Measurement of the Wire Tension in MWPCs

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The wires in multiwire proportional chambers have to be held under proper mechanical tension which is in large chambers usually close to the limit defined by the tensile strength of the wire. Too a low tension leads to deviation of the wires from the ideal position which results in changes of the gas amplification of the chamber thereby affecting the detection efficiency and it reduces the high-voltage stability of the chamber. On the other hand, too a strong tension can pull the wires out of the joints which hold them in place or break the wires

Usually the wire tension T is derived from the resonance frequency f of the wire via the relationship:

$$T = 4\, f^{2} L^{2} \bullet \rho_L$$

with L being the length of the wire and ρ_L the wire mass per length unit. The oscillations are usually excited with a low-frequency AC current which is driven through the wire in the presence of a magnetic field. This requires access to both ends of each wire which is in most cases only possible when the chamber is disassembled.

In order to make routine checks of the wire tension while the chamber is in operating condition we applied a technique which is schematically described in Fig.1.

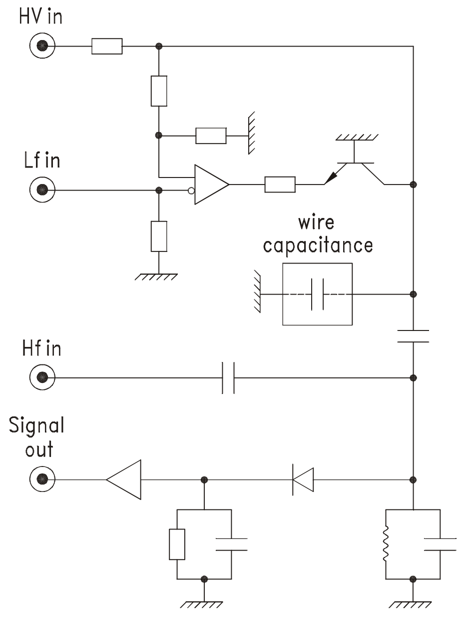

Fig. 1: Circuit for the measurement of the wire resonance frequency. In the upper part of the scheme DC high voltage is modulated with a low frequency signal which is fed into the chamber. The wires under measurement are coupled with a high-frequency resonance circuit in the lower part of the scheme.

Access is needed only to single wire ends. Mechanical oscillations of the wires are excited with a low frequency (typicaly 200 - 300 Hz) high-voltage signal which is applied to a pair of neighbouring wires one of them being grounded. This signal with amplitudes up to 1500 Volt is generated with a HV transistor in the upper part of the scheme. The resonance of the wire is identified via changes of the capacitance between the wires which is modulated with the frequency of the oscillating wire. This capacitance is made part of a high-frequency resonance circuit which is shown in the lower part of Fig. 1. It is excited with a low-voltage signal the frequency of which is close to the Hf resonance of the circuit of about few MHz. Mechanical oscillations of the wire result in a spread of the hf amplitude which is largest at the wire resonance. The resonance condition is made visible on an oscilloscope. The setup is schematically shown in Fig. 1.

We have systematically investigated the side detector chambers of the ANKE spectrometer which have been build at Forschungszentrum Rossendorf. For these the precise information about the wire tension is particularly important since the chambers are large and had to be built with fairly narrow frames due to space limitations at the experiment. As a consequence the frames are deformed under the force of the wires and have to be pre-bent before the wires are mounted. Fig. 2 shows as an example the results for one of the large chambers at ANKE. The actual values of the wire tension are rather close to the design value of 0.8 Newton which indicates that high precision has been achieved in the winding and production process of the chamber.

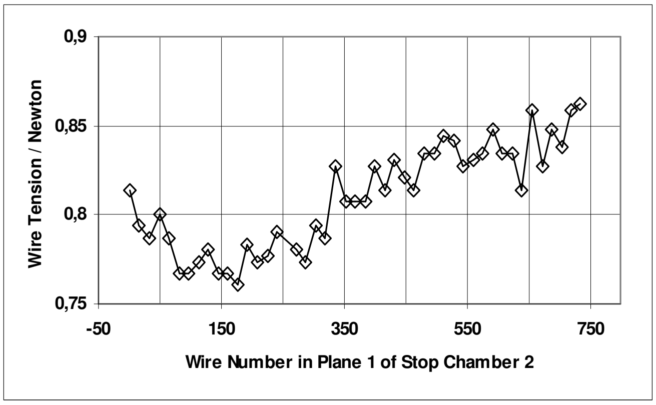

Fig. 2: Wire tension in a plane with vertical wires. Only every 16th wire is shown

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