



SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

RDM Experience in Texas

SHRP2 R06C Peer Exchange

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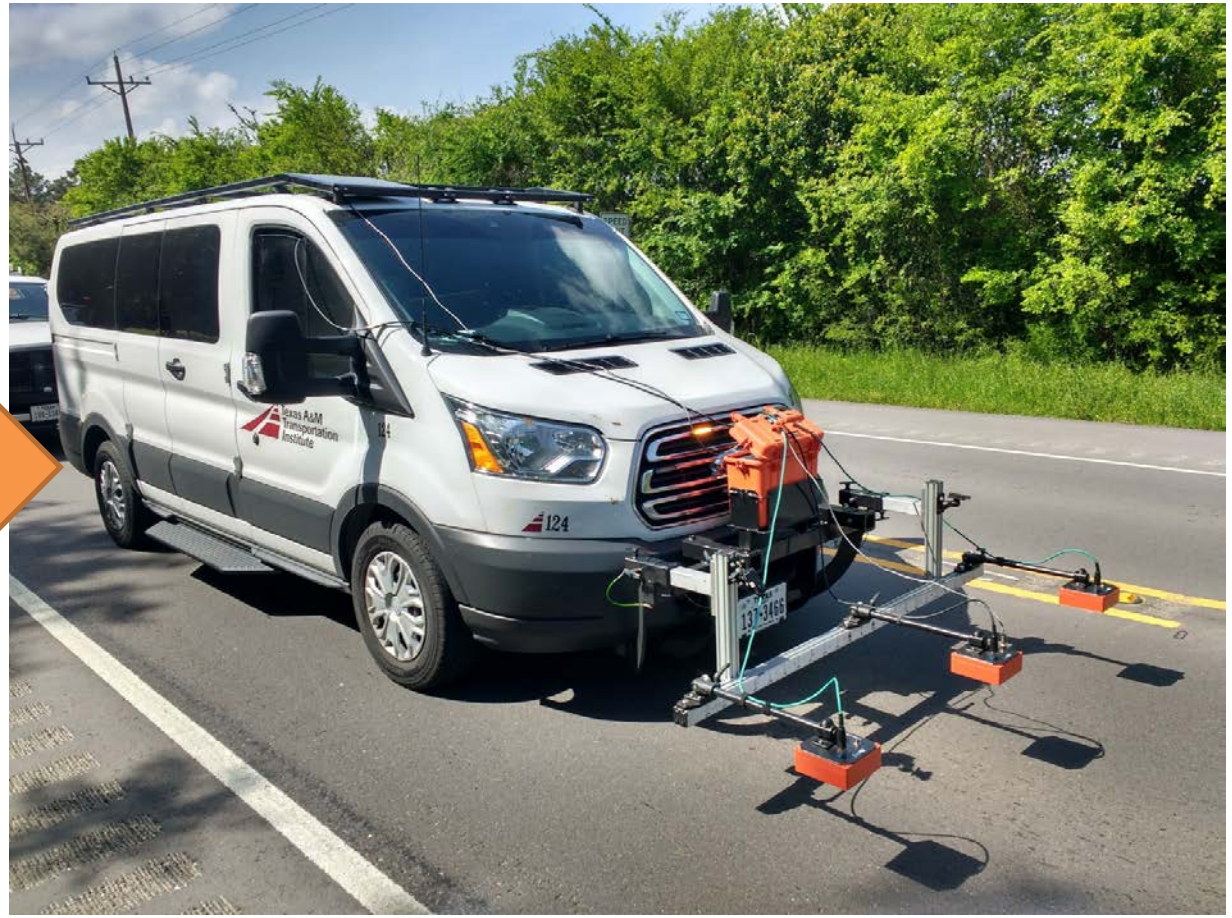
U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

Overview

- Vehicle-mounted system
- Deployment on 5 additional projects
  - New construction
  - Forensics
- Laboratory testing
- Future work

