



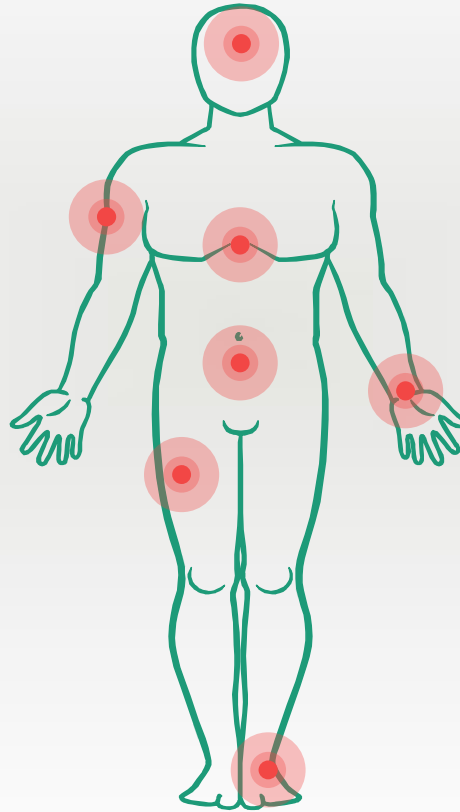
Human Applications

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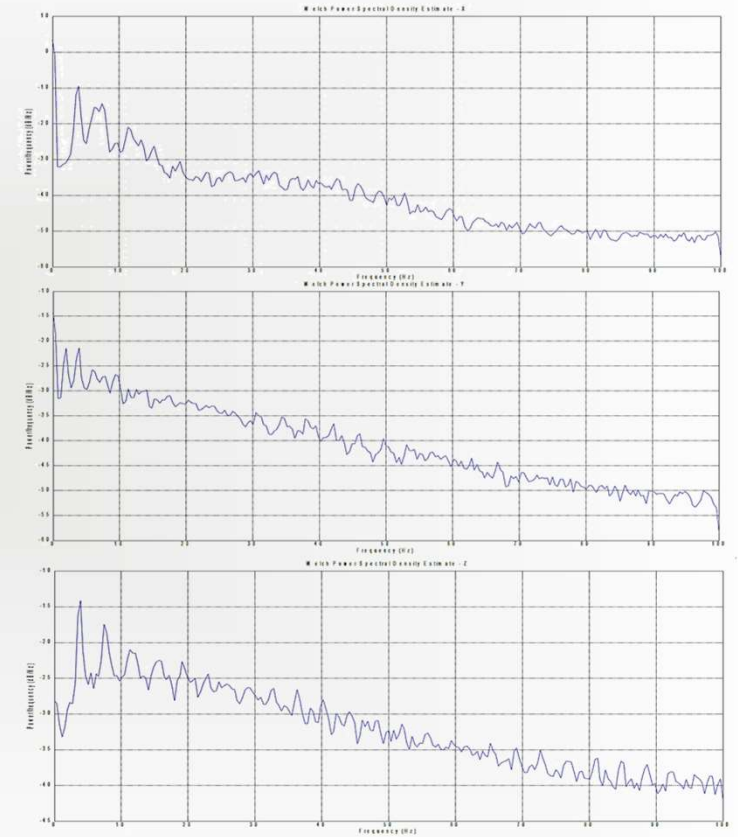
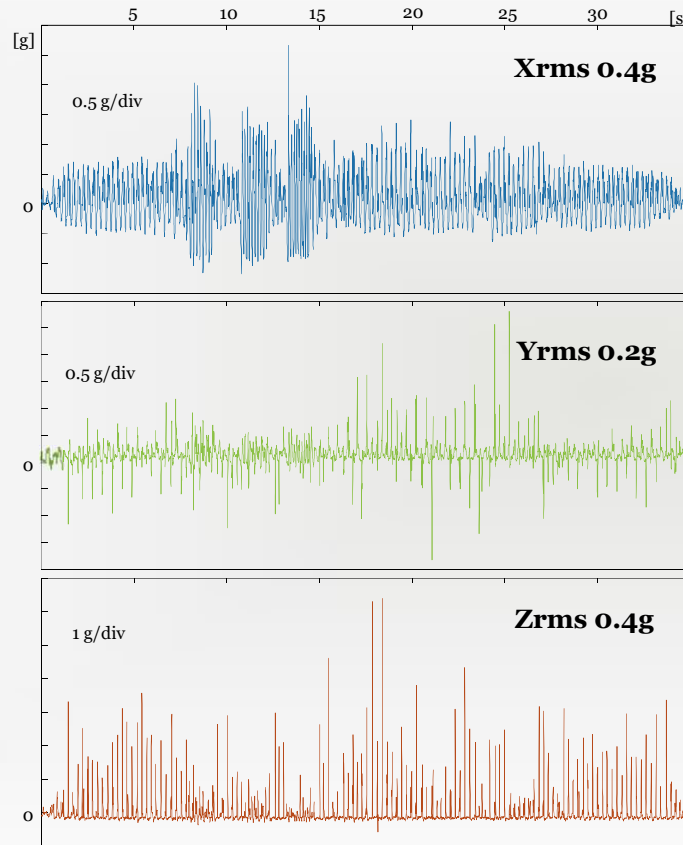
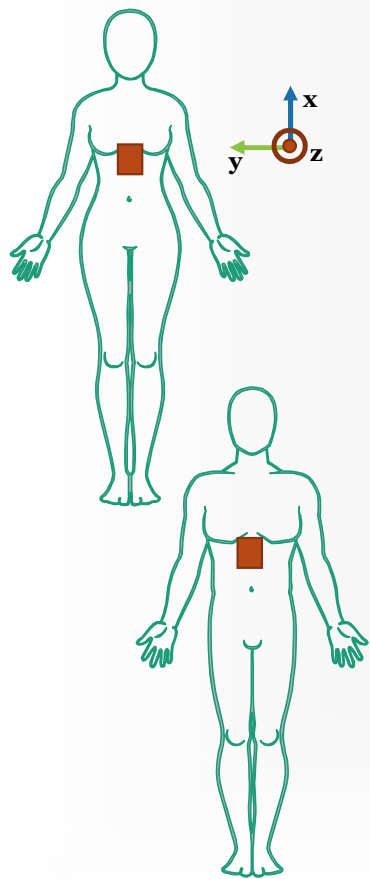
Human Energy

