Proposal*
for the
Testing of Prototype Detectors for the SDC**
at Fermilab

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** Listing of the SDC members in Appendix A

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1.0 INTRODUCTION

The Solenoid Detector Collaboration (SDC) has proposed to design and build a general purpose, magnetic detector for use at the SSC. A brief description of the SDC detector concept is given in the Expression of Interest, which is available in the Fermilab Library and from SSCL. The SDC is in the process of preparing a Letter of Intent for the detector to the SSC Laboratory for submission by November 30, 1990. We assume that a formal proposal to the SSCL will subsequently be due in late 1991.

The SDC detector is an enormous enterprise, and has within its scope many R&D efforts. The goals of test beam work at FNAL are to provide the incisive R&D tests by which the technologies being considered by the SDC may be evaluated. The 1993 Fixed Target run at Fermilab is pivotal to the SDC R&D effort. It represents the first time that substantially engineered "fullscale" prototype detectors for the SDC can be mounted. Conversely, it is the last run before the Main Injector is thought to begin construction.

The SDC collaboration intends to test several tracking technologies; pixels, Si strips, straw tubes ,and scintillating fiber tracking. Possible calorimeter options include scintillator tile calorimetry, spaghetti calorimetry, liquid argon calorimetry, and warm liquid calorimetry. Muon tracking options will also be explored. Front end electronics, trigger strategies, and DAQ architecture will also be given stringent tests in intense hadron beams. The goal would be to test well engineered prototypes so as to make incisive tests of these competing technologies.

The character of the SDC detector is evolving rapidly. At this time we cannot specify precisely the technologies to be tested in the Fermilab test beams. The collaboration is in the process of winnowing calorimeter and tracking technologies. By the summer of 1991, the SDC will have composed a complete and comprehensive R&D plan, embodying selections which are made by that time. What is described in the body of the text are the broad outlines of goals and the resultant implications for required levels of support. Details are only available, at present, in system level R&D proposals, which are not germane to the SDC proper. However, given the evolving Fermilab fixed target program, it is prudent to submit a proposal at this time.

2.0 BEAM REQUEST

The characteristics of Fermilab beamlines are given in Table 1, while their physical locations are shown in Fig. 1 - with their current occupants also labelled. Given the ensemble of tests spelled out in the Appendices, it is clear that the SDC requires at least one dedicated, high quality beamline.

It is a requirement that the beam momentum be tunable from 15 to 300 GeV at a minimum. Extending the range upwards allows for better calibration points for exploring compositeness, while extending the lower limit allows one to map out non-linearities in calorimeter response, and thus better estimate total jet energies. The low energy points are important because the fragmentation function D(z) peaks at low z, as 1/z. Therefore a good multijet spectroscopic measurement requires mapping the calorimeter response down to low momentum. The SDC thus puts a premium on the dynamic range of the beam. We also wish to check that the electron/hadron response ratio is not strongly energy dependent over the range of momenta relevant to SSC jet physics. Calorimeter tests imply that hadron-electron tagging (at a few parts in 10^3) is essential in order to study e/π separation. The tagging/enrichment might be provided by means of Cherenkov counters which would need to perform over this entire momentum range. Alternatively, electron beam operation, as in MB, would provide the needed cleanliness factor.

In order to simulate SSC rates, 1 particle/bucket or ~50 MHz rate would be useful. Fast detectors, which can resolve individual events at the SSC, must confront such rates. The beam should be tagged with one bucket time resolution by a system of 1 mm PWC augmented by scintillator hodoscopes. The momentum must be tagged to $dp/p < 1\%$ so as not to obscure the calorimetric "constant term." The spot size should be small, $\lesssim$ 1 cm radius, and should be tagged to a precision better that that expected by detectors placed at the electromagnetic shower maximum, $\lesssim$ 1 mm.

3.0 FLOOR SPACE, DWELL TIMES, SERVICES

It is expected that the SDC will need to dwell in a suitable beam over the entire Fixed Target Run of 1993. Of the beamlines shown in Fig. 1, MP or NT are possible candidates for a test beam site. A comparable effort to the SDC that now exists in MT (CDF) and NW (DØ). The floor layouts for these 2 experiments are shown in Fig. 2 and 3 respectively. A total floor space 40' (transverse) x 120' (longitudinal - 4 stations) appears to be adequate. A control room equivalent to four "portakamps" appears to be roughly sized to the task.

Many services will be required. Rigging of $\lesssim$100 T full scale calorimeter modules will be needed. Typical modules are thought to be roughly < 100 T since that is the road limit for transport to SSCL. It is thought that the rigging of these modules would only be done initially. Survey will also be periodically needed. Crane coverage of 20 T capacity would be most desirable. That capacity would make the heavy rigging jobs occur very infrequently. Each station (4 total) will require a transporter of some flexibility. An example of the transporter used in liquid argon tests would be the DØ layout shown in Fig. 4.

Consumables for the various detectors will be another necessity. Wire tracking systems will need gases, mixing stations, and exhaust systems. Liquid ionization calorimetry will require dewars (liquid argon) or liquid handling and safety procedures (warm liquids).

4.0 SAFETY ISSUES

The SDC intends to act in strict compliance with FNAL safety standards. Nevertheless, the SDC will require review and certification of the services mentioned in Section 3. For example, an ODH and CRYO safety review will be needed for liquid argon calorimeter tests. Similarly, warm liquid reviews are needed to ensure safe liquid filling, sealing, and operating of the modules.

In addition, all mechanical stands and supports will need to be reviewed by Fermilab engineers. All transporter fixtures will also require certification. Tracking systems will need to be reviewed for flammable gas safety. Finally, all user supplied electrical/electronic installations will need to be certified by the Fermilab electrical safety committee in the Research Division.

5.0 CONTROL ROOM, DAQ, AND SOFTWARE

As stated above, the SDC test beam site will need a DAQ control room area sized to about four "portakamps." Although the SDC will have as one of its goals the checkout of a prototype trigger/DAQ system, initial data taking implies using the existing Fermilab standard system. To that end, the SDC requests for Fermilab PREP support are in the form of standard trigger/DAQ hardware.

The SDC will use Fermilab standard front end electronics, on line computing, data logging, and offline tools. Software support for the integration and maintenance of these standard tools is also requested.

It is anticipated that trigger requirements will be minimal; the SDC will use the beam tagging already presumed to exist. Front end electronics needs will be either supplied by the SDC or will be met by using Fermilab standard equipment. Since the front ends are intimately connected to the detectors in the SSC, it is likely that the SDC will provide the appropriate front ends for all prototypes. Digitization modules, and DAQ will use the FNAL support system most congruent to the needs of the SDC. Data logging computers and storage devices will be Fermilab standards.

