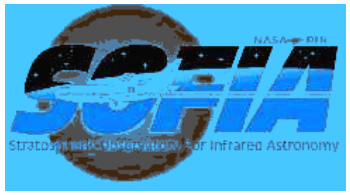


HAWC Electrical System

Dale Sandford

Steve Meyer

HAWC Electrical Systems
Team Members and Responsibilities

Dale Sandford, U of Chicago	- Science Data Acquisition and Control - Electronics Systems Engineering
Dr. Rick Shafer, GSFC	- Data Systems Design and Software Interface
Mitch Davis, GSFC	- Grounding and Shielding Consultant
Alfonso Hermida, GFSC	- Electro-optical System Control System
Steve Meyer, GSFC	- Electrical Systems Engineering

HAWC Electrical Systems Requirements

- Signal Processing of a 12x32 Silicon Pop Up Detector (SPUD)
  - Minimum 1 KHZ sample rate
  - Noise level < 10% of JFET/SPUD noise level
- Control electromechanical (optics) and ADR systems
- Generate housekeeping and safety telemetry data
- Isolate and filter incoming power
- Provide RF Filtering and RF and Magnetic Shielding on all Lines Entering Cryostat
- Must operate in SOFIA environment
  - Comply with all FAA Regulations and Safety Requirements
  - Comply with SOFIA Weight, Volume, Emissions and Power Requirements
  - Maintainable by SSMOC staff
  - Able to operate in EMF of telescope torque motors

HAWC Electrical Design Goals

- Use Existing Designs Where Possible to Reduce Risk and Cost
- Make use of Commercial Off The Shelf (COTS) Electronics and Enclosures to Minimize Development Costs
- When Possible Make Design Choices Compatible with Forthcoming Projects and Industry Trends
- Choose Data System Components to Maximize use of Off the Shelf Software Drivers and Communication Protocols
- Develop ETU and Run System Tests on High Risk Components
- Keep All Digital Switching Electronics Optically Isolated from Sensitive Cryostat Signals
- Make the Instrument "Plug and Play" Requiring Only Standard Workstation Connections to Operate.

