Ground Penetrating Radar (GPR) for Pavement Condition Evaluation

by

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Roanoke, VA

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Presentation Outline

- Background
- GPR Equipment and Software
- Pavement Applications
- Future Prospects

What is GPR?

- Transmits pulsed radio waves through pavement materials
- Waves reflect at material boundaries
- Arrival time and strength of reflections determine material depths, thicknesses, and properties

What does GPR Detect?

- Thickness of pavement layers
- Reinforcing steel
- Density variations
- Subsurface moisture
- Voids

Evolution of GPR

- 1960's,70's - early development
  - Military applications
  - Tunnel and mine detection
- 1980's - Initial adaptation to highways
- 1990's - Practical development and implementation for pavements
- 2000+ - Adaptation by highway agencies

GPR Equipment

- Data acquisition and control systems
- GPR antennas
  - Air Coupled
  - Ground Coupled

1 GHz Horn Antennas

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Current Horn Antennas

1 GHz Horns

2 GHz Horns

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Ground-Coupled Antennas

1.5 GHz

500 MHz

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Equipment Summary

- Antennas have become more compact
- Electronics have become more stable
- Range of frequencies has expanded
  - Provides higher resolutions, greater depths of penetration

Software and Data Interpretation

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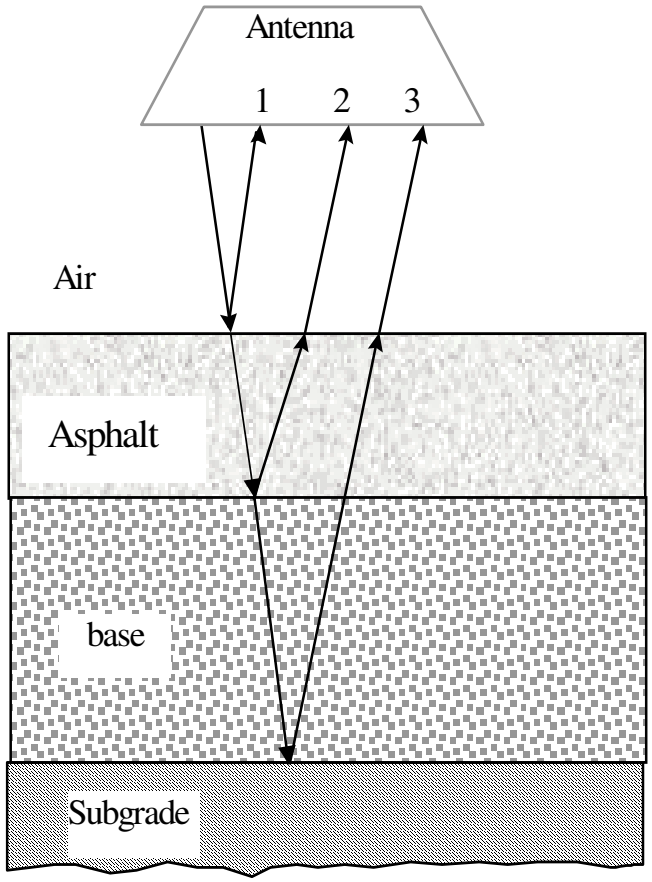
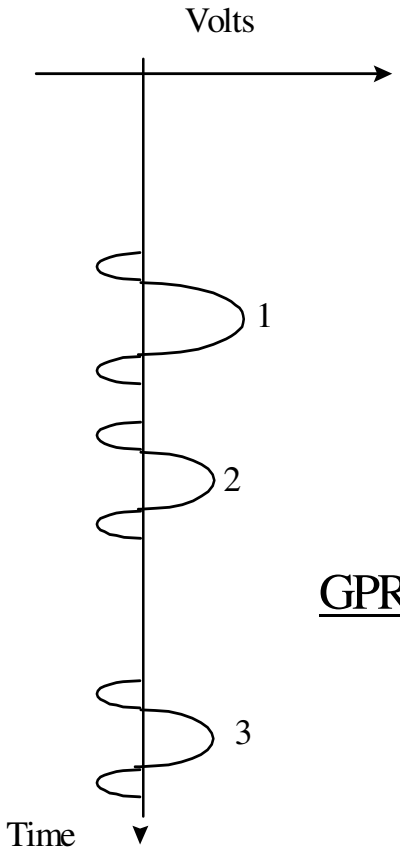
Principles of GPR Application

