NPRE ILLINOIS
DEPARTMENT OF NUCLEAR, PLASMA, AND RADIOLOGICAL ENGINEERING

NPRE Laboratory Facilities

Talbot Laboratory, 104 S. Wright Street

Multiphase Thermo-fluid Dynamics Laboratory
11 Talbot Laboratory *(Director, Caleb Brooks)*

This laboratory performs experiments related to thermal hydraulics and multiphase flow. Phenomena studied include boiling, condensation, critical heat flux, natural circulation, two-phase flow instabilities, bubble dynamics, and two-phase transport. Utilizing advanced instrumentation, data from these experiments are used in model development and validation of computational tools.

Socio-Technical Risk Analysis (SoTeRiA) Laboratory
127 Talbot Laboratory *(Director, Zahra Mohaghegh)*

The SoTeRiA Laboratory is evolving Probabilistic Risk Assessment (PRA) by explicitly incorporating the underlying science of accident causation into risk scenarios. This laboratory pioneered two key areas of theoretical and methodological innovations: (1) spatio-temporal causal modeling of social and physical failure mechanisms in PRA, and (2) the fusion of big data analytics with PRA. The Lab's current projects for the nuclear power industry include: Fire PRA; Location-specific Loss-Of-Coolant Accident (LOCA) Frequency Estimations; Risk-Informed Resolution of Generic Safety Issue 191; Human and Organizational Influences on System Risk; Risk-Informed Regulation; and Risk-Informed Emergency Preparedness, Planning and Response.

Virtual Education and Research Laboratory
135 Talbot Laboratory *(Director, Rizwan Uddin)*

Researchers in this laboratory develop virtual models of nuclear power plants and laboratory experiments via a video game engine known as Unity 3-D. The main goals for creating these virtual models are to improve both education and workplace training.

High Temperature Nuclear Materials Laboratory
209A, B, C Talbot Laboratory *(Director, James F. Stubbins)*

Researchers in this laboratory test nuclear materials mechanical properties under a wide range of conditions. Particularly, the scientists test materials under stress and at high temperatures for a duration of thousands of hours.

Radiation Detection and Isotope Identification Laboratory
209D Talbot Laboratory *(Director, Clair J. Sullivan)*

The Radiation Detection and Isotope Identification group focuses on the creation of a variety of hardware and software solutions to assist in the fields of nuclear nonproliferation, homeland security, and emergency response.

High Temperature Environmental Exposure Laboratory
209E Talbot Laboratory *(Director, Brent J. Heuser)*

A simultaneous thermal analyzer with combined thermogravimetric and differential scanning calorimetry function is housed in this laboratory. The response of LWR fuel cladding materials in high temperature steam environments for improved accident tolerance is currently of interest.

Non-Equilibrium Matter Laboratory
220B Talbot Laboratory *(Director, Yang Zhang)*

This laboratory focuses on the study of non-equilibrium matter, with particular emphasis on liquids and soft matter, using integrated neutron and synchrotron light experimental probes and atomistic modeling and simulation. The structure and dynamics of these systems are either inherently complex or driven away from equilibrium by extreme conditions. In particular, our current interests include a range of fundamental and technical problems involving slow phenomena and rare events, such as: materials far from equilibrium and in extreme environments; extreme properties of liquids; and glassy or jammed soft matters.

Radiation Detection and Imaging Laboratory
220C Talbot Laboratory *(Director, Ling-Jian Meng)*

The Radiation Detection and Imaging Lab focuses on developing non-invasive imaging technology for use in preclinical medical research. Many of our current endeavors focus on developing semiconductor Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET). These works challenge the current state of the art for spatial resolution and system sensitivity. The use of highly pixelated CdTe detectors has driven our work to break into a spatial resolution on the order of 300 microns for both PET and SPECT. Our work in SPECT has also challenged the limits of aperture sensitivity through the engineering of the compound-eye aperture.

Nuclear Materials Fabrication and Studies Laboratory
220D Talbot Laboratory *(Director, Brent J. Heuser)*

Nuclear materials are fabricated and studied in this laboratory. Fabrication techniques include thin film growth of oxides and metal overlayers. Bulk metal hydrides are fabricated and studied as well. Hydrogen and deuterium mass transport is investigated. Hydrogen in Zr-based alloys and Pd are of current interest. Nuclear materials are fabricated and studied in this laboratory. Fabrication techniques include thin film growth of oxides and metal overlayers. Bulk metal hydrides are fabricated and studied as well. Hydrogen and deuterium mass transport is investigated. Hydrogen in Zr-based alloys and Pd are of current interest.

