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| Traveler Title | Cavity Vertical Testing |
| Traveler Abstract | Cryogenic RF testing of JLEIC |
| Traveler ID | SRFRD-VTA-CAV-VTRF-JLEIC |
| Traveler Revision  | R1 |
| Traveler Author | SUBA |
| Traveler Date | 6-Mar-23 |
| NCR Informative Emails |  |
| NCR Dispositioners |  |
| D3 Emails |  |
| Approval Names | SUBA | JTKENT | KDAVIS |  |
| Approval Signatures |  |  |  |  |
| Approval Dates |  |  |  |  |
| Approval Title | Author | Reviewer | Reviewer | Project Manager |

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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. |
| [VTA SOP](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-20642/VTA%20Cryo%20Use%20Procedures.pdf) | [C100R VTA Test Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-245459/C100R-PR-VTA-CAV-VTRF-R2.pdf) | [VTA Cavity Test Data Processing Template](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-247085/VTRF_Data_Processing_Spreadshet_Templete.xlsm) |  |  |
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| Revision Note |  |
| R1 | Initial release of this Traveler. Based on C100R-CAV-VTRF-R3 |

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| Step No. | Instructions | Data Input |
| 1 | Input C100 CEBAF 7-cells cavity ID.Note any special handling, processing (chemistry or bake) or off-normal conditions associated with this cavity before test. | [[CAVSN]] <<CAVSN>>[[SpecialHandling]] <<COMMENT>> |
| 2 | Enter the LabView file name, without special characters. (Valid example: C100-RI-045\_YYMMDD.txt). | [[LabviewFile]] <<TEXT>> |
| 3 | Record Test Date, Dewar No, Top Plate ID and Operator(s). | [[TestDate]] <<TIMESTAMP>>[[Dewar]]{{3,4,5,7,8}} <<SELECT>>[[VTATSSN]]<<VTATSSN>>[[TestOperator1]] <<VTAOPS>>[[TestOperator2]] <<VTAOPS>>  |
| 4 | Record cavity vacuum pressure, if so instrumented.If during cooling down a lambda leak of 5x10-6 mbar or greater at 2.07K is identified:* choose option No for Cavity Vacuum OK
* record pertinent information in the Cavity Vacuum Comment
* abort RF power test
* launch NCR
 | [[CavityVacuum]] <<SCINOT>>[[VacuumUnit]]{{mBarr, Torr}} <<SELECT>> [[CavityVacuumOK]] <<YESNO>>[[CavityVacuumComment]] <<COMMENT>> |
| 5 | Record Dewar helium bath liquid level, temperature and baratron pressure.Do not continue unless Dewar LHe level is above the end group.Start cavity testing at (29+/-0.1) Torr, which corresponds to about 2.07K.  | [[DewarLHeLevelcm]] <<FLOAT>>(cm)[[DewarTempK]] <<FLOAT>>(K)[[DewarPressureTorr]] <<FLOAT>>(Torr) |
| 6 | Zero power meters then calibrate cables at cavity fundamental frequency as specified in the1497 MHz VTA RF Testing Procedure[.](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-48113/CP-C100-CAV-VTRF-R2.docx) If the NO radio button is chosen, launch D3 and record pertinent information.  | [[PowermetersZeroed]] <<YESNO>>[[CableCalibrationOK]] <<YESNO>>[[CableCalibrationComment]] <<COMMENT>> |

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| **Step No** | **Instructions** | **Data Inputs** |
| 7 | Perform Pi Mode measurements using a network analyzer in accordance with the 1497 MHz VTA RF Testing Procedure.Example of cavity mode frequencies: |  |
| 7\_7Pi = 1496.7075 MHz  | [[Freq\_7\_7Pi]] <<FLOAT>>(MHz) |
| 6\_7Pi = 1495.4688 MHz  | [[Freq\_6\_7Pi]] <<FLOAT>>(MHz) |
| 5\_7Pi = 1492.0414 MHz  | [[Freq\_5\_7Pi]] <<FLOAT>>(MHz) |
| 4\_7Pi = 1487.1299 MHz  | [[Freq\_4\_7Pi]] <<FLOAT>>(MHz) |
| 3\_7Pi = 1481.7767 MHz  | [[Freq\_3\_7Pi]] <<FLOAT>>(MHz) |
| 2\_7Pi = 1476.9200 MHz  | [[Freq\_2\_7Pi]] <<FLOAT>>(MHz) |
| 1\_7Pi = 1473.6405 MHz  | [[Freq\_1\_7Pi]] <<FLOAT>>(MHz) |
| 8 | At 2.07 K, record dewar pressure and lock frequency displayed on the frequency counter.**Lock frequency specifications:*** **Low: 1496.400MHz**
* **High: 1496.800 MHz**

