Facilities & Other Resources

The proposed research project will be completed at the University of Wisconsin-Madison, which has a diverse set of research facilities and personnel available. As a large research institution with a large research hospital situated on campus, our research team is well positioned to take advantage of the tremendous resources available close at hand. The following pages outline our resources and describe the variety of tools at our disposal.

Clinical:

The Clinical Science Center (CSC) is a 450-bed tertiary care facility, providing access to a full spectrum of patients for clinical research. The University of Wisconsin Hospital and Clinics (UWHC) has been consistently ranked as one of America's top hospitals by U.S. News and World Report magazine. The hospital has more than 900 active medical staff that annually care for more than 20,000 inpatients from throughout Wisconsin and around the world. More than 100 primary care and specialty clinics handle more than 400,000 outpatients visits yearly. Approximately 100 mastectomies are performed annually at our institution for larger invasive carcinomas, extensive ductal carcinoma in situ (DCIS) or prophylactically in patients with familial cancer risk or contralateral malignancy. This capacity gives us a great opportunity to acquire the proposed 150 mastectomy samples in three year-period.

The Department of Radiology provides a full range of traditional and advanced technologic imaging, including six state-of-the-art CT scanners, four digital mammography units, two digital breast tomosynthesis (DBT) units, one stereotactic breast biopsy unit, ten ultrasound units, five 1.5 T MR scanners, a GE combined angiography/MRI system (XMR), two clinical/research 3.0 T MRI units a PET imaging system, and a GE PET/CT multi-slice unit.

Breast Imaging Section: The breast imaging facility in the Department of Radiology is an American College of Radiology (ACR) Breast Imaging Center of Excellence with state-of-the-art imaging equipment, including all digital mammography, breast MRI, breast ultrasound, and stereotactic, MRI-guided, and ultrasound-guided breast biopsy capabilities. The DBT systems are state-of-the-art Hologic Selenia Dimensions units (Bedford, MA). Each digital mammography or DBT unit is equipped with both a premium acquisition workstation (AWS) in the exam room and a standard AWS in the adjacent reading room. The standard AWS is equipped with Computer Aided Detection (CAD) system to help detect abnormal areas on the mammogram/DBT images.

UW Breast Center is a subdivision of UWHC that embodies a comprehensive multidisciplinary approach with a full spectrum of clinical and support services to help patients improve their breast health. **The Division of General Surgery** provides a wide range of breast surgical services including axillary lymph node dissection, core needle biopsy, lumpectomy or partial mastectomy, modified radical mastectomy, needle-localized biopsy, needle-localized excision, sentinel lymph node biopsy, simple mastectomy, and skin-sparing and/or nipple-sparing mastectomy, etc.

The Department of Pathology and Laboratory Medicine provides pathological analysis to millions of specimens annually. Its anatomic pathology service comprises surgical pathology, cytopathology, hematopathology and autopsy pathology. Subspecialty surgical pathologists are available to consult on all the organ systems and different disease categories.

Computation: A 13 node computing cluster is available consisting of rack mount computers running scientific Linux. 8 of the nodes feature 2 AMD dual-core Opteron Processors with 8 GB of total memory. 3 of the nodes feature 4 AMD quad-core Opteron Processors with two of the nodes featuring 32 and one with 64 GB of total memory. The other two nodes feature AMD single core Opteron Processors. The software available on the cluster includes MatLab as well as GNU FORTRAN, C, and C++ compilers. In addition, the physics team has multiple dedicated workstations running Microsoft Windows as well as Linux; these workstations are equipped with high-end nVidia GPUs (including GTX 580, Titan Black, and Titan Z cards) for parallel computation. Our MACs and PCs have word processors, plotting programs, spreadsheets, drawing packages, presentation, image viewing, and analysis packages. We have developed a research database system that includes all relevant clinical or physiologic data.

