The Proton Improvement Plan - II (PIP-II) project is underway at Fermilab with an international collaboration involving CEA in the development and testing of 650 MHz cryomodules. The risk analysis related to cryomodule operation proposed to add a vacuum gauge on the power coupler to prevent the untimely rupture of its ceramic. Due to the advanced design of the cryomodules, the gauge needs to be integrated inside the insulation vacuum to reduce the impact of this new modification. The lack of experience feedback on a similar operating condition requires an experimental validation before the implementation. This article details the experimental tests carried out before the approval of this solution.

**MOTIVATION AND CONTEXT**

Adapting the choice to the operating conditions

First, the vacuum gauge (VG) need to be preserved from too low temperatures when the cryomodule is cold. Proposed solution: RF window will operate at room temperature and will be equipped with heaters and copper straps to keep it warm during the cold operation. The same solution could be applied to the VG, if needed.

Second, each VG is equipped with a permanent magnet. Proposed solution: A magnetic shielding will be added to protect SC cavities from magnetic field and prevent the magnetization of the cryomodule components.

Third, the activation of the cold cathode gauges requires a potential voltage of 3.3 V. It represents a risk of creation of electron discharge during the vacuum pumping down, as predicted by Paschen’s law. Proposed solution: The operating procedure should automatically disable the VGs high voltage bias for a while during the cryomodule operation. This operation has no consequence on the protection role fulfilled by the VG as the RF will be naturally switched off during that period.

**EXPERIMENTAL VALIDATION OF THE USE OF COLD CATHODE VACUUM GAUGE INSIDE THE CRYOMODULE INSULATION VACUUM**

**CHOICE OF THE VACUUM GAUGE**

**EXPERIMENTAL SET-UP**

**Objective of the experiment**

Our objective is to check the following performances:

- The VG measurement consistency: comparing the PIP-650 MHz vacuum gauge measurements values atmospheric pressure vs under insulation vacuum.
- The VG thermal stability: verifying that operation under vacuum does not increase the gauge temperature due to the lack of convective heat transfer
- The VG operation reliability: observing the behavior consistency during relatively long continuous operation under vacuum.

**TEST RESULTS**

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