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BEVATRON OPERATION AND DEVELOPMENT. 53
January through March 1967

Robert W. Allison, Kenneth C. Crebbin, and Robert Frias
June 2, 1967

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ABSTRACT

Repair work on the main motor generators continued through this quarter. Construction work was started for the foundation and shielding of the new two-channel external proton beam system. The Bevatron main control room was expanded to provide additional console space to handle the increasingly complex experimental program and beam-sharing problems. The Bevatron magnet sectors were realigned on a new tilted plane to return the closed orbit to the gap center line. Repairs were made on parts of the injector system. Measurements of the linac E and wall H fields were made.
1. SHUTDOWN

The shutdown, started on December 19, 1966, continued through this quarter. The major job during the shutdown was to replace the fractured rotor poles of the main motor generator sets. The discovery and nature of the failure were recorded in the preceding quarterly report. The time to do the work on the motor generators was estimated to be about 4 months. Because of the length of this shutdown, we decided to speed up the planned construction work on the new external proton beam (EPB) channel. This work, including an overhaul of the motor generator sets, had been planned for the summer of 1967. Included in the EPB construction program is the removal of the old EPB channel and the bubble chamber building, installation of a new shielding foundation and shielding for the double EPB system, and installation of the beam transport, targetry, and monitoring for the new system. Engineering design was speeded up and the jobs put out for bid as early as possible.

The job of removing the old concrete floor along the EPB channel started February 27 and the new shielding foundation is to be completed by May 1. Removal of the bubble chamber building (Bldg. 59) is scheduled to start May 15. Roof construction on the first two and a half bays of the new EPB hall was completed on the first of March. The area of this construction work is shown in Fig. 1.

The need for more space in the main control room has grown as the complexity and flexibility of the Bevatron and experiments have increased. To take care of this need, the main control room console area and rack space were increased. This is shown in plan view in Fig. 2. The completed control room is shown in Fig. 3.

Measurements made early in December 1966 indicated that the Bevatron magnet was vertically misaligned. Calculations showed that as a result the beam was low by approximately 0.9 in. in the north target area. Measurements made in the east and south straight sections placed the beam on the calculated closed orbit. Measurements in the north straight section could not be made because of the failure of the main motor generators. A plot of the magnet gap elevations, slopes, and calculated closed orbit for the December 1966 survey is shown in Fig. 4.

The Bevatron magnet is surveyed at a set of arbitrary points on the bottom of each magnet sector. A computer program then calculates the gap elevation and slope from these points. The computer program is based on a previous survey in the gap, which is correlated with a simultaneous survey on the bottom of the magnet.

The Bevatron magnet consists of four quadrants of 36 sectors each. Each sector is supported by one jack on the inner radius and two jacks at the outer radius of the magnet. The inner and outer radius jacks are 231 inches apart. The gap center-line elevation and slope of each sector are adjusted by these jacks. The vacuum tank is continuous through 36 sectors. Therefore care must be taken, when adjusting the jacks on adjacent sectors, that excessive sheer is not applied to the vacuum tank walls. We limit the
Fig. 1. Layout of new external-beam experimental hall.
Fig. 2. Bevatron main control room layout.
Fig. 3. Bevatron main control room.
Fig. 4. December 1966 survey of Bevatron magnet.
normal differential between adjacent sectors to 0.020 in. during jacking. If the final differential between sectors, specified by the jacking schedule, is greater than 0.040 in., a measurement is made in the gap between adjacent pole tips. If the differential is real the jacking schedule is followed. If it is not real the jacking schedule is modified and the computer program is modified to correct it for future surveys.

It was easier to put the Bevatron magnets on a new plane rather than returning to the old plane of 1963. We chose a plane that required the least amount of movement of magnet elements. The three points that determine the plane were chosen as the elevation of the gap center line at the north, east, and south straight sections. By choosing these three points we had to move only one tangent tank. The new gap center line and slope were calculated for each sector. These were then converted to changes in magnet sector elevations. The new gap center-line elevation, slope, and calculated closed orbit are shown in Fig. 5.

II. INJECTOR
R. W. Allison, Jr.

While the Bevatron motor generator sets were being repaired several modifications were made on the injector. They were as follows:

Mechanical Overhaul
1. Four linac drift tubes (2 through 5) were removed and resoldered to repair air leaks which had developed since the initial construction of the linear accelerator in 1961.
2. Because of (1) and the beam deflection problem (which we reported in UCRL-17001) the entrance section optical alignment equipment was assembled and the linac drift-tube alignment checked. The drift tubes were found to be in alignment within ±0.005 in. at the input and ±0.015 in. at the exit end.
3. The pre-accelerator and linear accelerator were set to the Bevatron median plane. A displacement from this plane of 1/64 in. was found at the linac entrance.
4. The linac exit section was realigned and the swept field emittance equipment reinstalled.
5. The ion gun exit section was modified by adding a swept field-emittance device. In order to provide space for this equipment the four jaw chunks and swing cup were removed. The buncher was moved upstream by one βλ and turned 180 deg.

With the addition of these diagnostic devices it will now be possible to measure the beam emittance accurately at both the linac entrance and exit. Provision is being made to control these instruments with the digital control system which was recently added to the injector.

Measurement of the Linac E field

In addition to the modifications described above, the E field in the linear accelerator was measured by use of a perturbation. The objectives of this measurement were:
1. To determine the E field in the operating machine, and the axial transit time factors.
2. To measure the wall H field for several tank tilts.
Fig. 5. New gap elevation, slope, and calculated closed orbit in Bevatron magnet, March 1967.
In order to insure reproducibility in the measurements, the tank wall probes were rebuilt (eliminating a third harmonic resonance) and calibrated by using a dc test cavity. The tank side turners (20) were rebuilt with precision gear drives and bearings. The setting accuracy was ±0.1 deg.

The data were taken by use of the PDP-5 control computer; 12,500 data points were taken at intervals of from 0.5 to 1 mm along the linear accelerator, in 3-minute runs. A 3/16-in.-diameter perturbing ball was used. The frequency perturbation was 50 Hz out of 199.3 MHz.

It is our hope to use these measurements and the diagnostic equipment just installed to study the dynamics of the linear accelerator and to provide a check on the computational programs which are being developed for new machine design. (MURA and ANL are also doing this experiment.)

III. MOTOR GENERATOR

    Robert Frias

The shutdown for generator pole replacement continued through the entire first quarter of 1967. Resumption of Bevatron operation is scheduled for the latter part of May. The Westinghouse Electric Corporation was contracted to supply all manpower and material necessary to complete the pole replacement. A complete refurbishing of both Bevatron motor generator sets was also included in the contract.

Repair Schedule

Sixteen new generator poles were received from the Westinghouse East Pittsburgh plant on March 1. The old poles had been removed by that date. Pole installation should be completed by April 15. At least a month of additional work is necessary to secure the poles to the rotor and to complete the specified refurbishing.

Analysis of Failure

At present, an extensive study is in progress in order to determine the relationship of Bevatron pulsing modes to the fatigue life of pole-lamination steel. This study includes cyclic fatigue tests of steel test samples as well as complete physical and chemical property tests. In addition a complete theoretical analysis will augment these studies.

Tests for determining actual stress levels under operating conditions are planned for the earliest running date.

An LRL Engineering Report of test results will be published as soon as the study is completed.
REFERENCES


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