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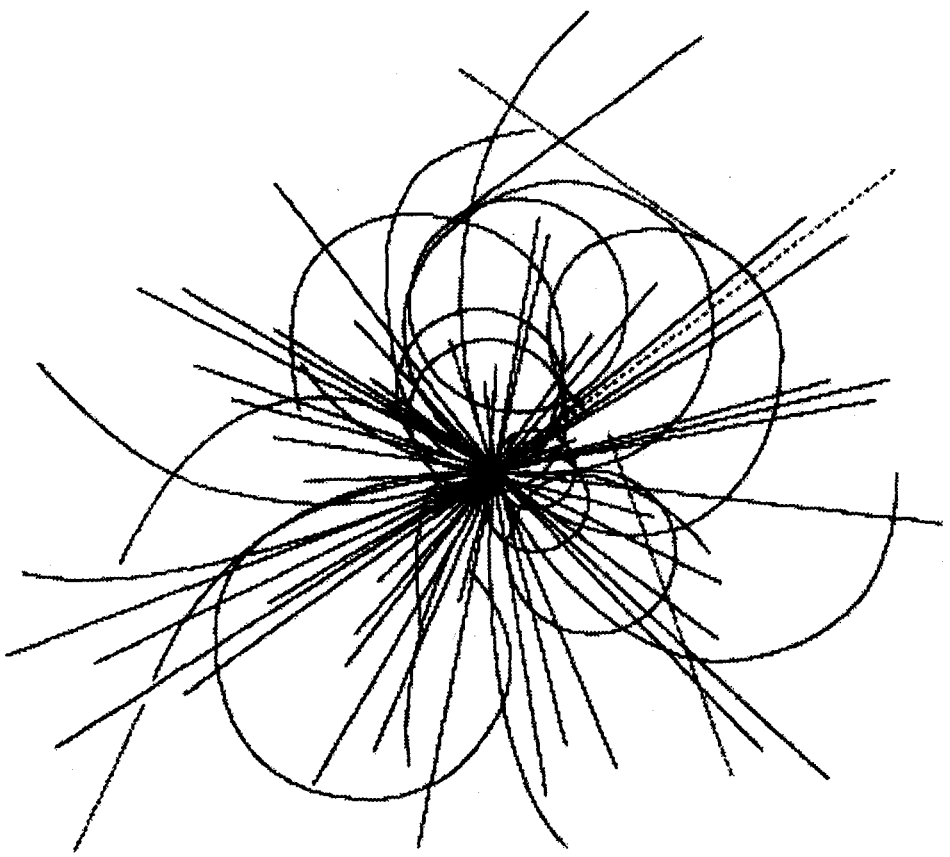

Superconducting Super Collider Laboratory

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BUSINESS OPPORTUNITIES IN THE SSCL GLOBAL CONTROL SYSTEM

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INTRODUCTION

The SSC consists of a series of six accelerators: an injector complex made up of a LINAC, a Low Energy Booster (LEB), a Medium Energy Booster (MEB), and High Energy Booster (HEB), as well as two storage rings together known as the "Collider". Although controls requirements and issues related to this complex of accelerators are not inherently different from those of other large accelerator laboratories, some special problems result from the large number of control points involved (greater than 500,000), the great distances between the various components (up to 100 Km), and the very high reliability required (.986 availability for the global control system).

The SSCL will employ an integrated control system, which at the highest level is called the Global Accelerator Control System (GACS). The GACS is defined as that system which provides the infrastructure and environment in which all systems directly affecting the accelerated beam are integrated, operated and controlled. The GACS is divided into two primary subsystems, Beam Controls and Process Controls. Beam Controls are those required to operate systems which directly support beam acceleration, steering, focusing and diagnostics. The precisely timed and synchronized, high speed, high quality Beam Controls are required only during beam operations. In contrast, the Process Controls operate independently, update at slower rates and do not require precise timing or synchronization.

BEAM CONTROL SYSTEM

The SSCL Beam Control System (BCS) must interface with various accelerator subsystems including RF, Magnet Power Systems, Quench Protection Systems, Beam Instrumentation, Beam Synchronization Systems, Beam Abort/Permit Systems, and Personnel Safety Systems. The BCS will provide all of the Operator Stations, Engineering Development Stations, VME crates, VXI crates, commercially available I/O modules, communications modules, and Control software necessary for accelerator control. Table 1 shows the anticipated quantities of the equipment types described below.

