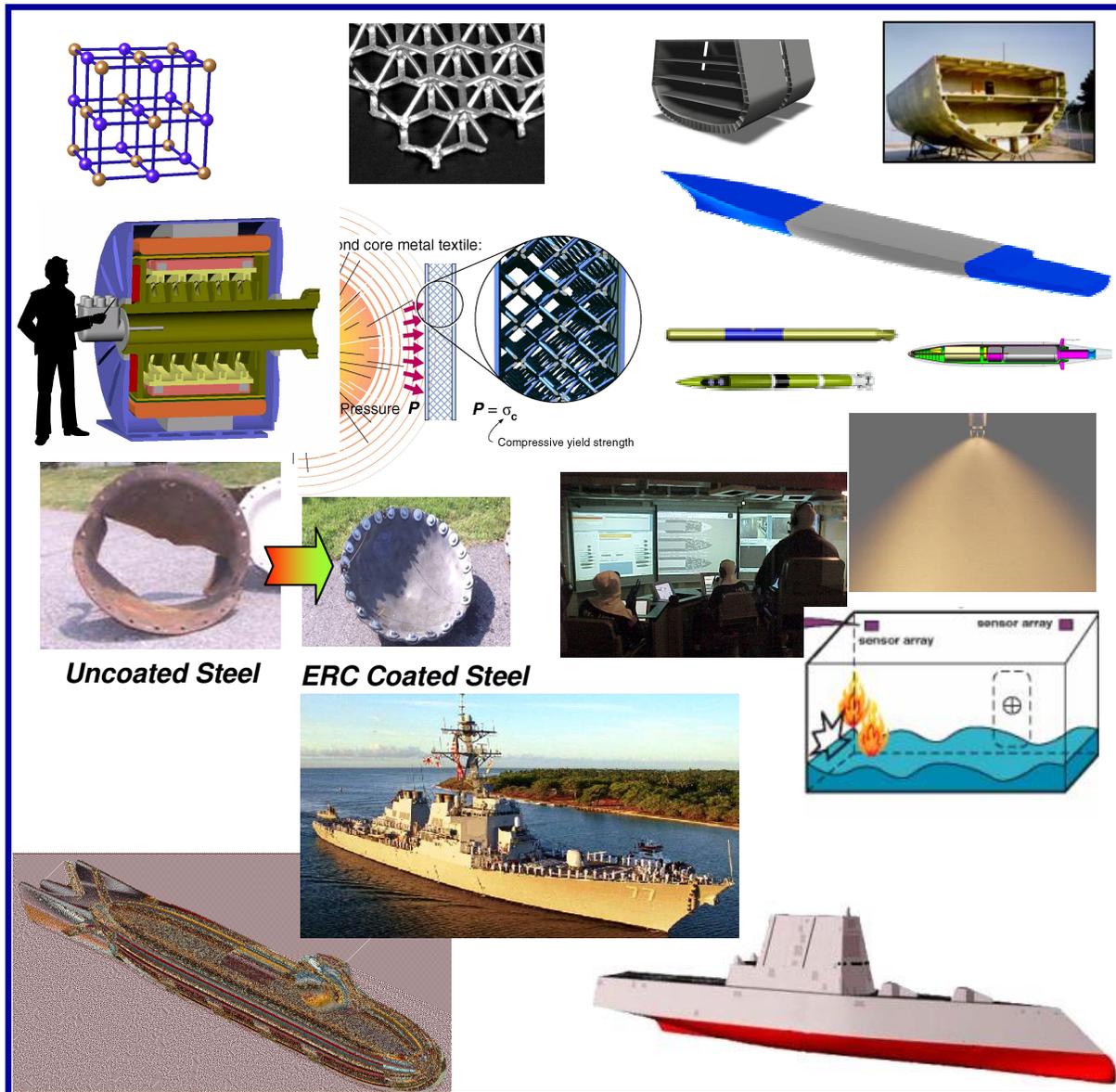


Engineering, Materials & Physical Sciences Science & Technology Department



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Research Thrusts

- ∅ **Physical Sciences S&T Division (331)**
 - Environmental Quality
 - Novel Power & Energy Transfer
 - Non-Linear Dynamics
- ∅ **Materials S&T Division (332)**
 - Structural Materials
 - Functional Materials
 - Maintenance Reduction Technologies
- ∅ **Mechanics & Energy Conversion S&T Division (333)**
 - Undersea Weaponry
 - Energetic Materials
 - Hydromechanics
- ∅ **Ship Hull, Mechanical & Electrical Systems S&T Division (334)**
 - Reduced Signatures
 - Advanced Electrical Power Systems
 - Hull Life Assurance
 - Distributed Intelligence for Automated Survivability
- ∅ **Naval Ship S&T Office (33X)**
 - Advanced Platform Concepts

