BERKELEY LAB

Facilities: Capital Projects
Lawrence Berkeley National Laboratory
One Cyclotron Road
Berkeley, CA 94720

Date: April 24, 2009

To: LBNL - BSO

Subject Project: B71 Super HILAC Project
S/C No.:
P.O. No.
PID/WO No.

ATTENTION: KIM V. ABBOTT

We are:

X	forwarding to you herewith
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	Shop Drawings
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3 Orig. Historic American Engineering Record – HAER No. CA-186-B

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X	For your reference.
	Reviewed as noted. Please furnish ____ corrected copies to our office for final approval.
	The above ____ is (are) issued for your approval and/or comments.

Remarks: Kim,

Attached please find written historical and descriptive data for the B71 Super HILAC project.

Thank you.

By Jennetta Ocean
Project Administrator
510-486-7461

File No.

w/c:	wo/c:		w/c:	wo/c:	
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UNIVERSITY OF CALIFORNIA RADIATION LABORATORY, SUPERHILAC
(Ernest Orlando Lawrence Berkeley National Laboratory, Building 71)
1 Cyclotron Road
Alameda County
California

HAER No. CA-186-B

PHOTOGRAPHS
WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
PACIFIC WEST REGIONAL OFFICE
National Park Service
1111 Jackson Street
Suite 700
Oakland, CA 94607

HISTORIC AMERICAN ENGINEERING RECORD

UNIVERSITY OF CALIFORNIA RADIATION LABORATORY, SUPERHILAC
(Ernest Orlando Lawrence Berkeley National Laboratory, Building 71)

HAER NO. CA-186-B

Location: North side of McMillan Road, Lawrence Berkeley National Laboratory, Berkeley, Alameda County, California

U.S.G.S. Briones Valley (CA) Topographic Map
UTM Coordinates: Zone 10, 565959E, 4192283N

Date of Construction: 1957-1974

Architect: Corlett and Spackman, San Francisco, California

Engineer: University of California, Plant Engineering

Present Owner: U. S. Department of Energy, Berkeley Site Office

Present Use: L'Oasis laboratory, Center for Beam Physics/Ion Beam technology offices, Electrodynamics laboratory, Laser Optics laboratory, and Low Beta laboratory.

Significance: Building 71 at the Department of Energy's (DOE) Lawrence Berkeley National Laboratory (Berkeley Laboratory) is a nuclear physics research facility that formerly focused on large accelerator-based research. Constructed in phases from 1957-1974, Building 71 housed the Heavy Ion Linear Accelerator (Hilac), SuperHilac, and Bevalac particle accelerators that were in successive operation from 1957 to 1993. In 2007, the DOE determined that Building 71 is eligible for the National Register of Historic Places (National Register) because of the important role the building has played in the nuclear physics and accelerator development and research activities at the Berkeley Laboratory. Scientists used the accelerators to maintain the Laboratory's position as a world-leading accelerator facility, establish a nationally-recognized biomedical program, and explore the potential of heavy ion beams in cancer therapy. By 1974, Building 71 was the only research facility in the world where scientists accelerated to high energies the nuclei of all the elements of the periodic table. Building 71 became the country's leading facility for heavy-ion research, attracting scientists from universities and laboratories throughout the United States and world-wide.

Report Prepared By: David Harvey, Senior Project Scientist/Architectural Historian
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Date: July 2008

I. DESCRIPTION

Building 71 - Location and General Description
Building 71, situated on McMillan Road at the Department of Energy's (DOE) Lawrence Berkeley National Laboratory (Berkeley Laboratory) (Figure 1) in Berkeley, California, historically housed several particle accelerators. Building 71 and the other accelerator buildings at the Berkeley Laboratory were constructed over a period of time independently of one another rather than as a cohesive planning effort. The 184 inch cyclotron, which was housed in Building 6, was constructed during the Second World War and was the first cyclotron constructed at the new hill top location of the Radiation Laboratory (Berkeley Laboratory). Building 10, which was constructed onto Building 6, housed one of world's first post-war linear accelerators. Building 25 and the Laboratory's first synchrotron were completed during the early post-World War II era, while the Bevatron was completed in Building 51 during the mid-1950s. In most cases, Berkeley Laboratory buildings are not sited by common function in tight clusters as the steep topography at the hill site presents a limited array of building sites. The scarcity of building locations and the development and construction of accelerator facilities over several decades is reflected in the somewhat dispersed locations of accelerator and accelerator support buildings throughout the Berkeley Laboratory.

Constructed in phases from 1957 to 1974, Building 71 is a nuclear physics research facility that formerly focused on large accelerator-based research. Between 1957 and 1993, Building 71 housed and operated in succession the Heavy Ion Linear Accelerator (Hilac), the SuperHilac, and the Bevalac particle accelerators.

Building 71 - Physical Description of the Hilac/SuperHilac/Bevalac

Function/Use
Building 71 is a nuclear physics research facility that formerly focused on large accelerator-based research. The facility housed the Hilac/SuperHilac/Bevalac accelerators. Heavy ion physics began at the Berkeley Laboratory with the opening of the Hilac in 1957, an Alvarez linear accelerator capable of producing nuclei of elements as heavy as argon. Scientists and engineers in Building 71 discovered and synthesized elements 102 to 105. In 1971-72, after extensive modification, the accelerator was converted to the SuperHilac capable of increased acceleration of heavy ions and the development of new ion beams for elements heavier than uranium. The main control room was the nerve center for the SuperHilac, which controlled and monitored the operation of the facility including electronic systems, beam injection, and computer systems. In 1973-74, the SuperHilac was combined with the Bevatron to establish the Bevalac. The Bevalac was used for medical research, cosmic ray experiments, and radiation therapy for the treatment of cancer. After an upgrade in 1981, the Bevalac became the only accelerator in the world capable of accelerating to near light-speed all of the naturally occurring elements of the periodic table.

