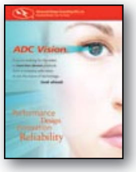
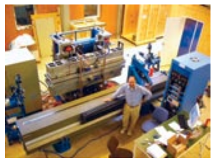
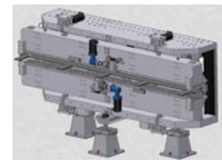
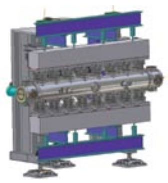
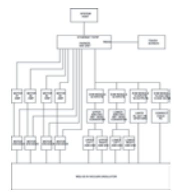

ADC Vision





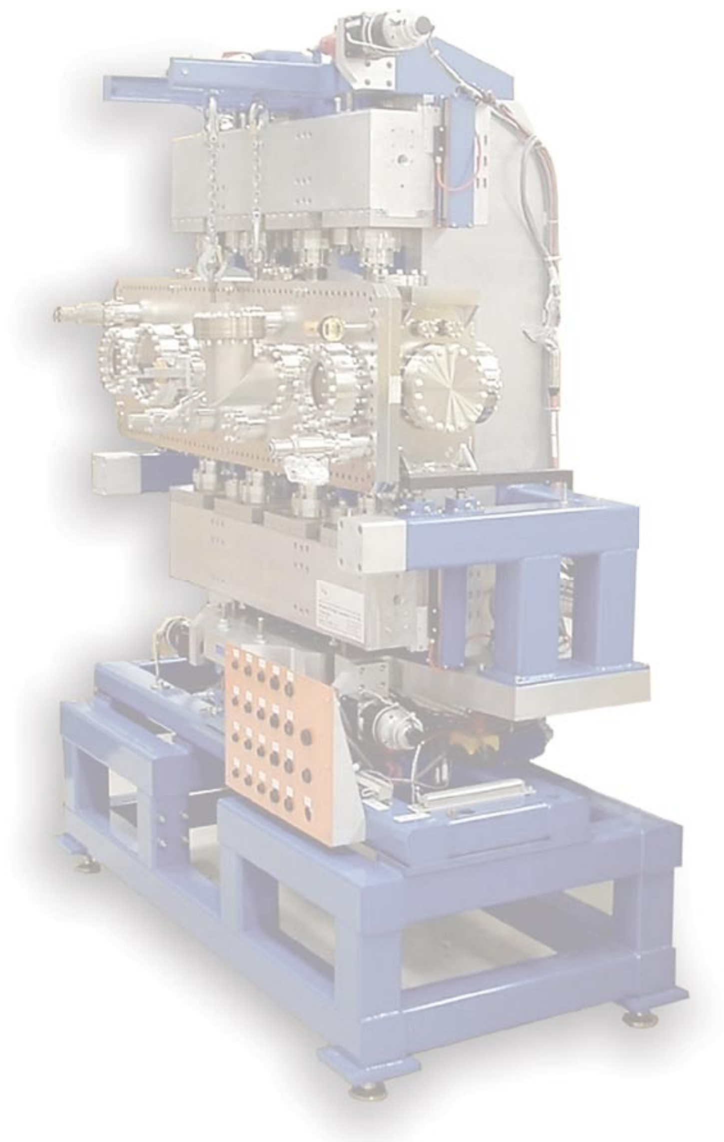





WIGGLER CONTROL

126 Ridge Road • P.O. Box 187 • Lansing, NY 14882 Advanced Design Consulting USA, Inc.

Insertion Devices



Introduction

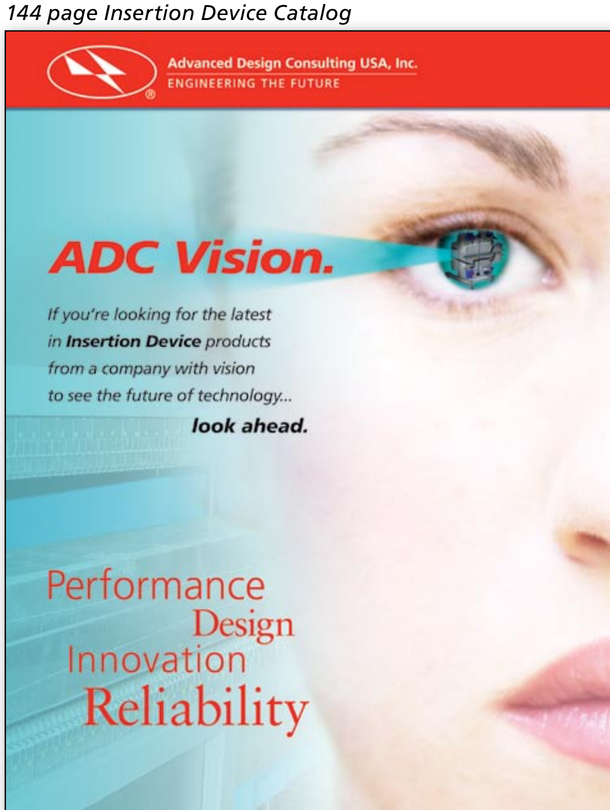
ADC provides complete design, fabrication, testing, installation and training of custom insertion devices including Planar Devices, Elliptical Polarization Undulators (EPU), In-Vacuum Planar Undulators, In-Vacuum EPU and Wigglers. ADC has built a solid track record delivering state-of-the-art Insertion Devices for facilities around the world. We would be happy to discuss and provide a schedule and cost for the following items:

- Planar Undulator
- Elliptical Polarized Undulator (EPU)
- Wiggler Insertion Device
- In-Vacuum Undulator
- Cryo-Ready In-Vacuum Undulator
- Elliptical Polarized Undulator (EPU)
- Magnetic Field Measurement System

ADC's state-of-the-art measurement facility enables in-house magnetic testing and calibration. Our facility has a dedicated temperature controlled clean room.

ADC has produced a comprehensive 144-page, full-color Insertion Device Products catalog for physicists in the synchrotron community. The catalog features a complete discussion on Control & Instrumentation, Magnetic Measurement System, Magnetic Design, Mechanical Design, Finite Element Analysis, **a comprehensive Insertion Device Primer,** and finally, training and education. A free copy of the catalog can be downloaded from www.adc9001.com.

