

Application of smart materials in energy recovery. Energy harvesting

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APPLICATION OF SMART MATERIALS IN ENERGY RECOVERY. ENERGY HARVESTING

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Outline

- Introduction - energy harvesting
- Smart magnetic materials - properties and applications
- Energy harvesting - development magnetostrictive harvesters and examples of applications



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Introduction

- How to supply wireless sensor, microcontrollers, actuators, autonomus sytems ,... ?

Source of energy:

- Accumulated
 - battery, gasoline, hydrogen, ...
- Environment
 - solar, wind, water, temperature gradients





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Idea for Mechanical Energy Harvesting

- How to convert „free energy”/vibrations - idea for scavenging energy ?
- Smart materials - cross effects
 - Piezoelectric
 - Giant magnetostrictive materials (Terfenol-D, NiMnGa) and magneto-mechanical effects

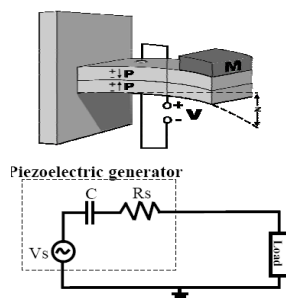


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Typical energy conversion systems

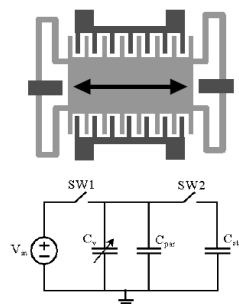
Piezoelectric

Strain in piezoelectric material causes a charge separation (voltage across capacitor)



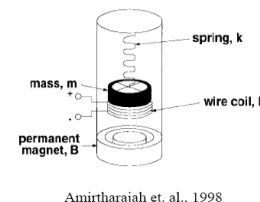
Capacitive

Change in capacitance causes either voltage or charge increase.



Inductive

Coil moves through magnetic field causing current in wire.



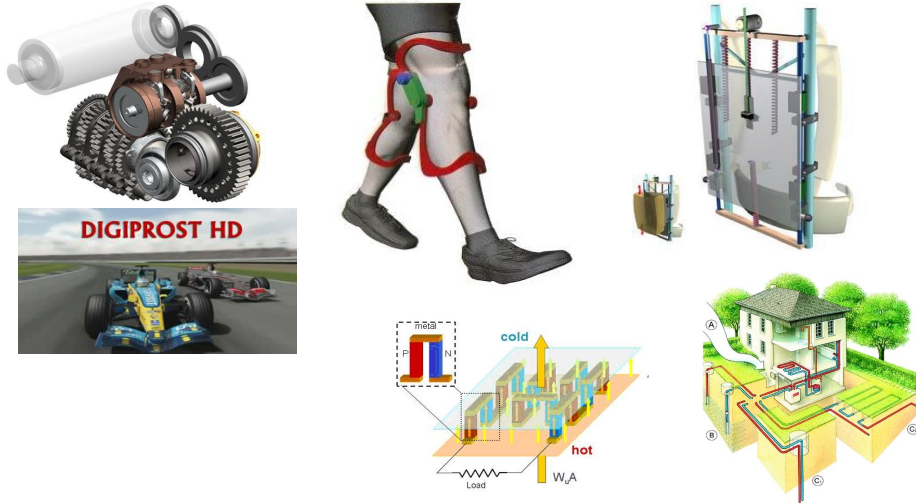
Amirtharajah et. al., 1998

Shad Roundy- Energy Scavenging for Wireless Sensor Nodes with a Focus on Vibration-to-Electricity Conversion



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New applications



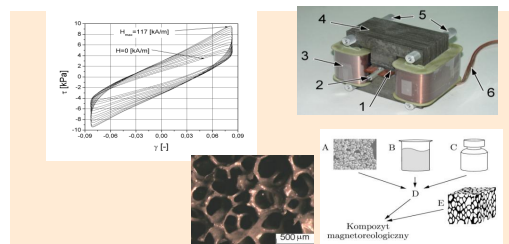
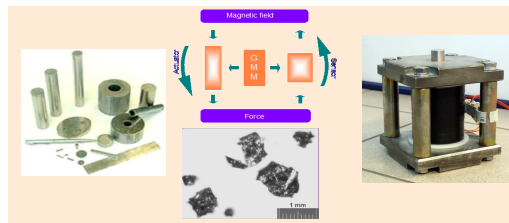
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OUR INVESTIGATIONS

