Testing of the Authenticatable Container Tracking System (ACTS)

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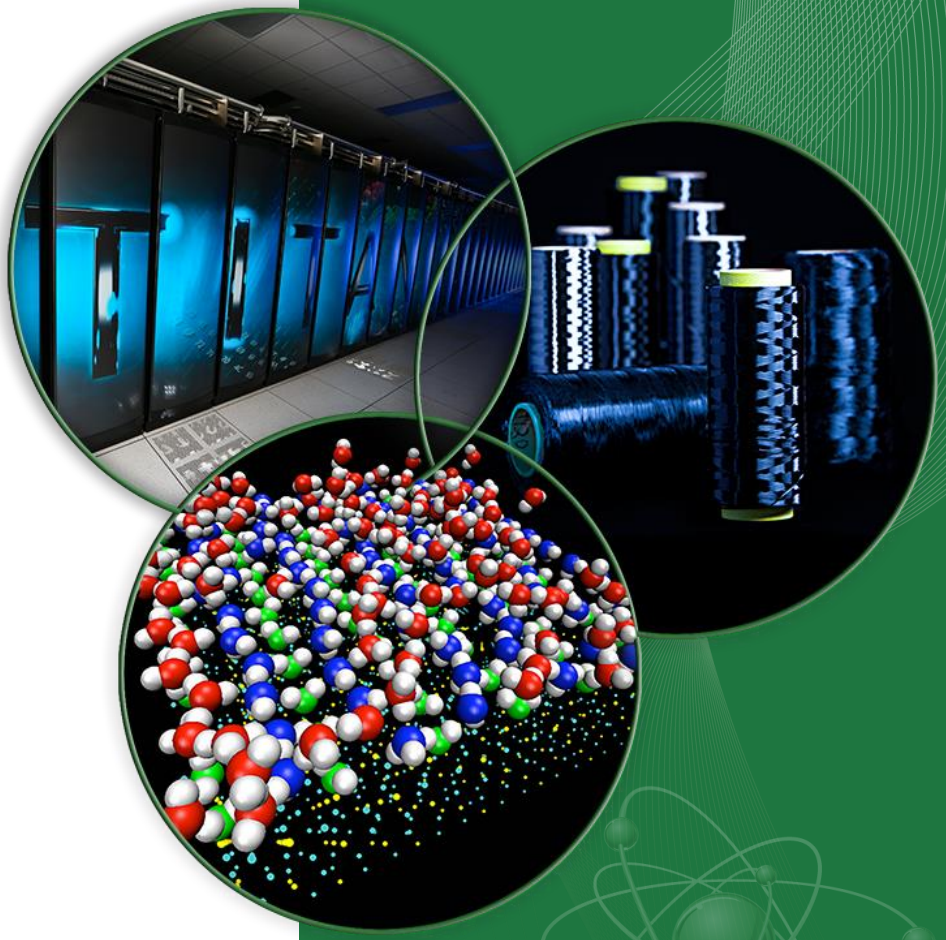

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The concept for the Authenticatable Container Tracking System (ACTS)……

- The ACTS concept is to provide a *universal platform*, compatible with ARG-US, for active monitoring of device containment and device position and report status at regular intervals via selectable communication methods.
- ACTS will also provide its own power, store events in memory, work with other applicable systems and follow IAEA best practices for data encryption and authentication.
- ACTS is planned to incorporate a *universal interface architecture* that will enable future modules to be easily interfaced to the basic system thus providing an integration path for new technologies.
- The core design philosophy will be container agnostic.
- Partners for this system are Oak Ridge National laboratory (ORNL), Argonne National Laboratory (ANL), Savannah River National laboratory, (SRNL), and commercialization partner Aquila.

