FD2-VD DAQ CDR:
Slow Control overview and requirements

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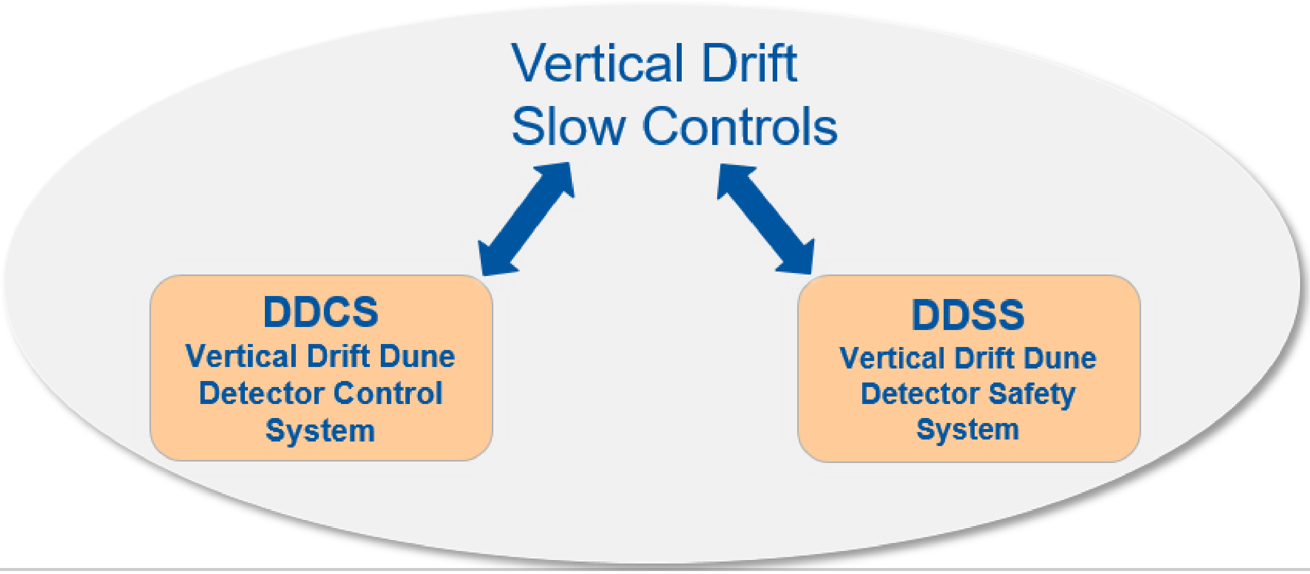
Contents

Introduction

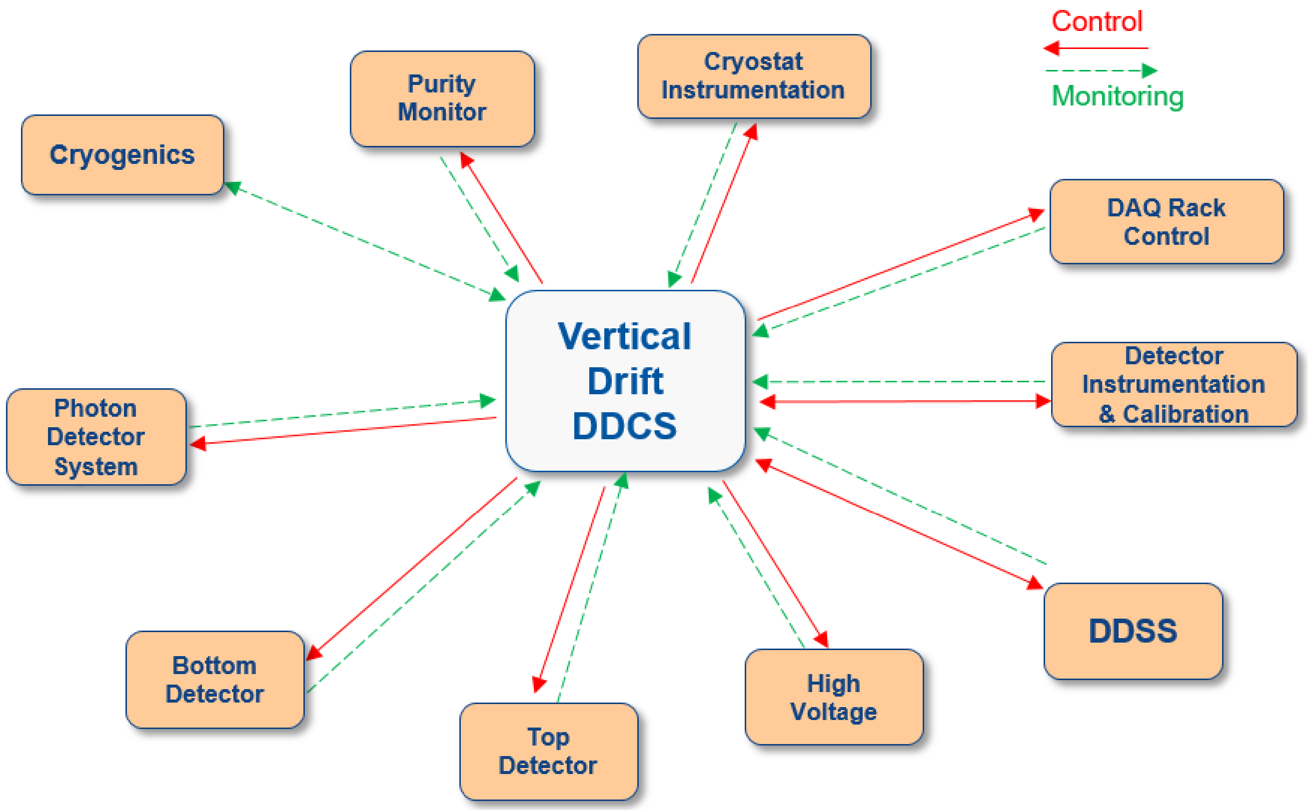
- The Vertical Drift Slow Control SC is assured by two subsystems:
    - Detector Control System DDCS
    - Detector Safety System DDSS

