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TEMPERATURE MEASUREMENTS DURING MIRROR ALIGNMENT IN SPRING 2001

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1 Introduction

The mechanical structure of COMPASS RICH-1 mirror wall is an aluminium space truss included in an aluminium frame and each mirror is fixed to one node of the truss [1]. This supporting structure is fixed via its frame onto the RICH-1 aluminium vessel. Thus the geometry of the mirror wall is subject to deformation when the environmental temperature changes. During mirror alignment operations, in May 2001, no thermalisation of the RICH-1 vessel was available. The temperature of the mirror wall mechanical structure was monitored with the purpose of correlating the temperature variation and the angular rotations of the mirror themselves (some rotation is expected when temperature varies; please note that the alignment is an angular adjustment of the individual mirror segments [2], [3]).

2 System for temperature measurements

Ten temperature sensors PT100 have been used. They were read via the temperature monitoring system in operation at COMPASS during the year 2000 run. The read-out is done by Profibus CPUs DP/FMS 1.5 MB (by WAGO) via Profibus ADCs (by WAGO) [4].

Nine sensors are positioned on the mirror wall in contact with the aluminium structure; their location is indicated in table 1. The tenth sensor (n. 10) is not in

sensor n.	height	horizontal location
1	lowest mirror raw	Jura side
2	lowest mirror raw	centre
4	lowest mirror raw	Saleve side
8	mid height	Jura side
7	mid height	centre
3	mid height	Saleve side
9	highest mirror raw	Jura side
5	highest mirror raw	centre
6	highest mirror raw	Saleve side

Table 1: Sensor locations.

contact with the aluminium body, but measures the temperature in the air near to the centre of the mirror wall.

The read-out system provides a reading resolution of 0.1^0. Data are stored on file according to the following algorithm: whenever a sensor registers a temperature variation of at least 0.2^0 (absolute value), the new value and the time are recorded. Some on-line display tools are available:

- a display that provides, for each sensor, the last value read and the date and time of the last temperature value stored on file
- for each sensor, a plot of temperature versus time; the temperature and time ranges can be set intercactively (fig. 1).

The software tools are derived from the existing ones used during year 2000 run.

3 Temperature measurements, general features

A relative calibration of the sensors has been performed keeping all of them in the same place (within a few cm) for a few hours. An arbitrary reference value is fixed for these measurements and off-sets are set correspondingly. Corrections for temperature off-sets are given in table 2.

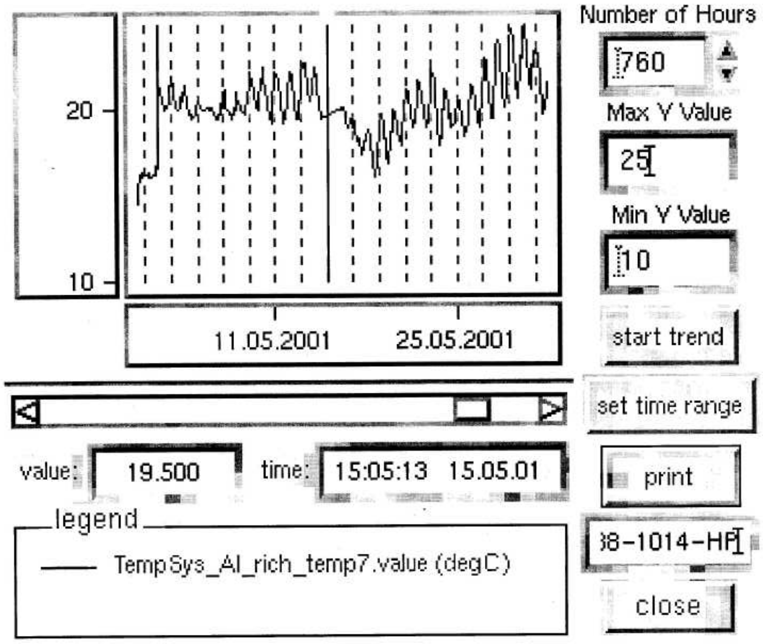

Figure 1: Temperature measured with sensor 7 versus time.

