High School Outreach at the NSLS

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University of Chicago
Center for Advanced Radiation Sources

Scott Bronson (BNL OEP)
Lisa Miller (NSLS)

Overview: Training and Education Initiatives

White type = BNL Office of Education programs, Blue type = NSLS programs; Red type = joint efforts.

K-12	Undergraduate level	Graduate level	Beyond Grad level & Training
• Science Learning Center programs • Grant-funded programs: structural biology, nano, environmental chemistry **(remote access)** *• Joint Effort: Remote access experiments between high schools and NSLS scientists on experimental floor (NSF grant)* *• possible secondary-level education web modules*	• Community College Institute (CCI) • Science Undergraduate Laboratory Internship (SULI) • College Science & Technology Entry Program (CSTEP) • College Mini-Semester *• Joint Effort:Summer School at NSLS* *• NSLS: XAFS training modules on web and at NSLS* *•NSLS: Scattering training modules on web and at NSLS*	• Faculty and Student Teams (FaST) *• NSLS: Course on synchrotron instrumentation at Stony Brook University and NSLS* *• NSLS: internships offered through Masters of Synchrotron Instrumentation degree program at Stony Brook University* *• NSLS: XAFS training modules on web and at NSLS* *•NSLS: Scattering training modules on web and at NSLS*	• Teacher training workshops *• Joint Effort: Historically Black Colleges & University (HBCU) Program* *• NSLS: Topical Area Workshops (Crystallization, XAFS, Users Meeting…)* *• NSLS: postdoc hires* *• NSLS: XAFS training modules on web and at NSLS* *•NSLS: Scattering training modules on web and at NSLS*

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Bringing Big Science into the Classroom: BNL's NSLS and CFN
Monday, May 24, 2010

Over 100 Registered Attendees, over 50% were High School Teachers and Administrators

Workshop Goals

• Provide high school science teachers the opportunity to learn how the NSLS and CFN are used for research tools

• Learn how they can use these resources to conduct real scientific measurements with their students

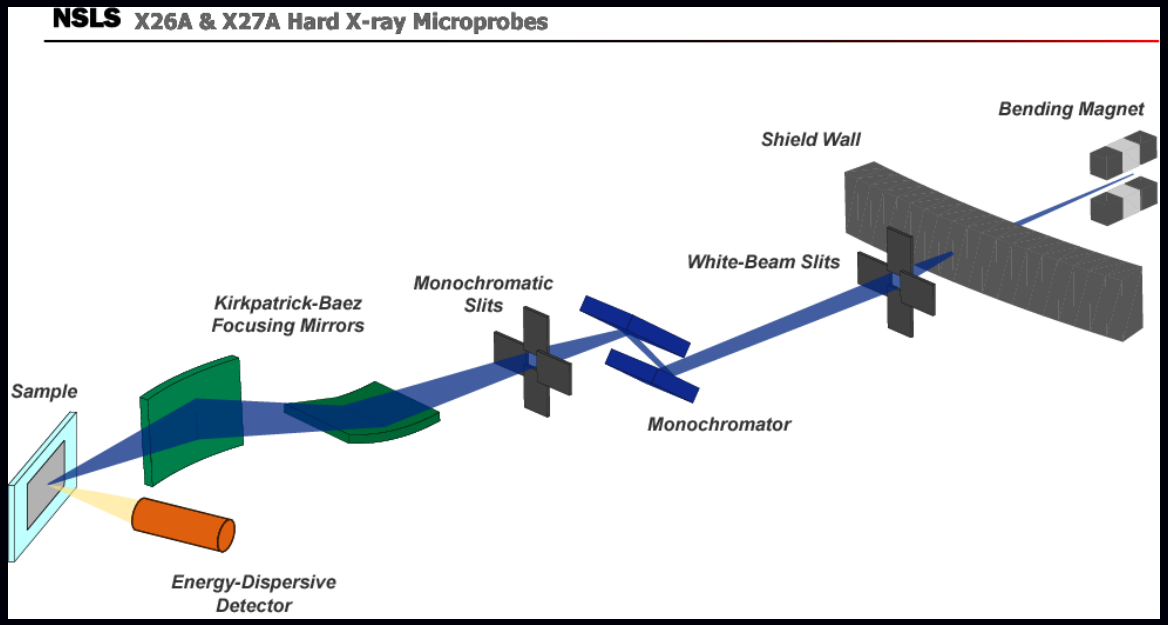
• Learn about internet-enabled tools that can allow classrooms to use these instruments remotely

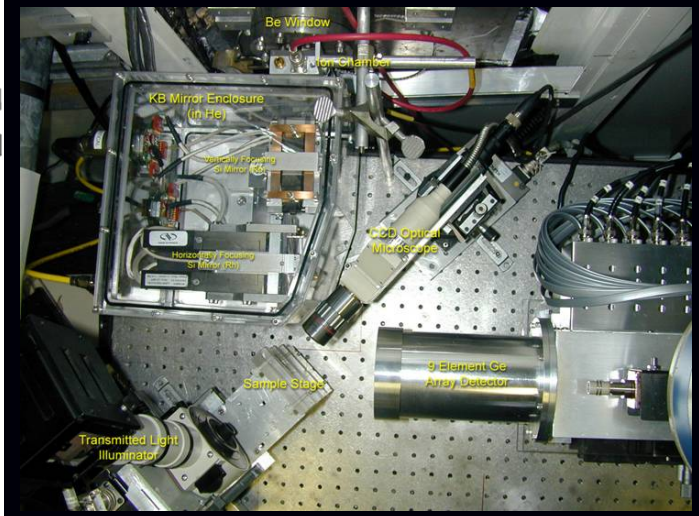
• Introduce local scientific problems that can be investigated by students using these facilities

• Show beamline scientists what resources are available at BNL to allow them to participate

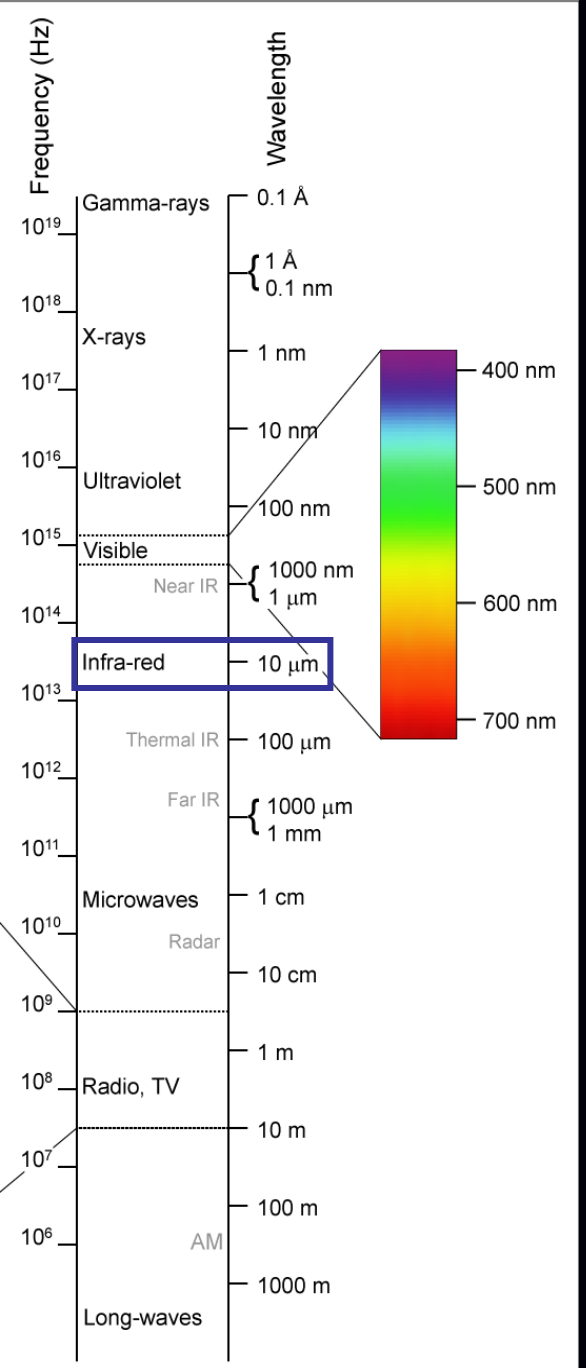
Synchrotron X-ray Microprobes

- *These beamlines focus these bright beams to very small size (<10 µm …f.y.i human hair is ~100 µm diameter) to:*
  - *Examine the distribution of elements at micron scale*
  - *Evaluate the molecular form of these elements*
  - *Determine the mineralogy of a sample at micron scale*



