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Measurement of the maximum drift time in the Calypso MDT chamber

A. Negri - University of Pavia and INFN
P. Bagnaia, C. Bini, P. Oberson, S. Rosati - University of Rome and INFN

1. Introduction

Recently [1] some results have been shown about the spread of the maximum drift time in a sample of MDT tubes with a serial gas distribution. The difference in drift velocity has been attributed to the amount of water vapour in the MDT gas, in a quantity which depends on the position of the tube along the gas flow path.

This effect, if not corrected, has unpleasant consequences. The definition of a common r(t) relation for all the MDTs in the same spatial region becomes impossible and, therefore, the autocalibration procedure is compromised. In order to have the same fraction of water vapour everywhere, it has also been suggested to design the gas flow scheme, such that all the tubes are in parallel with respect to the gas distribution.

In this note, we describe the measurement of the maximum drift time in the Calypso chamber, using data taken in the H8 test beam during the summer 1996.

2. Set-up

Calypso [2] consists of two separate multilayers, in the following called Calypso 1 and Calypso 2. Each multilayer is made of three layers of staggered tubes, of 1.5 cm radius and 260 cm total length, for a total of 96 tubes for each chamber. The gas mixture was Ar (91%), N_2 (4%), CH_4

contains 9 tubes in series, connected by NORYL jumpers and fixed with O-Rings to the endplugs.

In the following, the tubes are numbered from 1 to 9, according to their position in the chain. If the water vapour comes mainly from the jumpers or from a bad gas tightness at the jumper-endplug connection, the maximum drift time of a given tube should exhibit a linear dependence on its position number, as observed in [1].

3. Method of analysis

The maximum drift time has been evaluated with two independent methods.

a) In the first method, for each individual tube the time distribution of the hits has been fitted with an appropriate function :

$$N(t) = P_1 + \frac{P_2 + P_3 \cdot \exp(-t / P_4)}{\left[1 + \exp\left(\frac{P_5 - t}{A}\right)\right] \cdot \left[1 + \exp\left(\frac{t - P_6}{B}\right)\right]} \qquad (3.1)$$

where *N(t)* is the number of hits in each drift time interval. The parameters *P1...P6* are fitted for each tube. *P1* represents the constant uncorrelated background, *P2, P3* and *P4* describe the non-uniform top of the distribution, and finally *P5* and *P6* fit the minimum and maximum drift time. *A* and *B* are fixed in all the fits and describe the shape of the rise and the fall of the distribution. We notice that *P4* and the ratio *P3/P2* are essentially the same, within the errors, for all the tubes and could be held constant in the fit without substantial differences in the results.The maximum drift time of a tube is defined as :

$$\Delta t = P_6 - P_5 \qquad (3.2)$$

Note that the value of Δt and its error are independent from t_0. Fig. 1 shows a typical time spectrum, with the fit superimposed, after subtracting the tube t_0 (for the method, see [2]). Fig. 2 shows the values of Δt, as a function of the tube position number. The statistical errors are given by the fit. The points suggest a systematic discrepancy between Calipso 1 and Calypso 2, possibly due to the different TDC clock. However, no dependence on the position number up to a fraction of nanosecond is apparent.

b) In the second method, the maximum drift time is measured with the help of another tube, in the following called the auxiliary tube, in the same multilayer along the track path. For tubes belonging to the first and third layer, the auxiliary tube is the one in the middle layer, while for tubes in the middle layer we use the tube which follows along the track. Since this method requires that all the tubes along the track are fully efficient, we have restricted the analysis to Calypso 2.

