	290	1:1 P
Davis-U. of Washington		4/20/66	4/22/66	Emulsion exposure	2	17	2	17	1:1 P
Murthy-of Mich.	P-14	5/24/66	5/29/66	Test gas proportional counter	3	29	3	29	1:1 S
* 12 periods reported in UCRL-16809 now considered to be secondary experiment.									
† Recap of Experiment 45 (LRL-Alvarez, UCRL-Ticho, Purdue-Touffest, Illinois-Kruse)									
	45	5/2/65	In progress						
							213	1818	1:1 P
							21	233	1:1 S

We have frequently experienced variations of beam intensity in the external proton beam which could not be correlated with variations in the extraction system. These variations were sometimes a simple drop in intensity level which could be restored by readjusting the beam tracking and extraction system, or were a continuous fluctuation of intensity level in the extracted beam. The intensity variations were particularly large (up to 50%) if the beam was being shared simultaneously on the energy-loss target for the extracted beam and another internal target, as in the operational mode described in reference 1. It was finally noted by some of the more astute members of the operations crew that these variations occurred when the overhead cranes were in operation or when the cranes had been moved to a new azimuthal location. A test run was then made using the extracted beam intensity as a monitor. The crane was moved azimuthally around the Bevatron magnet in a number of steps. The azimuthal position of the crane carriage and the intensity of the extracted beam were recorded. A plot of this is shown in Fig. 2. There are two crane carriages on the track around the Bevatron magnet. Additional runs of beam intensity versus crane positions were made to determine if effect on the beam was caused by relative position of the two cranes. We also wanted to determine if there were relative positions where we could place the cranes to minimize the effect on the Bevatron tracking. These tests showed a minimum effect when the cranes were over the straight sections and an apparent single-crane effect rather than an effect based on the relative positions of the two cranes.

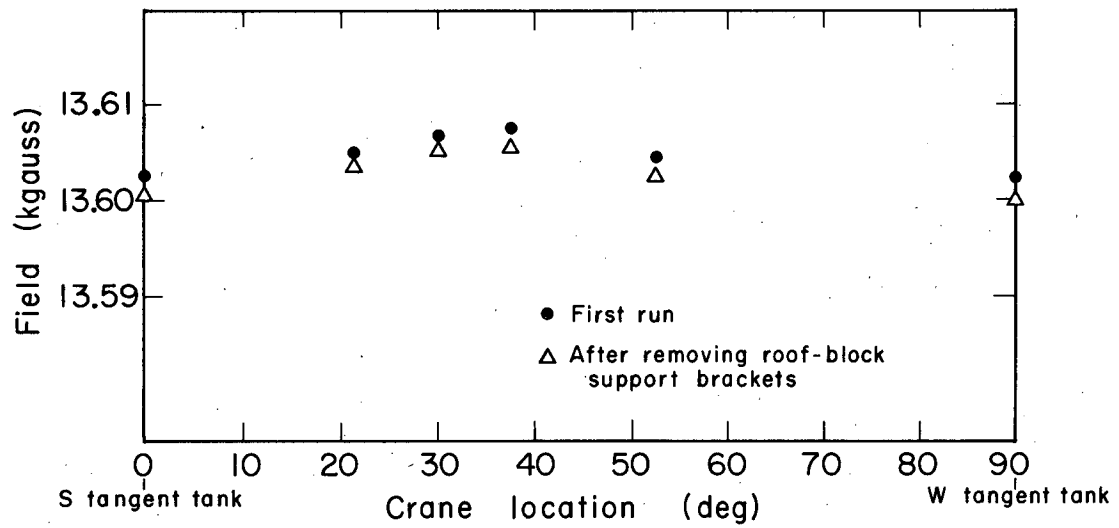
We have a probe for measuring the magnetic field and gradient in quadrant II of the Bevatron magnet. This probe was put near the center of the Bevatron-magnet aperture and the magnetic field measured as a function of the crane-carriage position. A plot of this is shown in Fig. 3. When the crane carriage is in the region of the field probe, the magnetic field is raised by about 5 gauss.

From the field plot we can estimate a change of about 1 to 2 kgauss for the $\int H d\ell$ through one quadrant. This is consistent with a displacement of about 0.3 to 0.4 in. observed on the radial-position electrode for the following case. One crane was placed over the west straight section and the other crane over the east straight section. The radial position of the beam was read in the south tangent tank on the radial-position electrodes. The cranes were then moved to the north tangent-tank area with one crane over the exit section of quadrant III and the other crane over the entrance section of quadrant IV. The position was again read in the south on the radial position electrode. The change in radius for the two cases was between 0.3 to 0.4 inch. There are also a number of steel support structures mounted on top of the main shielding over the quadrants of the Bevatron magnet. These structures are used to provide temporary storage of roof blocks removed from the straight sections during shutdown periods. These steel structures were removed in the region of the field probe to determine whether they were providing a coupling between the Bevatron magnet and the crane carriage. Another plot of field versus crane-carriage position was made. This is shown in Fig. 3. The effect of removing the iron was to lower the field by about 3 gauss, but the 5-gauss effect from the crane was the same. The effect is apparently one of adding more iron to the return path and reducing



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Fig. 2. External-proton-beam intensity versus position of the two radial traveling cranes over the Bevatron ring. Crane B was parked at three different positions, indicated by the dot-dash lines. Crane A was then moved around the ring and the external-proton-beam intensity was plotted as a function of the azimuthal position of crane A at 15-deg intervals, for crane-B positions Δ , X, and (or) $\odot$. Note the increased effect when the two cranes are close in Quad II. Numbers 1 through 31 indicate the building columns used as reference points for the crane positions.



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Fig. 3. Field probe versus crane position.

the leakage flux from the Bevatron magnet. At lower magnetic-field values, the effect was reduced. The present solution is to try to limit crane operation during critical running periods and to park the cranes over the straight sections when they are not in use.

IV. MAGNET POWER SUPPLY

The magnet pulsing record is shown in Table II.

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REFERENCES

1. Kenneth C. Crebbin, Bevatron Operation and Development. 48, UCRL-16741, May 1966.
2. Kenneth C. Crebbin, Fred H. G. Lothrop, and Robert Frias, Bevatron Operation and Development. 49, UCRL-16809, May 1966.

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