End-Cap Alignment Data Acquisition Electronics

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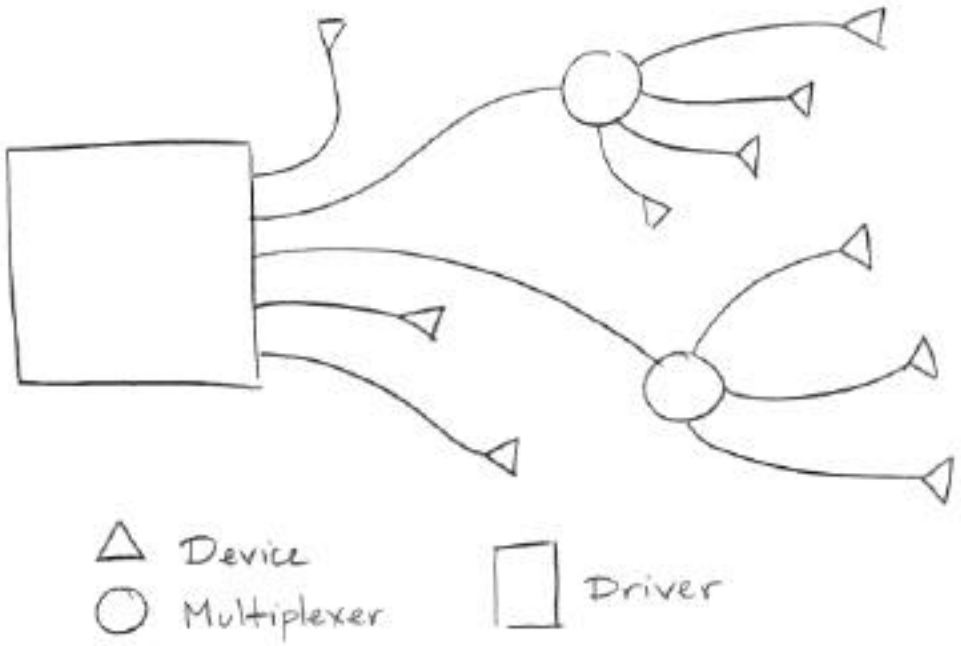
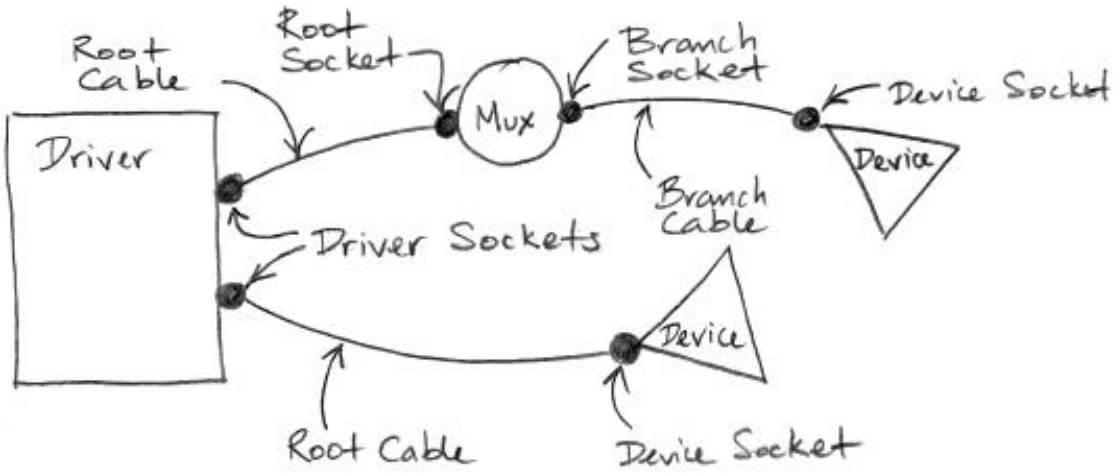
Long-Wire Data Acquisition System

General-purpose data acquisition system
Designed at Brandeis
Apply to ATLAS End-Cap Alignment



ATLAS: all devices connect to muxes

LWDAQ Components



All cables CAT-5 (8 wires)

up to 100 m long (solid core)

up to 30 m long (stranded core)

