

Common SBN Detector Controls System (DCS) WG Update

S. Gollapinni (UTK), A. Fava (FNAL)

SBN Collaboration Meeting
September 21, 2018

DCS Common Effort

- Realization that DCS is one place where there is a lot of scope for common effort — so far this has been overwhelmingly true!
- Both experiments converged on using EPICS as the primary Input Output Controller (IOC) for Slow Controls — this makes a lot of software tools development common
- Some hardware systems (e.g. PDS, cameras, ground monitoring, RPS) & Software interfaces(Cryogenics, DAQ, Beam) between both experiments are common — thus making shared effort possible
- All this led to the formation of the common SBN DCS WG — thanks to B. Rebel for making the suggestion

Common SBN DCS meetings

Co-conveners: S. Gollapinni (SBND L3), A. Fava (ICARUS)

- SBN Combined DCS meetings started in Oct. 2017
- Currently, we meet once every 4 weeks
- Active with several members from both experiments and updates at corresponding experiment DAQ and SBN online meetings.
- List of meetings: <https://sbn-docdb.fnal.gov/cgi-bin/private/ListEventsBy?authorid=723>
- Google sheet to collect resources/personnel and effort sharing b/n ICARUS and SBND: <https://docs.google.com/spreadsheets/d/1OrYs-j1YYwZUZcGvs3WxmhhCLXK0VcTil5mCrvK58-4/edit#gid=232170301>
- Mailing list “[SBND-DCS](#)” — subscribe if you are interested!

EPICS

- **E**xperimental **P**hysics and **I**ndustrial **C**ontrol **S**ystem (EPICS)
- Designed for big experiments (e.g. D0, SNS, NOvA)
- Provides highly evolved software
 - manages real-time data exchange
 - scalable to large number of channels
 - readout rates from $< 1/\text{hr}$ to $> 60 \text{ Hz}$
- EPICS **C**ontrol **S**ystem **S**tudio (CSS) for displays and operator interface
- Alarm System and Archiver nicely integrates into the CSS framework
- EPICS successfully used at MicroBooNE (first demonstration for a large-scale LArTPC); also will be used at Mu2e — a lot of expertise/tools already available and makes things uniform across all 3 experiments

Shifter Overview Display

Standard MicroBooNE Slow Controls display page

Alarm area panel

Slow Monitor Control Overview

Overview panel

Alarm Area Panel

Buttons: BeamData, CrateRails, Cryo, LASER, OnDetPower, PCStatus, PMTHV, RackFans, RackProt, RackTemps, TPCDrift, ZMON, ArPurify, DAOSStatus

Slow Monitor Control Overview

EPICS softloc heartbeat

ALARM Panel Color Scheme

- INVALID
- MAJOR
- MINOR
- Acknowledged, any state (in alarm windows only)
- OK (no alarm)

Important note to Shifters:
Acknowledgement affects only alarm windows. On display panels (like this one), the high severity alarm color is always shown, even if the alarm is acknowledged.

Computer Room: DAQ1, DAQ2, DAQ3, DAQ4, Networks, PC

Other: Cryo, Beam, DAQ, Enviro

Alarm Tree

uB_slowmoncon_alarm

- Area: BeamData (invalid-ack'ed/UDF_ALARM)
- Area: CrateRails
 - System: TPC1_1
 - System: TPC2
 - System: TPC3
 - System: TPC4
 - System: TPC5
 - System: TRPM_10
- Area: Cryo (major-ack'ed/HIHI_ALARM)
- Area: LASER (invalid-ack'ed/No Connection)
- Area: OnDetPower (invalid-ack'ed/READ_ALARM)
- Area: PCStatus (MINOR/HIGH_ALARM)

Alarm table

Alarm Table

Current Alarms (3)

PV	Description	Alarm Time	Current Sev	Current Sta	Alarm Seve	Alarm Stat	Alarm Value
uB_PCStatus_PCXX	MINOR alarm: percent usage of /data via C	2015/09/23 11:50:03	MINOR	HIGH_ALAI	MINOR	HIGH_ALAI	70
uB_RackTemps_TPC	MINOR alarm: Temperature probe 2 uB_Ra	2015/09/23 11:18:552	MINOR	HIGH_ALAI	MINOR	HIGH_ALAI	32.0
uB_RackTemps_DAI	MINOR alarm: Temperature probe 2 uB_Ra	2015/09/23 11:02:274	MINOR	HIGH_ALAI	MINOR	HIGH_ALAI	32.0

