The Dynamic Photo-Mechanics Laboratory

Established 1981

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Dynamic Photo-Mechanics Laboratory

DPML Objectives

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"To perform outstanding research, jointly carried out by faculty, researchers and students."

Common Areas Focused

- Experimental Solid Mechanics
- Shock Tube Loading
- Underwater Implosion
- Optical Methods
- Blast Mitigation
- Nano and Functional-Graded Materials
- Fracture Mechanics
- Composite Materials
- Wave Propagation
- Numerical Simulations

In the News

VICE NEWS

12 WPRI EYEwitness NEWS

Discovery CHANNEL

NATIONAL INSTITUTE FOR UNDERSEA VEHICLE TECHNOLOGY

Funding Agencies

NAVSEA NAVAL SEA SYSTEMS COMMAND

NSF

NEEC Naval Engineering Education Center

Department of Transportation United States of America

RI dot

Office of Naval Research ONR Science & Technology

Naval Undersea Warfare Center NUWC

Science to Shape the Future of the Army Army Research Office 1951

STANLEY BOSTITCH

United States Navy

U.S.ARMY

Air Force Office of Scientific Research United States Air Force

NATIONAL INSTITUTE FOR UNDERSEA VEHICLE TECHNOLOGY

Collaborators

Caltech

Indian Institute of Technology Kanpur

Stanford University

SEM

UCONN UNIVERSITY OF CONNECTICUT

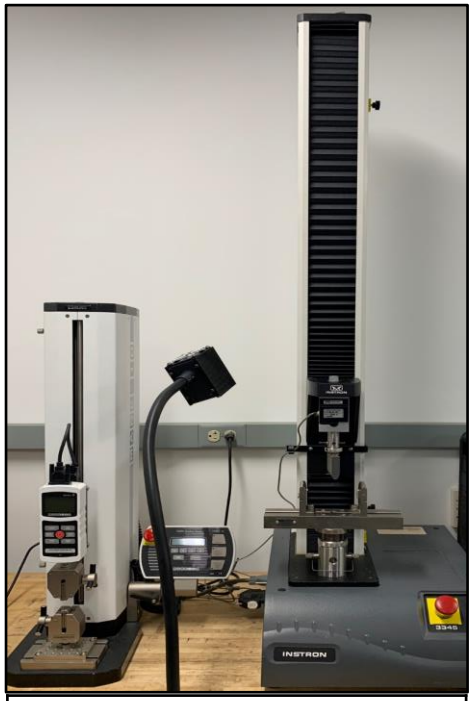
Facilities, Equipment and other Resources

The lab is spread across more than 5000 sq. feet area, located in two buildings and supplemented by URI workshop equipped with state-of-the art machining facilities

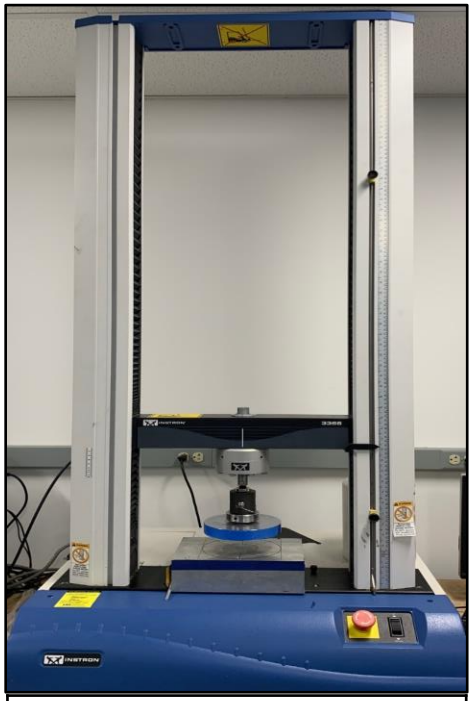
- Universal Testing Equipment
- Specialized Experimental setups
- High speed Photography and DIC setups
- Specialized fabrication and machining setups

Universal Testing Machines

SHIMADZU AGX	
Load cell	250KN/100KN
Loading rates	0.001- 500 mm/min
Resolution	F: ± 0.5 % U: ± 0.1 %



INSTRON 3345	
Load cell	5KN
Loading rates	0.05- 1000 mm/min
Resolution	F: ± 0.5 % U: ± 0.1 %



INSTRON 3366	
Load cell	10KN
Loading rates	0.005- 500 mm/min
Resolution	F: ± 0.5 % U: ± 0.1 %

INSTRON 5585	
Load cell	250KN
Loading rates	0.001- 500 mm/min
Resolution	F: ± 0.4 %(1/10th) U: ± 0.015mm

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Electromagnetic Force Fatigue and Endurance Testing System

