### 0.0.1 High Voltage Supplies and Control

**Overview** All of the detector systems in Hall C use high voltages, from hundreds to several thousand volts, to either power photomultiplier tubes or maintain electric fields around sense wires in drift chambers. These include scintillators, drift chambers, scintillators, shower detectors, and aerogel Cherenkovs.

#### Hazards

The personnel hazard with these devices is the high voltage. This same hazard can damage phototubes if voltage is left on when tubes are exposed to room lighting.

#### Mitigations

- All user configurable high voltage cabling/patching is made with coaxial cables rated for high voltage with SHV connectors.
- High voltage shall be turned off before disconnecting (or connecting) high voltage cables from (or to) phototubes, power supplies or patch panels.
- High voltage shall be turned off and high voltage cables shall be removed from phototubes before handling phototubes or the detector elements they are used with.
- Current limits are set on power supplys to trip high voltage in case of shorts or shocks.
- External metal parts of detectors such as mu-metal shields are wrapped with electrical tape. Exposed metal parts are grounded through both the HV cable and signal cable grounds.

#### Responsible Personnel

The individuals responsible for the operation of the high voltage system are shown in Table 1.

All the detector elements in the SHMS and HMS require the use of High Voltage. The high voltage supplies for the detectors are located in the electronics room and second floor of the counting house. They are connected to

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|---|---|---|---|---|---|
| | | Tel | Pager | | |
| Stephen Wood | Hall-A/C | 7367 | 593-6656 | saw@jlab.org | |
| Mahlon Long | Hall-A/C | 6436 | 770-5562 | mlong@jlab.org | |
| Joe Beaufait | Hall-A/C | 7131 | 256-2776 | beaufait@jlab.org | |
| Jack Segal | Hall-A/C | 7242 | | segal@jlab.org | |

Table 1: Detector high voltage responsible personnel.

the detector shield houses through multiconductor high voltage patch systems, and to the detectors through coaxial cables with SHV connectors. During experiments the control of the high voltage supplies is done remotely via any of the computers at the console the Hall C counting house.

As a general rule no work should be done on detectors which are under High Voltage and High Voltage cables should never be removed or installed while the supply is on.

### High Voltage Configuration and Operation

The CAEN Distributed High Voltage System is responsible for providing high voltage power to all HMS and SHMS detector systems. This system is a networked system made up of individual crates (Controllers) each of which can hold several independent high voltage modules (Cards). The crates are a mix of SY403 mainframes which hold four cards with 16 SHV outputs and newer SY4527 mainframes holding up to 8 cards with 24 SHV outputs each. (Other cards with different numbers of channels and different high voltage connector form factors are available, but only the described types are currently used in Hall C.) There are several flavors of cards in use with the Hall C detector systems which are listed in Tables 2 and 3. A given crate may have a mix of card types, although cards can not be exchanged between SY403 and SY4527 crates.

The system is typically controlled through EPICS. Various methods of direct/local control are available for the two different crate types.

HV channel assignments currently in effect are indicated in two files ("group_map" and "channel_map") in the directories $EPICSHL/HV/hms_all (for HMS) and $EPICSHL/HV/shms_all (for SHMS) when logged in as cvxwrks to one of the cdaq machines.

Table 2: Specifications of SY403 High-Voltage Cards used in Hall C Detector Systems.

| Card type | Max Voltage | Max Current | Detector System |
|---|---|---|---|
| A403 (or A503) | –3000V | 3.0mA | Hodo/Shower |
| A503P | +3000V | 3.0mA | Cerenkov/Aerogel |
| A505 | –3000V | 200$\mu$A | Drift Chambers |

Table 3: Specifications of SY4527 High-Voltage Cards used in Hall C Detector Systems.

| Card type | Max Voltage | Max Current | Detector System |
|---|---|---|---|
| A1535SN | –3500V | 3.0mA | Hodo/Shower/Heavy Gas |
| A1535SP | +3500V | 3.0mA | Noble Gas/Aerogel |

## General Operation

**Normal Operation:** In general the high voltage system will be controlled or monitored from the counting house using the EPICS slow control system. Operation of the EPICS graphical interfaces is described in the CAEN HV Operation Howto [2].