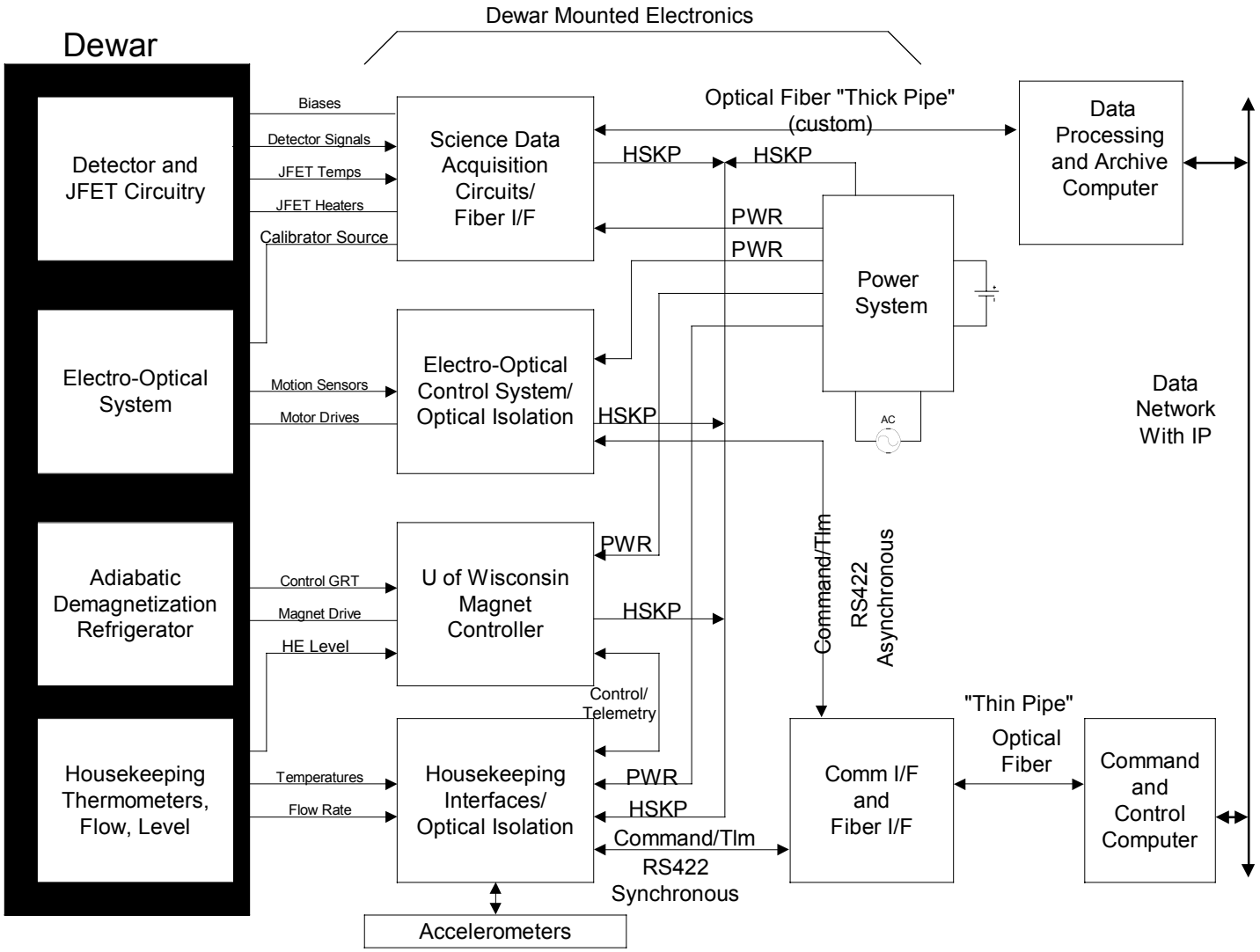
HAWC Electrical Subsystems

- Science Data Acquisition System
  - Detector/JFET Array, Amplification, Filtering, Digitization, Fiber Interface, JFET Temperature Control, Chopper Interface, Bias Sources, Calibration Source Driver, Timing/Control Interface
- ADR Control System
  - Magnet, Control GRT(s), U of Wisconsin Magnet Controller and Driver, Liquid He Level Sensor Interface
- Electro-Optical Control System
  - Motors, Motor Drivers, Position and Hard Limit Sensors, Position Sensor Interfaces, Motion Controller, Communications Interface

HAWC Electrical Subsystems

- Housekeeping and Command and Control System
  - ADR Magnet Controller Analog and Digital Interface, Cryostat Thermometer Monitoring, Subsystem Voltage/Current/ Temperature Monitoring, Accelerometer I/F, Flow Meter I/F, Subsystem to User Workstation Communications Interface
- Power Subsystem
  - SOFIA Source Power Filtering, Subsystem Power Supplies, Battery Replaceable Science Data Power Supply, Secondary Power Filtering and Regulation, Remote and Local Power Switching, Voltage and Current Monitors, Fusing and Overvoltage Protection

