

# **NPS Status**

### Aaron Brown and the Detector Support Group February 2, 2023





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### **Overview**

• NeXt Generation CAD system (NX12) model of NPS



6 C<sup>5A</sup>

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## **LabVIEW Control and Monitoring System**



#### LabVIEW screen





### **Thermal Readback**

Thermal readback Phoebus screen tested and debugged
 – Screens uploaded to *cdaql3* and to <u>Github</u>

C CS-Studio (Phoebus) - 🗆 🗙							C CS-Studio (Phoebus) -							×					
CZ temps monitoring test ×									cz T controls test ×										
							100 %	-	•	• •	Front crystal zone				100 5	%	•	•	• •
Front Crystal Zone Temperature Sensor Monitoring [°C]								temperature monitoring	Front Crystal Zone Temperature Sensor Controls										
Crystal	т	Avg	Out of high	limit low	Crystal	т	Avg	Out high	of limit low		Serveri	crystal	Alarr Iow	n limit high	crystal	Alarn Iow	n limit high		
0	20.1	20.1	$\bigcirc$	$\bigcirc$	540	22.6	22.6	$\bigcirc$				0	0	60	540	0	60	]	
5	18.1	18.1	$\bigcirc$	$\bigcirc$	550	12.3	12.3					5	0	60	550	0	60		
10	17.5	17.5		$\bigcirc$	560	13.5	13.5			10	0	60	560	0	60				
15	19.4	19.4	$\bigcirc$	$\bigcirc$	570	16.5	16.5				15	-	60	570		60			
20	10.2	10.2	$\bigcirc$	$\bigcirc$	684	18.1	18.1			20	-	60	684		60				
25	12.8	12.8		$\bigcirc$	689	14.8	14.8					25	L o	00	699		00		
30	21.3	21.3		$\bigcirc$	694	21.3	21.3		<b> </b>   <b> </b>   Fro	ont crystal zone	20		60	665		00			
35	20.3	20.3		$\bigcirc$	699	15.6	15.6			ter	mperature control screen	30	0	60	694	0	60		
180	20.7	20.7	$\bigcirc$	$\bigcirc$	704	18.3	18.3					35	0	60	699	0	60		
185	20.3	20.3	$\overline{\mathbf{O}}$	$\bigcirc$	709	19.8	19.8	$\overline{\mathbf{O}}$				180	0	60	704	0	60		
190	15.7	15.7	$\overline{\mathbf{O}}$	Ŏ	714	13.5	13.5	$\overline{\mathbf{O}}$				185	0	60	709	0	60		
195	11.6	11.6	Ŏ	Ŏ	719	21.0	21.0	Ŏ	Ŏ			190	0	60	714	0	60		
200	13.9	13.9	Ŏ	Ŏ	864	17.6	17.6	$\mathbf{i}$				195	0	60	719	0	60		
205	19.6	19.6	Ŏ	Ŏ	869	14.3	14.3	ŏ				200	0	60	864	0	60		
1	1		-	-											1		1 1		

