The background of the slide features a large, semi-transparent seal of the Alabama Department of Forensic Sciences. The seal is circular and contains a map of Alabama with various rivers labeled, including the Mississippi, Alabama, and Tennessee. The text "ALABAMA DEPARTMENT OF FORENSIC SCIENCES" is written around the perimeter of the seal, and there are stars on the left and right sides.

PRELIMINARY INVESTIGATION OF SCIENCE GL'S 3D COMPARATOR SOFTWARE TO PROVIDE OBJECTIVE FIREARMS AND TOOL MARK DATA

Derrick S. McClarin, M.S.F.S.
Alabama Department of Forensic Sciences
AFTE 2010 Annual Conference
5/3/2010

Preface

- National Academy of Sciences (NAS) Report "**Strengthening Forensic Science in the United States: A Path Forward**"
 - Subjectivity
 - Bias
 - Lack of Statistical Data
 - Scientific Validity not established

Preface

Alabama Department of Forensic Sciences (ADFS) response to report

- ADFS is the second oldest crime laboratory in the nation (established in 1935)
- 10 labs throughout the state of Alabama, 3 of which have the Firearms and Tool Marks discipline (Birmingham, Mobile, Montgomery)

Preface

ADFS response to report (cont.)

- Independent State Agency (services are provided to both law enforcement and defense entities)
- Accredited in 2003 (ASCLD/LAB)
 - Re-accredited in 2008
- Working toward ISO 17025 Accreditation
- ADFS prides itself in Quality Assurance
 - 100% Verification

Preface

ADFS response to report (cont.)

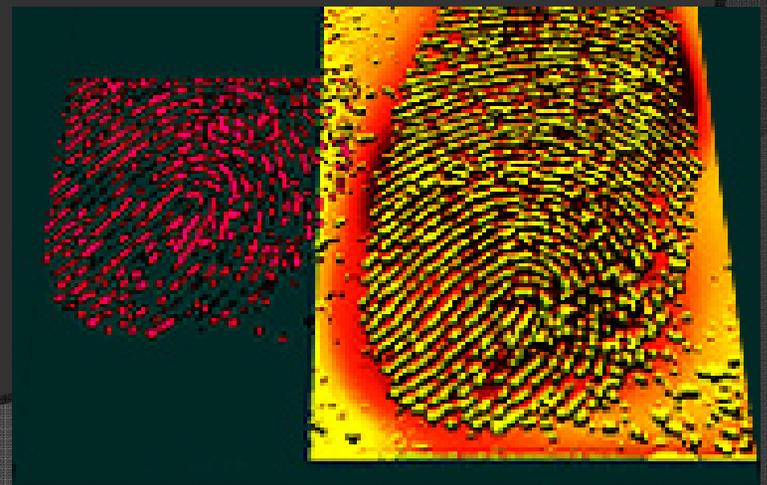
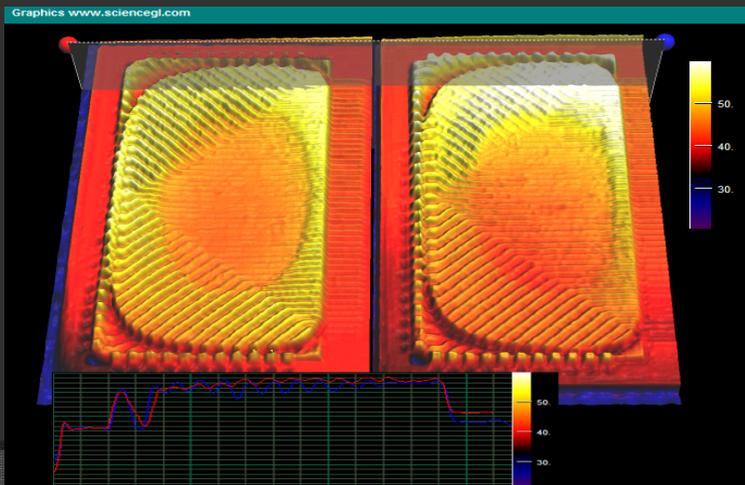
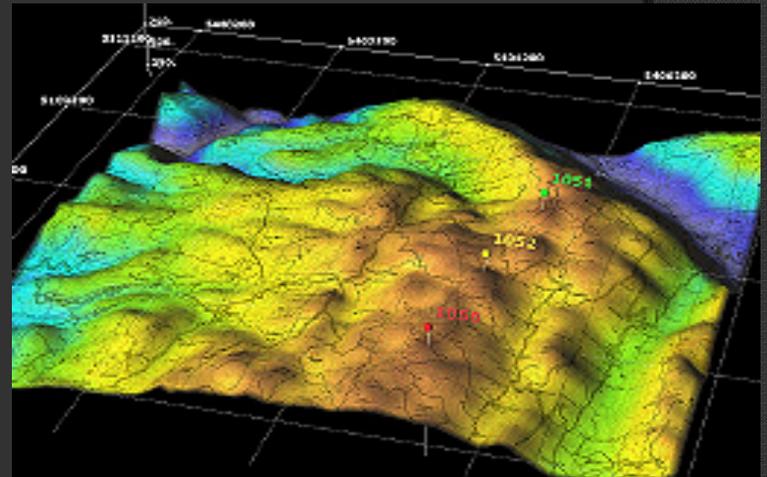
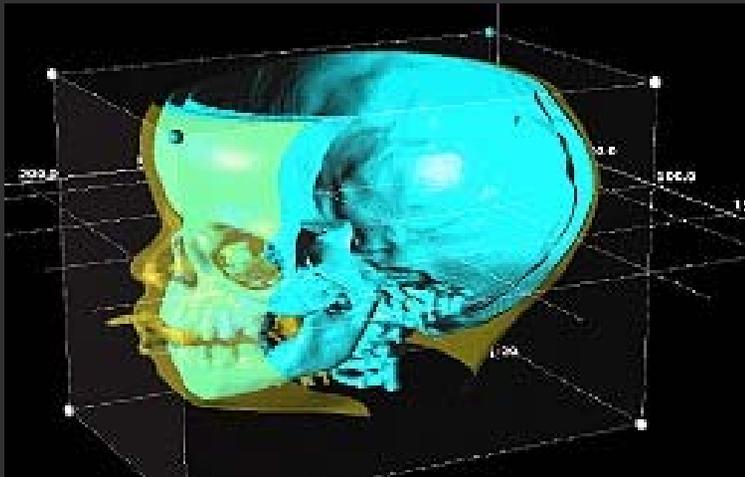
- Methods/Procedures meet or exceed national guidelines and standards (adheres to guidelines set forth by the Scientific Working Groups such as SWGGUN)
- Standard procedures and reporting terminology adopted throughout the ADFS FA/TM discipline
- **“ADFS looks forward to working with the federal government and other professional organizations towards fulfilling the mandate of this report.”**

My Background

- ◎ B.S. Chemistry-Lambuth University (2000)
- ◎ M.S. Forensic Sciences-UAB (2003)
- ◎ 7 years experience as a Forensic Scientist with ADFS
- ◎ Strong instrumental background (ELISA, GC/MS, GC/FID, UV Spectrophotometer, etc.)

Cont.

- ① One of the responsibilities that I have in the Firearms and Tool Marks discipline is to research new or existing technologies that may be beneficial.
- ① I have taken on the task of evaluating both hardware and software available for topographical analysis.



“Finding” Science GL

- Signed up with GlobalSpec [engineering search engine]
- Looking at various software technologies and clicked on a link for Science GL
- Mr. Alex Onik (Science GL) called a few days later and explained the capabilities of their software.

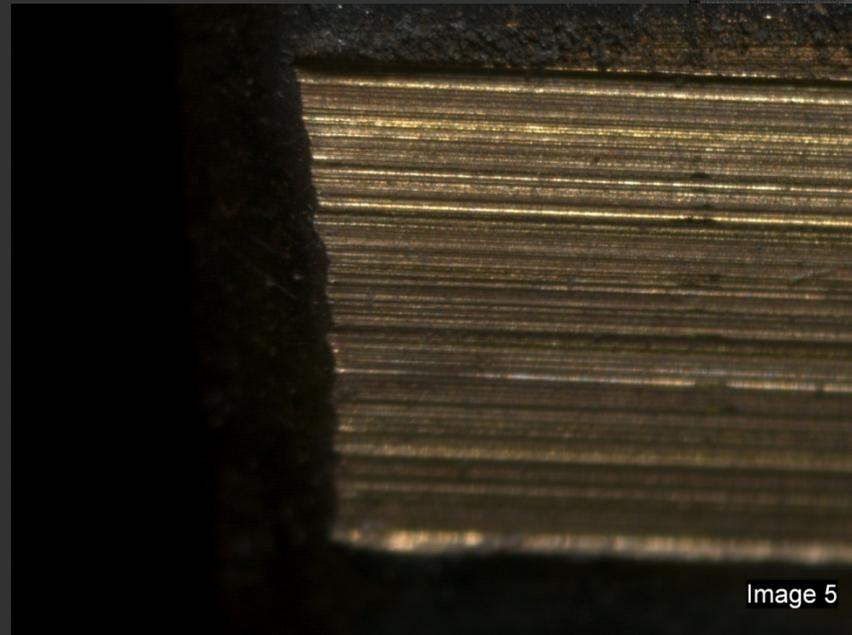
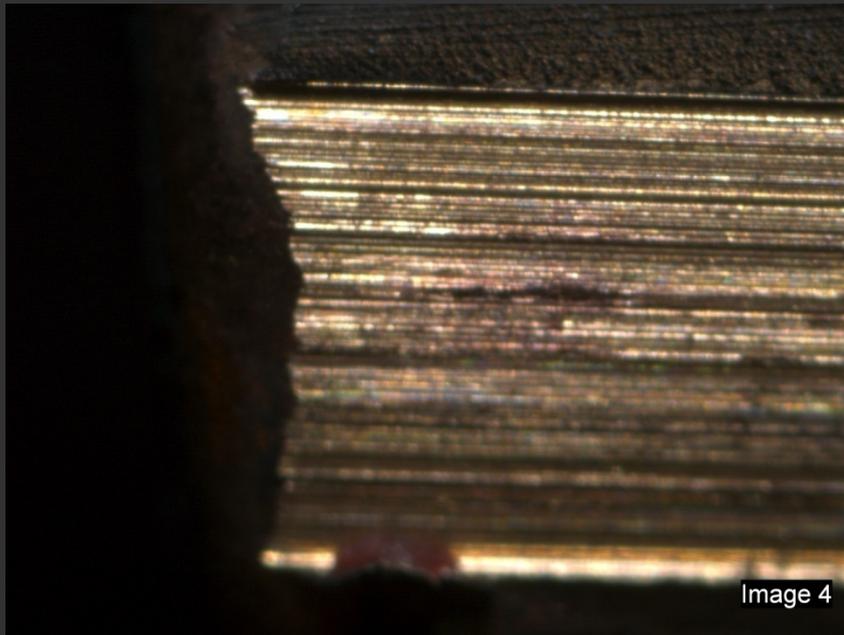
Images



