Development of Marine Thermoelectric Heat Recovery Systems

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Topics of Discussion

- **Why the integration of thermoelectrics into the marine industry would be beneficial for both parties**
- **Milestones accomplished by our research program**
- **Our first prototype TEG design and its potential integration into the industry**

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Same Problem, Greater Magnitude

- Have similar propulsion means, but marine has a much larger scale
- Larger Economies of Scale
- Heightened Port Restrictions and Engine Emissions Standards Imminent
- 90% of International Cargo Transported via ships

Top Picture Courtesy of MMA Public Relations
Bottom Picture Courtesy of "http://www.dssglobalsecurity.com/Featured_Solutions_PRW4.html"

Advantages of the Marine Industry

- Has the greatest consistent temperature differential
  - Exhaust and Sea Water
- The equipment is much larger and has greater throughputs
- Virtually no limitations on weight and space
- Has a myriad of potential waste heat recovery locations
- The ability to retrofit every vessel easily
  - Regardless of use of conventional waste heat recovery

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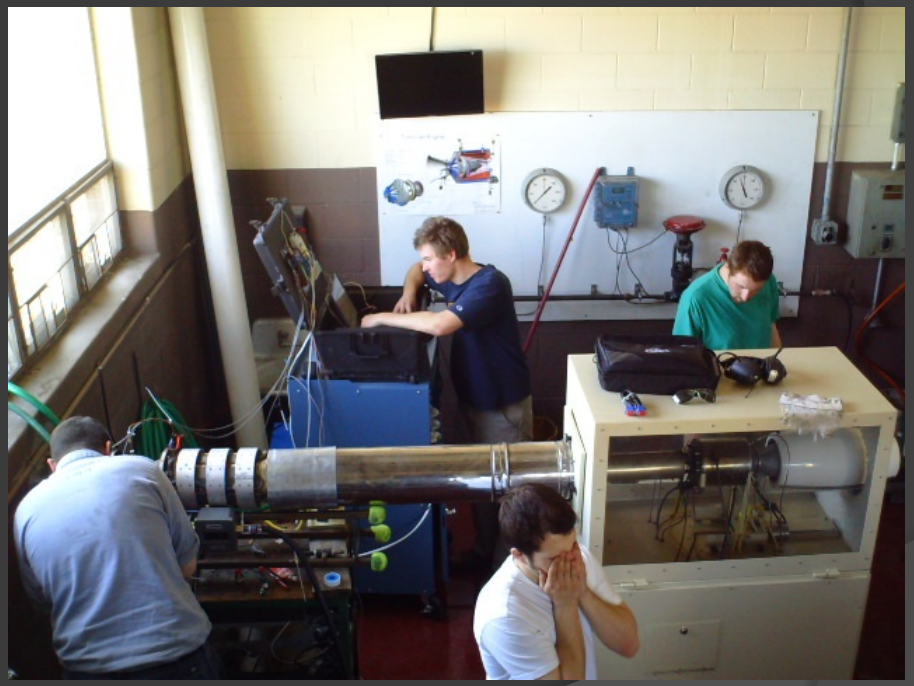
Origins - 2008

