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FUTURE US SCIENTIFIC PROGRAM

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ABSTRACT

Central to planning for the future program of high energy physics in the US is the Superconducting Super Collider. While it is being built during roughly the next decade, the present HEP laboratories plan an extensive program of physics measurements. Upgrades and new facilities will allow a vigorous program.

Planning for the future of high energy physics in the US is predicated on the completion of the Superconducting Supercollider (SSC) roughly at the end of the decade. With that assumption, planning and budgeting are underway at varying levels of definiteness for (a) physics exploitation of existing accelerators, (b) additions to existing accelerators which can be completed before the SSC, and (c) longer-range projects which follow the SSC. Use of existing accelerators includes vigorous programs at Fermilab (collider and fixed target), SLAC (SLD at the SLAC Linear Collider), Cornell (CLEO at CESR), and Brookhaven (HEP use of the AGS merging into the heavy ion collider program). Proposed upgrades within the decade include the main injector at Fermilab and possible B factories at SLAC and Cornell.

SSC

The SSC is the major new facility intended to lead the US program into the next century. The 53 mile (85 km) circumference ring generously surrounds the town of Waxahachie, Texas, south of Dallas (see Fig. 1). Officially construction has started and seems likely to

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Schematic Location of SSC Facilities

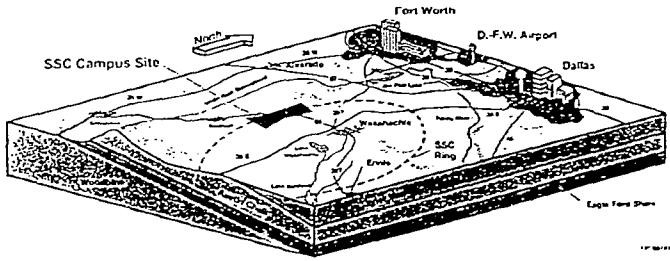

Fig. 1: The location of the Superconducting Super Collider ring, south of Dallas, Texas.

proceed with high probability in spite of pockets of opposition in Congress. As designed, the SSC will provide pp collisions with a luminosity of 10^{33} cm^{-2} sec^{-1} and a center of mass energy of 40 TeV. With appropriate detectors, these parameters permit exploration of the mechanism of electroweak symmetry breaking, whether by the simple scalar Higgs or not. The mass range for discovery of new particles (the Higgs and/or new quarks, leptons, gauge bosons, etc.) extends well into the TeV range. As these proceedings are being written, acquisition of the land is Texas is well advanced, and Congress seems likely to appropriate more than 80% of the amount requested by the President for Fiscal Year 1992. Progress so far, though still preliminary, is consistent with the planned turnon in September, 1999.

Detectors are needed to turn colliding protons into physics and a very large number of physicists from the US and other countries have shown interest in the experimental program. The initial call for Expressions of Interest (EoI) due in May, 1990, produced fifteen responses. Four of those were for the large high-p_T detectors, for which the Program Advisory Committee (PAC) recommended calling for Letters of Intent (LoI), which were due in November, 1990. In December, the PAC recommended approval of the Solenoidal Detector

Collaboration to proceed to the next step of a Proposal and Design Report, which will be due in April, 1992. It also recommended that the Laboratory conduct negotiations with the L* collaboration to resolve some questions. After April, the negotiations with L* failed and a new collaboration (as yet unnamed) has formed to define a second detector for the SSC. They have submitted an EoI to the Laboratory and the PAC and are preparing an LoI with a better defined detector.

