

# HPS beamline commissioning document v4.0

June 14, 2019

Authors: Ken Moffeit, Stepan Stepanyan, and Takashi Maruyama  
Document Contact: Stepan Stepanyan

**Beam:** Beam energy 4.55 GeV (+/-). Beam current as low as possible to give good readings on beam diagnostics instrumentation (~10 nA).

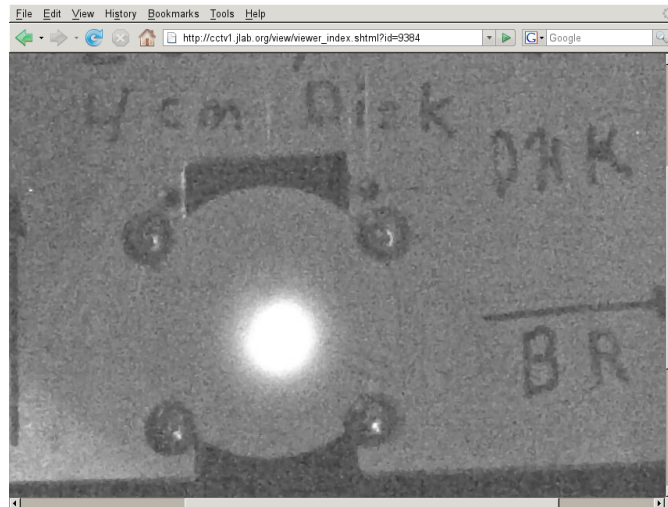
**For location of beam line element please consult beamline drawings on Figure 5 and Figure 6 in Appendix.**

## **A) Beam to Hall-B tagger dump – Accelerator Operations**

1. Hall-B tagger magnet is ON with current appropriate to actual beam energy.
2. Diagnostics, beam viewer, at tagger dump live and checked out.
3. HPS detectors (especially tracking detectors) must be OFF
4. All halo counters (upstream, tagger, midstream, downstream and HPS) must be ON and **masked** in beam Fast Shut Down (FSD) system
5. The Hall-B "blank" collimator with no hole is on the beam
6. The chicane magnets are OFF if this is the first time beam will be established for HPS after accelerator configuration change. Otherwise, if the beam trajectory is already established for this machine setting, chicane can be ON
7. Ask MCC to energize the tagger dipole magnet. They will ask to switch the beam type to "Photon"

### **Accelerator Operations:**

1. Define the incoming trajectory of the beam.
2. Bring beam to the tagger beam line dump centered appropriately.



**Figure 1. Tagger viewer**

3. **Harp Wire scan:** Accelerator Operation and HPS: Measure beam size using two harp wire scanners - one at the beginning of the upstream tunnel (2C21 harp), the second before the Hall-B tagger magnet (“tagger” or 2C24 harp). Measure beam size and position at <10 nanoamps (current limit for harp) with beam going to tagger dump. Work with MCC operators to obtain desired beam profile. Typically, widths at 2C21 harp  $\sigma < 200 \mu\text{m}$ , while at 2C24 (tagger) harp  $\sigma < 500 \mu\text{m}$ . In general it is a good practice to check newly measured beam parameters against last good/acceptable tune.
4. **Do not spend too much time “tuning” on the tagger dump**, but make sure the beam sizes are close to expected and the rates on upstream halo counters are less than 10 Hz.

#### **B) HPS Pre-setup before bringing beam to alcove and dump**

- 1) **Tagger Magnet** is turned off and degaussed.
- 2) **Chicane magnets** off.
- 3) Position 20 mm diameter Hall-B collimator on the beam
- 4) **Silicon Detector:** Voltages off. Upper and lower moveable silicon detector elements fully retracted. Silicon detector cooling system on and temperatures monitored.
- 5) **HPS production Target** retracted out of beam path.
- 6) **Set 3.94 mm HPS Protection Collimator in place if beam trajectory is known.** When beam is delivered to the FC for the first time after a long down or machine configuration change (e.g. pass change), when HPS SVT protection collimator position relative to the beam trajectory may not be known, the collimator must be retracted.
- 7) **Ecal detector** voltages off with cooling, etc. operational.

- 8) **Beam halo counters** and other **beam diagnostic** instrumentation ON.  
Halo counter FSD is unmasked
- 9) **Chromax beam viewer** is on
- 10) **Verify that the beamline vacuum is good.**

