Improving the Quality of Pavement Profile Measurements

Benchmark Profiler Experiment

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Themes of the “BPE”

- Develop distributed reference measurement.
- Provide incentive for innovation.
- Compare profile, not index.
- Specify performance, not method.
- Emphasize construction quality control.
- Test under diverse conditions.

Technical Development

- Field Procedures
- Filtering
- Trace Comparison
- Reporting
- Test Sections
- Benchmark Measurements

Resources

“Critical Profiler Accuracy Requirements.” University of Michigan Transportation Research Institute Report UMTRI-2005-24 (2005) 115 pp.

“Benchmark Testing Plan.” FHWA Contract DTFH61-07-C-00024 Task B Report, University of Michigan Transportation Research Institute (2009) 51 p.

“Benchmark Profiler Field Manual.” University of Michigan Transportation Research Institute (2011).

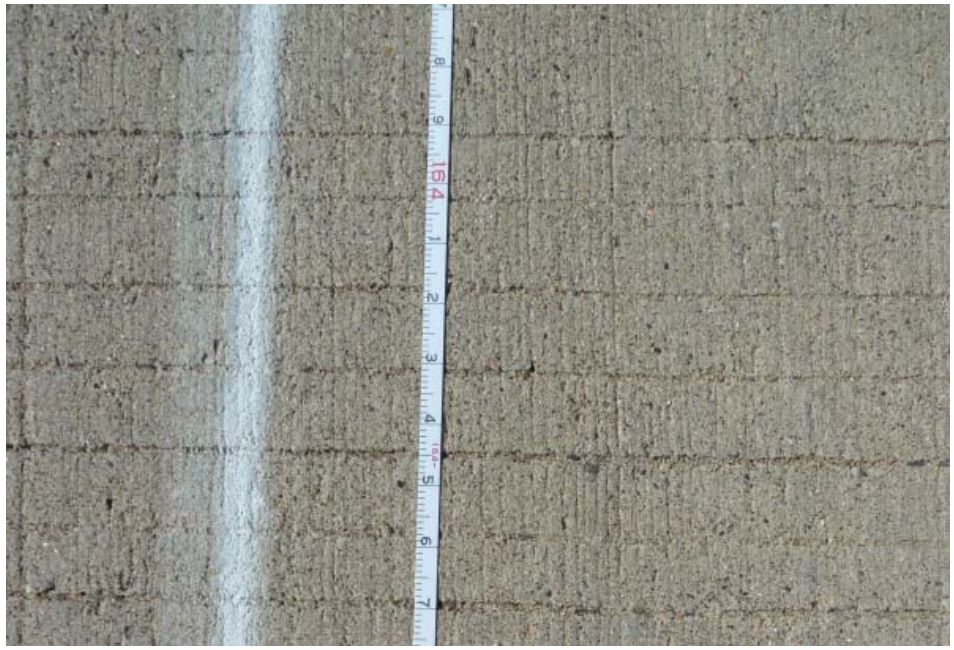
“Benchmark Test Evaluation Report” University of Michigan Transportation Research Institute (September 2011).

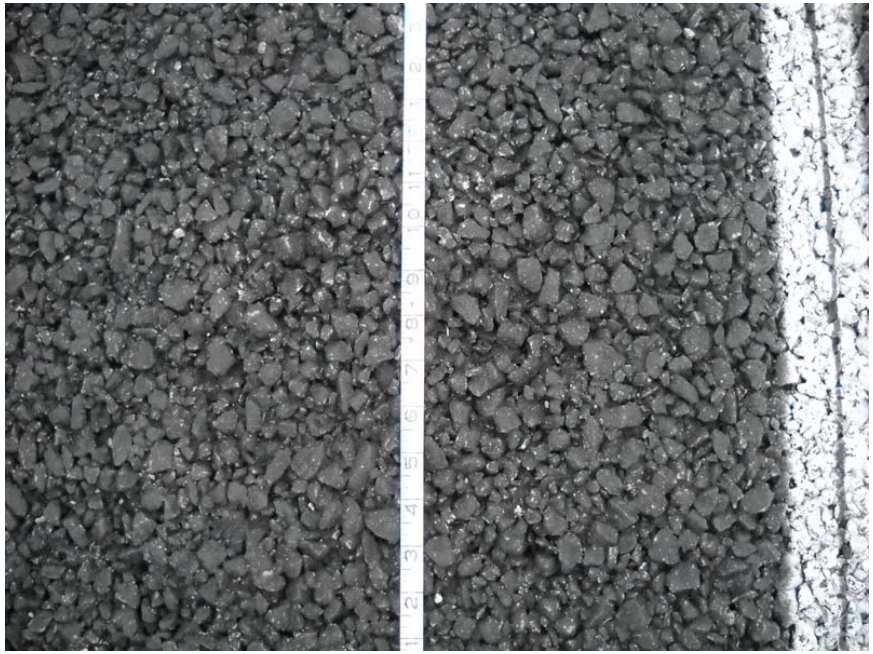
“Benchmark Testing Plan.” University of Michigan Transportation Research Institute (January 2013).

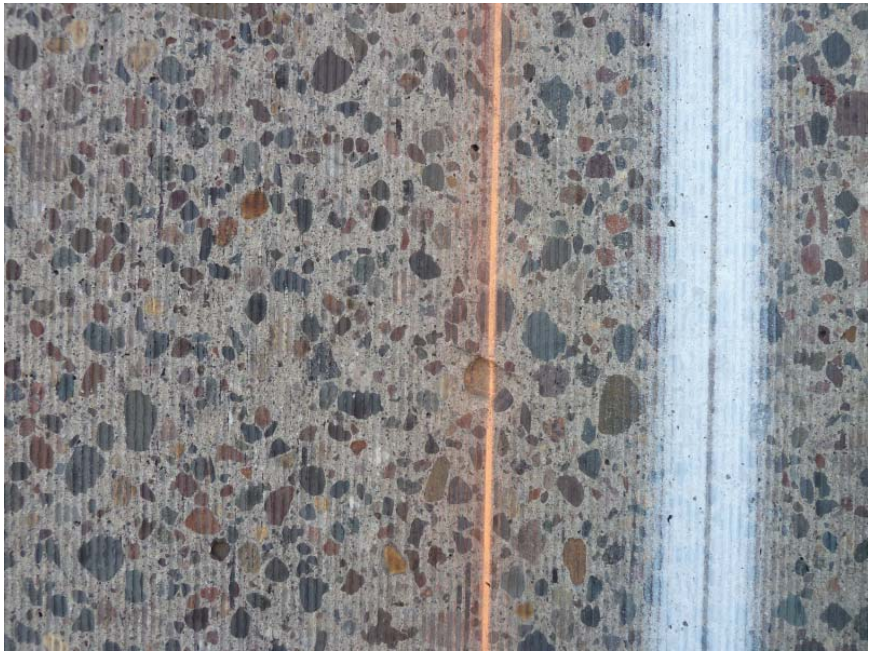
Accuracy and Repeatability

Cross correlate:

