Radio Frequency Identification Pilot Project

ICAR / 2008

Kansas State University
And
Kansas Animal Health Dept.
Bryan Rickard
6/19/2008

Overview:

- *Kansas NAIS – RFID Pilot Project*

NAIS & RFID Technology…

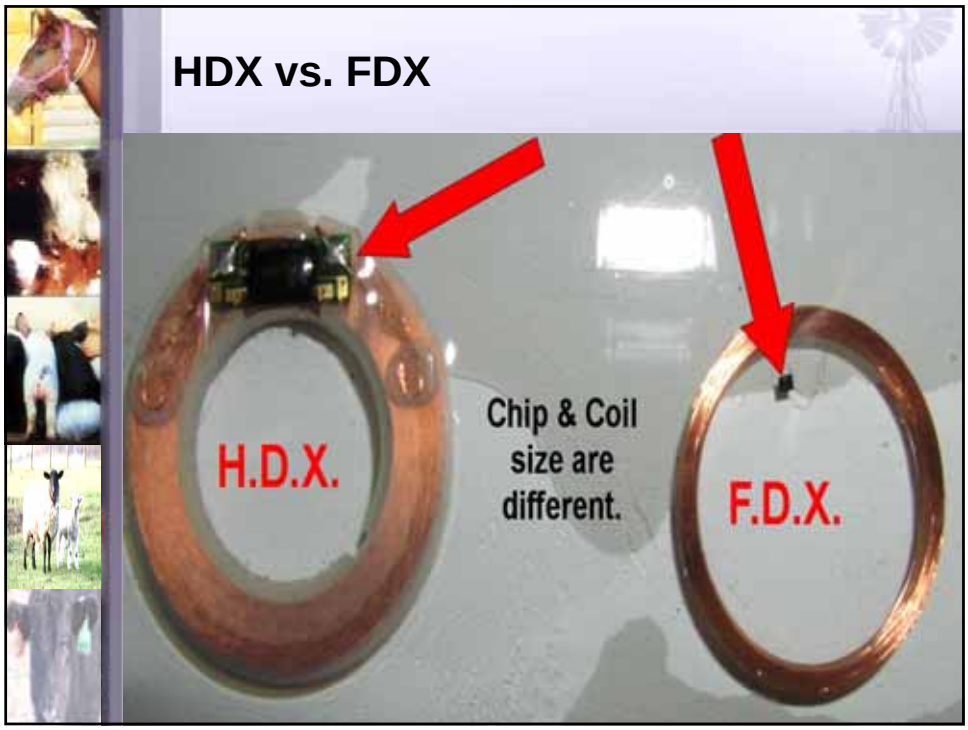
What is RFID?

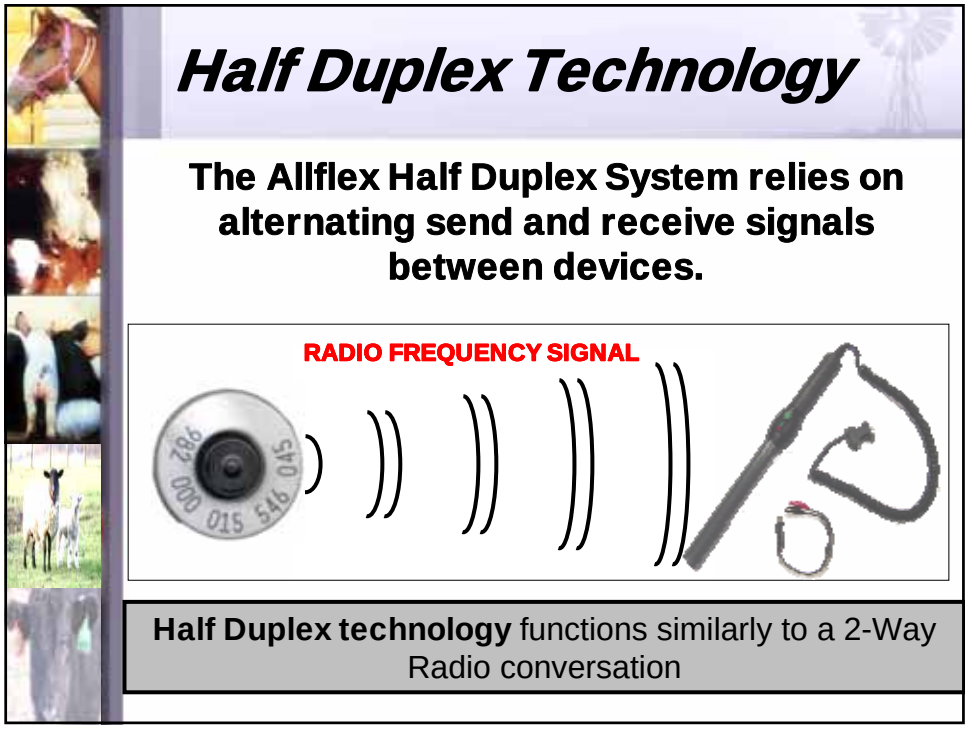
Radio Frequency ID (RFID) uses low frequency radio transmission to send a signal between an ID device and a reader.

RFID transponders are either

‘Active’ or ‘Passive’

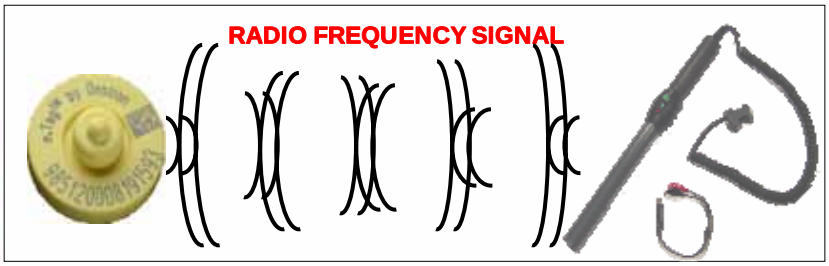
‘Full Duplex’ or ‘Half Duplex’


HDX vs. FDX
H.D.X.
Chip & Coil size are different.
F.D.X.


Half Duplex Technology
The Allflex Half Duplex System relies on alternating send and receive signals between devices.
RADIO FREQUENCY SIGNAL
Half Duplex technology functions similarly to a 2-Way Radio conversation

Full Duplex Technology

A Full Duplex system relies on constant sending and receiving of the RFID signal between devices.



The *Full Duplex* (FDX) technology functions similarly to a telephone conversation.

RFID Standards

134.2 kHz Low Frequency Passive RFID

International Organization for Standardization

- **ISO Standards:**
  - **ISO 11784**
    - Radio Frequency ID of Animals, Code Structure—Specifies the RFID code for use with animals.
  - **ISO 11785**
    - Radio Frequency ID of Animals, Technical Concept—Deals with how a transponder is activated and how the information stored in the transponder is transferred to a transceiver.

Why Standardize ?

- **Maintains competition within the market-place, without allowing a stand alone technology to develop.**
- **Enables compatibility among ISO approved readers and ISO approved tags.**
- **Understand that all tags and readers aren't created equally and although they may be ISO approved, there are performance differences.**