All plugs modular 8-way

Device and root sockets shielded

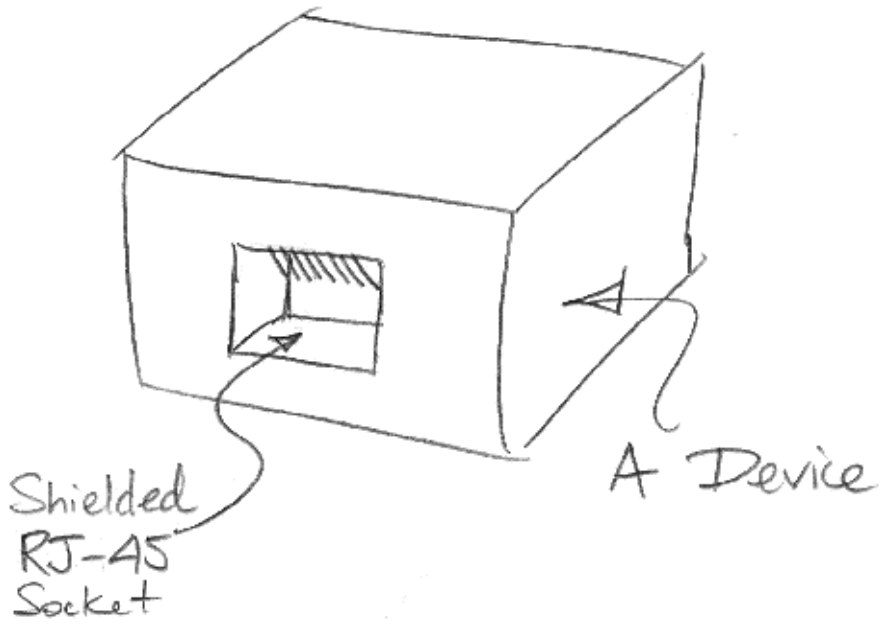
Branch and Driver Sockets unshielded

All power delivered by driver (4 wires)

All signals LVDS (4 wires)

No ground loops

LWDAQ Device



RJ-45 shield connects to chassis

Shield also connects to circuit 0V through:

- 1 kΩ or greater resistance
- 10 nF or smaller capacitance

Device can be ‘asleep’ or ‘awake’

- ATLAS: sleep power <50 mW
- ATLAS: awake power up to 3 W

Receives a 16-bit command in 4 µs

Returns LVDS analog or digital data

Example Devices

Inplane Sensor Head (A2036):

- 1 CCD

Proximity Mask Head (A2045):

- 1 LED array

BCAM Head (A2038):

- 2 CCDs
- 4 lasers

Bar Head (A2044):

- 2 CCDs
- 2 LED arrays
- 4 platinum RTDs

LWDAQ Cable

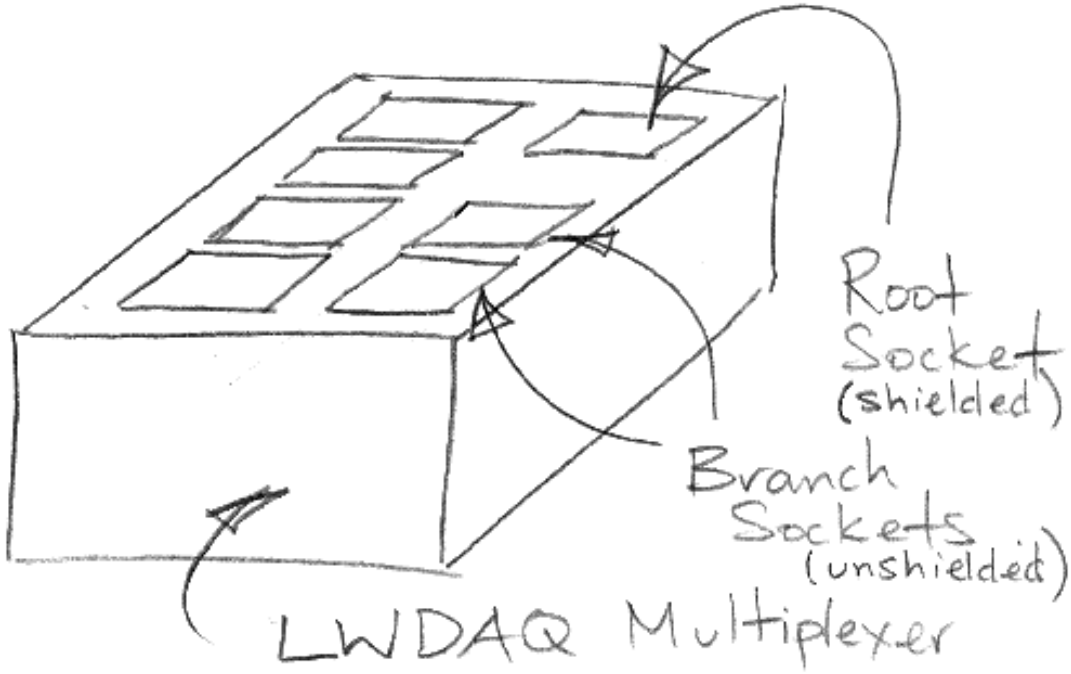
ATLAS device cables:

- from devices to multiplexers
- stranded core (more flexible)
- foil shield
- up to 20 m long
- boots used for color-coding
- standard cable, vendor chosen
- $60 per 100 m

ATLAS root cables:

- from multiplexers to drivers in USA15
- solid core (lower dispersion)
- foil shield
- up to 100 m long
- special-order cable, vendor chosen
- $60 per 100 m

LWDAQ Multiplexer



Root socket shield connects to chassis

Shield also connects to circuit 0V through:

1 kΩ or greater resistance

1 µF or smaller capacitance

Can provide up to sixteen branch sockets

Receives a 16-bit addresse in 4 µs

Example Multiplexers

Device Multiplexer (A2030):

- 12 branch sockets
- prototype multiplexer

Chamber Multiplexer (A2046):

- 10 branch sockets
- mounts on chamber HV cross plate
- 135 mm x 55 mm x 20 mm
- power consumption <300 mW
- all inputs and outputs diode-clamped

Long Bar Multiplexer (Planned Jan-03):

- 16 branch sockets
- mounts on long alignment bars
- 200 mm x 55 mm x 20 mm

LWDAQ Driver

Provides one or more driver sockets

Transmits commands to devices

Transmits addresses to multiplexers

Coordinates data acquisition

- provides timing for CCD readout
- measures propagation delays
- compensates for propagation delays
- times source flashes

Digitizes returned analog data

- 16-bit ADC, 100 kSPS, 10 kHz filter
- 8-bit ADC, 40 MSPS, 10 MHz filter
- 8-bit ADC with clamp, 2 MSPs

Stores digitized data in on-board RAM

Monitors device power supplies

Example LWDAQ Drivers

Prototype Driver (A2031):

- 6U VME board
- prototype driver
- 10 driver sockets
- no 16-bit ADC
- no power monitoring