paths of the selected and the auxiliary tube equals the tube radius. Therefore, small drift times in the auxiliary tube are correlated with the highest times in the selected tube. We retain events with one hit in the auxiliary tube in a time window between 35 and 45 nanoseconds, after subtracting the tube t_0. For these events the time distribution of the hits in the selected tube is fitted with a gaussian curve, and the mean value is taken as a measurement of the drift time:

$$\Delta t' = < t_{\text{selected}} - t_0 > \qquad (3.3)$$

The time window is chosen far from t_0, to avoid the pathological region of small efficiency near the wall of the selected tube, but at values small enough to keep the effect under study at a reasonable size. In this way, the measured time $\Delta t'$ does not correspond to the maximum time, but rather it is the time associated to a drift path d, such that

$$d \cong \text{radius} - r(t = 35 \div 45\text{nsec}). \qquad (3.4)$$

However, the difference between the values of $\Delta t'$ for two tubes is equivalent to the difference between the maximum drift times. Fig. 3 shows some typical time distributions, together with their fits. Fig. 4, analogous to fig. 2, shows the times $\Delta t'$ correspondent to different tube position numbers. The errors are computed by summing in quadrature the statistical uncertainties of the fit of fig.3 and of t_0. Also in this case, no dependence on the tube position is observed. By comparing Fig.2 and 4, we notice that the two methods, even if essentially independent, give similar results for Calypso 2.

4. Conclusion

No effect dependent on the tube position along the gas path is visible up to a fraction of nanosecond.

References

[1] T. Sammer - 31st Atlas Muon Testbeam Meeting, 11th February 1997;
S. Kircher - 32nd Atlas Muon Testbeam Meeting, 4th March 1997.

[2] A. Biscossa et al. - Atlas MUON-NO-136 (15 January 1997).

