Design and Test of a PSD System for the TPS Girder

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Abstract

An automatic adjusting girder system for all girders in the storage ring was proposed as a prototype and feasibility study for the TPS (Taiwan Photon Source) project at NSRRC. It is designed to provide strong support for the magnets and also as an alignment scheme to align the girders precisely and quickly with less manpower. In this girder system, each girder is supported with 6 motorized cam movers on 3 pedestals to carry out 6-axis adjustments. With a Nivel 202 on each girder, several touch sensors between consecutive girders, as well as a laser PSD(Position Sensitive Device) system between straight section girders, a feedback controlled full ring automatic tuning girder system is established. Comparing with aforementioned mechanical touch sensors, the PSD system is non-contact and has better accurate resolution in the long distance. The main components of a PSD system are a laser and four position sensitive devices. With two devices on each side of a long girder section, the distance and angle deviations in transverse direction can be measured. The testing result of the prototype shows a resolution of 2 μm can be reached in the distance of 20m. This paper presents all details of designs and tests of the laser PSD system

Introduction

TPS girder system is designed to possess precisely adjustable characteristics. It is a very important issue to measure the distance and angle deviations in TPS girder system. In the long distance and non-contact condition, traditional mechanical touch sensors can not achieve the desired level of a high accurate resolution. The operation algorithm and tests are shown in this paper.

Conclusion

From the experiments, the PSD system is non-contact and has better accurate resolution in the long straight distance. The testing result of the prototype shows a resolution of 2 μm in the distance of 20m can be reached. But all conditions of the experimentation keep in high stable level with much manpower. Our next step is setting up standard operating procedures to install all PSD systems.

System Design

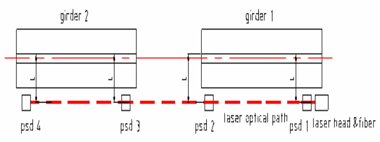

Figure1 The operation algorithm of the PSD system

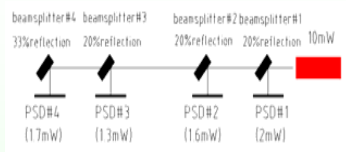

Figure2 The main structure of the PSD system

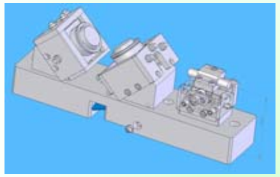

Figure3 Lenses and a lens adjustment mechanism

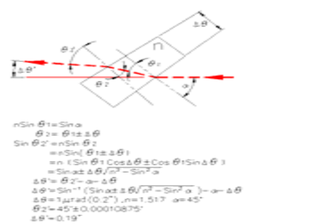

Figure4 The optical path of a lens

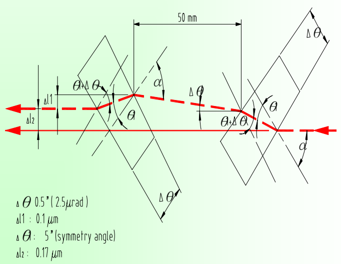

Figure5 The optical path of the refraction lens and compensated lens

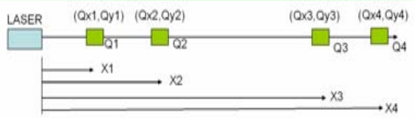

Figure6 The relative position of a laser and PSDs

$$\theta = \frac{(QX2'-QX2)-(QX1'-QX1)}{X2-X1}$$

$$\Rightarrow QX3'-QX3 = [(QX2'-QX2)-(QX1'-QX1)]\frac{X3-X1}{X2-X1} + (QX1'-QX1)$$

$$\Rightarrow QX3' = QX3 + [(QX2'-QX2)-(QX1'-QX1)]\frac{X3-X1}{X2-X1} + (QX1'-QX1)$$

$$\Rightarrow QY3' = QY3 + [(QY2'-QY2)-(QY1'-QY1)]\frac{X3-X1}{X2-X1} + (QY1'-QY1) \rightarrow (1)$$

$$\Rightarrow QX4' = QX4 + [(QX2'-QX2)-(QX1'-QX1)]\frac{X4-X1}{X2-X1} + (QX1'-QX1)$$

$$\Rightarrow QY4' = QY4 + [(QY2'-QY2)-(QY1'-QY1)]\frac{X4-X1}{X2-X1} + (QY1'-QY1) \rightarrow (2)$$

Test and Result

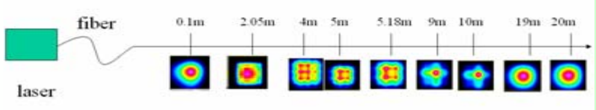

Figure6 A laser's profiles

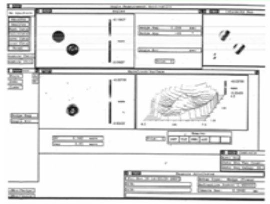

Figure7 The flatness and parallelism of a lens

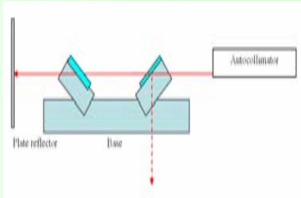

Figure8 The structure of a PSD System and autocollimator

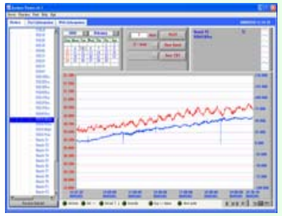

Figure9 A floating phenomenon of a laser beam

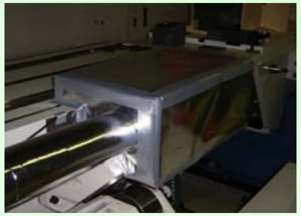

Figure10 The isolation cube

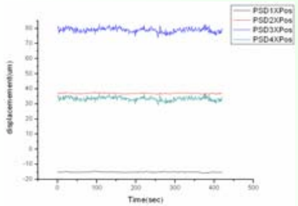

Figure11 The raw measurement in X

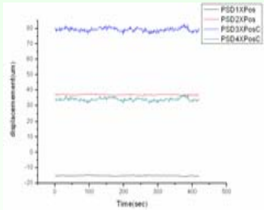

Figure12 The compensated measurement in X

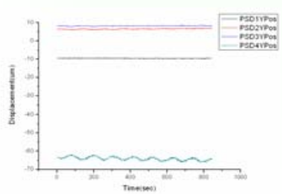

Figure13 The raw measurement in Y

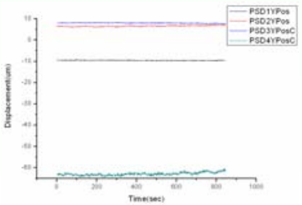

Figure14 The compensated measurement in Y