Performance of Pharma Tags — An Empirical Approach

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About RFID Alliance Lab

- Provide useful, timely, credible, and unbiased data to end users of RFID products
- Constituents
  - **University of Kansas / ITTC**: Primary research contributor
  - **RFID Journal**: Initial funding, distributor, advertisement
  - **Rush Tracking Systems**: Initiator, subject expert, industry lesion
- Business model
  - Sell reports (~$1,000 / report) to finance future reports
  - Advisory Board
    - Site license to reports
    - Use facilities, products

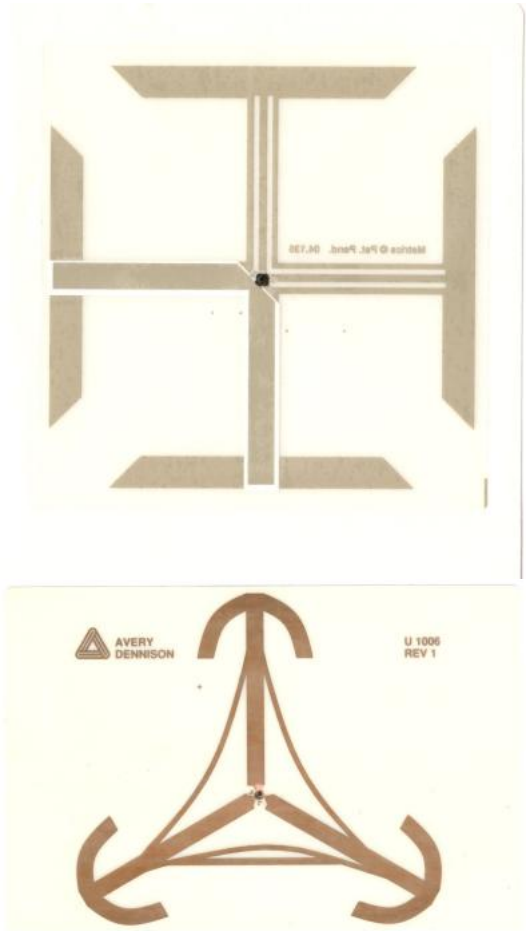
Why us, why now?

- RFID Revolution is under way; the train has left the station (are you on board?)
  - Disruptive technology
  - “Black magic?”
- Need to separate facts from hype
  - Educate
  - Press releases don’t present all relevant facts
  - Problems / issues not exposed, little or no data
- Focus on technology: what do you (end users) need to know?

Passive EPC Tags Analyzed by Lab (partial)

Tags:

- Matrics X2040
- Avery Triflex
- Rafsec 457
- Rafsec 458
- Alien 9250
- Alien 9338
- Alien 9254
- Avery U1014
- Matrics I2010
- Avery DS1