sensor n.	temperature corrections (degrees)
1	+0.5
2	+0.2
3	0.
4	-0.3
5	+0.7
6	+0.1
7	-0.1
8	-0.3
9	-0.1
10	-0.3

Table 2: Relative correction for temperature off-sets for the 10 temperature sensors in operation during mirror alignment in Spring 2001

The environmental conditions of RICH-1 volume during May 2001 are the following:

- the upstream window is in place and the upper detector frame is replaced by a steinless steel foil
- the openings of the downstream window, the door, the lower detector frame are closed with plastic foils
- dry, filtered air is injected (flow rate: 3 m^3/h); this air is heated, but due to the small flow, the impact of this heating on the temperature inside RICH-1 is very limited.

Temperatures have been measured during the whole month of May 2001, i.e. during the whole alignment period, a part:

- period 15/5 10:30 - 16/5 16:30; the whole system was not restarted after a power failure
- sensor n. 2 was not working (cable disconnected) in period 8/5 14:00 - 11/5 19:00.

The main features of the measured temperature are:

- in the environmental conditions present during the alignment exercise, the measured temperatures are a function of the height
- the temperature difference between the highest sensor set and the lowest sensor set varies in time; during May 2001 this difference was at most 2^0
- the temperature behaviour versus time is very similar for all sensor, if the intrinsic and height off-sets are taken into account (see, for instance, fig. 1):
  - the temperature variations during the first half of May are quite small, with typical daily maximum-minimum excursion between 2^0 and 3^0 (the heating system of the hall was in operation and this has probably helped in stabilising the temperature)
  - during the second half of May, temperature variations are quite severe (heating system off, relevant weather variations); a daily cycle is still observed (variation between 3^0 and 4^0) on top of an important slope; the difference between maximum and minimum temperature measured in this period is about 7^0.

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4 Temperature and mirror alignments

The angular alignment of 40 mirrors (among the 116 installed and aligned) has been checked again after a few days [3]; in general, the temperature values during the alignment and the check measurement were different. Three of the checked mirrors have been found quite rotated and they have been re-aligned. The reason for this behaviour is not understood. The temperature measurement is not available for the check measurement of 8 mirrors.

The plot of the difference between the angular position as registered during the two measurements in presented in Figure 2 for the angles in the horizontal ($\delta\theta_x$) and vertical ($\delta\theta_y$) planes. For each single mirror, the temperature is the mean value measured by the nearest group of sensors (according to the various locations of the individual mirrors in the mirror wall, between 2 and 4 sensors are used). No correlation between temperature variation and difference of the measured angle values is observed.

The plot of $\delta\theta_y$ versus $\delta\theta_x$ (fig. 3) does not indicate correlations.

The standard deviations of the distributions of $\delta\theta_x$ and $\delta\theta_y$ (fig. 4) are both about 0.1 mrad, indicating that the resolution of the angular measurement is about 0.07 mrad.

