Field Experiment for Accuracy Verification of Pavement Inspection in TRUE Project

By
Kazuya Tomiyama (Kitami Institute of Technology, Japan)
Hiroyuki Mashito (Toa Road Corporation, Japan)
Shuich Kameyama (Hokkaido University of Science)
Hiroyasu Nakamura (NIPPO Corporation, Japan)

Contents

Section 1

Introduction

Who's PDRG?

Pavement Diagnosis Researchers Group

- a specific nonprofit organization established in 2006
- the former FWD Research Group established in 1995

Scope: Measurement, inspection, data analysis, and evaluation of *structural* and *functional* characteristics of pavements

Consists of

- public agencies
- contractors
- consultants
- vendors
- academia

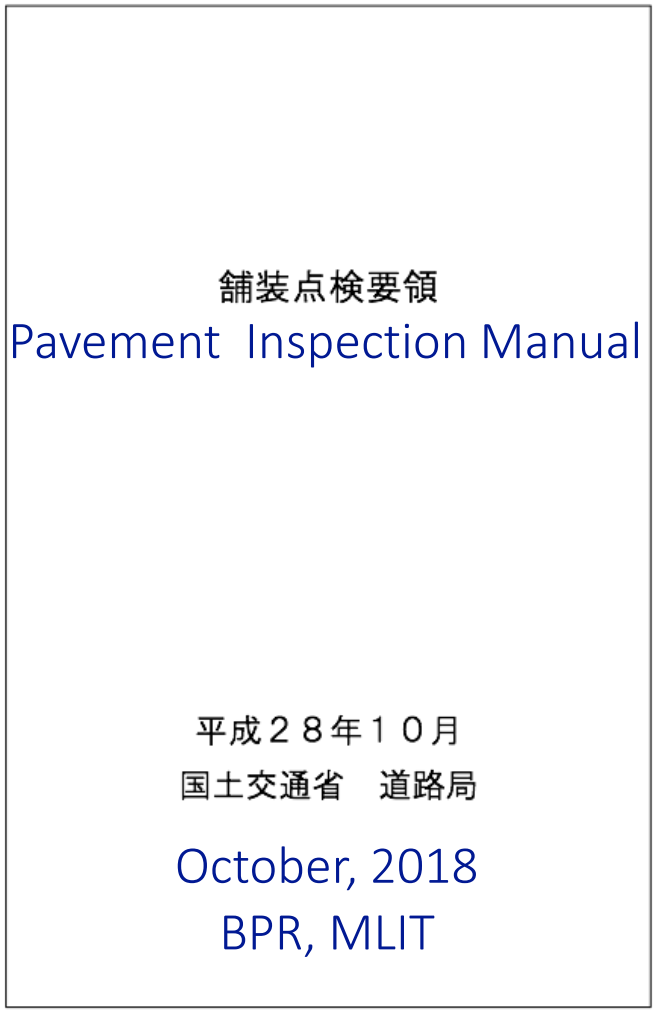
Objectives

- Exchange idea and information
- Improve and spread technologies
- Provide knowledge and information
- Provide technical support

Road Surface Situations in Japan

- A lot of aged pavements
- Shortage of budgets for maintenance and rehabilitation
- Retirement of experienced engineers

Specific Strategy in Japan



The Road Bureau of Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has issued...

Pavement Inspection Manual (2016)

- introducing ***the International Roughness Index (IRI)***
- to construct a ***Maintenance Cycle***

