



# Advantages of Density Profiling Systems: MnDOT Perspective

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# Advantages of Density Profiling Systems: Get Better Density

- **Adequate density is critical to pavement life** – *Any improvements DPS creates in achieved density will pay off*
- *DPS Provides Asphalt Compaction Assessment that is:*
  - Real-time display
  - Continuous coverage



- MnDOT AMT Unit

# Advantages of Density Profiling Systems: Reduce Coring

- **Nobody likes taking cores** – *Coring destructs new pavements and the process of extracting cores is labor intensive and can be unsafe*
  - *DPS measurements can be converted to %Voids without cutting any cores:*
    - Use exact configuration of production mix QA/QC samples
      - Design voids
      - Medium voids (-250 grams same height)
      - High voids (-500 grams same height)

Chapter 2 “part A”

Plant Mixed Material Sample (PMMS) Fabrication

<https://www.youtube.com/watch?v=pkIzk2DbPI0>



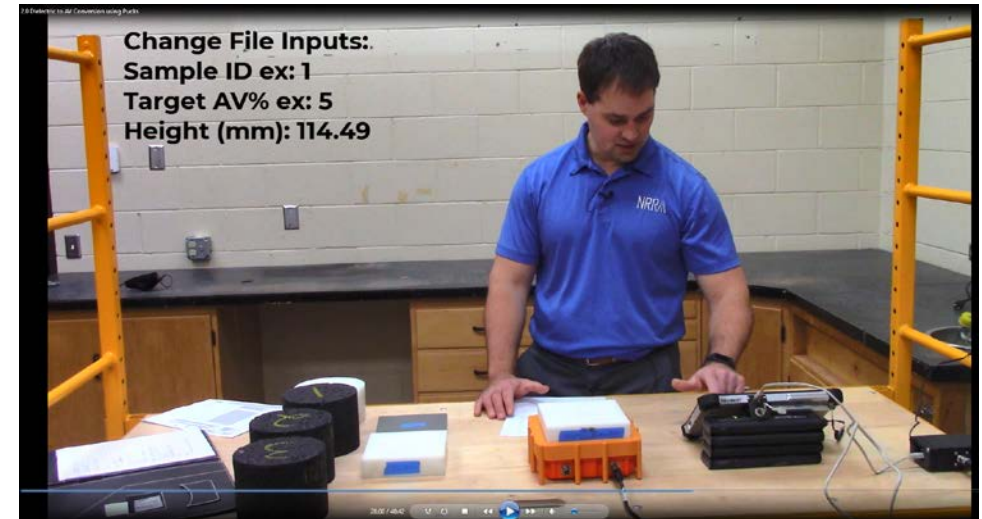
# Advantages of Density Profiling Systems: Reduce Coring

- **Nobody likes taking cores** – *Coring destructs new pavements and the process of extracting cores is labor intensive and can be unsafe*
- *DPS measurements can be collected using lab kit:*
  - Complete 60 second test right after extruding sample to obtain DPS measurement (dielectric)



3/30/2021

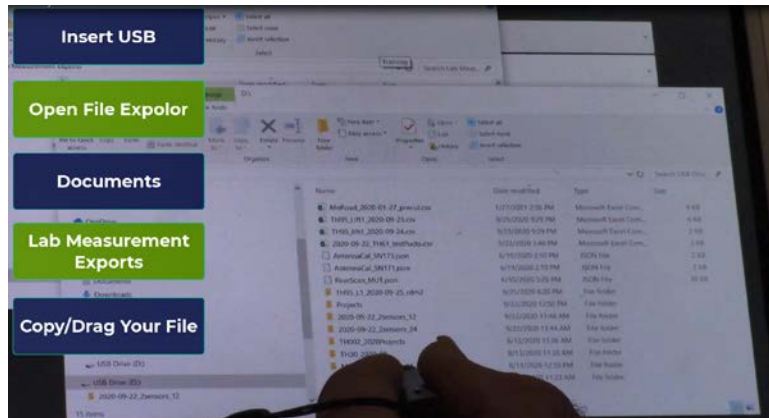
## Chapter 2, part B: Measuring Dielectric of the PMMS



