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BC2 Requirements

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Brief Summary: This specification summarizes physics requirements for the second bunch compressor chicane in the LCLS (BC2).

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BC2 Bunch Compressor Chicane Requirements

The second bunch compressor chicane (BC2) is composed of four new dipole magnets to be located in place of the eight existing SLAC 3-m linac sections 24-7a,b,c,d, and 24-8a,b,c,d, as shown in Figure 1 below. The requirements of this chicane are to compress a single 1-nC, 195-μm long (rms) electron bunch, at a repetition rate of 120 Hz, at 4.54 GeV to an rms length of 22 μm. This is accomplished by phasing the L2-Linac at an off-crest RF phase (–41˚ with respect to accelerating crest) in order to energy-chirp the bunch. In addition, the transverse slice-emittance of the electron bunch must be well preserved to a level of <10% growth in both planes, especially with respect to the coherent synchrotron radiation (CSR) produced during compression.

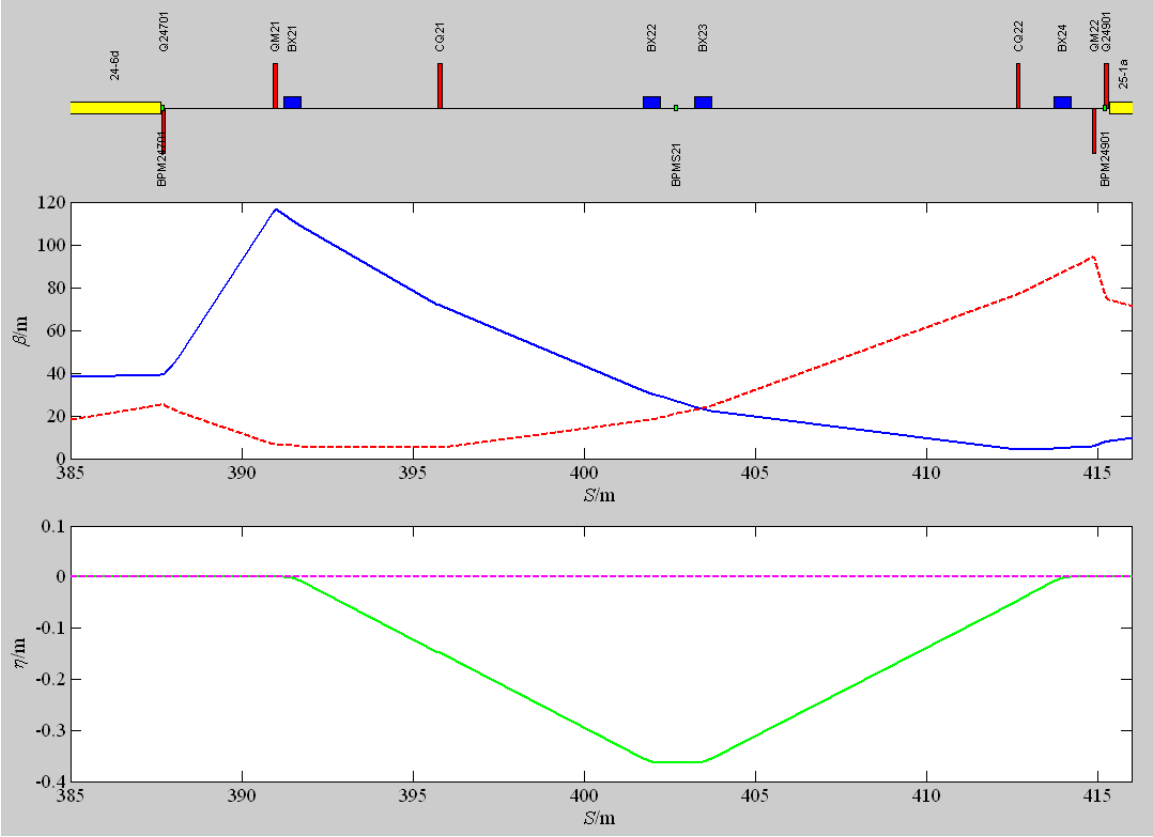

Figure 1: BC2 schematic layout with optical functions and nearby device names. The blue rectangles in the map at top are the BC2 dipole magnets.

At its center (between the 2nd and 3rd dipoles), the chicane must include a high resolution BPM (~40 μm rms) to drive an energy feedback system, a beam profile monitor (OTR) to measure the chirped rms energy spread, and independently adjustable left and right collimator jaws to allow off-energy particle collimation. Additionally, two small (nominally zero strength) 'tweaker' quadrupole magnets (CQ21 and CQ22 in Fig. 1) must be located just inboard of the outer dipoles to allow empirical correction of the horizontal dispersion.

The chicane needs to be adjustable in R_{56} (see Table 1), and switchable to zero strength to allow high-energy, high-charge test beams in the SLAC linac (non LCLS operations). This requirement, and the need for a small aperture BPM and high dipole field quality over a large aperture, suggest that the two inner dipoles be placed on a horizontal sliding translation stage to allow the BPM, the OTR-monitor, the collimators, and the inner dipoles all to translate horizontally between zero and 520 mm. This translation can be slow, requiring up to a few minutes and reproducing its position to <250 μm.

The BC2 system also includes nearby matching quadrupoles to minimize the effects of synchrotron radiation on the horizontal emittance.

Table 1 lists some of the main parameters of BC2.

Table 1: BC2 parameters (1 nC, 120 Hz).

Parameter Description	**Symbol**	**Value**	**Unit**
Nominal electron energy	E	4.54	GeV
Initial and final bunch length (rms)	σ_z	190 - 22	μm
Active length of system	L	22.5	m
Relative energy spread of e^- bunch (rms)	σ_E/E	0.7	%
Bend angle of each chicane dipole	$\lvert\theta_B\rvert$	1.98	deg
Nominal $\lvert R_{56}\rvert$ (and operational range)	$\lvert R_{56}\rvert$	25 (10 to 50)	mm
Length of chicane dipoles	L_B	50	cm