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ADC's Insertion Devices and Magnetic Measurement Systems Capabilities

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Abstract

In this paper ADC will discuss ADC's major improved capabilities for building Wiggler Insertion Devices, Undulator Planar Devices, Elliptical Polarized Undulators (EPU), In-Vacuum Undulators (IVU), Cryogenic Cooled in-vacuum Undulators (CPMU), Super Conductive Undulator and Insertion Device Magnetic Measurement Systems. ADC has designed, built and delivered Insertion Devices and Magnetic Measurement Systems to such facilities as MAX-lab (two EPUs, a Planar, and Measurement System), ALBA and ASP (Wigglers), BNL (CPMU), SSRF (two IVUs and a Measurement System), PAL (one IVU and Measurement System), NSRRC (one 4m EPU), and SRC (Planar and EPU).

The ADC magnetic field measurement system is a sophisticated and sensitive machine for the measurement of magnetic fields in undulators (Planer, EPU, and Apple II), wigglers, and in-vacuum ID units. The magnetic fields are measured using 3 axis hall-effect probes, mounted orthogonally, to a thin wand. The wand is mounted to a carriage that rides on vacuum air bearings. The base is granite. A flip coil is provided on two vertical towers with X, Y and Theta axes. Special software is provided to assist in homing, movement, and data collection and analysis.

INSERTION DEVICES

ADC has worked hard developing capabilities, design standards, procedures, and training staff to provide "Turn-Key" insertion devices and magnetic measurement systems complete with in-house and customer site training. ADC's support includes magnetic calculations and design, detail mechanical design, finite element analysis using ANSYS, manufacturing and assembly, magnet sorting and shimming, complete customized turn-key controller/driver, software interfaced with EPICs, installation and training, and continuous future support. The following chart summarizes projects completed by ADC. Three project examples can be seen to the right and on the following page in Figure 1, Figure 2, and Figure 3.

Type	Facility	Country	Length
Wiggler	CHESS	USA	2 m
EPU	CLS	Canada	2 m
Planar	CLS	Canada	1.5 m
Planar	MAX-Lab	Sweden	2 m
EPU	MAX-Lab	Sweden	2 m
Apple	MAX-Lab	Sweden	2 m
Planar	SRC	USA	1 m
EPU	SRC	USA	1 m
Wiggler	ASP	Australia	2 m
EPU	NSRRC	Taiwan	4 m
Wiggler	ALBA	Spain	1 m
In- Vac	SSRF	China	2 m
In- Vac	SSRF	China	2 m
CPMU	BNL	USA	1 m
In- Vac	PAL	Korea	2 m

Table 1: Insertion devices delivered

Figure 1: BNL Cryogenic cooled in-vacuum undulator in the ring

Figure 2: One meter wiggler insertion device for ALBA Synchrotron

Figure 3: SRC elliptical polarized undulator-EPU

MAGNETIC MEASUREMENT SYSTEM

ADC's magnetic measurement systems (MMS) are being used all over the world by major synchrotron facilities. The following chart, Table 2, summarizes projects completed by ADC. Figure 4 to the right is an example of a magnetic measurement system.

Type	Facility	Country	Length
MMS	MAX-Lab	Sweden	4 m
MMS	SSRF	China	5 m
MMS	PAL	Korea	5 m
IFMS	BNL	USA	7 m
MMS	Danfysik	Denmark	7 m
MMS	ADC	USA	8 m

Table 2: Magnetic measurement systems delivered

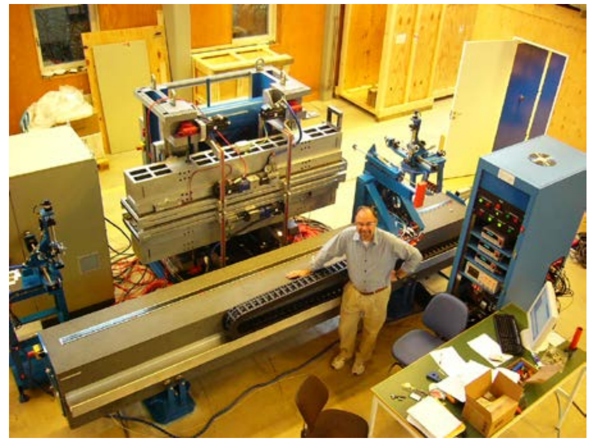

Figure 4: Four meter insertion device magnetic measurement system for MAX-lab

ADC'S NEW MEASUREMENT BENCH

This new bench is necessary to meet the magnetic field measurement tolerances that are required for today's insertion devices. The ADC bench incorporates axes of rotation that are able to optimize the rotation of the hall probe as well as increased travel in X, Y, and Z directions. In order to do this, we needed to build a granite carriage that rides on captured air bearings. We have enclosed and magnetically shielded the Z linear motor and provided improved cable management; see Figure 5 below.

