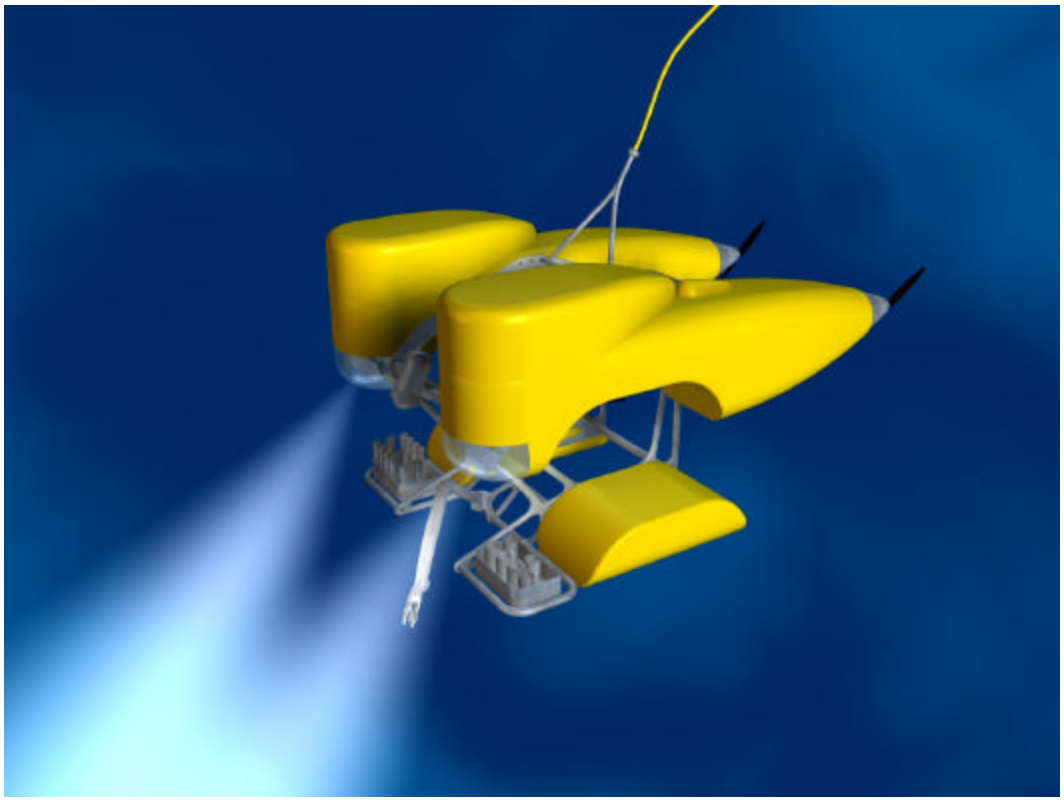
HROV Project Update



Spring DESSC Meeting

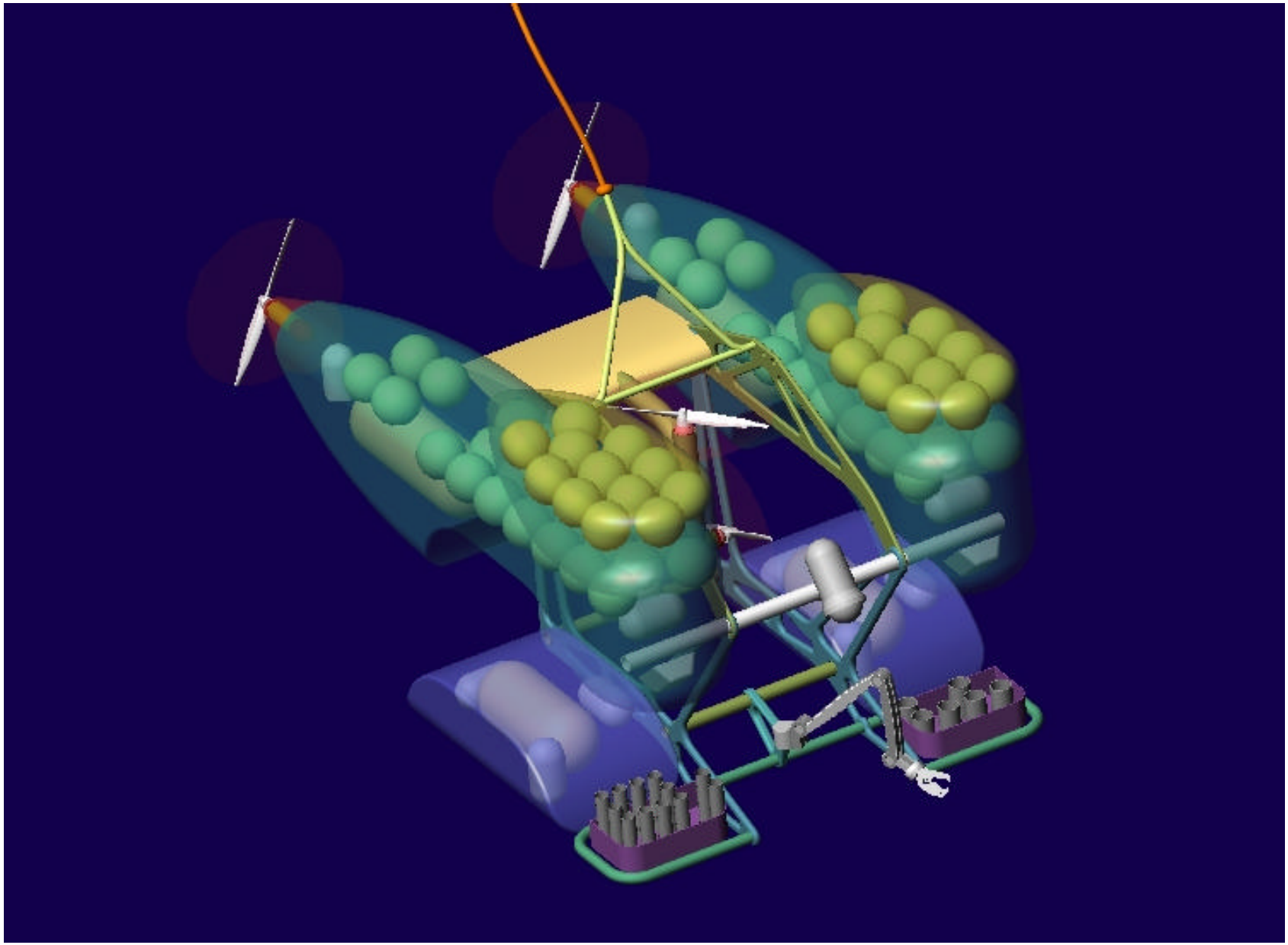
Project Milestones

- 11KM Floatation on order
- Work Space analysis underway
- Manipulator development underway
- Main processor selection/evaluation
- Telemetry specification and selection
- Battery pack prototype in design
- LED elements selected and pressure tolerant forward looking array design underway
- Microfiber tether development:
  - Deployment modeling ongoing
  - Initial field tests (vehicle maneuvering and deep elevator deployment)
- Conceptual vehicle development complete and now being evaluated for stability/control
- Main pressure cases in NDT