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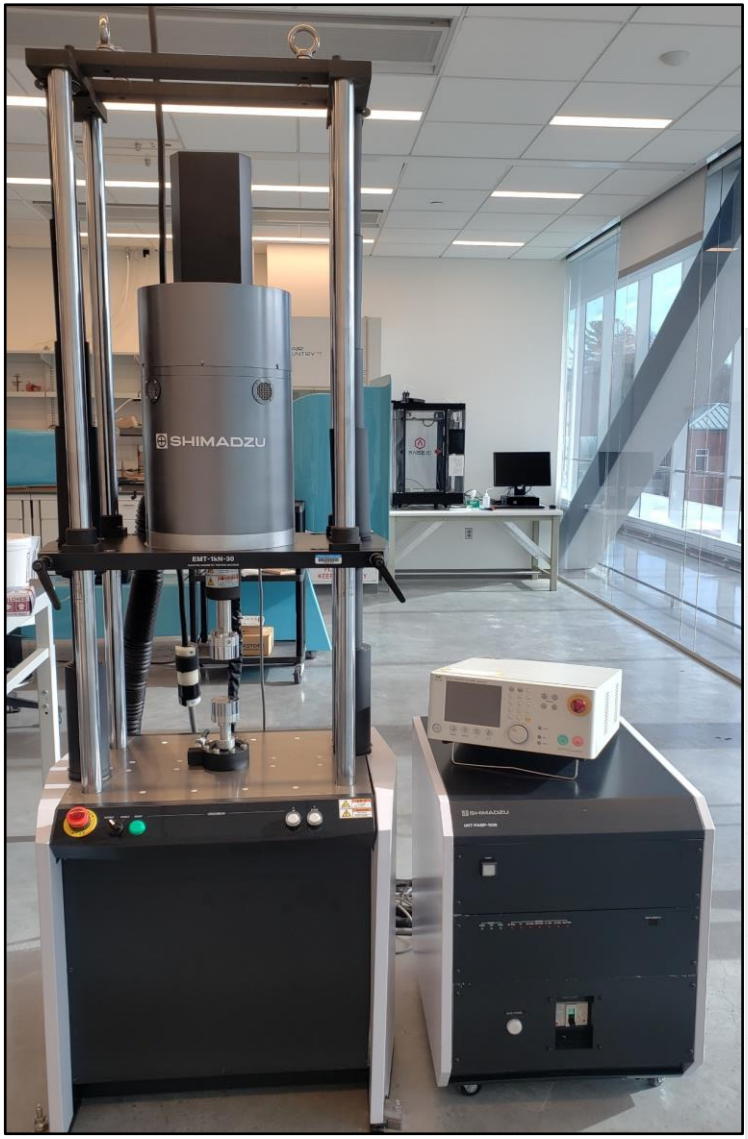

SHIMADZU EMT - 1kNV-30

High-speed repeated load tests can be carried out with a maximum velocity of 1 m/s, and maximum stroke of ±30 mm, using clean and quiet electromagnetic force as the driving power, without the use of oil.

Maximum test force	±1 kN (static and dynamic tests)
Stroke	±30mm
Cycle speed and amplitude	See amplitude characteristics charts.
Max. speed	1m/s
Max. frequency	200Hz
Controller	Servo Controller 4830
Controlled items	Test force and stroke (two can be added as option)
Test force range and indication accuracy	Rangeless Within ±0.5 % of indicated value or ±0.02 % of maximum test force
Stroke range and indication accuracy	Rangeless Within ±1 % of indicated value or ±0.1 % of rated value
Operating noise	62 dB (reference value measured 1 m from front of main unit and floor)

Dynamic
Photo-Mechanics
Laboratory

High Speed Puncture Impact Testing Machine

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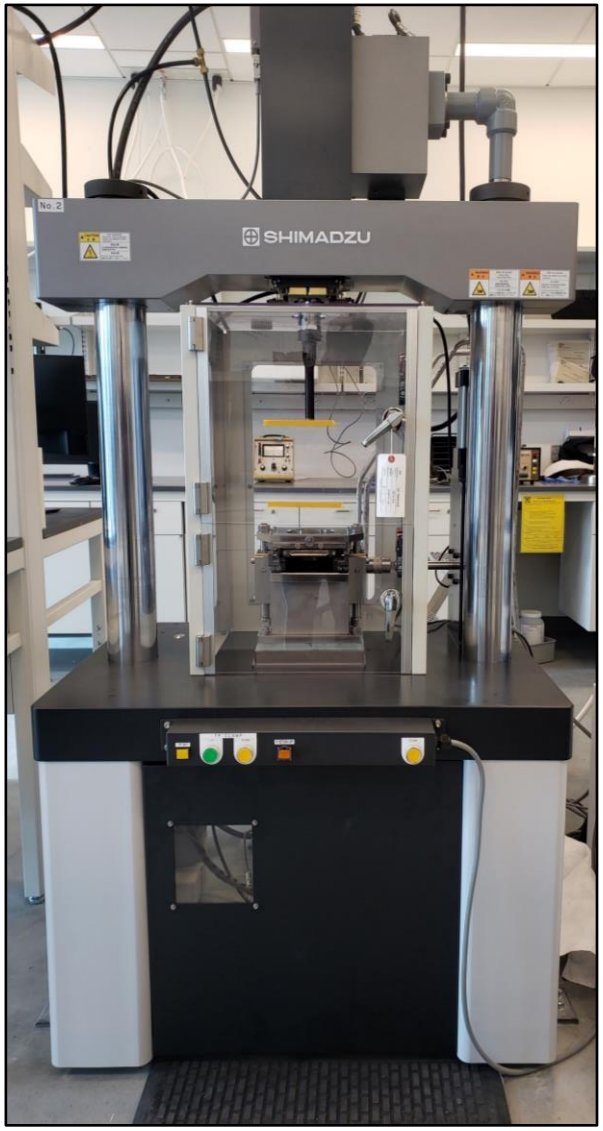

SHIMADZU HITS-PX

Impact testing involves puncturing a flat plate specimen with a striker that has a semi-spherical tip. This testing machine allows various data, such as test force vs. displacement curves, max. test force values, energy, and displacement to be obtained easily.

