

# Use of close range photogrammetry to characterise texture in HRA pavements

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# Some important tyres



# Enveloping and the road / tire interface

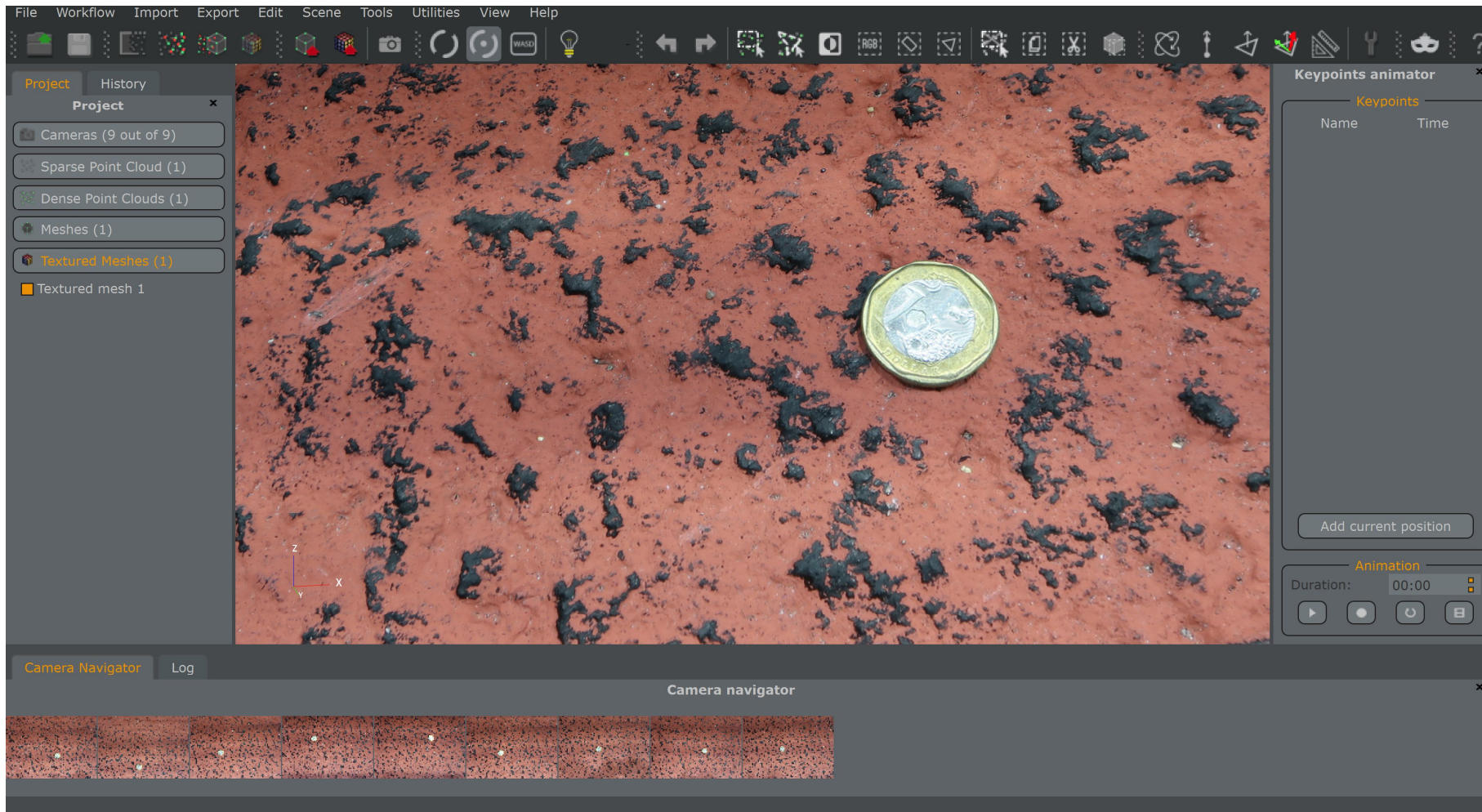
- ▶ The road / tire interface is a complex 3-dimensional surface that changes over the life of a road surfacing.
- ▶ This makes understanding what is happening quite difficult.
- ▶ What is being specified, designed and measured?
- ▶ Now starting to be explained by the Principle of Enveloping.
- ▶ Proposed by the recently completed European ROSANNE project.

