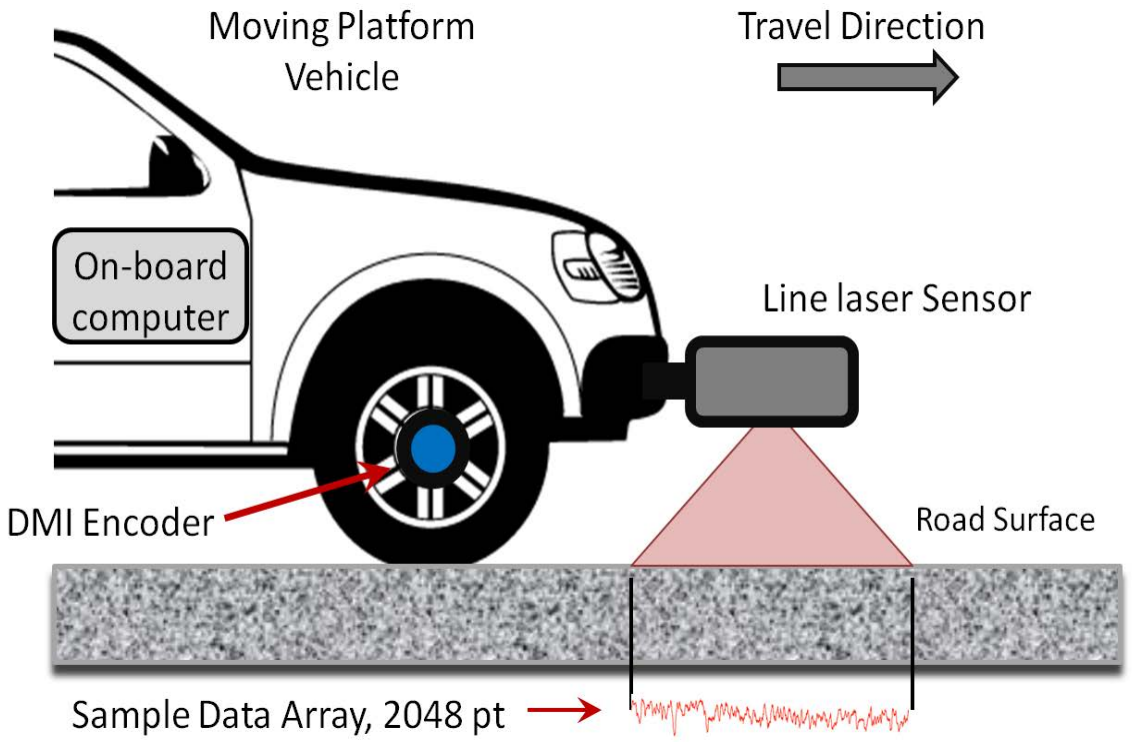
Moving Reference Road Profiler

By

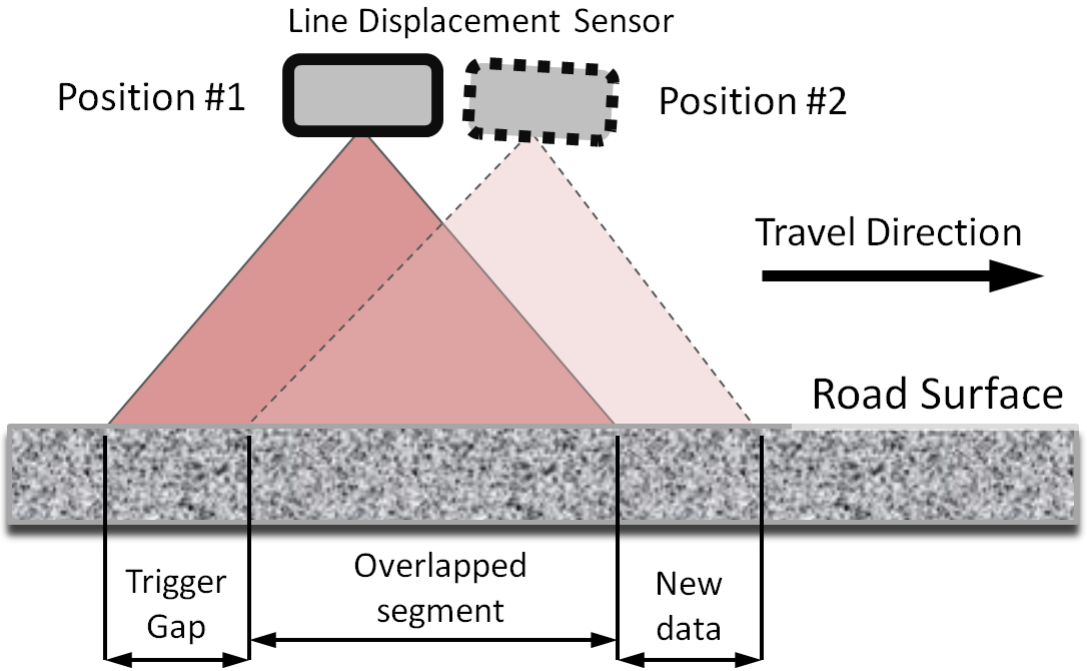
Yaxiong (Robin) Huang

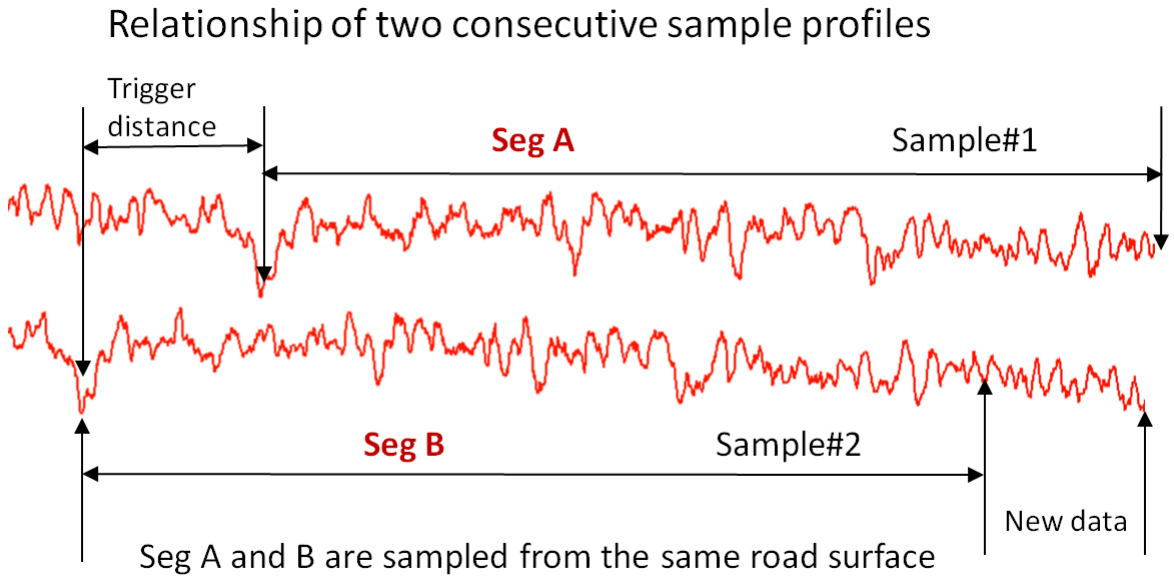
What is the Moving Reference Road Profiler



- Non-inertial type, no accelerometer
- 2K or 4K line laser sensor
- Take a 20” long profile at one time
- Sample gap is much shorter than profile length
- No vibration between data point
- Use previous profile as reference
