



U.S. DEPARTMENT OF
ENERGY



Hall D WEDM

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Detector Support Group
August 7, 2019

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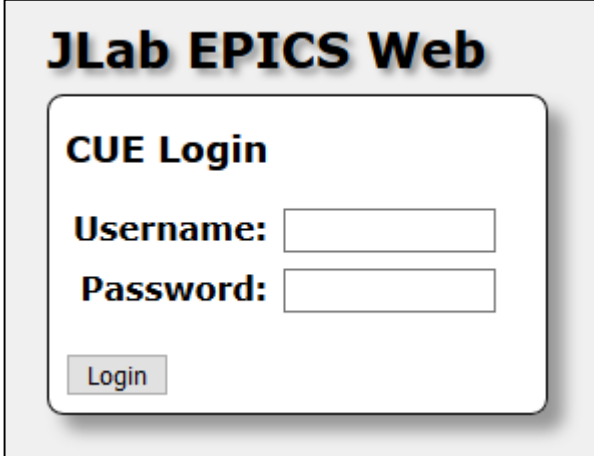
- Overview
 - Hall D controls and monitoring
 - WEDM
- How CSS-BOY screens are converted to WEDM
- WEDM screens created for Hall D
- Problems faced
- Conclusion

Hall D's Current EPICS System

- Hall D's EPICS system uses Control Systems Studio (CSS) screens for user interfaces
- Screens accessible by remotely accessing controls server
 - Must go through “hallgw” (accelerator firewall gateway) with two-factor authentication if offsite
- DSG proposed converting critical operations screens to WEDM to improve ease of offsite monitoring

Web Extensible Display Manager (WEDM)

- Displays EDM screens as HTML in web browser
 - Login with CUE username and password required
- Read-only access; no controls
- Alarm display capabilities
 - Alarm values must already exist in IOC database
- Requires .opi files from CSS to be converted to .edl files for EDM



JLab EPICS Web

CUE Login

Username:

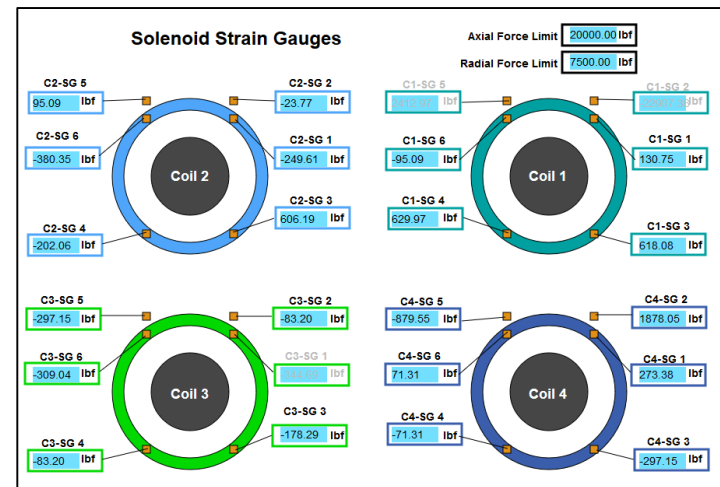
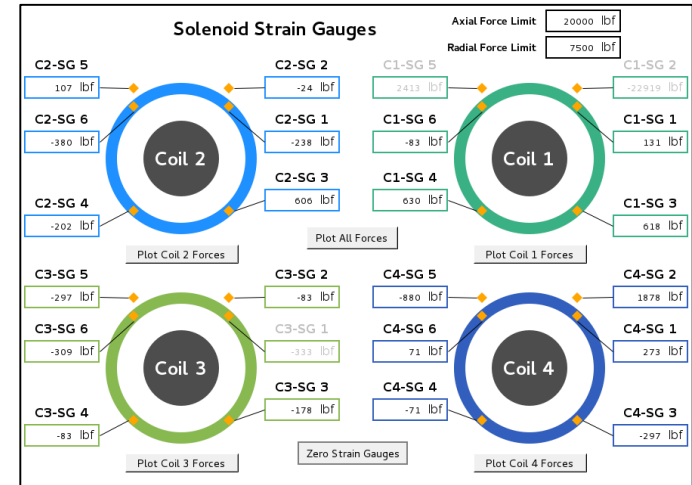
Password:

Login

WEDM log-in screen

How CSS Screens are Converted to WEDM

- Both .opi and .edl file formats are text
 - CSS .opi files are XML
 - EDM .edl files are plain text
- DSG-developed script parses .opi file for widgets and then creates equivalent widgets in .edl file
- Widgets able to convert:
 - Static text
 - PNG images
 - Lines
 - Bar monitors
 - Circles
 - Text monitors
 - Rectangles
 - LEDs
 - GIF images

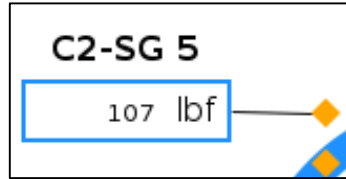


Comparison of Solenoid Strain Gauges CSS screen (top) and WEDM screen (bottom).

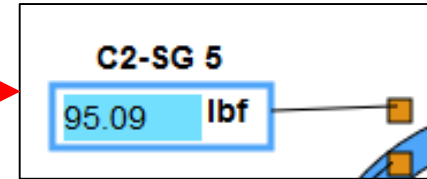
Example Conversion of Widget

Indicator in CSS .opi File

Indicator in WEDM .edl File



Graphics



```
<widget typeId="org.csstudio.opibuilder.widgets.TextUpdate" version="1.0">
  <border_alarm_sensitive>true</border_alarm_sensitive>
  <visible>true</visible>
  <vertical_alignment>1</vertical_alignment>
  <show_units>false</show_units>
  <uid>6dbd36b3:145d20a1167:-7197</uid>
  <auto_size>false</auto_size>
  <rotation_angle>0.0</rotation_angle>
  <scripts />
  <height>20</height>
  <name>Coil2-SG5</name>
  <forecolor_alarm_sensitive>false</forecolor_alarm_sensitive>
  <scale_options>
    <width_scalable>true</width_scalable>
    <height_scalable>true</height_scalable>
    <keep_wh_ratio>false</keep_wh_ratio>
  </scale_options>
  <format_type>0</format_type>
  <precision_from_pv>false</precision_from_pv>
  <transparent>false</transparent>
  <pv_name>SOL1::Solenoid_Magnet-Coil2-SG5</pv_name>
  <background_color>
    <color red="255" green="255" blue="255" />
  </background_color>
  <foreground_color>
    <color red="0" green="0" blue="0" />
  </foreground_color>
  <widget type>Text Update</widget type>
  <enabled>true</enabled>
  <text>####</text>
  <backcolor_alarm_sensitive>false</backcolor_alarm_sensitive>
  <precision>0</precision>
  <font>
    <opifont.name fontName="Sans" height="10" style="0">Default</opifont.name>
  </font>
  <width>60</width>
  <border_style>0</border_style>
  <rules />
  <pv_value />
  <border_width>1</border_width>
  <border_color>
    <color red="0" green="128" blue="255" />
  </border_color>
  <horizontal_alignment>2</horizontal_alignment>
  <actions hook="true" hook_all="true">
    <action type="OPEN_OPI_IN_VIEW">
      <path>stripchart.opi</path>
      <macros>
        <include_parent_macros>true</include_parent_macros>
        <input_pv>$(pv_name)</input_pv>
        <input_name>$(name)</input_name>
      </macros>
      <position>4</position>
      <description></description>
    </action>
  </actions>
  <cy>29</cy>
  <wrap_words>false</wrap_words>
  <tooltip>$(pv_name)</tooltip>
  <x>6</x>
</widget>
```

