LCLS Engineering Specifications Document # 1.3 – 107	Injector-Linac	Revision 0

LCLS Injector-Linac Toroid Engineering Specification

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Change History Log

Rev Number	Revision Date	Sections Affected	Description of Change
000	10-6-2005	All	Initial Version

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Summary

The toroid beam current monitor will be designed for installation in LCLS beamlines to measure electron beam current. This specification is based on decades of SLAC experience in the design and fabrication of toroid beam current monitors.

Design Specifications

Toroid Design Parameters

The injector and linac systems require 2 different toroid designs. Each design will have a different clear aperture through the vacuum envelope. The 2 different ceramic gap diameters necessitate a ferrite toroid diameter that is matched to each ceramic gap diameter. The bellows and Kovar transitions will be matched to each diameter. The external envelope of each toroid will be identical. The connector placement and wiring design will be identical for the 2 designs. The ferrite toroid and electrical features of the design will have identical performance characteristics.

Toroid Geometry

The toroid geometry will conform to the geometry shown in Figure 1. The nominal dimensions for the 4 toroid designs are listed in Table 1.

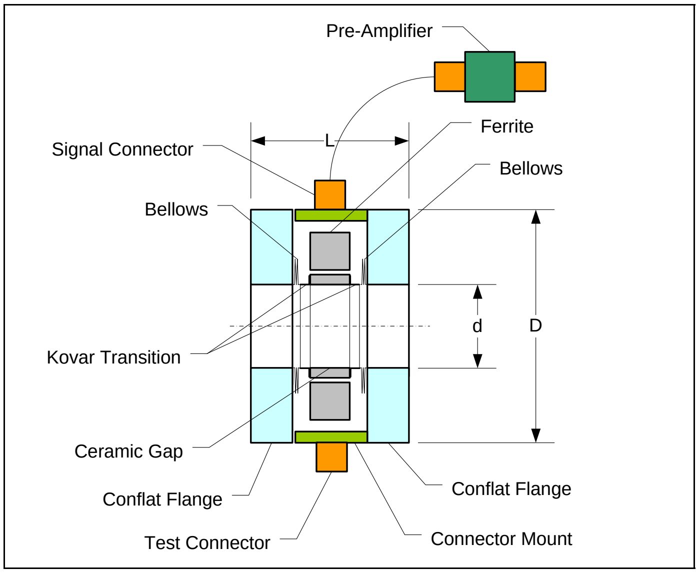

Figure 1 Toroid Geometry

Value	Toroid 1	Toroid 2	BCS Toroid	Dump Toroid
D	3.38 (3-3/8 CFF)	2.75 (2-3/4 CFF)	3.38 (3-3/8 CFF)	TBD
d	1.370	.875	1.370	TBD
L	1.80	1.80	1.80	TBD
Signals	1 output, 1 test	1 output, 1 test	2 output, 1 test	TBD

Table 1 Toroid Dimensions
(inches)

Toroid Type Definition

- Toroid 1 is in the GTL region.
- Toroid 2 is in the region downbeam from L0.
- The BCS toroid is in the GTL region and is a dual function BCS/beam current device.
- The dump toroid is in the linac beam dump line.

Materials

All materials in vacuum will be mill certified. Mill certifications will be included with manufacturing travelers during fabrication, assembly, and test. The fabrication travelers and all documentation will be stored in the project data base after device installation.

Component	Material
Ceramic Vacuum chamber	Al_2O_3 alumina ceramic
Vacuum Flanges	304 Stainless
Toroid	Ferrite
Braze Alloy - Kovar to Ceramic Gap	Active Brazing Alloy[i]
Transitions	Kovar
Beam charge bleeding material	Kovar (sputtered)
Bellows	TIG welded type 347/304 SS

Table 2 Material Definitions

Ceramic Vacuum Chamber Design

- The toroid vacuum chamber and associated materials will have a nominal maximum magnetic permeability of $\mu \leq 1.05$.
- The chamber will use conflat flanges to effect a vacuum seal.
- The vacuum chamber (ceramic gap) will consists of an alumina ceramic tube brazed to kovar transitions with mechanical strain relief provided by a bellows on either one or both ends.
- The chamber will achieve a maximum pressure of 5.0E-09 torr @ 25 ° C.
- The assembly will be bakeable at a maximum of 200° C.

Internal Coating

The ceramic gap will have a conductive kovar coating sputtered on the inside diameter to prevent electrical charging of the ceramic surface. The coating thickness will be yield a sheet surface resistance of ~1.0 MΩ/sq.± 0.1 MΩ/sq.

Electrical Connectors and Wiring

- Test input connector will be type N.
- Signal output connector will be TWINAX type.
- Wiring will be bakeable, radiation hard.

Preamplifier

The toroid will be supplied with a remote preamplifier connected by cable to the toroid. There must be limited degradation of the signal quality due to cable losses. The toroid plus preamplifier must meet the performance requirements listed in Table 3. The toroid electrical properties must therefore match those of the preamplifier electronics.

The preamplifier will process the beam-induced signal from the toroid and output a DC signal that can be read by a gated 0-10 volt ADC in the LCLS control system. The bandwidth of the toroid and preamplifier will be sufficient for single pulse measurement of the beam charge, over the charge and frequency range specified in Table 3.

The preamplifier unit will also provide a calibration signal to be connected to the test input connector of the toroid. The calibration pulse supplied by the unit enables an absolute scale determination of the electron beam charge with an accuracy of 25 pC. The linearity of the response to the beam charge will be better than 2.5 % over the entire measuring range.

Performance Specifications

The Toroids with pre-amplifier will be designed and constructed to meet the following specifications:

Parameter	**Value**
Charge and Frequency Range	2-1200 picoCoulombs single pulse measurement at a frequency range of 1 Hz < *f* < 120 Hz
Resolution	2 picoCoulombs
Readout	0 - 1000 millivolts
Low Range Charge Accuracy	2% RMS (linear)
High Range Charge Accuracy	2.5% RMS (linear)

Table 3 Performance Specifications

Reference

i The reference braze alloy is an "Active Brazing Alloy" (ABA)® from Wesgo Metals. This alloy may be used or a conventional molybdenum-manganese sintered – nickel plating ceramic surface preparation with copper-gold braze alloy.