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RuBee (IEEE 1902.1) Wireless Sensor Tag Applications in Aerospace and Defense: An Introduction to Harsh Environment Wireless Sensors and Prognostic Health Management.

Visible Assets, Inc.

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RuBee.

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RuBee (IEEE 1902.1) is a proven magnetic wireless technology, that emits no RF, automatically reads tags and sensors with 100% accuracy in harsh steel and water environments; is cost competitive; with 1,500 Active RuBee Worldwide Sites; and 20 Million Hours of 100% Reads.

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The Ten RuBee Advantages

1.Harsh Environment Immune

Inside steel, on steel
In water and through water up to 70' range
Under ground through dirt, water and snow

2.Approved by DoE and NNSA for Use in Secure Areas

No Compromising Emanations
No Tempest Risk
No Target Risk
No Eavesdropping Risk

3.Approved by DoD (NAVSEA) For Use on Small Arms

No Target Risk

4.Approved by FDA, Human Safe Meets IEEE C95.1

Mayo Clinic EMI Studies (ICD, Pacemaker, Equipment)

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The Ten RuBee Advantages

5. **Explosive Safe HERF Safe Meets Army STD 385-64**
   - **Sandia Study: Zero safe separation distance (SSD) on explosives**

6. **Approved by DoE for Use on Strategic Weapons**
   - **Sandia Study: Zero safe separation distance (SSD) on Nuclear Weapons**

7. **NAVSEA Tested HERO ZERO for fused ordnance**
   - **Tags: Zero safe separation distance on fused ordnance**
   - **Base Stations: Zero safe separation distance on fused ordnance**
   - **Handheld: Zero safe separation distance on fused ordnance**

8. **No Multipath Reflections**
   - **Translated means no destructive nulls in harsh steel environments**
   - **Signal strength can be used as a “tape measure” for tag distance**
   - **100% accurate read rates, even in harsh steel environments achieved**

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The Ten RuBee Advantages

9.Ultra Low Power – Optional 25 Year Battery Life

5 Year, 10 Year, 15 Year Field Tested Battery Life
Field Proven 25 Year Battery Life.

10. Sealed Potted Intrinsically Safe Tag

Tags and battery totally sealed meet ATE Zone 0, IP67, MIL STD 810F IEC 60079 Class IIC. Potted with 832-B IEC-60079-18 Epoxy

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RuBee Sensor Tags

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RuBee Tags come in many sizes and shapes

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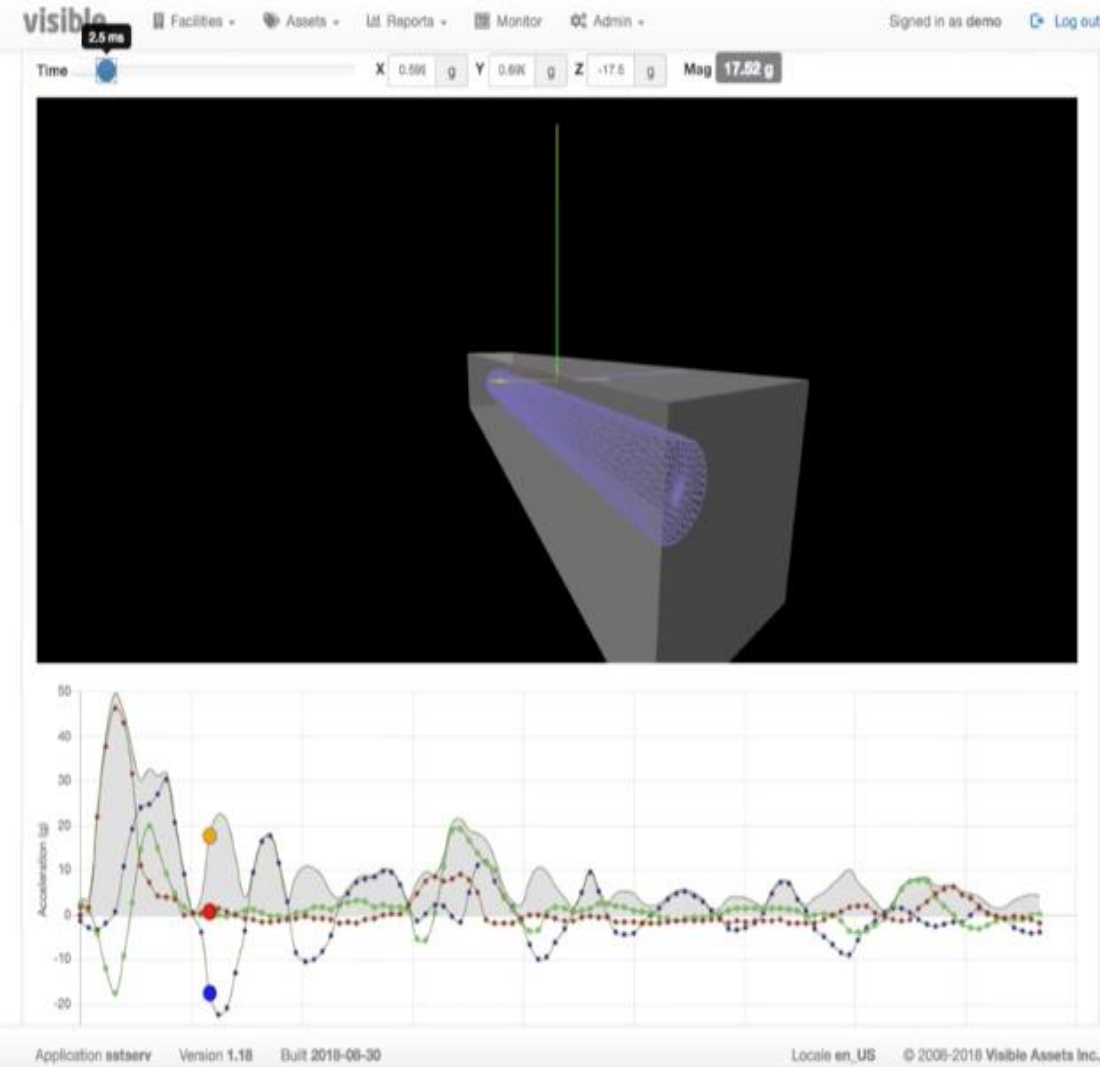
RuBee Sensor Tags