- Communicating, exchanging data, controlled, operated by the Vertical Drift Slow Controls



Introduction. DDCS

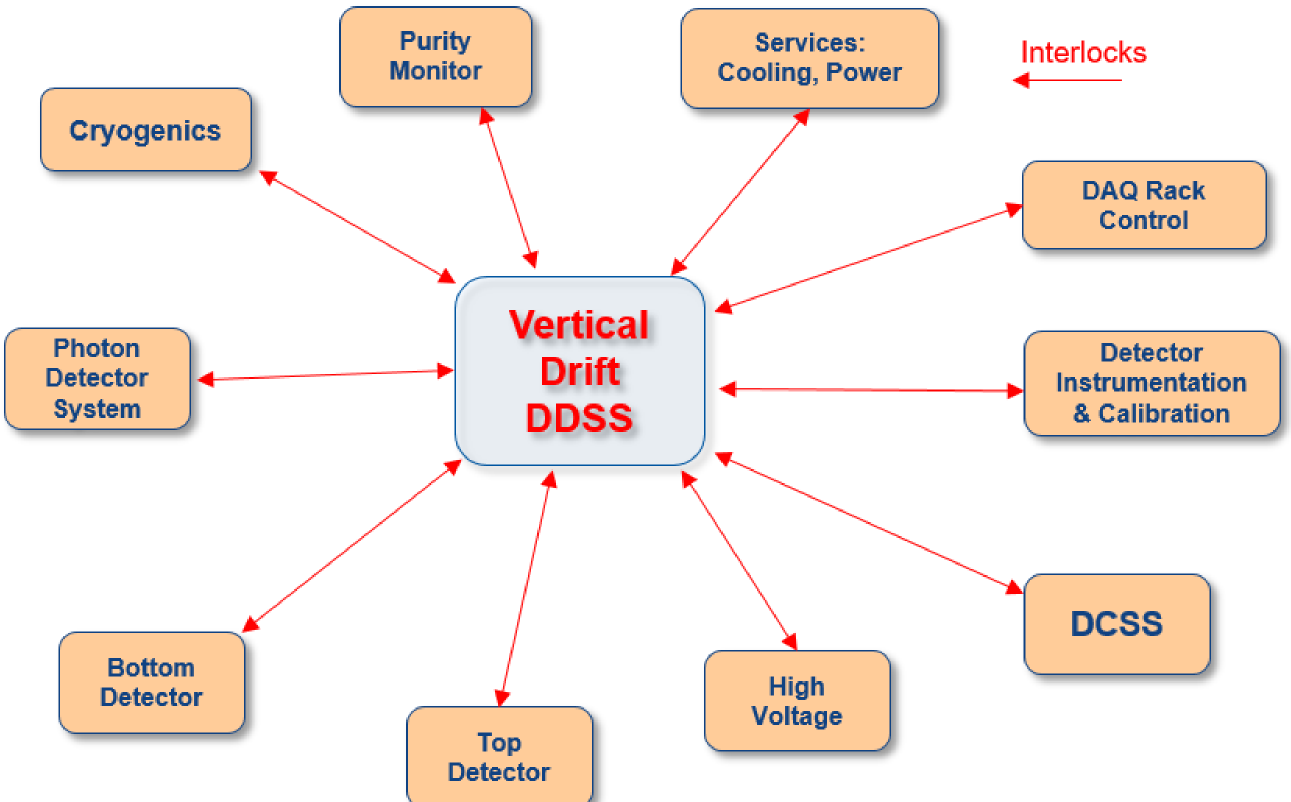
- The Detector Control System DDCS involves all the subsystems and elements (hardware and software) that integrate the detector allowing its correct operation and supervision.



