



... for a brighter future

Plans for Future Beamlines

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X-Ray Science Division

Monthly Users Operations Meeting

January 31, 2007



U.S. Department
of Energy

UChicago ►
Argonne_{LLC}



Pictures from the Summer of 2004



Strategic Planning

Goal:

Strategic planning for most compelling opportunities for the scientific growth areas in the next 5 - 10 years at the Advanced Photon Source

Workshops

- **Future Directions in Synchrotron Environmental Science** (S. Sutton, K. Kemner, S. Kelly)
- **Emerging Areas in Biological Crystallography** (W. Hendrickson, J. Helliwell)
- **Frontier Science Using Soft X-rays** (R. Rosenberg, JC Campuzano)
- **Science with High-Energy X-rays** (D. Haeffner)
- **Membrane Science** (M. Firestone, T. Irving, J. Wang, R. Winans)
- **Emerging Scientific Opportunities Using X-ray Imaging** (F. De Carlo, W.K. Lee, G. Long, S. Stock)
- **Time Domain Science Using X-ray Techniques** (L. Chen, D. Reis, L. Young, S. Milton)
- **Mesosopic and Nanoscopic Science** (S. Sinha, E. Isaacs)
- **Nanomagnetism Using X-ray Techniques** (S. Bader, L.H. Lewis, G. Srajer)

Outcome

Not surprising:

All workshops made compelling cases for dedicated facilities!

Status:

- Summer 2004: Four uncommitted sectors
- Winter 2006: Still four uncommitted sectors

Beyond the Summer of 2004

1. Transition Within \Rightarrow dedicated XOR beamlines:

- High-energy ($E > 50$ keV) beamline: 1-ID
- Imaging beamline: 32-ID
- Powder diffraction: 11-BM

Discussions on:

- Small/wide angle x-ray scattering scattering: 12-ID
- Surface and interface scattering: 12-ID
- *Time-resolved picosecond scattering: 7-ID*
-
-

Beyond the Summer of 2004 - Partnerships

2. Several groups formed partnerships to develop new beamlines:

- Intermediate X-ray Energy Spectroscopy and Scattering
- BioNanoprobe
- Diffraction in High Field
- Fuel Spray and Time-Resolved Imaging (NEW)

Fuel Spray and Time-Resolved Imaging: 7-BM

PI-Jin Wang (APS)

Chris Powell (ANL-Energy Systems)

Scott Parish (General Motors)

Rolf Reitz (University of Wisconsin)

David Hung (Visteon Corporation)

Ming-chai Lai (Wayne State University)

Sol Gruner (Cornell University)

Status:

- Letter of Intent submitted to SAC (last week)

Funding:

- **Commitment by DOE OFCVT for \$850K**

Winter 2006

DOE requested a plan for building out the remaining sectors

- Focus on ID-beamlines

We followed up:

- White paper written
- Distributed to SAC (last week)

Featured Areas

1. Intermediate Energy X-ray Spectroscopy and Scattering

2. BioNanoprobe

3. Diffraction in High Magnetic Field

4. Intermediate Energy X-Ray Magnetism

5. In-Situ Surface and Interface Science

6. Advanced X-Ray Imaging

⇒ High impact science

⇒ Consistent with the XOR Strategic Plan

⇒ Compatible with ERL Upgrade

Intermediate Energy X-Ray (IEX) Spectroscopy and Scattering

PI: Juan Carlos Campuzano (University of Illinois Chicago)

Co-PIs: Peter Abbamonte (University of Illinois Urbana Champaign)

James Allen (University of Michigan)

Richard Rosenberg (APS)

Status:

- Letter of Intent submitted and approved by SAC
- Full proposal peer reviewed
- Recommendation to proceed and seek funding

October 2006: Proposal submitted to NSF 04-23

Funds requested: \$4.97M for beamline only

BioNanoprobe

PI: Gayle Woloschak (Northwestern University)

Co-PIs: Peter A. Lay (University of Sydney, Australia)

James E. Penner-Hahn (University of Michigan)

Thomas V. O'Halloran (Northwestern University)

Stefan Vogt, Barry Lai (APS) and Jörg Maser (APS/CNM)

Status:

- Letter of Intent submitted and approved by SAC
- Full proposal peer reviewed
- Recommendation to proceed and seek funding

May 2006: Letter of Intent submitted to NIH-NIBIB

(recommended by NCRR)

Response: Submit a full proposal to NIH-NIGMS; Waiting...