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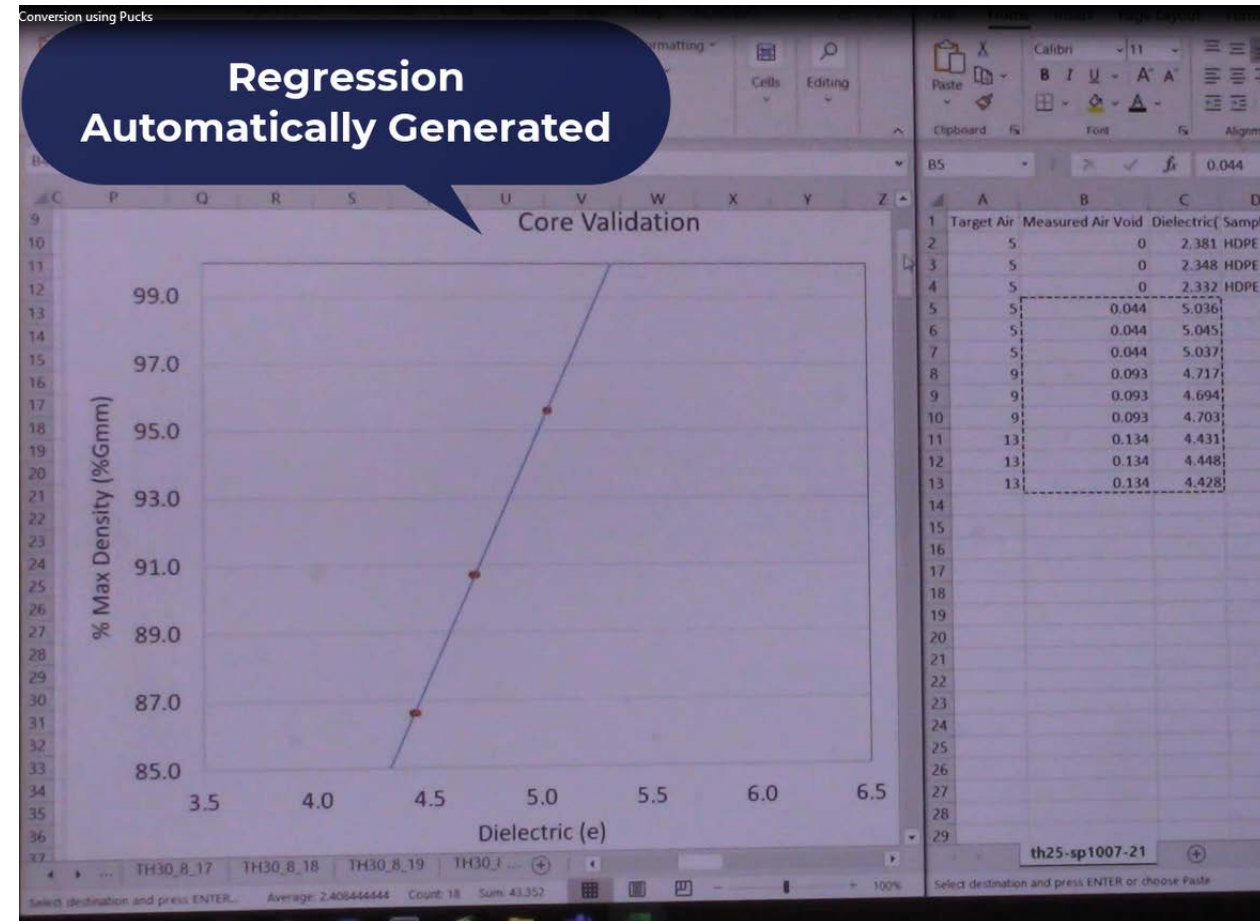
# Advantages of Density Profiling Systems: Reduce Coring

- **Nobody likes taking cores** – *Coring destructs new pavements and the process of extracting cores is labor intensive and can be unsafe*
- *Convert DPS measurements to Voids!*
  - Results directly exported in excel and Pavescan compatible format for same day use
  - Can use previous day cal if no mix changes



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## Chapter 2, part B: Measuring Dielectric of the PMMS

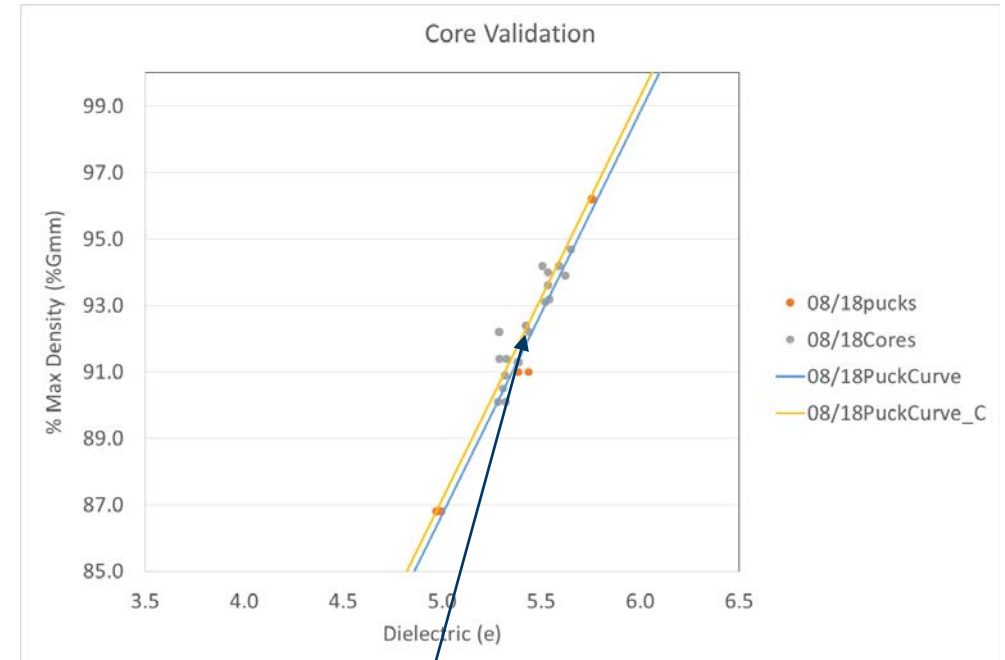


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# Advantages of Density Profiling Systems: Reduce Coring

- **Nobody likes taking cores** – *Coring destructs new pavements and the process of extracting cores is labor intensive and can be unsafe*
  - *Use Cores for Validation*
    - Static measurements at core locations can be used to validate Void% calibrations
    - ZERO extra cores taken!!!
    - All cores used for validation where already selected for coring as part of the normal QA
    - 28 unique paving days with validation cores
    - 266 validation cores with dielectric values



