User Program Development

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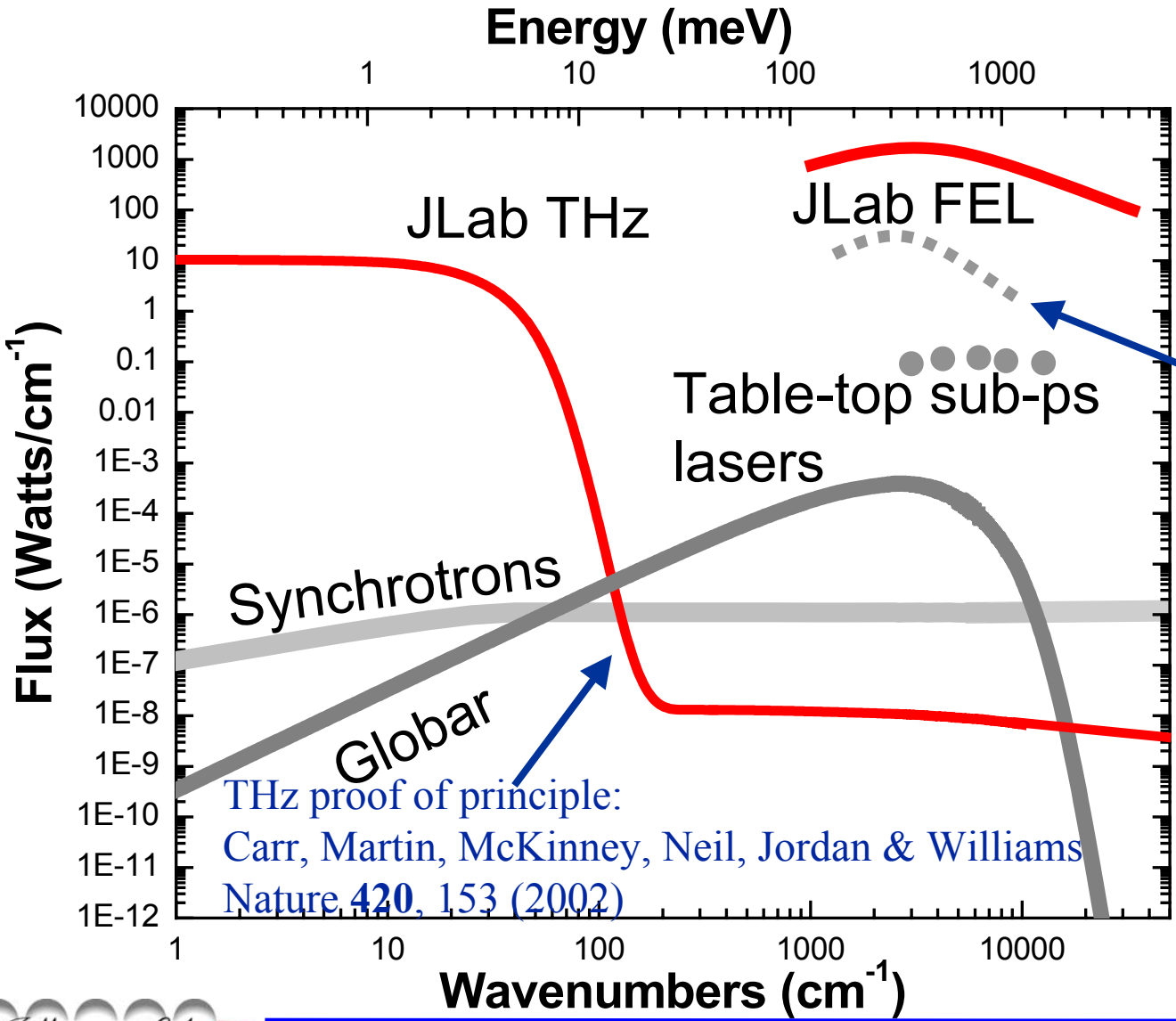
User / LPC Meeting, March 10-11, 2004

User Chronology

- October 1999 1st run of 1 kW FEL
- February, July, Oct. 2000 3 runs
- April 2000 formation of PAC
- October 2000 first meeting of PAC
- February, June, August, Oct. 2001 4 runs
- November 2001 shutdown of 1 kW FEL
- January – Sept. 2002, installation of 10 kW FEL
- October 2002 – present, commissioning..
  - no user beam for 2 years, what have **we** been doing?

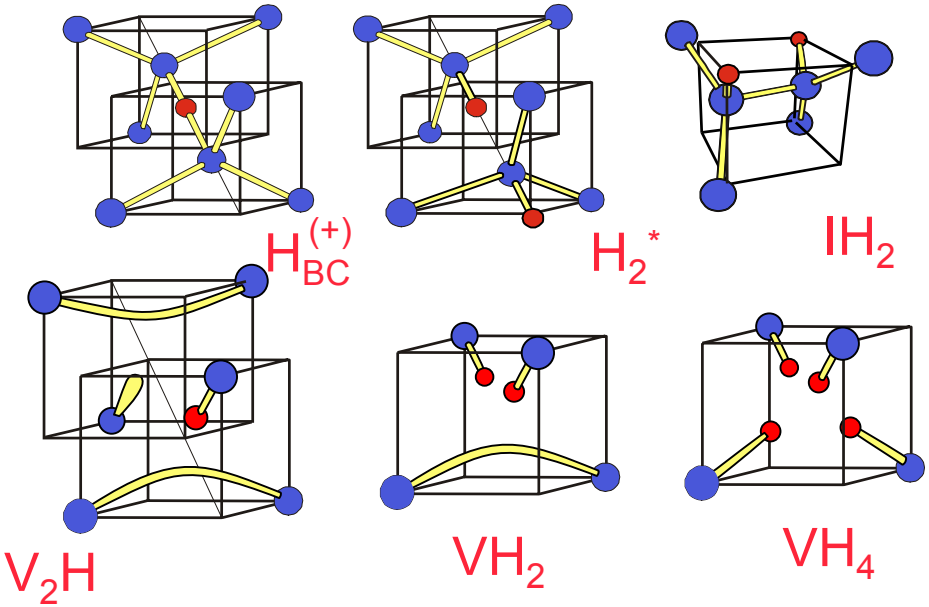
Jefferson Lab facility unique spectroscopic range



FEL proof of principle: Neil et al. Phys. Rev.Letts **84**, 662 (2000)

THz proof of principle: Carr, Martin, McKinney, Neil, Jordan & Williams Nature **420**, 153 (2002)

Re-cap - Science at the JLab FEL - H/Si



Luepke et al. CWM
Feldman et al. Vanderbilt

Phys. Rev. Lett. **88**, 135501, 2002
Phys. Rev. B. **65**, 035214, 2002.
Phys. Rev. Lett. **87**, 145501, 2001
Phys. Rev. Let. **85**, 1452 2000
J. Appl. Phys. **93** 2316 2003