Acknowledged Alarms (65)

PV	Description	Alarm Time	Current Sev	Current Sta	Alarm Seve	Alarm Stat	Alarm Value
uB_Cryo_IFIX_1_0F	major-ack'ed alarm: V Pump - P2 vacuum	2015/09/23 09:14:133	MAJOR	HIHI_ALAR	major-ack'e	HIHI_ALAR	863.475
uB_OnDetPower_TR	major-ack'ed alarm: Channel read current	2015/09/21 21:37:609	MAJOR	HIHI_ALAR	major-ack'e	HIHI_ALAR	0.000016
uB_PMTHV_TRPM	minor-ack'ed alarm: PMTHV State uB M4	2015/09/21 19:25:845	MINOR	STATE_AL	minor-ack'e	STATE_AL	OFF
uB_PMTHV_TRPM	minor-ack'ed alarm: PMTHV State uB M4	2015/09/21 19:17:149	MINOR	STATE_AL	minor-ack'e	STATE_AL	OFF

Identical Naming convention

- Important to agree on a naming convention from the beginning to make things more uniform b/n both experiments
- Following the MicroBooNE model:
(detector)_(subsystem)_(rack)_(location)/(variable_name)

Where,

detector = SBND or ICARUS
subsystem = subsystem name (e.g. DAQ, Beam, Cryo)
rack = the rack where device is located
location = (unit)_(channel), could be just (unit) or even something else in some cases unit could be create or a module in a power supply
variable_name = the quantity being reported or controlled e.g. voltage, temperature etc.

Examples: SBND_CrateRails_2_2/VOLT_READ, ICARUS_Cryo_Pump1/flowrate

Device List

Orange = common systems; Gray = Expt. do not have the system

Sub-system	Hardware expert		Software interface expert (IOC/pipeline script)	
	SBND	ICARUS	SBND	ICARUS
TPC cathode HV	S. Tufanli	F. Sergiampietri X. Yang	A. Hackenberg	
TPC wire bias HV	J. Crespo		W. Tang	D. Nicklaus
	B. Yu			A. Fava
	L. Camilleri			
	G. Karagiorgi			
Cold TPC electronics	J. Fried		W. Tang	
	Elizabeth Worcester			
	J. Crespo			
	G. Karagiorgi			
	L. Camilleri			
Warm TPC electronics	G. Karagiorgi	G. Rampazzo	W. Tang	D. Nicklaus
	L. Camilleri	L. Castellani		W. Ketchum
	J. Crespo			
Photodetection System HV	R. Van De Water; R. Cooper B. Badgett	GL. Raselli		N. Moggi M. Rossella
Photodetection system electronics	R. Van De Water; R. Cooper; B. Badgett	GL. Raselli		N. Moggi M. Rossella
Photodetection calibration system		M. Bonesini		
CRT	I. Kreslo	A. Schukraft		
		U. Kose		
Laser	I. Kreslo			
Purity monitor				
Cryogenics	M. Geynisman	A. Menegolli		T. Nichols
		B. Norris		
		C. Montanari		
Ground monitor	P. Rublnov	L. Bagby	W. Tang, B. Badgett	
Beam	T. Kobilarcik			
Trigger	R. Cooper; Nuno	T. Cervi		
	J. Crespo	G. Meng		
	B. Badgett	A. Fava		
Rack protection system	L. Bagby, T. Nichols	L. Bagby		
Rack temperature probes	L. Bagby, T. Nichols			
Rack fans	L. Bagby, T. Nichols			
Slow control chassis	S. Gollapinni, D. Huffman, L. Bagby, T. Nichols		S. Gollapinni, W. Tang	
Rack Power Distribution Units (PDUs)			W. Tang	W. Tang
Network	A. Bobyshev	A. Bobyshev		
	S. Wilson	S. Wilson		
Environment/building	S. Gollapinni			
Cameras	J. Schultz	J. Schultz	J. Schultz	J. Schultz
DAQ server CPU hardware	W. Ketchum	W. Ketchum		W. Ketchum
	Bill Badgett			
DAQ Status	W. Ketchum			
Hardware interlock	L. Bagby, T. Nichols?	L. Bagby		
GPS & Timing	Bill Badgett	Bill Badgett	Bill Badgett	Bill Badgett

