

25th Annual Road Profiler Users' Group Meeting

Implementation of Cross Correlation for Profiler Accuracy and Repeatability Testing

September 17, 2013

Steven M. Karamihas



Outline

- Basics
- Thresholds
- Wavebands
- Filtering
- DMI Error
- Short Wavelength Content

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- **Basics**
- Thresholds
- Wavebands
- Filtering
- DMI Error
- Short Wavelength Content

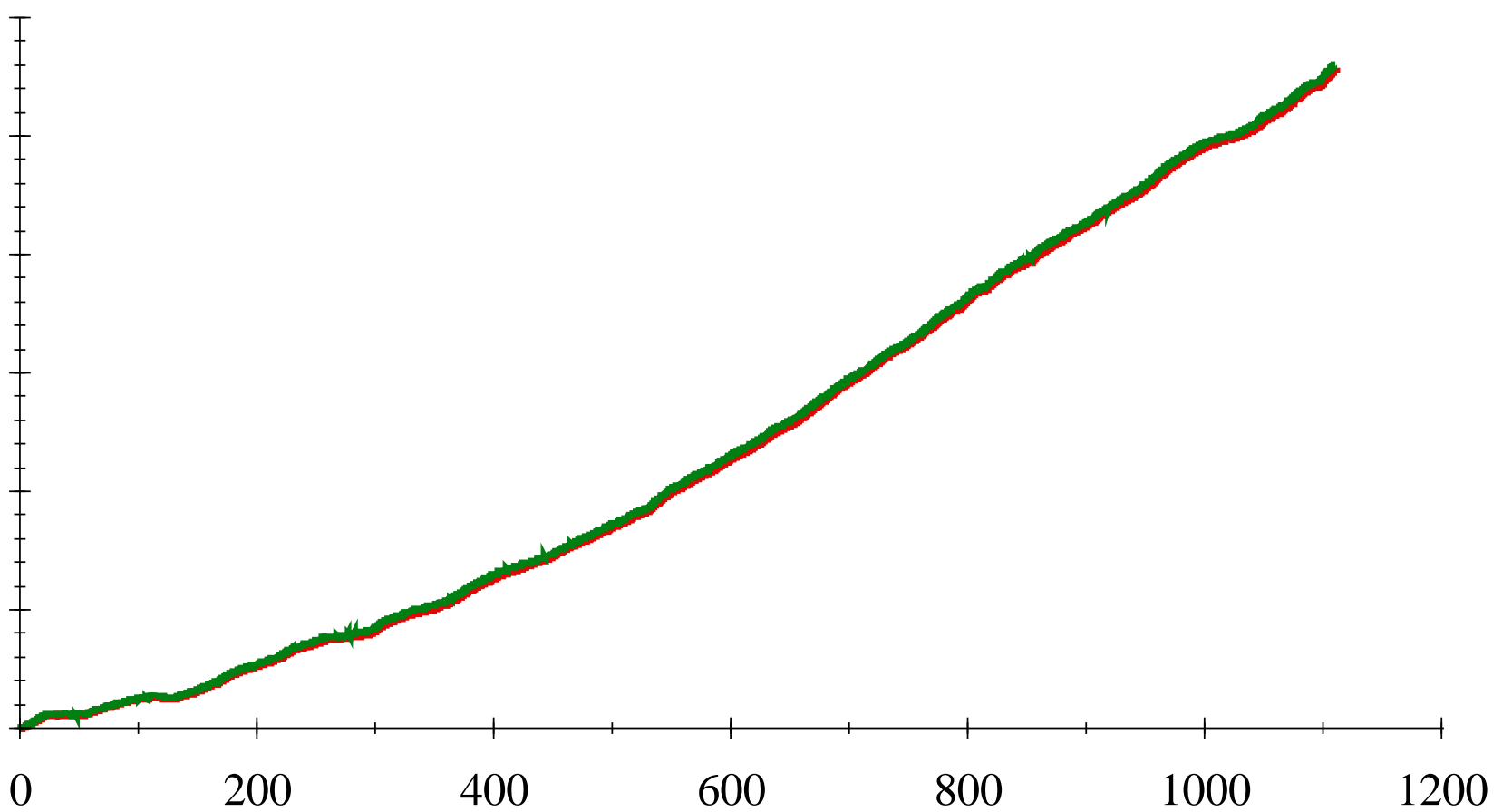
Two Traces

Profile (in)

60
50
40
30
20
10
0

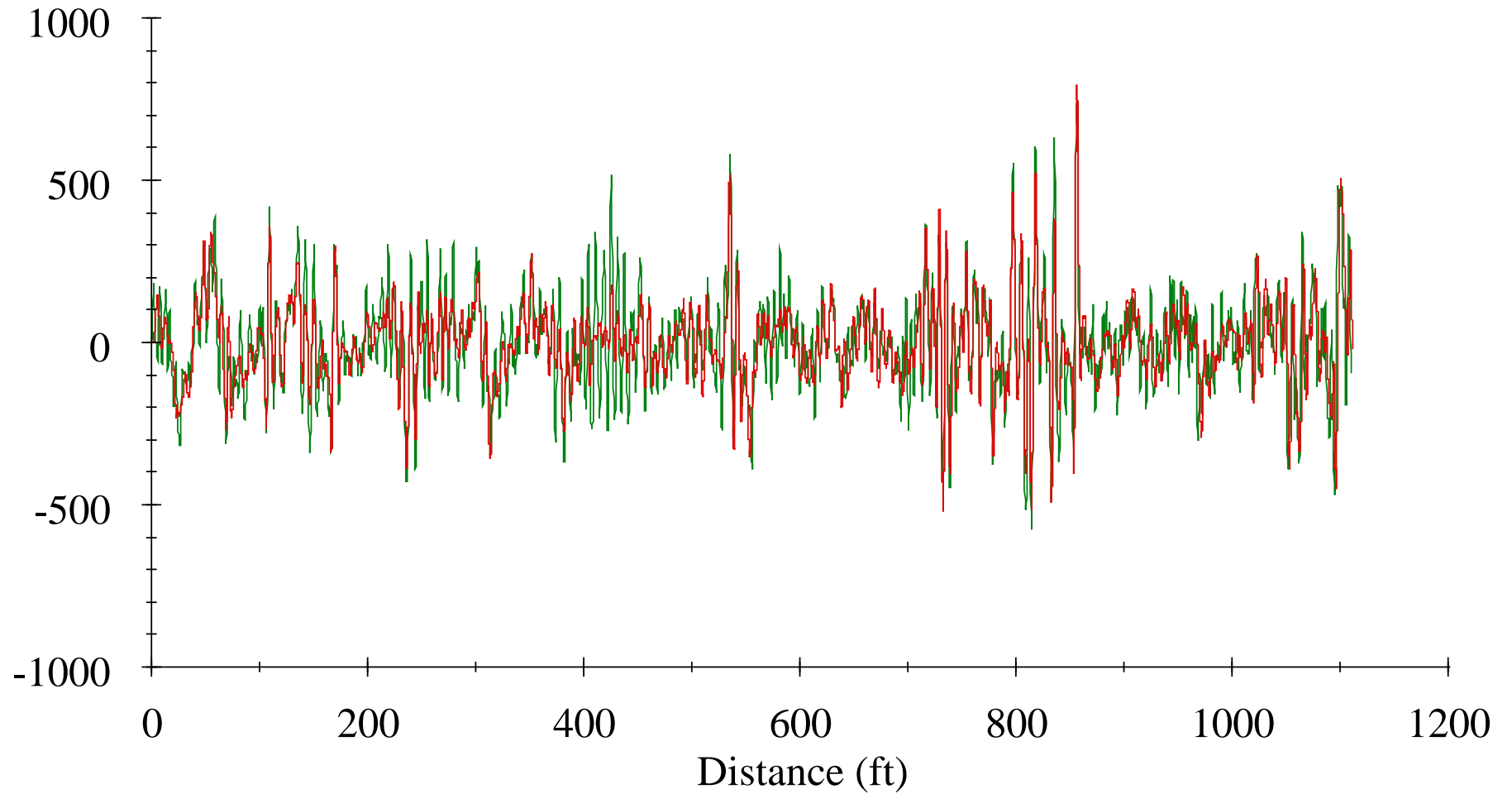
0 200 400 600 800 1000 1200

Distance (ft)