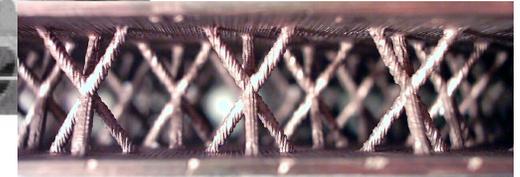
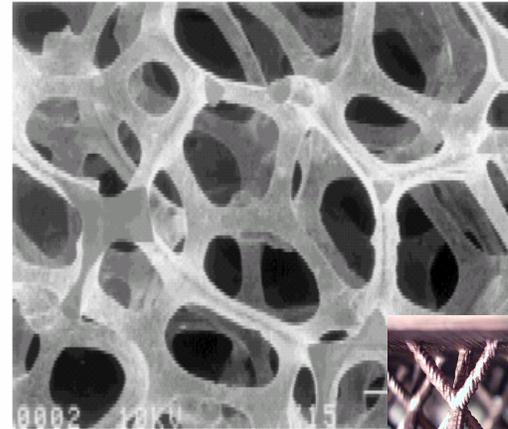
FROM NANOSTRUCTURES TO AIRCRAFT CARRIERS



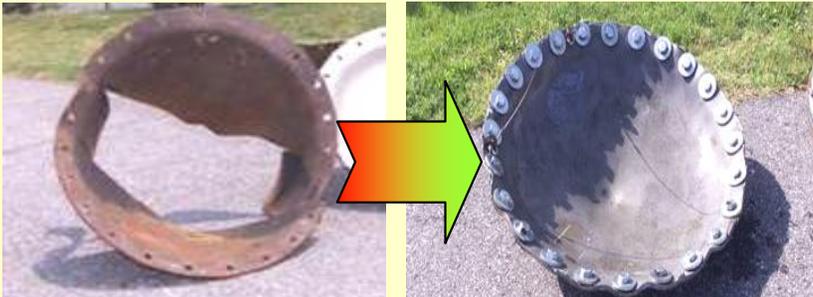
Outline

- **Selected Science & Technology initiatives**
 - ∅ **Ship Survivability**
 - Shock and Blast Effects on Structures
 - Damage Control – Fire Suppression
 - ∅ **Weight Reduction**
 - Materials and Welding
 - Jet Blast Deflector
 - ∅ **Reduced Maintenance**
 - Single Tank Coating
 - Shafts and gearing
 - ∅ **Electric Warship**
 - ∅ **Advanced Platform Demonstrators**
 - ∅ **ASW Improvement (Undersea Weapons)**
 - Single Crystals
- **Summary**

Shock and Blast Effects on Structures



Explosion Resistant Coating



Uncoated Steel

ERC Coated Steel

- ACTD is No. 2 on Navy & USMC Lists
- ERC is being deployed on vehicles in-theater (TSWG funding).

