



RFD CM REPAIR AND TESTING IN M7

N. Valverde, S. Barriere, T. Capelli, S. Calvo, M. Garlasche, P. Minginette, J. Swieszek, K. Turaj, on behalf of HL-LHC WP4



13.02.2024

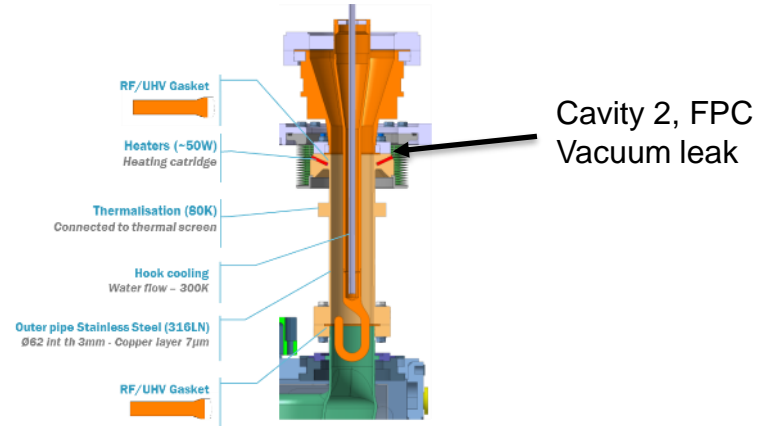
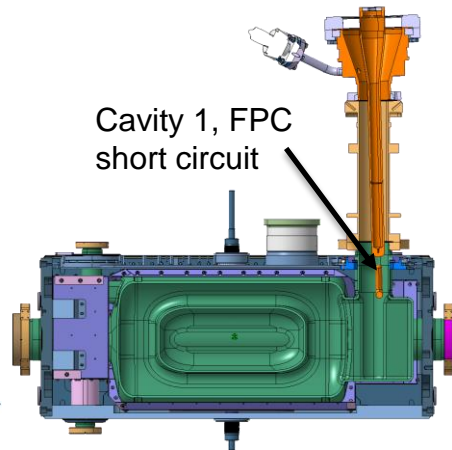
RFD cryomodule for SPS-test

During qualification program at CERN, 2 non-conformities found leading to a delay in the installation at SPS (YETS 24-25)



RFD-SPS tests, Issues

- Two issues identified during SM18 tests
 - Tilt of the FPC on Cav 1
 - Vacuum leak on the FPC of Cav 2
- Source of the two problems under investigation with UK team, but we believe occurred during an alignment procedure (mismatch between cavity string & cryostat)



Planning Repair RFD CM for SPS-test

Tentative Planning RFD-CM M7

2024

February

March

April

May

June

July

August

Sept.

Repair leak beam vacuum FPC Cav2

Preparation CM for cool down

Inst. IOT in SM18 + DSO test

Cold RF test at 2K – *RF powering with IOT (Cav. 2 only)

Repair FCP cavity 1

Preparation CM for cool down

Cold RF test at 2K- *RF powering with IOT. (Cav. 2 & 1)

**RF powering: Max. 50 kW continuous wave
Cold test dates to be agreed with CRG*

13.02.2024

Repair Leak on cav.2

1st Repair on cavity 2

Access to cavity 2 is needed on both sides of the cryomodule and on the top, to install tooling and get access to the FPC.

