Slow-Control System and Alignment Monitoring of the ATLAS Cosmic-Ray Test-Facility

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The Cosmic-Ray Test Facility of the LMU Munich [1] is currently used to commission and calibrate 88 drift tube (MDT) chambers of the Atlas Muon Spectrometer which are build in collaboration with the Max-Planck-Institute für Physik.

A stand-alone, object oriented slow-control program has been developed in C++ to control aspects of the test facility and monitor and record slowly changing operating parameters.

The slow-control program is responsible for the mixing of the chamber gases (a 2-component gas for the MDTs and a 3-component gas for the Streamer chambers), the pressure control, the monitoring of the chamber alignment, and the readout of temperature probes and important operating voltages. Controlled devices are configured via a small set of ASCII files and can be added or removed from the readout during runtime. All collected data are stored in a MySQL database and will thus be easily available to the off-line analysis programs. Critical conditions are distributed via email or SMS to the operators.

A web interface (see fig. 1), with access to about 25 pages, provides an on-line overview of the current data and their evolution over the last 24 hours.

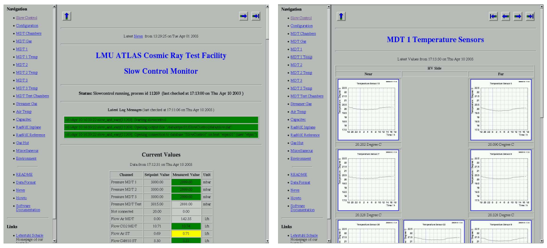

Fig. 1: Screen shots of the slow-control web pages: Main page (left), Temperature sensors of one of the MDT chambers (right).

In the current setup, three MDT chambers—which are built of two times three layers of 72 drift tubes (each tube has a diameter of 3 cm and a length of 3.8 m)—are operated in the Cosmic-Ray Test-Facility. Two of these chambers, the so-called reference chambers, are used to reconstruct the tracks of the cosmic muons, and are situated above and below the chamber which is tested.

In addition to a complete verification of the function of the tested chamber and its electronics, the relative wire positions of its 432 tubes and the distances of the tube layers with respect to each other will be measured with a precision of about 10 μm [2].

To achieve this precision, the knowledge of the relative positions of the three chambers at a scale of 5-10 μm is necessary. Since it is not possible to mechanically stabilize the Cosmic-Ray test stand with its dimensions of 3 m $\times$ 4 m $\times$ 3.5 m to this level, the chamber positions are monitored.

The alignment monitoring employs two contact-free systems. An optical system, using 8 so-called RasNiK sensors—each consisting of an illuminated coded mask which is projected by a lens onto a CCD camera—monitors the relative position of the two MDT reference chambers [4]. The RasNiK sensors are sensitive in all three dimensions with an intrinsic precision of less than 1 μm perpendicular to and 100-200 μm along their optical axis. The mask and the lens are mounted on the upper chamber, the CCD camera on the lower reference chamber. To increase the measurement precision of vertical chamber movements four RasNiK sensors are tilted by 36°.

A capacitive system measures the position of the test chamber with respect to the upper reference chamber [3]. Eight sensors are arranged in two singlets and two triplets situated above steel steps. The singlets and the middle sensor of the triplets monitor the vertical distance to the top of the step, the other sensors are situated over the edges of the steps and are thus also sensitive to horizontal chamber displacements.

Both systems have been successfully operated over several month and show a measurement precision of about 5 μm (the seemingly reduced resolution of the RasNiK sensors is due to density and temperature fluctuations of the air caused by the climatisation of the experimental hall which change the optical properties) [5].

The chambers show a clearly visible relative movement in the order of 20-50 μm with a period of 24 hours (see fig. 2). These movements are especially pronounced if large temperature changes occur outside the hall and are most likely caused by the mechanical coupling of the test facility to the walls of the hall. This coupling will be removed in the near future, hopefully reducing the chamber movements.

Efforts to include the measured chamber movements, as well as chamber deformations—which are also monitored with RasNiK sensors built into the chambers—in the analysis of the cosmic-ray data (instead of selecting periods of stability) are ongoing.

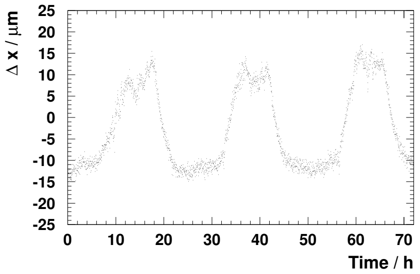

Fig. 2: Relative position of the two reference chambers with respect to each other as a function of time for three consecutive days.

References

[1] T. Trefzger *et al.*, Annual report 1999, p. 106
[2] F. Rauscher *et al.*, this report, p.102
[3] A. Kraus *et al.*, Annual report 2000, p. 66
[4] J. Elmsheuser *et al.*, Annual report 2001, p. 90
[5] W. Stiller, diploma thesis, LMU München, 2002