In case of a dead high voltage channel, the high voltage cable for a given detector element can be moved to a spare high voltage channel, if available. (The channel_map file, described above shows which channels are in use.) Care must be taken to always use the correct type of HV (positive vs. negative, vs. drift chamber supply). The procedure to make these changes is described in the CAEN HV Operation Howto [2]. Any changes in HV configuration shall be documented in the logbook.

For more complicated changes to the HV configuration, such as changing or adding HV cards or mainframes, consult and expert and the Caen High Voltage System EPICS Controls Expert Howto [3].

**Important Features:** The user can program several important features for individual cards and/or channels. The most common are:

- HV limits – 2 types including a hardware maximum (common to a card) set with a pot on the front panel of each card and a software maximum for each channel.
- Current Trip Value – The current over which the system will indicate an alarm status and initiate a trip off of that channel.
- Current Trip Time – The amount of time the system will allow the alarm condition before actually switching off that channel.
- Ramp-up Value – The number of volts/sec the voltage will ramp to its set point upon switching on the channel.
- Other Features – See the CAEN Technical Information Manual.

**Direct/Local Operation** The SY403 mainframes may be controlled through the front panel or an RS232 interface, while the SY4527 The high voltage main frames can be controlled through a web interface. These methods of control are described in the CAEN HV Operation Howto [2] and the vendor manuals for the SY403 [4] and SY4527 [5]. These modes of control are meant for diagnostics and testing of a detector system prior to running.

**Safety Concerns/Caveats** There are a number of cautions one should observe when operating the CAEN HV equipment to avoid damage and insure proper functioning:

- Use only proper SHV connectors and approved cables when connecting equipment to the supply.
- **DO NOT** attach/remove HV cables when loads are present on the channel ( a red LED above each channel indicates the presence of a load).
- Insure adequate ventilation around crates to avoid overheating of the electronics.
- Wait 2-3 minutes after switching off a crate before removal of a HV card.

- Insure proper static precautions when handling HV cards.

For proper EPICS control operation (SY403):

- Inter-crate connections must be unbroken and terminated at the last crate at 50 Ohms. All crates must be powered on.
- Crate numbers for each crate in the chain must be distinct and different from 0 (i.e. 1-99)
- The HV Enable switch (on the front panel of each crate) must be on.
- One should refrain from any local operation of crates when the EPICS system is active.

**High Voltage System Checkout**

Before starting an experiment, or before using the high voltage system to test detectors, proper functioning of the HV supplies and EPICS controls should be verified with this checklist.

- Check EPICS: Using the EPICS Control system as described in the CAEN HV Operation Howto [2], verify that voltage set points and current/voltage limits are read by the control system.
- Verify Operation: For the detector(s) of interest, individually turn on each channel. Verify that the channel reaches the desired set voltage. If the readback voltage exceeds the set voltage by more than a few volts (Overvoltage), or fails to reach full voltage (Undervoltage), immediately turn off the channel, report the observation in the logbook and consult an expert.
- Verify Limits: Make a backup of HV settings. For each channel in the detector, set a current limit below the current being drawn by the detector channel. Verify that each channel trips. Similarly, set a maximum voltage for each channel below the set point and verify that the voltage limit is enforced. (This may change voltage set points, so they may need to be restored from backup.) Consult an expert if any channels fail to trip on overcurrent or if maximum voltage is not enfored.

- Interlocks: If any high voltage systems are interlocked with other systems, verify that assertion of the interlock signal turns off high voltage.

# Bibliography

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[3] S. A. Wood. Caen high voltage system epics controls. URL http://hallcweb.jlab.org/document/howtos/PDF/CAEN_HV_expert.pdf. Hall C Expert Howto.

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