# Advantages of Density Profiling Systems: Better Coverage

- **Limitations of the current method –**

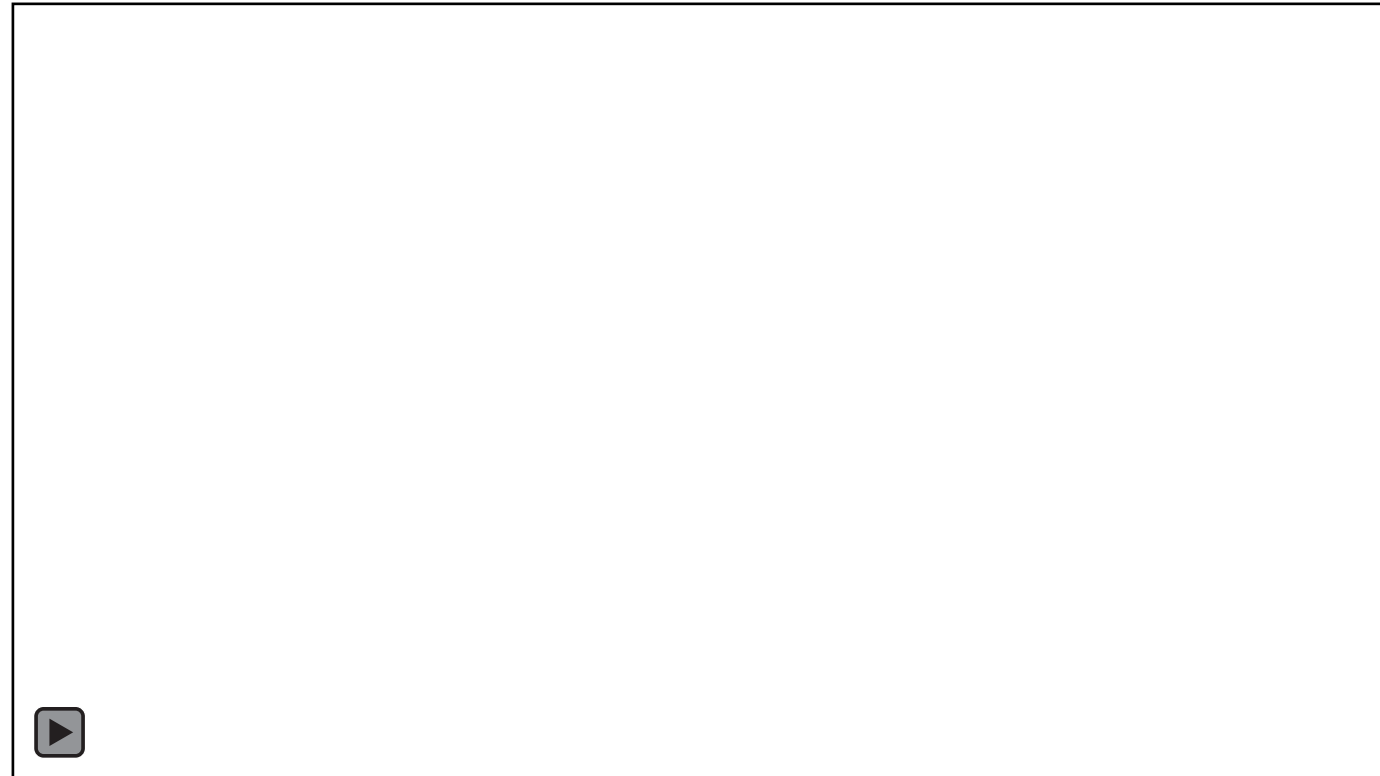
*Coring does not provide adequate coverage to make confident assessment of achieved pavement compaction*

- *How to deploy continuous coverage*

*Voids% measurements?*

- Gator Mounted
- Moveable Bracket for single pass
- 100% CL Joint Coverage
- Random sample of remaining mat

<https://www.youtube.com/watch?v=bNXoG7Xatw0>



# Advantages of Density Profiling Systems: Better Coverage

- **Limitations of the current method**
  - *Coring does not provide adequate coverage to make confident assessment of achieved pavement compaction*

- *How to deploy continuous coverage Voids% measurements?*

- Robot

- Safety
- Unbiased data collection
- Pre-program core validation locations
- Communication with rollers

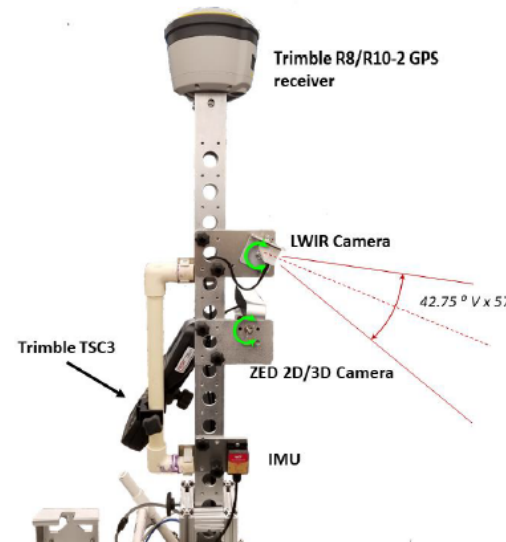


Figure 2.2. Sensor instrumentation mast.

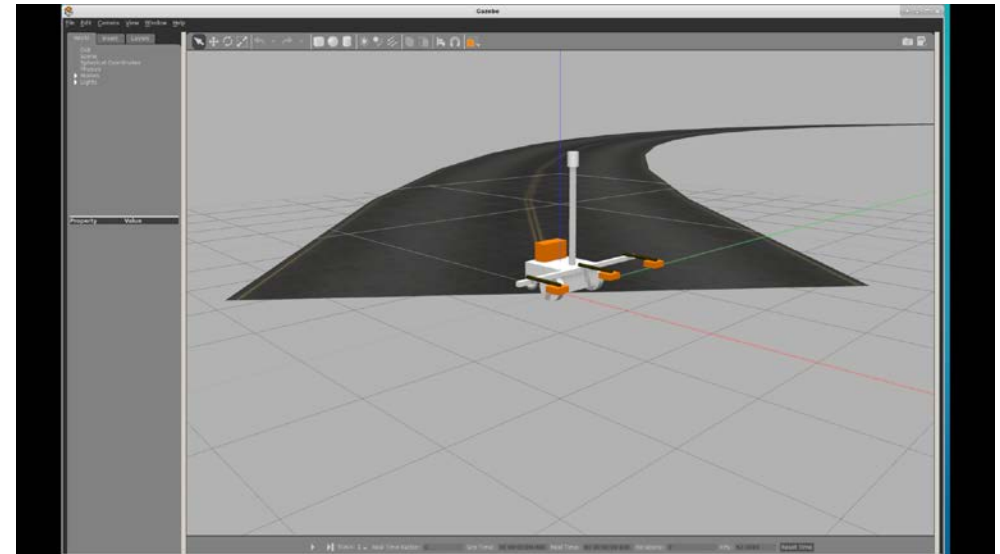


Figure 1.1. LEFT-Integrated Robot; RIGHT-integrated GPR system shows mounted GPR sensor array and data acquisition system during field test on fresh asphalt.