### **C) Beam to alcove and dump**

1. Beam current  $\sim 10$  nA, high enough currents so that the nA BPMs are reliable.

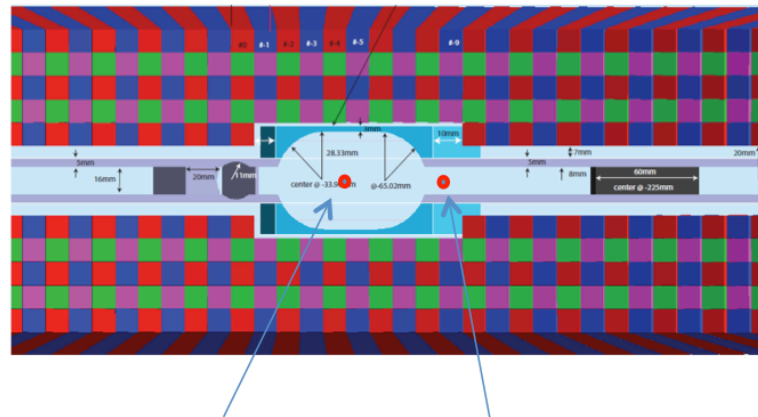
#### **Accelerator Operations:**

2. **Bring beam through Hall B beam line** and HPS system in alcove to dump.
3. View beam on **Chromax beam viewer** downstream of the HPS.
4. Check rates on halo counters upstream of the HPS chicane (Upstream, Tagger, Midstream and Downstream halo counter) they should not exceed  $\sim 100$  Hz
5. If the SVT protection collimator was not positioned, run Collimator wire scan to find the position of the collimator
6. Check that beam is roughly centered in SVT protection collimator by performing halo rate vs. y scan, basically moving collimator up and down with a tiny steps and recording HPS halo counter rates.
7. Measure the beam current on Faraday cup and compare with 2C21 and 2C24 nA BPM readings, should be the same within  $\sim 10\%$ .
8. **Measure beam profile and position with wire Harps** 2H01A and 2H02A. Note: the distance between 2H01A and 2H02A wire harps is 10x of the distance between 2H02A and the HPS target and no optical elements in between. From profile measurements with these two harps one can easily project beam size on the target. Adjust Quad doublets (MQA2H00.K1 and MQA2H00A.K1) to achieve required beam profile. Record beam profiles in logbook

### **D) Turning on the chicane magnets**

1. Record the beam position at Chromax viewer
2. Turn off beam
3. Set chicane magnets to correct currents for beam energy and return beam to dump.
4. Verify position of beam at Chromax viewer is still within tolerance.
5. If the beam position has moved, consult with beam line expert.

### E) HPS and Accelerator Operations – center beam in Ecal vacuum chamber



Chicane on      Chicane off

**Figure 2 Beam positions at the upstream face of the ECal vacuum chamber.**

## Insert HPS production target – a quick over all check

1. Beam current 25 – 30 nA
2. Put 4 $\mu$ m target in
3. With HPS target in a gamma beam and Coulomb scattered electron beam are produced.
4. Verify Ecal and halo counter rates are more or less consistent with the rates during the Spring 2015 run, and no anomalous hits are observed.
5. Put 8 $\mu$ m target in and make sure the rates scale with the target thickness.
6. Move the target vertically by  $\sim 0.5$  mm and make sure the rates are stable.

**F) HPS and Accelerator Operations –center beam in HPS silicon detector.**

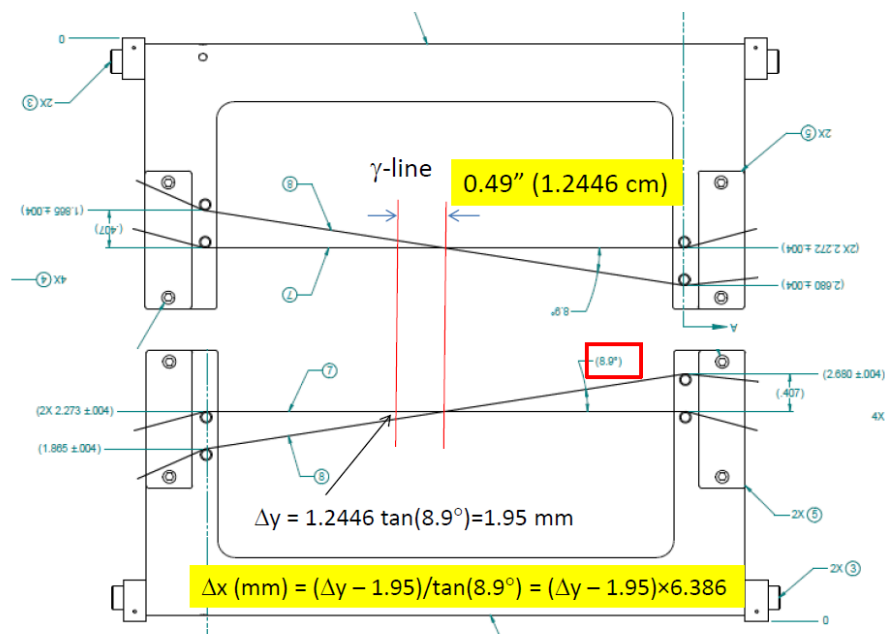


Figure 3. SVT wires

1. Beam current 25 nanoamps.
2. Ecal voltage on.
3. HPS production target **out**.
4. Downstream halo counter ON. Note that the ECal response will measure when the beam is hitting the silicon detector wires.
5. Do wire scans. Each scan should cover both horizontal and tilted wires.
6. **Center beam vertically and horizontally** on silicon detector wires
7. If the beam position is off, ask MCC operators to move the beam.
8. Verify beam position is okay at the beam dump viewer and that ECal rates are OK.
9. Perform 2H02A harp scan after beam is centered on SVT
10. Insert HPS production target and verify the ECal and trigger rates are OK.