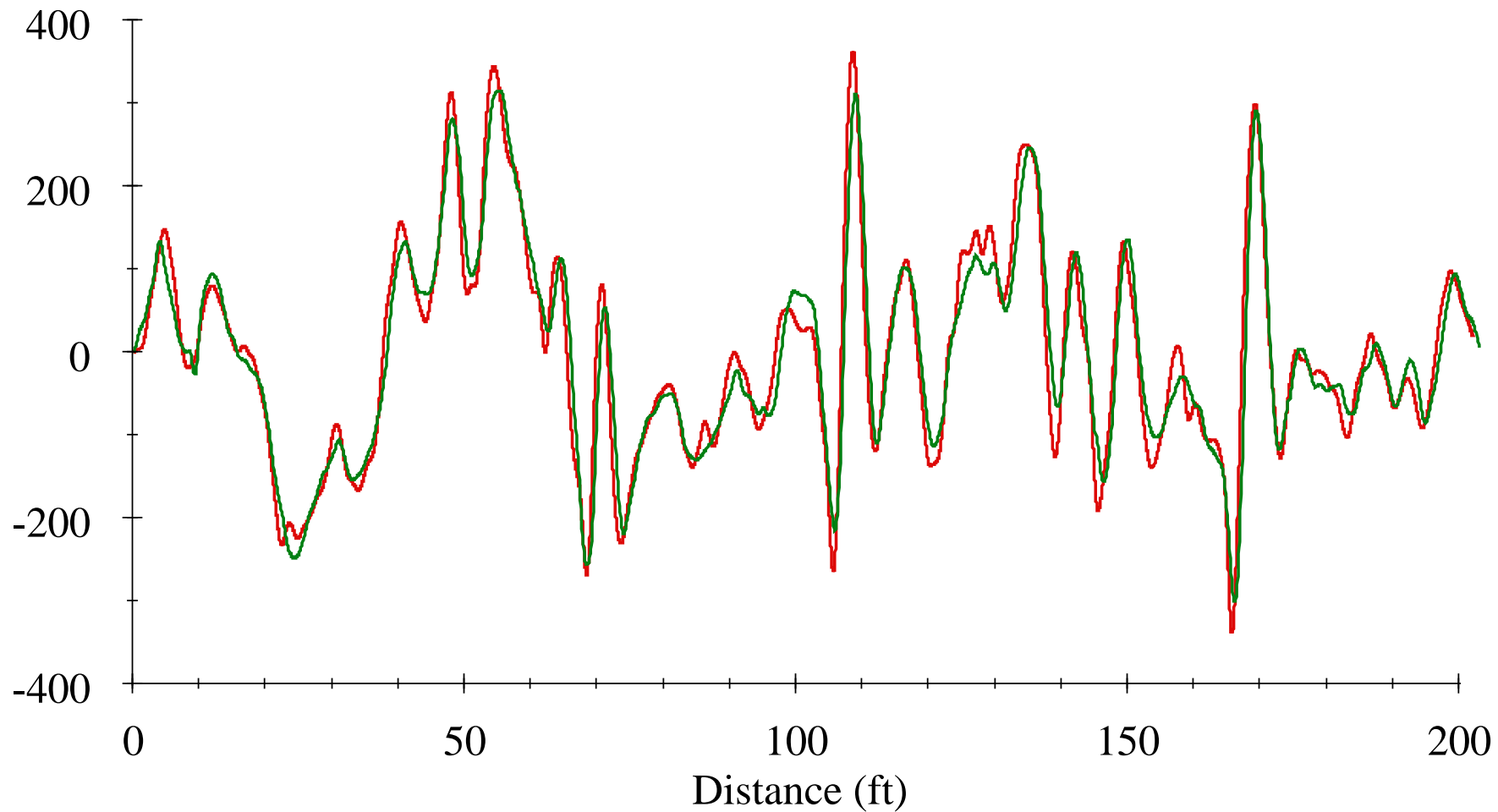
Two Filtered Traces

IRI Filtered Trace (in/mi)



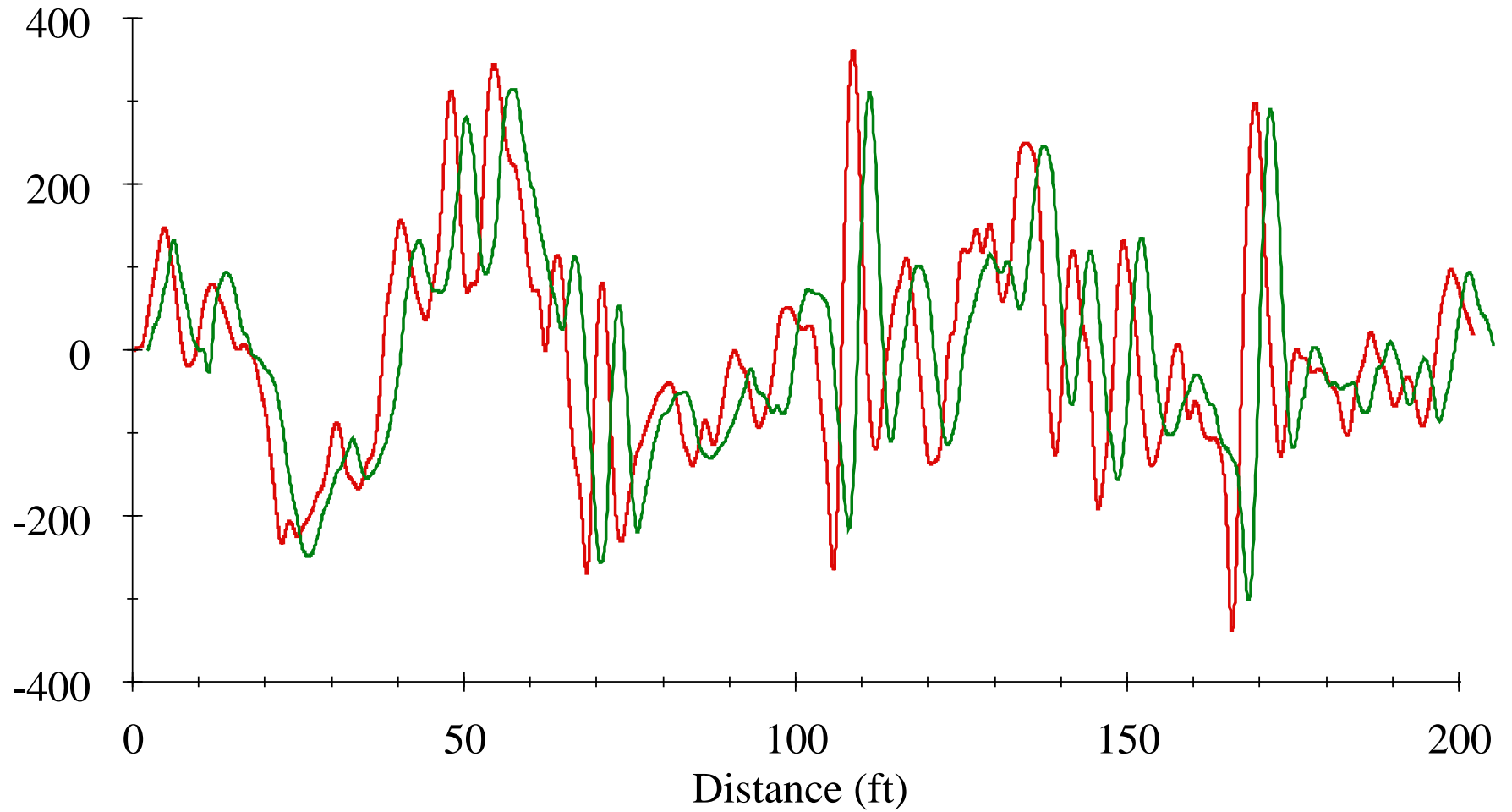
“Good” Agreement

IRI Filtered Trace (in/mi)



Shifted Traces

IRI Filtered Trace (in/mi)