# Advantages of Density Profiling Systems: ICT Fit

- **Fits well with current intelligent construction technologies (ICT) – MnDOT** has nice full coverage maps of process related information such as pass counts and temperature when each roller hits the mat, but no similar coverage method of evaluated end compaction result
  - *Real-time feedback*
    - Monitor effect of any process change on actual achieved density



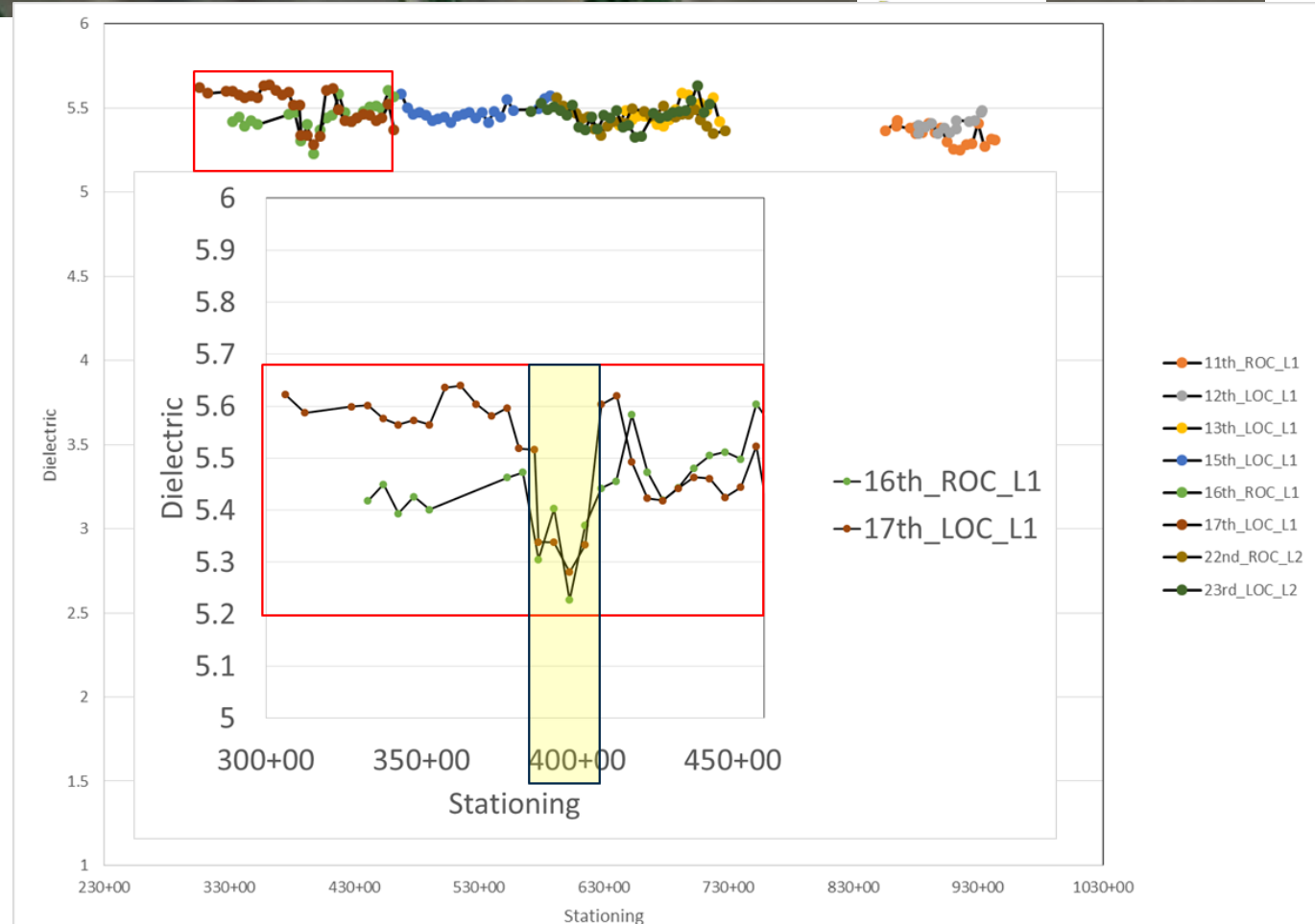
# Advantages of Density Profiling Systems: ICT Fit



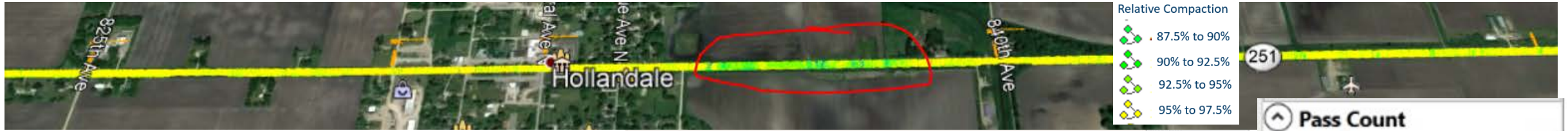
- Fits well with current intelligent construction technologies (ICT) – *MnDOT has nice full coverage maps of process related information such as pass counts and temperature when each roller hits the mat, but no similar coverage method of evaluated end compaction result*

- Full Picture QA

- Both Cores and DPS showed very good compaction for majority of the 13 mile project (~94% to 97% on average)
- 0.5 mile stretch showed poor compaction starting at Station 390 (~90% to 93% compaction)