- Phase I – Mechanical Feasibility

R/V *Friendship*



SR30 Microturbine

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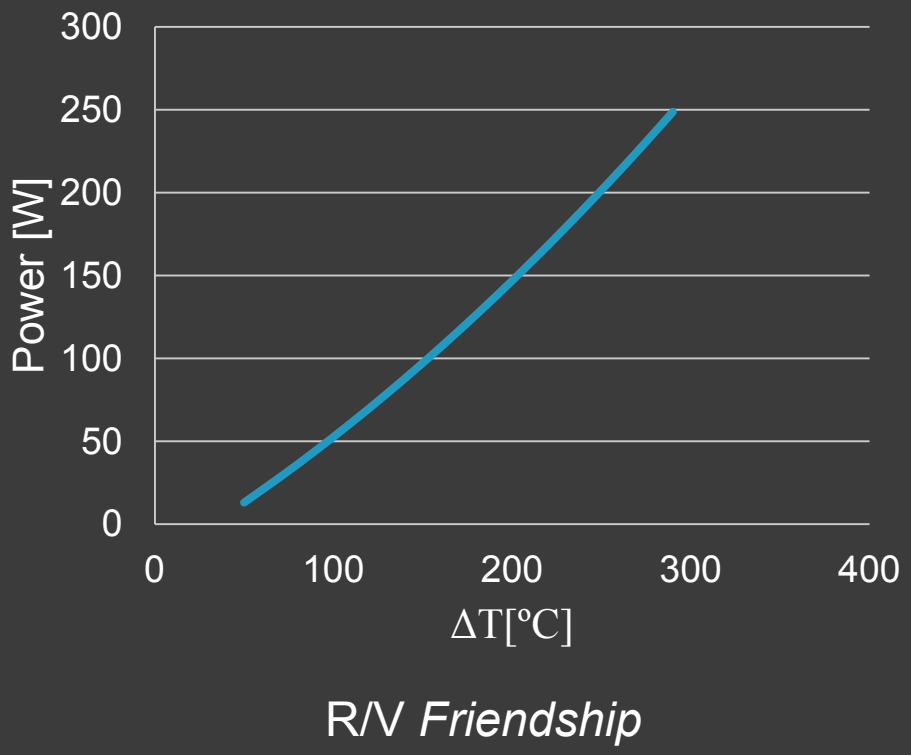
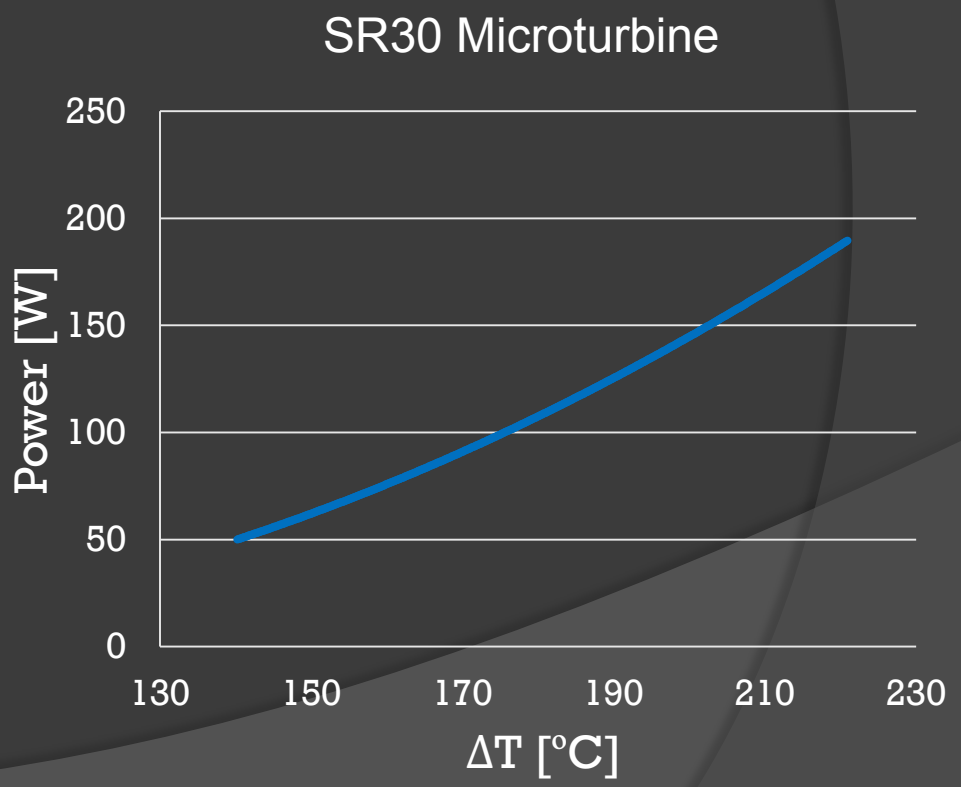
Origins - Data



R/V *Friendship*



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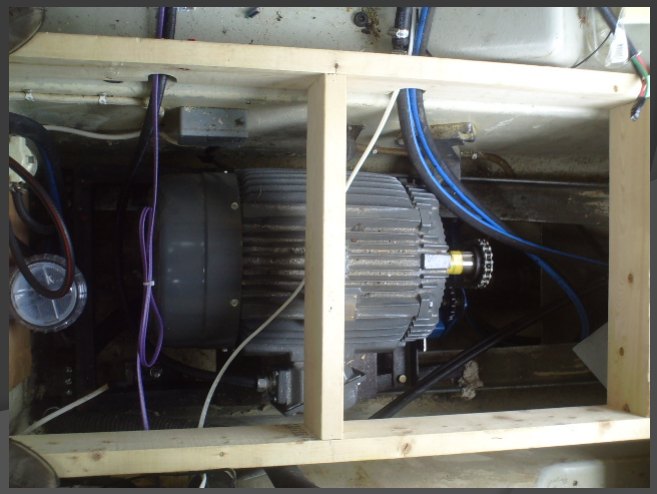
Thermoelectric Hybrid Vessel - 2010



