Florida Department of
TRANSPORTATION

FDOT'S Experience with 3D RADAR

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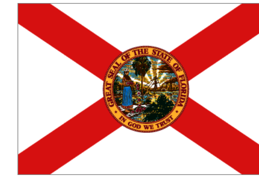
Outline

- History
- Florida DOT GPR Experience
- GPR Applications
- FDOT Objectives of R06D IAP
- 3D RADAR Field Testing
- Lessons Learned

Historical Background

- Early 1980’s to Current
  - Thickness Determination (Pre-Design)
  - Density Study
  - Forensic Investigations (Sinkhole, Utilities)
  - Bridge Deck Evaluations (Rebar Depth, Deterioration Mapping)
- Equipment
  - Air-Launched GPR
  - Ground- Coupled GPR
  - Rolling Density Meter (PaveScan)

State of Florida



- 2018 Population: 20 million
  - 3rd most populous state in the US
- 94 million annual visitors
- State Highway System (FDOT Maintained)
  - 43,500 total lane miles
  - 12,000 centerline miles

Department's Mission

- Ensure a safe transportation system
  - High Speed Non-Contact Technology
  - Support Design Initiatives
- Make data driven decisions

FDOT Goals

- Statewide Evaluation of In-service Roadways
  - Pavement Layer Thickness
- Pavement Forensic Investigations
  - Delamination/Premature Failure/Distress
  - Sinkholes/Voids
  - Utility Search
  - Buried Object Search
  - Density
- Bridge Forensic Investigations
  - Bridge Deck Deterioration Mapping
  - Bridge Rebar Cover
- Experimental Projects
  - New Materials
  - Construction Methods

FLORIDA’S GPR EXPERIENCE

FDOT Program Overview

- Based on Current GSSI GPR:
- Full Time Year Round Program
- 2,500 Lane Miles of Markings per Year (Project Level)
  - Pavement Layer thickness
- Forensic and Special Requests
  - Research, Safety, or District needs
    - Up to 50 Projects per year

Current GPR Limitations

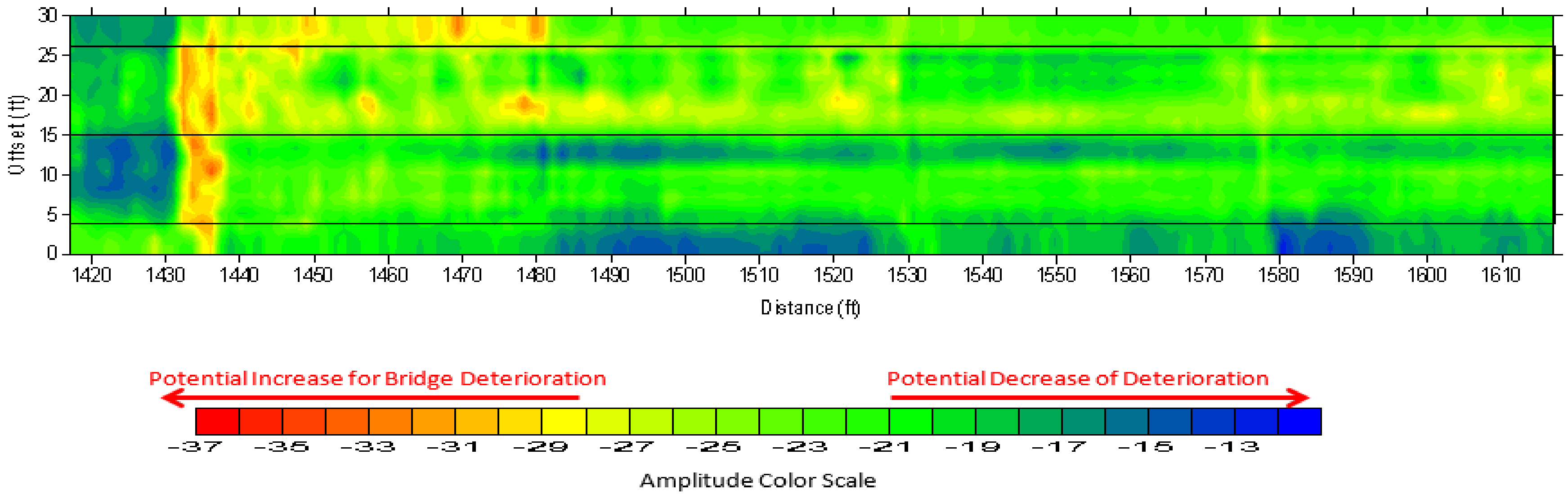
- Single Frequency
- Limited Depth
  - Air-Launched GPR
- Not full lane coverage
- Site Specific – Ground Coupled GPR
  - Requires Maintenance of Traffic (MOT)

Sinkhole Investigation

- Pavement depression on SR 24 in Gainesville, FL
- Southbound Lanes
- Steel plate used to temporarily cover pavement depression

Bridge Deck Survey

- Bridge Number 940045
- SR A1A, Roadway Section 94060 (MP 0.330 to 0.719)
- Bridge Length = 2,054 ft.
- Bridge Width = 30 ft.
- Steel Grate from 1,314 ft. to 1,417 ft. from South End of Bridge (Excluded from Contour)

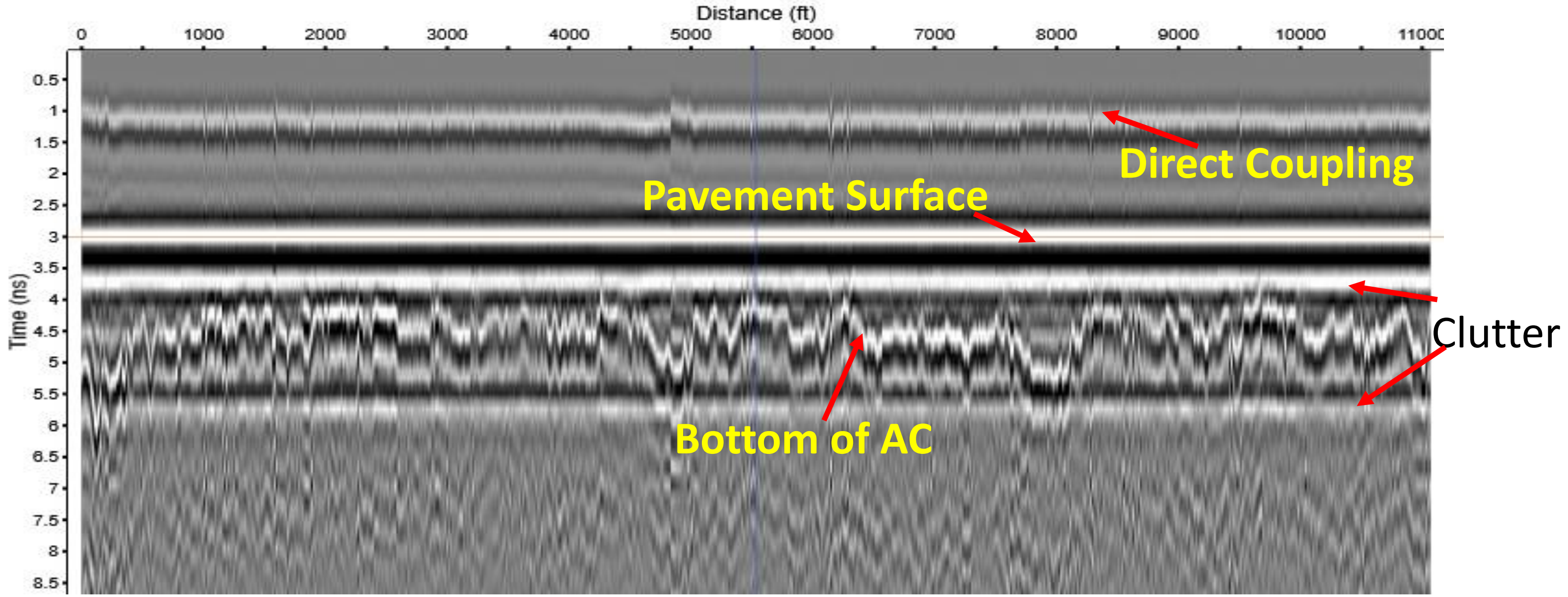


FDOT Objectives of R06D IAP

- Primary:
  - Detection of pavement delamination
  - 3D GPR Technology
- Secondary:
  - Detection of voids under concrete pavement
  - Detection of dowel bar alignment
  - Evaluation of density variations in new asphalt pavement
  - Identification and quantification of delamination in older bridge decks
  - Detection of voids over culverts, and sink holes

