SLAC-PUB-3558
January 1985
(N)

SLAC SITE DESIGN AESTHETICS*

F. F. Hall
Senior Staff Member
Stanford Linear Accelerator Center (SLAC)
Stanford University
Stanford, California

ABSTRACT

Stanford Linear Accelerator Center (SLAC) is a single mission laboratory dedicated to basic research in high energy particle physics. SLAC site also houses Stanford Synchrotron Radiation Laboratory (SSRL) which is a multi-mission laboratory for research using beams of ultraviolet light and low energy photons as emitted tangentially from SLAC colliding beam facilities. This paper discusses various aspects of SLAC site design aesthetics under following headings:

1. Imposed footprint of SLAC
2. Description of Selected Site
3. Use of earth cover for radiation and sight screens
4. Use of landscaping for cosmetic purposes
5. Use of exterior paint colors to soften SLAC impact on neighbors
6. Relocation of SLAC main entrance
7. Relocation of SLAC collider arcs and experimental hall
8. Parking lots and storage yards
9. Land use zoning at SLAC

IMPOSED FOOTPRINT OF SLAC

SLAC's Linac is 3 km long which length is subdivided into 30 Sectors each 100 m long. Most but not all electron beam injectors are located in a Main Injector Sector Zero at west end of Linac. There are three beam analyzer stations located in Sectors One, Ten and Twenty. There are two Damping Ring Vaults (one North and one South) at end of Sector One for SLAC's Linear Collider Project (SLC). There are two beam takeoff tunnels to north side at Sectors Ten and Twenty. There are two Positron Sources at Sectors Eleven and Twenty. There is an electron beam injector located at Sector Twenty-five.

*Work supported by the Department of Energy, contract DE-AC03-76SF00515.

(Invited talk presented at the Department of Energy Site Planning and Facility Management Conference, October 16-18, 1984, Santa Fe, N. Mexico)

SLAC Linac is followed by its Beam Switchyard and four principal experimental areas as follows:

1. North Yard for SPEAR colliding ring, Stanford Synchrotron Radiation Laboratory (SSRL) and End Station "A".
2. South Yard for End Stations "B" and "C" and research facility utilities.
3. Positron Electron Project (PEP) colliding ring with Experimental Halls located at Interaction Regions 2, 4, 5 (for SSRL), 6, 8, 10 (underground vault only) and 12 o'clock positions.
4. SLC North Arc and South Arc Tunnels with a single Experimental Hall located beyond PEP's 3 o'clock position. These are being constructed at present.

SLAC shops are located parallel to and to north of Linac Sectors Twenty-six through Thirty and Linac Beam Switchyard. SLAC offices and Laboratories are located north of shops and Linac Sector Thirty. SLAC storage yards, master power substation and principal research utilities are located parallel to and to south of Linac Sectors Twenty-six through Thirty and Linac Beam Switchyard.

SLAC Linac is "level" at east end of Sector Thirty. Linac Machine thus runs down hill from its West End at an angle of approximately one-third degree. Linac Beam Switchyard and SLAC experimental yards are "level" and thus curve down to east in an arc having a radius of 6,606 km along centerline of Linac. Imposed footprint of SLAC can be roughly shown by a small portable model. SEE EXHIBIT ONE.

This is also roughly true of a plan view of a SLAC site which contains a minimal area for SLAC's footprint plus reasonable setbacks all around. SEE FIGURE ONE. SLAC land west of IS-280 is 300 m wide.

DESCRIPTION OF SELECTED SITE

Stanford University land holdings are large enough to include two possible sites for SLAC. These two sites required no land investment. Other possible San Francisco Bay Area sites for SLAC suffered in comparison due to (1) increased cost for land procurement, (2) remoteness from Stanford University

main campus and (3) physical shortcomings such as "too hilly," "bayshore mud" etc. These considerations focussed attention on Stanford Land sites which were (1) Sand Hill Road Site and (2) Felt Lake Site. A rough comparison follows:

Site Description	Sand Hill Road	Felt Lake
Orientation	East-West	Northwest-Southeast
Relation to San Andreas Seismic Fault Line	Transverse	Parallel
Relation to Route of Future Interstate 280	Transverse	Parallel
Presence of Inactive Seismic Fault Lines	Yes	Yes
Presence of Land Slippage Planes	Few	Many
Average Distance from Hoover Tower	5 km	5 km
Length Tieline	X	X plus 3 km
Length of Shortest 60 KV Backup Tieline	Y	Y
Surface Drainage	Good	Good
Surface Topography	Hilly	Hilly
Comparative Ground Cover	Live oak groves	Barren

Selection of Sand Hill Road Site for SLAC over Felt Lake Site cannot be faulted.

