Upgrade of the high voltage control system for the PPAC detector

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A position-sensitive Parallel Plate Avalanche Counter (PPAC) was installed at each focal plane of the BigRIPS separator to measure the magnetic rigidity of the radioactive isotope (RI) beams. Previous research has demonstrated stable operation of the PPAC detector at approximately 1 MHz via the proper application of high voltage (HV) specific to the atomic numbers of the RI beams.¹⁾ If the HV is set excessively high, a discharge of the PPAC will cause the HV modules to trip more frequently, significantly reducing the efficiency of the PPAC detector and rendering it unusable. The replacement of the PPAC detector requires 3–4 hours and wastes the machine time (MT) of the user. Automatically optimizing the HV for the PPAC detector enables the MT to be operated efficiently. To realize this automation system, we have upgraded the HV system for the PPAC detector and developed its control system.

We have implemented 11 NHR-4020R modules and one NHR-4060R module for the HV power supply and three iCSmini2 modules as the controller for operating them.²⁾ Figure 1 shows the picture of the HV controller and the HV modules for F8- and F12-PPACs. The WebSocket application programming interface of these controllers enables bidirectional push communication, changing the set value of the HV modules as well as providing real-time updates on status changes from the HV modules. We developed a novel control system for the PPAC HV system using the BYACO ecosystem.³⁾



Fig. 1. Photograph of the PPAC HV controller and HV modules for F8- and F12-PPACs.

Figure 2 shows the web-based graphical user interface (GUI) of the PPAC HV control system, written using the React JavaScript library.⁴⁾ The GUI displays information on the measured voltage and current values, the set voltage value, and the off/on status for each HV module. It facilitated the modification of the set voltage and toggle the off/on status. A fine-tuning window

PP/																		
	AC HI	Control						Print Save Load All Set All On All Off										
BigRIP	S (F1∼F	7) Zero	Degr	ee (F8~F11)	S	AMURA	I (F8,F12)	Trip	Log									
F1-1 Cur.		F1-1 Read		F1-1 Set					F1-2 Cur		F1-2 Read		F1-2 Set					
0.4	μΑ	-0.03	v	760.00	v	Set	Off	Reset	-0.4	μΑ	-0.29	v	760.00	v	Set		Off	Rese
E2-1 Dar. E2-1 Reed E2-1 Set								E22 Dat E22 Read E22 Set										
0.1	μΑ	789.99	v	790.00	v	Set	💶 On	Reset	0.0	μΑ	784.87	v	785.00	v	Set		On	Rese
F3-1A Out							F3-18 Cur. F3-18 Read F3-18 Set											
0.4	μA	749.99	٧	750.00	v	Set	💶 On	Reset	0.4	μΑ	749.95	v	750.00	٧	Set		On	Rese
F3-2A Our. F3-2A Read F3-2A Set							F3-28 Cur. F3-28 Read F3-28 Set											
0.6	μA	760.00	۷	760.00	v	Set	🔍 0n	Reset	0.7	μA	770.00	۷	770.00	v	Set		On	Rese
F4 Cur.		F4 Read		F4 Set					F6 Cur.		F6 Read		F6 Set					
-0.1	μA	-0.03	٧	800.00	v	Set	Off	Reset	-0.1	μΑ	-0.03	٧	750.00	٧	Set		Off	Rese
F5-1A Cur. F5-1A Read F5-1A Set								F5-18 Cur. F5-18 Read F5-18 Set										
0.1	μΑ	745.00	٧	745.00	v	Set	🔍 0n	Reset	0.1	μΑ	750.00	٧	750.00	v	Set		On	Rese
F5-2A Cur. F5-2A Read F5-2A Set								FS-28 Car. FS-28 Read FS-28 Set										
0.1	μΑ	755.00	٧	755.00	v	Set	🔍 On	Reset	0.1	μΑ	750.00	٧	750.00	v	Set		On	Rese
F7-1A Our: F7-1A Read F7-1A Set								F7-18 Cur: F7-18 Read F7-18 Set										
0.1	μA	750.00	٧	750.00	V	Set	🔍 On	Reset	-0.1	μΑ	755.00	٧	755.00	٧	Set		On	Rese
F7-2A Cu		F7-2A Read		F7-2A Set					F7-28 C	r	F7-28 Read		F7-2B Set					
		740.00	v	740.00	v	Set	On	Reset	0.0		750.00	v	750.00	v	Set	-	On	Dore

Fig. 2. Web-based GUI of the PPAC HV control system.

pops up with a right-click on the set voltage display window, allowing quick adjustments in 5 V increments from -30 V to +30 V. When the HV module trips, the display frame indicating the current turns red immediately, accompanied by an alert message and warning sound. The "Reset" button then becomes available to clear the trip status; when pressed, the trip status is cleared and the warning sound stops. Selecting the "BigRIPS," "ZeroDegree," and "SAMURAI" tabs display the HV status of the PPACs at F1 to F7, F8 to F11, and F8 and F12, respectively. The "All On" and "All Off" buttons facilitate the simultaneous activation or deactivation of all displayed PPACs. The "All Set" button facilitates the setting of empirically appropriate values specific to the atomic numbers of the RI beams, or arbitrary values, for all displayed PPACs. The "Save" button stores the current set voltage values in a file, and the "Load" button retrieves the set voltage values from the saved file and updates the set voltage values immediately. Selecting the "Trip Log" tab displays a two-dimensional graph of the total number of trips versus their time of occurrence for the past one day, one week, or two weeks. The BY-ACO server records the measured voltage and current values, set voltage value, off/on status, and trip status along with the timing of the change.

The PPAC HV control system has been integrated into the BYACO ecosystem. In the future, we plan to develop an automatic PPAC HV optimization system for both the BigRIPS separator and ZeroDegree spectrometer.

References

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