Images

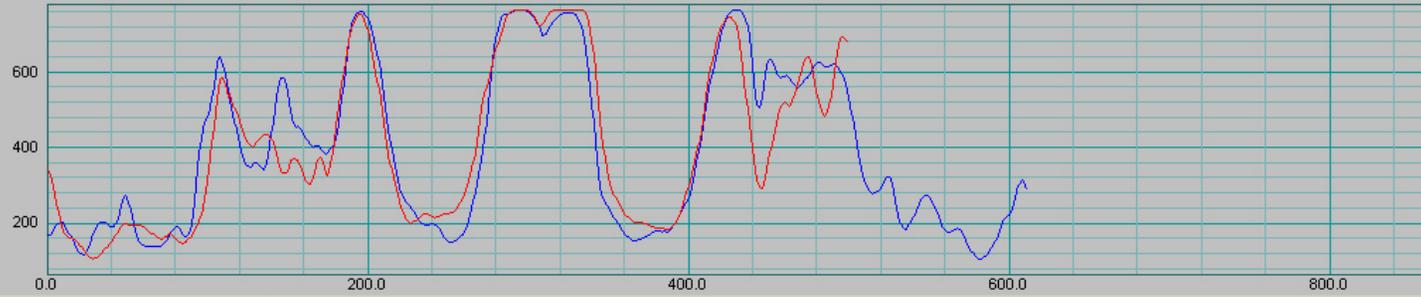


Images

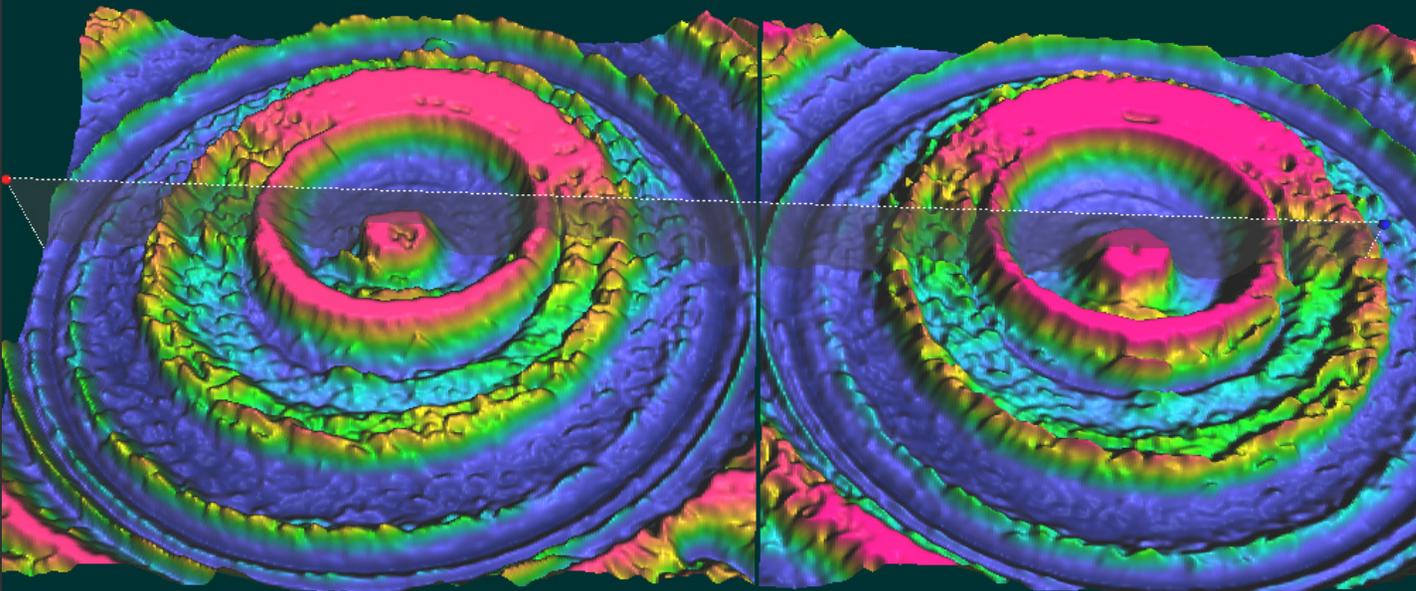


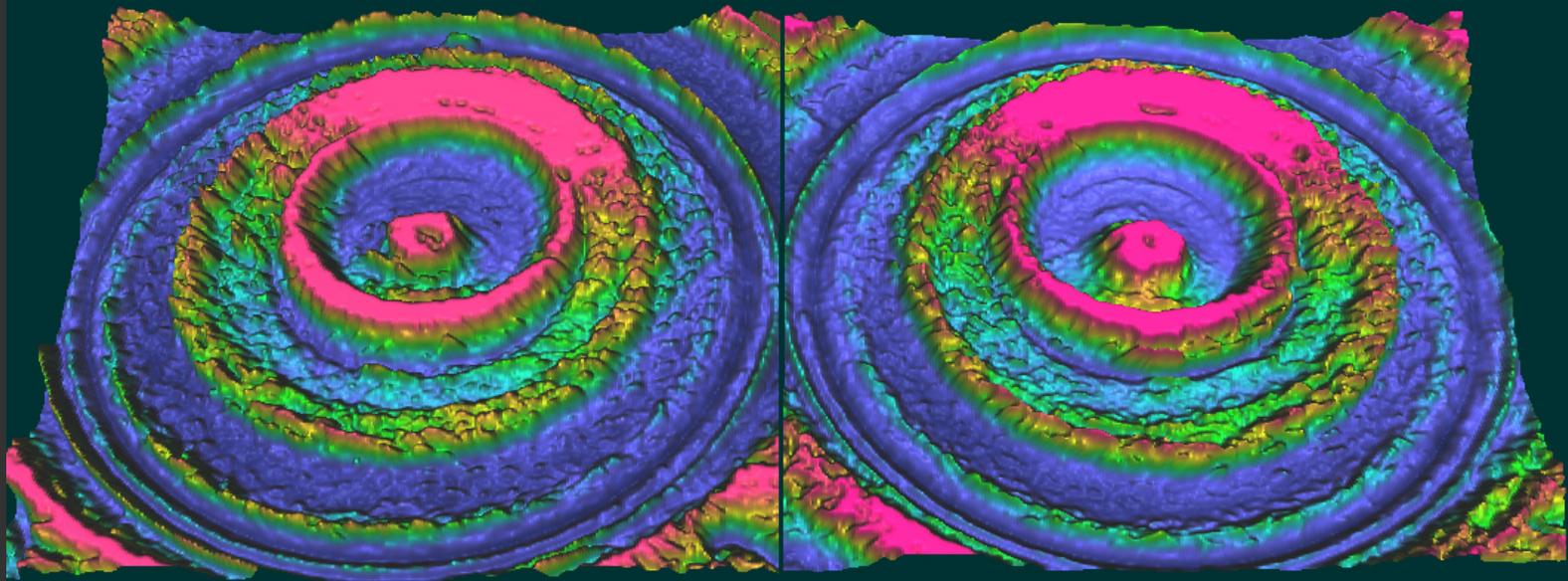
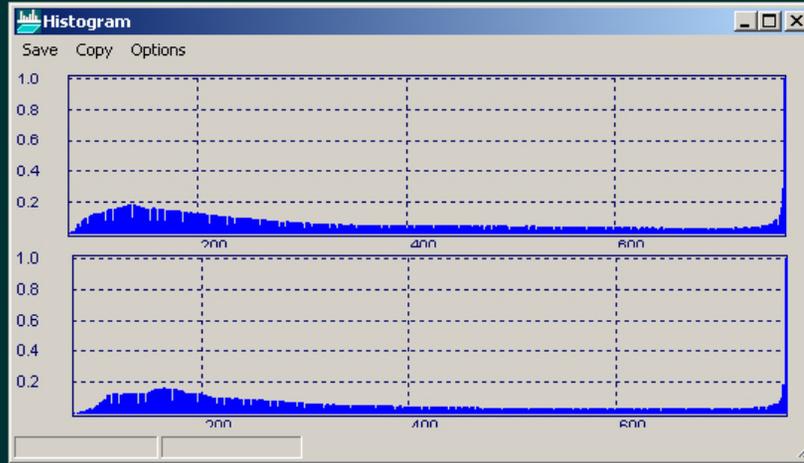
2D cut View