High-Level “Common” Activities — will evolve more in the future

Task	Reference person	
	SBND	ICARUS
1) Graphical User Interface		G. Sava
1.1) CSS panel		G. Sava
1.2) Alarm generation		G. Sava
1.3) Archiving of information		G. Sava
2) Database	I. Lepetic	
2.1) Set-up of tables	I. Lepetic	
2.2) Scripts for retrieving info from db	I. Lepetic	
2.3) Consistency check of PV naming		
3) UPS packaging	G. Lukhanin	
4) Documentation		
4.1) Maintenance of wiki page		
4.2) Shifter's handbooks & training		

Status of Common Activities

Green=done; Orange=ongoing; Gray=not started

Hardware (Interfaces)

- Photon Detector System power supply (ongoing)
- Rack Power Distribution Units (Done!)
- Ground Monitoring (Done!)
- Cameras (ongoing)
- Cryogenics Status (ongoing)
- DAQ monitoring (ongoing)
- Beam Status
- Network
- Rack Protection System
- Environment/Building
- Interlock bit monitoring
- GPS & Timing

High-level Software

- UPS Packaging
- Graphical User Interface
- Archiver Database
- Alarm Server
- Documentation (Expert & Shifter)

We could use more people to help with these activities

Software Activities

- All common software (EPICS, CSS, alarm server, NetSNMP), has been made available to both experiments as UPS packages ([G. Lukhanin](#))
 - Packaging and maintenance provided by Gennadiy for both experiments
- EPICS input/output applications written for various systems
- Monitoring displays developed using EPICS CSS
- The Archiver database has been developed and implemented for history tracking ([I. Lepetic](#), IIT graduate student)
 - Common database tools are being developed

