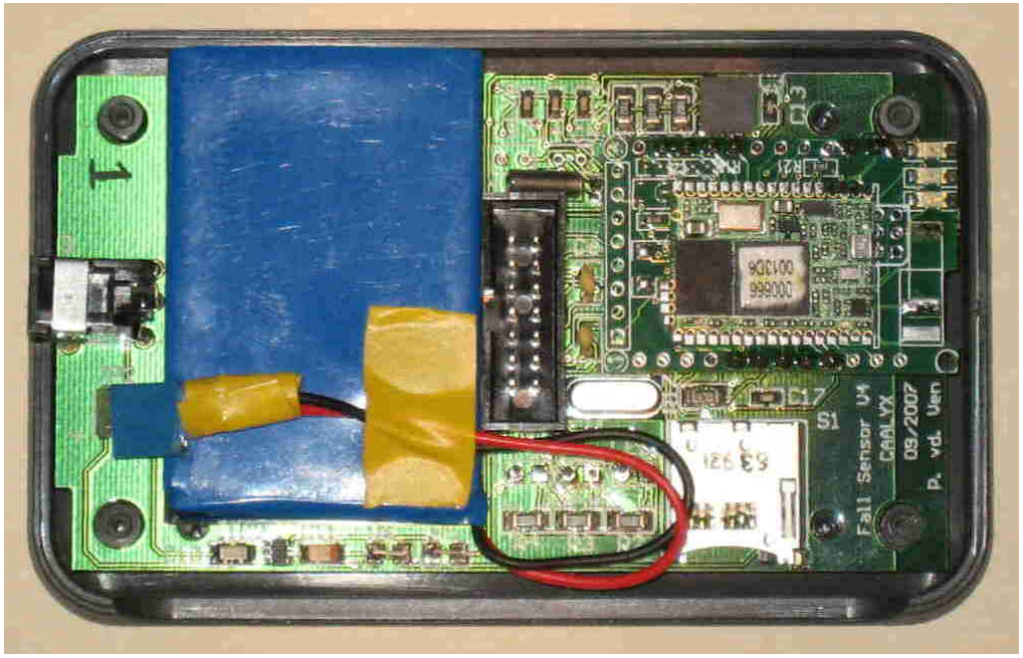
A wireless platform for fall and mobility monitoring in health care



Pepijn van de Ven

BodyNets 2008, March 12-15

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CAALYX Project Outline

- Complete Ambient Assisted Living Experiment
- European Commission 6th Framework €1,850,000
- Wearable Light Device integrating a system of health and vital signs sensors for elderly people
- BAN communicates to server using Nokia N95
- State-of-the-art communication system for remote health administration and social contacts
- Intelligent sensors for identification of emergencies

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CAALYX Project Outline

- Sensors:
  - Vital health signs
    - ECG
    - Pulse Oximeter
    - Blood pressure
    - Weight
    - Glucose
  - Emergency identification
    - Fall and mobility sensor
      - ECG
      - Pulse Oximeter

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Fall Sensor Requirements

- Low power
- Minimum 12 hrs operation with full online logging without recharging
- Weight less than 150 gr.
- Tri-axial accelerometers
- Bluetooth communications with nokia N95
- Full access to hardware
- Flexibility in data flows
  - Bluetooth for raw sensor data
  - Bluetooth only for messages / SD card for raw