# Enveloping - European ROSANNE project (2016)



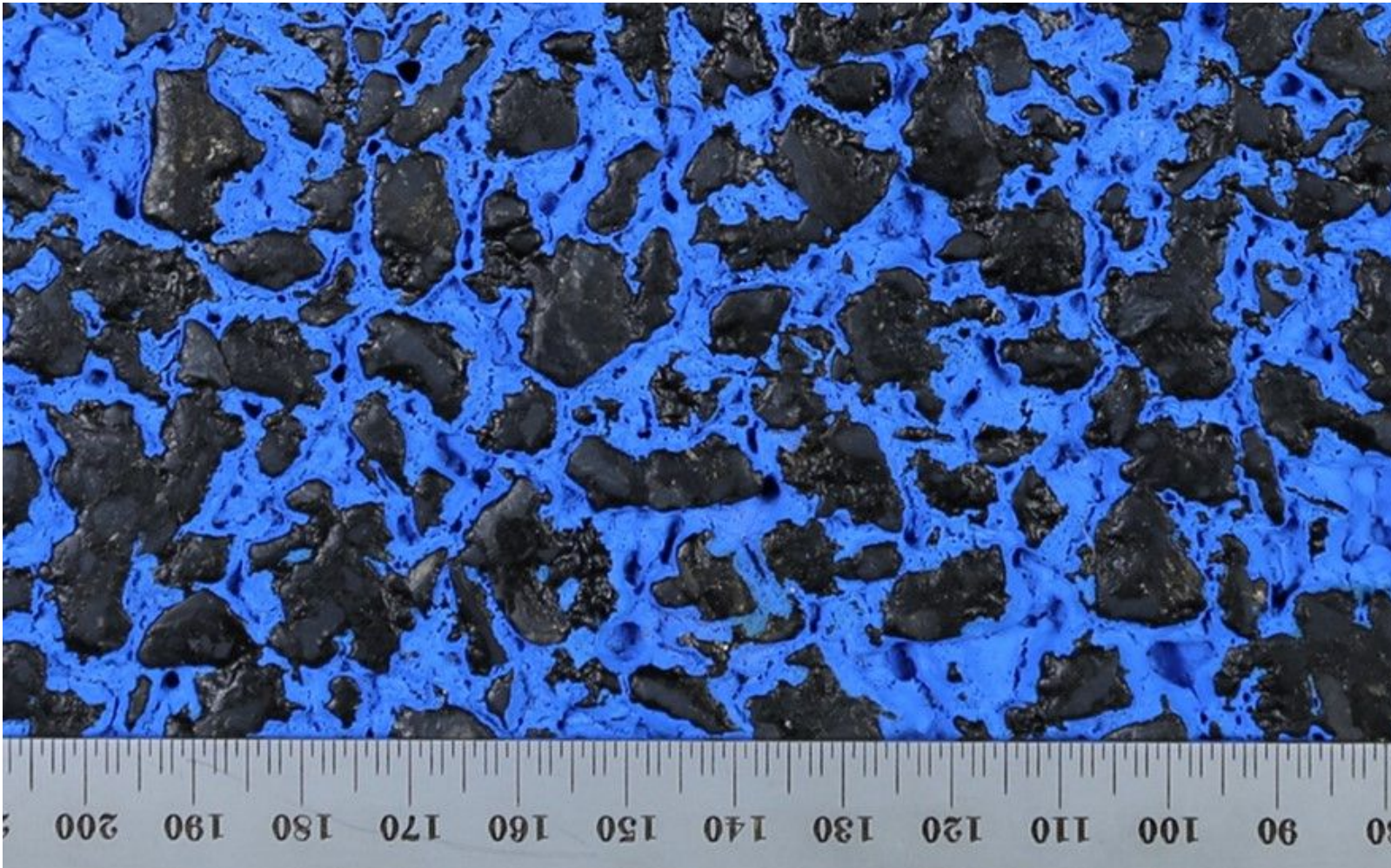


# Enveloping shown by ultra soft soft tyre rubber on a red high friction paint



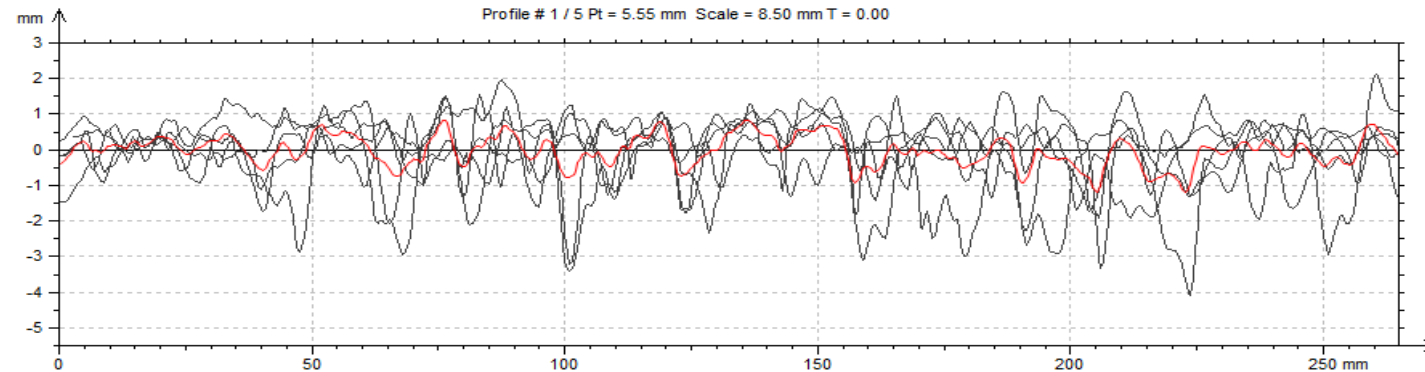


# Enveloping of the tire / asphalt interface shown by paint removal

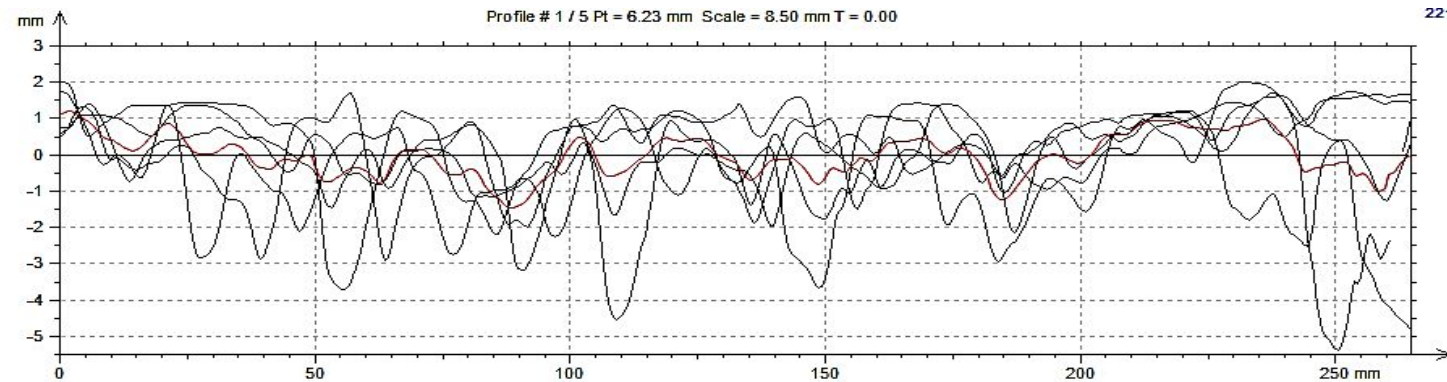


# 2D profiles for SMA10 and hot rolled asphalt

SMA



Chipped  
HRA



221



# Keeping it simple - taking photographs (phone or camera)





No black boxes - just off-the-shelf  
cameras and software

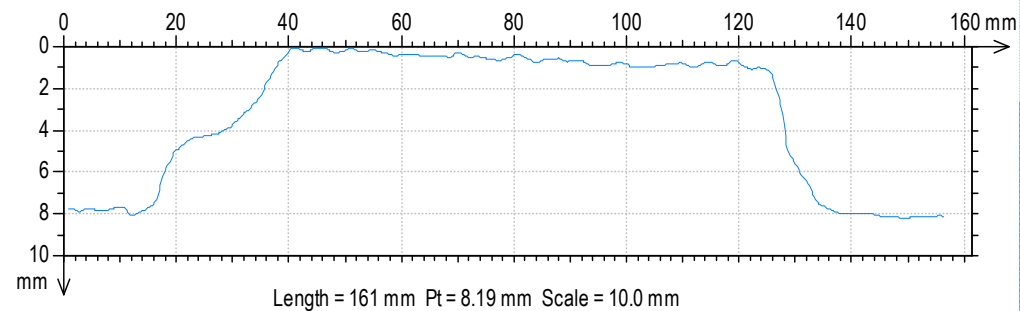
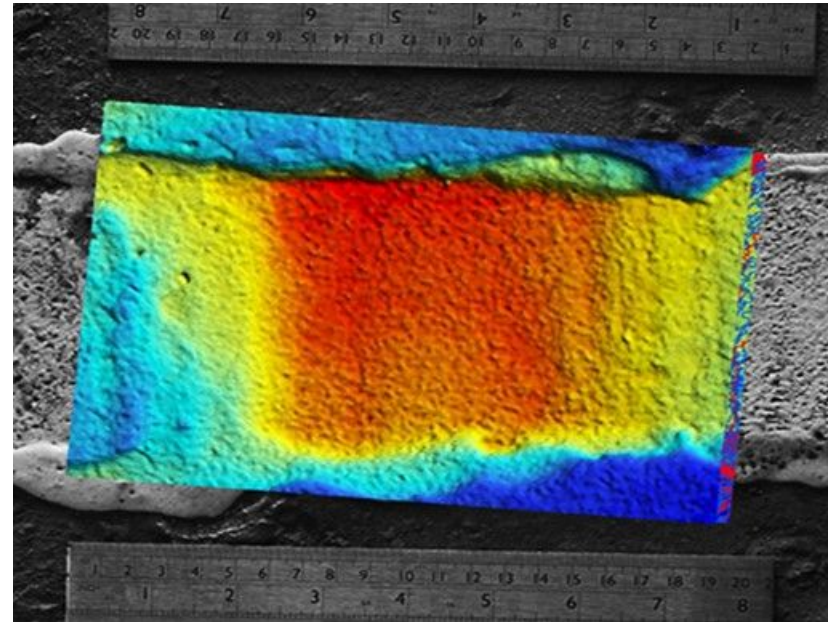


3DF Zephyr PRO  
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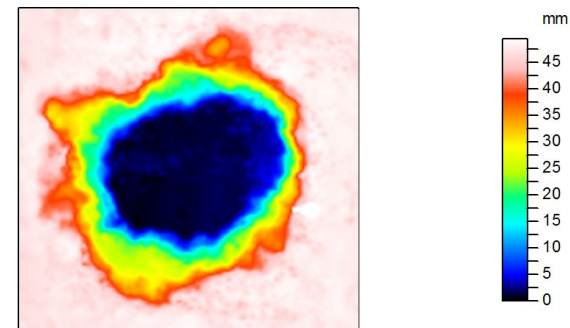
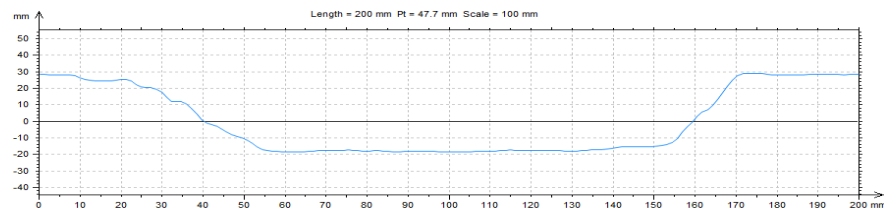
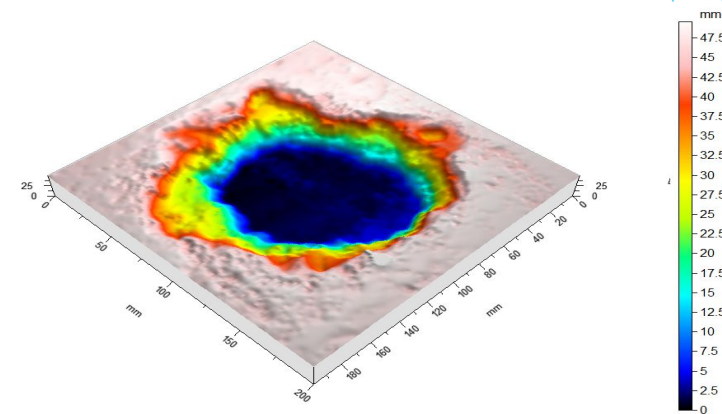
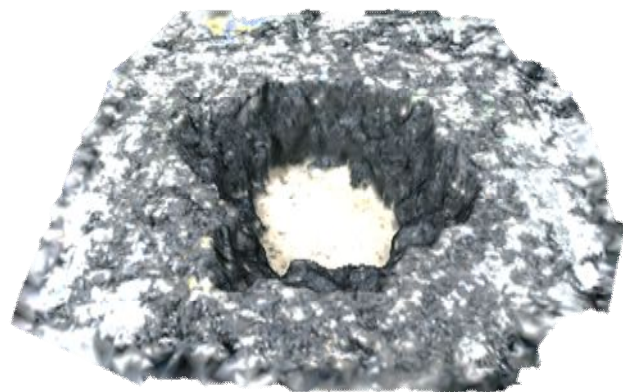


