

Temporary SBND TPC Ramping - Expert Page

Back to Permanent TPC Ramping Page | Back to Shielding Page

Ramping Control

Full-Cap Termination Booth (PC1)			Cool Booth (C2) TPC1 (Hot)			Warm Booth (W3) TPC1 (Hot)			Warm Booth (W4) TPC1 (Hot)		
V504-V1	On	Pass	V504-V1	On	Pass	V504-V1	On	Pass	V504-V1	On	Pass
A-D	Ramp/Down	Pass	A-D	Ramp/Down	Pass	A-D	Ramp/Down	Pass	A-D	Ramp/Down	Pass
MODE	Off	Apply	MODE	Off	Apply	MODE	Off	Apply	MODE	Off	Apply

TPC0 Status

TPC0-650-000/Power: NE InCh-Gas T Trip, SE InCh-Gas B Status, NW InCh-Gas B Trip, SW InCh-Gas

TPC0-650-000/TPC1: TPC1-650-000/TPC1

Full-Cap Termination Booth (PC1)

Mod	PC1-01	PC1-02	PC1-03	PC1-04	PC1-05	PC1-06	PC1-07	PC1-08	PC1-09	PC1-10	PC1-11	PC1-12	PC1-13	PC1-14	PC1-15	PC1-16	PC1-17	PC1-18	PC1-19	PC1-20
Mod	PC1-01	PC1-02	PC1-03	PC1-04	PC1-05	PC1-06	PC1-07	PC1-08	PC1-09	PC1-10	PC1-11	PC1-12	PC1-13	PC1-14	PC1-15	PC1-16	PC1-17	PC1-18	PC1-19	PC1-20
Mod	PC1-01	PC1-02	PC1-03	PC1-04	PC1-05	PC1-06	PC1-07	PC1-08	PC1-09	PC1-10	PC1-11	PC1-12	PC1-13	PC1-14	PC1-15	PC1-16	PC1-17	PC1-18	PC1-19	PC1-20

Cool Booth (C2)

Mod	C2-01	C2-02	C2-03	C2-04	C2-05	C2-06	C2-07	C2-08	C2-09	C2-10	C2-11	C2-12	C2-13	C2-14	C2-15	C2-16	C2-17	C2-18	C2-19	C2-20
Mod	C2-01	C2-02	C2-03	C2-04	C2-05	C2-06	C2-07	C2-08	C2-09	C2-10	C2-11	C2-12	C2-13	C2-14	C2-15	C2-16	C2-17	C2-18	C2-19	C2-20
Mod	C2-01	C2-02	C2-03	C2-04	C2-05	C2-06	C2-07	C2-08	C2-09	C2-10	C2-11	C2-12	C2-13	C2-14	C2-15	C2-16	C2-17	C2-18	C2-19	C2-20

Warm Booth (W3) and (W4)

Mod	W3-01	W3-02	W3-03	W3-04	W3-05	W3-06	W3-07	W3-08	W3-09	W3-10	W3-11	W3-12	W3-13	W3-14	W3-15	W3-16	W3-17	W3-18	W3-19	W3-20
Mod	W3-01	W3-02	W3-03	W3-04	W3-05	W3-06	W3-07	W3-08	W3-09	W3-10	W3-11	W3-12	W3-13	W3-14	W3-15	W3-16	W3-17	W3-18	W3-19	W3-20
Mod	W3-01	W3-02	W3-03	W3-04	W3-05	W3-06	W3-07	W3-08	W3-09	W3-10	W3-11	W3-12	W3-13	W3-14	W3-15	W3-16	W3-17	W3-18	W3-19	W3-20

Cool Booth (C2)

Mod	C2-01	C2-02	C2-03	C2-04	C2-05	C2-06	C2-07	C2-08	C2-09	C2-10	C2-11	C2-12	C2-13	C2-14	C2-15	C2-16	C2-17	C2-18	C2-19	C2-20
Mod	C2-01	C2-02	C2-03	C2-04	C2-05	C2-06	C2-07	C2-08	C2-09	C2-10	C2-11	C2-12	C2-13	C2-14	C2-15	C2-16	C2-17	C2-18	C2-19	C2-20
Mod	C2-01	C2-02	C2-03	C2-04	C2-05	C2-06	C2-07	C2-08	C2-09	C2-10	C2-11	C2-12	C2-13	C2-14	C2-15	C2-16	C2-17	C2-18	C2-19	C2-20

Cool Electronics Protection Divides Status

Div	1	2	3	4	5	6
Div1	OK	OK	OK	OK	OK	OK
Div2	OK	OK	OK	OK	OK	OK
Div3	OK	OK	OK	OK	OK	OK
Div4	OK	OK	OK	OK	OK	OK



Detector Control and Monitoring Infrastructure

Sungbin Oh, Minerba Betancourt, and Mun Jung Jung
 SBND Operations Readiness Review
 February 21-22, 2024



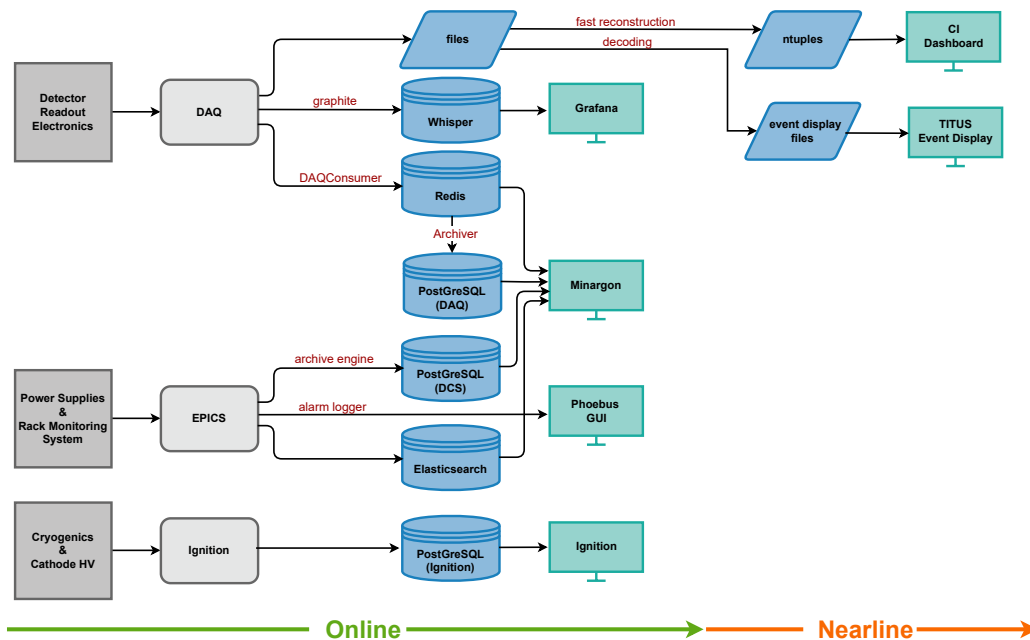
Main Focus



- Answering the charge question 2-c
 - “Is there a plan for **monitoring the beam and the data quality** and has the infrastructure been tested? If not, what actions are required to complete the data quality monitoring system before physics data-taking?”
- From detector control system and monitoring side
 - Including data quality monitoring system!

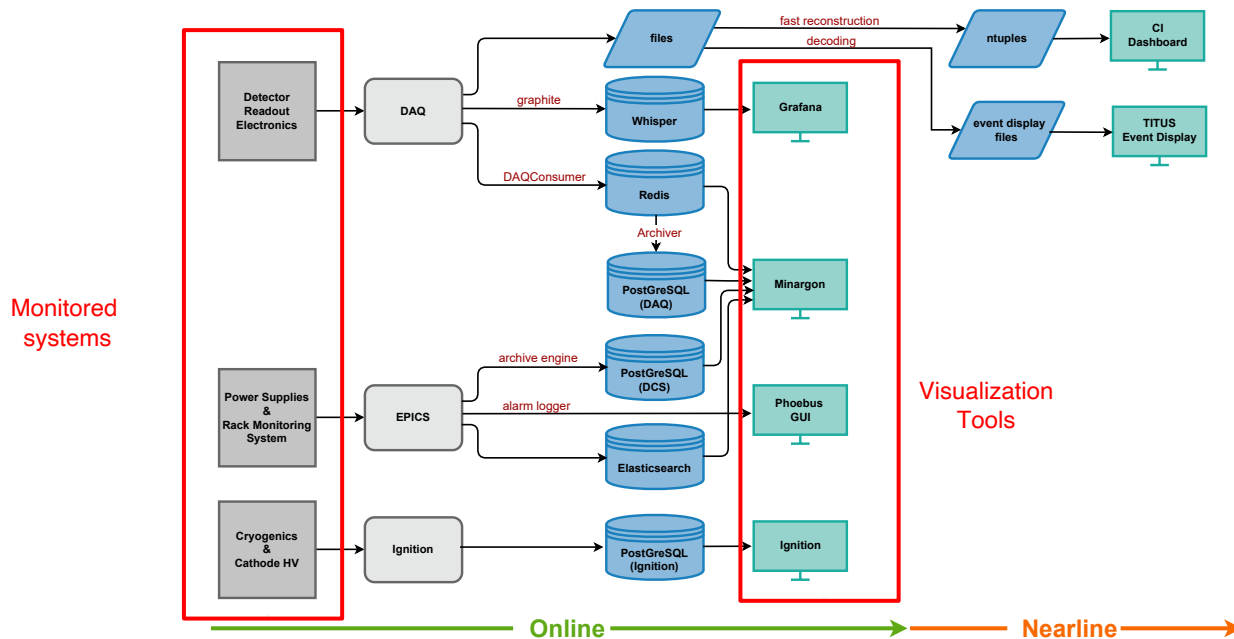
Detector Control and Monitoring System Overview