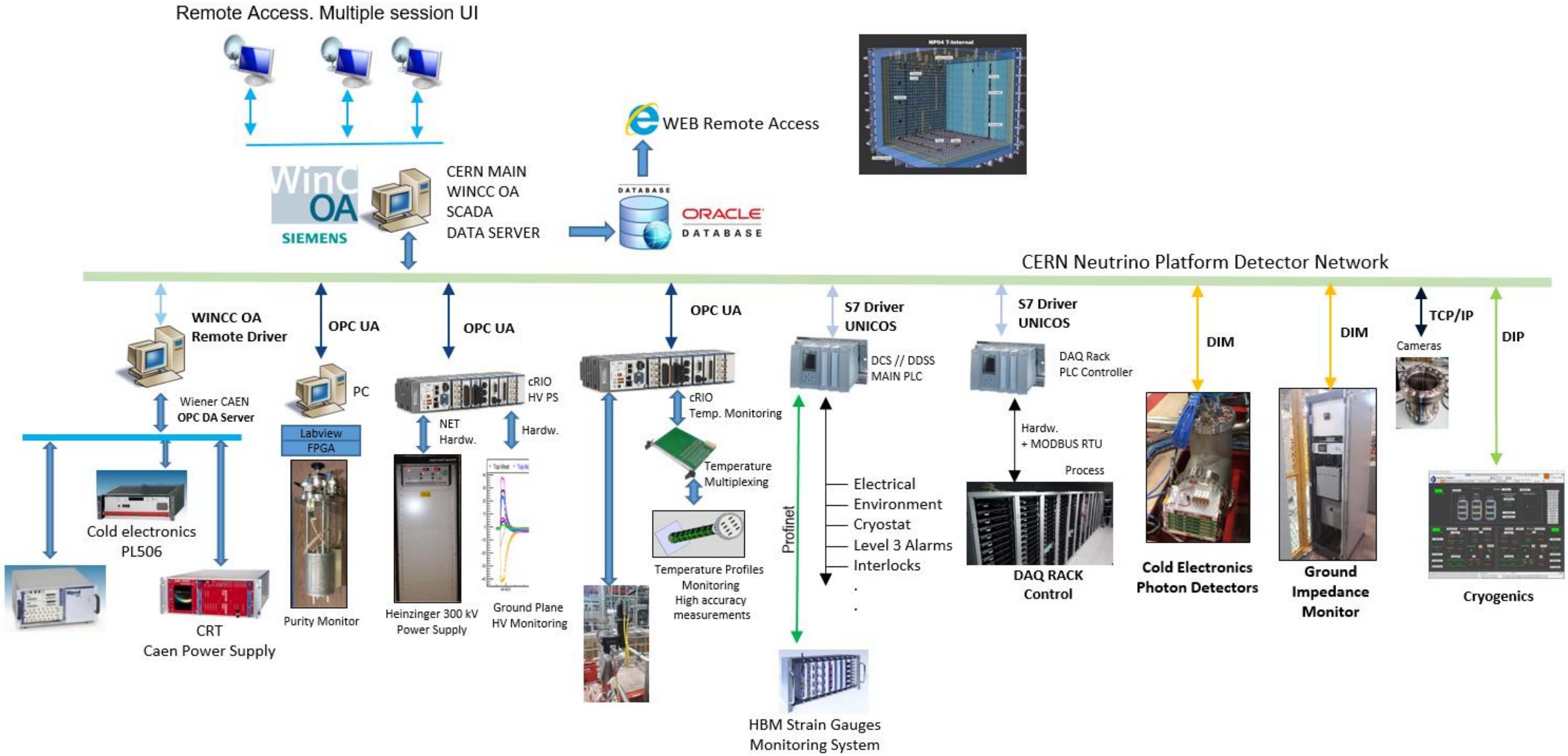
Original from protoDUNE SinglePhase CW 01/2019

Introduction. DDSS

- The Detector Safety System DDSS assures the safety of the detectors , including all subsystems and elements (hardware and software) that integrate the detector, allowing the operation in safe conditions

