GEM TN-93-434

GEM Computing Subsystem-Working Group Meeting Global Control and Online System Requirements and Schedule

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July 6, 1993

Abstract;

Transparencies of the meeting of July 6th-7th, 1993 on requirements and schedule for the Global Control System and for the On-Line System.

GEM Global Control System Meeting 7/6/93

Name	Institution	Subsystem	email
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GEM SLOW CONTROLS WORKSHOP - JULY 6, 1993

9:00 OVERVIEW OF GLOBAL CONTROL SYSTEM (20min+10min discussion, McFarlane)
Goals, schedules, support to subsystems, EPICS, integration issues (modularity, slow control hw and sw standards, compatibility with EPICS, subsystem/GCS boundary), GEM human interface, implementation, possible problems.

9:30 EPICS OVERVIEW (20min+10min discussion, Dalesio)
What it provides, what it doesn't provide, integration techniques.

10:00 BREAK (15min)

10:15 SUBSYTEM REQUIREMENTS
Short (20min +10min discussion each) presentations from subsystem representatives. Topics: subsystems monitoring and control needs, numbers of channels, implementation plans and schedule (short term, long term and test beams), required support from GEM GCS, problems/questions:

- 10:15 Muon System (Glebov)
- 10:45 Calorimeters (Wisniewski)
- 11:15 Data Acquisition (Lau)

11:45 LUNCH

1:00 SUBSYTEM REQUIREMENTS (continued)

- 1:00 Online + Offline Computing (McFarlane?)
- 1:30 Accelerator (Moore)
- 2:00 Magnet (?)
- 2:30 FNAL tests (Morelos)

3:00 BREAK (30min)

3:30 DISCUSSION OF GCS IMPLEMENTATION
Time scales, early use by subsystems, FNAL TB, integration issues, what is needed from from GEM GCS, what is needed from subsystems, availability of EPICS

- 3:30 GEM requirements and EPICS: response from Dalesio - (~15min)
- 3:45 Discussion (~45min)

4:30 BREAK (15min)

4:45 ACTION PLANS (~45min)

- work on developing action plans
- near term goals?
- steering committee? working groups?
- next meeting?

5:30 END

Notes on meeting of GCS group 7/6/93 (K. McFarlane)

-- See also transparencies of presentations

Scope issues

Q: How is loop closed for integration of monitoring systems?

Calor. monitoring group is J. Rutherfoord, Snow (Nebraska)

Q: Who does calibrations, thresholds: subsystem, GCS, or electronics?

Interface coordinator is Lynn Parlier (ICD).

Partial response:
Hardware interface is at modules: GCS will provide IOCs (VME crates and controllers). Subsystem will provide sensors, actuators, cables, modules. This is in ICD. In case of on-board monitoring systems connected by networks it is not clear where the line is. However the fiber link itself is cheap (~$200).

The GCS group will provide programming support: the team will be large enough to have a dedicated FTE for each major subsystem to do IOC and interface programming.

The GCS group will define standards for software and hardware, and recommendations for hardware (Industrial bus, DAC, ADC, binary I/O, timers, etc.). (The question of sensor/actuator recommendations will be considered, but even recommendations would come from the subsystems.)

The question of safety systems is somewhat unclear -- responsibility for design and certification must be clarified. An outside contractor may be asked to supply a certified system that has an EPICS interface.

Calorimeter:

W. Wisniewski.
1,000 temperature points in EM section (>100, < 10,000).
100 strain gauges.
Add to presentation 6) sensors/analyzers for liquid purity

J. Voyles will be contact for cryogenics. The same plant will be used for the magnet as for the calorimeter.

Time scale on WW's items:
1) Cryogenics RFP for Accel. systems (likely GEM will use near-identical system -- End 1993. Must get specs. for EPICS interface into RFP.
2) Now?
3) Now?
4) Firm up numbers within 12 months
5) Now?

First calorimeter -- 1998 (1999 schedule)
Test at Argonne -- 1998 (1999 schedule)

FNAL test 1) J. Voyles responsible
2) 'Off-the-shelf' done by calorimter group; currently unknown
Oct. 1994, calor. at FNAL, 2 month cool down.

Tracker

No rep. present. But cables are difficulty. Tracker may not want to add more than there already are. Either monitor/control via one or two fibers, or use existing data links.

Additional Notes on GCS group meeting 7/6/93 (T. Kozlowski)

GEM safety systems:
- interface to GCS needs definition
- Ken Schwarz and Ron Woolley are contacts
- Rich Perry contact for PASS
- IR5 safety working group meets every 2 weeks (July 8, 1993)

EPICS (Dalesio):
- Motif will be in release 3.12 (in 3-4 months), may want to install alpha release on GEM Test Bed (contact Dalesio)
- discussion about usefulness of a user and/or newsgroup for EPICS, Gary Word will get a list of users from Bob Dalesio, and make a proposal in regard to establishing a newsgroup (where?)
- external (to SSCL) users may have to sign an EPICS agreement (no cost) to port it to their systems

Calorimeter (Wisniewski):
- FNAL TB: delivery to FNAL at end of 1994, need transporter control at that time
- 1st assembly will be in NAB (?) in 1998, will need some monitoring
- cryogenics control system (independent of GCS) needs input from GCS calorimeter sensors

Electronics (Lau):
- how slow controls signals get to and from frontends is not well defined (separate - fiber - paths? via DAQ stream?), needs to be defined including interface to EPICS
- there is an ICD (Lau) for electronics

Accelerator (Moore):
- accelerator tuning not dependent on detector for luminosity measurement (but maybe for precision measurement)
- EPICS gateway will know about a predefined set of channels available to the outside world
- can detector be warned (need it be) of beam loss conditions? (Rolf Bork is a contact about this question)
- use of detector BPMs? (contact is Bob Webber)

Magnet (Voyles):
- Voyles is a liason between GEM/EPICS and magnet people at LLNL

FNAL TB (Morelos):
- need to identify all slow controls and monitoring it makes sense to connect to EPICS (all transporters? HV?, beam cerenkov?, etc.)
- Carl Timmer (AT-8, LANL) is working on EPICS control of calorimeter transporter
- EPICS access to FNAL EPICURE slow controls system needs to be investigated (FNAL contact: Therese Watts); facililty to put EPICURE data into EPICS database?

Action items:
- need GEM GCS ICD for subsystem interfaces
- investigate what is needed to adapt use of EPICS (test bed system?) to some TTR controls and monitoring
- next meeting in about 6-8 weeks (end of August?)

Accelerator (Tom Moore)

EPICS is designing 'gateway.' Most accel. parameters will come across gateway. Timing will have its own system.
Parameters like current, Abort status, PASS. GEM will pass back info. e.g. collision rates, GEM field.

Accelerator controls low-beta quads, but nothing in between. Who does BPM?

Muons (V. Glebov)

TTR prototype tests -- End '93
Alignment tests -- 1994
FNAL tests -- two transporters, one large, one small inside magnet
FNAL 18-deg. test 7/96

Magnet

Full coil test.
Wisconsin test?
Cryo plant (note RFP to go out in 6 mos.)

EFD responsibilities (J.V.):

Muon gas system
calorimeter controls
Mechanical utilities HVAC, vacuum (beam line, warm bore) Gerry Chapman, low cond. water.

Discussion of EPICS

Access control is not yet in EPICS; undrway is a system by ability to login to specific workstation by specific user. This probably needs extension, e.g. to AC for 'window' or 'panel.'

ACTION ITEMS

1) Bob Dalesio, A.Morelos and V. Glebov will examine existing TTR equipment to see what is involved in putting an EPICS system on it.
2) J.V. and Bob D. will get in touch with ASD to ensure that messaging specs. are put in cryo. RFP so that it is consistent with EPICS/GCS.
3) Norm Lau will review the grounding issues raised by GCS
4) J.V. and Tom Moore will get more details, specifications on the accelerator interface
5) The EPICS team (Bob D.) will prepare some response on the following:
   a) Access control in distributed EPICS system.
   b) migration of 'old' data from the EPICS archive to mass storage in a transparent way.
   c) Unix IOC emulator
   d) dual (redundant) support of Channel access
   e) Motif interface (alpha version)

6) K. McF, Tom Kozlowski will address the interface issues, with GEM subsystems, with accelerator.
7) The EMS interface and requirements will be examined more closely and responsibilities defined (KMcF, TK, Ronn Woolley). Coordination within PRD and with SDC is an issue.