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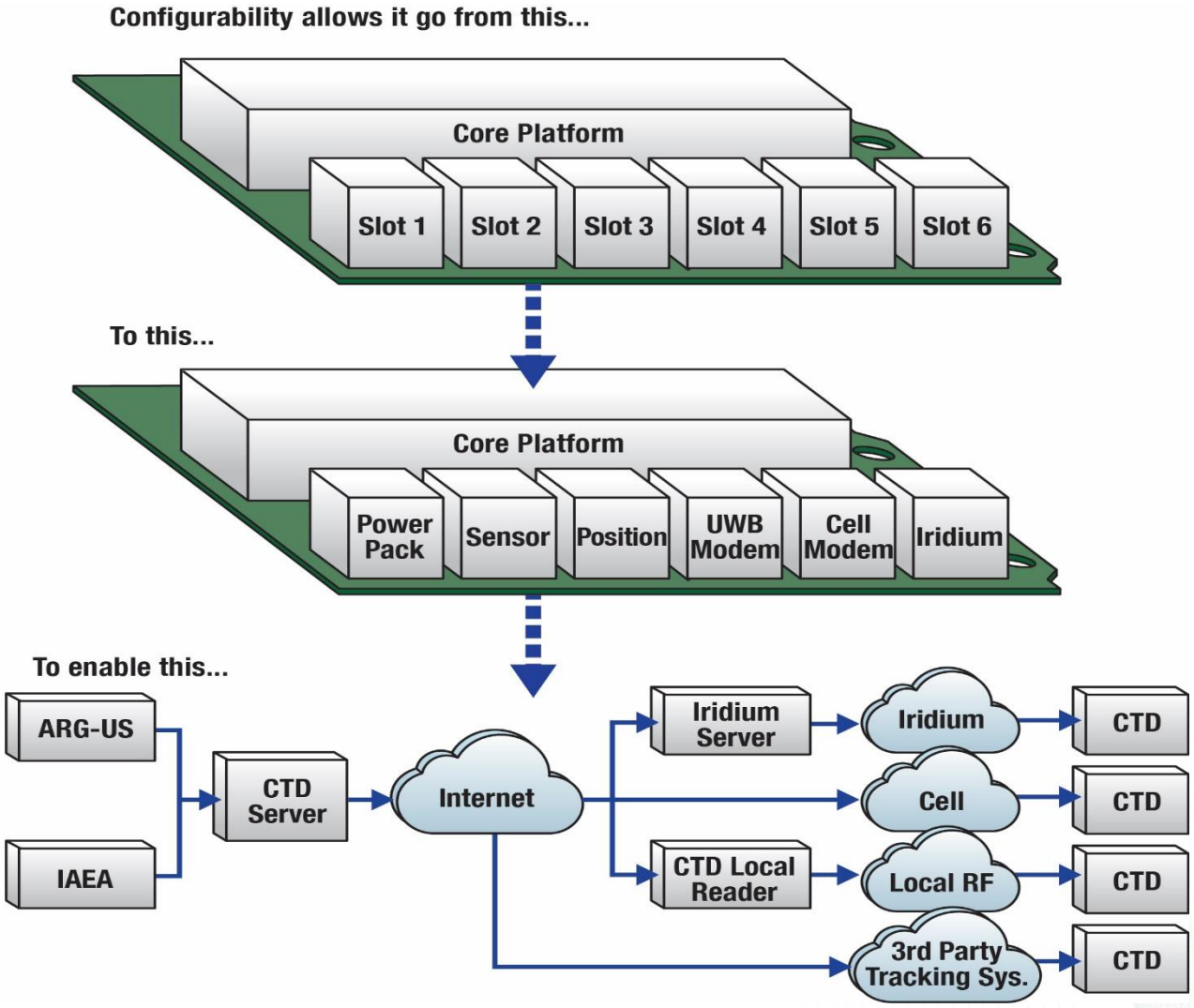
What is a potential CONOPS for ACTS?



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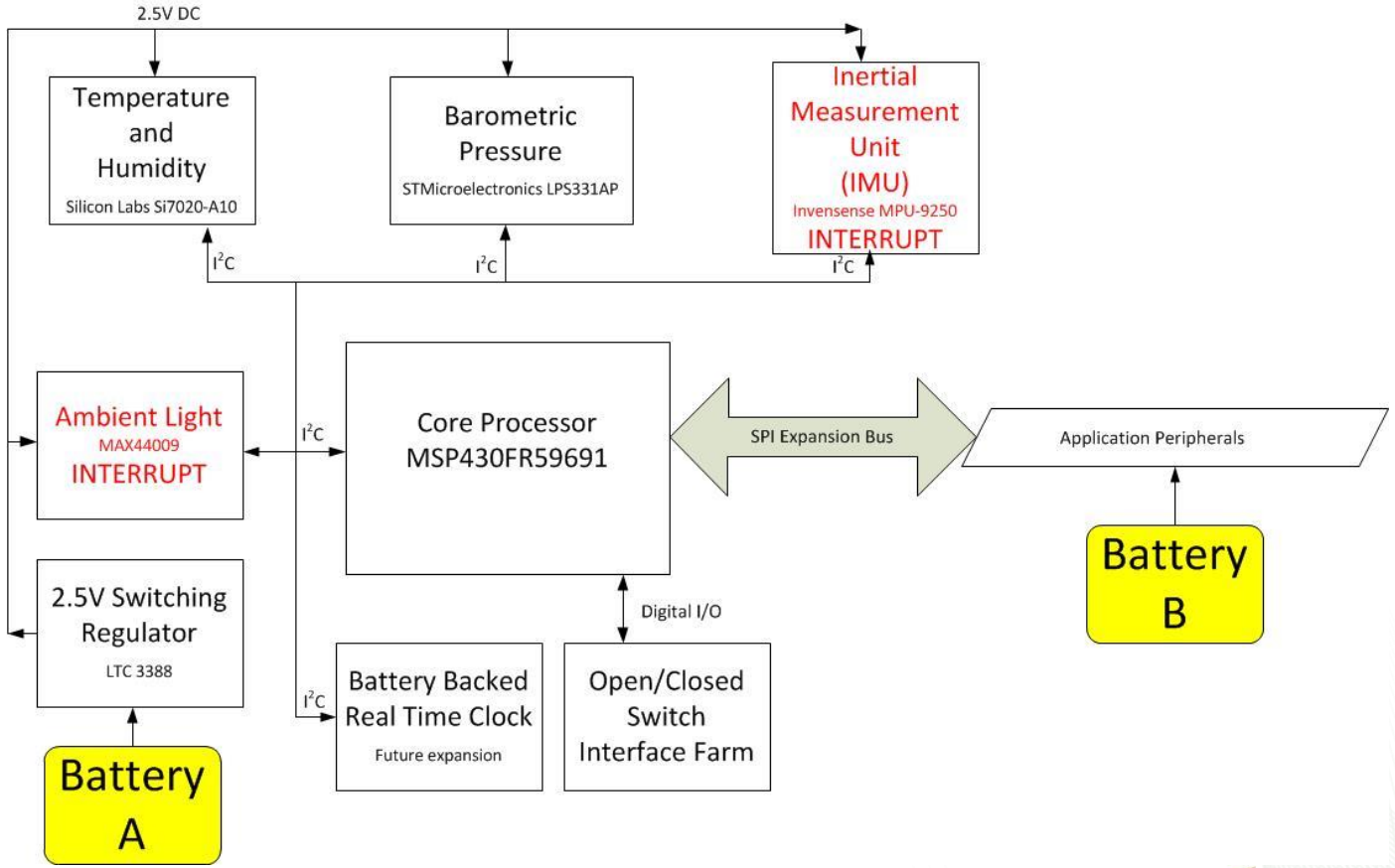
The ACTS Motherboard Architecture, built on the low-power MSP family of processors, incorporates a base set of relevant sensors and a peripheral interface for matching ACTS to specific applications.



