MTA Instrumentation

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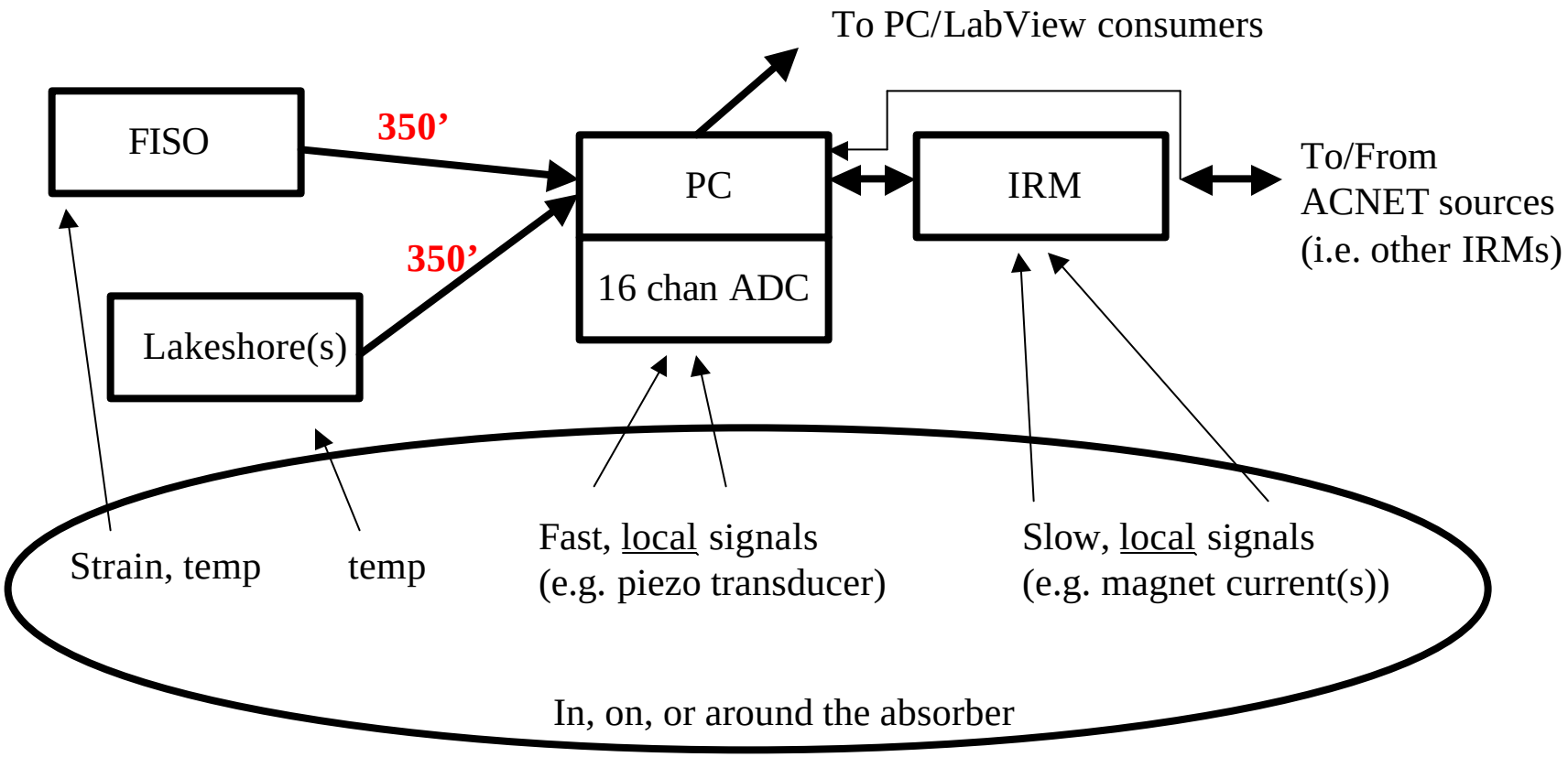
MTA Instrumentation Data Paths



Signals inside (the cryostat)

- 32 (cryo) temperatures
  - 16 sensors inside absorber, 16 outside
    - Front and back faces
  - readout via Lakeshore 218S(s), GPIB + LabView (PC)
- Multiple fibers
  - FISO fiber optic channels (4 fibers)
    - strain, temperature
  - Laser occlusion (2 fibers)
    - Edgar Black looking at a scheme using standard data fibers…

