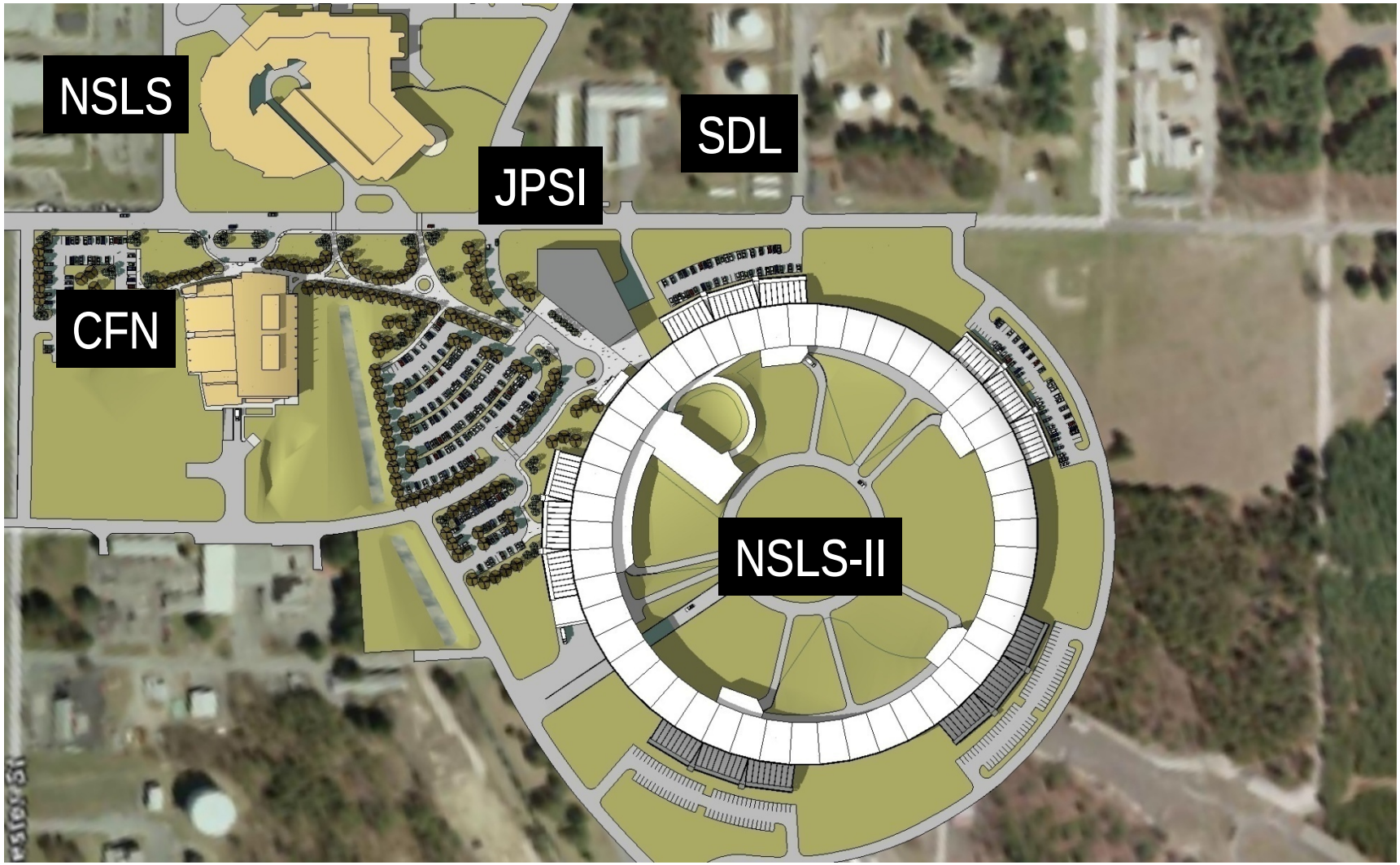
NSLS Introduction and HBCU initiative



Chi-Chang Kao
National Synchrotron Light Source
Brookhaven National Laboratory

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NSLS Today

VUV Storage Ring:

51 m circumference

E = 0.808 GeV

I= 1.0 A

7 bunches

Orbital Period = 170 ns

Pulse Width = 320 ps

X-Ray Storage Ring:

170 m circumference

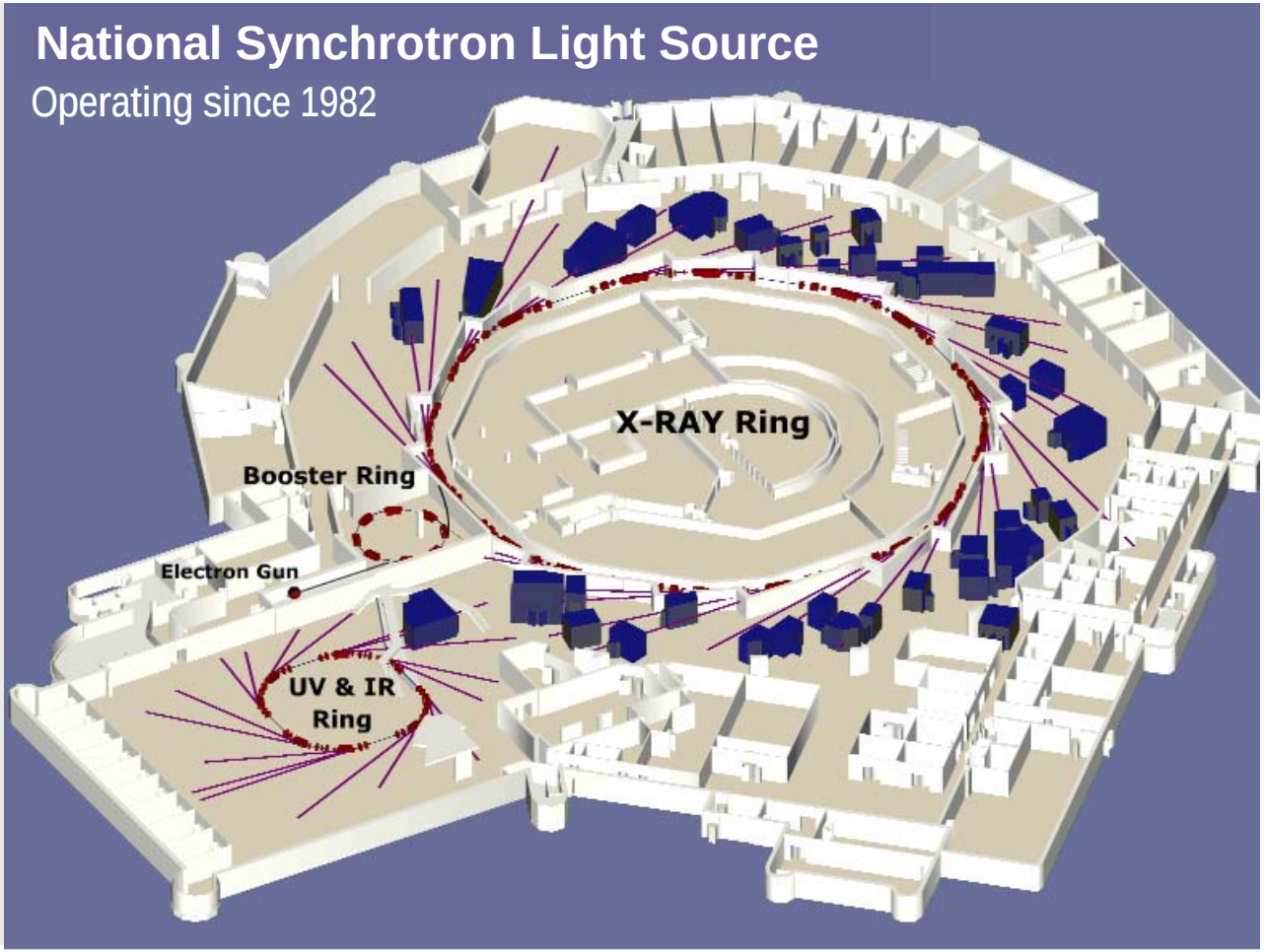
E = 2.8 GeV

I = 280 mA

25 bunches

Orbital Period = 567 ns

Pulse Width = 290 ps



- 65 operational beamlines which support ~2200 users annually

Distribution of Operating Instruments

- **Macromolecular Crystallography**
  X3A, X4A, X4C, **X6A**, X8C, X12B, X12C, **X25**, X26C, X29, X28C

- **Imaging and Microprobes**
  U2B, **U10B**, X1A1, X1A2, X2B, **X13B**, **X15A**, X26A, **X27A**

