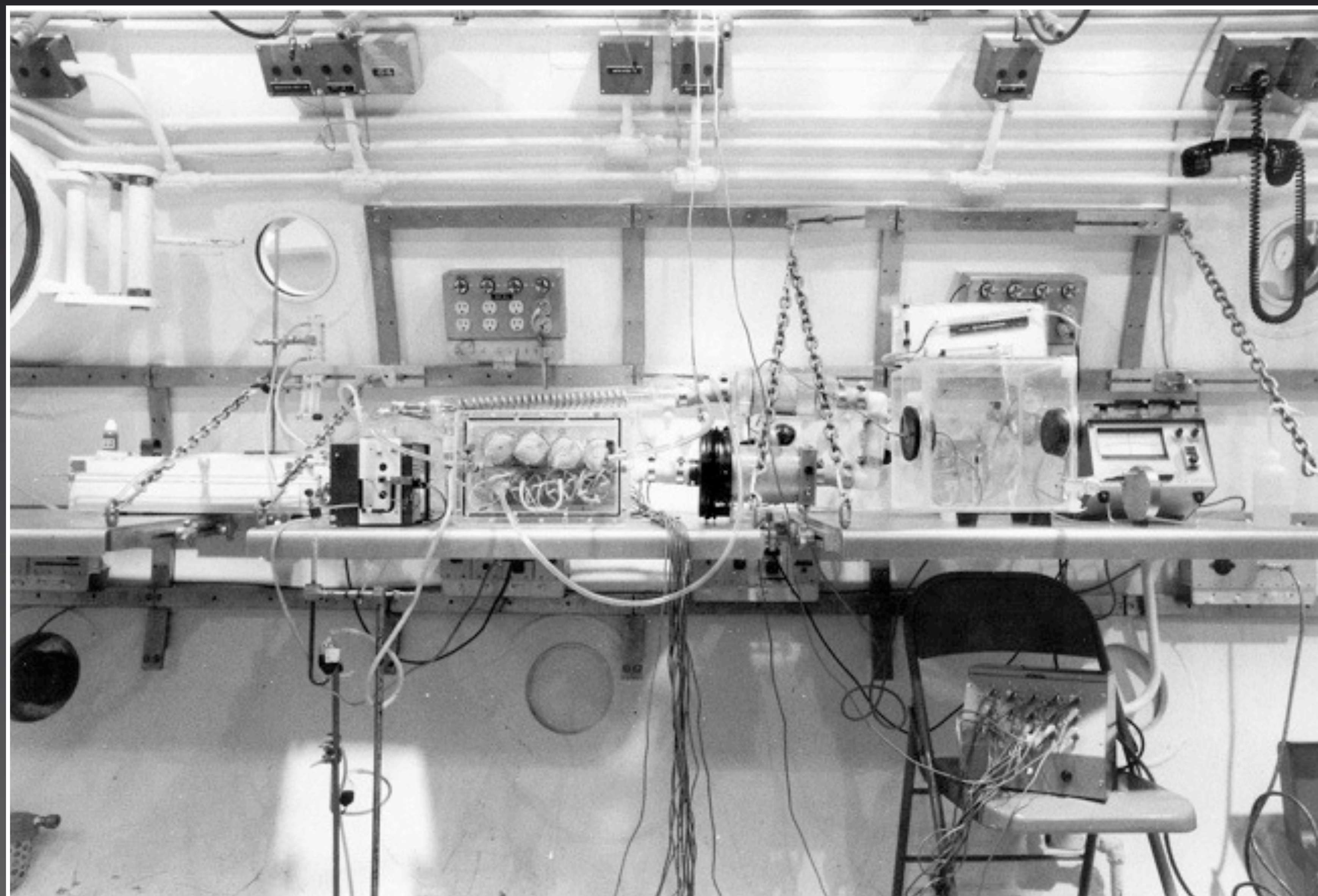
William Herr

Overview of Past Projects

This presentation shows some of the projects I have worked on and been fortunate enough to have photographs to remember them.



U of P IFEM – O_2 Toxicity

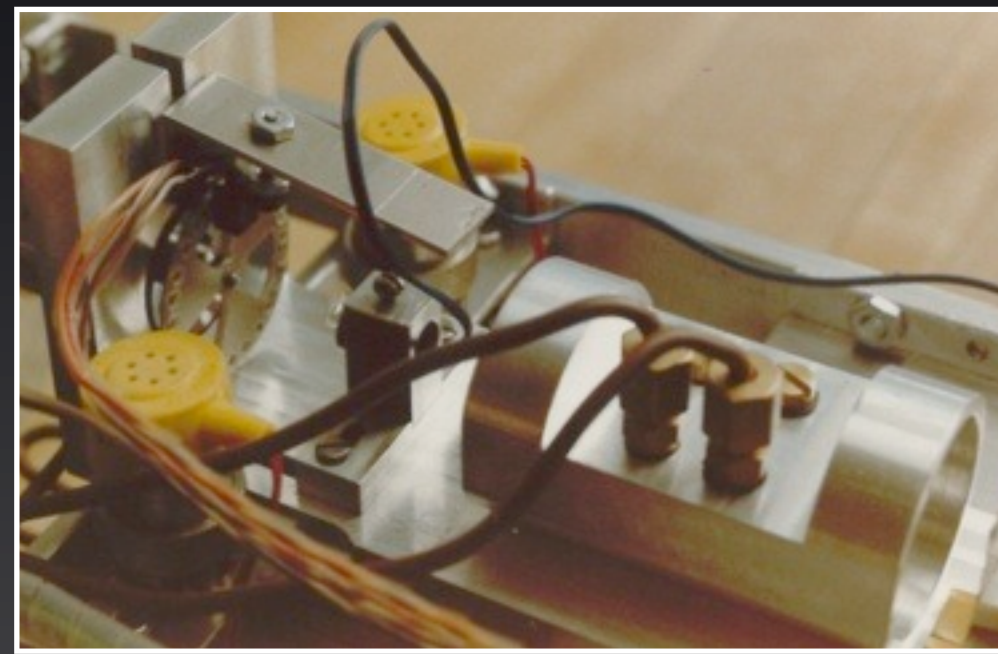
What began as a 6 month Directed Studies credit while finishing my Undergraduate Degree at Drexel, turned into a three year job as a Research Technician at the Institute for Environmental Medicine in the University of Pennsylvania Medical School. I was given lead responsibility to design, build and execute a series of experiments to measure the affect of 100% O_2 on rats at 4 ATA in the Hyperbaric Chamber. I did everything from designing the experiment, machining the enclosures, doing the dives and processing the data.

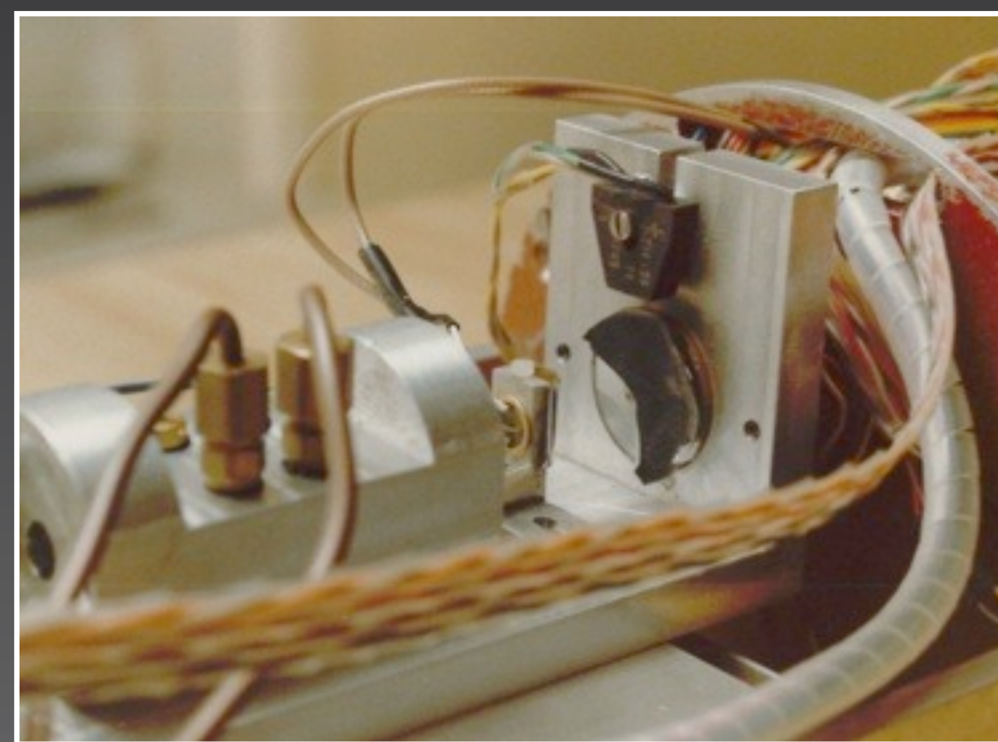
U of P IFEM – PS IV

During my tenure at IFEM I had the honor to function as the lead integration engineer for Predictive Studies IV and work under Robert Gelfand, BioEngineer in charge of facility and Dr. Lambertsen, the Founder of IFEM and Father of Underwater Medicine. The test subjects were instrumented to measure a broad array of signals during dives to 1200 FSW (37 ATA) with 2 hour excursions to 1600 FSW (50 ATA). Dive profiles involved 7-10 days at depth and 9 days of decompression.

University of New Hampshire Research Project
Acoustic Spread Spectrum Modem Testing

I was funded to develop a data link for the University’s Autonomous Underwater Vehicle, EAVE-EAST. The system was built upon a standard UART and transmitted each bit at a different acoustic frequency channel to overcome the multiple path environment common in shallow water and under ice. The circuit form factor was designed for a cylindrical pressure vessel and was common to my Master’s Thesis Project shown on the next slide. Testing was performed under the ice of Lake Winnipesaukee.

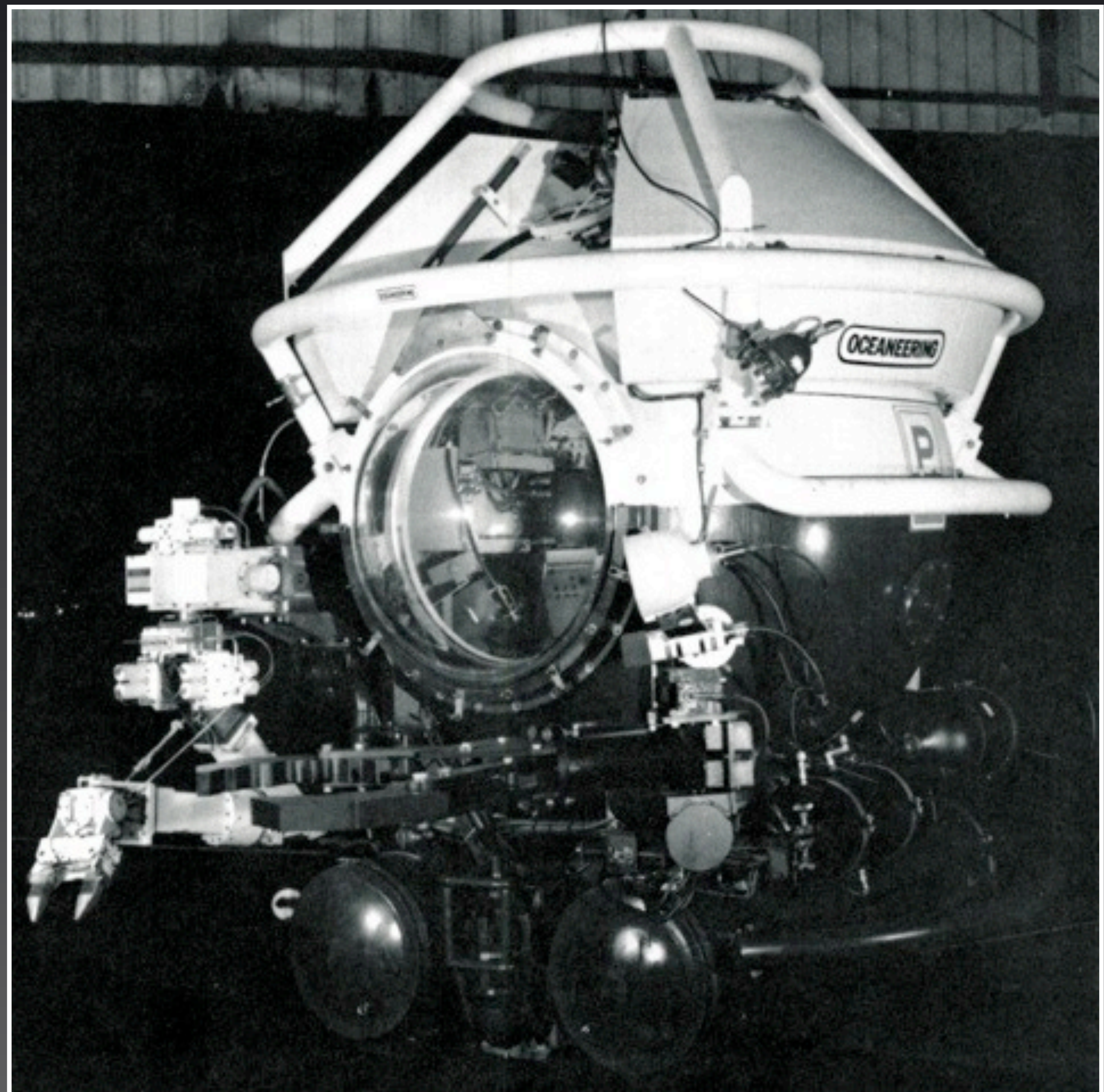




UNH – Master's Thesis

CO_2 Spectrophotometer for Divers

My Master's Thesis dealt with calibration of the pressure broadening affects in a non-dispersive infrared spectrophotometer operating at 4.25u. I machined and assembled a diaphragm sample pump, sample cell and optical bench. A phase locked brushless motor for chopping the source for measurement by a synchronous amplifier and a stepper motor for selecting the optical channel. An Intersil IM-6100 microprocessor which emulated the PDP-8 minicomputer was used. I adapted and tuned the PDP-8 Floating Point Package in assembler and all the control and processing were implemented in assembler as well.

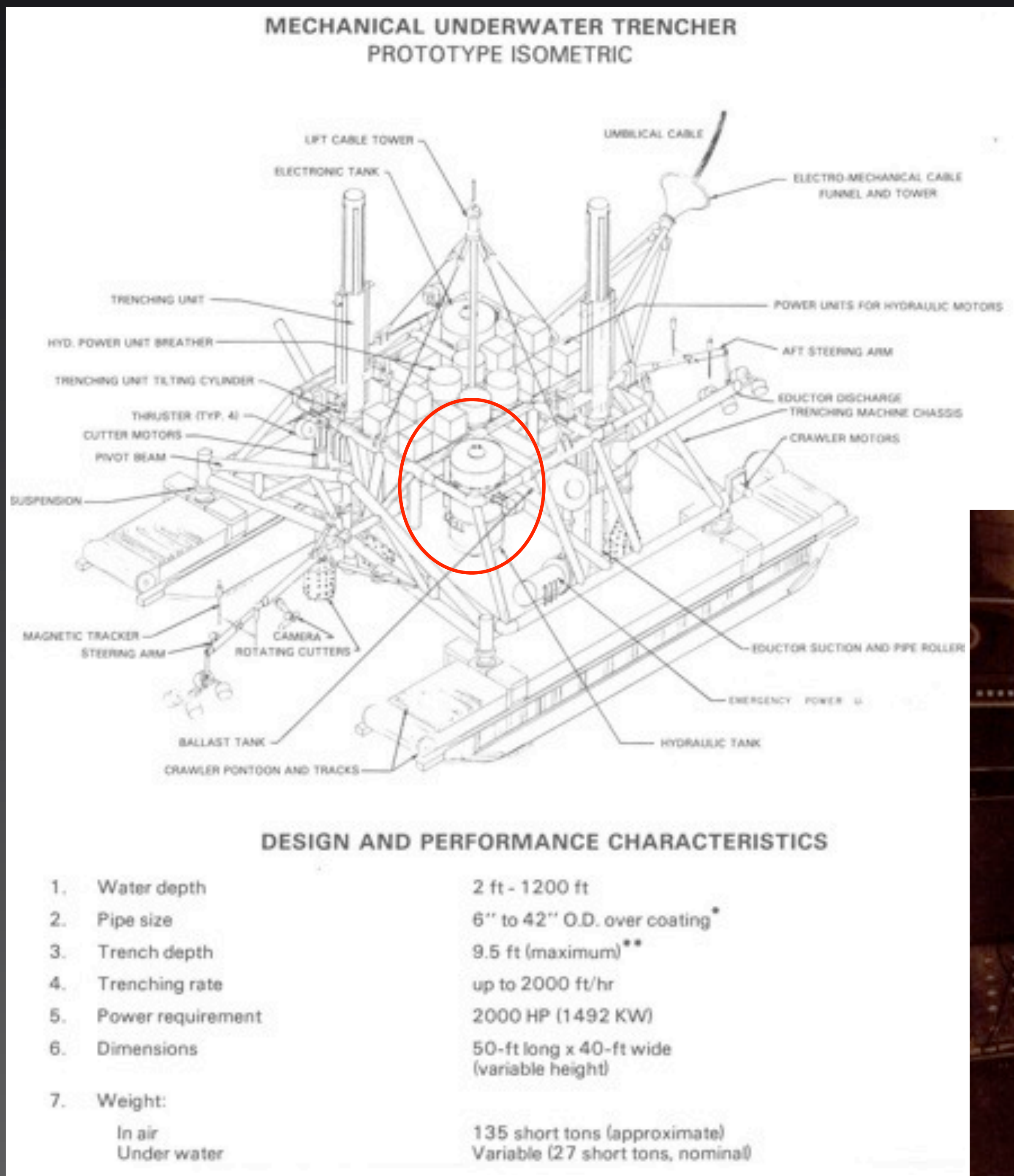


Manned Undersea Operations

My first job out of Graduate School was at Perry Oceanographic in Riviera Beach Florida, where I was hired for my knowledge of Underwater life support requirements. I was fortunate to get to serve as a field support engineer on a vessel operating in the Mediterranean Sea between Tunisia and Sicily, supporting the touchdown of new gas pipelines being laid by the worlds largest pipeline barge. The dynamically positioned ship we operated from had a Remotely Operated Vehicle (RCV-225), a Perry Submersible, and a Perry Bell similar to the one pictured above. The bell was deployed through a moon pool. I worked on the handling system or in the Bell at 2000 feet and oversaw maintenance and battery charging between dives.