Text

```
endObjectProperties
# (Textupdate)
object TextupdateClass
beginObjectProperties
major 10
minor 0
release 0
x 18
y 112
w 60
h 20
controlPv "SOL:i::Solenoid Magnet-Coil2-SG5"
fgColor index 14
fgAlarm
bgColor index 51
fill
font "helvetica-medium-r-14.0"
endObjectProperties
# (Textupdate)
```



Hall D WEDM Screens Requested

1. BCAL Chillers
2. ComCal Chiller
3. FDC Chiller
4. Beamline Vacuum
5. ComCal Environment
6. DIRC Environment
7. CDC/FDC Gas System
8. Hall D Ambient Environment
9. Tagger NMR Controls
10. Solenoid Power Supply
11. Solenoid Strain Gauges
12. Solenoid Interlocks
13. Solenoid Voltage Taps
14. Solenoid Vacuum Pumps
15. Solenoid Cryogenics
16. Solenoid Coil 1 Temperatures
17. Solenoid Coil 2 Temperatures
18. Solenoid Coil 3 Temperatures
19. Solenoid Coil 4 Temperatures

BCAL, ComCal, and FDC Chillers

BCAL Chiller (Downstream)		BCAL Chiller (Upstream)	
Temperature	0.00 2.00 -17.78 C	Temperature	63.96 F 17.75 C
Error Status	9.00	Error Status	None
Sensor Type	9.00	Sensor Type	RTD 100 Ohm
RTD	0.00000	RTD	0.31702
Ambient Temperature	0.00 2.00	Ambient Temperature	103.32 F
Coolant Flow	gal/min	Coolant Flow	gal/min

FDC Chiller

STOPPED

Locally Set

Temperature 0.00 0.00 C

Flow Rate 0.00 GPM

Pressure 0.00 MPa

ALARM FLAGS

- Water Leak Detect Fault
- Incorrect Phase Error Fault
- RFGT High Press Fault
- CPRSR Overheat Fault
- Reservoir Low Level Fault
- Reservoir Low Level Warning
- Reservoir High Level Warning
- Temp. Fuse Cutout Fault
- Reservoir High Temp. Fault
- Reserved--
- Reservoir High Temp. Warning
- Return Low Flow Fault
- Return Low Flow Warning
- Heater Breaker Trip Fault
- Pump Breaker Trip Fault
- CPRSR Breaker Trip Fault
- Interlock Fuse Cutout Fault
- DC Power Fuse Cutout Fault
- FAN Motor Stop Warning
- Internal Pump Time Out Warning
- Controller Error Fault
- Memory Data Error Fault
- Communication Error Warning
- DI Low Level Warning
- Pump Inverter Error Fault
- DNET Comm. Error Warning
- DNET Comm. Error Fault
- CPRSR INV Error Fault

STATUS

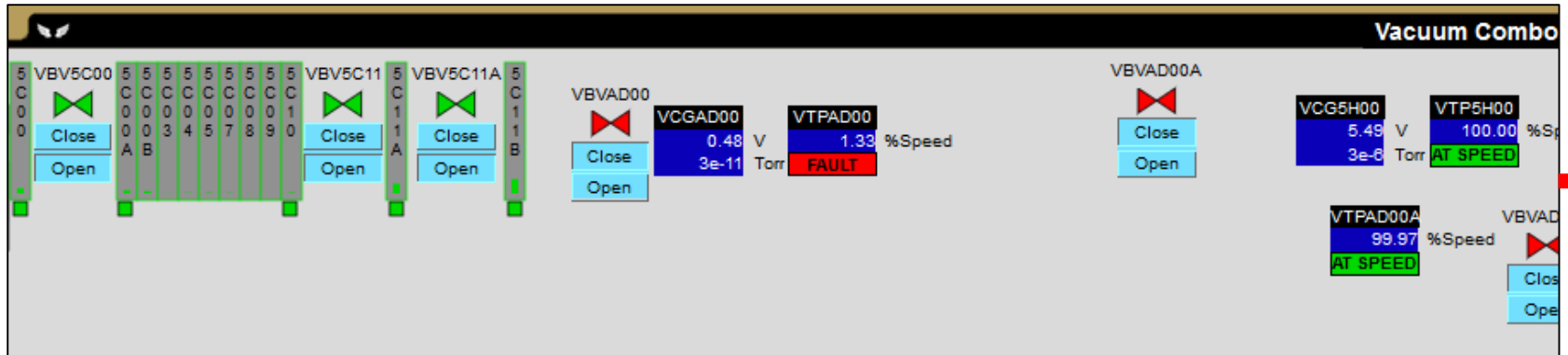
- Run (0=Stop, 1=Run)
- Fault Occurred
- Warning
- Flow Units (0=LPM, 1=GPM)
- Press Units (0=MPa, 1=PSI)
- Remote (0=Local, 1=Remote)
- AUTO PURGE Ready
- AUTO PURGE Running
- Time Out
- Temp Ready

COMCAL Chiller

Temperature	
Error Status	
Sensor Type	
RTD	
Ambient Temperature	

Empty indicators for ComCal Chiller are due to PVs being undefined in IOC at time of screenshot, not problem with WEDM screen.

Beamline Vacuum



To show entire screen on one slide in a way that is readable, screen is split into two parts.

ComCal Environment

COMCAL ENVIRONMENT

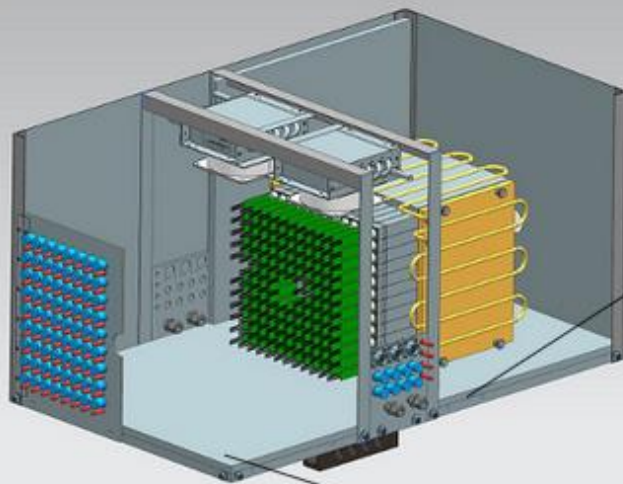
Dark Box Environment Variables	Interlock	Limit Readback	Interlock Override
Diode Temp	-5.89 °C	23.00	Green
RTD_5	850.00 °C	25.00	Green
Humidity	1.19 % RH	69.00	Green
Hall Light Sensor	0.01 V	69.00	Green