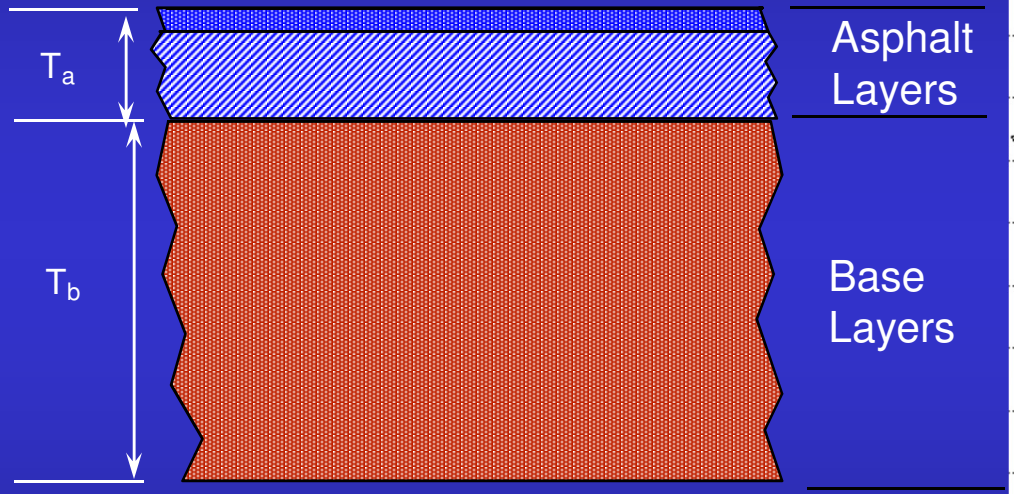


Measurement Setup

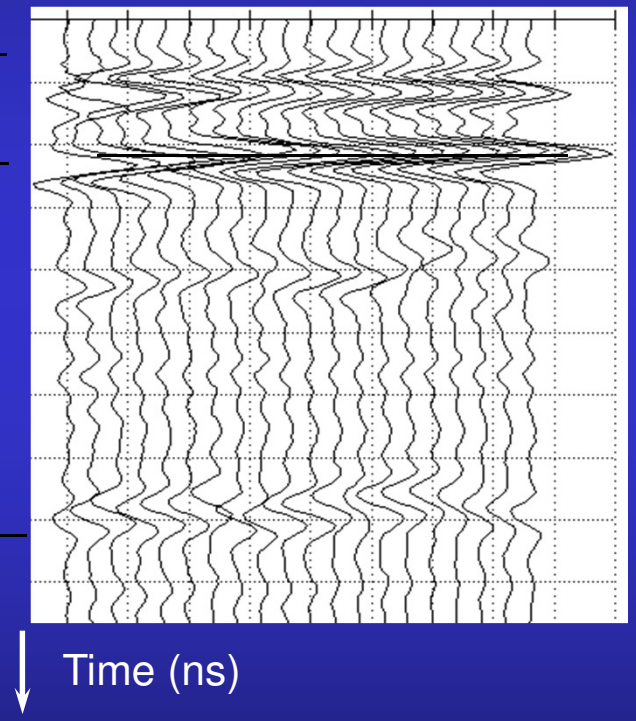


GPR Record

Sample of Data