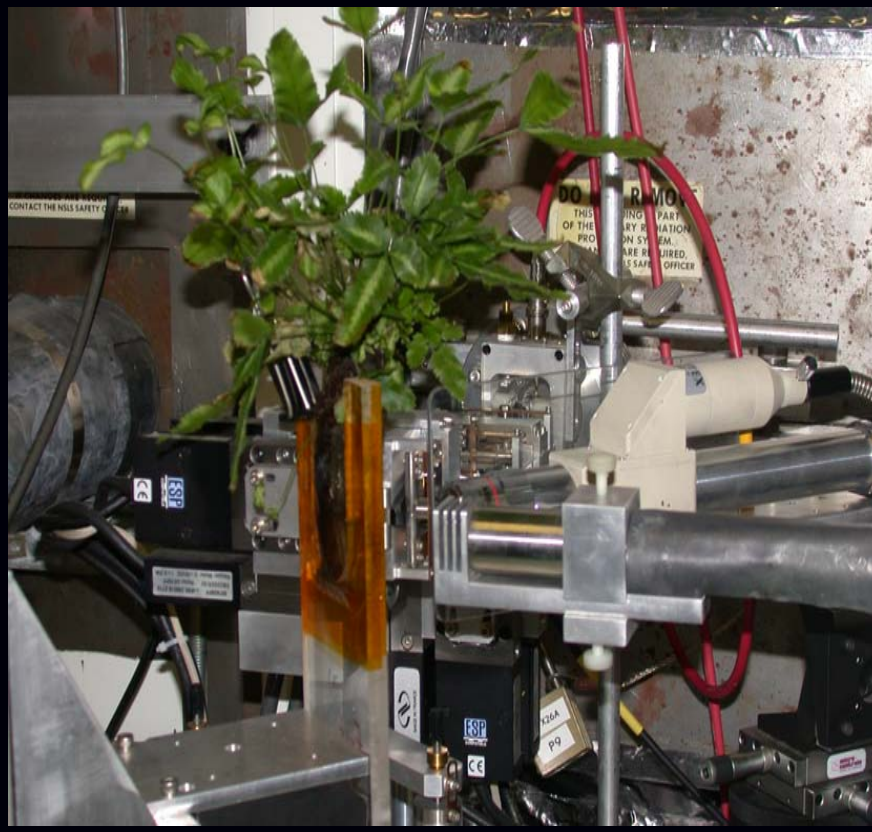


Mid-Infrared "Cameras"



Techniques we chose to highlight require minimal sample preparation

- *X-rays are penetrative and the power deposited to a sample from the beam is very low*
- *Samples can be analyzed in a wet or moist state (in-situ)*
- *Large samples can be analyzed and the analysis generally requires only the most minimal of sample preparation*
- *In its simplest form experiments are done as an "imaging" technique where image "intensity" directly correlates to element concentration*
- *You get a broad range of elements simultaneously*



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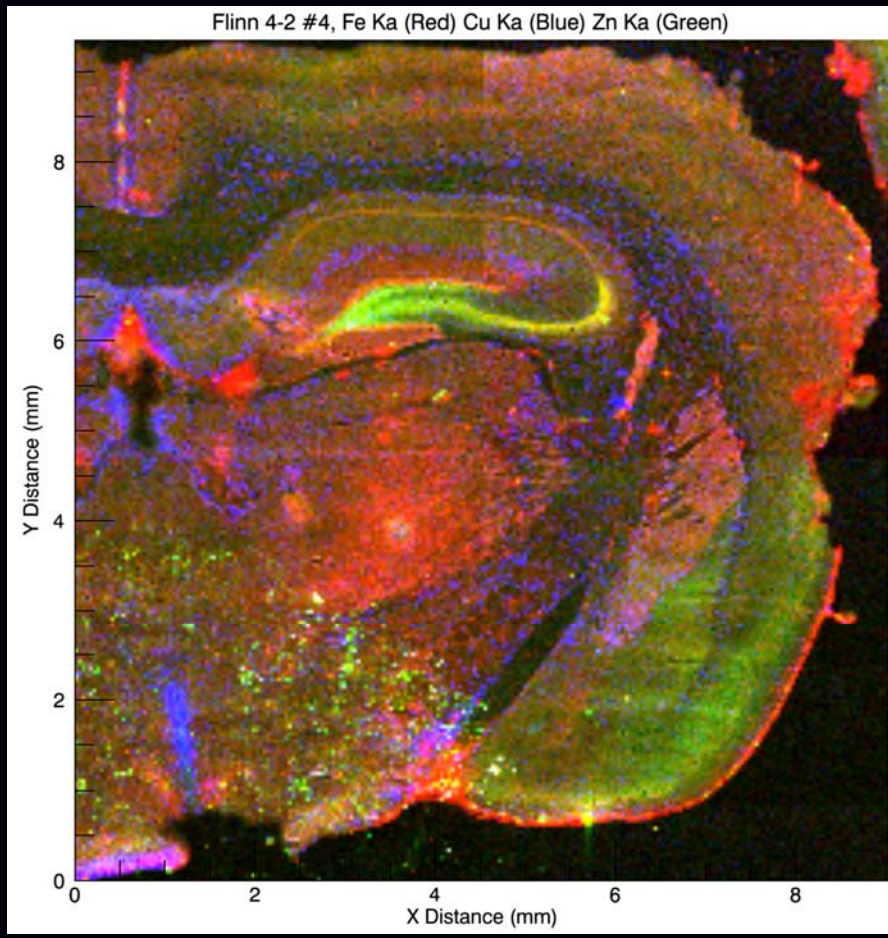

