

FEL Procedure: Beam Transport Setup From Module to First Light Dump

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Estimated Time to Perform: 24 Hours (3 Shifts)

Procedure Overview

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The beamline with relevant diagnostics and correction elements is shown in Figure 1. The procedure assumes system setup into the energy recovery dump with module running beam at approximately 20 MeV. This procedure will bring the module up to full energy, thread the beam into the dump, check the orbit, finalize the module phases, and check/set the matching telescopes.

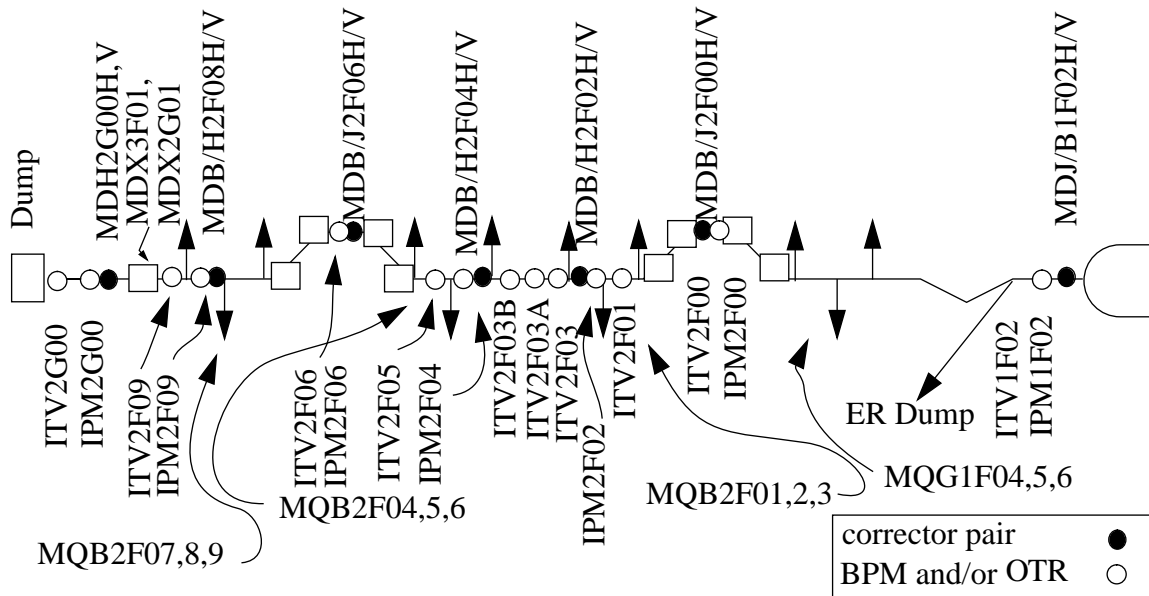


Figure 1: Schematic of transport to first light dump.

The procedure will use tune-up beam for all operations.

Prerequisites

1. Cryomodule setup procedure complete
2. Cavities and module phased at 20 MeV in energy recovery (ER) dump
3. 20 MeV beam in delivery to ER dump
4. Diagnostics and trims as in Figure 1; this version assumes a complete machine installation and certification that all components meet design specification.
5. Wiggler out
6. Download “First Light Setup Transport” magnet excitation settings **** (snap file name for file with dipole and quad excitations for first light transport at nominal energy, exclusive of reinjection chicane and main recirculator dipoles).
7. Verify main recirculator dipole string is standardized and that trim winding MDX2G01 on MDX3F01 is set to zero remnant field integral of DX3F01 and is standardized according to Karn protocol.

Procedure Steps



1.0 Full Energy Setup of Module

This step takes beam from the energy recovery dump, sets it to nominal energy, and directs it into the recirculator.

1. Shut off beam
2. Change reinjection chicane setpoint to required value for nominal energy, and standardize string
3. Increase cavity gradients to provide nominal energy gain from module - this is presently defined to be 38 MeV kinetic energy.
4. Beam on.