USE OF EARTHCOVER FOR RADIATION SHIELDING & SIGHT SCREENS

Such use of earthcover received considerable attention early on. SLAC Linac is located in a tunnel having 8 m earth cover along Linac and 12 m earth cover over its Beam Switchyard. Linac auxiliary equipment items are located in a Klystron Gallery located on top of Linac earth cover directly over Linac Tunnel. All Linac Utilities are run underground just below Klystron Gallery grade or above ground and inside Klystron Gallery. Beam Switchyard is handled similarly except there is no continuous

auxiliary surface structure. All Experimental Areas are located below original grade and all Experimental Utilities are run underground. Construction economics dictated major arrangements as follows:

Construction Component	Construction Method Used
Linac Structures	Cut and Cover
Beam Switchyard	Cut and Cover
End Stations, SPEAR, SSRL	In excavated yards
PEP Ring Tunnels	Half mined & Half Cut and Cover
PEP Experimental Halls	In excavated yards
SLC Tunnels	Almost all mined
SLC Experimental Hall	In an excavated yard with deep pits for servicing and using detectors

Original SLAC layout was arranged to equalize cut and cover. This resulted in Experimental Yards that were shielded from SLAC neighbors by natural earth berms. PEP layout was also arranged to equalize cut and cover which resulted in exposure of IR-12 and IR-2 to view of SLAC neighbors to north along Sand Hill Road while IR-4, IR-5, IR-6 and IR-8 were partially or completely exposed to view of SLAC neighbors to south along Alpine Road and Ladera (part of City of Menlo Park) and across Interstate 280. SLC layout necessarily resulted in much excess fill so that artificial sight berms have been added to hide PEP IR-12, IR-2 and IR-3 (SLC). SLAC shops, offices and laboratories are necessarily close to original ground surfaces and posed a more normal aesthetic challenge.

Much smaller sight berms have been used to hide such eyesores as parking lots, open storage yards, service yards, utility equipment and research experiments located outside of planned research yards. Here "sight berms" can also be read "concrete masonry walls," "precast concrete panel walls," "closely planted shrubs or trees," or "diamond mesh fencing with integral redwood slats."

USE OF LANDSCAPING FOR COSMETIC PURPOSES

Landscaping can be a key element of site design aesthetics and its use at SLAC has been stressed from beginning with so so results. Original site was open grazing land with mature oaks widely dispersed alone or in small

groves. Oak population is declining due to spread of SLAC construction, winter storm losses and especially due to root fungus attack during recent wet winters. Live, valley and blue oaks are native to site.

Fill between Linac Tunnel and Klystron Gallery was compacted to 95% and heat losses keep ground near Linac Tunnel about 15°K higher than normal. Eucalyptus trees were planted at 3 m centers at both sides of Klystron Gallery. Today many are missing, many are stunted (root bound), while some have done well.

Lines of eucalyptus and Mediterranean pines have been used for screening SLAC Shops service yards. Overzealous pruning and extensive winter storm damage have reduced value of this program. Lines of oleander bushes have done well at SLAC, as have small groves of coast redwoods. Ground covers such as hypericum were not native, do poorly and require heroics for survival but Algerian ivy and ice plant have been used successfully.

Major element of SLAC landscaping has been grass lawns in between and around our Main Campus offices and laboratories. Growing grass at SLAC has been easy. All it takes is daily watering, weekly mowing, quarterly feeding, biannual dethatching and large annual outlays of money.

PEP landscaping called for extensive planting of coast redwoods or pines with underground irrigation at roots. Unfortunately, all trees planted were smallest size sold and of same age. So far "pigmy forests of PEP" have been a disappointment and we have planted older, larger trees here and there to create an uneven skyline.

USE OF EXTERIOR PAINT COLORS TO SOFTEN SLAC IMPACT ON NEIGHBORS

Original Main Campus buildings at SLAC featured following architectural vocabulary:

1: Dark red, fluted, sheetmetal sight screens as necessary to hide roof-mounted HVAC equipment.

