

Linear Collider-Related R&D at Argonne

Kwang-Je Kim

Linear Collider Organization Meeting

FNAL

February 17, 2004

Linear Collider R&D at ANL started 2-years ago with the CARA (Coordination of Accelerator Research at Argonne)

- A new cross-divisional activity started in April 2002 to coordinate accelerator R&D at ANL that has been pursued independently by several divisions
- Participation from three ALD areas: PBCS (HEP, CHEM, PHY, IPNS), APS (ASD, AOD, XFD), and EEST (ET)
- Benefits:
 - Increased research efficiency by sharing resources and manpower
 - Strengthened accelerator science at ANL on existing program and new initiatives
 - A body to respond to collaboration and other opportunities from outside

FY03 CARA Activities

- Monthly meetings
- Beams and Applications Seminar series
- Cross-divisional, cross-ALD LDRD research
 - Linear collider LDRD
 - SCRF processing lab (ANL, FNAL)
 - High-brightness beams (HEP and ASD)
 - Damping ring studies (AOD, XFD)
 - VUV FEL user facility development (AOD, ASD, XFD)
 - Run II collaboration initiated
- *The CARA initiative has been widely supported by both scientific staff and the lab management, has made a positive impact on ANL accelerator research, and has been noticed and praised by scientists and management from other national laboratories.*

FY04 CARA Activities

- Approved as an ANL Emerging Initiative Area
 - Consolidate and expand coordination and R&D at ANL
- Continue FY03 research
 - High-brightness electron beams in linacs and in rings, VUV FEL, high-gradient SCRF
- Expand coordination/collaboration outside ANL, to neighboring institutions under IAAP framework
 - SCRF collaboration with FNAL
 - New collaborative projects with FNAL to improve Tevatron run II luminosity
 - Joint faculty position with NIU for advanced heavy ion beam dynamics
- Additional topics
 - Ultra-fast laser techniques, RF cavity breakdown, EPICS for emerging platform, second harmonic cavity for RCS

FY04 CARA Research Supporting the Emerging Initiative on Accelerator R&D; Total 2M\$

Acceleration Techniques

		Divisions
RF photocathode gun*	W. Gai, J. Lewellen	HEP, ASD
Damping rings for LC*	L. Emery	AOD
SC Damping Wiggler	S.H. Kim	XFD
Next-generation SR rings	M. Borland and L. Emery	AOD
High-voltage breakdown*	Z. Insepov, J.P. Alain, J.H. Norem	ET, HEP
Second harmonic cavity for RCS	J. Dooling, R. Kustom	IPNS, ASD
EPICS for emerging platform	N. Arnold, A. Johnson, ...	ASD

VUV FEL

LEUTL FEL operation	S. Milton	ASD
Optics and wigglers	E. Moog, P. Den Hartog	XFD
OTR Diagnostics	A. Lumpkin	AOD

Ultrafast Laser Techniques

Develop 10-fs synchronization	R. Crowell, Y. Li	CHEM, ASD
-------------------------------	-------------------	-----------

IAAP Collaborative Research with FNAL and NIU

Booster beam dynamics	K. Harkay, J. Dooling, J. Norem	ASD, IPNS, HEP
Recycler vacuum	J. Noonan, G. Goepfner	ASD
Tevatron optics modeling	V. Sajaev	ASD
OTR imaging for p and pbar	A. Lumpkin	AOD
Electron cooling	W. Gai	HEP
High-gradient SCRF*	K. Shepard, M. Kelly	PHY
Heavy ion beam dynamics	P. Ostroumov, J. Nolen	PHY
SCRF development*	K.-J. Kim	ASD