- Full speed range operation
- For profile, texture, and faulting

Concept of moving reference

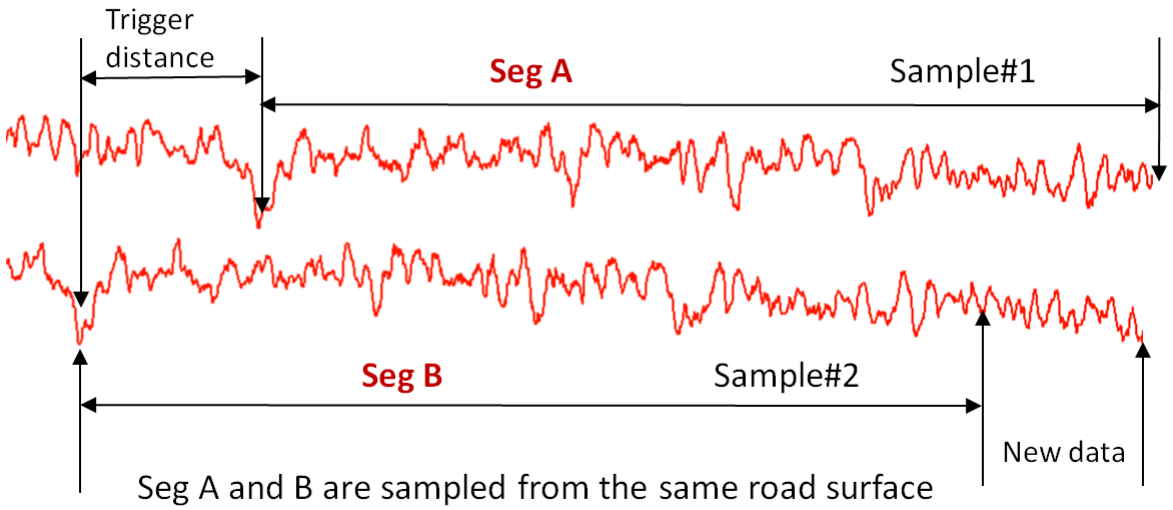




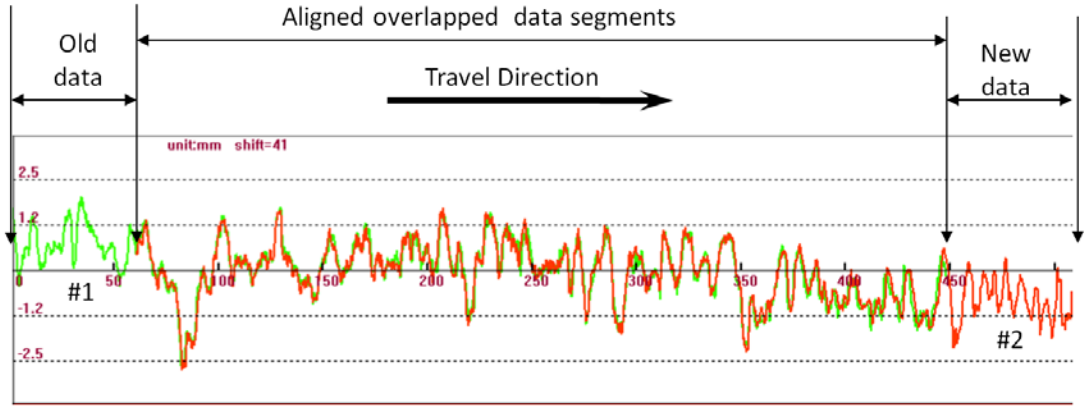
1) Every point in a profile taken at the same time and the same vehicle motion
2) If a part of a profile aligned to the ground truth, all data aligned
3) If Seg B aligned to Seg A, then Sample#2 aligned to Sample#1
4) Seg A can be used as a reference to the entire Sample#2

