

Wireless Charging Testing to Support Code & Standards Development

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INL's Electric Vehicle Infrastructure (EVI) Lab

- Support codes and standards development and harmonization
 - Test results of state of the art charging systems
- Measure performance metrics
 - System efficiency
 - EM-field emissions
 - Power quality
 - Response to dynamic grid events
 - Cyber security vulnerability assessment
- Wide range of input power
 - 120 VAC to 480 VAC 3 ϕ
 - 400 kVA total capability
- Bench and vehicle testing capabilities



<https://avt.inl.gov/panos/EVLTour/?startscene=pano5141>

Bench sub-system testing

- Standardized testing for technology evaluation
- Fiberglass frame and fasteners supports the vehicle side coil and power electronics
- Vehicle emulation modules
 - Battery emulator
 - DC load w/ variable resistance
 - Communications



Vehicle testing

- Testing of specific system integration tuned and calibrated for the specific vehicle application
- Non-metallic vehicle ramps used to elevate vehicle to provide necessary space for the coil positioning system



J2954 Interoperability Testing at INL: In Progress

- INL testing to support SAE J2954 development

- Testing of 8 WPT systems

- Efficiency
- EM-field
- Power Quality

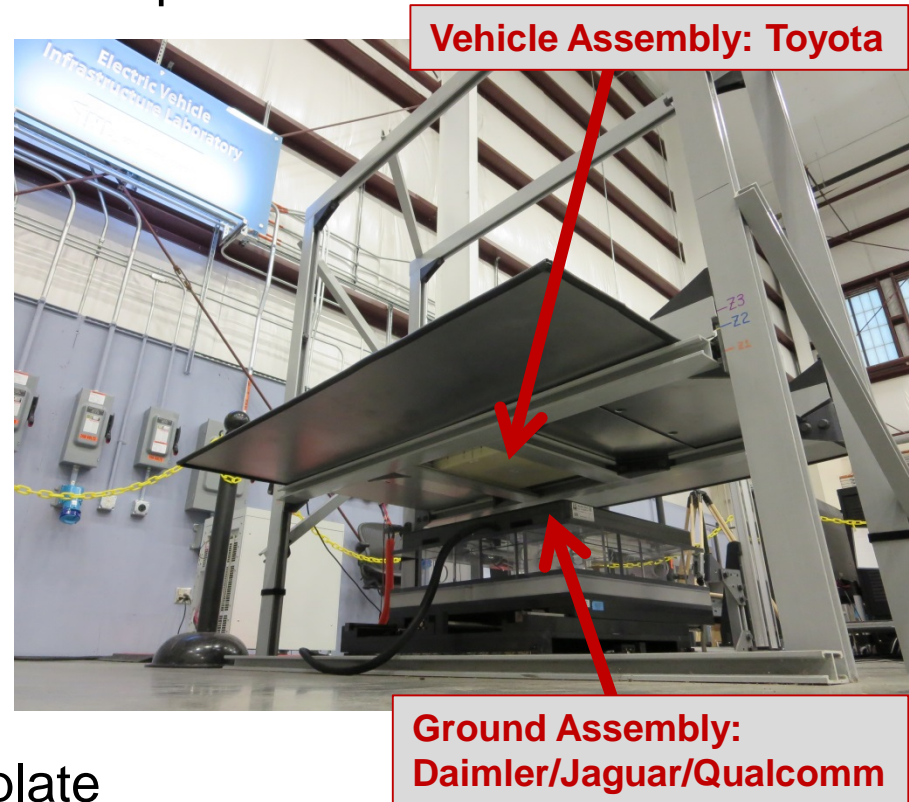
- Range of conditions

- X & Y misalignment
- Z coil gap
- Power Level
- Battery voltage

- Steel vehicle floor pan mimic plate

- Aluminum shield plate

- Test results will enable solid decisions for codes and standards development



Matched & Interoperable Testing

- Total # of tests = **22**
 - Matched Tests = **8**
 - 2: Toyota (WPT1) / Z1 & Z2
 - 3: Nissan (WPT2) / Z1, Z2, & Z3
 - 3: DJQ (WPT2) / Z1, Z2, & Z3
 - Interoperable Tests = **14**

Completed: Aug26

Matched
Interoperable

Vehicle Assembly

		Totoyta			Nissan/WiTricity			Daimler/Jaguar/Qualcomm		
		Z1	Z2	Z3	Z1	Z2	Z3	Z1	Z2	Z3
Ground Assembly	Totoyta WPT1	3.5 kW	3.5 kW	--	3.5 kW	3.5 kW	--	3.5 kW	3.5 kW	--
	N/W WPT2	3.5 kW	3.5 kW	--	7.0 kW	7.0 kW	7.0 kW	7.0 kW	7.0 kW	7.0 kW
	DJQ WPT2	3.5 kW	3.5 kW	--	7.0 kW	7.0 kW	7.0 kW	7.0 kW	7.0 kW	7.0 kW

- To date, measured efficiency up to: 93.3% (AC to DC)
- No failures (successful power transfer at all test points)
- Currently on test: *vehicle assembly*: Daimler/Jaguar/ Qualcomm
ground assembly: Nissan/WiTricity

Summary

- INL test results supports codes and standards development
 - Refining and validating test procedures
 - Identifying EM-field safety requirements and test procedures
 - Results enable robust decisions for
 - Test procedures
 - Setup requirements
 - System design requirements for interoperability
- Bench testing enables standardized technology comparison
- Vehicle testing characterizes actual system performance in vehicle

Acknowledgement

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More Information

<http://avt.inl.gov>

<http://at.inl.gov>

Back-up slides

EVI Lab Measurement Equipment

- Efficiency and Electrical Power Quality
 - Hioki 3390 Power Meter
 - 0.15% accuracy
 - 4 channels
 - Voltage
 - Current Probes
- Electro-magnetic field
 - Narda EHP-200a
 - 9 kHz – 30 MHz
- Surface Temperature
 - FLIR SC640 infrared camera connected to PC
- Custom LabVIEW host control and data acquisition

