DESIGN AND DEVELOPMENT OF A SYSTEM OF HYBRID TYPE TO MEASURE THE MAGNETIC FIELD OF A CRYOGENIC UNDULATOR

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Abstract

A cryogenic permanent-magnet undulator (length 2 m, period length 15 mm) is under development for Taiwan Photon Source (TPS). *To obtain a magnetic-field distribution of the cryogenic undulator after it is cooled to an operating target temperature below 80 K, a device of hybrid type combining a Hall probe and stretched-wire method has been designed and developed, to perform the field measurement at low temperature and in an ultra-high vacuum environment. This poster describes mainly the entire system, including kernel components, control systems and preliminary test results.*

SYSTEM REQUIREMENTS

The field-measurement devices must be placed in a narrow clearance space of the ultra-high vacuum environment around a vacuum chamber, magnet array and a nearby cooling system. Adjacent components in the vicinity of the magnets and the field-measurement device must neither interfere with each other nor perturb the signal source. As stated above, *a compact design is a crucial and essential element of the system development. The movement requirements of the measurement system are listed in Table 1.*

Table 1: Movement Requirements of Each Method

Method	Stretch Wire	Hall Probe
Stroke range		
Vertical	±1 mm	±5 mm
Transverse	±22 mm	±1 mm
Longitudinal	-	2.4 m
Scanning Speed	10 mm/s	3 mm/s

System Composition - Hardware

Figure 1 displays the overall construction of the system to measure a magnetic field. The free space between vacuum chambers is used to accommodate the measured undulator. According to the functions of the system, the field-measurement equipment *of hybrid type can be divided into two portions, a Hall probe and a stretched wire.*

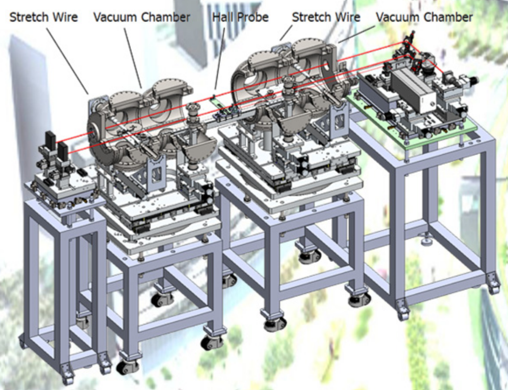

Figure 1: Overview of the measurement system.

Control and Data Acquisition System

Figure 2 shows an architectural diagram of the entire control and data acquisition system. *As the core of the control system, a computer monitors the x-y positions of the Hall probe through two quad-cell PSD and corrects them with two rail-supported x-y stages. It also controls the movements of the x-y stages of the stretched-wire movement and the Hall probe rotary stepping motor. After measurement, this computer reads data of a voltmeter and a digital integrator and plots the measurement results.*

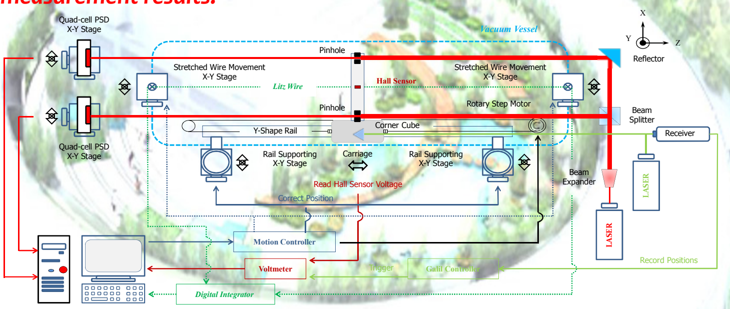

Figure 2: Diagram of the control and data acquisition system.

VERIFICATION OF RESULTS

To verify the function and performance of the system *under the vacuum-sealed condition at 10^{-4} Pa*, a couple of magnet arrays (length 0.2 m) of period length 22 mm and a gap fixed at 7 mm would be dedicated to testing, as shown in Fig. 3. Figure 4 shows that *the reproducibility of Hall probe system is better than 0.2° in RMS phase error*, which indicates that this system is reliable to examine an undulator in a vacuum environment.

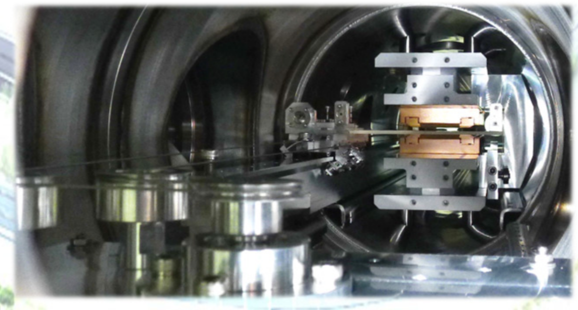

Figure 3: Magnetic-field measurement of IU22 with 0.2 m long.

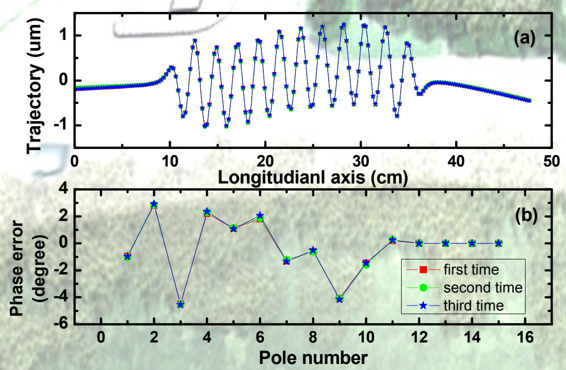

Figure 4: Result of measurement of the magnetic field.

CONCLUSION

The design of a system of hybrid type to measure the magnetic field of a cryogenic permanent-magnet undulator is proposed. The fabrication of Hall-probe components has been accomplished; some significant *experiments of the system have been performed at room temperature and in a vacuum environment. The test results confirm that the engineering architecture enables collection of information about the magnetic field.* Calibration of the Hall probe at varied temperature and testing of the reliability at cryogenic temperature are required. The stretched-wire parts are under fabrication and will also be tested.

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