Pedometer-type Energy Harvester

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Outline

- Introduction
- Problem Statement
- Design Requirements
- Solution Approach
- System Specifications
- Project Management
- Future Work
- Conclusions & Questions

Introduction

- The need for environmentally friendly energy solutions is the major driver for a system like the Pedometer-type Energy Harvester
- The PEH harnesses energy from the bodies of young/active persons for use as a power source

Problem Statement

Design a PEH that:

- is portable
- converts human motion into electrical energy
- stores harvested energy for use in recharging electrical accessories

Design Requirements

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The PEH should:

- Generate 5Vdc @50 – 100mA (or 12V version)
- Charge battery up to 5 WHr
- Operating Temp: -10 – 40 Celsius
- Deliver Power: Nominal to a USB device, Large to battery reserve
- Provide external indicator of power condition

Current Status of Art

- Sanyo's Pedometer Charger

- Ugly Sneakers Power Generator

- Knee Brace

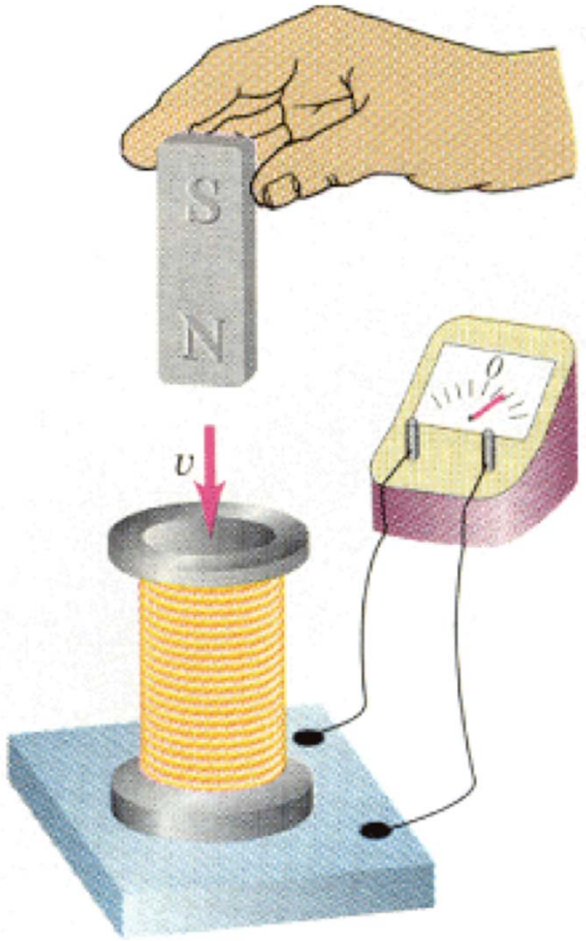
Current Status of Art

- Knee Brace

• Nominal power output:	8-14W (1.5m/s walking sped)
• Maximum power output:	25W (15 degree down slope)
• Effort Level setting:	10 levels
• Output voltage:	5V to 16.8V (2 to 4 Li Ion cells)
• Maximum output current:	5A
• Operating temperature:	-20C to + 50C
• Storage temperature:	-40C to + 70C

Solution Approach

- Using Faraday's Law of Induction, we intend to use a magnet that passes through a copper coil which, when you move, induces voltage in the coil generating electricity
- The generated electric energy will then be stored in a rechargeable battery for use by the owner
- An adapter will be added at the other end of the battery for whatever suitable connector the user desires



Solution Approach

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- Alternative Solution: Series Combination of Tubes

Pros

- More redundant than the single tube approach. One tube can act as a failover for the other