Description of Physical Appearance

Building 71 and the surrounding complex were constructed in several stages (or "increments") from 1957 to 1965 (Dobkin and Corbett 1994). Accelerator development and construction in Building 71 continued through 1974. Corlett and Spackman, a San Francisco architectural firm, designed Increments I-IV including several other smaller additions to Building 71.

Exterior
Building 71 is a modified rectangular structure with an east-west orientation that was built in several phases into the adjacent hillside. The downhill side of Building 71 is a two-story structure, while the uphill side is a one-story structure. Building 71 was originally shaped as two parallel rectangles with unequal height. Today, the main building covers approximately 57,000 square feet in area. The larger downhill rectangle measures 191 feet by 29 feet by 38 feet high and housed the accelerator facilities. The SuperHilac's additions were constructed on all sides of the building, giving the structure an irregular shape. The building reflects an industrial style with linear, symmetrical features and minimal façade ornamentation. The building has a steel-frame construction; a flat roof, precast concrete panel exterior walls; fluted metal and insulated and laminated metal panel cladding occasionally broken up by horizontal bands of clear glass windows; and a monochrome painted exterior.

Interior
The Building 71 high bay or high ceiling section housed two injectors, a linear accelerator, and a switchyard. A third injector was located in a smaller high bay adjacent to the main building. The main high bay included the starting point of the 550-foot beam transfer line that consisted of an aluminum pipe four to six inches in diameter. The main high bay also housed the control room, pulse line room, transformer and rectifiers, electronic equipment room, target caves, injector room, and accelerator shop and laboratory.

The 120-foot long pre-stripper and the 90-foot long post-stripper tanks, several pieces of supporting infrastructure, and drift tubes are currently what remain of the SuperHilac and the Bevalac in the high bay. (There are 135 drift tubes in the pre-stripper tank and 78 drift tubes in the post-stripper tank.) The Bevalac includes the Bevatron accelerator in Building 51, which is still largely intact. The three injectors, portions of the linear accelerator, the switchyard magnets, and the beam transfer line have been removed from the high bay of Building 71. Most of the caves have also been extensively modified and/or removed. Offices, laboratories, shops, storage areas, and mechanized support services are to be located in the rear of Building 71. The original 20,000-pound ceiling crane is intact on the high bay ceiling.

The high bay interior consists of typical industrial features such as concrete and metal walls, a concrete floor, a metal ceiling, and shop equipment and machinery. The rest of Building 71 consists of labs, shops and offices with tile floors, exposed and acoustic tile ceilings, and concrete, gypsum, and plasterboard walls.

II. HISTORICAL CONTEXT

The following section provides a (1) general definition of particle accelerators and the types of large research particle accelerators established at the Berkeley Laboratory, and (2) a context of historic accelerator development and research at the Berkeley Laboratory, specifically in Building 71 and at other national and international accelerator locations.

Types of Particle Accelerators

Particle accelerators are devices that use electrical fields to produce high-energy, high-speed beams of extremely small, charged particles. These particles can be subatomic particles (electrons, protons), anti-particles (every particle has a corresponding antiparticle), or charged atoms (ions). Key to the function of the particle accelerator is the powerful effect or force that electrical fields can have on charged particles.

Particle accelerators can be found in relatively small and ubiquitous applications. For example, the cathode ray tube of the household television set contains all major components found in much larger accelerators, including a particle source, accelerator, focusing and directional agents, and targets. Larger but still common accelerators are used in commercial and medical applications such as X-ray machines and for cancer radiation therapy.

Far less common are large research accelerators, which are million times more powerful than the accelerator in a television. These accelerators can be small enough to exist within a large room, or be many miles long. The largest are often installed in underground tunnels or large concrete housings, and they require enormous quantities of energy to operate.

In nuclear physics, a particle accelerator is a device that uses electric fields to propel electrically charged particles to high speeds and contain them, usually in preparation for collision with a research target. Particle accelerators are machines that accelerate atomic particles to high energy, or, in other words, use electrical impulses to speed particles up to high energy in a vacuum. The chief purpose of the particle accelerator is exploring and penetrating the nucleus of the atom, altering the structure of nuclei, and determining what happens when particles collide.

Research particle accelerators are often used to probe the fundamental nature of matter. This is done by smashing particles with very high energy against each other, such that complex particle detectors may then record the results. Far reaching questions such as the composition and origin of the universe, of matter, mass, energy, and of theoretical dimensions are all being researched by scientists employing large research particle accelerators.

Circular and Linear Particle Research Accelerators

Two basic particle research accelerators, circular and linear (straight line) accelerators have been in use at the Berkeley Laboratory since the Laboratory's inception.

Circular Accelerators
In circular accelerators, particles move in a circle until they reach sufficient energy using electromagnets. The earliest circular particle accelerators were cyclotrons. The cyclotron, invented by nuclear physicist and Nobel Prize recipient Ernest O. Lawrence of the University of California, Berkeley (UCB) during the late 1920s, is a circular particle accelerator in which charged particles receives repeated synchronized accelerations by electrical fields as the particles spiral outward from their source. Circular accelerators explore and penetrate the nucleus of the atom, alter the structure of nuclei, and determine what happens when particles collide. The magnets in the accelerators are used to guide the particles while they are being accelerated.