DarkBox Environment Variables

Fan1 Speed	0.00	RPM
Fan2 Speed	0.00	RPM
Chiller Flow	0.00	GPM
Nitrogen Flow	15.90	LNH

Fan Control Readback ■

HV Interlock ■



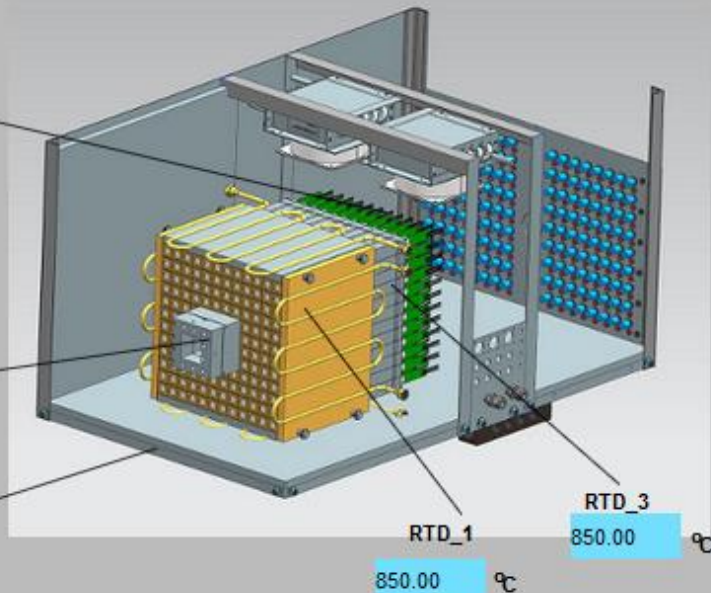
Environment
Temp/Humidity/Light

RTD_5
850.00 °C

RTD_4
850.00 °C

RTD_2
850.00 °C

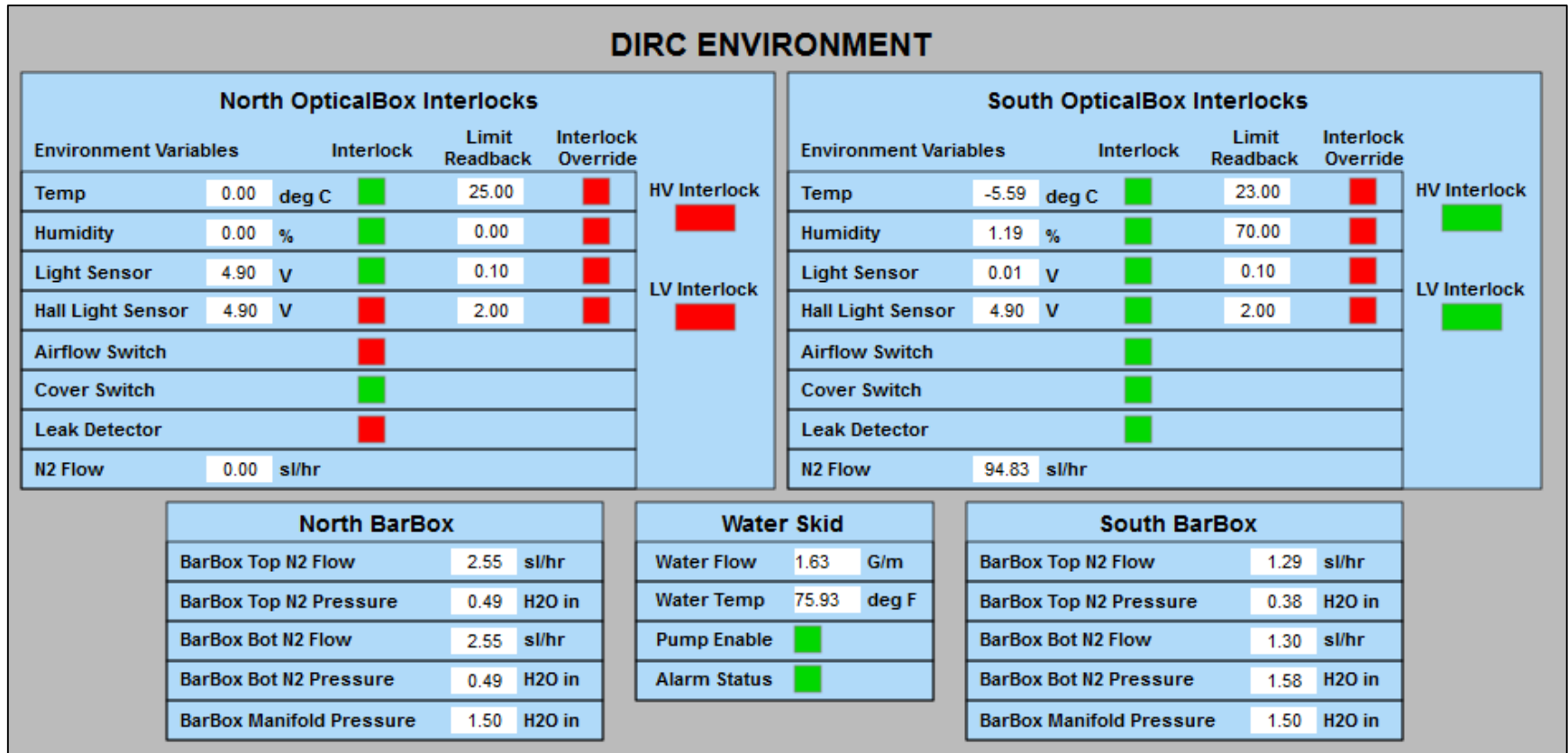
RTD_0
850.00 °C



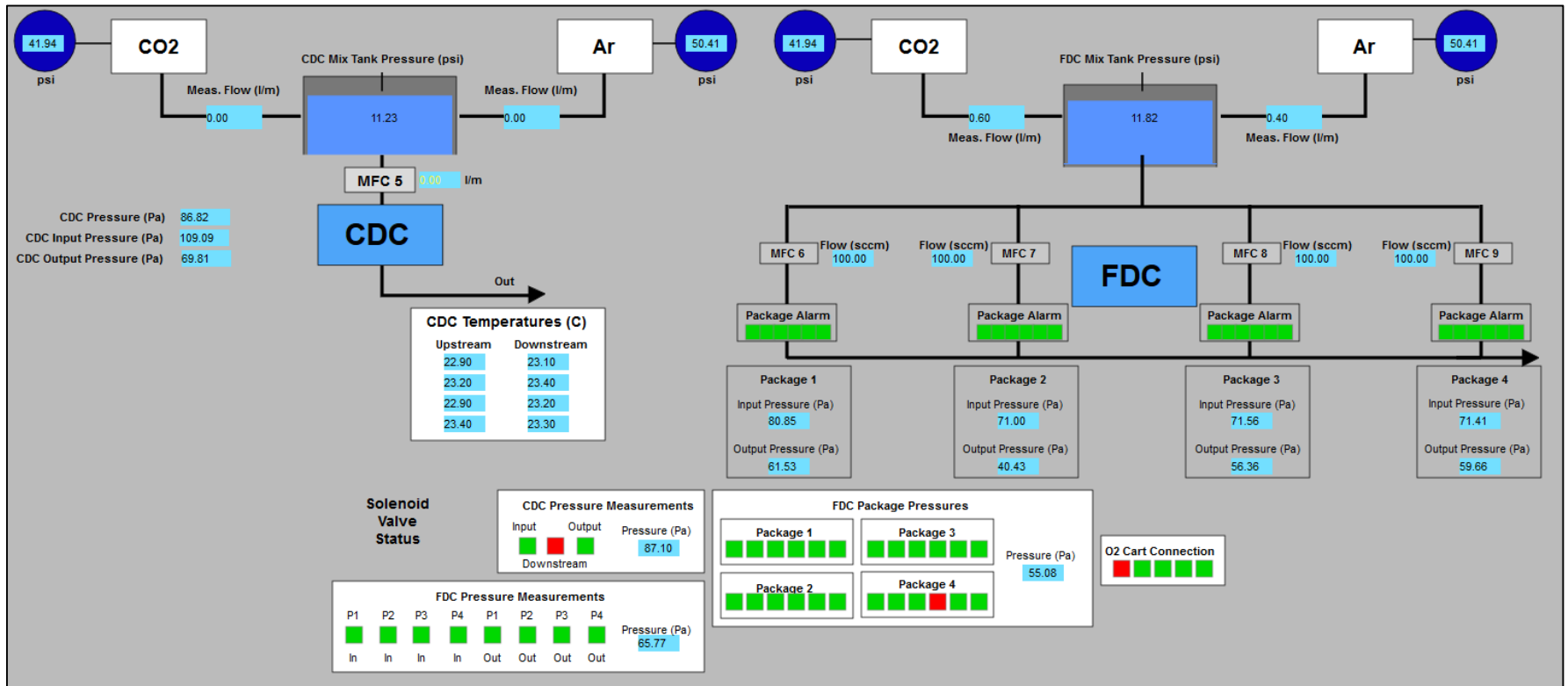
RTD_1
850.00 °C

RTD_3
850.00 °C

DIRC Environment


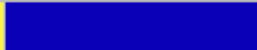
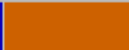

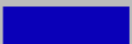





FDC/CDC Gas System



Hall Ambient Environment and Tagger NMR

Hall Weather				
Upstream of Solenoid		Downstream of Solenoid		Hall Pressure
Temperature (F)	Humidity (%)	Temperature (F)	Humidity (%)	100.45 kPa
76.00	33.00	76.00	32.00	

HDNMR NMR Probe		
Lock Status	Measured Magnetic Field Value	Field Units
		
Mode		
Field Pol		
Search		
DAC		
Probe		

Empty indicators for HDNMR NMR Probe are due to PVs being undefined in IOC at time of screenshot, not problem with WEDM screen.

Solenoid MPS, Strain Gauges, and Vacuum

MPS Auto Control

COMM ■