# How thick was the line marking?

- 3d model based on Phillips photographs
- Colour used to show thickness
- Analysis shows the line marking is between 7 to 8 mm thick



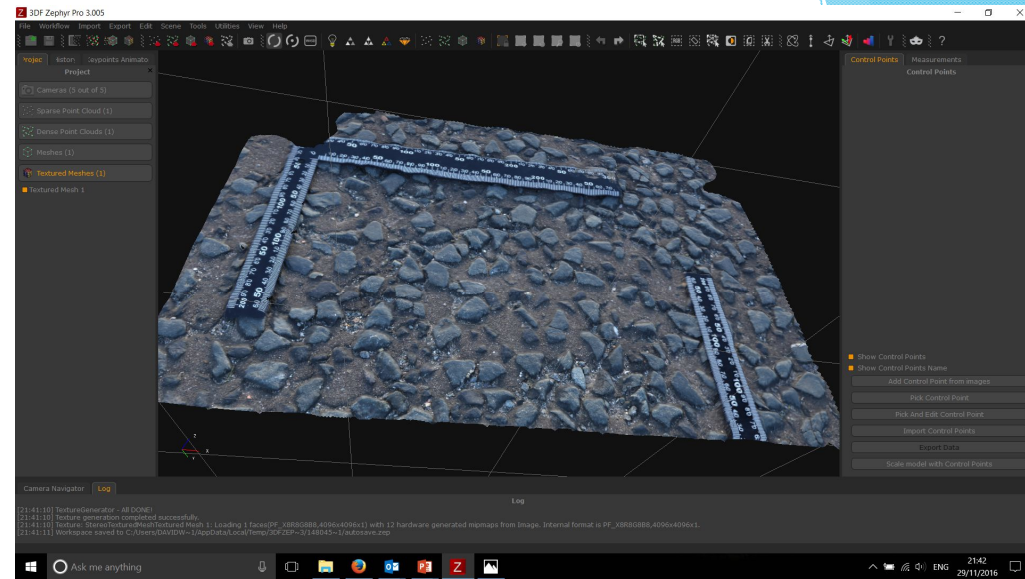
# 3D analysis of a laboratory pothole



Horizontal Area	18916 mm <sup>2</sup>
Developed Area	29165 mm <sup>2</sup>
Complexity	54.2 %
Depth	46.2 mm
Volume	469959 mm <sup>3</sup>
Perimeter	568 mm