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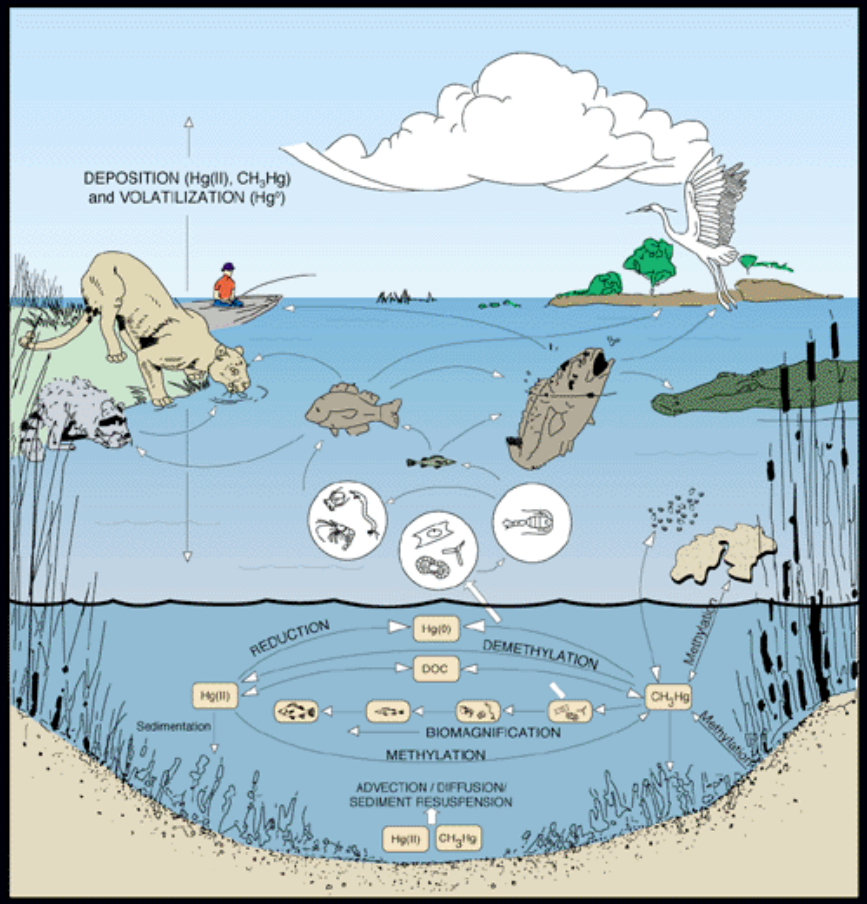
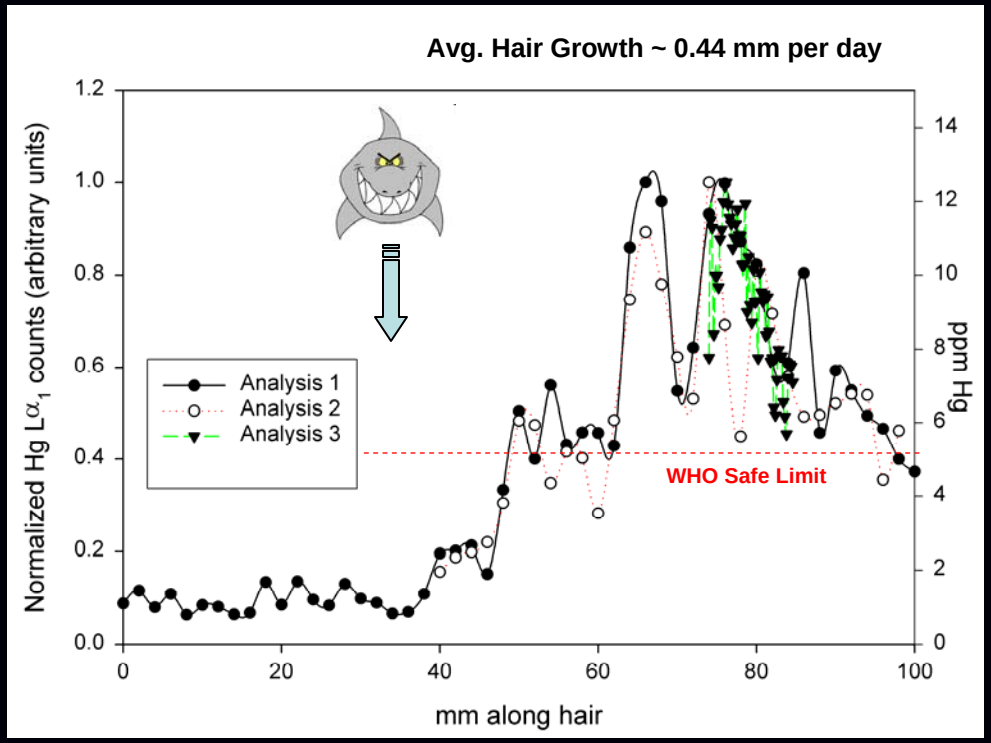
Human Health Risks From Methyl Mercury In Fish

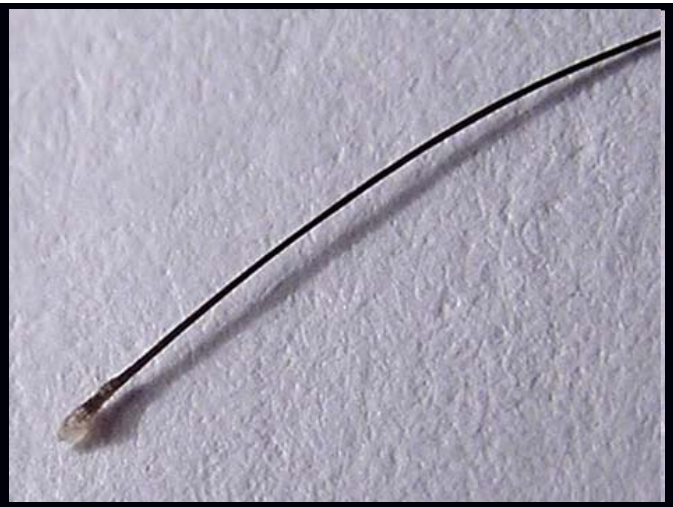


- Mercury is a naturally occurring element that is found in air, water and food.
- Most people are exposed to mercury via food. Fish take up mercury as they feed. This mercury is in the more toxic, methylmercury form.
- Pregnant women - or, rather, their unborn babies - are at the greatest risk. Babies developing in the uterus (womb) seem to be most vulnerable to the effects of mercury on their nervous systems.

Tony Lanzirotti and Keith Jones (BNL), NSLS
Lanzirotti, A., Jones, K.W., Clarkson, T.W., and Grandjean, P. (2001) Human health risks of methyl mercury. National Synchrotron Light Source Activity Report 2001, 97-99.

Human Health Risks From Methyl Mercury In Fish





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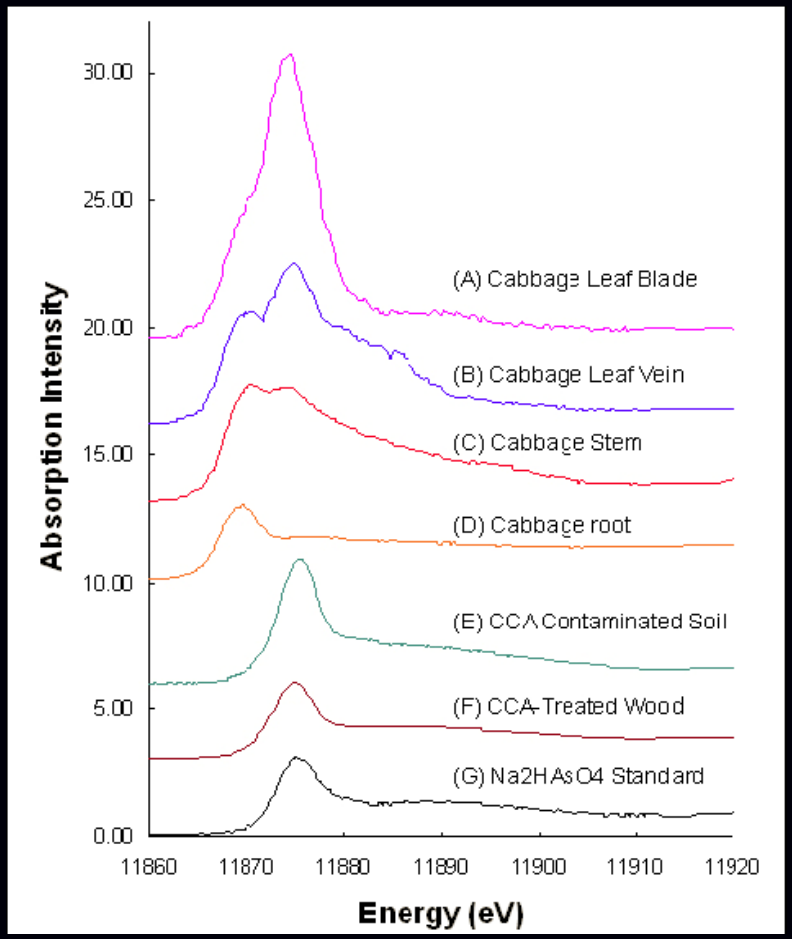
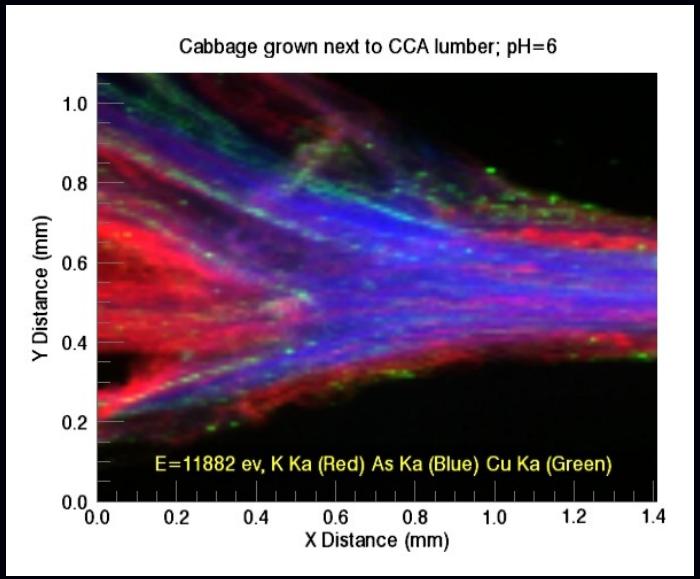
Tony Lanzirotti and Keith Jones (BNL), NSLS

