FEL TEST PLAN WORKSHEET

PROGRAM DEPUTY APPROVAL	COMPLETION INFORMATION
FEL Exp Coordinator Signoff: ________________ Date: _______	Completion Date: _____________
PI Reviewer Signoff: __________________ Date: ___________	Crew Chief/PI Signoff: ____________________________
Expiration Date (max. 90 days from approval): _____________	Comments (partial completion, etc.):
Presentation Required? ❑ yes ❑ no	☐

NOTE: Information addressing the appropriate content of each of the following sections can be found in Section 2.0 of the Test Plan Instructions.

Test Plan Title: **Rough Injector Setup**

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Revision Number: Rev. 3, 9/23/97

Brief Purpose of Test

Initial setup of machine from front flange of injector cryounit to front flange of cryo-module

Anticipated Benefits

Beam Conditions Required

Complete all of the following tables, entering a value or an **X** in the appropriate spaces:

Beam Type/Current (enter value)

Beam Type	Beam Current
Beam Off	
Pulsed (std. current = 1 μA)[a]	x
CW	

a. The standard current for pulsed beam operation is 1 μA. If your test requires pulsed beam current >1 μA, then specify the required current and provide a brief explanation next to the specified current.

Beam Energy (select one)

Beam Off	350 keV	10 MeV	42 MeV	Energy Recovery dump
		x		

Beam Termination Point (select one)

Inj Dump	ER Dump	Straight Ahead Dump	Other (specify)
x			

Type of Test (select one)

Invasive (disrupts beam delivery)	Non-invasive (does not disrupt beam delivery)
x	

Time Required

8 hours

Preferred Time of Test

dayshift

Staff Required to Execute the Test (including contact info)

Legg / Douglas

Controlled Access Requirements

None scheduled

Hardware and/or Software Changes Required

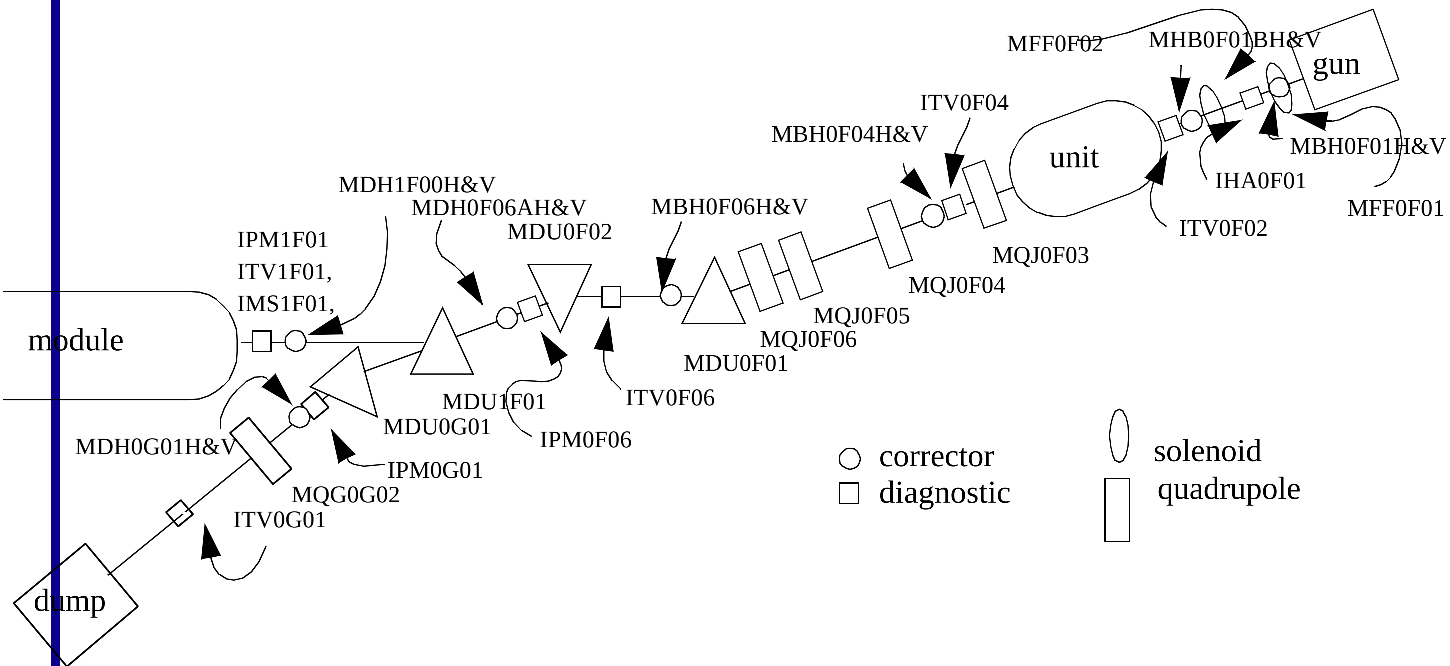
NOTE: If software changes are part of the test plan, include the name of the application, the old revision level, the new revision level, and if applicable, whether or not it is possible to roll back to the old revision level (are there hardware limitations, etc.).