Cellular Materials

- Initial results show potential for 10X more blast resistance



Damage Control – Fire Suppression

RSVP - CG61 Monterey



- wireless data communication
- crew status awareness
- machinery system situational awareness

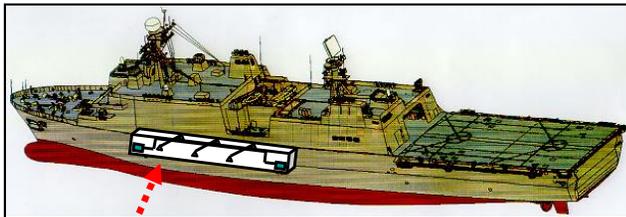
DCARM – ex-Shadwell



- firemain survivability
- smoke ejection
- water mist fire suppression
- door closure sensors



Water Mist Fire Suppression - LPD-17



Machinery space water mist fire suppression system

Autonomic Fire Suppression System – DD(X)



- Fully automated response to fires
- Automated firemain break detection & isolation
- Automated cooling of battle damage area

Next Steps

- Water Mist Fire Suppression
 - ∅ Hybrid water mist system for suppressing electronic space fires
 - ∅ Blast Mitigation Water Mist System
- Advanced volume sensor for real-time automated surveillance (fire, flooding, CBM, and security)



Maintenance Reduction Technologies

Technical Issues/Challenges

- Ø Zero Maintenance Materials
- Ø Prognostics for Smart Systems
- Ø Marine Corrosion Control
- Ø Affordable, Ready Turbine Engines

Naval Impact

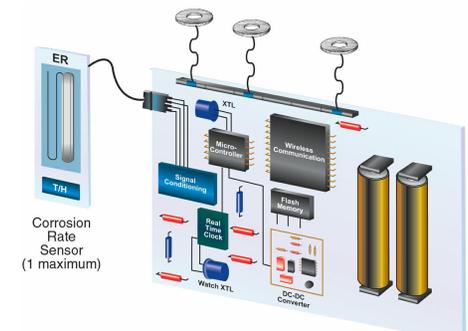
- Ø Materials/Processes for Total Ownership
- Ø Cost (TOC) Reduction
- Ø Cost Avoidance in Billions
- Ø Tactical Asset Management for Seabasing
- Ø Achieving CNO Readiness Requirements

Transition Opportunities

- Ø Turbine Engines for Legacy and Future Aircraft
- Ø Ship Tank Coatings
- Ø AAV Mission Life Prediction
- Ø Nanostructured Ceramic Coatings
- Ø Future Pier Construction



F414



C2MS



AAAV

Ship Tank Coatings

Product Description

- Rapid Cure Single Coating System for Corrosion Control
 - ∅ Solvent Free
 - ∅ Edge Retentive
 - ∅ One High Build

Payoff

- NPV \$250M
- Quick return to service
- Applicable in hot and cold weather
- Waterborne (pier-side) application capability
- Long-life and durable (>current systems)

USS WHIDBEY ISLAND LSD-41 Seawater Ballast Tank 3-129-1-W

Application of Madison Marithane II (Ultra Polyurethane)