2.0 Initial Thread Of Beam to Dump

This step threads beam to the first light dump

CAUTION: Many components of the system (such as magnet pole pieces) are neither radiation nor heat tolerant. **Do not allow the beam to dwell in arbitrary locations for extended periods of time.**

CAUTION: Unlike most CEBAF applications, the diagnostic and corrector numbering in the following procedure is not necessarily sequential. Exercise care to steer to designated diagnostic using only the designated correctors, in the indicated order. Do not in any circumstances use the trim winding MDX2G01 for steering purposes. It is to be set using excitation curves only.

1. Verify beam is centered on ITV1F01A and IPM1F02. If needed, steer to center of ITV1F01A using MDJ1F00H and MDH1F00V. If view and BPM do not agree to ~1 mm, log error and CATER BPM problem. This will probably occur, as BPMs may not read properly until March 1998.
2. Using MDJ1F02H and MDB1F02V, steer beam to center of ITV2F00. If beam does not appear, vary energy in 1% steps using vernier cavity gradient from 10% below nominal to 10% above, and scan using these correctors. If beam still does not appear, call Principle investigator.
3. Cross check horizontal position of beam - verify that IPM2F00 reads 0 (to within ~1 mm) when beam is centered on ITV2F00. If not, log error and CATER BPM problem. See above comments about BPMs.
4. Verify beam is at least roughly centered in MQG1F03, 4 and 5. If not, steer to center through this triplet (by centering in MQG1F04) using MDJ1F02H and MDB1F02V.

CAUTION: Beam should remain on and more or less centered in ITV2F00 during this operation. If it is not, log error, CATER, and contact Magnet System Owner to investigate misalignment of reinjection chicane, upstream triplet, or optical cavity chicane elements.

CAUTION: If it is NOT possible to center in the quad while keeping the beam on ITV2F00, log error and contact Principle Investigator

5. Using MDB2F00H and MDJ2F00V, steer to center of ITV2F01 and IPM2F02. Verify both diagnostics give the same answer (to within ~1 mm). If not, log error and CATER BPM problem. Revisit above comments about BPMs.
6. Using MDB2F02H and MDH2F02V, steer to centers of ITV2F03, 3A, 3B, 4, and IPM2F04. Verify that IPM2F04 gives results consistent with being centered on OTRs (to within 1 mm). If not, log error and CATER BPM problem. Same BPM remarks.
7. Using MDB2F04H and MDH2F04V, steer to center of ITV2F06 and IPM2F06. Verify both diagnostics agree to ~1 mm. If not, log error and CATER BPM problem. Yaddah, yaddah, yaddah, BPMs.
8. Using MDB2F06H and MDJ2F06V, steer to center of ITV2F09 and IPM2F09. Verify both diagnostics agree to ~1 mm. If not, log error and CATER BPM problem.
9. Is IPM2G00 deemed trustworthy (i.e., can it be cal'ed and is there a meaningful check on the offsets)?

YES: Proceed as follows to thread beam to dump using IPM2G00

- a. Using MDB2F08H and MDH2F08V, steer to center of IPM2G00.
- b. Using MDH2G00H and V, steer to defined location on dump using ITV2G00. Execute dump setup procedure. Beam is now threaded to dump.



- c. Review values on MDB2F08H, MDH2F08V, MDH2G00H and MDH2G00V to verify that no orbit kinks have been created due to spurious readings on IPM2G00.
- NO:** CATER IPM2G00 and proceed as follows to thread beam to dump without using IPM2G00.
- a. Verify that MDH2G00H and V are set to zero field integral and standardized.
 - b. Using MDB2F08H and MDH2F08V, steer to defined location on dump using ITV2G00. Execute dump setup procedure. Beam is now threaded to dump.

3.0 Refined Phasing of Cryomodule

This step phases the cryomodule and sets the energy (if needed). Future updates should include use of Happek device for precision phase measurements following module.