Acceleration of Profiler Development

Class 1

- Rod and Level
- Static Dipstick

Class 3

- RTRRMSs
- Smartphone Devices

Class 2

- High-speed Inertial Profilers

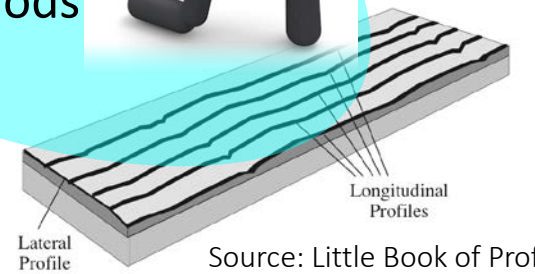
Accuracy: High ← → Low

Convenience: Low → High

Conflict between Accuracy and Convenience

Class 4

- Visual Inspection
- Subjective Methods



Source: Little Book of Profiling

Brief History

1998 PIARC EVEN in Japan (7 devices)

⋮

2014 PDRG TRUE Project 1st Experiment (34 devices)

⋮

2016 PDRG TRUE Project 2nd Experiment (28 devices)

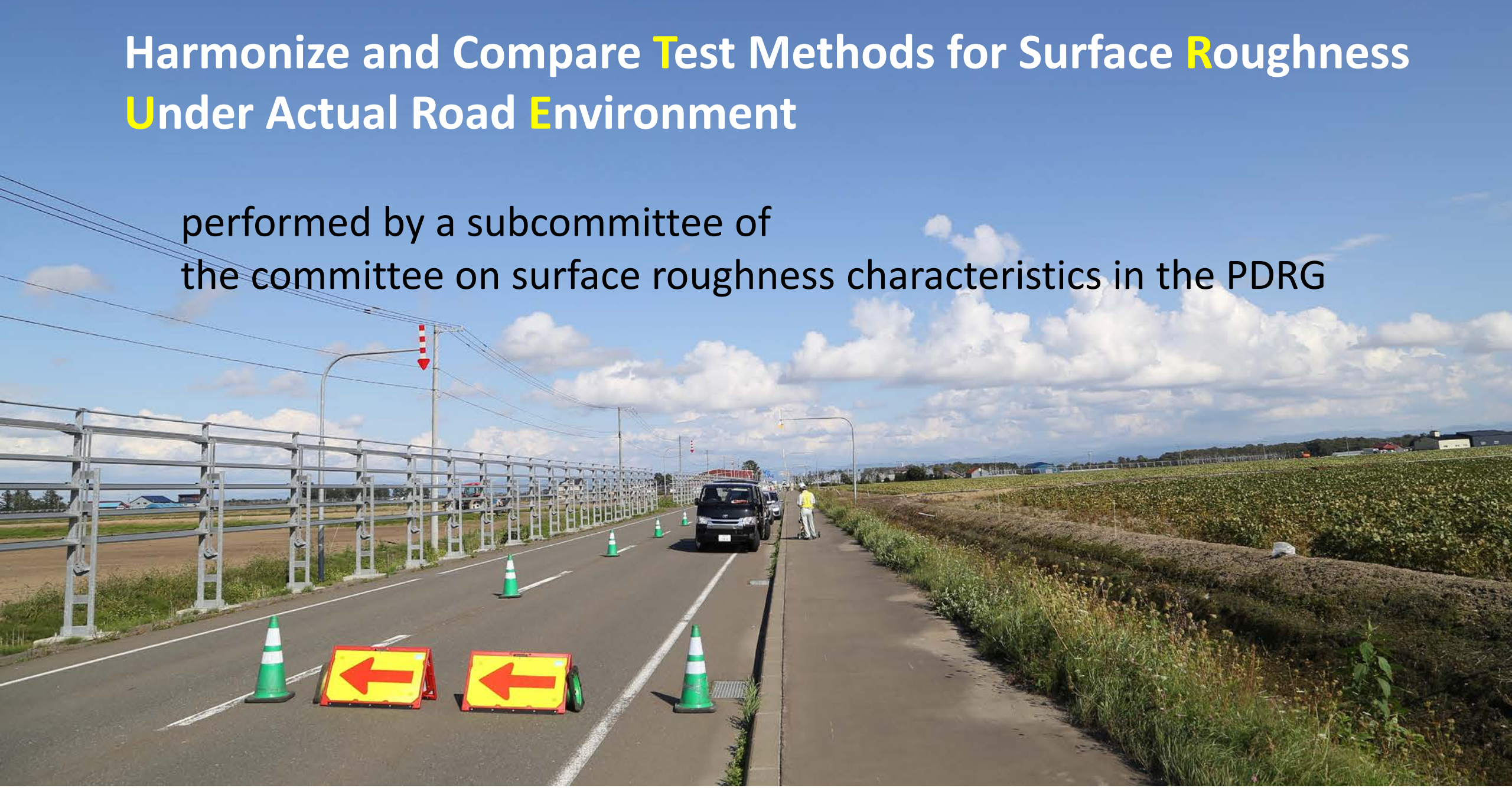
⋮

2018 PDRG TRUE Project 3rd Experiment (28 devices)

30 years on the Road To Progressively Better Data

Harmonize and Compare Test Methods for Surface Roughness Under Actual Road Environment

performed by a subcommittee of
the committee on surface roughness characteristics in the PDRG



Section 2

Overview of the TRUE Project

The Mission and Policy of TRUE Project

Improving Technologies of Surface Measurement Devices under Actual Road Environment by

- supporting the experiment operations
- analyzing the data obtained in experiments
- reporting and publishing the outcomes of activities

Features

- involving both high- and low-speed devices
  -> enhancing introduction and development of new devices
- conducting the experiments not only on highway but also local roads -> fit for the purpose

History of TRUE Project

Pre-experiment
Establish the reference measures (PWRI)

Draft Guideline for Pavement Inspection (2013)

- Accuracy Overview

TRUE 2014
(1st Exp. Sep. 2014)

FWD and GPR Survey 2014

Pavement Inspection Manual (2016)

- Overseas Participation
- Extra Test Section

TRUE 2016
(2nd Exp. Sep. 2016)

FWD Survey 2016

- Accuracy Report
- Device Groping

TRUE 2018
(3rd Exp. Sep. 2018)
postponed due to earthquake

- High quality reference profiles and open data for inter-comparison
- Meeting engineers and exchange information

30 years on the Road To Progressively Better Data

Test Sites

The experiments were conducted on prefectural roads with the cooperation of Hokkaido prefecture of Japan.

- 200 m long with 20 m and 5 m additional extents
- including arterial and residential roads

Summary of Test Sites

Site	Section	Road Class	Length (m)	IRI (mm/m) for 200 m	
				FY 2014	FY 2016
1	Section 1-1	Arterial	200	2.6	2.6
	Section 1-2			1.8	1.8
	Section 1-3 *			N/A	2.4
2	Section 2-1	Residential		6.3	6.5
	Section 2-2			4.5	4.5

* Section 1-3 was measured only in the second experiment in 2016

Participated Devices

Number of the Participated Devices

	FY 2014	FY 2016	FY2018	Total
High-Speed Devices	20	15	12	47
Low-speed Devices	14	13	16	43
Total	34	28	28	90

Inertial Profiler

MMS

Walking Profiler

Low-speed Profiler

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Data Recording and Reporting

Test Site	 Arterial Road	 Residential Road
Driving Speed	40, 50, 60 km/h	20, 30, 40 km/h
Num. of Rept.	3	
IRI	.xlsx; 10 and 200 m fixed interval	
Profile	.csv; possible minimum longitudinal sampling interval	