2: Overhung roofs with off-white fasciae and soffits except for Auditorium, utility buildings and Fire House.

3: Exposed columns covered with decorative concrete masonry units except for

shops which have bare steel columns painted off-white.

4: Vertical strip windows adjacent to and halfway between columns.

5: Continuous vertical panels of fluted sheetmetal painted standard Homespun Brown between adjacent windows.

6: Variations to 1: through 5: above are provided by (a) large areas of flat concrete masonry units as for Auditorium walls, (b) occasional ornamental exterior stairways, (c) occasional ornamental exterior overhead walkways, bridges or balconies, and occasional areas at grade of glass curtain walls. SEE FIGURES TWO, THREE, FOUR and FIVE.

Newer Main Campus buildings have a warmer red for sheetmetal sight screens or no sight screens at all; use of exposed columns has been de-emphasized and our Computer Building is entirely of concrete with large, tinted windows at its main lobby and third floor offices which are better suited to people who by and large have two eyes arranged side by side with vision field twice wider than it is high.

SLAC Main Campus buildings are visible from Sand Hill Road and IS-280. These buildings are one, two and three stories high so that building height has not been a problem. Above-listed architectural vocabulary has met with general approval of SLAC neighbors and need not be discussed further in this paper.

SLAC Klystron Gallery is 3 km long. Long straight lines are broken up visually by rolling hill topography and landscaping of site, roof-mounted exhauster housings (5 per sector) and 3 m wide alcoves (31 on north side for control rooms, two on north side for maintenance shops, one on north side for visitor look-see purposes, 30 on south side for mechanical equipment, 30 on south side for Linac Tunnel access ladders, 15 on south side to screen variable voltage substation transformers and one on south side for SLC Damping Ring Controls).

To this, an unsung hero of original architect firm added unique use of exterior colors. Homespun Brown can be standard, dark or light. Main body of Klystron Gallery is 10 m wide and is arranged as a double overhung Garrison Colonial. Light Homespun Brown was selected for roofs and alcove walls. Standard Homespun Brown was selected for 3 m high lower wall panels while dark Homespun Brown was applied to 1 m high overhung panels. Homespun Brown is tan when first applied, but gradually gains an olive drab green tint as it weathers. Marriage of three tones of olive drab tans with predominant live oaks and native grasses has been successful irrespective of season (wet and greener in winter and dry and yellower in summer). This paint treatment tends to paint out structures and will be discussed below for other SLAC structures.

SLAC Computer Building was completed in 1975. Architectural specifications called for two tones of Homespun Brown, but were vague as to which went where. Painter did one-half of north facade predominantly dark. An ad hoc committee rejected this sample 7 to 1. Painter redid one-half of north facade reversing light and dark tones. Same ad hoc committee endorsed new sample 8 to 0 and we still like it. SEE FIGURE SIX.

Architectural treatment of PEP project structures diverged from SLAC treatment. Overhung roofs were out and upper 1 m to 3 m received prepainted flat sheet metal panels while lower prepainted sheetmetal panels are fluted. Approved colors were to be dark brown flat fasciae, yellowish tan fluted paneling and burnt orange for large roll-up doors.

Original PEP project had no plans for experimentation at 6:00 o'clock position. Belatedly a High Resolution Spectrometer (HRS) was authorized for transfer, together with its 100-ton crane from ANL to SLAC. HRS detector is an 8 m cubic weighing 1,800 tons having a superconducting solenoid which, together with its lifting strongback, weighs 117 tons.

PEP facilities under construction were inadequate and a new 20 m wide by 20 m high by 50 m long steel-framed Experimental Hall with a new counting house was authorized for PEP 6:00 o'clock. Large truck door at south end was located at west end of facade to allow solenoid carrier turnabout to take place on SLAC leased land (just barely). Building crane had been upgraded

to 120 tons to unload solenoid and building siding had not been painted, so it resembled a giant tin mushroom.

All visible PEP structures were now being criticized by SLAC staff and SLAC neighbors. PEP pre-painted colors as installed were glossy warm chocolate fasciae above hazelnut (pinkish tan) fluted siding having salmon roe-colored large roll-up doors.