Cons

- More expensive
- Heavy

Solution Approach

- Alternative Solution: Toroidal Coil generator

Pros

- Require less turns of coil
- Continuous flow of current

Cons

- Time to construct
- Less Practical

Decision Matrix

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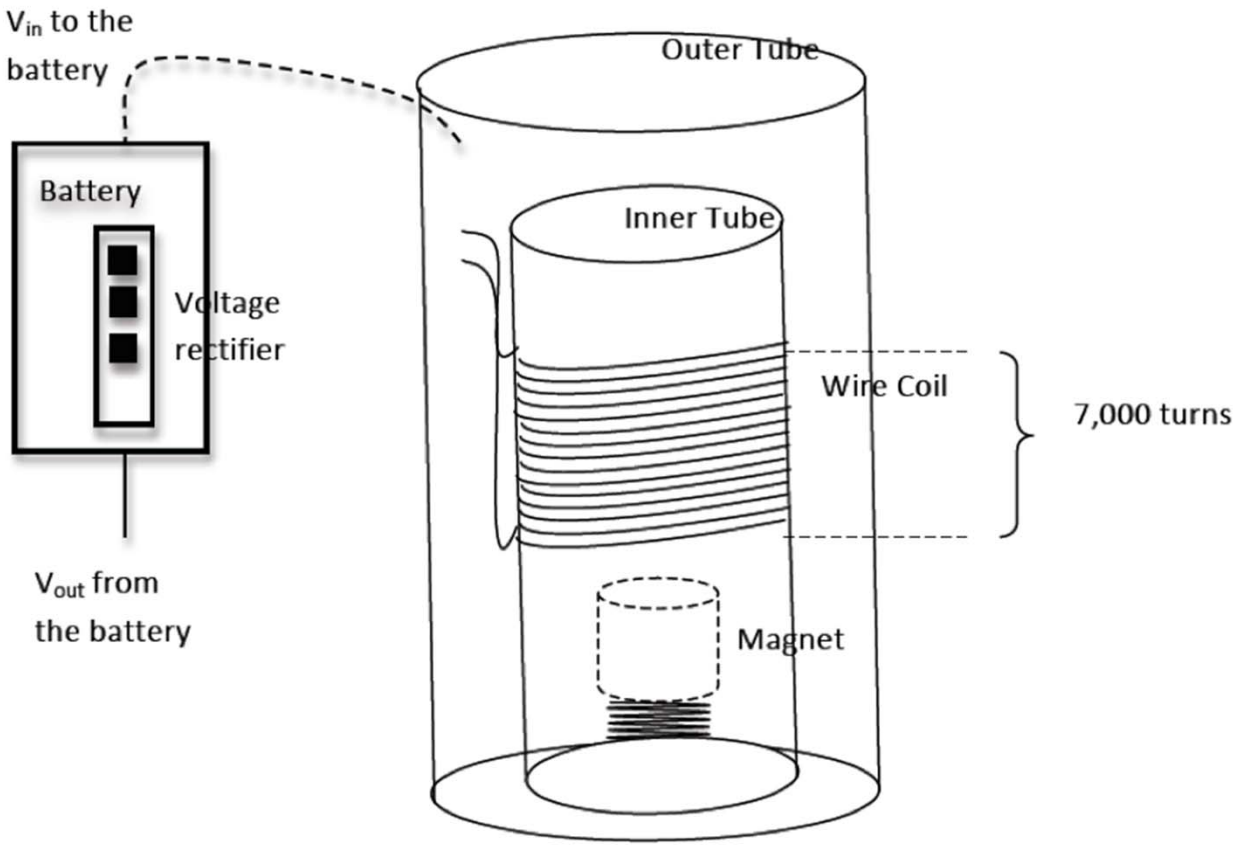
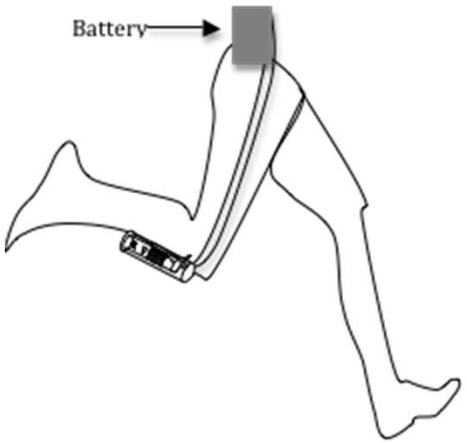
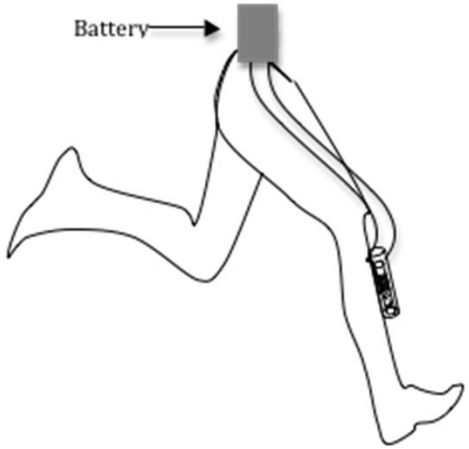
Selection Criteria	Weight	Primary Solution	Several Tubes	Toroid Tube
Weight	5	3	1	4
Cost	5	4	2	2
Feasible	5	4	4	1
User friendly	5	4	3	1
Total	25	15	10	8

