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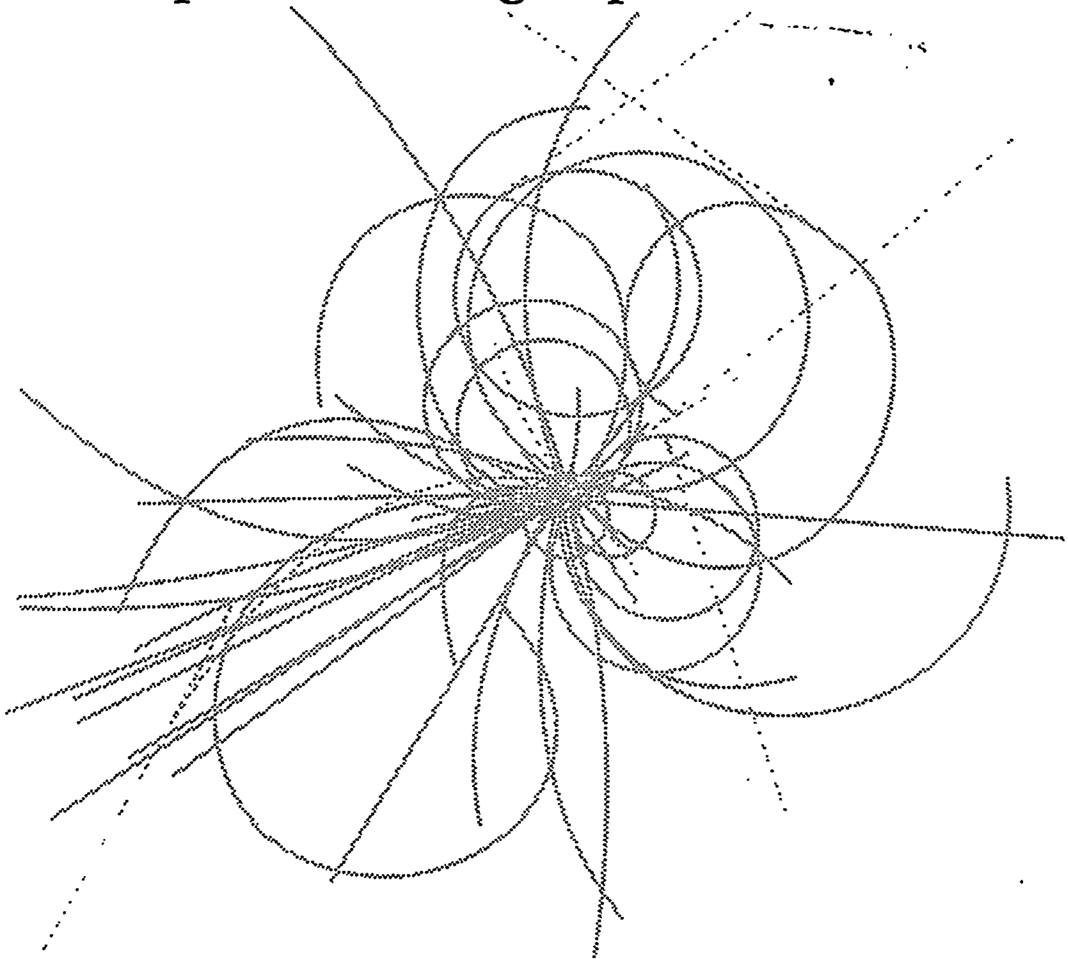
Superconducting Super Collider Laboratory



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The Status of Detectors at the SSC

Raymond J. Stefanski

A. Introduction

The announcement of the location of the SSC at the site near Waxahachie, Texas was made in January, 1989. Since then a great many important steps have been taken toward the start of the new Laboratory. Some 900 people have been brought to the site as the starting nucleus of the staff that will ultimate number about 2200. A design baseline has been completed that includes a conceptual design for the accelerator, and the detectors. Also, the process has begun to determine the configuration of detectors that will be built for the SSC.

This process has several steps, and now the first of these has been taken: The detector collaborations have submitted the Expression of Interest to the Laboratory. These were reviewed by Laboratory management and the Physics Advisory Committee in July, 1990 and recommendations were made to the collaborations. Decisions were deferred for all of the detectors. But perhaps the most significant recommendation was the request to reduce the size and cost of the general purpose detectors.

The detector collaborations are now reviewing their initial designs to prepare for the Letters of Intent, the next step in the detector planning process. This is clearly a difficult and crucial step in that the redesign of the detectors must be done with minimal reduction in detector quality. It is an interesting time in the development of the new laboratory, and a crucial time for the ultimate physics that will be done at the SSC.

B. The Development of the Site

The most general configuration of the site includes a plan for a East and West Campus with a diamond by-pass configuration on each side. (See Figure 1.) This configuration would allow ultimately for eight Intersecting Regions. The initial construction of the Laboratory will include four IR's, two of which will be for large general purpose detectors. There may also be provision for an extracted beam from the SSC to a 20 TeV fixed target area to be used mainly for Beauty Physics and test beams.

The site plans include provision for all of the support structures needed for the Accelerator and detectors. With regard to detectors, the plan includes buildings for office space and laboratories, detector assembly areas, utility buildings and buildings to cover the access shafts to the detector halls. The staff requirements for the detectors are estimated to be about 1300 people including 500 visiting scientists and engineers. Provision is made for about 40 Mwatts of power for the detectors and supporting buildings in the baseline design.

