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Publication Date

1966-12-01

UCRL-17224

University of California

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Radiation Laboratory

BEVATRON OPERATION AND DEVELOPMENT. 51

July through September 1966

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Research and Development

UCRL-17224
UC-28
Particle Accel. and
High-Voltage Machines
TID-4500 (49th Ed.)

UNIVERSITY OF CALIFORNIA
Lawrence Radiation Laboratory
Berkeley, California

AEC Contract No. W-7405-eng-48

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July through September 1966

Robert W. Allison and Kenneth C. Crebbin

December 1, 1966

1968 1-1-68 1-1-68

Printed in the United States of America
Available from
Clearinghouse for Federal Scientific and Technical Information
National Bureau of Standards, U.S. Department of Commerce
Springfield, Virginia 22151
Price: Printed Copy \$3.00; Microfiche \$0.65

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Contents

Abstract	v
I. Machine Operation and Experimental Program	1
II. Shutdown	6
III. Bevatron Development and Studies	6
IV. Magnet Power Supply	10
Staff	12
References	13

*Preceding Quarterly Reports: UCRL-17223, UCRL-16809

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July through September 1966

Robert W. Allison and Kenneth C. Crebbin

Lawrence Radiation Laboratory
University of California
Berkeley, California

December 1, 1966

ABSTRACT

The beam was on for experimenters 89% of the scheduled operating time. During this quarter, the Bevatron accelerated 2.26×10^{18} protons. The craneway and building frame were installed this quarter for a new external-proton-beam experimental hall. Four different modes of magnet pulsing were used this quarter including the new "mezzanine" mode of operation. There were two scheduled shutdowns, primarily for routine inspection of the main motor-generator journals and bearings. A vacuum gasket on a Bevatron vacuum-tank port that had been damaged by radiation was replaced and the vacuum port redesigned to minimize future damage to the gasket. Initial tests were conducted on computer control of the Bevatron inflector system.

I. MACHINE OPERATION AND EXPERIMENTAL PROGRAM

The Bevatron operations record is shown in Fig. 1. The beam was off 4.6% of the scheduled operating time because of equipment failure and 6.4% of the time for experimental setups, tuning, and routine checks. The beam was on 89% of the scheduled operating time. During this quarter, the Bevatron accelerated 2.26×10^{18} protons.

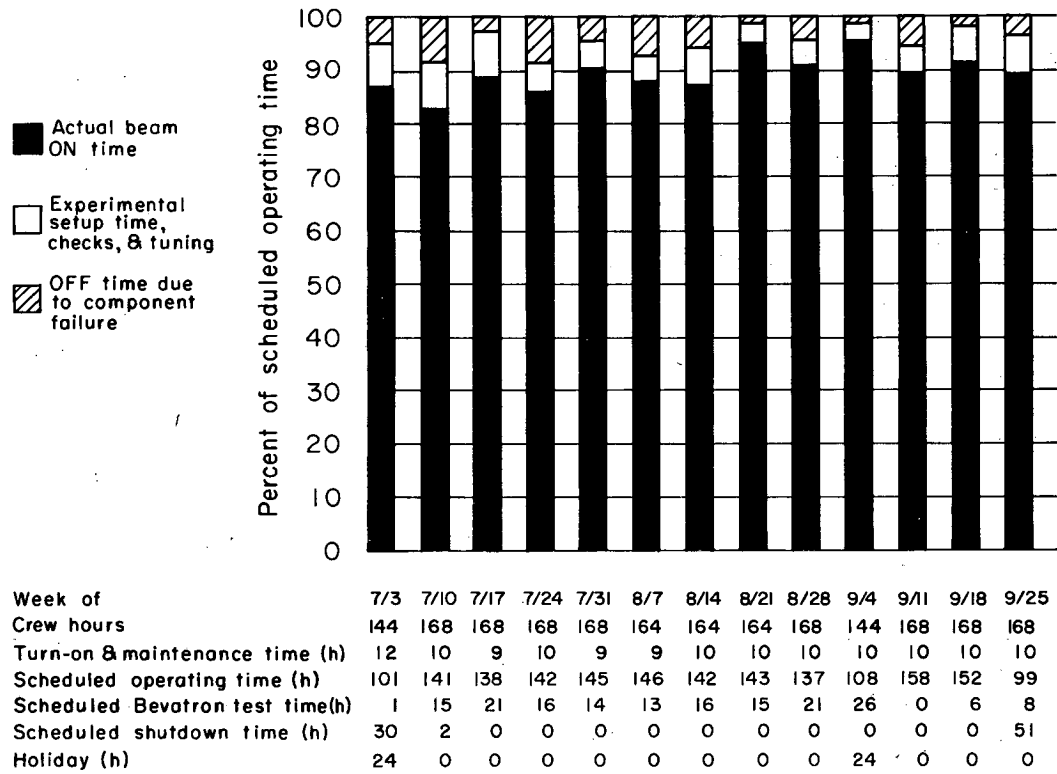
Over the past few years we have achieved fairly stable operation of the Bevatron at beam levels of 3×10^{12} protons per pulse. This stable operation together with more flexible magnet-pulsing modes and better beam distribution between internal and external beam targets has permitted an increase in the number of experiments that can be run simultaneously. At the same time, the experiments have become more complicated. They require more equipment and floor space and take longer to complete. This has resulted in extreme congestion in the experimental hall. Some of the external-proton-beam experiments have gone outside the Bevatron building and have run into a space conflict with the building housing the 72-in. hydrogen bubble chamber. This is shown in Fig. 2.

