

SOLID-STATE AREA-SCAN LIDAR FOR PAVEMENT PROFILE MEASUREMENT

(AASHTO R56 COMPLIANT) AND AUTOMATED DISTRESS READINESS

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THIS IS NOT A SALES PITCH

This is about how pavement measurement is evolving.

For decades, we've measured roads the way we measure a heartbeat...

one line at a time.

Today, I want to show you what happens when we finally get the full MRI

we can measure the entire surface.



WHAT IS SOLID-STATE AREA-SCAN LIDAR?

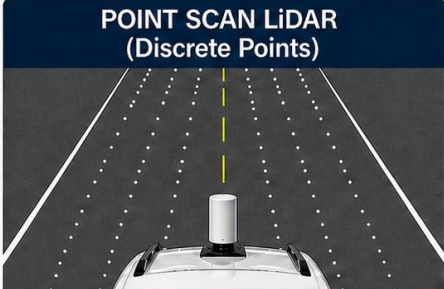
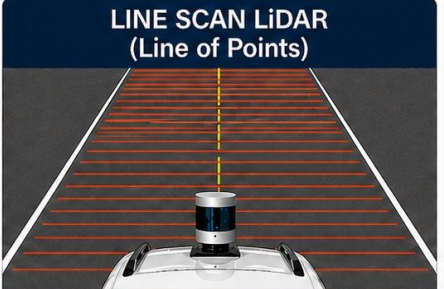
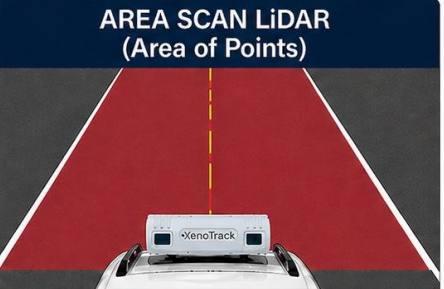


Solid-state, area-scan (flash) LiDAR

- No spinning parts
- No mirrors
- No line scanning

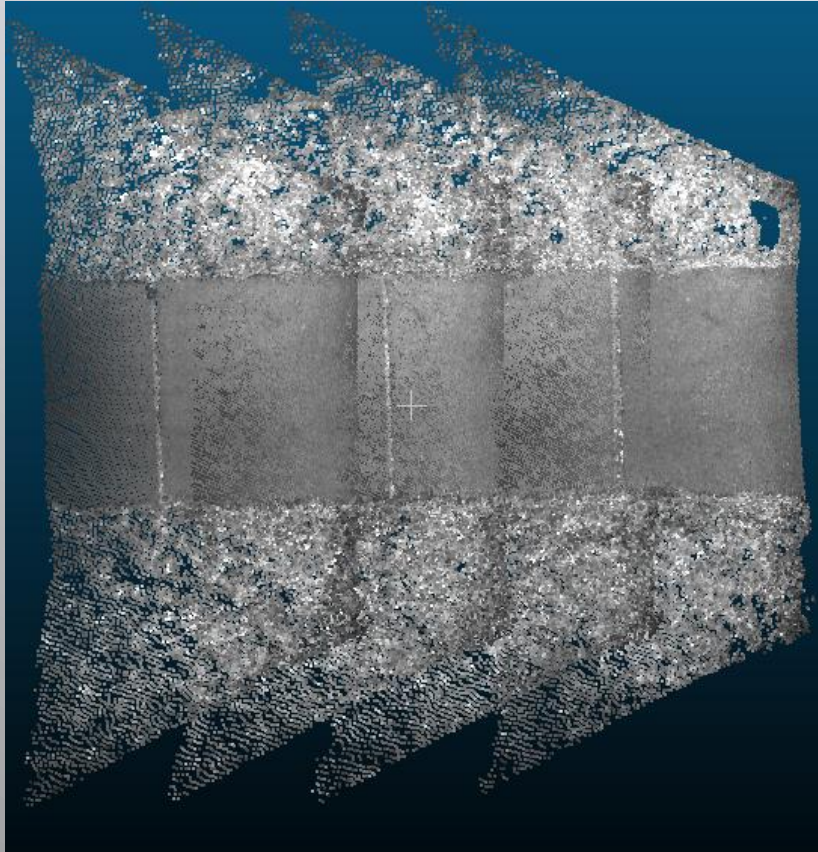
Captures the **entire lane surface in one measurement**

