A Novel Monitoring System for Electronic Instrumentation

Mary Ann Antonioli, Peter Bonneau, Tanest Chinwanawich, Brian Eng, Michael Ferguson,
Tony Madany, Marc McMullen, Armenak Stepanyan, Werth Teachey and Amrit Yegneswaran

Physics Division, Thomas Jefferson National Accelerator Facility, Newport News, Va 23606
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This paper presents a synopsis of a National Instruments' (NI) Field Point devices and LabVIEW software based monitoring system, the HMS Monitoring System (HMS) that has been designed, developed and commissioned to monitor by acquiring and analyzing the performance-indicator signals, AC/DC voltages, currents, temperatures and fan statuses, the performance of the electronic instrumentation of the Continuous Electron Beam Accelerator Facility's Large Acceptance Spectrometer (CLAS) at Jefferson Laboratory and to gather diagnostic data that aid in the engendering of problem-history files which serve as databases that help debug instrumentation, prioritize servicing, and provide warning of potential problems – overall promoting optimal performance, minimal downtime and maximal safety.

HMS that monitors the performance of a variety of off-the-shelf and custom-built electronics, several types of crates and power supplies, and a myriad of read-out components, the electronic instrumentation of about 40,000 CLAS signal-channels, comprises the Crate Data Recorder (CDR) that acquires, analyzes and checks about 1600 performance-indicator signals generated by about 150 crates[†] and initiates recording of signal faults, signals values that are out of operational limits, the AC Sensor and Controller (ACSC) that in conjunction with the BiRa Systems' Reset Module senses the crate's power status and enables remote resetting of many of the crates, and the Control Instrumentation (CI), which consists of Reset, Relay, Power Router and Breakout Modules that facilitate rebooting or taking the CDR and the ACSC offline.
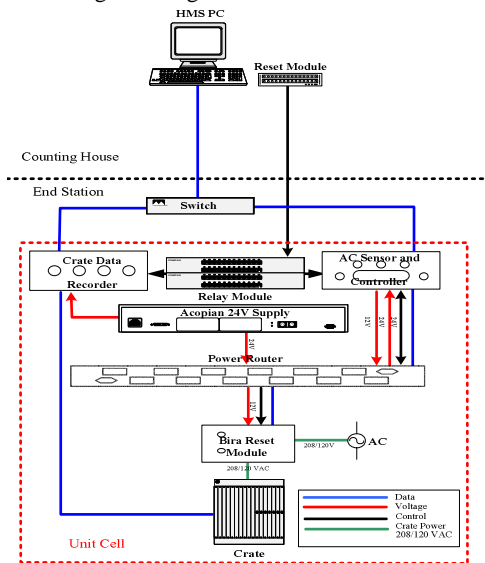

Figure 1: Unit Cell Configuration.

Installed in each area[†] into which the end station is partitioned for monitoring, and networked in a bus topology are CDRs and ACSCs, configured with a combination of Field Point devices and downloaded with software written in LabVIEW, and the CI, which together form the unit cell whose layout, Figure 1, shows that: the CDR receives data directly from the crate's status-connector or custom-built read-out card[§], the crate's power status is routed via the Power Router to the ACSC, the 24 VDC Acopian Supply provides control power for the units, the Reset and Relay modules control the CDR and the ACSC, while the Power Router the BiRa

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[†]The Appendix lists types and counts of crates, power supplies, monitored signals and areas, and shows the overall layout of the system.
[§] NIM, CAMAC and FASTBUS crates need special read-out cards, as they do not have built-in status-connectors.

Reset Module, and that the information from the CDR and the ACSC is forwarded via the 100 Mbps CAT 5 cable over the 96-subnet switch and the 100 Mbps fiber to the central computer, Monitor, IP Address: 129.57.96.18, in the counting house that runs the monitoring program which works in a broadcast and datalog error only mode.
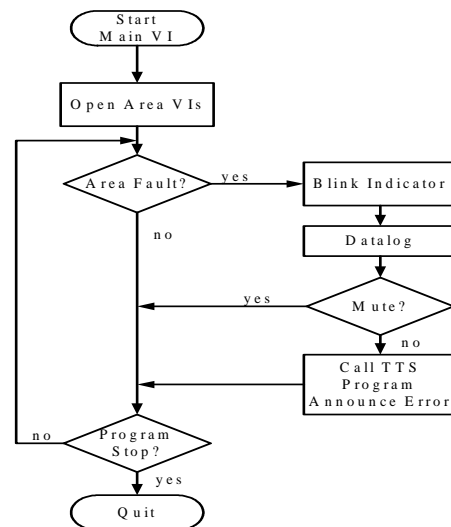

Figure 2: Program Flowchart.

