ATLAS Muon Grounding

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1. Local MDT chamber grounding

Muon chambers are constructed in layers of Monitored Drift Tubes (MDTs) in integral Faraday enclosures. A typical chamber consists of several hundred such tubes in three or four layers of MDTs. The barrel and forward systems consist of several hundred such chambers each. The "skin" of the Faraday enclosure of each chamber serves as its local ground. To insure this connection, a ground contact is made with each MDT as well as with all enclosed on-chamber electronics. A block diagram of the scheme is shown below.

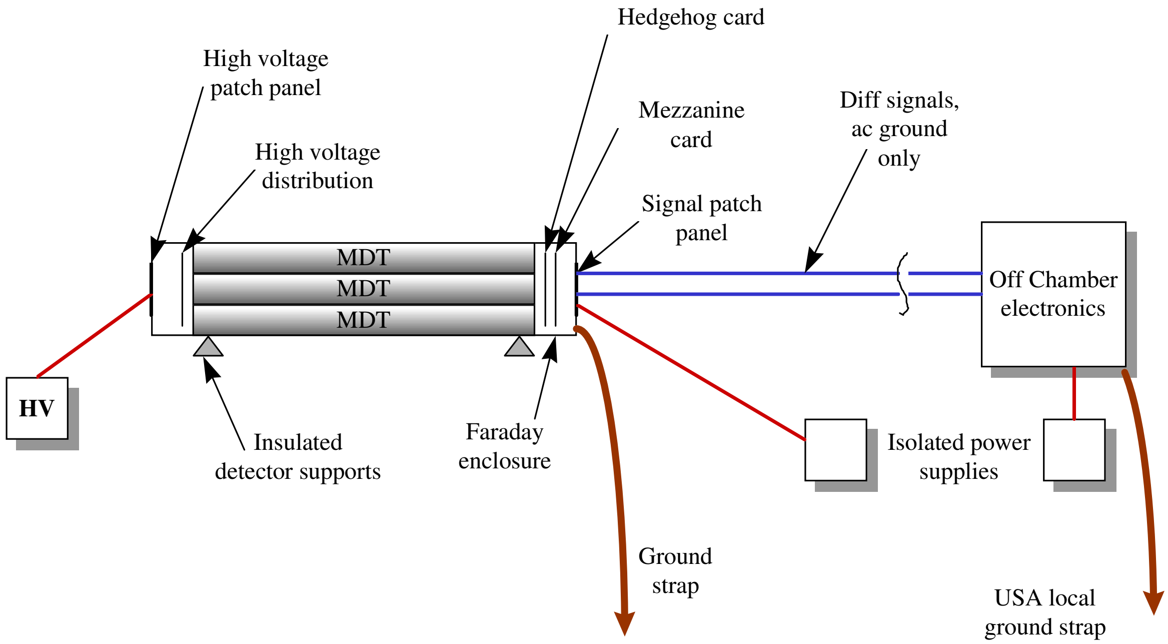

Fig.1

1.1 High voltage

High voltage is distributed to individual MDTs at the "far end" of each chamber. There are several hv connections per chamber entering a

High Voltage Patch Panel. The panel contains several SHV connectors with isolated grounds. The SHV grounds are connected through series resistors to local chamber ground. The series resistors, of order one to several kilohms serves to break potential ground loops in the high voltage distribution. No further isolation of the high voltage supplies is considered required. For reasons of safety, the high voltage ground should not be floating at the supplies. In this way, most commercial high voltage supplies could be used.

1.2 On-chamber readout electronics

On-chamber electronics consists of ASDs and TDCs mounted on mezzanine cards at the “signal end” of the chamber. A detail of the signal end is shown below.

