

# NPS HV System Evaluation

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**Definition: Rated Voltage**

Rated voltage is defined as the maximum voltage at which the device can be operated safely. After further increasing the voltage, the device may fail to operate and may be damaged permanently.

For NPS the PMT bases will be operated safely at 900VDC +/- 10%??

- I did not locate this value in the documentation
- Perhaps the PMT manufacturer data sheet lists this value

Manufactures ratings are based on the intended application and not product capability. Materials used for connectors show breakdown voltages >> than rated voltage because altitude, temperature, environment variables are used which are not applicable for the NPS enclosure.

**Findings:**

This system has gone through an Experimental Equipment Readiness Review on 15-May-2019

There is an abundance of very good documentation for all equipment/cabling/electronics that will reside within the NPS detector 'enclosure'.

This enclosure is definitely considered a custom design and there are several thousand parts within the enclosure that include custom circuit boards, cabling, electronic components, Photo-Multipliers, and cooling fans. Review of mechanical support materials and mechanical fittings and structural designs is not part of this report.

There appears to be a change from ERR presentations regarding the NPS 'roof' HV patch panel. Original design mentions the use of a 52pin Radial connector interface. The existing design uses a 52pin Radial connector for the end of the HV cable that connects to the A7030 CAEN HV module, but the other end uses multiple multi-pin connectors that mate to a custom patch panel circuit board.

Electrical testing has been performed for the HV custom patch panel circuit boards successfully to safely operate the PMT.

The NPS detector enclosure is designed, assembled and includes a very detailed assembly/disassembly procedure.

**Comments:**

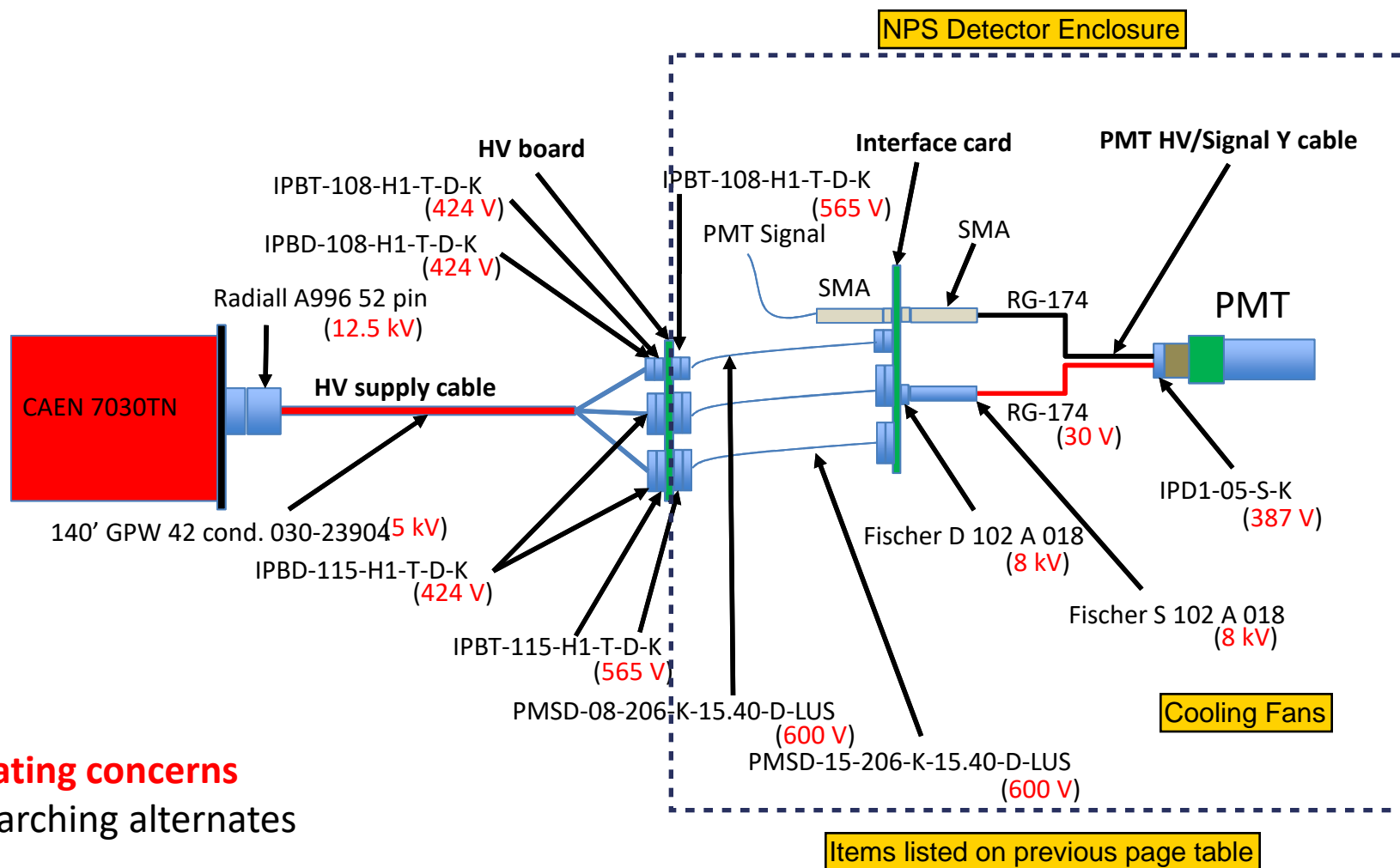
- I did not locate any information on the power cord/cable/source for the cooling fans that are mounted inside the NPS detector enclosure
- HV Interlocks and prevention of HV during “Bleaching Mode”
  - As a naïve approach it appears that the NPS detector enclosure can be interlocked so if any external panel is removed the HV mainframe/modules will immediately remove power
    - I did not locate an interlock schematic or logic diagram to show how this will be accomplished
    - Statements of using the CAEN software trip points is very important but interlock design must use engineered control to lockout HV for servicing items inside the enclosure or when in the ‘Bleaching Mode’
    - Provisions have been designed into the LED Pulser/Bleaching control board to inhibit Bleaching function with external signal
- The JLAB ES&H manual, chapter 6230: Appendix T1 lists a Class 1 hazard as >50VAC or 60VDC  $\leq$  5mA
  - Each of the channels from the A7030 HV module can only deliver 1mA so these outputs are considered low hazard
  - The power source for the cooling fans may be 120VAC, so connection must follow Class 2 wiring and connectors per NEC