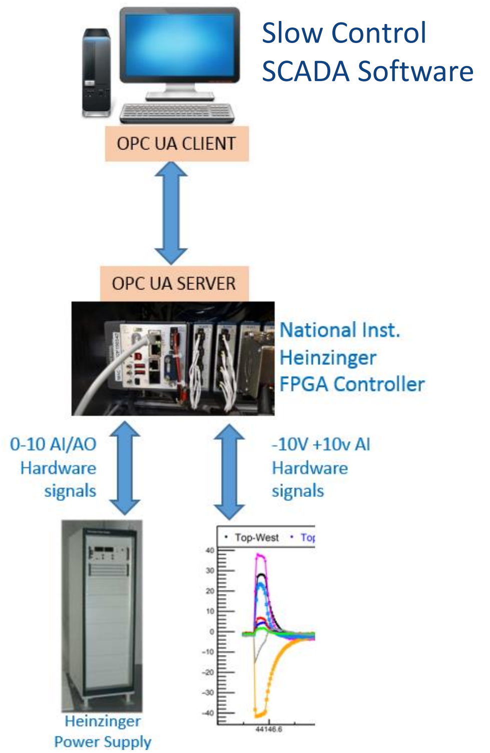


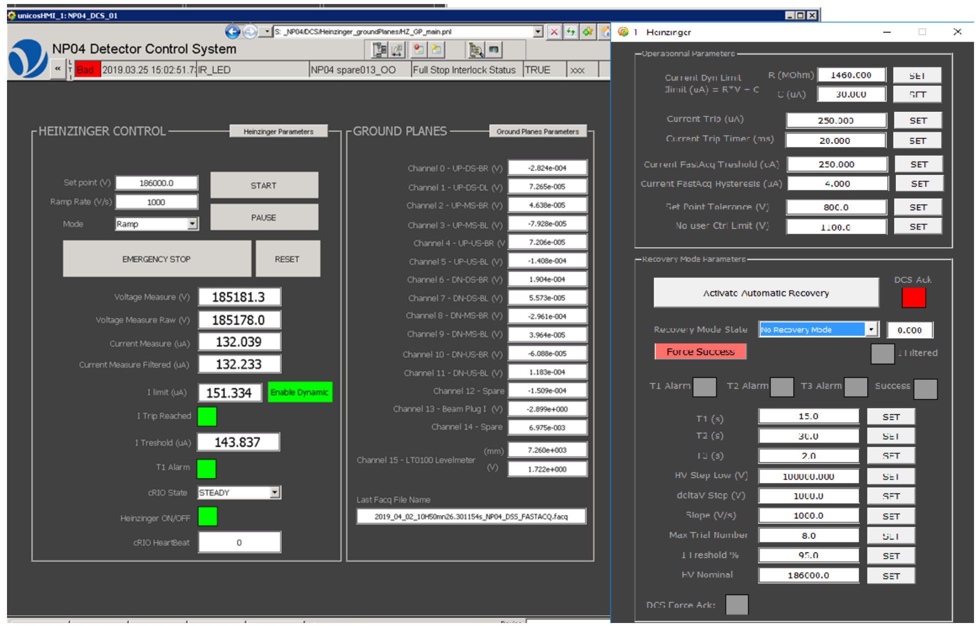
protoDUNE Single Phase Slow Control Layout



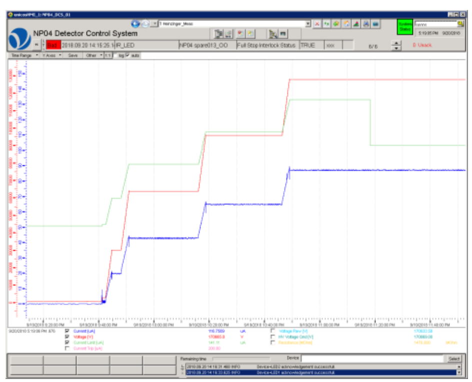
protoDUNE Single Phase Slow Control. HV integration Example

The data is transmitted to Real-Time controller, connected and integrated to the SCADA DCS program by means of the OPC UA driver for HV control, operation and monitor.

