

AREMA C&S Conference

May 22, 2007

Improving Hot Box Detector Performance Through Technology



Introduction

- **Performance based comparison of HBD's**
 - **Existing performance was 6.5 Sigma**
 - **BUT – When we stopped a train we found a hot journal only 31% of the time !!**
- **What do we do to improve ?**
 - **For several years we had been replacing the older HBD systems.**
 - **All the remaining systems, on BNSF, are capable of digital processing.**
 - **This allows the “capture” of the profile of the alarm heat.**
 - **With the profile we could verify the validity of the alarms.**

The plan

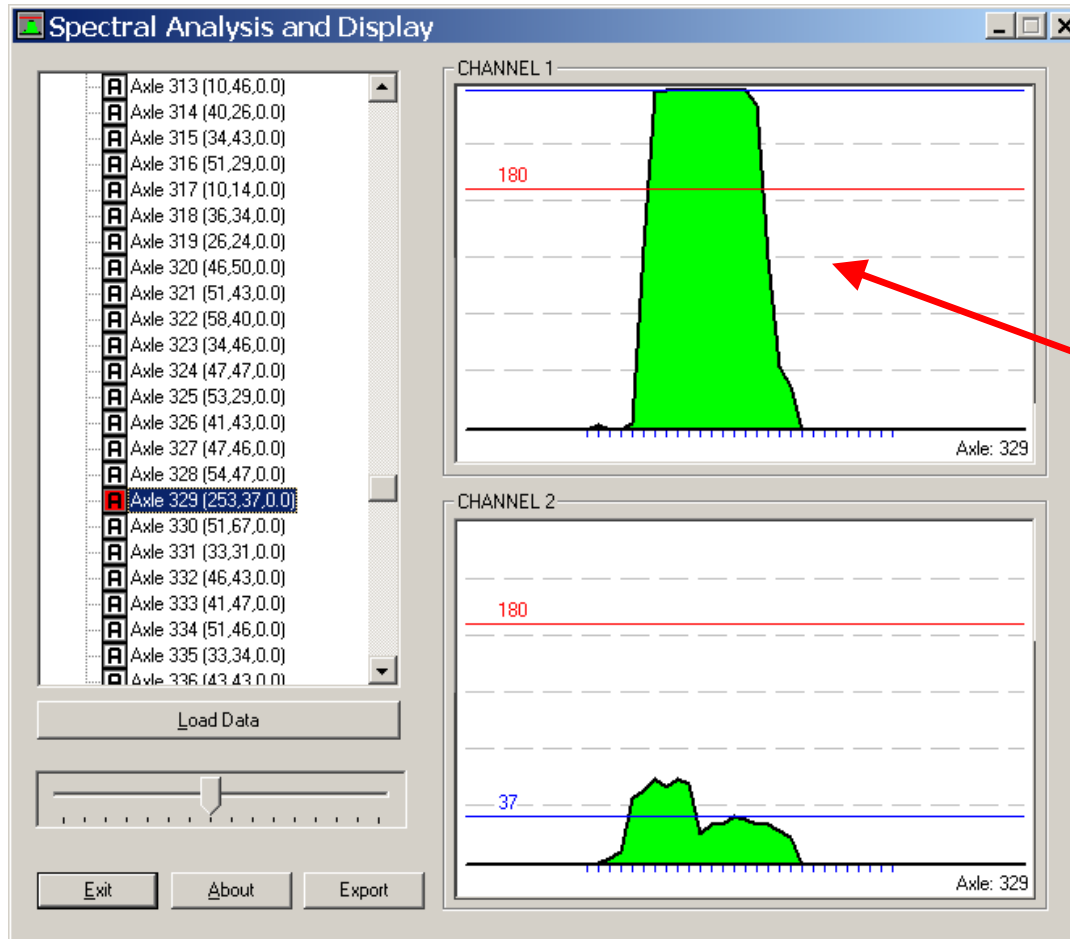
- **Profiles for all alarms were captured for two months.**
- **GE-Transportation provided a 6 Sigma “Black Belt” to assist with the project.**
- **I analyzed the profiles and classified the cause for each false alarm.**
- **Most of the time when the train crew reported “Nothing Found” the profile would indicate it wasn’t valid heat.**
- **The profiles would show:**
 - **Microphonic problems**
 - **Sun / Brakes**
 - **Loose Connection**

Definitions

● **Microphonic**

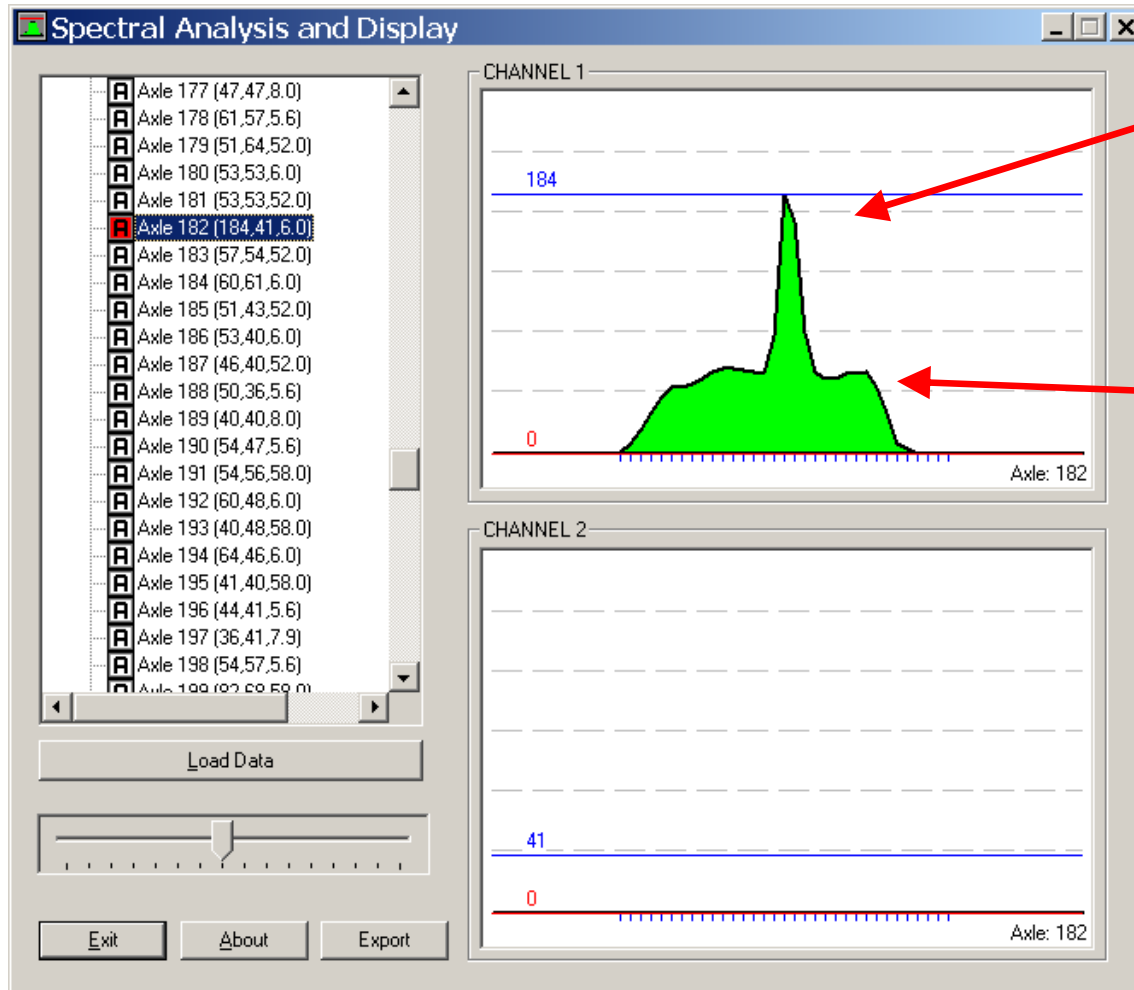
- **The normal failure mode of a Pyro is to become “noisy”.**
- **This noise can be caused by loose components in the Pyro or by extreme track forces from flat wheel or poor track conditions.**
- **In these conditions the Pyro acts like a microphone and will give an output proportional to these forces.**
- **This is a “Microphonic” output.**
- **A Microphonic output is a transient response and is of short duration in respect to total gate.**