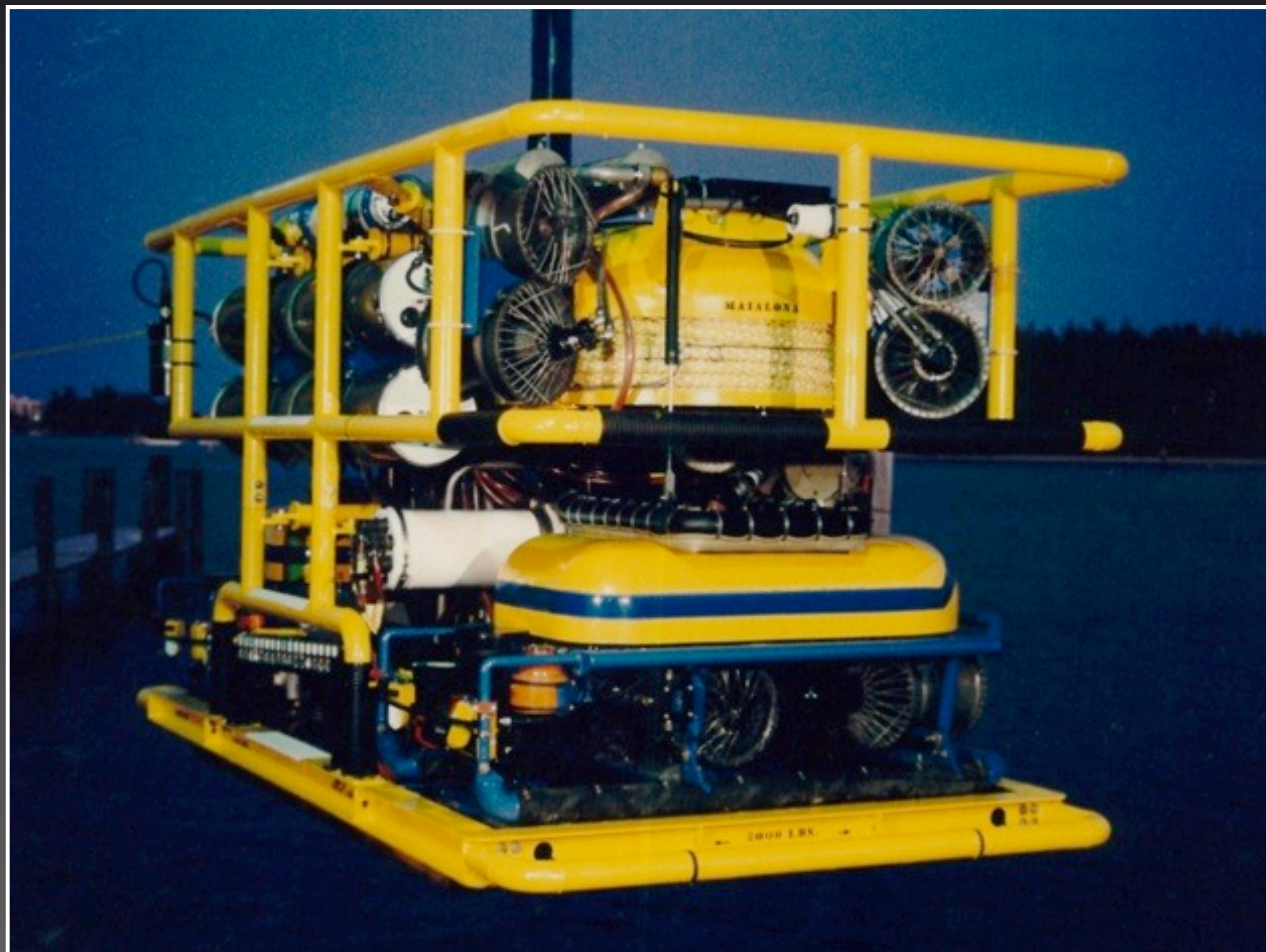
Remotely Operated Vehicles

These are examples of the standard Perry ROVs. I provided various engineering support, including console display development, Oil rig sacrificial anode replacement subsystem design, electro-potential measurement subsystem, ball covered tether cable functional trouble shooting by scuba, hall-effect heading sensor integration and magnetic compensation.



Pipeline Trencher

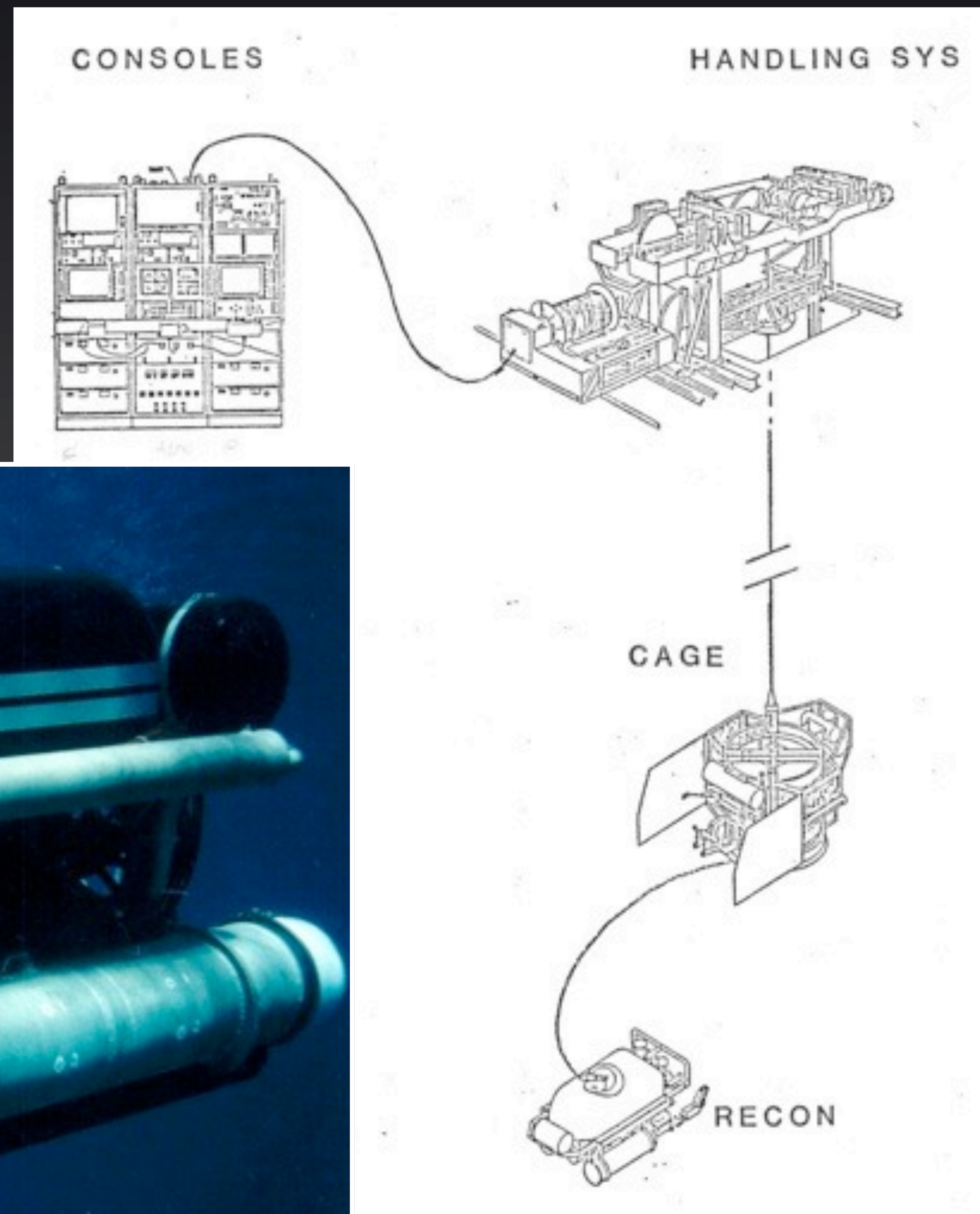
Perry was developing the control system for this massive Brown and Root Pipe Trenching System. The Controls consisted of 10 Intel 8086 Single Board Computers topside and ten on the trencher housed in the cylindrical pressure vessel, circled in red, which was large enough for a man to stand in while working on the electronics rack. I added an 11th SBC to control a 9 track magnetic tape just visible in the top left of the photo, to log all system parameters. I implemented a Low level functional interface allowing tape readback and rentry in assembler as well as programming a GUI.

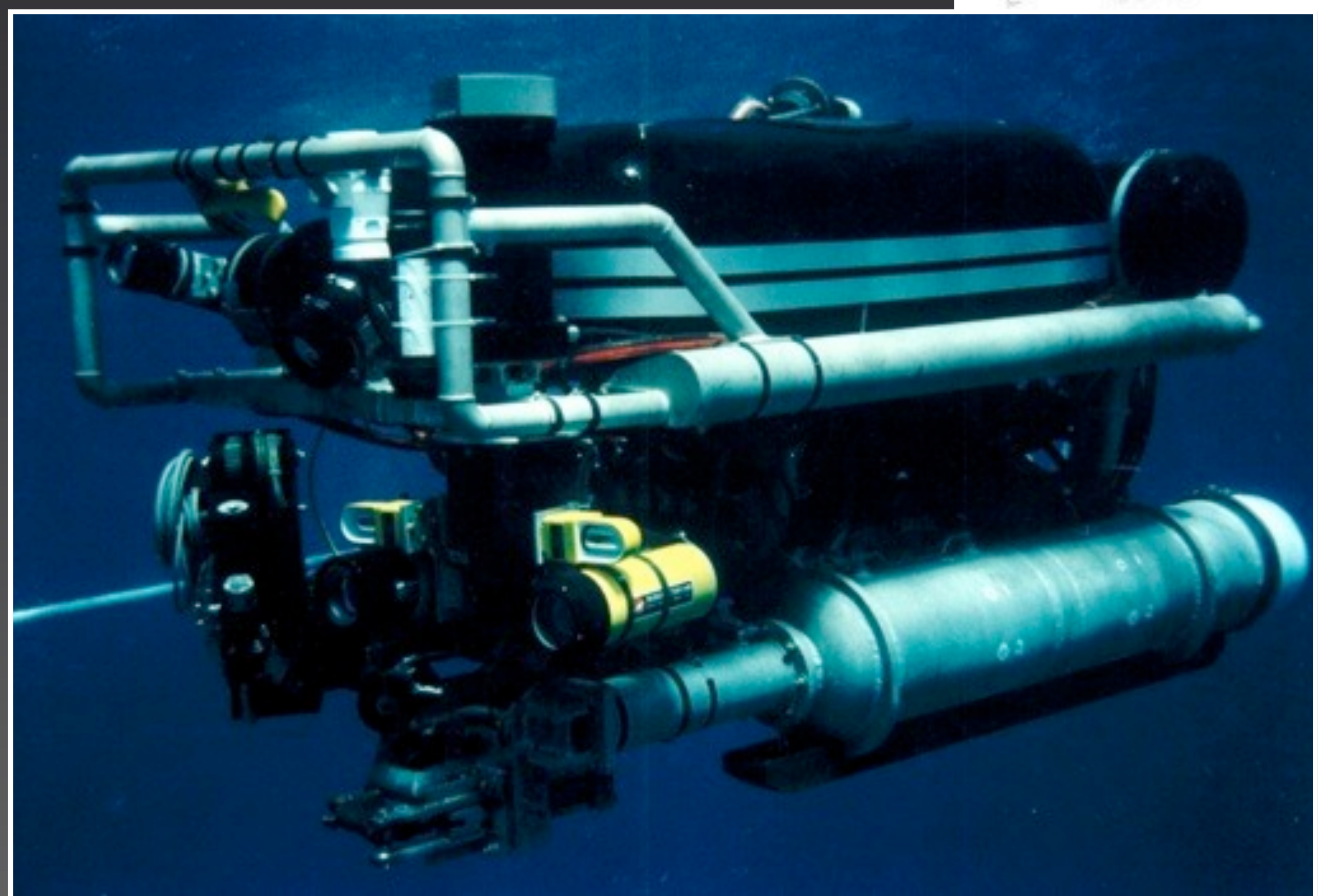


Pipeline Repair System

I was a member of the team that designed this dual ROV dynamically position controlled, tethered payload positioning vehicle for the Italian Oil Company Siapam. Various large work modules (2-4X the size of the vehicle) were attached to the bottom and transported to the seabed where the ROV’s flew out to provide visual feedback to position the work module over the pipe. Beyounf the standard ROV integration issues, I integrated Triaxial servo accelerometers and Long and Ultra-short Acoustic Positioning Systems.

