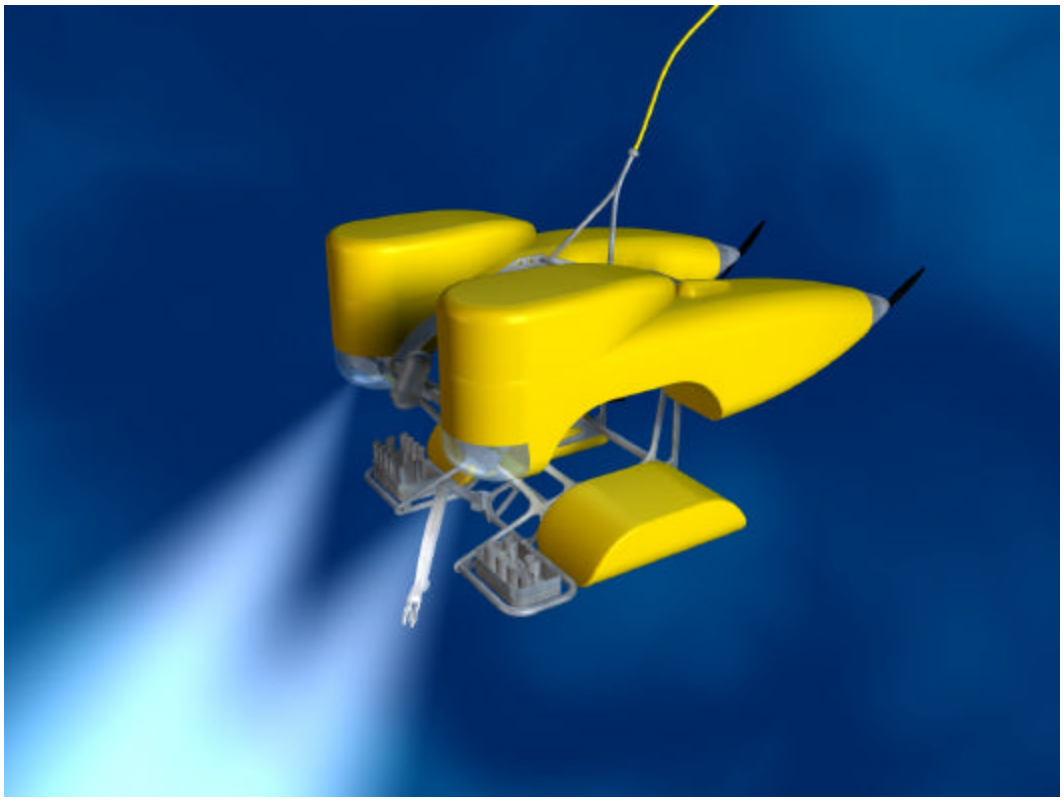
HROV Project Update



Fall DESSC Meeting

Dec. 12, 2004

Project Milestones

- 11KM Floatation development complete:
  - Syntactic SG of .58
  - Ceramic sphere SG of .40
- Work Space design tools in place.
- Electric Manipulator development underway
- Advisory Panel established
- Prototype LED lighting array built and tested
- Microfiber tether development:
  - Pressure testing of candidates
  - Modeling
  - Initial field tests
- Conceptual vehicle development underway
- Main pressure cases in production

Advisory Panel

- Review and advise on Science Mission Requirements (e.g. capabilities, sensors)
- Provide input regarding established project priorities as they relate to identified risks.
- Assist in planning and advocate for science use during initial missions.
- Recommend public outreach and education opportunities.

Advisory Panel Members

- Keir Becker
- Chuck Fisher
- Patty Fryer
- Melanie Holland
- Deb Kelly
- Jim McFarlane

HROV Basic Design Philosophy

- Build on previous experience when possible
- Identify risks and aggressively address early in the project
- Integrate into ongoing NDSF operational and WHOI technology developments
- Limit operational team support to 4 people
- Minimize weight and power to keep core system to a single 20 foot ISO shipping container

Science Mission Requirements

- Push coring
- Heat-flow probe (1 to 1.5 M long)
- Hi/Lo temperature probes
- Geotechnical/Geochemical
- Rock sampling/drilling
- Flexible science sensor payload interface
- Biological sampling (grabs/boxes)
- Water Sampling (hot/cold)
- Water column sensing (e.g. methane)
- High resolution bathymetry

Manipulative capabilities

- Push coring
- Temperature and heat flow probe
- Sensor deployments
- Rock sampling
- Rock coring
- Biological sampling
- Water sampling
- Re-design tools for HROV rather than limit design of HROV based on tools

Workspace Summary

- Payload of 75 lb
- Total Sampling System Weight 300 lb
- 1 cubic meter volume for sample storage
- Manipulation Integrated into Workspace
  - May involve a manip with less DOF than JII 7 function, 6 DOF
  - Build on JI and JII workspace use

QuickTime™ and a
Animation decompressor
are needed to see this picture.