3D RADAR – Mounting Systems

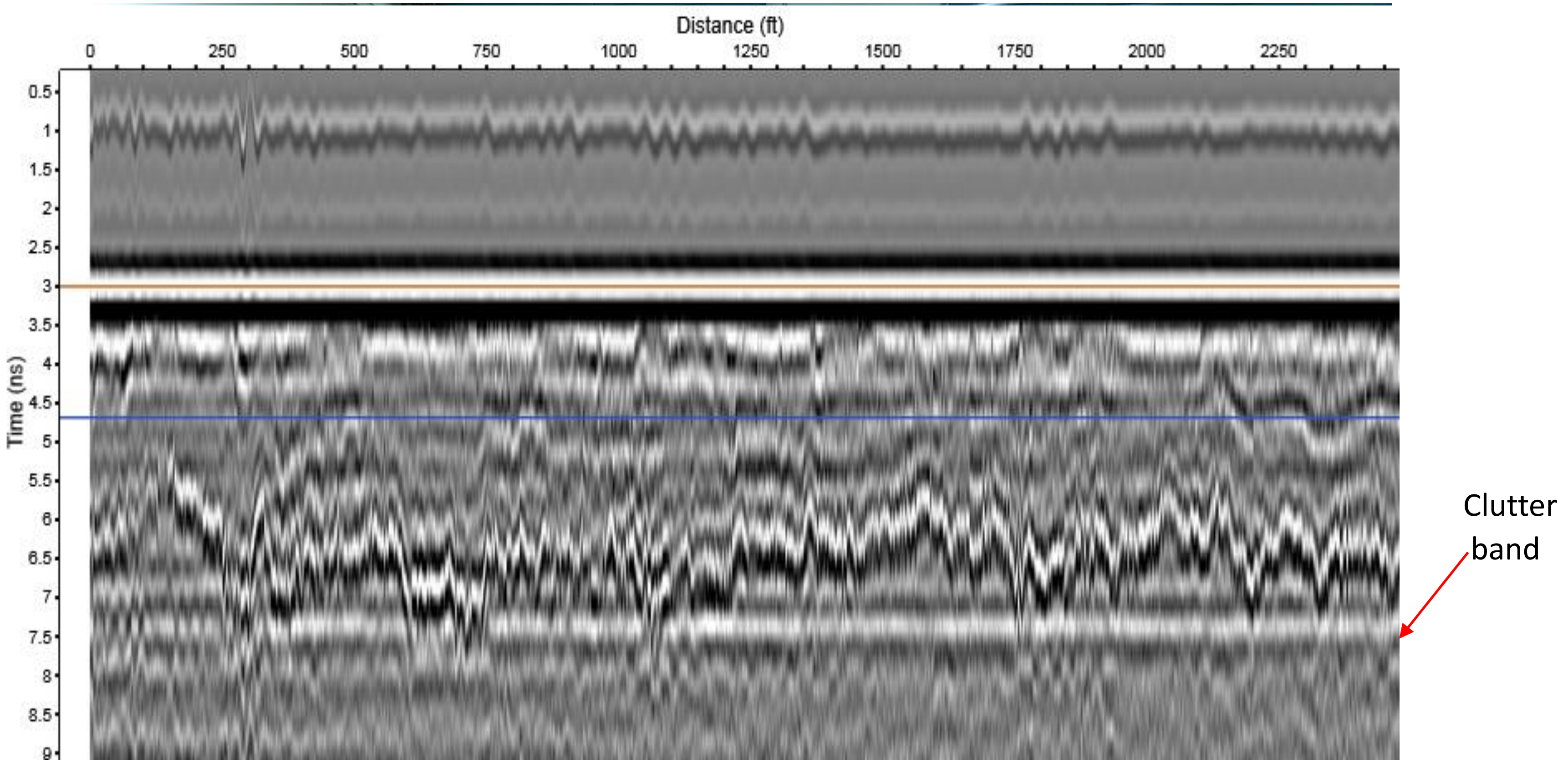
- Mounting Systems:
  - Issues with existing mounting
  - Clutter problem not solved



GPR reflection interference ("clutter") caused by vehicle proximity and mounting

3D RADAR – Mounting Systems

- Development of improved mounting
- FDOT: 4ft offset and 15in height



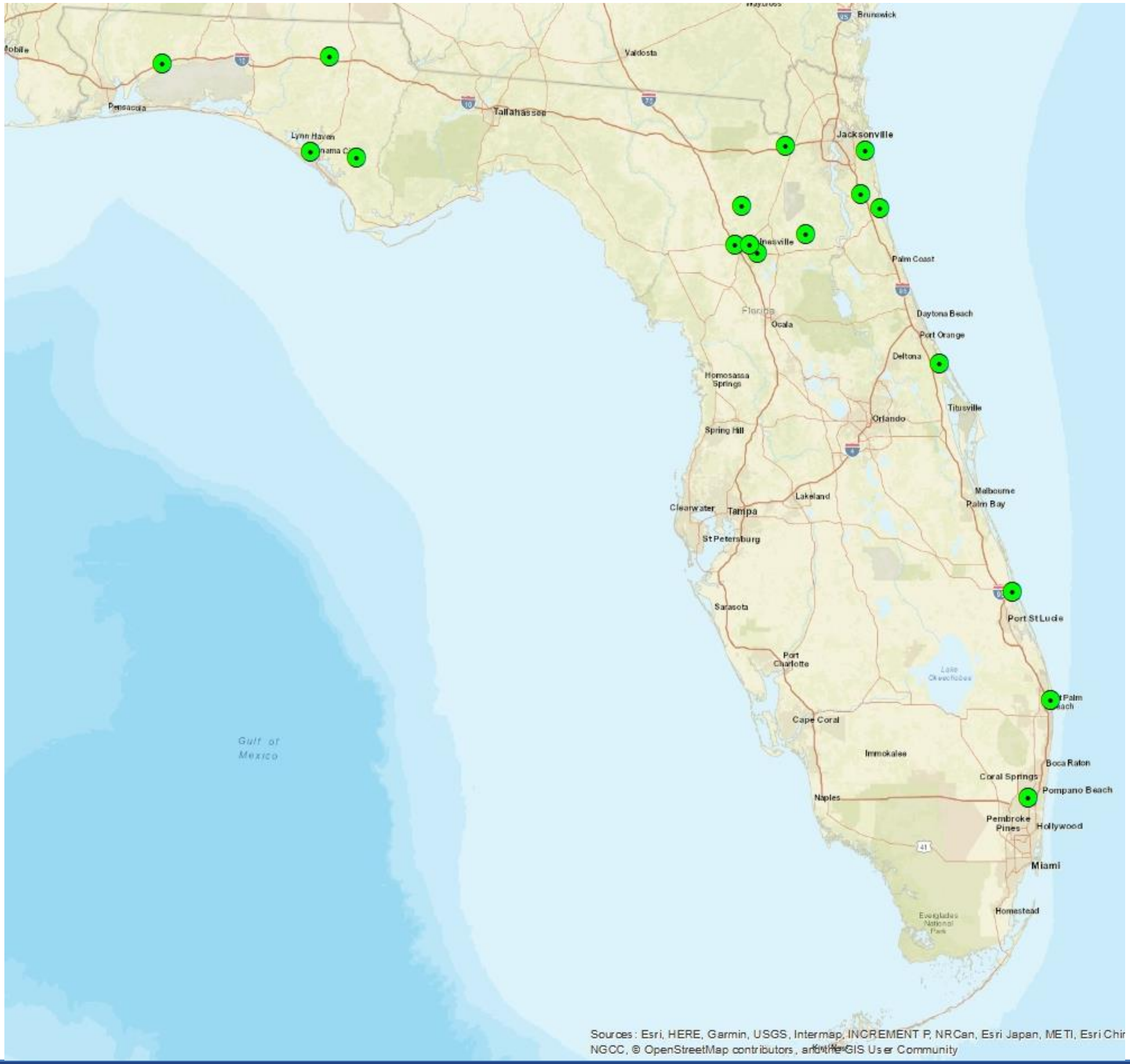
Antenna Mounting Observations

- “Clutter” is caused by reverberations from the pavement and nearby objects
- Some clutter is intrinsic to the antenna, and some is related to the mounting system and proximity to the vehicle.
- For most analyses, it will be necessary to do background removal starting just below the pavement surface, in order to effectively remove the clutter.
- Sometimes background removal takes away some of the real data
- Best approach is to mount the antenna in a way to minimize clutter

3D RADAR FIELD TEST

3D RADAR SYSTEM

- Evaluation of 17 In-service Roadways
  - Pavement
  - Bridges



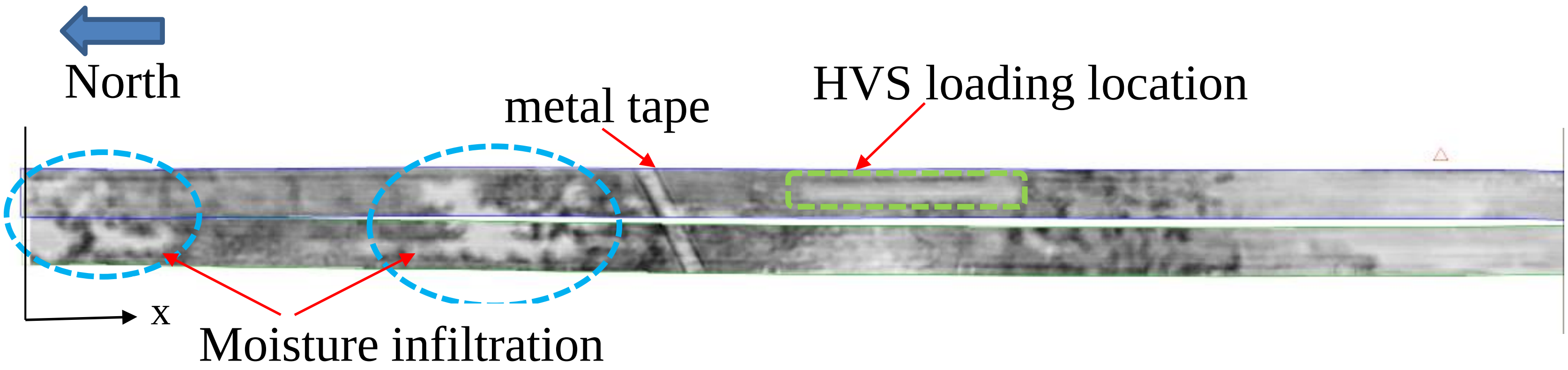
3D RADAR Testing

- Testing at SMO Test Lanes:
  - Evaluation of first 150 feet of Lanes 3, 4, 5

3D RADAR Testing – FDOT SMO

- SMO Test Lane 3 – Debonding - Delamination

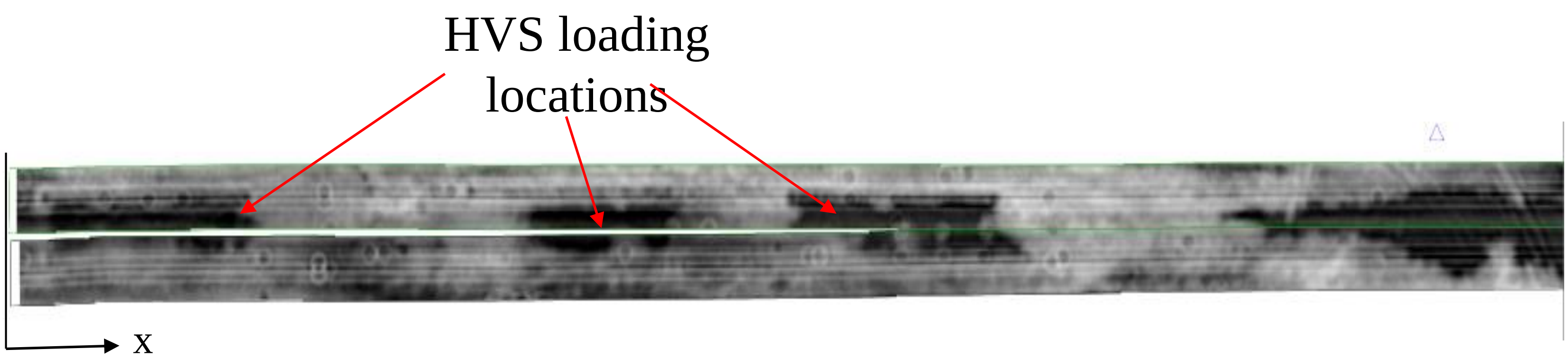
Lane 3 -3D Radar depth slice at 2"



