SLAC LINAC PREPARATIONS FOR FACET*

R. Erickson#, L. Bentson, D. Kharakh, A. Owens, P. Schuh, J. Seeman, J. C. Sheppard, M. Stanek, W. Wittmer, G. Yocky, U. Wienands, SLAC, Menlo Park, CA 94025, U.S.A.

Abstract

The SLAC 3km linear electron accelerator has been cut at the two-thirds point to provide beams to two independent programs. The last third provides the electron beam for the Linac Coherent Light Source (LCLS), leaving the first two-thirds available for FACET, the new experimental facility for accelerator science and test beams. In this paper, we describe this separation and projects to prepare the linac for the FACET experimental program.

SEPARATION OF LCLS AND FACET

The SLAC 2-mile linear accelerator has been cut at the two-thirds point to support two simultaneous and independent science programs. The Linac Coherent Light Source (LCLS), which uses only the last third of the linac, has been running to support user programs for nearly a year, while the rest of the linac has been idle. The FACET project will use the first two-thirds of the linac to provide electron and positron beams for plasma wakefield acceleration experiments and other advanced accelerator science programs. Sector 20 of the linac tunnel, which is immediately upstream of the two-thirds point, is being prepared to accommodate a new beam transport and focusing system and user apparatus for a variety of experiments requiring high-energy, low emittance beams. To prepare for the construction of FACET and to accommodate future users, several modifications have been made to the existing linac and tunnel.

LINAC CONFIGURATION

Figure 1 is a schematic representation of the major accelerator systems associated with the SLAC linac. The linac is organized in 31 sectors, each of which is approximately 100 m long. The positron source, which has been in use since the earliest days of the SLAC Linear Collider more than 20 years ago, uses an electron beam extracted from the linac in Sector 19. A new electron injector system based on an RF gun was constructed in a side tunnel in Sector 21 to provide the electron beam needed for the LCLS. Sector 20, the section of tunnel between the positron source and LCLS injector, is ideally suited for the new FACET facility.

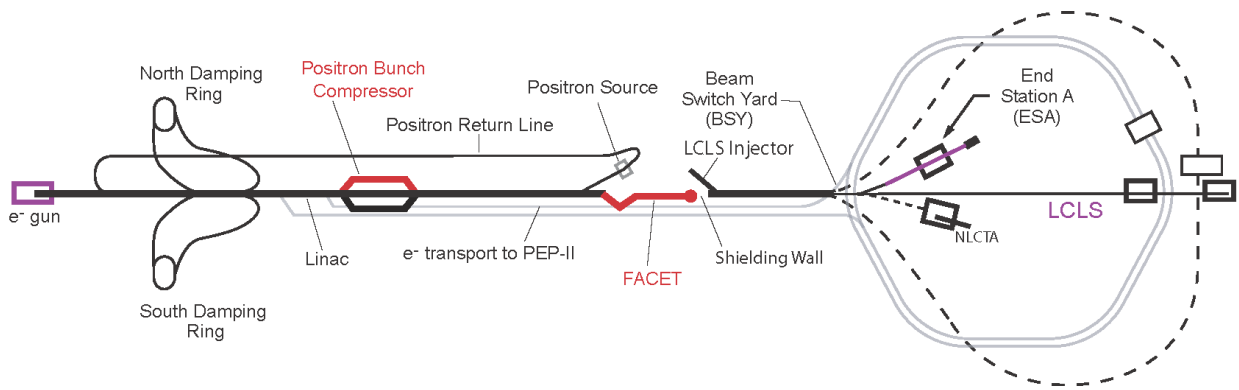

Figure 1: Schematic representation of the SLAC Linear Accelerator Facility with FACET and the LCLS, showing the location of the shielding wall that divides the tunnel between Sectors 20 and 21 (not to scale).

As originally designed, the entire linac tunnel had to be locked and interlocked to exclude people as a condition for accelerating a beam. The last third of the linac runs nearly continuously to support LCLS programs whenever the linac is available, and this demand for uninterrupted linac operation is likely to continue indefinitely. Even short interruptions must be kept to a minimum to maintain the high quality x-ray beams needed for the LCLS experiments.

In contrast, the FACET users are likely to need frequent entries into the tunnel to install, adjust, and modify their experimental apparatus as the science program evolves. To reconcile these incompatible requirements, several projects have been initiated to effectively divide the linac into two nearly independent facilities. The two most fundamental changes are the addition of a massive shielding wall in the tunnel near the downstream end of Sector 20, and just upstream of the LCLS injection point, and a major reconfiguration of the personnel protection system (PPS) to allow for access to the area upstream of the shielding wall while the LCLS is operating.

SHIELDING WALL

The shielding wall was constructed from concrete shielding blocks salvaged from previous SLAC

experiments. These blocks were cut to fit tightly together to span the height and width of the tunnel with numerous small penetrations to accommodate existing pipes and cable trays and the electron and positron transport lines that were part of the PEP-II injection system. The wall is approximately two feet thick in the beam direction and is supplemented with steel plates. The blocks are secured to the tunnel floor and walls to withstand seismic shocks.