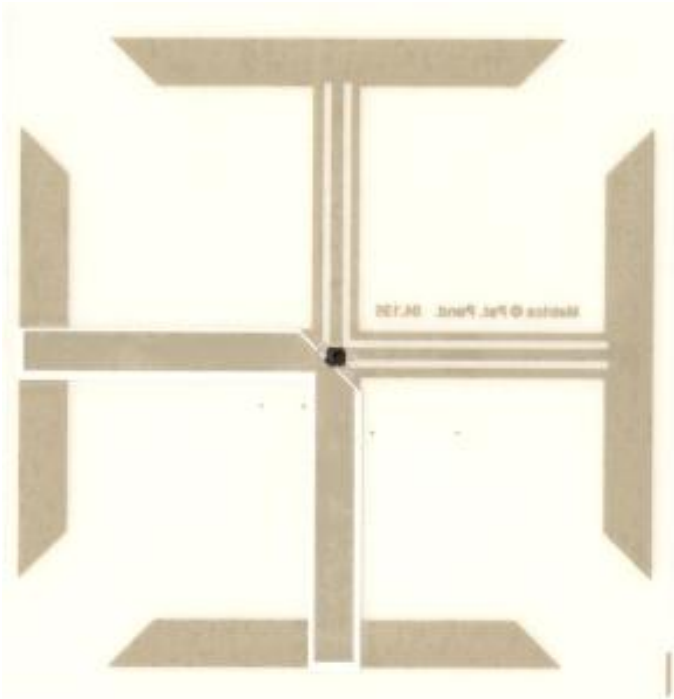


RFID and Pharma

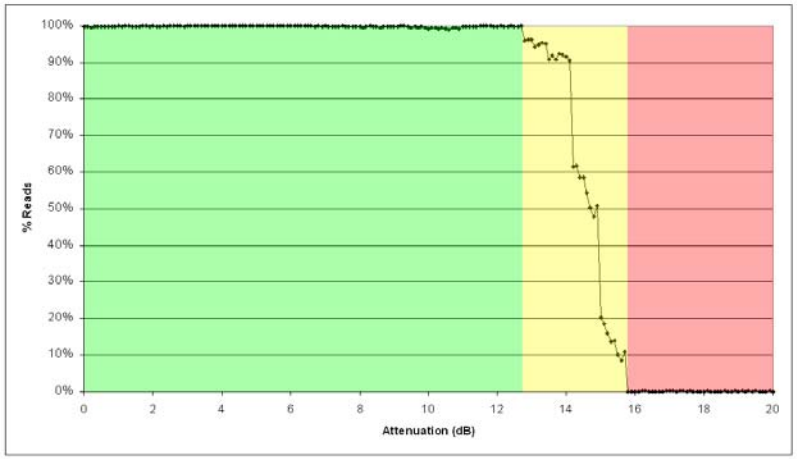
- EPC RFID tags generally focus case- and palette-level tagging
- Physically large (95×15 to 95×106 mm)
- High performance (20+ feet read range)
- Usually read in small quantities
- Writable

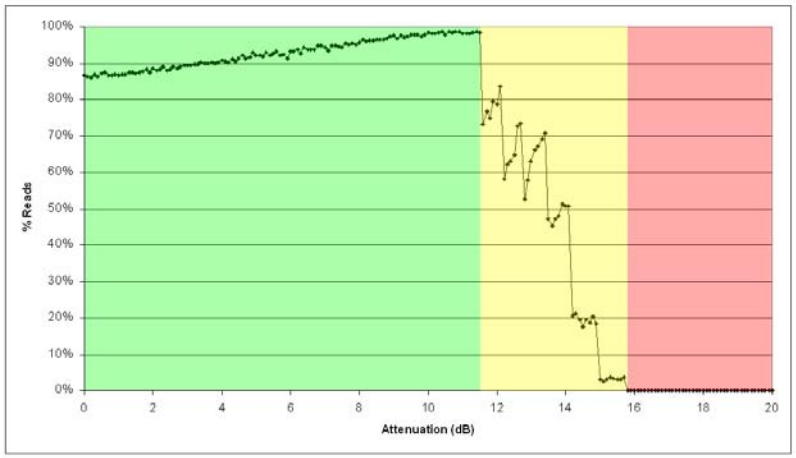
- Pharma tags focus on item-level tagging
- Physically small (25×25 to 30×36 mm)
- Low performance (~5 feet)
- Often read in large populations
- Read-only or lockable

Matrics Pharma vs. Matrics X2040 (Size to scale)