Vehicle-Mounted System



Vehicle-Mounted System

Previous Project Deployment

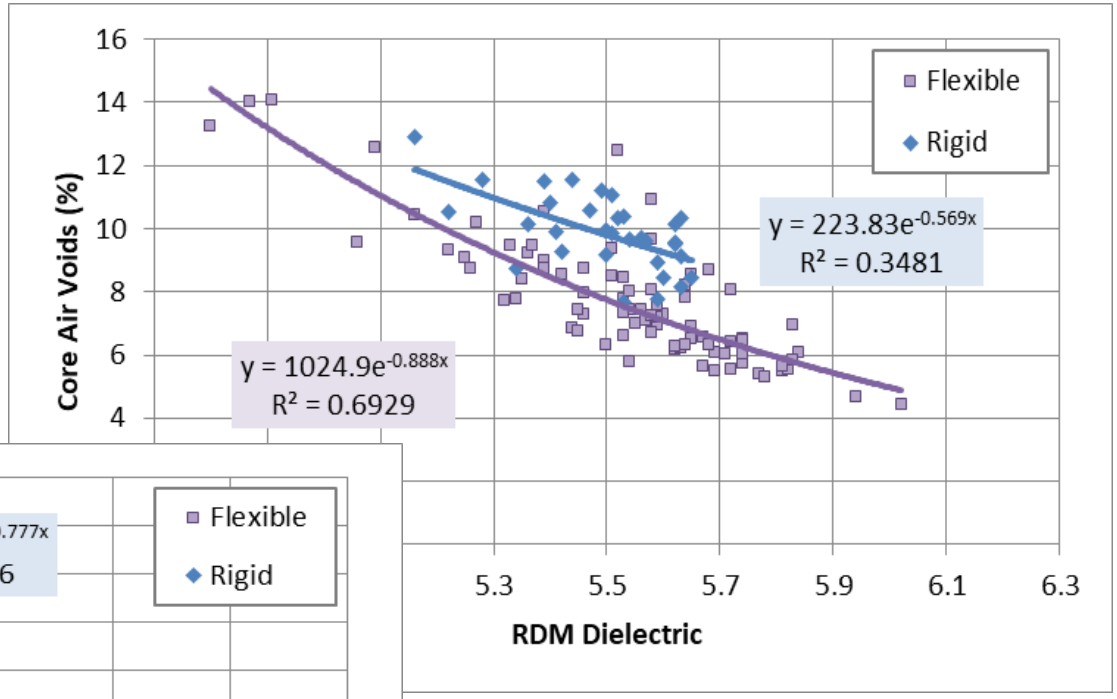
		Project	Mix Type	NMAS	Binder Type	Optimum AC (%)	Aggregate Type	Theo. Max SG	Thickness (in.)
Gen 1 & 2		FM 1887	TOM-C	3/8	70-22	6.7	Limestone	2.474	1.0
		RM 12	TOM-F	No. 4	76-22	7.3	Sandstone	2.348	0.5
		Riverside	DG Ty-C	1/2	76-22	4.8	Limestone	2.447	2.0
Gen 3	Phase I	US 183	TOM-F	No. 4	76-22	7.2	Sandstone	2.376	0.75
		US 90	SP Ty-D	3/8	70-22	5.2	Quartzite Limestone	2.443	1.5
		IH 10	SP Ty-C	1/2	64-22	5.1	Sandstone Limestone	2.462	2.0
		FM 31	DG Ty-D	3/8	64-22	5.4	…	2.481	2.0
	Phase II	SH 6-VM	DG Ty-D	3/8	64-22	5.2	Dolomite Gravel	2.447	2.0
		SH 6-Waco	TOM-C	3/8	76-22	6.6	Sandstone Dolomite	2.434	1.25
		SH 30	SMA-C	1/2	76-22	6.0	Sandstone Dolomite	2.405	2.0

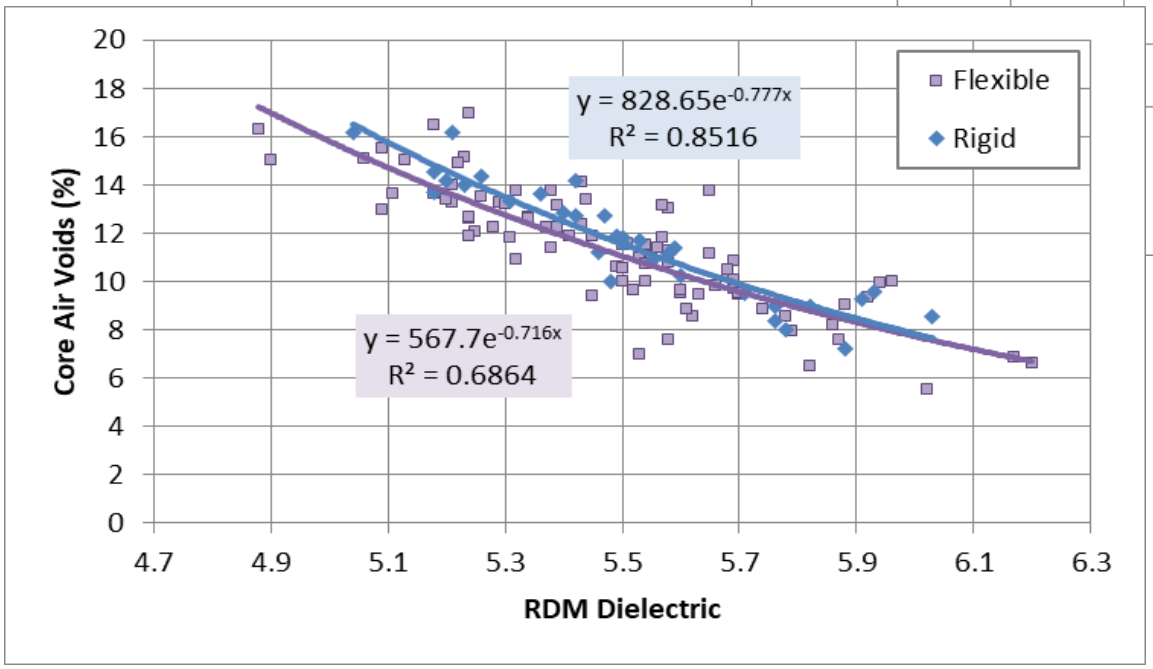
Recent Project Deployment

Project	Mix Type	NMAS	Binder Type	Optimum AC (%)	Aggregate Type	Theo. Max SG	Thickness (in.)
RELLIS Campus	DG-D	3/8	64-22	5.0	Limestone	2.571	2.0
	TOM-F	No. 4	76-22	7.2	Dolomite	2.515	0.75
US 287	SP Ty-C	1/2	64-22	4.8	Sandstone, Limestone	2.504	2.0
SL 79	DG Ty-B	1/2	64-22	4.5	Gravel	2.451	3.5
SH 149	SP Ty-C	1/2	70-22	5.3	Quartzite, Limestone	2.470	1.5
IH 45	SMA-C	1/2	-	-	Trap Rock, Limestone	-	2.0
TBD							
TBD							