Produces a dense 3D elevation map (X, Y, Z)

POINT SCAN LiDAR (Discrete Points)	LINE SCAN LiDAR (Line of Points)	AREA SCAN LiDAR (Area of Points)
 <p>PAVEMENT POINT CLOUD EXAMPLE</p>	 <p>PAVEMENT POINT CLOUD EXAMPLE</p>	 <p>PAVEMENT POINT CLOUD EXAMPLE</p>
<ul style="list-style-type: none">• Individual points collected one at a time• Lower data density• More gaps between points• Good for general mapping• Less detail of pavement surface	<ul style="list-style-type: none">• Entire line captured at once• Higher point density than point scan• Better coverage and detail• Common for mobile mapping• Good for road surface modeling	<ul style="list-style-type: none">• Entire area captured instantly• Highest point density• Complete coverage with no gaps• Excellent for detailed surface modeling• Best for asset inventory and analysis
<p>💡 Area scan LiDAR captures exponentially more data, delivering the most complete and accurate representation of the pavement.</p>		<p>Point Scan < Line Scan < Area Scan (Data Density & Coverage)</p>

Key takeaway: it measures a surface, not a set of sampled lines.

FROM RAW DATA TO A 3D SURFACE



Data:

- Each pixel → distance → 3D point
- Frames are combined along the vehicle path to create a **continuous surface model**
- Calibration and filtering ensure accuracy

Result:

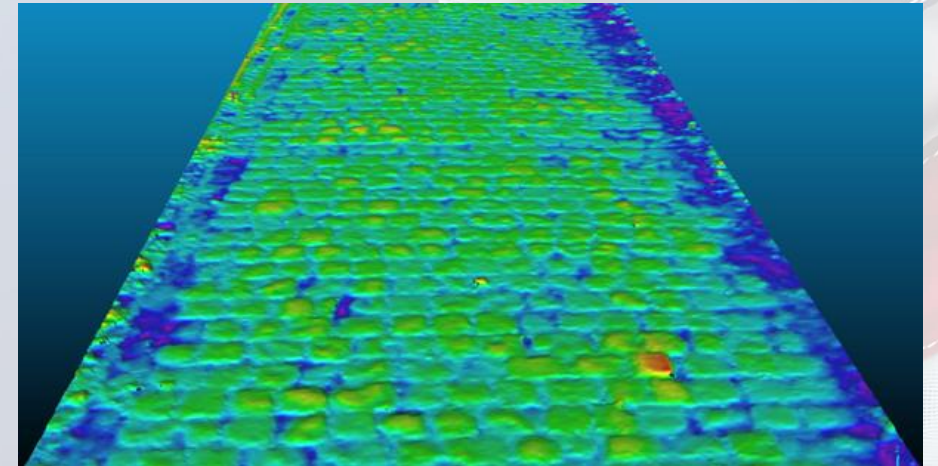
- Dense point cloud / height map (exportable to open formats like LAS/LAZ/CSV).
- Full-lane coverage
- No gaps between measurements

Key takeaway: Every pixel becomes a precise 3D point, stitched into a continuous, calibrated full-lane surface—delivering dense, gap-free geometry ready for analysis.

DERIVING LONGITUDINAL PROFILE (IRI-READY)



- From the measured surface, you **extract wheelpaths anywhere you choose** (not fixed sensors).
- The system computes longitudinal profiles and applies standard processing aligned with **AASHTO R56**.
- Those profiles produce **IRI**.
- Because the profile is **derived from a measured surface**, you're not interpolating between sparse points.