Outline

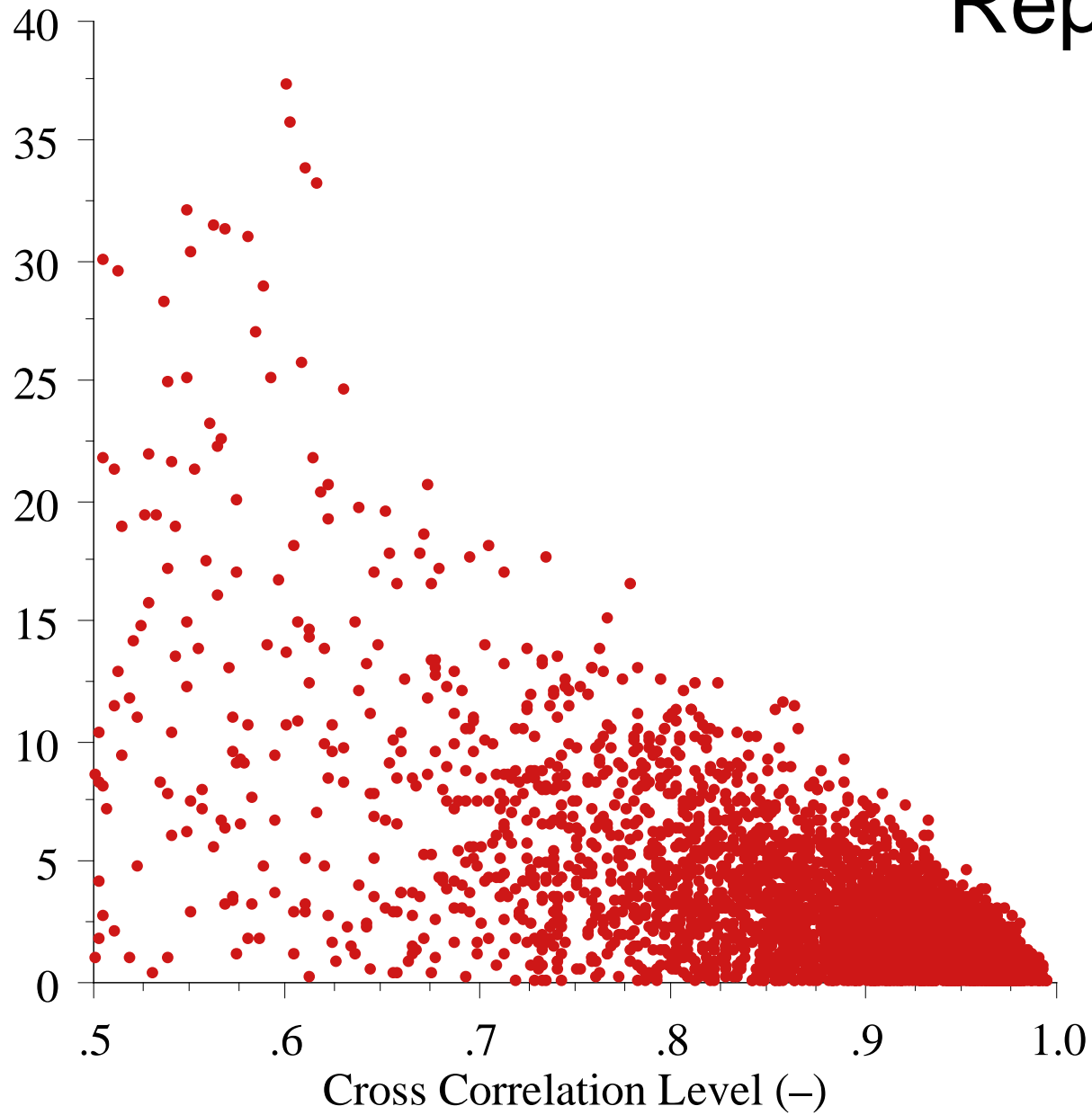
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2004 FHWA Profiler Round-up

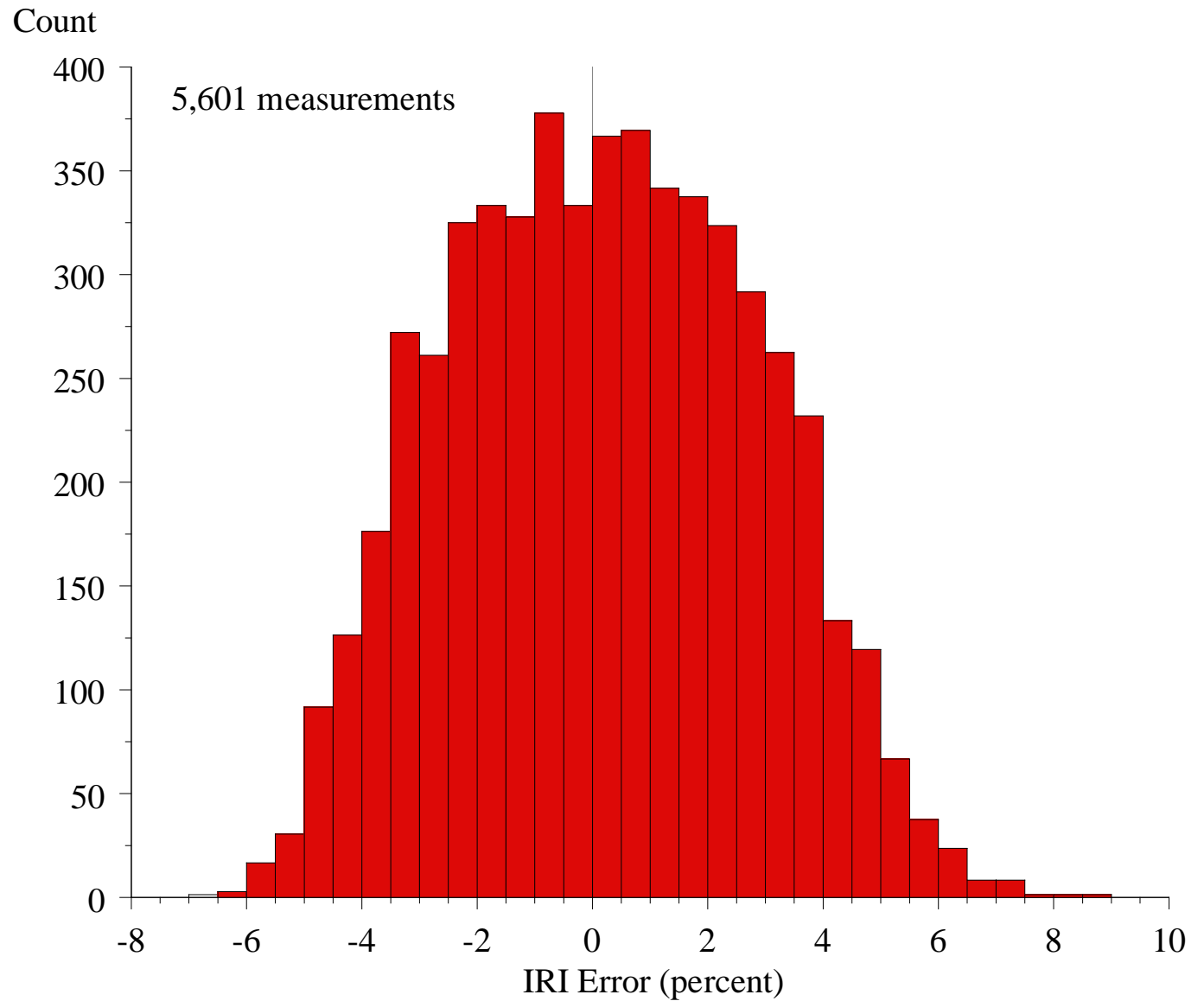


Repeatability

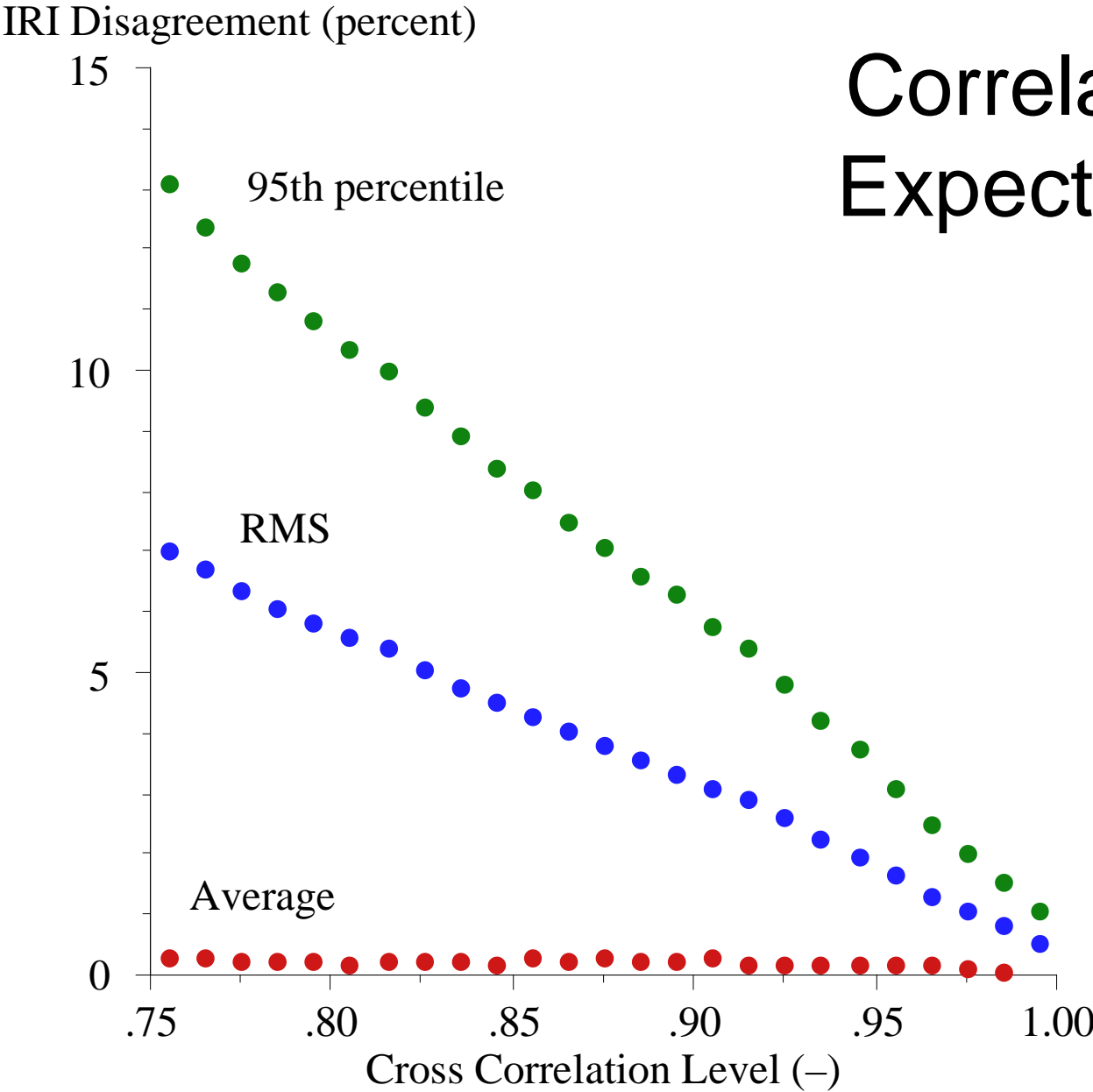
Absolute IRI Difference (percent)



