PROGRESS IN THE TEVATRON II PROJECT

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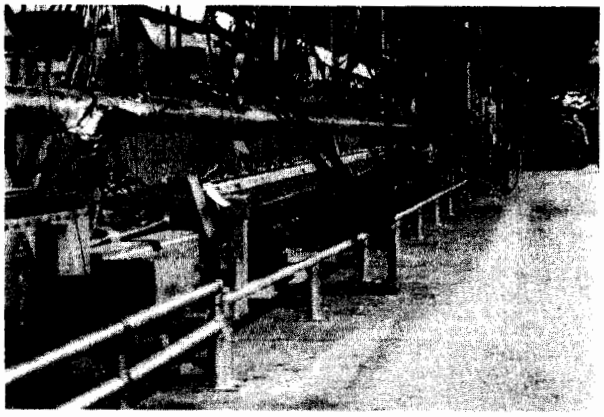
Introduction

Four more months have passed since the last report of progress on the TeV II project (upgrade of the extraction, switchyard, and fixed-target areas for 1-TeV physics). Many projects are now reaching completion and many more are well underway. A few are not really started yet, but by the time of the next report, some work will have gone forward in every one of the projects.

The TeV II upgrade began in January of 1982 and will be complete by fall of 1985. Below, we comment on the work going ahead in the various project areas.

Extraction

Significant progress has been made in completing the extraction system for the Tevatron. All the required elements have been installed in the accelerator tunnel except for two electrostatic septa, which will not be installed until beam has been accelerated. Items that are installed, shown in the accompanying photo by Roger Dixon, include five Lambertson



Looking downstream in Transfer Hall. Visible from left to right are the downstream extraction Lambertson magnet, a Saver orbit bump magnet, and the tilted Energy Doubler dipoles in the extraction channel. The Main Ring and Saver bending magnets are

magnets in A0, three Doubler magnets that make up the extracted beam channel in the Transfer Hall, and ten air-core quadrupoles, some of which are pulsed to initiate fast resonant extraction and some of which are varied under computer control to smooth the spill during slow resonant extraction.

The principal activity on extraction hardware is presently concentrated on the QXR spill-feedback system. This is a microprocessor-based system that controls and smooths the extracted beam spill from the Tevatron. Much of the hardware has been completed and bench-tested. The system should be installed and operational during July for possible use at that time.

Switchyard

The Switchyard begins in the Transfer Hall and terminates with eight primary beams directed to the three experimental areas. The major projects in the Switchyard for the Tevatron II upgrade include the superconducting Right Bend to the Proton Area, an additional primary beam to the Meson Area, an additional beam to the Neutrino Area, plus upgrade of the beam electrostatic splitting stations to 1-TeV capability. Other work consists of a general energy upgrade involving the addition of bending and focusing power to all beam lines.

The Right Bend, which is the major horizontal bend to the Proton Laboratory, was the single largest effort in the Switchyard. It involved the replacement of 34 conventional dipoles in Switchyard Enclosures B and D with 14 Energy Saver dipoles. It was also necessary to construct approximately 1000 feet of liquid-helium transfer line and another 1000 feet of low-pressure helium header. Also included in the Right Bend project were the addition of a satellite refrigerator at the Switchyard Service Building and various helium connections to the Main Ring A2 Service Building that make all of the Switchyard cryogenic systems part of the Energy Saver system. This connection provides additional refrigeration to the Switchyard from the Central Helium Liquefier.

At present 99% of the Right Bend tunnel installation is complete. The only tasks remaining involve electrical hookup and some testing. Work is still proceeding on helium piping and electrical installation in the Switchyard Service Building. This work is 95% complete. The transfer lines are complete except for a few connections and the final leak check. The Switchyard compressors have run and liquid helium has been transported from A2 to the Switchyard Service Building. Cooldown of the Right Bend is expected in July.

The second major task in the Switchyard is the upgrade of the beam-splitting stations. Involved is the construction and installation of 21 electrostatic septa. At this time 11 of the new septa have been installed in the Proton split, the Meson

split, and the Proton 3-way split. Seven septa for the Meson 3-way split are still under construction with a completion date projected for August. Three septa to split the new muon beam from the neutrino beam will not be built and installed until 1984.

The splitting-station upgrade has also involved the implementation of a completely redesigned septum-moving system that will eventually lead to computer-controlled alignment. It will also be possible to adjust beam splits by moving septa rather than adjusting the beam position on the septa with magnetic beam components. These improvements should result in greater beam stability for experimenters.

