The NanoWire

"NANO NEWS IS GOOD NEWS"

ISSUE #6, FALL 2007

INSIDE THIS ISSUE:

New Equipment !

STS PECVD System

The system is installed in LISE cleanroom and its main characteristics are as followings: Dual-Frequency powered upper electrode; RF biased lower electrode, heated up to 400°C; single wafer loadlock up to 6" wafer; be able to deposit SiO2, Si3N4, low stress Si3N4, a-Si, P- or B- doped a-Si, and BPSG; Windows 2000 software control PC; Internet remote control capability. For more information contact Ling Xie (lxie@cns.fas.harvard.edu, 617-496-9069).

Veeco AFM

Located in the Metrology bay of LISE Nanofabrication Facility, the new Veeco NanoMan VS AFM (atomic force microscope) incorporates the proven Dimension™ platform, the advanced NanoScope V controller, making it the system suitable for measuring surface characteristic of semiconductor wafers, lithography masks, photonics devices, and other samples up to 200mm in diameter. The Operation Modes and Applications include:

Contact AFM mode, Tapping AFM Mode (same as AC mode in Asylum AFM), Lateral Force Mode, Torsion Resonance (TR) Mode , Magnetic Force Imaging, Electric Force Imaging , Nanolithography and Manipulation

Please contact Jiangdong Deng for training on this instrument (jdengcns.fas.harvard.edu, 617-495-3396).

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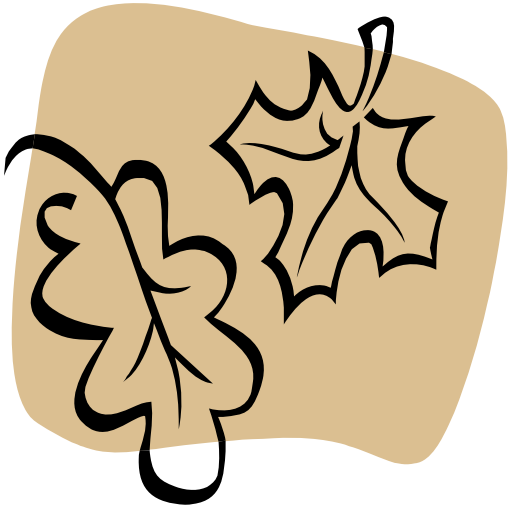
Harvard University Center for Nanoscale Systems

Letter from the Director

After years of planning and construction I am pleased to report that the shared laboratory spaces of the LISE building are finally being fitted with relocated and new instruments, and are open for use. These openings represent a significant intersection of two destinies – those of our Center for Nanoscale Systems and the LISE building. These destinies were linked when LISE was commissioned as a multi-disciplinary, pan-departmental facility, with a mission to support experimentation with significant scientific apparatus which could not be affordably or efficiently operated in independent faculty labs. In support of that mission, LISE was designed to support the environmental requirements of these instruments, and CNS was charged to operate these instruments productively, fairly, reliably, and affordably. So after the many years of preparation, it's wonderful to finally be ramping up operations here in LISE.

As you begin to use the LISE core laboratories you will find that our operations function in three main locations. The LISE basement level "B" (with levels "M" "G" and "B" all underneath the birch tree grove on the roof of the building, it's not always obvious what one means by "basement") is the home to low vibration imaging and materials apparatus including our TEMs, SEMs, sample preparation area, XPS and one of two new FIBs (the other being in the cleanroom). The "G" level under the LISE tower houses three suites for materials characterization including AFM, NSOM, and confocal microscopy, a bio-materials lab with ultra-microtome, and a nanochemical room



supporting our Soft Lithography Foundry and our nanoparticle facility. On the "G" level under the birch grove is the LISE cleanroom where all the operations from our two McKay cleanrooms are moving. The CNS administrative offices are now on the 3rd floor of the tower near the LISE conference rooms and building manager, Thomas Tribble.

There is much news to report, but this autumn issue of the Nanowire will provide only an overview of the many changes associated with our move into LISE. While you wait for our winter issue and more details on new instruments, please direct any questions you may have about our operations during this relocation period to me at emartin@cns.fas.harvard.edu.

