



U.S. Department  
of Transportation  
Federal Highway  
Administration



# Fundamentals of Intelligent Compaction (IC)

By

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# What is Intelligent Compaction (IC) ?

- IC in simple form: “ it is nothing but addition of Science and Technology into the Art of Compaction”
- Compaction is one of the most important processes in roadway construction
- It plays very critical role in achieving long lasting pavements

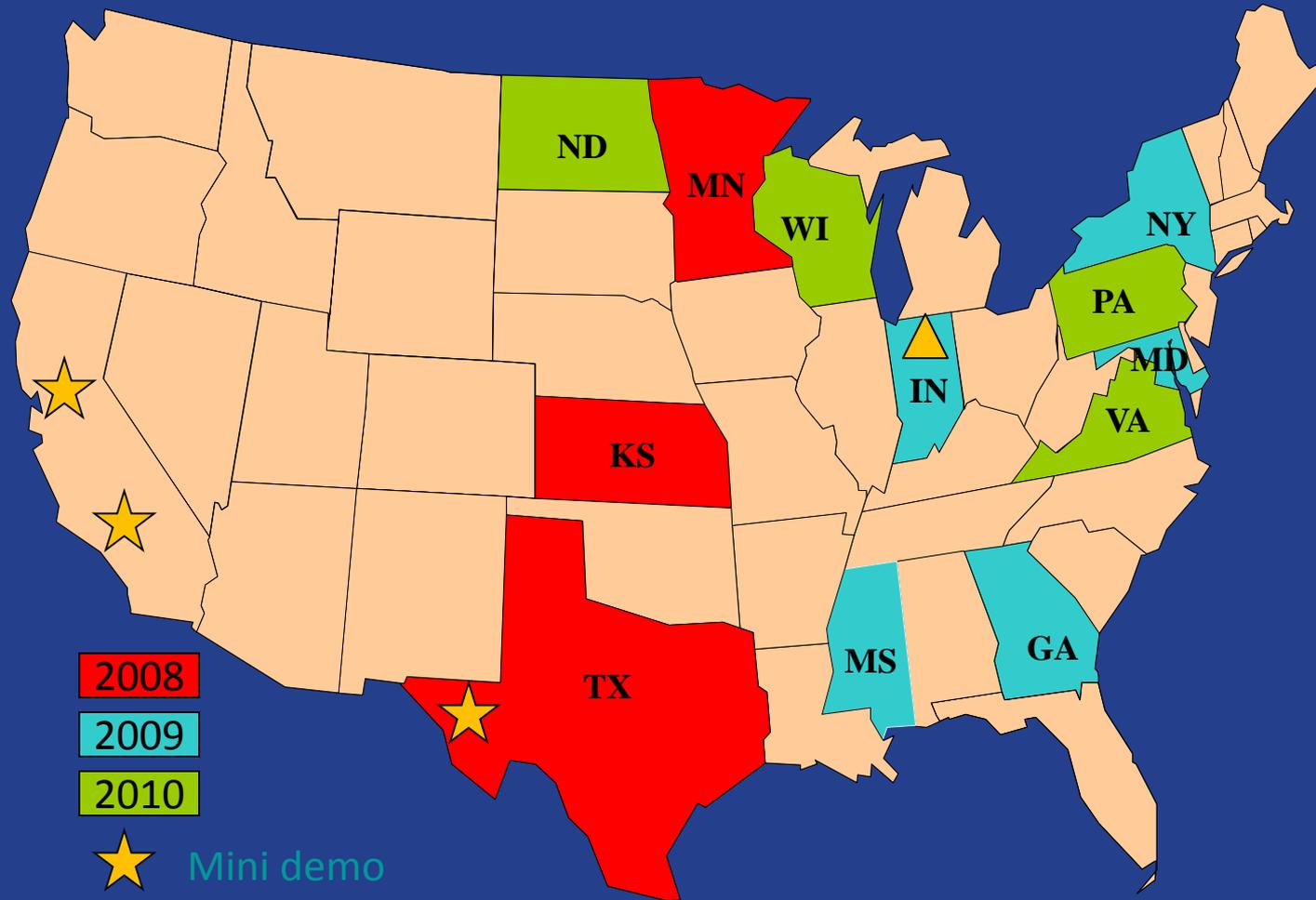


# FHWA Pooled Fund IC Project 2008-11

- Demonstrate HMA IC Technologies to Agencies and Industry
- Develop Experience and Expertise within DOT Organizations
- Assist the DOT's in the development of Quality Control Specifications
- Identification and prioritization for further research and data analysis



# IC-TPF States



2008

2009

2010

★ Mini demo

▲ 2 demos



# Why Intelligent Compaction?

- Compaction is one of the most important processes in roadway construction.
- It is essential in achieving high quality, uniform compacted materials, which better ensures long-lasting performance.
- Efficiency of operation: Compaction effort only applied when and where needed.



