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A Procedure to Center in the Beampipe Before the Cryounit Using Pressure Rise

Stephen Benson, April 20, 2011

Though the injector setup procedure tries to center in the electron beam optical elements before the injector cryounit, there are often losses in the transport from the gun to the cryounit for high charge beams. These may be due to asymmetric transverse distributions or a misalignment of the beam pipe with respect to the optical elements. This procedure uses the loss of the beam in the gun region to center the beam in the beam pipe to minimize loss.

Inputs: It is assumed that the the injector setup procedure has already been run and that the operators have done as good a job as possible in centering in the electron beam optical elements in the injector:

1. While running tune-up beam, verify that the beam is "centered" in the cryounit (this means it does not steer the beam at 1F01 when the laser/buncher gang phase is changed by +/- 5 degrees) and centered in the last two quadrpoles after the cryounit.
2. Perform a mini-phase procedure.
3. Verify that loss-less beam can be run to the 1G dump.
4. Set up strip charts to monitor the pressure in between the gun and the cryounit (make sure that the UHV pressure monitor is on this chart as well).
5. Turn on full charge CW beam to 1G dump. Note the pressure rise in the region aftter the gun. ~~3.0-7~~ 3.0 - 9.3
6. Lower the charge to half of full charge and raise the repetition rate to 9.37 MHz. See if the pressure rise is larger or smaller. If it is the same the problem is not with the steering. 4.3 - 2.9
7. Switch back to 4.68 MHz beam at full charge. Measure the pressure rise vs. charge as the charge is varied by +/- 20 %. Record this. 4 → 12.0 → 3.2
8. With the charge at 135 pC, zero the BPMs.
9. Change the first gun corrector (0F01) by a couple G-cm. Use the next two correctors to rezero the trajectory after the unit. See if the pressure goes up or down. If it goes down, keep going that direction until no change in pressure is seen. If it goes up, switch directions and move until no change in pressure is seen.
10. Repeat step 9 with the other axis of the first corrector.
11. When both axes are optimized, remeasure the pressure vs. charge as in step 7.
12. Perform an allsave.

+ 7.7 → 3.2

14 Appendix 5

Rough phasing cavity 3 This procedure is a quick check or a way of recovering the phase of cavity 3 if it has been grossly disturbed.

14.1 Set cavity 3's phase difference from cavity 4's phase the same as in the last setup (this phase difference has been very stable).

14.2 Again, adjust the DL/B gang phase to approach the correct spot on ITV0F04 per Appendix 1.

14.3 Extract ITV0F04.

14.4 Inert ITV0F06.

14.5 If spot is missing, go to Appendix 4.

14.6 Reestablish spot on ITV0F06.

14.7 Record original FELINJ field integral.

14.8 Raise or lower FELINJ in 10G-cm steps (wait for slow EPICS update rate) until spot appears on ITV0F06.

14.9 Adjust beam centroid to be centered horizontally using FELINJ and vertically to about 1/3 from the top using MVT0F04AV.

14.10 Go to 5.5.

14.11 Dither phase of cavity 3 more negative (say between 20°-60°) and back. Start in 2° steps and count button clicks.

14.12 Centroid of spot should go off the screen to the left and come back to the same place.

14.13 Crest of cavity 3's phasing is half way between the phases of the two end values.

14.14 Set cavity 3 20° positive from this crest.

14.15 Reposition the spot to the horizontal center of ITV0F06 by altering the FELINJ bus value.

15 Appendix 6

Alternative method for centering in the second solenoid (MMF0F02)

15.1 Move the solenoid strength in the same direction as the sign of the nominal value to focus the beam spot on ITV0F02 to its minimum size and record the position of the centroid on the viewer.

15.2 Then restore the solenoid strength to its nominal value and use the MBH0F01A correctors to position the center of this larger spot on the location of the focused spot.

15.3 Double check by repeating the procedure and making sure the center of the focused spot is in the same place as the center of the larger spot with the nominal setting.