The monitoring program's ***Main.VI***[η], Figure 2 shows the flow-chart, calls in the code's ***Open Area VIs*** section ***Area VIs*** that check the performance-indicator signals in specified areas, *e.g.*, ***Area.VI***: ***SFL1N.VI*** monitors Space Frame Level 1 North, and if an ***Area.VI*** detects a signal fault then the information is broadcasted to the ***Main VI*** and the software's ***Blink Indicator*** part makes that area's indicator display a signal fault status after which the ***Datalog*** section of the code logs date, time, error address and error information in an EXCEL spreadsheet, subsequent to which ***Call Text To Speech (TTS)*** issues an audio-visual alarm to alert personnel, provided the mute feature for the CDR that detected the error is not selected and finally the choice to quit program is presented by the ***Program Stop*** section which if not opted permits ***Main VI*** to begin the loop again and which if opted causes ***Main VI*** to signal ***Area VIs*** to close and wait for all *sub-VIs* to terminate before halting execution.

To conclude, HMS, which is functioning as designed, has the following features: scalable architecture, parallel monitoring at the CDR level, portable software that broadcasts and logs only error information, and interface capability – other control systems such as the Experimental Physics and Industrial Control System (EPICS) can be interfaced with HMS.

[η] LabVIEW files are called *Virtual Instruments (VIs)*

Monitored Signals	Crate Types							
	ADB	CAEN	CAMAC	FASTBUS	LeCroy	NIM	VME	VXI
+5 (I)				√				
-5.2 (I)				√				
-2 (I)				√				
+15 (I)				√				
-15 (I)				√				
AC OK	√	√	√	√	√	√	√	√
AC Reset	√	√	√	√			√	√
CH Status		√						
Check Passed		√						
Crate Temp 1	√	√	√	√	√	√	√	√
Crate Temp 2	√	√	√	√	√	√	√	√
DC OK	√		√				√	√
DC OK +5				√				
DC OK –5.2				√				
DC OK -2				√				
DC OK +15				√				
DC OK -15				√				
Fan Status	√			√		√		
HV Error					√			
Interlock					√			
(I) Trip +5				√				
(I) Trip –5.2				√				
(I) Trip -2				√				
(I) Trip +15				√				
(I) Trip -15				√				
Module Reset				√			√	√
Over Temp	√		√	√		√	√	√
Power Fail						√		
Reset 1			√		√	√		
Smoke Alarm				√				
System Reset		√					√	√
TCI Reset	√							

Table 1: Monitored Signals.

Area	CDR	ACSC	Accopian‡	BiRa‡ Module	Power Router	ADB†	CAEN‡	CAMAC	FASTBUS	LeCroy‡	NIM	VME	VXI
SFL0	1		1	2	1	0	0	0	1	3	6	1	0
SFL1N	1	1	1	14	1	6	1	0	2	0	4	5	0
SFL1S	1	1	1	9	1	6	1	0	2	0	2	1	0
SFL2N	1	1	1	11	1	7	1	0	3	0	1	0	0
SFL3N	1	1	1	8	1	6	0	0	2	0	1	0	0
SFL3S	1	1	1	8	1	6	0	0	2	0	1	0	0
FCD2	1	2	1	10	1	0	0	9	4	0	4	3	3
FCD3	1	1	1	1	1	0	0	1	0	10	10	1	0
SCLIS	1	1	1	6	1	0	4	4	1	1	8	1	0
Pi Tower	1		1	1	1	0	0	6	1	1	0	0	0

Table 2: Types and counts of crates and power supplies and monitored areas.

