**Title**

Bevalac Operation's Update



**Author**

Lawrence Berkeley National Laboratory

**Publication Date**

1986-04-01

PUB-496-4-86
No. 2

# BEVALAC OPERATION'S UPDATE

This is the second in a series of informal reports on BEVALAC operations. We plan now to send this report out twice a year at the same time the 'call for proposals' from the Program Advisory Committee is sent out. Your comments and submission of information are welcomed. (GK)

## A. General User Information

It is our goal to make the Bevalac a more user-friendly environment. As many of you have indicated, this is by no means an easy task, as getting an experiment set up and running requires interacting with a bewilderingly large number of people from different support groups. It seems as if a prerequisite for a successful experiment requires "knowing the ropes" to a much greater degree than the typical user has time for.

Although our resources are limited, and stretched rather thin, we certainly have willing hands to help the experimenter in need. There is not a person on the floor who will not provide assistance to an experimenter if asked. All of our staff understands that it is our mission to maximize good science output from the Bevalac, and that this is best served by striving for the greatest degree of success in each experiment.

Coordinating the interfacing between users and the accelerator resources is the responsibility of Gary Krebs. In his role as "EPB Czar" he has control of affairs in the experimental areas, and can marshal available resources wherever they are needed to smooth the way for an experiment. (Jose Alonso)

Lawrence Berkeley Laboratory, University of California, Berkeley, CA 94720.
Supported by the U.S. Dept. of Energy under Contract No. DE-AC03-76SF00098.
Lawrence Berkeley Laboratory is an equal opportunity employer.

B. BEVALAC ELECTRONICS POOL

An unofficial electronics pool was started some time ago to try to coordinate the use and repair of experimenters' electronic equipment. The pool has been fairly successful and has grown in size. Electronic modules can be checked out through Gary Krebs or George Constantian. It is the experimenters obligation to return borrowed equipment on time. (GK)

C. MOTEL BEVALAC

This user rest area was finally completed in the fall of 1985. The area contains two cots, lamps, desk, and phone, and is available to experimenters when their experiment is running. The area can be reserved at the ARC office through Fred Lothrop. (GK)

D. BEVATRON OPERATIONS

Our experimental program this year has been concentrating on longer runs for fewer experiments; we have generally made available two-week periods for each run, each week comprised of an overnight tuneup shift and a weekend of data-taking operation. In addition, fast switching of ions and energies between the nuclear science experiment and the radiotherapy program has been inaugurated. While it does not yet make the therapy program virtually transparent to the nuclear science program, it does eliminate the changeover periods at the end of each therapy session and enhance the opportunities for the overnight experimenter.

Deficit reduction in the form of the Gramm-Rudman law has affected the Bevalac rather severely. We have been forced to absorb a 4+% cut in our annual appropriation, effective during the last seven months of the fiscal year. In addition, we must absorb increased power costs as a result of contract changes between us and our suppliers. The net effect has been to shorten the operating year substantially, providing total research time for the year of approximately 1900 hours for nuclear science and 950 hours for biology and medicine. We will cease Bevalac operation on or about May 2, and revert to Bevatron operation with the local injector for 12 research shifts per week for the first three weeks of May. Complete shutdown will be on or around May 22. Moreover, it has been necessary to reduce our work force a small but significant amount. The result, of course, is that we must lower the rate at which projects are done, and be especially careful of priorities, such that the approved research programs are well executed. (Fred Lothrop)

E. LOCAL INJECTOR

The recently upgraded local Injector consists of a sputter PIG ion source, and a 200 MHz RFQ/Alvarez linac chain. It has been in continuous service since October 1, 1986, with approximately 90% of its operation dedicated to neon running. In this mode, operational reliability has steadily improved and presently exceeds 90%. Use of thinner stripper foils, together with improvements in the 5 MeV/n injection parameters have recently improved pulse-to-pulse stability and pushed the neon intensities to record levels: $1.4 \times 10^{10}$ circulating particles/pulse and $7 \times 10^{9}$ extracted particles/pulse at F1, exceeding the original design goals for Local Injector performance. A system of attenuators has been added in the 5 MeV/n line permitting pulse to pulse intensity modulation for experimenter needs.

