The controller design for kicker magnet adjustment mechanism in SSRF

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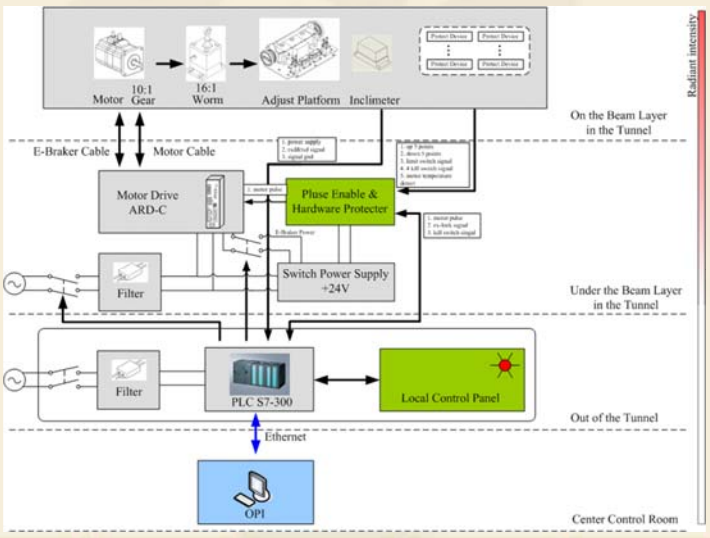
The kicker magnet adjustment mechanism controller in SSRF is to improve the efficiency of injection by changing the magnet real-time, especially in the top-up mode. The controller mainly consists of Programmable logic controller (PLC), stepper motor, reducer, worm and mechanism. PLC controls the stepper motors for adjusting the azimuth of the magnet, monitors and regulates the magnet with inclinometer sensor. It also monitors the interlock. In addition, the controller is provided with local and remote working mode. This paper mainly introduces related hardware and software designs for this device..

Introduction

Shanghai Synchrotron Radiation Facility, currently in routine operation stage for nearly two years, and SSRF storage ring will run in top-up operation mode. while in the Injecting, the electron beam which comes from the high energy beam transport line will be bumped to the closed orbit. To ensuring photon beam position stability, the beam in the storage must be remaining its orbit while travelling the injector. This may make the beam deviate from the designed orbit, and reduce the injection efficiency. In order to reduce the impact of injection, we developed this device. It can be able to precisely measure the magnetic azimuth angle, and adjust it in real time

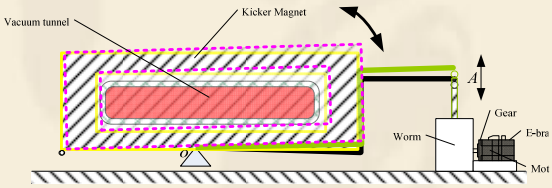
Architecture

the controller based on PLC, with the auxiliary hardware circuit, it selects the control object, adjusts the platform motion, detects the position and provides the protection. By the switching, the controller can scan the current location of four the platform as well as focus on one. While in the scanning mode, the four position feedback information is received by the PLC cycle, Otherwise, when in the adjusting mode, one of four kickers is focused, and the power supply of other kicker motor is cut off, so as to ensure the accuracy of selected objects, but also improve the safety performance. In addition, the stepper motors are equipped with brake system used as motion safety protection.
Then there is an emergency, the motor is braking, and the platform is secured. Besides local interface, the controller also provides remote interface via Ethernet.



Mechanical structure

The Platform is fixed on the point O. and the other underlay is the worm. When the stepper motor rotates, the worm controls points A movement up and down, then the magnet platform rotates slightly as the center O, the relative position between magnet and beam then to be adjusted.



Position feedback control and Safety protection

Position feedback is derived from inclinometer through optical fiber, through which PLC's SM340 module can acquire the real-time and high-precision position information. The controller based on SIEMENS S7-300 PLC has so fast scanning speed and the adjusting range is so small that it can use close-loop control technology .
In this controller, software limit, kill switch and mechanical hard stop are used to implement up and down position protection. Software limits on the one hand prohibit setting value beyond the normal range. Kill switch can cut off pulses by hardware as well as give signal to PLC. Mechanical hard stops are used to stall the motor if the kill switch fails.

Software design and Conclusions

Software designs are composed of two parts, one is program design based on PLC, and the other is program design based on EPICS.
By using this device to tilt the magnet, the rms value of the first 200 laps Track is less than $\pm 4\mu m$, which one can reached $\pm 100\mu m$ before tilt optimized.