PHENIX.ONCS.tn45.0

SUMMARY OF SUBDETECTOR ANCILLARY SYSTEMS

ONCS Group

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Abstract

This document gives an overview of the ancillary systems requirement and channel count of the PHENIX detector.

Contents

1 BB

1.1 High Voltage

Photo tubes of BB are classified with these gains, and single common high voltage is supplied to a group of 8 photo tubes in average. Depending on the number of photo tubes in the class of gain, the number of tubes in a group may change from 5 to 10. 8 high voltage channels are required for every arm of BB and 16 channels in total. The lowest voltage is -2000 V for the group of high gain tubes, and the highest is -2800 V for the group of low gain tubes in the normal operation. The maximum HV current for a tube is about 0.55 mA in the current design of the breeder of the BB tubes. The maximum current capacity of one HV channel should be larger than $0.55mA/ch \times 10ch = 5.5mA$. The voltages and currents of the HV channels is monitored in every 1 minute, and recorded in every 30 minutes.

Item	Value	Comment
Number of HV channels	16	HV channel : PMT $\simeq$ 1:8, PMT = 128 ch
HV module type	LC 1461N - m006	
Voltage	-2000 $\sim$ -2800V	in normal operation
PMT HV current	0.55 mA	single tube
	5.5 mA	single HV channel (10 tubes at maximum)
readback frequency	$\simeq$ 1 min	for online monitoring only
recording frequency	$\simeq$ 30 min	for archiving

Table 1: BB HV system specification and monitoring parameters

1.2 Temperature Monitoring

BB consists of 2 "arms" (north and south), and every arm consists of 2 "halves" (upper and lower). Every "half" has 5 thermo-sensors. 2 of the sensors are fixed to the housing of BB, and other 3 are fixed to PMTs. So, $(2 + 3) \times 2 \times 2 = 20$ sensors are required for the BB detector itself. Temperature monitoring of signal cables is also needed to correct the temperature dependence of the propagation time of PMT signals for a precise timing measurement. Thermo-sensors are fixed to the signal cable bundle (about 5 m) at every 1 m. Then, 6 sensors are used in one signal cable bundle, and 12 sensors in total (two cable bundles at north and south). The thermo-sensor is the Chromel-Alumel (CA) thermocouple. The sensors are connected to an ADC module chosen by ONCS (one thermo-sensor to one ADC channel). The temperature information is monitored in every 1 minute and recorded in every 10 minutes.

1.3 Cooling Gas Flow Monitoring

A cooling gas flow is used to carry heat away from the BB PMTs and to keep the temperature of the BB PMTs at reasonable level. The gas flow is monitored with flow sensors which indicate the amount of gas flow with a DC voltage. Each arm (north and south) has one gas flow sensor. The DC voltage outputs from the sensors are monitored with an ADC module chosen by ONCS. The gas flow is monitored in every 1 minutes.

1.4 Questions, open issues:

- Can GPIB be used for the temperature monitoring? Comment: ONCS will decide on a common ADC that should be used in as many systems as possible. Currently we are considering the VSAM module, a Keithley 2000 is also under consideration.
- Device for cooling gas flow monitor is not specified yet (about 10 l/m)

Item	Value	Comment
Number of sensors	20	in BB detector
	12	in cable bundle
Sensor type	Chromel-Alumel (CA) thermocouple	
Voltage range	-4 mV $\sim$ 4 mV	
Required accuracy	0.5^{o} C	
update frequency	1 min	
recording frequency	10 min	

Table 2: BB temperature monitoring parameters

Item	Value	Comment
Number of sensors	2	north and south
Sensor type	not specified yet	
Voltage range	not specified yet	
update frequency	1 min	

Table 3: BB cooling gas flow monitoring parameters

2 MVD ANCILLARY SYSTEMS

Refer to figure 1 for a schematic of the MVD ancillary systems. Logically, the MVD can be divided into east and west halves, and each half is read out to its north and south ends. Thus here are 4 motherboards with connections to the outside world.

In each quarter, there are 42 MCM temperature sensors, and 35 LDO voltages to be read out. In addition, the temperature at 3 locations on the motherboard is monitored, for a total of 80 voltages per quarter. There is not enough space to feed 80 signals out, so they are converted by ADC's on the motherboard, multiplexed together and fed out over a serial link, one per motherboard. The serial lines go to the MVD 'Black Box', which is located in one of the pockets of the CM support structure. This box is now envisioned to be a 6U VME crate, with a controller running VxWorks, to allow easy access to, and control of the modules in the crate.

The serial lines are handled by a digital I/O module, which is controlled by a C-program running in the crate's CPU, (much as we currently talk to the Xilinxes in the MVD clean tent). Details are in a subsection 2.1 below. The data then end up in memory or on disk, and we are trying to find out how to get them from there into EPICS-land. An EPICS 'virtual unix device' would do the trick, but this has not been located yet.

Each MCM also has 2 analog spy lines, one connected to the preamp output and one to the AMU output, for a maximum total of 42x2 per quarter. These signals are multiplexed on the motherboard, so that only 2 analog lines per quarter are fed out. In the Black Box these will be digitized by 6-bit FADC's, running at 40 MHz. We can use one Glink per 2 FADC's (actually since a Glink is 20 bits wide we could have 3 FADC's per link) to get the data to the counting house, where 8 DAC's turn the signals back into analog, so we can look at them with a scope. Details are in subsection 2.2 below.