The additional of another RF driver planned for the summer of 1986, will make the drive chains for the two Alvarez tanks independent. This will greatly simplify the re-tuning of the RF system which is required when ion species are changed and will permit greater flexibility in the scheduling of the Local Injector. (R. Gough)

F. BEAM 26

Some quadrupoles were removed from this beam line for use in the AIP '85 project. Since beam 43 is at least temporarily out of commission due to the removal of the plastic ball, substitutes were taken from beam 43 to make the beam line operational. During extensive surveying of the beam line during the AIP '85 project the line was found to have several magnets misaligned. The magnet positions were all corrected in December 1985 and an additional wire chamber was placed after the beam 26 M1 magnet to aid in the tuning of the beam line. All magnets except for some vertical steering magnets can be controlled at the main control room. The experimenters maintain control of the final two vertical bending magnets so that they are able to align the beam on the target center, in the presence of various streamer chamber magnetic fields. In both a test run and an experiment the line tuned up very easily. The main control room was able to deliver beam quickly to the experimenters. (GK)

G. BEAM 30

Beam 30 is presently set up to run a two pion correlation experiment in March 1986. In addition, the dilepton spectrometer (DLS) group is in the process of setting up their system. The new DLS magnets' fields were measured and the magnets have been installed. Also installed in this large detection system are the DLS drift chambers and Cerenkov detector arrays. The DLS group had a fast electronics shack built outside the beam line. We have two VAX 750 computers and peripherals available at this beam line for data collection and analysis. The DLS group expects to complete detector tests during the present running period with their actual experiment occurring in the fall of 1986.

H. BEAM 39

The low energy beam line was run in Dec. 1985 for the LANL, ORNL, BNL, Weizman Inst. collaboration. The experiment (753H) measured charged particles and light fragment spectra in coincidence with fission and other heavy fragments. Since an extensive setup was required for the detection apparatus, the group will maintain their setup in the beam 39 cave until the fall of '86 when subsequent experimental runs will complete their experiment. (GK)

I. BEAM 40

A number of experiments have been run on this beam line since October 1985. Two atomic physics experiments (H. Gould, et al) were recently completed. In addition a new time of flight system was tested with interesting results and two NASA experiments were successfully completed (H. Crawford). A liquid argon calorimeter test cell was exposed to p, $^{4}He$ and Ar ions to check the saturation properties of the scintillation and ionization signals (T. Doke et al). New position sensitive scintillator foils were tested for time and position resolution using an oxygen beam (D. Greiner, R. Debbe). A drift cell active target for experiments at BNL and CERN was successfully tested in the 2 GeV $^{16}O$ beam. (GK)

J. BEAM 42

During the current running period two experiments and a detector test have been made. One of the experiments, E772H, was completed with two weekend runs in January. Inclusive measurements of projectile fragmentation with ~1.5 GeV Nb, Ne, Fe and La beams using the 40 cm x 30 cm prototype drift chamber and the Cerenkov velocity detector concluded this experiment which was started last spring using an Ar beam.

As a graphic demonstration of projectile fragmentation for radioactive beams, INS's E690H, was run for two weekends at the end of November. In this experiment interaction cross sections were measured using beams of $^{3,4,6,8}$He, $^{6,7,8,9,11}$Li, $^{8,10}$Be at 790 MeV/nucleon. The beams of radioactive nuclei were produced through the projectile fragmentation of 800 MeV/nucleon $^{11}$B and $^{20}$Ne and separated by magnetic analysis in the HISS beam line. Interaction cross sections for the separated beams were then measured using the HISS spectrometer.

Unfortunately, two other experiments scheduled for this running period had to be postponed due to a failure of the HISS dipole. In February a known leak from the liquid nitrogen cooling coils to the thermal isolation vacuum became too large to maintain liquid helium temperatures. Work on this problem has begun and could take 5-6 weeks to complete.