The energy that can be harvested from human body movement depends from many variables





Human Energy





Possible applications

Operators / Employees Tracking System in office

- Operators / Employees location and tracking analysis
- Touch-less access control



School Kids Tracking System

- School Kids watching
- Email information to parents during walking to school / home.



Alarming for Off-limits area

- Detection of off-limits area and equipment

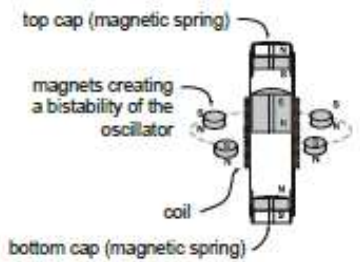


Elderly Tracking System

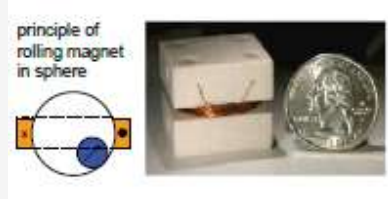
- Elderly watching inside and outside house



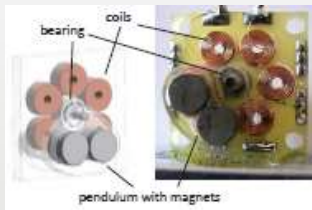
Body Movement Harvesting



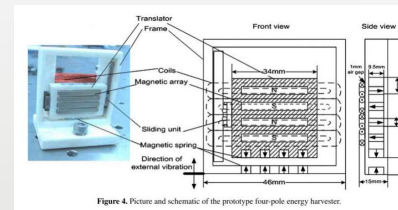
Mann and Owens,
J. Sound Vib. , 2010.



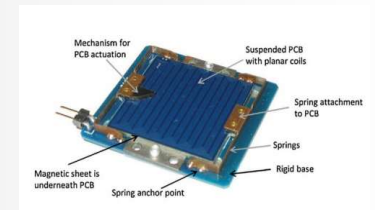
Bowers and Arnold, JMM, 2009.