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Functional X-ray Imaging Laboratory (FXIL)

225F Talbot Laboratory *(Director, Ling-Jian Meng)*

FXIL consists of a walk-in closet equipped with four different X-ray sources, a wide variety of X-ray imaging and spectroscopic detectors, an optical photon imaging camera based on state-of-the-art intensified EMCCD detectors, and potentially a regular emission tomography system integrated ion beam line. The facility offers highly unique X-ray imaging techniques for a wide range of biomedical imaging applications, including micro X-ray computed tomography (CT), X-ray florescent CT (XFCT), X-ray luminescent CT (XLCT) and nanobeam therapy. The equipment can be used in microbiology and nano-medicine, potentially novel bio-imaging technologies, and to monitor cancer micro-biology.

Micro/Nano Technology Laboratory
208 N. Wright Street

Radiation Surface Science and Engineering Laboratory

1302 MNTL *(Director, J.P. Allain)*

The RSSEL group designs self-organized nanostructures and mesostructures with directed irradiation synthesis and directed plasma nanosynthesis to enable multi-functional and multi-scale properties at surface and interfaces of dissimilar material systems (e.g. polymer and metals, ceramics and biomaterials). Research areas include: advanced functional biointerfaces, advanced fusion interfaces, multi-scale computational irradiation surface science, nanostructured functional materials, sustainable nanomanufacturing, and in-situ, in-operando diagnostics.

Nuclear Engineering Laboratory
100 S. Goodwin Avenue

Helicon Injected Inertial Plasma Electrostatic Rocket (HIIPER) Laboratory

102 NEL *(Director, George H. Miley)*

This lab conducts research on HIIPER, a space propulsion concept that utilizes elements from inertial electrostatic confinement (IEC) fusion theory. HIIPER is similar to a typical ion thruster, however it uses a helicon plasma generation stage to create a dense argon plasma, which is then fed into IEC grids that are being studied to extract and accelerate this plasma. This work builds off of the lab's over 20 years of study of IEC grids for both fusion and space propulsion applications. Experiments on HIIPER are conducted in a spherical vacuum chamber, with plasma supplied from a radio frequency power supply and helicon antenna.

Fusion Studies Laboratory

104 NEL *(Director, George H. Miley)*

Condensed phases of hydrogen in metals is the primary interest of this laboratory. The properties of trapping sites at defect structures are currently being investigated in thin films and nanoparticles. Current experiments include characterizing the effects of plasma treatments, cryo-milling, and hydride cycling on the creation of these defect structures. COMSOL modeling is also done for metal hydride chemisorption and heat transfer in porous media. Various equipment: Thermal Desorption Spectroscopy (TDS) unit, liquid N2 stainless-steel ball mill, dual use high-pressure/high-vacuum systems, and a DC HV plasma apparatus. These studies are relevant to Inertial Confinement Fusion, hydrogen storage, and High Temperature Superconductivity.

Fuel Cell Research Laboratory

106/107 NEL *(Director, George H. Miley)*

Researchers in this laboratory conduct fuel cell research including liquid fuel and oxidizer specialized MEA; Membrane Electrode Assembly design, manufacturing and testing in Room 106 with fume hood, sink, precision pump, cell voltage monitoring and measurement incorporate with high accuracy of electrical load, etc. Most of the mechanical work to manufacture bi-polar as well as end plate for the fuel cell stack assembly is being done in Room 107, equipped with various mechanical tools. The majority of the fuel cell research has been built upon the laboratory's sodium borohydride chemistry conducted since 2005.

Nuclear Radiation Laboratory
201 S. Goodwin Avenue

Center for Plasma-Material Interactions (CPMI)

(Director, David N. Ruzic)

The primary objective of CPMI is the study of plasma-material interactions relevant to fusion, semiconductor manufacturing, and plasma processing through a combination of computational and experimental means. CPMI has facilities for the study of fusion materials, High Intensity Pulsed Magnetron Sputtering (HIPMS), liquid metals, Extreme Ultraviolet Lithography (EUVL), laser-material interactions, and more. Projects are supported by both government and commercial partners to further the application and knowledge of plasma physics.

Nuclear Radiation Laboratory
201 S. Goodwin Avenue

Hybrid Illinois Device for Research and Applications (HIDRA) *(Research Professor, Daniel Andruczyk)*

HIDRA combines a tokamak and a stellarator. Here are some of its uses:

- Evaluate whether a full toroidal liquid metal loop can operate in a toroidal machine
- Test low recycling regimes
- Determine whether deuterium can be removed and recycled easily
- Provide a test bed for advanced materials testing, processing, and development of in-situ diagnostics to measure the time-scale of plasma-material interactions and how material surfaces respond to the fusion plasma
- Design an advanced multi-user facility named HIDRA-MAT for innovative materials testing and processing
- Address fundamental problems of edge plasma physics
- Calibrate numerical kinetic models of cross-field electron transport in partially ionized conditions
- Extend CPMI's investigation of lithium walls for small-scale, linear fusion devices to a medium-sized toroidal device
- Explore the science of continuous vapor shielding
- Address fundamental questions regarding the survivability of materials exposed to high heat fluxes