HPS beamline commissioning document v2.0

March 7, 2015

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Beam: Beam energy 2.2GeV (+/-). Beam current as low as possible to give good readings on beam diagnostics instrumentation (~5 nA).

For location of beam line element please consult beamline drawings on Error! Reference source not found. **and** Error! Reference source not found. **in Appendix.**

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

1. Hall-B tagger magnet and other magnets in beam line are ON with current appropriate to actual beam energy.
2. Diagnostics at tagger dump live and checked out.
3. Verify that beam delivery is interlocked with tagger magnet.

Accelerator Operations:

4. Define the incoming trajectory of the beam and initiate feedback loop.
5. Bring beam to the tagger beam line dump centered appropriately.

Tagger Screen

6. **Harp Wire scan:** Accelerator Operation and HPS: Measure beam size using two harp wire scanners - one in the tunnel (harp 2C21) and second before the Hall-B tagger magnet (the tagger harp, 2C24). Measure beam size and position at <10 nanoamps (current limit for harp) with beam going

to tagger dump. Adjust beam line quads upstream of tagger magnet to obtain desired beam profile.

7. **Beam current scans:** Measure beam halo as a function of beam current from 1 to 200 nanoamps.
   a) Position Harp wire away from core of beam and vary beam current. Set Harp wire away from core of beam, e.g. 100 microns (~2 sigma) above and below beam center. Measure halo counter PMTs as a function of beam current. Verify scaling of beam tails with increasing current. (Note that the halo counter PMTs will saturate if the beam core at 200 nanoamps hits the Harp wire.)
   b) Do beam current scans with the Harp wire in at least two different positions, for example, at 100 microns and 150 microns (~2 and 3 sigma). But the positions will depend on the Harp scan result at low current described above.
   c) If a long halo tail is measured in step 7 above, perform beam current scan at 250 microns and 500 microns (~ 5 and 10 sigma).

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

1) **Silicon Detector**: Voltages off. Upper and lower moveable silicon detector elements fully retracted. HPS wires in silicon detector retracted**.** Silicon detector cooling system on and temperatures monitored.
2) **HPS production Target** retracted out of beam path.
3) **HPS Protection Collimator** retracted out of beam path.
4) **Ecal detector** voltages off with cooling, etc. operational.
5) **Chicane magnets** off.
6) **Beam halo counters** and other **beam diagnostic** instrumentation ON.

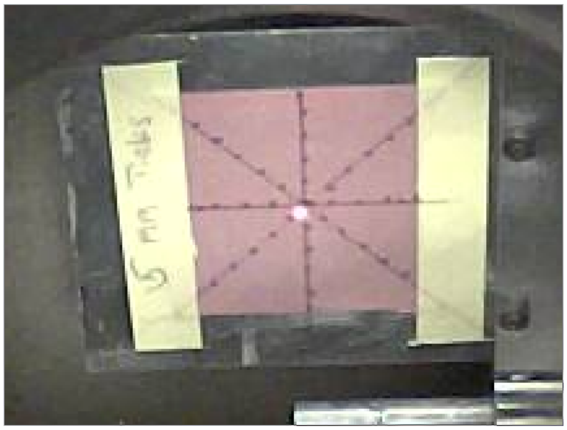
C) Beam to alcove and dump

1. Beam current 5 - 10 nA, high enough currents so that the BPMs are reliable.
2. Consider using CEBAF pulsed mode at 60 Hz for initial optics tuning.
3. After an acceptable beam profile and stability is achieved turn off tagger magnet and degauss. Reset beam interlock to the tagger magnet.
4. Verify that the beamline vacuum is correct, BPMs, halo monitors, etc. operational.

Accelerator Operations:

5. **Upstream correctors should be used to get the beam centered at the dump. 2H00/2H02 Correctors can be used as long as the parallel transport is possible.**
6. **Quad doublets** on 2H00 guider (MQA2H00.K1 and MQA2H00A.K1) should have no currents.

7. **Bring beam through Hall B beam line** and HPS system in alcove to dump.
8. View beam with **insertable beam viewer** downstream of the HPS and make sure the beam is at x=y=0 within ~1 mm on the viewer.