(more) Signals inside

- Piezo vibration sensor
  - Available channel, but no sensor
  - Readout via (16 chan/12 bit) ADC and LabView (PC)
- Local (64 chan/16 bit) IRM channels
  - Readout via LabView

Signals outside

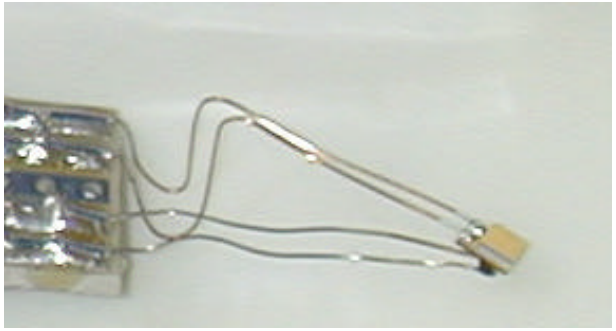
- Many voltages, currents, temperatures, pressures
  - magnets, beam position monitors, etc.
  - Most available from local IRM or ACNET (other IRMs)
    - via LabView
  - or Quadlog-PLC
    - Dedicated controller(s) used by Cryo system

Instrumentation (1)

- Lakeshore 218S
  - 8 channel cryo temperature monitor
    - 20mV (diodes) or 50 mΩ (RTD) resolution
      - 10's of mK at 20K
  - 16 readings/s (/channel)
  - GPIB interface (to PC)
  - 4 units in-hand (and a spare)
    - Will need to consider (re)calibration protocols

Instrumentation (2)

- CX-1030-SD Cernox RTD sensors (12)
  - -6.7 Ω/K at 20K (e.g. calibrated device X28829)
  - Better suited for lower temperatures
  - Recommended for use in magnetic fields (B<19T)
  - Rad hard
- CX-1050-SD Cernox RTD sensors (24)
  - -25 Ω/K at 20K (e.g. calibrated device X27990)
  - Fermi “favorite”
- Also
  - TG-120PL GaAlAs diodes (4)
    - -180mV/K at 4.2 K
    - for B < 5 T, but no longer claimed to be rad hard…



Instrumentation (3)

- FISO Fiber-optic strain and temperature
  - BUS chassis, with 4 (up to 8) modules
    - 1000 readings/s
    - RS-232 interface (to PC)

- FOS-N strain sensors
  - +/- 5000 με; 0.01% full scale; 0.2mm O.D.
- FOT-L temp sensors
  - 0.1 K resolution; 1.5mm x 32mm (10mm active)
  - Slow: 1.5 second response…

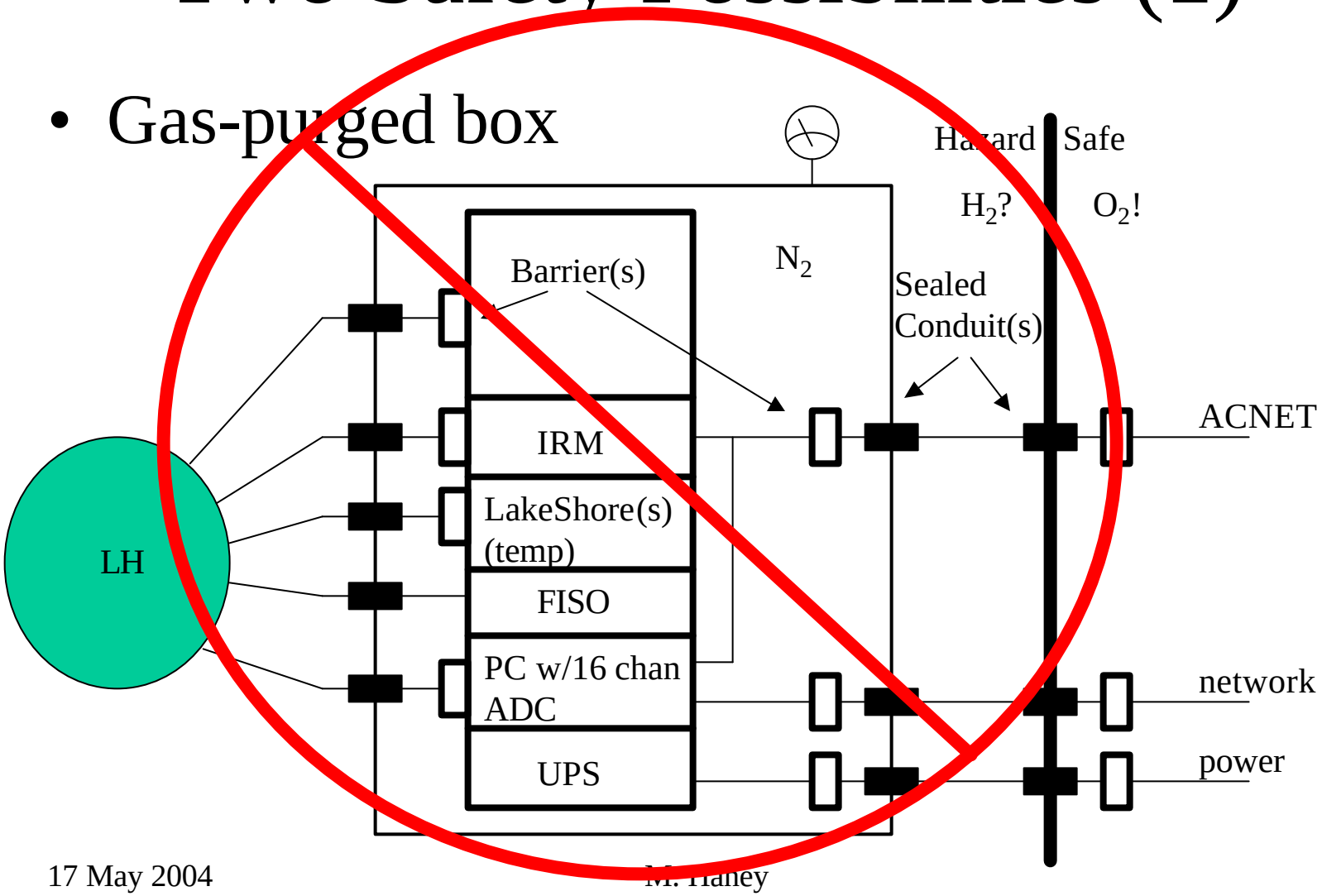
Instrumentation (4)

