Replacement Resources for Current and Anticipated SLAC SMS Group Support for LCLS*

Dave Dowell and Peter Stefan Rev 5: 2008/4/28

1. Identify LCLS support from SLAC SMS Group
    a. current support
        i. injector/cathode
            1. Cathode Qualification System

The current cathode support consists of operation of the Cathode Qualification System (CQS) with capabilities for QE vs wavelength measurements, ion cleaning, and XPS and AES characterization of the LCLS cathodes. This system was built using a combination of LCLS and SMS resources. This system has now been moved to the Klystron Building Cathode Lab and is being reassembled and its operation tested before B. Kirby leaves April 7. A technician, Dale Miller has taken responsibility for moving the CQS, is being trained on its operation and will be operating it to provide LCLS cathodes. This has been done with the support of the Klystron Dept., but future budget is needed to maintain and operate this system. This system would become a resource for the Sector 0 ITF, as described in the last R&D proposal to BES.

            2. Cathode storage

There are three UHV vacuum chambers for storing LCLS cathodes. These chambers have UV-transmitting windows and an electrical pickup for measuring the QE. The UV source is a Xenon lamp and tunable monochromator. The monochromator and one storage chamber has been moved to the Load Lock room at Sector 20 for QE studies. The other chambers with cathodes are in the Klystron Cathode Lab. Axel Brachmann is working putting the Load Lock room system together.

        ii. Electron beam diagnostics
            1. Polishing of metal surfaces

The metal mirrors used in the YAG screen assembles were hand polished by SMS.

        iii. LCLS undulator chamber
            1. Surface roughness measurements using AFM and profilometer.
                a. The SMS AFM and profilometer have been moved to the Klystron Dept. Support will be needed to install and operate these systems.
            2.
        iv. quality assurance/failure analysis

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This work was performed in support of the LCLS project at SLAC.

1. Electron Microscope (EM) measurements of surface structure and particle contaminates
    a. The two EM's will remain in the basement of Central Lab Annex and can be operated by Lisa Laurent (Klystron Dept.).
2. Other analysis can be provided commercially by http://www.imrtest.com/

We suggest that a continuing contract be opened with a qualified materials testing company to expedite any future work. The time it takes to establish a contract would be unacceptable when an emergency strikes. SLAC should consider sending known samples for analysis to the potential vendor in a trial to verify the quality of work and response time.

b. anticipated possible/future support areas
    i. injector/cathode
        1. New cathodes will be needed for the LCLS gun and the ITF.
            a. Single crystal copper cathode should be fabricated and characterized
            b. CsBr cathode
                i. The collaboration with the Piero Pianetta Group (SSRL) to develop the CsBr cathode for the LCLS gun should continue. This work can be done using the CQS with Juan Maldonado (SSRL).
        2. New R&D gun and diagnostics for ITF
        3. Cathode R&D
            a. We have established and will continue our informal collaboration with Howard Padmore's group at LBNL. This group has agreed to provide us with PEEM analysis of cathode surfaces and thermal emittance and angular distribution measurements. SMS provided a sample for these studies.
            b. There is also an informal collaboration with John Smedley (T. Rao's group at BNL) on laser cleaning. SMS has been providing the samples for the BNL studies.
    ii. quality assurance/failure analysis

Provided by one of the vendors listed below.

2. Identify Possible Replacement Resources
    a. discuss options and resources with Bob Kirby

This has been done and critical equipment has been moved to Klystron and S20 load lock room. Additional equipment moved to Klystron includes the profilometer, hardness measurement and misc. metallographic equipment.

b. trained SLAC technical staff to operate Cathode Qualification System

Axel Brachmann (LCLS) has taken over the software for the CQS and the cathode storage chamber testing systems. And Dale Miller (Klystron) is being trained on the CQS. Budget is needed to support Dale, and a small level of M&S is needed for both systems.

c. Electron Microscopes, AFM and Profilometer

The EM's will remain in the Central Lab Annex and be operated by Lisa Laurent (Klystron). The profilometer has been moved to Klystron.

d. Stanford campus facilities
    i. Stanford Nanocharacterization Laboratory:

        A reasonable range of surface analytical techniques is available at SNL. However, the emphasis is certainly on student/user use. The availability of the technical staff for "service" work is certainly not assured; they are very busy. (See Appendix A at the end of this document.)