**Recommendations:** See Cable/Connector Table on next page

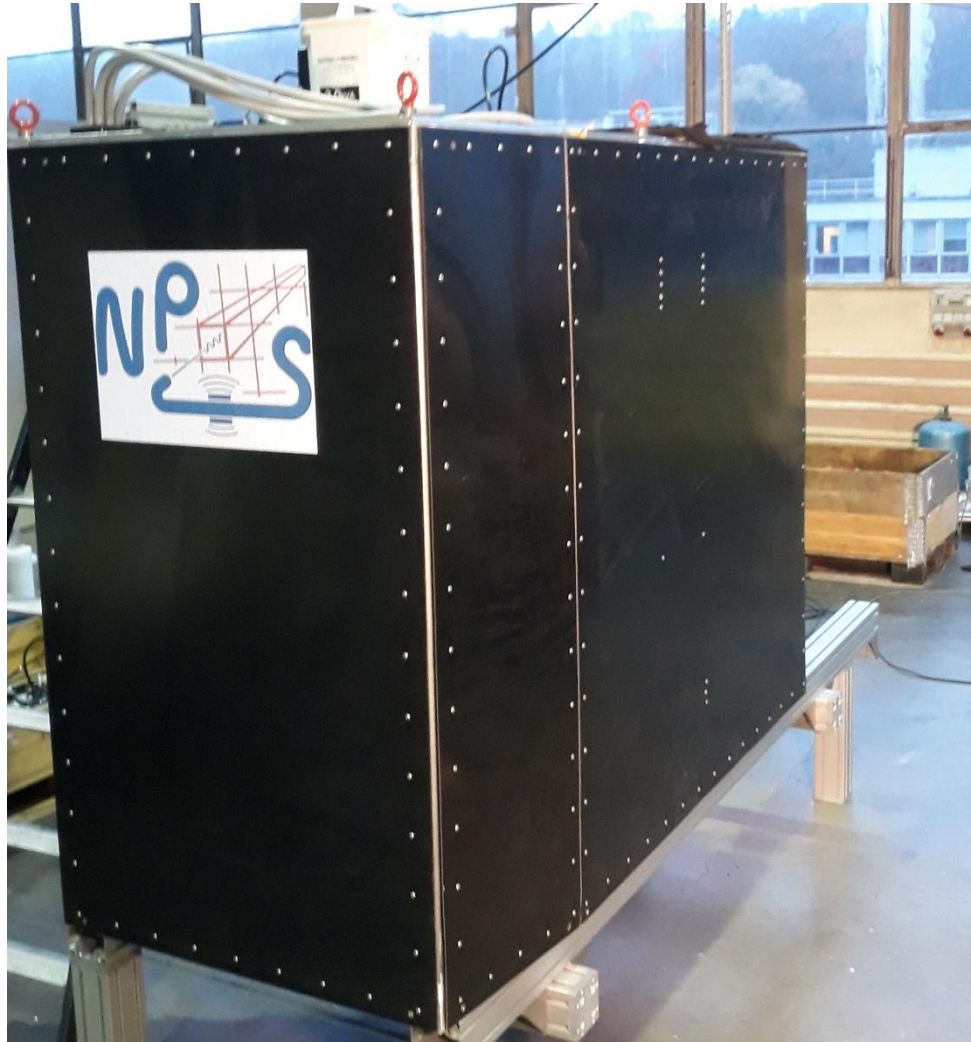
1. Green -- These items are OK for use on the NPS detector enclosure.
2. Yellow – These may be OK as well, but I did not see any information on testing at the operating voltage. Pins have been spaced more than adequately for the PMT operating voltage, but this should be checked.
3. Create and review an engineered control interlock system for the requirements of NO HV conditions.
  - a. NO HV permitted when;
    - Servicing detector components
    - When Detector is in “Bleaching Mode”