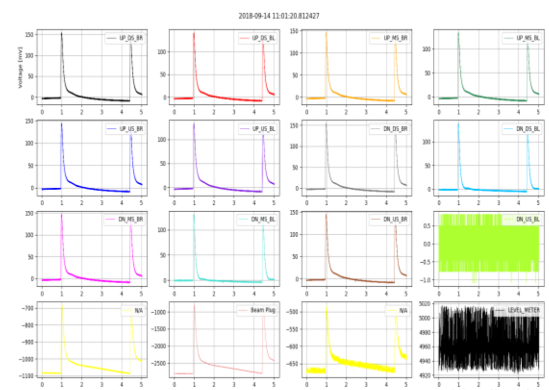




Heinzinger HV Control Panel

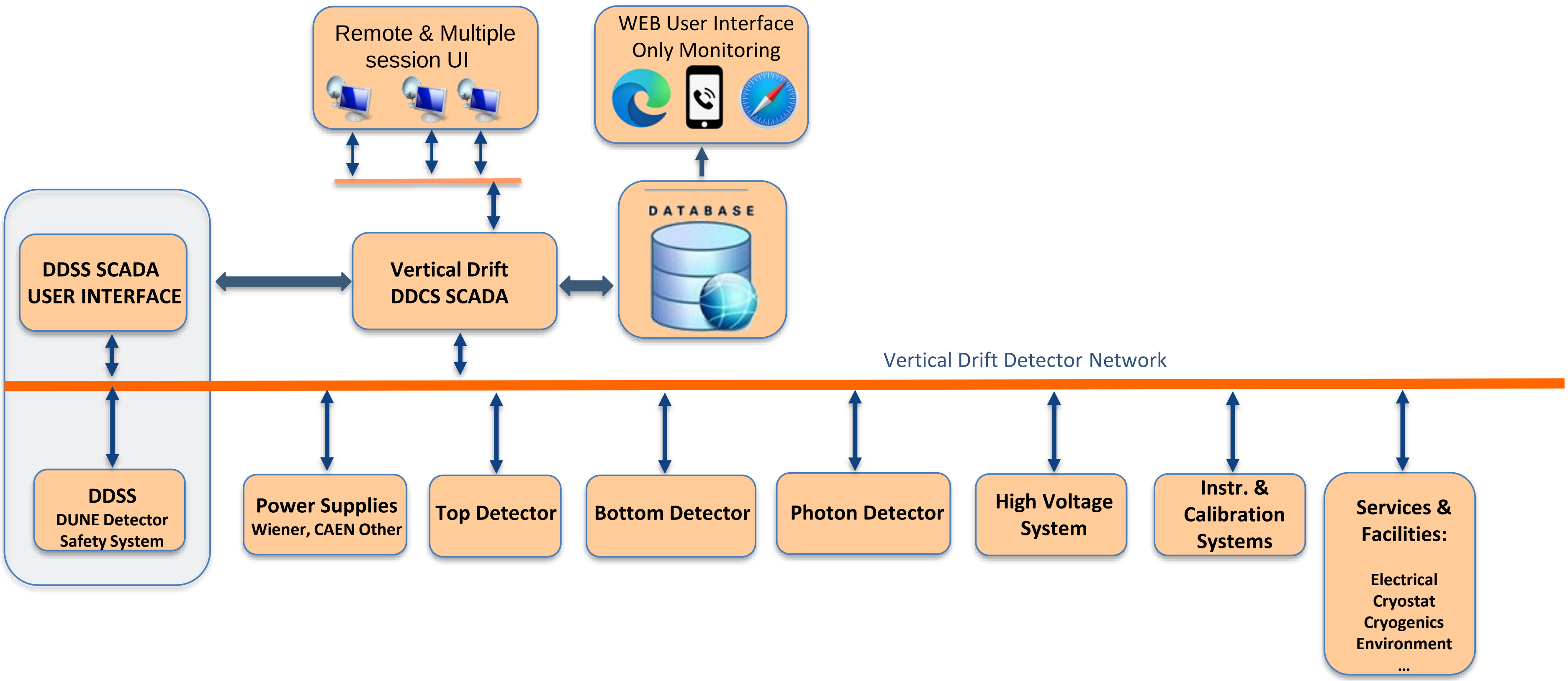


Ramp up by steps on 20/09/2021 at 9:40 PM



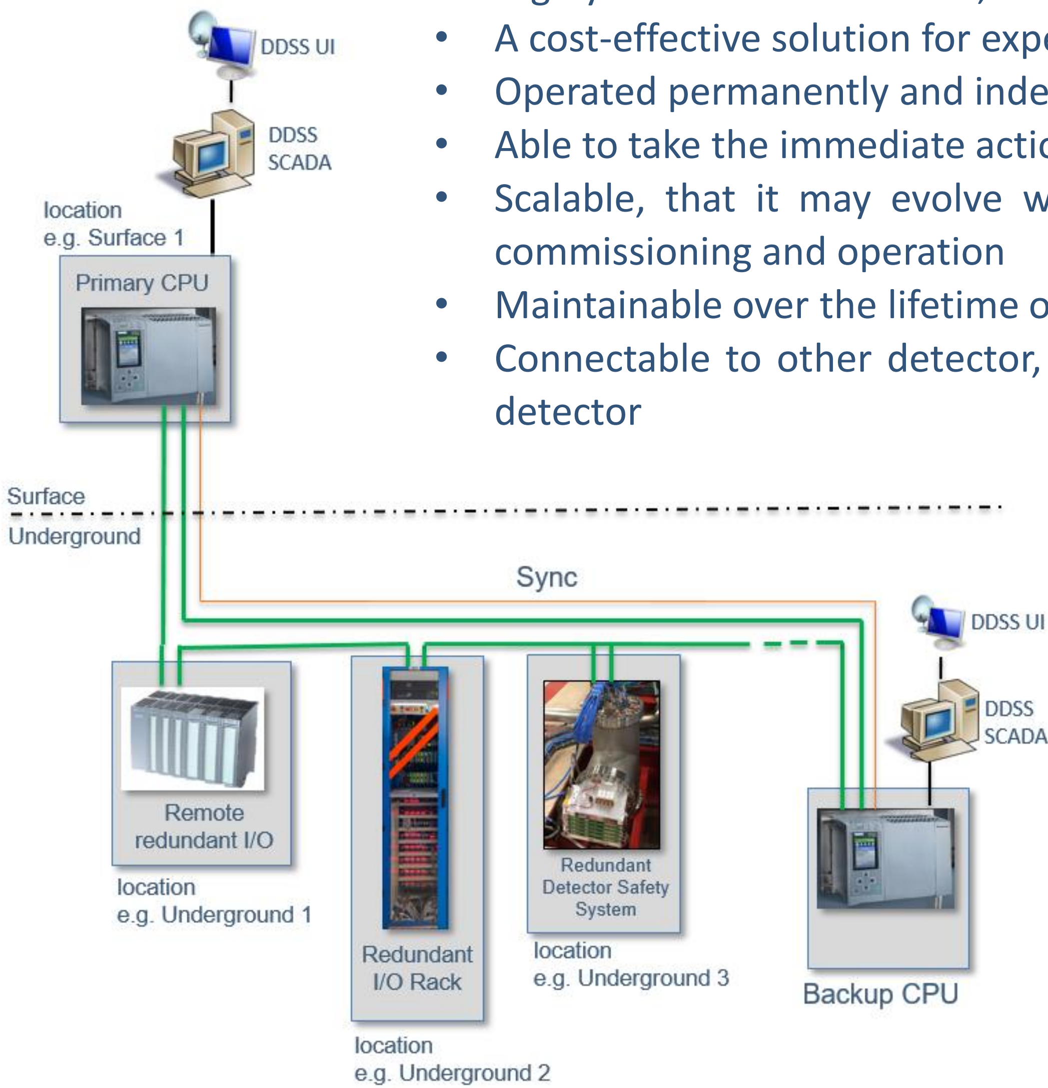
Ground Planes & Beam Plug discharge event on 14/09/2018

Vertical Drift DUNE Detector Control System Layout. DDCS



Vertical Drift DUNE Detector Safety System Layout. DDSS

- Highly reliable and available, as well simple and robust
- A cost-effective solution for experiment safety
- Operated permanently and independently of the DDCS state
- Able to take the immediate action to protect the equipment
- Scalable, that it may evolve with the experiments during their assembly, commissioning and operation
- Maintainable over the lifetime of the experiments
- Connectable to other detector, subdetector or any other equipment of the detector



