FNAL* Main Injector Quadrupole Vacuum Chamber

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Abstract

Recycling the existing Main Ring quadrupoles presented engineering with an array of technical and environmental problems. The solution addressed the higher Main Injector vacuum requirements, maximization of the horizontal aperture, longitudinal space limitations, magnet recycling time constraints, tooling costs, and minimizing radioactive debris. Inserting a newly processed oval tube inside the existing star shaped tube eliminated the need to separate the welded and epoxied half cores, thus satisfying all the criteria.

I. INTRODUCTION

Within the existing Main Ring enclosure some 200 quadrupoles provide focusing functions for the 22 year old synchrotron. Currently 127 of these quadrupoles are scheduled for installation into the Main Injector Ring. All Main Ring quads possess a star shaped vacuum chamber formed from 304 stainless steel sheet which is sandwiched between welded half cores and are epoxy vacuum impregnated into place during the coil impregnation process. The vacuum chamber stainless is unprocessed except for superficial cleaning at the time of fabrication and at magnet installation. Today, after two decades of pumping, the average Main Ring vacuum pressure is approximately 8×10^{-8} Torr while the desired Main Injector pressure is 1×10^{-8} Torr. In an effort to achieve the desired Main Injector pressure rapidly (on the order of six months) the newly fabricated dipoles will contain an oval chamber made of electropolished and chemically cleaned 316L stainless steel assembled using established ultra high vacuum techniques. Therefore it becomes important to "do something" with the quad chambers to upgrade their vacuum performance nearly a Torr-decade.

II. CONSTRAINTS

The Main Ring is scheduled to provide protons to the Tevatron until Main Injector civil construction begins at the RF hall. At this time the final Main Ring shutdown will begin and is scheduled to conclude seven months later. This time frame provides ample time to remeasure the 127 quads and perform cosmetic upgrades to each magnet prior to installation into the Main Injector Ring. However, it is impossible to separate the half cores, "burn" the epoxy, remove the vacuum chamber, rewrap the coils, assemble and remeasure the magnet with a new vacuum chamber installed within the time allowed. Additionally, a substantial amount of radioactive debris would be generated causing severe control and disposal problems.

In principle, the existing quad chambers could be salvaged by cutting the end flanges from the tubes and creating equipment and procedures required to polish and clean the tubes within the magnets. Once again radioactive debris would be generated in the form of stainless chips (not particularly severe) and many gallons of cleaning solutions, alcohol, and distilled water. In all probability this procedure would result in chambers somewhat inferior to the newly fabricated dipole chambers due to the limited space and awkward length to cross section ratio.

Finally, it has been determined that the horizontal and vertical apertures in the new dipoles are also sufficient for the quadrupoles.

III. SOLUTION

The solution chosen which satisfies all the constraints also is the most economical. It is planned to slip a new tube, identical in cross section to the dipole tube, through the existing star shaped chamber after the Main Ring style flanges have been removed. The economy results from purchasing additional lengths of the dipole tube which incurs no additional tooling or set up costs. After the tube has been positioned, aligned, and welded within the quad, one end flange is added prior to final leak check. It needs to be mentioned that the new quad chamber will also house a beam position monitor approximately one meter long. The final cross sectional configuration is shown in Fig. 1.

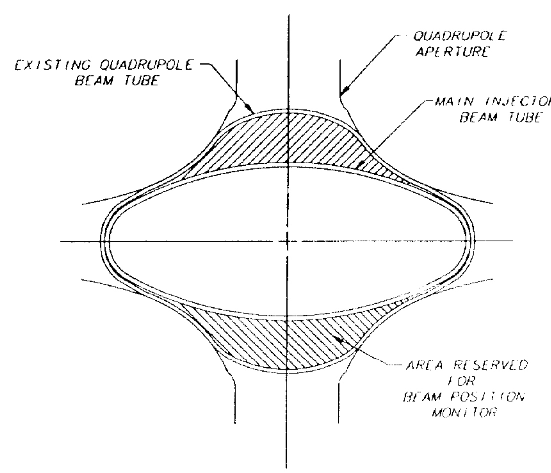

Fig. 1

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