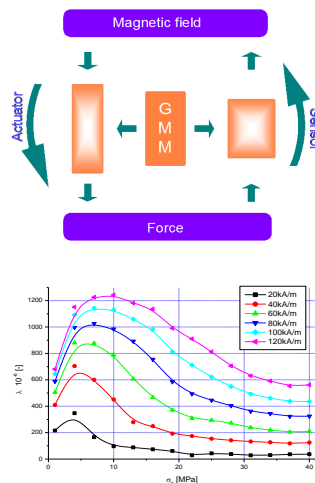
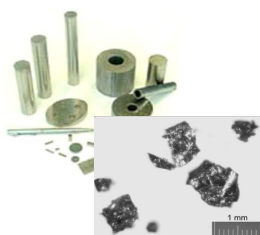
SMART magnetic materials and adaptronic structures

Research and development:

- Giant magnetostrictive materials (Terfenol-D, NiMgGa),
- Giant magnetocaloric materials (lanthanides),
- Magnetorheological materials:
 - ✓ Ferrofluids,
 - ✓ Magnetorheological fluids,
 - ✓ Magnetorheological composites.



Giant Magnetostrictive Materials





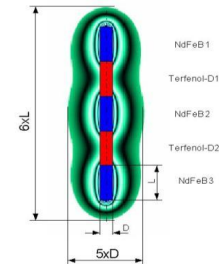
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SMART materials in energy harvesting

Our ideas for energy harvesting:

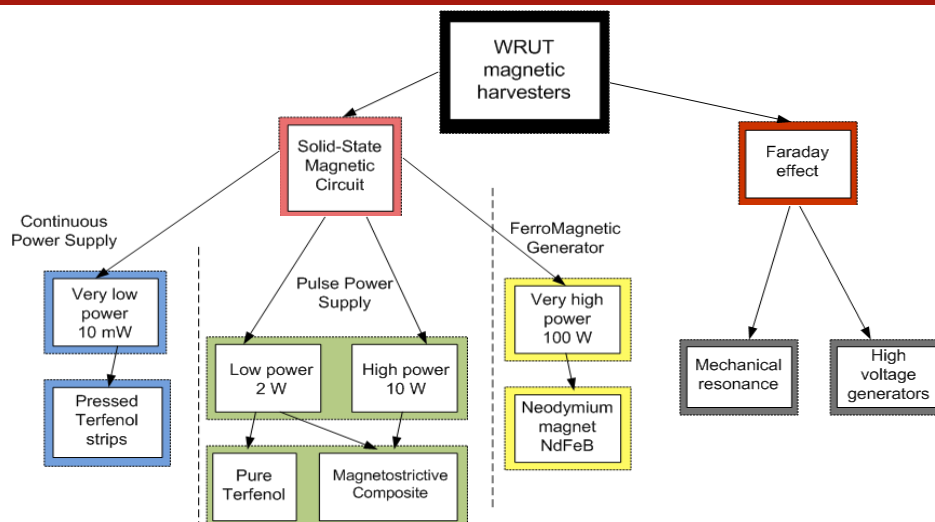
- Physical effects:
 - vibrations,
 - mechanical impact.

