

# ACNET Devices Related to the Hadron and Muon Monitors

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# Hadron and Muon Monitor

## ACNET Devices

- Low Level Devices : **E:HADMDS[i] and E:MMA#DS[i]; # = 1, 2, 3; i = 104-199**  
**E:HADMPD[i] and E:MMA#PD[i]; # = 1, 2, 3; i = 104-199**
- High Level Devices : **E:HADINT and E:MM#INT; # = 1,2,3.**
- Higher Level Devices : **E:HADCNT and E:MM#CNT; # = 1,2,3.**  
**E:HADPRC and E:MM#PRC; # = 1,2,3.**
- Highest Level Devices : **E:HADCOR and E:MM#COR; # = 1,2,3.**
- Other : **E:HADXAV and E:MM#XAV; # = 1,2,3.**  
**E:HADYAV and E:MM#YAV; # = 1,2,3.**

(SELECT "MATCHING" IN LUMBERJACK WHEN PLOTTING POT NORMALIZED QUANTITIES.)

- Related Devices : **E:HMHV<sub>i</sub> and E:MM#HV<sub>j</sub>, i = 1-8; # = 1,2,3; j = 1-3**  
**E:HMGPR and E:MM#GPR; # = 1,2,3**  
**E:HMRTD**  
**E:MM#RTD; # = 1,2,3**  
**E:HMGF and E:MM#GF; # = 1,2,3**

# E:HADMDS[i] and E:MMA#DS[i]

(low level)

- **E:HADMDS[i] and E:MMA#DS[i]; # = 1, 2, 3; i = [104 -199]. Units = Volts**
  - Have existed since the beginning of time (i.e. start of NuMI beam in Dec 2004)
  - Unused Channels = i.e. not connected to a chamber
    - Unused hadron monitor channels = [105-151]
    - Unused muon monitor channels = [137-151]
  - These array buffers store the raw reading from each channel of the monitors' swic scanner ON \$A9. \$A9 is the event which signals beam is being delivered to NuMI. THIS IS THE SIGNAL READING. Reading comes from the VME front end. There is a conversion applied in the VME front end which takes the readings from ADC's to Volts. Those channels not actually connected to a chamber are above.
  - The swic scanners are triggered on \$A9+0.01ms. The gate is 16.666s (must be to avoid 60Hz noise). The E:HADMDS[i] and E:MMA#DS[i] buffers are filled after \$A9+0.01ms+16.666ms+~3ms. Read into lumberjack in NUMI logger on AD+1.9sec.
  - **IMPORTANT: MUST SELECT "MATCHING" IN LUMBERJACK WHEN PLOTTING POT NORMALIZED QUANTITIES!**

# E:HADMPD[i] and E:MMA#PD[i]

(low level)

- **E:HADMPD[i] and E:MMA#PD[i]; # = 1, 2, 3; i = [104 -199]. Units = Volts.**
  - Have existed since Jan 2008 but were not correct. Only use after April 10 2009.
  - Unused Channels = i.e. not connected to a chamber
    - Unused hadron monitor channels = [105-151]
    - Unused muon monitor channels = [137-151]
  - These array buffers store the raw reading from each channel of the monitors' swic scanner ON \$AD. \$AD is the event which comes ~1.2 secs before \$A9. Thus there is no beam during this reading. THIS IS THE PEDESTAL. Reading comes from the VME front end. There is a conversion applied in the VME front end which takes the readings from ADC's to Volts. Those channels not actually connected to a chamber are above.
  - The swic scanners are triggered on \$AD+1.1s. The gate is 16.666s (must be to avoid 60Hz noise). The E:HADMPD[i] and E:MMA#PD[i] buffers are filled after \$AD+1.1s+16.666ms+~3ms. Read into lumberjack in NUMI logger on AD+1.9sec.

# E:HADINT and E:MM#INT

(high level)

- **E:HADINT and E:MM#INT; #= 1,2,3.** Units = Volts.
  - Have existed since the beginning of time (i.e. start of NuMI beam in Dec 2004)
  - These devices are the sum of the readings from each pixel of each monitor. No corrections are applied (raw data).
  - In acnet code speak:
    - $E:HADINT = \text{SUM}(i= 104, 152-199) E:HADMDS[i]$ .
    - $E:MM\#INT = \text{SUM}(i= 104-136, 152-199) E:MMA1DS[i]$ .
  - Calculated in VME front end.
  - These devices are computed after the  $E:HADMDS[i]$  and  $E:MMA\#DS[i]$  buffers are filled. Read into lumberjack in NUMI logger on AD+1.5sec.
  - **IMPORTANT: MUST SELECT “MATCHING” IN LUMBERJACK WHEN PLOTTING POT NORMALIZED QUANTITIES!**