Upgrade of the primary Switchyard beam lines has proceeded from upstream, beginning in the Transfer Hall, to downstream. Work has been completed in the Transfer Hall and Enclosure B. These areas are presently under vacuum. The remaining primary Switchyard Enclosures (C, D, E) have 99% of the beam-line elements installed with vacuum and alignment work underway. Work is proceeding in this area while beam is tuned in the Saver. Completion of C, D, and E areas is expected in July.

As mentioned above, the electrostatic septa for the Meson 3-way split have not been installed. Also not installed are various other beam-line components in the F and G manholes, as well as in Meshall. Final electrical installation in this area awaits the completion of a new G2 Service Building that will house power supplies and other equipment necessary to operate the meson and neutrino beams. All of this work is to be completed in September.

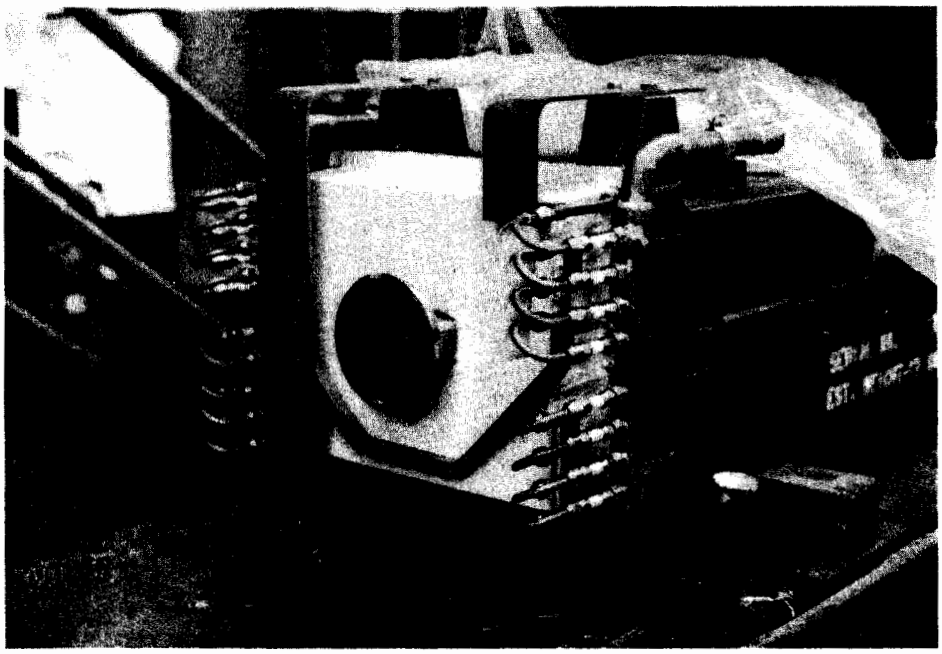
A last major effort for the Tevatron II upgrade of the Switchyard is the implementation of the new Tevatron control system. This work is well underway, and the new system has already been used to control the Switchyard helium compressors which were used during cooldown of the Saver. The control system should be fully operational during July.

All in all, work is nearing completion in the Switchyard and no obstacles are presently seen for delivering beam to all three experimental areas in the fall.

Meson Experimental Area

The entire primary proton beam target plan for Meson was changed to accommodate 1-TeV physics. The old philosophy of having a single primary target viewed by several secondary-beam transports has been scrapped in favor of a triple primary-beam split and three separate target stations. It is much more economical of protons to split up the primary beam and let each secondary beam enjoy 0° particle production. The first of the modified B1 dipoles that will transport the three primary beams

to their targets is shown below as it came out of the Magnet Factory. In the case of Meson, there will be three primary



The first new modified B1 dipole, needed for transporting the three Meson Area primary beams to their respective targets, shown coming off the production line in the Fermilab Magnet Facility.

(Photo by Fermilab Photo Unit)

targets in three separate target-shielding piles located in the former Meson Experimental Hall. This building thus becomes the Meson Target Hall. It is in the background of the construction photo shown on the top of the next page.

Plans for the three target stations have been completed and purchase of steel shielding slabs and concrete shielding blocks has been underway for some time. A significant fraction of the steel and large numbers of concrete blocks are already here and ready for stacking. Dave Eartly of EAD has supervised the design of a modular shielding stack that will eliminate virtually all the cutting and machining of shielding steel. It will be laid in and welded essentially as it comes from the steel mill. This approach saves money without compromising function.

New primary beam focusing enclosures are being built upstream of the Meson Target Hall. The competely new M West primary line will enter the target hall through the new M West enclosure seen under construction here.