- Gateway E-4000 PC
  - 1.8 GHz, 1Gbyte RAM, 0.5Gbyte cache
  - 120Gbyte disk, Windows 2000
  - 15” LCD flat panel display
  - 640x480 CCD camera, microphone

- PCI-MIO-16E-1
  - 16 channel ADC, 1.25 Msample/s, 12 bits, +/-10 V
- Tripplite Internet Office UPS
  - 500 VA
  - 30 minutes (nominal) power for PC
    - But mostly intended as power filter for Lakeshore 218’s

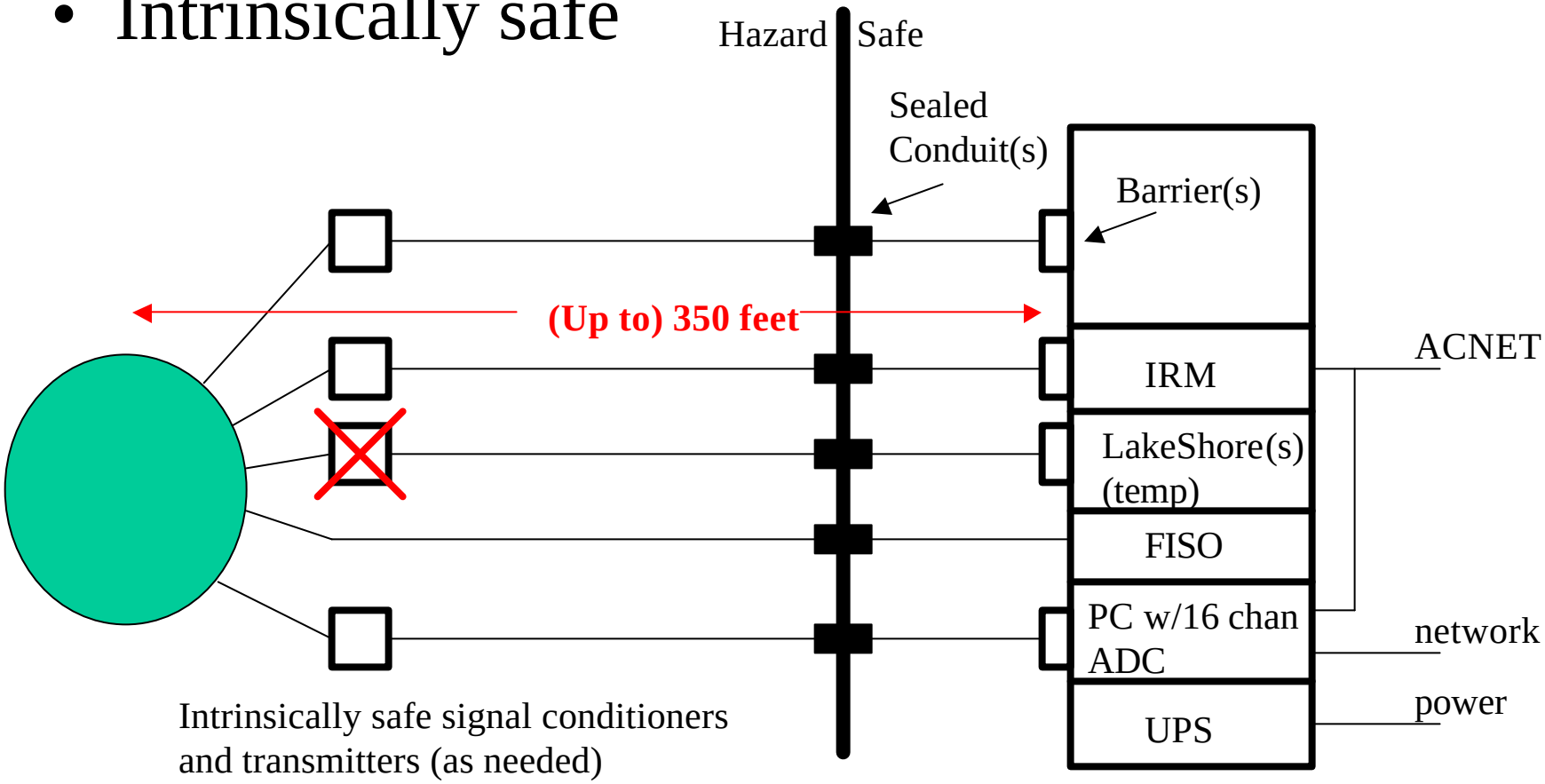
Two Safety Possibilities (1)

