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| Traveler Title | LCLS HE Production Cryomodule Assembly Traveler Cold Mass Phase 1 | | | |
| Traveler Abstract | This traveler details the assembly and in-process quality control inspections of the LCLS HE Cold Mass Phase 1. All work will be completed in the Cryomodule Assembly areas and performed by authorized and trained personnel. The scope of work begins with a completed, delivered Cavity String and ends with an assembly ready to move under the 4 poster for Phase 2 work. | | | |
| Traveler ID | L2HE-CMA-CM-ASSY1 | | | |
| Traveler Revision | R1 | | | |
| Traveler Author | J. Fischer | | | |
| Traveler Date | 12-Apr-22 | | | |
| NCR Informative Emails | areilly,hogan | | | |
| NCR Dispositioners | fischer,jjcamp | | | |
| D3 Emails | areilly,fischer,hogan,jjcamp | | | |
| Approval Names | J. Fischer | J. Campbell | A. Reilly | J. Hogan |
| Approval Signatures |  |  |  |  |
| Approval Dates |  |  |  |  |
| Approval Title | Author/Group Lead | Technical Reviewer | SRF Dept Head | Project Lead |

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| References | List and Hyperlink all documents related to this traveler. This includes, but is not limited to: safety (THAs, SOPs, etc), drawings, procedures, and facility related documents. | | | |
| [PQR026-WPS026 Orbital Welding](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-115429/PQR026-WPS026.pdf) | [PQR027-WPS027 Orbital Welding](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-115431/PQR027-WPS027.pdf) | [F10127865\_D\_DWG1 Cavity String](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254210/F10127865_D_DWG1-%20Cavity%20String-Cold%20Mass1.pdf) | [F10009375-U-DWG1-Magnet pkg](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254204/F10009375-U-DWG1-Magnet.pdf) | [F10144930- CM P&ID](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254211/F10144930---(UPDATED%2019feb2021)_COLOR_SHEET1.pdf) |
| [F10020678-anti roll bracket](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-134844/F10020678-%20anti%20roll%20bracket%202.pdf) | [Risk Assessment Matrix 1.2](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-165074/Risk%20Assessment%20and%20MitigationRev1.2.xlsx) | [Master Threaded Fastener List](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-154981/Cryomodule_Threaded_Fasteners_20180406.xlsx) | [WS2 Fastener Views](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-159378/LCLS%20II%20-%20WS2-%20PPT.pptx) | [WS2 Threaded Fastener Sign Off](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-154983/Workstation%202%20signoff.docx) |
| [F10015802\_F\_DWG1- HV Weldment](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254205/F10015802_F_DWG1-%20HV%20Weldment.pdf) | [WS2 Threaded Fastener List](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-154982/Wokstation%202%20Torque.xlsx) | [F10048652-G-DWG1- HV Magnetic Shielding](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254206/F10048652-G-DWG1-%20HV%20Magnetic%20Shielding.pdf) | [F10151272-A-DWG1- HV Magnetic Shielding Cav 1](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254207/F10151272-A-DWG1-%20HV%20Magnetic%20Shielding%20Cav%201.pdf) | [F10151275-A-DWG1- HV Magnetic Shielding Cav 6](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254208/F10151275-A-DWG1-%20HV%20Magnetic%20Shielding%20Cav%206.pdf) |
| [L2HE Cavity String Inspection Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254227/Cavity%20string%20inspection%20procedure.docx) | [L2HE Cavity String Fiducial Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254226/Cavity%20string%20fiducial%20procedure.docx) | [L2HE SPQA Fiducial Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254228/Inspection%20of%20FERMI%20LCLSII%20quads.docx) | [L2HE SPQA Prealignment Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254229/SPQA%20Prealignment%20procedure.docx) |  |