9.8 Take a Happek scan and record as part of the FLOG.

10 Appendix 1

List of views and Information

ITV0F02 Typical ceramic beam viewer view

ITV0F04 Typical OTR view

ITV0F06 Typical OTR view

1st M55 Cavity Longitudinal phase space depicted in the response of the M55 cavity.

2nd M55 Cavity Longitudinal phase space depicted in the response of the M55 cavity.

Multislit Horizontal and vertical transverse phase space.

ITV1F00 Typical OTR view (with or without beam recirculation).

11 Appendix 2

Buncher zero crossing by Transient Phasing

11.1 Look at the Buncher GASK signal on a TEK scope. Use 50μsec per division.

11.2 Approximate zero crossing is obtained when the areas, within the pulse width interval, above and below the abscissa are the same.

12 Appendix 3

With the loss (in the controls) of phase relationships between cavities 3 and 4 – reestablishing a spot on ITV0F04.

12.1 Change the DL/B gang phase in 10° steps, first to +180° then to -180° from the starting phase position while attempting to find a spot on ITV0F04.

12.2 If no spot is found, repeat the change above, but dither the phase of cavity 3 through ±180° for every 10° change of the DL/B.

12.3 Be mindful of RF trips from backward accelerating cavities.

12.4 Record new phase values as part of FLOG.

12.5 If no spot is found, call System Owner.

13 Appendix 4

To find spot on ITV0F06

13.1 Dither the DL/B gang phase ±15° in one degree steps.

13.2 If spot still doesn't appear, set DL/B phase to original phase angle and dither the phase of cavity 3 through ±15° in small steps.

13.3 If spot doesn't approach shape, phase of Section 8 will restore it.

13.4 If spot doesn't appear, call System Owner.

8.10.12 Adjust beam to center of MQJ0F06 using the MDB0F05 correctors.

8.10.13 Twiddle restore or restore the recorded field for MQJ0F06.

8.10.14 Close drive laser operator shutter. Place MQJ0F06 on hysteresis. Open drive laser operator shutter.

8.10.15 Record the field values of the MBH0F03 and MDB0F05 correctors as part of the FLOG.

8.10.16 Extract ITV0F06.

8.11 Zero the Cryounit's gang phase.

8.11.1 Incorporate the gang phase of the DL/B by adding the gang phase to the drive laser phase and the Buncher phase and bring the gang phase to zero.

8.11.2 Record the new phases as part of the FLOG.

8.12 Assure a low value for MDB1F01H corrector and center beam in Cryounit through IPM0F06A.

8.12.1 If corrector MDB1F01H is set less than or equal to 200G-cm go to Section 9.

8.12.2 Otherwise, observe ITV1F02. Set corrector to 80G-cm.

8.12.3 Center beam in viewer by using the MDB0F06 correctors.

8.12.4 Observe ITV1F00.

8.12.5 Center beam in viewer by using the MDB0F06A correctors.

8.12.6 Zero the beam in absolute horizontal IPM0F06A by first adjusting the MBH0F06H corrector.

8.12.7 Go back to the start of this section for several cycles until setting the MBH0F06H corrector allows horizontal centering on both ITV1F02 and absolute horizontal IPM0F06A.

8.12.7.1 If this can't be achieved, substitute a change in the FELINJ field integral for the final adjustment in the MBH0F06H corrector.

8.12.8 Record the field values for the correctors and, if changed, the new FELINJ field integral as part of the FLOG.

8.13 FLOG a WesCam image for ITV0F04 and ITV0F06.

9 Final checks and hand-off to recirculation

Note: most of this section is only required in extreme cases of machine recovery. Skip to 9.7 for a Happek scan.

9.1 Verify that the betatron phase advance in the Linac agrees with the spreadsheet model.

9.1.1 If not, change the quad values until it does.

9.2 Take a series of WesCam images of the spot sizes on the Linac viewers (ITV1F02 through ITV2F06).

9.3 Fit the images to find the best fit to the spreadsheet model.

9.4 Use the spreadsheet model to adjust MQJ0F05 and MQJ0F06 to get the best match to the Linac.

9.5 Reload the 2F through 5F magnet settings from a good All-Save.

9.6 Optimize the phase of the Linac sections so that they are the correct angle off crest.

9.7 Insert ITV4F03 and observe the Happek signal. Optimize the signal using the MQT2F07 and MQT2F09 trim quads and sextupoles. Verify that there is no high energy tail on the distribution visible at SLM5F02.