Scientific Sensors

- SeaBird 49 FastCAT CTD
  - 2 CTD's on vehicle
  - Includes integral pump for T/C sensors
  - Pressure: 0 – 11,000 m, accuracy 0.1% full scale range
  - Conductivity: 0 to 9 S/m, accuracy 0.0003 S/m
  - Temperature: -5° to +35° C, accuracy 0.002° C
- Honeywell HMR2300 3-Axis Digital Magnetometer
  - Range ±2 gauss, <70 µgauss resolution
- Optical Backscatter Sensor
  - Manufacturer TBD

Proposed Scientific Interface

- RS-232 serial ports
- 0-5VDC analog input, low bandwidth
- Flexible voltage interface (typical 12/24VDC)
- ?? Whrs power available for scientific gear
- Other considerations?

Video Equipment Summary

	Configuration	Resolution	Storage
Pixelfly	Mosaics & stills in AUV or HROV mode	1.4+ megapixels	Internal hard disk + uplink
Documentation camera	Hi-resolution color stills for AUV and HROV sampling modes	3.3+ megapixels	Internal 1GB card (approx 800 images
Standard video camera	Quality color video in HROV approach and sampling modes	>400 TVL	Uplink
Utility camera	High sensitivity B&W video for HROV approach and sampling modes	>400 TVL	Uplink

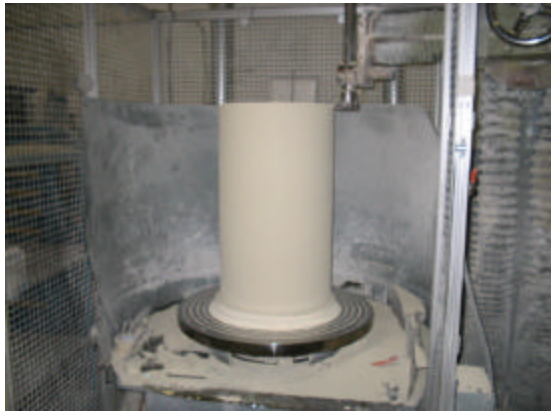
Ceramic Housing Manufacture

CoorsTek, Golden, Colorado

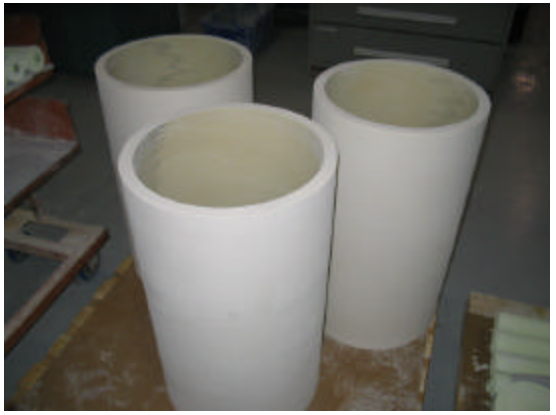
Process	Status
Isostatically pressed 0.960 alumina powder	Tooling made, pressing in progress
Machined to ~20% oversize in green state	In progress
Fired	Scheduled
Diamond ground to final dimensions, all surfaces	Scheduled

Pressed

Machining Green



Ready for Firing

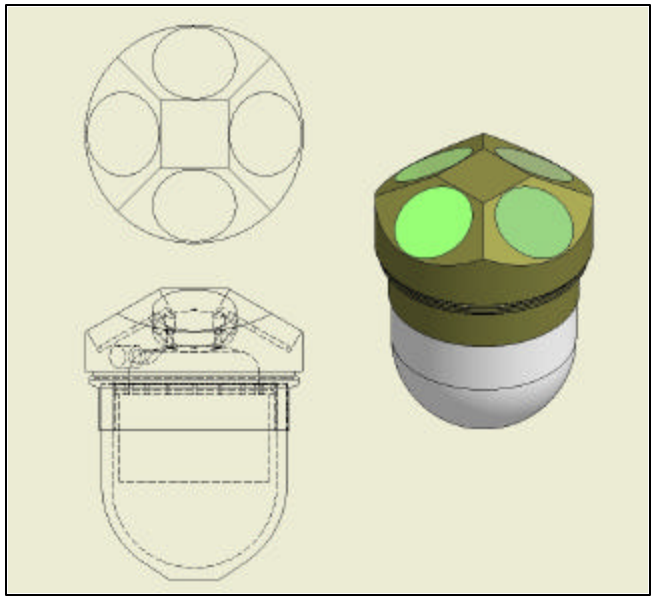


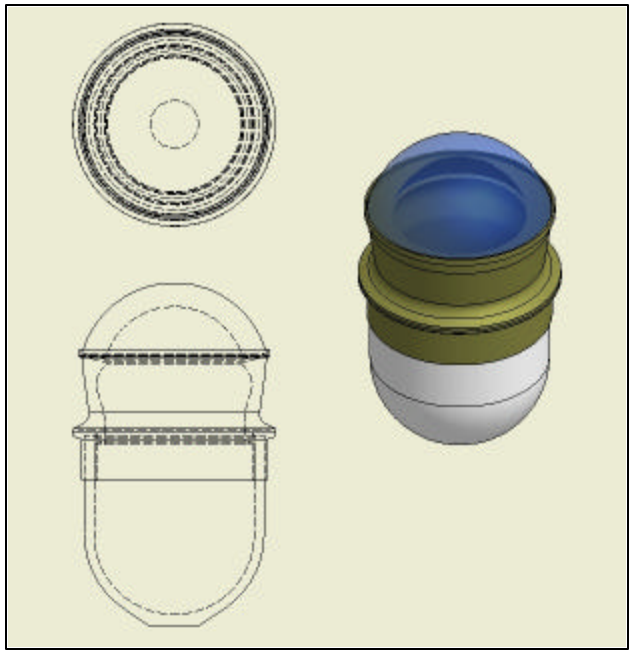
Utility Housings

Versatile packaging for electronics outside of the main pressure vessel

List of Instruments

1) Doppler
2) GPS/ Iridium beacon and LBL
3) Altimeter and Pressure transducer
4) Digital still camera
5) Motion camera
6) High altitude digital camera





