SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Advanced Methods to Identify Asphalt Pavement Delamination (R06D) Ground Penetrating Radar (GPR)

AASHTO & FHWA Welcome

Kate Kurgan, AASHTO
Monica Jurado, FHWA

Webinar
June 28, 2018

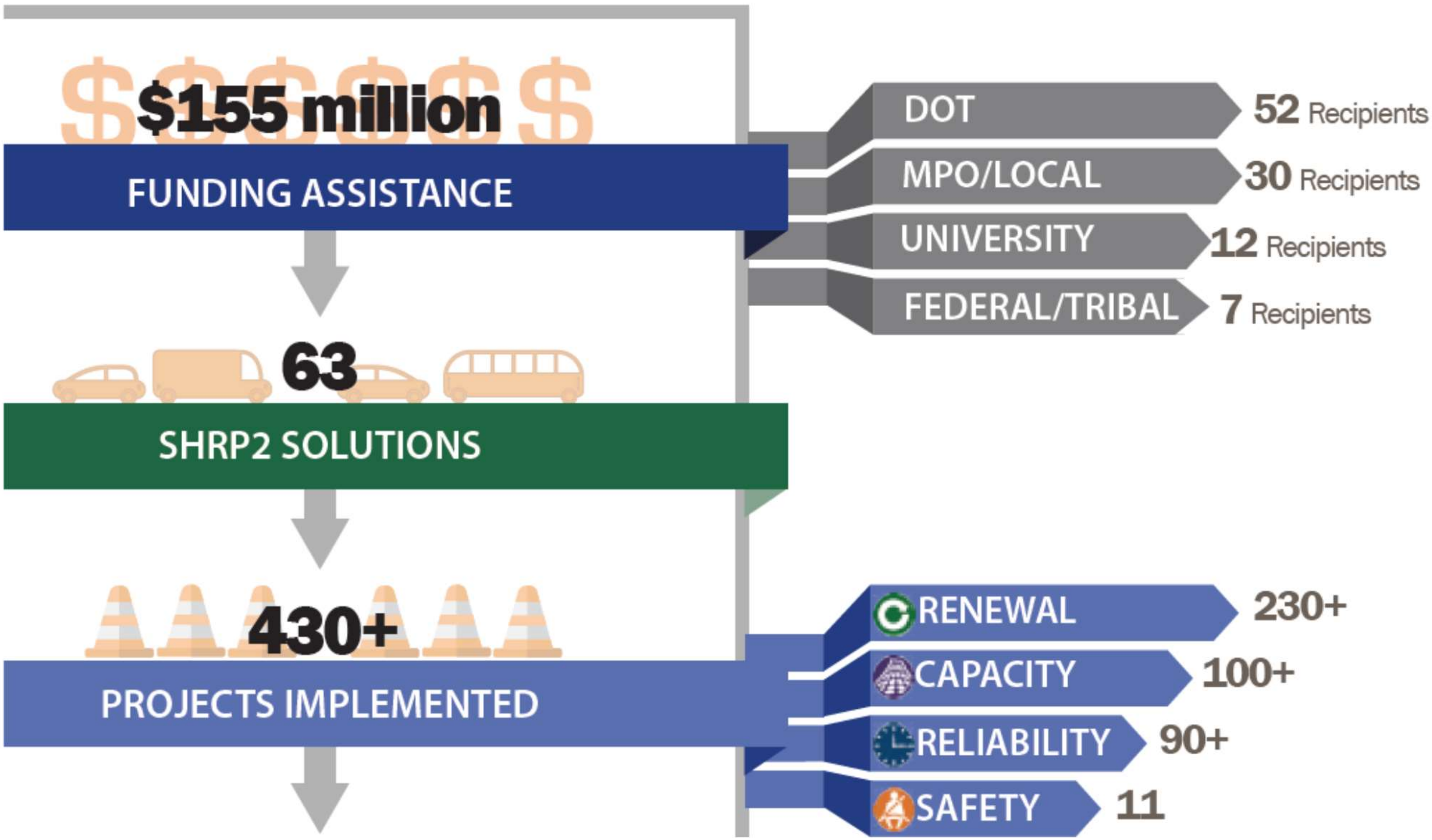
U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

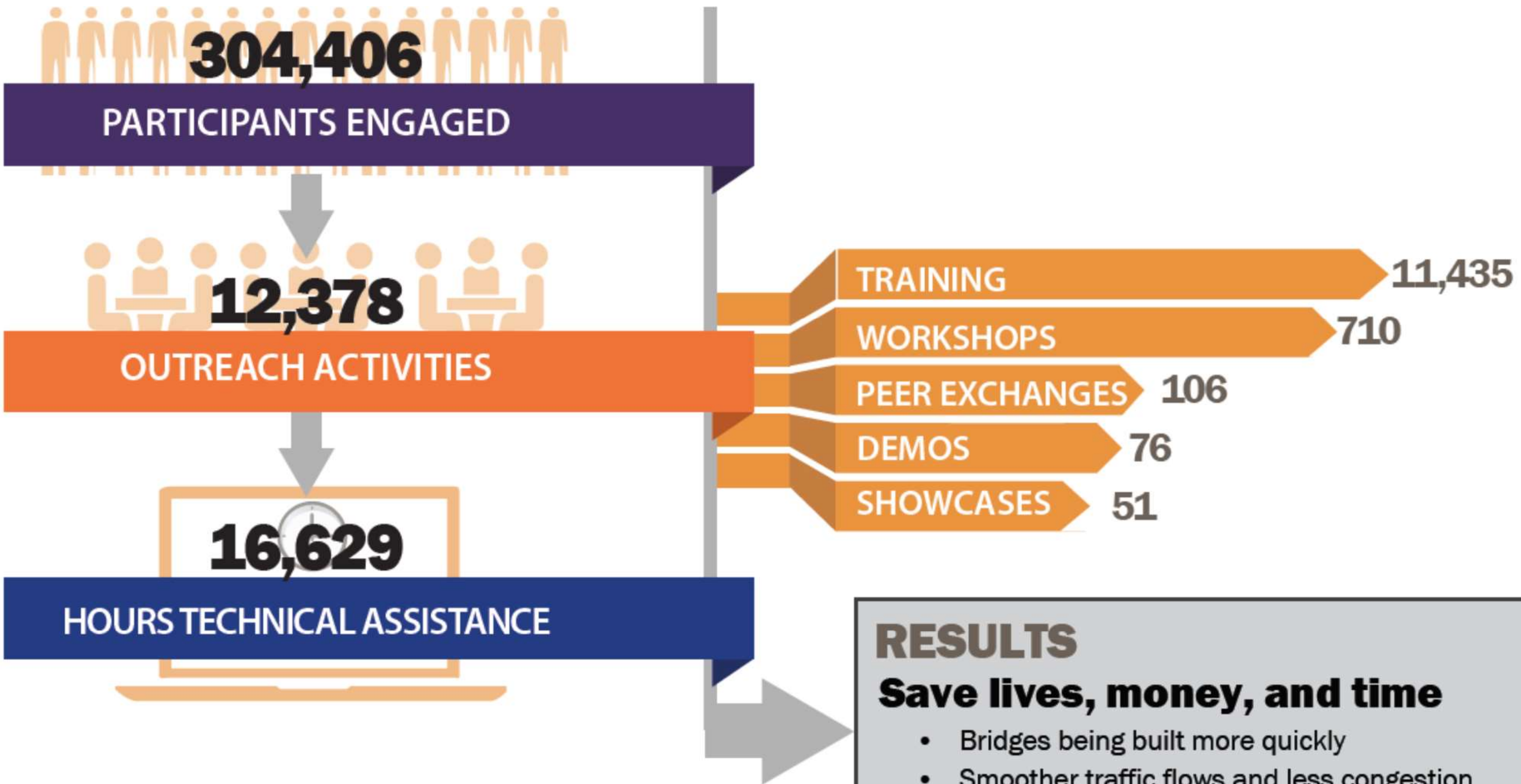
Webinar Agenda

- AASHTO & FHWA Introduction
- R06D Overview
- GPR Technology Features
- Agency Evaluation – Texas/New Mexico
- Agency Evaluation – California
- Agency Evaluation – Minnesota
- Analysis Automation – Minnesota
- Questions and Answers

SHRP2 Implementation: INNOVATE – IMPLEMENT - IMPROVE



SHRP2 Implementation:
INNOVATE – IMPLEMENT - IMPROVE



RESULTS

Save lives, money, and time

- Bridges being built more quickly
- Smoother traffic flows and less congestion
- Reduced construction costs
- Safer roadways
- Smarter environmental reviews

SHRP2 Focus Areas

Safety: fostering safer driving through analysis of driver, roadway, and vehicle factors in crashes, near crashes, and ordinary driving

Reliability: reducing congestion and creating more predictable travel times through better operations

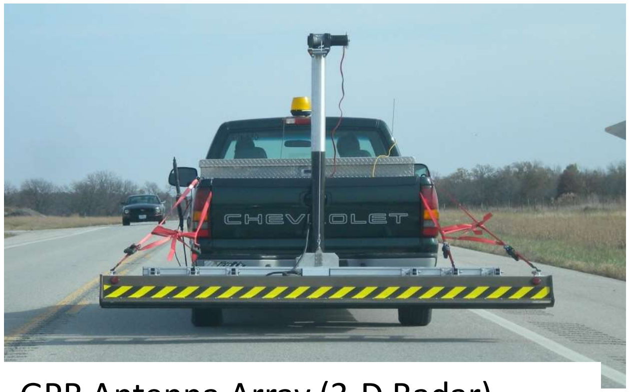
Capacity: planning and designing a highway system that offers minimum disruption and meets the environmental and economic needs of the community

Renewal: rapid maintenance and repair of the deteriorating infrastructure using already-available resources, innovations, and technologies

Advanced Methods to Identifying Pavement Delamination (R06D)

CHALLENGE:

Asphalt pavements with delamination problems experience considerable early damage. Rapid detection of the existence and extent of delamination is key for determining appropriate rehab strategies and extending pavement life.

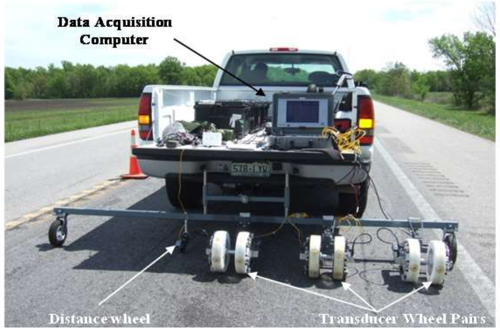


GPR Antenna Array (3-D Radar)

RESEARCH:

Identify and develop NDT technology that can:

- Detect & quantify delamination in HMA
- Operate at reasonable traveling speed
- Cover full-lane width



Impact Echo (IE) /
Spectral Analysis of Surface Waves (SASW)
Scanning System

ROUND 7 Proof-of-Concept Agencies:

- FL, TX, NM, MN, CA & KY
- Focused on field validation and assist in advancement of one or both technologies.

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Advanced Methods to Identify Asphalt Pavement Delamination (R06D) - GPR

Overview of R06D Project

Michael Heitzman, PE, PhD
Asst. Director
NCAT

Webinar
June 28, 2018

U.S. Department of Transportation
Federal Highway Administration

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Asphalt Delamination

SHRP2 R06D Project Goal

Identify and develop NDT technology that can:

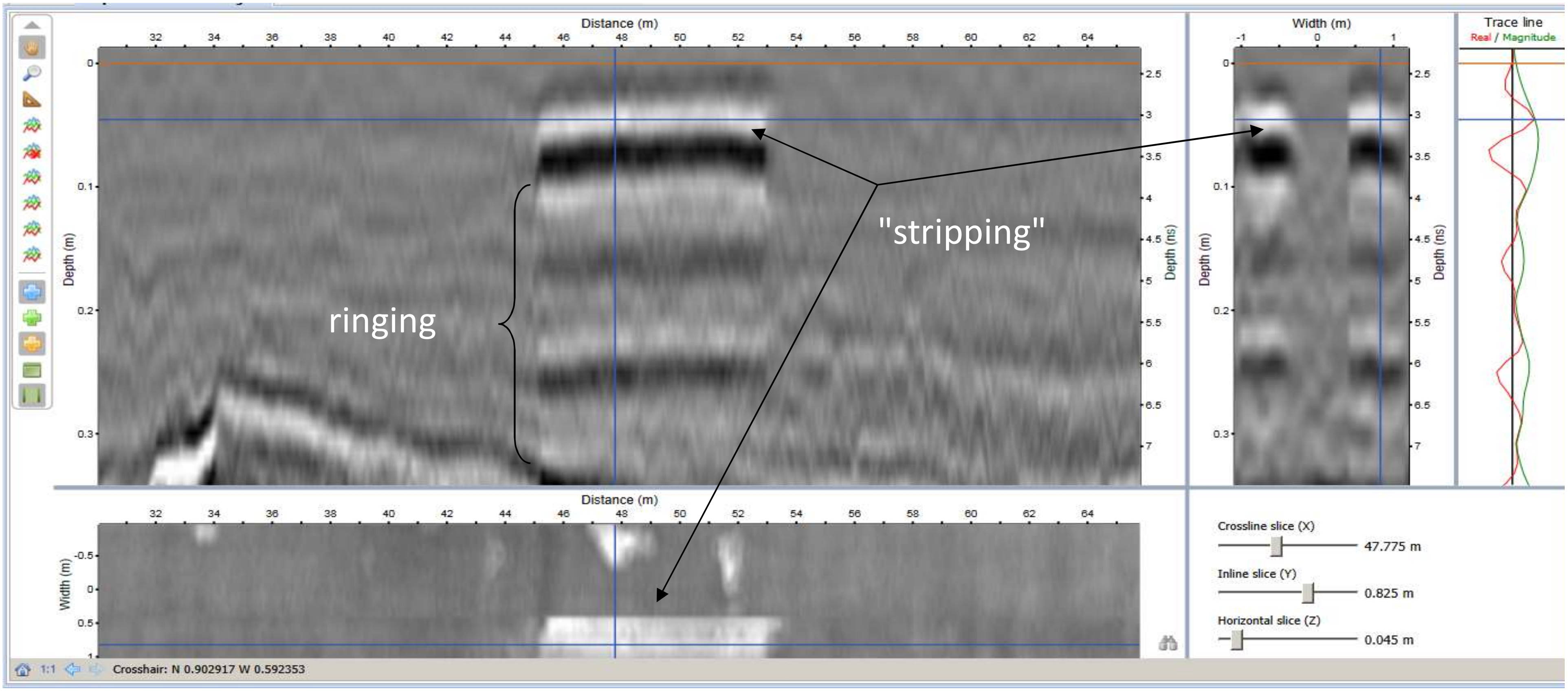
- Detect delamination in HMA
- Operate at reasonable traveling speed
- Cover full lane width

R06D Research Overview

1. Identify candidate NDT technologies
2. Evaluate potential to meet the goals
3. Select NDT technologies with high potential to achieve goals
4. Promote development of hardware and software
5. Validate equipment improvements
6. Examine performance in field conditions
7. Demonstrate NDT to interested agencies

Building Delamination Sections

GPR Data Display (NCAT test track section)



GPR by 3D Radar

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Advanced Methods to Identify Asphalt Pavement Delamination (R06D)
GPR Step Frequency Antenna Array

Kent Martin
USA Sales Manager
3D-Radar

Webinar
June 28, 2018

U.S. Department of Transportation
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About 3d-Radar

- Founded in 2001 to bring Step-Frequency (SF) 3D Ground Penetrating Radar (GPR) to the Defense and Civil markets
- Located in Trondheim and Oslo, Norway and Charlotte, NC USA
- Patented intellectual property (Norwegian Patent No. 0316658 and U.S. Patent No. 7,170,449 for unique antenna array)
- As of May 2014, part of Chemring Sensors and Electronic Systems

Technology

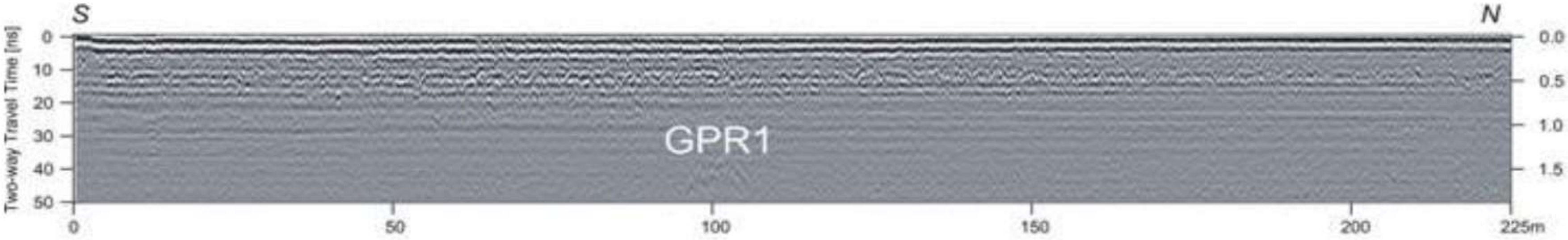
- Step-frequency GPR technology and multi-channel antenna arrays
- Embedded processing technology for Real-Time tomography
- Advanced post-processing software with geo-referenced output

3D-Radar

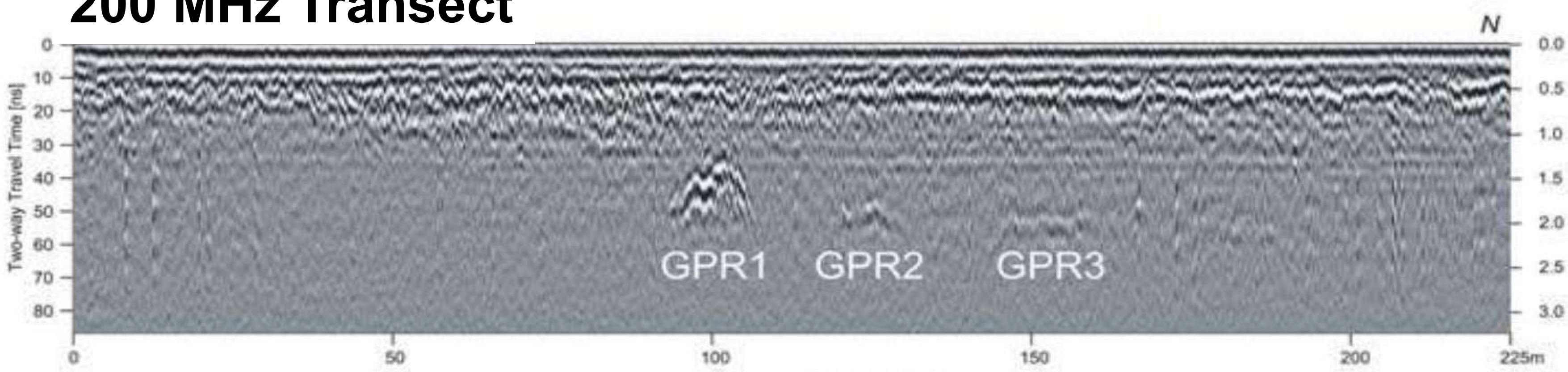
Frequency vs. Resolution of Anomalies

<u>Same transect</u> – two different GPR frequency antennas

400 MHz Transect



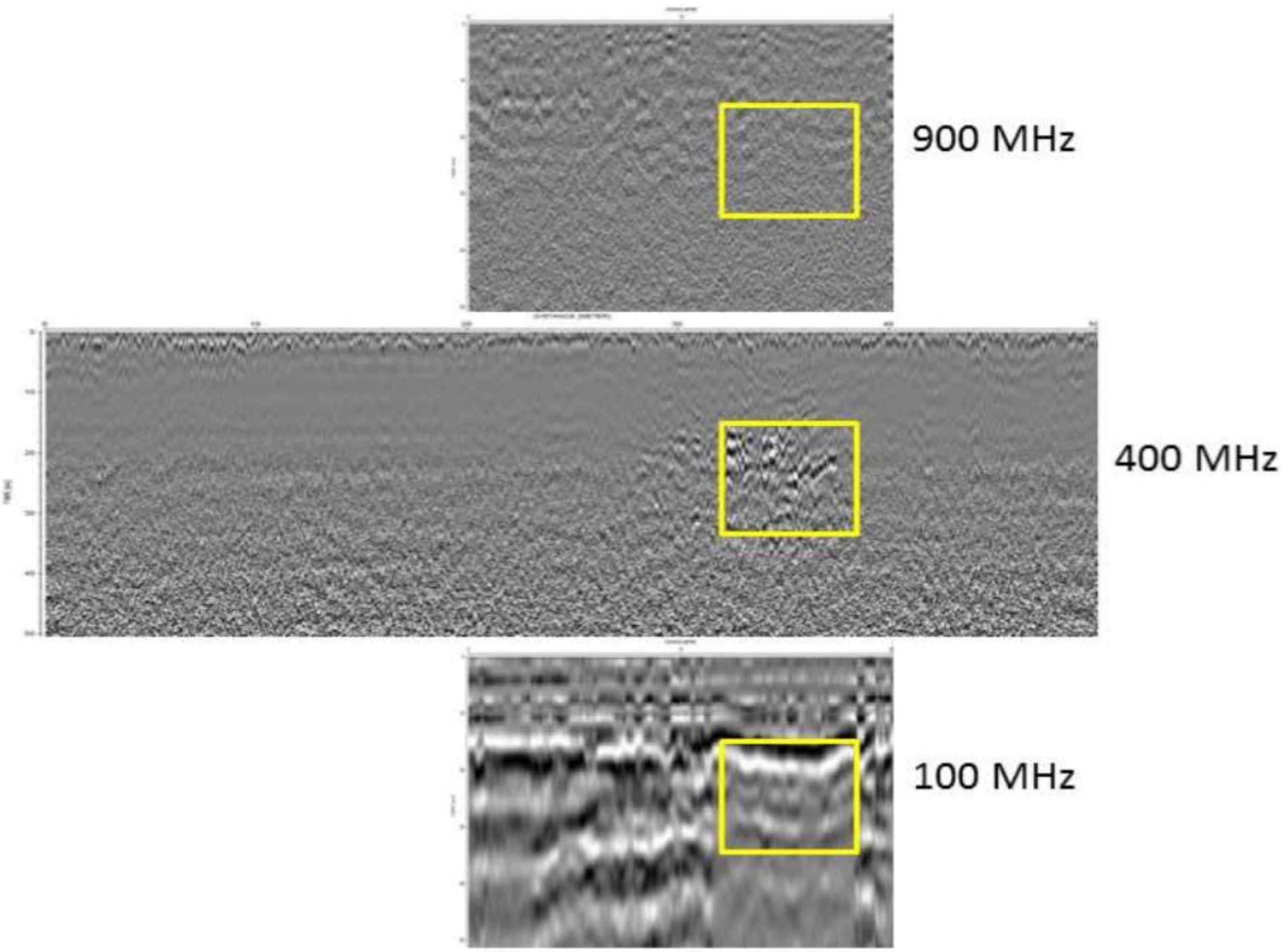
200 MHz Transect



Frequency vs. Resolution of Anomalies

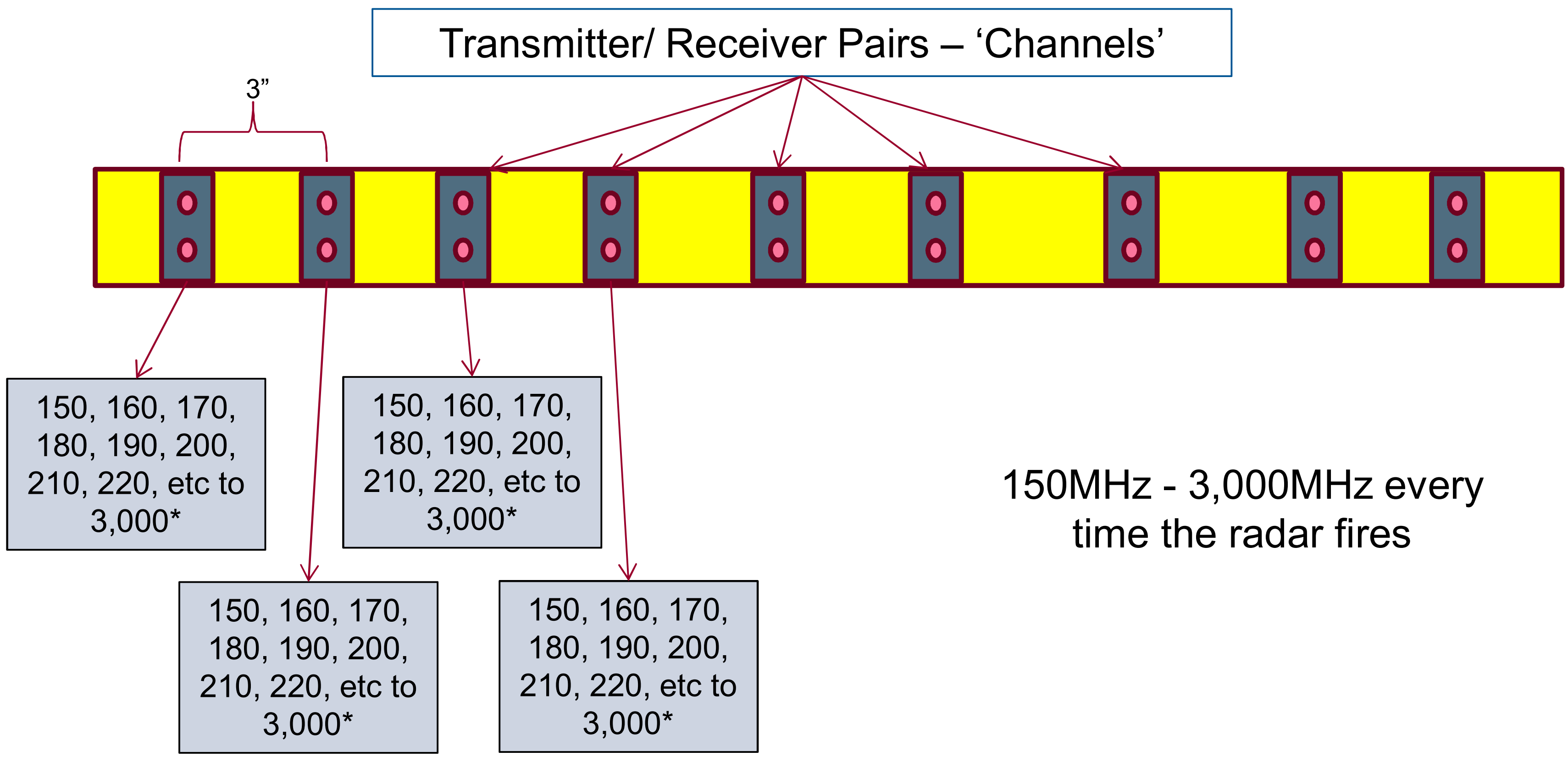
Same transect – three different frequency antennas

Same time scales



Lower Frequency 'sees' Deeper

Step Frequency/ Ultra Wideband Radar



3D Radar uses the full range of frequencies to optimize resolution for each depth point.