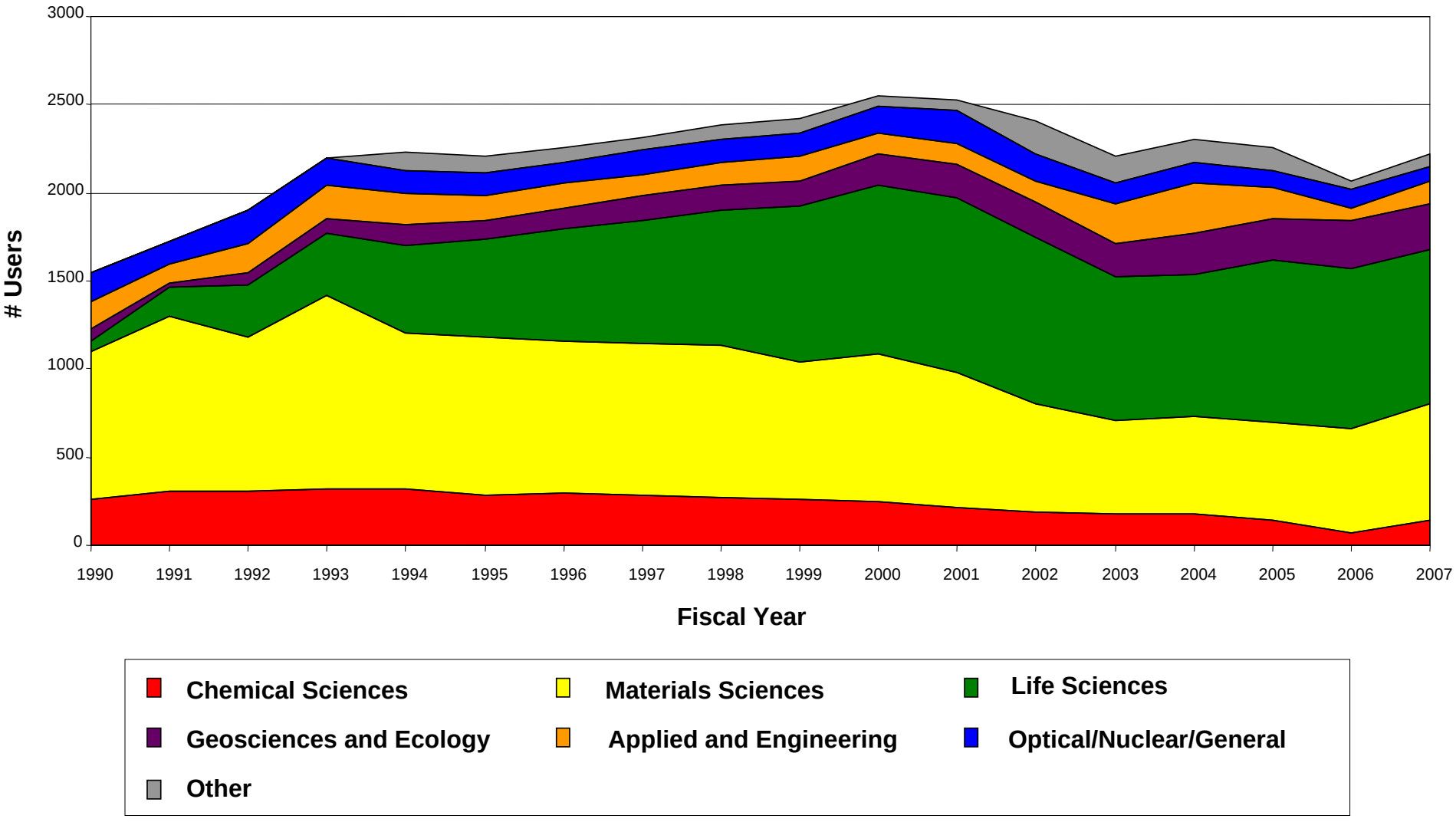
- **X-Ray Scattering & Diffraction**
  X1B, **X6B**, **X9**, X10A, X10B, **X13A**, X20A, X20C, **X21**, X22A, X22B, X22C, X27C

- **Powder/Single Crystal Diffraction & High Pressure**
  U2A, X7B, X14A, X16C, **X17B1**, **X17B2**, **X17B3**, **X17C**, X18A, X19C

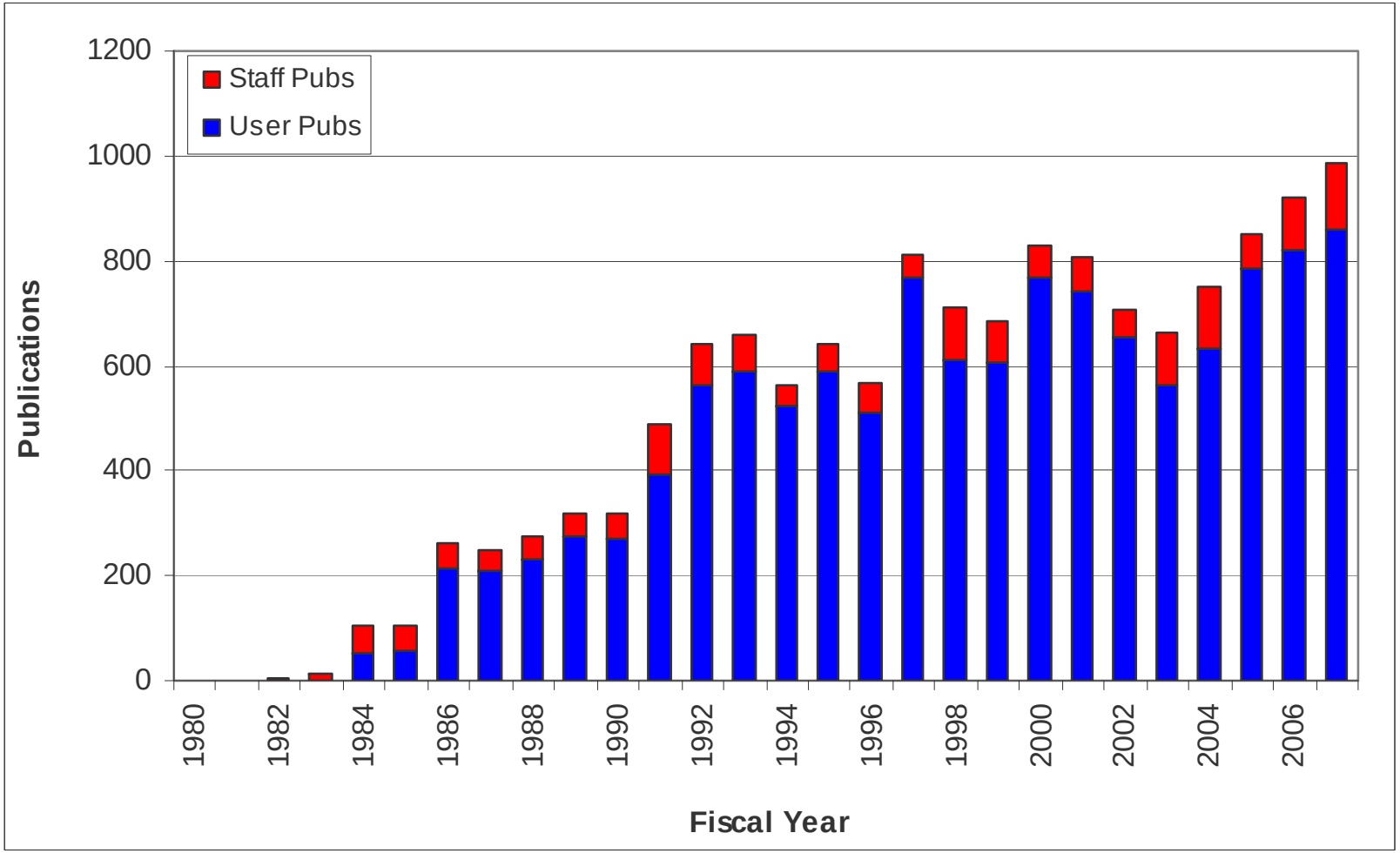
- **X-ray Spectroscopy**
  X3B, X10C, X11A, X11B, X15B, **X18B**, **X19A**, X23A2, X23B, X24A, X27B

- **IR, VUV and Soft X-ray Spectroscopy**
  U1A, U3C, U4A, **U4B**, **U5UA**, U7A, U9B, U11, U12A, **U12IR**, U13UB, X8A, X24C