To relieve this congestion, a new external-proton-beam hall has been planned. The new hall is to be constructed in several stages. The craneway and building frame were installed this quarter. Full use of the new area cannot be achieved until the bubble-chamber building is removed. This will occur in the second half of 1967. A plan view of the new area and the proposed double external-beam channel is shown in Fig. 3.

During the construction of the craneway and building structure, it was necessary for reasons of safety to shutdown the 72- and 25-in. bubble chambers and other users of liquid hydrogen in the area. In addition it was necessary to clear personnel from the construction area during day shift during the week. This temporarily restricted the Bevatron experimental program to running only for the internal-beam experiments during hours of construction. Some of the external-proton-beam experiments were run during the night and on weekends when there was no overhead construction work in progress.

Four modes of magnet pulsing were used this quarter. The first and major mode was a 900-msec flat top at 5.3 BeV. The 72-in. hydrogen bubble chamber took a 300- μ sec spill at the start of the flat top. This short beam spill was placed on a target at F1 in the external beam channel. The secondary beam from this target went to the 72-in. bubble chamber. The remaining beam was spilled in a long spill (700 to 800 msec) for counter experiments. Experiments 43A and 48, at the external-proton-beam third focus, could not be run simultaneously because of conflicting radiation-background requirements. These two experiments ran alternately, sharing the long spill simultaneously with internal experiment 47A and external-beam experiment 40 at the second focus in the external-beam channel. (See Fig. 4a.)

The second mode of magnet pulsing was a 300-msec flat top at 6.1 BeV. In this mode both experiments took secondary beams from internal targets. The first took a 300- μ sec short spill to the 25-in. hydrogen bubble chamber. The second spill (Fig. 4b) was 200-msec-long on the Masek target, experiment 50.



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Fig. 1. Operations record.