**Actual step progression is determined by the scan settings.*

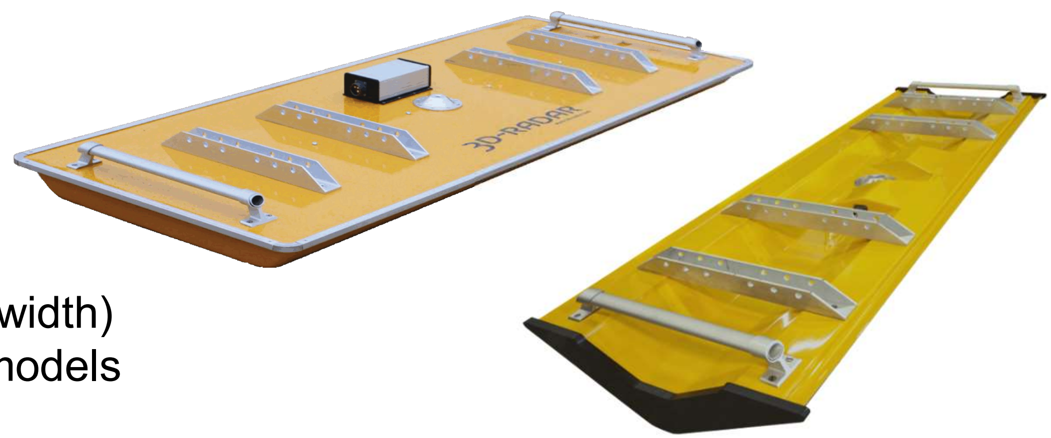
3D-Radar

3d-Radar Core Products

GeoScope 3D GPR and Ultra-wideband Antenna Arrays

GeoScope™ MkIV
3-dimensional GPR

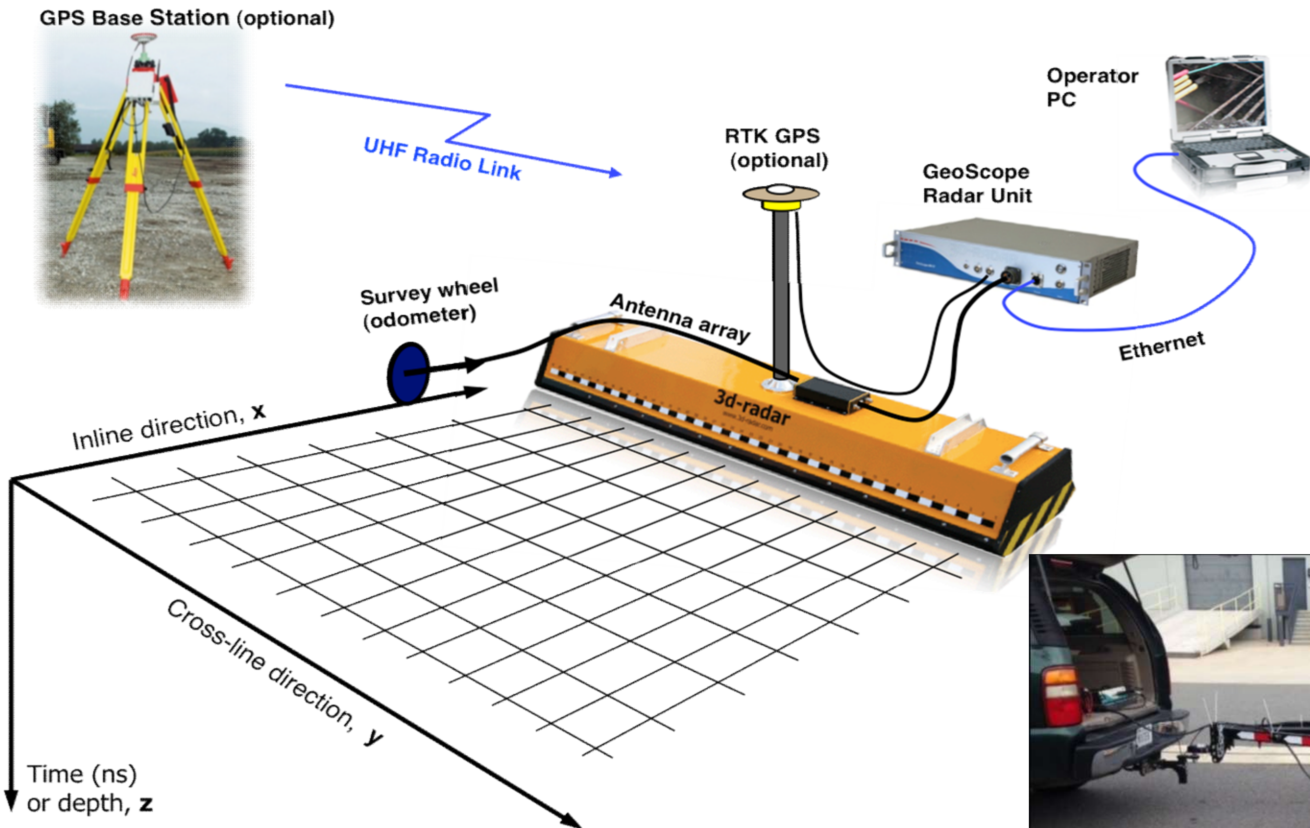
- Step-frequency continuous waveform Radar
- Real-time 3D Display
- Dual Receiver architecture
- 100 MHz - 3000 MHz
- GPS / Total Station interface



DX series & DXG series
ultra-wideband antenna arrays

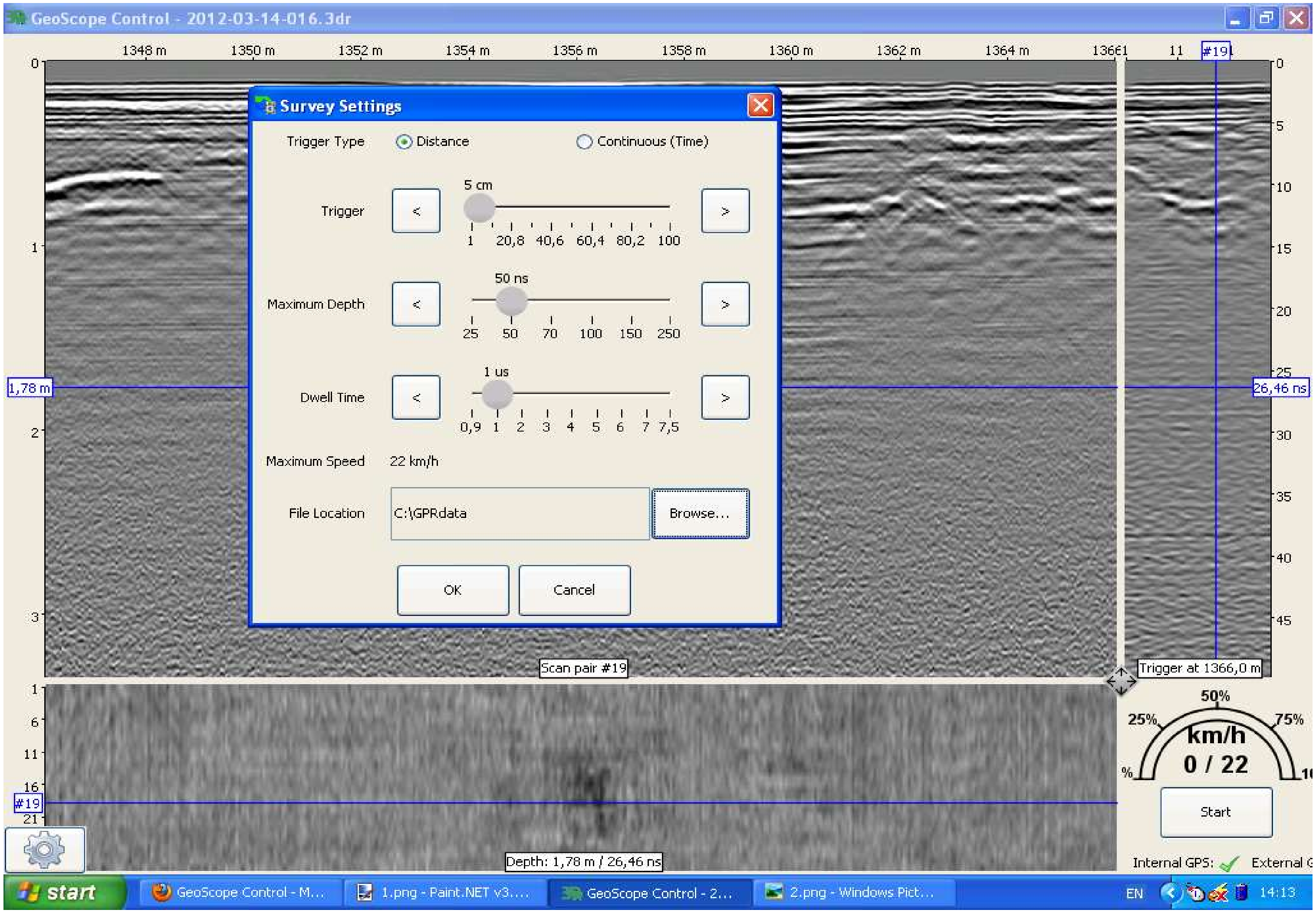
- 200 MHz - 3.0 GHz
- 75mm channel spacing
- 8 - 41 channels (0.6 – 3.1m scan width)
- Air-coupled and ground-coupled models
- Built-in GPS for time reference

Principles of Operation



3D-Radar

Real-Time 3D Display

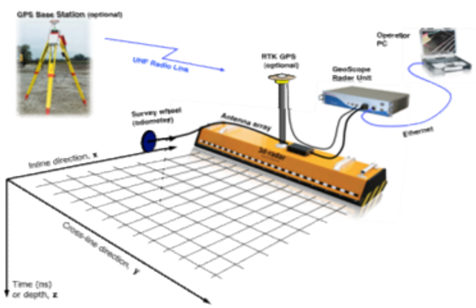


3D-Radar

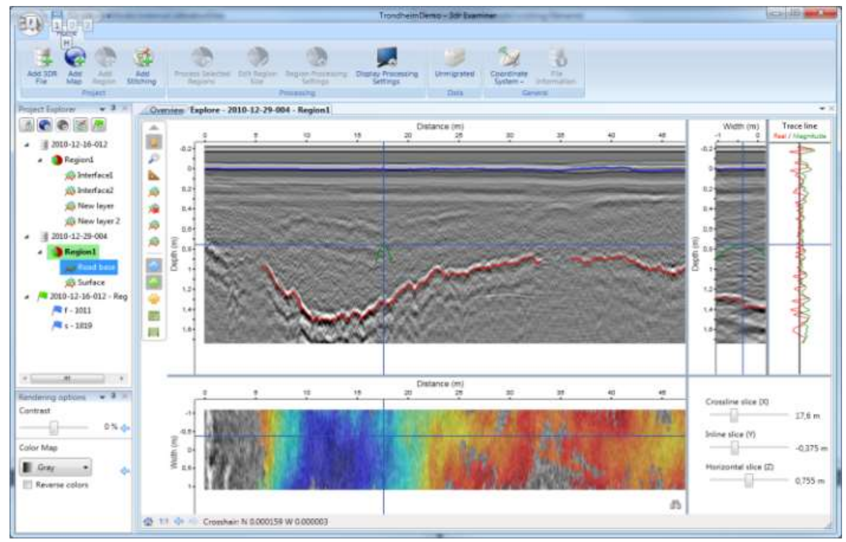
3d-Radar Data Processing Workflow

Post-processing, Data Analysis & Interpretation software

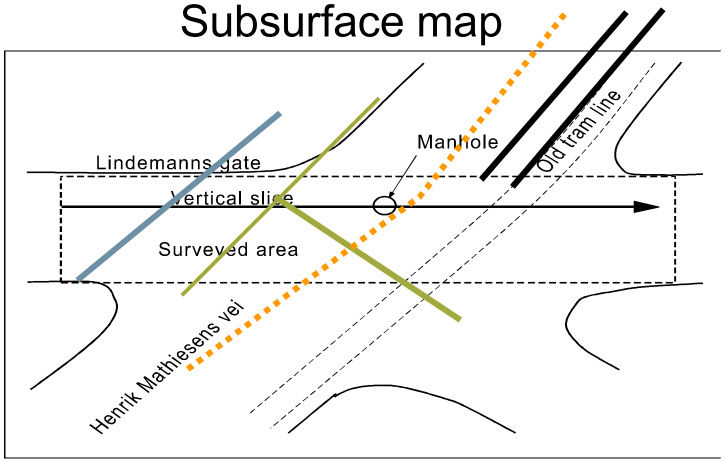
Radar scanning & Data Collection



3D GPR Data Processing
and Visualization (3DR Examiner)



Subsurface map



Feature Extraction
and Reporting

3D-Radar Examiner

Designed to handle huge datasets

- No data reduction
- Post processing performed on full dataset

Drastically reduced processing time

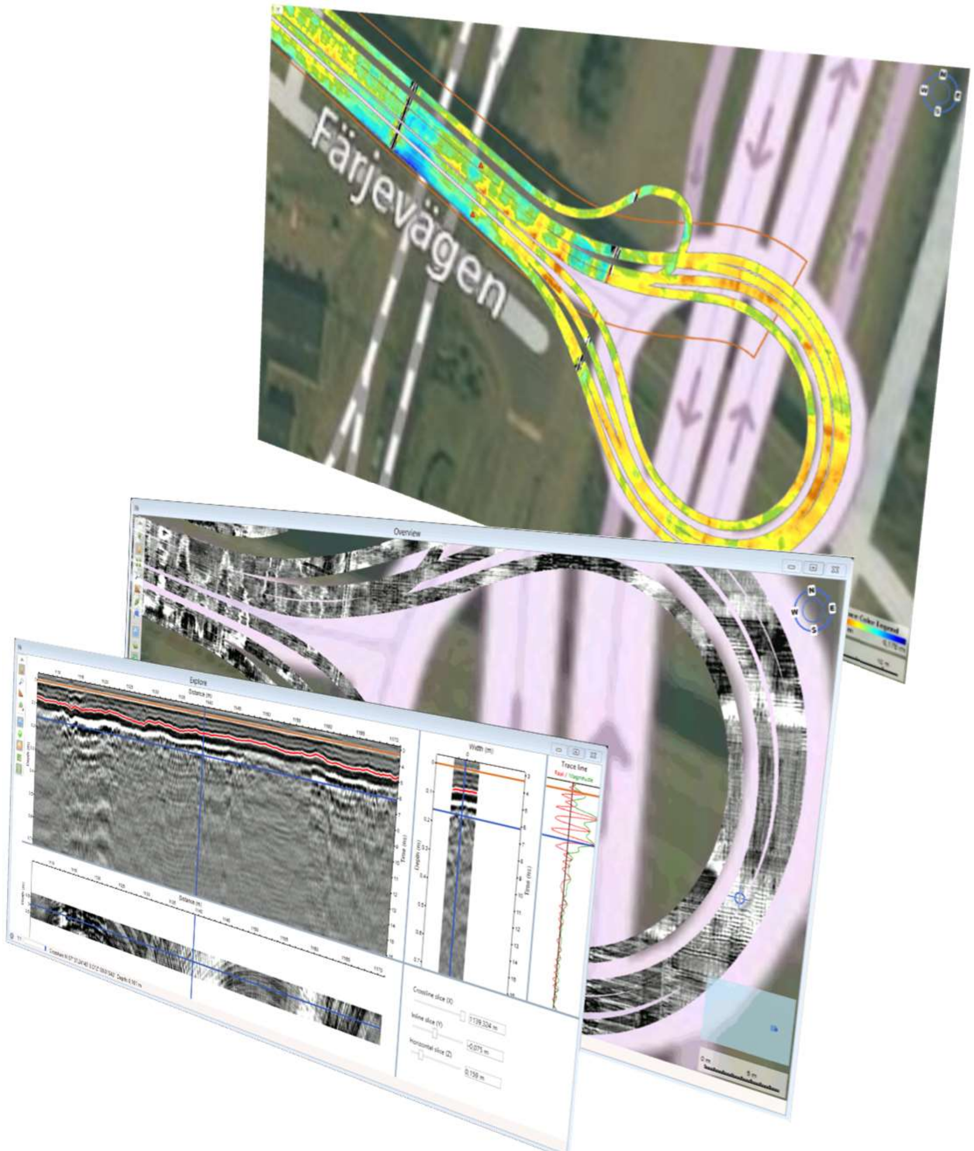
- Data available for analysis almost immediately after the survey

Intuitive GUI

- Easy extraction of meaningful data

High positioning accuracy

- State-of-the-art GPS outliers filtering



3D-Radar

3D-Radar Examiner

Easy to use annotation function

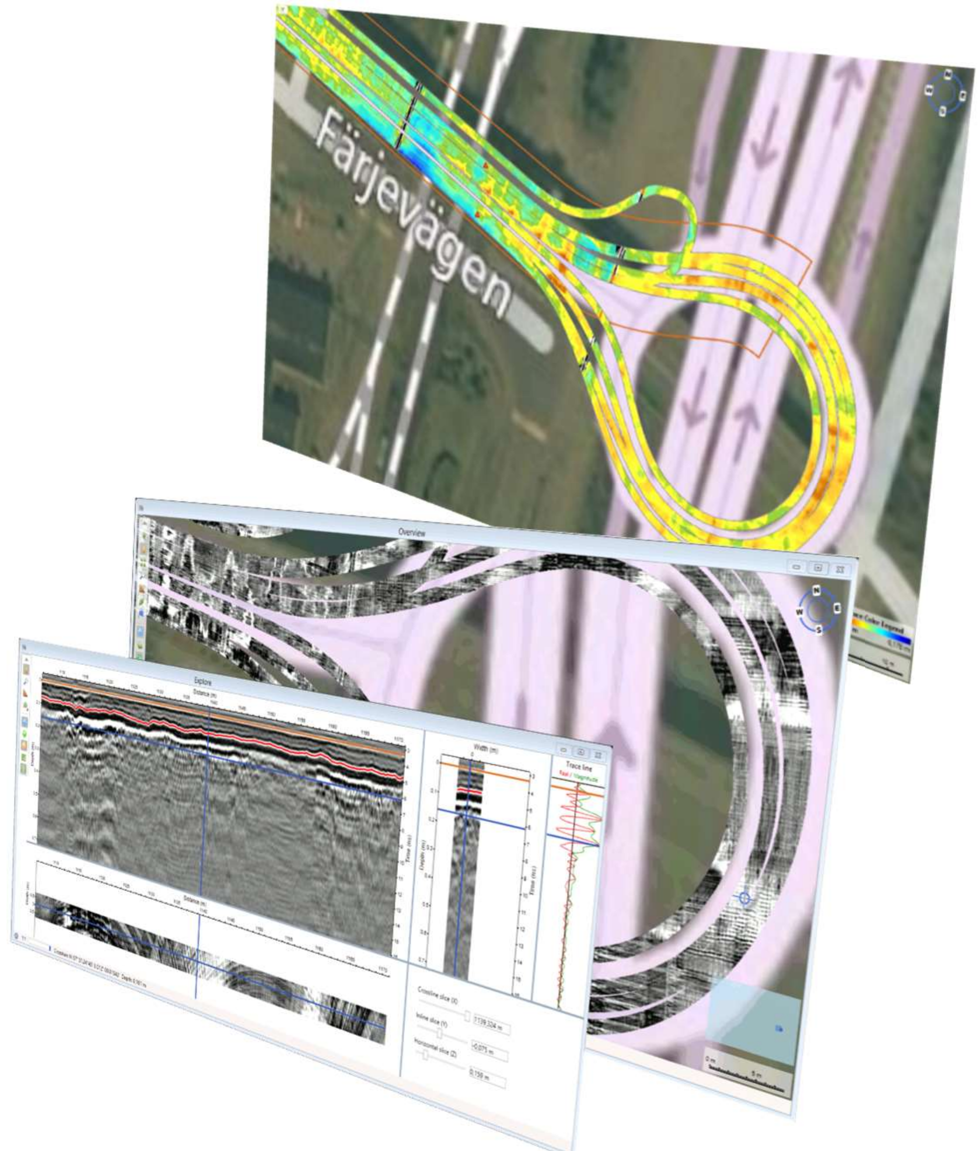
- Annotations exported with subsurface images

Import/Export of geo-referenced maps and images

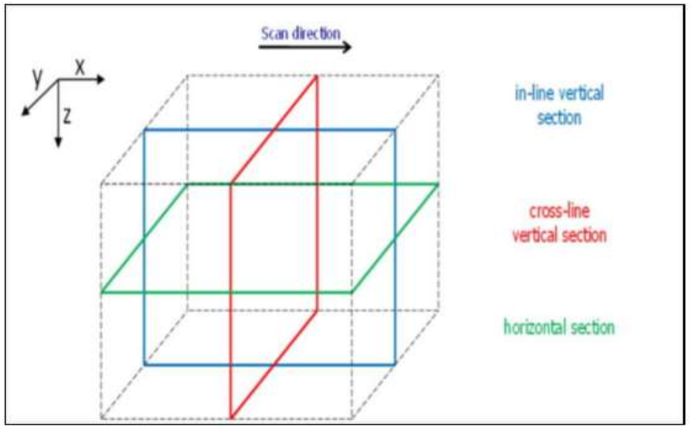
- AutoCAD, Google Earth, Video

Fully documented SW development kit

- Integration of specific algorithms

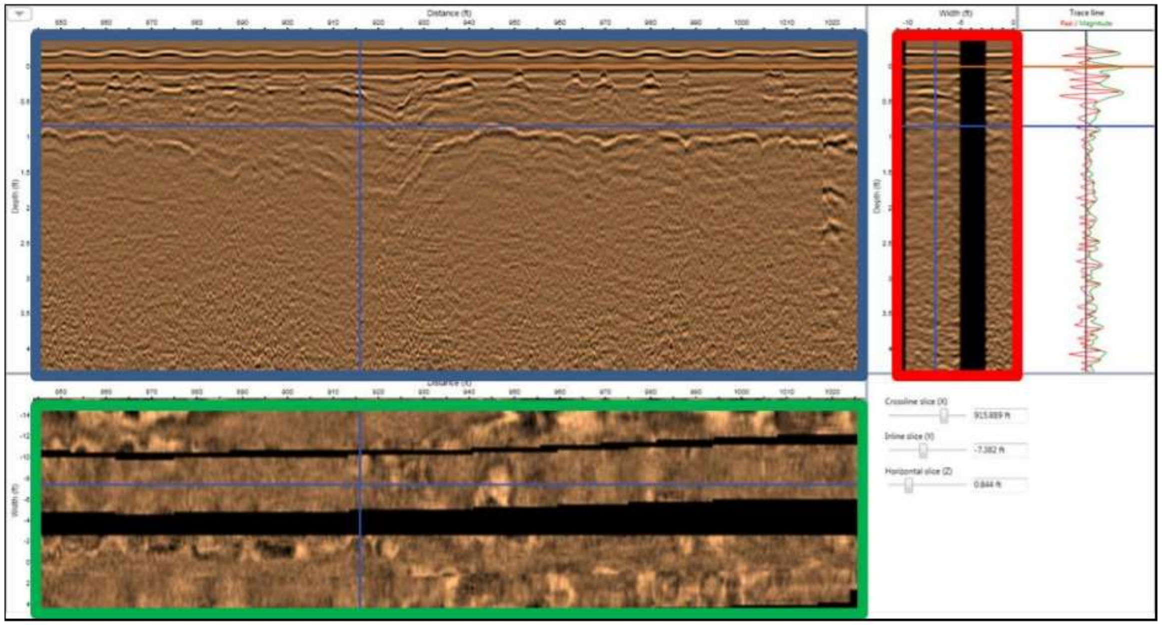


3D-Radar Examiner



Depiction of a data cube

Scan Direction → Antenna Width



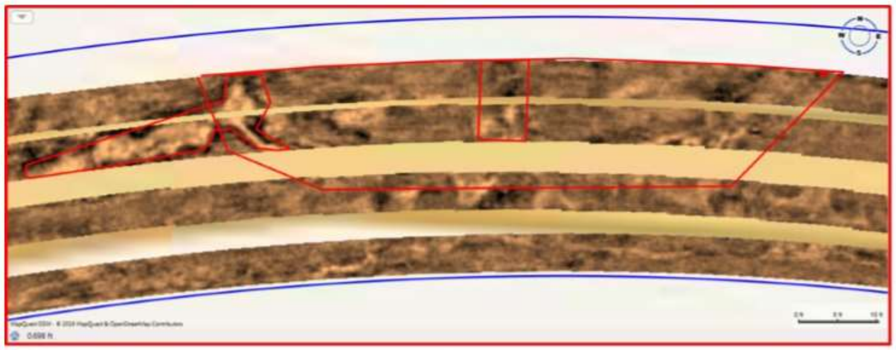
Time Slice

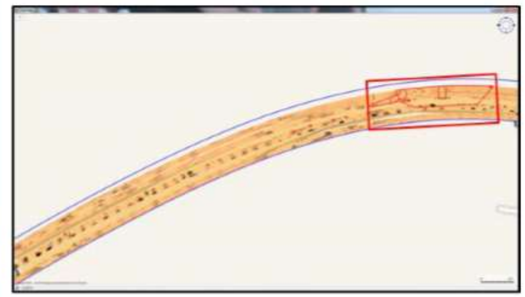
Example of 3D-Radar Examiner software

3D-Radar

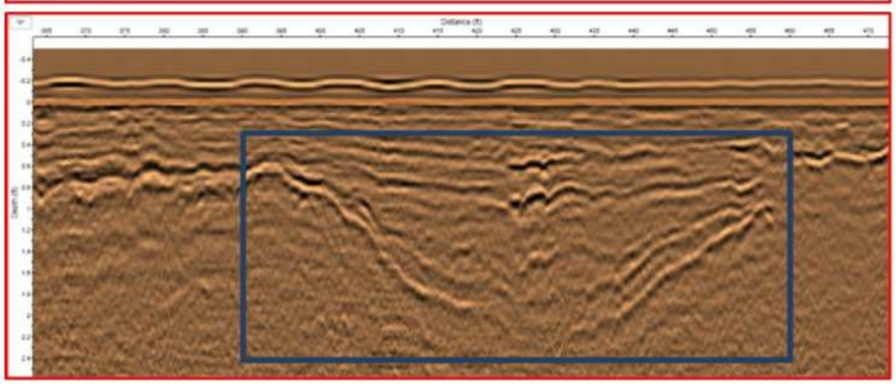
3D-Radar Examiner

Region 4			
Type	Location	Area (sq. ft)	Depth (ft)
SP1	N37° 09' 46.98566" W113° 01' 28.02437"	1153.08	2.299





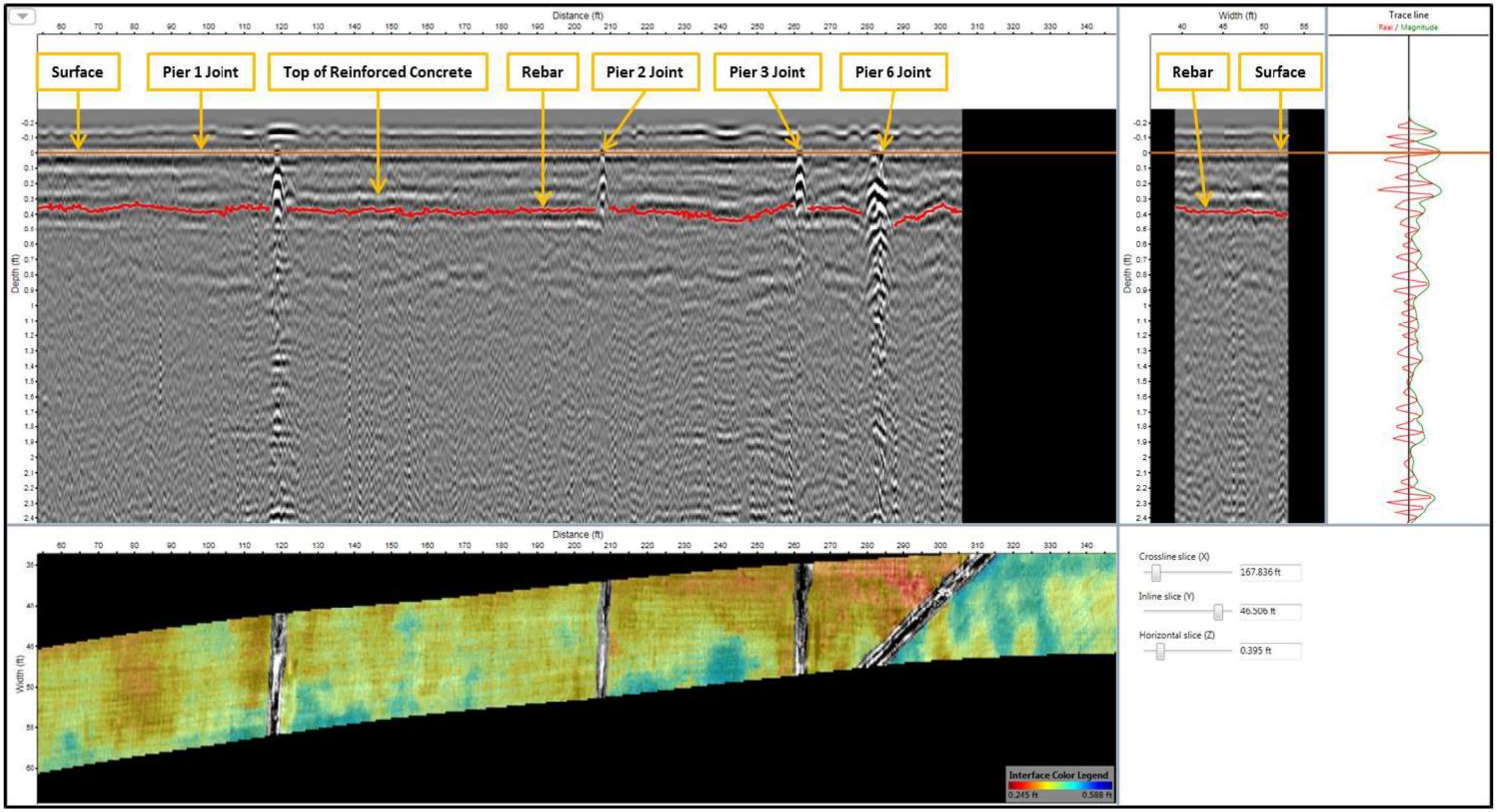
Section 1 Overview



Region 4 Overview

The area within the blue box represents the soft spot. It has an area of 1153.08 sq ft and goes down to a depth of 2.299.'

