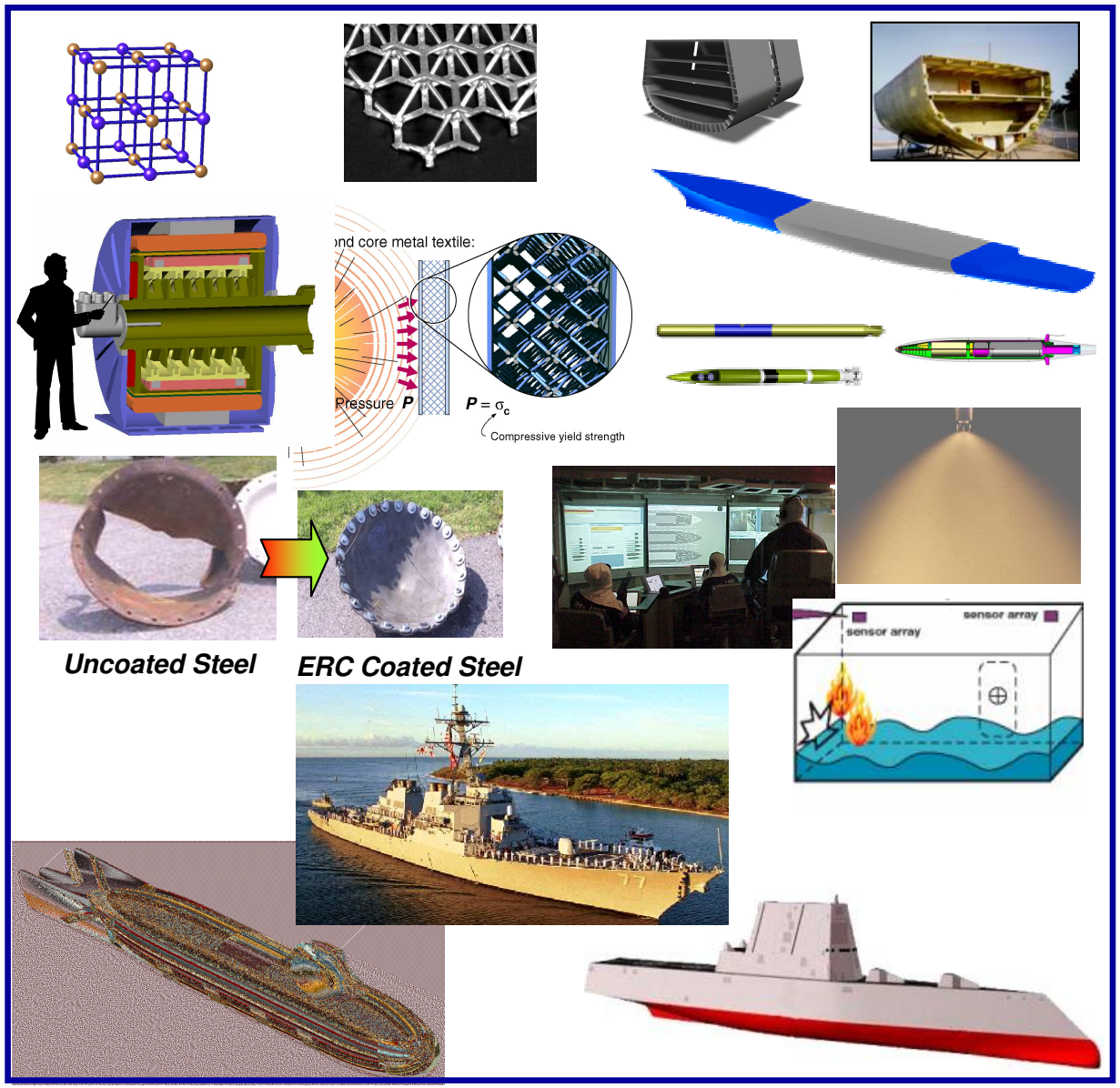
Engineering, Materials & Physical Sciences
Science & Technology Department