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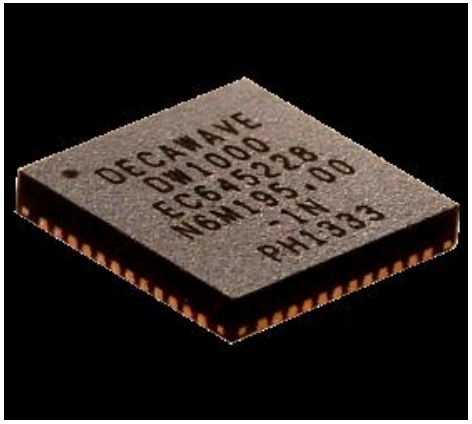
The box was designed to be waterproof

- Made from 3-D printed ABS
- Printed on Stratasys Fortus 400mc
- Painted/waterproofed with RustOleum paint for plastic indoor/outdoor 248649

DecaWave DW1000



- Single chip UWB transceiver
- IEEE802.15.4-2011
- Real Time Location capabilities (10cm indoors)
- Up to 6.8 Mbps
- Coherent receiver (300m range)
- Short packet durations (11,000 tags in a 20m radius)
- Highly immune to multipath fading
- Low power consumption (mode dependent)

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Planned Smart Peripherals

- Peripherals to the motherboard with their own MSP-430 and a common interface
- DW1000 transceiver
- Iridium transceiver
- GPS
- Micro SD Card
- Turbo GPS
- SC-HSM (smart card hardware security module)
  - IAEA PKI Infrastructure
  - Encrypt and or sign data
  - Basically a variant of the micro SD Card peripheral

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Data Collection Tools

- DecaRanging Listener
- ACTS PC Communications
- ARG-US Translator
- DecaRange RTLS

Wireless anchor

USB anchor

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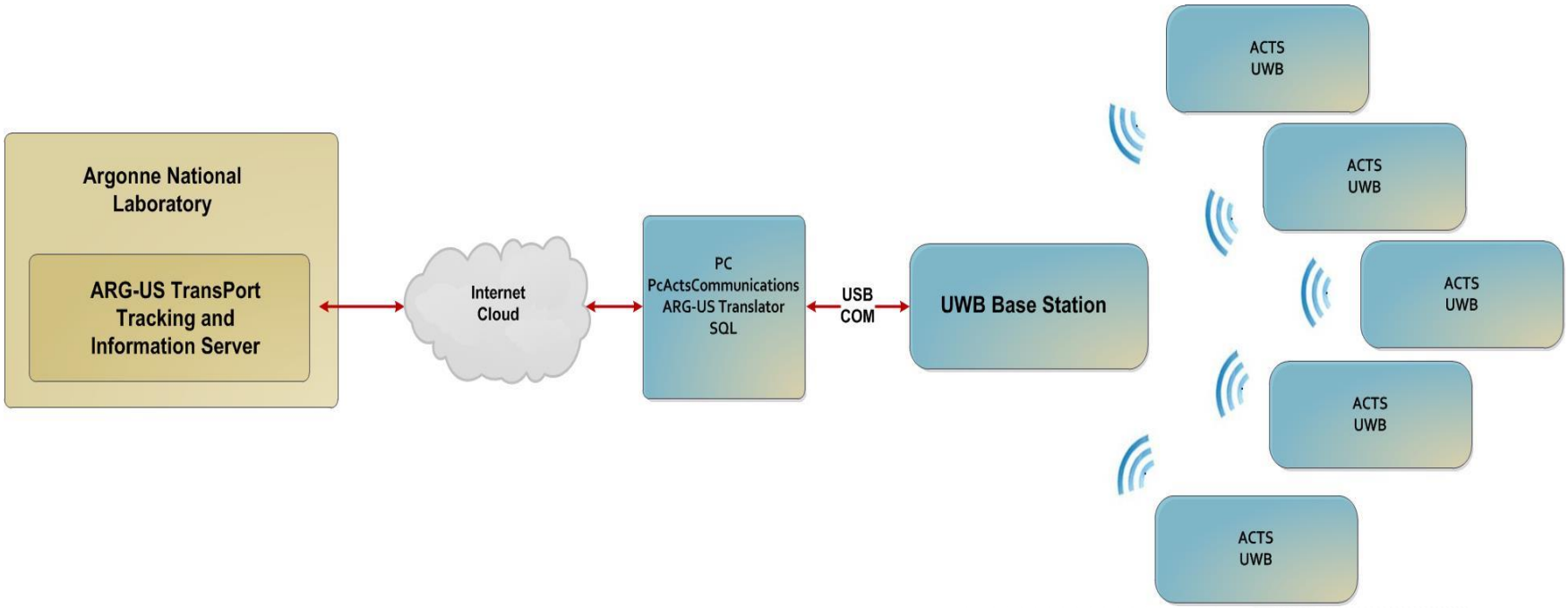
The testing hardware configuration used five different tags and various servers that collected ACTS messages.