Noah Clay

"If you don't have data, then all you have is another opinion."
-R. Nagarajan, former manager

Noah Clay was born in Belize City, Belize and grew up in Red Hook, NY. He attended SUNY Oswego where he earned a Bachelor of Science degree in Physics and then earned his Masters Degree in Electrical Engineering from Tufts University. He worked at Infinera for several years making photonic integrated circuits and worked for the past two years at Goodrich Corporation making photon counting avalanche photodiodes before joining CNS. He was hired in May 2007 as the Principle Nanofabrication Engineer and was promoted in September to Manager of the Nanofabrication Facility.

Noah currently resides in Lunenburg, MA with his wife and two sons, ages 1½ years and 3 weeks (at the time of the interview). His favorite pastimes are sailing and hiking.

Maureen Daniels

"While they were saying among themselves it cannot be done, it was done."
-Helen Keller

Maureen was born on the South Shore of Massachusetts and moved to Orange County California when she was 8. Fond of beaches, she eventually moved closer to the ocean and lived in Laguna, Seal, and Huntington Beaches. Seeking change, she moved to Boston 5 ½ years ago. She began working at Harvard's Environmental Health & Safety (EH&S) Department in 2003 in a position similar to the one she has now at CNS. She moved from EH&S to CNS this past October.

Maureen currently lives near Davis Square in Cambridge. Her recreational activities include her passion for photography, fine dining and travel.

Mac Hathaway

Mac Hathaway is one of the newer members of our team. Originally from NH, he now lives in Maynard, where he serves on the Planning Board. He is our new Equipment Engineer, setting up the brand new LISE cleanroom, and also assisting our cleanroom users with their research. Mac's previous experience in this field included stints at Ulvac Technologies, located in North Andover, Massachusetts, Lam Research, Oxford Instruments, and the Notre Dame Nuclear Structures Lab. He helped design the layout and facilities of the cleanroom at Ulvac, as well as purchasing equipment and supplies for the facility there. After that, he worked at Lam Research Corporation, at what is currently Intel's Hudson plant, working on oxide deposition. He became a CNS staff member on the 18th of October and says he's happy to be here.

As mentioned above, Mac lives in Maynard, with his wife and 2 daughters ages 7 and 9 years old. He attended the University of Notre Dame, in South Bend, Indiana and received a Bachelor of Science degree in Mechanical Engineering. It was at Notre Dame that he was first "drawn in" by the singular charms of high-vacuum physics. During his free time Mac enjoys recording classical music. He recently recorded the Windsor Music Chamber Group at Follen Church in Lexington and a vocal recital at BU's Marsh Chapel, which Mac says has "great acoustics". He would also like to direct everyone's attention to the regular Thursday noon organ recitals at the Busch-Reisinger Museum, across Oxford St.

How to Become a Center for Nanoscale Systems (CNS) User

CNS welcomes users from other academic and non-academic institutions to become Users of the CNS facilities. The majority of our facilities/tools are considered part of the NNIN program. Enrollment as a CNS/NNIN User is required in order to use any tool that is considered part of the NNIN. In order to determine whether the facility/tool that you wish to use is part of the NNIN program, please see the Facilities section of the CNS website. To become a CNS/NNIN User go to the CNS website /User Info: *http://www.cns.fas.harvard.edu/*.

If the facility/tool you are interested in using is not part of the CNS/NNIN User Program, you do not need to go through the enrollment process. Please contact the CNS staff member in charge of that tool and inquire about training and usage. That information can be found in the Facilities section of our website. CNS welcomes users from other academic and non-academic institutions to become Users of the CNS facilities.

If the facility/tool you are interested in using is not part of the CNS/NNIN User Program, you do not need to go through the enrollment process. Please contact the CNS staff member in charge of that tool and inquire about training and usage. That information can be found in the Facilities section of our website.

There are 10 steps to becoming a Nanofabrication Facility User

1. Enroll as a CNS/NNIN User

2. Complete Harvard EH&S Lab Safety Training

There is a CNS specific version of this training that is held every Tuesday morning from 9:30 to 10:45 a.m in room 303 of the Laboratory for Integrated Science and Engineering (LISE), 11 Oxford St., Cambridge, MA 02138. This version of the training is tailored specifically to use of CNS facilities and it is preferred that users attend this one. You do not need to register in advance in order to attend. If you have any questions or concerns regarding this training, please contact John Sweeney at: john_sweeney@harvard.edu

3. Re-read the School of Engineering and Applied Sciences/Physics/Earth and Planetary Sciences Department Safety Manual if it has been over six months since the last time you read it.