- IRI filter output (0.98),
- the long waveband (0.98),
- the medium waveband (0.98), and
- the short waveband (0.94).



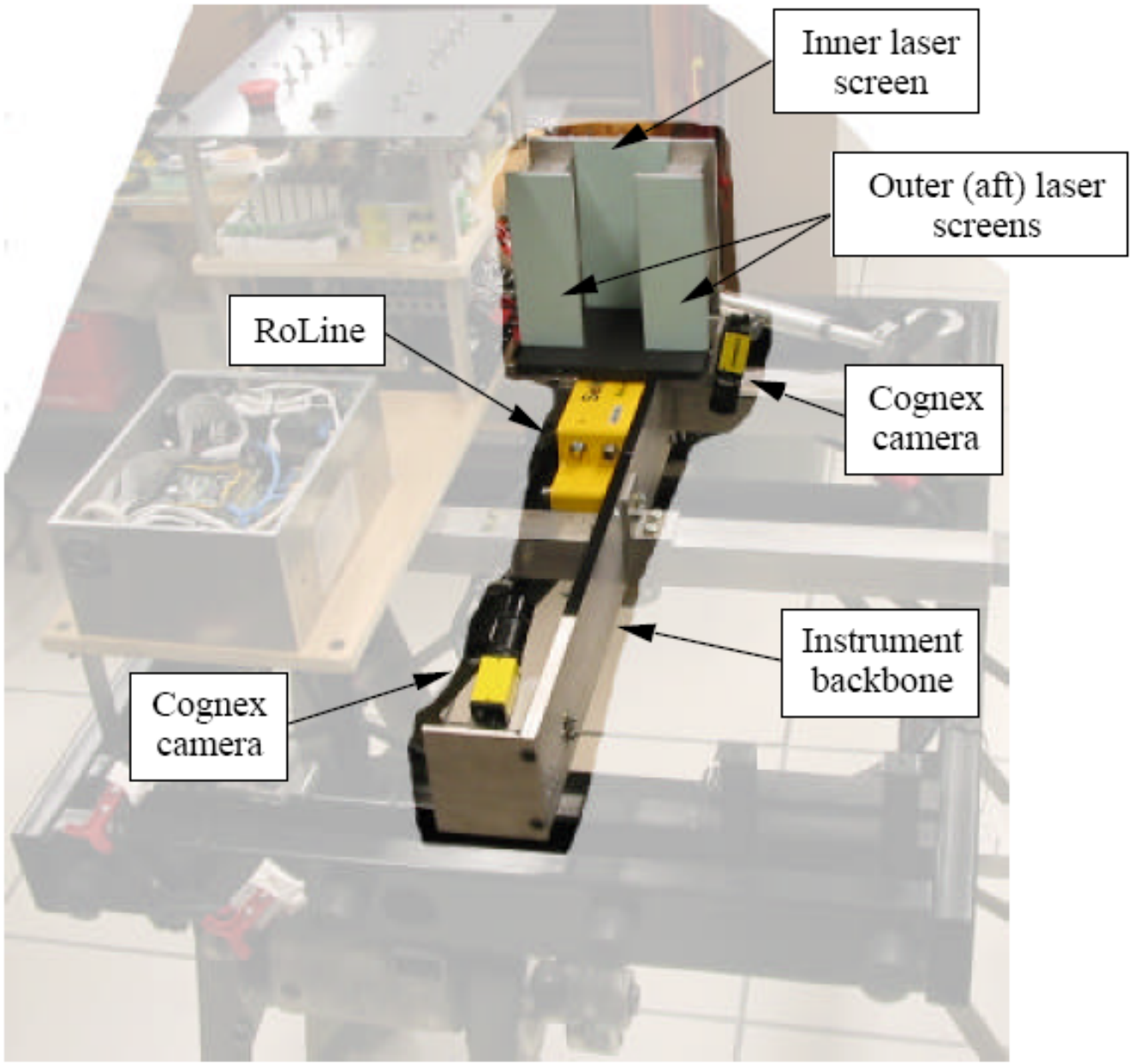





UMTRI

Profiling Cart

Reference Laser


Inner laser screen
Outer (aft) laser screens
RoLine
Cognex camera
Instrument backbone
Cognex camera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2009-2010 Participants

Reporting

Benchmark Test Evaluation Report

Test Section: Nasty chip seal with lose rocks

Date: 01-Jan-2008

Device: Precision Rod and Level

Operator(s): ACME Surveying

Recording Interval: 3 mm

Use Moving Average: Yes

Up-Sampling: Not needed.

Results for Profile:

	Repeatability		Accuracy	
Waveband	Score	Result	Score	Result
IRI	0.99	Pass	0.99	Pass
Long	0.99	Pass	0.98	Pass
Medium	0.99	Pass	0.97	Fail
Short	0.97	Pass	0.89	Fail

Result for Longitudinal Distance: Pass

2013 Experiment

- MnRoad only.
- Four devices showed interest.
- Two devices participated.