It comprises multiple tools for the various components of the experiment



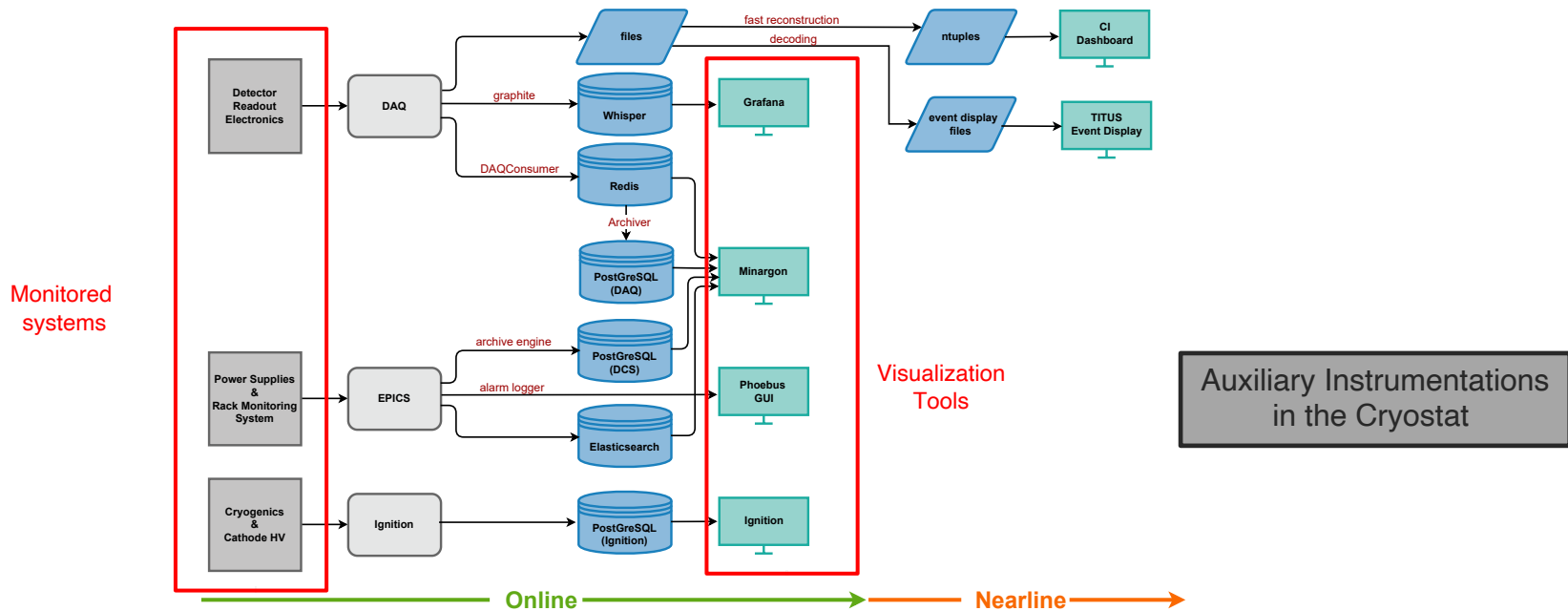
Detector Control and Monitoring System Overview

It comprises multiple tools for the various components of the experiment



Detector Control and Monitoring System Overview

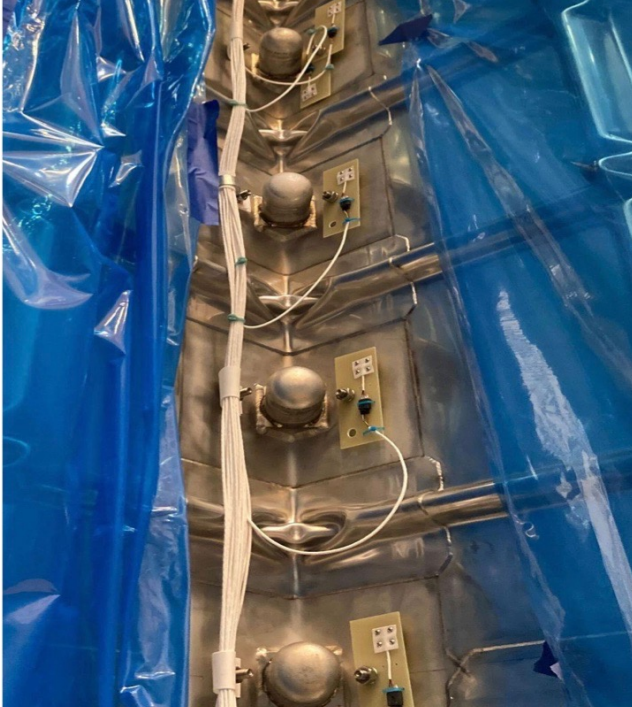
It comprises multiple tools for the various components of the experiment





Auxiliary Instrumentations in the Cryostat

Resistance temperature detectors (RTDs)



- They are 4-wire PT100 Class A devices from Omega with 0.55 K precision
- 79 RTDs
 - 36 on the cryostat walls
 - 18 on the TPCs
 - 25 outside the cryostat
- Measured temperatures are archived in the Ignition DB
 - Visualized in the Ignition (next page)

Resistance temperature detectors (RTDs)



SBND Cryogenics

Current Time: 2024-02-06 04:17:0...

Logged In: Guest

No Critical Alarms

3 Alarms

46 Diagnostic Alarms

Lock Screen

Switch User

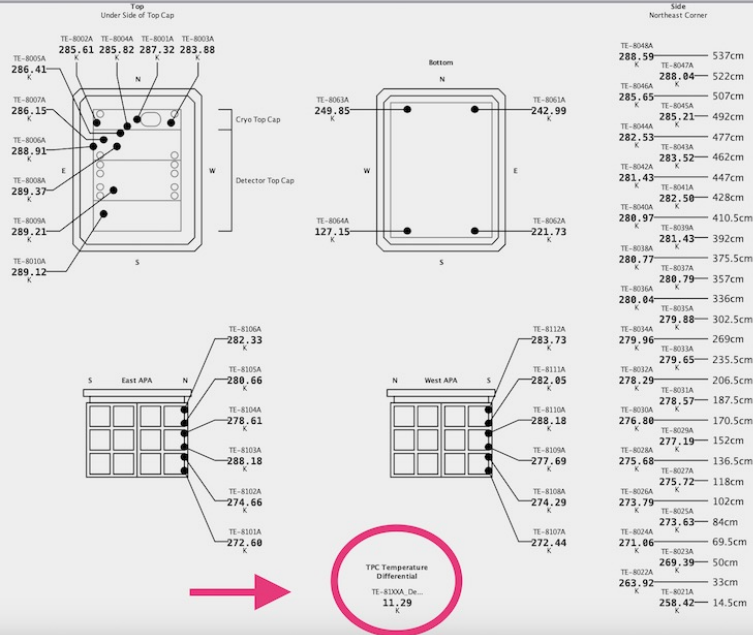
Logout

Sessions: 9

Add Desktop

- Cryogenics
 - Overview
 - Ar Phase Separator
 - Condenser
 - Condenser Unit
 - Gas Purification
 - Gas Analysis
 - LAr Circulation
 - LAr Dewar
 - LAr Purification
 - LN2 Dewar
 - Nitrogen Purge
 - ODH
 - Purity Monitor
 - Regeneration
- Cryostat Temperatures
 - Inner Walls & TPC**
 - Insulation Space
 - Outer Walls
- Detector
 - TPC Protection
- Miscellaneous
 - Alarms
 - PLCs
 - Roster Management
 - Tag Admin
 - User Management

