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| Statement of Work for Fabricating LCLS-II-CMRB Cavity Tuner Frames |
| **Document Number:** | F10132292-SOW | **Date:** | 4/15/2025 |
| **Revision Number:** | 1 | **Project:** | L2RB |
| **Author:** | Peter Owen | **Department Owner:** | SRF Ops |

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# Acronyms

Use this section to define any acronyms that are in the document

* TJNAF – Thomas Jefferson National Accelerator Facility
* SLAC – Stanford Linear Accelerator Center
* LCLS – Linear Coherent Light Source
* (CM)RB – Cryomodule Rebuild subproject for the LCLS Accelerator
* SOTR – Subcontracting Officer’s Technical Representative
* PO – Procurement Officer
* ARO – After Receipt of Order
* BPS – Braze Procedure Specification
* BPQR – Braze Procedure Qualification Record
* WPS – Welding Procedure Specification
* WPQR – Welding Procedure Qualification Record
* PO# – Purchase Order Number

# Introduction

The LCLS-II project at the SLAC National Accelerator Laboratory is a free electron laser source based on the successfully operating Linac Coherent Light Source at SLAC. The LCLS-II Accelerator System contains a 4 GeV continuous-wave superconducting linear accelerator in the first kilometer of the SLAC linear accelerator tunnel.

The accelerator is made up of 35 Cryomodules, each of which contains eight superconducting cavities made of niobium. The Cryomodule Rebuild project (LCLS-II-CMRB) will refurbish two cryomodules that were built for the initial LCLS-II project but never installed. These modules will be rebuilt to a higher specification, which includes a modified tuner design. The production of these cryomodules will take place at Thomas Jefferson National Accelerator Facility (TJNAF).

The cavity tuner is used to adjust the shape of the cavity to attain the desired natural frequency. Small discrepancies in cavity manufacture mean that resonant frequencies lie within a general range. The tuner assembly counteracts the differences in cavity geometry by increasing or relaxing the compressive force on the cavity and brings it to the correct resonant frequency.

The company to which the contract has been awarded will be hereafter referred to as the ‘Subcontractor’.

# Scope

This statement of work outlines the requirements for fabricating and assembling Cavity Tuner assemblies for TJNAF.

# Procurement Officer’s Technical Representative (TR)

The SOTR is a TJNAF employee assigned to interface with the Subcontractor on technical matters after Subcontract award. The SOTR is only authorized to provide technical direction within the scope of the Subcontract. Any modification to the scope or terms of the Subcontract must be approved in advance by the TJNAF Procurement Officer.

After Subcontract award, the SOTR will assist the Subcontractor in the interpretation of technical requirements as outlined in the contract. Any clarification provided by the SOTR concerning the work to be performed shall not be construed as a change to the Subcontract. Only the TJNAF PO is authorized to accept nonconforming work; waive any requirement of this Subcontract; or modify any term or condition of this Subcontract.

All direction from the SOTR and the PO shall be provided in writing.

SOTR: Peter Owen

Phone: 1-757-269-7746

Email: powen@jlab.org

# Applicable Documents

## Manufacturing drawings

Assembly drawings are nested up to 3 levels below the top assembly drawing for each type of tuner. The tables below list the drawings referenced by each drawing level.