# Taking photographs in a carpark

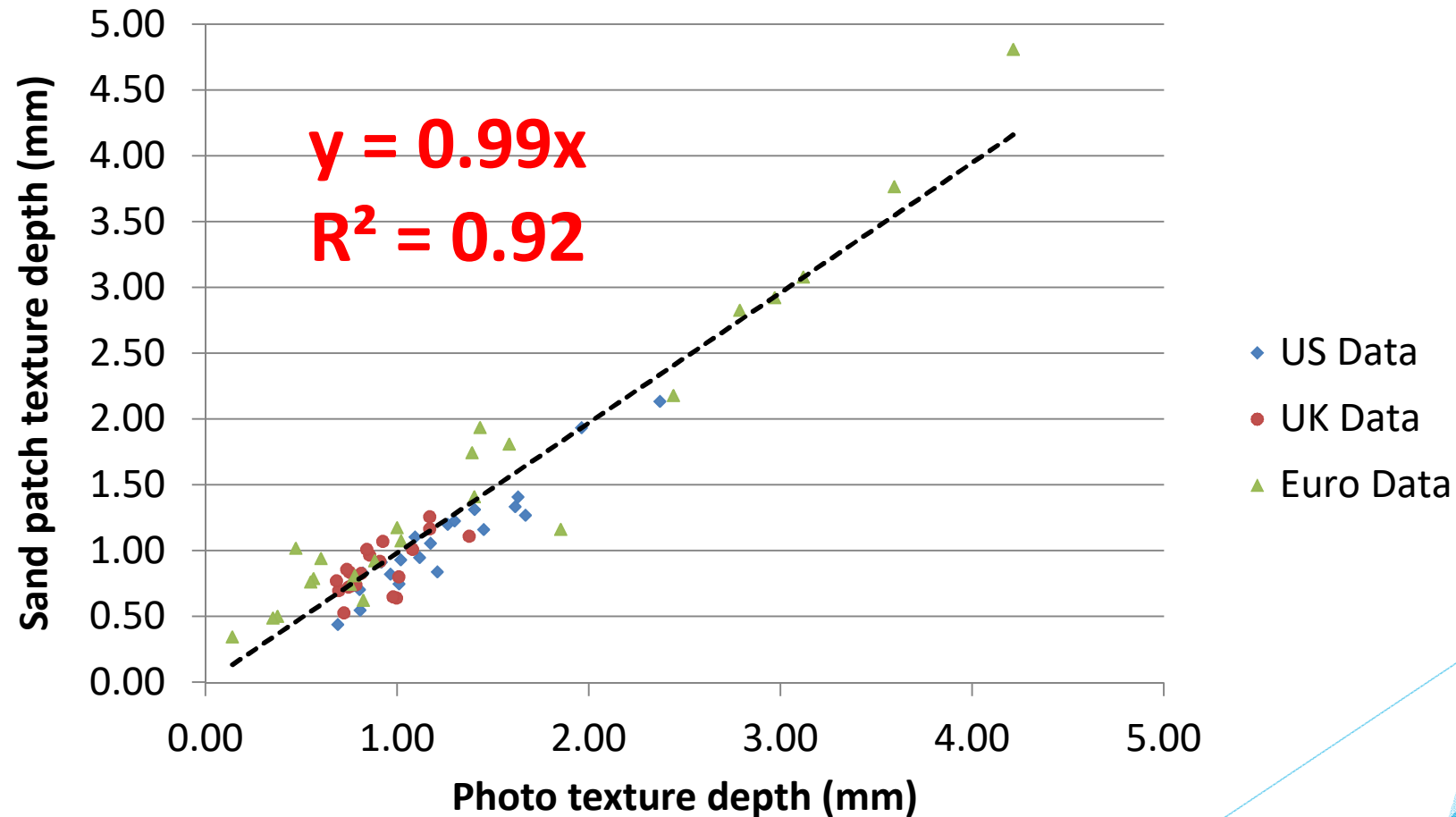




# 3D model v. sand patch



# Comparison of texture depth data using photographs and sand patch

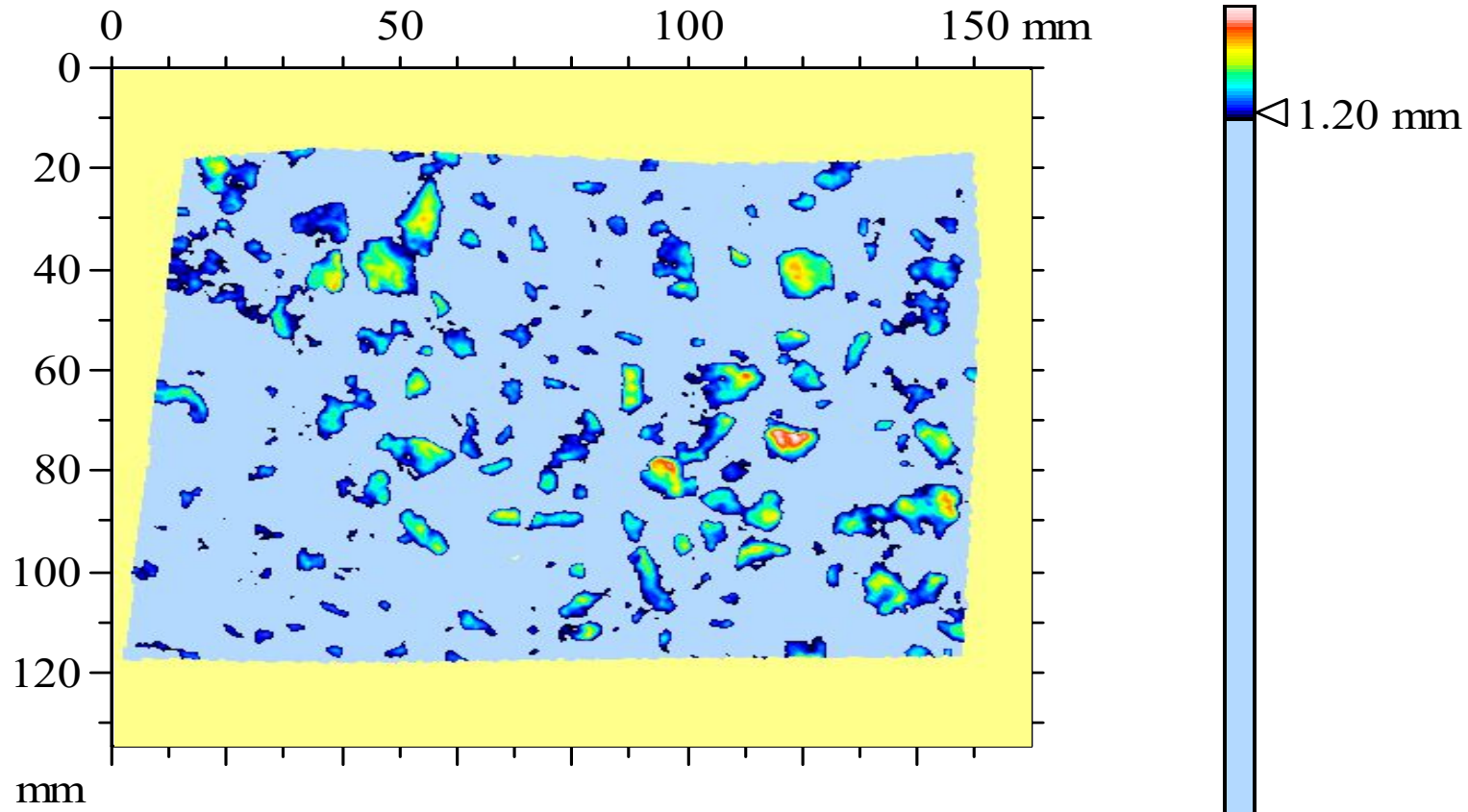




# Development of secondary textures during early life trafficking

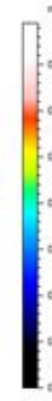
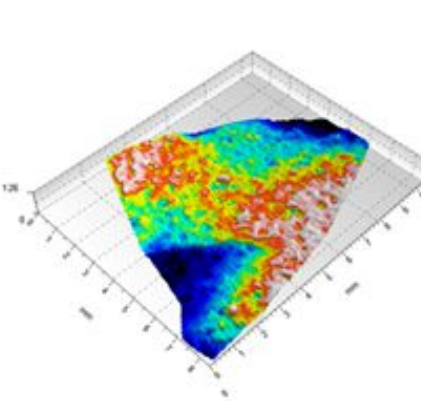
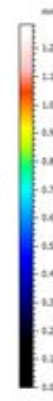
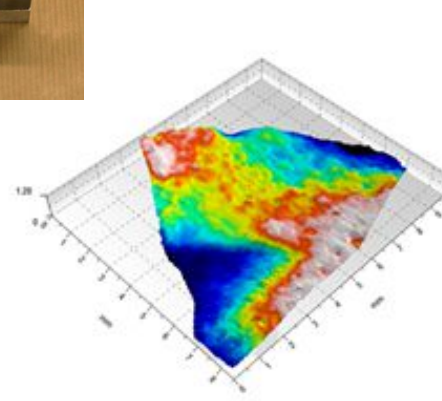
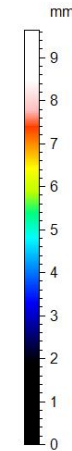
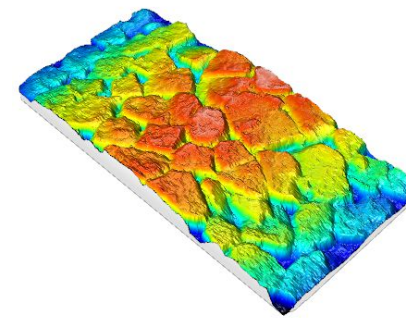
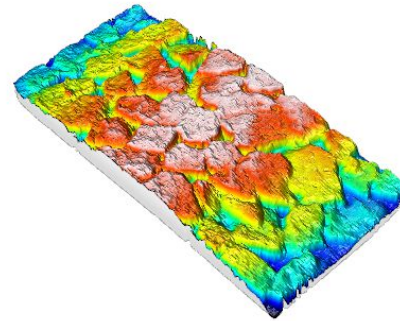
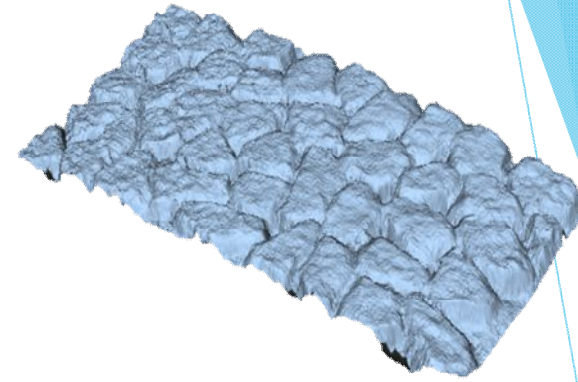
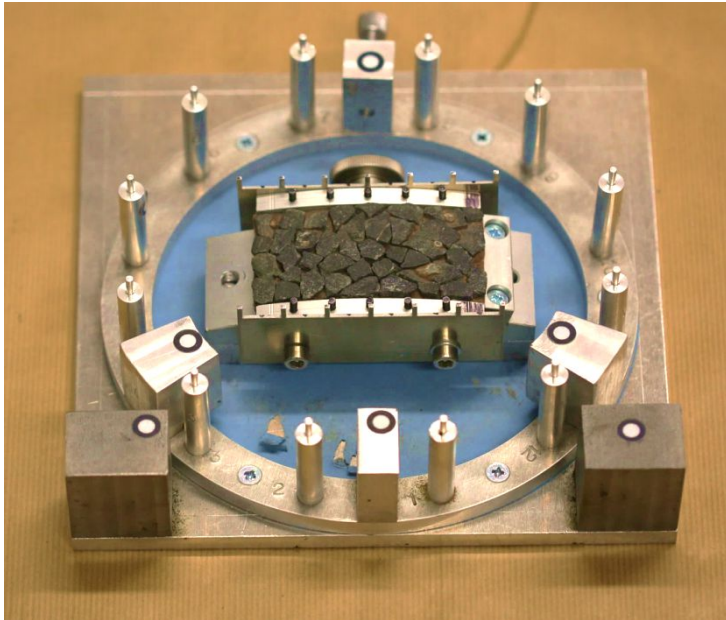