This section - Sand interface area (unbonded) – 1.4"

3D RADAR Testing

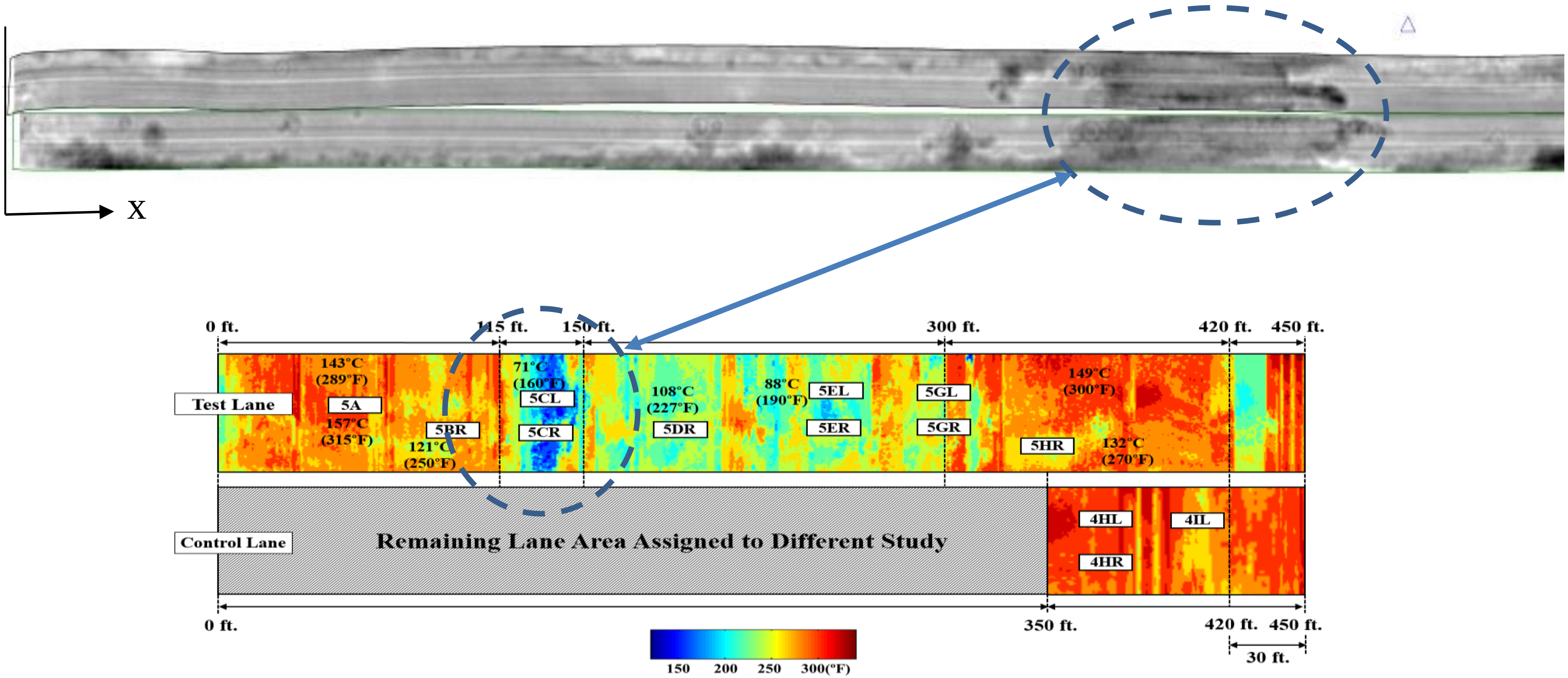
- SMO Test Lane 4 – Density



3D RADAR Testing

- SMO Test Lane 5 – Segregation

Lane 5 - depth slice at 1.5”



Temperature profile map

3D RADAR Testing

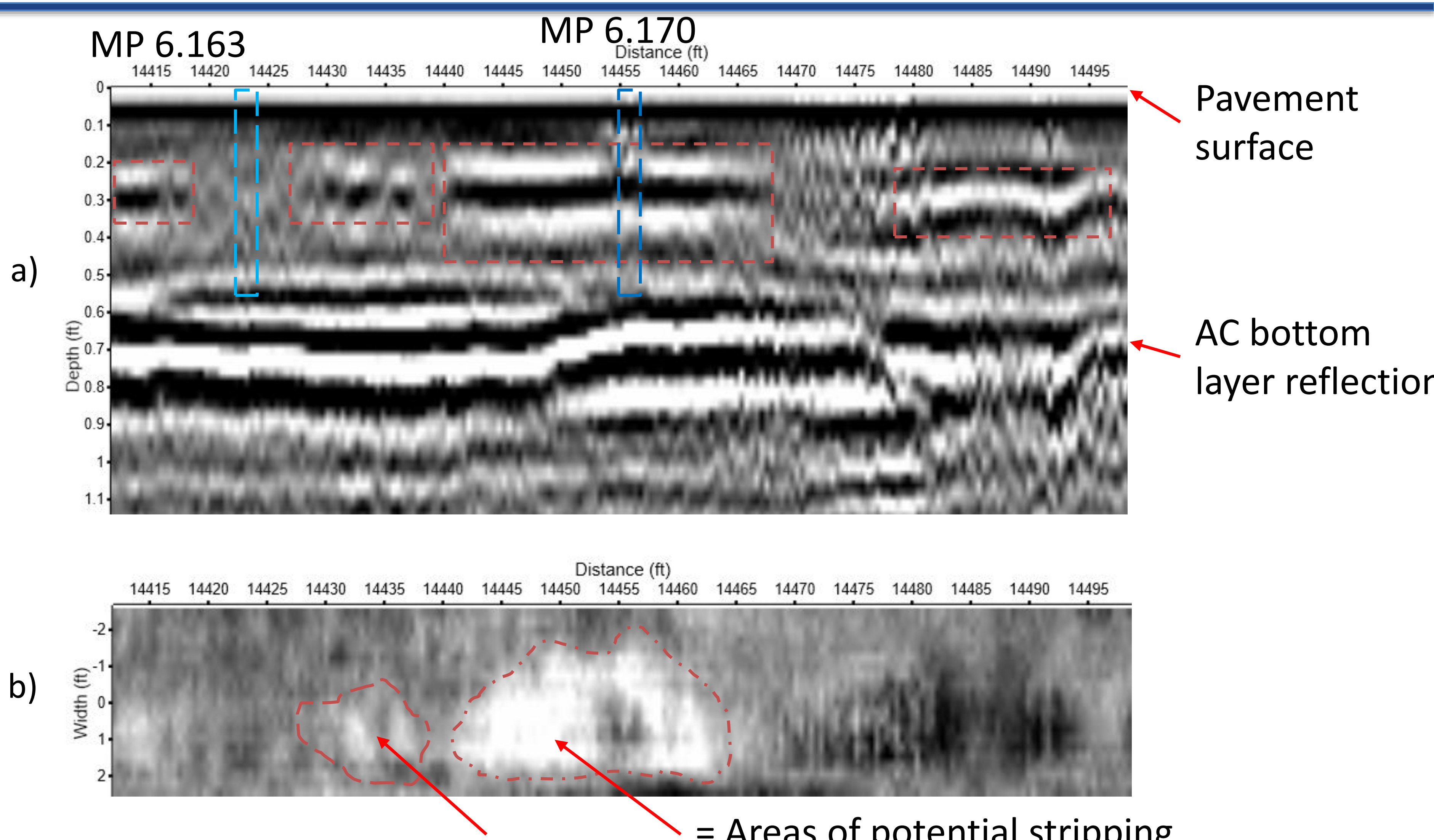
- Stripping and Moisture Damage
  - Interstate 10, Duval County, MP 0 – 8.989

Observed Distresses on I-10

3D Radar Testing – I-10

- Pavement consists of multiple layers
  - Friction course, 2 structural courses, ARMI layer
- Total thickness = 7 inches
- Seven cores taken at different areas
  - Four showed internal damage to the pavement structure
- Four lines of 3D Radar data were collected
  - Two in the travel lane in each direction