# Why Intelligent Compaction?

## Shortcomings in Conventional Compaction



Limited  
On-The-Fly  
Feedback



Over-  
Compaction

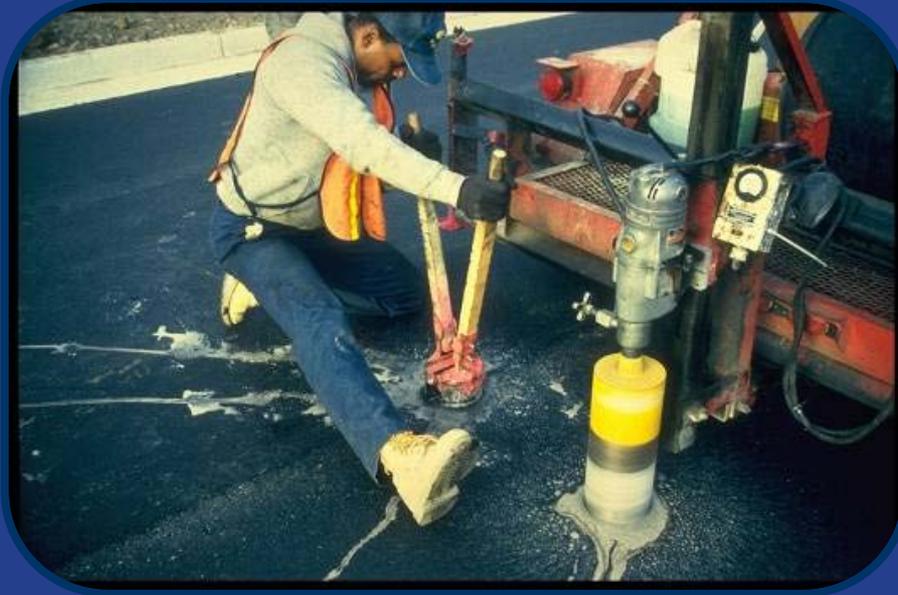


Under-  
Compaction  
Leads to  
Distresses



# Why Intelligent Compaction?

## Shortcomings in Conventional Acceptance



Limited Number  
of Locations



After Compaction  
is Complete



## Traditional Compaction Testing Method



1 / 1,000,000



## Compaction Testing and Coverage Mapping with AccuGrade



100 % Coverage



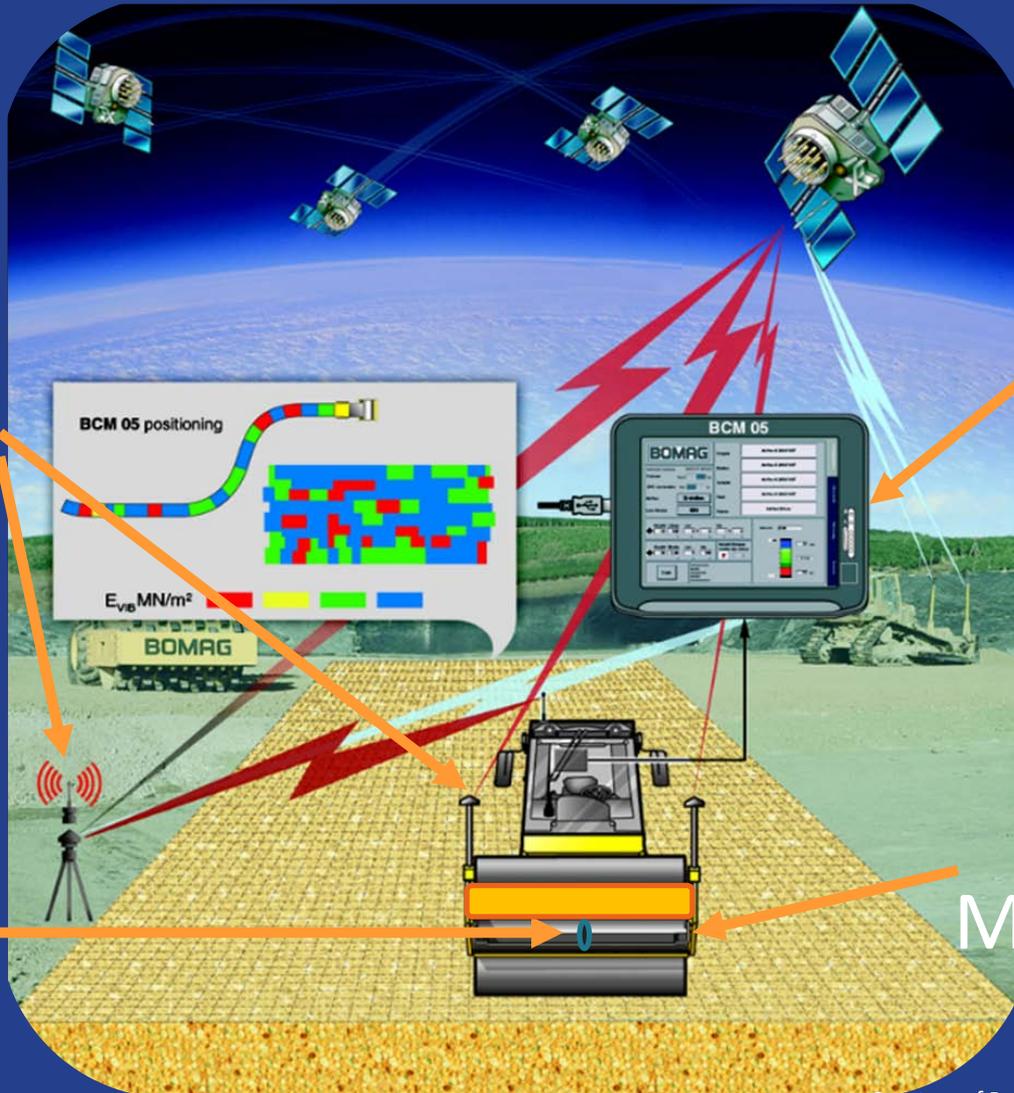
- **How IC Rollers Work:**

IC machines are vibratory rollers with accelerometers mounted on the axel of drums, global positioning system, Infra-red temperature sensors (for asphalt), and on-board computers that can display color-coded maps in real-time to track roller passes, asphalt surface temperatures, and stiffness of compacted materials.



