HPS beamline commissioning document v3.0

January 12, 2016

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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).

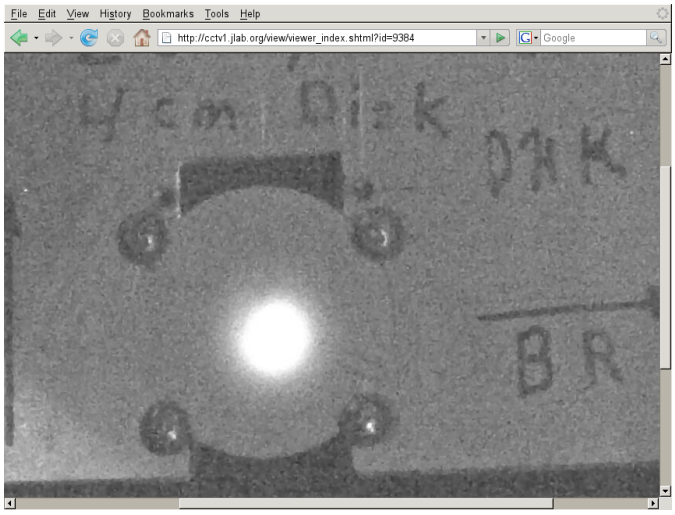
For location of beam line element please consult beamline drawings on Figure 4 **and** Figure 5 **in Appendix.**

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. Verify that beam delivery is interlocked with tagger magnet (set beam type "photon" on the control GUI).

Accelerator Operations:

4. Define the incoming trajectory of the beam.
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 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.

7. **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) **Silicon Detector**: Voltages off. Upper and lower moveable silicon detector elements fully retracted. Silicon detector cooling system on and temperatures monitored.
4) **HPS production Target** retracted out of beam path.
5) **Set 4 mm HPS Protection Collimator in place.**
6) **Ecal detector** voltages off with cooling, etc. operational.
7) **Beam halo counters** and other **beam diagnostic** instrumentation ON.
8) **Chromax beam viewer** is on
9) **Verify that the beamline vacuum is good.**

C) Beam to alcove and dump

1. Beam current 5 - 10 nA, high enough currents so that the nA BPMs are reliable.
2. Consider using CEBAF pulsed mode at 60 Hz for initial optics tuning.

Accelerator Operations:

3. **Bring beam through Hall B beam line** and HPS system in alcove to dump.
4. View beam on **Chromax beam viewer** downstream of the HPS.
5. Check that beam is roughly centered in SVT protection collimator by performing halo rate vs. y scan.
6. Measure the beam current on Faraday cup and compare with 2C21 and 2C24 nA BPM readings, should be the same within ~10%.
7. **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.
8. 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.
9. Ask MCC to calibrate stripline BPMs, 2H00 and 2H02. Beam current > 25 nA. After calibration ask to run orbit locks.

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

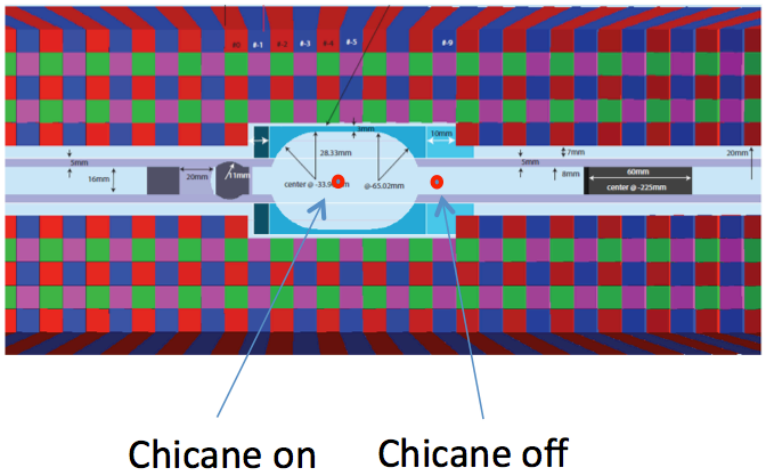


Figure 1 Beam positions at the upstream face of the ECal vacuum chamber.

Vertical centering in Ecal vacuum chamber

1. Beam current at least 25 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 ECals are roughly equal. If the rates are not equal, use the vertical corrector magnets on girder 2H00 (near tagger magnet) to correct. Verify beam is located appropriately at Chromax viewer.
5. Check alignment of the SVT collimator, and adjust collimator position if needed.

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.

Insert HPS production target – a quick over all check

1. Beam current 25 – 30 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 Spring 2015 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.