We decided to paint new 6:00 o'clock structures three tones of Homespun Brown (dark at top, standard Homespun Brown at fluted mid-walls and light Homespun Brown at fluted lower walls and large roll-up doors) while counting house would have two tones (dark fasciae and light fluted walls). Result was an immediate and unqualified success. Painted PEP 6:00 o'clock Experimental Hall blends into hillsides to north very nicely. SEE FIGURE SEVEN.

Based on this quick fix, it was decided to bite bullet and remaining PEP structures were painted out, using two tones of Homespun Brown. Subsequent complaints from SLAC neighbors have had to do with equipment noise and too much night lighting. Continued abatement efforts have overcome these deficiencies as well. Newer SLC Experimental Hall at PEP 3:00 o'clock and SSRL Beam Line Facility at PEP 5:00 o'clock, will also be painted out using two or three tones of Homespun Brown.

RELOCATION OF SLAC MAIN ENTRANCE

Present location of SLAC Main Entrance was selected with site design aesthetics in mind. How this happens to be is of interest. Its north end is part of Saga Lane, Sand Hill Road intersection. Its south end is at northeast corner of SLAC Main Campus Quadrangle and just east of SLAC Visitors Parking Lot. Route between these points is a lazy "S" located in a natural swale leading down from SLAC Loop Road to Sand Hill Road.

When above arrangement was proposed it was rejected by City of Menlo Park and our initial main entrance was made a part of Monte Rosa Street, San Hill Road intersection, where it languished for several years. Later, during a major widening of Sand Hill Road intersection at Monte Rosa Street was deleted and SLAC was directed to move its main entrance to Saga Lane where it "naturally" belongs.

RELOCATION OF SLAC COLLIDER ARCS, TUNNELS AND EXPERIMENTAL HALL

Conceptual design report for SLC had north and south arc tunnels (NAT & SAT) starting from within east end of BSY and bending down slowly while crossing existing research yard. NAT passed just south of a City of Menlo Park park and SFWD Hetch-Hetchy pipe line right of way. SAT crossed under an existing horse training facility well outside of SLAC Boundary. Beam Collision Point was on a ridge having a thick cover of trees overlooking a steep drop to Alpine Road at east end of SLAC leased land.

Conceptual design had a number of objectionable features:

1. NAT/SAT exit routes from BSY were at base of existing retaining walls and would pass through existing research utility tunnels.
2. Construction shielding cover within SLAC Research Yard would require augmentation, using steel-loaded concrete and precast concrete blocks at significantly increased cost.
3. SAT route crossed low, wet land within horse training facility adjacent to San Francisquito Creek.
4. SLC Experimental Hall location required removal of over 200 trees to allow construction as shown.
5. SLC Experimental Hall location would be directly visible from houses in Stanford Hills to north and across Alpine Road to east.
6. SLC Experimental Hall as shown was as big as SLAC End Station "A" and would be impossible to hide.
7. A mistake in layout made it necessary for NAT to pass under city park or SFWD land or both, or if swung to south SAT would cross San Francisquito Creek within flood control domain of U.S. Corp of Engineers in order to reach SLC Collision Point as shown.

Fortunately combination of inadequate construction money, very unhappy SLAC neighbors, adverse impact to on-going SLAC programs and need to lay out NAT/SAT tunnels correctly forced a redesign. Tunnels while still on paper are easy to relocate. New design put NAT/SAT starting point at west end of BSY allowing SLC beams to leave through side walls and then drop below research yard retaining wall substructures and utility tunnels. Permission was obtained from City of Menlo Park for NAT to pass under existing park land. These changes allowed SAT to be moved north to higher, drier land

and SLC Interaction Point moved west by over 200 m to lower ground and only nine live oaks stand in way of progress.

As finally designed, SLC Experimental Hall is set into west side of highest hill at SLAC and when completed will be visible from off site only from high land at distances of several km. Excavation for SLC Experimental Hall service yard is almost complete and fill was used to form a long sight berm which hides PEP IR-12, NAT access yard, PEP IR-2, Experiment E-137 and SLC Experimental Hall from nearest SLAC neighbors along north side of Sand Hill Road and in Stanford Hills. This sight berm has been contoured to appear natural and will be landscaped. SEE FIGURE EIGHT.

