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OPTICAL AIGNMENT OF SEGMENTED MIRRORS TO THE FLUORESCENCE DETECTORS OF THE PIERRE AUGER OBSERVATORY (PAO).

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Abstract

The telescopes of the Pierre Auger fluorescence detector will be use a segmented mirrors. To align them have developed three proposals which use: a) the image of the diaphragm border, b) the image of a screen with concentric circles and c) the Ronchi pattern. We have developed a new method. Instead of straight lines of Ronchi ruling, we use a grid with circular lines. In this case we obtain a moiré pattern by mean of which the experimental setup is simplified and the sensitive of the alignment is improved.

I.- INTRODUCTION

The florescence detector telescopes for the Auger observatory will be a Schmidt camera[1]. And to avoid the vignetting effect, the border shape must be square one[2]. The Puebla's Optical group had proposed three differents methods to align the segmented mirror of the fluorescence detector telescopes: a) we used the image of the border of the diaphragm . In this case if the segments are aligned then the diaphragm border image must be an exact circle. Adding, the diameter of the image must be equal than the actual diaphragm diameter. In figures 1a and 1b they are shown the cases of segments misaligned and aligned respectively. b) we have used a circular screen located at the diaphragm plane we can see this a method as generalization of the method above described, see figure 2a and 2b. c) we have used a Ronchi ruling located near to the curvature center . The ruling and its image will form a moiré pattern[3] (or ronchigram).In figure 3a it is shown a ronchigram with segments misaligned. If the segments are aligned then the frequencies of each fringe pattern must be equal among them, see figure 3b. And if the ruling is located at the curvature center then the fringes must disappear.

II.- NEW METHOD TO ALIGN

In this new method we use the circular symmetry (methods a and b) and the high frequency of the Ronchi ruling (method c). The ruling is illuminated with lightday then we do not need any external source.

We locate at the center of the diaphragm a screen with concentric circles (≈ 20 cir/inch).Each segment mirror forms an image of the circular screen. The image and the original screen will be superposed and they will form a moiré pattern[3]. If the curvature center of the segment is located at the center of the diaphragm then the moiré pattern will have circular symmetry, see figure 4a. In other case this symmetry point is lost and the moiré pattern has a symmetry line which defines the displacement between the original and image screens, see figure 4b. This means that we can know the displacement of the curvature center of the segment. If the diaphragm center is located exactly at the curvature center then the moiré fringes must disappear (remember that diaphragm center it is located the circular screen). All segments are aligned when the total moiré pattern has a circular symmetry.

In order to verify our experimental results we have used a Schmidt, four segments mirrors camera[1], see figure 5. In figure 6a it is shown the moiré pattern for the misaligned segments and in figure 6b, it is shown the case in which the segments are aligned. In figure 6c we show the case, for which only one segment is misaligned.

III.- CONCLUSIONS

a) This new method to align the segments has the next advantages:It is more sensitive that the other geometrical methods $\pm\left(\frac{1}{100}\right)^{\circ}$, b) It is very easy to understand and interpret (this is very important for the technician), c) The experimental setup is very simple (we do not need external source of light, special conditions.. etc.), d)This method can be used to align the segments and to align transverse and axially the diaphragm.

REFERENCES

1.- Cordero-Dávila et al *"Proposal for the optical system of the fluorescence detector of the Auger project"* in International Report Auger Collaboration, GAP-96-039.

2.- J. Castro-Ramos and A. Cordero Dávila *"Design of a Maksutov-Bouwers camera for the fluorescence detector"* in Pierre Auger project, GAP (in revision).

3.- K. Creath and J.C. Wyant *"Moiré and fringe projection techniques"* in Optical Shop Testing, 2nd de, D. Malacara, Wiley, New York, 1992. pp 653-683.