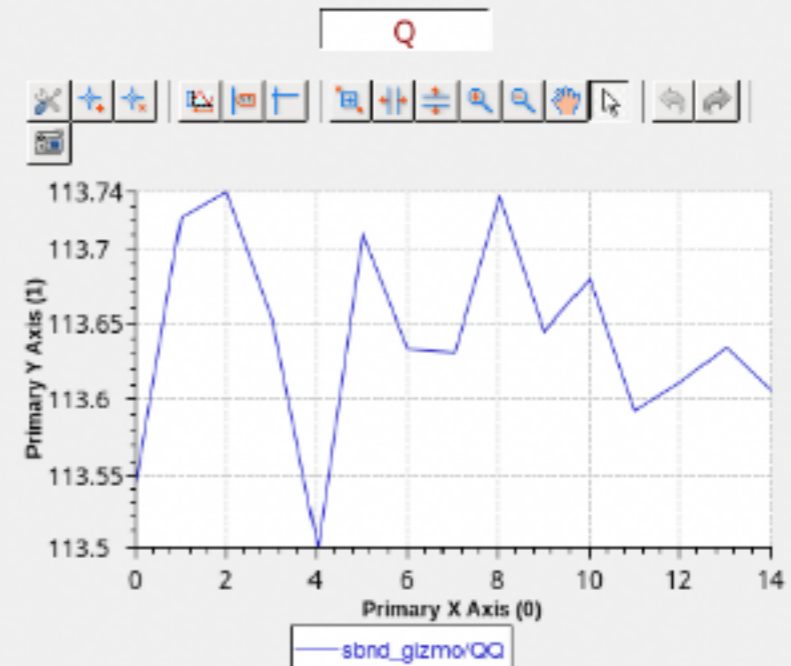
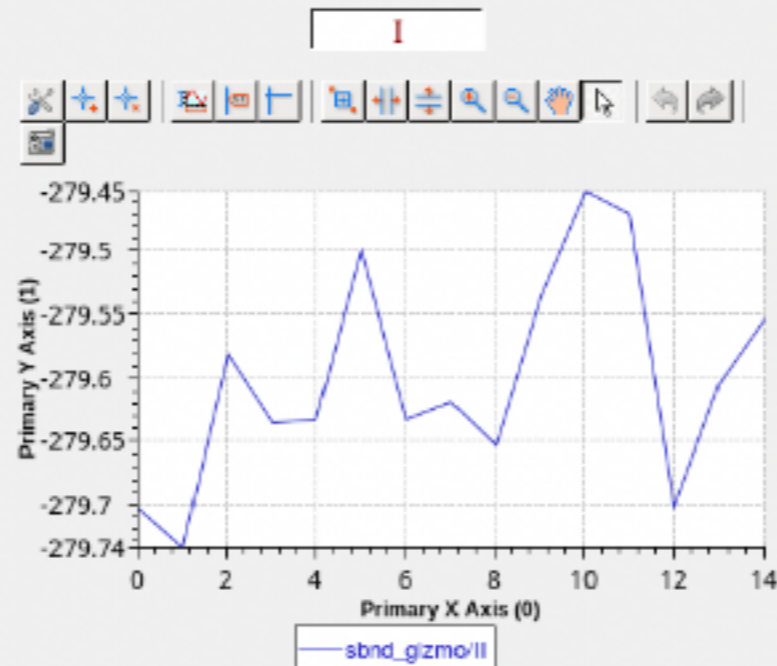
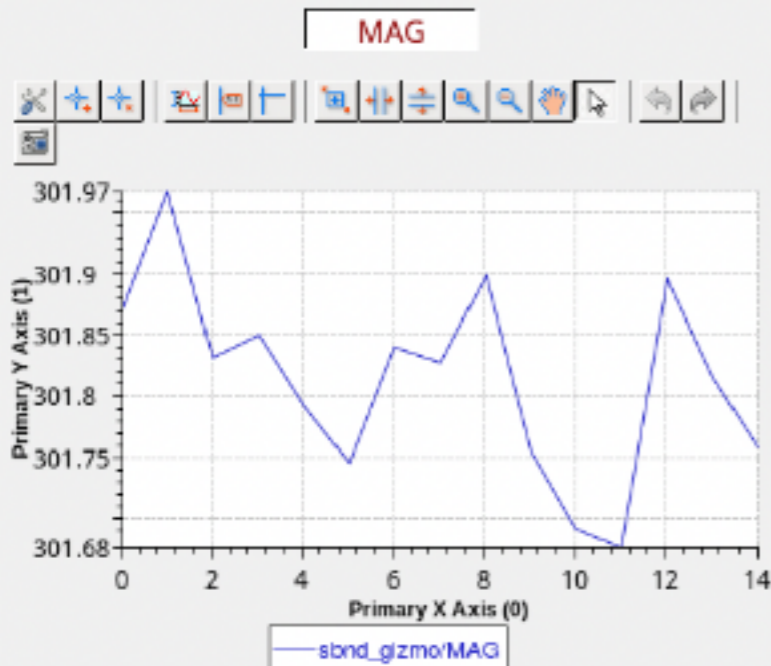
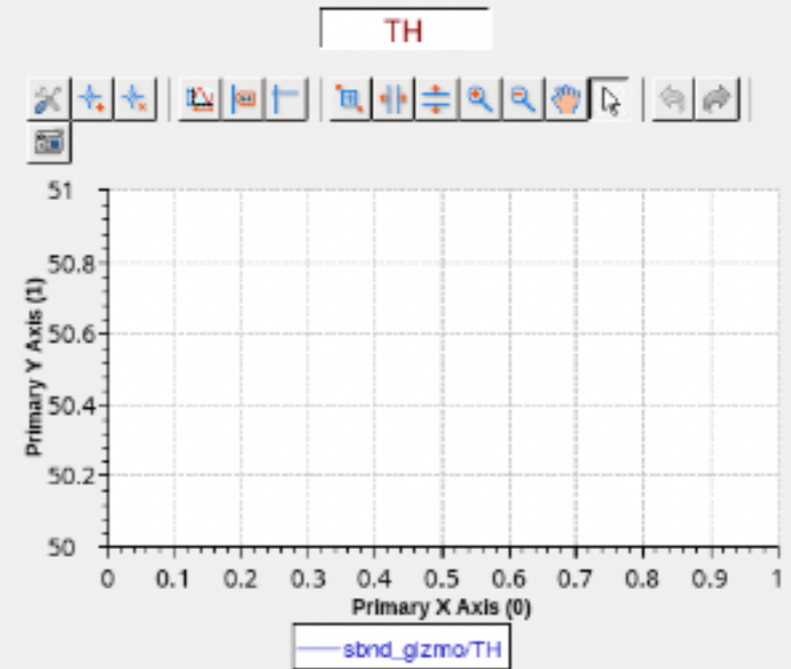
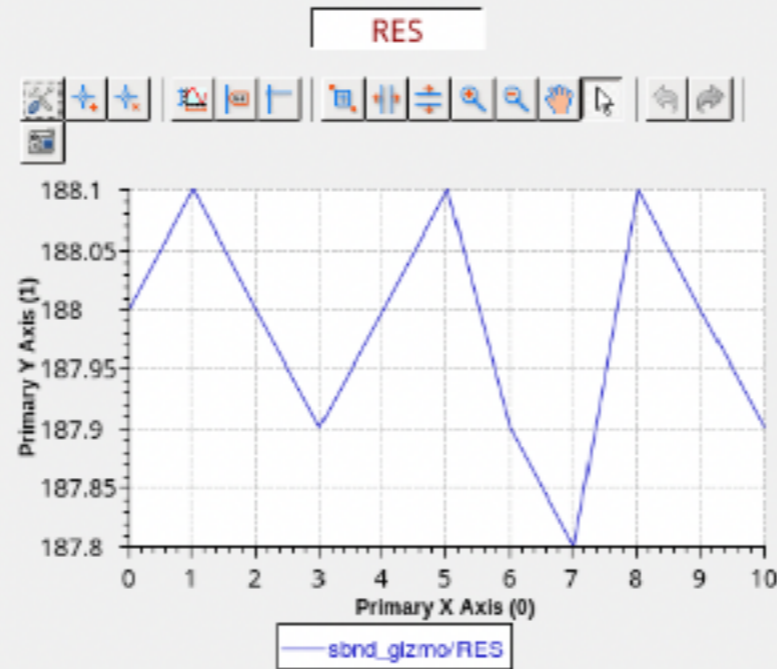
Ground Monitoring

