HAWC CDR

February 1-2, 2001

Housekeeping System and ADR Controller

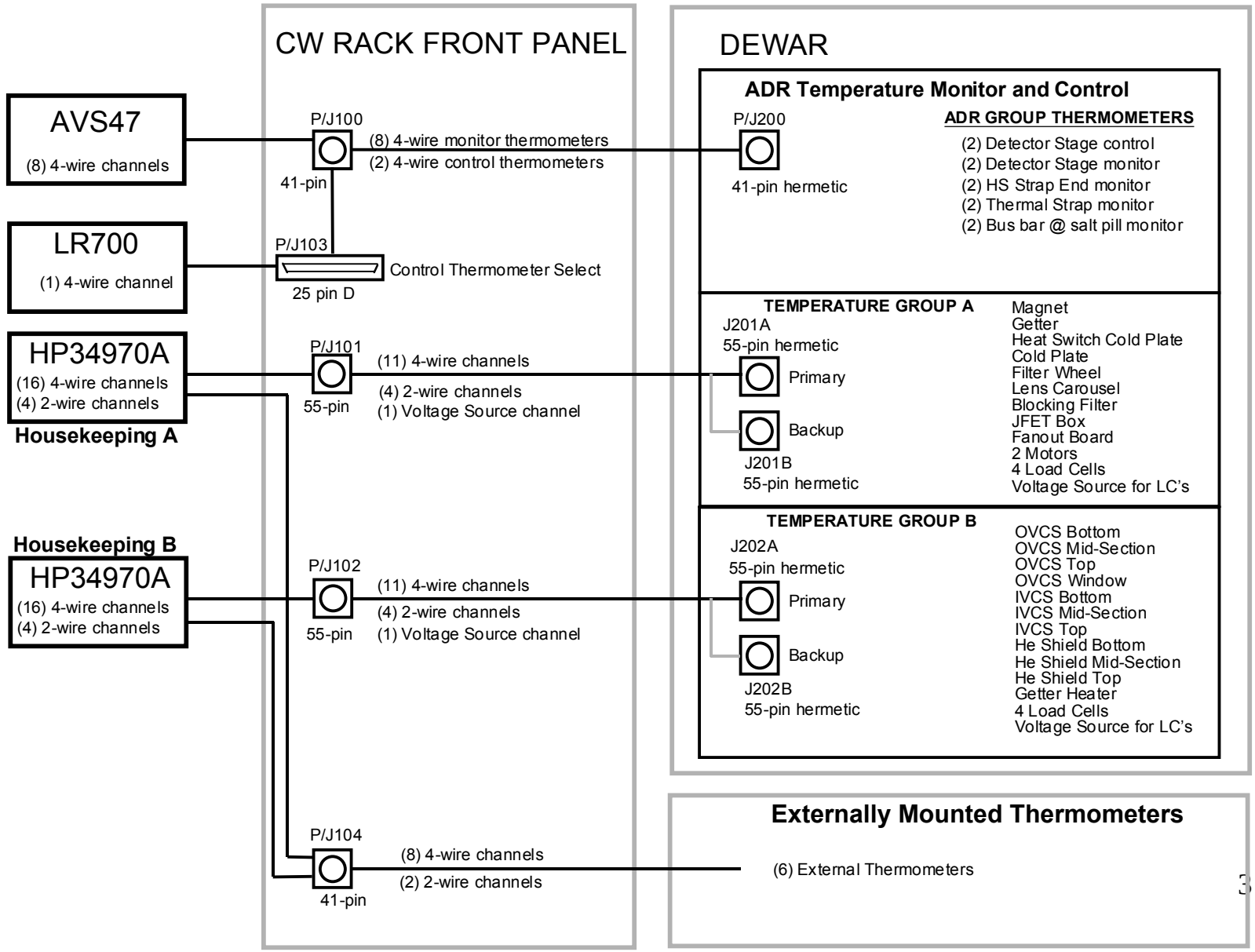
Tony Cazeau and David Sohl

HAWC Housekeeping and ADR Controller

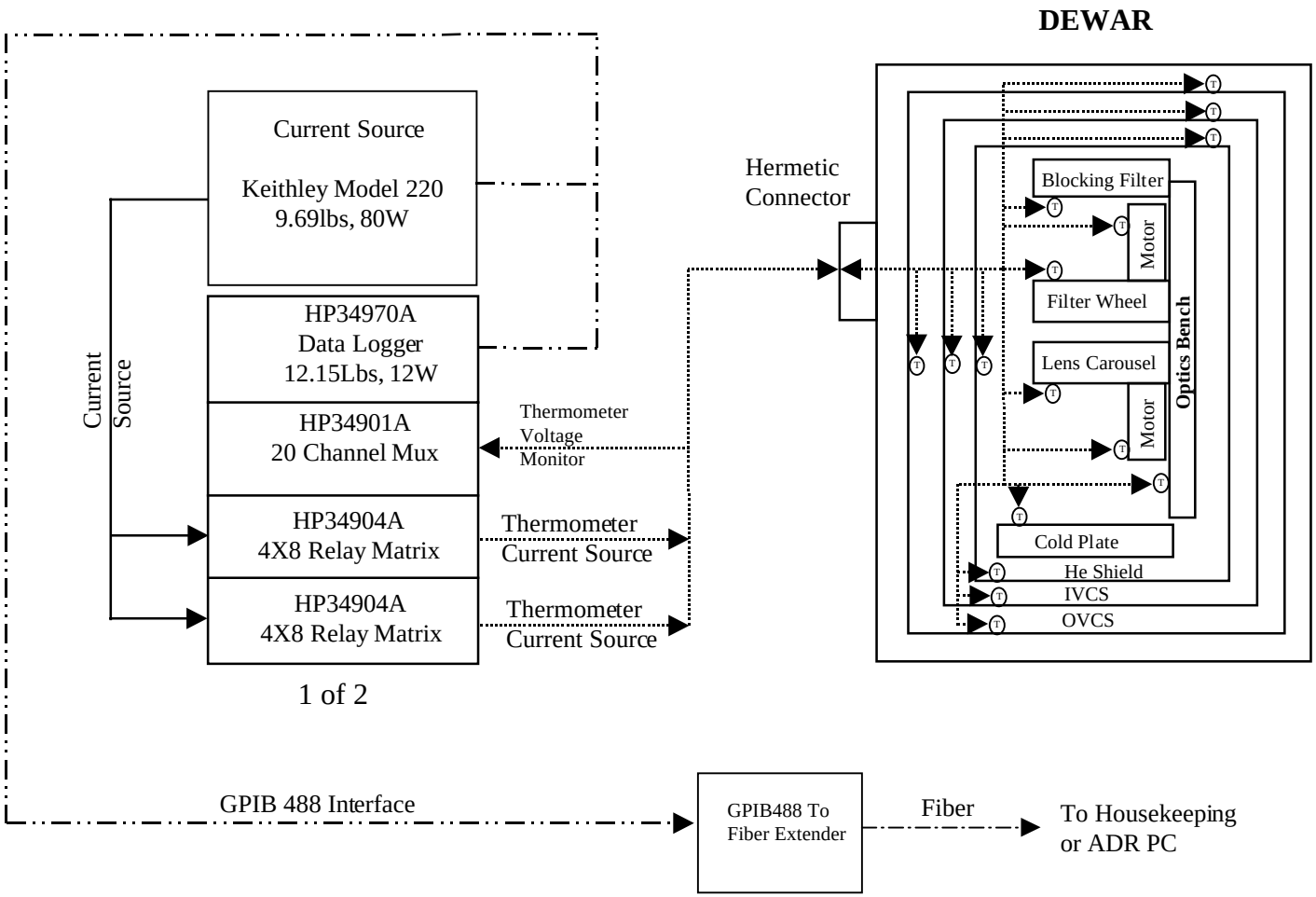
- **The HAWC Housekeeping System performs the following functions**
  - Read out thermometers to monitor the state of the He4 cryostat
  - Read out status thermometers on the ADR
  - Monitor load cells
  - Monitor liquid helium level
  - Flag out of limits conditions
  - Provide HAWC Housekeeping data to ICS
  - Sensor readout rates vary according to activity
    - Dewar cooldown/warmup, dewar refill, ADR recycling, flight operations, etc.