SARS

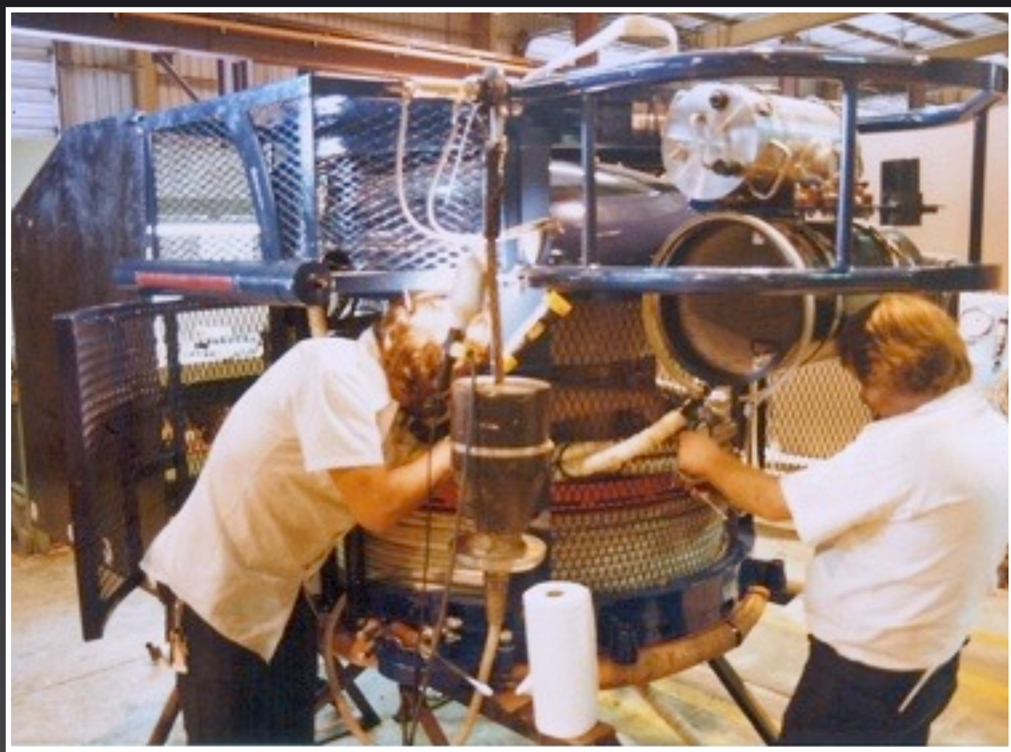




Search and Recovery System

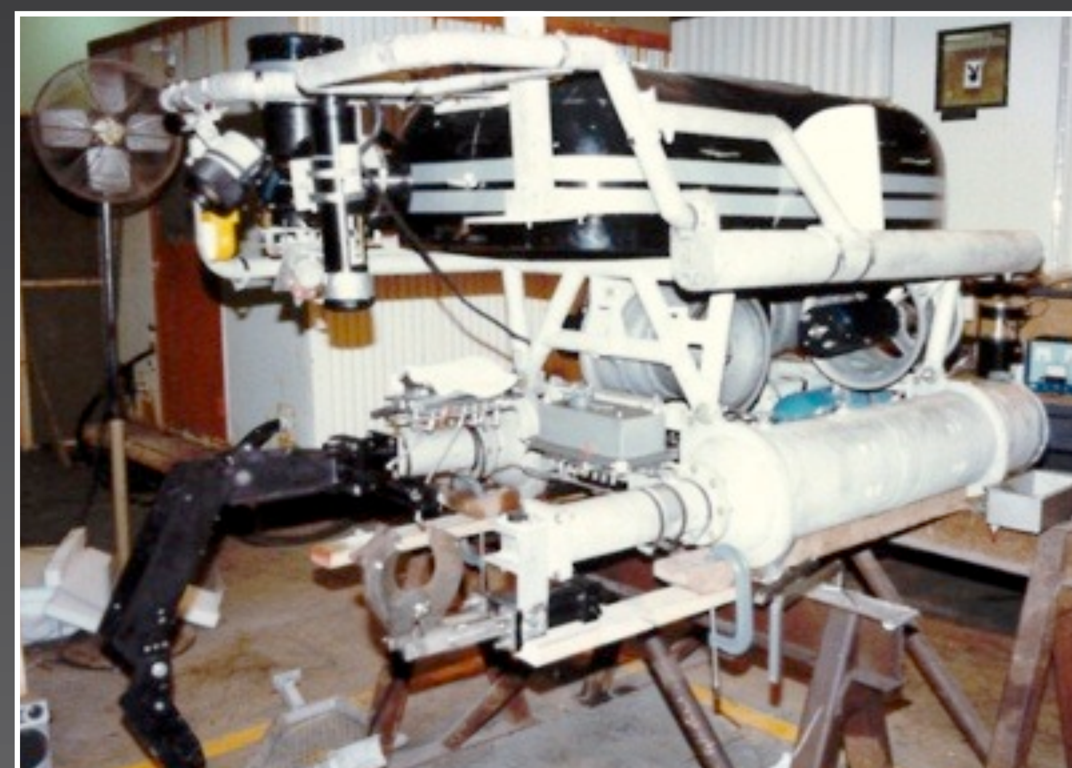
I started on the SARS project at the preliminary design stage as one of three Electrical Engineers and progressed to Lead Electrical and finally Project Engineer during the extensive Sea Trials and Customer Training/Shakedown Operations.

Cage



Cage Umbilical

ROV



ROV Electronics/Power Modules

System Electrical Engineering

These are some of the primary elements I was responsible for: Handling System and Cage Slip-rings; Custom Cage Torque Balanced Signal, Power and Lift Umbilical (top-right); Custom Underwater Connectors; ROV Electronics Modules with Step-Down Transformers (bottom-left), Power Supplies, STD Bus Controller, AC/DC 8 Channel Ground Fault Measurement (top-right); Data and Video; DC Thrusters; Cameras, Lighting and Imaging Sonar; Sidescan Sonar; Gyrocompass and Attitude sensing; Manipulators, Documentation with wiring diagrams and schematics.

Consoles - Human Interface

These are the SARS System Operator Consoles. I was responsible for Mission Planning and Human Factor considerations in the Console Component arrangement as well as detailed design from component selection through cable routing and shock and vibration.

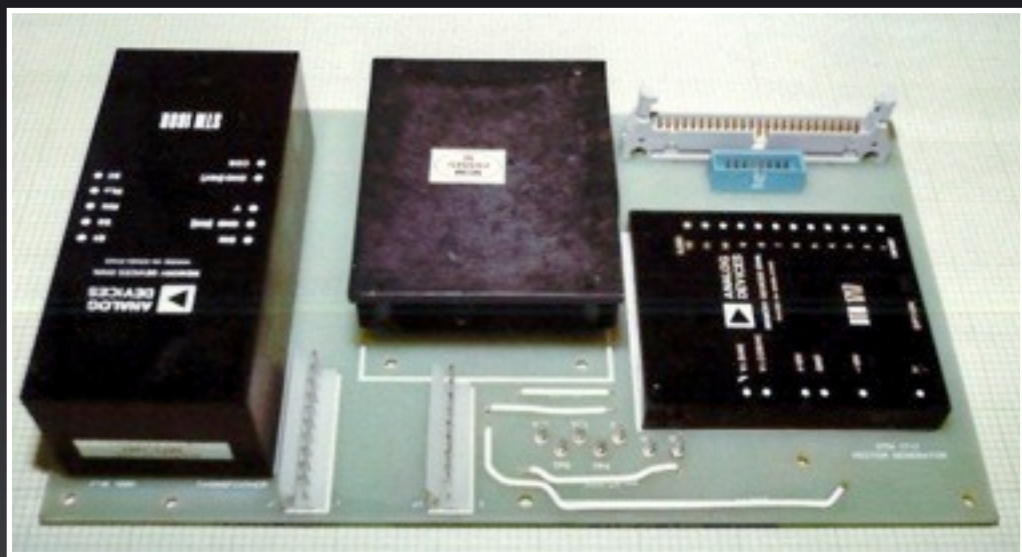
SARS Operations Vessel

Lee Stocking Island, Exumas, Bahamas

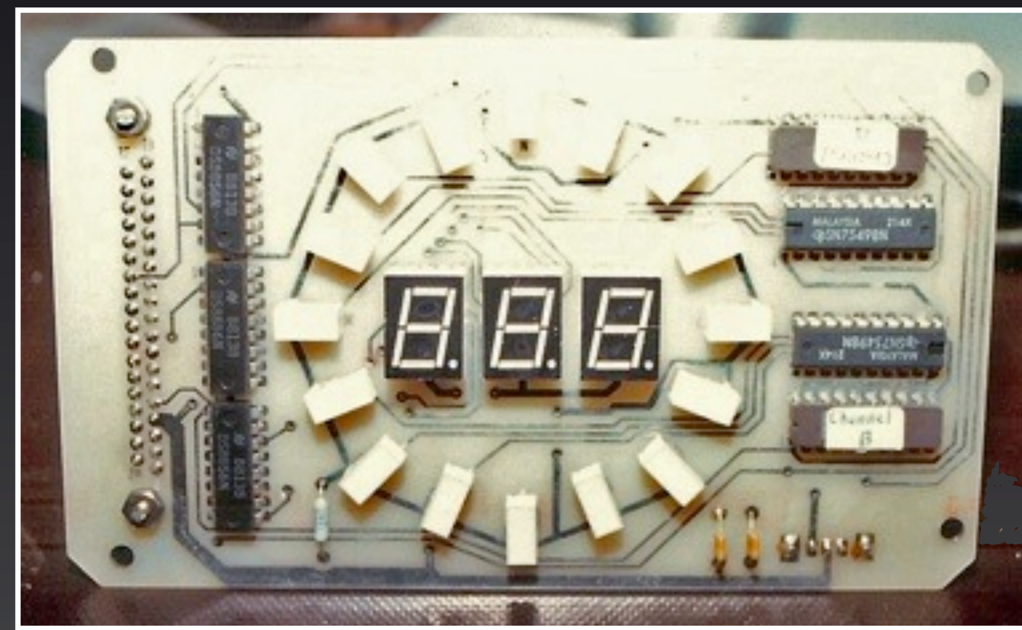
Test and Training Ops

I was in charge of the 6 week program on Lee Stocking Island in the Exumas, Bahamas. We operated 24-7 rotating three crews from housing on shore, to fully shake out the system and procedures and train the customer's staff.

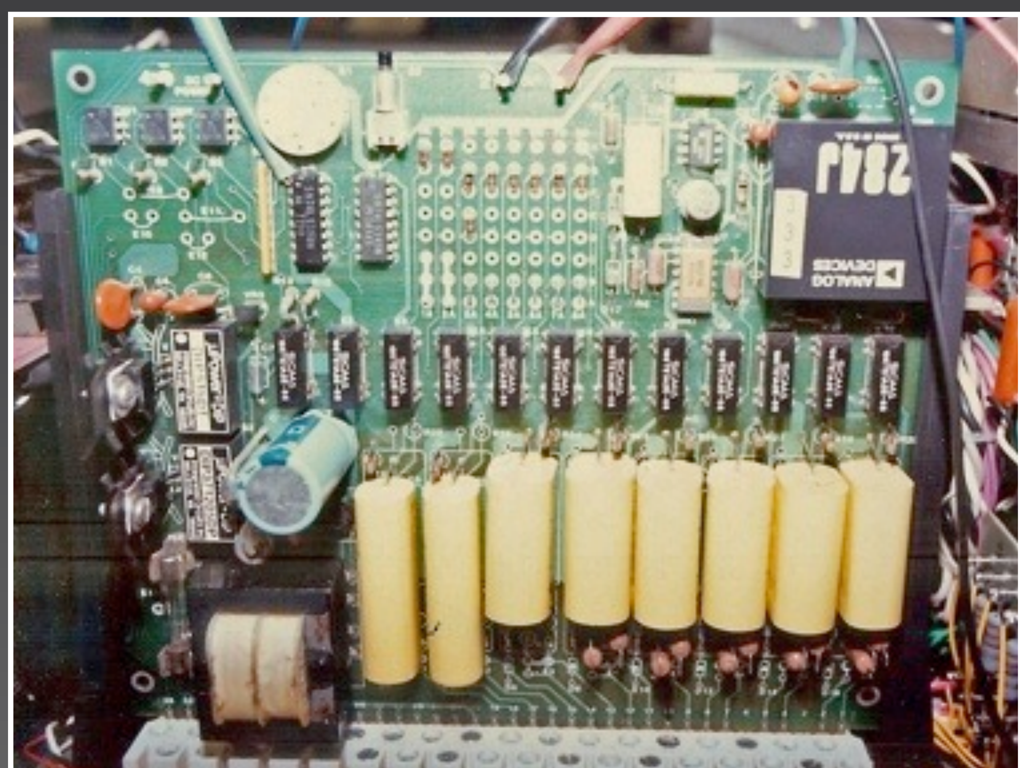
Synchro Resolver



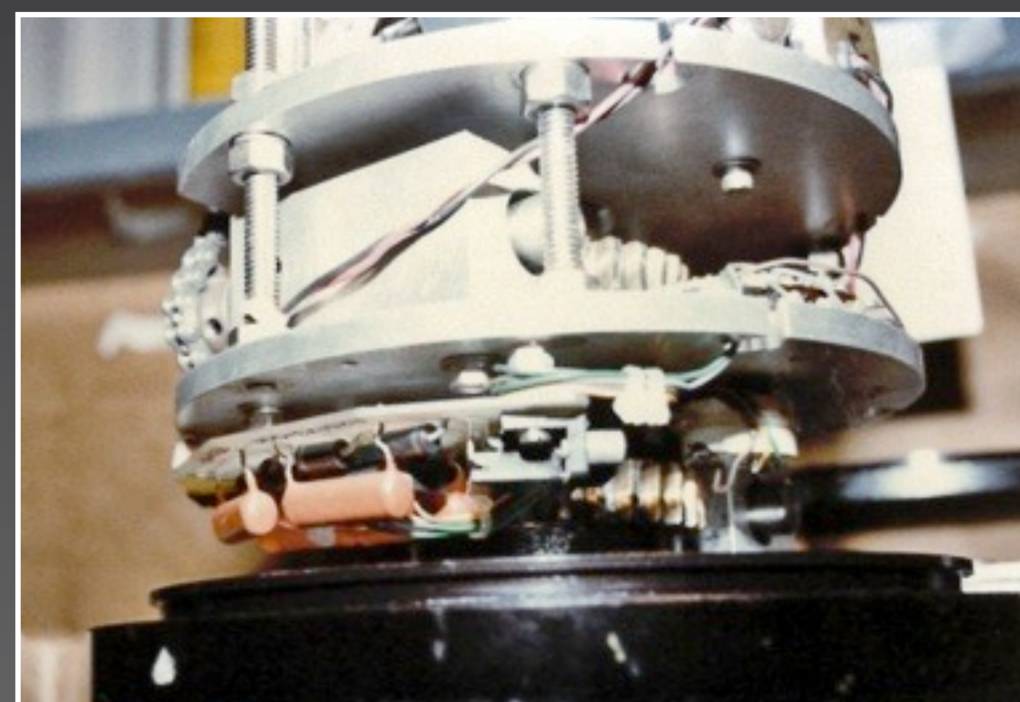
Console Heading Rose and Readout



8 Channel AC/DC Ground Fault Measurement

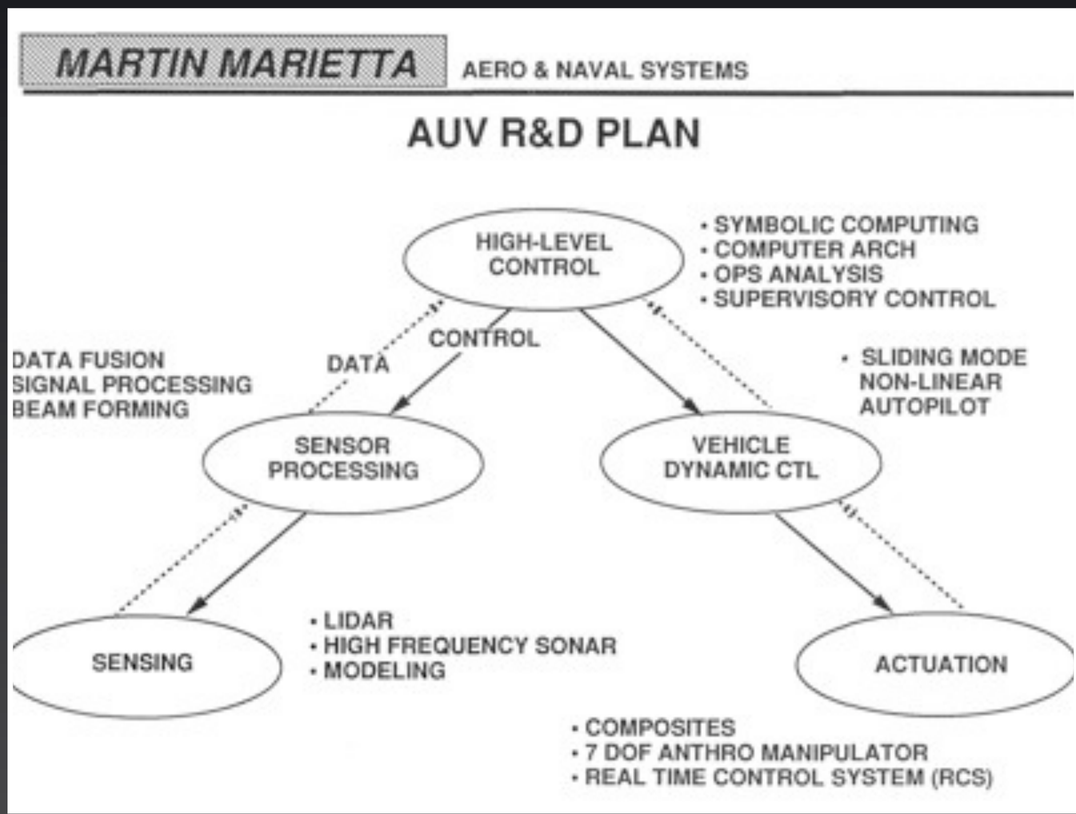


1st Generation µStrip PCA Set

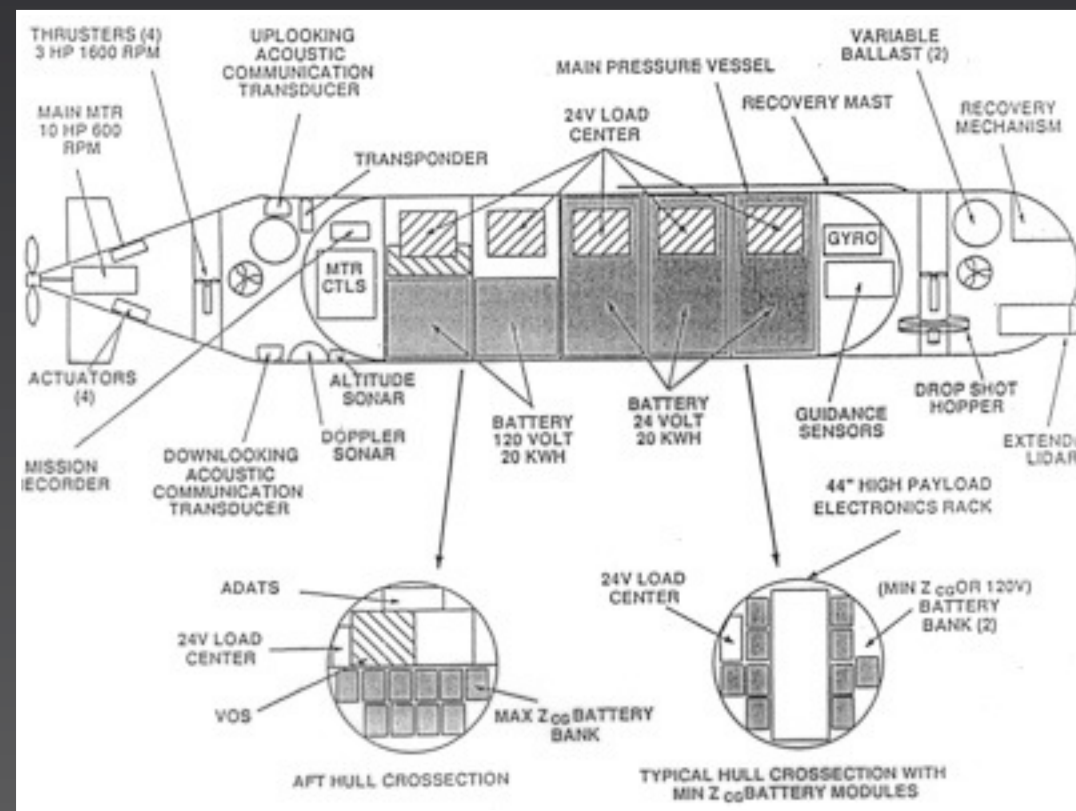


PCB Design

These are a sampling of PCAs I design, built and tested while with Perry Oceangraphics. I was the first to do PCBs and had to develop the documentation and work flow standards for the company.



