Gas-Tightness of the ATLAS Muon Drift Chambers

R. Hertenberger, O. Biebel, M. Boutemeur, J. Dubbert, F. Fiedler, A. Leins, T. Nunnemann, F. Rauscher, D. Schaile, A. Staude, H. Steffens, R. Ströhmer, R. Vertesi, and C. Zupancic

An ATLAS MDT (monitored drift tube) chamber consists of 432 single drift tubes that are grouped into two multilayers of 3 rows with 72 tubes, each. Each drift tube is connected by 8 o-ring seals to the central gas distribution. To control the tightness of the 3456 o-ring sealings we fill each chamber with 2600 mbar of Ar and 400 mbar of He. The leaking helium is then detected from outside with a helium leak detector (Alcatel ASM 142) in sniffer mode. To increase the dwell time of the helium at the leakage and thus the detection sensitivity the gas connections of 3 to 9 drift tubes can be covered with the structures shown in Figure 1. The snorchel of the helium sniffer detector is inserted through a hole in the transparent part of the covers to test the surrounding of each o-ring. Special types of covering structures are used additionally. They are adapted to the geometry of particular connections and enable their fast and reliable check in case of an eventual leakage. Most leakages are caused by dirt, hairs, scratches or damaged o-rings and have been removed. At two of the 12 tested chambers we observed tiny cracks in the plastic endplups, the holding structures of the anode wires. These cracks are momentarily irreparable but only two particularly bad tubes out of 5184 tubes in total had to be taken out of operation. A complete scan of all connections lasts about 3 hours. Usually two or three iterations including repair and recheck of leaking connections are necessary to get the chambers sufficiently tight. The total working time for all iterations is about 2 days per chamber. For determination of the final leak-rate 3 more days are needed to monitor the pressure-drop $\frac{dp}{dt}$ as a function of time.

Precise and temperature stabilized baratrons (MKS 690A) with an accuracy of 0.1 mbar are used to monitor the pressure of each multilayer sepaprately, NTC semiconductor temperature sensors provide temperature compensation. Back diffusion of air into the ATLAS MDT drift tubes is limiting the allowed maximum leak rate per single drift tube to $2.0 \times 10^{-5} \frac{mbar\,l}{s}$. A chamber has a volume of about 1140 l. The maximum leak rate of $8.6 \times 10^{-3} \frac{mbar\,l}{s}$ for one chamber corresponds to an allowed pressure drop of only 0.65 mbar per day.

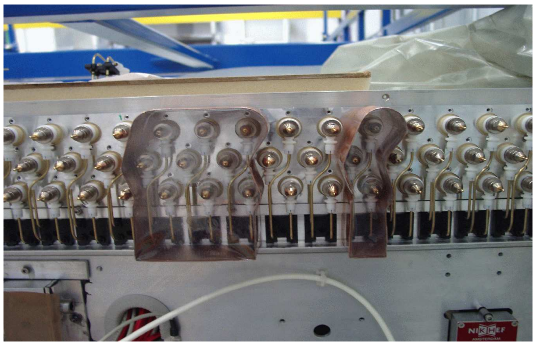

Fig. 1: View on the endcaps of the muon drift tubes with the gas distribution assembly. Each of the 432 drift tubes is sealed with 8 o-rings.

Figure 2 shows for the chamber BOS1C16 a measurement of pressure (black curve) and temperature (coloured curves) over a period of 150 hours. The observed day-night variations of the pressure are due to temperature variations. A temperature difference of 0.1 K induces a pressure difference of about 1 mbar at the working point of 3000 mbar and 293 K. For temperature compensation the monitored temperature T is modified to $T_m = T \times \frac{P_a}{T_a}$+offset. The subscripts a refer to averaged pressure and temperature, the offset is adapted such that T_m fits the pressure data. The difference between pressure P and modified temperature T_m, should be constant in case of a tight chamber. The pressure drop at this chamber corresponds to $0.65\ \frac{mbar}{d}$.

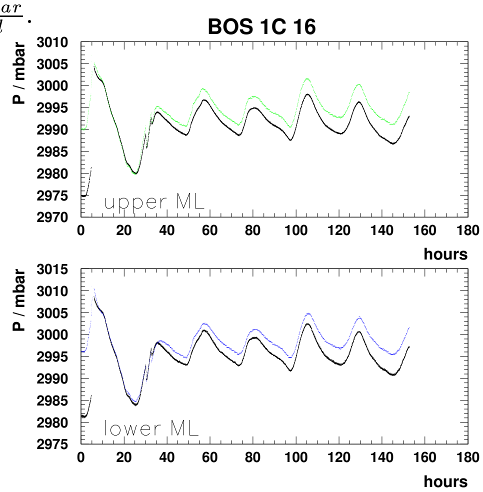

Fig. 2: Time dependence of pressure (black) and temperature (coloured) in an ATLAS muon drift chamber over a period of 150 hours for both multilayers. The temperature is modified according to the gas law. The offset is adapted to fit the pressure data. The day-night variations of the pressure are due to temperature variations in the surrounding.

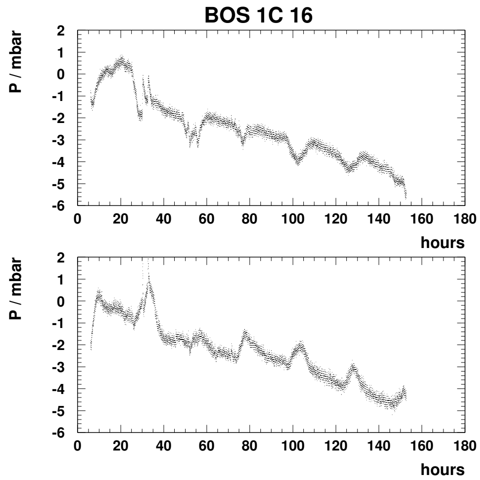

Fig. 3: Temperature compensated curves: P = P - T_m for upper and lower multilayer.

12 chambers have been tested in 2003, their leak-rates are given in [1]. Only 2 chambers with cracked endplugs have leak-rates slightly above the limit. The other chambers fullfill the ATLAS requirement.

References

[1] J. Dubbert *et al.*, this report, p. 88