- Shock
- Vibration
- Temperature
- Humidity
- Atmospheric Pressure

- Reads Through Al Case
- 20 Year Battery

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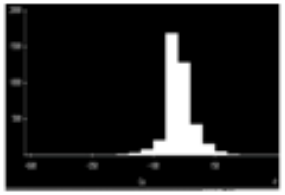
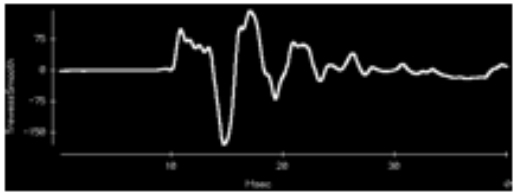
Example Sensor Data Map

Histogram



Data Log Date/Time vs Signal



Max

Event 1	*Red Flag*	*20 Bin x 12 Histogram*	*100 (144) x 12 Data Log*
Event 2		*20 Bin x 12 Histogram*	*100 (144) x 12 Data Log*
Event 3		*20 Bin x 12 Histogram*	*100 (144) x 12 Data Log*
Event 4		*20 Bin x 12 Histogram*	*100 (144) x 12 Data Log*
Event 5		*20 Bin x 12 Histogram*	*100 (144) x 12 Data Log*
Event 6		*20 Bin x 12 Histogram*	*100 (144) x 12 Data Log*
Event 7		*20 Bin x 12 Histogram*	*100 (144) x 12 Data Log*
Event 8		*20 Bin x 12 Histogram*	*100 (144) x 12 Data Log*

Min

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Asset Class Overview

192.168.15.105:8085/sstserv/

visible. Facilities Assets Reports Monitor Admin Signed in as **demo** Log out

Home / Asset Classes / Overview

Overview

+ Create Class

Asset Classes

Class	Last Read	Total	Safe	Out of range	Critical
T1 All configurations	2018-10-15 17:45:45 EDT 31 minutes ago	20	20	0	0
T2 All configurations	2018-10-15 17:45:45 EDT 31 minutes ago	20	20	0	0
T3 All configurations	2018-10-15 17:45:45 EDT 31 minutes ago	20	20	0	0
T4 All configurations	2018-10-15 17:45:45 EDT 31 minutes ago	20	20	0	0
T5 All configurations	2018-10-15 17:45:45 EDT 31 minutes ago	20	20	0	0

System status

Next scan
2018-10-16 06:00:00 EDT
12 hours from now

Last scan
N/A

Recently Viewed

Application **sstserv** Version **1.32t** Built **2018-10-02** Locale **en_US** © 2008-2018 **Visible Assets Inc.**

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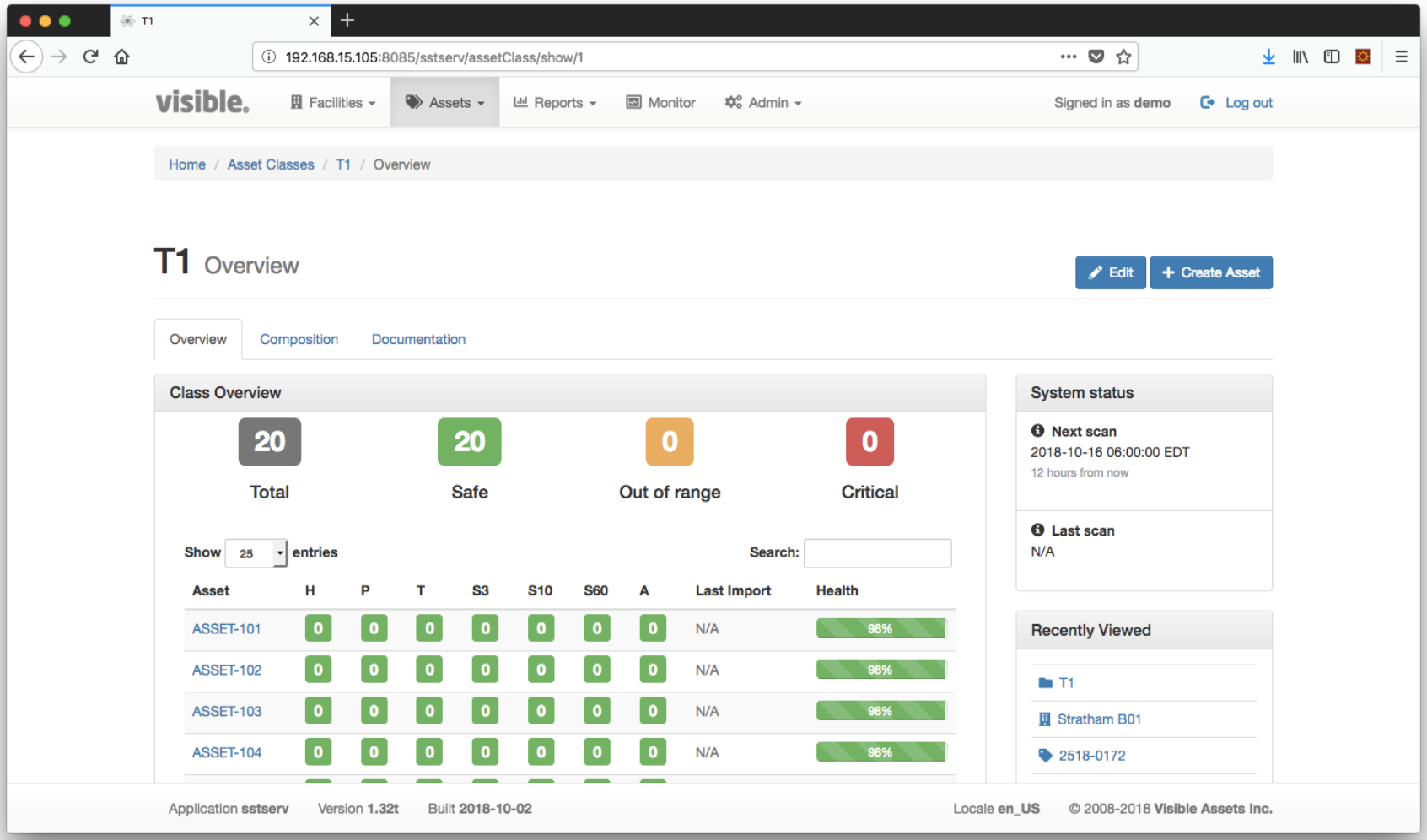

