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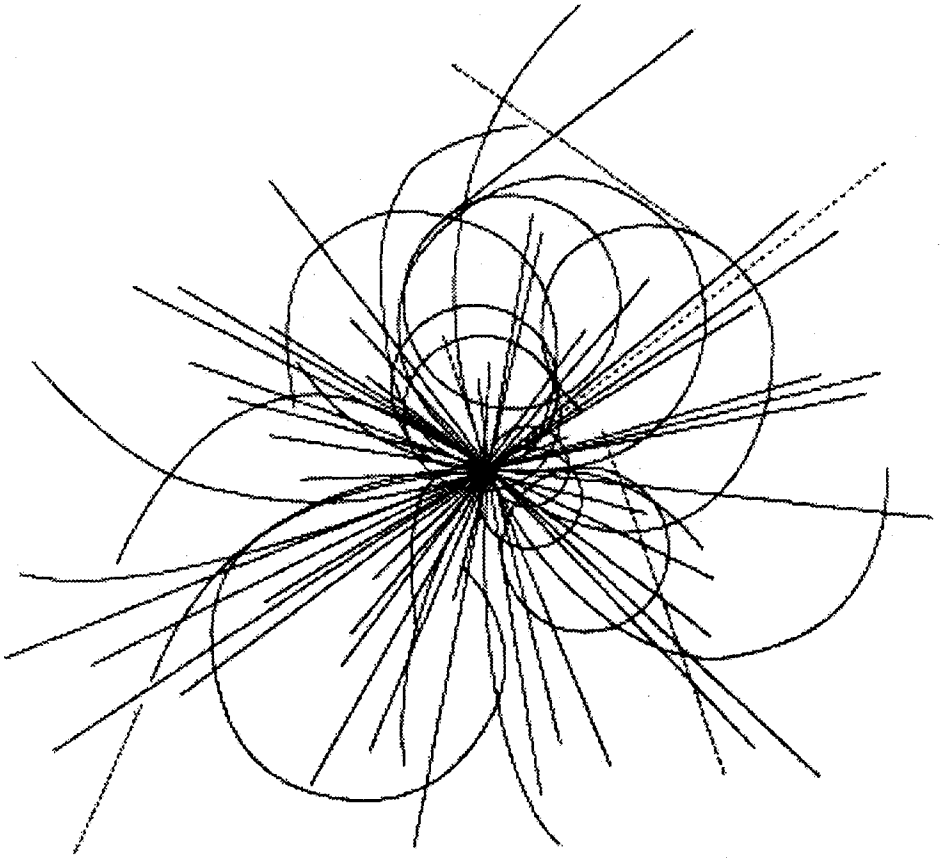

Superconducting Super Collider Laboratory

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The Accelerator Systems String Test Program*

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THE ACCELERATOR SYSTEMS STRING TEST PROGRAM

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INTRODUCTION

The Accelerator Systems String Test (ASST) complex is located at the N15 site in Ellis County Texas. The complex was initially constructed to demonstrate the operation of a standard half-cell of the Collider machine lattice using prototypical superconducting magnets. The ASST half cell consisted of five 50 mm aperture dipoles, one 40-mm aperture quadrupole and three spool pieces. This demonstration was a Congressionally-mandated milestone for the Superconducting Super Collider Laboratory (SSCL) and was scheduled for completion by October 1, 1992. The milestone test (Run 1) was completed with the successful powering of the half cell to 6500 A in mid-August, 1992.[1]

ASST PROGRAM MANAGEMENT

The completion of the milestone marked a transition point for the ASST management structure. The task force organization that was used for the milestone effort was focused on accomplishing a single task. When that task was completed, the organization was dissolved and the ASST entered a new phase. The planning for this transition was started well in advance of the completion of the milestone. The new organization had to focus on the operation of a test facility rather than accomplishing a single task as before. The philosophy that drove the new organizational structure adopted for the ASST was simple. The SSCL required a facility where technical components could be integrated into collider prototypical systems and subsystems for testing and operation. Without this capability, the SSCL could not meet the quality assurance goals stated for the laboratory by test verification of the superconducting accelerator's [the Collider and High Energy Booster (HEB)] level 3B specifications.[2,3] In addition to providing a test bed for systems and personnel training, the ASST test program needed to provide for testing critical component parameters that could not be verified in single component testing. One example of this would be the heat leak to the 4 K cryogenic circuit in the superconducting magnets. Another would be the response of spool piece components to magnet quenches.