Probability Distribution 0.92-0.93



Correlation versus Expected IRI Error



Summary Statistics

Cross Correlation Range		Number of Comparisons	Error Level in IRI Measurement (Percent)				
From	To		Average	RMS	95th Percentile	Low	High
0.99	1.00	13	-0.15	0.52	1.07	-1.07	0.81
0.98	0.99	171	0.04	0.83	1.54	-1.38	3.42
0.97	0.98	849	0.10	1.04	2.00	-3.49	3.79
0.96	0.97	2054	0.16	1.31	2.48	-4.16	4.81
0.95	0.96	3095	0.20	1.64	3.12	-4.87	5.21
0.94	0.95	3963	0.18	1.96	3.73	-5.78	6.84
0.93	0.94	4965	0.18	2.26	4.23	-6.22	6.82
0.92	0.93	5601	0.18	2.62	4.80	-6.62	8.92
0.91	0.92	6398	0.20	2.93	5.43	-7.65	9.12
0.90	0.91	7096	0.27	3.11	5.76	-8.11	9.57
0.89	0.90	7490	0.24	3.33	6.30	-8.71	11.72
0.88	0.89	8028	0.23	3.56	6.63	-10.77	11.82
0.87	0.88	8432	0.29	3.80	7.10	-10.38	12.23
0.86	0.87	8485	0.21	4.04	7.50	-10.97	13.36
0.85	0.86	8754	0.27	4.29	8.05	-11.48	14.76
0.84	0.85	9123	0.19	4.53	8.41	-12.97	14.73
0.83	0.84	8988	0.23	4.76	8.92	-12.99	15.99
0.82	0.83	8809	0.27	5.08	9.42	-14.22	16.69
0.81	0.82	8691	0.21	5.40	10.00	-14.45	17.62
0.80	0.81	8742	0.19	5.62	10.37	-15.24	18.15
0.79	0.80	8455	0.22	5.82	10.82	-15.40	20.72

Summary Statistics

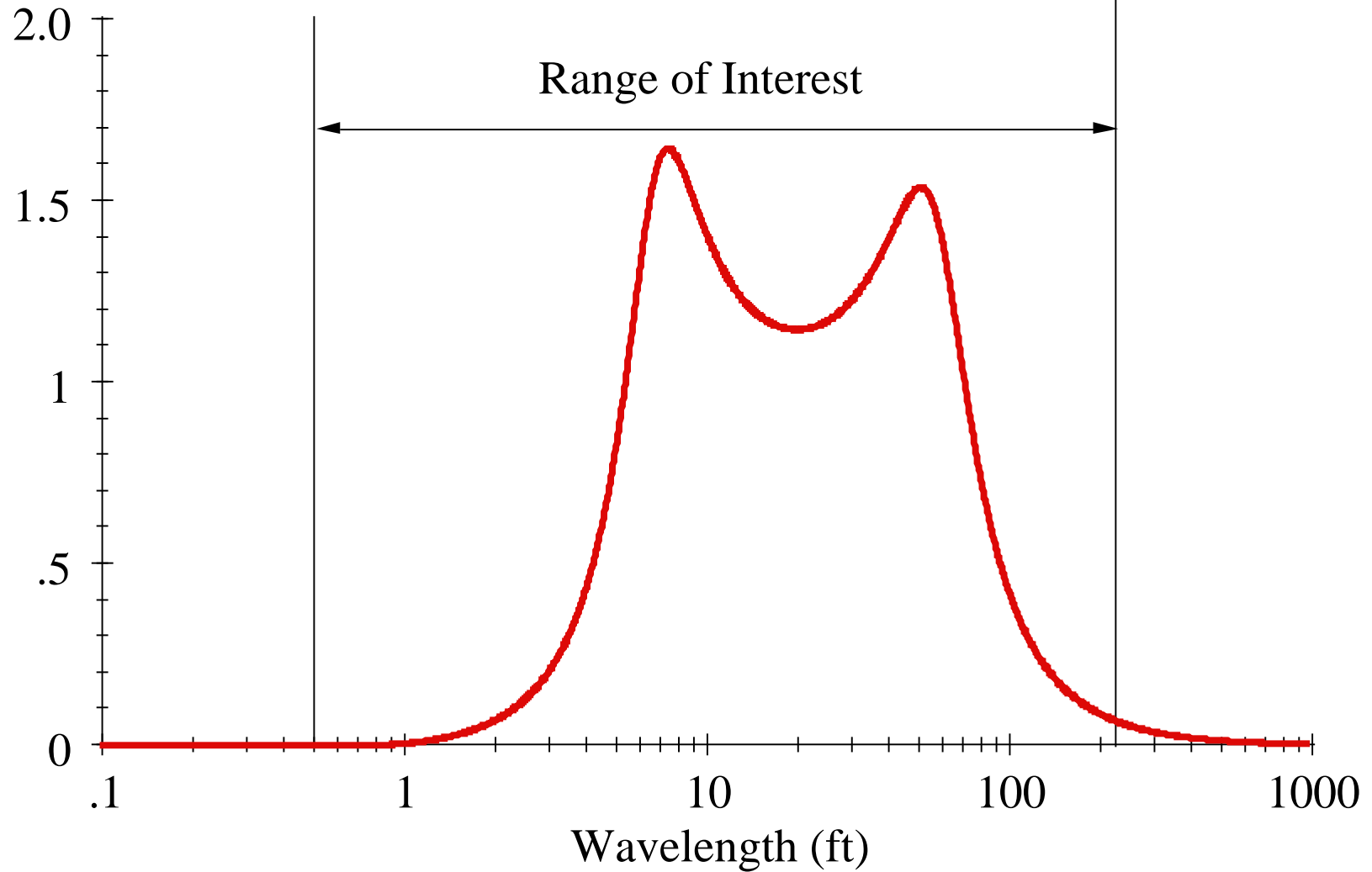
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- Thresholds
- **Wavebands**
- Filtering
- DMI Error
- Short Wavelength Content