If the cavity does not meet the lock frequency specification, select NO and launch an NCR. | [[LockFrequency]] <<FLOAT>>(MHz) [[DewarPressure\_Torr]] <<FLOAT>>(Torr)[[LockFreqMeetsSpec]] <<YESNO>> |
| 9 | At 2.07K and with cavity field of 4-5 MV/m (approximately 1-3 W), determine the cavity coupling. If the cavity appears to be critically coupled, perform the steps in the procedure to determine coupling. If the cavity is critically coupled, select Overcoupled.Optional: Upload oscilloscope data. | [[CavityCoupling]] {{Overcoupled, Undercoupled}} <<SELECT>>[[TDS\_txt]] <<FILEUPLOAD>> |
| 10 | Perform decay measurements and record Eacc, Qo, Qext2, Qext1, %error, radiation, QextHOMaand QextHOMb**.**Typical values during decay measurements for: |  |
| Eacc: (5+/-1) MV/m | [[Eacc]] <<FLOAT>> (MV/m) |
| Qo: 1.2-1.6 e10 | [[Qo]] <<SCINOT>> |
| **Qext1: 0.8-1.2 e10** | [[Qextin]] <<SCINOT>> |
| **Qext2: 0.8-1.8 e12** | [[Qextfp]] <<SCINOT>> |
| %error: 8-13 | [[Qextfperror]] <<FLOAT>> (%) |
| Radiation: <= 0.03 mR/hr | [[Rad]] <<SCINOT>> (mR/hr) |
| **QextHOMa: >= 3e12** | [[QextHOMa]] <<SCINOT>> |
| **QextHOMb: >=3e12** | [[QextHOMb]] <<SCINOT>> |

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| **Step No** | **Instructions** | **Data Inputs** |
| 11 | **Initial Power Rise**Test the cavity performance over its full dynamic range. Observe the administrative limits:* Emax administrative limit 27MV/m
* FE Limit 1000 mR/hr
* HOM Power limit of 10 W

Be sure to capture a clean data set from which to generate a Qo-vs-Eacc-Rad and f-vs-Eacc2 curves.Record the follow values from the initial power rise. |  |
| **Initial maximum cavity gradient achieved (Emax)** **Acceptance criteria is Emax >=25 MV/m** | [[Init\_EmaxMVm]] <<FLOAT>> (MV/m) |
| Initial Qo value at maximum cavity gradient. | [[Init\_QoAtEmax]] <<SCINOT>>  |
| **Initial Qo at 20+/-0.3 MV/m.****Acceptance criteria Qo at 20+/-0.3 MV/m >= 8e9** | [[Init\_QoAt20MVm]] <<SCINOT>> (MV/m) |
| Initial value for radiation at (20+/-0.3) MV/m. | [[Init\_RadAt20MVm]] <<SCINOT>> (mR/h) |
| **Initial FEonset: onset of field emission (FE onset, defined to be the first measured gradient where measured radiation is >= 1e-2 mR/hr).** **If no field emission is detected up to administrative limit (27MV/m), check the FE Free box.****Acceptance criteria is FE Free to the administrative limit (27 MV/m).** | [[Init\_FEonsetMVm]] <<FLOAT>> (MV/m)[[Init\_FEFree]] <<CHECKBOX>> |
| Initial Rmax value for the highest radiation level inside Dewar lid. If Rmax is background up to the administrative limit (27MV/m), insert 1e-3 mR/m for this parameter. | [[Init\_Radmax]] <<SCINOT>> (mR/h) |
| 12 | Are additional power rise(s) required and/or RF processing?If yes, continue to the next step.If no, select the checkbox and skip the Final Power Rise section. This will copy the initial power rise data into the final power rise data fields. | [[AdditionalRun]] <<YESNO>>[[If the box is checked, the intial values are copied into the final values]] <<NOTE>>

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| Initial Value Name | Final Value Name |
| Init\_EmaxMVm | Final\_EmaxMVm |
| Init\_QoAtEmax | Final\_QoAtEmax |
| Init\_QoAt20MVm | Final\_Q0At20MVm |
| Init\_RadAt20MVm | Final\_RadAt20MVm |
| Init\_FEonsetMVm | Final\_FEonsetMVm |
| Init\_FEFree | Final\_FEFree |
| Init\_Radmax | Final\_Radmax |

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| 13 | **Final Power Rise**Test the cavity performance over its full dynamic range. Observe the administrative limits:* Emax administrative limit 27MV/m
* FE Limit 1000 mR/hr
* HOM Power limit of 10 W