Kansas Animal Health Department

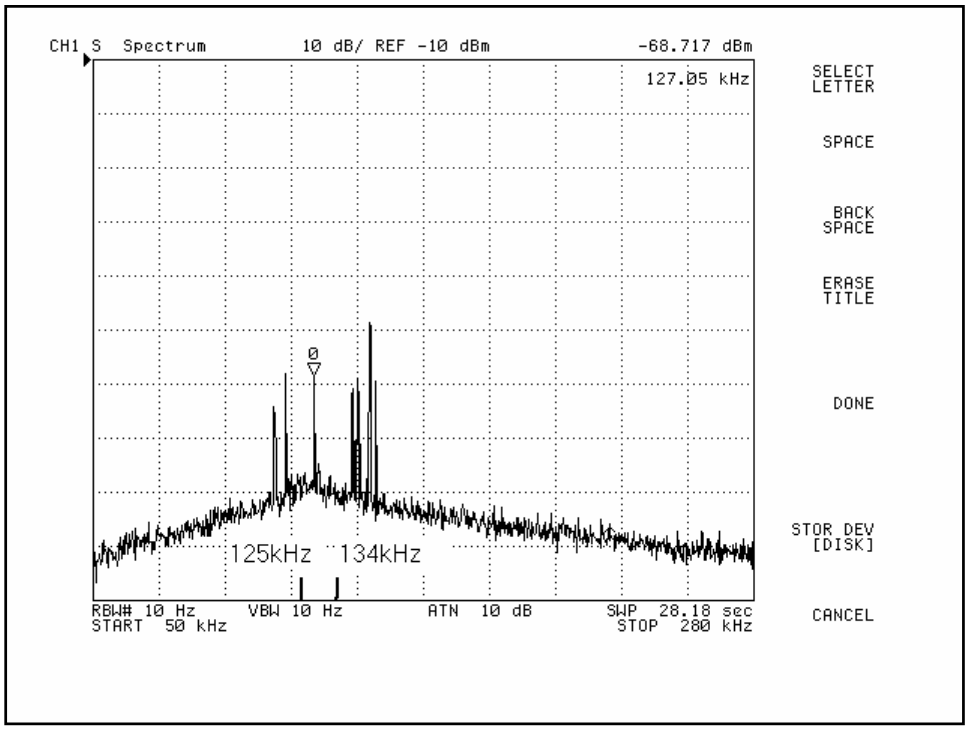
2006-2007 USDA NAIS Pilot Project

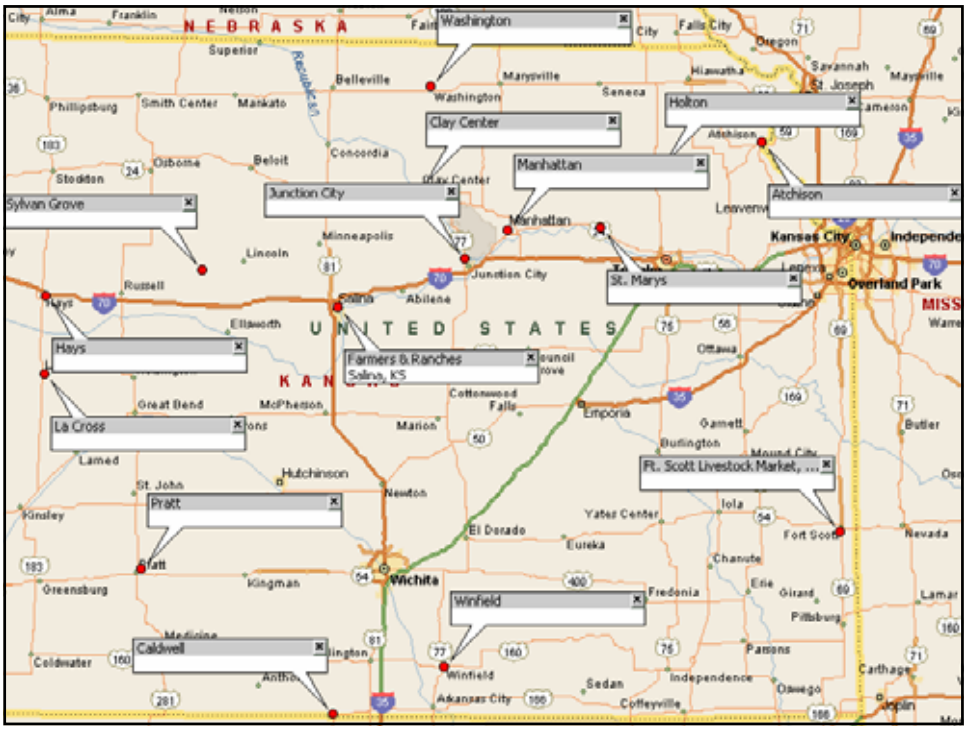
National Animal Identification System -- Pilot Program --

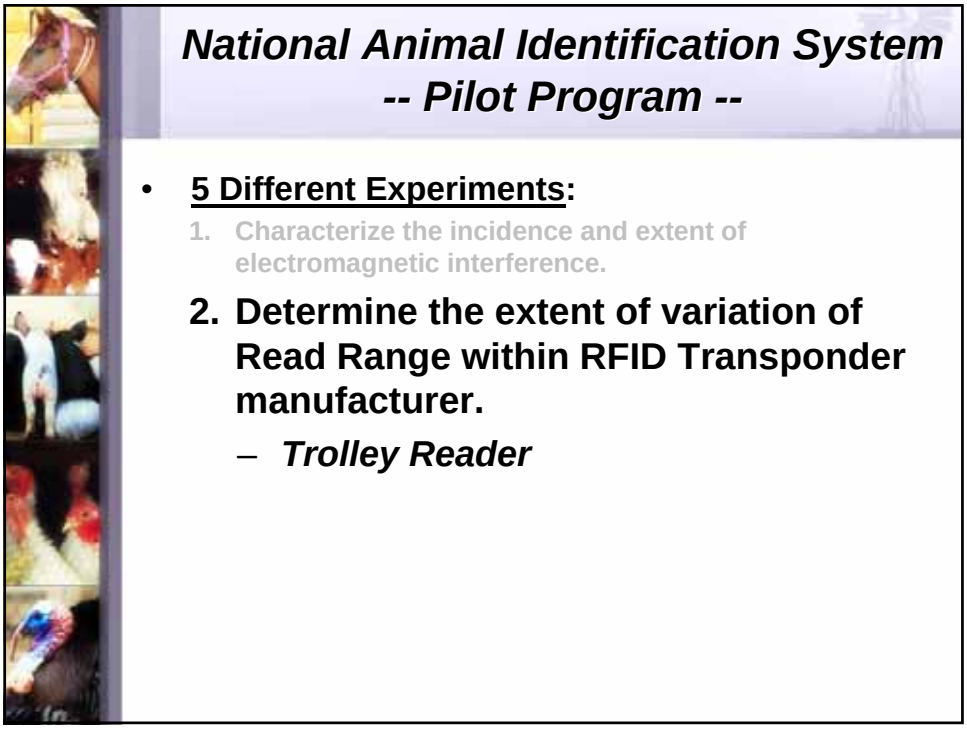
- **5 Different Experiments:**
  1. **Characterize the incidence and extent of electromagnetic interference affecting RFID functionality in Livestock Markets, Feed Yards, and Slaughter Facilities.**

National Animal Identification System -- Pilot Program --

- **5 Different Experiments:**
  1. **Characterize the incidence and extent of electromagnetic interference = EMI affecting RFID function in Livestock Markets, Feed Yards, and Harvest Facilities.**

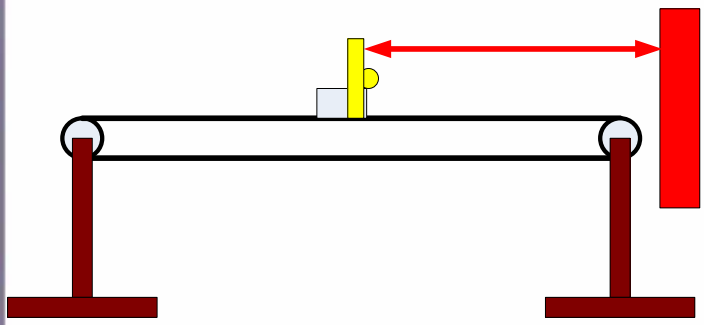

CH1 S Spectrum
10 dB/ REF -10 dBm
-68.717 dBm
127.05 kHz
SELECT LETTER
SPACE
BACK SPACE
ERASE TITLE
DONE
STOR DEV [DISK]
CANCEL
125kHz
134kHz
RBW# 10 Hz
VBW 10 Hz
ATN 10 dB
SWP 28.18 sec
START 50 kHz
STOP 280 kHz


Washington
Clay Center
Manhattan
Junction City
Sylvan Grove
Holton
Atchison
St. Marys
Hays
Farmers & Ranches
Salina, KS
La Cross
Pratt
Ft. Scott Livestock Market, ...
Winfield
Caldwell
Wichita
UNITED STATES
NEBRASKA
KANSAS


National Animal Identification System
-- Pilot Program --
• 5 Different Experiments:
1. Characterize the incidence and extent of electromagnetic interference.
2. Determine the extent of variation of Read Range within RFID Transponder manufacturer.
– Trolley Reader

Trolley Reader

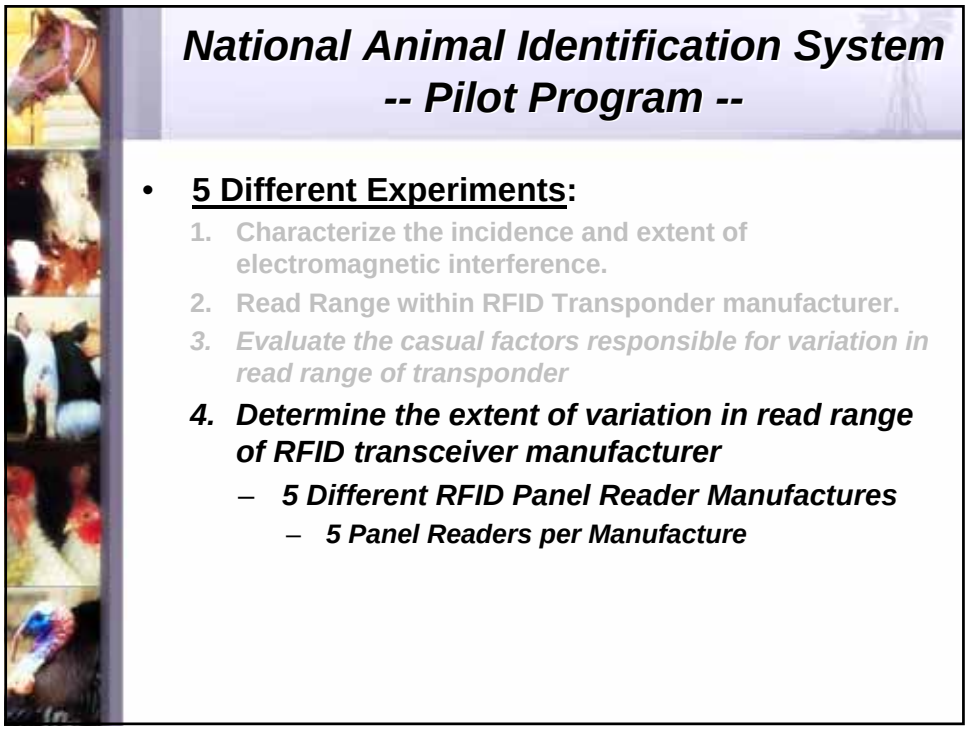
- **Side View**:



Motor

National Animal Identification System -- Pilot Program --

- **5 Different Experiments**:
  1. Characterize the incidence and extent of electromagnetic interference.
  2. Read Range within RFID Transponder manufacturer.
  3. **Evaluate the casual factors responsible for variation in read range of transponder.**
     - ***Resonant Frequency** = (A measure of the radio frequency at which RFID Tag Signal is being sent to the RFID Reader.)*
     - ***Voltage Response testing** = (Strength of signal from RFID tag to RFID tag reader.)*
       - *Oscilloscope*


National Animal Identification System
-- Pilot Program --
5 Different Experiments:
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2. Read Range within RFID Transponder manufacturer.
3. Evaluate the casual factors responsible for variation in read range of transponder
4. Determine the extent of variation in read range of RFID transceiver manufacturer
– 5 Different RFID Panel Reader Manufactures
– 5 Panel Readers per Manufacture

National Animal Identification System -- Pilot Program --

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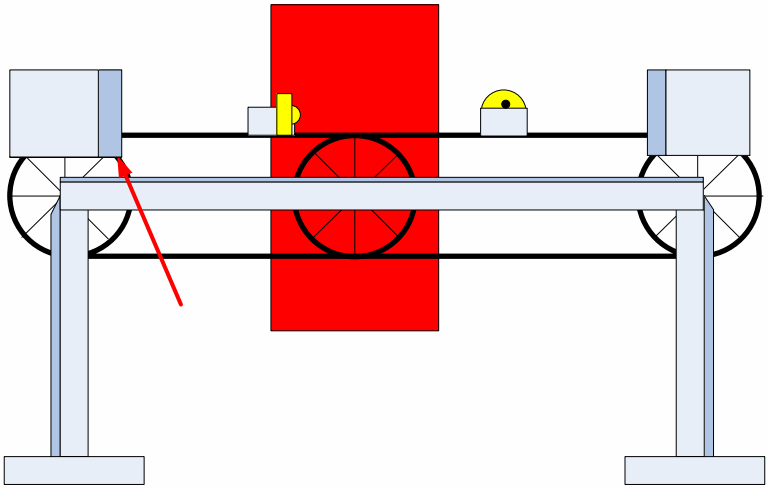
  5. **Access the effects of orientation and rate of movement of RFID transponders on transponder readability in a lab environment.**
     - ***Variable Speed Belt Reader***

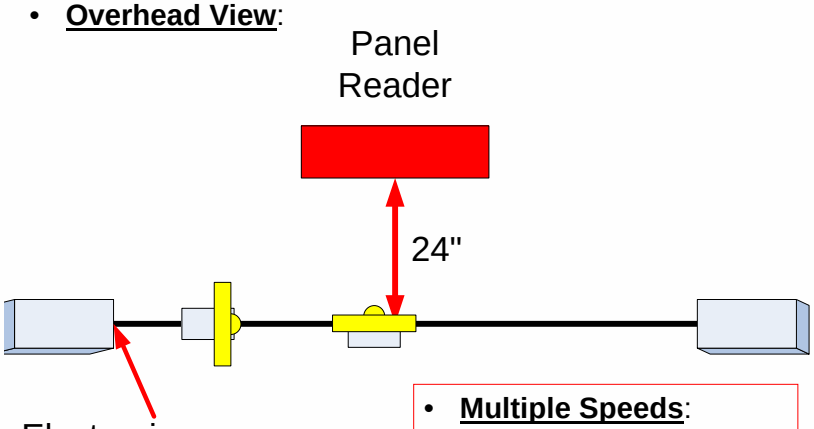
Belt Reader

- **Side View**:



Belt Reader

- **Overhead View**:



- **Multiple Speeds**:
  - **3.28 ft/s**
  - **10 ft/s**

National Animal Identification System -- Pilot Program --

Transponders consisted of six different types (n=500/type) including:

- **Allflex HDX High Performance Ultra EID Tag**
- **Allflex FDX Lightweight Ultra Bovine EID Tag**
- **Destron FDX-B E. Tag®**
- **Farnam New Z® Tag (FDX)**
- **Temple FDX Tamper Evident EID Tag**
- **Y-Tex ISO TechStar™ II FDX**

National Animal Identification System -- Pilot Program --

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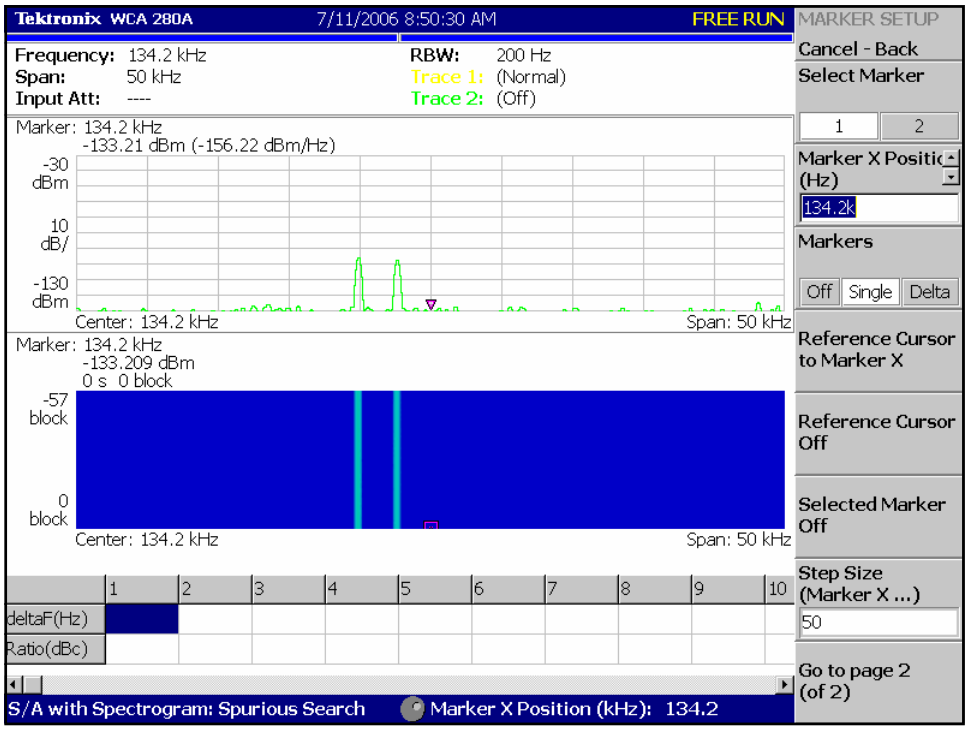
- Allflex FDX Lightweight Ultra Bovine EID Tag
- **Destron FDX-B *E. Tag*®**
  - ***EM Microelectronic Chip***
  - ***Phillips HiTag Chip***
  - ***HiTag with Washer***
- Farnam New Z® Tag (FDX)
- Temple FDX Tamper Evident EID Tag
- Y-Tex ISO TechStar™ II FDX