Profile Alignment

Relationship of two consecutive sample profiles

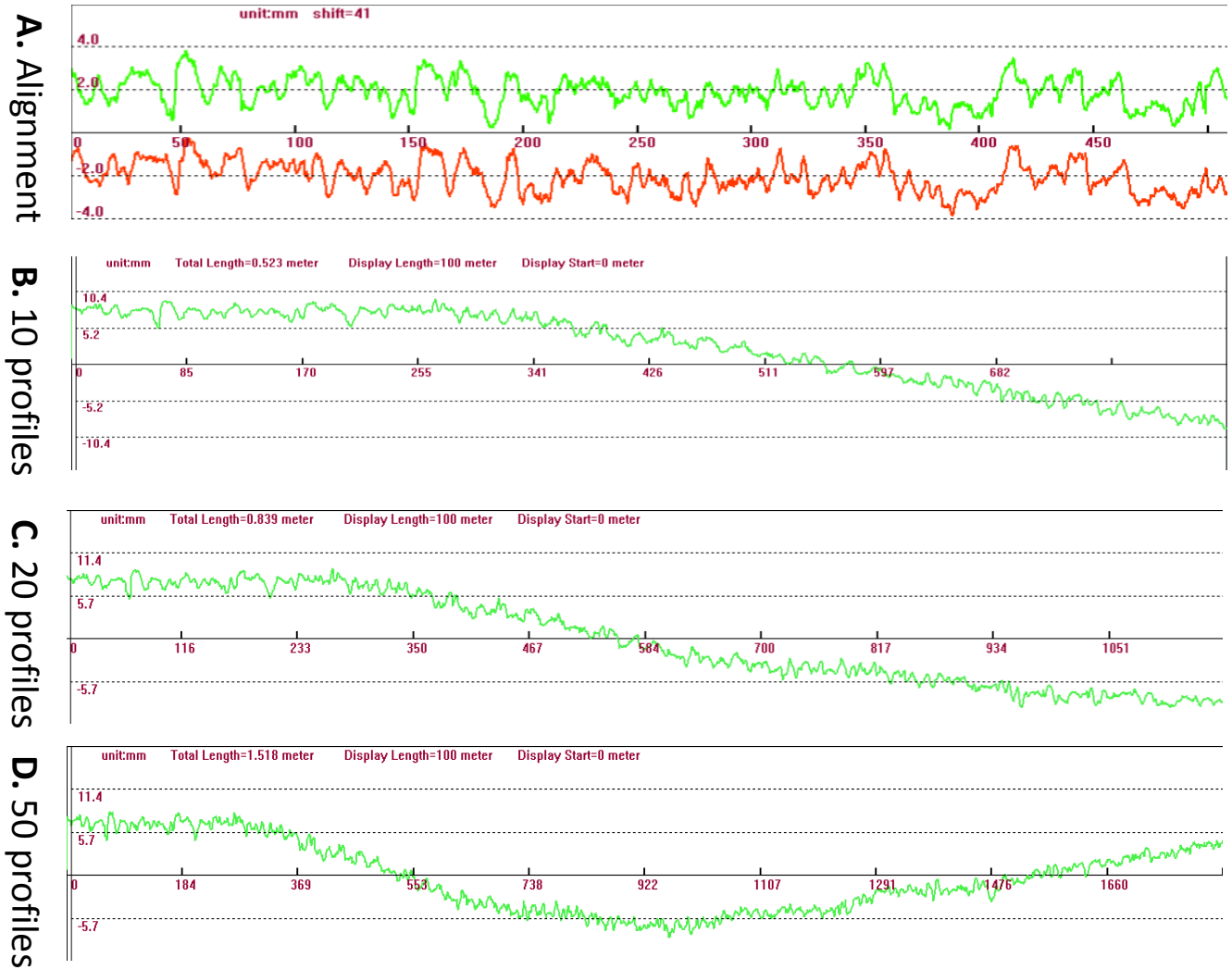


Seg A and B are sampled from the same road surface



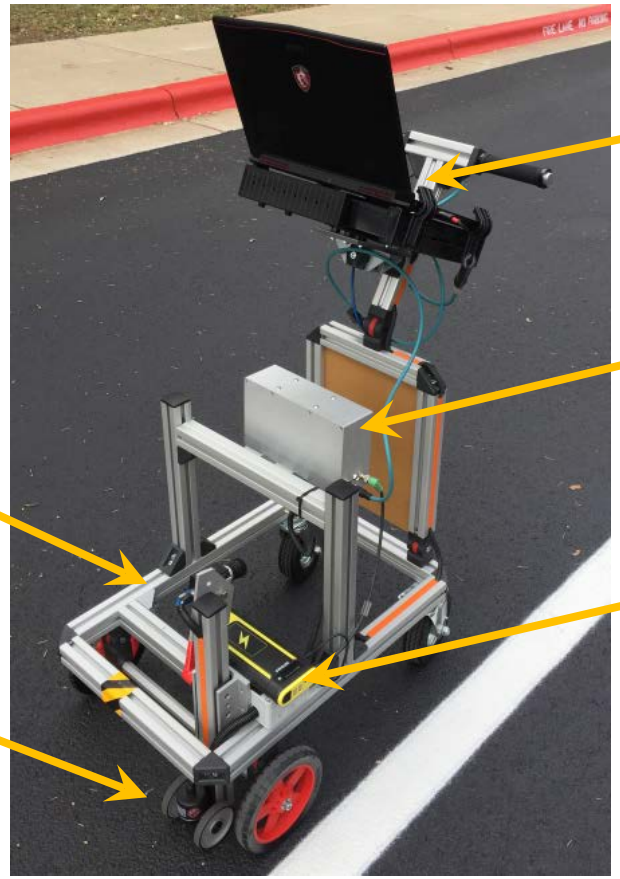
1) Align two profiles with data point shift
2) Calculate differences between overlapped segments
3) Remove these difference from the entire Sample #2 data
4) Then the entire Sample #2 will align to Sample #1
5) Assuming Sample # represents the ground truth
6) Then the new data portion is aligned to ground truth