Key Takeaway: Deriving profile from measured geometry, not reconstructing it

WHY IT WORKS AT ANY SPEED



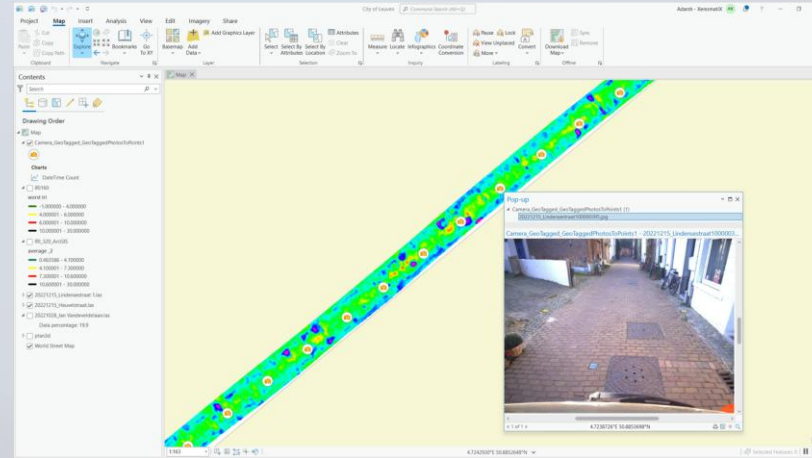
Traditional inertial profilers depend on **vehicle motion** (accelerometers + velocity).

Performance degrades at low speed or stops

Area-scan LiDAR measures geometry directly

Works at:

- Highway speed
 - Low speed
 - Zero speed
-
- You don't need motion to measure shape when you capture the full surface in 3D.



Key Takeaway: Solid-State Area-Scan LiDAR works at all speeds.

VALIDATION (CREDIBILITY ANCHOR)

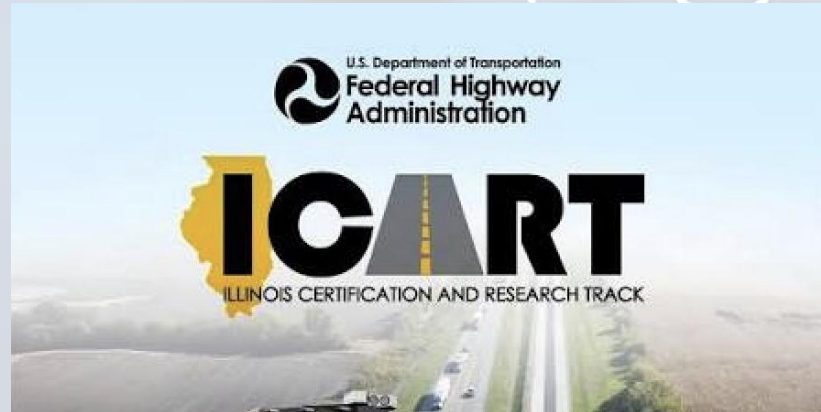


Validated at:

- National Center for Asphalt Technology (NCAT)
- Illinois Certification and Research Track (iCART)

Tested across real-world surfaces

Repeatable and consistent results



Key takeaway: Certified Longitudinal Profiler

INDEPENDENT BENCHMARK

ERPUG evaluation of road inspection systems: duraBAST 2024



<https://xenomatix.com/wp-content/uploads/2025/12/VTI-Durabast-report-Dec2025.pdf>