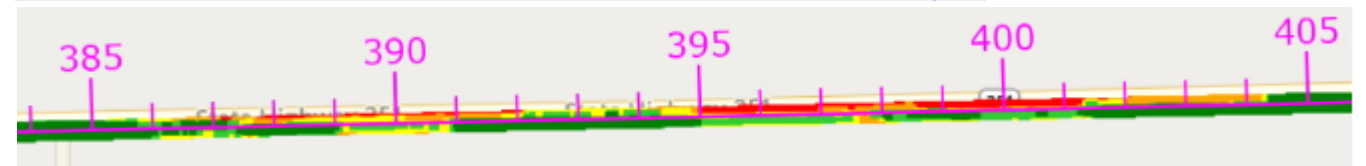
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- Full Picture QA

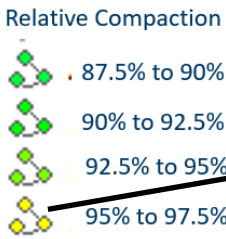
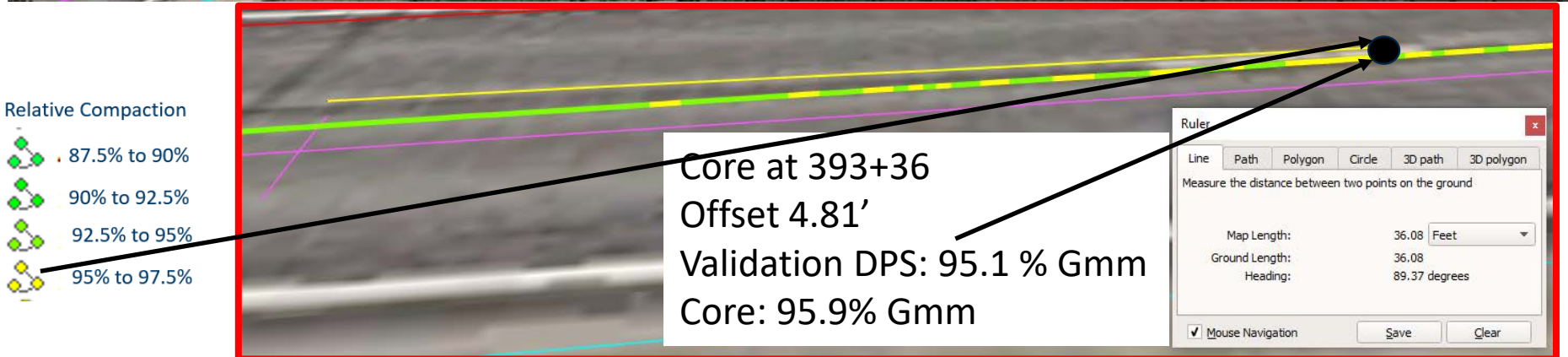
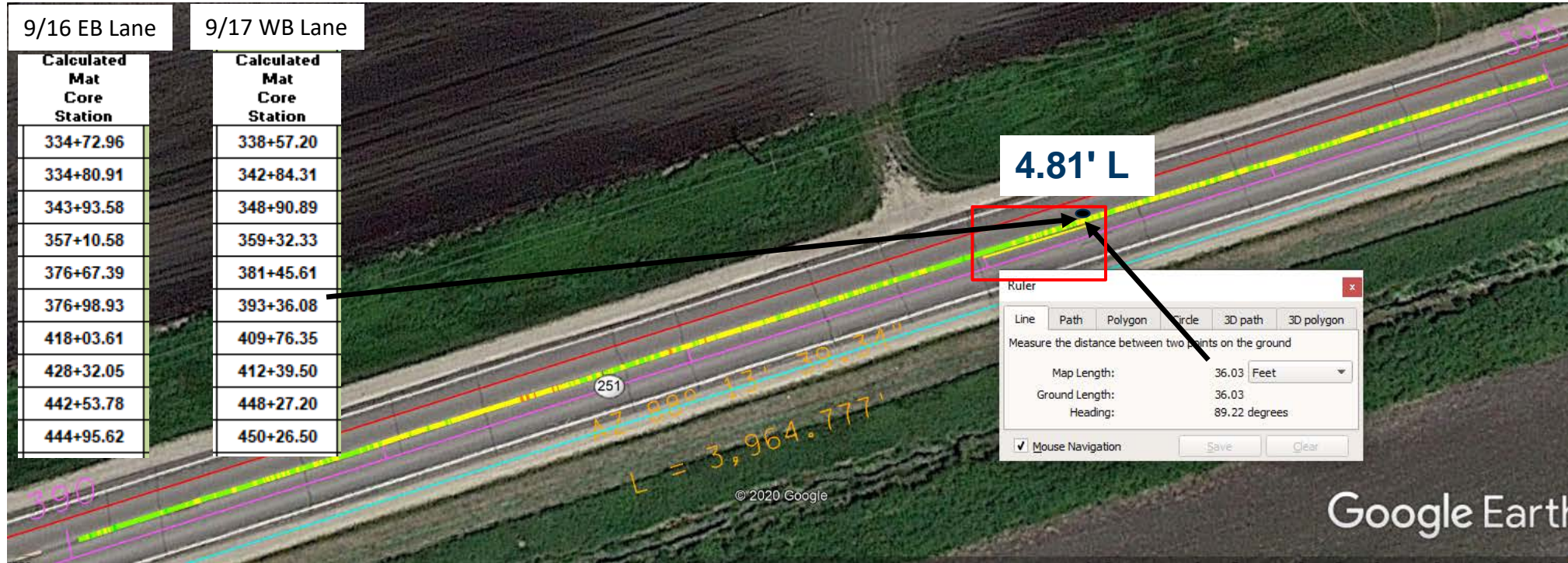
- ICT confirms issues
  - Low Vibratory Pass count
  - Low Temperature at first pass



# What's the big deal? Our regular Core QA procedure should ID the problem, right?..... RIGHT?..... RIGHT?????

- No cores in the Eastbound problem spot. 😞
- But the Westbound had a core in the affected Area! 😎
- Unfortunately, the core happened to be in a spot with good compaction 😞
  - DPS confirmed good compaction at that specific location
- Shows limitation of random core coverage