NSLS User Trend



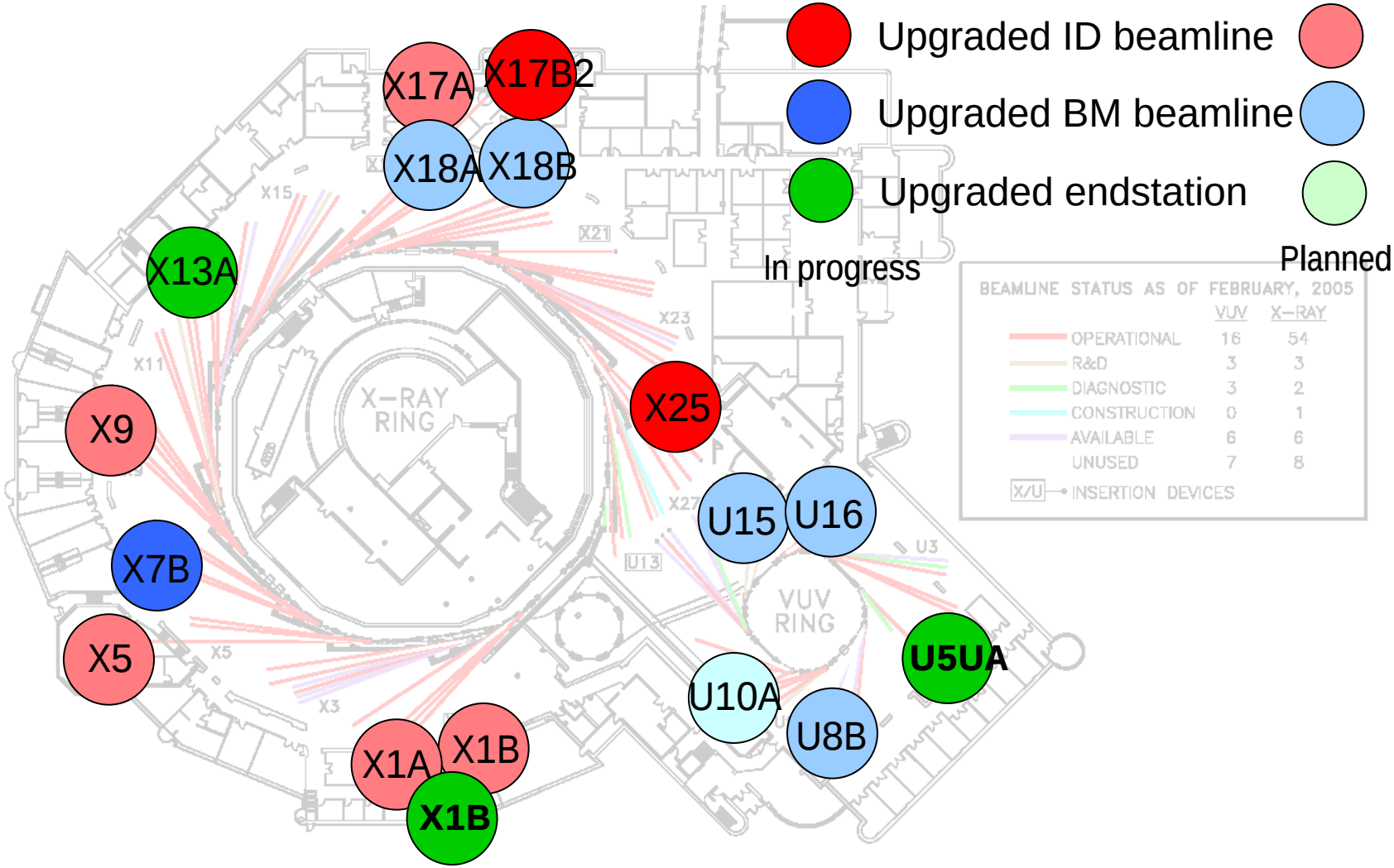
Publications



- Premier* publications represent (Impact factor > 6) ~25% of total pubs
- Staff publications represent ~10% of total NSLS publications

Selected Scientific Highlights

Strategic Plan Guides Scientific Program Development and Beamline Upgrade



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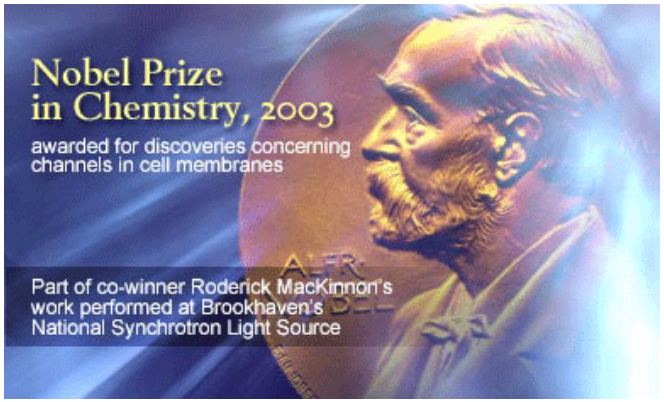
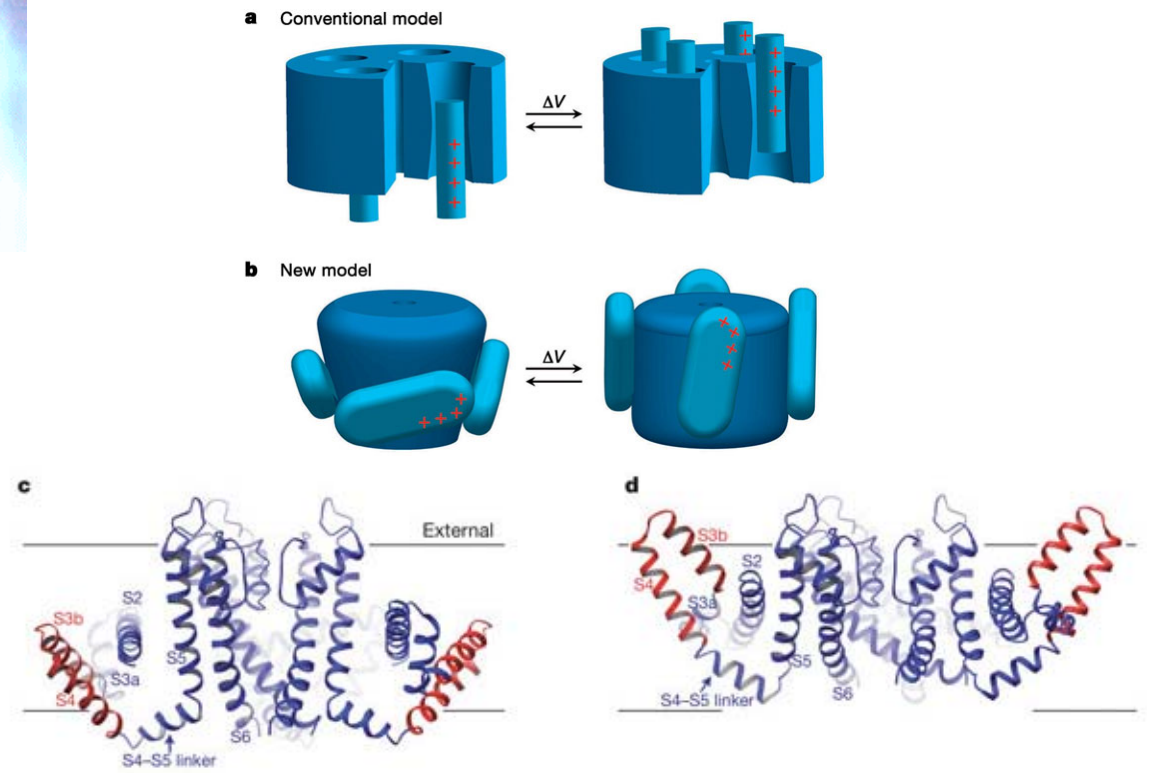
Structural Biology – Macromolecular Crystallography