RELLIS Test Sections

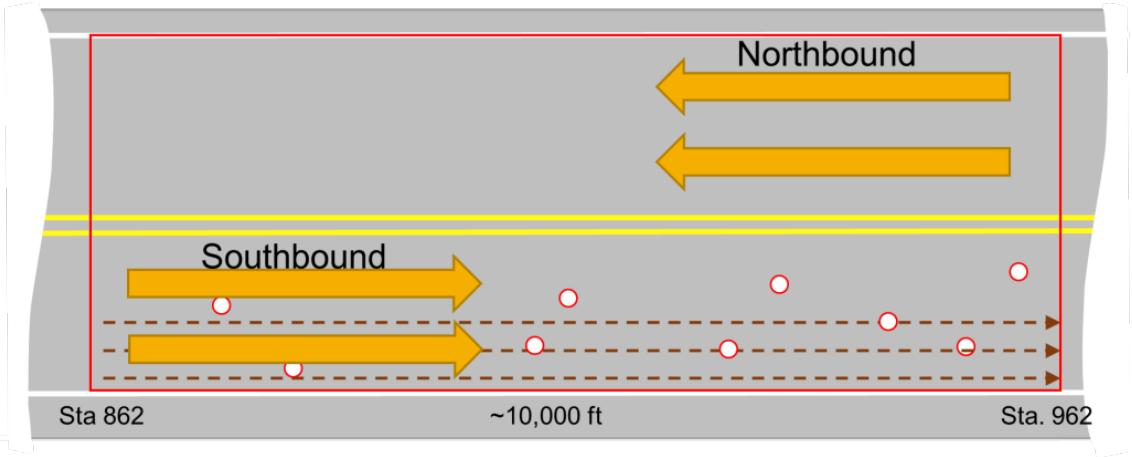
DG Type D (Intermediate)