None

Setup Procedure

1. Beam to IHA0F01 with appropriate pulse structure
2. Unit with RF on idle
3. Magnets appropriately powered for transport to 10 MeV dump (verify MDU1F01 switched out, MDU0G01 switched on, quads downloaded).
4. Appropriate valves open, valve upstream of module closed

Test Procedure



1.0 Beam Through Unit

1. Verify proper beam position at IHA0F01, or, if new setup, center beam in solenoid MFF0F01.
2. Steer to center of ITV0F02 using MBH0F01H & V.
3. Center beam in solenoid MFF0F02 using MBH0F01H & V. Note that this may leave beam uncentered in buncher, the consequencs of which must be discussed. Beam centering in MFF0F01 and MFF0F02 is used to define “straight line” injection into the unit.
4. Thread beam through unit to center of downstream viewer ITV0F04 using MHB0F01BH&V
5. Power up 1st cavity, dial phase to restore beam to viewer; resteer with MHB0F01BH&V
6. Power up 2nd cavity, dial phase to restore beam to viewer; resteer with MHB0F01BH&V
7. Use transient phasing procedure to transient phase unit.
8. Modulate unit RF phase or laser phase and center in unit using MBH0F01H & V and MHB0F01BH&V.
9. Turn off RF or laser modulation
10. Cross-check beam position on IHA0F01, ITV0F02, and ITV0F04, (recheck centers in MFF0F01 and MFF0F02) noting if the beam has moved from any center of either during Step 7. This indicates an alignment problem with either the beamline or the unit.

2.0 Beam into injection line

1. Thread beam to ITV0F06 using MBH0F04V and by varying unit RF gradiants in 0.1 MV/m steps to steer beam horizontally at dispersed location. These 1% changes in energy will move the beam horizontally ~5 mm per step at ITV0F06, where the dispersion is ~0.5 m. (This step fiducializes the energy to the excitation of dipole MDU0F01.)
   a. When the beam appears at ITV0F06, center it by adjusting the unit gradiants. Aperture scan horizontally using MBH0F04H, and center beam in any upstream aperture constrictions with MBH0F04H, while holding beam fixed at ITV0F06 by adjusting the unit gradiants. (This is to avoid “clipping the corner” at MDU0F01). When completed, proceed to 2.
   b. If the beam fails to appear at ITV0F06, there is a steering error/energy mismatch - probably at MDU0F01. Grid search for the beam by scanning the aperture using MBH0F04H&V while stepping the unit gradiants from ~8 MV/m to 12 MV/m in 0.1 MV/m steps. BLMs may provide useful guidance in this activity. When beam is found, proceed to 2.
2. Center in MQJ0F05/4 using MBH0F04H&V. After centering in the quad, return beam to horizontal center of ITV0F06 by adjusting unit gradiants; return beam to vertical center by adjusting MBH0F06V.
3. Verify that beam has appeared at IPM0F06.
4. Aperture scan chamber at IPM0F06 using correctors MBH0F06V&H to fiducialize/calibrate IPM0F06.
5. Roughly crest RF cavities/gang phase unit using dispersed beam reading on IPM0F06 or ITV0F04 at MDU0F02. The dispersion at this point is ~0.5 m. If position has shifted after cresting, adjust unit gradiants to restore beam positions and thereby match beam energy to dipole excitations.