Fiber Tether Design

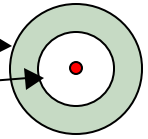
Progress Report

- Tether Candidates: Two Candidate Fibers Identified
  - Commercially available.
  - Pressure tested to 17,000 psi in August 2004.
  - Cable pack winding services available (SPAWAR, SCI).
- Tether Hydrodynamic Simulation
  - WHOI Cable dynamic simulation program – validated and extended by HROV team.
  - Feasibility studies show both cables can work.
- Experimental Tether Deployment
  - Four prototype cable packs designed and built.
  - Candidate fibers tested successfully in 2000m deployment in San Clemente Canyon in Nov 2004.

Candidates for HROV Tether

0.25 mm Polymer Buffer

0.12 mm Optical Fiber



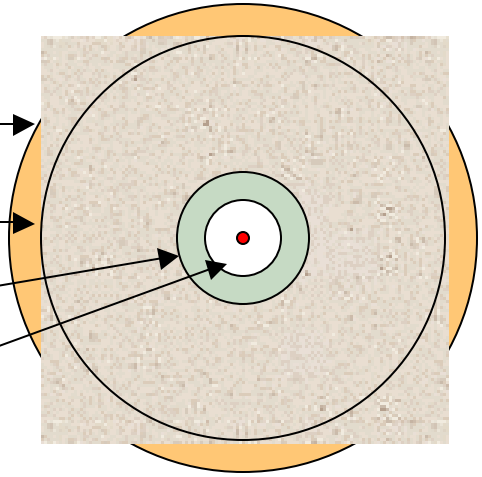
Buffered Optical Fiber

0.78 mm Anti-Abrasion Jacket