(Photo by Fermilab Photo Unit)

The precision baseplate in each target pile supports the target assembly and the target-sweeping magnets. The baseplates are the only elements built to precise tolerances; they control placement and orientation of the beam-handling elements. The plates are designed to allow convenient remote handling of highly radioactive target-system magnets and dumps in case of failure. Design is complete and fabrication is underway.

For the first Tevatron running period, an attenuation target in the old Meson target box will still be used, and the target train for this interim system is being fabricated in the EAD Target Service Building. The train will serve in later runs as a primary beam-transport and collimator system with one (or more) transmission targets to service the M Bottom test beam.

A great deal of effort on the part of EAD has gone into the Meson cryogenics system "Meson Cryo Central." A set of three Saver-type satellite helium refrigerators is grouped together in a single building, from which the seven cryo-magnet strings in the Meson primary beam area will be controlled from common helium supply and return mains. At present, the superconducting magnet strings for the interim M6 and M East proton beams are completely

installed and the cryo hookup is finished. The refrigerators themselves are reaching completion and the controls system is being tested. Cooldown and power tests come later in the summer. The entire cryogenics effort is on schedule and is expected to be ready for operation for the HEP program in October.

Downstream of the Meson Target Hall where the new M-West and M Polarized secondary beams will be built, activity has focused on the final optical design for these beams. Following a preliminary review of MW in May, both the MW and MP beams are considered completely designed. Now that this step has been completed, the detailed design of the two new experimental halls can be initiated and a Title I plan for the Meson North Area started. These steps will be pursued in late summer and early fall of 1983.

Neutrino Experimental Area

Work in the Neutrino Area has focused on bringing primary protons of 1 TeV into the Neutrino Target Hall for use in the N Center, N East, and N West beams. The primary switch between NW and NE is being fabricated as are the beam-handling devices for Front Hall. Primary beam will be brought into Labs D and G for beam-commissioning tests in the second part of the first running period. A test beam will be formed using the NW beam transport viewing a target in the existing Neutrino Target Manhole. Most of the equipment for this beam is already in place and checked out. The NE beam to Labs D and G will be put in place in fall of 1983.

Plans for the Prompt Neutrino and Muon beams are essentially complete and a Title I study of the civil construction, roads, and utilities for the area containing these new beams will commence soon. The new Lab F building for the holographic 32-in. bubble chamber (E636) and the new Lab G building for experiment E690 are out for bid; construction will begin in June. Both buildings will be ready for experimental occupancy by February 1984. A small equipment room will be built as an addition to Lab B for the laser needed by the 15-ft bubble chamber holography system.

Plans for the new Muon Laboratory are being completed and the first phases of construction will commence in July. Construction of this building is a complicated operation because the large superconducting Chicago Cyclotron Magnet must be moved into position before the hall is constructed and the building then built around it. The magnet move will be done this summer, and preliminary preparations are already underway for the project.

The neutrino experimental program will start in the second Tevatron running period with a 600-GeV broad-band triplet run. Construction of the triplet and dichromatics trains is proceeding steadily, and it is expected that a test of a train at the end of the first running period will be possible. A new feature of

neutrino beams in the Tevatron will be the location of the primary target about 300 feet upstream of the old target station. The new target method will not only increase neutrino yields via a longer decay path but will also permit more effective monitoring of the parent hadron-beam intensities and phase-space properties. This function is critical to the effective functioning of the 1-TeV era dichromatic neutrino beams.

Proton Experimental Area

The primary beam handling for the upgraded existing beams in the Proton Area has already been completed and checked out, including the satellite refrigerator for the superconducting bends in Enclosure H. The magnets themselves have not yet been cooled down, due to a problem in welding of components, but this difficulty is now repaired and the magnets are to be tested in the near future.

The second cryogenic refrigerator, used to feed magnets for the P East beam, is now being installed. When this installation is complete, the cryogenic refrigeration for the Proton Area will be finished.

