

Government/Industry Meeting

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The Intersection of
Engineering and Policy.

Vehicle Test Device Radar Return Characteristics: Quantifying Variability and Wear

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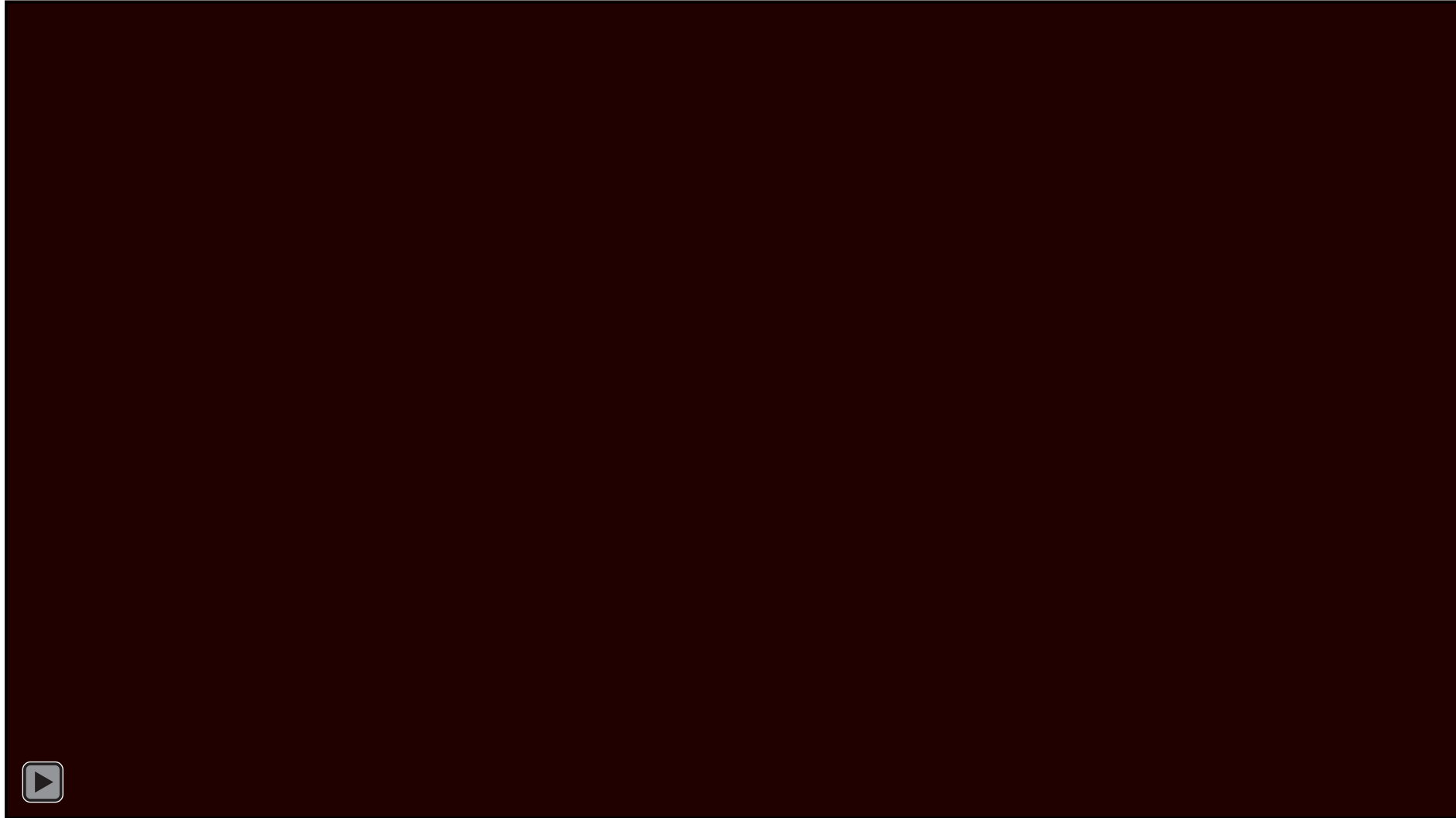
M.S.M.E.