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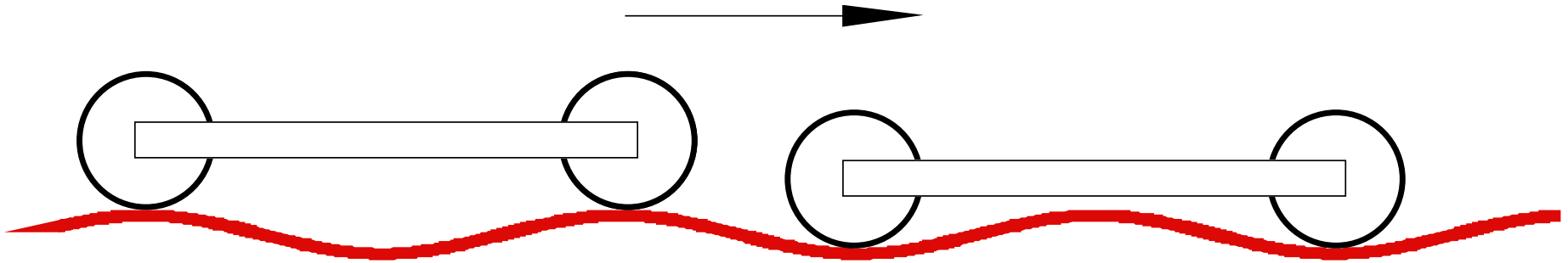
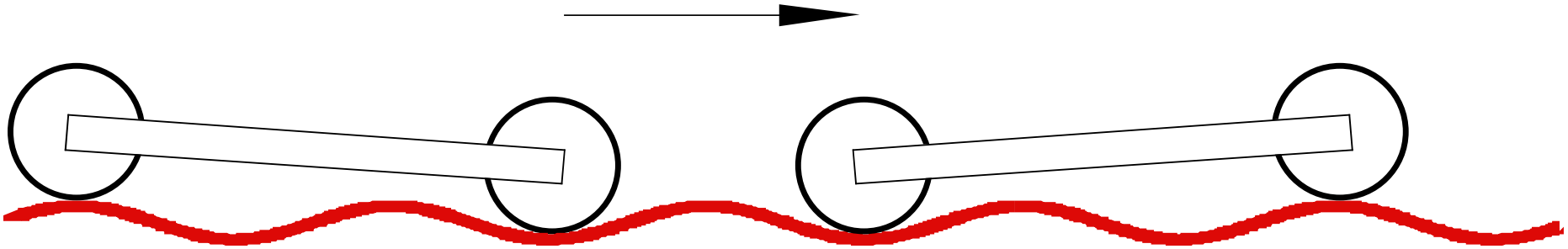
Wheelbase Filtering