Part 3 – Cross Sectional (On-Ramp – Between South Abutment and Pier 6 Joint)



The above image is a cross-sectional view of the on-ramp between the South Abutment and Pier 6 Joint.

3D-Radar

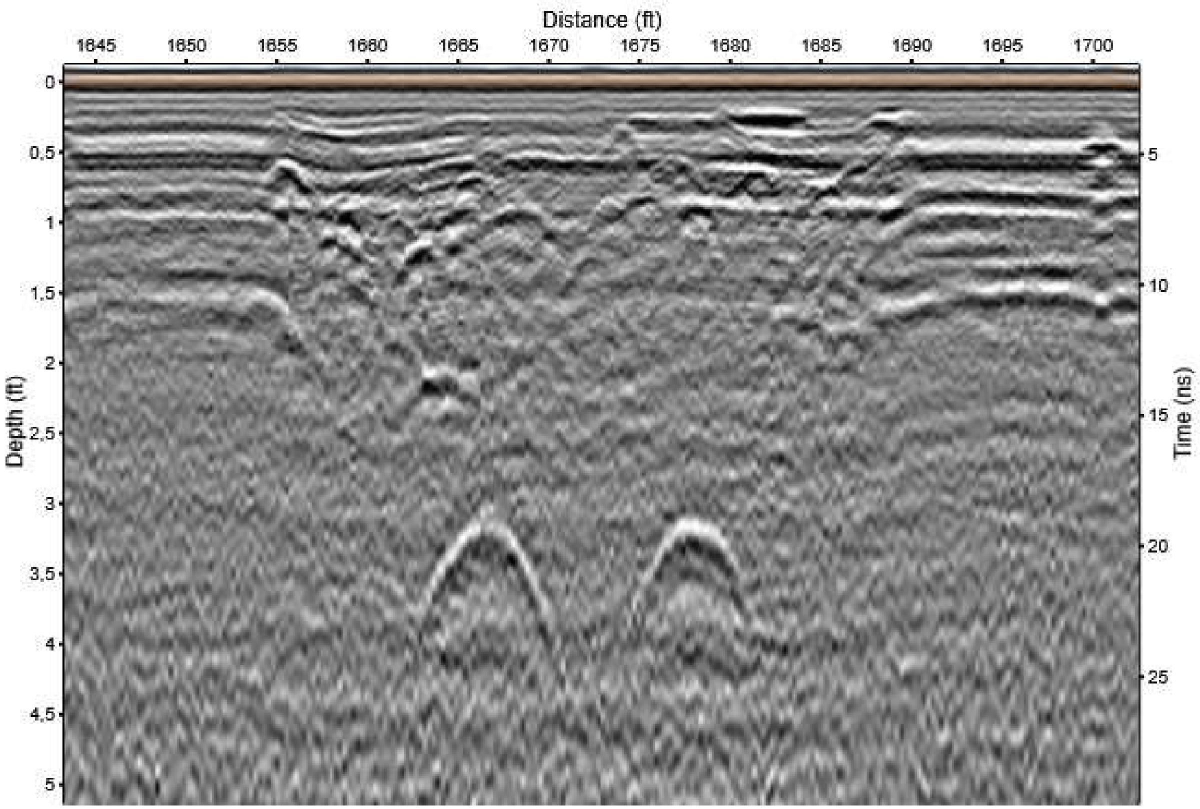
Road Inspection

Measurements:

- Pavement thickness and quality
- Base and sub base layers
- Delamination

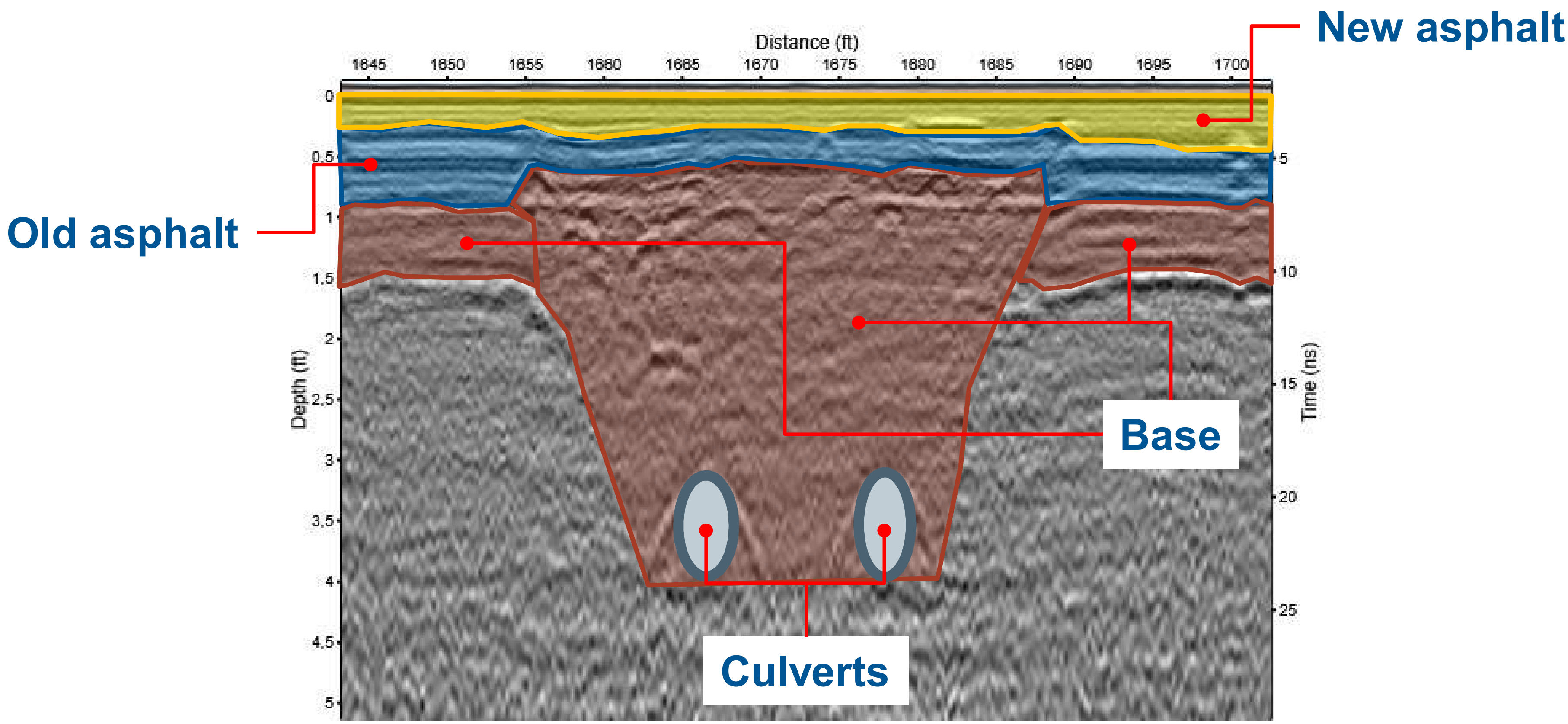
Survey area (detail)

Data example: vertical section (GPR data)



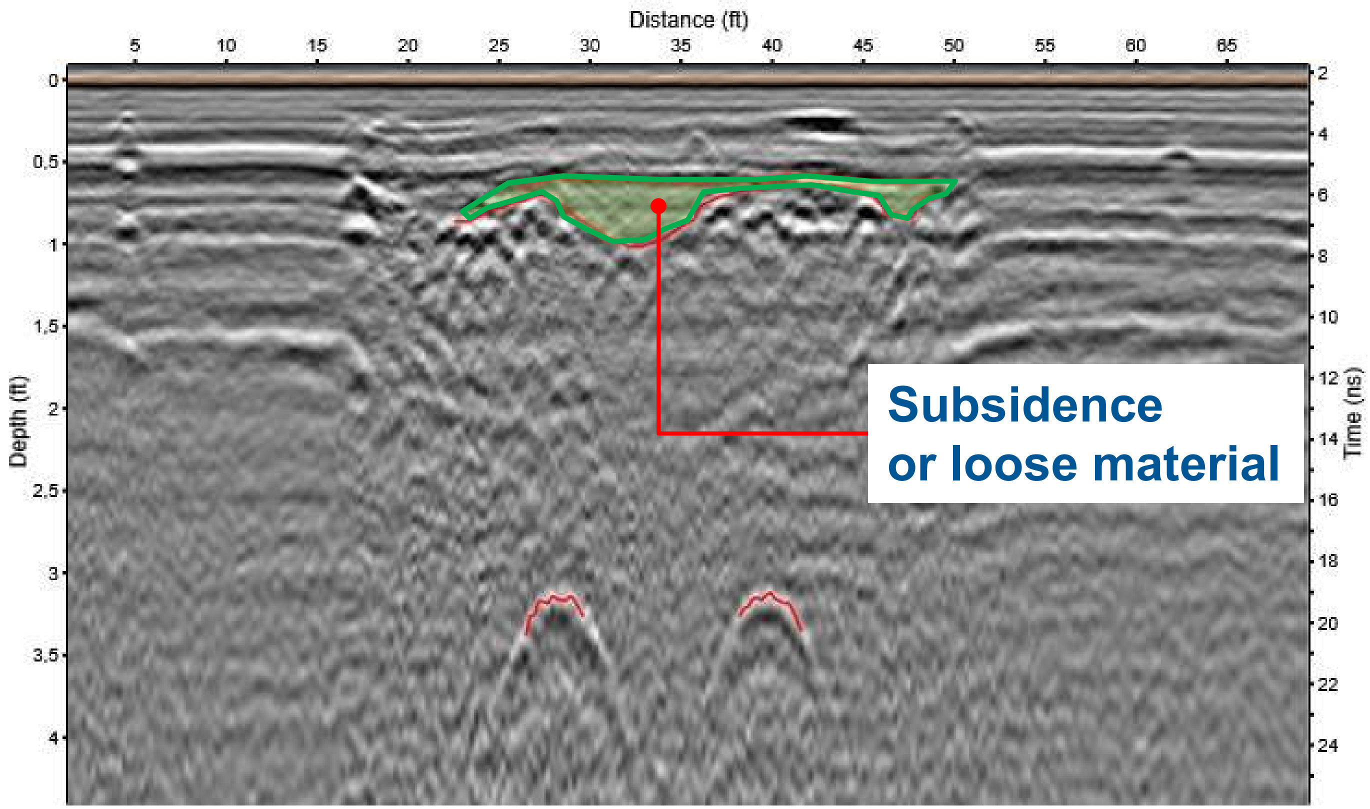
3D-Radar

Data example: vertical section (interpretation)



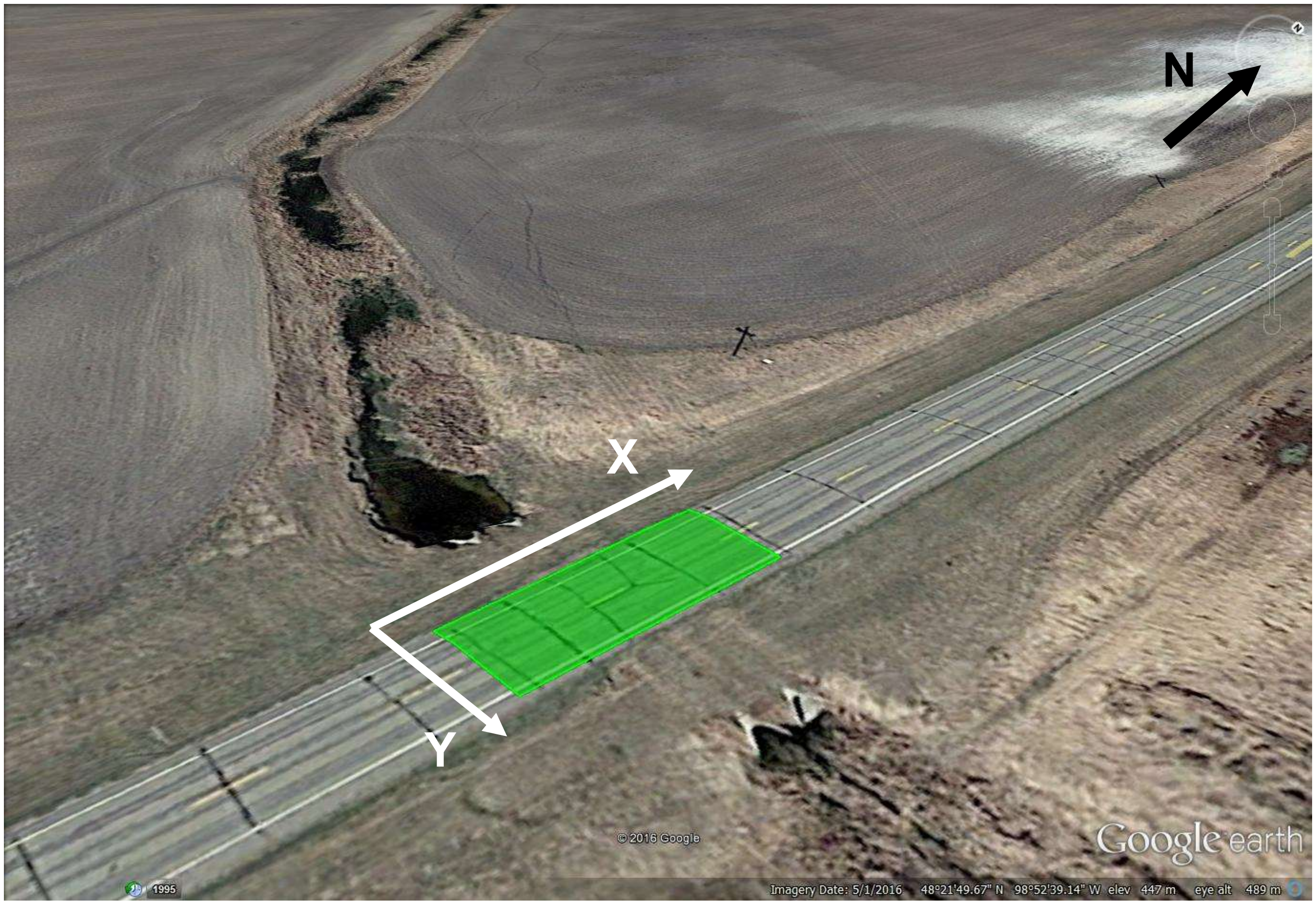
3D-Radar

Data example: vertical section, subsidence below asphalt



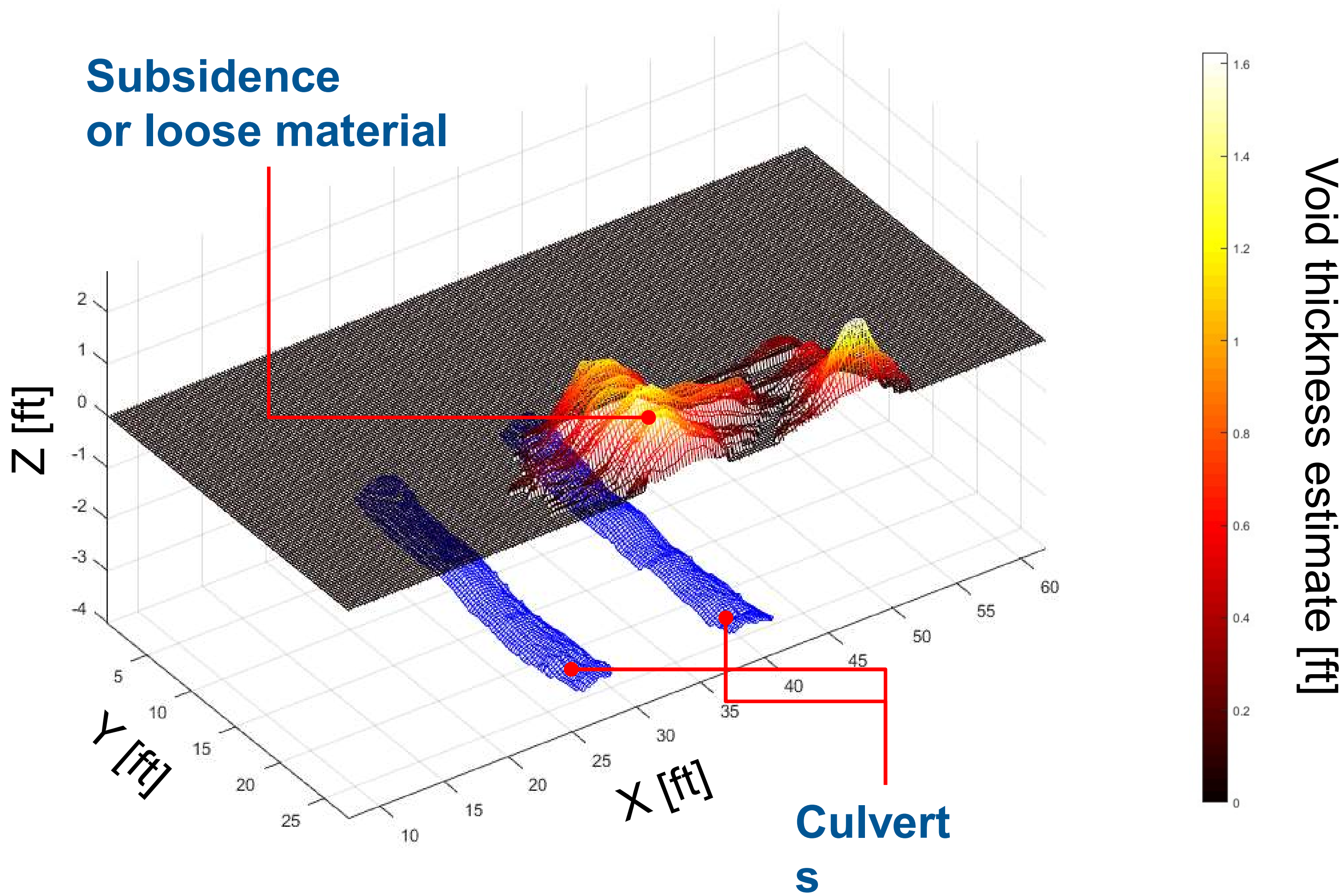
3D-Radar

Area of interest: reference



3D-Radar

Area of interest: subsidence reconstruction
Total volume: ~93.5 ft^3



3D-Radar

Antennae Mounting Options

3D-Radar

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Advanced Methods to Identify Asphalt Pavement Delamination(R06D)

TX & NM DOTs Evaluation

Darlene Goehl, PE
Research Specialist
Texas A&M Transportation Institute

Webinar

June 28, 2018

Texas A&M Transportation Institute

New Mexico Department of Transportation
Mobility for Everyone

Texas Department of Transportation

U.S. Department of Transportation
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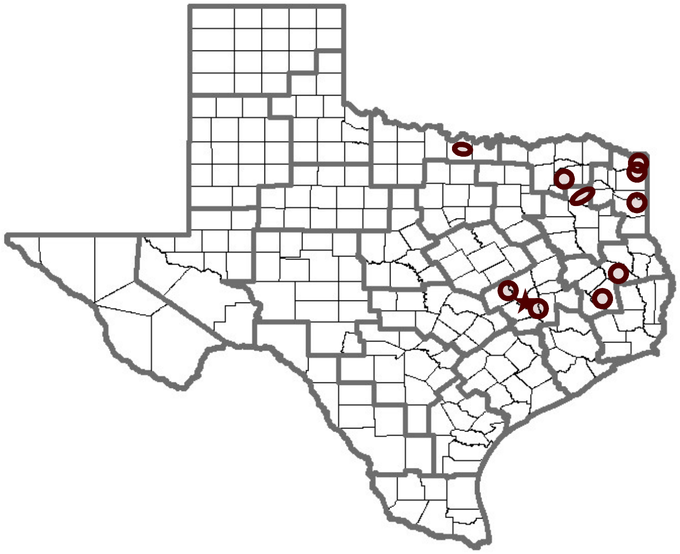
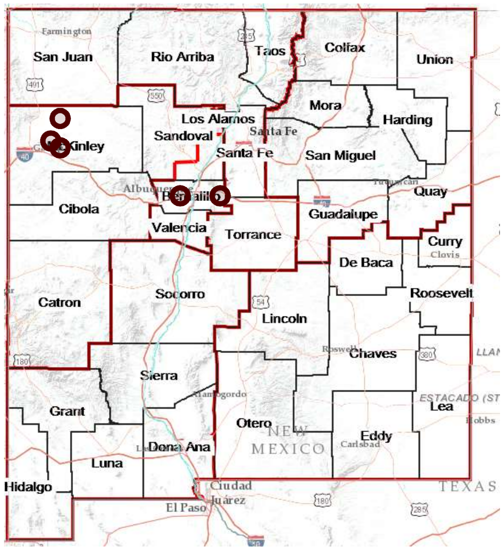
GPR Test Locations - Texas



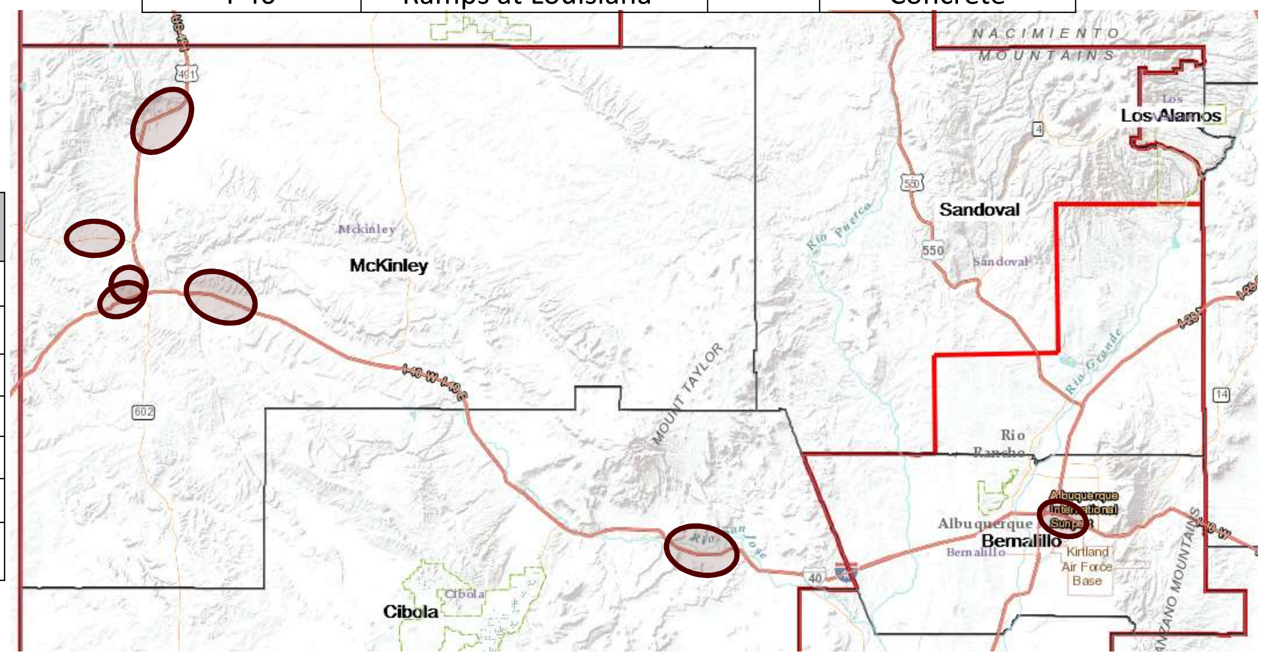
HWY	District	County	Limits	(mi)
US 59	Lufkin	Polk	Milton Creek to end grass median S of Leggett	3.9
US 69	Lufkin	Angelina	Start FM 841 E for 3 mi	3
SH 19	Paris	Hopkins	Delta Co. to Sulphur Springs	12.5
US 59	Atlanta	Harrison	Marion Co. line to FM 1997	3.1
IH 30	Atlanta	Bowie	State Line to TRM 218	6
IH 30	Atlanta	Titus, Morris	TRM 153 to TRM 181	30
US 82	Wichita Falls	Montague	Nocona to St. Jo	12
US 79	Bryan	Milam	FM 2095 to Brazos River	4.5
FM 2347	Bryan	Brazos	FM 2154 to FM 2818	1

GPR Test Locations – New Mexico



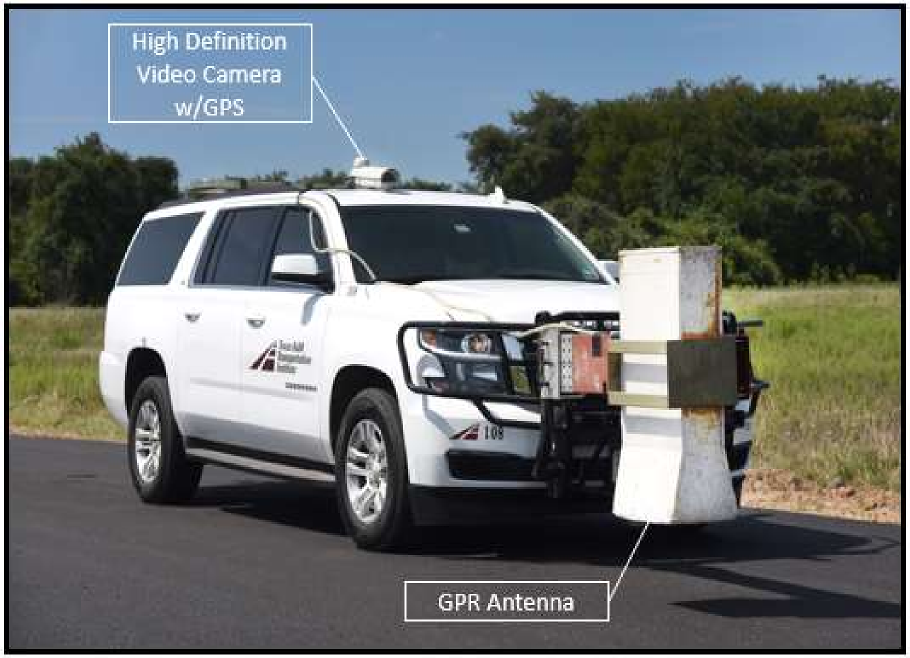
HWY	MP	MP	LENGTH (mi)	Comments
NM 264	11	14	3	Flexible
NM 491	27.5	28.5	1	Flexible
I-40	16	18	2	Concrete – 4 lane
Jefferson Ave.	Metro Ave.	US491	~1	Concrete
I-40	38	42.5	4.5	Flexible
I-40	42.5	45.5	3	Flexible
I-40	140	141	1	Flexible
I-40	Ramps at Louisiana			Concrete

Bridge	Rdwy	Feature Intersected
9040	NM-309	BNSF Railroad
9013	61-Z000	Belen Highline Canal
6489	I-40 WBL	BNSF RAILROAD
8678	FR-4004	I-40 EBLS/WBLS @mp 39.9
6362	I-40 EBL	BNSF Railroad Spur
7157	NM-566	Rio Puerco/BNSF R/R
7158	NM-566	RIO PUERCO (NORTH FORK)



GPR – Comparison to Texas System

TTI 1GHz System



3D Radar System

~6' wide with 21 channels

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Collection Settings 3D Radar

3D-Radar Collection Settings						
Pavement Surface	**[2]Trigger Spacing**		**Time Window**	**Dwell Time**	**Max Speed**	
	(in)	**(cm)**	**(ns)**	**(us)**	**(Km/hr)**	**(mph)**
Concrete & BRG	3.0	7.6	50	0.6	70	43.5
[1]concrete/flexible	6.0	15.5	50	0.6	144	89
Flexible	12.0	30.5	50	0.6	282	175

1. Use for concrete pavement when need to test at >45mph; use for flexible pavement when closer spacing is needed;
2. Trigger Spacing can be increased to 36” in order to save data storage and still provide adequate network level data. If spacing is adjusted, use multiples of 3".