Linear Accelerators
In linear accelerators, particles are accelerated in a straight line toward a target of interest at one end. Linear accelerators have been widely used in medicine for radiotherapy and radiosurgery. Scientists Luis Alvarez and Wolfgang Panofsky constructed the Linac, one of the first linear accelerators in the world, in 1947 in Building 10 at Berkeley Laboratory. At 40 feet in length, the Linac was at the time the world's longest accelerator. Currently the longest linear accelerator in the world is the Stanford Linear Accelerator (SLAC), which is 3 km (2 miles) long. The SLAC is a national DOE laboratory operated by Stanford University.

Lawrence and Cyclotron Development
Ernest Lawrence's invention and successful design of the cyclotron, and his decision to explore the inner world of the atom, started a revolution in physics, which gave rise to the fields of nuclear chemistry and high-energy physics in the United States. Lawrence developed the cyclotron to be able to accelerate electrically charged atomic particles to extremely high speeds using a magnetic field, pushing protons up to unprecedented speeds and letting them smash against targets (Harvey 2002). In 1929, Lawrence built the world's first cyclotron at UCB, an 11-inch, circular particle accelerator.

Lawrence's initial research efforts led to the establishment of the Radiation Laboratory in 1931 as an accelerator laboratory on the UCB campus. The Radiation Laboratory provided the needed facilities for Lawrence and his assistants to improve the cyclotron, which led to the development of the 27-inch and 37-inch cyclotrons during the mid-1930s.

The Radiation Laboratory's association with accelerator research evolved with the development of larger cyclotrons by Lawrence and his associates, and the Radiation Laboratory became a center for aspiring physicists and chemists. As accelerators grew larger and their needs for power increased, new accelerators were built. The successful completion of the 60-inch cyclotron in 1937 led Lawrence to propose a much larger and more powerful accelerator, the 184-inch cyclotron. In 1939, with limited space available on UCB campus for a new cyclotron, Lawrence and University officials chose Charter Hill overlooking the campus as the new home for the Radiation Laboratory to locate the 184-inch cyclotron and other proposed Radiation Laboratory facilities (Harvey 2002).

(Charter Hill along with the 97 acre Frank Wilson tract makes up the present site of the Berkeley Laboratory.)

Lawrence was awarded the Nobel Prize in physics in 1939 for his invention and development of the cyclotron. Lawrence was recognized for his important cyclotron research and its effect on the field of physics, and for the use of the cyclotron to produce artificial radioactive elements (Harvey 2002).

Accelerator Development and Second World War

Constructed between 1940 and 1942, the 184-inch cyclotron became a war time priority for the United States. The expansion of the Radiation Laboratory during the Second World War was partly due to the increase in funding for nuclear fission research at selected locations around the country. General Leslie Groves, head of the Manhattan Engineer District of the U. S. Army Corps of Engineers (which operated the Manhattan Project), supported Lawrence's cyclotron research efforts during World War II by providing funding to the development of the 184-inch cyclotron. In turn, Lawrence's research efforts assisted the war effort with his redesign of the 184-inch cyclotron for military use and subsequent development of the electromagnetic separation of uranium-235 in nuclear explosives. The magnet for the 184-inch cyclotron was used to separate the fissile or explosive part of the natural uranium (U-235) from its much more plentiful companion isotope, U-238. This process contributed to the production of the atomic bomb that detonated over Hiroshima and resulted in a quick ending to World War II.

After the war, the 184-inch cyclotron was completed for its original purpose as a synchrocyclotron, or synchrotron, incorporating the principle of phase stability. A synchrotron is a circular accelerator in which the magnetic field (to turn the particles so they circulate) and the electric field (to accelerate the particles) are synchronized with the particle beam. The 184-inch cyclotron helped physicists identify the first known sub-nuclear particle discovered with an accelerator, and served as a valuable instrument for biological and medical research. Available funding for development of the 184-inch cyclotron and other wartime facilities allowed rapid development of the new Radiation Laboratory on Charter Hill during the post-war era.

Accelerator Development and Post-War Nuclear Physics

The partnership of the physics community with the U. S. government's weapons program during World War II continued during the post-war period. Lawrence's contribution to the success of the atomic bomb research and production during the war ensured government support for the continued expansion of laboratory programs and facilities during the post-war period.

The United State's arms race with the Soviet Union during the Cold War led to increased government funding for physics research and accelerator projects at Berkeley Laboratory that had potential military applications (Brown et al 1989; in Dobkin and Corbett 1994). The development of new and larger particle accelerators was part of the post-war expansion of the Radiation Laboratory. The 184-inch cyclotron, located in Building 6, was completed for its intended use in 1946. Soon after the war the synchrotron in Building 25 and Luis Alvarez's linear accelerator in Building 10 were completed.

The Federal government's increased appropriations and support of particle accelerator development and nuclear physics at the Berkeley Laboratory during the postwar era was reflected in the construction of the next generation of accelerators/cyclotrons during the 1950s and 60s. This included the Bevatron in Building 51, Hilac/SuperHilac in Building 71, the 88-inch cyclotron in Building 88, and the combined Bevatron and the SuperHilac accelerator functions (the Bevalac) in Buildings 51 and 71. These particle accelerators were at the time the most extensive group of accelerators with heavy-ion capability in the United States. Physical and biomedical scientists at Berkeley Laboratory used the accelerators as research tools to study the cosmos, man's adaptability to space, the atomic nucleus, and ways to improve medical therapy techniques.