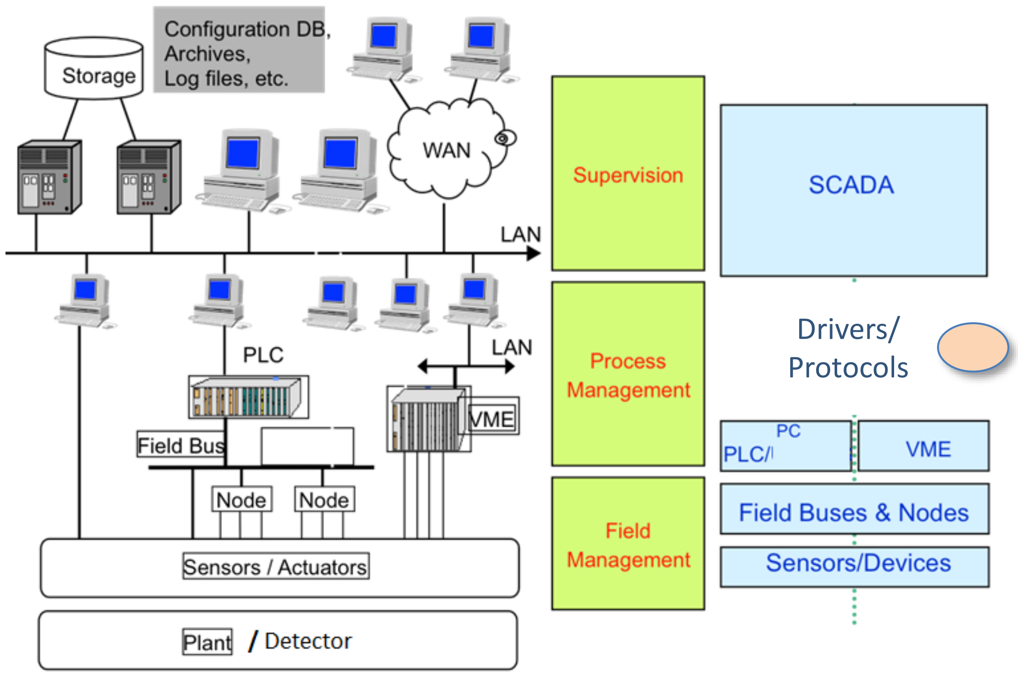
The core of the DDSS is the redundant PLC, e.g. SIEMENS S7-400H.

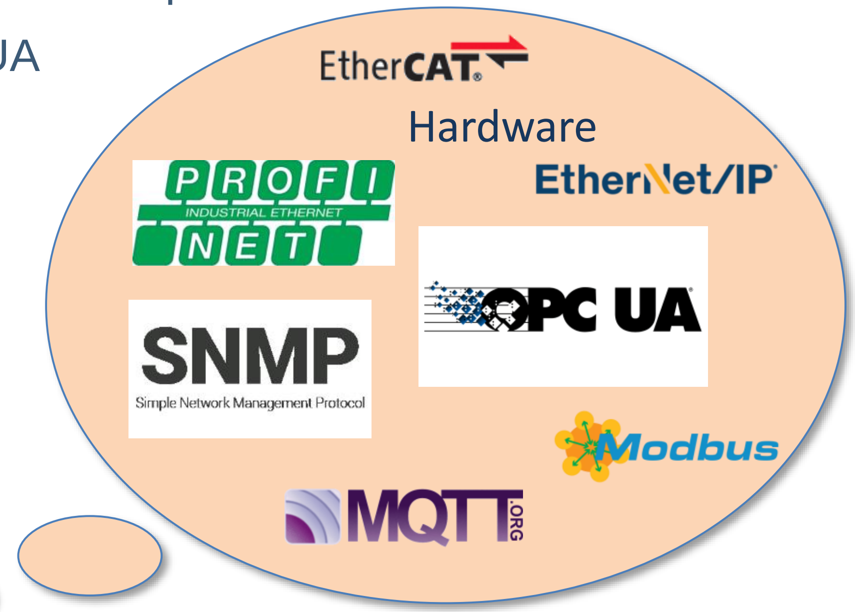
The two S7-400 CPUS synchronized with optical fiber, run the same code, comparing their states, in case of problem in one CPU, the redundant takes over

The two S7-400 CPUS are mounted in different locations (e.g. one underground the other in the surface)

Slow Control requirement. Connectivity

- The essential point of the Slow Controls is the connectivity
- The openness to a comprehensive range of drivers or protocols
- Vertical Drift DDCS gives priority to the OPC UA





Slow Control Requirement. Scalability

From M. Verzocchi, Bottom Detector

Single Phase Cold Electronics

6 Low Voltage Channels
36 HV Channels

X 37 OPC items /channel <u>1110 items</u>

Total: 256 positive (16 ISEG modules with 16-channels each), 320 negative (20 ISEG modules with 16-channels) each

This requires four MPOD crates each with 4 positive and 5 negative ISEG modules

Each WIEC requires one channel of a WIENER PL506 (6 channels each)

- Need 17 WIENER crates to provide power to the 100 WIECs (1.8-2.5 kW per crate)

