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A NEW RONCHI TESTER TO THE MIRRORS OF THE FLUORESCENCE DETECTOR OF THE PIERRE AUGER OBSERVATORY (PAO).

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Abstract

We have developed an improved Ronchi tester which can be used to test the mirrors of the telescopes of the Auger fluorescence detector. The illumination system uses an LED that emits in two wave-length bands. It can be used optimally with either a CCD camera or the naked eye. By adjusting the irradiance of the source, it can be used for testing the quality of mirror with or without aluminum coating and with different curvatures.

1.- Introduction

The actual Ronchi tester is shown in figure 1. Two lenses and one prism are used in the condenser[1,2]. The light source is a white-light tungsten lamp illuminating a pinhole or a slit parallel to the ruling lines[1]. Anderson and Porter[3] suggested allowing the grating to extend over the lamp instead of employing a slit source. To test a concave mirror, Patorsky and Cornejo-rodríguez[4] have found that the setup can be simplified by illuminating the source part of the grating with daylight and setting just behind this part a strip of aluminum and using sunlight to illuminate the Ronchi ruling.

2.- The equivalence between the Ronchi and moiré fringes

We have obtained ronchigrams by using an aluminated mirror and daylight (without the aluminum foil). We have used this setup to test a very fast mirror and to align a multistep spheres for the Hindle test[5, 6]. With a positive lens we have used two gratings, see figures 2a and 2b. The first grating is illuminated with a hand-lamp and this Ronchi ruling is imaged by the lens on the second grating and therefore we have obtained a moiré pattern. With this setup we have recorded two typical moiré patterns[7] caused by an object and an image straight-line gratings with a) the same frequency but the second ruling is tilted, see figure 2a, and b) different frequencies and no tilt, see figure 2b. In both cases the second ruling is axially displaced from the image ruling and then we have obtained the defocusing effect[8].

2.- New Ronchi tester

Assuming that the Ronchi and moiré patterns are equivalent we have improved the Ronchi tester by using a LED front behind the Ronchi ruling, see. The LED can be located near to the Ronchi ruling because this source does not dissipate heat. This LED can emit in two wavelength bands which are centered at 560 and 635 nm. This is a useful think because we need to observe optimally with the eye (560 nm) and record with the CCD camera (635 nm). With the aid of the power supply it is possible to change the irradiance of the LED. We have analyzed several options in order to feed the LED. According to the objectives we have chosen the next two: a) A battery of 9V in series with a resistance (720 Ω, 1 W) and a potentiometer (5kΩ).. The duration of this battery is 40 continuos hours, approximately. This option will be very useful to align the fast segmented mirrors in the site. And b) A resistance (1kΩ)in series with a potentiometer (5KΩ) and 4 Zener diodes (1N4754A, 39V, 1W). The LED lights when the voltage arrives to the voltage of rupture of the Zener diodes. The maximum values of voltage and current were in the LED were 51.3 V and 5.1 mA, respectively. In figure 3 it is shown the final version of this new Ronchi tester. The two options have the next advantages: compact, irradiance variable, two wavelength bands and inexpensive.

We have used the new Ronchi tester to test lenses and mirrors. In figures 4a, 4b and 4c they are shown the obtained patterns for a lens, an aluminated parabolic mirror and a segmented spherical mirror, respectively.

In all cases we record the ronchigrams with the aid of a EDC-1000 CCD camera.

CONCLUSIONS

The new Ronchi tester which we developed is compact, versatile and in general economic one and overall it will be useful to test and align the mirrors of the fluorescence detector of the Pierre Auger project.

References

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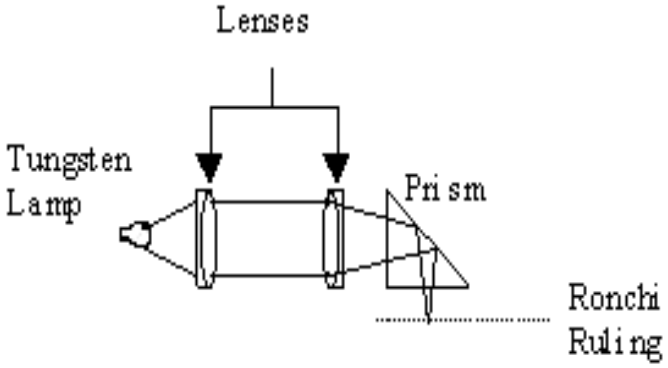

Figure 1.- Ronchi tester

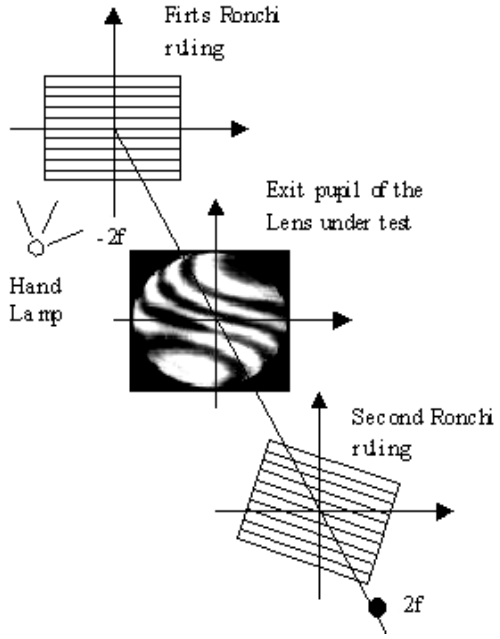

Figure 2a.- Testing a lens with Ronchi rulings of same frequency

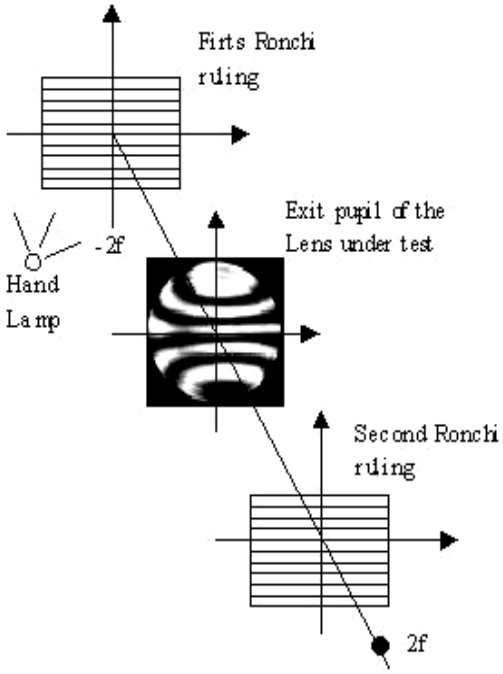

Figure 2b.- Testing a lens with Ronchi rulings of different frequencies.

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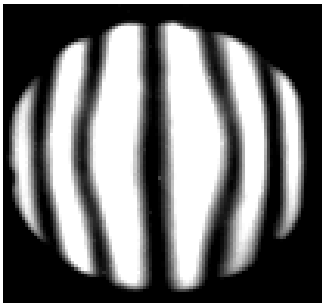
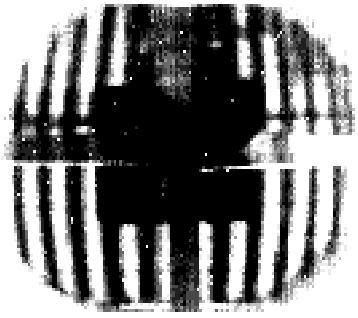
3.- New Ronchi tester

(a)



(b)



(c)

Figure 4.- Pattern of Ronchi of: (a) lens, (b) aluminated parabolic mirror and (c) segmented spherical mirror