Cryostat Inner Walls and TPC Frame

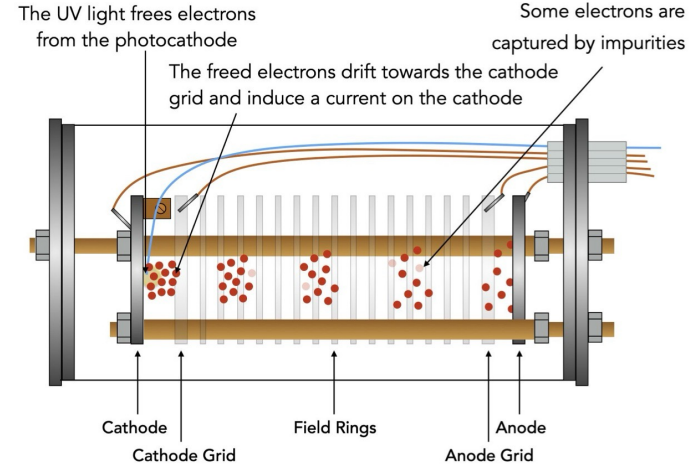
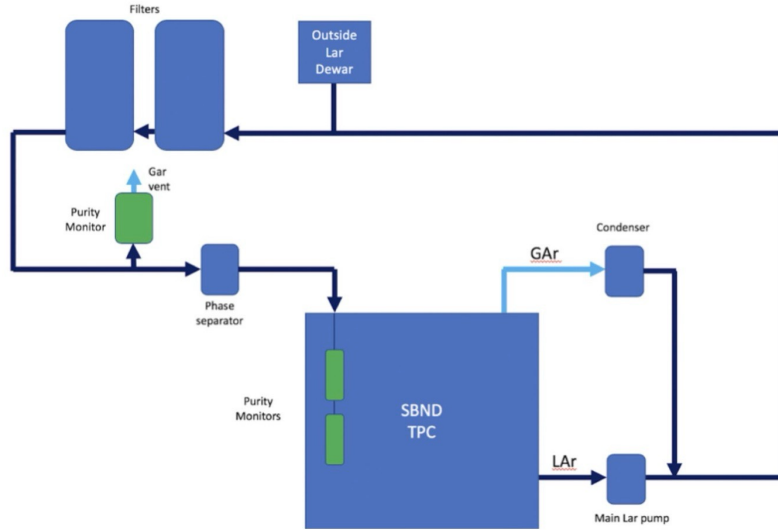


One of RTD pages

- RTDs at inner walls and inside TPC are presented



Liquid Argon (LAr) Purity Monitors



- Measures electronegative contamination, especially O_2 and H_2O molecules, in LAr
- Three monitors (green) : one long inline after filters, two inside TPC (one long and one short)
 - Electron cloud generated at the cathode drifts toward the anode : amplitude of charge signals are compared
- Have independent control & DAQ system : variables are reported to EPICS for monitoring

Liquid Argon (LAr) Purity Monitors



The screenshot shows a web browser window with the title 'Purity Monitor'. The browser tabs include 'Welcome x', 'SBND Alarm Tree x', 'File Browser x', 'PrM_Shift x', 'Summary x', and '* PV'. The main content area displays a table with three columns: 'Inline', 'Short', and 'Long'. The rows represent various variables: V(cathode) (V), V(anode, grid) (V), V(anode) (V), Q(cathode) (mV), Q(anode) (mV), t(drift) (ms), and τ(life) (ms). A 'Latest Lifetime Update' row is at the bottom. All data cells in the table have a red border.

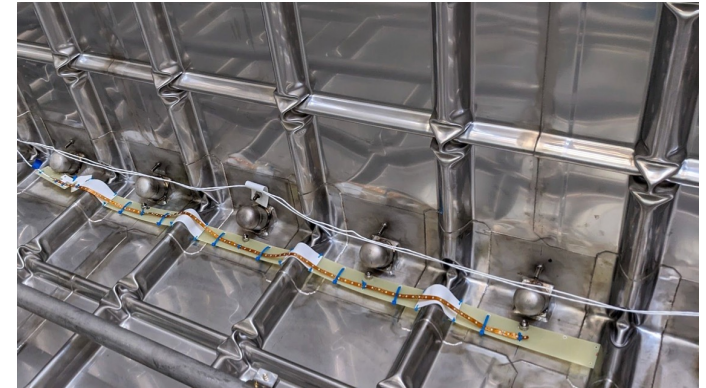
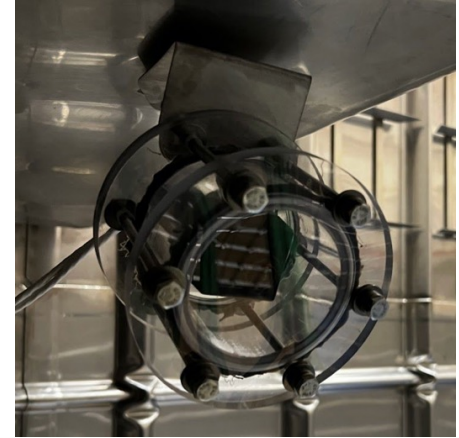
	Inline	Short	Long
V(cathode) (V)	-114.34	-196.35	-118.90
V(anode, grid) (V)	4281.25	2486.00	4350.52
V(anode) (V)	4363.70	2369.43	4428.11
Q(cathode) (mV)	7.14	670.47	342.97
Q(anode) (mV)	3.26	66.94	21.73
t(drift) (ms)	2886.50	1182.50	1354.50
τ(life) (ms)	3688.61	513.19	490.93
Latest Lifetime Update	Feb 12 2024 16:48:52	Feb 12 2024 16:48:58	Feb 12 2024 16:48:57

- Purity monitor variables are visualized in the Phoebus
- Please ignore red borders
 - Working on defining alarm ranges
- All voltages, charge signals, and times are presented
 - They are also archived into the EPICS PostgreSQL DB

Cameras

Five cameras are installed inside the cryostat

- 3.0 Megapixel - 2304 x 1296P
- Installed inside enclosures together with heaters
- Can see only visible light
 - Five 5 ft long yellow LED strips are installed in strategic places of the cryostat walls
 - Interlock to protect photon detectors
 - Color balance shifts to green in lower temperature
- Cameras have independent control/monitoring system



Cameras



Pictures from detector cooling down process

- HV feedthrough view
- Top
 - LEDs have yellow color balance at ~ 240 K
- Bottom
 - LEDs have green color balance at ~ 140 K



Show the next page

SBND Alarm Area Panel X

Building (Gizmo/GPS)

Drift HV



Detector Control System (DCS)

PDS Readout

Display X

85 %

SBND Alarm Tree X

SBND

Color Code

OK

Warning

Alarm

Invalid

Acknowledged

- Building (Gizmo/GPS)
 - GIZMO
 - PV: sbnd_gizmo/connection
 - PV: sbnd_gizmo/li
 - PV: sbnd_gizmo/mag
 - PV: sbnd_gizmo/qq
 - PV: sbnd_gizmo/res
 - PV: sbnd_gizmo/th
 - SBND HV
 - PV: sbnd_tpc_east_0_7/outputMeasurementCurrent - MAJOR_ACK/LOLO_ALARM (MAJOR/LOLO_ALARM)
 - PV: sbnd_tpc_east_0_7/outputMeasurementSenseVoltage - MAJOR_ACK/LOLO_ALARM (MAJOR/LOLO_ALARM)
 - PDS Readout
 - Rack Monitors

PV	Description	Alarm Severity	Alarm Status	Alarm Time
No active alarms				
Acknowledged Alarms: 2				
PV	Description	Alarm Severity	Alarm Status	Alarm Time
sbnd_tpc_east_0_7/outputMeasur...	sbnd_tpc_east_0_7/outputMeasurementCurrent	MAJOR_ACK	LOLO_ALARM	2024-02-01 15:51:17
sbnd_tpc_east_0_7/outputMeasur...	sbnd_tpc_east_0_7/outputMeasurementSenseVoltage	MAJOR_ACK	LOLO_ALARM	2024-02-01 15:51:17



Detector Control System (DCS) – Overview

The DCS monitors

- Power supplies
 - Voltages for photon detection system, TPC planes, and readout electronics
- Rack monitoring system
 - Device temperatures, power distribution units, cooling fans, and rack protection system
- Things will be described later in this presentation
 - DAQ, cryo-control, and main cathode plane power supply

Purpose

- Control/monitor hardware, archive important variables, and present alarm status

Detector Control System (DCS) – Structure



The EPICS (Experimental Physics and Industrial Control System)

- Direct communication with hardware
 - Provides a single simple protocol to users for various devices
 - A controlled or monitored variable is called as a process variable (PV)
- An Open Source software for detector control/monitor systems
- PIP-II, ICARUS, Mu2e,,, we have growing expertise on it in Fermilab

The Phoebus (CS-Studio)

- Provides GUI views for PVs
- Its sub-package, “Alarm-server” and “Alarm-logger”, are used for alarm feature