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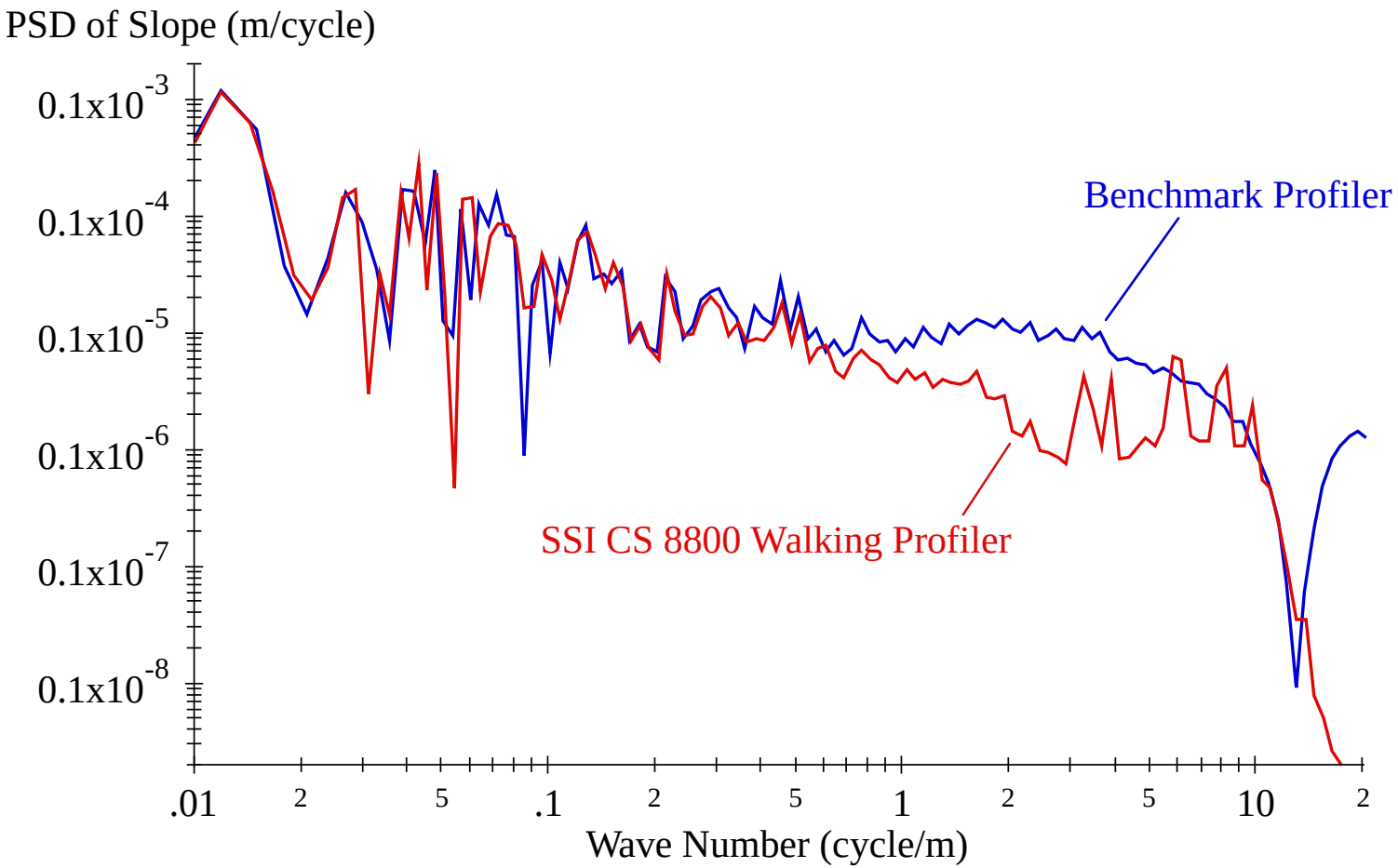
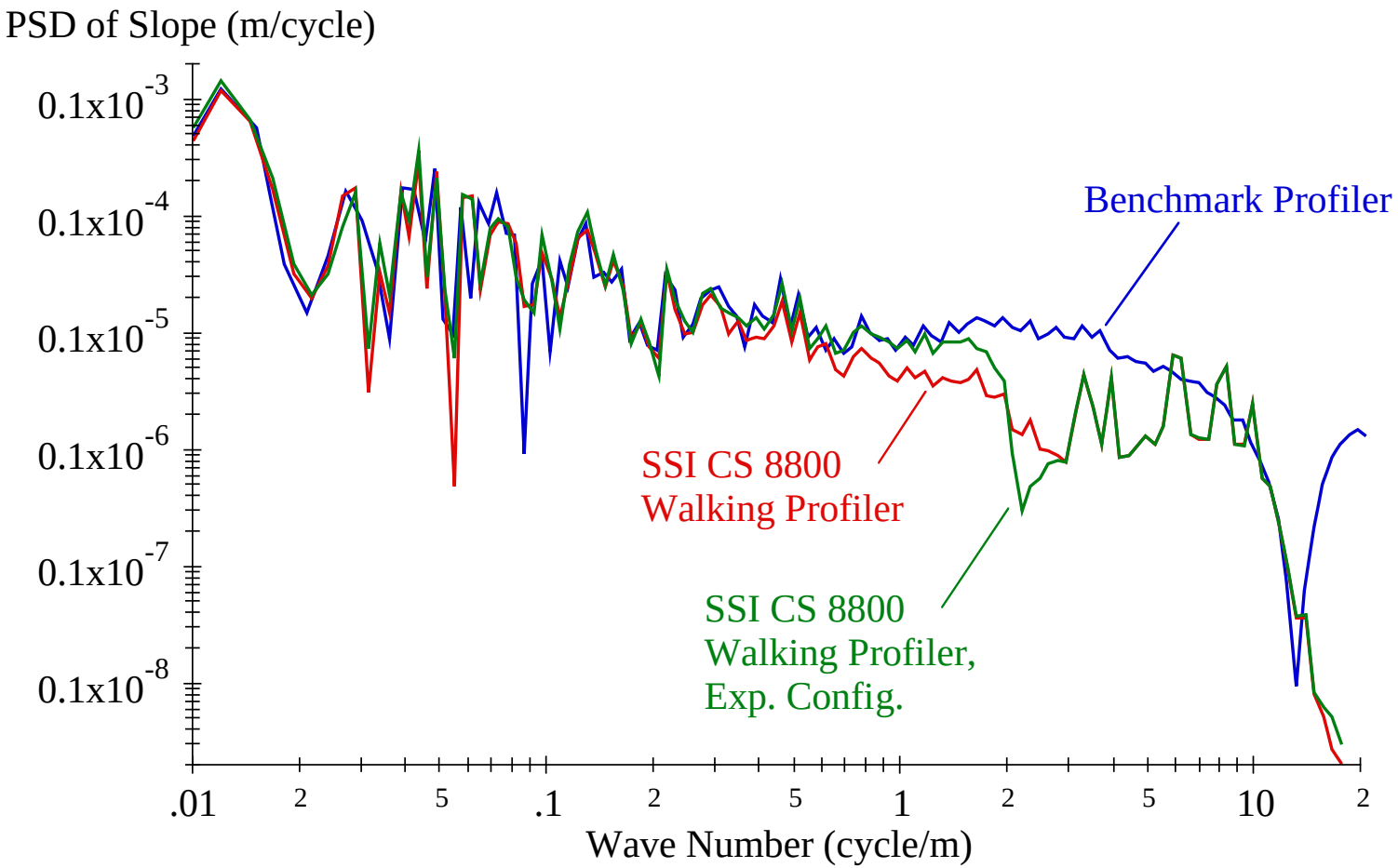
SSI CS8800, DGAC



SSI CS8800 Exp. Config., DGAC



SSI CS8800

Profile Accuracy Scores:

	Waveband			
Test Section	IRI	Long	Medium	Short
Dense Graded AC	0.901	0.978	0.870	0.166
Pervious HMA	0.936	0.946	0.935	0.108
Chip Seal	0.942	0.972	0.926	0.128
Transverse Tining	0.941	**0.988**	0.937	0.053
Diamond Grinding†	0.937	**0.986**	0.910	0.077
Diamond Grinding††	0.923	**0.987**	0.868	0.080
Longitudinal Tining	0.892	0.970	0.888	0.329