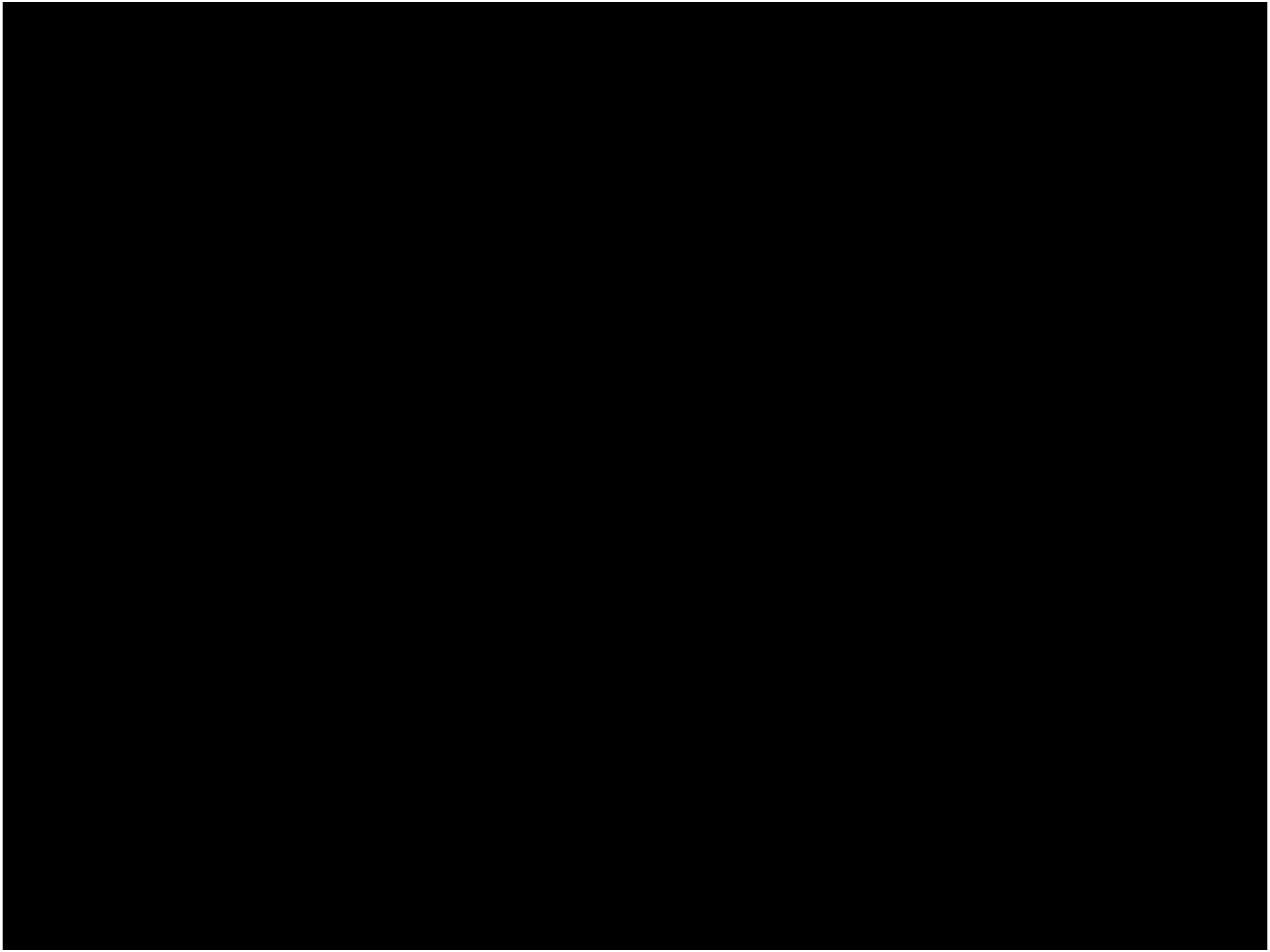
0.76 mm FRP Strength Member

0.25 mm Polymer Buffer

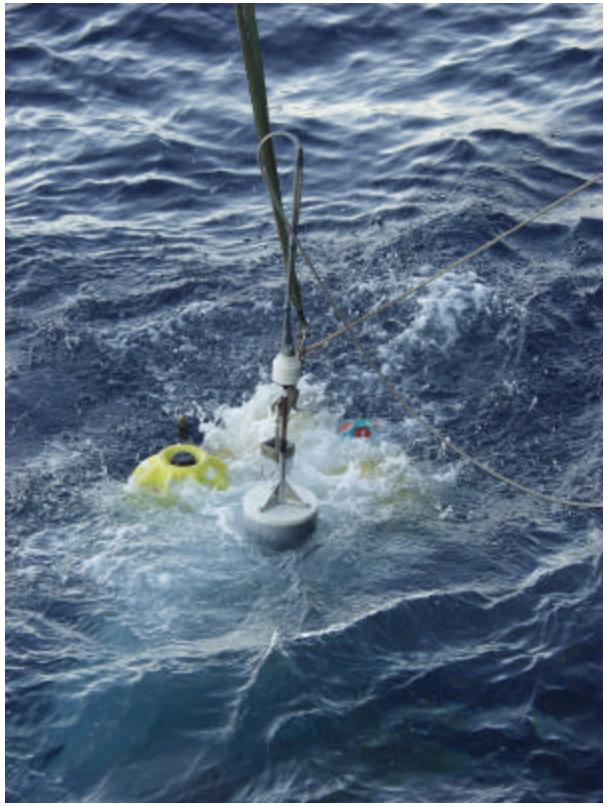
0.12 mm Optical Fiber



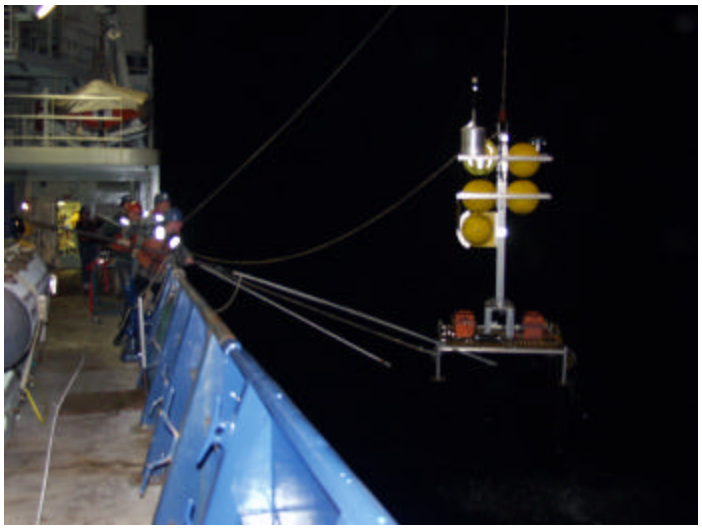
Fiber Optic Micro Cable (FOMC)



Scenes from Microfiber Testing



Elevator on its way. Note the flex hose connecting the canister to the ship



Recovering the elevator at night

Hi-tech cable recovery equipment

San Clemente Island Test Results

- FOMC survived for 4 hours until test was terminated
- Buffered Optical Fiber survived for 3:45
  - Fiber broke 112m from end of flex hose, close to ship
  - Fracture analysis of broken end
    - Cause: excessive tension caused by build-up of adhesive from FOMC in flex-hose combined with ship motion
    - No evidence of external damage due to marine life