Note: Collection settings are preliminary and final recommendations are still under review.

GPR Comparison - Collection

TTI 1GHz System

- Flexible Pavement
  - Collect at Highway Speed
  - Collection interval 24”+
  - Data Storage Required
    - US 59, 3.35 miles 1 run required ~19,000 KB of storage

3D Radar System

- Flexible Pavement
  - Collect at Highway Speed
  - Collection interval 12”+
  - Significant Data Storage Required
    - US 59, 3.35 miles 1 run required 1,578,000 KB of storage (83x more than TTI System)

TTI – PaveCheck Software

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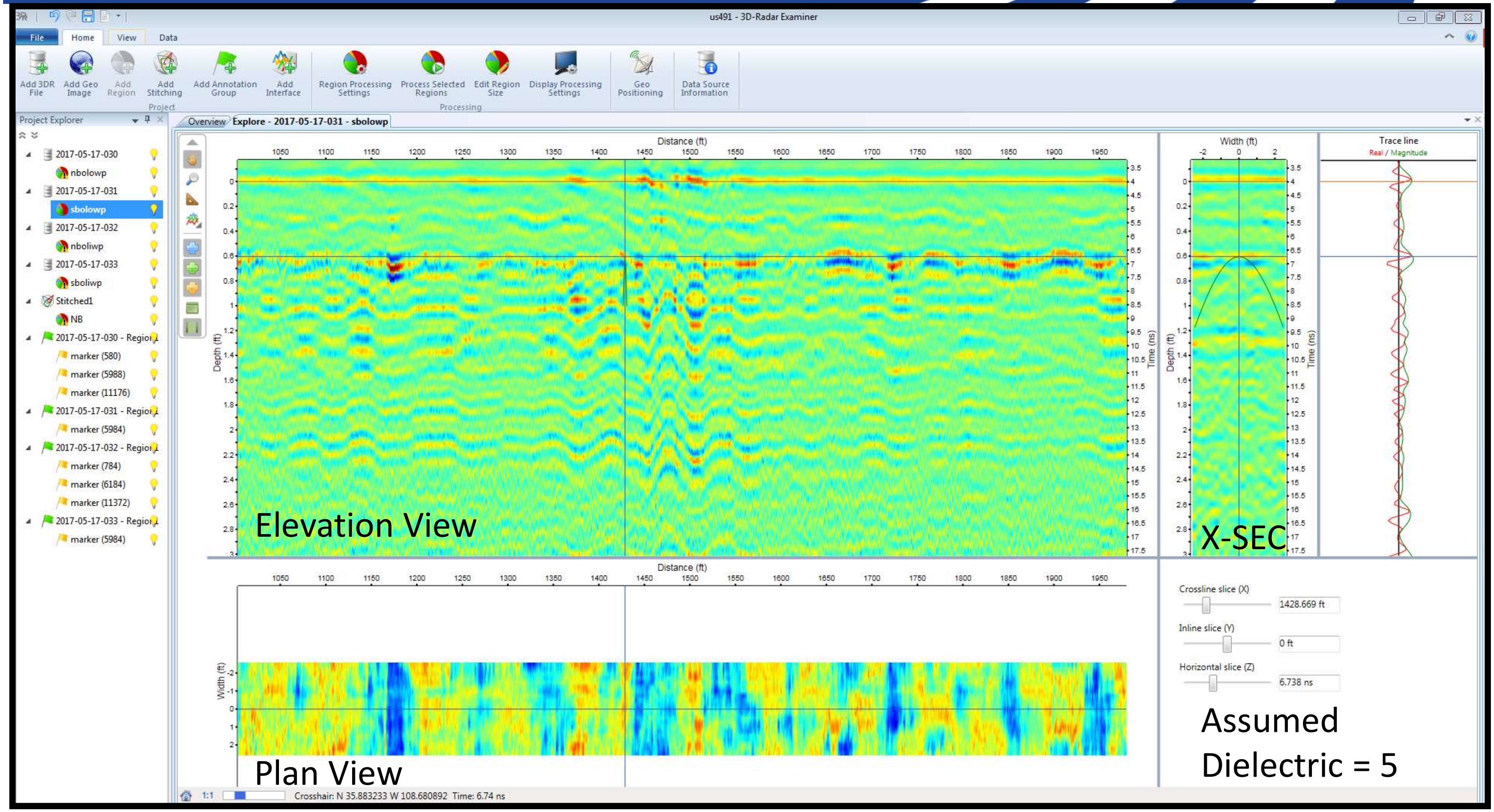
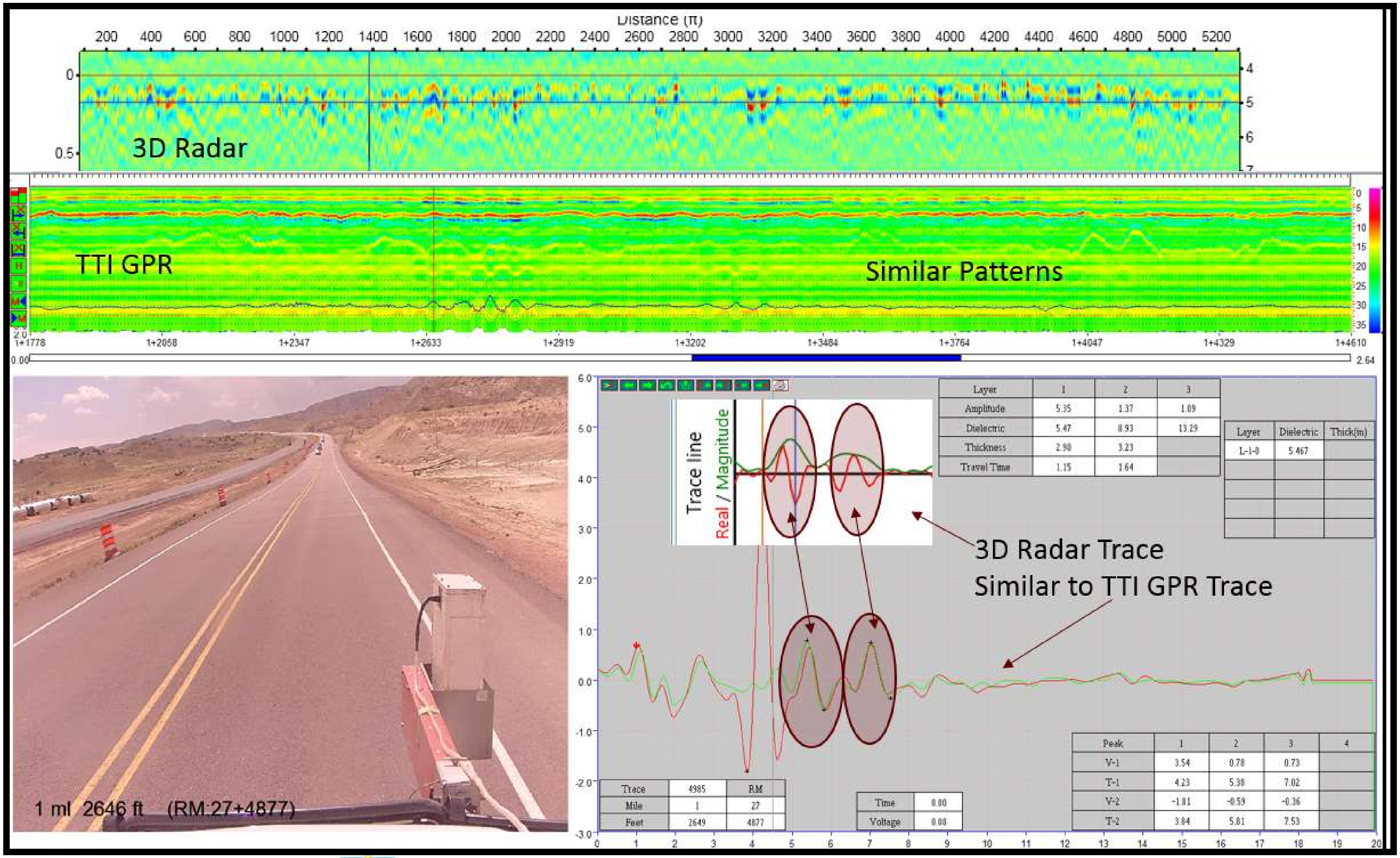
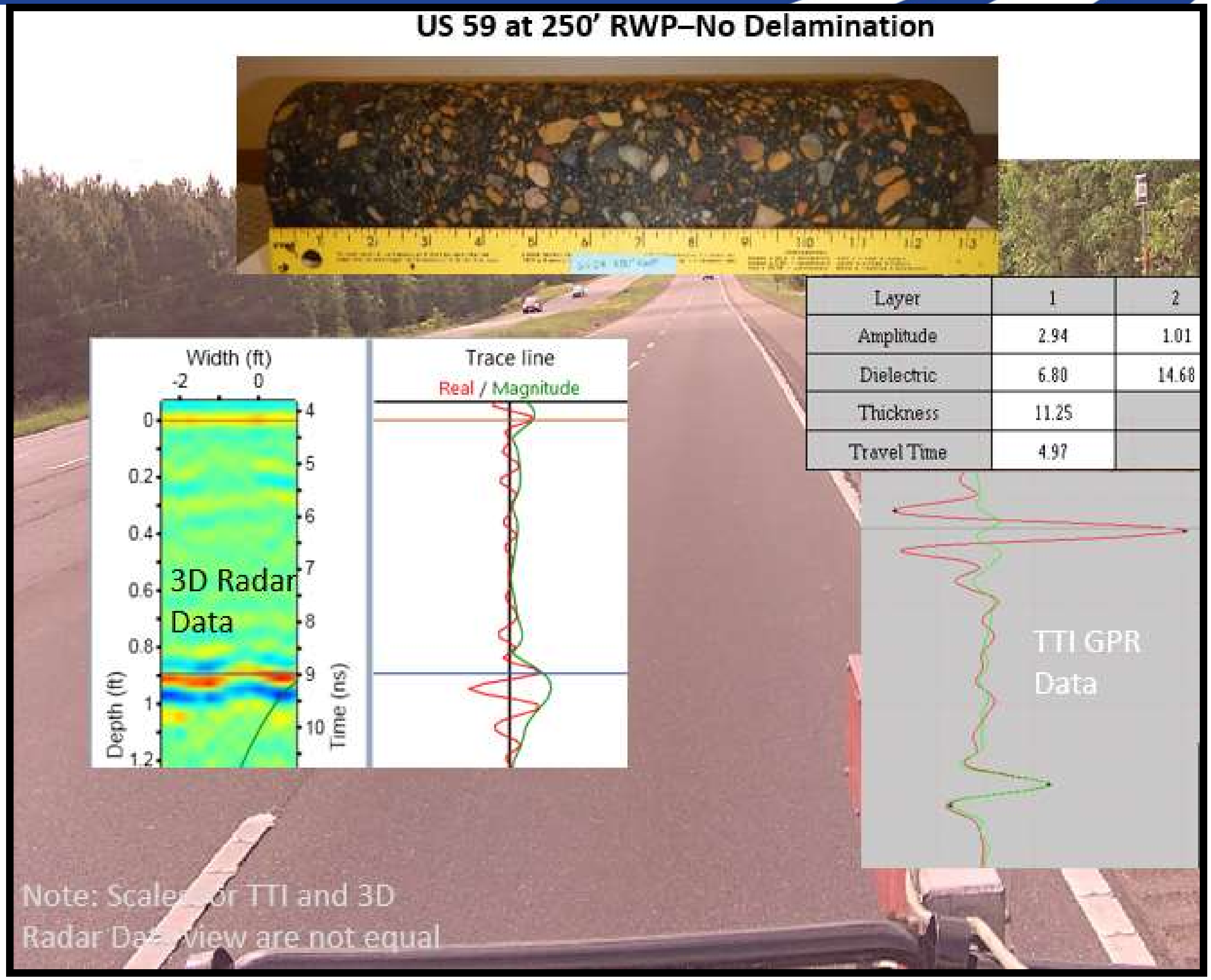
3D Radar Examiner Software



Comparison


Distance (ft)
3D Radar
TTI GPR
Similar Patterns
Trace line
Real / Magnitude
3D Radar Trace
Similar to TTI GPR Trace
1 mi 2646 ft (RM:27+4877)

Texas Core



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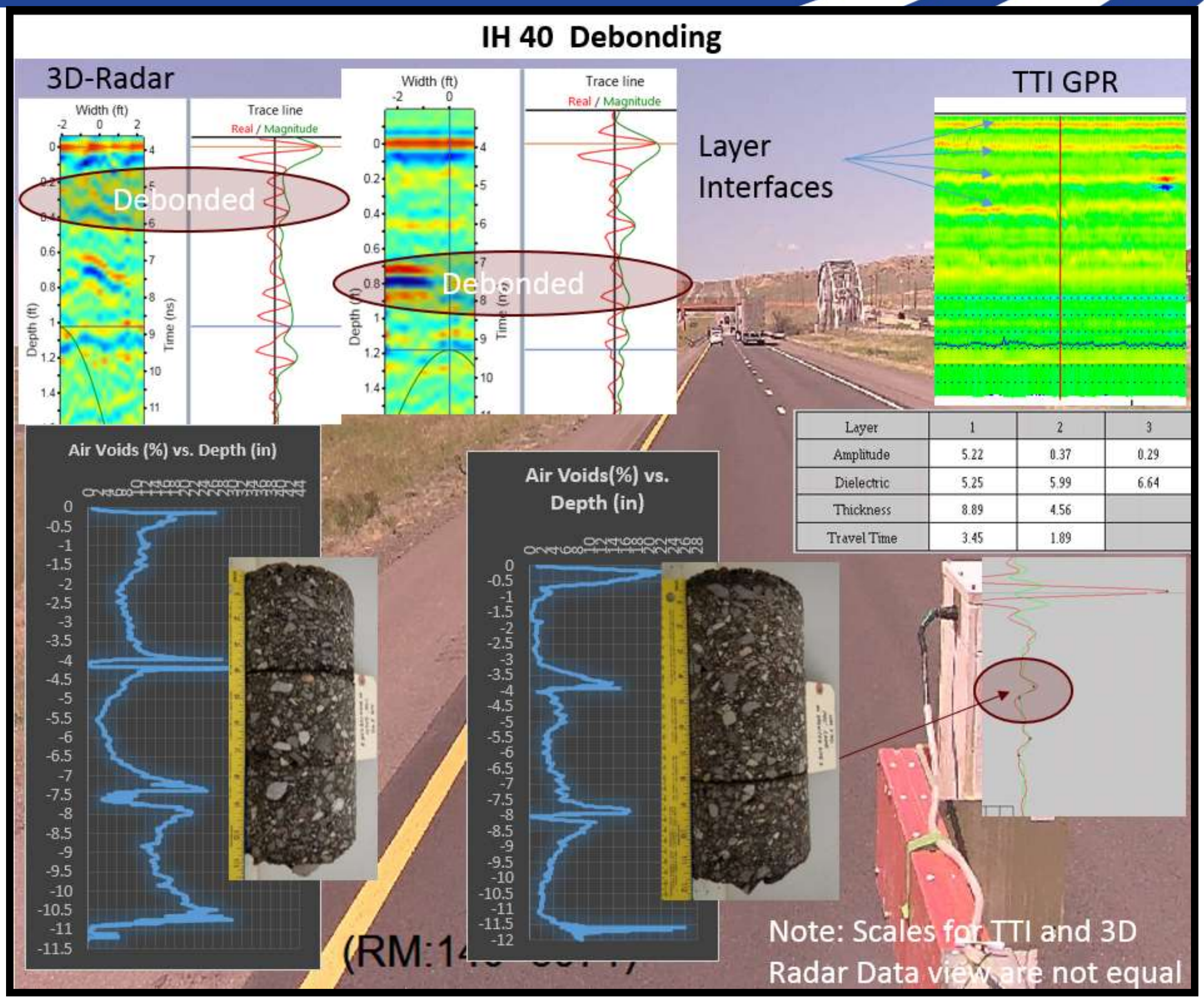
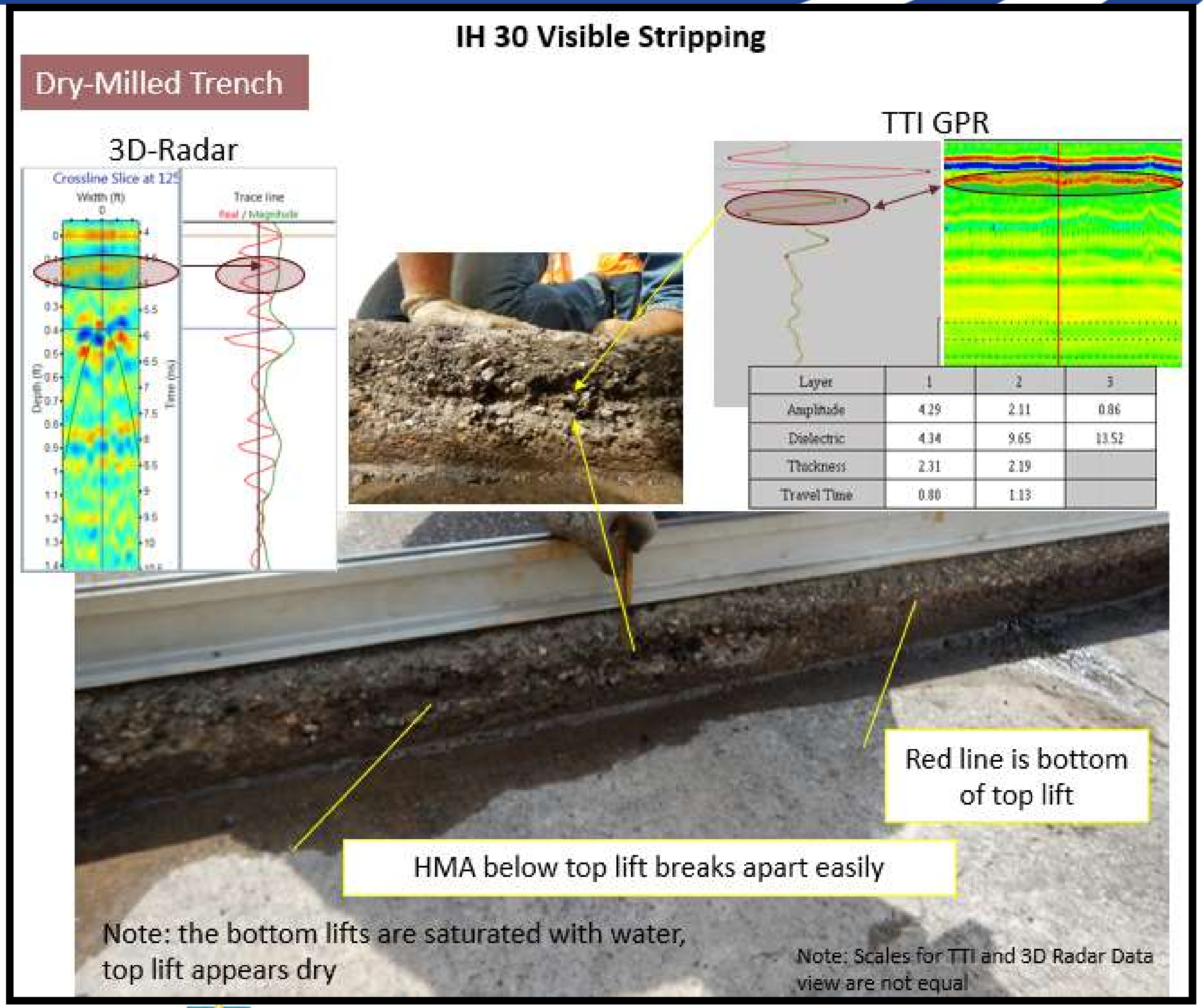
New Mexico Cores



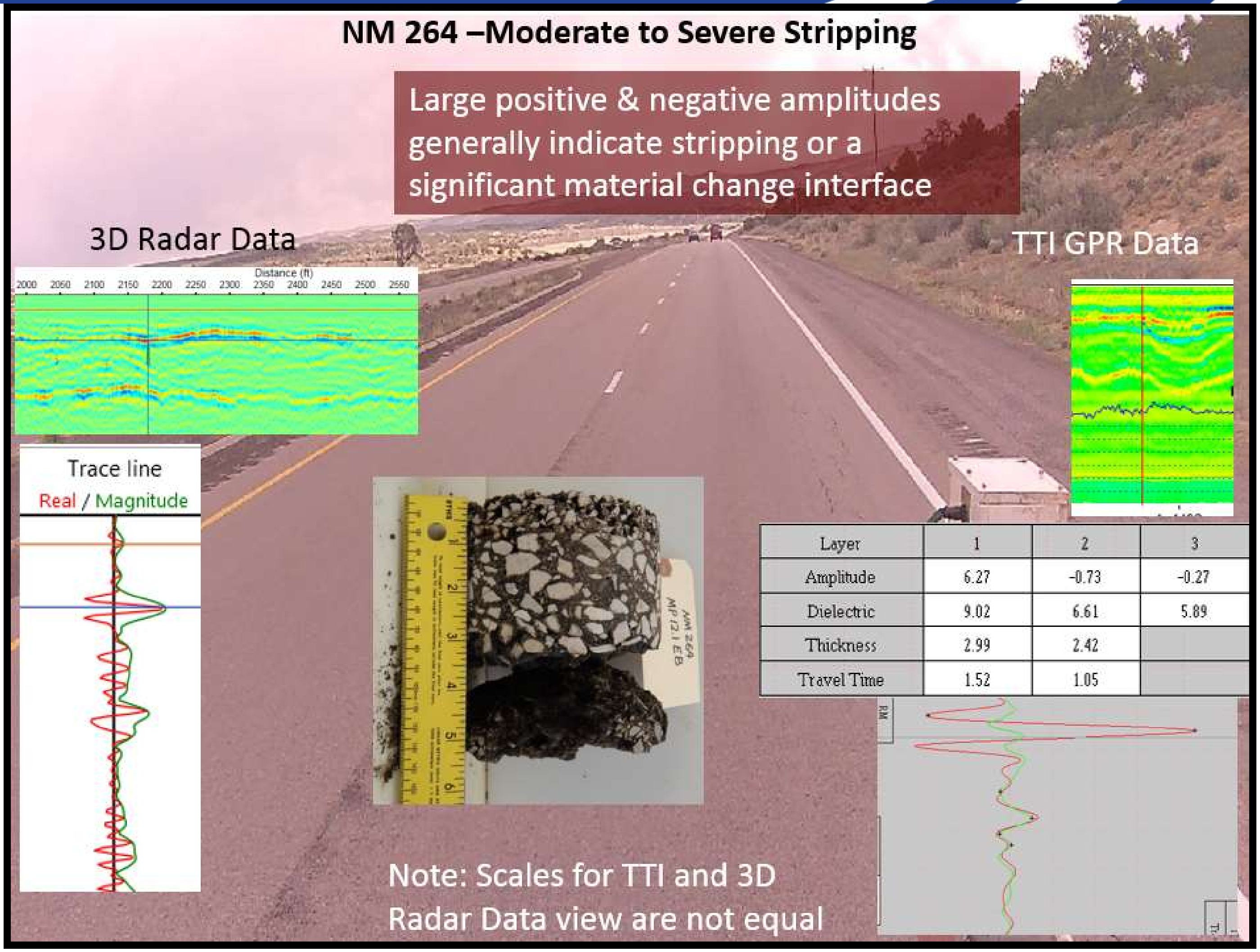
Layer	1	2	3
Amplitude	5.22	0.37	0.29
Dielectric	5.25	5.99	6.64
Thickness	8.89	4.56	
Travel Time	3.45	1.89	

Texas Trench Cut

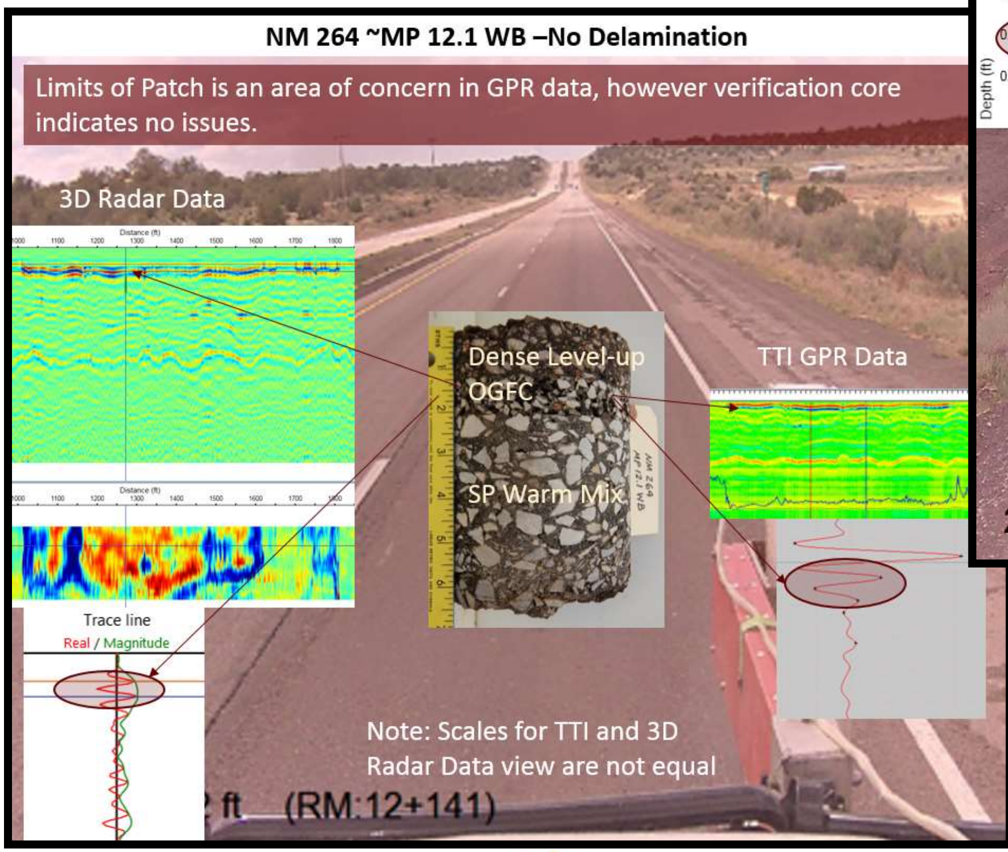


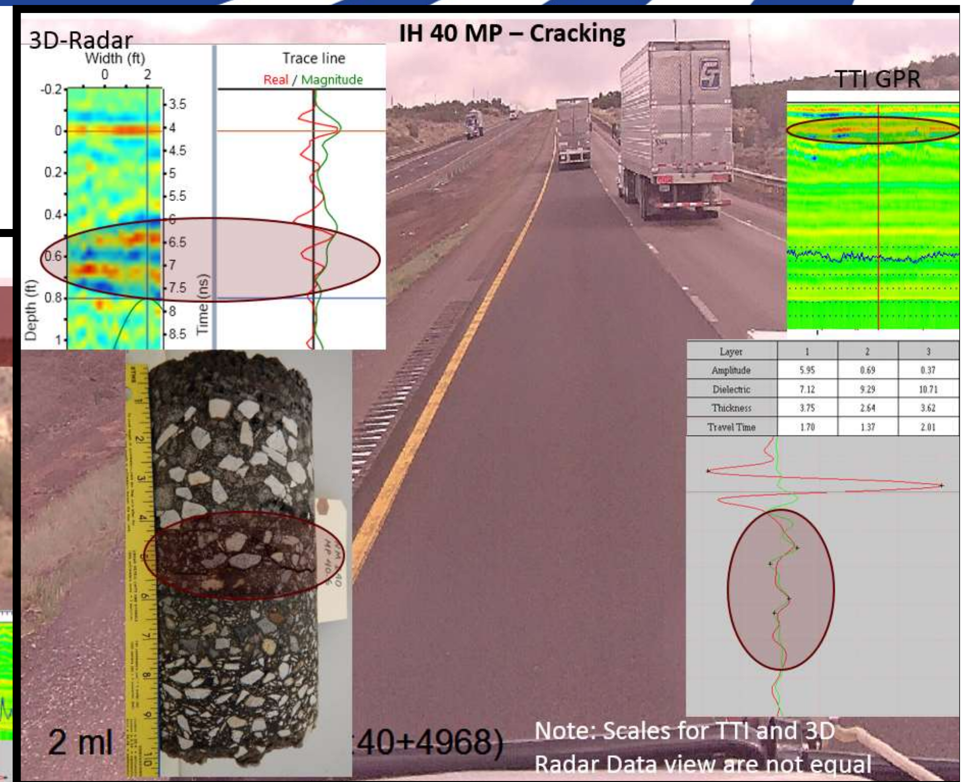
Layer	1	2	3
Amplitude	4.29	2.11	0.86
Dielectric	4.34	9.65	13.52
Thickness	2.31	2.19	
Travel Time	0.80	1.13	