- **The ADR Control Electronics perform the following functions**
  - Recycle the ADR prior to flight
  - Maintain detector temperature during science operations

Housekeeping and ADR Controller Resource Allocation



Housekeeping System Block Diagram



Housekeeping Group A Sensor Readout Requirements

Location/Purpose	Temperature range	Required Resolution	Sensor type(s)	Quantity	Min readout interval	When necessary	Typ. readout interval	Readout method	Provided by
HS-cold plate	1-10 K	5 mK	Cernox RTD	2	15 sec	Mission duration	120 sec	HP34970A (Group A)	GSFC 552
Magnet	1-300 K	5 mK	Cernox RTD	2	15 sec	dewar cooldown	120 sec	HP34970A (Group A)	GSFC 552
Fanout Board	1-10 K	5 mK	Cernox RTD	2	15 sec	Mission duration	120 sec	HP34970A (Group A)	GSFC 552
JFET box exterior	1-10 K	5 mK	Cernox RTD	2	15 sec	Mission duration	120 sec	HP34970A (Group A)	GSFC 552
Filter wheel (TBD)	1-10 K	.5 K	Cernox RTD	2	1 sec	dewar cooldown	After changing pos	HP34970A (Group A)	GSFC 552
Lens carousel (TBD)	1-10 K	.5 K	Cernox RTD	2	1 sec	dewar cooldown	After changing pos	HP34970A (Group A)	GSFC 552
Blocking filter	1-10 K	.5 K	Cernox RTD	2	1 sec	Mission duration	After changing pos	HP34970A (Group A)	GSFC 552
Filter wheel mtr	1-10 K	.5 K	Cernox RTD	2	1 sec	Mission duration	After changing pos	HP34970A (Group A)	GSFC 552
Lens carousel mtr	1-10 K	.5 K	Cernox RTD	2	1 sec	Mission duration	After changing pos	HP34970A (Group A)	GSFC 552

Housekeeping Group B Sensor Readout Requirements

Location/Purpose	Temperature range	Required Resolution	Sensor type(s)	Quantity	Min readout interval	When necessary	Typ. readout interval	Readout method	Provided by
OVCS - Bottom	30-300 K	.5 K	PRT	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
OVCS - Mid	30-300 K	.5 K	PRT	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
OVCS - Top	30-300 K	.5 K	PRT	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
OVCS window	30-300 K	.5 K	PRT	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
MCS - Bottom	30-300 K	.5 K	PRT	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
MCS - Mid	30-300 K	.5 K	PRT	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
MCS - Top	30-300 K	.5 K	PRT	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
Cold plate	1-300 K	5 mK-.5 K	Cernox RTD	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
He shield - Bottom	1-300 K	5 mK-.5 K	Cernox RTD	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
He shield- Mid	1-300 K	5 mK-.5 K	Cernox RTD	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552
He shield - Top	1-300 K	5 mK-.5 K	Cernox RTD	2	15 sec	dewar cooldown	120 sec	HP34970A (Group B)	GSFC 552

Housekeeping Group TBD Sensor Readout Requirements

Location/Purpose	Temperature range	Required Resolution	Sensor type(s)	Quantity	Min readout interval	When necessary	Typ. readout interval	Readout method	Provided by
Hot Plate	TBD	TBD	PRT	1	TBD	TBD	TBD	HP34970A (Group TBD)	UC
Cal Point Source	TBD	TBD	PRT	1	TBD	TBD	TBD	HP34970A (Group TBD)	UC
"Fold Mirror" 1	TBD	TBD	PRT	1	TBD	TBD	TBD	HP34970A (Group TBD)	UC
"Fold Mirror" 1	TBD	TBD	PRT	1	TBD	TBD	TBD	HP34970A (Group TBD)	UC
External window	TBD	TBD	PRT	1	TBD	TBD	TBD	HP34970A (Group TBD)	UC
Spare	TBD	TBD	PRT	1	TBD	TBD	TBD	HP34970A (Group TBD)	UC

ADR Control Sensor Readout Requirements

Location/Purpose	Temperature range	Required Resolution	Sensor type(s)	Quantity	Min readout interval	When necessary	Typ. readout interval	Readout method	Provided by
Detector stage	.1-10 K	.01 mK or better	RoxRTD	2	continuous	Science ops	n/a	LR700 (ADR group)	GSFC 552

