

# FREIA Laboratory
# Dept. of Physics and Astronomy
# Uppsala University

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## Engineering Specification

# ESS Dressed Spoke Cavity Test

| *Prepared by* | *Checked by* | *Approved by* |
|---|---|---|
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*Distribution List*

**ESS Dressed Spoke Cavity Test**

| Step | Process or Check Item | Overall Time [days] | In Bunker [days] | Team | Sub-step | Work Description | Acceptance Criteria | Check Sheet | Parts | Tools and Instruments | Utilities and Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | Week starting 9 January | | | | | | | | | | |
| **1** | Shipment from Orsay to Uppsala | 2 | | | | | | | | | mobile crane, fork lift |
| **2** | Arrival, unloading | | | | | | | | | | mobile crane, fork lift |
| **3** | Unpacking | | | | a | opening box | | | | | |
| | | | | | b | read-out shock data logger | | | | | |
| | | | | | | | | | | | |
| | Week starting 16 January | | | | | | | | | | |
| **4** | Inspection | | | | a | external inspection | no visual damage | | | | |
| | | | | | b | mechanical parts | | | | | |
| | | | | | c | instrumentation connections | electrical | | | multimeter, test box | |
| | | | | | e | cold tuner verification | piezo and stepper motor | | | | |
| **5** | Instrumentation | | | | a | temperature sensors | | | | | |
| | | | | | b | heaters | | | | | |
| | | | | | | | | | | | |
| | Week starting 23 January | | | | | | | | | | |
| **6** | Test insertion | 2 | | | a | put cavity on the insertion tooling | | | | | |
| | | | | | b | roll cavity inside HNOSS | | | | | |
| | | | | | c | verify final position | | | | | |
| | | | | | d | verify vacuum connection | | | | | |
| | | | | | e | verify cryogenic connections | | | | | |
| **7** | Instrumentation | 1 | | | a | connect cavity instrumentation to HNOSS | | | | | |
| | | | | | b | verify instrumentation | | | | | |
| **8** | Remove cavity from HNOSS | 0.5 | | | | roll cavity out from HNOSS | | | | | |
| **9** | Instrumentation | 0.5 | | | | install remaining two temperature sensors | | | | | |
| **10** | MLI | 1 | | | | install MLI | | | | | |
| | | | | | | | | | | | |
| | Week starting 30 January | | | | | | | | | | |
| **11** | Re-arrange insertion tool | 0.5 | | | a | lift cavity from insertion tooling | | | | | |
| | | | | | b | re-arrange insertion tooling | | | | | |
| | | | | | c | put cavity back on the insertion tooling | | | | | |
| **12** | Insertion | 1 | | | a | roll cavity inside HNOSS | | | | insertion tool | |
| | | | | | b | lower cavity to final position | | | | | |
| | | | | | c | attach cavity to tie rods | | | | tie rods | |
| | | | | | d | adjust cavity position | level, rotation | | | | |
| **13** | Bellows | 1 | | | a | installation bellows for power coupler | | | | | |
| | | | | | b | final adjustment cavity position | level, rotation | | | | |
| **14** | Cavity connection | 1 | | | a | connect cavity cryogenic lines | | | | | |
| | | | | | b | connect cavity vacuum line | | | | | |
| | | | | | c | connect instrumentation | | | | | |
| | | | | | d | connect cold tuner system | | | | | |
| **15** | Leak test | 0.5 | | | a | vacuum line | | | | | |
| | | | | | b | cryogenics line | | | | | |
| **16** | Vacuum | | | | | start cavity vacuum pumps | | | | | |
| **17** | Instrumentation | 0.5 | | | a | instrumentation check | | | | multimeter, test box | |
| | | | | | b | cold tuner check | | | | | |
| **18** | Power coupler installation | 1 | | | a | install antenna | | | | IPNO tooling | |
| | | | | | b | install door knob | | | | | |
| | | | | | | | | | | | |
| | Week starting 6 February | | | | | | | | | | |
| **19** | Power coupler connection | | | | a | connect cooling water | | | | | |
| | | | | | b | connect SHe cooling | | | | | |
| | | | | | c | connect instrumentation | | | | | |
| **20** | Power coupler instrumentation | | | | | instrumentation check | | | | multimeter, test box | |
| **21** | RF distribution | | | | | final connection waveguides | | | | | |
| **22** | Closure HNOSS | | | | a | close thermal shield | | | | | |
| | | | | | b | close flanges | | | | | |
| | | | | | c | close main doors | | | | | |
| **23** | Leak test | | | | | vacuum leak test HNOSS | | | | | |
| **24** | Vacuum | | | | | start HNOSS vacuum pumps | | | | | |
| **25** | Close bunker | | | | | close main bunker gate | | | | | |
| **26** | Measurement | | | | a | S parameter measurement | Qext | | | VNA | |
| | | | | | b | tuning range of the slow step tuner at warm temperature | | | | Labview, VNA | |

