Meeting notes 201 MHz cavity workshop May 28-29 2013

Jim Volk

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Present

Yagmur Torun, R Pasquinelli, Maria Leonova, Al Morretti, Luca Somaschini, Dave Peterson, J Volk, Allan DeMello, Steve Virostek, Derun Li,…

# Introduction:

The purpose is to test a MICE type cavity with an electro polished and water washed surface. The objective is to install this cavity in the MTA hall and operate it for 106 pulses with no magnetic field and then a similar number of pulses with a magnetic field. There may also be pulsing with 400 MeV beam that decision will be made at a later date.

The cavity, vacuum vessel and tuners are all currently at Lab 6 in the Village. The actuators for the tuners are at Fermilab and have been tested by Lucca. The Lab 6 clean room needs to be cleaned and a plan for transport and handling needs to be worked out. We need a crane and some fixtures in the clean room and at MTA to handle the cavity during installation. There is a long list of items and loose ends that need to be tied up during this workshop. We need to assign responsibilities for tasks so that they get done.

The schedule will be run for 3 weeks that is about 106 pulses with no magnetic field then another 3 weeks (106 pulses) with the highest magnetic field possible. This will be in the fringe field of the solenoid. It has not been decided if running at different values of the magnetic field is worth the effort. After that a beam tests maybe done both with and without field. In addition there maybe test with different gases in the cavity these issues can be decided at a later date.

# LRF-7

Al Moretti discussed the controls for LRF-7. That last time this was used Al controlled the amplitude, frequency, and phase more or less by hand. This needs to be upgraded to a LabView program to provide more precise control and be more useful to everyone. The slides have a schematic of what needs to be done. Dave Peterson is the right person to do the LabView programming. This should be ready to test into a dummy load by the week of June 3 to 7.

# Tuners and Controls:

Luca Somaschini presented slides on his work with the air actuators to be used with the tuners on the cavity. Using a linear transducer and actuators he studied the relation between deflections of the hoops as a function of pressure. While the tuners have a small amount of hysteresis all repeat well as the pressure is increased and decreased over a range of 160 psi. Each piston behaves in the same manner. These calibration curves are important since the linear transducers cannot be used in vacuum due to outgassing. To accurately deform the cavity and change the frequency we will have to rely on air pressure in the cylinders. There is a question of being able to drill and tap small holes in the tuners for mounting of transducers. Will this affect the performance of the tuners? The plan is to test the all the actuators and tuners on the cavity in Lab 6. The transducers will be used to determine the calibration of deflection versus pressure this will be needed when the cavity is installed in MTA. Another issue that LBL needs to answer is; what is the maximum deflection that the tuners can stand before they are deformed. To protect the tuners relief valves will be used and set at a level to prevent deformation of the tuners.

There was some discussion about gas to use, either clean compressed air, or boil off from a liquid nitrogen Dewar. Luca presented a schematic showing the layout of the gas system. The system still needs modifications and decision on where things will get mounted. There was some discussion on tubing material. Concern was expressed about using nonmetallic tubing in a radiation area in addition to having instrumentation in the magnetic field. Most of the controls will be mounted on the west wall outside of the 300 Gauss line; the manifolds for each valve should be near the valves to reduce the amount of tubing and pressure drop. More work is needed here. Fermilab will do the detail design of the air system.

Other questions raised were what is the defection versus frequency curve? Is there an LBL study or model of this? Who has the quarter.sat model of the cavity? Is that Tian Huan?

# RF diagnostic ports:

Luca reported on the assignment of ports for the cavity he has a naming convention based on angle as measured counter clock wise from the vertical. Ports 15, 19, 21, 23, 27 and 29 are reserved for actuators these need 3 3/8 conflat flanges. Water feed troughs are ports 25 and 26. We need to have at least 2 or perhaps 3 sets of gaskets for each flange. The actuators will be removed for shipping from Lab 6 to MTA. Port 24 will be for microphones and port 22 for thermo couples the exact number is not as of yet determined. Port 23 is the 8 inch conflat for the vacuum pump. The top ports 11, 12, 13, 14, and 30 are reserved for instrumentation ion gauges, RGA, spark detectors ect. Ports 34 and 35 are for the RF couplers. There are still some free ports, there will need to be brackets and strain reliefs designed for all the cables coming out of these ports.