3D GPR Data at Core Locations on I-10

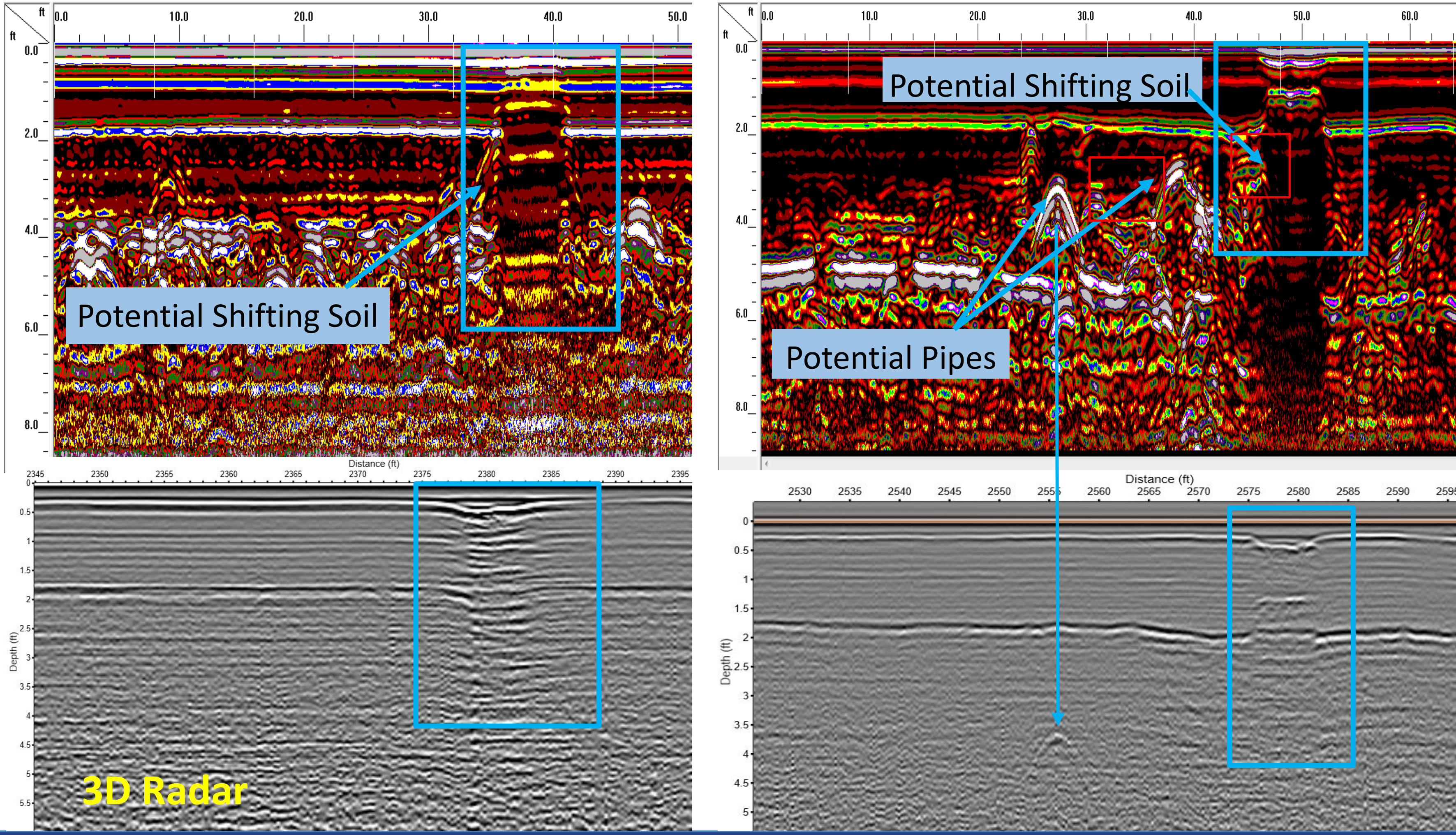


Subsidence Study

- State 24 (Waldo Road) near Gainesville, FL
- Pavement depression experienced over the years near drainage inlet location
- FDOT 400 MHz GSSI system used initially
- Results compared to 3D Radar
- Similar comparison done for I-75 subsidence study

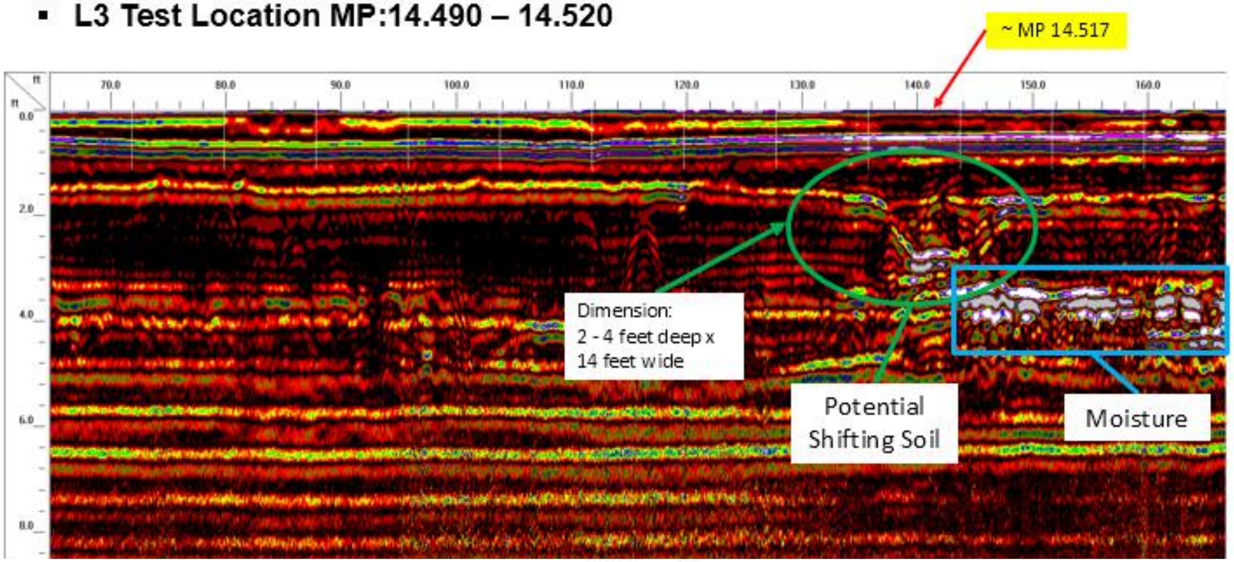
Subsidence Study

- 400 MHz GSSI System vs. 3D RADAR Results

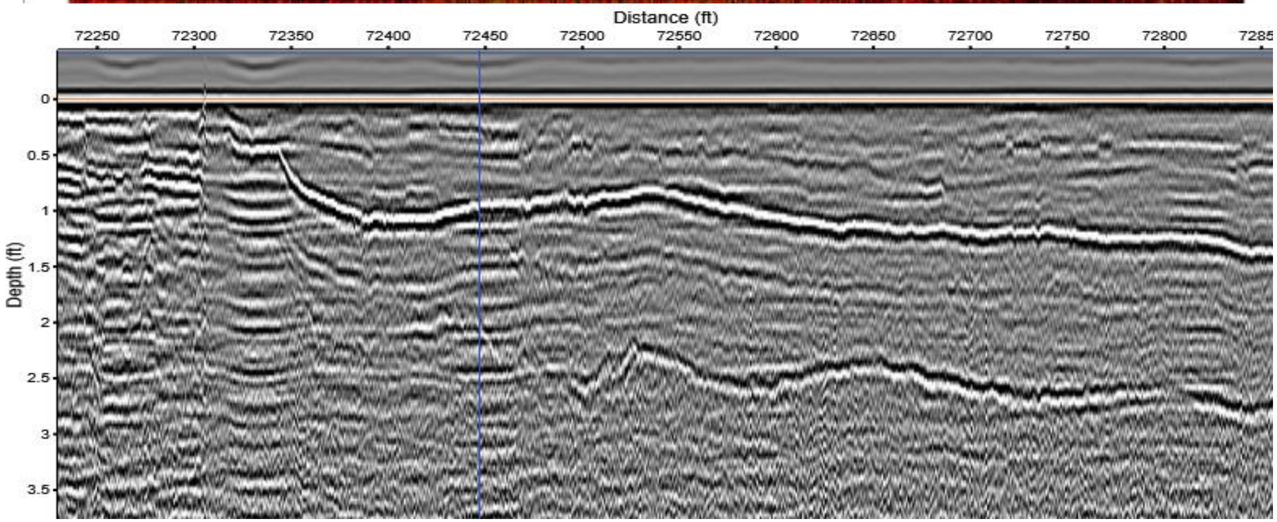


Subsidence Study – I-75

- **L3 Test Location MP:14.490 – 14.520**



400 MHz



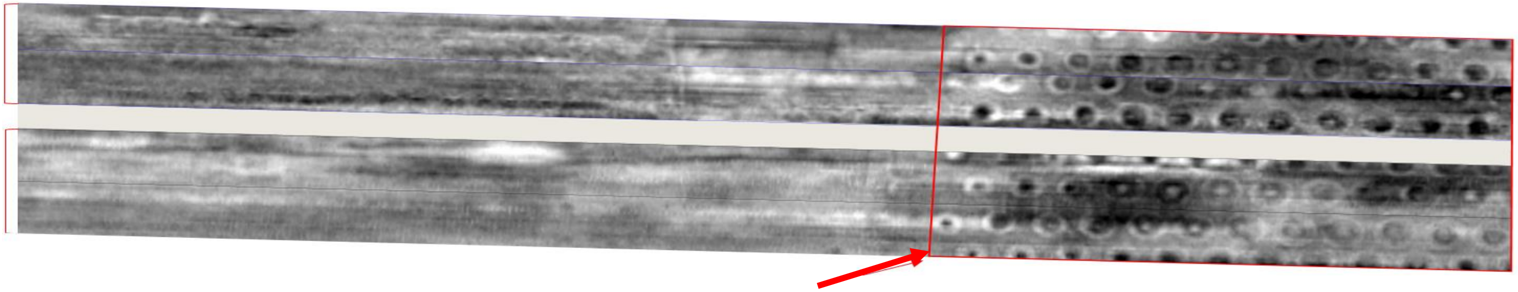
3D Radar

Subsurface Soil Stabilized Columns (SCC)

- Subsurface Soil Stabilized Columns (SCC)
  - SR 100, Putnam County, MP 7.000 – 8.000
  - Columns installed to mitigate roadway settlement