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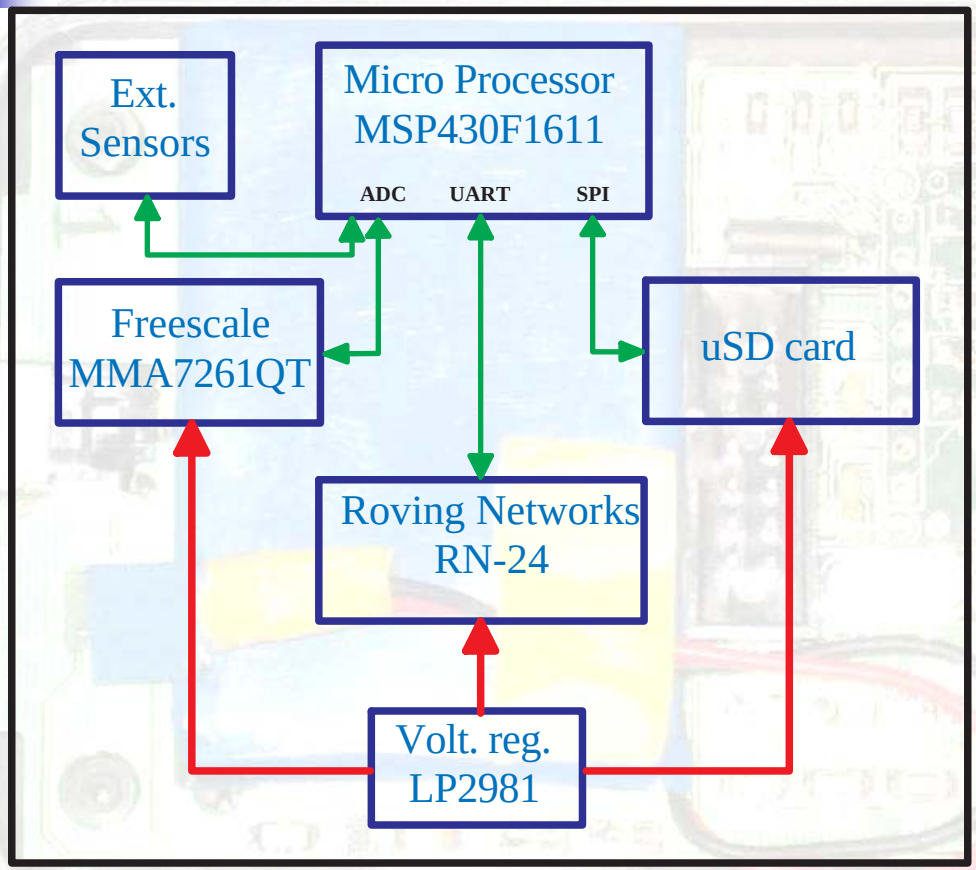
Existing Solutions

- MoteIV
  - 802.15.4 radio
  - bi-axial accelerometer
  - Low power
  - Specialised programming language TinyOS
- SHIMMER
  - Tri-axial accelerometer
  - Bluetooth radio
  - Low power
  - No / limited availability of platform
  - IP issues due to prohibitive Intel user agreement
  - TinyOS

Advantages of Customised Solution

- Form factor can be chosen and changed
- Weight can be chosen and changed
  - Weight vs Power ratio is dominating factor
- Full access to Bluetooth radio
- Ease of adding additional peripherals / functionality
  - uSD card, master/slave switch for Bluetooth
- Minimise software overhead
- Ease of future innovations

Fall Sensor Development



- Fall algorithm based on acceleration and temporal triggers.
- C libraries for:
  - Timer functions
  - BT comm.
  - SD storage
  - Sensor config.