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

Manipulator and Workspace

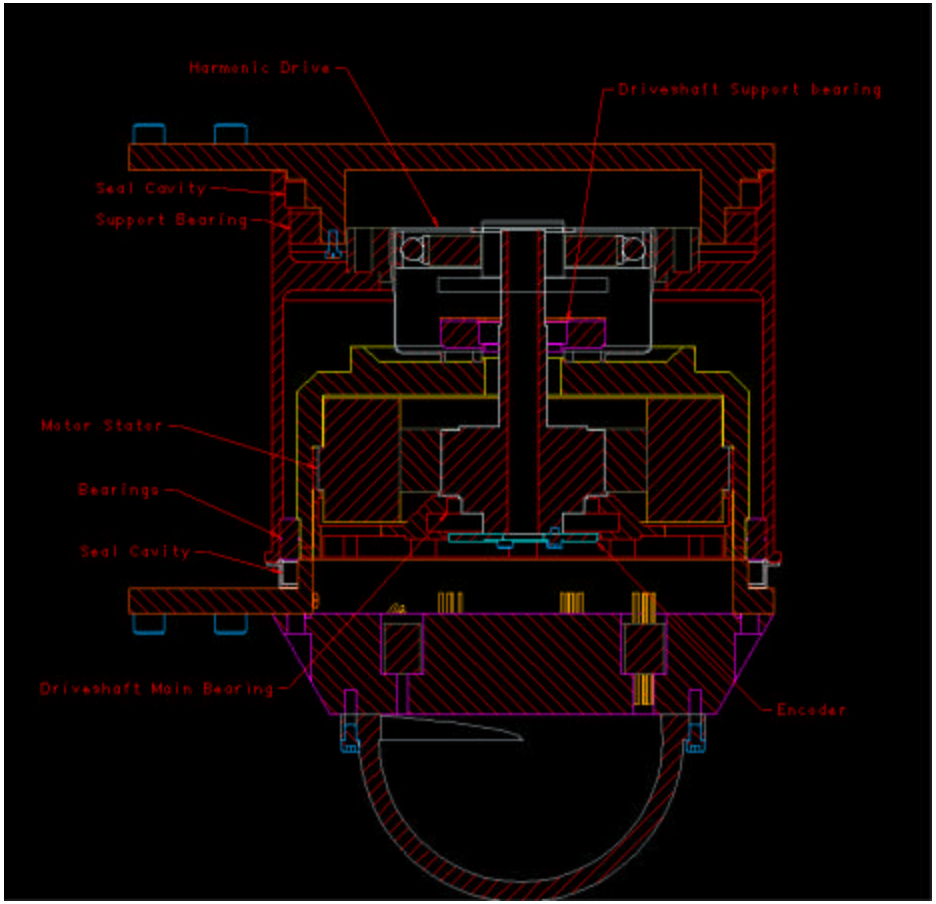


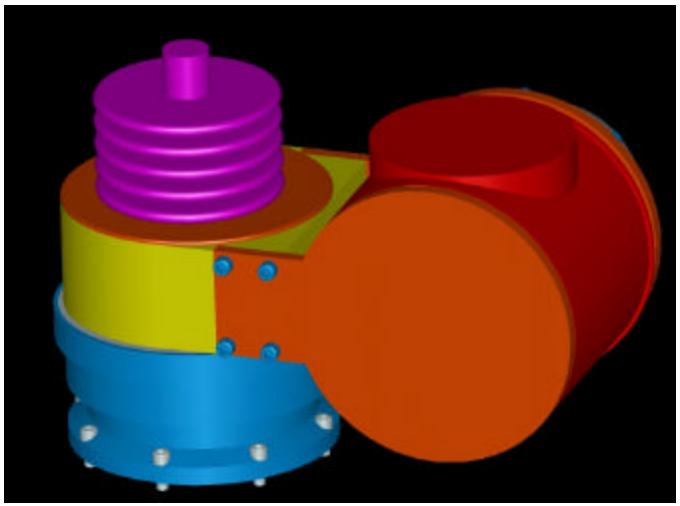
QuickTime™ and a
Animation decompressor
are needed to see this picture.

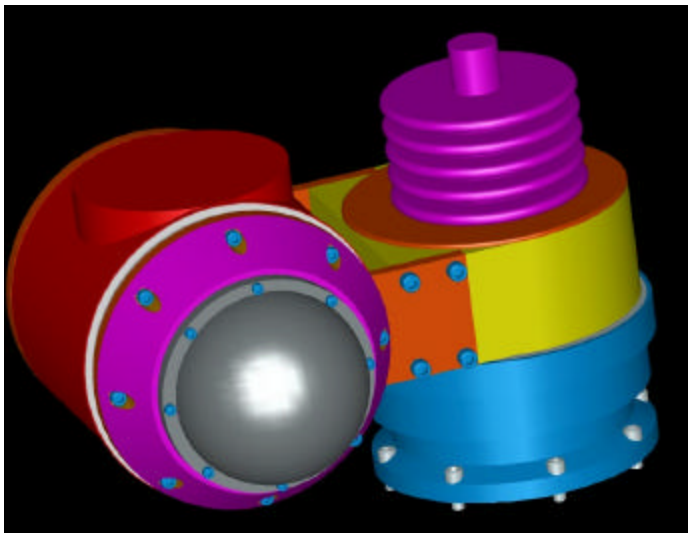
Manipulative capabilities

- 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

Candidate Manipulator Joint Design







Workspace Summary

- Payload of 75 lb
- Total Sampling System Weight 300 lb
- 1 cubic meter volume for sample storage
- Manipulation Integrated into Workspace