Analysis Method

Description

Systematic Error

Random Error

Good ← **Bias (Portability)** → Poor

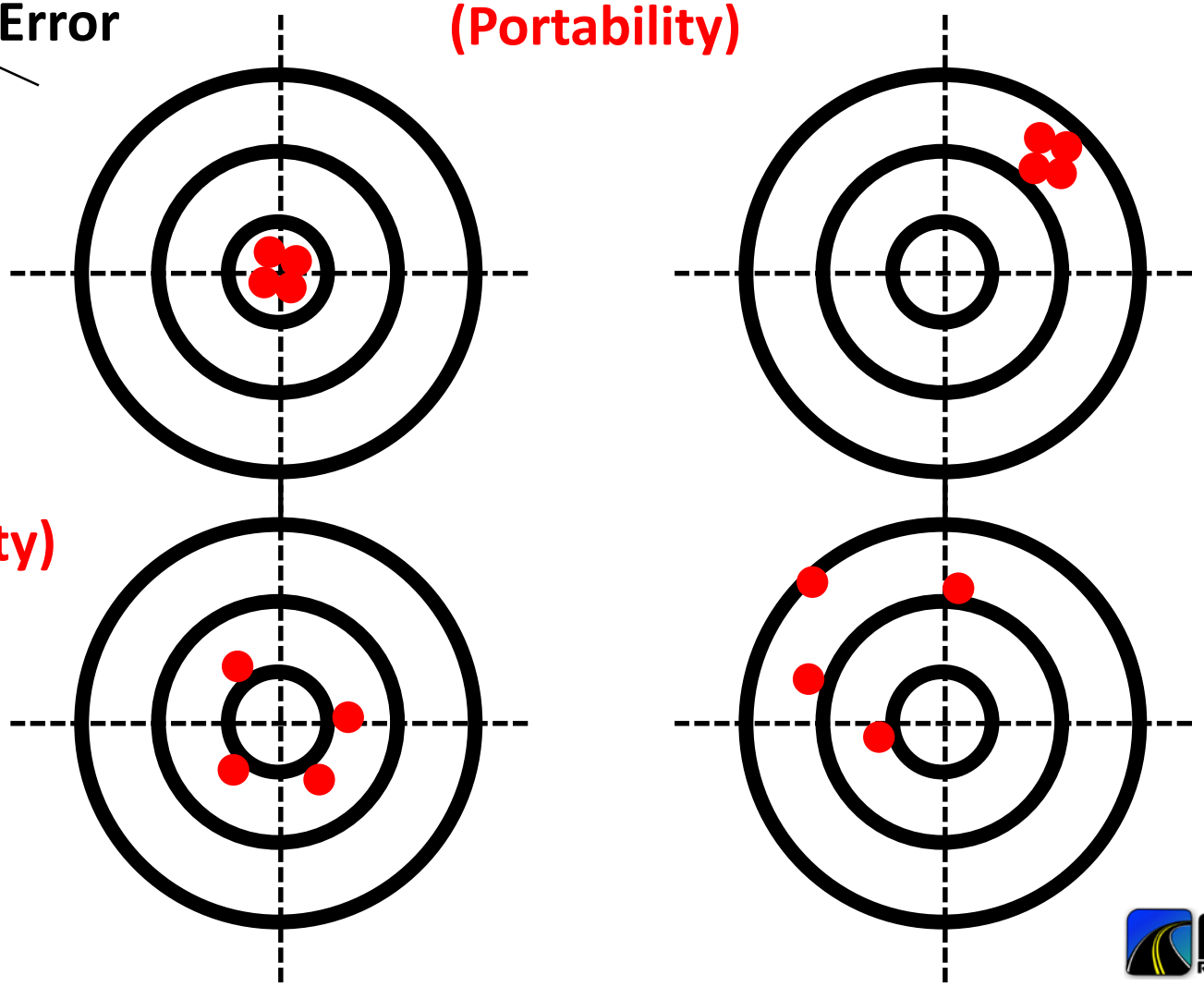
Good

↑

Precision (Repeatability)

↓

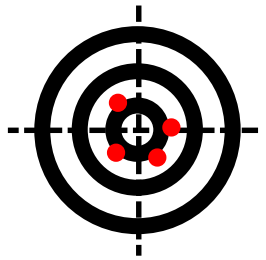
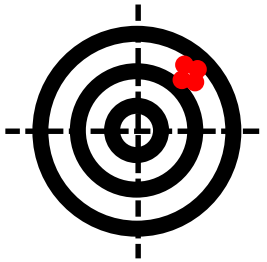
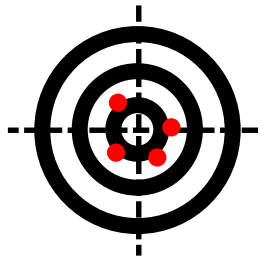
Poor



30 years on the Road To Progressively Better Data

Analysis Method

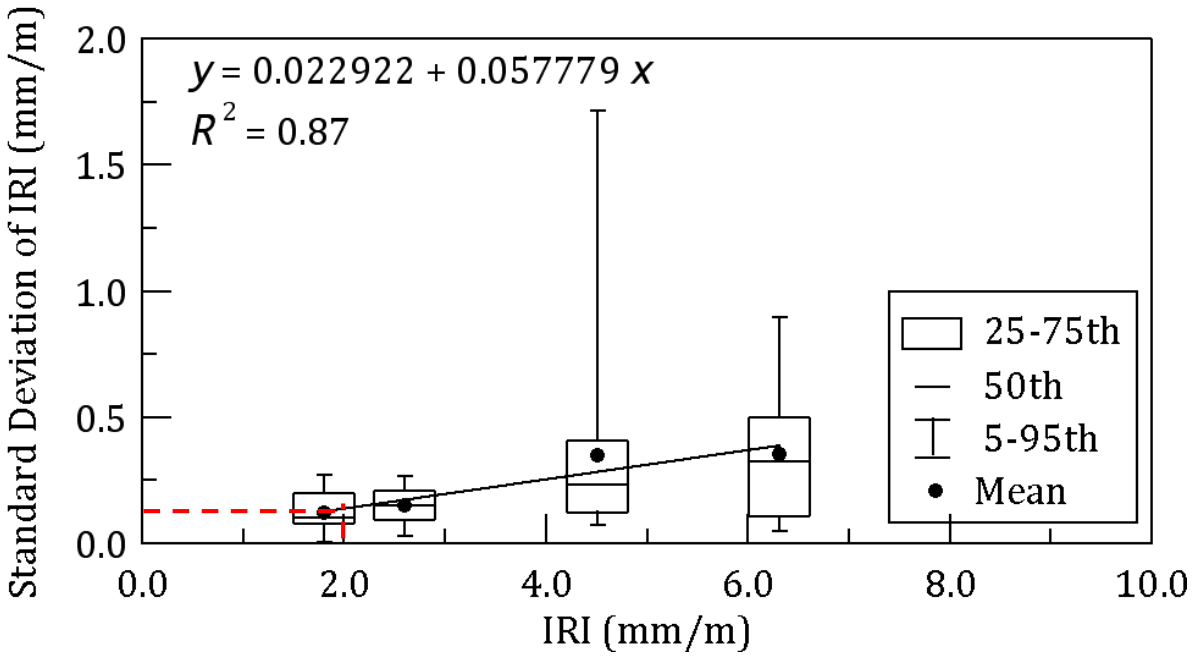
Details

	Error	Factor	Description
Repeatability (Precision)	**Random** An ability to repeat the measures with a same profiler	**Within** Deviation from the average obtained with repeated runs	
Reproducibility and Portability (Bias)	Systematic An ability to repeat the measures with a different profiler	Between Deviation from the average obtained with an expected value	
Influence of Speed (only for high-speed devices)	Systematic An ability to repeat the measures on different operation speeds	Within Deviation from the average obtained with repeated runs	