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

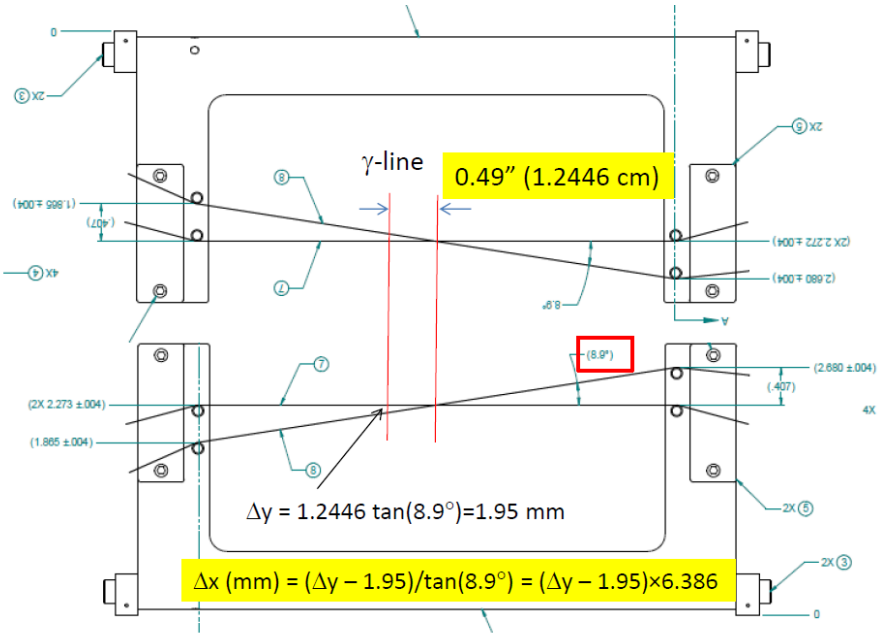


Figure 2. SVT Wires

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.

F) Position HPS Protection Collimator

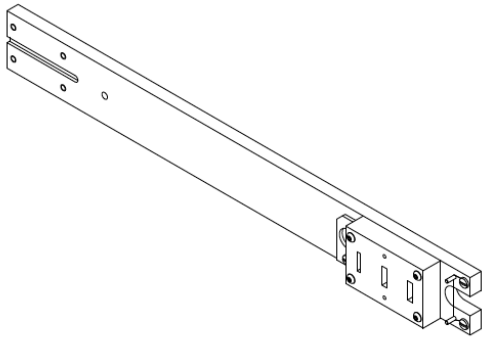


Figure 3. SVT Protection Collimator

1. Remove HPS production target
2. Find location of **SVT protection collimator** by scanning collimator vertically.
3. With beam off move HPS Protection Collimator ladder to have 2.82 mm gap centered on beam.
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).

G) **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× of normal rates.

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 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 scalers, 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