Valid Heat



Valid Alarm

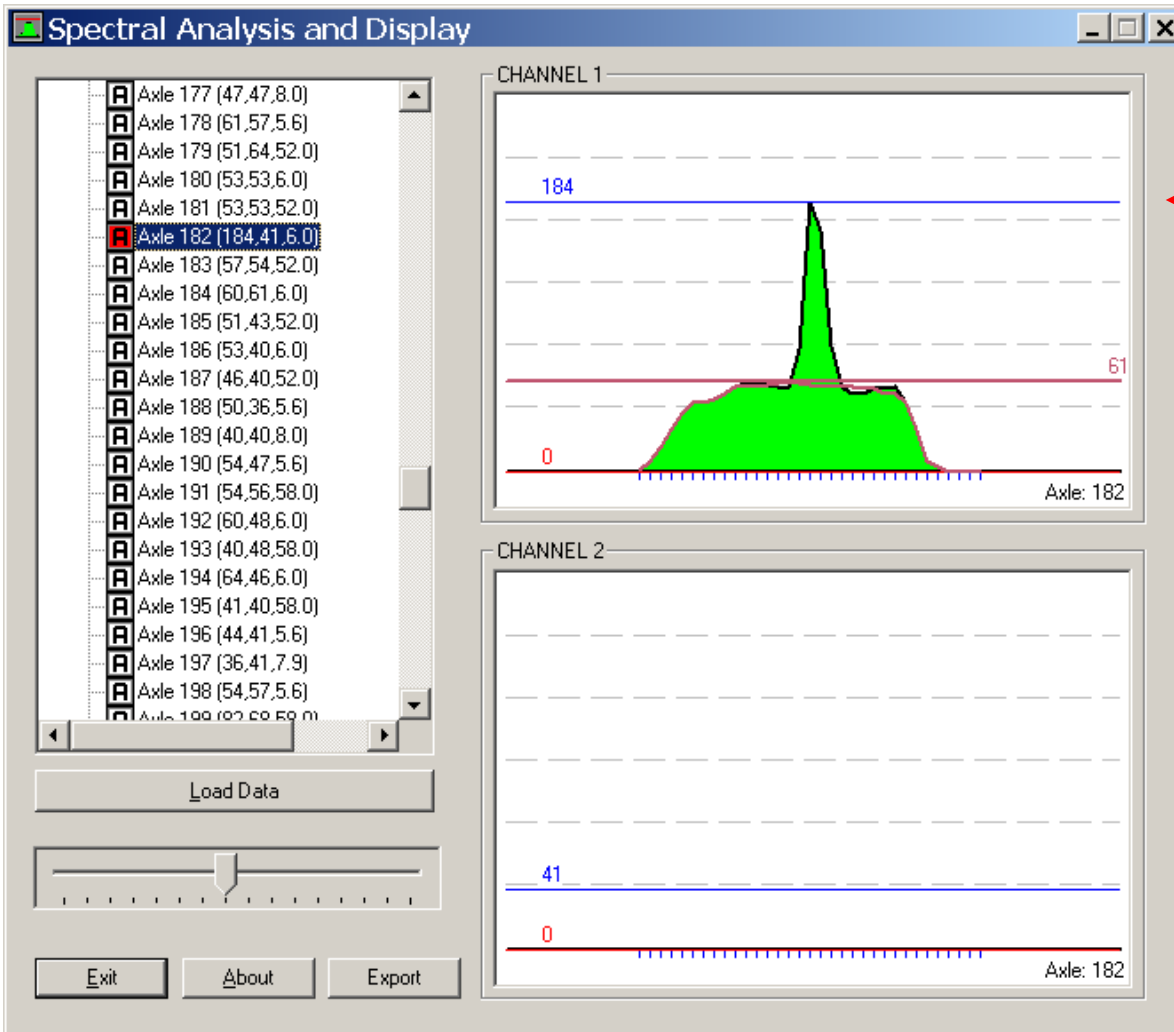
Microphonic Example



**Note: Narrow Pulse
This is Microphonic**

**Actual Bearing
Heat**

Example of 9-Point Median Filter



← **Unfiltered 184**

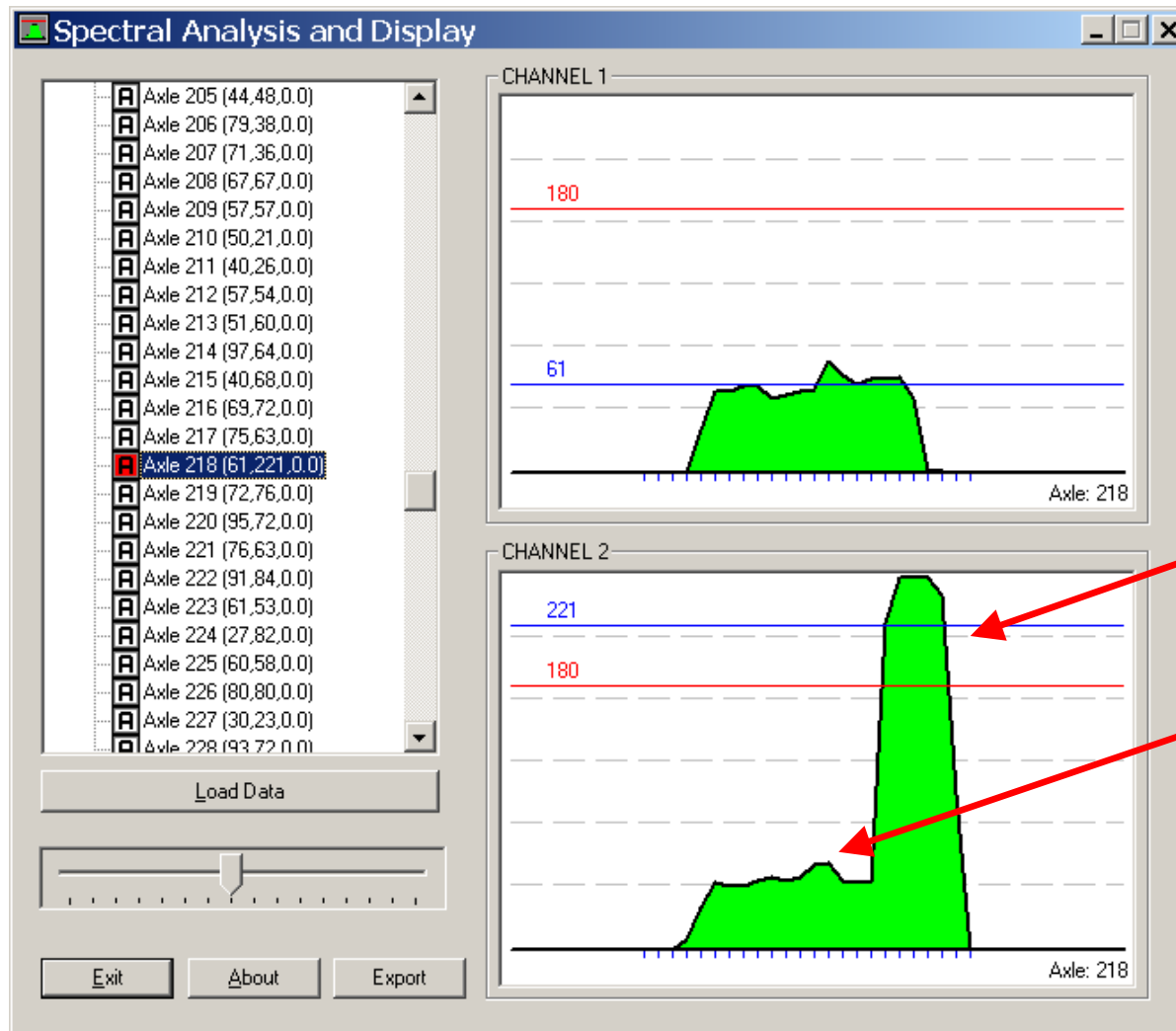
← **Filtered 61**

Definitions

● Sun Shot

- The sun has unlimited energy and produces energy in the full light spectrum.
- The HBD systems are filtered to accept only energy in the 7 to 14 microns wave length.
- There are times when the sun is in direct line with the HBD scan angle.
- At these times, if the rail car does not completely shield the sun from the scanner, the sun will cause a false alarm.
- This false alarm is called a “Sun Shot”