GEM | Global Control System meeting 7/6/93 ①
online system K. McFarlane

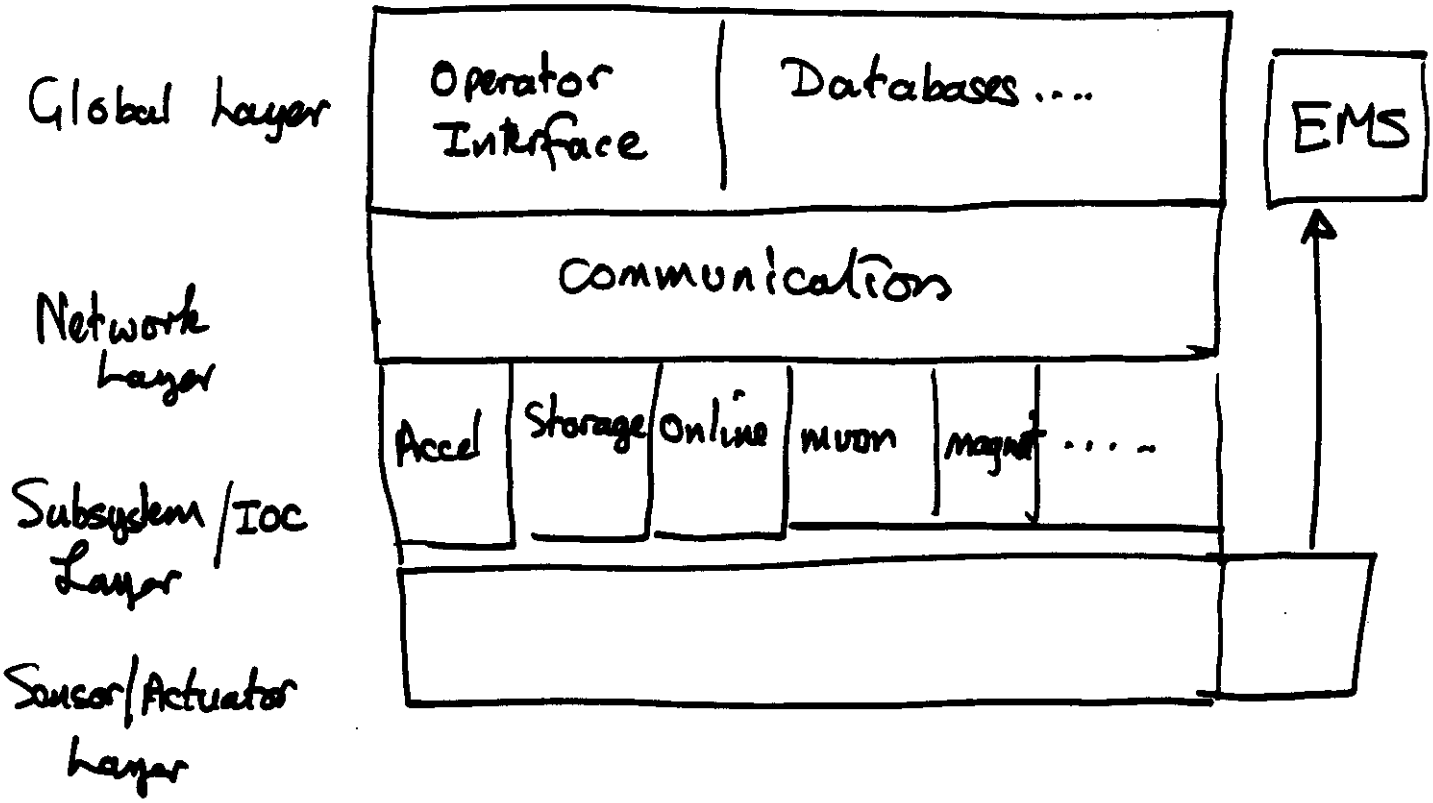
Goals of Meeting

- Formation of working group
- Definition of scope
- Collection of Requirements
- Development of specifications
- Definition of architecture
- Assessment of manpower available/needed
- Development of Schedule (→ 2002)
  - Test beams (FNAL + SSCL ?)
  - Tests during construction & commissioning (? 1996)

Online System

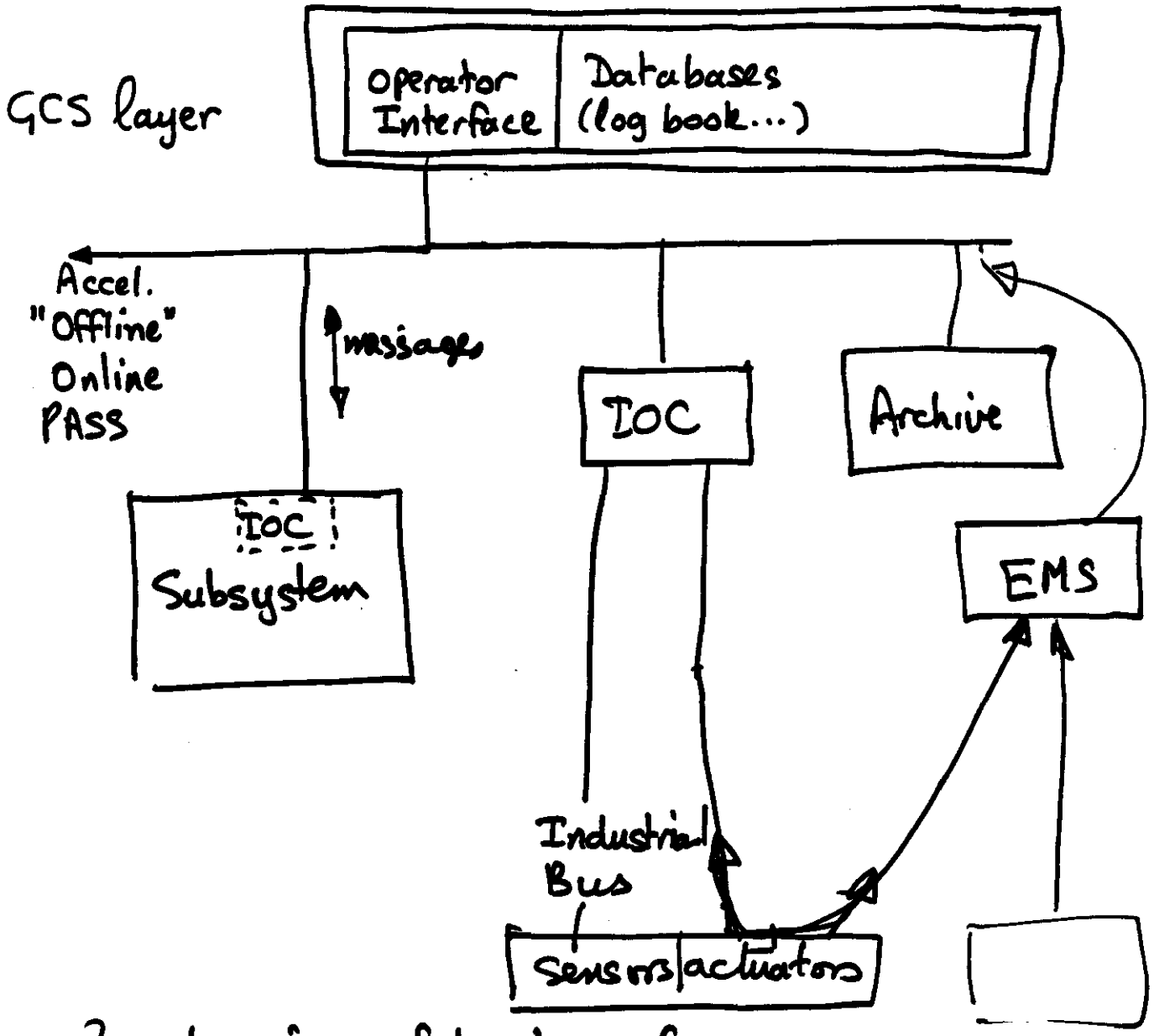
Interface to DAQ.

General Architecture of GCS



General Architecture

Layered Model



? Logging of subsystem info.

Computing System Parameters

There are two primary components of GEM computing which directly interface with other detector subsystems: the Global Control System (GCS), which includes the Slow Control and Monitoring System (SCMS), and the Online System (ONS). These will be linked by networks and other communication links. This document specifies only elements located at IR5.

Global Control System (GCS)

The GCS and SCMS are to be capable of:

- Scanning (monitoring) all SCMS parameters in less than one minute
- Logging alarms at 100 Hz or better
- Responding to operator requests in less than 1 second.

Control functions will have three levels, all of which will be access-controlled:

1. General (accessible to all authorized shift personnel)
2. Special (confined to subsystem personnel and systems)
3. Safety-related (may be automatic).

There will be four levels of monitor and status information (all levels are to be available on request):

- Level A: Information only
- Level B: Warning of out of-range-condition requiring adjustment or maintenance in due time
- Level C: Alarm requiring immediate intervention to return detector to valid state
- Level D: Alarm requiring immediate response by emergency (EMS) personnel, such as a fire or rescue.

