

# ISU – FHWA – ACPA Concrete Pavement Surface Characteristics Program

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**May, 2006**

National Concrete Pavement  
Technology Center



Uniting agencies, industry, and researchers  
concrete pavement technology



U.S. Department  
of Transportation

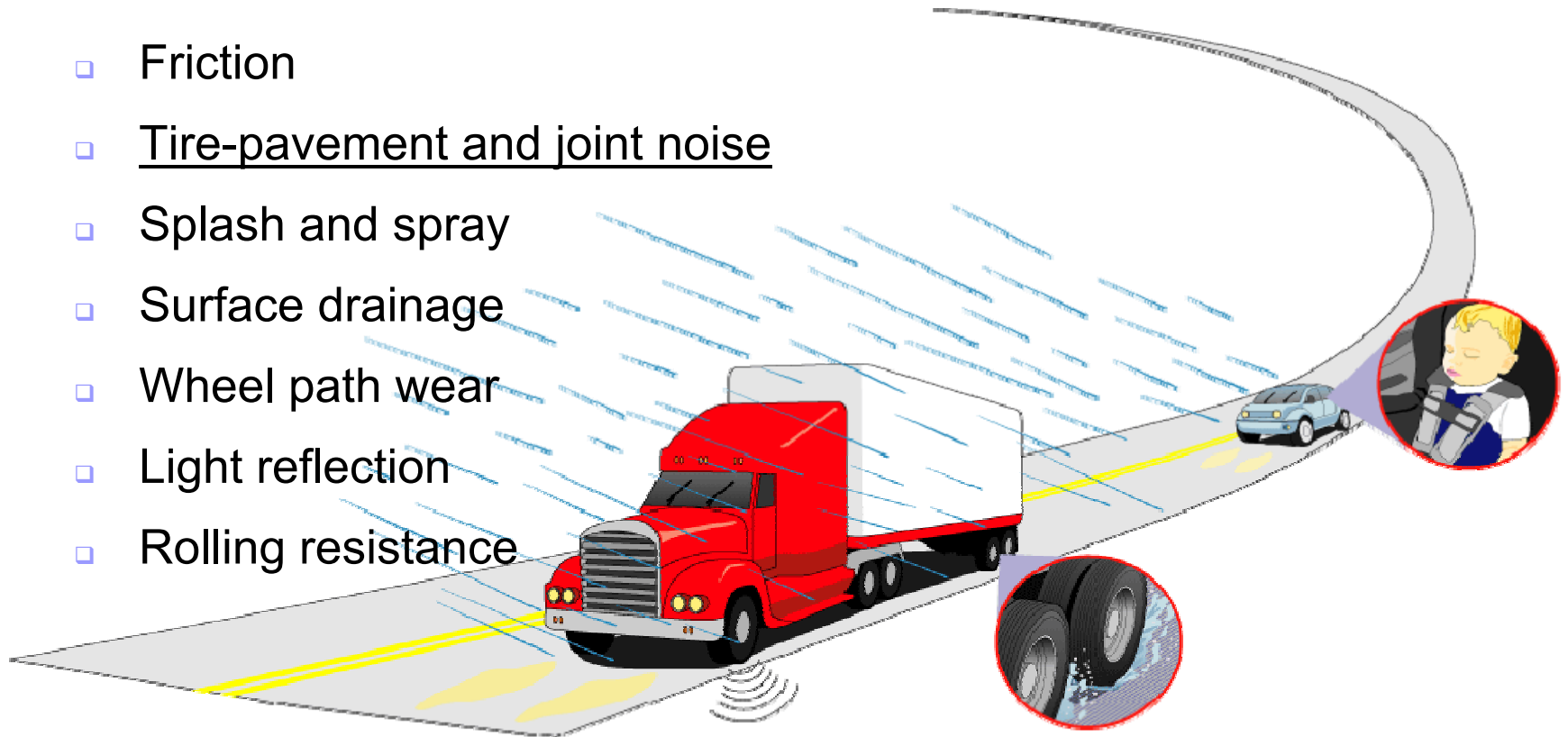
**Federal Highway  
Administration**



# Surface Characteristics

Any factors that effect:

- ❑ Smoothness
- ❑ Friction
- ❑ Tire-pavement and joint noise
- ❑ Splash and spray
- ❑ Surface drainage
- ❑ Wheel path wear
- ❑ Light reflection
- ❑ Rolling resistance



# HIGHWAY NOISE

- World wide the public demands quieter environments on and around highway facilities
- Safety and smoothness can't be compromised
- Has both rural and urban elements
- One of the most important issues to the concrete paving industry

# SURFACE CHARACTERISTICS

- Impacts the breadth of the concrete construction industry
  - Materials
  - Mix
  - Construction
  - Equipment
  - Maintenance

# ISU & FHWA & ACPA

## Management Goals

- To implement the Quiet Pavements International Scan findings
- To leverage funds
- To leverage experiences
- To promote unified solutions

# ISU & FHWA & ACPA

## Technical Goals

- To understand the relationship between noise and texturing/grinding
- To develop the noise-texture-time relationship
- To develop construction techniques that are repeatable and cost effective
- To evaluate non-texturing options
  - *Porous, stamped, exposed aggregate, etc.*

# Project Team

## Iowa State University

- Paul Wiegand, Dale Harrington, Tom Cackler, Jim Cable

## TDC Partners, Ltd.

- Ted Ferragut

## The Transtec Group, Inc.

- Robert Rasmussen, Eric Mun, Robert Light
- George Chang, Bebe Resendez

## Expert Consultants

- Steve Karamihas, Bob Bernhard, Ulf Sandberg, Judy Rochat
- Bob Prisby, Gary Fick

# Project Team

ACPA / IGGA

Jerry Voigt

Larry Scofield

John Roberts

FHWA

Mark Swanlund



# RESEARCH PLAN

- Part 1: Strategic Plan
- Part 2: Field Experiments
- Part 3: Continued Field Experiments and Innovative Surfaces
- ***One goal is to determine texture/noise relationship, not eliminate texture types***

# Part 1 STRATEGIC PLAN STATUS

- Initial plan completed in September, 2005
- Update to be completed in May, 2006

# PART 2 FIELD DATA COLLECTION

- Partnership with FHWA, NCPTC, ACPA, and the Iowa Highway Research Board
- Three types of data
  - Type 1: New construction & Grinding (1-3)
  - Type 2: Existing, but relatively new (6 to 7)
  - Type 3: Existing, all ages (21-28)

# Site Selection\*

Type 1 New	<u>IA</u> , (TBD)
Type 2 Existing	<u>CO</u> , <u>ND</u> , <u>KS</u> , <u>IA</u> , <u>GA</u> , WI
Type 3 Existing	<u>CO</u> , <u>MN</u> , <u>IA</u> , <u>ND</u> , <u>KS</u> , <u>AL</u> , <u>GA</u> , <u>NC</u> , <u>VA</u> , IN, OH, MI, MO, CA, AZ, TX, Quebec

\* Sites identified to date, funds driven

# Sections to Date

To Date: Over 100 Textures Tested

- 37 Transverse Tining (incl. 1 skewed)
- 23 Longitudinal Tining (incl. 1 sinusoidal)
- 15 Diamond Ground
- 15 Drag (Burlap, Turf, Broom, and Carpet)
- 6 Grooved (2 longitudinal, 4 transverse)
- 3 Exposed aggregate
- 1 Shot peened
- 1 Milled
- 5 HMA

Over 230 unique test sections for a total of over 57,000 ft

# Measurements

## Noise

- ❑ On-Board Sound Intensity (OBSI)
- ❑ Wayside
- ❑ In-Vehicle

## Smoothness

- ❑ Inertial Profiler

## Macrotexture

- ❑ RoboTex (LMI line laser)
- ❑ Circular Texture Meter (CTM)
- ❑ Digital imaging
- ❑ Sand patch

## Microtexture / Friction

- ❑ Locked wheel skid trailer (smooth tire)
- ❑ Dynamic Friction Tester (DFT)

# Noise Protocols

## On-Board Sound Intensity (OBSI)

- ❑ SI differs from “noise trailer” which measures less sophisticated technique
- ❑ Paired microphones in SI allow for directionalized measurement
- ❑ Shielding from external noise sources not required