DURABAST - 23 EVALUATED SYSTEMS



CV Equipment Vectra (NextRoad group), two systems (France)
Norwegian Public Roads Administration (Norway)
GRID (Czech Republic)
Roadscanners (Finland)
Université Gustave Eiffel, three systems (France)
VARS (Czech Republic) *
Ramboll (Sweden) *
XenomatiX Solid State Area Scan LiDAR (Belgium)
Nordic Geo Center (Finland)
Univrses (Sweden)
Austrian Institute of Technology (AIT) (Austria)
Sina ASTM Group (Italy) *
NCC Infrastructure (Sweden)
Danish Road Directorate (Denmark) *
ARRB Systems AB (Australia)
Fugro (Netherlands) *
Leica Geosystems (Switzerland)
Geodrom (Czech Republic)
Mercedes Benz (Germany)
VTI (Sweden) *

BENCHMARK RESULTS

ERPUG evaluation of road inspection systems: duraBAST 2024

Area-scan LiDAR performs strongly across all metrics



	Participants	Systems meeting target	Solid State Area Scan LiDAR
IRI	21	8	2
Rut depth	13	5	3
Sliding wire rut depth	10	5	2
Hilliness	12	10	1 (ex aequos)
MPD	12	3	5
WLP sigma(evenness)	3	3	1
Position	17	13	1 (ex aequos)
Height	13	6	1 (ex aequos)

AASHTO R56 FIT: DERIVE COMPLIANT PROFILES FROM DENSE 3D DATA



Capture dense 3D lane surface

Full elevation surface is collected across the lane rather than along sparse traces.

Extract profiles from measured geometry

Longitudinal profiles are derived from the surface model in the desired wheel paths.

Process within current certification framework

Profile calculations can stay aligned with established inertial-profiler criteria (AASHTO R56).

Extend analytically without changing the sensor

The full surface remains available for rutting, crossfall, cracking, and deformation outputs.

Key Takeaway: The hardware does not need to change when the analytics expand.

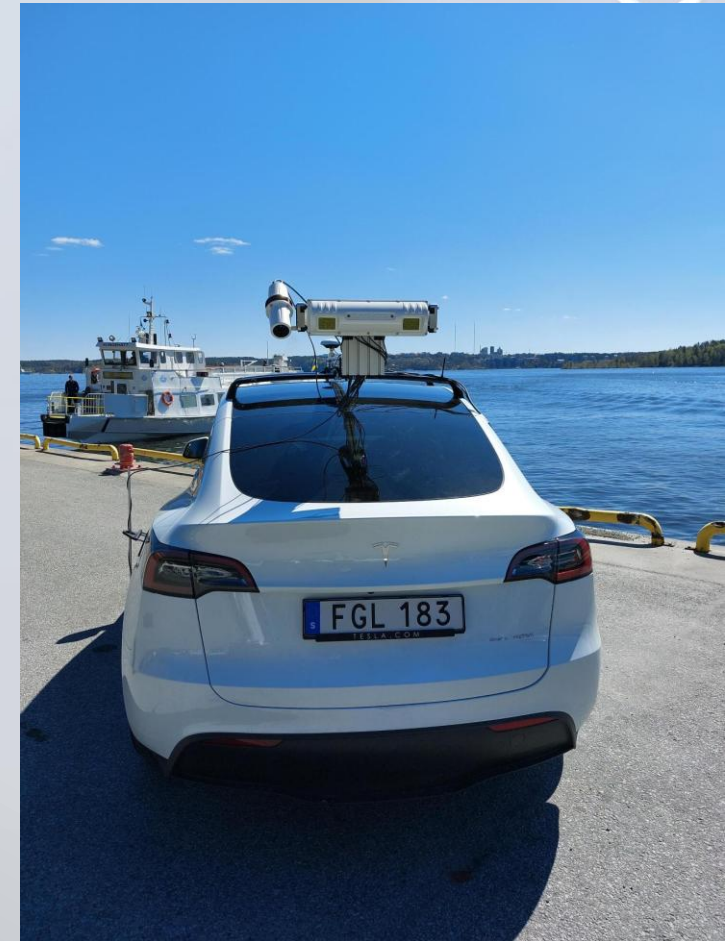
SAME DATA → MULTIPLE ANALYTICS (NO NEW HARDWARE)



From the same 3D surface (often with a synchronized camera for texture/context), you can compute:

- **Transverse profile / rutting** (direct cross-section from the surface)
- **Cross slope & drainage** (height maps → ponding risk)
- **Distress & PCI workflows aligned with ASTM D6433**
- **Construction verification** (as-built vs design)
- **Foreign object detection (FOD)**
- **Milling models** (true 3D surface for planning)

It's not a different system ... it's the same dataset.