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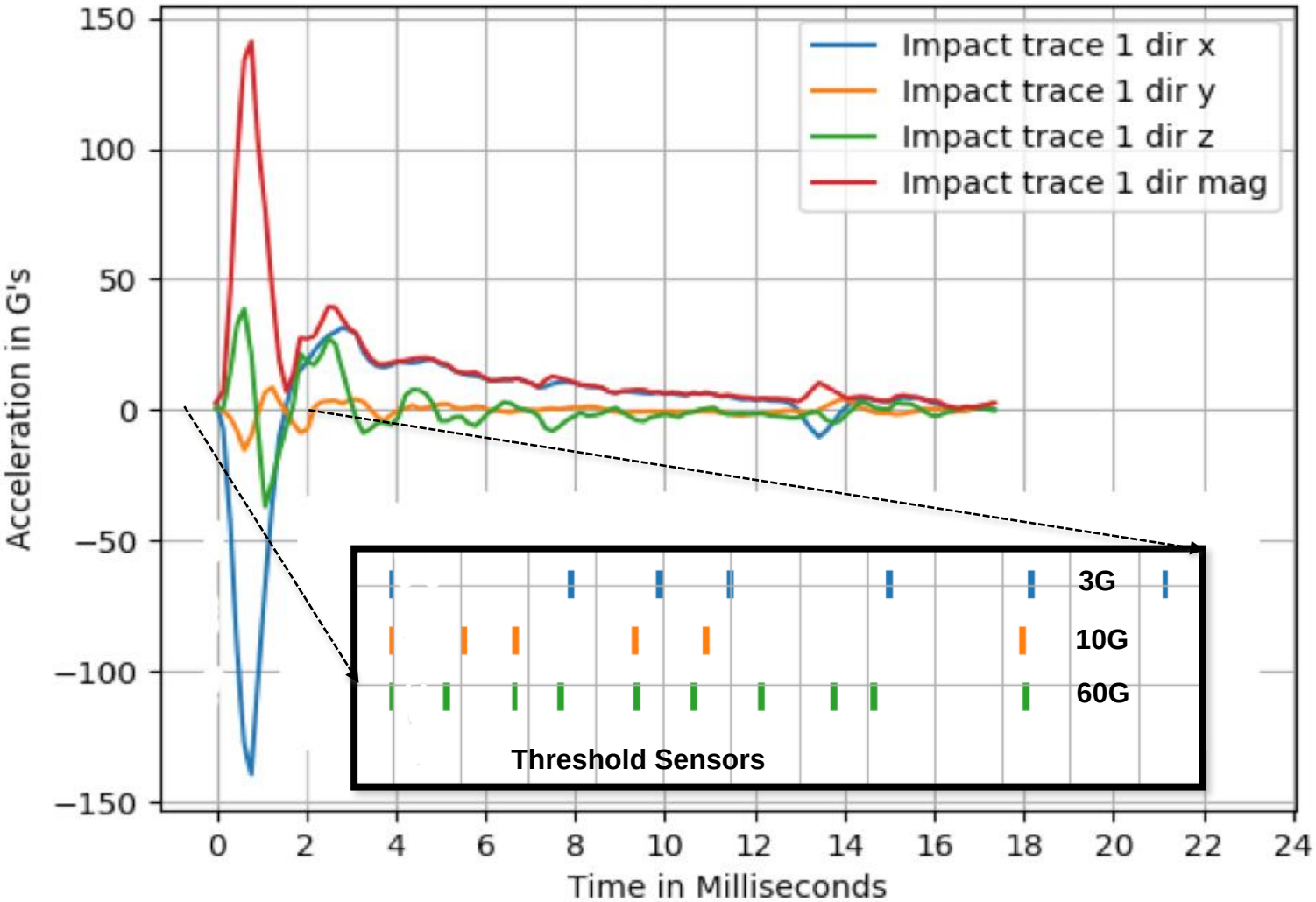
RuBee Sensor Tags