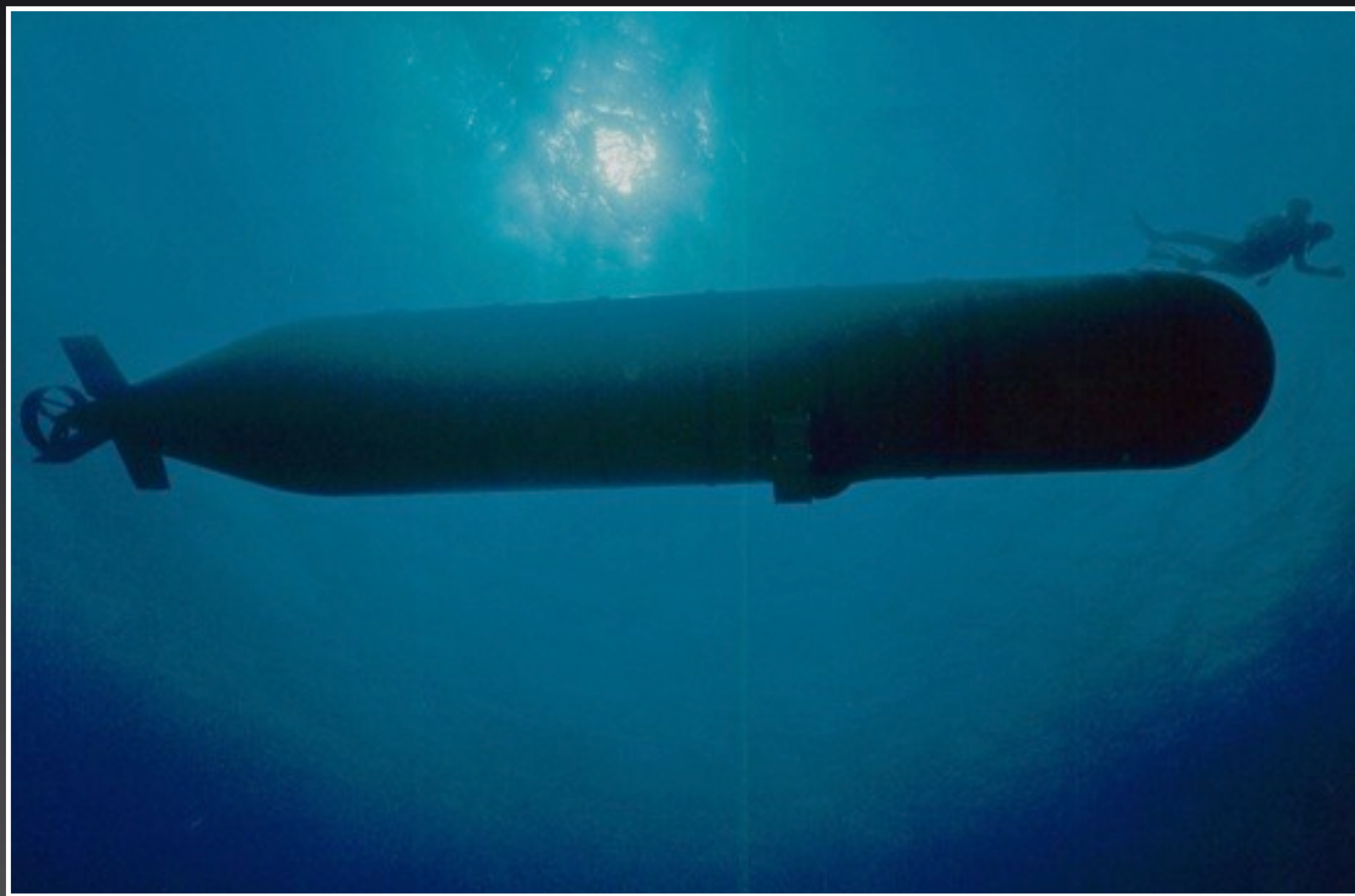
MUST Lab: Mobile Undersea Test Lab

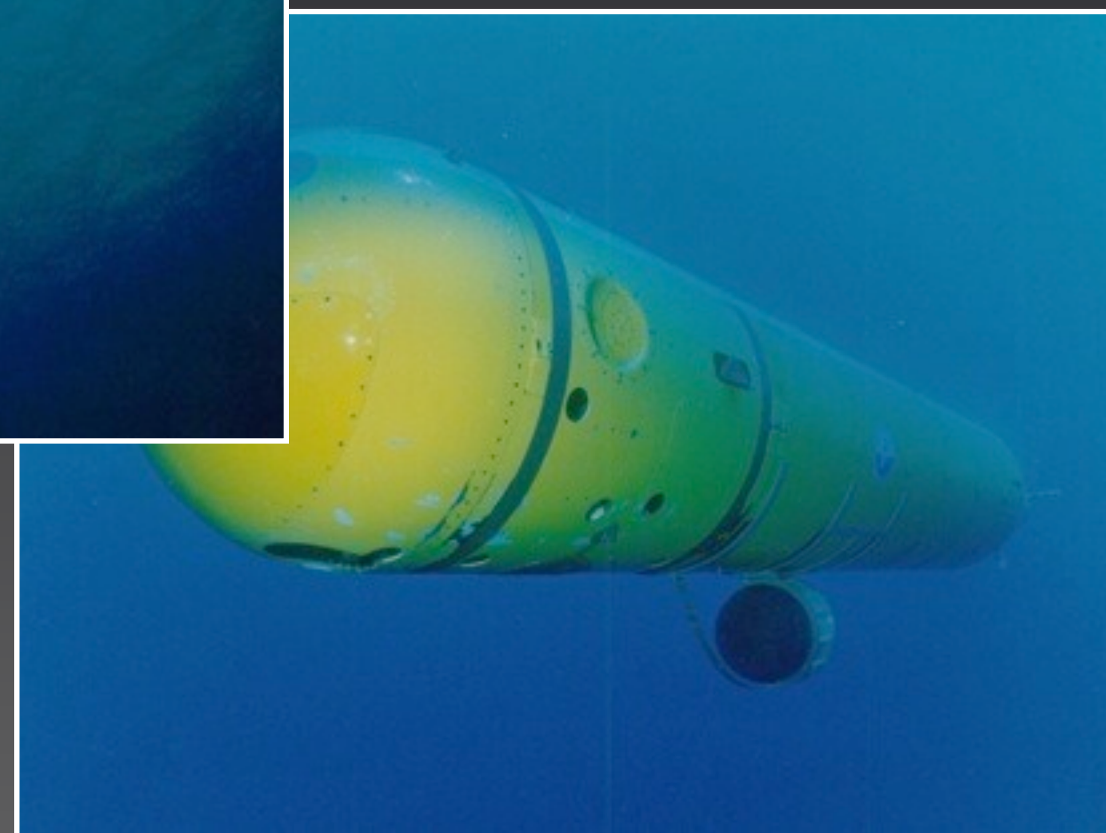


Autonomous Underwater Vehicle (AUV)

Based on experience and my role in the success of SARS, I was recruited to work at Martin Marietta Aero and Naval System as the Principal Investigator of an Internal R&D Project on Artificial Intelligence Software Control of an Autonomous Submarine, from Mission Planning through Operations at Sea. While the core of the project was AI software development, I branched out into non-acoustic sensing (Laser Radar) and robust Sliding Mode Control to have more-tangle results for scoring well by the Government Labs. Scores for all three years were high and supported allowable rating for the O/H funding.

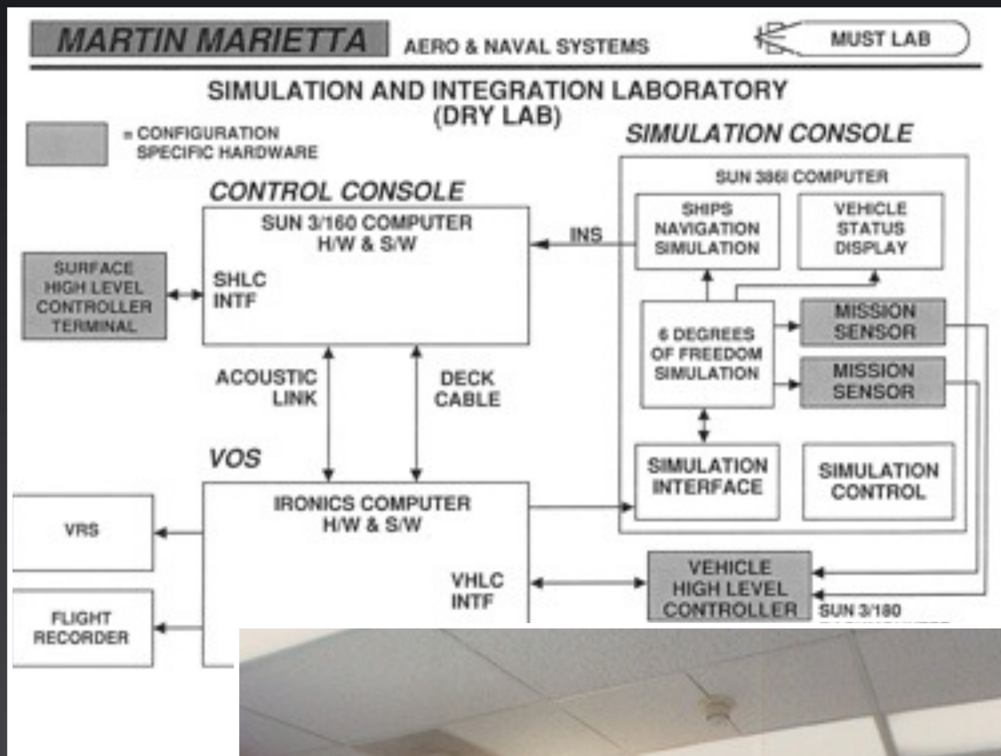
Based on the success of concept development and simulated results I was tasked as Project Manager to build a battery powered autonomous vehicle to serve as a testbed to demonstrated real-world performance.

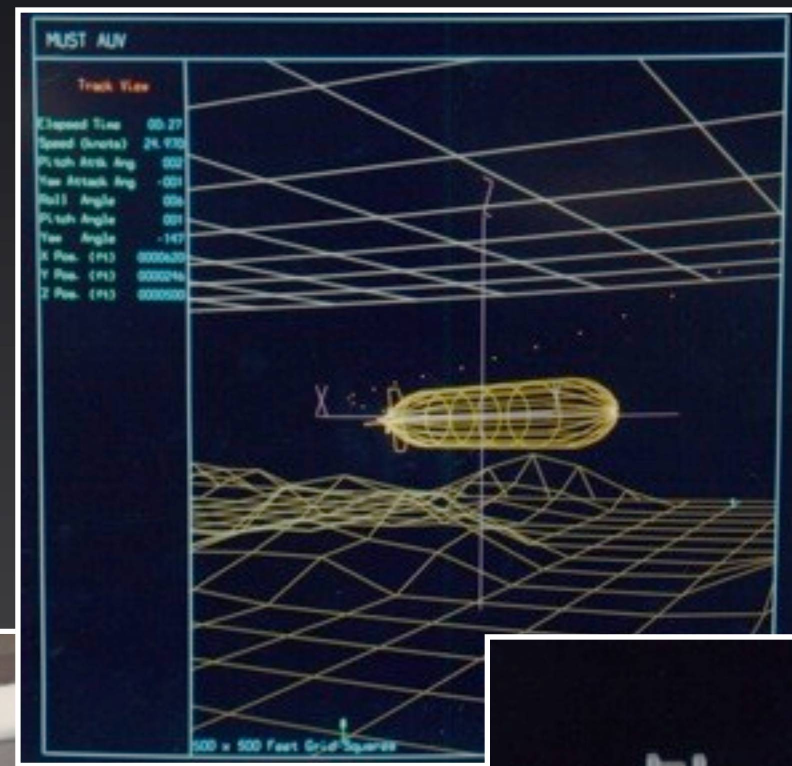


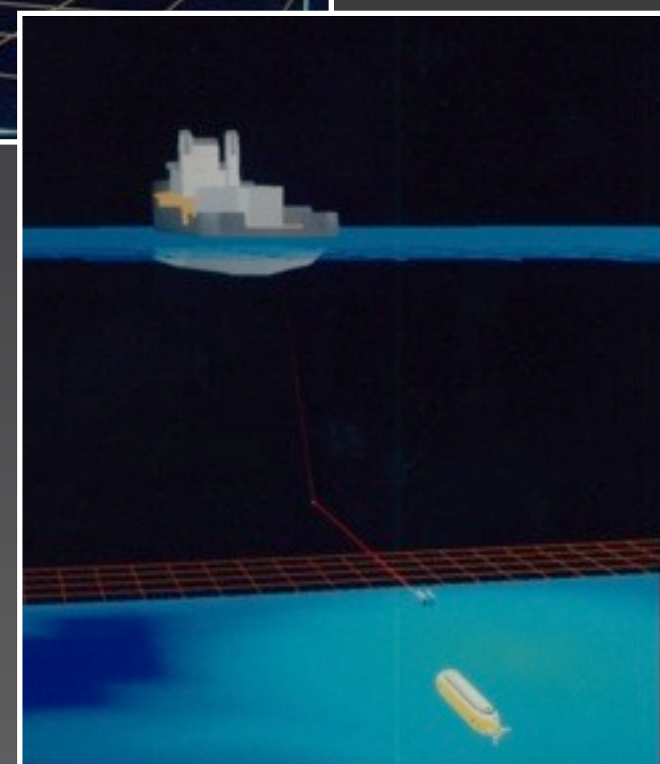


Mobile Undersea Systems Test (MUST) Lab

The MUST vehicle was 40 feet long and 4.5 feet in diameter. This size is put into perspective by the diver's silhouette in the photograph. With sufficient sealed Lead Acid batteries installed to make such a volume sink, the vehicle had sufficient energy to operate for 48 hours at 2.5 knots while sourcing up to 7.5 Kw to the payload electronics.