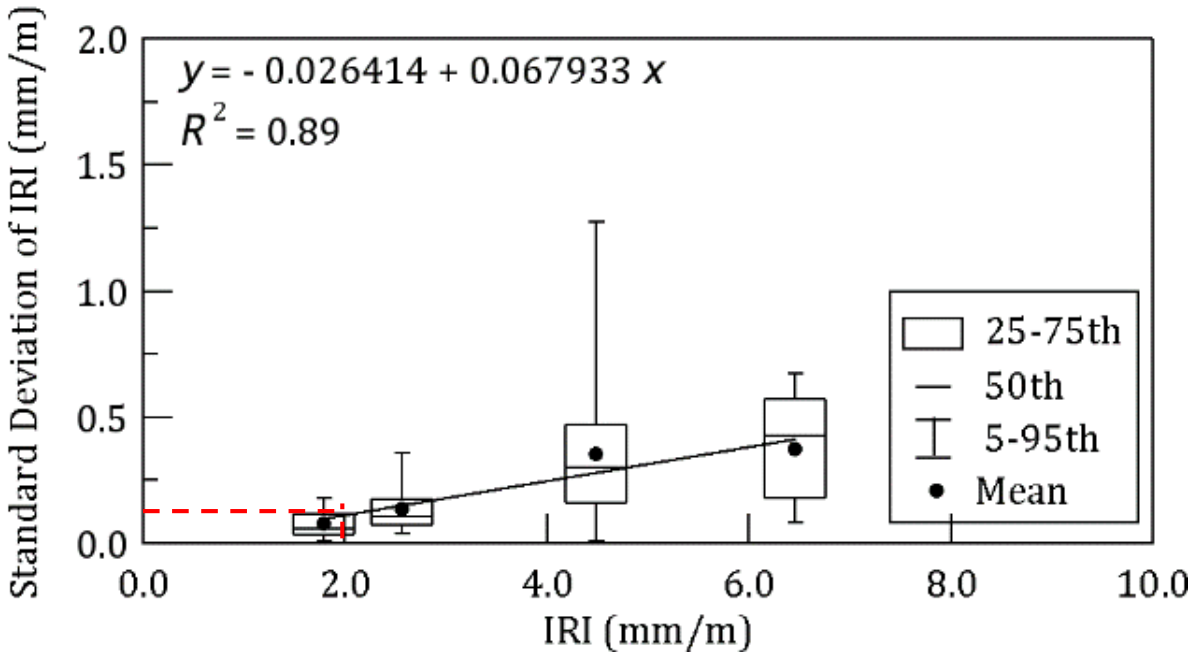
Section 3

Experiment Results

Influence of Operating Speed



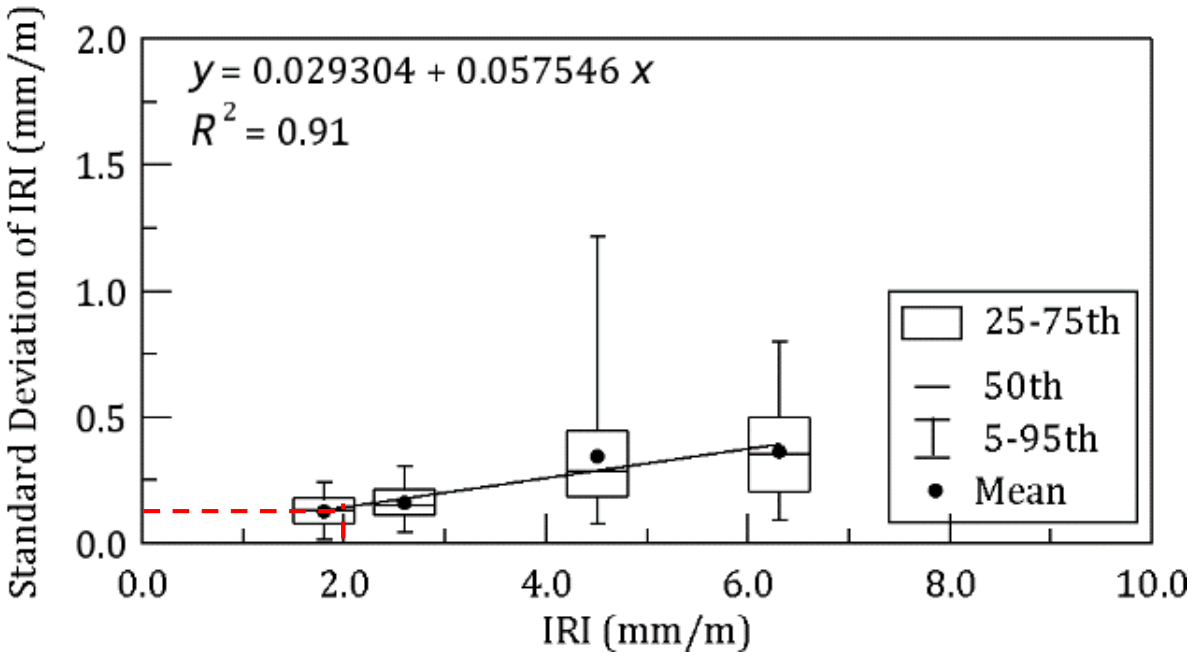
First Experiment in 2014



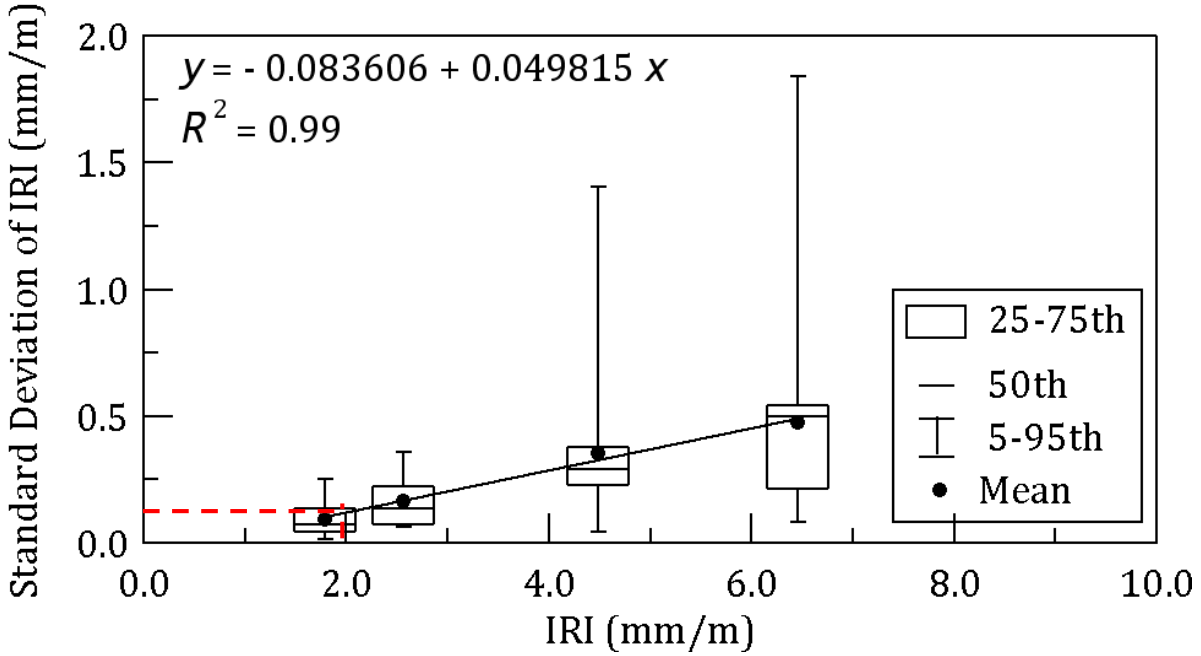
Second Experiment in 2016

Within 10% precision of the measured IRI values
on the 75th percentile (e.g. 2.0 ± 0.2 mm/m)