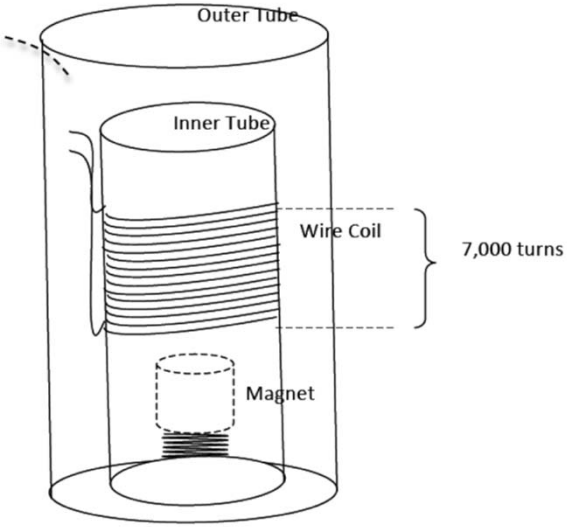
Solution Approach

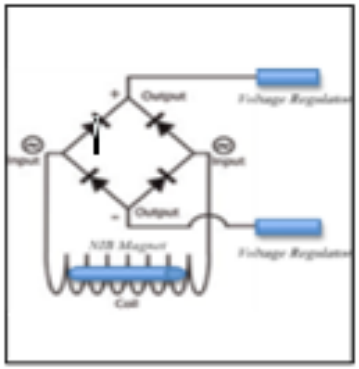


Solution Approach

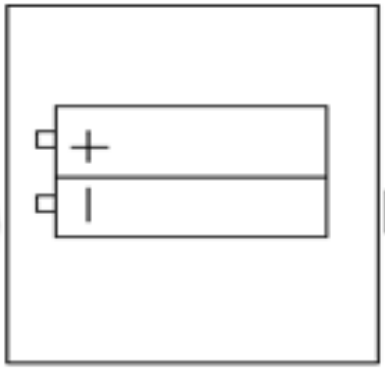








Transmission Circuit



Rechargeable Battery

Multiple outlets for charging devices

Electronic devices

Engineering Approach

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$$E = -N\frac{d\phi}{dt}$$

N – Number of turns
A – Surface area of tube
B_o – Magnetic field intensity in the middle of tube
B_{END} – Magnetic field intensity at end of the tube
g – gravitational force
L – Length of the tube
t – Time for one oscillation
E – Induced emf
$\frac{d\phi}{dt}$ – Rate change of flux

$$N = \frac{E}{A\frac{B_o - B_{END}}{\Delta t}}$$

$$= \frac{E}{A\frac{\frac{B_o}{1+\frac{L}{2}}}{\sqrt{\frac{L}{g}}}}$$

$$N = \frac{E}{AB_o\frac{2\sqrt{g}}{(2+L)\sqrt{L}}}$$

System Specifications

$$Frequency = 3.5Hz$$

$$\begin{aligned} Total\ length\ of\ wire &= 7000 \times 3.92\ inches \\ &= 27{,}489\ inches \\ &= 2290\ feet \end{aligned}$$

$$Weight\ of\ the\ wire = \frac{0.7692\ lb}{1000\ ft} \times 2290\ ft$$

$$= 1.76\ lb$$

$$Resistance\ of\ wire = 1.76\ lb \times 53.061\ \frac{\Omega}{lb}$$

$$= 93.46\ \Omega$$

System Specifications

Weight Calculation

Coil	=	1.76 lb
Magnet	=	0.28 lb
Tube	=	0.09 lb
Stoppers + Spring	=	0.10 lb
Battery	=	0.50 lb
Rectifier+ Wires	=	0.10 lb
Total Weight of Device	**=**	**2.83 lb**

System Specifications

Specifications:
Input: 5VDC 500mA
Output: 5VDC 800mA Max.
Push capacity button with green LED indicator for battery condition
-1st LED = 35% of full capacity
-2nd LED = 60% of full capacity
-3rd LED= 100% of full capacity
Built-in Battery: Li-Ion 3.7V 1800mAh
Operate temperature: 0'C - 45'C