There is an issue about spark detectors, having PMT near the cavity in the fringe field of the magnet will not work. Optical fiber will be needed to run from inside the cavity to somewhere outside away from the fringe field to PMTs. To get these fibers and various other signals out of the cavity a tophat with 4 ports and a hole for the fibers will need to be designed. Al Morretti has a sketch. The spacing is limited and installation will prove challenging due to the tight space. Ryan Schultz will do detailed design of the tophat

The RF wave guides will have SF6, this is a greenhouse gas and we need to limit any leaks and releases of SF6 to the atmosphere. Silva Wilson the waste coordinator for AD is the person to coordinate this with J Volk will follow up on this issue. There needs to be a cable list assembled describing what each cable is for what type of cable it is and where it goes.

Other details that need to be worked out;

1. Faraday cup to measure dark current
2. How is the RF cavity grounded?
3. 3D model of top hat inside of vacuum vessel.
4. Installation procedure for MTA hall
5. Detailed list of measurements to be made at Lab 6.

# Allan DeMllo called in from LBL:

Allan called in to answer several questions;

1. All fasteners are metric, all threaded holes are metric we need to get a supply of metric bolts. All bolts should be silver plated to prevent galling in the stainless steel vacuum vessel.
2. The maximum allowable deflection of the tuners is ± 2mm.
3. It is allowable to drill and tap small holes in the tuners for mounting of transducers. 1 to 2 mm diameter.
4. It is allowable to operate tuners on the cavity when not under vacuum. It is allow able to put tuners on cavity and test the actuators in air.
5. The gas for the actuators needs to be clean, no oil or water.
6. MICE does not want any sort of plastic tubing used, all piping should be copper or stainless steel. There is no design yet but the actuators manifold can be mounted on the vacuum vessel to keep lines short. Fermilab will do this design.
7. LBL did not test deflection vs frequency; there is a simulation that gives 44 kHz per mm for a range of 460kHz. Alan DeMello will provide Fermilab with the model.
8. The water feed through may be in the box at Fermi need to check.
9. There are 6 ports for the actuators, 2 for water, 2 for the coupler, 1 for vacuum, 1 for a burst disc. All others are available for instrumentation.

We are still coming to an agreement on making the couplers. The LBL and Fermi shop prices were not all that different. LBL shop has more time to make. It may take as long as 14 weeks to get the couplers. There is an issue with TiN plating. Can it be done on some of the smaller parts, and the sequence of plating. Allan DeMello and Alan Bross need to work that out. In addition the purchasing of the off the shelf parts who will do that either LBL or Fermi. There is also the issue of spool pieces for the couplers. Are they in the box at Fermi? Yagmur will check later today.

# Day 2 May 29

# Alignment and safety issues

J Volk presented an alignment plan. The Vacuum vessel has been fiducailized with 18 nests that will receive a laser tracker ball that has a corner reflector. The ports, doors and body fiducials were all measured at lab 6. When the cavity is in the clean room alignment will use a laser tracker to measure the shape of the cavity and relate the center of the cavity to the RF coupler ports. When the cavity is installed in the vacuum vessel it will be adjusted with the struts such that the couplers will fit through the vacuum vessel ports and into the cavity. The position of the cavity will then be referenced to the outside fidicuials. Then the doors are placed on the vacuum vessel at MTA the fiducials on the doors will be referenced to the body fiducials. Then the vacuum vessel will be set to the beam line.

J Volk presented a list of documents or notes that need to be prepared to receive the necessary approvals;

1. Job Hazard Analysis (JHA) for installation of the cavity inside the vacuum vessel at Lab 6. Volk to prepare following the installation procedure that is to be worked out at this meeting.
2. Mechanical review of fixtures for installation of cavity. R Schultz will do this as part of the design process.
3. Engineering note of transport stand R Schultz will provide as part of design process.
4. Pressure vessel review for vacuum vessel. The vacuum vessel is not regarded as a pressure vessel at Fermi but a short note stating the dimensions and reasons for this must be written, J Volk will this note.
5. JHA for installation in MTA. This will follow from the procedure that will be written, J Volk to take care of.
6. Inform Radiation safety of new device in MTA hall J Volk to take care of.

# RF plumbing:

Al Moretti discussed what pieces of wave guide will be required to mate the new couplers to the existing wave guides in the MTA hall. The couplers will be built at the LBL shop and paid for by Fermi. (Note at a later part of the day there was some discussion regarding the length of the couplers. Al Moretti wants them ½ inches longer than currently specified to mate with existing RF. Al DeMello will work with Moretti on this). The existing Beryllium windows will be re-used on the new cavity. LBL has more windows available if needed.