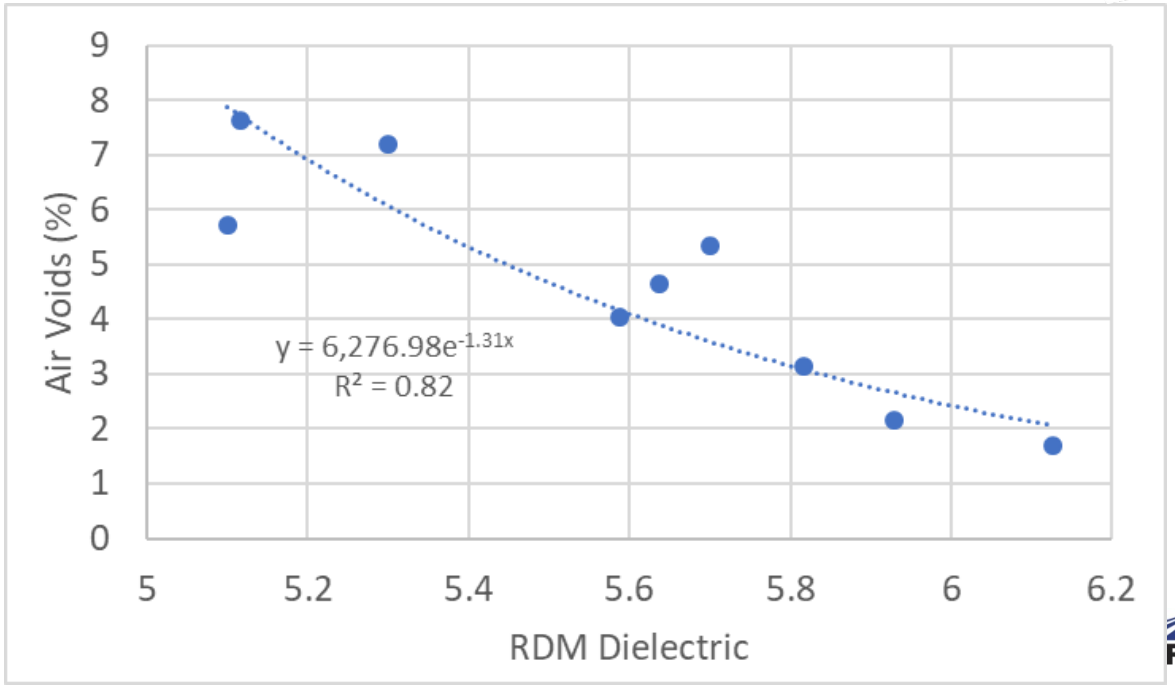




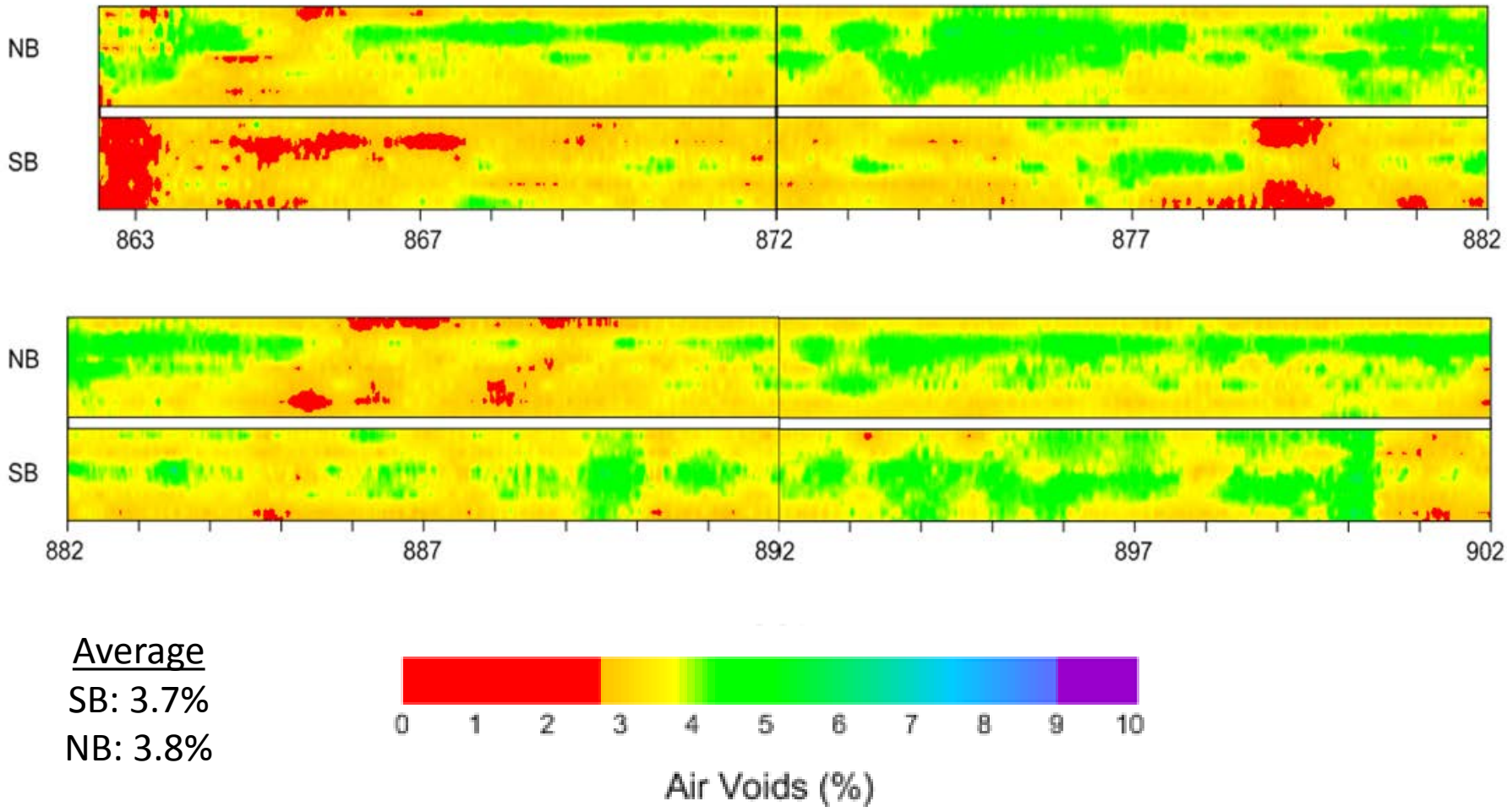
TOM-F (Surface)

US 287 – Groveton (forensics)





US 287 – Groveton (forensics)