Repeatability of High-speed Devices



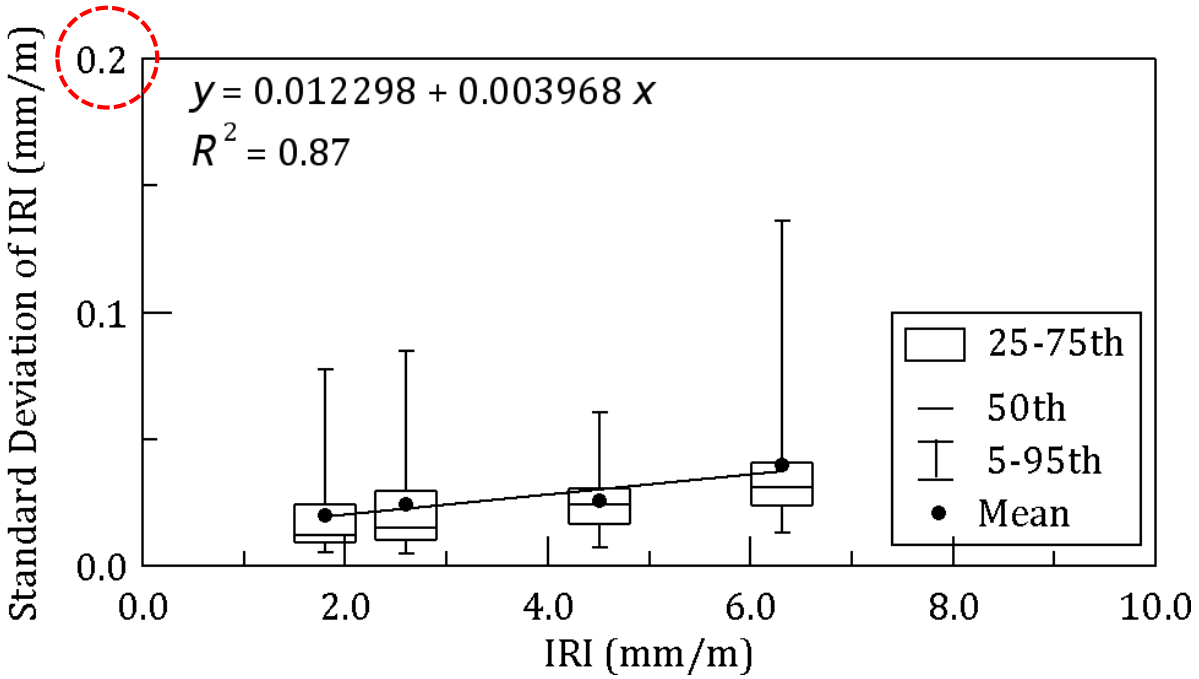
First Experiment in 2014



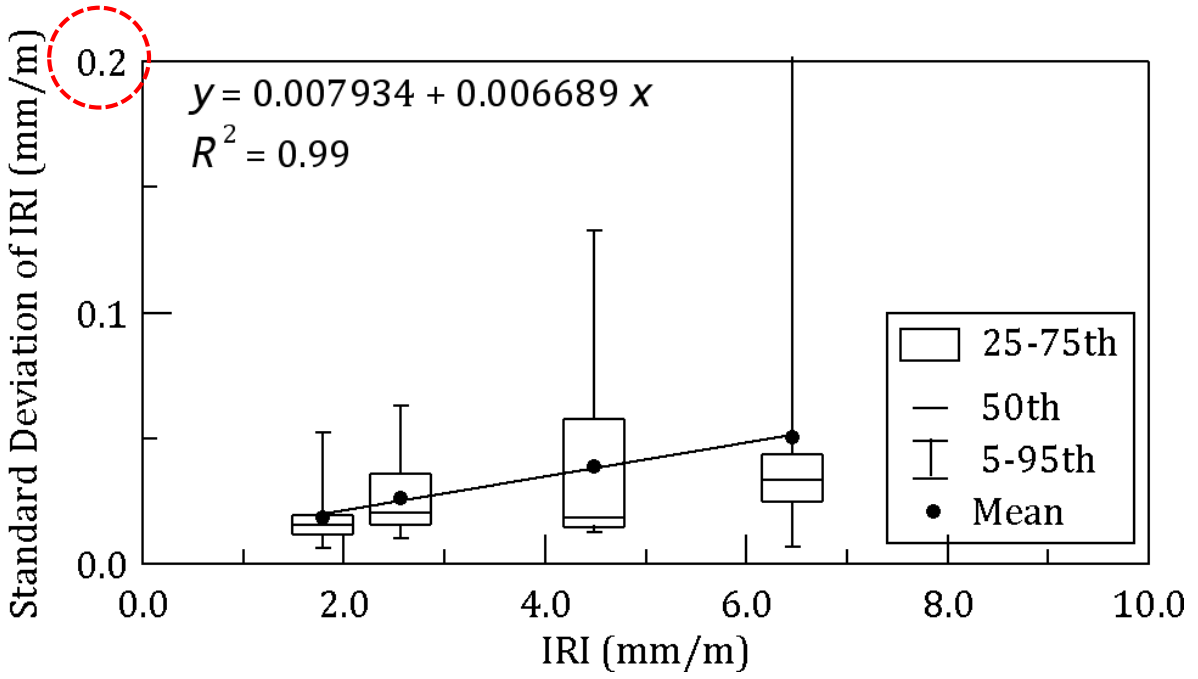
Second Experiment in 2016

Within 10% precision of the measured IRI values
on the 75th percentile (e.g. 2.0 ± 0.2 mm/m)