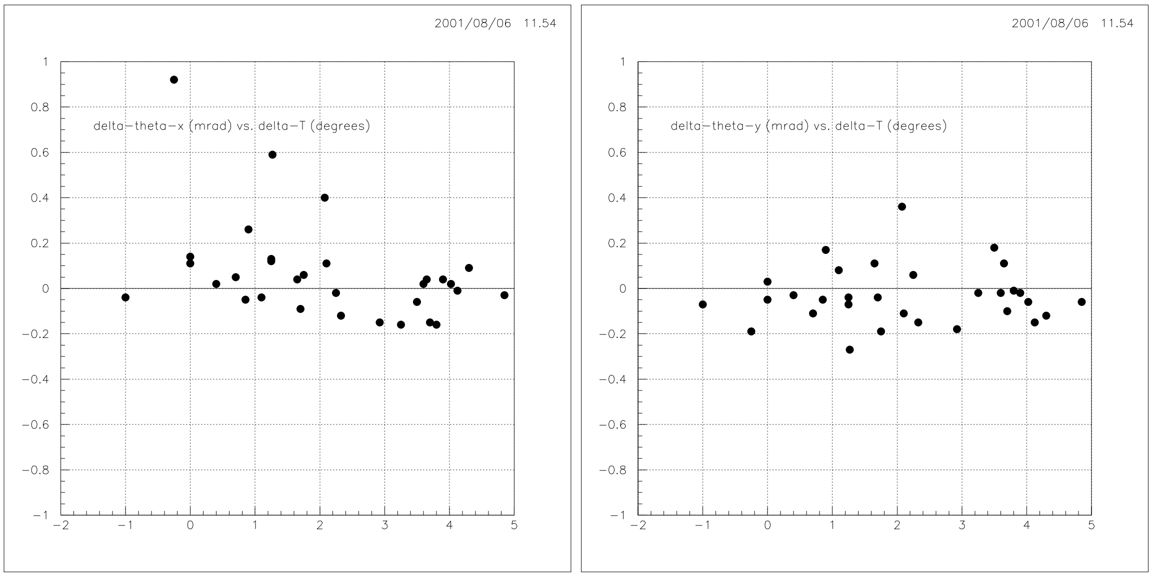

Figure 2: Difference between the angular position registered during the two measurements for the angles in the horizontal plane ($\delta\theta_x$) and vertical plane ($\delta\theta_y$).

5 Conclusions

No correlation between angular position of the mirrors and temperature has been observed for temperature variations up to 5^0.

The estimated resolution of the angular measurement of the mirror position is 0.07 mrad. Three (out of 40) checked mirrors have shown relevant angular misalignments when measured the second time. The source of this 7.5% cases of bad alignments is presently not explained.

Acknowledgements

J.-Ch. Gayde has designed the mirror alignment method and supervised the whole mirror alignment exercise.

V. Sougoniev has designed and put in operation the temperature measuring system in 2000.

H. Milcent has adapted the software tools for this application.

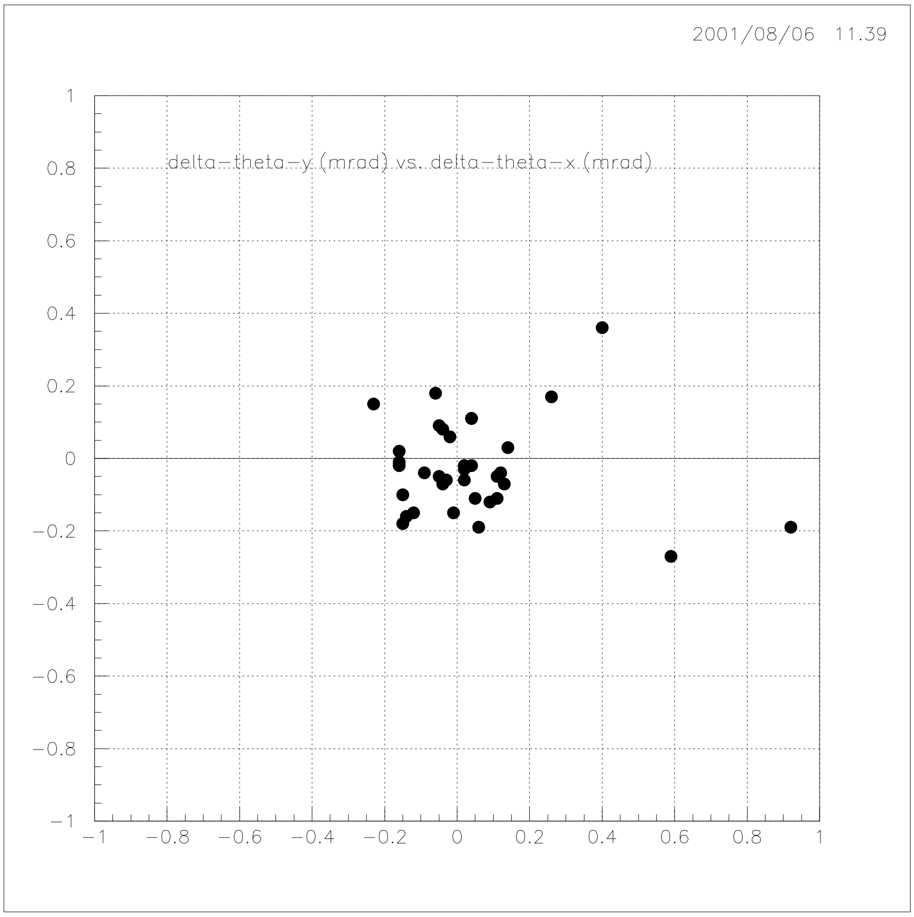

Figure 3: Difference between the angular position registered during the two measurements for the angles in the vertical plane ($\delta\theta_y$) versus the analogous difference in the horizontal plane ($\delta\theta_x$).