144 page Insertion Device Catalog

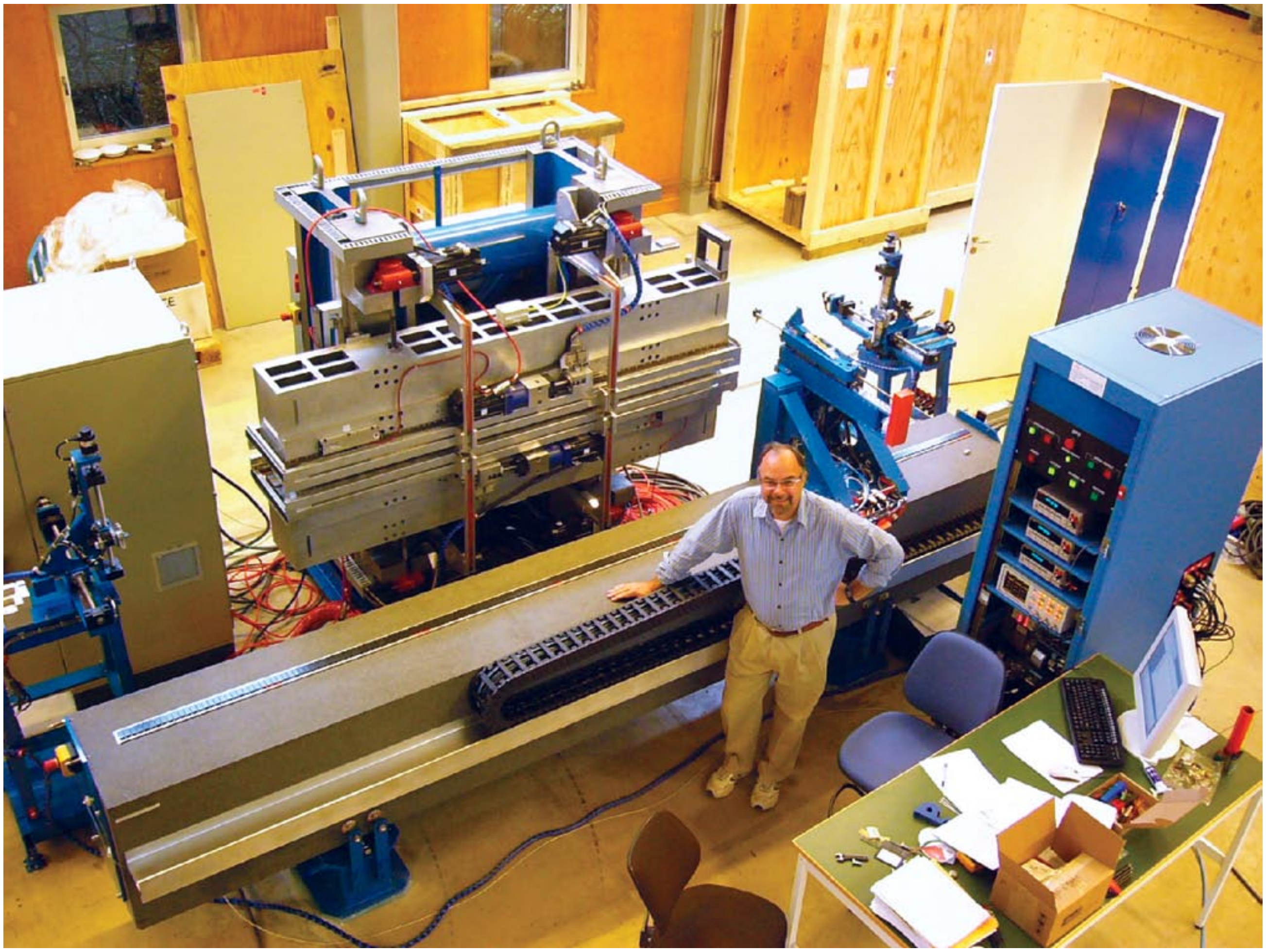


To obtain a copy of this catalog, please contact ADC or download it from www.adc9001.com

Magnetic Field Measurement System

ADC offers a portable magnetic field measurement system for characterizing field measurements of ID units. The full system includes a measurement bench, flip coil, and sorting bench. The following is a description of the portable system.

This measurement bench is considered portable because the weight of the granite beam, which is the heaviest item, is approximately 3800 pounds. This is well within the lifting capacity of most fork lifts and floor trucks. The granite beam is 300 x 300 x 5500 mm and forms the stable base and precise guidance required for accurate magnetic field measurements. The granite is lapped flat on the top and front sides not to exceed 23 microns on either surface. These surfaces also form the guidance for the carriage which rides on vacuum-air bearings. The granite is supported on 3 points using 2 custom stands.



MAGNETIC FIELD MEASUREMENT SYSTEM SPECIFICATIONS	
GRANITE DIMENSIONS	Length - 5500 mm, Width - 300 mm, Height - 300 mm, Weight - 3992 Kg
GRANITE TOLERANCE	Top Flatness – 25 um overall or better (first beam achieved 22 um overall)
	Side Straightness – 25 um overall or better (first beam achieved 7 um overall)
POWER	120 VAC, Single Phase, 15 Amps, Ground,
AIR	100 PSI, 1 SCFM, 2 micron, filter, dry,
VACUUM	28 inches of Hg, pump provided
TRAVEL	Long Axis – 5000 mm,
	Vertical – 200 mm,
	Horizontal - 300 mm
BALL SCREWS	10 turns per inch 1/2 inch diameter
POSITION FEEDBACK	Long Axis - 79.25 nm per count , Renishaw Laser
	Vertical Axis – 50 nm per count, Renishaw Tape Scale
	Horizontal Axis – 50 nm per count, Renishaw Tape Scale
MAGNETIC FIELD MEASUREMENT	Resolution - .2 mT
	Accuracy - .1% digital output, 2T range
TRIGGER DISTANCE	Programmable