Average
SB: 3.7%
NB: 3.8%

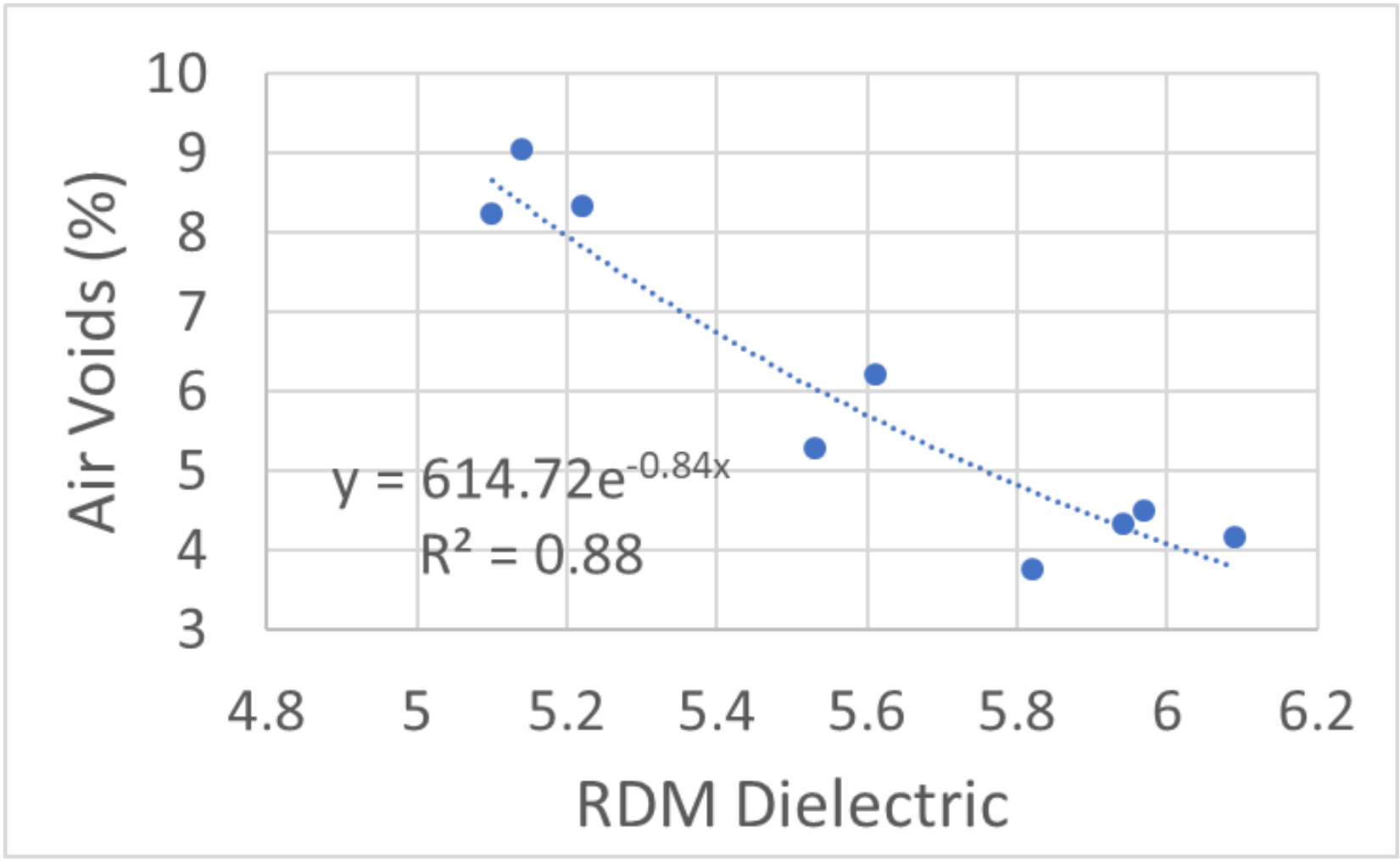
Findings

- RDM effective for decision making.
- Initial vs. long-term density
  - What is the relationship?
  - Would calibration change?
- Difficult measuring core locations in vehicle.
  - Requires 2 or 3 people.
  - Marking start/stop location.
  - Software currently does not calculate voids at marked point.
  - Minimize impact of vehicle pitch?

SL 79 – Del Rio

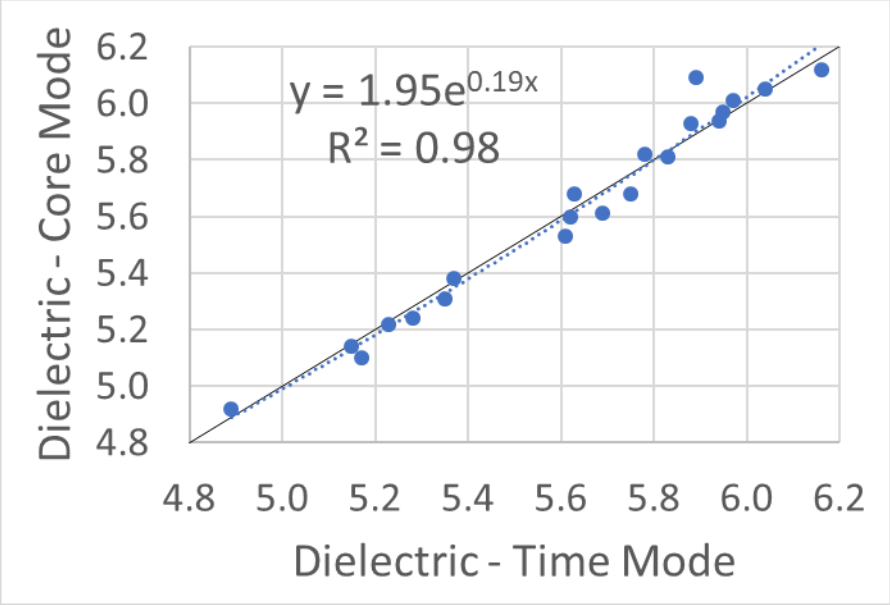
- 3.5-inch Type B
- Gravel mixture

SL 79 – Del Rio


Air Voids (%)
10
9
8
7
6
5
4
3
y = 614.72e-0.84x
R² = 0.88
4.8
5
5.2
5.4
5.6
5.8
6
6.2
RDM Dielectric