W. Tang, P. Rubinov, B. Badgett

Custom-built ground monitoring box for both SBND and ICARUS — slow monitoring/controls now available

Gizmo Real Time

RES	187.9
TH	50.0
MAG	301.757
I	-279.555
Q	113.605



Rack Power Distribution Units (PDUs) Control & Monitoring

W. Tang

APC PDU Status

Main Switch ●

More Status (Click Me)

Outlet 1 ●	"NIM Crate"	Outlet 13 ●	"Outlet 13"
Outlet 2 ●	"NIM Fan Tray"	Outlet 14 ●	"Outlet 14"
Outlet 3 ●	"Outlet 3"	Outlet 15 ●	"Outlet 15"
Outlet 4 ●	"Outlet 4"	Outlet 16 ●	"Outlet 16"
Outlet 5 ●	"Outlet 5"	Outlet 17 ●	"Outlet 17"
Outlet 6 ●	"Outlet 6"	Outlet 18 ●	"Outlet 18"
Outlet 7 ●	"Outlet 7"	Outlet 19 ●	"Outlet 19"
Outlet 8 ●	"Outlet 8"	Outlet 20 ●	"Outlet 20"
Outlet 9 ●	"CAEN VME Crate"	Outlet 21 ●	"Outlet 21"
Outlet 10 ●	"Outlet 10"	Outlet 22 ●	"Outlet 22"
Outlet 11 ●	"Outlet 11"	Outlet 23 ●	"Outlet 23"
Outlet 12 ●	"Outlet 12"	Outlet 24 ●	"Outlet 24"