Shock and Vibration



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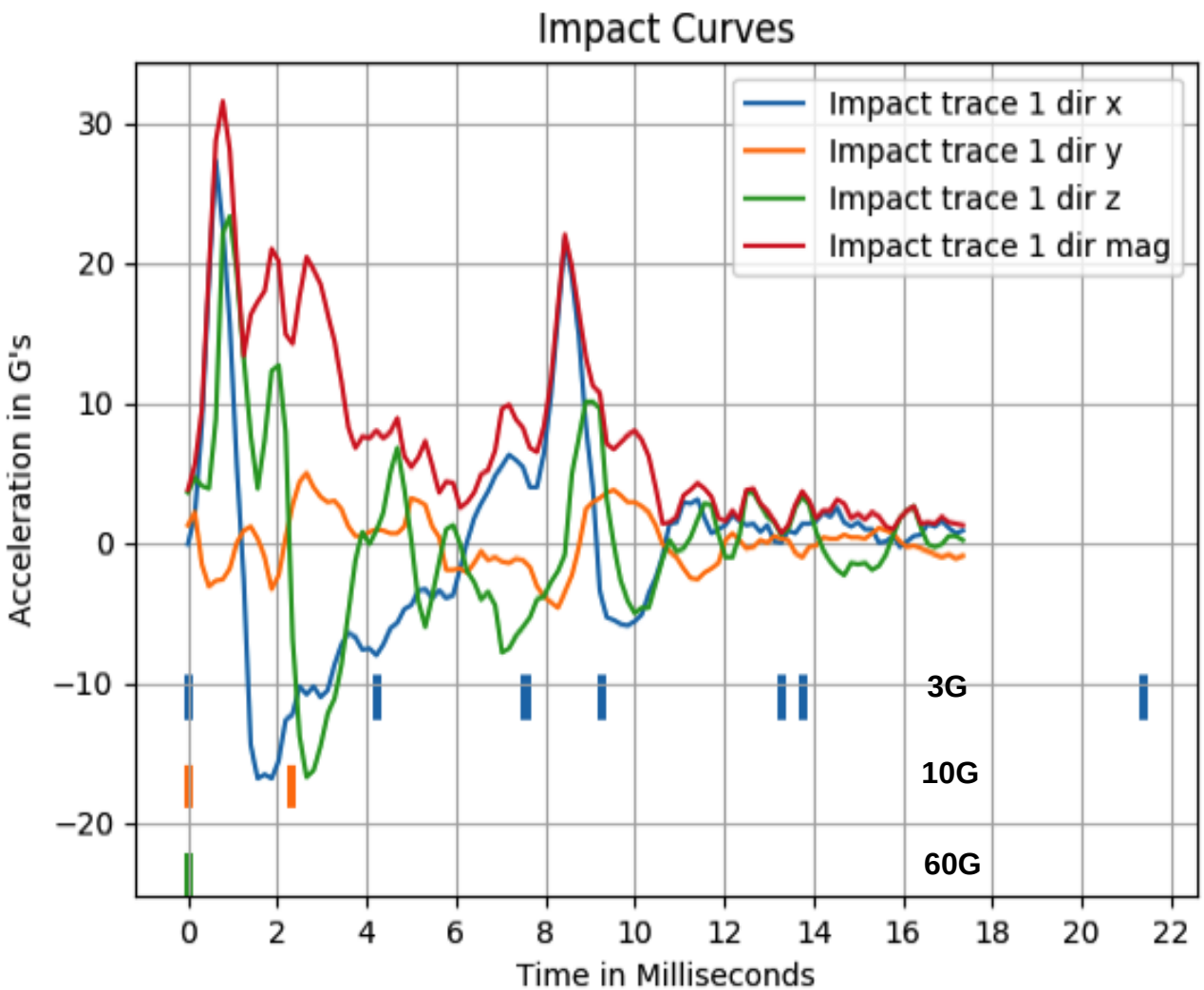
RuBee Sensor Tags

Shock and Vibration



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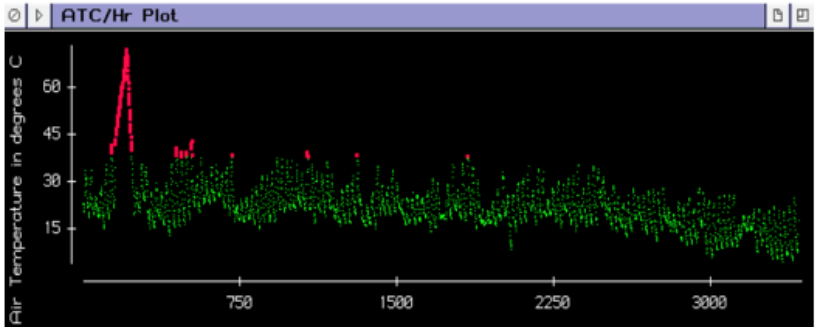
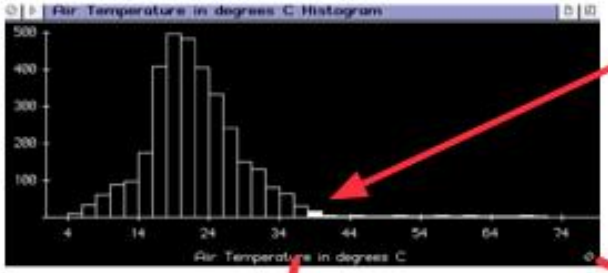
RuBee Sensor Tags