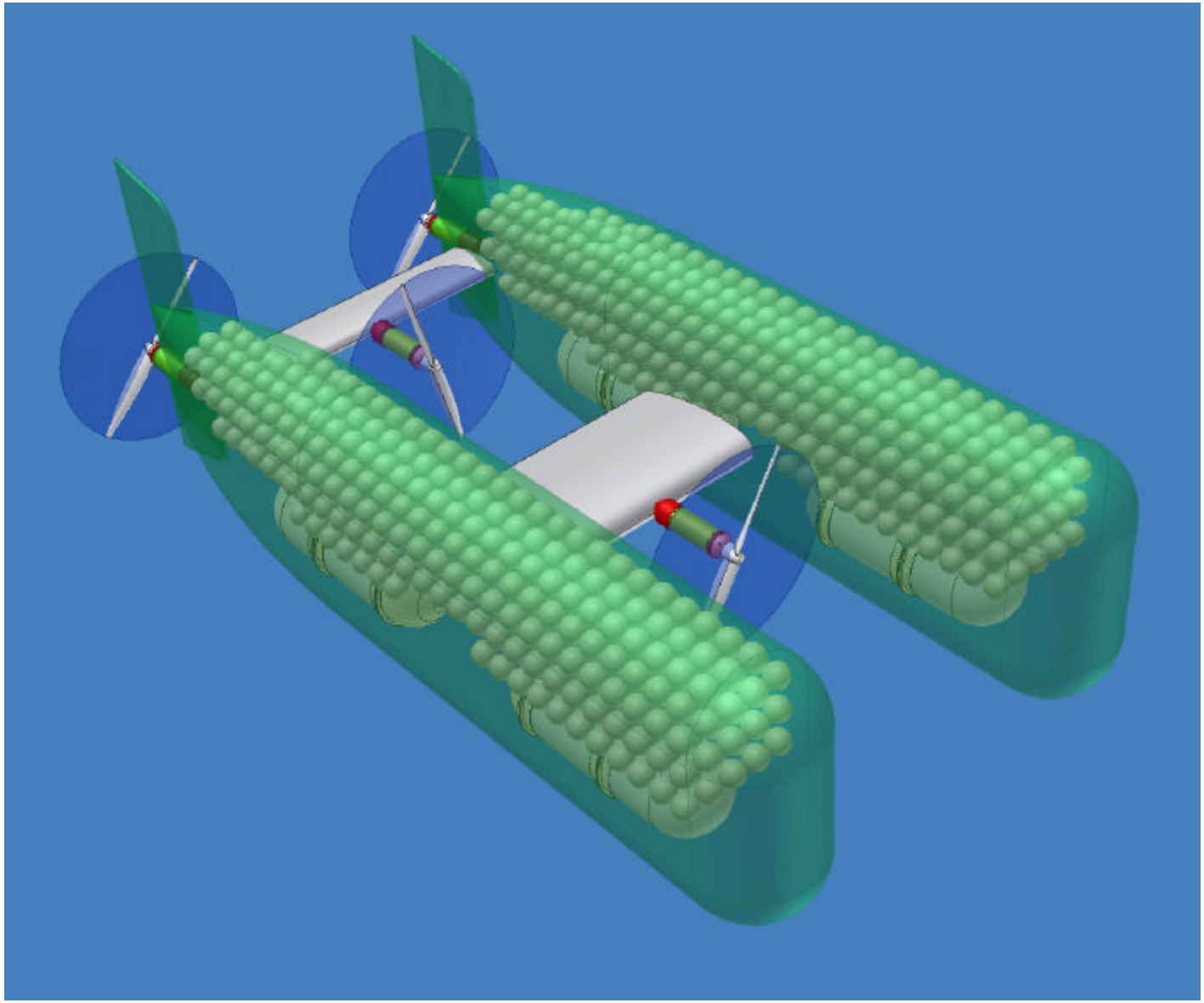
Scientific Sensors

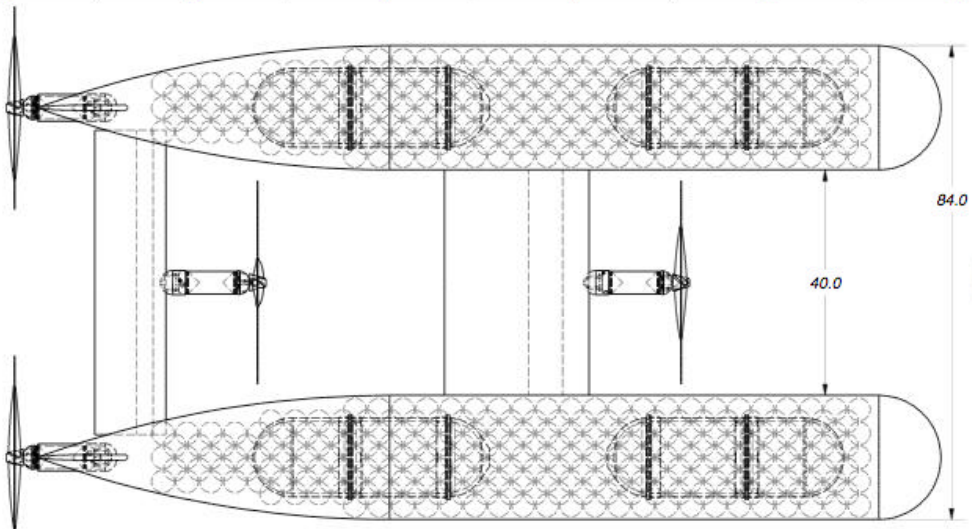
- SeaBird 49 FastCAT CTD
  - 2 CTD's on vehicle
  - Includes integral pump for T/C sensors
  - Pressure: 0 – 11,000 m, accuracy 0.1% full scale range
  - Conductivity: 0 to 9 S/m, accuracy 0.0003 S/m
  - Temperature: -5° to +35° C, accuracy 0.002° C
- Honeywell HMR2300 3-Axis Digital Magnetometer
  -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