Cryogenic Jumper

<Wall side>

<Corridor side>

Cryogenic Jumper

Cavity 2

Cavity 2

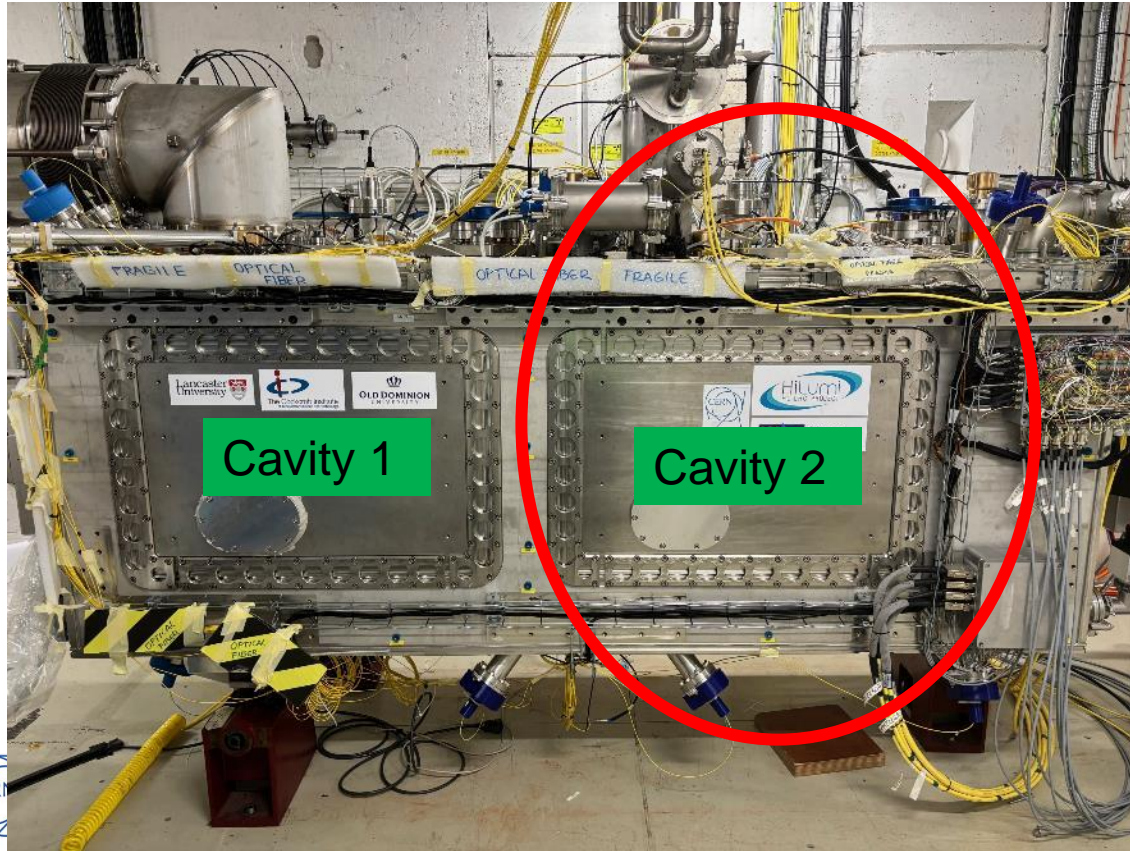
<Corridor side>

<Wall side>