Copy Options Zoom+ Zoom--



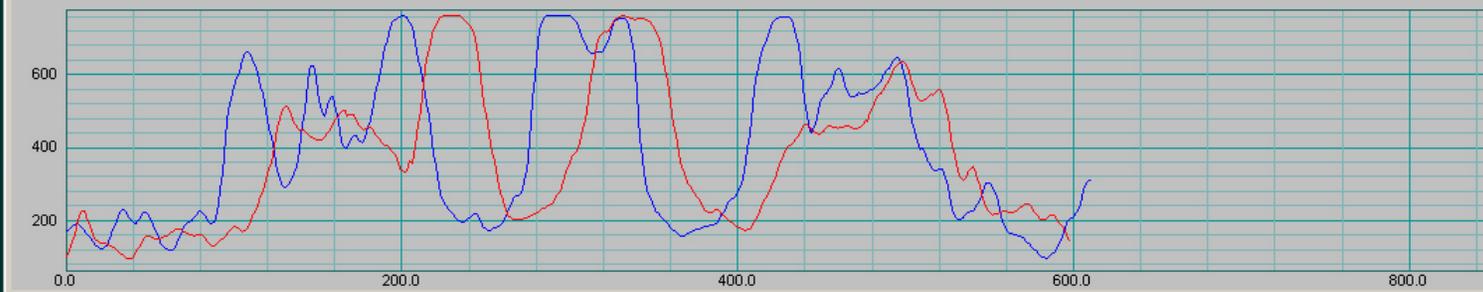
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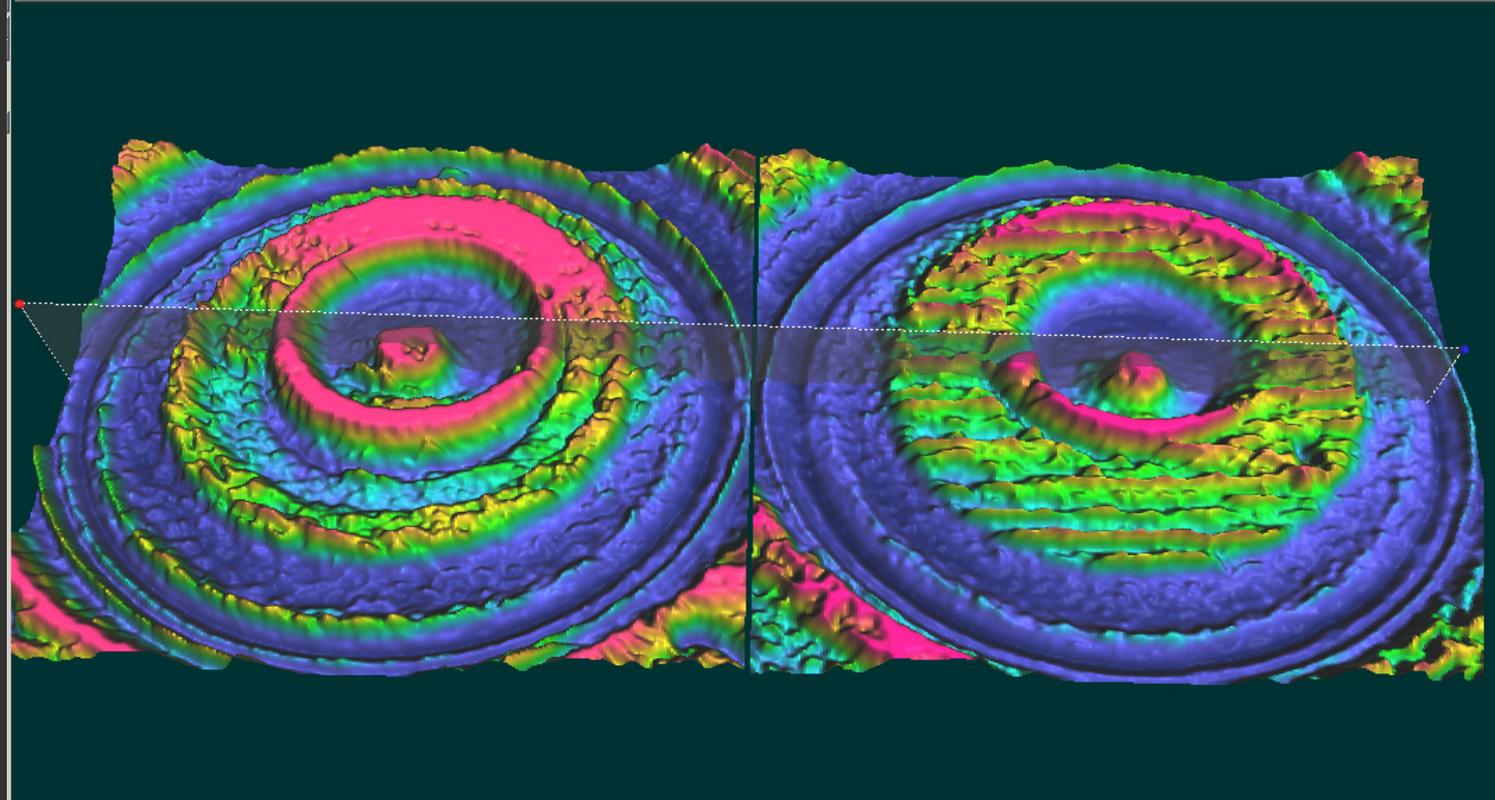


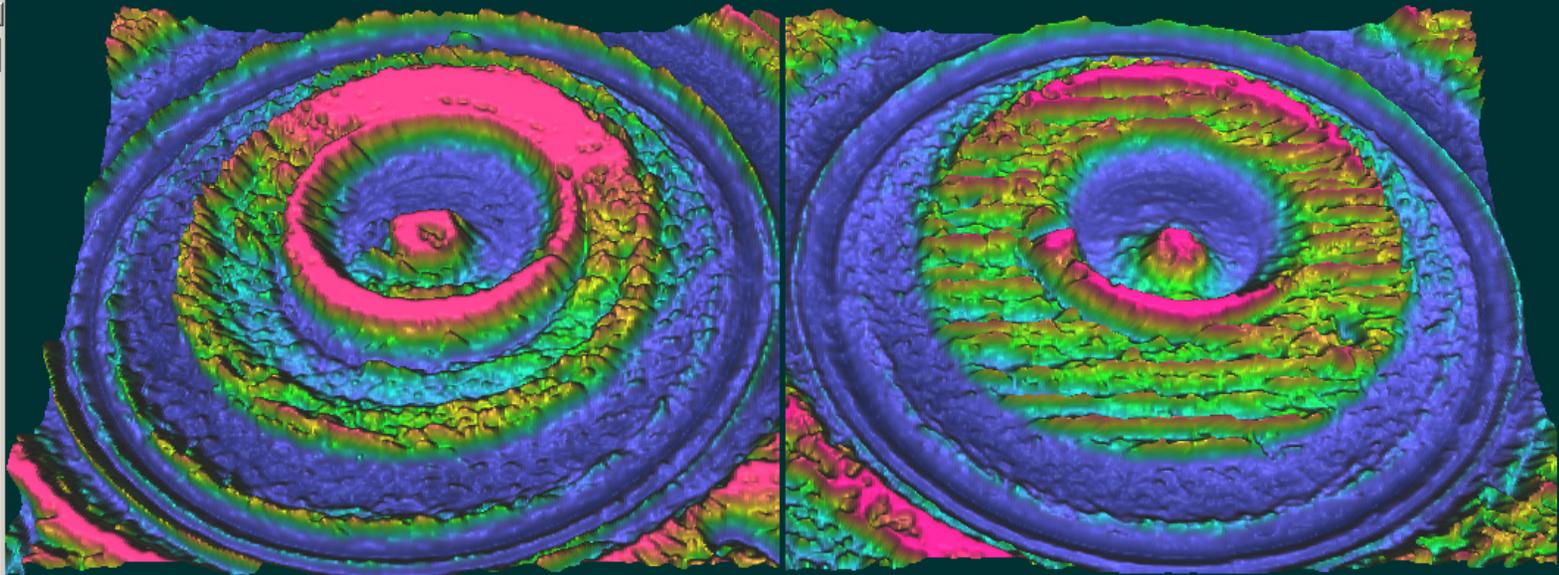
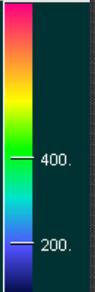
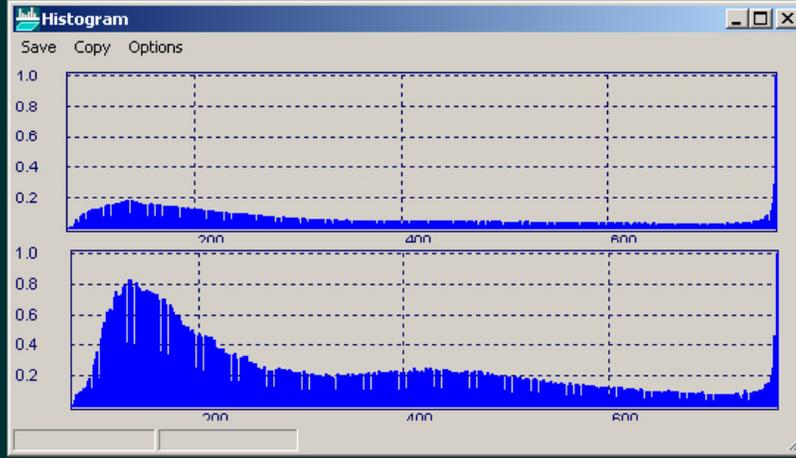
2D cut View

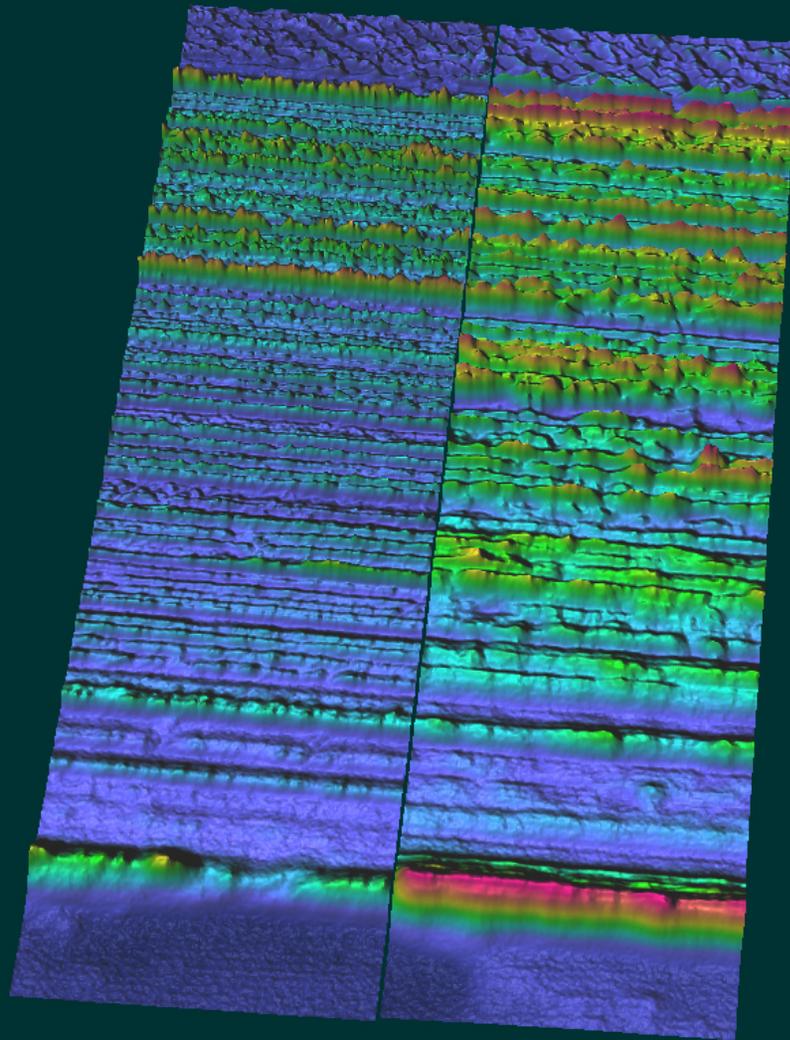
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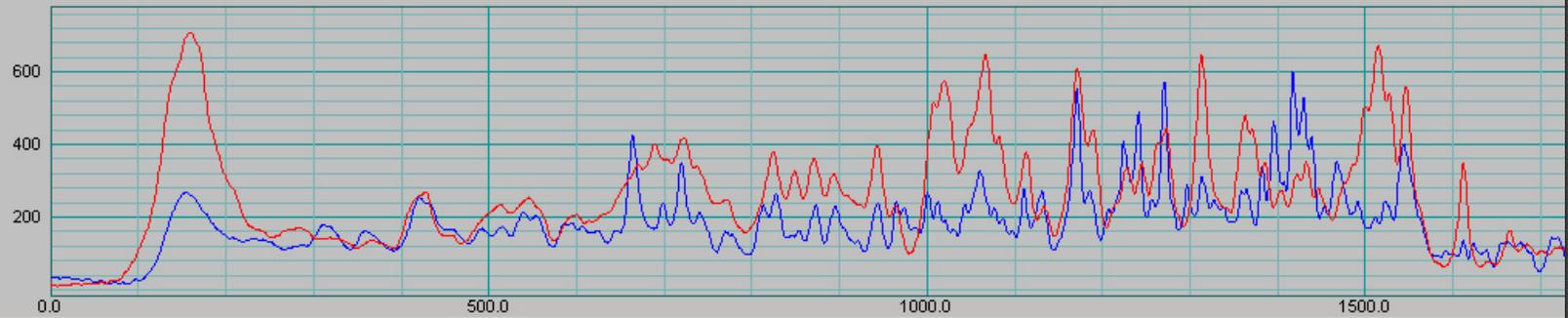