Pavement Structure



GPR Record

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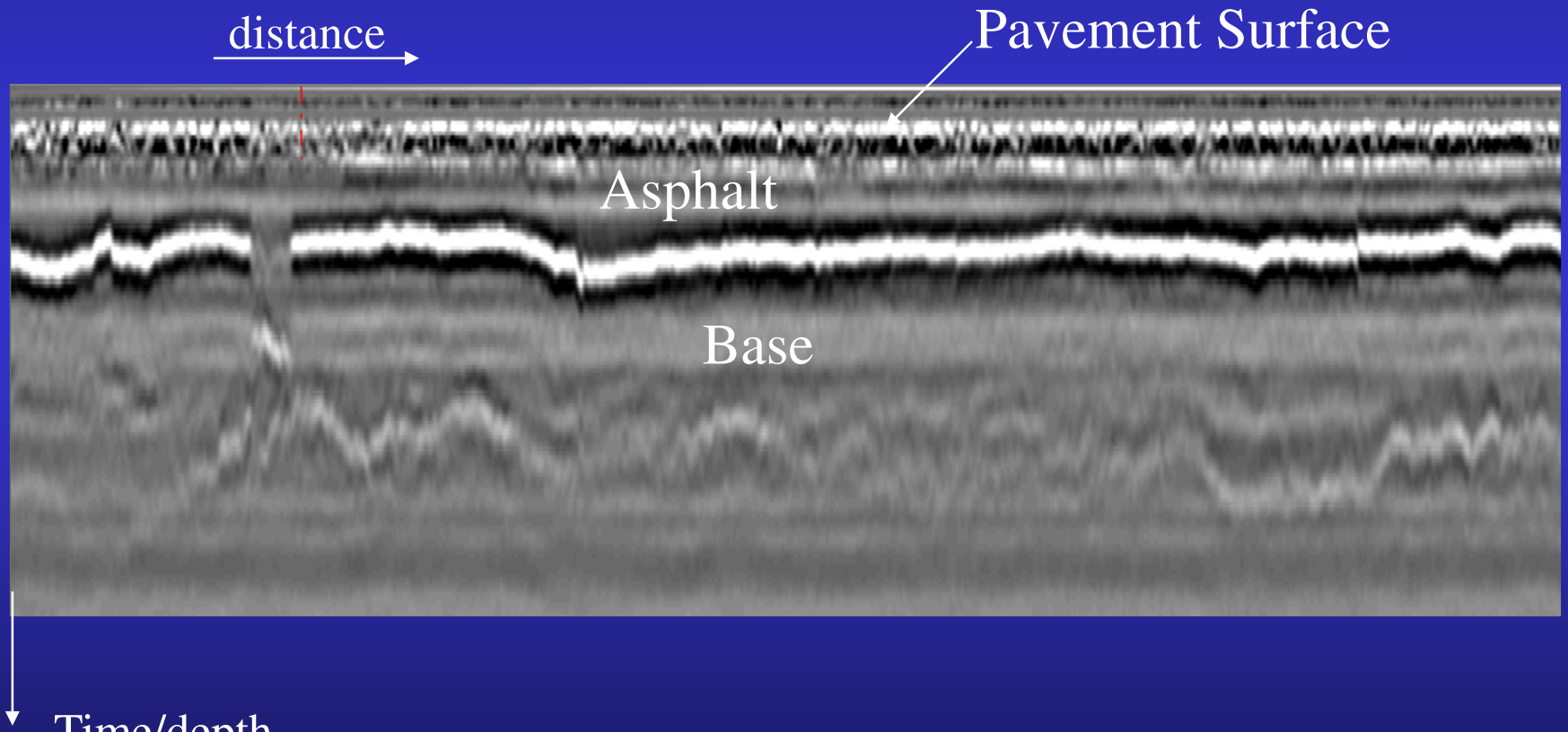
Sample Graphic GPR Data