9. Measure the beam current on Faraday cup.
10. **Measure beam profile and position with Harp** located downstream of the 2H02 girder, 2H02A HARP, just before the first chicane magnet. Verify beam size is as expected. Adjust Quad doublets (MQA2H00.K1 and MQA2H00A.K1) to achieve required beam profile. Record beam skewness.
11. View beam spot with insertable OTR monitor and compare with the HARP measurement on beam skewness. If there is a significant skewness, use the 2H01 skew quad to correct it.

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

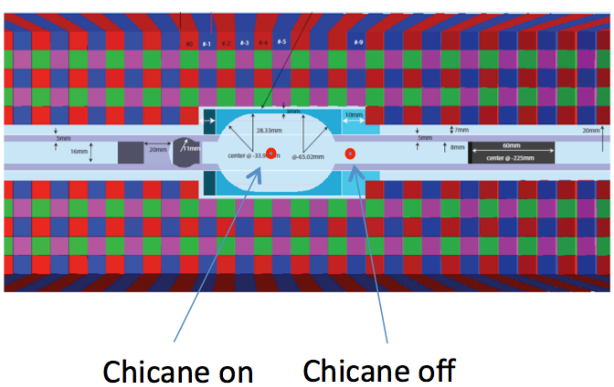


Figure 1 Beam positions at the upstream face of the ECal vacuum chamber.

Vertical centering in Ecal vacuum chamber

1. Beam current less than 5 nanoamps
2. Chicane magnets off.

3. ECal detector ON. Halo counters downstream of HPS ON.
4. Make sure that the rates on the top and bottom counters are roughly equal. If the rates are not equal, use the vertical corrector magnets on girder 2H00 (near tagger magnet) or 2H02 to correct. Verify beam is located appropriately at the dump.

Turning on the chicane magnets

1. Set chicane magnets to correct currents for beam energy and return beam to dump.
2. Verify position of beam at beam dump is still within tolerance.

Insert HPS production target – a quick over all check

1. Beam current 5 – 10 nA
2. Put 4μm 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 December run, and no anomalous hits are observed.
5. Put 8μm target in and make sure the rates scale with the target thickness.
6. Move the target vertically by ~0.5 mm and make sure the rates are stable.
7. Move the beam horizontally using the corrector 2H02, and make sure the rates are stable.
8. Put Carbon and Polyethylene targets and check the rates.

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

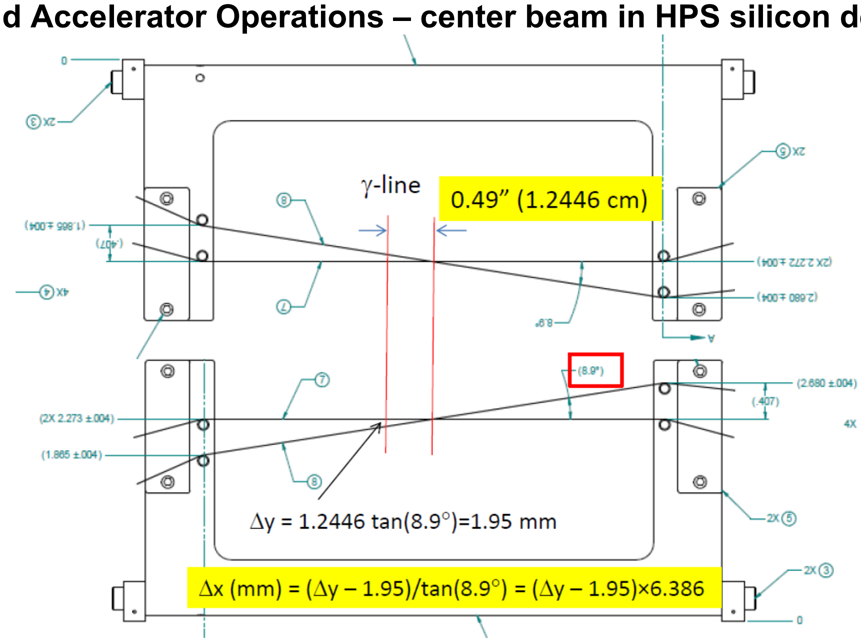


Figure 2 SVT Wires.