Pack's dimension (LxWxH): 86mm(3.4") x 51mm(2.0") x 15mm(0.6")
Pack's weight:2.5 Oz (71 grams)

System Specifications

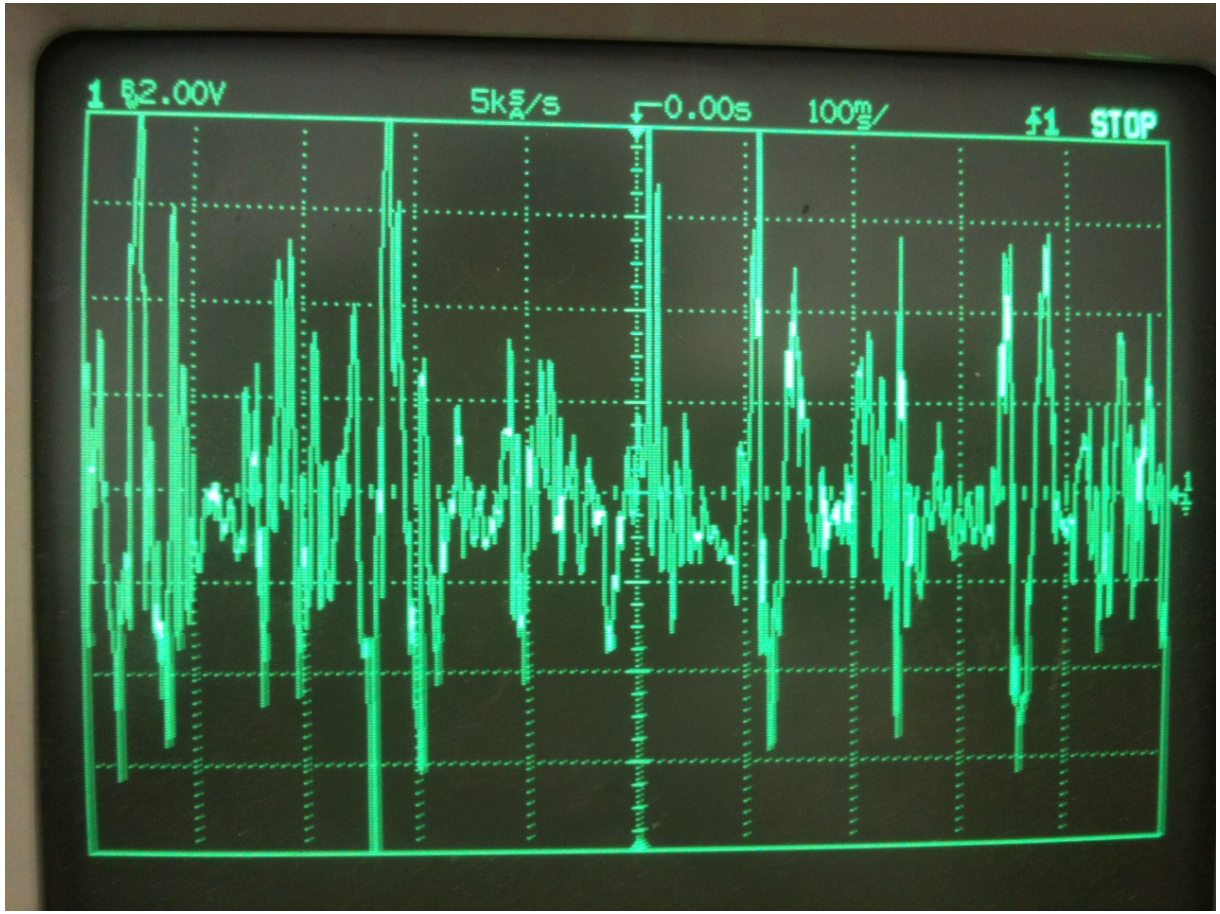
Project Management

Costs

- Magnets..... $10
- Wires.....$200
- Tubes.....$30
- Circuit Elements.....$20
- Battery.....$65