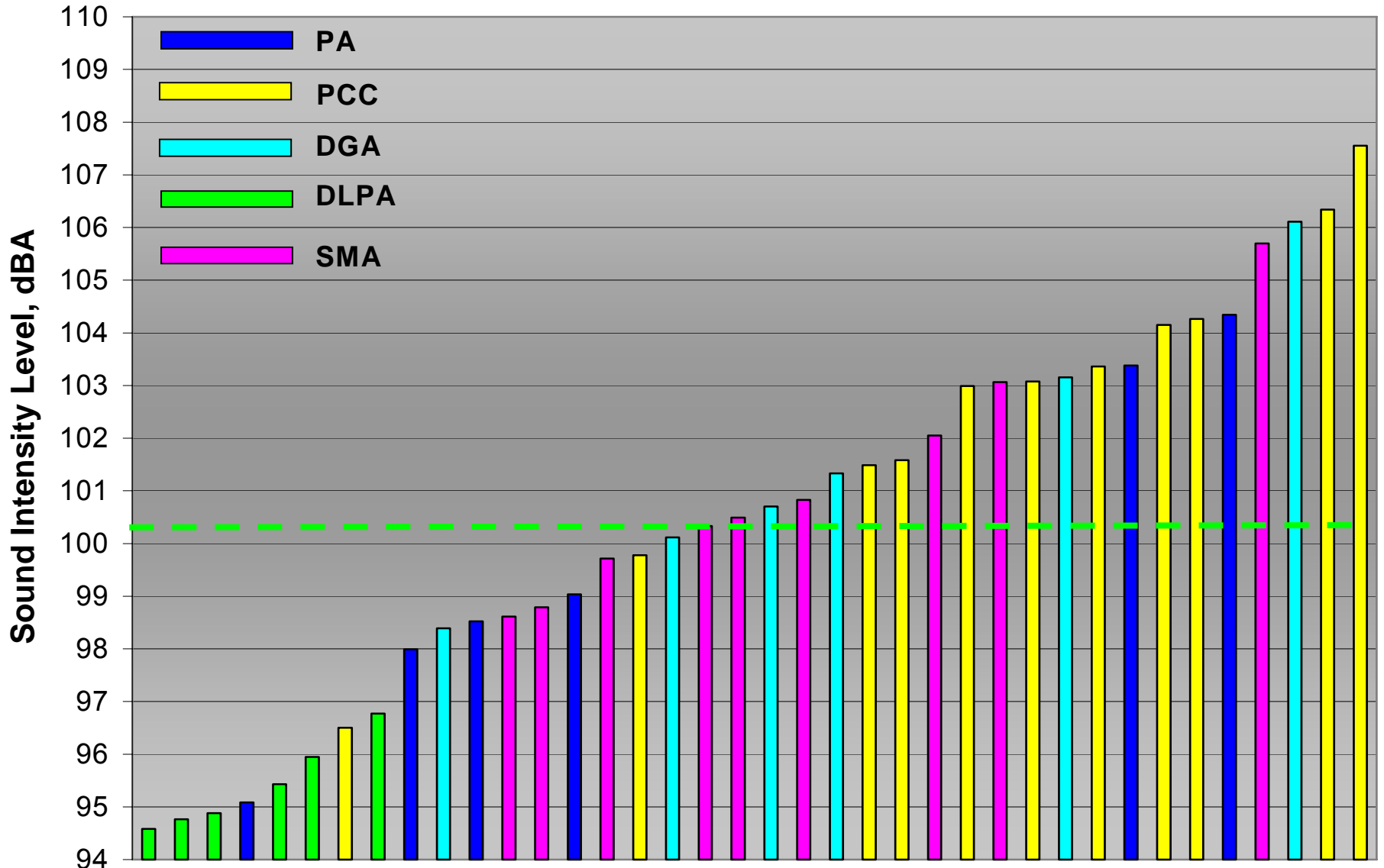


# RoboTex Texture Device



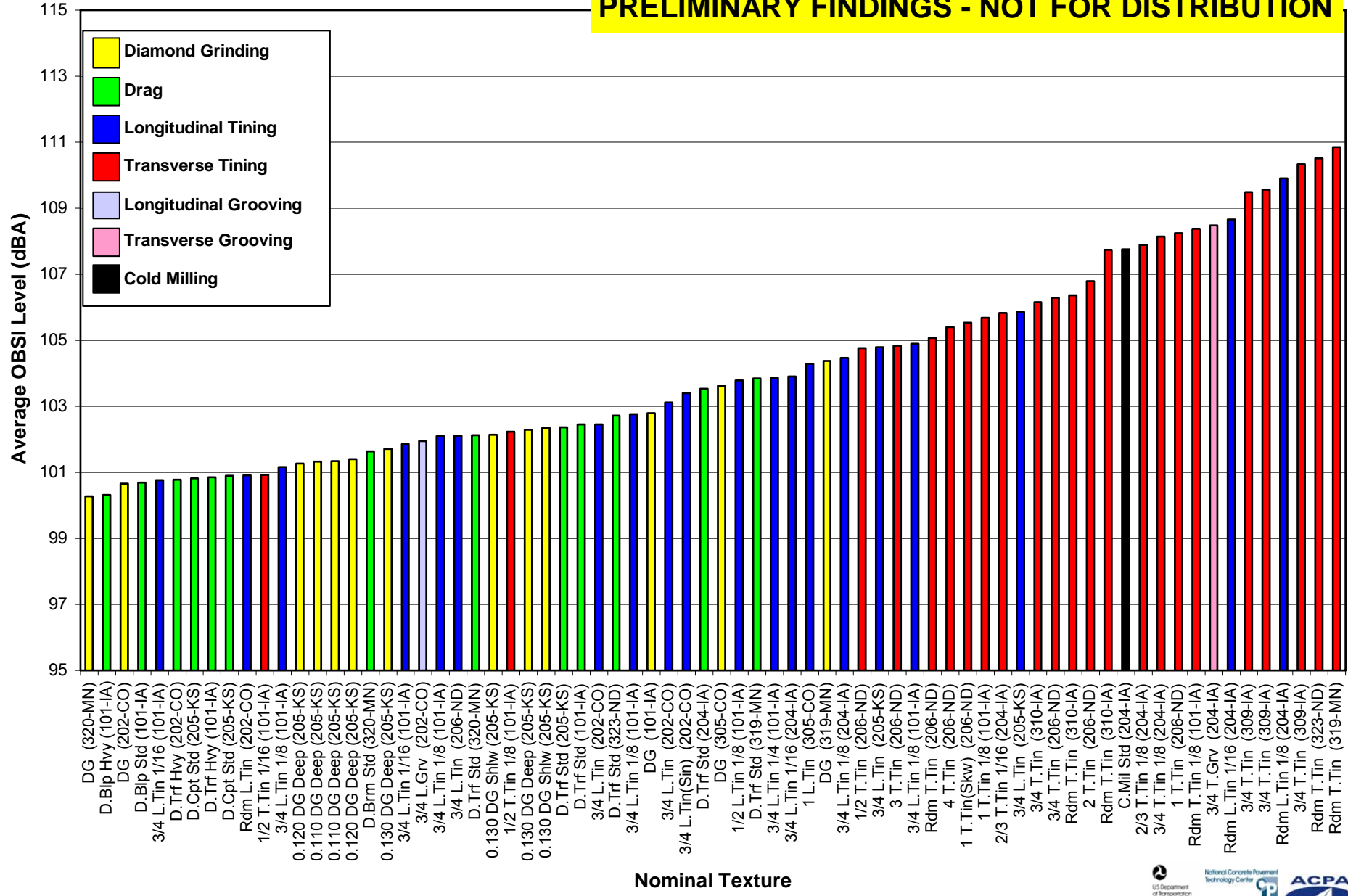


# European Pavements at 97 km/h



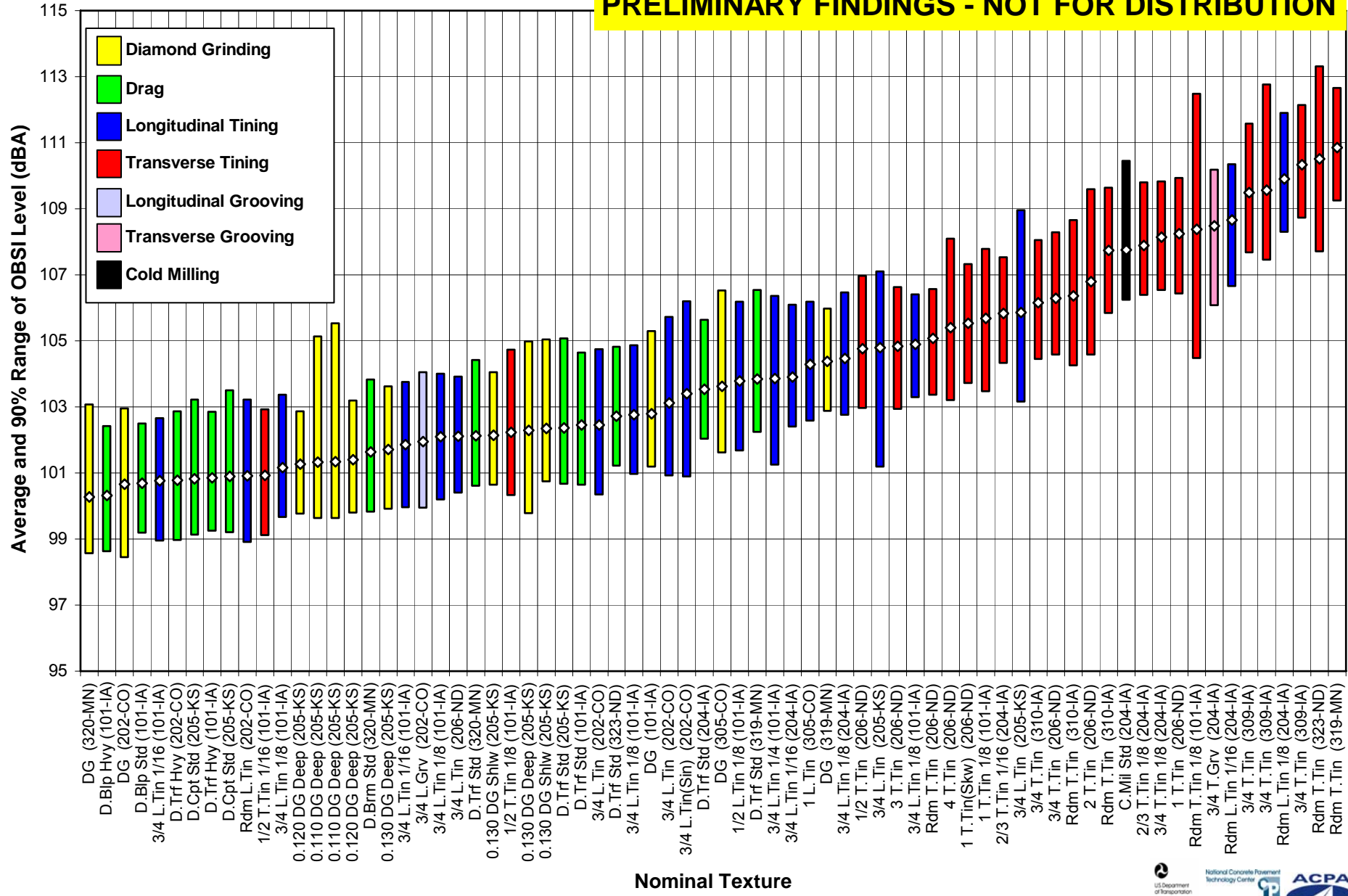
# Preliminary Catalog Results

**PRELIMINARY FINDINGS - NOT FOR DISTRIBUTION**



# Preliminary Catalog Results

**PRELIMINARY FINDINGS - NOT FOR DISTRIBUTION**



# CAUTION !!!

- All of these sites are different ages, different traffic, different environment, etc., etc., etc.
- All of these sites are shown in terms of NOMINAL texture.
- Rarely is the ACTUAL texture dimension the same as NOMINAL.
- There is a HUGE overlap in noise for these textures. You will find transverse, longitudinal, and grinding on both the loudest and the quietest.

Iowa DOT  
Type 1 Testing

US Highway 30  
Near Marshalltown, IA

# Type 1 Iowa DOT

## Data Collection

### Noise

- Tire/Pavement (OBSI)
- In-Vehicle
- Wayside (Roadside)

### Texture

Smoothness

Friction

## Collection Periods

- Pre-Broom / Pre-Traffic
- Post-Broom / Pre-Traffic
- Post-Broom / Opening
- Spring 2006 (3-6 mos.)
- Fall 2006 (1 year)

# Type 1 Iowa DOT

<b><i>Texture</i></b>	<b><i>Spacing (in.)</i></b>	<b><i>Depth (in.)</i></b>	<b><i>Pre-texturing</i></b>
Longitudinal Tining	1	1/8	Burlap Drag
Longitudinal Tining	3/4	1/4	Burlap Drag
Longitudinal Tining	3/4	1/8	Burlap Drag
Longitudinal Tining	3/4	1/8	none
Longitudinal Tining	3/4	1/8	Burlap Drag
Longitudinal Tining	3/4	1/8	Artificial Turf
Longitudinal Tining	3/4	1/16	Artificial Turf
Longitudinal Tining	3/4	1/16	Burlap Drag
Longitudinal Tining	1/2	1/8	Burlap Drag
Burlap Drag	n/a	(Heavy Weight)	none
Burlap Drag	n/a	(Standard Weight)	none
Artificial Turf Drag	n/a	(Standard Weight)	none
Artificial Turf Drag	n/a	(Heavy Weight)	none
Transverse Tining	1/2	1/8	Burlap Drag
Transverse Tining	1/2	1/16	Burlap Drag
Transverse Tining	1	1/8	Burlap Drag
Transverse Tining	Random**	1/8	Burlap Drag