- Gas-purged box

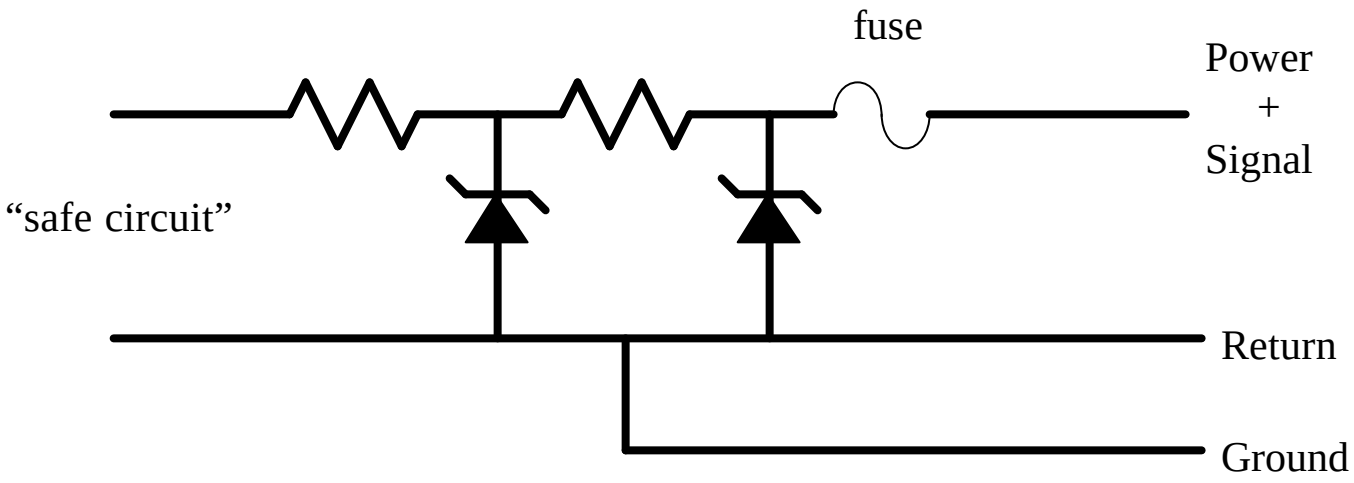


Two Safety Possibilities (2)