HROV lighting requirements

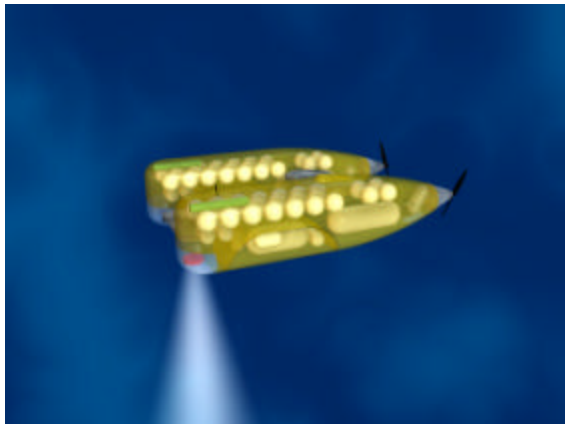
- Strobe capability
- Low power consumption
- Pressure tolerant
- Uniform illumination field

LED Lighting Characteristics

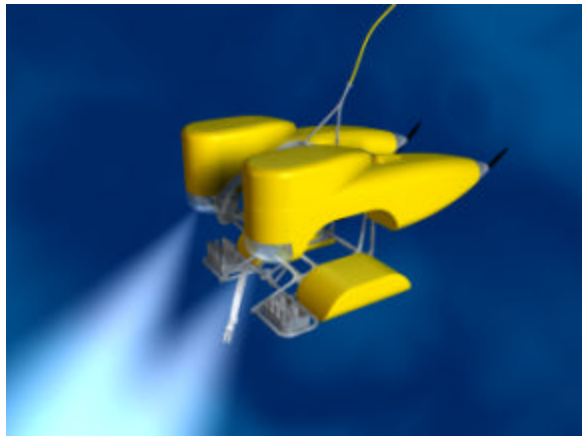
- Ability to strobe
- High electrical to optical conversion efficiency
- Pressure tolerant design
- Ability to create a spatially flat illumination field to match the camera field of view
- Discrete color for best “effective transmission” through water
- Color correction for chromatic attenuation

Two Task Dependent Arrays

- One downward looking, survey array
  - ~60 element
  - 500nm (blue/green)
  - Range 5m to 20m (optimally 10m)

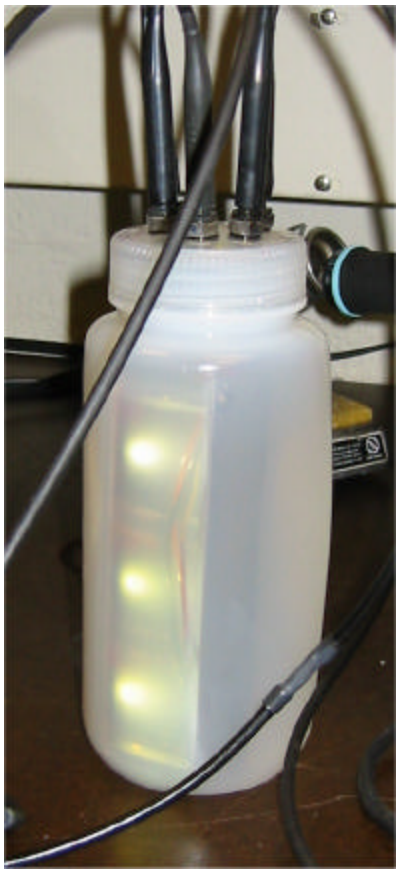


- Two forward looking, task arrays
  - 20 to 30 elements
  - Broad spectrum for close up color and video
  - Range 1m to 5m
  - Aimable array coupled with camera motion



10kpsi pressure test

- Results:
  - Batch 1, (3 leds) survived overnight 10kpsi
  - Batch 2, (3 leds) two of three elements failed at ~9kpsi.
- Corrective action:
  - Speaking with vender regarding selection
  - Revived vender search