Diffraction in High Field

PI: Valery Kiryukhin (Rutgers University)

Co-PIs: Young S. Lee (Massachusetts Institute of Technology)

Bruce Gaulin (McMaster University)

Greg Boebinger (National High Magnetic Field Laboratory)

Mark Bird (National High Magnetic Field Laboratory)

Tom Rosenbaum (University of Chicago)

Zahir Islam and Jonathan Lang (APS)

Status:

- Letter of Intent submitted and approved by SAC
- Full proposal to be submitted
- Proceeded to seek funding for the high field magnet design

October 2006: Proposal submitted to NSF 05-513 (IMR-MIP)*

Funds requested: \$2.85M for conceptual and engineering design

***To be co-reviewed by DOE-BES**

Other Beamlines - Evolving Partnerships - Magnetism

4. Intermediate Energy X-Ray Magnetism

William Bailey - Columbia University

Jacques Tchakhalian - University of Arkansas

Scott Chambers - Pacific Northwest National Laboratory

Bernhard Keimer - Max Planck Institute

Peter Schiffer - Penn State University

David Keavney, John Freeland, Richard Rosenberg (APS)

Other Beamlines - Evolving Partnerships - Surface & Interface

5. In-Situ Surface and Interface Science

Darryl Schlom (Penn State University)

Michael Bedzyk (Northwestern University)

Tai Chiang (University of Illinois Urbana Champaign)

Karl Ludwig (Boston University)

Paul Miceli (University of Missouri)

Paul Zschack (APS)

Paul Fenter, Paul Fuoss, Brian Stephenson (ANL)

Other Beamlines - Evolving Partnerships - Advanced Imaging

6. Advanced X-ray Imaging

Stewart Stock (Northwestern University Medical School)

Mark Westneat (Field Museum of Chicago)

Jon Harrison (Arizona State University)

Melina Hale (University of Chicago)

Julian Solway (University of Chicago Hospitals)

Qun Shen, Ian McNulty, Kamel Fezzaa, Wah Keat Lee (APS)

Status Summary

	Letter of Intent	Full Proposal	Seek Non-DOE-Funding
Intermediate Energy	√	√	√
Bio Nanoprobe	√	√	√
Diffraction in High Field	√		√
Magnetism			
Surface and Interface			
Advanced Imaging			

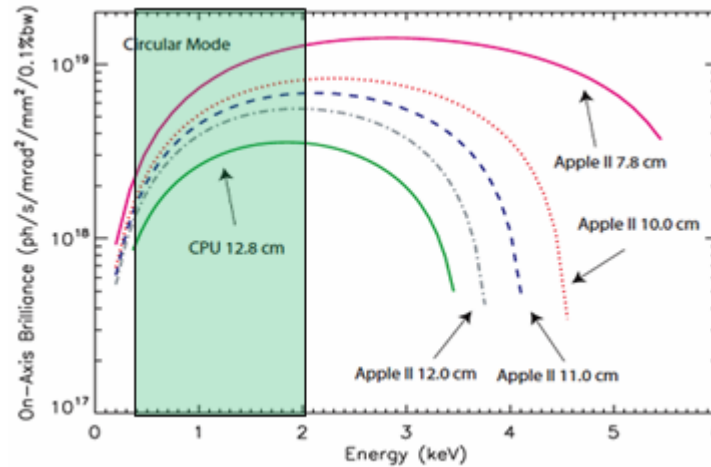
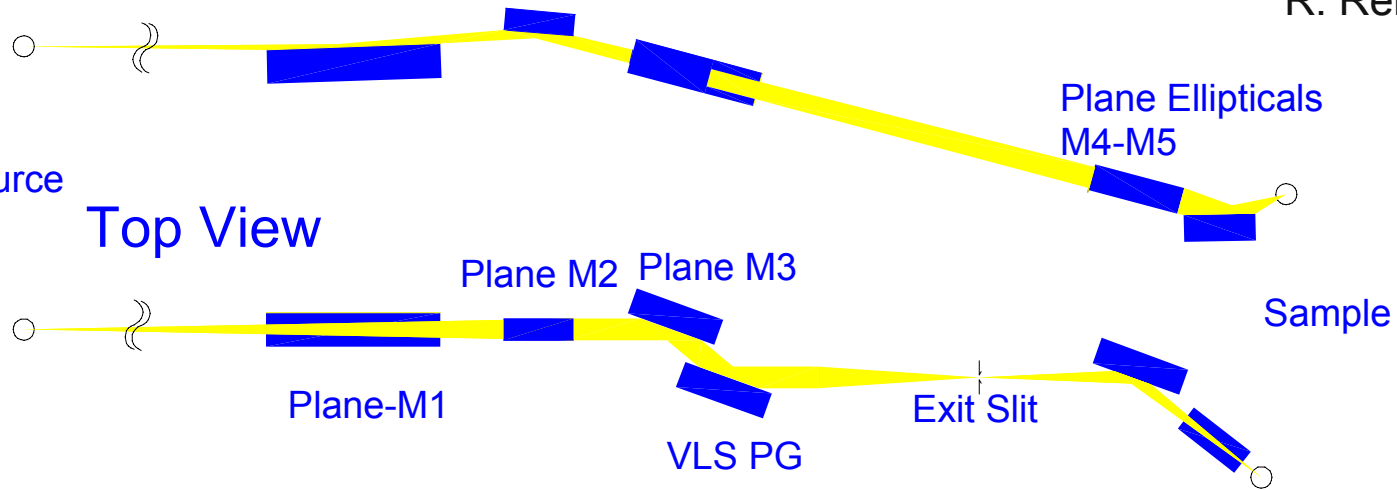
IEX Proposed Beamline - Optics Layout*

