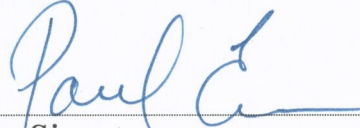
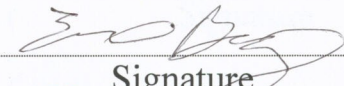
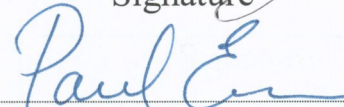
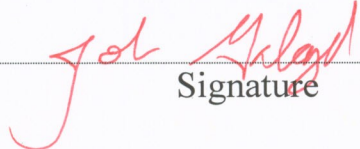


LCLS Physics Requirements Document # 1.3-003		Linac	Revision 0
<u>BC1 Requirements</u>			
Paul Emma (Author)		Signature	5/6/04 Date
Eric Bong (System Manager)		Signature	5/5/04 Date
Paul Emma (System Physicist)		Signature	5/6/04 Date
John Galayda (Project Director)		Signature	12 MAY 2004 Date

Brief Summary: This specification summarizes physics requirements for the first bunch compressor chicane in the LCLS (BC1).

Keywords: Linac, Bunch Compressor

Key WBS#'s: 1.3

BC1 Bunch Compressor Chicane Requirements

The first bunch compressor chicane (BC1) is composed of four new dipole magnets to be located in place of the five existing SLAC 3-m linac sections 21-2a,b,c,d, and 21-3a, as shown in Figure 1 below. The requirements of this chicane are to compress a single 1-nC, 830- μm long (rms) electron bunch, at a repetition rate of 120 Hz, at 250 MeV to an rms length of 190 μm . This is accomplished by phasing the L1-Linac at an off-crest RF phase (-25° 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 $<4\%$ growth in both planes, especially with respect to the coherent synchrotron radiation (CSR) produced during compression. Detailed specifications and calculations are explained in reference [1].

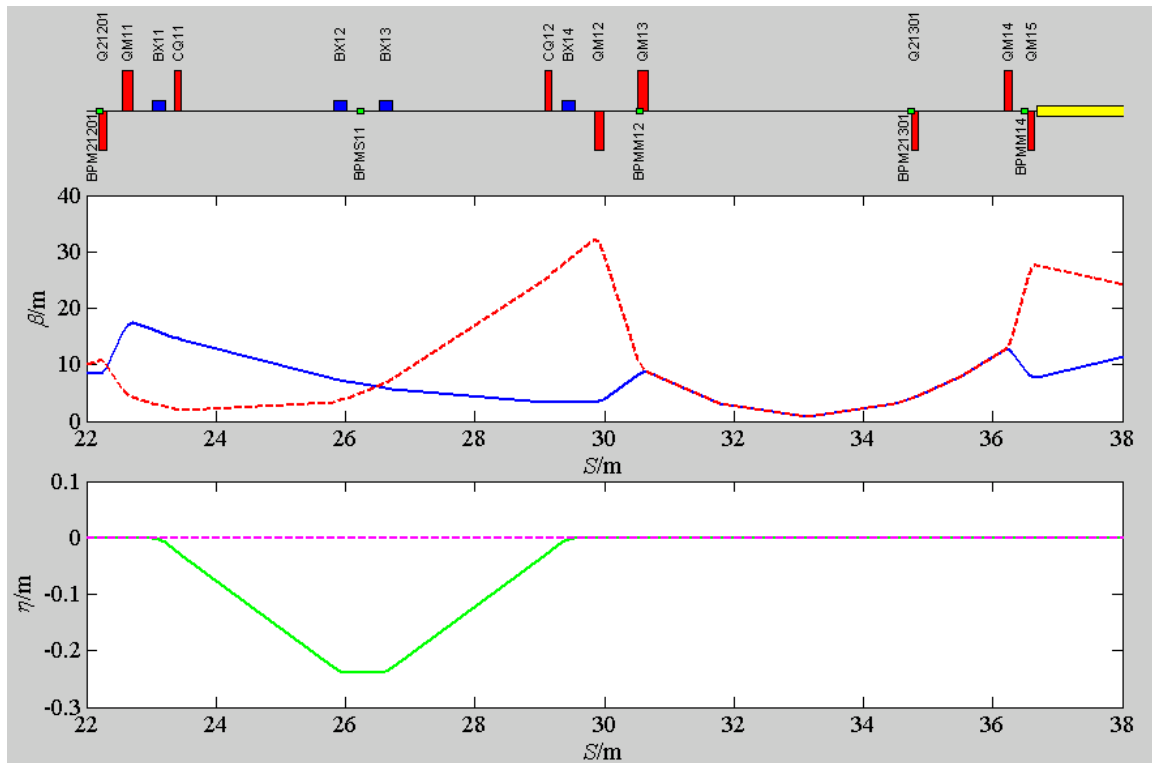


Figure 1: BC1 schematic layout with optical functions and nearby device names. The blue rectangles in the map at top are the BC1 dipole magnets.

At its center (between the 2nd and 3rd dipoles), the chicane must include a high resolution BPM ($\sim 20 \mu\text{m}$ 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 (CQ11 and CQ12 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 320 mm. This translation can be slow, requiring up to a few minutes and reproducing its position to $<250 \mu\text{m}$.

The BC1 system also includes nearby matching quadrupoles and beam profile monitor diagnostics (wire-scanners and OTR monitors located at $S \approx 32$ to 35 m in Fig. 1) to measure the projected and slice emittance after BC1.

Table 1 lists some of the main parameters of BC1.

Table 1: BC1 parameters (1 nC, 120 Hz).

Parameter Description	Symbol	Value	Unit
Initial to final electron energy	E	250	MeV
Initial and final bunch length (rms)	σ_z	830 - 190	μm
Active length of system	L	6.3	m
Relative energy spread of e^- bunch (rms)	σ_E/E	1.5	%
Bend angle of chicane dipoles	$ \theta_B $	4.820	deg
Nominal $ R_{56} $ (and operational range)	$ R_{56} $	39 (15 to 65)	mm
Length of chicane dipoles	L_B	20.32	cm

[1] P. Emma, *Design Parameters and Tolerances for the LCLS First Bunch Compressor Chicane*, ‘BC1’, <http://www-ssrl.slac.stanford.edu/lcls/linac/notes/bc1.pdf>.