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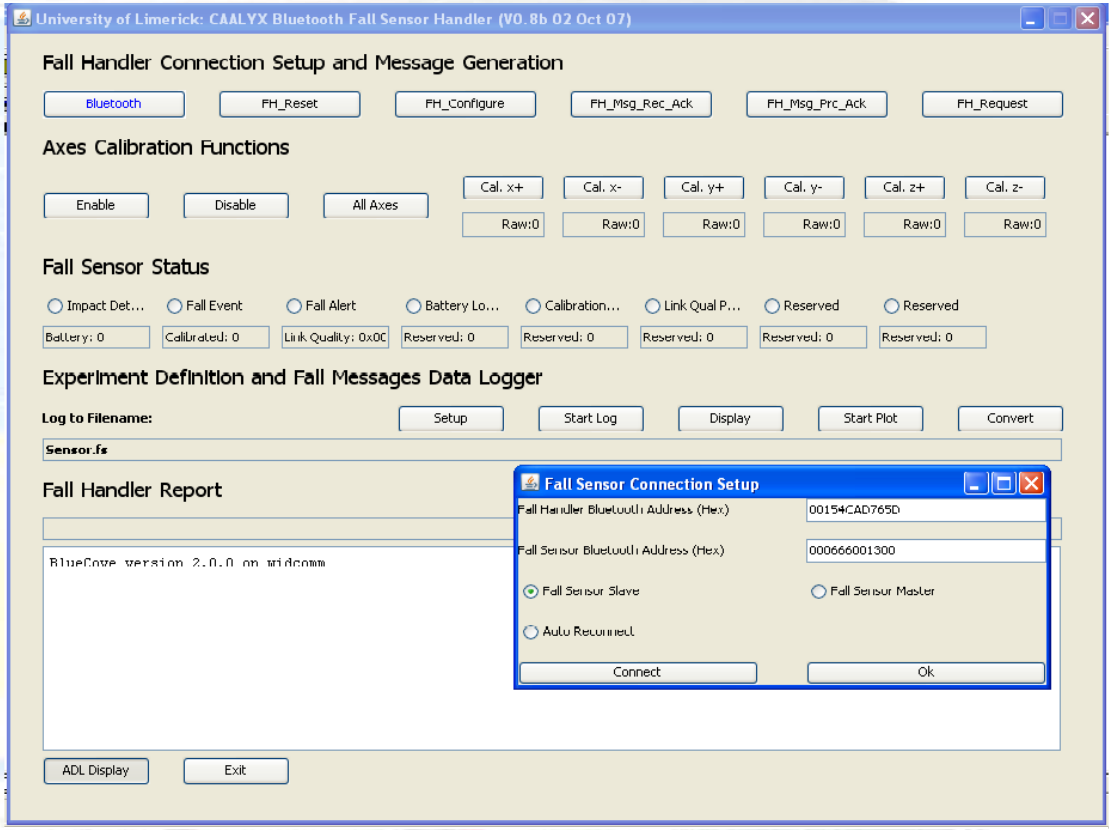
Java Fall Handler / Configuration interface

- Data logging
- Data plotting
- Sensor calibration
- Sensor configuration
- Matlab for data analysis



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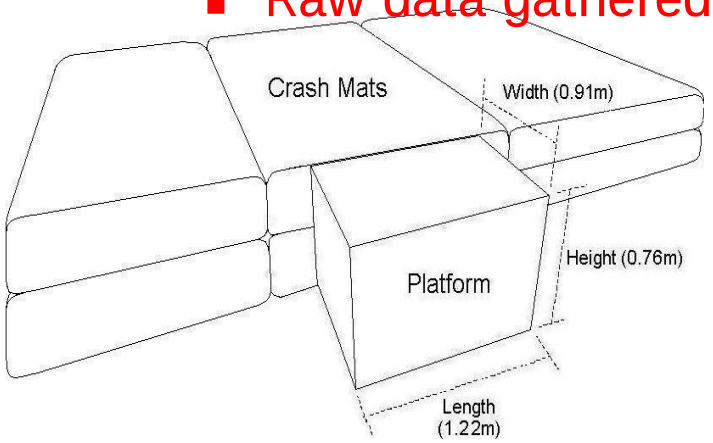
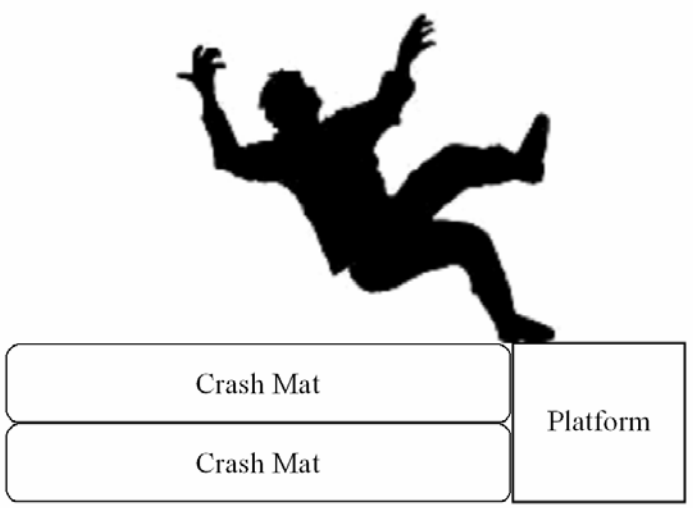
Limerick Fall Trials using Young Healthy Subjects