Profile alignment and connection



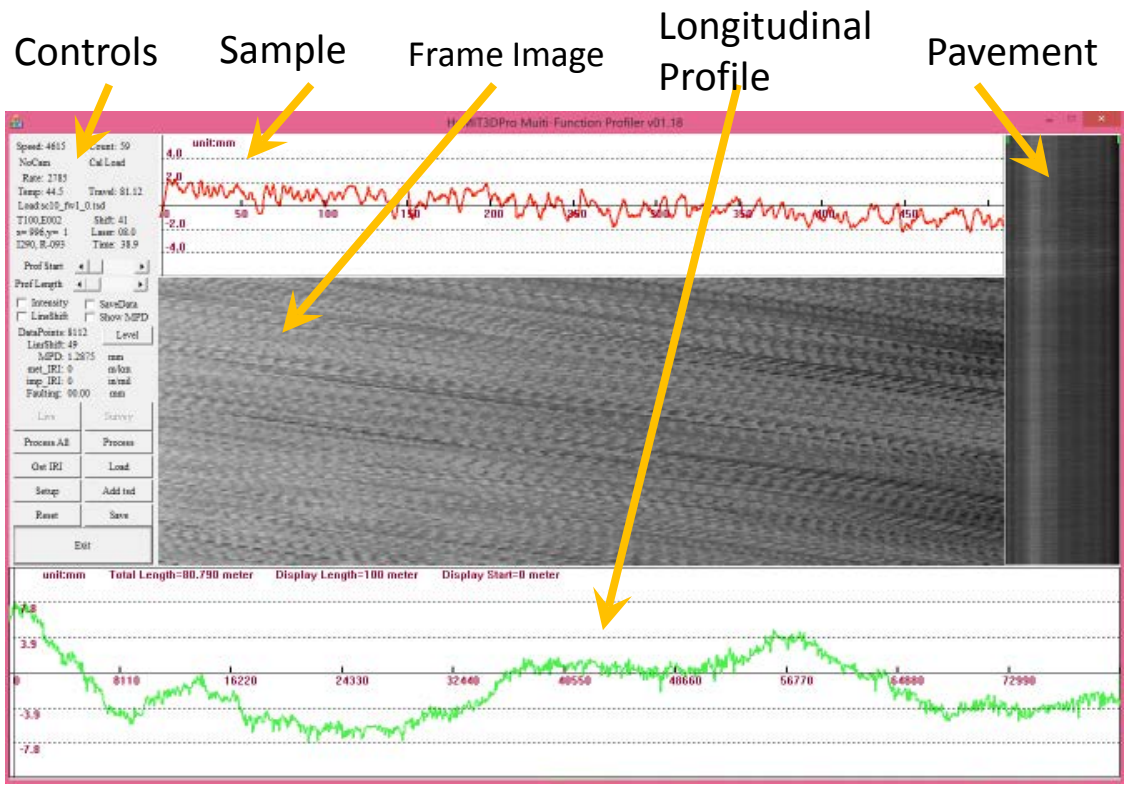
1) A. Alignment shows two sample profiles aligned by distance
2) There are slight difference of two profiles due to positions
3) B. to D. show connected longitudinal profile
4) The length of the longitudinal profile increases with number of sample profiles
5) The longitudinal profile is used for IRI calculation
6) Sample profiles are used for texture and faulting calculation

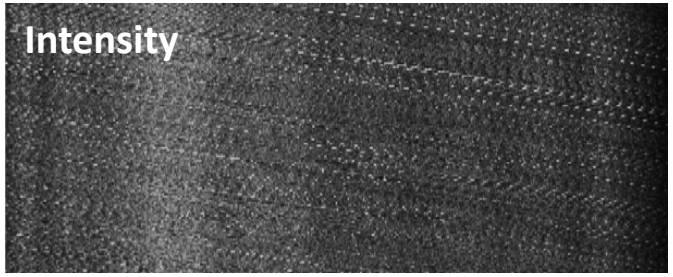
Test systems for experiment

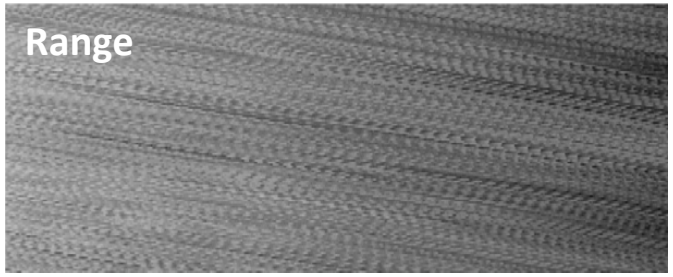


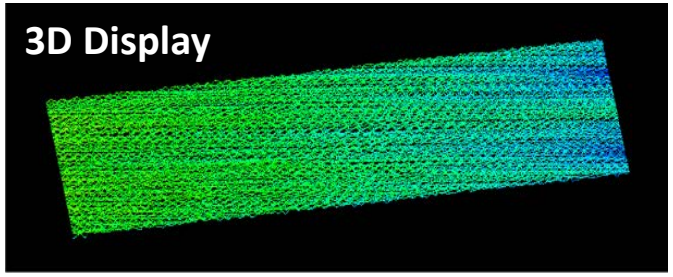
1) Push car type walking profiler and vehicle mount all speed profiler
2) Special designed high power line laser sensor for all pavement and all speed