# Intelligent Compaction

Global  
Positioning  
System  
GPS



Onboard  
Report  
System

Temperature  
Sensors

Continuous  
Measurement  
System



# HAMM Double Drum IC System



HCQ GPS Navigator



GPS Receiver



Temperature Sensors

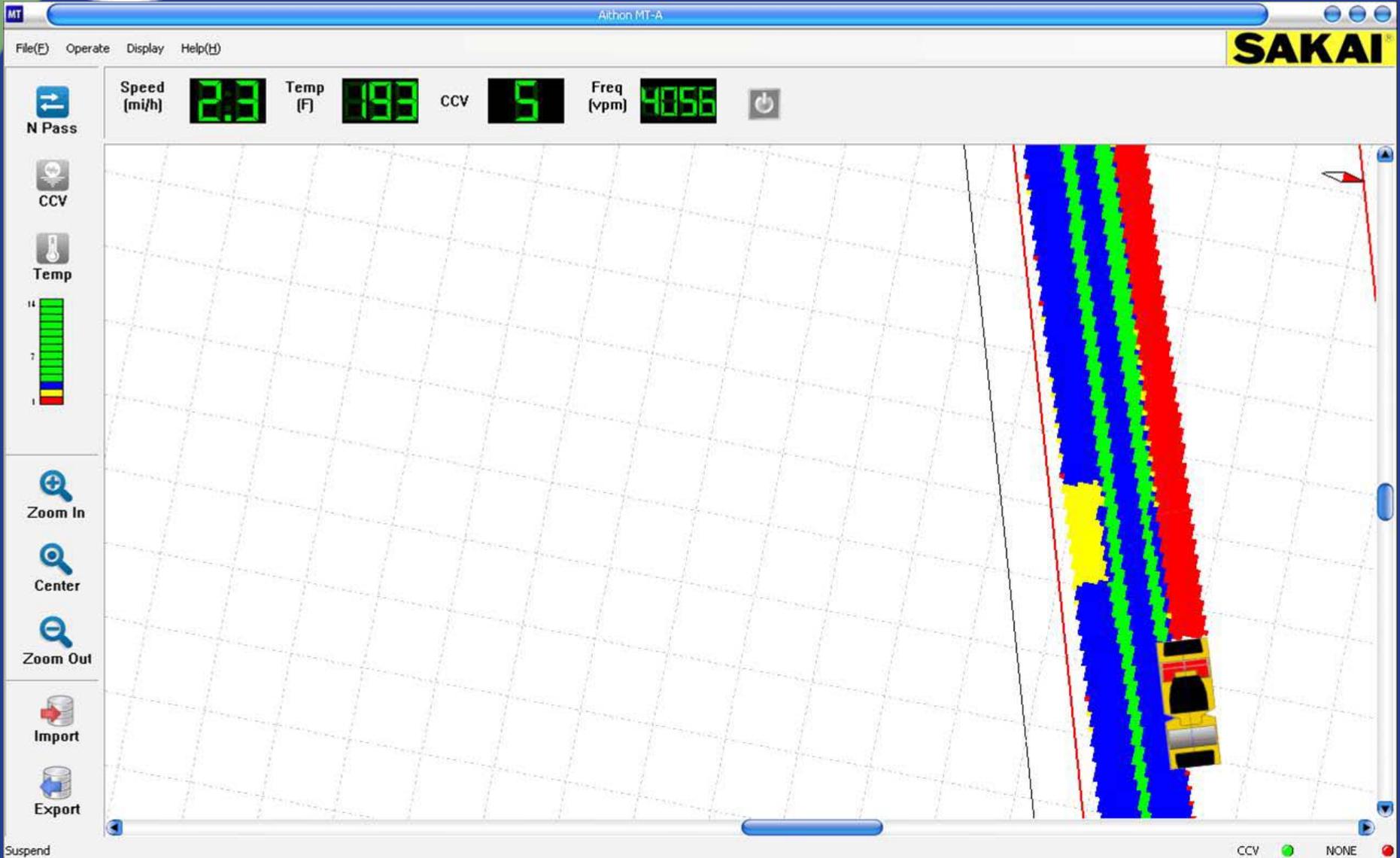


Accelerometer



Control Panel

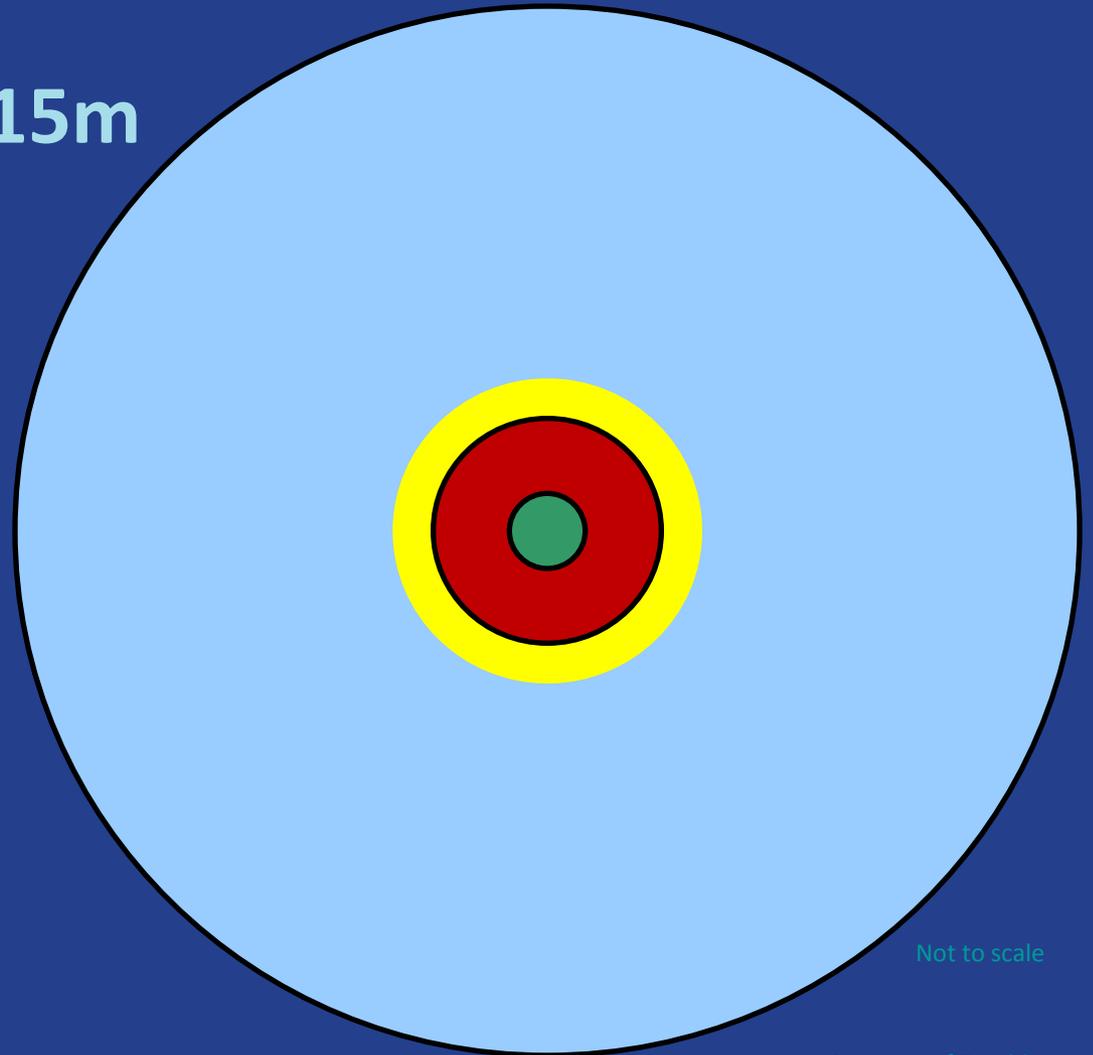
# Color-Coded On-Board Display





# GPS Precisions

- Autonomous: 10 - 15m
