Setting-up halo counters

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, one counter, located behind the HPS ECal has 3/4" PMT. The max operating voltage for 2" PMTs should not exceed 2300 V, the small PMT, XP2802, has 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 a 16-channel Jorger and to a 32-channel Struck scalers. The Hall-B harps for the HPS run 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 Jorger scalers used in harp scans have been repeated in these two IOCs. 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.

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 chanber, right behind the ECal

1 Initial settings of gains and thresholds

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 changing gain of PMTs by changing HV settings. Initially, without beam, Gain-Threshold settings are chosen in such a way that the 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". If this fails, you can login as hpsrun on clonioc1, then enter :

```
hpsrun@clonioc1> medm -x /misc/clas12/hps/v0.2.2/apps/medm/scaler.adl &
```

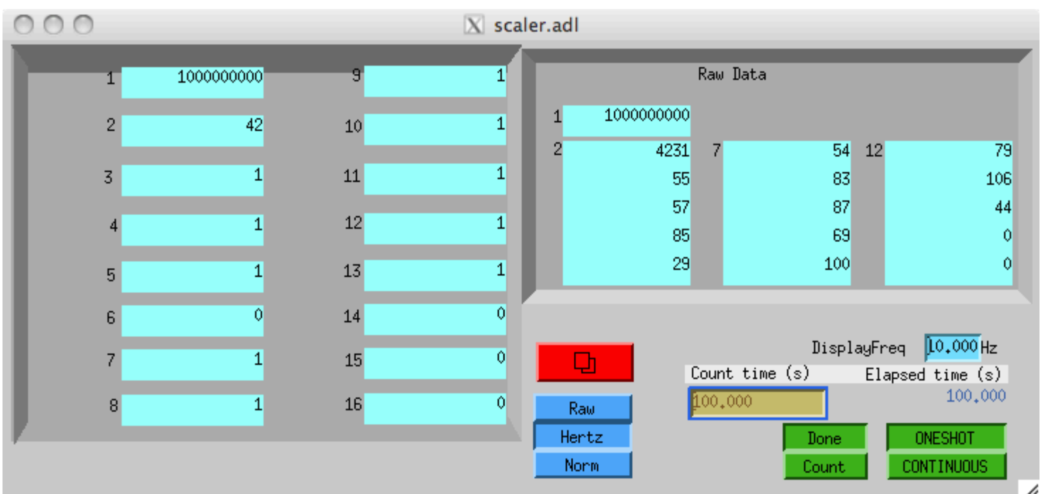

Figure 1: Jorger scaler viewer, no beam, counts on the right are for 100 seconds, on the left in Hz.

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

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

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 $\sim$ 10 nA beam current
- 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 $\sim$ 25 V and perform harp scan again and check. Since beam time is limited, 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

- park wire (most important is the horizontal wire that will see vertical motion) close to the beam and watch rate on halo counters as a function of time

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@clonioc1> 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 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@clonioc1> ping hvecal4
hpsrun@clonioc1> 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.