3 Functional Description of the Facility

3.1 Injector

The injector contains a thermionic-cathode gun and two X-band accelerator sections. The gun current is 1.5-A nominal (3-A maximum), accelerated electrostatically to 0.15 MeV. The gun pulse has 0.125-microsecond duration which is set by a fixed network. The pulse-repetition rate is limited by hardware to a maximum of 10 Hz. A pair of 0.9-m-long X-band accelerator sections, powered by a single 50-MW klystron with a dedicated pulse modulator, boost the beam energy by 70 MeV. (The zero-current accelerating gradient is 50 MV/m.) Detailed modeling of the injector indicates that the net current loss in the injector will be approximately 30%.

Chicane

A magnetic chicane downstream from the injector, Figure 3.1, contains a pair of bends that offset the beam axis by 9 inches, and a second pair of bends that restore the beam to its original axis. Two fixed collimators and one adjustable collimator are positioned between the two pairs of bends. The nominal beam power entering the chicane is 100 W.

Faraday Cup

An insertable Faraday cup downstream from the chicane, when inserted into the beam line, will absorb the full beam power in a re-entrant block of tungsten.

Linac

The linac contains three pairs of 1.8-m-long X-band accelerator sections. Each pair is powered by a single 50-MW klystron with a dedicated pulse modulator. Each pair boosts the energy of the nominal-current beam by 135 MeV, for a total energy gain of 405 MeV. (The zero-current accelerating gradient is 50 MV/m.) The dominant source of radiation in the linac is expected to be small, distributed beam losses. The net loss is expected to be much less than 0.5%, consistent with experience in the SLAC linac and Final Focus Test Beam. However, for the purpose of estimating the radiation doses, a net loss of 0.5% at the highest energy, concentrated at a single point, is assumed.

Spectrometer and Beam Dump

A 12-degree spectrometer line, and a straight-ahead line, both terminate in an iron and concrete beam dump. The dump will absorb the full beam power. The iron target will be cooled by natural convection and thermal radiation. Water cooling will not be necessary, nor will it be provided.

High-Power Radiofrequency System

Radiofrequency (rf) power for the NLCTA will be provided by four 50-MW X-band klystrons. The klystron peak power will be quadrupled by SLED II rf pulse compressors. These klystrons and pulse compressors represent a new microwave technology being developed at SLAC, which is the *raison d'être* for the NLCTA. The klystrons will produce 50 MW of microwave power at 11.424 GHz in 1.5-microsecond-long pulses. The pulse compressors will compress the rf pulse length from 1.5 microseconds to 0.25 microsecond, and boost the peak power by a factor of 4. The resulting 200-MW microwave pulse, split between a pair of accelerator sections, will boost the energy of the linac beam by 130–180 MeV, depending on the current loading the accelerator.

The NLCTA's X-band klystrons present no new hazards relative to the SLC's S-Band klystrons. Relative to the S-band klystrons, the X-band klystrons will operate at somewhat higher voltage (440 kV versus 350 kV), but at lower perveance (1.2 $\mu A/V^{3/2}$ versus 1.8 $\mu A/V^{3/2}$), and at shorter pulse-length (1.5 μs versus 3.5 μs). Consequently, the total beam energy in an NLCTA X-band klystron will be lower than in an SLC S-band klystron.

The operations staff will conduct radiation hazard surveys periodically to ensure that the klystrons and other high-power rf components are appropriately shielded for both x-rays and microwaves.

Upgrade Plans

A future upgrade of the rf system is planned in which the rf power will be tripled by replacing each 50-MW klystron with a pair of 75-MW klystrons, which will increase the accelerating gradient in the injector and in the linac by a factor of $\sqrt{3}$. A future upgrade of the injector, which would increase the peak current and change the micropulse structure, may be desirable to advance NLC accelerator-development studies. The injector upgrade as planned would increase the pulse current to 3-A nominal and 4.5-A maximum.

Conventional Structures

The NLCTA facility, which is partially contained inside End Station B, consists of an above-ground beam-line enclosure, banks of instrumentation, controls, and power supply racks, a 3.33-MW electrical substation, and a control building. Figure 3.2 shows the layout of the NLCTA buildings.

