

# IRI Measurements Best Practices



# High Speed Profiler



5k GoCator  
Line Laser

Laptop

Novatel  
GPS  
Receiver

Data  
Acquisition  
Unit

Wheel  
Encoder

# High Speed Profiler “Stop and Go”

Smart 7  
GPS  
Receiver

Additional  
Laser

Laptop

Data  
Acquisition  
Unit

Wheel  
Encoder



# Laser Height Sensor

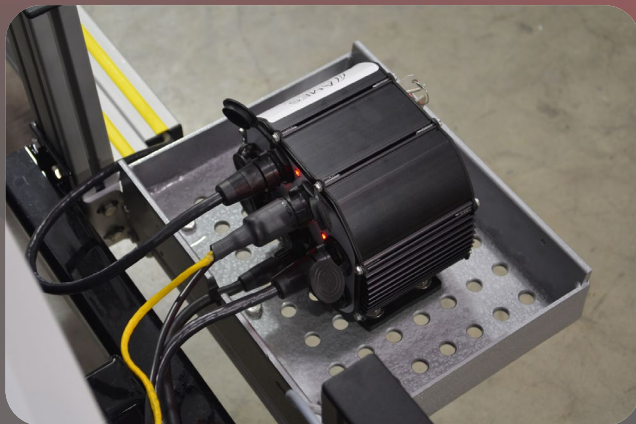
[Back to 8300](#)

[Back to stop & go](#)

- Laser Samples 5,000 / sec
- Average raw laser height every inch
- Bridging algorithm removes surface texture
- Simulates how a tire contacts the pavement
- Line laser is beneficial on open graded, ground, and tined pavements
- Can reduce IRI values by as much as 30% on heavily textured pavements



# Data Acquisition Unit



- DAU Hub connects system to laptop via ethernet port
- 6 COM ports, Power, GPS, DMI
- Uses 12V Power from vehicle to power all components

# “Stop & Go” Laser

- Stop & Go System uses additional laser sensors in each wheel path
- Same 5k Gocator line laser
- Additional sensor compensates for vehicle pitch
- Data from front and back sensor is merged to report single profile in each wheel path



# “Stop & Go” Technology



## GPS Receiver with Integral IMU Sensor

- GPS / IMU sensor Measures pitch, roll, and yaw of the vehicle
- Removes the error caused by the Stop / Start event

# Toughbook Laptop



- Panasonic Toughbook
- Ethernet cable from the DAU
- Used for data collection, calibration and analysis
- Mounts inside using a standard vehicle laptop mount