Side View

*R. Reininger

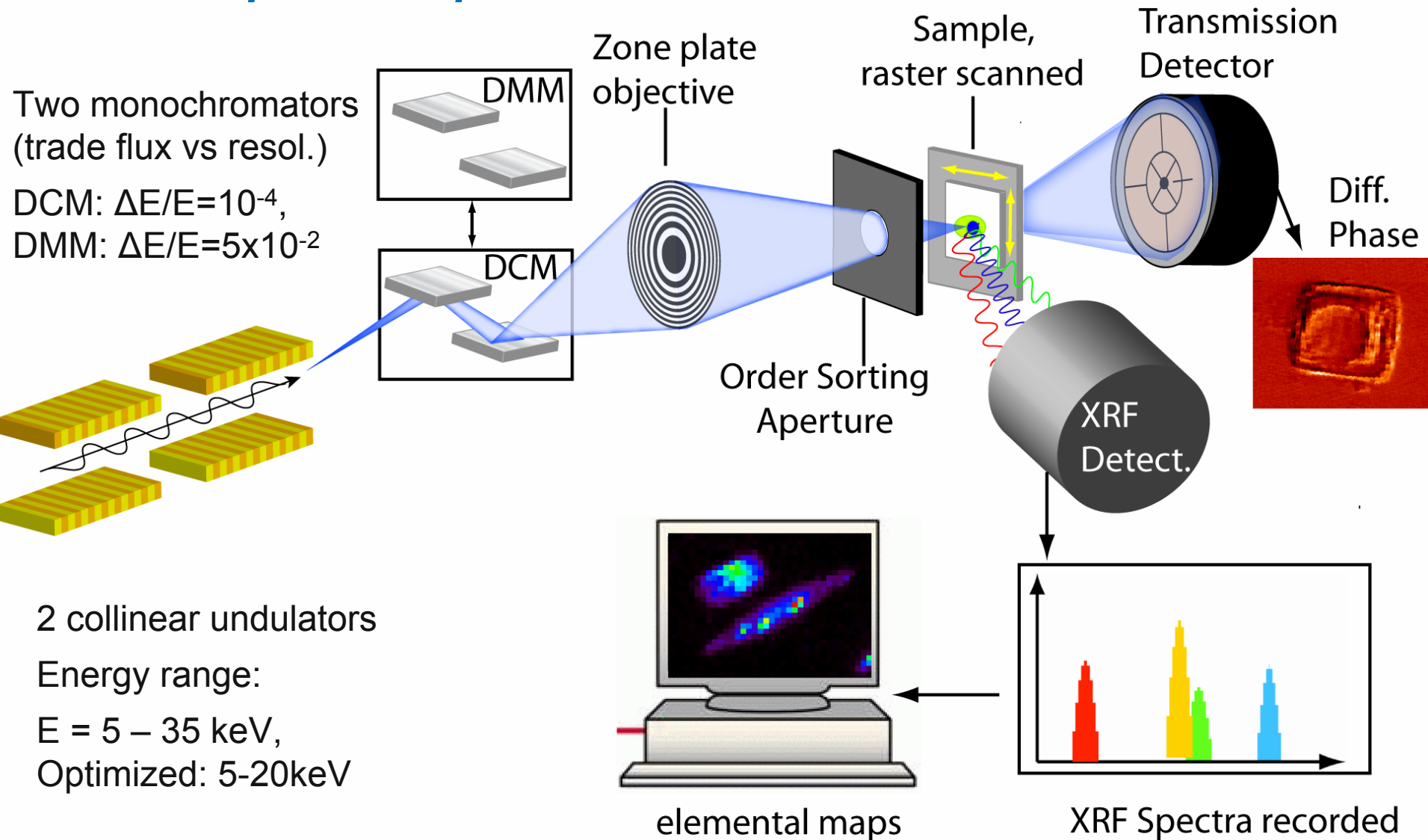
Source

Top View



R. Dejus

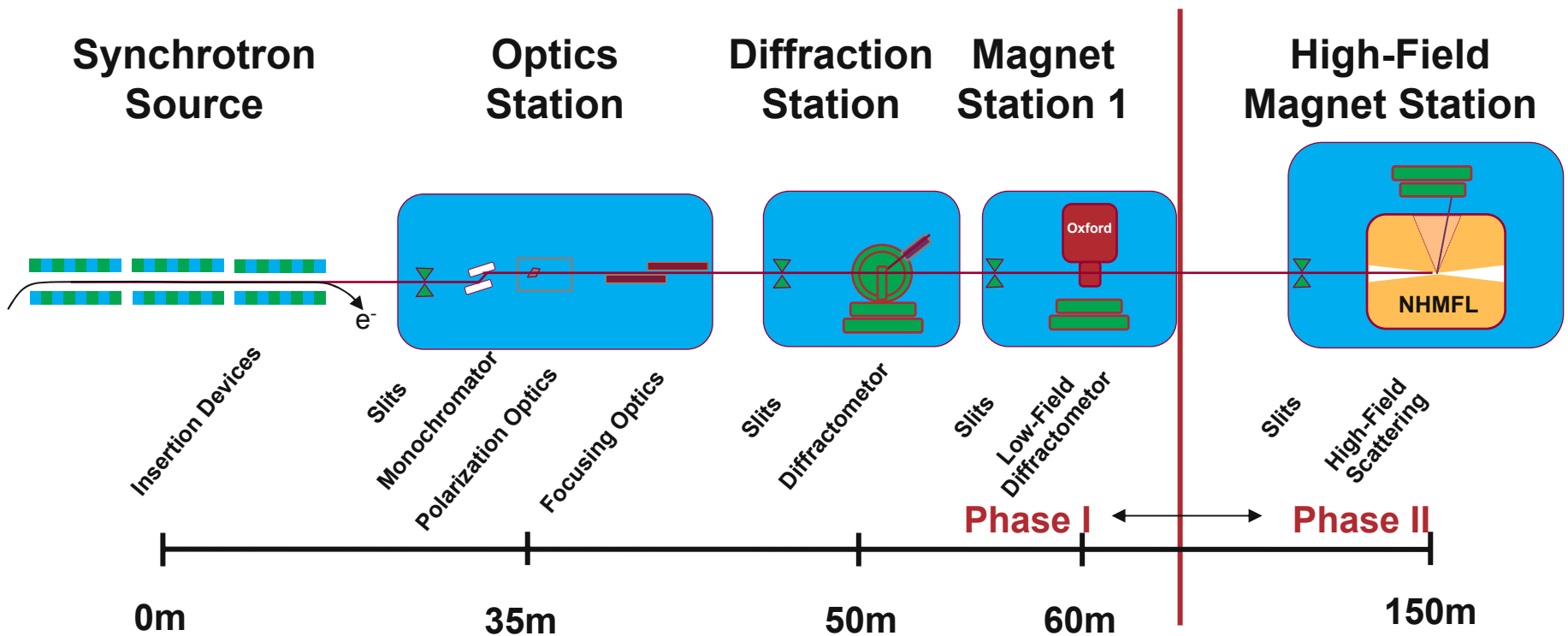
BioNanoprobe Proposed Beamline



Spatial resolution: Mapping: $\delta=20$ nm; Spectroscopy: $\delta=50$ nm; In vacuum, cryo-system