Initial "in beam tests" of the newly constructed 1.5 m x 2.0 m drift chamber were made as this could be done without the HISS dipole. Preliminary results from this test are encouraging; the large chamber behaves much like the smaller prototype and the new fastbus ADC system used for this chamber worked successfully. Work is progressing to implement the full set of planes and wires.

The front end data aquisition computer was upgraded from a PDP 11/45 to a VAX 750. The new computer was used for both the E772H experiment and the drift chamber test. (H. Wieman)

K. BEAM 43 Plastic Ball

In December of '85 the Plastic Ball detector had its final series of experimental runs at the Bevalac. The experiment (773H) measured two-pion correlations using incident beams of Au and Nb. The Plastic Ball collaboration of GSI/LBL has been a highly successful program at the Bevalac. Results from this detector system have yielded especially interesting information about the size and shape of the emitting system in heavy-ion collisions.

The Plastic Ball detector was removed from the beam 43 cave area and shipped to CERN along with its accompanying computer and electronics. (GK)

L. BEAM 44

This beam line was the first tested upon the completion of the magnet changes in the AIP '85 project. All aspects of the beam line performed as expected. The line was used in October 1985 as a kaon spectrometer by the Igo-Carroll group. About 100 times more kaons were gathered per time unit than in the groups previous kaon runs. This improvement was due to the optimization of the beam line for high acceptance. Beam 44 was also designed as a low energy beam line. The 60 in. scattering chamber, previously at beam 39, was moved into the beam 44 cave. An experiment was performed using the scattering chamber in January 1986. As well as running as a low energy beam line and kaon spectrometer, beam 44 is an excellent beam line for radioactive beam deliver. The presence of four bends with accompanying collimators allows for the separation and delivery of a single isotope produced by fragmentation at F1. Several tests have been carried out to use this capability, and the Osaka-INS group is gearing up for their full experiment in the fall of '86. Presently, there are both a PDP 11/45 and PDP 11/44 computer associated with the beam line. In June of 1986 the PDP/11/45 will be moved back to the HISS area. (GK)

## M. UPDATE ON THE ACCELERATOR IMPROVEMENT PROJECT '85 (AIP '85)

This AIP project had three main goals:

- The widening of the vertical aperture in the upstream external-particle-beam area of the BEVALAC.
- The inclusion in the external-particle-beam area at the BEVALAC of two quadrupole magnets. These magnets were necessary to allow the more efficient capture and transport of radioactive beams produced by targets at F1 (first external focal point from the BEVALAC).
- To increase the number of wire chambers and collimators to allow for better monitoring and diagnostics of the beam lines and better beam shaping when required.

As of this writing, the project is almost 100% complete. The magnet changes required were completed on time so that the accelerator was running again as of October 1, 1985. This was an enormous amount of work for the BEVALAC operations staff. It is a credit to them all that they were able to have the accelerator up and running by the October 1st target date. All the beam lines were tested with only very few minor difficulties arising. An added bonus to this project was the surveying and realignment of all beamlines which were known or suspected of having alignment difficulties. (eg. beam 26)

The number of beam monitoring wire chambers was increased by ten. With this increase in the number of chambers we now find that very little transferring of wire chambers from beam line to beam line is required. Less transferring of wire chambers between beam lines has also resulted in greater reliability in chamber performance. Overall beam line readiness has improved.

Most of the six new collimator pairs (horizontal-vertical) have been installed. Some work still continues on the remote computer control of the collimators. We expect the computer control of the new collimators to be completed by the end of April. (GK)

N. ACCELERATOR IMPROVEMENT PROJECT 1986--Uranium Upgrade-II

This AIP project has as its main goal a factor of five increase in very heavy ion (Au, U) beam intensity delivered to BEVALAC experiments. Light ions will show some improvement also, but not as great. The newly developed Metal-Vapor Vacuum Arc (MEVVA) source will provide the increased beam intensity from the Abel injector terminal, but improvement is also needed in the terminal transport system and power supply, and the beam transport lines to make use of this higher intensity. MEVVA will be installed this summer, with increased intensity expected at fall startup. (B. Feinberg)