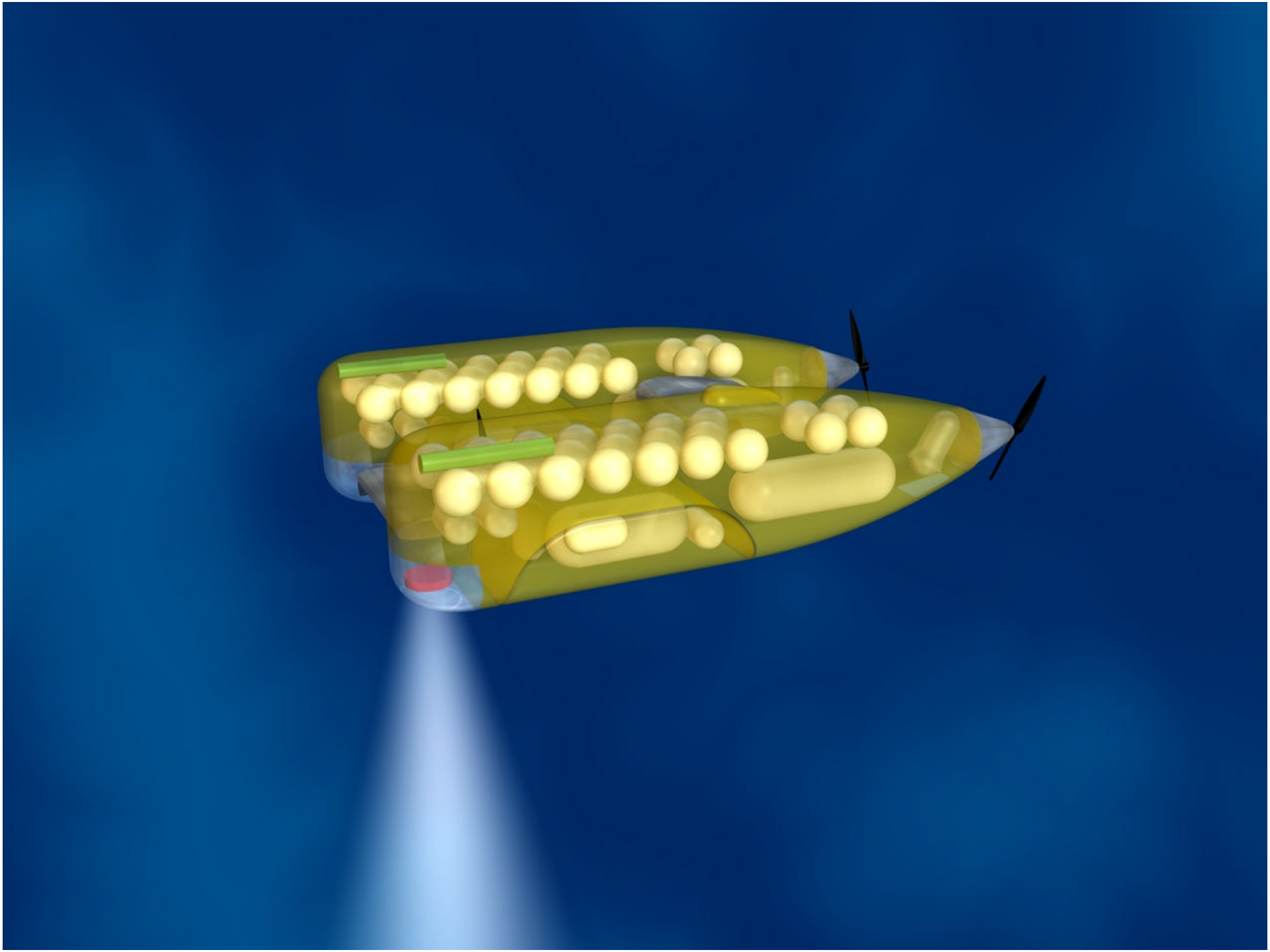


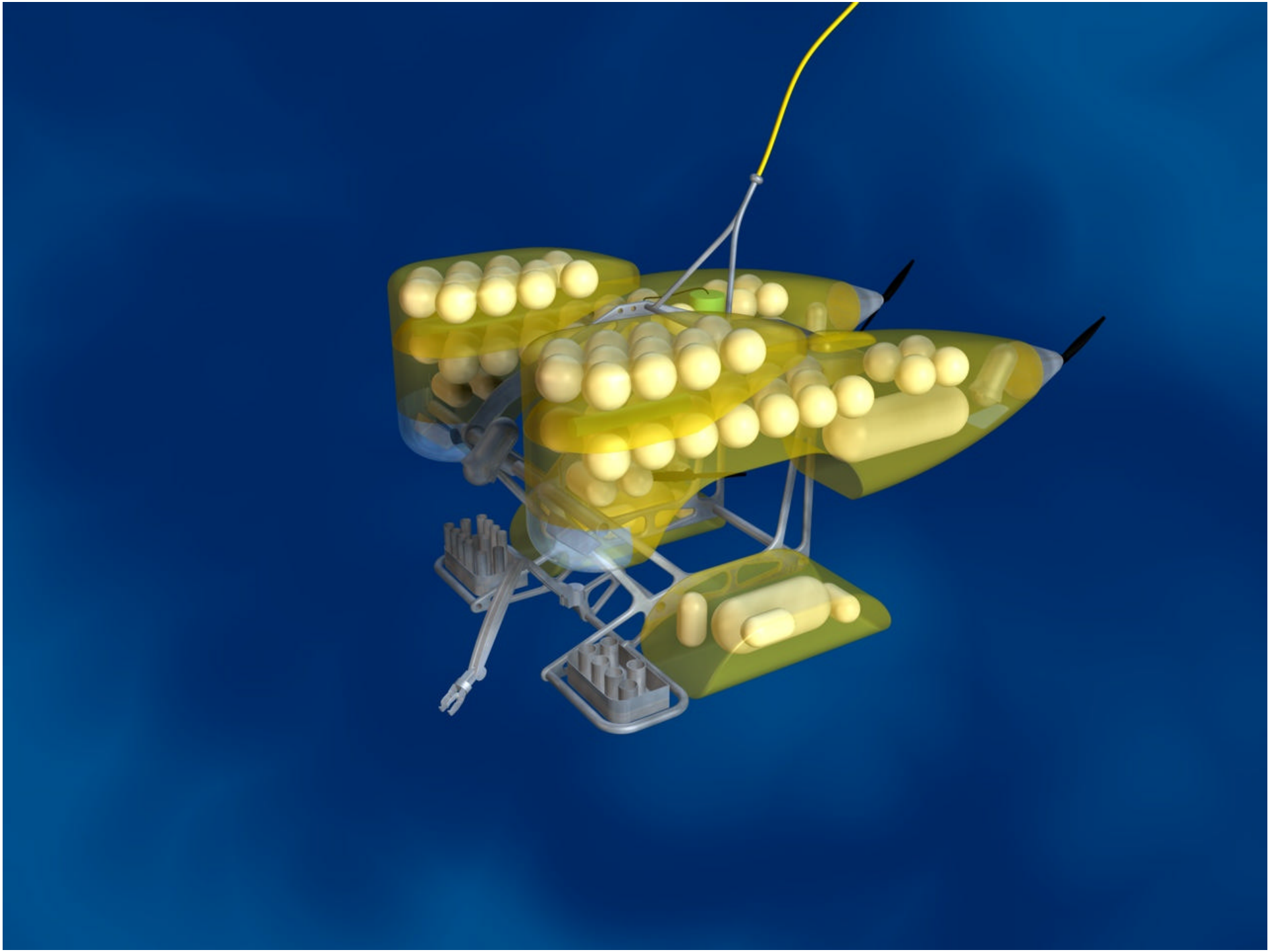
Oil filled test fixture

60 element “survey” array

LED configuration

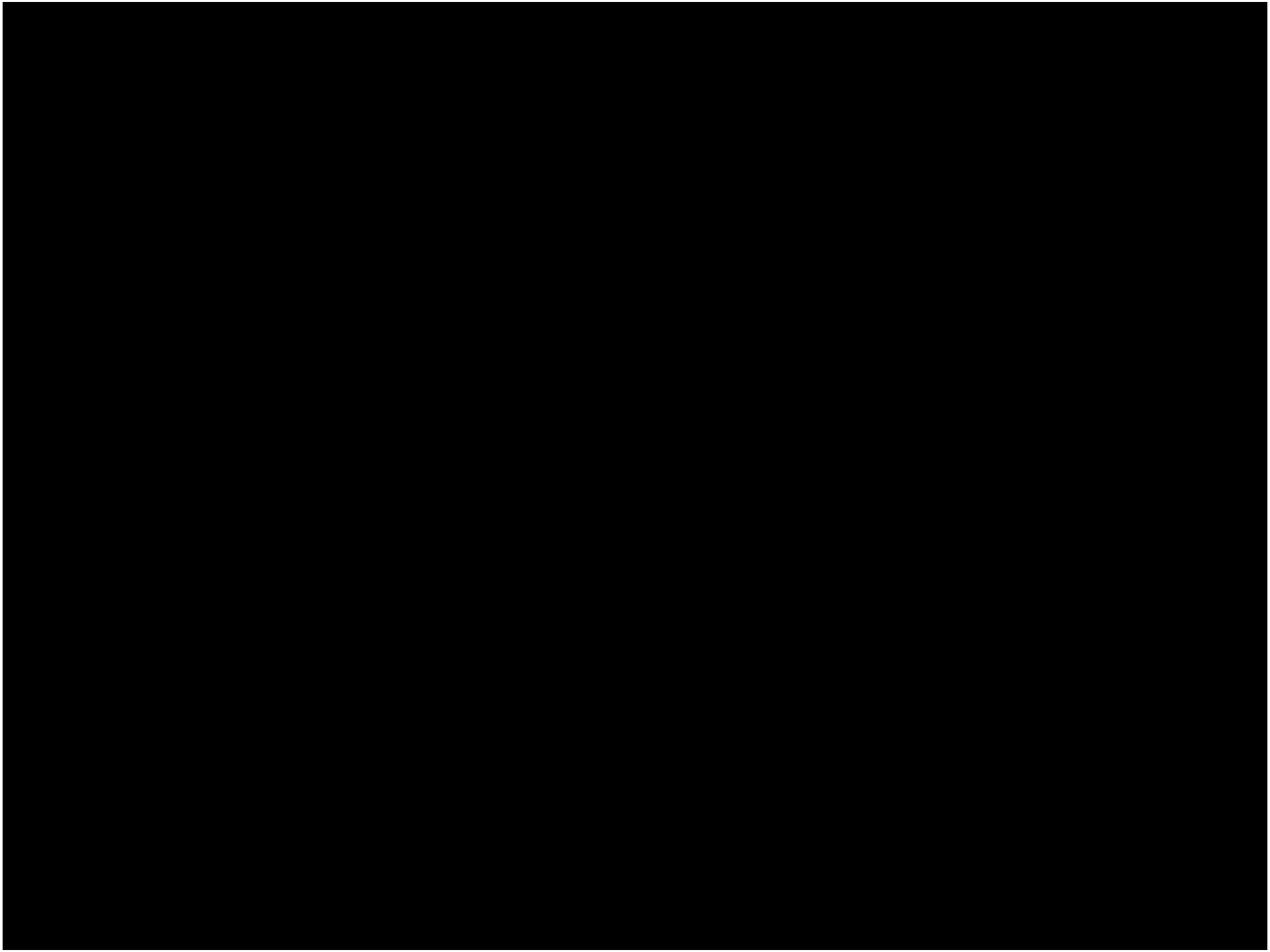
Array and
illumination pattern





Project Goals for CY 2005

- Complete conceptual development of both vehicle configurations leading to detailed structural design
- Complete manipulator design and have both hardware and software components in test
- Complete fabrication and test of main and auxiliary pressure housings
- Make final choices on propulsion and have fabrication underway
- Purchase of vendor supplied components
- Further tests of microfiber (deep elevator and shallow AUV