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Research Thrusts

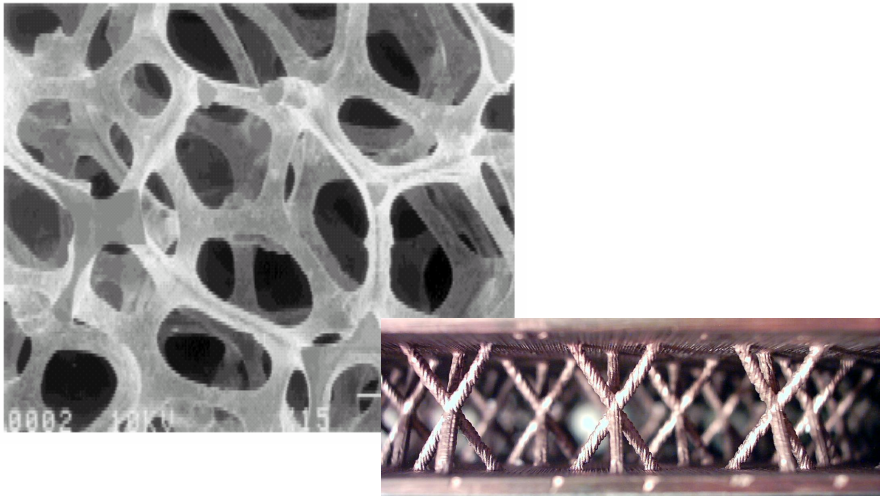
- Physical Sciences S&T Division (331)
  - Environmental Quality
  - Novel Power & Energy Transfer
  - Non-Linear Dynamics
- Materials S&T Division (332)
  - Structural Materials
  - Functional Materials
  - Maintenance Reduction Technologies
- Mechanics & Energy Conversion S&T Division (333)
  - Undersea 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

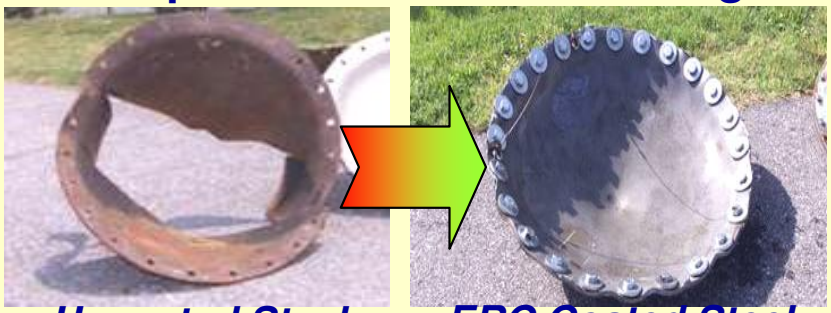
Outline

- Selected Science & Technology initiatives
  - Ø Ship Survivability
    - Shock and Blast Effects on Structures
    - Damage Control – Fire Suppression
  - Ø Weight Reduction
    - Materials and Welding
    - Jet Blast Deflector
  - Ø Reduced Maintenance
    - Single Tank Coating
    - Shafts and gearing
  - Ø Electric Warship
  - Ø Advanced Platform Demonstrators
  - Ø 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