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The Collider Machine Group was given the responsibility for the program management and the initial operation of the ASST. The ASST Test Group was formed from members of the Collider Machine Group and the Project Management Office (PMO) who participated in the milestone effort, and the support personnel from the ASST Task Force. The principle positions within the test group are the ASST Program Manager, the Program Physicist, Program Engineer, Program Analyst and the Systems Engineer. These people are assisted by six support staff members. The established reporting structure has the members of the test group reporting to the program manager, with the program manager reporting to the Collider Machine Leader who reports to the Deputy Project Manager for Superconducting Accelerators.

The ASST is an operating facility at the SSCL and as such, requires test technicians and operators to function. This type of personnel cannot be provided by the Collider Machine Group or PMO in general. The laboratory has recently established the Accelerator Operations Department (AO) under the Deputy Project Manager for Accelerator Operations within PMO. This department will ultimately be responsible for the operation of the Collider and the injector accelerators once they are commissioned by the machine groups. In the interim, AO provides the safety and operations oversight for the ASST. Eventually, AO will provide the test technicians and operators for the string test facility along with the operations management function. Until AO has the staff to provide these positions, the ASST Test Group will rely on the technical divisions, Magnet Systems Division (MSD), and Accelerator Systems Division (ASD), for technician support. Current staffing requests call for a core group of six test technicians to support the installation and checkout of string components. This group would then function as string operators during the testing phase of operations. This staffing requirement is now being filled by technicians from the Cryogenics, Mechanical Engineering, and Electrical Engineering Departments of ASD.

Two committees were established to assist the ASST Test Group with the program and operational aspects of the string test facility. The first was the ASST Safety Review Committee. This committee is composed of members of the SSCL not directly involved in the day-to-day operations of the string test. They are responsible for reviewing changes in component configurations or operating conditions at the string test with respect to compliance with the ASST Safety Analysis Report (SAR) and general safety requirement of the SSCL. Prior to commissioning the string for operation, the committee reviews any changes that have taken place since the last test run. If the committee is satisfied with the configuration and proposed operating envelope, a recommendation is made to the Deputy Project Manager for Accelerator Operations to grant the test group a permit to operate. During the commission phase, conditional permits to operate are often given prior to the general one.

The second committee established was the Program Steering Committee. This group is chaired by the ASST Program Manager and is composed of representatives from the superconducting machine groups in PMO, and the technical departments within ASD and MSD. The charge to this committee was to establish the test program direction by the review of test requests submitted to the ASST Test Group and the assignment priorities to those requests based on technical merit and the SSCL project requirements. The testing schedule, run configurations and integrated test plans are also reviewed and approved by the program steering committee. This group reports to the Deputy Project Manager for Superconducting Accelerators.

THE TESTING PROGRAM

In order to facilitate the submission and evaluation of test requests for the ASST, the test group developed a test request procedure and forms.4 During the period from August, 1992 through April, 1993, over 50 test requests were received by the test group. In the

beginning, the type of testing that was appropriate for the ASST was not well understood by the user community at the laboratory. Of the first 20 requests received, the steering committee rejected five of them. The rejected proposals generally involved measurements which could better be performed on single component test stands. Most test requests are now approved for integration into the testing program. The majority of the test requests come from the technical divisions and not the machine groups. ASD accounts for 50% of the submitted requests, followed by PMO with 28% and finally, MSD with 22%. However, test requests from PMO are largely generated by the ASST Test Group and are usually system level tests. These requests generally define the basic string configuration for a run, the testing priorities and require the most resources to support.