O. ACCELERATOR IMPROVEMENT PROJECT 1987--SuperHILAC Drift Tube Quadrupoles

During the last two years large drops have been noticed in the field strength of numerous quadrupole focussing magnets at the high energy end of the SuperHILAC Prestripper. Located inaccessibly inside drift tubes, these magnets are the key to transmission of beams through the Alvarez tanks, and any decrease in performance results in reduced beam intensity. The failure mechanism is overheating, leading to gradual deterioration of the epoxy, and eventually to shorted turns. The cause of the overheating is the many years of operation at and slightly above the rated limits to push for maximum transport of the heaviest beams. We have been replacing the worst magnets, about four per year during summer shutdowns, drawing from spare coils fabricated with the original production run dating from 1970.

This past summer a new coil was fabricated using exactly the same design as the original magnets, but employing more modern materials. Specifically, a Kapton layer was added for insulation and the original epoxy was replaced by a high-temperature epoxy. The operating temperature of a quadrupole was measured on a test stand and was shown to be above the curing temperature of the original epoxy, but well below that of the new epoxy, leading to the expectation of a significant increase in lifetime for the new quadrupoles.

In addition to replacing most magnets at the high energy end of the Prestripper with these upgraded conventional coils, about 48 magnets at the Prestripper entrance will also be replaced, by adjustable hybrid rare-earth permanent magnet quads (REQ's). These magnets offer the advantages of greater effective field strength, adjustability over a wide range of fields by rotating a ring containing properly aligned magnetic material, and no power consumption. Prototype magnets of this design are now being tested through an accelerated ten-year life-cycle.

The principal advantage of installing these magnets will be the added field gradient, leading to transmission improvements. The overall intensity gain, including the effect of replacing the failing magnets at the end of the Prestripper, is anticipated to be over a factor of two. (B. Feinberg)

P. <u>AIP FY 1988 - Bevalac Control Systems Upgrade</u>

The main Bevalac control systems have remained basically unchanged since the late 70's. In general, the system has operated well, but is just barely able to keep up with the tasks presently demanded of it. Over time, more and more hardware to be controlled has been added, as well as more operator interfacing, to the point that system saturation has occurred.