Temperature Arrhenius Life Calculation Example

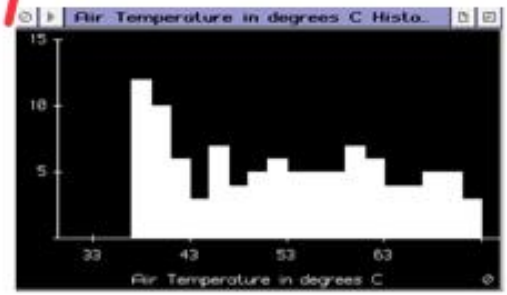


At 3,420 Hours Service Life reduced to 9.20 years

Temperature Histogram



38C Threshold



Count	102
Mean	52.6786
StdDev	10.6974
Min	38.1000
Max	71.9379

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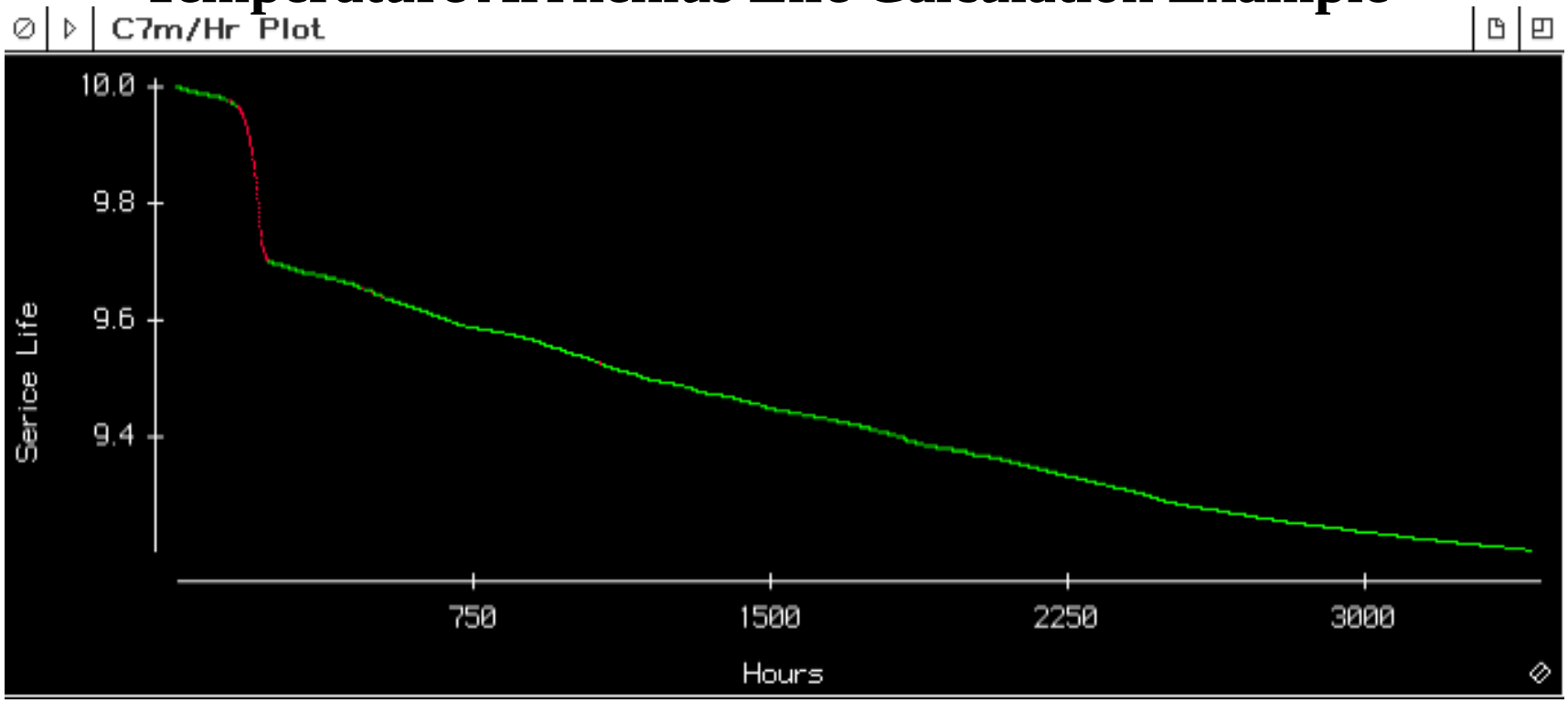
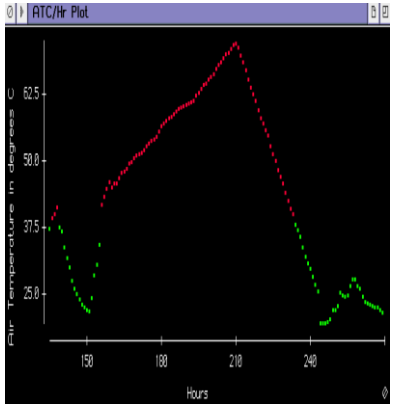
RuBee Sensor Tags