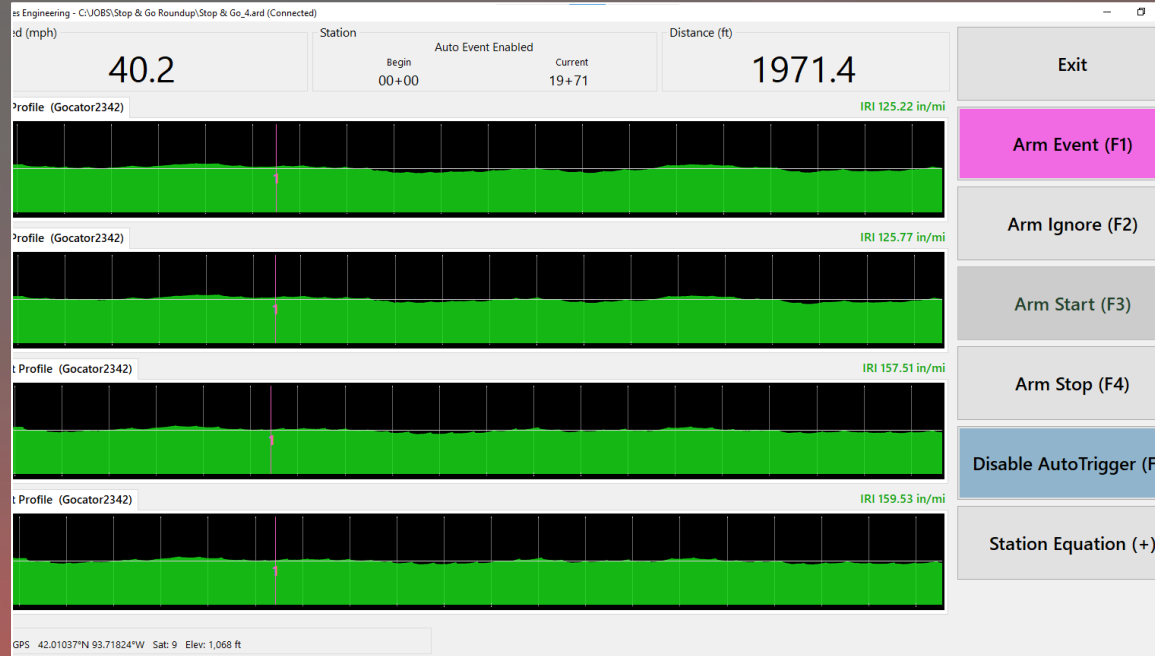
Panasonic  
Toughbook

# Ames Ver 6.1 data collection software

Back to  
8300

Back to  
stop & go

- Data collection screen shows status of all active sensors
- Reports any data alarms
- Displays raw profile, running avg IRI, speed & distance in real time
- Able to mark event, ignore and station equation locations



# Novatel GPS Receiver

[Back to 8300](#)

[Back to stop & go](#)

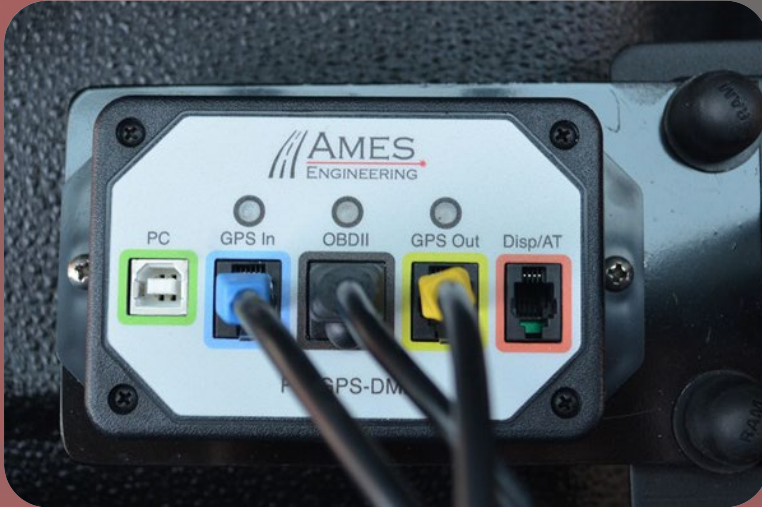
- 20Hz DGPS receiver collects GPS points into the profile data
- Can replace wheel encoder for distance measurement with the “GPS- DMP” option
- Output .km1 file to overlay IRI plot map view
- “GPS Tracer” option used to locate problem areas



# GPS DMI For Distance

[Back to 8300](#)

[Back to stop & go](#)



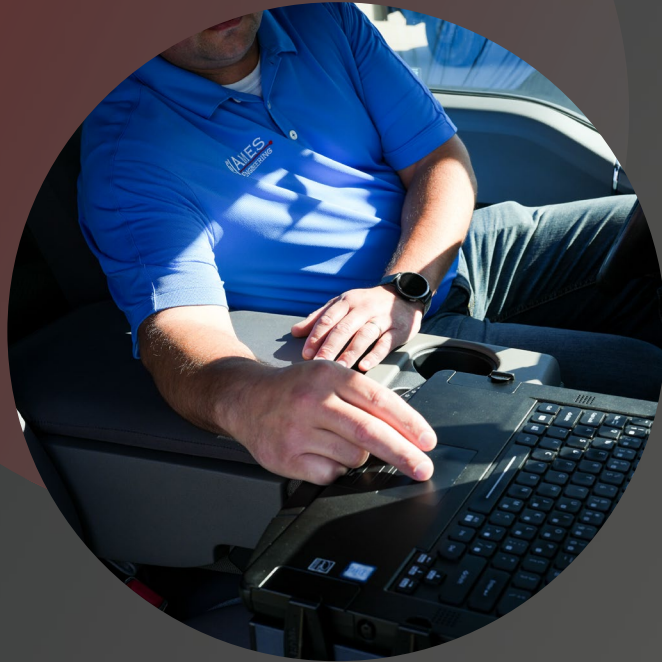
- Replaces the need for a wheel - mounted encoder to measure distance
- Does Not require calibration to a measured distance
- Utilizes GPS and vehicle speed sensor from the OBDII diagnostic port
- Eliminates DMI errors over long distances

# What is IRI?



- The International Roughness Index, or IRI was developed in 1986 by the World Bank
- It has become the standard throughout the world for measuring road smoothness
- Has been used for many years by state DOTs to monitor the condition of roadways