- Effects in SMART Magnetic Materials:
 - giant magnetostriction,
 - demagnetization of neodymium magnets,
 - change in shape (Shape memory alloys),
 - giant magnetoresistivity

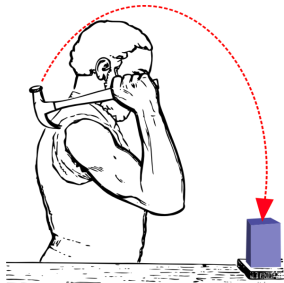


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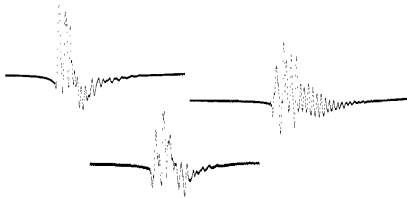
Overview of WRUT magnetic energy harvesters



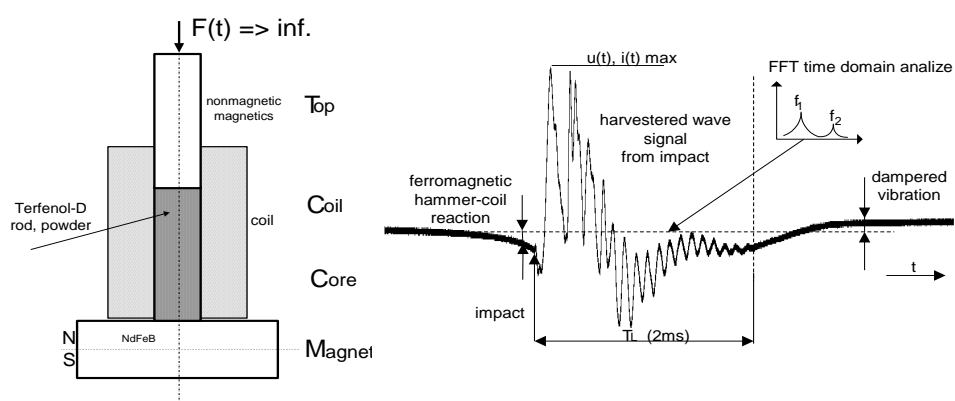
Impulse generation energy



- big amount of energy at short time
- single shoot
- different than vibration/resonance method



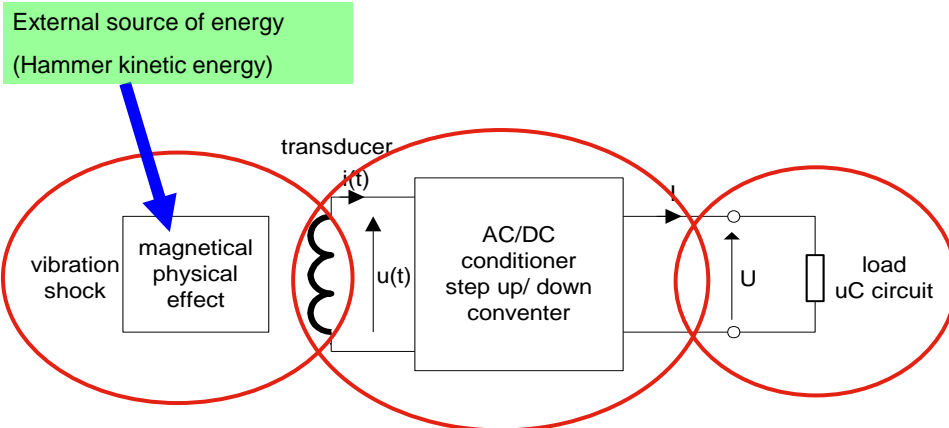
Prototype of EHD - Top Core Coil Magnet





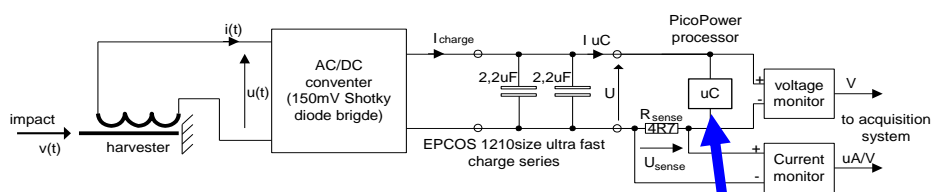
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Conceptual schema of Energy Harvesting Device (EHD)



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Application of EHD for supply uC node