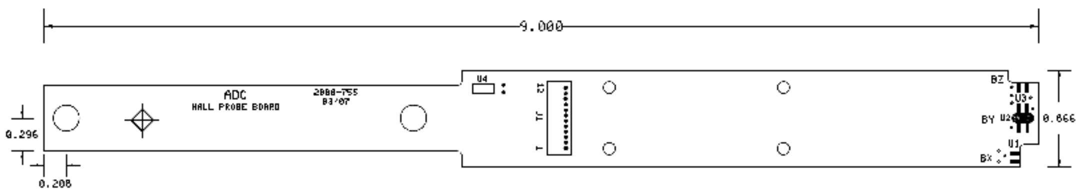
SPECIFICATIONS	
GRANITE DIMENSIONS	Length – 5000 mm, Width - 500 mm, Height - 500 mm, Weight - 3992 Kg
GRANITE TOLERANCE	Flatness – 2.5 um per 300 mm or better; Straightness – 2.5 um per 300 mm or better
POWER	240 or 480 VAC, Single Phase, 20 Amps, Ground
AIR	120 PSI, 1 SCFM, 2 micron, filter, dry,
VACUUM	28 inches of Hg, pump provided
TRAVEL	Long Axis – 3800 mm, Vertical – 290 mm, Horizontal - 290 mm
POSITION FEEDBACK	Long Axis -79.25 nm per count , Optodyne Laser; Vertical Axis – 50 nm per count, Renishaw Tape Scale; Horizontal Axis – 50 nm per count, Renishaw Tape Scale
MAGNETIC FILED MEASUREMENT	.1 Gauss to 1 Tesla, 20 bit range, as output by the FW Bell uncompensated port
DATA CONVERSION	22 bit range At the Kiethly DVM
TRIGGER DISTANCE	Programmable

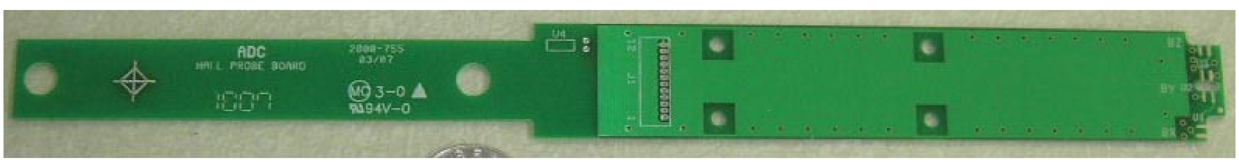
For More information please refer to Insertion Device catalog or contact ADC.

Part Number
MMMS-110

3 Axis Hall Probe

ADC has developed a 3 axis hall probe based on the popular ESRF design. This probe uses the same FW Bell GH-700 hall sensors but with the addition of an on board RTD for temperature measurement. In addition, ADC has designed this probe using 4 layer board technology. All signals lines are embedded between two layers of copper to reduce noise. While the 4 layer board is the same thickness, the extra layers make it mechanically stiffer. The fit and form factor is the same as the ESRF probe so that existing mounting and calibration fixtures can be used. The 10 pin, 2.5 mm pin spacing connector has been replaced with a 12 pin 1.5 mm connector. An adapter cable is used to interface to existing cable connections.