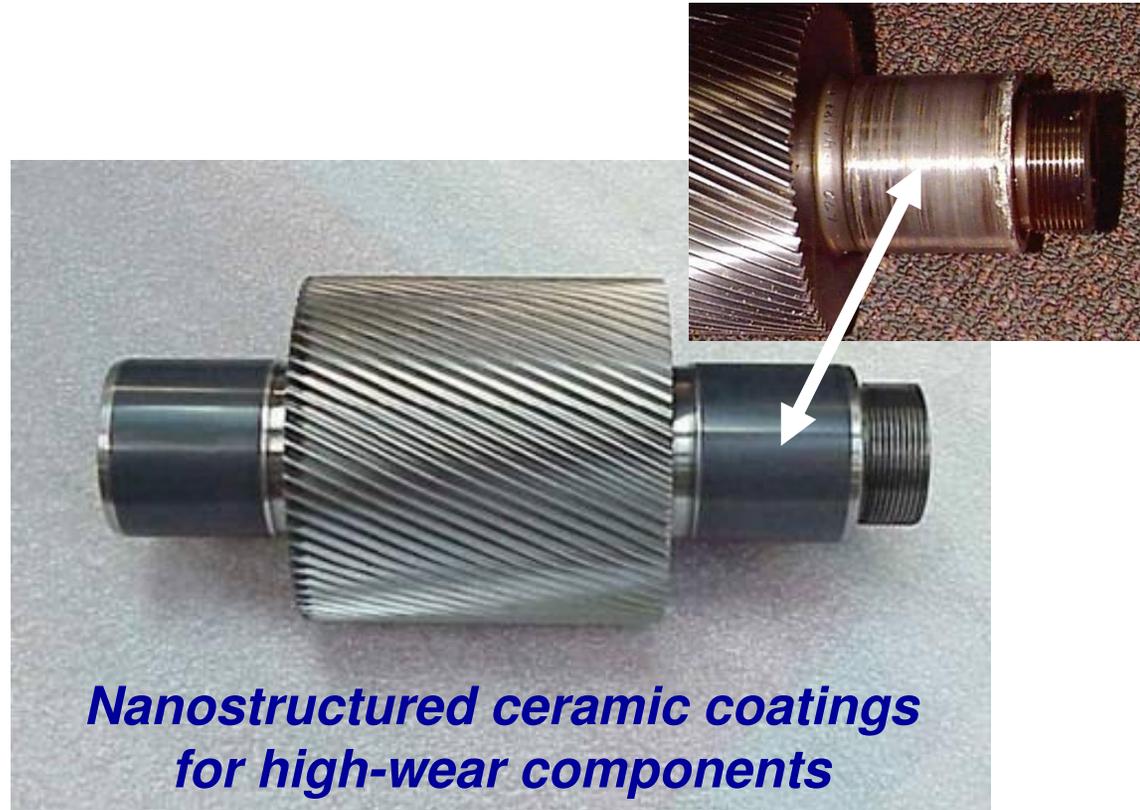


Nanostructured Ceramic Coatings (Zero Maintenance Materials)

First coatings applied to USS Chief's propulsion shafts in 2003—diver inspection indicates no detectable wear. Since installed in USS Ardent (shown) and Champion.



Saves \$1M annually across MCM-1 Avenger class



Nanostructured ceramic coatings for high-wear components

Nanostructured coatings with unprecedented damage tolerance & bond strength — now in service