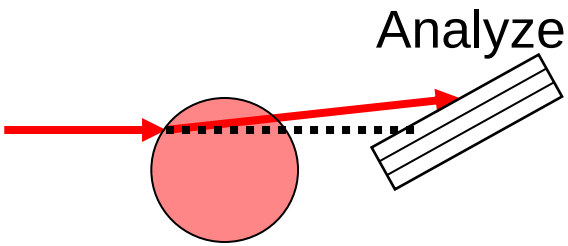


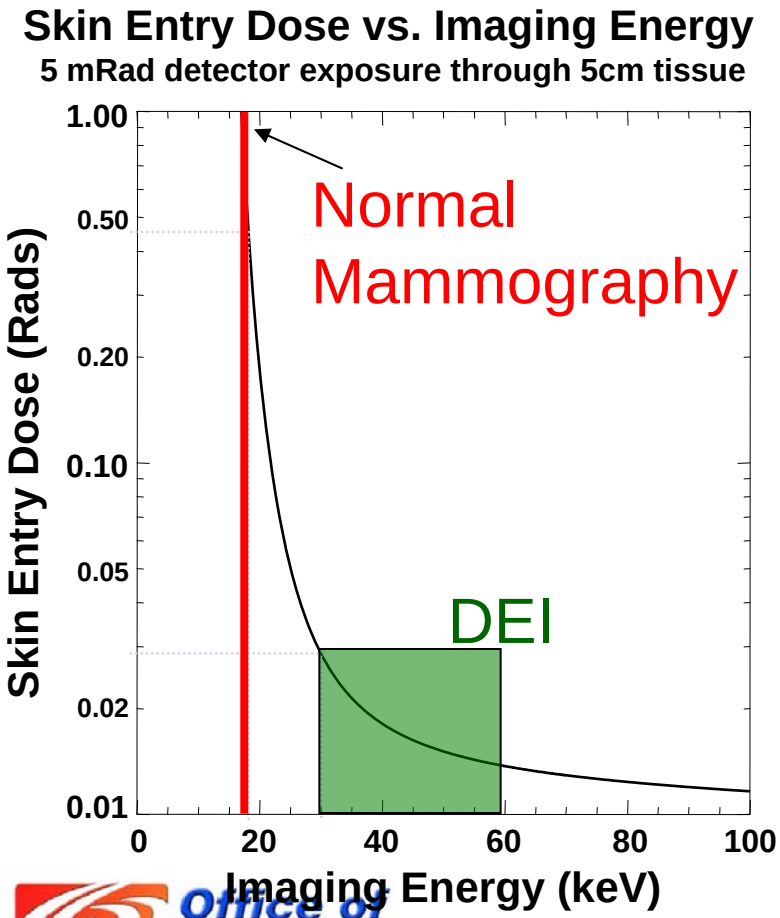
MacKinnon

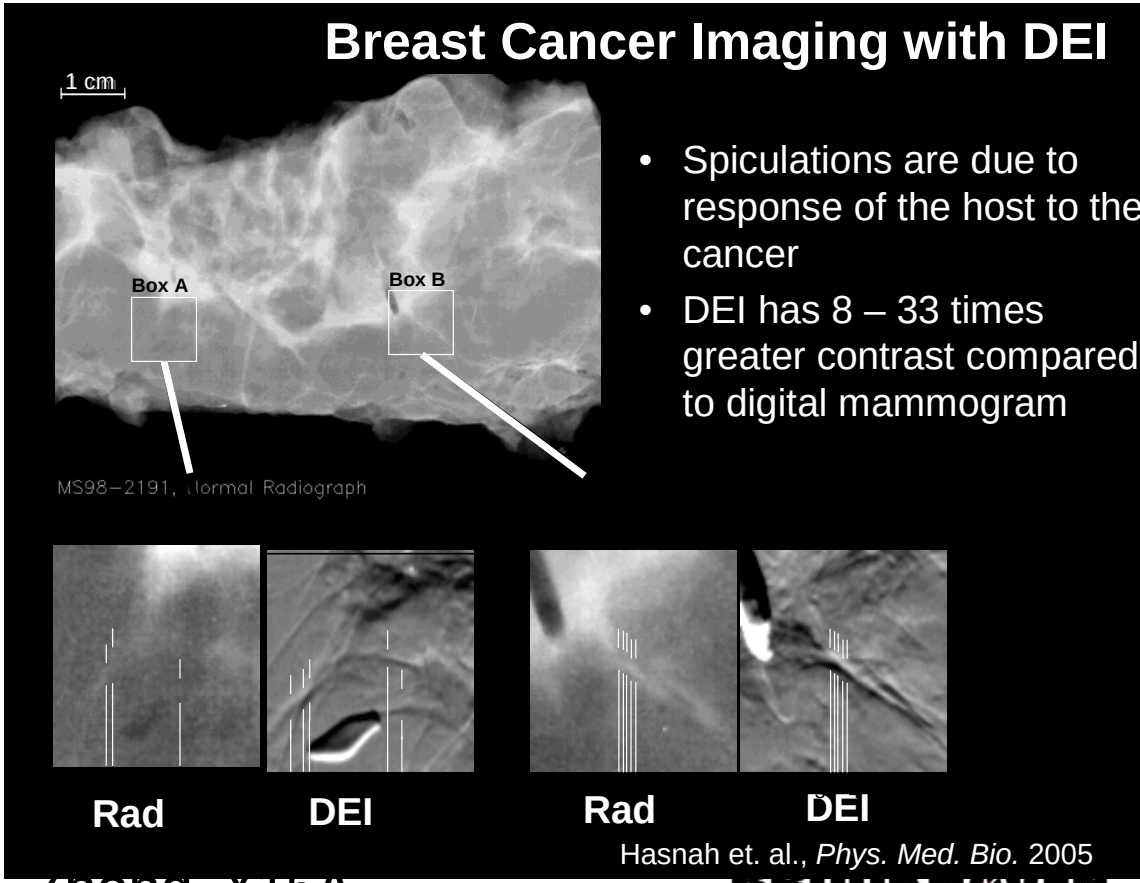


Medical Imaging – Diffraction Enhanced Imaging

Refraction contrast

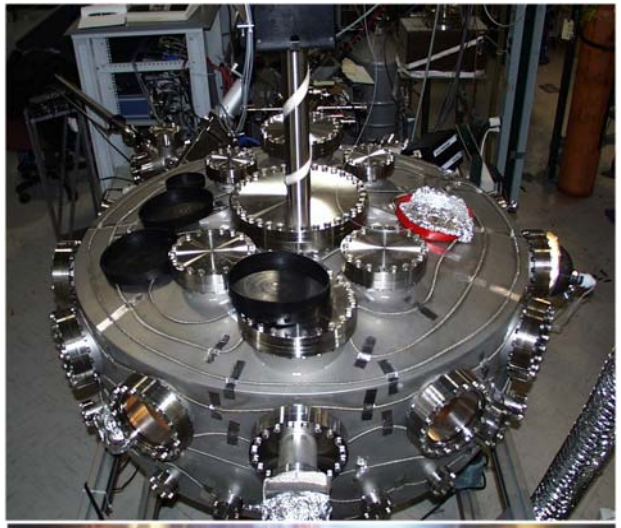


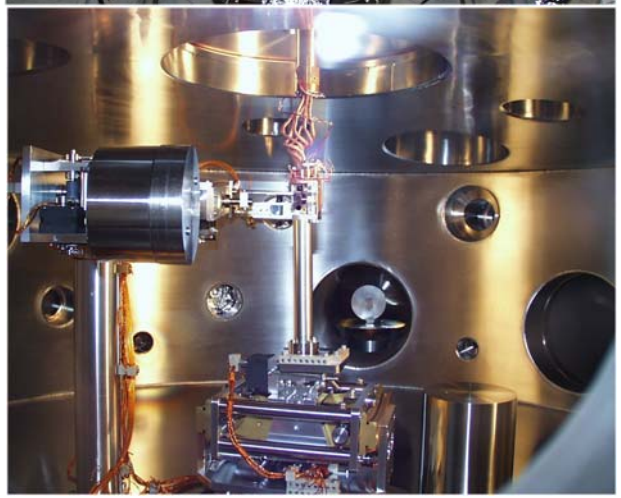


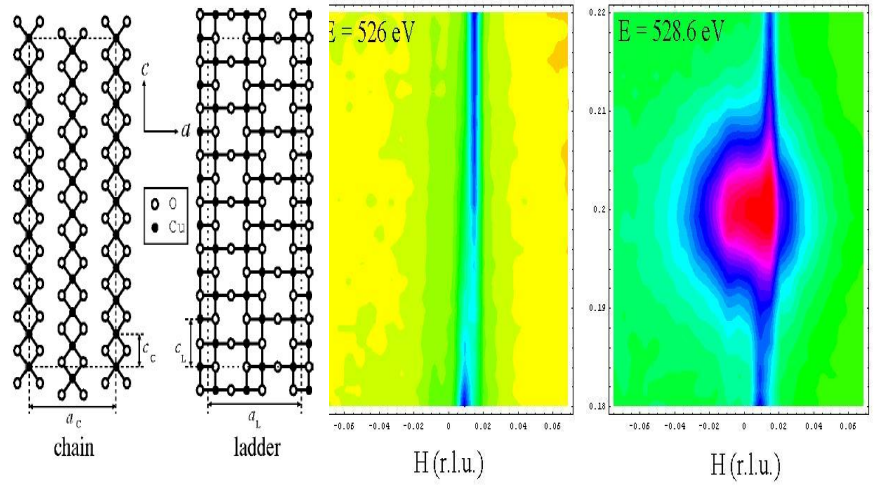


Zhong, X15A

Condensed Matter Physics: Resonant X-ray Scattering



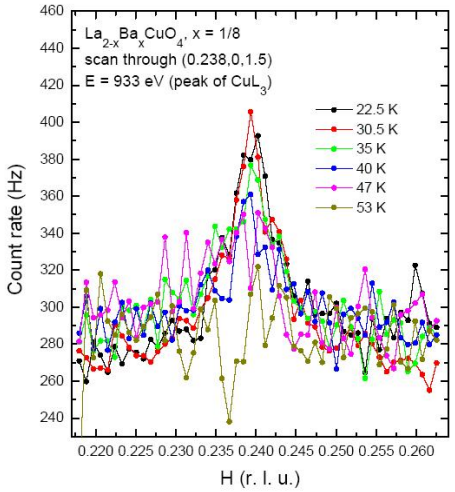




$Sr_{14-x}Ca_xCu_{24}O_{41}$ Abbamonte et al, Nature (2004)