S. Vogt

Diffraction in High Field Proposed Beamline



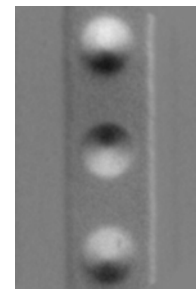
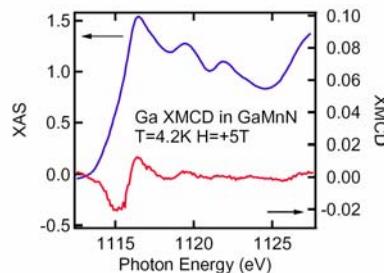
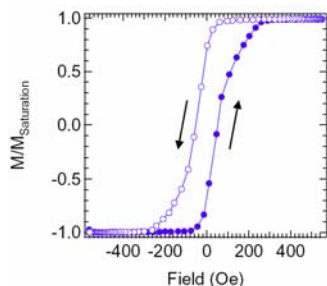
Unique sample environment → maximize beamline flexibility

- Maximize intensity on sample (flux limited)
- Large energy range
 - Multiple IDs (5x intensity @10keV, 20x intensity@50keV)
- Adjustable focusing
- Polarization control

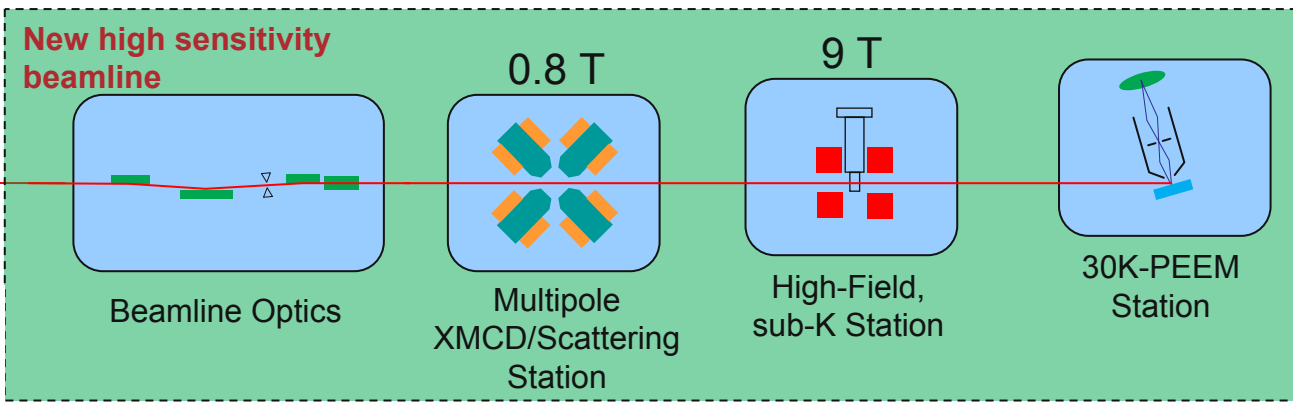
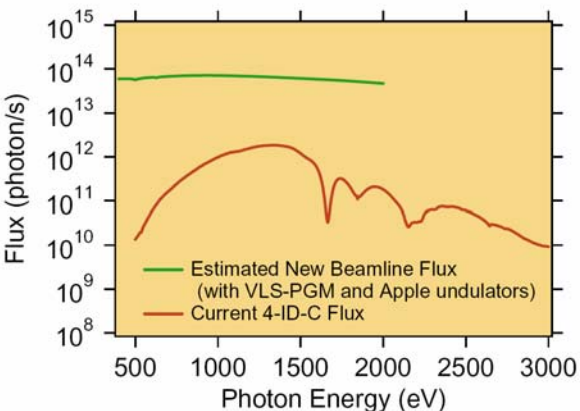
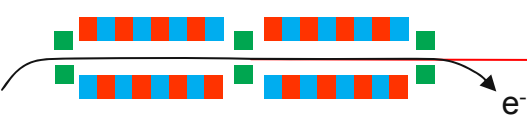
Z. Islam and J. Lang

