Commissioning Procedure

- beam from the end of the linac to the FEL dump

Skeleton procedure.

Steps in commissioning the LTU

1. Starting point:
beam to the end of the linac at 10 Hz (save electricity, don't need 120 Hz for a while)
nominally 14.1 GeV, charge in the range 0.2 – 1 nC
establish the energy initially in the SLC beamline by switching on the BSY magnet 50B1 and taking the beam to stopper PR55.
at this point energy can be measured with an existing BPM (needs > 0.5 nC charge) using energy feedback, FB31
linac emittance will have been measured on sector 28 wires
bunch lengths will have been measured with the RF deflecting cavities, although short bunches are not mandatory at this stage.

2. Starting at 1 Hz steer beam through BSY portion of LTU as far as 1st stopper after muon shield. At present this stopper is called ST61. It is before the first dog-leg bend in the LTU and serves to establish the launch into the LTU from the linac.

3. Having established energy on PR55 and launch on ST61, 1 Hz beam can then be steered through the dog-leg to the tune-up dump at the end of the LTU. Once the beam makes it to the LTU tune-up dump the beam rate may be raised to 10 Hz.
All LTU collimators are open at this point.

4. Re-establish energy feedback, this time using LTU dog-leg BPMs

5. Commission energy collimators and activate MPS based on beam loss at energy collimators. This MPS will rate limit the linac.

6. Commission orbit feedback through the LTU matching section.

7. Commission single bunch beam dumper (SBBD) in the LTU.

8. Commission transverse collimators in the LTU matching section.

9. Establish MPS based on beam loss at the transverse collimators with the SBBD as the active device which will rate limit the beam at the end of the LTU

10. Commission wire scanners in the matching section.

11. Commission the 6 new cavity BPMS and verify that they read the same orbit as the stripline BPMs.

12. Optics tuning of the LTU: correct residual dispersion from the dog-leg. Beta match to the end of the LTU based on wire scans.

13. Commissioning of bunch-length monitors can begin at this point, but they are not required for the next steps.

14. Beam will be declared ready for the undulator beam line when:
- Energy is established by feedback
- MPS is ready
- Orbit feedback is holding the launch stable
- Wire scans show emittance less than 10 um (generous enough?)
- Beta match shows beam is matched at the undulator entrance stopper (how do we spec a tolerance for 'good enough' here?)

15. First beam past the undulator stopper:
- 14.1 GeV (max energy)
- 0.2 nC charge
- launch and energy feedbacks 'green'
- beam stopped at SBBD
- open stopper at end of LTU
- single shot beam into undulator

16. Look for signal on first undulator cavity BPMs
Analyze undulator BPM readings for consistency with launch BPMs. E.g. is there an apparent angle at the entrance to the undulator.

17. If beam only makes it past a few BPMs then calculate change in launch angle required, put in stopper and re-establish beam with launch feedbacks so that their feedback setpoints can be changed accordingly.

> Stop beam at SBBD, open stopper at end of LTU, single shot beam into undulator and see if beam is transported further.
>
> Iterate until beam makes it to the end of the undulator beam line.

When converge, can now switch from single pulse mode to continuous 1 Hz.

18. Steer beam through dump line.

19. Commission dumpline energy, energy spread diagnostics.

20. Commission undulator MPS based on distributed loss monitor in undulator hall and the average current monitors.

21. Can now increase rate to 10 Hz, and we are ready for the next step which is beam based alignment in the undulator. Note that charge has remained at 0.2 nC up to now.

Contingency plan:

If the LTU was scheduled to be ready much earlier than the undulator and dump beam line (>6 months) consider putting a temporary shielding block behind the LTU tune-up dump to allow access to the undulator hall during LTU commissioning.