MPS State

Power OFF

Power ON

COMM Error

Final Goal **0 A**

MAX current **1370.00 A**

Setpoint **0.00 A 0.06 A/s**

Status Bits

MPS ON	0	Reg Module	12
Polarity		Preregulator	
Reg Transf		Phase	
DAC16		MPS Waterflow	
DAC17	5	Leakage	
Unit in %	6	Fuses	17
Fast Dump		Over Temp	18
Transistor		Door	
SUM Interlock		Magnet Water	
Over Current		Slow Dump	
DC Overload	11	MPS Ready	23
		n/c	

MPS fault appears

Current PXI **-0.5 A**

Current PLC **0.3 A**

Voltage **-0.001 V**

Field **-0.0003 T**

Thresholds

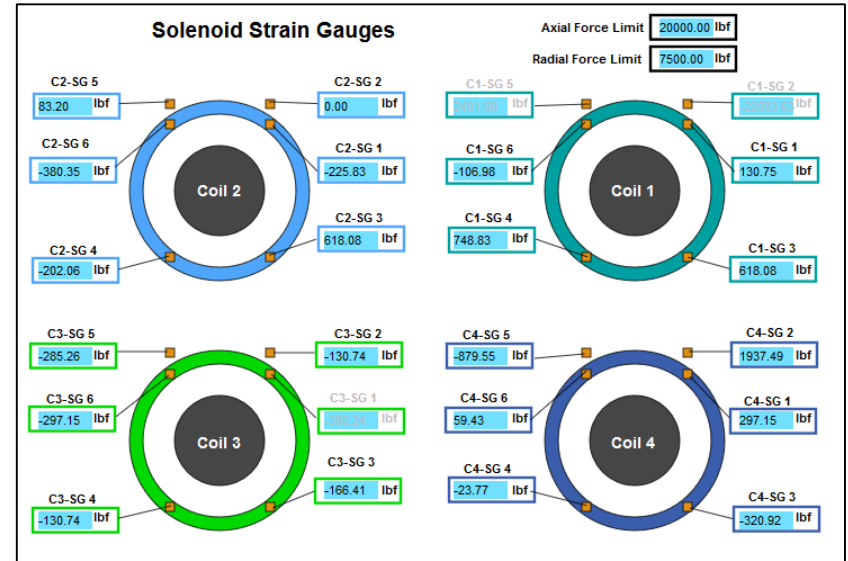
Quench Line **1620.00 A**

50 A Dump Threshold **1510.00 A**

25 A Warning Threshold **1484.75 A**

Normal Current **1460.00 A**

Dump Diode Reset Time **1000.00 ms**



Vacuum Status

Coil 1 - 4					
	Cold Cathod Gauges	Need Clean?	Convectron Gauges	Need Clean?	Pump & Valve Status
Chimney 2	4.62e-2 Torr	■	1.00e-4 Torr	■	Valve 2 Gate 1
Chimney 1	1.23e-7 Torr	■	1.00e-4 Torr	■	Valve 1 Gate 1
Chimney 3	4.56e-2 Torr	■	1.00e-4 Torr	■	Valve 3 Gate 1
Chimney 4	4.47e-2 Torr	■	1.00e-4 Torr	■	Valve 4 Gate 1
Manifold	4.49e-2 Torr	■	1.00e-4 Torr	■	Pump Speed 100.00 %