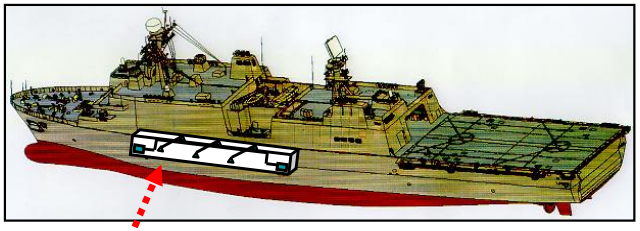
RSVP - CG61 Monterey

- 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

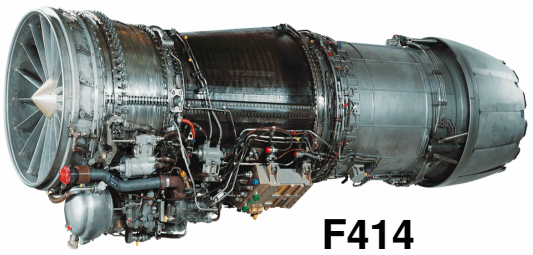
Next Steps

- **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

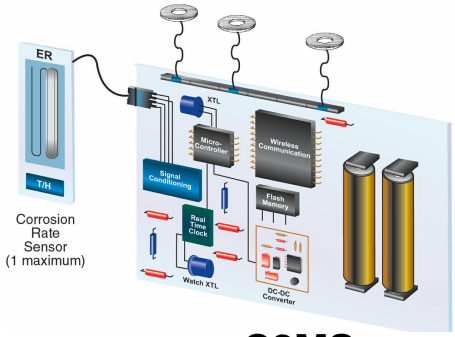
- Zero Maintenance Materials
- Prognostics for Smart Systems
- Marine Corrosion Control
- Affordable, Ready Turbine Engines



