

Cause and Effect in SR Improvements

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1.0 Some Bad Effects

Various general properties of the beam or SR is given. Some intermediate implications are listed, followed by a resulting (almost always) bad effect. The impacts of improving the beam qualities is generally: lower lifetime, lower charge per bunch, and ID radiation damage.

TABLE 1. Some bad effects

Desired Property	Intermediate effect	Resulting Bad Effect
Low horizontal emittance (in general)	High particle density	Low lifetime
Low vertical emittance	High particle density	Low lifetime
Low vertical emittance	Improves injection efficiency	Good: reduces ID radiation damage
More 5-mm aperture ID VC or 4-mm aperture ID VC	Higher beam losses at ID	Local ID radiation damage.
4-mm or 5-mm aperture	Injection problems	Lower single bunch charge
4-mm or 5-mm aperture	Need smaller BPLD limits	Possibly more trips or required beamline realignment
4-mm or 5-mm aperture	Higher impedance	Lower single bunch charge
10-m long ID VC	Higher impedance	Reduce single bunch charge
10-m long ID VC	Reduced acceptance	Local ID radiation damage
Higher bunch current	Higher HOM RF heating	Higher temperature on ceramic VC
Customized beta	Reduced acceptance	Injection losses, local ID damage
Run at 6 GeV	Higher particle density	Low lifetime
Run at 6 GeV	Lower damping and lower reduced single bunch charge instability thresholds	Lower single bunch charge

2.0 Methods to Reach Beam Properties

Here is a list of method to reach some (possibly) desired beam properties:

TABLE 2. Methods to reach beam properties

Beam property	Methods
Low horizontal emittance (factor 2)	Damping partition
Low horizontal emittance (various factors)	New quadrupole optics
Rounder beam	New quadrupole optics
Rounder beam	Adjust skew quadrupoles
Higher bunch charge	Reduce RF voltage
Higher bunch charge	Increase sextupole strength
Higher bunch charge	Feedback system (not designed yet)
Longer bunches	Reduce RF voltage

3.0 Cause and Effect

The cause column are the various possible changes made to the SR or to the beam properties that might serve User goals.

The effect column is the corresponding immediate effect. Some causes have several effects, and some effects lead to other effects.

Final effects are generally bad, i.e. low lifetime, radiation damage to ID.

TABLE 3. Cause and Effect in SR Improvement

Cause	Effect
Small gap chambers	Reduced acceptance
Customized beta functions or beam sizes	Reduced acceptance
Longer ID VC	Reduced acceptance effectively
Reduced aperture	Injection losses
Injection losses	Radiation damage to ID
Injection losses + low lifetime	Higher booster charge in topup
Converging beta and other special lattices	Stronger sextupoles
Additional quadrupoles to focus beam in straight section	Stronger sextupoles
Theoretically minimum horizontal emittance	Stronger sextupoles
Stronger sextupoles	Smaller dynamic aperture
Stronger sextupoles	Smaller momentum aperture
Small coupling	Smaller injection losses (good)
Small coupling	Low Lifetime
Larger coupling	Injection losses
Smaller dynamic aperture	Injection losses
Smaller momentum aperture	Lower lifetime
Higher bunch current	Higher HOM RF heating in ceramic VCs
Reduce RF voltage	Lower lifetime (usually)
Reduce RF voltage	Allows higher current per bunch
Reduce RF voltage	Lower HOM RF heating