Environmental Hazards of Pressure Treated Lumber

A 12 foot 2 x 6 contains enough arsenic, if released, to kill about 250 adults.



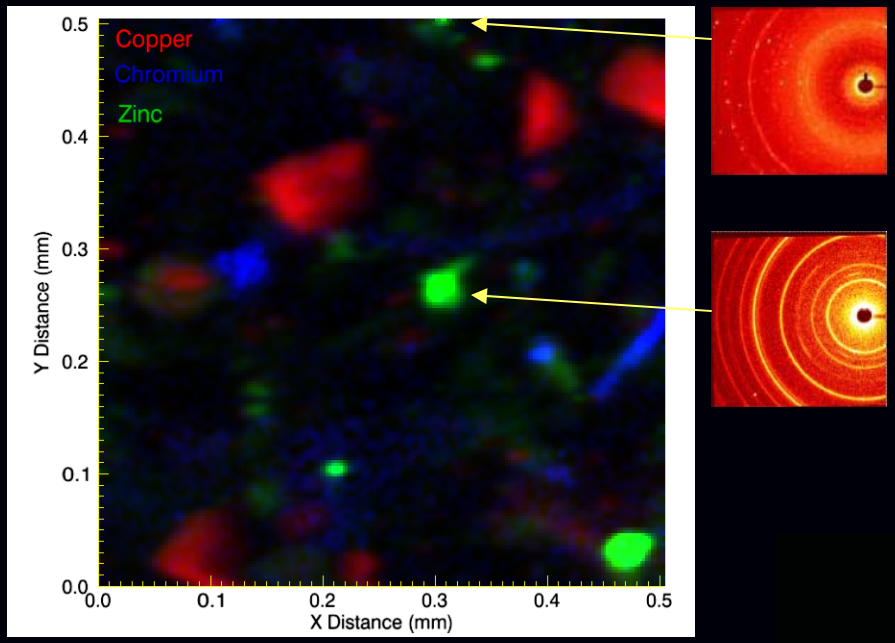


Satish Myneni and Matthew Cooper (Princeton) and Tony Lanzirotti, NSLS

Analyzing Dust Bunnies

Americans spend more than 80% of their time indoors
Understanding and managing risk requires understanding metal sources and species

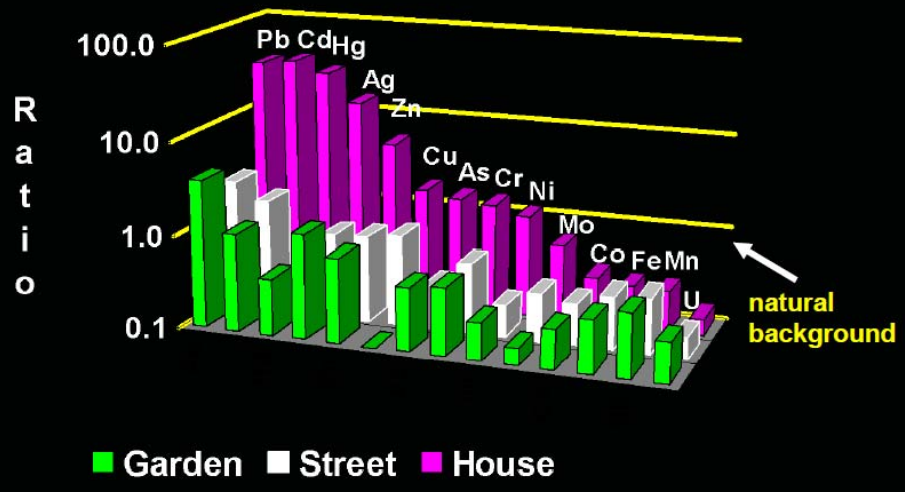
Analyzing Dust Bunnies



Analysis of Dust from homes in Ottawa, Canada
Identified particles:

- *calcite, vaterite, gypsum (wall boards)*
- *halite (table salt)*
- *portlandite (concrete)*
- *metallic Fe and Cu (electrical, appliances)*
- *Fe and Cu oxides (oxidized metals)*
- *wood cellulose, some high in Cu, Cr, As (CCA lumber)*
- *Pb carbonates and sulfates (paint and solder)*

Coupled X-ray fluorescence (chemistry), diffraction (mineralogy), and absorption spectroscopy (speciation) used to characterize variable components in house dust