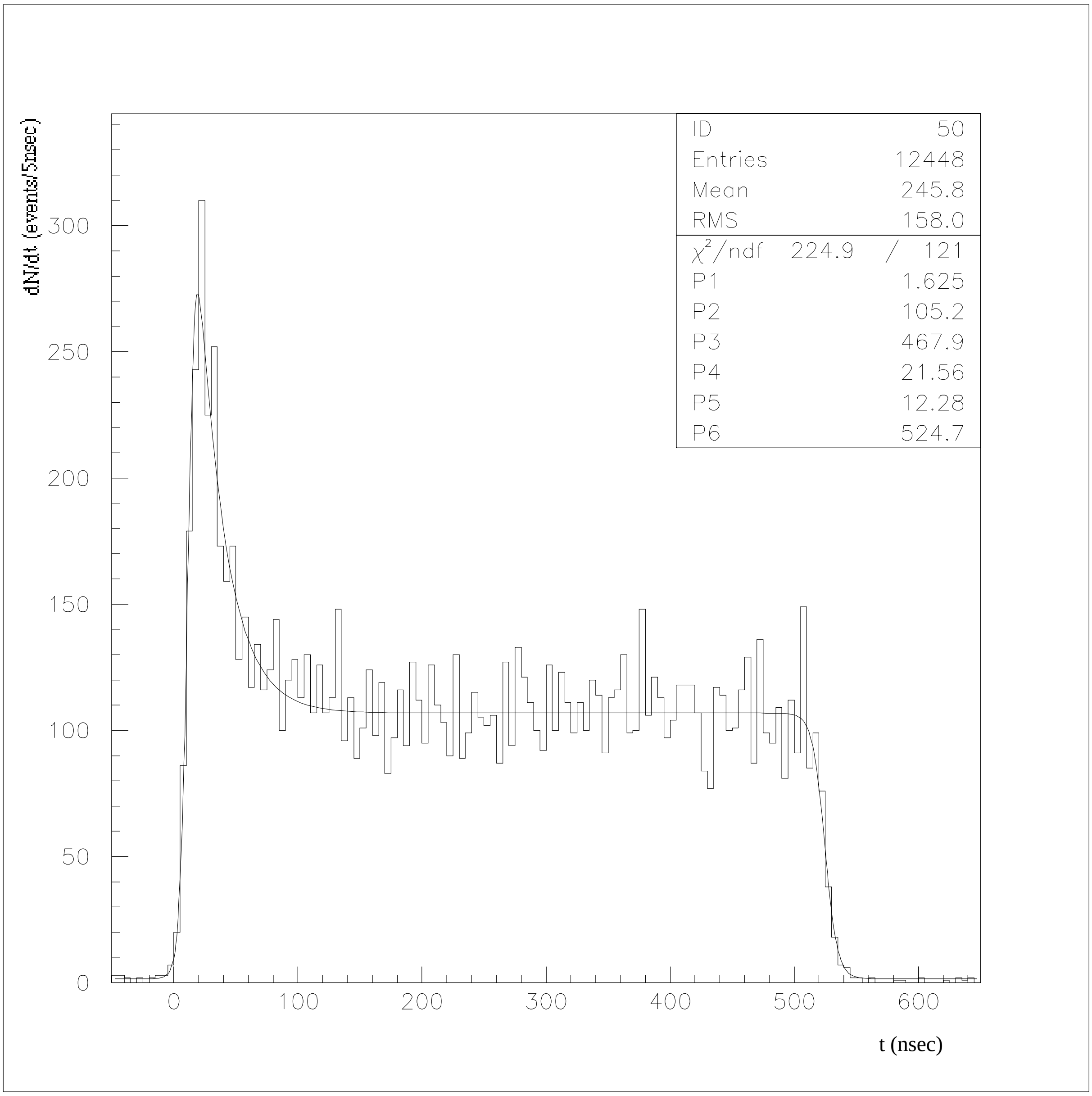

Fig. 1 - The time distribution of the hits of a tube. The fit is described in equation (3.1).