        Some modest microscopy facilities are available in the TEM sample preparation laboratory.

    ii. other possible Stanford campus facilities
        1. surface analytical techniques: none located to date
        2. metallography: see end of Appendix A
        3. microscopy: Some available at the Crystal Shop, and at the metallography facilities in MSE.
        4. thin film deposition: Known capability at Ginzton lab. Not clear if it will survive the upcoming move.

e. Commercial Facilities
    i. commercial metallography/failure analysis: http://www.imrtest.com/
    ii. Evans Analytical Group, Sunnyvale, California (surface analysis)

        A wide array of analytical techniques is available here, not only in their Sunnyvale laboratories but also in laboratories located in Texas, New York, and Arizona. Their website outlines straightforward procedures to submit samples for analysis. I also have their current Analytical Services Price List. Most of their customers are involved in the semiconductor industry. Clearly, "service" is the name of the game. Expedited service is available in several "tiers", at a price premium. From my tour, it is a professional service, professionally run.

Nevertheless, the sample-handling capabilities of the SMS small-spot XPS may be difficult to duplicate either at EAG or SNL. As I understand it, it was a custom design, capable of accepting samples up to 6 inches in diameter, and quite oddly shaped. Understandably, many commercially-interesting samples are either thin plates or large wafers. Large, oddly-shaped things are always difficult to transfer and position for analysis. If such analysis is needed for the LCLS, it may not be feasible to do on the outside.

3. SLAC Coordinator to match "issues" with "resource vendors"

A knowledgeable materials/surface scientist is needed to provide assistance in determining the course of action, the selection and oversight of vendors, and the evaluation of test results.

SMS Quality Assurance and Failure Analysis (from SLAC website)

1. QA and other analytical services:
    a. including failure analyses
        i. optical and electron microscopy
        ii. XPS
        iii. Auger spectroscopy
        iv. metallographic bulk analysis
        v. energy-dispersive x-ray analysis
    b. measurement techniques
        i. microbalances
        ii. surface profilometry
        iii. atomic force microscopy
        iv. spectrophotometry
        v. low-energy x-ray fluorescence for film thickness measurement
    c. materials qualification
        i. metallography
        ii. quantitative energy-dispersive x-ray spectrometry
    d. vacuum deposition of metal films
2. Recent examples of this service support:
    a. autopsy examination of SPEAR3 electron injector dispenser cathodes
    b. contamination analyses of EXO chamber materials
    c. post-mortems on LCLS test facility copper photocathodes
    d. QC on stainless flanges for LCLS construction
    e. Metallographer/Materials Scientist
        i. QC critical klystron-manufacturing materials
            1. particularly OFE copper.

Appendix A: Information and Tours of SNL, the Crystal Shop, and MSE Metallography Facilities

(Information grabbed from the web site, http://www.stanford.edu/group/snl/ , 2008/4/4.
Toured facilities 2008/4/14 & 25 [see end of document]. Peter Stefan)

Welcome to the Stanford Nanocharacterization Laboratory
located in the Geballe Laboratory for Advanced Materials

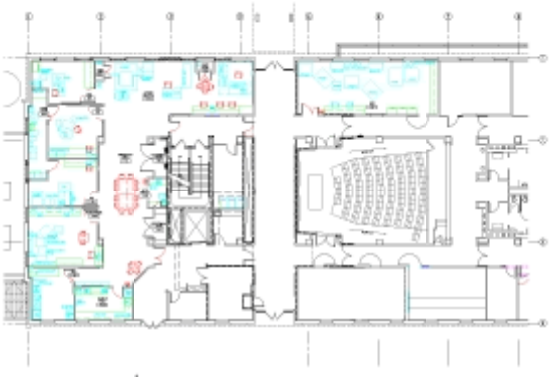
The Stanford Nanocharacterization Laboratory (SNL), housed within the Geballe Laboratory for Advanced Materials, provides modern facilities for the characterization of materials. It is a sister facility to the Stanford Nanofabrication Facility (SNF) in Stanford's National Nanotechnology Infrastructure Network (NNIN) program. The instruments are available for all qualified users in the Stanford community, and for Stanford collaborators both locally and globally. Our mission is to provide high quality, useful data and insight for as wide a range of users as possible. We have several types of high resolution microscopes, X-ray diffractometers, and surface science analytical instruments.

