# Technical Meeting – Shipping of Cryomodules

15 March 2017

**Attendees.**

SLAC: Tom Peterson (notes), Dave Schultz, John Galayda, Rob Coy, Karen Fant, Jose Chan, Marc Ross, Andrew Burrill

JLab: Ed Daly, Naeem Huque, Kirk Davis

Fermilab: Mike McGee, Camille Ginsburg

**General conclusions.**

1. People had a lot of questions about the shipping data (#1 below) and would like to come to a better understanding of that.
2. The project’s response to receiving a cryomodule at SLAC with out of tolerance shipping data has been discussed in general terms. I would say the following: rejecting a cryomodule at SLAC, not installing a cryomodule which has been shipped to SLAC, would occur only following additional in-depth examination to the extent practical, discussion of data by various experts and management, and a decision by cryogenic system management.

**Action items, notes.**

1. JLab shipping test data. Large, short duration acceleration spikes prompted discussion of the data and suggestion of further analysis and comparison of the SAVER9X data (“LCLS-II Cryomodule Shipping Test Preliminary Results,” by Naeem Huque) with other devices. Also, a suggestion was to talk with SAVER9X vendor about it. High frequency large acceleration spikes seem like small amplitude vibration of some kind.
2. 1.5 g agrees with DESY specification. General agreement that 1.5 g in any direction is a good specification.
3. Shock recorders are mounted with 2-sided tape and tie wraps if not boltable. Tie wrap is used especially so as not to place tape adhesive in tension or shear.
4. Always monitor shocks with all moves.
5. After arrival at SLAC, ship back the over the road devices. SLAC should add their own for monitoring moves after receipt of the cryomodules at SLAC.
6. Out of tolerance shipping data will require a decision about disposition. Perhaps out of tolerance data imply more thorough inspection than normal, depending on nature of data. For example, a large shock would imply closer look at alignment (perhaps open tuner access ports for inspection) and also electrical continuities. Beam vacuum loss would mean a serious problem including contamination, likely rejection (in my opinion). Insulating vacuum space pressure loss might imply a more thorough check for a leak. These checks are planned, anyway, but one might conceive more extensive checks in response to certain out-of-tolerance shipping data.
7. We did not have XFEL participation in this meeting.

**Agenda (with preliminary responses inserted).**

1. Ensure the requirements for the shipment of cryomodules as defined in

LCLSII-4.5-FR-0053-R1, 1.3 GHz Superconducting RF Cryomodule are adequate

and address the same requirements covered in the DESY shipping

specification "Transportation of Cryomodules,

DESY EV 010-04-S1. *We agree that requirements are adequate are consistent with the DESY cryomodule shipping requirements.*

2. Review instrumentation required for cryomodule shipments and ensure

appropriate devices will be installed for the shipping test. *Instrumentation will be adequate and appropriate; discussion revolved around better understanding of the shipping test data.*

3. Review how this data will be captured and used to determine if a more

in depth inspection of the cryomodule is required based on cryomodule

arriving outside of the allowable shipping parameters. (shock, vacuum,

loss of positive purge). *I think follow up to out of tolerance data upon arrival at SLAC is still a somewhat open topic – any additional comments? Or perhaps the statement #2 in general conclusions says enough.*

4. Ensure the planned shipping test will provide representative data to

ensure shipments to SLAC will not be compromised. *We agree that the shipping test provided representative data for shipping to SLAC. There was some discussion of further tests such as shipping a “dummy” cryomodule over longer distances and/or a shaker test, but no conclusion to recommend pursuing these.*

5. Review lessons learned from XFEL cryomodule shipments. - A request has been sent to Kay Jensch. *Still awaiting a response.*

The technical meeting deliverables will be:

1. A report addressing how each of these 5 items has been satisfactorily

addressed.

2. A set of procedures on how to read out the instrumentation mounted on

each cryomodule. - (Due after first shipments to SLAC are prepared)

**Reference.**

“Cryomodule Receiving, Acceptance, Storage, and Installation Requirements,” LCLSII-4.1-PP-0703-R0. This document references many other relevant documents for cryomodule shipping. Among them is “1.3 GHz Superconducting RF Cryomodule,” LCLSII-4.5-FR-0053, which includes the following shipping requirements:

 (d) Shipping [8, 9]

i. Provisions will be made to limit the loads seen by the Cryomodule to

a. Maximum transmitted vertical shock acceleration < 1.5 g

b. Maximum transmitted transverse shock acceleration < 1.5 g

c. Maximum transmitted longitudinal shock acceleration < 1.5 g

ii. A bonded and insured transport company shall be used.

iii. All overland transport shall be on air-ride suspension trucks

iv. Shock recording shall be provided on the cryomodule as well as on the shipping

container.

v. The shipping containment shall ensure that the cryomodule remains dry.

vi. The cryostat vacuum space shall be sealed and shipped under a slight positive pressure

using dry nitrogen.