I/O Controllers and Interfaces

The GCS interacts with other detector subsystems partly through the SCMS, where the interface is via Input-Output Controller crates (IOCs). The IOC is a 20-slot VME crate which is provided by the SCMS to support data-collection and control modules provided by the subsystems. The number and location of IOCs assigned to the subsystems are given in the following table:

Subsystem	Number of IOCs
Facilities	1
Muon system	1
Calorimeters	1
Tracker	1
Beam pipe	1
Electronics/DAQ	1
Magnet (power and cryogenics)	1 ?
Detector Hall	1
Utility shaft	1
Utility Building	1 ← Cryogenics
Gas mixing building	1

n addition to the IOCs, the GCS will have interfaces to other systems, which may be OC controllers, as follows:

System	Type (and number) of interfaces
Accelerator	Network (1)
Safety (EMS) for fire, ODH, PASS, etc.	Network (1) Hardwired (TBD)
General network	Network (1)
Main Campus operations room	Network (1)

Online System

The ONS will have the following capabilities:

- Input bandwidth of 12.8 GByte/s
- Output bandwidth of 4 Gbyte/s

In addition, the downstream systems must accept the output bandwidth and be capable storing 170 MByte/s.

Networks and Communication

We specify here the equivalent area of conduit needed for the GCS and the ONS. This assumes 40% fill and a staged installation. We use as a standard unit a 4-inch conduit which can carry four 1.25-inch inner ducts. The SAB hub may be located on the secon level of the SAB south wing. The conduits are:

Origin	Termination	Size (conduits)
East Campus Hub	SAB hub	1 2
NAB	SAB hub	1
Electronics Shaft	Online room (SAB)	36
Gas mixing building	Utility building	1
Utility building	SAB hub	1
Utility shaft	SAB hub	1
Detector Hall	SAB hub	1
Detector Hall	Electronics Room	36

Power and UPS

The power and UPS requirements for the systems are as follows:

System	Power required	UPS time
GCS	100 kVA	30 minutes
Online system	0.8 MVA	5 minutes
Networks	10 kVA	30 minutes
Safety systems, including safety-related networks	20 kVA	indefinite (emergency power)

Protection of equipment . . . 6

GEM Muon System Slow Control Requirements

Vladimir Glebov

07/06/93

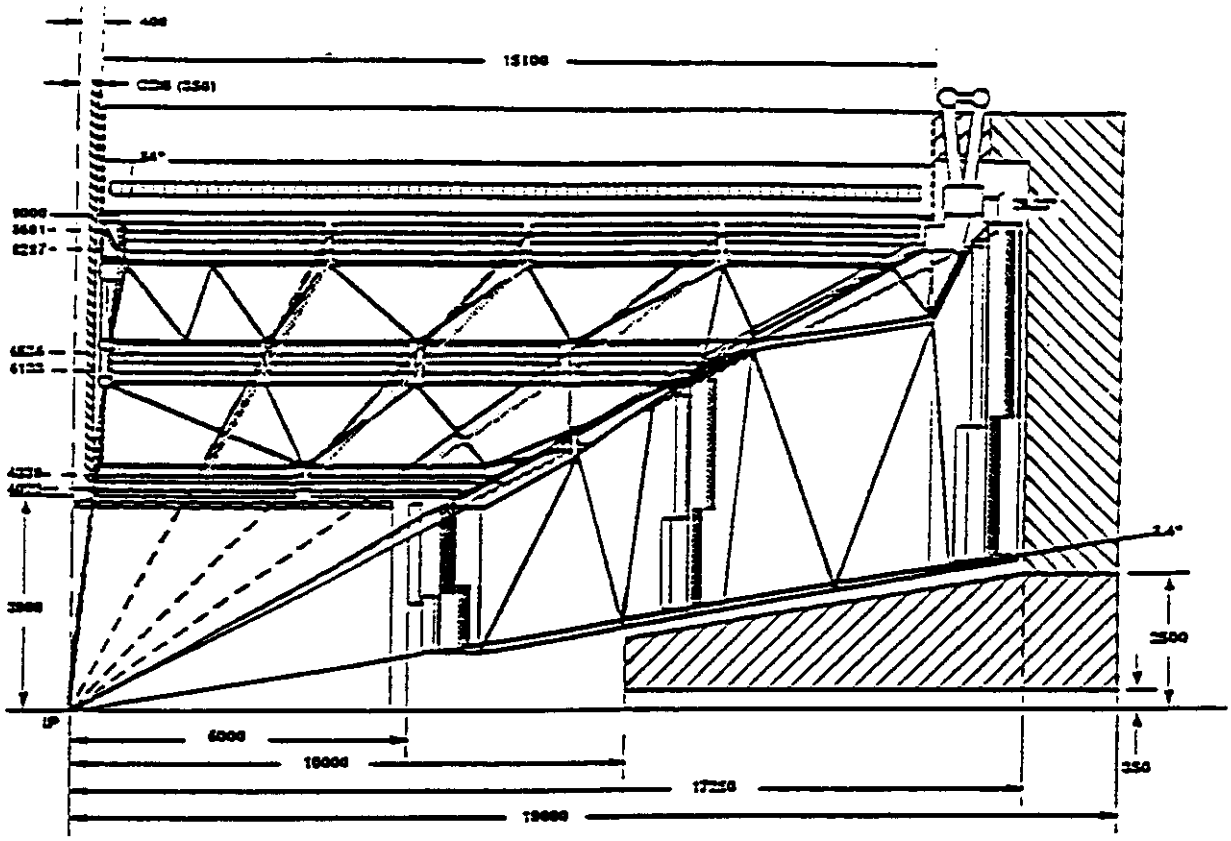


Figure 4.1.1a: Overview of GEM Muon Sytem (quadrant elevation view)

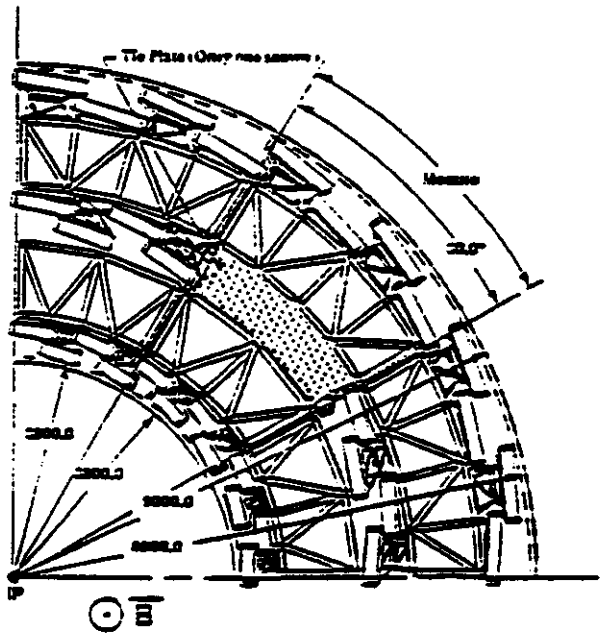


Figure 4.1b: Muon System End View (1/4 Section) View from North End of UG Hall

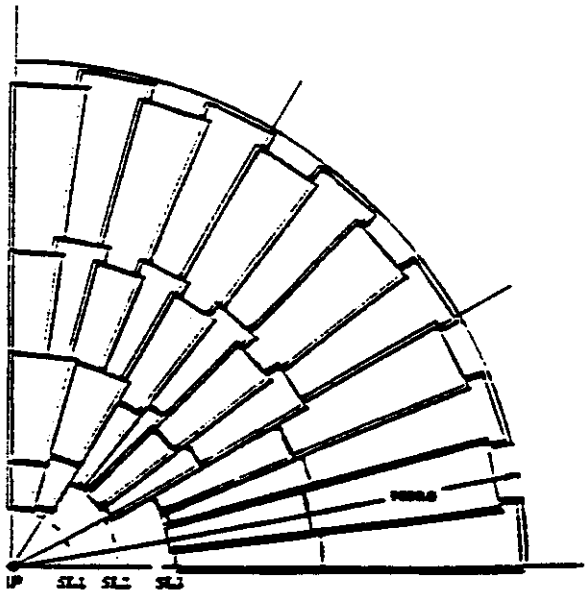


Figure 4.1c: Endcap Muon Chamber Layout (1/4 Section) View from IP

Fig. 4-1

GEM Muon System

Subsystems:

- Muon chambers
- Muon alignment system
- Level 1 Muon Trigger
- High Voltage system
- Low Voltage system
- Muon gas system
- Servo-control for 3-point mounted chamber package.