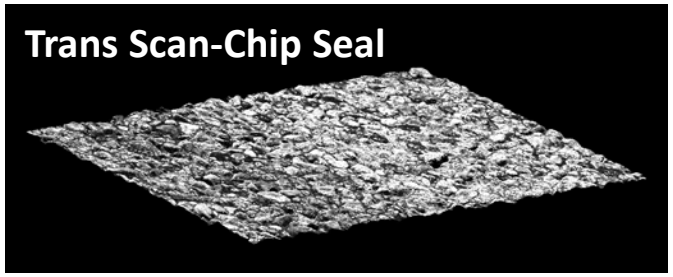
System Control

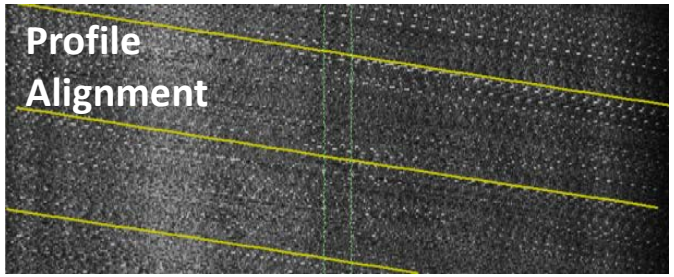


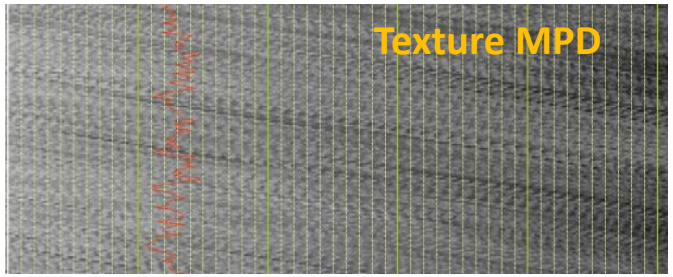


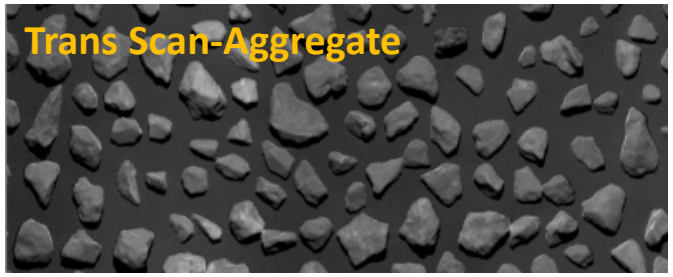


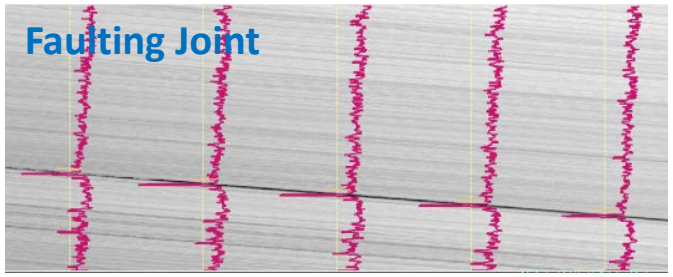










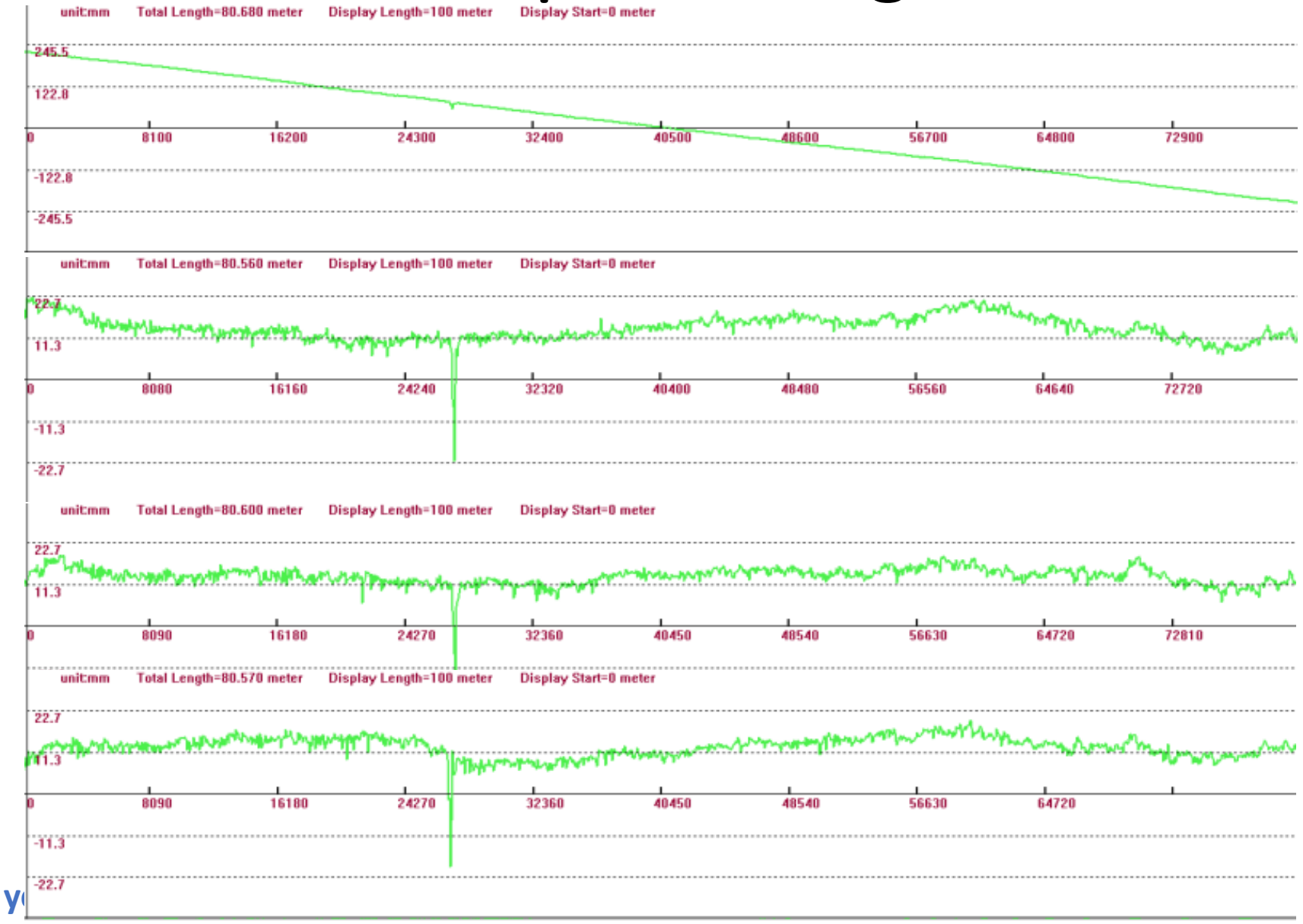


- Controls: User control and data display
- Sample: Sample profile, for each selected sample array
- Frame Image: 128 samples form a image frame
- Pavement: accumulation of 50 frames, loop display