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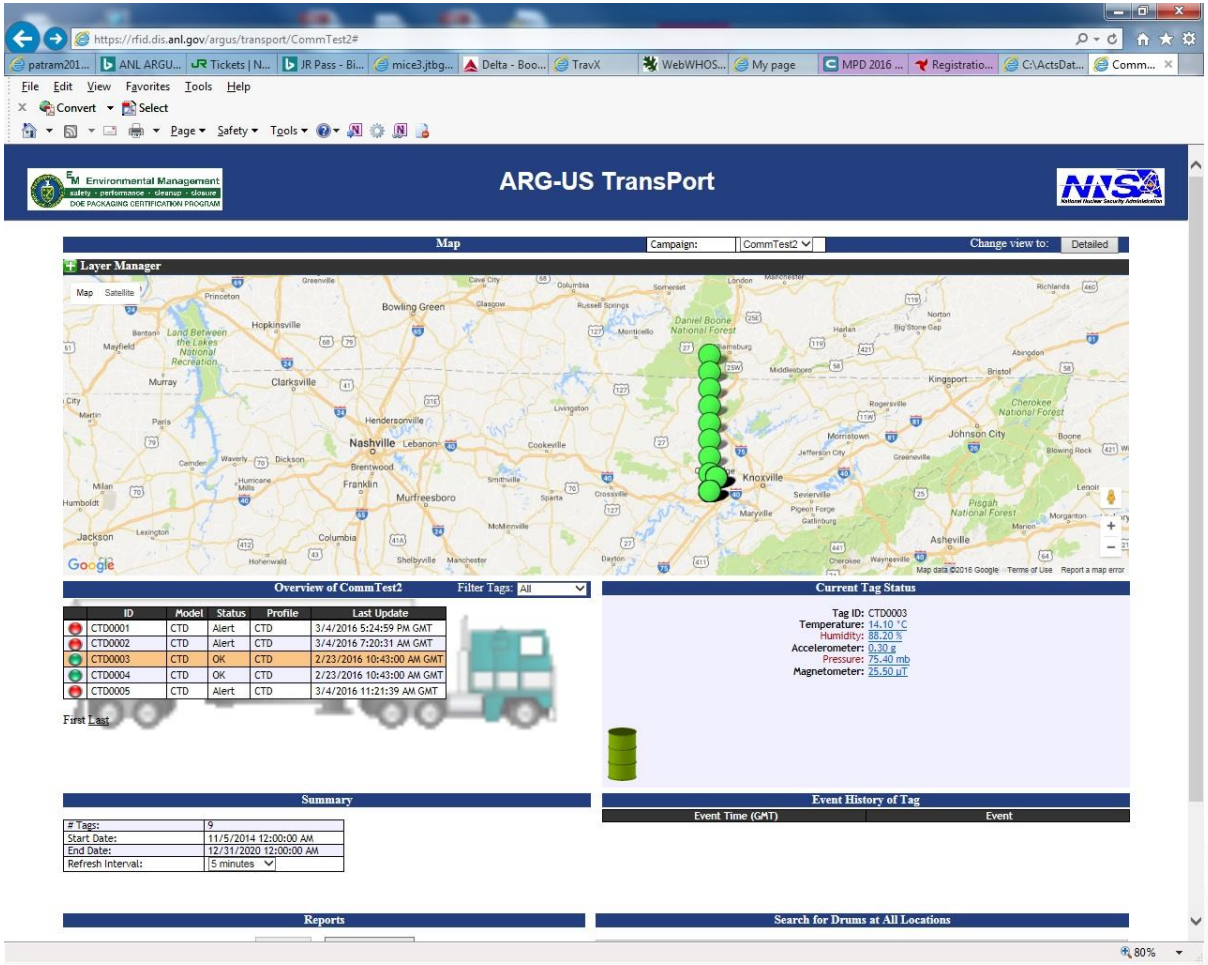
ACTS data were transmitted to the ARG-US TransPort Server.



Location testing - indoor

- Three EVK1000s as base stations
- Three EVK1000s as tags
- Cluttered lab – to within 1 ft.
- Repeatable
- Ranging capability has not yet been ported to MSP430
- Test planned to use 3-D imager to verify location measurements