Muon Chambers

Barrel	Endcaps	Total
960 CSC	480 CSC	1440 CSC

Muon Monitor Board on each chamber

Control:

1) Trigger condition
2) Gate width and delay
3) Threshold of the cathode amplifiers
4) Threshold of the anode amplifiers
5) Test pulse amplitude, width and delay

Monitor:

1) Voltage and current of LVPS
2) HV current in each plane of chamber
3) Gas input and output pressure
4) Gas input and output flow rate
5) Water input and output flow rate
6) Temperature on chamber, electronics and water cooling system

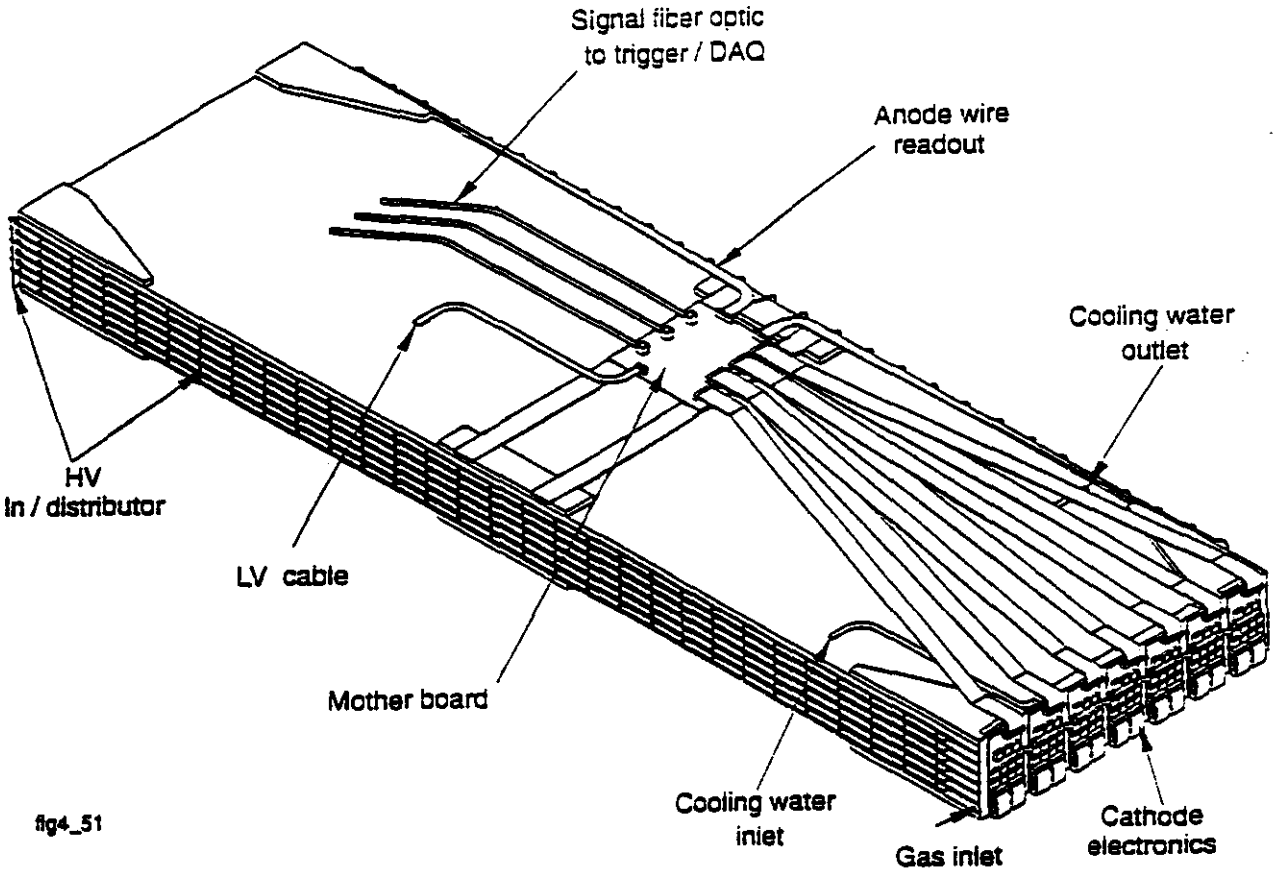

Signal fiber optic
to trigger / DAQ
Anode wire
readout
Cooling water
outlet
HV
In / distributor
LV cable
Mother board
Cooling water
inlet
Gas inlet
Cathode
electronics