# Use of 3D model to evaluate tyre/surface interaction

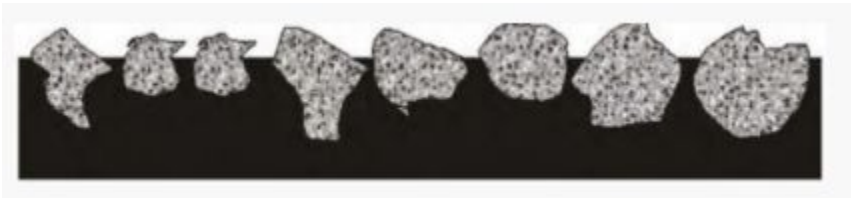




# PSV 3D modelling techniques to quantify change in microtexture

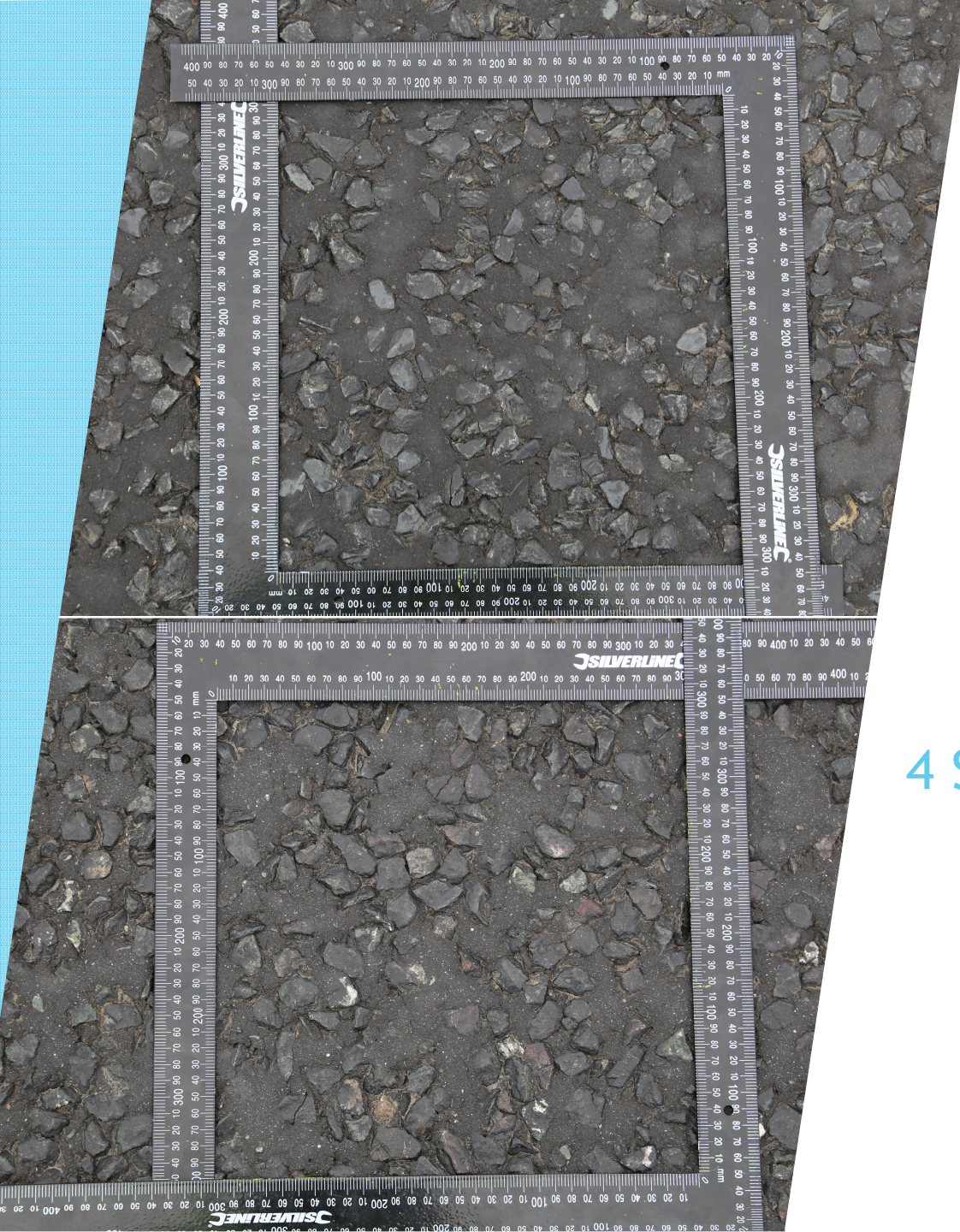


To develop a test which can identify whether a HRA surface has positive or non-positive macrotexture



