

Setting-up halo counters and beam stability studies

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The Hall-B halo counters are used to monitor beam quality by measuring beam-halo interactions with whatever around the beam and for performing wire harp scans to quantify beam profile. These are PMT based devices with acrylic disks attached to the photocathode (some have scintillator disk). They measure light generated in the acrylic (Cherenkov light) or in the scintillator from interactions of beam related secondaries. For the beam quality monitoring, the rate increase in these counters will mean interaction of the beam tails with beam pipes or supports of a target, for example, while during the harp scan rate increase will come from beam-wire interaction and the rate dependence on the wire position will show beam profile.

For the HPS run there are 12 halo counters distributed along the beam line. In Table 1, location and other characteristics of the halo counters are presented. Most of counters use 2" PMTs, two counters, located behind the HPS ECal have 3/4" PMT. The max operating voltage for 2" PMTs should not exceed 2300 V, the small PMTs, XP2802 and XP1912, have max working voltage 1200 V. Each PMT signal is sent to a discriminator. One of outputs of the discriminator is connected to a level translator and then to 16-channel Jorger and to 32-channel Struck scalars. The Hall-B harps on the HPS beamline are controlled from two hardware IOCs, *classc1* located on the upstream side of the Hall, inside the beamline racks on the first level of the space frame, and *classc4* locate on the downstream end, in the beamline rack on the pie-tower. In order to have identical harp scan file from both IOCs, the inputs to the Jorger scalars in two IOCs, which are used in harp scans, have been made identical. In order to do so, signals from the upstream counters, after the discriminator, have been sent to the downstream scaler

and vice-versa. In both IOCs first 16 channels of the Struck scalers are also identical and are the same as for Jorger scalers.

1 Initial settings of gains and thresholds

The NIM discriminators are used for the halo counter signals. Thresholds on these discriminators are set manually. The initial threshold settings for the most are ~ 25 mV and will not change during the beam counter calibration or during the run. Calibration will include setting the gain of PMTs by changing the HV. Initially, without beam, gain-threshold settings are chosen in such a way that most of counters count ≤ 1 Hz on the scalers, as shown in Figure 1. To bring up this Jorger scaler window, find the medm window corresponding the main hps.epics interface, use the mouse to click on “File”, “Open” and select “scaler.adl” for the Jorger scaler in IOC *classc4* and ”scaler_c.adl” for the one in IOC *classc1*. If this fails, you can login as hpsrun on clonoc1, then enter :

```
hpsrun@clonsl1> medm -x /usr/local//clas12/hps/prod/apps/medm/scaler.adl &
```

or

```
hpsrun@clonsl1> medm -x /usr/local//clas12/hps/prod/apps/medm/scaler_c.adl &
```

The HV settings corresponding to the scaler readout in Figure 1 are shown in Table 2.

2 Setting the gains (HVs) for harp operation

The initial gain settings for halo counters should be adjusted with beam to get proper beam characteristics. The beam profile, especially S/B ratio for wire passing through the beam depends on the location of the counter and its gain. The low gain may mimic low S/B ratio, while too high gain will increase PMT ”dark” counts and make false rates from beam tails. One should carefully chose gains to keep PMT ”dark” rate low while increase sensitivity to beam-wire interactions. In order to achieve optimal settings for halo counter gains (voltages) the following can be done:

- perform harp scans using relevant harps with initial gain setting of halo counters and ~ 10 nA beam current

Table 1: Hall-B beam halo counters for the HPS run.

| # | Name | Scaler # | HV | Comment |
|----|--------|----------|--------------|--|
| 1 | Upst-L | 3 | HVHPS1 15-0 | 2" PMT, located 30 cm downstream of the 2C24 ("tagger") harp |
| 2 | Upst-R | 4 | HVHPS1 15-1 | 2" PMT, located 30 cm downstream of the 2C24 ("tagger") harp |
| 3 | Tagg-L | 5 | HVHPS1 15-2 | On the tagger vacuum box, about 2 m downstream of the magnet edge |
| 4 | Tagg-R | 6 | HVHPS1 15-3 | On the tagger vacuum box, about 2 m downstream of the magnet edge |
| 5 | Tagg-T | 7 | HVHPS1 15-18 | On the tagger vacuum box, about 2 m downstream of the magnet edge |
| 6 | Down-L | 8 | HVECAL4 0-2 | Inside the forward carriage apex (downstream end) |
| 7 | Down-R | 9 | HVECAL4 0-3 | Inside the forward carriage apex (downstream end) |
| 8 | Down-T | 10 | HVECAL4 0-1 | Inside the forward carriage apex (downstream end) |
| 9 | Down-B | 11 | HVECAL4 0-0 | Inside the forward carriage apex (downstream end) |
| 10 | HPS-L | 12 | HVHPS1 15-4 | Around the beam pipe, between the first Frascati dipole and the analyzing magnet |
| 11 | HPS-R | 13 | HVHPS1 15-5 | Around the beam pipe, between the first Frascati dipole and the analyzing magnet |
| 12 | HPS-T | 14 | HVHPS1 15-8 | On top of the last Frascati dipole vacuum chamber, right behind the ECal |
| 13 | HPS-SC | 15 | HVHPS1 15-9 | Behind ECal has a scintillator on photocathode |