Motivation

- The appearance of an object can affect how an ADAS responds to it.
 - Perception $\Rightarrow$ Classification $\Rightarrow$ Response
- “Appearance” may be objectively assessed in different ways:
 - Visual (dimensional, distinguishing features)
 - Infrared (near and far)
 - Radar cross section
- Understanding the feasibility of performing in-the-field radar cross section (RCS) measurements was of interest.
 - Evaluating the consistency of reference objects
 - Comparing the RCS values of new test surrogates to thresholds defined in ISO 19206:3 (2021)
 - Quantifying the effect of vehicle test device (VTD) wear

Example of How Test Surrogate Wear is Incurred

Lead Vehicle Stopped (50 km/h impact speed)



Calibration Measurements (Trihedral Specifications)

- Eravant: SAJ-043-S1 (right)
 - Trihedral Corner Reflector, 109mm
 - 10.0 dB-m² @ 76-77 GHz
- Eravant: SAJ-020-S1-1.97
 - Trihedral Corner Reflector, 50mm
 - -3.6 dB-m² @ 76-77 GHz



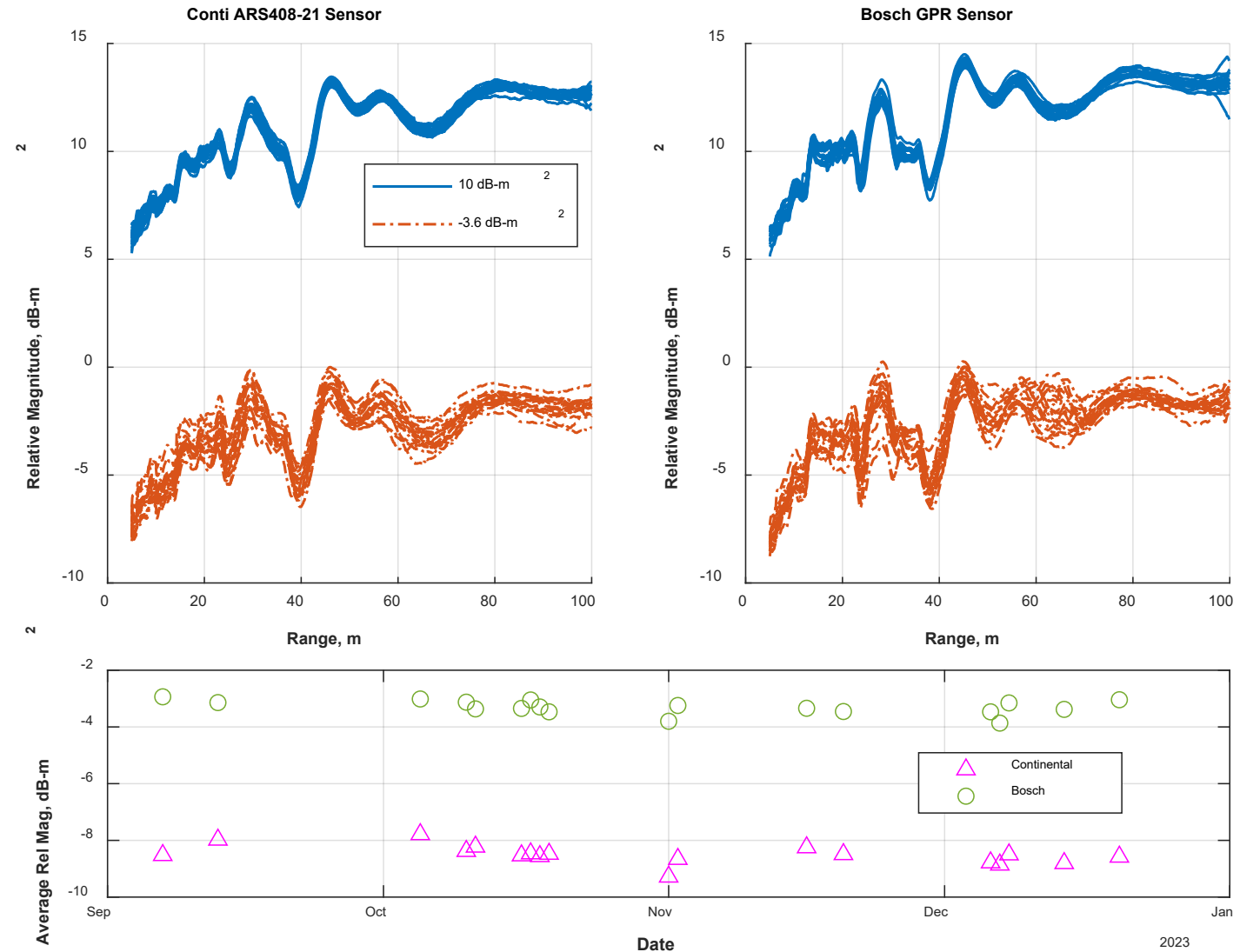
Measurement Equipment

- Commercially available self powered robotic cart
- Two automotive grade radars
- INS and IMU for location and performance tracking
- Fixed-angle, variable range measurements
 - From 100 to 5 m
 - Angles of 180°, 150°, and -150°



Calibration Correction Values

- Performed at a Fixed Angle approach of 180°
- Occurred once on the same day the object measurements were taken
- 18 composite lines per grouping



Vehicle Test Devices (VTD) Evaluated

AB Dynamics/Dynamic Research Inc. – Soft Car 360 (DRI)

- Model SC-FF-7 Revision G
- Secured to an AB Dynamics GST120 robotic platform



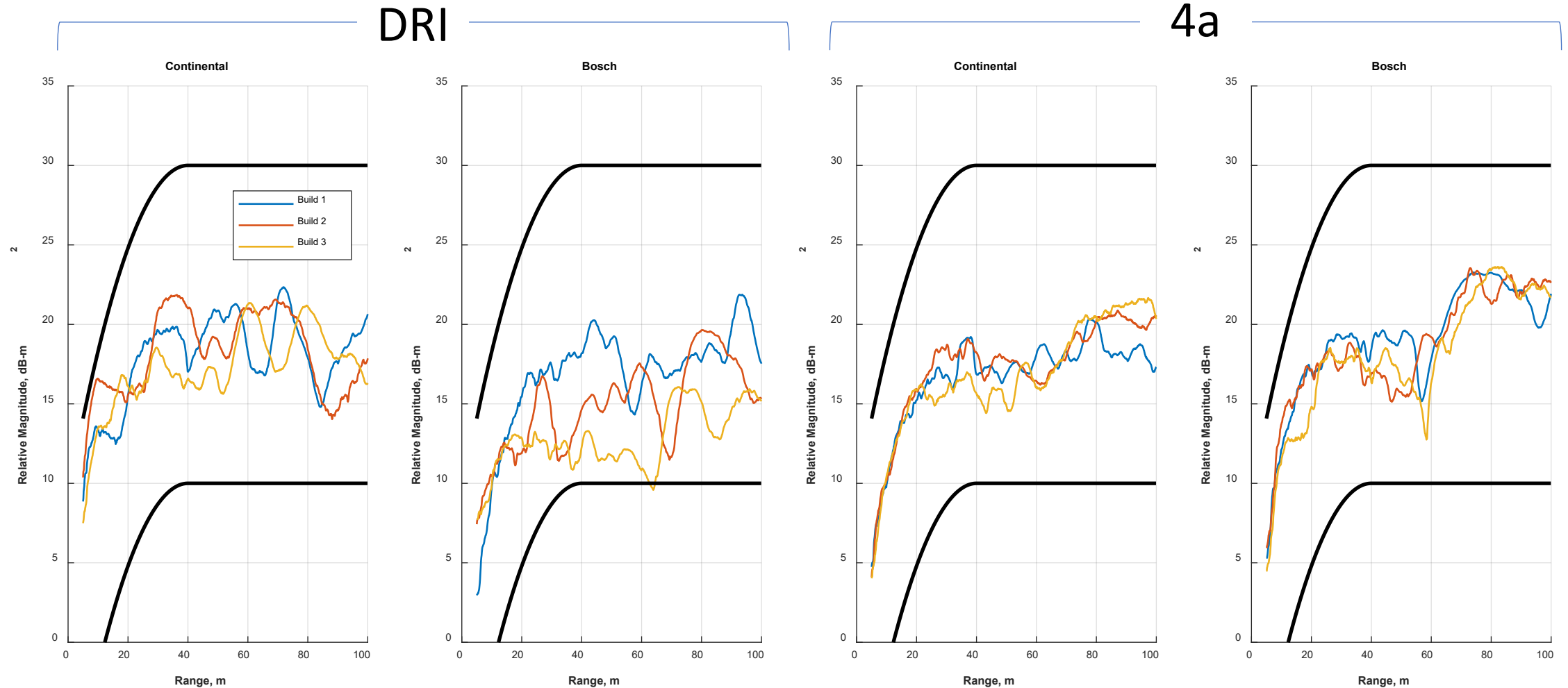
4activeSystems – 4activeC2 (4a)