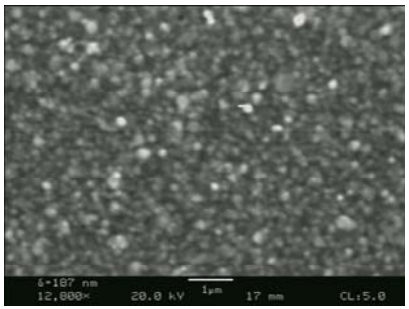
Major program in hydrogen vibrational dynamics
– Luepke 3:15pm today

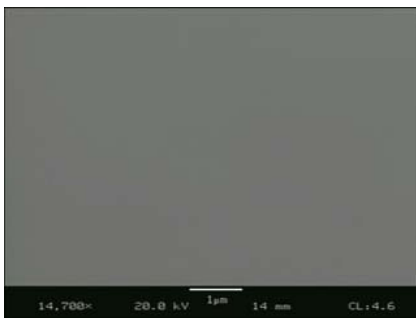
Defect	ω_H (cm^{-1})	T_1 (ps)	T_1 (ps)	ω_D (cm^{-1})
H_2^*	2062.1	1.9	4.8	1500.1
IH_2	1987.1	12	20	1446.5
IH_2	1990.0	11	18	1448.7
VH_2	2122.3	60	70	1547.9
VH_2	2145.1	42	55	1565.1
VH_4	2223.0	56	143	1617.5
$HV{\cdot}VH_{(110)}$	2072.5	295	93	1510.4

Re-cap - Science at the JLab FEL - PLD

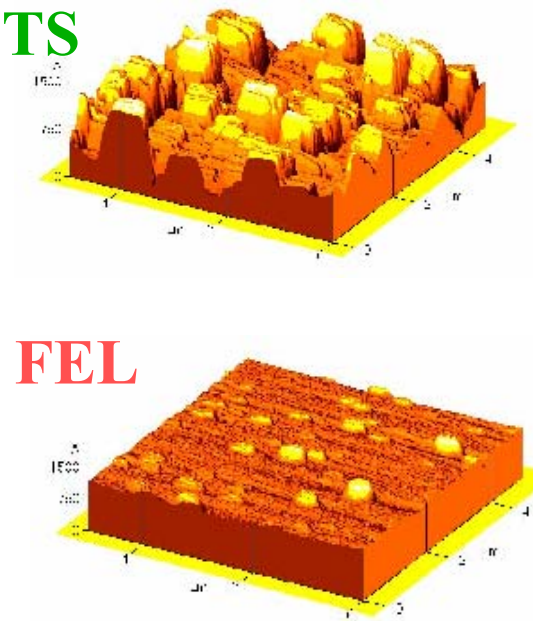
Pulsed laser deposition of $Ni_{80}Fe_{20}$ "Permalloy" films with the JLab-FEL