6.0 TEST STATIONS FOR THE SDC

There will be 4 test stations within the floor space provided. By comparison, DØ in NWA (Fig. 3) has three stations -1 for tracking (FDC, CDC), 1 for liquid argon calorimetry, and 1 for muons (Fe beam stop). The SDC floor plan is assumed to have 4 stations, 1 for liquid ionization calorimetry, 1 for scintillation based calorimetry, 1 for tracking, and 1 for muon detection. It is assumed that each station has temperature and humidity control, rather than requiring that the entire beamline be climate controlled. A crude schematic of a possible layout is shown in Fig. 5.

6.1 STATION 1 - TRACKING

The crucial issues for tracking are resolution and rate capability. Station 1 has a space 15' x 15' which will accomodate 4 m long straw chamber and fiber tracking prototypes. The beam tagging system will not be required to provide precision tracking for fiber or straws. A simple platform (e.g. DØ) will provide translations and rotations.

Services for straws will include gas mixing and handling. For fibers the main issue is likely to be cryogenic support for the SSPM's (solid state photomutipliers). A cryo heat load of 10 Watts at 7 degrees has been estimated. A LN2 dewar for preamp cooling is another likely request for services.

Tests of precision tracking systems, silicon pixels and/or strips, will require a high level of survey support in order to locate the detectors accurately. For precision silicon detector tests a silicon beam telescope will be needed. In addition, butane gas is a potential silicon system coolant, which would require safety review by Fermilab.

A possible layout of the support stands and the tracking station is given in Appendix B, along with a more detailed description of Station 1.

High rate (1 particle/RF bucket) will be desirable to address the issue of rate capabilities of the tracking prototypes. For resolution studies, any moderate beam rate (~ few kHz) will saturate data logging capabilities.

All electronics needs not supplied by the SDC (front ends) will be met by using FNAL standard HV, LV, Monitoring, Trig, and DAQ Systems.

6.2 STATION 2 - SCINTILLATOR BASED CALORIMETRY

Some outstanding issues for this technology are compensation in composites of Fe + Pb + C + scint, uniformity of response, resolution, e/π ratio, and radiation resistance. Some of these issues were already addressed in the 1990 FNAL running period or will be studied during the second phase of this fixed target running period. The types of modules to be tested may include tile + fiber readout and "spaghetti" calorimetry.

The station covers a surface area 25' x 25'. This station is similar to that in CDF-MT. Translations and rotations are provided by the support stand. Full-scale projective tower modules, ($50T < W < 100T$) will be tested. This implies extensive rigging and installation needs. Survey requests will be modest and sporadic.

Beam running with purified e and purified π beams will be needed to study e/π rejection. Uniformity scans and compensation studies will require modest beam rates (~ few kHz). Occasional running with each RF bucket populated would be highly desirable in order to study event resolution at the SSC. The gate width dependence of all calorimeter quantities must be studied to see if 1 bunch crossing can be resolved.

The electronics needs for Station 2 are modest. The SDC collaboration will supply front end detectors (PMT and/or APD). As with Station 1, all other needs will be met by adopting the current FNAL standards.

6.3 STATION 3 - LIQUID IONIZATION BASED CALORIMETRY

The issues to be resolved which are particular to this technology include the fast operation of preamps in the liquid and the feasibility of the appropriate shaping of signals so as to clip the slow ion mobility in liquids. Both argon and warm liquids may be investigated. Coupling to preamps via both magnetic and electrostatic transformers will be studied.

Station 3 has transporters, services (LA Dewar), safety pit/sump, cryostat, and a Faraday cage rather similiar to those provided to DØ - NW. The SDC effort will require liquid handling capabilities and the support of Fermilab for safety review of all special services. Fermilab cryo operating support will be essential.

The beam time and beam quality requirements are essentially identical to those of Station 2. Rigging and installation are also similiar. However, the SDC will supply the test cryostat. Certification of that cryostat for rigging and cryogenics will be the joint responsibility of Fermilab and the SDC.

As with Station 2, the SDC will provide preamps, shapers, and sample and hold electronics. The other electronics which is required, e.g. FADC, will be supplied by Fermilab. Special monitoring systems, e.g. LA level, LA purity test cells, will be supplied by the SDC. Presumably much of this equipment may be copied from DØ. The requirements for HV will be more severe, e.g. DØ, than for Station 2.

6.4 STATION 4 - MUON DETECTION

The muon station is located behind an iron beam stop. If fluences behind more exotic absorbers such as Uranium become an issue, the relevant prototype calorimeters, located at station 2 or 3, can be used as a beam stop. The issues to be studied are hadronic punchthrough, muon momentum measurement, (in the presence of bremsstrahlung, etc.) and muon trigger schemes.

A magnetized iron toroid will be supplied by Fermilab (muon spoiler). This device will be surrounded by tracking supplied by the SDC which will study muon reconstruction. Momentum tagging from the beam system good to $\sim \pm 2\%$ will be required. As in the 1990 run, an ensemble of Bonner spheres is requested from Fermilab to map the neutron background.

Aside from the toroid, the support stands, survey requirements, rigging installation, gas supplies, gas mixing and other services are very similiar to those needed for Station 1 (fiber and straw tube tracking).

Since the muon system is intrinsically low rate, it places only very loose requirements on the beam quality. Running with both π and μ (beam stop "in") will be required. The most serious need is for high energy muons; the critical energy is about 300 GeV in iron. In order to address muon tracking in the presence of radiation, high energy, $\gtrsim$ 400 GeV, muons are needed. High momentum beam transport for this test beam is, therefore, highly desirable.

As for Station 2, the SDC will supply front end electronics and adopt Fermilab standards for higher level electronics as needed.

6.5 ALL STATIONS - DAQ/TRIGGER

The SDC will attempt to study various DAQ prototypes in this test beam. Testing a DAQ prototype on real equipment in a real beam is a high priority for the SDC. The electronics for the SDC will be integrated to the detector to an extent unknown in previous collider experiments. Crucial issues for front ends include radiation damage, cooling, and LV services. Details are given in Appendix C.

The rates in the SDC are roughly 1000 times those of presently existing hadron collider facilities. Obviously crucial triggering/DAQ issues have to do with pipeline data storage and trigger schemes. Given the SSC design luminosity, RF (53 MHz) synched operation with a beam rate such that each bucket is occupied would be extremely useful.

It is assumed that the SDC will use beam time on all stations for DAQ/trigger tests as such prototypes become available. Fermilab engineering support to integrate and interface these higher level electronics into standard FNAL systems will be required. Programming support by Fermilab will be required if standard FNAL software (e.g. PANDA) is to be used reliably and expeditiously. Fermilab safety review of user supplied electronics will be mandatory.