F414

Naval Impact

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



C2MS

Transition Opportunities

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

AAAV

Ship Tank Coatings

Product Description

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

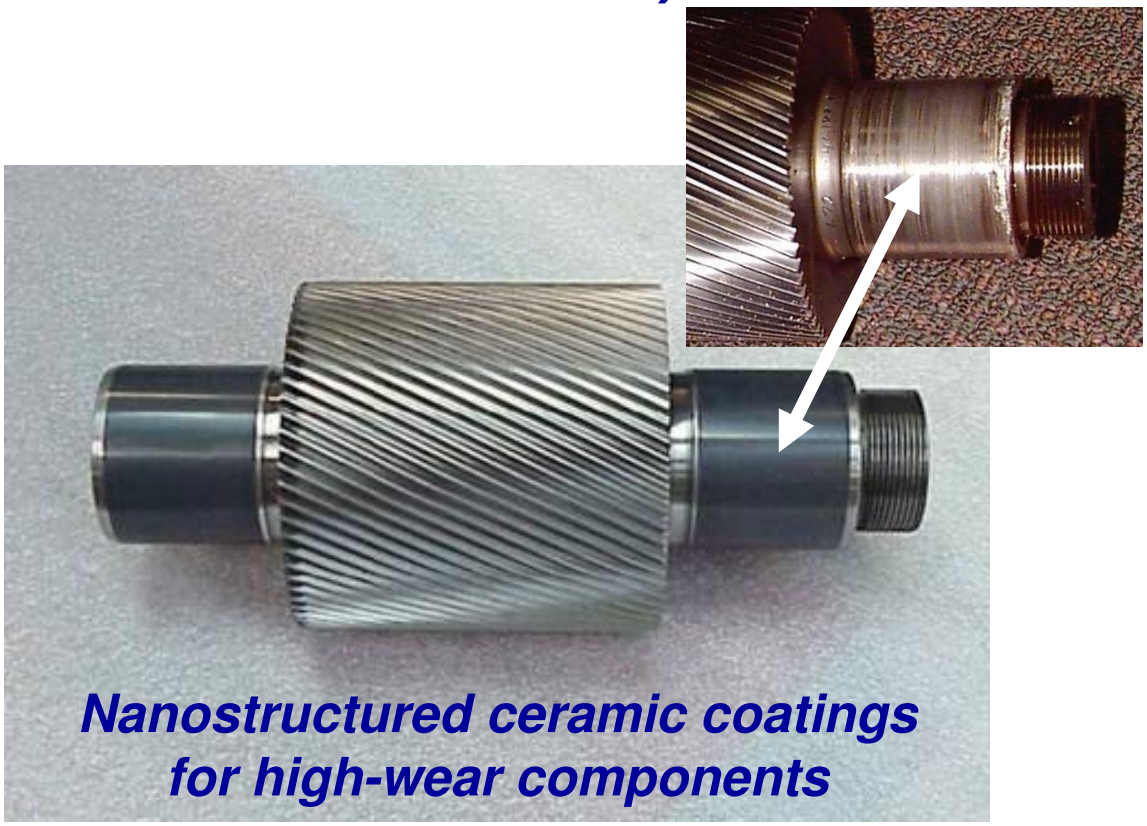
Payoff

- 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)