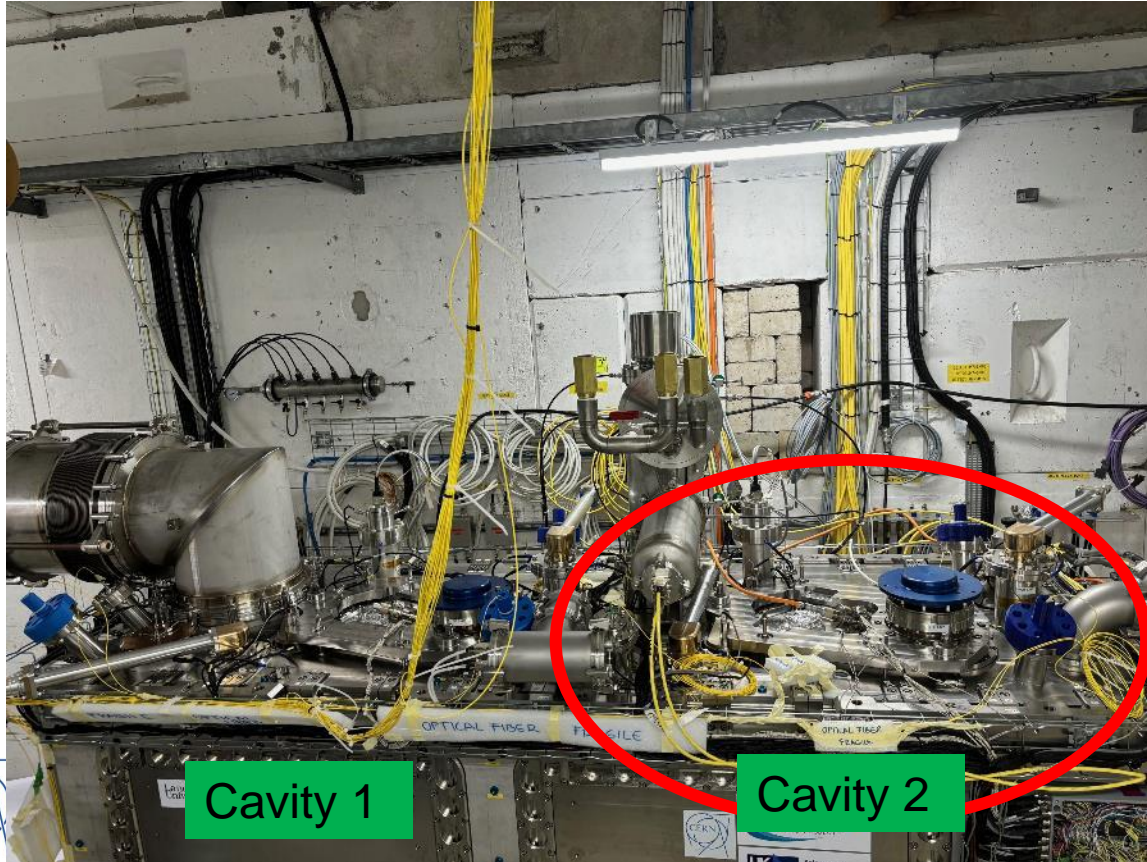


Repair Leak on cav.2

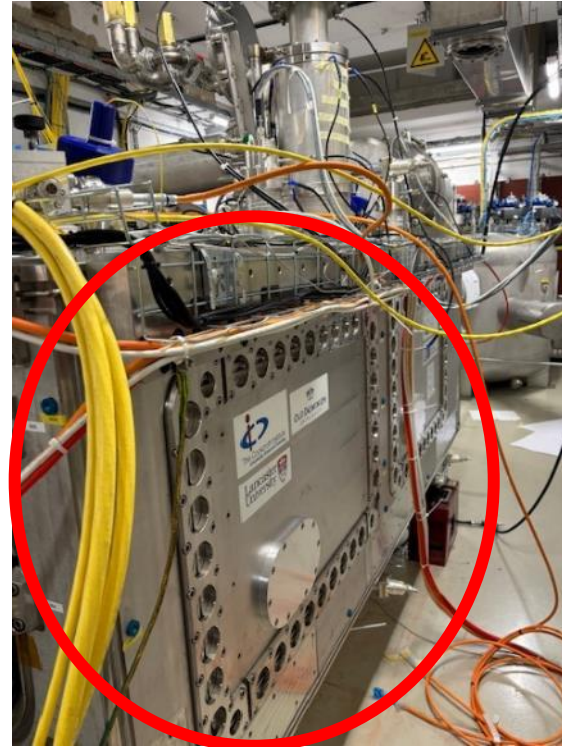
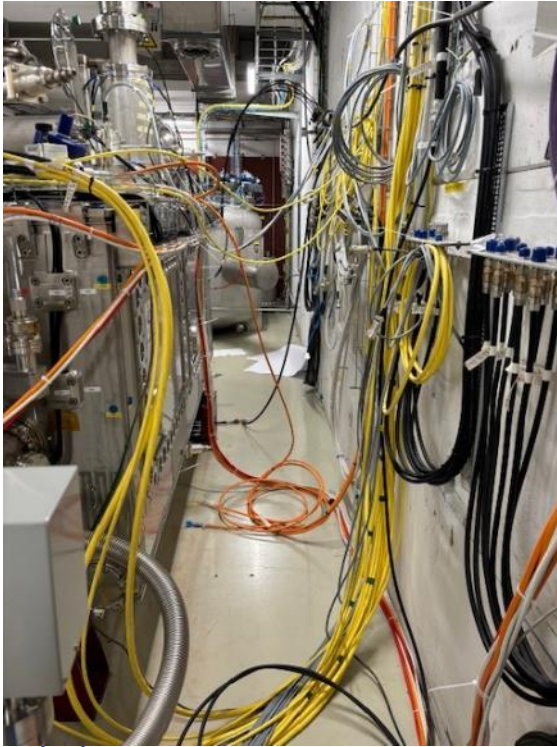
Removal of cabling cavity 2 side is needed