| **Top Assembly** | **F10132292** |
| --- | --- |
| **Sub-Assembly Level 1** | **Sub-Assembly Level 2** | **Sub-Assembly Level 3** |
| F10006870 | F10008691 | F10006845 |
|  |  | F10007034 |
|  |  | F10018523 |
|  |  | F10042116 |
|  |  | FC0008961 |
|  |  | FC0014519 |
|  | F10037715 |  |
|  | F10037798 |  |
|  | FC0010532 |  |
|  | F10008748 |  |
|  | FC0021470 |  |
|  | FC0021488 |  |
|  | FC0049219 |  |
|  | FC0050800 |  |
|  | FC0059874 |  |
|  | FC0051653 |  |
|  | F10059090 |  |
|  | FC0018649 |  |
| F10132295 | F10007032 | F10015832 |
|  |  | F10015831 |
|  | F10132301 | F10006845 |
|  |  | F10008781 |
|  |  | F10132302 |
|  | F10008752 | F10008749 |
|  |  | F10008751 |
|  |  | F10042116 |
|  |  | FC0008961 |
|  |  | FC0014519 |
|  |  | F10006871 |
|  | F10132294 | F10132296 |
|  |  | F10008751 |
|  |  | F10008685 |
|  | F10008761 |  |
|  | F10008762 |  |
|  | F10008764 |  |
|  | F10132298 |  |
|  | F10030720 |  |
|  | F10031139 |  |
|  | F10031616 |  |
|  | F10037716 |  |
|  | F10037798 |  |
|  | FC0010532 |  |
|  | FC0010533 |  |
|  | FC0015564 |  |
|  | FC0018119 |  |
|  | FC0018654 |  |
|  | FC0021488 |  |
|  | FC0021492 |  |
|  | FC0004014 |  |
|  | FC0051653 |  |
|  | FC0045778 |  |
|  | FC0045779 |  |
|  | FC0049219 |  |
|  | FC0049222 |  |
|  | FC0050986 |  |
|  | FC0021491 |  |
|  | F10008756 |  |
|  | FC0059874 |  |
|  | FC0059875 |  |
|  | F10071030 |  |
| F10007030 | F10007027 |  |
|  | F10007028 |  |
|  | F10007029 |  |
|  | FC0049219 |  |
|  | FC0022079 |  |
|  | FC0034474 |  |
|  | FC0034475 |  |
| F10031141 |  |  |
| F10031142 |  |  |
| FC0010532 |  |  |
| FC0014519 |  |  |
| FC0015553 |  |  |
| FC0015564 |  |  |
| FC0018653 |  |  |
| FC0018654 |  |  |
| FC0046546 |  |  |
| FC0059883 |  |  |

Table 1: Applicable Documents for F10132292

| **Top Assembly** | **F10138922** |
| --- | --- |
| **Sub-Assembly Level 1** | **Sub-Assembly Level 2** | **Sub-Assembly Level 3** |
| F10138923 | F10007032 | F10015831 |
|  |  | F10015832 |
|  | F10132301 | F10006845 |
|  |  | F10008781 |
|  |  | F10132302 |
|  | F10077209 | F10006871 |
|  |  | F10008751 |
|  |  | F10042116 |
|  |  | F10077210 |
|  |  | FC0008961 |
|  |  | FC0014519 |
|  | F10132294 | F10132296 |
|  |  | F10008751 |
|  |  | F10008685 |
|  | F10008752 | F10008749 |
|  |  | F10008751 |
|  |  | F10042116 |
|  |  | FC0008961 |
|  |  | FC0014519 |
|  |  | F10006871 |
|  | F10008761 |  |
|  | F10008762 |  |
|  | F10008764 |  |
|  | F10132298 |  |
|  | F10030720 |  |
|  | F10031139 |  |
|  | F10031616 |  |
|  | F10037716 |  |
|  | F10037798 |  |
|  | FC0010532 |  |
|  | FC0010533 |  |
|  | FC0015564 |  |
|  | FC0018119 |  |
|  | FC0018654 |  |
|  | FC0018119 |  |
|  | FC0018654 |  |
|  | FC0021488 |  |
|  | FC0021492 |  |
|  | FC0004014 |  |
|  | FC0051653 |  |
|  | FC0045778 |  |
|  | FC0045779 |  |
|  | FC0049219 |  |
|  | FC0049222 |  |
|  | FC0050986 |  |
|  | FC0021491 |  |
|  | F10008756 |  |
|  | FC0059874 |  |
|  | FC0059875 |  |
|  | F10071030 |  |
| F10077237 | F10077236 | F10006845 |
|  |  | F10007034 |
|  |  | F10042116 |
|  |  | F10077217 |
|  |  | FC0008961 |
|  |  | FC0014519 |
|  | F10037715 |  |
|  | F10037798 |  |
|  | FC0010532 |  |
|  | F10008748 |  |
|  | FC0021470 |  |
|  | FC0021488 |  |
|  | FC0049219 |  |
|  | FC0050800 |  |
|  | FC0059874 |  |
| F10007030 | F10007027 |  |
|  | F10007028 |  |
|  | F10007029 |  |
|  | FC0049219 |  |
|  | FC0022079 |  |
|  | FC0034474 |  |
|  | FC0034475 |  |
| F10031141 |  |  |
| F10031142 |  |  |
| FC0010532 |  |  |
| FC0014519 |  |  |
| FC0015553 |  |  |
| FC0015564 |  |  |
| FC0018653 |  |  |
| FC0018654 |  |  |
| FC0046546 |  |  |
| FC0059883 |  |  |