End Station B (Building 62) is a reinforced poured-concrete structure completed in 1966. Interior dimensions at floor level are 150 feet (east-west) by 75 feet (north-south) by 50 feet high. The north and south walls have large openings for moving equipment in and out. A 20 feet by 20 feet portion of the south opening has a motorized 2-foot-thick concrete door. Other openings in the north, south, and east walls are approximately 12 feet high × 70 feet wide, and are covered with 2-foot-thick portable concrete blocks. All walls and the roof are concrete, with minimum thicknesses of 2 feet, varying as required by structural considerations. The roof slabs are supported on steel girders. The floor slab is made of 6-inch thick, un-reinforced concrete on a 6-inch untreated base of coarse graded aggregate. The building is a large single-story concrete structure designed as a rigid frame. There are large sections of uninterrupted walls designed to carry large earthquake-induced shear forces into the sandstone foundation. End Station B is ventilated by nine roof-mounted 25,000-cfm exhaust fans.

The above-ground beam-line enclosure was recently constructed from poured, reinforced concrete blocks. The walls are 6 feet thick. The roof is 4 feet thick. The interior measures 10 feet high by 9 feet wide by 170 feet long. Approximately half of the enclosure is contained inside End Station B;

the rest extends beyond the end station by about 80 feet, to the east. The beam dump, which will consist of iron, lead, and concrete, will be at the east end of the accelerator housing. The interior walls of the enclosure are painted white. The concrete floor is sealed. Access and egress is provided through two radiation mazes: one at the west end, which connects to End Station B; and one on the south side, which connects to the outside. Cross-ventilation is provided by the two mazes, and can be assisted by using portable electric fans, when necessary. Telephones are spaced approximately 50 feet apart inside the enclosure. Figure 3.3 shows a cross-sectional view of the NLCTA beam-line housing.

Approximately 70 racks of instrumentation, controls, and power supplies for the NLCTA are contained inside End Station B. Cables run in overhead trays that enter the beam-line housing through the west maze.

The new 3.33-MW substation (Building 501) provides power to the NLCTA, to End Station B, and to the southern part of the Research Yard. This single-story structure, which measures 20 feet by 39 feet, is made of steel-reinforced masonry-block walls, with a sheet-metal roof, on a 4-inch-thick concrete slab foundation.

The new control building (Building 128) contains the NLCTA operations control room, a conference room, an office, and a toilet. This single-story, sheet-metal, steel-frame structure measures 26 feet by 42 feet

3.9 Cooling Water

NLCTA components will be cooled by an existing Research Yard LCW circuit (at 275 psi pressure). A new Low Conductivity Water (LCW) closed circuit has been constructed for cooling the NLCTA accelerator sections. This accelerator LCW circuit operates at 45 psi and is temperature-stabilized to 45° ± 0.1°C. Heat from the accelerator LCW circuit will be transferred by heat exchanger into the Research Yard LCW circuit.

For operational support and maintenance purposes, the LCW circuits used for the NLCTA project will be part of the SLAC's overall LCW system, which is tested routinely for tritium and hazardous constituents.

The NLCTA beam dump will not be water-cooled. Significant radioactivation of LCW is not expected to be a problem.

3.10 Power Supplies

The beam line magnets in the NLCTA will include 34 air-core solenoids in the injector; four steel-core dipoles that make a chicane for manipulating the longitudinal phase space of the beam; 33 iron-core quads with trim windings for steering correction throughout the chicane, linac, and spectrometer; and an iron-core (horizontal) dipole for momentum analysis in the spectrometer, used in conjunction with a ferrite-loaded (vertical) kicker and a kicker-compensator dipole. The low-voltage, high-current power supplies for these magnets will be interlocked through the Personnel Protection System such that the power supplies must be turned off for unrestricted access to the accelerator housing. A special restricted-access mode called RASK ("restricted access with safety key") will be supported, in which qualified persons may work inside the housing while the power supplies are turned on under administrative control.

An additional 20 air-core steering-corrector magnets are distributed throughout the injector and spectrometer. The low-voltage, low-current power supplies for these magnets do not constitute an electrical hazard, and will not be controlled by the Personnel Protection System.