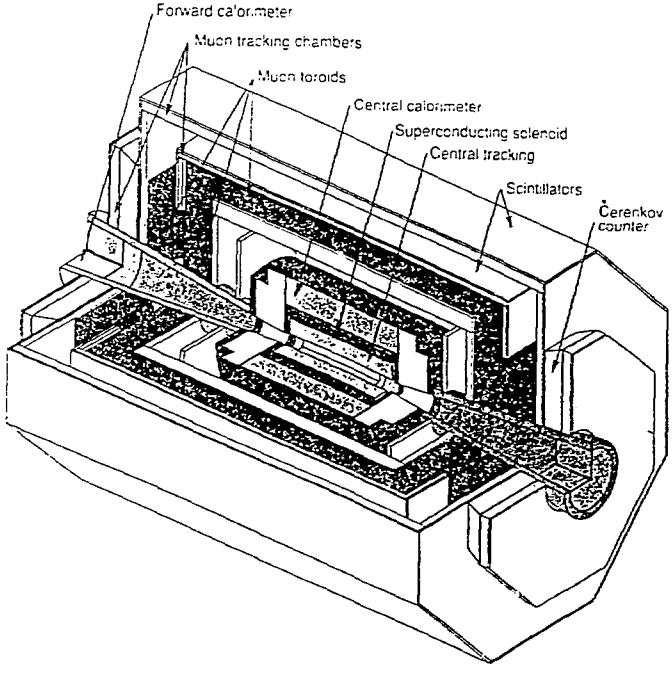

Fig. 2: An isometric view showing the major components of the SDC detector as described in the Letter of Intent.

In addition to two large detectors, it is intended to have some number of smaller, more specialized detectors. The PAC will define the manner of proposing and selecting those detectors in the near future.

FNAL

While construction of the SSC and its commissioning for physics is given top priority in the US program during the next decade, a recent

subpanel of the High Energy Physics Advisory Panel (HEPAP) has emphasized the need to continue a vigorous experimental program while the SSC is being built. A substantial part of this pre-SSC program will be carried out at the Fermi National Accelerator Laboratory (FNAL), where currently the highest energy protons are available. In the immediate future, FNAL's program is to finish the current fixed target tune, which will run until December, 1990. There will then be an extended collider run with the new D0 detector in addition to CDF, which will extend, with some interruption through 1993.

Two upgrades to the FNAL accelerator system are planned in order to make possible increasingly sensitive physics measurements during the decade. The first, a replacement of the linac, is already underway. The project will be finished, during a break in the collider run, by March, 1993.

A larger upgrade project is known as the Main Injector (see Fig. 3) and is planned to completely replace the FNAL main ring, the original warm accelerator which now acts as an injector to the superconducting Tevatron and very importantly produces protons that create antiprotons as part of the antiproton source for the Tevatron collider. The two large rings presently share a tunnel, leading to some interference between their operations. In particular, the main ring is operated for antiproton production while the collider is operating with coasting beams, leading to the possibility of backgrounds in the collider detectors.

The proposed main injector will be a new 150 GeV proton ring, outside of the main tunnel and designed for its role of injector to the Tevatron and the antiproton source. It will supply substantially more protons than the current main ring and be easier to operate and maintain. In addition, it will be possible to use it for dedicated experiments needing lower energy beams, in parallel with it use to feed the Tevatron. Congress appears to be on track to provide initial construction funding in FY 1992 for the main injector. Completion is planned for 1995.

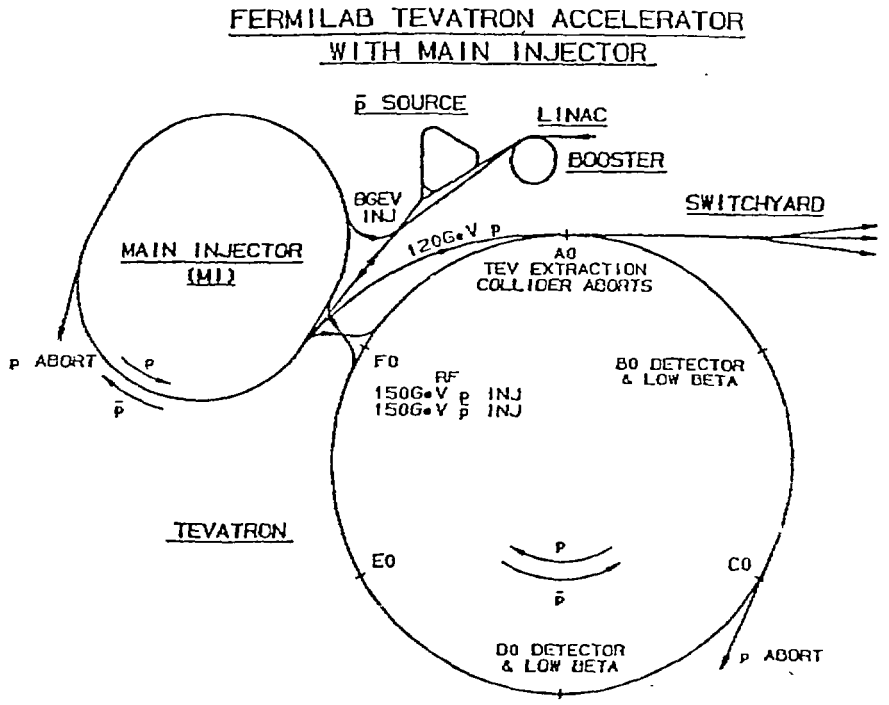

Fig. 3: Schematic view of the planned FNAL main injector with connections to the Booster, Antiproton Source, Tevatron, and Switchyard.