4. Complete the online Cleanroom User Protocol (CUP) training

5. Take and pass the online CUP Quiz

6. Read the Protocol for User Supplied Chemicals in the Cleanrooms

7. Complete McKay Cleanrooms Orientation.

Please contact one of the CNS Nanofabrication Facility staff members listed below to schedule a brief cleanroom orientation specifically for the McKay Cleanrooms. Please print out and bring a copy of the Cleanroom User Orientation Form to your scheduled orientation session.

USERS ARE RESPONSIBLE FOR PRINTING OUT AND BRINGING THIS FORM TO THE ORIENTATION. Upon completion, the CNS NF staff member will sign the last page of the form. You will also need to sign it as well. Once signed, the form needs to be turned into the CNS Admin. Office (LISE 306) in person or by fax 617-384-7302.

Nanofabrication Facility Staff available for conducting the McKay Cleanrooms Orientation:

Ed Macomber, 617-384-5227, eddiemac@cns.fas.harvard.edu
John Tsakirgis, 617-384-9651, jtsakirg@cns.fas.harvard.edu

8. For internal users, your HUID will be automatically activated within 48 hours upon completion of steps 1-7 for both McKay Labs cleanroom facilities. External users will have to contact the CNS Administrative Office at nninap-ply@cns.fas.harvard.edu in order to get a generic access card. Upon completing step 8, you are considered a McKay Cleanroom General Nanofabrication Facility User. This status entitles you to use any cleanroom or back-end tools in either McKay Labs Cleanroom that does not require additional, tool specific training and qualification.
See Below for additional steps required to become a qualified user of the new LISE cleanroom.

9. Attend LISE Cleanroom Orientation

Users must attend a LISE specific orientation in order to gain access to the LISE cleanroom (G07). This special orientation is given every Tuesday at 11am in LISE 303 by Harvard Environmental Health and Safety. If due to other commitments, you can never make that date/time, you will need to contact EH&S Officer, John Sweeney at john_sweeney@cns.fas.harvard.edu to set up a day and time for a special session of the LISE cleanroom orientation. This orientation is different than the McKay Cleanrooms orientation as there are different safety protocols.

10. Upon completion of the LISE specific cleanroom user orientation, you need to go to the CNS Admin. Office to get set up in the iris reader system that is used to access the LISE cleanroom. The only times that CNS will set users up in the iris reader system are:
Weekday Afternoons from 3:00 - 4:30 or Immediately following the Tuesday LISE cleanroom orientation session (all times are limited to the first twelve users on a first come, first served basis)

CNS has a LISE Iris Reader System Form on the Forms page of the User Info section of our web site. The Admin Office also has copies of this form available.

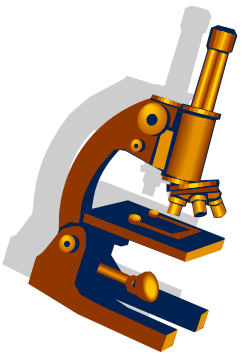
Once steps 1-10 are completed, you will be considered both a McKay and LISE General Nanofabrication Facility User.

Imaging and Analysis Facility Use

In order to become a User of one of the Imaging and Analysis facility tools you must contact the CNS staff member in charge of that facility/tool and arrange for training or assistance. To determine which staff member you should contact, please consult the Facilities section of our website.

Materials Synthesis Facility Use

In order to become a User of one of the Materials Synthesis facility tools you must contact the CNS staff member in charge of that facility/tool and arrange for training or assistance. To determine which staff member you should contact, please consult the Facilities section of our site.



New Equipment !