Positive Macrotexture

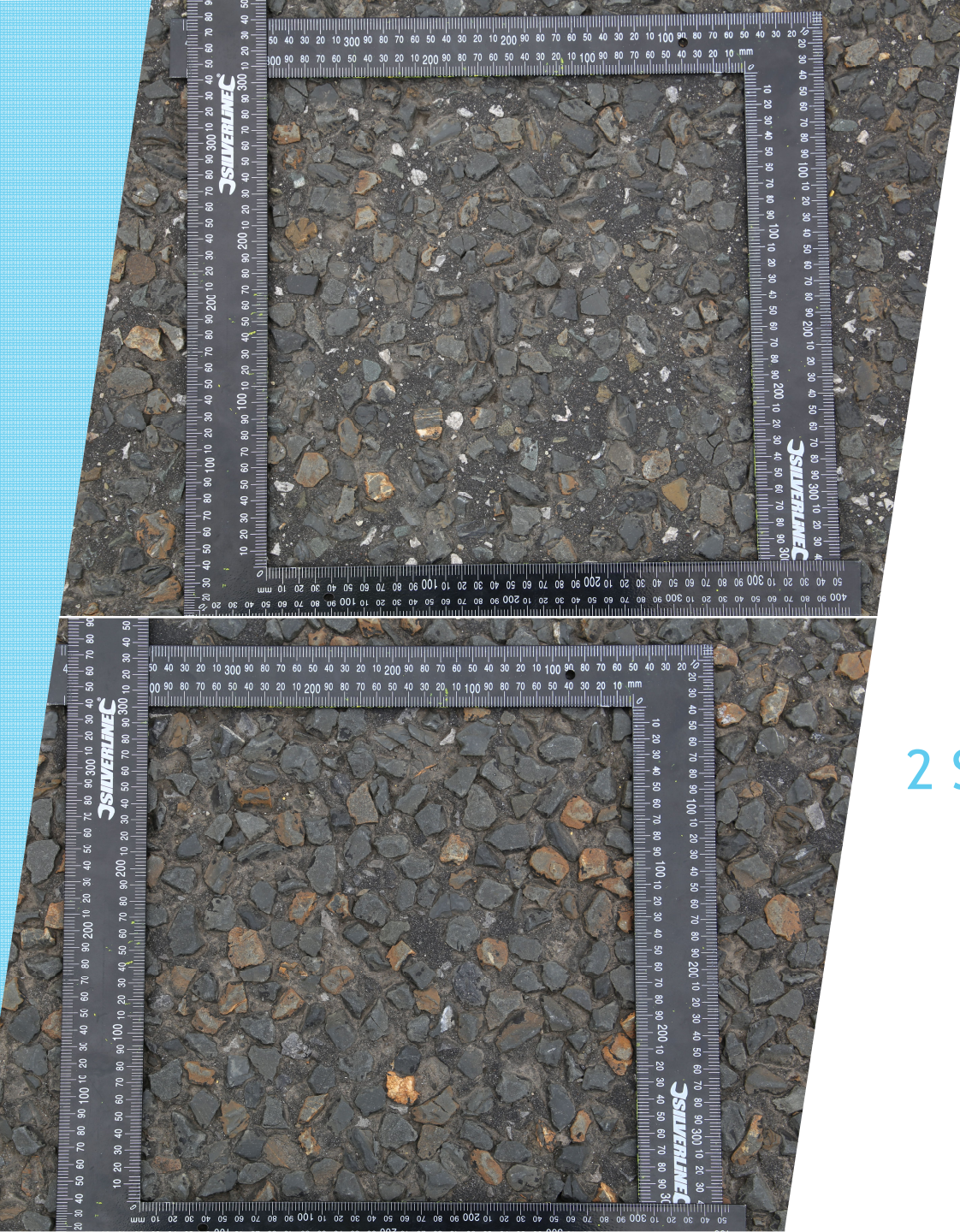




# Non-Positive Texture

4 Sites x 20 test locations per site  
= 80 Test Locations



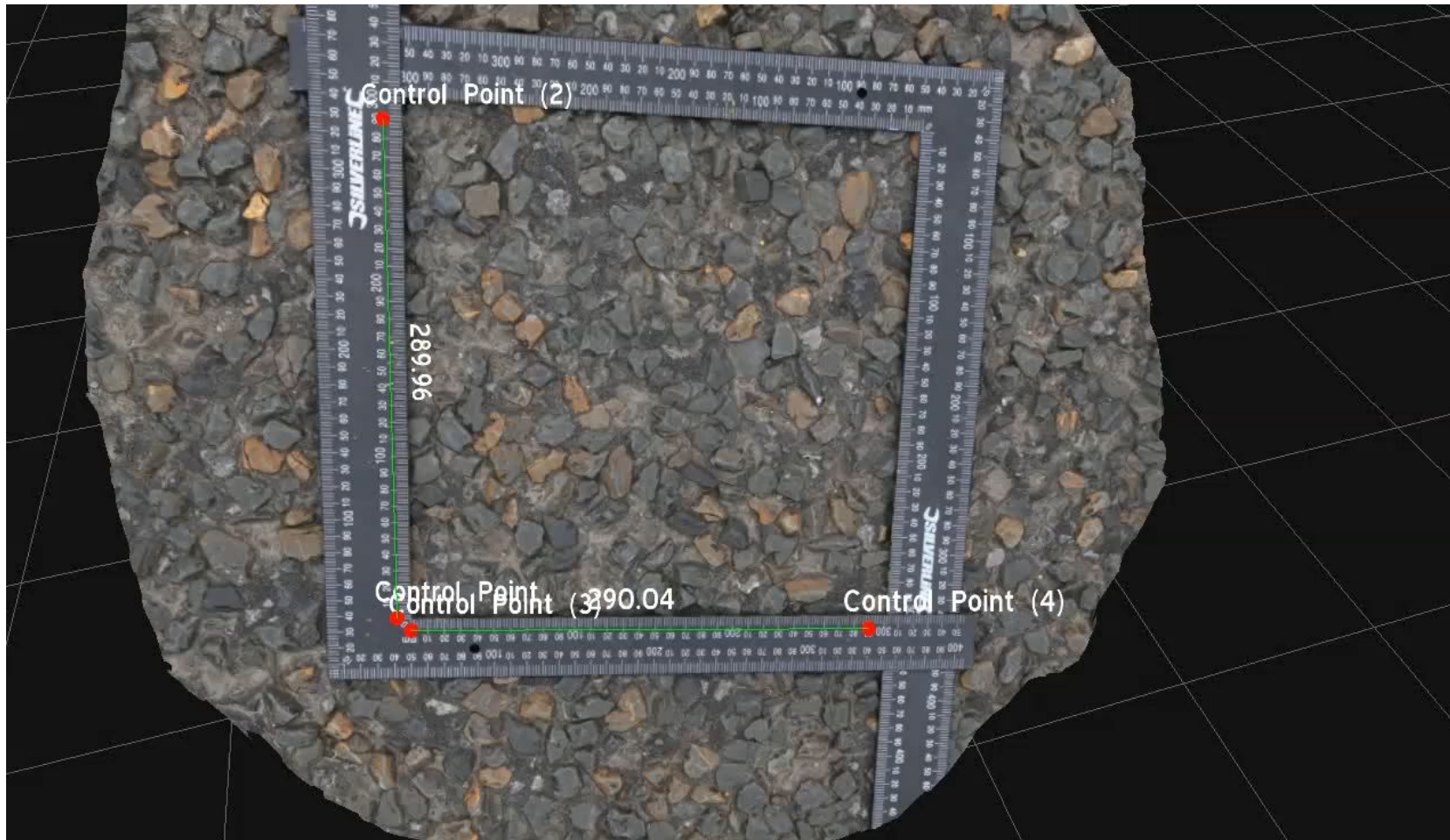


# Positive Texture

2 Sites x 20 test locations per site  
= 40 Test Locations



# Zephyr Pro Modelling



# 3D Models from CRP Images

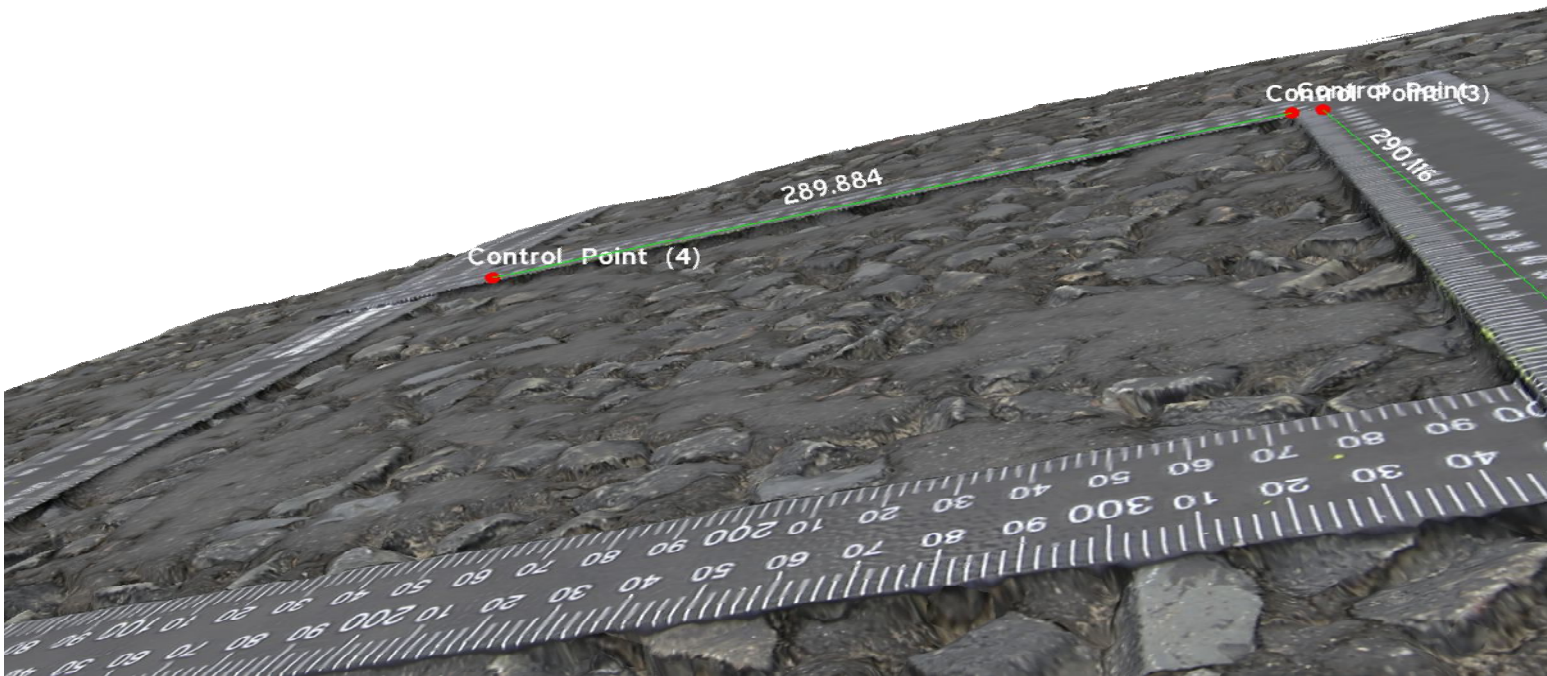
Positive HRA





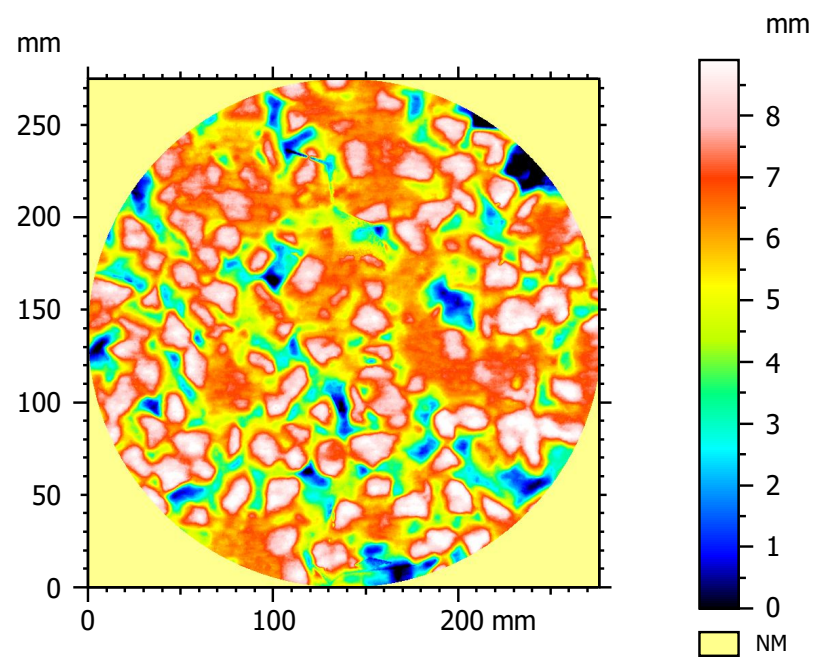
# 3D Models from CRP Images

## Non-Positive HRA

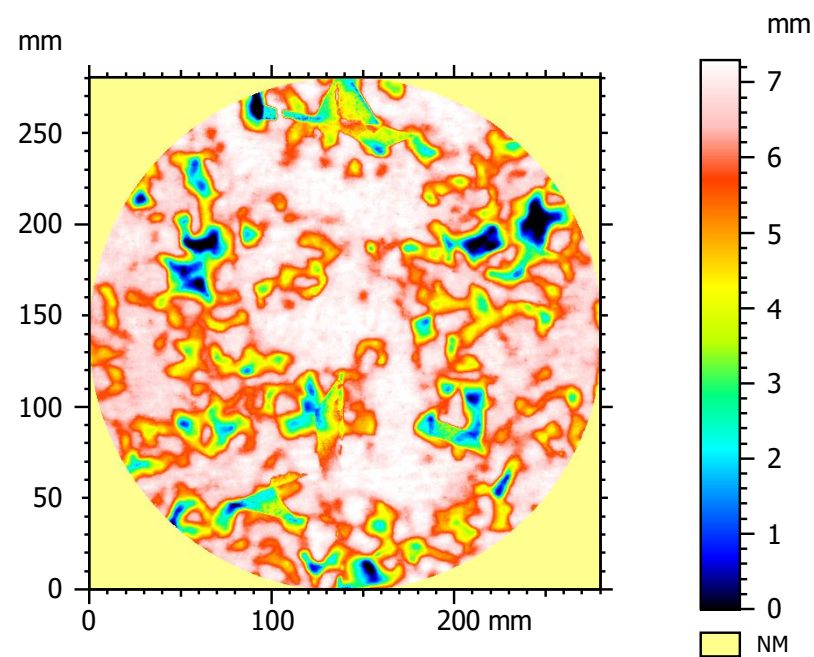


# Mountains Map Models

## Positive HRA



## Non-Positive HRA



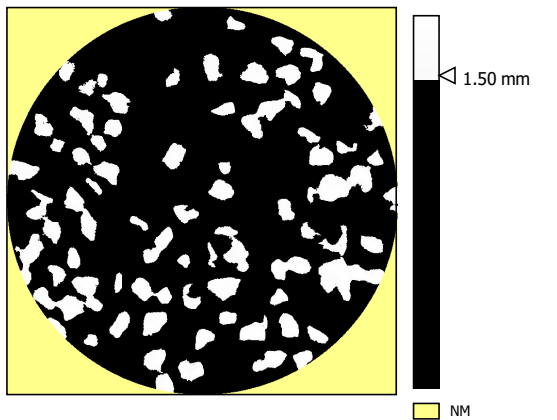


# Islands Analysis Module

- Used to quantify the volume of islands, i.e. of distinct areas of material above a given height in a surface
- A virtual horizontal slice is taken through the surface at a user defined threshold.
- The islands are the portions of the model which project above this slice.
- This is analogous to discrete stone chips protruding above the surface of the mastic in a positive-textured HRA.