Impact Test Force	10 kN (static and dynamic tests)	
Maximum Speed	20m/s	
Range Of Speed Settings	1m/s to 20 m/s	
Piston Stroke	300mm	
Force Amplifier	Range	20%, 50%, 100% of load detector rating
	Accuracy	100% range: Within ±0.5% of range full scale 20%, 50% range :Within ±1.0% of range full scale
	Response Frequency	DC-100kHz (-3db)
Displacement Amplifier	Range	10%, 20%, 50%, 100% of displacement detector rating
	Accuracy	within 1.0% of range full scale
	Response Frequency	DC-10kHz (-3db)

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High Speed Puncture Impact Testing Machine with Thermostatic chamber

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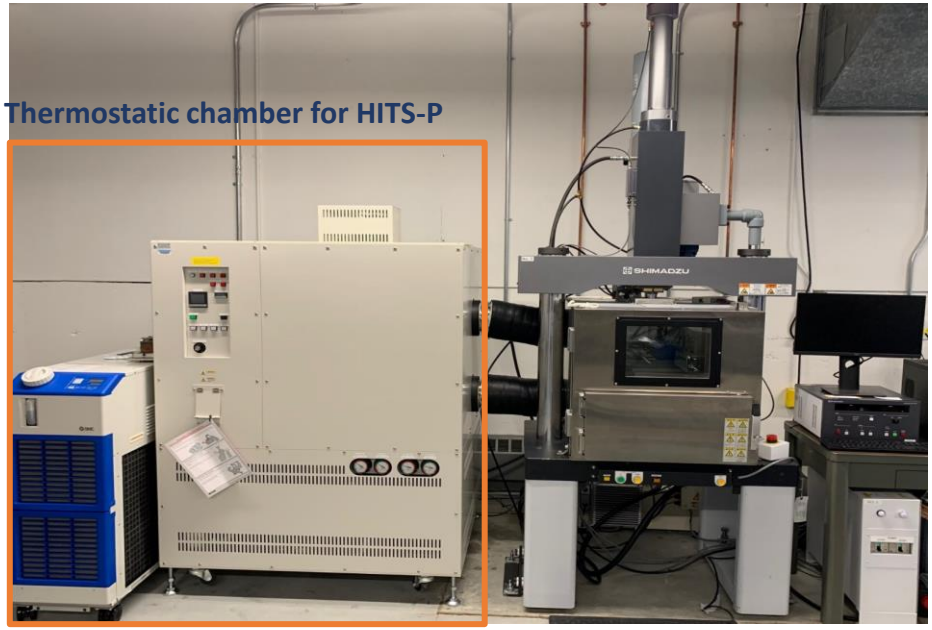
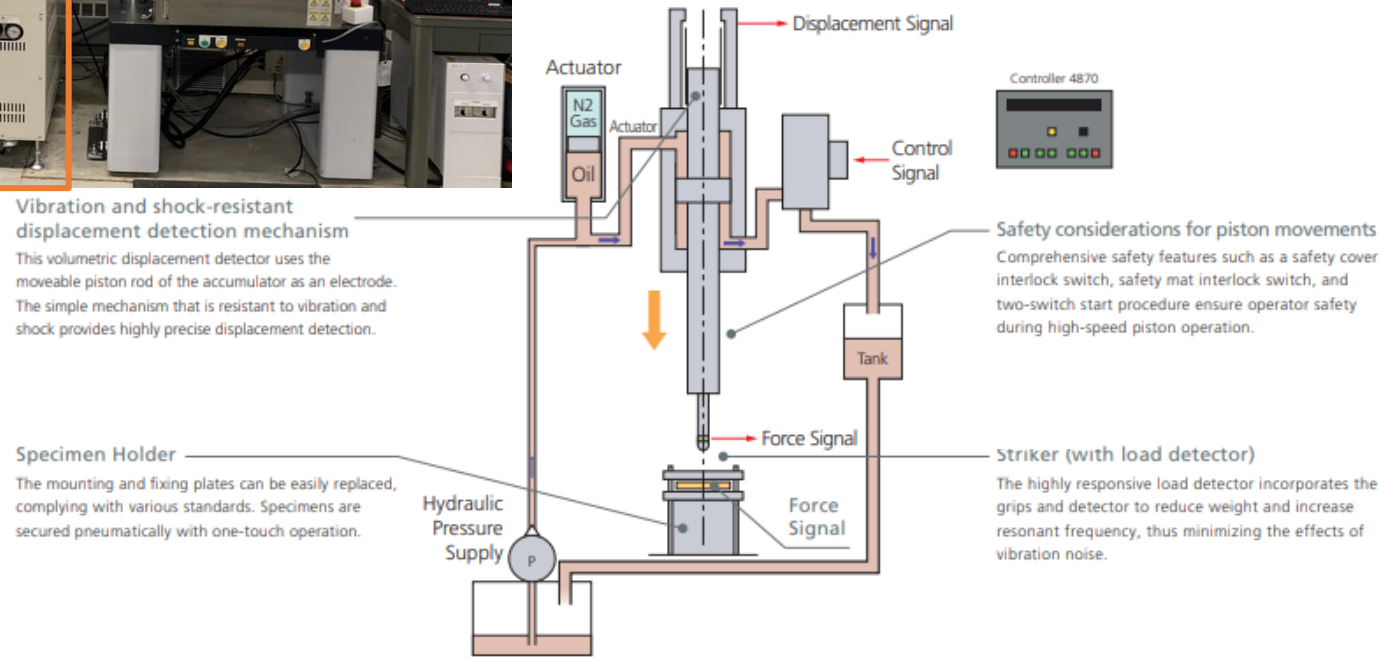


Temperature Range	-40˚C to +150˚C with two refrigerating sources



Vibration and shock-resistant displacement detection mechanism

This volumetric displacement detector uses the moveable piston rod of the accumulator as an electrode. The simple mechanism that is resistant to vibration and shock provides highly precise displacement detection.

Safety considerations for piston movements

Comprehensive safety features such as a safety cover interlock switch, safety mat interlock switch, and two-switch start procedure ensure operator safety during high-speed piston operation.

Specimen Holder

The mounting and fixing plates can be easily replaced, complying with various standards. Specimens are secured pneumatically with one-touch operation.

Striker (with load detector)

The highly responsive load detector incorporates the grips and detector to reduce weight and increase resonant frequency, thus minimizing the effects of vibration noise.

