Main Linac Beam Dynamics in Alternating Operation

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Main Linac beam dynamics in Alternating operation

- Main Linac will be tuned for low energy (colliding) beam.
- Most magnets are DC. Only RF will be changed.
- Can high energy beam (for e+ production) go through the linac tuned for high energy beam?
 - Orbit
 - Emittance

Main Linac Simulation (1)

- Low energy beam (Final beam energy 100 GeV)
 - Initial 15 GeV
 - All cavities have the same gradient.
- High energy beam: Final beam energy 150 GeV (or 250 GeV)
 - Assume gradient will be changed pulse by pulse. But not magnet setting.
 - Orbit will be different from the low energy beam
 - Emittance growth can be large

Main Linac Simulation (2)

Simulation procedure:

- Set "standard" alignment errors.
- Perform DFS correction for low energy beam
- Track high energy beam for the same alignment and magnet setting.
 - Change Only RF setting.

Note

- Linac is curved following the earth.
- 10 linacs (random seeds) were simulated this time.
- Similar studies were reported in ALCPG2009 (Albuquerque), with slightly different assumptions, e.g. beam energies.

150 GeV Beam Vertical Orbit Difference in linacs tuned for 100 GeV beam



150 GeV Beam Vertical Emittance

in linacs tuned for 100 GeV beam



250 GeV Beam Vertical Orbit Difference

in linacs tuned for 100 GeV beam



250 GeV Beam Vertical Emittance

in linacs tuned for 100 GeV beam



Summary + solutions (1)

In Main Linac tuned for low energy beam (100 GeV):

- High energy beam (150 GeV) at linac end will have
 - Vertical orbit ∆y~1 mm
 - Vertical emittance $\gamma \varepsilon_y \sim 1$ um (nominal x 50) (250 GeV beam will be worse:
 - Vertical orbit ∆y~6 mm
 - Vertical emittance $\gamma \varepsilon_v \sim 4$ um (nominal x 200))

No problem in ML.

For down stream:

- Probably x50 emittance is OK.
- But, need orbit correction (Pulse by pulse changing magnets.)

Summary + solutions (2)

- Need orbit corrections for both high and low energy beams → alternately changing magnets
- In undulators
 - Orbit of high energy beam should be good.
 - Emittance of low energy beam should be preserved.
 - Can be satisfied both?
 - If not, low energy beam bypass undulator?
- High energy beam may cause problems around IP?
 bypass IP (go to e+ dump)?.

Possible Solutions

Pulse-by-pulse switching magnets (How Many?). No additional lines..

