T4CM Engineering Workshop Rollup
Fermilab, July 18-20, 2007

During the 3 day workshop, the mechanical design of the T4CM was reviewed by the design collaboration. The goals of this workshop were to identify outstanding design issues and to clarify the purpose of building a T4CM. This memo describes the action items needed to complete the design tasks as well as defining the T4CM purpose. A new schedule for completing the design is also included.

T4CM Purpose: The T4CM's main purpose is to test the sensitivity of the quadrupole magnet package mounted under the center post of the cryomodule rather than at the usual end position. The magnet mounted at the cryomodule end has been more prone to vibration and misalignment. The center of the cryomodule, directly under the fixed post, provides the most stable location for the magnet package. The T4CM will have additional instrumentation to take adequate measurements of the magnet package location both in the warm and cold positions. If this design modification does not perform significantly better than the previous end support design, then an alternative support and alignment system, or a separate cryomodule for the magnet, must be investigated.

A secondary purpose of building this cryomodule at Fermilab is to gain experience in the design, procurement, and assembly of a complete cryomodule. To-date, only existing TTF style cryomodules and cavity strings are being built at Fermilab. Beginning now, Fermilab and the ILC collaborators need to be able to develop every aspect of a complete cryomodule. North American standards, vendors, codes, etc. should be implemented so that technical expertise in the Americas can move forward. Note: the cryomodule is still a metric design.

Action Items: (provided in the order listed in the workshop agenda)

- Cavity design status: There is no current plan to modify the existing cavity design for the T4CM. The cavities will all be "short" end style cavities with bladetuners. INFN Milan will continue to work on developing end-group modifications for future, lower cost, cavity designs but the changes will not be deployed in the T4CM.
- Cavity interconnect bellows and flanges: INFN Pisa has been working on a new interconnect design. The study is not complete. Preliminary results show that the spring constant of the seal is too soft and at cold temperatures, the seal is not robust enough. INFN Pisa will continue to work on the seal geometry to eliminate this problem. The overall consensus was to avoid using the helicoil spring insert as it would create too many particles in the cleanroom. Other options to use an aluminum diamond shaped seal with modified flanges to fit within the 71.8mm cavity-to-cavity gap will be readdressed at Fermilab.

- Helium vessel design: For the T4CM, the bi-metallic transition from Dubna will be used to transition from the vessel to the helium supply pipe. The helium supply pipe and bellows will be fabricated from 316L stainless steel. The vessel will be modified at the ends to work with a cavity "cone" shaped flange transition that INFN Milan will design. This transition will be an extension to the standard cavity cone flange and will replace the "L" shaped existing transition.
- Bi-metallic transitions: INFN Pisa has been working with Dubna on bi-metallic titanium-to-stainless steel transition tubes. The evidence presented at this collaboration workshop suggested that the proper amount of testing had been completed with success. The use of this new transition was accepted and will be rolled into the T4CM titanium vessel design. INFN will pursue an order from Dubna and will supply these parts to Fermilab to be used in the fabrication of helium vessels. The first helium vessel using this transition joint will be tested at Fermilab in 2008. The current plan is to use this new transition in the type 4 cryomodule.
- Bladetuner and slim tuner: INFN Milan has made very good progress in the design of a slim, stainless steel tuner. They will continue to develop this tuner. The T4CM is designed in such a way that the final Bladetuner choice will not impact the helium vessel or magnetic shielding design. We will continue to design the T4CM using the heavier, lever arm style, titanium bladetuner until INFN has completed their design and validation.
- Magnetic shielding, external: The magnetic shielding design is now frozen. There were concerns raised about the actual shielding flux lines due to the overlapping sheet-metal parts. A magnetic study should be performed at Fermilab assuming small gaps between the shield's sliding components.
- BPM development: Fermilab is designing the next generation, waveguide style BPM. The prototype BPM will be studied this summer and plans have begun to integrate the design with the quad magnet package. The T4CM will assume that this new BPM is attached to the quad magnet and that its alignment will be achieved through the alignment of the quad magnet.
- Quad magnet development: Fermilab will be testing a quad / corrector magnet package prototype this summer. Follow-up plans will be to design a *real* T4CM quad magnet package with an integrated BPM. If this real magnet package is not ready for installation into the T4CM, a dummy magnet package will be used instead. The prototype magnet and ILC magnet parameters do not meet the requirements for a New Muon Lab installation; the magnet is too strong. Therefore, the T4CM magnet parameters for NML at Fermilab need to be defined.
- Cavity string layout: We will maintain the 71.8mm cavity-to-cavity spacing and now focus our work on the 8 cavity with 1 magnet cryomodule design. The magnet package will be located under the center support post. The cavity string will include the HOM absorber and will have a Gate-valve at each end. A study must be done to see if an additional WPM can be mounted directly off of the cavity bladetuner flanges. A conflict with the cryo end-cap and feed-cap designs may prohibit this design feature.
- Magnetic shielding, internal: KEK has been working on an internal magnetic shield design and presented their findings. Although it looks promising, this new

design will not be integrated into the helium vessel design at this time. It is too much of a design change to be able to implement by our scheduled deadlines.

- HGRP design: The T4CM will use the standard gas pipe as designed by INFN Milan and as built by Zanon; rolled sheet with seam welds. There is also an option to use a DESY supplied 310 mm OD pipe. The standard pipe is 312mm in diameter. Follow up is needed with DESY on pipe availability.
- Needle bearings and alignment: The standard needle bearing will be used for the T4CM. However, it was proposed to open the alignment capability up to plus or minus 4mm instead of 3mm. Proposals for alternative bearings were discussed but will not be implemented on this T4CM.
- Heat shields: We decided to go back to the standard heat shield mounting and welding configuration. The stamped, sliding hook method was discarded. Penetrations still need to be designed to work with the quad magnet package current leads.
- Vacuum cryovessel: Basically done except for the ports required for the quad magnet current leads and laser measuring. MC ports to be welded from the inside rather than on the outside as in the older designs. The vessel does not need to be painted on the inner surfaces.
- Vibration studies: The vibration study has no impact on the current T4CM design. However, Fermilab should begin to develop plans for the installation of vibration instrumentation as well as developing a testing plan.
- Cryo pipe sizes and layout: Pipe sizes were modified per the January workshop recommendations. The center point locations of each pipe have not changed.
- Jack stands: The Indian design utilizing 3 jacks will be implemented. This should be verified with the New Muon Lab chief engineer.
- Cold posts: No modifications to the cold posts are necessary for the T4CM.
- Shipping: Since the T4CM will be fabricated and installed at Fermilab, no special features need to be designed into the T4CM in regards to shipping.
- Laser measuring of magnet vibration: It was requested that the T4CM design collaboration install a glass port and line-of-sight directly to the magnet so that a laser can be used for measuring magnet vibration. Fermilab will discuss this with the alignment group and will propose a design modification to the T4CM group.
- Electrical Feedthrus: Since the T4CM will be operated at Fermilab, the type of electrical connectors needs to be coordinated. The traditional DESY style connectors should not be assumed.
- EDMS Issues: After several months of database problems with DESY's EDMS, we are getting much closer to resolving our problems. UGS has been working very hard with Lars Hagge and his staff at DESY to fix the database problems we've been having with our large assemblies. A patch has been rolled out into the test environment and will soon be implemented in the working environment.