ADR Monitor Sensor Readout Requirements

Location/Purpose	Temperature range	Required Resolution	Sensor type(s)	Quantity	Min readout interval	When necessary	Typ. readout interval	Readout method	Provided by
Thermal strap	.1-10 K	.01 mK	Rox RTD	2	15 sec	ADR recycling	120 sec	AVS-47 (ADR group)	GSFC 552
Bus bar @ salt pill	.1-10 K	.1 mK	Rox RTD	2	15 sec	ADR recycling	120 sec	AVS-47 (ADR group)	GSFC 552
HS-strap end	.1-10 K	1-5 mK	Rox RTD	2	15 sec	Mission duration	120 sec	AVS-47 (ADR group)	GSFC 552
Detector stage	.1-10 K	.01 mK or better	Rox RTD	2	15 sec	Science ops	n/a	AVS47 (ADR group)	GSFC 552

Housekeeping Capabilities

- **Housekeeping system sampling rates exceed all requirements described in HAWC Temperature Sensor Specifications**
  - Maximum sample rate of 80 channels/sec (based on minimum aperture time of 333msecs, no settle time, one reading each for plus and minus currents, 1 switch closure and 1 switch open on 4X8 relay matrix, 2 HP34970A's running in parallel)
  - Maximum single channel sample rate of 1500 samples/sec (based on minimum aperture time of 333msecs, no reversing of current source, no switching of matrix and channel switches)
- **Readout resolution meets all requirements**
  - High sampling rates described above give lowest resolution of 4.5 digits
  - Allowance for settling time and up to 50,000 samples/channel for averaging improve resolution to 6.5 digits with readout rate in excess of requirements

Housekeeping Status

- **Housekeeping software in test controlling HP34970A and Keithley220 in Lab**
- **Software has been tested with ICS software via TCP/IP**
  - Commanding from ICS via TCP/IP successfully tested
  - Data stream to ICS via TCP/IP successfully tested
- **All outstanding COTS equipment received**
- **Wiring of Counter Balance Rack completed**
- **Interconnect cabling between Counter Weight Rack and Cryostat completed**
- **All wiring completed 21 December 2000**