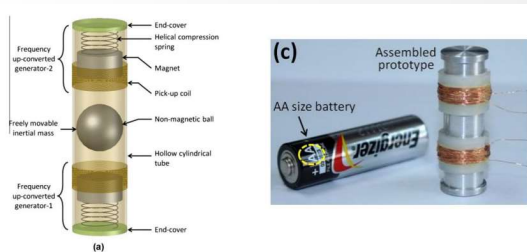
Spreemann, Manoli,
Folkmer and Mintenbeck,
JMM, 2006.



Cheng and Arnold, JMM, 2010



Roundy and Takahashi,
Sensors & Actuators, 2013



Miah and Park,
Energy Conversion & Management,
2015

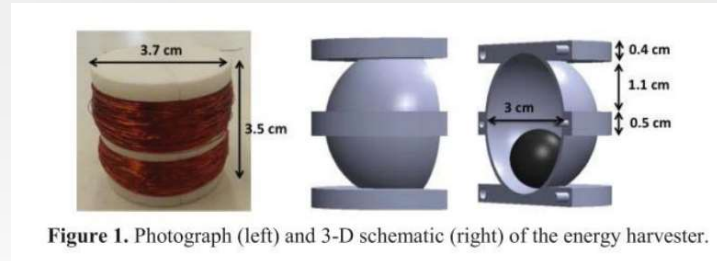


Figure 1. Photograph (left) and 3-D schematic (right) of the energy harvester.

Rao et. al., PowerMEMS, 2013

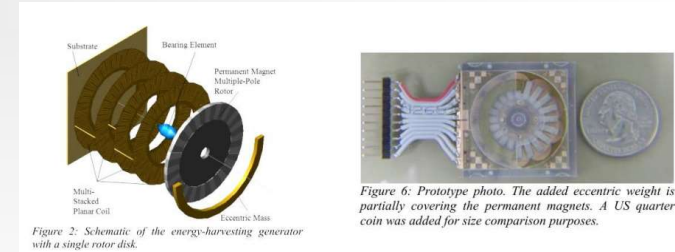


Figure 2: Schematic of the energy-harvesting generator with a single rotor disk.

Romero et. al., IEEE MEMS, 2011

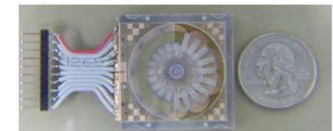


Figure 6: Prototype photo. The added eccentric weight is partially covering the permanent magnets. A US quarter coin is added for size comparison purposes.

Wearable power supply

<http://www.getampy.com>



“An hour of exercise can produce up to 1 hour smart phone battery life.”

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Wearable power supply

Miniature Technology, Infinite World



<http://www.star-m.jp/eng>

EH12
Approx. 5Hz
37x25x8 mm
Approx 12g
Approx 2.6 mW / at 0.1 G



EH12

<http://www.star-m.jp/eng/products/develop/de02.html>





Wearable device



Feature

- Product to support IoT solution and Industry 4.0
- Energy harvested with walking motion
- Beacon without battery inside the device
- Signal transmitted with a built-in wireless communication module
- Small size, light weight and water resistance

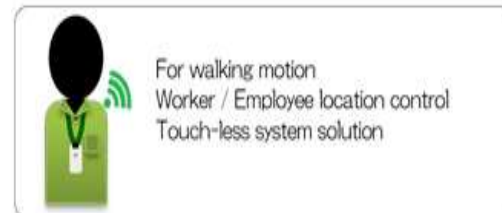
Item	Specification
Model	EB10-B / EB10-E
Frequency response	Approx. 5Hz
Outer dimensions	48 x 28 x 15mm
Weight	Approx. 20 g
Wireless protocol	BLE / EnOcean



Feature

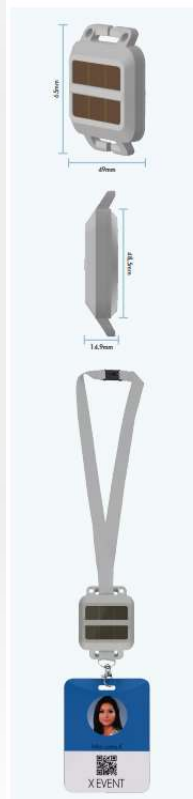
- Card type thinner beacon without battery inside the device
- It works as an active Company Entrance Card and looks very natural
- Solution tool for People Tracking System in office

Item	Specification
Model	EB20
Frequency response	Approx. 5Hz
Outer dimensions	54 x 85.6 x 5mm
Weight	Approx. 20 g
Wireless protocol	BLE





Wearable device



BLUbadge

Environmentally Powered Attendee Tracking solution for Events and Meetings

No batteries required. RFID & Bluetooth. Indefinite lifespan using just kinetic and solar. (Patent pending).