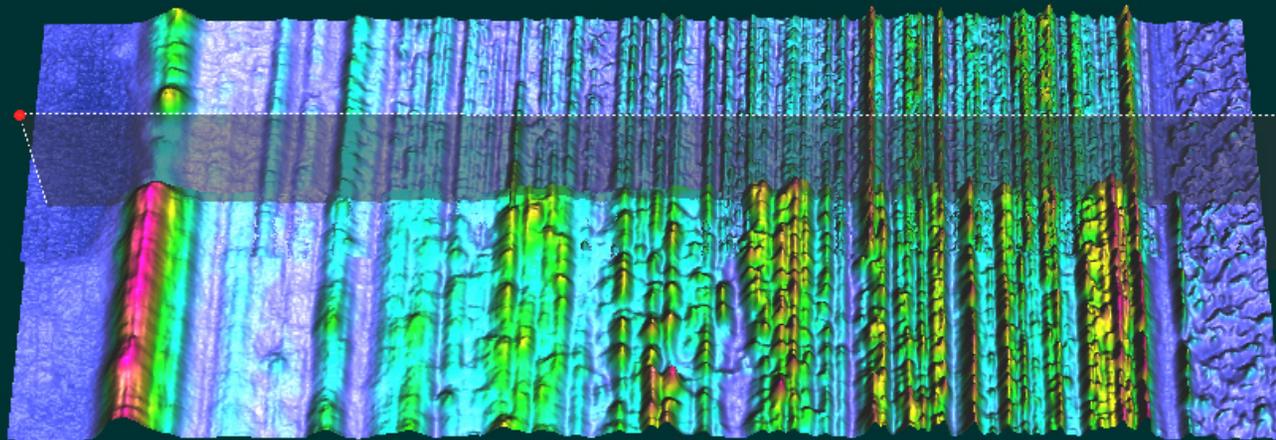


2D cut View

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Fit not active Marker dist

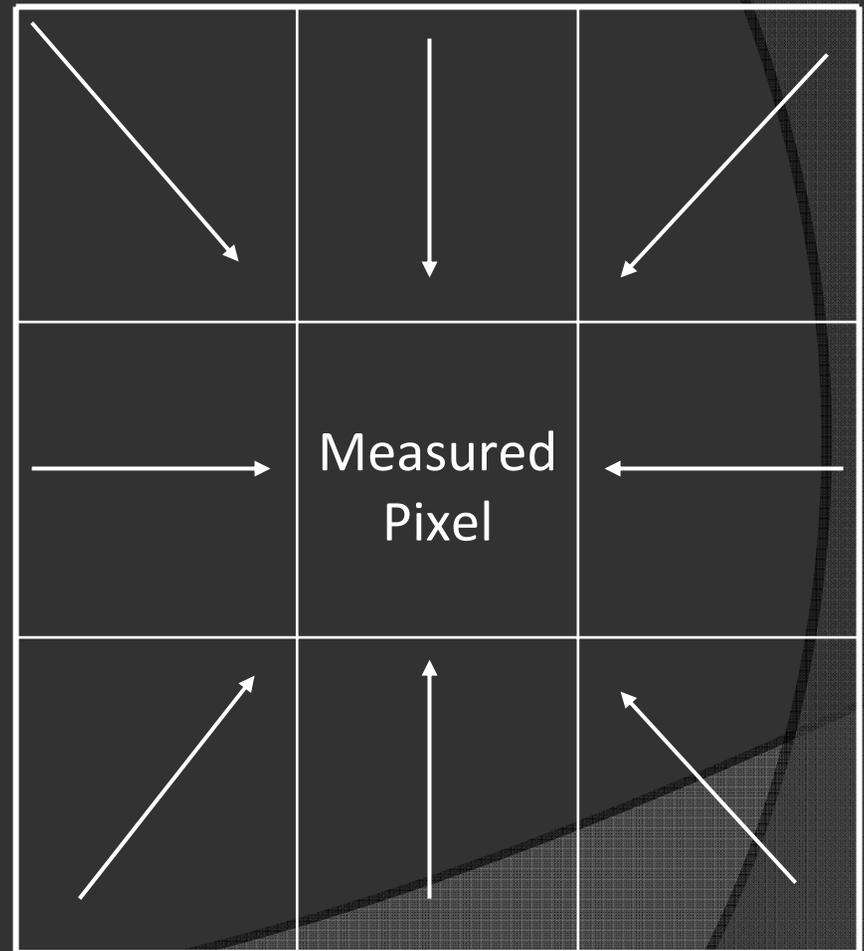


Trial Software

- This initial data piqued the interest of our Department and prompted further investigation
- I obtained a trial software package which gave me the ability to upload my own images
- Training was minimal
- Didn't have a fully functional software

2D→3D Rendering

- This software approximates the height present in each pixel of an image by looking at the inclination of the light. In effect, it is looking at a single pixel and maps this pixel according to the light reflectance in the 8 pixels that surround it



2D→3D Comparison

- Science GL explained that it is imperative to maintain the same lighting conditions for both samples so that a comparison can be made.
- Focus should also be constant between the two images.

Images

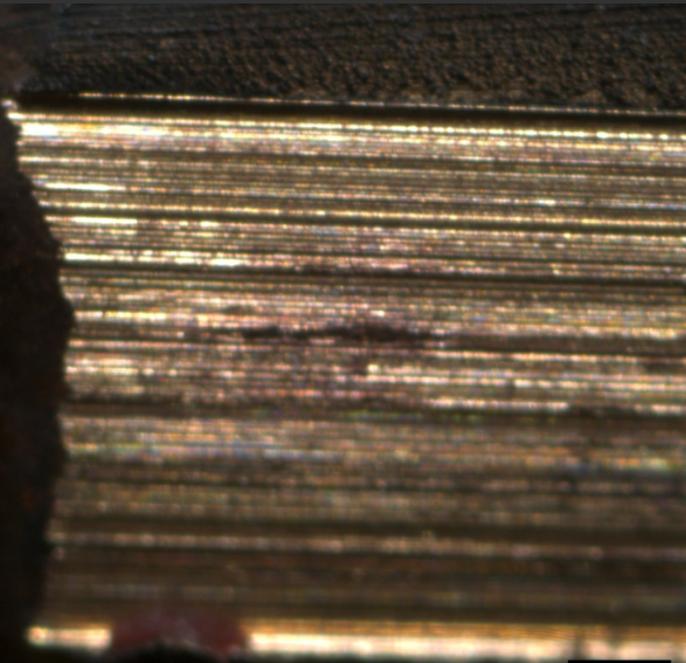


Image 4

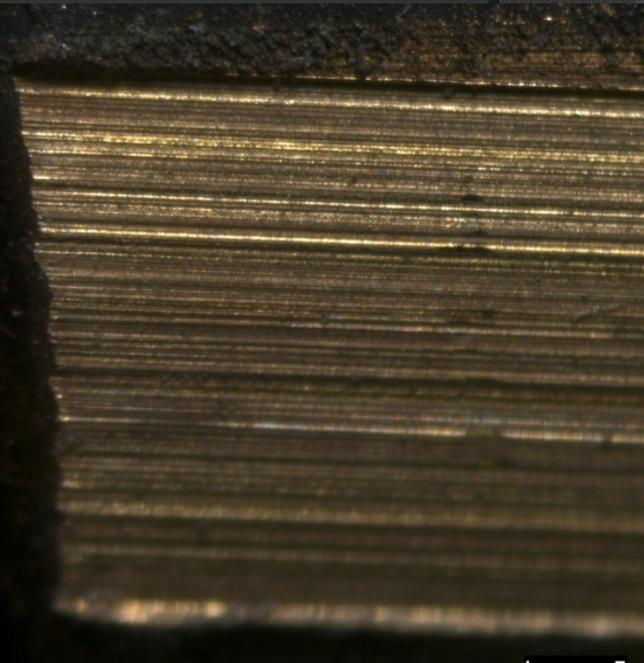
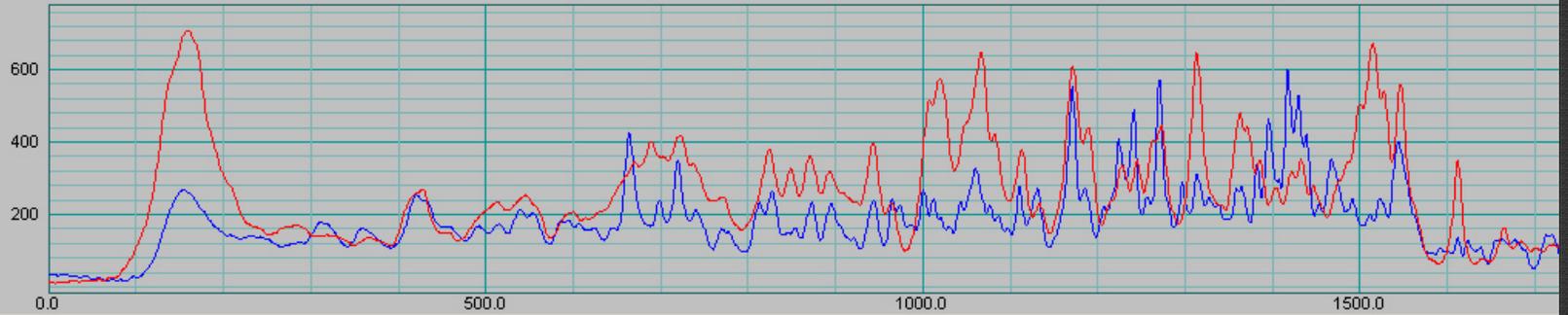