9.7.1 If there is a tail, increase the trim quads until it disappears.

8.7.12 Reestablish relative horizontal IPM1F01 and IPM1F03 spikes back to zero using the correctors. Use:

- MBH0F03H delta = +75G-cm.
- MDB0F05H delta = -46G-cm.
- MVT0F03V delta = +6G-cm.

8.8 Check phase of cavity 3.

8.8.1 Set the DL/B gang phase to the crest phase equivalent to cavity 4 crest phase as found in 8.7 (or to zero, if IPM0F06A was within tolerance on the first round).

8.8.2 Zero the DL/B gang phase.

8.8.3 Set cavity 3 to the latest "Running Phase" (20° off crest) as determined in 8.3.

8.8.4 Increase cavity 3's gradient by 1/Cos20°, 1.0642, to correct the energy.

8.8.5 Reestablish relative horizontal IPM1F01 and IPM1F03 spikes back to zero using the correctors. Use:

- MBH0F03H delta = -75G-cm.
- MDB0F05H delta = +46G-cm.
- MVT0F03V delta = -6G-cm.

8.8.6 If the above relative horizontal BPM spikes are not zeroed, further adjust the above magnet values.

8.8.7 If needed, adjust cavity 3 gradient to zero energy at IPM0F06A absolute.

8.8.8 Record actual field values as part of the FLOG.

8.8.9 Iterate back through 8.2.6.

8.9 Move cavity 3 to its "Running Phase" (usually +10° off crest).

8.9.1 Use the MBH0F03H and MDB0F05H correctors to zero the trajectory (deltas=3/4 of the deltas from 8.2).

8.9.2 Change the cavity 3 gradient to zero the horizontal position at IPM0F06A absolute.

8.10 Check centering in Cryounit and through the telescope quads.

8.10.1 Set cavity 3 to latest "Running Phase" as determined in 8.3.

8.10.2 Perform the re-centering in the Cryounit per Section 4 as a check.

8.10.3 Twiddle restore or restore the recorded corrector values saved in 7.6 to remove the temporary orbit established in Section 8.1.

8.10.4 Insert ITV0F06A.

8.10.5 Take quads MQJ0F05 and MQJ0F06 off hysteresis.

8.10.6 Twiddle save or record the integral field gradient values of the quads.

8.10.7 Dither field of MQJ0F05 ±200G-cm.

8.10.8 Adjust beam to center of MQJ0F05 using the MBH0F03 correctors.

8.10.9 Twiddle restore or restore the recorded field for MQJ0F05.

8.10.10 Close drive laser operator shutter. Place MQJ0F05 on hysteresis. Open drive laser operator shutter.

8.10.11 Dither field of MQJ0F06 ±200G-cm.

8.4.3 Decrease cavity 3's gradient, GSETnew = GSET * (Cos20°). Cos20° = 0.9397.

8.4.4 Correct orbit (zero IPM1F01 and IPM1F03 using the MBH0F03H and MDB0F05H correctors).

8.4.5 If needed, adjust cavity 3's gradient to zero energy at IPM0F06A absolute.

8.5 Assume cavity 4 is at nominal crest.

NOTE: since cavity 4 is the "anchor" for the phase numbers and hence its phase number remains a constant, we change its phase by altering the Drive Laser/Buncher (DL/B) gang phase.

8.5.1 Record the DL/B gang phase equivalent to cavity 4 crest phase.

8.5.2 Add 10° to the phase of cavity 4 by subtracting 10° from the DL/B gang phase.

8.5.3 Reestablish relative horizontal IPM1F01 and IPM1F03 spikes back to zero using the correctors. Hint (these deltas also accommodate cavity 3 being on crest):

- These deltas are delta/2 from 8.3.
- MBH0F03H delta = +75G-cm.
- MDB0F05H delta = -46G-cm.
- MVT0F03V delta = +6G-cm.

