Automatic precise alignment of Sagnac interferometer

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Abstract: A Sagnac interferometer whose optical diameter is 80mm and spectral channel is 75 is introduced based on its working principle. The method of precision alignment is introduced in detail, which includes the installation of primary alignment plane, the precise location of splitting prism, the precise adjustment of long-arm and short-arm reflector. Through the installation of alignment reference and the masterly reference transformation, the precise alignment of separated Sagnac interferometer is achieved based on the principle of auto-collimation, whose position accuracy is better than 0.01mm, angle accuracy is better than 1", primary working plane is better than 1".

Key words: Spectrology; Precise alignment; Sagnac interferometer; Position accuracy; Angle accuracy;

1 Introduction

The Sagnac lateral shearing interferometer[1-6] is constructed by the triangle common path structure. It is less affected by external vibration and air flow. It has strong anti-interference ability and the most widely used. In practical applications, the size of the interferometer is increasing with the increasing resolution of the imaging spectrometer, which makes the alignment more difficult. The alignment used only by manual adjustment cannot reach the alignment accuracy. This paper proposes an automatic adjustment system, by using the corresponding control system to realize the precise adjustment of the interferometer.

2 The basic principle of the Sagnac interferometer

Figure 1 is a typical entitative Sagnac interferometer, which consists of two semi-prisms. The angle between the plane mirrors is 45 degrees. The incident angle of collimated beam at the splitting surface is 45 degrees. When a beam is reflected, it is transmitted clockwise. The other beam passes through the surface of the beam in a counter clockwise direction. If the two semi-prisms have a certain displacement, there will occur shearing interference.

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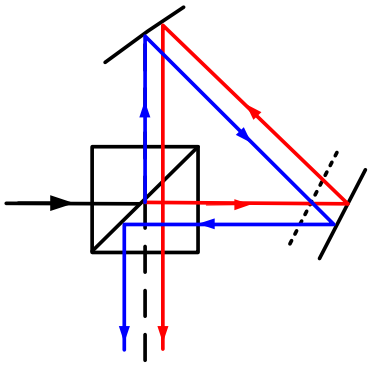

Fig.1 Structure of entitative Sagnac interferometer

The spectral channel number of the Sagnac interferometer introduced in this paper is N=75, and the pupil D=85mm. The design requires the angle between the incident light and the emitted light of the interferometer is 90°±10”. The position accuracy of the interferometer is better than 0.01mm, and the accuracy of the installation angle is better than 10". The coincidence degree of the main section of the system is better than 10".

3 Automatic assembly and adjustment system

Figure 2 shows a customized adjustment system, which consist of static platform and moving platform. The semi-prism is installed on the static platform by absorption; another piece of semi-prism is installed on the moving platform by absorption. The moving semi-prism can realize its translation and rotation adjustment of two degrees of freedom by the motion platform. The translation motion accuracy is higher than 0.01mm, and the pitch adjustment accuracy is better than 5".

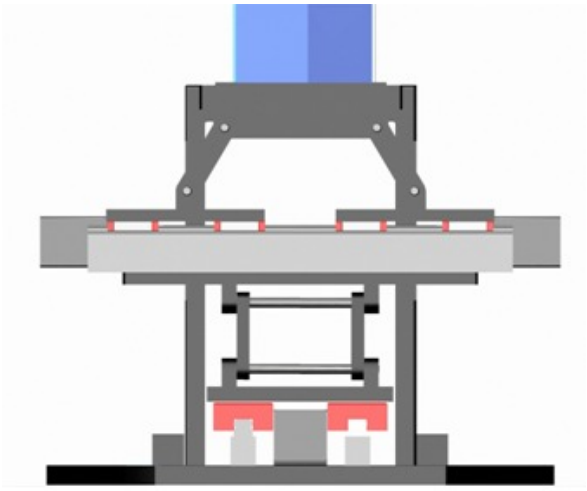

Fig.2 Customized adjustment system

Figure 3 is the diagram of the process layout. The parallel pipe of large field of view provides an endless distance of cross wire target. After shearing interferometer occurs, the interference fringes are imaged on the detector through the imaging lens.