A. Reilly et al. CWM
J. Appl. Phys. 95 3098 (2003)

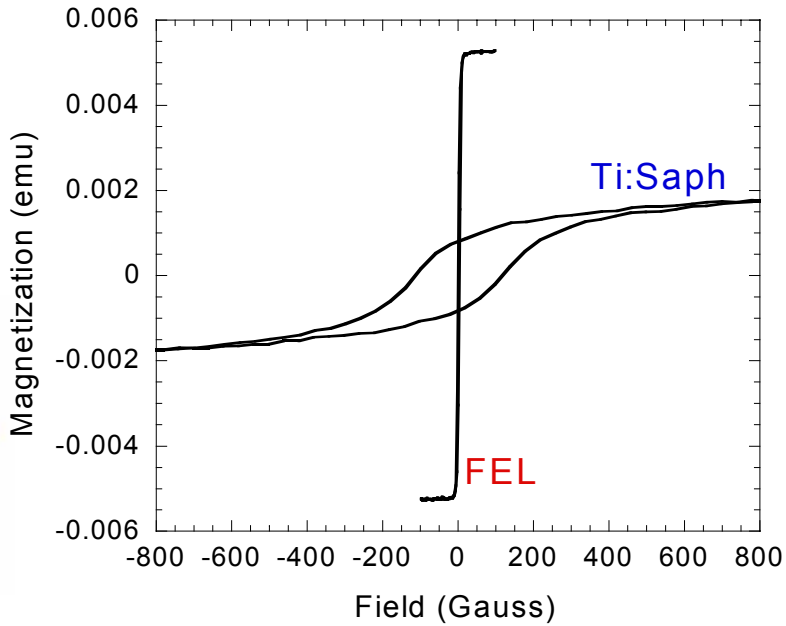




SEM

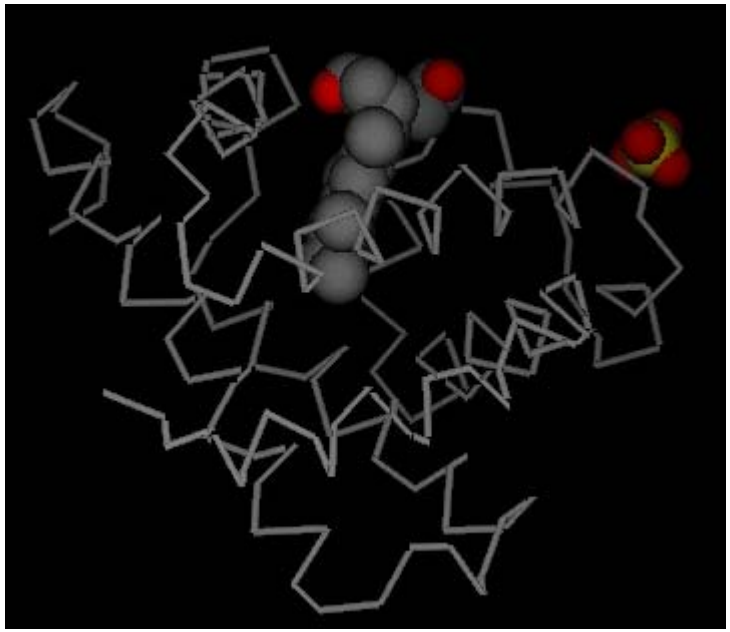


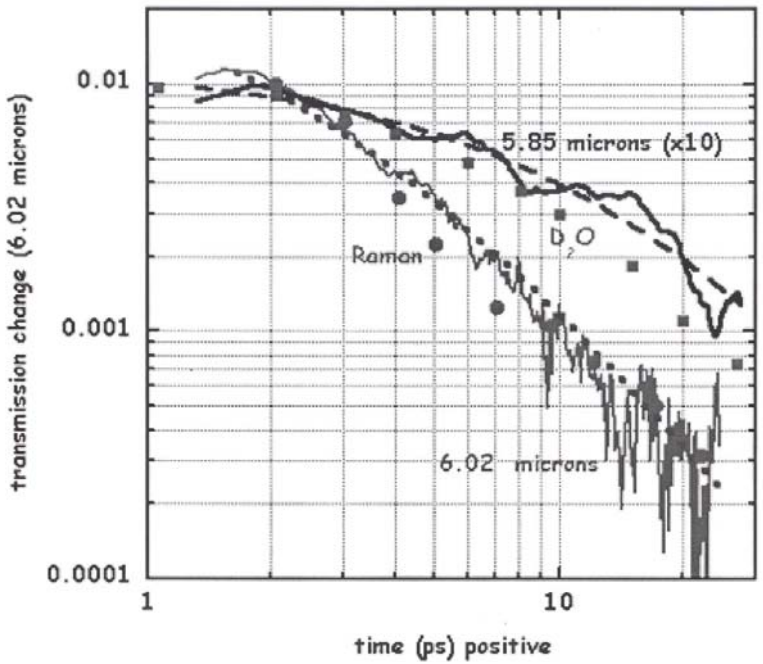
AFM



Magnetic Hysteresis

Re-cap – Protein dynamics





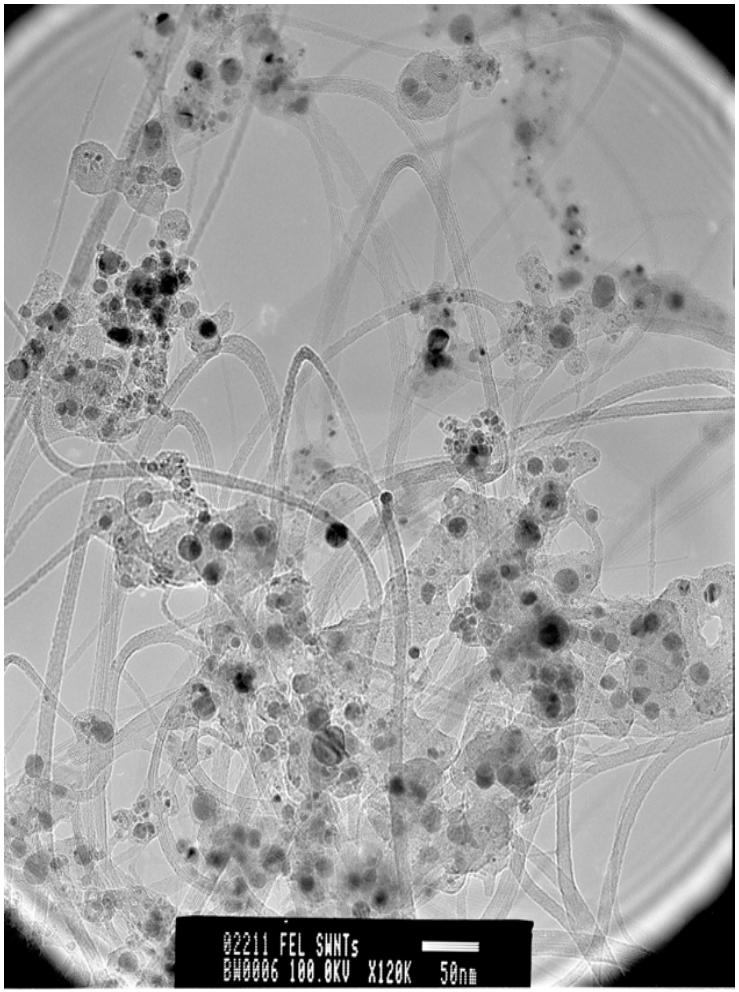
powerlaw decay: $(t/\tau)^{-2}$, τ = 2.1 ps at 6.02 um, 15 ps at 5.8

Dynamics of myoglobin Amide I ($CONH_2$) band. Felix FEL replicated at J-Lab.

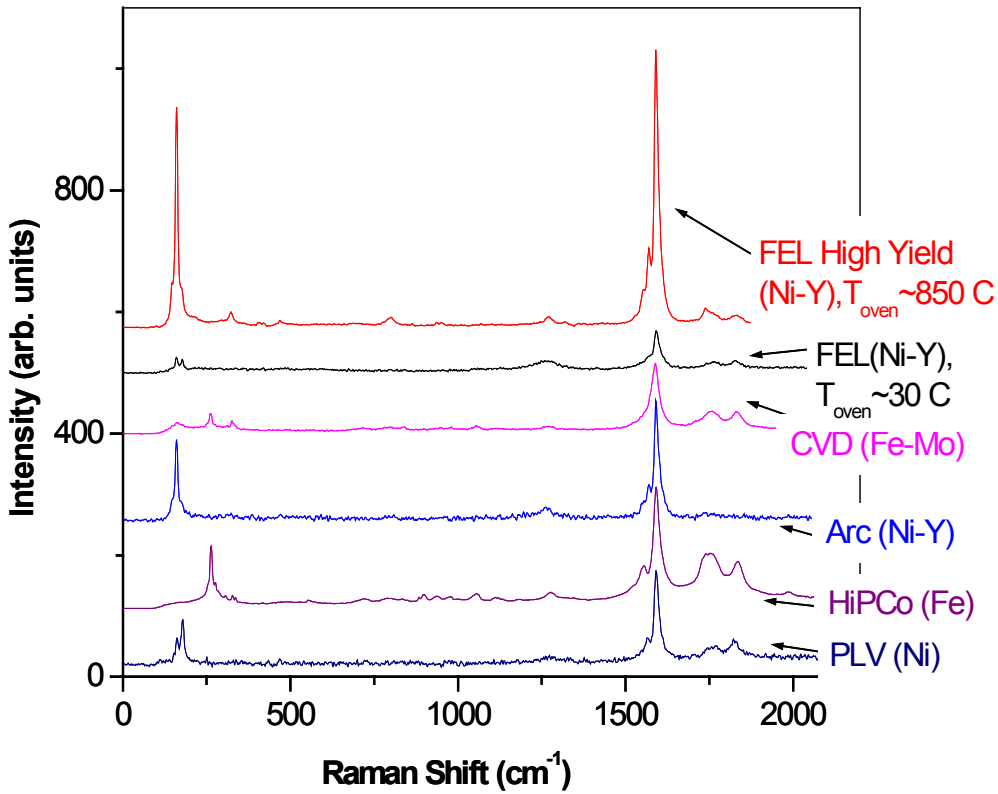
A. Xie, L. van der Meer, W. Houff, R.H. Austin Phys. Rev. Letts. 84 5435, 2000 at FELIX repeated at JLab **AUSTIN 3:55pm today**