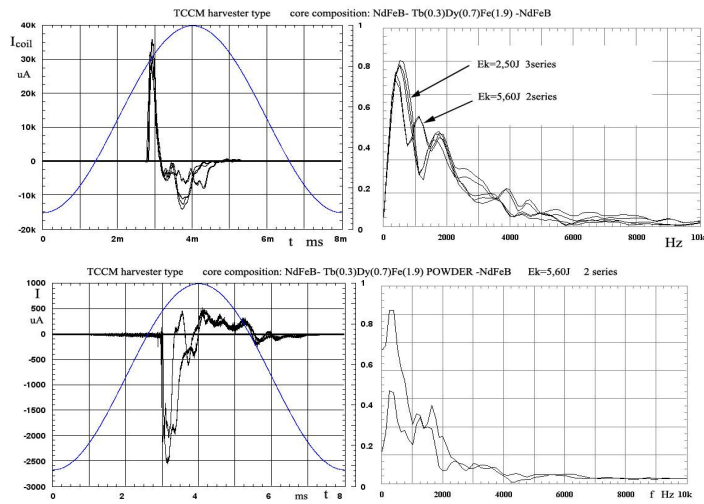


uC - ATmega48V
1.8 - 5.5 Volt supply



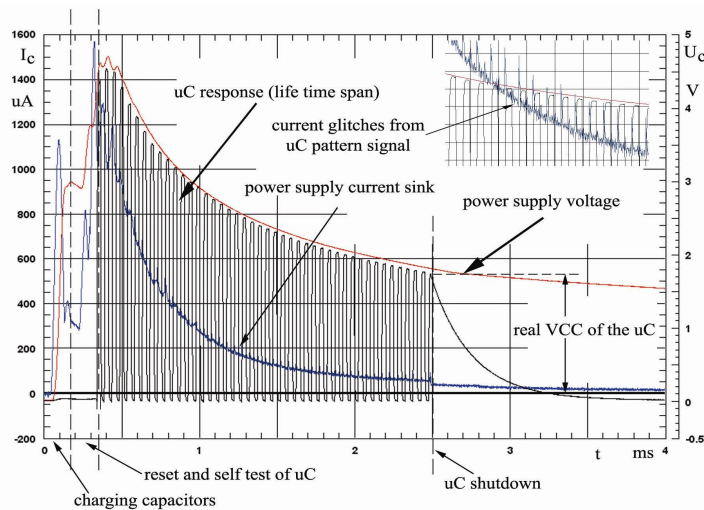
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Core composition: Terfenol-D



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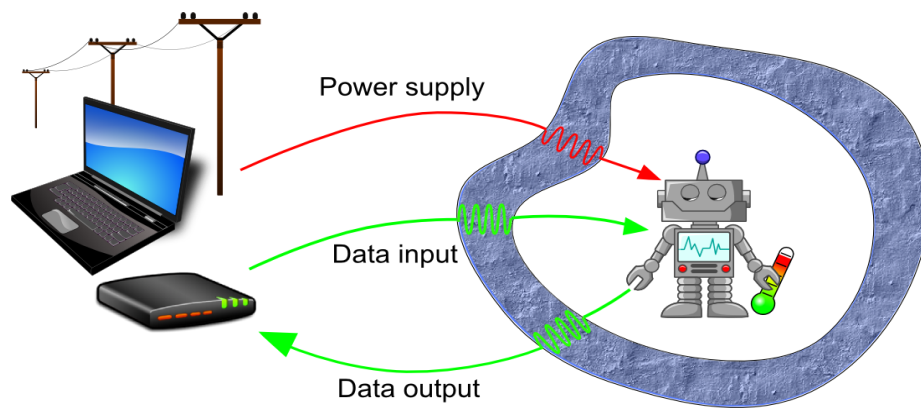
uC supplying from impulse





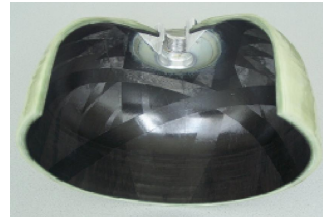
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Power and data transmission for isolated systems