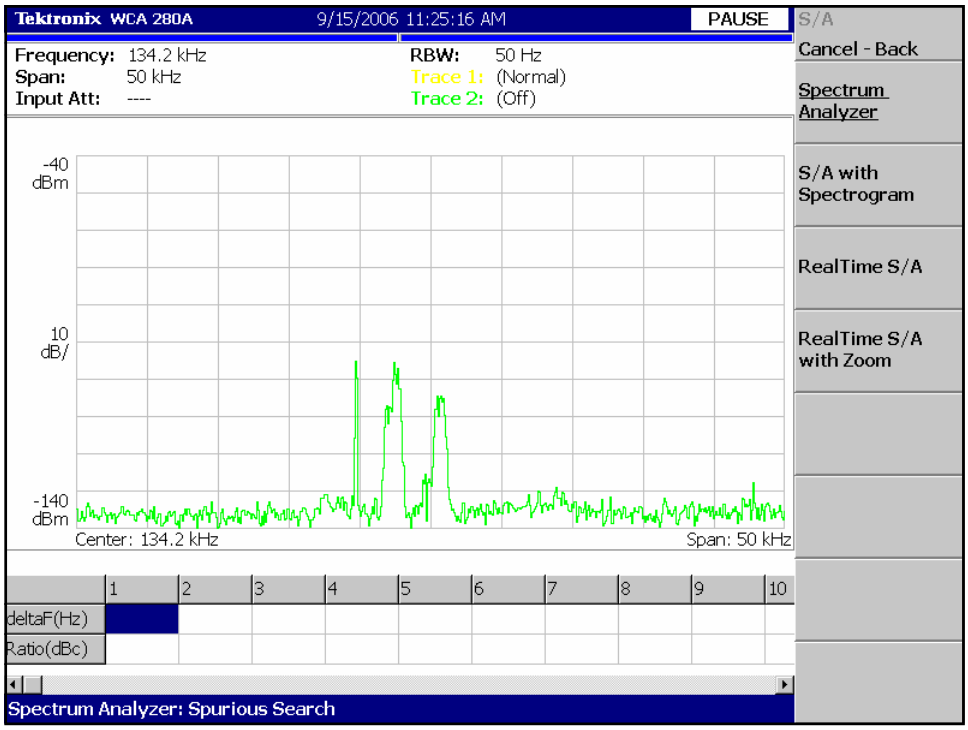
National Animal Identification System -- Pilot Program --

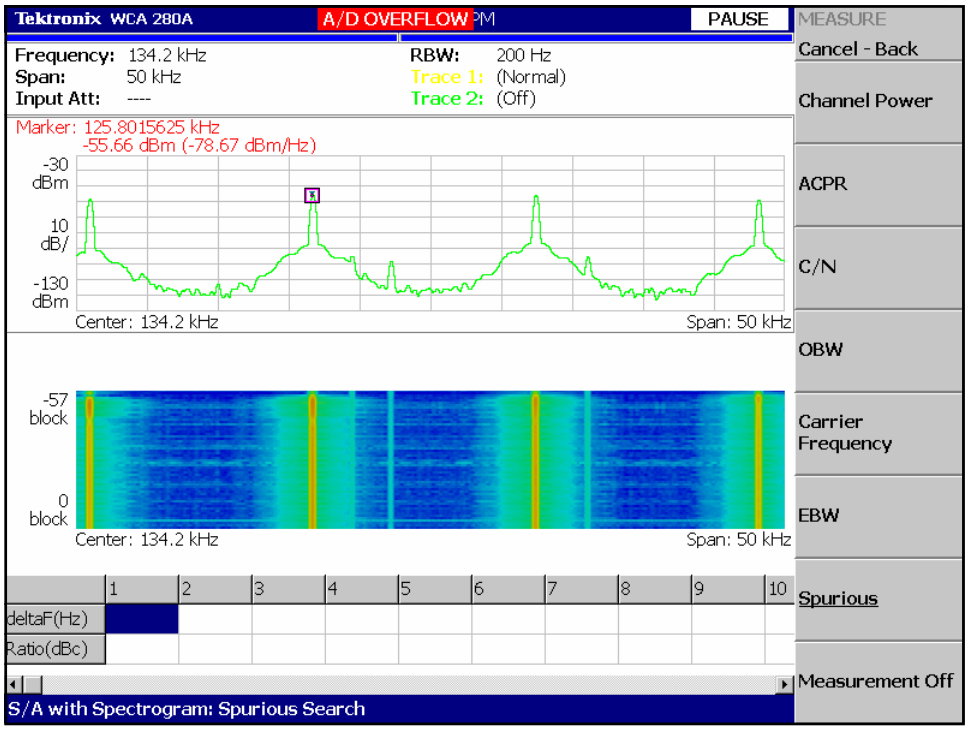
- **<u>Summation of the 5 Experiments</u>:**
  - **From the 3000 tags tested (*from the five different RFID manufacturers*), a set of "*pedigree tags*" was created (tested during experiments 1-6)**
    - ***Of the 3000 RFID tags, we will statistically sort the tags into a ranking (by performance of the experiment results) in to a group of the Bottom 25% Performers (poorest performance)/ Middle 50% / Top 25% (best performers)***
  - **The middle 50% of the "Pedigree Tags" will be placed in animals and tracked, (RFID tag reads captured), through the animal's production cycle.**
    - **Livestock Market / Feed Yard / Harvest Facility**
    - **Results of the RFID read rates will be reported as such.**

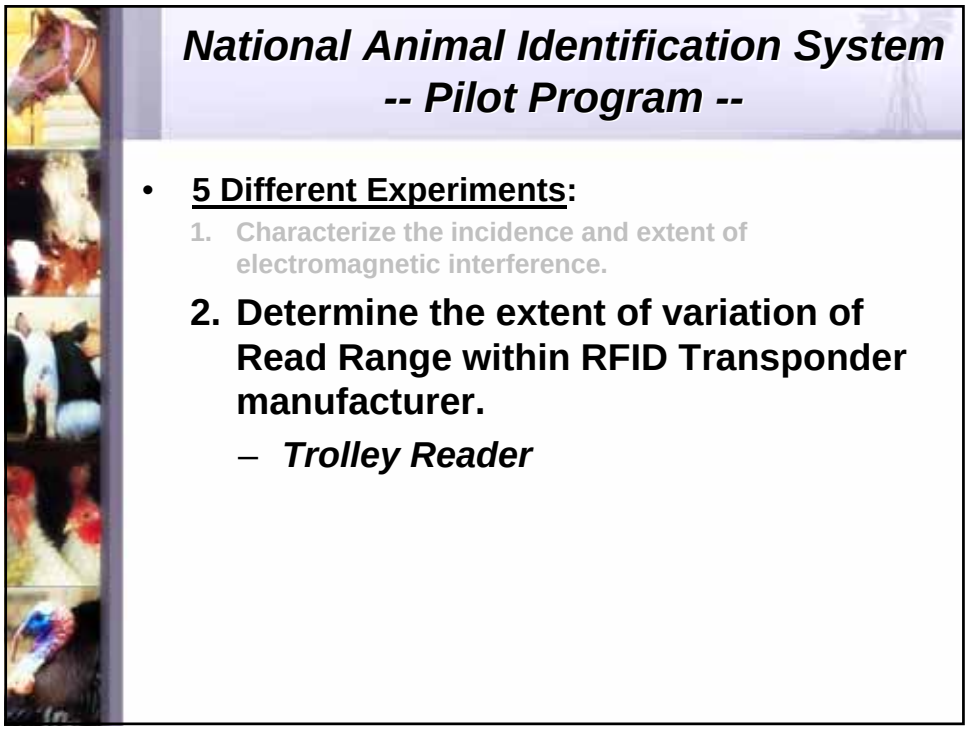
National Animal Identification System -- Pilot Program --

- **<u>5 Different Experiments</u>:**
  1. **Characterize the incidence and extent of electromagnetic interference affecting RFID function in Livestock Markets, Feed Yards, and Harvest Facilities.**
     - ***Spectrum Analyzer***
       - ***Livestock market***
         - ***Unload Facilities***
         - ***Sale Ring Exit***
         - ***Load-out Facilities***


Tektronix WCA 280A
7/11/2006 8:50:30 AM
FREE RUN
Frequency: 134.2 kHz
Span: 50 kHz
Input Att: ----
RBW: 200 Hz
Trace 1: (Normal)
Trace 2: (Off)
Marker: 134.2 kHz
-133.21 dBm (-156.22 dBm/Hz)
-30 dBm
10 dB/
-130 dBm
Center: 134.2 kHz
Span: 50 kHz
Marker: 134.2 kHz
-133.209 dBm
0 s 0 block
-57 block
0 block
Center: 134.2 kHz
Span: 50 kHz
1 2 3 4 5 6 7 8 9 10
deltaF(Hz)
Ratio(dBc)
S/A with Spectrogram: Spurious Search
Marker X Position (kHz): 134.2
MARKER SETUP
Cancel - Back
Select Marker
1
2
Marker X Positic (Hz)
134.2k
Markers
Off
Single
Delta
Reference Cursor to Marker X
Reference Cursor Off
Selected Marker Off
Step Size (Marker X ...)
50
Go to page 2 (of 2)


Tektronix WCA 280A
9/15/2006 11:25:16 AM
PAUSE
Frequency: 134.2 kHz
Span: 50 kHz
Input Att: ----
RBW: 50 Hz
Trace 1: (Normal)
Trace 2: (Off)
-40 dBm
10 dB/
-140 dBm
Center: 134.2 kHz
Span: 50 kHz
1 2 3 4 5 6 7 8 9 10
deltaF(Hz)
Ratio(dBc)
Spectrum Analyzer: Spurious Search
S/A
Cancel - Back
Spectrum Analyzer
S/A with Spectrogram
RealTime S/A
RealTime S/A with Zoom


