First Experience with the Drift Tube Electronics for the ATLAS Muon Spectrometer at the Cosmic Ray Facility

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In the ATLAS muon spectrometer chambers consisting of drift tubes will be used. The drift tubes are made of aluminium and are filled with a mixture of argon and CO_2 at an absolute pressure of 3 *bar*. In the middle of each tube an anode wire is stretched, to which a positive high voltage of 3080 V is applied. A muon crossing the gas volume will leave a ionisation trace. The electrons will drift to the wire and cause a proportional signal. This signal is amplified, shaped and discriminated. The time of this signal is measured relative to the time the muon passed the setup.

For the drift tube chambers of the ATLAS muon spectrometer a highly integrated readout electronics is used. On one side of the tube the high voltage is supplied and the tube is terminated for high frequency signals by the so called high-voltage hedgehog boards. On the other side the signal is picked up by an AC coupling on the signal hedgehog board. The hedgehog boards are mounted on the ends of the tubes. Directly on the hedgehog boards are mounted the mezzanine cards, which house the circuits for the analog signal processing (ASD - amplifier shaper discriminator) and the TDCs. Each hedgehog or mezzanine card is connected to 24 tubes. The mezzanine cards are connected to the chamber service module (CSM) which reads out all the TDCs of one chamber. The CSM also distributes the trigger and the clock signal to the TDCs.

The electronics consists of several components which were each built by different institutes in the USA, Japan and Italy. The LMU played a major role in the commissioning of the whole on-chamber readout chain. It turned out that the high integration of the electronics lead to pickup problems. Because of the integration of eight channels in one ASD chip there are long traces transporting unamplified signals on the signal hedgehog board. As the TDCs are also directly mounted on the chamber, there are also digital signals (e.g. the clock) close to these long traces. Therefore it is important to make the electronic insensitive against pickup with the help of a Faraday cage and a good grounding scheme.

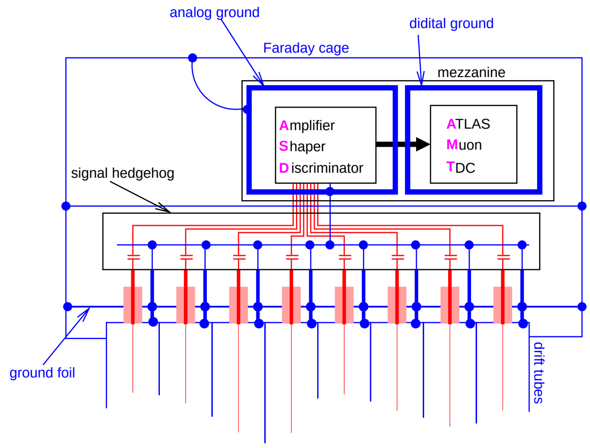

Fig. 1: Schematic view of the ground connection.

In fig. 1 a schematic view of the ground connections is shown. As the tubes are glued together with Araldite, the electrical connection of the tube walls has to be asserted with the ground foil. The mezzanine card consists of two separate parts, the analog and the digital part, each with their own ground areas. Only the analog ground is connected to the ground traces of the hedgehog card. It was seen that an additional ground connection between the analog ground of the mezzanine card and the Faraday cage reduces the noise sensitivity considerably.

On the high voltage side it turned out that a connection between the ground of the high voltage cable and the Faraday cage on the outside of the cage is of advantage.

After installing these grounding connections the pickup was stable at a low rate. The rate of accidental hits was such that only 0.05 % of the triggers have an accidental hit in the accepted time range. The grounding scheme was tested and used for data taking at the muon test beam at CERN and at our cosmic ray test facility.

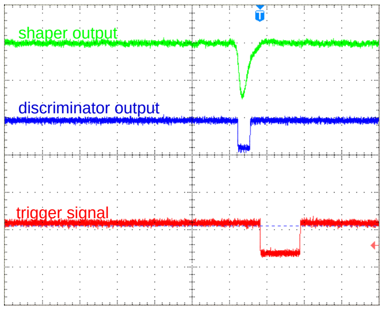

Fig. 2: Signals created by a cosmic muon.

The mezzanine card is equipped with a number of test points for looking at the pulses with a scope. In fig. 2 the signal created by a cosmic muon is shown. The trace at the bottom is the signal from a scintillator trigger, which triggered the oscilloscope. The line at the top is the signal after the shaper, in the middle is the output of the discriminator. One can see that any ripples on the shaper output are much lower than the muon signal.

References

[1] ASD Amplifier-Shaper-Discriminator, ATLAS Internal Document
[2] AMT-1 & 2 User's Manual, Internal Document
[3] CSM Design & CSM-0 Production, Internal Document