HAWC Electrical Systems Block Diagram



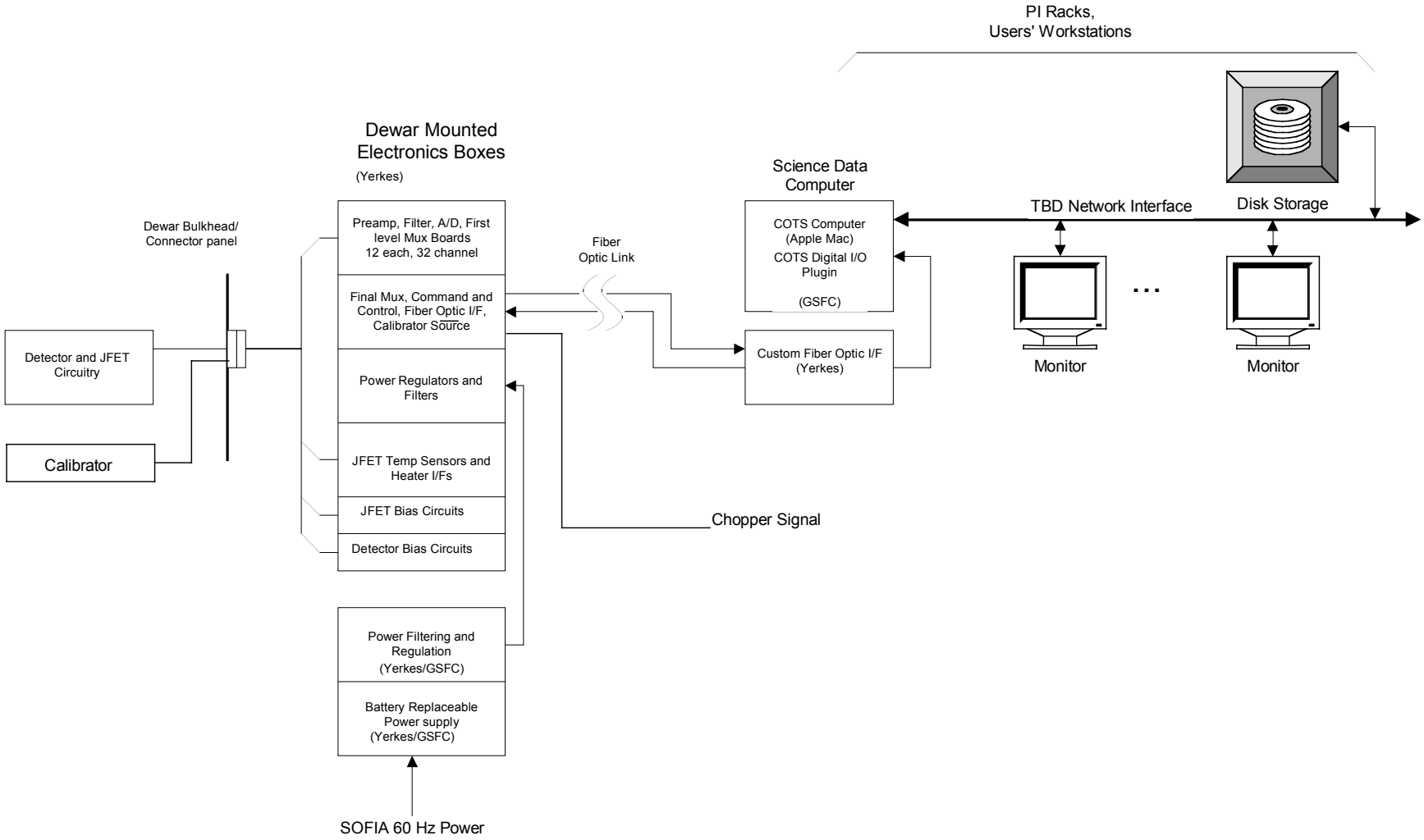
HAWC Science Data Acquisition System

- Basic circuit design based on proven KAO system
  - One preamp and ADC per channel
  - Preamp A/C coupled to SPUD detector
  - 16-bit delta-sigma ADC
- KAO system redesigned for HAWC to:
  - Reduce size and weight
  - Reduce manufacturing and component cost
  - Increase reliability
  - Lower power consumption and heat output
  - Handle larger detector array