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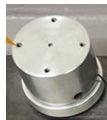
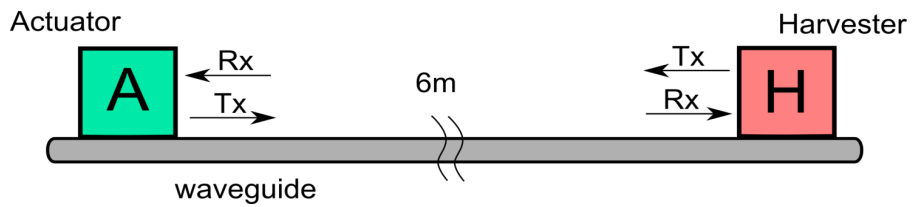
High pressure vessels and Structural Health Monitoring





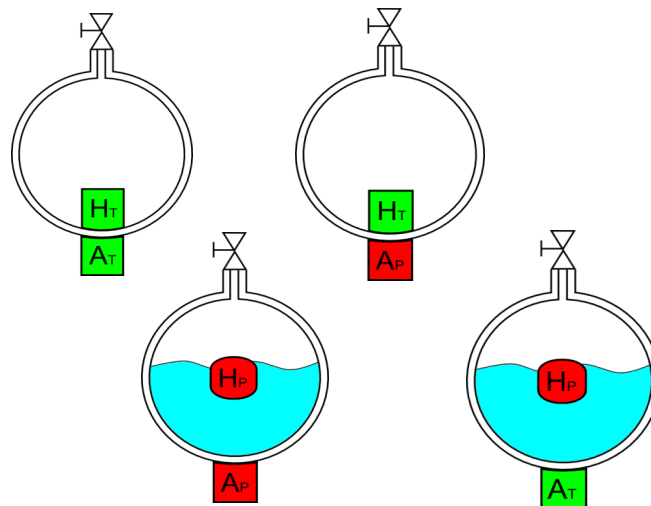
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Idea of power and data transmission between actuator and harvester



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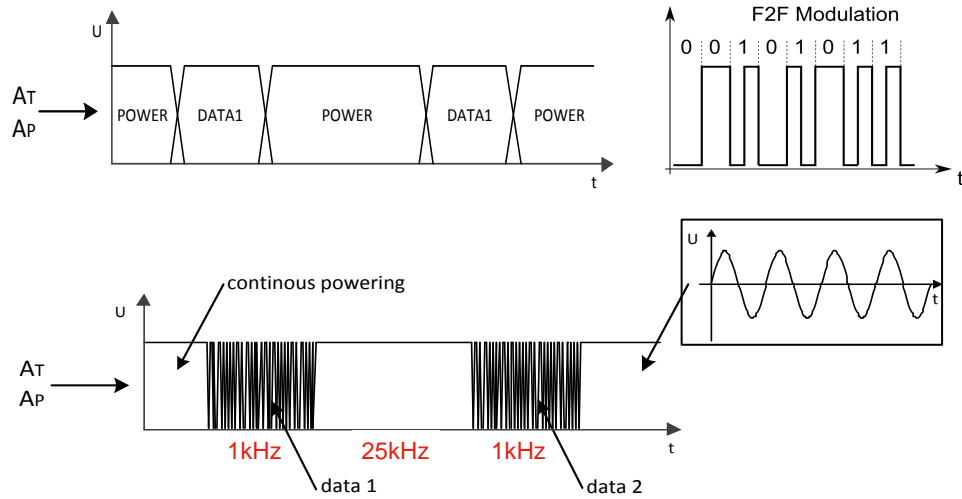
Configuration A<->H for closed containers