# Type 1 Iowa DOT





# Type 1 Iowa DOT



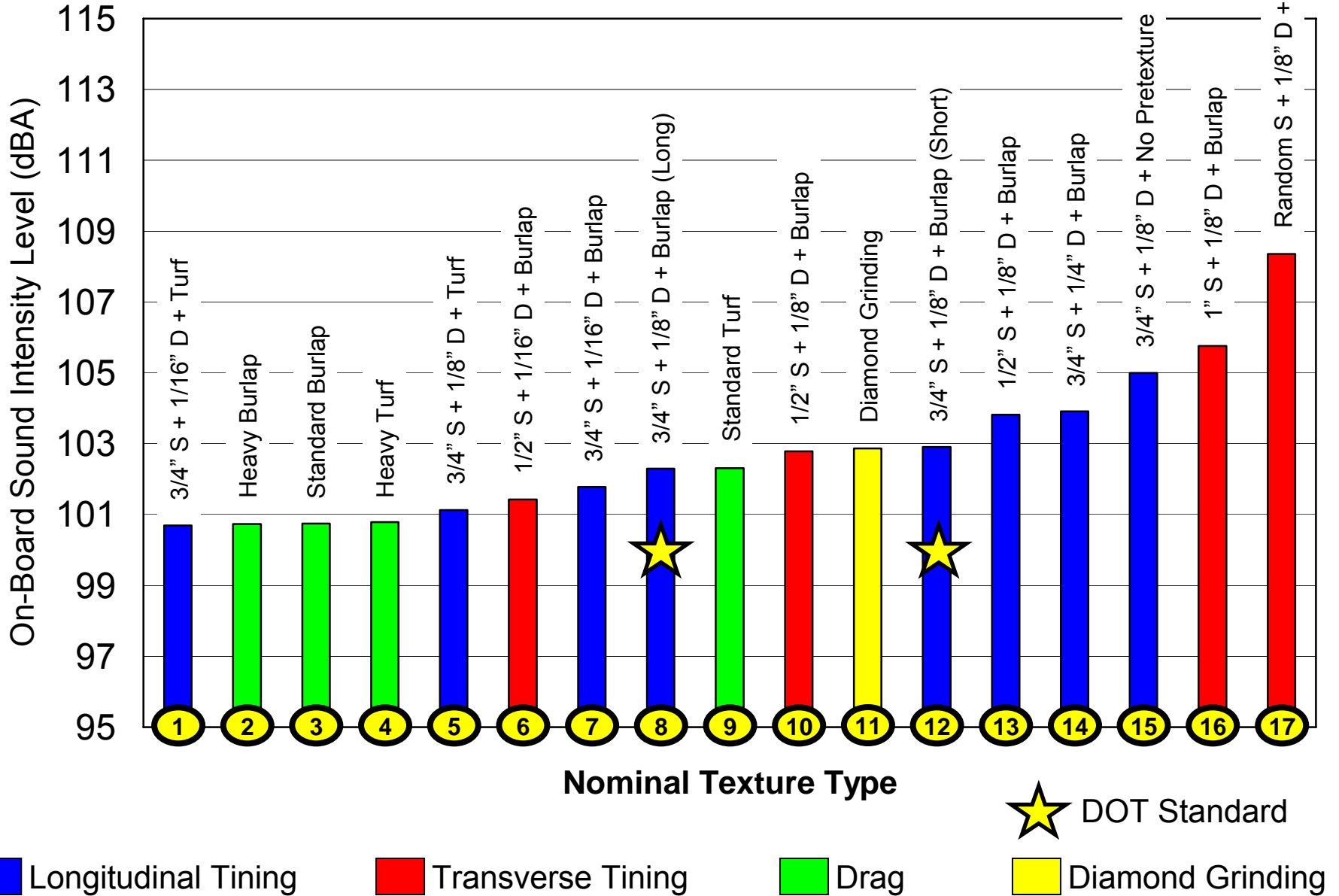
# Type 1 Iowa DOT



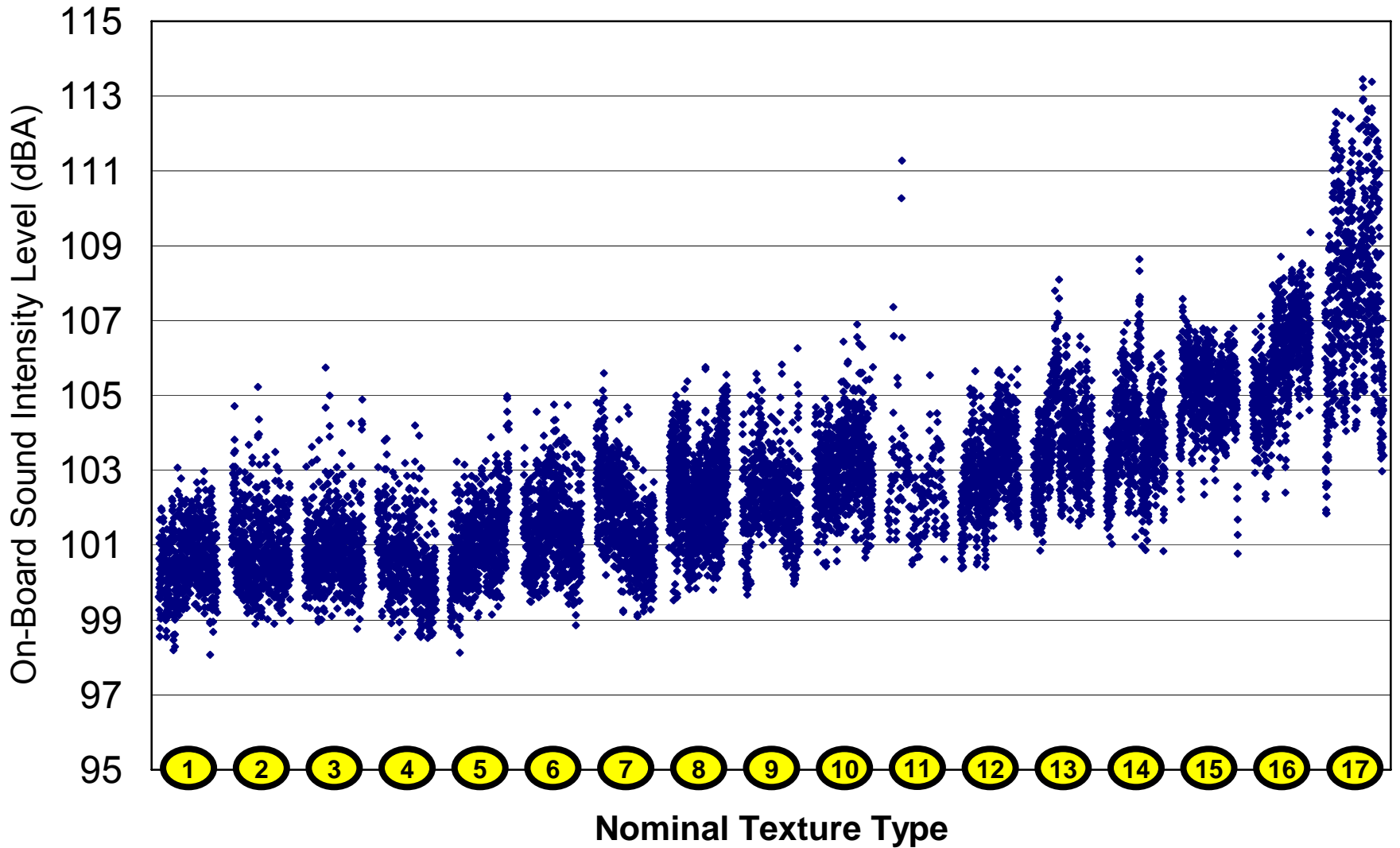
# Type 1 Iowa DOT



Test Section Average On-Board Sound Intensity Levels - IA - US 30 (Ty. 1)  
 Post-Broom/Pre-Traffic - A.M. (10/22/05-11/8/05)



5-ft. Moving Average On-Board Sound Intensity Levels - IA - US 30 (Ty. 1)  
Post-Broom/Pre-Traffic - A.M. (10/22/05-11/8/05)



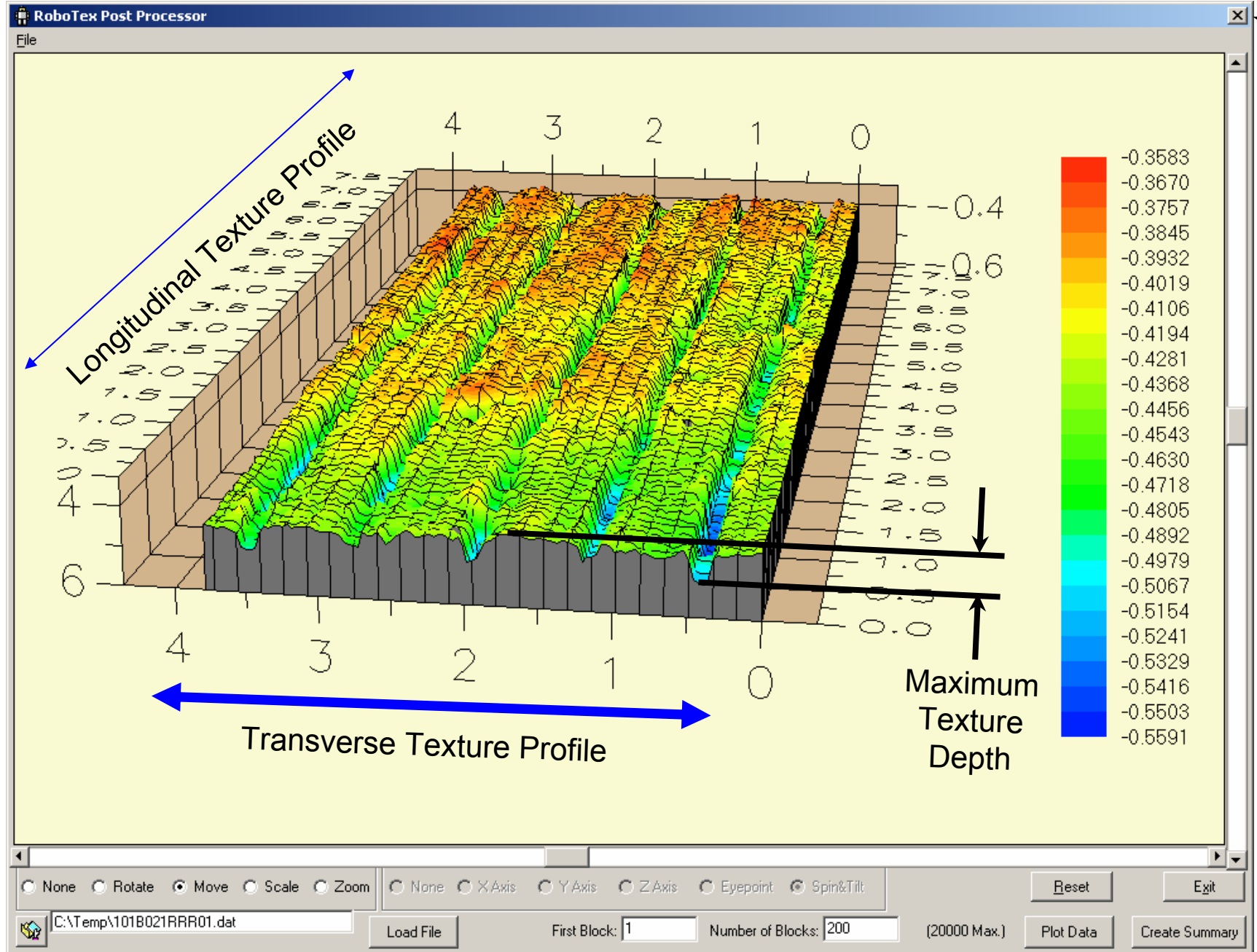
# 1/8" Deep Longitudinal 3/4" Spacing + Burlap (Long Section)