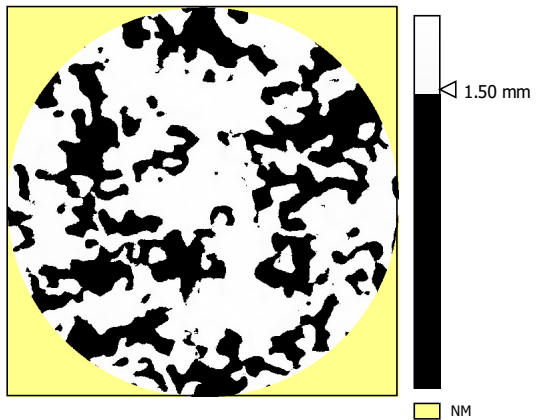
# Mountains Map Island Models

## Positive HRA



Number of islands	71			
Threshold	1.50	mm		
Parameters	Unit	Grain #1	Grain #2	...
Area	mm <sup>2</sup>	670	636	...
Volume	mm <sup>3</sup>	631	498	...
Max height	mm	1.50	1.50	...
Height/Surface ratio	mm/mm <sup>2</sup>	0.00224	0.00236	...

## Non-Positive HRA

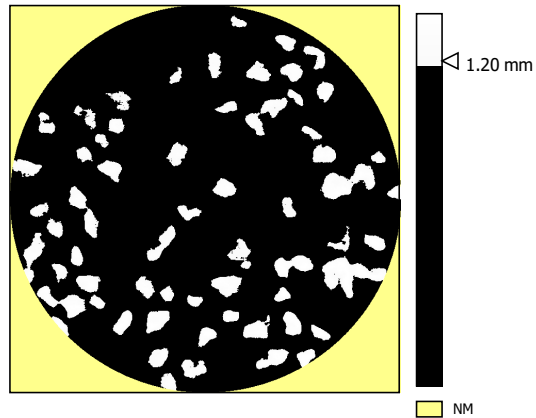


Number of islands	9			
Threshold	1.50	mm		
Parameters	Unit	Grain #1	Grain #2	...
Area	mm <sup>2</sup>	35947	901	...
Volume	mm <sup>3</sup>	31637	586	...
Max height	mm	1.50	1.47	...
Height/Surface ratio	mm/mm <sup>2</sup>	4.17e-05	0.00163	...



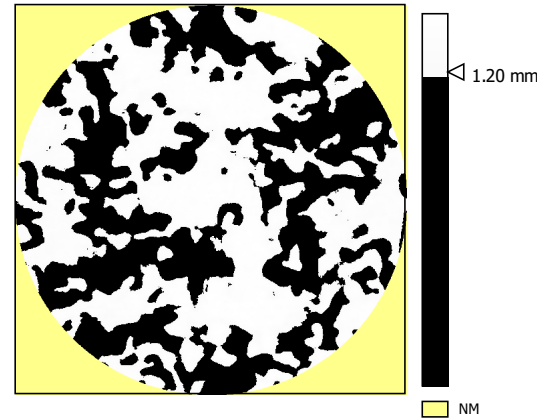
# Mountains Map Island Models - 1.2 mm

## Positive HRA



Number of islands	62			
Threshold	1.20	mm		
Parameters	Unit	Grain #1	Grain #2	...
Area	mm <sup>2</sup>	588	473	...
Volume	mm <sup>3</sup>	434	310	...
Max height	mm	1.20	1.20	...
Height/Surface ratio	mm/mm <sup>2</sup>	0.00204	0.00254	...

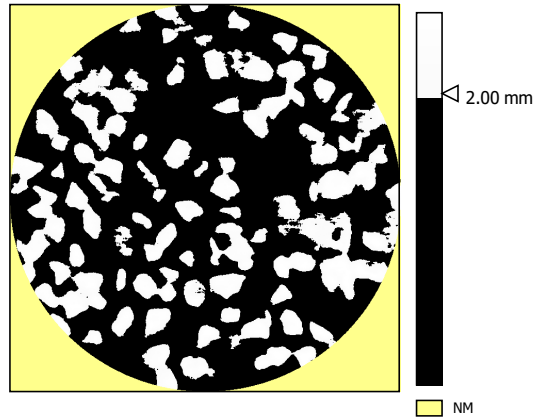
## Non-Positive HRA



Number of islands	17			
Threshold	1.20	mm		
Parameters	Unit	Grain #1	Grain #2	...
Area	mm <sup>2</sup>	25593	4142	...
Volume	mm <sup>3</sup>	17914	2153	...
Max height	mm	1.20	1.20	...
Height/Surface ratio	mm/mm <sup>2</sup>	4.69e-05	0.00029	...

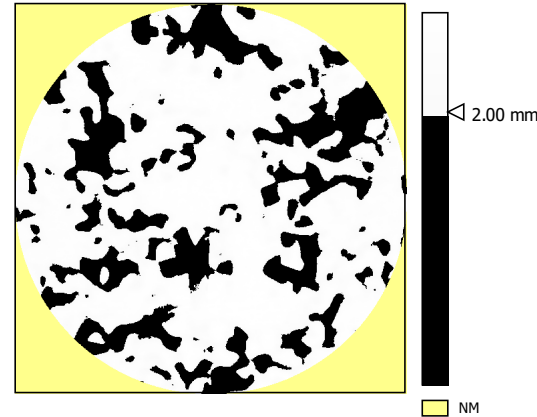
# Mountains Map Island Models - 2.0 mm

## Positive HRA



Number of islands	63			
Threshold	2.00	mm		
Parameters	Unit	Grain #1	Grain #2	...
Area	mm <sup>2</sup>	1717	966	...
Volume	mm <sup>3</sup>	1490	1011	...
Max height	mm	2.00	2.00	...
Height/Surface ratio	mm/mm <sup>2</sup>	0.00116	0.00207	...

