LIGO Control and Data System Control and Monitoring

LIGO NSF Review

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LIGO-G970091-00-C

LIGO Control and Data System Control and Monitoring

- Definition:

  ›› For design purposes, the LIGO CDS has been divided into 3 major components: Control and Monitoring, Data Acquisition and Interferometer Diagnostics.

  ›› The Control and Monitoring systems are designed as a Distributed Control System and provide and cabling, electronics hardware and software required to monitor and control each of the LIGO subsystems, i.e. vacuum, Interferometer subsystems, etc.

- Purpose of talk:

  ›› Present a general overview of the control and monitoring portion of the LIGO CDS

  ›› Present the conceptual designs for the ASC wavefront sensing and control and ASC video systems as an illustrative of how the various components of the LIGO CDS are being used to develop controls for the various LIGO systems.

LIGO Control and Monitoring
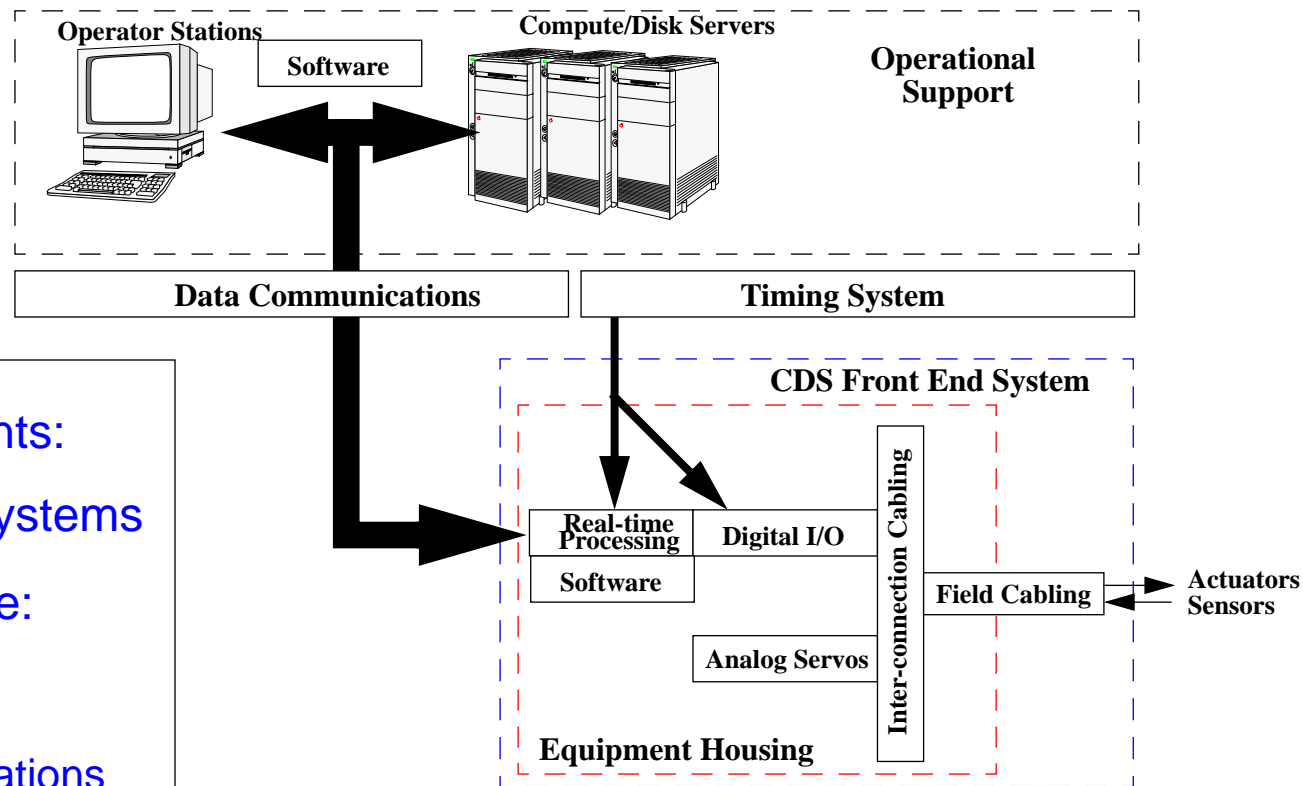
- **Major Components:**
  - ›› Front End Systems
  - ›› Infrastructure:
    - – Timing
    - – Communications
    - – Operations Support