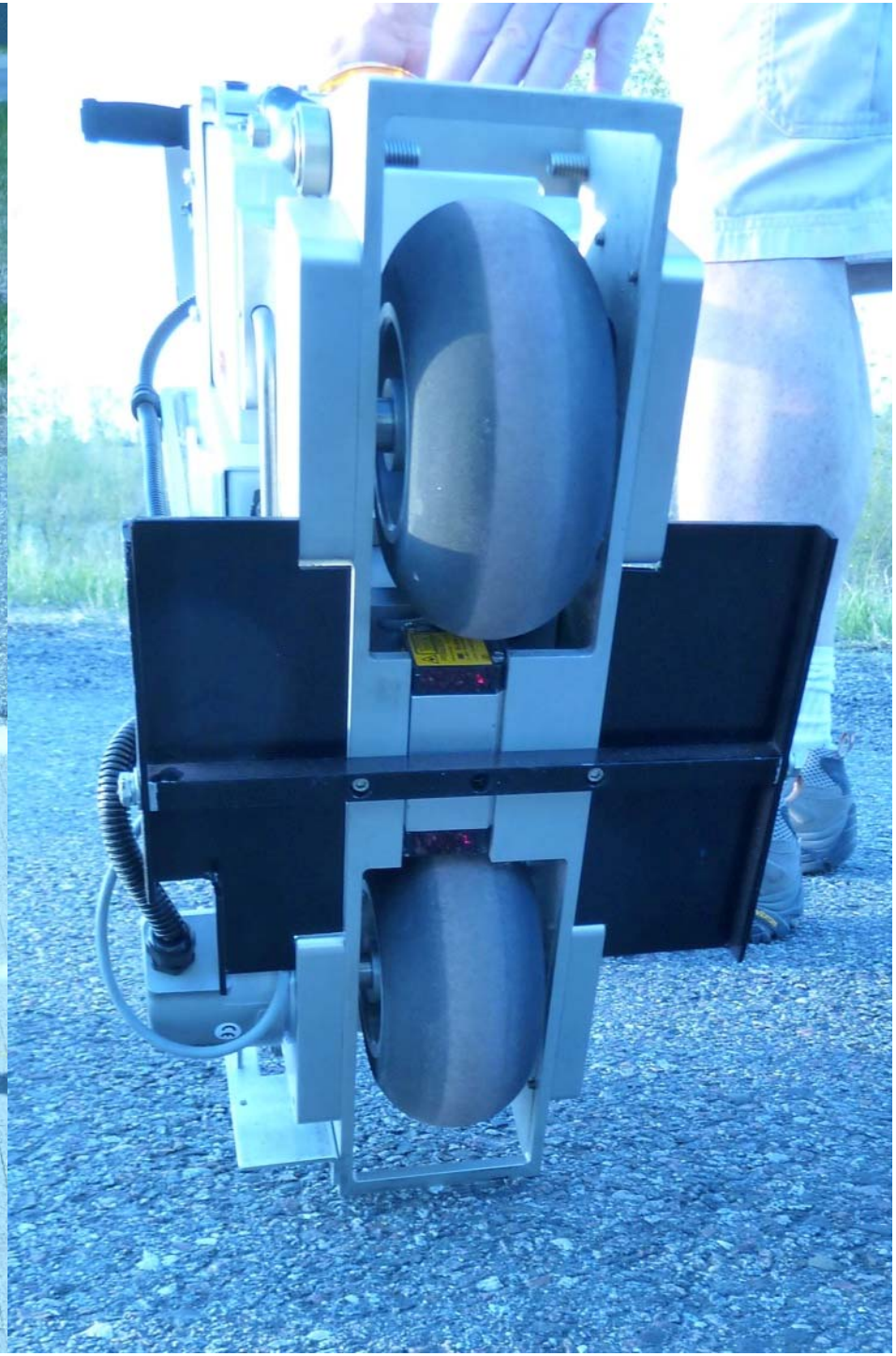
† First Visit †† Second Visit

Profile Repeatability Scores:

	Waveband			
Test Section	IRI	Long	Medium	Short
Dense Graded AC	0.975	0.968	0.972	0.314
Pervious HMA	0.977	0.966	0.976	0.631
Chip Seal	**0.982**	**0.993**	**0.981**	0.694
Transverse Tining	0.960	**0.990**	0.934	0.383
Diamond Grinding†	0.927	0.979	0.900	0.234
Diamond Grinding††	0.927	**0.989**	0.881	0.265
Longitudinal Tining	**0.987**	**0.982**	**0.988**	0.783