### G) Position HPS Protection Collimator

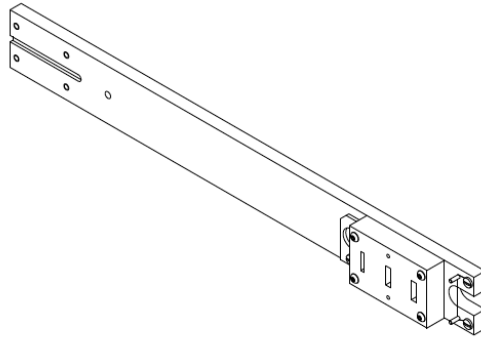


Figure 4 SVT protection collimator stick.

1. Remove HPS production target
2. Find location of **SVT protection collimator** by scanning collimator vertically using collimator “Wire scan” GUI.
3. With beam off move HPS Protection Collimator ladder to have **3.94 mm** gap centered on beam. Note that distance between collimator wire and the center of the gap is 1.802 in motor units (which is in inches)
4. Fine tune HPS PC vertical position by moving HPS Protection Collimator ladder up and down (with steps of 0.1 mm until edges are clearly seen).

### H) Setup trip levels halo counters in FSD.

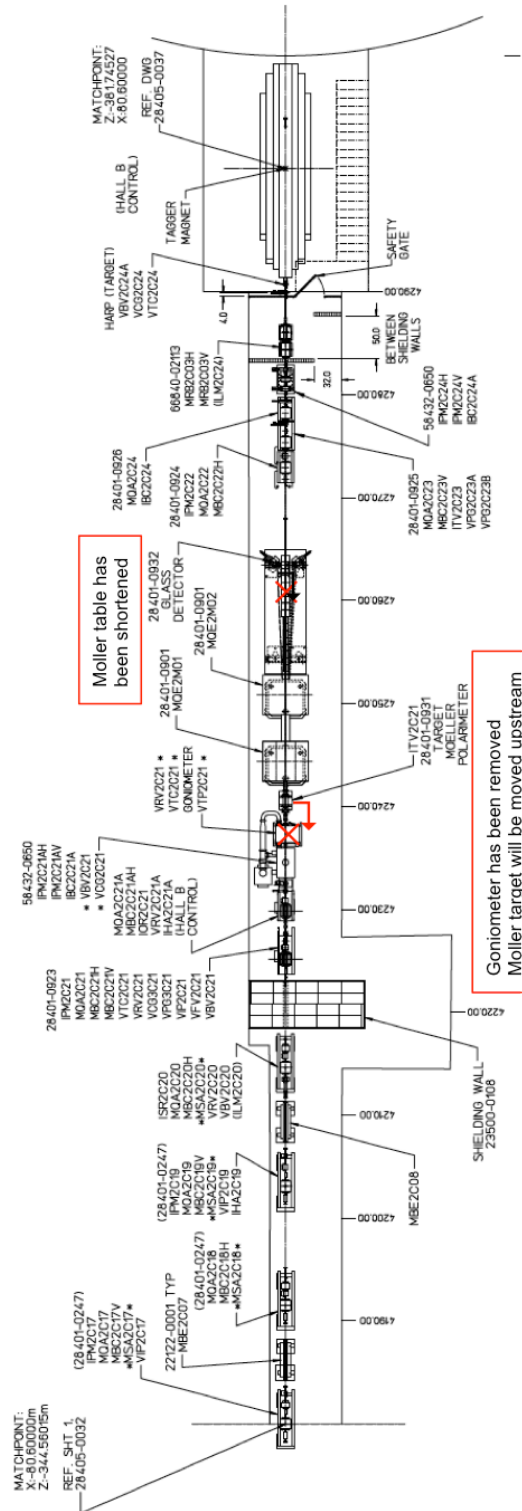
1. HPS target is **IN**.
2. Downstream halo counters ON, record rate of halo counter OR going to FSD input.
3. Set trip limits on halo counters in FSD such that FSD will be initiated when the rate exceeds  $1.3\times$  of normal rates.

### I) Tests after beam through HPS is established, chicane currents are set and rates on halo counters are as expected.

1. HPS target is out.
2. Downstream halo counters and ECal ON.
3. Verify that FSD system is active.
4. SVT is retracted and voltages OFF.
5. Move the SVT protection collimator edge to say 300 micron from the beam center. It will initiate higher rates on the halo counters when beam moves and will allow better understanding of beam motion.
6. Run beam at nominal current (200 nA) for several hours, and using struck scalars, read and store rates of the halo counters and Ecal channels (use WaveForm utility). This should be repeated for both beam up and beam down positions.

7. The expected average beam trip rate is 5/hour, running a shift (4 hours per position) should give us good understanding of beam position stability and beam motion during the trips.
8. This covers normal operation and beam trip situation.

## Appendix: Hall B Beamline



**Figure 5. Upstream beamline.**