PDU PS Alarm	1
PDU Total Outlets	24
PDU Phase number	1
PDU Break number	2
PDU Power	43
PDU Power Factor	98
PDU AP Power	44
PDU Peak Power	85
PDU Energy	9973

PDU Name	"sbnd-pdu21"	PDU Model	"AP8932"
Hardware Version	"02"	Software Version	"6.4.6"
Location	"D0/3/313 Rack SBND-TEST-02"	Contact	"William Badgett badgett@fnal.gov"
Manufacture	"03/24/2017"	Serial Number	"ZA1712114439"

Control (Click Me)

Configuration (Click Me)

Peak Power Time

"01/31/2018 16:18:44"

Peak Power Start

"03/24/2017 02:14:53"

Energy Start

"03/24/2017 02:15:13"

PDS & Camera Monitoring

- *Photon Detector Power Supply* (*N. Moggi*)
 - Successfully compiled EPICS control code for the CAEN supply as of last month.
 - Currently can read on/off variables and have established basic communication, need to work more to read voltages and other variables. New Beckhoff modules and a VME crate have arrived and will be tested soon.
- *Cameras* (*J. Shultz, FNAL Media Services*)
 - For detector hall monitoring
 - Jim, Angela, Sowjanya toured SBND/ICARUS buildings to understand optimal locations for cameras
 - Plan to go with Axis cameras; need some reconfiguration from the out-of-the box setup in order to live on the FNAL network
 - already used at other experiments (e.g. NOvA) so controls/monitoring exist

DAQ, Cryo & Beam Status

- *DAQ (W. Ketchum, W. Tang)*
 - [DAQ servers](#) (e.g. memory, CPU); [DAQ server hardware monitoring](#) (e.g. server fans, temperature sensors); [DAQ status](#) (e.g. run status)
 - Wes is working on the DAQ Grafana to EPICS interface; Wei is working on the EPICS “soft” IOC
- *Cryo Status (T. Nichols, W. Tang)*
 - Extract information from IFIX to EPICS using a python script
 - Tools exist at MicroBooNE; need to understand how to extract info from IFIX in the format needed
- *Beam Status:* Extract information from IFBeamDB into EPICS; monitoring tools exist at MicroBooNE, port them

SBND Vertical Slice Test (VST) Experience

- SBND VST was a great place to test common systems/tools in addition to SBND-specific systems to gain experience

Systems implemented at VST

Name	Type	IP	Usage	Module	App/GUI
sbnd-wps02	Wiener MPOD	131.225.150.199	wire bias	1 (8-ch) modules	✓
sbnd-wps03	Wiener PL506 (BNL)	131.225.150.202	TPC electronics	2 (6-ch) modules	✓
sbnd-wps04	Wiener PL506 (Nevis)	131.225.150.205	TPC electronics	1 (6-ch) modules	✓
sbnd-pdu21	APC AP8932	192.168.230.106	DAQ rack		✓

Common system

- Archiver was also implemented at VST — a lot of lessons learned (e.g. archiver dead bands, back-up archiver status monitoring etc.)
- Performance in general good for the slow controls model implemented