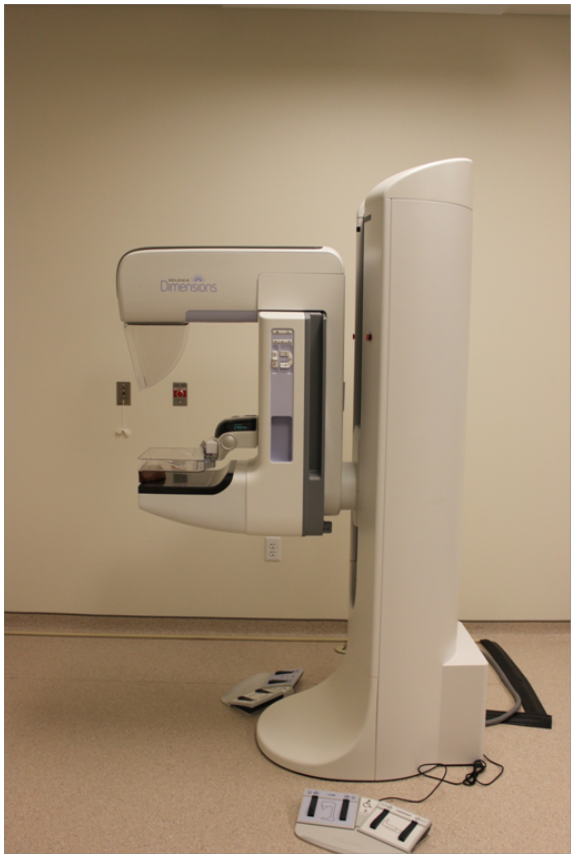
Office: Offices and secretarial work areas are located near the laboratories, and general secretarial and administrative services are available to all departmental faculty and staff. Adequate office space is available to all faculty and staff through their respective departments.

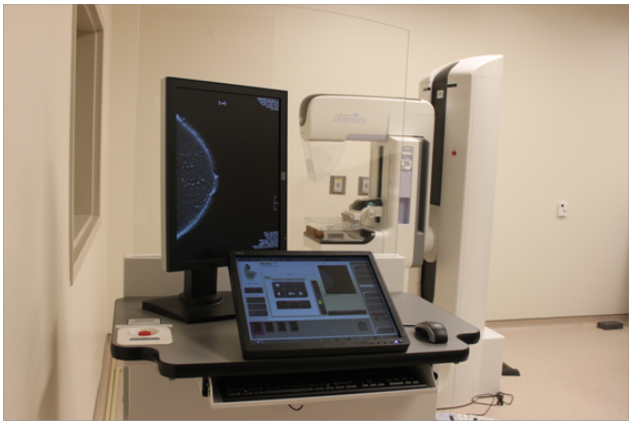
Interdisciplinary Medical Imaging Programs: A major strength in new imaging research is fostered by the strong ties between Radiology, Medical Physics, and Biomedical Engineering. The Department of Medical Physics consists of nearly 50 faculty, instructional and research support staff, and more than 100 graduate students. Many of the faculties have research interests and expertise in imaging. Imaging faculties in Biomedical Engineering also have co-appointments in Medical Physics.

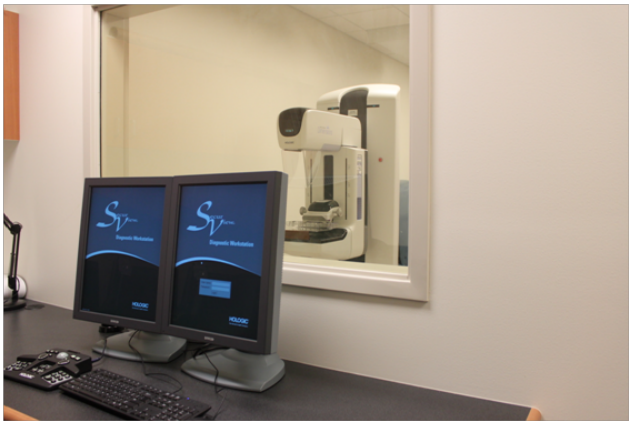
All UW faculty and staff members have access to UW support services including University Stores and Purchasing Departments, the Safety Department, Radiation and Biological Safety, Animal Use, Human Subjects committees, and departmental information technology (IT) supports. A world-class (Class-100) classroom is also located on campus. Other support services available on a fee-for-service basis include electronics and machine shops, medical illustration and photography services, and computer support. Each member has physical and electronic access to the excellent library facilities located at several locations on campus.