WB Lane

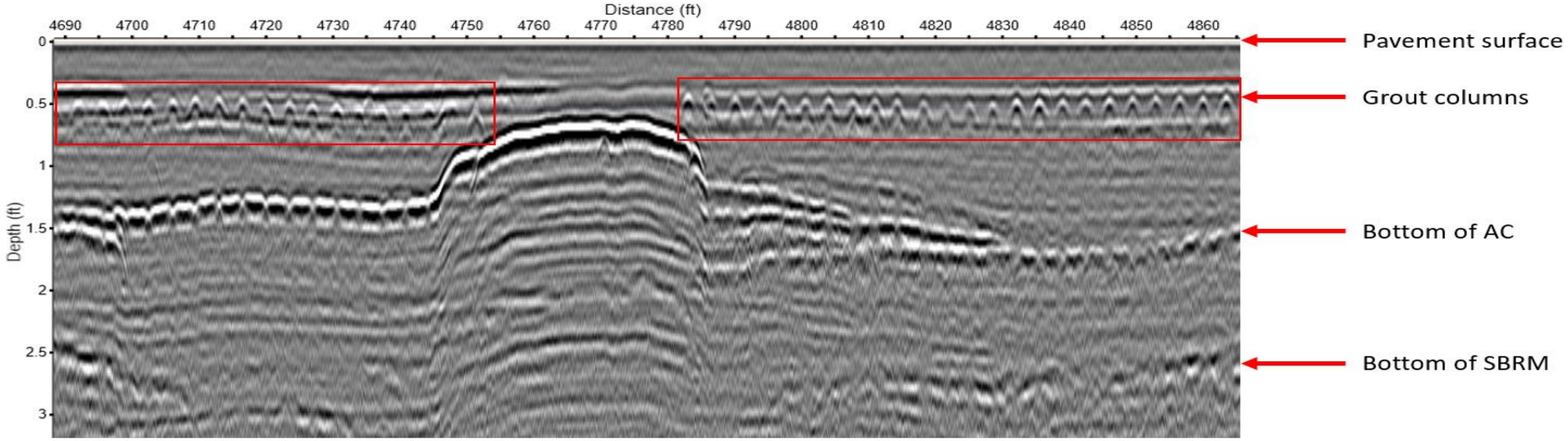
EB Lane

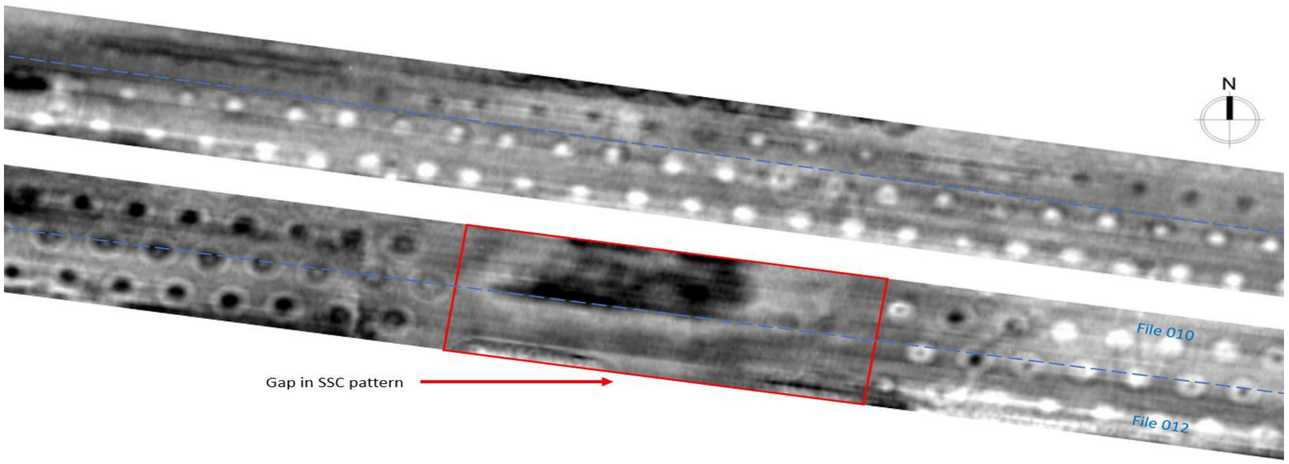


Area with installed Soil Stabilized Columns (SCC)

Subsurface Soil Stabilized Columns (SCC)

- Area with no SCC



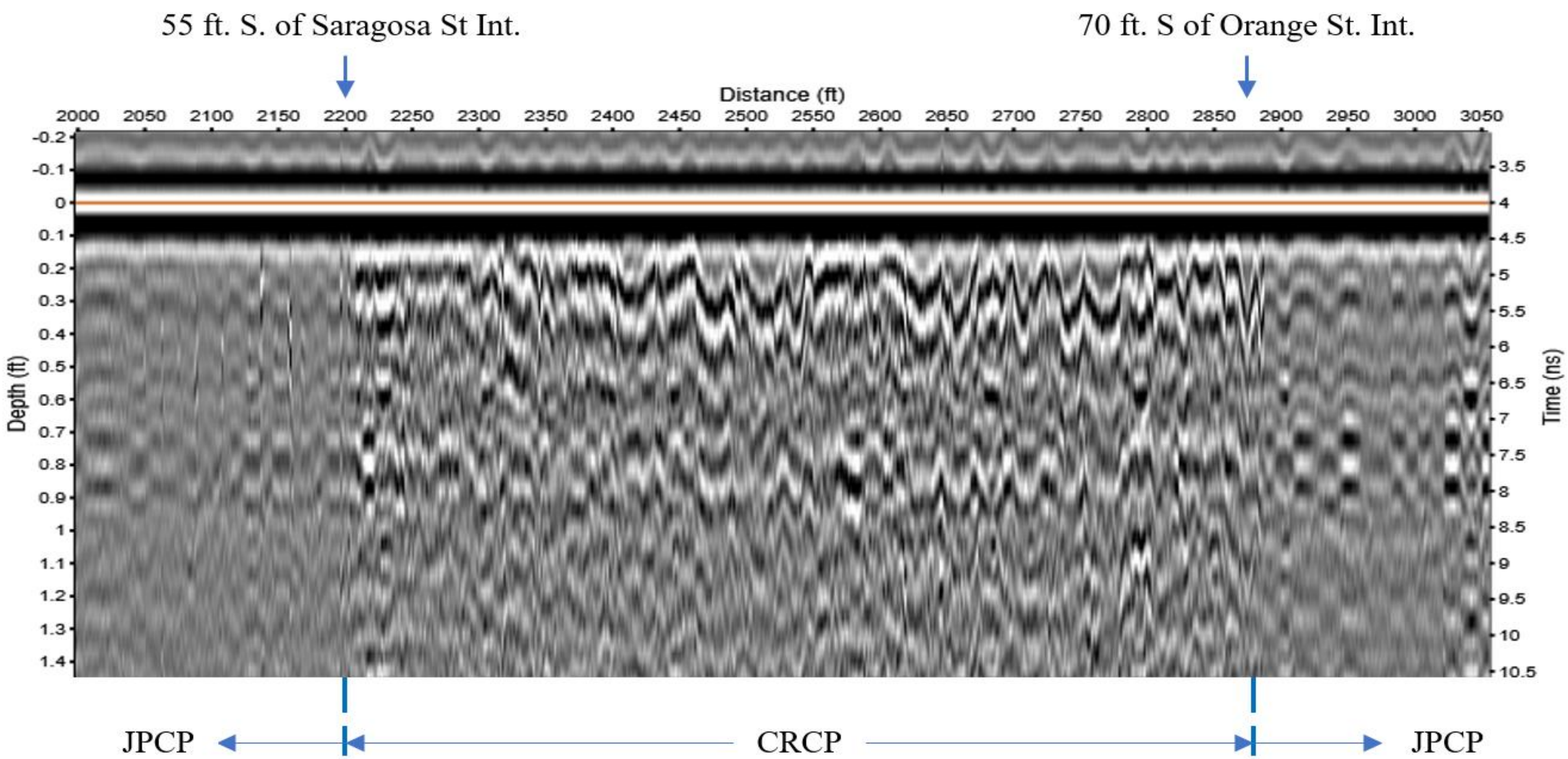


Detecting PCC under HMA

- Different types of concrete base (NB)
  - SR 5 (US 1) St. Johns County, 2-mile section, NB & SB
  - Detected location and type of concrete base
  - Identified area of extensive settlement

Detecting PCC under HMA

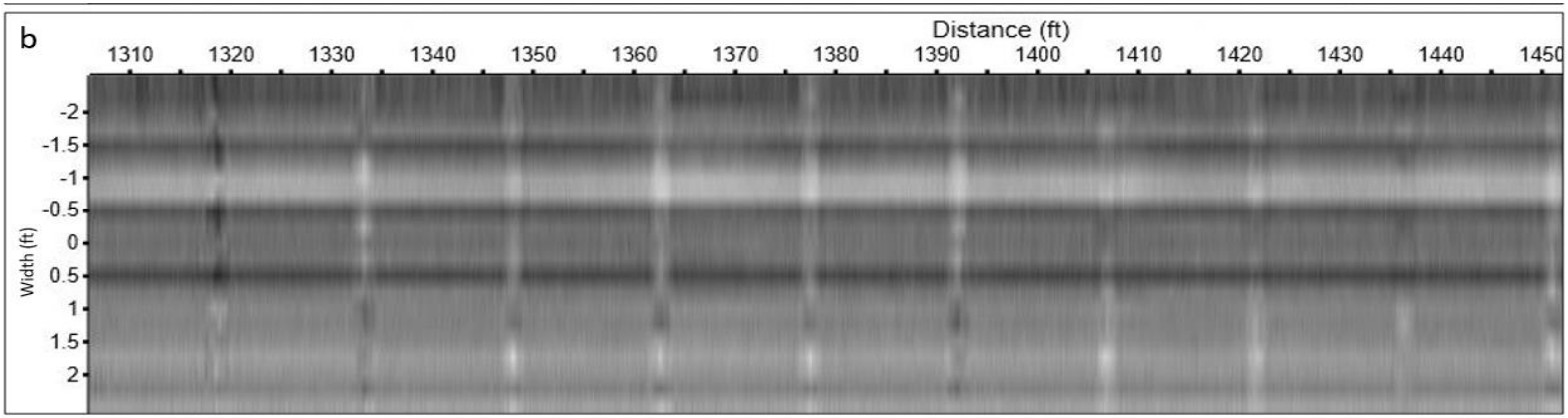
- SR 5 (US 1), St. Johns County, 2-mile section, NB & SB
  - Detected location and type of concrete base