Housekeeping Testing

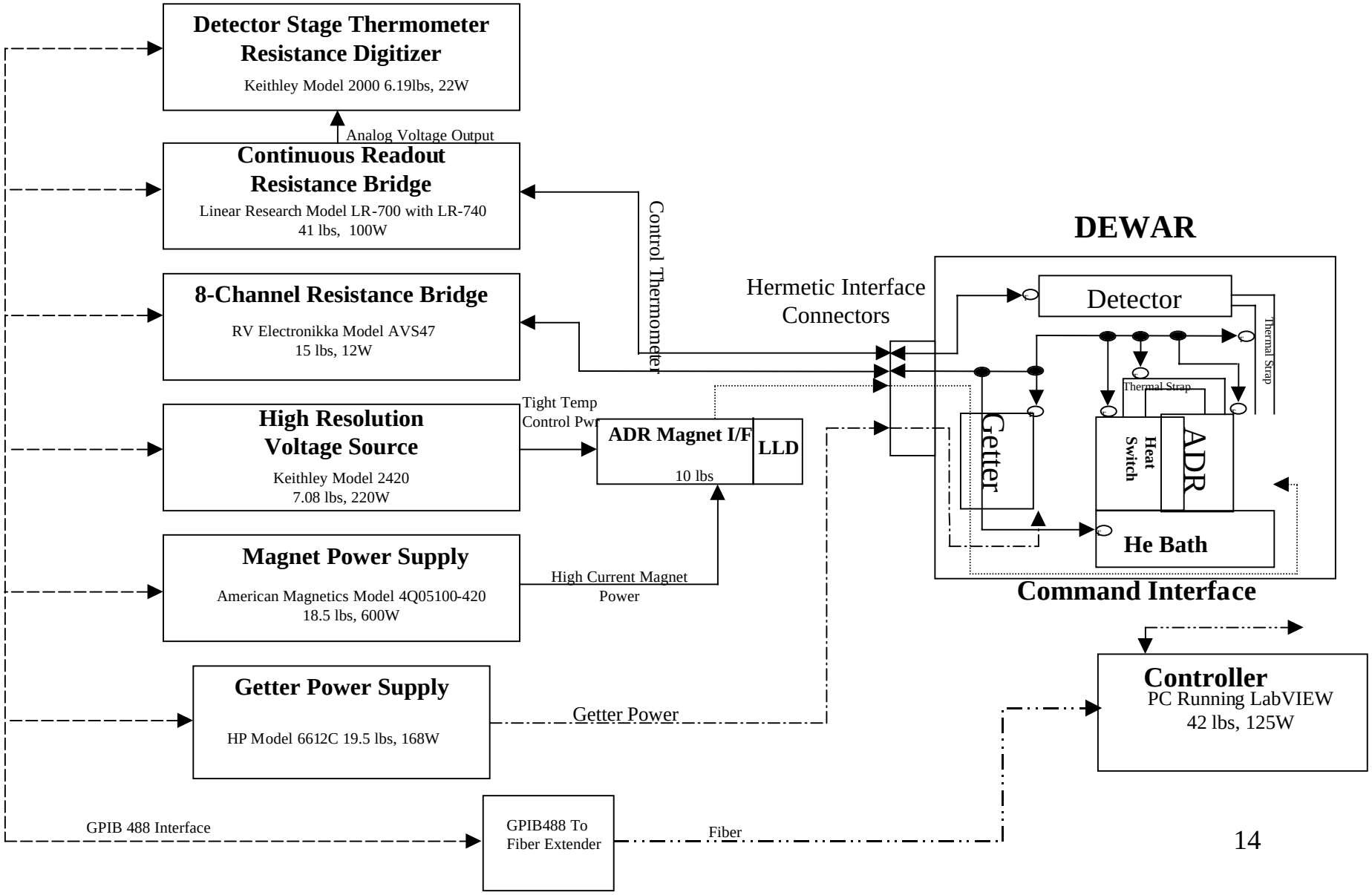
- **Command verification testing (Feb 2001)**
- **Full up system test with HAWC or SAFIRE ADR in non-flight cryostat (Feb 2001)**
- **Full up testing with ICS software (Feb 2001)**
- **Wiring verification to Housekeeping Electrical ICD (Feb 2001)**

HAWC ADR

- **Performance drivers for ADR electronics**
  - Detector temperature ≤ 0.2 K
  - 100% duty cycle during each mission
  - Detector temperature must be stable enough to avoid thermal noise and gain variations (see ADR section)
  - Autonomous operation

- **Electronics and software are needed for**
  - Recycling the ADR and establishing operating temperature
    - High-current magnet power supply
    - Heat switch control
    - Temperature monitoring (getter and ADR thermometers are used to chart progress of the cycle)
  - Transitioning to fine temperature control
    - Dedicated low temperature resistance bridge and precision temperature controller
    - Multiplexed bridge for reading out other low temperature thermometers

ADR Controller Block Diagram



HAWC ADR Software

- **Recycling**
  - Algorithms based on ADR controllers used in cryogenics lab since 1994
- **Temperature control**
  - Digital closed-loop control with high control bandwidth
  - Uses off-the-shelf LabVIEW PID controller from National Instruments.
  - Minor software modifications required for use on HAWC
- **Status**
  - Temperature controller has been tested with laboratory ADRs
    - Achieves desired level of control at frequencies below 1 Hz, and above 3 Hz (See ADR section)
  - Recycling routines are being written as HAWC ADR engineering tests continue
- **Software will be tested with the HAWC ADR in conjunction with Instrument Control Subsystem (ICS)**
  - First as standalone LabVIEW scripts without TCP/IP data transmit or command receive (in test now)
  - Second test with TCP/IP data transmit and command receive (Jan 2001)

HAWC ADR Hardware

- **All wiring completed December 2000**
- **All COTS equipment in house**

Testing Status

- **Wiring and hardware tested with Safire ADR and exceeded temperature control and regulation specifications for HAWC (December 2000)**

Open Issues

- **Status of electronics during take-off**
  - ADR performance (hold time) may be impacted if electronics must be off during take-off
    - Ramping the ADR magnet current to zero will cool the ADR to very low temperature (<50 mK)
    - Parasitic heat inputs will use up the ADR entropy capacity at a ~4x faster rate (approximately by the ratio of temperatures)