8.6 Adjust phase of cavity 3 to find it's crest.

8.6.1 If needed, adjust cavity 3's gradient to zero energy at IPM0F06A absolute.

8.6.2 Record the DL/B gang phase, call it Theta 1 (should be -10°).

8.6.3 If the relative horizontal BPM spikes are not zeroed, further adjust the above magnet values.

8.6.4 Record actual field values as part of the FLOG.

8.7 Establishing -10° off crest.

8.7.1 Zero the relative BPMs. This zeros the relative horizontal IPM0F06A reading.

8.7.2 Flog the phase of cavity 4 to -10° off crest by adding 20° to the DL/B gang phase.

8.7.3 Reestablish relative horizontal IPM1F01 and IPM1F03 spikes back to zero using the correctors. Use:

- MBH0F03H delta = -75G-cm.
- MDB0F05H delta = +46G-cm.
- MVT0F03V delta = -6G-cm.

8.7.4 If the above relative horizontal BPM spikes are not zeroed, further adjust the above magnet values.

8.7.5 Record actual field values as part of the FLOG.

8.7.6 Go to 8.8 when relative horizontal IPM0F06A absolute is less than 0.25mm (cavity 4 is phased correctly).

8.7.7 If IPM0F06A is not within the above tolerance, zero the relative horizontal IPM0F06A by adjusting the DL/B gang phase while maintaining the horizontal orbit at zero.

8.7.8 Record the adjusted DL/B gang phase, call it Theta 2.

8.7.9 Calculate and record the DL/B gang phase equivalent to cavity 4 crest phase as, (Theta1+Theta2) / 2.

8.7.10 Subtract 10° from the DL/B gang phase equivalent to cavity 4's crest phase.

8.7.11 Reset the DL/B gang phase to the above value (sets cavity 4 to +10° off crest).

Cos10° = 0.9848 and Cos20° = 0.9396.

- Steering in the following order using MVT0F03V to zero IPM0F06A, MBH0F03H for IPM1F01, and MDB0F05H for IPM1F03.

8.2.5 Correct energy (zero absolute IPM0F06A) with cavity 3 gradient, GSETnew from above.

8.2.6 Zero relative BPM spikes. Cavity 3 should be now at +20° off crest.

8.2.7 Change the phase of cavity 3 by -40°. Cavity 3 is now ~ -20° off crest.

8.2.8 Establish the original orbit by adjusting the relative horizontal IPM1F01 and IPM1F03 spikes back to zero using the correctors. Use:

- 0F03H delta = +149G-cm.
- 0F05H delta = -92G-cm.
- MVT0F03V delta = +12G-cm.

8.2.9 If the above relative horizontal BPM spikes are not zeroed, further adjust the above magnet values.

8.2.10 Record actual field values as part of the FLOG.

8.2.11 If relative horizontal IPM0F06A is less than 0.25mm, the "Running Phase" of cavity 3 was +20°.

- If the crest of cavity 4 has been determined already in 8.6, go to 8.9. Otherwise go to 8.4 to phase cavity 4.
- If the relative horizontal was greater than 0.25mm, continue to find the correct phase.

8.3 Adjust phase of cavity 3 to find it's crest.

8.3.1 Adjust phase of cavity 3 until relative IPM0F06A is zero white maintaining relative horizontal IPM1F01 and IPM1F03 at zero using the horizontal MBH0F03H and MDB0F05H correctors.

8.3.2 If the corrector values changed, record the change on the FLOG.

8.3.3 Record this negative side phase of cavity 3. Call it "Phi".

8.3.4 Calculate and record the new cavity 3 crest phase, CRESTnew = (RunningPhase + Phi) / 2.

8.3.5 Set cavity 3 to the new "Running Phase", RunningPhase = CRESTnew + 20°.

8.3.6 Reestablish relative horizontal IPM1F01 and IPM1F03 spikes back to zero using the correctors. Use the opposite of the deltas used earlier:

- MBH0F03H delta = -149G-cm.
- MDB0F05H delta = +92G-cm.
- MVT0F03V delta = -12G-cm.