Re-cap – Production of high quality C nanotubes

See Smith, Holloway & Siochi tomorrow 9:45

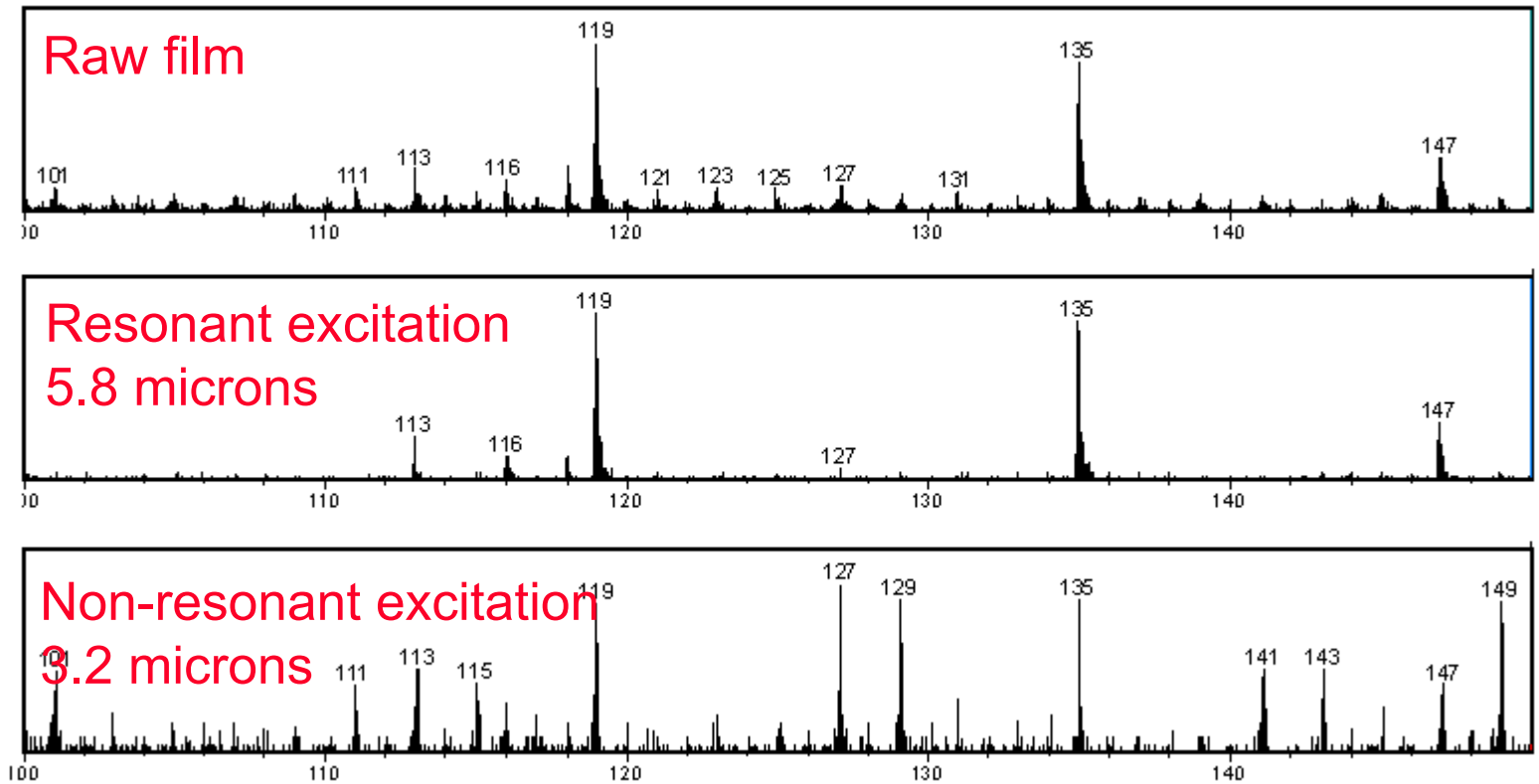


TEM indicates tube dia (~1.4 nm)
and small bundle size (~12 nm)



TEM images by D. Luzzi and B. Smith, UPenn

Resonant Pulsed Laser Deposition of Kapton



Unexpectedly, resonant excitation produces the best result with no dissociation.

Bubb et al. J. Appl. Phys. **91**, 9809 (2002)
Kelley Mat. Res, Soc. Symp. Proc., D. Kumar et al. eds., **617**, 2000

Future plans – FEL Upgrade

- Vibrational dynamics of hydrogen
- Carbon nanotubes
- Pulsed laser deposition
- Non-linear localized modes (THz)
- Higher energy/pulse enables AMO experiments

(also stacking cavity for up to 1 milliJoule/pulse)

- intramolecular vibrational energy transfer
- induction & control of surface chemical reactions
- dynamics within Bose-Einstein condensate

- UV photobiology, photomedicine, machining (Helvajian)

User Program Development

Most important funding driver is science. Agencies want to fund research at a scientific frontier, and we have several at the FEL.

User Program Development

Current list of initiatives:

- DOE Basic Energy Sciences (FEL/THz)
- DOE Biological and Environmental Research (FEL/THz)
- Army Research Office (THz)
- DARPA (THz)
- DARPA (X-ray Lithography)

Note: All of the above would provide operating funds for basic research

Office of Science Initiative

- 12/02 Ray Orbach, Head, Office of Science requests proposals for 20 year road-map, invites JLab to participate.
- 01/03 Jefferson Lab submitted 10 page proposal to DOE-BES.
- 02/03 Jefferson Lab invited to present proposal to sub-committee of Basic Energy Sciences Advisory Committee.

BESAC Recommendations

Office of Science
U.S. DEPARTMENT OF ENERGY

- Science is “critical”, mandate to develop national user community **with BES help** via workshop(s).

- Cost is modest “Therefore, it should be possible to develop these sources without the kind of full-scale new facilities requests needed for X-ray or neutron facilities”.

- “The DOE BES should take a lead role in the development of the basis for energy recovery linear accelerators (ERL), which may outperform the conventional hard X-ray storage ring sources envisioned for a decade from now in both brightness and short bunches”.

Office of Science
U.S. DEPARTMENT OF ENERGY

DOE-NSF-NIH Workshop on Opportunities in THz Science (Feb 12-14, 2004)

THz frequencies are an electromagnetic frontier in a gap that is relatively unexplored and which presents opportunities at several frontiers.

- THz is a timescale frontier at the quantum level
- An application frontier for remote sensing, quantum control and medical imaging
- A source frontier.

Workshop chaired by Mark Sherwin (UCSB), Charlie Schmuttenmaer (Yale) and Phil Bucksbaum (U. Michigan). Self-set deadline for report first draft 3-31-04.

BER Initiative

NIBIB-DOE Workshop on Biomedical Imaging:
Optical and X-ray Technologies

February 10-11, 2004; Bethesda Marriott, Bethesda MD
Chaired by Peter Kirchner and Ari Patrinos

THz Project

FY 2003 project funded at $0.74M by ARO

Deliverables:

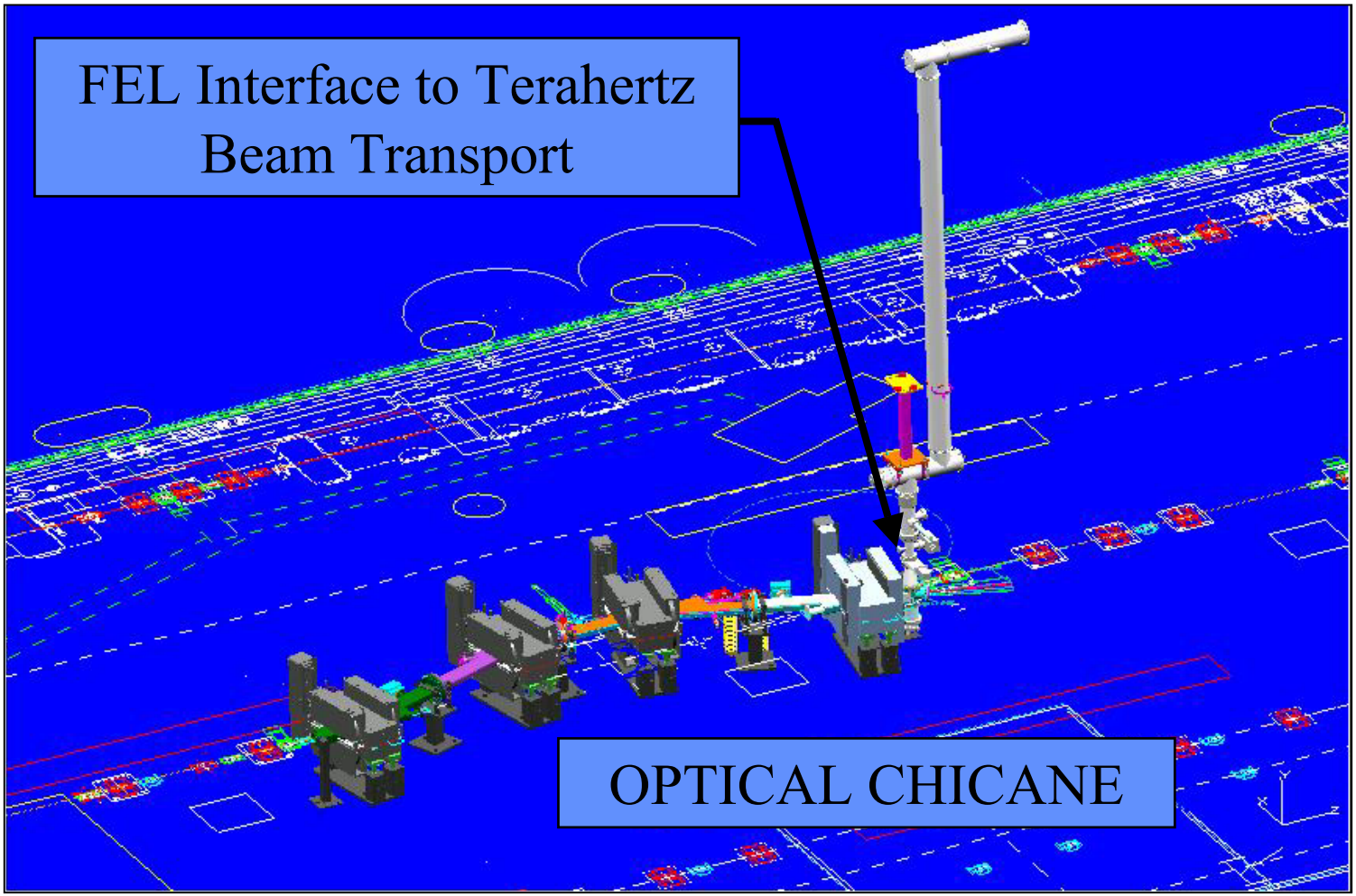
1. Jefferson Lab and AES

Design, fabricate and commission a THz beamline at Jefferson Lab & perform proof-of-principle experiments of mine detection $333.7

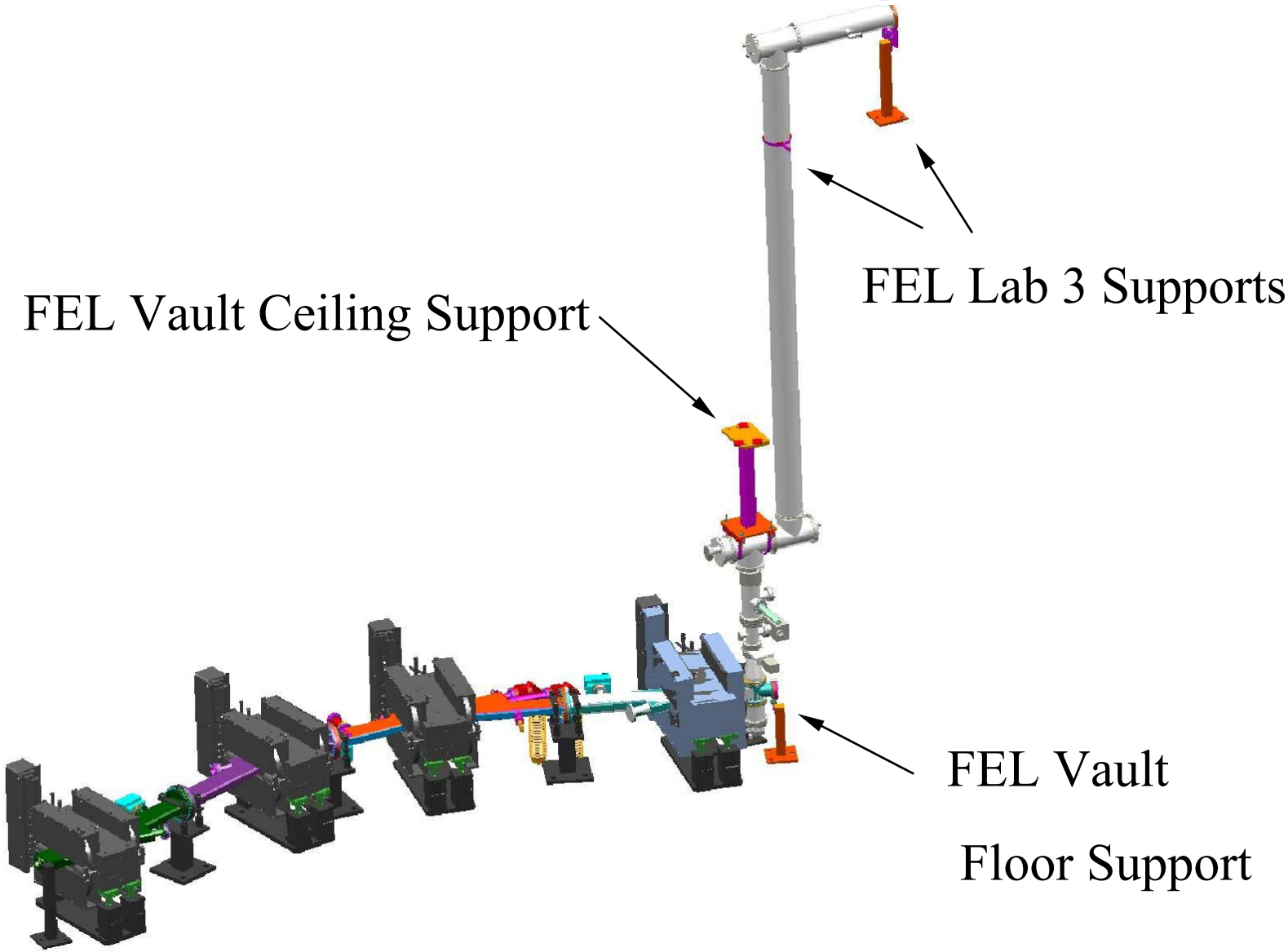
2. AES and Jefferson Lab

Develop requirements and make pre-conceptual design of compact robust, transportable THz system $384.8

You Are Here


FEL Interface to Terahertz
Beam Transport
OPTICAL CHICANE

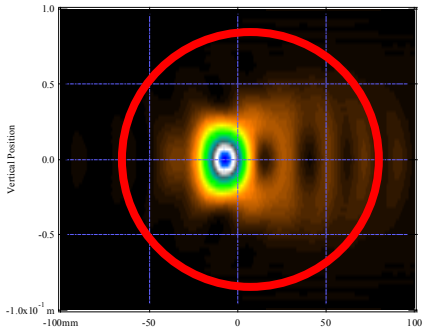
Terahertz Beam Line Complete



THz Beamline Optical Philosophy

- Operable to 0.1 THz
- 6” Optics
- Point to point focusing
- Compatible with FEL optical beam transport
  - mirror holders
  - mirror remote manipulation
  - support structures
- Jog to allow for radiation shielding

