Laser-Based Technology for Automated Rut Measurement in Accelerated Pavement Testing

Tom Byron
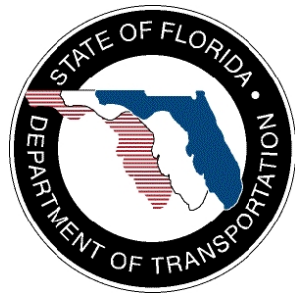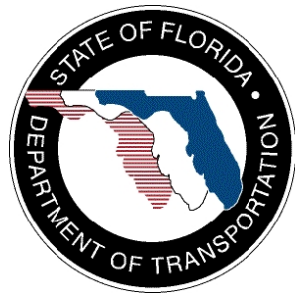
Salil Gokhale

Bouzid Choubane

Overview

- Florida's APT program
- Pavement profile measurements
- Implementation of non-contact profiling in APT
- Data collection and analysis functions
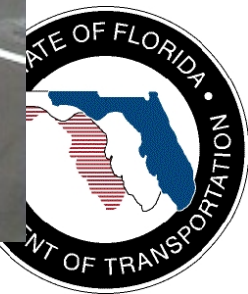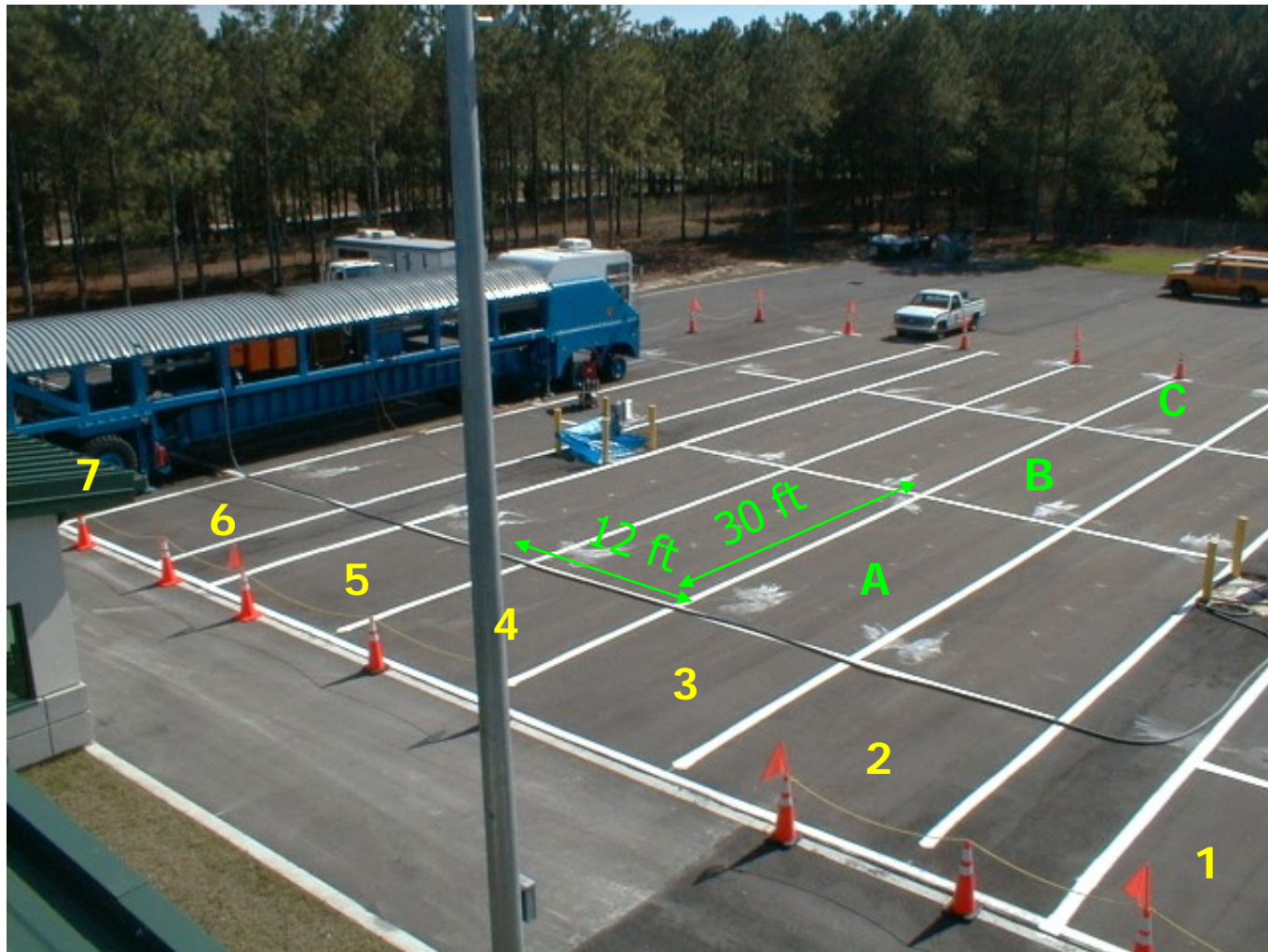- Automated rut measurements
- Other applications

FDOT's APT Program

- **Initiated in Year 2000**
- **To date:**
  - 2 flexible pavement experiments
  - 1 rigid pavement experiment
  - 1 composite pavement experiment
  - 2 geotechnical experiments
  - 1 miscellaneous experiment – Raised pavement markers

APT Site

APT Site

Moisture Control Capability

Heavy Vehicle Simulator (HVS)

Diesel or Electric Power
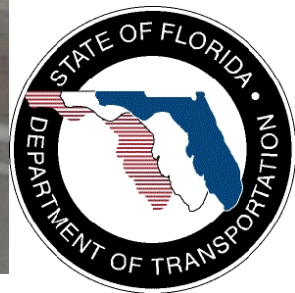
Weight: 50+ t, Length: 23 m

Height: 4 m, Width: 3.7m

Loading: 31 – 200 kN

Wheel speed: 13 kph

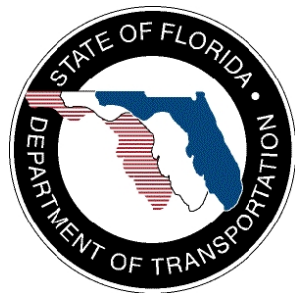Maximum Passes per day:

29,000 bi-directional

14,000 uni-directional

Additional Features

- **Environmental Chamber (Radiant heater)**
  - 50 mm styrofoam with aluminum siding
  - Most tests are conducted at a controlled temperature
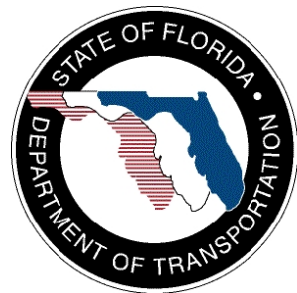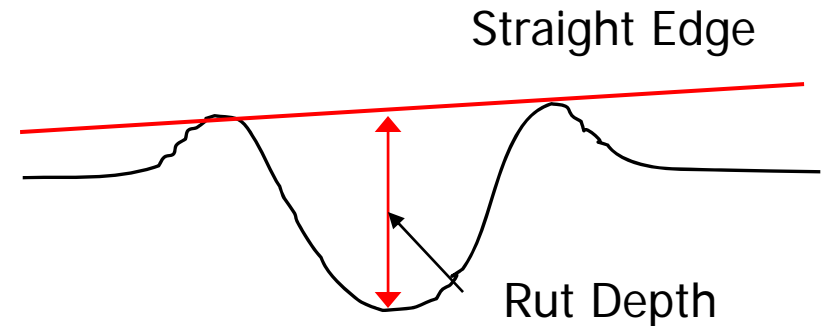- **Single or dual tire**
- **Laser profiling system**

Pavement Profile Measurements

- ## In most APT experiments:
  - ### Characterizing test pavement surface
  - ### Measurement of permanent deformation
  - ### Accurate mapping of cracks
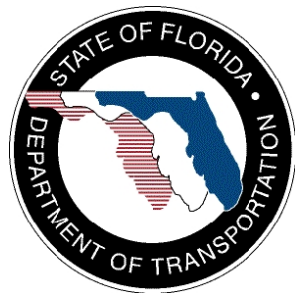
Measurement of Rut Depth

- ## Manual Methods
  - ### Straight edge

- ## Automated Methods
  - ### Non contact profilers
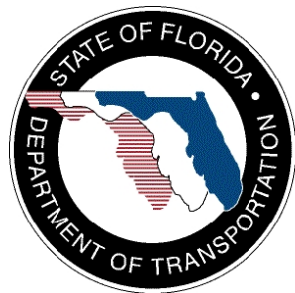 - ### Various proprietary devices

Straight Edge

Rut Depth

Manual Rut Measurements

- **Advantages**
  - Widely accepted as base-line measurements
  - Very easy to perform

- **Disadvantages**
  - Time consuming and labor intensive
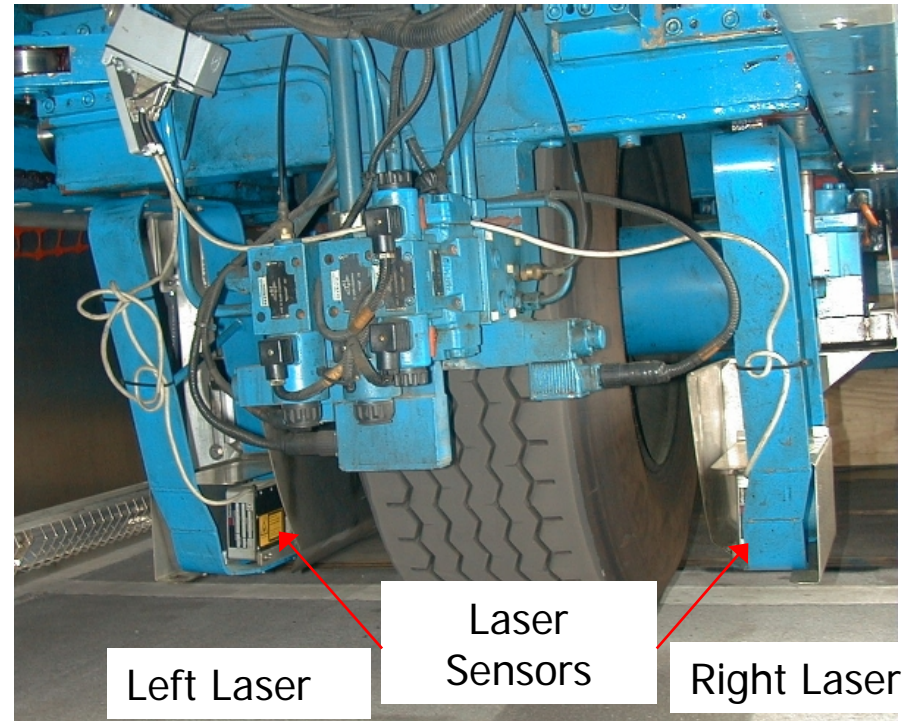 - Limited data points, therefore difficult to obtain entire test surface profile
  - More chances of measurement error

Automated Rut Measurements

- FDOT Laser Profiling System
  - Fully automated
  - Entire surface profile is obtained
  - One set of profiles is taken in less than 10 minutes
  - Highly accurate
  - Does not tie up personnel
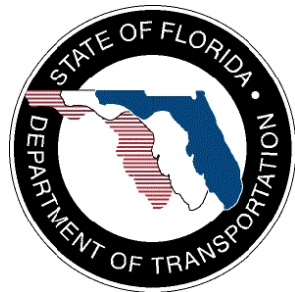
Laser Profiling System

- Two 16 kHz Lasers, mounted 762mm (30 in) apart

- Very accurate

- Wheel carriage travels at 4 kph during data collection

- Carriage is 'unloaded'

Left Laser

Laser Sensors

Right Laser

Pavement Profiles

Data collection:

Wheel unloaded

Profile time = 10 minutes

1524 mm

(5 ft)

WHEEL PATH

Test Wheel and Carriage

Left Laser

Right Laser

5892 mm

(20 ft)