*Linear collider related

Examples of LC Research

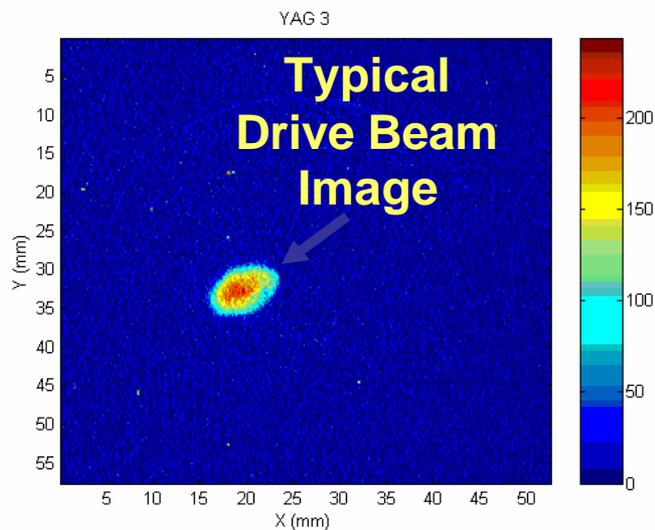
- Compact wakefield measurement based on RF photocathode beams
- Damping ring studies
- Superconducting wiggler development
- SCRF development
 - Chemical processing facility
 - Higher performance SCRF

A Compact Wakefield Measurement Facility (Progress since Summer '03)

1. High-brightness Drive Gun

Preliminary Emittance Measurements for 1 nC

- 2 – 8 μm based on PARMELA
- 5 - 15 μm based on TRACE 3D



2. Downstream Optics

Hired two students to from U of C to study various BPM options

- Stripline BPM
- Button BPM
- YAG screen
- ??