- Intrinsically safe



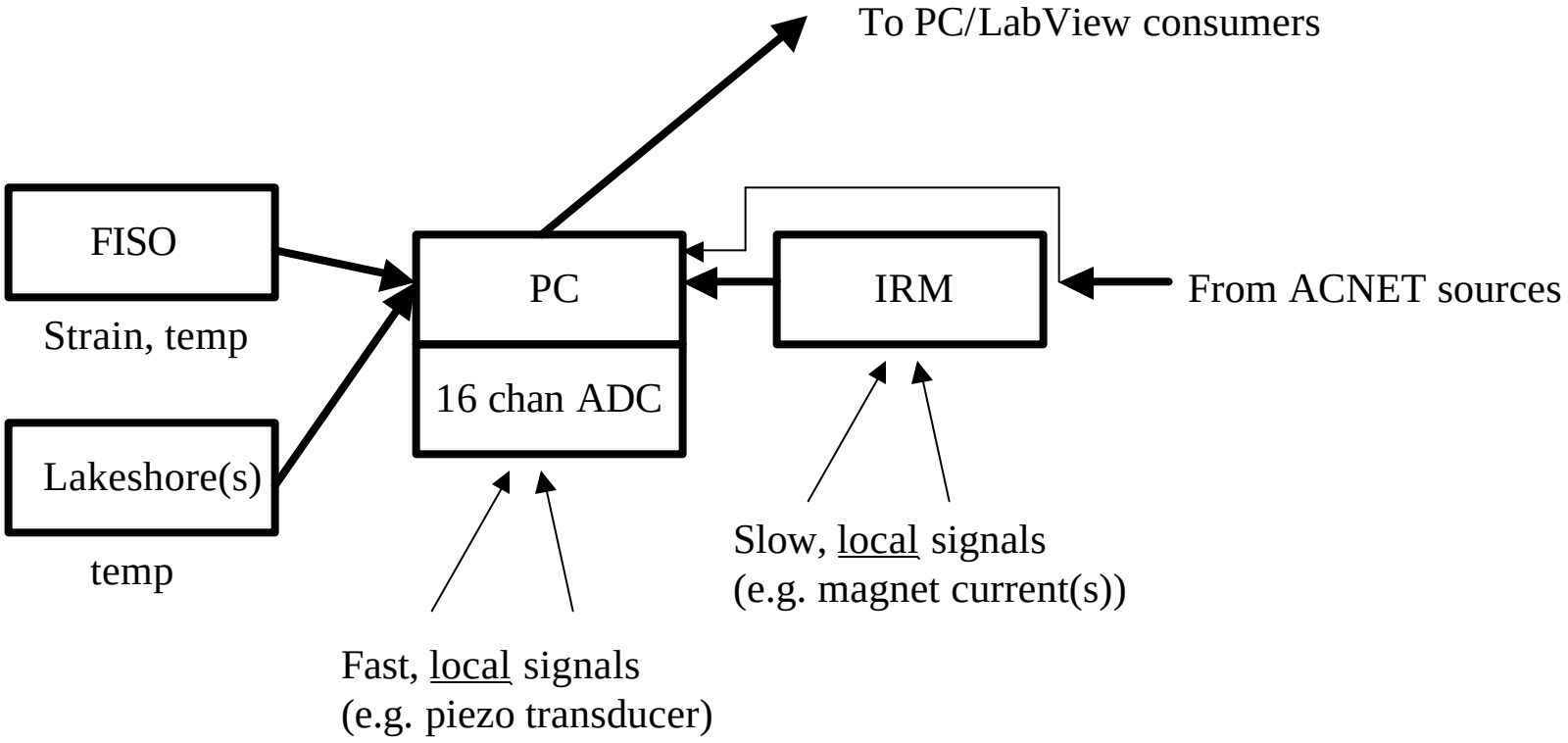
(basic) Barrier



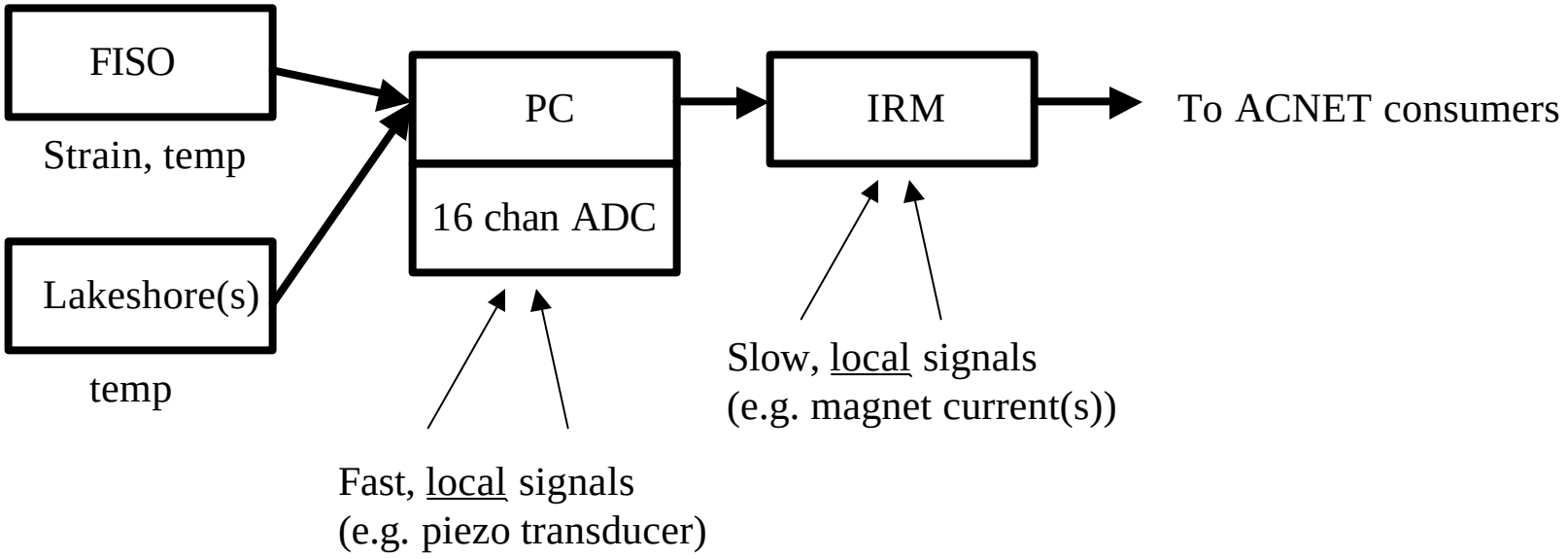
Instrumentation (5)

- MTL7055ac barriers
  - Low level AC
    - 24 Ω per line
    - 3 V max
- MTL7060ac barriers
  - Star-connected AC
    - 101 Ω per line
    - 8.5 V max

MTA Instrumentation: Data Paths: LabView Perspective

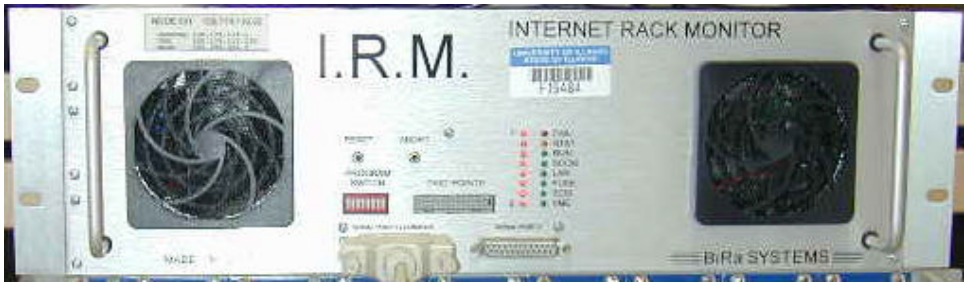


MTA Instrumentation: Data Paths: ACNET Perspective



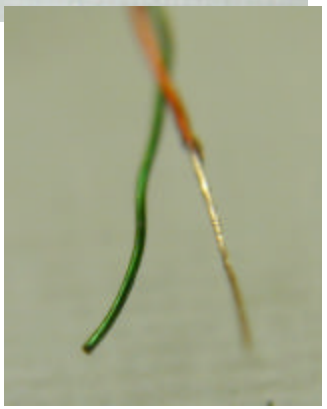
Instrumentation (6)

- IRM
  - 64 channel multiplexed ADC
    - 16 bit, 100 Ksamples/s
  - ACNET network connection
    - All PC data will be posted to IRM for ACNET access



Wire Considerations - inside

- QuadTwist
  - 2-pair, 36 AWG phosphor bronze
  - Formvar insulated, color-coded
  - Compared to 32 AWG manganin
    - QT is pre-twisted, color coded pairs, 0.63 smaller, yet 0.6 less DC resistance(!)
    - But, QT has 1.9 greater thermal loss, and end-prep is (somewhat) delicate work
      - If I can do it, it can't be that delicate…



Internal Shielding

- Stainless steel (36 AWG) drain, with foil around pairs
  - See next slide (foil+drain)
- Stainless steel braid around all
  - Easier to handle than stainless conduit