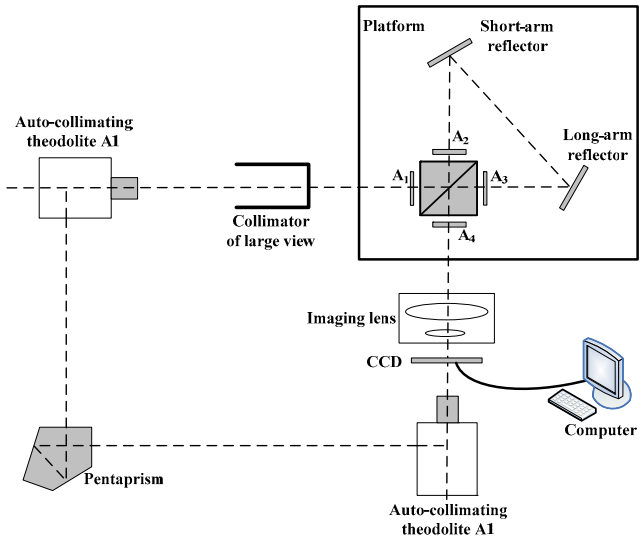

Fig.3 Diagram of process layout

First, the main plane datum of the alignment needs to be established. Through the self collimating theodolite A1 and the self collimating theodolite B1, whose self aligning accuracy is better than 0.5. The angle between the incident light and the ejection light of the interferometer is 90 degrees, which is determined by the optical axis angle of the two self collimating theodolites, which is shown in Figure 4.

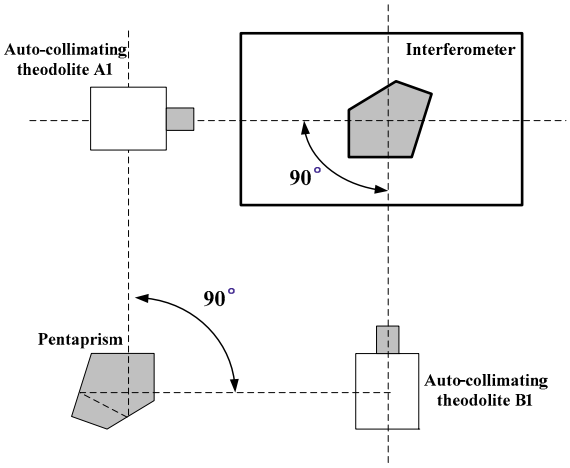

Fig. 4 Diagram of adjustment

System alignment benchmark building is completed; the entity Sagnac interferometer is placed in the automatic adjusting system. By calculate the interference image interpretation software, the

amount of shear interferometer and fringe inclination can be calculated. By adjusting the freedom degree of the adjusting system, the corresponding degree of freedom adjustment of the entity Sagnac interferometer can be realized.

4 Conclusion

In this paper, the core component of spatially modulated fourier transform imaging spectrometer –the Sagnac interferometer's principle is introduced, also a precise alignment method which based on the principle of self collimation is introduced. Based on the automatic adjustment of the system design, a high precision alignment interferometer can be achieved and it has guiding significance for other forms of alignment of the interferometer.

References

[1] Li Yan. Optical design and stray light analysis of the high resolution hyper-spectral imager based on LASIS theory [D]. Graduate University of Chinese Academy of Sciences,2009

[2] Bai Jia-guang, Wang Zhong-hou. A Study on Design M ethod for Sagnac Interferometer of Lateral Shearing Spatially Modulated Imaging Intereferometry[J]. SPACECRAFT NGINEERING, 2010,19(2) :87-91

[3] Chen Li-wu, Zhao Bao-chang. The analysis of the relationship between angle tolerance of Sagnac prism and the spectrum differentiation of the interferometer spectrometer[J]. ACTA PHOTONICA SINICA, 2006,35(7) :022-1026

[4] YANG Jianfeng, RUAN Ping. Large aperture static imaging spectroscopy[C].Proc SPIE, 2003, 4897:318-325

[5] Xiangli Bin, Zhao Bao-chang. Spatially Modulated Imaging Intereferometry[J]. ACTA OPTICA SINICA,1998, 18 (1) :18-22

[6] Ye Quanyi, Gao Yingjie, Tian Jin etc. Stability control system of fiber Mach-Zehnder interferometer based on 3 dB fiber coupler[J]. Infrared and Laser Engineering, 2017,46(10): 1022003-1022003(5).