- Longitudinal Profile: accumulated surface profile

30 years on the Road To Progressively Better Data

RPUG Road Profile Users' Group

Profile and IRI processing



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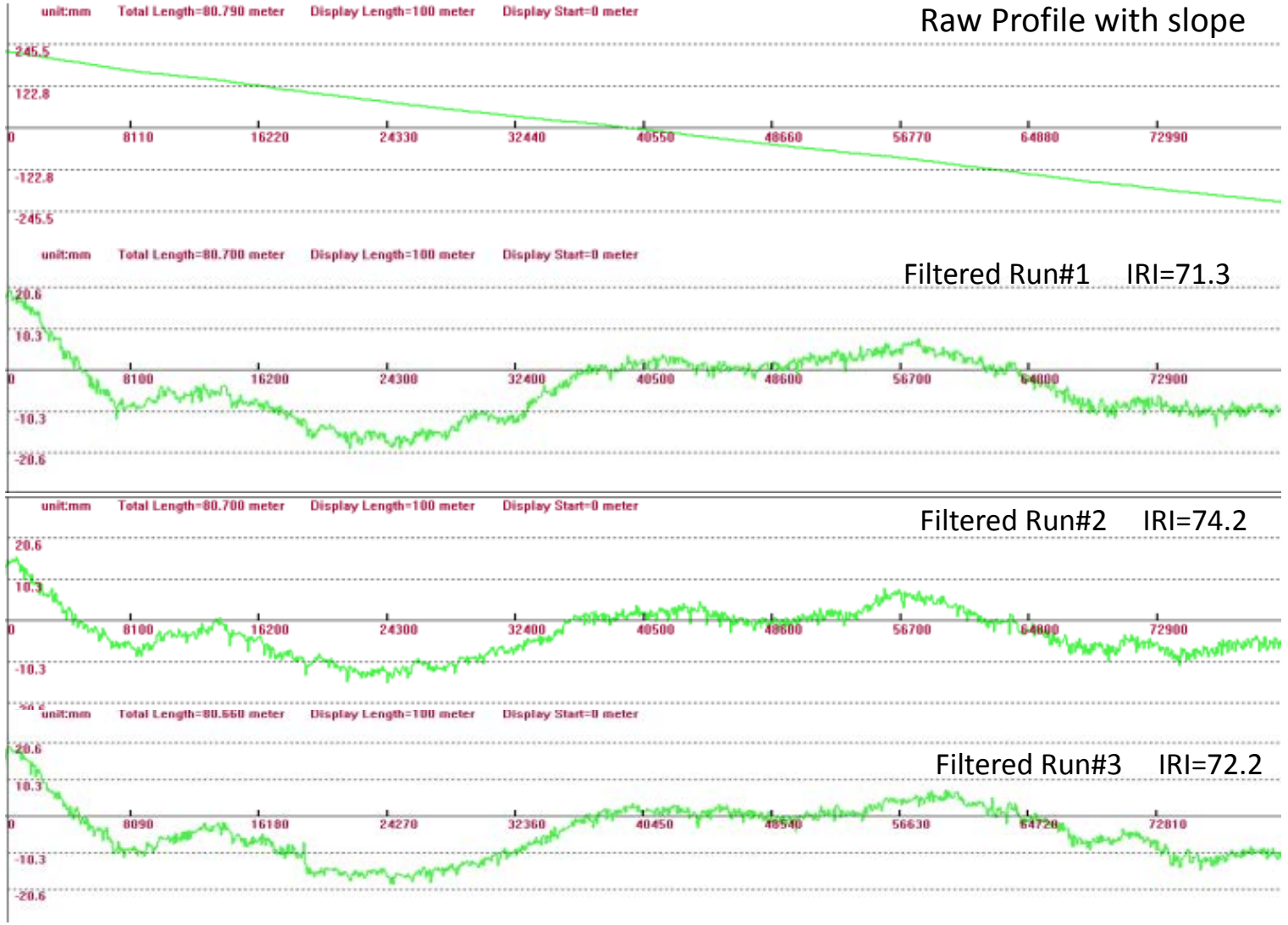

- Slope value determined by: start position, path, road slope
- Filtered: a 40 meter high pass filter allied
- IRI calculated with a standard software from ASTM E1926 codes