Version of control and monitoring screens to be used for testing





## **Phoebus High Voltage Control and Monitoring**

C CS-Studio@cdaql3	Row 35	00-35	01-35	02-35	03-35	04-35	05-35	06-35	07-35	08-35	09-35	10-35
Overview ×			Off		Off	On						
85 %	Voltage [V]	<hchv21:00:< td=""><td>1.13</td><td><hchv21:02:< td=""><td>1.33</td><td>0.63</td><td>0.60</td><td>1.06</td><td>1.51</td><td>0.00</td><td>1.15</td><td>2000.11</td></hchv21:02:<></td></hchv21:00:<>	1.13	<hchv21:02:< td=""><td>1.33</td><td>0.63</td><td>0.60</td><td>1.06</td><td>1.51</td><td>0.00</td><td>1.15</td><td>2000.11</td></hchv21:02:<>	1.33	0.63	0.60	1.06	1.51	0.00	1.15	2000.11
	Current [uA]	<hchv21:00:< td=""><td>-0.026</td><td><hchv21:02:< td=""><td>-0.010</td><td>-0.010</td><td>0.006</td><td>-0.030</td><td>-0.032</td><td>-0.082</td><td>-0.090</td><td>681.616</td></hchv21:02:<></td></hchv21:00:<>	-0.026	<hchv21:02:< td=""><td>-0.010</td><td>-0.010</td><td>0.006</td><td>-0.030</td><td>-0.032</td><td>-0.082</td><td>-0.090</td><td>681.616</td></hchv21:02:<>	-0.010	-0.010	0.006	-0.030	-0.032	-0.082	-0.090	681.616
	Pow 34	00-34	01-34	02-34	03-34	04-34	05-34	06-34	07-34	08-34	09-34	10-34
	1000 34		Off		Off	On						
		 hchv21:00:	1.01	<hc></hc> hchv21:02:	1.48	1 11	1.05	0.42	1.22	0.30	0.99	1999.97
	Voltage [V]	chchv21:00:	-0.202	<hchv21:02< td=""><td>0.000</td><td>-0.004</td><td>-0.024</td><td>-0.086</td><td>-0.090</td><td>-0.106</td><td>-0.078</td><td>682 598</td></hchv21:02<>	0.000	-0.004	-0.024	-0.086	-0.090	-0.106	-0.078	682 598
	Current [uA]	sherry21.00.	0.202	SHCHV21.02.	0.000	0.004	0.024	0.000	0.000	0.100	0.010	002.000
	Row 33	00-33	01-33	02-33	03-33	04-33	05-33	06-33	07-33	08-33	09-33	10-33
			Off		Off	On						
	Voltage [V]	<hchv21:00:< td=""><td>1.26</td><td><hchv21:02:< td=""><td>1.40</td><td>0.32</td><td>0.44</td><td>0.00</td><td>1.07</td><td>1.63</td><td>0.85</td><td>2000.19</td></hchv21:02:<></td></hchv21:00:<>	1.26	<hchv21:02:< td=""><td>1.40</td><td>0.32</td><td>0.44</td><td>0.00</td><td>1.07</td><td>1.63</td><td>0.85</td><td>2000.19</td></hchv21:02:<>	1.40	0.32	0.44	0.00	1.07	1.63	0.85	2000.19
	Current [uA]	<hchv21:00:< td=""><td>-0.130</td><td><hchv21:02:< td=""><td>-0.006</td><td>-0.010</td><td>-0.028</td><td>-0.042</td><td>0.018</td><td>-0.074</td><td>-0.024</td><td>682 190</td></hchv21:02:<></td></hchv21:00:<>	-0.130	<hchv21:02:< td=""><td>-0.006</td><td>-0.010</td><td>-0.028</td><td>-0.042</td><td>0.018</td><td>-0.074</td><td>-0.024</td><td>682 190</td></hchv21:02:<>	-0.006	-0.010	-0.028	-0.042	0.018	-0.074	-0.024	682 190
	Pow 32	00-32	01-32	02-32	03-32	04-32	05-32	06-32	07-32	08-32	09-32	10-32
	NOW 32		Off		Off	On						