Albert Ghiorso

Albert Ghiorso, a chemist who worked during World War II for the Manhattan Project at Chicago's Metallurgical Laboratory, joined Berkeley Laboratory in 1946. Conducting research mainly in Building 71 over the next 30 years, Ghiorso was co-discoverer of 12 transuranium elements at Berkeley Laboratory using the Hilac, SuperHilac and Bevalac accelerators. Ghiorso played a prominent role in establishing and developing the Hilac/SuperHilac and in combining the operations/functions of the Bevatron and the SuperHilac to create the Bevalac. As former head of research operations at the Hilac/SuperHilac, Ghiorso was instrumental in keeping the Berkeley Laboratory as the world's premier center for heavy-element research through his role in establishing the Bevalac and its early development.

Bevatron (HAER NO. CA-186-A)

The Atomic Energy Commission's (AEC) authorization of the construction of the Bevatron symbolized the dominant role that the Berkeley Laboratory had assumed in high energy physics. The Bevatron was the first significant development of a particle accelerator at the laboratory during the 1950s.

Completed in 1954, the Bevatron (Building 51) was the Berkeley Laboratory's largest particle accelerator at the time, and the nation's leading high-energy physics facility (Radiation Laboratory 1957). In fact, with an unprecedented energy range of 6.2 BeV (billion electron volts), the Bevatron was the most powerful accelerator in the world, and dominated the field of high energy physics through the early 1960s (UCRL 1969).

Radiation Laboratory engineer William Brobeck and his staff designed the Bevatron as a proton synchrotron, a machine that accelerates protons to near light-speed. During acceleration, the particles were focused into a beam that was steered to strike a target. When a beam of protons from the Bevatron struck a target, interactions occurred between the speeding protons and the stationary nuclei of the target.

> . . . The Bevatron was designed . . . as . . . a circular accelerator in which particles were kept in a circle of constant radius by a magnetic guide field . . . as the particles were accelerated by a radio frequency voltage (Dobkin and Corbett 1994, p. 9).

During the 1950s and 1960s, four Nobel prizes were awarded for particle physics research conducted in whole or in part at the Bevatron, including Berkeley Laboratory scientists Emilio Segre and Owen Chamberlain's 1959 Nobel Prize in Physics for their discovery of the antiproton.

By the late 1960s, the Bevatron was superseded by more powerful accelerators at other national laboratories. This was a period of substantial United States government support for physics research and rapid advances in accelerator design at other major universities and scientific institutions around the country. The Bevatron, however, received a new lease on life in the early 1970s when Berkeley Laboratory scientist Albert Ghiorso and a team of scientists merged the Bevatron with the SuperHilac, a linear accelerator located in Building 71, to create the Bevalac.

Linear Accelerators in Building 71

Beginning in 1957, Berkeley Laboratory scientists and engineers operated in succession the Hilac/SuperHilac/Bevalac accelerators until the Bevalac (and SuperHilac) was shut down in 1993. Scientists used the accelerators to help the Laboratory maintain its position as a world-leading accelerator facility, to establish the Laboratory's biomedical program and explore the potential of heavy ion beams in cancer therapy (Ghiorso 2001; in Harvey 2007).

Accelerator Process

The Hilac/SuperHilac and Bevalac accelerators used one-to-three (Cockcroft-Walton) injectors, which supplied the ions and energy to move the beams to an accelerating resonant tank, where further acceleration occurred. The first injector, named Eve, was an air-insulated 750 kV Cockcroft-Walton injector. The second injector, called Adam, was a pressurized 2.5 MV Cockcroft-Walton injector used to produce ions of heavier elements. The third injector, named Abel, was added in 1981 and incorporated features of both of the first two injectors. After processing through the injectors and accelerating tank, the ions were moved or accelerated along to the 120-foot pre-stripper and the 90-foot post-stripper tanks, where the accelerated ions were "stripped" of some of their electrons and became positively charged. The ions then proceeded to the end of the accelerating column where switchyard magnets bent the beams to any of several possible target positions in experimental areas or caves. With the Bevalac, the beams were transported from the SuperHilac in Building 71 via a 550-foot transfer line to the Bevatron in Building 51. The transfer line used 12 bending magnets and 30 quadruple magnets to guide the beams along their way (Ghiorso 2006).

Hilac/SuperHilac

The Hilac was one of the first accelerators in the world built specifically for heavy-ion research. (A heavy ion is a charged atom with two or more protons in its nucleus.) "The Hilac was one of the first machines that could accelerate elements as heavy as argon to atom-smashing energies" (Berkeley Laboratory Research Review 1997, p. 16). The Hilac's basic components consisted of a Cockcroft-Walton generator-injector and two

Alvarez-type linear accelerators. The injector supplied the initial jolt of energy to the ions.

Between 1958 and 1970 the Hilac and Building 71 were the center for accelerator studies at the Berkeley Laboratory. A team of Hilac scientists in Building 71, headed by Glen Seaborg and Albert Ghiorso, used the Hilac to discover and synthesize elements 102-105. (Element 106-Seaborgium was produced by the SuperHilac in 1974.)

The Hilac was modified and upgraded during the 1960s. A major modification occurred when the Hilac was converted to the SuperHilac in 1971-72, which enabled the machine to accelerate beams of all ions at higher speeds. The SuperHilac, with the addition of two accelerator tanks and three injectors, was able to accelerate heavier ions and natural elements at higher rates and energies than the Hilac. The SuperHilac was capable of accelerating all the elements from hydrogen to uranium.