The ePower™ BLUbadge provides a reliable, cost effective Attendee Tracking solution for Events and Meetings. Designed for use in all typical high value locations such as: Session/Meeting Rooms, Exhibitor Booths, Entry/Exits and other public areas.

Generates clean energy from the environment around it to power Passive UHF RFID or Low Energy Bluetooth (BT LE) communications. No batteries to replace or dispose of every couple days. Includes an Indoor Light harvesting system, a Kinetic harvesting system and power management.



Features

- Generates clean energy from the environment
- No batteries to replace or dispose of
- Boosted Passive RFID Range (12 - 20ft)
- Bluetooth LE Beacon for greater reliability and range
- Uses Indoor and low light energy >100 lux, and movement for power
- Full recharge in as little as 4 seconds
- Programmable Microcontroller allows you to manage power and communications
- Designed to hold industry standard ID badges
- EPC Gen 2 Passive RFID Tags for easy configuration and management.



Specifications

- Dimensions 65mm x 48.5mm x 14.9mm/0.59in / 2.5in x 1.9in x0.59in
- Weight 25g / 0.88oz
- Min. light levels 100 lux
- Bluetooth Beacon Transmission rate: Approx. 2-14 second intervals



Related Products

The following products close the loop when designing and deploying solutions

- RFID Scanner
- Bluetooth BLE Scanners
- Mesh Network for greater reliability and flexibility in deciding where to deploy scanners

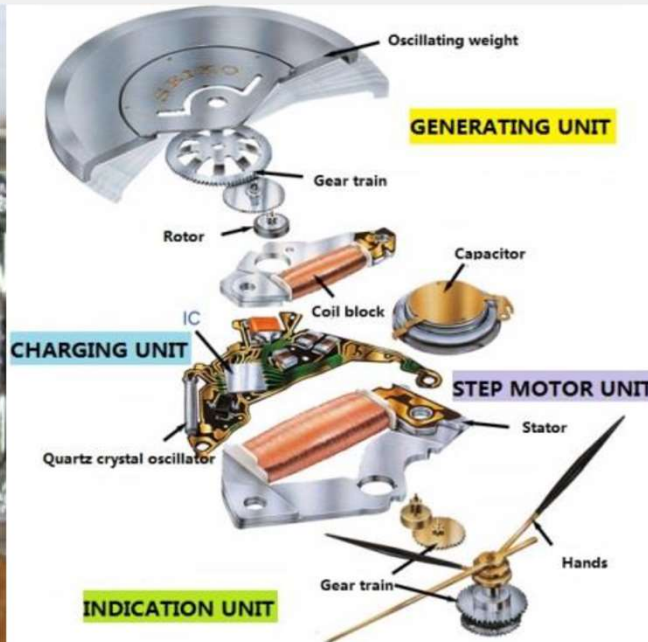
For more information contact:

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epower@abts.com | (305) 865-4380 ext. 119

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Wearable device



5-10 μW average
Mitcheson, 2010
Paradiso and Starner,
2005



Wearable device



Apple WATCH



Apple WATCH SPORT



Apple WATCH EDITION

- Apple Watch** (38 mm version)
- Battery: 205 mAh, 3.6 V = 738 J
 - Lifetime: 5 –18 hrs → 14 –41 mW
 - 14 –41 mW average power draw



Wearable device

There is about 1 order of magnitude gap between what current and research devices provide ($\sim 10 \text{ uW}$) and what wearable systems need ($\sim 100 \text{ uW}$).