Repair Leak on cav.2

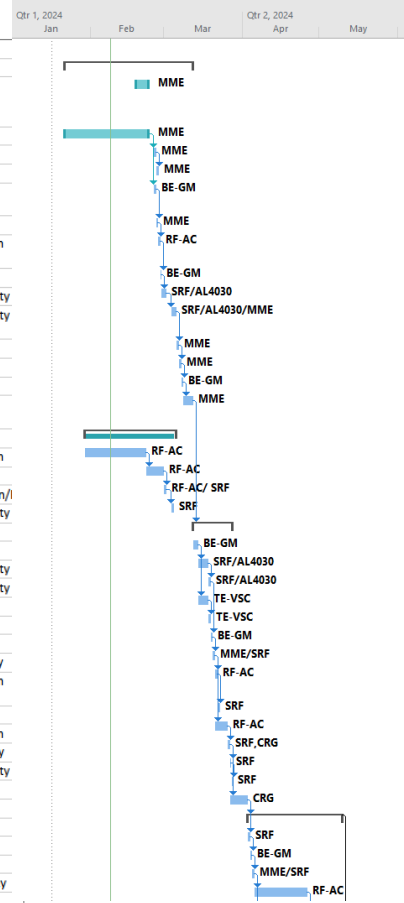


Repair Leak on cav.2



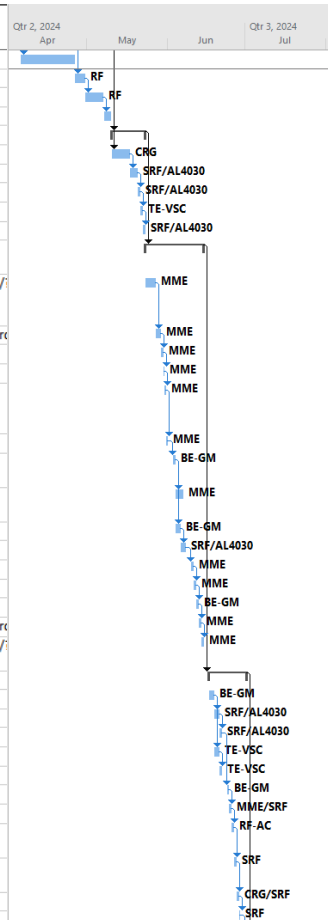
Repair tentative planning

| ID | Task Mode | Task Name | Duration | Start | Finish | PreResource Names | Text1 |
|----|-----------|---|-----------|--------------|--------------|--------------------------|------------|
| 1 | | RFD CM | | | | | |
| 2 | | Repair leak on cav2 (beam vacuum at PA) | 36.5 days | Mon 22/01/24 | Tue 12/03/24 | | |
| 3 | | Removal of side doors cav2 both sides,MLI, tuner cav.2. Removal CRG ,Align, RF. cabling | 5 days | Mon 19/02/24 | Fri 23/02/24 | MME | Simon |
| 4 | | Tooling fabrication | 25 days | Mon 22/01/24 | Fri 23/02/24 | MME | Simon |
| 5 | | Installation tooling to support cav.2 | 1 day | Mon 26/02/24 | Mon 26/02/24 | 4 MME | Simon |
| 6 | | Remove cavity support plate | 1 day | Tue 27/02/24 | Tue 27/02/24 | 5 MME | Simon |
| 7 | | Alignment check during installation tooling and removal of support | 1 day | Mon 26/02/24 | Mon 26/02/24 | 4 BE-GM | |
| 8 | | Visual inspection with endoscope | 0.5 days | Tue 27/02/24 | Tue 27/02/24 | 7 MME | Simon |
| 9 | | Re-Tightening flange FPC cav2 between main body and double wall tube | 1 day | Tue 27/02/24 | Wed 28/02/24 | 8 RF-AC | Sebastien |
| 10 | | FPC position check | 0.5 days | Wed 28/02/24 | Wed 28/02/24 | 9 BE-GM | |
| 11 | | Pumping beam vacuum | 2 days | Thu 29/02/24 | Fri 01/03/24 | 10 SRF/AL403/Nuria/Katy | |
| 12 | | leak test beam vacuum, with endoscope, and RGA | 2 days | Mon 04/03/24 | Tue 05/03/24 | 11 SRF/AL403/Nuria/Katy | |
| 13 | | Removal tooling supporting cav.2 | 1 day | Wed 06/03/24 | Wed 06/03/24 | 12 MME | Simon |
| 14 | | Installation cavity support plate | 1 day | Thu 07/03/24 | Thu 07/03/24 | 13 MME | Simon |
| 15 | | Alignment | 0.5 days | Fri 08/03/24 | Fri 08/03/24 | 14 BE-GM | |
| 16 | | Installation MLI, side doors cav.2, tuner and cabling | 2 days | Fri 08/03/24 | Tue 12/03/24 | 15 MME | Simon |
| 17 | | IOT | 26 days? | Tue 30/01/24 | Tue 05/03/24 | | |
| 18 | | Installation IOT | 18 days | Tue 30/01/24 | Thu 22/02/24 | RF-AC | Sebastien |