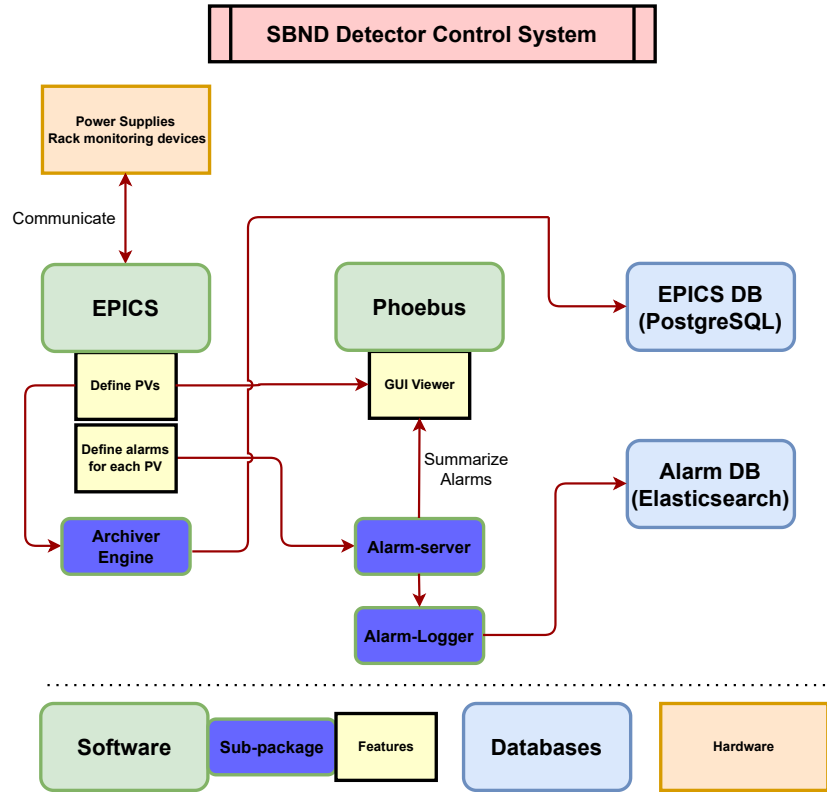
The Archiver engine and PostgreSQL DB

- The archiver engine of the EPICS archives PVs into a dedicated PostgreSQL DB (“EPICS DB”)

The Elasticsearch DB

- Alarm histories are archived in a separate DB with the Elasticsearch

Detector Control System (DCS) – Structure

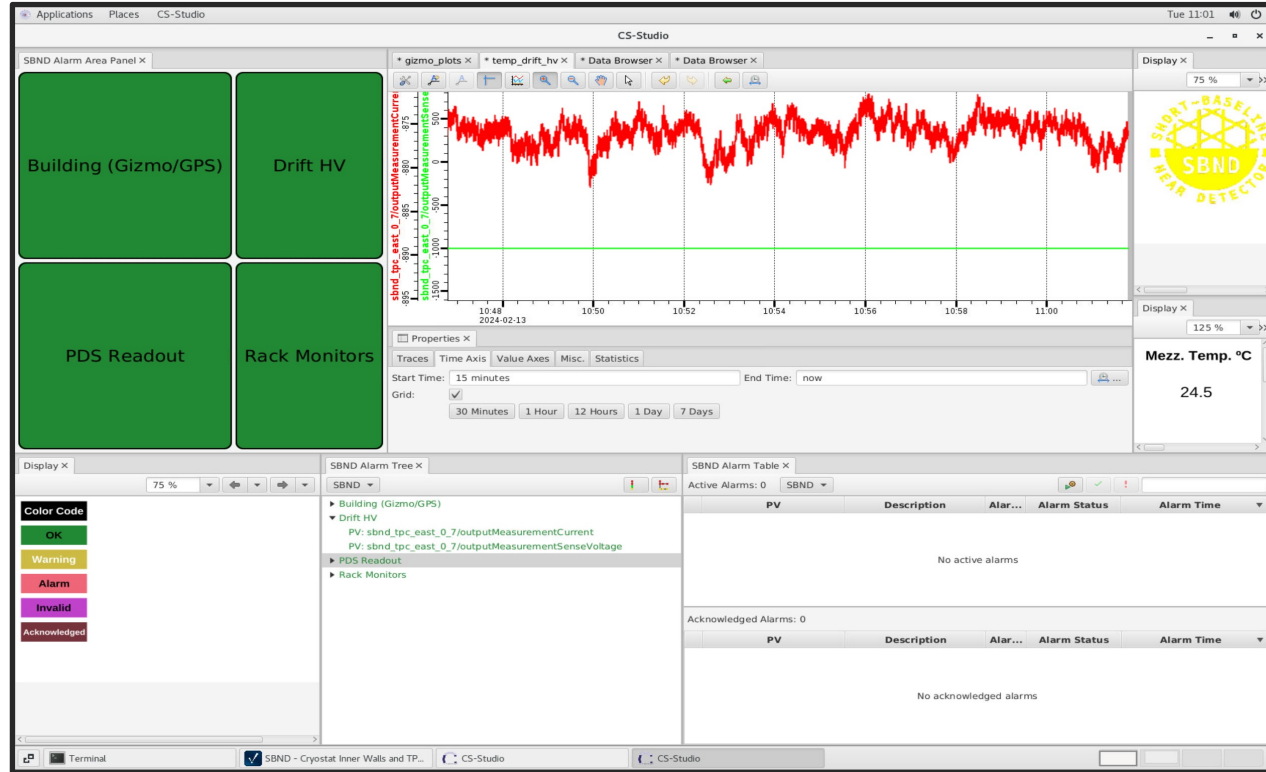


Detector Control System (DCS) – Shifter's Window



The Phoebus is used to provide shifter window for the DCS

- Alarms for sub-systems are summarized
- SBND symbol changes its color to indicate if shifter's connection is alive
 - Every 0.2 sec with 5 colors
- Shifters and experts can add plots for any variable in time series
- Being used for shift these days



Detector Control System (DCS) – Experts Pages



Power supply control and monitoring pages are provided with the Phoebus

- All power supplies for CRT/TPC readout, PDS HV, and TPC planes have dedicated windows

(Example)
TPC bias voltage
control/monitoring
page for experts

Temporary SBND TPC MPOD Ramping - Expert Page

Back to Permanent TPC Ramp Page Back to Read-only Page

Ramping Control

Field Cage Termination Boards (FCTB)	Cover Boards (CB) - TPC 0 (West)	Cover Boards (CB) - TPC 1 (East)	U Plane - TPC 0 (West)	U Plane - TPC 1 (East)	V Plane - TPC 0 (West)	V Plane - TPC 1 (East)
V(Set, V): 4.0 On Ramp Down Pause Ramping Apply Off	V(Set, V): <loc://cb_w On Pause Ramping Apply Off	V(Set, V): <loc://cb_e On Pause Ramping Apply Off	V(Set, V): <loc//u_w On Pause Ramping Apply Off	V(Set, V): <loc//u_e On Pause Ramping Apply Off	V(Set, V): <loc//v_w On Pause Ramping Apply Off	V(Set, V): <loc//v_e On Pause Ramping Apply Off

MPOD Status

MPOD Mini-crates Powers: MPOD-WEST TPC0 (On), MPOD-EAST TPC1 (On)

NE North-East	T Top
SE South-East	B Bottom
NW North-West	S Side
SW South-West	

Field Cage Termination Boards (FCTBs)

West	East				
FCTB(W1)	FCTB(W2)	FCTB(W3)	FCTB(W4)	FCTB(W5)	FCTB(W6)
V(Set, V): 0.000 V	0.000 V	0.000 V	0.000 V	0.000 V	0.000 V
(limit, nA): 3999.9 nA	5299.9 nA	3999.9 nA	3999.9 nA	5299.9 nA	3999.9 nA
V(Read, V): 0.115 V	0.147 V	0.109 V	0.114 V	0.156 V	0.140 V
R(Read, nA): 201.6 nA	193.9 nA	182.7 nA	180.4 nA	194.3 nA	225.8 nA
R(kOhm): 0.572564	0.749536	0.593951	0.629545	0.803412	0.618781

Cover Boards (CBs)

West	East	
CB(SW)	CB(NW)	CB(SE)
V(Set, V): 3.800 V	3.800 V	3.500 V
(limit, nA): 2058.0 nA	2058.0 nA	2058.0 nA
V(Read, V): -0.031 V	-0.162 V	-0.068 V
R(Read, nA): 2.0 nA	2.8 nA	2.0 nA
R(kOhm): 15.26150	62.31384	34.245

Wire Biases (V and U planes)

West	U		East	
Y(SW)	Y(NW)	Y(SE)	Y(NE)	U
V(Set, V): 3.000 V	3.000 V	3.200 V	2.800 V	3.100 V
(limit, nA): 801.7 nA	801.7 nA	2058.0 nA	801.7 nA	2058.0 nA
V(Read, V): -0.034 V	-0.036 V	-0.088 V	-0.048 V	-0.043 V
R(Read, nA): -1.5 nA	-1.5 nA	0.1 nA	-1.4 nA	-1.7 nA
R(kOhm): 22.68866	24.23066	879.3299	34.62642	25.53176