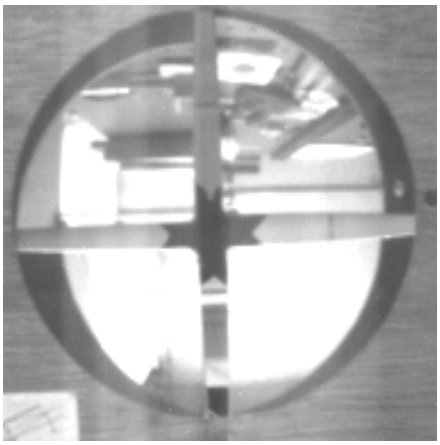

Figure 1a.- Segments misaligned

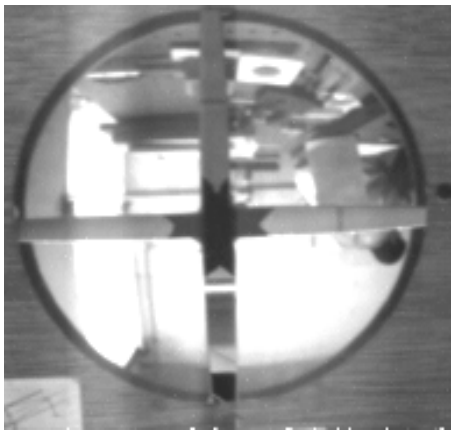

Figure 1b.- Segments aligned

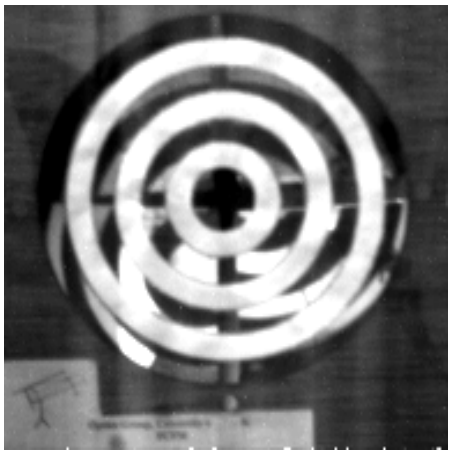

Figure 2a.- Segments misaligned

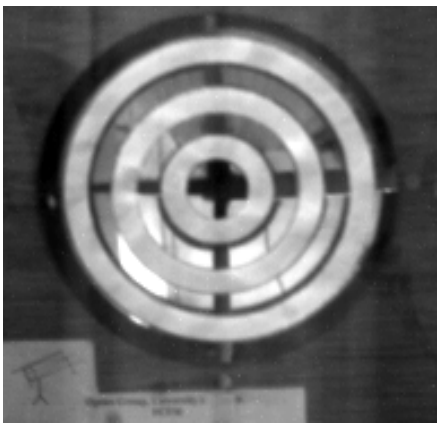

Figure 2b.- Segments aligned

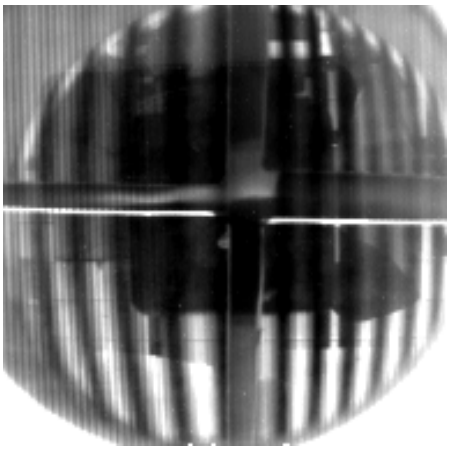

Figure 3a.- Segments misaligned

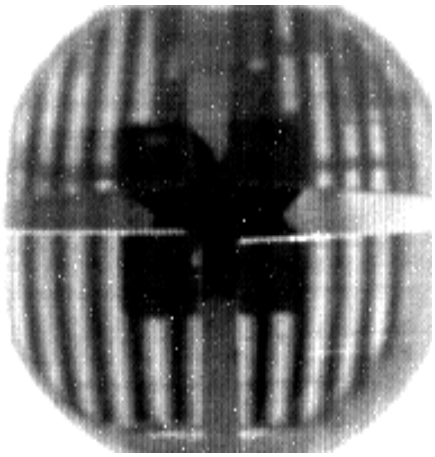

Figure 3b.- Segments aligned