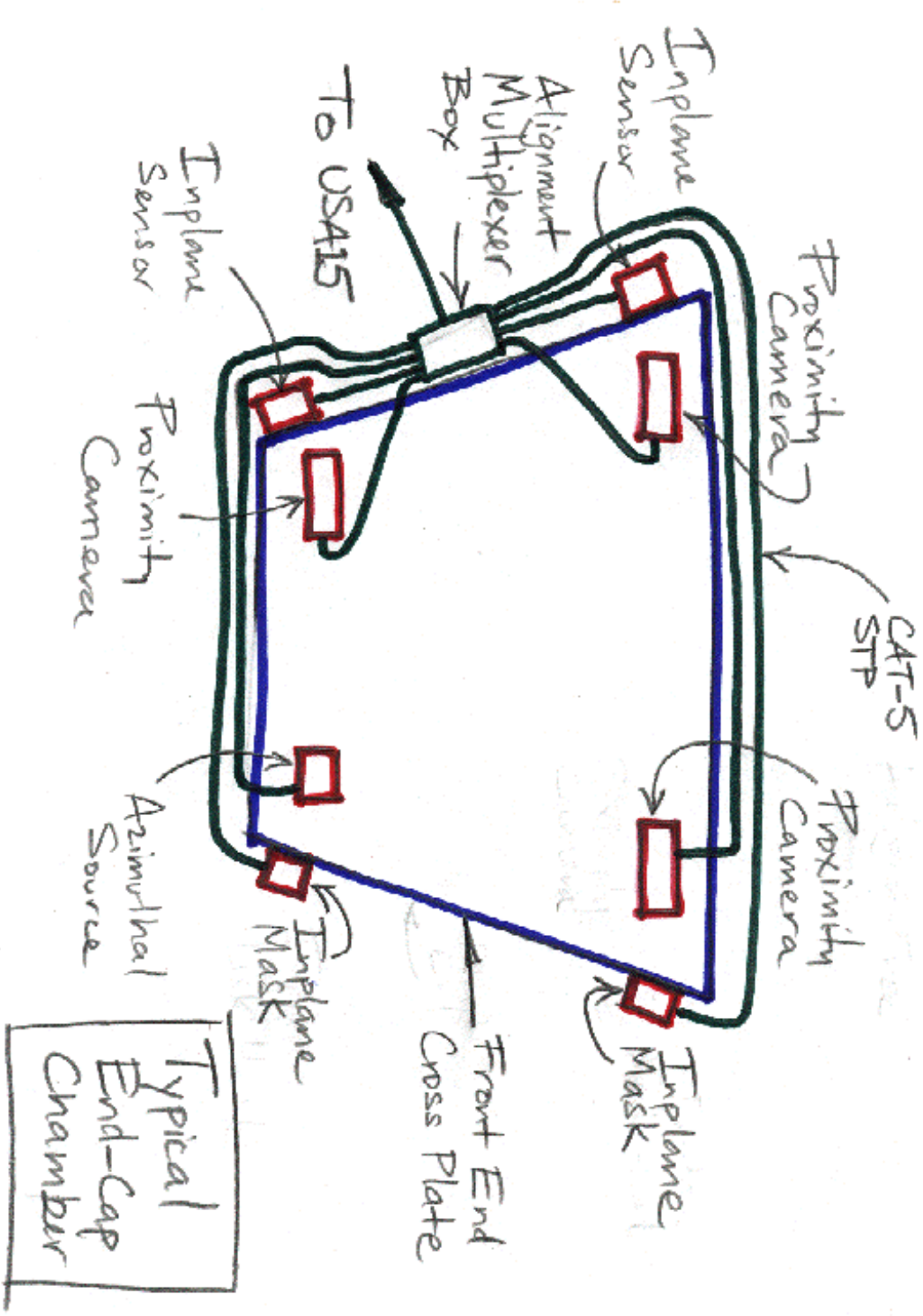
ATLAS Driver (A2037):