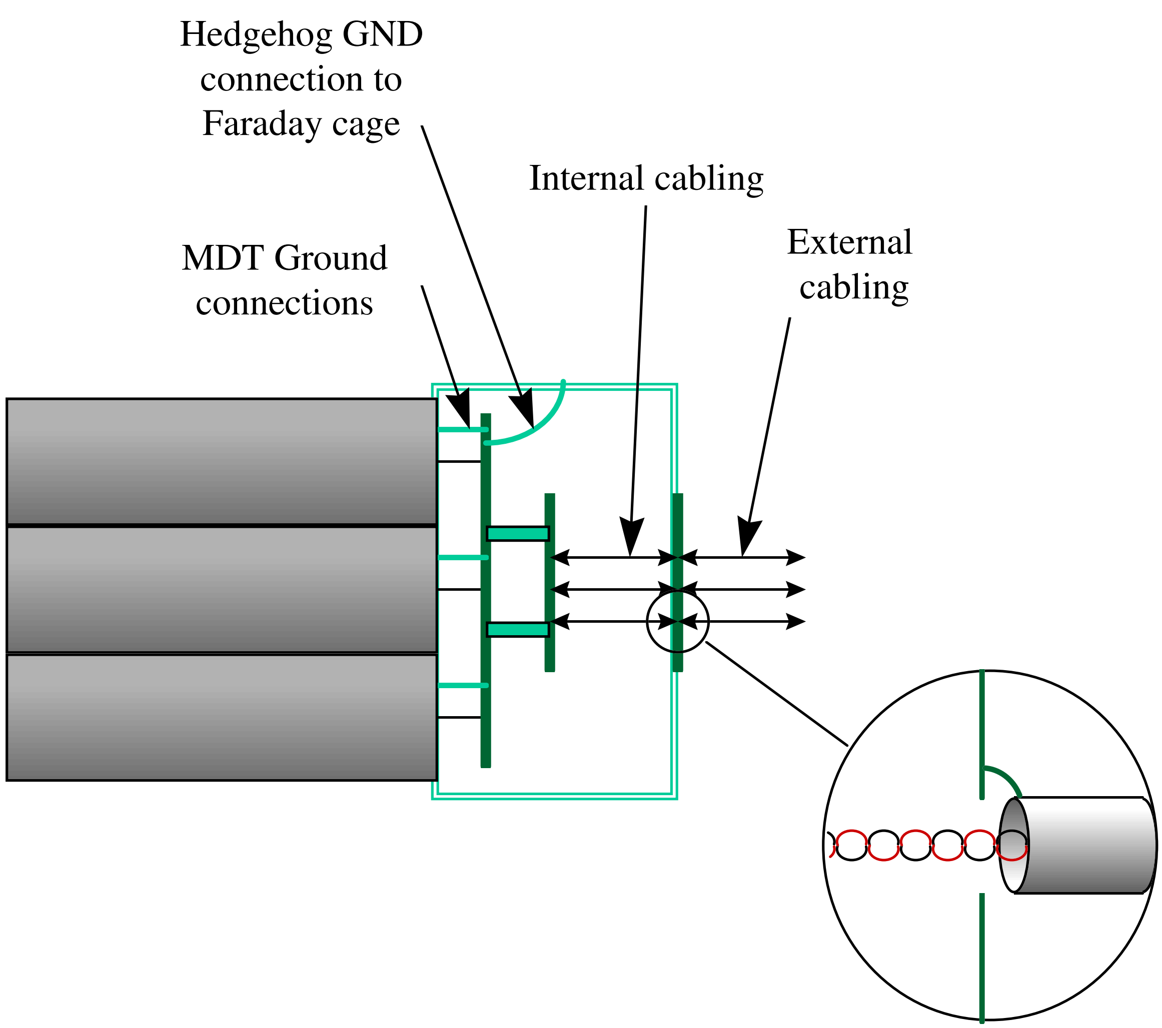

Fig. 2

The MDT layered structure, being based on epoxy mechanical joining techniques, cannot be relied upon for consistent ground connections. Each MDT however, provides a ground pin which is connected to the hedgehog card. This in turn is strapped to the Faraday cage.

Connections to the front end cards are

a) ***Front End Links*** : LVDS, shielded twisted pairs. This link carries the muon TDC data to the RODs and DAQ system. The cable shield is connected to the chamber ground at one end (Faraday enclosure) and is connected to off-chamber electronics through a capacitor to break the ground connection.
b) ***DCS (detector control)*** : LVDS, shielded twisted pairs. This link serves the purpose of digital download/upload of constants residing in the front end electronics and readout of small number of voltages and temperature sensors residing on the mezzanine cards . The cable shield is connected to the chamber ground at one end and is connected to off-chamber electronics through a capacitor to break the ground connection.
c) ***PCS (phase calibration)***: Low voltage swing differential signals, not necessarily LVDS. These are bi-directional signals used for timing calibration and are connected between neighboring chambers. The cable shield is tied to the local Faraday shield grounds through a parallel capacitor and resistor. The capacitor serves to make the ac ground connection while the resistor, of order 1k or larger, serves to establish a dc level without creating ground loops. This is essential, as the PCS system requires a web-like set of interconnections between neighboring chambers.

In general, the internal cabling will be done via unshielded twisted pair unless found to be necessary for reasons of crosstalk.

1.3 Low voltage supplies

Low voltage supplies for on-chamber electronics will be considered floating. That is, the power return is connected to the mezzanine card ground and in turn to the Faraday enclosure ground, but not to the local safety ground at the power supply. For this latter purpose, a “safety ground” device consisting of diodes or saturable inductors may be utilized for safety purposes. We envision that the muon system will follow ATLAS wide guidelines in this regard.