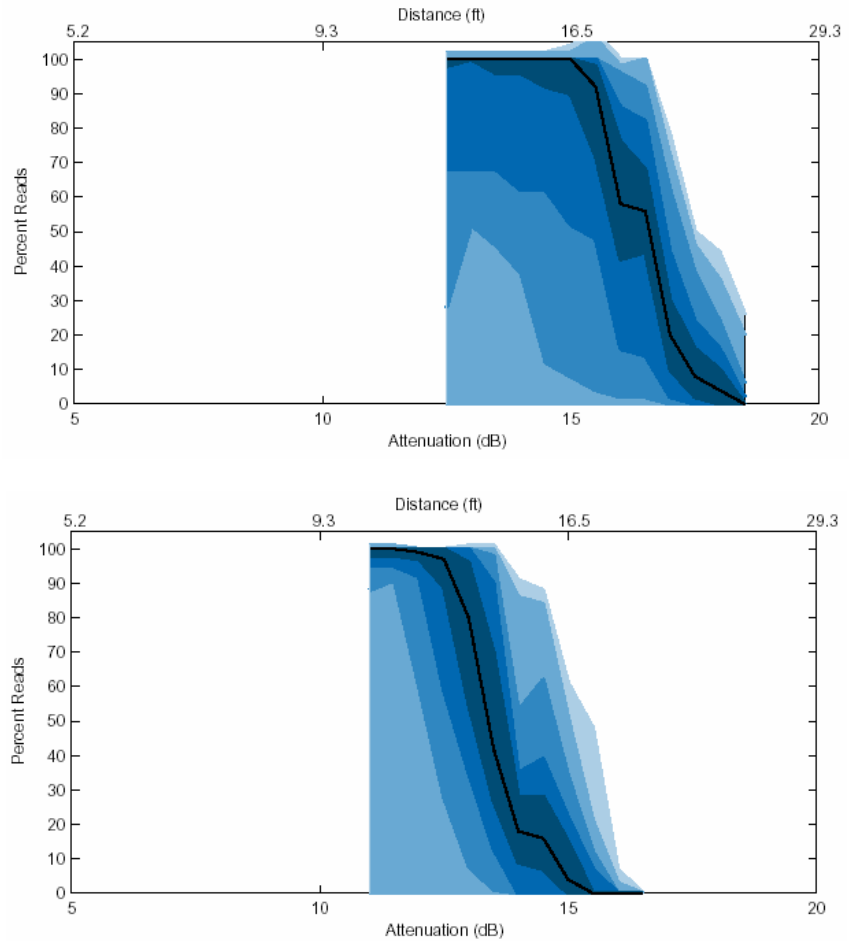
Tag Performance vs. Distance





- Typical Class 0, 1 percent reads vs. attenuation (distance)
- Strong in-field
  - 100% vs 85-99%
- Weak in-field
  - Bumpy ride down
- Out of field
  - 0 vs 0.13% “phantom” reads

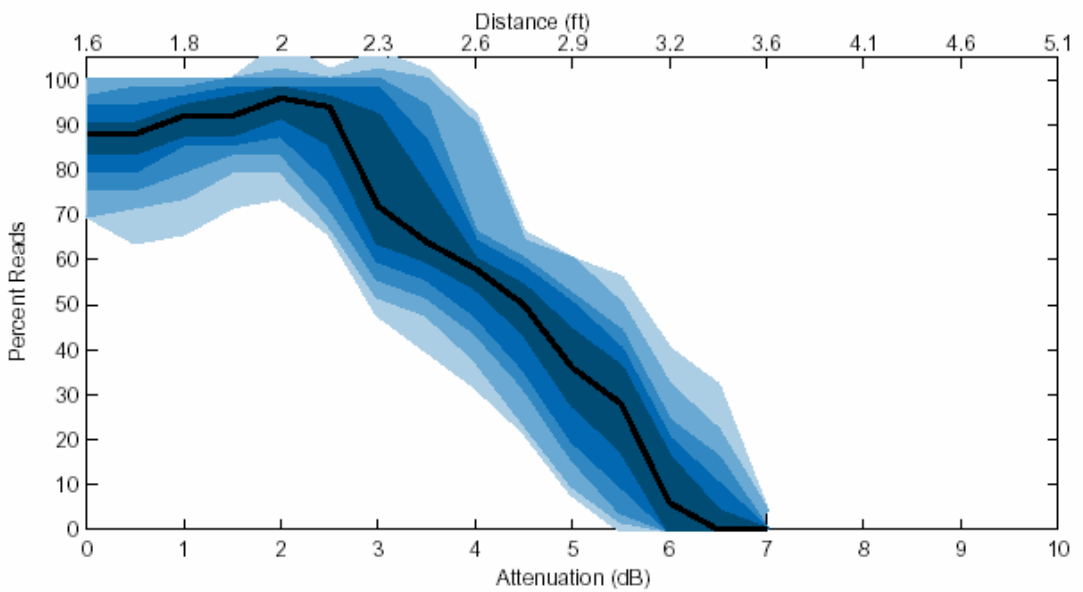
Tag Variation — The Bad News



- Tags vary in performance
  - Model to model
  - Tag to tag
- Narrow bands = high quality
- Far right = high performance