9/16 EB Lane	9/17 WB Lane
Calculated Mat Core Station	Calculated Mat Core Station
334+72.96	338+57.20
334+80.91	342+84.31
343+93.58	348+90.89
357+10.58	359+32.33
376+67.39	381+45.61
376+98.93	393+36.08
418+03.61	409+76.35
428+32.05	412+39.50
442+53.78	448+27.20
444+95.62	450+26.50



# OK, but maybe we just got unlucky with the cores this time...

- New “Playback Range Filter” allows for on-site analysis.
  - Filter data to look specifically at problem area

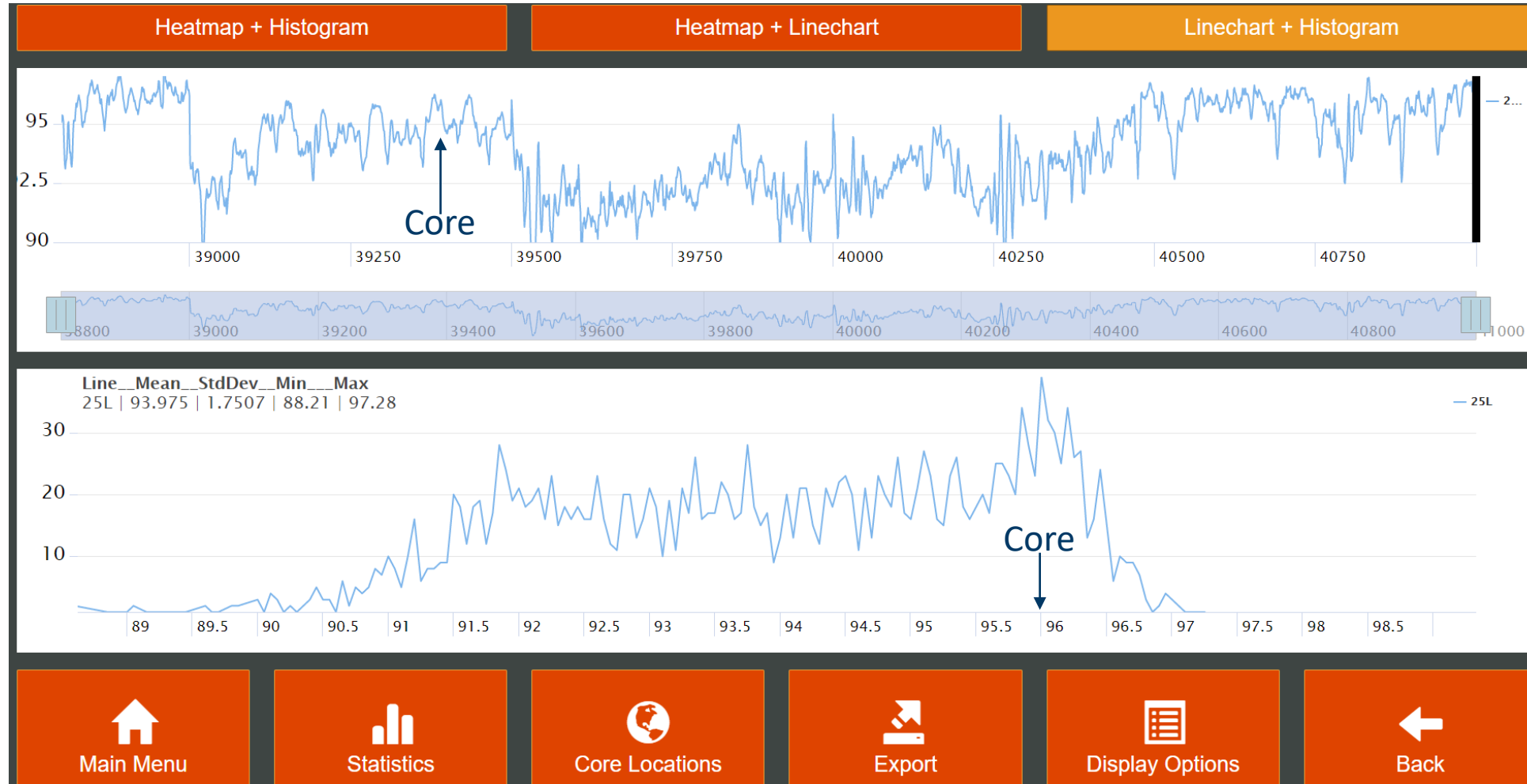
Playback Range Filter PaveScan.RDM

Mat/Joint	<input type="checkbox"/>	Mat Lines	<input type="checkbox"/>	Joint Lines	<input type="checkbox"/>
Distance Range	<input checked="" type="checkbox"/>	Start	<input type="text" value="38800"/>	End	<input type="text" value="41000"/>
Exclude	<input type="checkbox"/>	Range	<input type="text"/>		
Lot/Sublot	<input type="checkbox"/>	Lot	<input type="text" value="35"/>	Sublot	<input type="text" value="--ALL--"/>
Lift	<input type="checkbox"/>	Lift	<input type="text" value="1"/>		
Sensor S/N	<input type="checkbox"/>	Serial Number	<input type="text" value="171"/> <input type="text" value="173"/> <input type="text" value="181"/>	Select Offsets	<input type="text" value="0.5L"/> <input type="text" value="2L"/> <input type="text" value="3.5L"/> <input type="text" value="23.5L"/> <input type="text" value="25L"/>
Lateral Offsets	<input checked="" type="checkbox"/>				