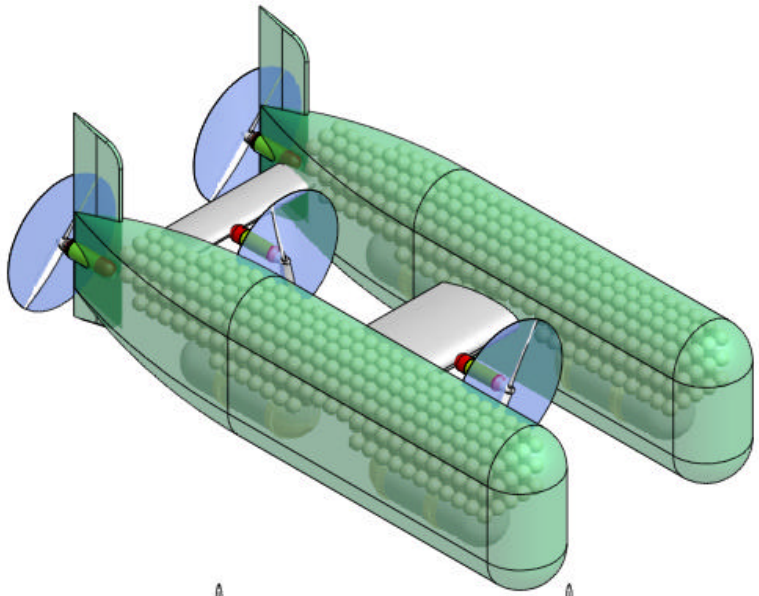
Proposed Scientific Interface

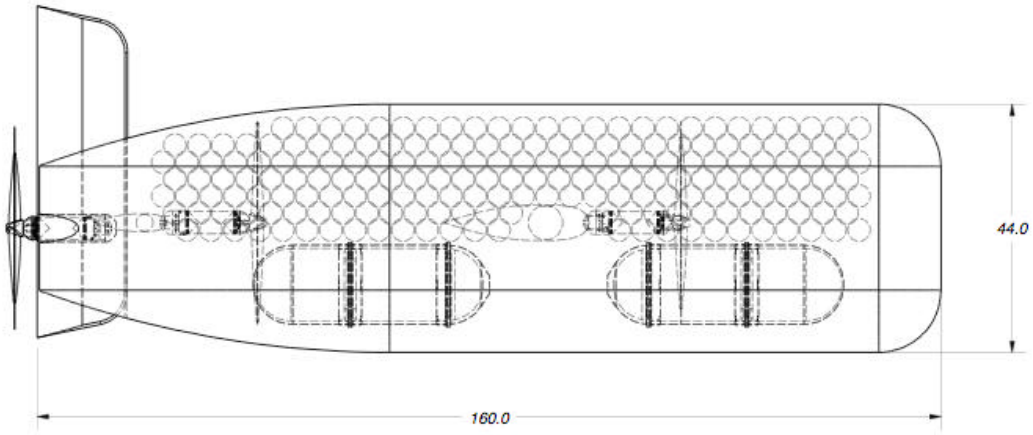
- RS-232 serial ports
- Ethernet
- 0-5VDC analog input, low bandwidth
- Flexible voltage interface (typical 12/24VDC)

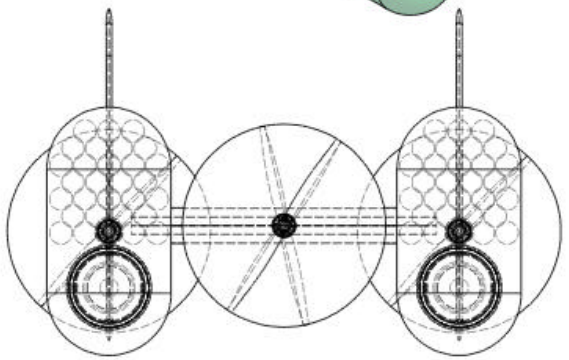
HROV in AUV Mode











AIR WT	2600 LB
SPHERE QTY	1520
BG	3.95 IN

UNLESS OTHERWISE NOTED:
DIMENSIONS IN INCHES
TOLERANCES:
DECIMAL: xx ± 0.01, .xxx ± 0.005
ANGULAR: ± 1 deg
BREAK ALL SHARP EDGES R0.02 MIN
MATERIAL
FINISH: SEE APPLICABLE NOTES

DESIGN
DRAFT
CHECKED
DATE: 6/6/2005

WOODS HOLE OCEANOGRAPHIC INSTITUTION
APPLIED OCEAN PHYSICS & ENGINEERING
86 WATER STREET, WOODS HOLE, MA, 02543

TITLE
H11K VEHICLE
AUV FLOW STUDY MODEL

SIZE: B
DWG NO: VCT_AUV_Model
REV
SCALE
SHEET 1 OF ←

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

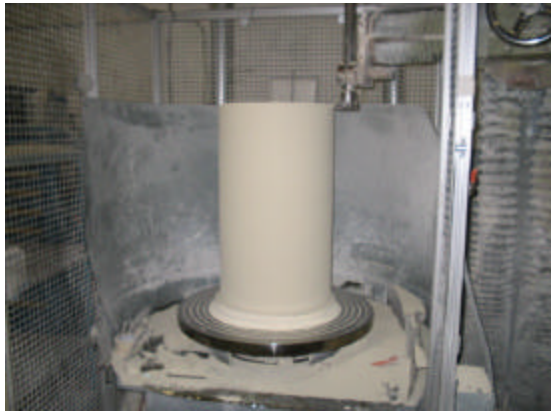
Ceramic Housing Manufacture

CoorsTek, Golden, Colorado

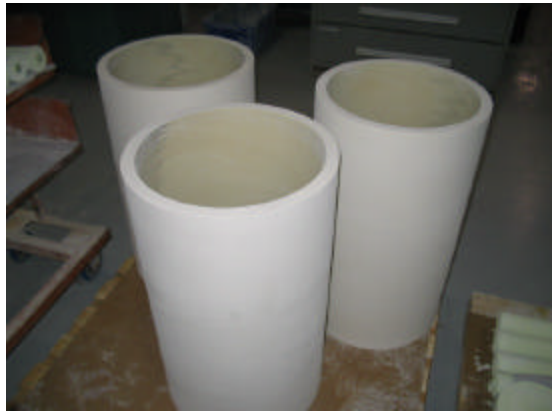
Process	Status
•Isostatically pressed 0.960 alumina powder	Complete
•Machined to ~20% oversize in green state	Complete
•Fired	Complete
•Diamond ground to final dimensions, all surfaces	Complete
•Final ultrasonic inspection	Underway