Repeatability of Low-speed Devices



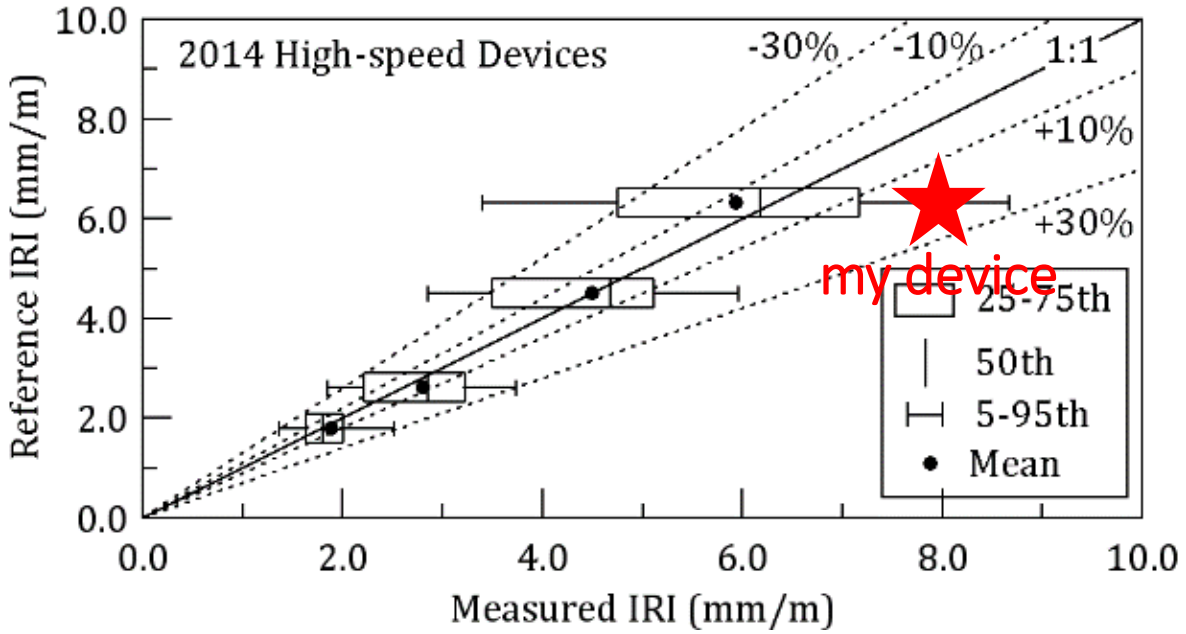
First Experiment in 2014



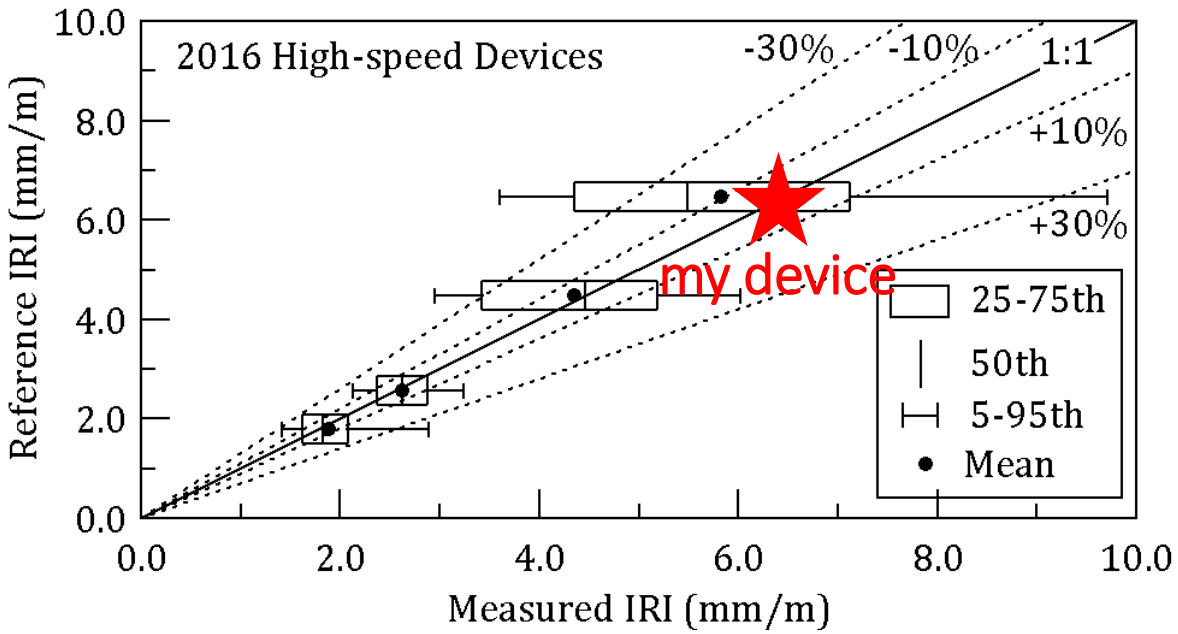
Second Experiment in 2016

Within 1% precision of the measured IRI values
on the 75th percentile (e.g. 2.0 ± 0.02 mm/m)