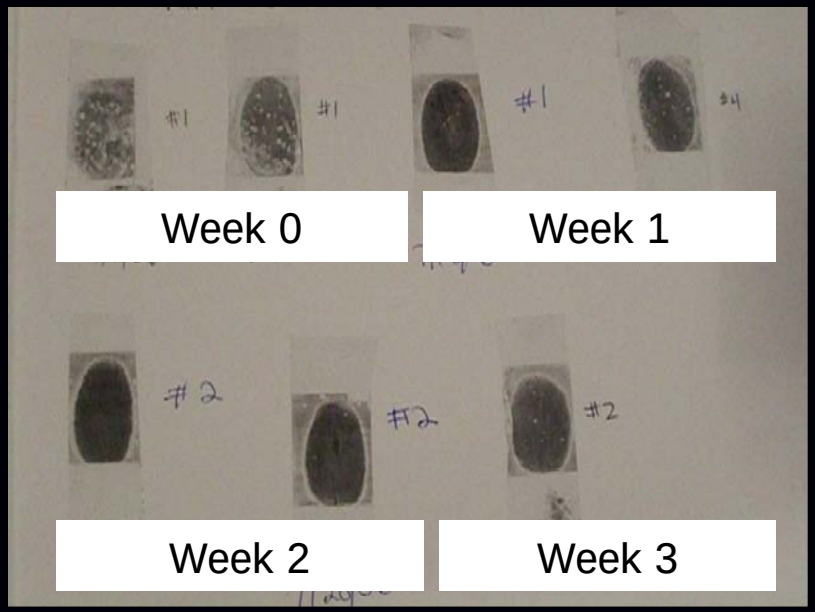


Rasmussen et al. 2001. *Sci. Tot. Environ.* 267(1-3) 125-140

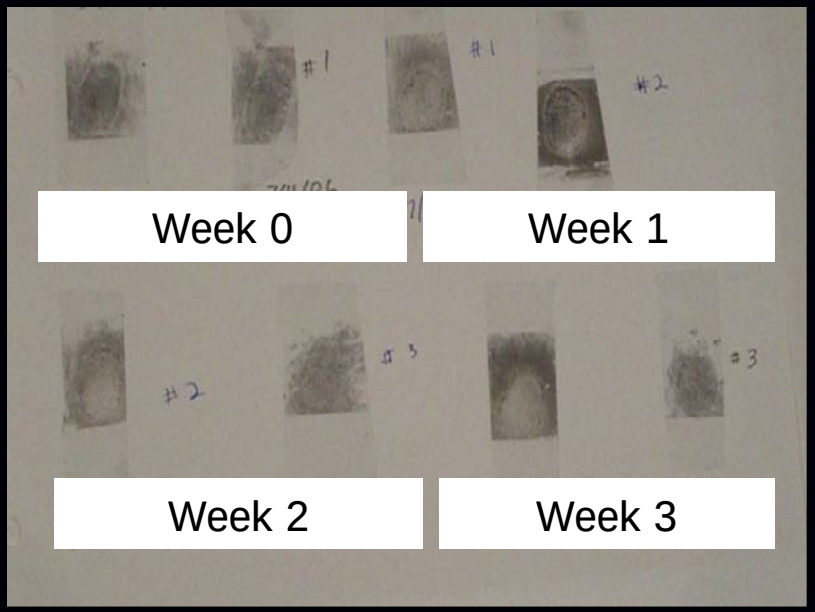
Heather Jamieson (Queen's U.), Steve Walker (Queen's U.), Tony Lanzirotti, Health Canada, NSLS

Children's vs. Adults' Fingerprints

Fathers



Sons



Why do children's fingerprints disappear faster than adults?

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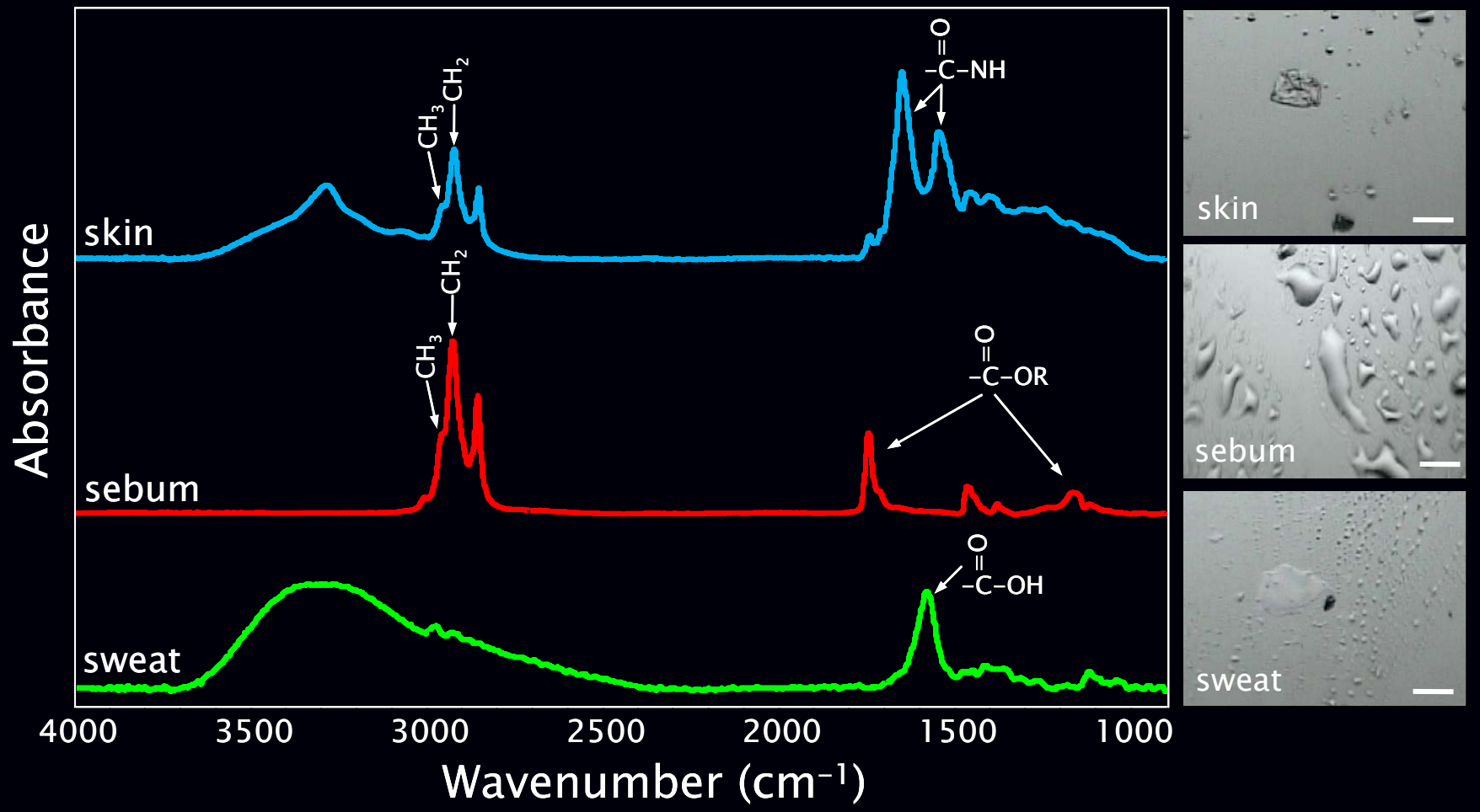
Children's vs. Adults' Fingerprints



