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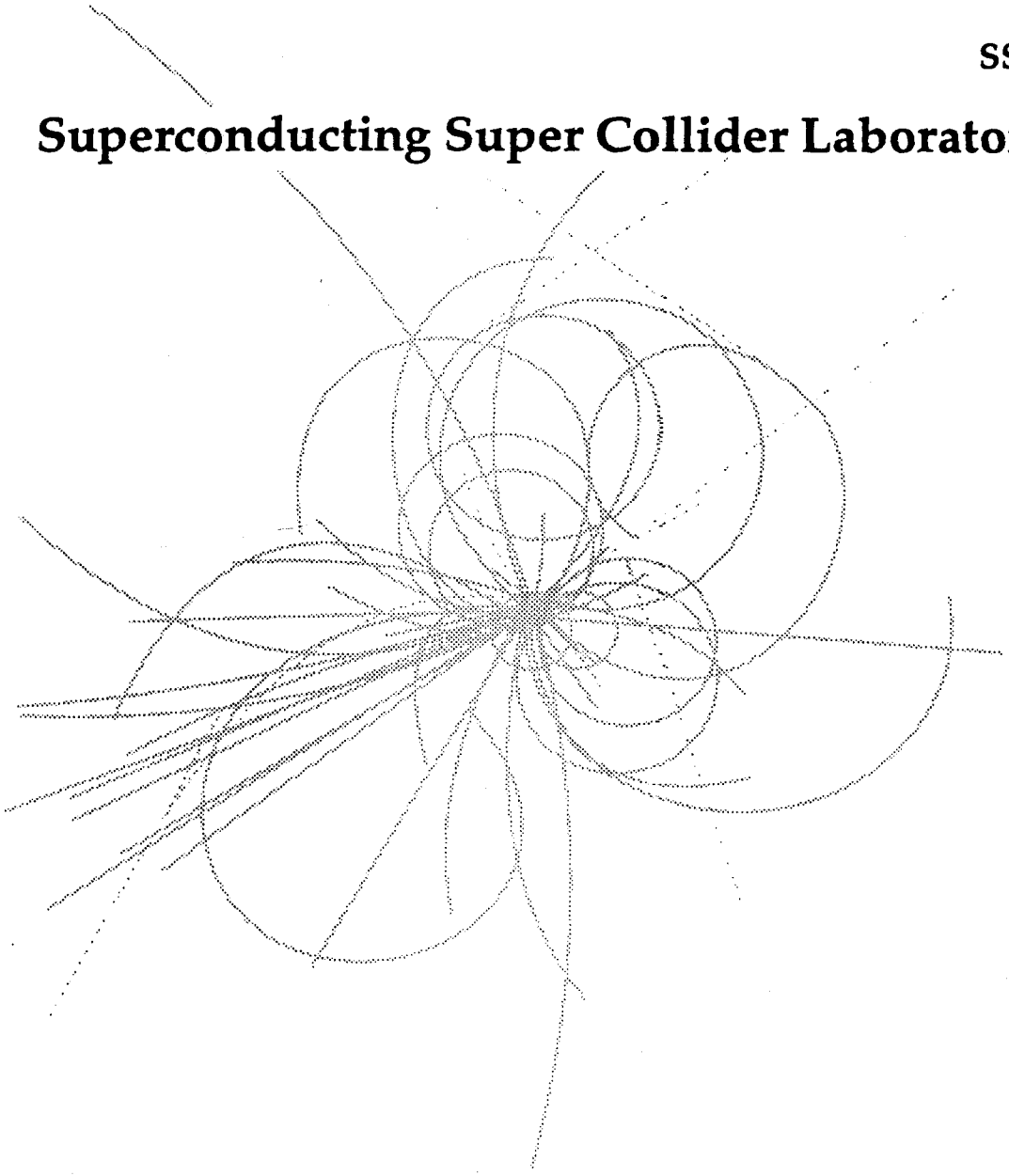
Superconducting Super Collider Laboratory



Technology Transfer Considerations for the Collider Dipole Magnet

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TECHNOLOGY TRANSFER CONSIDERATIONS FOR THE COLLIDER DIPOLE MAGNET

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Abstract: The R&D program at the national laboratories has resulted in significant advances in design and fabrication methods for the Collider Dipole Magnets. The status of the transfer of the technology developed by the laboratories is reviewed. The continuation of the technology transfer program is discussed with a description of: (1) the relation of technology transfer activities to collider dipole product development; (2) content of the program relating to key magnet performance issues; and (3) methods to implement the program.

