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| **L2HE Cryomodule Assembly Alignment Procedure** |
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| **Document Owner:** | Steve Hardisty/John Fischer | **Department Owner:** | SRF Ops |
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# Purpose and Scope

The purpose of this document is to describe the Alignment Procedure when assembling the L2HE Cryomodules. The work begins after the Cold Mass has been inserted into the Vacuum Vessel and roughly aligned by the CMA Technical Staff. The Alignment data is captured in the Alignment Spread Sheet and uploaded into the appropriate Assembly Traveler for record.

# Terms, Definitions, and Reference Docs

Cold Mass-partial assembly the includes the upper cold mass and cavities

Vacuum Vessel- weldment that houses the Cold Mass

[F10127855\_A\_CM Top Assy Dwg](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-261916/F10127855_A_DWG1.pdf)

[F10127864-A-Cold Mass Dwg](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-261917/F10127864-A-DWG1.pdf)

# Roles and Responsibilities

The following actions are to be performed by knowledgeable, authorized Technicians only. Consult the Group Lead for details.

# Procedure

**PROCEDURE TO ALIGN COLD MASS ASSEMBLY INSIDE VACUUM VESSEL AND FIDUCIALIZE CRYOMODULE**

**INITIAL EACH STEP WHEN COMPLETE**

 Lock down VV assembly to floor rails to prevent from moving during alignment.

 Clean fiducial holes to ensure the shoulder of survey nests sit properly against the fiducial block.

 Label fiducial holes.

\_\_\_\_\_\_ Make sure lock down bolts contact VV completely when screwed in.

 Ensure that no more than six threads are exposed on the inner and outer adjusters of the bottle jacks supporting the VV. There is no stop built into these jacks and they can disengage causing the VV to topple over. Locate 4 hydraulic jacks under VV support holes to position the load as installed in beam line. Shim packs can be placed above jack under support hole.

 Take roll out of VV top ports using precision level. Set pitch normal to gravity using a laser tracker in a gravity frame. Tolerance is **<0.10 mm** coplanar to perpendicular gravity using final tracker shots measuring pitch and roll.

 Make sure all 4 support jacks have equal pressure.

 While observing with tracker, perform a “shake test” to make sure vessel is not rocking or moving in Z. Correct issues and repeat leveling process if necessary.

 Establish right handed coordinate system + X is to the beam left, Y is up, Z is downstream using VV fixed end flanges for the Z axis and plane of top ports to fix roll. The coupler 5 port’s circle bolt pattern at **421.4 mm** sets the Z origin. DO NOT USE STRING Z OF 421.7. Twelve equally spaced measurements around the end flanges and 4 equally spaced Y measurements on each VV port along outer perimeter (12 total) to establish roll plane. This requires “walking around” the vessel with the tracker. Fiducials should be measured from at least 2 setups and checked for repeatability measuring from 3rd setup if necessary.

 Measure all 8 coupler port bolt hole circles and the top center of the VV post’s inside circle to determine if Z=0 needs to shift for maximum clearance.

 Using the fiducial data from the UCM/string alignment, set the pitch, roll, and height of each of the 3 UCM/CS top hats. Make sure the Top Hat horizontal adjusters are backed off. While setting roll and height, start with the farthest out from ideal making small movements consecutively between each top hat to ensure CS does not twist. Tolerance is **<0.10 mm** coplanar and **<0.25 mm** centering.

 Align UCM/CS along Z using center top hat fiducial. Bring Top Hat horizontal adjusters up to bare and back off slightly before moving. This ensures the string does not twist. Tolerance **<0.25 mm**.

 Align Top Hats horizontally starting with furthest out making small movements consecutively between the 3. Tolerance is **<0.10 mm collinear, and 0.25 mm position**. Make sure that Ideal X location of center top hat fiducial is obtained from UCM/string alignment survey.

 Check XYZ alignment and fine tune if necessary.

 Lock all vertical adjuster nuts. Lock all center Top Hat horizontal adjuster bolts and nuts. Lock both sets of outboard horizontal adjuster bolts to finger tight. Lock the horizontal adjuster nuts in place. Note that 2 wrenches are need to be used to fix the bolt while the nut is locked. The 2 outboard Top hats must be allowed to “shrink” when cold.

 Have a second person check that all bolts and lock nuts are making contact and locked in correctly.

 Check XYZ alignment and repeat all steps of UCM alignment if necessary. The VV top ports should be checked for roll using the precision level to ensure no twisting was caused form CS alignment.

 After final alignment is complete, survey UCM/CS top hats.

 Measure vacuum vessel top posts height and inside diameter.

 Measure GHRP’s.

 Measure UCM feedthrough pipes (6 each end).

 Measure gate valve flanges (XYZ), and fiducials on each valve.

 Measure cavity couplers XYZ at beam right cap. (8 total)

 Make sure all vacuum vessel fiducials are measured at least 2 times with good geometry.

 Process the data and fill in a report.

# **Release and Revision History**

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| Rev # | Revision or update: | Effective: |
| A | Initial version | 7/8/2023 |
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# **Approvals**

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| --- | --- | --- |
| Approved by: | Signature: | Date: |
| **Document Owner/Align Lead** | Steve Hardisty |  |
| **Cryomodule Group Lead** | John Fischer |  |
| **Secondary Reviewer CMA** | Jeff Campbell |  |
| **Alignment Group Representative** | Robert Mares |  |