DESIGN OF MAIN COUPLER FOR 650 MHz SC CAVITIES OF PIP-II PROJECT*

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Abstract

Proton Improvement Plan-II at Fermilab has designed an 800MeV superconducting pulsed linac which is also capable of running in CW mode. The high energy section from 185MeV to 800MeV will be using cryomodules with two types of 650MHz elliptical cavities. Both types of cryomodules will include six 5-cell elliptical cavities. Each cavity will have one coupler. Updated design of the 650 MHz main coupler is reported.

INTRODUCTION

A multi-MW proton accelerator facility based on an H- linear accelerator using superconducting RF technology, Proton Improvement Plan-II (PIP II), is being developed at Fermilab to support the intensity frontier research in elementary particle physics. The high energy section from 185MeV to 800MeV will be using two types of 650MHz elliptical cavities. The low beta (LB), βg =0.61 portion would accelerate proton from 185MeV-500MeV, while high beta (HB), βg = 0.92 portion of the linac would accelerate from 500 to 800 MeV. Both types of cryomodules will include six 5-cell elliptical cavities. [1] Each cavity will have one coupler, see Figure 1. Coupler is compatible with both types of 650 MHz cavities. Each HB cavity requires ~100 kW CW RF power for 5 mA beam current operation This paper presents updated mechanical design of main coupler for PXIE HB and LB 650 MHz cavities.

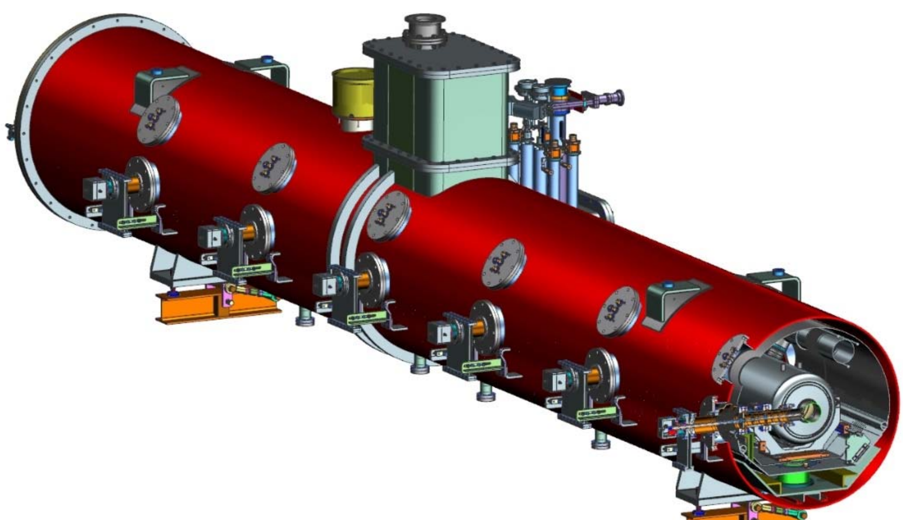

Figure 1: Cross sectional view of HB 650 MHz cryomodule.

* Work supported by DOE.
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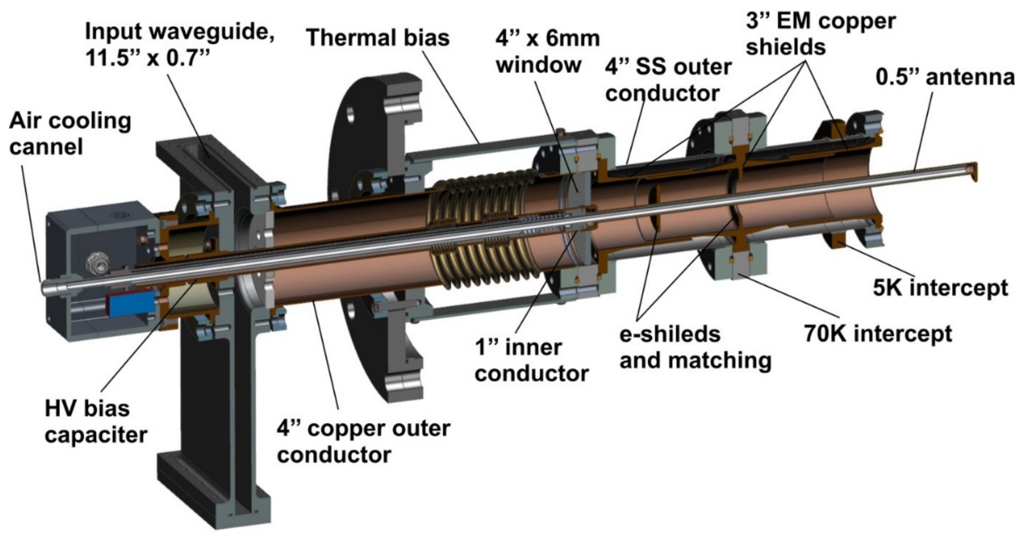

Figure 2: Cross sectional view of 650 MHz main coupler.

COUPLER DESIGN

The coupler structure is presented in Figure 2.

Main components of Coupler include a vacuum part connected to input waveguide section with flexible coaxial line. The input waveguide section is followed by a capacitor and instrumentation box. Since the previous publication [2], several changes were made in the design of the 650MHz main power coupler

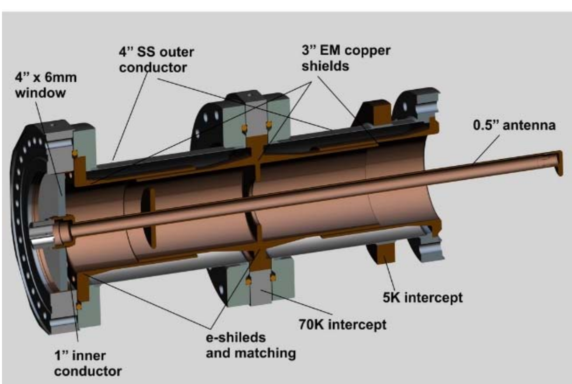

Figure 3: Vacuum part, EM shields version.

