MDT Chamber Commissioning at LMU Munich

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The following steps are performed for each BOS/F chamber tested at the LMU Cosmic Ray Facility. The chambers are built at the Max-Planck-Institut für Physik and consists of 432 tubes arranged in two multilayers of three tube layers. Each layer has 72 tubes, the tube length is 3.74 m.
An introduction to the Cosmic Ray Facility can be found in at the agenda of the Precision Chamber Meeting February 2004 [1]

- **Wire Resistance Measurement**

  The wire resistance of each tube is measured[1]

  - Check for broken wires (transportation/handling)
  - Check for bad contacts between signal cap and tube thread

  The typical wire resistance is 165-175 Ohms; if a tube shows an increased resistance (by 20% or more), we try to fix it by slightly turning the signal caps. Broken wires can be identified by infinite resistance and possible electric connections from the signal cap to the tube wall/ground pin

  All data is logged

  Time: 1 hour per multilayer
  Manpower: 2 persons

  In tubes with broken wires the wire is tried to be pulled out of the tube, which afterwards is disconnected from the read-out/HV cards (signal caps without the pin, insulated with a Plexiglas cover, as the distance to the hedgehog card is only in the order of 1 mm) and from the gas system on both sides (see fig. 1)

- **Leak Test**[2]

  The chamber is filled with an Ar/He mixture to the nominal pressure of 3 bars (300-400 mbar He)

  A helium leak detector (Alcatel ASM 142) is used in sniffer mode to check all connections to the tubes, the usual background is at 5×10^{-6} mbar l/s, the threshold is usually set to 1.5 $\times$ background. A mask is used to localize the search (see fig. 2)

[1] This measurement is also performed at MPI after the gas system is mounted
[2] A first leak search is performed at MPI before delivery of the chamber

Leaks are caused by

1) Dirt (mostly ”hairs” or wire residuals) on the O-ring seals (most cases)
2) Damaged half jumper (mostly due to production)
3) Bad O-ring grooves in the endplugs (rare)
4) Bad O-ring grooves in the gas bar (rare)
5) Cracks in the endplugs extending over the O-ring groove (rare)

In the cases 1 and 2 the triplet the exchanged, in cases 3 and 4 the groove is additionally polished with finely grained sandpaper.

If a leak cannot be repaired the tube is disconnected from the read-out/HV cards (signal caps without the pin, insulated with a Plexiglas cover, as the distance to the hedgehog card is only in the order of 1 mm) and from the gas system on both sides (see fig. 1)

The external connections to the chamber (Swagelok) are also checked and in case of leaks tightened or exchanged

The procedure is iterated until no leaks are found

All leaks found and the performed repair steps are logged

Time: 1 hour per multilayer and side
1 iteration per day
Manpower: 1 person

The leak rate is measured over several days for each multilayer separately (MKS Baratron 690 absolute pressure sensor with a resolution of 0.1 mbar, the chamber temperature is monitored) and logged

Leak Rate / ATLAS	Exp. measurement time / d
10	1/2–1
2	2
1	3
0.3	5

- **Gas Filling**

  After the leak test, the chamber is filled with Ar/CO_2 =93/7. The chamber is evacuated, filled with Ar/CO_2 to about 500 mbar and evacuated again. This procedure is repeated 3 times. The chamber is then filled to the nominal pressure of 3 bar.

  Time: 1 1/2 days for purging
  1/4 day final filling
  Manpower: 1 person

- **Hedgehog cards MECCA Test**

  The signal and HV hedgehog cards are mounted after visual inspection. A MECCA test is performed and failing/suspicious cards are exchanged.

  Time: 1–few hours
  Manpower: 1 person

- **HV Test**

  The HV test is performed at the nominal voltage of 3080 V. The current of each tube layer is measured after 1 min, 2min and 5 min (HV supply: ISEG SHQ124, resolution 1nA)

  The allowed upper limit is 1 nA / tube which corresponds to 72 nA per layer after 5 minutes. The usual current at 30-40% rel. humidity is about 25 nA / layer. If an increased current is observed a tube by tube inspection is made.