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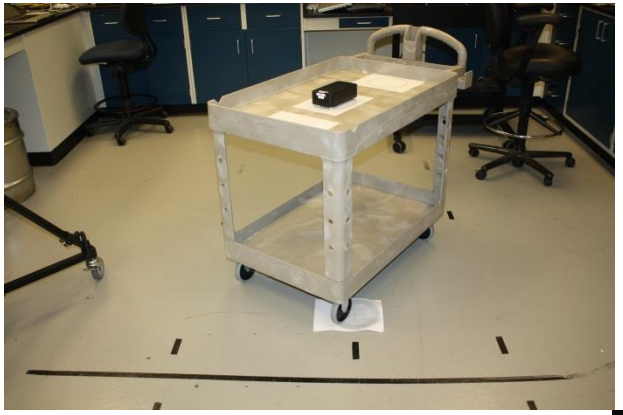
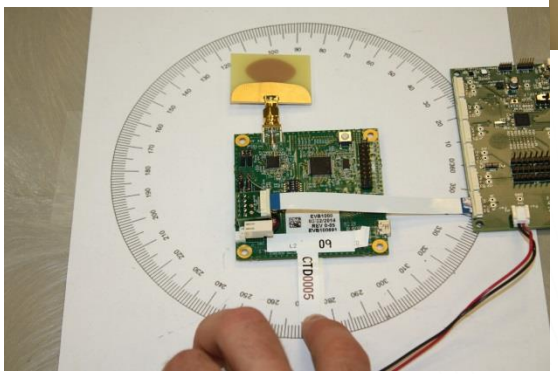
Sensor testing – indoor

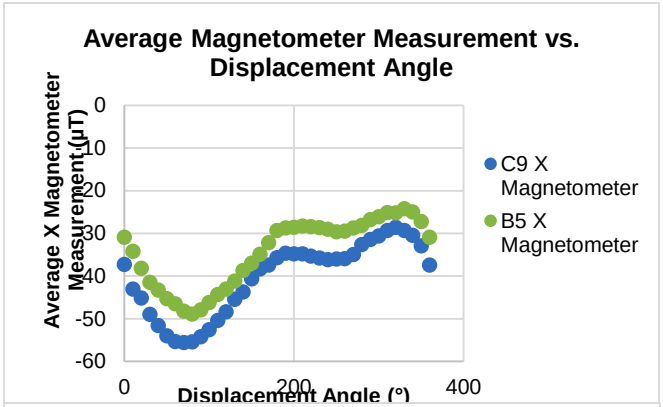
- Testing indoor has included
  - Magnetometer orientation response
  - Accelerometer
  - Temp, Humidity, pressure
  - Light
  - Magnetic field vs. lift
- Testing outdoor included
  - Included weatherized base station
  - Waterproofing box testing/redesign

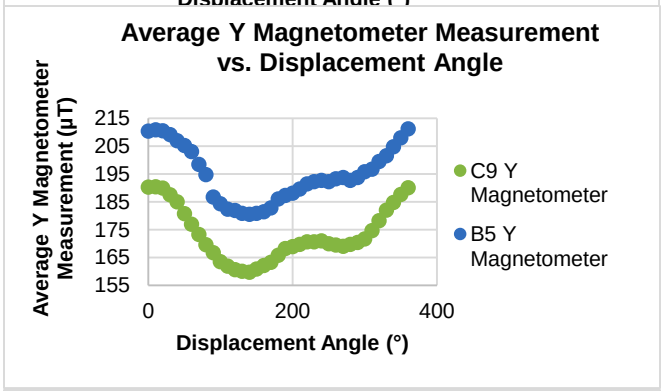


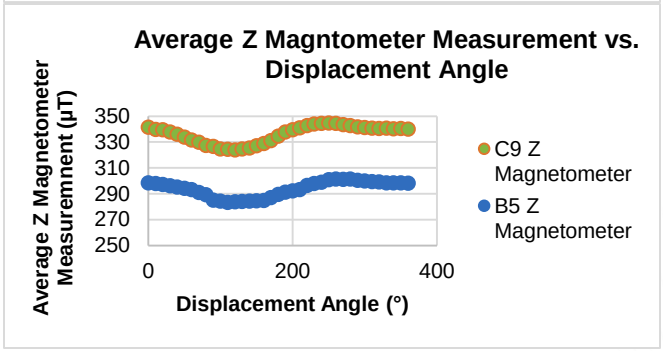


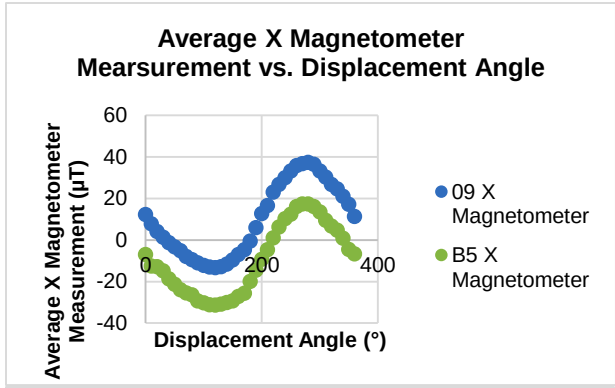
Location testing – indoor (Magnetometer)

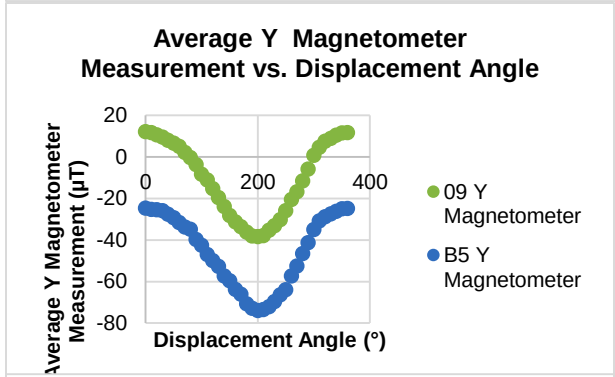
- Testing scope is to determine relative performance not absolute (crosstalk, interference, etc.)
- 1st column is the complete box
- 2nd column is the magnets and batteries removed from the box
- Peaks are approximately correct for local magnetic field
- Batteries obviously provide some position-dependent shielding
- New box design will provide power from flat-pack batteries which are more symmetric