102.3 dBA

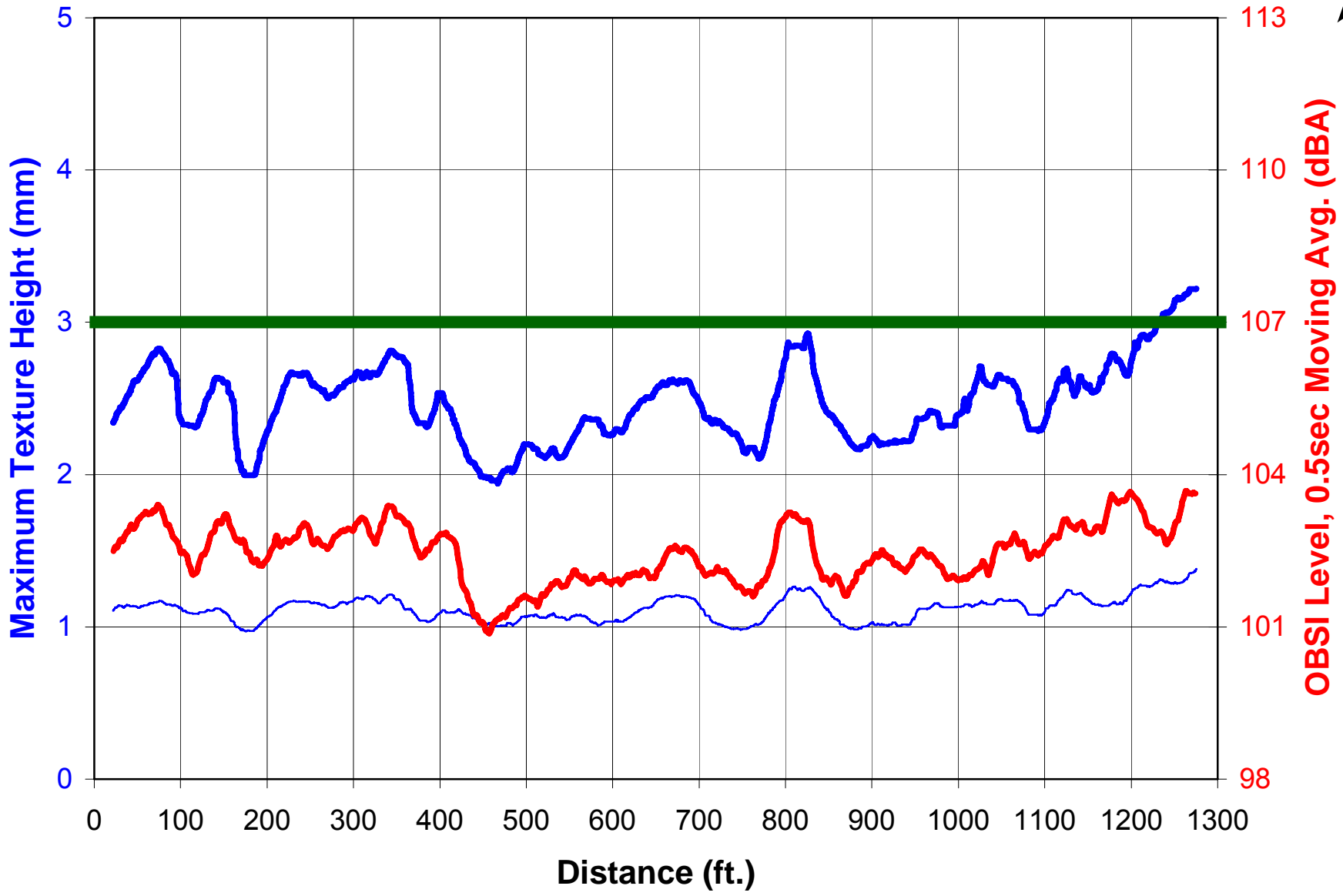


# 1/8" Deep Longitudinal 3/4" Spacing + Burlap (Long Section)

102.3 dBA



# 1/8" Deep Longitudinal 3/4" Spacing + Burlap (Long Section) 102.3 dBA



-  OBSI Level
-  Transverse Texture
-  Longitudinal Texture
-  Nominal Depth



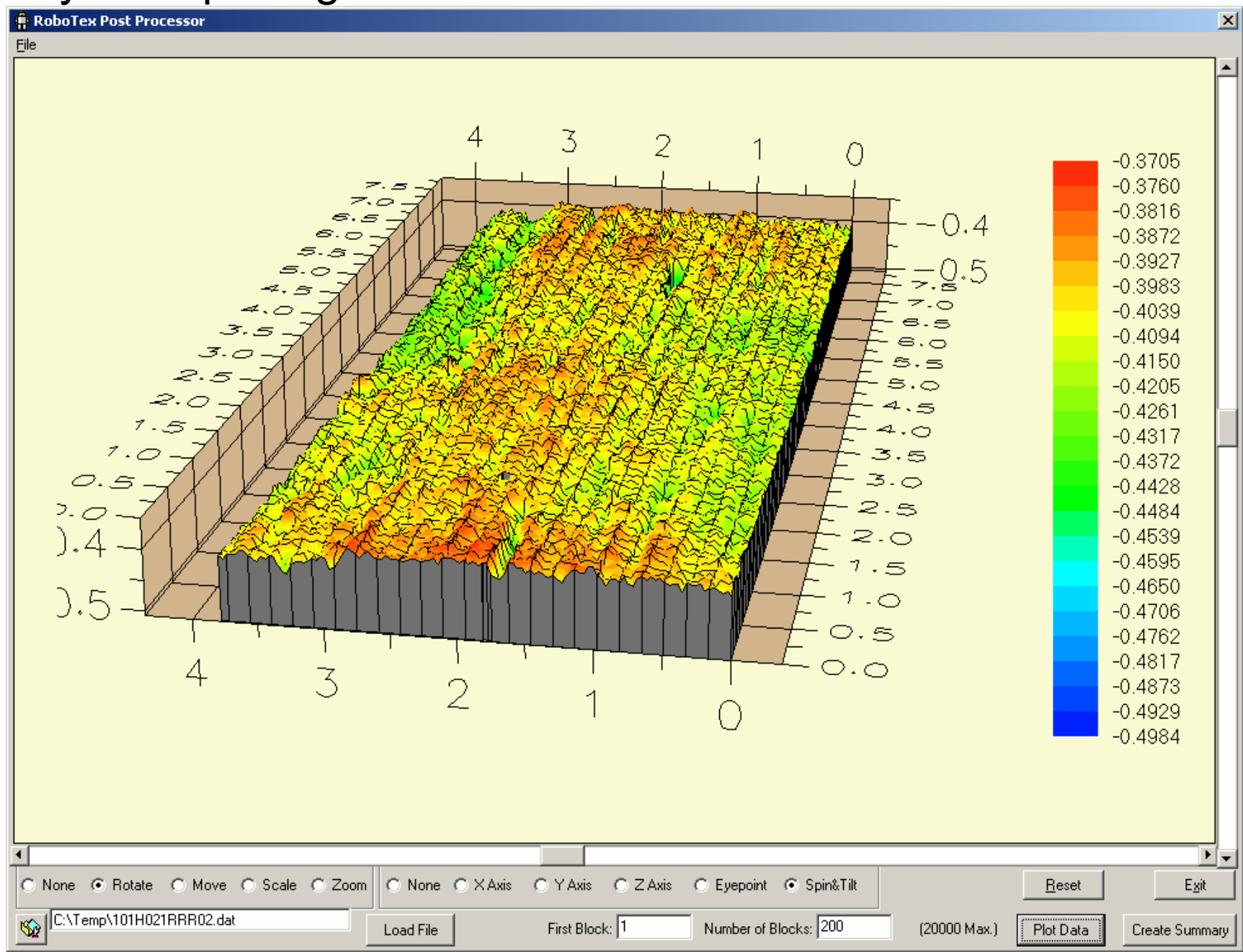
# Heavy Burlap Drag

100.7 dBA 



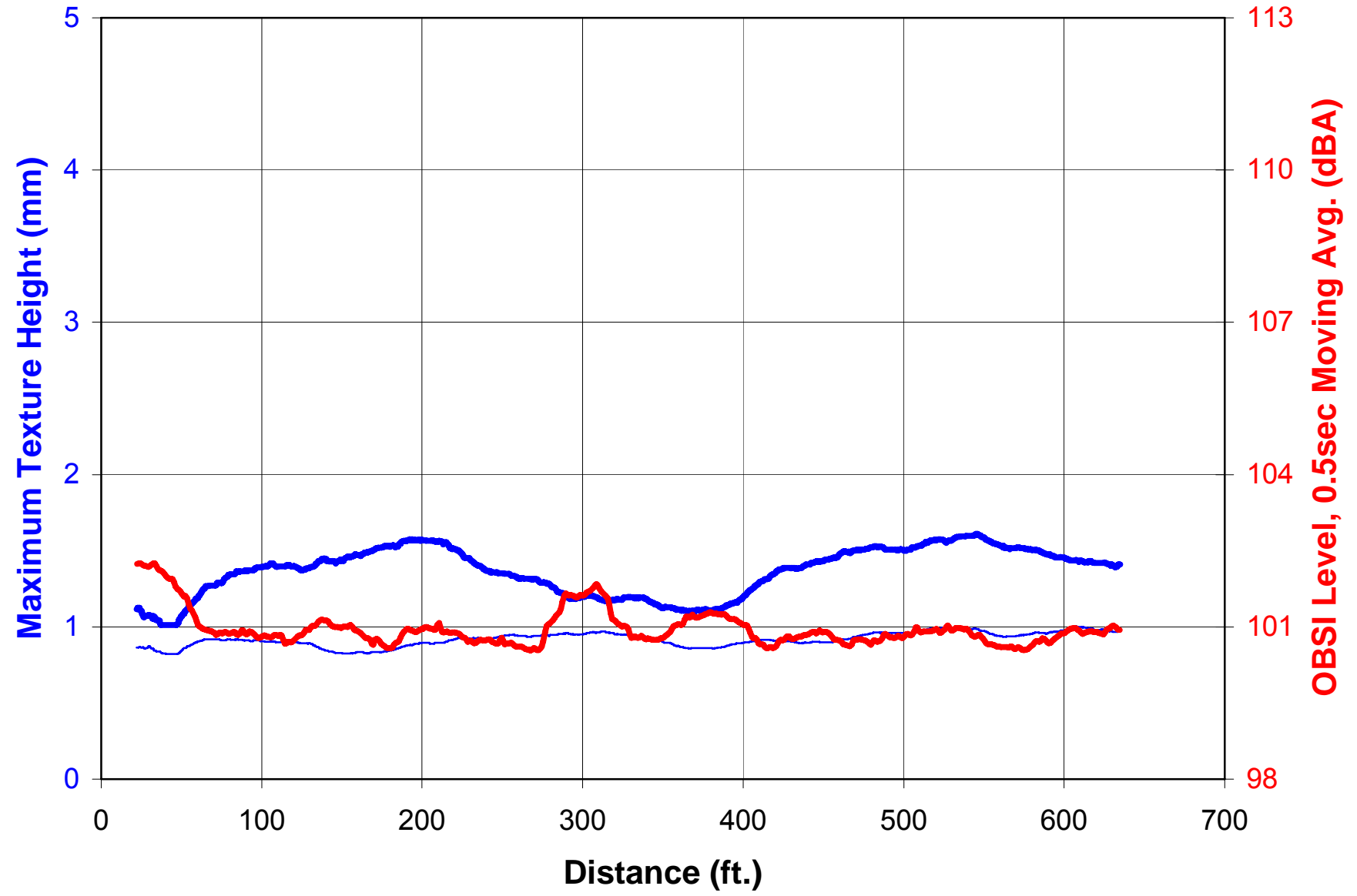
# Heavy Burlap Drag

100.7 dBA 2



# Heavy Burlap Drag

100.7 dBA **2**