# E:HADCNT and E:MM#CNT

(higher level)

- **E:HADCNT and E:MM#CNT; #= 1,2,3.** Units = Volts.
  - Have existed since Jan 2008 but were not correct. Only use after April 10 2009.
  - These devices are the pedestal corrected sum of the readings from each pixel of each monitor.
  - In acnet code speak:
    - $E:HADCNT = \text{SUM}(i= 104, 152-199) [E:HADMDS[i] - E:HADMPD[i]].$
    - $E:MM\#CNT = \text{SUM}(i= 104-136, 152-199) [E:MMA1DS[i] - E:MMA\#PD[i].$
  - For the DS buffers see the previous page. For the PD buffers: The swic scanners are triggered on \$AD+1.1s. The gate is 16.666s (must be to avoid 60Hz noise). The E:HADMPD[i] and E:MMA#PD[i] buffers are filled after \$AD+1.1s+16.666ms+~3ms. Read into lumberjack in NUMI logger on AD+1.5sec.
  - **IMPORTANT: MUST SELECT “MATCHING” IN LUMBERJACK WHEN PLOTTING POT NORMALIZED QUANTITIES!**

# E:HADPRC and E:MM#PRC

(higher level)

- **E:HADPRC and E:MM#PRC; #= 1,2,3.** Units = Volts.
  - These devices are the pressure corrected(only) sum of the readings from each pixel of each monitor.
  - In acnet code speak:
    - $E:HADPRC = E:HADINT * [ 1.0 - 0.00105*(E:HMGPR - 700.0)]$ .
    - $E:MM\#PRC = E:MM\#INT * [ 1.0 - 0.00105*(E:MM\#GPR - 800.0)]$ .
  - E:HMGPR and E:MM#GPR is the pressure readings of the monitor gas at the electronics rack in torr. These devices are read out every 2mins. See my thesis for the origin of the 0.00105 correction factor.
  - These devices are computed on \$A5 (timeline is \$A5-\$AD-\$A9), so the computation is 1 spill behind. The time stamp is pushed back to the previous \$AD+0.3s so when plotting the POT normalized quantities the readings match for each spill. These devices are logged in Lumberjack in the Stats logger.
  - **IMPORTANT: MUST SELECT “MATCHING” IN LUMBERJACK WHEN PLOTTING POT NORMALIZED QUANTITIES!**

# E:HADCOR and E:MM#COR

(highest level)

- **E:HADCOR and E:MM#COR; #= 1,2,3.** Units = Volts.
  - These devices are the pedestal, calibration and pressure corrected sum of the readings from each pixel of each monitor.
  - In acnet code speak:
    - $$\text{E:HADCOR} = \{ \text{SUM}(i= 104, 152-199) [ ( \text{E:HADMDS}[i] - \text{E:HADMPD}[i] ) * \text{hadcal}[i] ] \}$$
$$* [ 1.0 - 0.00105 * (\text{E:HMGPR} - 700.0) ].$$
    - $$\text{E:MM#PRC} = \{ \text{SUM}(i= 104, 152-199) [ ( \text{E:MMA\#DS}[i] - \text{E:MMA\#PD}[i] ) * \text{mm\#cal}[i] ] \}$$
$$* [ 1.0 - 0.00105 * (\text{E:MM\#GPR} - 800.0) ].$$
  - See previous slide for an explanation of the devices. hadcal[] and mm#cal[] are the calibration constants determined before the monitors' installation (see Dharma's thesis).
  - These devices are computed on \$A5 (timeline is \$A5-\$AD-\$A9), so the computation is 1 spill behind. The time stamp is pushed back to the previous \$AD+0.3s so when plotting the POT normalized quantities the readings match for each spill. These devices are logged in Lumberjack in the Stats logger.
  - **IMPORTANT: MUST SELECT "MATCHING" IN LUMBERJACK WHEN PLOTTING POT NORMALIZED QUANTITIES!**



# E:HADXAV and E:MM#XAV

# E:HADYAV and E:MM#YAV

- **E:HADXAV and E:MM#XAV; #= 1,2,3.** Units = inches.  
**E:HADYAV and E:MM#YAV; #= 1,2,3.** Units = inches.
  - Have existed since the beginning of time (i.e. start of NuMI beam in Dec 2004)
  - These devices are the gaussian average of the X and Y monitor profiles. X and Y profiles are made using E:HADMDS[i] and E:MMA#DS[i]. The profiles are fit to a gaussian.
  - Might be calculated in VME front end.
  - These devices are computed after the E:HADMDS[i] and E:MMA#DS[i] buffers are filled. Read into lumberjack in NUMI logger on AD+1.5sec.