Notation
SFL#(N/S): Space Frame Level # (North/South)
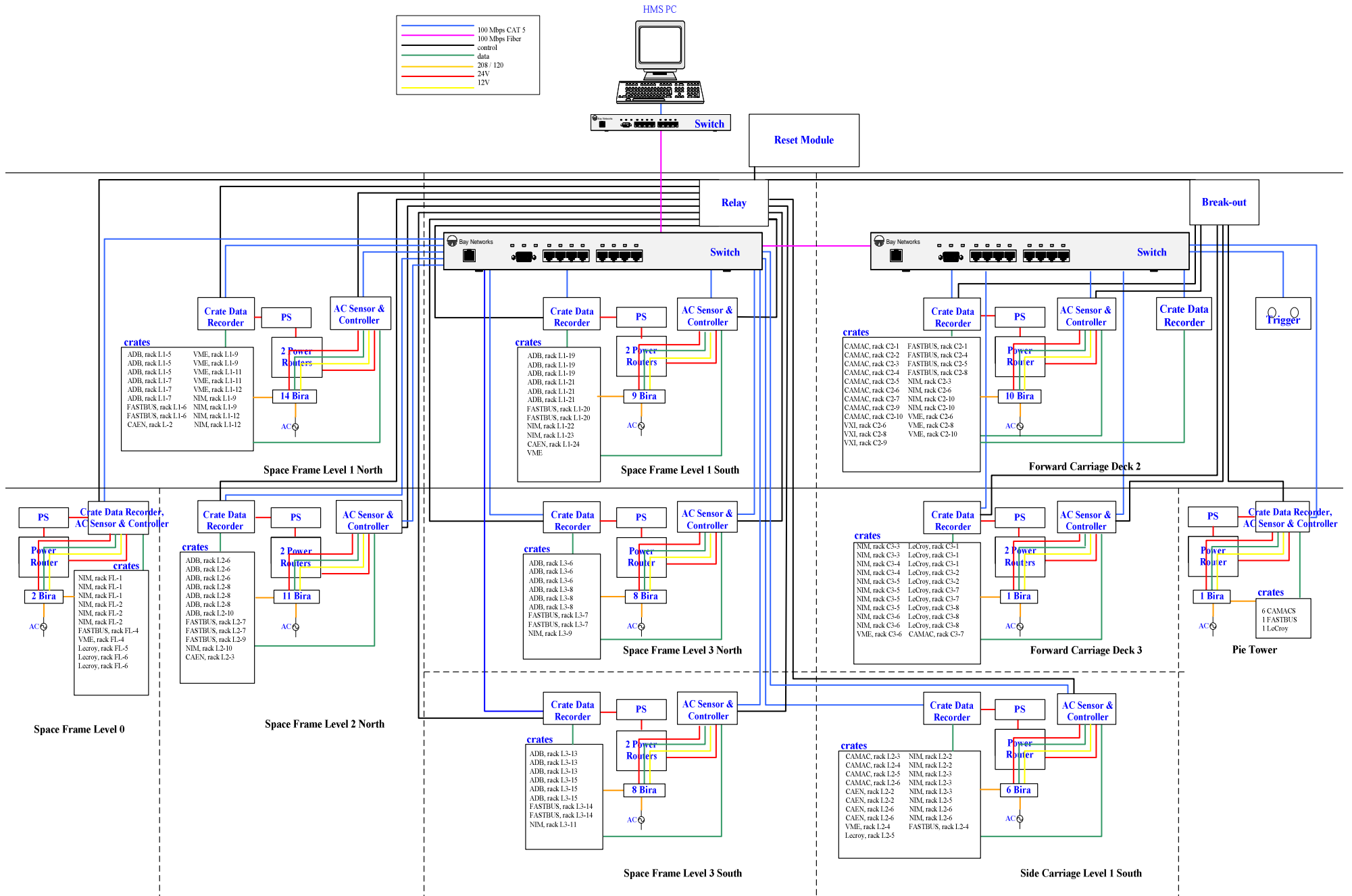FCD#: Forward Carriage Deck

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‡ Company Name
† Analog to Digital Board.

Figure 3: Overall Layout.