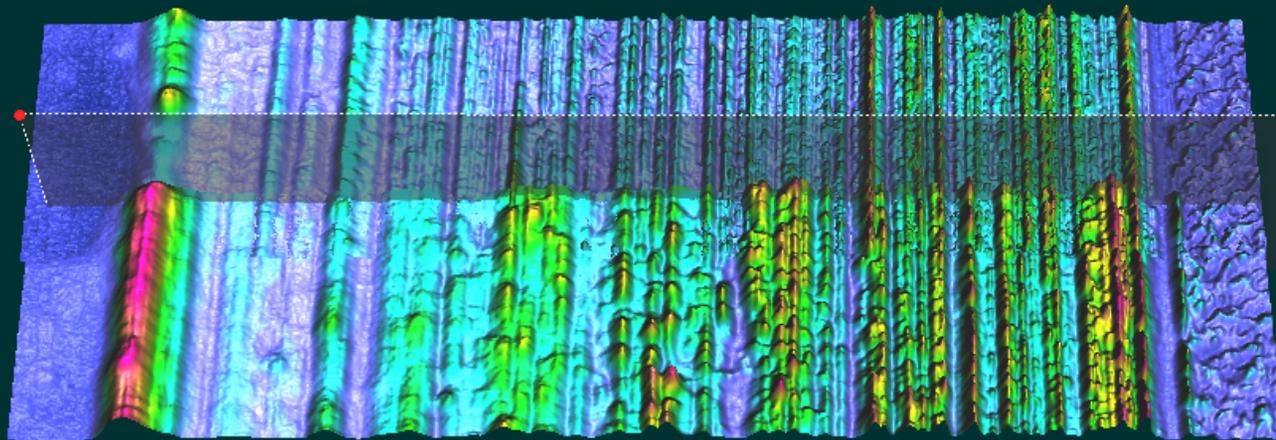
Image 5

2D cut View

Copy Options Zoom+ Zoom--



Fit not active Marker dist

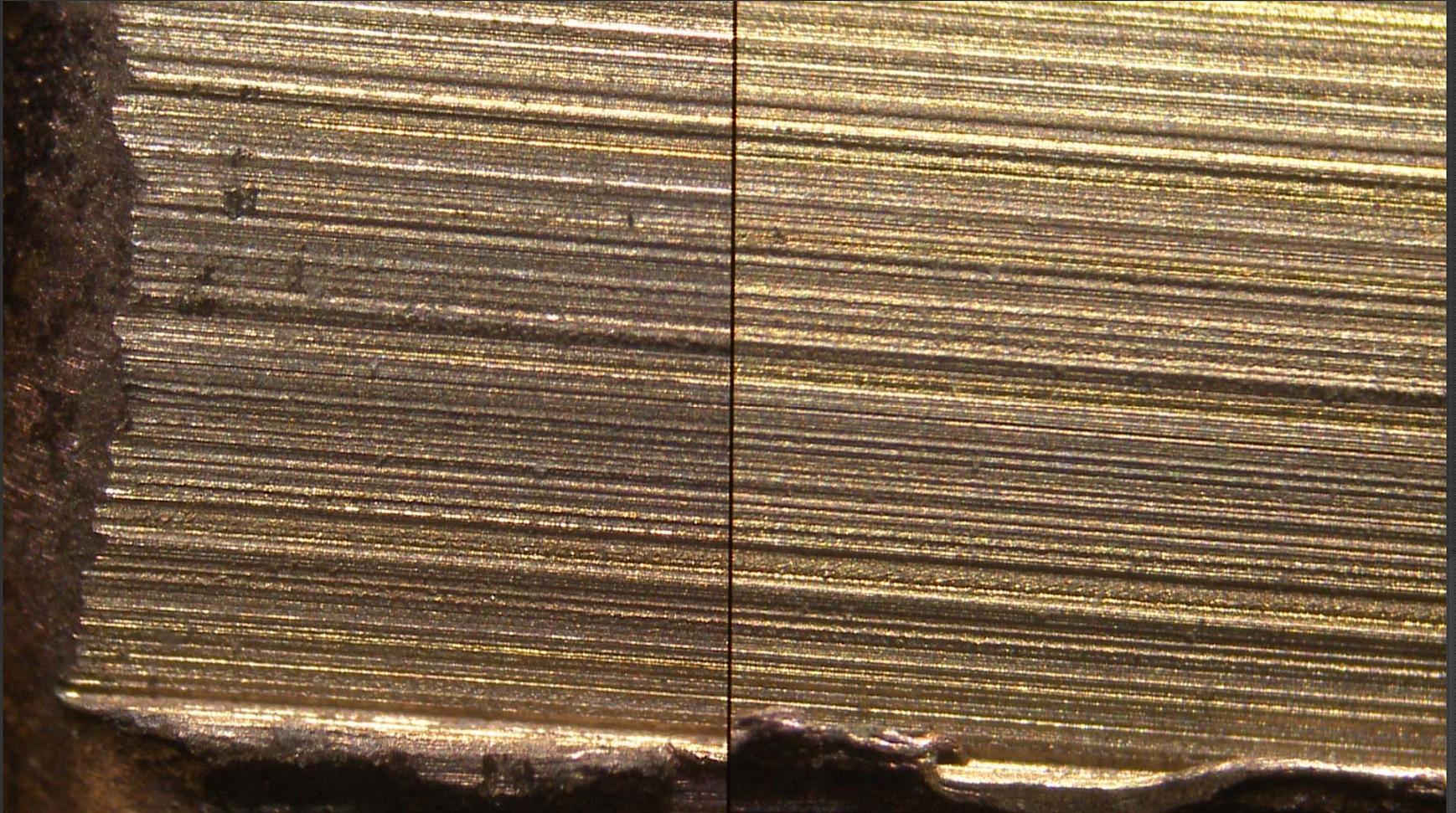


2D→3D (cont.)

- When looking at 2D images, this software is purely enhancement of each pixel with more detail than the human eye can pick up.
- This “pseudo” 3D image can be manipulated and evaluated in the Science GL’s 3D space