Operator Stations

Compute/Disk Servers

Operational Support

Software

Data Communications

Timing System

CDS Front End System

Real-time Processing

Digital I/O

Inter-connection Cabling

Software

Field Cabling

Actuators Sensors

Analog Servos

Equipment Housing

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LIGO Front End Systems

- Front End I/O Bus- VME
- Real-Time Control Processors: present
  - ›› Heurikon Baja4700: MIPS based
  - ›› Motorola MVME162-333: 68040 based
  - ›› VxWorks operating system
  - ›› DSP based processors for advanced signal processing
- Analog Servos and Signal Conditioning
  - ›› Modules developed in 6U Eurocard format
  - ›› Field boxes for signal amplification and conditioning near sensors/actuators
- Equipment Housing
  - ›› 19 inch equipment racks
  - ›› interconnect wiring through DIN rail blocks on side of rack
  - ›› Critical signals routed directly

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LIGO CDS Infrastructure

- Timing System
  - ›› GPS based
  - ›› Antennas and receivers located at each building
  - ›› Time info available via the VME backplane
  - ›› slave units use IRIG-B connections
  - ›› Various clocks output via the front panel
- Communications
  - ›› ATM backbone: OC-3
  - ›› Direct fiber connections for reflective memory
  - ›› Video to ATM converters for video transmission