Intermediate Energy Magnetism Proposed Beamline

- Dual Apple undulators on 8m straight with Varied Line Spacing Plane Grating:
 - High flux from 400-2000 eV
 - Fast polarization switching
 - Upgraded instrumentation



Fast-switching
helical
undulators

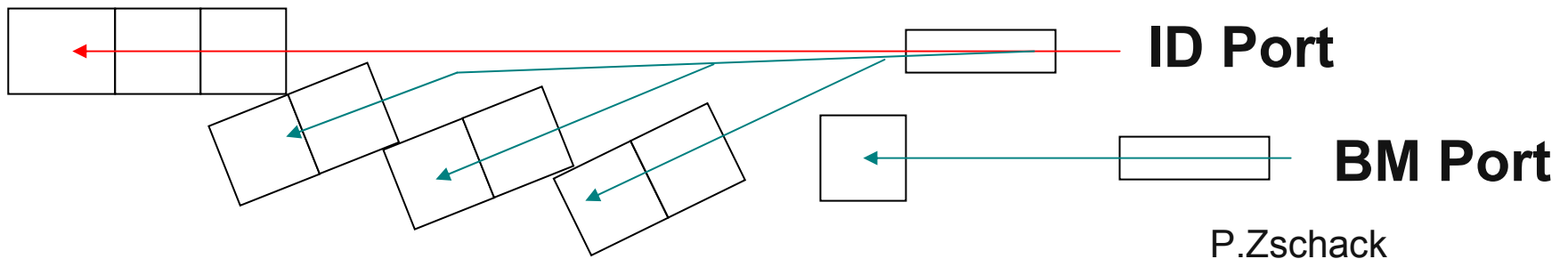
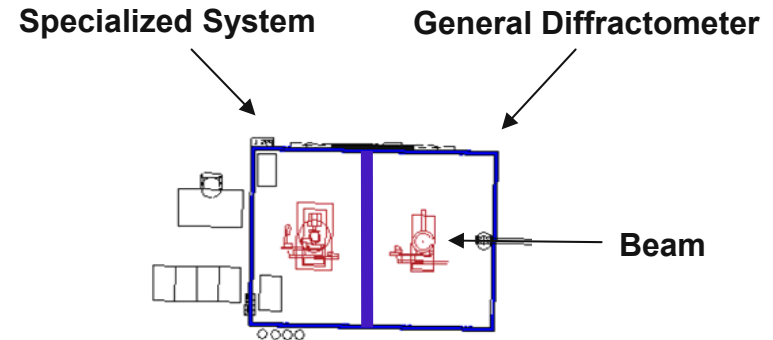
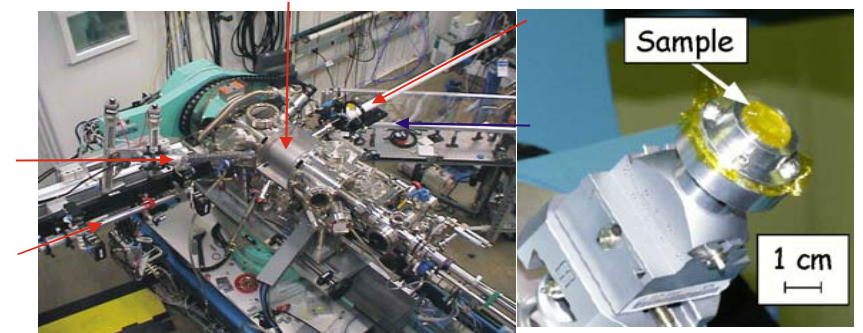