| 19 | | Comissioning IOT and prep for DSO test | 5 days | Fri 23/02/24 | Thu 29/02/24 | 18 RF-AC | Joan |
| 20 | | Test of interlock system | 1 day | Fri 01/03/24 | Fri 01/03/24 | 19 RF-AC/ SRF Katy/Joan/ | |
| 21 | | DSO test (close bunker earlier) | 1 day | Mon 04/03/24 | Mon 04/03/24 | 20 SRF | Nuria/Katy |
| 22 | | Preparation for cool down | 11.5 days | Tue 12/03/24 | Wed 27/03/24 | 16 | |
| 23 | | Alignment check and measurements | 2 days | Tue 12/03/24 | Thu 14/03/24 | BE-GM | |
| 24 | | Pump insulation vacuum | 2 days | Thu 14/03/24 | Mon 18/03/24 | 23 SRF/AL403/Nuria/Katy | |
| 25 | | Leak test insu vacuum | 1 day | Mon 18/03/24 | Tue 19/03/24 | 24 SRF/AL403/Nuria/Katy | |
| 26 | | Pump second beam pipe | 2 days | Thu 14/03/24 | Mon 18/03/24 | 23 TE-VSC | Anthony |
| 27 | | Leak test second beam pipe | 1 day | Mon 18/03/24 | Tue 19/03/24 | 26 TE-VSC | Anthony |
| 28 | | Alignment measurements under vacuum | 0.5 days | Tue 19/03/24 | Tue 19/03/24 | 25 BE-GM | |
| 29 | | Tuner test at warm | 1 day | Wed 20/03/24 | Wed 20/03/24 | 28 MME/SRF | Kurt/Katy |
| 30 | | Installation waveguide on cav.2 and adaptors on HOMs and FA | 1 day | Thu 21/03/24 | Thu 21/03/24 | 29 RF-AC | Sebastien |
| 31 | | RF measurements at warm on cav.2 | 1 day | Fri 22/03/24 | Fri 22/03/24 | 30 SRF | Katy |
| 32 | | Installation coaxial lines | 3 days | Thu 21/03/24 | Mon 25/03/24 | 29 RF-AC | Sebastien |
| 33 | | Signal checks (CRG, RF) | 1 day | Tue 26/03/24 | Tue 26/03/24 | 32 SRF,CRG | CRG, Katy |
| 34 | | Close bunker | 0.5 days | Wed 27/03/24 | Wed 27/03/24 | 33 SRF | Nuria/Katy |
| 35 | | Interlock checks | 0.5 days | Wed 27/03/24 | Wed 27/03/24 | 34 SRF | Katy |
| 36 | | Cool Down | 5 days | Wed 27/03/24 | Tue 02/04/24 | 33 CRG | |
| 37 | | Measurements at 2K | 27.5 days | Wed 03/04/24 | Fri 10/05/24 | 36 | |
| 38 | | RF measurements at 2K | 1 day | Wed 03/04/24 | Wed 03/04/24 | 36 SRF | Katy |
| 39 | | Alignment 2K | 0.5 days | Thu 04/04/24 | Thu 04/04/24 | 38 BE-GM | |
| 40 | | Tuner test | 1 day | Thu 04/04/24 | Fri 05/04/24 | 39 MME/SRF | Kurt/ Katy |
| 41 | | RF processing up to full power on cav2 | 15 days | Fri 05/04/24 | Fri 26/04/24 | 40 RF-AC | Eric |