# OK, but maybe we just got unlucky with the cores this time. . .

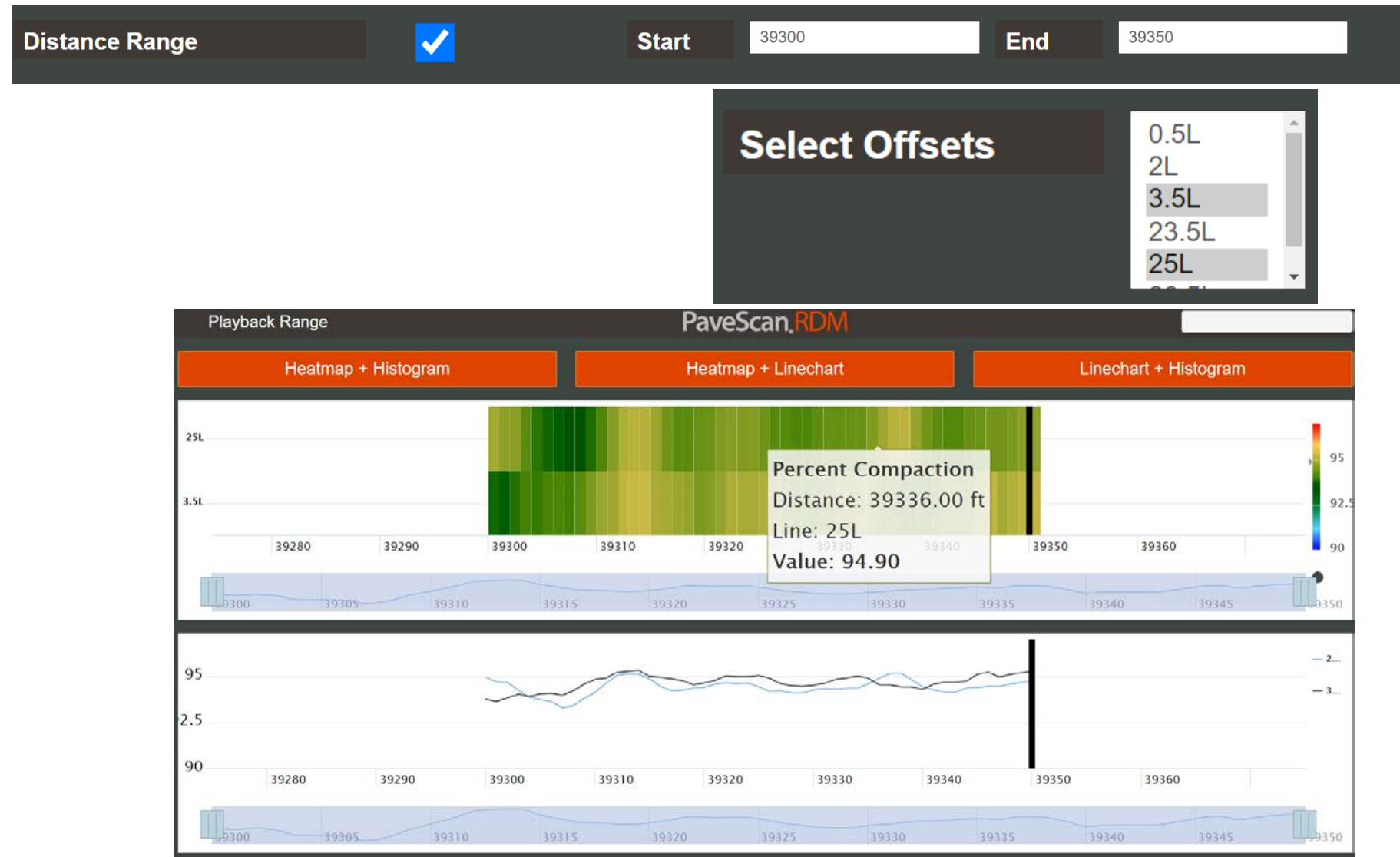
## Or, maybe our assumptions about the way we should analyze pavement are wrong?

- New “Playback Range Filter” allows for on-site analysis.
  - Observe Scatterplot to see local drops
  - Observe Histogram to see probability of each density range



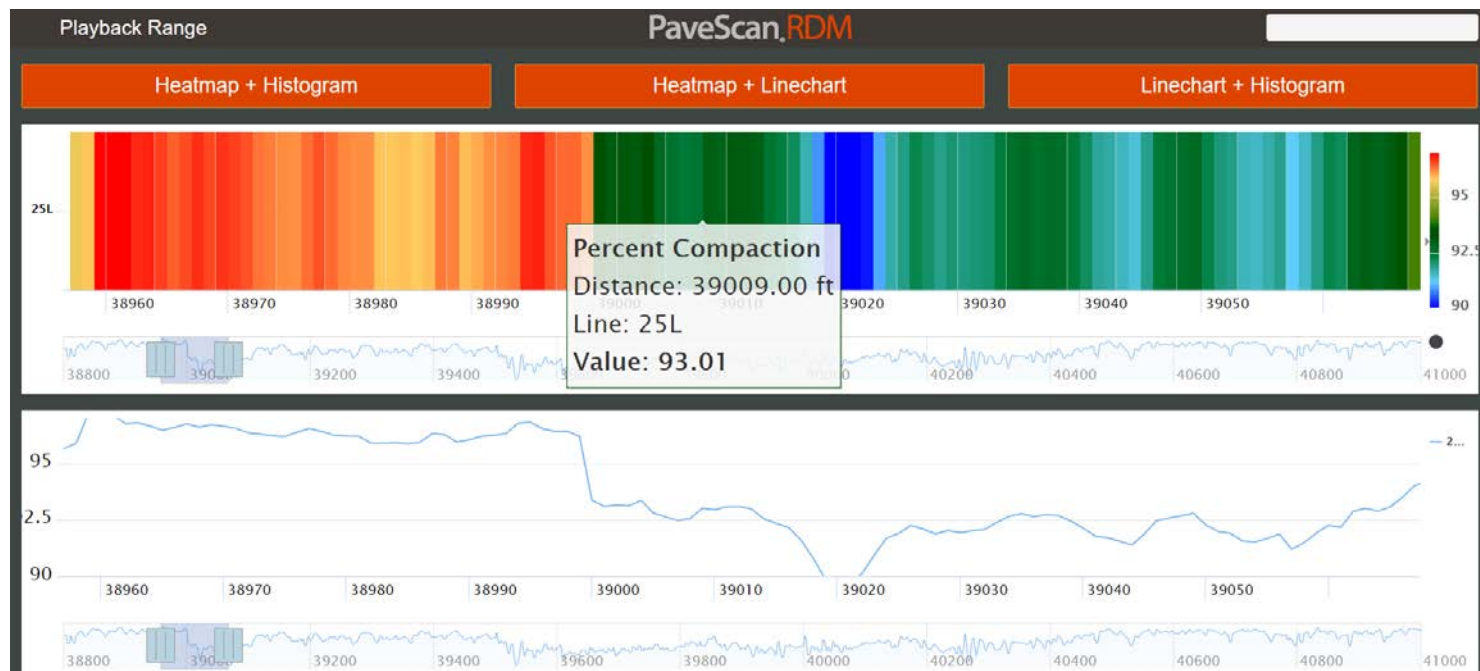
# Further Playback Analysis: Zoomed in at Core