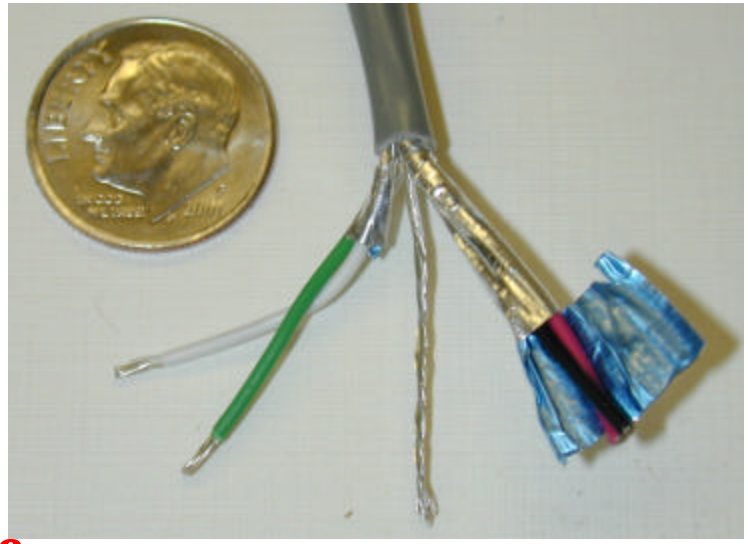
Mr. Gasket Steel Braid Hose Cover Kit (Blue)
Part: Mr. Gasket 8091

Braided stainless steel look for less. Blue anodized aluminum, Flex-Braid engine kit

This Dress Up Kit combines Flex-Braid stainless steel-style hose sleeving with aluminum Pro-Hex hose clamp covers. This kit includes:

3 ft. of vacuum line sleeving
4 ft. of fuel line sleeving
12 ft. of heater hose sleeving
4 1/2 ft of radiator hose sleeving
4 blue fuel line fittings
4 blue heater hose fittings
2 blue upper radiator hose fittings
Shrink sleeves for vacuum line

Wire Considerations - outside



- Shielded twisted pair
  - Using 2-pair here
    - foil-out, common drain
  - Recommend

    Belden 9332 (8 runs)
    - **Power Limited Tray Cable**
    - **9-pair, 22AWG, foil-in, drain-per-pair**
      - Consistent with Lakeshore 218 shielding
        - » 4-wire measurement, shield-per-pair

Fiber

- For FISO sensors
  - 50/125, multimode
  - **Recommend L-Com FOB500B2-M (4 runs)**
    - **2-fiber bulk breakout**

BREAKOUT CABLE

- Number of Fibers: 2, 4, 6, 12. Other fiber counts available by custom request
- Jacket: Plenum - OFNP rated
- Operating Temperature: -20°C - +70°C
- Indoor or Outdoor Use

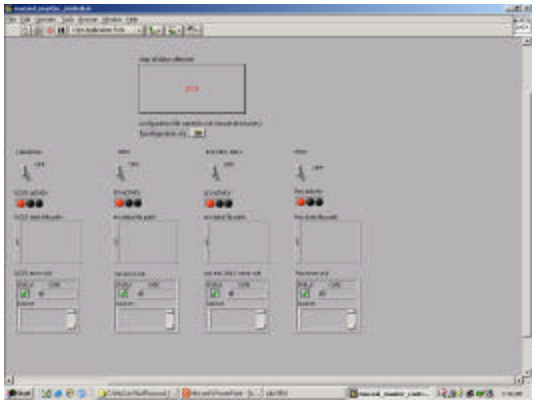
Breakout cable is the most user friendly because each fiber has it's own jacket and aramid strength elements. Due to this, each fiber is extremely strong and rugged. Breakout fiber is also very stiff.

Item #	Description	Price/m
FOB625B2-M	1 meter interval 2 count 62.5/125 bulk breakout	2.50
FOB625B4-M	1 meter interval 4 count 62.5/125 bulk breakout	4.50
FOB625B6-M	1 meter interval 6 count 62.5/125 bulk breakout	6.50
FOB625B12-M	1 meter interval 12 count 62.5/125 bulk breakout	12.50
FOB500B2-M	1 meter interval 2 count 50/125 bulk breakout	2.50
FOB500B4-M	1 meter interval 4 count 50/125 bulk breakout	4.50
FOB500B6-M	1 meter interval 6 count 50/125 bulk breakout	6.50
FOB500B12-M	1 meter interval 12 count 50/125 bulk breakout	12.50
FOBSNGB2-M	1 meter interval 2 count 9/125 bulk breakout	1.96
FOBSNGB4-M	1 meter interval 4 count 9/125 bulk breakout	3.45
FOBSNGB6-M	1 meter interval 6 count 9/125 bulk breakout	4.96
FOBSNGB12-M	1 meter interval 12 count 9/125 bulk breakout	8.85