There are a few more signals generated by temperature, flow and humidity probes located on or near the cooling units, which in the current design will be serviced by one of the ONCS-standard devices, see http://www.rhic.bnl.gov/phenix/WWW/lists/phenix-online-l/0215.html.

There will be (approximately) 10 pin-diode radiation monitors (see href="http://www-lib.fnal.gov/archive/1997/tm/TM-2012.html), 4 on each pole face and 2 near the beam pipe at z=0. These will be in place before the MVD is installed to characterize the radiation environment. The central ones will be removed when the MVD arrives, but the 8 on the pole faces will remain in place. Each unit has its own amp and discriminator, and the signals go to scalers in the Black Box, which makes the counts available to EPICS.

The Black Box will also contain the interface (CC-121) to the standard Phenix HV system (LeCroy 1458). A patch panel is needed to convert the HV supply cables/connectors to the cables/connectors which go up to the MVD. This patch panel may end up as a passive module in the Black Box.

In addition the box provides low voltage to the crate which houses the MVD interface boards (DCM, timing, control, trigger inerface modules), and power to the external sensors. These low-voltage are likely to be 8 double-wide 6U modules. There is no room in the crate for all this, so the LV modules will be housed in a physically separate crate, but logically connected by a VME extender connection. This is indicated by the dotted line.

The chillers of the cooling systems are controlled via RS-232 communications. There are so-called 'Industry packs', which may do the job. See http://www.greenspring.com/VTS/show.html.

[1] At the moment, we have identified the following sensors. Note that these are *not yet (October 97)* the final decisions.

- Air velocity: Omega, FMA-905-V. Range 10-5000 SFPM, input 15-24V, output 0-5V. Cost $822.
- Humidity and Temperature: Omega HX11V. Range 0-100C, 5-9512-36V, output 1-5V. Cost $205
- Liquid level: Omega LVU-232S. Input 120V AC. Cost $399.
- Temperature: Omega DP41-TC-A, with KMTSS-125G-6 type K thermocouple. Input 120V AC, output 0-5V.

Omega Engineering can be reached at phone 1-800-826-6342, fax 1-800-848-4271.

- Primary (MCM) air cooling system, one per East/West half.
  Each system will consist of a water chiller, a water/air heat exchanger, an air blower and a throttling valve. Temperature, flow and humidity of the air going to the MVD MCM plena will be measured.
  Attributes:
  - system local/remote control (binary in/out)
  - water chiller on/off (binary in/out)
  - water chiller temperature setpoint (analog in/out)
  - air inlet temperature (analog in)
  - air inlet flow (analog in)
  - air inlet humidity (analog in)
  - fan speed [or throttling valve?] (analog in/out)
  - fan on/off (binary in/out)
- Secondary (enclosure) air cooling system, one for both East/West halves.
  This system will consist of a water chiller/dehumidifier controlled by a humidity probe/controller. The dehumidifier will have a condensation liquid level sensor, controlling a drain valve. In addition there is a water chiller, a water/air heat exchanger, an air blower and a throttling valve. Temperature, flow and humidity of the air going to the MVD enclosure will be measured.
  Attributes:
  - system local/remote control (binary in/out)
  - dehumidifier water chiller on/off (binary in/out)
  - dehumidifier water chiller temperature setpoint (analog in/out)
  - dehumidifier condensation liquid level sensor (analog in)
  - dehumidifier drain valve position (digital in)
  - air loop water chiller on/off (binary in/out)
  - air loop water chiller temperature setpoint (analog in/out)

  - air inlet temperature (analog in)
  - air inlet flow (analog in)
  - air inlet humidity (analog in)
  - fan speed [or throttling valve?] (analog in/out)
  - fan on/off (binary in/out)

- Mother Board Voltage Regulator Cooling (1 system)
  This system consists of a liquid chiller unit including a pump. The liquid inlet temperature and flow are measured.
  Attributes:
  - water flow (analog in)
  - input temperature (analog in)
  - output temperature (analog in)
  - on/off (binary in/out)
  - local/remote control (binary in/out)

- Temperature
  Attributes:
  - temperature (analog in)

  Locations:
  - 3 per Mother Board (total of 12)
  - 1 per MCM (total of 136)

- Low Voltage
  Attributes:
  - voltage (analog in)

  Locations:
  - 35 per Mother Board (total of 140)

- Radiation sensors
  Attributes:
  - scaler counts (digital in)

  Locations:
  - 8 on the nosecones, 2 on the beampipe

2.1 Details of Serial Temperature and Voltage Readout

Refer to figure 2 for a schematic. To read out the numerous voltages on the motherboard (of which there are 4), the following scheme is proposed:

The MAXIM Max186 is an 8-channel, serial, 12-bit ADC. We will have 12 on each motherboard. In order for a particular chip to become active, its CS-bar line needs to be pulled low. Using 4 bits and a multiplexer, one chip at a time is thus activated.
(We will not use the 'shutdown feature' of this chip, but tie this line high in order to use the internal voltage reference of the 186).

Next, in order to choose which of the 8 analog channels gets digitized, and to set up other parameters, a string of 8 bits needs to be clocked into the chip. This is done using the DIN and SCLK lines. After the data is clocked in, the clock keeps on running, in order to clock the data out. The data appears on DOUT one click after SSTRB goes high.