Pressed

Machining Green



Ready for Firing

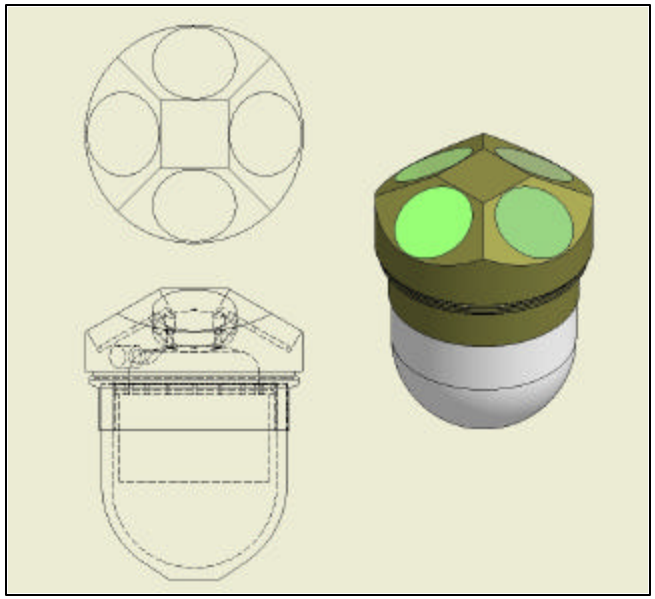


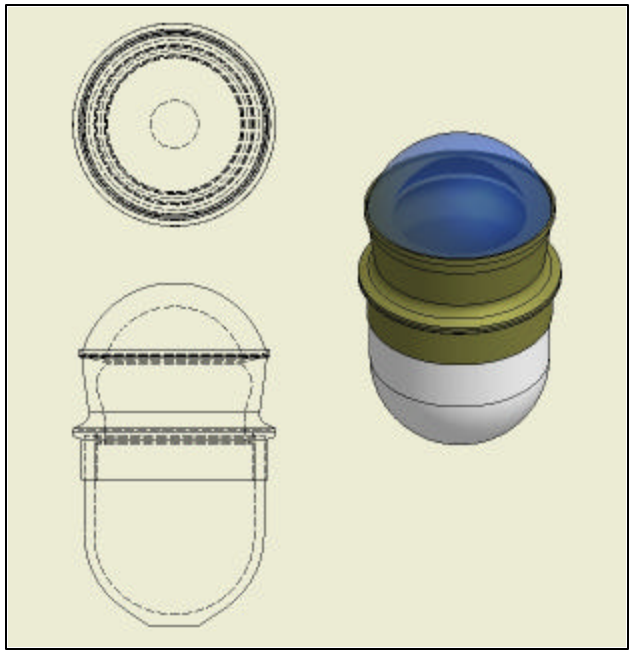
Utility Housings

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





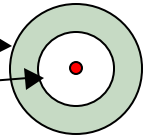
Fiber Tether Design

- 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.
  - Further tests planned Fall ‘05

Candidates for HROV Tether

0.25 mm Polymer Buffer

0.12 mm Optical Fiber



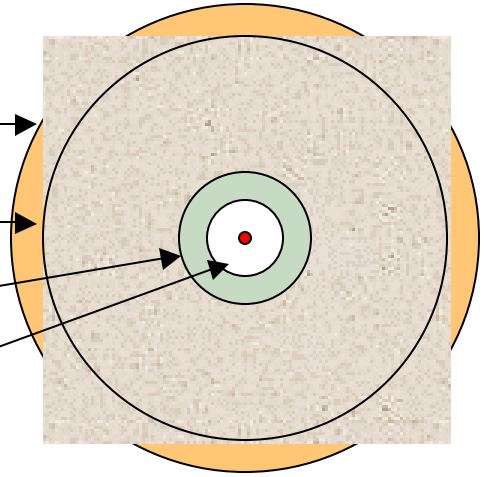
Buffered Optical Fiber

0.78 mm Anti-Abrasion Jacket

0.76 mm FRP Strength Member

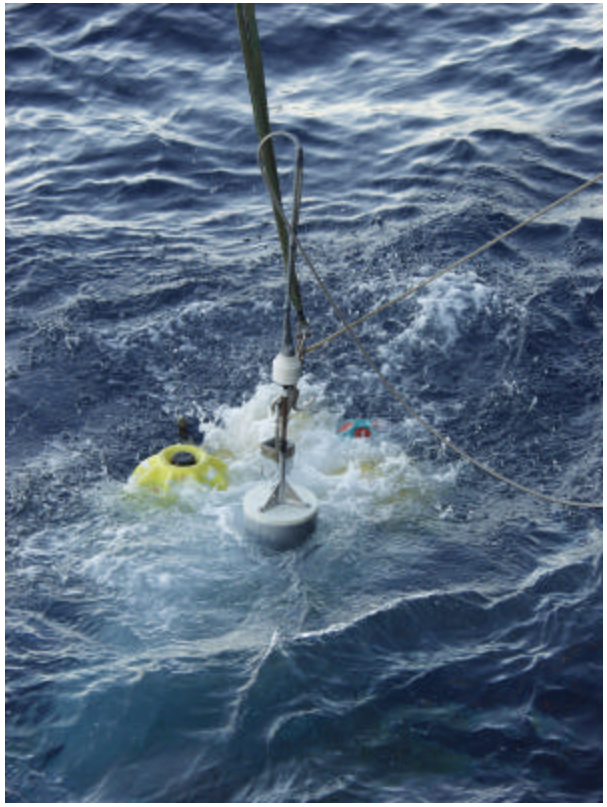
0.25 mm Polymer Buffer

0.12 mm Optical Fiber

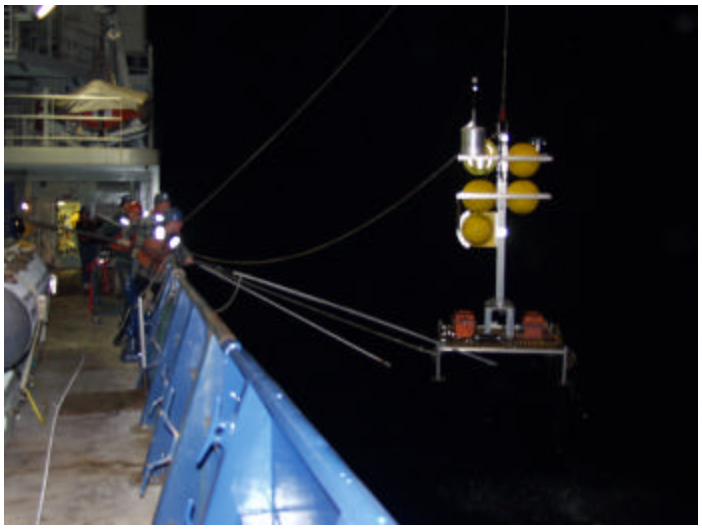


Fiber Optic Micro Cable (FOMC)