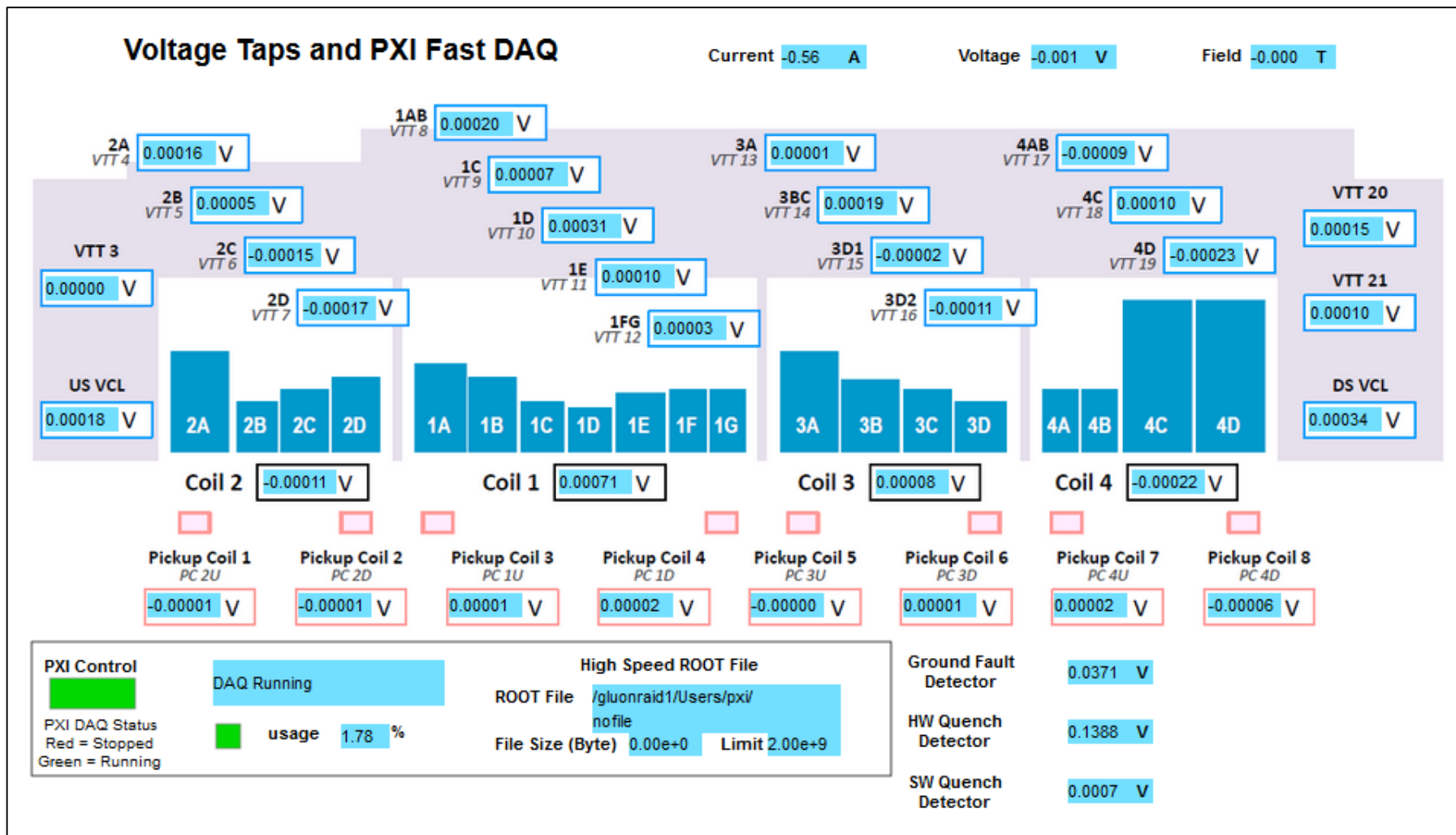
Valve Status
0 = Closed
1 = Open

Distribution Box					
	Cold Cathod Gauges	Need Clean?	Convectron Gauges	Need Clean?	Pump & Valve Status
Chimney Pump Out	1.91e-8 Torr	■	1.00e-4 Torr	■	Pump Speed 101.00 % Gate Value 1

