

LCLS Physics		
Requirements Document # 1.3-002	Linac	Revision 1
<u>L1-Linac Requirements</u>		
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Brief Summary: This specification summarizes physics requirements for the first linac section in the LCLS (L1-Linac).

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LCLS L1-Linac Requirements

The L1-linac (L1) is composed of the three existing SLAC linac sections 21-1b, 21-1c, and 21-1d, as shown in Figure 1 below. The requirements of this linac section are to accelerate a single 1-nC, 1-mm long electron bunch, at a repetition rate of 120 Hz, from 135 MeV to 250 MeV with the existing S-band (2.856 GHz) RF. This must be accomplished at an off-crest RF phase (-25° with respect to accelerating crest) in order to energy-chirp the bunch in preparation for bunch compression in the BC1 chicane, just beyond L1. In addition, the transverse slice-emittance of the electron bunch must be well preserved to a level of $<4\%$ growth in both planes.

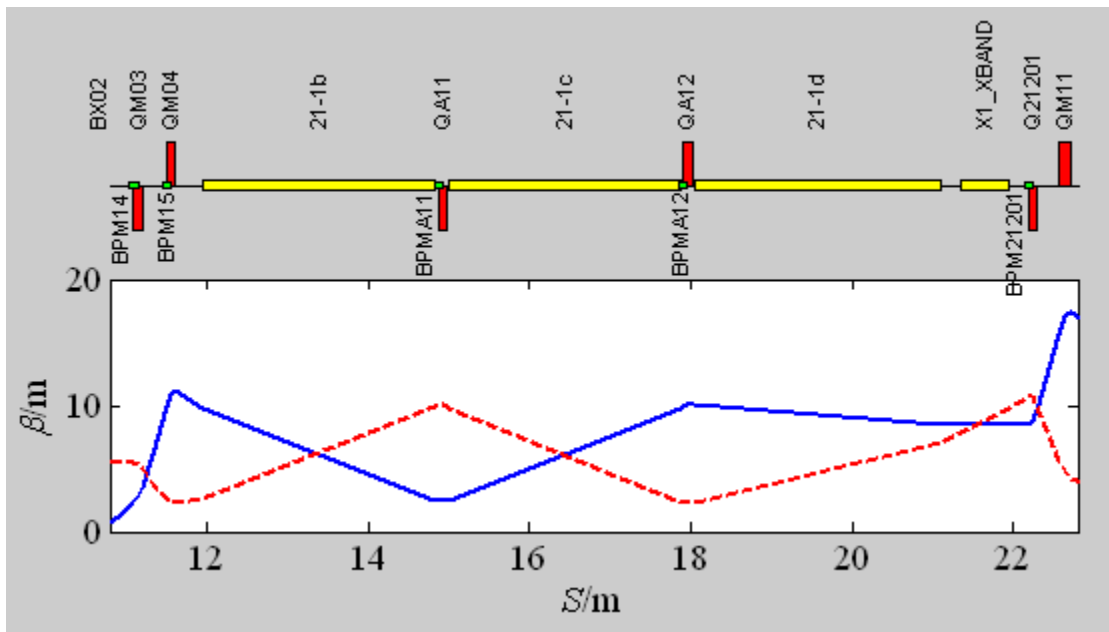


Figure 1: L1-Linac schematic layout with beta functions and device names.

The low energy beam in the L1-Linac requires more frequent focusing stations than provided by the existing linac in sector-21 and thus two new quadrupole magnets must be added after the 21-1b and the 21-1c sections. New beam position monitors (BPMs) and x and y steering corrector magnets (not shown) are also required very near these new quadrupoles in order to control the trajectory to within $250 \mu\text{m}$.

In order to allow more linear bunch compression, a short (60 cm) X-band (11.424 GHz) RF section is included just after the three L1 S-band sections. This section operates with a decelerating voltage of 19 MV (at crest), but phased near the negative RF crest (phase of -160°). Therefore, the S-band RF sections must accelerate up to 268 MeV, where after the X-band decelerates down to 250 MeV. Both the S-band and the X-band contribute to the linear energy-chirp of 1.6% rms prior to the BC1 chicane.

The S-band RF must be stable to 0.1-deg rms with its one klystron. The RF amplitude must be stable to 0.1% rms, while the X-band RF must be stable to 0.5-deg-X rms with its one klystron and its RF amplitude must be stable to 0.25% rms

Table 1 lists some of the main parameters of the L1-Linac.

Table 1: L1-Linac parameters (1 nC, 120 Hz).

Parameter Description	Symbol	Value	Unit
Initial to final electron energy	E	135 to 250	MeV
Bunch length (rms)	σ_x	830	μm
Active length of system	L	8.8	m
Relative energy spread of e^- bunch (rms)	σ_E/E	0.1 to 1.6	%
RF phase of S-band sections	ϕ_s	-25	S-deg
RF phase of X-band sections	ϕ_x	-160	X-deg
S-band voltage at crest (not incl. ~15% overhead)	ΔV_s	147	MV
S-band mean phase stability (rms)	$\Delta\phi_s$	0.1	deg-S
S-band mean amplitude stability (rms)	$\Delta V_s/V_{s0}$	0.1	%
X-band voltage at crest (not incl. ~15% overhead)	ΔV_x	19	MV
X-band mean phase stability (rms)	$\Delta\phi_x$	0.5	deg-S
X-band mean amplitude stability (rms)	$\Delta V_x/V_{x0}$	0.25	%