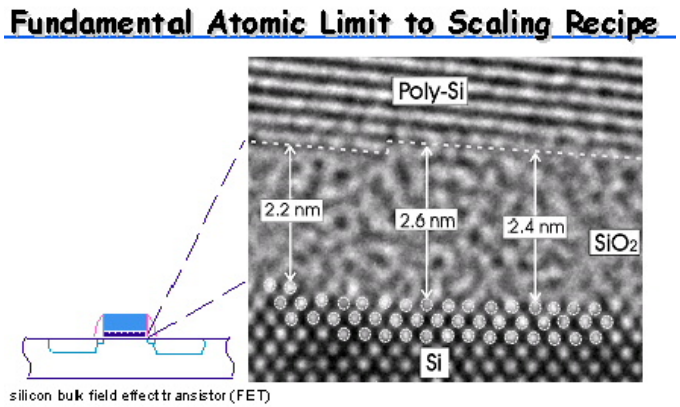
Direct observation of charge stripes

Nature-Material(2006)

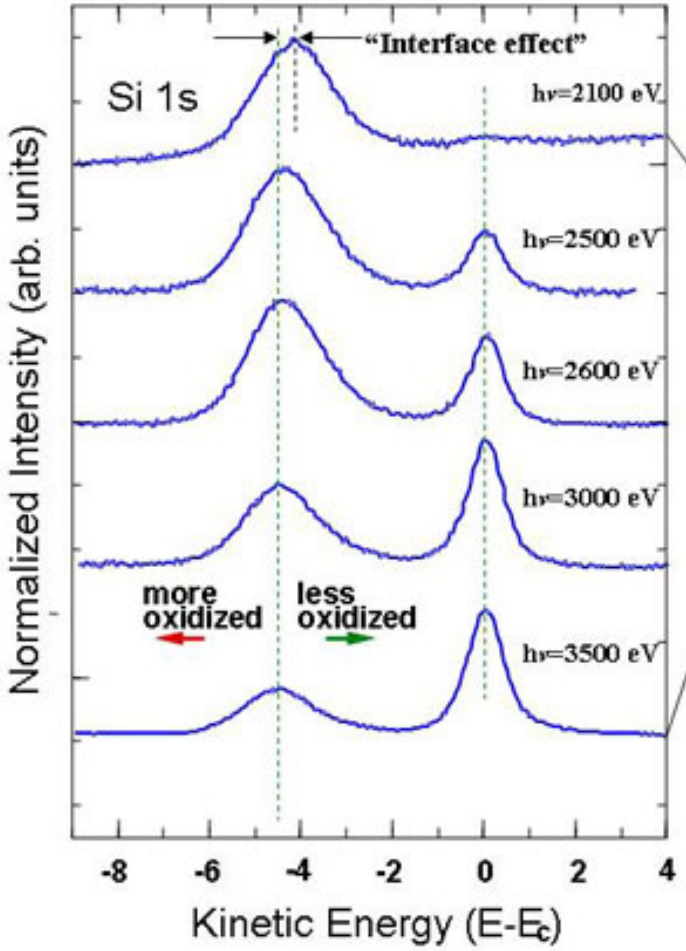


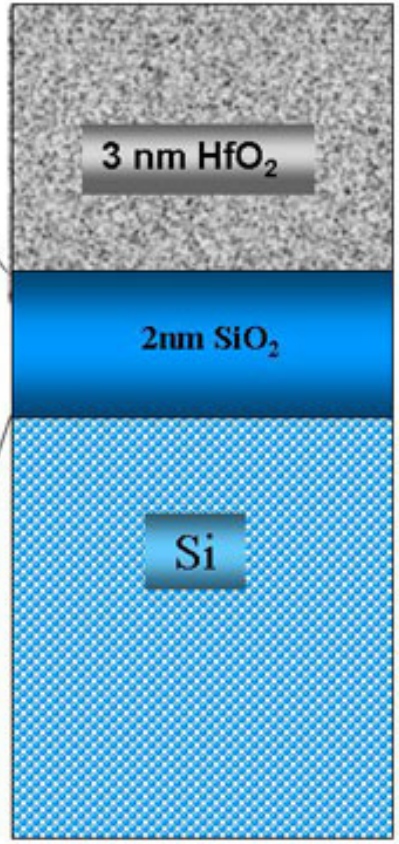
High K dielectric in metal-oxide field-effect transistor

Variable High Energy Photoemission: Probing buried interfaces



- High leakage current for <2nm SiO2
- Hf based oxides are promising, but not good enough
- Modifying of Hf oxides thin film to optimize their properties





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Patrick S. Lysaght SEMATECH
Joseph C. Woicik and Daniel A. Fischer NIST (JAP)

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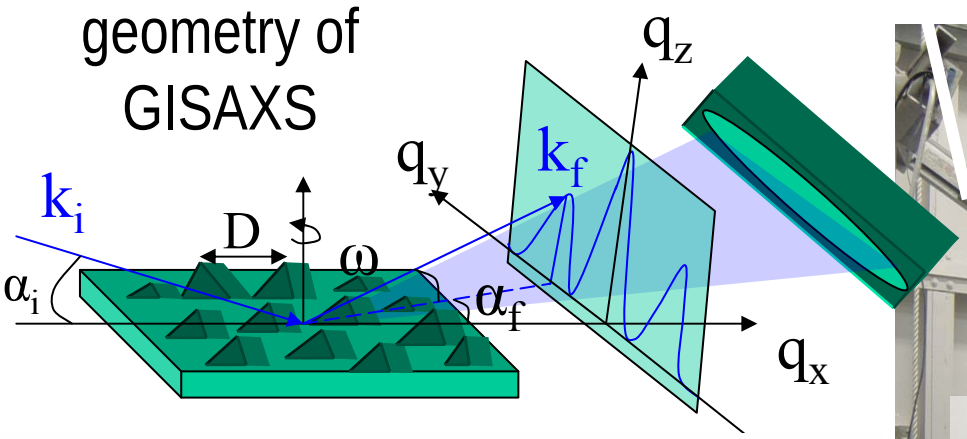
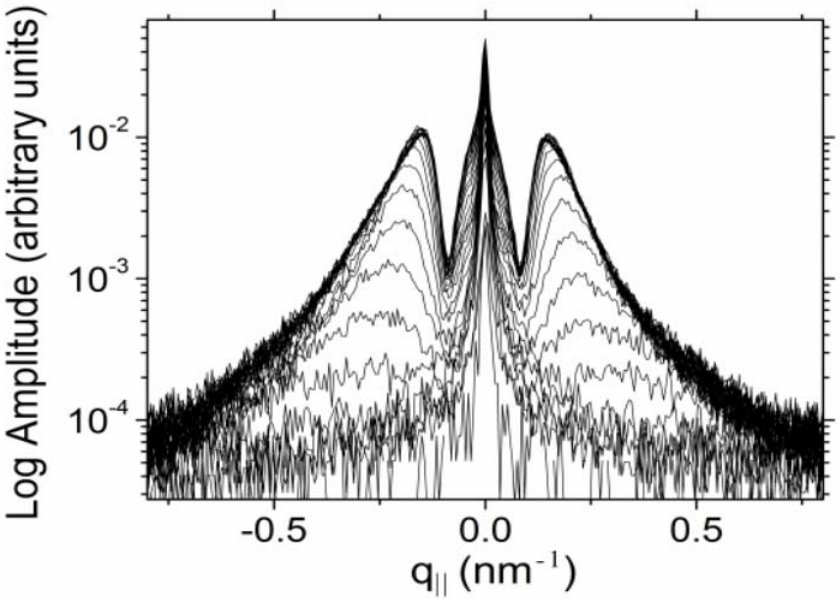
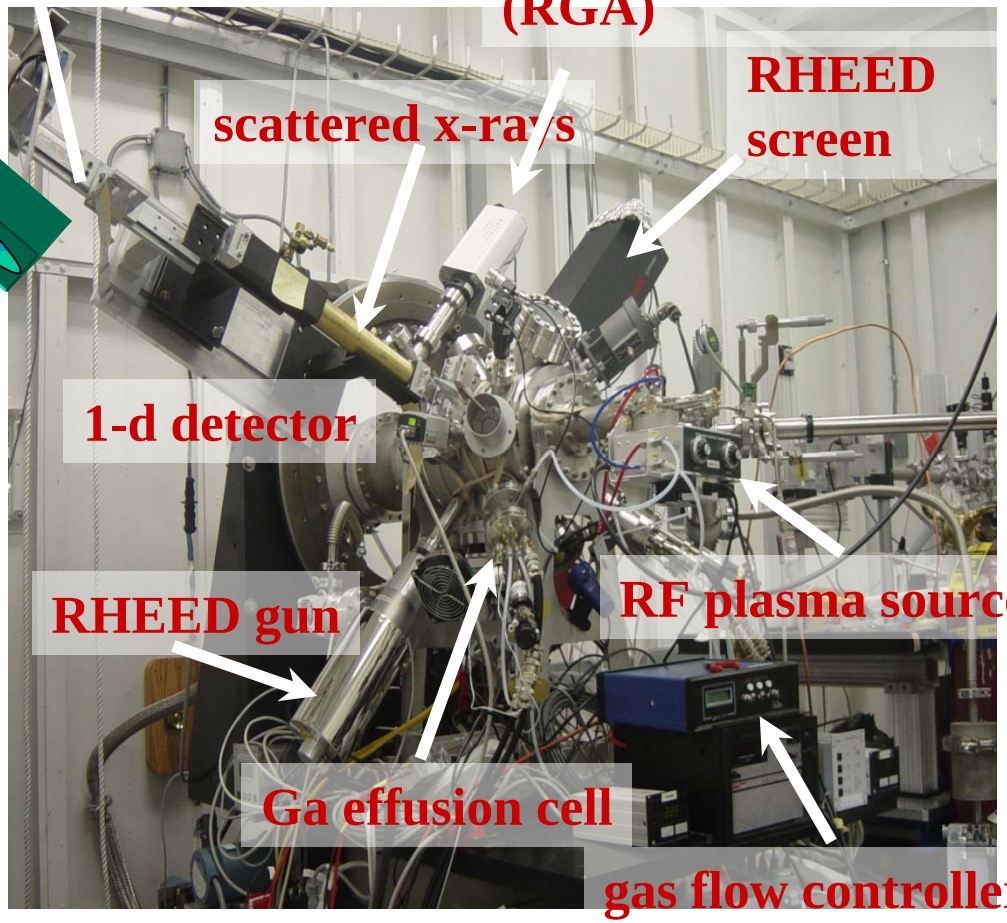
Materials Sciences: Real-time X-ray Scattering