Reproducibility of High-speed Devices



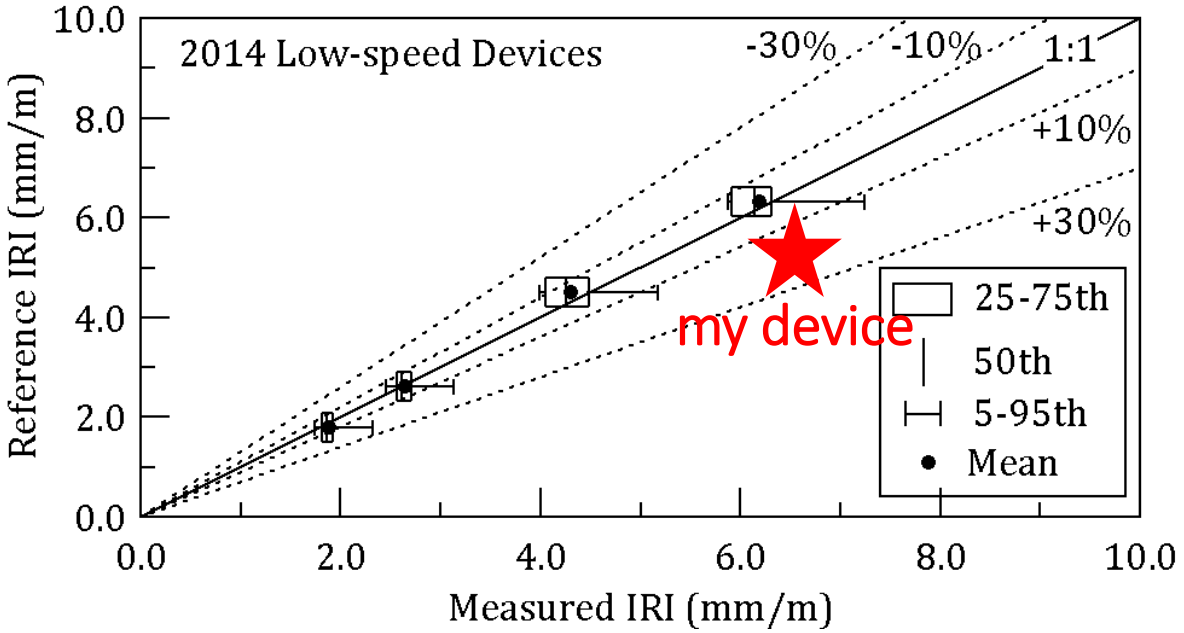
First Experiment in 2014



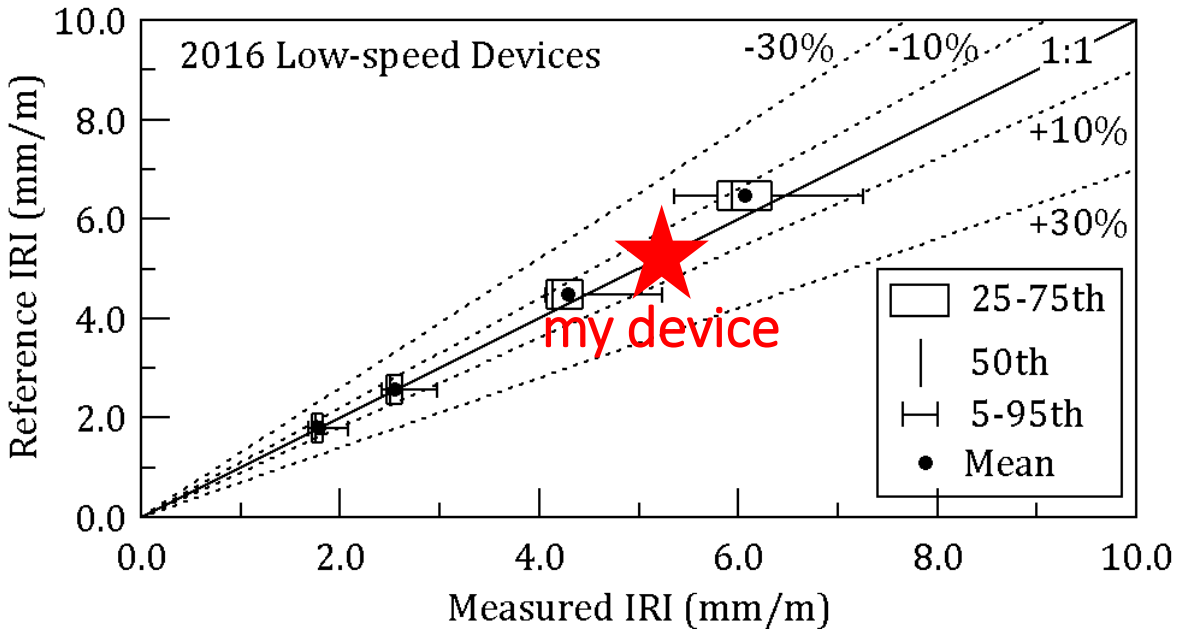
Second Experiment in 2016

Within 10 % (some devices exceeded 30%)
on the 50th-75th percentile

Reproducibility of Low-speed Devices



First Experiment in 2014



Second Experiment in 2016

Within 10 % (some devices exceeded 30%)
on the 25th-75th percentile

Section 4

Recent Works

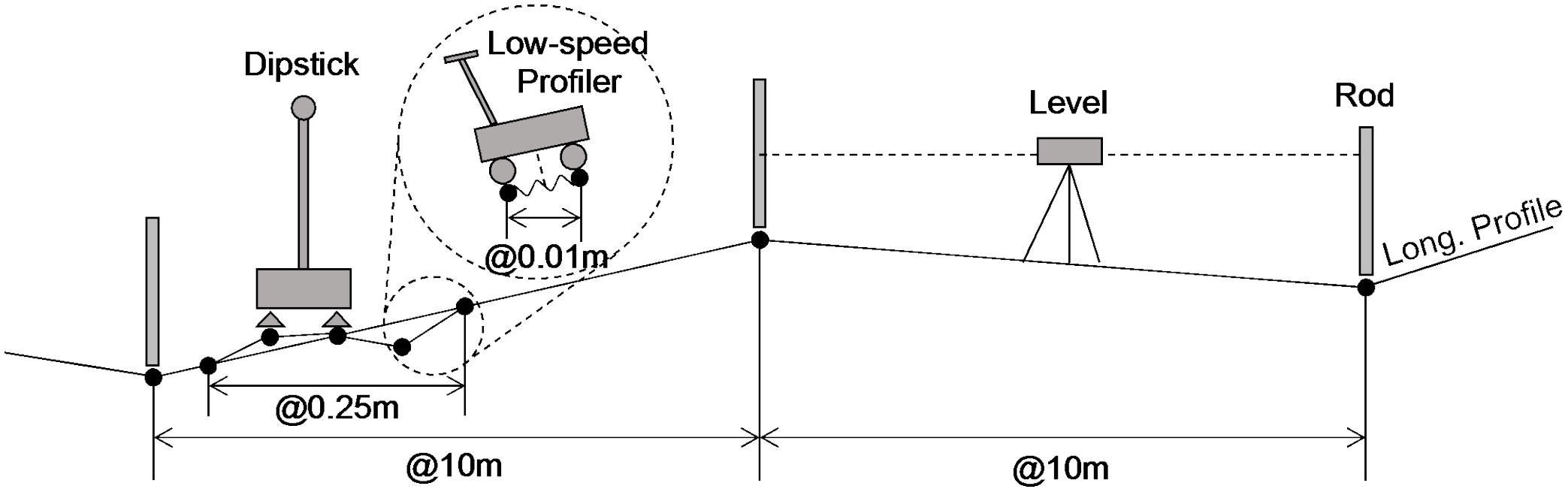
Device Grouping (since 2018)

Group		Requirement					Profiler Class
I	A	Subjective	Visual insp. / Ride exp.		On Vehicle		Class 4
	B		Visual Inspection		By Walk		
II	A	Profile-based Method	Static		Direct Measurement		Class 1
	B				Indirect Measurement		
III	A		Dynamic	Low-Speed	Non-contact		Class 2
	B1				Contact	Dedicated Device	
	B2					Multi-purpose Device	
IV	A			High-Speed	Non-contact		
	B1				Contact	Dedicated Device	
	B2					Multi-purpose Device	
V	A	Response Type			Non-contact		Class 3
	B1				Contact	Dedicated Device	
	B2					Multi-purpose Device	
VI	-	Otherwise					-

Measurement of “True” Profiles

Basic 3 steps:

1. The Dipstick: 0.25 m interval for IRI sensitivity
2. Rod and Level: 10 m interval for slope
3. Low-speed profiler: 0.01 m interval for roughness