Cold Electronics Protection Diodes Status

Crate	WIB	1	2	3	4	5	6
Crate 1	FEMB1	OK	OK	OK	OK	OK	OK
	FEMB2	OK	OK	OK	OK	OK	OK
	FEMB3	OK	OK	OK	OK	OK	OK
	FEMB4	OK	OK	OK	OK	OK	OK
Crate 2	FEMB1	OK	OK	OK	OK	OK	OK
	FEMB2	OK	OK	OK	OK	OK	OK
	FEMB3	OK	OK	OK	OK	OK	OK
	FEMB4	OK	OK	OK	OK	OK	OK
Crate 3	FEMB1	OK	OK	OK	OK	OK	OK
	FEMB2	OK	OK	OK	OK	OK	OK
	FEMB3	OK	OK	OK	OK	OK	OK
	FEMB4	OK	OK	OK	OK	OK	OK
Crate 4	FEMB1	OK	OK	OK	OK	OK	OK
	FEMB2	OK	OK	OK	OK	OK	OK
	FEMB3	OK	OK	OK	OK	OK	OK
	FEMB4	OK	OK	OK	OK	OK	OK



SBND Cryo Monitor

"DB update" will flash red when the latest timestamp of a PV is older than 3 minutes

West APA

PV	te-8107a
value	115.970
timestamp	2024-02-12 18:18
DB update	●

East APA

PV	te-8108a
value	116.999
timestamp	2024-02-12 18:18
DB update	●

Cryo Bottom

PV	te-8062a	te-8022a
value	86.410	86.330
timestamp	2024-02-12 18:18	2024-02-12 18:18
DB update	●	●

Cryo Wall

PV	te-8035a
value	121.388
timestamp	2024-02-12 18:18
DB update	●

Cryo Top

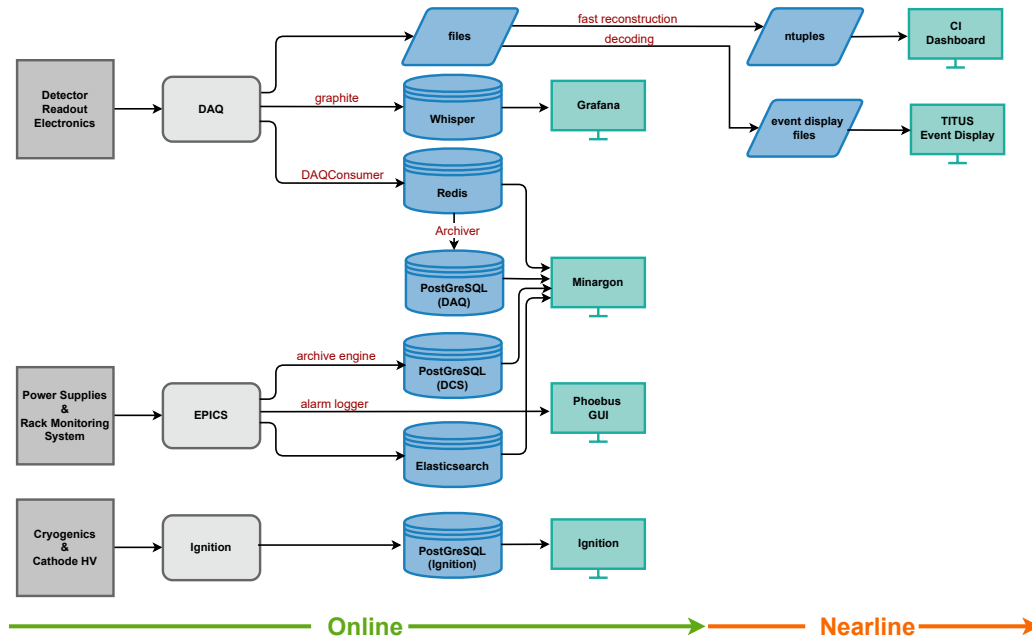
PV	te-8003a
value	172.919
timestamp	2024-02-12 18:18
DB update	●

Monitoring System (Including Data Quality Monitoring)

Detector Control and Monitoring System Overview



Reminder for overall structure



DAQ Monitoring



- DAQ health is monitored through the Grafana monitoring system
- 24 to 48 hours of live DAQ data can be monitored in different formats of tables and plots
- **Various DAQ metrics** including system metrics, event-building metrics, board-reader metrics, memory buffer status, and trigger and event rate metrics **are monitored**





Online Data Quality Monitoring (DQM)

- DQM system calculates and displays detector metrics in real-time
 - Raw data is dispatched from the DAQ to the DQM system
 - DQM analyzer calculates metrics and saves to the in-memory Redis database
 - Minargon website displays the data in multiple formats
- The same infrastructure is in routine use for operations at the ICARUS experiment
- Data can be organized in multiple tiers for subsystem experts and shifters
 - Time-series metrics and waveforms for detector components
 - Higher-level summary of metrics
 - Detector status reports for shifters from alarm levels defined by experts
- **Tools for monitoring the TPC, CRT, PDS, trigger system and the timing system are in place**

Online Data Quality Monitoring (DQM)



Shifter DQM overview page

SBND Monitoring TPC ▾ CRT ▾ PMT ▾ Trigger ▾ Cryo ▾ DCS (shifter) ▾ DCS (expert) ▾ DCS (others) ▾

SBND Online Monitoring

External Links

shifter feedback: [click here](#)
operations wiki: [click here](#)
BNB Status: [click here](#)
E-Log: [click here](#)

Meta Data	
Redis memory usage:	0.07GB / 1.11%
Redis heartbeat:	ON
DAQConsumer:	OFF

DQM system status

Detector Status	
TPC Status:	OK
PMT Status:	NOT OK, Bad PMT: 160
CRT Status:	OK
Trigger Status:	OK

Detector status report

Online Data Quality Monitoring (DQM)



Shifter DQM overview page

SBND Monitoring TPC CRT PMT Trigger Cryo DCS (shifter) DCS (expert) DCS (others)

SBND Online Monitoring

External Links

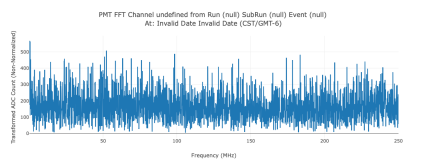
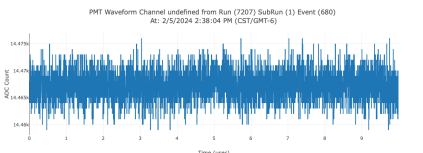
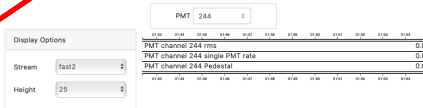
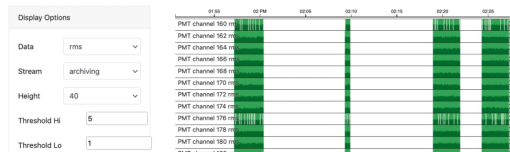
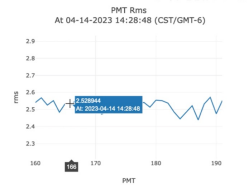
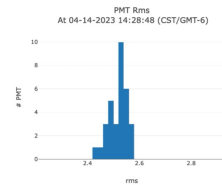
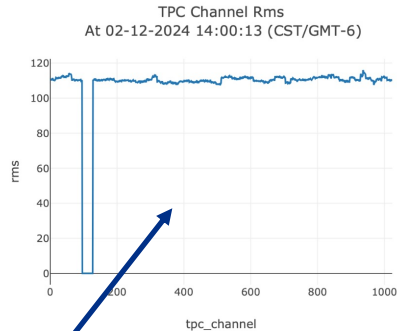
- shifter feedback: [click here](#)
- operations wiki: [click here](#)
- BNB Status: [click here](#)
- E-Log: [click here](#)

Meta Data

Redis memory usage:	0.07GB / 1.11%
Redis heartbeat:	ON
DAQConsumer:	OFF

Detector Status

TPC Status:	OK
PMT Status:	NOT OK, Bad PMT: 160
CRT Status:	OK
Trigger Status:	OK



DCS Monitoring



- The Minargon website is connected to the EPICS database and supports browsing history of DCS process variables and their alarms

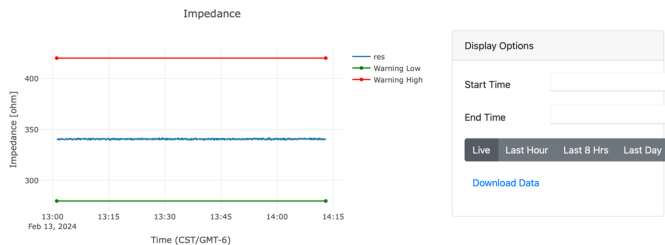
SBND Monitoring TPC CRT PMT Trigger Cryo DCS (shifter) DCS (expert) DCS (others)

SBN DCS Slow Controls Process Variables

- sbnd_online_prd
- AlarmHeartbeat
- anodehv
- sbnd_cs_ne
- current
- curr_limit
- sense_volt

SBND Monitoring TPC CRT PMT Trigger Cryo DCS (shifter) DCS (expert) DCS (others)

Gizmo



SBND Monitoring TPC CRT PMT Trigger Cryo DCS (shifter) DCS (expert) DCS (others)

Slow Control Alarms History

Plots can be zoomed, dragged and hovered. Double click to snap axis to fit data. Email alexander.wilkinson.20@ucl.ac.uk with any questions.