fig4_51

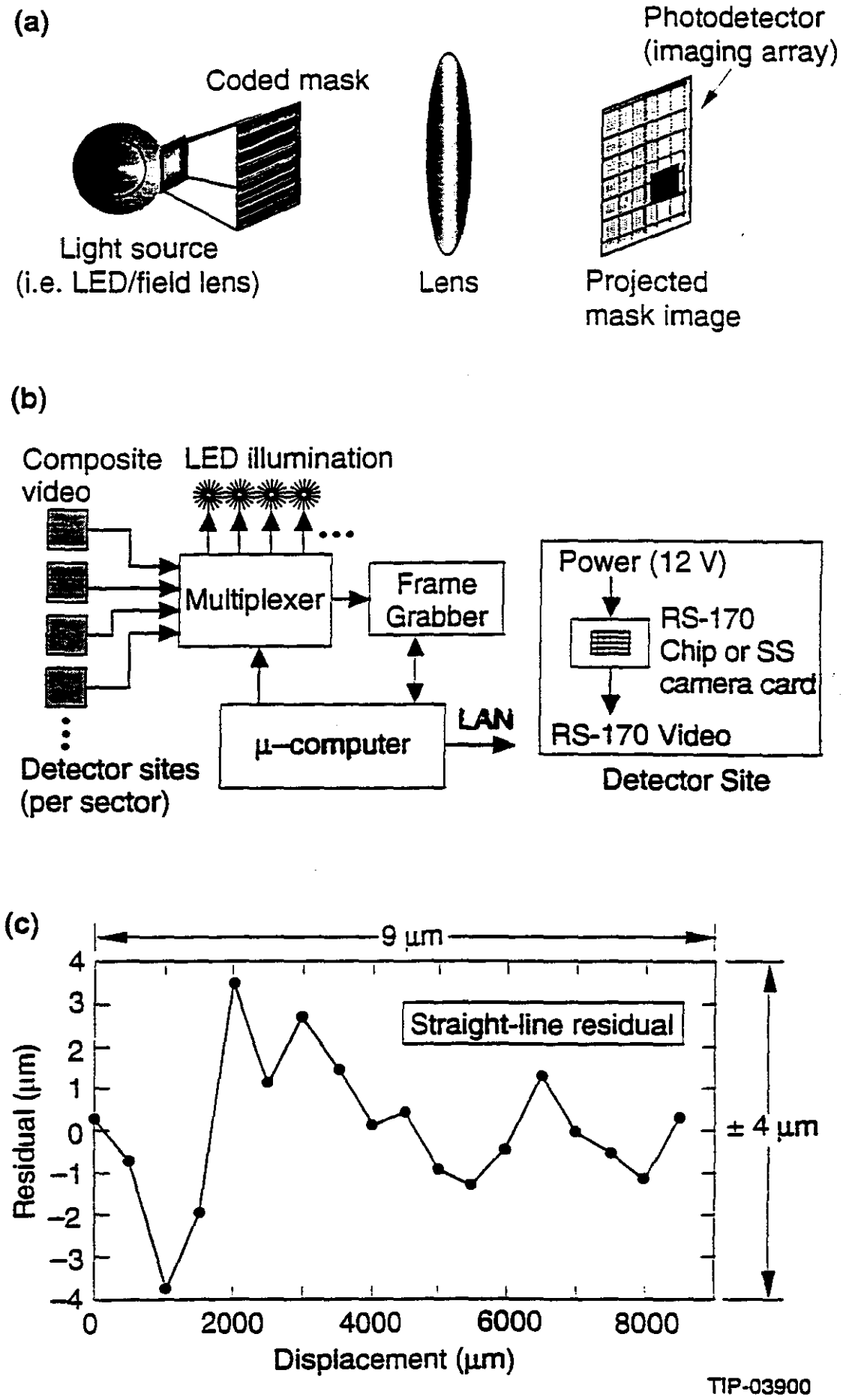
Muon Alignment System

Requirement : 25 μm

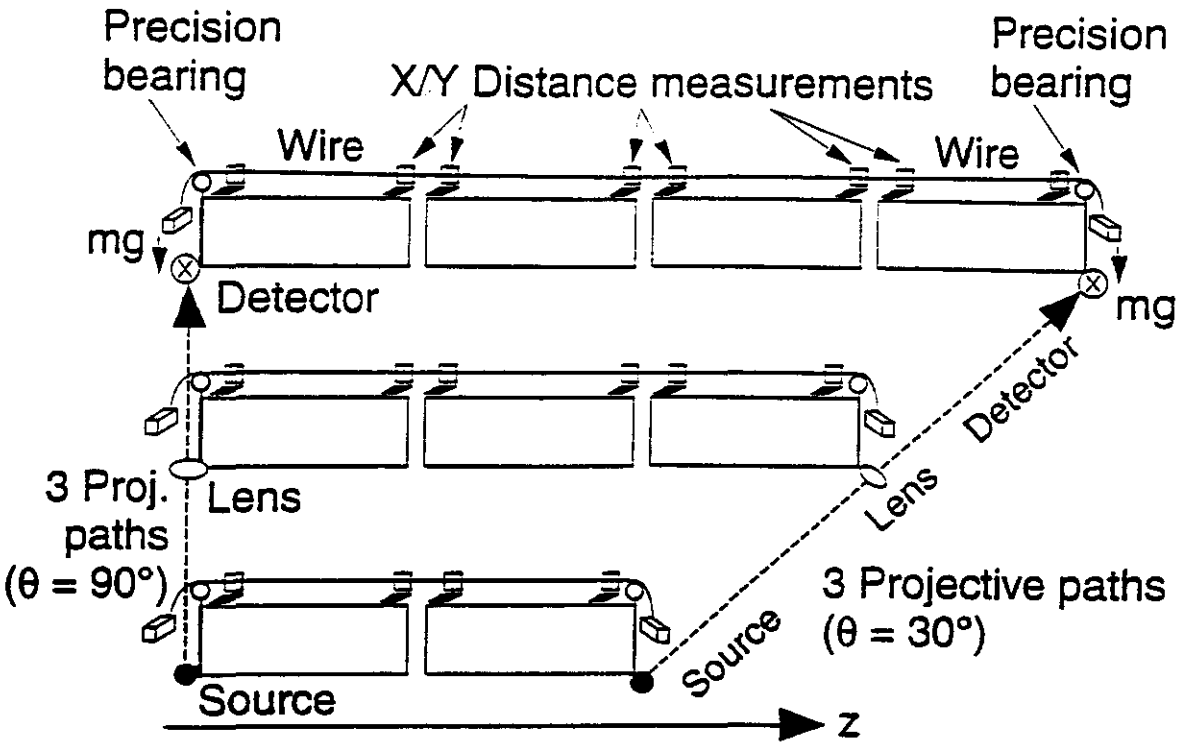
Dynamically monitor the relative alignment by straightness monitor

Barrel	Endcaps
2304	960

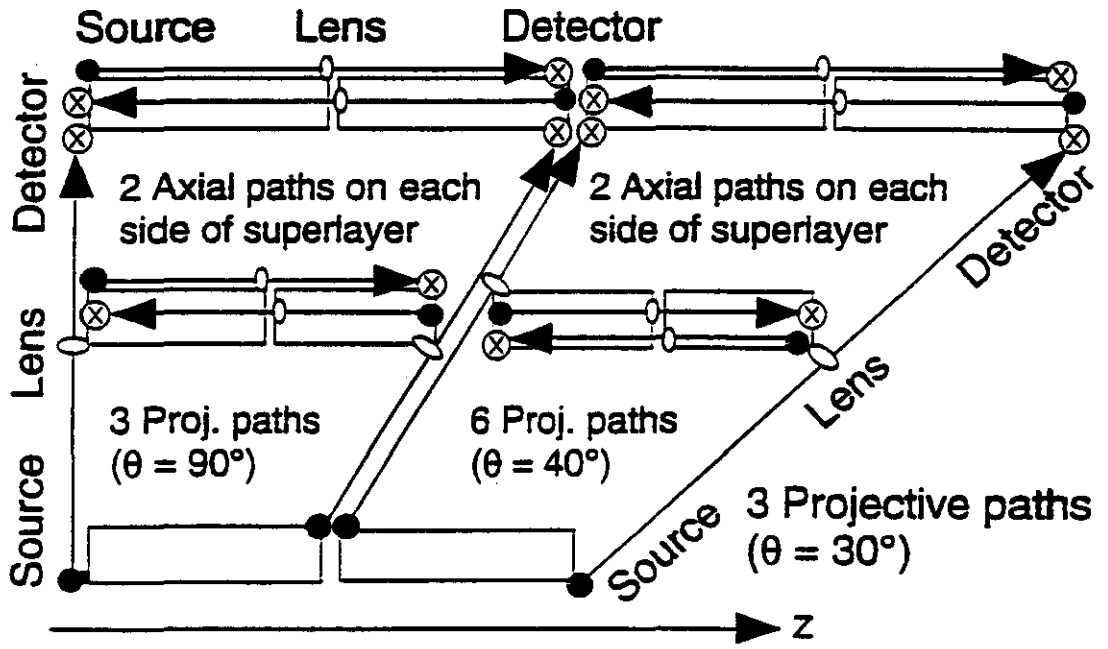
One processor/multiplexer per $\Delta\phi = 30°$ slice $\Rightarrow$ 24 DAQ Systems


(a)
Photodetector
(imaging array)
Coded mask
Light source
(i.e. LED/field lens)
Lens
Projected
mask image
(b)
Composite
video
LED illumination
Multiplexer
Frame
Grabber
Power (12 V)
RS-170
Chip or SS
camera card
RS-170 Video
Detector Site
LAN
μ–computer
Detector sites
(per sector)
(c)
9 μm
Straight-line residual
± 4 μm
Residual (μm)
Displacement (μm)
TIP-03900

(a)


Precision bearing
X/Y Distance measurements
Precision bearing
Wire
Wire
mg
Detector
mg
Detector
3 Proj. paths (θ = 90°)
Lens
Lens
3 Projective paths (θ = 30°)
Source
Source
z

(b)


Source
Lens
Detector
Detector
2 Axial paths on each side of superlayer
2 Axial paths on each side of superlayer
Detector
Lens
3 Proj. paths (θ = 90°)
6 Proj. paths (θ = 40°)
Lens
Source
3 Projective paths (θ = 30°)
Source
z

TIP-03890

Level 1 Muon Trigger

On-chamber electronics ⇒ Muon Monitor Board

Off-chamber electronics ⇒ GEM Rack Monitor

Level 1 Muon Trigger → ~ 8 crates

GEM Rack Monitor

1) Power supply voltages for each crate
2) Power supply currents for each crate
3) Temperatures of air and water
4) Water input and output flow rate

Level 1 Muon Trigger:

Downloading system

GEM High Voltage System

Single H.V. system for all of the GEM detectors

- Common Hardware
- Same Control System
- Same Control Software

DØ designed and produced such H.V. system

8 subsystems: LAr Cal., M.C., V.D., TRD ....

Current/Voltage ranges:

~100 V → 7kV (+/-)

~10 nA → 1 mA

3650 HV channels

VME 6U crate, 48 H.V. chan./crate

68020 μ Proc., Full computer of set and read functions:

V_{set}, I_{oc}, V_{out}, I_{out}, V_{max}

Muon High Voltage System

1440 Chambers	8,832 Planes
⇓	⇓
1440 HV Channels	8,832 HV Channels
⇓	⇓
30 HV crates	184 HV crates

Muon HV Requirements

Superlayer :	SL1	SL2	SL3
Operating Voltage:	2.6 kV	3.4 kV	4.0 kV
Max. Current :	~10 μA	~10 μA	~10 μA

GEM Low Voltage System

Single Low Voltage system for the GEM

- Common Hardware
- Same Control System
- Same Control Software

Similar to GEM Rack Monitor

1) Power supply voltages
2) Power supply currents
3) Temperatures
4) Water flow rate

Muon System:

LVPS for Muon Electronics

LVPS for Muon Alignment

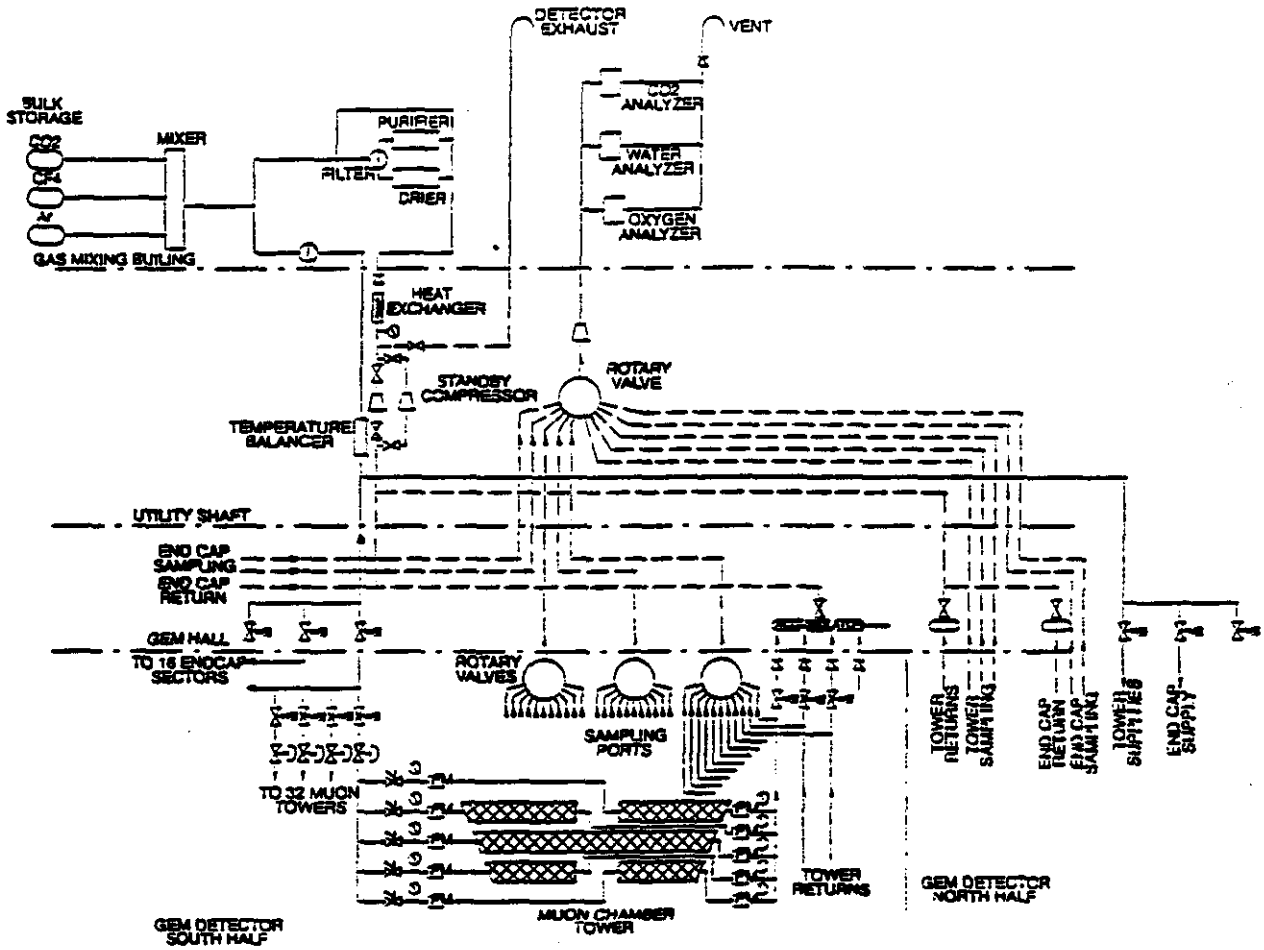
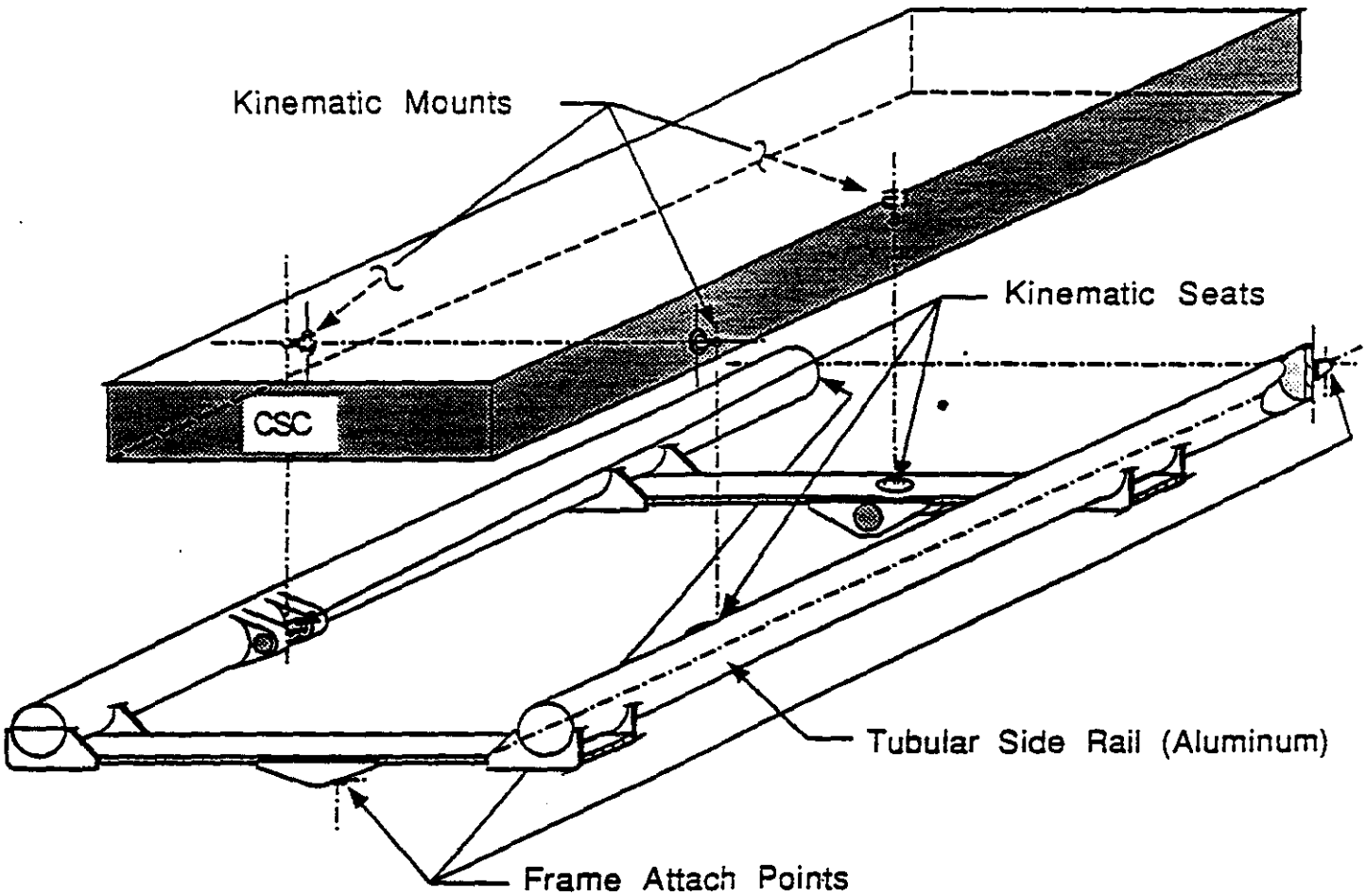

DETECTOR EXHAUST
VENT
BULK STORAGE
CO2
CH4
Ar
MIXER
PURIFIER
FILTER
DRIER
CO2 ANALYZER
WATER ANALYZER
OXYGEN ANALYZER
GAS MIXING BUILDING
HEAT EXCHANGER
STANDBY COMPRESSOR
ROTARY VALVE
TEMPERATURE BALANCER
UTILITY SHAFT
END CAP SAMPLING
END CAP RETURN
GEM HALL
TO 16 ENDCAP SECTORS
ROTARY VALVES
SAMPLING PORTS
TOWER RETURNS
TOWER SAMPLING
END CAP RETURN
END CAP SAMPLING
TOWER SUPPLIES
END CAP SUPPLY
TO 32 MUON TOWERS
TOWER RETURNS
GEM DETECTOR NORTH HALF
GEM DETECTOR SOUTH HALF
MUON CHAMBER TOWER

fig 4-91


Kinematic Mounts
Kinematic Seats
CSC
Tubular Side Rail (Aluminum)
Frame Attach Points

Calorimeter

1) Sensors and controls for valves, vacuum pumps, fluid storage tanks, gauges, vapor pressure bulbs, etc....

2) Sensors for temperature

   i) chains of platinum resistors on liquid vessel walls (in vacuum volume)

   ii) platinum resistors attached to modules inside the liquid

   (note: number earlier given for (i) is probably too large; (ii) will probably grow in number since we will need to control (ρ)(T) near EM modules very well — even though we have active heating elements (electronics) there —)

3) Sensors for liquid levels
   - probably capacitive
   - coarse sample till near top where level sensing should be $\lesssim$ 1cm instead of ~15 cm in rest of cryostat

4) Strain gauges at critical points → EM suspension points, stays, etc.

5) conventional monitoring: water cooling temp; junction box voltages, currents, etc.

6) Purity Monitoring

Slow Control - Electronics

- Crates, racks, heat exchanges, electronics rooms, etc.
  - DC voltages, temperatures, dew point, water leak, water flow, pump, humidity and smoke alarms, etc.

- Low voltage and High voltage power supplies
  - on/off, voltages, currents, overvoltage

- Subsystem front-end circuits
  - calibration, threshold adjustment, enable/disable