Dedicated Hologic Selenia Dimensions Digital Breast Tomosynthesis System for Research in PI's Laboratory

A Hologic Selenia Dimensions digital breast tomosynthesis (DBT) system is dedicated for research use. This FDA-approved system provides both traditional full-field digital mammography and DBT imaging. It uses a tungsten-anode Variant M113T x-ray tube with 0.1/0.3 mm nominal focal spot size and a 24 cm x 29 cm Hologic amorphous selenium flat panel digital detector with 70 μm native pixel size. The tube is mounted in a gantry that rotates over an angular span of 15° during each DBT data acquisition to acquire 15 x-ray measurements. The system is equipped with an in-room acquisition workstation (AWS 5000) system and SecurView DX diagnostic workstation in the adjacent reading room.

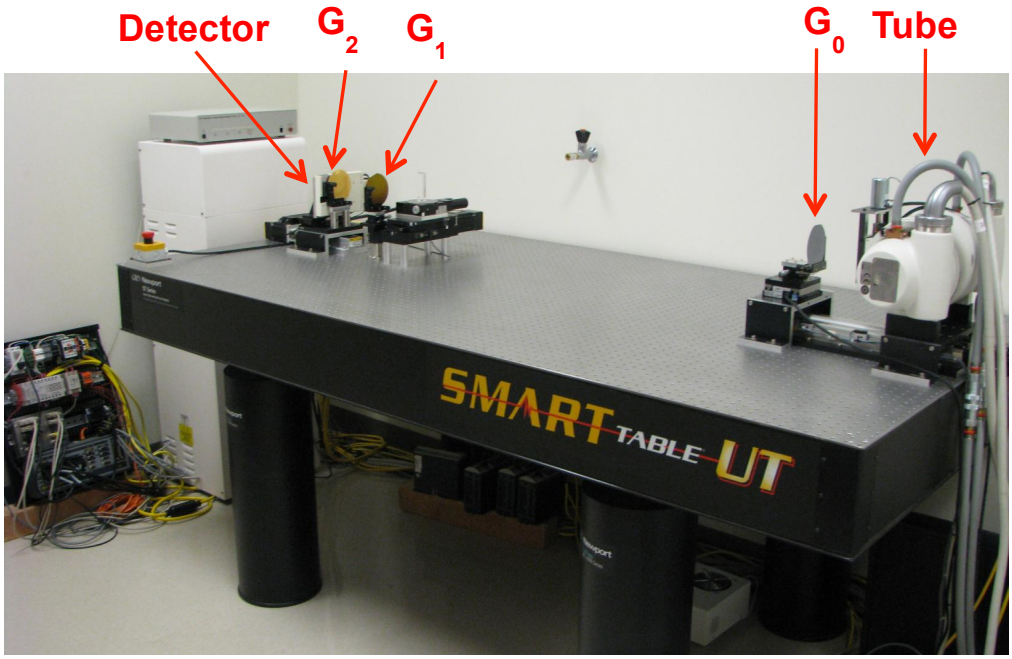


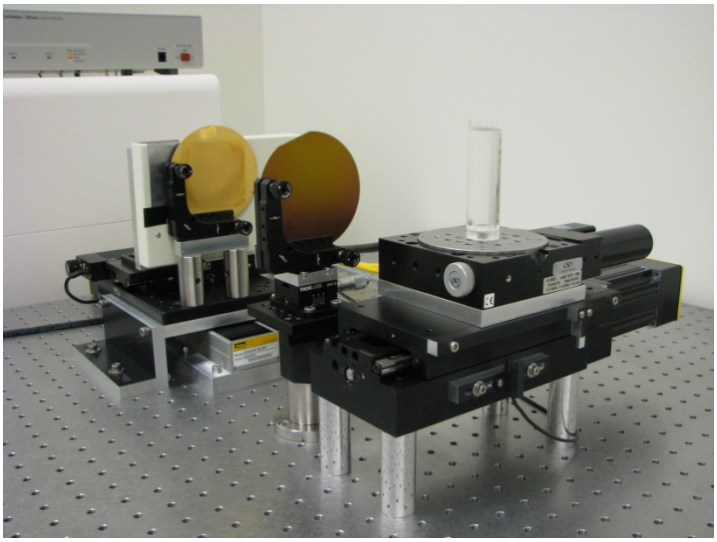


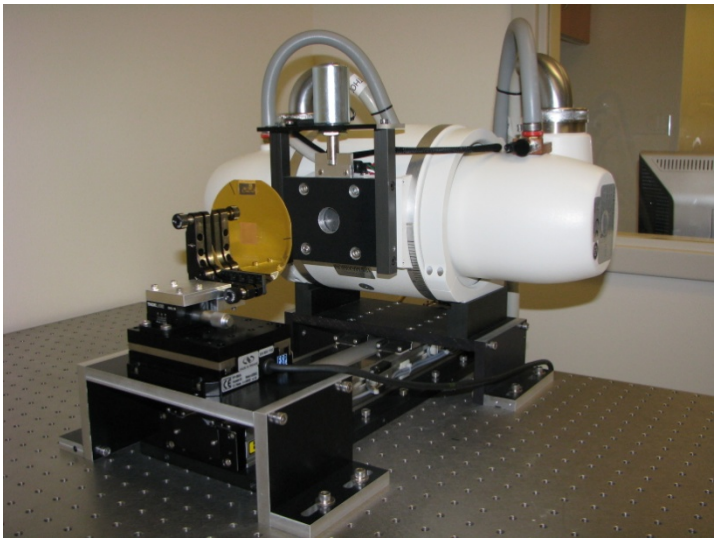


Multi-Contrast Cone-Beam CT Benchtop in PI's Laboratory

A benchtop multi-contrast cone-beam CT system designed and constructed by the UW CT group provides a platform to develop and test multi-contrast imaging techniques which allow simultaneous measurement of electron density, effective atomic number and small-angle scattering in a single acquisition. The system includes a Varian G-1582 x-ray tube, a Rad-Icon Shad-o-Box 2048EV detector, CPI Indico 100 x-ray generator, Parker 6K8 and National Instruments ESP300 motion controllers and closed-loop servo control on each axis. Three x-ray gratings, labeled G_0, G_1, and G_2 in the figure below, form a Talbot-Lau interferometer and enable measurement of x-ray refraction. This system provides spatial resolution equivalent to micro CT and the modular hardware and software design allows quick system reconfiguration for new experiments.