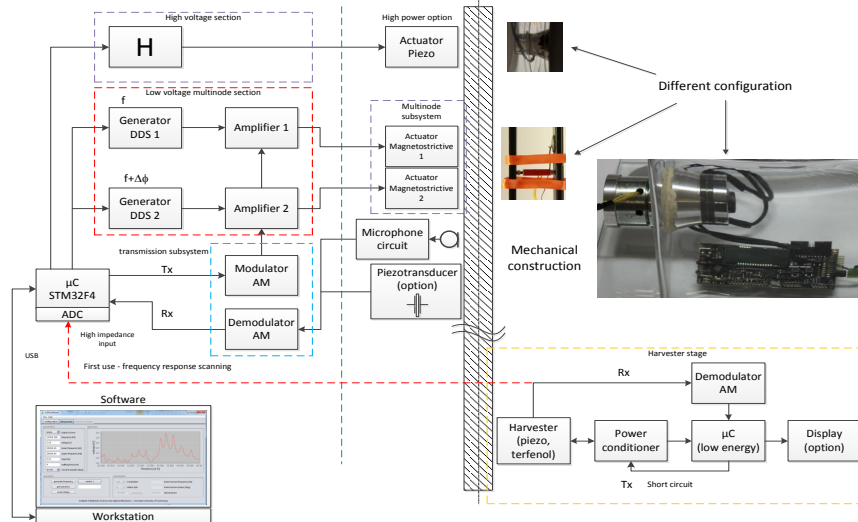
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Idea of data transmission to Harvesting Node Tx



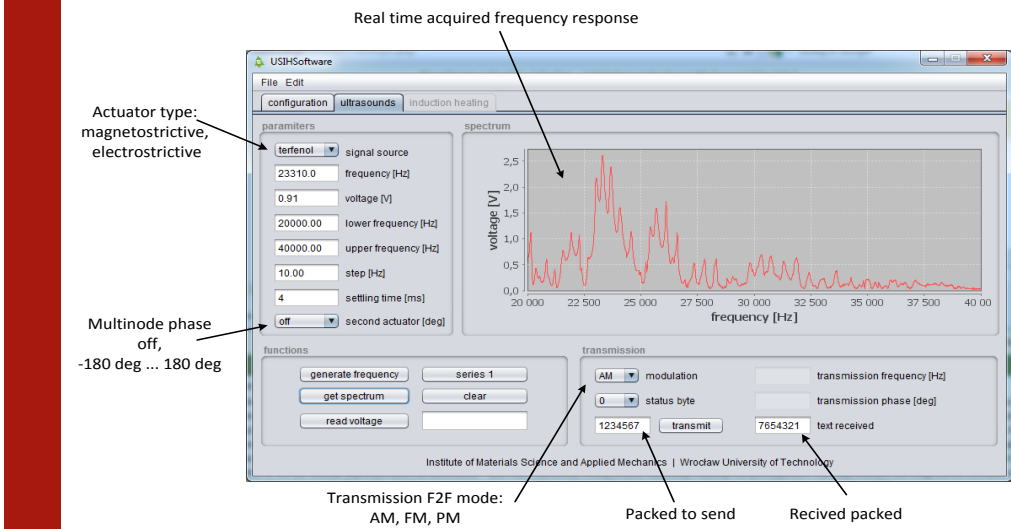
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Block diagram of the position of the transmission of electrical power and data