Range	Lower Bound	Upper Bound	% Included
Black	50%	50%	1 tag
Darkest	30%	70%	40%
	15%	85%	70%
	6.5%	93.5%	87%
	1%	99%	98%
Lightest	0%	100%	100%

Pharma Tag Performance

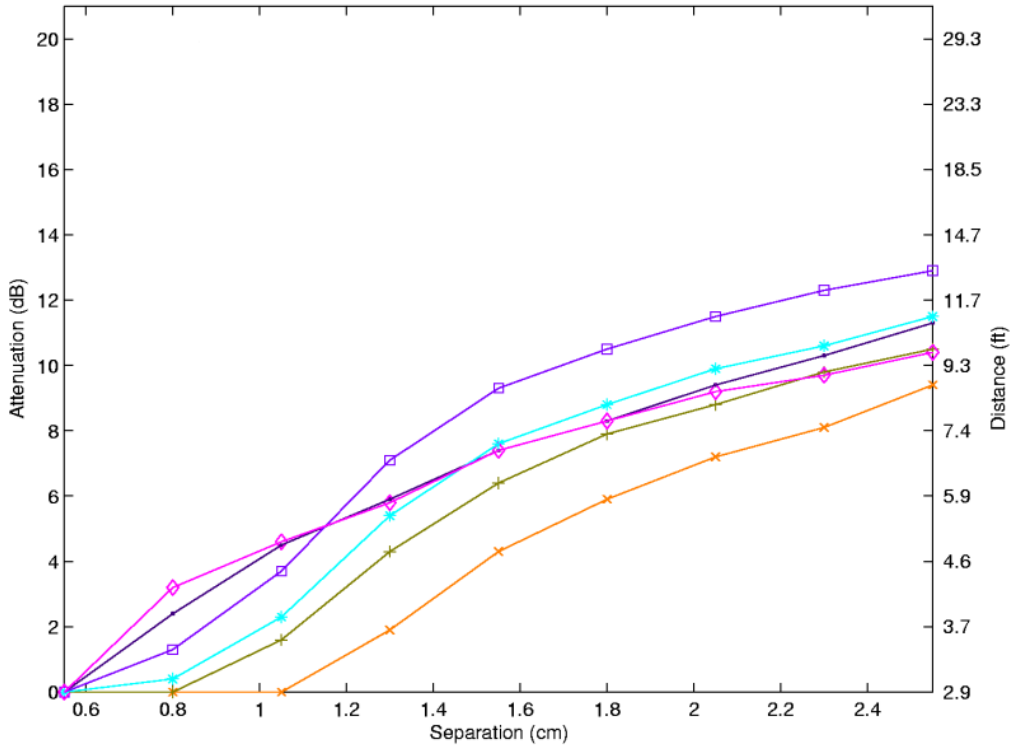


- Narrow bands indicate good quality
- Very far left indicates poor performance

Performance of Class 1 Tags near Water

Differences readily apparent

- Pink best close, but shallow slope
- Purple good close, but best further
- Best tag:
  - 150% more efficient than worst
  - 60% further distance
- Some tags are tuned for applications
  - Free air perf. not always fair metric