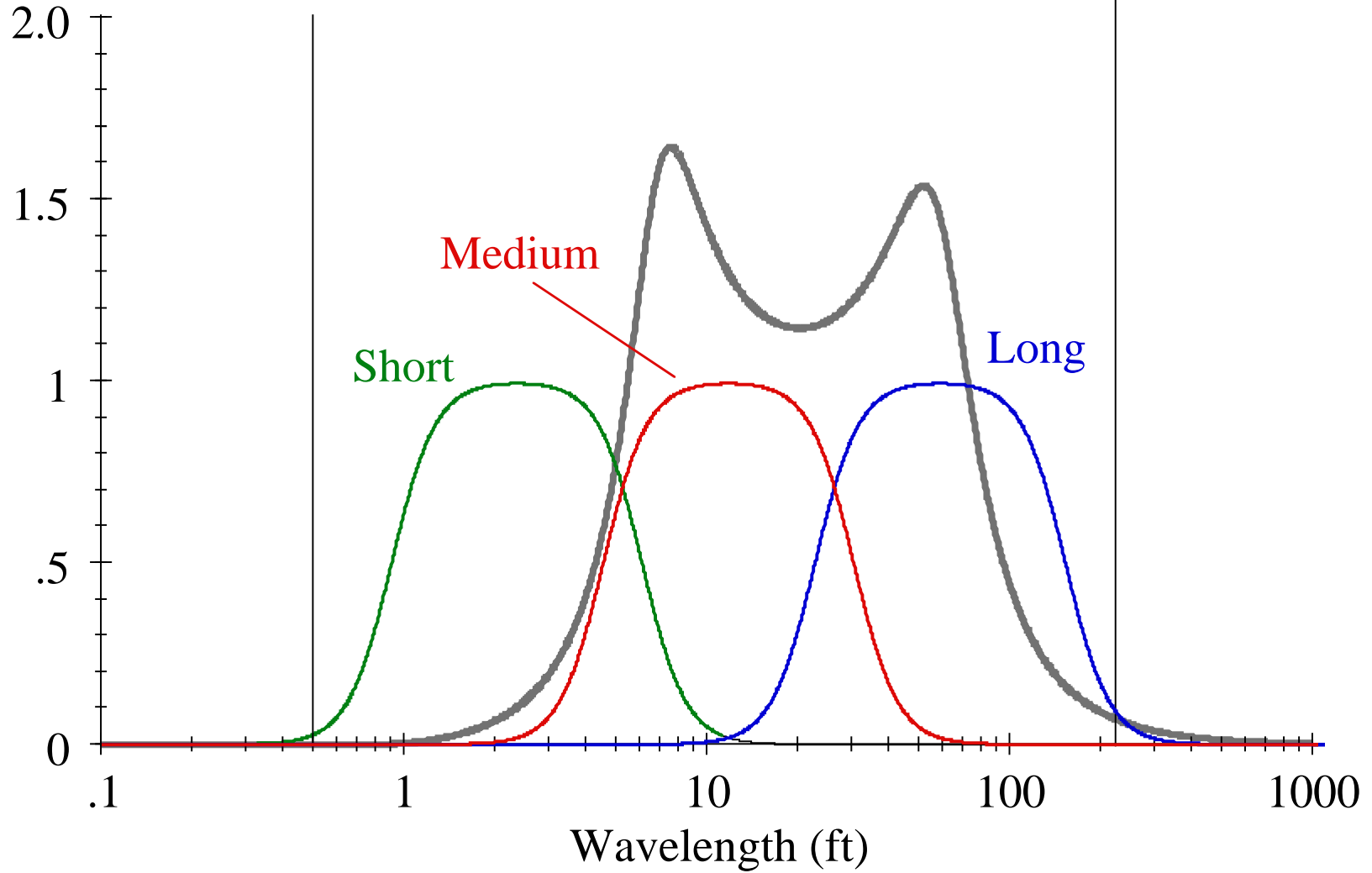
Waveband

Gain for Profile Slope



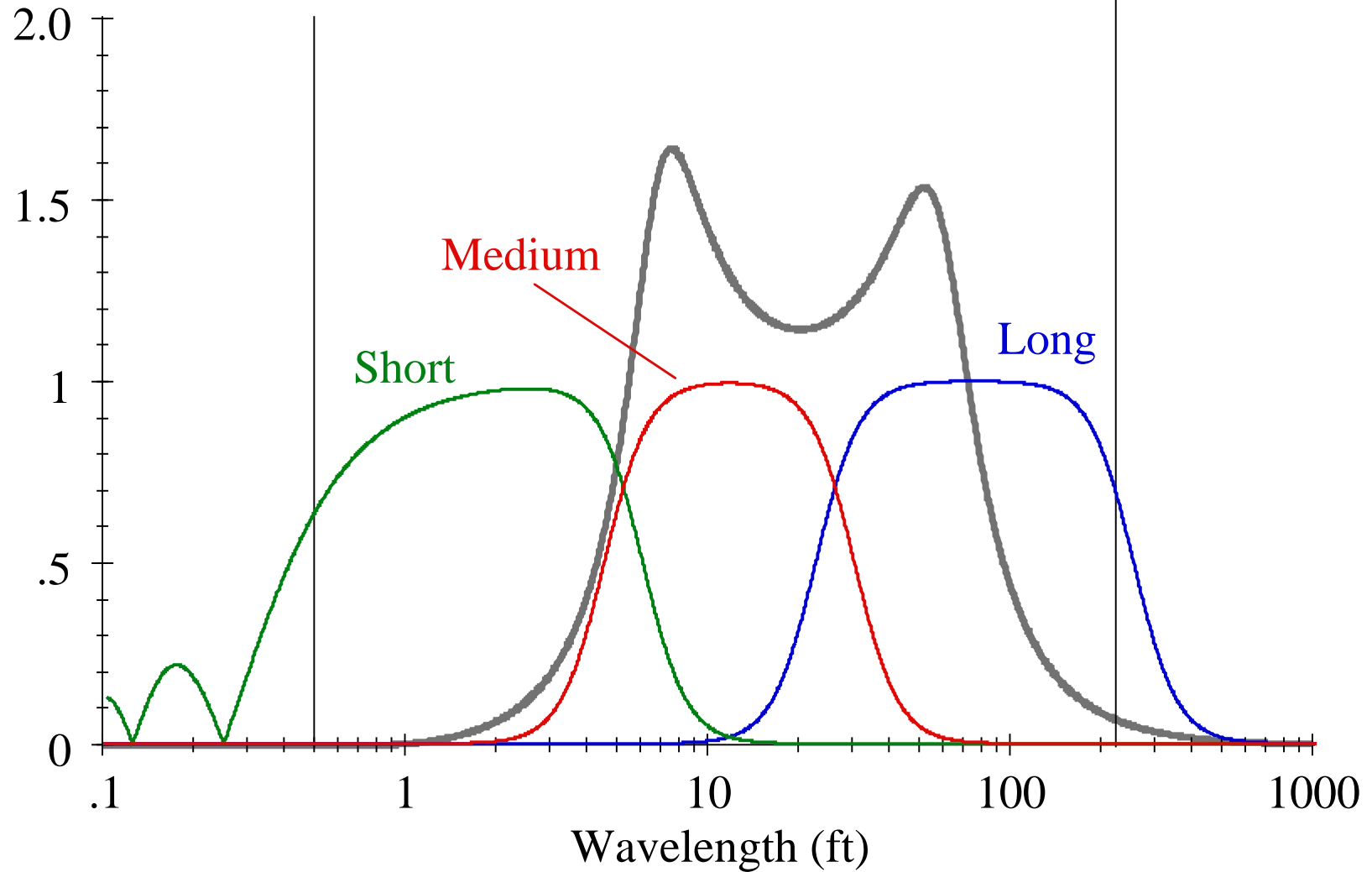
Wavebands

Gain for Profile Slope



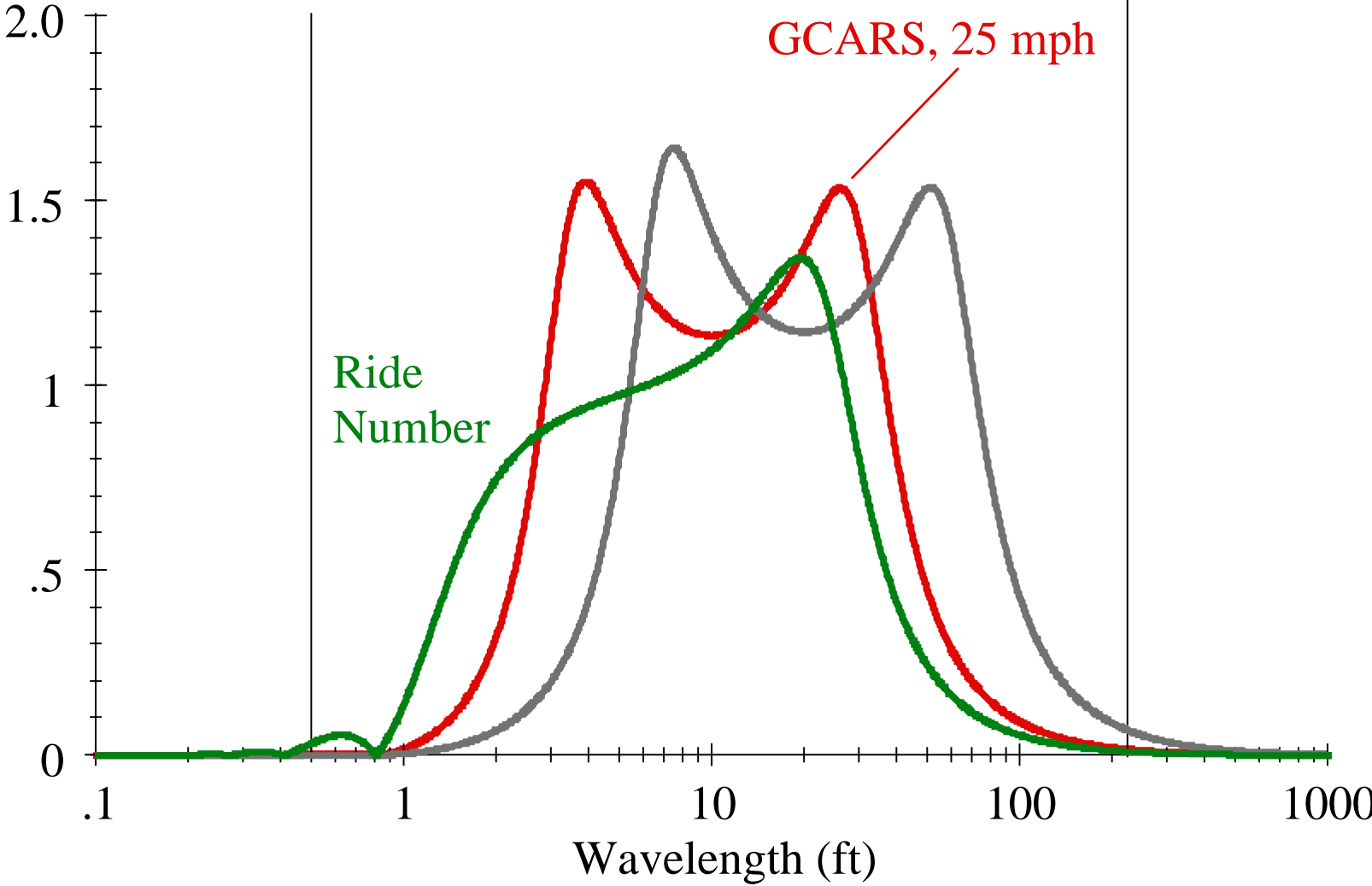
More Wavebands.....

Gain for Profile Slope



Ride Number