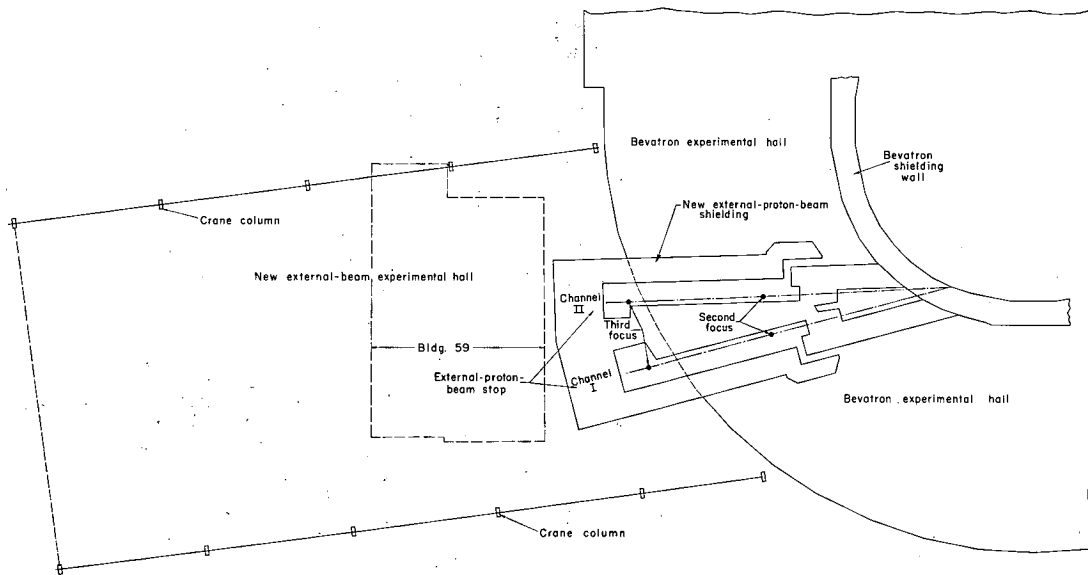
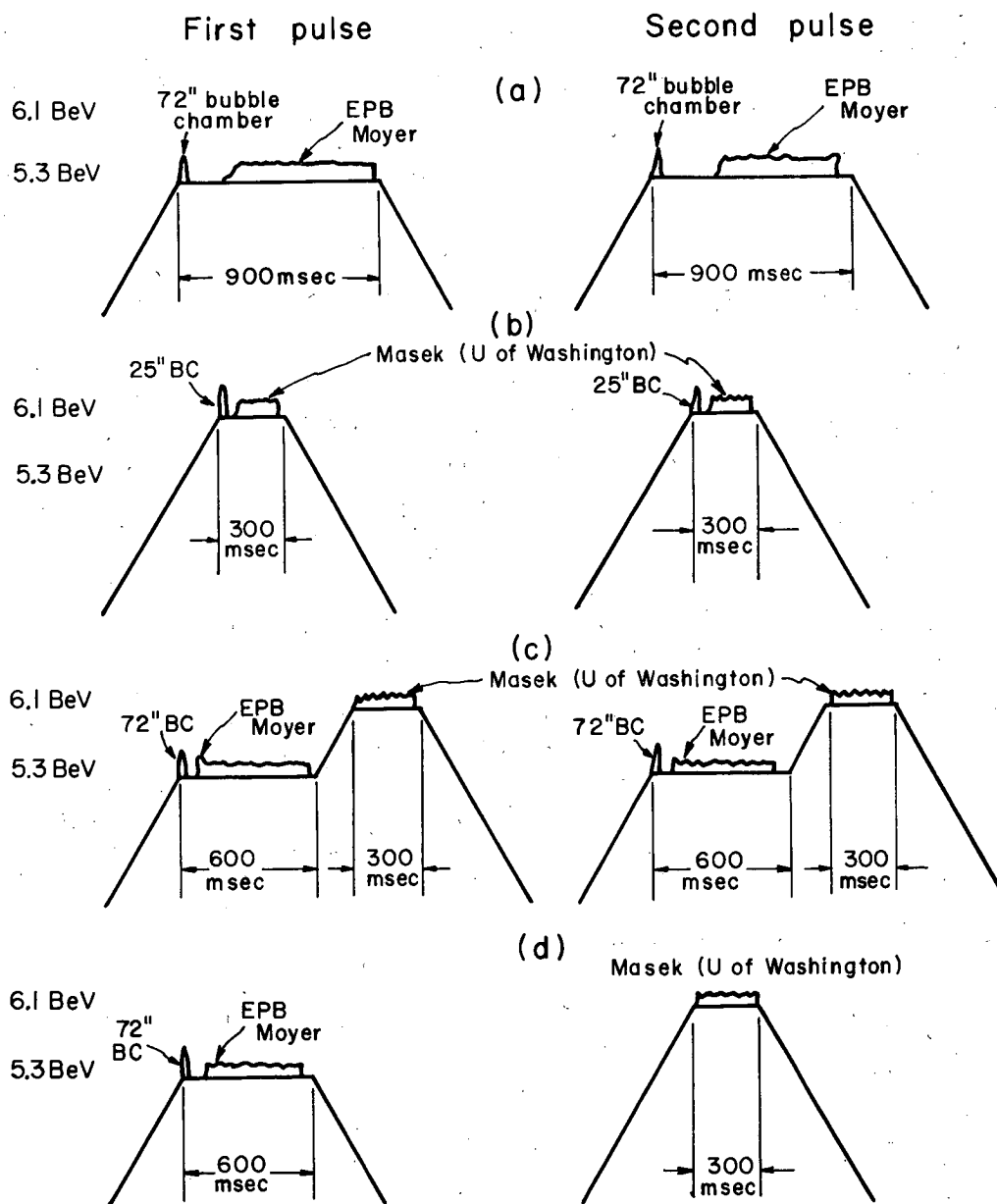