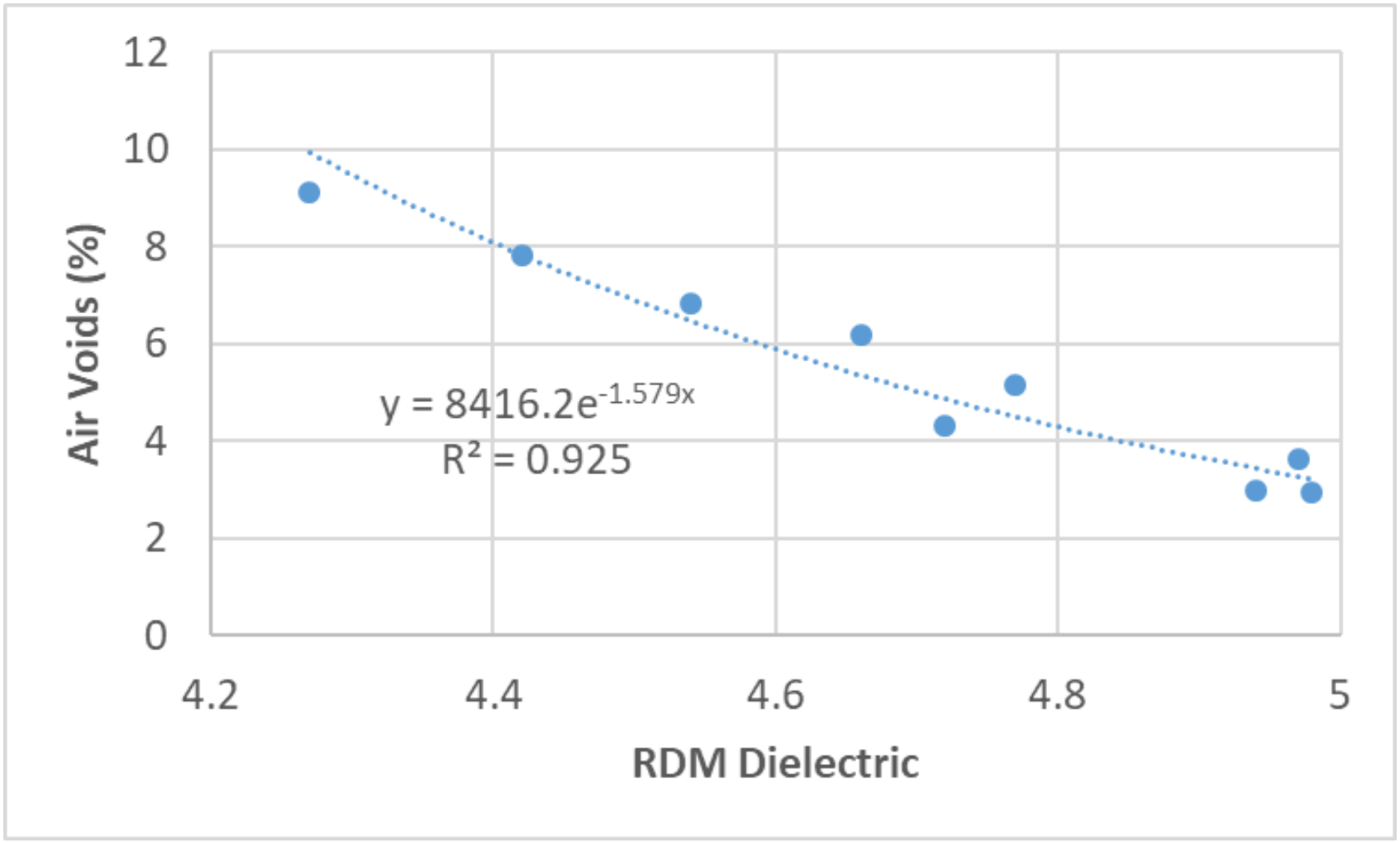
Findings

- Surface dielectric correlated with density in thick sample.
- Antenna problems
  - Readings different among antennas
- Measuring core locations.
  - Gave-up on taking core measurements from vehicle.
  - Time mode vs core mode