Scattering geometry of GISAXS





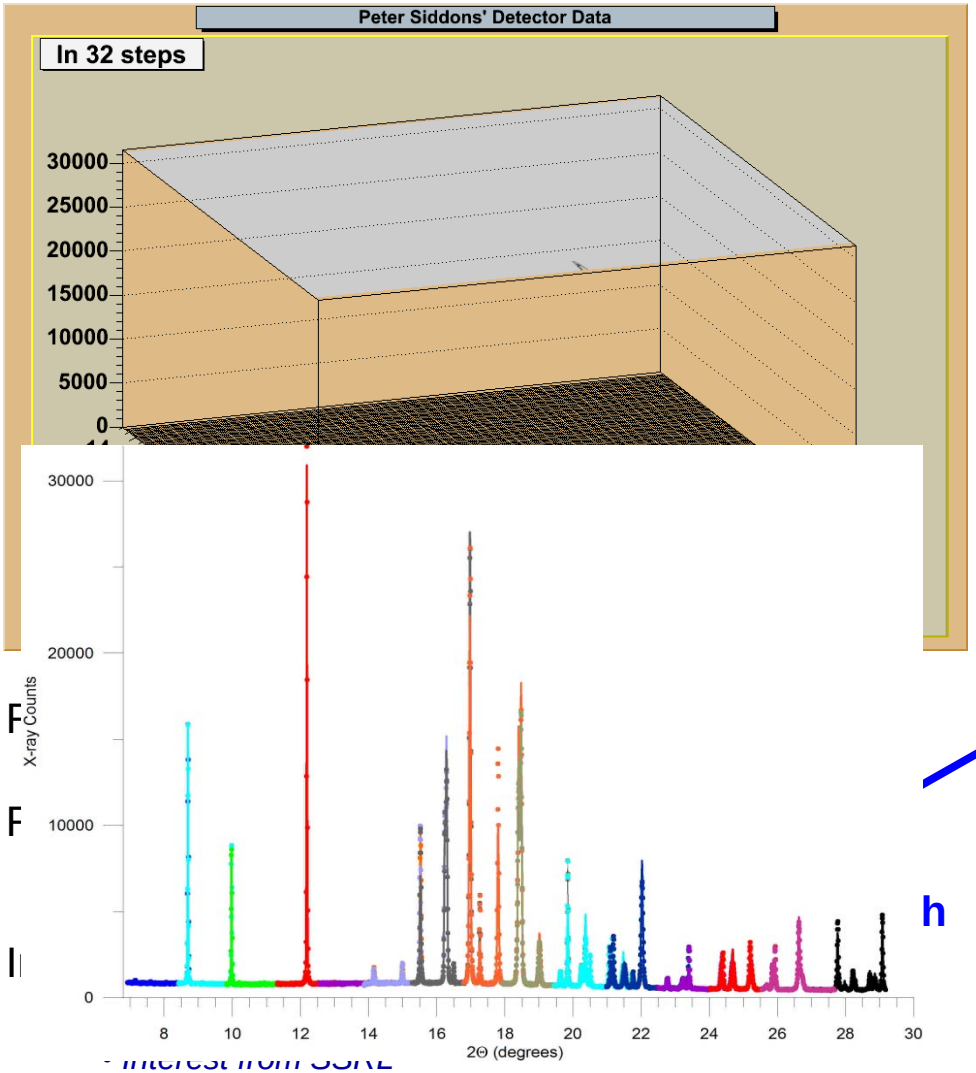


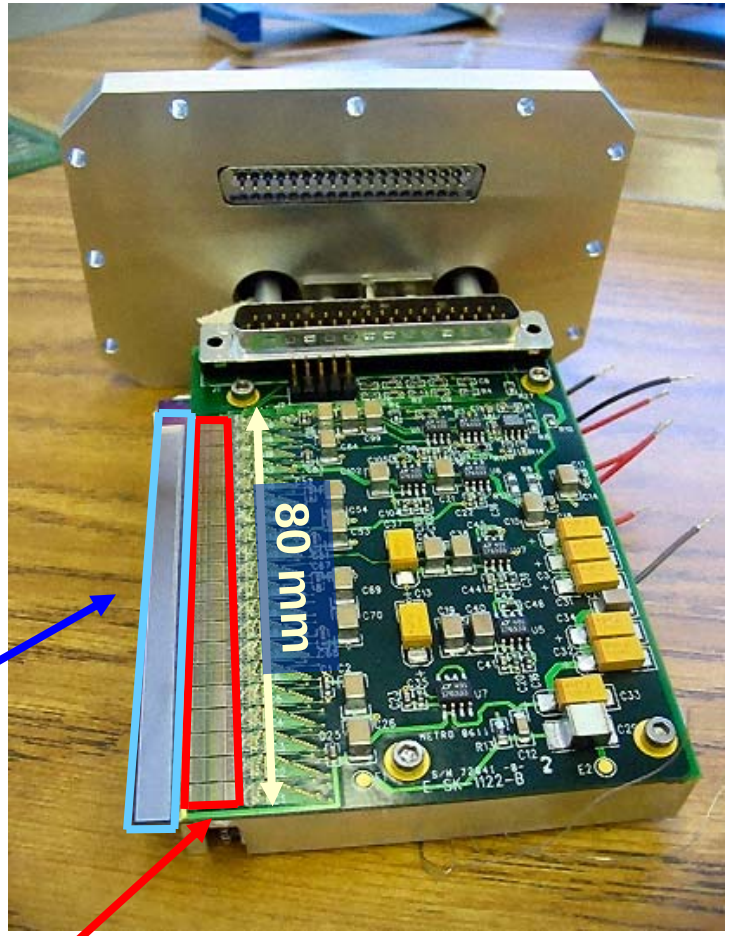
Ludwig(BU) and Headrick (Vermont), X21

NSLS Detectors Development

- A series of detectors for selected SR applications has been developed over the past ~5 years
- Key technologies:
  - Silicon pad and strip detectors (Instrumentation)
  - CMOS Application Specific ICs (Instrumentation)
  - Advanced Data Acquisition hardware and software (NSLS)
- The highly parallel architectures enabled by these technologies lead to significant performance advantages

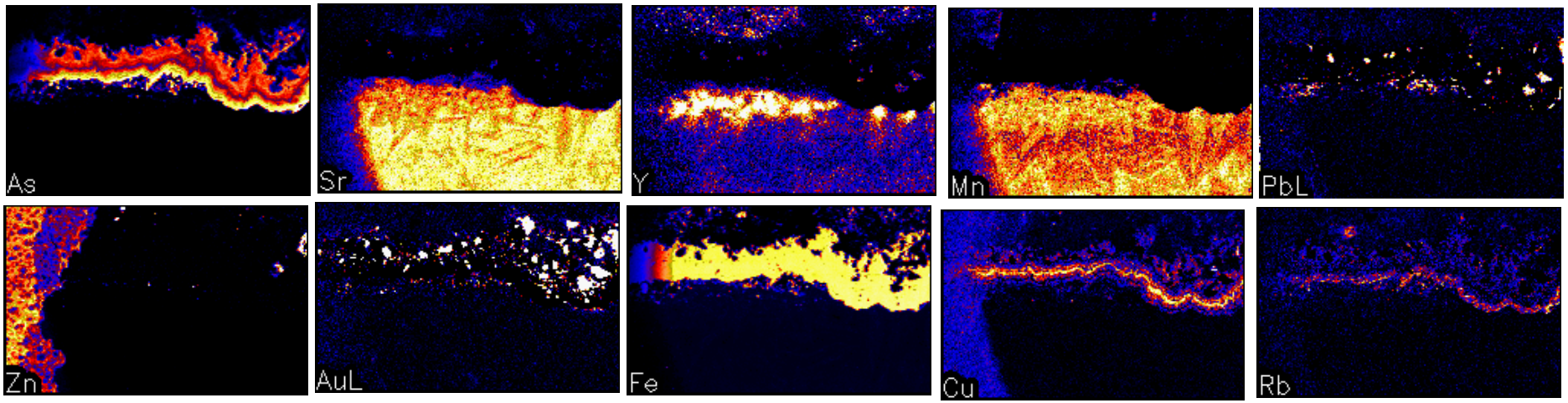
Detector for Diffraction Applications





20 ASICs
low-noise preamp
+ discr. + counter

Rapid XRF Elemental Mapping (BNL/CSIRO collaboration)