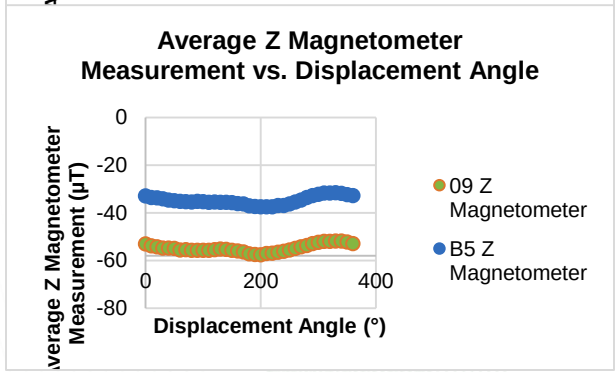






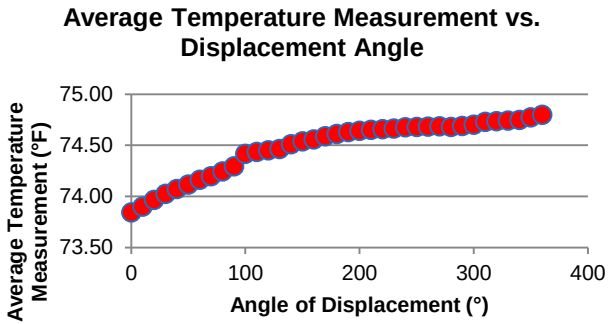


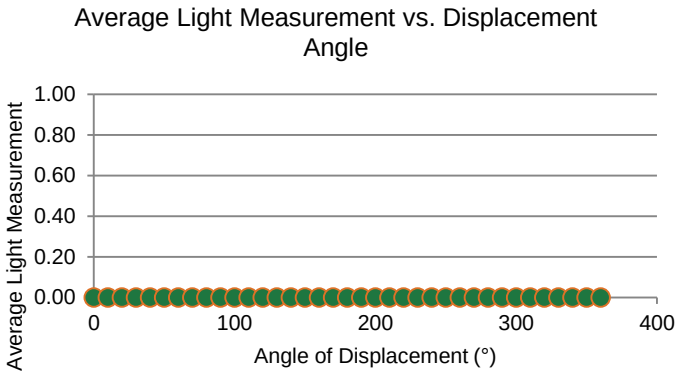


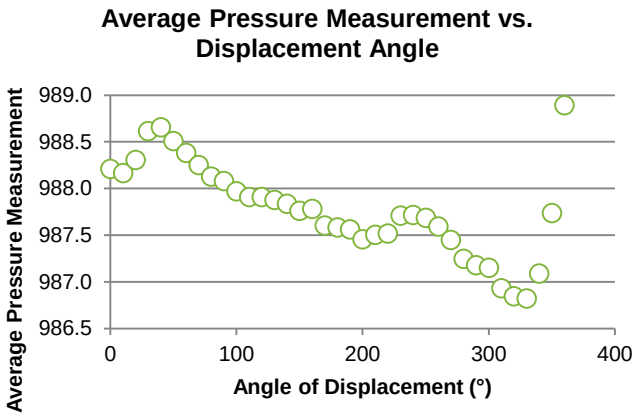


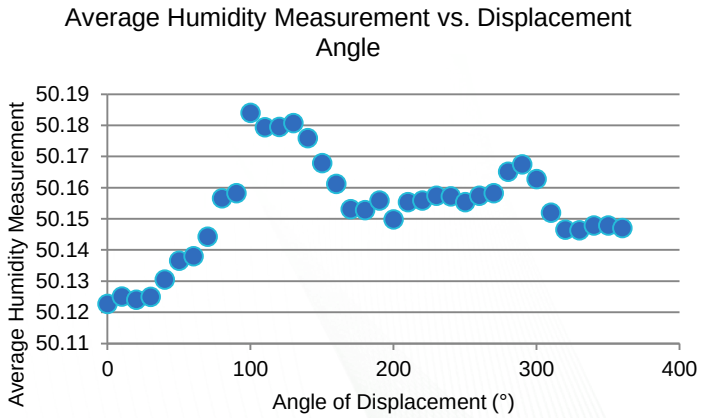
Sensor testing – indoor (Environmental sensors)
Box B5, location B

- Variation in our stable but uncontrolled lab is minimal
- Environmental chamber testing is next.