25mm (1 in) Test Section
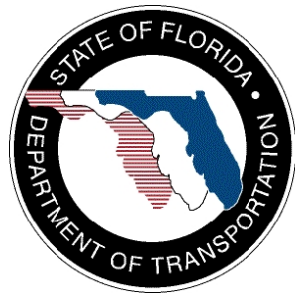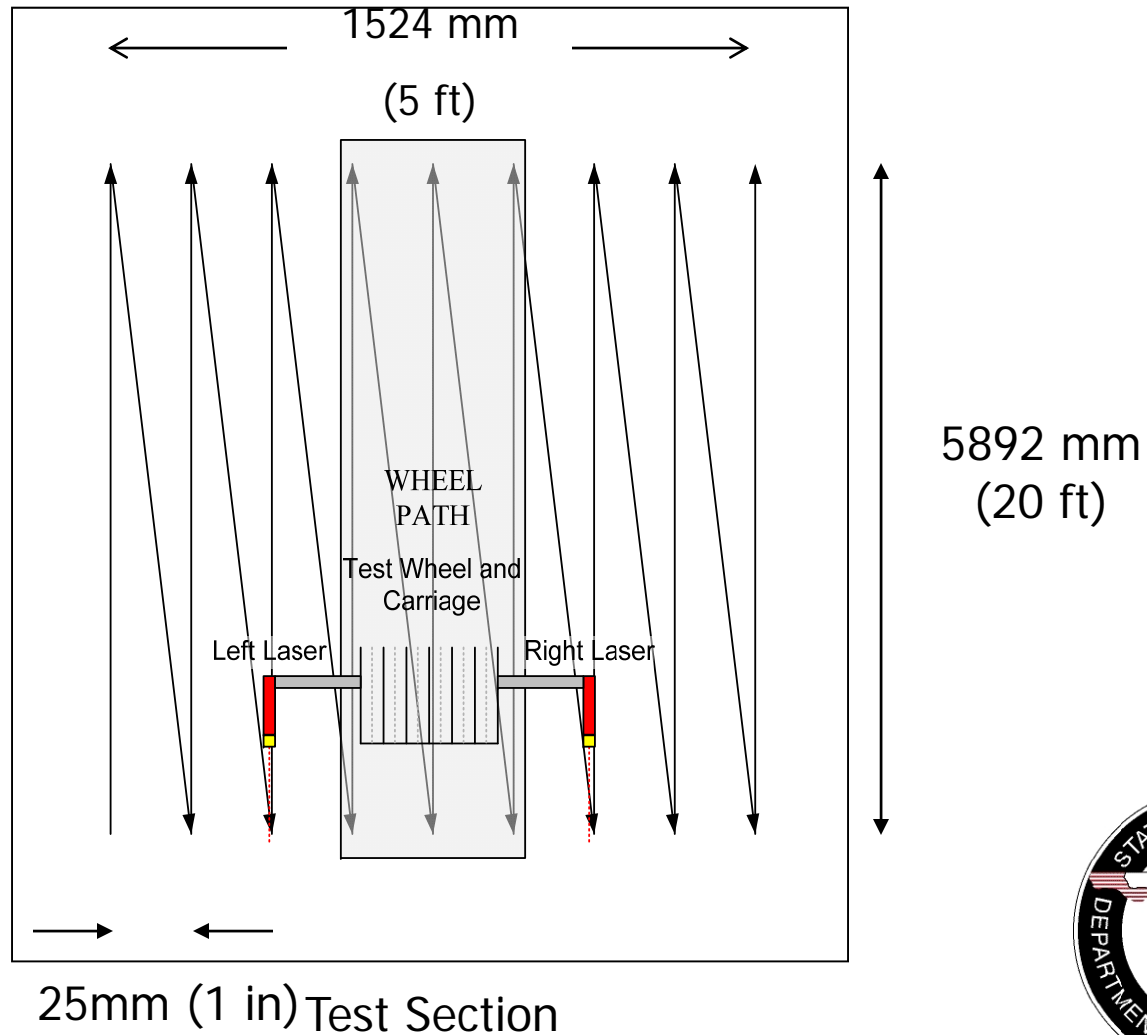
Data Collection

- 2 sets of data are acquired, one from each laser

- Data is averaged every 100 mm in the longitudinal direction

- Results in a 58 x 134 data array

- Data saved in ASCII format
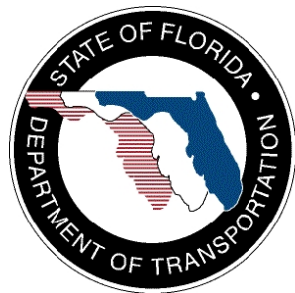
Data Acquisition
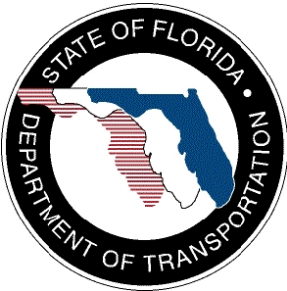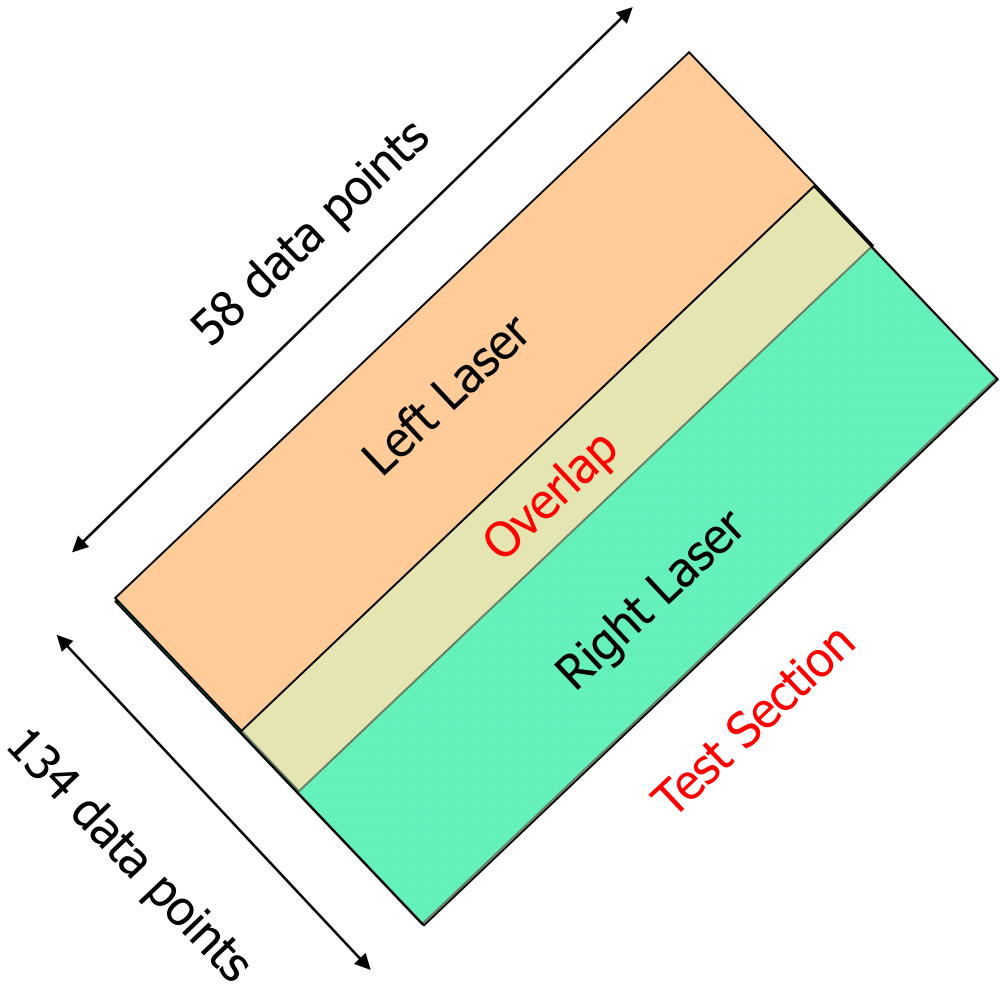
Data Analysis