Increased luminosity for collider operations is a main goal of both upgrade projects. When they are finished, collider luminosity is expected to be 5 x 10^{31} cm^{-2} sec^{-1} or more.

The two large collider detectors plan substantial upgrades both to improve their capabilities and to permit operation with the higher luminosity and shorter bunch spacing of the collider. CDF will have a new silicon vertex detector in the 1992 run and then for future runs plans upgrades of the forward calorimeter, trigger, and electronics. D0 is being commissioned during the 1992 run. Planned upgrades include the addition of a magnetic field to assist in studies of b physics. Improvements are also being planned to the tracking system and to triggering and electronics.

The physics measurements and searches planned for the 1990's at FNAL show many opportunities for complementary measurements in the collider and fixed target programs. In the near-term collider program, discovery of the top quark, if its mass is within range, is the first physics goal, but more generally FNAL sees a number of measurements aimed at measuring the masses of quarks and neutrinos. An intriguing possibility for the fixed target program is a long-baseline neutrino oscillation experiment with the main injector, aiming the neutrino beam through the earth at one of the underground laboratories, such as IMB, Soudan, or Dumand. Other physics topics that will receive attention from both parts of the program include measuring the magnetic moment of gauge bosons, searches for new particles, CP violation in the K and B systems, and the interactions of tau neutrinos.

Electron Machines

Vigorous programs at electron accelerators are central parts of the US physics program for the next decade. Both SLAC and Cornell have current collider programs from which much interesting physics is expected. At SLAC, SLD is beginning operations at the SLAC Linear Collider (SLC). Though the SLD does not compete with LEP in luminosity, it will exploit its ability to study electron-positron collisions using polarized electrons. In particular, precision studies of the Weinberg angle and $b\bar{b}$ mixing will be possible.

Cornell is making use of the upgraded CESR electron-positron collider and the CLEO II detector. They will continue their emphasis on measurements of CKM matrix parameters and b physics. A new round of collider upgrades are planned, with improvements to the RF system, optics of the collider, and the positron source. In addition, more bunches will be provided.

For the latter part of the decade, there is great interest in the possibility of high luminosity B factories. Both SLAC and Cornell have made proposals for asymmetric B factories, which are under

consideration by the Department of Energy (for SLAC) and the National Science Foundation (for Cornell). If a B factory can be built within financial constraints, it will allow precision investigation of $b\bar{b}$ mixing and CP violation in the b system.

The other major focus of the electron-positron program is on continued development of linear collider technology. This has a longer time horizon and is seen as the probable technology for the next large machine, after LHC and SSC. Within the US, linear collider development is focused at SLAC. Fig. 4 shows a concept for a high energy linear collider system.

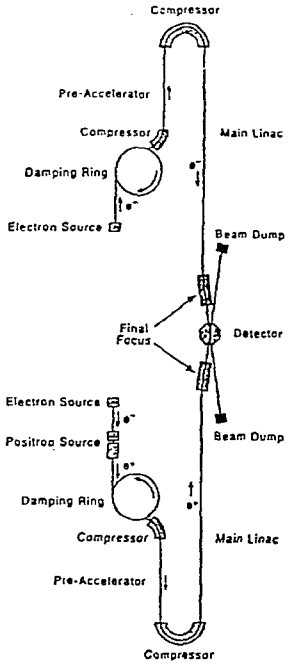

Fig. 4: Schematic of a Next Linear Collider, reflecting R&D at SLAC.

Other Plans

Finally, the US high energy physics program includes a continuing pgogram at the Brookhaven AGS, as well as a number of non-accelerator experiments. Brookhaven is focussing on precisions measurements such as rare K decays and g-2. It is benefitting from the higher

intensity provided by the new booster. Increasingly, the program at BNL is moving toward heavy ion physics and the advent of heavy ion collisions with RHIC.

The non-accelerator program in the US has a number of experiments that probe the physics of elementary particles in ways not accessible to accelerator-based detectors. It is expected that experiments during the next decade should provide much new information on the nature of dark matter, the existence of magnetic monopoles, and on the nature of neutrinos as observed both from supernovas and more locally from the sun.

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