Pressure test of MuTr gas windows

Paul E. Reimer

April 22, 1999

Abstract

This document outlines the successful pressure test of a MuTr Station 2 gas window. The tested window was made of 5 mil Mylar stretched across a Station 2 frame. To achieve the desired width of Mylar to cover the full frame, two separate pieces of mylar were seamed together for the test.

Phenix Muon Tracking (MuTr) Station 2 uses tracking chambers in which the gas volume is maintained by 5 mil mylar windows. During operation, the chambers will have a pressure that is 5 Torr (approximately 0.1 PSI) above the ambient atmospheric pressure. While this pressure difference is very slight and well below the "bursting strength" of the Mylar (66 psi/mil according to DuPont) caution still dictates performing a test on a full scale chamber window.

The gas volume of Station 2 can be *roughly* described as a circular disk, with a 19 mm gap between the front and rear gas windows. This disk is divided into octants which form the basic unit enclosing the gas volume. The test outlined below involves one such octant whose dimensions, which are given in Table 1, match those of the South Arm of the MuTr system. A Station 2 octant for the North Arm is slightly larger. The window was prepared by gluing (with DP460 epoxy) a sheet of 5 mil Mylar to the station 2 frame. Since mylar of sufficient width was not available to cover the entire width of the frame, two sheet of mylar were seamed, edge to edge, together. In the seaming process, the mylar was was roughened using a plasma arc, and two inch strips of 1 mil mylar were epoxied to the top and bottom of the seam. To simulate the chamber, a rubber gasket was placed on a flat Aluminum surface, followed by an "empty" Aluminum frame and another rubber gasket. Then the frame with the window was stacked on top of this, with the window side down. Figure 1 shows a schematic drawing of this test.

The test outlined below is a hydrostatic test. There is no energy stored in the system, above that provided by the gravitational potential of the column of water used to provide the pressure. To produce a pressure of 5 Torr (25 Torr), a column of water 6.8 cm (34.0 cm) high is needed. Ordinary tap water was used for this test.

Station 2 uses a gas mixture of Ar:CO_2:CF_4. This is a *non-flammable* gas, and we do not plan on ever upgrading to a flammable mixture. Brookhaven National Laboratory does not have a specific policy for testing large volume, low pressure chambers which contain *non-flammable* gases. There are some guidelines for chambers containing flammable mixtures, however, and we have tried to adhere to these guidelines.

The chamber was slowly filed with water, and the air inside the chamber was allowed to vent. When the chamber was completely full of water, the chamber was pressurized with an additional 34 cm of water

Table 1: Dimensions of a Station 2 octant. The actual gap is only 19 mm. The effective gap given in this table allows for bowing of the windows.

	South Arm	North Arm
Outer Radius (cm)	219	283
Inner Radius (cm)	64	57
Octant Surface (cm^2)	1.7×10^4	3.0×10^4
Effective Gap (cm)	3.5	3.5
Volume (liters)	60.3	106

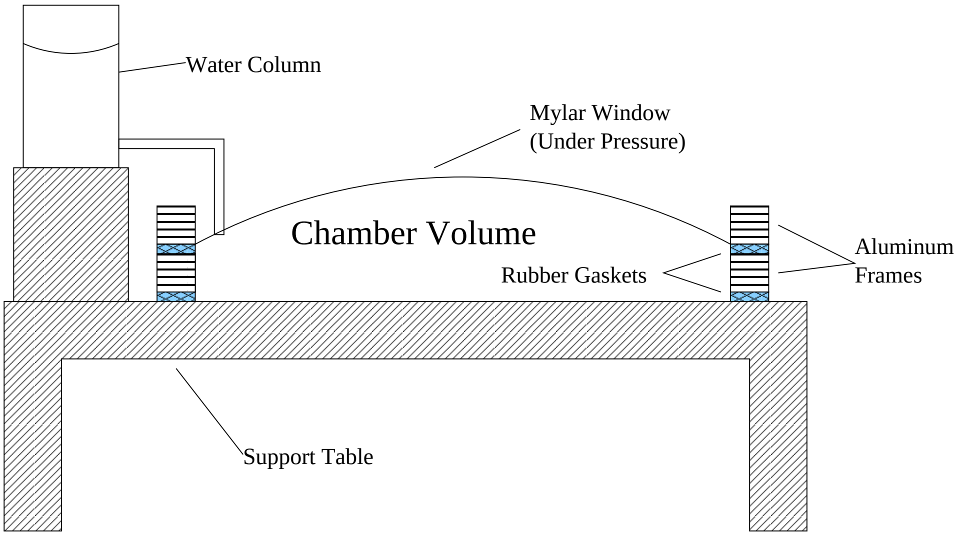

Figure 1: A cross sectional view of the pressure test on the Station 2 chamber. The mylar window was glued to the upper aluminum frame.

column (5× over pressure). At this point, the deflection of the window was measured to be 3.2 cm at the center of the lower half. The chamber was left under pressure for four hours, and the window deflection was periodically measured. For the entire four hours, the deflection remained at a constant 3.2 cm. The pressure on the chamber was then cycled 5 times from 1 cm water column (wc) to 34 cm wc and the deflection measured on each cycle was found to be 3.2 cm (no change). As a final test, the window was pressurized with an additional 10 cm wc to a total of 44 cm wc (32 Torr).

At no point during the test did the window leak or show signs of excessive stress. There were small leaks between the frames and the rubber gasket. The point of these test, however was not to test this seal, and the actual chambers will use a rubber o-ring for this seal which will provide a much better seal.

A post-test inspection of the mylar seam showed it to be in good condition. The glue between the mylar and the aluminum frame was also inspected. This inspection revealed that there were areas on between the frame and the mylar where uneven pressure was applied during the epoxy curing process which produced bubbles between the frame and the mylar.

In conclusion, the 5 mil seamed mylar windows easily withstood a 5× over pressure for four hours with no additional creep of the mylar over the four hours once the chamber was pressurized. In addition, the chamber was pressure cycled several times and withstood pressure of 6.5 × over normal operating pressure.