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Dynamic Mechanical Analysis (DMA)

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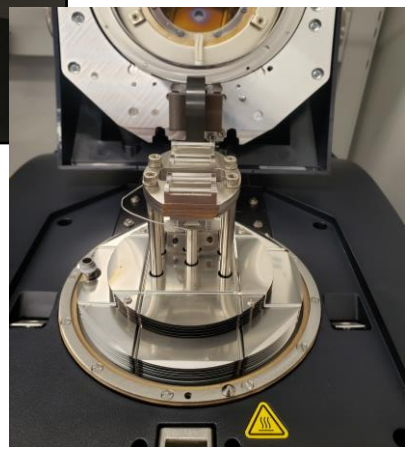
Discovery DMA 850

Maximum Force	18 N
Minimum Force	0.0001 N
Force Resolution	0.00001 N
Frequency Range	0.001 to 200 Hz
Dynamic Deformation Range	±0.005 to 10,000 µm
Strain Resolution	0.1nm
Modulus Range	10^3 to 3×10^{12} Pa
Modulus Precision	± 1%
Tan δ Sensitivity	0.0001
Tan δ Resolution	0.00001
Temperature Range	Standard Furnace: -160°C to 600°C RH Accessory: 5°C to 120°C
Time-Temperature Superposition	YES



Dynamic Mechanical Analysis (DMA) is a testing technique that measures the physical properties of solids and polymer melts, reports modulus and damping, and is programmable to measure force, stress, strain, frequency and temperature

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High-Pressure Underwater Experiment Facility

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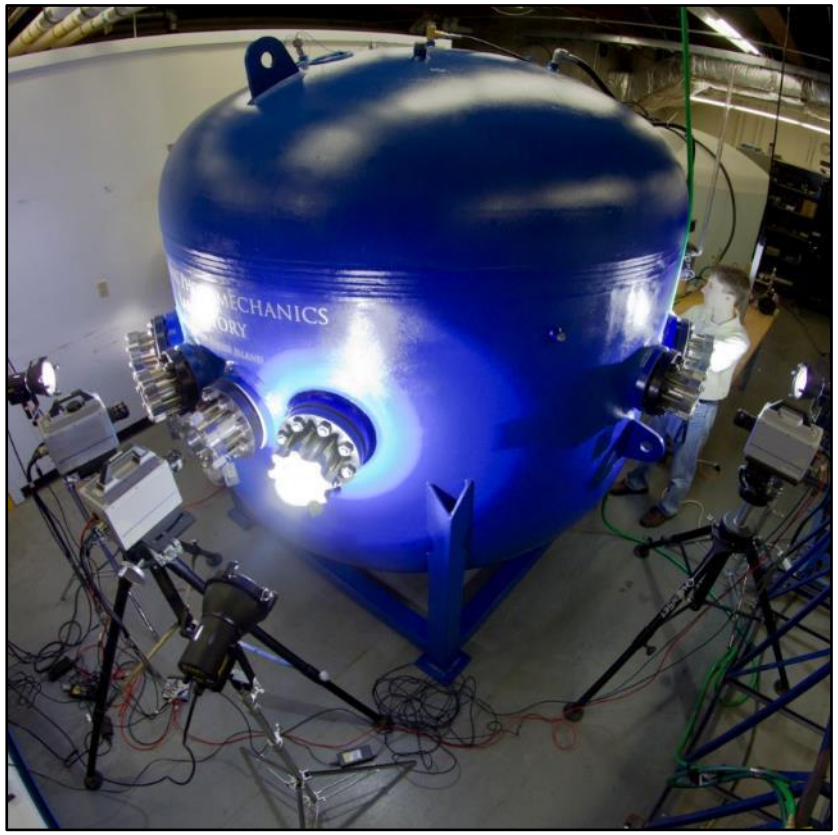

The **High-Pressure Underwater Experiment Facility** is utilized to replicate extreme underwater environments. With the use of flood lights and high-speed cameras, dynamic phenomena can be observed in hydro-static pressures simulating sea depths of up to 2000 ft.

Vessel Diameter	2.1 m (semi-spherical)
Reflection Free time	1.4 msec
Rated pressure	6.89 MPa
Windows	8 optically clear windows mounted at mid span of the vessel

Specimen suspended horizontally in a **large, spherical pressure vessel**

Tourmaline pressure transducers mounted at controlled stand-off distances at several locations about the implodable

Hydrostatic **pressure increased gradually** near the expected collapse pressure (~0.08MPa/min)

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Underwater Explosive (UNDEX) Facility

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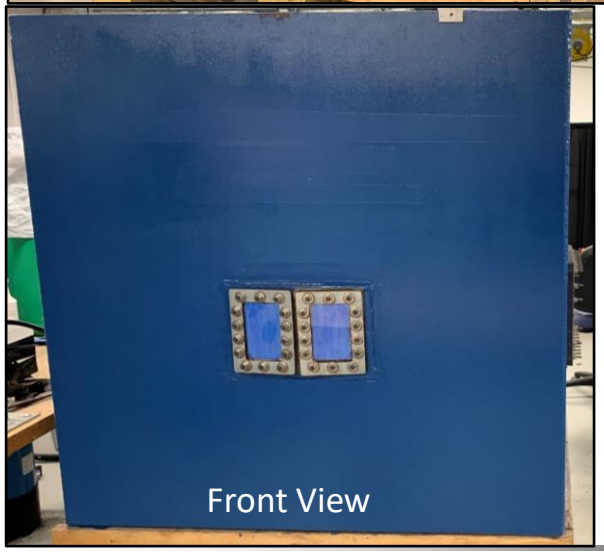
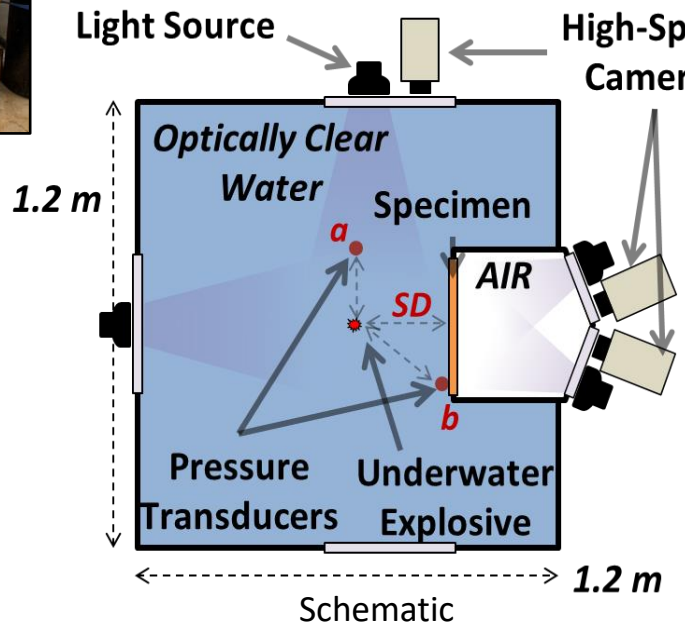