Total Cost = **$325**

Supporting Information



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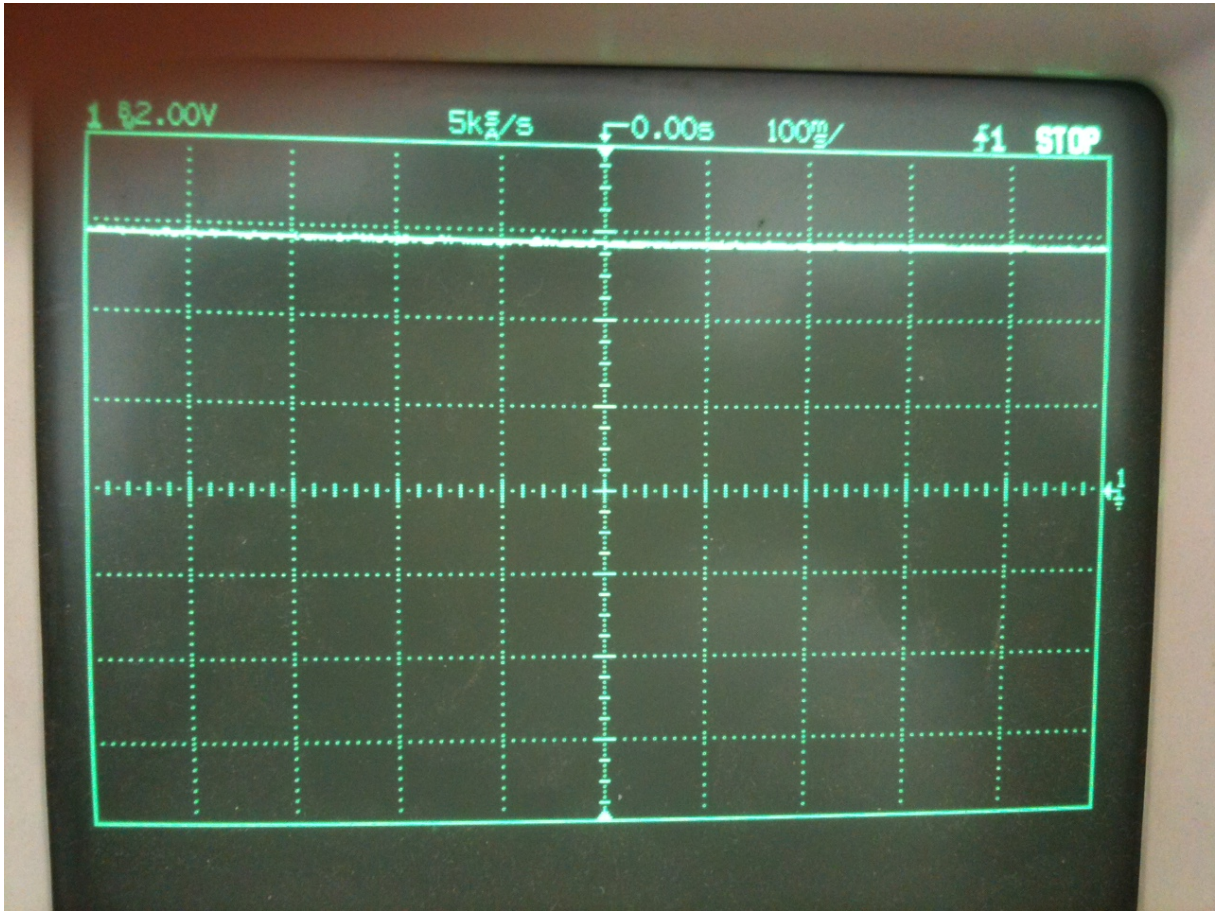