Show alarms for system(s):

Building (Gizmo or GPS) Gizmo Gizmo

Hide alarms for:

- OK
- Disconnected
- disconnected
- UDF_ALARM
- LOLO_ALARM
- LOW_ALARM

Go!

Showing alarms for Building (Gizmo or GPS)GIZMO/GIZMO from 2023-10-31 19:00:00.000 to 2024-02-13 14:10:05.765. Total logged alarms: 86

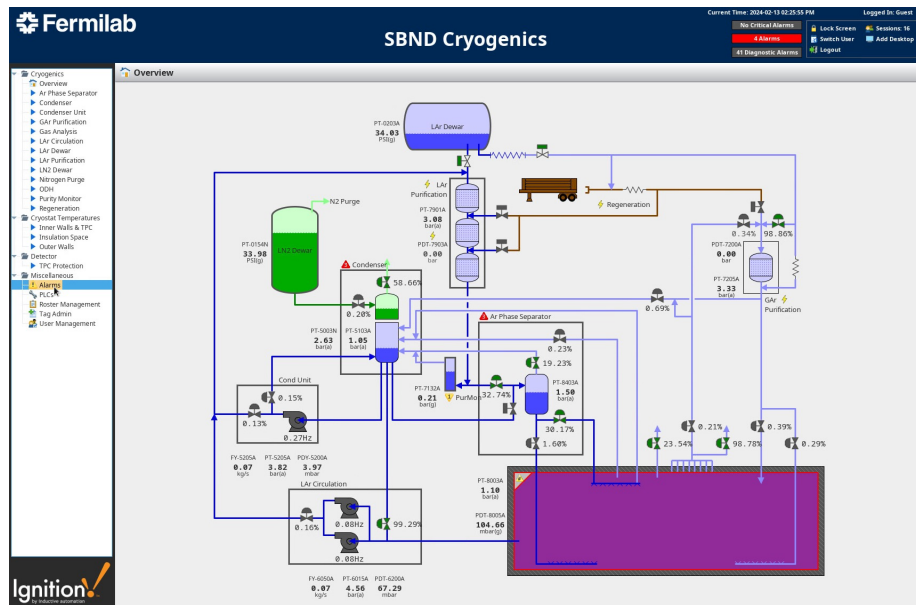
Alarm History

pv Name	Time	Message	Value
sbnd_gzmo/te	2024-02-08 13:14:22.491	HIGH_ALARM	46.646999399130
sbnd_gzmo/h	2024-02-08 09:36:11.299	Disconnected	
sbnd_gzmo/i	2024-02-08 09:36:11.299	Disconnected	
sbnd_gzmo/res	2024-02-08 09:36:11.299	Disconnected	
sbnd_gzmo/mag	2024-02-08 09:36:11.299	Disconnected	
sbnd_gzmo/te	2024-02-08 09:36:11.299	Disconnected	
sbnd_gzmo/connection	2024-02-08 09:36:11.299	Disconnected	
sbnd_gzmo/te	2024-02-07	LOLO_ALARM	-47.063999917602

Cryogenic & Drift HV Monitoring



- The Ignition program provides control and detailed summary of the status of the cryogenic system and drift HV, including alarms that can be set dynamically
- The Software license is supported by Fermilab



Active Time	Label	Priority	Current State	Ack'd By
2/15/24, 2:27 PM	LT-8025A High Interlock	High	Active, Acknowledged	inichols
2/15/24, 2:27 PM	LT-8026A Low Interlock	High	Active, Acknowledged	inichols
2/14/24, 10:50 AM	PT-6015A High Interlock	High	Active, Acknowledged	koshelev
12/28/23, 3:51 PM	TE-7982A IO Error	Diagnostic	Active, Acknowledged	
12/28/23, 3:51 PM	PDT-7903A IO Error	Diagnostic	Active, Acknowledged	
12/28/23, 3:51 PM	TE-7983A IO Error	Diagnostic	Active, Acknowledged	
12/28/23, 3:51 PM	TE-7984A IO Error	Diagnostic	Active, Acknowledged	
12/28/23, 3:51 PM	TE-7985A IO Error	Diagnostic	Active, Acknowledged	
12/28/23, 3:51 PM	TE-7981A IO Error	Diagnostic	Active, Acknowledged	
1/29/24, 12:17 PM	PT-8214A IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TE-96311 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TY-96501 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	HE-9620 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	PMT-link IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TY-96201 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TY-96301 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TY-96101 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TY-96141 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TE-96041 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	HE-9600 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TE-96341 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TE-96511 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	HE-9630 IO Error	Diagnostic	Active, Acknowledged	
2/1/24, 4:24 PM	TE-96521 IO Error	Diagnostic	Active, Acknowledged	

Cryogenic & Drift HV Monitoring



- The Minargon website is connected to the Ignition database and supports browsing of selected cryogenic process variable values
- Drift HV will be added into the Ignition system soon
 - A channel of TPC plane power supply is being used for temporary purpose



SBND Cryo Monitor

"DB update" will flash red when the latest timestamp of a PV is older than 3 minutes

West APA

PV	te-8107a	te-8112a
value	113.830	129.990
timestamp	2024-02-12 21:53	2024-02-12 21:53
DB update	●	●

East APA

PV	te-8101a	te-8106a
value	113.800	129.690
timestamp	2024-02-12 21:53	2024-02-12 21:53
DB update	●	●

Cryo Bottom

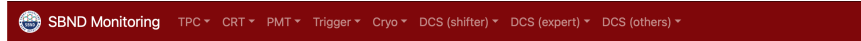
PV	te-8062a	te-8022a
value	86.419	86.419
timestamp	2024-02-12 21:53	2024-02-12 21:53
DB update	●	●

Cryo Wall

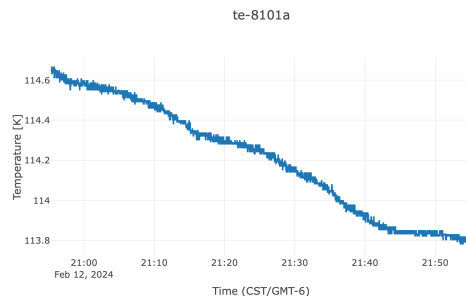
PV	te-8035a
value	120.220
timestamp	2024-02-12 21:53
DB update	●

Cryo Top

PV	te-8003a
value	172.709
timestamp	2024-02-12 21:53
DB update	●



Cryo Stream



Display Options

Start Time

End Time

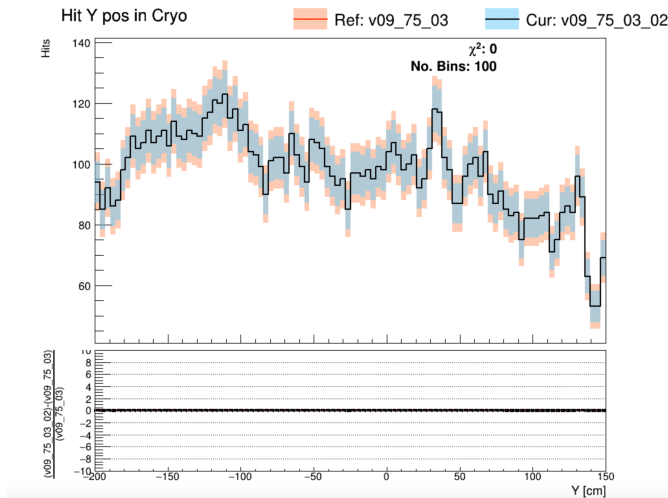
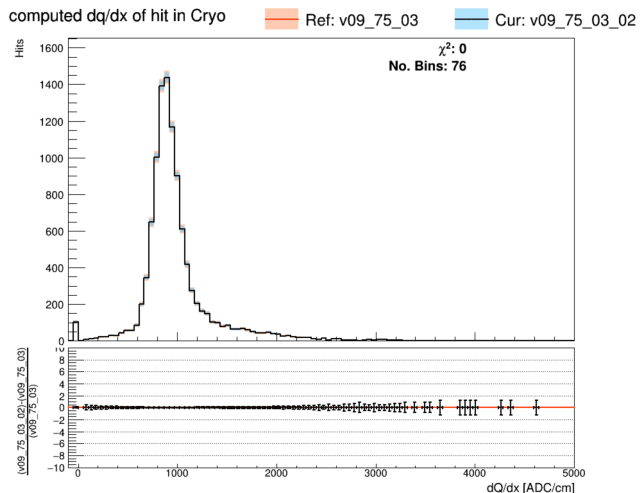
[Download Data](#)

Nearline Monitoring



- Developing a nearline workflow for shifters
 - Higher level metrics using fast reconstruction of TPC, PDS, and CRT data
 - To validate neutrino interaction data quality before full data processing
 - Using continuous integration (CI) for comparison with reference runs that are confirmed as stable