New Mexico Core

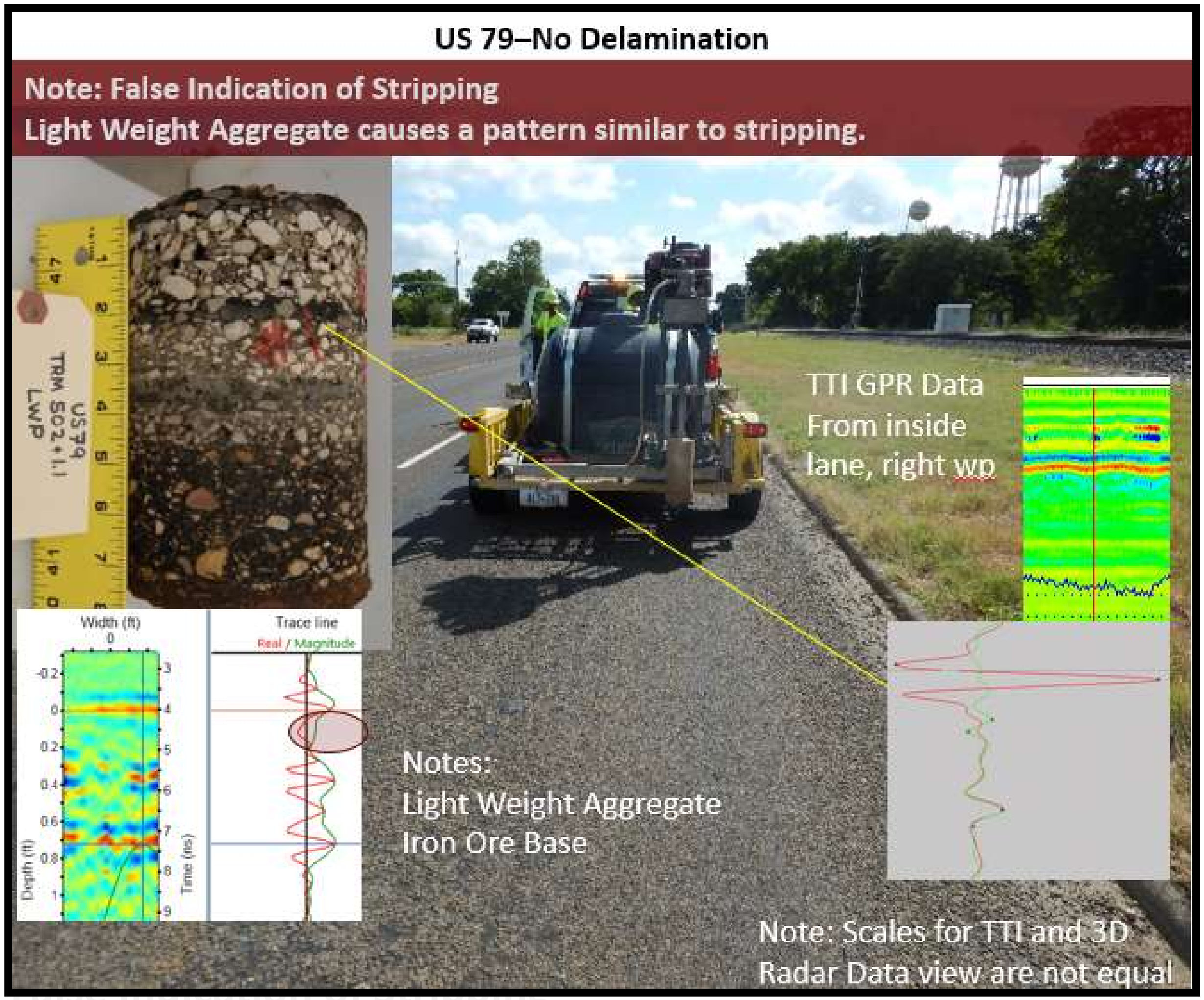


New Mexico Cores





Texas Cores


US 79–No Delamination
Note: False Indication of Stripping
Light Weight Aggregate causes a pattern similar to stripping.
TTI GPR Data
From inside
lane, right wp
Width (ft)
Trace line
Real / Magnitude
Depth (ft)
Time (ns)
Notes:
Light Weight Aggregate
Iron Ore Base
Note: Scales for TTI and 3D
Radar Data view are not equal

Overview

- In general the patterns follow the patterns we expect based on past experience.
  - The false patterns encountered, both in New Mexico and Texas, help justify the need to take verification cores.
- It is very difficult to distinguish between severity of deterioration/delamination.
  - While the patterns are similar, severe stripping tends to have much larger amplitude.
- Applications for Concrete Pavement
  - Dowel alignment (examples not discussed)
- Recommendations
  - Improve data storage efficiency for collection
  - Examiner Software
    - Integrate video/images
    - Calculate dielectric and layer thickness based on calculated dielectrics
  - Continue to evaluate the 3D Radar System

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Advanced Methods to Identify Asphalt Pavement Delamination (R06D) - GPR
California DOT Evaluation

Bill Owen
Chief, Geophysics and Geology Branch
CALTRANS

Webinar
June 28, 2018

U.S. Department of Transportation
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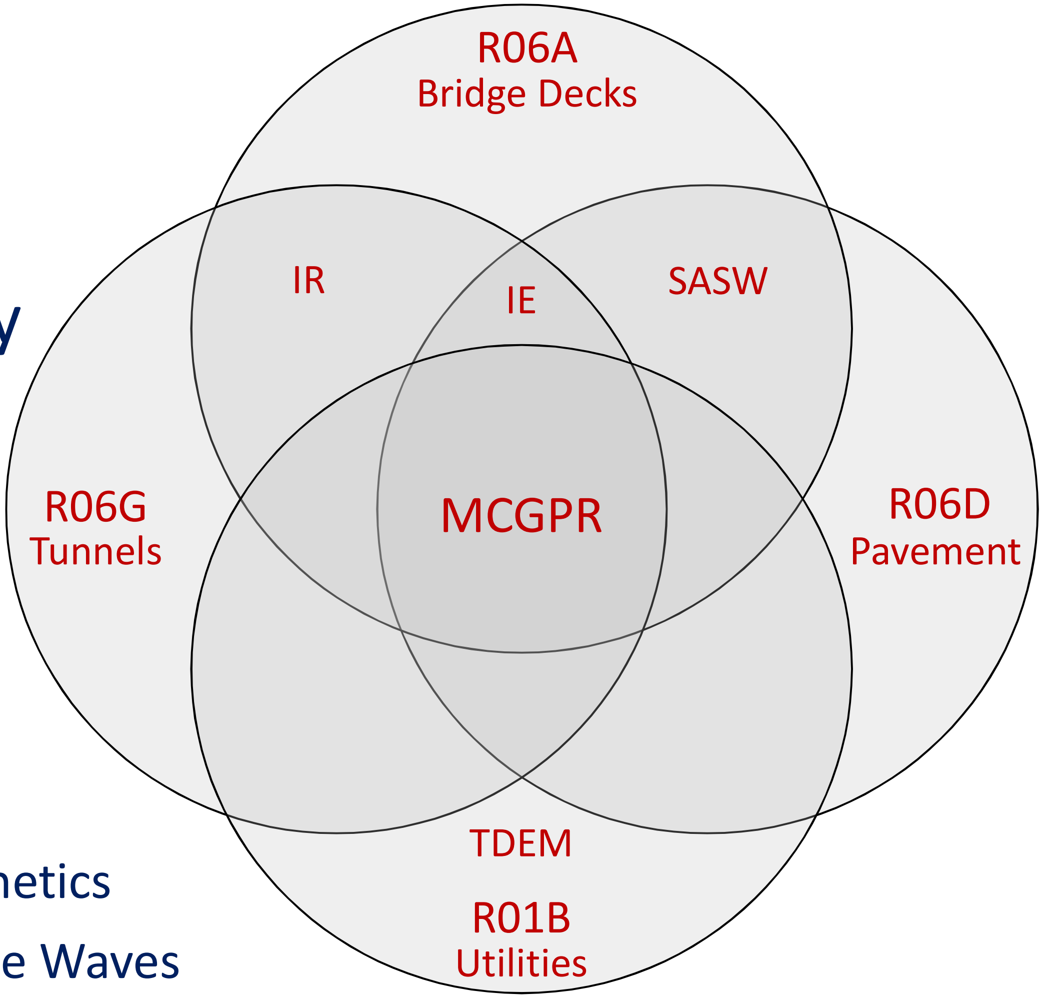
SHRP2 Technology Overlap

- No single grant provides full funding
- Leverage multiple grants for technology acquisition



IE – Impact Echo

IR – Infrared (Thermal Imaging)

TDEM – Time Domain Electromagnetics

SASW – Spectral Analysis of Surface Waves

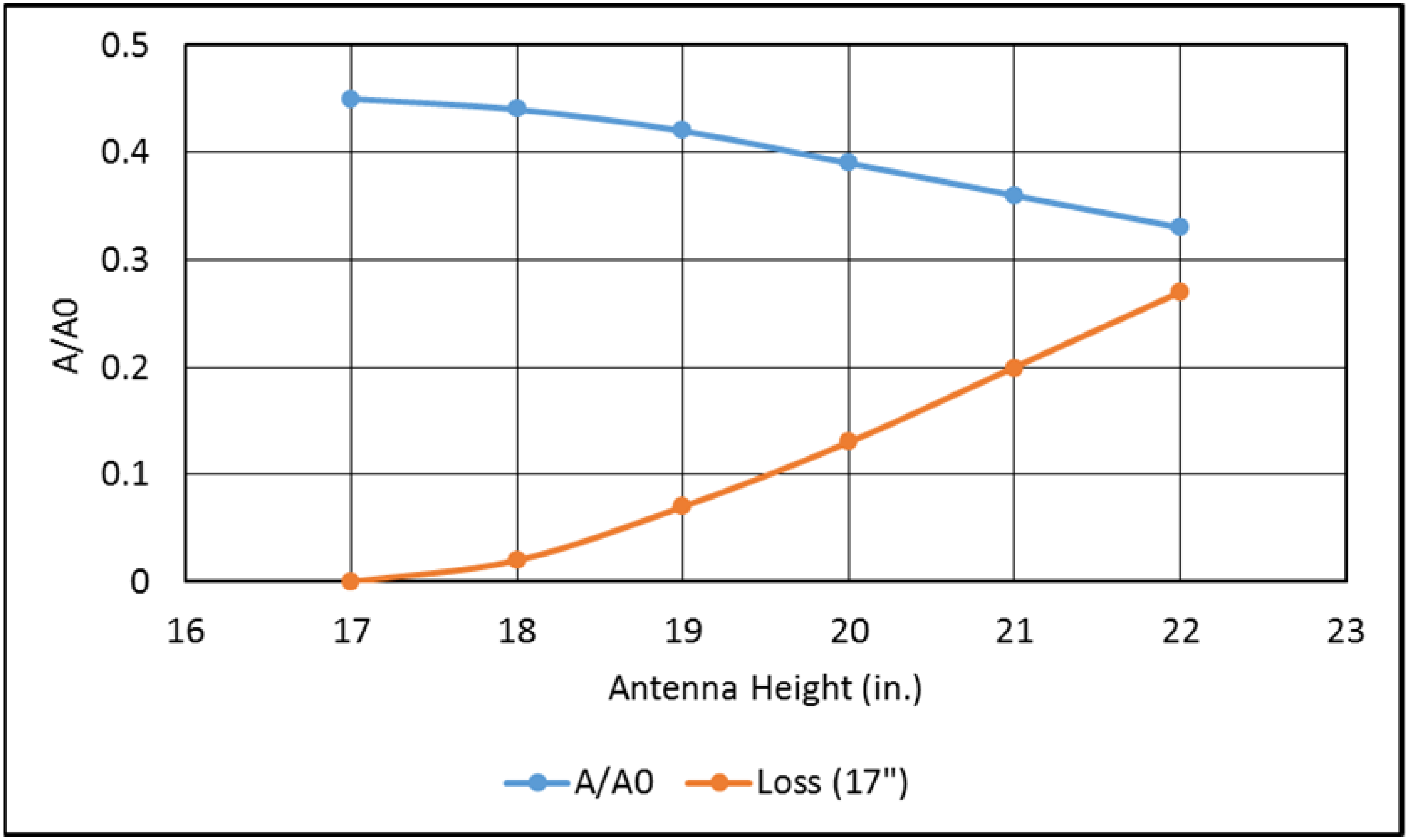
MCGPR – Multichannel Ground Penetrating Radar

3D Radar Implementation

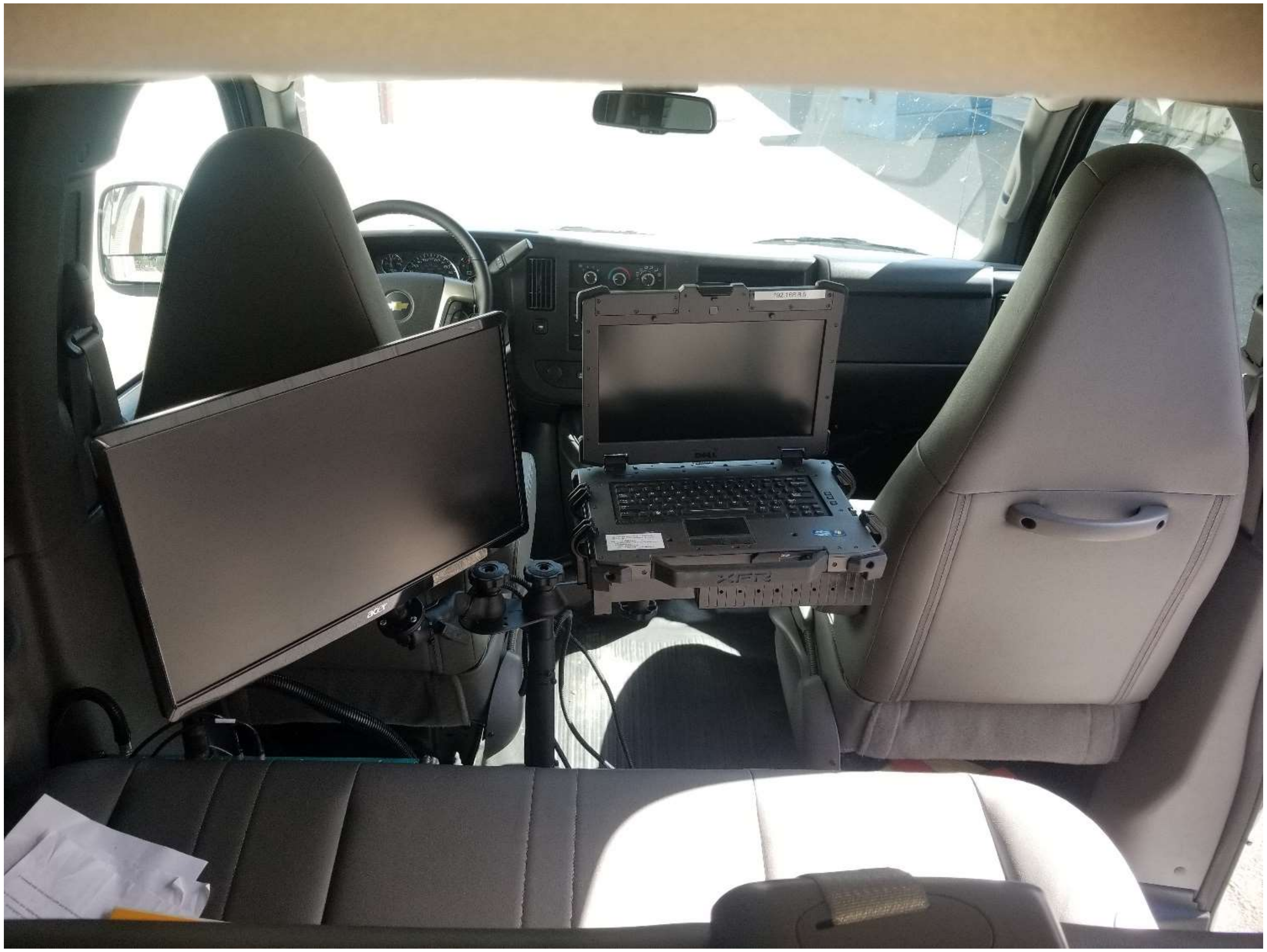
- Collaboration at State & National Level
  - Funding through FHWA & AASHTO
  - Design and Fabrication through CT-GS and CT-DOE
  - Installation and Testing through CT-GS and UC Davis
- Implementation Challenges
  - Short Delivery Schedule
  - Rigid Mounting System
  - Reliable Power Supply
  - I/O From Multiple Data Streams

Caltrans 3D Radar Van

Energy Loss vs. Antenna Height



3D Radar Van, Interior



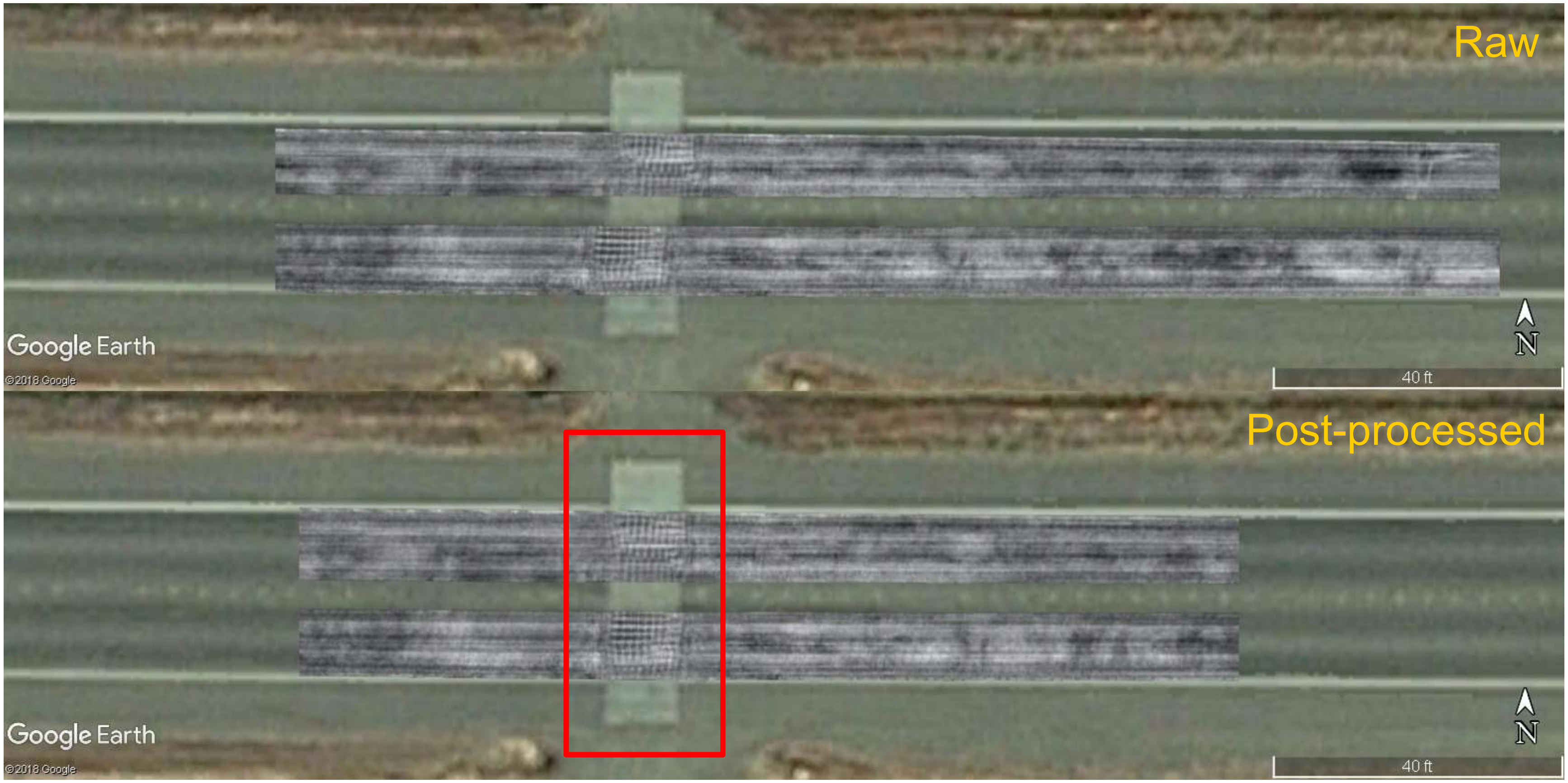
3D Radar Van, Field Trials

POS LV - GNSS Aided Inertial Navigation

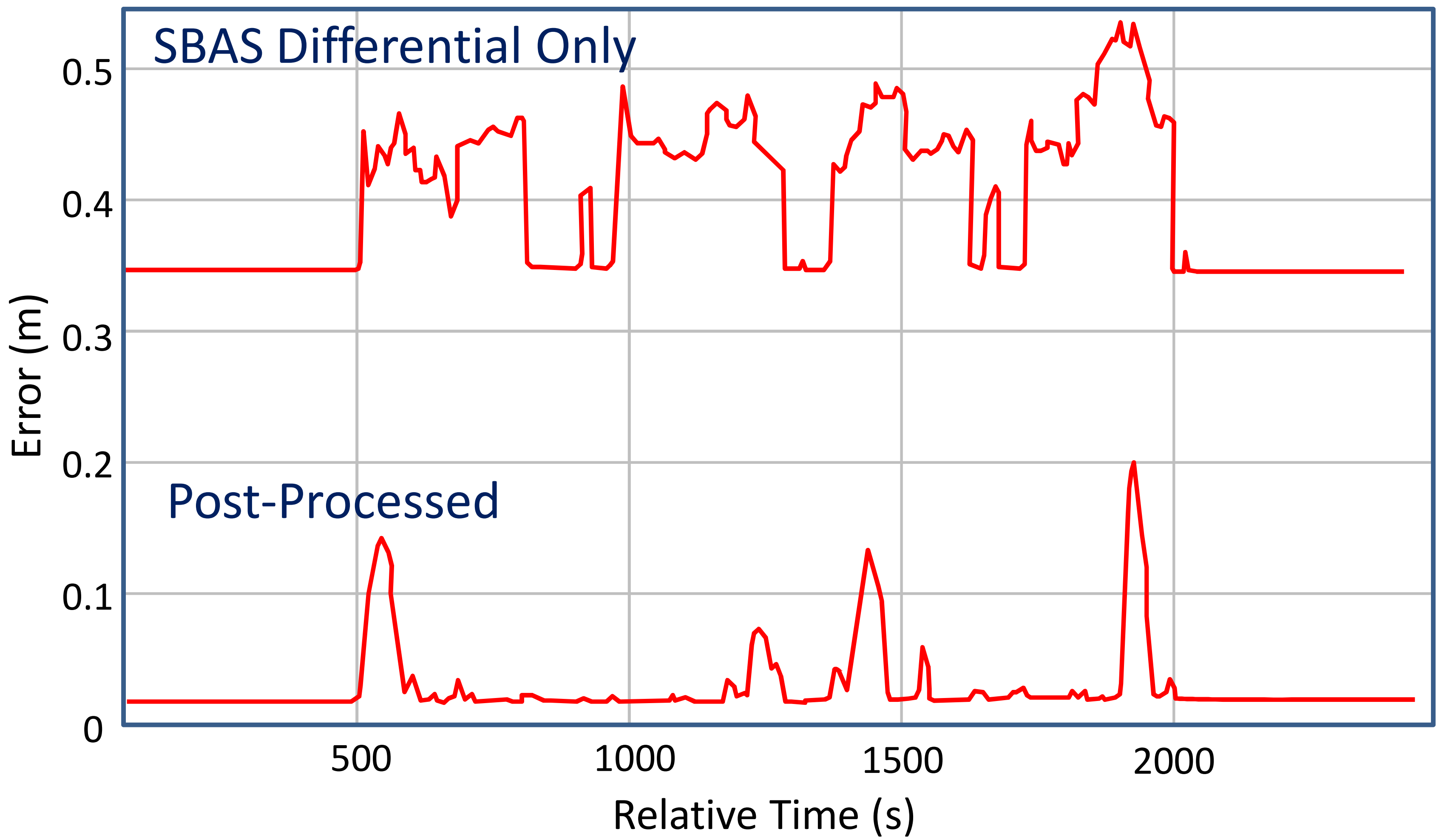
- Dual Antenna GNSS
  - position, attitude & heading
- Three-axis IMU
  - Accelerometer & gyroscope
  - 100 Hz output
- DMI Odometer
  - Up to 20,000 pulse/m
- Integrated processor
- PC interface
  - Real-time output
  - User parameter controls

https://www.applanix.com/img/gallery/pos_lv_imu_ant_dmi.png

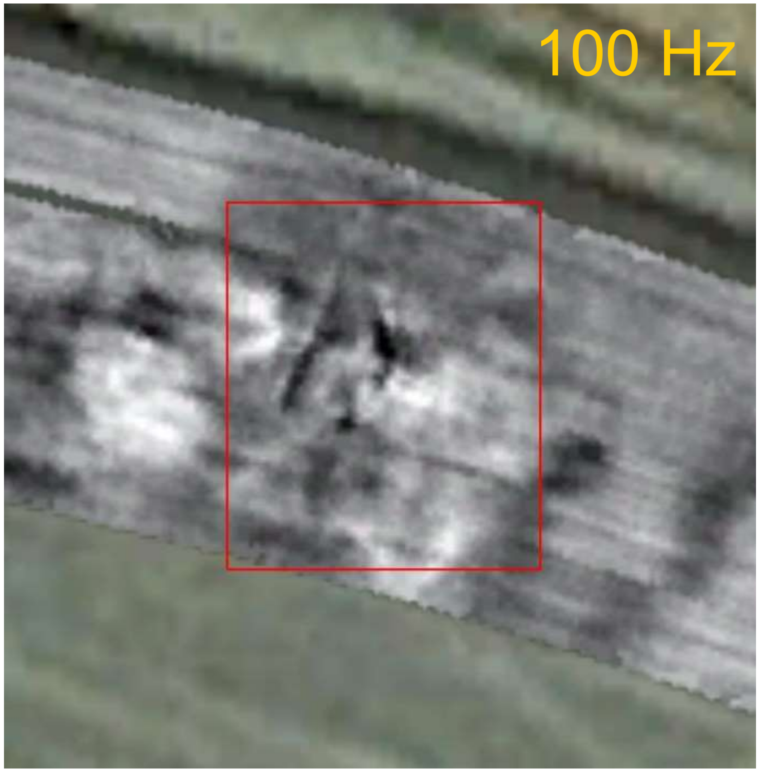
Examiner Image Correction
50 MPH



GNSS Post-Processing



Examiner Image Quality vs. Position Sample Rate



Acknowledgements

- FHWA/AASHTO
- National Center for Asphalt Technology
- University of California, Davis
  - ✓ Advanced Highway Materials Research Center
- 3D Radar
- Applanix
- California Department of Transportation
  - ✓ Division of Equipment
  - ✓ Office of Land Surveys
  - ✓ Pavement Program
  - ✓ Geophysics and Geology Branch

SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Advanced Methods to Identify Asphalt Pavement Delamination (R06D) - GPR

Minnesota DOT Evaluation: Calibration

Kyle Hoegh
Research Scientist
MnDOT

Webinar
June 28, 2018

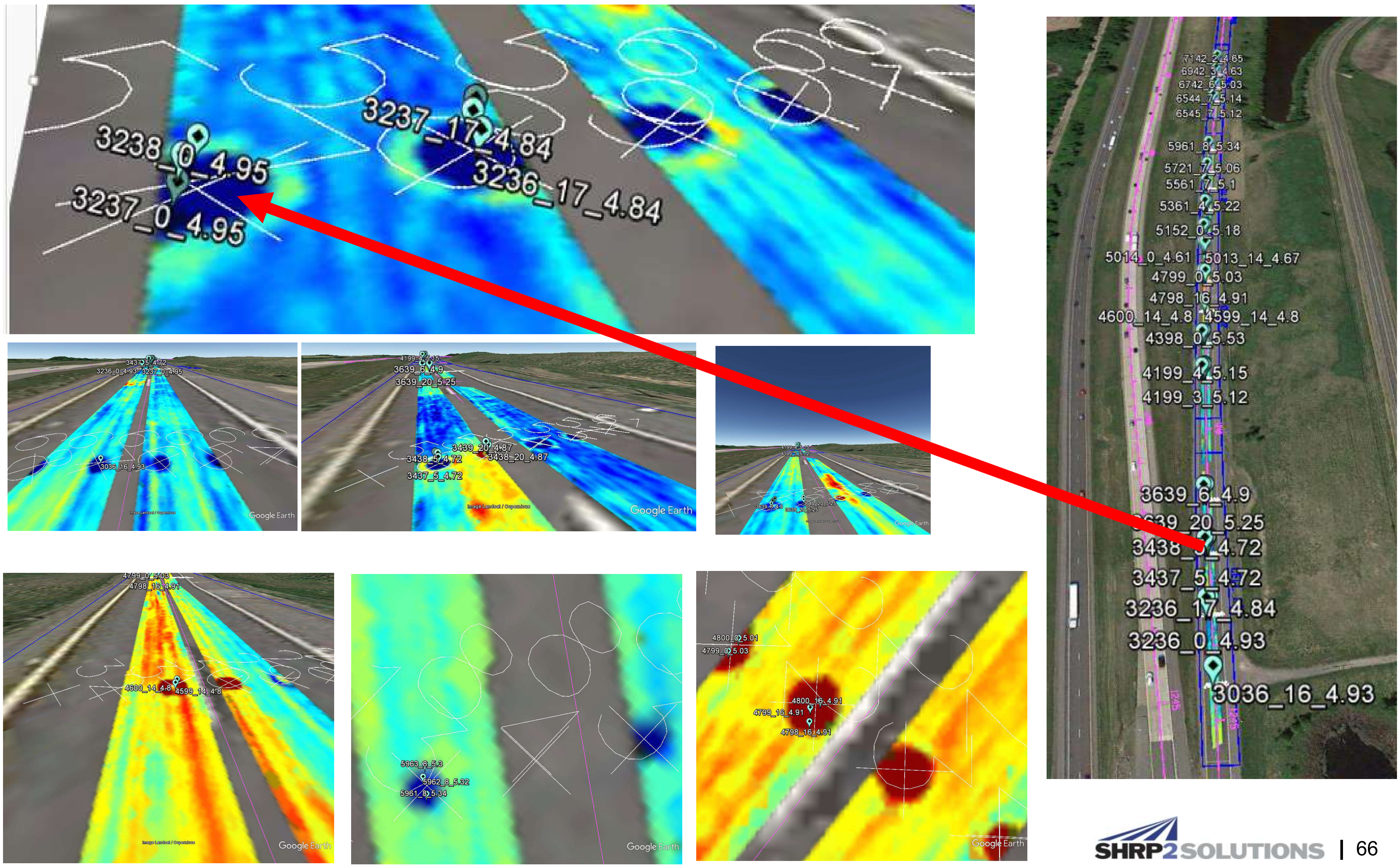
U.S. Department of Transportation
Federal Highway Administration

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO

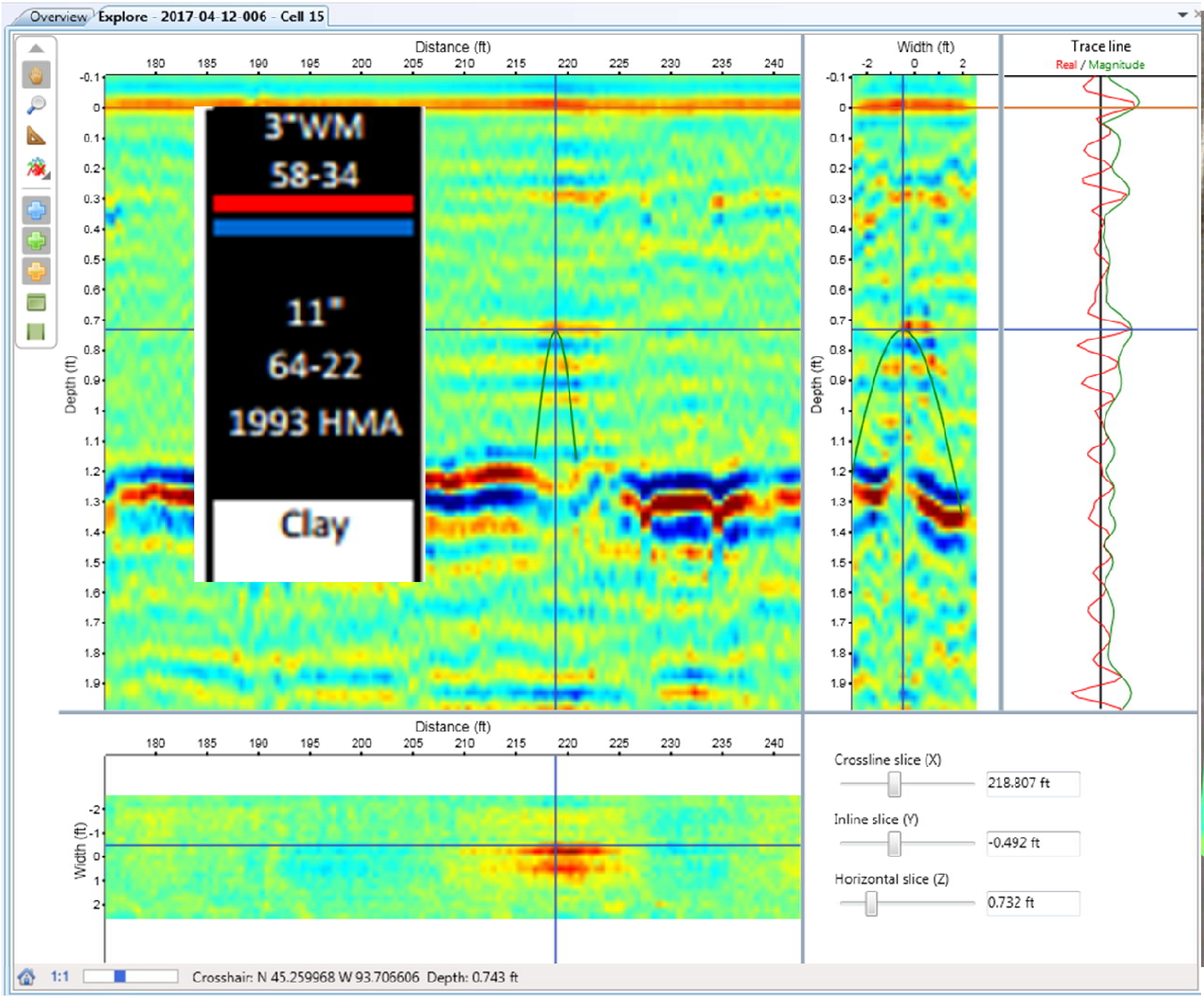
Calibration/Validation Topics

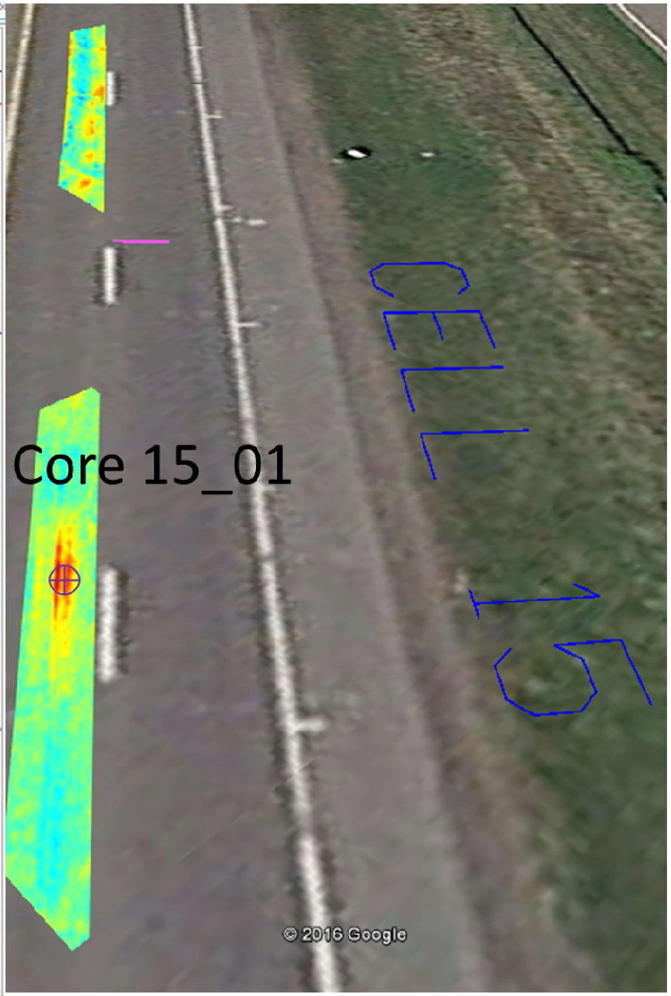
- Highway Speed GPS accuracy (MnROAD)
- Controlled Laboratory Tests (Metal Plate and HDPE plastic)
  - Sampling Rate
  - Metal Calibration
  - Air Calibration

Highway Speed GPS accuracy (MnROAD)

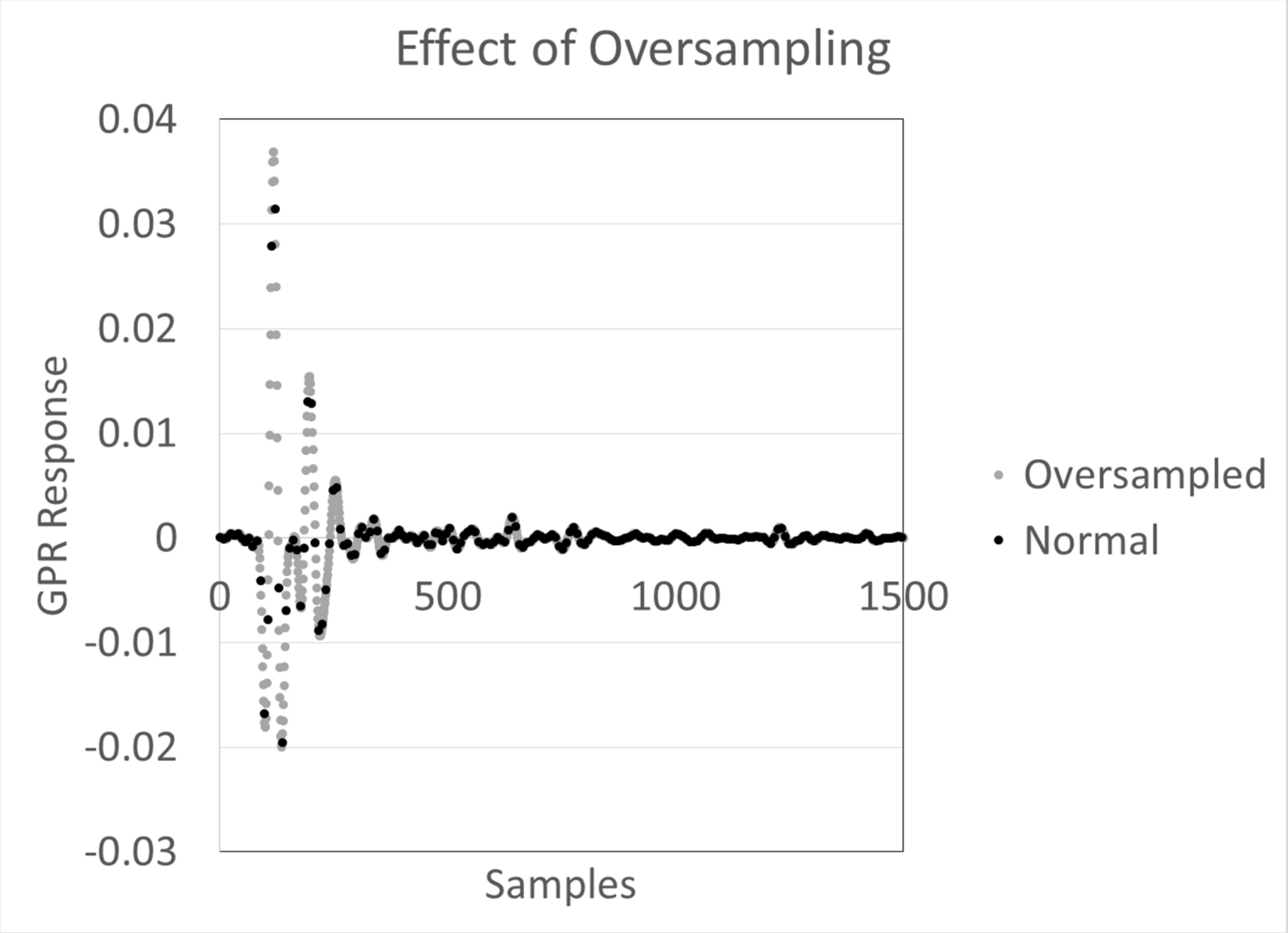


GPS accuracy: Implications for Implementation

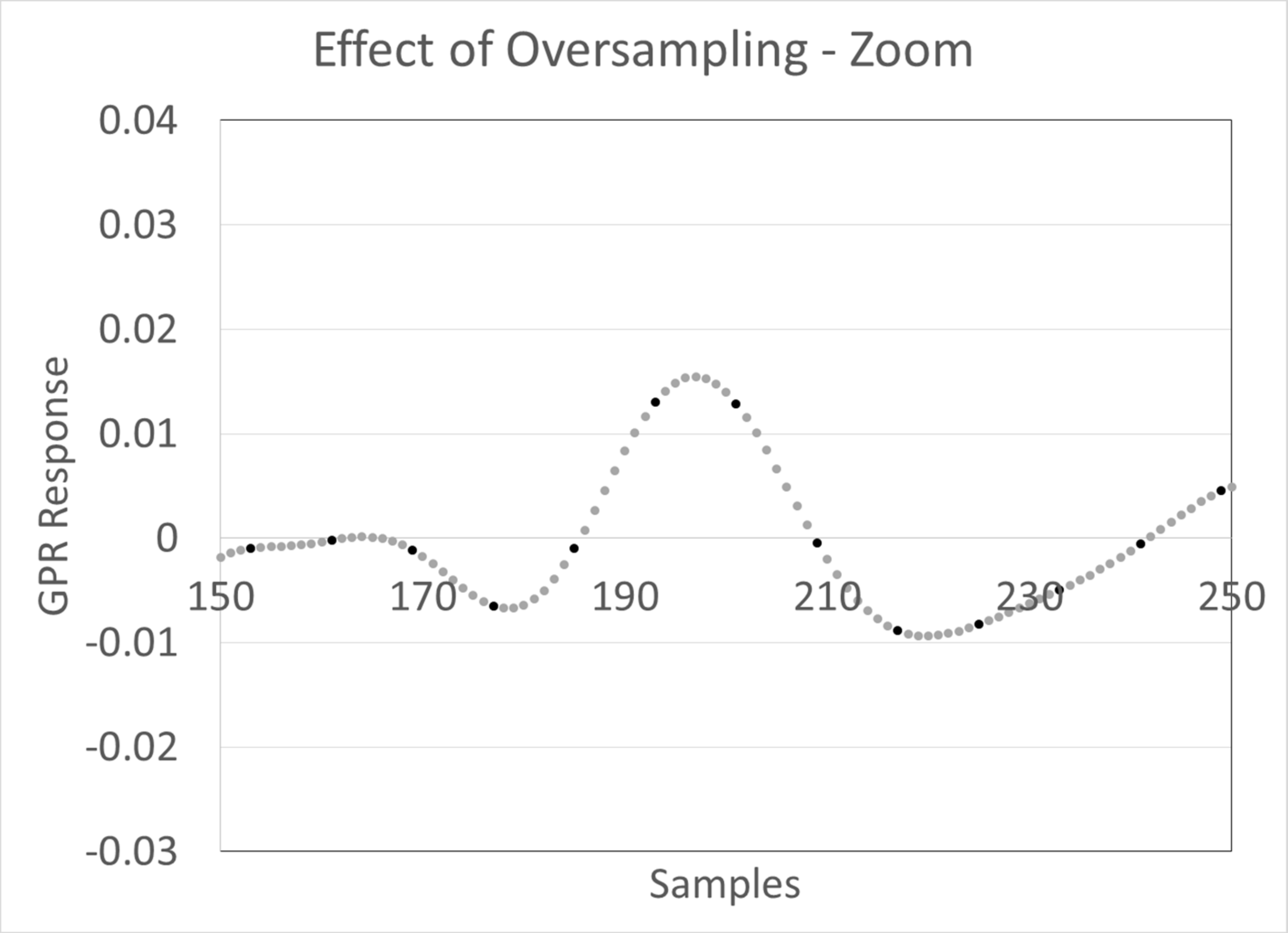




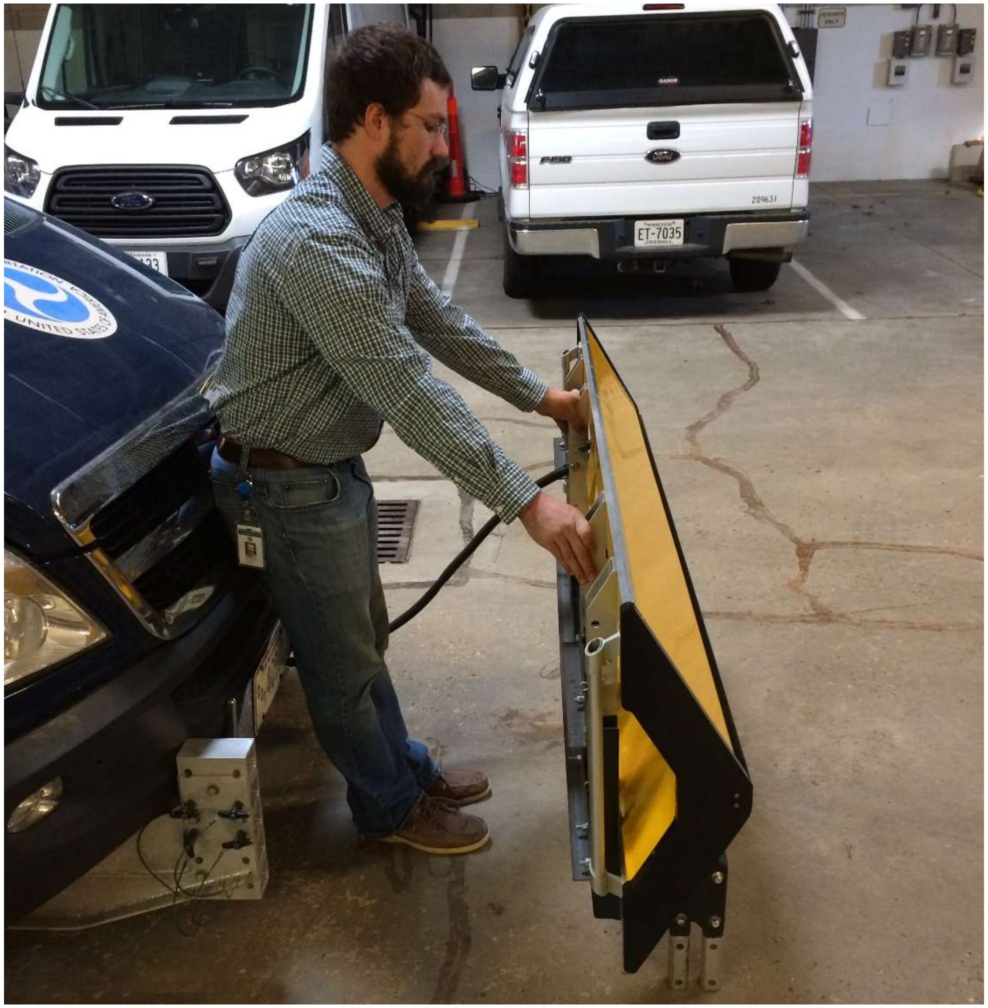
Controlled Laboratory Tests: Sampling Rate



Controlled Laboratory Tests: Sampling Rate



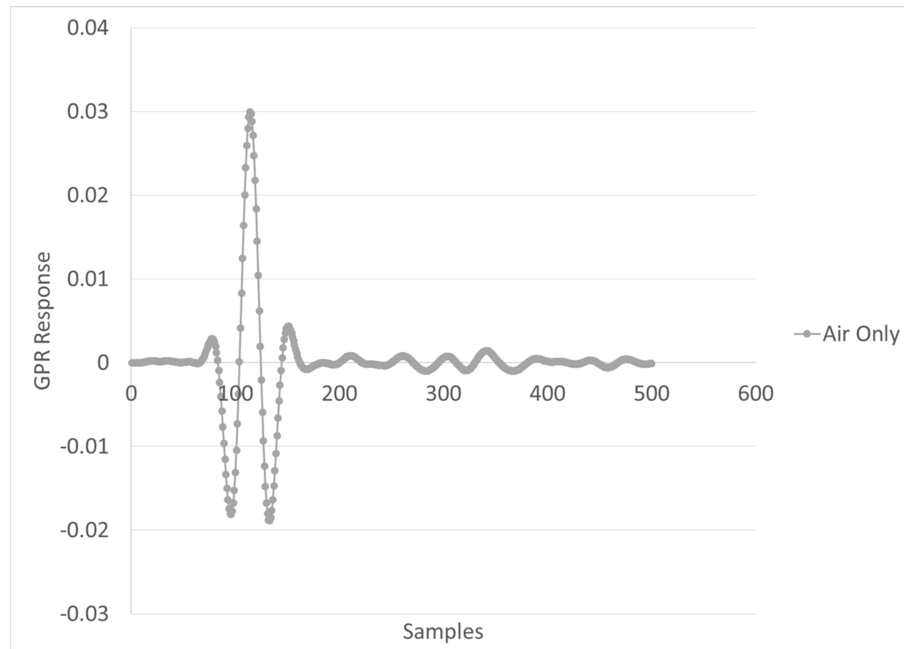
Controlled Laboratory Tests: Air Calibration



Extract "Air Wave"

– Face antenna away from the surface

– Eliminate portion of the signal that is only affected by the antenna

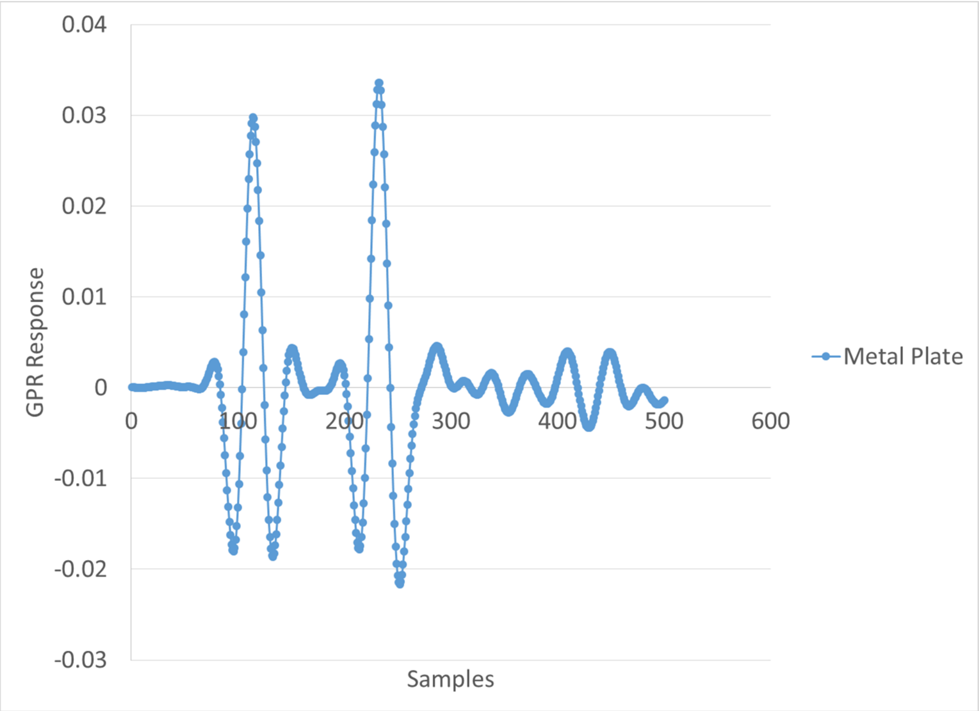


Controlled Laboratory Tests: Metal Calibration

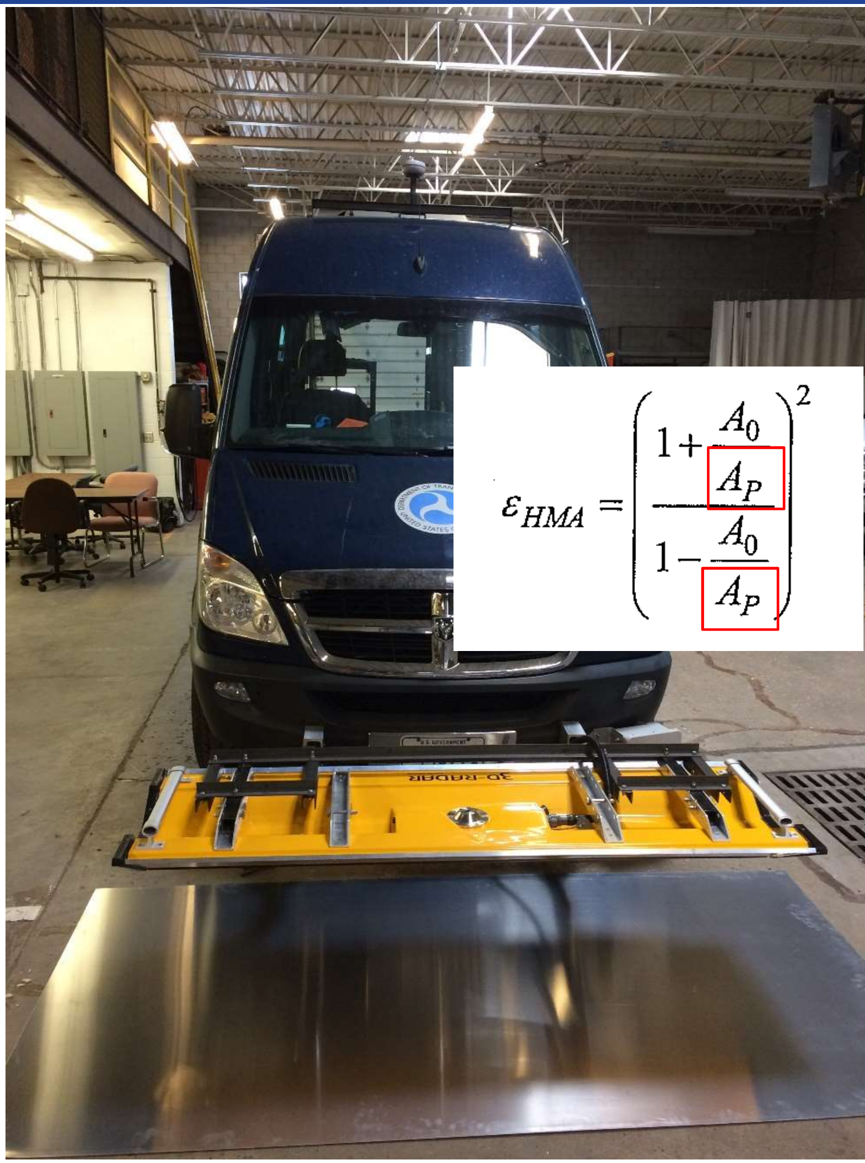
4'x8' Metal Surface Reflection Amplitude