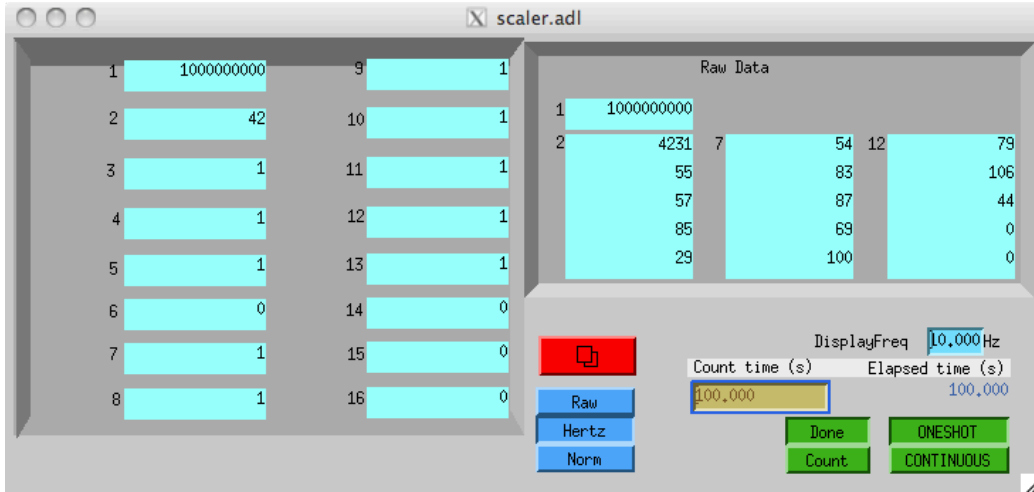


Figure 1: Jorger scaler viewer, no beam, counts on the right are for 100 seconds, on the left in Hz.

Table 2: Initial HV settings for halo counters.

| # | Scaler | HV Channel | HV value (V) |
|----|--------|--------------|--------------|
| 1 | 3 | HVHPS1 15-0 | 1750 |
| 2 | 4 | HVHPS1 15-1 | 1825 |
| 3 | 5 | HVHPS1 15-2 | 1515 |
| 4 | 6 | HVHPS1 15-3 | 1600 ? |
| 5 | 7 | HVHPS1 15-18 | 1600 |
| 6 | 8 | HVECAL4 0-2 | 1920 |
| 7 | 9 | HVECAL4 0-3 | 1920 |
| 8 | 10 | HVECAL4 0-1 | 1420 |
| 9 | 11 | HVECAL4 0-0 | 1450 |
| 10 | 12 | HVHPS1 15-4 | 1920 |
| 11 | 13 | HVHPS1 15-5 | 1840 |
| 12 | 14 | HVHPS1 15-8 | 950 |
| 13 | 15 | HVHPS1 15-9 | 950 |

- using harp analyzer define the best counters for the given harp (can be many) and check S/B ratio (ratio of the number of counts at the peak of the distribution to the number of counts far away from the peak). For good beam and correct gain settings, this ratio should be $> few \times 10^4$
- increase voltage on the counters with steps of ~ 25 V and perform harp scan again and check. Since beam time is limited, gain studies can be done with two or more harps simultaneously, analyzing different set of counters for different harps
- increasing gain will also increase background, so S/B should be analyzed after every increase. If distribution of count rates as a function of position looks flat at the peak, it means PMT is saturated, do not increase PMT voltage anymore, instead go down to see nice Gaussian peak (also do not exceed V_{max} as was defined at the beginning of the document)
- above studies can be repeated with higher current beam, e.g. 20 nA. Always look for the PMT saturation

3 Beam stability studies

If the beam quality is satisfactory and halo counters are calibrated, beam stability can be studied in two ways:

- perform many harp scans with lower harp speed, then faster readout and check beam position and width stability
- if beam destination is the "Hall-B tagger dump", park wire of the 2C24 harp close to the beam (most important is the horizontal wire that will see vertical motion) and watch rates on halo counters as a function of time. If the beam destination is the "Hall-B Faraday cup", instead of the wire, the edge of the HPS collimator can be parked close to the beam

It is important to make sure that orbit locks are operational. Above studies will verify correct operations of orbit locks.

4 Study of beam motion during the trip

When beam destination is the "Hall-B Faraday cup", the HPS collimator parked close to the beam can be used to study beam motion when beam trips occur. For this studies the Struck scaler in IOC *classc4* must be configured to buffer inputs in 10 μ s intervals. The scaler application¹ will read and write to a file filled buffers. File will contain a time stamp for each buffer that can be used to trace the time of the trip. Only 16 out of 32 channels of the Struck are need. The 10 MHZ clock will be one of the channels. In each stored 10 μ s buffer 100 counts are expected for the clock input.

The HPS collimator should be positioned close enough to the beam to have a few hundred kHz rate for halo counters downstream of the collimator, so in each 10 μ s buffer one would expect few counts for halo counters. The time of the beam trip is expected to be less than 50 μ s. If beam moves during this time, the 4 - 5 buffers before beam is OFF should show continuous rate increase if beam closing to the collimator edge is faster than beam intensity drop. If no rate increase is observed, it does not mean that beam did not move before it wen OFF, it just means that at the location of the collimator beam intensity did not increase.

Studies must be done in two settings of the collimator, when lower edge is close to the beam and when upper edge is close to the beam.

Appendix : setting the HV without EPICS interface

The EPICS interface is currently not up-to-date to control the beamline HV. To control the HV in Table 2 we can use the crate direct access.

To access the HV crate HVHPS1 we can use telnet :

```
hpsrun@clons11> telnet hvhps1 1527
username : user
password : user
```

The highlight cursor should appear on "Main". Hit [enter] and the down arrow to select "Channels" then hit [return]. The beamline channels in 2

¹Hovanes will provide the application

are located on the last slot, board 15. To logout, use [tab] then “Main”, “Logout” and [enter].

To access the crate HVECAL4 we can use :

```
hpsrun@clonsl1> ping hvecal4
hpsrun@clonsl1> caenhv hvecal4
```

In the interface, select with the mouse “File”, “Connect”. Check the IP address obtained with ping if the connection would fail.

```
username : admin
password : admin
```

The beamline channels in 2 are located on the first slot, board 0.