TEST PLAN

PROGRAM DEPUTY APPROVAL	COMPLETION INFORMATION
Program Deputy Signoff: _____	Completion Date: _____
Signoff Date: _____	Crew Chief Signoff: _____
Expiration Date (max. 90 days from approval): _____	Comments (partial completion, etc.):
Presentation Required? ❑ yes ❑ no Operations Review ❑	❑

Test Plan Title: **Helium Processing of NL04**

Author(s): Charles Reece

Date Submitted:

Revision Number: Rev. 6, 11/21/96

Brief Purpose of Test

To improve the cavities in NL04 by reducing the electron field emission in the cavities during operation at high gradients. This will make the module capable of supporting higher energy operation of the accelerator.

Anticipated Benefits

All 8 cavities in NL04 are presently limited in gradient by field emission. We anticipate an increase in the usable voltage of the module from 26 to above 31 MV.

Beam Conditions Required

REQUIRED INFORMATION: CW or pulsed beam? Desired current and energy. Beam termination point (i.e., 45 MEV dump, N. Stub dump, BSY dump, etc.). Is the test invasive or noninvasive?

no beam

Time Required

25 hours without beam, (5 hours with RF + 16 hours cryocycle + 4 hours with RF)

Preferred Time of Test

Facility Development - maintenance down .

Staff Required to Execute the Test (including contact info)

Crew - Mike Tiefenback, Chas. Reece X7645, Ganapati Myneni X7657, Mike Drury x7493 + cryo support during thermal cycle

Controlled Access Requirements

A few entries to open or close a manual valve.

Hardware and/or Software Changes Required

NOTE: If software changes are part of the test plan, include the name of the application, the old revision level, the new revision level, and if applicable, whether or not it is possible to roll back to the old revision level (are there hardware limitations, etc.).

Set up taps for NL04 to 10.4kv+5% = 10.92kv > 4300kW {done}

Download high GSET_max values (14 MV/m) to enable stressing. {done}

Setup Procedure

PRELIMINARY SETUP STEPS

1. Move needed mechanical equipment into the tunnel.

a. clean turbopump -

b. gas supply and control system
The calibrated volume is made by Vacuum Technology Inc. The volume is 493.6 cc and the calibration is traceable to NIST.

The pressure of the high purity helium 99.999% in the calibrated volume is monitored by Type 127A 100 torr full scale Baratron from MKS Instruments.

The Servo driven remote controlled valve model is 216 and made by Granville-Phillips corp.

2. Isolate the CM - <u>close beamline valves</u>.

3. Establish turbo pump ready for pumping on beamline, but valved out.

4. <u>Establish pressure monitoring with RGA</u> (MKS PPT 050EM), viewable from NLSB.

a. An alternative Teledyne thin film sensor is also connected to monitor beamline vacuum in the pressure range >5e-5 torr.

5. Position GM tubes at either end of the module and position between each pair of warm rf windows. {done}

6. Precheck gas delivery system - standard volume charged and pressure reading active.

7. Establish that system is leak tight and stable.

8. Verify that the remote valve control is functional.

a. Power switch must be ON.

b. Control switch must be ON, else controller gives command to seek home (closed limit switch) and maintain holding torque.

c. Manual control is provided by the spring return OPEN-CLOSE switch.

d. Always monitor closely the pressure indication of the helium volume anytime that changes are made to the valve position.

e. The nominal volume is 0.5 liters and the maximum total helium required is 4 torr-liters.

Thus, the pressure reading must not be allowed to change by more that 8 torr after the test begins.

f. Note starting pressure reading in the logbook.

9. Establish power permit.

10. Open /usr/user1/reaves/dm/highgradm.adl and select NL04.

11. Get HV on in NL04, ensure that NL03 and NL05 are off.

12. Measure radiation production versus GMES individually for all 8 cavities. {done for all but cavity #6} do cavity 6.

13. Bugger interlocks to enable rf without beamline vacuum ion pump ok - this is done by (1) ensuring that pump controller is off (2) disconnecting pump cable at the back of the controller, (3) turning pump controller back on (4) noting the change in the operations log.

Test Procedure

1. **Turn all 8 cavities on at __stressed but stable___ GSETs. See Table 1.**

Table 1: Reference gradients for NL04

Cavity	GSET.DRVH values for 11/12/96 without He processing	Stressed Gradients 5/96	Target Field for Processing (write in based on rad measurements)
1	6.3	6.3	6.6
2	6.9	8.8	9.0
3	7.7	8.9	8.5
4	8.1	9.5	7.5
5	5.15	5.3 - arcer	5.5
6	4.9	5.9 - arcer	6.0
7	5.5	7.6	8.0
8	4.9	7.6	8.5