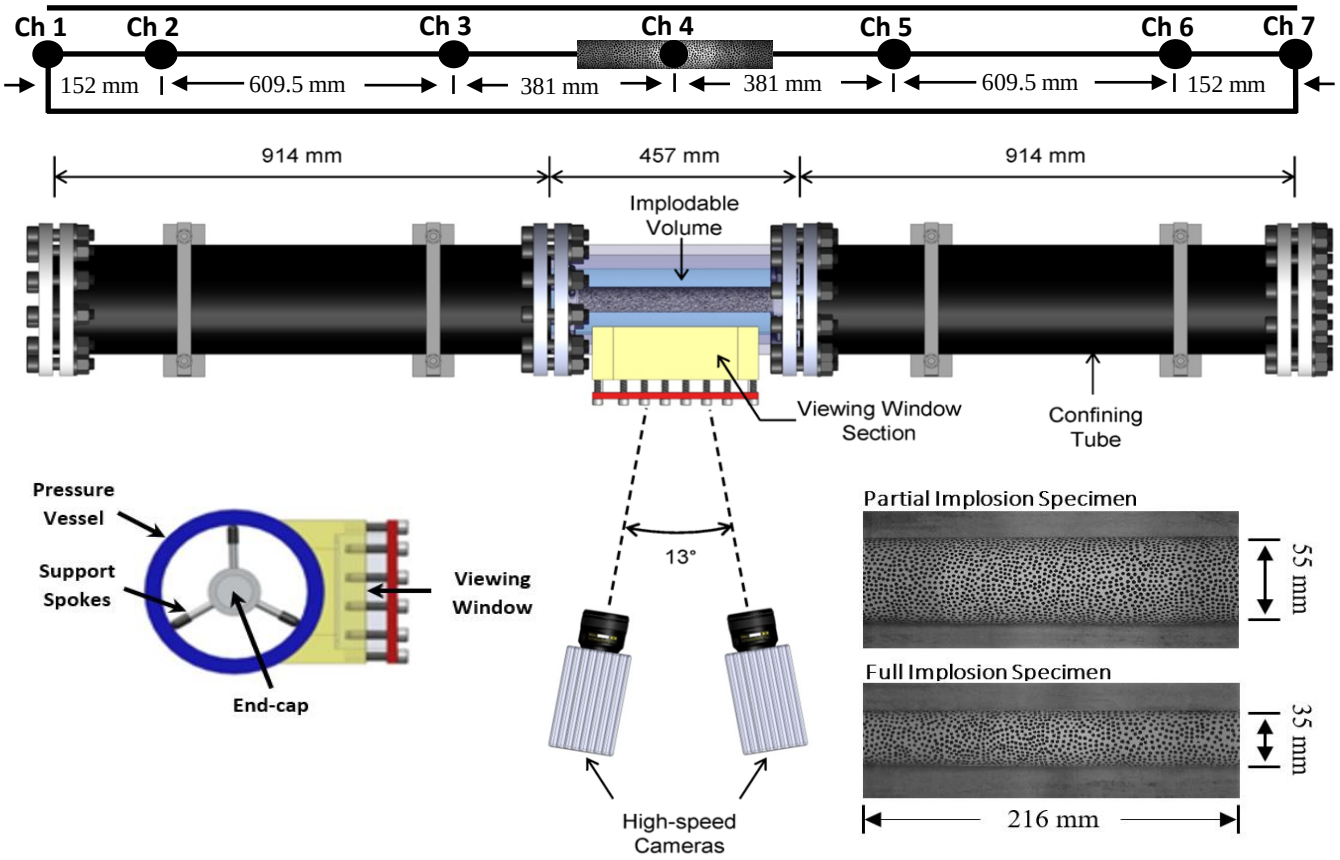
The **Underwater Explosive (UNDEX) facility** is used to replicate the shock loading conditions close to the surface. With angled viewports at the front, it allows 2 cameras to be arranged in a stereo imaging configuration for 3D image correlation and the side views support 2D image correlation.



Schematic

Vessel Length	1.2 m (Square)
Pressurized	No
Windows	2 angled windows at the front with one windows on each other sides

High-Pressure Underwater Experiment Facility with confined energy



Tube inner Diameter	7”
Tube Wall Thickness	0.75”
Sensors	Dynamic Pressure transducers – PCB-113B22 rise time of 1 s, resolution of 0.14 kPa (0.02 psi) and high resonant frequency (500 kHz)

This facility enables hydrostatic loading of cylindrical shells under confining tube which reveals the influence of limited hydrostatic energy available on implosion process

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Shock Tube Facility

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The **shock tube** is used to simulate a blast by directing a controlled shock-wave towards a specimen. Novel materials are investigated with a variety of configurations and even at high temperatures.