THE ROLE OF TECHNOLOGY TRANSFER IN THE DIPOLE ACQUISITION PLAN

The acquisition strategy for the Collider Dipole Magnets (CDM) outlines some of the aspects of the role of the technology transfer in the dipole magnet procurement program. The leader subcontractor is responsible for the development of the CDM to meet system performance requirements as specified in the Prime Item Development Specification. As he is expected to provide significant intellectual content, he will not be required to accept as "proven" any technology or design provided. The subcontractor will be held accountable for all material provided and will have to defend the validity of his design approach to the CDM. The lone exception is the development of the superconducting cable for the magnets, which is the responsibility of the Superconducting Super Collider Laboratory (SSCL). The subcontractor will be free to question and alter the present baseline of the magnet that was developed in the R&D programs at the laboratories, if such changes lead to a more reliable, less costly design.

The national labs, particularly Brookhaven (BNL) and Fermilab (FNAL), that have been involved in the R&D program for the CDM will participate in the transfer of technology to the subcontractor and assist the SSCL in providing scientific and technical support to the

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subcontractor. Existing contracts between the participating labs and the SSCL include provisions for supporting industrial activities on behalf of the SSCL. Contracts for Fiscal Years (FY) 1991 and 1992 will include increasing emphasis on these activities. Although there will no longer be SSC magnet production activities at the supporting national laboratories beyond FY 92, contracts for continued industrial support are expected to be awarded.

It is expected that laboratory personnel will make important contributions to the magnet development program and that subcontractor personnel will visit the labs. However, all interactions involving the subcontractor will be closely coordinated through the SSCL.

When the subcontractor requests support in a specific area, the SSCL will evaluate the request and determine the most beneficial method for providing the required assistance. If it is decided that lab support is needed, the SSCL will make the necessary arrangements with the lab to ensure that the desired results are achieved. As the program advances it is anticipated that the expertise being accrued by the SSCL will lead to less laboratory involvement being requested by the subcontractor.

STATUS OF THE R&D PROGRAM TECHNOLOGY TRANSFER

Previous Technology Transfer Activities

A formal program at BNL in January 1989 under the auspices of the Central Design Group acquainted potential magnet fabrication subcontractors with the technology for the 40-mm-aperture dipole magnets developed there. There were three activities associated with this program. One was a series of lectures on magnet technology, including performance requirements, design procedures, magnet test results, and quality assurance issues pertaining to the cold mass design developed at BNL. In addition, copies of specifications of all processes and materials as well as detailed drawings of magnet components were presented. The program was completed with work station demonstrations and displays of all major magnet fabrication steps.

A meeting held at FNAL in February 1989 emphasized work on the cryostat that had been done there and included discussion of the design and testing of demonstration cold masses and work station demonstrations. In October of that year another Phase I Development Program was held at the SSCL in conjunction with a meeting for potential bidders for CDM development and production. This program also included technology transfer data in the form of presentations and, in addition to the update of the BNL cold mass technology, presentations by FNAL personnel on the design approach for the cold mass and associated tooling in the version of the 40-mm-aperture magnet being developed there.

OBJECTIVES OF THE PRESENT PROGRAM

Initially, the technology transfer program appeared to be aimed at instructing prospective vendors in the technique of building the versions of the dipole magnets being developed at the laboratories. However, the magnet acquisition strategy, as explained above, calls for the development of the magnet design by the subcontractor. Thus, the technology transfer program has now been geared to that approach. The present objective of the program is not to tell the subcontractor how to design and build the magnets but rather to present him with the knowledge and expertise gained in the R&D programs at the laboratories so that he can best determine the design approach to be taken for the magnet design that he will develop and defend according to the acquisition plan.

Technology transfer is organized to recognize that the subcontractor is responsible for designing the magnet to meet performance requirements:

- Quench performance requirements.
- Field quality specifications.
- Electrical integrity requirements.
- Heat leak and magnet alignment requirements.
- Requirements for operational environment conditions.

In addition, two other key items are regarded as necessary to verify magnet performance:

- Cryogenic testing and measuring technology.
- Superconducting wire and cable technology.