# E:HMHV*i*

- **E:HMHV*i***; *i* = 1-8. Units = Volts.
- E:HMHV*i* are the high voltage readings from the drogues supplying the HV to the hadron monitor. The layout is below.

## High Voltage Map

HADRON MONITOR Channels(seen from beams eye view)

One Droge provides the HV to one row, but each pixel connects to the HV through its own HV cable. The fan-out occurs at the HV distribution box in the electronics rack

	Column		1	2	3	4	5	6	7	
	Row									
E:HMHV1	1	upper left	48	49	50	51	52	53	54	gas line is here
E:HMHV2	2		55	56	57	58	59	60	61	upper right
E:HMHV3	3		62	63	64	65	66	67	68	
E:HMHV4	4		69	70	71	72	73	74	75	
E:HMHV5	5		76	77	78	79	80	81	82	
E:HMHV6	6		83	84	85	86	87	88	89	
E:HMHV7	7	lower left	90	91	92	93	94	95	0	lower right
E:HMHV8 – Extra										

- Prior to Nov 2007, all drogues are set to 130V. After Nov 2007, all drogues are set to 90V.
- Logged in LUMBERJACK in the NuMI 2min datalogger. E:HMHV4 is also logged in the NUMI AD+1.5s datalogger.

# E:MM#HVj

- **E:MM#HVj**; # = 1,2,3; j = 1-3. Units = Volts.
  - E:MM1HVj, E:MM2HVj and E:MM3HVj are the high voltage readings from the drogues supplying the HV to muon monitors 1, 2 and 3 respectively. The layout for a single monitor is below.

## High Voltage Map

MUON MONITOR Channels(seen from beams eye view)

One Droge provides the HV to 3 columns, but each column(tube) connects to the HV through its own HV cable. That fan-out occurs at the HV distribution box in the electronics rack. The fan-out to each chamber occurs at the tube.

Tube #, Column Row		E: MM#HV1			E: MM#HV2			E: MM#HV3			# = 1,2 or 3
		1	2	3	4	5	6	7	8	9	
1	upper left	48	57	66	75	84	93	6	15	24	upper right
2		49	58	67	76	85	94	7	16	25	
3		50	59	68	77	86	95	8	17	26	
4		51	60	69	78	87	0	9	18	27	
5		52	61	70	79	88	1	10	19	28	
6		53	62	71	80	89	2	11	20	29	
7		54	63	72	81	90	3	12	21	30	
8		55	64	73	82	91	4	13	22	31	
9	lower left	56	65	74	83	92	5	14	23	32	lower right

hv feed throughs are here

- All HV drogues are set to 300V.
- Logged in LUMBERJACK in the NuMI 2min datalogger.

# E:HMGPR and E:MM#GPR

- **E:HMGPR and E:MM#GPR; # = 1,2,3; Units = torr.**
  - E:HMGPR, E:MM1GPR, E:MM2GPR and E:MM3GPR are the pressures in the gas lines of the hadron monitor, and muon monitors 1, 2 and 3 respectively. The measurement is taken at the underground electronics rack just after the gas line fans out to the individual monitors.
  - Logged in LUMBERJACK in the NuMI 2min datalogger.

# E:HMGF and E:MM#GF

- **E:HMGF and E:MM#GF; # = 1,2,3; Units = torr.**
  - E:HMGF, E:MM1GF, E:MM2GF and E:MM3GF are flow rates of the helium gas to the the hadron monitor, and muon monitors 1, 2 and 3 respectively. The measurement is taken by flow meters at the underground electronics rack just after the gas line fans out to the individual monitors. The flow meter needle valve can be manually controlled to change the flow rates.
  - Logged in LUMBERJACK in the NuMI 2min datalogger.

# E:MM#RTD

- **E:MM#RTD**; # = 1,2,3; Units = F.
  - E:MM1RTD, E:MM2RTD and E:MM3RTD are temperatures in alcoves 1, 2 and 3, respectively. The measurement is taken somewhere near the monitor itself.
  - Logged in LUMBERJACK in the NuMI 2min datalogger.