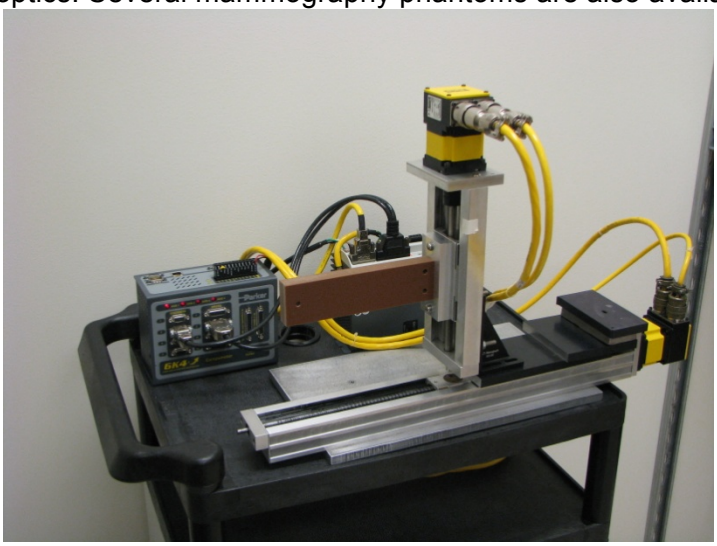




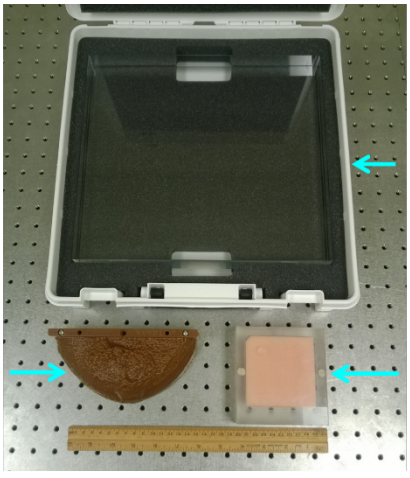


Additional Laboratory Equipment in PI's Lab

Other equipment owned by our group includes a motion phantom providing up to four axes of control for CT studies of dynamic objects, a Radcal 9095 dose and kVp measurement system, a Hamamatsu L10321 100 kVp microfocus x-ray source, as well as various power supplies, test equipment, data acquisition devices, raw materials, and motion control equipment. An electroplating station including a computer-controlled multiple output plating supply and a custom wafer plating cell has been constructed for plating of gratings for x-ray optics. Several mammography phantoms are also available.