 OBSI Level     Transverse Texture     Longitudinal Texture

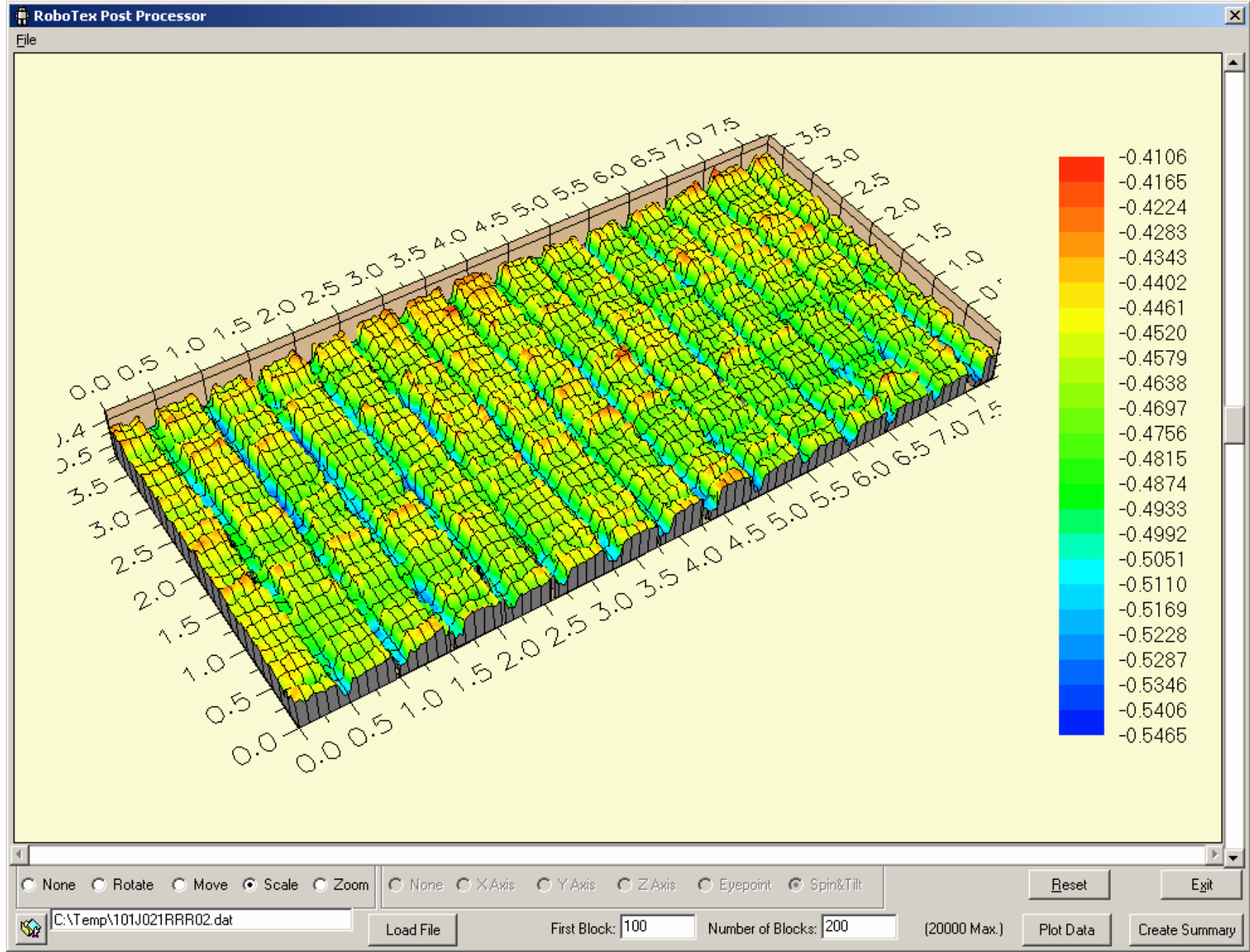
# 1/16" Deep Transverse 1/2" Spacing + Burlap

101.4 dBA **6**




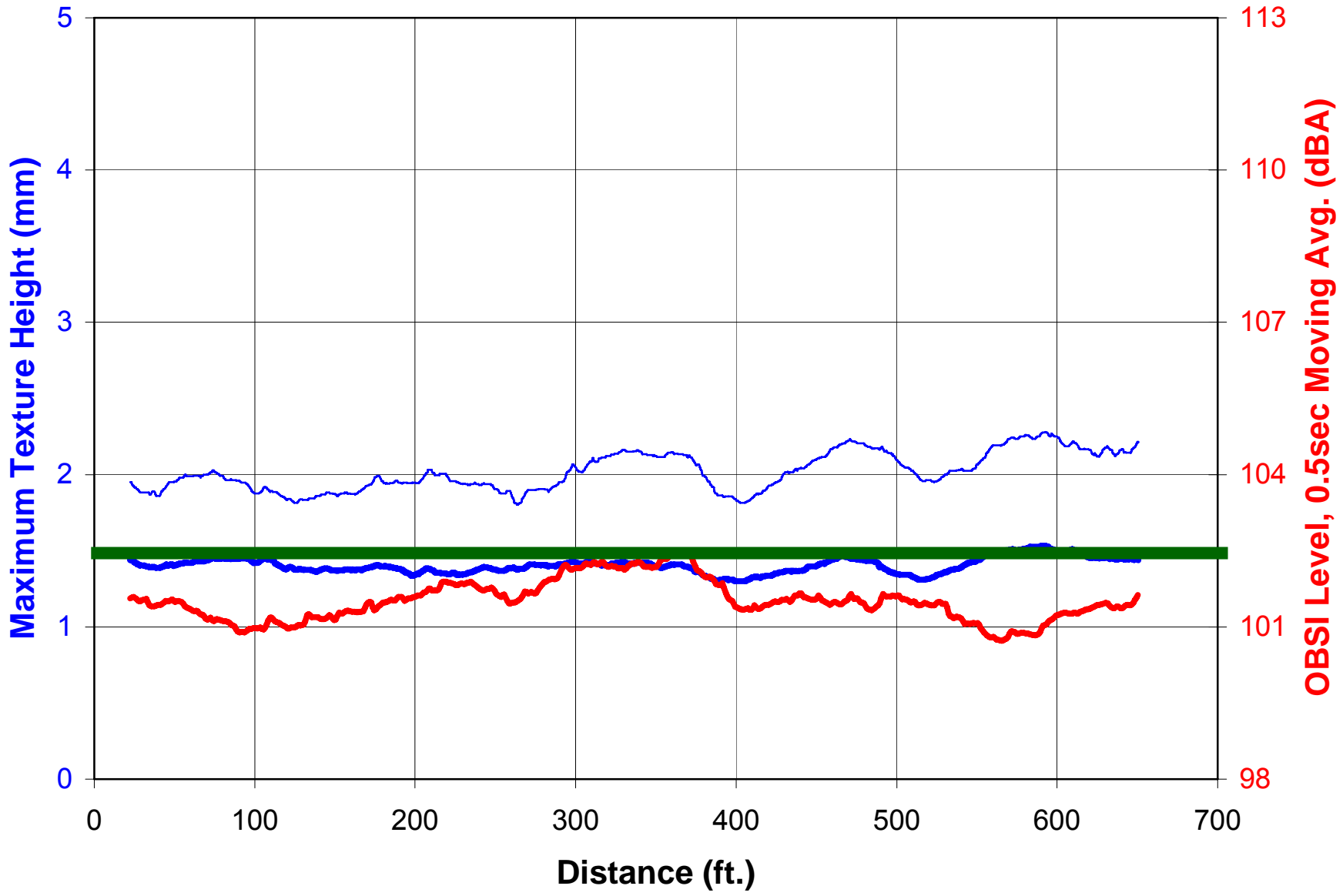
# 1/16" Deep Transverse 1/2" Spacing + Burlap

101.4 dBA **6**




# 1/16" Deep Transverse 1/2" Spacing + Burlap

101.4 dBA 



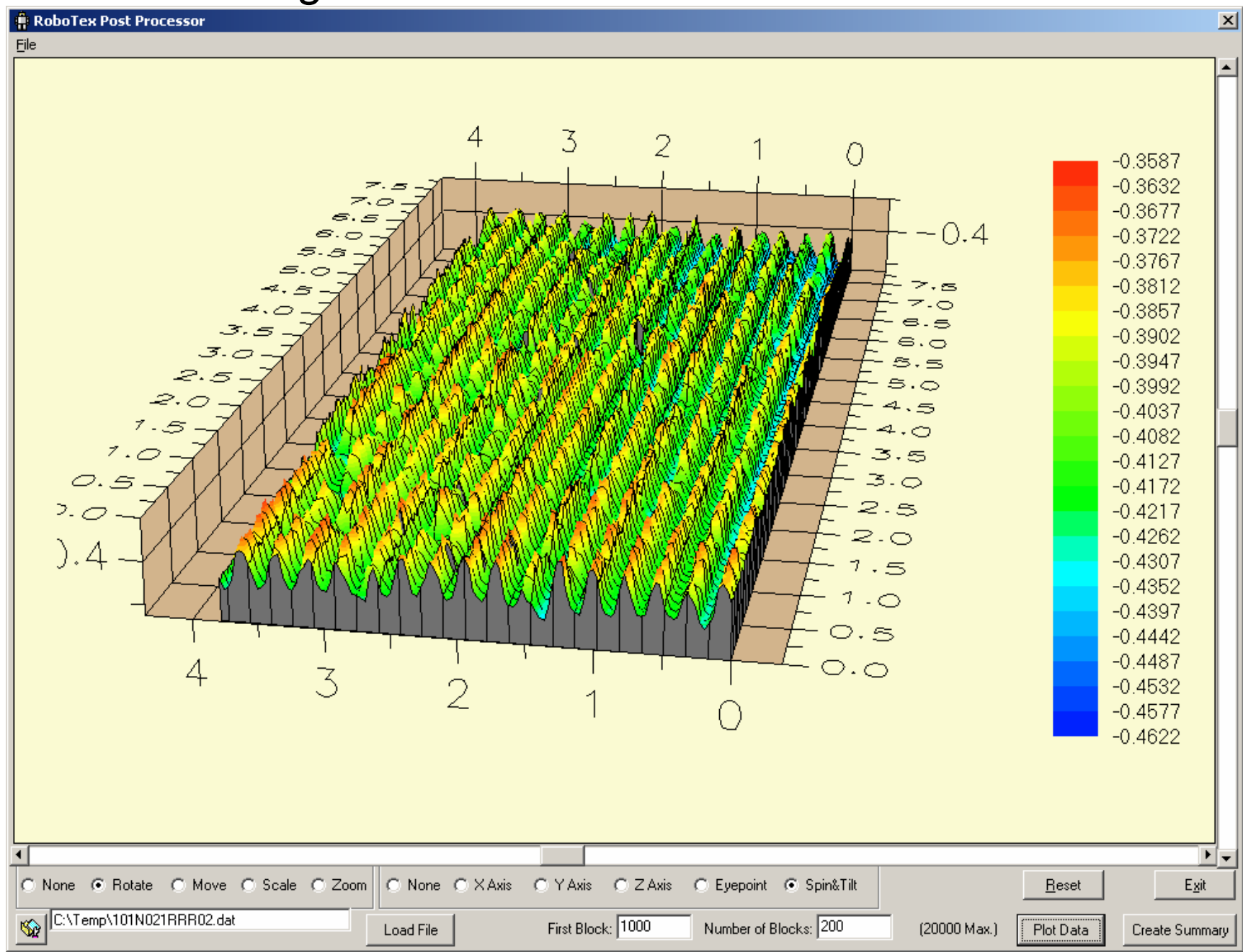
-  OBSI Level
-  Transverse Texture
-  Longitudinal Texture
-  Nominal Depth

