# Aging Tests for the ATLAS Muon Drift Tubes

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The aluminum drift-tubes (MDT's) of the ATLAS muon spectrometer are expected to accumulate charges of up to 0.6 C/(cm of wire) during ten years of operation. Therefore aging tests are in progress. In five setups up to 80 tubes can be irradiated simultaneously. The influence of the drift gas on the aging performance was studied. The amount of gas flow, different additives to the drift-gas, different cathode coatings, the cathode cleanliness, the irradiation rate, the length of the irradiation zone, the gas gain (high voltage) and the construction material in the gas volume were varied to determine their influence on the aging performance.

I will focus my talk on two aspects. In the first place, on the dependence of aging on the irradiation rate, on the length of the irradiation zone, and on the applied high voltage (gas gain). These dependencies dictate which gas to choose. They make extrapolation from the laboratory conditions to the full experiment difficult. Secondly, I will speak on the choice of the gas for the MDT's.

**Summary of Talk:** The requirements for the ATLAS Monitored-Drift-Tubes (MDT's) are hard to meet. At the rather high irradiation rate of up to 100 Hz/cm$^2$ (without safety factor of 5) a single-wire resolution in space of 80 $\mu$m has to be achieved. As under these conditions already small changes in pulse height or shape degrade the resolution, we consider the end of the lifetime of a tube at the point when the original pulse height is reduced to 70%. The target value is an accumulated charge of 600 mC/cm at a gas gain of $2 \cdot 10^4$. We started in 1995 with aging tests and in this talk I want to concentrate on what we think to be some of the most important issues. Using a set of short drift-tubes we managed to find a gas that could collect more than 5 C/cm without any sign of aging and yet had good performance concerning the drift properties. This mixture: $Ar/CH_4/N_2/CO_2$ 94:3:2:1 has a very linear r–t relation and a short enough maximal drift time for the high-rate environment. When we tested this gas in full-length tubes at the high irradation facility in CERN, the tubes became inefficient at 80mC/cm. In order to understand this, we made detailed studies on the dependence of aging on the following parameters: cathode cleanliness, amount of gas flow as well as irradiation rate, length of irradiation zone and the applied HV. If the life time depended only on the amount of collected charge/(cm of wire), the last three parameters should not effect aging. On tubes made as identical as possible we measured that the accumulated charge at the end of the lifetime decreases from 5 C/cm at 3350 V to less than 0.2 C/cm at 3505 V. (The pulse charge was doubled under the latter condition.) Increasing the irradiation rate from 0.350 kHz/cm to 12.5 kHz/cm reduced the lifetime by a factor of five. By nearly doubling the irradiation zone from 25 mm to 45 mm the lifetime was reduced by a factor between two and three. These results illuminate the problems with aging tests that are meant to give reliable results for the final detector in a short time and on a small scale. As we do not understand how to extrapolate from the laboratory conditions to the final experiment, we propose to use $Ar/CO_2$ 93:7 as drift-gas. With this gas the tubes did not age, even if all parameters are varied to values above the design limits. Nevertheless, we observed that small impurities in the gas immediately cause aging.