1. Using IPM2F00/ITV2F00 and IPM2F06/ITV2F06 readings, crest cavities individually.
2. Using IPM2F00/ITV2F00 and IPM2F06/ITV2F06 readings, gang phase module.

CAUTION: Cavity steering may be an issue. To verify it is *not*, monitor readings on nondispersive location BPMS - IPM1F02, IPM2F02, IPM2F04, IPM2F09 - while varying phase to certify that beam does not move significantly during phasing (motions must be less than ~0.5 mm). If this is not the case, log observations and contact Principle Investigator. Precise phasing will not be possible if RF steering exceeds indicated tolerance; orbit lock using MDJ1F00H, MDH1F00V, MDJ1F02H and MDB1F02V, and nondispersive BPMs IPM1F02, IPM2F02, IPM2F04, IPM2F09 and IPM2G00 will be required.

3. Set cavity phases to **** (value established by Yunn/PARMELA).
4. Verify that beam is centered at all diagnostics. If not centered at undispersed locations 1F02, 2F01/2, 2F04/5, 2F08/9, and 2G00, resteer using MDJ1F00H, MDH1F00V, MDJ1F02H and MDB1F02V only to restore positions to center.
5. If not centered on ITV2F00/IPM2F00 and ITV2F06/IPM2F06, adjust vernier cavity pair gradients to recenter. Verify this does not steer beam on OTRs/BPMs outside of optical cavity chicanes. If it does, record observations, review cautionary remark in Step 3.2, and iterate Steps 3.4-5 until beam is centered on all diagnostics. In this iteration, steer using MDJ1F00H, MDH1F00V, MDJ1F02H and MDB1F02V and vernier cavity pair gradients only. If this does not converge after 3 iterations, record observations and call the Principle Investigator.

4.0 RESOLVE Measurements of Transport

This step certifies the lattice in preparation for beam properties measurements and setting of the matching telescopes



1. Execute RESOLVE measurement procedure on module to dump transport to obtain data for off-line study and certification of optics.
2. Verify dispersive behavior of chicanes is within tolerance (residual dispersions of order 1 cm or smaller)
3. Verify betatron oscillations of principle rays are within tolerance (TBD).
4. Verify momentum compaction of module to wiggler transport using Happek devices.

5.0 Beam Envelope Matching, Module to Wiggler Insertion

This step characterizes beam properties and sets the upstream telescope matching the cryomodule to the wiggler insertion. Future revisions should instruct how to fully characterize the longitudinal phase space at the wiggler and match it to FEL longitudinal acceptance by adjusting the injector and linac.

1. Measure emittance at wiggler insertion (ITV2F01 through ITV2F04) using emittance measurement procedure developed by Piot. Verify emittance is within tolerance; if not, call principle investigator.
2. Using results from above measurement, establish momentum spread using spot measurements at ITV2F00 and ITV2F06 and back-propagated emittance results. Measure bunch length using Happek devices before and after wiggler. Verify bunch compression occurs and that longitudinal phase space is within tolerance; if not, call principle investigator.
3. Using MQGF04 through MQB2F03, rematch beam to nominal transport values at wiggler insertion
4. Resteer using method outlined in Steps 1.1 through 1.10 of this procedure.
5. Repeat Step 4 to verify successful rematch.



6.0 Beam Envelope Matching, Wiggler Insertion to Dump

This step sets the downstream telescope matching the wiggler insertion to the dump.

1. Measure emittance on 2G00 dump leg using procedure developed by Piot
2. Using results from above measurement, establish momentum spread using spot measurement at ITV2F06 and back-propagated emittance result.
3. Using MQB2F03 through MQG2F09, rematch beam to nominal transport values at dump.
4. Resteer using method outlined in Steps 1.7 through 1.10 of this procedure.
5. Repeat Step 5.1 to verify successful rematch.