- New “Playback Range Filter” allows for on-site analysis.
  - Zoom and get precise measurements as needed
  - Swerve and closest straight pass confirm core location is at high spot of problem location



# Further Playback Analysis: Zoomed in at Drop In Density

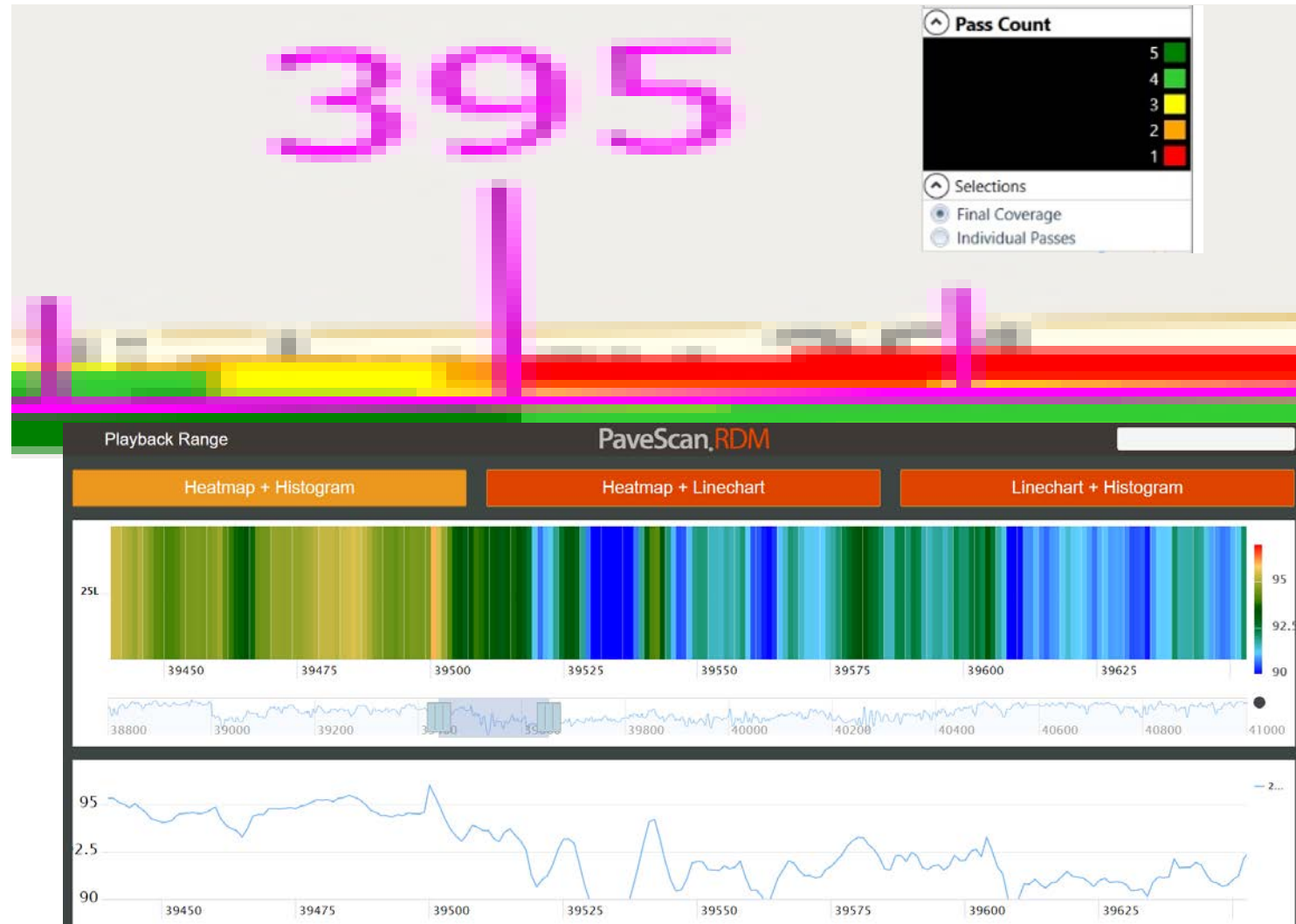
- New “Playback Range Filter” allows for on-site analysis.
  - Drop in Compaction by DPS directly corresponds to lack of vibratory roller passes and low temperature on initial compaction





# Further Playback Analysis: Zoomed in at Drop In Density

- New “Playback Range Filter” allows for on-site analysis.
- Drop in Compaction by DPS directly corresponds to lack of vibratory roller passes



# Advantages of Density Profiling Systems: Motivation

- **Adequate density is critical to pavement life** – *Any improvements DPS creates in achieved density will pay off*
- **Nobody likes taking cores** – *Coring destructs new pavements and the process of extracting cores is labor intensive and can be unsafe*
- **Limitations of the current method** – *Coring does not provide adequate coverage to make confident assessment of achieved pavement compaction*
- **Fits well with current intelligent construction technologies (ICT)** – *MnDOT has nice full coverage maps of process related information such as pass counts and temperature when each roller hits the mat, but no similar coverage method of evaluated end compaction result*