† First Visit †† Second Visit


SURPRO
SURPRO




SurPRO
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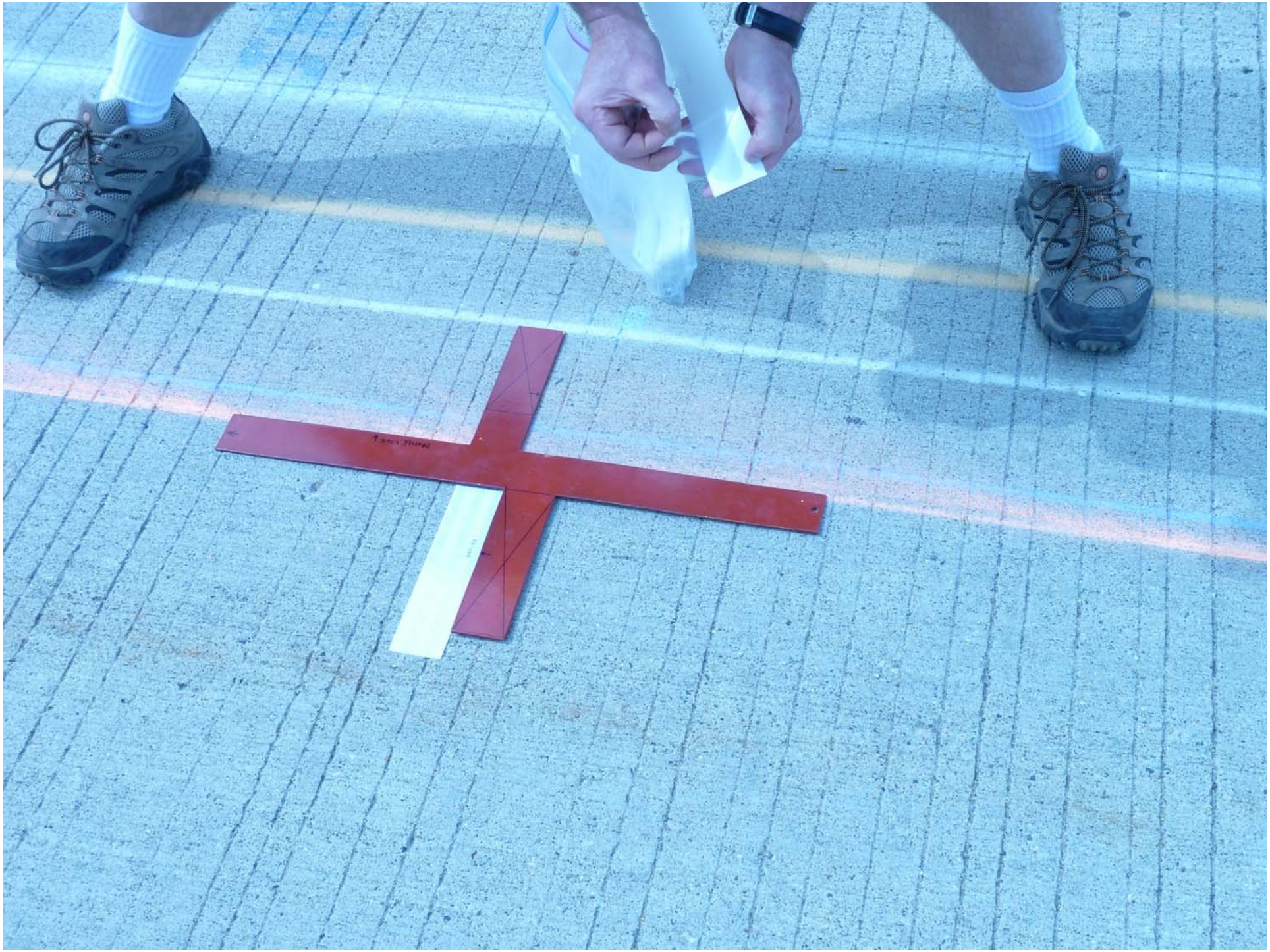
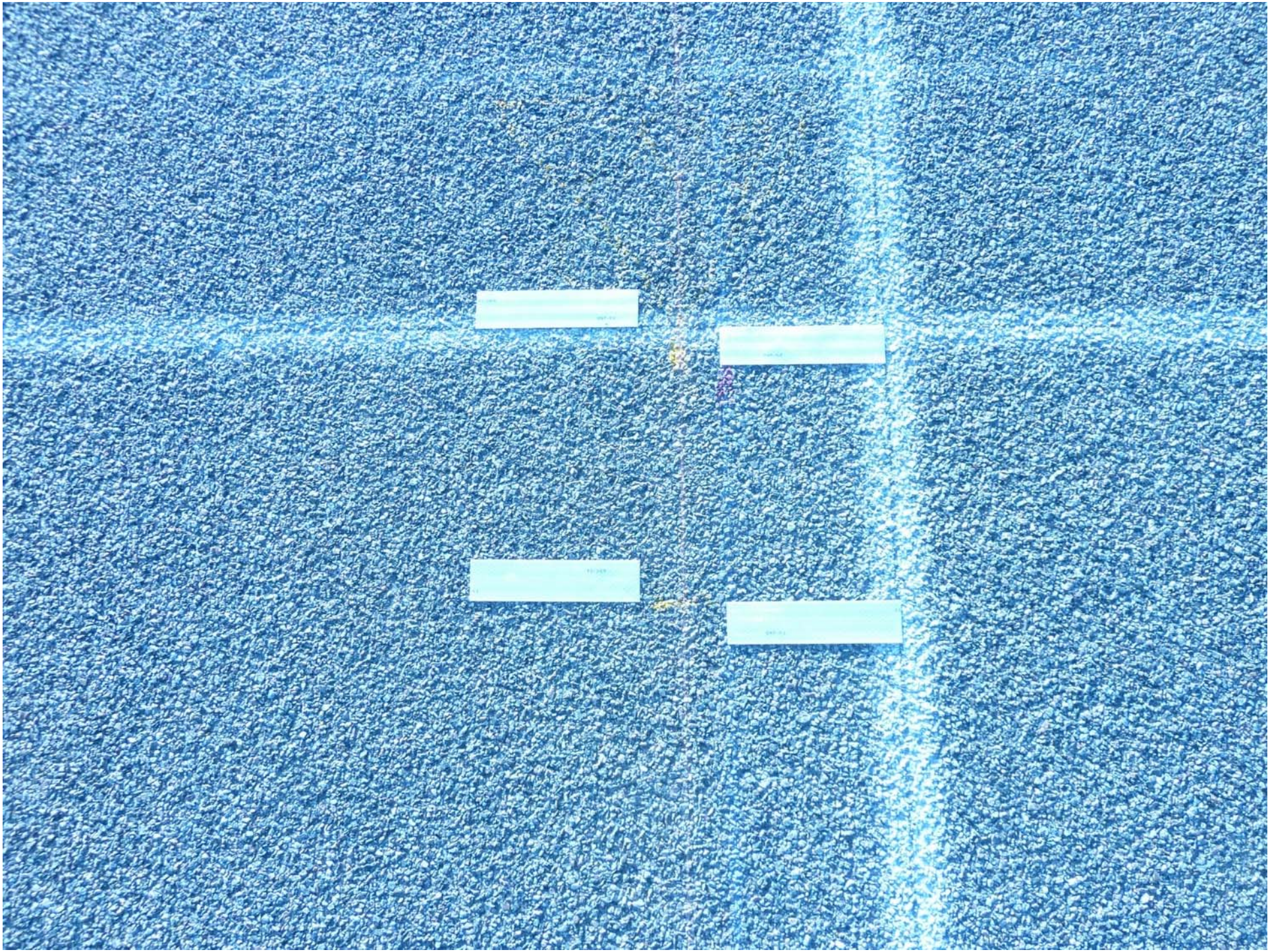
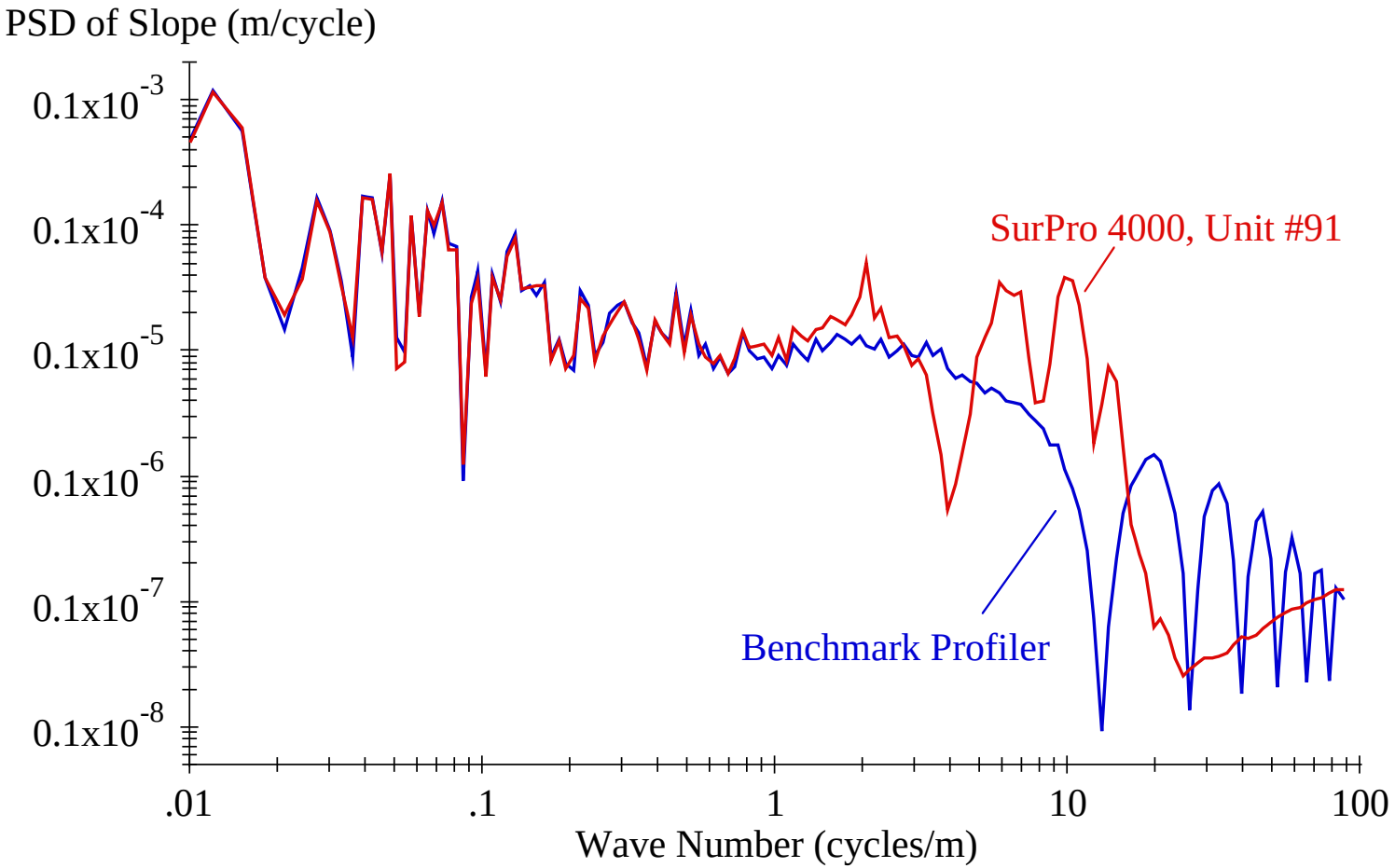