Wearable device

USB connector is integrated into the shoe upper



Electronics suite is integrated into the shoe sole and can be indefinitely powered by the harvester

Harvester Specifications

Power output (per one shoe)	1 W (nominal) 10 to 15 W (peak)
Voltage	9 V
Current	up to 1.5 A
Temperature	-20 °C to 65 °C
Humidity	up to 100%
Integrated Storage	4 W Hour
Walking time to full charge	4 Hours
Embedded electronics	GPS, accelerometer, temperature sensor, Bluetooth module

INSTEP
NANOPOWER

<http://www.instepnanopower.com>

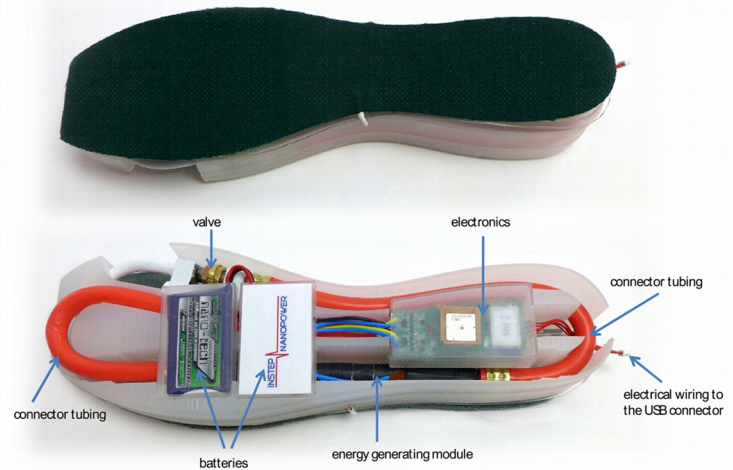
Energy harvester removed from the shoe



Electrical energy can be generated by either walking or by rocking the foot heel-to-toe while standing



The information about the user current location, state of the battery embedded in the shoe, number of steps, and the foot temperature is transmitted using Bluetooth link to the custom-developed application running on the Android phone.



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Wearable device



<http://www.energyharvesters.com/walking-chargertrade.html>

Claim 1 watt nominal power underlying technology is not disclosed



Medical device

A strong market pull for pacemaker and home health monitoring applications:

- Time to market could be long in the medical field
- Not all medical applications may require energy harvesting power solutions (cochlear implants, wrist blood pressure measurements...)

Medical device

Pacemaker Market:

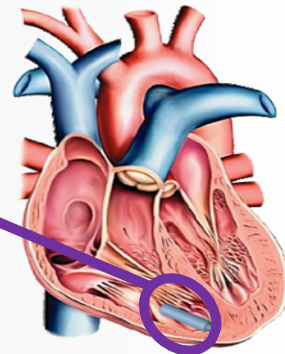
- Size: 600,000 units (2012)
- Mature: 3-5% CAGR
- Lithium batteries are widely used
- Main specifications: 50 μ W power consumption, 2.8V, 2Ah (typically), capable to deliver 25 μ J

Problems:

- **Limited lifespan: 5 -10 years**
 - costly replacement: \leq \$20,000
 - serious operation for the patient
- **Large size battery:** \approx half device size
- **Corrosion** of wires between heart and pacemaker



blogs.umnhealth.org/9-19-2014



Energy harvesting market drivers

- Infinite lifespan \Rightarrow no replacement cost
- Very small size ($< 0.5 \text{ cm}^3$) \Rightarrow harvester near the heart electrodes \Rightarrow no wires

Energy harvesting main challenges

- Low frequencies of the heartbeat
- Very long homologation procedure



Animal Applications

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Animals needs E.H.?