- DGPS: 0.5 - 5m
- Float : 1 m
- Fixed : 1-3 cm

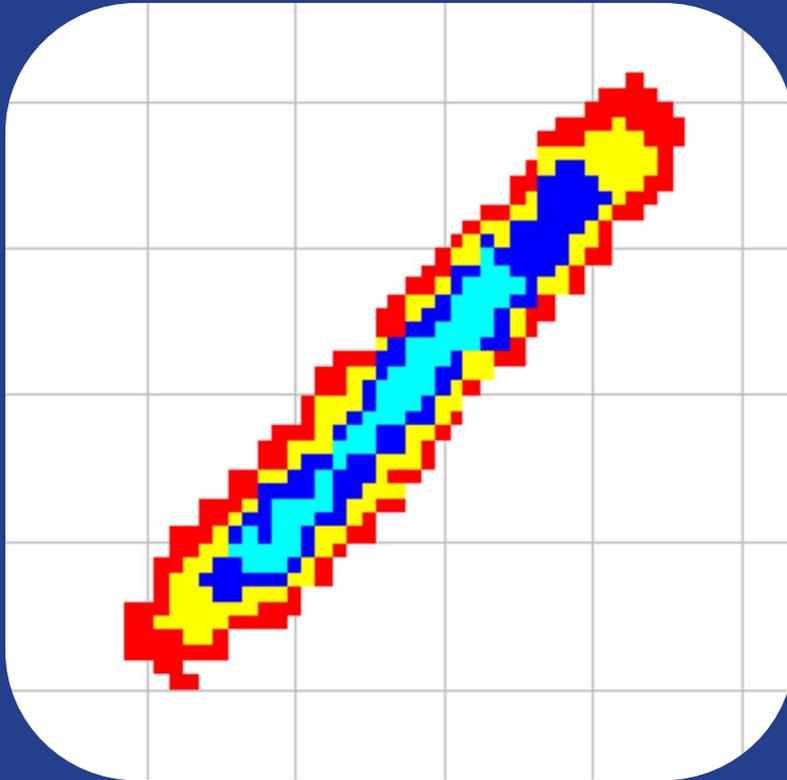


Not to scale

Courtesy of Trimble

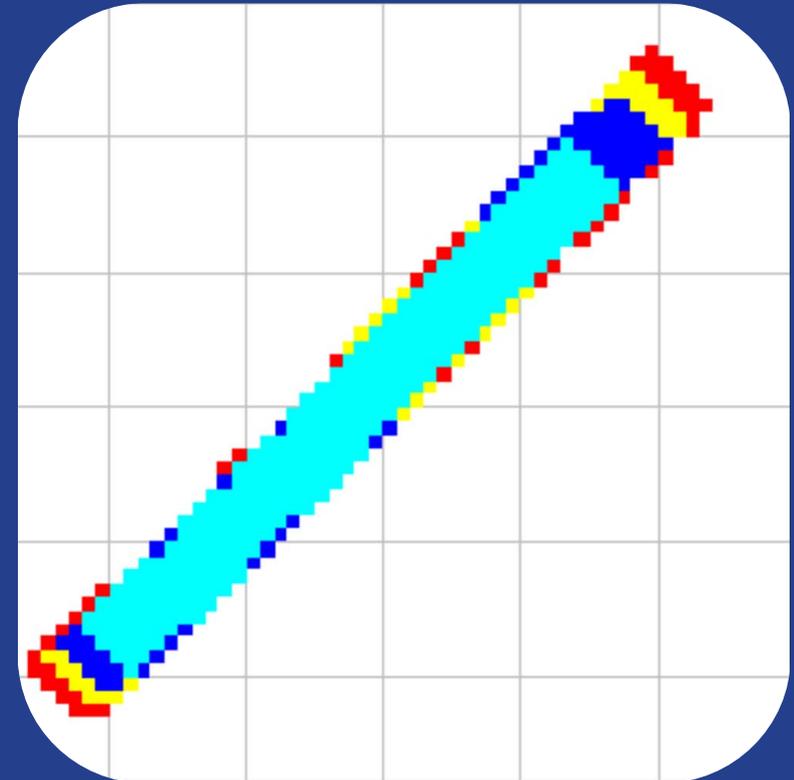
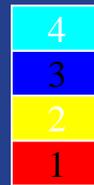