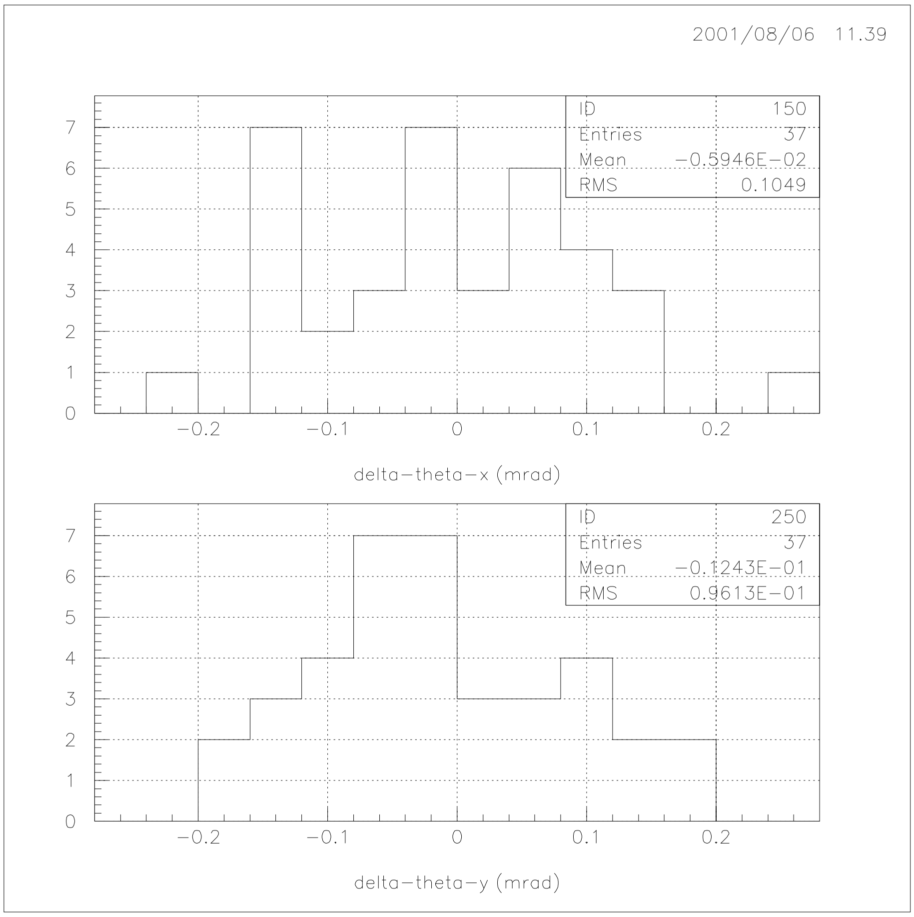

Figure 4: Distributions of $\delta\theta_x$, upper plot and $\delta\theta_y$, lower plot .

References

[1] P. Dalloz and R. Valbuena, *The COMPASS RICH-1 mirror wall geometry*, EST-ESI/99-08, rev.2, March 2000 and COMPASS note 2000-6.

[2] J.-Ch. Gayde, *COMPASS-RICH 1, Reglage de l'orientation de 10 miroirs du RICH, measures du 5 et 6 juin 2000*.

[3] J.-Ch. Gayde, *COMPASS-RICH 1, Reglage de l'orientation de 116 miroirs du RICH, measures du 2 mai au 1er juin 2001*.

[4] V. Sougoniev, *COMPASS detector control system - status and development*, 2000.