End

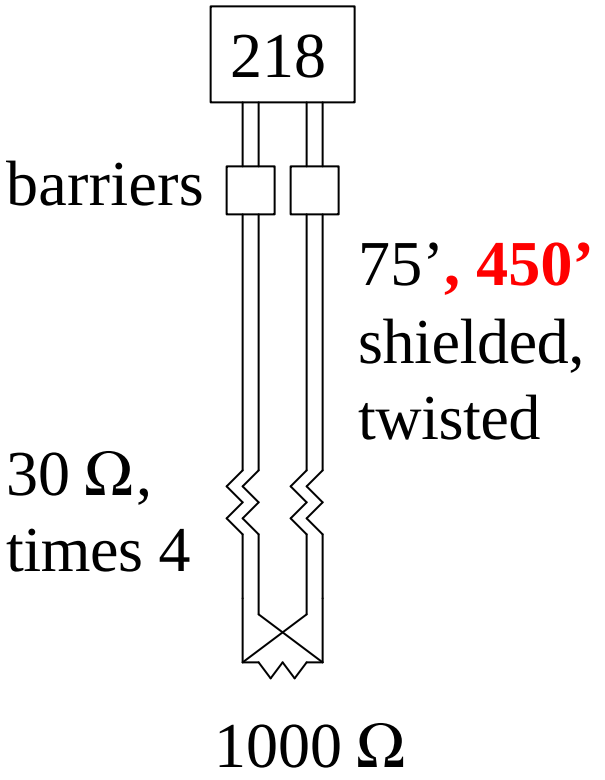
Status

- Hardware acquired
  - PC, FISO, Lakeshore (temp) +sensors, IRM, etc.
    - All major items in-hand
- Software written
  - IRM communications: to, from
  - Lakeshore readout
  - FISO readout
    - All major elements written and integrated
      - For one Lakeshore 218…
- Intrinsically safe solutions (barriers)



Testing

- Lakeshore 218 monitor
- MTL7055ac (low level) and MTL7060ac (star-connected)
  - Intrinsically Safe Barriers
- 23m (75 ft) of shielded twisted pair **(repeated with 75+375 ft)**
  - 2-pair, 22 AWG, belfoil (out), common drain
    - $76/500ft from Digikey
- 30 Ω on each of the 4 wires,
  - to mimic 2m of 32 AWG manganin wire
    - Lakeshore MW-32
    - 13.5 Ω/m at 4.2K, 14.3 Ω/m at 77K
- 1000 Ω load resistor
  - Compare to CX-1050-SD-4L
    - @14.000K, R = 819.7521 Ω; dR/dT = -50.16117 Ω/K
    - @20.000K, R = 607.6232 Ω; dR/dT = -25.14299 Ω/K



Results

- Cleanliness is paramount!
  - 10 μA excitation, so nanoamps of leakage are significant!
- **Shielding is vital**
  - **Strong sensitivity to HBM interference if shield not connected**
- Worst-case deviation: 0.5 Ω
  - 1000 Ω on back of 218, *vs* full test setup
    - At dR/dT = -25.14299 Ω/K …
    - 0.0199 K (systematic) error

Other/Work in Progress

- Recently acquired
  - Keithley 7001 switch mainframe, 7013s isolated switch module
- **Recently purchased**
  - Keithley 2700 6 ½ digit multimeter
- Goals
  - Confirm quantitative cleanliness (little/no leakage)
  - Confirm (non)effect of thermoelectric (junction) voltages

Backup Slides

Open Issues

- Wire+Shielding Concerns
  - Cable plant into solenoid
    - Shielded-twisted pairs (two pairs per Cernox)
      - Shield drains carried from Lakeshore(s) to sensors (not grounded)
    - Grounding
      - Details depend on overall MuCool grounding scheme
  - Common mode (surges) due to magnets
    - Need to protect electronics without burning barriers
  - Noise/sensitivity issues

Open Issues (2)

- FISO temp/strain sensors
  - Qualification at cryogenic temps
- Software Concerns
  - System integration
    - 3 more LakeShore 218's
  - Remote control of PC
    - PCAnyWhere *vs* VNC
      - Fermi network security policies…