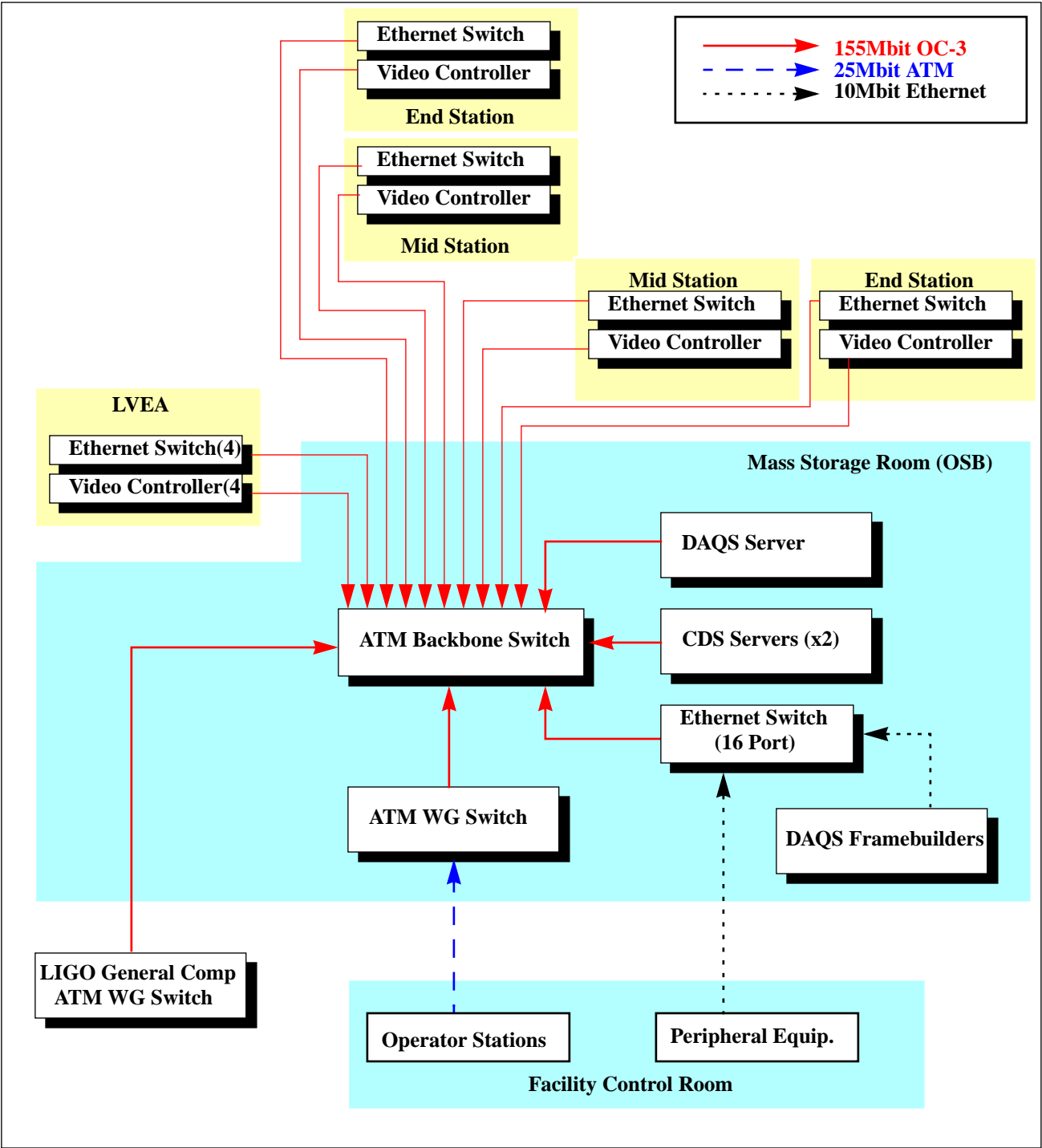# LIGO CDS Communications

**Figure 1: CDS Control and Monitoring Network**

LIGO CDS Infrastructure Operations Support

- Operator Stations
    - ›› Fixed Control Room Consoles
    - ›› Portable Operator Stations (laptops)
    - ›› Remote Access
- Computer and Mass Storage Area
    - ›› Control and Monitoring Server
    - ›› UPSs
- Human-Machine Interface
   - ›› MEDM
    - ›› SAMMI

LIGO CDS Infrastructure Operations Support

- EPICS provides:

  ›› Data Archival and Retrieval

  ›› Alarm Management

  ›› Save and Restore

- System Diagnostics are being developed for:
  ›› Status of CDS software modules
  ›› Status of CDS I/O modules
  ›› Status of CDS networks
  ›› Status of CDS mass storage systems

- Applications Programmer's Interfaces are used to interface other software and systems to the Control and Monitoring system.