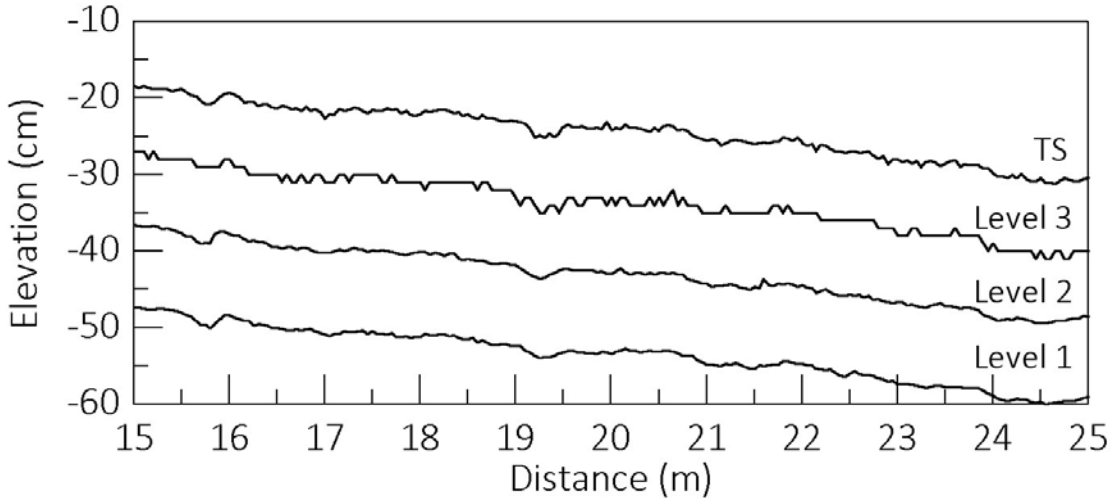
Benchmark Testing

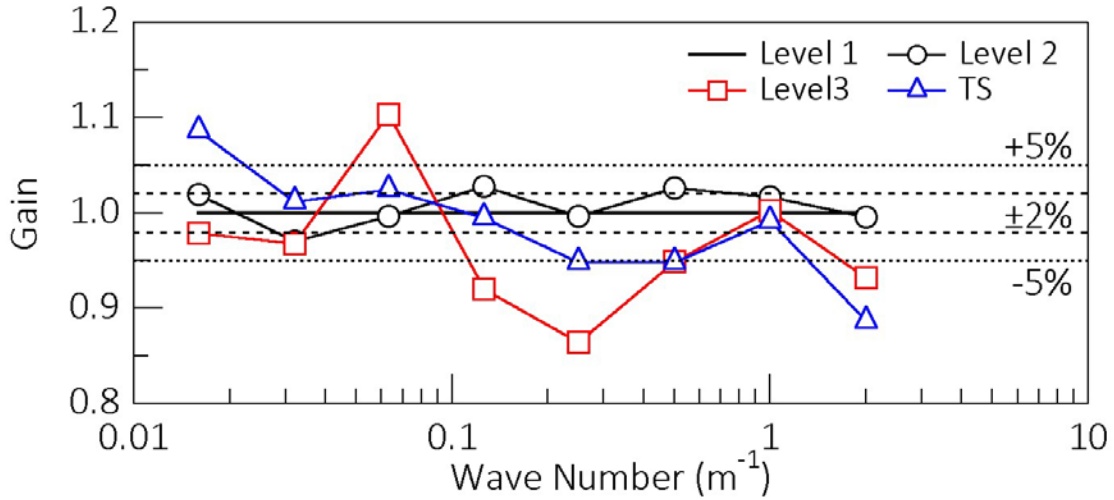
Candidate Device

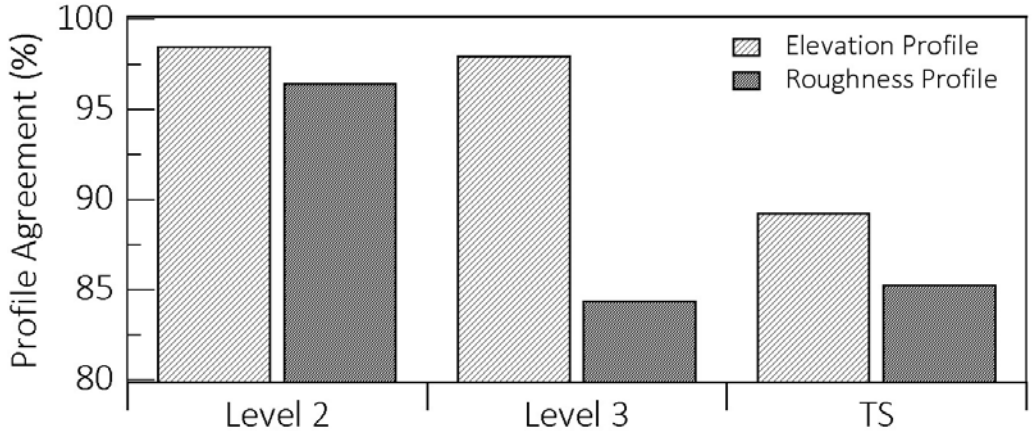
Device	Level	Name/Resolution
Digital Level	1	DiNi 0.3 (Trimble)
Bar-code Leveling Staff	1	0.01 mm
Digital Level	2	DL-502 (TOPCON)
Bar-code Leveling Staff	2	0.1 mm
Auto Level	3	AT-M3 (TOPCON)
Leveling Staff	-	1 mm
Total Station	1	TS15 1'' (Leica)
		0.1 mm

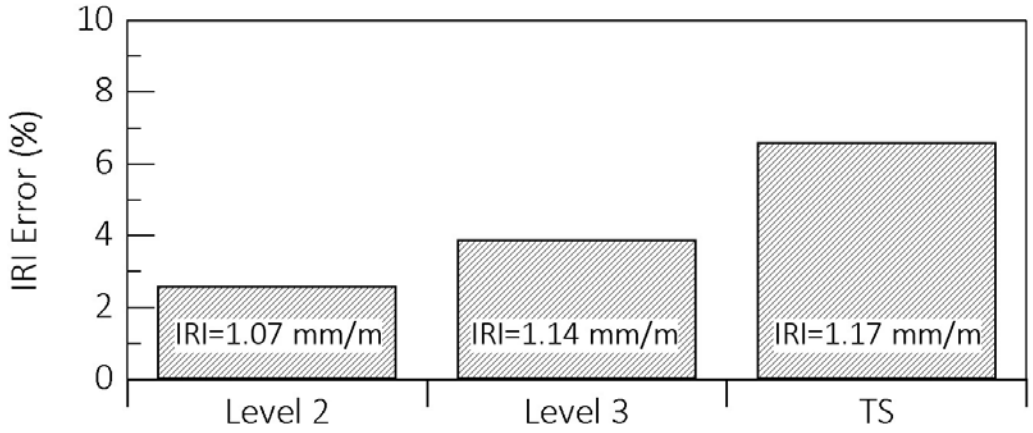
30 years on the Road To Progressively Better Data

Testing Result









Summary

PDRG TRUE Project

- Harmonize and Compare Test Methods for Surface Roughness Under Actual Road Environment
- First and second experiments were conducted at Hokkaido, Japan in 2014 and 2016
- Not all of the devices used in Japan, but a number of them have been involved in this Project.

Analysis of Experiment Results

- Influence of operating speed for high-speed devices
- Repeatability
- Reproducibility and Portability

Summary

Additional Data

- Structural Properties were measured immediately after the experiments.
  - FWD (Falling Weight Deflectometer)
  - GPR (Ground Penetrating Radar)

  Relationship between functional and structural properties?

Next event - coming soon

- Third experiment will be held in October, 2018
- It will provide a certification of measurement accuracy

Thank you

Contact:
Kazuya Tomiyama, Dr. Eng.
Associate Professor
Kitami Institute of Technology
tomiyama@mail.kitami-it.ac.jp

Questions?