SAME DATA, BROADER OUTCOMES



- Dense 3D surfaces inherently support cracking, rutting, faulting, and surface deformation analysis
- The agency adoption path can be incremental: start with profile compliance, then add analytics through software.
- That preserves the vehicle, mounting, and collection workflow while widening program value.

Profiler

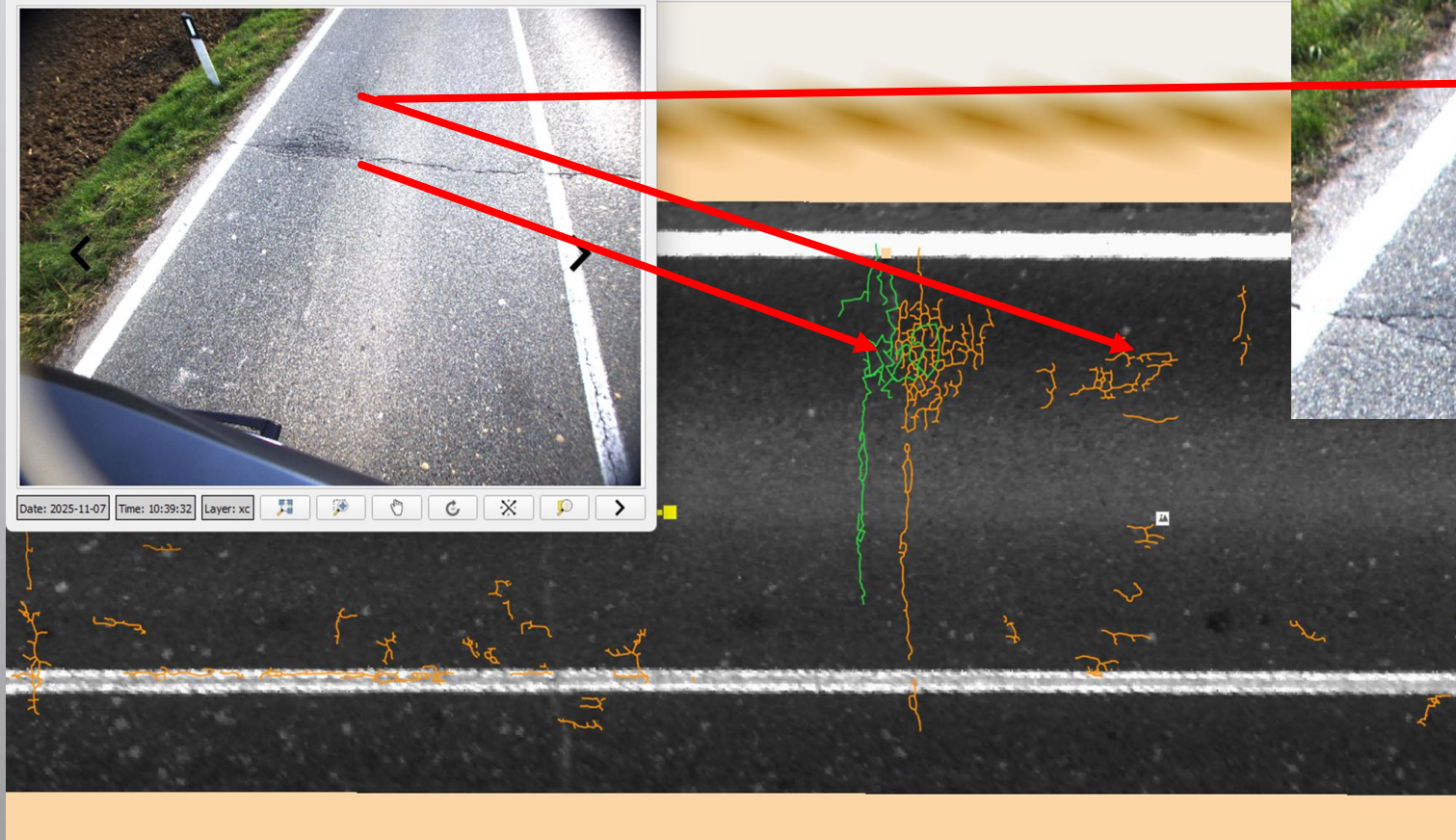
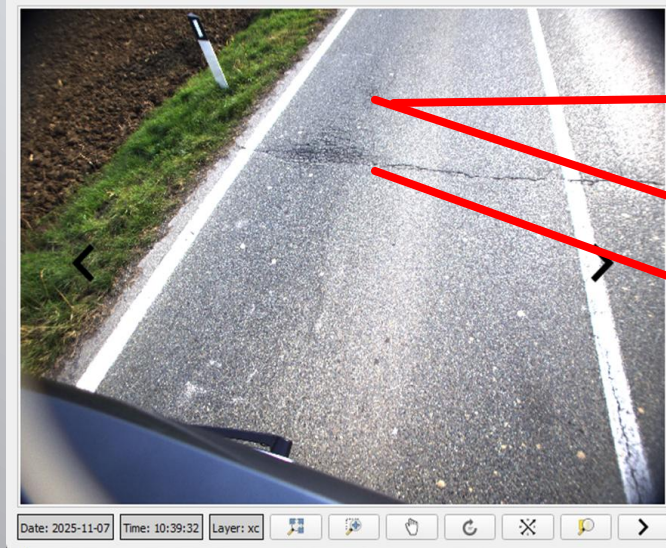
IRI
profiles
rut depth
crossfall