The existing vacuum system in the MTA hall will be re-used. This consists of a scroll pump, a turbo pump, an ion pump with gauges mounted on the west wall and a getter pump that mounts on the flange at the bottom of the vacuum vessel. There needs to be a review of the system capability for pumping down the new system. There is a sleeve that connects the cavity to the pump out port such that most of the pumping is in the cavity. An ultimate pressure of 10-8 Torr for the cavity and 10-6 Torr for the vacuum vessel is expected. The vacuum vessel has been pumped down to 10-7 Torr at Lab 6. Al DeMello will look at old vacuum calculations and forward information onto Ryan Schultz. Fermi engineers will look at existing system and verify that it can achieve the necessary vacuum levels in a reasonable time.

Ryan Schultz will work up design for tophat and work out installation procedures. The tophat will sample the cavity vacuum; have fibers for spark detection and RF pickups for the cavity.

# RF measurements

1. The frequency is dependent on the windows. LBL has pick up loops that were used to originally measure the cavity. These will be sent to Fermilab.
2. Measure the cavity first with the flat copper plates on. Use the LBL loops to get the S1, S2 and resonant frequency.
3. Install the tuners and re-measure.
4. Put on the Beryllium windows and re-measure.
5. Install the cavity and re-measure it will now be possible to use the actuators to change the tuners and deform the cavity. Calibration curves of pressure vs deflection need to be made at this time. Linear transducers can be installed on the tuners to measure the deflection as a function of pressure.

There are four configurations of the beryllium window bulge these are;

1. Upstream bulge in downstream bulge in
2. Upstream bulge in downstream bulge out
3. Upstream bulge out downstream bulge in
4. Upstream bulge out downstream bulge out

LBL tested the cavity with the windows as Upstream in dwonstream out configuration. There is the question of how the cavity can be matched to the LINAC RF frequency. This will have to be worked out in Lab 6. If possible this work should be done with the tophat installed. It is expected that the tophat will change the frequency of the cavity.

The issue of conditioning the couplers was discussed. It was determined that building a separate conditioning stand for the couplers would take too long and divert manpower from other necessary tasks. The couplers will be conditioned along with the cavity in the MTA hall at first with no magnetic field. A detailed procedure needs to be written the basic plan is to go up in 50 kWatt steps while watching the vacuum in the cavity. It will be necessary to inspect the couplers from time to time during the conditioning. This will all be in the procedure.

Part of the tuning process will be rotating the couplers to find the optimal resonant frequency. LBL will have scribe marks on external parts of the couplers so that the rotation angle can be measured during this process.

This issue of titanium nitride plating was discussed. It may not be possible to get the plating deep inside of the couplers. This could be an issue with multi pacting. The entire assembly process for the couplers is still not clear at this time. LBL needs to work this out.

# Various issues:

1. Who is responsible for vacuum calculations? Ryan Schultz and Bradly Verdant will check the MTA pump system, LBL to provide information on Vacuum vessel with cavity
2. What is the condition of compressed air in the MTA hall? Is the air used for the beam stop clean and free of oil and dirt? Is it adequate for the actuators? Is it better to use boil off from the liquid nitrogen dewar or add a new air system? RS and BV to investigate
3. Fermi will design the tophat, Al Moretti will work with Ryan Schultz on this.

# Assembly in Lab 6:

Ryan Schultz presented his plan for Lab 6 work;

1. Remove existing cavity and gantry crane from MTA. These will have to go out through the labyrinth.
2. Move vacuum vessel and cavity in box into clean room
3. Move in gantry and rotation and insertion stands in clean room.
4. Remove cavity from box.
5. Remove box from clean room.
6. Clean everything in clean room.
7. Using gantry lift cavity onto rotation fixture,
8. Install tuners while cavity is horizontal.
9. Rotate cavity to the vertical position.
10. Bring to insertion stand and transfer cavity.
11. Disassemble rotation stand and remove
12. Reference cavity to tuner ports
13. Bring vacuum vessel to insertion stand
14. Insert cavity and attach struts.
15. Align cavity in vacuum vessel.
16. Reference cavity to fiducials on vacuum vessel.
17. Attach actuators.
18. Insert couplers.
19. Put on lexan windows.
20. Do RF testing.
21. Prepare to transport to MTA, remove couplers, actuators and any other item that could be snagged during transport.
22. Move to MTA
23. Roll in through labyrinth.
24. Use 3 ton gantry to transfer vacuum vessel from transport stand to beam line stand.
25. Place vacuum vessel on beam line and align
26. Re install actuators, couplers, and anything else removed for transport.
27. Put on doors and pump down system.
28. Do RF testing.

There was some discussion regarding testing in Lab 6 as opposed to doing the entire operation in MTA. The general consensus was to do the testing in Lab 6 before moving. There was also some discussion regarding the usefulness of vacuum testing the system at Lab 6.

The last item of the day was a detailed assembly list for the chamber. This is being revised and will be posted soon. J Volk will use this list to generate a JHA for the work.