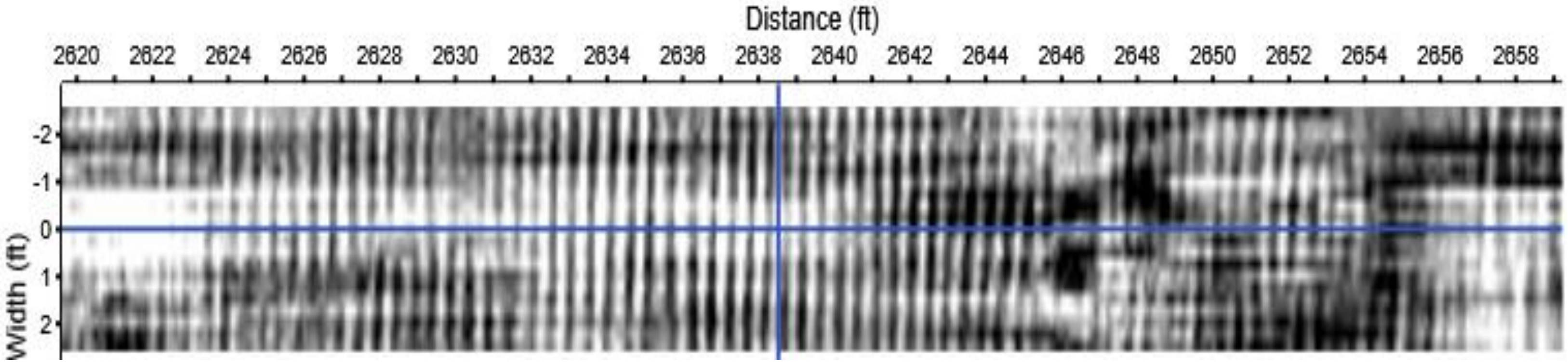
Different types of concrete base (NB)

Detecting PCC under HMA

JCPC Joints at 15 feet

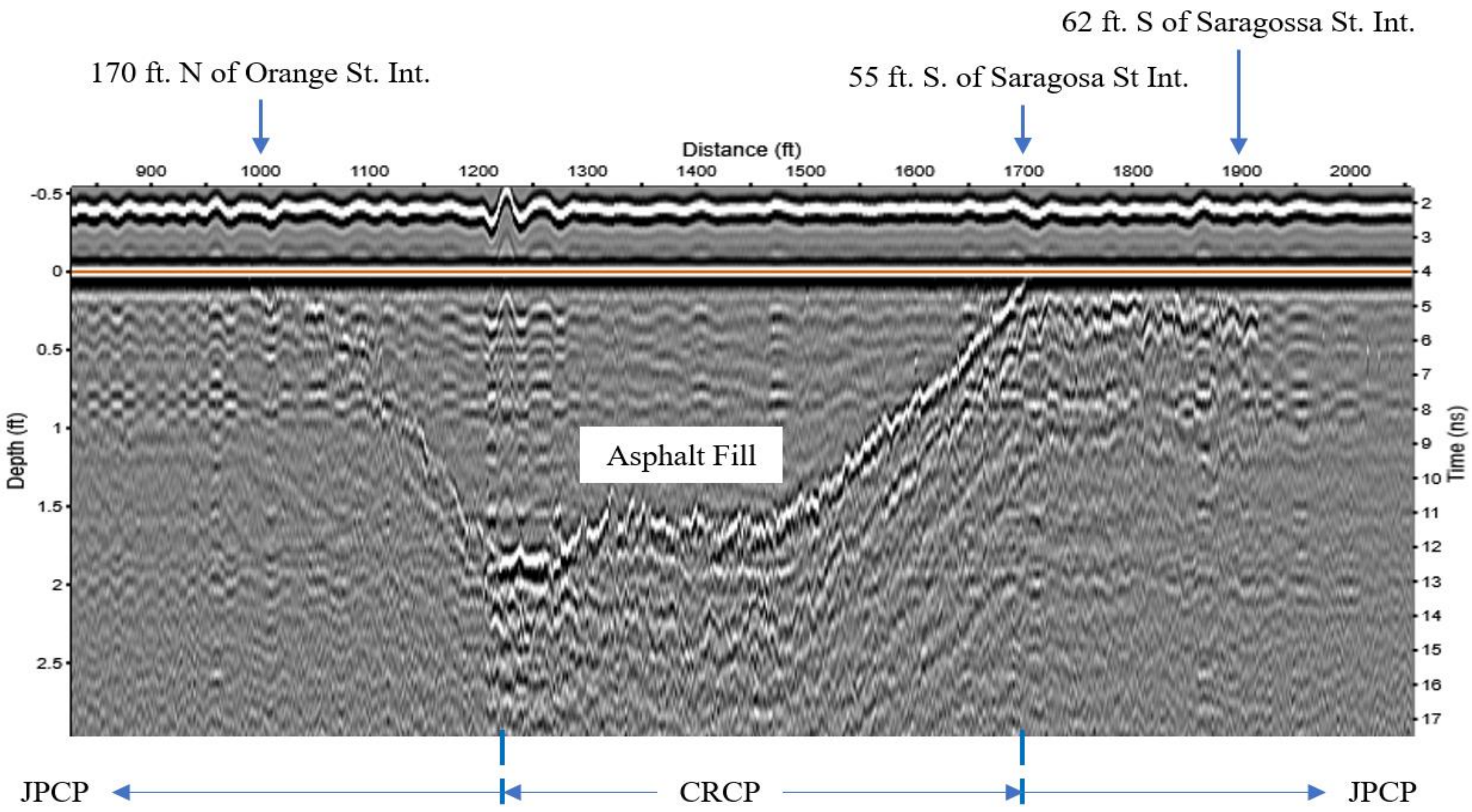


CRCP Transverse Rebar at 6 inches



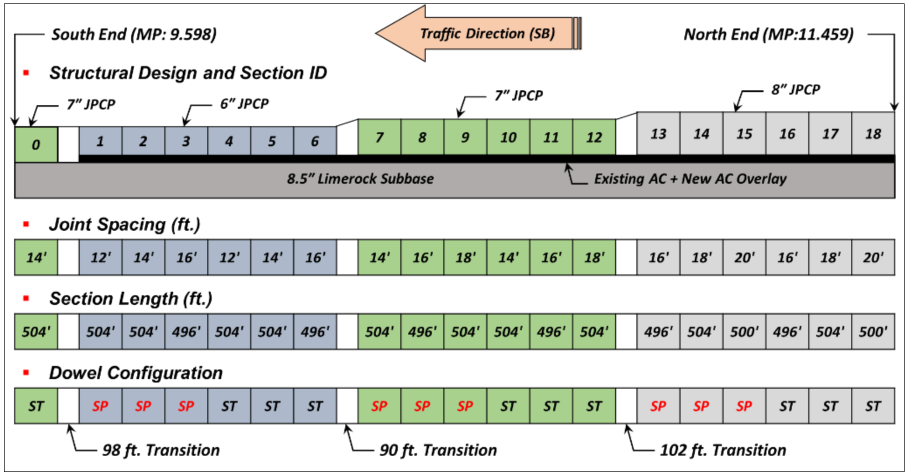
Detecting PCC under HMA

- Area of pavement settlement (SB)



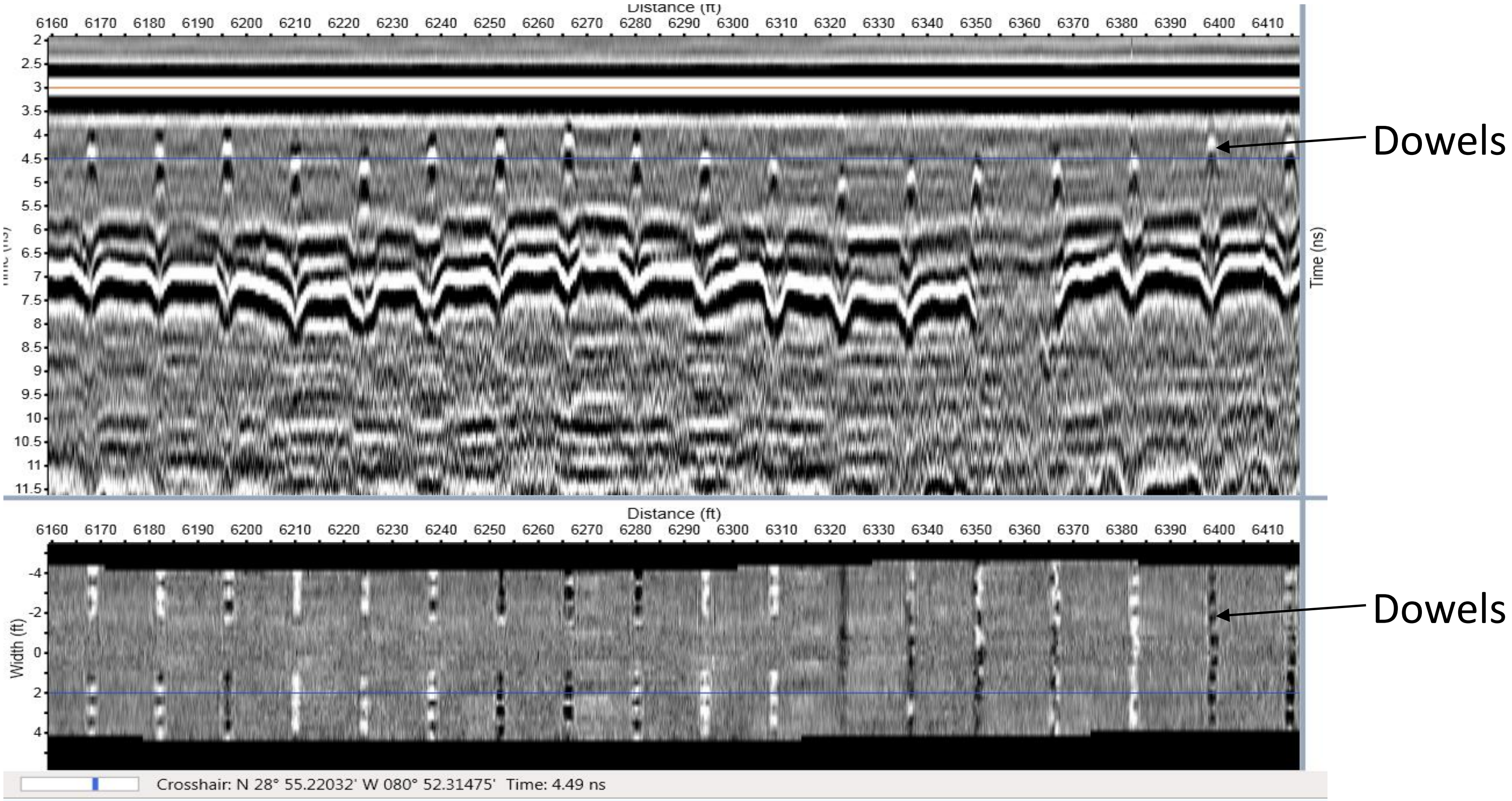
Dowel Bar Detection

- SR 5 (US 1) Volusia County, MP 9.600 – 11.500 (SB)
- White-topping thicknesses – 6”, 7” and 8”
- Specially designed with different dowel patterns:
  - 12 dowels spaced at 12” centers starting at 6” from pavement edge
  - 3 dowels in each wheelpath spaced at 12” centers beginning at 12” from each edge
  - No dowels



