Mirror misalignment control system and prototype setup

J. Bendarouach∗[1], *C. Höhne*[1], *and T. Mahmoud*[1]
[1]Justus Liebig University, Giessen

An important aspect to guarantee a stable and precise operation of any RICH detector is the alignment of the mirrors. The alignment itself has two aspects: the initial alignment during setup and a misalignment monitoring during operation. For the monitoring, methods have been established based on data or an independent control of the mirror positions. The CLAM method, developed by COMPASS [1] is an example of the latter and is tested for a future realization in the CBM-RICH. This article describes a test setup on a small scale that has been implemented in the RICH prototype and tested in beam during the RICH beamtime at CERN-PS in November 2014.

The principle of the CLAM (Continuous Line Alignment Monitoring) alignment procedure [1] is to monitor over time mirror displacements via photographic images. A grid of retro-reflective material is glued on the inner part of the RICH entrance window.

The grid is made of retro-reflective stripes, forming a regular grid-shaped pattern, and of photogrammetric target dots, glued at each of the stripes crossings and on the mirror frame (Fig. 1 left). A set of four cameras are arranged at the edges of the entrance window and around each camera a set of three LEDs are fixed (Fig. 1 right). The LEDs are switched on to illuminate the grid through the mirrors.

A downscaled version with one camera only has been implemented in the RICH prototype detector and tested at CERN.

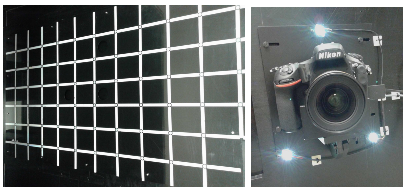

Figure 1: CLAM equipments used in the RICH prototype. Retro-reflective grid, with target dots (left). CLAM camera, surrounded by three LEDs (right).

Figure 2 shows two pictures taken for the aligned mirror system (left picture) and with misalignment by 2 mrad of the lower left mirror (right picture). Figure 3 illustrates ring reconstructions using these two setups. For the misaligned case an extreme example is shown with a B axis of the ellipse fit of 3.6; the average radius is 4.6.

∗This work was supported by HIC for FAIR, by the GSI F&E-Cooperation with Giessen, and by BMBF grant 05P12RGFCG.

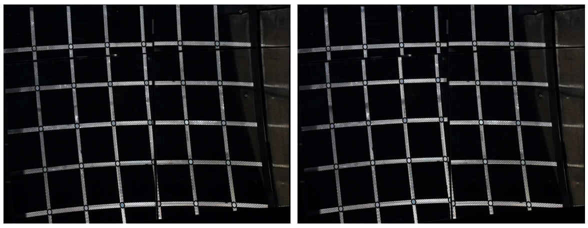

Figure 2: Reflection of the grid on the RICH mirrors. Lines not broken at mirror edges is a sign of alignment (left). If they appear broken this reveals misalignment (right). Here lower left mirror misalignment is 2 mrad.

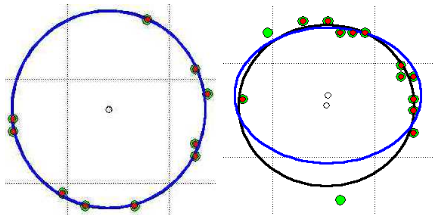

Figure 3: Single event reconstructions for beams going between the two lower mirrors. Ring reconstruction using an aligned setup (left) and a misalignment of 2 mrad (right).

A first qualitative look at mirror displacements can be given, when looking at the continuity of the reflected stripes. Indeed if a mirror is displaced with regard to one of its neighbors, stripes will appear broken at mirror edges (Fig. 2 right). Stripes are then cut into two shifted parts. According to the shift, it is possible to deduce the relative misalignment of mirrors [2].

A quantitative evaluation can also be made with this setup, when considering photogrammetry. From the relative positions of target centers to external marked reference points, the orientation of mirrors can be extracted [3]. This procedure will be implemented in a next step.

Currently the analysis of the beamtime data is ongoing and correction routines for the misalignment are in preparation.

References

[1] S. Costa et al., Nucl. Instr. Meth. Phys. Res. A 553 (2005) 135

[2] M. Sulc et al., Nucl. Instr. Meth. Phys. Res. A 595 (2008) 194

[3] L. Steiger et al., Nucl. Instr. Meth. Phys. Res. A 639 (2011) 219

DOI:10.15120/GR-2015-1-MU-NQM-CBM-06