Total amount of WIENER channels = 678 channels

X 37 OPC items /channel = <u>**25086 items**</u>

Unified Automation UaExpert - The OPC Unified Architecture Client - NP04*

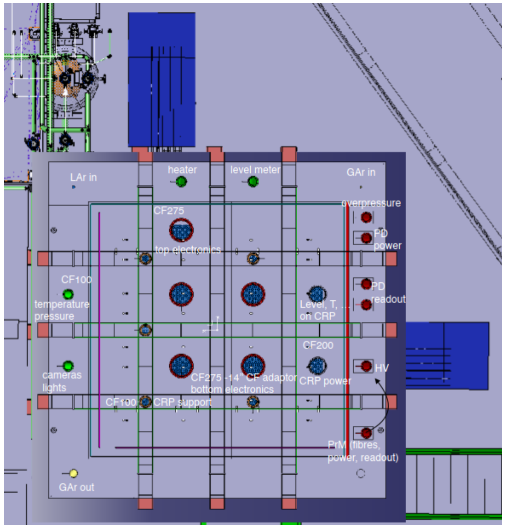
#	Server	Node Id	Display Name	Value	Datatype	Source Timestamp	Server Timestamp	Status
1	MPOD	NS2|String|MPOD_CE_RACK4...	FailureMaxCurrent	false	Boolean	16:58:06.702	16:58:07.659	Good
2	MPOD	NS2|String|MPOD_CE_RACK4...	FailureMaxPower	false	Boolean	16:58:06.702	16:58:07.659	Good
3	MPOD	NS2|String|MPOD_CE_RACK4...	FailureMaxSenseVoltage	false	Boolean	16:58:06.702	16:58:07.659	Good
4	MPOD	NS2|String|MPOD_CE_RACK4...	FailureMaxTemperature	false	Boolean	16:58:06.702	16:58:07.659	Good
5	MPOD	NS2|String|MPOD_CE_RACK4...	FailureMaxTerminalVoltage	false	Boolean	16:58:06.702	16:58:07.659	Good
6	MPOD	NS2|String|MPOD_CE_RACK4...	FailureMinSenseVoltage	false	Boolean	16:58:06.702	16:58:07.659	Good
7	MPOD	NS2|String|MPOD_CE_RACK4...	FailureTimeout	false	Boolean	16:58:06.702	16:58:07.659	Good
8	MPOD	NS2|String|MPOD_CE_RACK4...	Inhibit	false	Boolean	16:58:06.702	16:58:07.659	Good
9	MPOD	NS2|String|MPOD_CE_RACK4...	On	false	Boolean	16:58:06.702	16:58:07.659	Good
10	MPOD	NS2|String|MPOD_CE_RACK4...	RampDown	false	Boolean	16:58:06.702	16:58:07.659	Good
11	MPOD	NS2|String|MPOD_CE_RACK4...	RampUp	false	Boolean	16:58:06.702	16:58:07.659	Good
12	MPOD	NS2|String|MPOD_CE_RACK4...	Inhibit	1	Int32	16:58:05.001	16:58:07.659	Good
13	MPOD	NS2|String|MPOD_CE_RACK4...	MaxCurrent	1	Int32	16:58:05.001	16:58:07.659	Good
14	MPOD	NS2|String|MPOD_CE_RACK4...	MaxPower	0	Int32	16:58:05.001	16:58:07.659	Good
15	MPOD	NS2|String|MPOD_CE_RACK4...	MaxSenseVoltage	0	Int32	16:58:05.001	16:58:07.659	Good
16	MPOD	NS2|String|MPOD_CE_RACK4...	MaxTemperature	0	Int32	16:58:05.001	16:58:07.659	Good
17	MPOD	NS2|String|MPOD_CE_RACK4...	MaxTerminalVoltage	0	Int32	16:58:05.001	16:58:07.659	Good
18	MPOD	NS2|String|MPOD_CE_RACK4...	MinSenseVoltage	0	Int32	16:58:05.001	16:58:07.659	Good
19	MPOD	NS2|String|MPOD_CE_RACK4...	Timeout	0	Int32	16:58:05.001	16:58:07.659	Good
20	MPOD	NS2|String|MPOD_CE_RACK4...	ClearEvents	false	Boolean	16:36:39.894	16:58:07.659	Good
21	MPOD	NS2|String|MPOD_CE_RACK4...	Current	0.001	Float	16:58:04.901	16:58:07.659	Good
22	MPOD	NS2|String|MPOD_CE_RACK4...	GroupNumber	0	Int32	16:58:04.901	16:58:07.659	Good
23	MPOD	NS2|String|MPOD_CE_RACK4...	MeasurementCurrent	3.85976e-011	Float	16:59:03.834	16:59:03.834	Good
24	MPOD	NS2|String|MPOD_CE_RACK4...	MeasurementSenseVoltage	0.0187143	Float	16:59:03.734	16:59:03.734	Good
25	MPOD	NS2|String|MPOD_CE_RACK4...	MeasurementTemperature	33	Float	16:58:06.702	16:58:07.659	Good
26	MPOD	NS2|String|MPOD_CE_RACK4...	MeasurementTerminalVoltage	0.0187143	Float	16:59:03.834	16:59:03.834	Good
27	MPOD	NS2|String|MPOD_CE_RACK4...	Name	U0	String	16:36:45.491	16:58:07.659	Good
28	MPOD	NS2|String|MPOD_CE_RACK4...	OnOff	false	Boolean	16:36:39.894	16:58:07.659	Good
29	MPOD	NS2|String|MPOD_CE_RACK4...	SupervisionMaxCurrent	0.001	Float	16:58:05.001	16:58:07.659	Good
30	MPOD	NS2|String|MPOD_CE_RACK4...	SupervisionMaxPower	-1.#QNAN	Float	16:58:05.001	16:58:07.659	Good
31	MPOD	NS2|String|MPOD_CE_RACK4...	SupervisionMaxSenseVoltage	-1.#QNAN	Float	16:58:05.001	16:58:07.659	Good
32	MPOD	NS2|String|MPOD_CE_RACK4...	SupervisionMaxTerminalVoltage	100	Float	16:58:05.001	16:58:07.659	Good
33	MPOD	NS2|String|MPOD_CE_RACK4...	SupervisionMinSenseVoltage	-1.#QNAN	Float	16:58:05.001	16:58:07.659	Good
34	MPOD	NS2|String|MPOD_CE_RACK4...	TripTimeMaxCurrent	500	Float	16:58:05.001	16:58:07.659	Good
35	MPOD	NS2|String|MPOD_CE_RACK4...	Voltage	0	Float	16:58:04.901	16:58:07.659	Good
36	MPOD	NS2|String|MPOD_CE_RACK4...	VoltageFallRate	-30	Float	16:58:04.901	16:58:07.659	Good
37	MPOD	NS2|String|MPOD_CE_RACK4...	VoltageRiseRate	-30	Float	16:58:04.901	16:58:07.659	Good