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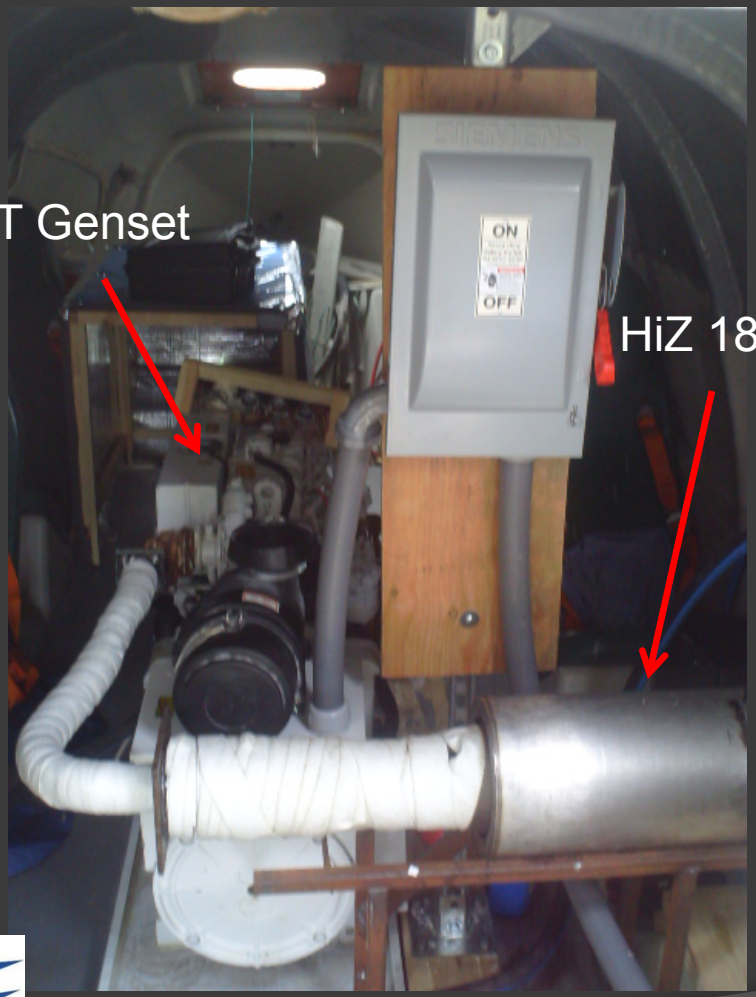
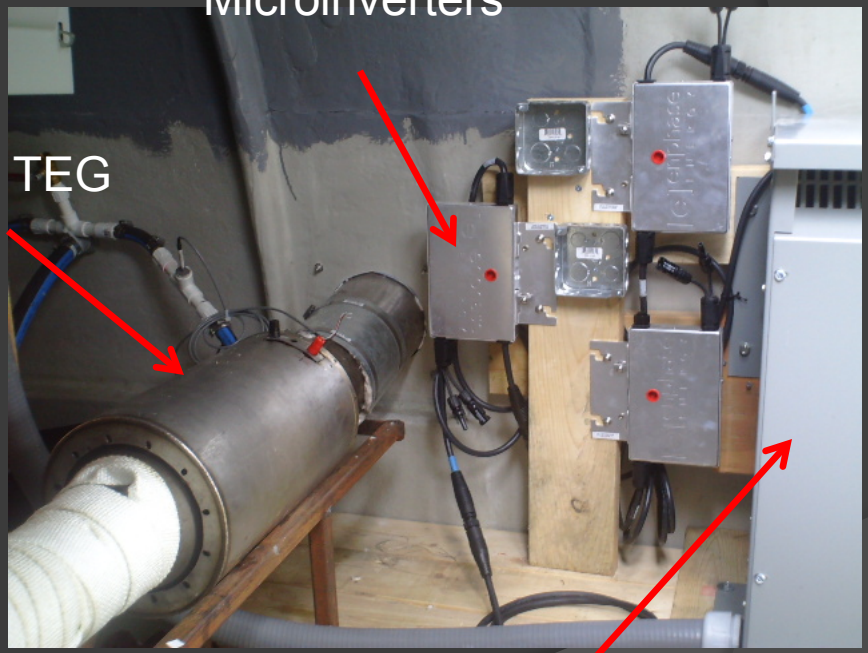
Inside the Vessel