- 6U VME board
- 8 branch sockets
- in production

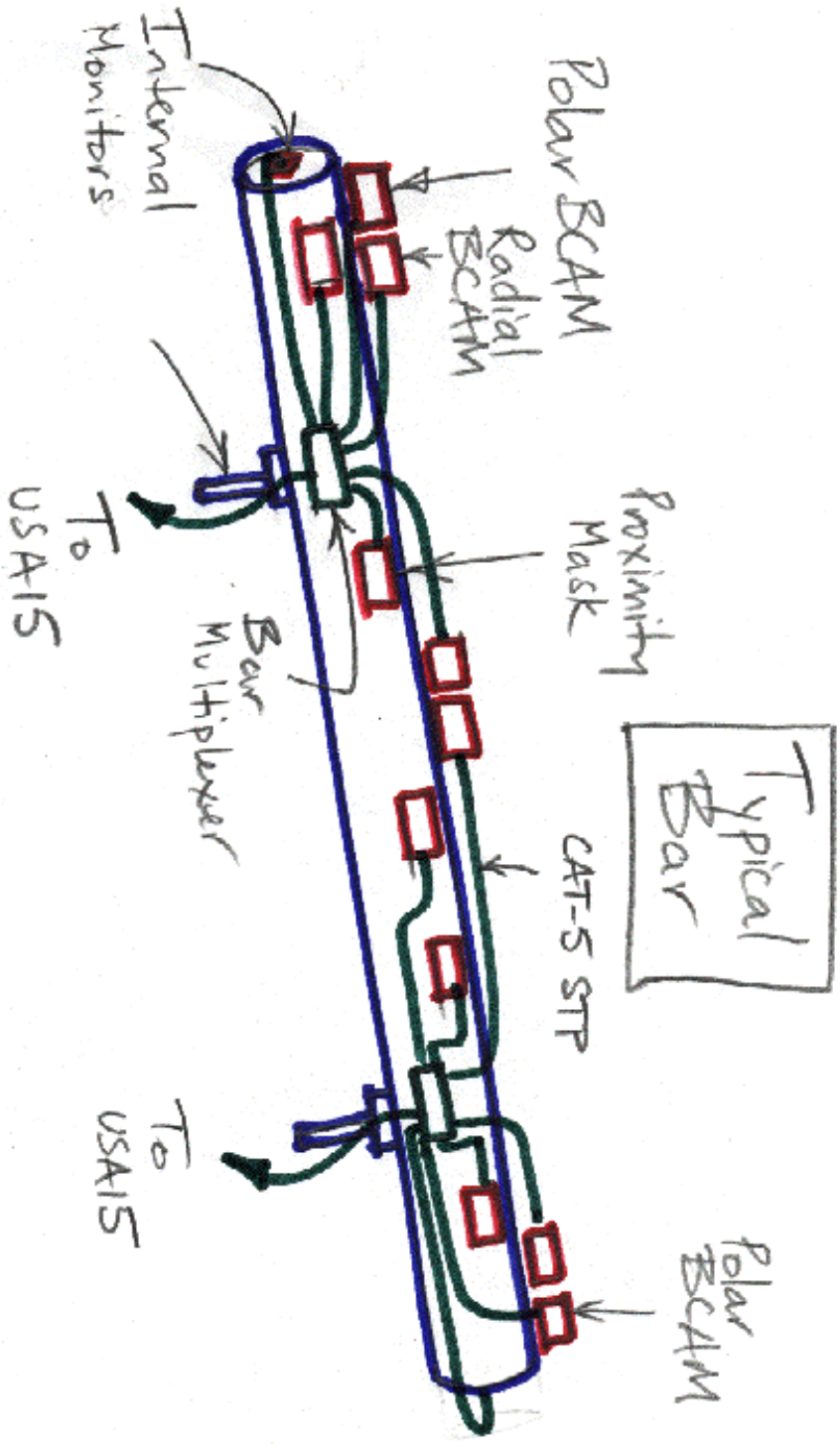
Portable Driver (Planned for Apr-03):