After the 12 bits are received, the next byte into DIN will select the next analog channel on this chip, and so on. Once all 8 channels are done, the bits into the multiplexer will select the next Max186 chip and the process repeats.

On the Black-Box end, a small program in the VME crate processor will read and write the 8 lines via a digital I/O module, much in the way we now have the XIL program load the Xilinx chips on the mother board in the clean tent.

QUESTIONS TO BE RESOLVED:
1) The VME CPU runs the C program and ends up with the values in its memory, or writes them to disk. How do we get the numbers from there into EPICS? Is this done with a Virtual Device?
2) Can we have EPICS fire up this serial program?

WHAT CAN BE DONE RIGHT NOW:
Obtain an ADC chip, and use the existing hardware in the MVD clean tent (HP, VME, CAMAC, I/O module) to write the control program and verify this scheme.

DEVICE TYPE	DEVICES	ANA.I	BIN.I	ANA.O	BIN.O
HV	136				
LVs	150	150			
Temperatures	148	148			
MCM cooling	2	10	6	4	6
Secondary cooling	1	7	4	3	3
Regulator cooling	1	3	2		2
Radiation sensors	10		10		
(Spy channels)	(272)	(272)			
TOTAL	448 (720)	318 (590)	22	7	11

Table 4: MVD Ancillary System Channel Counts. Numbers in parentheses include channels that are not handled by EPICS

2.2 Details of Analog Spy Line Readout

Refer to figure 3 for a schematic of the proposed scheme. Each MCM has 2 spy channels, one at the preamp output and one at the AMU output, for a total of 2x42 analog channels per MVD motherboard (of which there ar 4). We propose to use Analog Devices ADG46, which are analog multiplexers. They take 16 inputs, and connect one of these to the output, depending on the value of 4 switch bits (a0-a3), and on the level of the enable line.

Shown in figure 3 is the proposed arrangement for 1 motherboard. There are 3 pairs of multiplexers (2 pairs are drawn), each pair sharing an enable line, since we always want to look at the preamp and AMU signals from the same MCM. Thus an MCM is selected by setting the appropriate levels on enable1,2,3 and a0-a3.

From each mother board there are 7 digital lines going in and 2 analog lines coming out. On the Black-Box end, a small program in the VME crate processor will read and write the 7 lines via a digital I/O module, the same way as in section 2.1.

As shown in figure 1, the analog signals are put onto Glink and sent to the control room, where they are un-converted.

One further option is to multiplex the signals in the black box down from 4 pairs to 1 pair, so that only 2 Glinks go to the control room, one preamp signal and one AMU signal.

QUESTIONS TO BE RESOLVED:
1) Can we have EPICS fire up this serial program?
Comment (Jan 14, 1998):
The "EPICS way" of doing things would be to treat the VME crate controller as an EPICS IOC. One way to resolve this issue is to agree on a work division in which the MVD group is responsible for bringing all the data into VME memory, where the ONCS group will fill EPICS records.

WHAT CAN BE DONE RIGHT NOW:
Obtain a multiplexer, and use the existing hardware in the MVD clean tent (HP, VME, CAMAC, I/O module) to write the control program and verify this scheme.