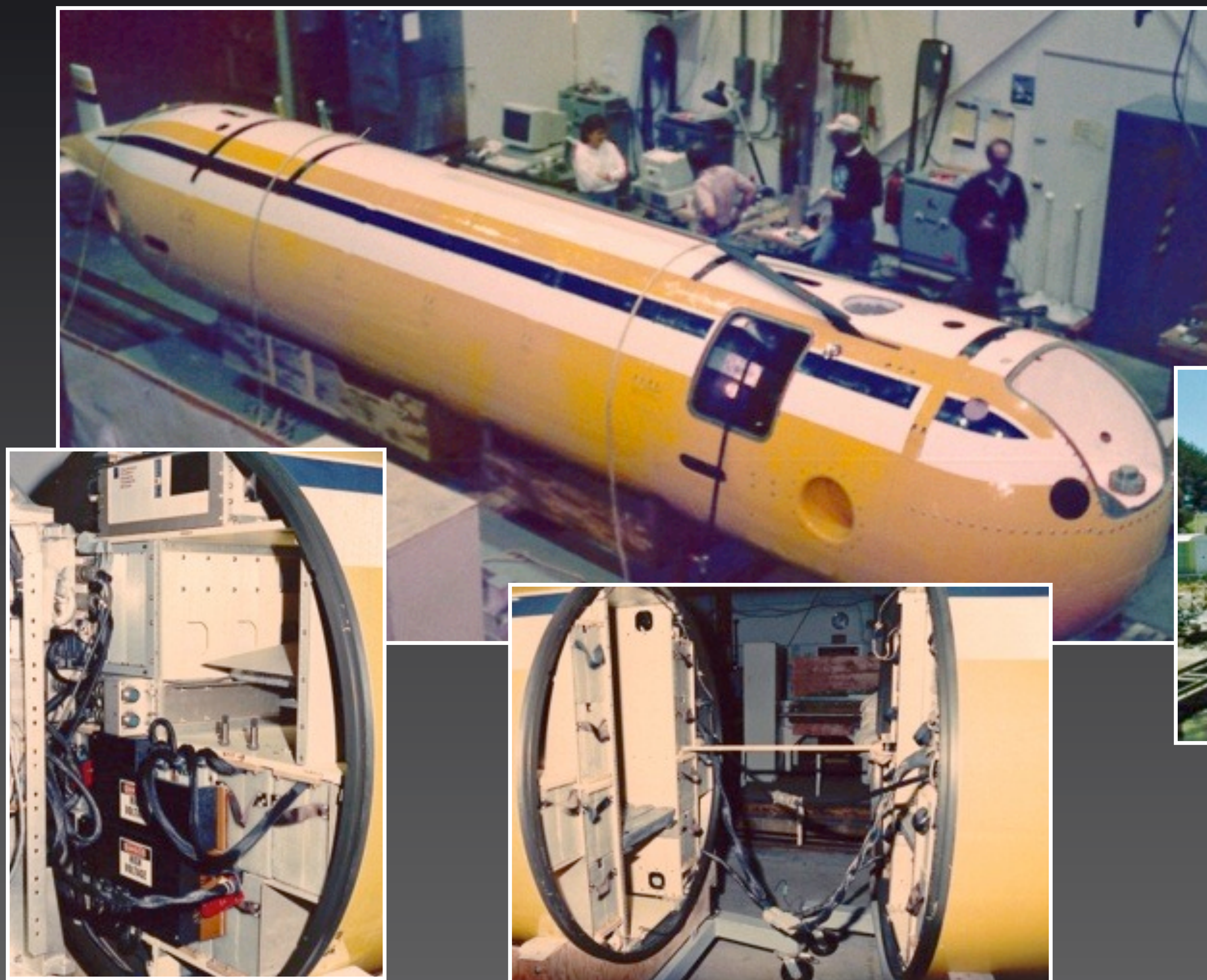
Dry Mockup and Simulations

Based on our experience in accurate 6 DOF hydrodynamic simulations of the MK-50 torpedo, we developed a similarly accurate model of MUST. The hydro model formed the basis for increasing complex simulations. Initial work focused vehicle maneuvers related to neutralization of shallow water mines. Results were displayed with vector graphics using Evans and Sutherland workstations. More complete simulations related to sensitive military mission which included the Launch and Recovery Phases were implemented with Silicon Graphics and Sun Workstations.

MUST was assembled and deployed in San Diego, while my group was located at the original Glenn L. Martin campus in Middle River, east of Baltimore Maryland. To facilitate payload development and testing, an accurate physical MUST mockup was built in Middle River. This “Dry Lab” was the foundation for a complete hardware-in-the-loop mission simulation.

Segmented Pressure Vessel

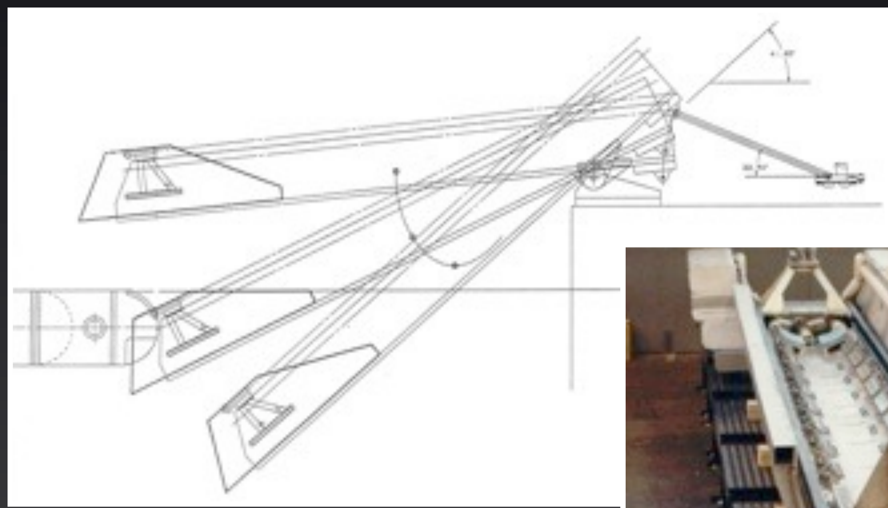
The pressure vessel was machined from custom manufactured Aluminum from Alcoa. The pressure vessel was designed of cylindrical segments to support modular experiment payloads and rapid access for changes and debugging. The result was a bolstered shell design where each joint was supported by a circular I-beam. The pressure vessel design was the subject of extensive Finite Element Analysis which pushed the boundaries for thin shell software of the complex boundary conditions. Once the parts of the vessel are snugged together, external clamps at each joint were installed compress the joint o-rings and hold the vessel together until submerged. Once submerged the differential pressure assured that the vessel stayed together. The vessel’s conservative operational rating was 2,000 feet. In the bottom picture the assembled vessel is shown anodized just before it was subjected to a hydrostatic test in a large chamber.



Deep Quest

Flexible Payload Capability

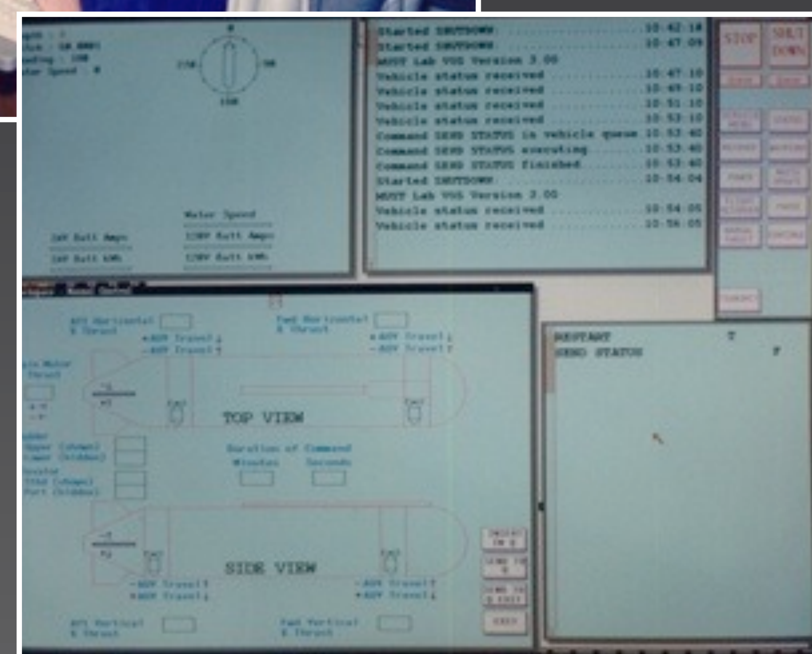
We rented the Lockheed Marine Facility on Harbor Island, San Diego from which the famous Deep Quest operated, to assemble initially deploy MUST. In the cross section views the primary MUST controls are shown on the left and the standard payload 19” EIA Rack configuration with batteries on either side is whown in the center picture.



Innovative Launch & Recovery

The Launch and Recovery System basic concept was derived from the NOSC AUSS AUV system. However AUSS was a much smaller, lighter vehicle. The ramp is articulated so that even is heavy seas, the nose contact point is always submerged at the proper level to mate with MUST. When MUST surfaces, it deploys a line with a float that is picked up and feed into the Vehicle Connection Cart. The AUSS system was refined for the larger MUST and Delrin Glide approach produced a robust operation system. While it was routinely avoided, to prove the system, MUST was operated in Sea State 5 swells.

Vehicle Container Custom Base



Turnkey At-Sea Operation

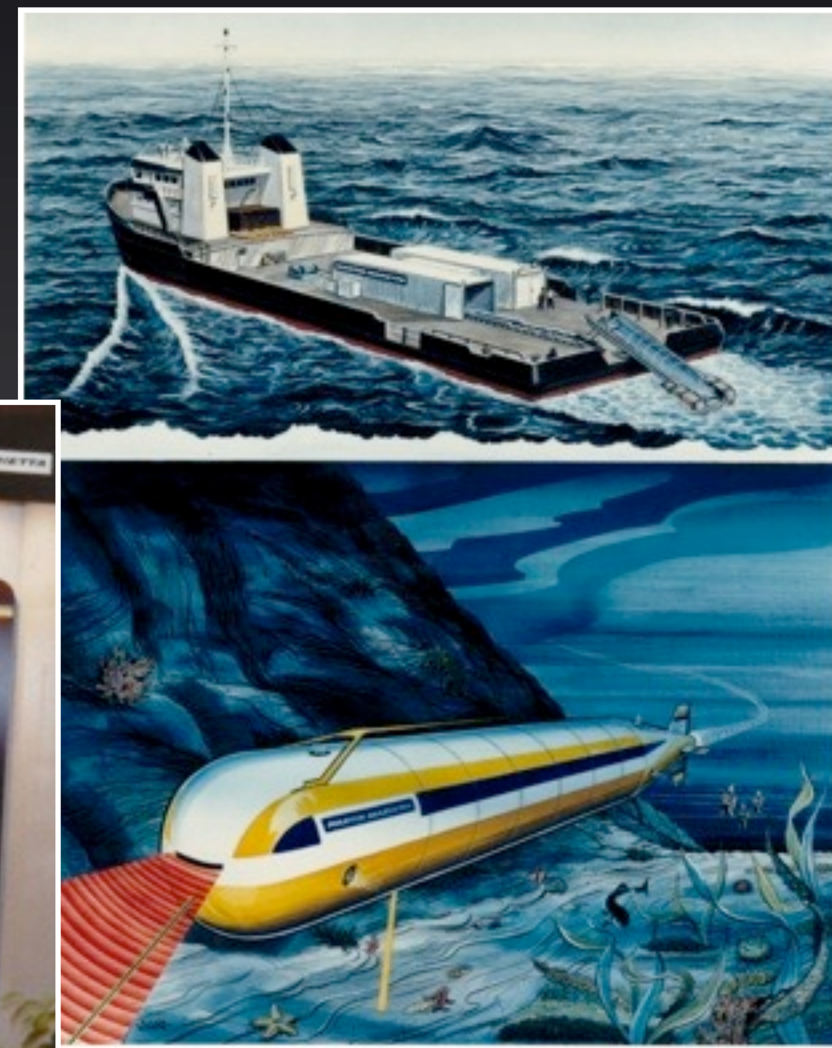
The normal approach of using ISO Shipping containers to build the MUST ship-board van was followed however the vehicle van base was custom fabricated to provide the structural precision and rigidity to allow MUST to be pulled into the van, pressure vessel segments separated and reassembled reliably to permit payload turnaround at sea on the deck of a flexing ship. The Control Van was connected by a companionway, making an operable work space during payload processing and pre-dive checkout.

The Operator GUI was implemented with graphics on workstations to avoid the cost of custom consoles and maintain the flexibility essential to R&D.

While MUST operated autonomously, its position was tracked from the ship with an Ultra-short Acoustic Baseline System and conditions were monitored by a low speed acoustic data link.

High Level Briefings

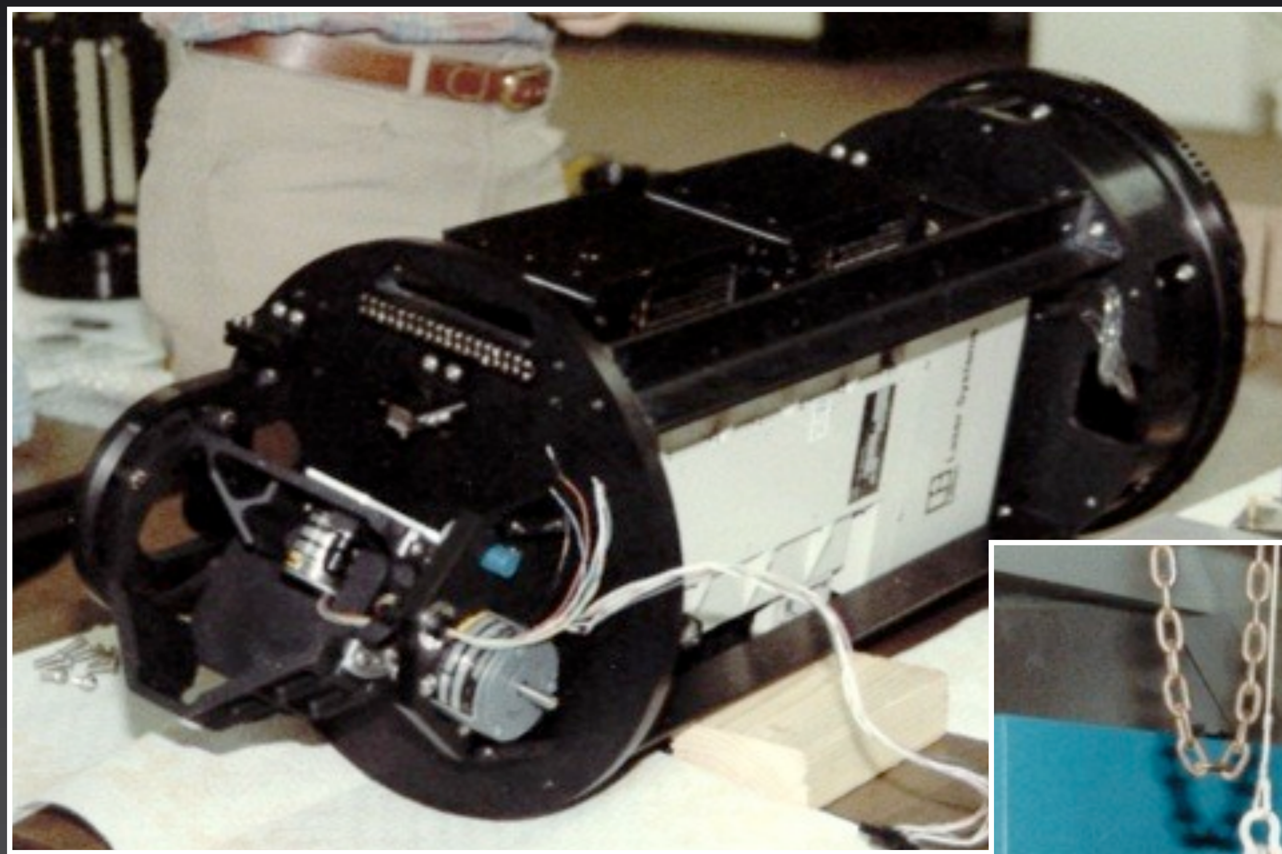
While the MUST Project work was dominated by diverse engineering challenges, significant time was devoted to technical and marketing presentations. Monthly progress reports we gived to the VP of Engineering and there was a constant stream of visitors and potential customers, from Silva Earle to Navy Brass. In the pictures I had to fly out at 0600 to give a tour of MUST to the Admiral in Charge of the Pacific Submarine Fleet.