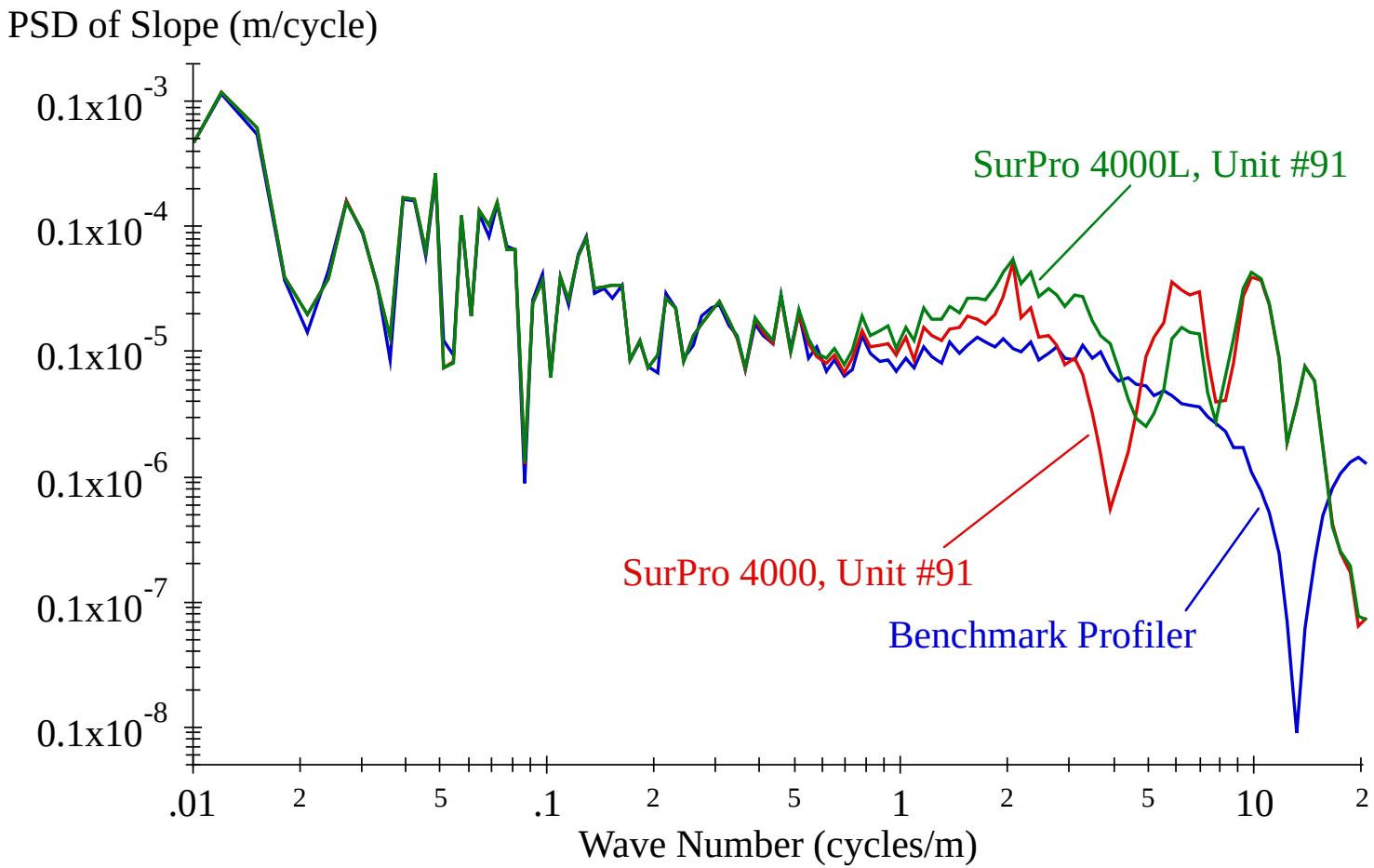



SURPRO
SURPRO
TC4000

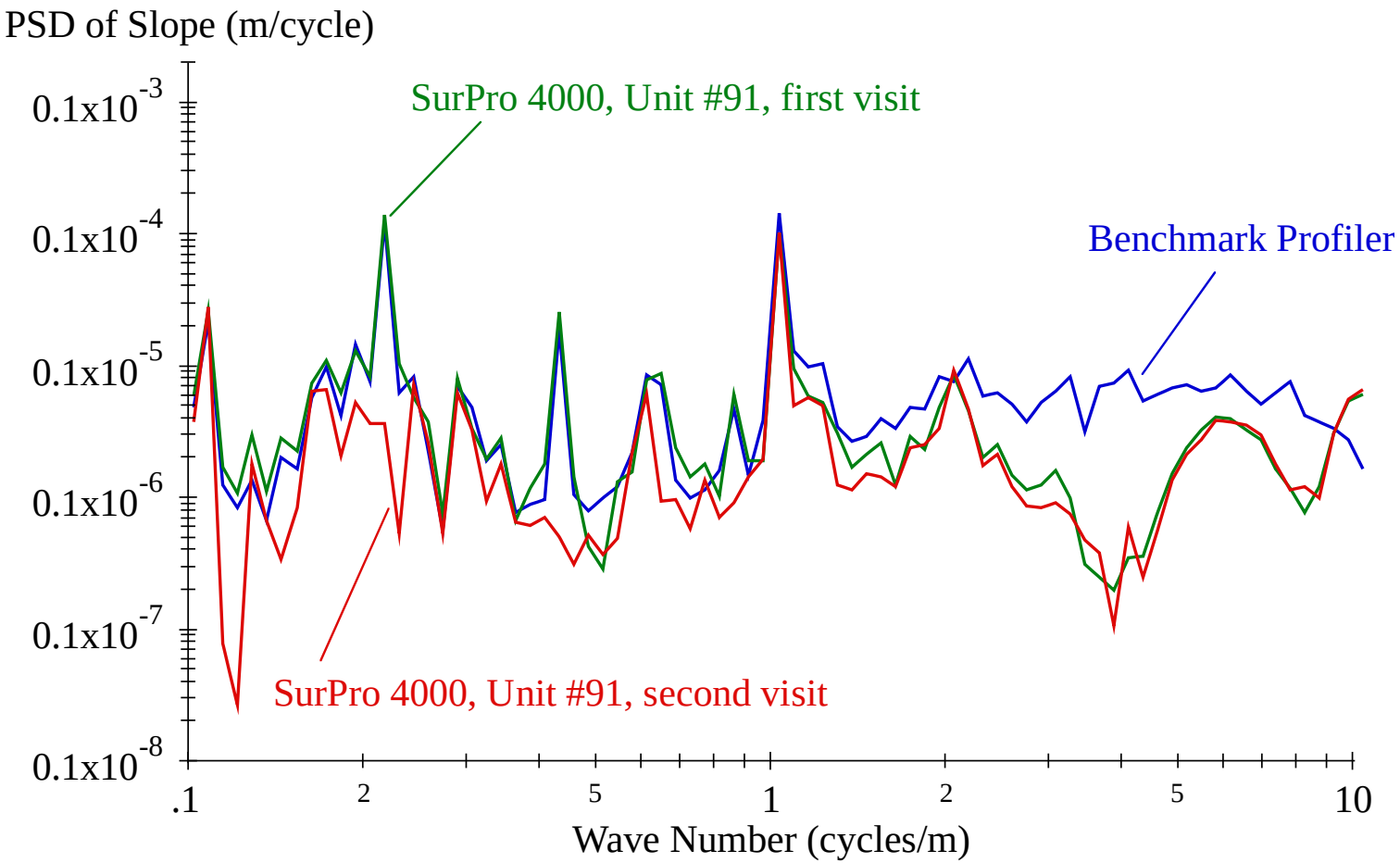
SurPro 4000, Unit 91, DGAC



SurPro 4000L, Unit 91, DGAC



SurPro 4000, Unit 91, Diamond Ground



ICC SurPro 4000, Unit 91

Profile Accuracy Scores:

	Waveband			
Test Section	IRI	Long	Medium	Short
Dense Graded AC	0.966	**0.984**	0.978	0.183
Pervious HMA	0.952	**0.991**	0.960	0.203
Chip Seal	0.948	**0.997**	0.953	0.151
Transverse Tining	0.945	**0.995**	0.928	0.257
Diamond Grinding†	0.848	**0.994**	0.795	0.173
Diamond Grinding††	0.644	**0.992**	0.306	0.152
Longitudinal Tining	0.812	0.962	0.801	0.466

† First Visit †† Second Visit

Profile Repeatability Scores:

	Waveband			
Test Section	IRI	Long	Medium	Short
Dense Graded AC	**0.992**	**0.998**	**0.990**	0.804
Pervious HMA	**0.995**	**0.997**	**0.994**	0.718
Chip Seal	**0.992**	**1.000**	**0.990**	0.825
Transverse Tining	**0.991**	**0.999**	**0.986**	0.880
Diamond Grinding†	0.935	**0.999**	0.899	0.668
Diamond Grinding††	**0.988**	**1.000**	0.962	0.707
Longitudinal Tining	**0.987**	**0.999**	**0.985**	0.895

† First Visit †† Second Visit

Benchmark Profiler

Profile Repeatability Scores:

	Waveband			
Test Section	IRI	Long	Medium	Short
Dense Graded AC	**0.986**	**0.997**	**0.982**	0.804
Pervious HMA	**0.992**	**0.997**	**0.985**	0.860
Chip Seal	**0.990**	**1.000**	**0.986**	0.868
Transverse Tining	**0.994**	**1.000**	**0.992**	0.934
Diamond Grinding	0.974	**0.999**	0.954	0.404
Longitudinal Tining	0.979	**0.981**	0.979	0.773

Points for Discussion

- Jointed PCC confounded the experiment.
- The Benchmark Profiler would not have qualified.

- We have not achieved our original goals.
- We have achieved much.
- More improvement will take investment.
- Cooperation is needed.

Thank you.