

HIGH FREQUENCY RFID

Dickinson Research Extension Center



What is RFID?

- Radio Frequency Identification
Low-Frequency (134.2 khz)
current
- High-Frequency (916 mhz -
6.5 ghz) future???



Current RFID Design

- Low Frequency (134.2 khz)
- Range 2 – 6 inches
- Reads individual animals



Previous Work

The electronic nature of RFID cattle tags makes a national ID system feasible - a system which can help track and trace-back disease outbreaks.

Many countries already have extensive studies under way, incorporating millions of animals.




Biosecurity Program

RFID is a part of the Bio-security project

- RFID: To track a cow from birth to death, electronic ID tied to a data base would be essential.
- Low-frequency ID is the current standard and is being tested.
- Our feeling is that high-frequency will be necessary.
 - Faster, more efficient when dealing with thousands of head of cattle.



Biosecurity Program

- Objective: If a disease breaks out, a rapid response team can travel to the site.
 - GPS mapping developed to portray site location and land topology.
 - Cooperation of a diverse group of veterinarians, animal and range scientists, etc.
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RFID Testing Objectives

Determine....

- The distance tags can be read.
- If walking or running effects the read rate.
- If single-file or herd movement effects the read rate.
- The probability of detection can be expected under field conditions .

August 2004 Test

- Detect a cow using a high-frequency RFID tag?

Experiment:

- RFID tags are placed on seven cows.
- The cows are run under a single circular polarized antenna, 6 feet above the ground.
- The cows are run in single file.



Gate Design

- Objective: Determine what type of a gate is required
- Design: 5 x 6 foot door
- 4 antennas placed around door (2 top, 2 side)
- Result: All tags (2m, 4m, 6m) read fine



Gate Design

- 2 readers with 8 antennas
- Placed over a 12 foot wide alley



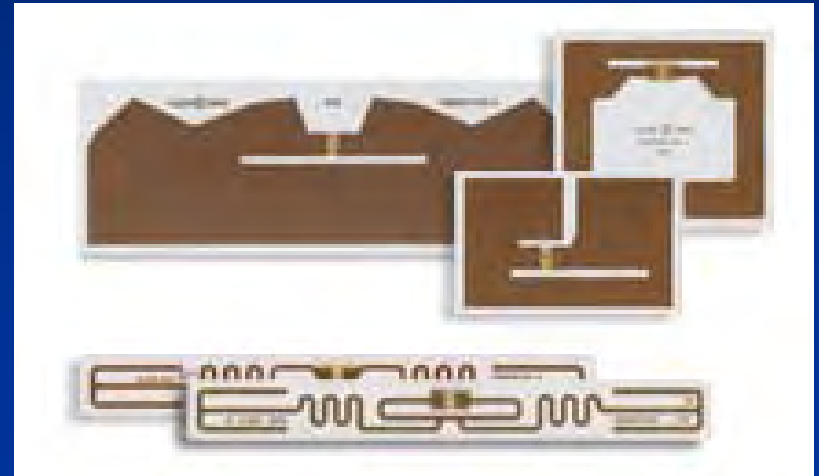
August 2004 Results

- Tags placed on the back of cows cannot be read.
 - The water in the cow is detuning the tags.
- Tags placed on the cow's ear tag can be read:
 - 13/13 reads.
- High-Frequency tags are far easier to read than low-frequency tags.