Damping Ring Research

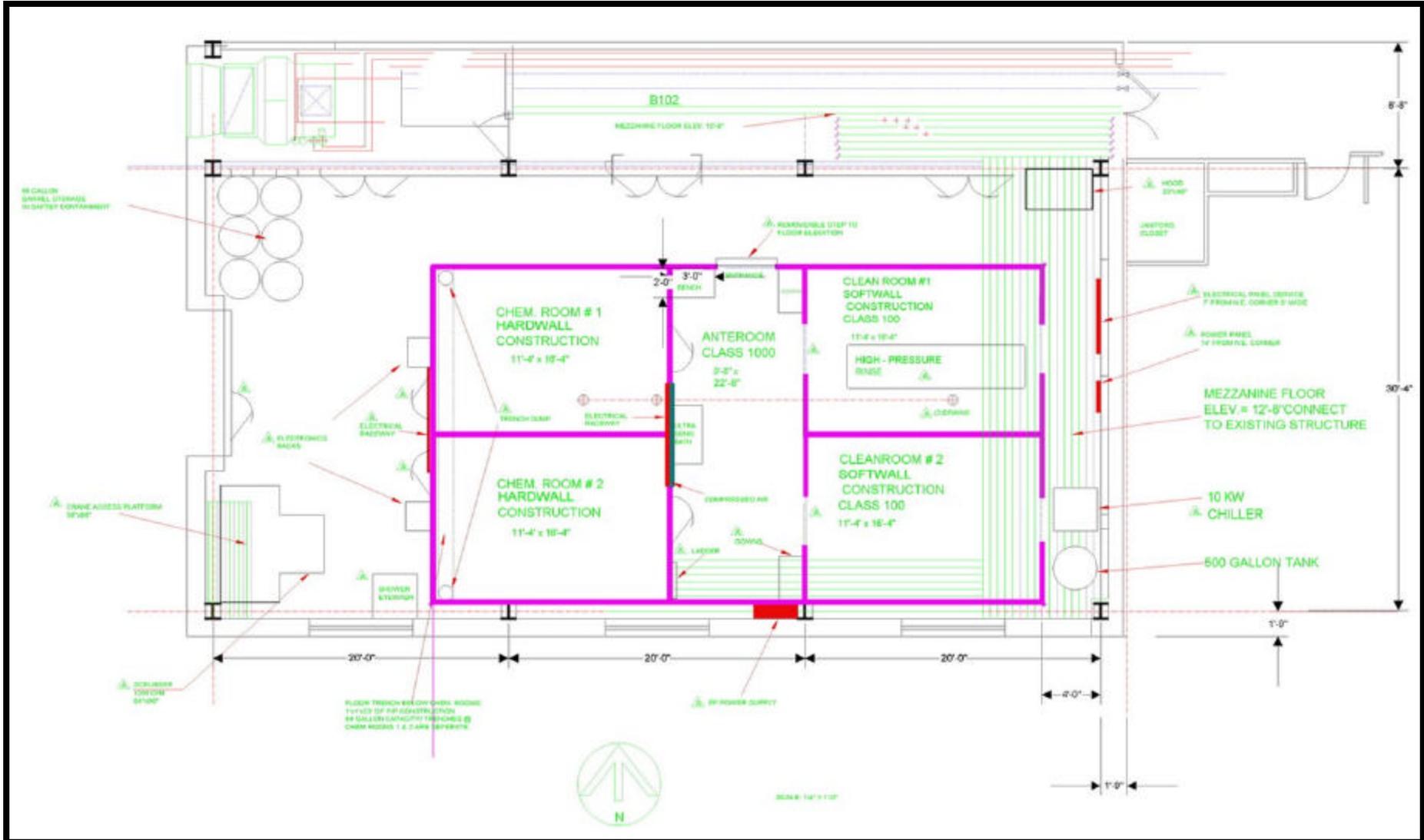
L. Emery

- APS Storage ring can serve as starting point in various technologies
- Use result from superconducting undulator research at APS for setting a design for wigglers
- State of the art orbit stability
- Linux cluster at our disposal to run intensive computer simulations