The conversion of the Hilac to the SuperHilac included two improvements: the ability to produce beams of extremely heavy ions of low energy for nuclear chemistry; and the use of the SuperHilac as an injector for a biomedical synchrotron for biomedical research (Dobkin and Corbett 1994).

Scientists used the SuperHilac to search for new chemical elements. The SuperHilac was designed to operate with multiple injectors that could accelerate all the natural elements and create synthetic elements known as transuranic elements.

Bevalac

The SuperHilac gained additional significance when a team of Berkeley Laboratory scientists led by nuclear physicist Albert Ghiorso connected it with the Bevatron to create the hybrid facility known as the Bevalac in 1974. The establishment of the Bevalac extended the user life of the Bevatron and SuperHilac another twenty-five years (Ghiorso 2006).

The late 1960s through the early 1970s was a period of reduced accelerator program activity at the Berkeley Laboratory, as much of the nation's high-energy physics research was conducted at other national laboratories with larger accelerators. Previously the world's foremost accelerator, the Bevatron was becoming obsolete as more powerful accelerators around the country were superseding it. This prompted a proposal by Albert Ghiorso and other Berkeley Laboratory scientists to combine and connect the accelerator applications of the Bevatron with the SuperHilac to create the Bevalac.

The Bevalac combined the best features of both facilities—the heavy ion and injector capability of the SuperHilac and the high-energy capability of the Bevatron. Ghiorso's idea for the connection between the two accelerators was to use the SuperHilac as a heavy ion source and injector for the Bevatron. The SuperHilac injected high-intensity beams of ions (as elementally heavy as iron) through the transfer line to the Bevatron where the ions were further accelerated to almost the speed of light. The use of the beam line was divided between one-third time for biomedical use and two-thirds for nuclear science experiments in a wide range of fields including heavy ion production, atomic physics, and cosmic ray simulation (Alonso 1977; in Dobkin and Corbett 1974). The transmission of the beam was controlled by computer monitoring and guidance.

Capable of accelerating even the heaviest of nuclei, the Bevalac was used to study how nuclei matter behaved under extreme conditions and how it changed from one physical state to another (Ghiorso 2006). The Bevalac's most important application was for medical research, mainly radiation therapy for the treatment of cancer. After an upgrade in 1981, which included a new injector, an upgraded transfer line, and a new high vacuum system in the Bevatron, the Bevalac was the only research facility in the world capable of accelerating the nuclei of all the elements of the periodic table to high energies (Ghiorso 2001). The Bevalac offered researchers high intensity beams of carbon, oxygen, neon, and argon, which were produced and accelerated in the SuperHilac and transferred through the beam line to the Bevatron for further acceleration. The Bevalac had up to 500 user association members who represented nuclear science and biological and medical interests from all over the world (Ghiorso 2001).

The establishment of the Bevalac expanded the research potential of both accelerators, ushering in a new era of research at the Laboratory. Because of the SuperHilac, the Bevalac had the ability to accelerate the heaviest elements in a high-energy beam. The facility became the only one in the world that could bombard targets with highly energized uranium ions.

The Bevalac also played an important role in the NASA space program. The Bevalac was the only accelerator in the United States capable of simulating the high-energy, heavy-ion components of cosmic rays. Instruments were exposed to heavy ion beams to evaluate their sensitivity to cosmic radiation in order to assess the health risks to astronauts of space travel (Ghiorso 2001).

The establishment of the Bevalac as a national accelerator facility led to the opening in 1975 of the Bevalac Biomedical Facility in the Berkeley Laboratory's Building 51 complex. The facility combined the biological and physical sciences in a program to use heavy ions clinically for diagnostic and therapeutic radiology. By the 1980s, the Bevalac was the only accelerator in the world capable of producing heavy ions with substantial beam penetration qualities that were suitable for medical applications.

The Bevalac, along with the 88-inch cyclotron, became the country's leading facility for heavy-ion research, drawing scientists from universities and laboratories throughout the United States and the world, including China, Japan, Germany and Israel.

Until the Bevalac (and SuperHilac) terminated operations in 1993, scientists used the Bevalac to help the Laboratory regain its position as a world-leading accelerator facility, and to restore the Laboratory's biomedical program (Ghiorso 2006).

The Building 71 complex currently houses the L'Oasis laboratory, the Center for Beam Physics/Ion Beam technology offices, and the Electrodynamics laboratory, Laser Optics laboratory, and Low Beta laboratory.

National and International Accelerator Facilities
With the closure of the Bevalac, the accelerator research it had pioneered was undertaken by other DOE accelerator facilities around the country, including the Fermi Labs' Tevatron in Ohio and the SLAC's colliders at Stanford University in California (Ghiorso 2006). The SLAC research program centers on experimental and theoretical research in elementary particle physics using electron beams and a broad program of research in atomic and solid-state physics, chemistry, biology, and medicine using synchrotron radiation. The two-mile long underground accelerator is the longest linear accelerator in the world, and it is reportedly the world's straightest object. Research at SLAC has produced three Nobel prizes in physics and contributed to research leading to a Nobel Prize in chemistry in 2006 (Ghiorso 2006).

There was significant development and expansion of accelerators during the last quarter of the 20th century, mainly in North America, Western Europe, Japan and the former Soviet Union (Bryant 1994; Panofsky 1997). Today, approximately 25 countries, which include China, India, South Korea, Taiwan, and Australia, have large research particle accelerators (Ghiorso 2006).