Property	Time Mode	Core Mode
Prediction (R^2)	0.831	0.802

SH 194 - Beckville



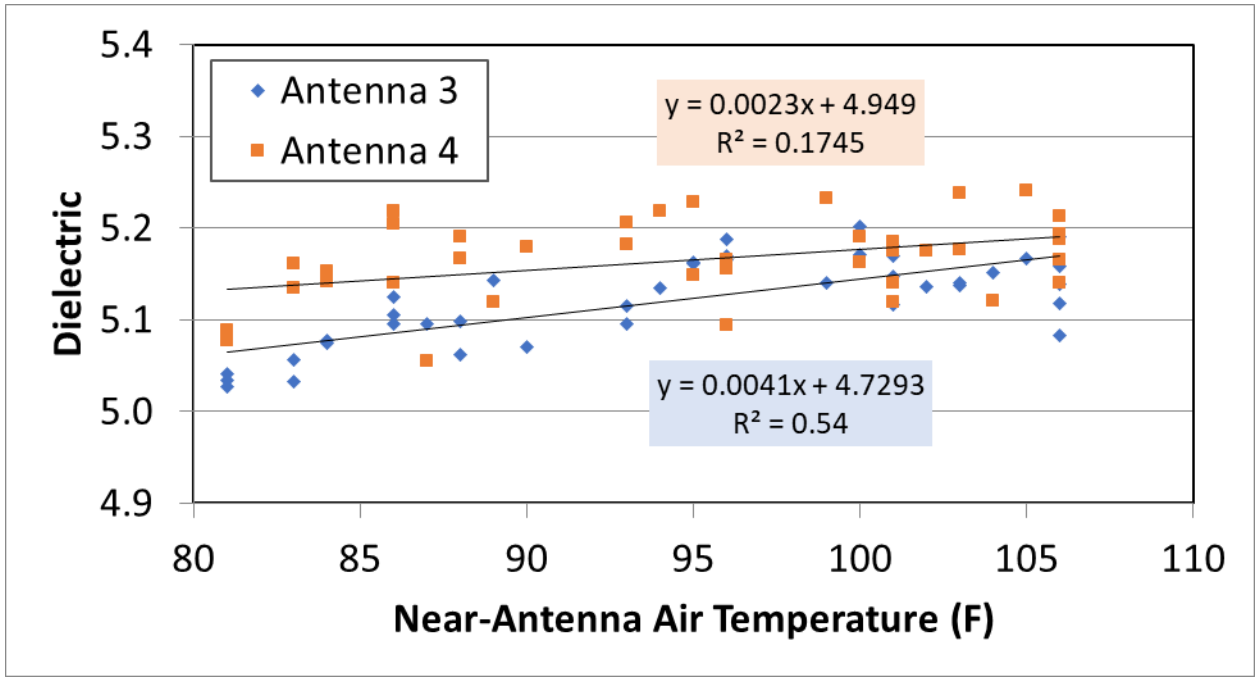
SH 194 – Beckville

Findings

- Recommend using vehicle+cart combination in the field to make distance and spot measurements.
- Observed high sensitivity to system calibration. Sometimes initial calibration is not good, or requires recalibration later in the day.
  - Not easy to recalibrate.

Laboratory Testing – Antenna Stability

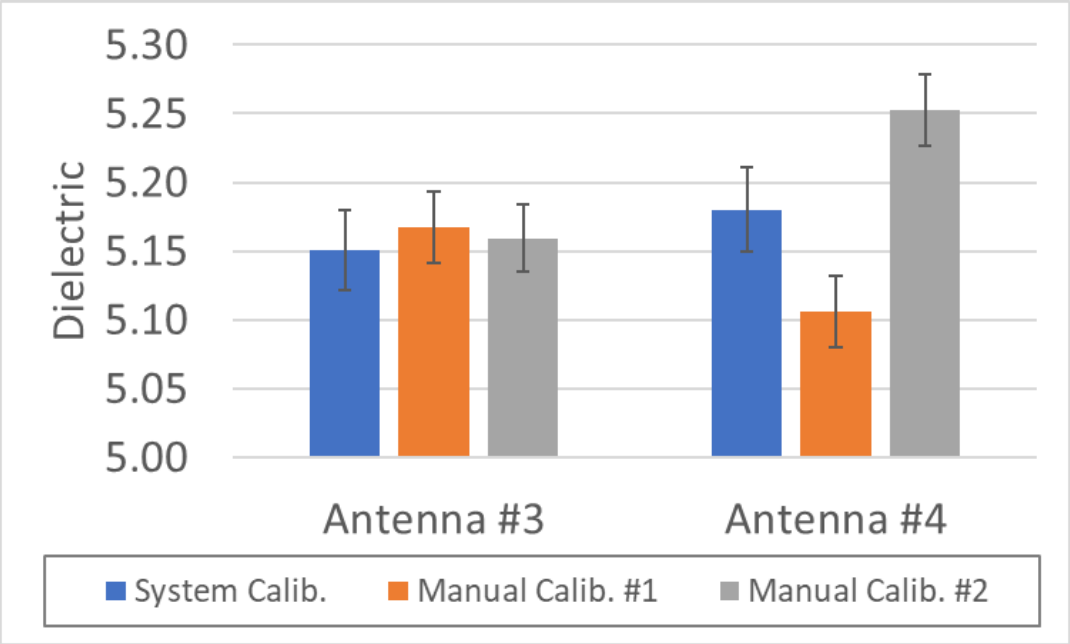
- Testing Plan
  - Leave system on for several hours outside.
  - Collect static time-mode data every 10 minutes.
  - Collect temperature data.
- Results