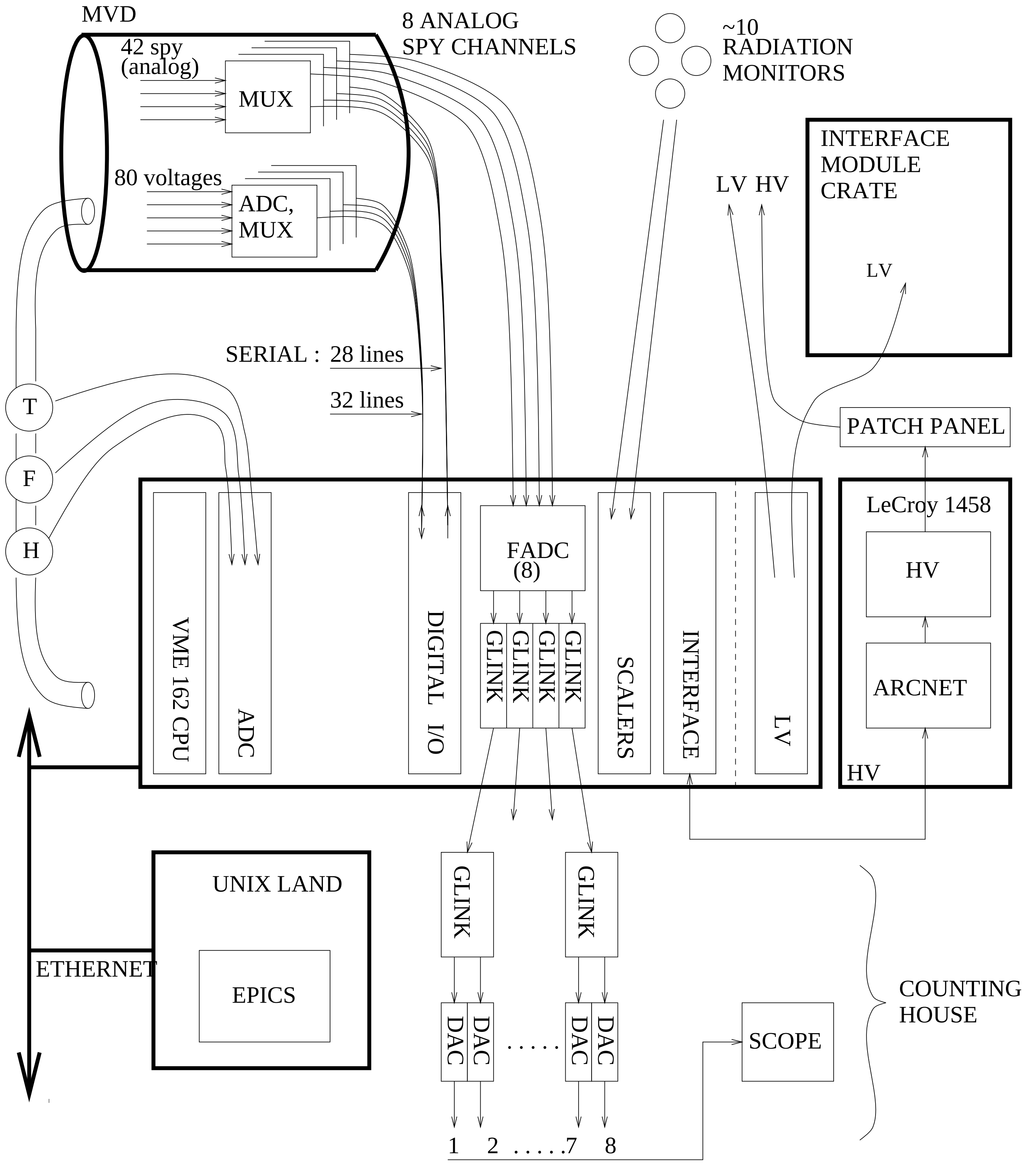

Figure 1: Schematic of the MVD ancillary systems

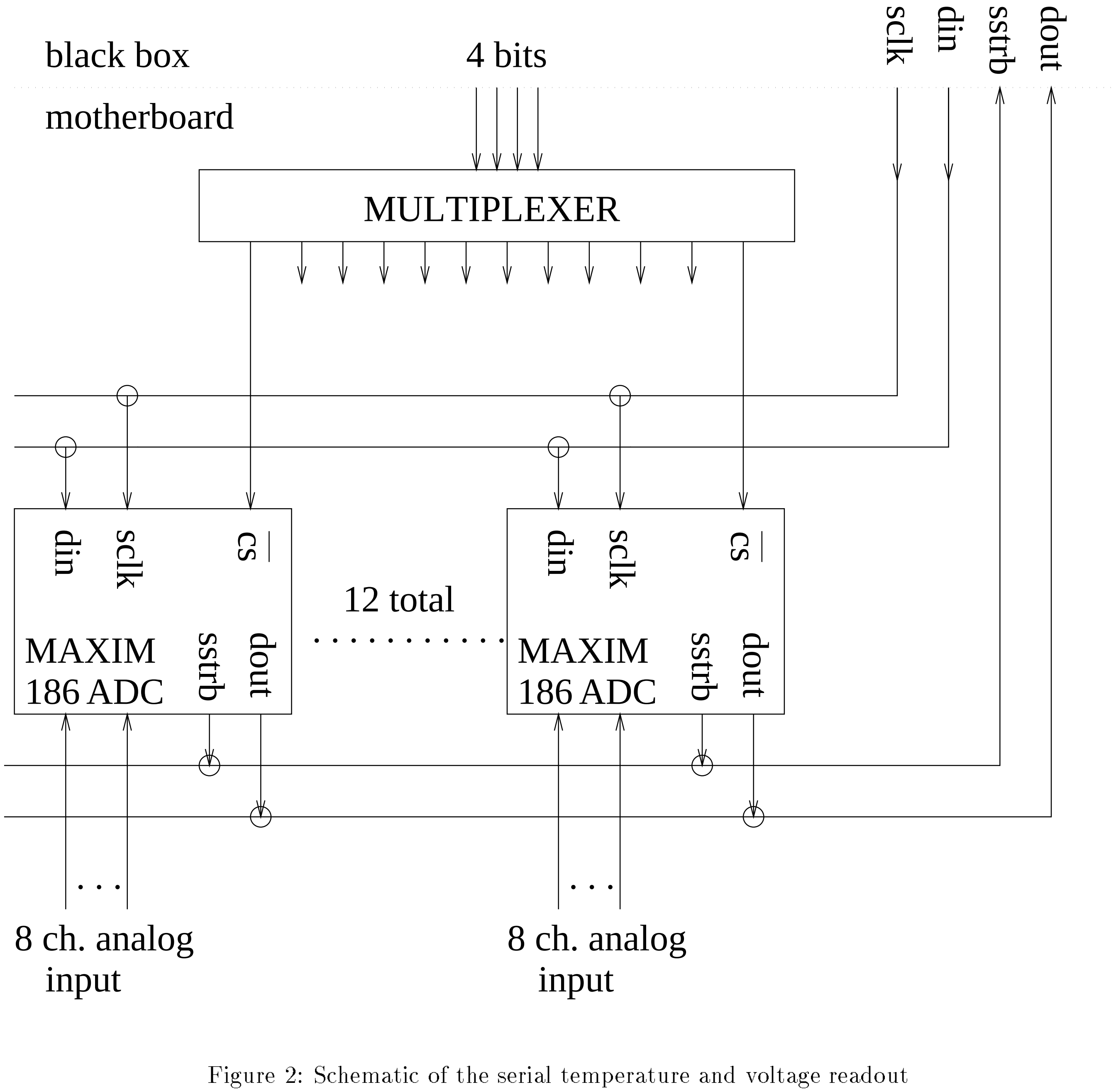

Figure 2: Schematic of the serial temperature and voltage readout

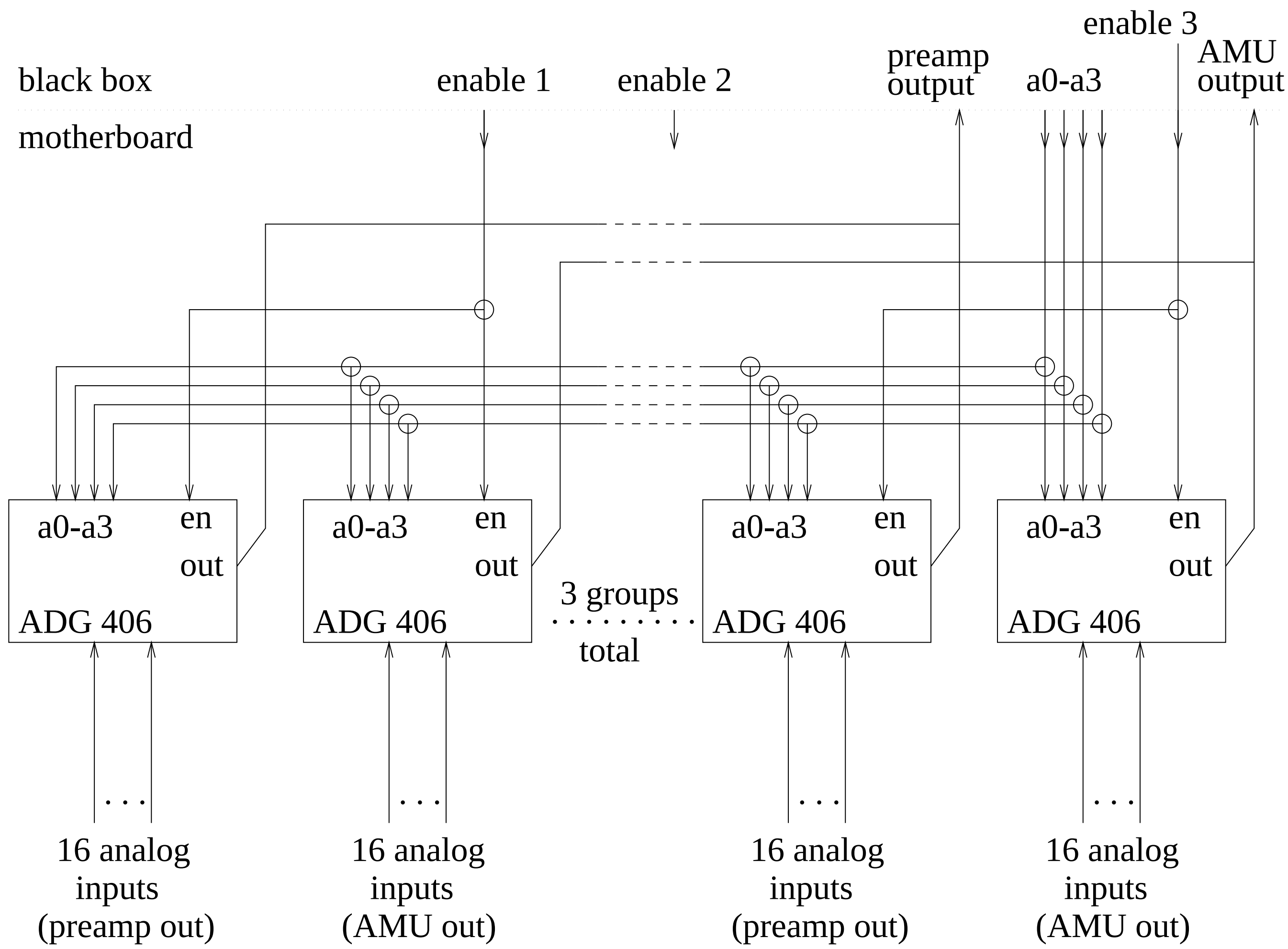

Figure 3: Schematic of the analog spy line readout

3 DC

3.1 High Voltage

Item	Value	Comment
Number of HV channels	320	4 HV channels / keystone
HV module type	1469 and 1471 N	
Voltage	-1500, -2000, -3500, -6000 V	
readback frequency	1/min	for online monitoring only
recording frequency	?	for archiving

3.2 Gas System

DC shares the gas system with the PC and is identical to the TEC gas system.

The current design of the gas system is modelled after the one developped by STAR and consists of a standalone PC that reads up to 80 channels of ancillary system data from a KEITHLEY 7000 switch system (see figure 4). The control is from the PC terminal over GPIB, the readings are sent to the EPICS system for archiving and alarms only.