- **Important Considerations**
  - Ensure data collection procedure and data format are standardized
  - Collection of initial or 'untested' pavement surface profile is essential
  - Algorithm for data processing
  - Overlapping data is very important
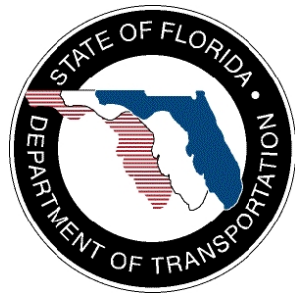
FDOT's Rut Analysis Program

- Developed in-house
- MS-Excel, Visual Basic for Applications (VBA) based
- Very easy to use
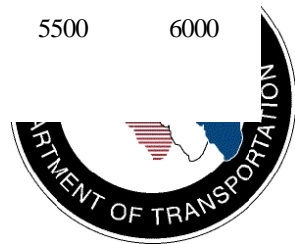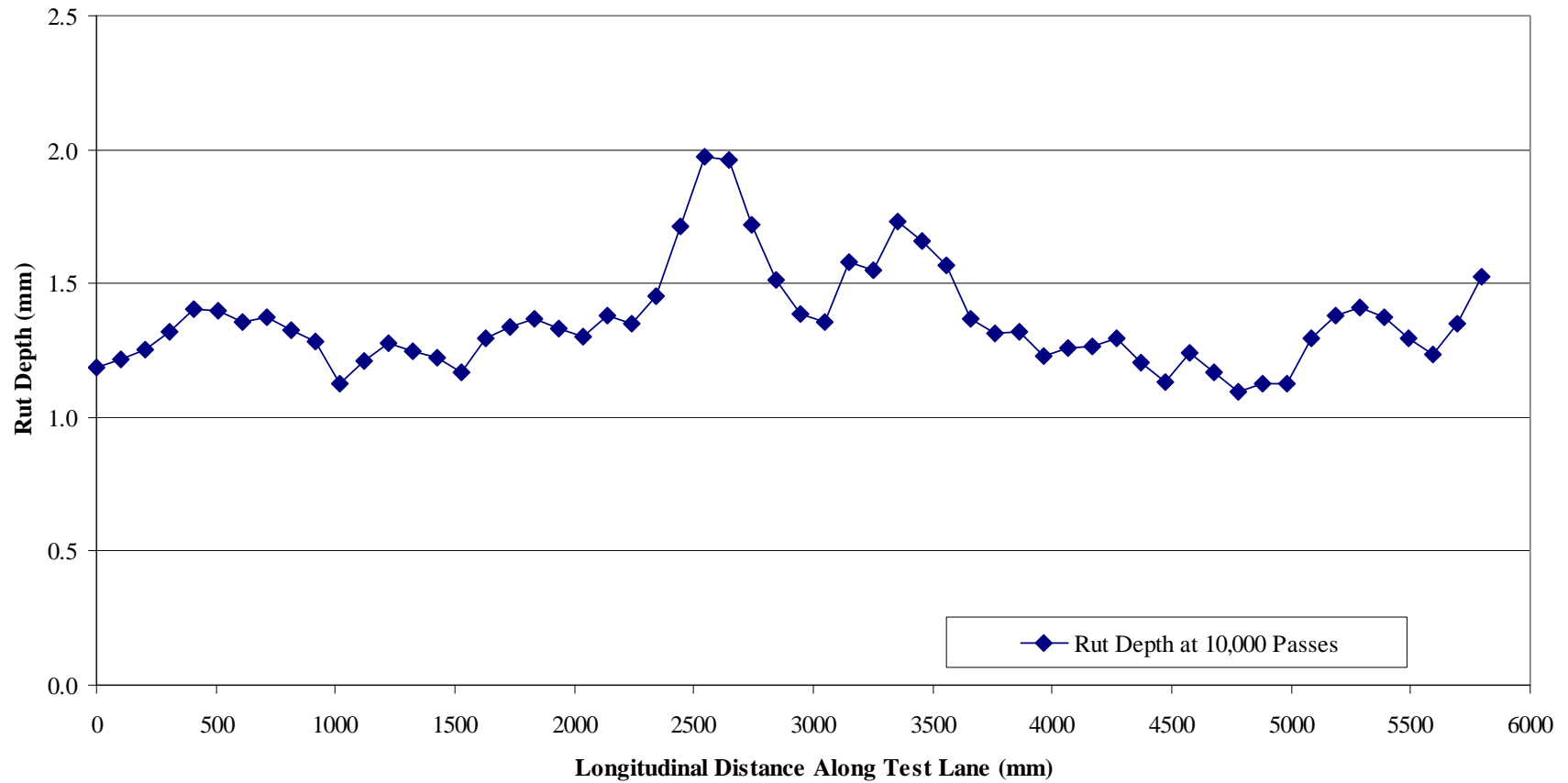- Complies, analyzes and stores data