Scenes from Microfiber Testing



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



Recovering the elevator at night

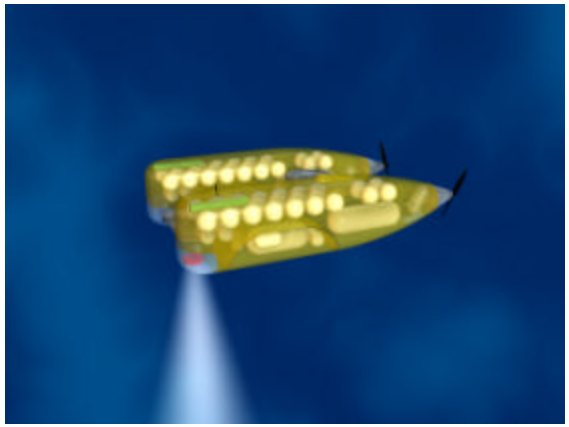
Hi-tech cable recovery equipment

San Clemente Island Test Results

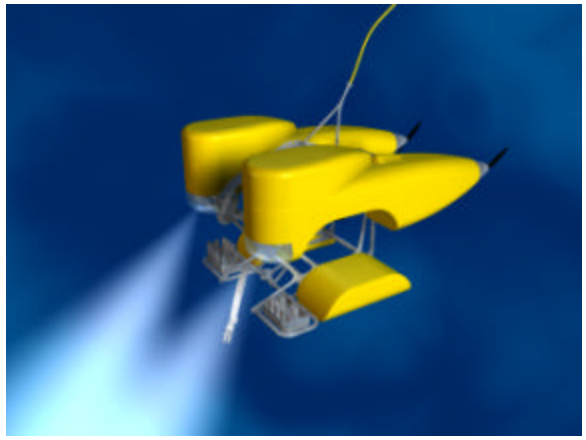
- FOMC survived for 4 hours until test was terminated
- Buffered Optical Fiber survived for 3:45
  - Fiber broke 112m from end of flex hose, close to ship
  - Fracture analysis of broken end
    - Cause: excessive tension caused by build-up of adhesive from FOMC in flex-hose combined with ship motion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