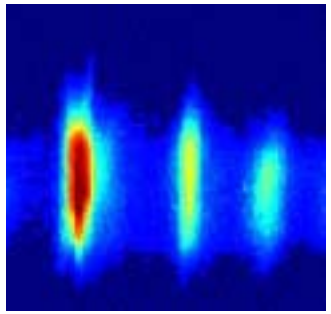
- Hardware: 32-element detector + 2 ASICs + digitizer/processor board.
- Dynamic Analysis real-time deconvolution demonstrated at 10^8 events/second.
- X-ray elemental images of Fiji pyrite collected at NSLS X27A beamline.
- 800x500 pixels of 10um x10um in 5 hr, 20X faster than conventional detector.
- Increase to 400 elements + NSLS-II brightness would give additional $\times 10^4$ gain.

Source Development Laboratory

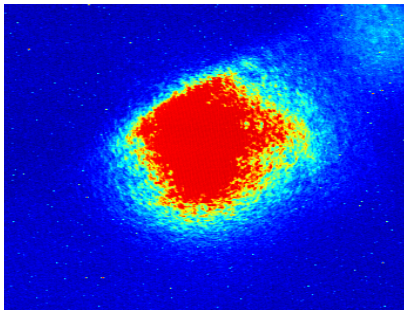
Operating IR & UV FEL Amplifier

300 MeV S-Band Linac

Bright Photo-Injector



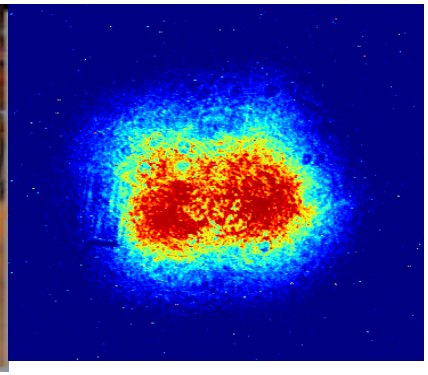
Beam Dynamics



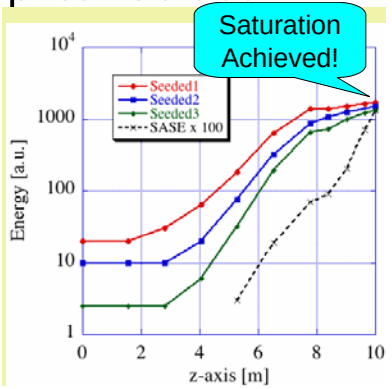
Optical Guided FEL

10 meter Undulator

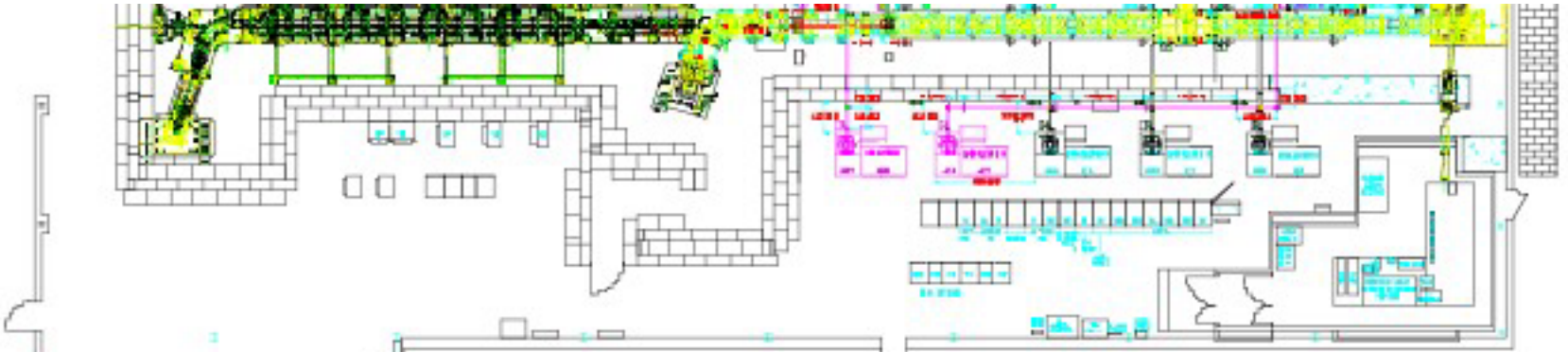
Chicane Compressor



FEL Harmonics

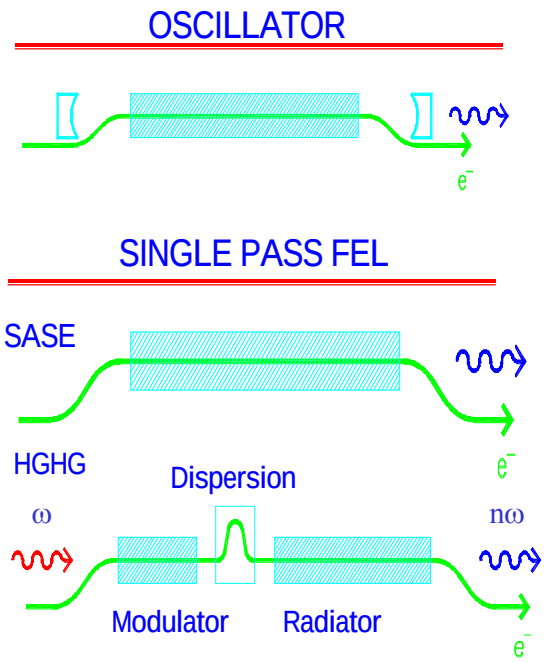


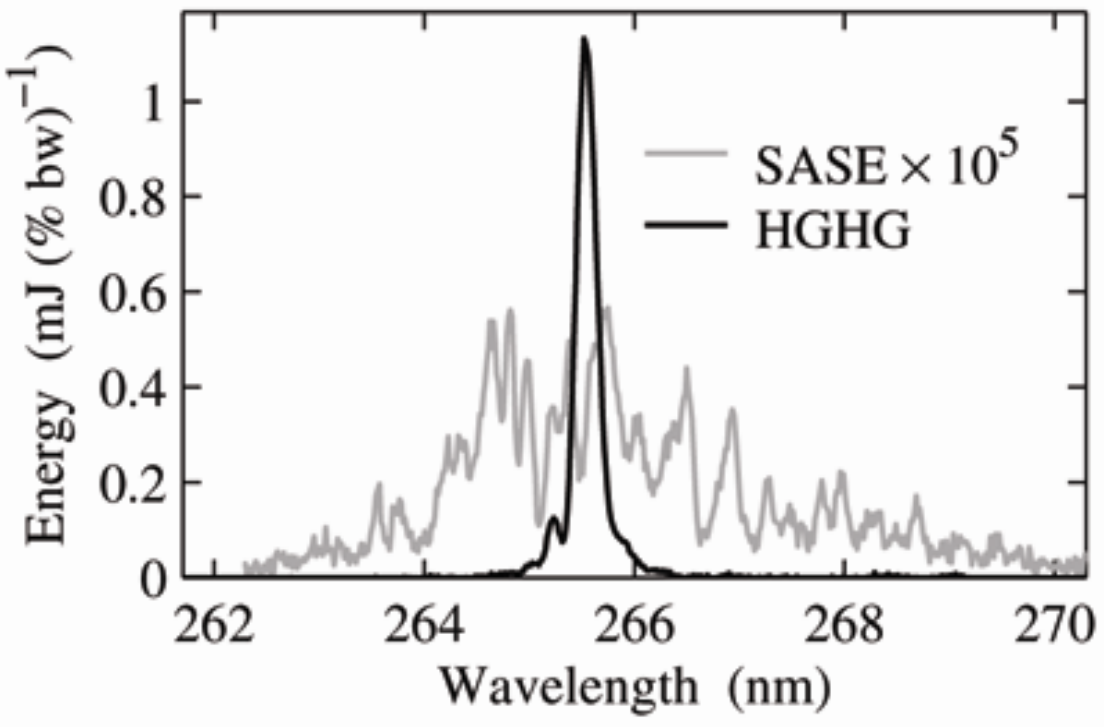
FEL Saturation



High Gain Harmonic Generation FEL

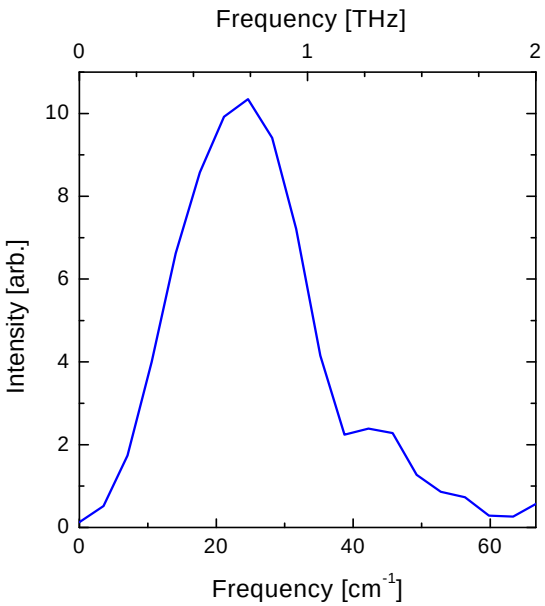
HGHG: 130 μJ / pulse

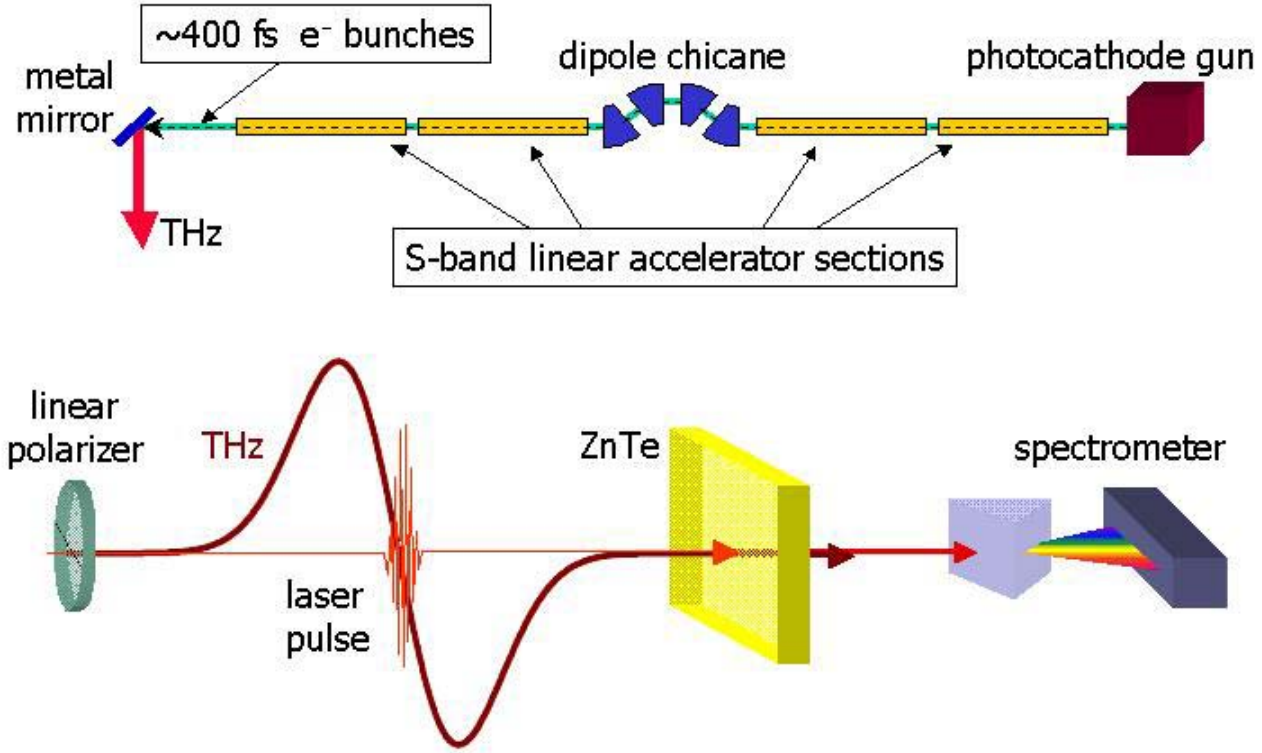




Yu, et. al., PRL 91, 74801 (2003)

Coherent Tera-Hz Transition Radiation





100 µJ in a single sub-psec pulse

E: 100kV – 1MV/ cm

H: > 0.1T

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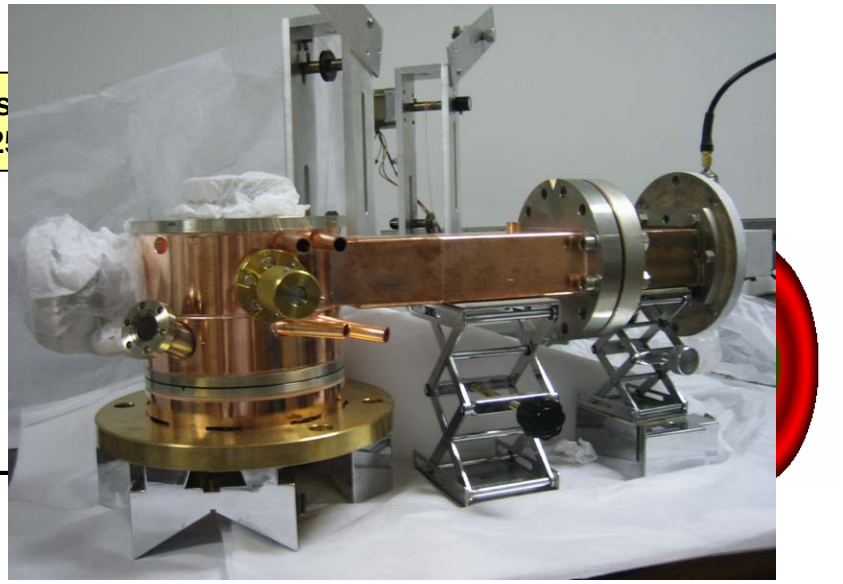
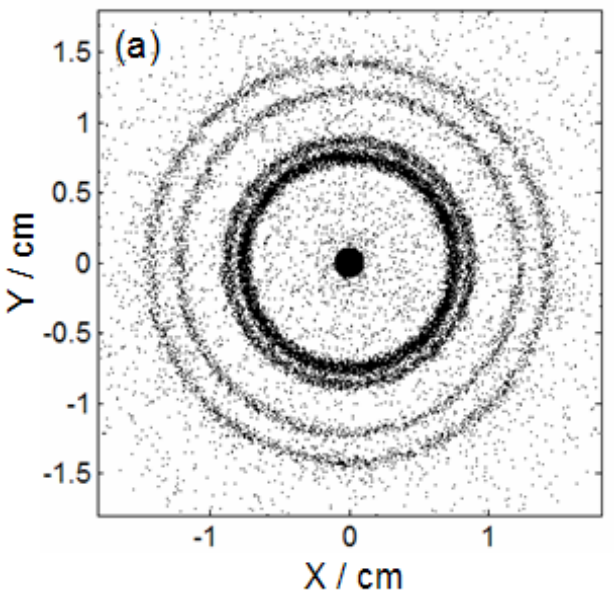
Ultrafast Electron Diffraction

Las
100-2

BNL



E-Beam: 1-4 MeV, 10^5-10^6 electrons



Latest BNL Optimization:
2.7 MeV diffraction pattern
R. Li & X.J. Wang

On track for first beam in Q4 FY08

NSLS/BNL HBCU Initiative