Be sure to capture a clean data set from which to generate a Qo-vs-Eacc-Rad and f-vs-Eacc2 curves.Record the follow values from the final power rise. |  |
| **Final maximum cavity gradient achieved (Emax)** **Acceptance criteria is Emax >=25 MV/m** | [[Final\_EmaxMVm]] <<FLOAT>> (MV/m) |
| Final Qo value at maximum cavity gradient. | [[Final\_QoAtEmax]] <<SCINOT>>  |
| **Final Qo at 20+/-0.3 MV/m.****Acceptance criteria Qo at 20+/-0.3 MV/m >= 8e9** | [[Final\_QoAt20MVm]] <<SCINOT>> (MV/m) |
| Initial value for radiation at (20+/-0.3) MV/m. | [[Final\_RadAt20MVm]] <<SCINOT>> (mR/h) |
| **Final FEonset: onset of field emission (FE onset, defined to be the first measured gradient where measured radiation is >= 1e-2 mR/hr).****If no field emission is detected up to administrative limit (27MV/m), check the FE Free box.****Acceptance criteria is FE Free to the administrative limit (27 MV/m).** | [[Final\_FEonsetMVm]] <<FLOAT>> (MV/m)[[Final\_FEFree]] <<CHECKBOX>> |
| Final Rmax value for the highest radiation level inside Dewar lid. If Rmax is background up to the administrative limit (27MV/m), insert 1e-3 mR/m for this parameter. | [[Final\_Radmax]] <<SCINOT>> (mR/h) |

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| **Step No** | **Instructions** | **Data Inputs** |
| 14 | Record cavity performance limitation. If the performance limit is Other, record performance limit description in the comment box.If any cavity performance value does not meet the acceptance criteria in by the final power rise, launch an NCR. | [[PerformancLimitAt2\_07K]] {{RF power,FE,Quench,Cable,Operator,Admin,Other}} <<SELECT>>[[PerformanceLimitAt2\_07K\_Other]] <<COMMENT>> |
| 15 | Final Record Lorentz detuning coefficient (slope of the linear fit frequency vs Eacc2).**Lorentz detuning coefficient specifications:*** **Low: -4.0**
* **High: -6.0**

If the coefficient does not meet the specification, launch an NCR. | [[KLOREN]] <<FLOAT>> (Hz/MVm2)[[KLORENMeetsSpec]] <<YESNO>>[[KLORENComment]] <<COMMENT>> |
| 16 | At 2.07K, if cavity is quench limited below Eacc 25MV/m, keeping the same Qextfp as used for the Pi mode, attempt to find the related unscaled Quench fields for each member of the fundamental passband. | [[EaccUnscaledQuench\_6\_7Pi]] <<FLOAT>> (MV/m)[[EaccUnscaledQuench\_5\_7Pi]] <<FLOAT>> (MV/m)[[EaccUnscaledQuench\_4\_7Pi]] <<FLOAT>> (MV/m)[[EaccUnscaledQuench\_3\_7Pi]] <<FLOAT>> (MV/m)[[EaccUnscaledQuench\_2\_7Pi]] <<FLOAT>> (MV/m)[[EaccUnscaledQuench\_1\_7Pi]] <<FLOAT>> (MV/m)[[QuenchStudyComment]] <<COMMENT>> |

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| **Step No** | **Instructions** | **Data Inputs** |
| 17 | Upload the raw data file with VTA RF testing results using file name: CavID raw data.txt. | [[RF\_TestRawData]] <<FILEUPLOAD>> |
| 18 | Process the raw data file using the Excel file template and upload the data file results using the file name: CAVID processed data.xlsx. | [[RF\_TestProcessed]] <<FILEUPLOAD>> |
| 19 | Upload processed Qo and Rad-vs-Eacc graph (in PDF format) using file name: CavID\_ QoAndRadvsEacc.pdf.Upload processed HOMa and HOMb vs Eacc graph (in PDF format) using file name: CavID\_HOMaHOMbvsEacc.pdf.Upload processed f-vs-Eacc2 graph (in PDF format) using file name: CavID\_FreqvsEacc2.pdf.Upload any additional processed data files collected during this test, in the test at the right (e.g. HOM power as a function of gradient, data mining) using a file name that includes the CavID and properly describes the graph content. | [[QoAndRadvsEacc]] <<FILEUPLOAD>>[[HOMaAndHOMbvsEacc]] <<FILEUPLOAD>>[[fvsEacc2]] <<FILEUPLOAD>>[[UploadFiles]] <<FILEUPLOAD>> |
| 20 | Record if the cavity passed all specifications in this traveler. If the cavity does not meet any specification, ensure an NCR is launched.**Cavity Acceptance Criteria:*** **Lock Frequency @ dewar pressure of 29 +/- 0.1 Torr**
	+ **Low: 1496.400 MHz**
	+ **High: 1496.800 MHz**
* **Qext1: 0.8-1.2 e10**
* **Qext2: 0.8-1.8 e12**
* **QextHOMa: >= 3e12**
* **QextHOMb: >= 3e12**
* **Emax >=25 MV/m**
* **Qo at 20+/-0.3 MV/m >= 8e9**
* **FE Free to the administrative limit (27 MV/m)**
* **Lorentz detuning coefficient specifications:**
	+ **Low: -4.0**
	+ **High: -6.0**
 | [[CavityMeetsSpecifications]] <<YESNO>> |