7.0 RADIATION DAMAGE TESTS

7.1 GOALS

The response of potential SDC detectors to the SSC radiation field is one of the crucial issues to be confronted by the SDC program of R&D. It appears to be likely that actual prototypes behave differently with radiation dose than their constituents. Therefore, fullscale exposures, over extended periods of time approximating SSC dwell times, are required. Several different exposures will be needed in order to address the issues raised by the SSC radiation environment.

7.2 ELECTRON EXPOSURE

The most stringent problems for the SDC calorimetry occur at electromagnetic shower maximum. For the "barrel and plug" this occurs at pseudorapidity of 3. The dose is ~ 50 Mrad for $L = 10^{34}/(cm^2 sec)$ over 10 years. This dose is well simulated by a 10.0 GeV electron beam with an integrated intensity of 10^{13} electron/cm^2. In order to reasonably simulate the dose rate, an exposure time of 1 year would be most useful. Possible test beam exposures at DUBNA, DESY, KEK, IHEP Beijing, and ORSAY are being explored. We assume that such long dwell times, dedicated solely to radiation exposure, are not possible at Fermilab. However, Fermilab beams in MP or PE could be used at roughly 100 GeV over a 2 week period. Such an exposure would simulate a 10 year exposure at design luminosity. The advantage of working at Fermilab would be that the test program is localized at one place and, therefore, more efficiently organized.

7.3 NEUTRON EXPOSURE

A major radiation worry for the tracking detector and its environment is expected to be neutrons in the neighborhood of 1 MeV. For a detector situated at 2 meters from the interaction region, the neutron fluence is expected to be of the order of $2 \times 10^{12}/cm^2/yr$. The effects of such a radiation field must be addressed.

The University of Michigan Phoenix Nuclear Reactor is one of several options available to the SDC to provide a test facility to expose detectors and their electronics, powered or unpowered. Packages of 2" diameter and up to 20" long can be exposed to fluences of between 3×10^8 and 2×10^{12} neutrons (>1 MeV)/cm^2/sec. (The package should be somewhat shorter to keep the dosage reasonably uniform over the package.) The staff of the reactor have expressed their willingness to cooperate in making these exposures. The Argonne Spallation Neutron Source is another possibility.

The relevance for Fermilab is that periodic exposures of detector modules may be needed. These exposures would be followed by a re-evaluation of the performance of the detector. Such tests imply an additional rigging burden for Fermilab. Backsplash from the calorimetry will be simulated in the tracking station by placing material downstream of the tracking modules. These tests imply additional rigging time.

7.4 HADRON EXPOSURE

The tracking system for the SDC, at radii < 20 cm will be exposed to $> 10^{15}$ mips/cm^2 for luminosity $L = 10^{34}/(cm^2 sec)$ over a period of 10 years (1 SSC year $= 10^7$ sec). It is very desirable to make short exposures of tracking system prototype detectors to such doses. Access to a Fermilab primary proton beamline for periods of a few days should be sufficient to make these tests.

8.0 SCHEDULING, FUNDING

The present schedule for FNAL is given in Table 2. Obviously, since it is not possible to install full-scale prototypes for the 1990/91 run, the first opportunity will exist in 1992/93 ($\gtrsim$ FY93). Since the present projected start date for SSCL is 1999, the first opportunity might well also be the last. Since critical choices among competing technologies must be made, the full-time use of a test beam by the SDC is absolutely essential. Many R&D proposals related to the SDC have beam tests as a pivotal component of their R&D program.

The level of support which is needed may be estimated by extrapolating from CDF and DØ. The costs per year for the last five fiscal years for the test beam activities of both CDF and DØ are shown in Table 3. A rough estimate for the FY90 period is also given. Obviously, cryogenics is a major component of the total. As a first pass, using Table 3, we estimate 100K$ for beamline outfitting, 700K$ for operating and equipment exclusive of cryogenics, and 400K$ for cryogenics. These estimates, given the DØ levels for FY89 and FY90, must be assumed to be spent each year.

APPENDICES:

A. EoI author list of the SDC.

B. Tracking Station Requirements.

C. DAQ Goals.

FERMILAB BEAM LINE PROPERTIES

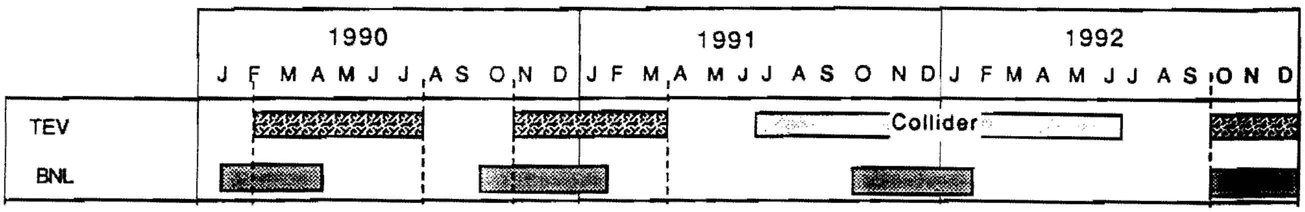
Beam	Momentum range (GeV/c)	$\pm\Delta p/p$ (%)	Production angle (mr)	Solid angle (μsr)	Particles	Flux per 10^{12} protons on target*	at (GeV/c)	Comments
PW	925(peak)				π^+, K^+, p	2×10^9	300	High intensity pion beam
		4	1.5		$\pi^-, K^-, \bar{p}$	6×10^8	300	
					$\pi, \bar{p}$	1×10^7	300	Tertiary beams
					p	$1\text{-}4 \times 10^9$	800	Primary protons
PB	500(peak)	12		4	$e^- + e^+$	$\sim 1 \times 10^8$	350	Wide band charged and neutral beam. Also capable of K_L^o, p, and π.
PE	500(peak)	1.7	0		π^+, K^+, p	$\sim 1.5 \times 10^9$	250	Also provides tagged photons
			0	10.	$\pi^-, K^-, \bar{p}$	$\sim 4 \times 10^7$	500	
PC	1000	16	0-3.5		π^-, K^-, Σ^- Ξ^-, Ω^-	3×10^8	450	Primary protons, neutral and charged hyperons
ME	1000(peak)	0.1			p	$\sim 4 \times 10^{12}$	1000	Primary protons
MP	200	5.0	0 ± 1.0		p	$\sim 10^7$	200	Polarized protons from 800 GeV primary
					$\bar{p}$	$\sim 10^6$		Polarized antiprotons from 800 GeV primary
					π^-	5×10^6		(Average polarization expected $\sim$ 30%)
MC	50-150		1-6		K_L^o	4×10^6	variable	Neutral beam with 800 GeV primary
					n	1×10^7	variable	
MB	20-200	5.0	2.5		π, K	3×10^6	75-100	Low intensity wide-angle test beam
					$e^\pm$	2×10^2	100	
MT	80-245	5.0	0		hadrons	1×10^6	75-245	Test beam
					$e^\pm$	500	25	
						500-2500	10-150	