Fig. 3. Future external-proton-beam channel in new experimental hall.



XBL671-17

Fig. 4. Bevatron magnet pulsing modes.

The third mode of magnet pulsing was our new mezzanine mode. The beam energy went to a 5.3-BeV mezzanine for 600 msec, and then up to a 6.1-BeV flat top for 300 msec. (See Fig. 4c.)

The fourth pulsing mode was one in which flat top came at 5.3 BeV for 600 msec on one pulse and 6.1 BeV for 300 msec on alternate pulses. This mode was used because of the requirements of experiment 50, which uses a pulsed high-field-strength magnet that can only be pulsed once every other Bevatron pulse. In addition this experiment requires all of the beam on its pulse. This mode is shown in Fig. 4d.

The experimental program for this quarter is summarized in Table I.

II. SHUTDOWN

The Bevatron was shutdown for two 24-hour periods over the fourth of July and Labor Day holidays. There were additional 2-day shutdowns on July 5 and 6 and September 26 and 27 to inspect the bearings and journals on the main motor-generator sets. This inspection routinely occurs after 1.3×10^6 magnet pulses, or about every three months. The bearings are checked for tarnishing and scraping. The shaft journals are given ultrasonic and "Magnaflux" inspection.

In the July shutdown a vacuum-port window and gasket were replaced because of radiation damage. The port is located in the west straight section near the exit port for the external proton beam. The location of this port is shown in Fig. 5. This is in the same area in which previous radiation damage to a gasket was reported.¹ Damage to the port window and gasket is shown in Fig. 6. This port and gasket were very close to the external proton beam at the point of exit from the Bevatron. Radiation damage and vacuum problems continued to trouble us with this port, so in the September shutdown an extension was welded on to the vacuum tank to move the window and gasket farther from the external proton beam. The remainder of the work during these two shutdowns was devoted to routine inspection and maintenance.

III. BEVATRON DEVELOPMENT AND STUDIES

Robert W. Allison Jr.

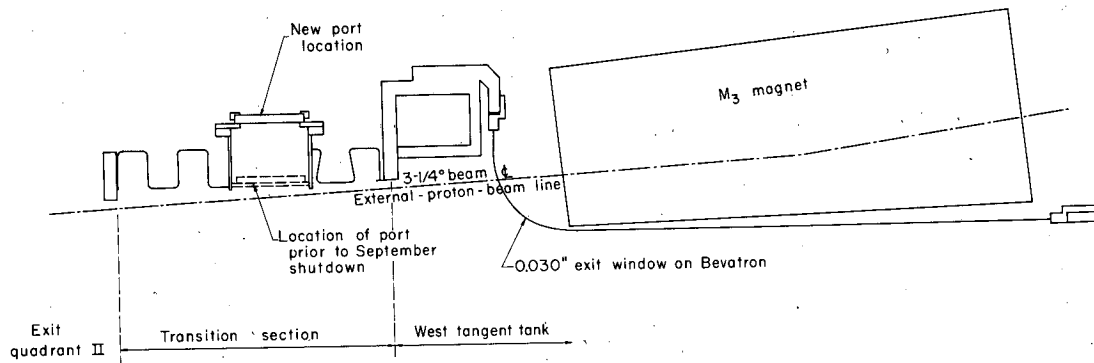
A. Digital Control of the Bevatron-Injector Inflection Trajectory²

Digital control has been installed on the Bevatron achromatic inflector to minimize pickup jitter in the Bevatron and to evaluate the digital-control system proposed for the 200-BeV Accelerator. A PDP-5 computer with interfacing provides 40 monitoring and 20 control channels. The interface communicates with the computer and the inflector system through time-division multiplexers. The system provides both automatic and manual control of the inflector deflection and focusing elements. At present, the system is being debugged, and the main programs written.