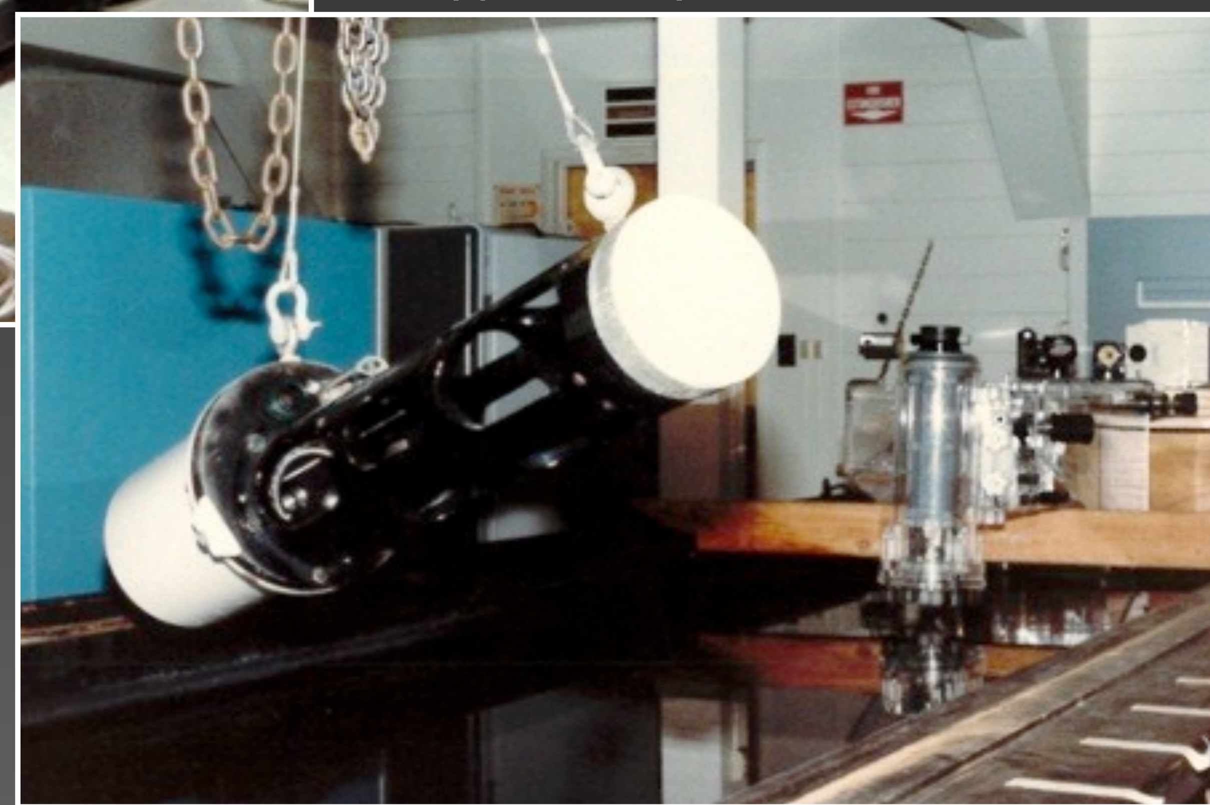
Marketing & Business Development

To support our marketing efforts, we commissioned an scale model of MUST with all the working parts accurately details. Also a painting showing the Surface ship with L&R system and Must undersea was completed. I supported the marketing efforts by preparing and presenting papers at conferences and operating a booth at trade shows.

Pulsed Lidar Assembly



Scripps Visibilty Lab

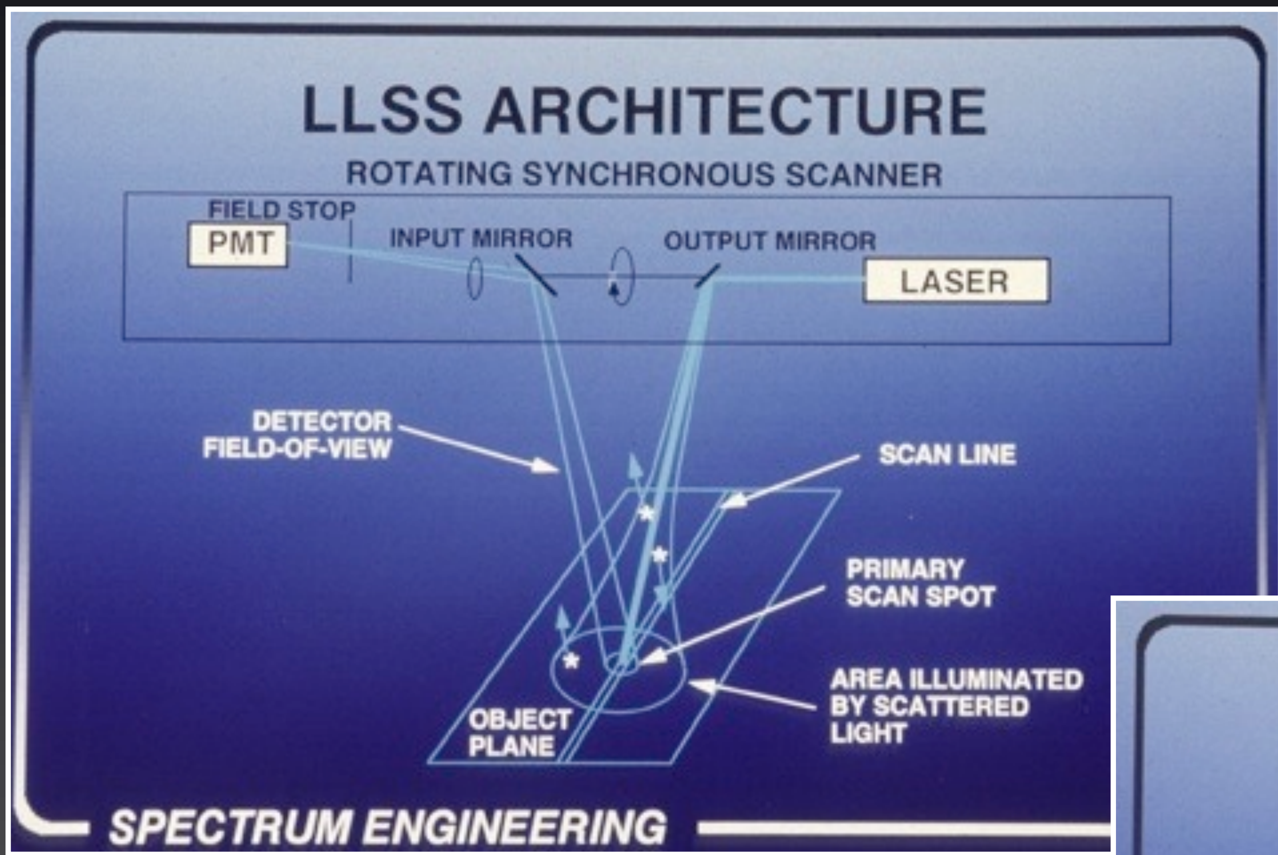


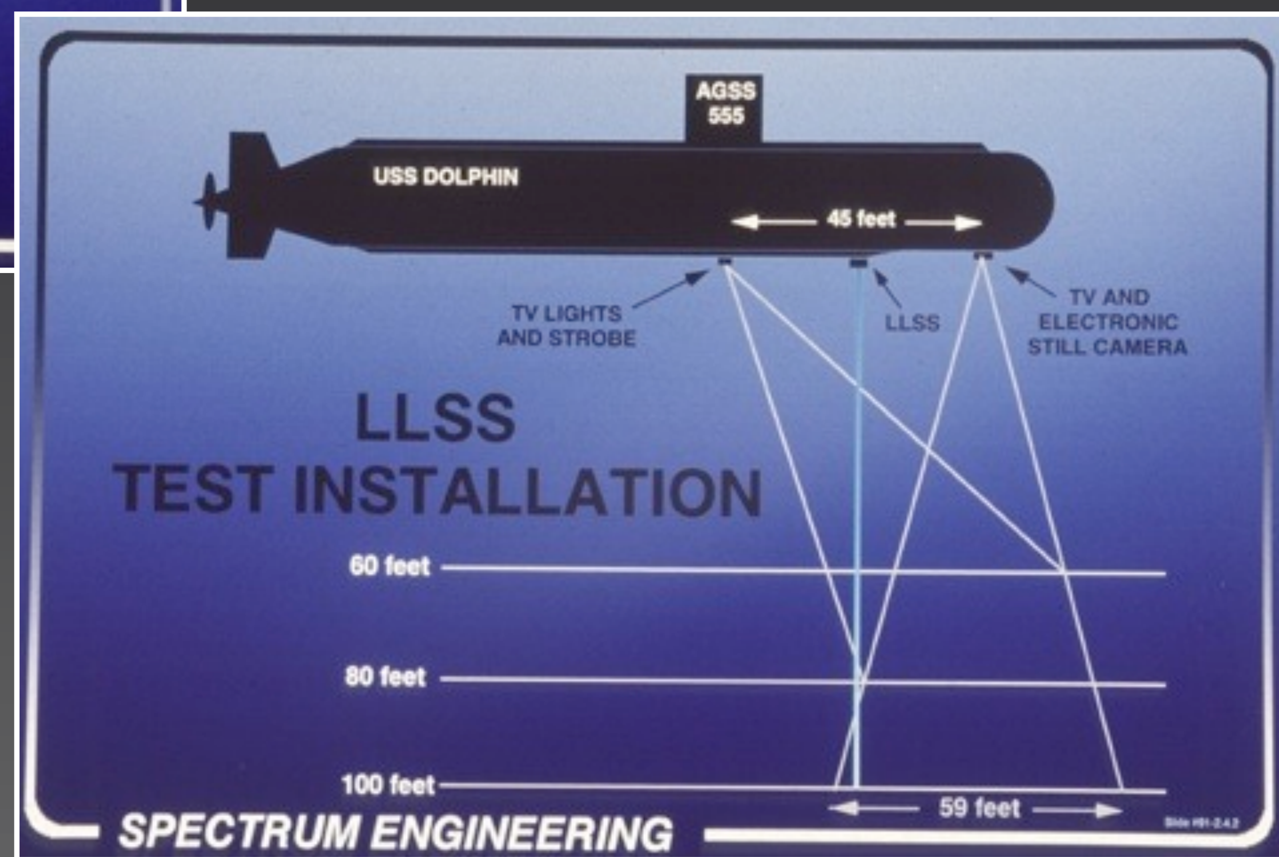
UW Pulsed Lidar R&D

As a part of the AUV IR&D, I directed the development and testing of a Nd:Yag pulsed laser ranger packaged in a pressure vessel with 2 axis scan mirrors, hemispherical pressure viewport, and flash camera detector. I was able to use an state-of-art laser from our Orlando Division. Initial testing was performed in the Scripts Visibility Lab which provided controlled absorption and scattering (measurement instruments hanging) to characterize the pulse stretching caused my the media so support optimal matched filter design for the receiver. During the course of this project, I had the opportunity to be briefed by all of Martin's key Lidar engineering working in satellite-to-sub laser communication, Army EO, Airborne tatical targeting, to name a few. I also performed a competitive procurement for a source for supporting technology or subcontracting. This exposure formed the broad foundation which supported by founding of Phoenix Scientific described in later slides. As the scope and complexity of this project grew, a full time Principal Investigator took over the transition to a field ready unit and testing in MUST.

Sailing Sabbatical - South Pacific

After too much engineering and proposal writing in Baltimore, much of it behind multiple locked doors in the basement and not enough time at sea with MUST, I elected to step off the tread mill and have some serious time at sea. So I sailed with my wife and another couple from San Diego along Mexico to Costa Rica, the Galapagos, Marquesas, Tuamotoes and French Polynesia. We occupied ourselves with celestial navigation, fishing, diving, underwater video, Ham radio, windsurfing and living!





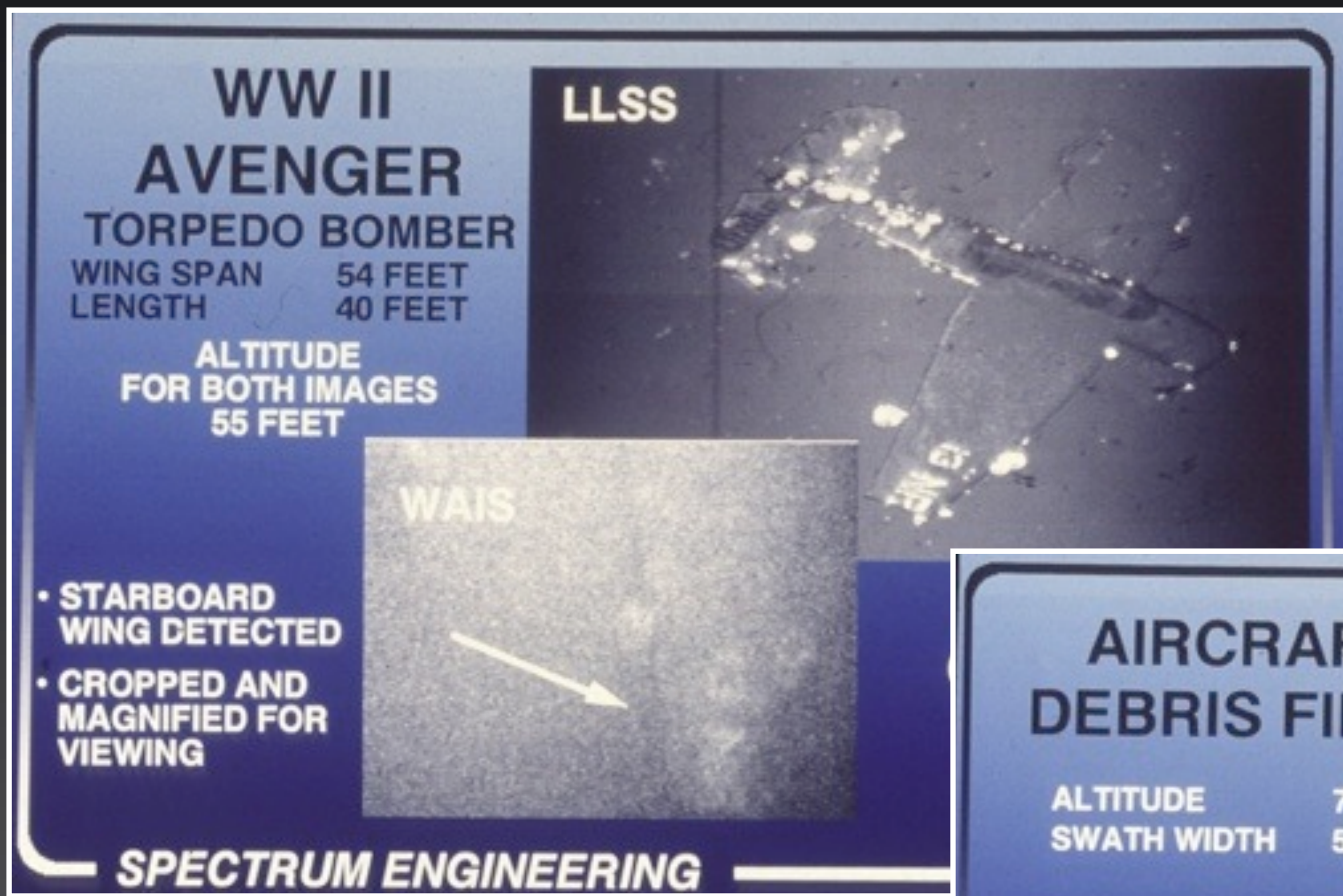
Unconventional Imaging

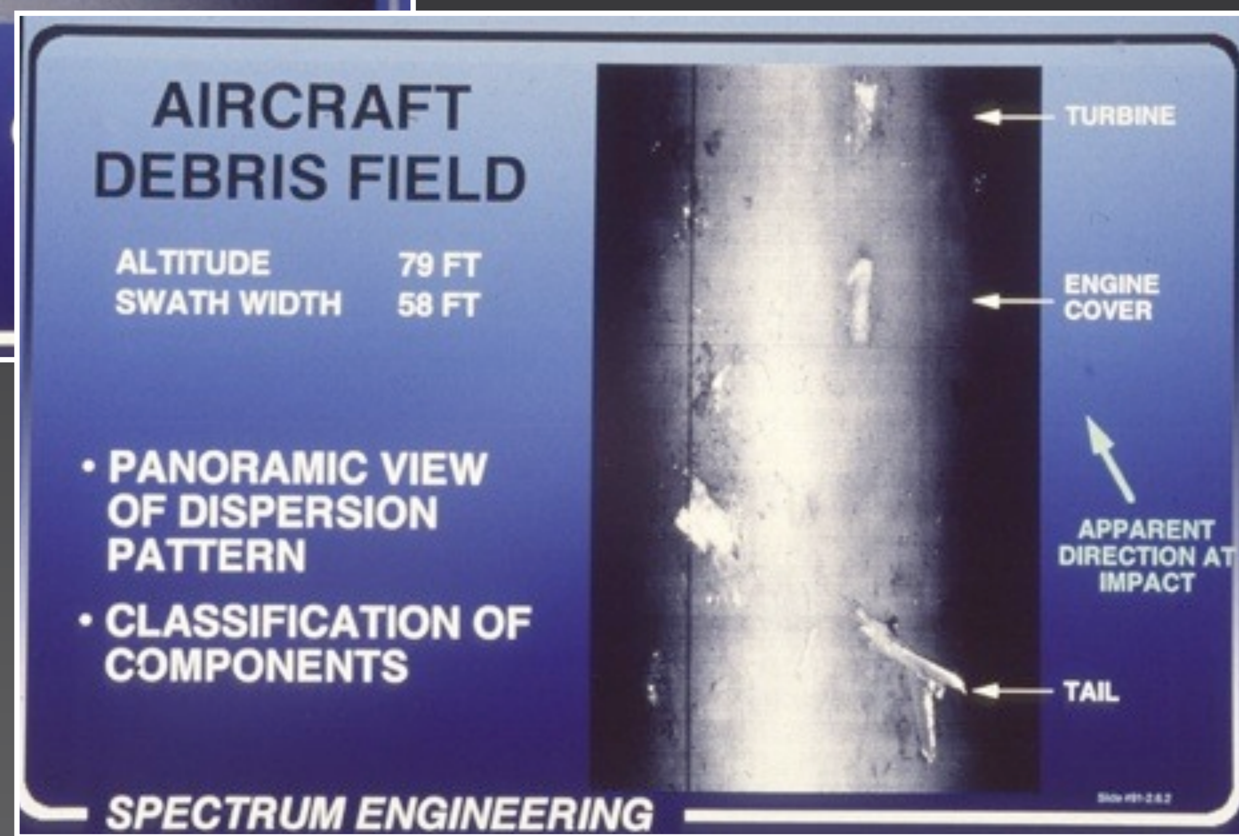
All too soon it was time to get back to work. I considered getting out of underwater work by melding my physiology and engineering backgrounds in the bioengineering field, but before I get too far down that path, my AUV Lidar subcontractor presented what they had started while I was sailing. The unconventional imaging system was creating incredible results and it was a natural for me to come on in the Business Develop arena.