		<hchv21:00:< td=""><td>1.07</td><td><hchv21.02< td=""><td>1.39</td><td>1.26</td><td>0.88</td><td>0.70</td><td>1.02</td><td>0.71</td><td>0.00</td><td>1999 99</td></hchv21.02<></td></hchv21:00:<>	1.07	<hchv21.02< td=""><td>1.39</td><td>1.26</td><td>0.88</td><td>0.70</td><td>1.02</td><td>0.71</td><td>0.00</td><td>1999 99</td></hchv21.02<>	1.39	1.26	0.88	0.70	1.02	0.71	0.00	1999 99
	Voltage [V]	<hchv21:00:< td=""><td>-0.038</td><td><hchv21:02< td=""><td>0.000</td><td>-0.004</td><td>-0.010</td><td>-0.050</td><td>-0.044</td><td>-0.114</td><td>-0.036</td><td>682 918</td></hchv21:02<></td></hchv21:00:<>	-0.038	<hchv21:02< td=""><td>0.000</td><td>-0.004</td><td>-0.010</td><td>-0.050</td><td>-0.044</td><td>-0.114</td><td>-0.036</td><td>682 918</td></hchv21:02<>	0.000	-0.004	-0.010	-0.050	-0.044	-0.114	-0.036	682 918
	Current [uA]	SHCHV21.00.	0.000	SHCHV21.02.	0.000	0.004	0.010	0.050	0.044	0.114	0.000	002.510
	Row 31	00-31	01-31	02-31	03-31	04-31	05-31	06-31	07-31	08-31	09-31	10-01
			Off		Off	On						
	Voltage [V]	<hchv21:00:< td=""><td>0.49</td><td><hchv21:02:< td=""><td>0.79</td><td>0.17</td><td>0.00</td><td>1.00</td><td>1.56</td><td>0.84</td><td>0.00</td><td>1999.98</td></hchv21:02:<></td></hchv21:00:<>	0.49	<hchv21:02:< td=""><td>0.79</td><td>0.17</td><td>0.00</td><td>1.00</td><td>1.56</td><td>0.84</td><td>0.00</td><td>1999.98</td></hchv21:02:<>	0.79	0.17	0.00	1.00	1.56	0.84	0.00	1999.98
	Current [uA]	<hchv21:00:< td=""><td>-0.098</td><td><hchv21:02:< td=""><td>0.002</td><td>-0.002</td><td>-0.006</td><td>-0.082</td><td>-0.108</td><td>-0.178</td><td>-0.050</td><td>683.618</td></hchv21:02:<></td></hchv21:00:<>	-0.098	<hchv21:02:< td=""><td>0.002</td><td>-0.002</td><td>-0.006</td><td>-0.082</td><td>-0.108</td><td>-0.178</td><td>-0.050</td><td>683.618</td></hchv21:02:<>	0.002	-0.002	-0.006	-0.082	-0.108	-0.178	-0.050	683.618
	Row 30	00-30	01-30	02-30	03-30	04-30	05-30	06-30	07-30	08-30	09-30	10-30
	Now So		Off		Off	On						
		<hchv21.00< td=""><td>0.88</td><td><hchv21.02< td=""><td>1.02</td><td>0.31</td><td>0.29</td><td>1.25</td><td>1.02</td><td>0.60</td><td>0.89</td><td>2000.08</td></hchv21.02<></td></hchv21.00<>	0.88	<hchv21.02< td=""><td>1.02</td><td>0.31</td><td>0.29</td><td>1.25</td><td>1.02</td><td>0.60</td><td>0.89</td><td>2000.08</td></hchv21.02<>	1.02	0.31	0.29	1.25	1.02	0.60	0.89	2000.08
	Voltage [V]	<hchv21.00< td=""><td>-0.066</td><td><hchv21.02< td=""><td>-0.016</td><td>-0.018</td><td>-0.030</td><td>-0.054</td><td>-0.060</td><td>-0.080</td><td>-0.100</td><td>684 722</td></hchv21.02<></td></hchv21.00<>	-0.066	<hchv21.02< td=""><td>-0.016</td><td>-0.018</td><td>-0.030</td><td>-0.054</td><td>-0.060</td><td>-0.080</td><td>-0.100</td><td>684 722</td></hchv21.02<>	-0.016	-0.018	-0.030	-0.054	-0.060	-0.080	-0.100	684 722
	Current [uA]				0.010							
	Row 29	00-29	01-29	02-29	03-29	04-29	05-29	06-29	07-29	08-29	09-29	10-29
			Ott		Off	Ott	Off	Off	Off	Ott	Ott	On
