U.S. Muon Accelerator Program Memorandum

From: Mark Palmer, MAP Director, Fermilab

To: Derun Li, MAP Laboratory Manager, LBNL

Subject: Review of MICE RF Module Vacuum System Concept

January 21, 2015

Dear Derun,

This memorandum is to identify key issues for discussion at the preliminary concept review of the MICE RF Module vacuum system design to be held on January 27-28, 2015. This review represents an intermediate step in our sign-off of the MICE RF Module (RFM) engineering design. The broader process aims for a review of the full RFM engineering design on the early April 2015 timescale (our goal is to hold the engineering review prior to the MICE Project Board Review to be held at RAL on April 16-17, 2015).

The primary issue at hand is to establish a vacuum system scheme that ensures operation of the interior of the RF cavity at the ~few $\times 10^{-8}$ Torr level while the external vacuum may be as high as 10^{-6} Torr. Please note that the reference value from the MuCool Test Area (MTA) using the MICE Single Cavity Test System (SCTS) is 4×10^{-8} Torr with an external vacuum measured in the 10^{-7}-10^{-6} Torr range[1]. Thus the LBNL design team should be prepared to present their design concepts as well as preliminary performance evaluations and module hardware protection requirements.

The MICE 201 MHz RF module has several unique features:

- The RF cavity is a closed pillbox design where the beam traverses thin Be windows that cover the irises;
- The RF system is intended for operation in Tesla-class magnetic fields; and
- The RF cavity utilizes a clean electropolished surface to improve its breakdown performance.

Thus, the following key questions should be addressed:

- How should the design of the RF couplers be modified to reduce the conductance that they provide between the internal and external vacuum volumes?
- Given the connections between the internal and external vacuum volumes (e.g., the RF couplers and the Be windows where they mate to the cavity surface), what is the

[1] Based on August 1, 2014 characterization of the SCTS in the MTA. At that time the vessel vacuum readings were: Left coupler 1 $\times 10^{-6}$ Torr, Right coupler 8.4 $\times 10^{-7}$ Torr, Vessel 1.7 $\times 10^{-7}$ Torr.

anticipated best differential pressure that will be attainable between the two vacuum volumes?

- What are the pumping requirements to achieve the performance described in the preceding item?
- Is the present specification for the external (rough) vacuum satisfactory for MICE operations with RF?
- What are the vacuum system design requirements to ensure that a failure of either the external or internal vacuum systems will not result in damage to the Be windows or other hardware in the RFM?

cc: Soren Prestemon, LBNL
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