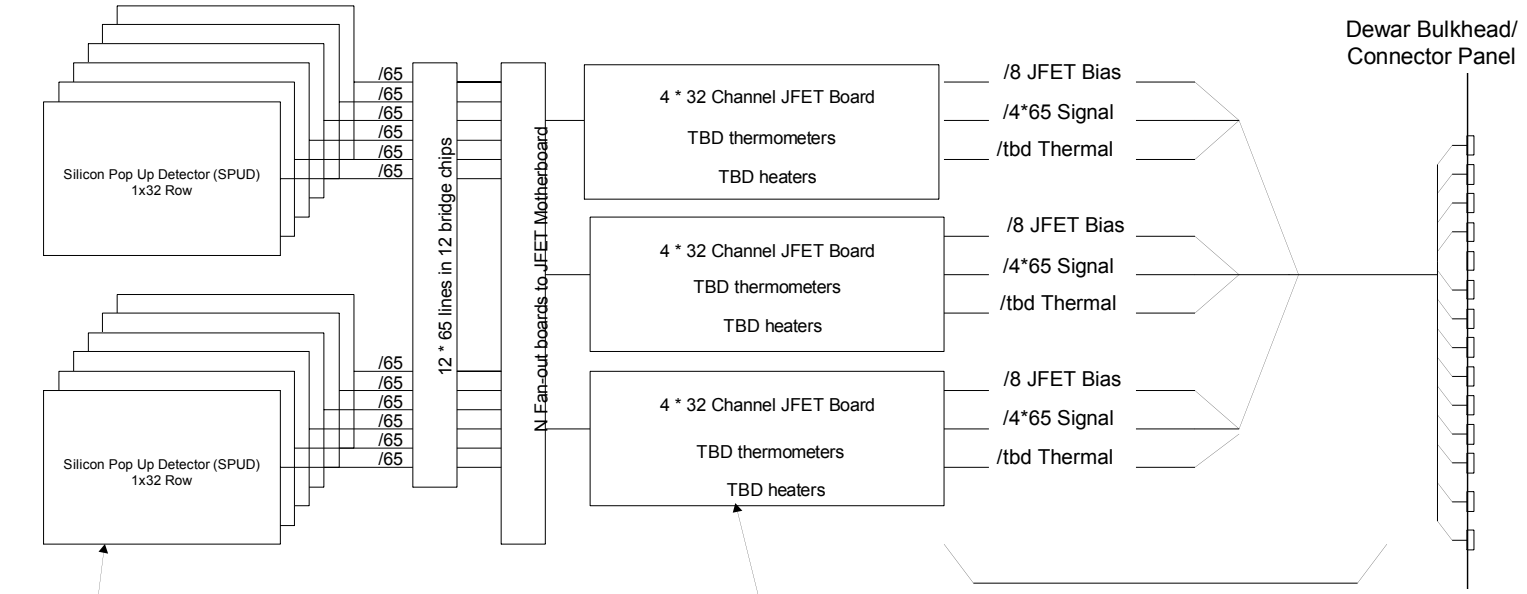
HAWC Science Data Acquisition System

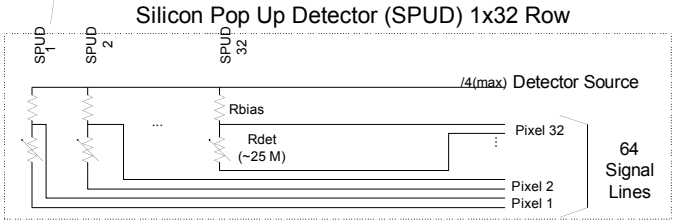
- Detector biases, JFET supply and signal conditioning components will have provisions to be run from battery power.
- Preamp, filtering, A/D converters, and first level MUX on single board to reduce signal path length and number of connections.
- Timing and control circuitry to provide synchronization of data system with chopper and calibration sources.
- Signal processing electronics will be electrically isolated from data system computers with a bi-directional fiber optics link.