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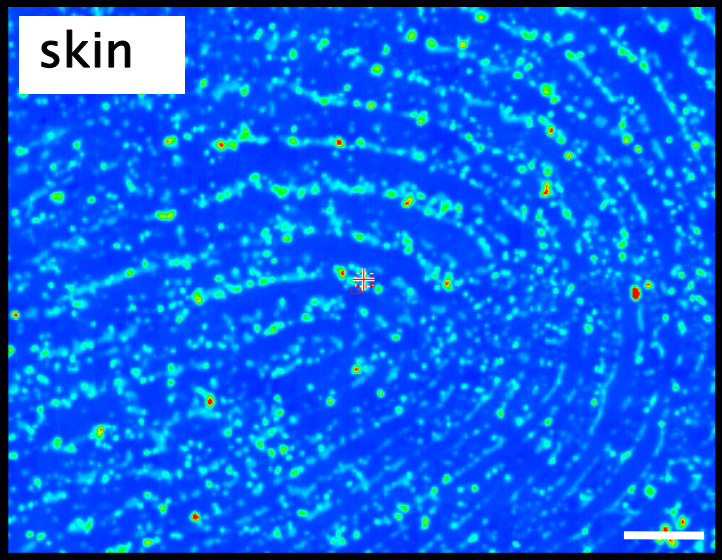
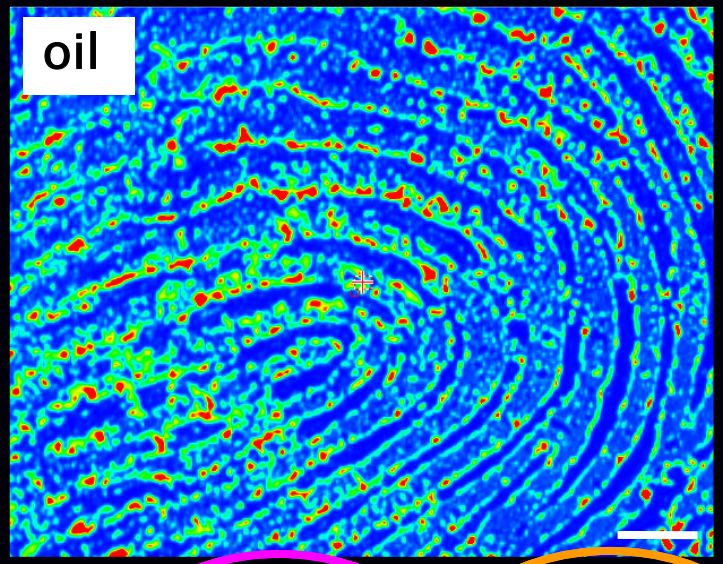
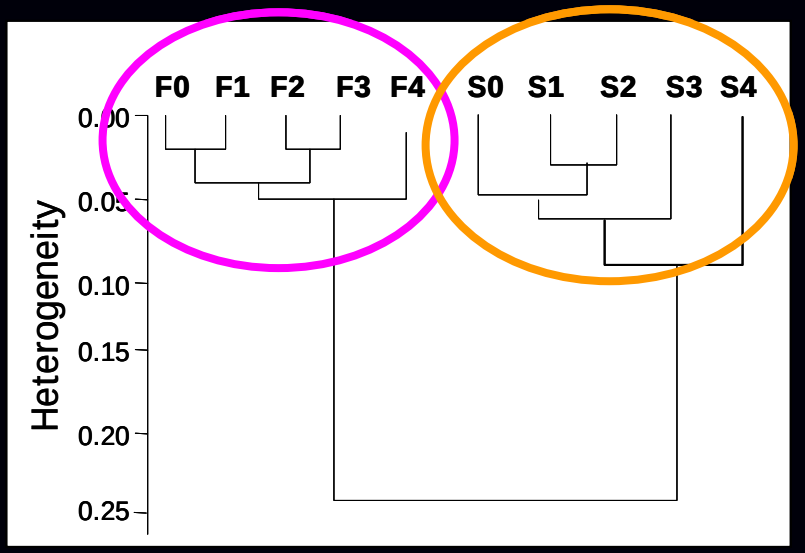
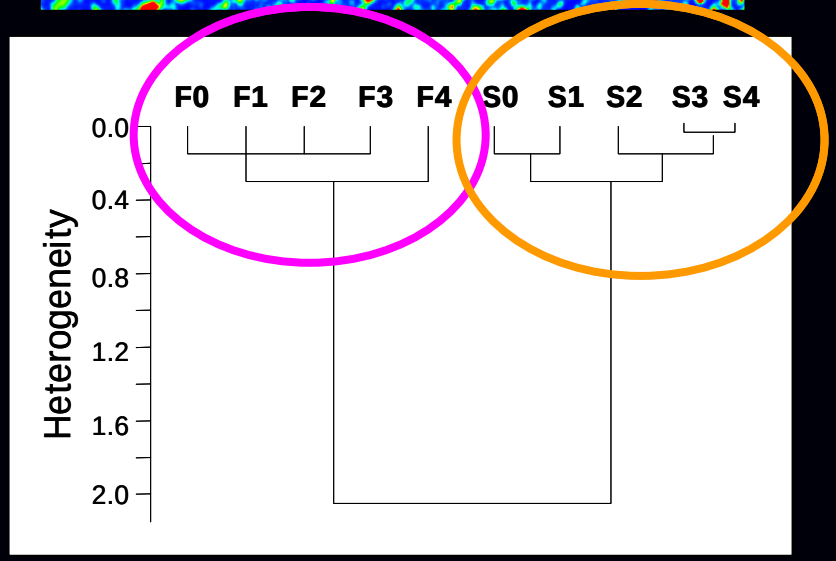
Antoine, et al., *J. Forensic Science*, 2010

FTIR Microscopy of Fingerprints



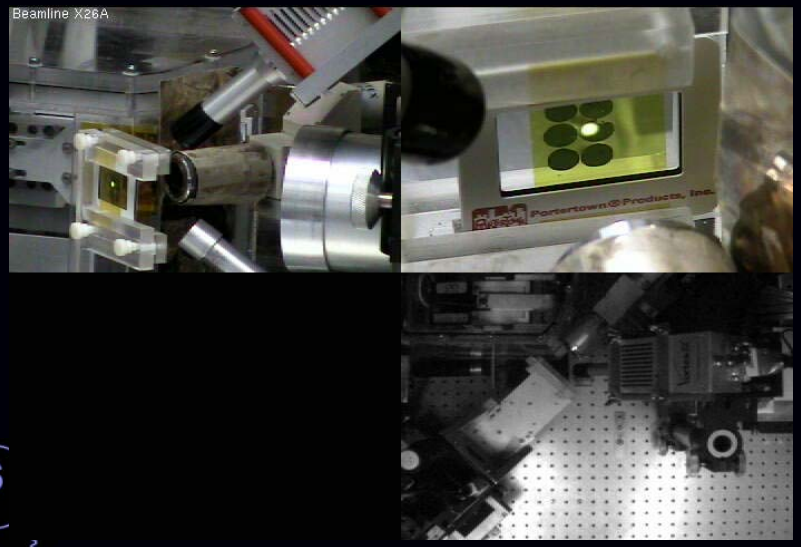






Fathers' prints cluster separately from the sons' prints

Ease of Use – Even from Afar



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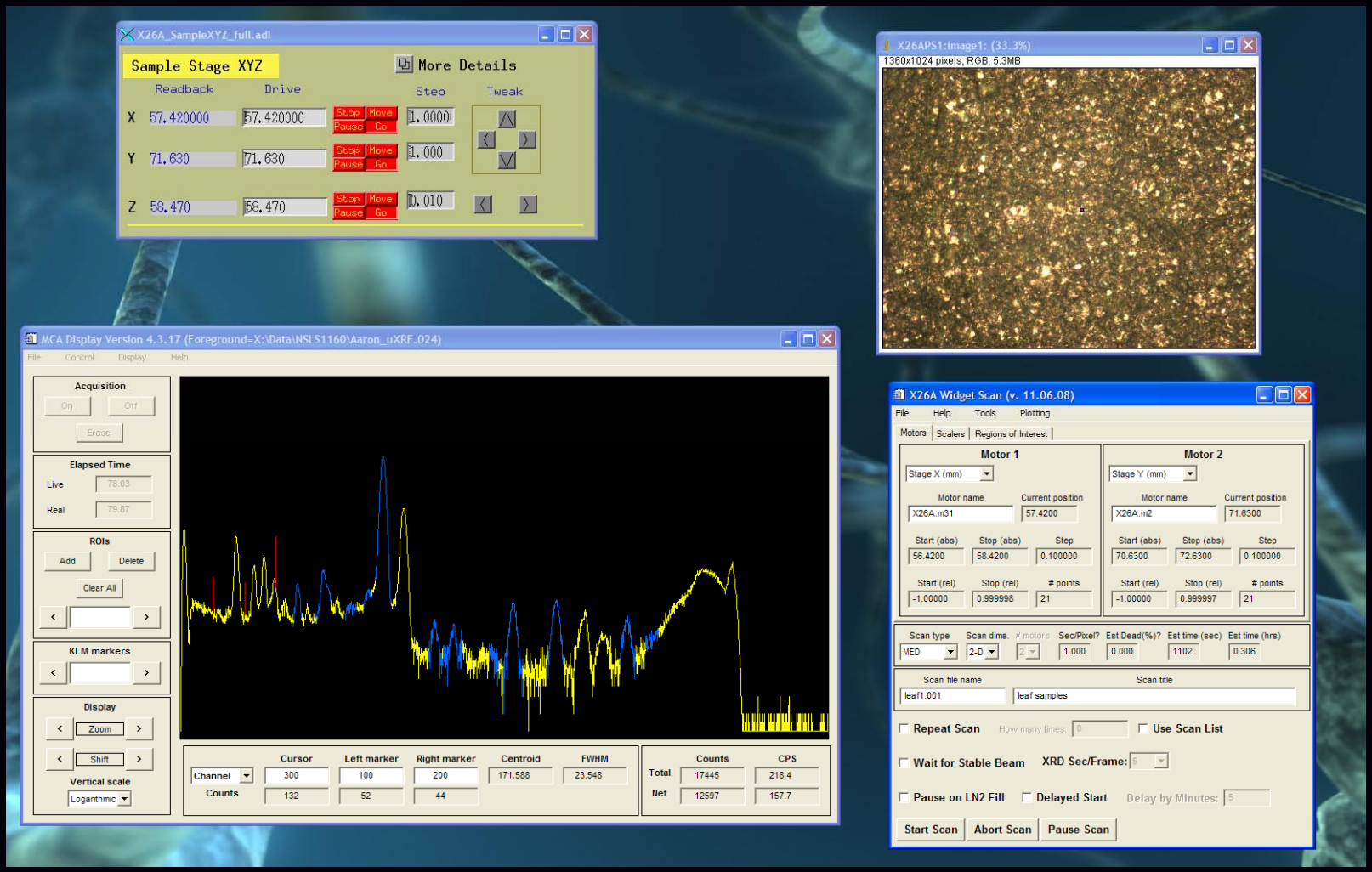