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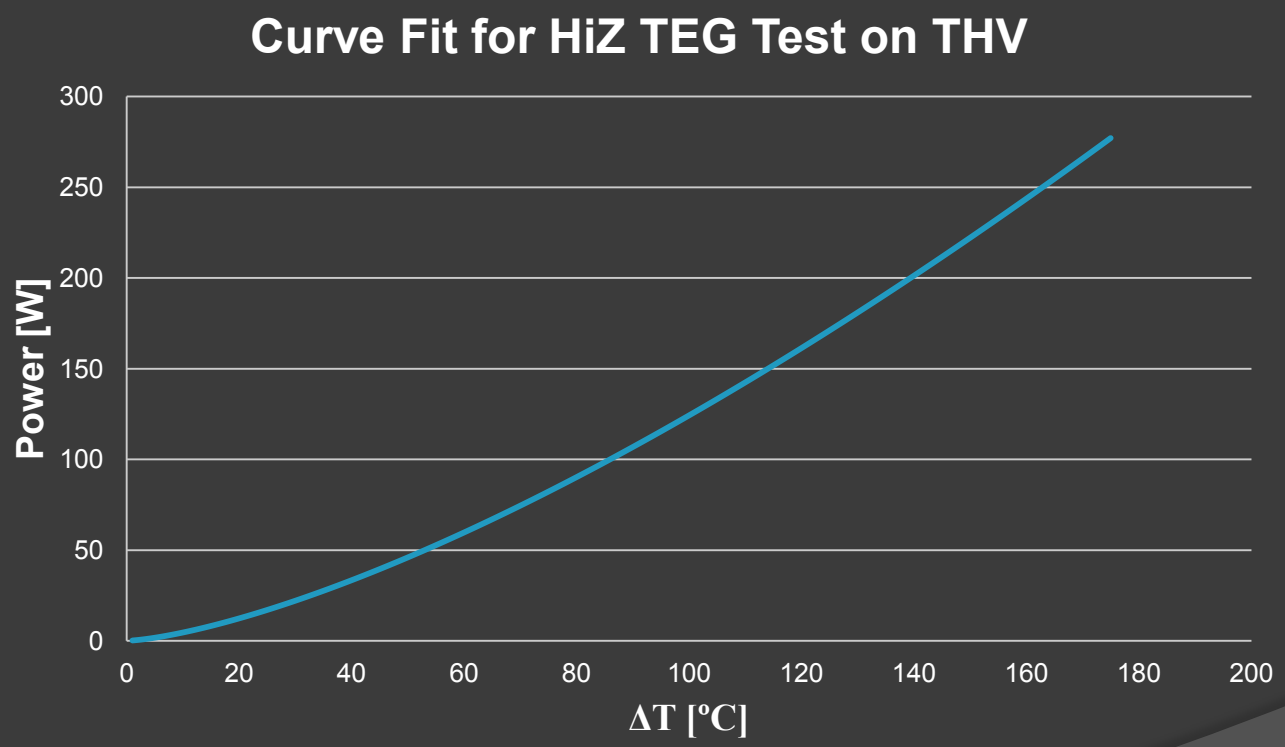
Baseline THV test



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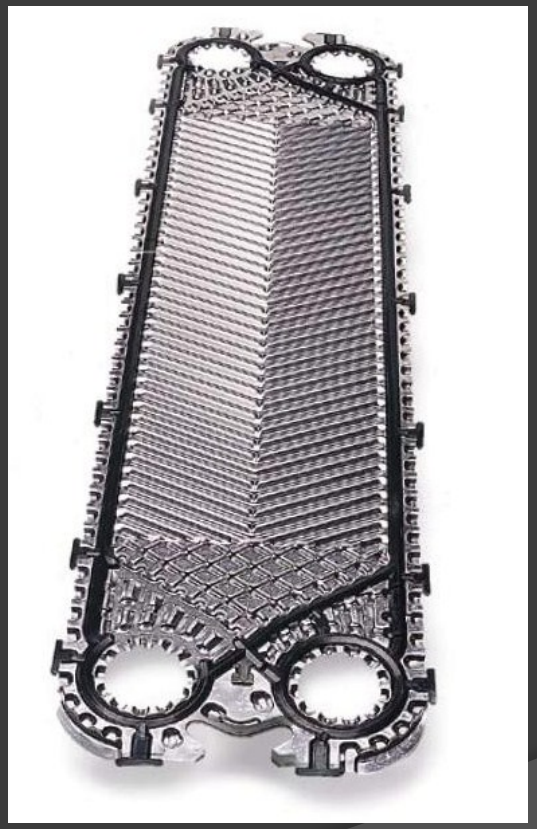
Creating a Marine Design



Source: Alfa Laval. "M3 Plate heat exchanger".