CI test result
Using MC sample



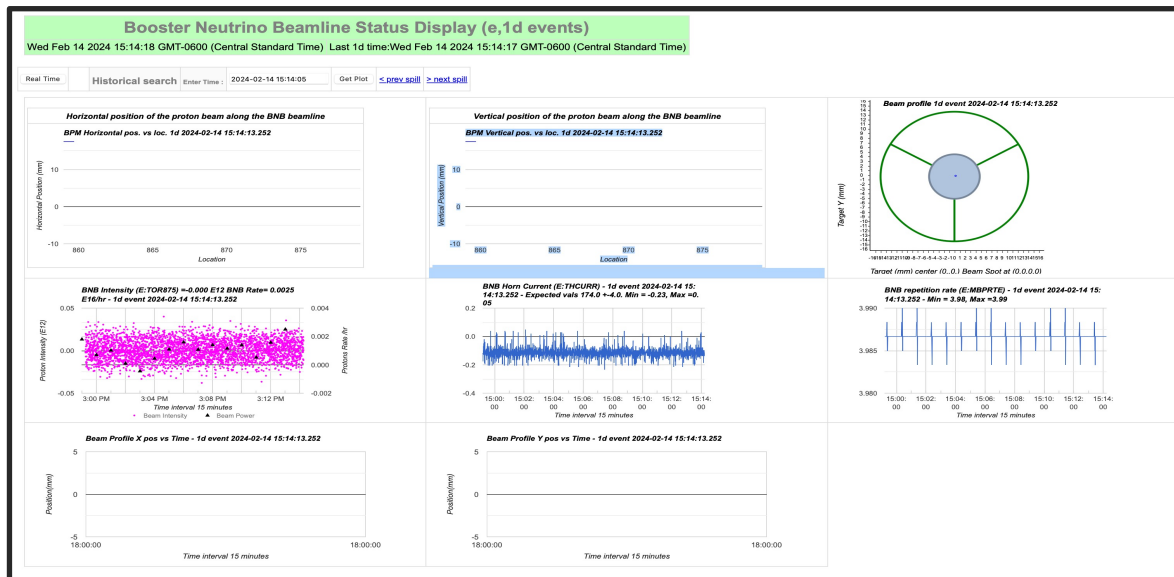
[Link](#)

Booster Neutrino Beamline Monitoring



The neutrino beam is monitored using tools

- Supported by Fermilab Beams Division and Computational Science and AI Directorate (CSAID)
- It includes proton intensity, BNB repetition rate, horn current, position of the proton beam along the BNB beam line and beam profile versus time





Databases

Databases Summary



- PostgreSQL DBs for EPICS, Ignition, and DAQ metrics
 - Supported by the Fermilab Information Technology Division
 - Main contact : Olga Vlasova
 - A main DB is hosted by the Fermilab computing resource *sbnd-db01*
 - A hot-backup is running on the *sbnd-db02* server at the SBN-ND building
 - A replica for offline access is at the Feynman Computing Center

- An Elasticsearch DB for archiving alarms from the EPICS
 - Hosted by a server (sbnd-dcs01) at the SBN-ND building
 - It uses SBN-ND NFS disk space



Summary

Summary



Auxiliary Instrumentations in the Cryostat

- Values from RTDs and LAr purity monitors are accessible from the Ignition and the Phoebus, respectively
- Cryostat camera is independent system

Detector control system

- The EPICS and Phoebus provides control system for power supplies and rack monitoring system
 - Windows for both shifters and detector experts are ready
- The Ignition provides control system for cryogenics and drift HV
 - The drift HV power supply will be added into the Ignition soon
 - Software license is supported by Fermilab

Summary



Monitoring system

- A set of various software packages monitors all components used for the SBND operation
 - The Minargon webpage, the Ignition, the Grafana, the Phoebus, and Fermilab Beams Division's beam monitoring tool
- DBs for archiving important variables are supported by Fermilab Information Technology Division
- Nearline monitoring workflow for data quality validation using reconstruction level metrics
 - Under development : CI test using MC sample was successful

For ORR charge question 2-C

- *“Is there a plan for monitoring the beam and the data quality and has the infrastructure been tested? If not, what actions are required to complete the data quality monitoring system before physics data-taking?”*
 - 1) Booster Neutrino Beam (BNB) monitoring tool is supported by Fermilab Beams Division/CSAID - ready
 - 2) Data quality monitoring modules and workflows are ready for TPC, PMT, CRT, and trigger
 - 3) Nearline monitoring for reconstruction level metrics is under development

Back Up

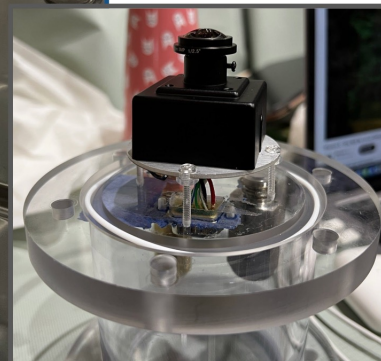
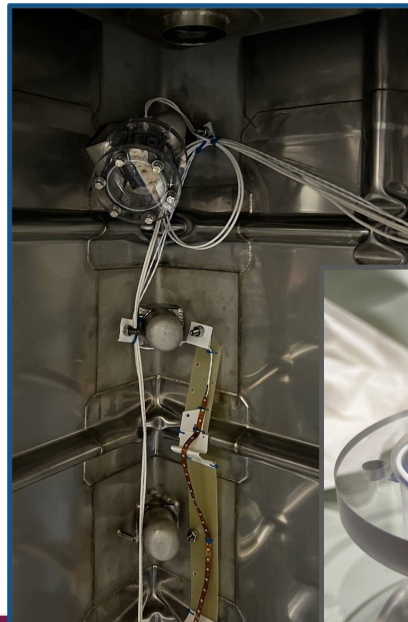
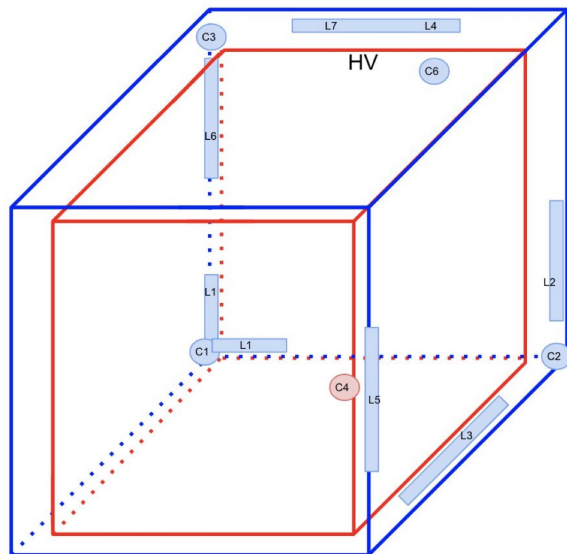


Auxiliary Instrumentations in the Cryostat

Auxiliary Instrumentation in the Cryostat - Cameras

Cameras and LEDs

This diagram shows the approximate position of the cameras and LED strips inside the cryostat.



Credit
Mônica Nunes



Show the next page

SBND Alarm Area Panel X

Building (Gizmo/GPS)

Drift HV



Properties X
Axes
Status
30 Minutes 1 Hour 12 Hours 1 Day 7 Days

125 %
Mezz. Temp. °C
25.0

Detector Control System (DCS)

Display X
85 %

- Color Code
- OK
- Warning
- Alarm
- Invalid
- Acknowledged

- SBND Alarm Tree X
- SBND
 - Building (Gizmo/GPS)
 - GIZMO
 - PV: sbnd_gizmo/connection
 - PV: sbnd_gizmo/li
 - PV: sbnd_gizmo/mag
 - PV: sbnd_gizmo/qq
 - PV: sbnd_gizmo/res
 - PV: sbnd_gizmo/th
 - SBND HV
 - PV: sbnd_tpc_east_0_7/outputMeasurementCurrent - MAJOR_ACK/LOLO_ALARM (MAJOR/LOLO_ALARM)
 - PV: sbnd_tpc_east_0_7/outputMeasurementSenseVoltage - MAJOR_ACK/LOLO_ALARM (MAJOR/LOLO_ALARM)
 - PDS Readout
 - Rack Monitors

PV	Description	Alarm Severity	Alarm Status	Alarm Time
No active alarms				

Acknowledged Alarms: 2

PV	Description	Alarm Severity	Alarm Status	Alarm Time
sbnd_tpc_east_0_7/outputMeasur...	sbnd_tpc_east_0_7/outputMeasurementCurrent	MAJOR_ACK	LOLO_ALARM	2024-02-01 15:51:17
sbnd_tpc_east_0_7/outputMeasur...	sbnd_tpc_east_0_7/outputMeasurementSenseVoltage	MAJOR_ACK	LOLO_ALARM	2024-02-01 15:51:17

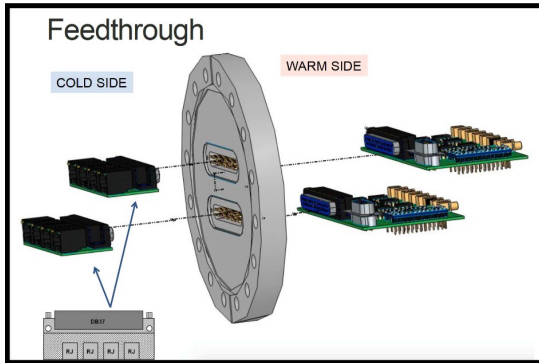
Detector Control System (DCS) – Detail (2) The EPICS



Each hardware has own communication protocol

**Example) APSAIA : 8 channels for each port, total 4 ports
(Each ARAPUCA uses 2 channels)**

Example) CAEN VME8100 (PDS readout)



CAEN Tools for Discovery
 Document type: User's Manual (MUT) Title: Mod. VME8100 VME64/64X 21 Slot 8U Crate Series
 Revision date: 14/09/2017 Revision: 11

8. Communication Protocol

This protocol is based on commands made of sequences of ASCII characters. The format of one command is the following :

\$CMD:*,CH*,PAR:***,VAL:***.**<Cr>**

field 'CH' is:

- 0..7 for commands related to one of possible channels
- 8 for commands related to the Crate.