MW	1000(peak)	10	0-4		primary p's	2×10^8		
					p	1.3×10^8	500	Beam transport to new
					π^+	2×10^7	500	multiparticle spectrometer;
					K^+	4×10^6	500	assumes 800 GeV on target
					π^-	2.7×10^7	500	
					K^-	8×10^5	500	
					$\bar{p}$	8×10^4	500	
NW	10-150	2	0-1	4-16	μ^-			Currently a test beam, intensity limited
					π^-	4×10^6	~ 100	
					e^-	6×10^4	~ 100	
NC-D	750(peak)	10	0	0.6	$\nu/\bar{\nu}$	5×10^6 ν/m^2**	500	Narrow band, sign-selected neutrino beam
NC-T	1000(peak)	100	0	6.0	$\nu/\bar{\nu}$	1.4×10^8 ν/m^2**	0-800	Broad band, quadrupole focus
NE	1000				p	1×10^9	800	To Labs G and D
	25-700	3.3	2	0.2	π^-	5×10^5	600	
NT	25-300	4.75	0-6	0.7	hadrons	$\sim 1 \times 10^6$	450	Test and calibration beam to Lab E neutrino detector and Lab F
NK	25-225	3.2	0-6	0.6	muons	5×10^3	225	Muon beam to Lab F
NM	100-700	14			$\mu^\pm$	$\sim 10^7$	500	Tevatron muon beam
NM (test	2.5-200	30	0		hadrons	$\sim 2 \times 10^4$		Test beams to muon spectrometer
modes)	5-200	30	0		electrons	$\sim 10^3$		

* For 800 GeV protons incident unless otherwise noted. Current beam spill is 23 sec, and cycle time is ~ 59 sec.

** Beam spill times variable (~ 1ms to 20 sec). Typically 3 fast pings available per accelerator cycle.

Table 2



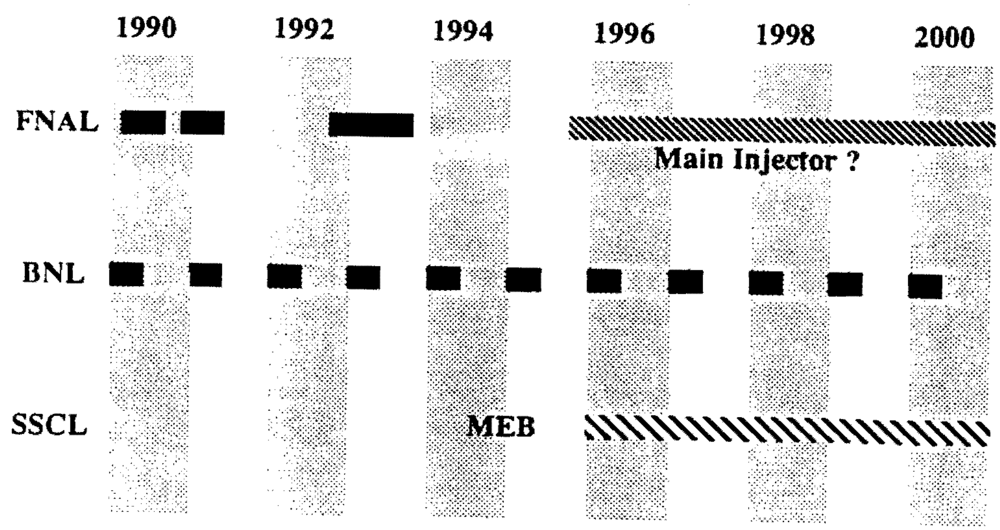


FIG. 46. Available test beam time at major laboratories during the next decade.

Anticipated test beam time needs for various subsystems (in hours).

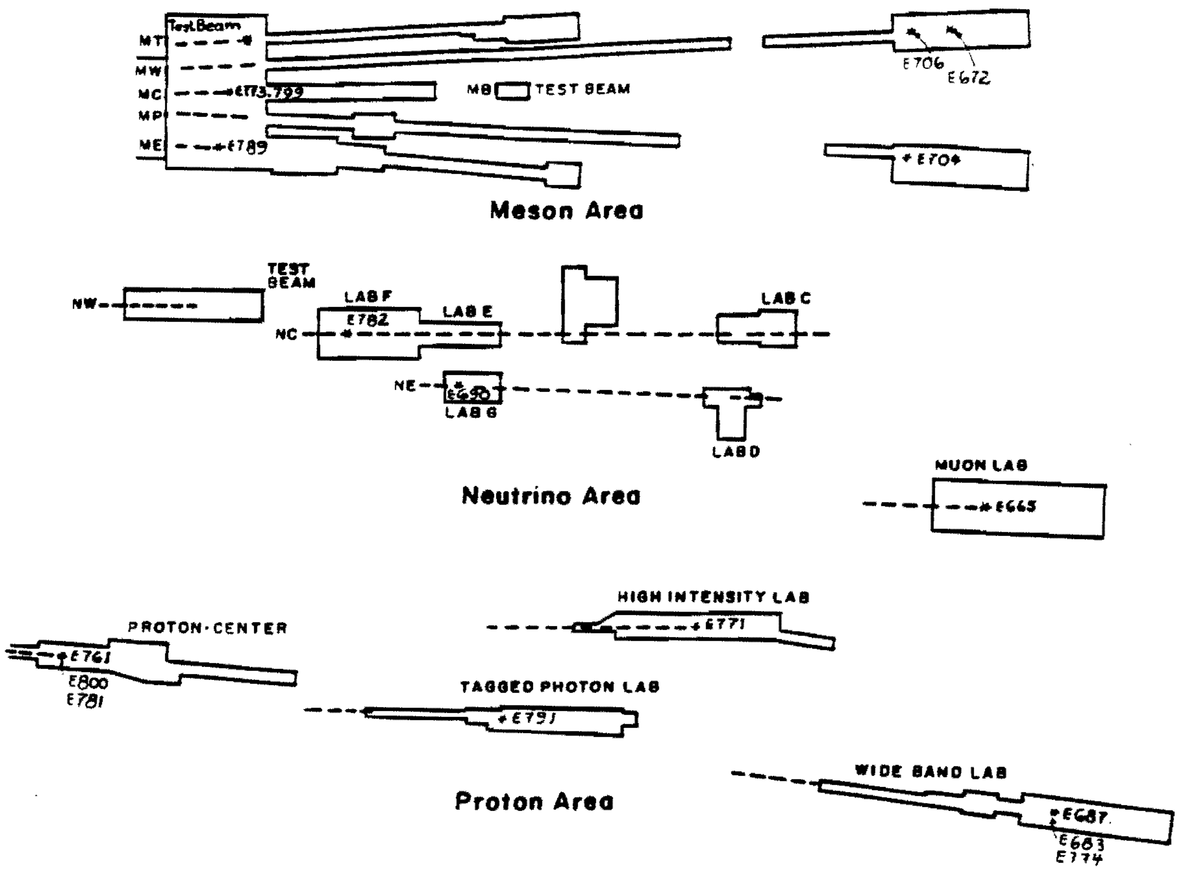
Item	R&D	Prototyping	System Tests	Calibration
Calorimetry	2000	2000	2000	2000
Tracking	200	500	500	0
Muon System	Parasitic	500	500	0