NPS Assembly/Board	Item Number	Component	Part Number	Voltage Rating (V)	NOTES
CAEN SY4527	1	Multislot Mainframe and Power supply	SY4527[LC]?	120VAC Input	Noted that unit has european CE testing which is not considered a NEC/OSHA Nationally Recognized Test Lab[NRTL] rating. JLAB policy has not been established for acceptance of CE testing.
CAEN A7030TN	2	Multi-output HV module	A7030TN	Power from CAEN mainframe	Fully enclosed HV module; 36 channels; 0-3kV @1mA; Common Floating return
HV supply cable	3	CAEN HV connector	Radiall A996 52 pin	12.5 kV	Original Equipment Manufactured [OEM] part. Rating well above the NPS operating Voltage.
	4	HV multiconductor - 42 cond.	GWP 030-23904	5 kV	This cable has a 5kV rating and is a multi-conductor cable with a shield and double insulated. [Overall cable jacket]
	5	Samtec 8 pin (male cable mount)	IPBD-08-D-K	424 V	Breakdown Voltage tested by manufacturer to 3900VAC. OK for application
	6	Samtec 15 pin (male cable mount)	IPBD-15-D-K (x2)	424 V	Breakdown Voltage tested by manufacturer to 3900VAC. OK for application
HV Board	7	Multilayer circuit board	?	?	These have been tested at 1kV. Test report on the NPS wiki
HV board connectors	8	Samtec 8 pin (female pcb mount)	IPBT-108-H1-T-D-K (1 per side of patch panel)	565 V	Breakdown Voltage tested by manufacturer to 1625VAC. OK for application
	9	Samtec 15 pin (female pcb mount)	IPBT-115-H1-T-D-K (x2 per side of patch panel)	565 V	Breakdown Voltage tested by manufacturer to 1625VAC. OK for application
Samtec ribbon cables	10	Samtec 8 conductor ribbon cable	PMSD-08-206-K-15.40-D-LUS	600 V	Datasheet lists testing at 675VAC and passing. No other data located to support higher Voltage testing value.
	11	Samtec 15 conductor ribbon cable	PMSD-15-206-K-15.40-D-LUS (x2)	600 V	Datasheet lists testing at 675VAC and passing. No other data located to support higher Voltage testing value.
Interface Board	12	Multilayer circuit board	?	?	These have been tested at 1kV. Test report on the NPS wiki
Interface Card Connectors	13	Samtec 8 pin (female pcb mount)	IPBT-108-H1-T-D-K	565 V	Datasheet lists several environmental testing with 1220VAC with pass status
	14	Samtec 15 pin (female pcb mount)	IPBT-115-H1-T-D-K (x2)	565 V	Datasheet lists several environmental testing with 1220VAC with pass status
	15	Fischer jack connector	D 102 A018	8 kV	The HV rating is well above the NPS rated Voltage.
	16	SMA right angle jack	142-0701-501 (1 per side of patch panel)	335 V	SMA connections are used strictly to transfer low level [ $\ll 50V$ ] pulse signal levels from the PMT to data acquisition electronics
PMT HV/Signal Y cable	17	Fischer plug connector	S 102 A018	8 kV	The HV rating is well above the NPS rated Voltage.
	18	SMA female cable mount	R19-003-04-032611011 (1 per side of patch panel)	335 V	SMA connections are used strictly to transfer low level [ $\ll 50V$ ] pulse signal levels from the PMT to data acquisition electronics
	19	Coax cable	RG-174u	30 V	Non-UL rating of 1500V per data sheet
	20	Samtec 5 pin male connector	IPD1-05-S-K	387 V	Datasheet lists several environmental tests with 825VAC. Connector pins selected to increase distance.
Internal cooling fans	21	Cooling fans	?	120VAC??	Assumption that these fans are 120VAC and monitored but not controlled remotely for speed/ON/OFF

# HV Connection Schematic



**HV rating concerns**  
 Researching alternates



NPS Detector enclosure

NO exposed components  
Access prohibited by many  
screws on multiple external  
panels.

HV must be in de-energized  
state before servicing or  
running in "Bleach" mode

77 : Close the box