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| Revision Note |  |
| R1 | Initial release of this Traveler. |

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| Step No. | Instructions | Data Input |
| 1 | Record the Cavity String S/N and vacuum level  Note: The L2HE Cryomodule assembly has many vulnerable components. Bellows in every vacuum circuit and process piping, feedthrus for the HOM's and Field Probe, and multiple interference points. The attached Risk Matrix identifies these in more detail and must be understood prior to performing any work. | [[CMSN]] <<CMSN>>  [[CSTSN]] <<CSTSN>>  [[VacuumLevel1]] <<TEXT>>  [[StartTech]] <<SRF>>  [[StartDate]] <<TIMESTAMP>> |
| 2 | Transfer the Cavity String from the clean room to the Cryomodule Assembly rails. The L2HE Cavity string is configured slightly different than L2, with a NEG and Ionpump installed on the down stream end of the string and Faraday on the upstream as shown in the model views below.  Use procedure [CP-L2PRO-CST-TSFR-CS Transfer Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-104430/CP-L2PRO-CST-TSFR-R1.pdf)    cid:25caed65-7b49-4090-a2d3-058704b1f6da  cid:f4b87859-ac30-4572-921e-981b61e048d5  cid:9fb90456-5067-440b-8efb-6011aa4f4d98 | [[TransferTech]] <<SRF>>  [[TransferDate]] <<TIMESTAMP>>  [[TransferComment]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 3 | Record the Cavity and BPM Feedthrough S/N's. Cavity position 1 is South on the Cryomodule Assembly rail. | [[RecordSNTech]] <<SRF>>  [[RecordSNDate]] <<TIMESTAMP>>  [[CAVSN1]] <<CAVSN>>  [[CAVSN2]] <<CAVSN>>  [[CAVSN3]] <<CAVSN>>  [[CAVSN4]] <<CAVSN>>  [[CAVSN5]] <<CAVSN>>  [[CAVSN6]] <<CAVSN>>  [[CAVSN7]] <<CAVSN>>  [[CAVSN8]] <<CAVSN>>  [[BPMTOP]] <<BPMSN>>  [[BPMWALL]] <<BPMSN>>  [[BPMBOTTOM]] <<BPMSN>>  [[BPMAISLE]] <<BPMSN>>  [[RecordSNComment]] <<COMMENT>> |
| 4 | Record the Cavity String vacuum level after moving is completed. | [[VacTech]] <<SRF>>  [[VacDate]] <<TIMESTAMP>>  [[VacComment]] <<COMMENT>>  [[VacuumLevel2]] <<TEXT>> |
| 5 | Use the WS2 Fastener Spreadsheet and sign off to complete the steps in the traveler.  [WS2 Threaded Fastener List](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-154982/Wokstation%202%20Torque.xlsx), [WS2 Threaded Fastener Sign Off](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-154983/Workstation%202%20signoff.docx), [WS2 Fastener Model Views](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-159378/LCLS%20II%20-%20WS2-%20PPT.pptx) | [[WS2FastnerTech]] <<SRFCMP>>  [[WS2FastnerDate]] <<TIMESTAMP>>  [[WS2FastnerComment]] <<COMMENT>> |
| 6 | Visually inspect the Cavity String Assembly, use [F10127865\_D\_DWG1 Cavity String](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254210/F10127865_D_DWG1-%20Cavity%20String-Cold%20Mass1.pdf) as the reference. Note any anomalies and notify lead personel. | [[VisualTech]] <<SRF>>  [[VisualDate]] <<TIMESTAMP>>  [[VisualComment]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 7 | Install the bellows protectors on all the exposed bellows. Use the rubber and metal combination as shown below. Finally, add the Red and White "**DANGER**" tape, which is a visual signifier that bellows are located in that area. | [[ProtectorsTech]] <<SRF>>  [[ProtectorsDate]] <<TIMESTAMP>>  [[ProtectorsComment]] <<COMMENT>>  [[QCReviewBellowsCovers]] {{fischer,jjcamp}} <<HOLDPOINT>> |
| 8 | Install the HOM Cu heat stationing clamp with .004" indium foil and cable saver. **Do not torque at this time. Instrumentation will be added at WS3**. | [[HOMCuTech]] <<SRF>>  [[HOMCuDate]] <<TIMESTAMP>>  [[HOMCuComment]] <<COMMENT>> |
| 9 | Perform RF checks; measure the Cavity passbands and HOM notch frequencies. RF Technician to upload the results. The Cavity String is evacuated. | [[RFTech]] <<SRF>>  [[RFDate]] <<TIMESTAMP>>  [[RFComment]] <<COMMENT>>  [[RFUpload]] <<FILEUPLOAD>> |