The Australian Synchrotron Education Program

Jonathan de Booy
Education and Outreach Officer

Australian Synchrotron

Synchrotron Science is part of the Science Curriculum for "High Schools" in the state of Victoria, Australia

"If we pay for it, you will teach it!"

- Web-Based Educational Virtual BeamLine (eVBL)
- Real synchrotron light to perform Young's double slit experiment
- Teachers book 30 minute time slots on a web based schedule
- Performed in Real-Time

- The eVBL is located in the ODB Hutch at the Australian Synchrotron
- Professional optical equipment has been used.
- This uses Live Beam - not simulated.

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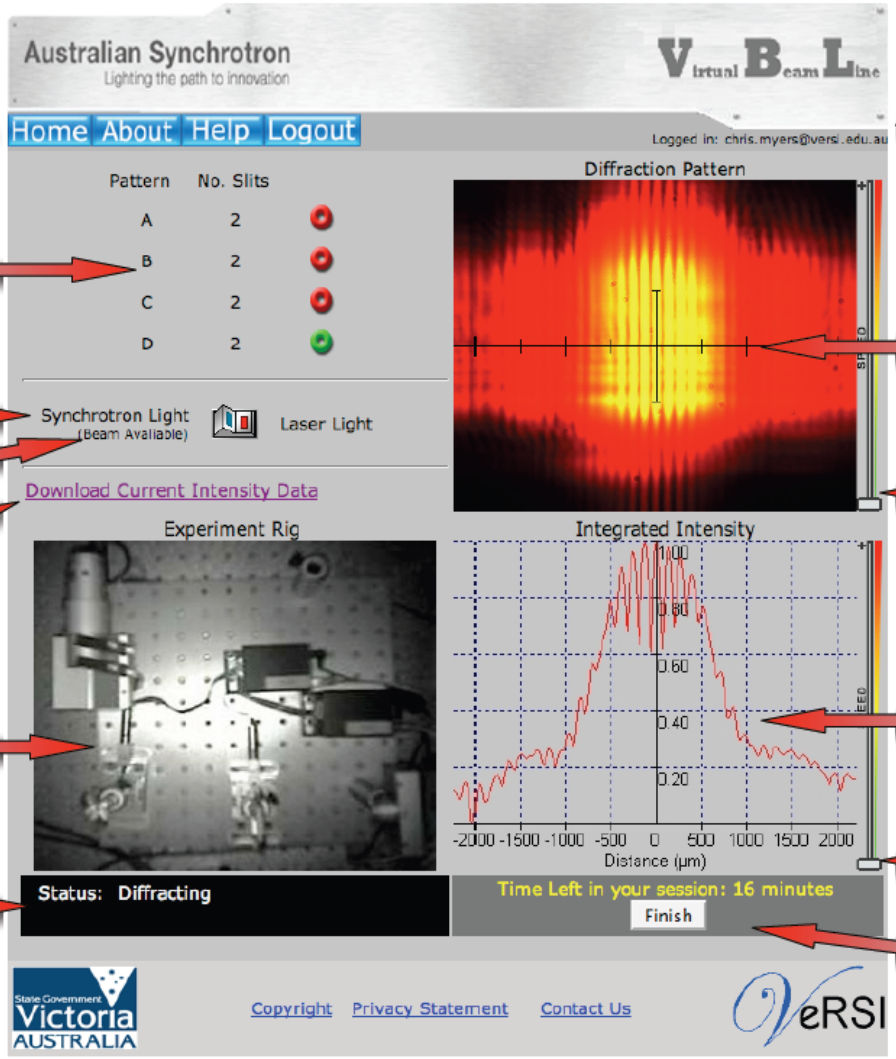
eVBL control window quick reference.



main navigation buttons.

Slit pattern selector area.
The green button indicates the currently selected Slit.
Click on a red button of an alternative slit to move that slit into the beam.
Buttons will be yellow whenmotors are in movement.

Light source selector.
This toggle switches between Synchrotron light and laser light.

The status of the synchrotron Light will be indicated here:

This link will take you to a separate page with the current data used to produce the intensity graph, at right.

Experiment Rig
This is a still image of the birds eye view of the experiment rig
Move your mouse over the different items will provide information on the rig's elements.

This status monitor will show the current activity of the eVBL.
e.g. the motors moving a different slit into place.

The logged in user will appear here.

Diffraction Image
This is the current diffraction image produced by the CCD camera.
This image is automatically refreshed.
If you click on the image a high resolution image will appear in a separate window.

This slider will increase the refresh rate of the image.
Internet speeds above 2 Mbps are required for higher refresh rates.

Integrated Intensity Graph
This is the current intensity graph, with data for the graph from the diffraction image above.
This image will automatically refresh.
If you click on the graph a larger graph will appear in a new window.

This slider will increase the refresh rate of the image.
Internet speeds above 2 Mbps are required for higher refresh rates.

This area will indicate if you are in view only mode, rather than control mode.
In control mode it will show the time remaining in the current session.
The finish button will take you back to the home page

SMART Teams

Students Modeling A Research Topic

Tim Herman
Milwaukee School of Engineering

A minimally-invasive, cost-effective way to introduce students to the research.

Teams of high school students work with a local research lab to create a physical model of a protein that is being investigated in the lab.

The magic of models…..

MSOE Center for BioMolecular Modeling

Study of bivalves from local Long Island estuaries

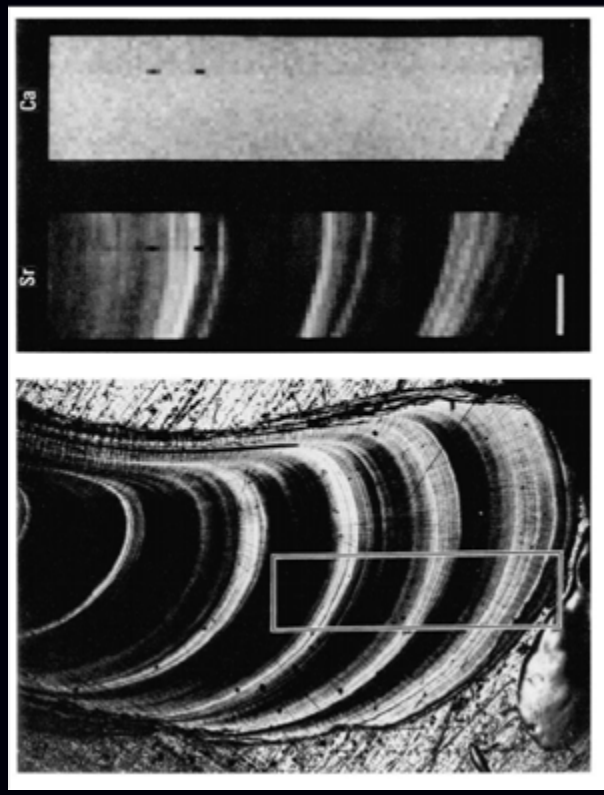
- Bivalves are useful as an indicator of environmental health in our estuaries with links to many different sciences.