Sun Shot Example



**Extra heat from
sun or brakes**

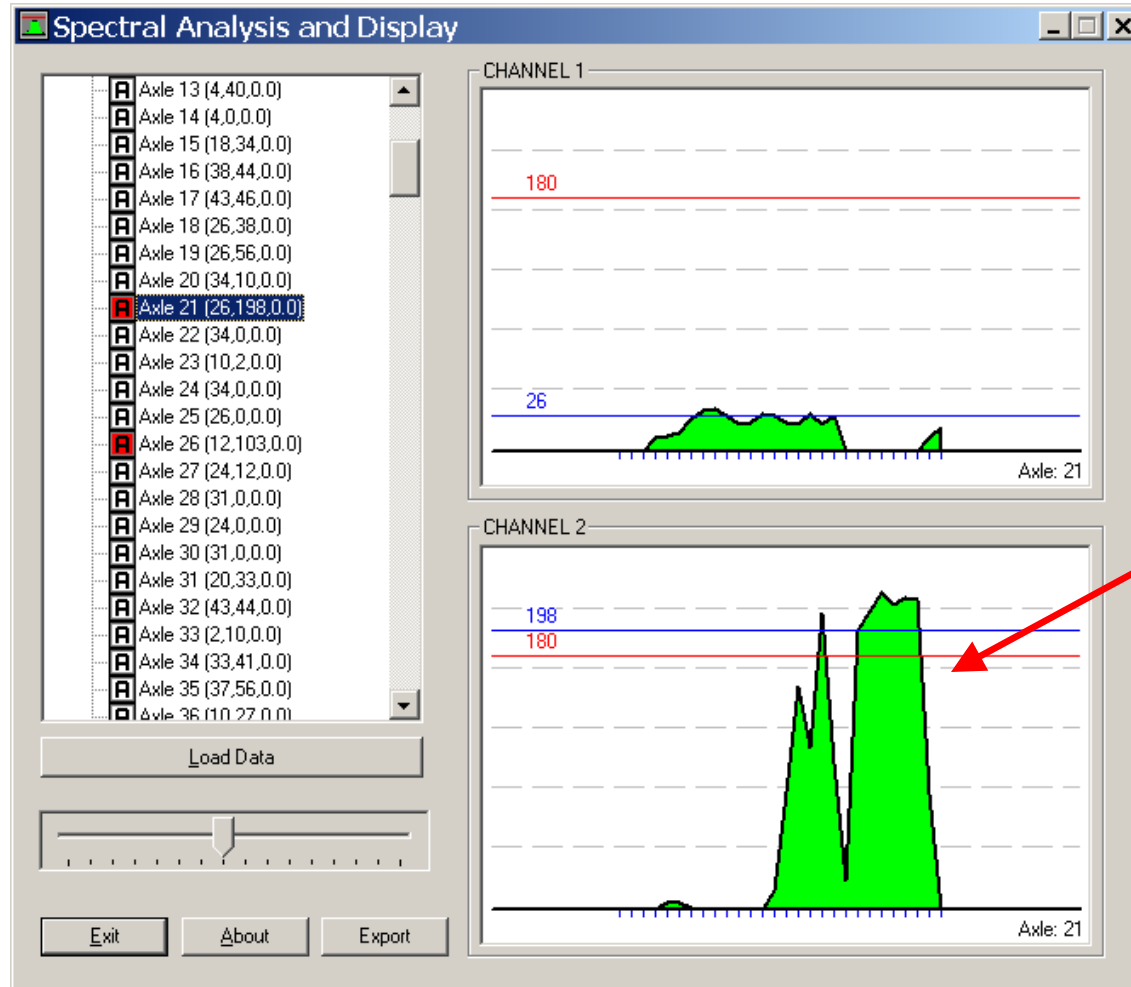
**Actual Bearing
Heat**

Definitions

● **Loose Connection**

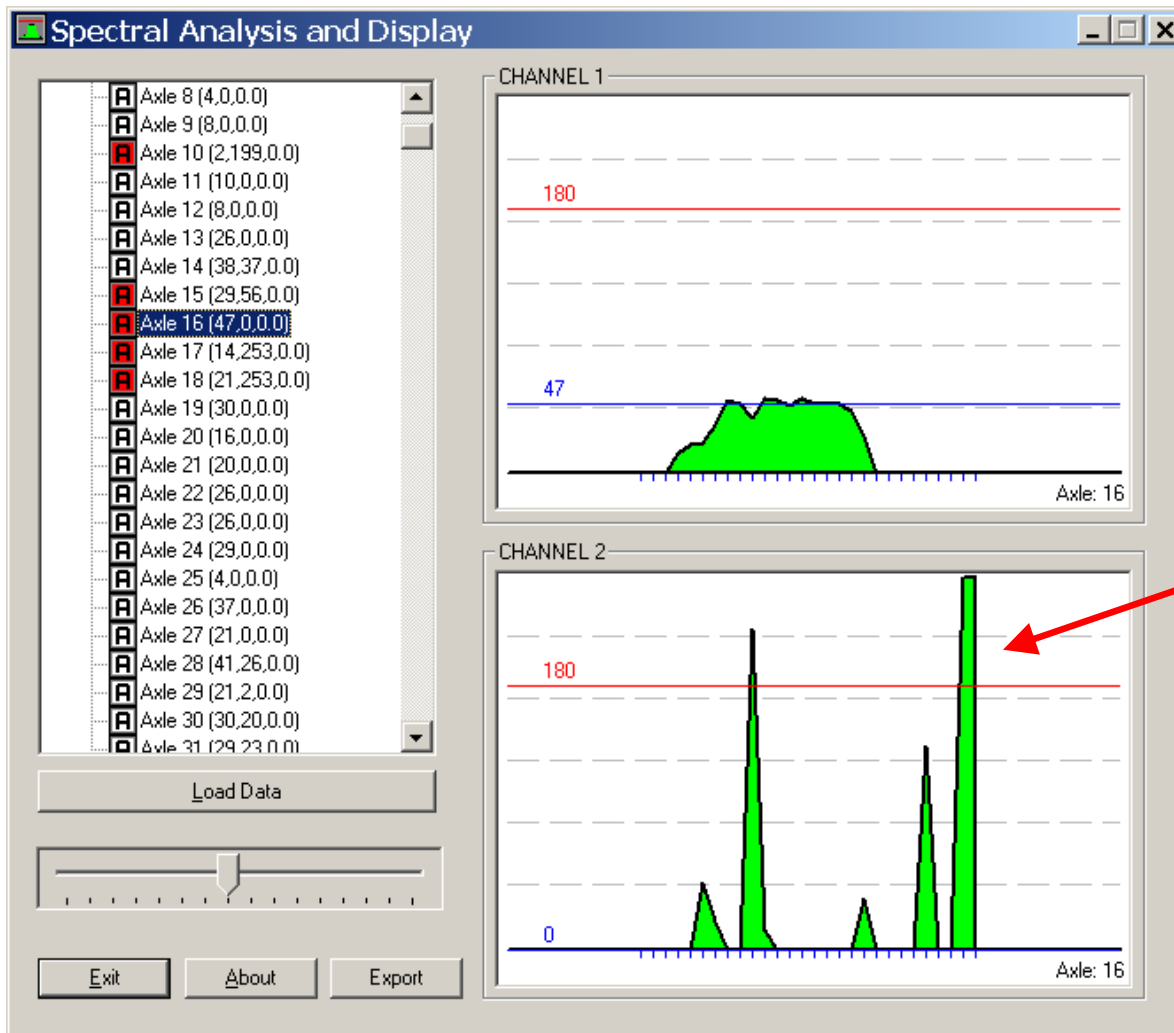
- **A loose connection can cause a transient response in the Pyro.**