Repair tentative planing

| ID | Task Mode | Task Name | Duration | Start | Finish | PreResource Names | Text1 |
|----|-----------|---|------------------|---------------------|---------------------|-------------------------|-------|
| 42 | | RP measurements | 15 days | Fri 05/04/24 | Fri 26/04/24 | 40 | |
| 43 | | LLRF checks at 2K | 2 days | Fri 26/04/24 | Tue 30/04/24 | 41 RF | |
| 44 | | Cavity validation at 2K with LLRF | 5 days | Tue 30/04/24 | Tue 07/05/24 | 43 RF | |
| 45 | | Dynamic and static heat loads | 3 days | Tue 07/05/24 | Fri 10/05/24 | 44 | |
| 46 | | Warm up | 9 days | Fri 10/05/24 | Thu 23/05/24 | 37 | |
| 47 | | Warm up | 5 days | Fri 10/05/24 | Fri 17/05/24 | 37 CRG | |
| 48 | | RGA beam vacuum | 1 day | Fri 17/05/24 | Mon 20/05/24 | 47 SRF/AL4030Nuria/Katy | |
| 49 | | Control venting of beam vacuum | 1 day | Mon 20/05/24 | Tue 21/05/24 | 48 SRF/AL4030Nuria/Katy | |
| 50 | | Control venting of second beam pipe | 1 day | Tue 21/05/24 | Wed 22/05/24 | 49 TE-VSC Anthony | |
| 51 | | Control venting insulation vaccum | 1 day | Wed 22/05/24 | Thu 23/05/24 | 50 SRF/AL4030Nuria/Katy | |
| 52 | | Repair FPC misalignment on cav.1 (beam vacuum at PA) | 16.5 days | Thu 23/05/24 | Fri 14/06/24 | 46 | |
| 53 | | Removal of side doors cav1 both sides,MLI, tuner cav.1. Removal CRG ,Align, RF, cabling | 2 days | Thu 23/05/24 | Mon 27/05/24 | MME Simon/Kurt/ | |
| 54 | | Installation mechanical instrumentation | 2 days | Mon 27/05/24 | Wed 29/05/24 | 53 MME M. Guinchar | |
| 55 | | Installation tooling to support cav. 1 | 1 day | Wed 29/05/24 | Thu 30/05/24 | 54 MME Simon | |
| 56 | | Remove cavity support plate on cav.1 | 0.5 days | Thu 30/05/24 | Thu 30/05/24 | 55 MME Simon | |
| 57 | | Installation tooling on the flange between cavity and double wall tube. Cav1 | 0.5 days | Fri 31/05/24 | Fri 31/05/24 | 56 MME Simon | |
| 58 | | Installation tooling on FPC window, cav1 | 0.5 days | Fri 31/05/24 | Fri 31/05/24 | 57 MME Simon | |
| 59 | | Alignment check during installation tooling and removal of support | 1 day | Mon 03/06/24 | Mon 03/06/24 | 58 BE-GM | |