The site plan is likely to change as the detector program takes shape. For example, the Laboratory is presently studying a configuration that would contain a diamond by-pass on only the West Campus in the initial construction. (See Figure 2.) All four of the initial detectors would be built on the West Campus, with the East Campus reserved for the future expansion. Furthermore, the large general purpose detectors would be built on the inner leg of the diamond where geological conditions favour the large detectors, and protection from radiation from the main beam is easier to design.

The site plan is likely to continue to change as the detector configuration becomes better defined. For example, many of the surface facilities will be defined after the detector assembly and maintenance requirements are more fully understood. Schedules and realized funding profiles can also affect the site plan as practical issues determine the rate at which structures can be built and their location.

C. Schedules

A schedule for the construction of detectors and their support facilities is shown in Figure 3. The construction of the detector halls is believed to require about 2.75 years. This will depend greatly on the geological conditions in the region of the hall and the size of the hall. Also the construction technique will be very important. If the halls are not too large, cavern construction may be feasible rather than open cut construction. This would require the removal of far less material, and would progress somewhat more rapidly. If open cut construction is necessary, the geology on the West Campus favours a shallow cut, thereby minimizing the amount of material required to be removed from the pit, and would proceed in less time than construction on the East Campus. The schedule given in Figure 3, is an average taken from a study of conventional construction required for several different detectors in different locations. It is used as a generic schedule for very broad planning purposes. More detailed schedules will be developed as the plans for detectors become more exact.

Similarly, a set of schedules was developed for different kinds of detectors, and these were put together into a sort of average generic schedule also shown in Figure 3. The detectors are believed to require about 3.5 years to construct. Clearly then, the hall and detector construction will together require about six years, and this leaves very little time in the early planning stages for the development and the proposals and the detector conceptual designs. It is expected that the design work for conventional construction will have to proceed even before final approval of the experiments is granted. This also implies that the design of the detector and the laboratory facilities must progress hand in hand as the proposals are written.

D. The Expressions of Interest

Of the fifteen submittals to the Laboratory of Expressions of Interest, four dealt with large general purpose detectors. These include SDC, L*, EMPACT, and TeXAS. Each detector is relatively unique in its properties and together they give a good representation of the overall capability of detectors at the SSC.

The SDC detector is characterized by excellent central tracking and a two Tesla field in the central region. This detector would also have excellent electromagnetic and hadron calorimetry located outside of the solenoid coil. The outside of the detector consists of magnetized steel to identify muons and the muon tracking system. The detector also has forward calorimetry and forward steel toroids for the muon system. Of the four detectors, SDC has the highest central field and thereby the best ability to measure the charge of high momentum tracks.

The L* detector has an extensive muon system consisting of a large solenoid magnet with very high precision tracking for muons. As given in the EoI, the detector has muon momentum resolution of about 2.5%. The calorimetry features BaF_2 electromagnetic calorimetry in the central region. The hadron calorimetry uses a silicon-lead sandwich configurtion where the silicon is the active medium. The detector also has forward magnets that are solenoids placed perpendicular to the beam axis to present a bending field along the beam axis. The magnets are filled with a muon tracking system . Forward calorimetry consists of liquid Xenon for the electromagnetic, and silicon-lead for the hadron calorimetry.

The EMPACT detector has no magnetic field in the central region. It features excellent muon tracking with an air core toroid magnet configuration. The muon tracking system resides entirely in non-field regions simplifying the tracking and matching problems. The calorimetry was left somewhat open in the EoI between Liquid Argon and Spaghetti calorimetry. The forward system also includes air core toroidal magnets for the muon tracking system, and forward calorimetry.

The TeXAS detector emphasizes minimal cost by using no magnetic field at all. Muon tagging and momentum measurement are determined with transition radiation detectors that are arranged around the interaction region in an eggshell configuration. Scintillating fibres are also prominently featured as part of the overall tracking system. Scintillating fibre calorimetry would be used in this detector.

After the deliberations of the PAC, the collaborations have begun to consider the changes needed to meet the recommendations. Perhaps most dramatic of these changes is the marriage of the EMPACT and TeXAS groups.

E. The Process of Change

Because the detector designs are complex, and the collaborations are dispersed all over the world, the changes to the detector designs is somewhat difficult. Nevertheless, several groups have begun extensive changes. The weight of the L* detector has been reduced by a factor of two, and the power required by the resistive magnet design is also substantially reduced. The EMPACT and TeXAS groups have joined forces, and it is even now too early to predict the changes that this will evolve in their detector design. They are considering using steel toroids for the muon system to save on cost and complexity.

The process of change will not be entirely understood until the Letters of Intent are submitted and the PAC has an opportunity to respond. By the end of the year the detector configuration will be far better determined.

F. The Test Beams

An important part of the detector program involves the availability of test beams. The schedule for test beams at the SSC is given in Figure 4. Beams from the MEB (200 GeV primary energy) should be available in 1996. The test beams will be capable of delivering high hadron yields for rate studies, will have high precision momentum tagging for calorimetry, and excellent electron tagging for electromagnetic calorimetry. Furthermore, beams will be available with several 200 GeV protons per bunch to simulate higher energy deposition in hadron calorimetry. The baseline design provides for three secondary beam-lines.

There will be no beam available at the SSC lab before 1996. In this period, the detector R&D and the detector prototype studies will have to be carried out at the existing laboratories. The availability of beam for SSC experiments at Serpukhov and other sites in the USSR could be very crucial for the SSC detectors.

G. Summary

The development of the designs for the SSC Laboratory, its support facilities and the detectors has come a long way since the site selection in Dallas, Texas. By the end of the year the detector configuration should be far better understood. As these decisions are made, the site as it is associated with the detectors will become more precisely determined.