Program Flow Chart
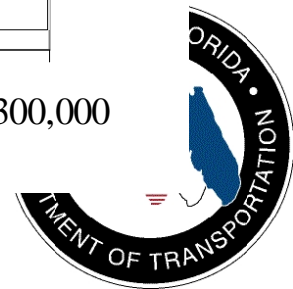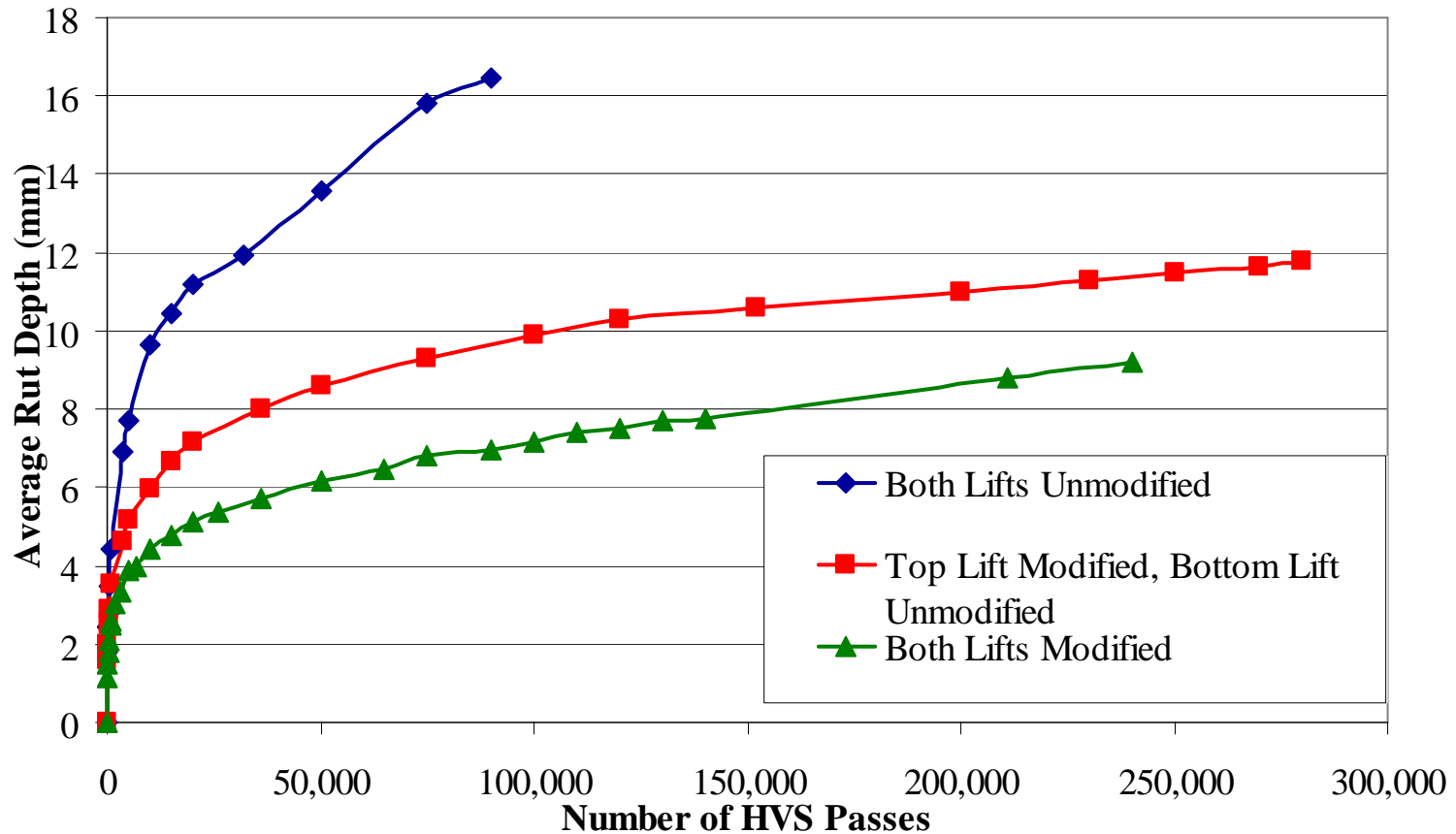
Typical Transverse Profile
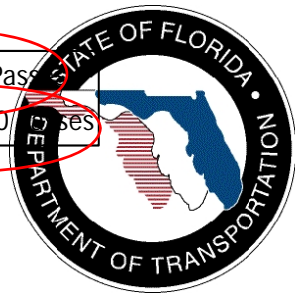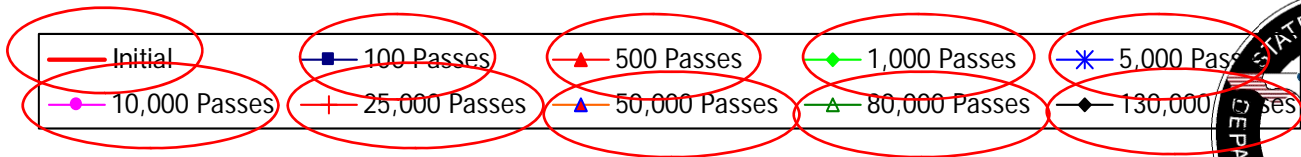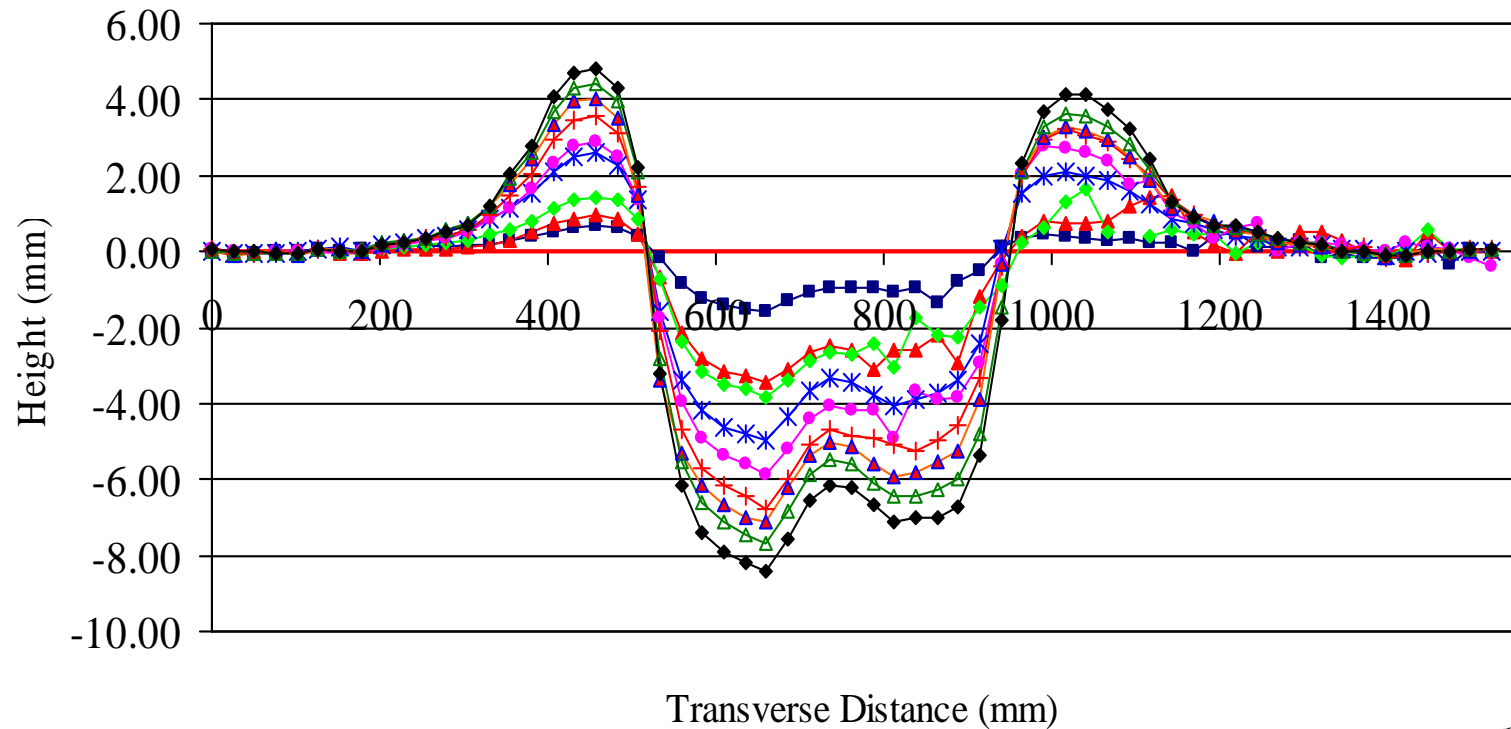
Calculation of Rut Depth
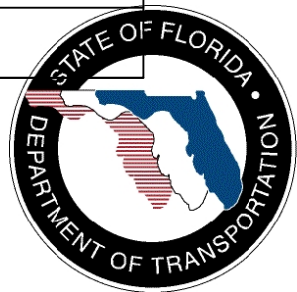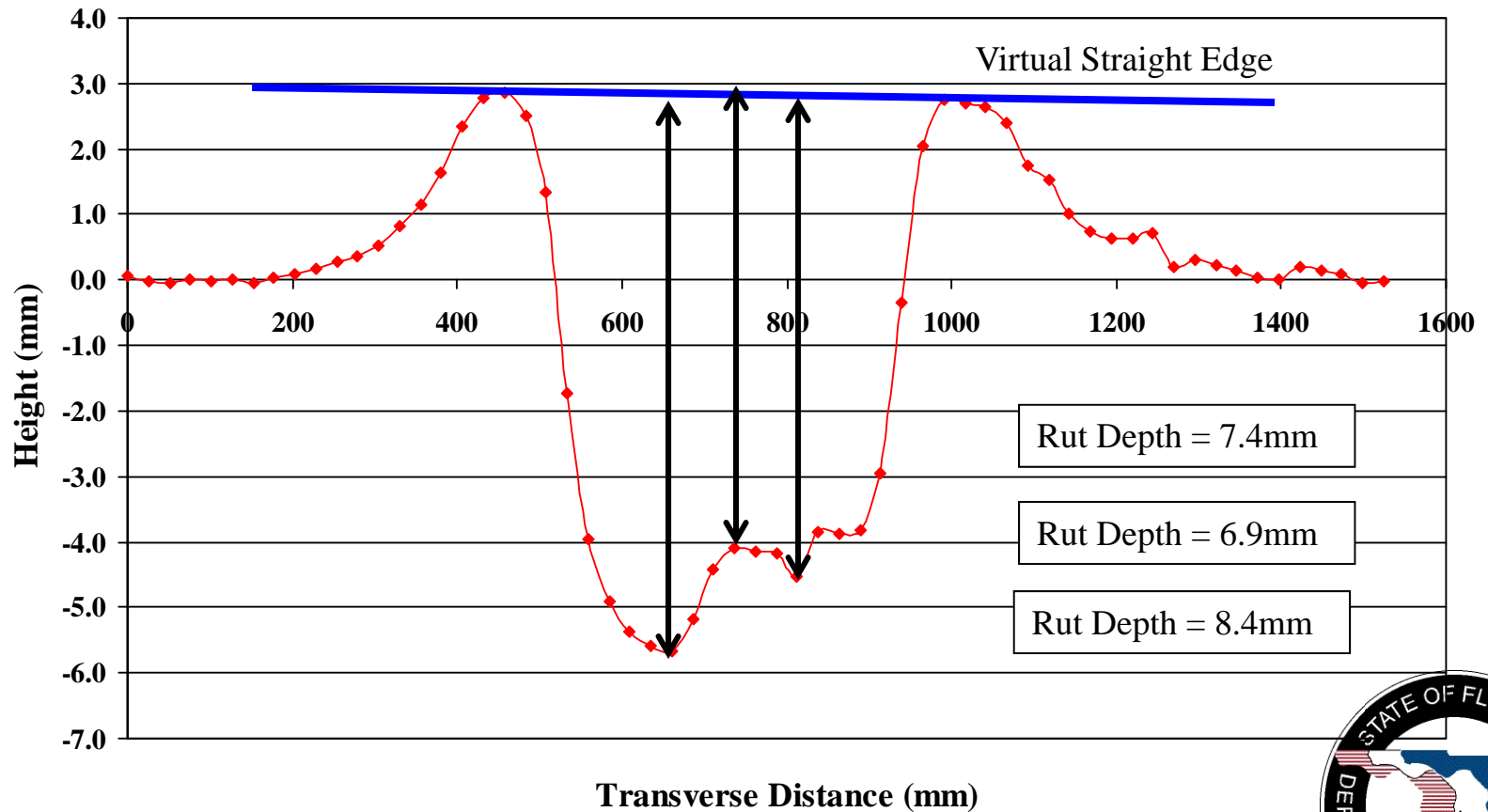