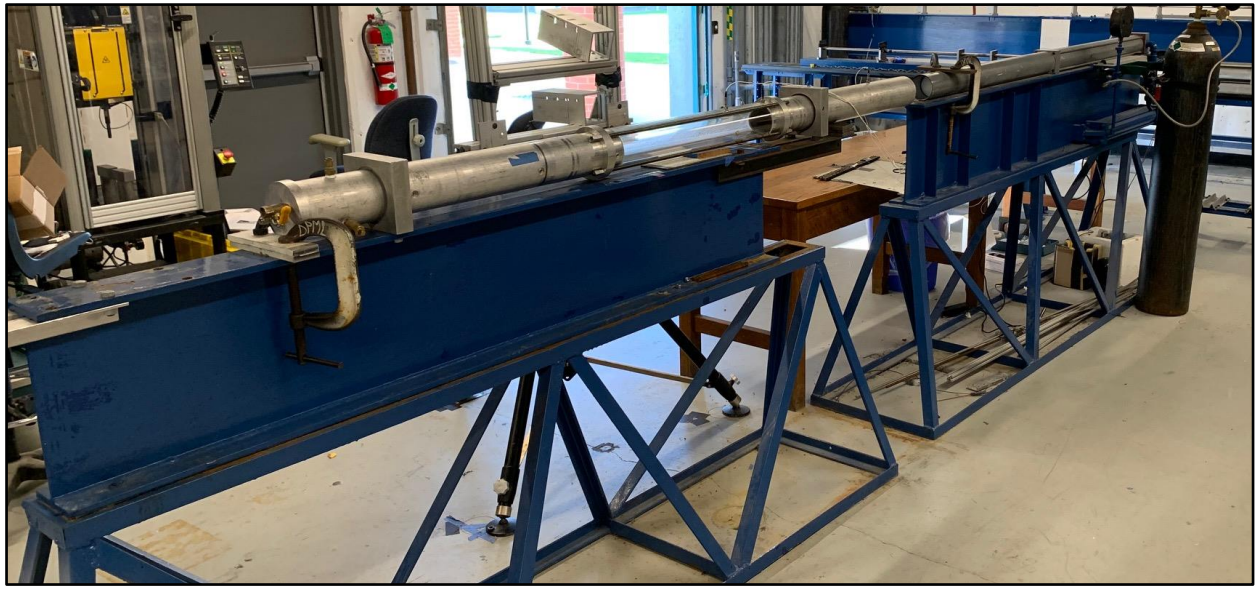
Shock Tube Diameter	6”
Shock tube muzzle Diameters	3” and 1.5“
Driver Pressures	17MPa
Incident Shock pressures	3.1 MPa
Reflected Shock pressures	22 MPa
Max shock wave velocities	Mach 4

Split Hopkinson Pressure Bar (SHPB)

Characterization of dynamic constitutive behavior and dynamic fracture toughness at room temperatures as well as elevated temperatures possible

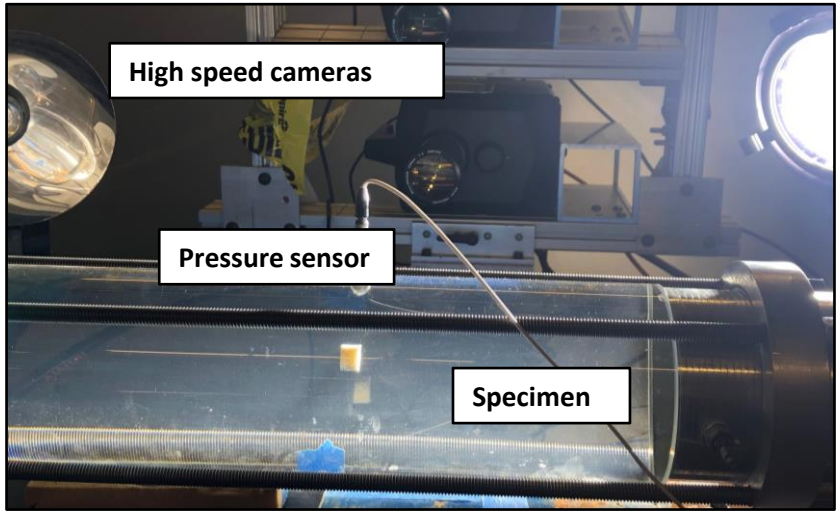
- Tensile and torsion SHPB test setups also available facilitating the study of materials under different modes of loading
- Capability to test hard and soft materials
- Strain Rate ranging from 100 – 10000 /s can be achieved

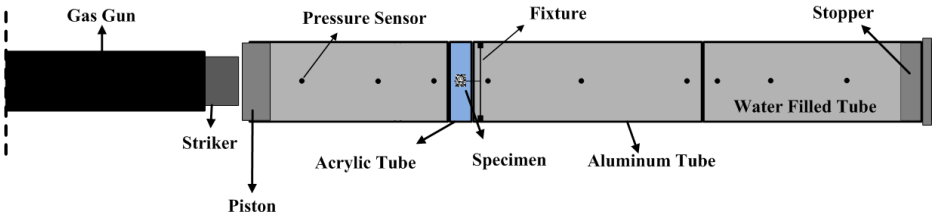
Underwater Shock Tube



The **gas gun driven water-filled tube** is an instrument used to simulate shock loading phenomena for a wide variety of soft materials under hydrostatic conditions.