Heavy-ion nuclear studies have continued at the Relativistic Heavy Ion Collider at Brookhaven, New York. Experiments in heavy-ion therapy led to the design of dedicated medical accelerators in California at the Proton Cancer Treatment and Therapy Centers at Loma Linda University and the University of California, Davis. Large research accelerators were being developed and are still in use at Brookhaven, New York; Saturne, France; Dubna, Russia; Argonne National Lab, Illinois; CERN, Switzerland; the SLAC in California; Fermi Lab, Ohio; Middleton, Massachusetts; and in Newport News, Virginia (Ghiroso 2006).

III. PROJECT INFORMATION

Project Scope
The BSO proposes to remove the NRHP-eligible features of the SuperHilac in Building 71. The project will entail disassembly and removal of the SuperHilac, ancillary support systems, and target cave shielding. The SuperHilac removal project is designed to greatly diminish seismic safety hazards by removing the remaining components of the SuperHilac, including its shielding, and opening up the space in the high bay for new construction.

The BSO has concluded that the attachment of the shielding to the building structure represents a serious seismic hazard. A large earthquake is likely to result in exterior structural damage and failure of the shielding bracing, causing severe overstress and racking of building columns adjacent to the SuperHilac, and potential collapse of the SuperHilac and the entire building.

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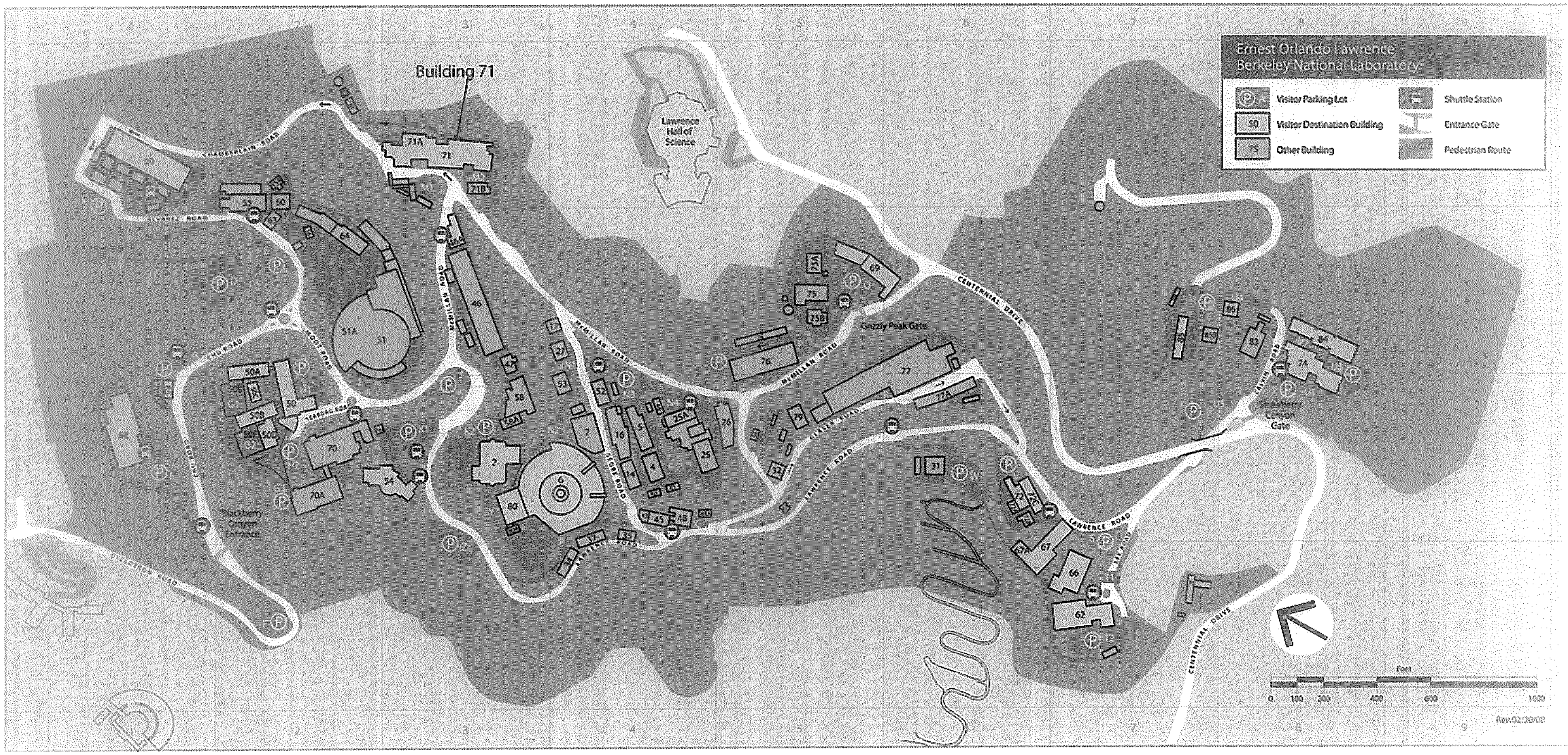
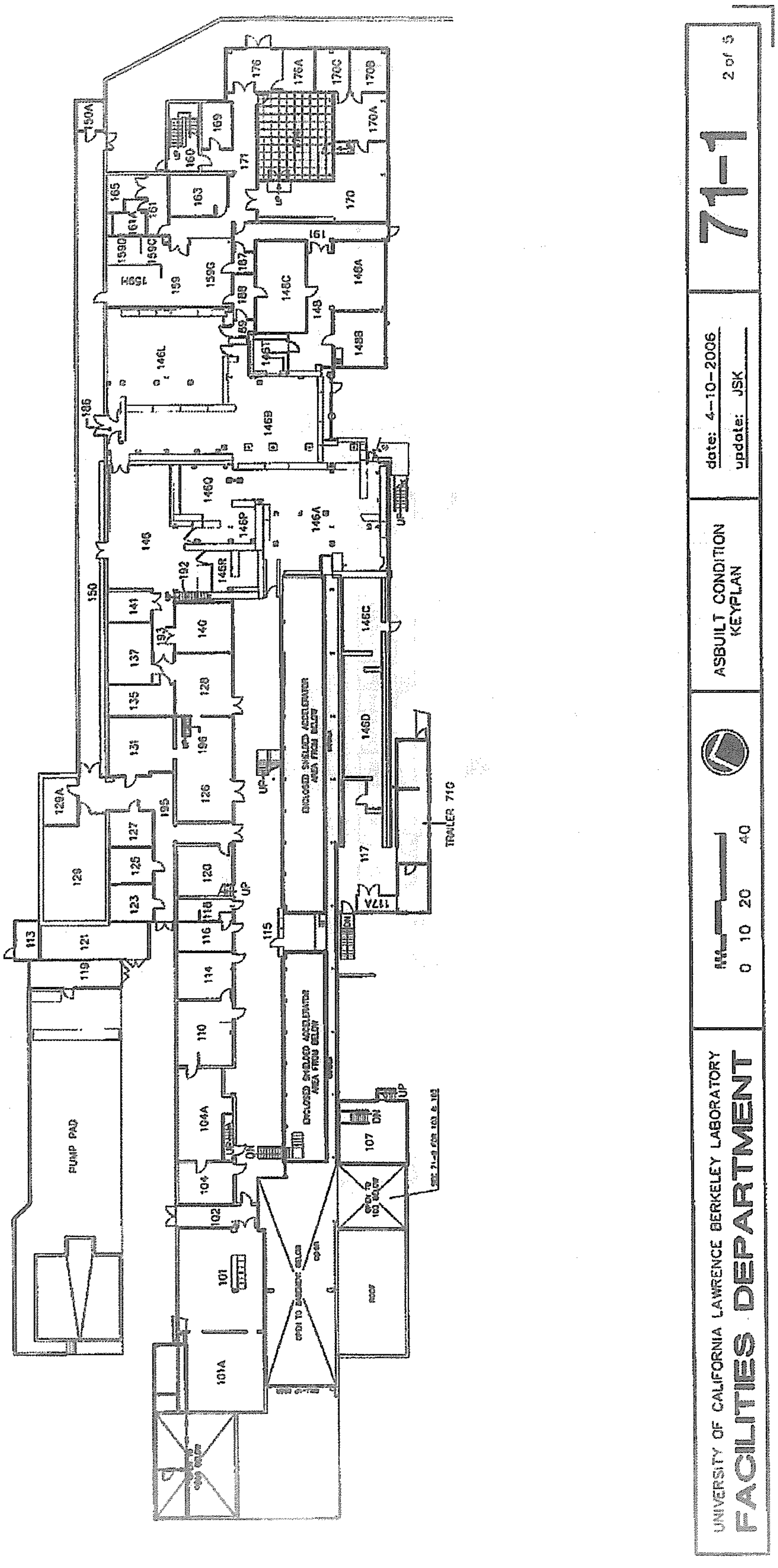