Tektronix WCA 280A
A/D OVERFLOW
PM
PAUSE
MEASURE
Cancel - Back
Frequency: 134.2 kHz
Span: 50 kHz
Input Att: ----
RBW: 200 Hz
Trace 1: (Normal)
Trace 2: (Off)
Channel Power
Marker: 125.8015625 kHz
-55.66 dBm (-78.67 dBm/Hz)
-30 dBm
10 dB/
-130 dBm
Center: 134.2 kHz
Span: 50 kHz
ACPR
C/N
OBW
-57 block
0 block
Center: 134.2 kHz
Span: 50 kHz
Carrier Frequency
EBW
1 2 3 4 5 6 7 8 9 10
deltaF(Hz)
Ratio(dBc)
Spurious
Measurement Off
S/A with Spectrogram: Spurious Search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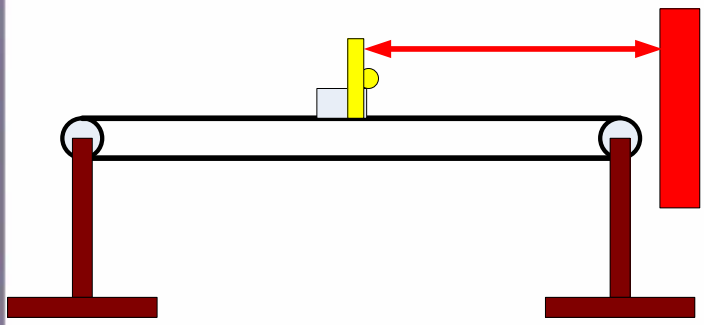

Motor

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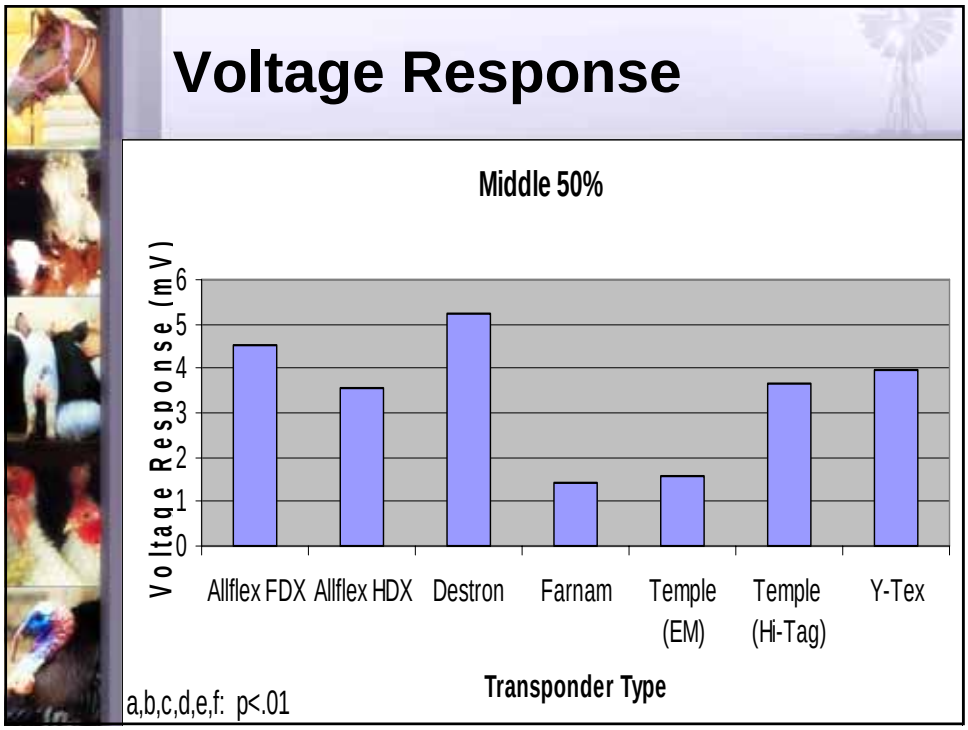
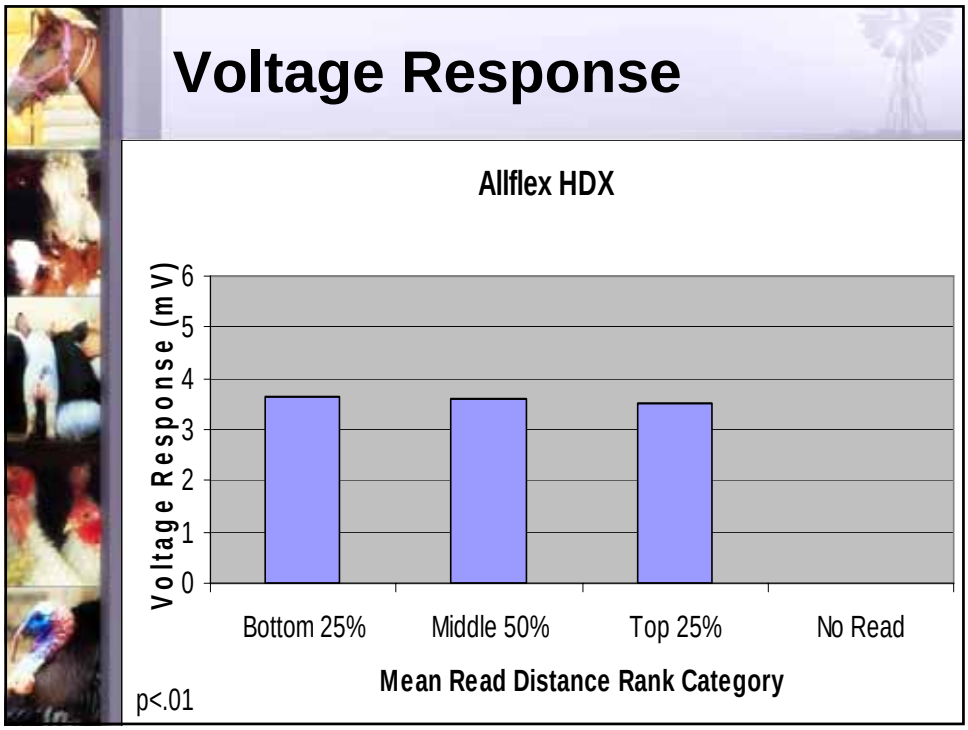
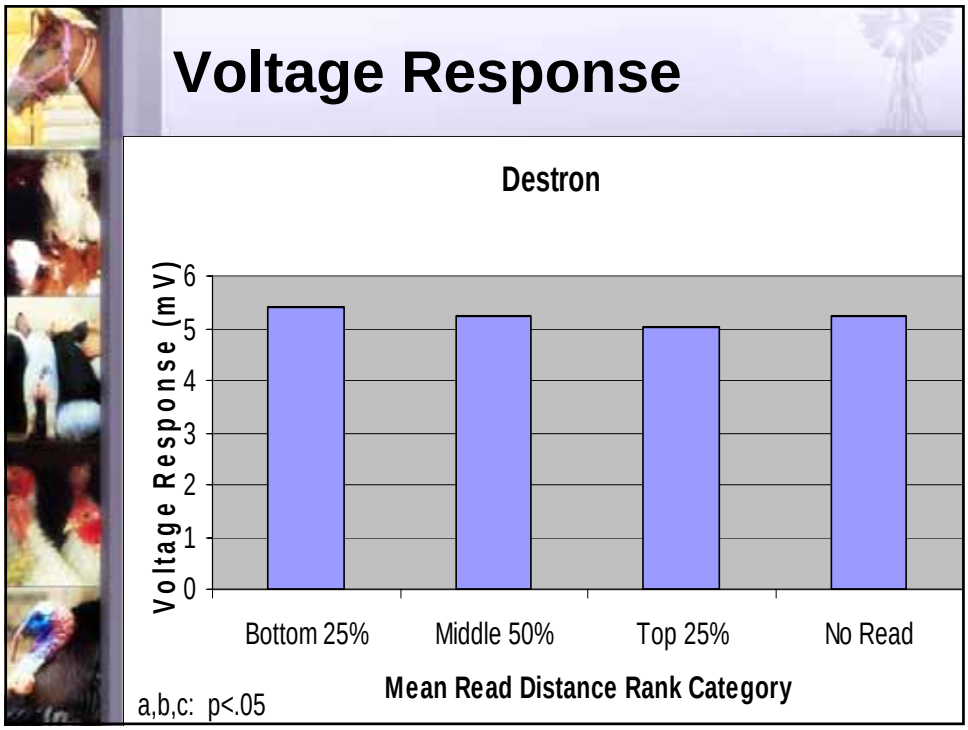
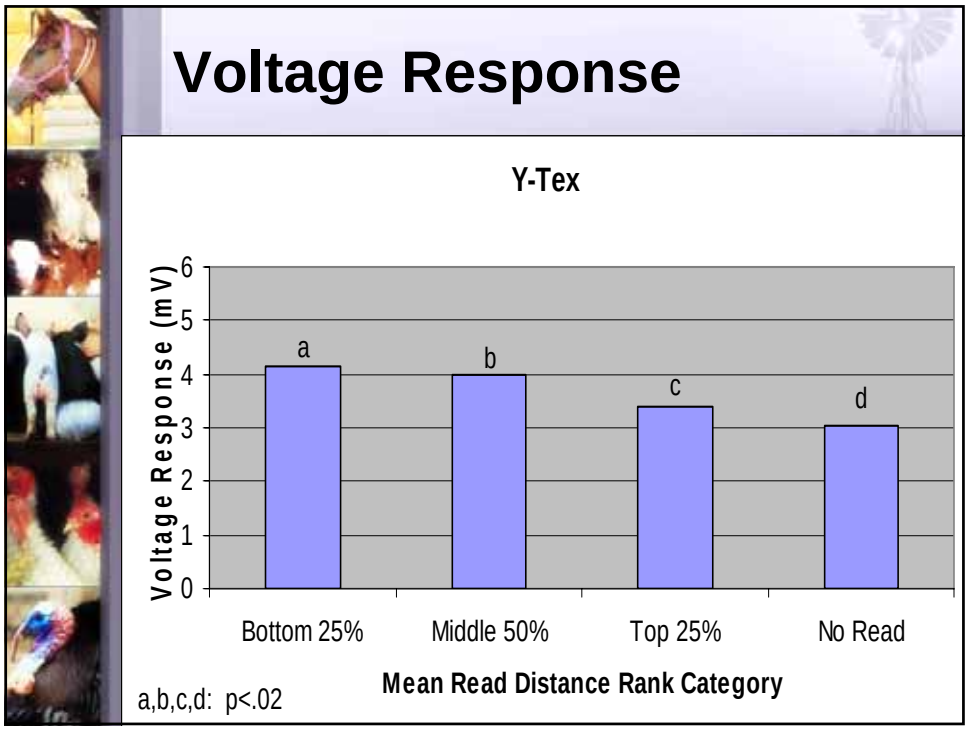
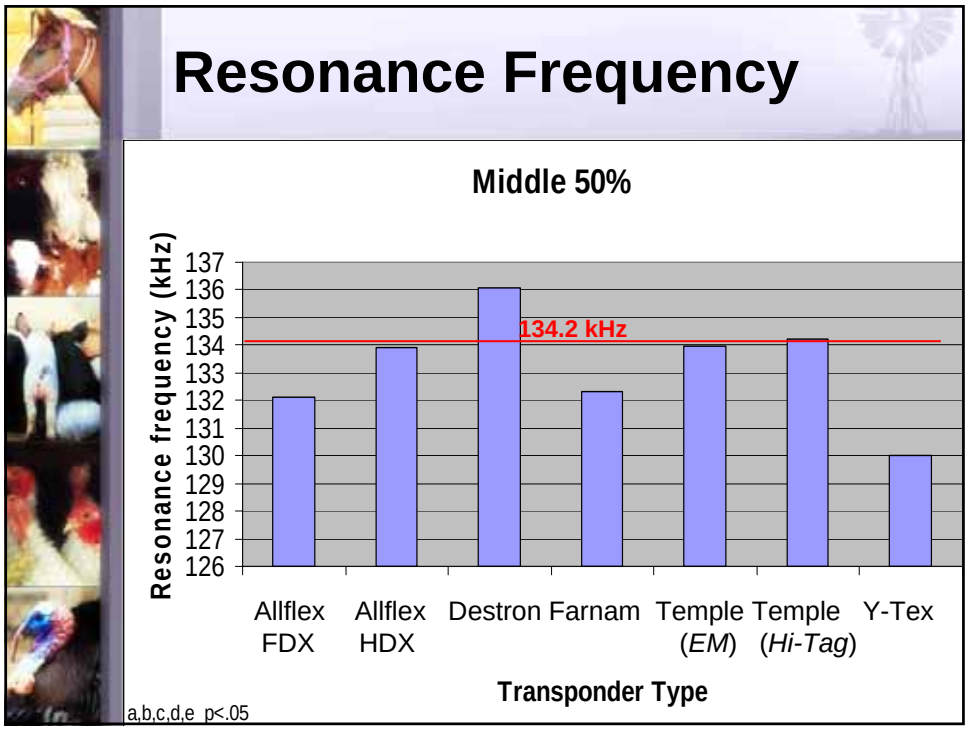
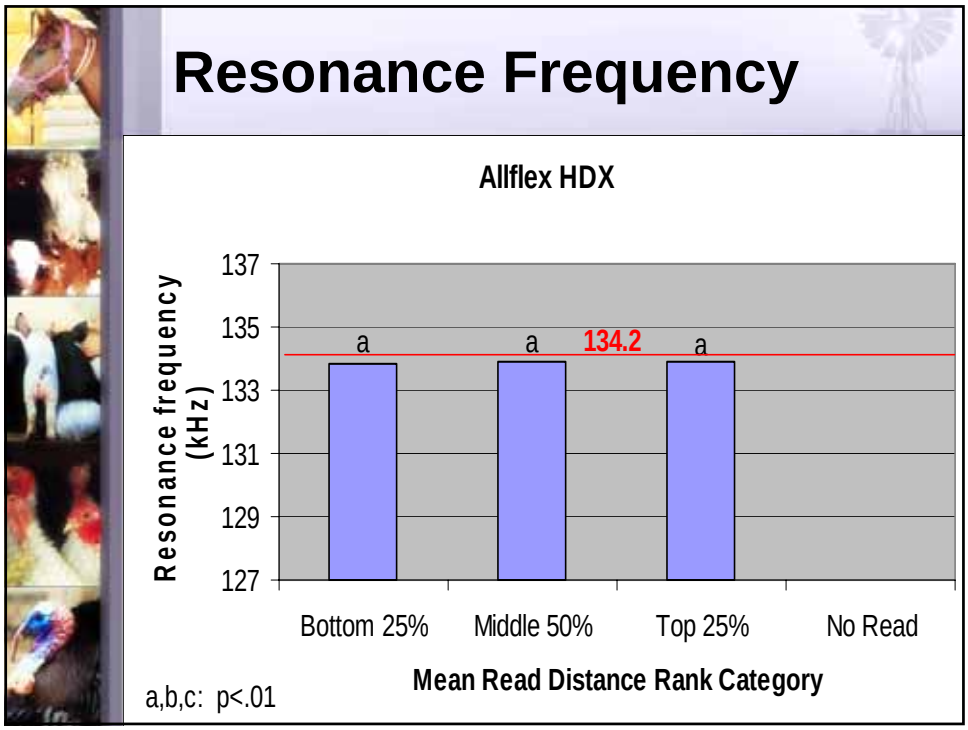