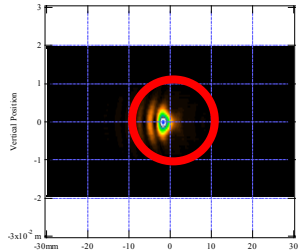
JFEL THz Beamline Optical Beam Patterns



200x200mm

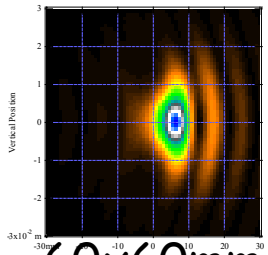
M4

F3

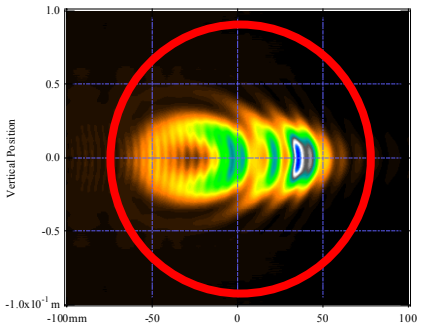


60x60mm

F2



60x60mm

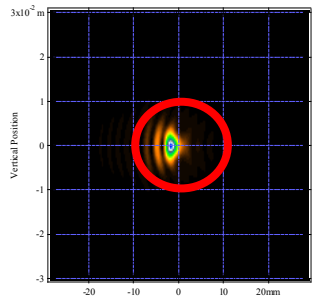


200x200mm

M2

372

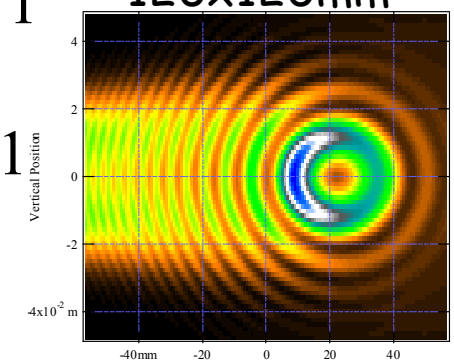
M3



60x60mm

F1

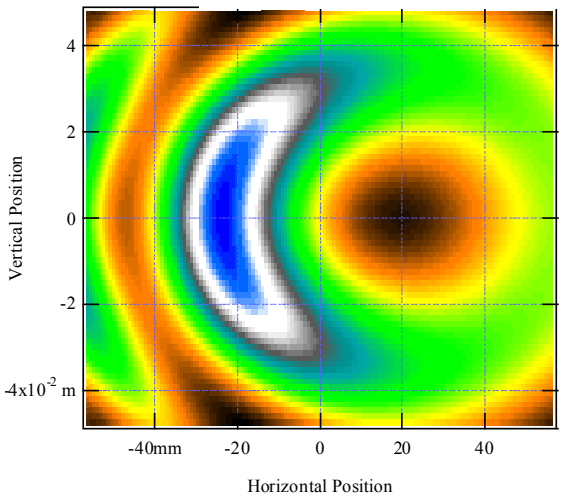
120x120mm

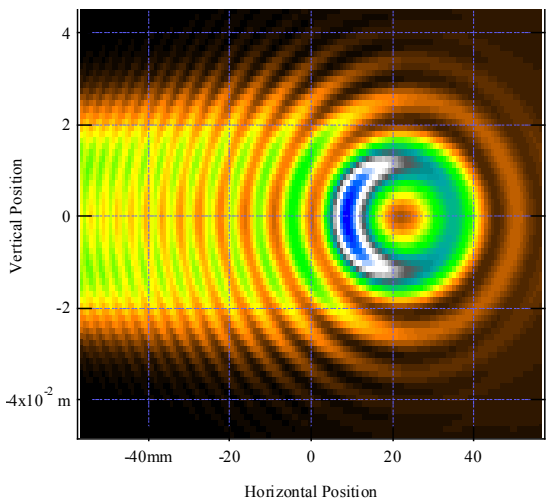


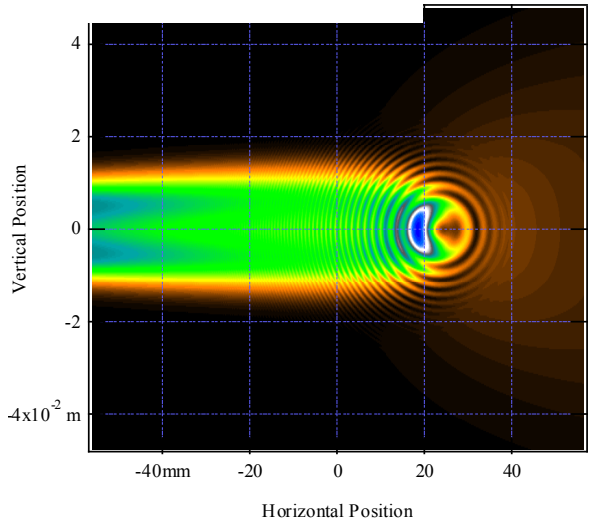
M1

Special thanks to
Oleg Chubar,
Paul Dumas.