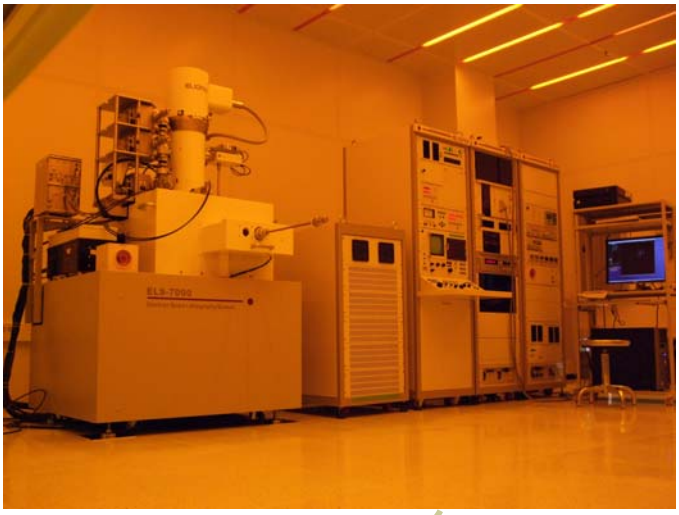
(continued from page 1)

Asylum 2 MFP-3DCoax AFM

The MFP-3D Coax AFM is a high-performance Atomic Force Microscope (AFM) designed for different research applications, including physics, materials science, polymers, chemistry, nanolithography, bioscience, and quantitative nanoscale measurements. It is a versatile AFM that combines molecular resolution imaging and pN force-based measurements on an inverted fluorescent optical microscope with a high speed camera. Combined with its ultra-low noise performance and unprecedented precision and accuracy, the MFP-3D Coax has raised the bar for AFM instrumentation in different CNS research areas. This instrument is located in LISE G04. For more information please contact Jiangdong Deng (jdeng@cns.fas.harvard.edu, 617-495-3396).

Elionix ELS-7000

The new Elionix ELS-7000 has 100kV capabilities to write fine patterns and to minimize proximity effects that occur when writing small patterns. In addition to the fine line capability, the stitching and overlay accuracy for writing small patterns over large areas is excellent on this system – specification is 30nm, but much better results were achieved during the installation tests. During the installation we were able to write finer lines, measuring 5nm, than what the manufacture specifies, 8nm. The instrument is located in LISE G07, the new cleanroom on the ground floor of the LISE building. For more information please contact Yuan Lu (ylu@cns.fas.harvard.edu, 617-495-2822).



FLS-2320 S Thin Film Stress

The FLX-2320-S determines stress by measuring the curvature change of pre- and post- film deposition. It can measure film stress from -65ºC to 500ºC at a heating rate up to 30ºC/min; handle wafer sizes from 75 mm to 200 mm; calculate biaxial modules of elasticity, linear expansion coefficient, and stress uniformity. The tool is located in LISE G07, the new Cleanroom, Metrology Bay. For more information contact Ling Xie (lxie@cns.fas.harvard.edu, 617-496-9069).

Biomaterials Lab

This lab is newly formed and houses biological imaging and cell culturing equipment including for a wide spectrum of projects including BL2. A sampling of available equipment is: multiple CO2 incubators, water baths (including a shaking), high volume centrifuge (with refrigerant capacity), ultra microtome, upright compound microscope, ultra-low temp. freezer, walk-in cold room, three laminar flow hoods (two which can be used for volatile chemical use), separate upright refrigerator and freezer, and many other small pieces of equipment. The bio room is located in LISE G-05, for more information contact Ellen Hodges (ehodges@cns.fas.harvard.edu, 617-384-8912).

KLA-Tencor P-16+ Contact Stylus Profiler

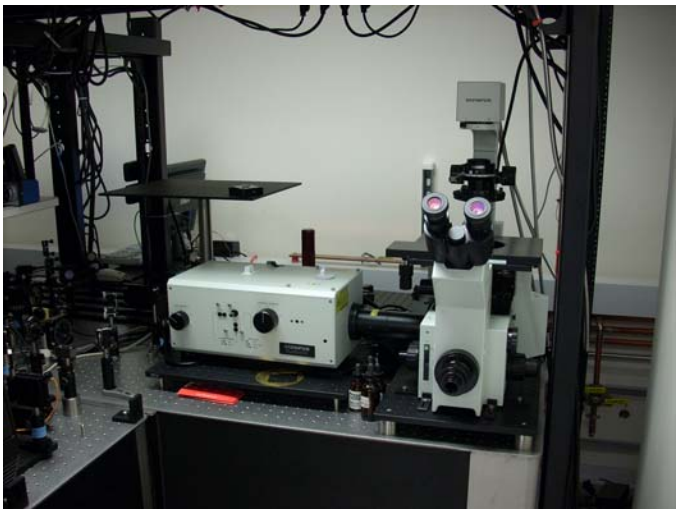
The KLA-Tencor P-16+ is a contact stylus-type surface profiler, which is capable of being utilized in a wide range of applications, such as CMP monitoring and bump metrology (semiconductor), thin film step height and stress analysis (material science), thin film head structure definition (data storage), microlense and diffuser shape (optoelectronics), etch rates and trench depth analysis (MEMS) as well as surface characterization of a variety of micro and nano structures in materials that are used across many industries from the general surface machining to biomedical devices. It delivers automated step height, surface contour, waviness and roughness measurements with detailed 2D or 3D analysis of topography for a variety of surfaces and materials, including soft materials like polydimethylsiloxane (PDMS). This instrument is located in LISE G06 (Soft Lithography Foundry). For more information please contact Fettah Kosar (fkosar@cns.fas.harvard.edu, 617-495-1738).