The program will provide information on why and how the laboratories resolved these key issues in a certain way, the test results obtained from that approach, and an assessment of the limit of knowledge to resolve key magnet performance issues.

IMPLEMENTATION PLANS FOR TECHNOLOGY TRANSFER

Working Groups

The formation of working groups to convey technical information to the subcontractor is considered to be a formal part of the program. These groups or committees are organized to address the key issues stated above. Each committee is chaired by an SSCL person; however, the committees are made up of people who have had hands-on experience in the particular technology to be conveyed by the group. Since the R&D work has been carried out mainly at the national laboratories, the groups would consist mostly of people from the laboratories who are willing to contribute their time and effort to the success of this program.

Initially, six working groups would be set up to address the key issues.in the following areas:

Cold Mass Design and Fabrication

Topics to include BNL experiences in the R&D program on 40-mm-aperture dipoles; FNAL variations of the 40-mm design and experiences; 50-mm-aperture demonstration magnets fabricated at BNL and FNAL; current status of the R&D program with conclusions and assessment of unresolved issues.

Cryostat Design and Fabrication

Provides an overview of designs used in various accelerator magnets; describes development of current design done at FNAL with test data relating to meeting requirements for heat leak and alignment; discusses fabrication and assembly techniques.

Cryogenic Testing

Warm and cold magnetic measurements. Covers methods of measuring quench performance and magnetic field quality developed in the R&D program; existing cold test facilities at the laboratories and SSCL test facility plans; special test instrumentation for

measuring coil mechanical data, quench locations, thermometry, etc.; design experiences and operation of magnetic measurement probes; measurements during magnet fabrication and methods used in supporting documentation; status of the measurement technology and unresolved issues.

Superconducting Wire and Cable Technology

Historical evolution leading to present design of the cable; fabrication process variables; vendor qualification program for superconductor procurements; cabling technology; technology for measuring strand and cable superconducting properties; low field and persistent current effects and present status; quality assurance considerations; unresolved issues pertaining to time-dependent effects, manufacturing process control, and manufacturing process parameters.

Quench Protection and Other Systems

Electrical, cryogenic, and vacuum systems required for the collider ring; quench protection systems and design experience with test results; magnet cooldown analyses and measurements; current status of systems topics and unresolved issues.

Operational Environment Considerations

Dynamic loads due to transportation and ground motion; temperature, voltage stress, and radiation effects on the magnets; reliability and safety considerations.

Hands-On Experience

Requirements for the fabrication of the five dipoles to be used in the Major Milestone Systems Demonstration Test in September 1992 call for the magnet to be assembled by subcontractor personnel. Since these magnets are planned to be assembled at Fermilab, the technology transfer program includes provisions for the magnets to be fabricated in compliance with the major milestone requirement. Thus, the subcontractor personnel will use SSC developed tooling at Fermilab to perform the required assembly operations, thereby obtaining early hands-on experience in fabricating magnets. It is planned that the industrial personnel under their own supervision will gain experience in the following areas of magnet fabrication:

- Wind and cure coils
- Inspect and test coils.
- Apply insulation, quench heater strips, and primary voltage taps.
- Assemble collar packs to coils and collar coils.
- Splice coil end connections and install end clamps.
- Install electrical bus work and power lead expansion joints.
- Assemble yokes to collared coil and weld helium containment shell to enclose cold mass.
- Assemble end plates and interconnection parts to cold mass.
- Check for leaks and perform pressure checks of the cold mass.
- Perform electrical and warm magnetic testing of assembled cold mass.

- Install cold mass onto its support posts and assemble cryostat from its various sub-assemblies and components.
- Insert cold mass into cryostat and cryostat into vacuum vessel.
- Final mechanical and electrical tests.

SCHEDULE FOR TECHNOLOGY TRANSFER—INTERACTION WITH MAGNET DEVELOPMENT

Figure 1 shows the tentative schedule of activities related to technology transfer in the magnet acquisition program. As soon as cost incurring for technology transfer is permitted, the activities would begin with assignment of subcontractor personnel to working groups and scheduling of formal sessions with the working groups. Since the CDM program is paced by the various design reviews which follow the technology transfer program, it is important that these activities proceed on schedule. At this writing, the complete outline for content of the sessions is in place and the presenters are preparing their outlines and material. It is expected that the formal session can begin approximately one month after cost incurring begins.

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