No hardware reset required

Profiler Expansion

cracking
faulting
deformation
PCI

SAME DATA, DISTRESS OUTCOMES



SUPERIOR DETECTION OF
BLOCK CRACK BRANCHES BY
AREA SCAN AND LINE-SCAN IS
FAILING TO DETECT SMALL
BLOCK CRACK

WHY AREA-SCAN BEATS POINT-SCAN AND LINE-SCAN



Point scan

- Samples one or a few points
- Sparse spatial coverage
- More interpolation between measurements
- Higher sensitivity to localized anomalies

Line scan

- Dense transverse strip
- Still limited longitudinal density
- Requires stitching across travel direction
- Good, but not a true continuous surface

Area scan LiDAR

- Dense 3D elevation surface across the lane
- Longitudinal profiles extracted from a measured surface
- Lower sensitivity to texture and transverse features
- Smaller Footprint Sensor
- Same data supports distress analytics

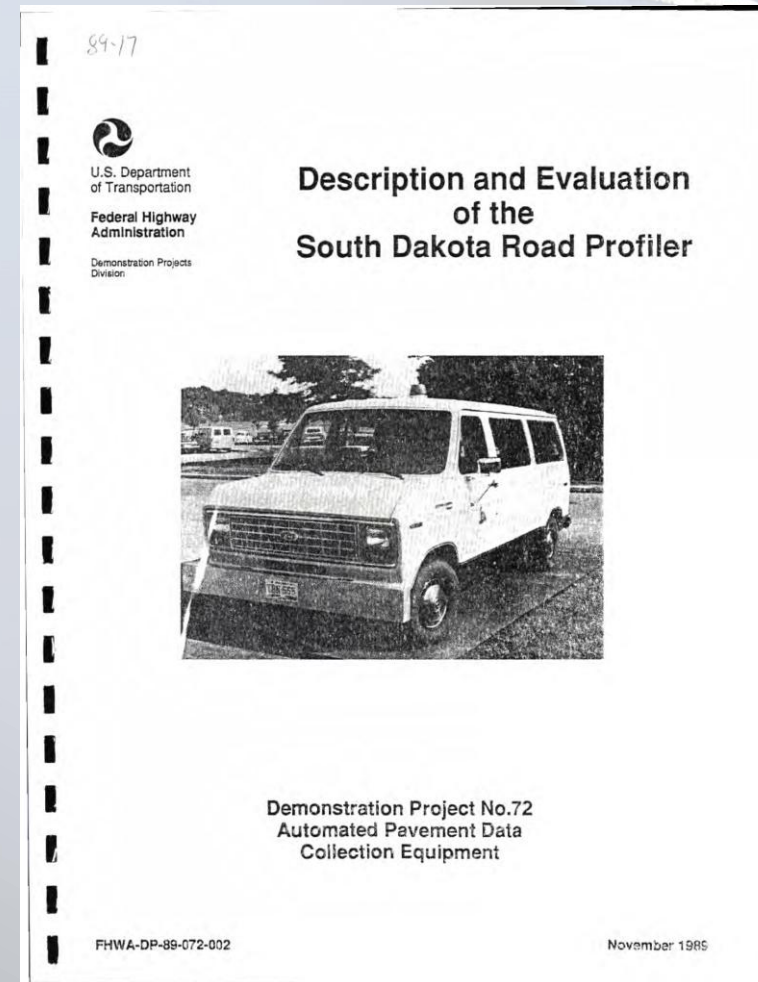
Key takeaway: area-scan measures a surface, not just a set of sampled traces.