NSLS and BNL office of education program are working with Historical Black Colleges and Universities (HBCU) to promote the use of synchrotron by HBCU faculty, and create a pipeline of future staff for the laboratory

Motivation:

- There is a need for instrument scientists and engineers with special expertise for NSLS and NSLS-II. These positions are difficult to fill and best trained by ourselves.
- HBCU is a talent pool that we could tap into. There is a chance to capture the brightest minority students early.
- Leverage the research infrastructure existing at major user facilities, such as NSLS and CFN, is a good way to enhance the research of HBCU faculty.

NSLS/BNL HBCU Initiative (cont.)

- Utilize existing BNL education programs to bring in HBCU junior/senior students, with the help of HBCU faculty, for short term visits.
- Encourage promising students to enroll in the Mater of Instrumentation program in the physics department of Stony Brook University.
- Students enrolled in the program will work with NSLS staff and HBCU faculties on their master thesis at the NSLS. Students will work part time at the NSLS during their study.
- Graduates of the program will become potential staff

Summary

- HBCU initiative is a key element of the NSLS strategic plan and BNL diversity initiative

- NSLS is committed to work closely with the BNL education office and HBCU consortium to build a pipeline of students and faculty research, as well as to explore innovative education programs and collaborative research

- NSLS will seed the MSI program starting 2009