- Trigger ~~simulation~~

- Software download into the firmware located in the in-/on-detector areas

- Data channel diagnostic system

- Interface between subsystem and global control system

- Crate separation to maintain electrical isolation

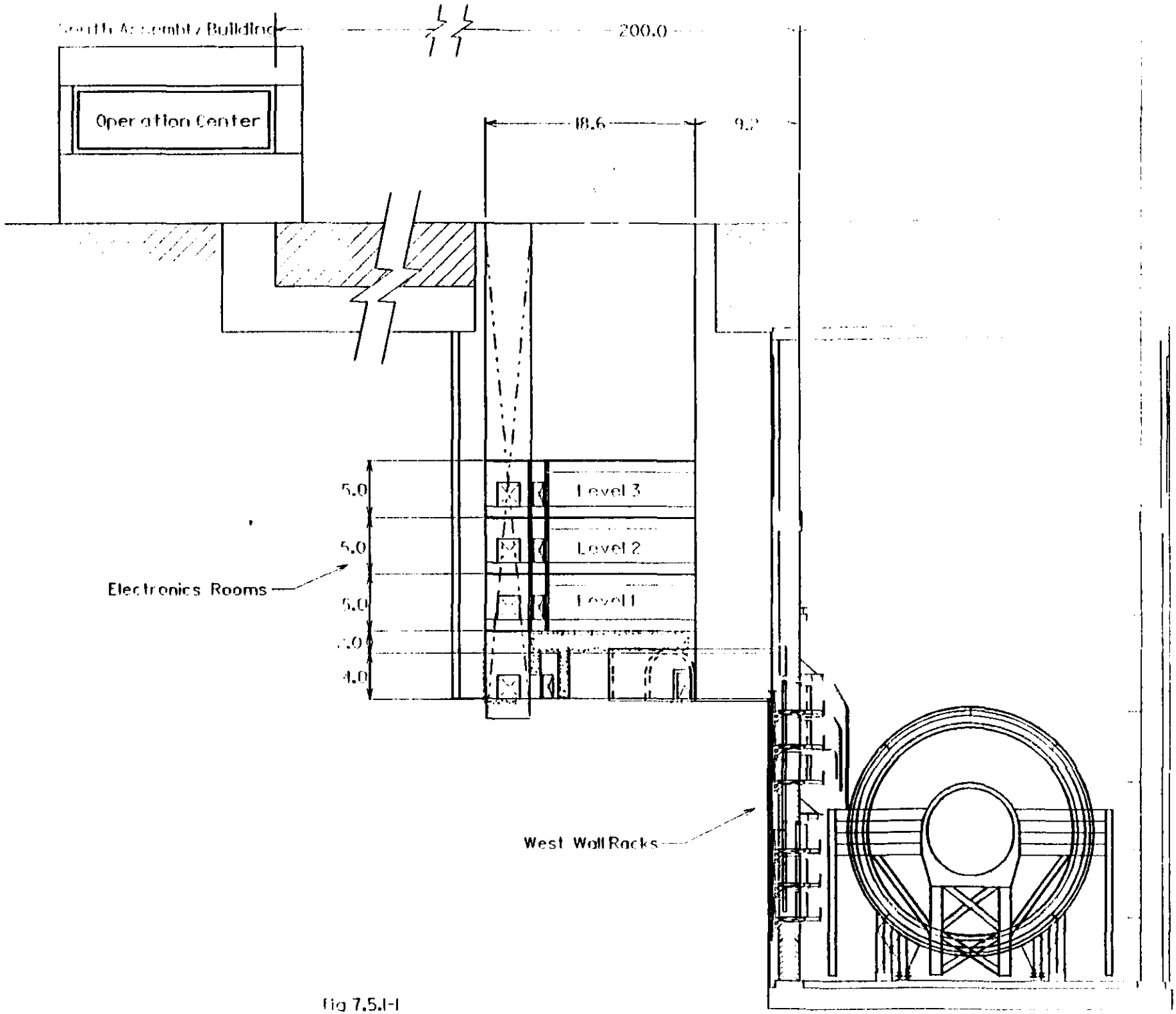

Operation Center
200.0
18.6
5.0
5.0
5.0
4.0
Level 3
Level 2
Level 1
Electronics Rooms
West Wall Racks

Fig 7.5.1-1

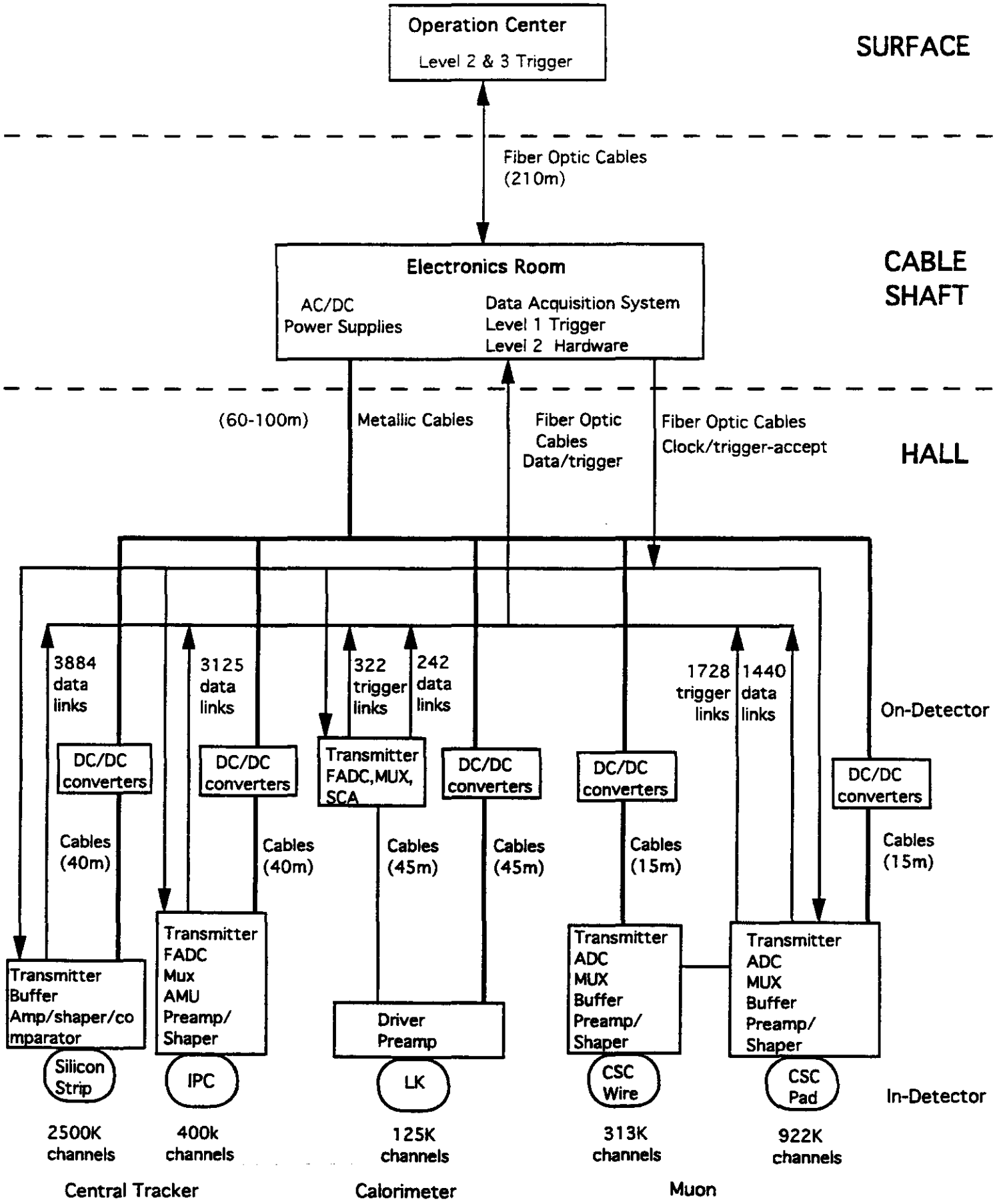


Figure 7.5.1-GEM Electronics System Layout

Item	Function	Parameter	Hi-Lo Limit	Initial Position	Location	Time Interval	Response time	Monitor/ control	Comments
	Crate	DC voltage	+/- 5volts		Elect. Room, Detector Hall	1 min.	10 sec.	Monitor	552 in the ER 627 in the Hall
			+/- 25volts			1 min.	10 sec.	Monitor	
	Rack	Temperature	60 - 90° F		Elect. Room, Detector Hall	1 min.	10 sec.	Monitor	184 racks in the ER 209 racks in the Hall
		Dew point	55° F			1 min.	10 sec.	Monitor	
		Water leak				1 min.	10 sec.	Monitor	
	Heat exchanger	Pri. in temp.	45° F		Elect. Room, Detector Hall	1 min.	10 sec.	Monitor	552 in the ER 627 in the Hall
		Pri. out temp.	60° F			1 min.	10 sec.	Monitor	
		Sec. in temp.	60° F			1 min.	10 sec.	Monitor	
		Sec. out temp.	64° F			1 min.	10 sec.	Monitor	
		Flow	15gpm			1 min.	10 sec.	Monitor	173 in the ER 209 in the Hall
		Fan	On/off	On		1 min.	10 sec.	Monitor	
		Pump	On/off	On		1 min.	10 sec.	Monitor	
	Room	Temperature	73±2° F		Elect. Room	1 min.	10 sec.	Monitor	4 floors
		Humidity	45±5%RH			1 min.	10 sec.	Monitor	
		Smoke/fire	On/off	Off		10 sec.	1 sec.	Monitor	

Electronics & DAQ Slow Control List (August 28, 1992)

Design Overview

GEM Magnet Controls

Gene Oberst

Lawrence Livermore National Laboratory
July 6, 1993

Magnet Control System Requirements

Three tier hierarchy:

Local controls for Vacuum, Cryogenics, Protection and Power Supply Systems

Magnet System Controls (supervisory)

GEM Slow Controls System (SCS)

<u>SCS is not included in the GEM Magnet scope</u>

Magnet Control System Requirements

Local Controls:

Provide stand - alone operation capability for each of the magnet subsystems for maintenance and test activities

Control and monitor functions limited to associated subsystem

Control and monitor functions presented as discrete elements with automated functions limited to those necessary for personnel and equipment safety

An interface for remote computer operation via the Magnet System Network will be provided

Magnet Control System Requirements

Vacuum Local Controls:

Controls the operation and monitors the status of a mechanical pump, roots blower, diffusion pumps and control valves.