Table 2: Applicable Documents for F10138922

## Applicable Codes and Standards

* All welding is to be in accordance with AWS D1.6: Structural Welding Code – Stainless Steel.

# Deliverables

## Manufactured Parts

The following assemblies are to be delivered as kits, including all sub-assemblies.

|  |  |  |
| --- | --- | --- |
| **Assembly Name** | **Drawing Number** | **Qty.** |
| ASSEMBLY , LEVER TUNER-15.66, 1.3GHz CAVITY | F10132292 | 14 |
| ASSY, LEVER TUNER-15.66, 1.3GHz CAVITY, EXTENDED ARMS | F10138922 | 2 |

Table 3: List of Manufactured Parts to be delivered by Subcontractor.

All units shall be delivered assembled according to the top assembly drawings in Table 3, and, with the exception of components listed in paragraph 6.1.1 below, packaged as “kits” as described in 6.1.6. All parts will be assembled as per the respective drawings, with the exception of those listed in paragraph 6.1.2.

Drawing numbers beginning with “FC” (e.g. FC0041219) are commercially purchased off-the-shelf components. If such a drawing is not included in the package, the Subcontractor will be expected to identify and procure the part as per the description given on the relevant assembly drawing.

### Fabrication Exceptions

The following components are not deliverables under this Subcontract:

* ACTUATOR, PIEZO – LOW TEMP AND VACUUM (FC0046546), Item 12 on drawings F1013392 and F10138922
* ELECTRIC MOTOR (FC0022079), Item 6 on drawing F10007030
* Items 2 and 9 on drawing F10077237: BRACKET1, END SWITCH and SWITCH, JAIDINGER S15-276
* Items 2 and 10 on drawing F10147498: BRACKET1, END SWITCH and SWITCH

### Assembly Exceptions

The following components should not be assembled as per the respective drawings but should be included as part of the kit for each top assembly (F10132292/F10138922).

* F10132292/F10138922: Items 2, 4, 5, and 13
* F10007030: Items 1, 2, 3, 4, 5, 7, and 8
* F10132295 and F10138923: Items 7, 9, 22 and 27
* F10077237: Items 5, 6, 7, 8, 10 and 11
* F10147498: Items 1, 7, 8, 9, 11 and 12

### Hardware requirements

* All #8-32 PHMS will be torqued to 17 in.lbs +/-2 in.lbs. All other fasteners should be tightened only by hand, or using screwdrivers
* All Silicon Bronze hardware must be of grade 651
* All hardware must be domestically sourced

### Bearing Assembly Coating

The Subcontractor must procure ball bearing assemblies from the manufacturer/distributor in a degreased condition. Two bearings of each size will be delivered to TJNAF for inspection prior to Tuner assembly at the Subcontractor. A suggested source for degreased bearing assemblies is Motion Industries. Prior to installation in the final assemblies, the bearing assemblies must be Dicronite coated. Documentation of the delivered bearings having been coated must be provided to TJNAF at the time of the first delivery.

### Bearing Fit Check

Ensure that the bearing (FC0045779) in drawing F10147499 ASSY, MAIN LEVER has a slight slip fit between parts F10132294 WELDMENT, MAIN LEVER HINGE and F10147500 WLDMT, TUNER SUPPORT. This can be ensured by checking the inner diameter in detail B of F10132296 HOLDER BEARING is within the written specification of 26mm +2/-0 mm.