This was a modern implementation of an old idea that was attempted in the 60s. But the result was an imaging system the diameter of MUST with spinning mirrors that were dangerous.

SOA Blue Laser Scanner Sub Deployed

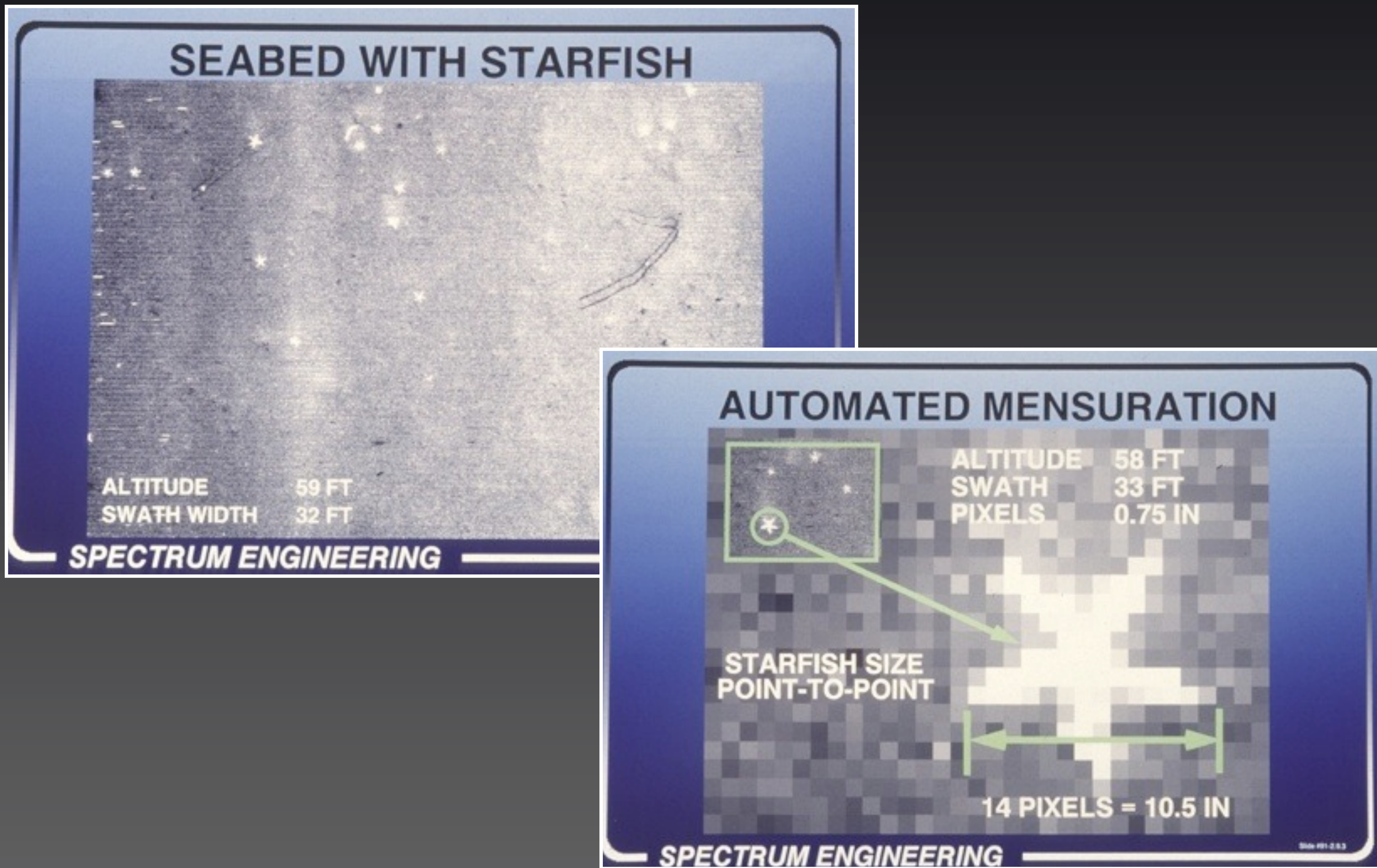
An argon laser was used to produce about 1 watt of blue light. It was so inefficient that a separate pressure vessel was needed to discharge the 7 Kw of waste heat to the sea. Eventually we got the first Frequency Doubled Yag lasers being developed by the government for incorporation into our system. They were much more efficient and simplified the cooling requirements. The system was operated off of the Dolphin (AGS-555), the only diesel submarine in the US Navy Fleet.





One-Pass Large Area HiRes Image

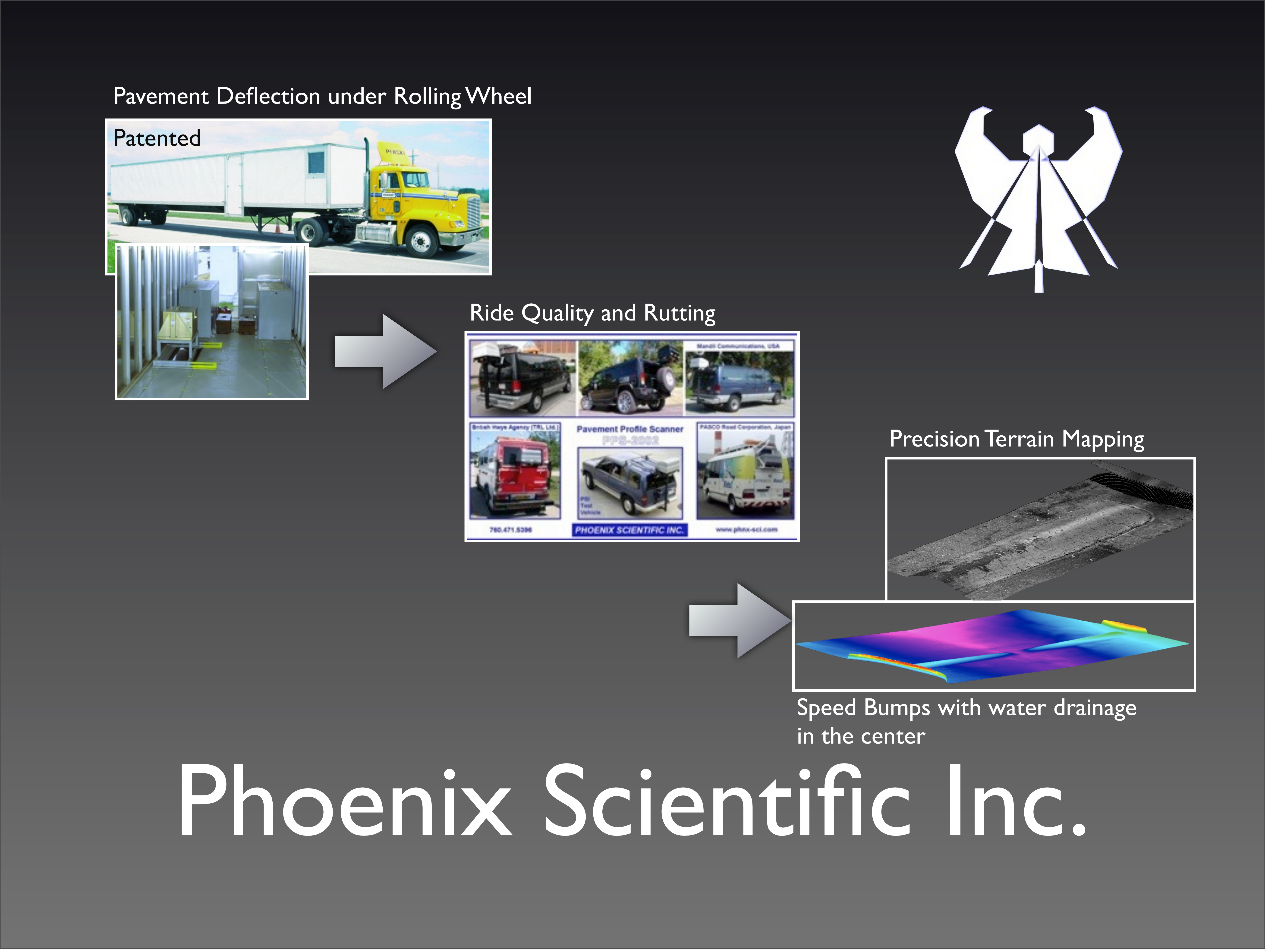
These early images show the ability of the system to produce a wide strip images in one pass that up until this time required piecing together still photos into a mosaic in post-processing. But it was the image quality that made the system compelling. The blurry image of the airplane wing was the best that the Navy could do at the time. Compare that to the full image of the same Grumman Avenger resting on the seabed of Solana Beach, California. Fins and sponges are visible in the image. The image of the debris field underscores the one-pass capability of the system.



Breakthrough Range/Resolution

Even biological objects were readily visible and even measurable, demonstrating the commercial/academic and well as military potential of the technology. In the course of marking this technology briefed secretive treasure salvers, executives at the National Geographic, the vice-presidents of Tokyo Broadcasting (for imaging WWII military artifacts in the South Pacific) to name a few.

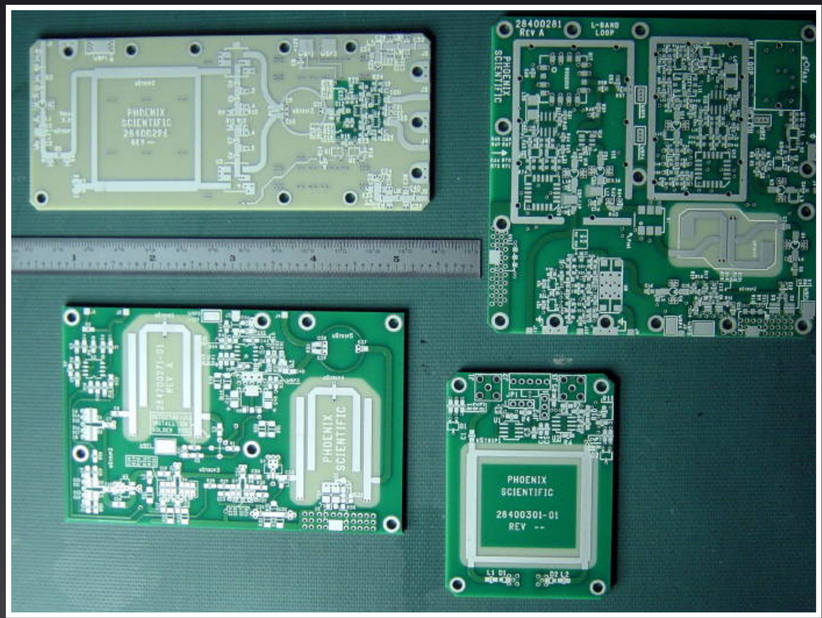
The government customer that funded this technology required little new business support as I knew them well and we were on target for their needs. The challenge was to diversify into commercial markets. The effort was short lived because the two owners entered into an adversarial court battle of the company that ulitmatle resulted in dissolution of the company.



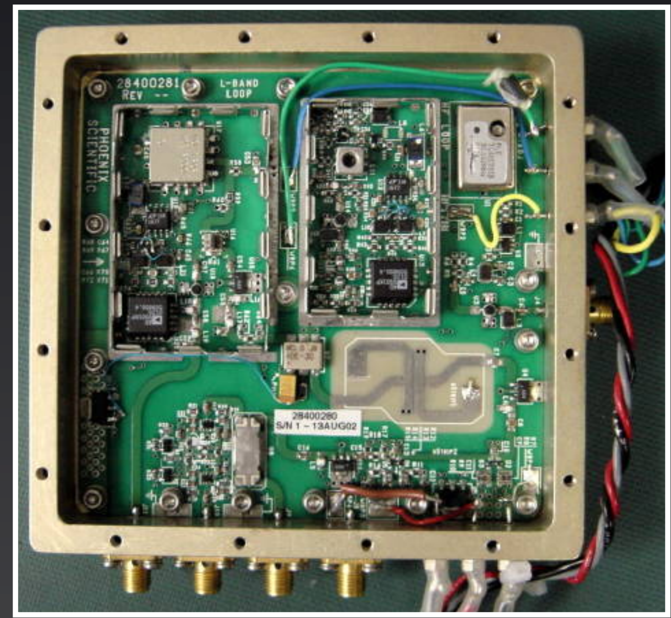
The UW imaging company went through an adversarial split and was sold to DOD Primes. Phoenix Scientific Inc (PSI) rose for the ashes during this evolution originally to continue UW imaging with one of the owners, but within months that direction was impeded by the dissolution process. I found that independently building PSI around all that I had learned, pursuing new applications and steering clear of the UW imaging owners' battles as a rewarding, challenging way to move into the future.

Over the years at PSI, I won funding, designed and built innovative laser ranging technology and applied it to three evolving applications, capturing commercial sales. [Please see PSI's website for details](). The following slides give a top level insight into the electronics of Phoenix Scientific Inc's (PSI) Laser Ranging Technology, because this information is not available from PSI's website.

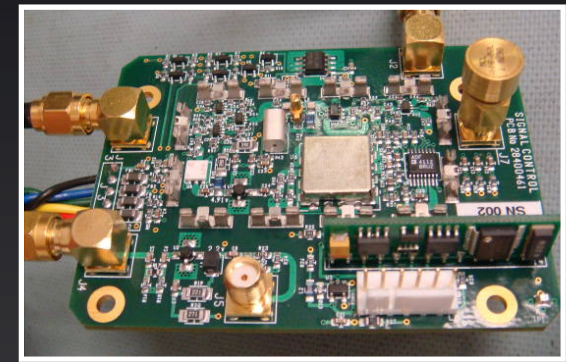
1st Generation µStrip PCA Set



DSB Exciter (1.5±0.025 GHz)