8.3.7 Record actual field values as part of the FLOG.

8.3.8 Correct the energy by zeroing IPM0F06A absolute with cavity 3 gradient.

8.3.9 Zero relative BPM spikes.

8.3.10 Go to 8.2.7 for an iteration.

8.4 Phase cavity 4.

8.4.1 Place cavity 3 on crest by subtracting 20° from the new "Running Phase" determined in 8.2.

8.4.2 Correct orbit (zero IPM1F01 and IPM1F03 using the MBH0F03H and MDB0F05H correctors).

6.12 Close drive laser operator shutter. Place MQJ0F06 on hysteresis. Open drive laser operator shutter.

7 Thread beam through Cryomodules

7.1 Restore relative BPM values and consult the relative BPM screen for injector setup or the present All-Save for that purpose.

7.2 Adjust the cavity 3 gradient to center the beam horizontally on ITV0F06.

7.3 Adjust the MDB0F06A correctors to center on the correct spot on ITV1F01 (the correct position is determined using alignment HeNe).

7.4 Adjust the MDB1F01 correctors to center the beam in the quads after zone 2. Use viewer ITV1F03.

7.5 Adjust the MDB1F03 correctors to center the beam in the quads after zone 3. Use viewer ITV1F04.

7.6 Adjust the MDB1F01A correctors to center the beam on the correct spot on ITV1F04A (again determined by the alignment HeNe). ↑ MDB1F04A ? MDB1F04 ?

7.7 Zero the BPMs and do an All-Save. This is the new setup for the injector phasing.

8 Setting the phases of cavity 3 and 4 by using IPM0F06A, IPM1F01, and IPM1F03 – The Spectrometer Method

The Injector Phasing Script automatically processes sections 8.1 through 8.9. Run the script and go to 8.10.

NOTE: Record all the FLOG information below in one FLOG, differentiating the various reading by the section number that called for them.

8.1 Setup a temporary orbit through the Cryounit.

8.1.1 Open relative BPM spike screen.

8.1.2 Use twiddle save to capture the values of (or record) the horizontal correctors at MBH0F03, MDB0F05, and MBH0F06.

8.1.3 Establish the new orbit.

- MBH0F03H delta = -80G-cm
- MDB0F05H delta = +88G-cm
- MBH0F06H delta = -50G-cm

8.1.4 This should almost zero the relative horizontal spikes at IPM1F01 and IPM1F03. If not, use MBH0F03H and MDB0F05H to zero the orbit.

8.1.5 Record actual field values as part of the FLOG referring to this section.

8.2 Find crest phase of cavity 3.

8.2.1 Zero the BPM rels.

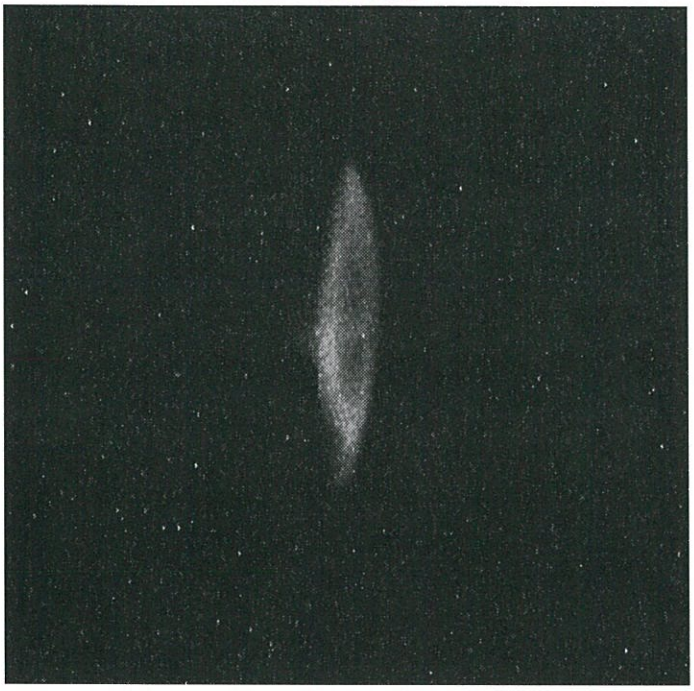
8.2.2 Record the cavity 3 phase as the latest "Running Phase". This running phase is typically +10° off crest. Cavity 3 needs to be at +20° off crest for phasing.