# GPS Accuracy for IC



Poor GPS

IC  
Pass  
Counts



Good GPS



# Single Drum IC Rollers

Ammann-Case



Caterpillar



HAMM-Wirtgen



## Soils and Subbase

Bomag



Dynapac



Sakai





# Double Drum IC Rollers

Bomag



HAMM-Wirtgen



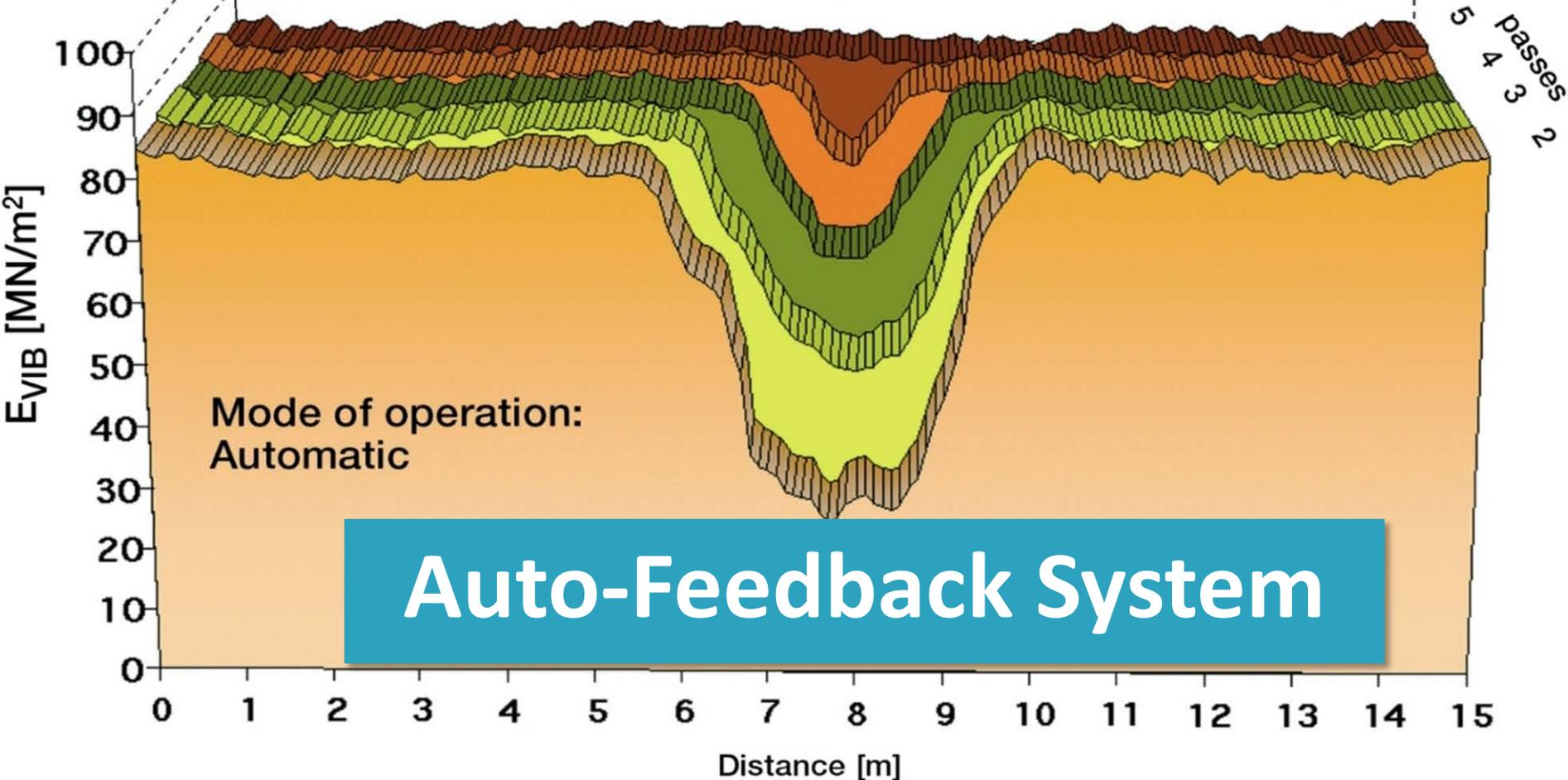
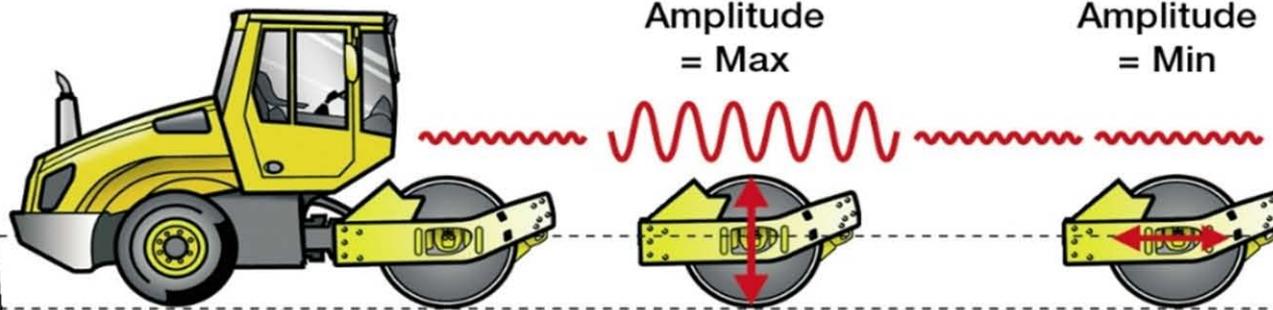
Caterpillar