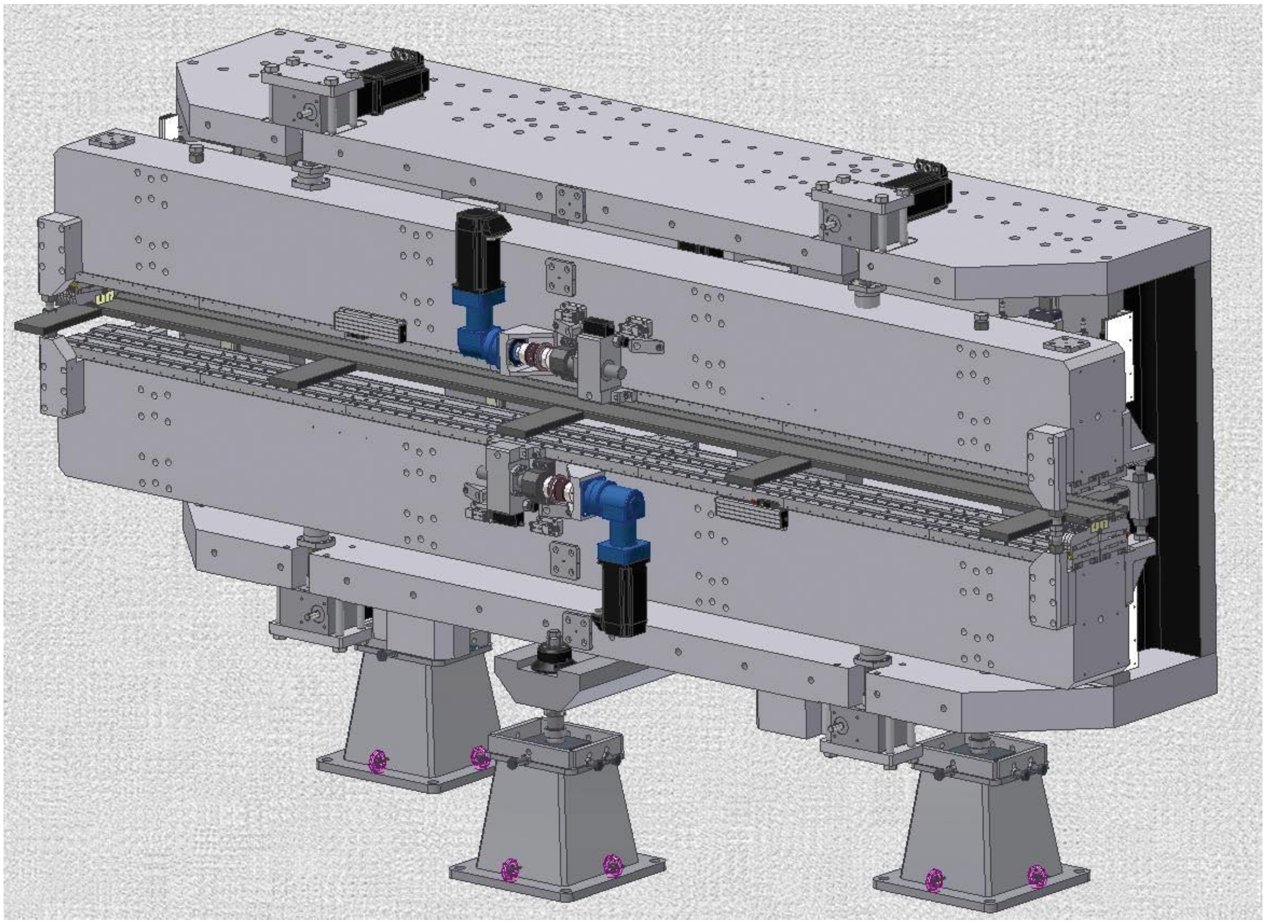


Part Number
3AHP-700

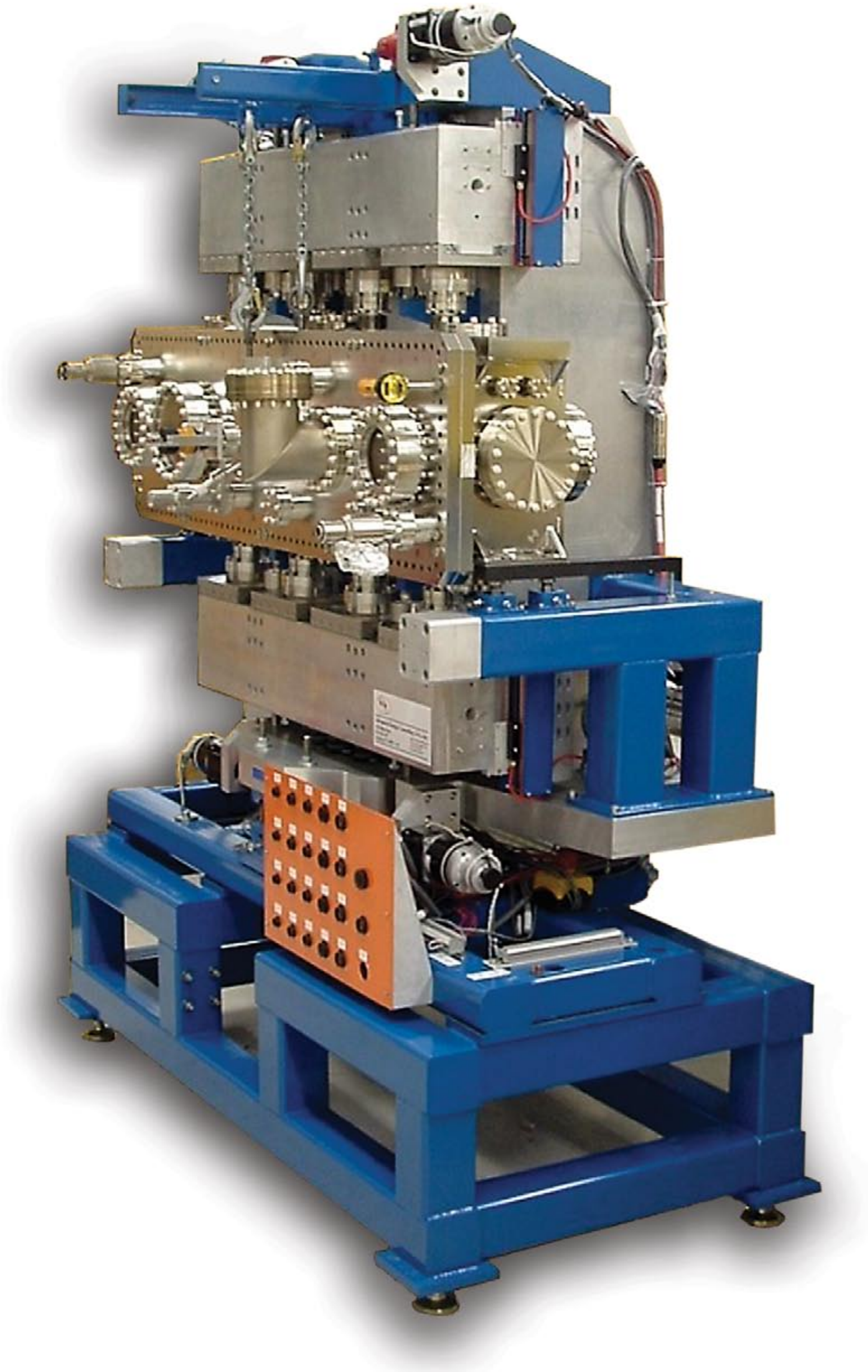
Insertion Devices

Wiggler for Australian Synchrotron Project and CHESS

Elliptically Polarizing Undulator (EPU) for Max-Lab, SLAC, NSRRC, SRC and CLS



Cryo-ready In-vacuum Undulator at the NSLS