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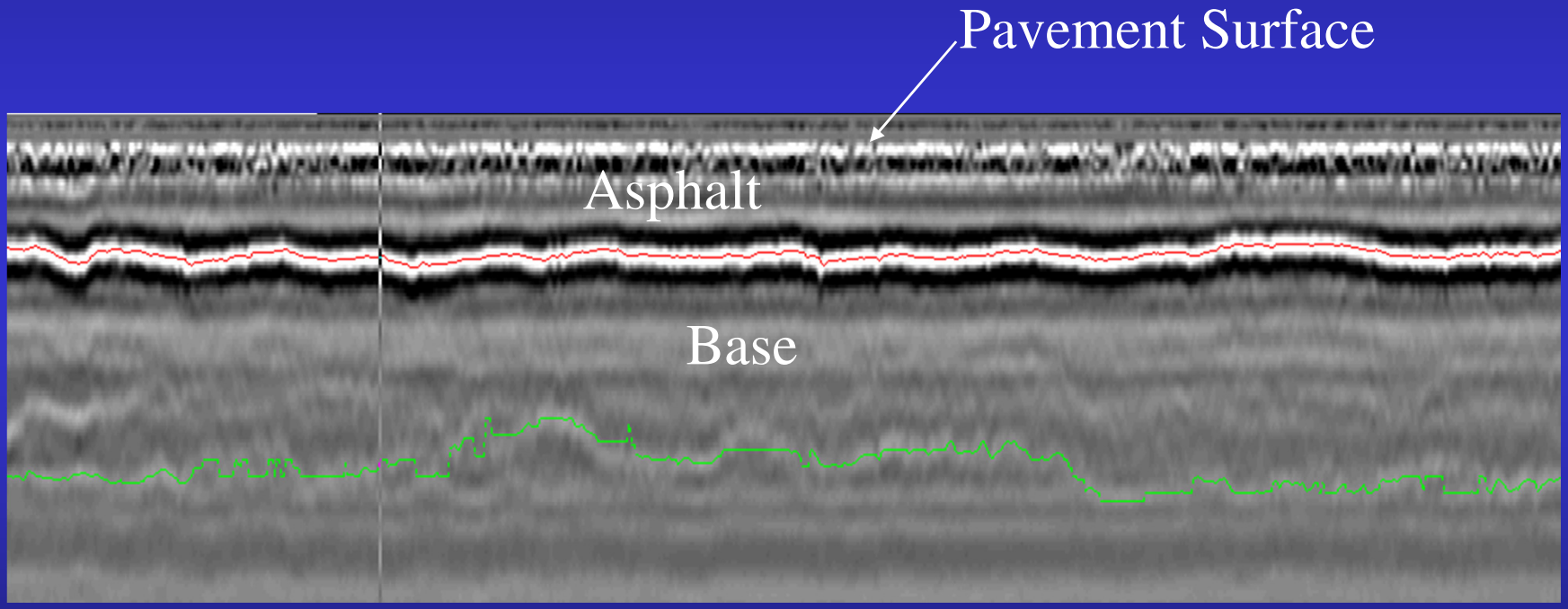
Sample Processed Graphic Data on Asphalt Pavement



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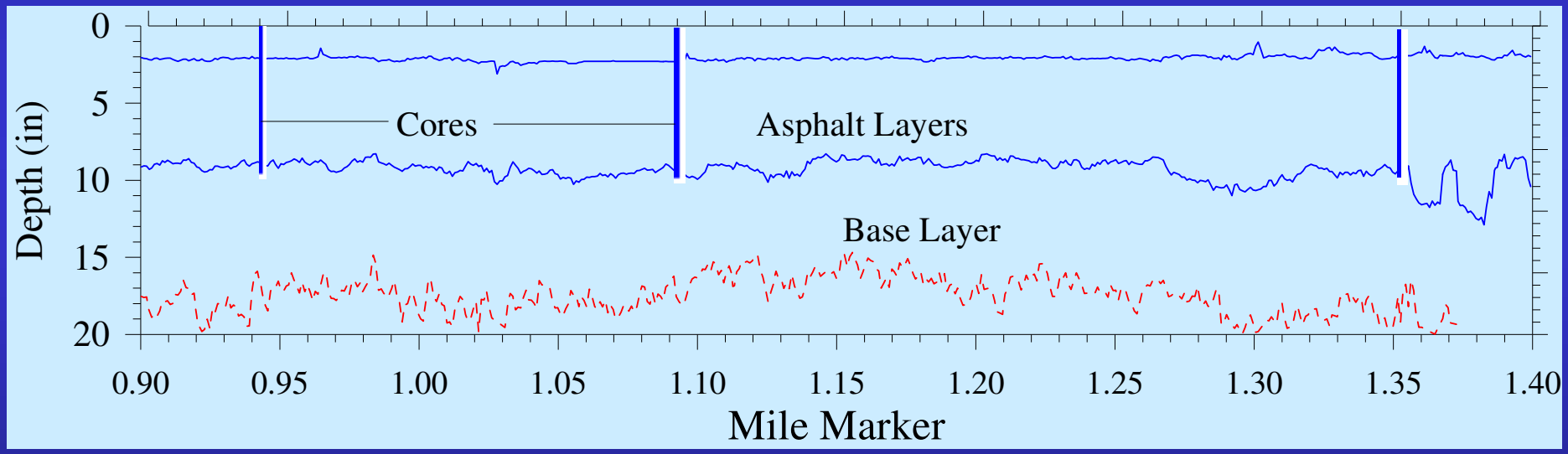
Linear Plot of Pavement Layer Thickness