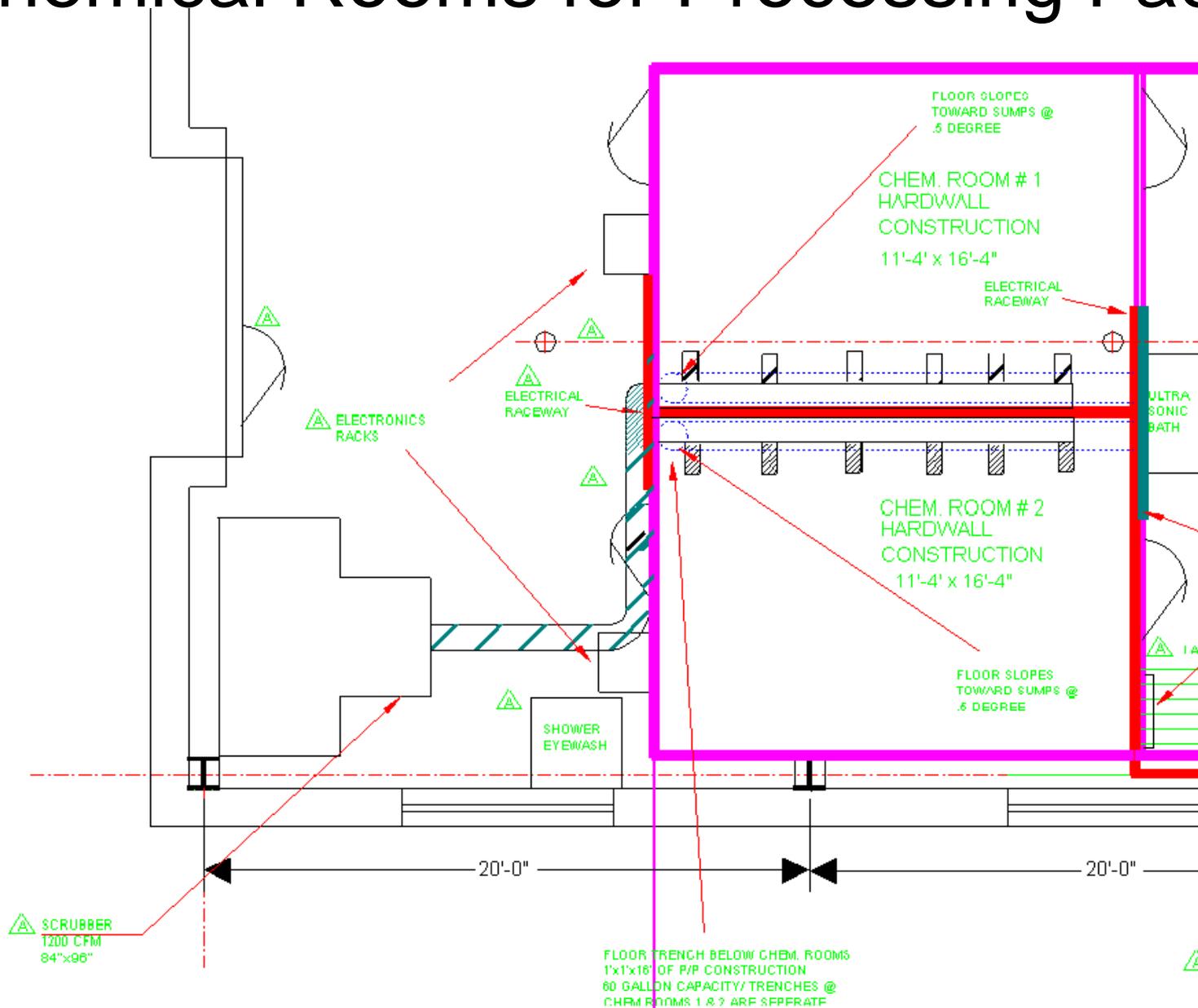
Research Topics

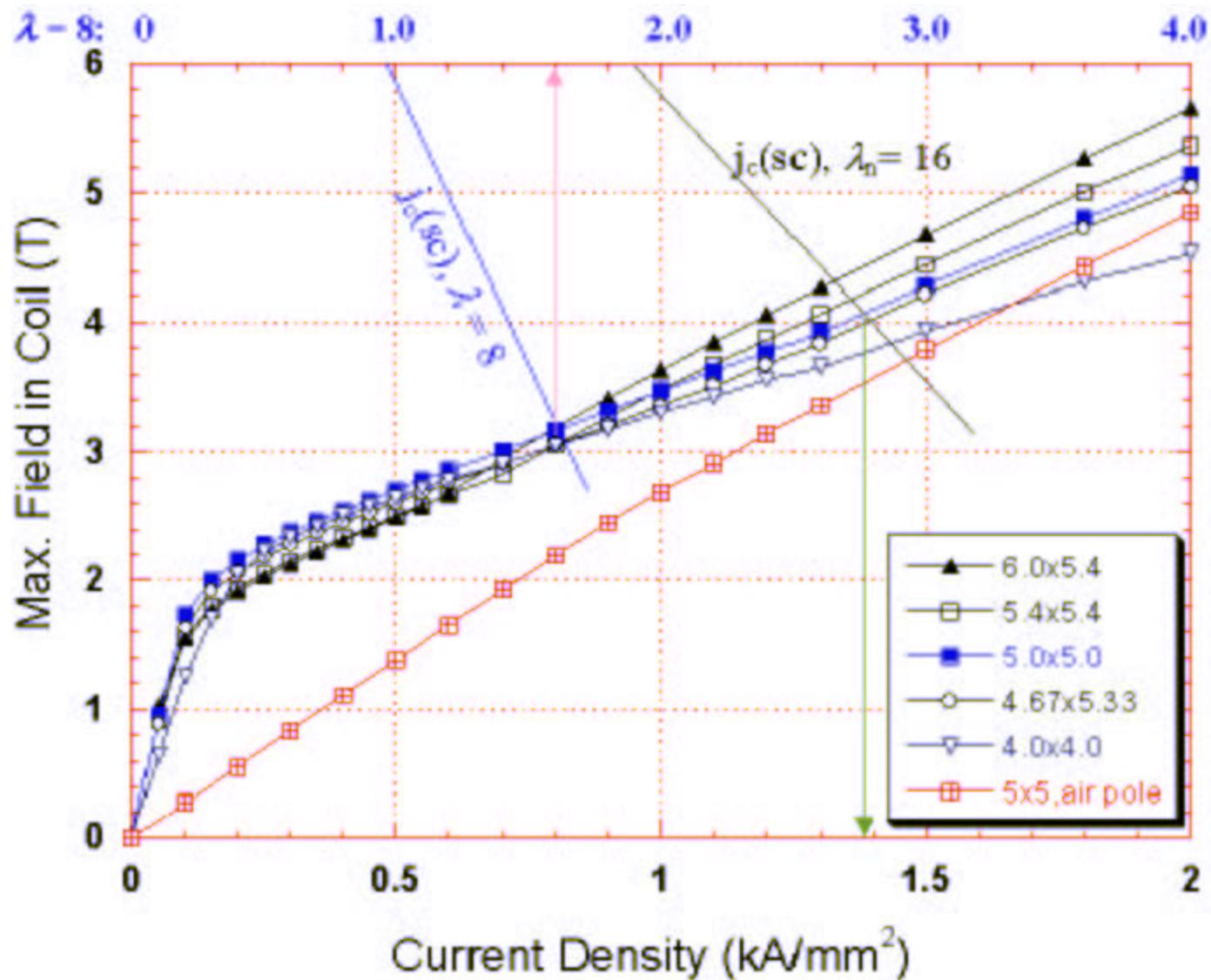
- Arc cell and wiggler optimization
- Study x/y coupling insertion for reducing space charge effects in large ring
- Implement symplectic tracking of wiggler nonlinearity (from Ying Wu, Duke U.) into elegant code
- Simulate fast orbit correction in damping ring with APS-type x-ray beam position monitors (BPMs) to stabilize orbit and extraction trajectory