Anthropomorphic solid water phantom

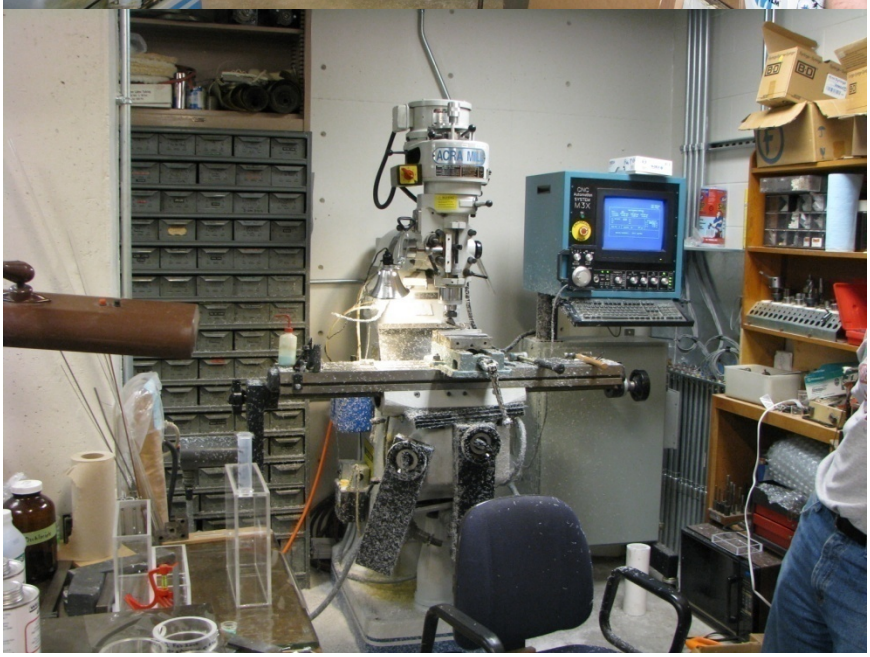


High purity PMMA slab

ACR Mammography accreditation phantom

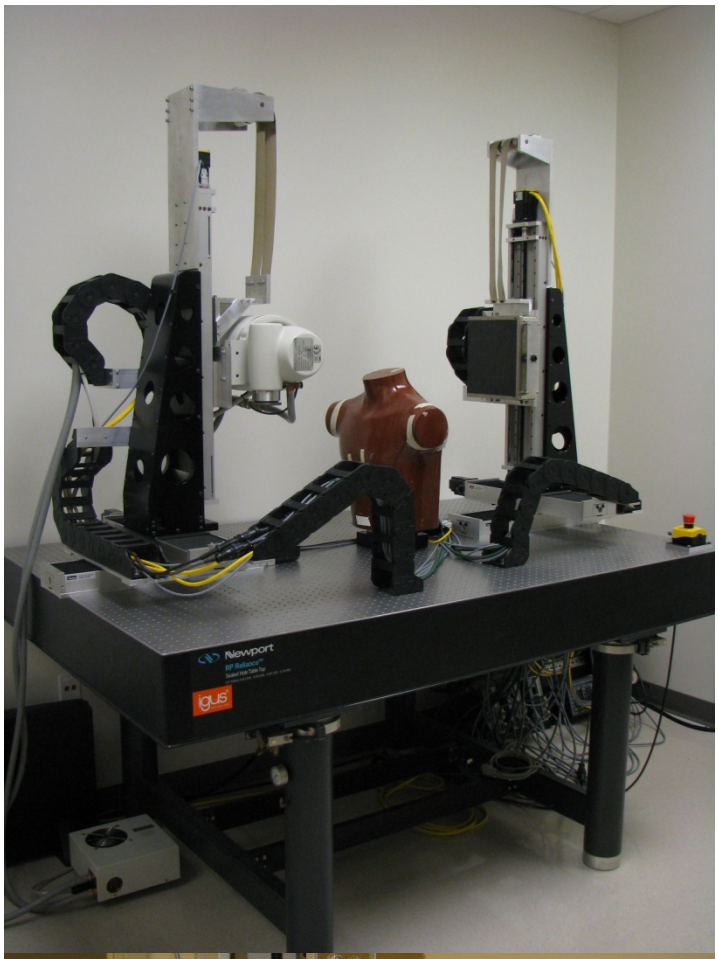
Medical Physics Machine Shop

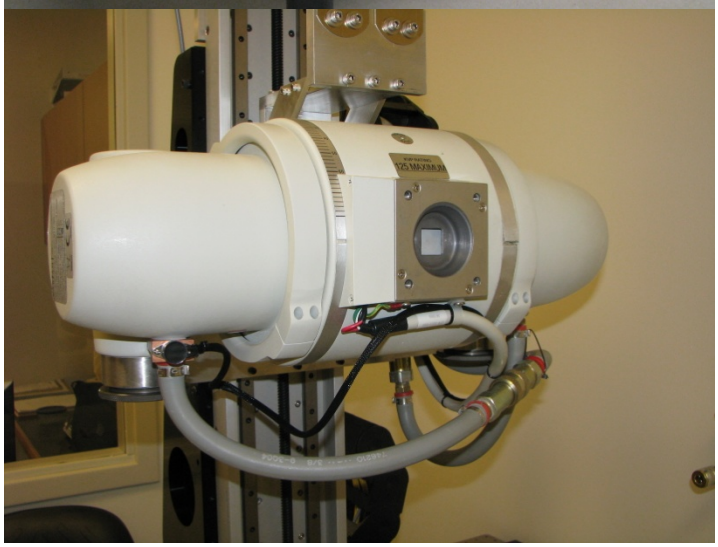
The medical physics machine shop located in the WIMR building, just one floor below our research laboratory, is a dedicated machine shop for students and faculty to have access to numerous pieces of machining equipment. Major pieces of equipment include three metal lathes; three manual vertical mills; one CNC vertical mill; one horizontal mill; three drill presses; a vertical bandsaw; a tablesaw; horizontal and cutoff metal saws; grinding, sanding, and polishing equipment; sheet metal working equipment; and brazing and welding equipment. There is one full-time medical physics machinist on hand to assist with design work and complex tasks. Access to the facility allows for quick implementation of experimental ideas at a reduced cost compared to hiring outside sources for fabrication of system components.