| 60 | | Adjusting FPC antenna for re-alignment on cav.1, | 3 days | Tue 04/06/24 | Thu 06/06/24 | 59 MME Simon | |
| 61 | | Position monitoring during deformation | 2 days | Tue 04/06/24 | Wed 05/06/24 | 59 BE-GM | |
| 62 | | leak test beam vacuum, and RGA | 2 days | Thu 06/06/24 | Fri 07/06/24 | 61 SRF/AL4030 | |
| 63 | | Removal toolings on cav1 | 1 day | Mon 10/06/24 | Mon 10/06/24 | 62 MME Simon | |
| 64 | | Installation cavity support plate | 1 day | Tue 11/06/24 | Tue 11/06/24 | 63 MME Simon | |
| 65 | | Alignment | 1 day | Wed 12/06/24 | Wed 12/06/24 | 64 BE-GM | |
| 66 | | Removal instrumentation | 1 day | Thu 13/06/24 | Thu 13/06/24 | 65 MME M. Guinchar | |
| 67 | | Installation MLI, side doors cav., tuner and cabling | 1 day | Fri 14/06/24 | Fri 14/06/24 | 66 MME Simon/Kurt/ | |
| 68 | | Preparation for cool down | 10.5 days | Mon 17/06/24 | Mon 01/07/24 | 52 | |
| 69 | | Alignment check and measurements | 2 days | Mon 17/06/24 | Tue 18/06/24 | BE-GM | |
| 70 | | Pump insulation vacuum | 2 days | Wed 19/06/24 | Thu 20/06/24 | 69 SRF/AL4030Nuria/Katy | |
| 71 | | Leak test insu vacuum | 1 day | Fri 21/06/24 | Fri 21/06/24 | 70 SRF/AL4030Nuria/Katy | |
| 72 | | Pump second beam pipe | 2 days | Wed 19/06/24 | Thu 20/06/24 | 69 TE-VSC Anthony | |
| 73 | | Leak test second beam pipe | 1 day | Fri 21/06/24 | Fri 21/06/24 | 72 TE-VSC Anthony | |
| 74 | | Alignment measurements under vacuum | 0.5 days | Mon 24/06/24 | Mon 24/06/24 | 71 BE-GM | |
| 75 | | Tuner test at warm | 1 day | Mon 24/06/24 | Tue 25/06/24 | 74 MME/SRF Kurt | |
| 76 | | Installation waveguide on cav.1 and adaptors on HDMS and FA | 1 day | Tue 25/06/24 | Wed 26/06/24 | 75 RF-AC Sebastien | |
| 77 | | RF measurements at warm on cav.1 and cav2 | 1 day | Wed 26/06/24 | Thu 27/06/24 | 76 SRF Katy | |
| 78 | | Signal checks (CRG, RF) | 1 day | Thu 27/06/24 | Fri 28/06/24 | 77 CRG/SRF CRG/Katy | |
| 79 | | Close bunker | 0.5 days | Fri 28/06/24 | Fri 28/06/24 | 78 SRF Nuria/Katy | |



Repair tentative planning

EDMS [3029792](#)