- **This loose connection could be any place in the Pyro output or power circuits.**
 - **Pyro**
 - **Scanner cable connector loose**
 - **Field end**
 - **House end**

Loose Connector Example



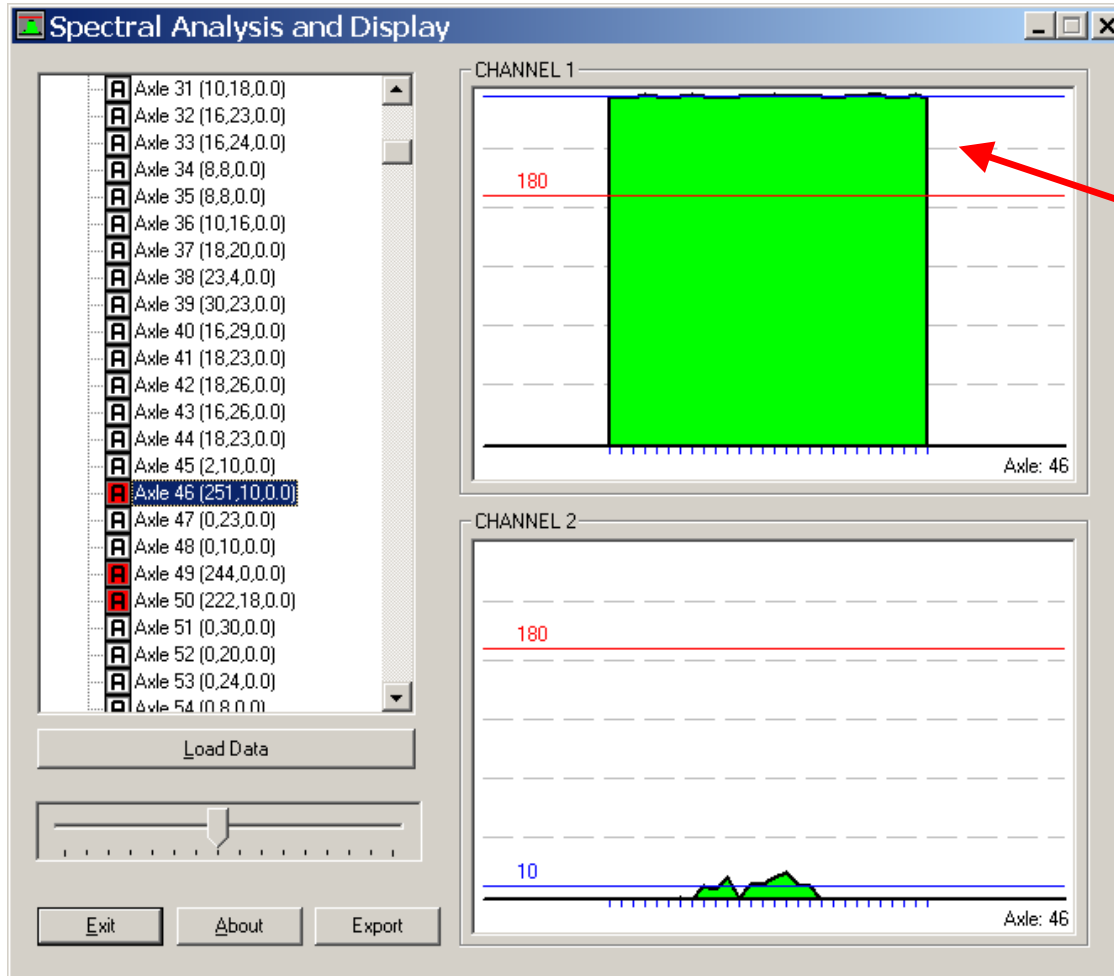
**Could have
multiple peaks
and valleys**