Gain for Profile Slope

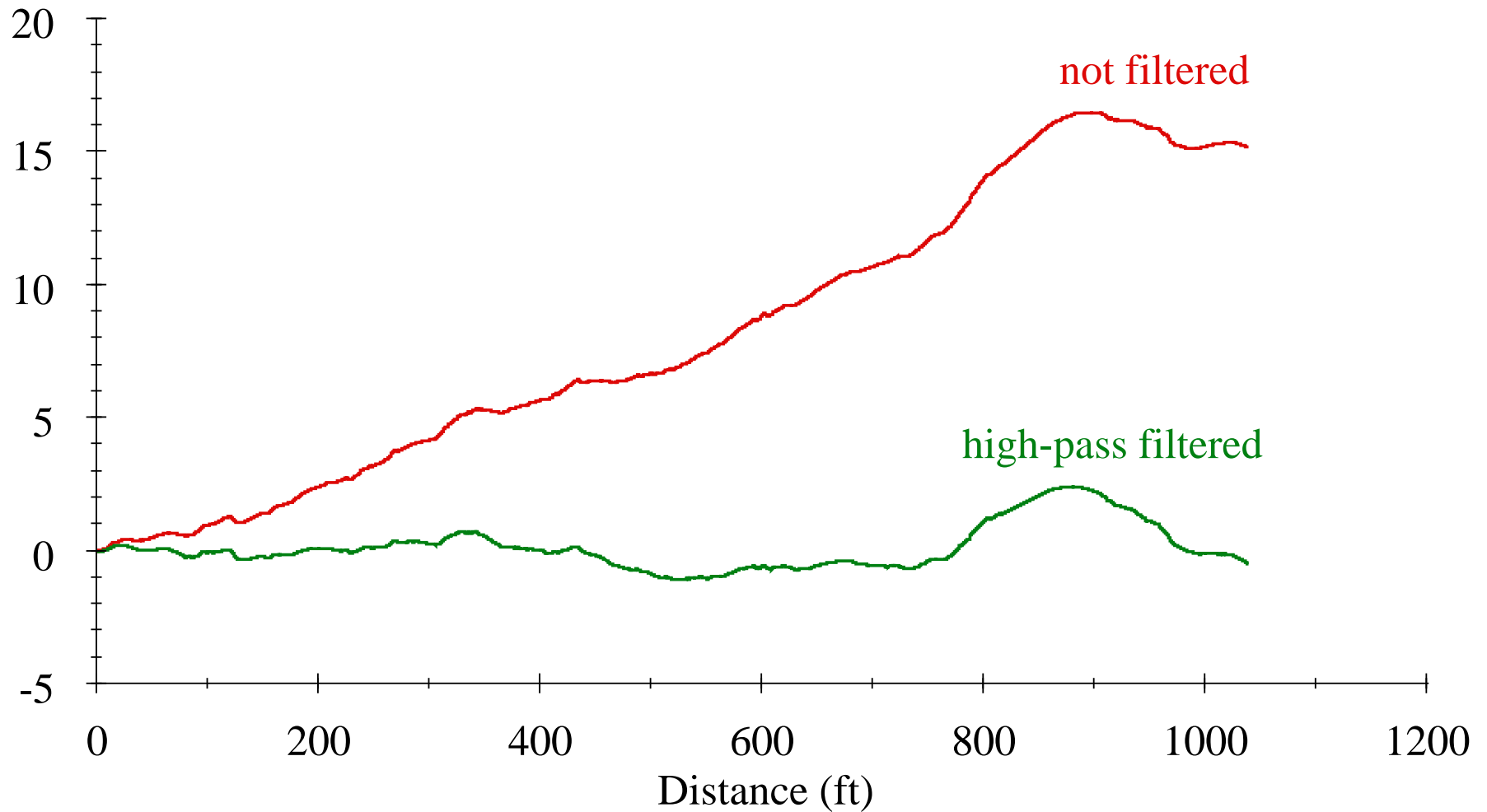


Outline

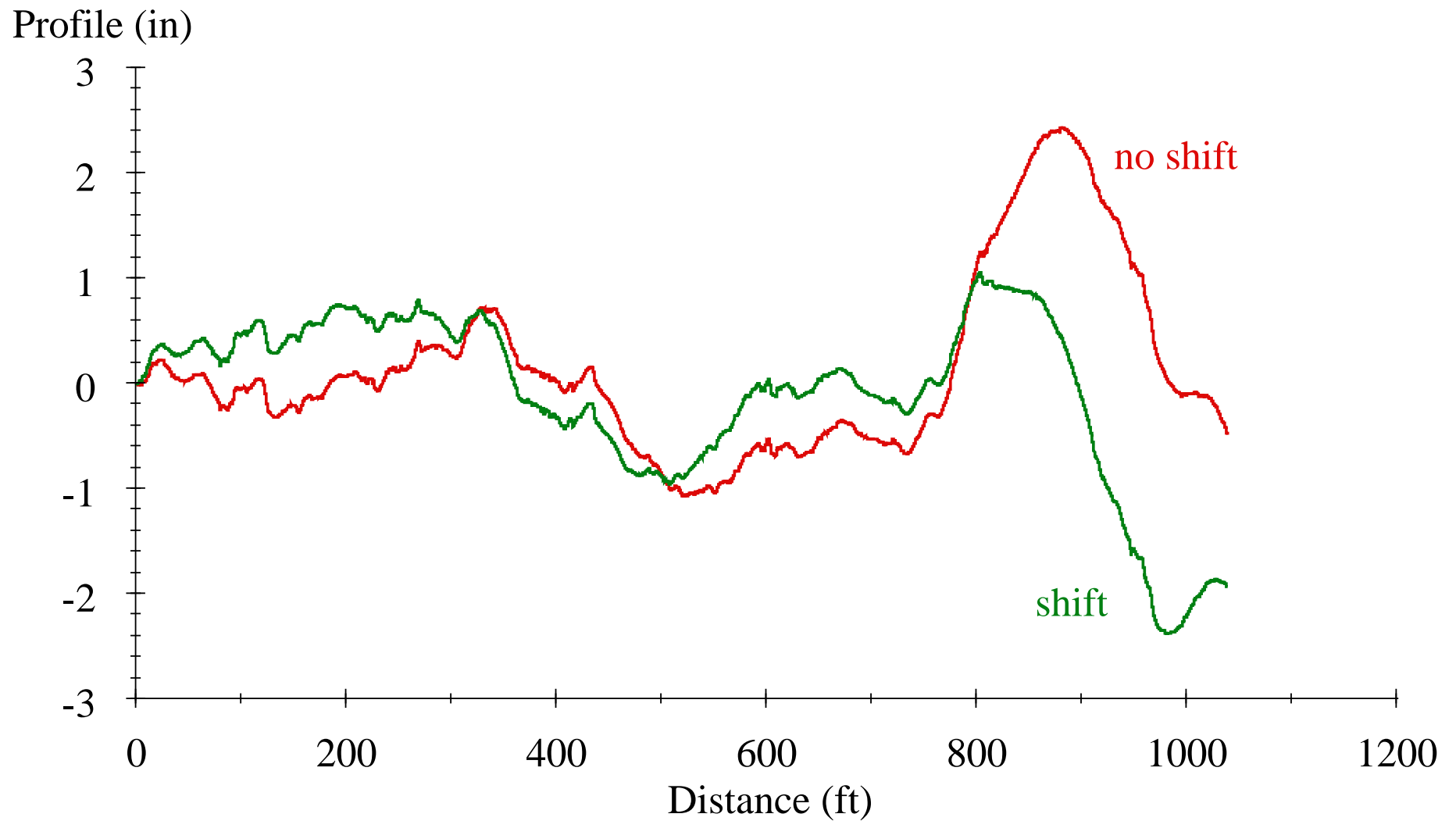
- Basics
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- **Filtering**
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Filtering: “300-ft high-pass”