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

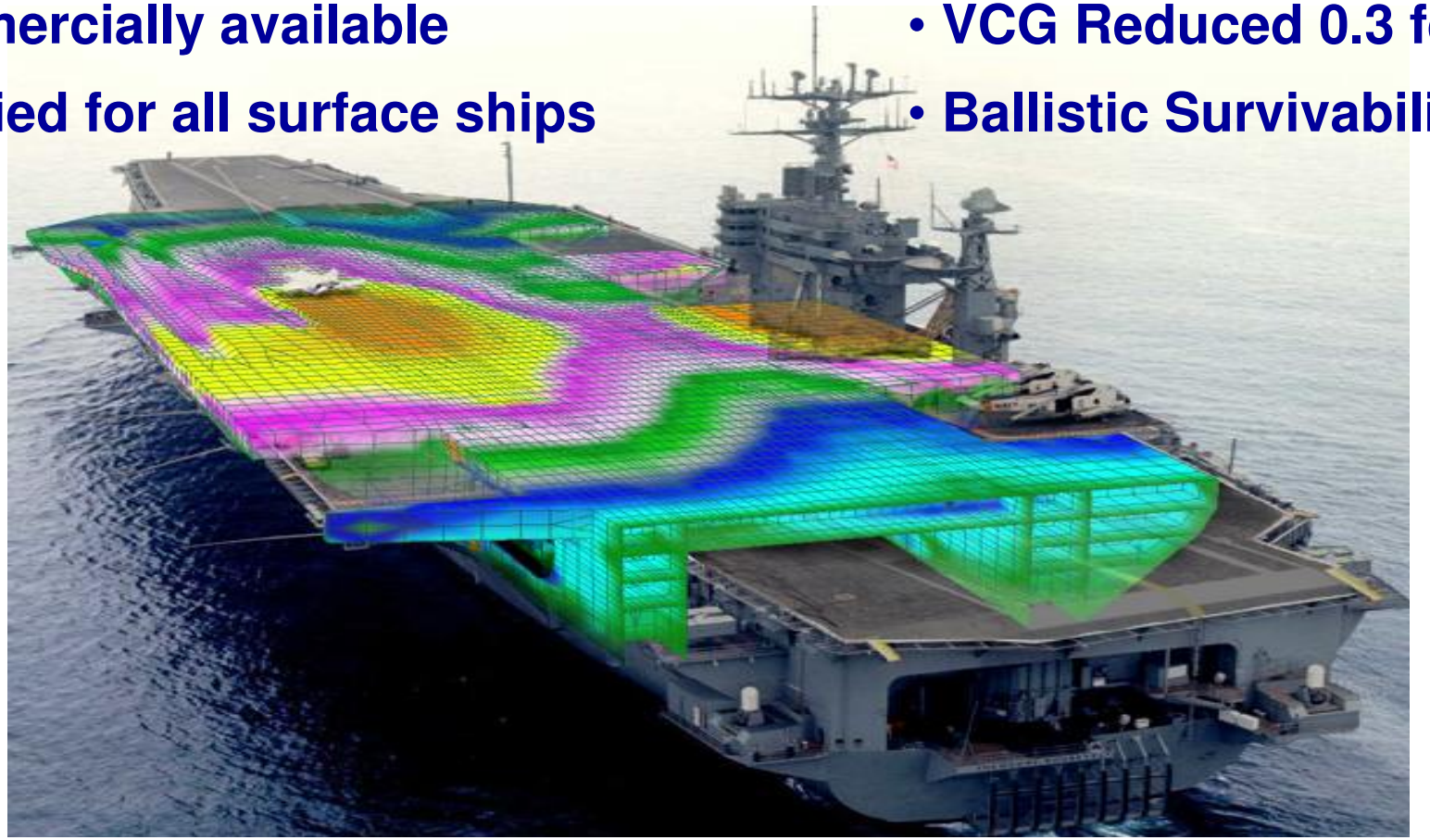
Advanced Steels

HSLA 65 Steel

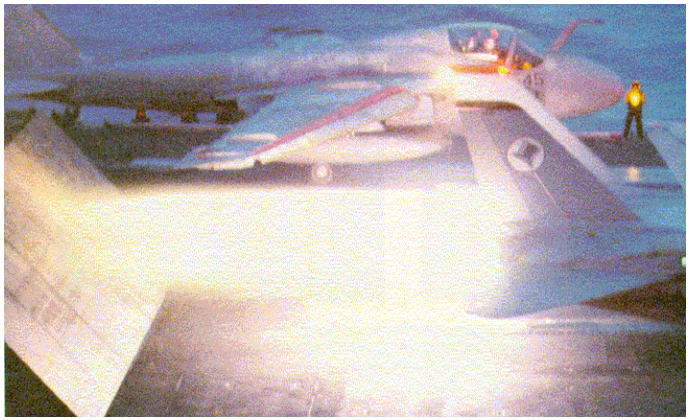
- Plate and structural shapes
- 800 L Ton Weight Savings
- Commercially available
- Certified for all surface ships

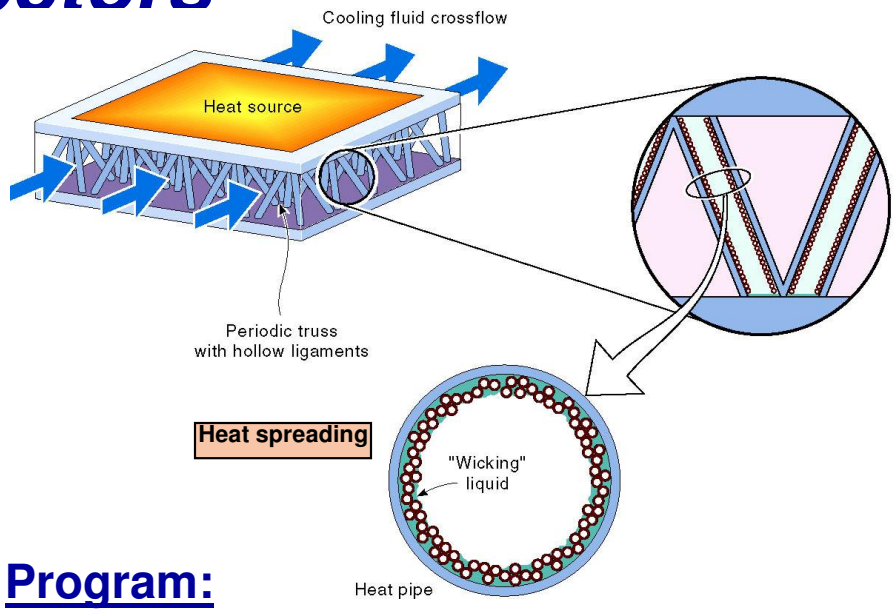
10-Ni Steels

- 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 ½ years
- ONR, DARPA, NNS, NAVAIR Lakehurst, UVA, RPI, MIT, CMI