Experiment	FY85	FY86	FY87	FY88	FY89	Total Costs
E775 (E741)(9/84)						
Oper	0.0	0.0	2.5	1.9	0.4	4.8
Equipt	17.1	5.5	262.0	181.9	82.0	548.5
MT beamline	"	0.3	81.2	3.0	5.7	90.2
Total	17.1	5.8	345.7	186.8	88.1	643.5
E740 (3/88)						
Oper	0.0	0.0	51.8	0.0	153.9	205.7
Cryo OP	0.0	0.0	0.0	30.6	9.4	40.0
Equipt	0.0	0.0	158.0	99.1	621.1	878.2
Cryo Equipt	0.0	0.0	0.0	91.7	230.8	322.5
NW beamline	7.2	2.5	6.9	0.1	0.0	16.7
Total	0.0	0.0	209.8	221.4	1015.2	1446.4

Estimated FY 90 costs

E775 166

E740 1304



Schematic drawing of the fixed-target experimental areas with locations of major experiments still to be completed. The drawings are not to scale.

Figure 1

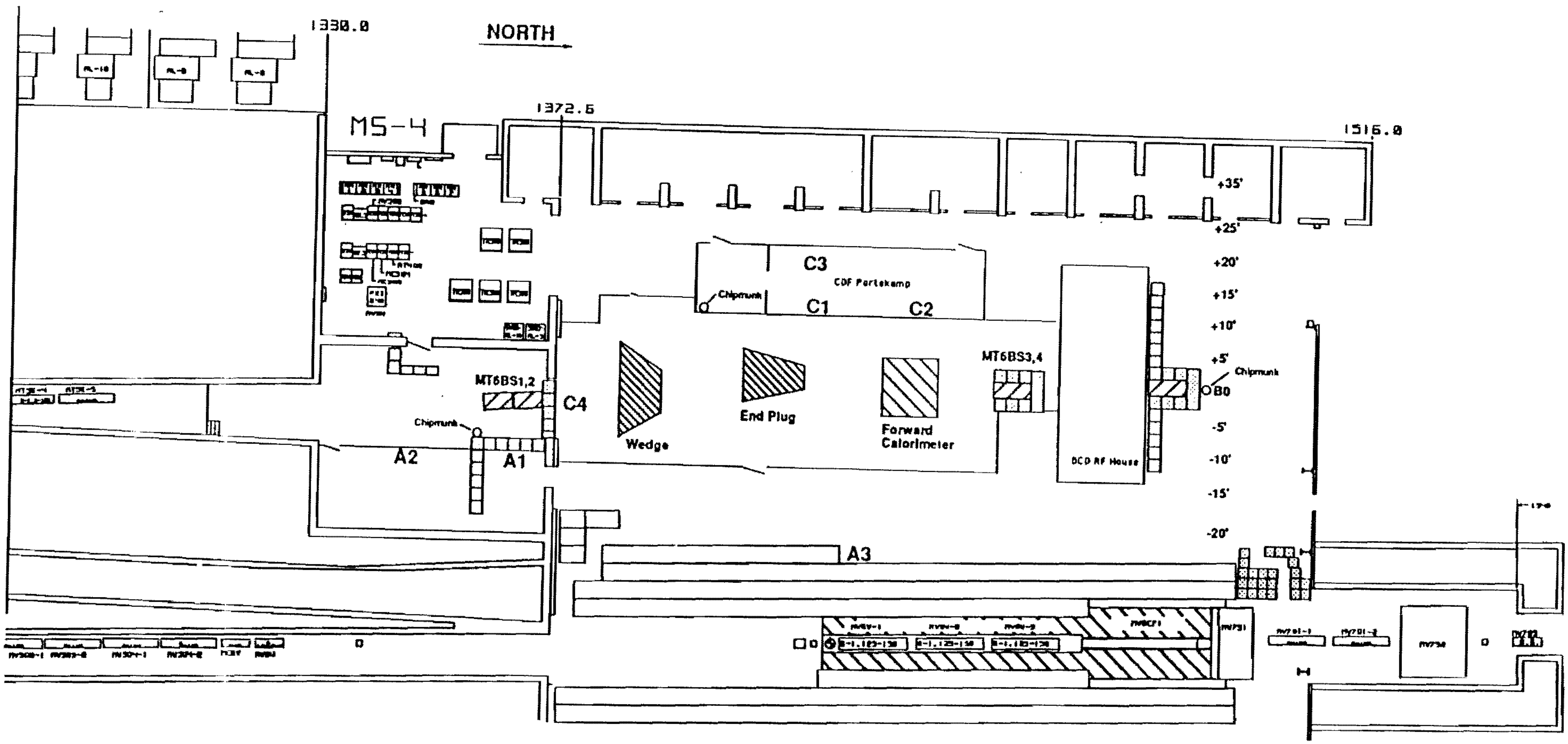
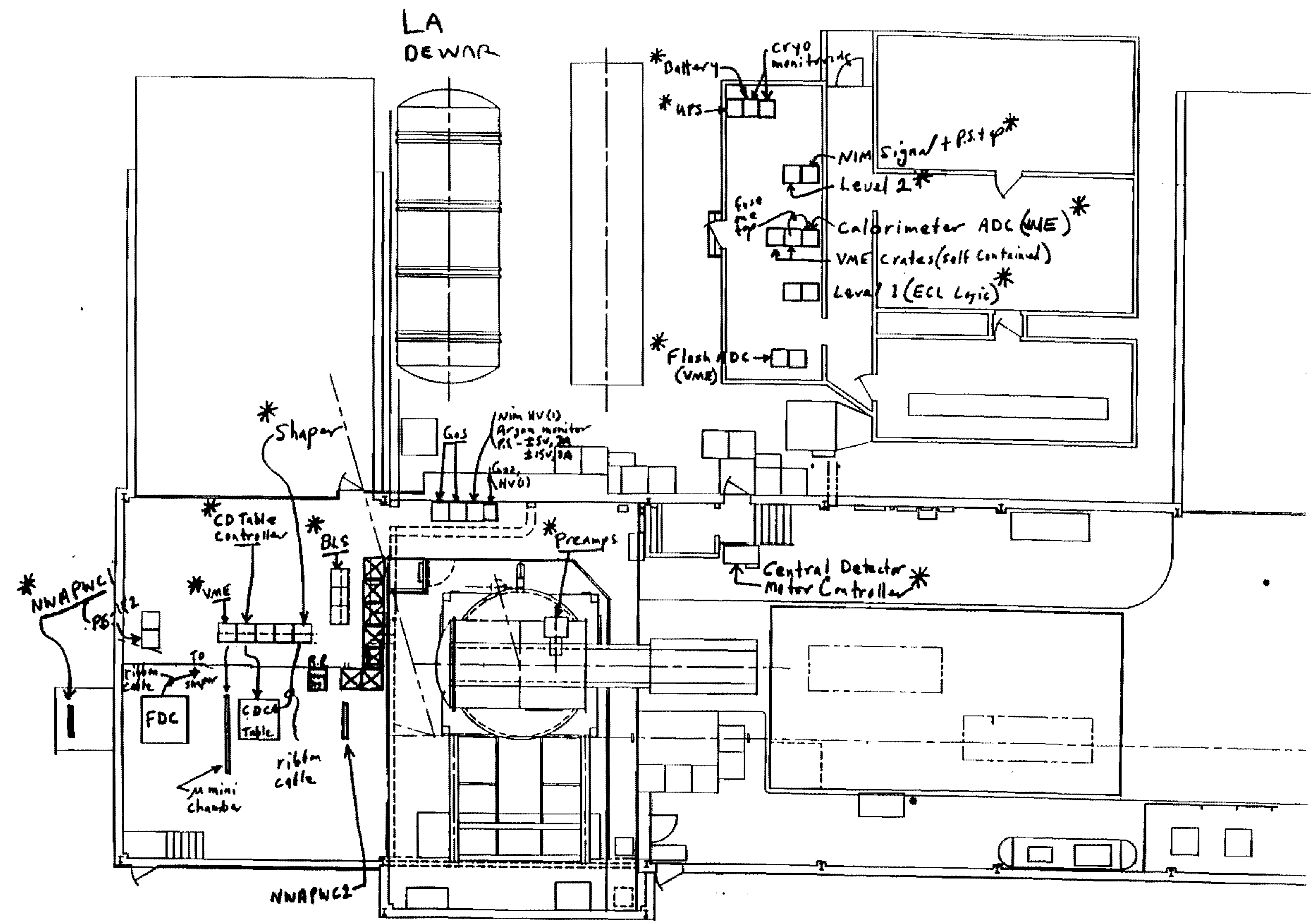

