Laboratory for AUTONOMOUS SYSTEMS RESEARCH

LASR FACILITIES

- **Prototyping High Bay**
- **Littoral High Bay**
- **Desert High Bay**
- **Tropical High Bay**
- **Human System Interaction Labs**
- **Power and Energy Lab**
- **Sensor Lab**
- **Ambient Air Test Facility**
- **Machine Shop and 3D Print Lab**
- **Collaborative Space**

U.S. NAVAL RESEARCH LABORATORY

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ABOUT

The Laboratory for Autonomous Systems Research contains a number of specialized high bays and laboratories to support our multidisciplinary research and development. The high bays recreate important environments and allow us to reduce the cost of research and development. The environments help to bridge the gap between bench science, where real-world conditions cannot be duplicated, and fielded experiments, which provide realism, but can be very expensive.

Prototyping High Bay

The prototyping high bay allows for the development and evaluation of autonomous systems. The high bay is approximately 150' by 75' by 30' high and includes a number of unique features and systems to support experimentation with a combination of ground and air vehicles, as well as people that are interacting with the systems.

- Real-time, accurate motion capture of many entities (vehicles and humans) for experimental ground truth or closed loop control. This system will allow tracking of 50 objects at 120hz to 1000hz with positional accuracy of 0.1mm and angular accuracy of 0.1 degrees within the full volume of the high bay.
- GPS repeaters allow testing of GPS systems and control.
- Directional sound system can inject appropriate environmental acoustic signals to allow, for example, emulation of movement of entities such as troops or vehicles.
- A 40' by 40' section on the floor can be flooded to a 4" depth.
- The high bay is observable (and operations can be controlled) from four separate human-interaction labs that have large windows overlooking the high bay. These observation windows have electrically operated metal shutters if isolation is needed.
- All windows and the skylight have shutters to allow operations in a dark environment.
- The high bay can accommodate use of internal combustion engines.
- A five-ton crane is available for moving equipment and materials within the high bay.

Littoral High Bay

The littoral zone is that part of a sea, lake or river that is close to the shore. The littoral high bay includes various tanks and pools to support the evaluation of autonomous systems, power and energy systems, and sensor systems that need to work in water environments and along the shore. The high bay is 54' by 76' by 28' tall overall and includes an overhead 5 Ton crane. A wide range of research is performed in this high bay, including integration of component technologies into working prototypes.

- 25' by 45' pool is 5.5 feet deep. A 16-channel wave generator provides directional waves. Saltwater or freshwater can be used in the pool. Freestanding structures can be used in the pool to hold equipment during wave generation.

- An underwater tracking system allows collection of ground truth data from experiments with small underwater vehicles. An above water system can also be integrated into the underwater system.
- A 16' diameter, 5' deep sediment tank, which contains seafloor sediment and sea water.
- Three 5' diameter, 4.5ft deep tanks are available for evaluating sensors and power and energy systems, as well as wet testing small vehicles.
- A portable 45' by 4' tank assembled from four sections is available.
- A five-ton crane can be used to move equipment and materials into place within the high bay.

Desert High Bay

The desert high bay provides sand and rock for evaluating autonomous systems designed for these challenging environments. The 2.5 foot deep sand pit allows evaluation of vehicles designed for desert environments. The facility also supports research in the development of passive and active sensors.

- A 44' by 30' by 28' overall high bay contains a 25' by 18' pit filled with 2.5' of sand.
- Two adjacent floor-to-ceiling simulated rock walls with natural outcroppings allow for evaluation of climbing vehicles.
- Special stage lighting can supply appropriate high contrast, low angle lighting conditions.
- Windows and a 20' x 20' skylight have shades to approximate night time conditions.
- Wind generators are available to create blowing sand conditions within the sand pit area.
- An area adjacent to the sand is available for staging and equipment with a partition for protection from blowing sand.
- An adjacent control room can be used for control of experiments.
- GPS repeater is available.
- A five-ton crane can be used to move equipment and materials into place within the high bay.

Tropical High Bay

The tropical high bay simulates a southeastern Asian rainforest. This 40' x 60' x 46' high green house has live growth, a stream, pond, and appropriate terrain. A variety of tropical plants, native to southeast Asian rain forests, are maintained in the greenhouse, with an appropriate density of plants and foliage, and a three-level canopy. The temperature is held constant at 80 degrees with 80% humidity. The terrain in the high bay is accurate and provides a realistic environment for autonomous ground vehicles. Development of ground, air and climbing vehicles is supported by this high bay, as well as sensor research.

- Can generate rain events up to six inches per hour with an overhead rain generation system.
- A catwalk at a 15' level is within the high-bay perimeter allows access and mounting of equipment.
- Power and network are available throughout the high bay.
- A separate observation room allows dry space for computers and observation during experiments.