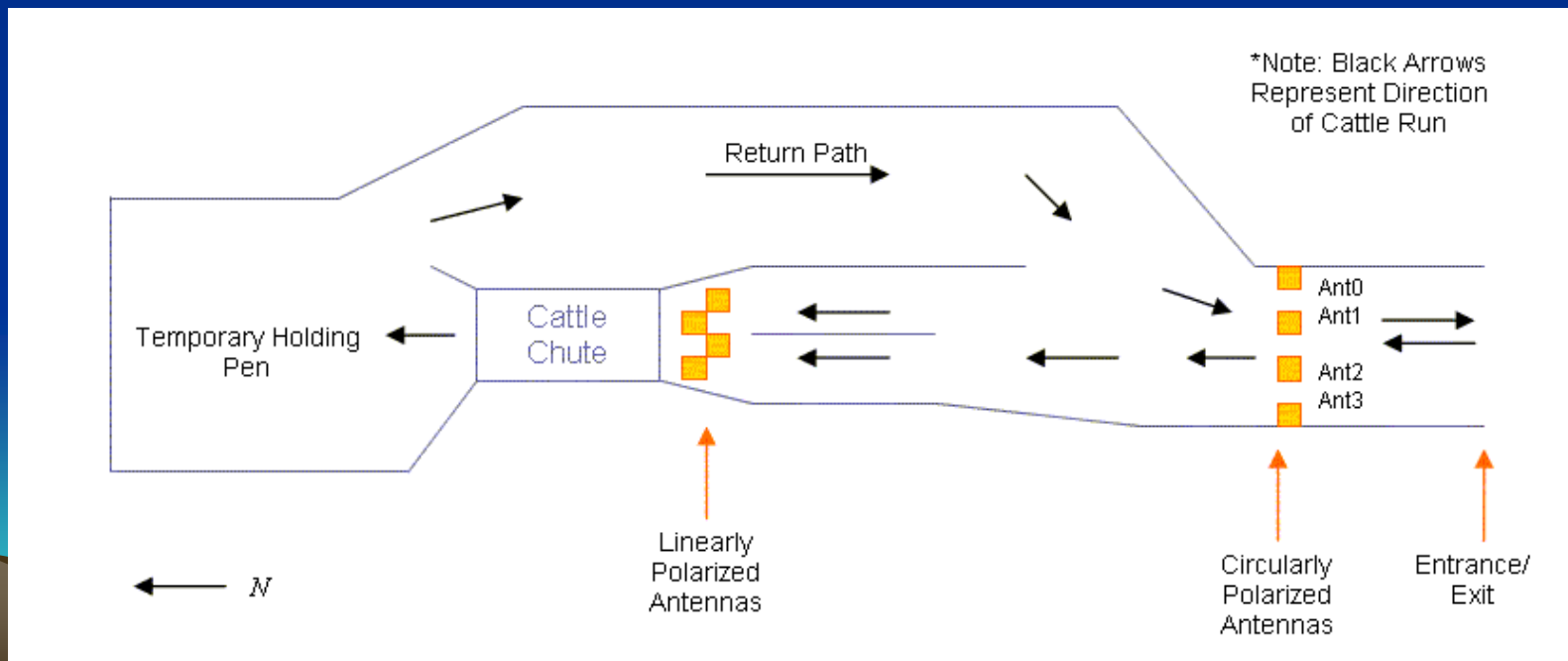
November 2004 Test

- 6m Tag: Alien M-tags are attached to an ear tag.
- 2m Tag: Alien squiggle tag is laminated between two cattle tags. The dielectric of the plastic detunes the antenna, reducing the range.



November 2004 Test

- Reader 1: 4 antennas over a 9 foot opening. Cows can move en-mass through this gate.
- Reader 2: 2 antennas over two 3 foot chutes. Cows must move single file through this chute.



How to interpret the data?

- Binomial Model:
 - Assume a tag is read or it isn't.
 - Assume each tag is pinged N times.
 - Each ping has a constant probability of detection.
 - Software will eliminate multiple reads.

Table 2: Summary of how many tags were read N times during a given run.

N: Number of Successful Reads	Single File, 6m Tags	Single File, 2m Tags	3m Gate, 6m Tag	3m Gate, 2m Tag
$N > 0$ (hit)	280	246	301	300
$N = 0$ (miss)	0	7	1	22

Fitting a Binomial Distribution

6m tags, single file

- A chi-squared test can tell you if the binomial distribution is consistent with the data.
 - If the data is inconsistent with the distribution, the chi squared value will be large.
- The range of p (probability of detection for a given ping) which results in chi-squared less than 20 (90% confidence interval) is given below
- $P(\text{Detection}) > 99.95\%$

Table 4: Chi Squared Test for Range of p , N , and the probability of detection

p	N	W	Chi squared	$P(\text{detect})$
0.05	110	120	21.2	99.95%
0.56	10	120	3.19	99.97%
0.61	10	120	21.43	99.99%

November 2004 Results

- Tags can be read successfully at a distance of at least 6 feet.
- Tags can be read with cattle at a brisk walk.
 - 280/280 reads for a 6m tag in single file
 - 301/302 reads for a 6m tag moving en-mass



November 2004 Results

- The design of the RFID tag is important.
 - 6m is good enough (280/280 reads)
 - 2m is not good enough (246/253 reads)
- The dielectric of the eartag will detune the RFID antenna, resulting in a short range
- Cattle moving single file at 18 foot range, the probability of detection was--
 - 98% with a 90% confidence level (280 out of 280 tags successfully read)
 - 99.95% with an 80% confidence level



Future Goals

- Research various high frequency antennas
- Determine the range vs. probability of detection for RFID ear tags.
- Determine reaction to climatic conditions.
- Incorporate RFID tags into an injection molded device.
- Determine cattle movements for effective RFID read rates. ie. Livestock yards
- Develop collaboration with various entities.