# E:HMRTD

- **E:HMRTD**; # = 1,2,3; Prior to July 2010 Units = F. After July 2010 Units = p.p.m..
  - Prior to November 2007 E:HMRTD is the temperature at the location of the hadron monitor. In Nov 2007 the hadron monitor was replaced. The new hadron monitor does not have a temperature sensor.
  - In July of 2010, a oxygen analyzer is connected to E:HMRTD. There after E:HMRTD is the O2 content in the helium gas line measured at the underground electronics rack just before the line fans out to the individual monitors.
  - Logged in LUMBERJACK in the NuMI 2min datalogger.

# Muon Monitor Gas Calibration Chamber ACNET Devices

- Low Level Devices : **E:MGSMPPD[104], E:MGSMPPD[105] and E:MGSMPPD[106].**
- High Level Devices : **E:MGSM1, E:MGSM2 and E:MGSM3**
  
- Related Devices: **E:MM1GPD, E:MM2GPD, E:MM3GPD**



# E:MGSMPD[i]

- **E:MGSMPD[i]; i = 104, 105, 106**
  - These devices are the readings from the gas calibration chamber located in the gas exhaust line of muon monitors 1(104), 2(105) and 3(106). No corrections are applied (raw data).
  - Reading comes from the VME front end. There is a conversion applied in the VME front end which takes the readings from ADC's to Volts.
  - The swic scanner is triggered on  $\$AD+0.1s$ . The gate is .5s. The E:MGSMPD buffer is filled after  $\$AD+0.1s+0.5s+\sim 3ms$ . Read into lumberjack in NUMI logger on  $AD+1.5sec$ .

# E:MGSM#

- **E:MGSM#; i = 1, 2, 3**
  - These devices are the pressure corrected readings from the gas calibration chamber located in the gas exhaust line of muon monitors 1, 2 and 3.
  - In acnet code speak:
    - $E:MGSM1 = E:MGSM[104] * [ 1.0 - 0.00141*(E:MM1GPR - 800.0)]$ .
    - $E:MGSM2 = E:MGSM[105] * [ 1.0 - 0.00141*(E:MM2GPR - 800.0)]$ .
    - $E:MGSM3 = E:MGSM[106] * [ 1.0 - 0.00141*(E:MM3GPR - 800.0)]$ .
  - E:MM#GPR is the pressure readings of the monitor gas at the electronics rack in torr. These devices are read out every 2mins.
  - These devices are computed on \$A5 (timeline is \$A5-\$AD-\$A9), so the computation is 1 spill behind. The time stamp is pushed back to the previous \$AD+0.3s. These devices are logged in Lumberjack in the Stats logger.

# E:MM#GPD

- **E:MM#GPD**; # = 1,2,3; Units = torr.
  - E:MM1GPD, E:MM2GPD and E:MM3GPD are the pressures in the gas lines of the hadron monitor, and muon monitors 1, 2 and 3 respectively. The measurement is taken at the location of the respective gas calibration chambers. Currently only pressure transducers in the lines of mm1 and mm2 exist. Because the device that reads out the mm1 transducer is broken the MM1 transducer is connected to the MM2 read out and the MM2 transducer is connected to the MM3 readout. Also, the readings are wrong. Reading are ~500torr, but they should be closer to 800torr.
  - Logged in LUMBERJACK in the NuMI 2min datalogger.

# Monitor Gas System ACNET

## Devices

- E:MGSH1
- E:MSGHP2
- E:MGSPUP
- E:MGSP

# E:MGSH1P1 and E:MGSH1P2

- **E:MGSH1P1 and E:MGSH1P2.** Units = psi.
  - E:MGSH1P1 and E:MGSH1P2 are the pressures in the gas lines of the manifold gas supply bottles(the 8-pack) and the single spare bottle respectively.
  - Logged in LUMBERJACK in the FixTr 2min datalogger.

# E:MGSPUP and E:MGSP

- **E:MGSPUP and E:MGSP.** Units = psi.
  - E:MGSPUP and E:MGSP are the pressures in the gas lines after the pressure regulation which steps the pressure from the bottles down from 2000psi to 60psi. E:MGSPUP is measured just after the step down at the gas supply rack in the MINOS service building. E:MGSP is measured at the underground electronics rack before the gas line fan out to the individual monitors.
  - E:MGSPUP is logged in LUMBERJACK in the FixTr 2min datalogger.
  - E:MGSP is logged in LUMBERJACK in the NUMI 2min datalogger.