- Estimated 2-3 orders of magnitude more flux
- Lock-in detection

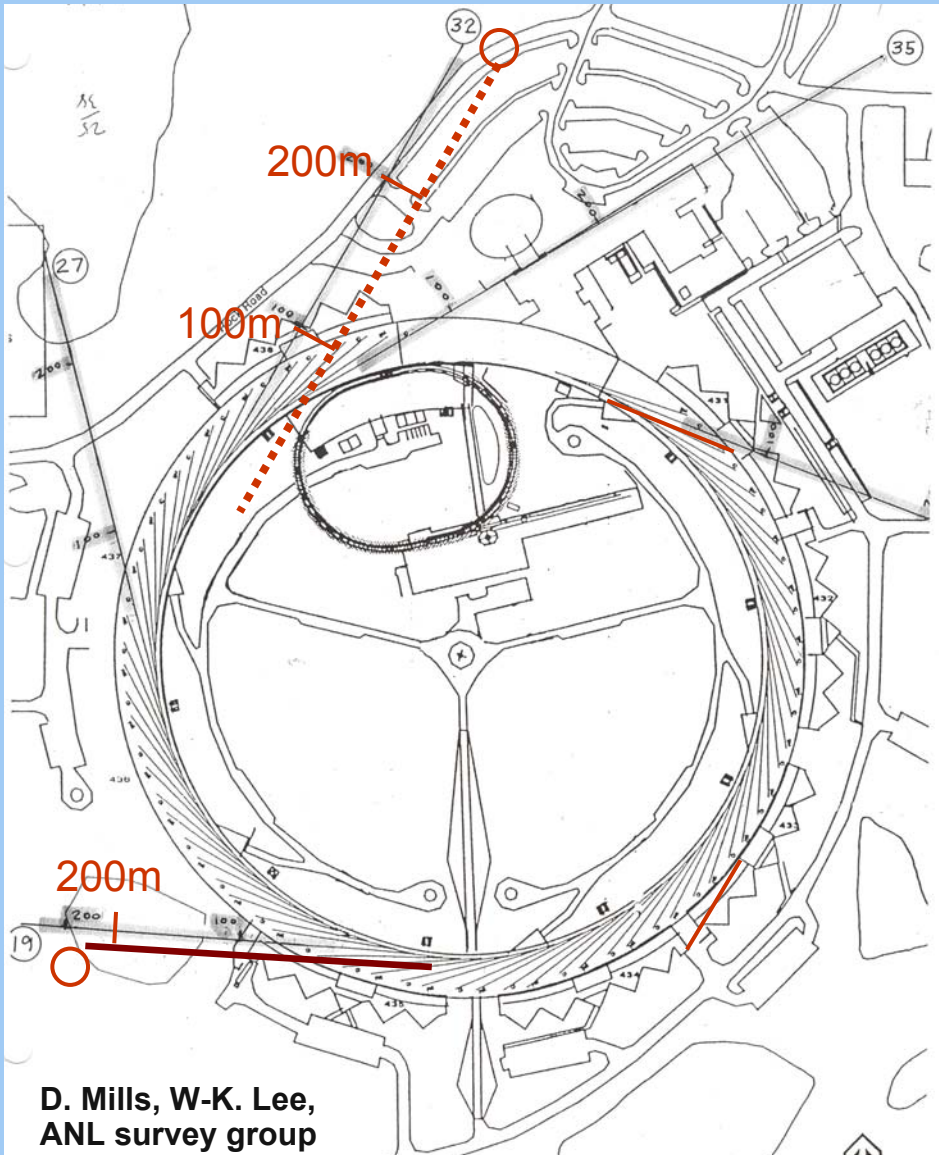
D. Keavney

In-Situ Surface and Interface Scattering Proposed Sector

- Dual-canted Undulator ID beam line
 - One fully tunable branch beam line
 - One fixed-energy branch
- One BM line (diffraction)
- 10 experimental stations
- 5 simultaneous x-ray experiments
- Specialized end-stations available off-line
- Environmental cells attach to general diffractometers



Advanced Imaging Beamline: Possible Locations



Techniques:

- Phase imaging / tomography
- Diffraction topography
- Diffraction enhanced/USAXS imaging
- Coherent Fresnel diffraction

Q. Shen

Summary

- **White paper distributed to SAC (last week)**
 - Science drivers
 - List of team members
 - Cost estimate
- **Proceed with APS approval process for each beamline**
- **In parallel, send a proposal to DOE**

Total request \$58M includes front ends and undulators