– Placed in the center of the antenna array

– Use the amplitude of the surface reflection to characterize the signal magnitude



Controlled Laboratory Tests: Metal Calibration

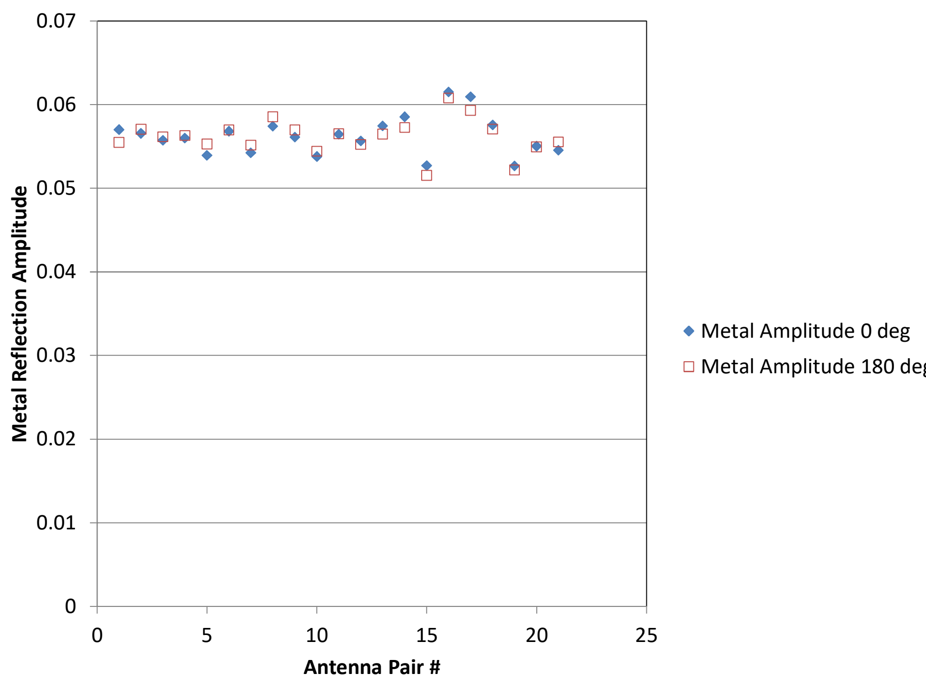


$$\varepsilon_{HMA} = \left(\frac{1 + \frac{A_0}{A_P}}{1 - \frac{A_0}{A_P}} \right)^2$$

4'x8' Metal Surface Reflection Amplitude

– Placed in the center of the antenna array

– Rotated 180 degrees and placed in the center of the antenna array



Controlled Laboratory Tests: HDPE Plastic

HDPE Surface Reflection Amplitude

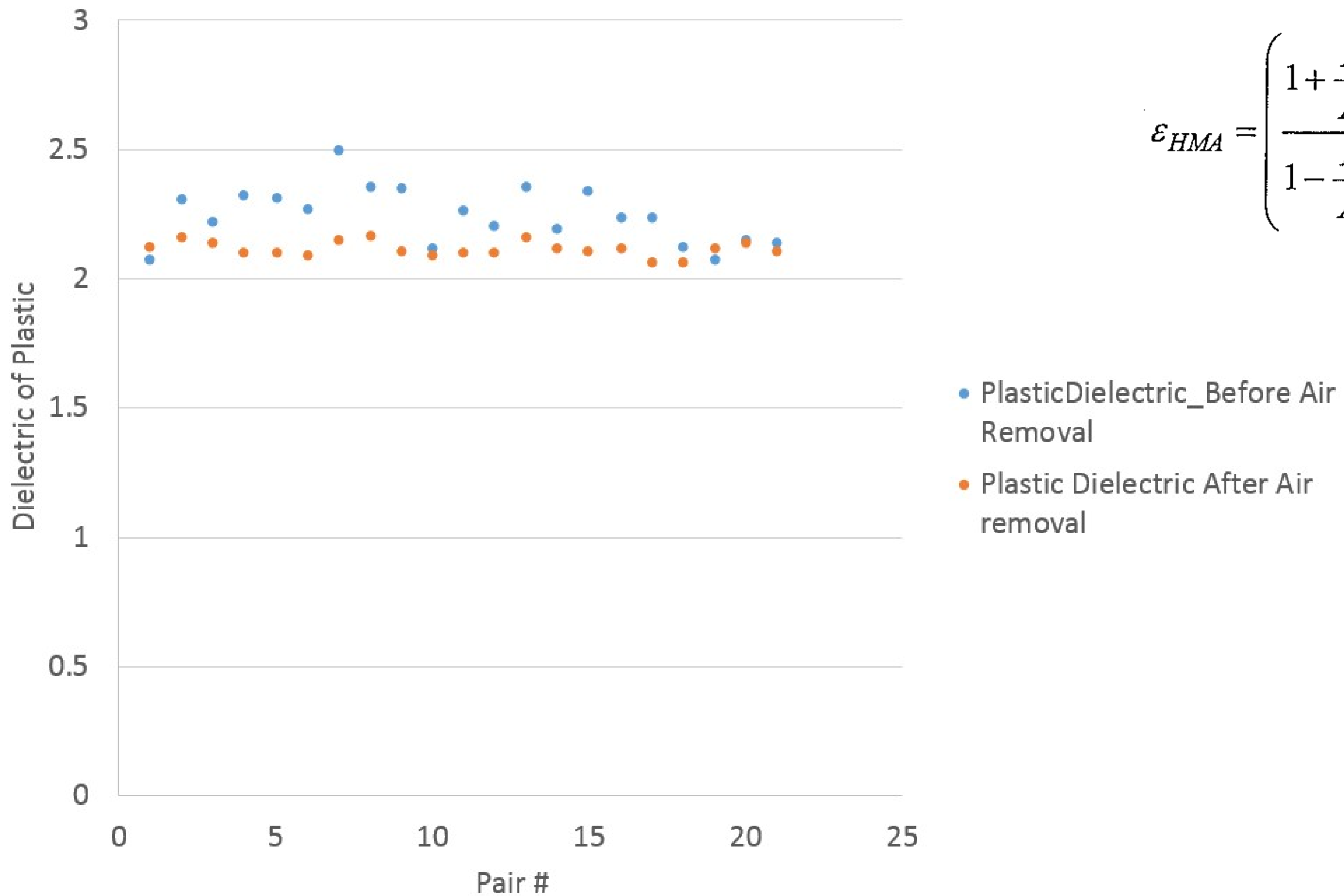
– Plastic Sheet (HDPE) Calibration

– Manufacturer Dielectric Listed: 2.30

– Known Dielectric can be used to evaluate effectiveness of air, metal, and oversampling calibrations

$$\varepsilon_{HMA} = \left(\frac{1 + \frac{A_0}{A_P}}{1 - \frac{A_0}{A_P}} \right)^2$$

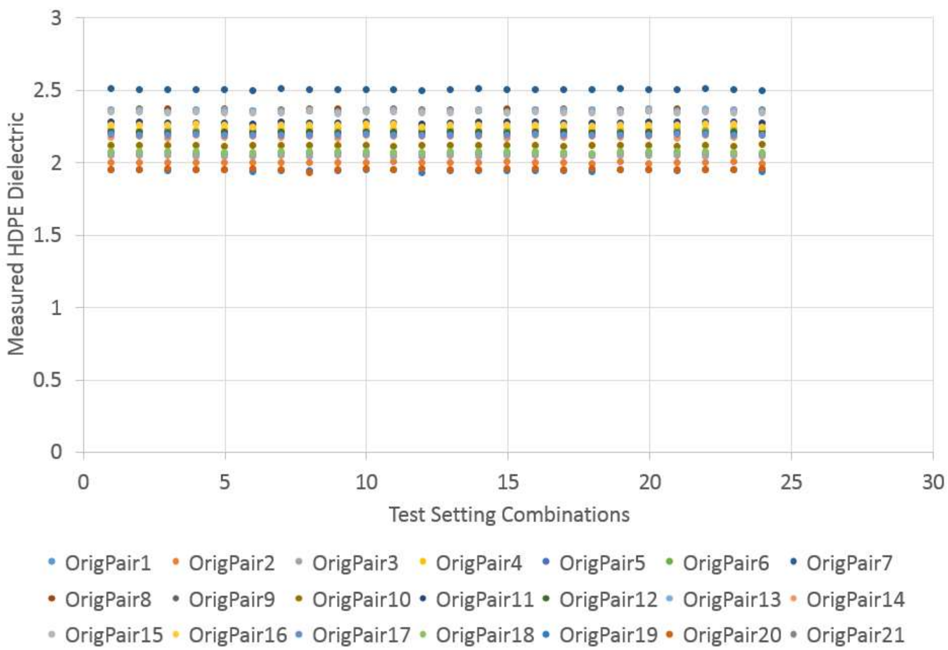
Controlled Laboratory Tests: HDPE Plastic Dielectric



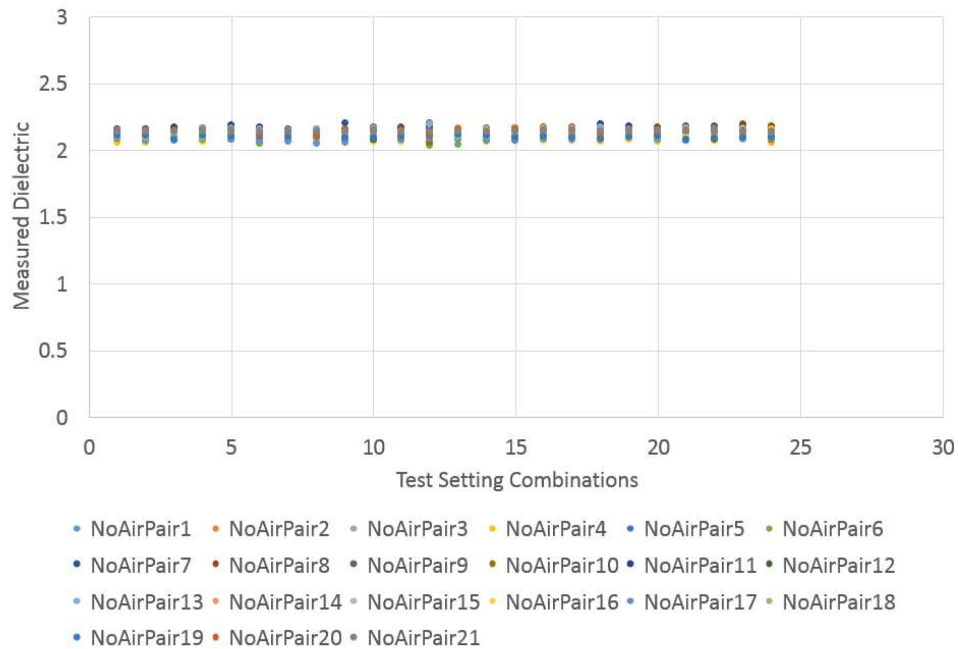
$$\varepsilon_{HMA} = \left(\frac{1 + \frac{A_0}{A_P}}{1 - \frac{A_0}{A_P}} \right)^2$$

Controlled Laboratory Tests: HDPE Plastic Dielectric Test

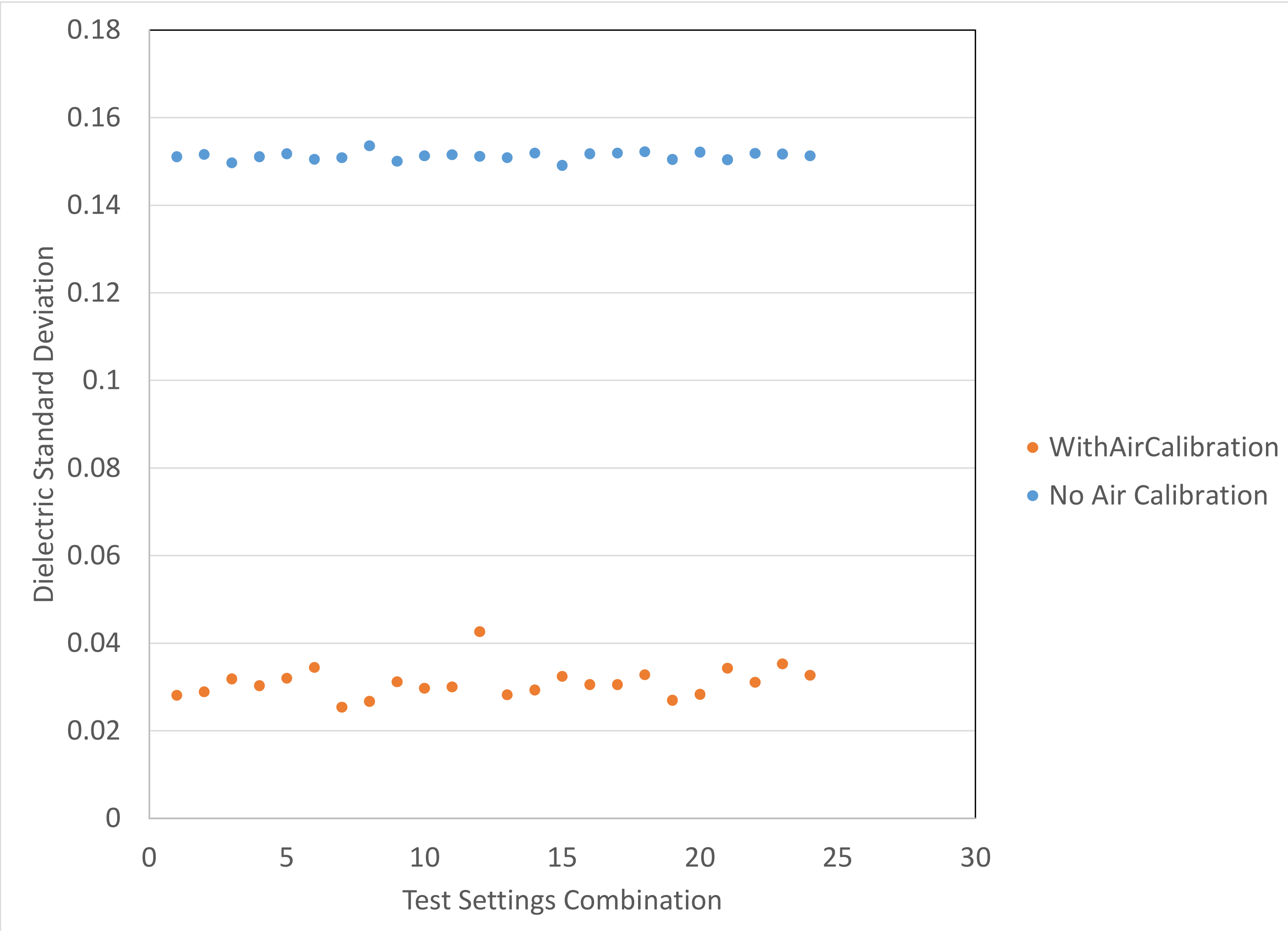
Prior to air calibration



After air calibration



Controlled Laboratory Tests: HDPE Plastic Dielectric Test



Calibration Result Implications

- 3D Radar equipment can integrate the GPS with the GPR data with high accuracy even at highway speed
  - Useful to integrate an external GPS connected to a virtual reference station or other correction method to get full potential of equipment
  - This allows for selection of validation cores fully based on GPS data
  - Improved accuracy and efficiency of selecting core validation locations
- Incorporation of oversampling, metal, and air calibration into analysis can improve 3D radar signal
  - 3D Radar is working on incorporating some of these calibration options, but none are currently available in examiner and require outside analysis.
  - Oversampling can improve digital representation of the true analogue signal which is important for amplitude calculations and filtering technique applications
  - Metal and air calibrations are critical to addressing antenna to antenna variation and reducing signal noise

SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Advanced Methods to Identify Asphalt Pavement Delamination (R06D)

Advances in GPR Signal Analysis

Shongtao Dai, PE, PhD
Research Operations Engineer
MnDOT

Webinar
June 28, 2018

U.S. Department of Transportation
Federal Highway Administration

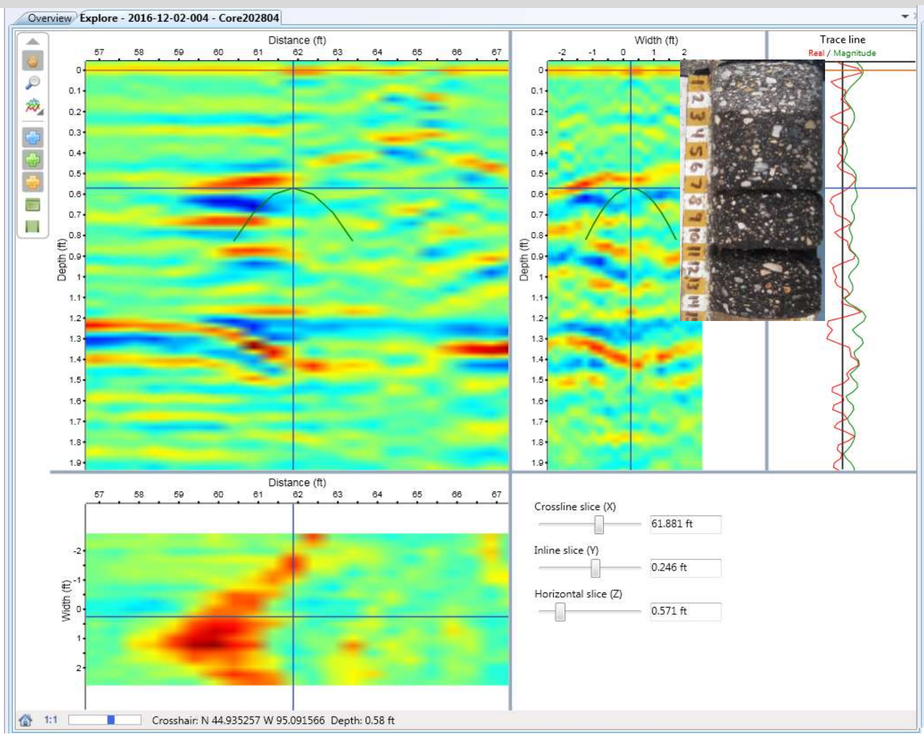
American Association of State Highway and Transportation Officials
AASHTO

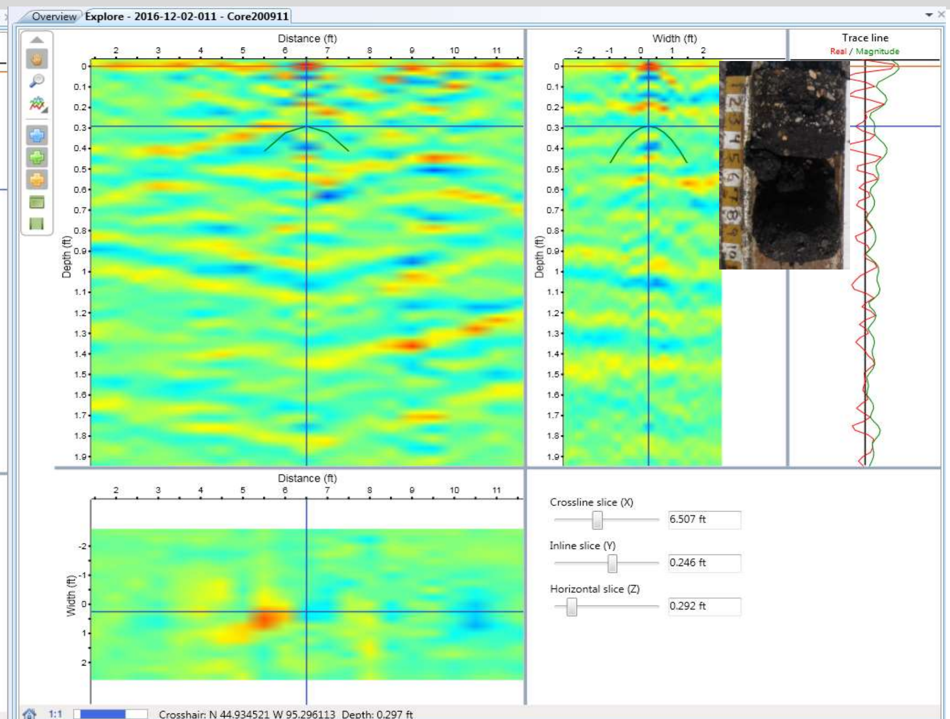
Acknowledgment

FHWA/SHRP2 (3D GPR equipment and funding)
3D Radar
NCAT
MnDOT District Offices

Using GPR to Detect Potential Stripping

- Looking at GPR images
  - Very subjective to the person analyzing the image
  - Time-consuming and labor intensive
- GPR can not definitively identify stripping

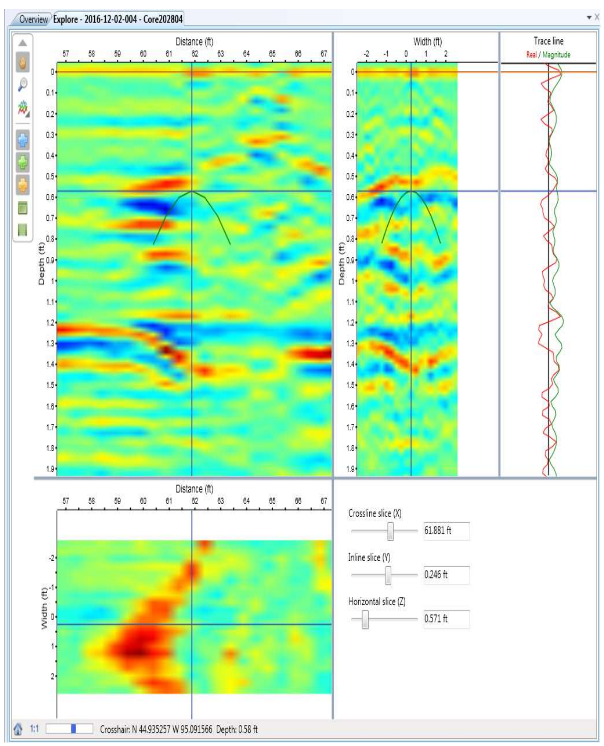


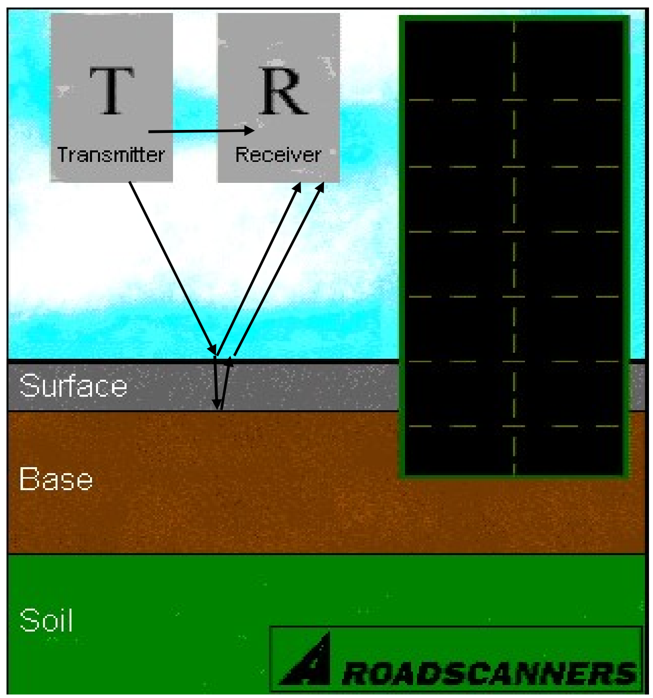


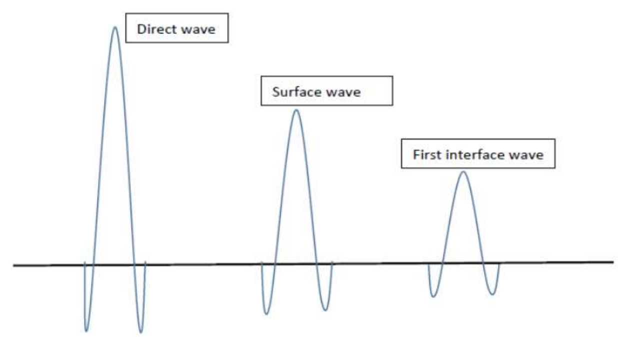
Concept of Signal Analysis

- ❑ **GPR image consists of a lot of time-history waveforms**
- ❑ **Each waveform contains some information about the pavement**

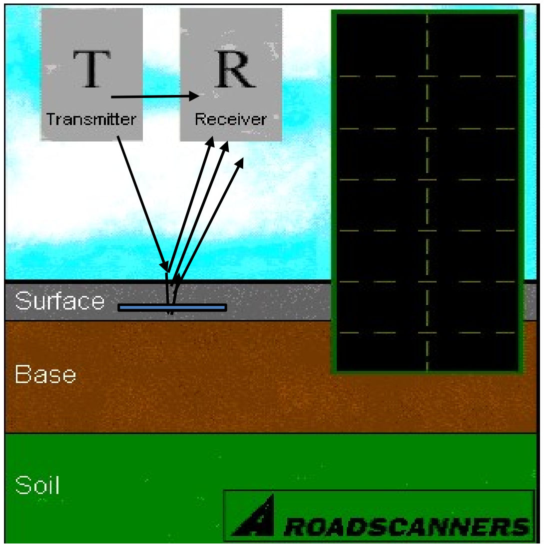
❑ **A Perfect (homogenous and uniform) Layered System**