Temperature Arrhenius Life Calculation Example





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Readers + Antennas

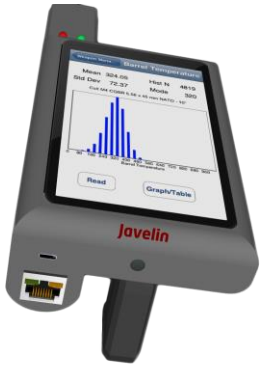
RuBee Fixed Routers

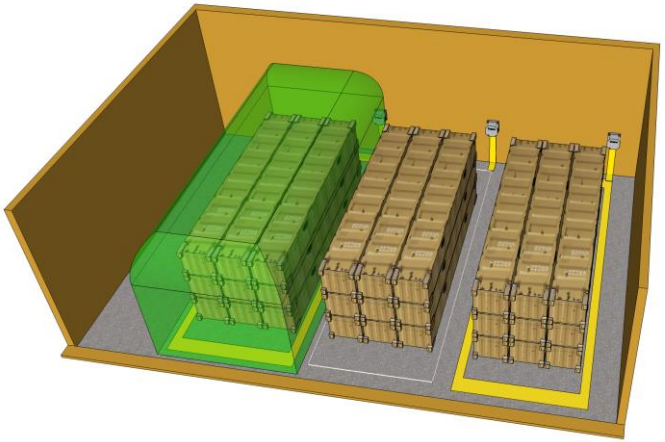
Nano loop

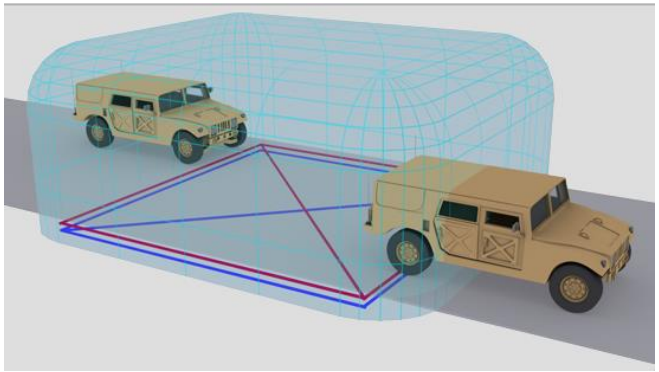
Nano Loop

RuBee Optimized Magnetic Wire

Mobile Readers







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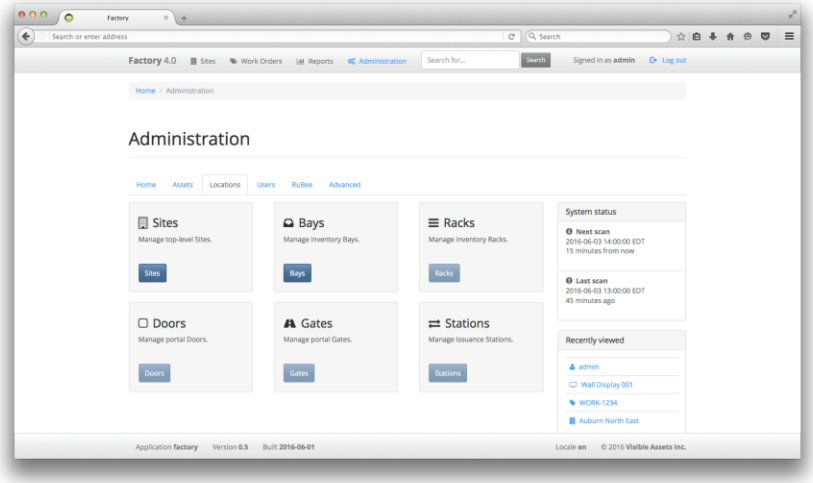
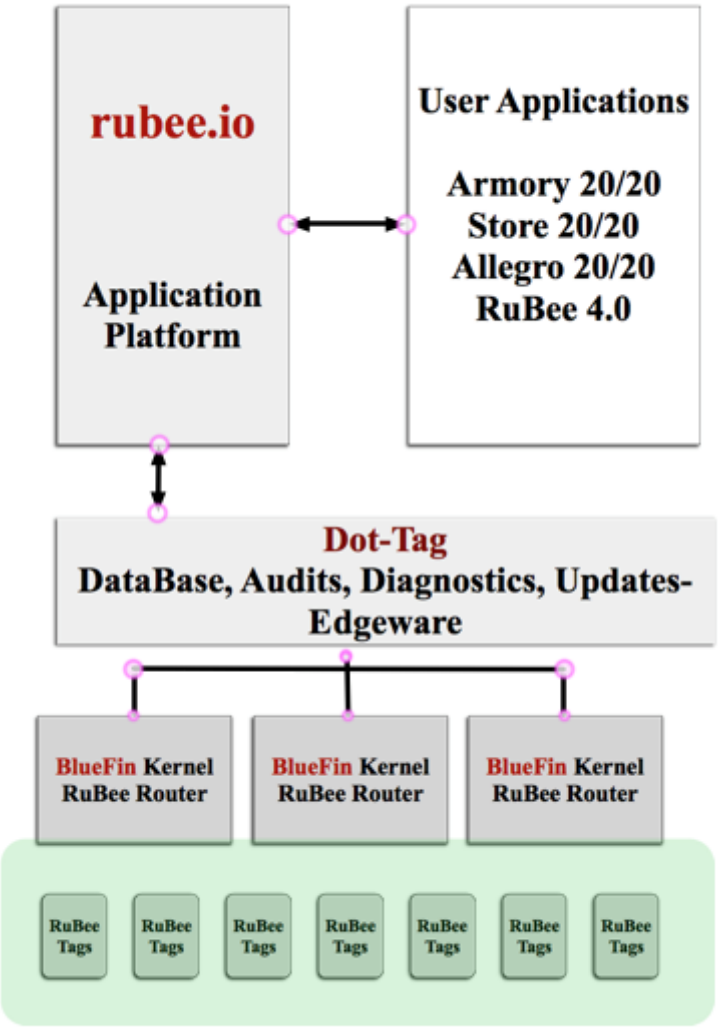
RuBee IO + Dot Tag

- RuBee IO is our Framework for Solution Products
  - Custom Assets, Locations, UI
  - User and Roles, Permissions
  - Integration with SAP, Oracle, and most other ERP Systems
- Dot Tag
  - RuBee System Diagnostics
  - Part 11 Signal Logs
  - AccuAudit - Blockchain





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What Makes RuBee so Different?

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The Answer: Physics

"A RuBee photon is magnetic ($\vec{B}$) not blocked by steel or water"

James Clerk Maxwell

Maxwell's Equation

$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0} \text{ (Gauss' Law - electrostatics)}$$

$$\nabla \cdot \vec{B} = 0 \text{ (Gauss' Law - magnetostatics)}$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \text{ (Faraday's Law)}$$

$$\nabla \times \vec{B} = \mu_0 \vec{J} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t} \text{ (Ampère-Maxwell Law)}$$

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The Answer: Physics

Undetectable E Power

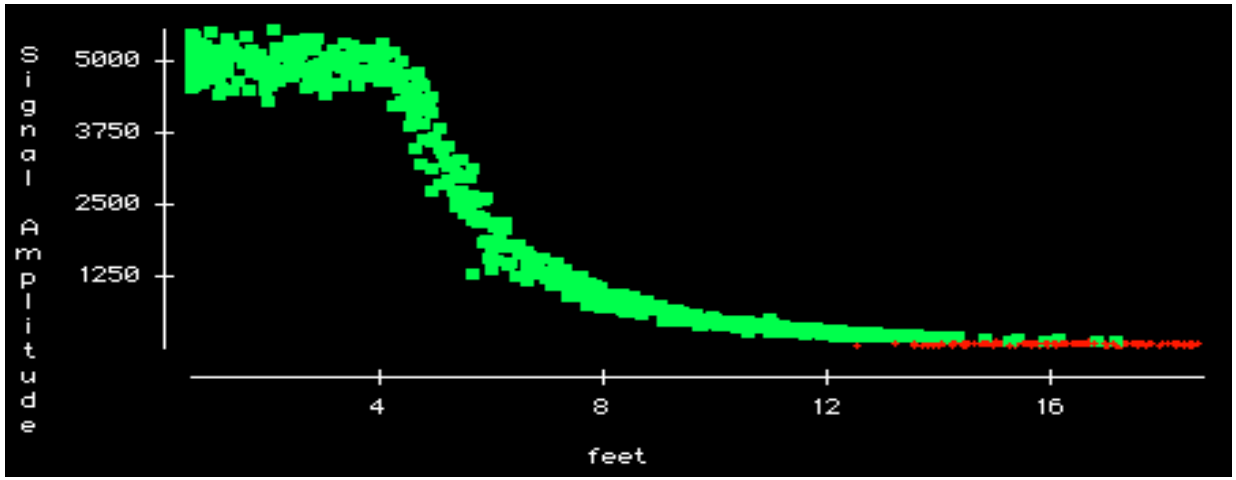
RuBee Wireless Does not Transmit using RF, “has no detectable RF power”