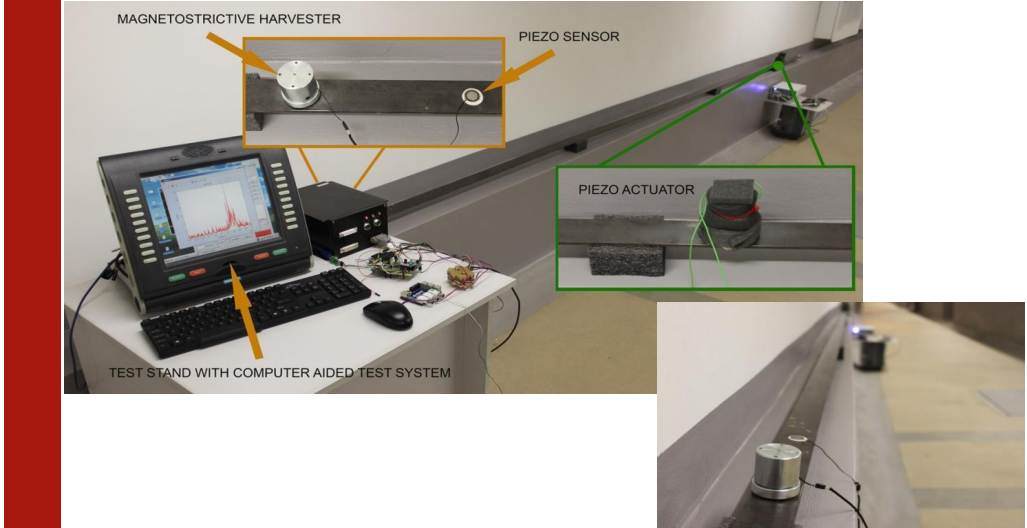




The software actuator-harvester coupled systems



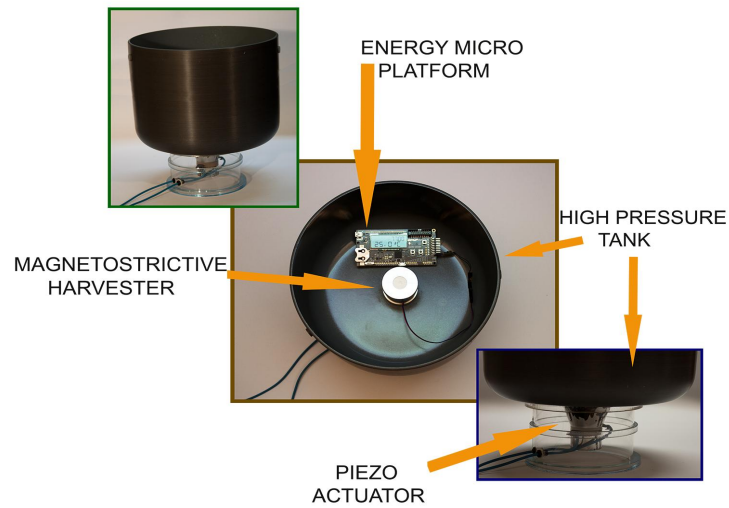
Power supply μ C system by ultrasonic wave on the single rail length 6m (AP \rightarrow HT)





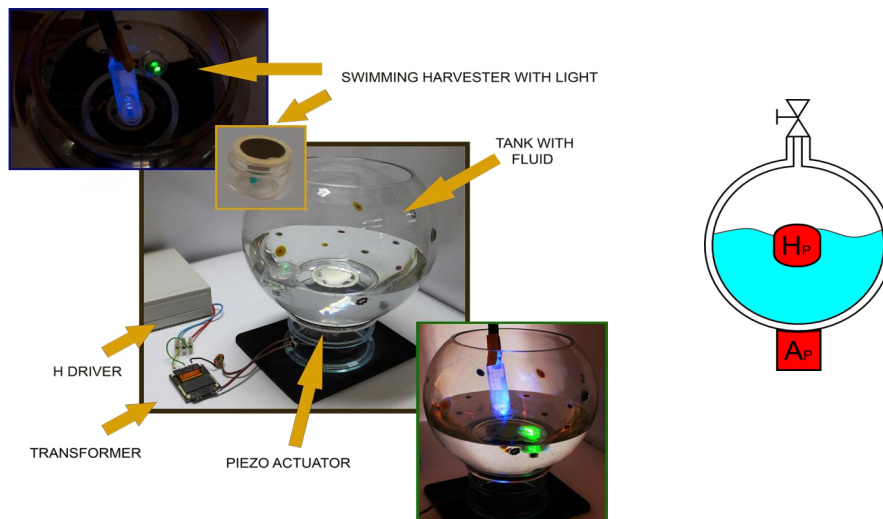
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Power and data transmission through the aluminium wall of the high pressure vessel



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Power supplied floating energy harvester systems by the vibrations in the glass vessel





Thank you for your attention