Loose Connector Example



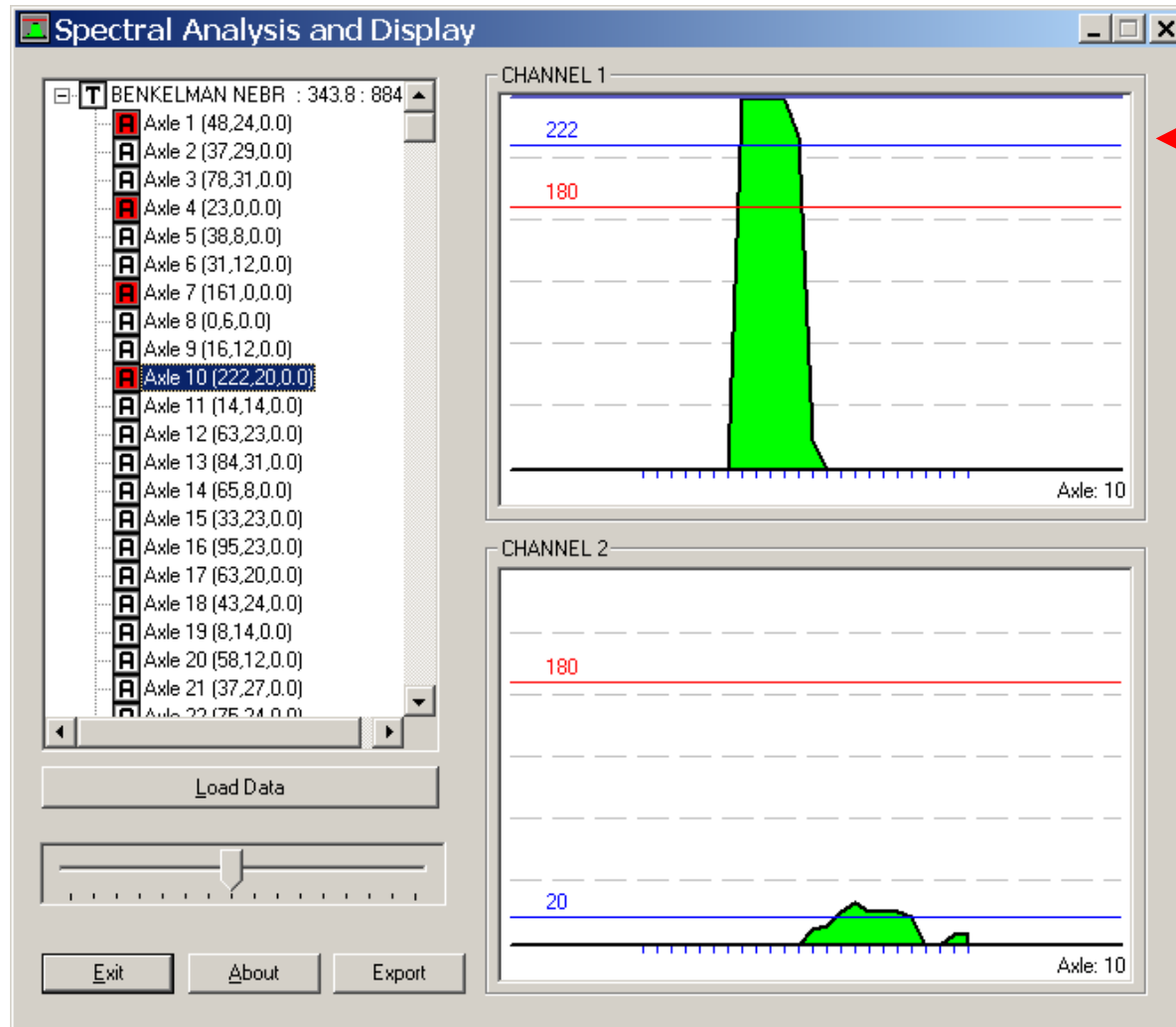
**Could have
multiple peaks
and valleys**

Loose Connector Example



Could be max reading for all samples

Existing 9-point Filter Results



← **Filtered Value 222**

Analysis

- **Existing 9-point Median filter was not providing complete correction of false alarms.**
- **When we had a false alarm at a detector.**
 - **We would alarm 2 or 3 trains before we understood there was a problem with the detector.**
 - **Once we understood there was a problem we would stop 1 or 2 more trains while we determined the cause of the problem.**