### Kit Configuration

Each completed assembly (F10132292/F10138922) and associated hardware will be boxed and shipped as a “kit” within the larger package or pallet etc. The kits will each have the serial number (see Section 11.2) clearly visible after opening the crate (or equivalent packaging). The intent is that all parts associated with each assembly located together for ease of accountability.

## Manufacturing Documentation Package:

The Subcontractor shall provide a documentation package with delivery that consists of objective evidence of compliance with Subcontract requirements. This package shall be complete, legible, indexed and traceable (as per serialization requirements in Section 10.3) to the item supplied and shall contain the following:

* Copies of reports of all required inspections, examinations and tests, properly validated by the Subcontractor’s authorized personnel, including proof of Dicronite coating on bearing assemblies
* A listing of the as-built configuration of the delivered item, which shall be defined by use of drawing numbers and revisions, unique parts lists or other such means of positive identification.
* Copies of Certified Material Test Reports must be provided for specified materials, showing mechanical and chemical properties.
* A Manufacturing Certificate of Compliance, signed by the Subcontractor’s Quality Assurance/Control Manager, stating that the supplied items conform in every respect to physical configuration and functional requirements of the Subcontract.

# Government-Furnished Equipment and Material (if applicable)

List the materials and/or equipment provided to the Subcontractor to aid in the completion of the contract. List in bullet form; examples include:

* Raw material
* Sub-assemblies to be modified (drawings should be included in Section 4, Table 1)

# Delivery Schedule

The Subcontractor shall agree to meet the delivery schedule shown in Table 4.

Delivery can be split into two lots, each containing 7 kits of F10132292 and 1 kit of F10138922. The two lots may be delivered together or separately, as long as they individually meet the lead time in Table 4. All parts shall be delivered to TJNAF, at the address in 11.3.

|  |  |  |
| --- | --- | --- |
| **Lot** | **Quantity to TJNAF** | **Lead Time** |
| 1 | 8 | 12 weeks ARO |
| 2 | 8 | 16 weeks ARO |

Table 4: Delivery Schedule

# After Award of Contract

The following documents must be provided to TJNAF no later than one week after award. In some cases, TJNAF may request one or all of these documents during the bidding process in order to gauge the Subcontractor’s capabilities.

* Quality Manual
* Welding and brazing documents (e.g. BPS, BPQR, WPS, WPQR)
* Manufacturing Plan
* Inspection Plan

# Meetings

## Kick-Off Meeting

Within 1 week after award of contract, TJNAF will schedule a Kick-Off Meeting with the Subcontractor. The meeting will include discussion of the following items:

* Technical objectives, requirements and specifications
* Fabrication, assembly, inspection and test plans, and documentation plans and status
* Identification of Mandatory Inspection Points (MIPs) and Milestones
* Assessment of risk areas and issues/concerns
* Shipping plan

## Production/Work Readiness Review

The Subcontractor shall hold a Production Readiness Review with TJNAF representatives at the Subcontractor’s facility, prior to the start of manufacturing; TJNAF reserves the right to hold this review via teleconference. It is required to provide assurance that the Subcontractor has the necessary plans and procedures for manufacturing the Tuner Assemblies. Five working days prior to the review, the Subcontractor shall provide the following documents for review:

* Final delivery schedule
* Procurement plan
* Fabrication plan
* Inspection and Test Plan (see Section 10.2)

# Inspection and Test Plan

The Inspection and Test Plan shall be discussed at the Kick-Off meeting, agreed upon and approved at the Production Readiness Review and shall be filled out during manufacturing.

At each production stage, inspection planning shall be prepared. Manufacturing planning with inspection points shall be available for TJNAF review upon request. The plan shall describe:

* The fabrication steps required
* Receiving inspection, in-process and end item inspection points
* References to applicable inspection criteria

For each inspecting activity, the procedure and accept/reject criteria shall be documented.

|  |  |  |
| --- | --- | --- |
| **Measurement** | **Nominal Value** | **Allowable Range** |
|  |  |  |

Table 5: Required tests

# Subcontractor Instructions

## Cleanliness

* The assembly process should be done in a clean, minimal-dust environment. Metal dust generation should be minimized during assembly. Particular care must be given to avoid any dust generation near the bearings.
* The Tuner assemblies shall be thoroughly cleaned of all scale, spatter, flux, lubricants and foreign materials prior to shipment. Cleaning agents suitable for the materials of construction shall be used, and if necessary, shall be neutralized. Complete drying shall follow cleaning. The Subcontractor shall be responsible for the selection and use of any and all appropriate means to accomplish this result.