Electric Warship

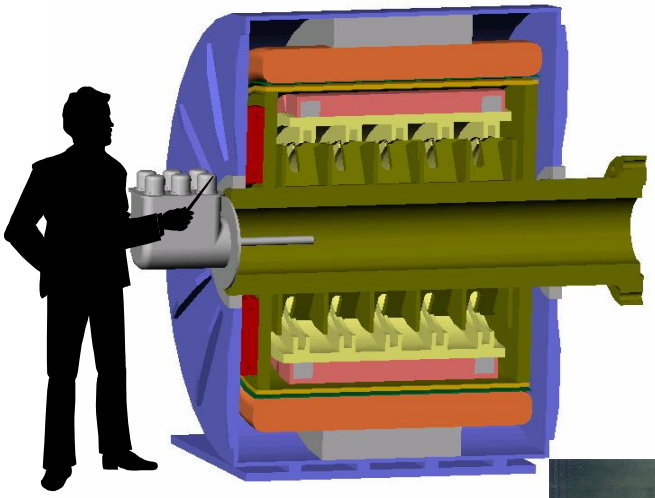
Developing the building blocks for future all-electric naval force.

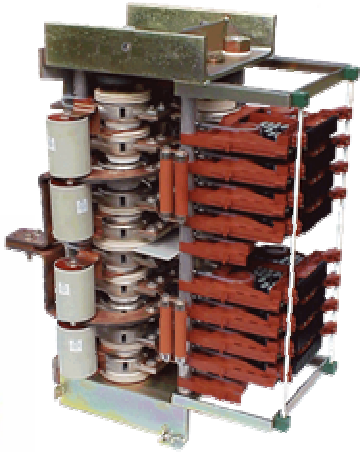
- Power Generation
- Energy Storage
- Control and Power Distribution
- Electric Weapons

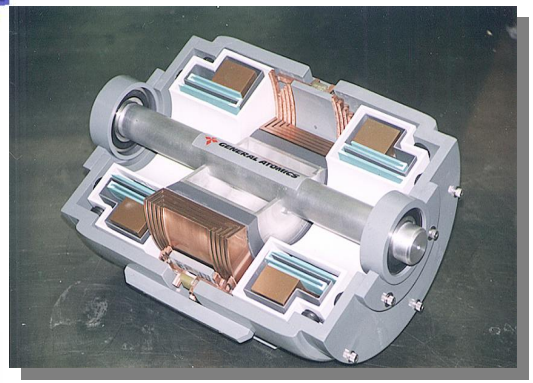
- **Focus:**
  - Increasing the power / energy density of component and machines
  - Developing distribution architectures using power electronics to allow dynamic reconfiguration and pulsed power loads
  - Improving rail gun life