3.0 Beam to dump

1. Using MDH0F06AV & H, thread beam to IPM0G01 .
2. Aperture scan chamber at IPM0G01 using MDH0F06AV & H to fiducialize/calibrate IPM0G01 .
3. Thread beam to ITV0G01 and beyond to dump using MDH0G01H&V. Center beam on ITV0G01 and at the dump with MDH0G01H&V. If this cannot be done, it implies the orbit is not leaving MDU0G01 parallel to the beamline axis, possibly due to one of the following:
   a. spurious reading on IPM0F06 and/or IPM0G01
   b. dipole string excitation errors, causing mismatch amongst MDU0F01, MDU0F02 and MDU0G01
   c. alignment errors in the beamline.

   Record all observations for off-line analysis.
4. Center beam in MQG0G02 using MDH0F06AH&V. Note if beam has moved on ITV0G01 or at the dump. This indicates the orbit is moving parallel to the beamline axis through the quad, possibly due to one of the following:
   a. spurious reading on IPM0F06 and/or IPM0G01
   b. dipole string excitation errors, causing mismatch amongst dipoles MDU0F01,

MDU0F02 and MDU0G01

c. alignment errors in the beamline.

Record all observations for off-line analysis.

5. With beam on ITV0G01, verify MQG0G02 is set for high-dispersion mode and accurately crest cavities and gang-phase the unit.

4.0 Set Cryomodule Energy Gain

1. Check for any systematic offsets of MBH0F06H/MBH0F06AH/MDH0G01H, indicating energy mismatch.
2. Adjust cavity gradients to reduce average corrector excitation to zero.
3. Verify orbit has not changed following gradient adjustment. A change is indicative of an alignment error in beamline or unit, or dipole/energy mismatch. Record observations for off-line analysis.

5.0 Measure Emittance

1. Set MQJ0F03 to zero Bdl for emittance measurement mode.
2. Measure emittance using multi-slit IMS0F03 and emittance measurement procedure.
3. Re-match beam envelopes and reset MQJ0F03,4,5 and 6 to provide design values for injection.

6.0 Measure Momentum Spread

1. With emittance data in hand and beam envelopes rematched, (and, having verified above that MQG0G02 is set to high dispersion mode), measure momentum spread, and verify RF phases.

7.0 Beam to Module

1. Shut beam off
2. Close injection dump line valves, open valves through cryomodule
3. Verify cryomodule RF on idle
4. Power down dipole string; switch direct bend MDU1F01 in and reverse bend MDU0G01 out.
5. Standardize dipoles
6. Turn beam on
7. Thread beam to ITV1F01/IPM1F01 using MDH0F06AV & H. Do not dawdle.
8. Thread beam through module to next diagnostic using MDH1F00H&V. Do not dawdle. Use cryomodule setup procedure to transport beam to energy recovery dump.

8.0 Comments

When transport of 10 MeV beam to energy recovery dump is accomplished, the Cryomodule Setup Procedure will review certain final details of the injection line setup.

These are as follows:

1. Aperture scan of chamber with MDH0F06AV&H to verify OTR and BPM fiducialization/calibration, alignment of beamline from MDU0F02 through injection point, and excitation of injection line dipoles
2. Beam emittance at injection point by repeating emittance measurement with IMS1F01
3. Bunch length at injection point using ITV1F01
4. Momentum spread measurement in energy recovery dump line
5. Measurement of injection line M_{56}. Note well that errors in this parameter are due to hardware problems and can be corrected only in hardware. If this is not possible, they must be compensated by changes in the injector operating point.

If steps 2 or 3 indicate a problem, the injector can be further optimized with beam transported to the energy recovery dump. Emittance measurements/rematches can be performed using IMS1F01; if precision momentum spread measurements are needed, they can be accommodated in the energy recovery dump.

Backout Procedure

1.

Test Results

Proceed with Injector Fine Setup Procedure.