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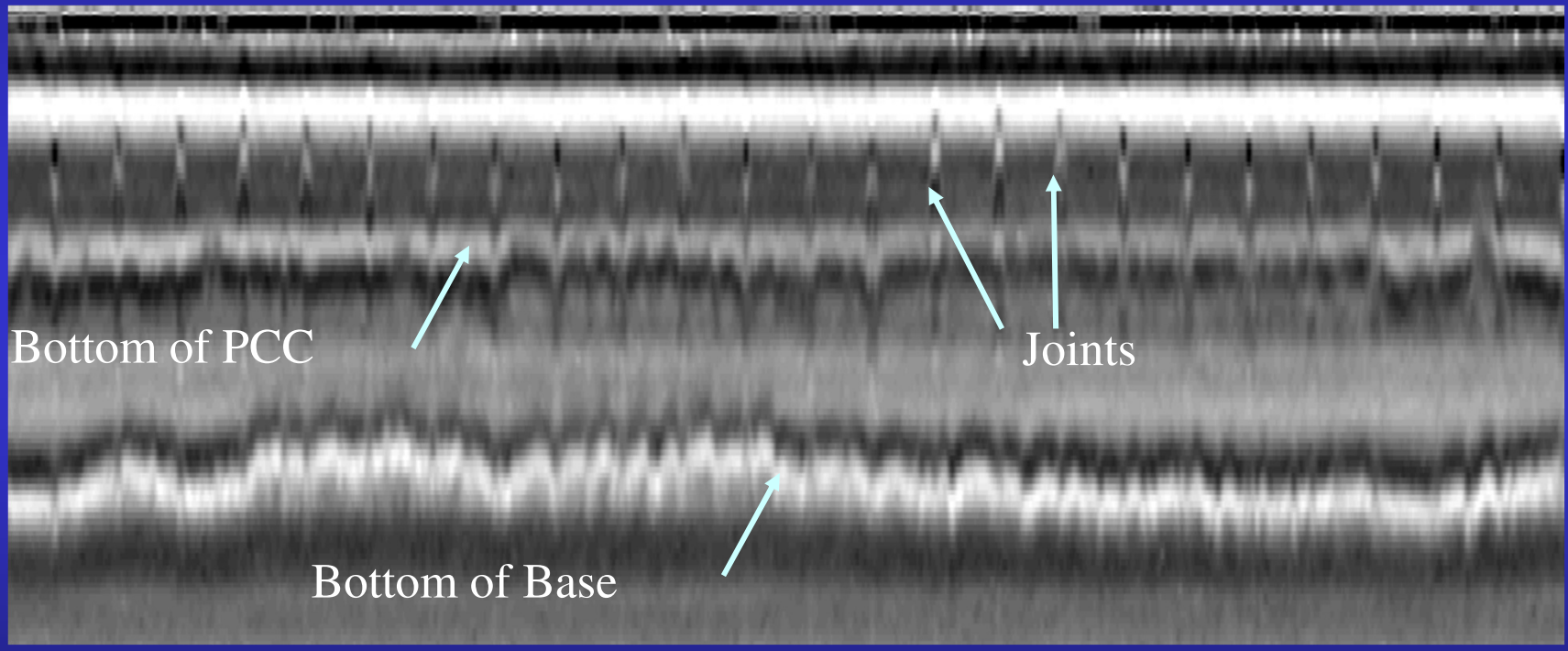
GPR Data for PCC Pavement