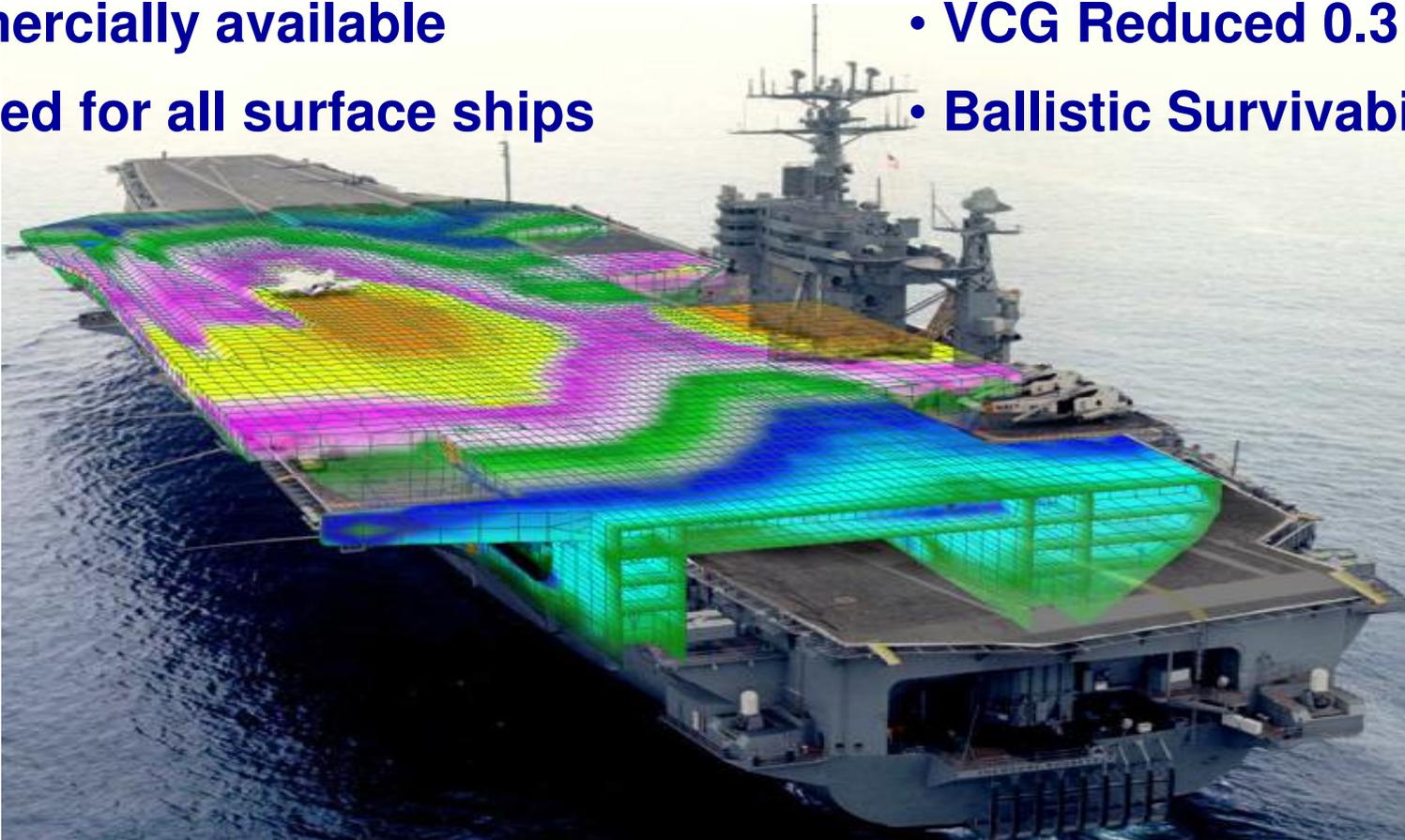
Advanced Steels

HSLA 65 Steel

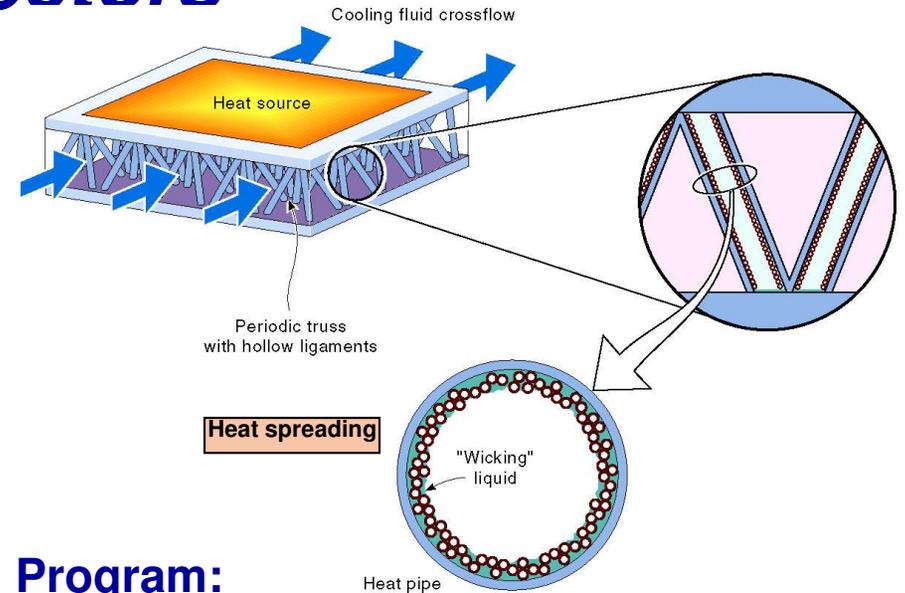
- Plate and structural shapes
- 800 L Ton Weight Savings
- Commercially available
- Certified for all surface ships

10-Ni Steels

- Flight Deck & Gallery Deck
- 800 L Ton Weight Savings
- VCG Reduced 0.3 feet
- Ballistic Survivability



Low Maintenance Passive Jet Blast Deflectors



Objective:

- Decrease weight (pumps, piping) and maintenance (corrosion)
- Cooling water availability for other applications
- Capability for future hotter engines

Approach:

- Exploit high heat transfer, ultra-light, cellular metal heat exchangers, embedded heat pipes (HP)

Payoff:

- 26% reduction in O&S costs vs MK 7
- Water availability for EMALS
- Weight reduction (up to 200,000#)

Program:

- Models/ simulations/ concepts
- Laboratory analyses/ evaluations
- Develop fabrication methods
- Sub-scale panel fabrication / feasibility demonstration
- Full scale panel fabrication/ evaluation

\$ / Time:

- \$14M / 2 1/2 years
- ONR, DARPA, NNS, NAVAIR Lakehurst, UVA, RPI, MIT, CMI



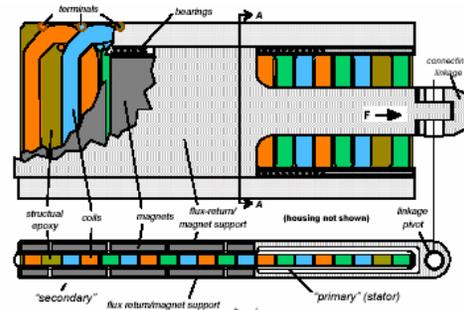
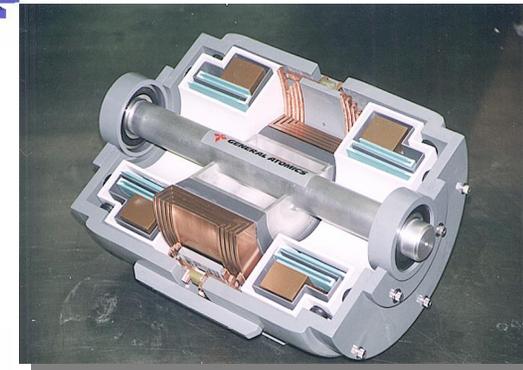
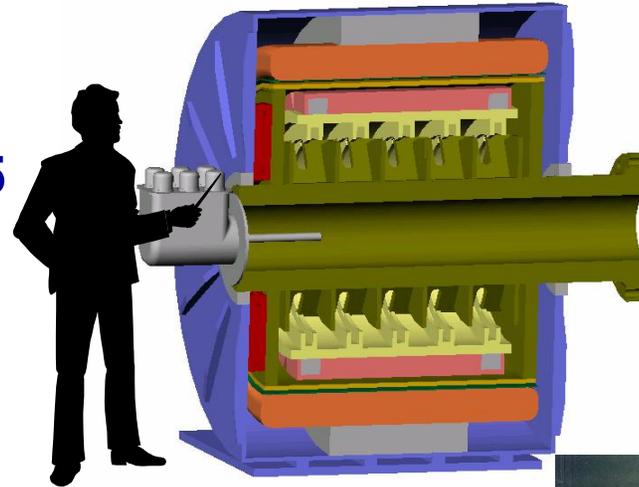
Electric Warship

Developing the building blocks for future all-electric naval force.

- ∅ **Power Generation**
- ∅ **Energy Storage**
- ∅ **Control and Power Distribution**
- ∅ **Electric Weapons**
- **Focus:**
 - ∅ **Increasing the power / energy density of component and machines**
 - ∅ **Developing distribution architectures using power electronics to allow dynamic reconfiguration and pulsed power loads**
 - ∅ **Improving rail gun life**

Electric Warship

- FY 01 – Demonstrated Electromagnetic Aircraft Recovery System concept for CVN-21
- FY 02 – Demonstrated programmable COTS power electronics-based aircraft electrical servicing station (AESS) on CVN-75
- FY 04 – Demonstrated linear motor controller technology for Electromagnetic Aircraft Launch System for CVN-21
- By mid-05 will complete Quiet Electric Drive (QED) SPM for SEAWOLF and VIRGINIA Classes
- By mid-05 will complete 500 kW PEM fuel cell and 650 kW Molten Carbonate fuel cell for DD(X)
- By FY 07 will complete 36MW HTS motor testing and by FY 08 will complete 36MW DC Homopolar SC motor
- Starting high torque, variable speed actuator program