Vacuum in the NLCTA beam line and high-power microwave systems will be produced and maintained by ion pumps. These pumps will be powered by high-voltage, low-current power supplies located in racks inside End Station B. The ion-pump high voltage is insulated by safe connectors.

3.11 Instrumentation and Control

Beam instrumentation in the NLCTA will include strip-line beam position monitors, beam-profile monitors that image the beam on phosphor screen, wire scanners, toroids, an insertable Faraday Cup, and adjustable collimators.

The control system for the NLCTA will be an extension of the SLAC control system that is currently used to operate the SLC, the Final Focus Test Beam, and the Polarized Gun Test Lab. The SLAC control system distributes control functions among a supervisory mainframe, remote workstation consoles for human interface, and remote microcomputers for actual hardware control.

The primary interface to instrumentation at SLAC and in the NLCTA is Computer-Automated Measurement and Control (CAMAC). However, parts of the NLCTA rf system may be controlled by instrumentation of a new open industry standard (IEEE-488 and VXI-bus). Such new modular electronics may be chosen for their superior capabilities in remote data processing, and will be interfaced to the SLAC control system via ethernet.

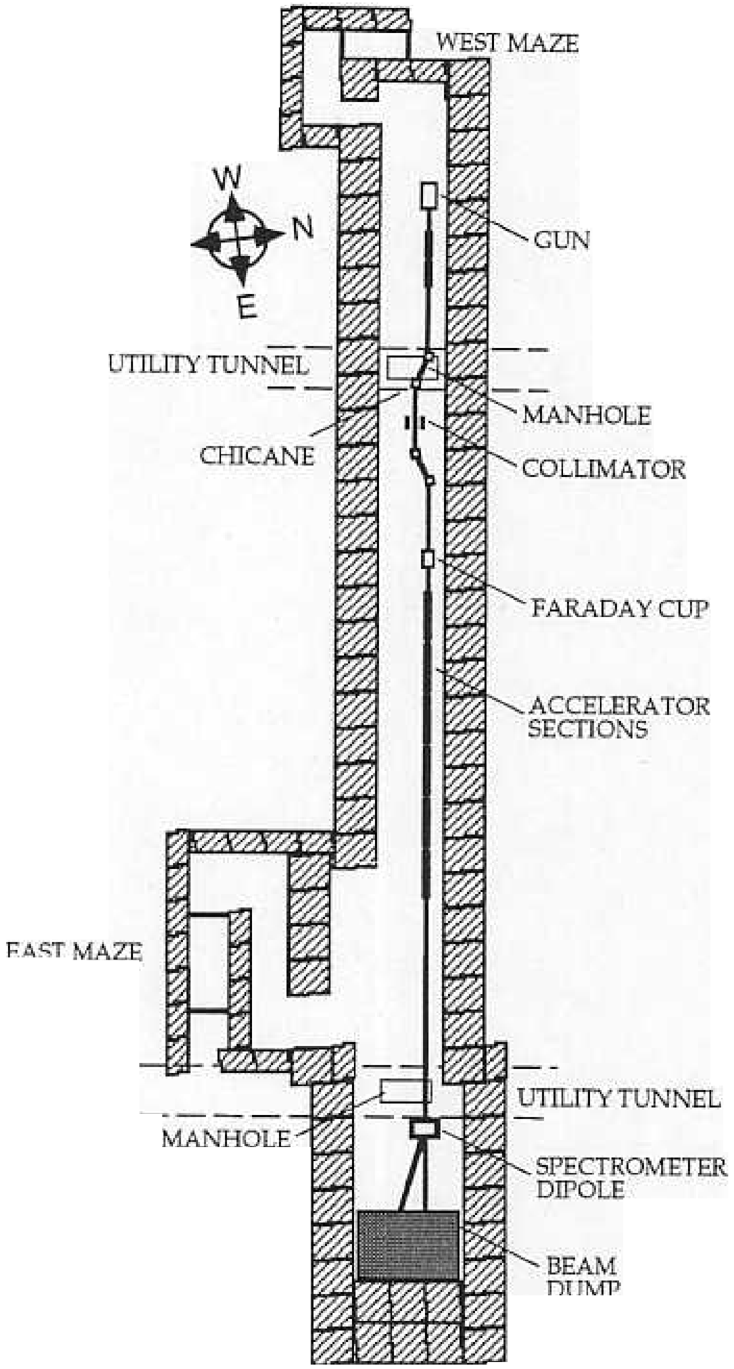
10 Quality Assurance

11 Decommissioning

Personnel Protection Systems

B Beam Containment System

C Beam Shut-off Ion Chamber System



igure Plan View of the CTA

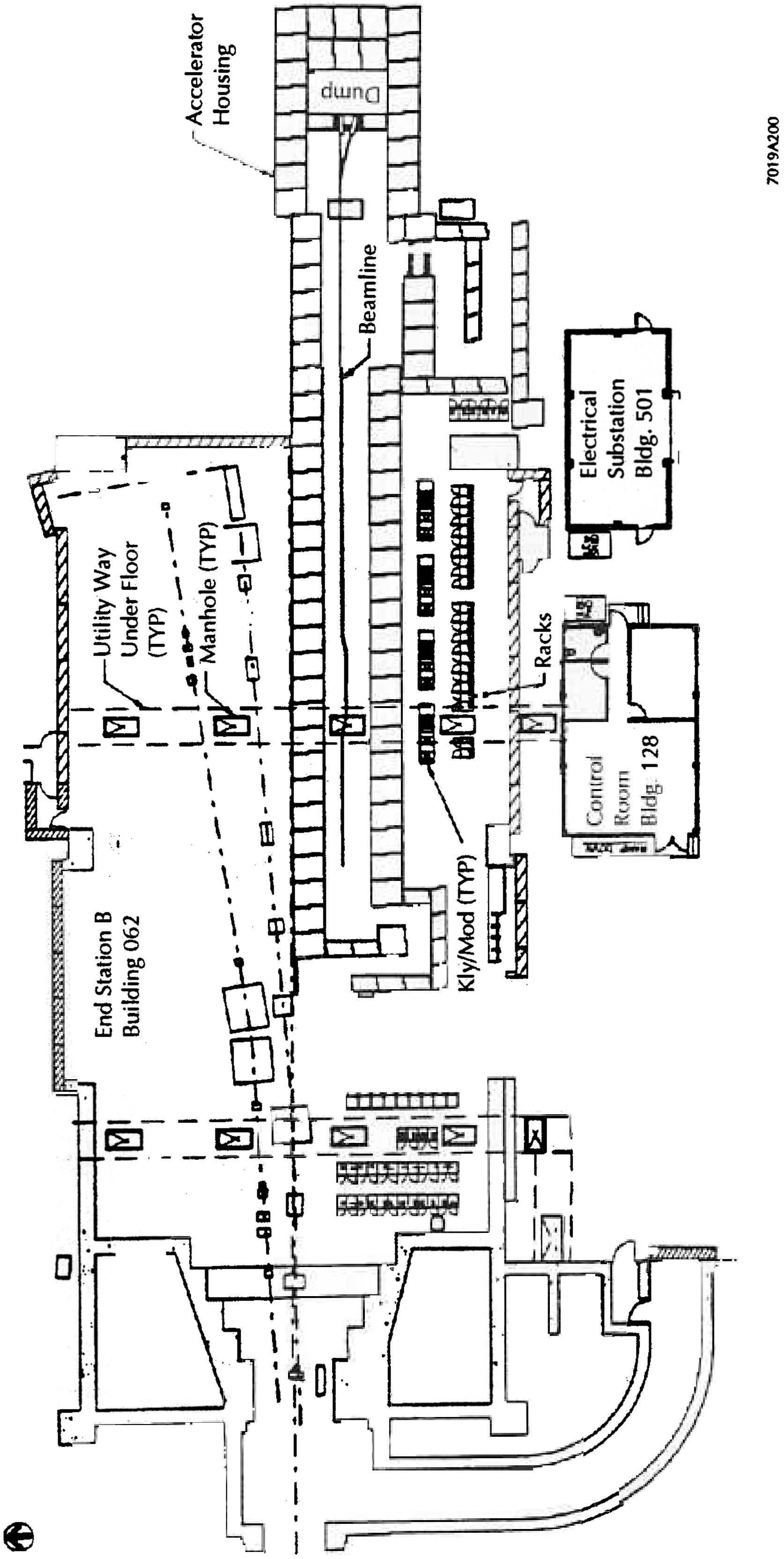


Figure 3.2: NLCTA Site Plan

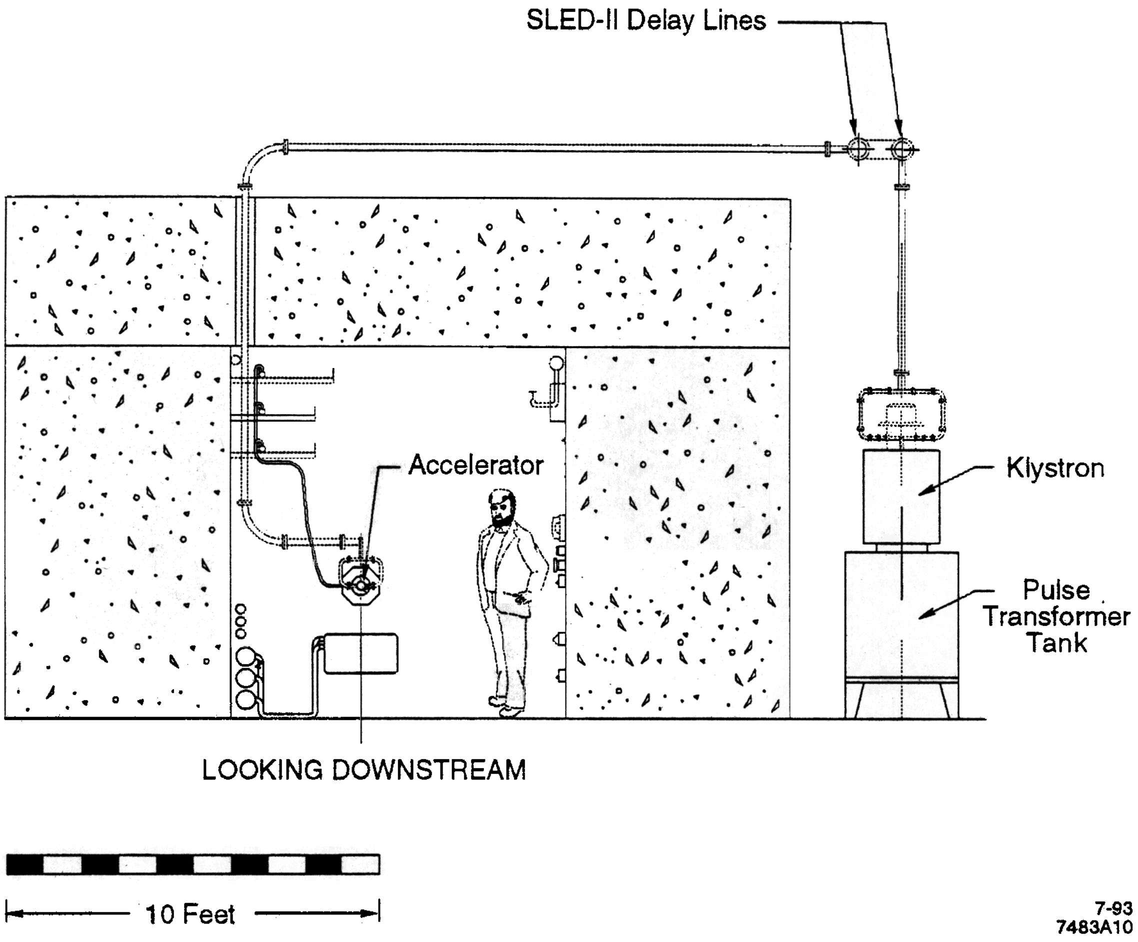


Figure 3.3: Cross-sectional View of the NLCTA Linac