Supporting Information

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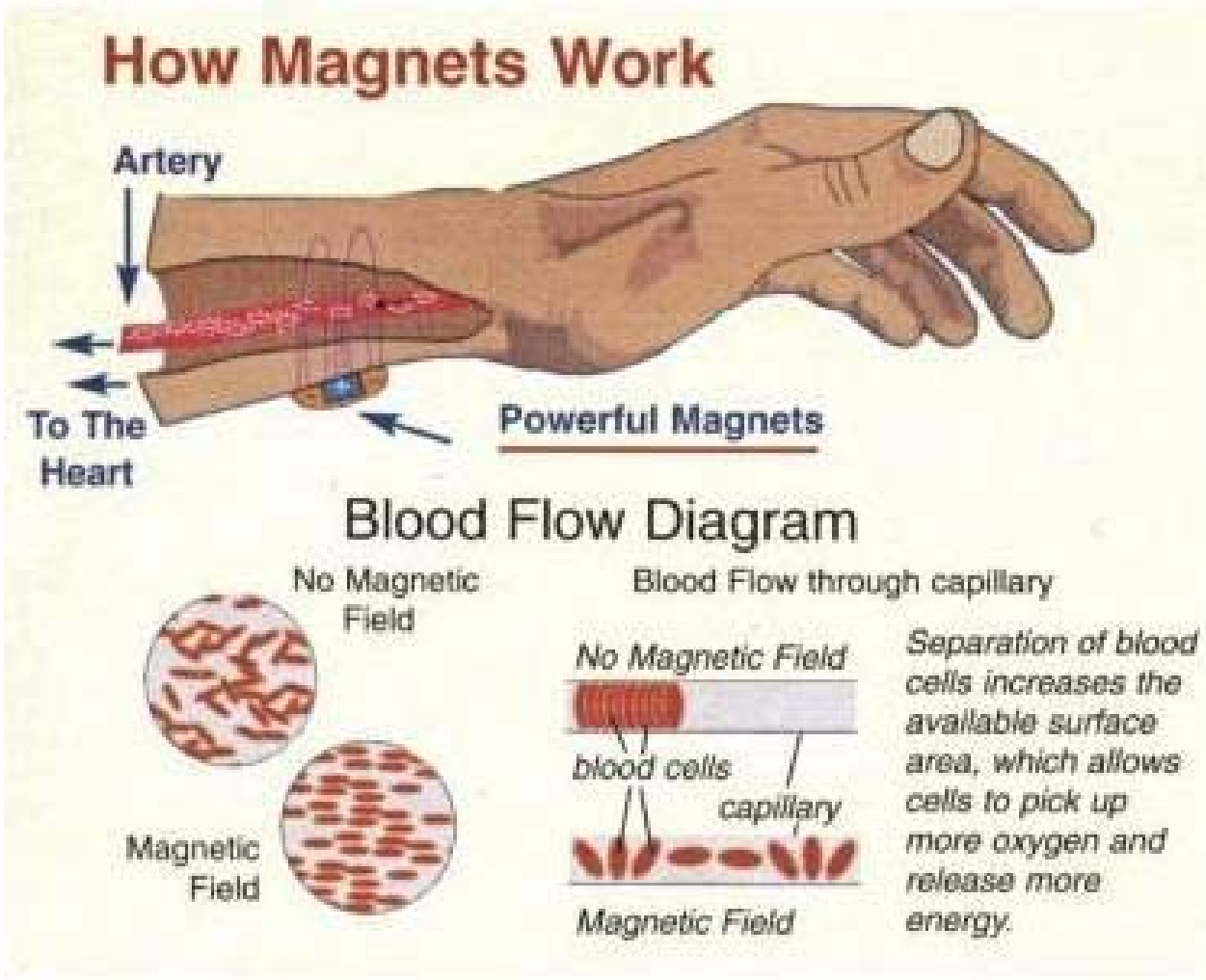
- <Demo video goes here>

Risk Monitoring/ Management

Risk	Monitoring/ Management
Powerful magnet may pose safety issues.	Research done to ensure magnets are not hazardous to health

Risk Monitoring/ Management



Risk Monitoring/ Management

- International Agency for Research on Cancer

"There is limited evidence in humans for the carcinogenicity of extremely low-frequency magnetic fields in relation to childhood leukaemia. There is inadequate evidence in humans for the carcinogenicity of extremely low-frequency magnetic fields in relation to all other cancers.."

Risk Monitoring/ Management

- National Institute of Environmental Health Sciences (NIEHS)

"After reviewing more than two decades of research in this area, NIEHS scientists have concluded that the overall pattern of results suggests a weak association between increasing exposure to EMFs and an increased risk of childhood leukemia. The few studies that have been conducted on adult exposures show no evidence of a link between residential EMF exposure and adult cancers, including leukemia, brain cancer, and breast cancer."

Future Work

- Develop a prototype using 2 tubes
  - Reduced resistance in the system
  - Balance the weight distribution on both legs
- Use a magnet with a stronger magnetic field intensity

Conclusion

- Performance Evaluation

Design Requirements	Our Solution
Generate 5Vdc @ 50mA	
Charge battery up to 5 WHr	
Operating Temp (-10◦C to 40◦C)	
Deliver Power Nominal to a USB device	
Provide external indicator of power condition	

Questions