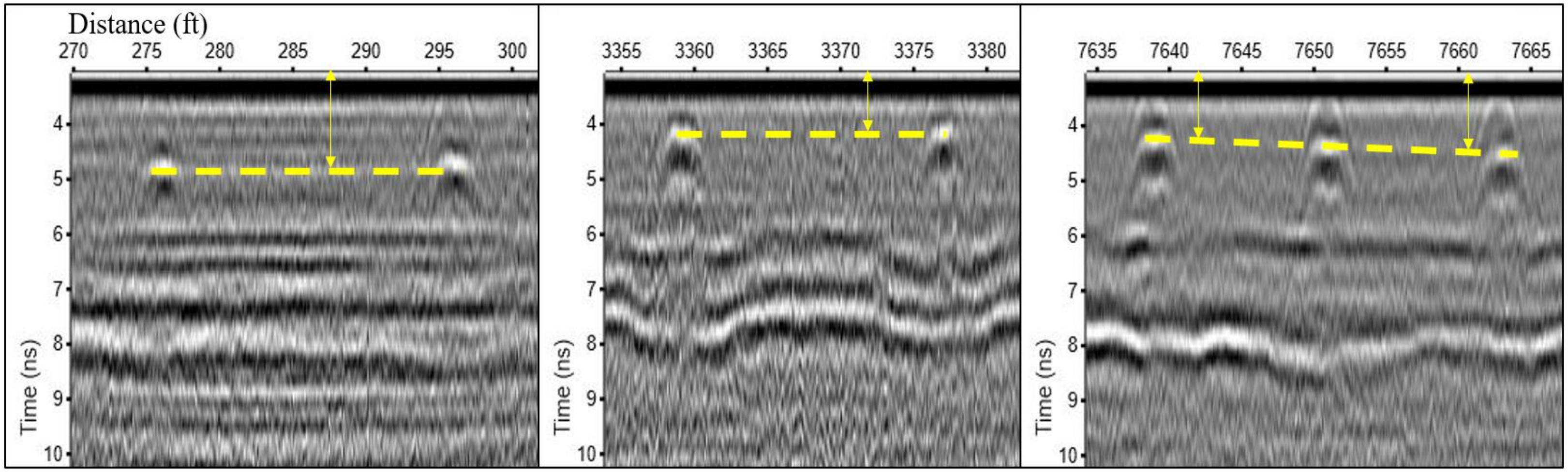
Dowel Bar Detection

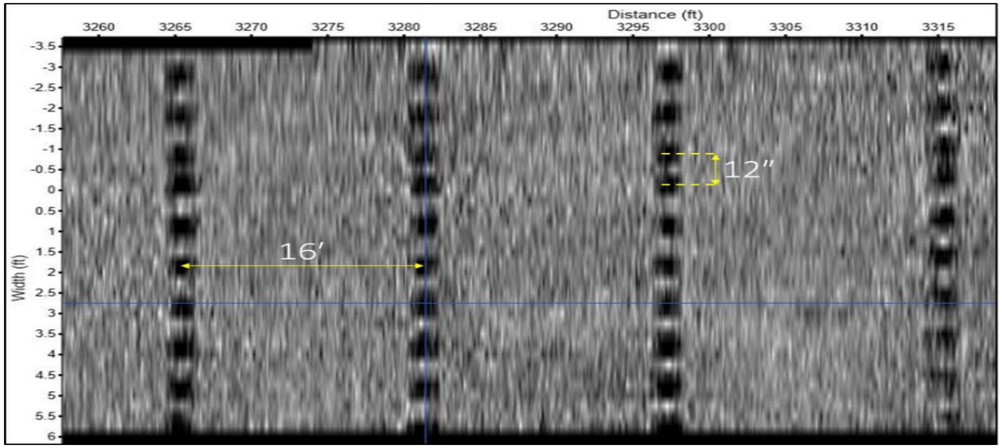
- 3D RADAR Results

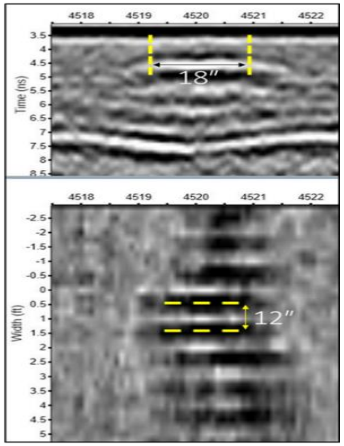


Dowel Bar Detection

- Dowel Bars – Position, Dimensions and Alignment





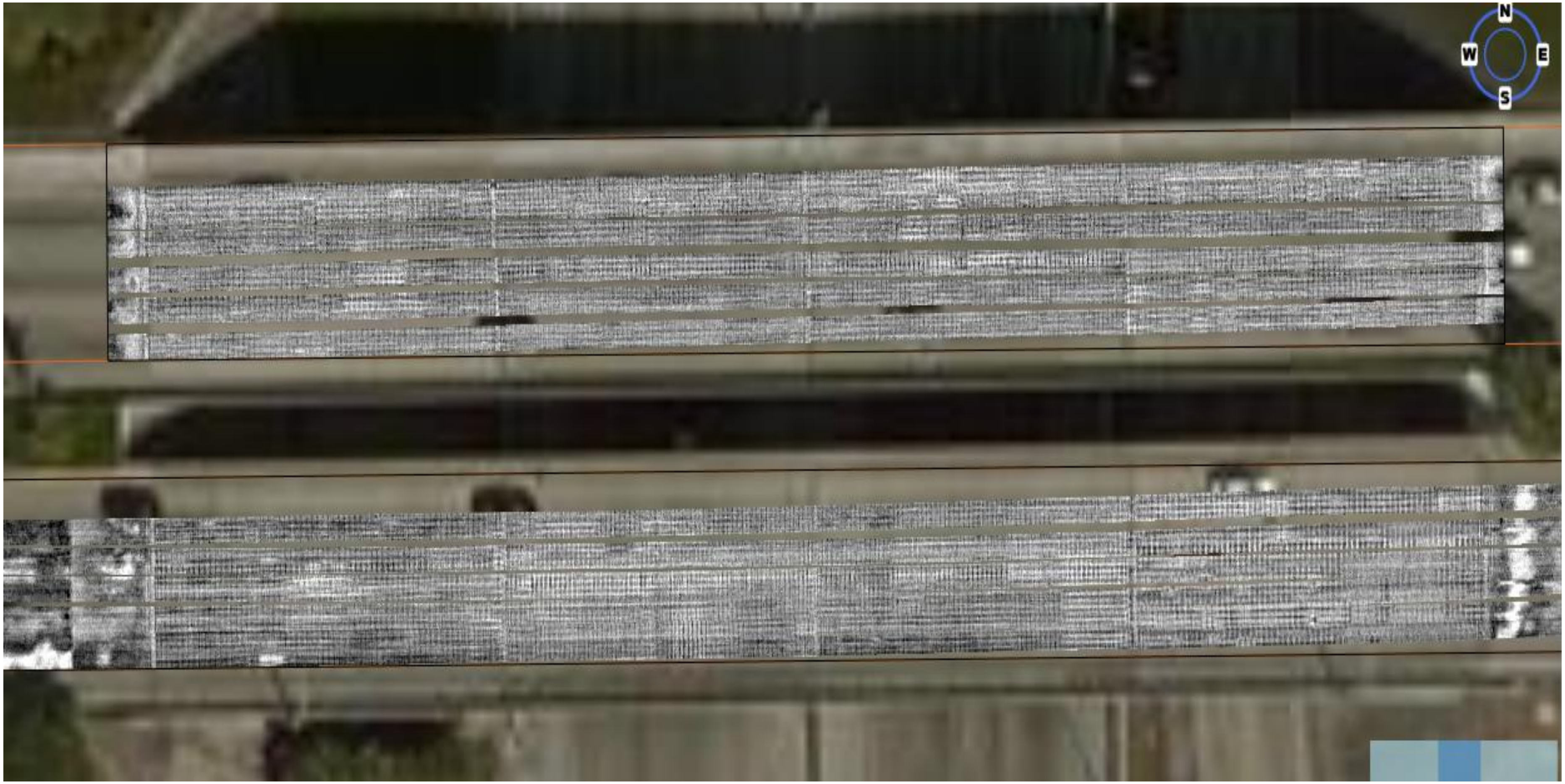


Bridge Deck Evaluation

- SR 816 Bridge, Broward County, 3 passes per lane
- Identify spans and structural changes between spans
- Locate rebar schedules in both directions
- Calculate rebar depth and areas of deck deterioration