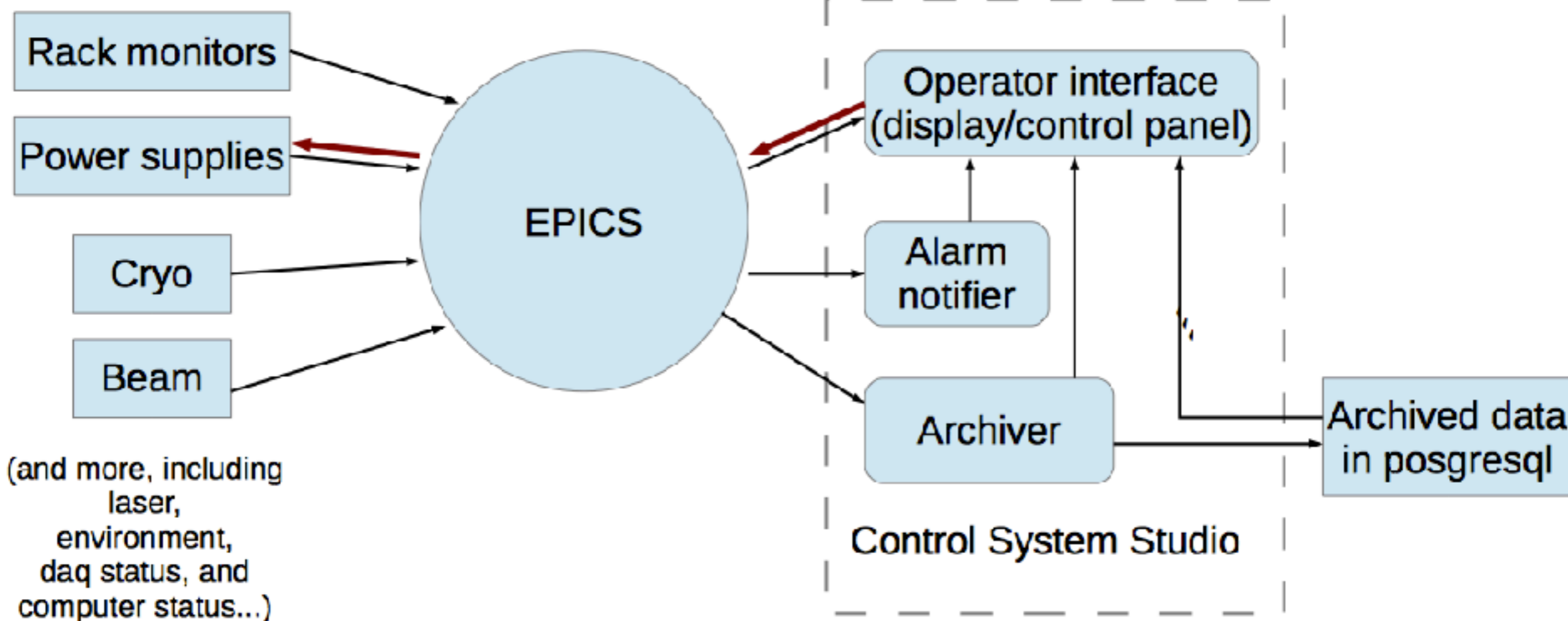
Next Steps

- Focus on implementing the Cryogenics monitoring
- Finalize camera configuration for detector halls and implement control and monitoring — need input from technical lead, building managers
- On the slow controls archiver, implement the alarm system and integrate alarm panels and tables in the GUIs
- Prepare top-level overview panels that will be similar between the two experiments
- *We could always use more people — help most welcome!*
 - *DCS tasks factorize well, so easy for people to jump in*
- Might increase the frequency of meetings given increased activity

Extras

Data Flow Model with EPICS

Data from hardware
and external sources



Milestones for common activities

Milestone	Date
Cryogenics status into EPICS	Nov. 2018
DAQ server/status monitoring into EPICS	Feb. 2019
Beam Status into EPICS	Feb. 2019
Cameras for monitoring access to the buildings operational	March 2019
Slow Controls Archiver, Alarm Server ready	March 2019
CSS GUI interface & navigation ready	April 2019
Expert/commissioning-level documentation ready	June 2019
Shifter-level documentation ready	Sept. 2019

SBND-specific updates

- More detailed presentation on SBND-side updates:
https://sbn-docdb.fnal.gov/cgi-bin/private/RetrieveFile?docid=8404&filename=sbnd_collaboration_2018_09_19_WT.pdf
- Controls for Wire bias and TPC electronics ready
- Rack Monitoring Box
 - Hardware Prototyping (T. Nicholas, D. Huffman)
 - Controls (W. Tang)

ICARUS-specific updates

- Architecture & design complete, except readout of drift HV system.
- Hardware mostly procured.
- Custom applications for primary PMT HV, TPC bias HV and PMT readout ready.
- Applications for PMT HV distribution, TPC readout and inner sensors under development.
- Software development of external system interfaces, archiver and CSS at early stages, largely done under the common SBN effort.
- Extensive tests needed for all components. Test stands available at CERN and Fermilab.