# Diamond Grinding

102.9 dBA 

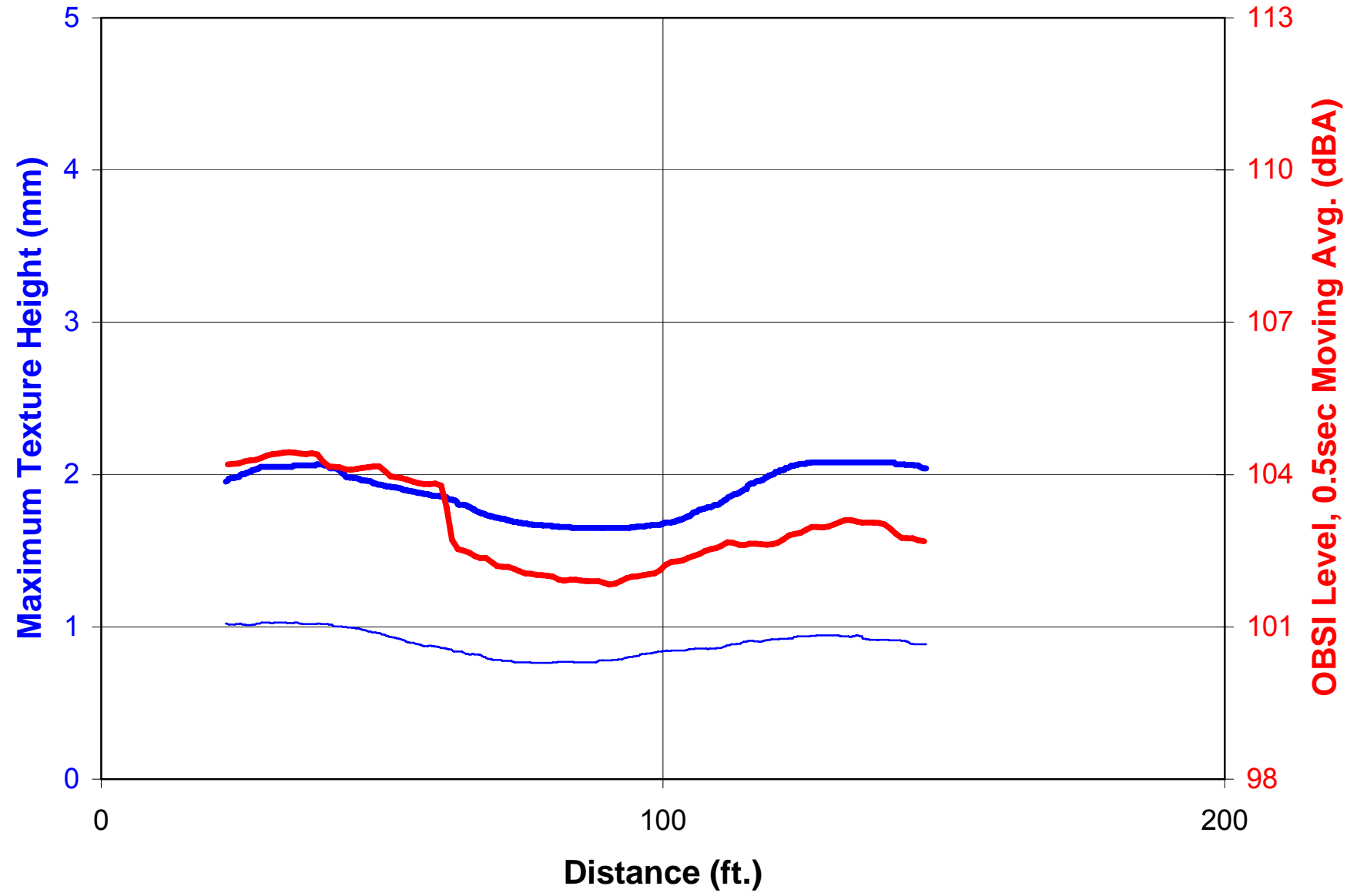


# Diamond Grinding





# Diamond Grinding

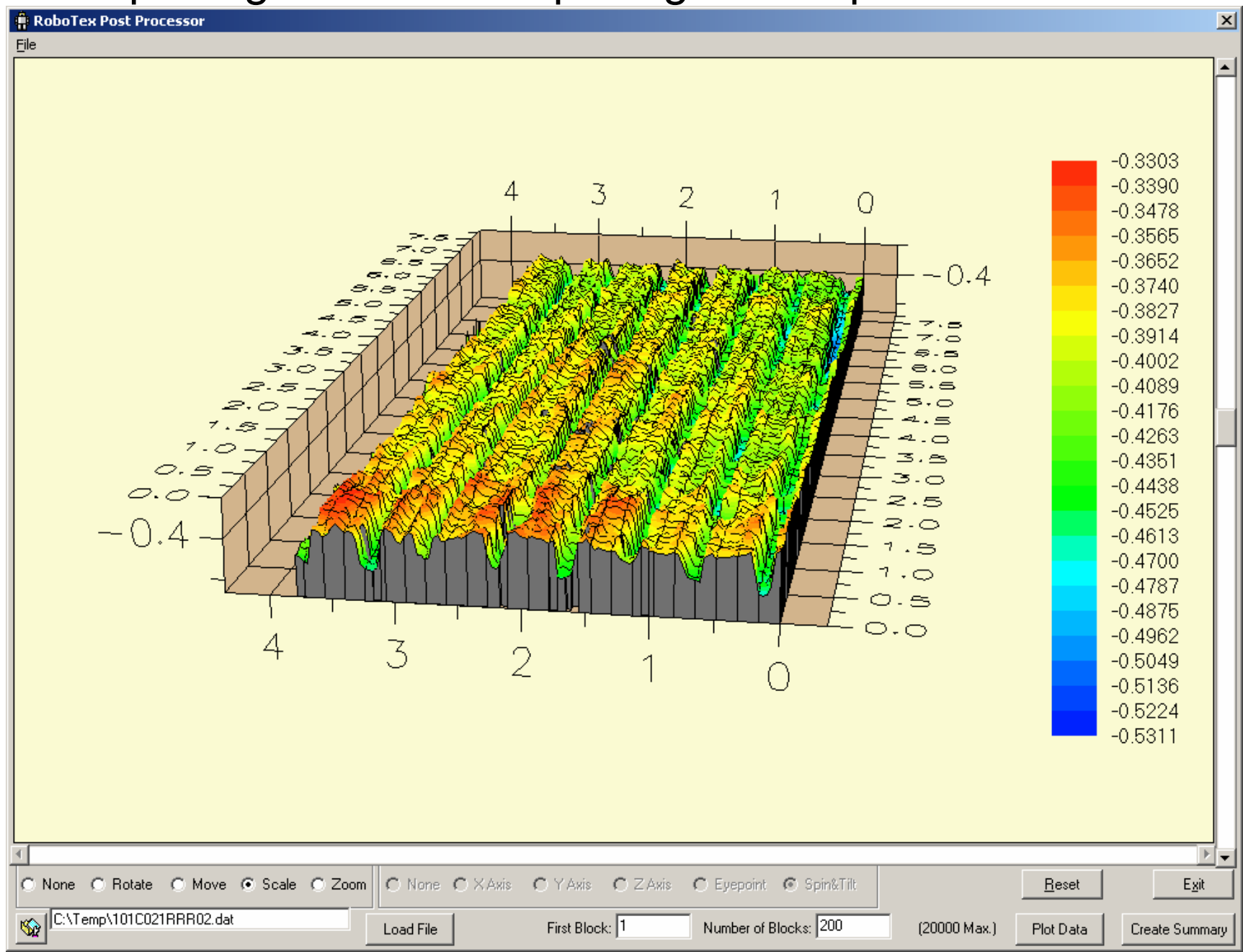


 OBSI Level     Transverse Texture     Longitudinal Texture

# 1/8" Deep Longitudinal 1/2" Spacing + Burlap

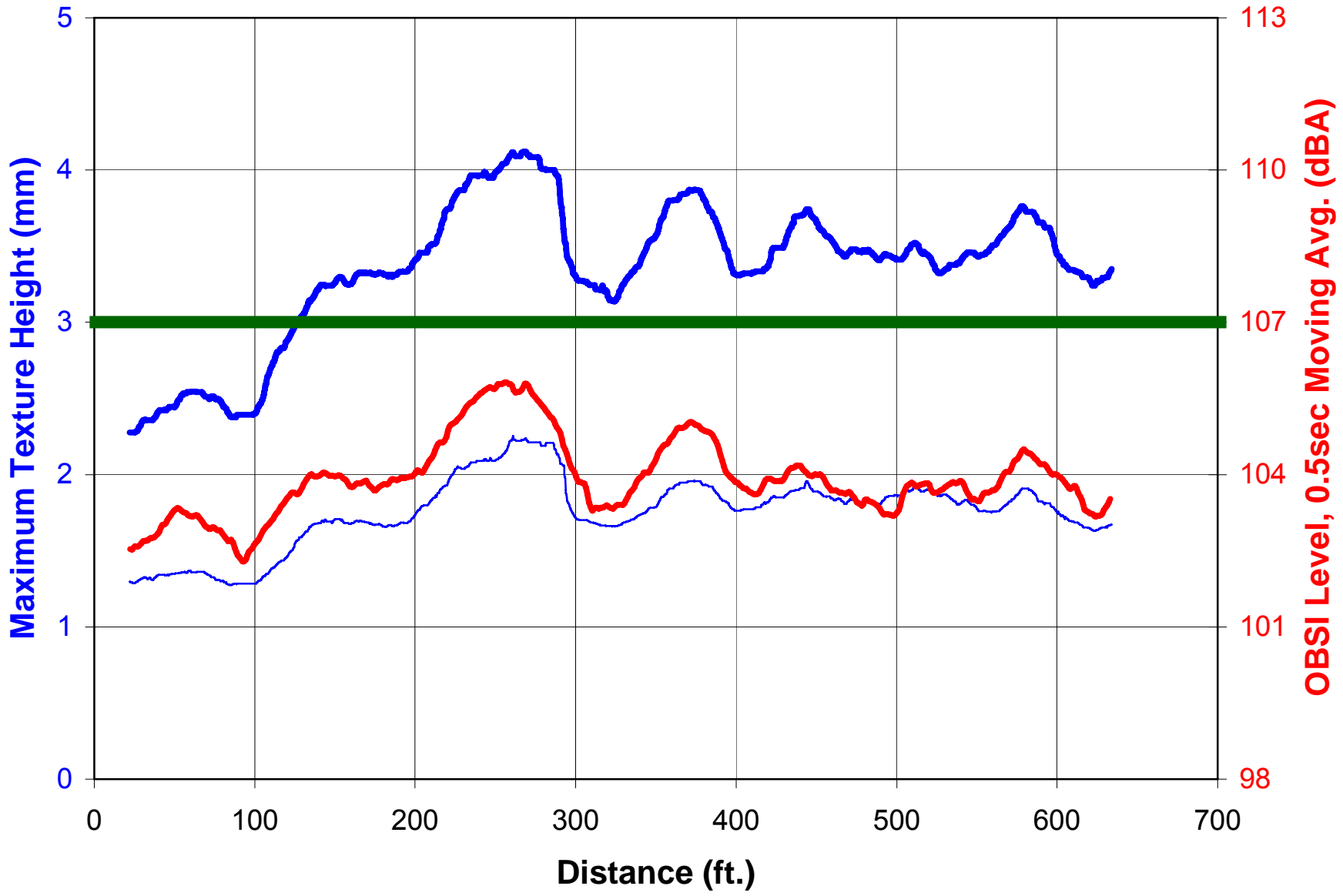


# 1/8" Deep Longitudinal 1/2" Spacing + Burlap



# 1/8" Deep Longitudinal 1/2" Spacing + Burlap

103.8 dBA 13