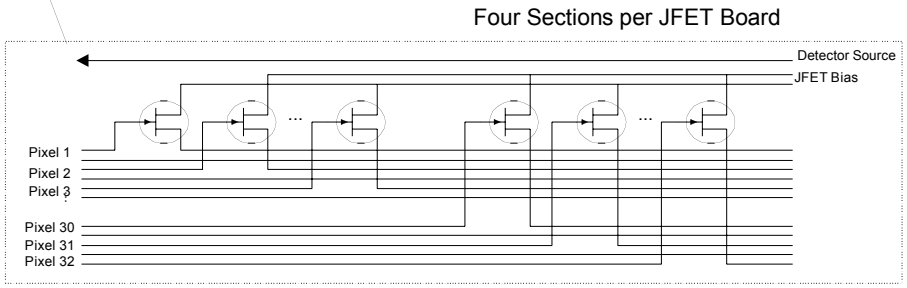
HAWC Science Data Acquisition System



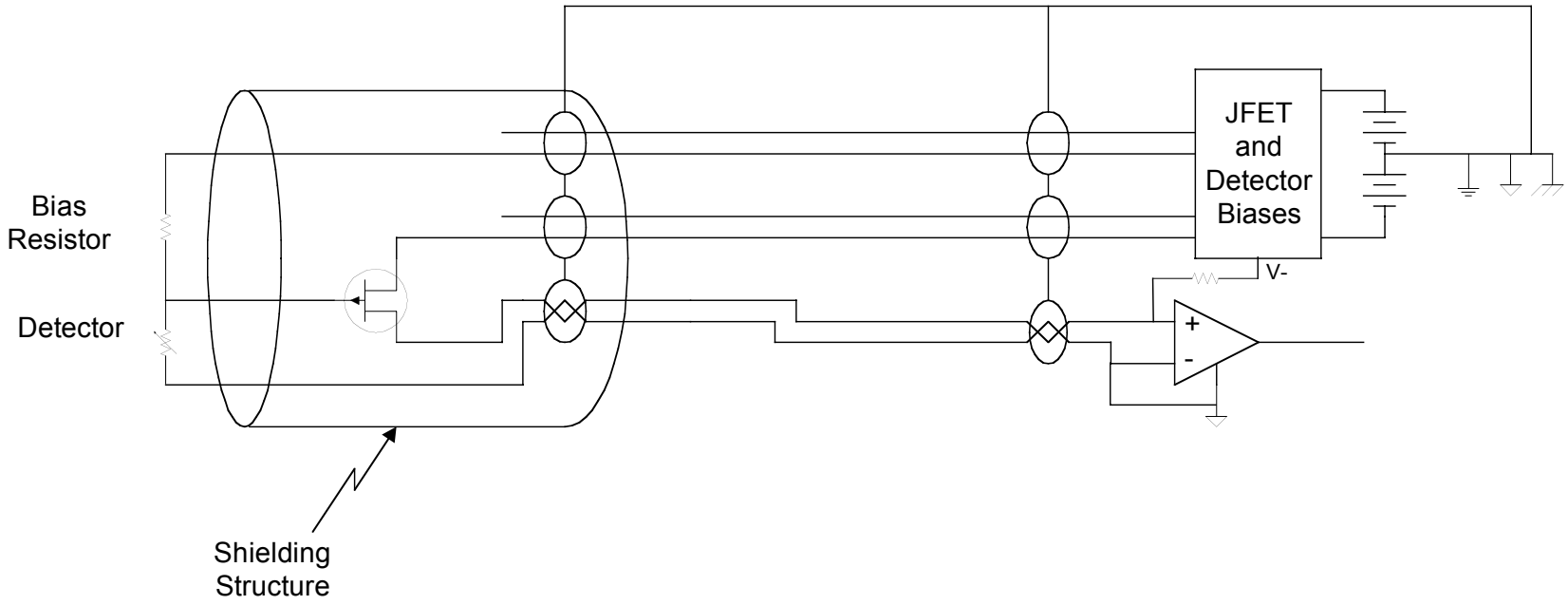