Comment:
The tracking group is responsible for the PC software (development and maintance) as well as the client program that interfaces to EPICS (there exists a prototype in use in STAR).

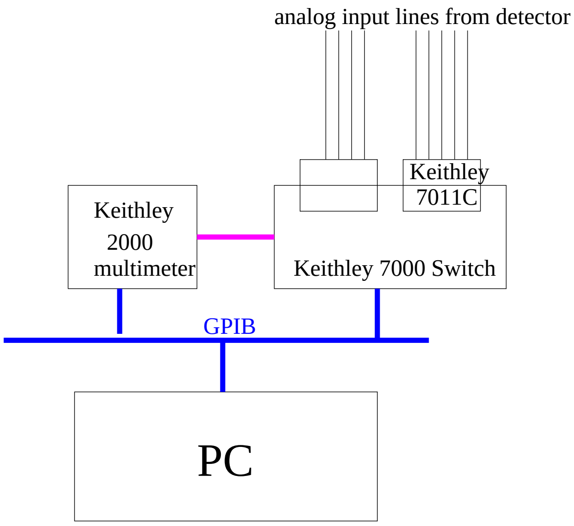

Figure 4: Schematic of the central tracking gas system

3.3 Questions

- Is there any other ancillary systems related to DC?

4 PC

4.1 High Voltage

Item	Value	Comment
Number of HV channels	96	2 per subsector
HV module type	1469P	
Voltage	+3500 V	
readback frequency	1/min	for online monitoring only
recording frequency	?	for archiving

4.2 Gas System

Shares gas system with DC.

4.3 Questions

- Is there any other ancillary systems related to PC?

5 TEC

5.1 High Voltage

Item	Value	Comment
Number of HV channels	256	
HV module type	1469N/P and 1471 N	
Voltage	+-500, 2000, -6000 V	
readback frequency	1/min	for online monitoring only
recording frequency	?	for archiving

5.2 FEM crate monitoring

The TEC FEMs is located in 16 racks (4 per side per arm) on the carriages. There is no special requirement for rack monitoring (whatever ONCS provides is fine).

5.3 Gas system

Identical to the DC gas system (see there).

6 RICH

6.1 High Voltage

The high voltage modules are on the top platforms.

Item	Valu e	Comment
number of HV channels	640	HV channel : PMT = 1 : 8
HV module type	LC 1461N-m100	
nominal voltage	-1.4 – -1.8 kV	
required accuracy	1 V	
nominal current	0.25 mA / PMT $\times$ 8	at -1800 V
required accuracy	0.01 mA	
read-back frequency	1 Hz	for online monitoring
recording frequency	30 min	for archiving

6.2 Temperature Monitoring

The PMT array temperature is monitored by 24 sensors (12 per arm, 6 per side) that are located on the PMT supermodules. The temperature sensors are connected by cables through the bottom end walls to ADC modules chosen by ONCS (one temperature sensor to one ADC channel).

Item	Value	Comment
number of sensors	24	
sensor type	thermo-couple	
voltage range	?	
required accuracy	1 degree C	
read-back frequency	1 Hz	for online monitoring
recording frequency	30 min	for archiving

6.3 Gas Flow Monitoring

The inlet gas flow is monitored for each arm, with electronic flow meters in the PHENIX gas mixing room.

Item	Value	Comment
number of sensors	2	
sensor type	unknown	
voltage range	?	
nominal flow	10 – 20 l/min	operation
	100 l/min	flushing
required accuracy	0.1 l/min	
read-back frequency	1 Hz	for online monitoring
recording frequency	30 min	for archiving

6.4 Gas Pressure Monitoring

The inside gas pressure is monitored at 2 locations in each vessel.

Item	Value	Comment
number of sensors	4	
sensor type	unknown	
voltage range	?	
nominal pressure	12 mm H_2O	above outside
required accuracy	1 mm H_2O	
read-back frequency	1 Hz	for online monitoring
recording frequency	30 min	for archiving

6.5 Inside Oxygen Content Monitoring

Each vessel has a penetration of the end wall to extract a gas sample flow. No internal cable exists.

Item	Value	Comment
number of sensors	4	
sensor type	unknown	
voltage range	?	
monitoring range	0 – 1,000 ppm	
required accuracy	1 ppm	
control range	0 – 25 %	for interlock
required accuracy	0.1 %	
read-back frequency	1 Hz	for online monitoring
recording frequency	30 min	for archiving

6.6 Water Level Monitoring

There is a water level monitoring at the lowest point in each vessel.

Item	Value	Comment
number of sensors	2	
sensor type	unknown	
voltage range	?	
required accuracy	'1 drop'	
read-back frequency	1 Hz	for online monitoring
recording frequency	30 min	for archiving

6.7 Outside Flammable Gas Monitoring

The RICH uses the PHENIX common flammable gas detection system.

Item	Value	Comment
number of sensors	8	
sensor type		part of PHENIX common monitoring
required accuracy		part of PHENIX common monitoring
read-back frequency	1 Hz	for online monitoring
recording frequency	30 min	for archiving

7 TOF

7.1 High Voltage

Item	Value	Comment
Number of HV channels	960	HV channel : PMT = 1:2
HV module type	CAEN	
Voltage	-1800 - -2000 V	
PMT HV current	0.5 - 0.6mA	
readback frequency	1/min	for online monitoring only
recording frequency	1/hour	for archiving

Comments:

- The ToF group is responsible for integrating their CAEN based HV system into EPICS.

