Reliability of multiwire proportional chambers in the field measurements: thermal and mechanical limits

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Mechanical Engineering Modelling MSc, Major in Solid Mechanics, 2020/2021/I.

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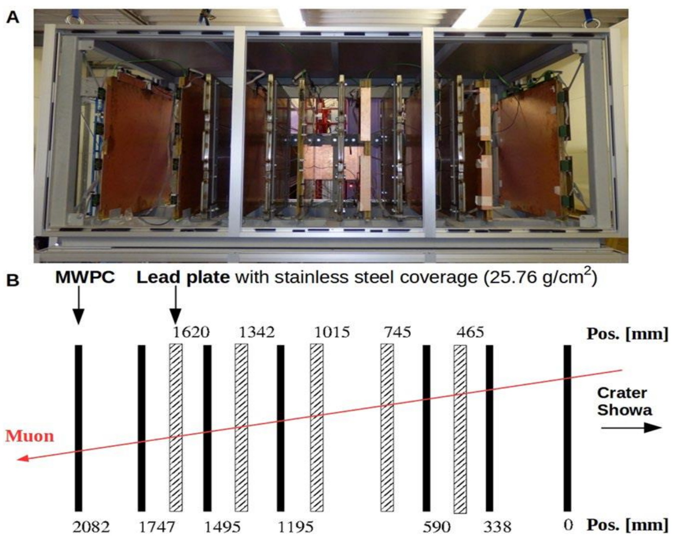
1. Introduction

The REGARD group is focused on the research and development of gaseous detectors through Charpak's idea which resulted the usage of the multiwire proportional chambers as the core element of an imaging system. The Hungarian-Japanese collaboration helped to establish the Multiwire proportional chamber-based Muon Observatory System (MMOS) in Japan near the Sakurajima volcano. This few years of work during the upgrade of the MMOS brought us a lot of experiences in this area including the possible limits of the system. My work aims to investigate the effects of the environmental parameters to our chambers and the effectiveness in a mechanical sense of the used adhesive.



1. Figure (**A**) *The photograph of mMOS system near the Sakurajima volcano in Japan.* (**B**) *Schematic view of 1 mMOS, currently 11 system is working continuously.*

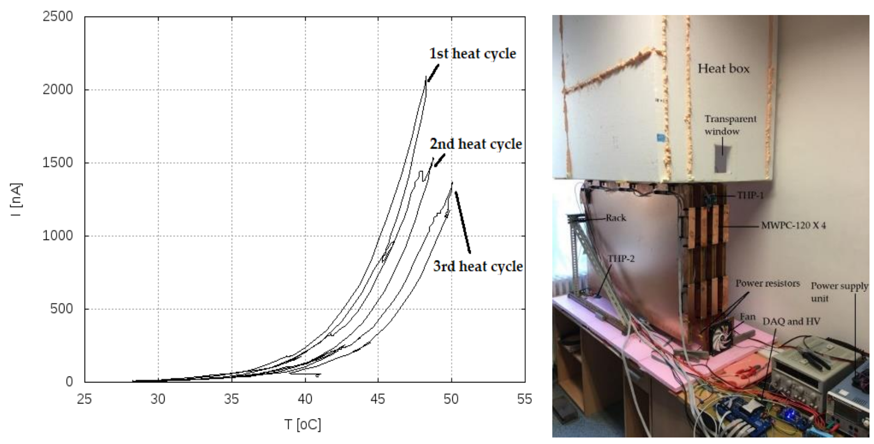
2. Applied methods

In the first section of the thesis, I investigated the effects of the environmental parameters (temperature, pressure) to our detectors. I successfully built a measurement setup that can imitate the outdoor conditions and our chambers can be tested. In this so called "heatbox" the temperature inside can be changed in a specified range and its effect can be characterized quantitatively.

In the second section I was interested in the mechanical properties of the adhesive that is used for the construction. During the transportation to Japan random vibration effects present that can damage the system. First I measured the tensile strength of the adhesive in different configuration. After that a modal testing and a Finite Element simulation was performed on one chamber. Due to the lack of the fatigue test, I validated my model with the measurement and successfully made the Random Vibration analysis on our chamber. In order to somehow connect the "static" (Tensile test) and "dynamic" (Vibration analysis) measurements a quite conservative approach was used to be on the safe side.

3. Results

I made a 1 month long measurement where the temperature was changed from 25 to 50°C and the pressure according to the weather. After applying corrections the different environmental effects could be charactherized quantitatively. During the measurement I observed an interesting "tempering effect" that resulted a higher temperature limit after applying each heat cycle that can be adapted in the construction.



2. Figure The current of the system as a function of the temperature. The temperature limit can be increased with heat cycles due to the „tempering effect"..

I compared the results from the different measurements and the first six eigenfrequencies are the same within 10%. In the next step the highest test profile was used with the highest scale factor for the Random Vibration analysis corresponding the most dangerous case. A relatively small damping ratio was applied resulted from the modal analysis. In the end even safety factor remains therefore the chambers can be transported without a problem.

Connection	Tensile strength	Simulation	S.f.
G10-base plate	σm=1.47 MPa	σrv=0.15 MPa	n=9.8
FR4-base plate	σm=1.47 MPa	σrv=0.46 MPa	n=3.2
Pillar-base plate	σm=5.7 MPa	σrv=2.12 MPa	n=2.7

1. Table The comparison of the results from tensile test and the vibration simulation.

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