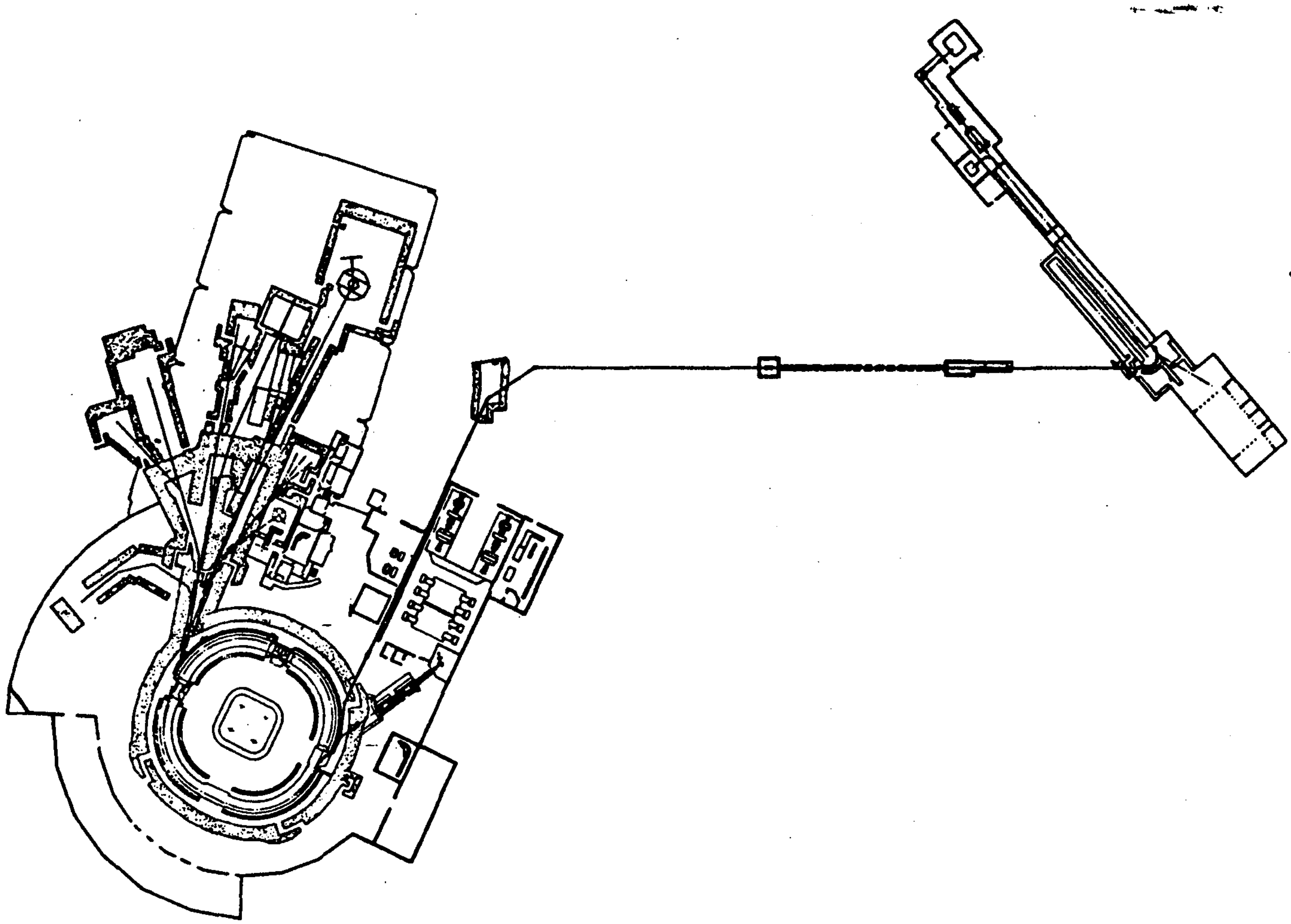
Advances in both computer technology and accelerator control over the past several years have been spectacular, and both these fields have matured to the point where application of developed techniques to the Bevalac environment can easily yield handsome dividends. It is proposed that the Bevalac control systems be upgraded to take advantage of these advances.

The scope of the proposed project is as follows. The existing control systems provide an excellent base on which to build and these systems will be left essentially intact to minimize hardware and software development. The operator interface functions, including display generation, will be offloaded, relieving the centrals from this time-consuming task. In place, each central--the two Modcomp IV's and the main Intel processors--will be connected to a high-bandwidth network to allow communications between them. Intelligent work-stations dedicated to operator input and control will be installed on the network as well. These work-stations (such as MicroVAX or Sun III) have highly sophisticated built-in operating systems and graphics software and will be the backbone of the operator-interface to the accelerator. They will also provide opportunities for accelerator modeling, "smart knob" assignments, and other features used so effectively in modern accelerator control systems at major laboratories around the world.

The principal goal of this project is to improve operational efficiency, by reducing tuning time, and by improving setup reproducibility. The addition of many more monitoring endpoints to the control system will reduce the burden on maintenance personnel by allowing rapid fault detection and self-diagnosis of components. In other words, more research hours with fewer people and lower operating costs. (Jose Alonso)

Q. Upgrade of the Bevatron

In order to enhance the heavy-ion program at the Bevalac and to provide new scientific opportunities the Nuclear Science Division and the Accelerator and Fusion Research Division have presented a preliminary proposal to the Nuclear Science Advisory Committee (NSAC) to replace the present Bevatron with a modern strong focussing synchrotron. This new accelerator ring would be placed within the existing Bevatron shielding utilizing the rest of the present Bevatron's peripherals and experimental areas. The new synchrotron would deliver beams over essentially the same energy range but with greatly improved intensity and duty factor. The upgrade of the Bevatron is expected to take just three years. (GK)



Lawrence Berkeley Laboratory
ARC Office
MS 51-208
University of California
Berkeley, CA 94720