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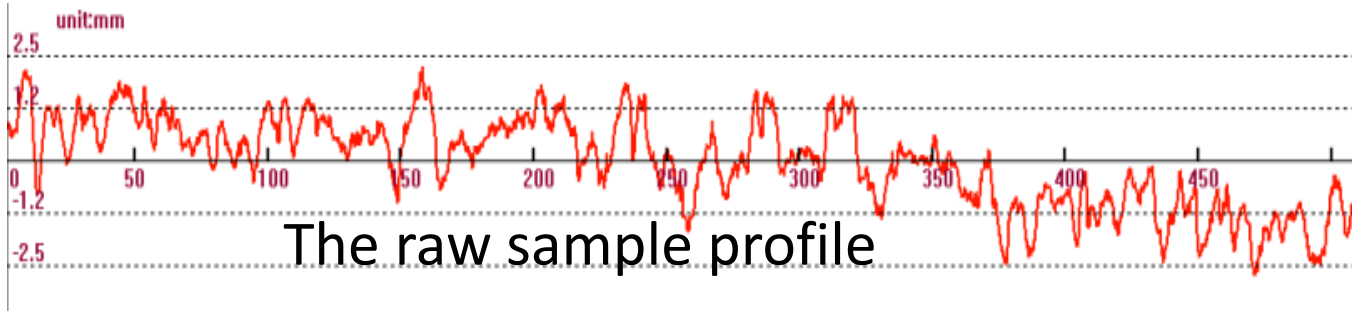
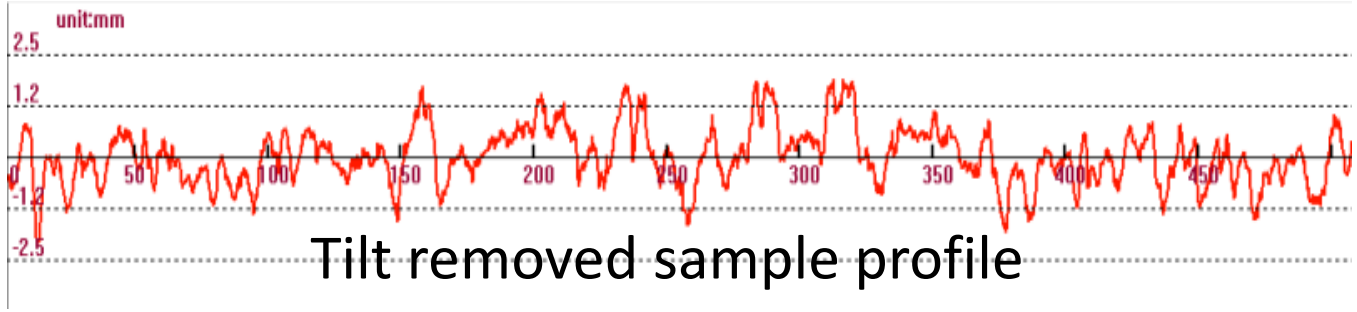
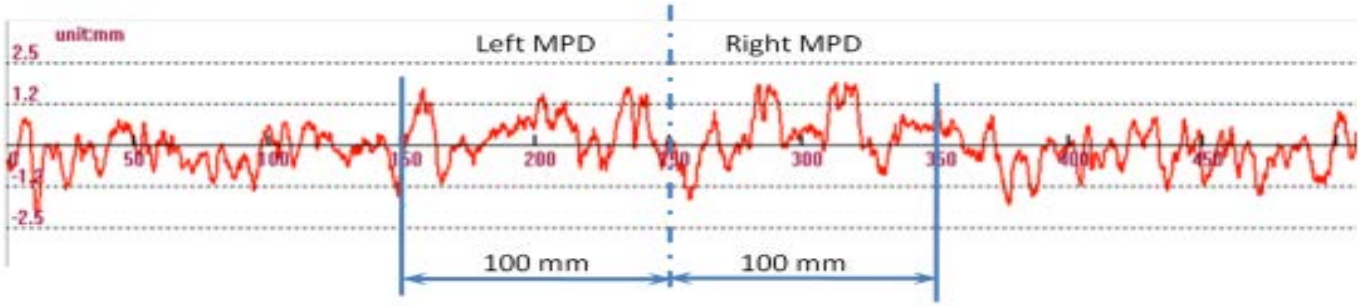
Texture Measurement



The raw sample profile



Tilt removed sample profile



1. Level the sample profile
2. Take two 100mm segment from left and right of the profile center
3. Calculate MPDs as defined in ASTM E1845
4. Using average MPD for the profile