8.2.3 Add 10° to the latest running phase of cavity 3. Cavity 3 is now ~20° off crest.

8.2.4 Correct the orbit by:

- Adjusting cavity 3's GSET by the expected energy change, GSETnew=GSET*(Cos10°/Cos20°).

5.5 Adjust the cavity 3 phase until the beam is centered horizontally on ITV0F06. Beam may be high because of mis-steering in the Cryounit. Adjust down with MBH0F03V. MVT0F03V



ITV0F06. The beam should be in the center of the viewer. This can be easily determined if the viewer lamps are turned on.

5.5.1.1 If beam is seen on ITV0F06, go to Section 6.

5.5.1.2 Otherwise, see Appendix 4 to correct before continuing.

6 Center in the last two quads of the telescope (MQJ0F05 and MQJ0F06)

6.1 Continue to look at the beam on IPM0F06A.

6.2 Take quads MQJ0F05 and MQJ0F06 off hysteresis.

6.3 Twiddle save or record the integral field gradient values of the quads.

6.4 Dither field of MQJ0F05 100G-cm.

6.5 Adjust beam to center of MQJ0F05 using the MBH0F03 and MBH0F05 correctors.

6.6 Twiddle restore or restore the recorded field for MQJ0F05.

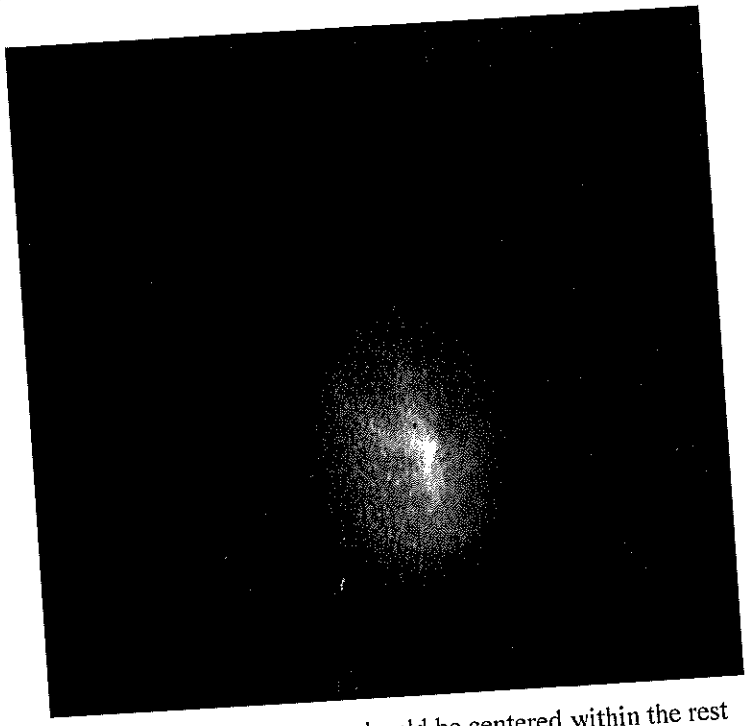
6.7 Close drive laser operator shutter. Place MQJ0F05 on hysteresis. Open drive laser operator shutter.

6.8 Dither field of MQJ0F06 ±50%.

6.9 Adjust beam to horizontal center of MQJ0F06 using the MBH 0F05H and MBH0F06H correctors.

6.10 Adjust beam to vertical center of MQJ0F06 using the MBH0F05V and MBH0F06V correctors.

6.11 Twiddle restore or restore the recorded field for MQJ0F06.



ITV0F04. The bright core should be centered within the rest of the beam spot

4.2 If running recirculated, insert the beam stop.

4.3 Striptool IPM1F01. Helps watch movement and trends of BPM position.

4.4 Dither the DL/B gang phase ±10°, around zero, in 5° steps. The tends to move when dithering from 0° to -10°, but should not move when dithering from -10° to 10°.