**Asphalt**

Sakai

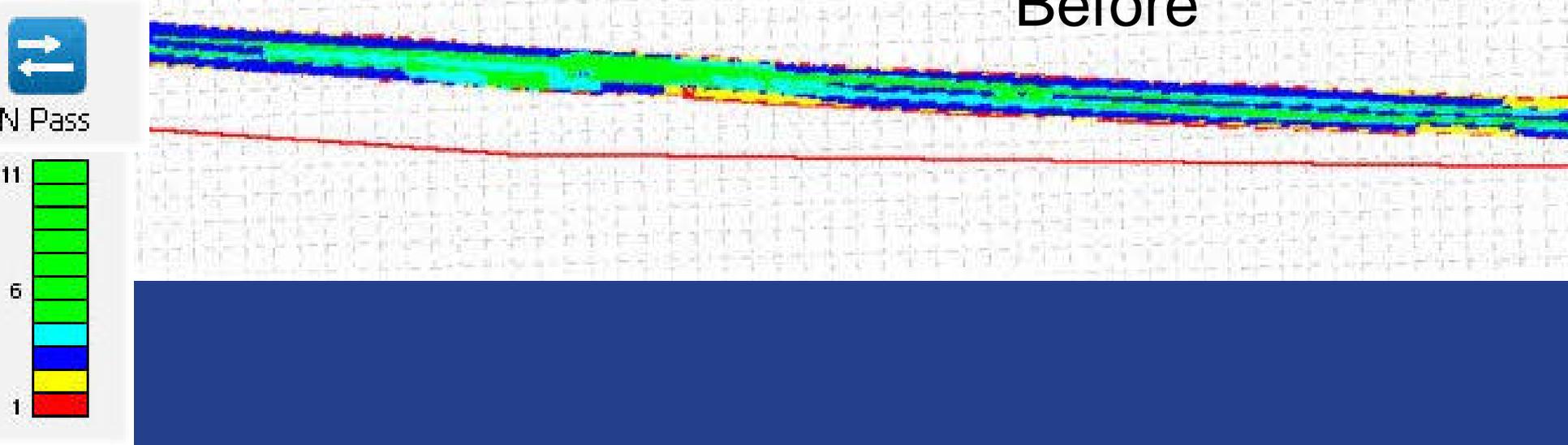




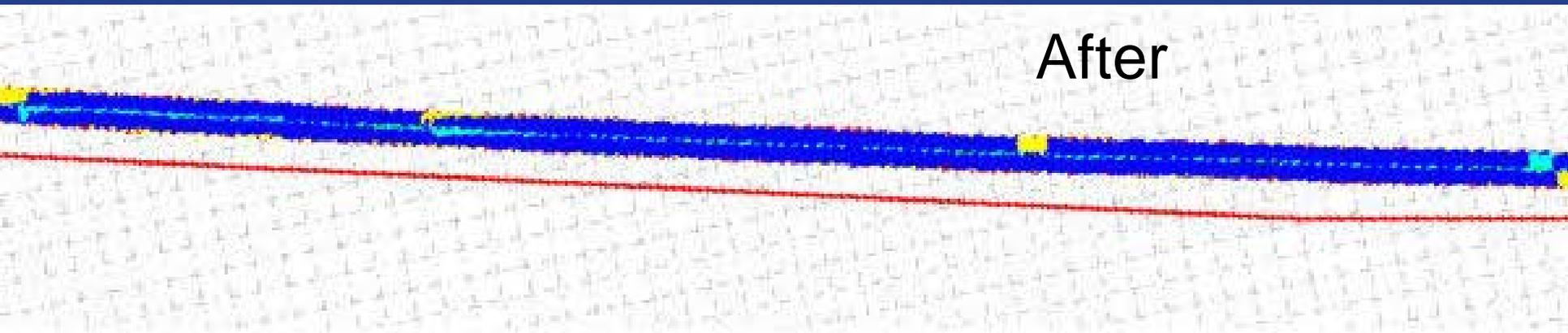


# Improved Rolling Pattern

Before



After





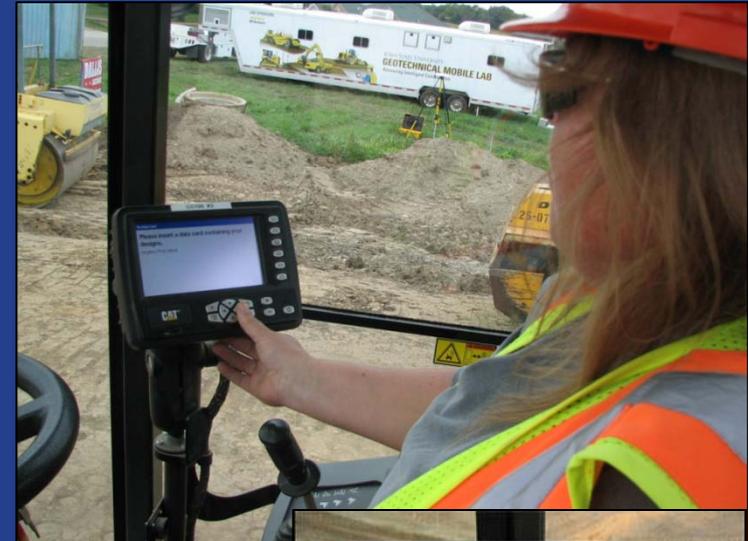
# Test Sections/Target Values

- **Dimensions of Test Sections**
  - 75 m X 6 m for Soils
  - 300 – 500 Tons for HMA
- **Evaluations for Each Lift Materials with cores**
- **Fixed Settings of IC Compaction**
- **Determination of Target Roller Passes and IC-MV**