PARKING LOTS AND STORAGE YARDS

Parking lots are of continuing interest at SLAC. Most large parking lots are about 20 years old. Some have been underutilized, while others are swamped. New parking spaces have been added with new construction which helps, but basic problem remains in that service yards adjacent to buildings become informal parking lots whenever walking distances can be shortened. A $150,000 budget for new parking was cancelled when we decided to restripe existing lots so as to acknowledge compact cars. For years we have planned to remove temporary buildings south of our Central Laboratory to create more close-in parking. These portable classrooms and trailers were first used for SLAC computation equipment, then became "PEP City" and currently are housing SLC project people. Recently we have been disposing of fill so as to create a large new parking lot site northeast of Central Laboratory, but at such a distance as to insure underutilization. SSRL impact is erratic. When SLAC Linac is off, parking is available anywhere. When SLAC Linac is on, parking near SPEAR ring is next to impossible after arrival of each day shift.

Storage yards for outdoor storage must be screened. Amount of cable reels, piping and equipment (often surplus) on hand increase faster than suitable screened yards can be made available. Overflow of items stored outdoors waxes and wanes alongside Klystron Gallery (in between alcoves) despite all efforts to scrap useless stuff. Inside Klystron Gallery there is at least one fenced storage cage 3 m wide by 10 m long per 100 m long sector, and sometimes two or more cages are used in single sectors. After a belated start we have been adding screened storage in recent years fast enough to stay even with problem. PEP project at one point preempted south side of Klystron Gallery to store material. In due time, all these items went away, but within a year new items threatened to fill every vacated space between alcoves. Ultimate in outdoor storage space is under IS-280 bridges (out of sight and dry).

LAND USE ZONING AT SLAC

From beginning, SLAC leased land use has been zoned as follows:

1. Linac mission oriented - Klystron Gallery and BSY east of IS-280 and all land west of IS-280
2. SLAC shops and service yards - a long strip of land north of Linac and extended east-west from IS-280 to SPEAR/SSRL complex
3. SLAC Main Campus - all land north of 2., above
4. SLAC storage yards and utilities - a long strip of land south of Linac and extended east-west from IS-280 to south research yard access road
5. SLAC research lands - all land east of 2., 3. and 4. above

In addition, SLAC structures may not occupy more than 20% of all SLAC leased land or be erected within 24 m of public roads and 12 m of all other SLAC leased land boundaries. Research area structures over 11 m above grade require Stanford University Trustee approval.

These land use restrictions are policed by SLAC Architectural Committee (SAC) who also update SLAC Master Plan from time to time. Present members are SLAC head of plant engineering (chairman), Stanford University director of planning, SLAC manager of space utilization, a SLAC person representing SLC project and several SLAC plant engineering project managers (one of whom is secretary). SAC is also pipeline for processing Board of Trustee presentations for SLAC and SSRL. SAC normally meets on last Tuesday of alternate months. One summer monthly meeting is dedicated to an annual tour of SLAC site.