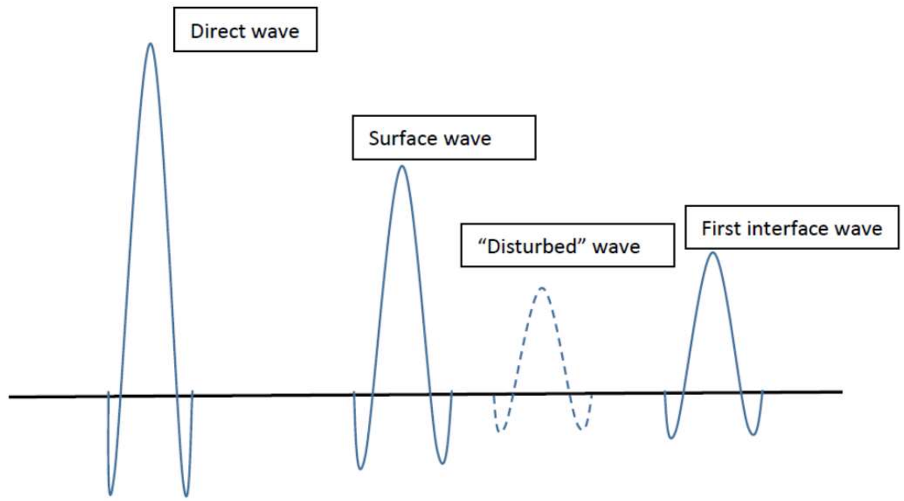




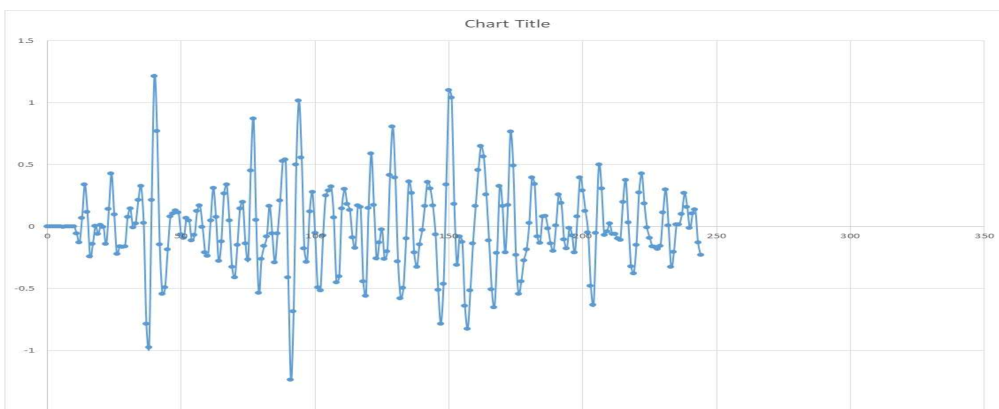


A Layered System with Defect (Stripping)





- **Real Signal Contains Noise**
  - Noise makes "disturbed" waveform less visible



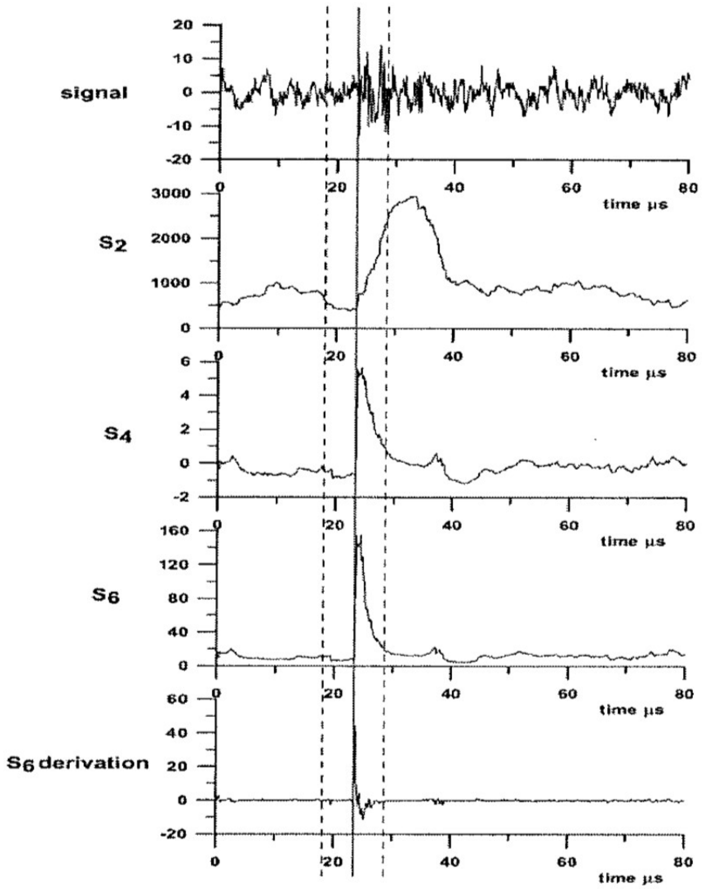
Purpose:

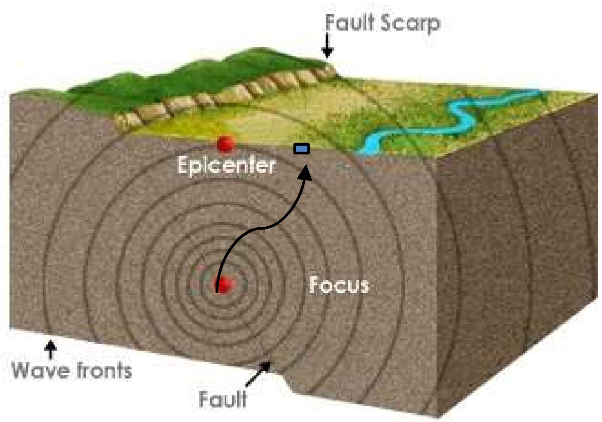
Evaluate different signal analysis methods to minimize noise and enhance “disturbed” signal by defect.

Eventually use computer to automatically pick the potential defects.

Signal Analysis Methods from Acoustic Emission (AE)

- AE is used for detecting earthquake
- First arrival of P wave used to estimate hypocenter location





$$S_2 = \sigma^2 = \frac{\sum_{i=1}^{N} (Y_i - \bar{Y})^2}{N - 1}.$$

$$S_4 = \text{kurtosis} = \frac{\sum_{i=1}^{N} (Y_i - \bar{Y})^4}{(N-1)\sigma^4} - 3.$$

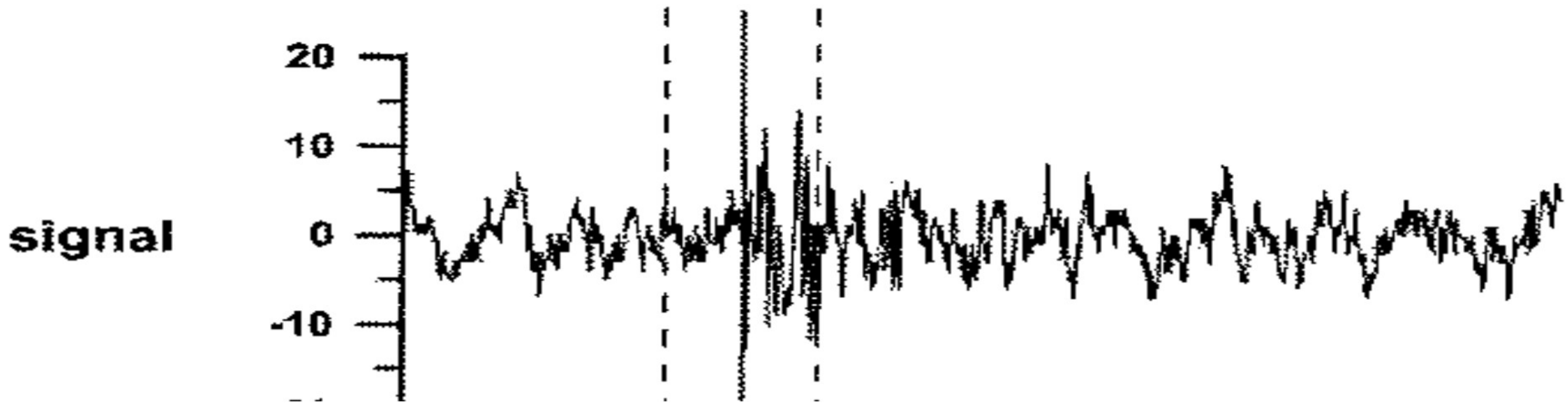
$$S_6 = \frac{\sum_{i=1}^{N} (Y_i - \bar{Y})^6}{(N-1)\sigma^6} - 15.$$

A first arrival identification system of AE Signals
T. Lokajicek and K Klima, Meas.Sci. Technol,2006

Maximum Energy Ratio

- Energy before and after the first arrival in a small time window has a large difference

$$R_p = \frac{\sum_{i=p+1}^{p+M} Y_i^2}{\sum_{i=p-M}^{p-1} Y_i^2}$$

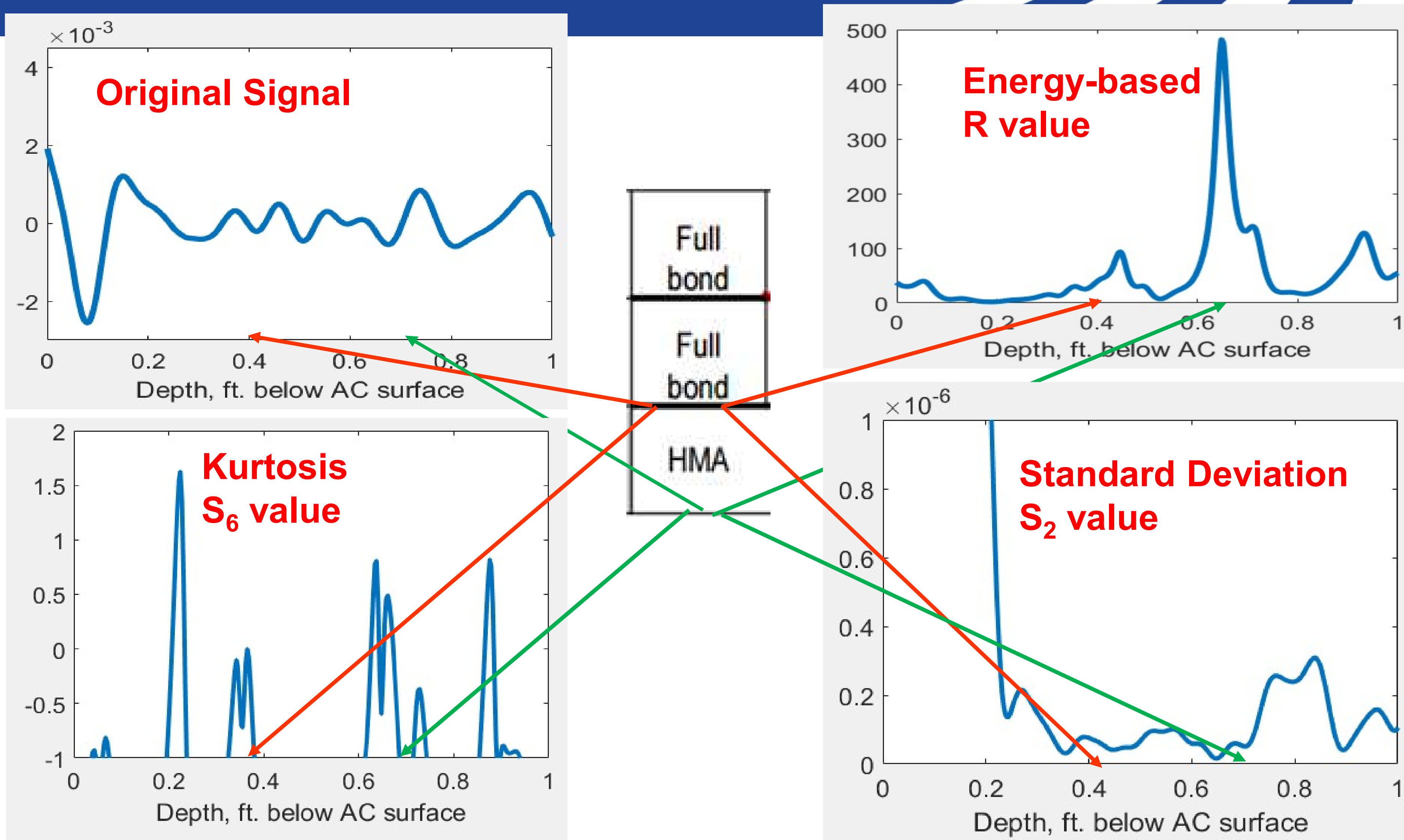


(Shah and Labuz, 1995)

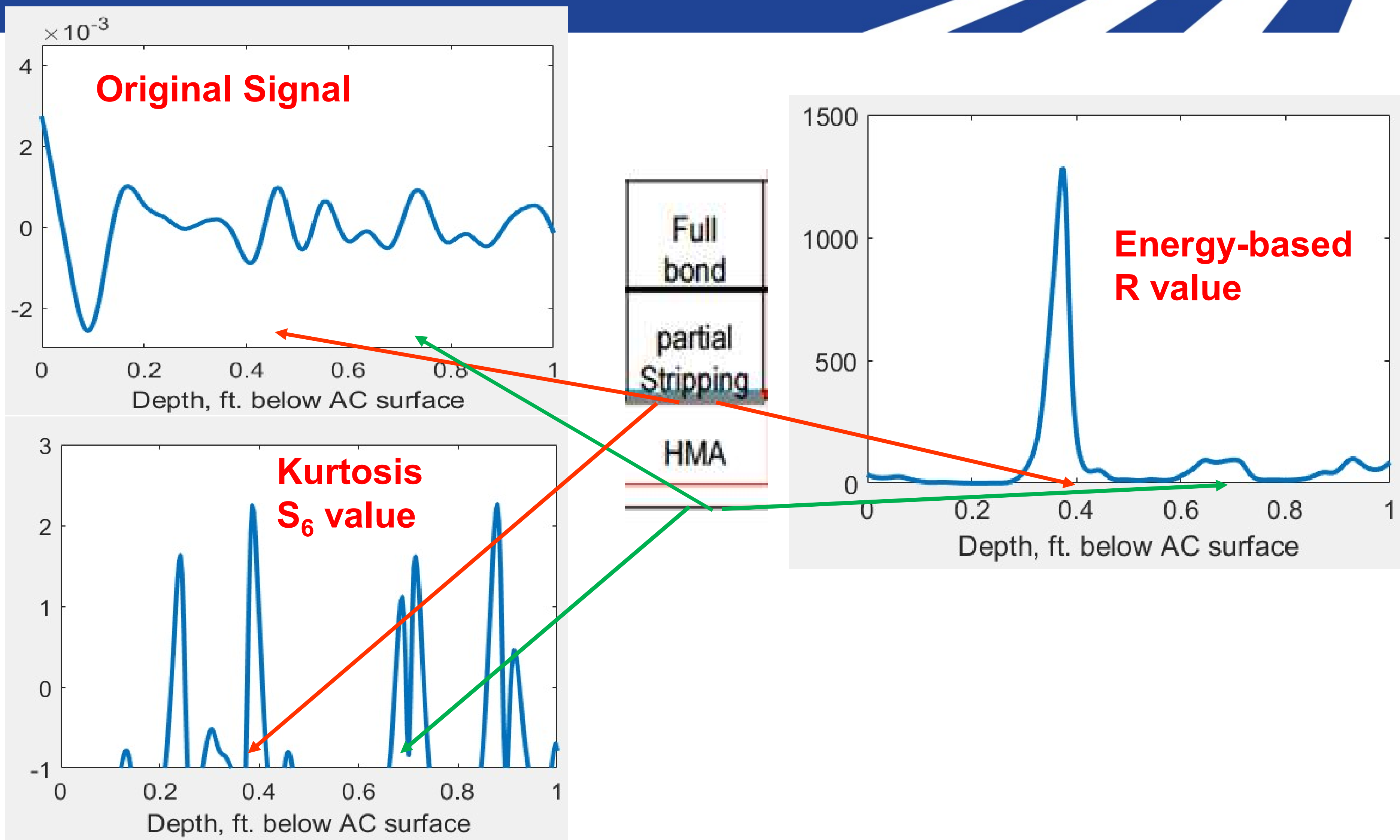
NCAT Test Sections

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
Top 2-inch lift	Full bond	Full bond	Full bond	Partial No bond	No bond	partial stripping	Full bond	Full bond	Full bond	Full bond
Bottom 3-inch lift	no bond	Full bond	Full bond	Full bond	Full bond	Full bond	Full bond	partial Stripping	partial No bond	No bond
Existing surface	PCC	PCC	HMA	HMA	HMA	HMA	HMA	HMA	HMA	HMA

Non-stripped Location



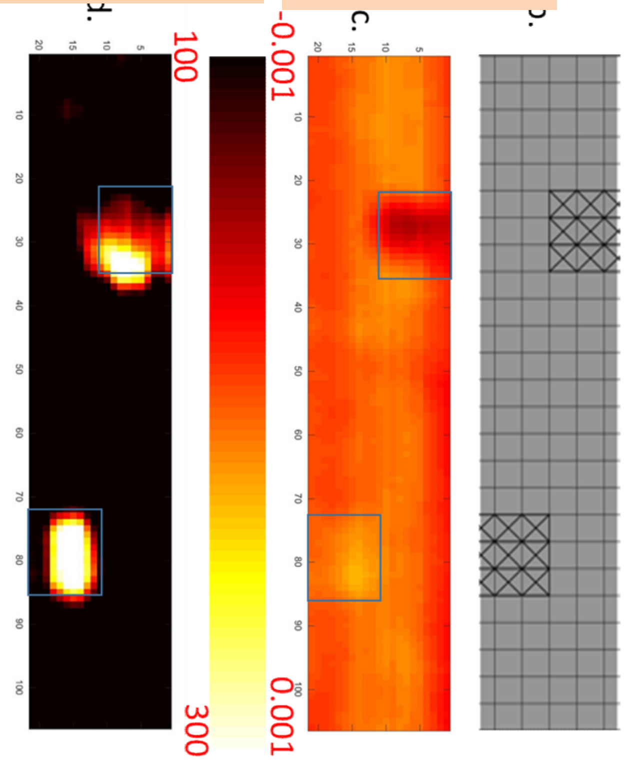
Stripped Location



Raw signal c-scan compared to the filtered data c-scan

C-scan of Energy-filtered Data

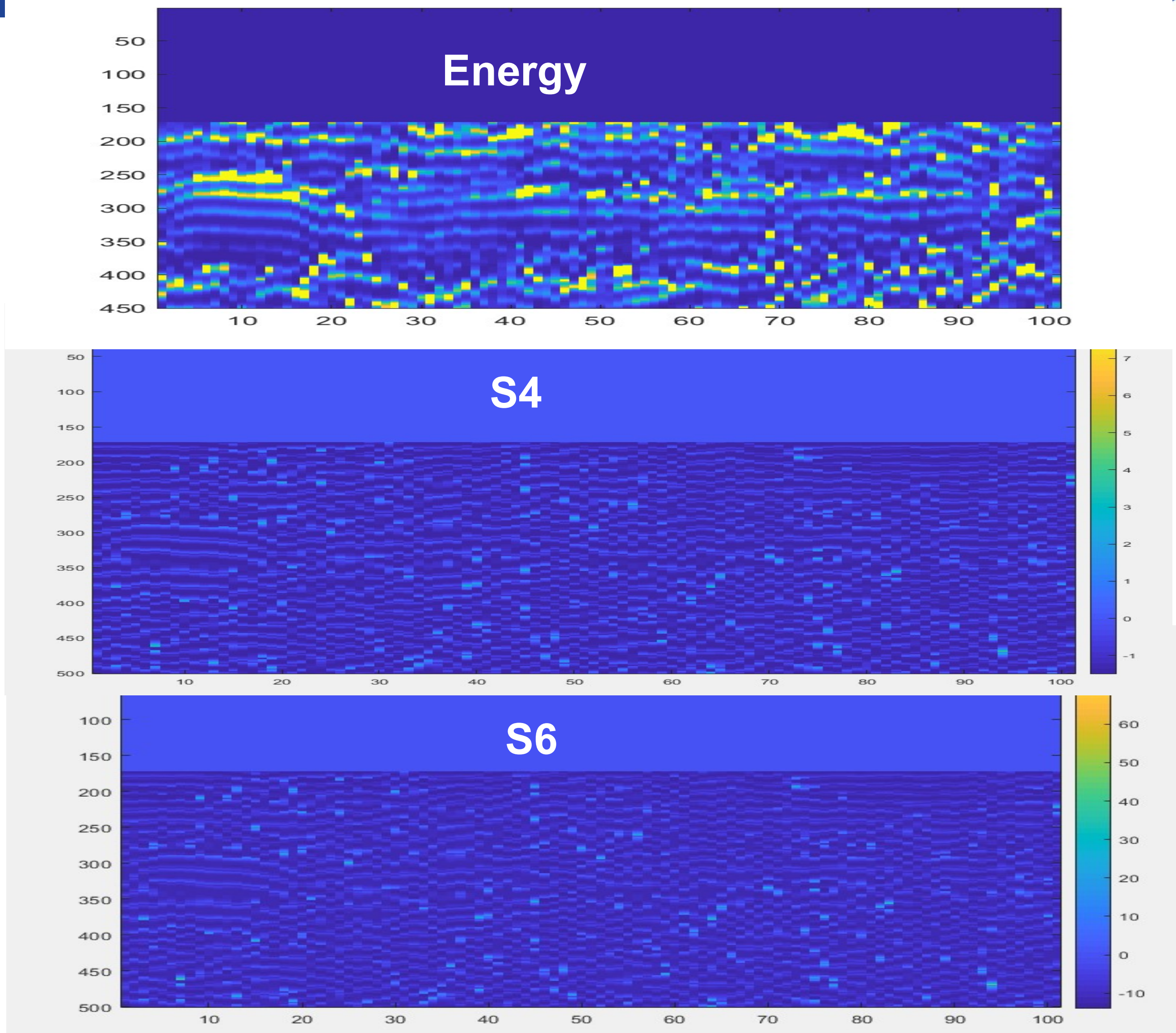
C-scan of Raw Data



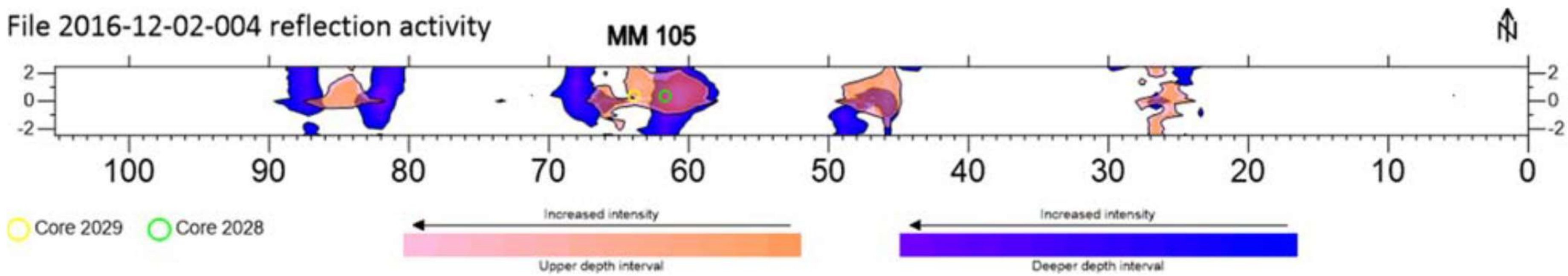
C-scan at design depth (~0.4 ft)

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10
Top 2-inch lift	Full bond	Full bond	Full bond	Partial No bond	No bond	partial stripping	Full bond	Full bond	Full bond	Full bond
Bottom 3-inch lift	no bond	Full bond	Full bond	Full bond	Full bond	Full bond	Full bond	partial Stripping	partial No bond	No bond
Existing surface	PCC	PCC	HMA	HMA	HMA	HMA	HMA	HMA	HMA	HMA

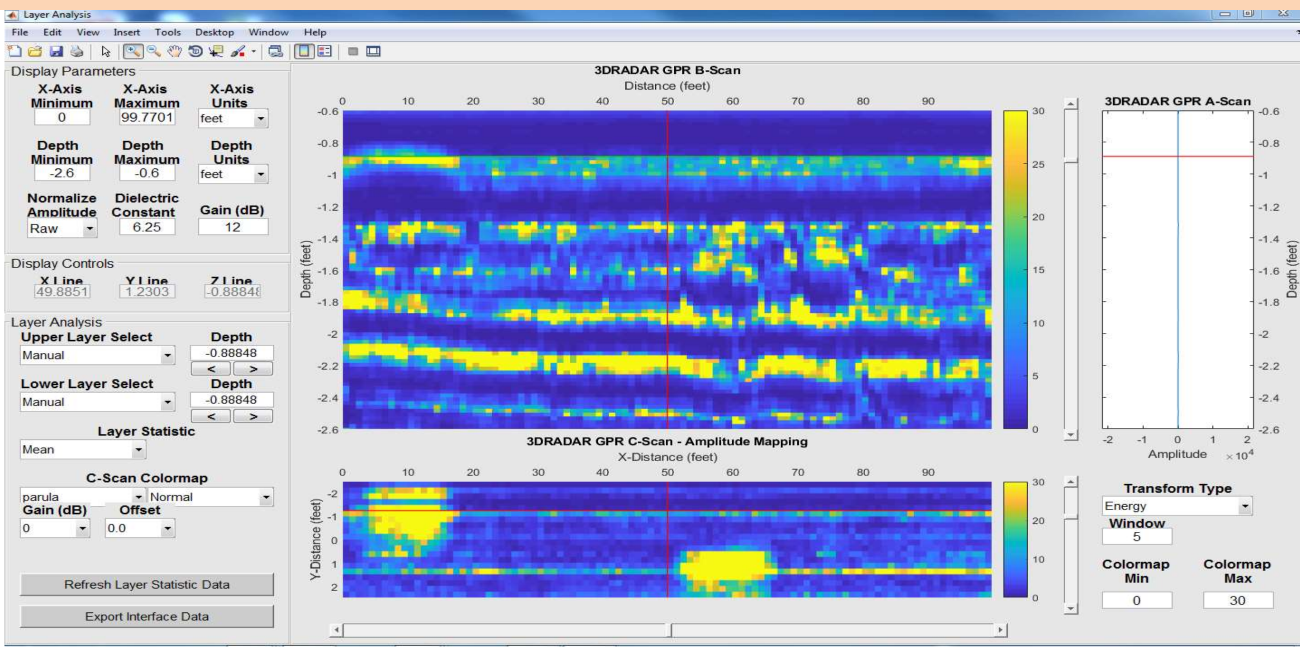
Analysis Results



ExploreGPR: Activity Method (Dr. Ken Maser)



- Energy method in ExploreGPR



Summary

- On-going effort.
- Energy, S4 and S6 analysis approaches successful in identifying stripping at a controlled section at NCAT.
- Need to be evaluated on multiple field projects where the stripping is more variable.
- Goal: Use different methods to analyze signal. If all or most methods indicate a common area with “unusual” activity, the area is worth to be investigated further, could be “stripping.”

SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Advanced Methods to Identify Asphalt Pavement Delamination (R06D) - GPR

Questions and Comments

Michael Heitzman, PE, PhD
Asst. Director
NCAT

Webinar
June 28, 2018

U.S. Department of Transportation
Federal Highway Administration

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AASHTO

Future R06D Events

SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

SHRP2 Peer Exchange
Advanced Methods to Identify Pavement Delamination (R06D)
August 1-3, 2018

https://fs6.formsite.com/Mrussell/form198/index.html

SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Photos courtesy: Geop

SHRP2 R06C Technologies to Enhance Quality Control on Asphalt Pavements: Surface Dielectric Profiling System using Ground Penetrating Radar (DPS GPR) Peer Exchange July 31-August 1

For More Information on R06D

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phutton@aashto.org

Additional Resources:

GoSHRP2 Website:	fhwa.dot.gov/GoSHRP2
AASHTO SHRP2 Website:	http://shrp2.transportation.org
R06D Product Page	http://shrp2.transportation.org/Pages/R06D.aspx

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