	Voltage [V]	<hchv21:00:< td=""><td>0.00</td><td><hchv21:02:< td=""><td>1.36</td><td>0.00</td><td>0.00</td><td>1.17</td><td>1.31</td><td>0.82</td><td>1.04</td><td>1999.98</td></hchv21:02:<></td></hchv21:00:<>	0.00	<hchv21:02:< td=""><td>1.36</td><td>0.00</td><td>0.00</td><td>1.17</td><td>1.31</td><td>0.82</td><td>1.04</td><td>1999.98</td></hchv21:02:<>	1.36	0.00	0.00	1.17	1.31	0.82	1.04	1999.98
	Current [uA]	<hchv21:00:< td=""><td>-0.056</td><td><hchv21:02:< td=""><td>0.000</td><td>0.000</td><td>0.006</td><td>-0.052</td><td>-0.106</td><td>-0.104</td><td>-0.062</td><td>684.218</td></hchv21:02:<></td></hchv21:00:<>	-0.056	<hchv21:02:< td=""><td>0.000</td><td>0.000</td><td>0.006</td><td>-0.052</td><td>-0.106</td><td>-0.104</td><td>-0.062</td><td>684.218</td></hchv21:02:<>	0.000	0.000	0.006	-0.052	-0.106	-0.104	-0.062	684.218
	Row 28	00-28	01-28	02-28	03-28	04-28	05-28	06-28	07-28	08-28	09-28	10-28
			Off		Off	On						
	Voltage [V]	<hchv21:00:< td=""><td>1.10</td><td><hchv21:02:< td=""><td>1.56</td><td>0.75</td><td>0.02</td><td>0.00</td><td>1.07</td><td>0.74</td><td>1.03</td><td>2000.13</td></hchv21:02:<></td></hchv21:00:<>	1.10	<hchv21:02:< td=""><td>1.56</td><td>0.75</td><td>0.02</td><td>0.00</td><td>1.07</td><td>0.74</td><td>1.03</td><td>2000.13</td></hchv21:02:<>	1.56	0.75	0.02	0.00	1.07	0.74	1.03	2000.13
	Current [uA]	<hchv21:00:< td=""><td>-0.076</td><td><hchv21:02:< td=""><td>-0.008</td><td>-0.010</td><td>-0.090</td><td>-0.060</td><td>0.002</td><td>-0.048</td><td>-0.058</td><td>682.246</td></hchv21:02:<></td></hchv21:00:<>	-0.076	<hchv21:02:< td=""><td>-0.008</td><td>-0.010</td><td>-0.090</td><td>-0.060</td><td>0.002</td><td>-0.048</td><td>-0.058</td><td>682.246</td></hchv21:02:<>	-0.008	-0.010	-0.090	-0.060	0.002	-0.048	-0.058	682.246
	Current [uA]	00.07	04.07	50.00	00.07	04.07	05.07	00.07	07.07	00.07	00.07	40.07
	Row 27	00-27	01-27	02-27	03-27	04-27	05-27	06-27	07-27	08-27	09-27	10-27
						On	On	On	On	On	On	
one	Voltage [V]	<hc><hchv21:00:< td=""><td>1.33</td><td><nchv21:02:< td=""><td>1.58</td><td>1.35</td><td>0.07</td><td>1.97</td><td>0.85</td><td>0.89</td><td>1.41</td><td>2000.08</td></nchv21:02:<></td></hchv21:00:<></hc>	1.33	<nchv21:02:< td=""><td>1.58</td><td>1.35</td><td>0.07</td><td>1.97</td><td>0.85</td><td>0.89</td><td>1.41</td><td>2000.08</td></nchv21:02:<>	1.58	1.35	0.07	1.97	0.85	0.89	1.41	2000.08
	Current [uA]	<hchv21:00:< td=""><td>0.042</td><td><nchv21:02:< td=""><td>-0.002</td><td>-0.004</td><td>0.054</td><td>0.022</td><td>0.030</td><td>-0.040</td><td>0.022</td><td>682.012</td></nchv21:02:<></td></hchv21:00:<>	0.042	<nchv21:02:< td=""><td>-0.002</td><td>-0.004</td><td>0.054</td><td>0.022</td><td>0.030</td><td>-0.040</td><td>0.022</td><td>682.012</td></nchv21:02:<>	-0.002	-0.004	0.054	0.022	0.030	-0.040	0.022	682.012