HAWC Detector and JFET Circuitry







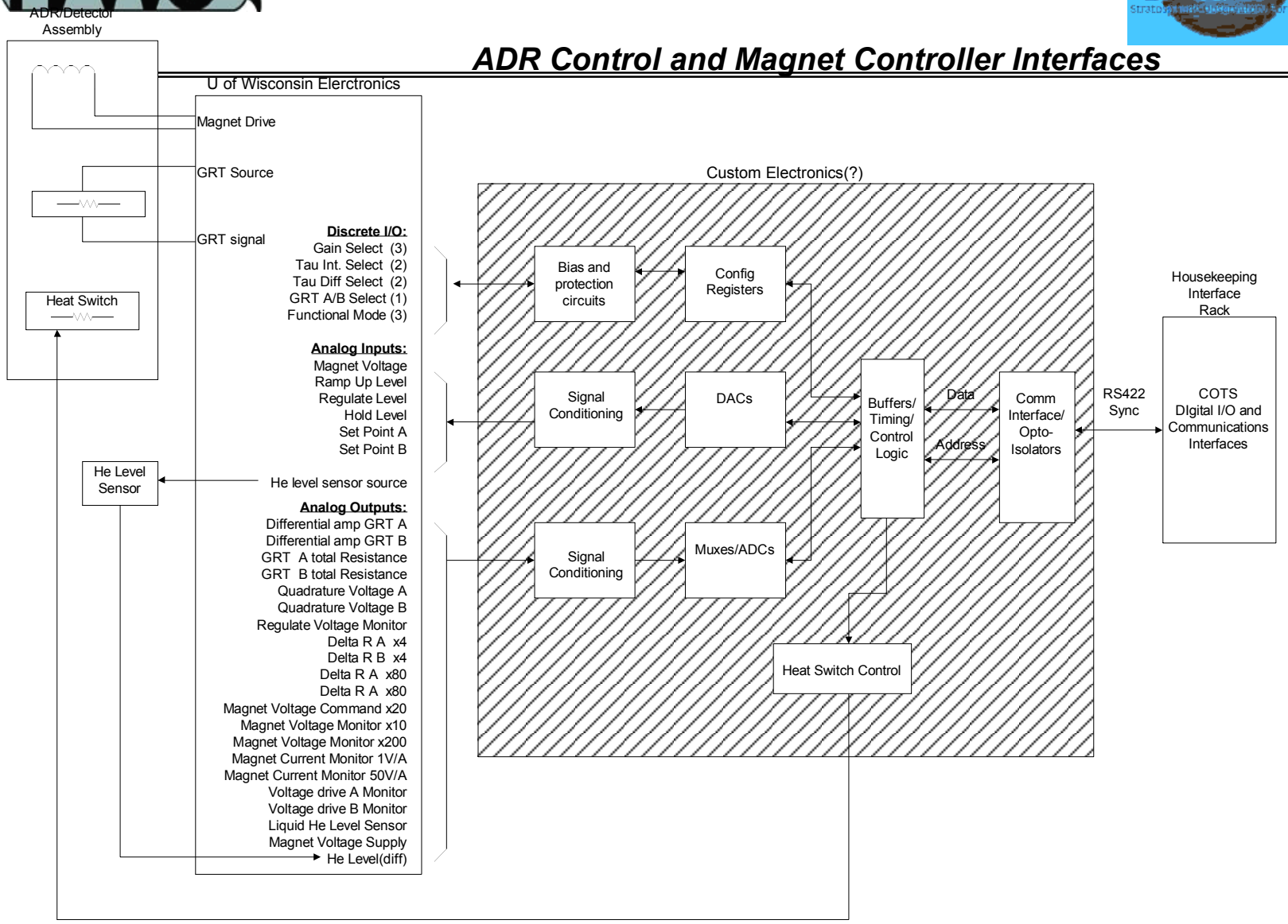
HAWC Detector Signal Grounding and Shielding