#63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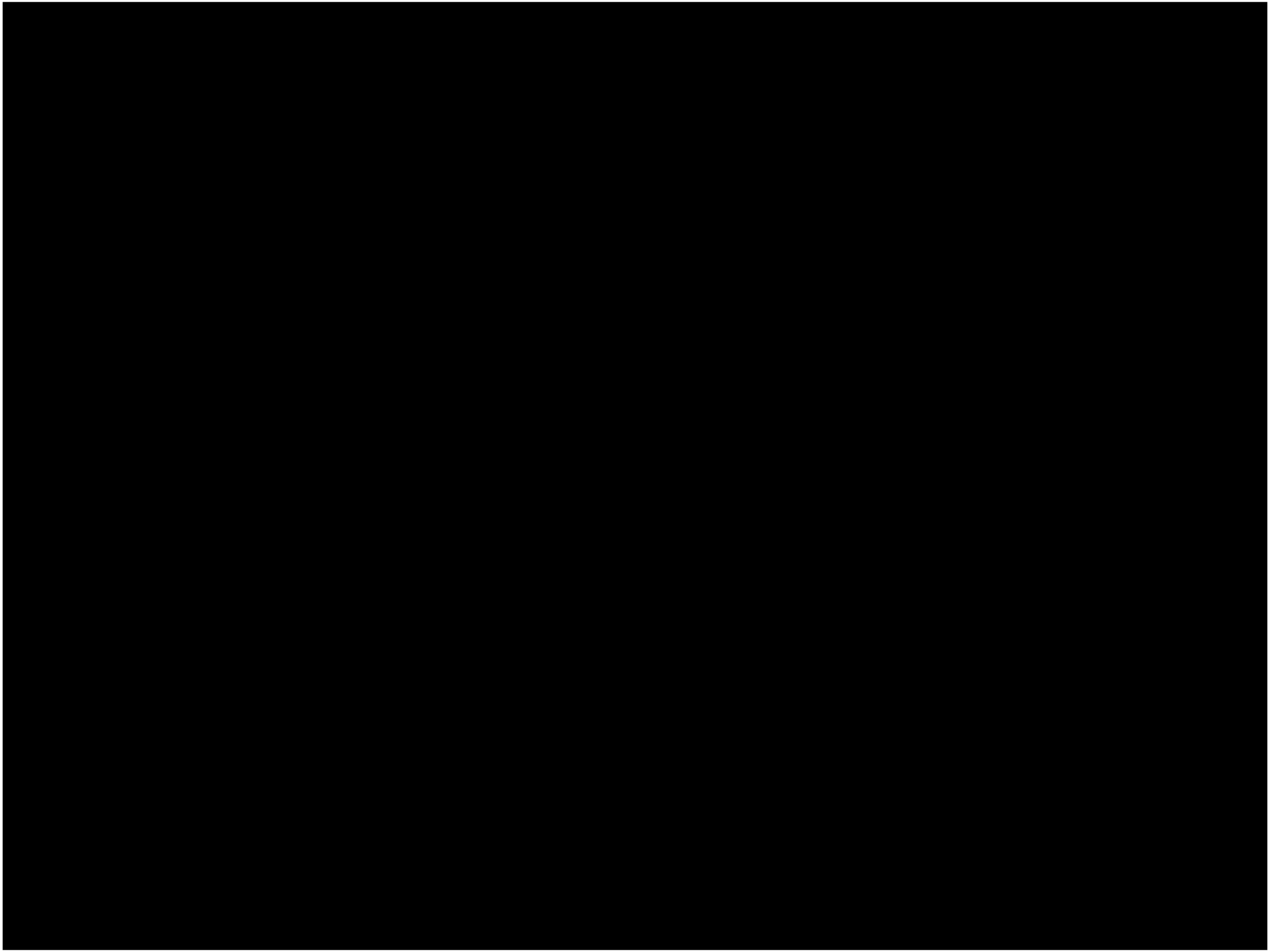

Weight/Balance

AUV

1120 kg (2460 lb) Air Wt

50 ceramic spheres

2.5 cu ft syntactic foam

50 lb (wet wt) payload

ROV

1510 kg (3320 lb) Air Wt

74 ceramic spheres

5 cu ft syntactic foam

100 lb (wet wt) payload

HROV Cable Candidates

	FOMC	Buffered Optical Fiber
Diameter (mm)	0.80	0.25
Dry Weight (kg/km)	0.90	0.06
Wet Weight (kg/km) (sea water)	0.38	0.02
Maximum Hanging Length In Water (m)	35,274	38,847
Weight of 11000 m in water (kg)	4.2	0.2
Working Strength (N)	133	6
Breaking Strength (N)	400	9*
Relative Survivability on Seafloor	good	poor
Relative Survivability in Water Column	good	fair
Maximum Operating Depth (m)	11,659.20	11,659.20
Maximum Operating Pressure (psi)	17,000.00	17,000.00
Maximum Operating Pressure (kpa)	117,211.60	117,211.60

* Proof test load for optical fiber