7.2 Low Voltage

LV will be made at BNL. Specifications have not been determined. Requirement for power is +6.5V, 2.3A/FEM, -6.3V, 3.4A/FEM.

Item	Value	Comment
Number of channels	to be determined	
Sensor type	DC power monitor	
Voltage range	$+-$ 6-7V	
Required accuracy	0.1V	
update frequency	30 min	
recording frequency	30 min	

7.3 Temperature Monitoring

There are 10 or 20 temperature monitors in the ToF system (1 or 2 per panel). The temperature sensors are connected by cable to an ADC module choosen by ONCS (one temperature sensor to one ADC channel). The temparature monitors will be interelocked to HV modules with a trip point of 50^{o}C.

Item	Value	Comment
Number of sensors	10 or 20	
Sensor type	?	
Voltage range	?	
Required accuracy	1^{o}C	
update frequency	30 min	
recording frequency	30 min	

7.4 Cooling Fan Monitoring

There are 60 DC power monitors for each cooling fan at the side rack of the TOF system.

Item	Value	Comment
Number of channels	60	
Sensor type	DC power monitor	
Voltage range	24 V	
Required accuracy	1 V	
update frequency	30 min	
recording frequency	30 min	

7.5 Questions

- The TOF will have smoke detectors. Note that safety related monitoring does not belong into ONCS area of responsibility.

- Answer:Smoke detectors will not be installed in TOF.

8 PbSc

8.1 High Voltage

Item	Value	Comment
Number of HV channels	324	48 PMTs per HV channels
HV module type	1461m104	
Voltage	-1200 - -1700 V	
readback frequency	1/min	for online monitoring only
recording frequency	no	for archiving

8.2 Monitoring

It is foreseen to monitor the currents at every PMT. Due to the high number of channels (over 15,000) it is foreseen to use a multiplexed readout at the sector level. Every sector has an interface board with an ADC which can measure the current of a preselected PMT. Communication with the interface boards is done through Arcnet from a PC initially.

Every sector has in addition two temperature sensors that can also be selected through Arcnet and read out in the same way as the PMTs.

Comments:
The group favours integration of the PMT monitoring system into EPICS at a later stage, which is the responsibility of the EMCAL group.
The temperature monitoring would favorably be done separate from the PMT monitoring if possible. As there are only a few channles, they could be read out by simple ADCs (?).

9 PbGl

9.1 High Voltage

Item	Value	Comment
Number of HV channels	9216	HV channel : PMT = 1:1
HV module type	HIVOC	
Voltage	0-1900 V	
readback frequency	1/min	for online monitoring only
recording frequency	$\approx$ 1/shift	for archiving

Comments:

- The PbGl has its own custom HV system. It is the PbGl group's responsibility to integrate this system into EPICS.

9.2 Temperatur Monitoring

Item	Value	Comment
Number of sensors (Rear)	16	1 per FEE column
Number of sensors (Front)	384	1 per SM
Sensor type	?	
Voltage range	?	
Required accuracy	0.1^o C relative	
update frequency	$\approx$ 30 min	
recording frequency	$\approx$ 30 min	

Existing sensors. Number to be readout could be much fewer.

10 MuTr

10.1 High Voltage

Item	Value	Comment
Number of HV channels	576	288 per arm,4 chan per anode plane
HV module type	LC 1469P	
Voltage	+1.8 - +2.6 kV	
HV current	<1 uA	per channel
readback frequency	?	for online monitoring only
recording frequency	$\simeq$ 30 min	for archiving

10.2 Detector and Alignment

Note: Hall probes for monitoring the magnetic field are not considered here. They are considered part of a separate Muon Arm magnet subsystem. There will probably be several hundred available per arm. Will all or any of these need to be monitored?

- Alignment monitor (7 per octant, 56 per arm)
  Attributes:
  - CCD output (binary in - 2 digitized words (8bit) per monitor)

  [Since the CCD output is more than a single bit wide, it is counted separately from the other binary input channels which are a single bit.]

- Arm Gas Volume (2 per arm)
  Attributes:
  - valve state (binary in)
  - valve control (binary out)
  - pressure sensor (analog in)
  - leak sensor (analog in)

- Station Gas Volume (6 per arm)
  Attributes:
  - valve state (binary in)
  - valve control (binary out)
  - pressure sensor (analog in)
  - leak sensor (analog in)

- Octant Gas Volume (48 per arm)
  Attributes:
  - valve state (binary in)
  - valve control (binary out)

- flow sensor (analog in)

- Recirculating gas system
  Attributes:
  - valve state (binary in) number not determined
  - valve control (binary out) number not determined
  - flow sensor (analog in)
  - gas purity sensor (analog in)

10.3 FEE Systems

10.3.1 Systems Inside the Magnets

- FEE Electrical

  Controls:
  Attributes: Power On/Off control @ FEM Power Card
  Device Type: Binary Out
  Count: 241 North Arm + 209 South Arm

  Attributes: Power On/Off control @ AnodesROC+OB feed
  Device Type: Binary Out
  Count: 72 North Arm + 72 South Arm

  Sensors:
  Attributes: Low Voltage @ FEM Backplane (FEM regulator out) Device Type: Analogue In
  Count: 241 North Arm + 209 South Arm