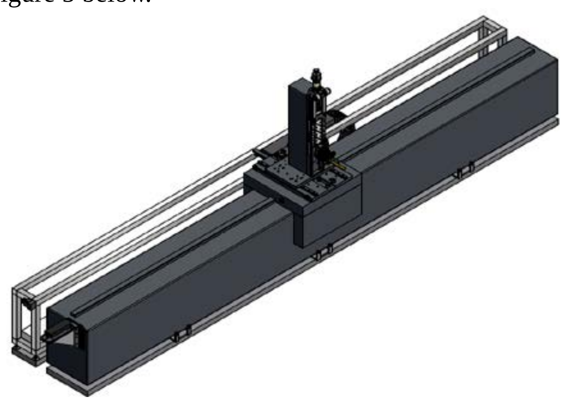

Figure 5: Measurement bench

The base granite is 8 meters long so that we can measure a full 7 meter insertion device. The beam rests on several feet directly on our vibration isolation vault.

The long Z axis consists of captured air bearings in the X direction and lift bearings in the Y direction. The carriage is made of 3 sections of granite for mass and thermal stability. The air bearings are made by NewWay air bearings in Aston, Pa. The drive consists of an ironless I-Force linear motor from Parker. The linear motor is magnetically shielded and shorting bars are applied at the ends to contain the field. The position feedback is derived from a Renishaw XL-80 laser system; see Figure 6 on the following page. This laser system, with the proper optics, can measure the errors associated with angular deviation, straightness, and flatness, allowing for the compensation of these errors as well as Z axis positioning. The laser is the standard for qualifying all other forms of position encoding. Triggers on programmable dimensions can be generated in X, Y, and Z directions.

Figure 6: Renishaw Laser System

The X, Y, P, Q, and R axes are constructed from ADC standard stages as shown at right. The linear X and Y stages have travel of 400 mm each. The Y axis is centred at 1200 mm nominal beam height but can be lifted for higher beam heights. The theta rotary axis (R) provides 360 degrees rotation and holds a pitch stage (P) and a small yaw axis (Q) both with +/- 10 degrees of travel. The pitch stage holds the hall probe fixture. The position feedback is derived from Renishaw Tonic linear encoders with +/- 1 um accuracy. The Hall probe is based on the 2D Senis probe now in use at DLS, MAX-lab, and DESY. The Y axis is counterbalanced for the weight of its slide and rotary axes. Precision ball screws are used on all axes along with crossed roller guide rails.

The 1st and 2nd integrals along with the multipoles are measured using two methods, a flip coil and/or an optional vibrating wire. The flip coil is used for larger gap devices while the vibrating wire is used for small (< 2 mm) gap devices. Both are accurate and proven methods.

The flip coil is based on the Integrated Field Measurement System (IFMS) ADC built for the magnetic lab at BNL for NSLS-II, shown in Figure 7 to the right. This flip coil system consists of 2 granite pedestals each with X, Y and Theta axes. The axes on one pedestal (typically upstream) form the master and the axes on the other pedestal form the slave. Master and slave axes move together. The X axes have 200 mm travel and the Y axes have 120 mm travel although these can optionally be extended. The theta motors consist of Yaskowa rotary servos. The rotational velocity is very precise. The granite pedestals shown below are custom to BNL for other reasons and do not need to be this large for a simple flip coil, for instance, the Z axes are not necessary unless using a Litz wire.

Figure 7: Integrated Field Measurement System (IFMS)

ADC'S MEASUREMENT SYSTEM SPECIFICATIONS

Granite: Dimensions	1 m W x 1 m H x 8 m L
Flatness	25 µm
Straightness	25 µm
Travel: X: 400 mm, Resolution 0.1 um, Accuracy ± 1 um Y: 400 mm, Resolution 0.1 um, Accuracy ± 1 um Z: 7500 mm, Resolution 0.1 um, Accuracy± .5 ppm Theta: ± 180 deg., Res 0.005 deg., Accuracy – 2 arc sec Pitch: ± 10 deg., Res 0.005 deg., Accuracy – 2 arc sec	
Nominal Beam Height	1200 mm
Hall Probe	Senis 2D Hall probe: J-YZb-20_Eb-400Hz-LN-1T Max Range: +/- 2T Resolution – 1 uT Linear Range (Blr) - +/- 1T Accuracy - .5% Blr Linearity - .25% Blr
Control Software	Wavemetrics IGOR
Analysis Software	ESRF B2E
Flip Coil Repeatability	1 Gcm or better
Flip Coil Resolution	0.1 Gcm or better

Table 3: ADC's MMS Specifications

REFERENCES

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