JFEL THz Beamline Optical Beam Patterns



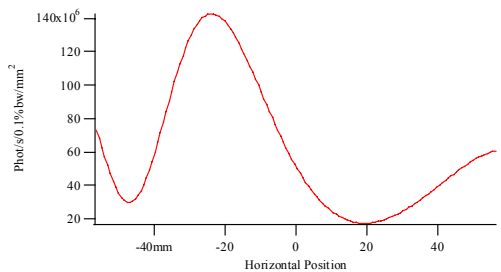


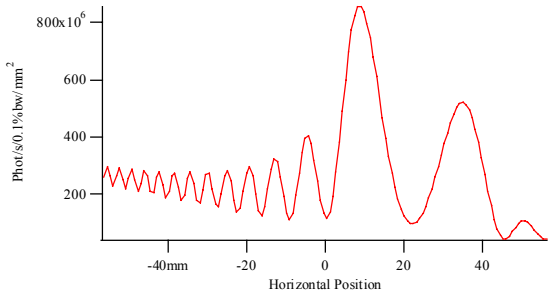


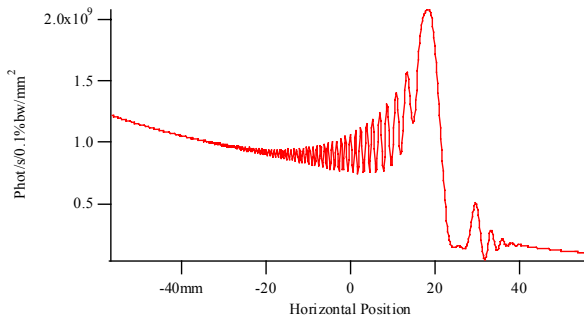
0.1 THz
3.3 cm^{-1}

1 THz
33 cm^{-1}

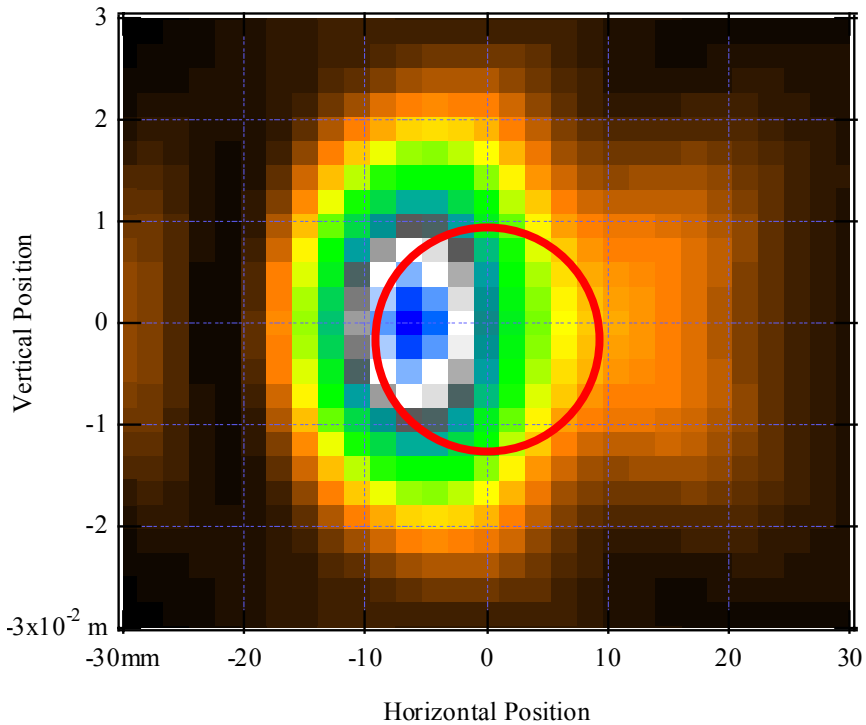
10 THz
330 cm^{-1}







JFEL THz Beamline Optical Beam Pattern



67.5% of light passes aperture as shown

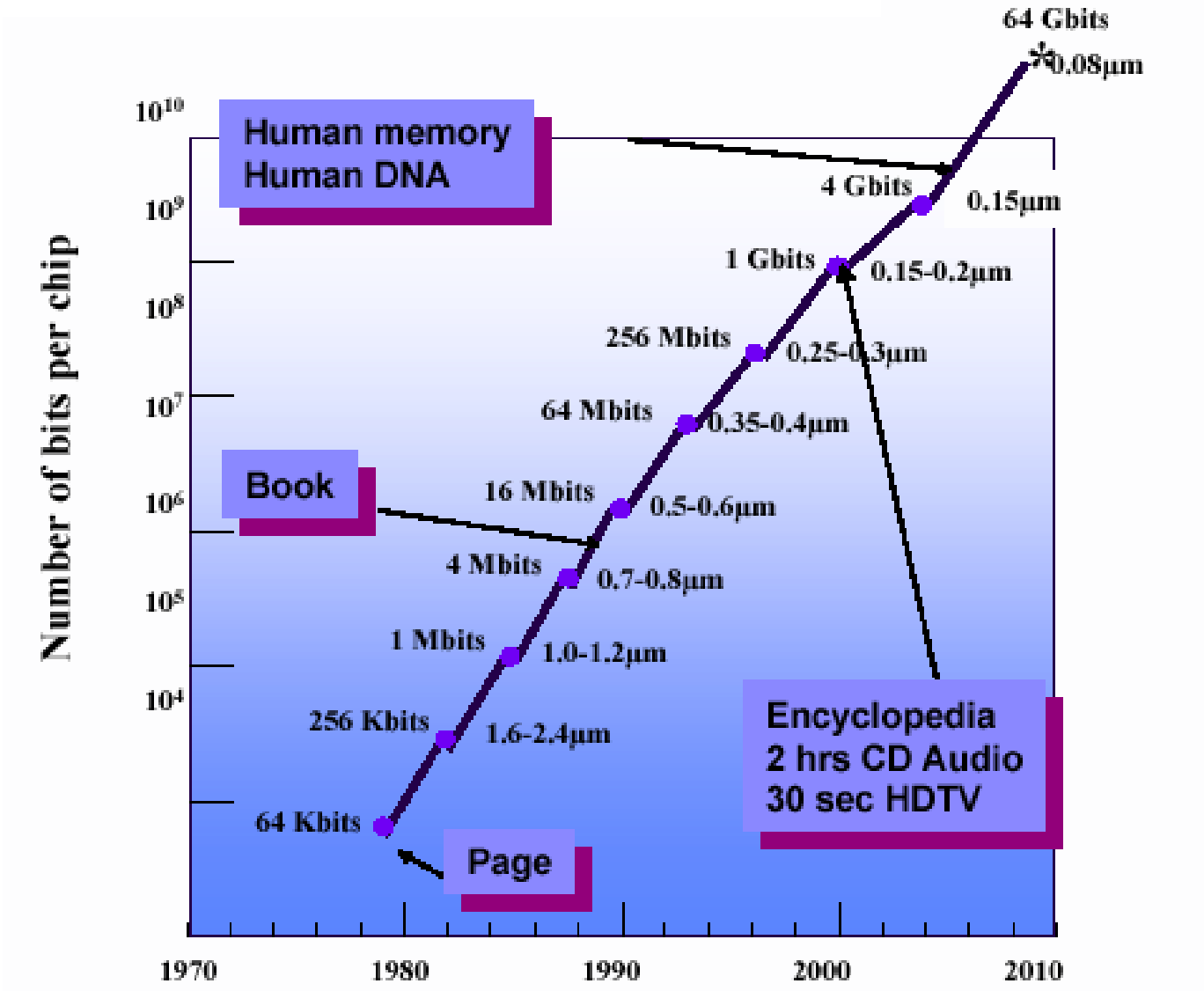
F1 for 3mm light with 20mm aperture

DARPA & X-Ray Lithography
Helios as the Source

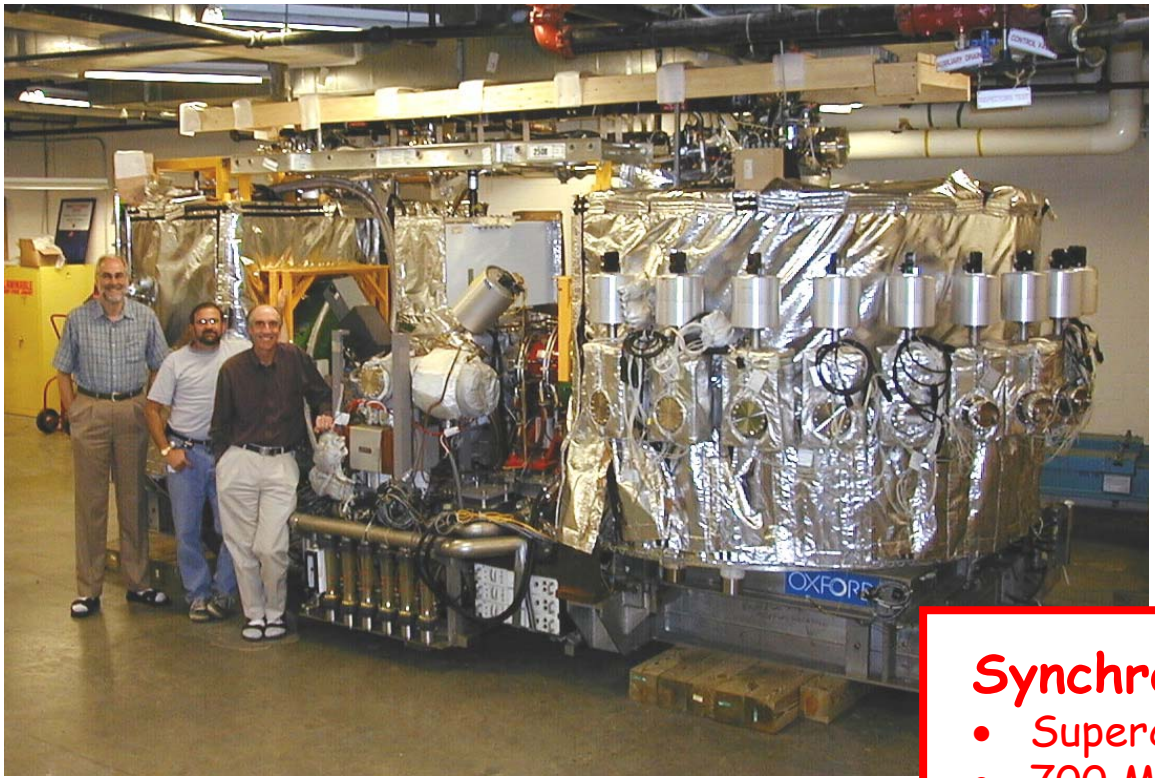
X-Ray Lithography consortium met again on Nov. 5, 2003.

Proposal was made to re-commission and operate Helios for 2 years for ~ $30M.

DARPA and X-ray Lithography



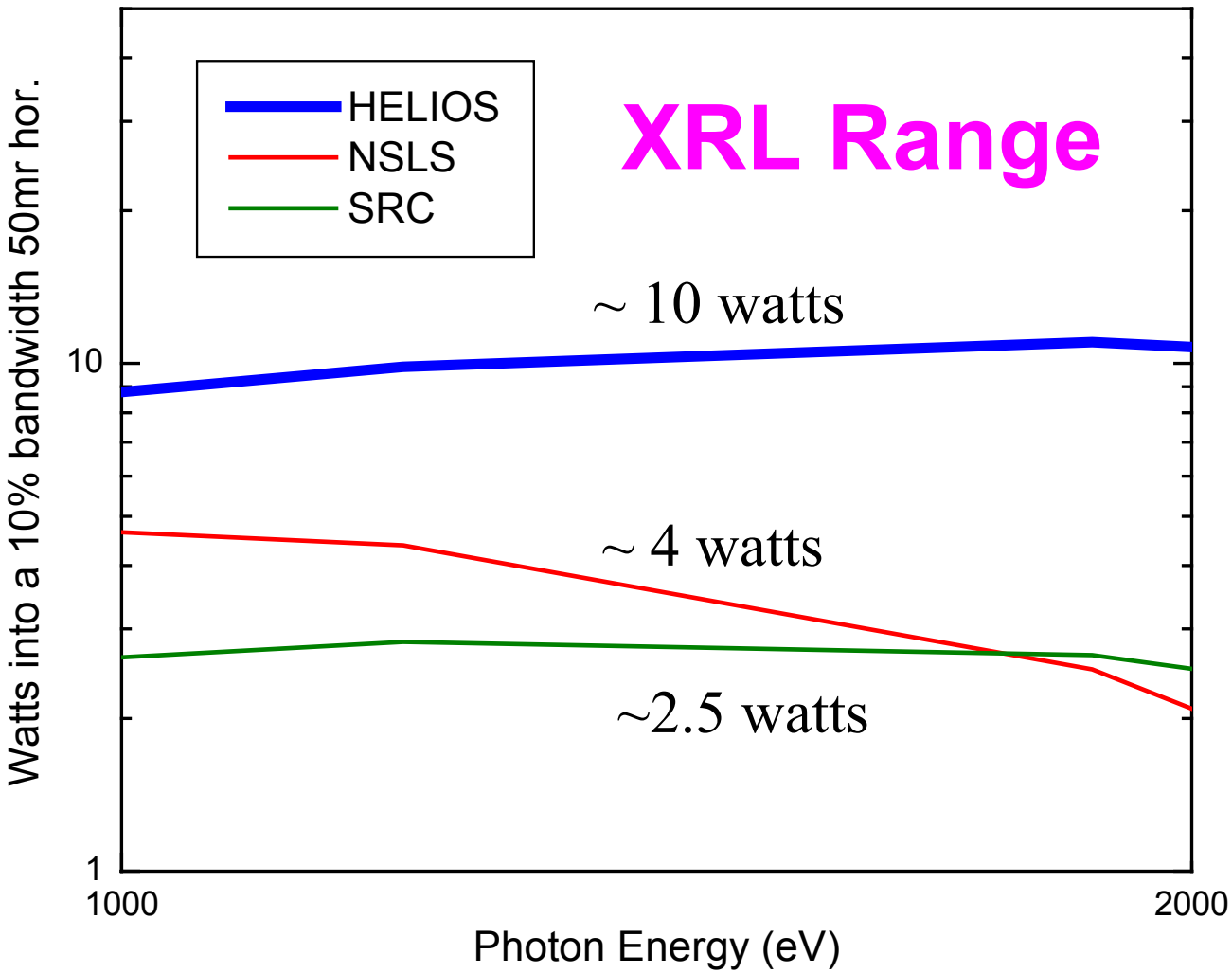
JLab Synchrotron Radiation Source - HELIOS-1



Synchrotron Specifications

- Superconducting ring, 4.5T max. field
- 700 MeV Electron Energy
- 500 MHz rf with 16 bunches
- synchronized with FEL at 125 MHz
- 10Å critical wavelength
- 800 milliamps of stored current

XRL – Synchrotron Power



X-Ray Lithography status, March 2004

- BAE Systems ready to propose project with JLab.
- Need at least one more partner.
- DARPA re-directs money for production of CRAM to entice industry.
- Helios would be available for basic research.

Where do you come in?????

- Letters of intent are necessary to enable us to plan development of laboratories.
- PAC will guide us in above.
- Ultimately we will invite beamtime proposals,
  - - when that happens……..

– don't forget registration and training!!

- See: www.jlab.org/FEL
  - Eye exam
  - EH&S
  - General Employee Radiological Training (GERT)
  - Oxygen Deficiency Hazard (ODH)
  - Laser safety training

- Experiment proposal submitted (Gwyn Williams)
  Approved by Program Advisory Committee
  Ranking based on science
  Good for 2 years

- Also need Laser Operational Plan
  & Experimental Safety Form