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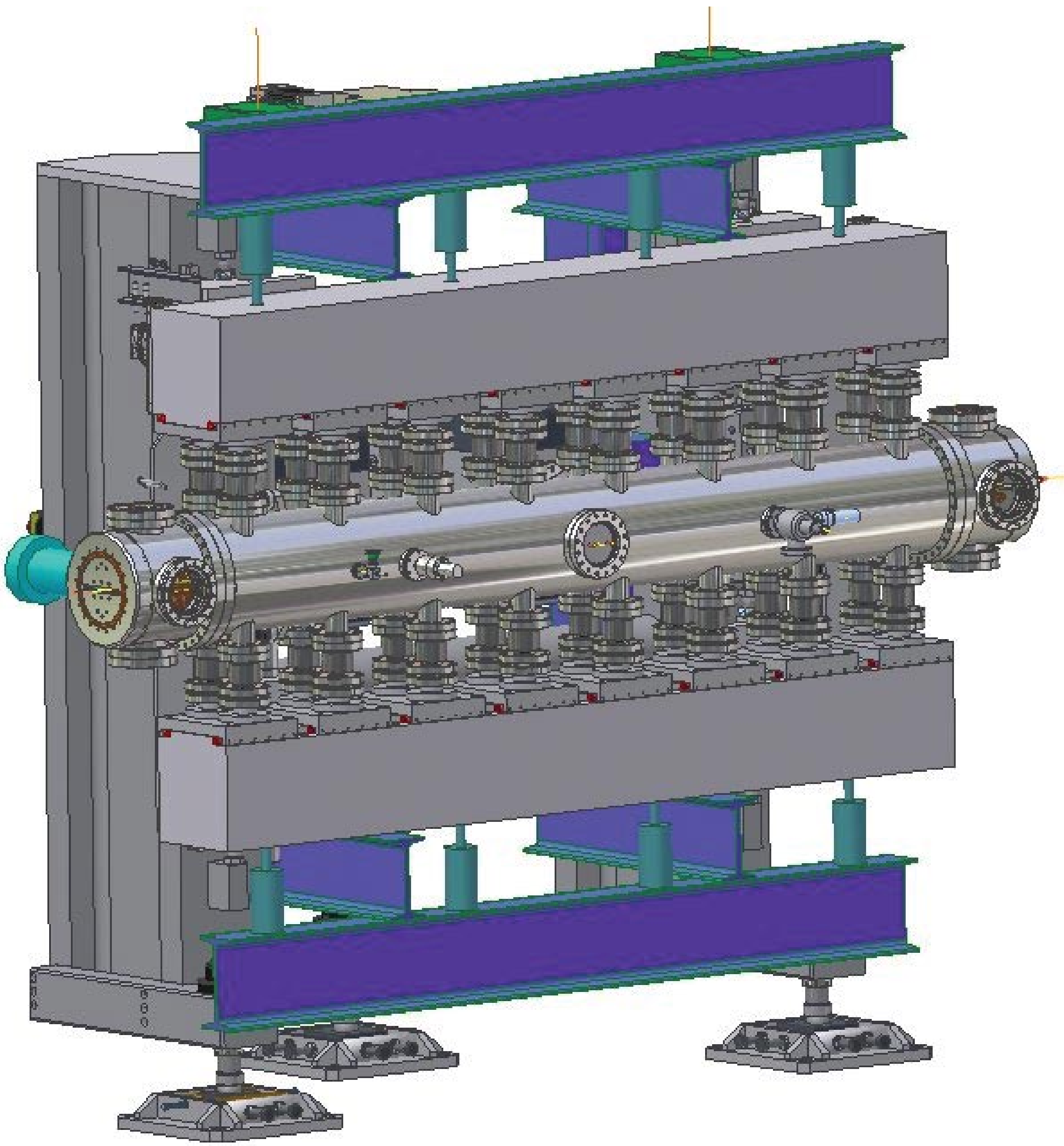
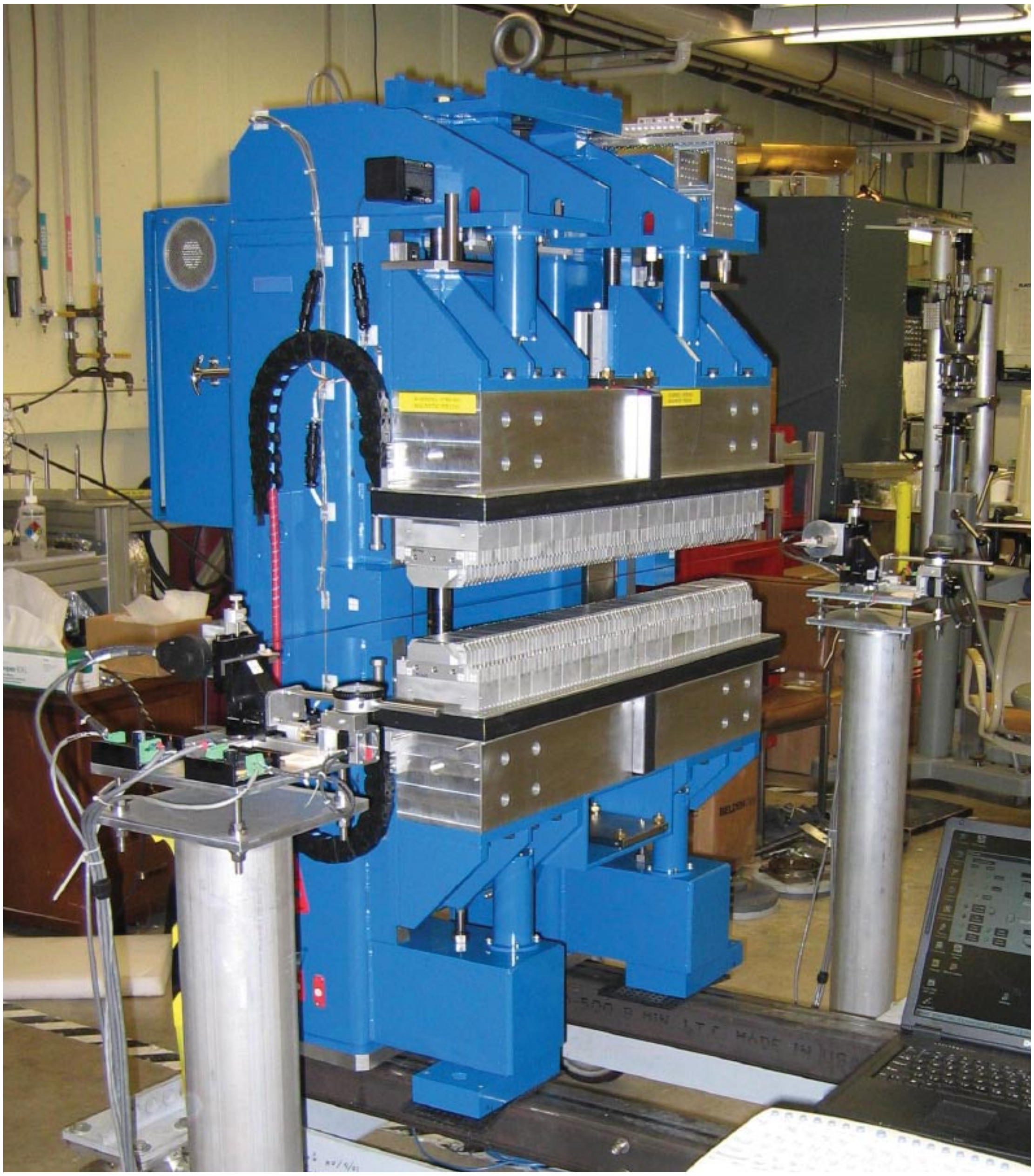
In-Vacuum Undulator for SSRF



Planar Undulator for SRC, CLS and Max-Lab



Control & Instrumentation for Insertion Deives

A description of the control and electronic design capabilities of ADC's controls group is presented along with examples of past projects.