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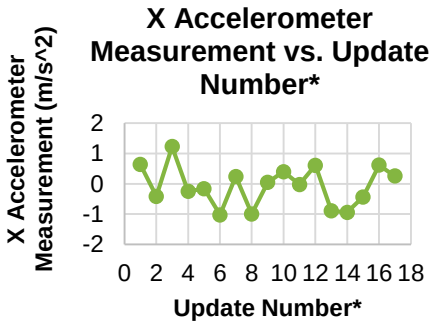
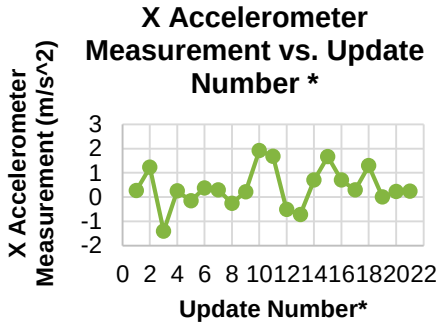
Sensor testing – indoor (Accelerometer)

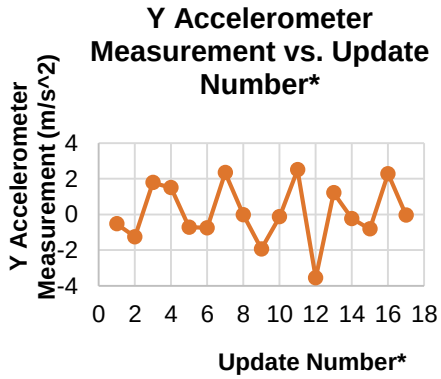
- The accelerometer was tested qualitatively by moving the box and stopping the movement with either a slow or fast action.
- 1st set of graphs represent a comparatively slow action.
- 2nd set of graphs represent a comparatively fast action.
- The large spikes in the Z-axis in the 2nd set is caused by the box lifting up as the cart was quickly stopped.

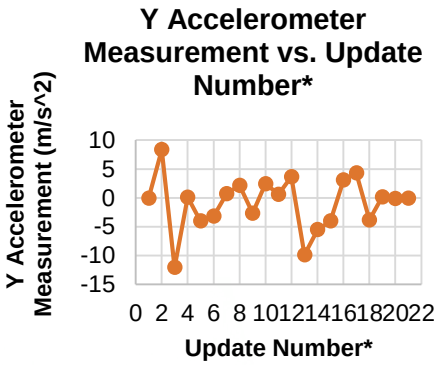
- Values make physical sense for the estimated qualitative force applied.

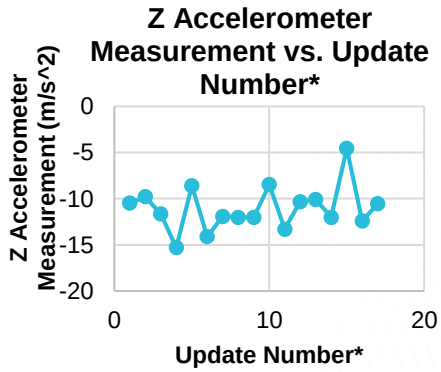
Box B3 qualitative accelerometer testing setup

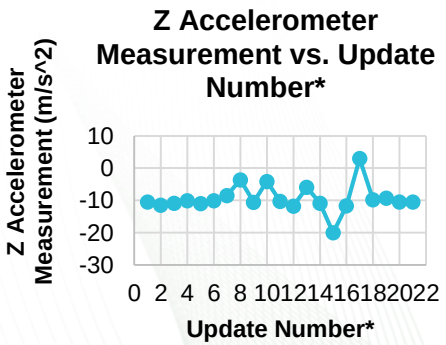












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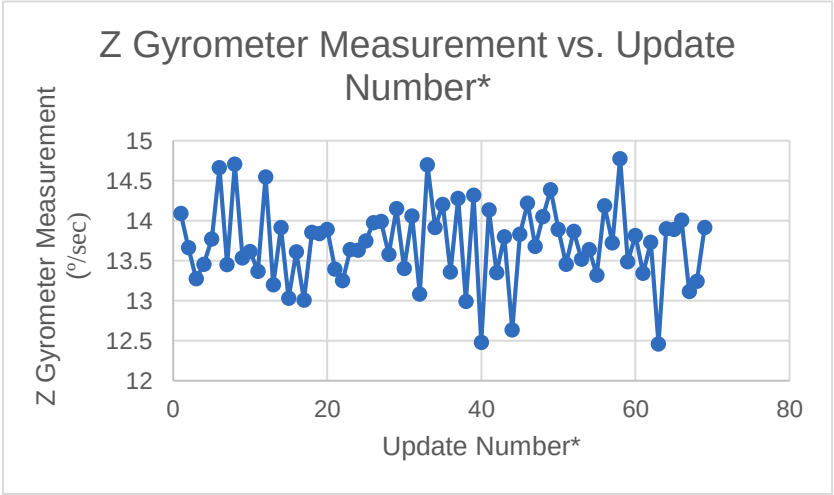
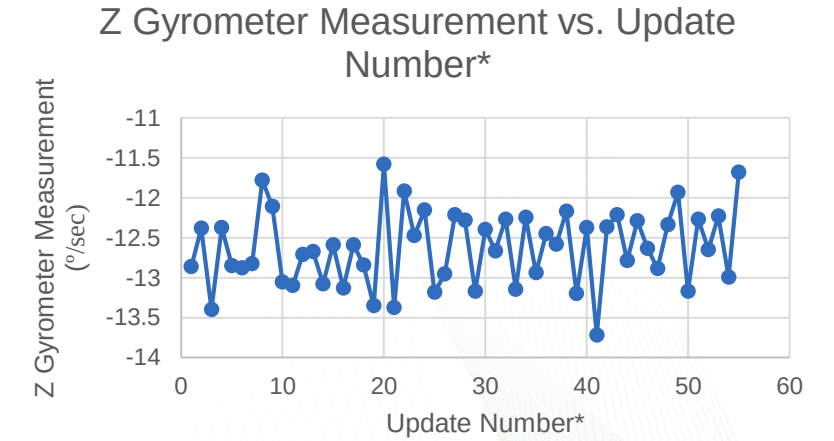
Sensor testing – indoor (Gyrometer)

- The gyrometer was tested using a turning table with an approximate angular velocity of 13.2º/sec.
- The box was oriented in the positive and negative Z-axis.
- The absolute values of the measurements differed.
- Difference was caused by differences in aligning the sensor with the middle of the table

- The 1st graph is the positive axis orientation.
- The 2nd graph is the negative axis orientation.