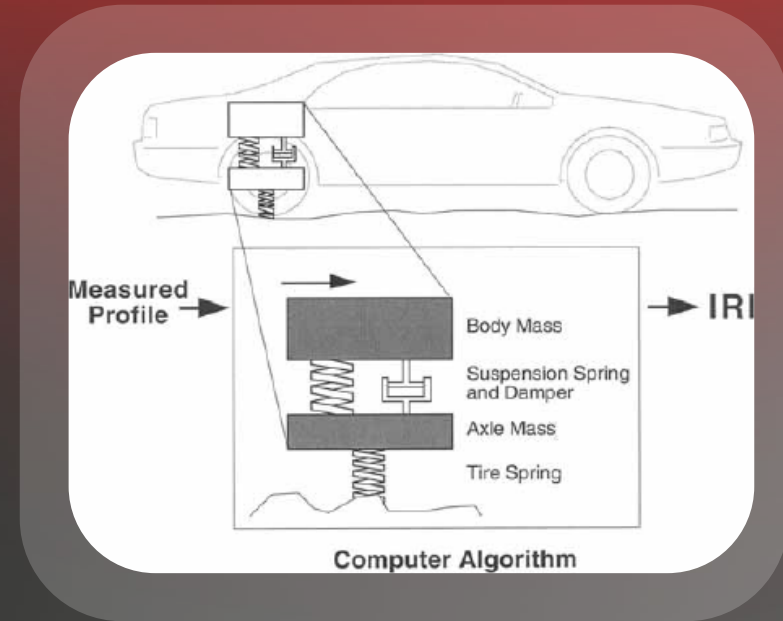
# What is the “International Roughness Index” (IRI)



- A true **Ride Indicator** that is based on how a vehicle reacts to roughness events in the pavement
- High Speed Profilers can measure true profile over a range of wavelengths that cause vehicle vibrations
- IRI is expressed in (in/mi) of roughness, and commonly reported over 0.1 mile segments for QC

# The “Quarter Car” Model

- The “Golden Car” IRI model is composed of a body (sprung) mass, suspension spring and damper, axle/tire (unsprung) mass, and tire spring with an assumed vehicle speed of 50 miles per hour
- Measured profile data is filtered using the IRI filter to identify features that cause a vehicles suspension to react
- The quarter car IRI model is primarily influenced by wavelengths between 4 to 100 feet
- Maximum sensitivity is at wavelengths of 8 to 50 feet



# Field Calibration Checks

[Back to 8300](#)

[Back to stop & go](#)



- (“Vertical Test” *Laser*) calibration blocks test using .25”, .50”, 100” gauge blocks (AASHTO R 56- 14)
- (“Bounce Test” *Accelerometer* ) verifies that the vehicle’s suspension movement is removed from the profile data (AASHTO R 56- 14)
- (“Distance Calibration”) Horizontal distance calibration. Calibrates the DMI sensor to a known distance

# Yearly Equipment Certification

[Back to 8300](#)

[Back to stop & go](#)



- Must pass certification at ICART track before used on any DOT project for QC/QA acceptance testing
- Checks repeatability and accuracy of the profile data
- Use “Proval ” software certification module for certification data analysis
- Most states also require operator certification

# Certification Data Analysis

*“A good profiler operator is just as important as a good profiler”*

- Requires 6- 10 repeat runs over a 500- 1000 ft test section
- Verifies system repeatability (precision) Cross correlation no less than 92
- Verifies system accuracy compared to a benchmark (bias) Cross correlation no less than 90
- Important Make sure you calibrate your DMI to the test section

## “Prova I” Cross Correlation Statistics

Statistics						
Statistic	Repeatability - Left			Repeatability - Right		
Comparison Count	15			15		
% Passing	100.00			100.00		
Mean	99.32			99.08		
Minimum	98.79			98.35		
Maximum	99.73			99.74		
Standard Deviation	0.3			0.4		
Grade	Passed			Passed		

Repeatability - Left Correlations (%)						
Run	2	3	4	5	6	
1	98.79	99.22	99.05	98.89	99.11	
2		99.37	99.73	99.62	99.44	
3			99.46	99.07	99.21	
4				99.59	99.73	
5					99.57	

Repeatability - Left Offsets (ft)						
Run	2	3	4	5	6	
1	-0.1	-0.1	-0.1	-0.2	0.0	
2		0.0	0.0	-0.1	0.1	
3			0.0	-0.1	0.1	
4				0.0	0.1	
5					0.1	

Repeatability - Right Correlations (%)						
Run	2	3	4	5	6	
1	98.85	99.12	98.95	99.34	98.35	
2		99.43	99.74	99.30	98.80	
3			99.29	99.42	98.40	
4				99.45	99.02	
5					98.69	