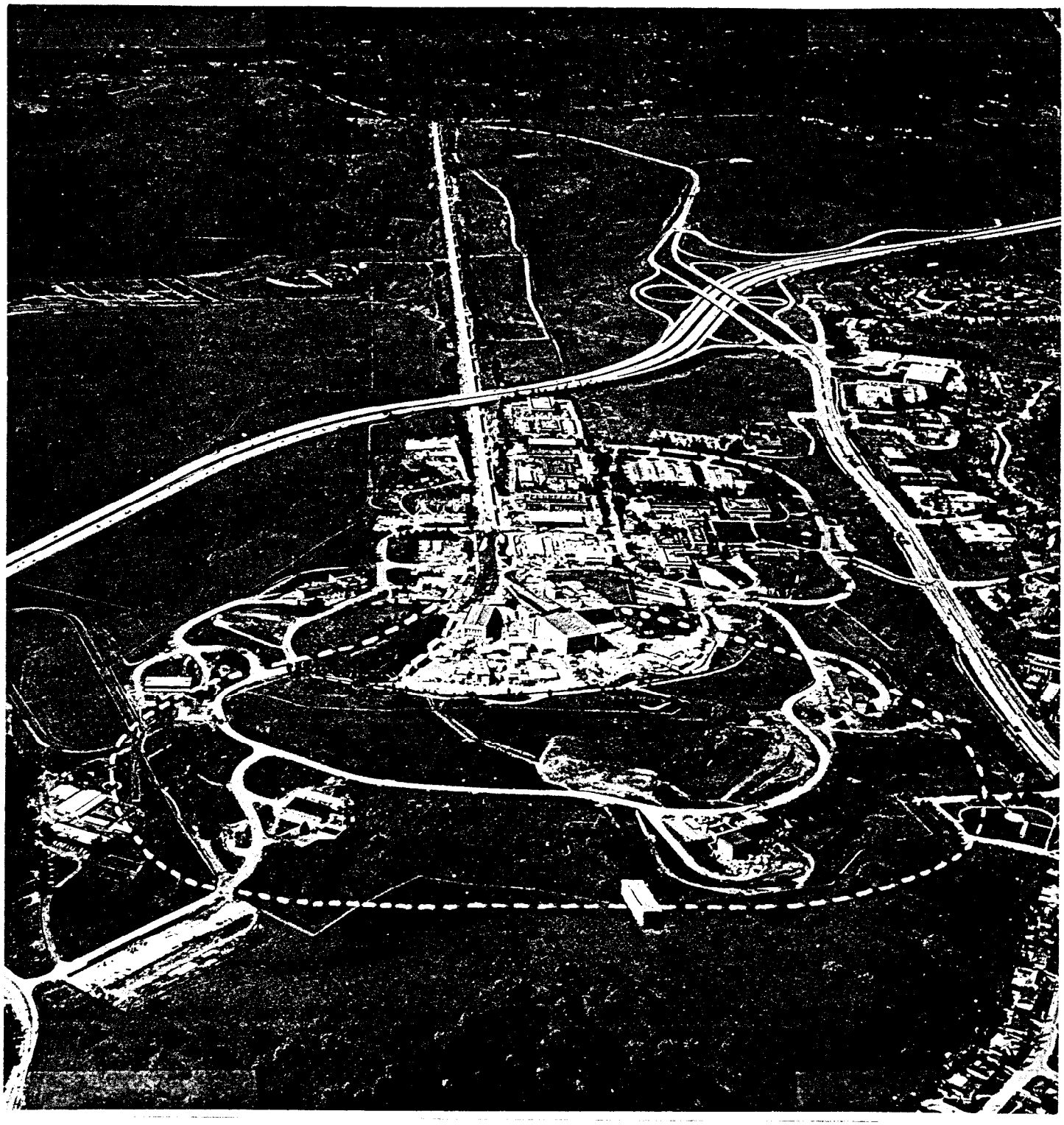

Fig. 1 SLAC Site - looking west. SLAC land west of Freeway is 300 m wide.