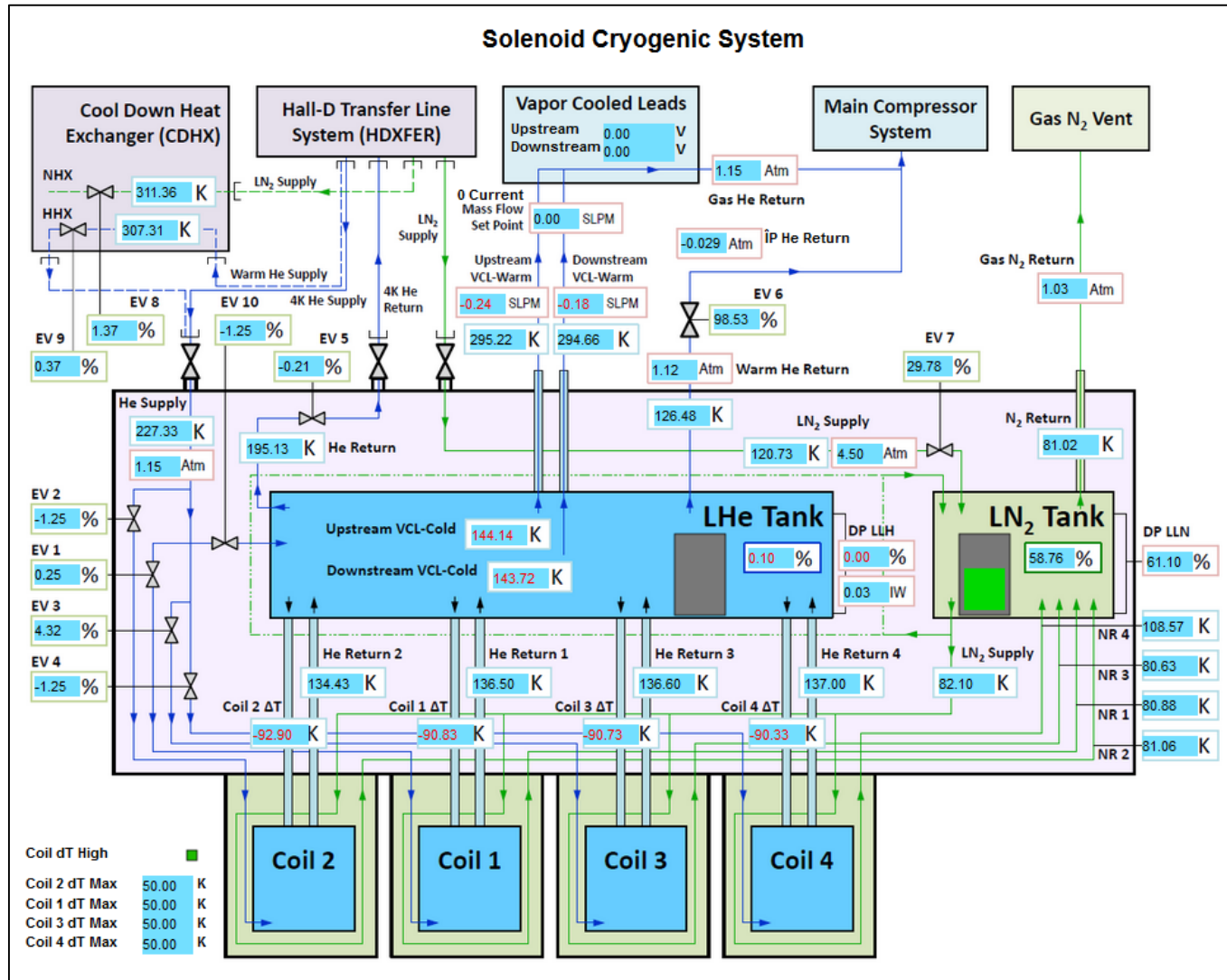
Solenoid Interlocks

Hardware SOE (Sequence of Events)		Software Quench Detector		Hardware Quench Detector		Communication Status	
MPS Interlocks		1st		1st			
MPS - Phase Detection		PLC Quench Detector		HW QD SUM		LakeShore 1	
MPS - AC Overcurrent		Software QD Error	0.001 V	HW QD U3		LakeShore 2	
MPS - Water Flow		PLC Sub-Coil QD		HW QD L3		LakeShore 3	
MPS - Overtemp String		MAX Subcoil Error	0.000 V	QD Error	0.159 V	Mass Flow COMM	
MPS - Slow Dump SUM		Coil 2 QD Voltage	0.000 V	Ground Fault Detector			
MPS - Ground Fault		2A (VTT4)		GFD Error	0.037 V		
MPS - CEBAF Overcurrent		2B (VTT5)		MPS Status			
MPS - Fast Dump SUM		2C (VTT6)		MPS Communication			
MPS - ESTOP/Door Switch		2D (VTT7)		MPS Interlock SUM			
MPS - Main Contactor		Coil 1 QD Voltage	0.000 V	Dump Diode Reset			
Slow Dump Interlocks		1st		Solenoid Status			
VT Cable Interlock		1C (VTT9)		Turn to Turn Short			
Cable Interlock		1D (VTT10)		Overcurrent			
PLC Watchdog		1E (VTT11)		Strain Gauge			
PLC Slow Dump		1F (VTT12)		Power Loss			
Fast Dump Interlocks		1st		Cryo Status			
Vacuum SUM		Coil 3 QD Voltage	0.000 V	Turbo Pump Low			
Helium Level		3A (VTT13)		Vacuum Pressure			
DS Lead Flow Low		3BC (VTT14)		He Supply Pressure High			
US Lead Flow Low		3D1 (VTT15)		He Tank Pressure High			
DS Lead Temp High		3D2 (VTT16)		N2 Supply Pressure High			
DSr Lead Temp High		Coil 4 QD Voltage	0.000 V	N2 Tank Pressure High			
US Lead Temp High		4AB (VTT17)		Mass Flow			
USr Lead Temp High		4C (VTT18)		He Pressure (Slow)			
DS Lead Voltage High		4D (VTT19)		He Pressure (Fast)			
US Lead Voltage High		Upstream Lead (VTT3)		N2 Pressure			
PLC Fast Dump Relay		DS Lead 1 (VTT20)		LHe Level			
Quench Detector		DS Lead 2 (VTT21)		LN2 Level			
HDR Cryo Monitor		PXI Status					
Current vs Pressure		Watchdog					
		DAQ Running					
		Error Bit					
				Thresholds			
				PLC Quench Detector	0.17 V		
				PLC Sub-coil QD	0.10 V		
				Overcurrent Delay	1.00 s		
				Max Current	1370.00 A		
				Mass Flow Deadband	16.00 slpm		
				Mass Flow Delay	7.00 s		
				Max He Press (Fast)	2.10 atm		
				LHe Level High	80.00 %		
				LHe Level Low	5.00 %		
				LN2 Level High	90.00 %		
				LN2 Level Low	30.00 %		
				Min Pump Speed	80.00 %		
				Max Vacuum Press	0.00 Torr		
				Max He Supply Press	4.50 atm		
				Max He Tank Press	1.35 atm		
				Max N2 Tank Press	3.00 atm		
				Max N2 Supply Press	4.90 atm		

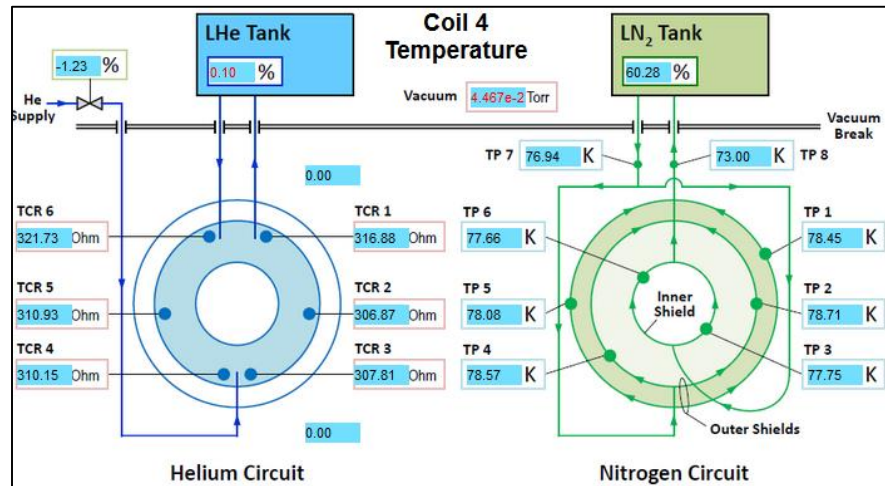
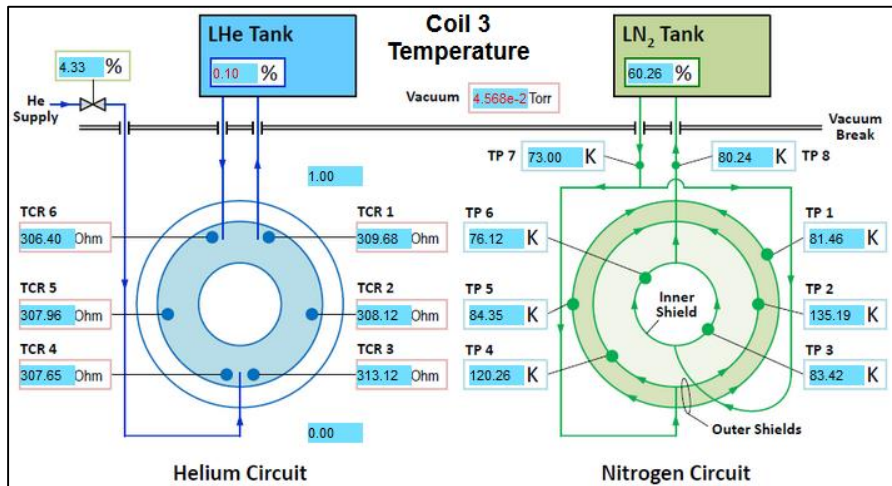
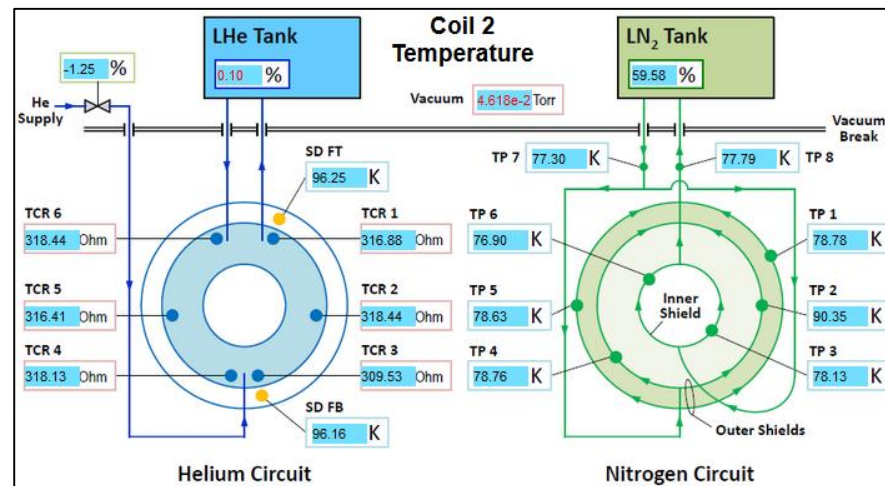
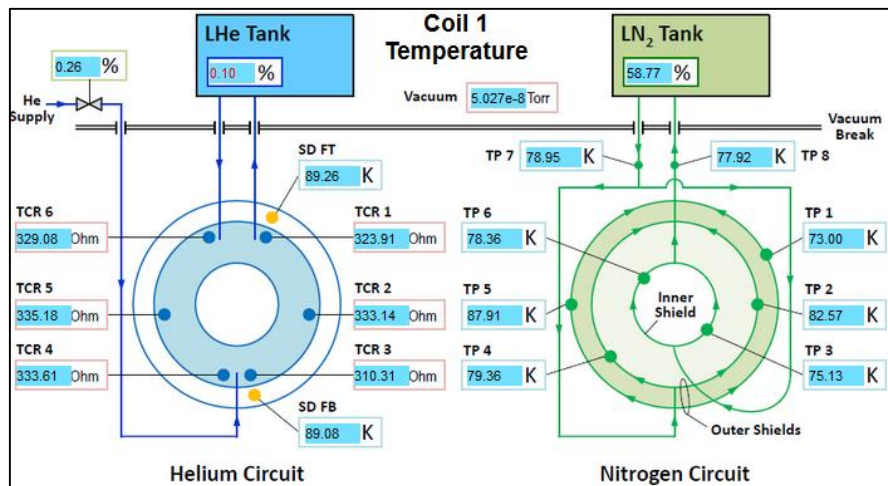
Solenoid Voltage Taps