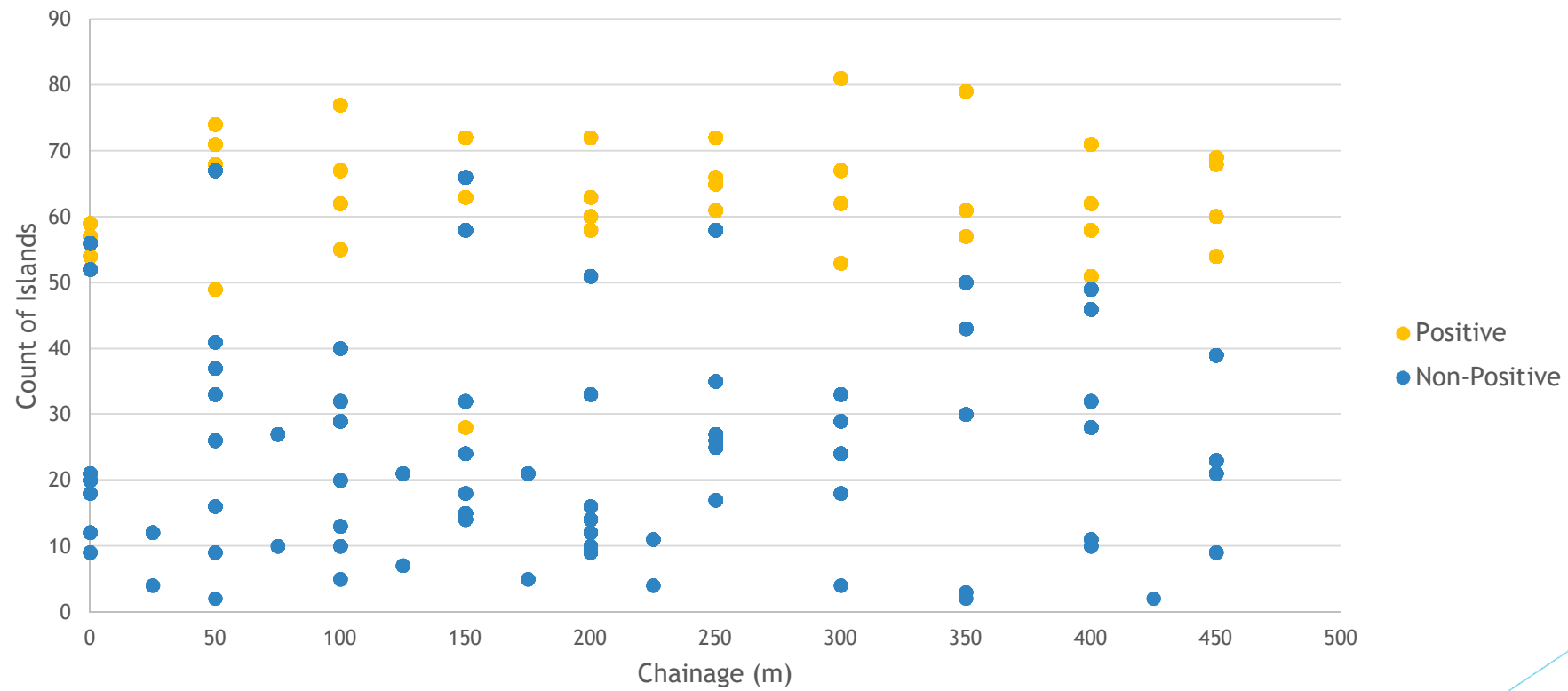
## Non-Positive HRA



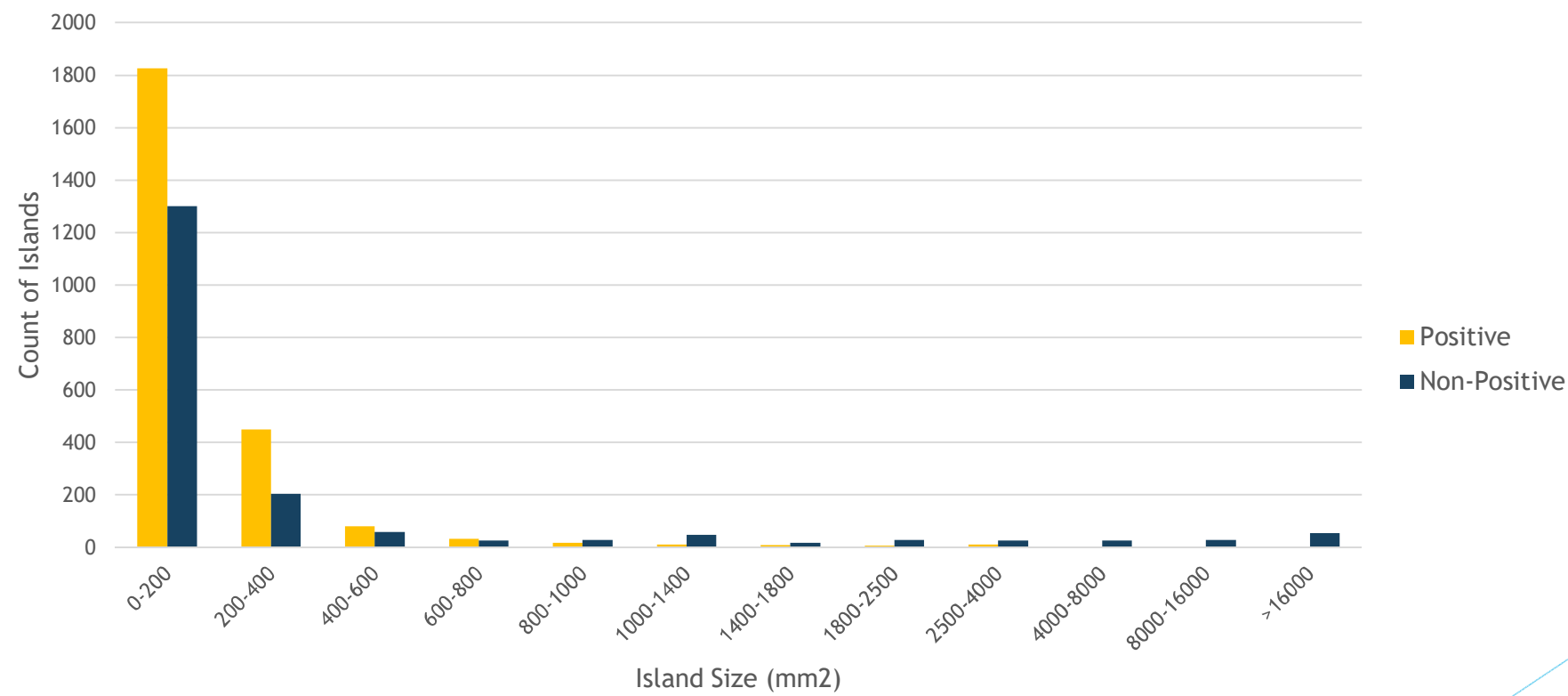
Number of islands	3			
Threshold	2.00	mm		
Parameters	Unit	Grain #1	Grain #2	...
Area	mm <sup>2</sup>	44119	61.0	...
Volume	mm <sup>3</sup>	54280	44.7	...
Max height	mm	2.00	1.30	...
Height/Surface ratio	mm/mm <sup>2</sup>	4.53e-05	0.0213	...



# Number of Islands



# Island Size Distribution





# Count50 Definition

For a given test location, Count50 for that location is the minimum number of islands (N) such that

$$\sum_{i=1}^N \frac{Area(i)}{Total\ Island\ Area} \times 100 \geq 50\%$$

where Area(1) = area of largest Island, Area(2) = area of second largest island...area(N) = area of N<sup>th</sup> largest island, i.e. Count50 is the minimum number of islands require to make up at least 50% of the total island area for a given test location.

# Count50 Examples

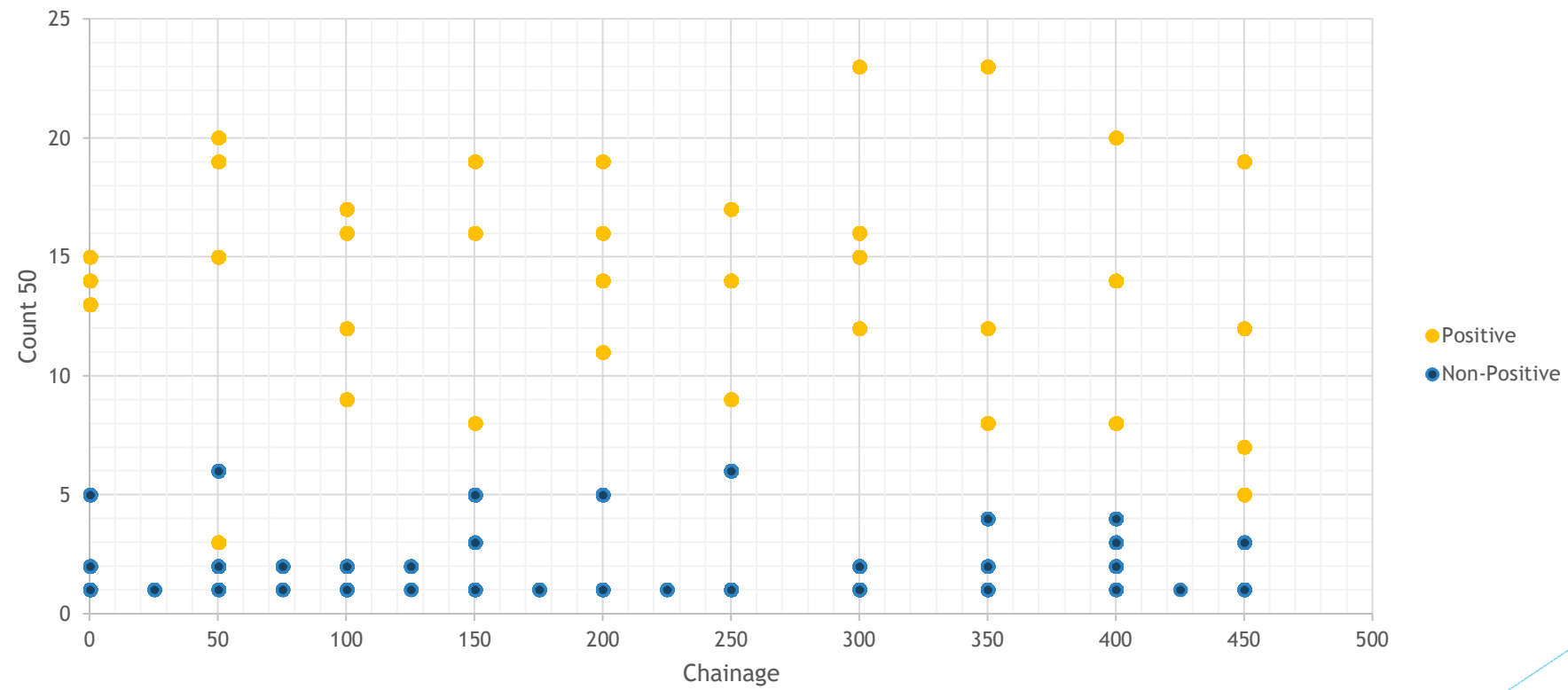
	Island Area	Running Total
1	30070	30070
2	2073	32144
3	1702	33846
4	249	34095
5	174	34268
6	168	34436
7	156	34593
8	152	34745
9	143	34888
10	140	35028
11	124	35152
12	97	35249
13	79	35328
14	69	35396
15	66	35462
16	56	35518
17	54	35572
18	52	35625
Total	35625	
50%	17812	

	Island Area	Running Total
1	712	712
2	558	1269
3	309	1579
4	265	1843
5	256	2100
6	219	2319
7	216	2534
8	214	2748
9	193	2941
10	178	3119
11	158	3277
12	146	3423
13	145	3568
...	...	...
...	...	...
50	51	6847
51	51	6898
52	50	6948
Total	6948	
50%	3474	

	Island Area	Running Total
1	592	592
2	456	1048
3	350	1398
4	323	1721
5	302	2023
6	267	2289
7	266	2555
8	263	2819
9	261	3080
10	245	3324
11	243	3567
12	240	3807
13	215	4022
14	207	4230
15	206	4436
16	199	4634
17	192	4827
18	184	5011
19	170	5181
20	160	5341
...	...	...
...	...	...
...	...	...
71	50	10163
72	50	10213
Total	10213	
50%	5107	



# Count50 Results



# Use in TII Specifications