Voltage Response
Middle 50%
Voltage Response (mV)
0
1
2
3
4
5
6
Allflex FDX
Allflex HDX
Destron
Farnam
Temple (EM)
Temple (Hi-Tag)
Y-Tex
Transponder Type
a,b,c,d,e,f: p<.01

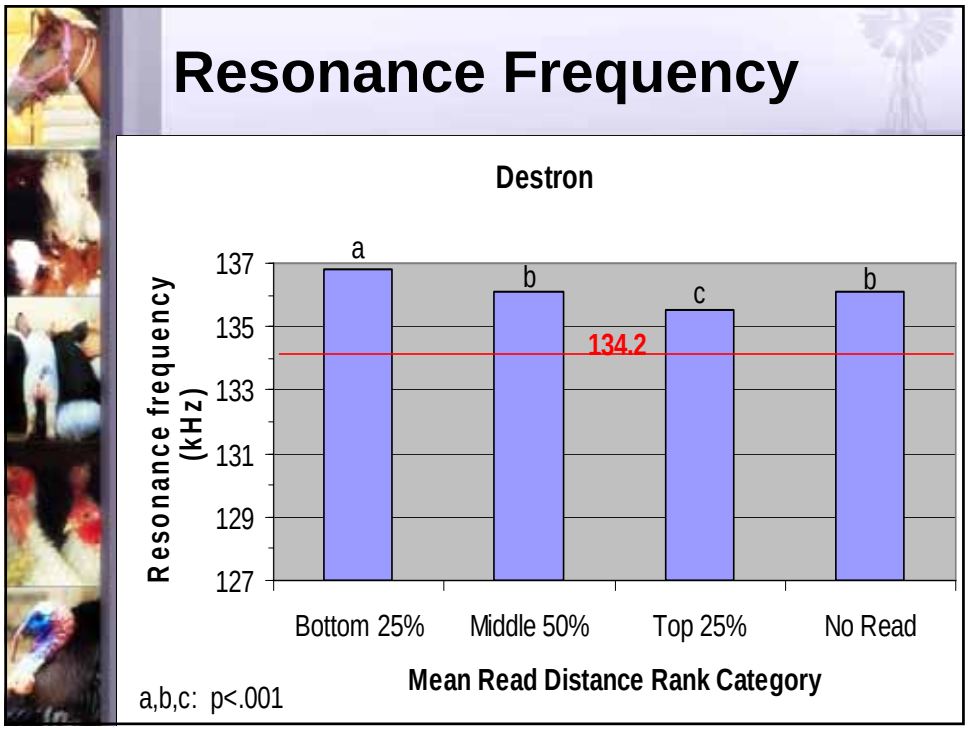

Voltage Response
Allflex HDX
Voltage Response (mV)
0
1
2
3
4
5
6
Bottom 25%
Middle 50%
Top 25%
No Read
Mean Read Distance Rank Category
p<.01


