

Parameter Table

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Full 3D effects are NOT taken into account in the quoted parameters. However, the hadrons are now modelled as points rather than discs. The electrons, however, are still treated as discs.

The modulator and kicker lengths are listed as 35m each. The precoolers still want long (~ 69 m) modulator/kicker. We therefore plan to keep a ~ 69 m region free of hadron magnets, but kick the electrons out early so as to achieve the desired electron/hadron overlap for the microbunched cooler.

275 GeV bunch length has been fixed at 7mm and 100 GeV bunch length has been fixed at 12mm. Parameters have been initially optimized on NERSC using a multi-objective genetic algorithm with constraints to keep large amplifier betas at 275 GeV and to minimize the effect of energy smearing of the hadron beam at 100 GeV. These effects are included in the cooling time estimates. Fine-tuning by hand was done on the final results.

Beam-beam effects give an estimated vertical IBS growth rate of 5 hours at 275 GeV, but there are still consistency issues that need to be resolved between different simulation methods.

All betas, dispersions, etc. are evaluated at the center of the relevant element for hadrons, with drift optics assumed. For electrons, the optics are assumed to be held constant across the element.

Hadron R56 and phase advances are evaluated from modulator center to kicker center. Strengths of the electron chicanes are evaluated from the end of the previous straight to the beginning of the next one. (Eg, the first chicane R56 is evaluated from the end of the modulator to the start of the first amplifier straight.)

Quoted beam sizes, energy spreads, etc. are all RMS of a Gaussian distribution, except for electron bunch length, which is assumed to be a Supergaussian with the order specified in the table. In this case, the total bunch charge is as quoted in the table, and the peak current is what we would have in the case of a Gaussian bunch with the specified bunch length and charge. The width of the Supergaussian is adjusted to match these parameters, and will have the form $I(z) = I_0 e^{-(z^2/2\sigma^2)^N}$ where $I_0 = \frac{Qc}{\sqrt{2\pi}\sigma_z}$ is the peak current, N is the order of the Supergaussian, $\sigma = \frac{N\sqrt{\pi}}{\Gamma(1/2N)}\sigma_z$, σ_z the Gaussian bunch length of the electron beam, and Q is the total bunch charge.

While the slice energy spread must be kept relatively small (1e-4), the total energy spread can be significantly larger - values of 1e-3 had only minor effects on the wake in previous versions of this table.

We quote parameters for proton cooling at 100 and 275 GeV in Tab. 1.

Room to improve: We'd like to look for more overhead at 100 GeV, where the presence of hadron drift in the modulator/kicker brings us above the IBS times, and ensure that these all match what can be achieved in 3D.

Table 1: Parameters for Longitudinal and Transverse Cooling at Store

Case	100 GeV	275 GeV
<i>Geometry</i>		
Modulator Length (m)	35	35
Kicker Length (m)	35	35
Number of Amplifier Drifts	2	2
Amplifier Drift Lengths (m)	47	47
<i>Proton Parameters</i>		
Protons per Bunch	6.9e10	6.9e10
Proton Bunch Length (cm)	7	6
Proton Fractional Energy Spread	9.7e-4	6.8e-4
Proton Emittance (x/y) (nm)	30 / 2.7	11.3 / 1
Horizontal/Vertical Proton Betas in Modulator (m)	16.982484 / 20.439205	17.091549 / 17.082313
Horizontal/Vertical Proton Alphas in Modulator	0 / 0	0 / 0
Horizontal/Vertical Proton Dispersion in Modulator (m)	0.472377 / 0.095042	0.324230 / 0.1
Horizontal/Vertical Proton Dispersion Derivative in Modulator	0.029998 / -0.009873	0.029999 / -0.006
Horizontal/Vertical Proton Betas in Kicker (m)	16.982484 / 20.439205	17.091549 / 17.082313
Horizontal/Vertical Proton Alphas in Kicker	0 / 0	0 / 0
Horizontal/Vertical Proton Dispersion in Kicker (m)	0.472377 / 0.095042	0.324230 / 0.1
Horizontal/Vertical Proton Dispersion Derivative in Kicker	-0.029998 / 0.009873	-0.029999 / 0.006
Proton Horizontal/Vertical Phase Advance (rad)	1.737 / 4.7	2.04 / 4.88
R56 in Proton Chicane (mm)	6.10	1.263
<i>Electron Parameters</i>		
Electron Bunch Charge (nC)	1	1
Electron Bunch Length (mm)	12	7
Electron Peak Current (A)	~ 10	~ 17
Electron Supergaussian Order	4	4
Electron Fractional Slice Energy Spread	1e-4	1e-4
Electron Normalized Emittance (x/y) (mm-mrad)	2.8 / 2.8	2.8 / 2.8
Horizontal/Vertical Electron Betas in Modulator (m)	112.252369 / 22.884408	76.417265 / 10.151699
Horizontal/Vertical Electron Betas in Kicker (m)	55.342503 / 6.355461	26.841407 / 2.504902
Horizontal/ Vertical Electron Betas in Amplifiers (m)	12.0 / 12.0	2.202721 / 2.202721
R56 in First Electron Chicane (mm)	28.824047	6.573
R56 in Second Electron Chicane (mm)	-19.32	-3.935
R56 in Third Electron Chicane (mm)	-20.860620	-4.139
<i>Cooling Times</i>		
Horizontal/Vertical/Longitudinal IBS Times (hours)	2.0 / 4.0 / 2.5	2.0 / 5? / 2.9
Horizontal/Vertical/Longitudinal Cooling Times (hours) ³	2.0 / 3.8 / 2.9	1.6 / 3.6 / 2.1