The Slow Controls has to provide the tools to facilitate and simplify the configuration, operation and archiving of such amount data/channels

Supervisory or Scada Software Requirements

- Homogeneity. Ideally the SC provides a homogeneous environment into which all its parts can be integrated
- Scalability
  - To connect to different subsystem and devices
  - Capacity to handle huge amounts of data.
- Openness.
  - Possibility of parallel developers
  - Comprehensive range of drivers and Connectivity
  - Priority to the OPC UA
- Data Archiving & Data retrieving
- User Interface. Data reporting, trending…
  - Multi-user system. User interface
  - Access Control. User rights
  - Web User Interface, Mobile User Interface (only monitoring)
- Redundancy (Passive or Active), suitable.

Vertical Drift Today. Coldbox

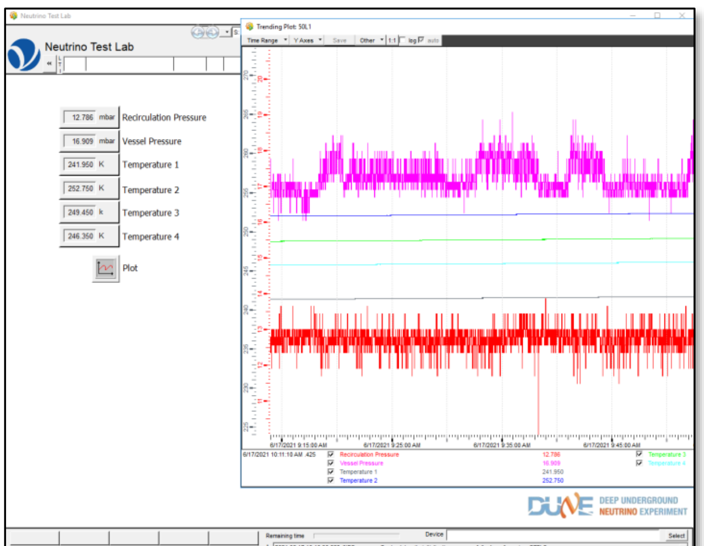


First VD Coldbox layout including rack arrangement a port assignment

- The VD coldbox is being installed using the Dual Phase protoDUNE infrastructure including the isolation detector ground.
- 5 racks will be installed close the coldbox for allocating the detector and slow control equipment.
- The SC will be based in the WINCC OA SCADA and using the facilities already in place for the Dual Phase Detector.
- Discussions are ongoing to define the specifications of the VD Slow control (DDCS and DDSS), the subsystems and the instrumentation
  - The cryogenics SC already well defined and
  - The instrumentation is already listed and the ports are assigned

Vertical Drift Today. Neutrino Test Lab

- Due to the high requests, a Slow Control project is being prepared for neutrino test facilities at CERN, mainly at Building 182
- The aim of this project is to support the validation of the different tests that are ongoing:
    - Vertical Drift 50 liters test
    - 300 kV High Voltage Feedthrough test



First NU Test Lab panel for CERN 50 Liters test

300 kV feedthrough test setup

VD SC CDR Summary

- We have a conceptual design for the Vertical Drift Slow Controls.
- This design follows the majority of the detectors as well the industrial control system standards
- The main requirements are understood but they will be completed first in the Coldbox and later in protoDUNE
- The team is not yet in place, meanwhile the project is driven by the CERN team in the interim

Backup

OPC (Open Platform Communications)

OPC Data Access

- OPC Data Access is a group of client-server **standards** that provides specifications for communicating **real-time** data.
- Is based on **Microsoft Windows** technology using the COM/DCOM (Distributed Component Object Model) for the exchange of data between software components.

OPC Unified Architecture

- OPC UA was designed to enhance and surpass the capabilities of the OPC Classic specifications
  - **Functional Equivalence**
  - **Platform Independence**
  - **Security**
  - **Extensible**

See more on: https://opcfoundation.org/

- Data storage