ANL-FNAL SC Surface Processing Facility



Chemical Rooms for Processing Facility





SC Wiggler Summary

(S.H. Kim)

- Short sample and model measurements confirm that parameters for 15 mm, 0.8 T SCU are achievable
- Remaining R&D items could influence final design, but no show stoppers
- Believe we will have option to go to industry to build to a performance specification or to build to our design with industry fabrication of cryostat and mechanical system by January 2004

The Need for Coordinating Accelerator Research in Chicago Area

- Chicago area has strong accelerator research capabilities spread over ANL, FNAL, and nearby university groups.
- However, advances in basic accelerator physics have been limited since the activities are scattered and usually subordinate to other research programs.
- A coordinated accelerator research program in broad areas of fundamental accelerator physics is necessary to enhance the level of productivity required for major next-generation projects.

Institute for Advanced Accelerator Physics (IAAP)

- Coordination/collaboration of ANL, FNAL, and nearby university groups
- Pursue topics in basic accelerator research not tied to other programmatic missions
- ANL and FNAL provide
 - Accelerators and infrastructure
 - Expertise in accelerator physics and operation
- University groups provide
 - Forefront knowledge in basic science necessary to extend the technology limits
 - Students and other manpower

Topics in Basic Accelerator Physics

- Higher electron beam brightness by a factor >10
 - Sub-angstrom x-ray lasers
- Higher acceleration gradient by a factor >10
 - Multi-TeV collider
 - Material limits, advanced accelerator concepts
- CW accelerators for high-average output
 - Superconducting RF, Increase Q by a factor of 10
- Femtosecond-attosecond timing control
 - Combine with, learn from, laser techniques
- Test accelerators, e.g., LC damping rings

The Laboratory-University Collaboration has Begun in Chicago Area

- ICAR (Illinois Consortium for Accelerator Research) funded by State of Illinois, mainly for muon collider/neutrino factory development with some diversification recently to other areas such as LC and FEL.
- NICADD (Northern Illinois Center for Accelerator and Detector Development) funded by DOE revitalizing the A0 research program.
- **IAAP will build on these successes.**