News update!

Our dedication ceremony was October 5, 2005. Please come by and take a tour of our facilities.

The 2007 Annual Report is available in word and pdf formats.

We are located in the Geballe Laboratory for Advanced Materials, on the Science and Engineering Quad at Stanford University.



Here is the floorplan of the facility. Click to zoom in to a particular area.

(this is the web “site map”)

About SNL

- SNL Staff members
- Visiting SNL
- FAQs

Equipment

- Focused Ion Beam Laboratory
- Transmission Electron Beam Laboratory
  - TEM Specimen Preparation Laboratory
- Sirion Scanning Electron Microscope Laboratory
- Electron Microprobe Analysis Laboratory
- X-Ray Photoelectron Spectroscopy Laboratory
- X-Ray Diffraction Laboratory
- Scanning Probe Microscopy Laboratory
- General Lab Information

Labmembers

- Notices
- Faculty Labmember list (alphabetical)
- Faculty Labmember list (departmental)
- Equipment Calendars
  - FIB
  - SEM
  - SPM
  - TEM
  - XPS
  - X-ray
- SU-13 Form
- Rate Chart

Research

SNL Affiliates

Links

Contacts

(list of equipment)

Focused Ion Beam (FIB) Laboratory

Transmission Electron Microscope (TEM) Facility

Sirion Scanning Electron Microscope (SEM) Laboratory

Electron Microprobe Analysis (EMPA) Laboratory

X-Ray Photoemission Spectroscopy (XPS/ESCA) Laboratory

X-Ray Diffraction (XRD) Laboratory

Scanning Probe Microscopy (SPM) Laboratory

TEM Specimen Preparation Laboratory

Scanning Auger Spectroscopy Laboratory

(This is the “rate schedule”. A little further explanation may be helpful.

The number of permanent technical staff members is small [5] and the number of users is large [> ~500]. Therefore, a primary role of the permanent staff is to train new users. Once trained, the user has access to the lab 24/7, for the cost listed as the "Equipment Usage Rate".

For some instruments, "service" work can be done. That is, if the staff can make time, they will run your sample for you. Only for those instruments for which a "Consultation Hourly Rate" is listed is service work available. When available [the time available by the staff is typically quite limited], the cost will be the sum of the Equipment Usage Rate and the Consultation Hourly Rate. Generally, this is approximately equal to the "Training Hourly Rate", since training also employs one of the staff members and usage of the equipment.)

Facility	Account No.	Equipment Usage Rate ($/hr)	Consultation Hourly Rate ($)	Training Hourly Rate ($)	Specimen Prep Hourly Rate ($)	Equipment usage Full-Month Rate ($)
FIB Laboratory	1059485 100 ACAEJ	65.00	55.00	120.00		1560.00
SEM Laboratory	1001026 100 ACACI	36.00	58.00	94.00		864.00
SPM Laboratory	1001011 100 ACACW	25.00		25.00*		600.00
TEM Laboratory CM-20	1001053 100 ACADZ	98.00	69.00	142.00	98.00	2352.00
XPS Laboratory	1001049 100 ACADK	55.00	63.00	118.00		1320.00
X-Ray Analytical Lab	1001010 100 ACACL	30.00		30.00*		720.00

* Training only, no service

Other Charges:

TEM: film $1/each

Note: Rates are subject to change without notice. This chart is current as of April 2007. Please check with the lab manager if you have any questions.