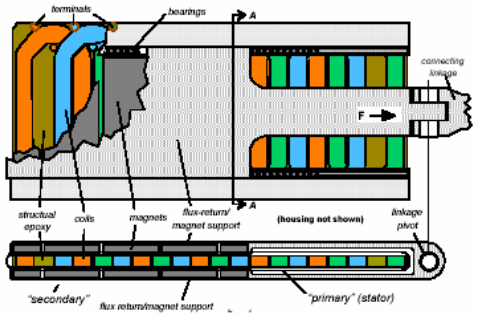
Electric Warship

- 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

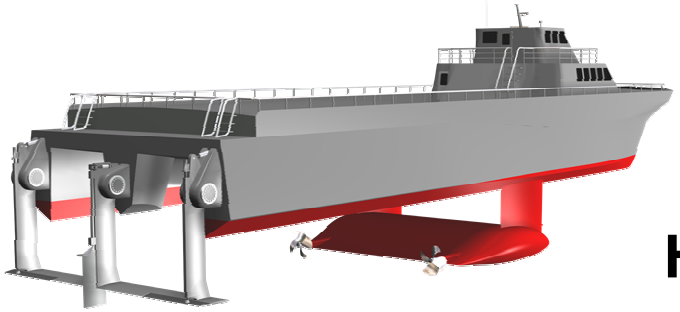








Advanced Platform Demonstrators

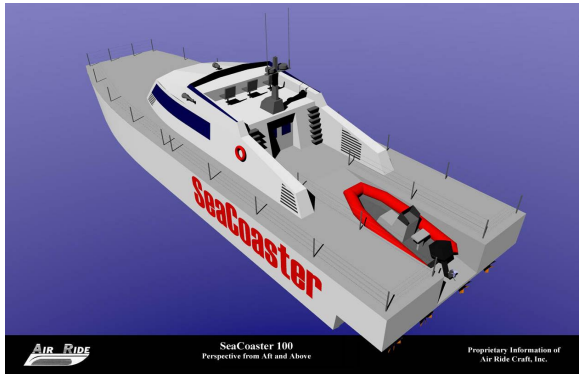


HYSWAC

HDV-100

SLICE

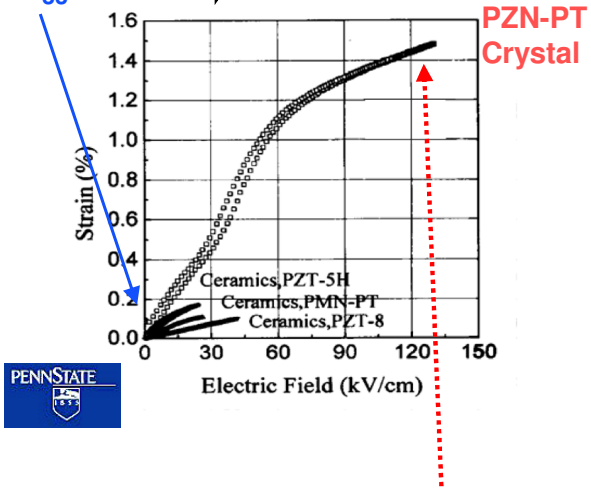
Small Water Craft Demonstrator



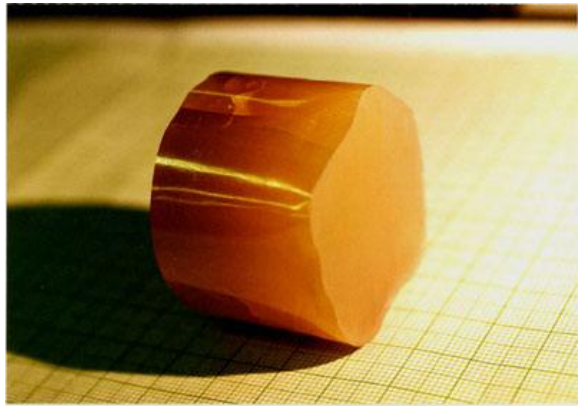
HS Cargo Vessel

PiezoCrystals

MINOR MIRACLE
k_{33}: 75% ➡ >90%

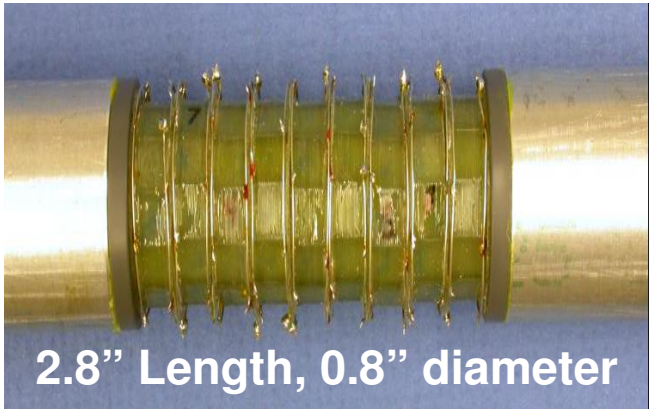


MAJOR MIRACLE
S: 0.1% ➡ >1.5%



HC Materials

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)