Repeatability - Right Offsets (ft)						
Run	2	3	4	5	6	
1	-0.1	-0.2	-0.2	-0.2	-0.1	
2		0.0	0.0	-0.1	0.1	
3			0.0	-0.1	0.1	
4				0.0	0.1	
5					0.1	

# AASHTO Guide Spec's

[Back to  
8300](#)

[Back to  
stop & go](#)

## AASHTO Guide Specs Equipment & Operator:

- M 328- 14: Standard Specification for Inertial Profiler
- R 56- 14: Standard Practice for Certification of Inertial Profiling Systems
- R 57- 10: Operating Inertial Profiling Systems

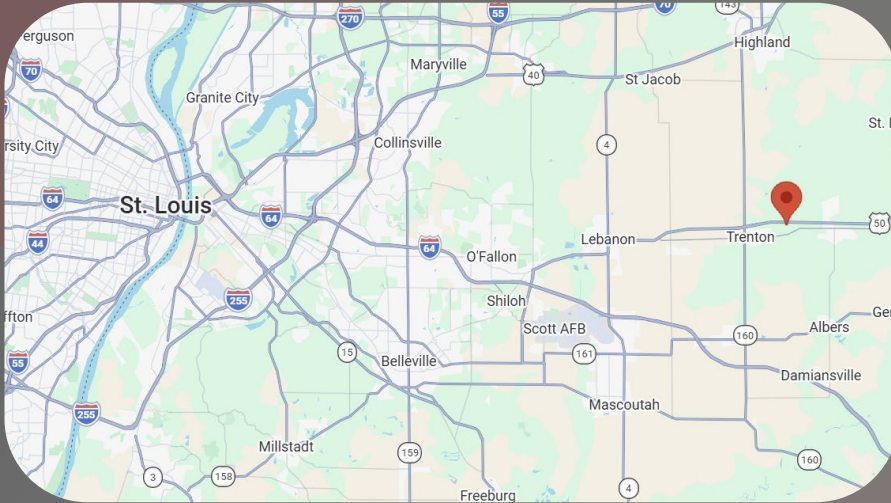




# ICART Test Track

[Back to 8300](#)

[Back to stop & go](#)



- MO- DOT Certification
- 📞 +1 (217) 782- 8582
- 📧 [john.senger@illinois.gov13255](mailto:john.senger@illinois.gov13255)
- 📍 Crackerneck Road  
Trenton, Illinois, IL 62293  
USA
- 🌐 [icart.setmore.com](http://icart.setmore.com)