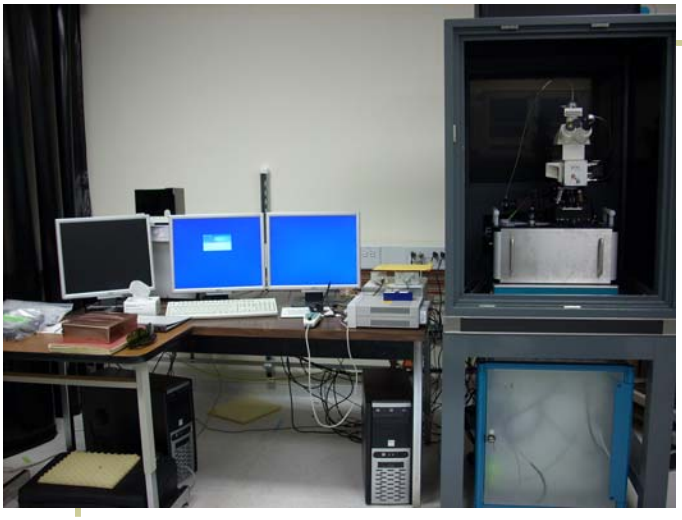
X-Tek HMXST 225 kV Micro-CT X-Ray Imaging System

The HMXST Micro-CT x-ray imaging system produces three dimensional images of biological, art, minerals and electronic component materials. The x-ray cabinet accommodates specimens up to 6” x 6” x 6”. The system is outfitted with an open source x-ray tube that has a resolution of 3-5 microns in reflection mode and 2 microns in transmission mode. The system has a Mo, W, Ag, and Cu x-ray targets. A Perkin Elmer 1621 x-ray panel provides 16” x 16” field of view with 3.5 frames per second readout and a pixel size of 2.5 microns. This system is located in LISE G27. For more information please contact Richard Schalek (rschalek@cns.fas.harvard.edu, 617-496-9682).

Olympus Fluoview 300 Confocal Microscope

The Olympus Fluoview 300 microscope is a laser scanning microscope that features three laser lines (488, 543, and 633 nm), one conventional confocal detectors, and two nondescanned (non-confocal) detectors. The microscope also offers multi-photon microscopy imaging modalities. This microscope is located in LISE G04. For more information please contact Martin Vogel (mvogel@cns.fas.harvard.edu, 617-496-8250).