We prepared two versions of 650 MHz coupler vacuum parts: one with electromagnetic (EM) and another with copper coated outer conductor.

The first version is shown on Figure 3. It consists of a 4 inch OD stainless steel outer conductor with a wall thickness of 0.6 mm, 3" diameter copper EM shields, a 0.5 inch OD copper antenna, and a 4" OD and 6 mm thick ceramic window. To prevent possible cavity contamination with copper flakes the inside surface of an outer conductor is not coated with copper. The coupler outer conductor has two thermal intercepts (at "5K" and "80K") located between cavity flange and ceramic window. In order to reduce secondary electron emission the vacuum side of the ceramic window is coated with TiN. The copper antenna is hollow. It is cooled with dry compressed air. Matching element is placed on the antenna. It will also shield ceramic window surface from charged particles.

The second version is shown in Figure 4.

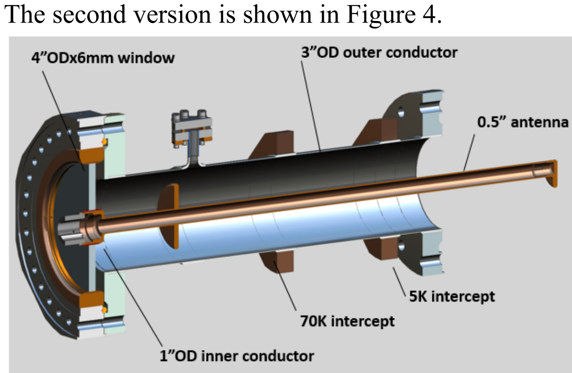

Figure 4: Vacuum part, copper coated version.

For this version vacuum part of the coupler consists of a 3" OD stainless steel outer conductor with a wall thickness of 0.6 mm, a copper antenna, and a ceramic window. The inside surface of an outer conductor is coated with copper.

We use the same ceramic window with antenna assembly on both versions.

The warm part consists of a flexible coaxial line, T-junction, capacitor and instrumentation box. The flexible coaxial line includes copper tubes, which are soft soldered to electrodeposited nickel alloy bellow coated with a thin layer of copper. One side of coaxial line ends with a diamond seal vacuum flange and another one with a modified 3 1/8 coaxial flange. The inner conductor located in the warm part of the coupler has a bigger diameter than

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the antenna. This design allows to apply high voltage bias to the antenna and supress possible multipactor. The instrumentation box located at the end of the coupler has the compressed air and high voltage bias connections. Inside of the box there is a photomultiplier that monitors ceramic surface activities.

THERMAL PROPERTY OF 650 MHZ COUPLER WITH EM SHIELDS

Simulations of thermal properties were done for 300 kW, CW, TW (matching load). Result are presented in the Table 1 and Figure 5.

Table 1: Results of Thermal Properties Simulations

	2K	5K	70K	293K	Air
Static (0 kW), W	**0.01**	**0.6**	**3.2**	**- 1.8**	**-2.1**
Total (300 kW), W	**1.4**	**1.6**	**10.2**	**33**	**195**

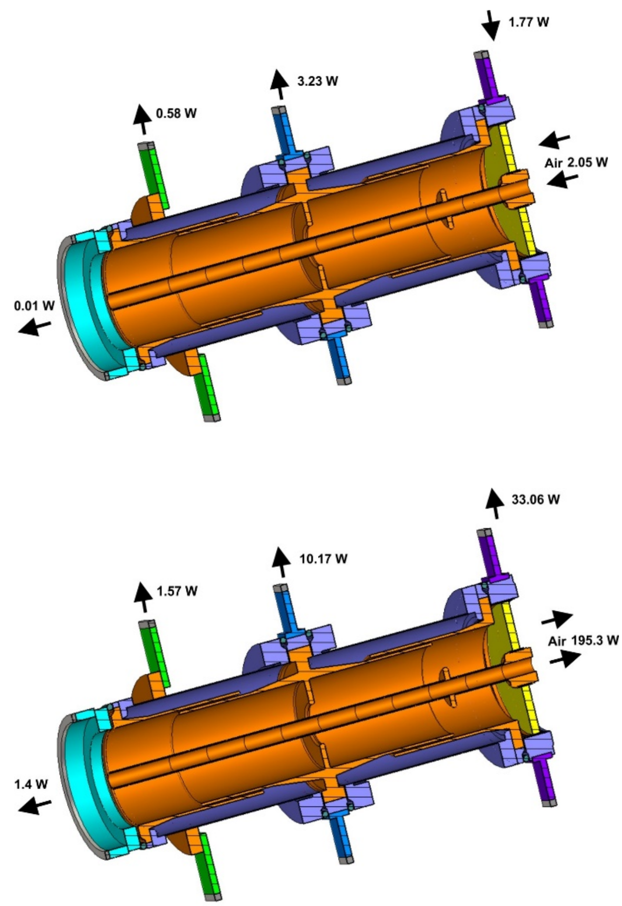

Figure 5: Results of thermal properties simulations.

CONCLUSIONS

The design of the 650 MHz Main Coupler for PXIE has been updated based on tests results of 325 MHz couplers and on new ideas.

REFERENCES

[1] V. Lebedev *et al.*, "The PIP-II Reference Design Report", Fermilab, 2015.

[2] S. Kazakov *et al.*, “Main Couplers for Project X,” in *Proc. IPAC 2012*, New Orleans, LA, USA, p. 2324.

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