# Verification Site



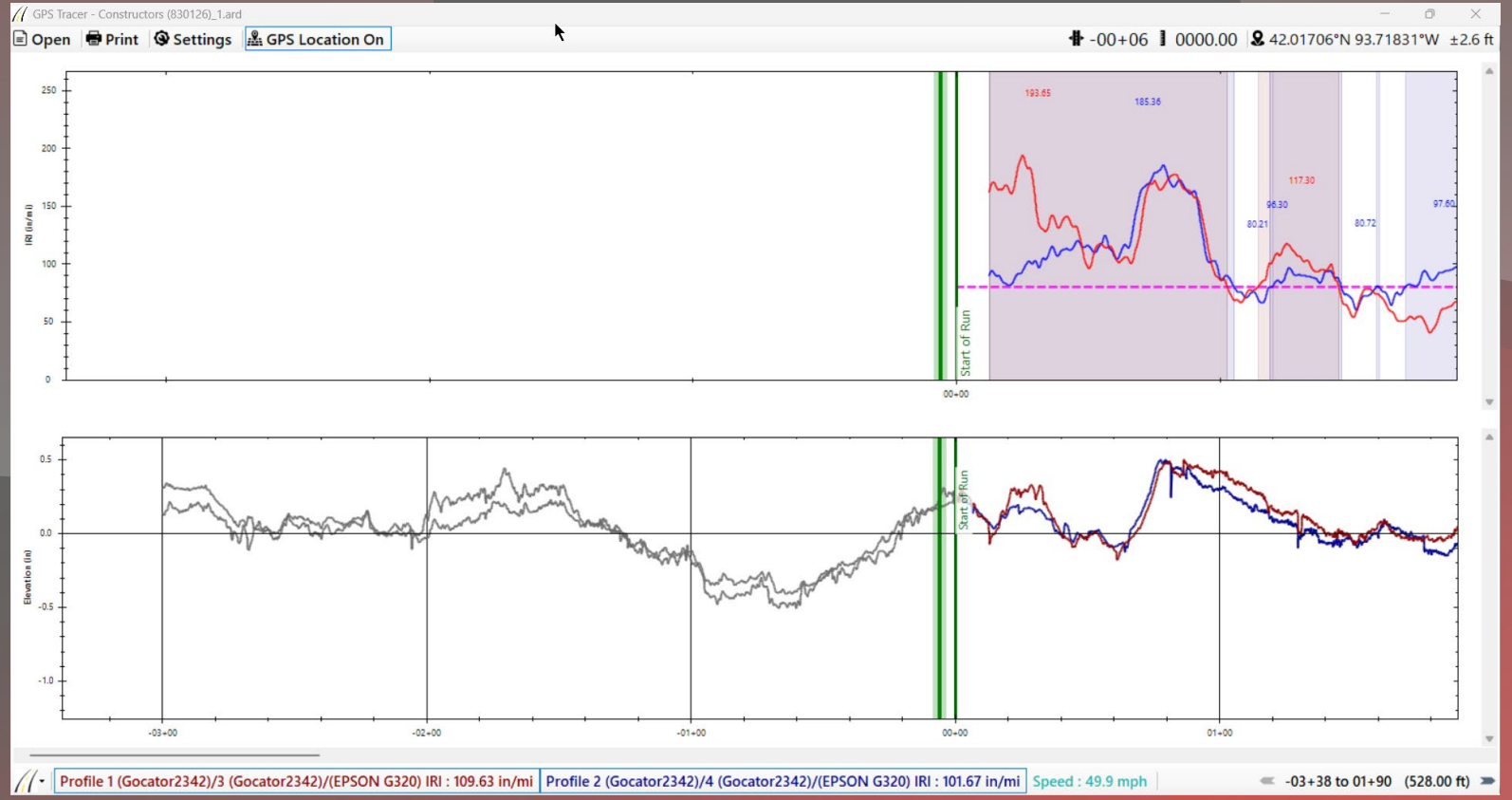
- Mark out a medium smooth test section near your project or office (528' – 1000')
- Make six repeat runs over test section to establish a baseline profile / IRI
- Use this verification site to validate results throughout the year
- Use “Proval ” certification module to check repeatability

# GPS Tracer

- Uses GPS points in profile data to locate problem areas
- Tracer line tracks your location as you drive through the project
- Excellent tool for marking must grind locations



# GPS Tracer



# GPS Reference Feature

[Back to 8300](#)

[Back to stop & go](#)

- Collect GPS pins for start, stop, and ignore sections
- Use these pin locations to crop profile data for analysis
- Beneficial for comparing results from different data files over time

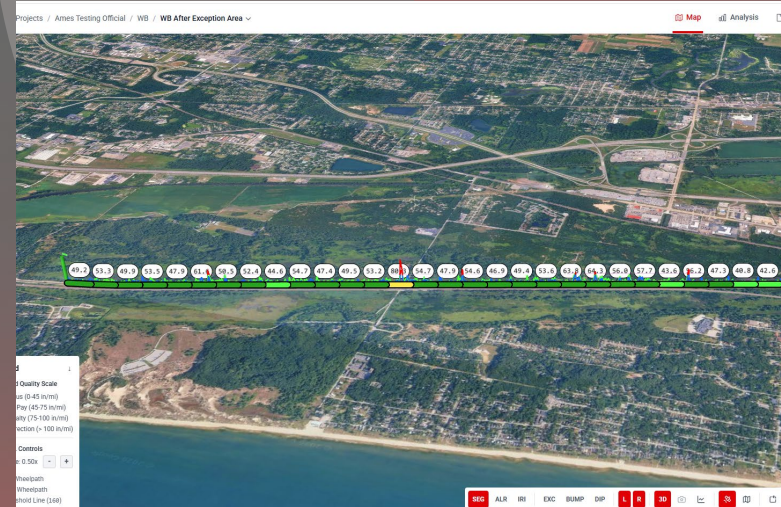


# “Ames Connect”

Back to  
8300

Back to  
stop & go

- Cloud based software for data sharing
- Map based smoothness reports
- Reports localized roughness
- Pay factor calculator using DOT pay table
- Shareable data throughout your company
- URL : [amesengconnect.com](https://amesengconnect.com)



# Thanks!

Follow us on social media for all the latest news!



Am e Engineering LLC



Ames\_Engineering



Ames Engineering LLC



Ames.Engineering



AmesEngineering

Do you have any questions?

[jon@amesengineering.com](mailto:jon@amesengineering.com)

+1 515 - 292 - 8194

[amesengineering.com](http://amesengineering.com)