Figure 1. Location of Building 71 in Lawrence Berkeley National Laboratory

KEY PLANS FOR BUILDING 71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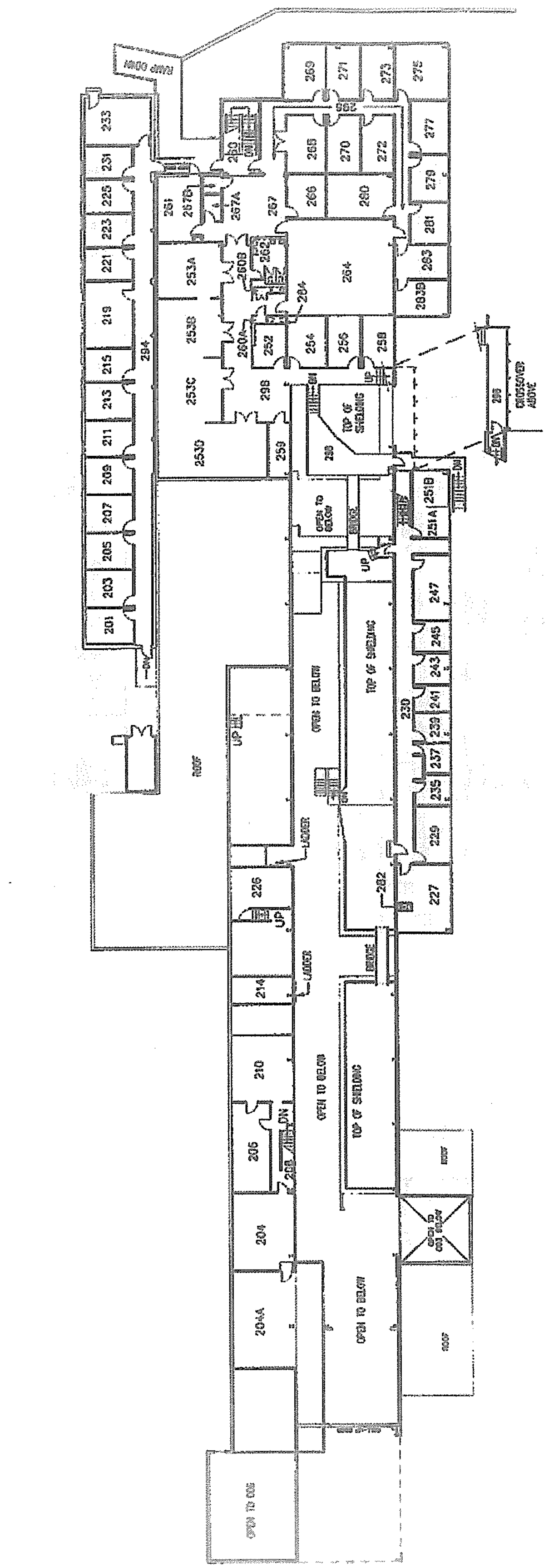
TRAILER 71G
ENCLOSED SHIELDED ACCELERATOR AREA FROM BELOW