LONGITUDINAL INERTIAL PROFILERS



Respect the Foundation

- Inertial profiling fundamentals
- Accelerometers + lasers + distance
- IRI, filtering, repeatability
- Proven and trusted



PROFILE: SAMPLING VS MEASURING

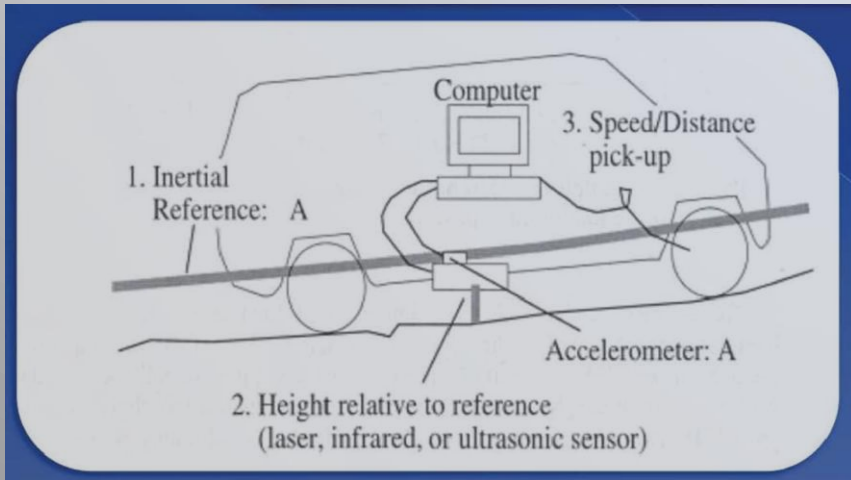


Traditional Systems

- Wheelpaths or slices only
- Interpolation required
- Speed dependent
- Multiple systems
- Misses defects between sensors

Area-Scan LiDAR

- Full-lane 3D surface
- No interpolation
- Works at any speed
- One dataset, multiple outputs
- Captures everything directly



Key takeaway: area-scan measures a surface, not just a set of sampled traces.

Three takeaways

- Area-scan LiDAR measures a surface, not a sparse sample.
- Independent duraBAsT results show Area-Scan LiDAR leading on core pavement metrics.
- The same 3D dataset supports profile compliance along with automated distress analysis.

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