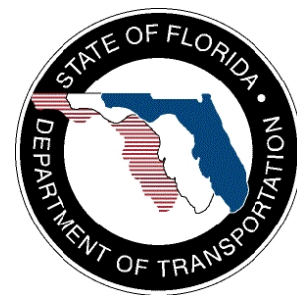# Longitudinal Variation of Rut Depth
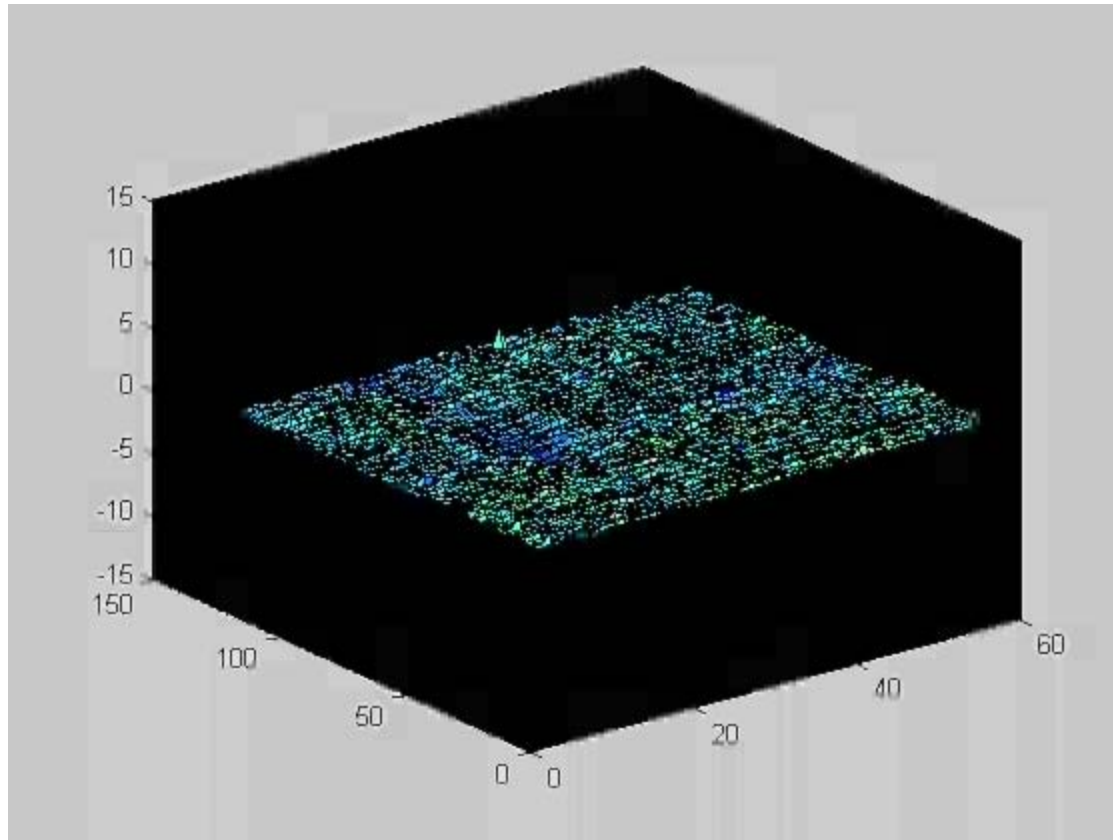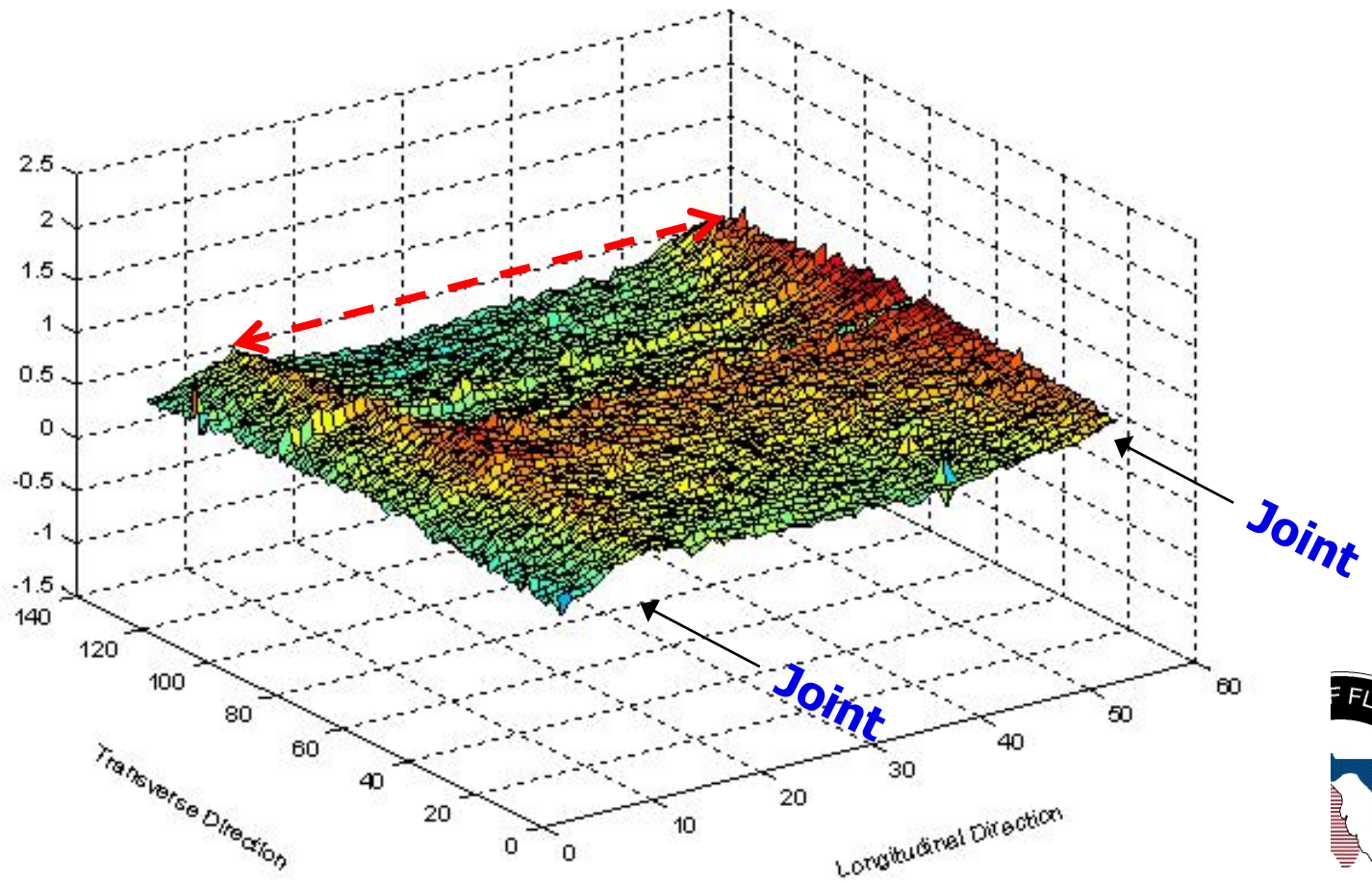
Rut Measurements
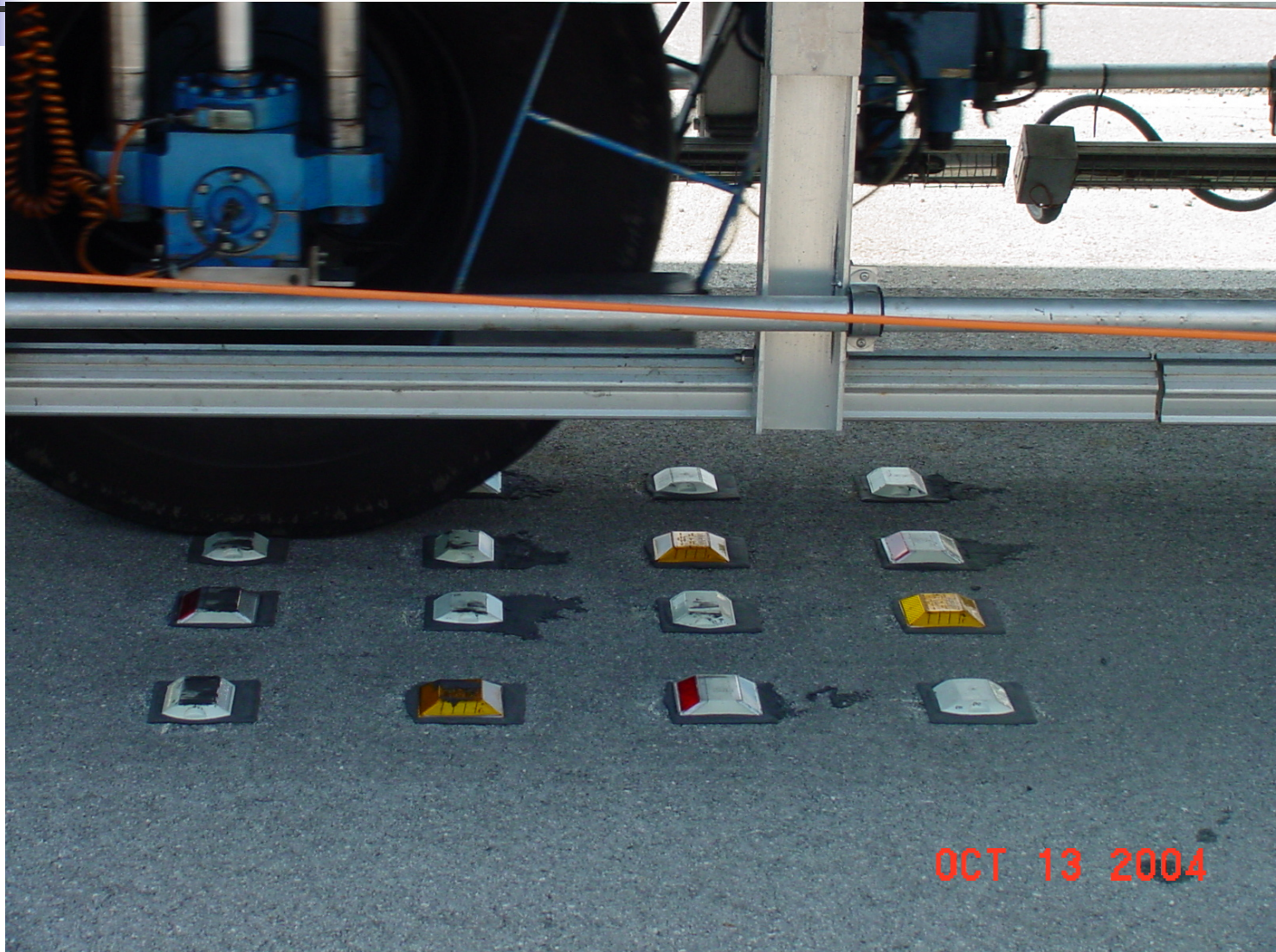
Laser Based Profiling System

Other Applications

Flexible Pavements – Rut Development
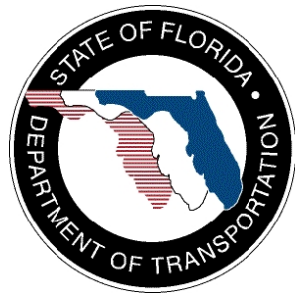
Rigid Pavements – Slab Curling

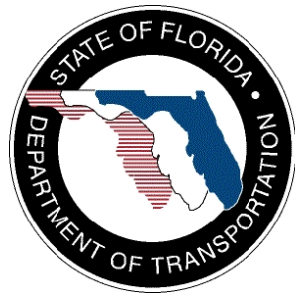# Raised Pavement Markers

FDOT's Experience

- Laser Based Profiling System
  - Extremely beneficial
  - Large savings in time and manpower resources
  - Entire surface profile is obtained
  - Data can be used for other analyses – Volume change analysis.

Presentation

- **Rut Initiation Mechanisms In Asphalt Mixtures as Generated Under APT Loading**
  - Recent and Significant Accelerated Pavement Testing Results, Session 708
  - Wednesday, January 12, 4.30 – 6.00pm
  - Shoreham

Questions?