Staff Directory: Functional area

Last, First	Responsibility or Title	Phone	Email
Beasley, Malcolm	Director, GLAM	723-1196	beasley@stanford.edu
Sinclair, Robert	Director, SNL	723-1102	bobsinc@stanford.edu
Marshall, Ann	FIB, SEM, TEM	723-3572	marshall@soe.stanford.edu
Vailionis, Arturas	XRD	723-0187	arturas.vailionis@stanford.edu
Jones, Bob	EMPA, SEM	725-1677	bobjones@pangea.stanford.edu
Hitzman, Charles	XPS, Auger		chitzman@stanford.edu
Chin, Richard	SNF/SNL Liaison, FIB, SEM, TEM	723-8142	rwchin@stanford.edu
Gage, Max	SPM (Graduate Student)	723-8103	davegage@stanford.edu
Oliver, Mark	SPM (Graduate Student)	724-8657	msoliver@stanford.edu
Chiu, Droni	Administrative Director	723-0400	dchiu@stanford.edu
Candido, Larry	Facilities & Safety Manager	723-7546	lhc@stanford.edu
Gibson, Mark	Lab Services Coordinator	723-4006	mdg@stanford.edu
Han, Carol	Accounting Associate	725-1457	carolhan@stanford.edu

Tours, 2008/4/14 & 25:

Rich Chin showed me the instruments and the TEM sample preparation laboratory. During the tour, I also met Bob Jones and Ann Marshall.

The labs are open and uncluttered, very similar to the architectural view on page 1. Most of the instruments are only a few years old at the most, and in good condition. Extensive use is made of the instruments. For some instruments, reservations are booked two weeks in advance and the instruments themselves are used an average of 20 hours a day. As many as 500 users are trained to use some of the instruments.

Nevertheless, it is clear that the primary purpose of the instruments is for student use. A primary role of the professional staff is training of users. They don't have much time for "service" work. For anything more elaborate than a single sample here or there, they much prefer to train a potential user. Once trained, a user has 24/7 access to the labs.

I also asked about metallographic capabilities and crystal/sample polishing. At present, the outlook is actually rather encouraging. The TEM polishing facilities at SNL are modest, and intended for small, TEM samples.

The present capabilities in the Materials Science and Engineering school have moved with the department from the Peterson building to the Durand building. These facilities do not include dedicated service staff; they are a "teaching laboratory". The

professor in charge of the lab, Dr. Seung Min Han, trains students and others in the use of the equipment. They have cutting, mounting, grinding, lapping, polishing, etching, and microscopic examination facilities. The lapping/polishing tables are all for "hand operations"; you hold the sample in your hands. Polishing for extended periods of time, therefore, is not a viable option.

There is another facility, associated with Applied Physics, called the Crystal Shop in the Ginzton lab. I initially saw the lab from the outside, and it appeared to include not only cutting, grinding, and polishing apparatus but also x-ray alignment gear. Tim Brand runs the shop. The Crystal Shop is alive and well, and there is a good chance that it will be moving to the new Applied Physics building. It is a two-person operation. They do all kinds of cutting, slicing, dicing, and polishing operations, both metals and non-metals. Except for very toxic things (they do polish GaAs, but in hooded, vented machines), they are willing to try almost anything. A first attempt at something new is generally at no charge, since they don't know if a satisfactory result can be obtained. If successful, they'll charge for subsequent work. The Crystal Shop receives about 20% of its work from Applied Physics, and the remainder mostly from Materials Science and Chemistry. They pay for themselves! General prototype work, and one or two of something, is their standard fare; they don't want to do thousands.

After visiting the lab, I'm impressed by the quantity and variety of work performed. Essentially all their polishing/lapping tables have planetary drive systems, to enable long-duration automatic polishing. They literally had half a dozen or more machines at work on various samples when I was there. Their "inbox" had additional work in the queue. It is in operation with a great depth of experience and expertise. It is run for good efficiency of effort; multiple samples are polished together in almost every case. It is quite impressive and is available to SLAC!