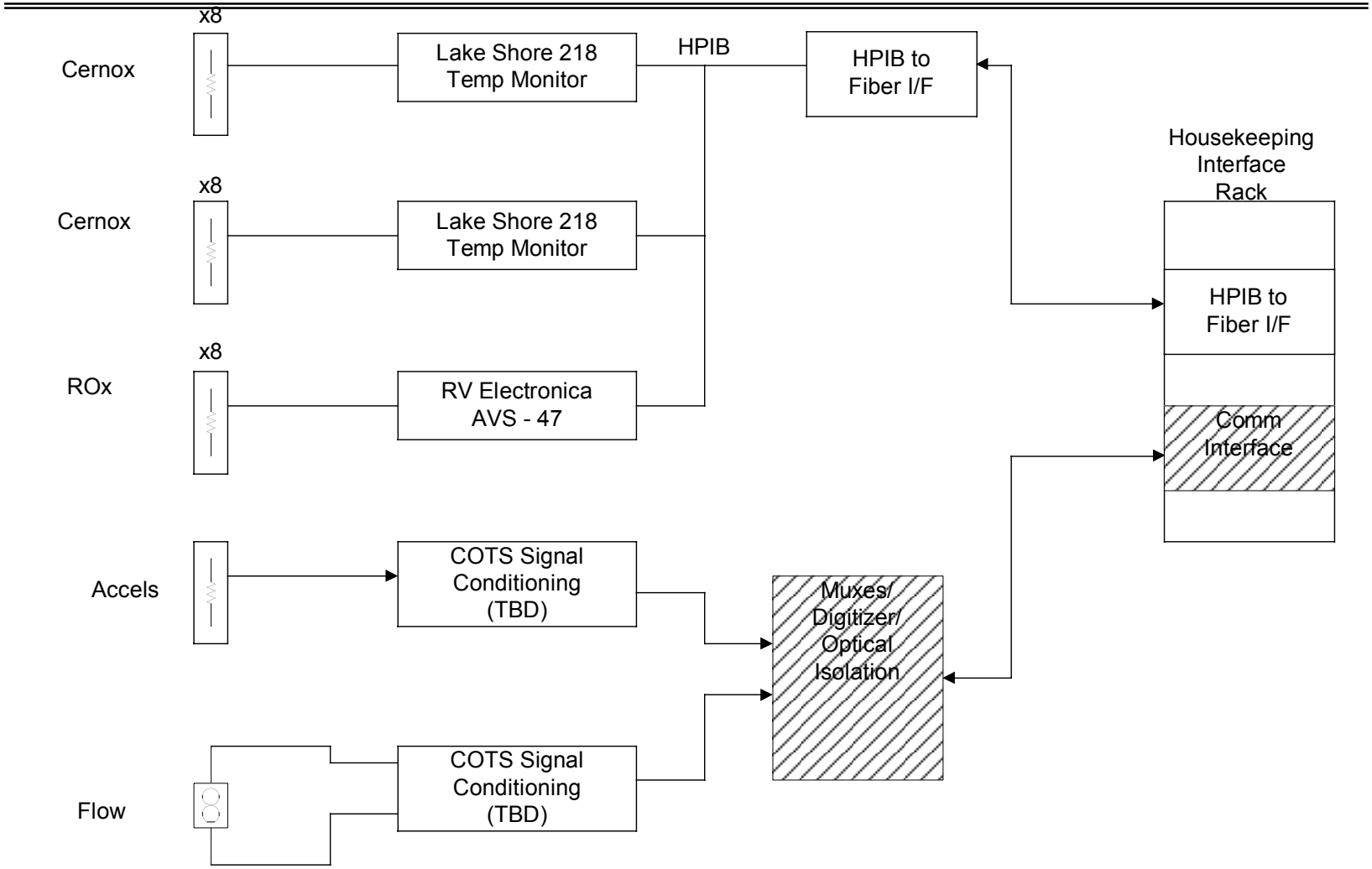
HAWC Housekeeping System

- Will contain some Commercial Off The Shelf (COTS) components for communications interfaces (micro-controller?)
- May also contain some custom electronics to control noise and provide optical isolation from COTS equipment.
- Provides interfaces to U of Wisconsin magnet controller
- Magnet controller also provides liquid He level detector interface.
- Provides control to the ADR heat switch.
- Provides interface to flow meters and accelerometers.
- Uses COTS equipment to measure temperatures with dewar.
- All systems will be optically isolated from the users' station.

ADR Control and Magnet Controller Interfaces



HAWC Housekeeping Interfaces Block Diagram



HAWC Power System

- Requires 60 Hz 115v at TBD amperes.
- Will meet the SOFIA specifications:
  - Single phase loads balanced among the three phases
  - 85% steady state operational power factor
  - In-rush current limited to <5X operating current for 8 ms or less
  - Shielding to provide 50 db attenuation from 30 Hz to 40 GHz
- Will meet MIL-STD-461 requirements for emissions and susceptibility
- Test method of MIL-STD-462
- Batteries and/or linear power supplies for science data components
- Linear power supplies for sensitive components
- Switching power supplies for cycling ADR magnet and optically isolated COTS components

Test and Development Plan

- Each subsystem will provide their own test bed environment.
- Subsystems will communicate via standard protocols using an ICD
  - Use of PCs with industry standard plug-ins
  - Each subsystem not dependant on custom test bed for testing
- Will make ETU of data processing boards and run tests with detector
- Where possible breadboards will be used.
- Long lead time items identified and to be ordered soon.
- CSA test to be run with ETU system
- Final PCB cut will be CSA results are gathered

HAWC Electrical System
Issues/Concerns

- Power consumption for battery operation
- System grounding and shielding performance not testable until SOFIA I&T
- Signal crosstalk with high component and cabling density