Analysis

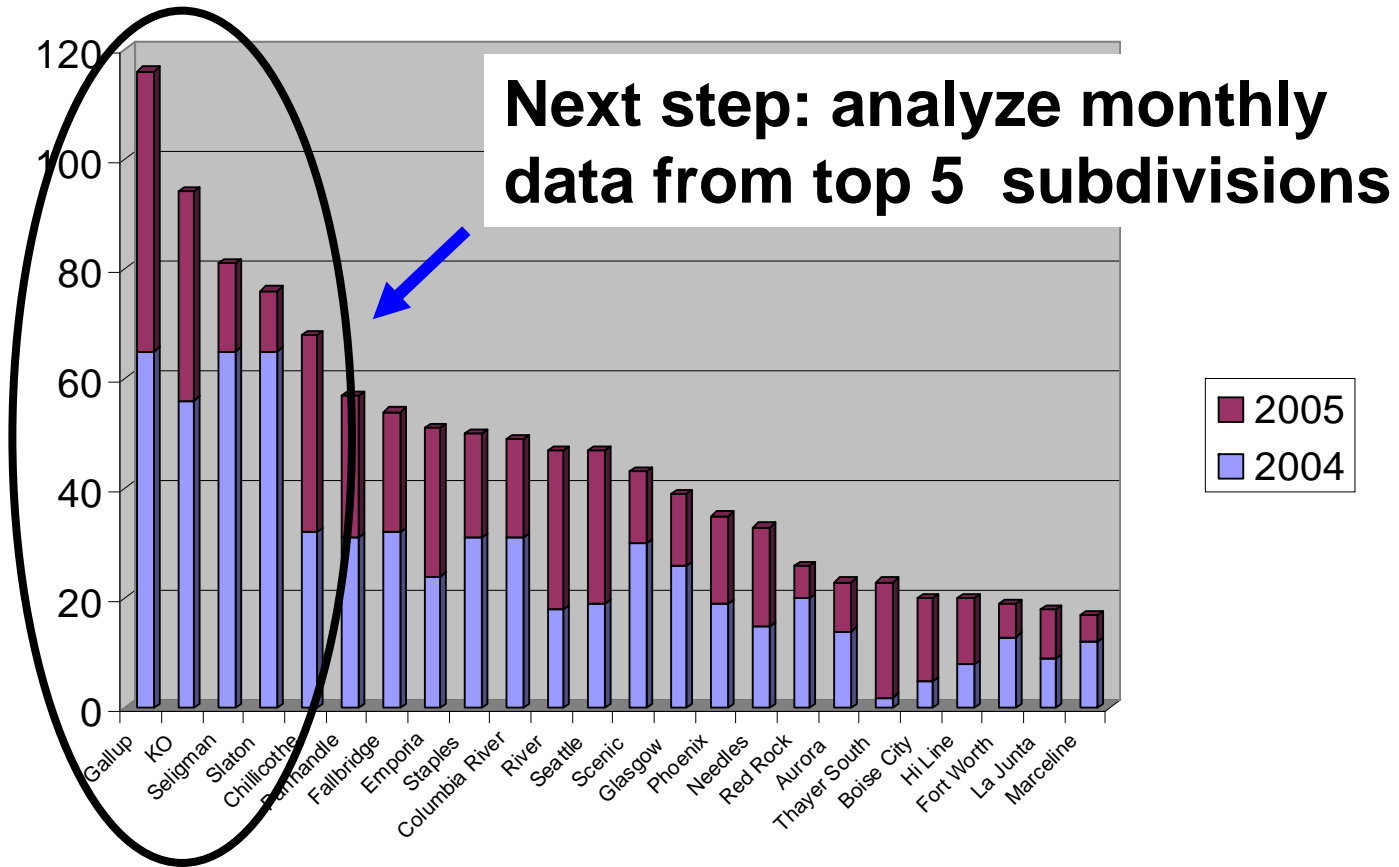
How do we Improve ?



Project Scope and Constraints

- **Narrow focus to the MicroHBD**
- **Focus on “Software only” solution**
- **Improvement must be verifiable in the office before deployment**
- **Improvement must be in place by “Peak Season” (November 2006)**