The design of the wall was complicated by the need to provide an emergency egress path through the tunnel in both directions. To provide this feature, the wall was constructed with a pedestrian maze that allows a person to walk through a passageway along the south side of the tunnel. Steel doors at both ends of the passageway are interlocked to trip off the beam hazards if either door is opened during operations. Figure 2 is a cutaway view of the wall structure showing the passageway. Figure 3 is a photograph of the finished shielding wall, taken from the FACET side looking downstream.

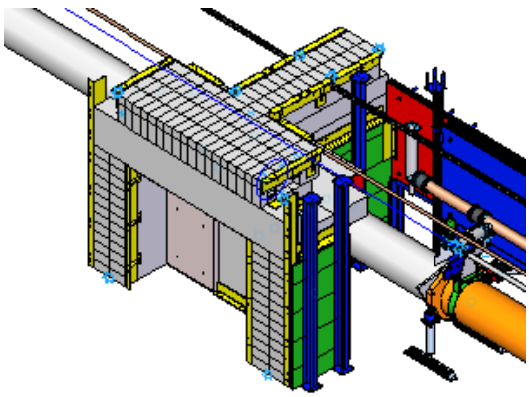

Figure 2: Mechanical design of Sector 20 shielding wall.

Figure 3: Completed shielding wall as seen from the tunnel in Sector 20.

The 2-ft diameter alignment light pipe is visible in both the figure and photograph. This pipe extends for the full length of the linac and provides an optical path for a laser-based alignment system. This alignment feature was judged to be too valuable to abandon, and so the wall was constructed to fit closely around the pipe. To provide radiation shielding over the light pipe opening, a movable stopper was constructed in a rectangular vacuum enclosure integrated into the light pipe. The stopper enclosure box is visible in the lower left corner of figure 3.

Persons working in the FACET area upstream of the wall are well shielded from any radiation that might back-scatter from the LCLS injection area in Sector 21. However, the converse is not true; no one will be allowed in the tunnel downstream of the wall when a beam is present in the FACET area. Enforcing the new access requirements requires significant modifications to the personnel protection system. These modifications are being done as part of a general upgrade of the linac PPS system.

SECTOR 19 STAIRWAY

As originally built, each sector is accessible by way of a vertical ladder installed in a "manway" shaft, which is a cylindrical opening from the Klystron Gallery to the tunnel approximately 35 feet below. Over the years, these manway shafts have provided the primary means for entering the linac tunnel. However, the height of the ladders makes them inherently hazardous, especially for persons carrying tools or other equipment. In addition to the manway shafts, larger equipment access shafts already exist at five-sector intervals and have been used for moving 10-foot accelerator structures and other large objects in and out of the tunnel. Sometime after the original construction, a stairway was installed in the shaft in Sector 4, and more recently a stairway was installed in Sector 24 to facilitate easy access to the LCLS injection and bunch compressor systems. A similar stairway will be installed in the equipment access shaft in Sector 19. This stairway will provide convenient access to the FACET focal point area where experimenters will set up their apparatus.

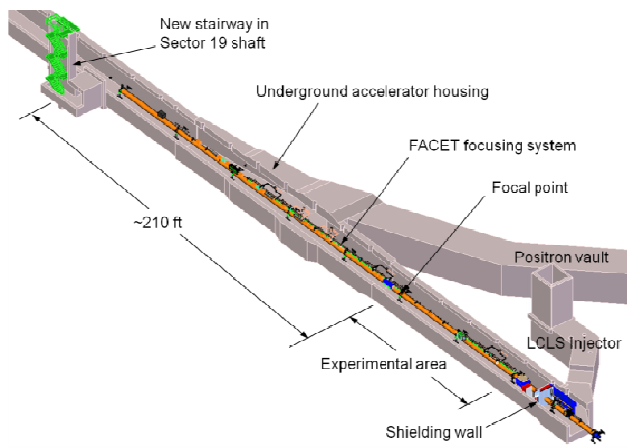

Figure 4: Cutaway view of the linac tunnel in Sector 20 showing the locations of the new stairway, the FACET systems, and the shielding wall.

CLEARING THE TUNNEL FOR FACET

In the past three months, essentially all the accelerator components from the BAS-II dump near the end of Sector 19 to the new shielding wall at the end of Sector 20 have been dismantled to make room for the anticipated new FACET transport magnets, beam diagnostics, and other instrumentation. The 10-foot-long copper accelerator structures were carefully stored for future use. Cooling water pipes were cut back and capped or bypassed, rectangular RF waveguide and vacuum manifold hardware was removed, and a large number of cables and conduits were removed or rerouted. Figures 5 and 6 are photographs taken in the tunnel before and after the accelerator components were removed. The FACET installation project is expected to begin in September 2010.

Figure 5: Sector 20 before the accelerator systems were removed. The linac is visible above the much larger alignment light pipe.

Figure 6: Sector 20 after the accelerator systems were removed. The tunnel is ready for the FACET magnets to be installed.

SUMMARY

A project is underway at SLAC to construct a facility for conducting experiments that require high-energy, low emittance, longitudinally compressed bunches of electrons or positrons. The FACET and LCLS sections of the linac tunnel have been separated by a massive shielding wall, and a stairway and other modifications have been added to facilitate easy access and emergency egress. The accelerator components have been dismantled and carefully removed from the area where the new FACET systems will soon be installed. The first electron beam to the FACET area is expected in 2011.