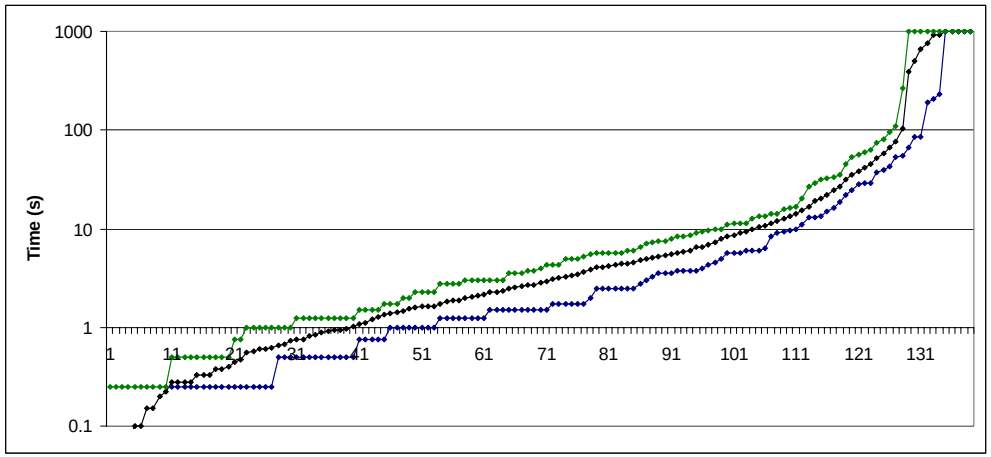
Tag Read Rate in Isolation

	Reader 1	Reader 2	Reader 3
"Fast" Class 1	24.1	61.4	
"Slow" Class 1	7.0	4.5	
Typical Class 0	6.5		8.8
Class 0 Pharma	6.1		7.6

- Two "classes" of Class 1 tags: Fast and Slow
- New, 96 bit Class 1 tags similar to "Slow"
  - May need to tune reader (timeout parameter)
- Class 0 tags steady
- Pharma Class 0 tag only slightly slower than other Class 0

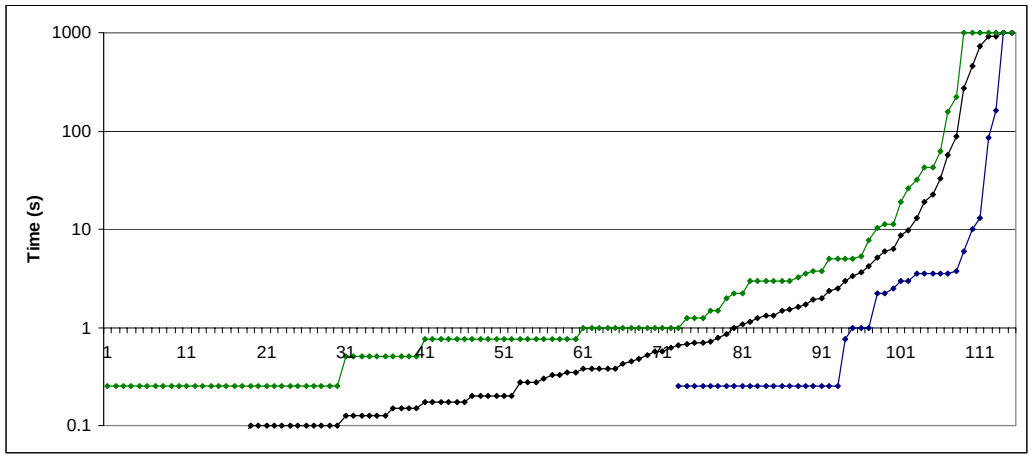
Read Rates in Populations

Class 1: Time to First Read



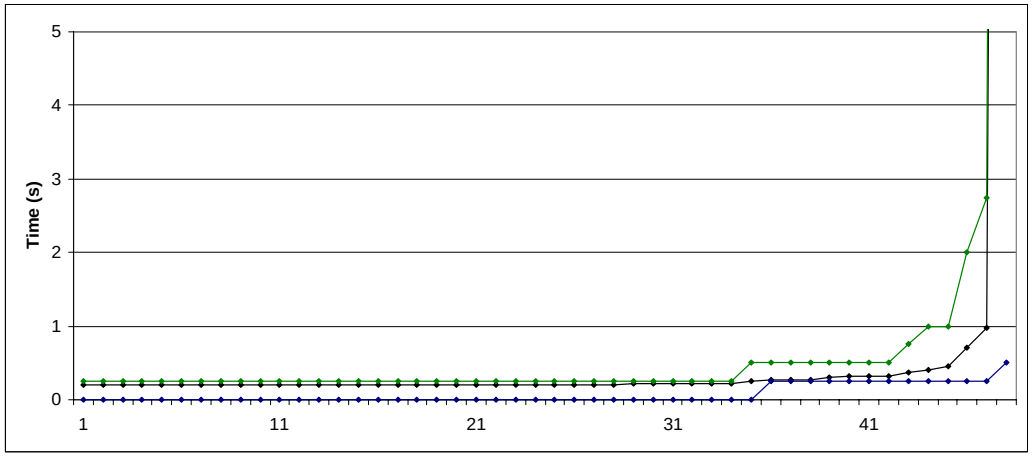
- ~140 Class 1 tags
- Perform experiment 10 times; show worst, median, best
- Note: Log Y axis
- Linear TTFR until about 85-90 tags, then exponential
- Last few tags sometimes unreadable