Δ0.1 dielectric
$\approx$ 0.2 - 1.2% voids

Laboratory Testing - Antenna Stability

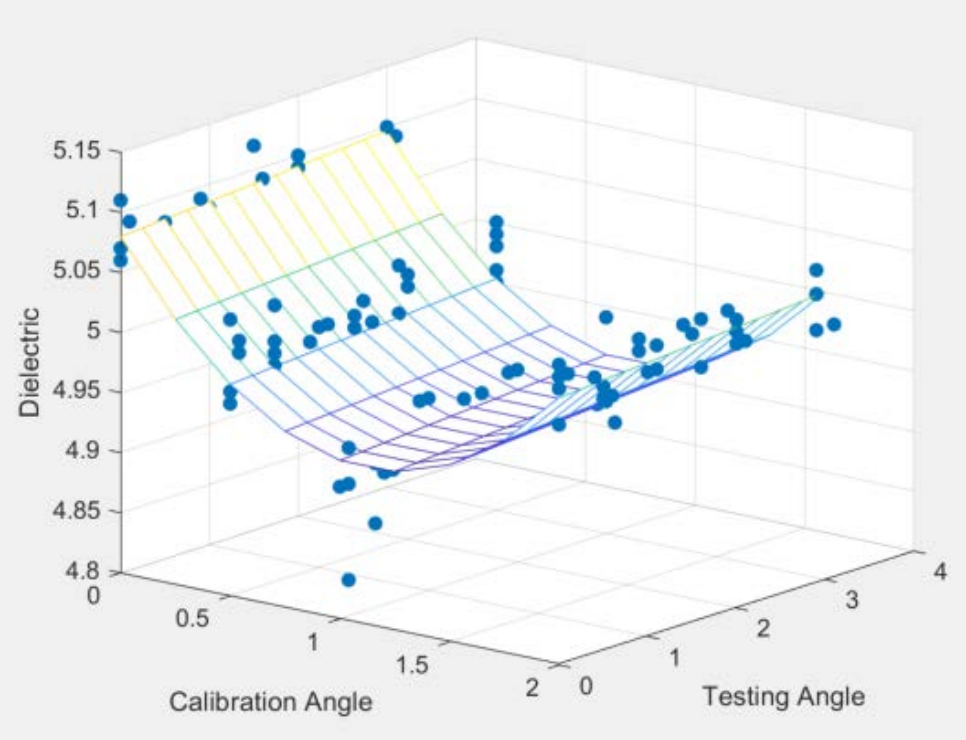
- Testing Plan
  - Leave system on for several hours outside.
  - Collect static time-mode data every 10 minutes.
  - Manually collect calibration data at beginning and end.
- Results

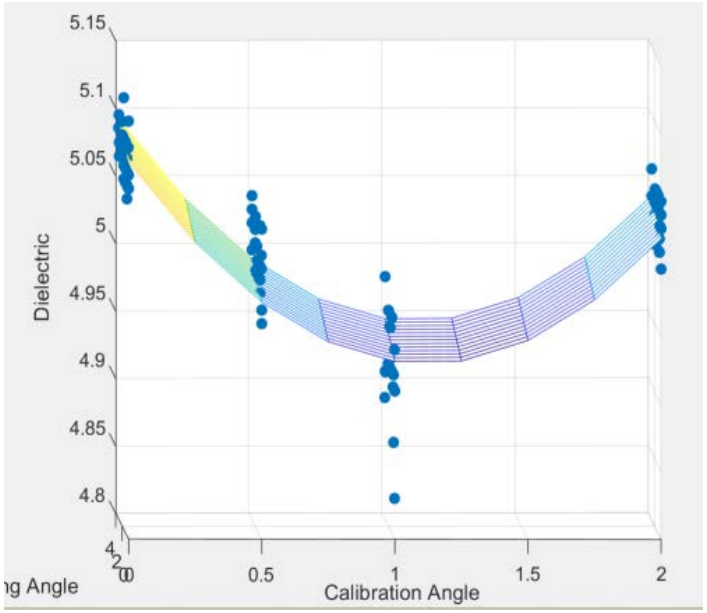


Δ0.1 dielectric
$\approx$ 0.6 - 1.2% voids

Laboratory Testing – Antenna Angle

- Testing Plan
  - Calibrations at 0, 1, and 2 degrees.
  - Test at 0, 0.5, 1.0, 1.5, 2, and 3 degrees.
- Results



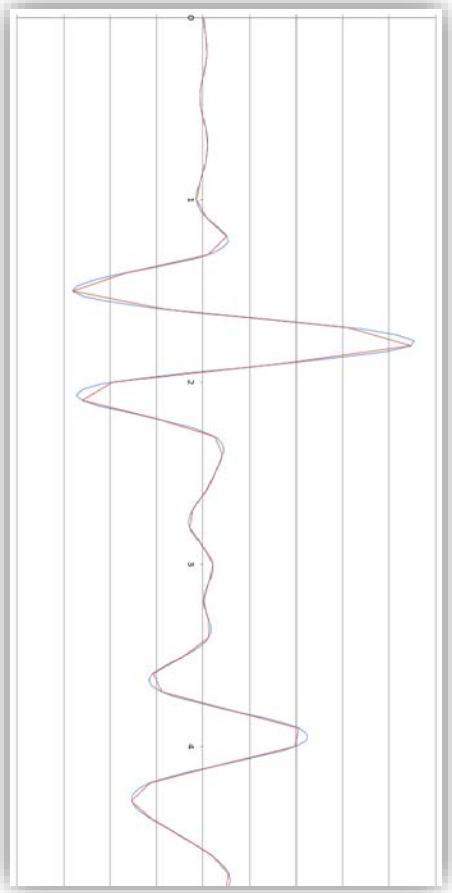


Laboratory Testing – Mix Composition

- 5 unique HMA design
  - Gradations
  - Aggregate types
  - Asphalt contents
- 8 variations from design

Asphalt Content	Coarse Agg. Substitution	Air Voids
Design	None	3
Design	None	8
Low	None	5
High	None	5
Design	Reduce	5
Design	Increase	5
Low	Increase	3
High	Reduce	8

Possible other GPR Solutions



Anticipated Future Needs and Activities

- Complete laboratory and field testing.
- Analyze field and laboratory data.
- Implement RDM as a QA tool on a larger scale.
- Further explore applications in forensics context.
- Evaluate suitability from other systems for possible application in density-measurement context.