Using the analog monitoring developed for beam control, we have adjusted the operating parameters of the inflection system for maximum

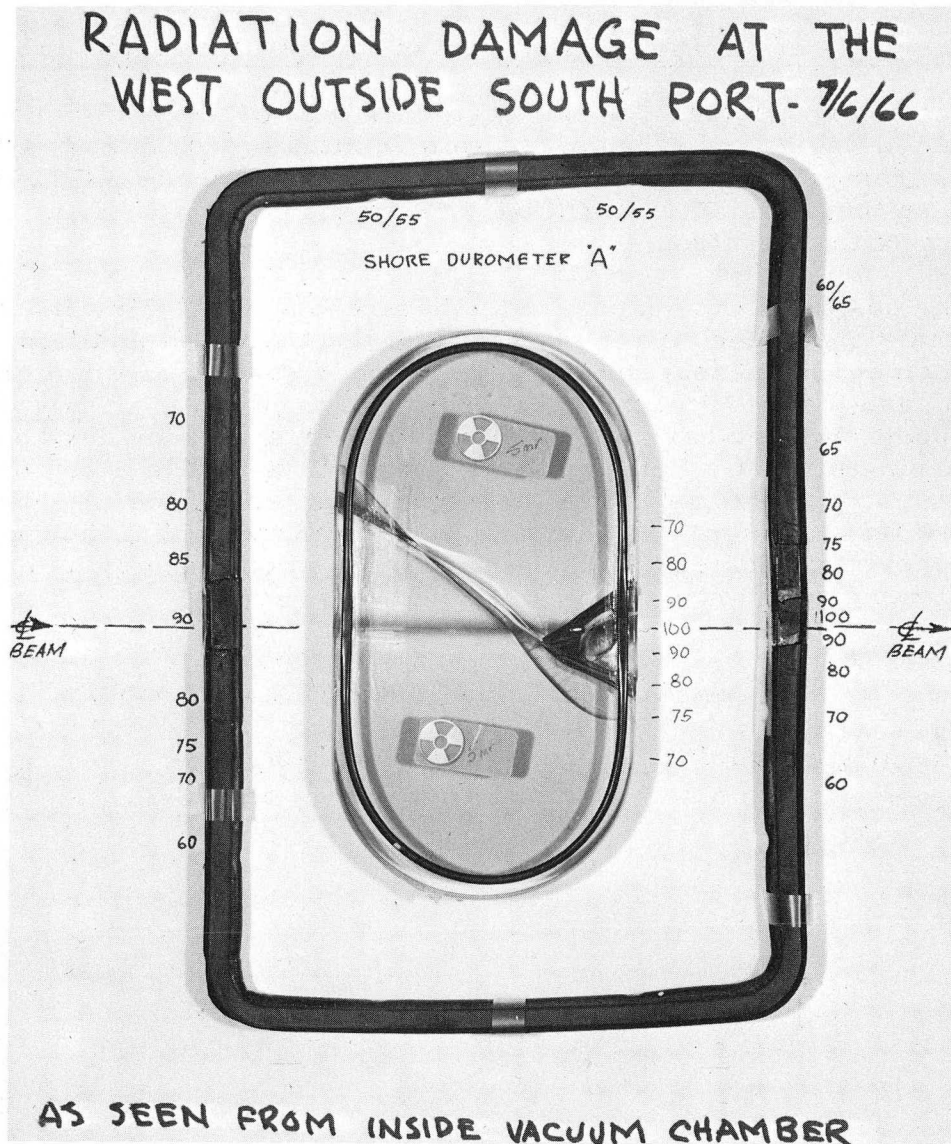
Table I. Summary of Bevatron experimental research program, July through September 1966