Base Station

10^{-9} Watts of E Power

40 Nanowatts

Tag 23



17 Feet (34 volume feet)

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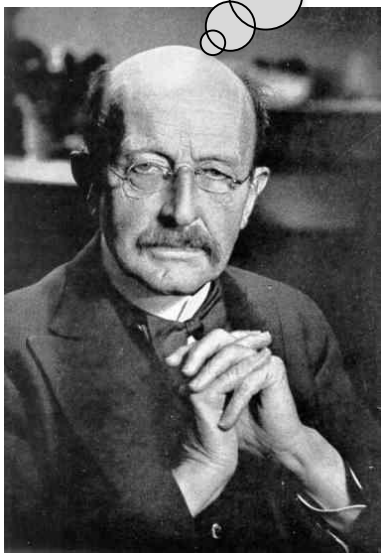
The Answer: Physics

"A RuBee photon requires 7,400 times less energy than a RFID photon"



Max Planck

Planck's Equation

$$E = h * \nu$$

E = energy in joules
h = Planck's constant
ν = frequency

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The Answer: Physics

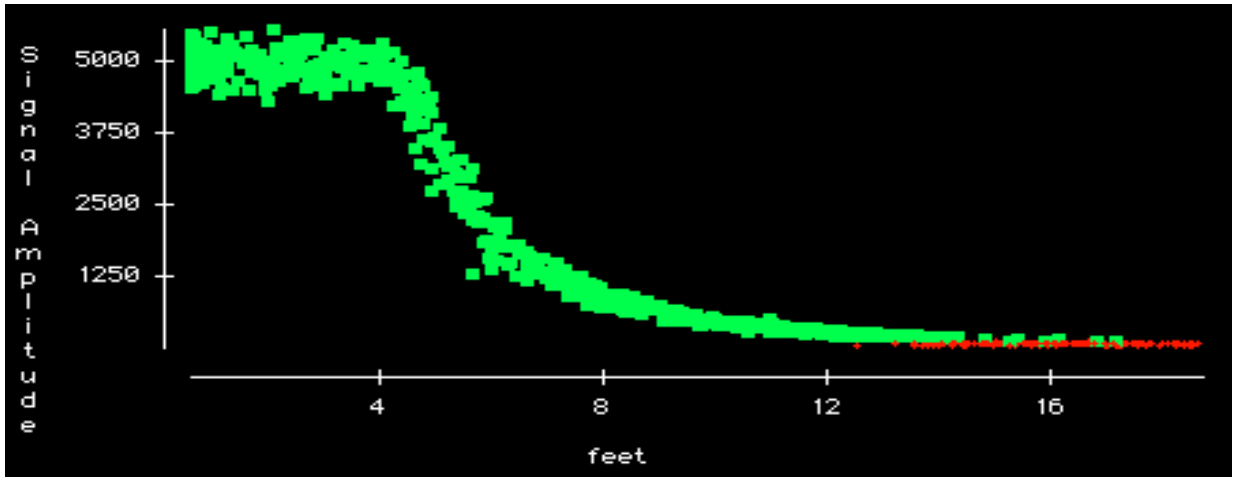
RuBee is Low Power B (magnetic energy)

RuBee wireless uses 1/5 to 1/30th the magnetic power found in many consumer exposed sites. Examples: airport metal detectors, and anti-theft protection systems in retail stores are all 5-10 times the power found in RuBee.

Base Station

600 mGauss B power from Base
50 mGauss B power from Tag

Tag 23



17 Feet (34 volume feet)

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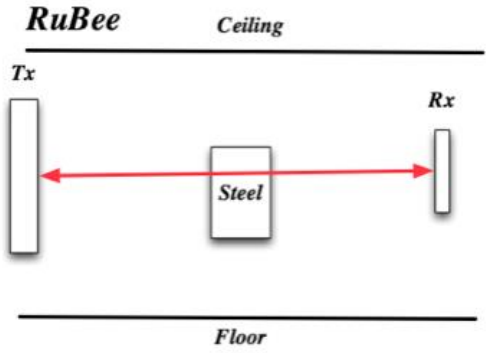
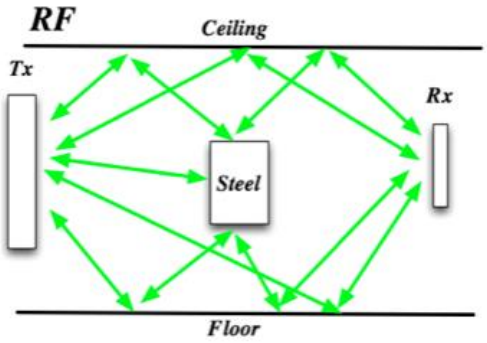
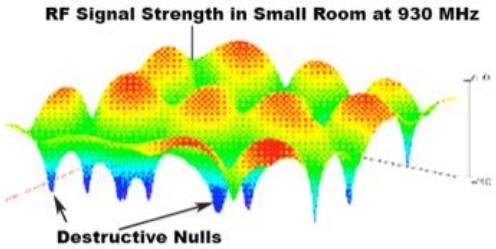
The Answer: Physics

