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EFFECT OF N₂ CONTAMINATION IN L3
FORWARD/BACKWARD MUON CHAMBERS

by

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Effect of N_2 Contamination in L3 Forward/Backward Muon Chambers.

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Abstract

Since the presence of a small amount of air is unavoidable in large drift chamber detectors, we present a study of the effect of N_2 contamination on the electron drift velocity in a working Forward/Backward Muon Chamber placed in the MIT cyclotron magnet. The nominal gas mixture, Ar:CO₂:iC₄H₁₀ (86:10:4), was varied by including as much as 1% N_2 . Results at B=0 and 0.5T are shown.

1 Introduction

Due to their finite leak rate, the forward/backward chambers will be subject to small contamination by nitrogen. This was investigated at the 1% level using F/B chamber 03, which is presently located at MIT [1].

Fig. 1 shows the measured leak rate of our chamber. We estimate the air contamination to be approximately 1% at a flow of 2l/min. The estimate was obtained by assuming a chamber volume of 800 liters and homogeneous mixing of the contamination. Note that the present leak rate of chamber 03 could increase by a factor 3-4 before reaching tolerance level.

2 Experiment

Fig. 2 shows the measured drift velocity in the chamber with a flow of 2l/min Ar:CO₂:iC₄H₁₀ (86:10:4). Drift times were determined using photoelectrons generated on the I-beam by a pulsed UV laser collimated to achieve a signal comparable in magnitude to that from cosmic muons. A photodiode placed outside of the chamber provided a constant trigger. We used 'prepulses' from direct laser hits on the signal wires to infer the absolute drift times. High voltage settings were calculated using the *Wire Chamber* program, table 1 [2]. The laser hit the I-beam 10cm into the chamber, well within the uniform field region [3]. We estimate the errors to be $\pm 0.5\%$ experimental and $\pm 0.5\%$ systematic, increasing to 1% at low E-fields due to signal degradation. Note that $\frac{5.15\text{cm}}{t_{\text{drift}}}$ was the formula used for the drift velocity parallel to the electric field, $V_{\parallel}$; corrections for the nonlinear electric field near the signal wire were ignored.

Superimposed in Figs. 2-4 are spline curves of measurements made using the test chamber described in ref.[4]. We include these as reference curves of the drift velocity of Ar:CO₂:iC₄H₁₀ (86:10:4). Referring again to Fig. 2, there is a clear discrepancy in shape between the two sets of data; the drift velocity measured in the F/B is suppressed below 1000V/cm and enhanced above. This difference is attributed to N₂ (air) contamination in the F/B chamber.

In an attempt to minimize air contamination we increased the flow rate an order of magnitude and repeated the measurement at 20.93 l/min. This corresponds to a gas turnover of approximately one chamber volume every 45 minutes. At this high flow rate, we expect around 0.1% N₂ in the chamber and, indeed, close agreement with the reference curve is observed at B=0 and 0.5T, fig.3a,b.

To verify the effect we repeated the experiment with a 1% admixture of N₂, fig.4a,b. One clearly sees a broadening of the plateau region and an increase in the drift velocity at high E-fields. These effects have been previously observed, ref. [4],[5] and are qualitatively predicted by the Magboltz program [6], fig.5. The presence of small quantities of dry air has been shown to have a very similar effect to that of comparable amounts of nitrogen [5].

3 Conclusion

Nitrogen contamination has been shown to have a significant effect on drift velocity in a working F/B muon chamber. In particular, suppression of the drift velocity plateaux suggests operating points somewhat higher than those chosen for pure gas.

4 Acknowledgements

We would like to thank Danning Ren of ETHZ for calculating voltage settings for the chamber. Also, we thank Mike Grossman for technical support.

5 References

- [1] *The Forward/Backward Muon Detector*. L3 internal note, 1992.
- [2] Wire Chamber Program (Garfield), Rob Veenhof, 1989.
- [3] *Determination of the Fiducial Volume of the L3 Forward/Backward Muon Chambers*. U.Becker *et al*, L3 internal note, 1994.
- [4] U.Becker *et al*, Nucl. Instr. and Meth. A 306 (1991) 194.
- [5] T.Zhao *et al*, Nucl. Instr. and Meth. A 340 (1994) 485.
- [6] Magboltz V2.2, S.Biagi, March 1990.

6 Figure Captions

Fig 1. Leak rate of F/B chamber 03. Note, the tolerance is exponential with $\tau=120$ min.

Fig 2. Drift velocity vs. E-field in F/B chamber at $B=0$, low flow rate. Reference curve measured using set-up described in ref.[4].

Fig 3a. Drift velocity vs. E-field in F/B chamber at $B=0$, high flow rate. Reference line same as that in fig.2.

Fig 3b. Drift velocity vs. E-field in F/B chamber at $B=0.5\text{T}$, high flow rate.

Fig 4a. Drift velocity vs. E-field in F/B chamber at $B=0$, 1% N_2 added.

Fig 4b. Drift velocity vs. E-field in F/B chamber at $B=0.5\text{T}$, 1% N_2 added.

Fig 5. Drift velocity vs. E-field at $B=0$, Magboltz calculations.

LEAK TEST F/B CHAMBER 03

fig. 1

E-drift (V/cm)	Vanode (V)	Vfield (V)	Vguard (V)	Vcathode (V)
400	2185	200	1190	-1080
500	2440	590	1430	-1350
600	2710	1010	1710	-1620
700	2990	1430	2000	-1890
800	3250	1840	2250	-2160
900	3440	2140	2440	-2430
1000	3630	2450	2630	-2700
1100	3880	2840	2870	-3000
1200	4060	3130	3050	-3250
1300	4220	3390	3190	-3500
1400	4430	3730	3400	-3800
1500	4730	4180	3700	-4050
1600	4920	4490	3880	-4300

Table 1. Voltage settings for surface field of 170 kV/cm.

fig. 2

fig. 3a

fig. 3b

fig. 4a

fig. 4b

fig. 5