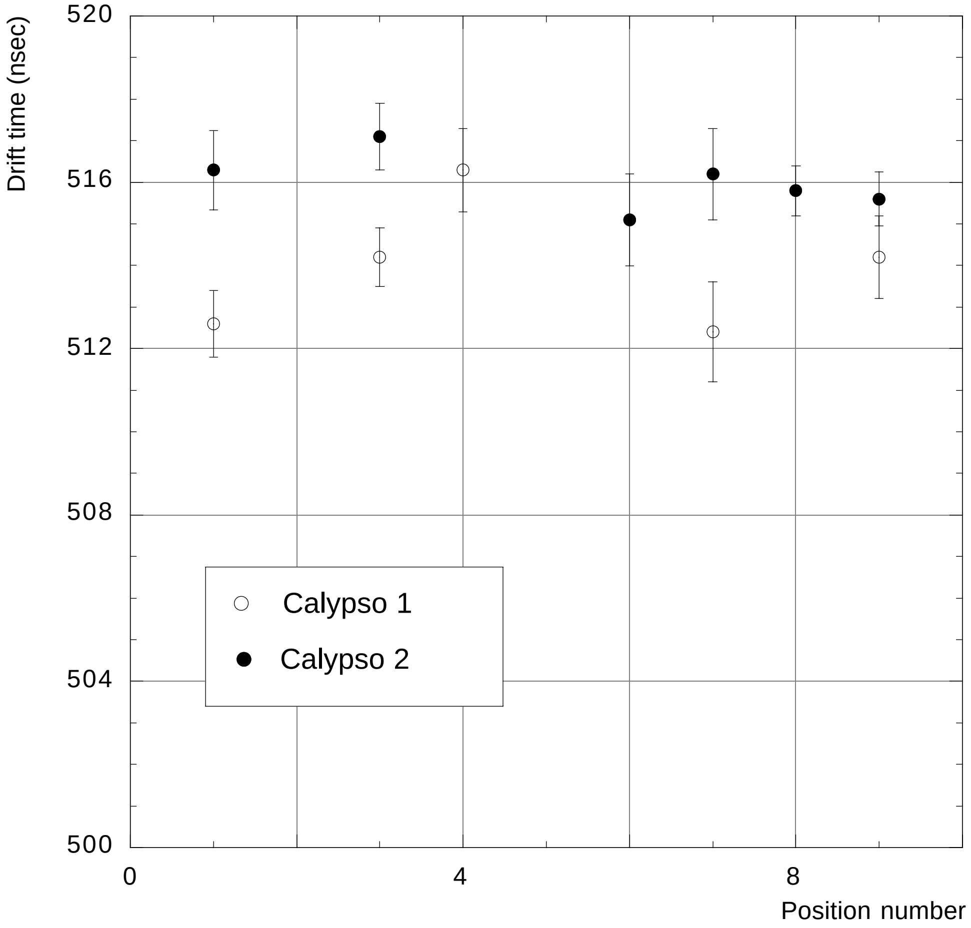

Fig. 2 - The value of the maximum drift time, computed with the method of § 3.a, as a function of the tube position number.