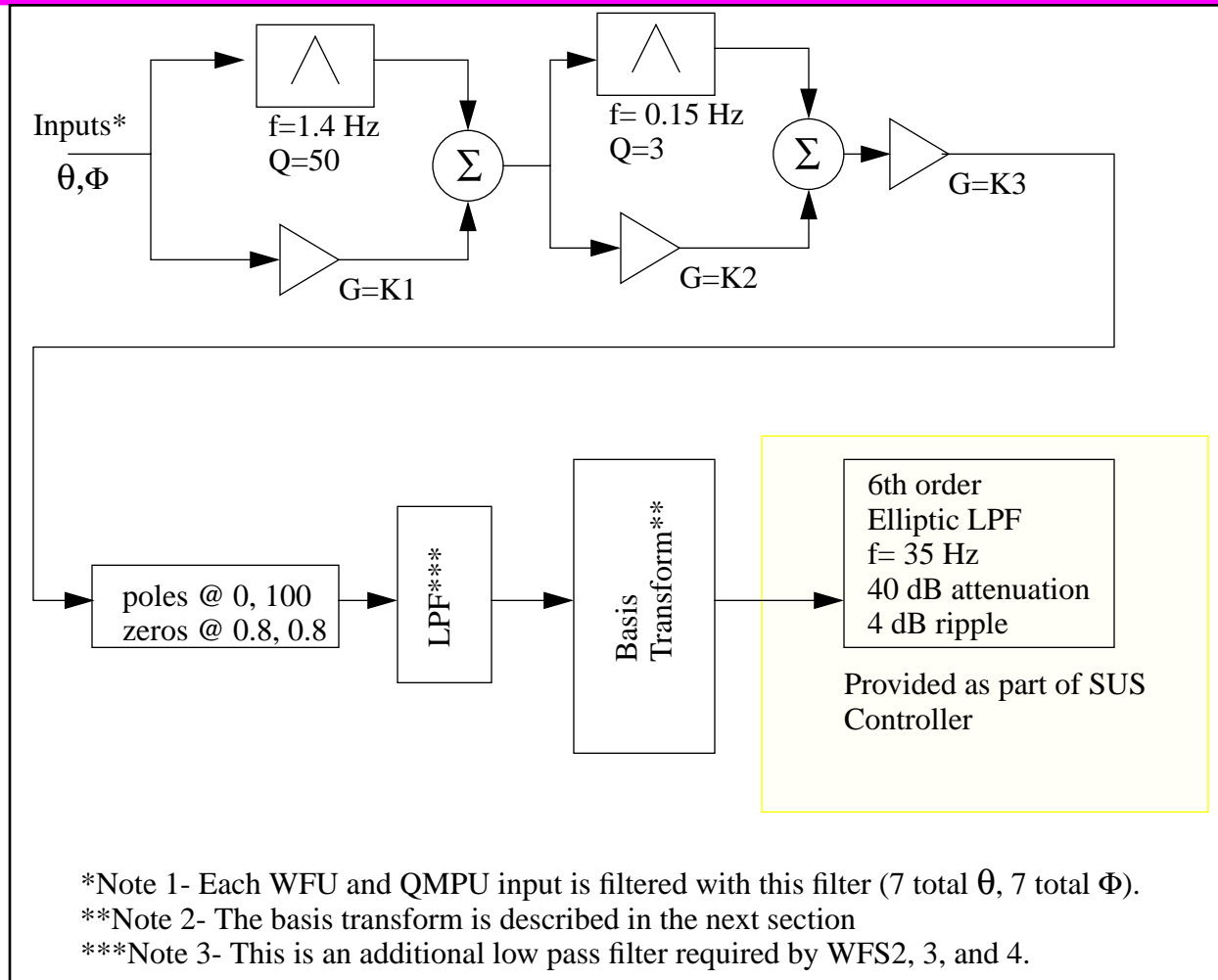LIGO-G970091-00-C

ASC Functional Layout

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