Testbeam Studies of Straw Drifttubes for the COMPASS Experiment

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The COMPASS Experiment

In order to study hadron structure and hadron spectroscopy the COMPASS collaboration is currently setting up a new state-of-the-art spectrometer with particle identification facilities and calorimetry, capable of standing beam intensities up to $2 \cdot 10^8$ particles per spill. The **CO**mmon **M**uon and **P**roton **A**pparatus for **S**tructure and **S**pectroscopy will be a multi-purpose setup to be used with either a hadron or a muon beam produced by the CERN Super Proton Synchrotron (see [1]).

The COMPASS group at Ludwig-Maximilians-Universität München is coordinating the activities related to the large-angle-tracking system based on thin-walled "straw" drift tubes.

CERN Testbeam Results

The aim is to obtain a spatial resolution of 100μm, so the maximum mechanical precision has to be achieved in the construction; the active area of one chamber module will be up to 320cm × 260cm. Each chamber module will be equipped with several layers of straws in different orientations. The total number of straws will be about 13.000.

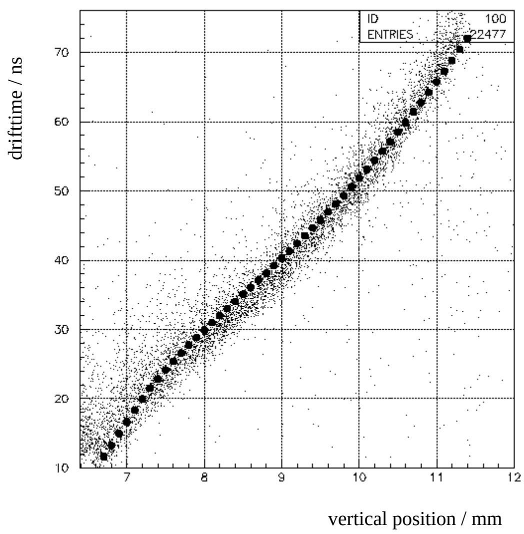

Fig. 1: Distance to drifttime relation measured with muons at CERN and calculated (circles) with the Garfield program [2]

The expected high particle flux does not allow to use a slow gas which could improve spatial resolution, and the well known (but not yet completely understood) driftchamber ageing phenomenon leads to further restrictions in the choice of chamber gas.

Fig.1 shows the distance to drifttime relation obtained with a muon beam in the CERN X5 area using an $Ar:CF_4:CH_4$ = 74:20:6 gas mixture under atmospheric pressure, the most likely COMPASS mixture to be used later.

Ageing Tests at the Tandem

The ageing safety was tested using 27MeV protons from Garching Tandem Accelerator. Far away from minimum ionizing energies 6-30 years of COMPASS operation (depending on the gas gain finally chosen) could be simulated within 3 days. The often quoted deadline of 1C/cm collected charge for drift chambers [3] was reached without observing a significant loss in pulseheight (less than 2%, see fig. 2).

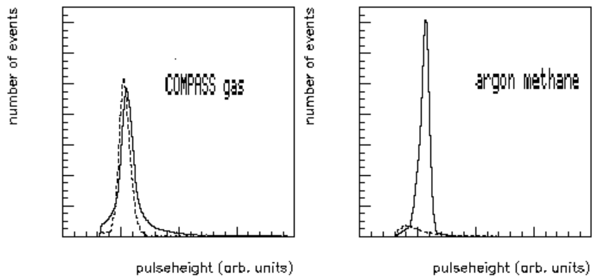

Fig. 2: Pulseheight spectra before (solid lines) and after proton irradiation (1.1C/cm, dotted lines). 5.9keV photons (^{55}Fe source)

To prove the sensitivity of this method in terms of ageing, some sample straws with an $Ar:CH_4$ = 90:10 gas mixture which is well known for causing strong ageing problems have been irradiated under the same conditions. Here 0.1C/cm were enough to make the detectors completely insensitive for 5,9keV photons from an ^{55}Fe source. Whether the "Malter effect", i.e. an increase in dark current due to an electric dipole layer on the cathode plane [4] will cause problems with the particle fluxes expected for the COMPASS experiment needs further investigation – during the test it was clearly visible.

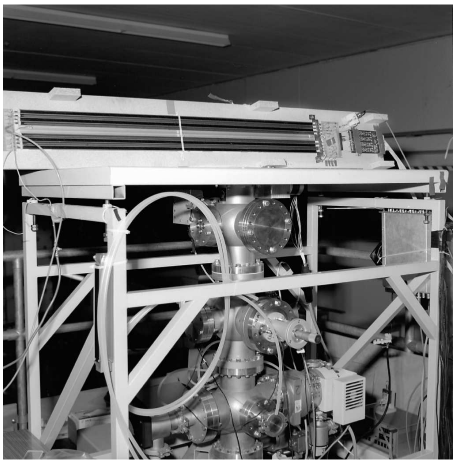

Fig. 3: Straw-test setup on top of the vertical Tandem beamline

References

[1] COMPASS, A Proposal for a **CO**mmon **M**uon and **P**roton **A**pparatus for **S**tructure and **S**pectroscopy, CERN/SPSLC **96-14** (SPSLC/P297) 1 March 1996

[2] R. Veenhof, Garfield, A drift chamber simulation program, CERN Program Library W5050 (1998)

[3] Proceedings of the Workshop on Radiation Damage to Wire Chambers, Jan. 1986, University of California, Berkeley, LBL 21 170 (1986) (unpublished)

[4] L. Malter, Phys. Rev **50** (1936) 48