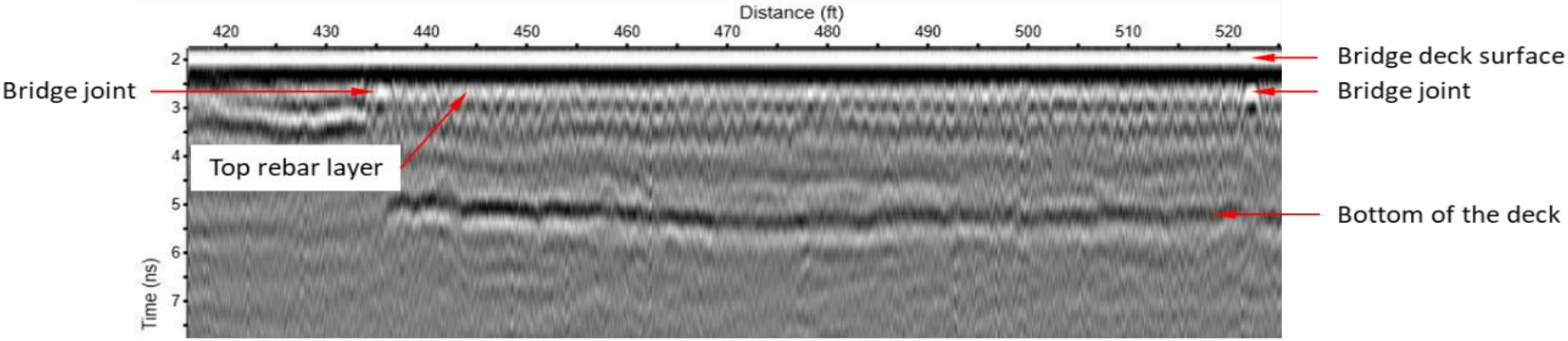
Bridge Deck Evaluation

- Bridge Deck – Overview Slice

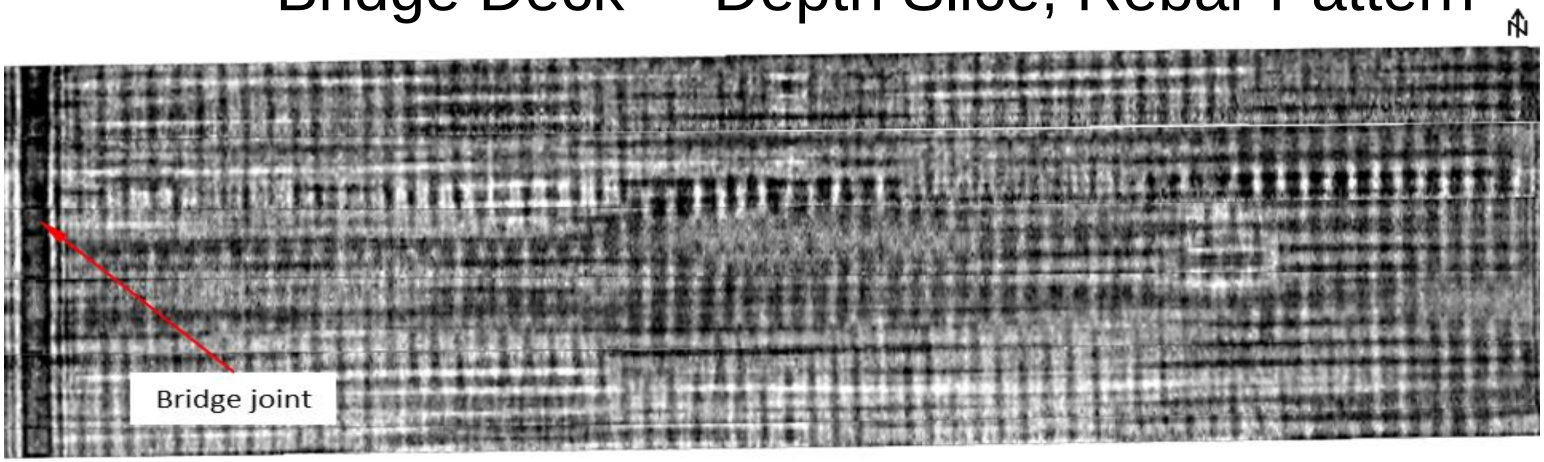


Bridge Deck Evaluation

Bridge Deck – B Scan

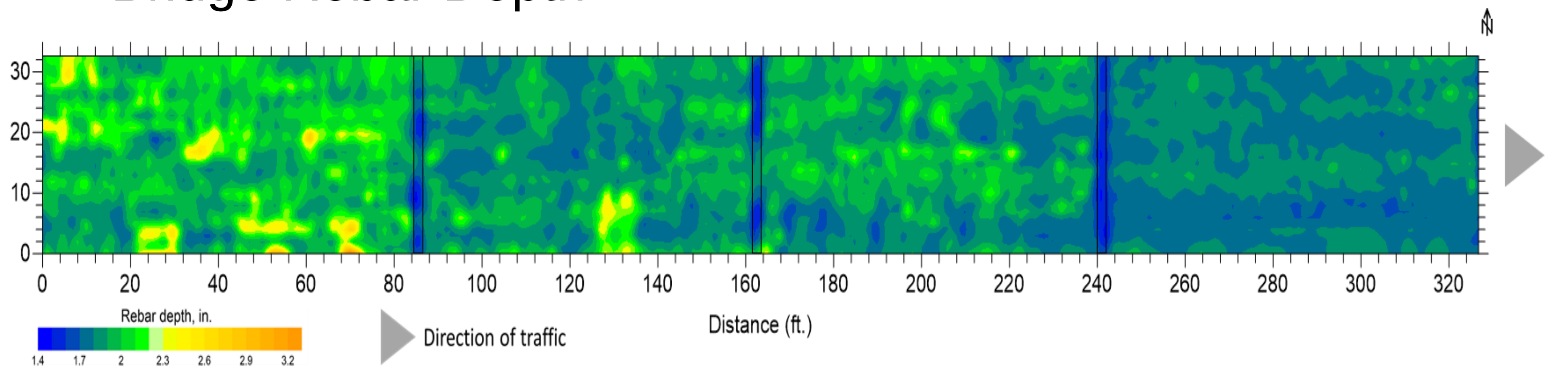


Bridge Deck – Depth Slice, Rebar Pattern

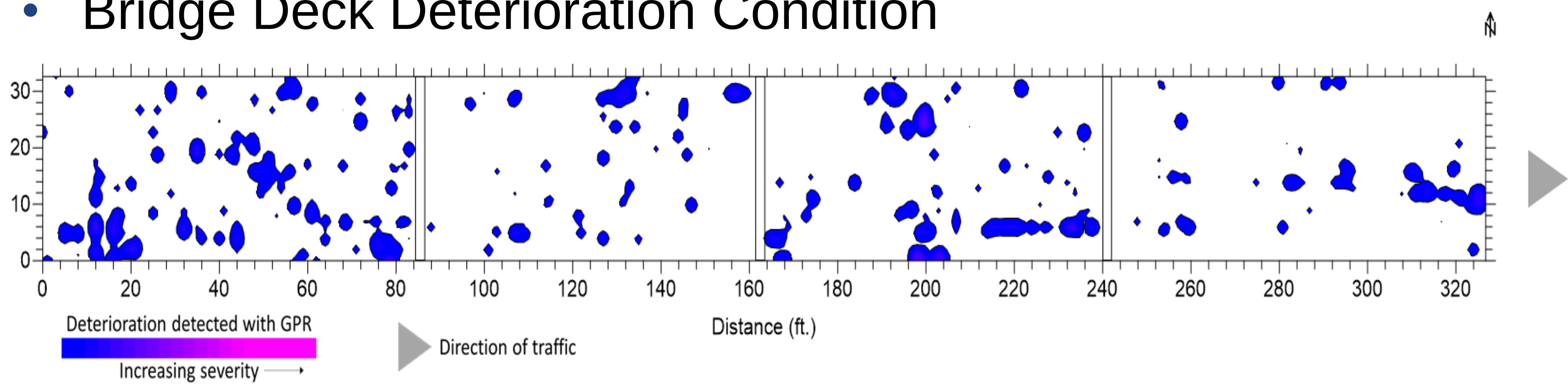


Bridge Deck Evaluation

- Bridge Rebar Depth

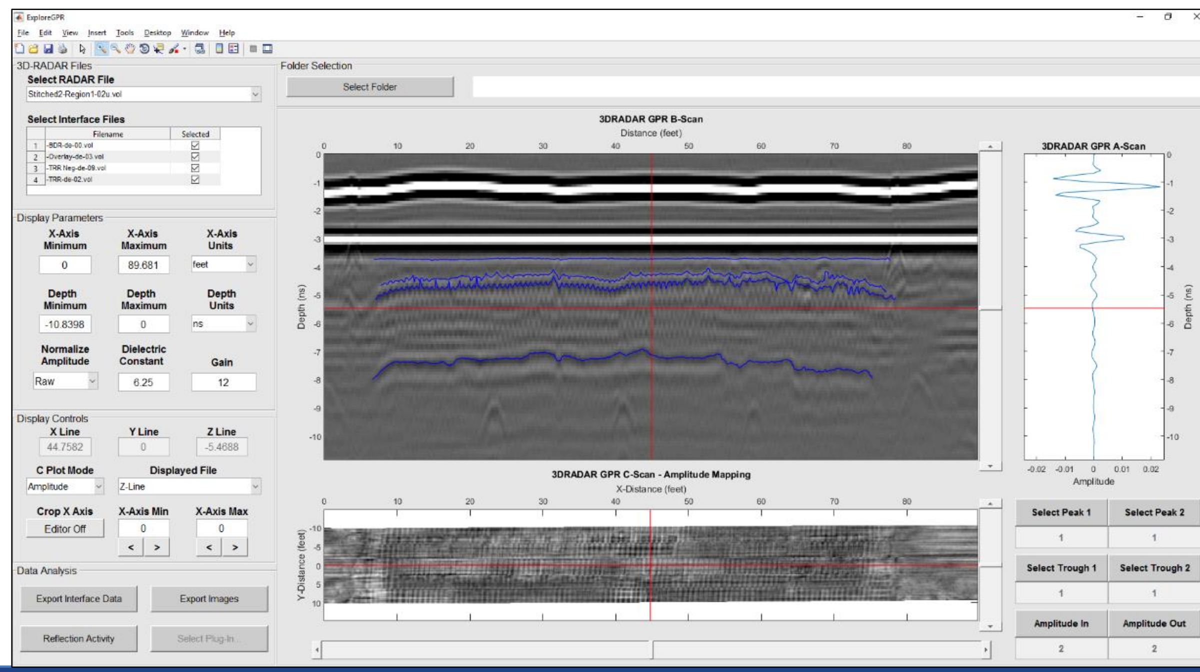


- Bridge Deck Deterioration Condition



Data Analysis Software

- ExploreGPR Software processes output of Examiner
- Provides data visualization, analysis, and reporting



Lessons Learned

- Subsurface conditions revealed via data visualization using Examiner
- Need to incorporate calibration files in order to accurately compute dielectric/density
- Quantitative data analysis using post-processing software, ExploreGPR
- Looking at return on Investment (ROI)

Questions/Comments