Voltage Response
Destron
Voltage Response (mV)
0
1
2
3
4
5
6
Bottom 25%
Middle 50%
Top 25%
No Read
Mean Read Distance Rank Category
a,b,c: p<.05

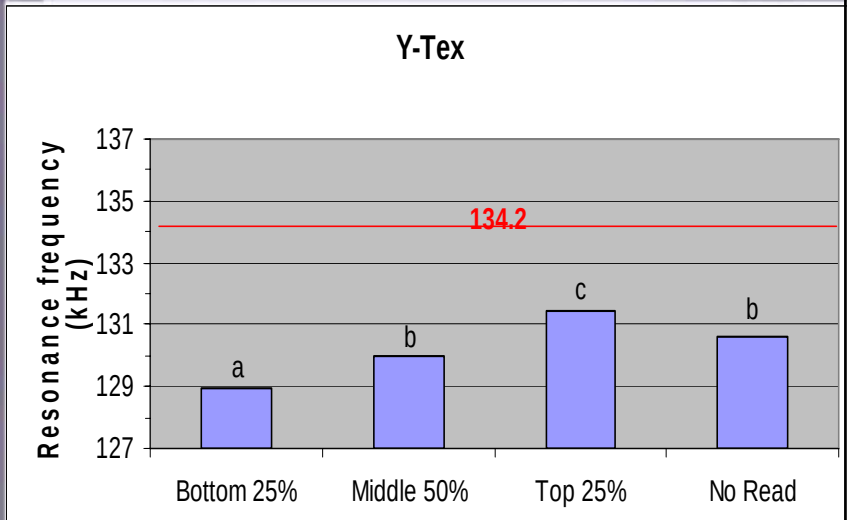

Voltage Response
Y-Tex
Voltage Response (mV)
0
1
2
3
4
5
6
a
b
c
d
Bottom 25%
Middle 50%
Top 25%
No Read
Mean Read Distance Rank Category
a,b,c,d: p<.02


Resonance Frequency
Middle 50%
Resonance frequency (kHz)
126
127
128
129
130
131
132
133
134
135
136
137
134.2 kHz
Allflex FDX
Allflex HDX
Destron
Farnam
Temple (EM)
Temple (Hi-Tag)
Y-Tex
Transponder Type
a,b,c,d,e p<.05


Resonance Frequency
Allflex HDX
Resonance frequency (kHz)
137
135
133
131
129
127
a
a
134.2
a
Bottom 25%
Middle 50%
Top 25%
No Read
Mean Read Distance Rank Category
a,b,c: p<.01

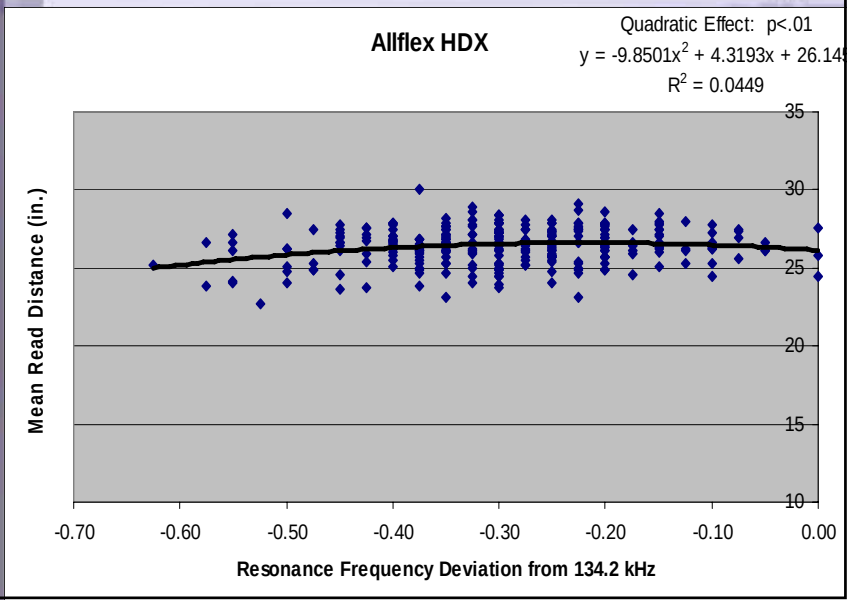

Resonance Frequency
Destron
Resonance frequency (kHz)
137
135
133
131
129
127
a
b
c
b
134.2
Bottom 25%
Middle 50%
Top 25%
No Read
Mean Read Distance Rank Category
a,b,c: p<.001