RuBee Has No Multi-Path Reflections

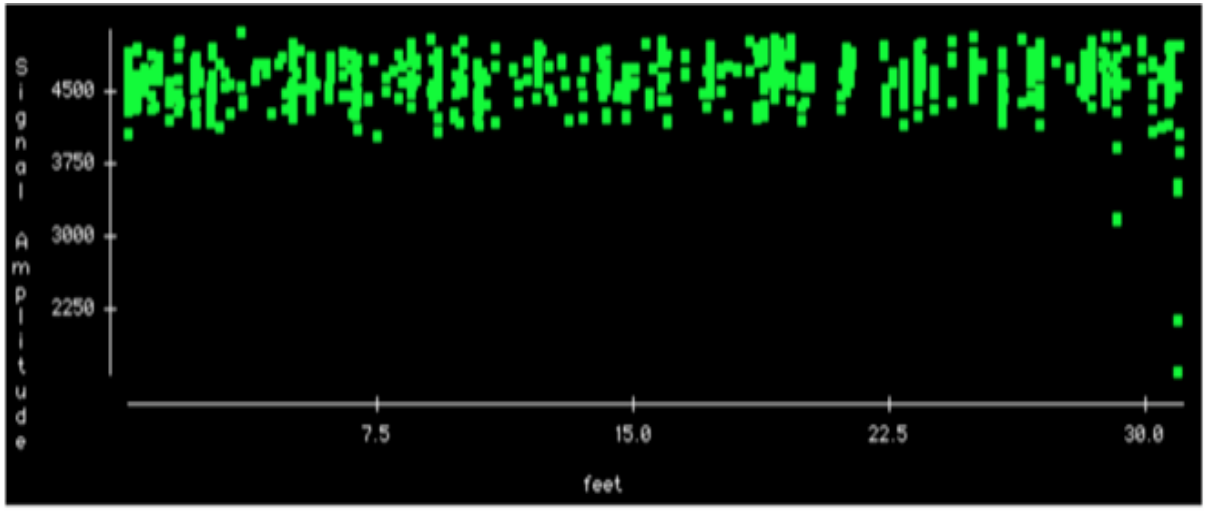






RF multi-path can create a swiss cheeses of nulls (credit SE Hill).

Signal Strength vs Distance Loop Antenna in Harsh Environment



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The Answer: Physics

From US Navy Report 8020/Q52/8554

Note:
Reverberation Chamber and Open Air Curves Superimpose

No Reflections Detected
Reverberation = Open Air

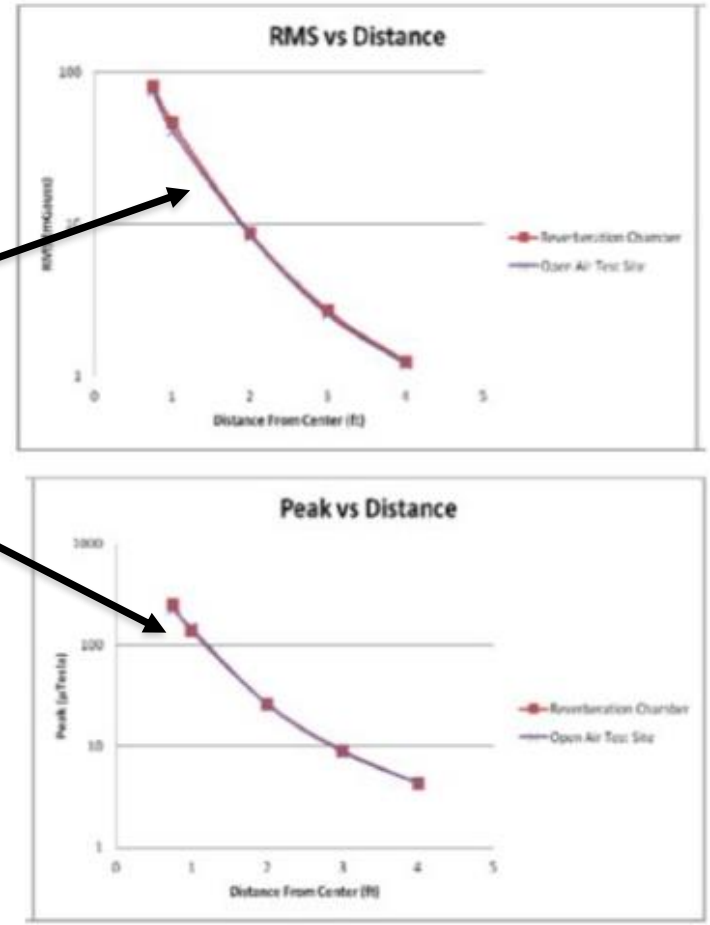

FIGURE 2. MEASUREMENTS AT OATS AND IN THE REVERBERATION CHAMBER USING THE MAGNETIC FIELD PROBE

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The Answer: Physics

Recent Independent Study:
Harsh Environment Read Rates @ 100%

Compared to competing technologies, RuBee brings the highest reliability and richest feature set.

	RFID	RuBee
Real-time store audits	80%	~100%
Real-time asset location	80%	~100%
Exit/entry detection	20-30%	~100%
Backroom rack audits	80%	~100%
Human safety	×	✓
Tag cost	High	Higher
Antenna visibility	Visible door gates Hard to conceal ceiling	Hidden nano loops or visible door gates

RFID has limitations, including:
- Data and read rate inaccuracies
- Location precision inaccuracies
- Security issues such as Tag modification or disablement and cloning
- Difficulty reading through objects, including water, concrete and metals
- Passivity (tags do not broadcast)

RuBee overcomes RFID's challenges:
- 100% accuracy reading rate
- Asset location reliability, which solves precision issues
- Enhanced security protocols
- Relying magnetism as opposed to radio frequencies
- Allows for accurate reads in harsh conditions, including liquids, metals, etc.

8

Capgemini Consulting AMBITION MADE POSSIBLE

applied innovation exchange

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Thank You

Video demonstrations:

Exit/Entry Detection: https://rubee.wistia.com/medias/t3pi2e5x8d
Sensor Tag Inside Case: https://rubee.wistia.com/medias/8sf6kn3kdp