4.4.1 If no movement is seen on IPM1F01, return the Buncher back to its original phase value and go to 5.0.

4.4.2 Otherwise, adjust MSX0F02 correctors until there is no movement while dithering the DL/B gang phase -10° to 10°.

5 Obtain spot on ITV0F06 & verify phase of Buncher is a zero crossing

5.1 Open relative BPM screen.

5.2 Striptool IPM0F06A. Helps watch movement and trends of BPM position.

5.3 Dither the Buncher gradient from 2.35 to 2.85 in one step. (+0.5 from starting value)

5.3.1 If no movement is seen, go to 6.0.

5.3.2 Otherwise, adjust drive laser phase starting with 5° steps until no movement is seen while dithering the Buncher gradient. Note that there is a remote possibility that the best Buncher phase is 180°. If this method does not work, establish initial zero crossing with transient phase from Appendix 2. Return when complete.

5.4 Reestablish spot on ITV0F06

Energy to beam may be lower than required for FELINJ magnet strengths

beam is "centered" go to 3.6. Otherwise, continue this section.

3.5.3 Adjust beam to center of second solenoid using MBH0F01A correctors (change step size to 1G-cm increments before adjusting).

3.5.4 When no movement between the zero to full positive field range of the solenoid is obtained, go to 3.6.

3.6 Restore the solenoid settings.

3.6.1 Close drive laser operator shutter.

3.6.2 Set MFF0F01 and MMF0F02 solenoids on hysteresis loop.

3.7 Increase beam intensity back to nominal values.

3.7.1 Withdraw ITV0F02.

3.7.2 Set DLPC to: 2Hz, 250μsec, 4MHz. Restore Buncher to gradient that was recorded earlier.

3.7.3 Retract ND2 filter if necessary.

3.7.4 Reset DLPC faults and use MPS mega-reset to correct beam mode.

3.7.5 Raise the attenuator to the value recorded earlier.

3.8 Establish rough beam spot on ITV0F04.

3.8.1 Make sure all BLMs are masked.

3.8.2 Observe ITV0F04.

3.8.3 Open drive laser operator shutter.

3.8.4 In the rare case that no spot is visible on the viewer, see Appendix 3. Return when the spot is visible.

3.8.5 Insert ND filters on ITV0F04 to avoid camera saturation.

3.8.6 If the spot is seen and approaches the desired location – Check the WesCam (it doesn't have to be perfect), go to 4.0.

3.8.7 If spot doesn't approach spot per Appendix 1, obtain the best spot by dithering Drive Laser/Buncher gang phase until spot does approach the wanted shape. Zero the gang phase and go to 4.0.

4 Beam through operation point in the Cryounit

4.1 Use MSX0F02 correctors to get a symmetric beam on ITV0F04.

3.2 Setup for centering in the Buncher and second solenoid (MMF0F02)

3.2.1 Before opening the drive laser operator shutter with the ceramic viewer in make sure that the ND2 filter is in and that the attenuator is set to 1%. Only increase the attenuator when the EO cells have been optimized.

3.2.2 Minimize ghost pulses when the drive laser operator shutter is open by:

- Set the DLPC to 1Hz, 1μsec, 584kHz.
- Adjusting the EO cells and minimizing the intensity of the ghost flashes on ITV0F02.
- Return to full charge beam by setting the DLPC to 2Hz, 250μsec, 4MHz.

old viewer

3.3 Center in the Buncher

3.3.1 Record second solenoid's setting (MMF0F02).

3.3.2 Take MFF0F01 and MMF0F02 off hysteresis.

3.3.3 Zero MMF0F02's field.

3.3.4 Record Buncher's gradient and phase.

3.3.5 Record the first solenoid's (MFF0F01) setting and the position of the beam on ITV0F02.

3.3.6 Lower the MFF0F01 strength (try 10 G-cm steps) until the spot is minimized on ITV0F02.

3.3.7 Change the MBH0F01 correctors step size to 1G-cm.

3.3.8 Using the MBH0F01 correctors, move the spot back to the recorded position (before the MFF0F01 was changed).

3.3.9 Bring up the sliders screen from the RF 4 Seater screen.

3.3.10 Increase the gradient of the Buncher to 3.2MV/m.

3.3.11 Carefully (don't spray beam around) dither the Buncher phase, starting a range of ±10° and, as improvement in centering is made, go to a full ±180°.