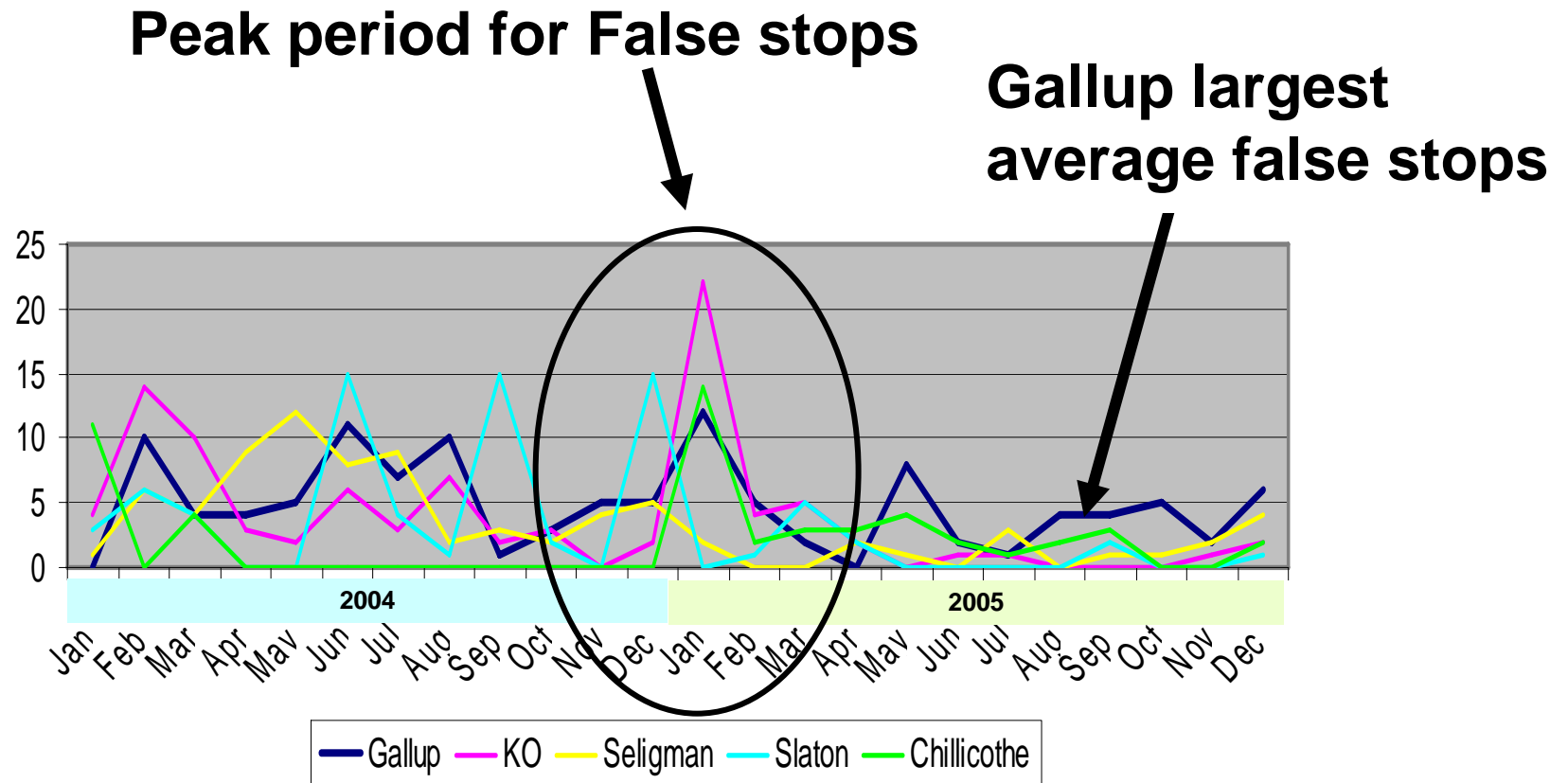
Highest False Stops by Subdivision



25 subdivisions account for 75% of false stops

66 subdivisions (not shown) account for the remaining 25% of false stops

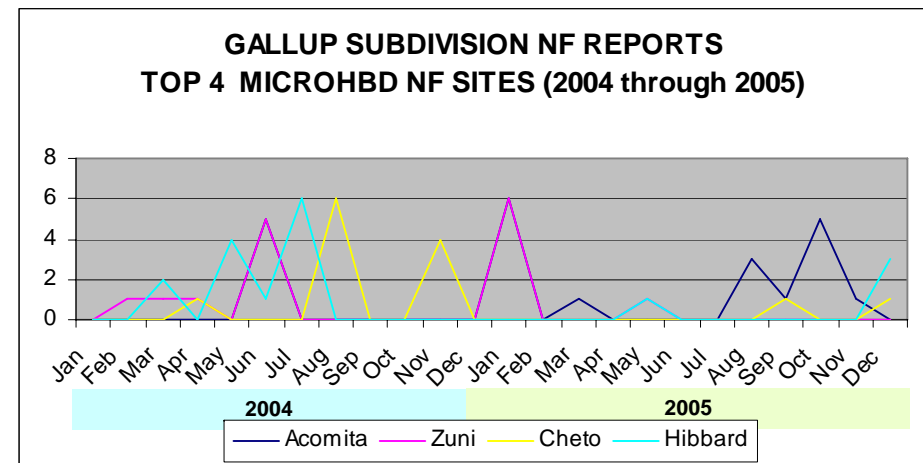
False Stops for Top 5 Sub-divisions 2004-2005



Significantly lower false stops in 2005 vs. 2004

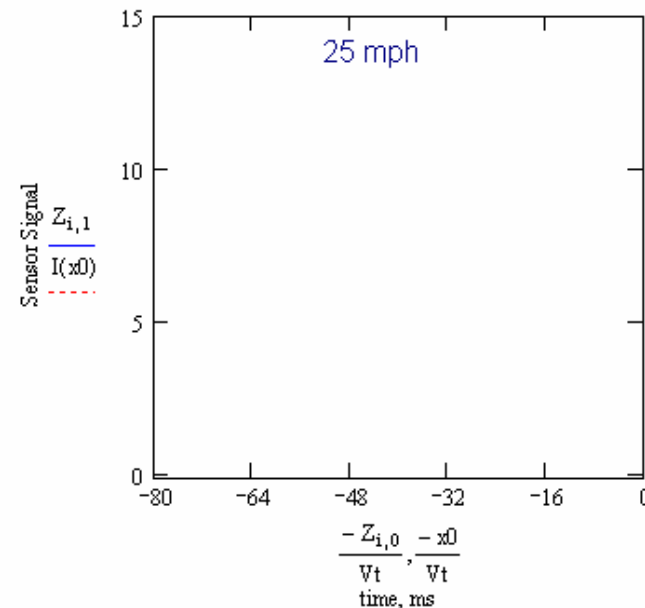
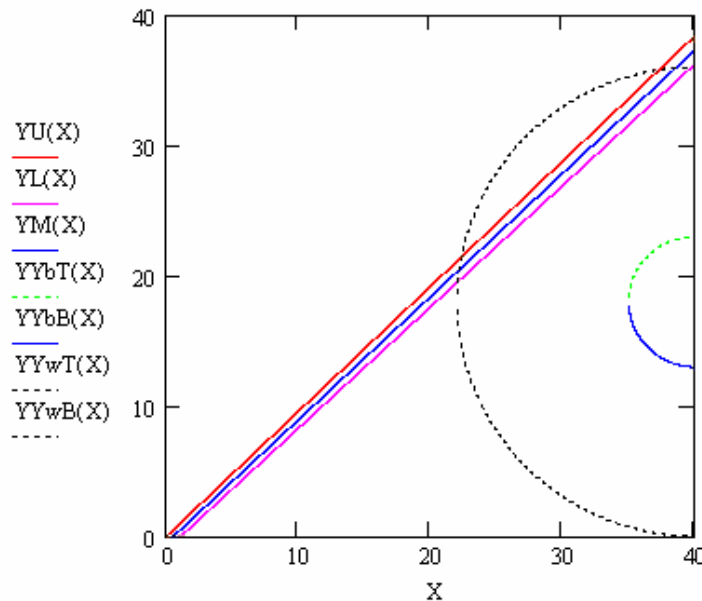
False Stops for Gallup Sub-division

- We looked at the false stops site-to-site distribution by month
- We decided against pursuing site visits due to random occurrence and low frequency of false stops
- Instead we shifted focus to collecting and analyzing the false stop bearing profiles