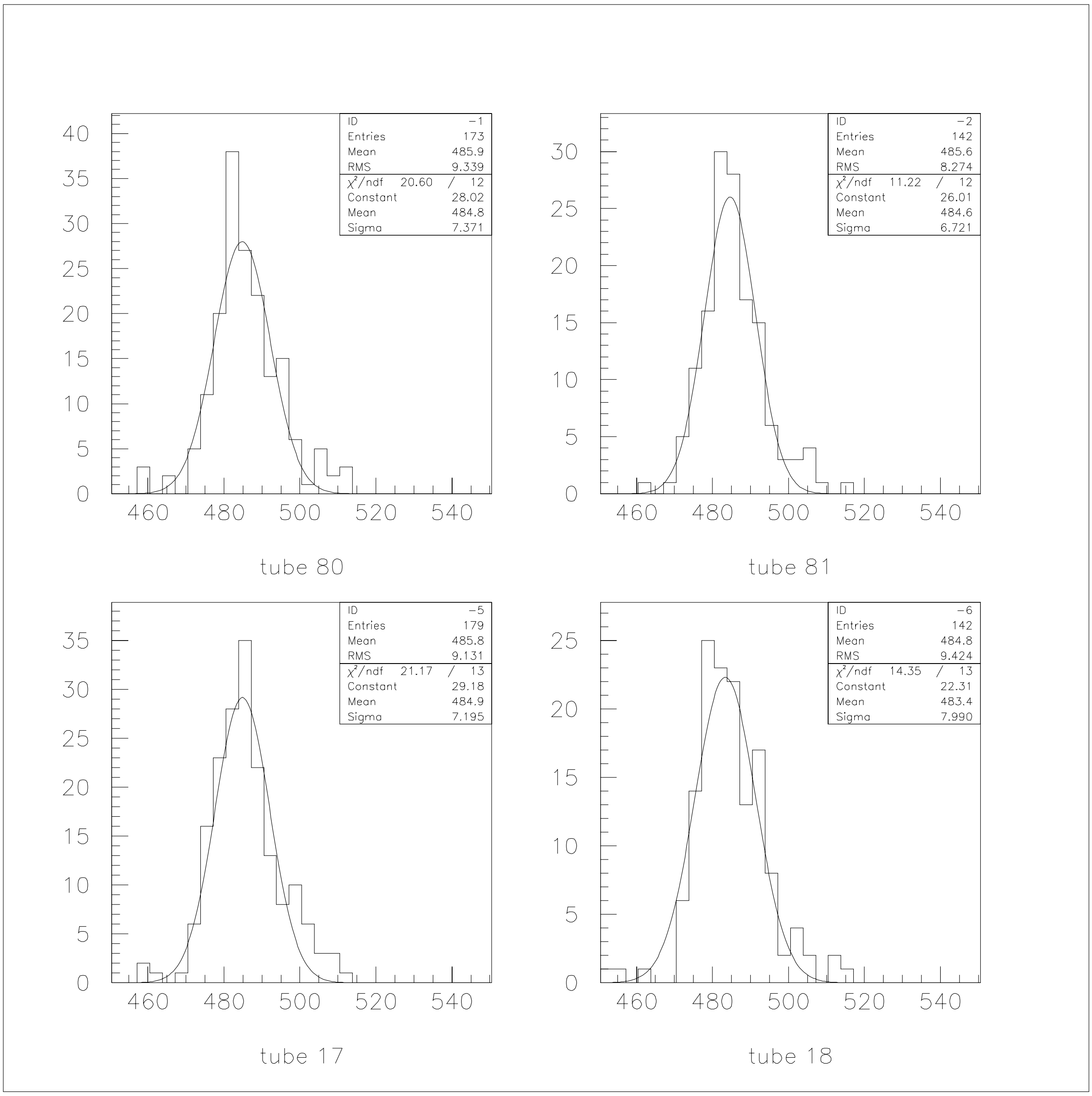

Fig. 3 - The time distribution of the hits with the selection described in § 3.b.

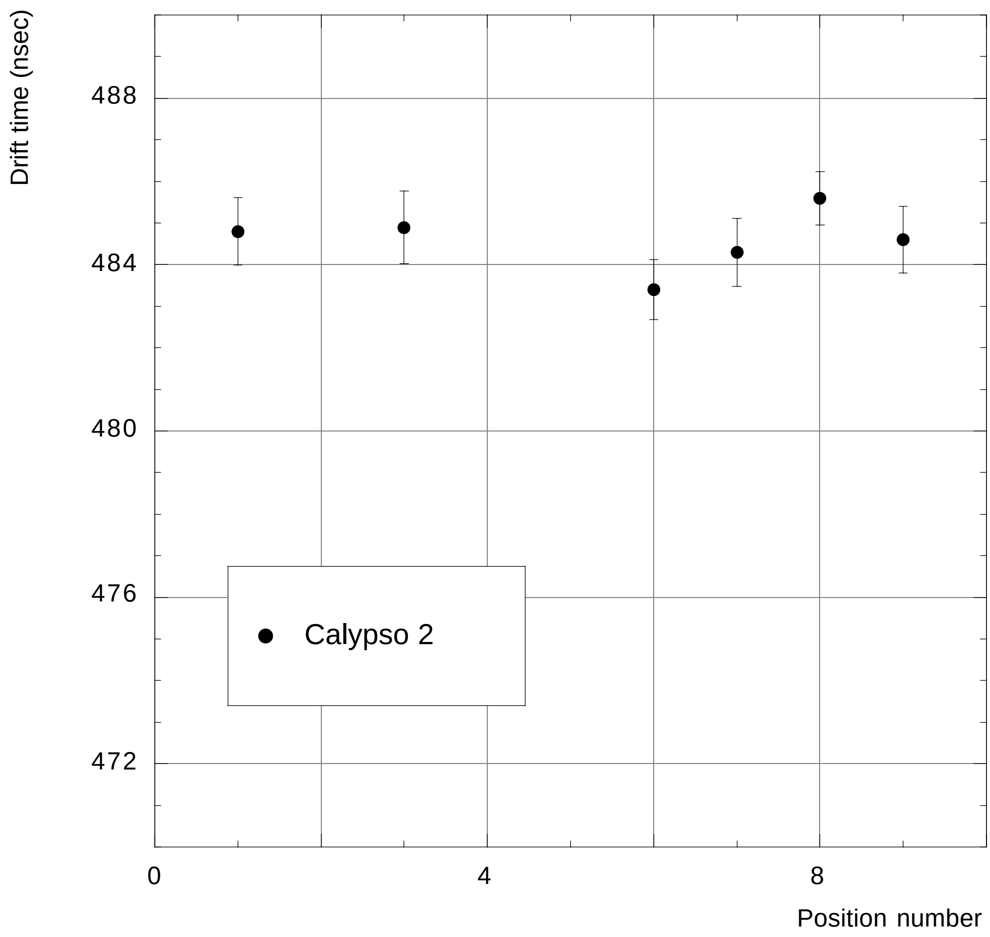

Fig. 4 - The value of the drift time $\Delta t'$, computed with the method of § 3.b, as a function of the tube position number.