1. Beam current less than 5 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. Move **silicon detector wires** in silicon detector to **center of HPS silicon detector**.
6. Do wire scans. Each scan should cover both horizontal and tilted wires.
7. **Center beam vertically** on silicon detector wires by adjusting upstream vertical corrector magnets on 2H02.
8. Verify beam position is okay at the beam dump.
9. **Center beam horizontally** on silicon detector wires: adjust 2H02 horizontal corrector magnet to get beam at the correct horizontal position relative to the SVT and within tolerance at the dump (~1 mm).
10. Verify that the beam is still horizontally and vertically centered in Ecal vacuum chamber within acceptable limit. Verify that the beam is still located appropriately at the dump.
11. Insert HPS production target and verify the ECal and trigger rates are OK.
12. Verify the beam position is OK in the ECal, the photon line and the beam dump.

F) Position HPS Protection Collimator

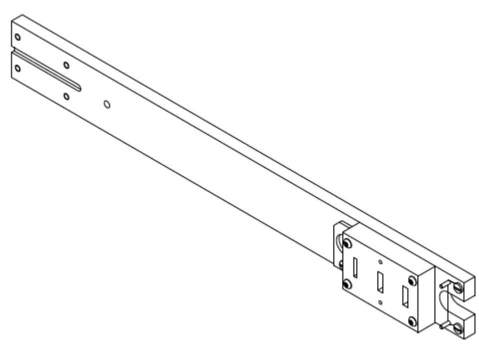


Figure 3 SVT protection collimator stick.

1. Find location of beam at **HPS protection collimator** with HPS Protection Collimator wire.
2. With beam off move HPS Protection Collimator ladder to have 3mm gap centered on beam.
3. Fine tune HPS PC vertical position by moving HPS Protection Collimator ladder up and down.

4. Move the collimator edge closer to the beam and study the trigger rates and the background level.

G) **Setup trip levels for BLMs and halo counters in FSD.**

1. HPS target is out.
2. Downstream halo counters ON.
3. Move the collimator closer to the beam and record current on BLMs and rates on downstream halo counters.
4. Set trip limits on BLM and halo counters in FSD such that FSD will be initiated when beam moves vertically from its nominal position more than 0.5mm.

H) **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 Fast Beam Shutoff 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 scalers, read and store rates of the halo counters and Ecal channels. 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