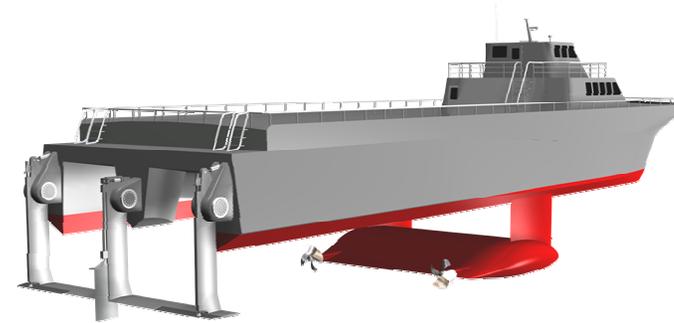




Advanced Platform Demonstrators



X-Craft



HYSWAC

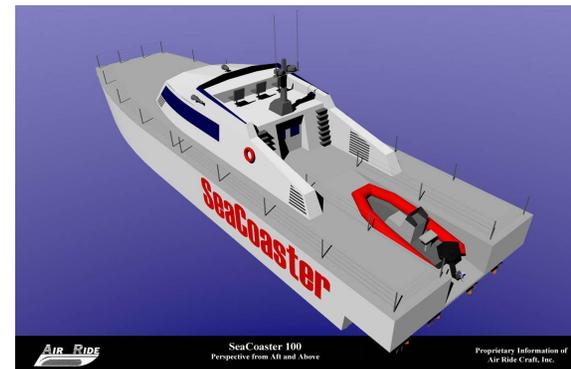


HDV-100



SLICE

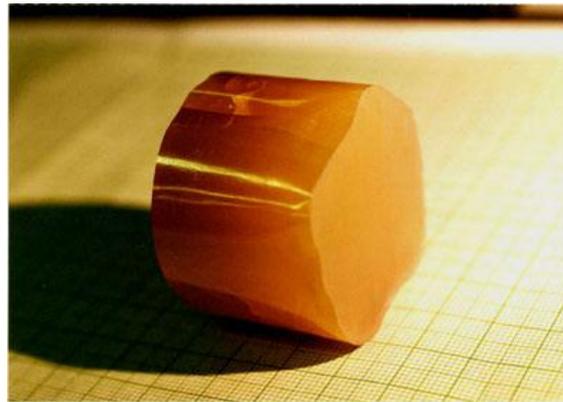
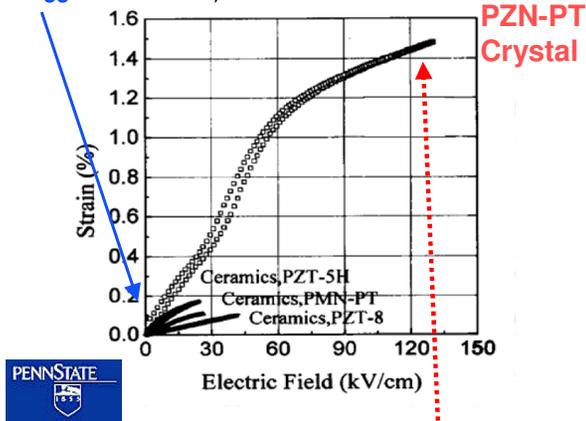
**Small Water
Craft
Demonstrator**



**HS Cargo
Vessel**

MINOR MIRACLE

K_{33} : 75% → >90%



HC Materials



2.8" Length, 0.8" diameter

MAJOR MIRACLE

S: 0.1% → >1.5%

Material Available for Device Prototyping

Cylindrical Source
<100th Size,
191% Bandwidth

Discovery

Coupling > 90%

Strain > 1.5%

PZN-PT PMN-PT

Crystal Growth

Bridgman Growth

Flux Growth

Solid State Growth

Demonstrations

Torpedo Countermeasures

Vector Velocity Sensor

Torpedo Guidance



Summary

ONR-33

Investing in cutting edge science to develop enabling technologies that provide improved HM&E, Materials and Undersea Weapons capabilities and products to the Fleets (in-service, next generation & generation after-next)