1.4 Detector controls, alignment

Detector control elements including temperature sensors and alignment devices will be mounted directly to the Faraday enclosure. These represent a potential source of ground loop difficulties which must be prevented. To do so, we adopt the policy that these devices are electrically isolated from the Faraday enclosure and thereby constitute a separate sub-system. The grounding scheme for this sub-system will be documented at a later date. It will, however, adhere to the general ATLAS grounding policy of ground isolation between sub-systems and transmission of signals differentially in the usual manner.

2. Global grounding

The muon system will use a ***star*** ground network for global grounding as shown below.

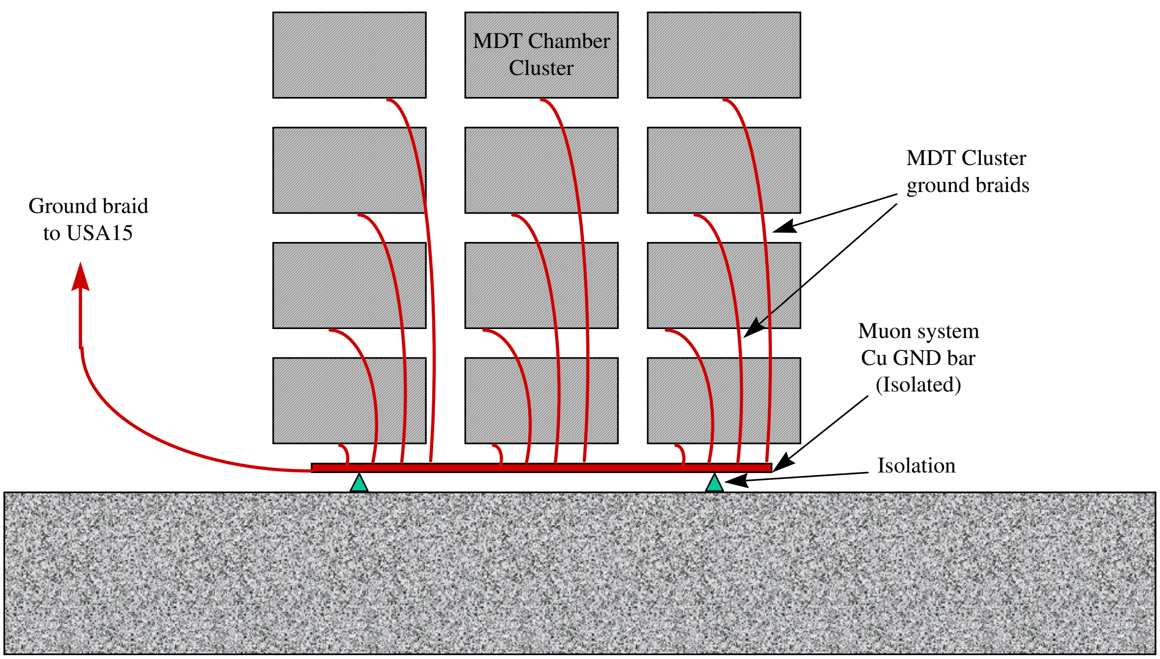

Fig. 3

2.1 Ground isolation and ground strap.

Each chamber will be fitted with a mechanical tab onto which a ground strap can be attached. The strap is envisioned to be a sizeable copper braid to establish a low inductance ground path to some designated detector wide "Ground". ***Chambers will be mounted on isolated mechanical mounts to the support structure in such a manner that when the ground strap is disconnected, a relatively high impedance exists between the chamber and Ground.*** This requirement constitutes a test which must be passed by all links including DCS, to the chambers.

2.2 Ground bar

The center of the star grounding network will be a copper grounding bar or plate located near the MDT chambers.. It will have tabs to receive the individual ground braids from the MDT clusters. While the ground plate will be electrically isolated from the support structure and from the rest of ATLAS, it could act as the center of a larger star network for other subsystems if that appears to be desirable at a later date.

2.3 Connection to USA15

Off chamber electronics (RODs) will be located in USA15 in crates with a local ground connection. This local ground, spanning multiple crates and racks, will be connected to the common star by means of an additional copper braid as shown in Fig. 3

3. ATLAS Global ground

The MDT global ground star network will be considered isolated from all other sub-system grounds. None the less, interconnections between it and these other ground networks would seem inevitable through crate connections in the DAQ, DCS and other sub-systems. Nothing in the MDT global grounding precludes utilizing the on-detector copper grounding bar, the hub of the MDT ground, as the center of a larger grounding network to be considered in the future.