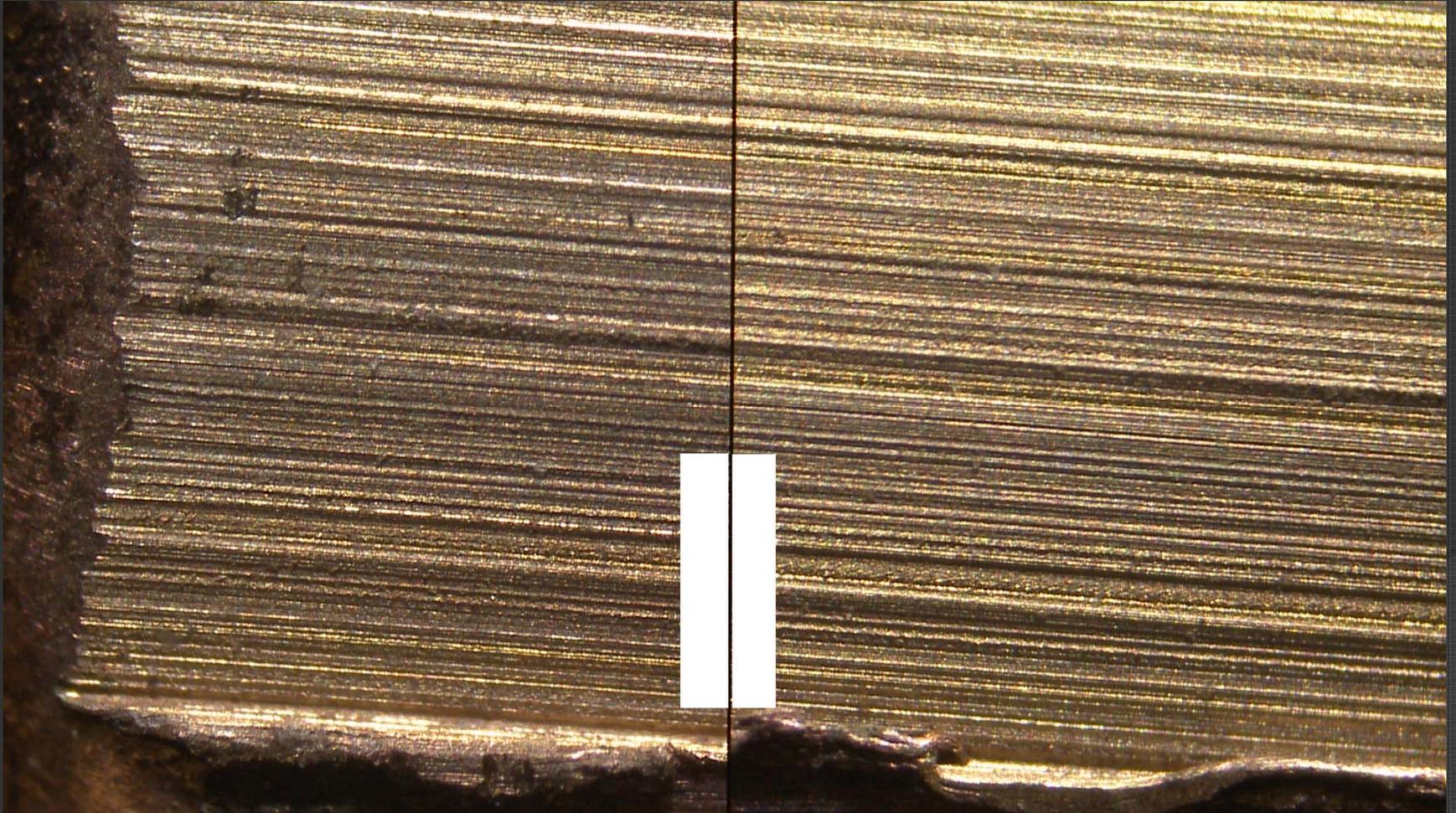
Examples

Region (Area) of Interest



Examples

Region (Area) of Interest

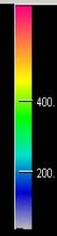
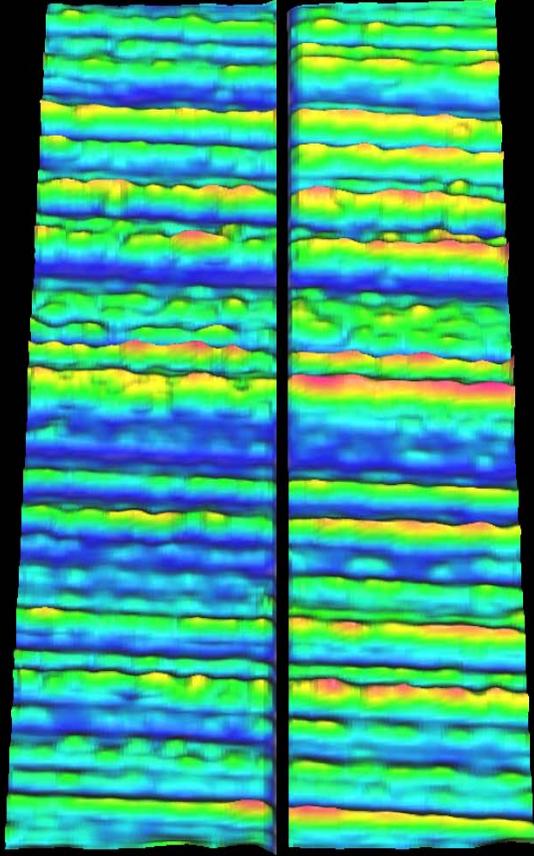


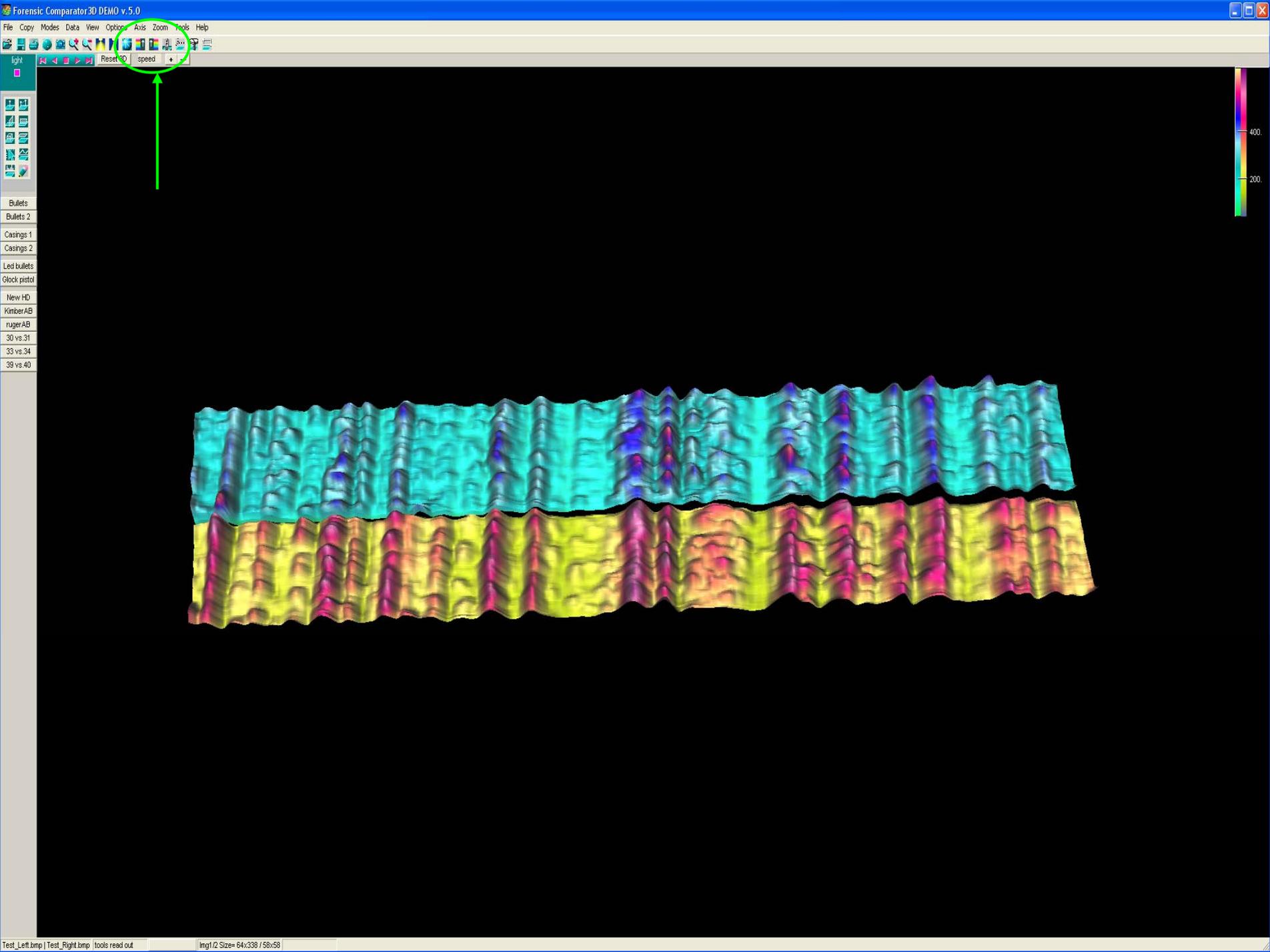


light [Reset 3D] speed + -

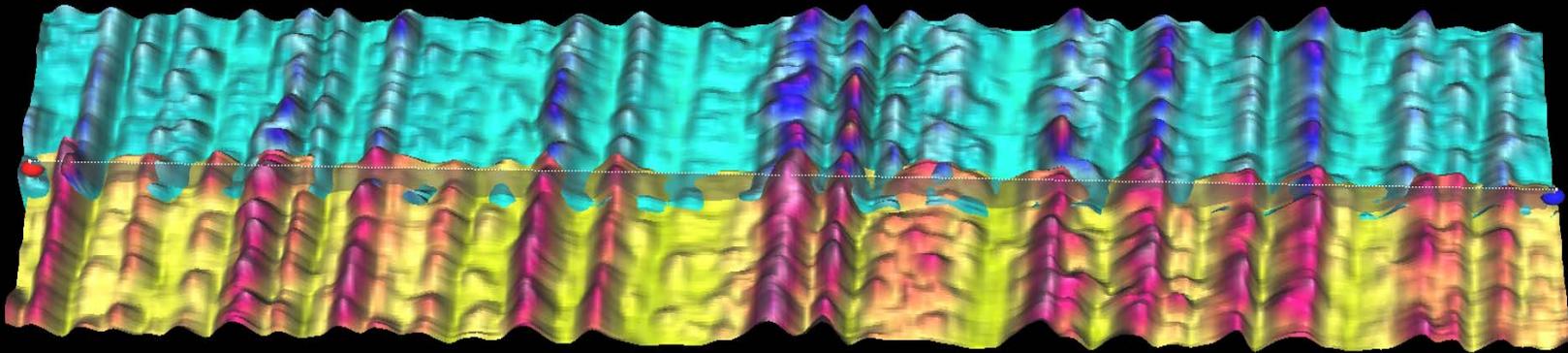


- Bullets
- Bullets 2
- Casings 1
- Casings 2
- Lead bullets
- Glock pistol
- New HD
- Kimber AB
- ruger AB
- 30 vs 31
- 33 vs 34
- 39 vs 40



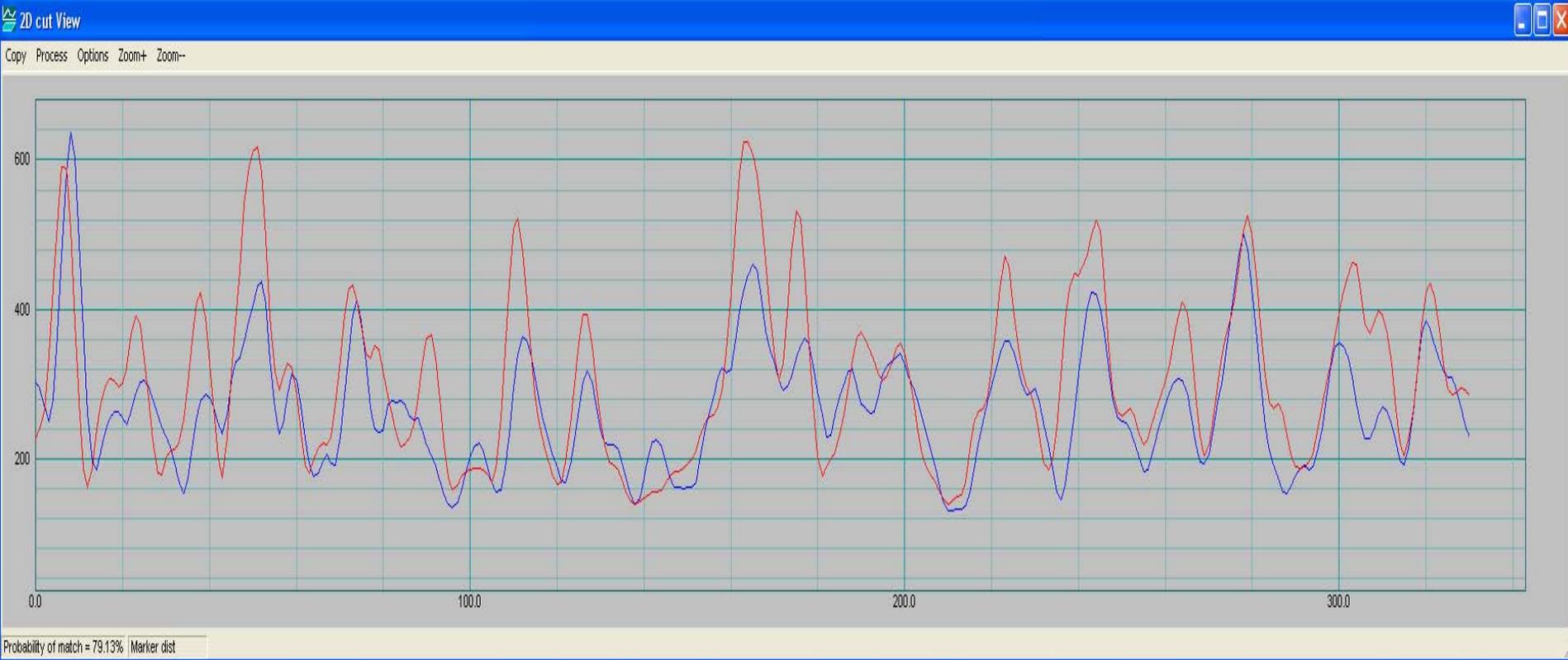


- light
- Bullets
- Bullets 2
- Casings 1
- Casings 2
- Led bullets
- Glock pistol
- New HD
- Kimber AB
- ruger AB
- 30 vs. 31
- 33 vs. 34
- 39 vs. 40