1330.0
NORTH
MS-4
1372.6
1516.0
+35'
+25'
+20'
+15'
+10'
+5'
-5'
-10'
-15'
-20'
C3
CDF Portakamp
Chipmunk
C1
C2
MT6BS3,4
MT6BS1,2
C4
Wedge
End Plug
Forward
Calorimeter
BCD RF House
Chipmunk
B0
Chipmunk
A2
A1
A3

Figure 2



LA
DEWAR
Battery
cryo monitoring
UPS
NIM Signal + P.S. top
Level 2
Calorimeter ADC (VME)
VME crates (self contained)
Level 1 (ECL Logic)
Flash ADC
(VME)
Shaper
Gas
Preamps
CD Table Controller
BLS
VME
NWAPWC1
FDC
CDC Table
ribbon cable
μ mini chamber
NWAPWC2
Central Detector Motor Controller

Figure 3

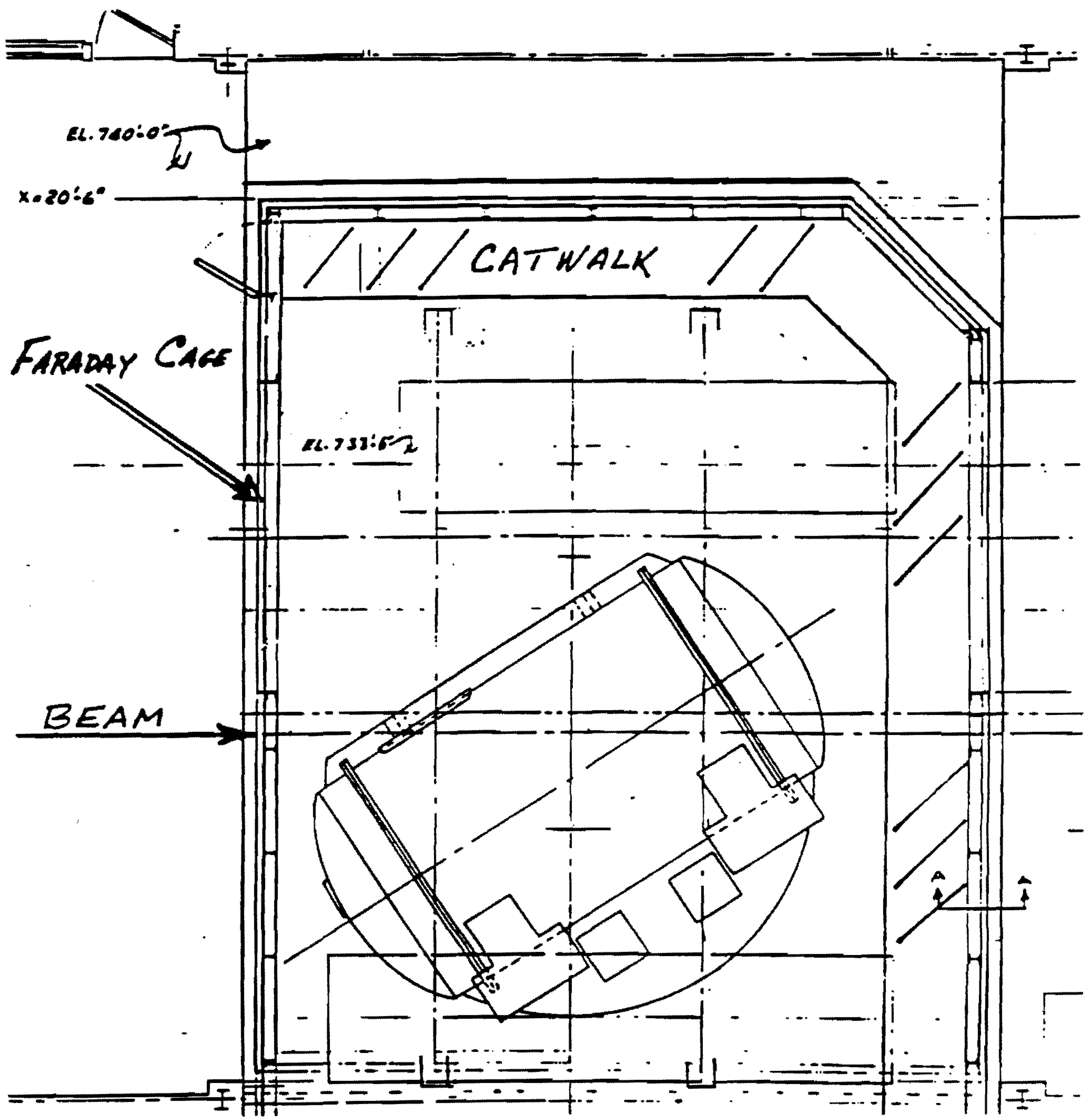


Figure 4

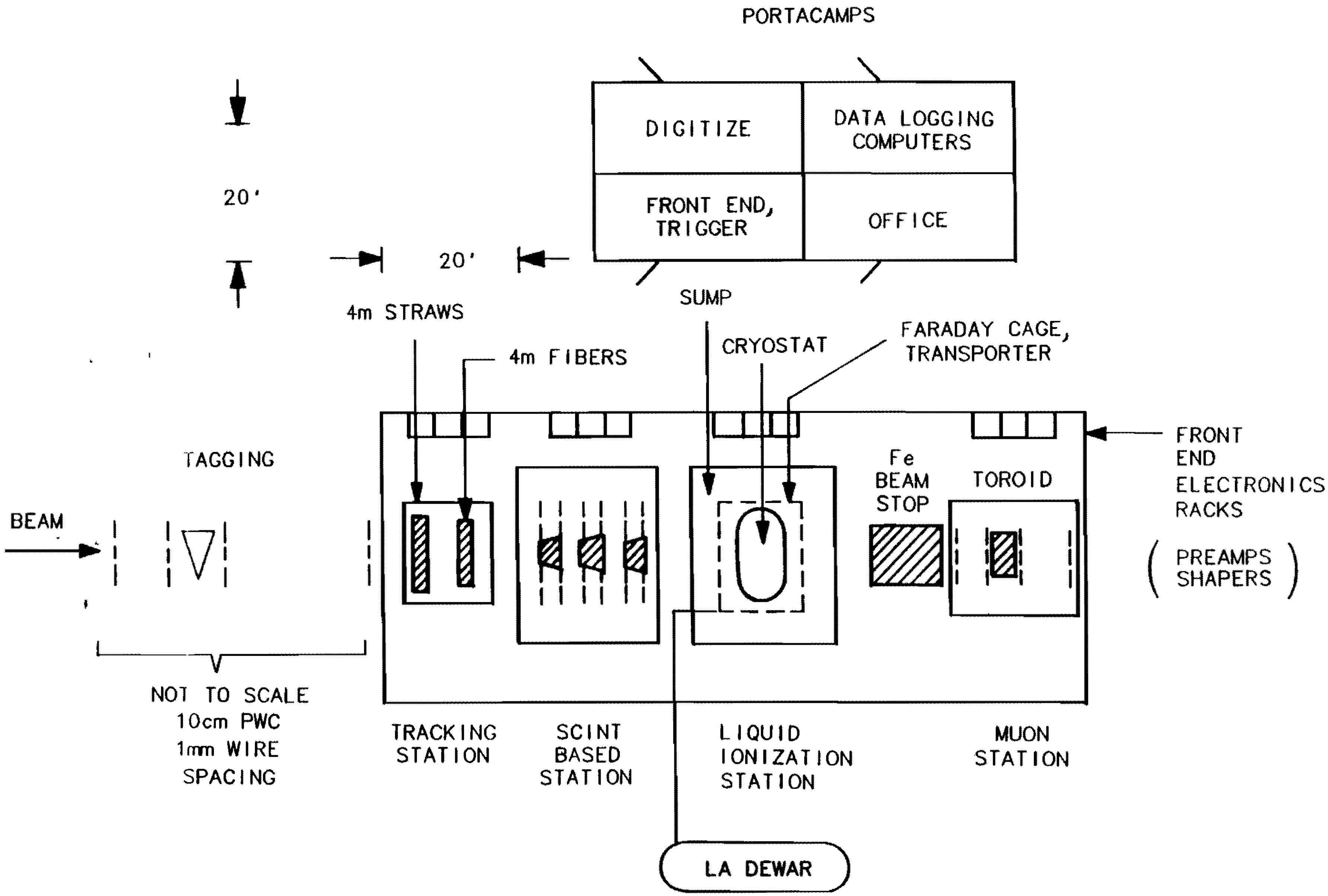

PORTACAMPS
DIGITIZE
DATA LOGGING COMPUTERS
FRONT END, TRIGGER
OFFICE
20'
20'
4m STRAWS
4m FIBERS
SUMP
CRYOSTAT
FARADAY CAGE, TRANSPORTER
TAGGING
BEAM
Fe BEAM STOP
TOROID
FRONT END ELECTRONICS RACKS
(PREAMPS SHAPERS)
NOT TO SCALE
10cm PWC
1mm WIRE SPACING
TRACKING STATION
SCINT BASED STATION
LIQUID IONIZATION STATION
MUON STATION
LA DEWAR

Figure 5

Members of the Solenoidal Detector Collaboration

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APPENDIX ON TRACKING SYSTEM STUDIES IN A TEST BEAM

Two types of tracking system tests and measurements are anticipated at this time. One would use a low intensity direct beam through the tracking detectors to measure their resolution and double hit separation capabilities. A test beam with precise knowledge of the particle trajectories is essential for these measurements. Of course simulations can and will be done but the measurements can not be eliminated if there is to be no doubt that the tracking system will work correctly and on schedule. All three types of particle tracking detector can be tested at the same time; that is, the silicon devices, the straw tubes and the scintillating fibers. An upstream beam telescope comprised of silicon strips is required to define the particle trajectories to better than 5 μm. The beam spot over which the particle trajectories are distributed should measure about 2 cm in both transverse dimensions and the divergence should be less than about 2 milliradians. A rotating table would put the particles through different regions of the detectors at different angles to check resolution as a function of those two variables.