- 10 young healthy males (<35 years) performing:
  - Simulated falls (In all directions with legs straight and knee flexion)
  - Normal ADL (Sitting, lying and walking)
  - Data on 480 Falls and 300 ADL collected
  - Raw data gathered by pc over BT (sampling rate = 200Hz)





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The Vest

- Fall Sensor Algorithm developed for accelerometers attached to the chest
- A custom vest was developed enabling positioning of the fall sensor on the chest or under the left arm
- (The Nokia N95 can be worn in a pocket above the right hip)

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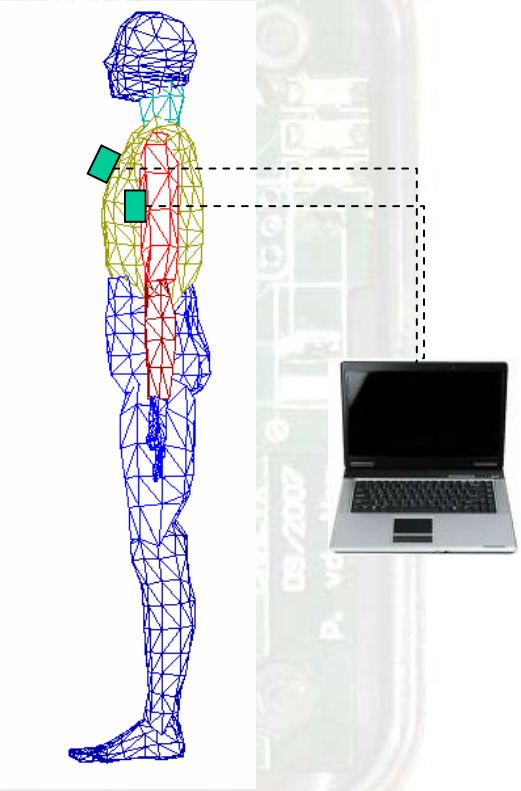
Fall Trials

- Wireless Fall Sensor Hardware Testing
  - Raw Tri-axial accelerometer signals sent over BT to a pc
  - Data rate of 28.8 kBit/s
  - Initial problems with internal BT module
  - No messages were lost during the trials
- The hardware and implemented fall algorithm were evaluated and shown to function as expected.
- Bluetooth connection very reliable



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Trials with Elderly Volunteers

- Interface to pc replaced with interface to N95
- Only events sent to ‘caretaker’ server where appropriate action can be undertaken
- Raw data gathering on micro SD cards.
  - 12.7 GB of data gathered from 9 SD cards over 4 weeks
  - Approximately 780 hours of relevant mobility and sensor data

Events	Quantity
Fall-events	532
Fall-recovery	199
Fall-alert	9

550 erroneous messages generated by one fall sensor (BT communication lost)