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| Step No. | Instructions | Data Input |
| 10 | Install the anti roll brackets onto each cavity. Secure and lock down.  [F10020678-Anti roll bracket](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-134844/F10020678-%20anti%20roll%20bracket%202.pdf) | [[AntiRollTech]] <<SRF>>  [[AntiRollDate]] <<TIMESTAMP>>  [[AntiRollComment]] <<COMMENT>> |
| 11 | Install the helium vessel heaters on cavities 1 thru 8.  Measure resistance of all heaters after installation (Prior to epoxy curing and repair/replace now if necessary) | [[SRFTMTech]] <<SRFTM>>  [[SRFTMDate]] <<TIMESTAMP>>  [[SRFTMComment]] <<COMMENT>> |
| 12 | Install the Berry bolts   * Install the Cold Coupler Flange support tooling * Install the CC 50K shield assy's * Attach the 5K clamp assy, use .004 indium at the interface to the coupler * Verify the 5k clamp rotation is correct, then install the Berry bolts * Finally, install the berry bolt sleeves, lock all hardware down and verify. * Remove the support fixture   Use [Berry Bolt Installation Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-152813/PROCEDURE%20FOR%20BERRY%20BOLTS%20INSTALL.docx) to perform the task.  [JL0029137 Berry Bolt Assy Dwg](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-152816/JL0029137-Berry%20Bolt%20Assembly.pdf), [JL0029139 Rev A- Berry Bolt](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-152814/JL0029139_A_PDF_1-%20BERRY%20SPECIAL%20BOLT.pdf), [JL0033287-Berry Bolt Stud](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-152815/JL0033287--Special%20Stud-BERRY.pdf)  \*\***Bolts should spin in easily by hand, adjust the 5 k clamp as required\*\*** | [[BerryBoltsTech]] <<SRF>>  [[BerryBoltsDate]] <<TIMESTAMP>>  [[BerryBoltsComment]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 13 | Install the main coupler platinum RTDs  Measure the resistance of all RTDs after the installation (Prior to epoxy curing and repair/replace now if necessary)  **Tighten the cold coupler 50k shield hardware before the epoxy cures. Restrain the leads.** | [[RTDTMTech]] <<SRFTM>>  [[RTDTMDate]] <<TIMESTAMP>>  [[RTDTMComment]] <<COMMENT>> |
| 14 | Verify the alignment of the Magnet/BPM Beamline Spool and adjust as needed. This is done prior to Magnet installation to improve fitup and use of the magnet tooling. Use [L2HE SPQA Fiducial Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254228/Inspection%20of%20FERMI%20LCLSII%20quads.docx), and [L2HE SPQA Prealignment Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254229/SPQA%20Prealignment%20procedure.docx) to complete this work. | [[MagAlignTech]] <<SRF>>  [[MagAlignDate]] <<TIMESTAMP>>  [[MagAlignComment]] <<COMMENT>> |
| 15 | Install and align the magnet tooling base to the cavity carriage tooling.The two halves of the split magnet will be installed around the Beam Line Spool tube. To begin, attach two hooks from the overhead crane to the two lifting lugs on the top of the split magnets and carefully lift the halves. Afix the support tray halves to the magnet halves then lower the split magnet onto the Transportation Cradle. Ensure that the lead clamps are facing away from the string assembly and flange. Move the magnet halves close to the spool tube, adjust the tooling as needed so the magnet bore is centered around the Spool. Lock in position with the locking screws. Remove the hooks and repeat the process until the halves meet and the assembly is centered. Secure together with 4 bolts ([FC0006126](https://vector-offsite.fnal.gov/TeamcenterDocumentLookup.asp?qsdocumentID=FC0006126)) two on each side per drawing [F10009375-U-DWG1-Magnet pkg](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254204/F10009375-U-DWG1-Magnet.pdf), Torque to 20 FT/LBS, as required in the Fastener Spread Sheet.  Note\*\*\*It is important to handle the Magnet leads carefully as they are fragile. | [[MagToolingTech]] <<SRF>>  [[MagToolingDate]] <<TIMESTAMP>>  [[MagToolingComment]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 16 | Attach the magnet to the BPM flange and ensure that the sliding tooling is locked.  \*\*\***It may be necessary to shim the magnet face or machine the hardware to achieve magnet alignment and roll\*\*\*** | [[MAGSN]] <<MAGSN>>  [[MAGTech]] <<SRF>>  [[MAGDate]] <<TIMESTAMP>>  [[MAGComment]] <<COMMENT>> |