| Step | Process or Check Item | Overall Time [days] | In Bunker [days] | Team | Sub-step | Work Description | Acceptance Criteria | Check Sheet | Parts | Tools and Instruments | Utilities and Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| **27** | RF | | | | | conditioning coupler | reach full power, pulse length | | | | RF source |
| **28** | Measurement | | | | | cavity frequncy checking | | | | VNA, Labview | |
| | | | | | | | | | | | |
| | Week starting 13 February | | | | | | | | | | |
| **29** | Cool down | 1 | | CRYO | a | cool down with LN2 of transfer line and thermal shield | | | | | LN2 |
| | | 2 | | | b | cool down to 4 K | | | | | Liquefier |
| | | 1 | | | c | stabilize at 4 K | | | | | |
| | | 1 | | | d | cool down to 2 K | | | | | 2K pumps |
| | | | | | e | cooling coupler | | | | | SHe pumps |
| | | | | | | | | | | | |
| | Week starting 13 February | | | | | | | | | | |
| **30** | Measurement | 1 | | | | sensitivity to helium pressure fluctuation | | | | VNA, Labview | |
| **31** | CTS Calibration | 0.5 | | | | tuning range of the slow step tuner at cold temperature | | | | Labview, SEL, frequency meter | |
| **32** | RF Calibration | 0.5 | | RF, CTRL | | cables re-calibration | | | | | |
| **33** | Cavity spectra | 0.5 | | RF | | fundamental and HOM spectra | | | | VNA | |
| **34** | Cold coupler re-conditioning | 0.5 | | RF | | conditioning coupler | reach full power, pulse length | | | | RF source |
| **35** | Measurement Q0 | 1 | | RF | a | Qloaded (3 dB bandwidth) | | | | VNA | RF source |
| | | | | | b | Qloaded (decay technique) | | | | pulsed SEL | |
| | | | | | c | Q0 (emitted power technique) | | | | pulsed SEL | RF source |
| **36** | Measurement Gradient | 1 | | RF | a | Eacc measurement | nomial gradient, max gradient | | | pulsed SEL | RF source |
| | | | | | b | X-ray emission | | | | pulsed SEL, Labview | |
| | | | | | c | electron activity in coupler | | | | | |
| | | | | | | | | | | | |
| | Week starting 20 February | | | | | | | | | | |
| **37** | Field emission | | | | | Onset and level of field emission | | | | | |
| **38** | Multipacting | | | | | Onset and level of Multipacting | | | | | |
| **39** | RF Compensation | | | | | Stabilization of the cavity field with LLRF | | | | | |
| **40** | Dynamic RF losses | 1 | | CRYO, RF | | | | | | | RF source |
| **41** | Lorenz detuning | 1 | | RF | | LDT measured in a pulsed test | | | | Signal generator driven loop | |
| **42** | Microphonics | 1 | | RF, CRYO | | | | | | | |
| | | | | | | | | | | | |
| | Week starting 27 February | | | | | | | | | | |
| **43** | Measurement Q0 | | | | | repeat Q0 measurement at 4K | | | | | |
| **44** | Repetition of any earlier measurements as deemed necessary | | | | | | | | | | |
| | | | | | | | | | | | |
| | Week starting 6 March | | | | | | | | | | |
| **45** | Warm-up | 5 | | CRYO | a | warm-up of cryomodule | | | | | |
| | | | | | b | cavity frequncy checking | | | | VNA,Labview | |
| | | | | | | open the main bunker gate | | | | | |
| | | | | | | | | | | | |
| | Week starting 13 March | | | | | | | | | | |
| **46** | Opening HNOSS | 1 | | | a | opening main doors | | | | | |
| | | | | | b | removal thermal shields | | | | | |
| **47** | Disconnect | 2 | | | a | RF | | | | | |
| | | | | | b | Instrumentation | | | | | |
| | | | | | c | Vacuum | | | | | |
| | | | | | d | Cryogenics | | | | | |
| | | | | | e | Cooling water | | | | | |
| **48** | Power coupler disconnection | 2 | | | a | disconnect waveguide | | | | | |
| | | | | | b | disconnect door knob | | | | | |
| | | | | | c | remove antenna | | | | | |
| | | | | | | | | | | | |
| | Week starting 20 March | | | | | | | | | | |
| **49** | Cavity disconnection | 2 | | | a | install insertion tool | | | | | |
| | | | | | b | remove power coupler bellows | | | | | |
| | | | | | c | move cavity from tie rods onto insertion tool | | | | | |
| | | | | | d | roll cavity out | | | | | |
| **50** | Move out of bunker | 0.5 | | | | Move cavity outside bunker | | | | | |
| **51** | Cleaning cavity | 2 | | | a | remove MLI | | | | | |
| | | | | | b | remove instrumentation | | | | | |
| | | | | | c | remove heaters | | | | | |
| | | | | | | | | | | | |
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| | | | | | | | | | | | |
| **51** | Inspection | 2 | | | | | | | | | |
| **52** | Prepare for transport | 3 | | | | | | | | | |
| | | | | | | | | | | | |
| | Week starting 3 April | | | | | | | | | | |
| **53** | Transport from Uppsala to Orsay | 3 | | | | Transport | | | | | |
| | | | | | | | | | | | |
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