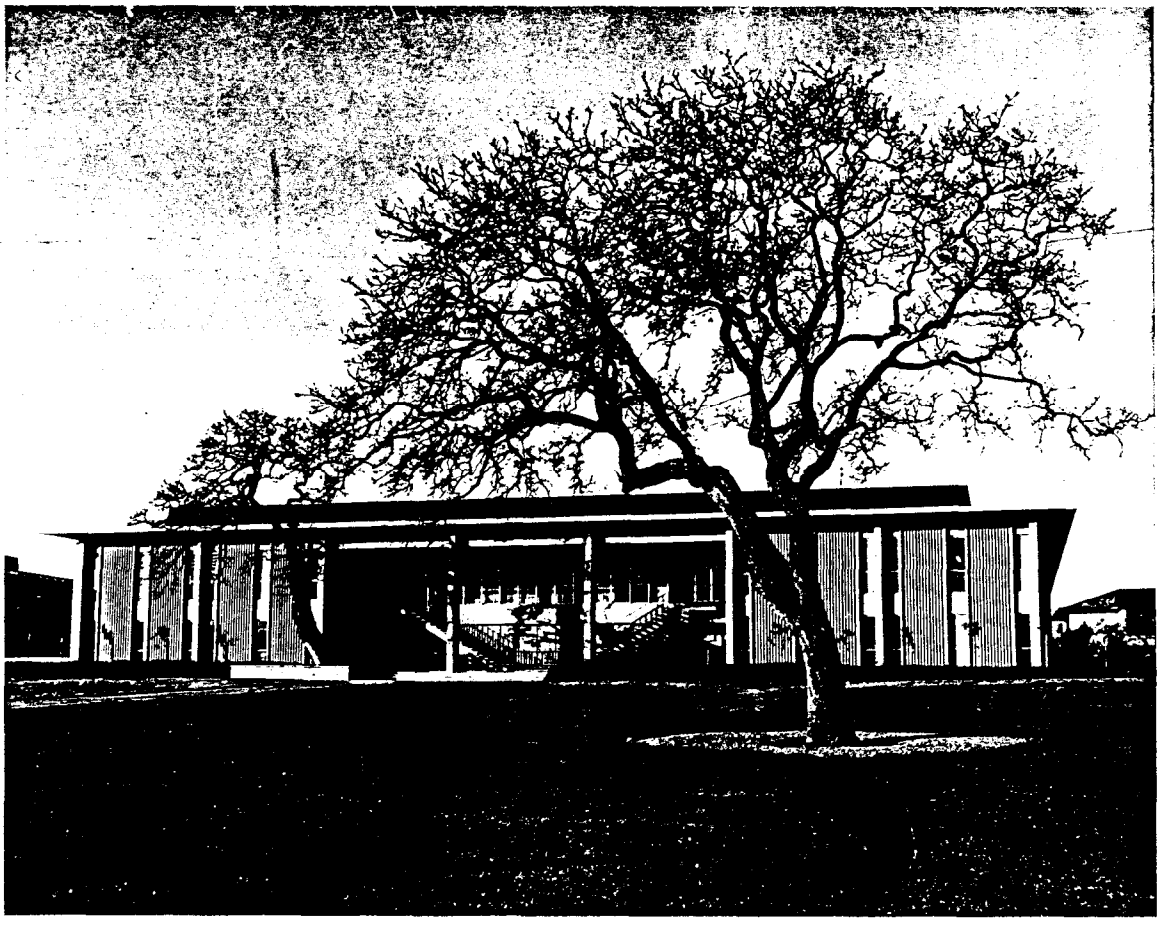

Fig. 2 SLAC Administration & Engineering Building - looking west.

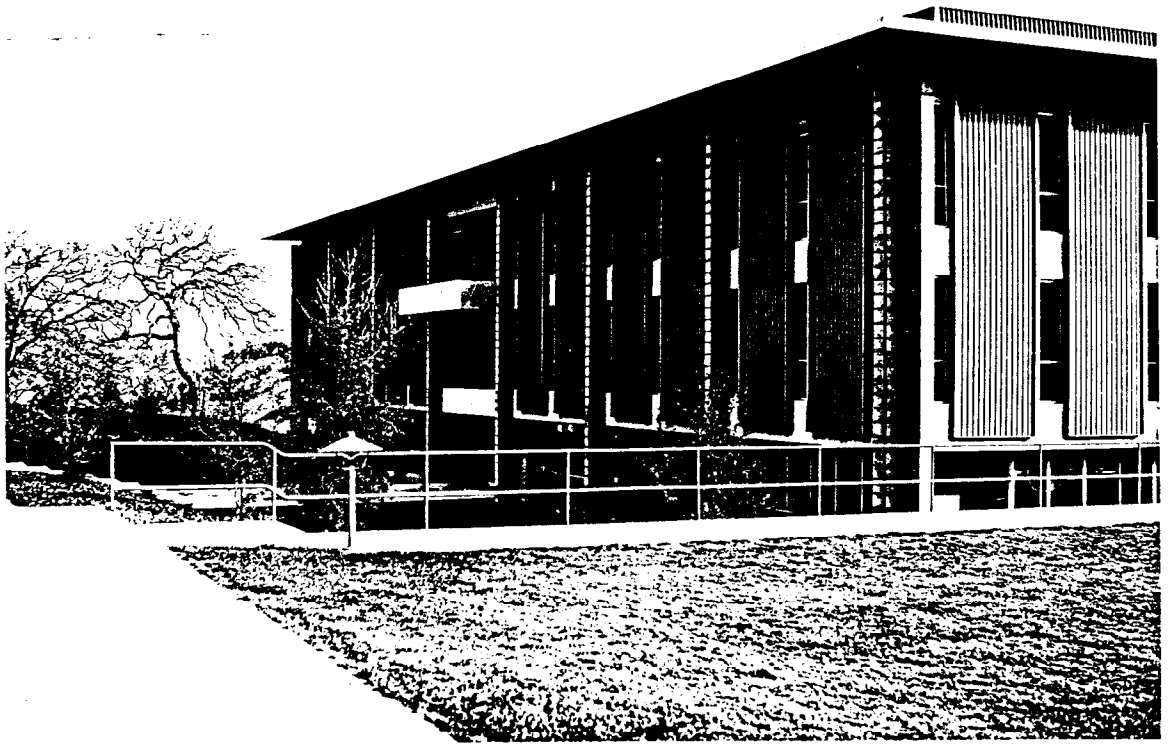

Fig. 3 SLAC Central Laboratory - looking southeast.