Human System Interaction Labs

Four 20' by 40' human-systems interaction labs support development of novel autonomous system interfaces, and research and testing of advanced human-system interaction techniques. These labs overlook the prototyping high bay. Two of the interactions labs are adjacent on the first floor and two are adjacent on the second floor. Each pair may be combined into a single 20' by 80' lab by opening a partition between the adjacent rooms.

- Overhead mounting system in ceiling allows monitors and other equipment to be mounted anywhere within the labs.
- Each HSI lab has a wall of glass overlooking the prototyping high bay. A metal shutter may be closed blocking the view of the prototyping high bay if needed.
- Power and network connections are available both in the ceiling and the floor as well as on the walls.
- The second floor HSI Lab 216 East can be used as a conference room up to the "Secret" level with seating for 70 people.

Power and Energy Lab

The power and energy lab provides a safe, controlled environment for the evaluation of new power and energy sources from the component level to integrated systems. The lab has the following features:

- Dry room for custom battery assembly and experimentation, particularly for lithium-based battery technology.
- Glovebox purged with argon for safe handling of lithium.
- Solar simulator for photovoltaic research.
- Environmental chambers for temperature and atmosphere stress testing.
- Gas manifolds dedicated to fuels and oxidizers (H2 & O2).
- Isolation room for safe evaluation of systems.

Sensor Lab

The sensor lab is available to test and calibrate a variety of individual chemical and biological sensors or complete sensor systems. This fully equipped laboratory is designed to serve as a test platform for sensor prototypes prior to full-scale field demonstrations and has some unique features:

- The Ambient Air Test Facility is used to calibrate and test sensor systems. In essence, the system acts like a low speed wind tunnel, bringing outside ambient air (either filtered or unfiltered) into along tunnel. Multiple aerosols of interest can be injected into the airstream in extremely minute but carefully measured quantities where they mix with the airstream. At the far end of the tunnel, the airstream can then be sampled by the sensors being calibrated or tested.
- The large walk-in environmental chamber (12' X 21' X 10') can be used to evaluate sensors and autonomous systems for temperature and humidity effects while simultaneously exposing them to test analytes at varying concentrations. This chamber can be controlled from -30 to +185 degrees F and from 10% to 95% relative humidity.
- The small environmental and altitude chamber (4' x 4' x 4' or 64 cubic feet) can be used to evaluate sensors for effects of temperature, humidity and pressure. It can be controlled from -50 to +350 degrees F, from 10% to 95% relative humidity, and the barometric pressure can be controlled up to +100,000 ft of altitude. It includes a flange that provides electrical, gas and liquid feedthroughs.
- Also housed in the sensor lab is a 10' by 10' anechoic chamber with an antenna characterization system, used to evaluate small communications systems for autonomous systems.
- The laboratory contains a full complement of instruments and equipment necessary for work with chemicals and biological materials at Biosafety Level 2 (BSL-2), including walk-in and bench top fume hoods and biosafety cabinets.

Ambient Air Test Facility

Part of the Sensor Lab, the Ambient Air Test Facility (AATF) provides continuous exposure of developmental sensors to outside air through an insulated duct with continuously variable flow velocities from 1 to 34 mph (0.5 to 17 m/s). Sections of the flow tube can be configured for isokinetic sample access.

- Main flow tube is 30 cm (1 ft) in diameter and approximately 13 m (40 ft) long.
- Specific simulants (surrogates) and interferents of either aerosol or vapor can be injected near the flow tube inlet, to provide well-mixed samples at test locations downstream. Several types of aerosol generators are currently attached.
- Monitors for wind speed, temperature, and relative humidity are incorporated at both the inlet and test regions to assure that ambient conditions are maintained.
- The inlet flow can be switched to a clean (filtered) flow at any time for calibration.
- Complete process (PID) control of air flow as a function of time, including simulant and interferent injection, and ambient or clean air is provided via convenient computer interface. All data monitoring (such as ambient conditions) can be synchronized with a common ethernet time clock.
- The lab is equipped with a variety of instruments for aerosol characterization and diagnostics.

Machine Shop and 3D Print Lab

The machine shop provides the machines and tools for both metal and woodworking to support the Laboratory's research and engineering staff. The 3D print lab contains an EOS P396 SLS Nylon 3D printer. Computers with CAD/CAM software (Solidworks and Inventor) are available to support the rapid design and production of parts for vehicles, sensors and power and energy systems. Because of the complexity of the printer only trained LASR staff are authorized to use it. NRL Researchers can submit .stl files for printing free of charge through the LASR website.

Collaborative Space

A collaborative area allows teams of researchers to work together. In addition to modular furniture designed to enhance collaboration, project offices are available for team leads to manage their projects. In addition, a meeting room with projection equipment can be reserved for up to 12 people. The second floor HSI Lab 216 East can be used as a conference room up to the "Secret" level with seating for 70 people. It includes a Projector and Public Address System.