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Farm Animals

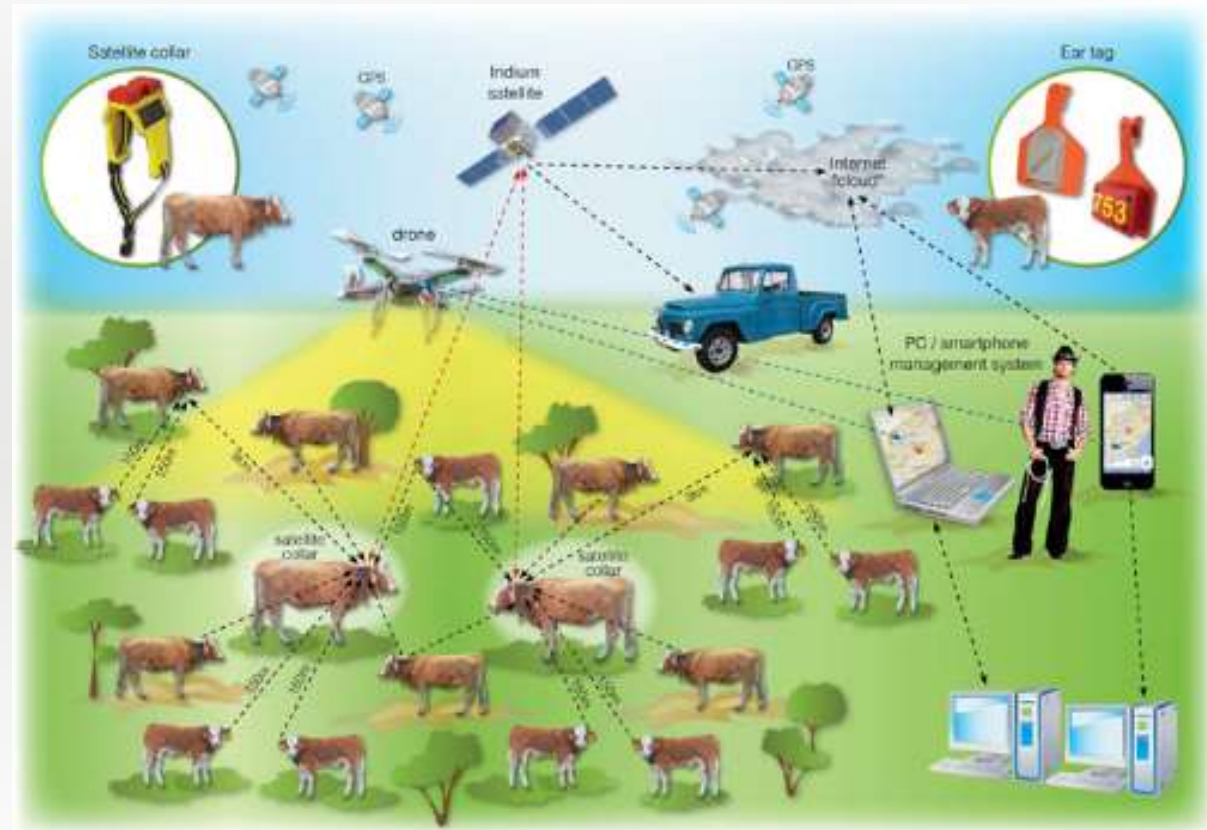
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Seven working years for collars without replacing batteries and three for Ear Tags



Farm Animals E.H.



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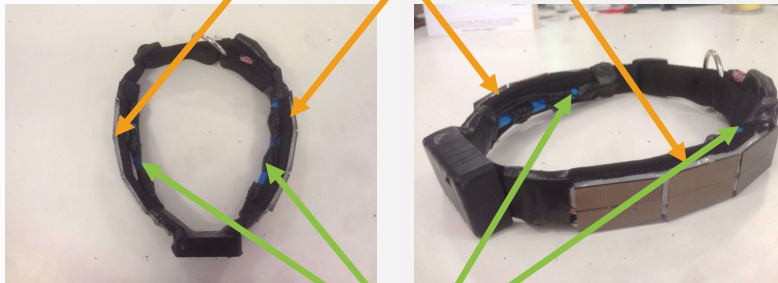
PETS