* Operated by the Universities Research Association, Inc., for the U.S. Department of Energy under Contract No. DE-AC35-89ER40486.

Table 1. Anticipated quantities of equipment.

Machine/ Equip.	LINAC	LEB	MEB	HEB	Collider	Main Control Room
Work-stations	3	6	8	10	10	12
File Servers	2	2	2	4	20	
X Terminals				2	10	36
Console Racks				2	10	12
VME/VXI Crates	60	100	100	296	1480	
VME/VXI Processors	60	100	100	296	1480	
Rack Power Supplies	15	25	25	100	400	
I/O modules	Numerous	Numerous	Numerous	Numerous	Numerous	
ADM	2	6	8	34	200	1
Fiber	1.23 Km	2.01 Km	5.41 Km	15.79 Km	96.68 Km	
Routers	1	1	1	2	10	1

Control Room Hardware

Operator stations will be UNIX workstations with at least 32 MByte of main memory, 2 to 6 GByte of disk storage, one keyboard, mouse, 3 to 4 displays (for control room) each and rated at 50-100 SPECmarks. In addition, the workstations will be required to support audio alarms and messages.

Control system file servers will be UNIX computers with at least 64 MByte of main memory, 4 to 10 GByte of disk space, one keyboard, mouse, one display each and rated at 50-100 SPECmarks.

X-terminals will be used as additional status displays in the Main Control Room and in each sector control room. It is also planned that a large video wall will be located in the Main Control Room. This video wall will be made up of multiple displays and will be used to display status information that is useful to operators and experimenters in the control room.

Peripherals such as printers, and disk drives will be procured for use in each sector control room and the Main Control Room.

Console racks will be 5 bay low profile racks. A table top will be attached to the console and will have space for an operator station keyboard, and mouse or trackball, and operator logbooks.

Communications Equipment

The SSCL will install a high speed telecommunications infrastructure to transmit the massive quantities of data over the geographically large site area. Network cable right of ways will be placed in the floor of the various accelerators. The backbone of the system is a redundant fiber Synchronous Optical Network (SONET).

Add-Drop-Multiplexers (ADM) will be used to interface the low speed T1, and OC-1 links with the main fiber backbone. ADM's will have various low speed connections ranging from T1 to OC-1 and high speed connections ranging from OC-3 to OC-48.

The fiber cable used in the communications system will be single mode, in 24 and 48 fiber cable bundles. The cable will meet or exceed NEC 770, NFPA 262-1985 and Bellcore Standard TR-20. The jacket will be Kevlar reinforced. Connectors will be FC/PC types. Small quantities (less than 5Km) of multi-mode cable will be used. Multi-mode connectors will be ST or SMA.

Routers will be used to interface standard networks such as Ethernet, or FDDI to the fiber backbone. T1 and OC-1 interface modules will be used to interface VME and VXI processors to the communications infrastructure.

Test equipment such as Optical Time Domain Reflectometers (OTDR) and fiber network analyzers will be purchased commercially and used to maintain and test the communications infrastructure.

Front End Equipment

Front End systems are those system that directly interface the GACS with accelerator subsystems such as RF, Magnet Power Supplies, and Beam Instrumentation Systems. The SSCL has chosen EPICS (Experimental Physics and Industrial Control System) as the software that will run in Front End System

processors. The primary hardware supported by EPICS is VME and VXI based, but some industrial I/O busses will be supported.

VME and VXI crates will be procured and located in control racks in the above ground buildings of the LINAC, LEB, MEB, HEB and Collider. In addition, crates will be located in each niche of the HEB and Collider. These crates will meet all minimum requirements of the VME and VXI specifications, respectively, plus additional specifications imposed by the SSCL on power supply regulation, minimum crate cooling requirements, cable routing, and physical size limitations.

VME and VXI processors will be procured for Front End Systems. These processors will meet the minimum performance specifications of Motorola 68040 processors and be capable of running EPICS.

VME and VXI I/O modules will be procured. These modules will be used to control and monitor the various systems to which the GACS must interface. Typical module and signal types include: 24 VDC inputs, 24 VDC Outputs, TTL Inputs, TTL Outputs, Contact Outputs, RTD's, Thermocouples, Silicon Diodes, Helium liquid level probes, 4-20 mA inputs, 4-20 mA Outputs, Analog Voltage Output (typically 0-5, +/- 5, 0-10, +/- 10 VDC), LVDT's, Strain Gauge, Analog Voltage Input (typically 0-5, +/- 5, 0-10, +/- 10 VDC).