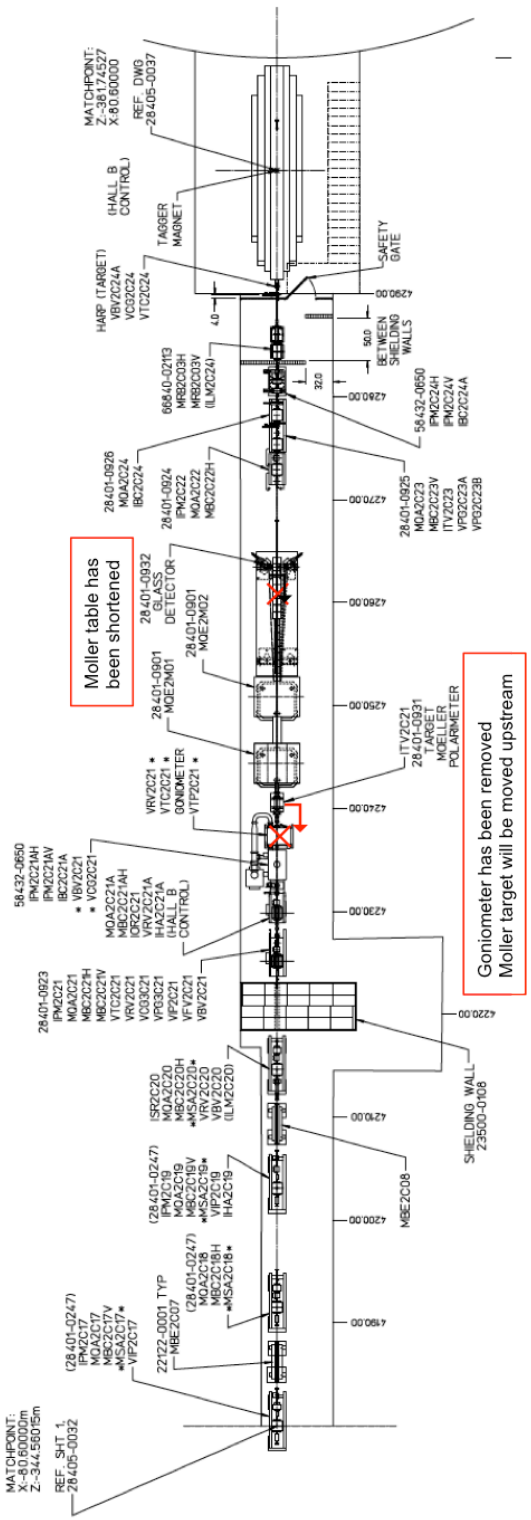


Figure 4. Beamline in the Upstream Tunnel

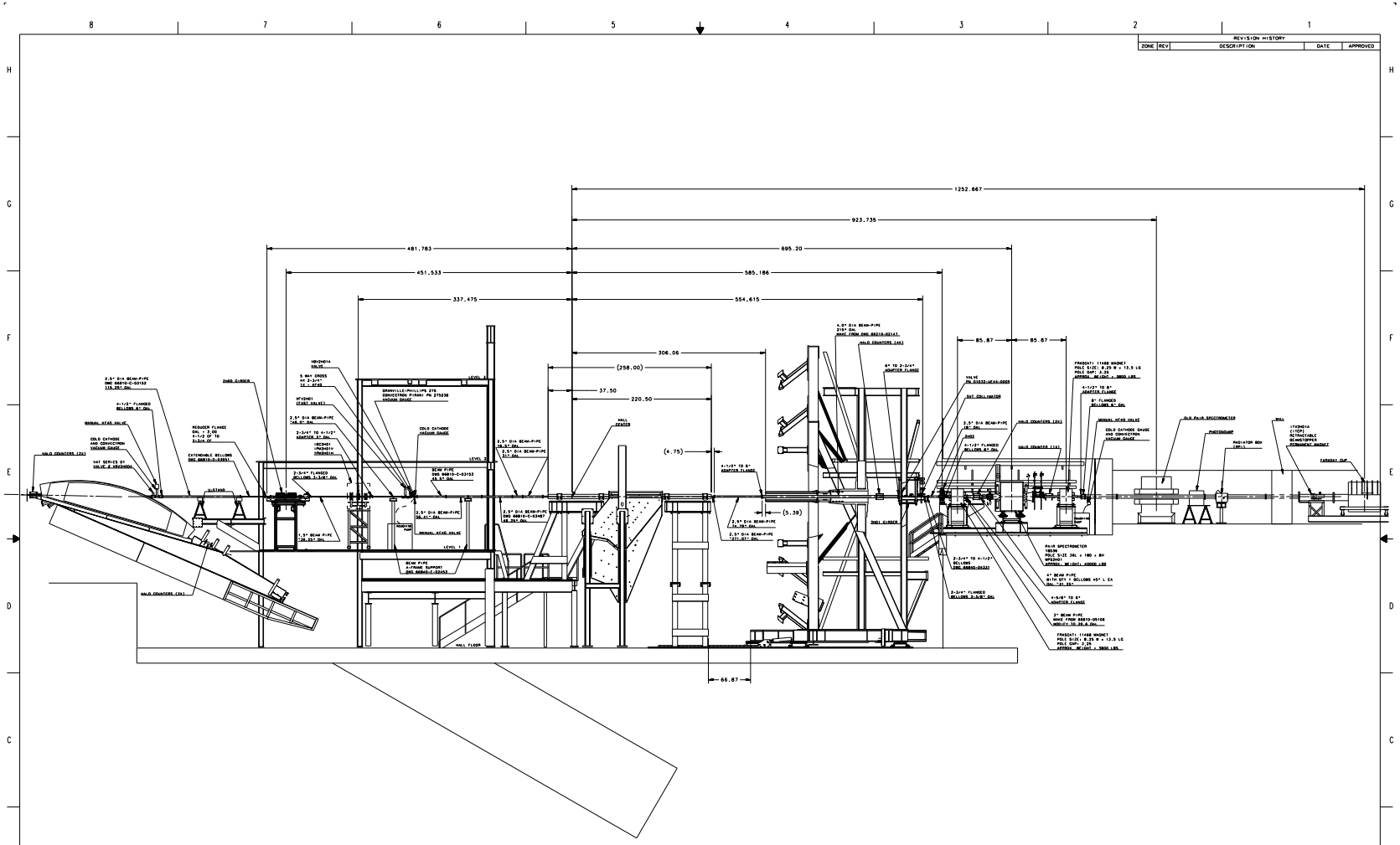


Figure 5. Beamline in the Hall