Two Task Dependent Arrays

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

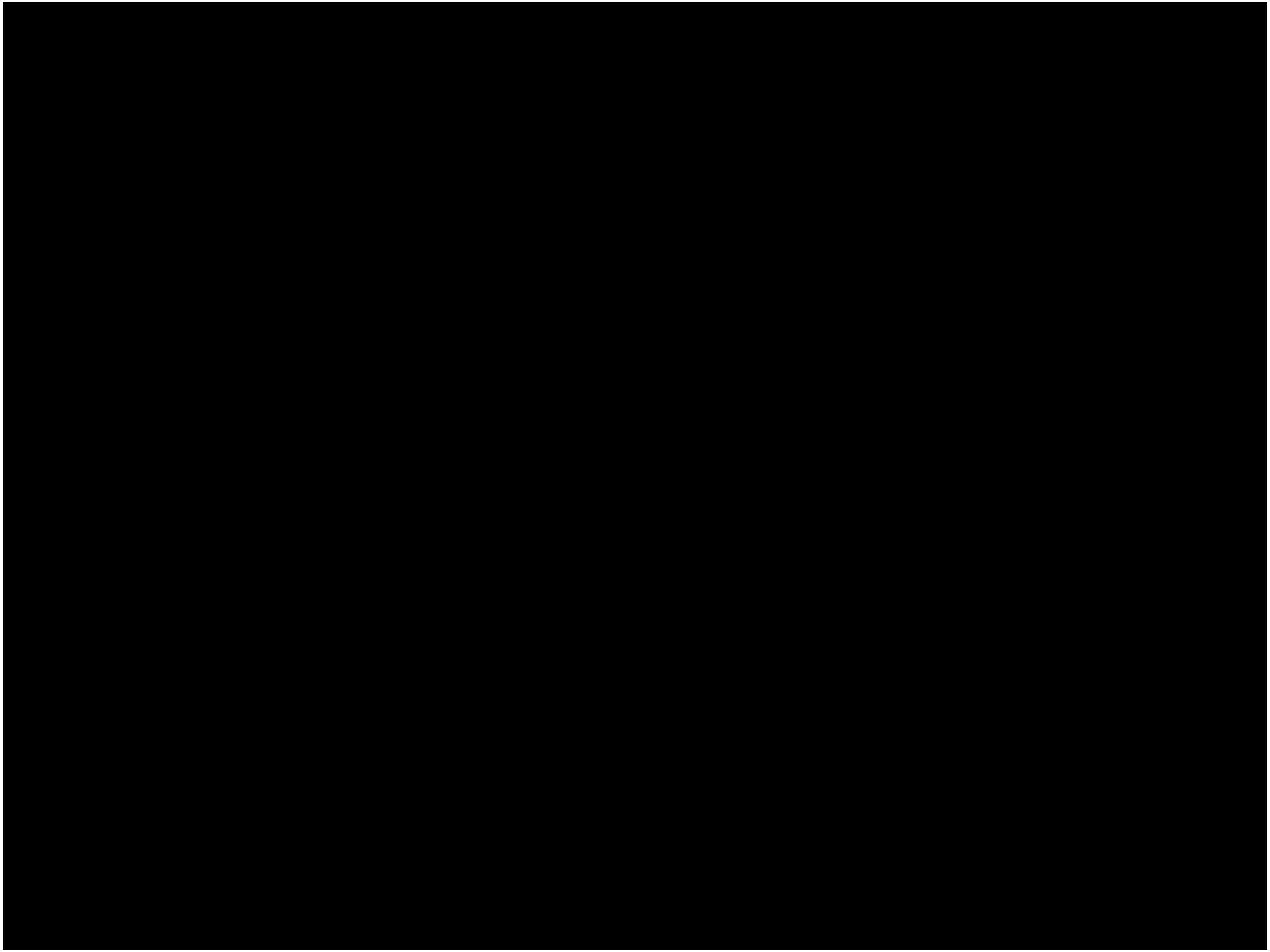


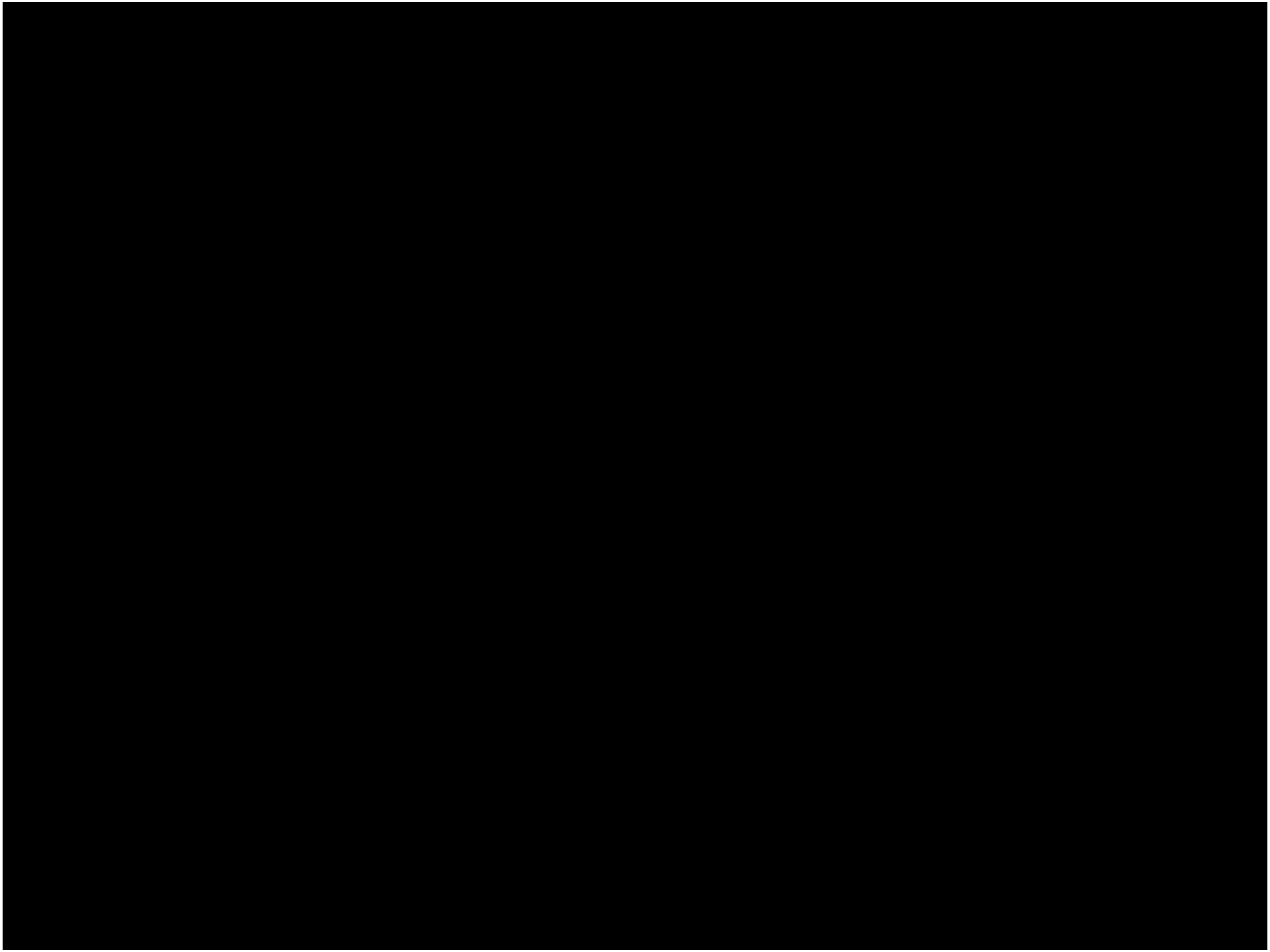
- Two forward looking, task arrays
  - 20 to 30 elements
  - Broad spectrum for close up color and video
  - Range 1m to 5m
  - Aimable array coupled with camera motion



Project Goals for CY 2005

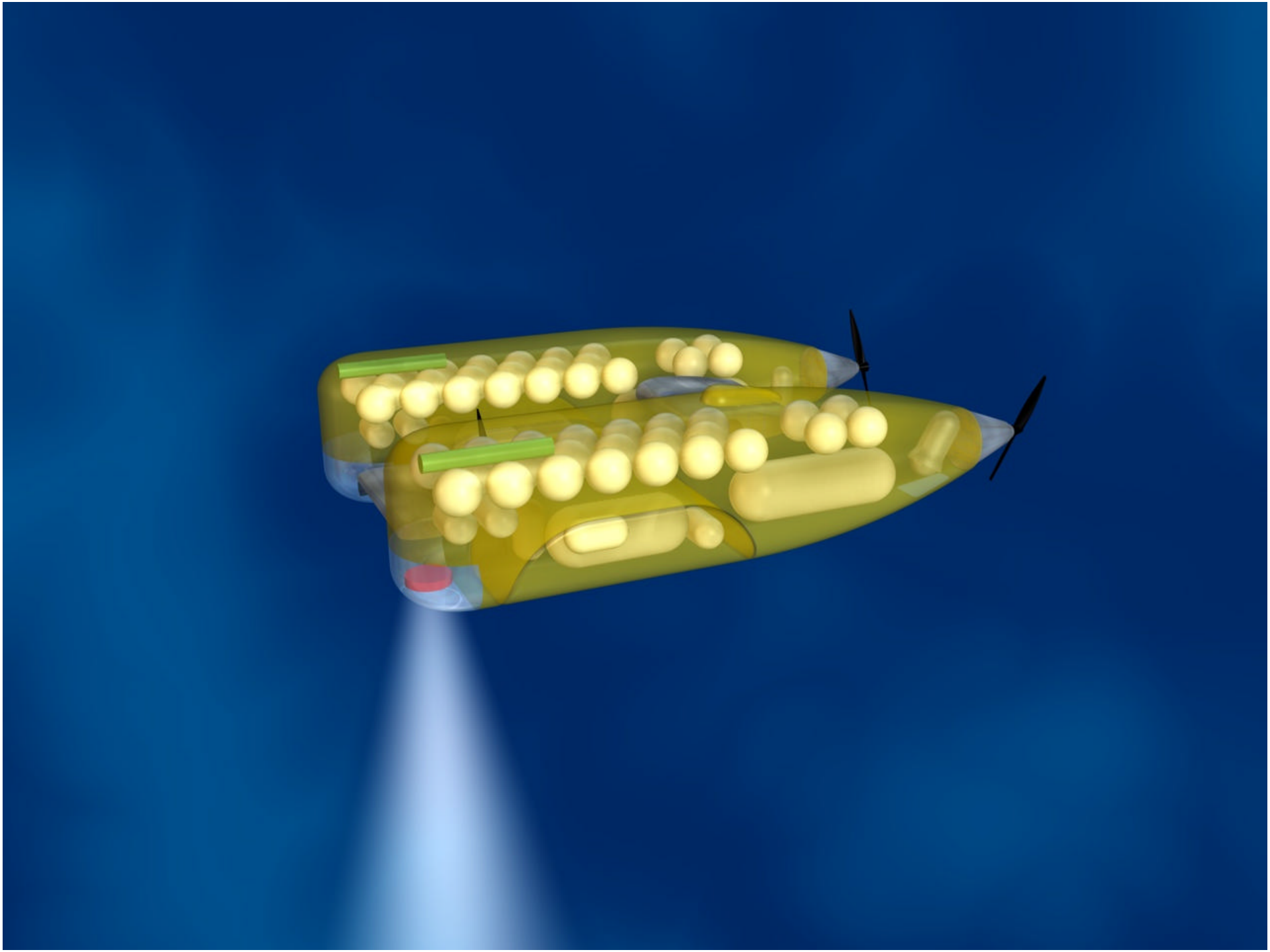
- Complete conceptual development of both vehicle configurations leading to detailed structural design
- Complete manipulator design and have both hardware and software components in test
- Complete fabrication and test of main and auxiliary pressure housings
- Make final choices on propulsion and have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