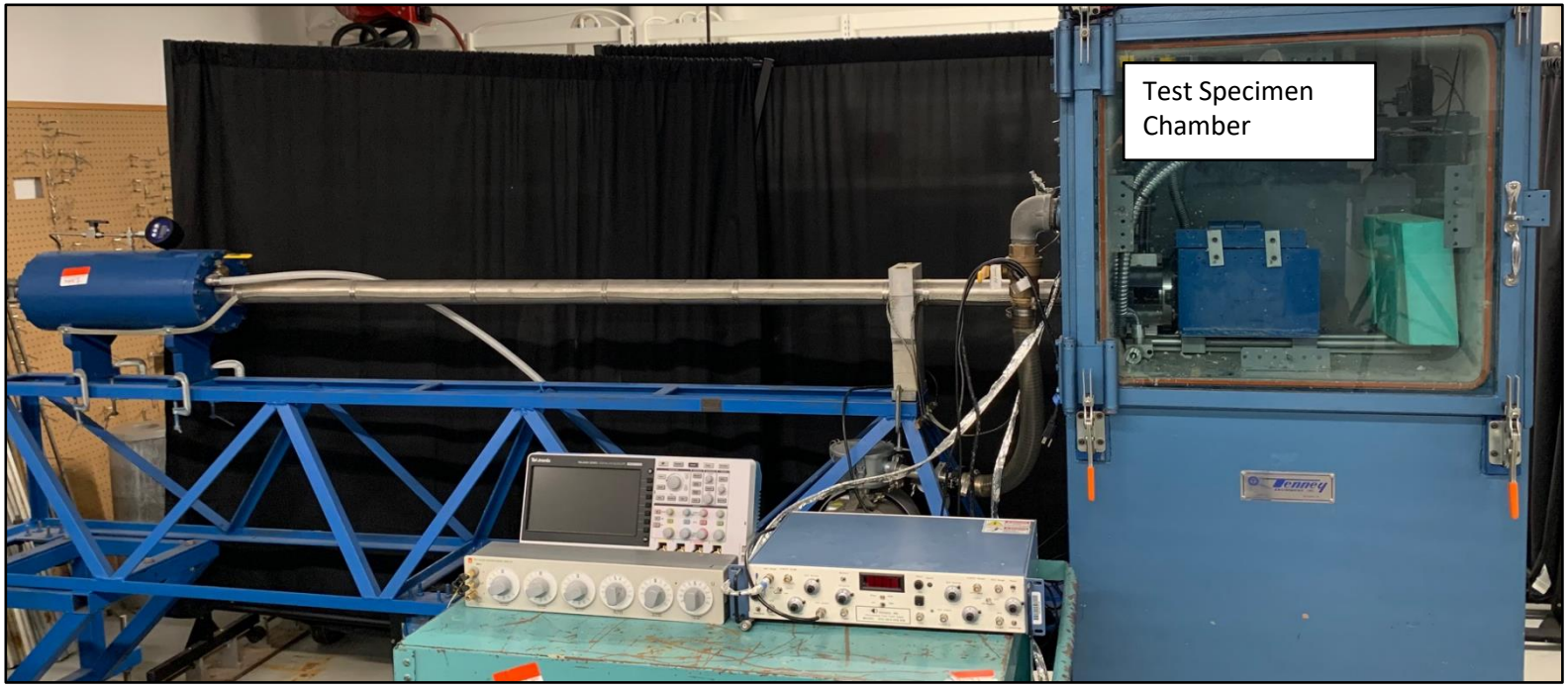
Shock Tube Diameter	3”





Equipped with high-speed SHIMADZU cameras and utilizing underwater 3D DIC it enables us to measure full field deformation for the specimen during shock loading.

Single Stage Evacuated Impactor



Plat Impact Testing for Very High Strain Rates 10^6/sec

Projectile Diameters	1” – 2”
Projectile Speeds	50 to 1000 m/s

Accelerated High pressure Aging facility

The **accelerated high-pressure aging facility (AHPAF)** is used to conduct water ingression studies and perform **accelerated life testing (ALT)**.

Vessels are rated for extended pressure holds at up to 6000psi and temperatures of up to 70 degrees Celsius.

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High Speed Photography Equipment

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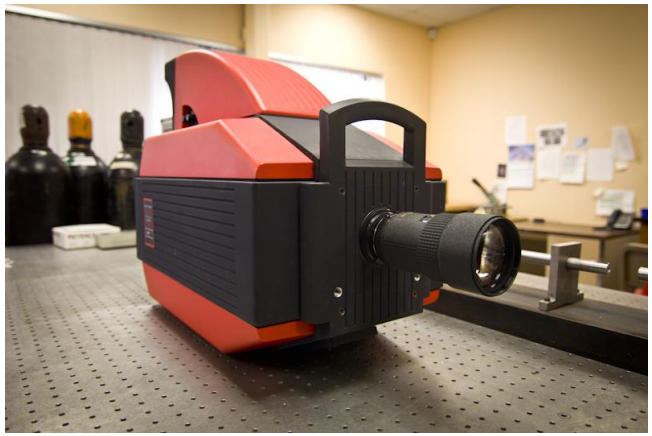
a



b

c

d

a	**FASTCAM NOVA S12** cameras can record up to 1million fps and are utilized for performing Digital Image Correlation (DIC) analysis in extreme environments. Qty: 2
b	The **IMACON 200** camera can take 16 frames at 200 million frames per second with 1280 x 1024 - pixel resolution. Qty: 1
c	**Shimadzu HPV-X2** Ultra-High-Speed cameras record at 10 million frames per second in High Resolution 3D DIC capable video. Qty: 2
d	**Photron Fastcam SA 1.1** cameras can record up to 675,000 fps and are utilized for performing Digital Image Correlation (DIC) analysis in extreme environments. Qty: 3

3D Printer

Carbon M2

A resin-based 3D printing technology that uses digital light projection, oxygen-permeable optics and engineering grade materials to produce polymeric parts.