Profile (in)

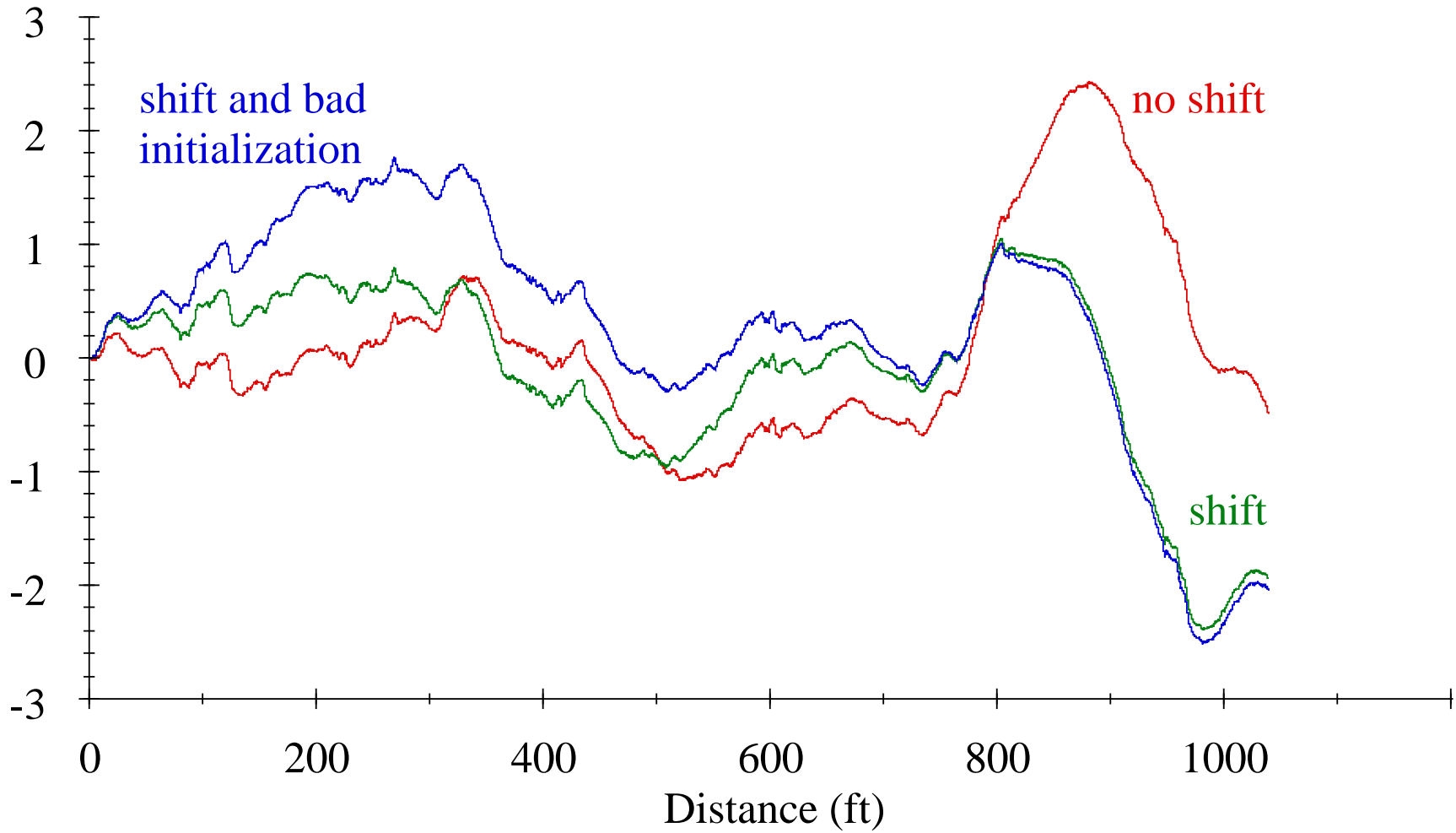


Filtered with and without Shift



Initialization

Profile (in)