Solenoid Cryogenics



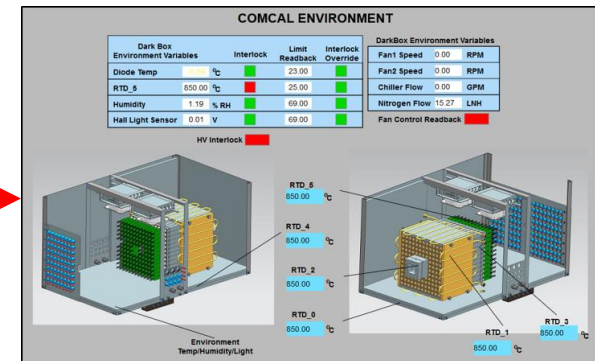
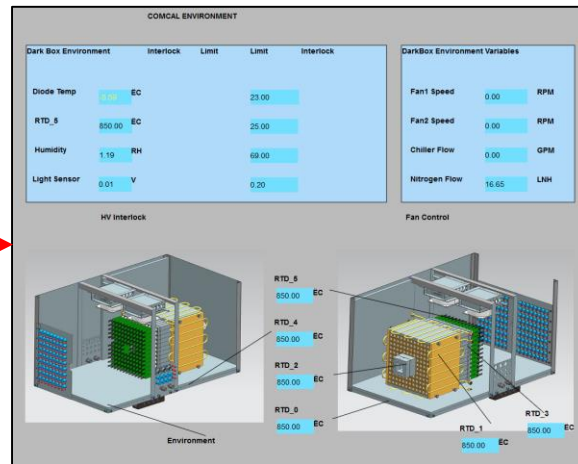
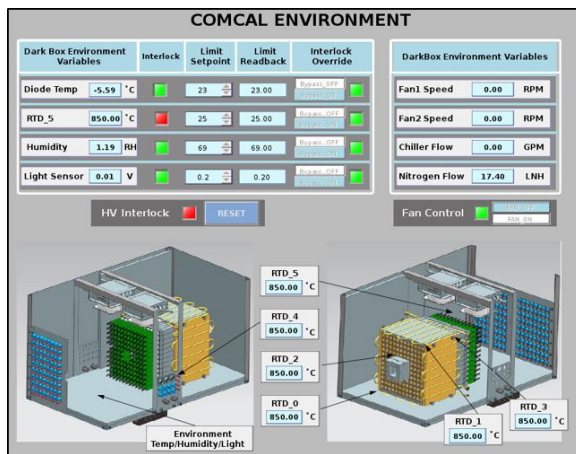
Solenoid Coils 1, 2, 3, and 4 Temperatures



Problems Faced

1. Lack of controls in WEDM and differences in text box behavior caused empty space to appear on converted screens

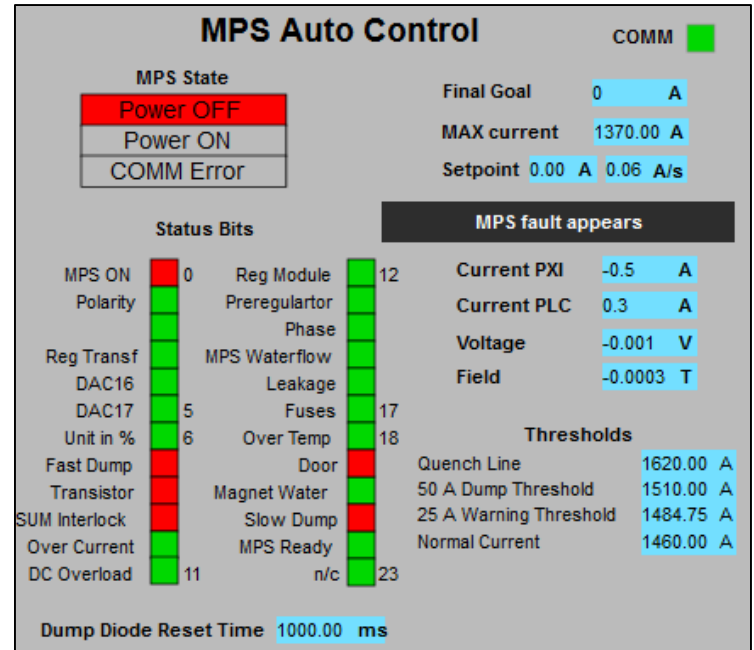
- Screens affected: all screens
- Solution: Rearrange WEDM screens to remove space from missing controls and manually resize text/text boxes