The second type of tracking system measurement is intended to test the high rate capabilities of both the tracking devices themselves and the track recognition hardware which must be included in either the first or second level trigger. For this it is desirable to have an intense radiation flux but one that is spread out over as much of the area of the detectors as possible. This will approach the distribution of particles in the tracking region of the SDC detector. A target can be placed in the beam at some upstream point and the energy of the beam can be run at a moderately low energy where the particle flux becomes less highly collimated but still there is a high multiplicity of produced particles. An adaptable mounting and moving mechanism would allow the flux to pass through the tracking devices in ways to match the typical trajectories in the SSC. The rotating table could be fitted with various mounting fixtures and linear translators and lifters to change the configurations with minimal access to the beam line. Beam quality here is not an issue but the beam intensity must be an the order of 50 MHz.

Special auxiliary equipment, besides electronics and cables etc., include a 7 degree He cryogenic system for the visible light photon counters, nitrogen cooling for the cool preamplifiers for the scintillating fibers, a special liquid butane cooling system for the silicon detectors and a flammable gas mixing and recycling system for the straw tube chambers. Accurate surveying of the detectors with respect to the beam line and with respect to each other is required.

Exclusive of upstream floor space requirements for beam related devices, the floor space required by the detectors is about 8 m along the beam line by 5 meters on each side of the beam line. Several test periods separated by periods for data analysis would be required. Total beam time of about 500 hrs is anticipated.

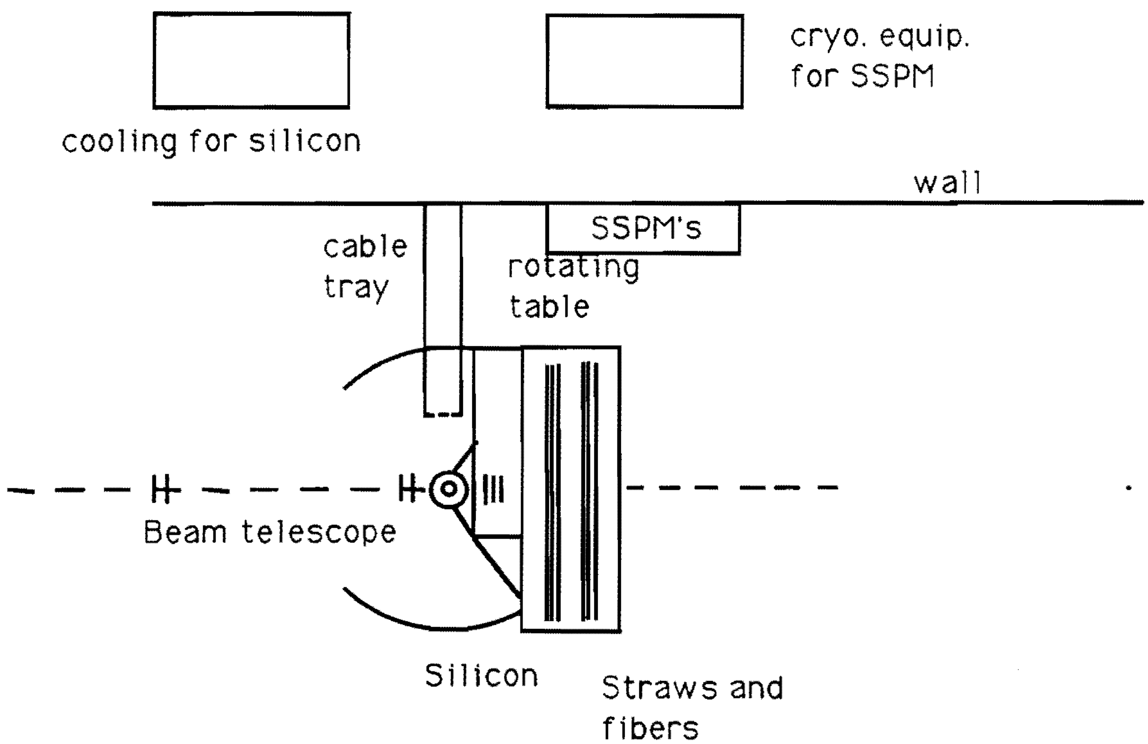

Fig. 6 . Arrangement for resolution measurement.

Appendix C

Test Beam DAQ

We propose to develop a common SDC DAQ system for use at the various 1993 test beam efforts. The goals of this effort include:

- Establish and implement a standardized interface and protocol for reading out front end electronics chips that is common to all detector systems. We are particularly concerned that individual detector systems may take independent and incompatible approaches to reading out their front ends.
- Avoid duplication of effort by providing a general purpose DAQ environment that can be easily cloned to satisfy the various test beam and electronics development projects in SDC.
- Provide a common and friendly user interface for the test beam.
- Gain experience in delivery of DAQ systems for the experiment.
- Provide a framework that will be used by the DAQ group for testing and evaluation of components of the SDC DAQ system. It may be necessary to setup up a dedicated DAQ test system similar to the test beam DAQ to avoid interfering with the test beam program.

It should be emphasized that our goal is not to develop the eventual SDC DAQ system at this time. Wherever possible, we will strive to adapt existing hardware and software to our immediate needs. One possibility would be to use DØ data cables, multiport memories, and VME based processors to accept, select, and analyze the data. This would allow 2 processor nodes and 500 MB/s or more data transfer speeds in each VME crate, with a wide selection of VME-based processors available.

The following is a preliminary list of items needed for DAQ system to be used for the 1993 test beam studies at Fermilab:

- Data collection network to extract data from the front end chips. If possible, this would be a first attempt at the data collection chip, but might also be an interface that simulates the function of the data collection chip.

- Long haul data cables to transport data from the data collection network to the event builder.
- Interface between data collection network and long haul data cable.
- Small scale processor farm and interfaces to the long haul data cables. The processor farm would perform data selection, analysis, calibration, data compression, and event buffering tasks. A software framework also needs to be developed for the farm.
- High speed data path between the processor farm and the host computer.
- Host Computer for the user interface, monitoring, control, calibration, and data recording.
- A software framework for the above tasks is to be developed, providing easy access to events for online study and user hooks to allow tasks such as monitoring, calibration, and data analysis. Where possible, existing DAQ software should be adapted to the needs of the test beam program. This is a large task requiring significant effort.
- Provision for reading out CAMAC, FASTBUS, and VME modules as needed for monitoring tasks and detectors that don't interface to the data collection network.
- Trigger simulator to supply needed trigger signals. This should be done in collaboration with the trigger group.
- Trigger/DAQ interface to provide trigger control, recording of trigger information, and assignment of farm processors to the incoming events. The interface should allow flexible partitioning since multiple detector systems will be present and should be able to operate either together or independently. The interface must also be able to throttle the trigger when the DAQ is no longer able to accept events.