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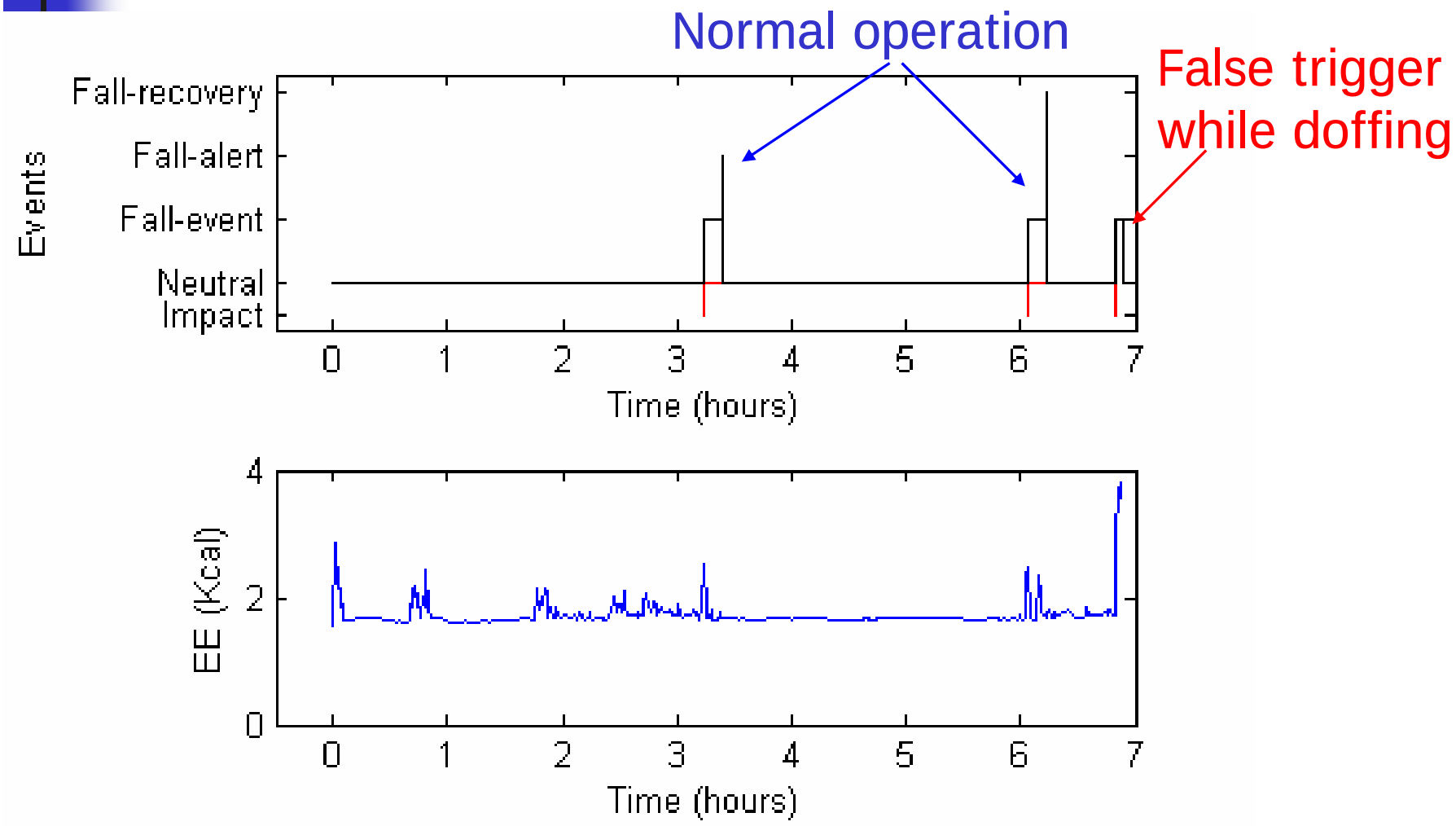
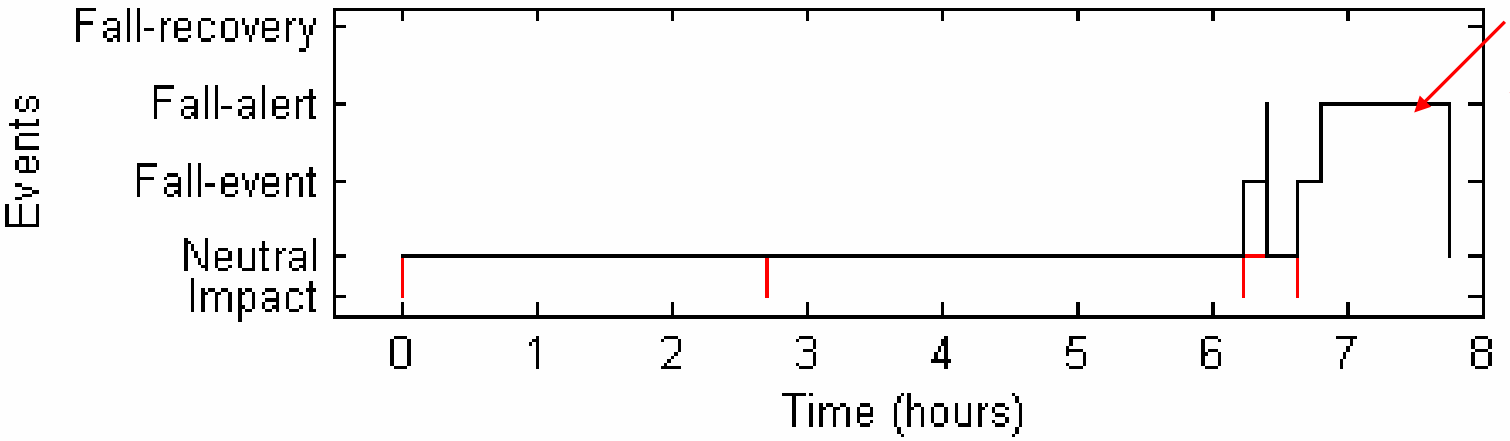
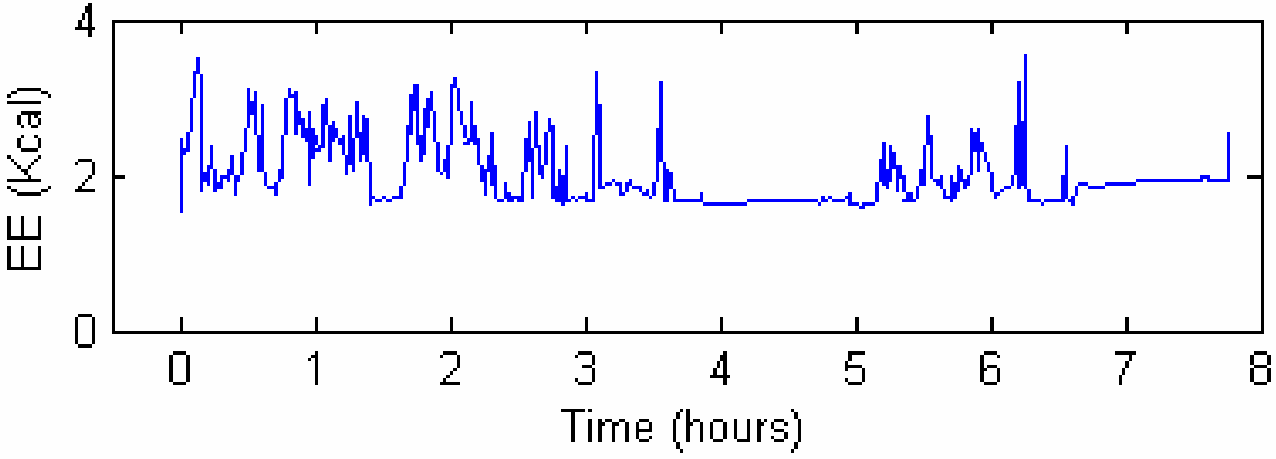
Data Analysis



Data Analysis



False trigger while doffing BT comm lost for extended period



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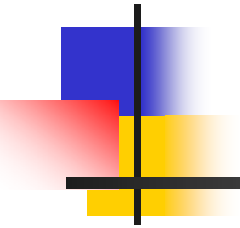

Questions ?