Groups	Run	Dates		Experiment	Beam time				Primary or secondary experiment	
		Start	End		This quarter (July - Sept.)		Start of run through Sept. 1966			
					12-Hour periods	Hours	12-Hour periods	Hours		
										Pulse schedule
Internal Groups										
Alvarez-Purdue-Illinois	45	5-2-65	8-22-66	π^- -p interactions in 72-in. bubble chamber	23	236	242	2477	1:1	P
Segrè-Chamberlain-Stiening	40	1-5-66	8-8-66	Polarization of K decays	33	1385	148	1665	1:1	P
Moyer-Helmholz-Parker	47A	5-19-66	In progress	Investigation of neutral particles	27	305	32	351	1:1	P
Lofgren-Cork-Wenzel	48	5-26-66	In progress	Diboson mass spectra	24	284	66	820	1:1	S
Segrè-Chamberlain-Wiegand	69	8-16-66	In progress	Study of solid-state detectors	34	381	38	416	1:1	P
Alvarez-Miller-Kurz	63	8-23-66	9-25-66	$\eta(959)$ production and decay	13	340	42	711	1:1	S
Chemistry-Hyde	P-13	9-21-66	In progress	Light-fragment production from interaction of heavy nuclei with protons	42	116	42	116	1:1	P
Segrè-Chamberlain-Chinowsky-UC-Irvine-Schultz	64	9-27-66	In progress	Multi- and strange-particle production	45	465	45	465	1:1	P
External Groups										
Masek-U. of Washington	50	3-18-66	In progress	Magnetic moment of Ξ^- cascade	6	69	6	69	1:1	P
Longo-Helland-U. of Michigan-UCLA	43	5-24-66	In progress	K_L^0 decays	13	148	13	148	1:1	P
Davis-U. of Washington	P-12	7-21-66	In progress	Spark-chamber tests	1	21	1	21	1:1	P
Camerini-U. of Wisconsin	59	8-9-66	In progress	K-d interaction in 25-in. bubble chamber	40	184	95	1063	1:1	S
Lander-UC-San Diego	P-16	8-21-66	8-30-66	π -nucleon scattering	24	255	29	309	1:1	P
Tollestrup-California Institute of Technology	P-18	9-9-66	9-9-66	Spark-chamber tests	5	60	5	60	1:2	P
		9-10-66	9-10-66		51	554	76	844	1:1	P
					5	51	41	473	1:1	S
					5	59	5	59	1:1	S
					10	109	10	109	1:1	P
					4	50	4	50	1:1	S
					1	5	1	5	1:1	P
					0	2	0	2	1:1	S
					0	4	0	4	1:2	S



XBL 671-18

Fig. 5. West tangent-tank area showing external-proton-beam line and location of port and gasket damaged by radiation.



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Fig. 6. Radiation damage and Durometer readings on the two gaskets at the west tangent-tank port. The fracture in the glass was not caused by radiation, but was suffered after removal of the port from the Bevatron.

charge survival in the Bevatron. As a result, the injection efficiency increased by 30%. The beam position (at each monitoring station) has also been set using closed-loop digital control. Resonant induction electrodes are used to detect the center of gravity of the beam. Three-pulse convergence has been obtained, with a resolution of ± 0.1 mm.

B. Measurements of the Linac Exit Beam of the Bevatron Injector³

The linear-accelerator exit beam has been measured to determine the presence of variations in beam position, emittance, or energy spread. These measurements have shown that beam-position movements due to voltage ripple on the preinjector and linac rf systems occur and affect the pick-up efficiency of the Bevatron.

The positions were measured with a resonant 200-MHz induction electrode that detects the center of gravity of the beam. In addition, a series of momentum measurements were made to study filamentation of the linac beam, and the effect of the prebuncher and debuncher. Energy ripple and beam-position jitter have been correlated. An emittance device that uses a sweeping magnetic field for measuring emittance has been constructed, and a preliminary study has been made of the linac emittance variation with intensity and tank gradient. A comparison of this device with the movable two-slit technique indicates that higher accuracy is obtained by using the swept-field rapid emittance equipment.

IV. MAGNET POWER SUPPLY

The magnet pulsing record is shown in Table II.

[illegible]

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3. Robert W. Allison Jr., Don M. Evans, Robert M. Richter, Allen J. Sherwood, and Emery Zajec, Measurement of the Linac Exit Beam of the Bevatron Injector, UCRL-17001, September 1966.

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