Power conditioning equipment such as rack mounted UPS's, isolation transformers, filter transformers, and DC power supplies will be procured for Front End System Racks. Interconnection devices such as terminal strips, terminal blocks and connectors will be used within racks and to connect to various accelerator subsystems and devices.

Commercial Software

Artificial Intelligence Supervisory Control packages and predictive failure analysis and simulation software may be procured for use within the GACS.

PROCESS CONTROL SYSTEM

The SSCL Process Control System (PCS) is divided into 15 separate, but linked systems that correspond to each of the 10 Collider sectors, 2 HEB sectors, the MEB, LEB, and LINAC. Specifically, the PCS includes the controls for HEB and Collider cryogenics refrigerators, transfer lines and spools pieces, and LEB, MEB, HEB and Collider vacuum, LCW, ICW, and Instrument Air systems. It has been estimated that the total number of I/O points covered by the PCS is in excess of 150,000 points.

Commercial vendors will be asked to supply all necessary components in the appropriate quantities for the SSCL PCS. Each Process Control System consists of Operator Stations, Engineering Development Stations, control processors, input and output modules, racks, power supplies, configuration software, and run-time system software. In addition, there are components that will reside in the SSCL Process Control Main Control Room. It is envisioned that these components will include Operator Stations and Engineering Development Stations and all necessary communications equipment to tie the Main Control Room to each sector PCS. These stations may be separate from the Beam Controls Operator and Engineering Development Stations.

The operator stations will contain all the hardware and software necessary to provide a Man-Machine Interface (MMI) and will consist of CRT displays, UNIX computers, keyboards, mouse and software to provide a variety of MMI displays.

The Engineering Development Stations will contain all hardware and software required to develop process control applications. The hardware will include UNIX computers, keyboards and a mouse. The configuration tools available within the system will allow the process engineer to configure a system and applications using ladder logic, function blocks, sequential function charts, or script. In addition the system will include an Applications Programmer's Interface (API) that will contain software routines and templates required to develop new interfaces and applications processes based on the C and C++ programming languages.

I/O modules and signal conditioning devices will be required in each niche of the Collider (approximately 200), each niche of the HEB (24), in each Sector Refrigerator (12), and in numerous locations in LEB and MEB. The number of I/O points in each niche of the Collider and HEB has been estimated to be 500 points, split approximately 60/40 binary to analog, respectively.

STATUS AND SCHEDULE

Beam Control System

Equipment for the BCS of each machine and the Main Control Room will be procured as follows:

Table 2. BCS Equipment Procurements.

Machine	Fiscal Year
LINAC	1993
LEB	1994
MEB	1995
HEB	1997
Collider	1997
Main Control Room	1994

Process Control System

It is currently planned that the SSCL Process Control System will be procured in multiple steps. The first part of the process will be the procurement of the first Collider sector's worth of equipment. This procurement will be a two step procurement. In the first step, the SSCL Controls Department will issue a Request for Proposal in which vendors will be asked to provide technical proposals for the first sector of the Process Control System. These proposals will be evaluated by the SSCL and the top three proposals will be selected for the second step of the procurement. In this step, the three successful vendors will be asked to provide evaluation systems that meet the minimum requirements set forth in the Prime Item Development Specification and Statement of Work. The SSCL will then evaluate each system in accordance with predefined evaluation criteria. An RFP for the delivery of the first sector's worth of equipment will then be issued. Award of the contract will be based on the results of the SSCL evaluation and responses to the RFP. A preliminary schedule of events for this first procurement is shown below.

Table 3. PCS Procurement Schedule.

CBD Announcement	April 1993
RFI Issued	May 1993
First RFP Issued	July 1993
Contract Award	November 1993
Evaluation Systems delivered	December 1993
RFP for sector equipment Issued	March 1994
Contract Award	May 1994
Equipment Delivery Complete	October 1994

Additional PCS sector procurements will be as follows:

Table 4. PCS Sector Procurement Schedule.

Fiscal Year	Sectors Procured
1994	2
1995	4
1996	6
1997	3