Interlock System of the Forward Tagger

Peter Bonneau, Mary Ann Antonioli, Sahin Arslan, Pablo Campero, Brian Eng, Amanda Hoebel, George Jacobs,
Mindy Leffel, Tyler Lemon, Marc McMullen, and Amrit Yegneswaran

Physics Division, Thomas Jefferson National Accelerator Facility, Newport News, VA 23606

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The network-independent, backup interlock system of the Forward Tagger (FT) is based on National Instruments' (NI) CompactRIO (cRIO) Programmable Automation Controller (PAC) platform and is designed to protect the detector from damage if the main, network-dependent, EPICS-based system fails.

The backup interlock system, based on National Instruments' cRIO PAC platform, is a reconfigurable, embedded control and acquisition system, the hardware architecture of which includes I/O modules, a reconfigurable field-programmable gate array (FPGA) chassis, and an embedded controller, which runs on a LabVIEW Real Time Linux Operating System. The cRIO system is mounted in a 5U NI chassis, Fig. 1, which contains 24 V and 5 V power supplies, and terminal blocks for low voltage distribution.
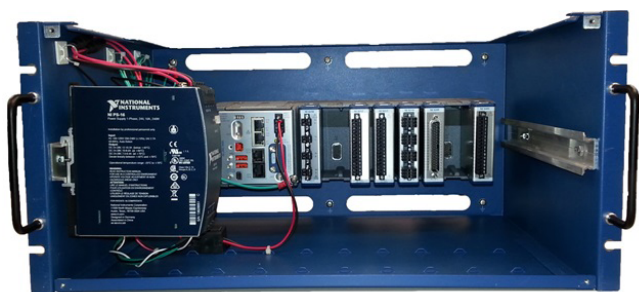

FIG. 1. Interior of NI chassis, housing the cRIO system.

Signals monitored by the system are calorimeter and hodoscope temperatures measured by PT100 RTDs, humidity by HIH-4000-003 sensors, and gas flow by an MKS gas flow meter; and the box lid switch signal, which disables high and low volt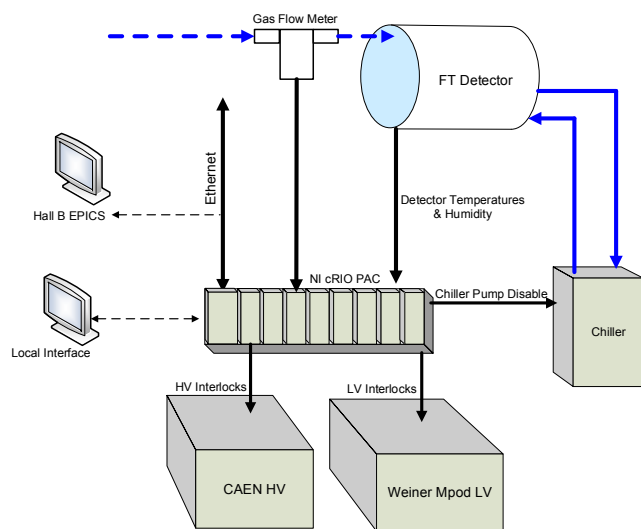age when the box lid is opened. The cRIO chassis obtains signals via direct connections to sensors and instrumentation, Fig 2.

There are seven high voltage modules—three 1530P modules, three A1737P modules, and one A1536HDM module. Each high voltage module is interlocked individually. To enable module channels, interlock signals are grounded.

Both Weiner Mpod IOMPV.8008LI low voltage modules are interlocked individually; a +5 V interlock signal enables module channels.

The Landau chiller is interlocked as well. The chiller has an expansion slot available for an independent interface to the interlock system. Using an LRZ 912 analog input/output accessory card and a 4−20 mA interface to the cRIO NI 9265 will allow the interlock system to turn the chiller pump on or off without interrupting the communication with the EPICS control system.

Table I details the type and number of signals monitored and the output interfaces to low voltage and high voltage crates and the chiller.

The interlock system controller will be configured to send the FT interlock status to the EPICS slow controls system using the standard cRIO-to-EPICS interface.

Table II details NI components needed for the FT interlock system. Components of the system are being procured and software development is in progress.

FIG. 2. Layout of the cRIO-based interlock system.

Signal type	# of channels	Input/output	Module
Calorimeter temperature	6	RTD inputs	NI 9216
Hodoscope temperature	2	RTD inputs	NI 9216
Calorimeter humidity	2	analog voltage inputs	NI 9205
Chiller interlock	1	analog current outputs	NI 9265
Hodoscope box lid switch	1	TTL-DIO inputs	NI 9401
HV interlock	7	relays	NI 9485
LV interlock	2	TTL-DIO outputs	NI 9401
Calorimeter gas flow	1	analog voltage input	NI 9205

TABLE I. Signal types, number of channels, input/output types, and NI modules used for the hardware interlock system.

Component	Part number	Model	Details	Units
Controller	783848-01	cRIO-9035	controller and chassis	1
RTD module	783664-01	NI 9216 with spring terminals	8-ch PT100 RTD 24-bit, 50S/s/ch, analog input module	1
Solid state relay	779600-01	NI 9485	8-ch, ±60 VDC, 750 mA (60 V ch-ch, 250 Vrms ch-earth isolated) SSR C Series module	1
16-Ch. analog input	779519-01	NI 9205 with spring terminals	16-ch (differential) ±200 mV to ±10 V, 16-bit, 250 kS/s analog input module	1
Analog output	783733-01	NI 9265 with spring terminals	0–20 mA, 16-bit, 100 kS/s, 4-ch AO module	1
DIO/TTL	779351-01	NI 9401 with D-sub	8-ch, 100 ns, TTL digital input/output module	1
cRIO blanks	196917-01	NI 9977	C-series blank cRIO modules	3
D-sub interface	781922-01	NI 9924	front-mount 25-pin D-sub to screw terminals	1
Rack mount	781989-01		rack mount kit for cDAQ/cRIO	1
Rail kit	157268-01		DIN rail mounting kit for 8-slot cRIO-9035	1
Power supply	781093-01	NI PS-15	power supply, 24 VDC, 5A, 100−120/200−240 VAC input	1

TABLE II. Forward Tagger interlock system components.