Controls and Electronic Capabilities

Advanced Design Consulting has several electrical /software engineers and build techs capable of providing custom circuit design and complete turn-key control systems. Some of our skills include integrated PLC design and programming, analog and digital circuit design, logic design including PLA and FPGA programming, stepper and servo motor applications, microprocessor, RFID, serial and RF communications, and system controllers.

We have a suite of instrumentation tools for test and measurement of temperature, position, angular displacement, tolerance, acceleration, vacuum, and motor controls with extensive stock components for prototyping and breadboard. Our electrical lab includes various precision DVMs, oscilloscopes, power supplies, and other tools.

Our design tool set includes Cadence Capture for circuit board design, Xilinx ISE for FPGA design, ModelSim for simulation, and StateCad. Schematics are drawn on various platforms with output to DXF.

Microprocessor experience is broad but recent projects focus on the PIC Micro Family from MicroChip. ICE units and code simulation for the PIC microprocessors are in-house.

Software skills and development platforms include Microsoft Visual C++, PERL, LabView, Visual Basic, CNC, and generic PLC (AB, NAIS, GE-Fanuc, Schneider, etc.) and Parker 6K and Accroloop.

Our primary skill, however, is the integration of these components into a functioning system, fully debugged, documented, and ready for operation.

Some of the controllers we have delivered are described below.

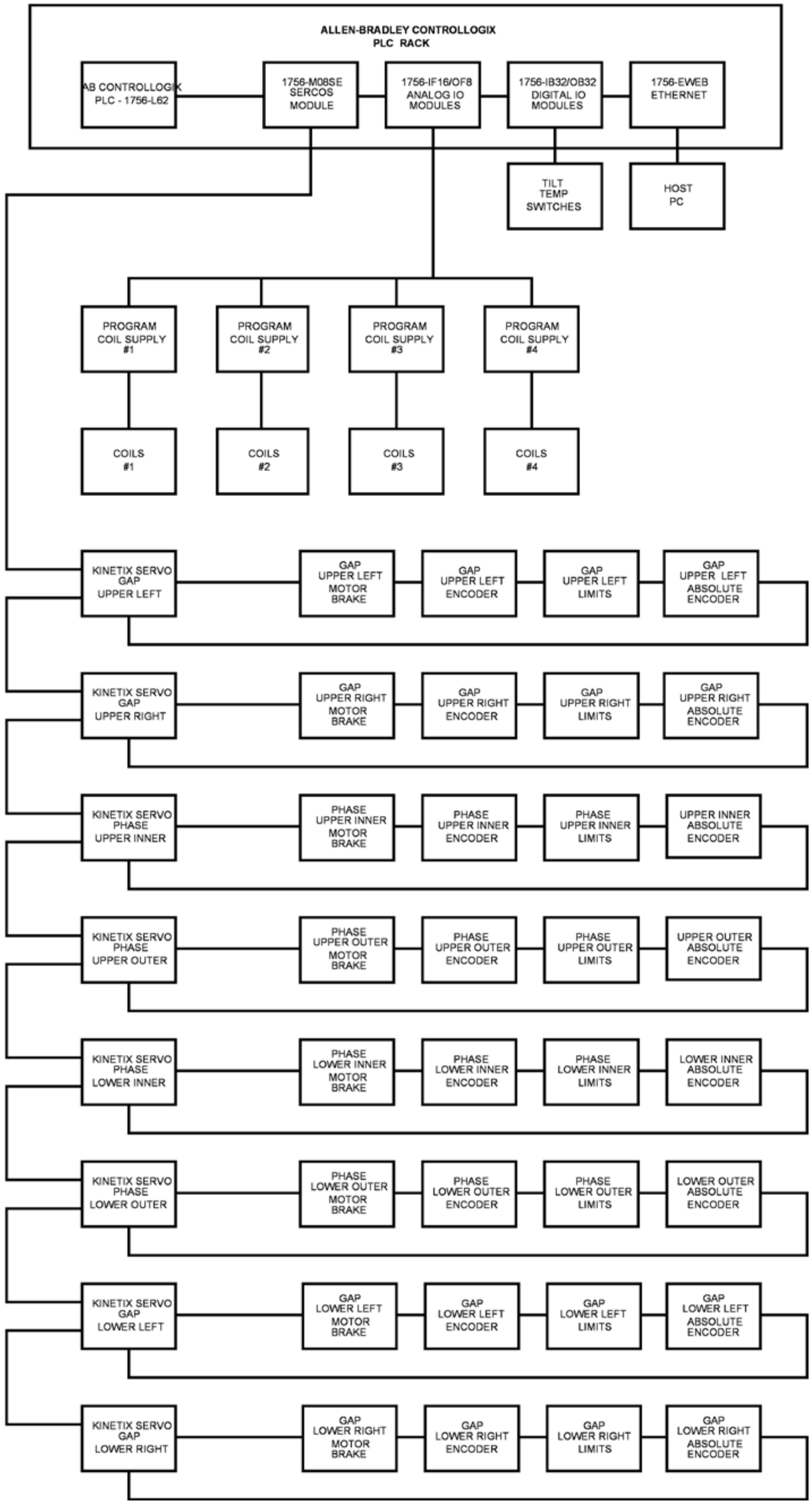
Max-Lab and NSRRC

ADC built 3, 2.8 meter, Insertion devices for Max-Lab at Lund, Sweden. The first was a full EPU, the second a planer, the third a partial EPU (2 fixed and 2 moveable magnet arrays). All three used the same Allen Bradley ControlLogix PLC with a Kinetix servo controller. All axes are servo controlled. The EPU used 8 axes; 4 on gap (2 top, 2 bottom) and one for each phase. The four servo gap control concept allowed exceptional gap control without helper springs. As the phases move through different polarities, the girders can alternately attract and repel each other to the point of levitation of the girders. High resolution absolute linear encoders (.1 um per count) were used to feed back position on each gap motor. In addition, redundant absolute rotary encoders on the motors closed a velocity loop while providing a backup to the linear encoders closing the position loop. The effect was dramatic. One could actually see the gap motors correcting for load changes as the phase axes moved. Gap repeatability was 1 micron or better. The motors follow a virtual master axis; this virtually eliminates following error between axes. This same controller will be applied to NSRRC's 4.6 meter EPU later this year. A control block diagram is shown on page 5-12.