WITec NSOM/AFM/Confocal Raman Microscope

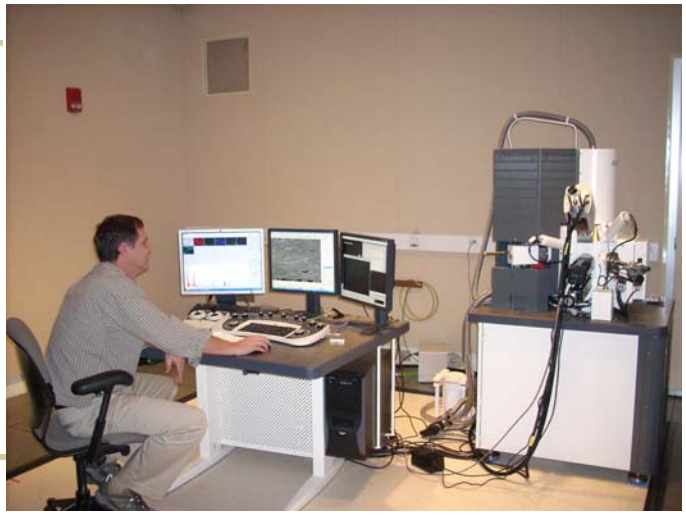
The Alpha300 is a user friendly Near-field Scanning Optical Microscopy (NSOM) that combines in a unique way the advantages of NSOM, Confocal Raman Microscopy and Atomic Force Microscopy in a single instruments. By simply rotating the objective turret, the user can choose from among Confocal Microscopy, NSOM or AFM. For NSOM, the alpha300 uses unique micro-fabricated SNOM-cantilever sensors for optical microscopy with spatial resolution below the diffraction limit. All standard optical modes such as transmission, reflection and fluorescence are available. The Alpha300-Confocal Raman Microscope offers the unique ability to acquire chemical information non-destructively with a resolution down to the optical diffraction limit (~ 200 nm). Due to the confocal setup, it is not only possible to collect information from the sample surface, but also to look deep inside transparent samples and even obtain 3D information. The Alpha300 integrates an AFM system with a scientific grade optical microscope for superior optical access and high-resolution sample survey. More specifically, the Digital Pulsed Force Mode in AFM, allowing local surface properties such as local adhesion or stiffness to be imaged along with topography on the nanometer scale. This microscope is located in LISE G04. For more information please contact Jiangdong Deng (jdeng@cns.fas.harvard.edu, 617-495-3396).

Zeiss Ultra55 SEM

Ultra high resolution capacity (down to 1 nm) with EDS (x-ray) energy dispersive spectrometer, and multiple detectors (including STEM). The SEM is located in LISE B15D and the contact person is Dave Lange (lange@cns.fas.harvard.edu, 617-495-2375).

Zeiss Supra55 VP SEM

Ultra high resolution capacity (down to 1 nm) at high vacuum. This system has a variable vacuum for imaging non-conductive samples. Features include EDS, multiple detectors and an electron back-scattered diffraction (EBSD) system for phase identification, crystal orientation and phase mapping using Kikuchi patterns. This SEM is located in LISE B15I and the contact person is Dave Lange (lange@cns.fas.harvard.edu, 617-495-2375).



Zeiss NVision 40 FIB (Focused Ion Beam)

Dual beam (ion and electron) for milling, etching, and imaging of a diverse array of samples. Contact Richard Schalek (rschalek@cns.fas.harvard.edu, 617-496-9682) for more information.

STS Inductive Coupled Plasma (ICP) Reactive Ion Etching (RIE) System

The STS ICP RIE is installed in LISE cleanroom and its main characteristics are as followings: ICP assembly upper electrode; RF biased lower electrode; chilled to 4 – 30°C; single wafer load-lock up to 6" wafer; available gases: SF6, CHF3, CH4, H2, Cl2, HBr, BCl3, Ar, N2, O2, and N2; To etch Si, SiO2, and Si3N4; Windows 2000 software control PC; Internet remote control capability. For more information contact Ling Xie (lxie@cns.fas.harvard.edu, 617-496-9069).

Clockwise from top-left: the new Computer Room in B-58 housing new computers and the computers previously housed in McKay 106; the new Zeiss NVision 40 FIB being removed from its shipping crate; the new Zeiss Ultra55 being assembled; the JEOL 2100 now housed in the LISE Imaging Suite, room B-15E.

Center: One of the ten emergency Shower/Eye Wash stations on the Ground and Basement floors of the new LISE Building, this one is located in the B-15 Imaging Suite. Be safe; know emergency procedures and the location of emergency equipment. If you have any safety related questions feel free to contact our dedicated Environmental Health and Safety Officer, John Sweeney at 617-495-1290.

Buckminster's Café located on the first floor of the LISE Building where you can enjoy Pete's Coffee and Teas, half price pastries after 5pm, a 24-hour coffee machine for those late nights, and on the second floor more secluded seating arrangements with a view of the café and roof top birch garden.

The Grey Room, an open lounge on the third floor of LISE that is great for studying, having small meetings, or taking a few minutes to sit and enjoy the view through the floor to ceiling windows.

Conference room 303, located on the third floor, is the largest of the three conference rooms. Lab Safety Training, LISE Cleanroom Training, CNS events, and a multitude of other meetings and activities take place here.

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