Fig. 4 SLAC Test Laboratory - looking southwest.

Fig. 5 SLAC Auditorium - looking east.

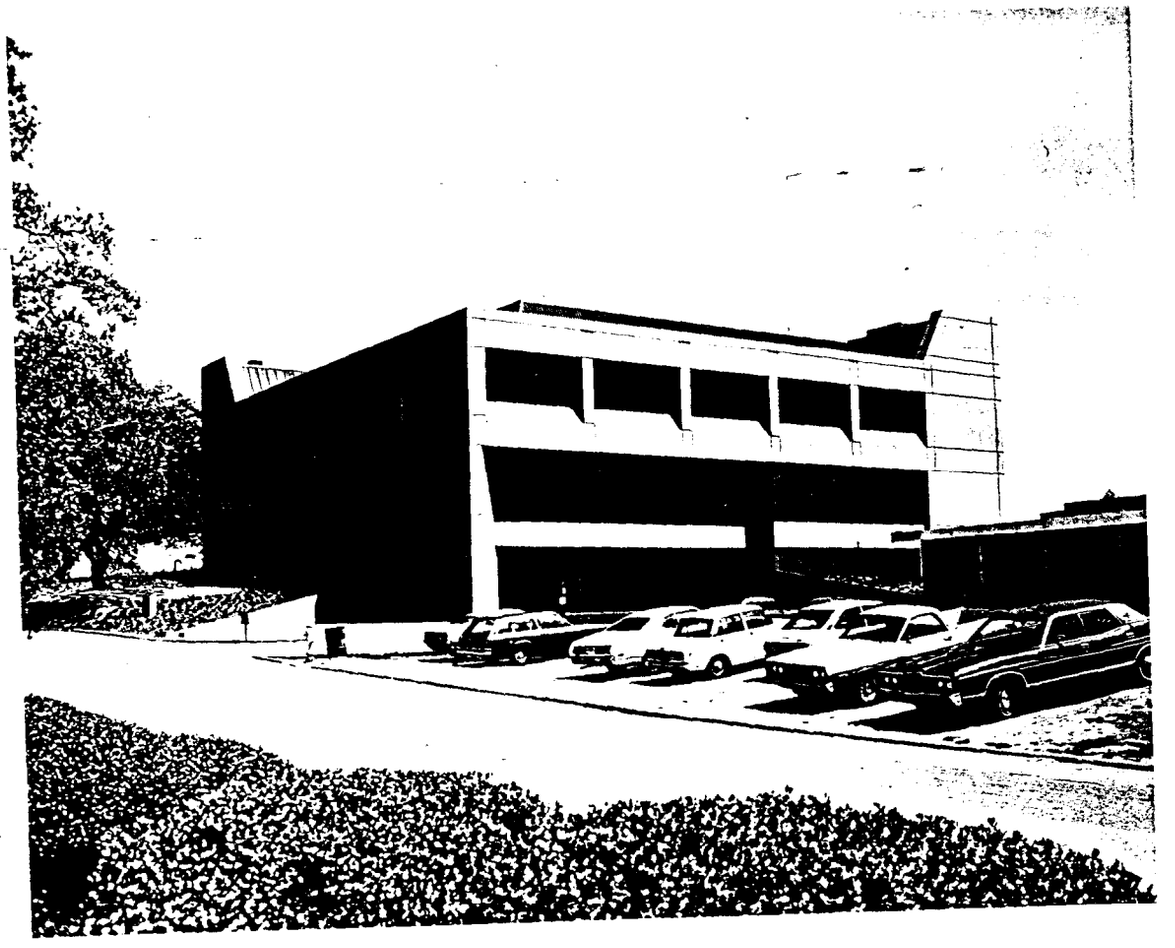

Fig. 6 SLAC Computation Center - looking southeast.

Fig. 7 PEP IR-6 Experimental Hall at SLAC - looking northeast.

Fig. 8 SLAC Site - looking west. PEP IR Halls & SLC Collider Hall are in foreground. Artificial sight berm lies between above structures and Sand Hill Road, Sharon Heights & Stanford Hills.