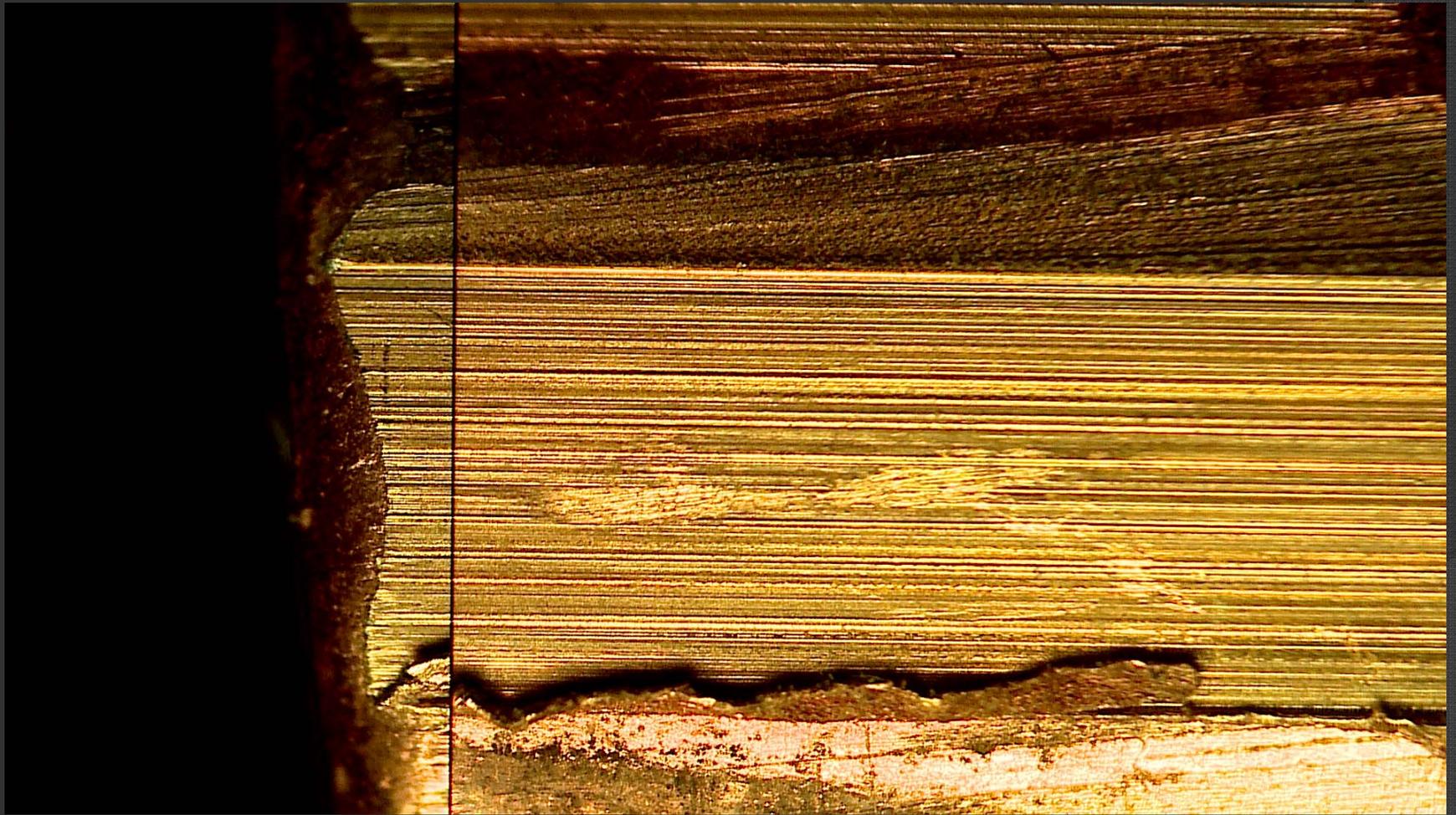
Comparison

Region of Interest

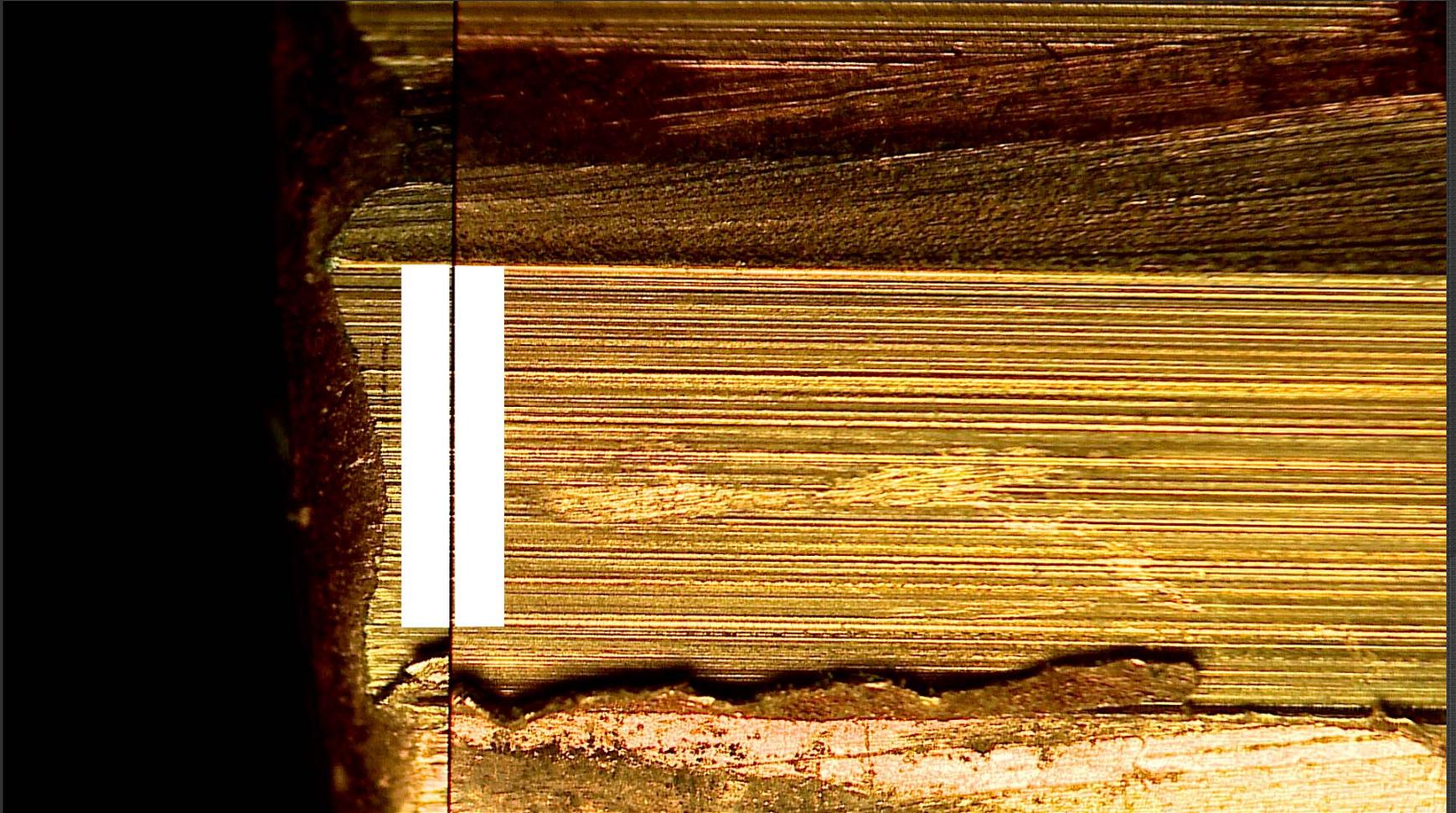


79.13%

Examples

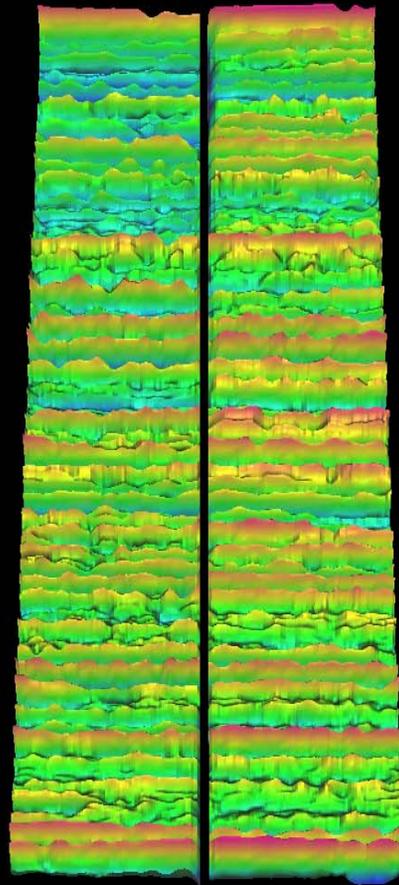


Examples





- Bullets 2
- Casings 1
- Casings 2
- Lead bullets
- Glock pistol
- New HD
- Kimber AB
- ruger AB
- 30 vs 31
- 33 vs 34
- 39 vs 40
- csv1
- csv2
- csv3