| 17 | Verify the alignment of the Beamline and Couplers using the L2HE Cavity String Procedures linked here. [L2HE Cavity String Inspection Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254227/Cavity%20string%20inspection%20procedure.docx), and [L2HE Cavity String Fiducial Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254226/Cavity%20string%20fiducial%20procedure.docx).  Align the magnet using the fiducial points and 4 carriage support studs. Once aligned, torque the interface hardware to 130 in/lbs. Use the Fastener Spread Sheet to achieve proper installation. | [[BLAlignTech]] <<SRF>>  [[BLAlignDate]] <<TIMESTAMP>>  [[BLAlignComment]] <<COMMENT>>  [[BLAlignUpload]] <<FILEUPLOAD>> |

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| Step No. | Instructions | Data Input |
| 18 | Install the 2 phase piping, it will be necessary to trim to fit. Welding to be done to LCLS2 Welding Procedures. Record the 2 phase bellows SN's and locations on the weld map.  Sub-assy's should be bench welded prior, using the orbital welder, including the Vortex, [F10074117- Vortex Assy](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-152818/F10074117___DWG1-%20VORTEX%20DWG.pdf)  Ends of 2 phase piping will need to be supported with temporary stands. | [[BP2PHSN]] <<BP2PHSN>>  [[BP2PHTech]] <<SRF>>  [[BP2PHDate]] <<TIMESTAMP>>  [[BP2PHComment]] <<COMMENT>>  [[QC2PhaseBellows]] {{fischer,jjcamp}} <<HOLDPOINT>> |
| 19 | Extend the 2 phase internal instrumentation (He LL) to accommodate the 2 phase pipe installation. Measure the resistance of the He LL after welding to verify.  **Note- DR11357,** [LLP Verification](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-152817/LLP%20Verification.pdf) | [[HeLLTech]] <<SRF>>  [[HeLLTMTech]] <<SRFTM>>  [[HeLLDate]] <<TIMESTAMP>>  [[HeLLComment]] <<COMMENT>> |
| 20 | Visually inspect all welds and complete the Weld Documentation. Upload the worksheets. Use ASME 31.3 for code compliance | [[WeldInspectTech]] <<SRF>>  [[WeldInspecDate]] <<TIMESTAMP>>  [[WeldInspecComment]] <<COMMENT>>  [[WeldInspecUpload]] <<FILEUPLOAD>> |
| 21 | Cover the Heater with Ti sheet and tack weld.  \*\* Leave 1" of the heater exposed on the **non-wire side** for mounting of the RTD.\*\* | [[HeaterTech]] <<SRF>>  [[HeaterDate]] <<TIMESTAMP>>  [[HeaterComment]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 22 | Install RTDs\_ HeVessel-TOP **(Cavities 1 and 5 only)**  Install RTDs\_ HeVessel- BTM **(Cavities 1 and 5 only)**  Measure resistance of all RTDs after installation (Prior to epoxy curing and repair/replace now if necessary) | [[RTDHeTMTech]] <<SRFTM>>  [[RTDHeTMDate]] <<TIMESTAMP>>  [[RTDHeTMComment]] <<COMMENT>> |
| 23 | Leak check the He circuit. \*\*\***Be sure all restraints are in place prior to evacuation**\*\*\* Upload the results. Will consist of 2 leak checks. Cavities 1-4, and 5-8.  Backfill 2 phase pipe with filtered N2. Cap ends.  [11141S0029\_2e-10 Leak Check Spec](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254223/11141S0029%202e-10%20Leak%20Check%20Final.pdf), [/11141S0033\_1e-9 Leak Check Spec](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254222/11141S0033%201e9%20Leak%20Check%20Final.pdf)  **\*\*\*Note- Bellows protection must be removed during the installation of the bellows restraints. This work is to be performed by Authorized Technicians only and bellows will be inspected after the leak check and restraints are removed. The bellows is to be recovered as in Step 7.\*\*\*** | [[LKCKTect]] <<SRF>>  [[LKCKDate]] <<TIMESTAMP>>  [[LKCKComment]] <<COMMENT>>  [[LKCKUpload]] <<FILEUPLOAD>>  [[QCBellowsAfterRemoval]] {{fischer,jjcamp}} <<HOLDPOINT>> |