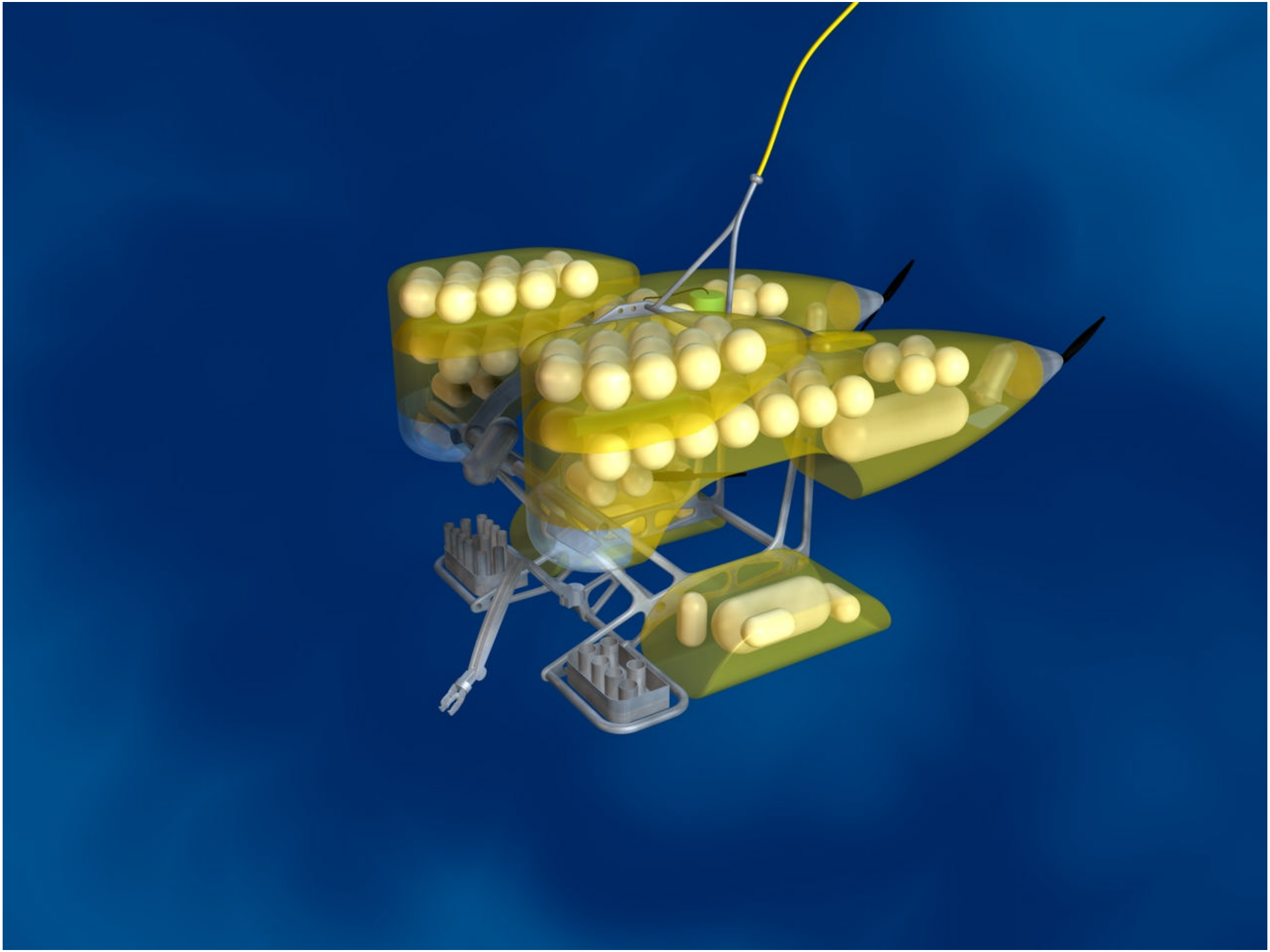




HROV Basic Design Philosophy

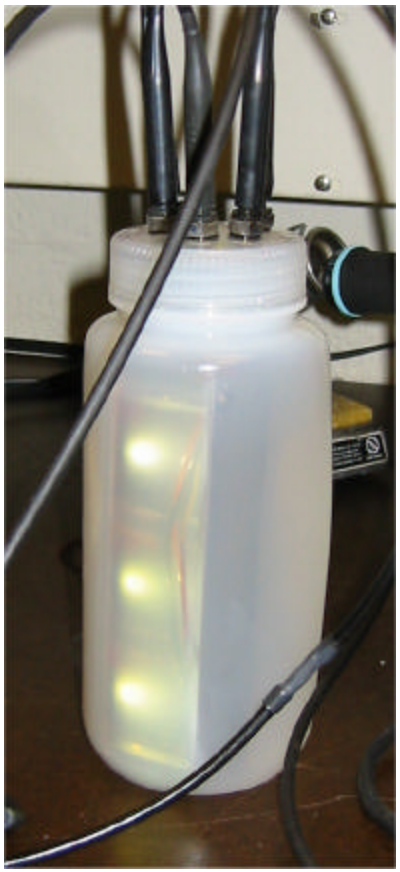
- Build on previous experience when possible
- Identify risks and aggressively address early in the project
- Integrate into ongoing NDSF operational and WHOI technology developments
- Limit operational team support to 4 people
- Minimize weight and power to keep core system to a single 20 foot ISO shipping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





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

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