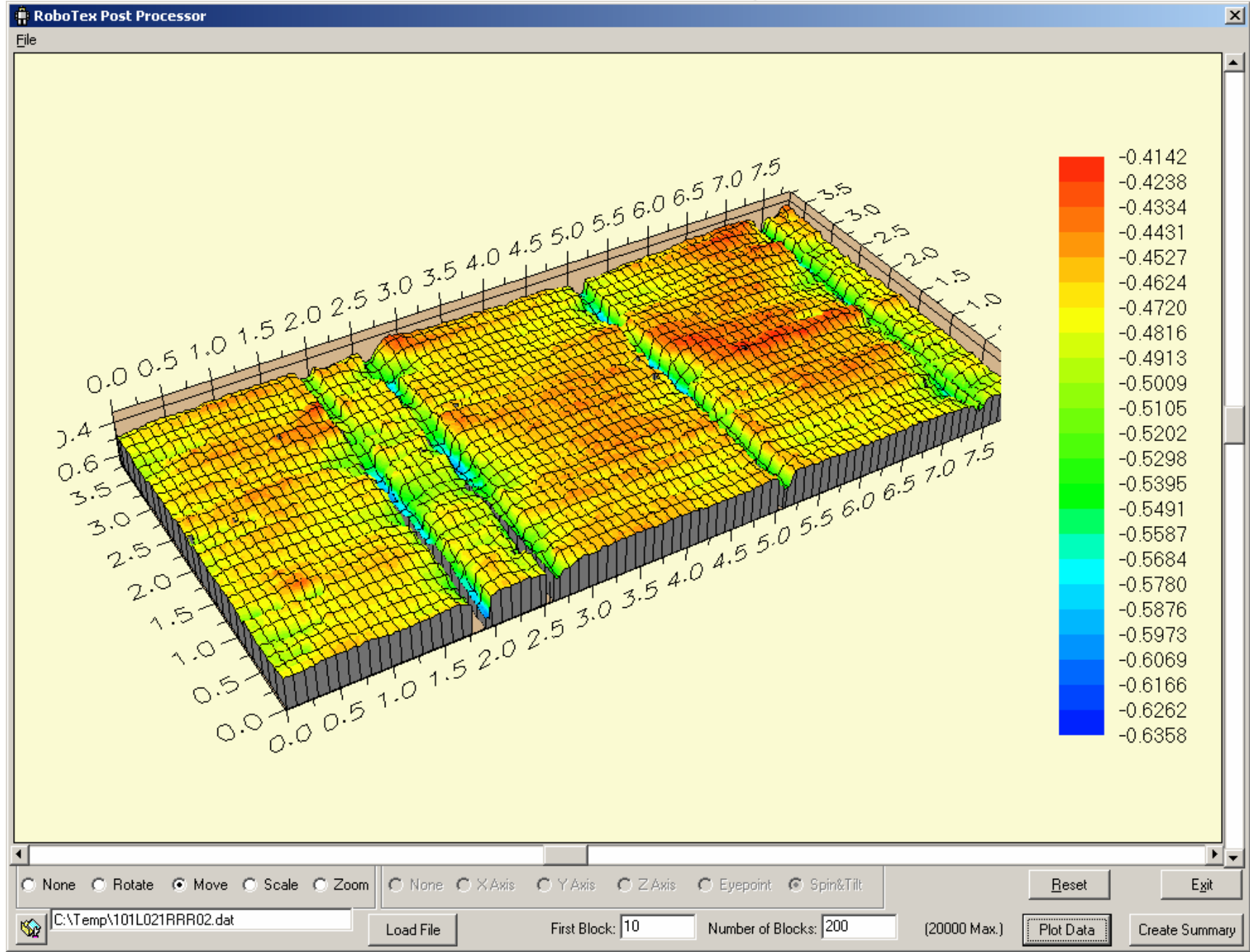
-  OBSI Level
-  Transverse Texture
-  Longitudinal Texture
-  Nominal Depth

# 1/8" Deep Transverse Random Spacing + Burlap

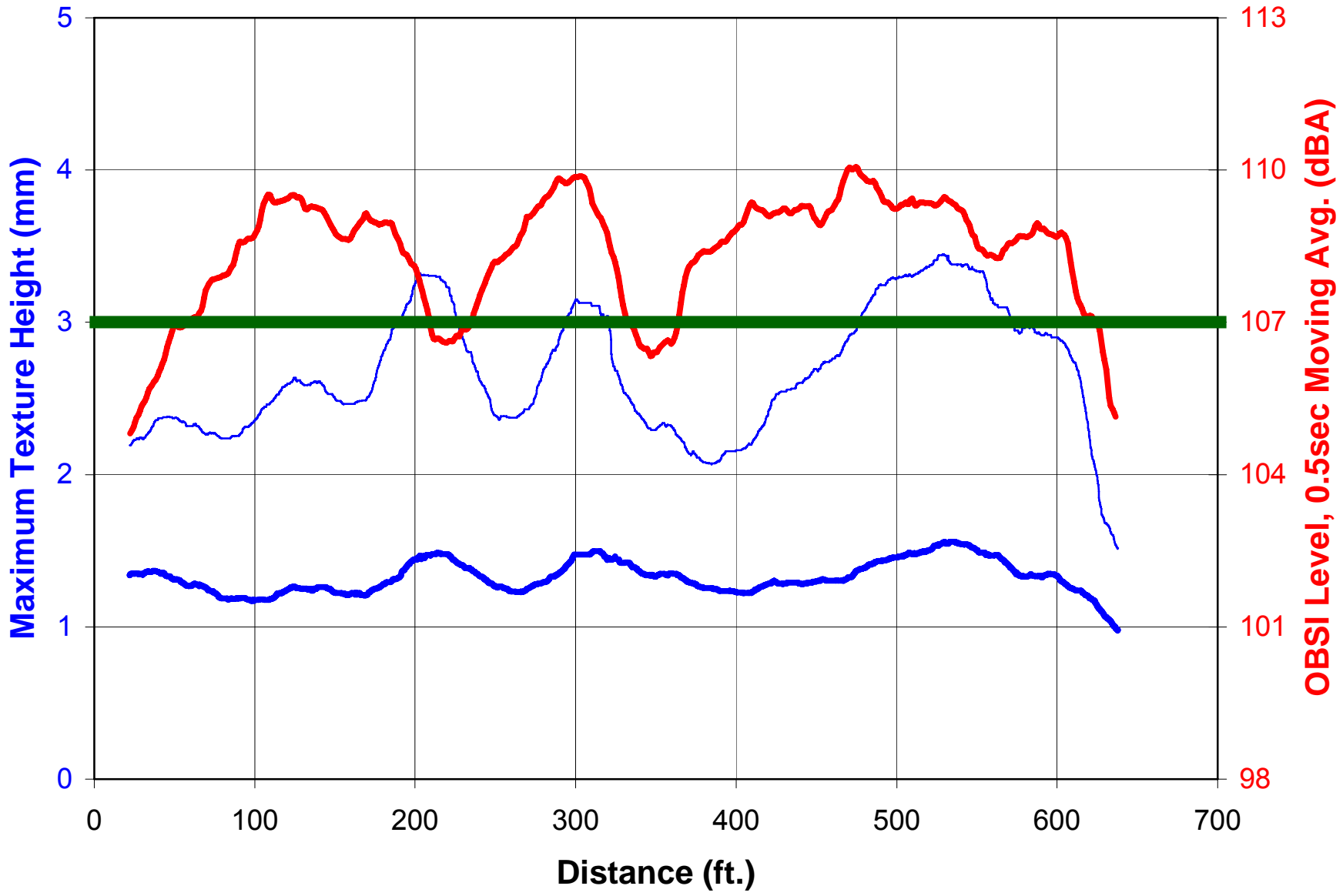
108.4 dBA 



# 1/8" Deep Transverse Random Spacing + Burlap




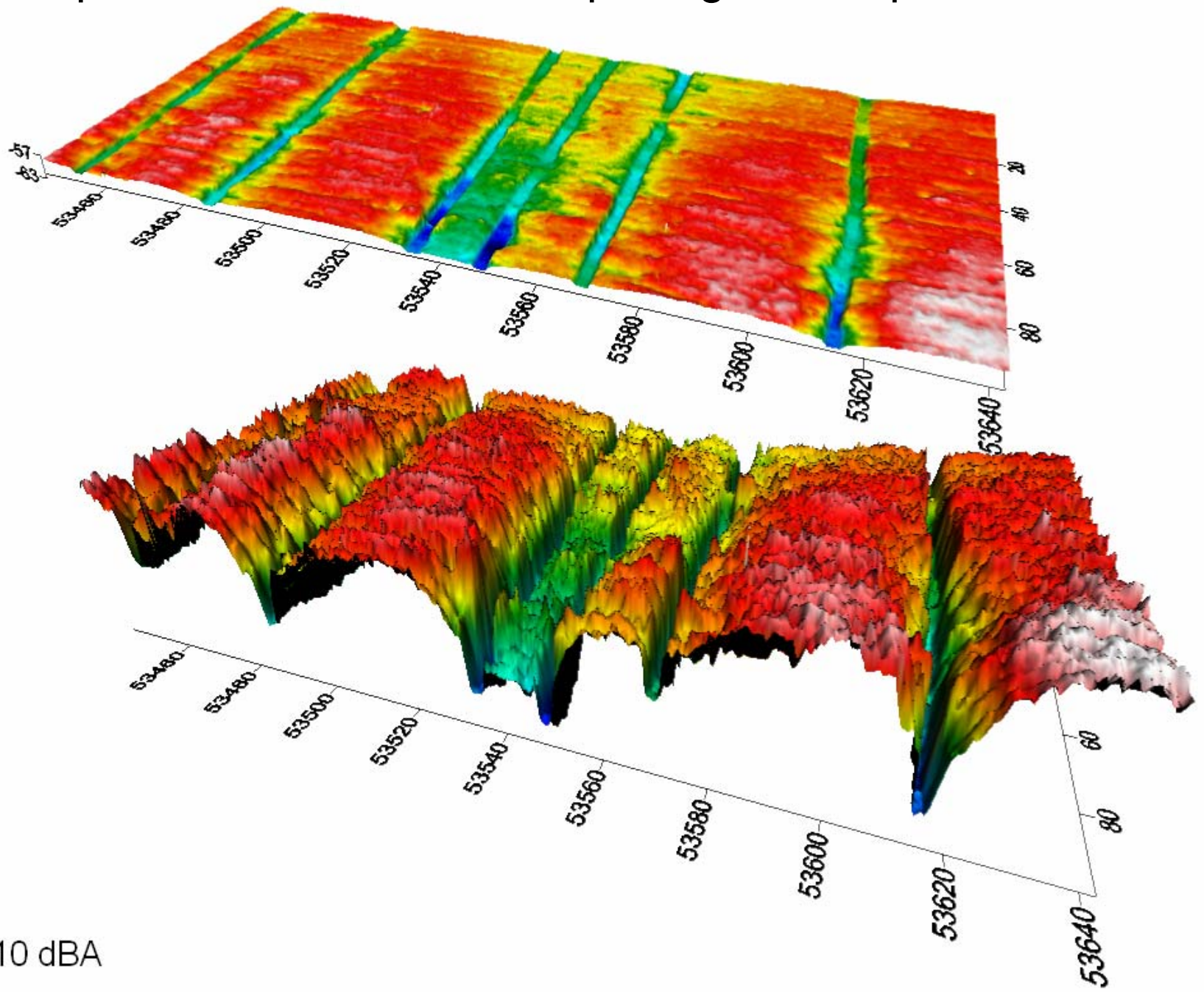
# 1/8" Deep Transverse Random Spacing + Burlap