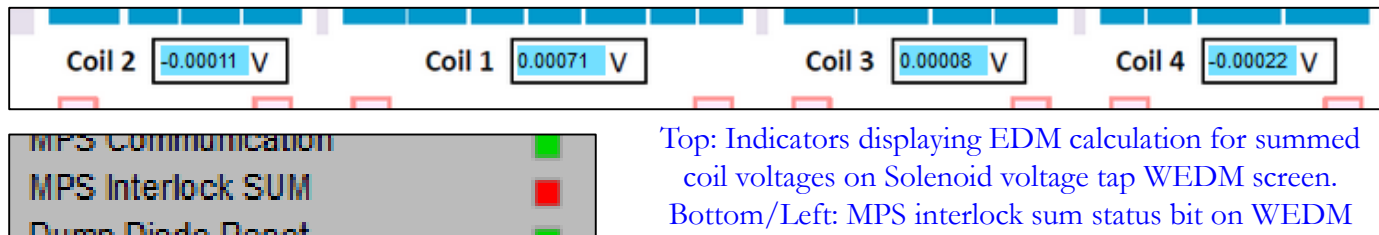
Comparison of ComCal Environment CSS screen (left), newly converted WEDM screen (middle) and deployed WEDM screen (right). WEDM screen leaves out “Limit Setpoint”, “Interlock Override”, “HV Interlock Reset”, and “Fan Control” controls. Script also does not transfer text sizes, requiring labels to be manually resized and placed.

Problems Faced

2. Some PVs were generated by script in CSS and do not exist outside of CSS runtime environment
- Screens affected: MPS auto control, Solenoid interlocks, Solenoid voltage taps
 - Solution: Add PVs to EPICS IOC for status bits and perform simple calculations in EDM



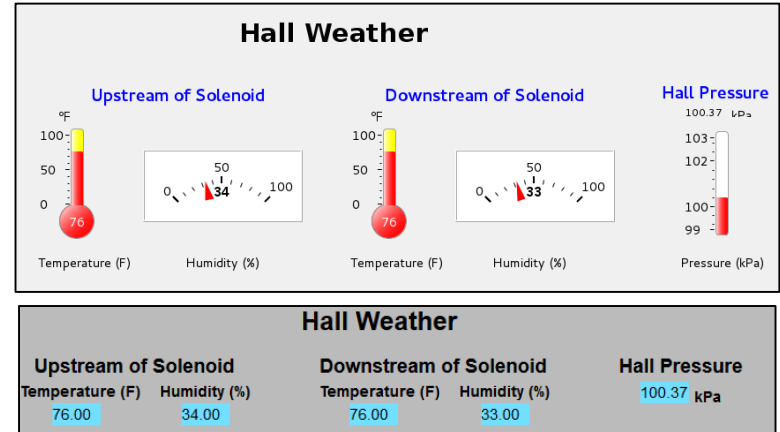
WEDM screen for MPS power supply. In CSS, PVs for status bit indicators were generated by script and had to be added to IOC for display in WEDM.



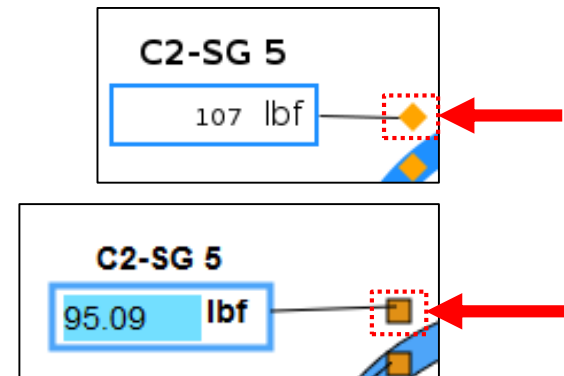
Top: Indicators displaying EDM calculation for summed coil voltages on Solenoid voltage tap WEDM screen.
Bottom/Left: MPS interlock sum status bit on WEDM Solenoid interlocks screen whose PV was added to IOC.

Problems Faced

3. Some CSS graphical widgets (thermometer, gauges, polygons) do not exist in WEDM.
- Screens affected: Hall D ambient environment, CDC/FDC gas system, Solenoid strain gauges
 - Solution: Replace widgets with text monitors and basic shapes.



Comparison of Hall Weather CSS screen (top) and WEDM screen (bottom). WEDM does not support thermometer and gauge graphical widgets, so they were replaced with text indicators in WEDM.



Top: Example of unsupported polygon in use on Solenoid strain gauge CSS screen.

Bottom: Example of polygon replaced with rectangle widget on Solenoid strain gauge WEDM screen.

Conclusion

- CSS screens converted to WEDM using DSG-developed script
 - Problems faced during conversion have all been resolved
- Screens added to WEDM server with WMenu links
 - <https://epicsweb.jlab.org/>
- **All 19 requested screens have been converted**

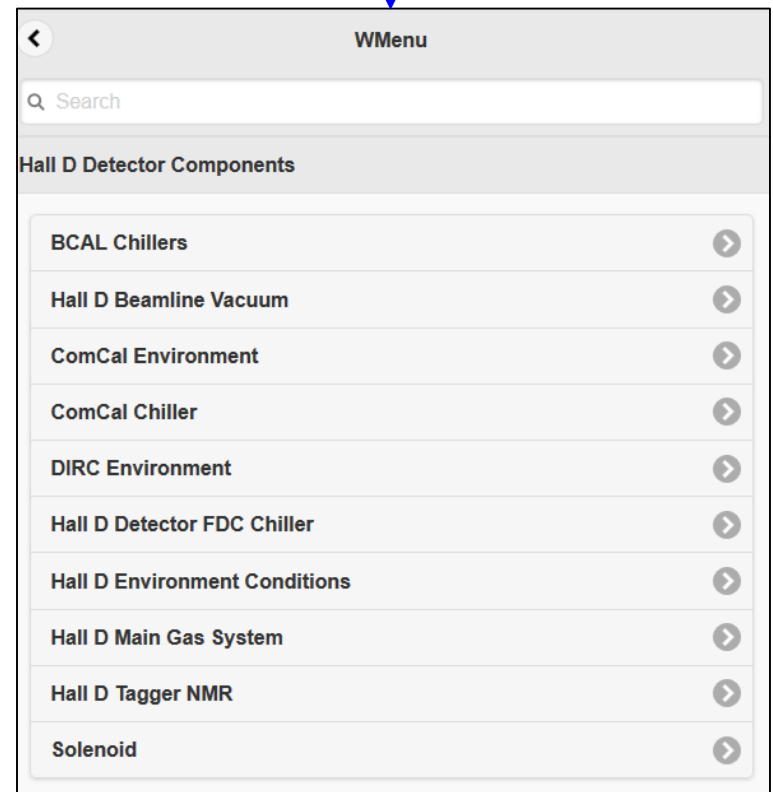
WMenu Path

Main Menu

└ Standalone Menu

└ Hall D Standalone Menu

└ Hall D Detector Components



WMenu links for all Hall D WEDM screens.