- Model 2 V7.10-12e
- Secured to an AB Dynamics GST100 robotic platform



VTD Baseline Build Repeatability Study (Fixed-Angle 180° Approach)

- Build __: Equates to the composite RCS return at given build



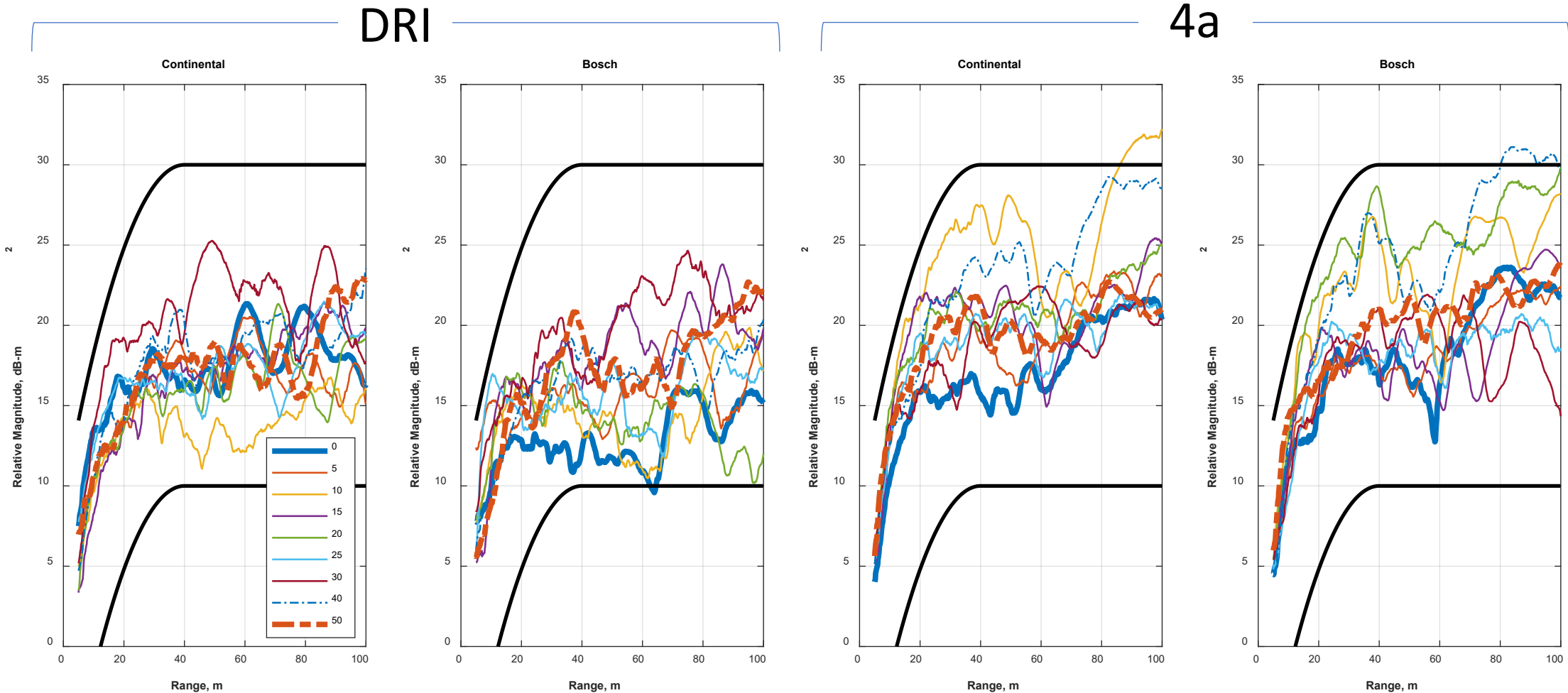
VTD RCS Degradation Setup

- The striking vehicle bumper/grill height allowed for nearly complete contact with the VTD's rear panel during an impact
- 20 kph impact speed into a stationary VTD for 50 iterations



VTD Degradation Study (Fixed-Angle Approach at 180°)

__ #: Equates to the composite RCS return at given number of strikes



Repeatability RCS In-Bound Summary of Results

Series	Set	Sub-set	Fixed-Range RCS Boundary (180°)		Fixed-Range RCS Boundary (150°)		Fixed-Range RCS Boundary (-150°)	
			>92%		>92%		>92%	
			Continental	Bosch	Continental	Bosch	Continental	Bosch
VTD Baseline	DRI	Build 1	100	100	100	100	100	100
		Build 2	100	100	100	100	100	100
		Build 3	100	98.1	100	100	100	100
	4a	Build 1	100	100	100	100	100	100
		Build 2	100	100	100	100	100	100
		Build 3	100	100	83.2	85.1	100	100
VTD Degradation	DRI	5 Impacts	100	100	100	100	100	100
		10 Impacts	100	100	100	100	100	100
		15 Impacts	100	100	100	100	100	100
		20 Impacts	100	100	100	100	100	100
		25 Impacts	100	100	100	100	100	100
		30 Impacts	100	100	100	100	100	100
		40 Impacts	100	100	100	100	100	100
		50 Impacts	100	100	100	100	100	100
	4a	5 Impacts	100	100	100	100	100	100
		10 Impacts	85.3	100	96.5	90.5	100	100
		15 Impacts	100	100	100	100	100	100