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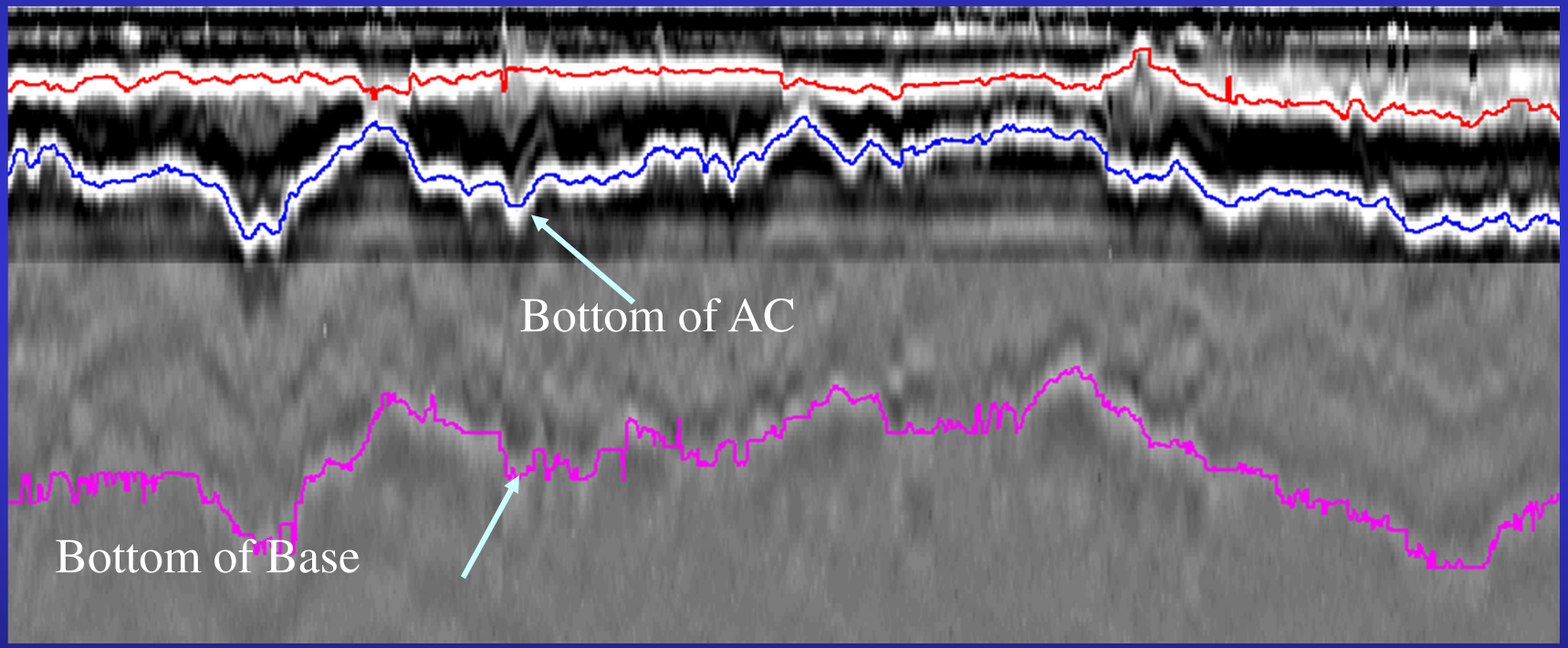
Typical Pavement Structure Data Analysis



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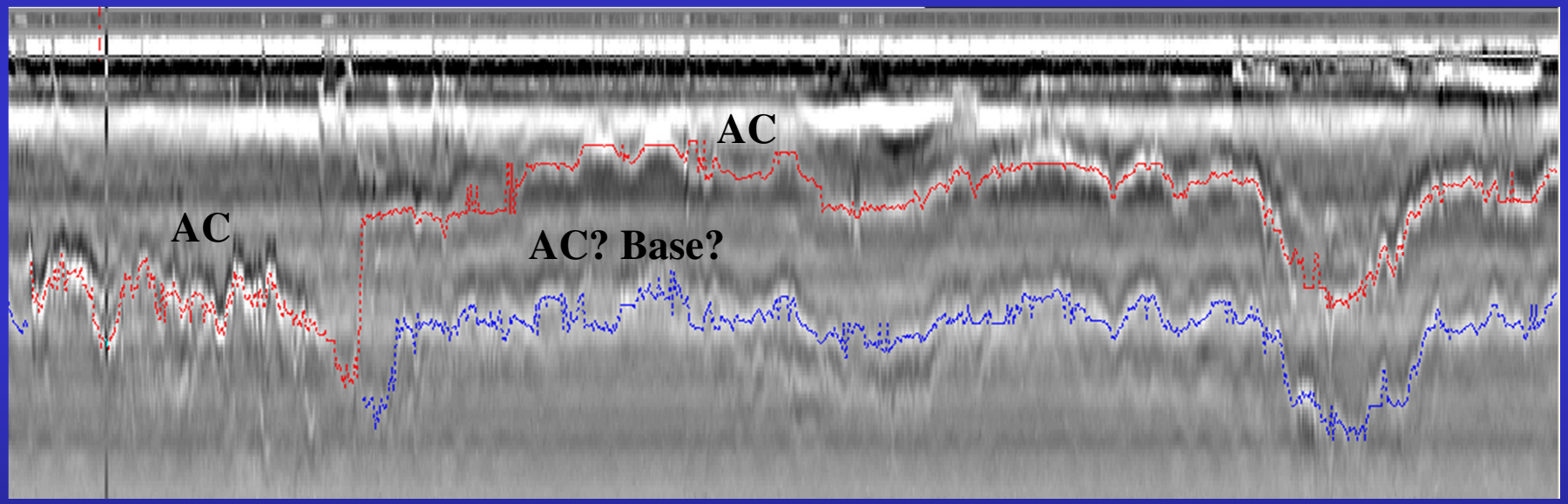
GPR Data with Unclear Interpretation