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Outdoor data collection

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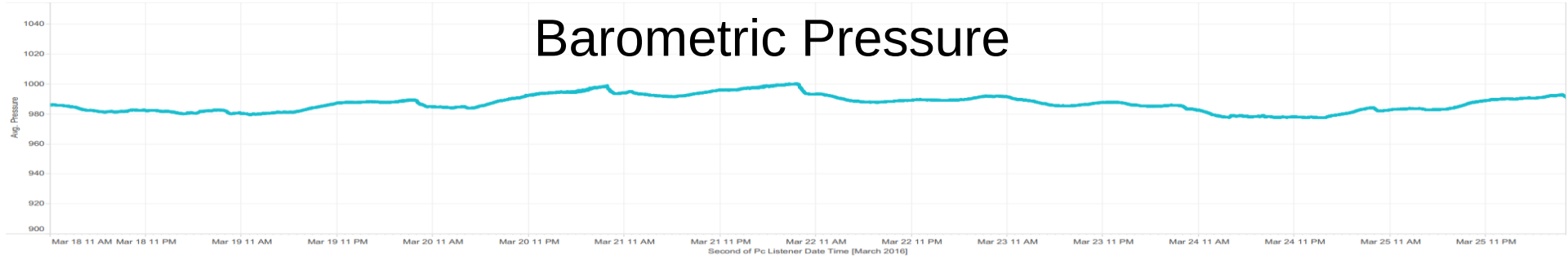
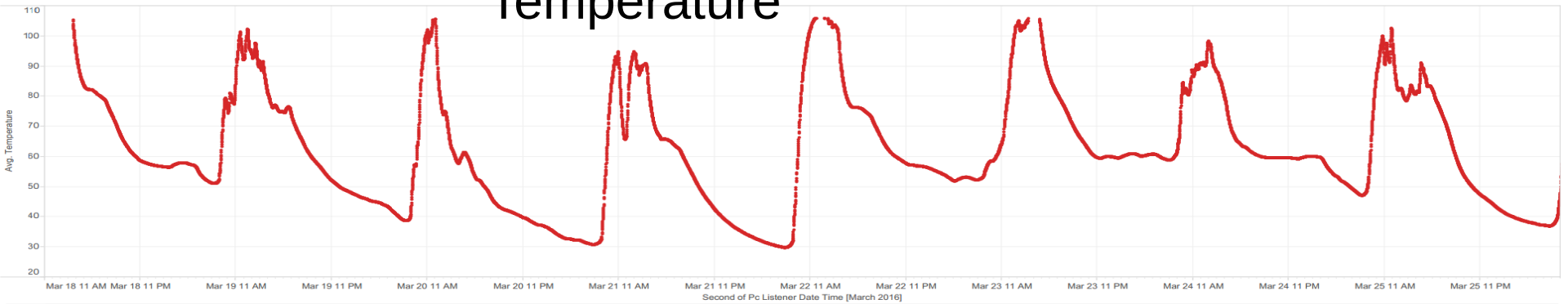
Outdoor data collection - March 18-25, 2016

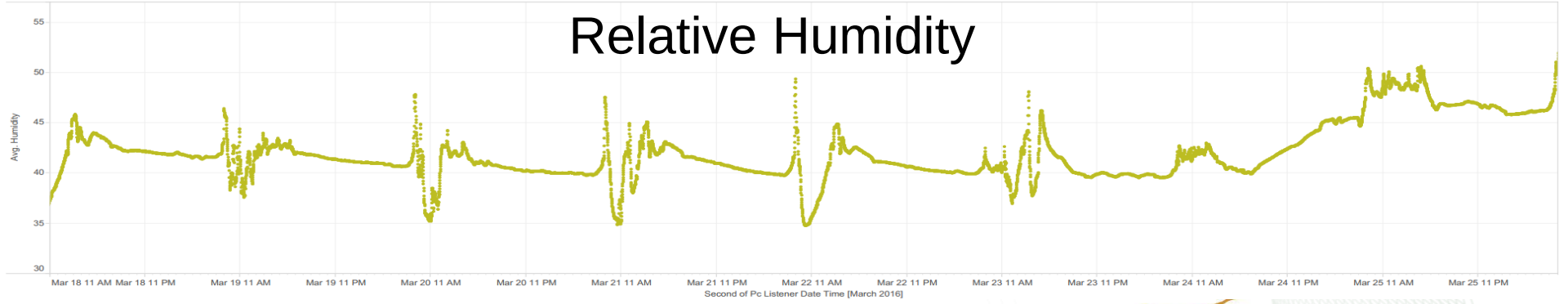
Barometric Pressure



Temperature



Relative Humidity



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Testing Plans

- Sensor testing in environmental chamber
- Begin intrusion testing and vulnerability review
- Battery life testing
- Rev C – Smaller form factor with flat battery, real-time clock, new box