2. **Confirm that WG vacua are stable by observing trends on striptool chart.**
   - **a.** Signals to monitor are VIP1L0420, 30, 40, 50.
3. **Establish logging of all relevant parameters.**
   - **a.** VIP1L04XX, R14(1-8)GSET, R14(1-8)GMES, R14(1-8)TDETA, R14XHP4RAD1-6
     CEV1L04JT.ORBV, CLL1L0450, CTD1L0410, CTD1L0460, R14XHTPA, R14XHTPHM
     R14XCHET1, R14XCHET3, R14XCHET5, R14XCHET7
1. **Record the radiation indications from the GM tubes.**
2. **Begin supplying helium on the beamline**
   - ***a.*** Establish flow at rate of 4 torr-liters /hour. (This corresponds to a pressure change rate on the helium charge of ~0.066 torr/(30 seconds).)
   - ***b.*** interrupt flow at any sign of instability.
   - ***c.*** target stable helium pressure range is 4.0 e-4 torr indicated by RGA. Expect the indicated pressure to overshoot significantly. Migration time of the helium on the cold surfaces is quite long (hours) although with the rf running, we hope that things will stablize much more quickly.
   - ***d.*** target helium charge is 4 torr-liters - **do not exceed this quantity. (This roughly corresponds to a change in the measured pressure in the helium charge of 8 torr.)**

3. **If a cavity trips off, try briefly to reestablish gradient, but do not be surprised if unable to establish any GMES, as one may expect to encounter a low-field (<1MV/m) multipacting barrier when helium is present. (If time permits, use the commissioner rf gear in pulsed mode only to establish the nominal PLL phase and VCO tune. Then, run CW to avoid difficulties with multipacting.)**
4. **Periodically, record the GM tube readings.**
5. **As possible, dwell at the stable GSET values until 30 minutes remain in the allotted time for rf processing.**
6. **When only 30 minutes remain, begin gradually raising the GSET values while monitoring WG vac to avoid a WGVF. Continue to slowly raise gradients toward 11 MV./m. If a cavity trips, try once to recover, then leave off if unsuccessful.**
7. **If a cavity trips off, note the maximum field reached and fault mode, if any.**
8. **Prior to boiling off LHe change low level alarm to -999 on guard alarmsetpoint screen.**
9. **2o minutes before time is out, leaving rf on, close the inlet JT valve. Keep RT valve open.**
10. **When rf is shut down, <u>turn beamline ion pump controllers OFF</u> to disable a false permissive to opening beamline gate valves.**
11. **Boiloff will begin. Apply 150-300 watts, this with ~15 watts static heat load will empty the CM in about 4–6.7 hours.**
    - **b.** Liquid level is CLL1L0450.
    - **c.** Make changes in heater settings in coordination with CHL operator.
    - **d.** Contact for local heater control during boiloff is <u>Kurt Macha x7407</u>.
    - **e.** Purpose is to identify and implement a method of rapid, yet controlled, boiloff and refill.
12. **Monitor temperatures.**
13. **When liquid level reaches 5%, reduce heaters to 60 watts. (Deliberately swing against equivalent heat in other modules?)**
14. **<u>Begin pump out of helium</u> with turbopump - recording pumpdown with RGA.**
15. **Allow cavities and helium vessel temperature to rise while monitoring the temperatures indicated for the midplane diodes. (**Signal names: R14XCHET1, R14XCHET3, R14XCHET5, R14XCHET7**)**
16. **When <u>all</u> midplane diode temperatures indicate > 15 K for more than 15 minutes, turn <u>heater off</u>.**
17. **Dwell in this state for at least one hour with turbo pump <u>active</u>.**
18. **Ensure that turbo pressure is <1e-7 torr then restart beamline ion pump by (1)turning controller off, (2) reconnecting pump cable, (3) restarting controller. Note reconnection in operations log.**

19. **Valve off turbopump if ion pump vacuum is recovering.**

20. **Begin cooldown and fill as quickly as appropriate for cold compressors. The sensitive part is opening the J-T valve.**

a. Depending on the system response, initial estimate is that 1L04 can be cooled and refilled in 5 to 12 hours.

b. With heater fuses removed, the fill rate may be slowly increased above 15% level then slowly reduced above 80%. (In normal operation the 1L04JT is 39% open with 86 watts of heat (electric and RF).)

c. About one hour prior to reaching 88% level, the EPICS controlled heater should have fuses installed after being switched to kill mode with zero watts requested. Immediately after insuring the ramped target reads zero, make the requested heat match the other cryomodules and switch to auto mode. The auto-heater control should take over. Ideally, the level should reach 90.5% with no overshoot soon after the heat ramps up to setpoint.

21. **Verify acceptable beamline vacuum reading.**

22. **When power permit is available, establish running at nominal gradients for ops, monitoring for vacuum problems.**

23. **Remeasure single cavity radiation production as a function of gradient and compare with initial baseline measurements.**

24. **After establishing stability at nominal operating levels, increase gradients to levels where arcing or some other limit is expected.**

25. **As time permits, measure arc rate to distinguish if conditioning has occurred.**

26. **Return GSET.DRVH values to their normal levels per Table 1 above (for now).**

Backout Procedure

1. Once helium as been admitted to the beamline, a thermal cycle of the module is necessary to get the helium back out.

Test Results