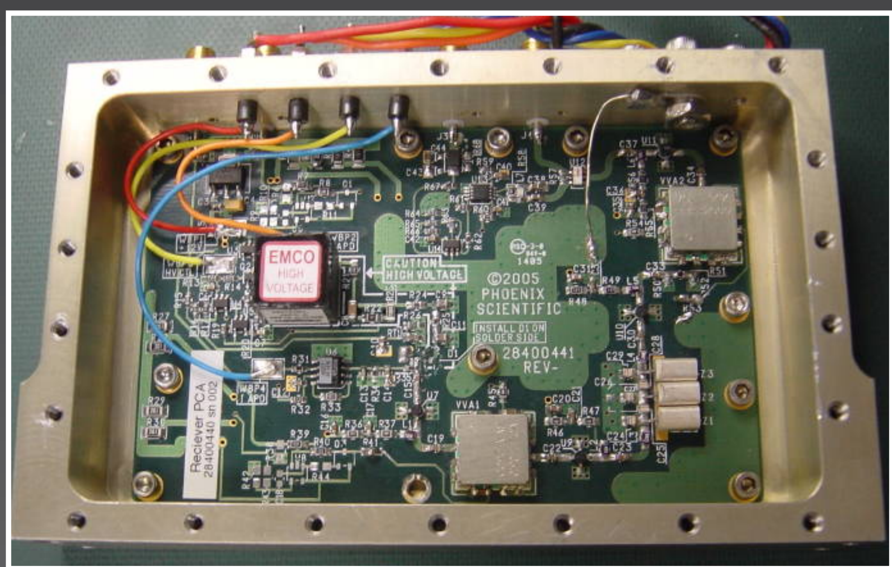


Signal Control PCA

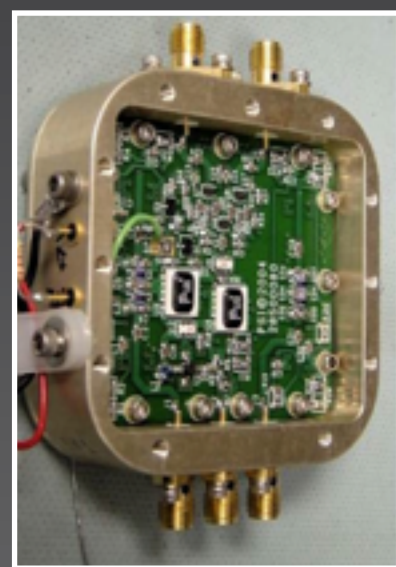


Laser and Data Interface PCAs on following slides

HV APD Receiver with 2 Stage AGC



Quadrature Processor



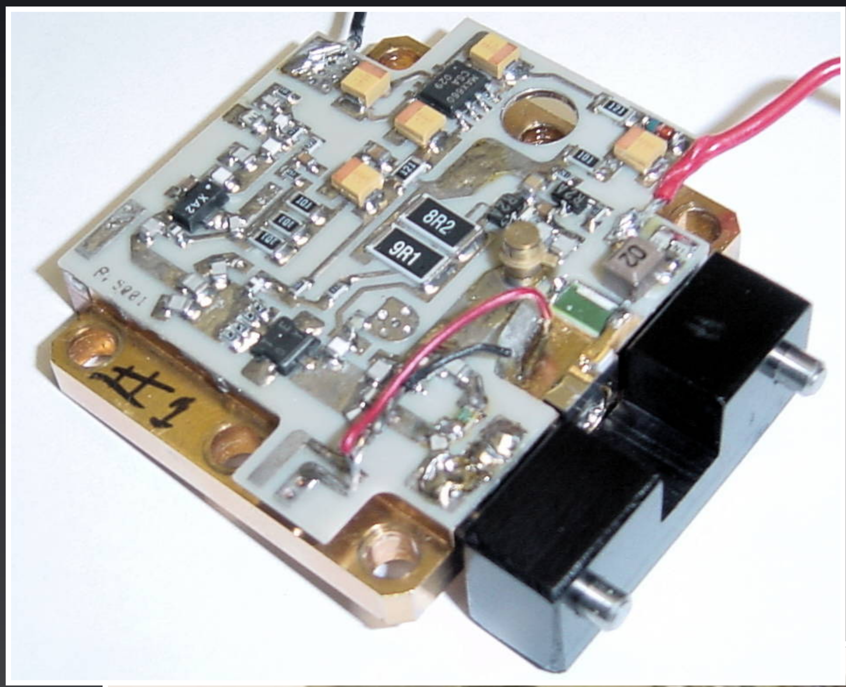
System Control and Power PCA

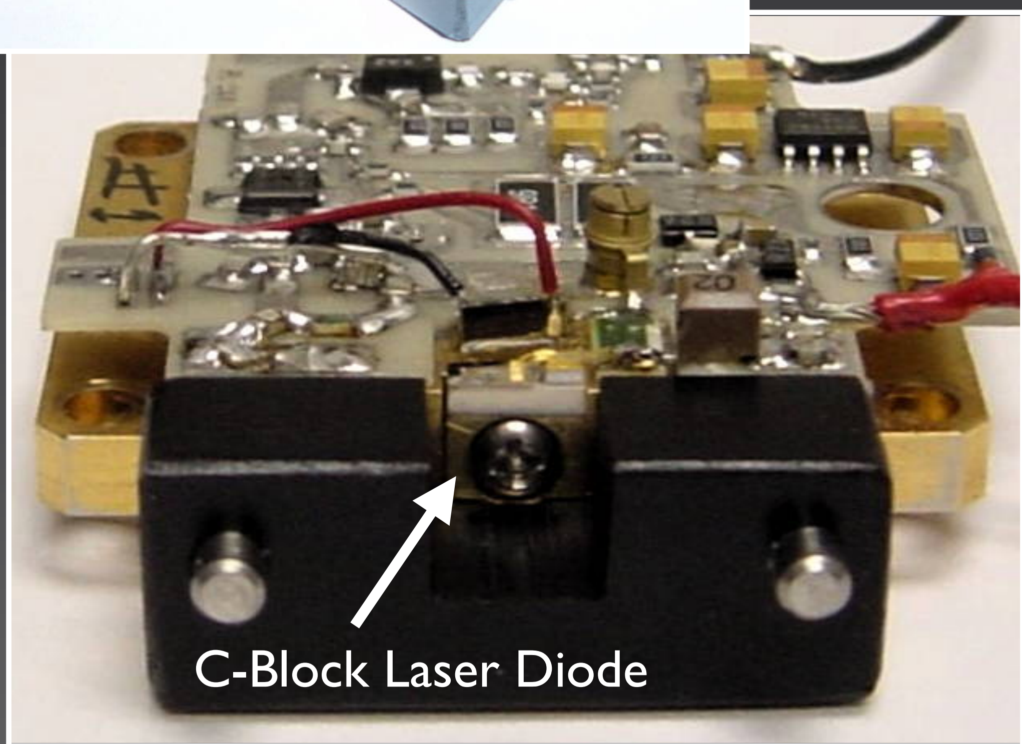
PSI Lidar PCB Set

At the heart of PSI's technology is the fasted most accurate phase-measurement laser radar that has been developed. A first generation system employed area intensive microstrip circuity, but by the second generation multilayer ceramics provided compact devices to replace the microstrip. The initial system was single sideband with an ambiguity of 10 cm. The second generation system DSB implementation yielded an ambiguity of 3.2 m.

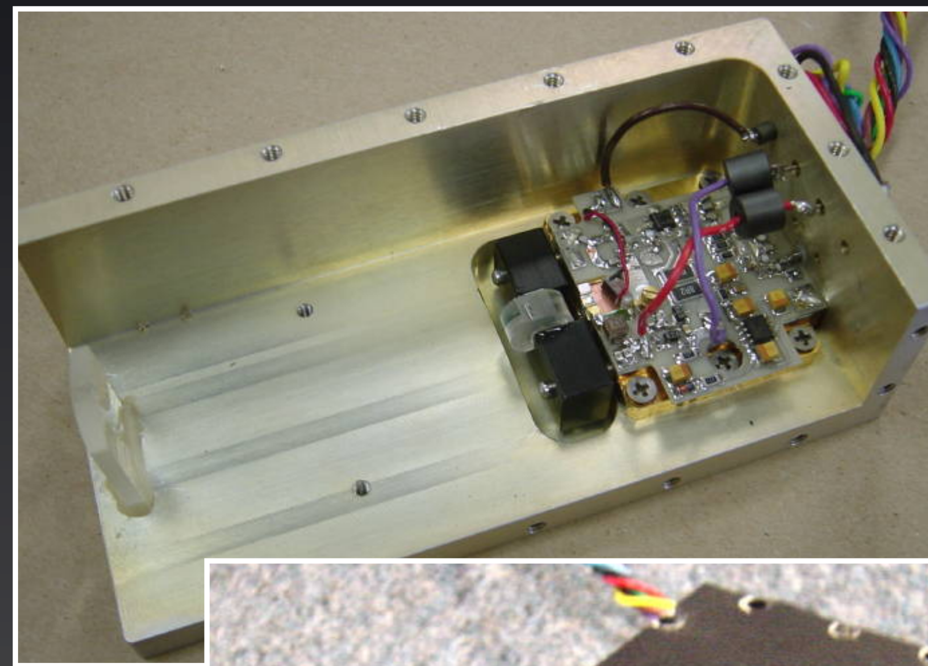
Range precision is between 25µ and 250µ (depending on target return) at a data rate of 1.258 MSPS. That is 1-10 thousandths of an inch from 7-10 feet in the air hitting road surfaces!

Laser Diode PCA





Collimated Laser Assembly (CLA)

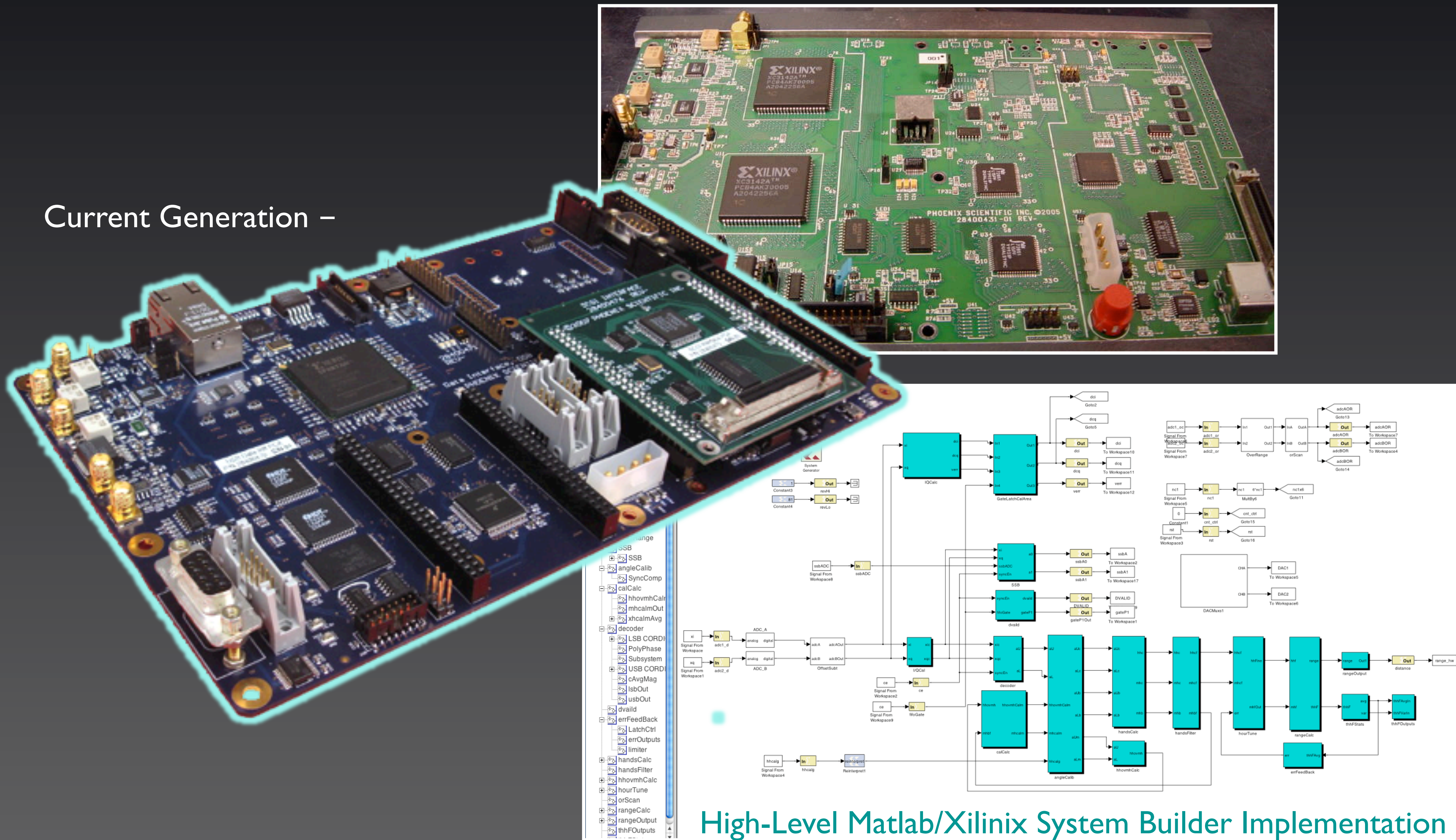


30dB RF Amp w/ Zmatch to 4w Laser Diode

At the heart of the implementation is linear modulation of a C-block laser diode at 1.5 Ghz. We designed and build this power amp and impedance match circuit inhouse. It includes a back photodiode for feedback power control. We use lasers form 1-4 watts that are 50 to 500 microns wide.

1st Generation –

Current Generation –

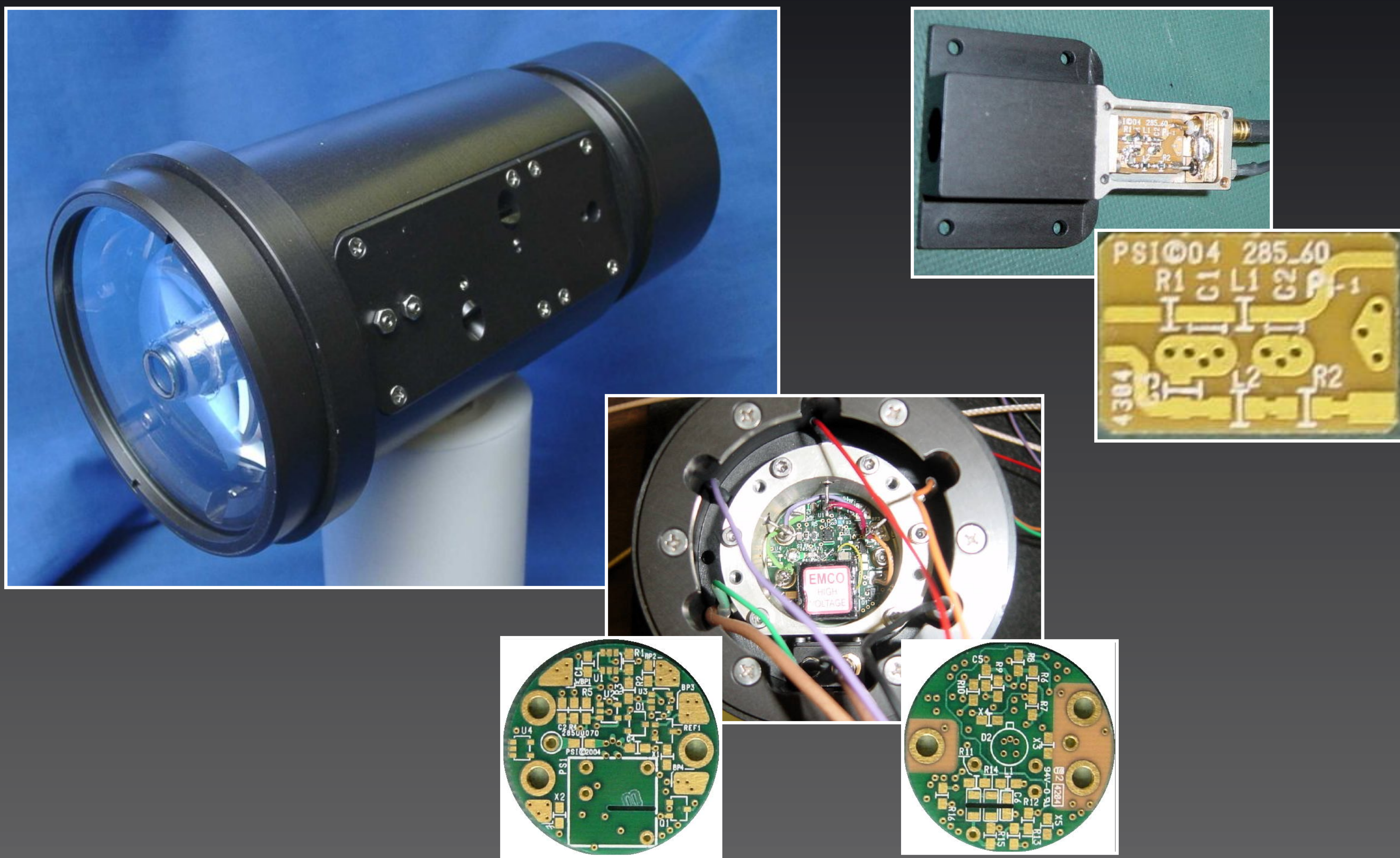


High-Level Matlab/Xilinix System Builder Implementation

SW Defined I&Q IF Demod

The first generation Data Interface card implemented a single IF A/D sequential I&Q sampling and stored raw A/D values which were pot-processed. The implementation with Xilinix 3000 series FPGAs were plagued with the various software optimization limitations of this early technology. The Current Generation employs a Spartan 900 pin BGA and the state-or-art robust development environment of Matlab and System Builder. Dual IF A/Ds sample I&Q synchronously at 30.192 MHz and the software defined implementation produces range and amplitude for storage at 7.548 MSPS. To maintain backward compatibility for the current data bus, the data is subsampled 1 of every 6 points. The card has a gigbit phy ready to source the higher data when a suitable customer requirement arises.

I personally laid out all the circuit boards except this last “blue” card, which was 12 layers to accommodate the I/O of the 900 pin BGA, on the interest of speed to market and access to the latest high-end PCB software.



Coaxial Ranging T/R Module

This coaxial module produces a 50mw spot 0.5mm in diameter at 1-7 feet and has the same performance, accuracy and data rate, as the high power scanner at a longer range. The laser is folded into the center window and all the surrounding area is focused onto the receiver's detector.