| ID | Task Mode | Task Name | Duration | Start | Finish | PreResource Names | Text1 |
|-----|-----------|--|-----------|--------------|--------------|-------------------|------------|
| 80 | | Interlock checks | 0.5 days | Mon 01/07/24 | Mon 01/07/24 | 79 SRF | Katy |
| 81 | | Cool Down | 5 days | Mon 01/07/24 | Mon 08/07/24 | 68 CRG | |
| 82 | | Measurements at 2K | 42.5 days | Mon 08/07/24 | Wed 04/09/24 | 81 | |
| 83 | | RF measurements at 2K | 1 day | Mon 08/07/24 | Tue 09/07/24 | 81 SRF | Katy |
| 84 | | Alignment 2K | 0.5 days | Tue 09/07/24 | Tue 09/07/24 | 83 BE-GM | |
| 85 | | Tuner test | 1 day | Wed 10/07/24 | Wed 10/07/24 | 84 MME/SRF | Kurt/Katy |
| 86 | | RF processing up to full power on both cavities | 30 days | Thu 11/07/24 | Wed 21/08/24 | 85 RF-AC | Eric |
| 87 | | RP measurements | 30 days | Thu 11/07/24 | Wed 21/08/24 | 85 | |
| 88 | | LLRF checks at 2K | 2 days | Thu 22/08/24 | Fri 23/08/24 | 86 RF | |
| 89 | | Cavity validation at 2K with LLRF | 5 days | Mon 26/08/24 | Fri 30/08/24 | 88 RF | |
| 90 | | Dynamic and static heat loads | 3 days | Mon 02/09/24 | Wed 04/09/24 | 89 | |
| 91 | | Warm up | 6 days | Thu 05/09/24 | Thu 12/09/24 | 82 | |
| 92 | | Warm up | 5 days | Thu 05/09/24 | Wed 11/09/24 | 82 CRG | |
| 93 | | RGA beam vacuum | 1 day | Thu 12/09/24 | Thu 12/09/24 | 92 SRF/AL403I | Nuria/Katy |
| 94 | | Preparation for transport to SPS: | 13.2 days | Fri 13/09/24 | Wed 02/10/24 | | |
| 95 | | Disconnect cabling: RF, coax lines, CRG, Survey, Radiation | 2 days | Fri 13/09/24 | Mon 16/09/24 | 91 BE-GM,CRG SRF | |
| 96 | | Control venting insulation vacuum | 2 days | Tue 17/09/24 | Wed 18/09/24 | 95 SRF/AL403I | Nuria/Katy |
| 97 | | Disconnect pumping group insulation | 0.5 days | Thu 19/09/24 | Thu 19/09/24 | 96 SRF/AL403I | Nuria/Katy |
| 98 | | Jumper | 5.5 days | Thu 19/09/24 | Thu 26/09/24 | | |
| 99 | | Disconnect Jumper | 0.5 days | Thu 19/09/24 | Thu 19/09/24 | 97 MME | Simon |
| 100 | | Cutting cryo lines | 1 day | Fri 20/09/24 | Fri 20/09/24 | 99 MME | Simon |
| 101 | | Weld partially cryolines for SPS | 2 days | Mon 23/09/24 | Tue 24/09/24 | 100MME | Simon |
| 102 | | Visual inspection | 1 day | Wed 25/09/24 | Wed 25/09/24 | 101MME | Simon |
| 103 | | leak check | 1 day | Thu 26/09/24 | Thu 26/09/24 | 102SRF/AL403I | Nuria/Katy |
| 104 | | Disconnect He gas supply (x4) | 0.5 days | Fri 27/09/24 | Fri 27/09/24 | 103CRG | |
| 105 | | Remove safety extension group (He guard) | 0.5 days | Fri 27/09/24 | Fri 27/09/24 | 104MME | Simon |
| 106 | | Installation laminar flow to remove the pumping group on beam vacuum | 1 day | Mon 30/09/24 | Mon 30/09/24 | 105SRF/AL403I | Nuria/Katy |
| 107 | | Beam vacuum remains pumping with ionic | 0.1 days | Tue 01/10/24 | Tue 01/10/24 | 106SRF/AL403I | Nuria/Katy |
| 108 | | Removal pumping group from second beam pump | 1 day | Tue 01/10/24 | Wed 02/10/24 | 107TE-VSC | Anthony |
| 109 | | Second beam vacuum remains pumping with ionic | 0.1 days | Wed 02/10/24 | Wed 02/10/24 | 108TE-VSC | Anthony |
| 110 | | CM ready for transport to SPS | 0 days | Wed 02/10/24 | Wed 02/10/24 | 109 | |