- Project led by Keith Jones at BNL

- **Longwood High School**: Ivan Suarez (Teacher) and Devon McGhee (Student).

- **Sayville High School**: Maria Brown and Janet Kaczmarek.

- Relatively high levels of As found in soft tissue and sediments.



Introducing Synchrotrons
into the Classroom

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What is InSync?

- A program to enable high school teachers and students to gain remote access to synchrotron beamtime through a competitive, peer-reviewed proposal process.
- The program will train both teachers and students to formulate a hypothesis-driven scientific problem and learn the skills of writing a competitive beamtime proposal.
- Supported and Funded the NSLS and DOE's Office of Workforce Development to enhance science education at the high school level.

Who can Participate?

- This program will start with local Long Island high schools.
- Any science program can participate
- We anticipate that in the future this will be expanded to a nationwide competition and involve all US synchrotrons.

Implementation

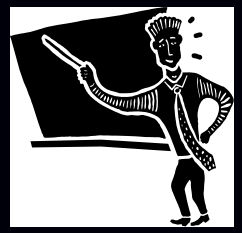
3 Day Teacher Training Course

Advice

Teachers & Students formulate a hypothesis and experiment

Teachers & Students submit Proposal

Peer Review



Proposals Receive 1-5 Rating

Highest Rated Scheduled for Remote Access

Score too low for this cycle On-line guest lecture

Implementation

Teacher training:

- Teachers interested in participating would first take part in an intensive, 3-day synchrotron training program at Brookhaven National Laboratory.
- Introduction to synchrotrons and techniques, hands-on experiments, tours, and proposal-writing sessions.

Implementation

Beamtime Proposals:

- Early in the fall term, teachers and students will formulate a hypothesis and set of experiments using conventional and synchrotron-based methods.
- A beamtime proposal will be written and submitted online
- An NSLS Proposal Review Panel (PRP) will review and score the proposals. The PRP will consist of a mix of synchrotron scientists and high school teachers, and ratings will be based on scientific merit and the educational nature of the project.
- The highest rated proposals will be allocated reserved beamtime

Implementation

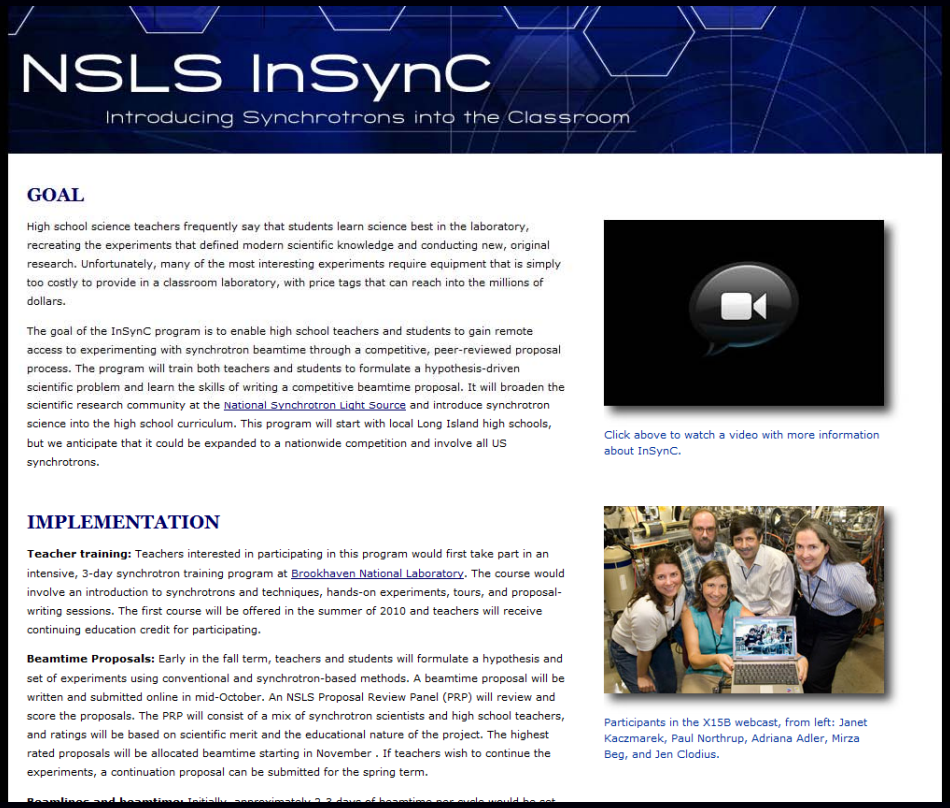
Available Beamlines & Beamtime:

- Initially, approximately 2-3 days of beamtime per cycle would be set aside at 4-6 beamlines for InSynC proposals.
- These will include:
  - X-ray fluorescence microprobe beamline
  - Infrared microscopy beamline
  - Protein crystallography beamline
- As additional beamlines are outfitted, more beamlines will be made available.

Implementation

Areas of Research:

- InSynC proposals will be accepted in all areas of scientific research.
- However, the need for synchrotron technique(s) should be emphasized and an appropriate beamline must be available.
- Initially, experiments in earth and environmental sciences, bioenergy, biomedical imaging, and structural biology are encouraged.
- Engineering proposals involving the development of robotics for beamline operations will also be considered.



NSLS InSynC

Introducing Synchrotrons into the Classroom

GOAL

High school science teachers frequently say that students learn science best in the laboratory, recreating the experiments that defined modern scientific knowledge and conducting new, original research. Unfortunately, many of the most interesting experiments require equipment that is simply too costly to provide in a classroom laboratory, with price tags that can reach into the millions of dollars.

The goal of the InSynC program is to enable high school teachers and students to gain remote access to experimenting with synchrotron beamtime through a competitive, peer-reviewed proposal process. The program will train both teachers and students to formulate a hypothesis-driven scientific problem and learn the skills of writing a competitive beamtime proposal. It will broaden the scientific research community at the National Synchrotron Light Source and introduce synchrotron science into the high school curriculum. This program will start with local Long Island high schools, but we anticipate that it could be expanded to a nationwide competition and involve all US synchrotrons.

Click above to watch a video with more information about InSynC.

IMPLEMENTATION

Teacher training: Teachers interested in participating in this program would first take part in an intensive, 3-day synchrotron training program at Brookhaven National Laboratory. The course would involve an introduction to synchrotrons and techniques, hands-on experiments, tours, and proposal-writing sessions. The first course will be offered in the summer of 2010 and teachers will receive continuing education credit for participating.

Beamtime Proposals: Early in the fall term, teachers and students will formulate a hypothesis and set of experiments using conventional and synchrotron-based methods. A beamtime proposal will be written and submitted online in mid-October. An NSLS Proposal Review Panel (PRP) will review and score the proposals. The PRP will consist of a mix of synchrotron scientists and high school teachers, and ratings will be based on scientific merit and the educational nature of the project. The highest rated proposals will be allocated beamtime starting in November . If teachers wish to continue the experiments, a continuation proposal can be submitted for the spring term.

Participants in the X15B webcast, from left: Janet Kaczmarek, Paul Northrup, Adriana Adler, Mirza Beg, and Jen Clodius.

Thank you:
- NSLS and JPSI
- DOE Office of Workforce Development
- OEP (Ken White, Mel Morris, Noel Blackburn)
- Keith Jones
- Our workshop speakers
- High School Teachers

NSLS InSynC Website: http://insync.nsls.bnl.gov/
or contact Scott Bronson (sbronson@bnl.gov, 631.344.4385)