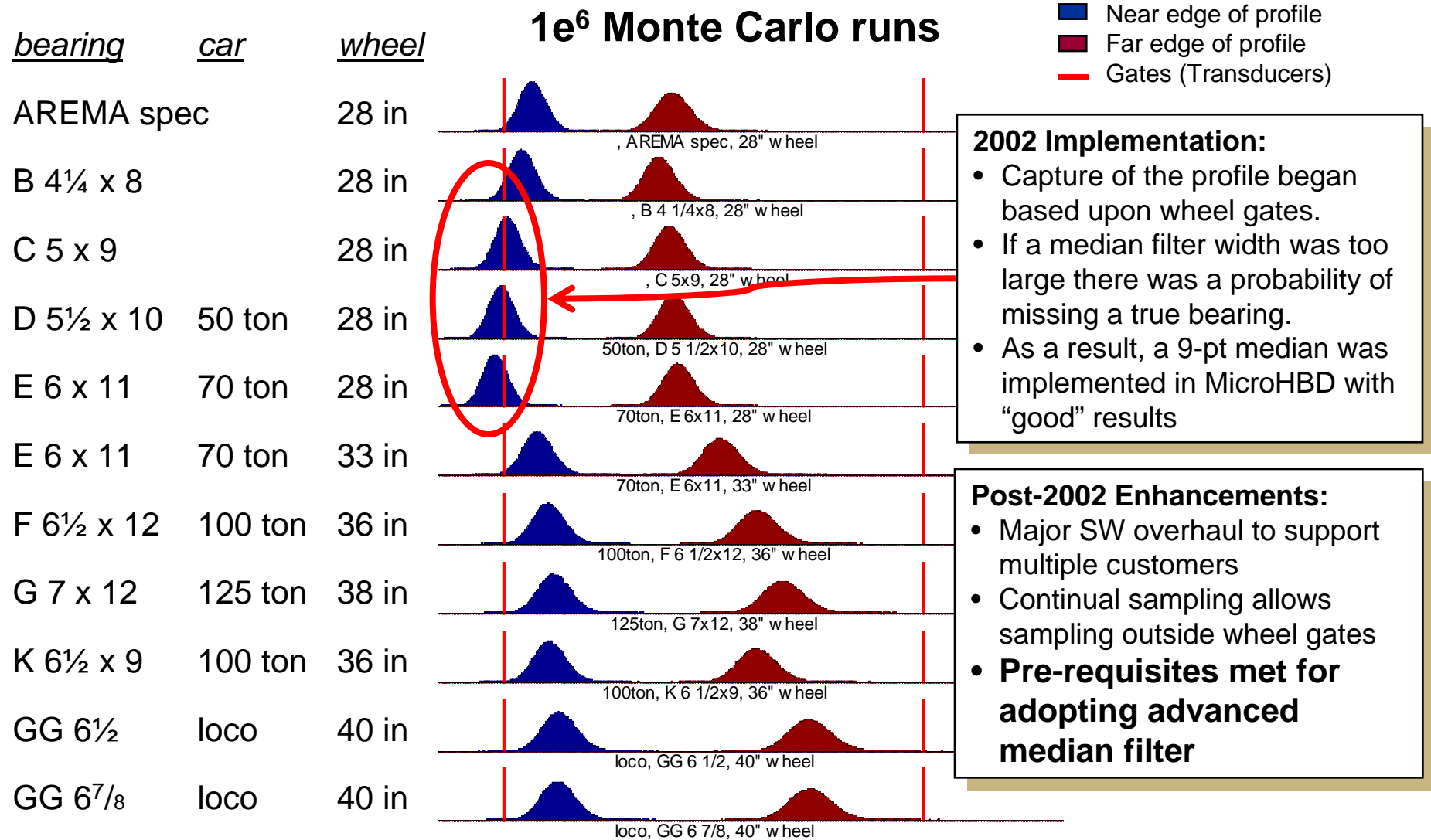
Global Research Center Study

History...The GE Global Research Center Schenectady, NY conducted research on HBD filtering technology to reduce False Stops in 2002.



- **GRC developed a model of the scanner**
- **Based upon the analysis of bearing profiles a median filter algorithm was developed and incorporated into MicroHBD software (Patent No. 6,911,914 B2)**

Profile Edges vs. Gating



Profile Analysis

- **BNSF provided bearing profiles for false stops**
- **34 false stop profiles captured for analysis**
- **Desk analysis determined that the advanced median filter would have filtered 27 of the 34 false stop profiles below the absolute alarm threshold.**

Date	Time	Location	ST	Axle	Reading	calculated advanced median result	eliminated alarm?
04/27/06	2:00	Wittenberg	MO	44	209	126	Y
04/28/06	10:30	Odessa	WA	200	207	57	Y
4/29/2006	19:40	Wayne	OK	97	252	253	N
4/29/2006	19:40	Wayne	OK	207	252	56	Y
4/30/2006	10:00	Acomita	NM	252	252	111	Y
04/30/06	17:20	Lakeside	NE	58 - 1	208	138	Y
04/30/06	17:20	Lakeside	NE	58 - 2	182	104	Y
05/01/06	9:10	Benkelman	NE	10	222	0	Y
05/04/06	16:50	Electra	TX	26	185	24	Y
05/05/06	0:30	Electra	TX	186	214	60	Y
5/5/2006	12:15	Wayne	OK	311	221	157	Y
5/6/2006	19:25	Wayne	OK	42	207	76	Y
5/7/2006	1:00	Wayne	OK	146	252	0	Y
5/7/2006	21:55	Winslow	AZ	132	221	223	N
5/7/2006	21:55	Winslow	AZ	133	251	253	N
5/7/2006	21:55	Winslow	AZ	134	251	253	N
5/7/2006	21:55	Winslow	AZ	135	208	210	N
5/7/2006	21:55	Winslow	AZ	136	194	196	N
05/11/06	22:38	Benkelman	NE	18	197	38	Y
05/11/06	10:14	Bellemont	AZ	27	252	253	N
05/11/06	10:14	Bellemont	AZ	29	191	0	Y
05/11/06	10:14	Bellemont	AZ	41	252	0	Y
05/12/06	4:03	Benkelman	NE	34	204	99	Y
05/17/06	16:45	Roland	KS	302	252	102	Y
5/20/2006	10:04	Angel	AZ	129	252	58	Y
5/20/2006	10:04	Angel	AZ	131	199	51	Y
05/21/06	5:40	Electra	TX	142	191	102	Y
5/22/2006	10:10	Angel	AZ	166?	201	71	Y
5/25/2006	10:08	Angel	AZ	162	182	0	Y
5/25/2006	10:08	Angel	AZ	191	233	0	Y
05/30/06	0:37	Ottawa	KS	308	187	102	Y
06/01/06	11:40	Miami	TX	302	251	84	Y
06/03/06	0:15	Chillicothe	TX	42	222	0	Y
06/15/06	15:14	Amory	MS	40	206	16	Y

Y 27
N 7

Implementation



Implementation

- **We were then confident that the advanced median filter would significantly reduce false stops if implemented in the MicroHBD**
- **BNSF tested the new software on the Gallup Subdivision.**
- **Results looked promising.**
- **After that test we were ready for full implementation.**

BNSF Results with 13 Point Filter

- BNSF wanted the benefits of improvements in velocity for “Peak Season” 2006.
- Needed new software installed prior to 11/15/2006
- BNSF has 738 of the GE Micro (2032) systems in-service.
- Goal was to have new software in-service on “Southern Transcon” and as much of the rest of the system as possible prior to peak season.
- Results:
 - With the new software installed on 67% of the 2032 systems
 - False Stops were reduced by **55 %**
(Based on per Million Axle Scanned)

We want MORE !!

- **This is a tremendous improvement.**
- **Looking at our stops now we still have issues with:**
 - **Sun**
 - **Loose Connections**
- **GE has committed to further software development.**
 - **Post Processing – Additional filtering**
 - **Filtered alarms to be reported as Integrity Failures**
 - **Report sufficient information for us to correct problems before we have events that unnecessarily reduce train velocity.**

Conclusion

- **There can be “New” solutions to “Old” problems.**
- **If Railroads and suppliers are committed to working on common problems.**
- **All of us, on both sides of the industry, have limited resources.**
 - **We MUST work together to leverage those resources.**
 - **We, on the Railroad side, must be willing to participate in the cost of this development.**
 - **The results can be dramatic !!**

Conclusion

Questions

Thank You !