Roughly, 80% of the test requests fall into two categories of testing. These catagories are the measurement of the thermal and electrical characteristics of the string system and components. The thermal tests typically focus on determining the heat leak to the various cryogenic circuits that exist in the dipole and quadrupole magnets, the spool pieces and the interconnect region between string components. The heat leak budget for these components is well defined and the capacity of the collider cryogenic system is based on those values. If the accelerator components fail to meet the defined budget, the capacity of the present design of the refrigerator system will be inadequate. During Run 2, which took place from November 1992 through January 1993, several weeks of testing were devoted to thermal measurements. During this period, heat leak measurements were made on the dipole magnets and the SPR spool. Measurements were also made of the temperature distribution of the heat shields in the interconnect region. The results of the heat leak measurements on the half-cell configuration acquired in Runs 1 and 2 indicate that the heat leak to the 4 K circuit in the dipoles is significantly over budget. These results are fully discussed in Reference 5.

Test requests for electrical measurements generally involve the magnet power system (CECAR), the quench protection system (QPS) and the response of string components to a magnet quench. During Run 2, tests were conducted on the energy dump time constant, the energy dump switch, the SPR spool bypass lead, the power supply regulation, the quench detection threshold, the down ramp rate response of the magnets, and the quench response of the string to quenches induced by spot and quench heaters. The principle results from the electrical tests for Run 2 are reported in Reference 6.

The initial full cell testing program (Run 3) at the ASST will start in June 1993 and last for approximately five months. The priorities for this run as determined by the ASST Program Steering Committee are first, the thermal measurements of the string using a highly instrumented dipole magnet (DCA323) and SPR spool piece; second, the measurement of the quench response of a full cell at 4.25 K and third, the testing of two prototype SPR spools designed and fabricated by vendors. The initial five month period of testing will address the first two priorities for the full cell program. The third priority, the testing of the two vendor spools in the string, will require an additional four to five months of effort.

FUTURE PROGRAM PLANS

The test program at the ASST has thus far used magnets designed by the laboratory and fabricated at either Fermi National Accelerator Laboratory (FNAL) or at Brookhaven National Laboratory (BNL) by industry. The data collected from these tests will be fed back into the design process of the industrial magnet vendors. The Collider Machine Group still has the responsibility to verify that the magnet designs produced by industry meet the Collider Level 3B Specifications. Planning is in progress for a full cell test of industry designed and built collider dipole and quadrupole magnets. This test would take place in the first half of FY95. The goals of this string test would be to verify the thermal and

electrical performance of the magnets and spools, to test the magnet stand design and installation techniques, and to provide a training exercise for the installation contractor selected to install the Collider components. This string test would be the final opportunity to test these components and procedures before the underground installation is started for the Early Cryo Loop Test.

The Early Cryo Loop Test is another M1 milestone for the Collider project and is currently scheduled for March 1996. This is a string test of four cells of the collider lattice installed in the tunnel starting at the N15 and proceeding northward. Planning for this test is in progress. The ASST Test Group will be responsible for the test plan and management of this effort. Since the Early Cryo Loop Test will be underground in the collider tunnel, the ASST surface facility will be available for other testing programs. The HEB Machine Group is in the process of defining such a test program. Currently, the HEB string test effort is being planned to start in FY96 and last for approximately one year. Given the shorter lengths of magnets, the HEB string test could be several cells in length.

SUMMARY

The SSCL has established a testing facility at the ASST complex dedicated to providing the scientific and engineering staff of the laboratory with a facility in which to test superconducting accelerator systems, subsystems and components. Two data-taking test runs have been completed using laboratory designed Collider prototype magnets in a half-cell configuration. A third testing period is scheduled for the summer of 1993 using a full cell of these prototype magnets. Future plans include the testing of a full-cell string of Collider magnets based on the industrial design. The ASST testing program for the Collider will culminate with the Early Cryo Loop Test, a SSCL M1 milestone tentatively scheduled for March, 1996. The HEB Machine Group has formulated plans to conduct HEB magnet string tests at the ASST beginning in FY96.

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