## Serialization

The Subcontractor shall engrave a unique serial number (only on the outside surface of F10077217 and F10018523) in a manner visible on the top assembly, according to the following naming convention:

XXXXXX-R-SSSS

|  |  |
| --- | --- |
| Where: |  |
| XXXXXXXXXX = | Top Assembly Part Number  |
| R = | Drawing Revision |
| SSSS = | Serial number of the part |
| For Example: | The ninth tuner (F10138922 Rev-B) fabricated shall be marked: F10138922-B-0009 |

# Preparation for Delivery

This section outlines the requirements for physical delivery to TJNAF. This section does not apply to services. Use the following as a guideline:

## Exterior Packaging

* The Subcontractor shall provide proper protection from shipping loads and environmental damage during transportation, loading, unloading, and storage.
* The Subcontractor shall assume all responsibilities, risks, labor, transportation and other costs for shipment of the tuner assemblies.
* The Subcontractor shall use any viable shipping means necessary to meet the required delivery schedules. However, due to the importance of maintaining program schedule, in cases of orders returned for rework or deliveries that, for whatever reason, exceed or are expected to exceed contracted scheduled delivery dates, the Subcontractor shall provide for no longer than 2-day shipping.

## Individual Packaging

### Kits

Each tuner frame kit shall be boxed and labeled in the following format:

L2RB CAVITY TUNER FRAME

PO# XXXXXX

[SERIAL NUMBER]

LOT: XX

SHIPMENT DATE: MM/DD/YYYY

As an example, if this contract is given the PO# 12354, and the serial number is 0011 (Rev C) and is shipped with the 2nd lot, then the label will be as follows:

L2RB CAVITY TUNER FRAME

PO# 12345

F10138922-C-0011

LOT 2

SHIPMENT DATE: 03/26/2025

### Individual Parts

Within each kit, all parts must be bagged and sealed.

* All bags will be labeled with the relevant drawing name and number (including hardware)
* Bags with unassembled parts from sub-assemblies shall be contained within their upper assembly bag in each kit
* Hardware of the same type can be stored in the same bag in each sub-assembly bag

Example with reference to Table 2:

* All unassembled parts from F10007030 will be individually bagged and labeled, with a bag for each Item number
* The labeled bags will be bagged together in a bag labeled F10007030 ASSEMBLY, MOTOR BLOCK
* The F10007030 will be delivered within the bag containing its upper assembly (i.e F10132292)

## TJNAF Delivery Address

Use the following format for the delivery address labeling:

L2RB CAVITY TUNER FRAME

[PART NAME] – [DRAWING NUMBER]

[SHIPMENT LOT#]

PO# XXXXX

Attention: Mike Dickey (ext. 7755) / Peter Owen (ext. 7746)

Jefferson Lab

12000 Jefferson Ave

Newport News

VA, 23606, USA

# Release and Revision History

|  |  |  |
| --- | --- | --- |
| **Rev #** | **Major Changes** | **Approval Date:** |
| - | Initial version. Adapted from LCLSII-HE order to LCLSII-CMRB order. This involved decreasing the quantities of kit assemblies and spares, and only delivering parts TJNAF. | DD Mmm YYYY |
|  |  |  |

# Approvals

|  |  |  |  |
| --- | --- | --- | --- |
| **Approved by:** | **Name:** | **Signature:** | **Date:** |
| Author | Peter Owen | In DocuShare |
| SOTR | Peter Owen | In DocuShare |
| Quality Engineer | Ashley Mitchell | In DocuShare |
| CAM  | Adam Grabowski | In DocuShare |