- 8 driver sockets
- ethernet TCP/IP interface
- power from AC adaptor

MDT Chamber DAQ



Alignment Bar DAQ



Detector Architecture

Devices in full system ≈ 5500

Multiplexers in full system ≈ 700

- 2 per bar, 96 bars
- 1 per chamber, 512 chambers

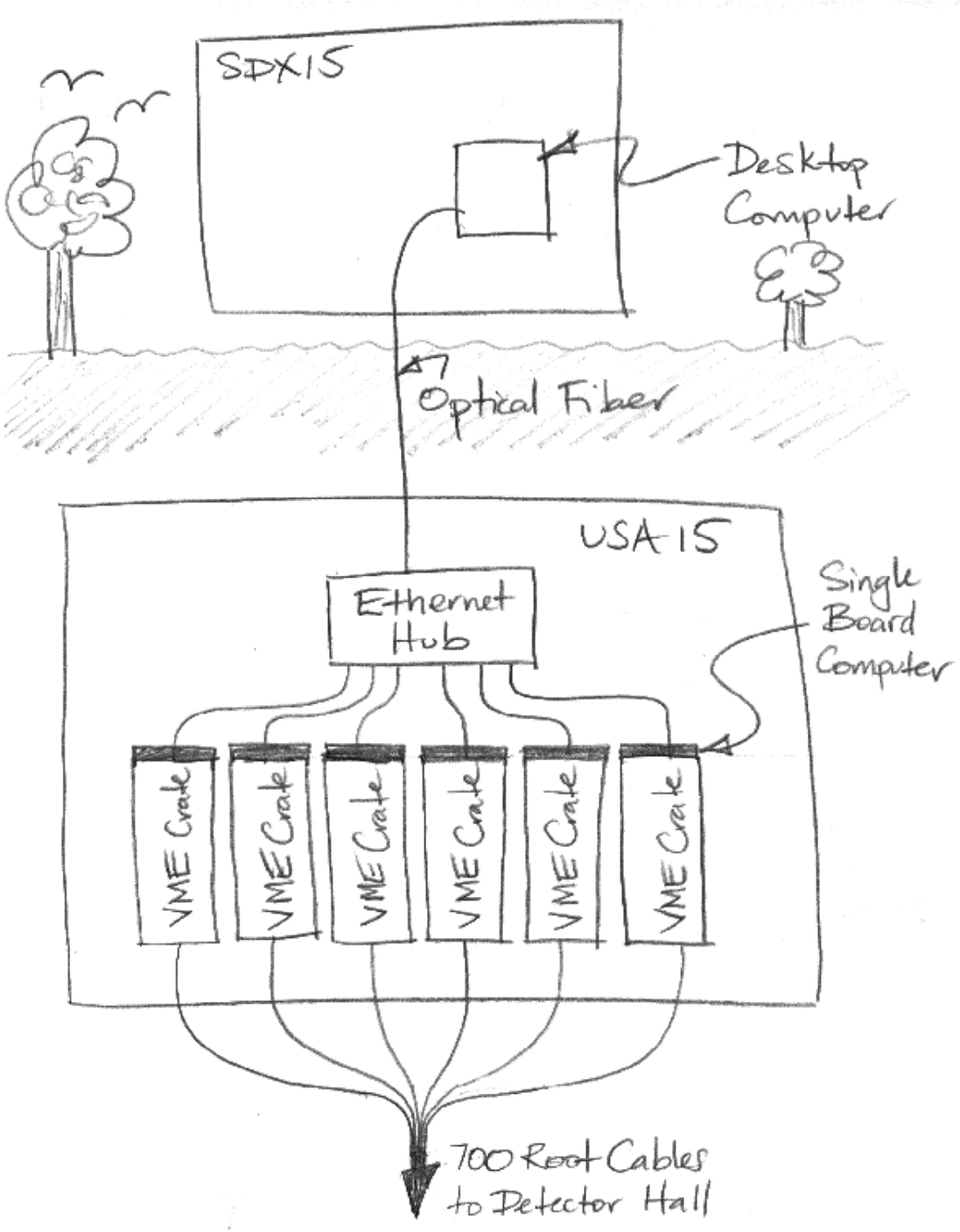
Full system power < 500 W

- <50 mW per device
- <300 mW per multiplexer
- duty cycle <0.1%

Root cables in full system ≈ 700

- 1 per multiplexer
- root cables to USA15

USA15 Architecture



Noise Tests

Apparatus

Harvard test chamber

inplane alignment system

shielded and unshielded LWDAQ cables

Procedure

Captured live images

Flashed LED arrays

Varied MDT readout threshold voltage

Arranged cables

Effect

No effect on MDT background hit rate

Can run LWDAQ cables anywhere

Radiation Tests

Neutrons: (1 Tn = 10^{12} 1-MeV eq n cm^{-2})

0.2 Tn max in end-cap (EI)

LEDs 90% power loss at 10 Tn

TC255P dark current high at 10 Tn

Laser diodes unaffected at 10 Tn

All other components >10 Tn

Ionizing: (1 Gy = 100 rad)

100 Gy max in end-cap (EM)

TC255P image sensor >1000 Gy

74VHC logic >1000 Gy

SN65LVDS180 >1000 Gy

DG411 analog switch ~1000 Gy

MAX6329 regulator ~300 Gy

EL2244 op-amp >1000 Gy

Radiation Strategy

Neutron Damage:

Fast image readout

Laser light sources

Ionizing Damage:

Diode-transistor regulator

Anticipate switch leakage current

Single Event Upsets:

Anticipate latch-up

Additional Safeguards:

In-situe anneal of device heads (≈60 C)

Power on-off to shift trapped charges

Summary

LWDAQ working at H8

No known problems with design

ATLAS cables selected

ATLAS drivers in production

ATLAS multiplexers in production

USA15 and SDX15 architecture decided

Spare capacity: two sockets per chamber