Resonance Frequency

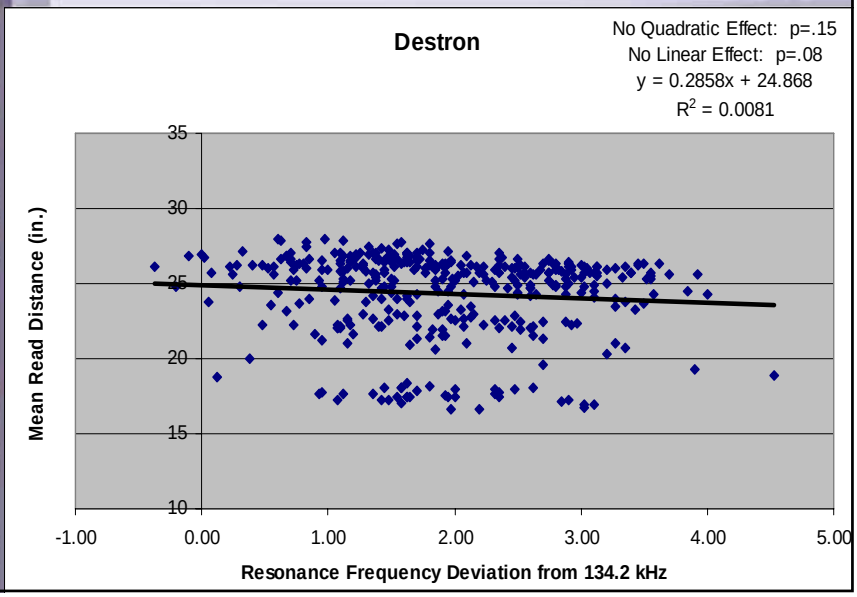


a,b,c: p<.02

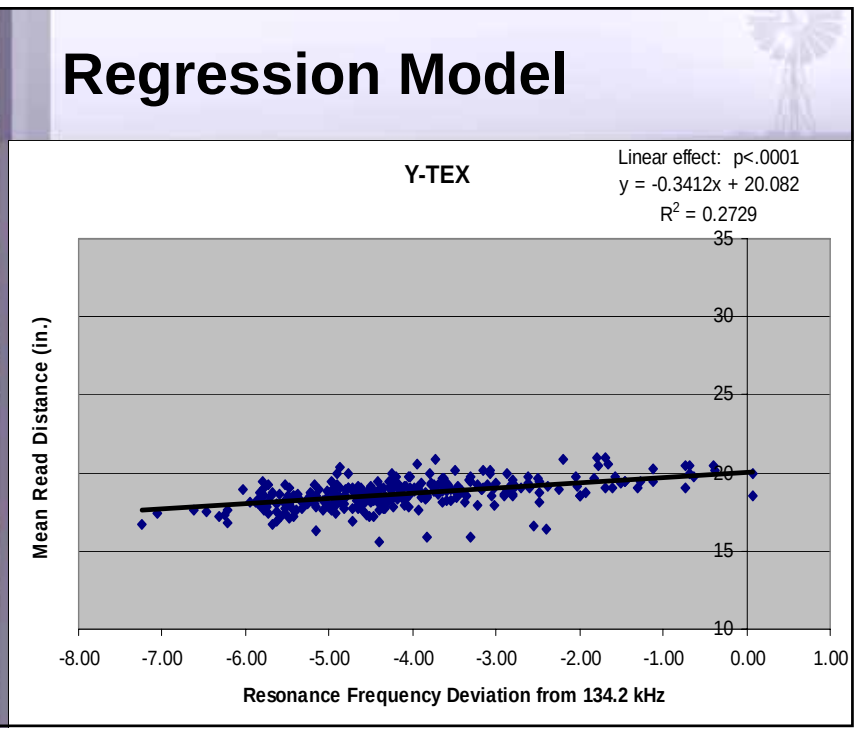
Regression Model



Regression Model



Regression Model



2006 Grant - *NAIS Pilot Program*

- **5 Different Experiments:**
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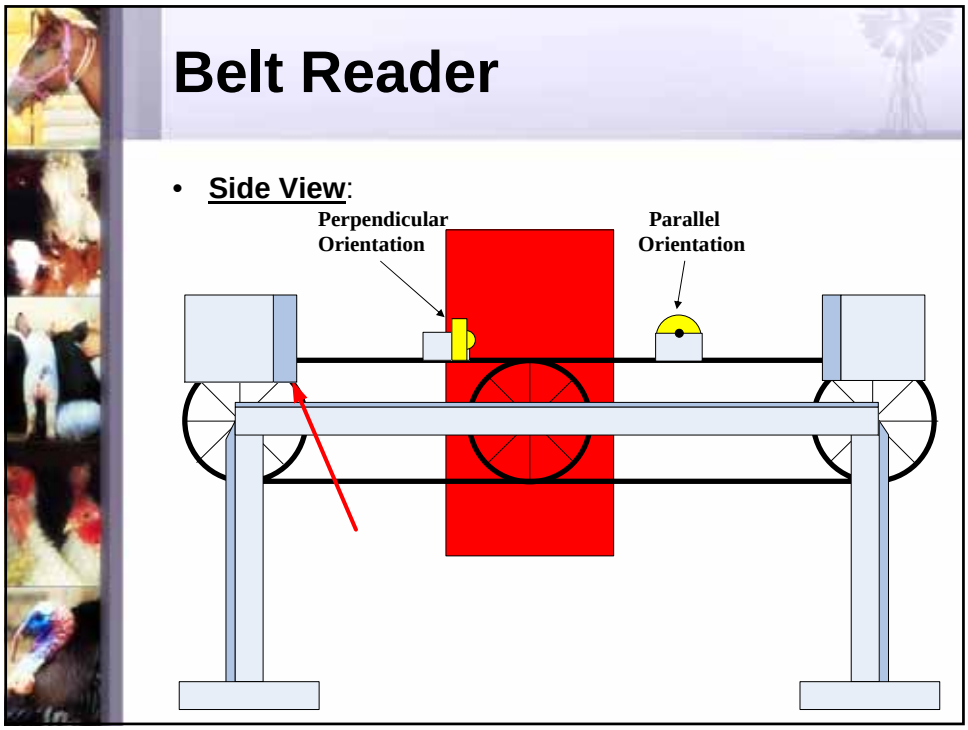
  4. *Determine the extent of variation in read range of RFID transceiver manufacturer*
  5. **Access the effects of orientation and rate of movement of RFID transponders on transponder readability in a lab environment.**
     - ***Variable Speed Belt Reader***

Tag Location (*i.e. Orientation*)

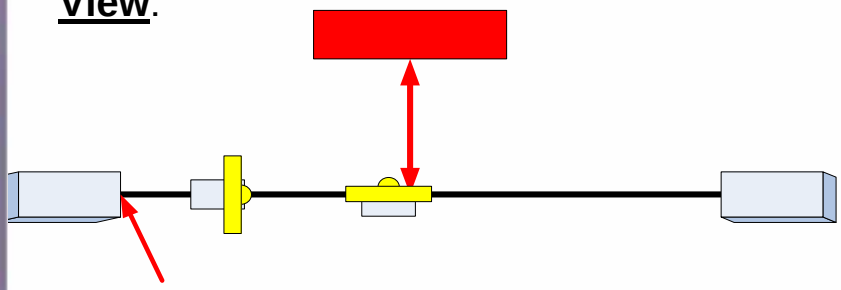


Motor

ectronic Eye

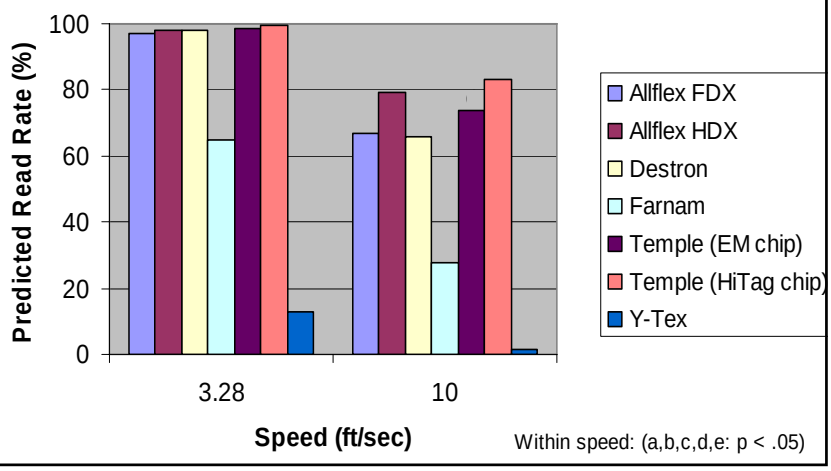
Belt Reader

Overhead View:

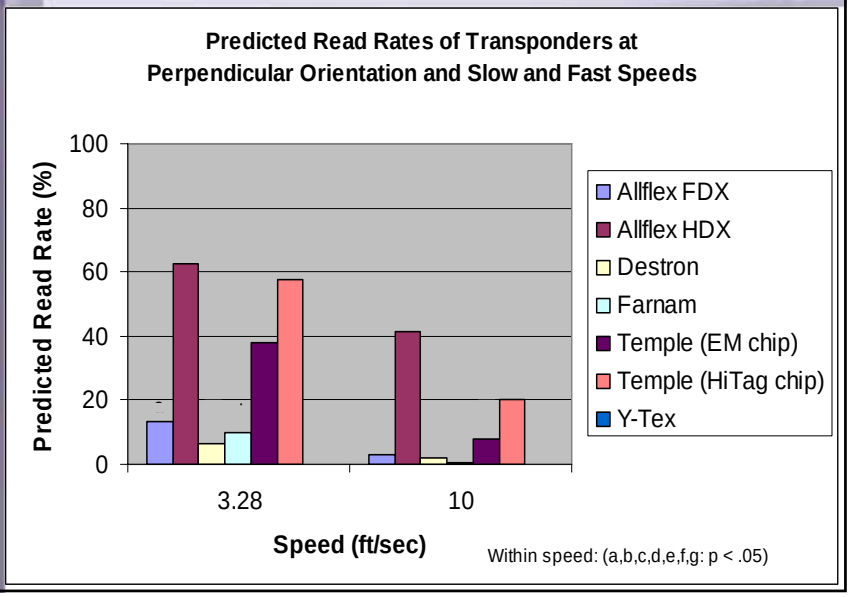


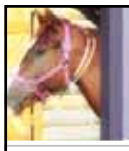
- **Multiple Speeds**:
  - **3.28 ft/s**
  - **10 ft/s**

Transponder Read Rate



Transponder Read Rate





Tag Location (*i.e. Orientation*)

	Location of Transponder in Ear				
	n	Primary	n	Top	
Transponder Type	Predicted Read Rate (%)[1]				P-value comparing ear location within a transponder type
Allflex FDX	97	99.06^{ab}	103	98.86^{a}	Non-significant
Allflex HDX	96	100.00^{a}	103	100.00^{a}	Non-significant
Destron FDX	100	92.90^{cd}	98	80.61^{e}	< .05
Farnam FDX	83	97.06^{bd}	79	99.37^{a}	Non-significant
Temple FDX (EM chip)	97	98.72^{ab}	92	98.95^{a}	Non-significant
Temple FDX[2] (HiTag chip)	6	100.00^{abc}	5	100.00^{ab}	Non-significant
Y-Tex FDX	102	98.49^{ab}	98	92.76^{b}	< .05
Without common superscripts: P-value (a,b,c,d) comparing transponder type within an ear location	581	< .05	588	< .05	
Transponder type x ear location interaction: $p < .0001$					

Tag Functionality

Transponder Type	Broken at Application	Lost Between Application and Harvest	Non-functional at Conclusion of Study
Allflex FDX	**0%** (0/200)	**0%** (0/200)	**0%** (0/193)
Allflex HDX	**0%** (0/200)	**0.5%** (1/200)	**0%** (0/193)
Destron FDX	**1%** (2/200)	**0.5%** (1/198)	**4.6%** (9/194)
Farnam FDX	**19%** (38/200)	**4.9%** (8/162)	**0.7%** (1/143)
Temple FDX (EM chip)	**0%** (0/189)	**0%** (0/189)	**0%** (0/183)
Temple FDX (HiTag chip)	**0%** (0/11)	**0%** (0/11)	**0%** (0/11)
Y-Tex FDX	**0%** (0/200)	**0%** (0/200)	**0%** (0/193)


THANK YOU!!!
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