  Attributes: Current @ FEM Power Card input Device Type: Analogue In Count: 241 North Arm + 209 South Arm

- FEE Cooling

  Controls: None

  Sensors:

  Attributes: Temperature @ each FEM DAQ Interface
  Device Type: Analogue In
  Count: 241 North Arm + 209 South Arm

  Attributes: Temperature twice within each AnodesROC+OB housing
  Device Type: Analogue In
  Count: 48 North Arm + 48 South Arm

- Environment
  Controls: None
  Sensors: None

10.3.2 Systems Outside the Magnets

- FEE Electrical

  Controls:
  Attributes: Power On/Off control to each LV power supply
  Device Type: Binary Out
  Count: 24 North Arm + 24 South Arm
  (WAG, and assuming 100-200A per 5V supply)

  Sensors:
  Attributes: Voltage @ each LV power supply output
  Device Type: Analogue In
  Count: 24 North Arm + 24 South Arm

  Attributes: Current @ each LV power supply output
  Device Type: Analogue In
  Count: 24 North Arm + 24 South Arm

- FEE Cooling

  Controls:

  Attributes: On/Off control @ outlet to each interior water manifold
  Device Type: Binary Out
  Count: 20 North Arm + 20 South Arm

  Sensors:
  Attributes: Temperature @ input to water supply manifold
  Device Type: Analogue In
  Count: 3 North Arm + 3 South Arm

  Attributes: Water flow @ input to water supply manifold
  Device Type: Analogue In
  Count: 3 North Arm + 3 South Arm

  Attributes: Temperature @ return from each interior water manifold
  Device Type: Analogue In
  Count: 20 North Arm + 20 South Arm

  Attributes: Water flow @ return from each interior manifold
  Device Type: Analogue In

Count: 20 North Arm + 20 South Arm

- FEE Environment

  Controls:
  Attributes: On/Off control @ output to each interior gas manifold
  Device Type: Binary Out
  Count: 20 North Arm + 20 South Arm

  Sensors:
  Attributes: N_2 gas flow @ input to gas supply manifold
  Device Type: Analogue In
  Count: 3 North Arm + 3 South Arm

  Attributes: N_2 gas flow @ return from each interior manifold
  Device Type: Analogue In
  Count: 20 North Arm + 20 South Arm

  Attributes: Humidity @ top & bottom of Stations 2 & 3 inside magnet
  Device Type: Analogue In
  Count: 4 North Arm + 4 South Arm

Questions:

- Are there any requirements on how these channels are read out? Single inputs to ADCs ok? ANSWER - Special attention has to be made for understanding the grounds and the effect the method of readout has on the noise that could be introduced. At a minimum the input to the ADC's should be differential to provide noise reduction. We would request that the choice of the ADC module and method of cabling be determined and distributed for comment so that we can determine if it can be integrated without introducing additional noise.

DEVICE TYPE	DEVICES	ANA.I	BIN.I	ANA.O	BIN.O
FEM LV (voltage)	498	498			
FEM LV (current)	48	48			
FEM power control	642				642
FEM water control	40				40
FEM gas control	40				40
FEM temperature	592	592			
FEE water flow	46	46			
FEM gas flow	46	46			
FEM Humidity	8	8			
Subtotal	1960	1238			722
Ambient temperature	20	20			
Gas reciculating	?				
Gas volume (valve)	112		112		112
Gas pressure	16	16			
Gas leak	16	16			
Gas flow	96	96			
Alignment CCD	224		224		
Subtotal	484	148	336		112
TOTAL	2444	1386	336		834

Table 5: Muon Tracking Ancillary System Counts (both arms)

11 Muon Identifier Ancillary Systems

11.1 High Voltage

Item	Value	Comment
Number of HV channels	600	300 per arm
HV module type	LC 1471P	
Voltage range	4.3 kV -300/+700	
HV current	100 μA	
readback frequency	?	for online monitoring only
recording frequency	$\simeq$ 30 min	for archiving

The counts are based on 5 gaps only, each with 6 panels.

11.2 Gas Monitoring System

- Gas flow monitoring:
  There are 600 gas chains (300 per arm), each chain has 2 valves (type?) and 2 pressure switches (type?), both are of binary type (on or off). Each gas chain (see figure) has two valve (read/write), an overpressure protection switch (read/write) and a flow/no-flow sensore (read/write).

- Flammable gas leak detector:
  There are 10 independent gas monitor systems (one per gap). Each one has 6 valves (one per panel) and a low count ADC.

DEVICE TYPE	DEVICES	ANA.I	BIN.I	ANA.O	BIN.O
Streamer tube gas volume	2400		2400		2400
Panel Leak Detector	60	60		60	
TOTAL	2460	60	2400	60	2400

Table 6: Muon ID Ancillary System Channel Counts (both arms)

Questions:

- It is necessary to multiplex the channels? How expensive is it to to have a non-multiplexed system?

  ANSWER: This requires further study and the answer will not be known until after the 10/97 Collaboration meeting. For now, the answer is that multiplexing may very well be required.

- Is the flammable gas leak detector necessary for safety? If so it should not be controlled by ONCS.

  ANSWER: This is a valid concern. But in order to be sure that we do not underestimate our ONCS request, let us keep the table as it is above until further notice.