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| Step No. | Instructions | Data Input |
| 24 | Wrap the helium vessels with 10 layers of MLI.(Thermolan)  \*\*The He Vessel RTDs on cavities 1 and 5 (TOP and BTM) should remain uncovered during MLI application.\*\*  **Trim the excess MLI around the HV bellows support lugs.**  [JLAB MLI Installation Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-115267/MLI%20Installation-CP-C100-CM-INST-MLI.docx)  **\*\*\*Note- Bellows protection must be removed during the installation of the MLI. This work is to be performed by Authorized Technicians only and the bellows is to be recovered as in Step 7. A post visual inspection of the entire bellows can not be done, due to being covered. Visually inspect available areas. \*\*\*** | [[MLITech]] <<SRF>>  [[MLIDate]] <<TIMESTAMP>>  [[MLIComment]] <<COMMENT>>  [[QCBellowsAfterMLI]] {{fischer,jjcamp}} <<HOLDPOINT>> |

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| Step No. | Instructions | Data Input |
| 25 | Install the Cavity Magnetic shields. Refer to "LCLS2 Magnetic Shield Installation" [464267 FNAL Mag Shield Rev 8](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-152829/464267%20Magnetic%20Shielding_V8.pdf). Shield package includes the HV lug cap and center section on the coupler side 2nd layer. Record the SN and vendor for each cavity.  [F10048652-G-DWG1- HV Magnetic Shielding](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254206/F10048652-G-DWG1-%20HV%20Magnetic%20Shielding.pdf), [F10151272-A-DWG1- HV Magnetic Shielding Cav 1](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254207/F10151272-A-DWG1-%20HV%20Magnetic%20Shielding%20Cav%201.pdf), [F10151275-A-DWG1- HV Magnetic Shielding Cav 6](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-254208/F10151275-A-DWG1-%20HV%20Magnetic%20Shielding%20Cav%206.pdf)  **Note: Middle section of second layer and endcaps are not installed at this step**.  **\*\*\*Note- Bellows protection must be removed during the installation of the Magnetic Shielding. This work is to be performed by Authorized Technicians only and the bellows is to be recovered as in Step 7. A post visual inspection of the entire bellows can not be done, due to being covered. Visually inspect available areas. \*\*\*** | [[MAGShieldTech]] <<SRF>>  [[MAGShieldDate]] <<TIMESTAMP>>  [[MAGShieldComment]] <<COMMENT>>  [[MAGShieldMap]] <<FILEUPLOAD>>  [[QCBellowsAfterMAGShield]] {{fischer,jjcamp}} <<HOLDPOINT>> |
| 26 | Install the Fluxgates between 1st and 2nd layers of HV magnetic shielding at specific locations. | [[FluxgatesTMTech]] <<SRFTM>>  [[FluxgatesDate]] <<TIMESTAMP>>  [[FluxgatesComment]] <<COMMENT>> |

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| Step No. | Instructions | Data Input |
| 27 | Record all instrumentation values. | [[InstrumentTMTech]] <<SRFTM>>  [[InstrumentDate]] <<TIMESTAMP>>  [[InstrumentCommen7]] <<COMMENT>>  [[InstrumentationUpload]] <<FILEUPLOAD>> |
| 28 | Upload the completed WS2 Threaded Fastener Sign Off sheet. Note any deviations. | [[WS2SignoffTech]] <<SRFCMP>>  [[WS2SignoffDate]] <<TIMESTAMP>>  [[WS2SignoffComment]] <<COMMENT>>  [[WS2SignoffFastenerSheet]] <<FILEUPLOAD>> |
| 29 | Cold Mass Phase 1 assembly is complete, ready for Phase 2 | [[CMASSDoneTech]] <<SRF>>  [[CMASSDoneDate]] <<TIMESTAMP>>  [[CMASSDoneComment]] <<COMMENT>>  [[CMASSDoneChecklist]] <<FILEUPLOAD>>  [[CMASSDoneVerify]] {{fischer,jjcamp}} <<HOLDPOINT>> |