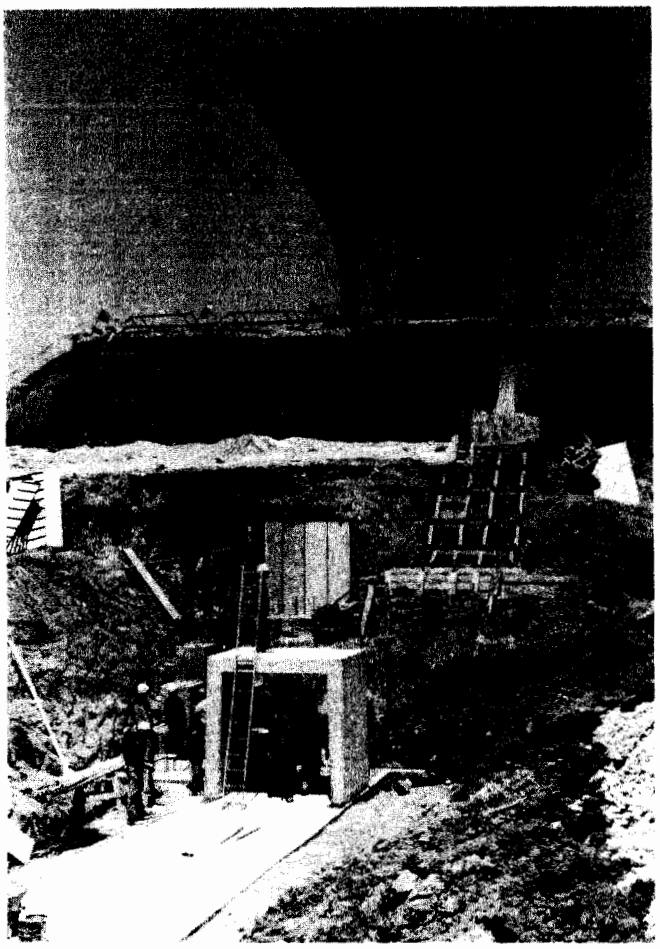
A large amount of civil construction is in progress or complete in the Proton Area. The formerly open EE1 pit is now rebuilt as an earth-shielding primary-beam handling area for the P East and wide-band beams. Construction of the new Enclosures K and P Center is presently underway with completion expected by October 1 (or earlier). The photograph on the next page shows their state in the middle of May.

A new primary-beam pipe is being installed between Enclosure K and the P East tunnel to accommodate the new 1-TeV wide-band beam. Design of the wide-band target system is going ahead at present, together with a comparable system for the new muon beam. Both target piles will be of the earth-shielded underground type.

The target-pile steel shielding for wide band will be located in a rebuilt version of the EE4 pit in Proton. Again, as in Meson, a plan has been developed that exploits commercially available steel slabs with virutally no machining or cutting needed to form the necessary radiation shield. Remote handling of the radioactive target components will be possible using an overhead crane in the target tunnel. The target plan is reaching completion and will be shortly followed by civil design of the new EE4 enclosure.

In recent weeks, the secondary-beam design of the wide-band beam has been improved by decreasing the power needed for the sweeping magnets downstream of the photon radiator target. Dipole magnets of the same design used in the antiproton accumulator ring will be used as electron-sweeping magnets, taking advantage of their energy-efficient design and conserving electric

power relative to the magnets planned earlier for this use. A useful bonus from the design change was a decreased tunnel size in the final stage of the wide-band beam.



A view of the Proton Area civil construction underway. A new underground enclosure, P Center, is being built to accommodate Tevatron primary beam which will be focused onto the P Center primary target. The Proton Pagoda is seen above the excavation.

(Photo by Fermilab Photo Unit)

At the same time as the design is being finalized for the wide-band beam, the criteria are being assembled for the new experimental hall to be built at the end of this beam. In a

short time, detailed design by the Tevatron Construction Group will begin on this building. It is expected that the hall will be ready for occupancy by the experimenters next summer.

The P West high-intensity beam will be ready for primary protons up to 1 TeV by October 1983. The secondary beam will go to 300 GeV and concentrate on negative pions and antiprotons for the first running periods.

Other Relevant Topics

One activity that is almost invisible to users of Fermilab beams, but that is essential to their success, is the production of conventional and superconducting magnets for them by the Fermilab Magnet Facility, a part of the Technical Sevices Section under Dick Lundy. In this area, the TeV II project is well **ahead** of schedule.

All the Saver-type superconducting magnets needed for the fixed-target upgrade are already completed and most are installed. A much larger number of new conventional magnets also had to be made. The organization for this effort was begun two years ago and the magnets are now rolling off the assembly lines. If all goes as presently planned, **all** the TeV II magnets will be completed by June 1984.

The rapid pace set in all the areas of activity will enable the TeV II project, if properly funded, to come in ahead of schedule and get 1-TeV physics with the new secondary beams into operation in advance of current plans. At present, we envision first operation of the new wide-band and Muon beams near the end of the second Tevatron running period in the spring of 1985. We certainly intend to continue dedicating ourselves and our resources to this goal!