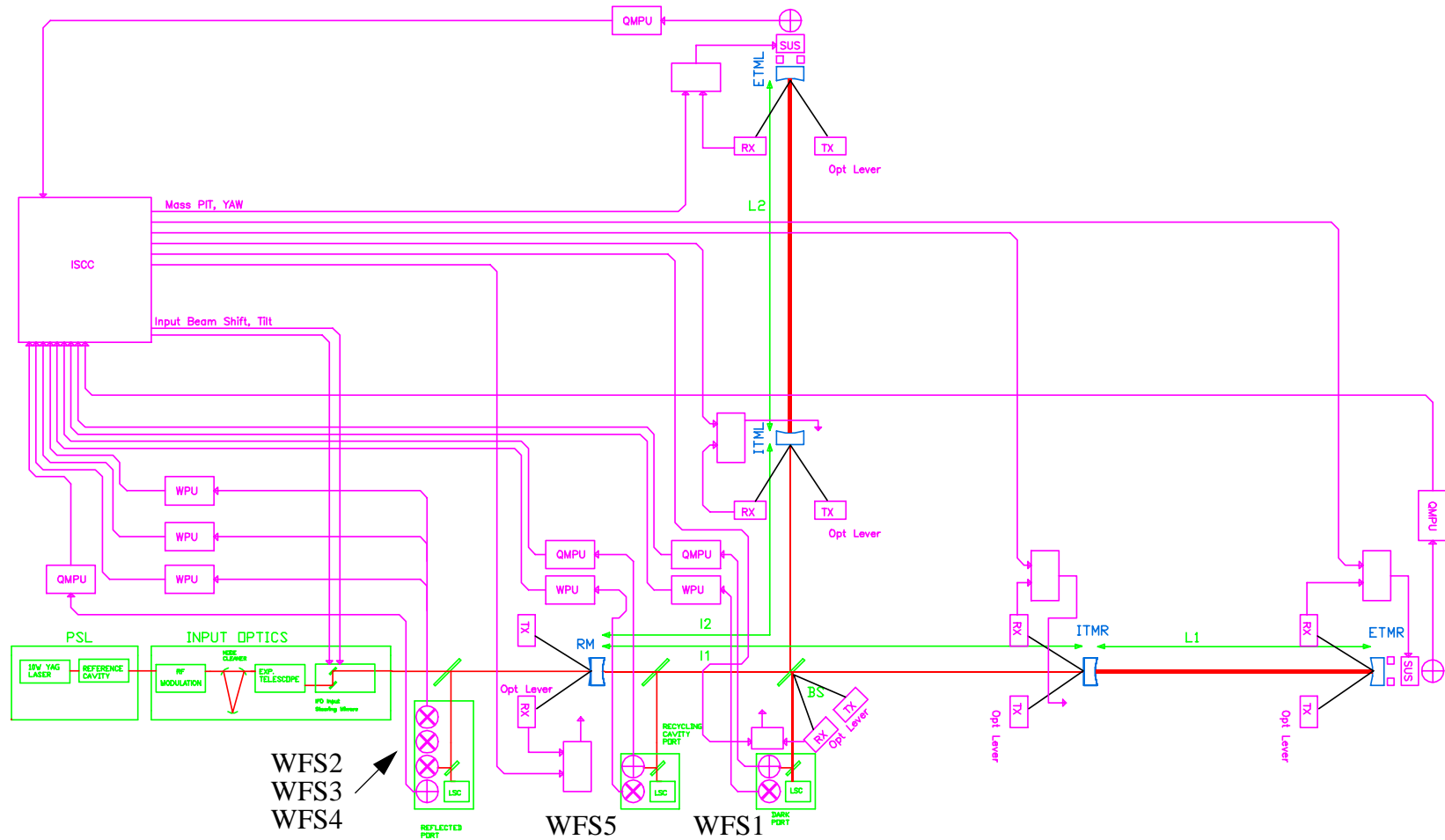
ASC Wavefront Processing Unit
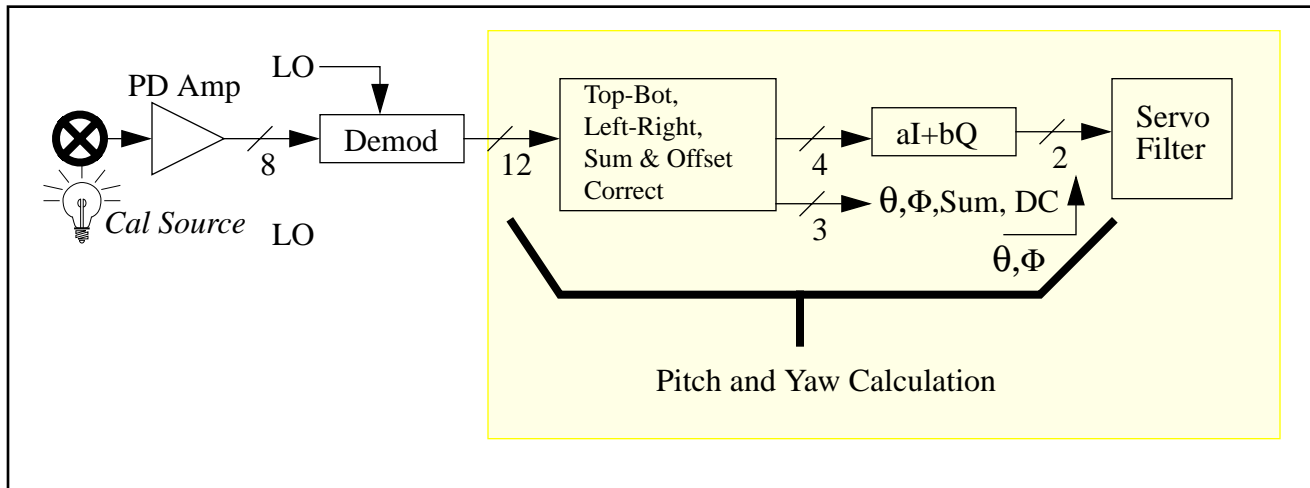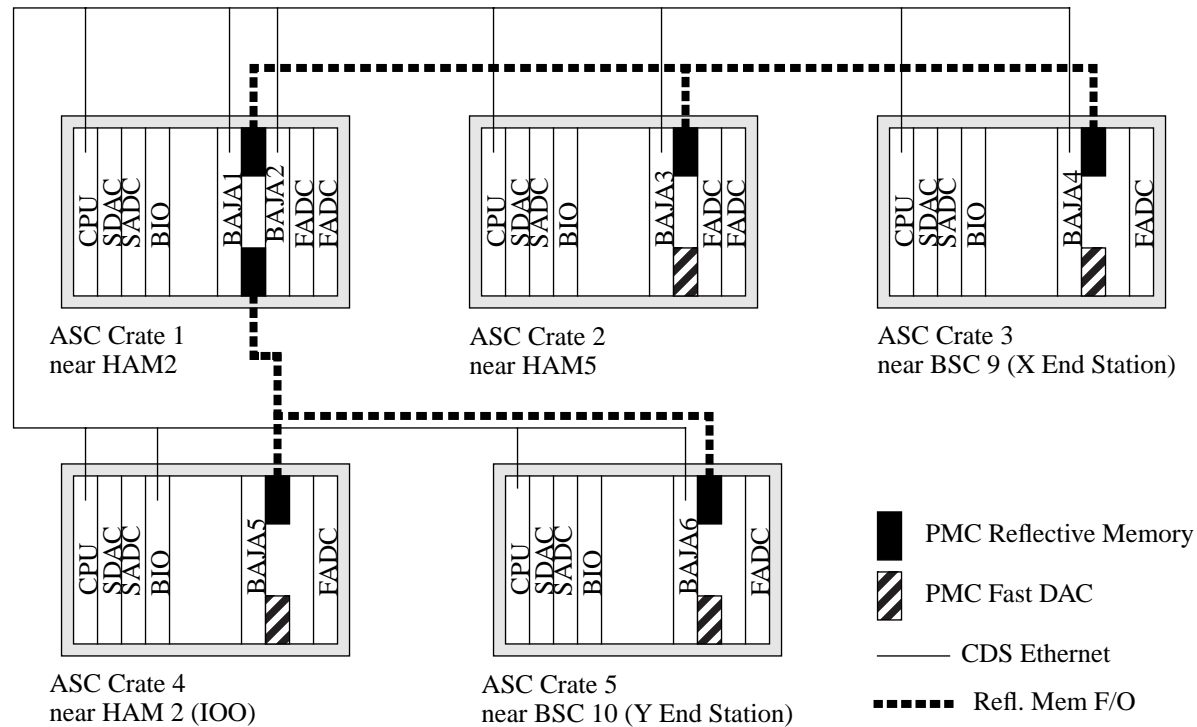