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Software/Interpretation

- Software developments have facilitated quantitative analysis
- Some interpretation is still required to distinguish layer types
- Fully automated processing is available for limited applications (density, FWD)

Pavement Applications

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Pavement Applications of GPR

- Pavement Management (Network)
- Rehabilitation Design (Project)
- Quality Assurance of New Pavement Construction (thickness, density)
- Subsurface Moisture/Drainage
- Location of Dowels
- Detection of Asphalt Stripping

GPR for Pavement Management

- Layer structure data for PMS
- Layer thickness for network FWD
- 100-200 lane miles per day coverage
- Results typically at 0.1 mile intervals

Rehabilitation Design

- Existing thickness for overlay design
- Bound layer thickness for design of in place recycling depths
- Thickness used with FWD data
- Locate areas of high moisture for drainage design
- Locate subsurface damage

Accelerated Rutting from Clogged Drains

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View of Clogged Drain

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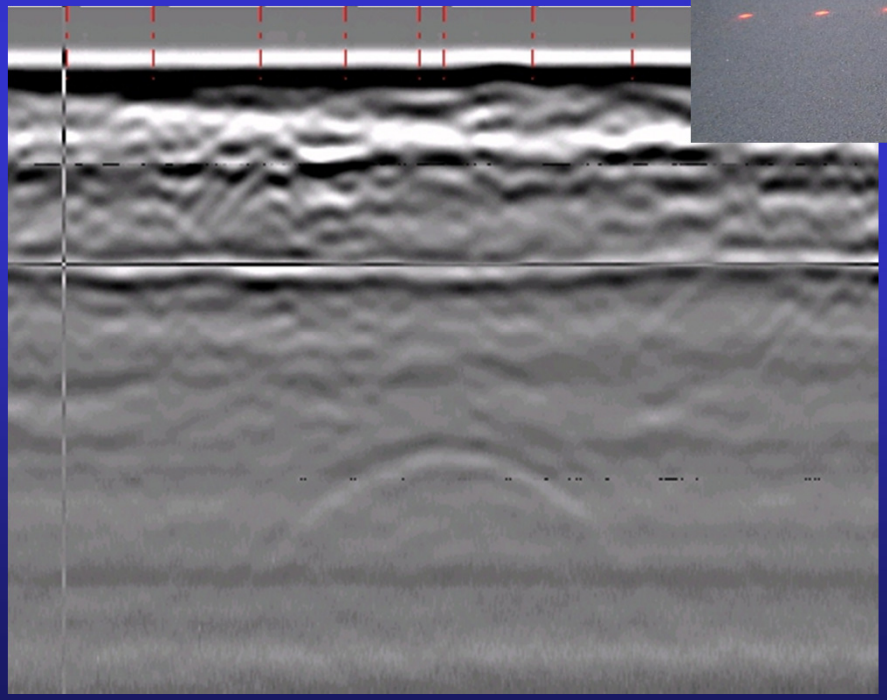
Detection of Drain with GPR