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Design Considerations

- Comparable to existing plate type heat exchanger design
- Will aid in engineer familiarity, so for a new technology, it will reduce maintenance down time
  - Plate replacements
  - Cleaning

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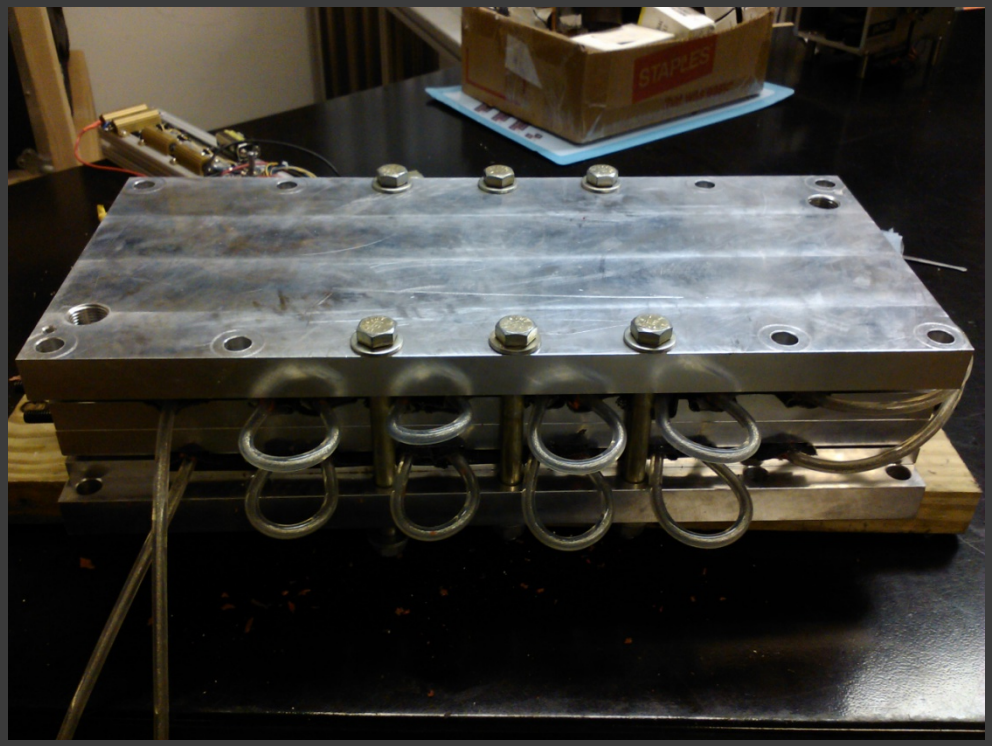
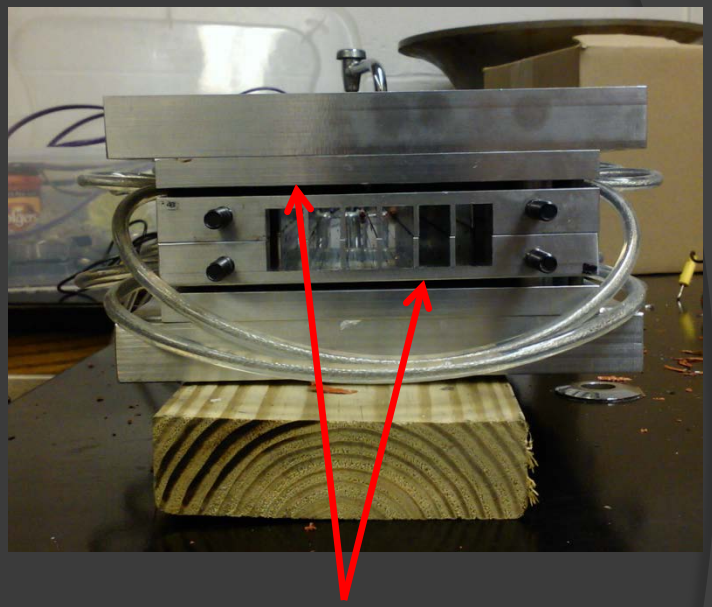
Thermoelectric Power Systems TEG





20 HZ14 Bismuth Telluride modules from Hi-Z Technology, Inc.

- Machined at the Advanced Manufacturing Center at the University of Maine

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Future Work

- Test and Evaluate the prototype TEG
  - THV to be put in water this week
- Use test data to validate existing models
  - Modify models to incorporate different plate surfaces
- Scale to larger vessel applications

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Acknowledgments

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