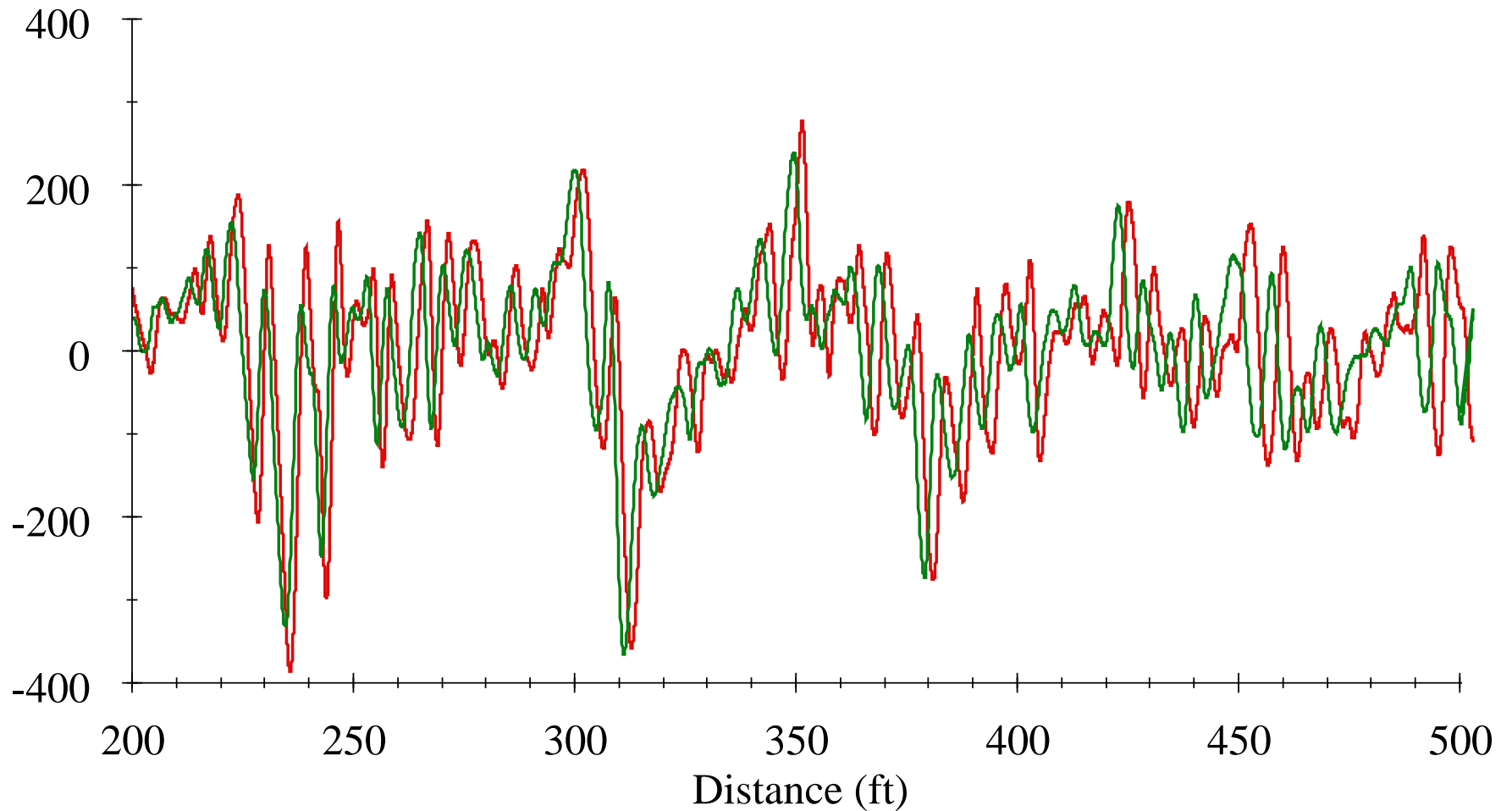


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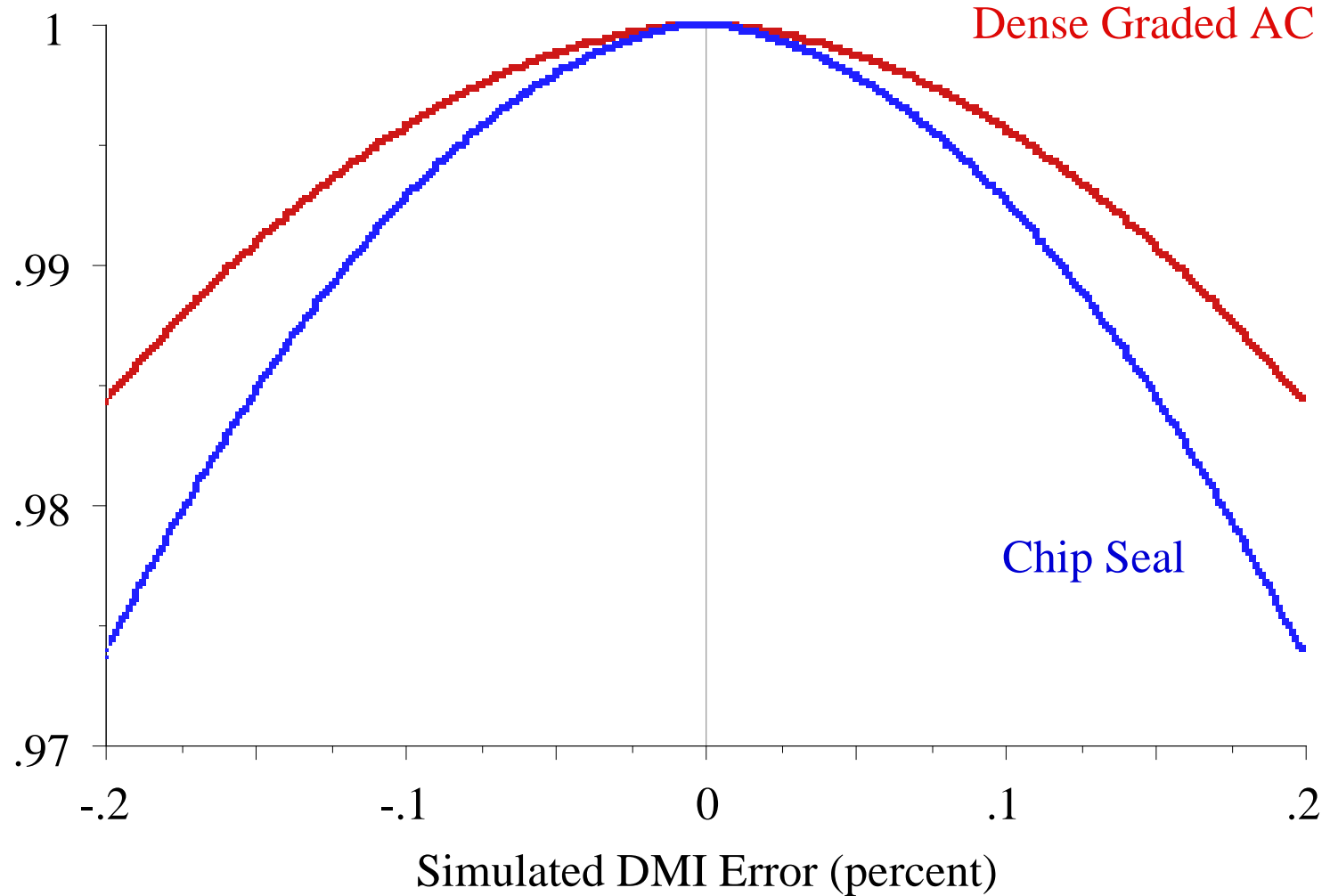
Downstream Look, DMI Error

IRI Filtered Trace (in/mi)

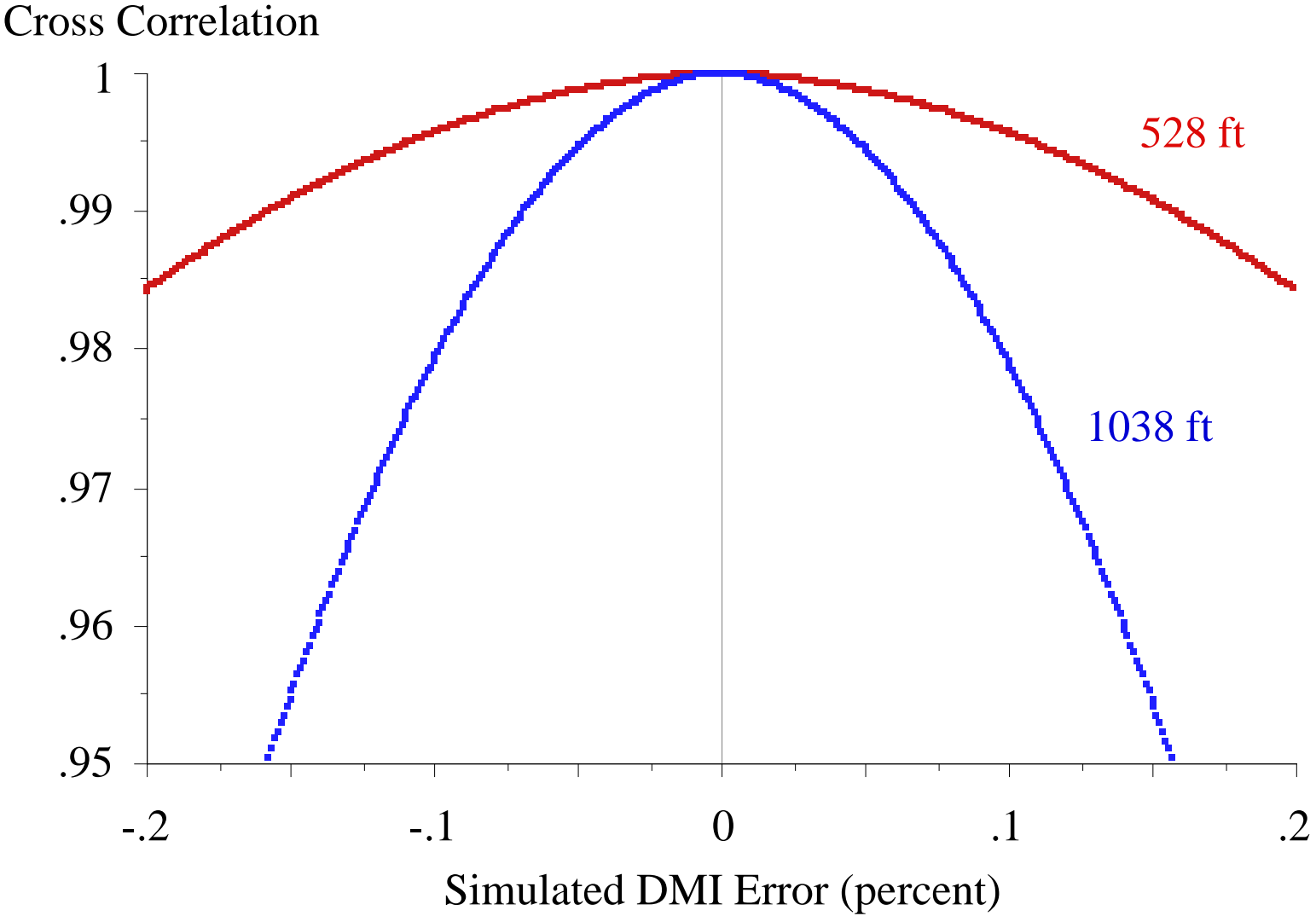


DMI Error, 528-foot Section

Cross Correlation



DMI Error



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Short Waveband

- No device can measure the short waveband accurately and cost effectively as part of the “complete” profile.
- Even if a profiler could, it would be very difficult to verify.

Edison's Dog



Thank you.