 OBSI Level     Transverse Texture     Longitudinal Texture     Nominal Depth

# 1/8" Deep Transverse Random Spacing + Burlap


108.4 dBA 

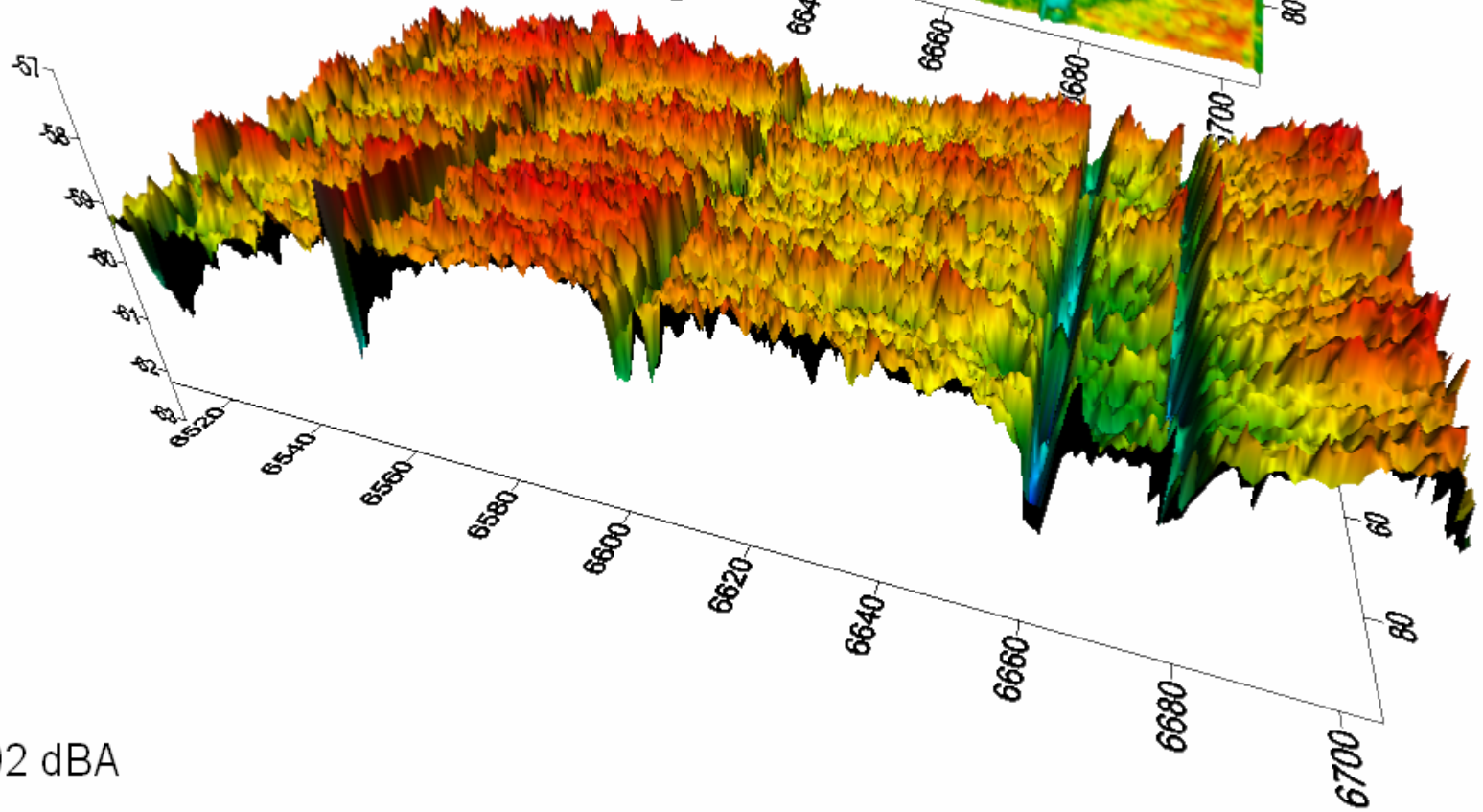
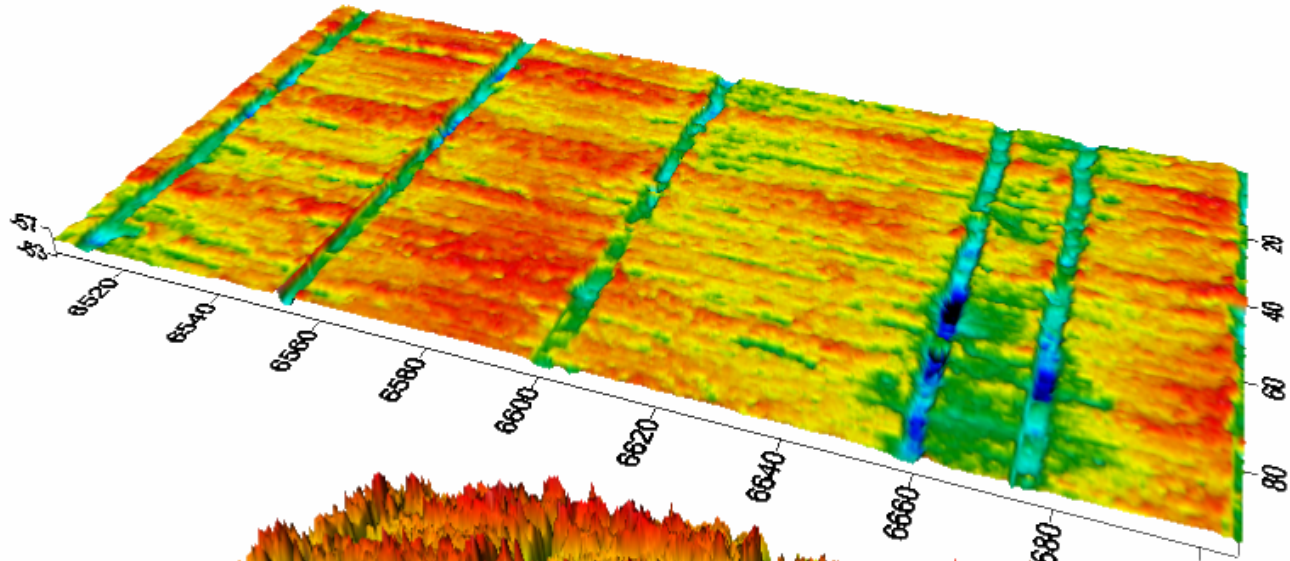


110 dBA



# 1/8" Deep Transverse Random Spacing + Burlap

108.4 dBA 



102 dBA

# Remember

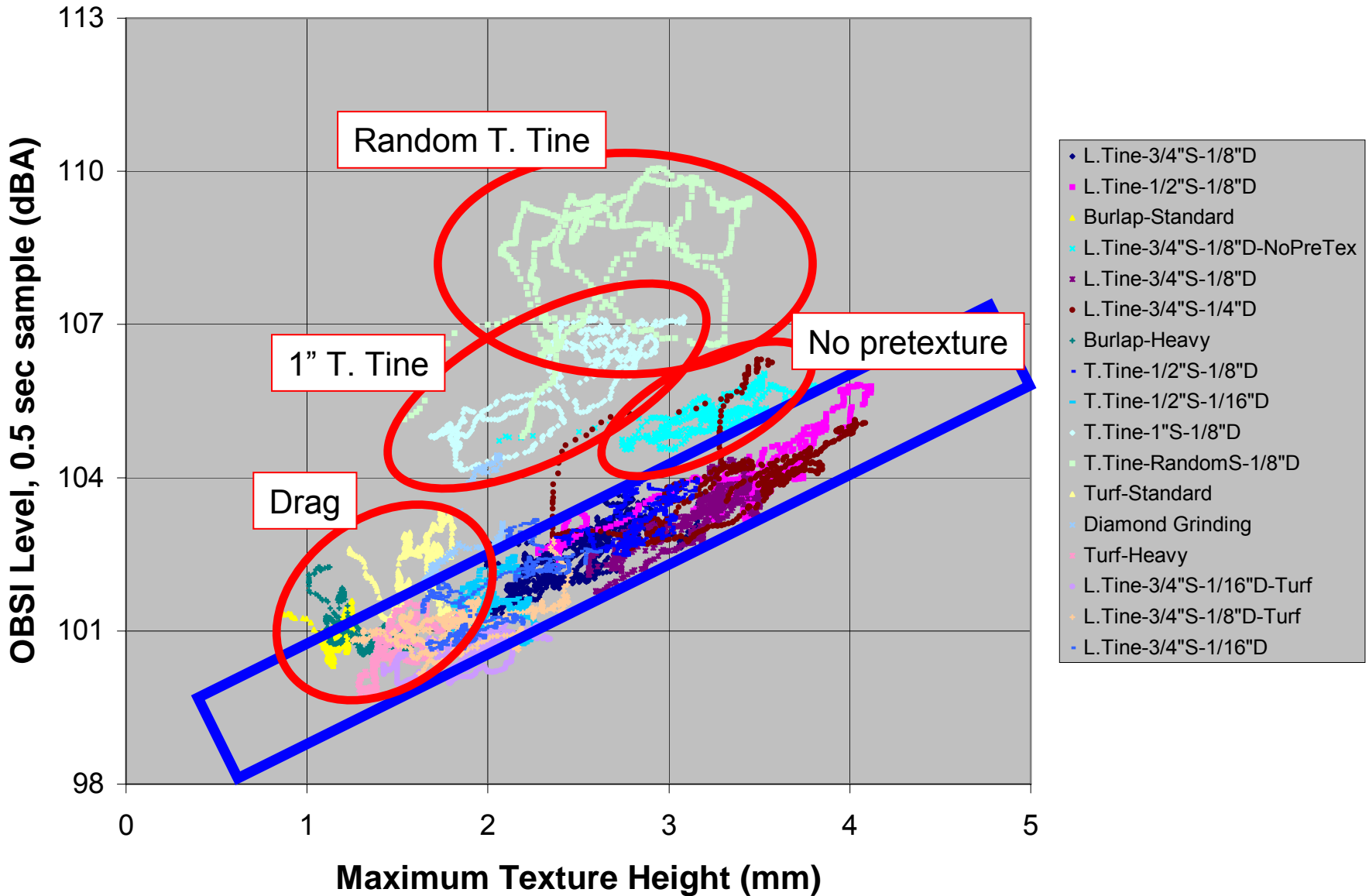
One job

One mix

One operator

One piece of equipment

# Texture vs. Noise



# Next Steps

- Categorize / rank ~200 unique nominal texture configurations
- Interrelate texture-noise-friction-smoothness
- Identify and reduce variability in texture and noise
- Analyze in-vehicle and wayside noise
- Conduct splash & spray experiment
- Develop texture specification
- Build trial sections to a “new” specification

# PART 3 INNOVATIVE SURFACE CHARACTERISTICS

## ■ Pooled fund

- California; Iowa; New York; Texas; Washington; Minnesota
- FHWA
- NCPTC
- ACPA/IGGA

# PART 3 INNOVATIVE SURFACE CHARACTERISTICS (cont.)

- Continue testing of Type 1 and Type 2 sites
- Influence construction of sites utilizing early results
- Evaluate innovative surfaces
  - Porous
  - Exposed Aggregate
  - Two-lift construction
  - Stamped/brushed

# FUTURE INITIATIVES

- Determine best practices for consistent texturing
- Develop specifications/controls for use by highway agencies
- Determine methods to monitor plastic concrete texturing for compliance with specifications

# FUTURE INITIATIVES

- Work with equipment manufacturers to develop equipment that will consistently meet the specified texture requirement and thus the “design noise”
- Long Range Plan management and updates



# FUTURE INITIATIVES

- Connect other interested industry experts/stakeholders
  - Purdue
  - Concrete Pavement Technology Program (CPTP)
- Improve communications with vehicle and tire industries

# ASSOCIATED STUDIES

- Porous Concrete
- Splash and Spray
- Traffic Noise Model

# Timeline

- Data Collection Thru July 2006
- Expert Task Group June 2006
- Specifications Fall 2006
- Formal Report Fall 2006
- Data Analysis Continuous

# National Concrete Pavement Technology Center



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