›› Photodiode amplifier located in field box near WFS head.

›› Demodulator module located in VME/Eurocard crate.

›› Pitch and yaw calculation, servo filtering and basis transformation implemented in software.

ASC Wavefront Servo Controller

*Note 1- Each WFU and QMPU input is filtered with this filter (7 total θ, 7 total Φ).
**Note 2- The basis transform is described in the next section
***Note 3- This is an additional low pass filter required by WFS2, 3, and 4.

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ASC CDS System Layout

ASC Crate 1
near HAM2

ASC Crate 2
near HAM5

ASC Crate 3
near BSC 9 (X End Station)

ASC Crate 4
near HAM 2 (IOO)

ASC Crate 5
near BSC 10 (Y End Station)

PMC Reflective Memory

PMC Fast DAC

———— CDS Ethernet

■■■■■■ Refl. Mem F/O

BAJA1 - WPU2 and Basis Transform
BAJA2 - WPU3 and WPU4
BAJA3- WPU5 and ITM output angles
BAJA4- X arm QMPU and X arm ETM output angles
BAJA5- WPU1 and RCM, BS and IB output angles
BAJA6- Y arm QMPU and Y arm ETM output angles

BAJA = Baja 4700 CPU
FADC = VMIC 3123
FDAC = VMIC 4116
SADC = TBD
SDAC = TBD
CPU = MVME 162-333
BIO = Binary I/O

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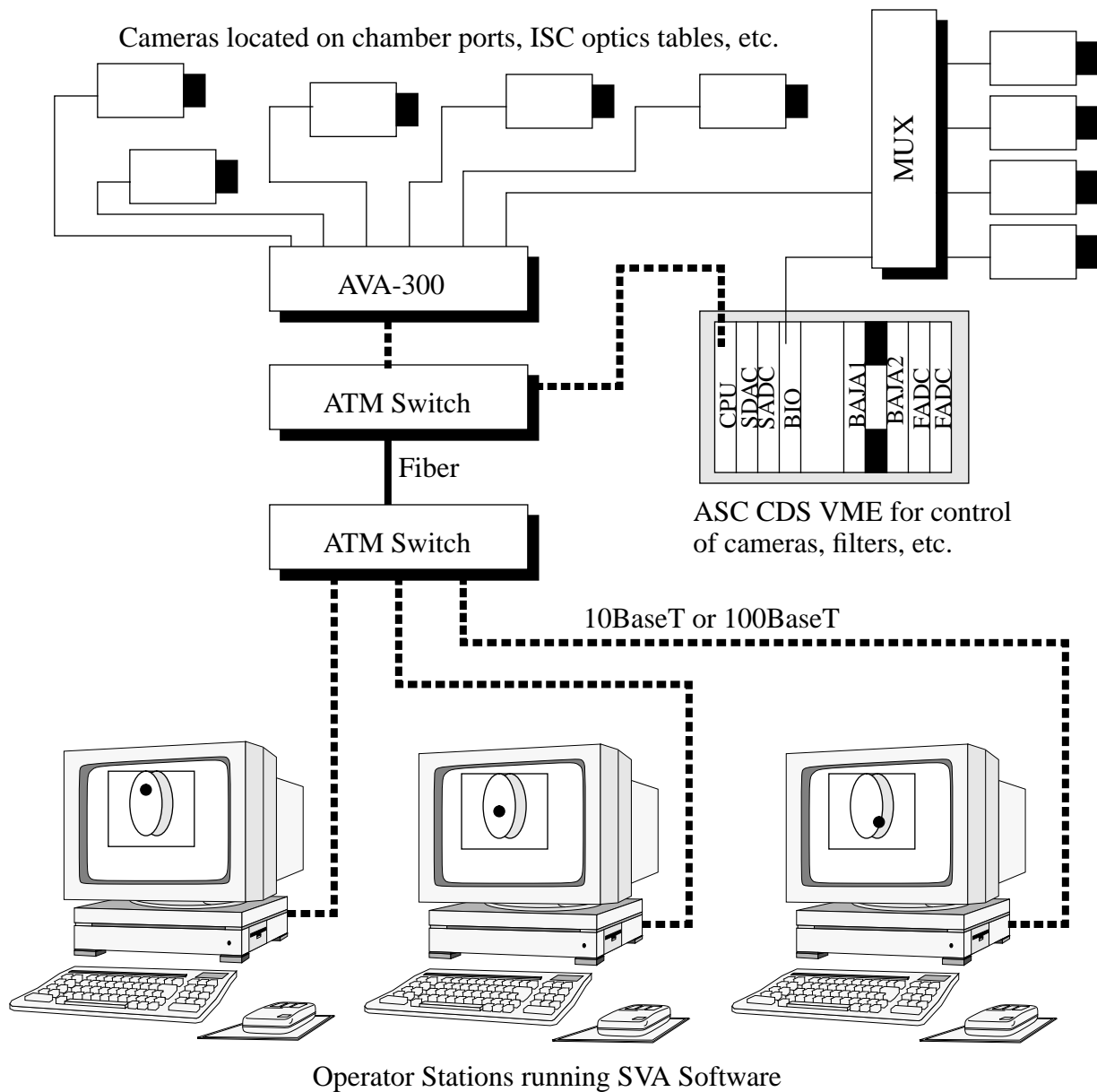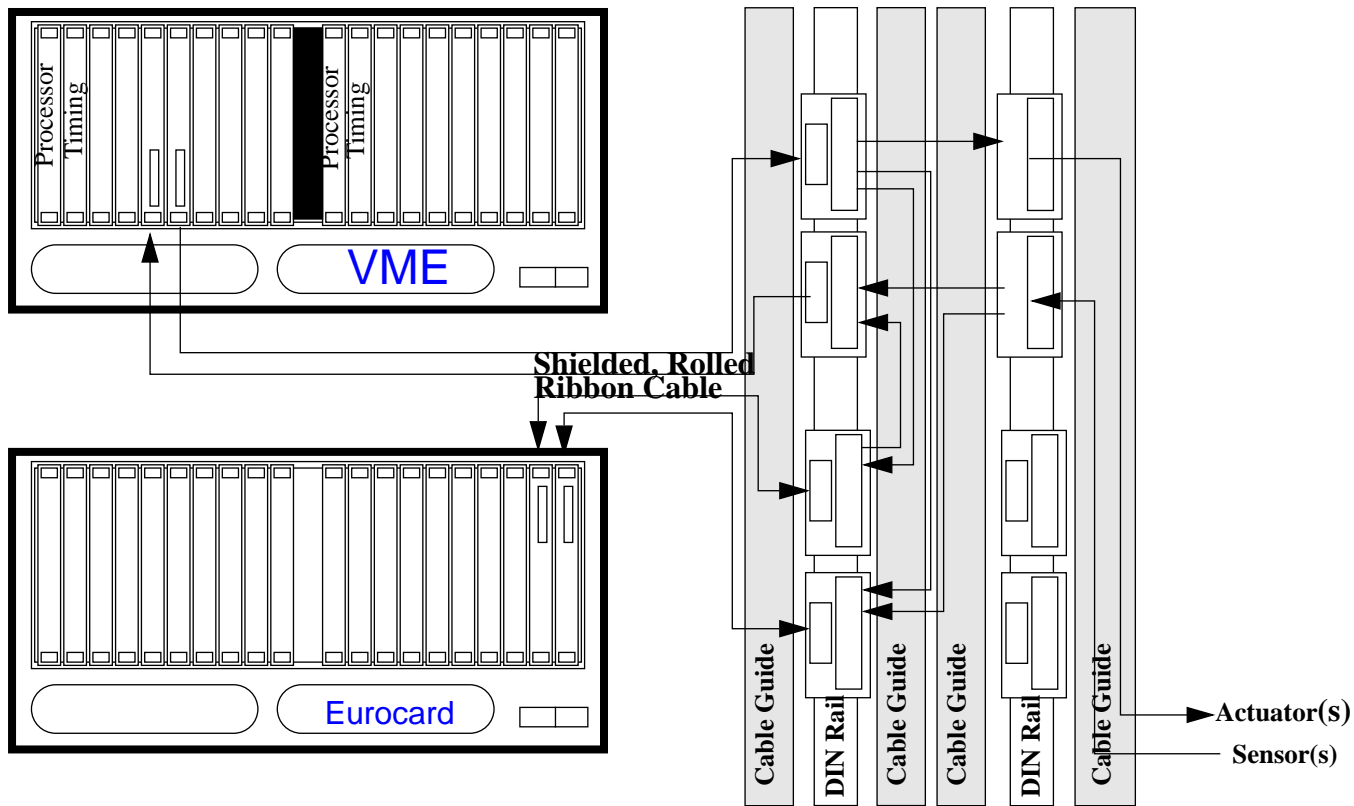
ASC CDS Camera Systems