SRC Planar

This was a controller based on a Delta-Tau PC104 PMAC which was specified by SRC. The software was written by SRC but the hardware implementation and debug was performed by ADC. It consisted of a single stepper motor for gap control and 4 analog correction coil controls.

MAX-LAB and NSRRC 8 Axis Control Concept



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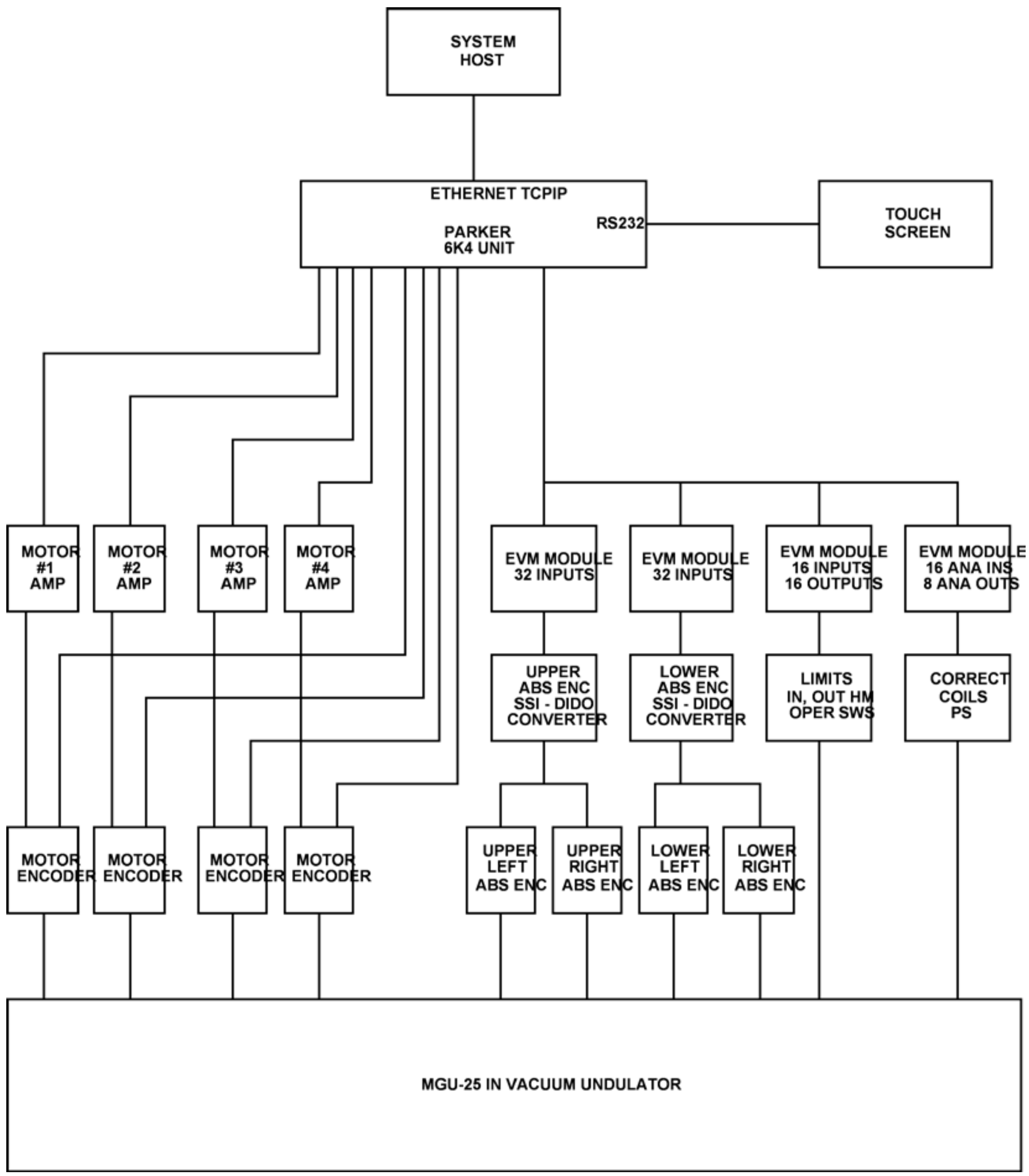
Brookhaven In-Vacuum Planar