Monitors vacuum pressure at various points in the subsystem external to the vacuum vessel.

Cryogenics Local Controls:

LHe System:

Controls the operation and monitors the status of refrigerators, control valves and throttle valves.

Monitors temperature and pressure transducers, dewar level indicators and vent valves

LN System:

Controls the operation and monitors the status of control valves and throttle valves.

Monitors dewar level indicators, liquid nitrogen temperature transducers and vent valve positions

Magnet Control System Requirements

Protection Local Controls:

Contains the circuitry to detect and validate magnet quenches and other off normal magnet operation

Issues commands to other magnet subsystems to initiate protective actions

All quench detection circuitry will be redundant

Power Supply Local Control:

Controls the operation and monitors the status of power supply on/off, DC power on/off, charge/discharge switch open/closed, interrupter open/closed, local/remote operation and interlock inhibit

Monitors current setpoint, current rampup setpoint, overcurrent setpoint, output volts, output current, ground tap current and interlock status.

Magnet Control System Requirements

Magnet System Control:

Provides supervisory control of the four magnet subsystems.

Capable of emulating all local control system functions

Consolidates local control functions into high level, automated sequences

Provides capability of operating the GEM magnet in a stand alone mode during commissioning and maintenance activities

Provides communication link between the magnet subsystems and the GEM Detector SCS

Magnet Control System Requirements

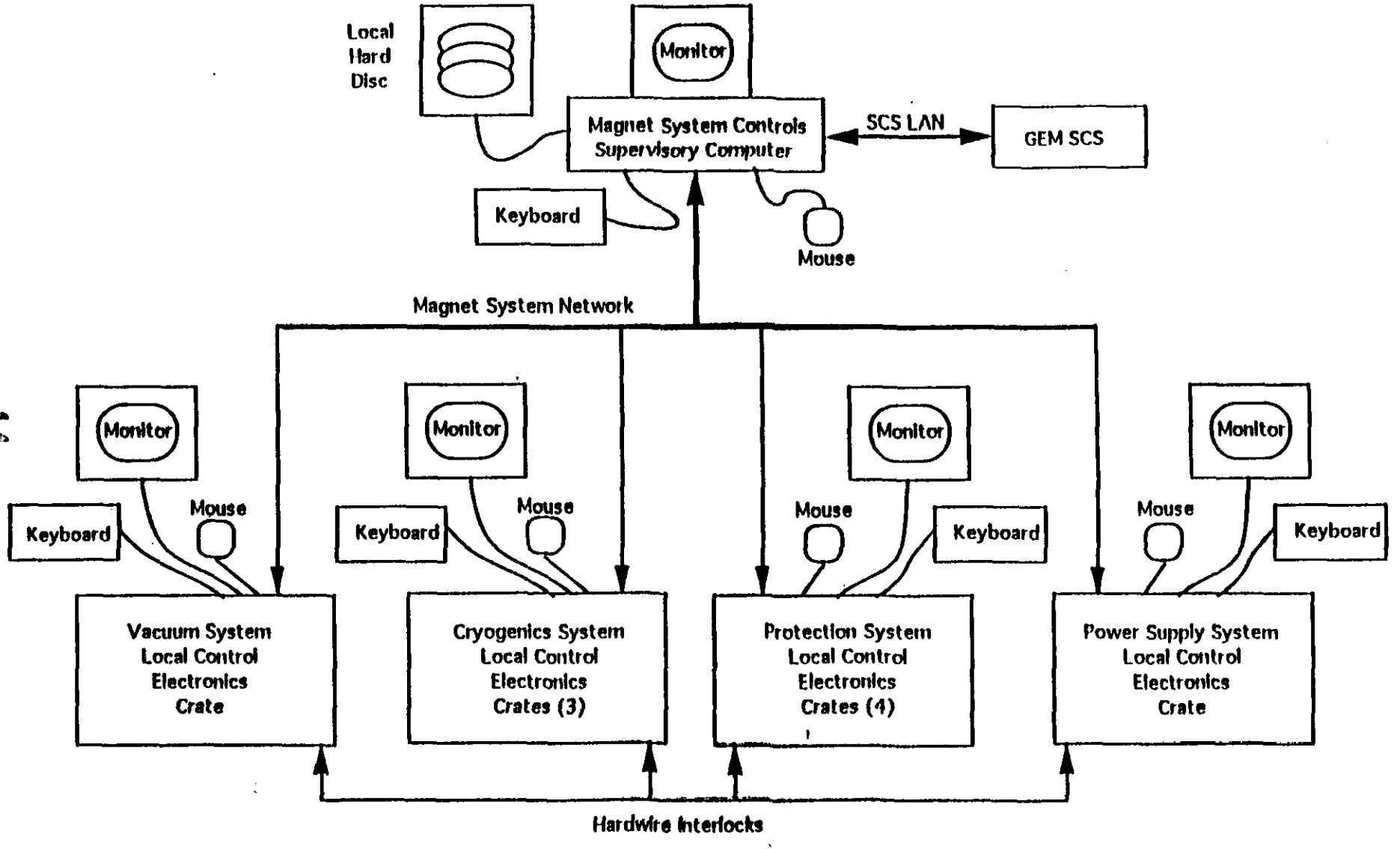
Systems will be implemented using standard commercial products wherever possible

We will use hardware and software standards adopted by SSC Controls wherever possible

SSC has selected EPICS as the standard for the process controls software

The hardware platform will probably be VXI and/or VME

GEM MAGNET CONTROLS



5/3/93

SUBSYSTEMS AT GEM_TEST_BEAM_FERMILAB

Calorimeter

- transporter
- temperature readings
- HV
- presure

CT

- transporter in magnet
- transporter for 18 degree
- LV (silicon bias voltage)

muon

- transporter in magnet
- transporter for 18 degree
- HV

non-GEM~2000 elements AT GEM_TEST_BEAM_FERMILAB

EPICURE

beam line magnets

current
field

SWIC'S

survey beam

magnet small GEM prototypes

current
field

Cerenkov (IBM / EPICS ?)

HV
presure
temperature

Syncroton (EPICS / EPICURE)

mover
HV

beam SSD

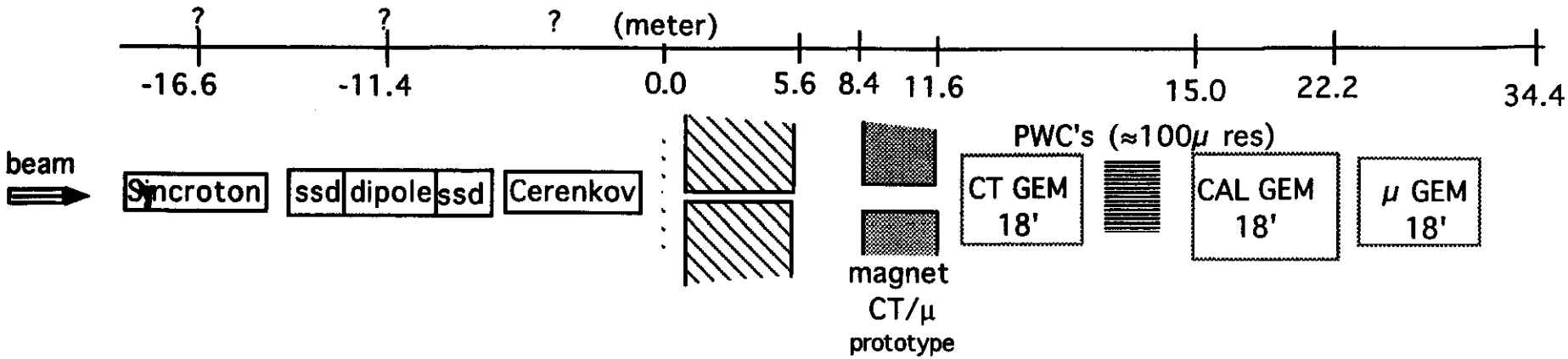
LV

miscelaneous scintillators

(veto hodoscope, beam trigger, ...)

HV

Most of HV from Le Croy (1440)



Dept. Phys. & Astr. U. of Rochester SWB-RL DWGNo TSP-6

Antonio Morelos 06Jul93

— DB of EPIC supported HW + SW

- safety system: need understands vv EPIC,
  - GEM ultimate responsible — not SSCL
  Ken ~~Ah~~ Schwartz + Woolsey.
  + PASS system (cf. Rich Perry)
  - this will probably choose a contractor
  - need schedule for EMS safety
    1 - 1½ yr for approval process