

(Un)Balancing the Linacs Michael Tiefenback Ops Staytreat 2017-08-02





Accelerator Operations Department



Reliability? Uptime improvement?... Really?

- Well, when you think about it, maybe....
- $E_{nl} = E_{sl}$: Design choice, not a law of nature
- What if one linac is better than the other?
- "Smoke 'em if you got 'em"
 - Sidestepping arbitrary limitations
 - Plan around and expand hardware limits
 - Think ahead to avoid constraints



Unbalanced Linacs...

- What is affected?
 - Momentum ratios for Spreaders/Recombiners
 - Relative polarization to users on different passes
- High passes asymptotically approach design ratios
- Largest problems with largest vertical dispersions
 - First and second pass vertical S/R
- What limits exist?
 - Shunt capacity
 - Recirculation arc magnet set points



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What relates to today? In practical terms:

• Reliability – It works when you ask

When something breaks, make the rest of it work.

• Availability – It works often enough

When greater capacity is available in a linac, use it.

• Performance – It works well enough

But More is better. (Sorry... couldn't resist)



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Unbalanced linac energy gain

- Set the Injector and Arc energies
- Configure the Linacs for the desired energy gain
- Configure the Arcs for the proper beam momenta
- Deliver beam to the halls

But first...

- Momentum ratios in S/R regions have little margin
- Common dipoles are off-ratio at the few-% level
- Correctors control trajectories in dispersive regions
- Shunt/Corrector powering and beamline aperture limit off-nominal S/R ratios





Estimates of limiting effects

- Dispersion in 1S/2S regions: ~1.4 meters
 - First common dipole must be matched to beam momentum to within ~1/2% (shunts important)
- Arcs dipole bus set to actual beam energy
 - +/- horizontal corrector margin
- "2nd common dipoles" in 3S/4S regions contribute to high pass beam offsets
- Dispersion for high arcs is of lesser magnitude, so principal limits are 1S/3S and 2S/4S bore margin



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Mitigations

Standard measures:

- Return bore in 1S/2S telescopes to 6GeV sizes
- Increase shunt or "shunt-adder" margin

Non-standard measures:

- Use multipass steering mechanism to create cm-scale separation of beams at ends of linacs
 - Retrofit elliptical S/R diff. pump apertures?
- Supplement 1st step S/R magnets to limit bore use



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What would we be preparing for?

Unbalanced linac configuration was initially pursued to allow use of upgraded accelerating capacity even when asymetrically installed, removing an artificial limit. It opens options:

- Maximizing total beam energy after loss of gradient
- Utilizing asymmetric gradient capacity, whether upgraded, or "found" (as we learn better to use it)
- Maximizing users' experimental reach via polarization
 - Alters the "magic energy" table





What tools should we make?

- LEM link between linacs for baseline configuration
 - Full minimization of trip rate across two linacs
 - Set Arc and Injector energies run-by-run
 - During a run, use LEM as now no new "setups"
- Configuration tools for S/R optimization
 - Assess magnet powering network limitations
 - Determine where magnet supplement is wise

Need some verification time, too, principally up to 3-pass