3.3.12 Observe ITV0F02.

3.3.13 Adjust beam position using MBH0F01 correctors so that the beam motion when the Buncher phase is changed is minimized. You will be able to dither the phase throughout the ±180° range when centering is achieved. The spot will move slightly in the horizontal plane, but not in he vertical plane.

3.4 Setup to center in the second solenoid (MMF0F02).

3.4.1 Return Buncher phase to the original value recorded.

3.4.2 Return MMF0F02 solenoid to original field value recorded in 3.3.

3.4.3 Note the position of the beam on ITV0F02 (Dry-Erase marker on the monitor).

3.4.4 Restore MFF0F01 to its original strength.

3.4.5 Move the beam back to the position noted using the MBH0F01 correctors.

3.4.6 Check Buncher centering (3.3.11).

3.5 Center in the second solenoid (MMF0F02).

3.5.1 Observe ITV0F02.

3.5.2 Upon careful centering using the MBH0F01A correctors, beam will move back and forth a small amount while the zero to full positive field range of the solenoid is exercised. No movement indicates that the

0 Introduction

This is the standard procedure for checking and re-setup of the injector beam. The start of the procedure assumes beam is already established to the 1G Dump via a "Golden File". For a new setup where the phase reference to the RF has been lost, appendices are provided that reestablish beam through the injector. Note that this is a living document and will change frequently to keep up to date with changes in our understanding of the machine.

1 Preconditions

1.1 FEL "on" per FEL Startup Procedure.

1.2 "Golden File" in use

1.3 Running 2 Hz, 250 us beam

1.4 BLMs are masked

1.5 Drive Laser is aligned (accomplished with the HVPS off).

2 Operational Methods

2.1 The relative phase of the laser and Buncher is determined by the change in injector energy with Buncher gradient and by the Buncher GASK signal. Neither is a perfect method for determining the zero crossing. A combination of both is best at this point to keep from wandering off in the parameter space.

2.2 Start with the latest Golden File that has recirculation. Ensure that the beam current is 135pC/p. Insert all the 3F viewers to protect the wiggler from high radiation levels. You could also switch to the 2G beam dump as a plan B.

2.3 Once the Buncher is established at zero crossing, the phases of the Drive Laser & Buncher form a set to be changed in unison. The gang phase for this pair is located on the 4 Seater screen.

2.4 Close the drive laser operator shutter during insertions and changes.

2.5 Cavity 4 of the Quarter is considered the anchor cavity in the phase coordinate system about which all phasing is performed. DO NOT change it's phase.

2.6 Avoid saturation on beam viewers by lowering the pulse width or pulse repetition rate. However, the charge per bunch monitors and BPMs only work at or above 200μsec.

3 Establish 135pC/p beam and Restore Injector Setup

3.1 To reestablish beam setup:

3.1.1 Restore a golden file that includes recirculation.

3.1.2 Set beam intensity to 135pC/p as observed on the 1G dump beam current monitor (BCM) using drive laser attenuator.

3.1.3 If beam can't be established this way, estimate a 135pC/p beam from the injector BCM, BPM wire sums, or viewer intensities. Use ~20% drive laser attenuator.

3.1.4 If running to the 2G dump (straight-ahead): restore 1F and 2F setups from All-Save or other suitable setup of beam to the 2G dump. Then using the MPS "Ops" screen, press the buttons to cycle the ARC1 magnets from machine mode 3 to machine mode 2. The ARC1 magnets should turn off at the end of their cycle. If not cycle back and forth again.

Procedure for: Injector Phasing

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