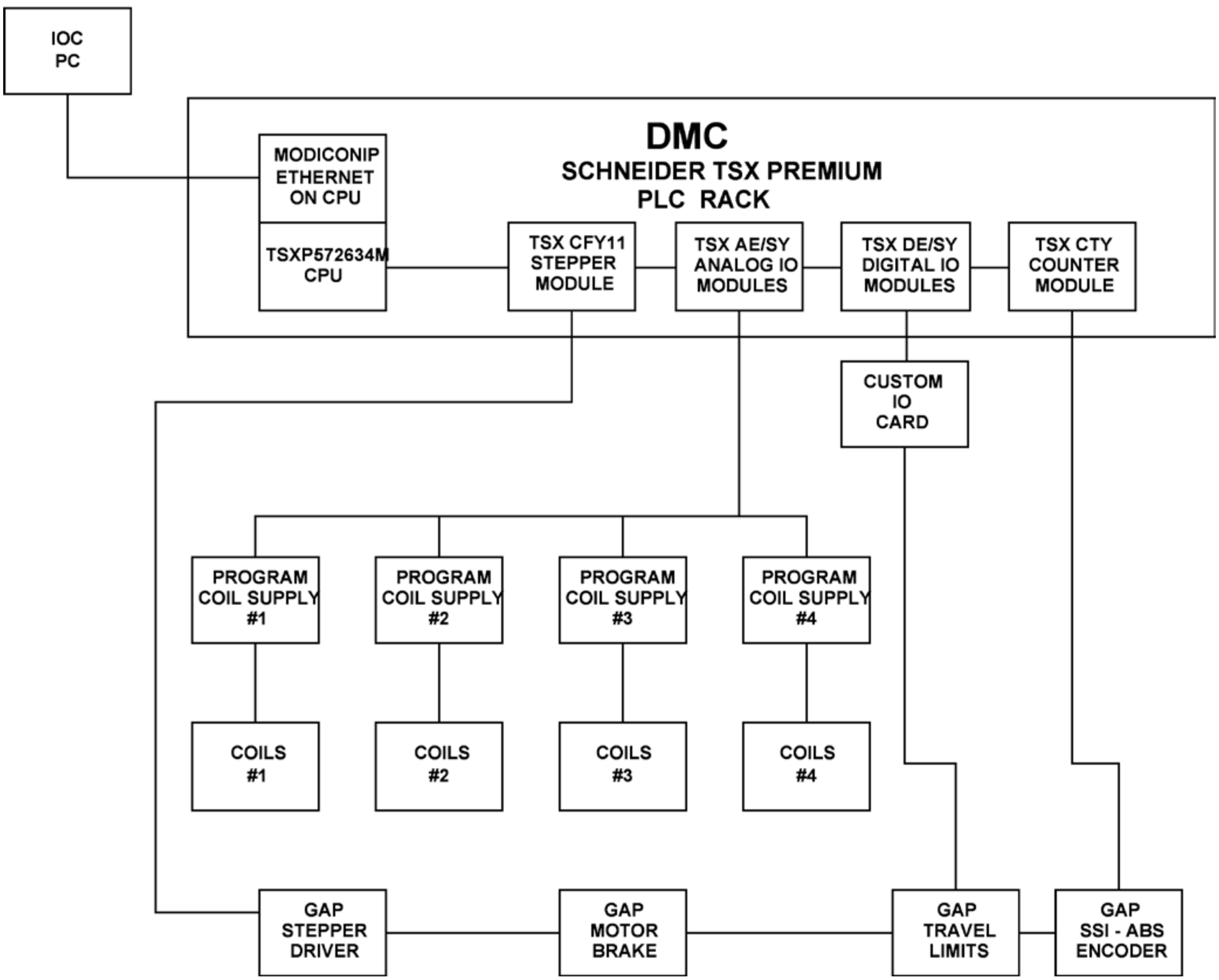
The Brookhaven X25 MGU in-vacuum planar was based on the same 4 motor gap control concept although stepper motors were used. Linear absolute encoders feed back position for each motor. It is difficult to find controllers that will contour motions using steppers, most require servos; however, the Parker 6K does allow master-slave contouring using steppers. The Parker 6K was chosen mainly for this reason but also because the software development time is somewhat reduced over other VME based controllers. Delivery time was critical on this project. The other major requirement was +/- 2 um repeatability on the magnet arrays through cryogenic temperature cycles. This problem was solved by the application of 2 Keyence optical micrometers that directly measured features on the magnet arrays through view ports in the chamber. This approach compensated for thermal growth at any temperature. The Parker 6K also provided a means to read the Keyence devices and then calculate and inject a correction factor into the positioning loop.



Australian Synchrotron Project Wiggler/SSRF China

The Australian Synchrotron Project Wiggler controller used a single stepper motor controlled by a Schneider Modicon Premium PLC. (China Wiggler used a SIEMENS S7-315.) The magnetic forces on a wiggler are much greater than an EPU so an extremely large stepper motor was required. The gap control program is much simplified with a single motor but then the positioning requirement is wide, +/- 100 um. The real challenge for this project turns out to be the interface to the EPICS program which is growing in acceptance in synchrotrons around the world. This interface was accomplished using a custom Schneider driver (written by ASP) that runs under EPICS on a Linux OS platform. Data is passed via located variables at the PLC. The data consists mainly of gap commands and status response but also data points are passed to arrays that control the correction coils. The PLC calculates an interpolation factor for the correction coil data based on the current gap and updates the control outputs for 4 correction coils all in 2 ms without impacting the position control.

ASP Wiggler Control Concept



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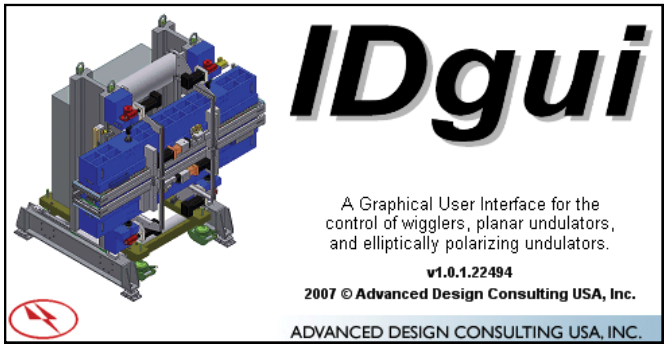
Software for Insertion Devices

ADC has developed software to control its state-of-the-art Apple II insertion devices. This type of ID uses a total of four servo motors to power ball screws at each end of the two main girders for gap and taper adjustment, and an additional four servo motors to power ball screws on each of four sub-girders for phase adjustment, comprising an 8-axis system. It's necessary to move the four girder motors in concert to precisely control magnetic gap and girder taper, and the phase motors must also be moved in concert to precisely control polarization of the produced photons.

Control hardware is based on the 1756-L62 PLC processor and Kinetix 6000 Motion Controller from Allen-Bradley. The software provides precise positioning of the girders and phases using Allen-Bradley 2.4kW servo motors and 0.1µm glass-scale linear encoders from TR Electronics. Error detection software monitors device parameters to maximize reliability and prevent beam-pipe damage. Velocity and position of all encoders are continuously monitored in order to detect encoder failure and prevent machine damage. A Graphical User Interface (GUI) was developed which communicates with the ID using TCP/IP.



EPICS Interface

ADC has interfaced the Schneider Modicon Premium PLC to EPCIS version 3.14.7 for a Wiggler built for the Australian Synchrotron Project. ASP provided an EPICS based driver for this PLC. ADC developed variables in an EPICS database to pass control parameters, status, and error conditions. ASP also provided a Redhat Linux development environment which ADC used to compile the database. An EPICS command line was used to send and receive data from the PLC using TCPIP Ethernet communications link on a Dell Laptop. This communication method was quite effective. Variables were addressed on both ends. Real, Integer, and Bit data types were passed.

ADC developed a GUI using the Schneider Modicon graphics package in the Unity Pro L development package. This provided a simple and easy way to debug and control the Wiggler for shimming and acceptance as well as verification of the EPICS interface. In addition to all motion control code, ADC also provided the PLC software to manage the correction coil update based on 20 element arrays (each) for gap, and 4 correction coils. This software interpolated the correction coil data based on gap and updated all 4 correction coils in less than 5 ms by executing in a Fast Task. The final GUI is presented below.