5. Line sensor takes no vibration between data points
6. High power laser sensor minimize the motion average effect

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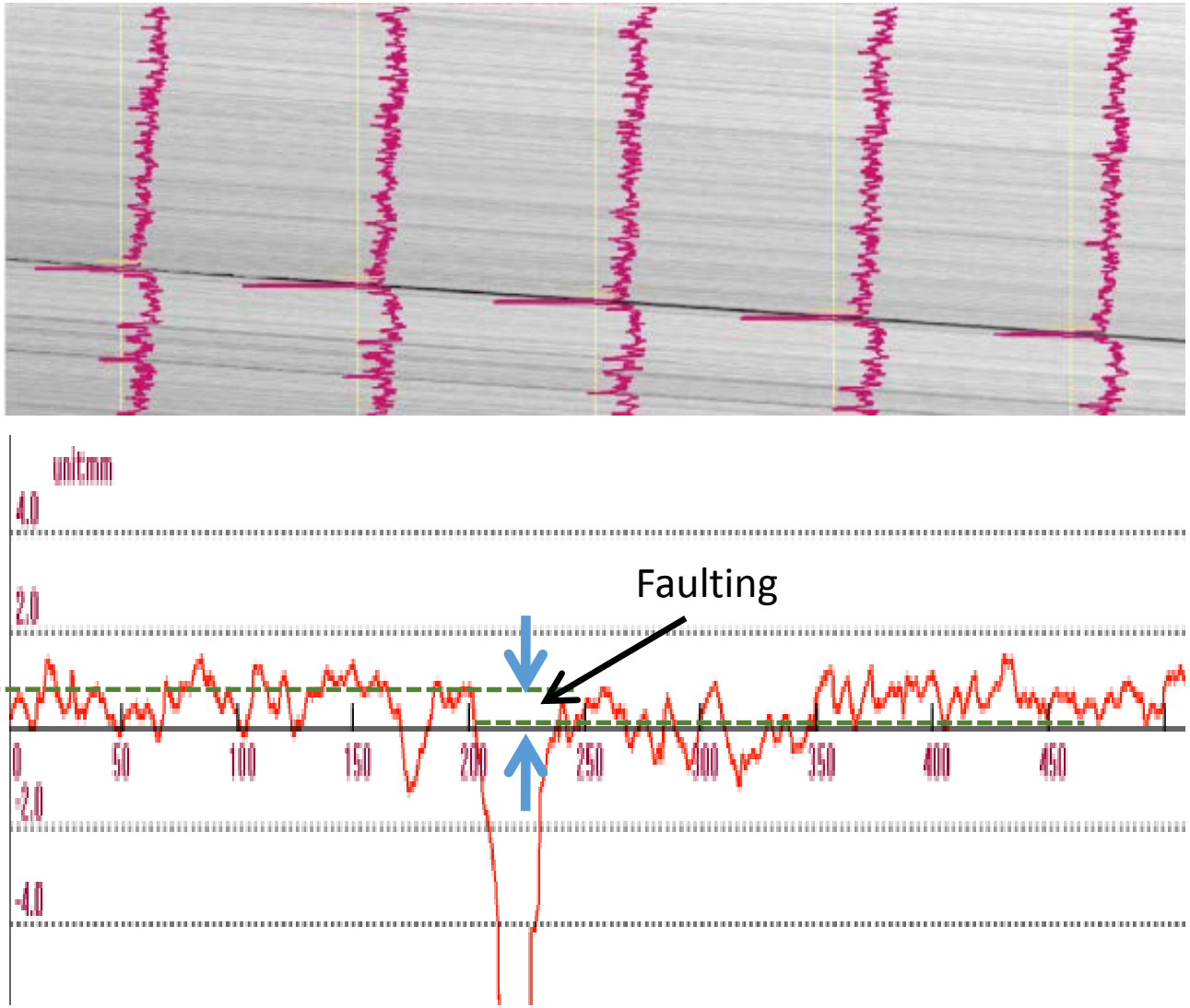
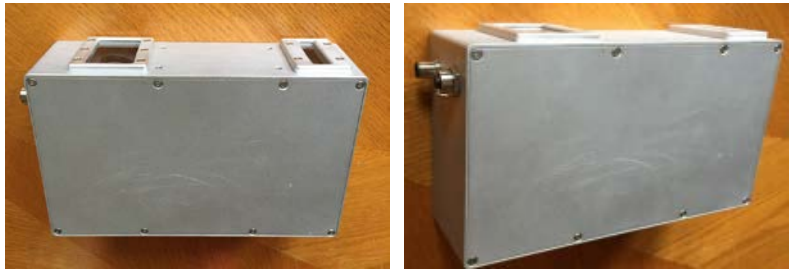
Concrete Faulting Measurement



1) When a 20 inch long laser travel perpendicular to a joint, there will be multiple interceptions
2) Processing each sample profile for joint detection
3) Do a 300 mm line fit on both side of the joint
4) Distance between two fitted lines at the center of the joint is the value of faulting
5) Test show the 3 points faulting algorithm is not accurate due to texture depth

System Specification (2K sensor)

Items	Vehicle mount	Walking Profiler	Unit/note
Travel Speed	0/0 to 120/70	0 to any walking speed	kmph/mph
Data Spacing	0.248/0.0098	0.248/0.0098	mm/inch in longitudinal
Sample coverage	508/20	508/20	mm/inch
Depth Resolution	0.02/0.0008	0.02/0.0008	mm/inch
Depth Range	±50/±2 (Absolute mode) ±100/±4 (tracking mode)	±50/±2	mm/inch
Profiling Speed	2.5 to 4.0 kHz	2.5 to 4.0 kHz	Depends on range setting
Profiling Control	Trigger/Timing	Trigger/Timing	
Trigger Distance	10/0.4	10/0.4	mm/inch
Output Data	IRI, MPD, Faulting, and more	IRI, MPD, Faulting, and more	(Profile, Texture, Faulting)
Mount Height	482/19	482/19	mm/inch
Connection	Gigbit Ethernet	Gigbit Ethernet	
Power	18 (30 at power-on)	18 (30 at power-on)	watts
Laser line width	≤0.2/0.008	≤0.2/0.008	mm/inch
Laser Power	≥1000	≥1000	mW
Sensor Weight	10/4.85	10/4.85	lb/kg



- High power laser allows very short exposure time.
- Minimize the moving average error
- Provides speed independent data

Summary

1) Moving reference method (MRM) can be use to remove platform unwanted motions. It can be used to align each short sample profile to form a contiouse long profile
2) Experiments show MRM is sensitive to travel path. Path wandering may cause profile drifts
3) Bad data due to potholes, very dark spots will interrupt MRM algorithm and profile
4) The drifts and interruptions in profile show some effects on IRI calculation
5) More tests have be planned for comparison and evaluation

Any Questions?

Thank You!

Dr. Yaxiong (Robin) Huang

HyMIT LLC

Austin, Texas

Tel: 512-255-9594

Email: yhuang_uk@yahoo.com