  If an internal discharge is found, the reverse voltage (-3080 V) is applied for 5-10 minutes and tube is remeasured. All tubes with discharges could be cured that way (statistics is low though, only 2 tubes had discharges so far). If the discharge would remain the tube would be disconnected from the read-out/HV cards (signal caps without the pin, insulated with a Plexiglas cover, as the distance to the hedgehog card is only in the order of 1 mm) and from the gas system on both sides (see fig. 1)

  Time: 1–few hours
  Manpower: 1 person

- **Cosmic Ray Measurements**

  All data from the cosmic ray measurements are stored

  - **Chamber Current**

    During operation the current drawn by the chamber is constantly monitored. HV trips are recorded

  - **Noisy tubes**

    Tubes with an excessive number of hits can be found quickly with cosmic ray data. In all cases the noise was generated on the hedgehog or mezzanine cards (currently we use the old mezzanine light cards in the Cosmic Ray Facility), which are then exchanged

  - **Drift Time Spectra**

    The drift time spectrum of each tube is fitted with analytic functions

    The leading edge is described by a Fermi function,

    $$F(t) = p_0 + \frac{A_0}{1 + \exp\left(\frac{t_0 - t}{T_0}\right)},$$

    here, p_0 denotes the noise level before the spectrum, A_0 the height of the spectrum, t_0 the midpoint of the leading edge and T_0 describes its width

    The trailing edge by a Fermi function which contains an additional linear term to account for the slope of the spectrum at its end

    $$G(t) = p_m + \frac{\alpha_m \cdot t + A_m}{1 + \exp\left(\frac{t - t_m}{T_m}\right)}$$

    here, p_m denotes the noise level behind the spectrum, A_m the height of the spectrum, t_m the midpoint of the trailing edge and T_m describes its width. α_m is the parameter of the linear term

    Tubes in which the width of the leading or trailing edge, or the length of the drift time spectrum, $t_m - t_0$ exceeds 3.5 σ_{Chamber} are separately logged

    See [2] for fit procedure

  - **Wire Positions**

    Tubes in which the measured y- or z-coordinate of the anode wire deviates more than 100 μm at a tube end from the layer fit are separately logged

  - **Alignment Platforms**

    Positions of alignment platforms are verified using a silicon strip detector setup for a sample of chambers

References

[1] J. Dubbert
The LMU Cosmic Ray Facility,
http://agenda.cern.ch/askArchive.php?base=agenda&categ=a04839&id=a04839s1t3/transparencies

[2] O. Kortner, F. Rauscher
Automatic Synchronization of Drift-Time Spectra and Maximum Drift-Time Measurement of an MDT, ATL-COM-MUON-2002-006, CERN 2002

Figure 1: Disconnected tube. The pin of the signal cap is removed and the cap covered with a plexiglas cover which is 1 mm thick and fits without touching the hedgehog card. The gas connection at the triplet is sealed with a stainless steel bolt.

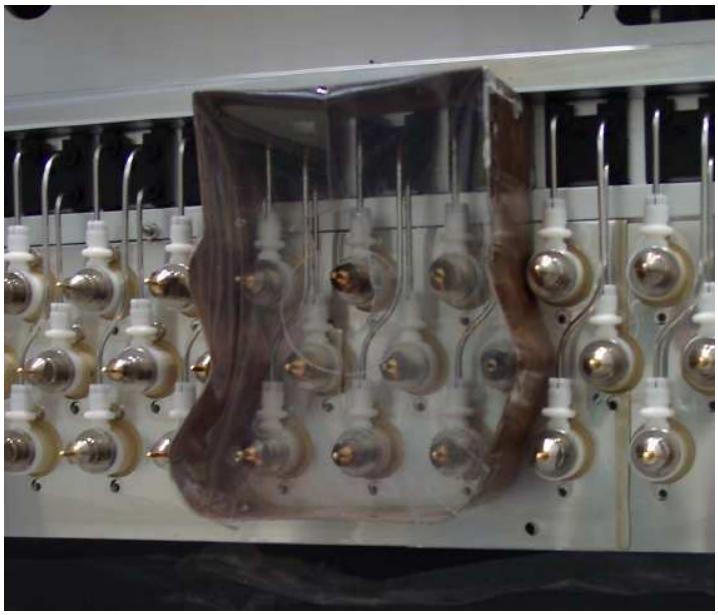

Figure 2: Mask used to localize the leak search.