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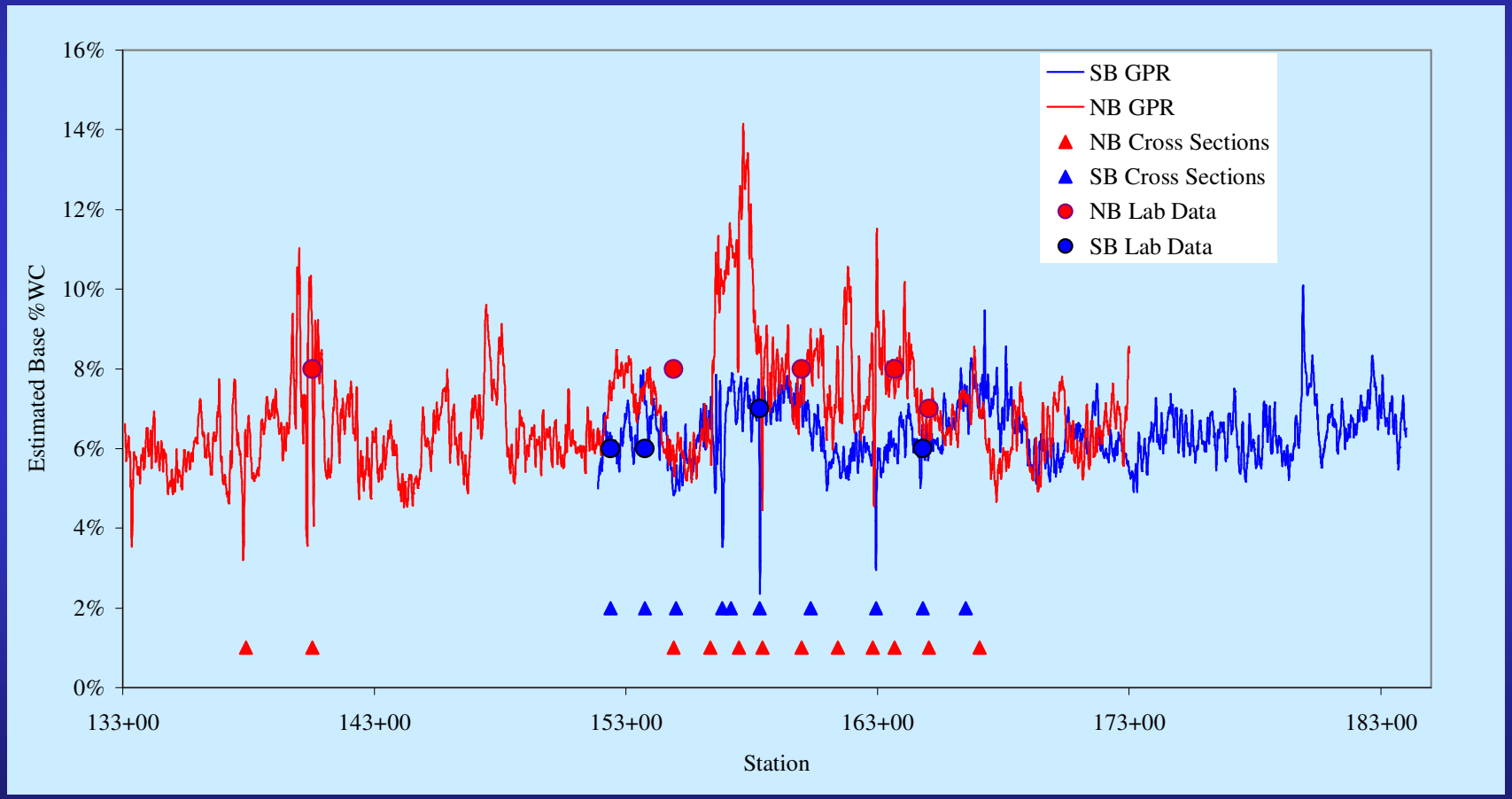
Base Moisture Content from GPR



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Future Prospects for GPR

- Equipment
  - More compact, portable (wireless) equipment
  - Implementation of antenna arrays
  - Increased frequency range for depth/detail
- Software
  - more automated, user friendly
- Applications
  - Improved detection capability for expanded applications