UNIVERSITY OF CALIFORNIA
LAWRENCE BERKELEY NATIONAL LABORATORY
FACILITIES DIVISION

0 10 20 40

ASBUILT CONDITION
KEYPLAN

date: 4-23-2004
update: JSK

71-2

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UNIVERSITY OF CALIFORNIA RADIATION LABORATORY, SUPERHILAC
(Ernest Orlando Lawrence Berkeley National Laboratory, Building 71)
1 Cyclotron Road
Alameda County
California

HAER No. CA-186-B

Roy Katlschmidt, Photographer, 2007

CA-186-B-1 SOUTHWEST ELEVATION OF BUILDING 71 (HIGH BAY) (LBNL CREATIVE SERVICES OFFICE, XBD 200707-00251-40)

CA-186-B-2 WEST END OF HIGH BAY, FORMER LOCATION OF AN INJECTOR FOR THE SUPERHILAC, BUILDING 71 (LBNL CREATIVE SERVICES OFFICE, XBD 200707-00251-28)

CA-186-B-3 WEST END OF HIGH BAY AND SUPERHILAC, BUILDING 71 (LBNL CREATIVE SERVICES OFFICE, XBD 200707-00251-38)

CA-186-B-4 SUPERHILAC ACCELERATOR TANK (UNDERNEATH), BUILDING 71 (LBNL CREATIVE SERVICES OFFICE, XBD 200707-00251-33)

CA-186-B-5 SUPERHILAC, BUILDING 71 (LBNL CREATIVE SERVICES OFFICE, XBD 200707-00251-25)

CA-186-B-6 SUPERHILAC, BUILDING 71 (LBNL CREATIVE SERVICES OFFICE, XBD 200707-00251-07)

CA-186-B-7 SUPERHILAC ACCELERATOR TANK (DRIFT TUBES), BUILDING 71 (LBNL CREATIVE SERVICES OFFICE, XBD 200707-00251-23)

Photograph numbers CA-186-B-8 through CA-186-B-15 are photocopies of historical photographs. The original photographs are located at Creative Services Office photography collection, Lawrence Berkeley National Laboratory, Berkeley, California.

CA-186-B-8 BUILDING 71 (HIGH BAY), HILAC (LBNL CREATIVE SERVICES OFFICE, #200701-00013, MID-1950S)

CA-186-B-9 BUILDING 71 (HIGH BAY), 120-FOOT HILAC (LBNL IMAGE LIBRARY COLLECTION, #9705-02177, 1965)

CA-186-B-10 BUILDING 71 (HIGH BAY), SUPERHILAC (LBNL IMAGE LIBRARY COLLECTION, #9607-3051, EARLY 1970S)

CA-186-B-11 AERIAL VIEW OF BUILDING 51, BEVATRON (FOREGROUND) AND BUILDING 71 (BACKGROUND), DEPICTING ROUTE OF BEVALAC BEAM LINE (LBNL IMAGE LIBRARY COLLECTION, #9605-02087, 1976)

CA-186-B-12 SUPERHILAC INJECTOR HIGH VOLTAGE RECTIFIER DECKS BENEATH ABEL'S TERMINAL HOUSE DWARF ENGINEER GERD BEHRSING, NO DATE (XBD9607-03140)

CA-186-B-13 B-71 SUPERHILAC EVE INJECTOR WITH J. SMITH, NO DATE (XBD200803-00104)

CA-186-B-14 B-71 SUPERHILAC ACCELERATING COLUMN INJECTOR WITH B. SORENSON, NO DATE (XBD-201803-01108)

CA-186-B-15 BLDG. 71 CONTROL ROOM, 2007 (XBD200708-00369-21)

Photograph numbers CA-186-B-16 through CA-186-B-18 are photocopies of engineering/construction drawings. The original documents are located at the Facilities Office, Lawrence Berkeley National Laboratory, Berkeley, California

CA-186-B-16 HEAVY ION ACCELERATOR, BUILDING 71, MAIN FLOOR PLAN, MEZZANINE PLAN, ROOF PLAN, ROOM FINISH, UNIVERSITY OF CALIFORNIA RADIATION LABORATORY, BERKELEY, BY CORLETT AND SPACKMAN, ARCHITECTS, SAN FRANCISCO, CALIFORNIA, DRAWING #A-2 (5N71A002), JULY 15, 1955.

CA-186-B-17 ALTERATIONS BUILDING 71 ADD'N, UNIVERSITY OF CALIFORNIA RADIATION LABORATORY PLANT ENGINEERING, DWG. NO. B71A0134A, OCTOBER 30, 1959.

CA-186-B-18 SUPERHILAC PRE AND POST STRIPPER SHELLS, LAWRENCE RADIATION LABORATORY, DWG. NO. 16FS41, FEBRUARY 1970.