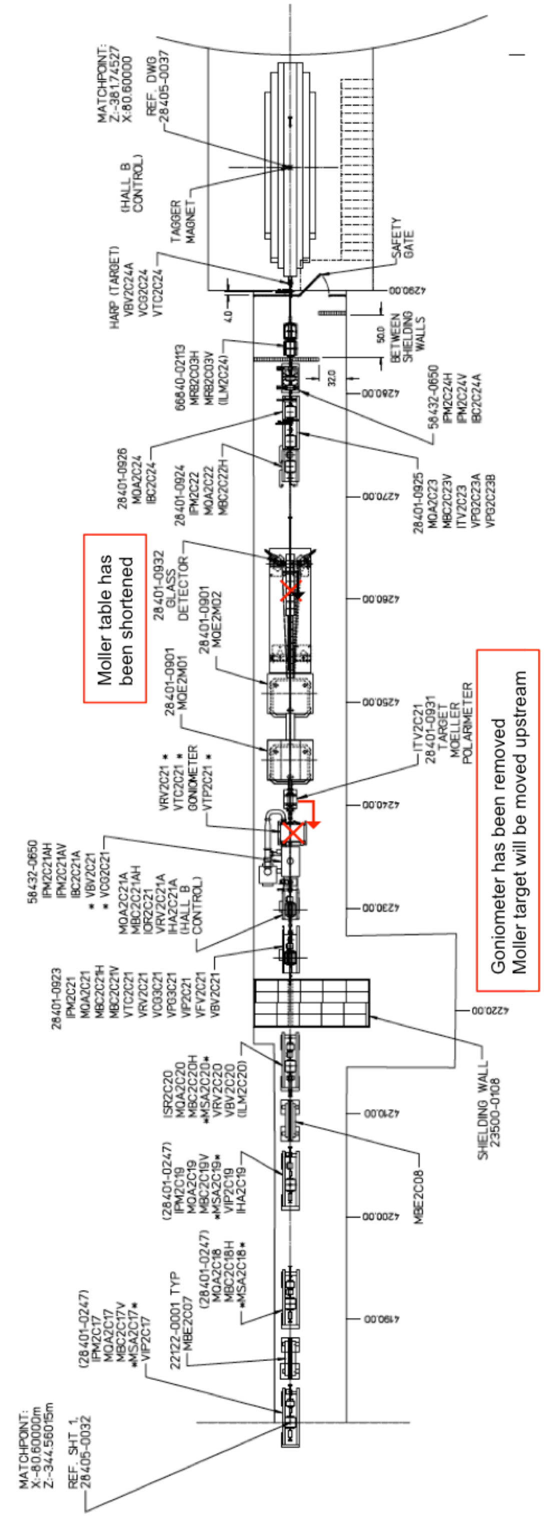


Figure 4 Upstream Tunnel

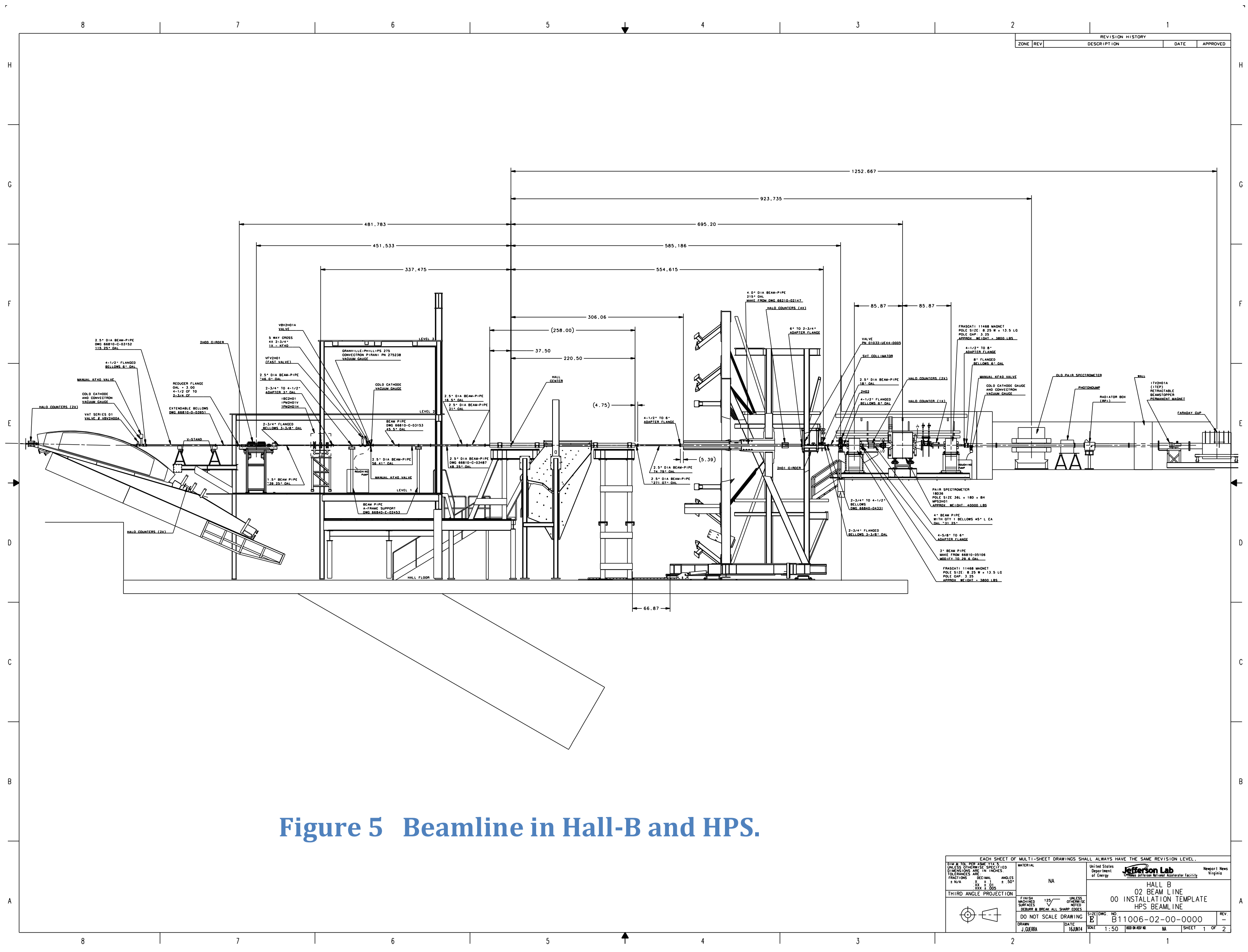


Figure 5 Beamline in Hall-B and HPS.