		20 Impacts	100	100	100	100	100	100
		25 Impacts	100	100	100	100	100	100
		30 Impacts	100	100	100	100	100	94.8
		40 Impacts	100	80.1	100	97.3	95.8	92.8
		50 Impacts	100	100	100	100	93.3	91.9

Concluding Remarks

- RCS qualitative consistency of the calibration trihedrals was successfully demonstrated, especially for the larger 10 dB-m² version
 - This is an important result as it indicates the measurement variations observed for the VTDs can be attributed to the VTDs themselves; not to equipment and/or evaluation method limitations
- Limited RCS variation was observed during the assembly and disassembly of the new VTD builds
- The RCS data shows that each VTD was mostly unaffected by the 50 repeated impacts performed at 20 km/h

Technical Report(s)

- Additional information available:

- Zeits, R., Forkenbrock, G.J., Davis, I., Fogle, E., Nagy, I., Neer, A., & Peterson, B. (2024, April). *Assessing the Effect of Wear on Vehicle Test Device Radar Return Characteristics*. Washington, DC: National Highway Traffic Safety Administration.
 - Available at www.regulations.gov, docket NHTSA-2023-0021-1067
- Zeits, R., Nagy, I., Peterson, B., Davis, I., Forkenbrock, G. J., & Neer, A. (2025, January). *Passenger vehicle surrogate test target radar return repeatability* (Report No. DOT HS 813 648). National Highway Traffic Safety Administration.
 - Available at <https://rosap.nhtl.bts.gov/view/dot/79093>

Thank You

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Transportation Research Center, Inc.