The format of the response string is one of the following:

- #CMD:ERR<Cr> Command Format wrong or command not recognised
- #CH:ERR<Cr> Channel Field not present or channel value wrong
- #PAR:ERR<Cr> Field parameter not present or parameter not recognised
- #VAL:ERR<Cr> Set Value wrong (<Min or >Max)
- #CMD:OK,VAL:*****<Cr> Command Ok ***** = value

8.1 Monitor Commands related to channel 'X' :

- \$CMD:MON,CH:X,PAR:NAME<Cr> Readout channel name (ex. +5V..)
- \$CMD:MON,CH:X,PAR:VSET<Cr> Readout value of the voltage Set
- \$CMD:MON,CH:X,PAR:VMIN<Cr> Readout minimum value of the voltage Set
- \$CMD:MON,CH:X,PAR:VMAX<Cr> Readout maximum value of the voltage Set
- \$CMD:MON,CH:X,PAR:VRES<Cr> Readout resolution value of the voltage Set
- \$CMD:MON,CH:X,PAR:OVP<Cr> Readout value Over Voltage Protection

- “d” : command dump operating conditions
- VCnXX.X<CR> : Set channel “n” voltage to X.XX volt
- vc335.2 : set CH3’s voltage to 35.2
- Two gains : H (high, 40) and L (low, 20)

Detector Control System (DCS) – Detail (2) The EPICS



The EPICS translates different communication protocols into a single protocol

- Channel access (ca)
 - Each variable from hardware are defined as a process variable (PV) inside the EPICS

- To read a value

- `$ caget <pv_name>`

```
(base) -bash-4.2$ caget sbnd_tpc_west_2_1/outputMeasurementSenseVoltage  
sbnd_tpc_west_2_1/outputMeasurementSenseVoltage -1477.82
```

- To write a value

- `$ caput <PV_name> <value>`

- Then, we use PV names for archiving, building GUI page, and alarming

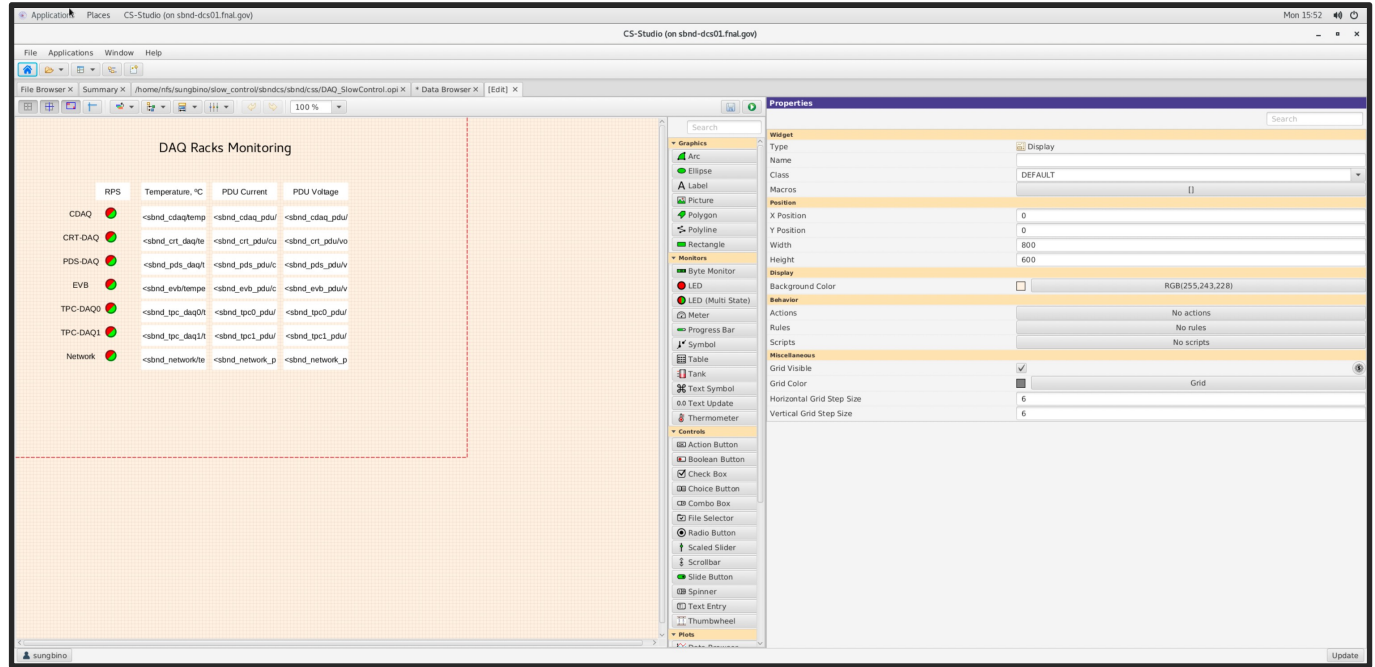
Detector Control System (DCS) – Detail (3) The Phoebus



The Phoebus is GUI page viewer/editor dedicated to the EPICS

- Can be used for both shifters and sub-system experts

(Example)
Editing DQA rack
Monitoring GUI page



Detector Control System (DCS) – Detail (4) Alarms

Alarm is important for recognizing problems with operation of the detector

- The EPICS : define safe ranges of each PV
 - There could be two ranges, MINOR alarm and MAJOR alarm
- The Phoebus : presents alarm status for each PV with alarm boarder

(Example)
Red borders for
MAJOR alarm

Purity Monitor			
	Inline	Short	Long
V(cathode) (V)	-114.34	-196.35	-118.90

- Alarm-server
 - Read an .xml configuration file that defines alarm tree structure
 - Alarm summary panel and table are also supported
- Alarm-logger : archives alarm history into an Elasticsearch DB



SBND Cryo Monitor

"DB update" will flash red when the latest timestamp of a PV is older than 3 minutes

West APA

PV	te-8107a	te-8112a
value	115.970	133.190
timestamp	2024-02-12 18:18:18	2024-02-12 18:18:18
DB update		

East APA

PV	te-8101a	te-8106a
value	116.550	132.979
timestamp	2024-02-12 18:18:18	2024-02-12 18:18:18
DB update		

Monitoring System (Including DQM)

Cryo Bottom

PV	te-8062a	te-8067a
value	86.410	86.330
timestamp	2024-02-12 18:18:18	2024-02-12 18:18:18
DB update		

Cryo Middle

PV	te-8030a
value	122.880
timestamp	2024-02-12 18:18:18
DB update	

Cryo Top

PV	te-8003a
value	172.919
timestamp	2024-02-12 18:18:18
DB update	



DAQ Monitoring Metrics

- Run number
- DAQ server time
- Memory metrics
- Event-building metrics such as
 - The number of empty or missing fragments
 - The time taken waiting for a process or to build events
- Board-reader metrics
- The status of various memory buffers
- Trigger and event rate metrics

DQM Metrics



- TPC
 - Channel waveforms and fast Fourier transforms (FFTs) will be monitored
 - Along with computed metrics such as noise RMS, baseline, hit occupancy and mean peak height
 - The values will be compared to reference values from stable operation
- PDS
 - RMS, baseline, hit occupancy and mean peak height will be monitored per photon detector (PD)
 - The values will be compared to reference values from stable operation
- CRT
 - Baseline, hit time, and maximum ADC value will be monitored per board
 - The values will be compared to reference values from stable operation

DQM Metrics



- White rabbit TDC
 - Timestamps of the different signals that are inputs to the White Rabbit TDC will be monitored and compared to ensure stable time alignment between beam, timing, and trigger signals
- Trigger
 - Low- and high-level trigger (LLT and HLT) production and analog sum of the MTC/A will be monitored.