Cameras located on chamber ports, ISC optics tables, etc.

MUX

AVA-300

ATM Switch

Fiber

ATM Switch

CPU
SDAC
SADC
BIO
BAJA1
BAJA2
FADC
FADC

ASC CDS VME for control
of cameras, filters, etc.

10BaseT or 100BaseT

Operator Stations running SVA Software

Figure 1: ASC CDS Camera Connections

LIGO CDS Front End Systems

Processor
Timing

Processor
Timing

VME

Eurocard

**Shielded, Rolled
Ribbon Cable**

Cable Guide

DIN Rail

Cable Guide

Cable Guide

DIN Rail

Cable Guide

Actuator(s)

Sensor(s)

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LIGO CDS Equipment Racks
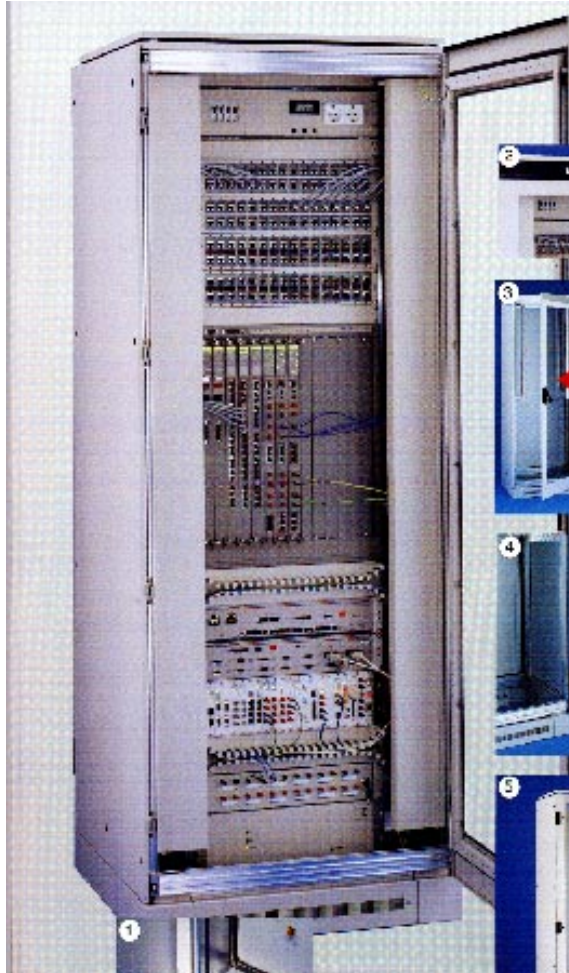
- Aluminum and sheet steel
- Dimensions: 31.5" x 35.4" x 84"
- Doors: Front/Rear/Side
- Side cable feed base
- 41U installation area (71.75")
- Load Capacity: 225 lbs.

LIGO CDS Timing Systems

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