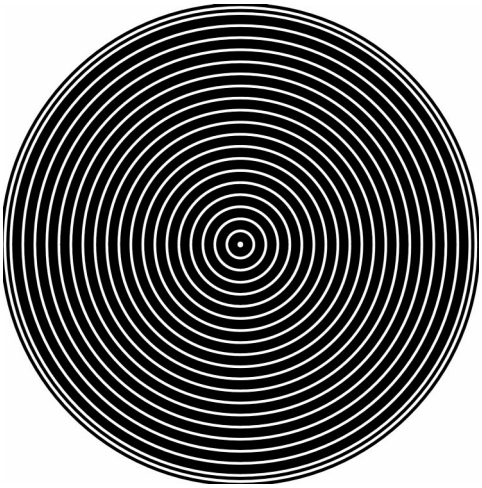

Figure 4a.- Pattern with circular symmetry

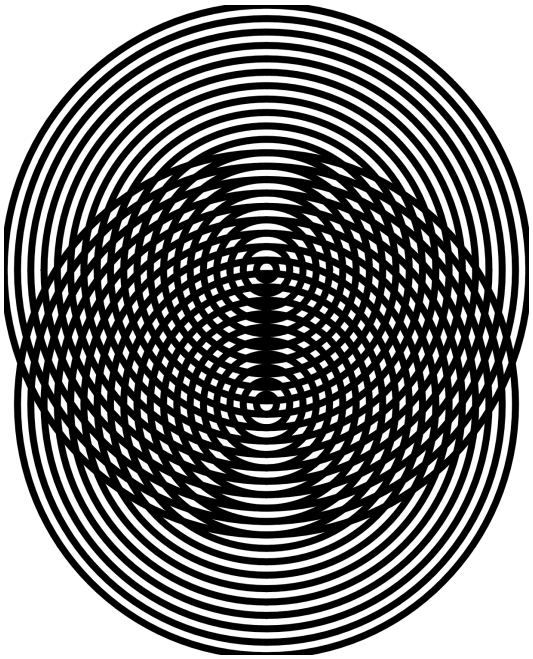

Figure 4b.- Pattern with displacement

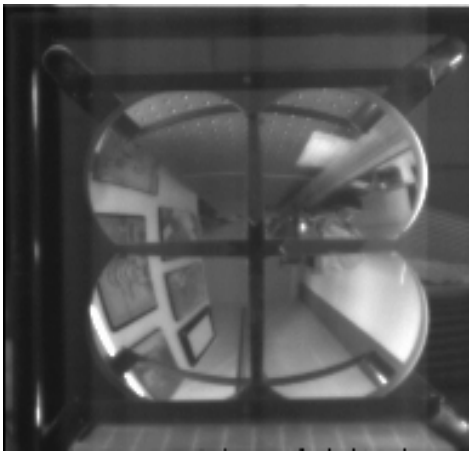

Figure 5.- Prototype real (Schmidt camera)

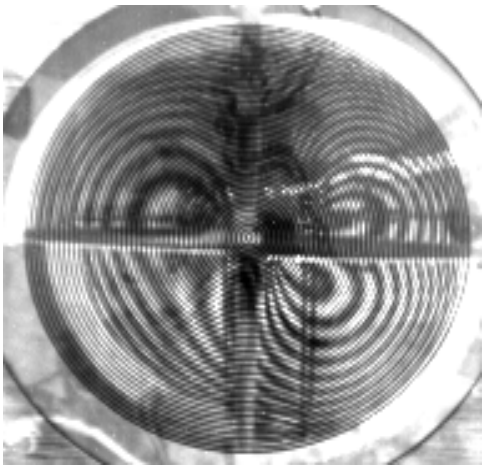

Figure 6a.- Segments misaligned

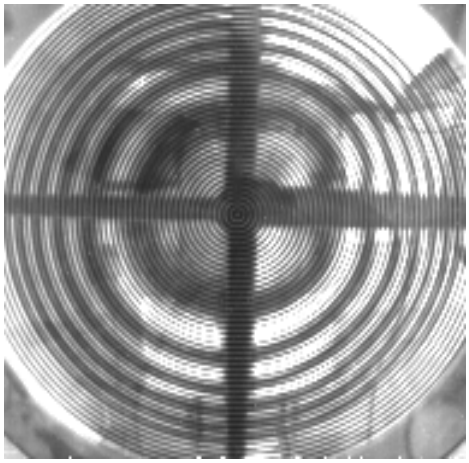

Figure 6b.- Segments aligned

Figure 6c.- One segment misaligned