Class 0: Time to First Read



- ~115 Class 0 tags
- Exponential past ~70 tags
- Much faster than Class 1

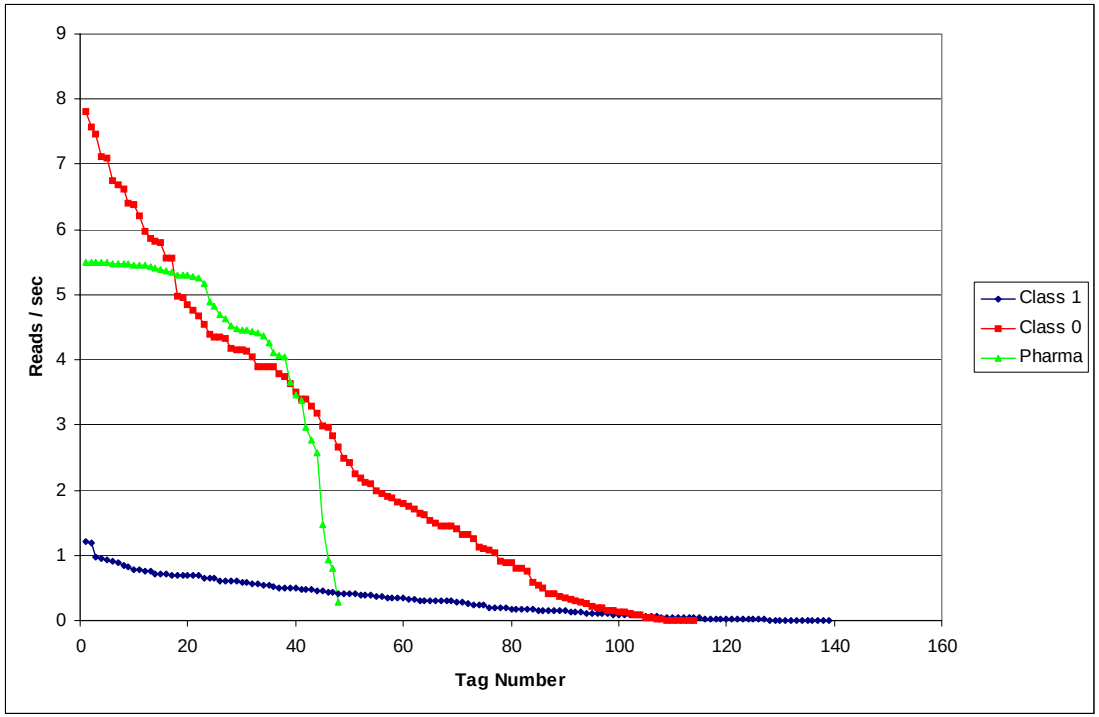
Pharma (Class 0) Time to First Read



- 48 Pharma tags, 42 on one plane
- Note: Linear Y axis
- Always reads 45 tags in 1 second, 47 in 3 seconds.

- Last tag(s) are problematic!

Tag Read Rates in Population



- Speculate:
  - Class 0 & Class 1 tags all weak-in-field
  - ~2/3 Pharma strong-in-field
- Class 0 scales much better than Class 1

Ingredients for Good Performance

- Use Class 0 for large populations
- A readable tag does not imply good performance
- Try to get *all* tags strong in field
- Coupling and shadowing happen
  - Tag density will negatively impact tag performance
  - Pharma tags seem to handle density well

Observations and Conclusions

- Pharma tags are different
  - Smaller, shorter range, designed for density
  - Higher quality (limited sampling)
- Good news: Pharma tags perform well
  - 0% dead and “quiet” vs. 1-19% for other EPC tags
- Key to performance: get all tags strong in field
- Pharma industry needs vendor-neutral education, procedures, standards