XY; Z resolution	75 µm; 25, 50 or 100 µm
Layer thickness	Layerless, isotropic parts
General Accuracy	Up to ±0.003 in + 0.001 in per in dimension size Up to ±70 µm + 1 µm per mm dimension size
Production Repeatability	Up to ±0.002 in Up to ±40 µm
Build volume	7.4 x 4.6 x 12.8 in 189 x 118 x 326 mm

Water Jet cutter

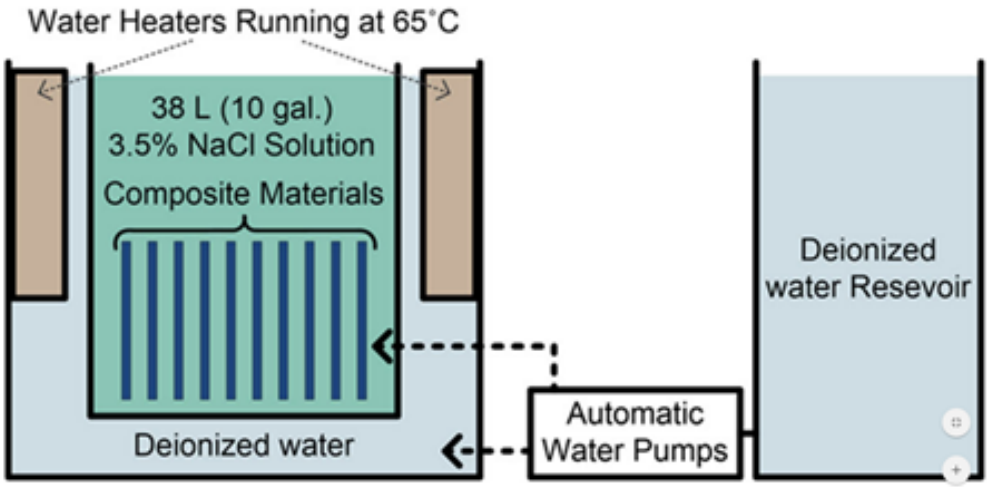
WAZER Desktop water jet cutter

Abrasive Flow rate	40g~150g/min
Abrasive capacity	30lbs (13.5 kg)
Cutting Area	12” x 18” (305 mm x 460 mm)
Cut Bed Size	13” x 19” (330 mm x 485 mm)
Kerf (width of cut)	.044 (1.2 mm)

Weathering facilities

UV Accelerated Weathering

Salt Water and High Temperature Accelerated Weathering



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The Orbital 1S Robotic 3D Printer

(Will be available August 2022)

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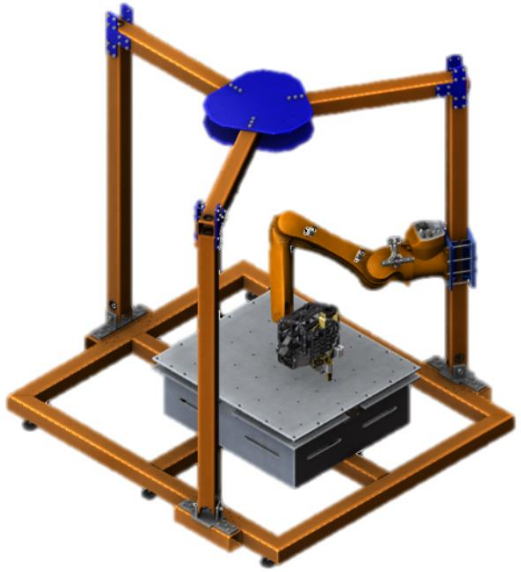
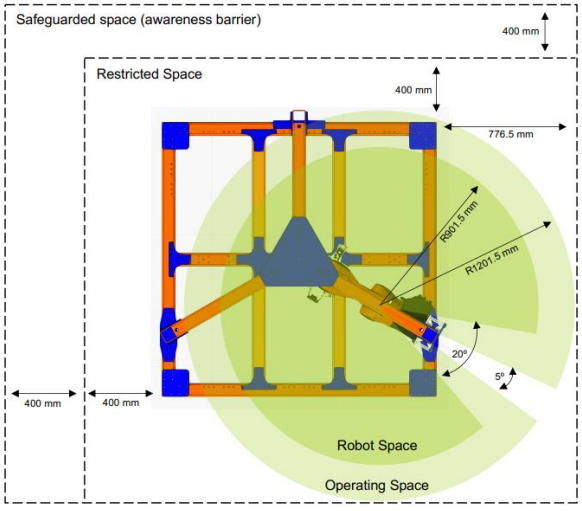


Robot:	KUKA KR 10 R1100 sixx
Controller:	KUKA KR C4 compact
Teach pendant:	KUKA smartPAD
Weight:	413.5 kg (911.68 lbs) without robot and build plate
Footprint (W×H×D):	2082.8 mm × 2255.6 mm × 2107.3 mm without robot
Degrees of freedom:	6 + 2 with base position and end-effector suspension
Power supply:	200-240 VAC, 50/60Hz
Acoustic noise:	Low
Collaboration operation:	Collision force/torque sensor, not human collaborative
Air line:	None
Working temperature:	5 °C to 45 °C (278 K to 318 K)
Working humidity:	0% to 90% uncondensed
Operating system:	Orb OS
Cabling:	Cable between robot and control cabinet (15 m) Cable between teach pendant and control cabinet (10 m) Cable pack between end-effector and control cabinet (15 m)



The printing mechanism, or end effector, uses a continuous fiber thermoplastic matrix system. With its unique in-situ impregnation step, the end-effector enables 3D printing of advanced lightweight composites with almost any type of feedstock thermoplastic and fiber yarn combination. This enables production of high-performance end-use structures. It is integrated with the Orbital S robotic additive manufacturing (AM) platform.