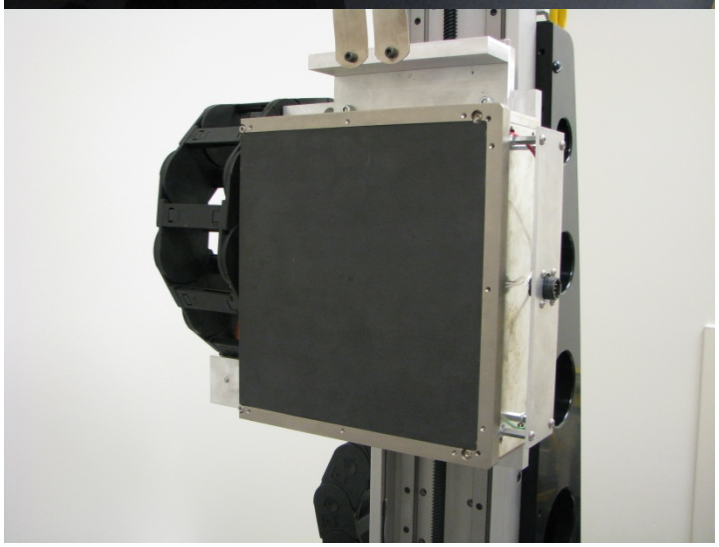


Absorption Cone-Beam CT Simulator Benchtop

A benchtop absorption CT simulator system designed and constructed by the UW CT group provides 7 degrees of freedom to simulate data acquisition from nearly any existing or proposed absorption CT scanner. Currently this system is configured with a Varian G-1592 x-ray tube, a CPI Indico 100 x-ray generator, a GE 20 cm x 20 cm flat-panel detector, and Parker 6K8 motion controller with closed-loop servo motor control of each axis.







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Dedicated GE Discovery CT750 HD CT Scanner for Research

A GE Discovery CT750 HD CT scanner is dedicated for CT research use. This fully-equipped 64-slice CT scanner provides capabilities for dual energy studies as well as cardiac and perfusion studies.

MicroAutomation 1006 Dicing Saws

Two MicroAutomation 1006 dicing saws installed at the Wisconsin Center for Applied Microelectronics (WCAM) class-100 cleanroom, UW-Madison (http://wcam.engr.wisc.edu/) provide high precision wafer cutting. The stage control of the dicing saw is driven by digital stepping motors and is programmable in all X, Y, Z, and theta axes. Once programmed to a specific dicing pattern, the MicroAutomation 1006's microprocessor computes and controls the dicing process for all subsequent wafers to be diced. Seven different types of blade are provided by the cleanroom, including a 17 μm-thick blade with 2 μm diamond grit.

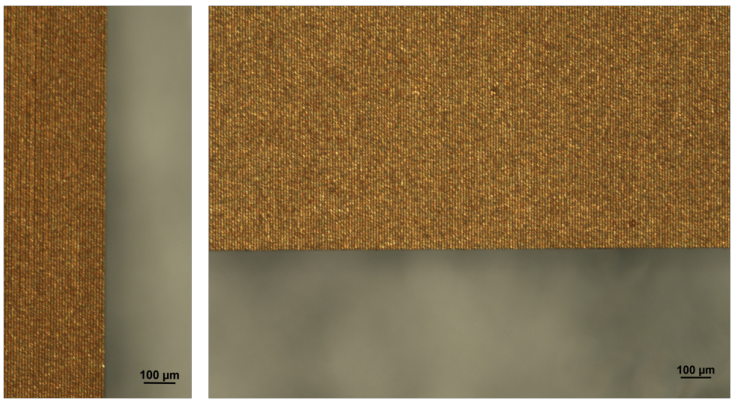

Figure on the left: Photo of the MicroAutomaton 1006 Dicing Saw. **Figure on the right**: Micrographs of a G2 grating diced using this dicing saw demonstrate precise cuts along both directions of the grating.

The WCAM is located in the Engineering Centers Building of UW-Madison, which is 1.3 miles from the PI's lab. Buses connecting these two locations are available for every 6 minutes. The contact PI (Dr. Li) is a certified and experienced (>4 years) user of this cleanroom and the dicing saws.