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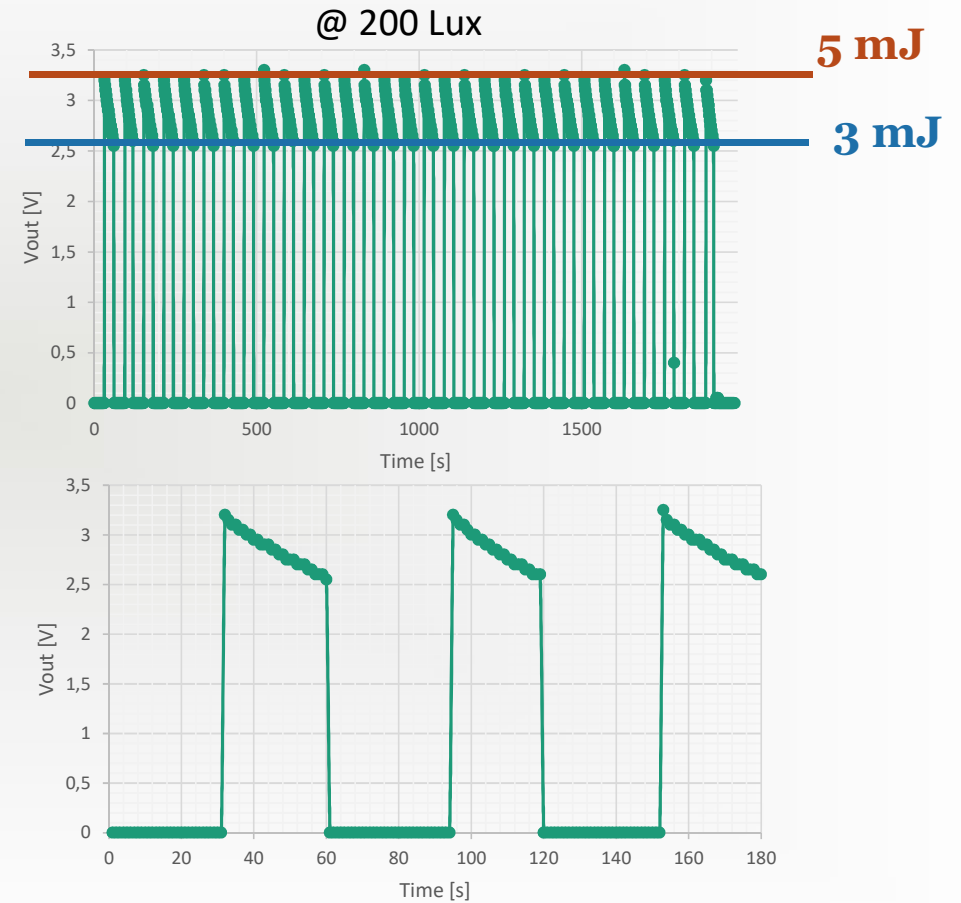


E.H. for pets

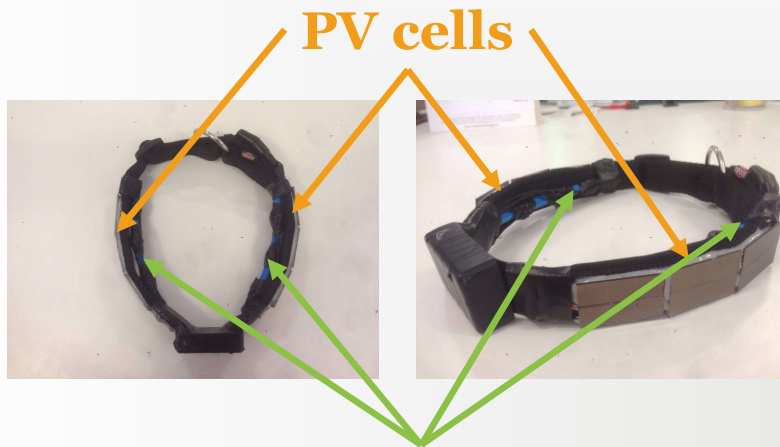
PV cells



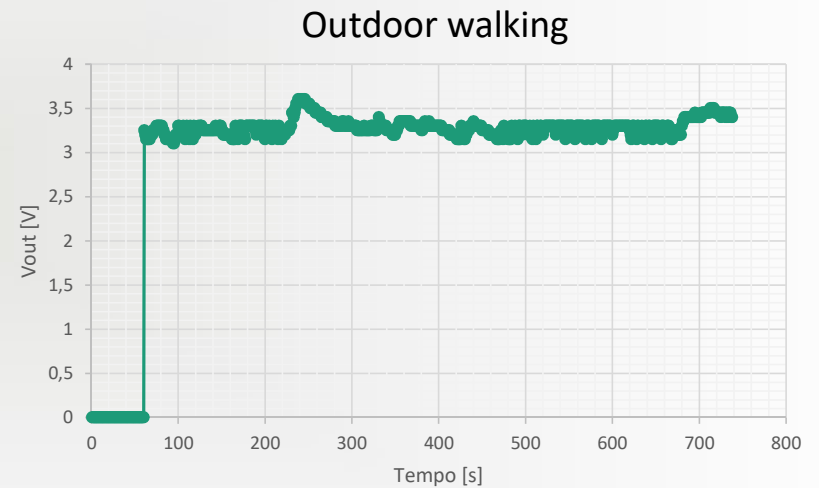
Vibrational Harvester



E.H. for pets



Vibrational Harvester





THANKS!!

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