Overview screen – magenta cells indicate an unconnected channel

Screen shows readback voltage, readback current, and status LED

 Adding ability to set maximum voltage and current for individual channels





## **Phoebus Low Voltage Control and Monitoring**

- Developed and tested IOC
  - EPICS Phoebus screen received data transmitted by the MPOD

				Voltage			Current	
Card	Channel	Power	Set	Readback	Difference	Set	Readback	Difference
0	0	Off	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<>	<hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<>	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<>	<hcnps< td=""></hcnps<>
	1	Off	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<>	<hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<>	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<>	<hcnps< td=""></hcnps<>
	2	Off	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<>	<hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<>	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<>	<hcnps< td=""></hcnps<>
	3	Off	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<>	<hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<>	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<>	<hcnps< td=""></hcnps<>
	4	Off	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<></td></hcnps<>	<hcnps< td=""><td><hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<></td></hcnps<>	<hcnps_< td=""><td><hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<></td></hcnps_<>	<hcnps< td=""><td><hcnps< td=""></hcnps<></td></hcnps<>	<hcnps< td=""></hcnps<>
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### EPICS Phoebus low voltage control and monitoring screen



2/2/2023



### **LED Control Screen**

- Control screen in development
  - LED control screen similar to high voltage control and monitoring screen

BLEACH PULSE	\$(h)
BLEACH       PULSE       Image: Constraint of the state of t	Power OFF Bleach Pulse
BLEACH       PULSE       Image: Constraint of the state of t	<ul> <li>Each cell is clickable and opens a pop-up screen to control individual LEDs</li> <li>Bleach mode is for recovering crystals from radiation damage</li> <li>Pulse mode is for calibration</li> </ul>

2/2/2023

### **Ansys Thermal Analysis**

Heat load of 0.3 W applied to the rear face (PMT end) of each crystal



Temperature distribution on front face of crystal



~15°C at front and ~13°C at rear;  $\Delta T$ =2°C



 $\Delta T$  of crystals; ~128 crystals have  $\Delta T > 1^{\circ}C$ ; light yield might be affected for crystals with  $\Delta T > 2^{\circ}C$ 



~20°C at front face and ~20°C at rear face;  $\Delta T{=}0^\circ C$ 



Isometric view of electronics zone temperature when four fans blow air at 3.33 m/s to the heat exchanger plates, which are at 10°C



Crystal temperatures; 575 crystals at ambient temp of 20°C

2/2/2023

**Detector Support Group** 

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### **Phoebus Alarm System Development**

• Alarm system

- Monitors process variables for alarm conditions

• Alarm system user interface

Configures alarm settings and acknowledges alarms

- EPICS IOC user interface
  - Controls process variable generation and sets alarm limits
    - Test system process variables produced by random number generators
  - Communicates via channel access interface
  - Provides alarm summary, status overview, hierarchical tree, unacknowledged alarms, and acknowledged alarms





### **Hardware Fabrication**

- Pre-shaped 602 foils for crystals
- Back-potted Radiall connector pins with Power 7718 Knot Filling Hot Melt Glue to prevent unseating of pins
- Tested cables before and after back-potting
- No voltage or current stability differences noticed





Hot Melt Glue

Back-potted connector



### **Keysight D-sub Extension Cables**



Jefferson Lab

### **Noise Reduction Tests**

- Implemented Faraday cage
- Fabricated antenna probe to locate source of noise



George and Aaron covering detector with aluminum foil





### Conclusion

- DSG contributing to all phases of NPS
  - Control and monitoring in LabVIEW and EPICS Phoebus
  - Development of Phoebus Alarm System
  - Ansys thermal analysis
  - Fabrication and testing of hardware





### **THANK YOU!**