# Benefits Observed by Contractors

- **Real-time feedback to operators**
  - Increased Accountability
  - Coverage
    - Prevent Gaps between passes
  - Compaction Curves
    - ↓ Number of Passes
  - Identify Weak Areas
  - Moisture Control (Grading Applications)
  - View Temp (HMA applications)
- **GPS System Transferrable**





# Benefits of IC

- Continuous record of material stiffness, coverage and temperature
- Improved uniform and consistent densities
- Identification of soft or non-compactable areas
- Increased productivity (knowing when and where to apply what effort of compaction)
- Reduction of over compaction and under compaction
- Encourages best roller compaction practices





# How IC Works



One system for all compaction needs



# Intelligent Compaction (Total of 25 Projects)

2004

- Mn/ROAD, Demo

2005

- US 53, Granular (Taconite)
- US 14, Non-Granular, Granular
- US 12, Base

2006

- TH 64, Granular
- Mn/ROAD, Misc — Non-Granular
- I-494 Valley Creek Road, Granular Shoulders

2007

- US 10, Staples, Granular
- US 10, Detroit Lakes, Non-Granular, Granular
- TH 60, Non-Granular, Granular
- TH 36, Non-Granular, Granular

2008

- CSAH 2, Non-Granular, Base
- CSAH 4, Base, HMA (Breakdown)

2008 (cont)

- CSAH 40, HMA (Breakdown)
- Mn/ROAD, Non-Granular, Granular, Base, Base, FDR, SFDR
- TH 60, Non-Granular, Granular
- **TH 71**, HMA (Breakdown)

2010

- TH169, HMA (Breakdown)
- TH 13, HMA (Breakdown)
- TH16, SFDR
- TH 610, Granular
- CSAH 10, Granular (Compactor Rejected)

2011

- TH35, HMA (Pneumatic, Static, Vibratory)
- TH 30, FDR, SFDR (Padfoot)
- TH 83, FDR (Padfoot)
- TH 212, FDR (Padfoot)
- TH 23, Granular (Compactor Rejected)



# IC Retrofit

**Presently only one manufacture who supplies retrofit equipment**

**Retrofit can be installed on any compactor from any manufacturer, used or new machines**

**Can be transferred between many machine types**



# Retrofit Single Drum IC Roller

Volvo with Trimble Retrofit





# Retrofit Double Drum IC Roller

Printer



Control Box

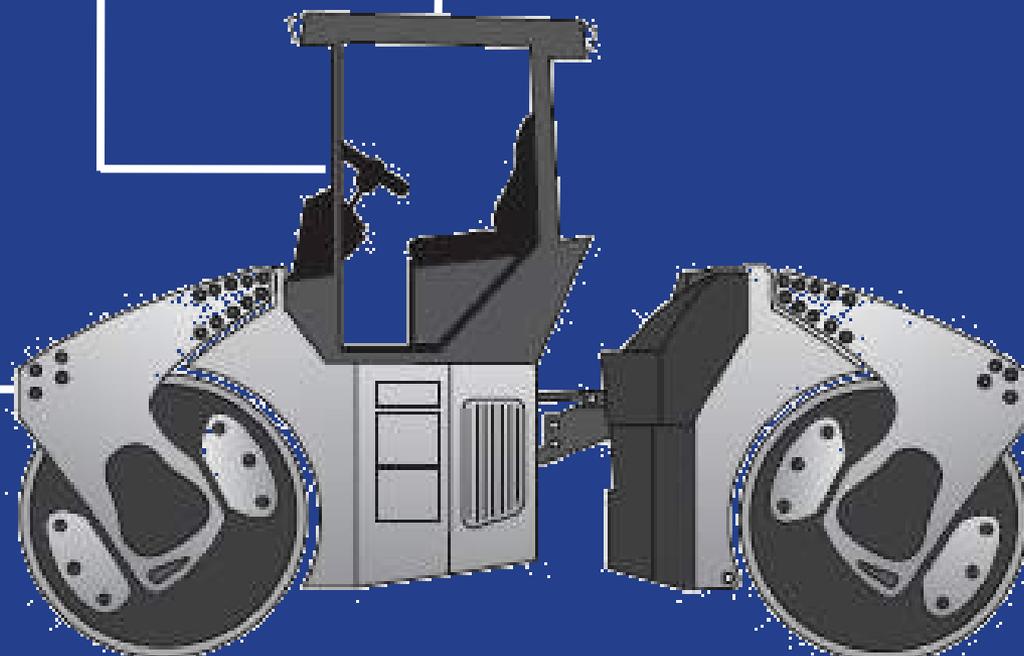
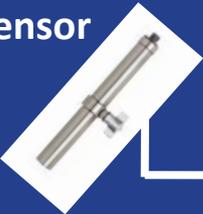


GNSS Receiver



Conventional Roller  
with Trimble Retrofit

Temperature  
Sensor



Temperature  
Sensor







# More information

- Every Day Counts
  - <http://www.fhwa.dot.gov/everydaycounts/>
- Intelligent Compaction
  - <http://www.intelligentcompaction.com/>