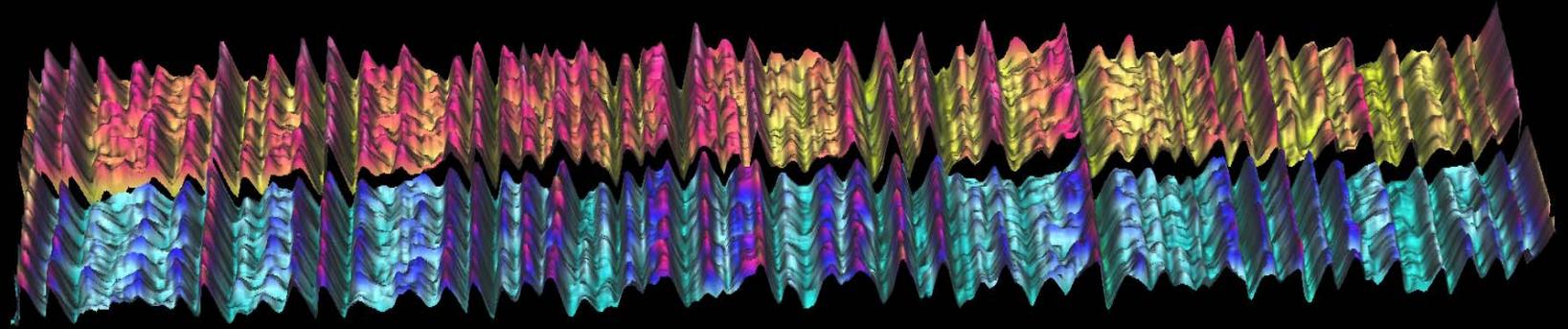




light
Reset 3D speed + -



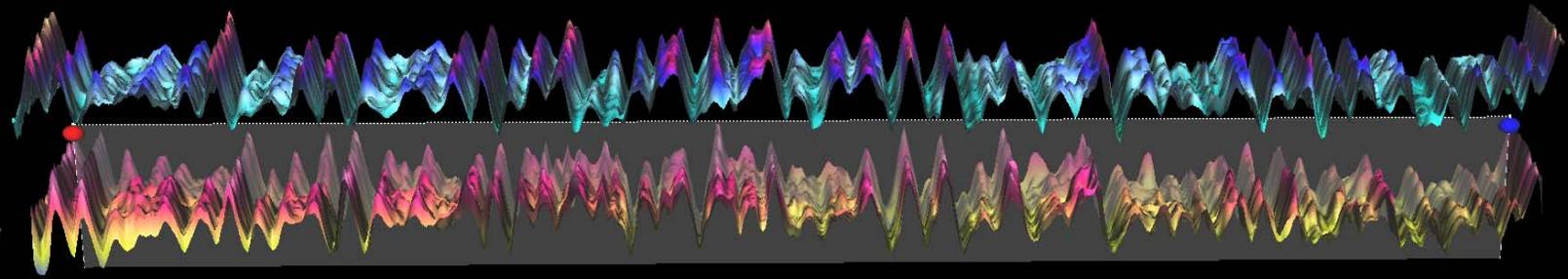
- Bullets 2
- Casings 1
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- New HD
- KimberAB
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- 30 vs 31
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- 39 vs 40
- csv1
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- csv3





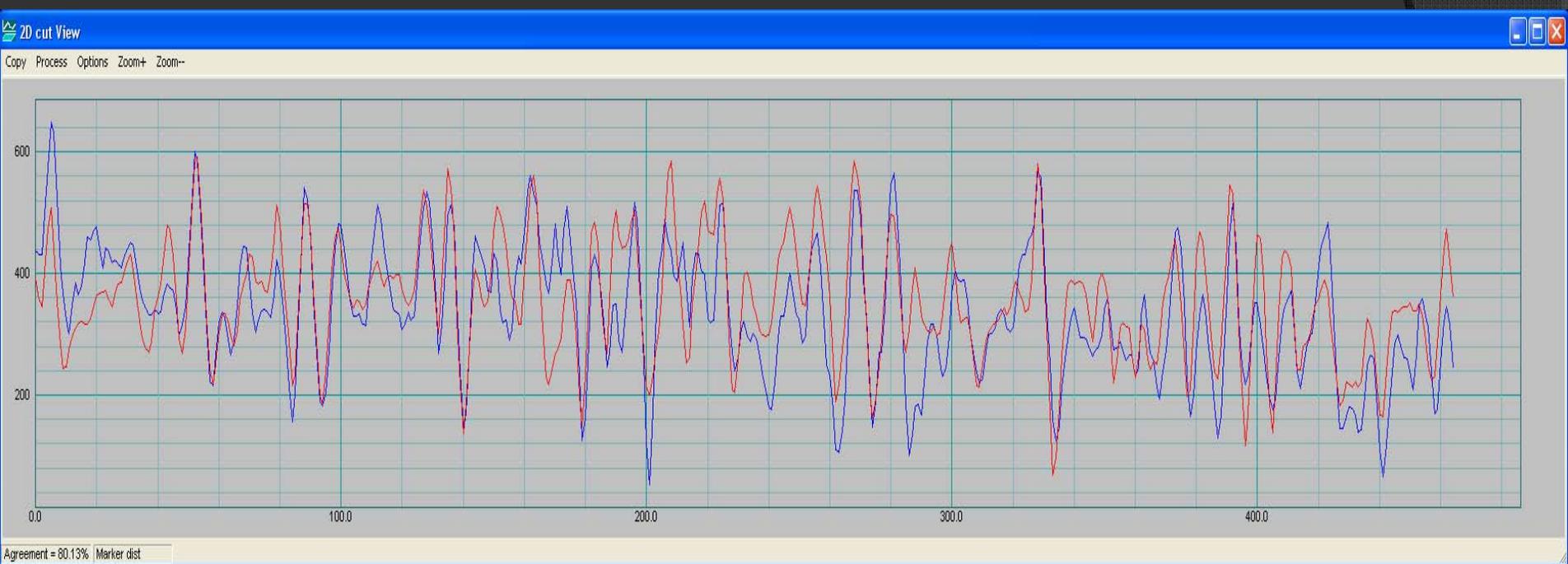
light
Reset 3D speed

- Bullets 2
- Casings 1
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- New HD
- KimberAB
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- 30 vs 31
- 33 vs 34
- 39 vs 40
- csv1
- csv2
- csv3



Comparison

Full Land Impression



80.13%

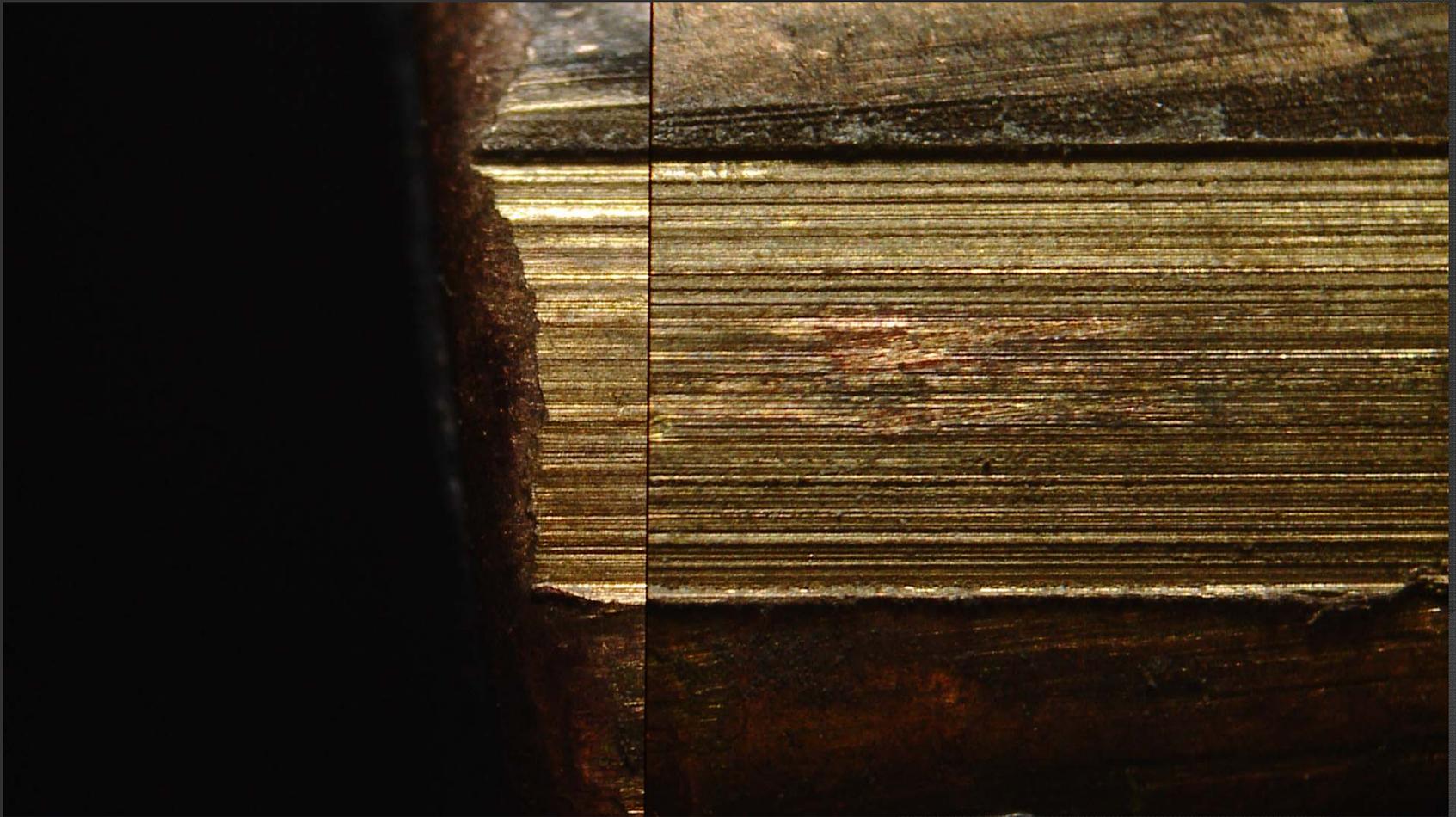
Agreement Calculation

$$\textcircled{\underline{X}} = \sqrt{(\sum((Y1-Y2)^2 / N_{\text{fit}}))}$$

- Where X is the agreement, $Y1$ and $Y2$ are the amplitudes of the respective curves, and N_{fit} is the number of points being evaluated in the line.

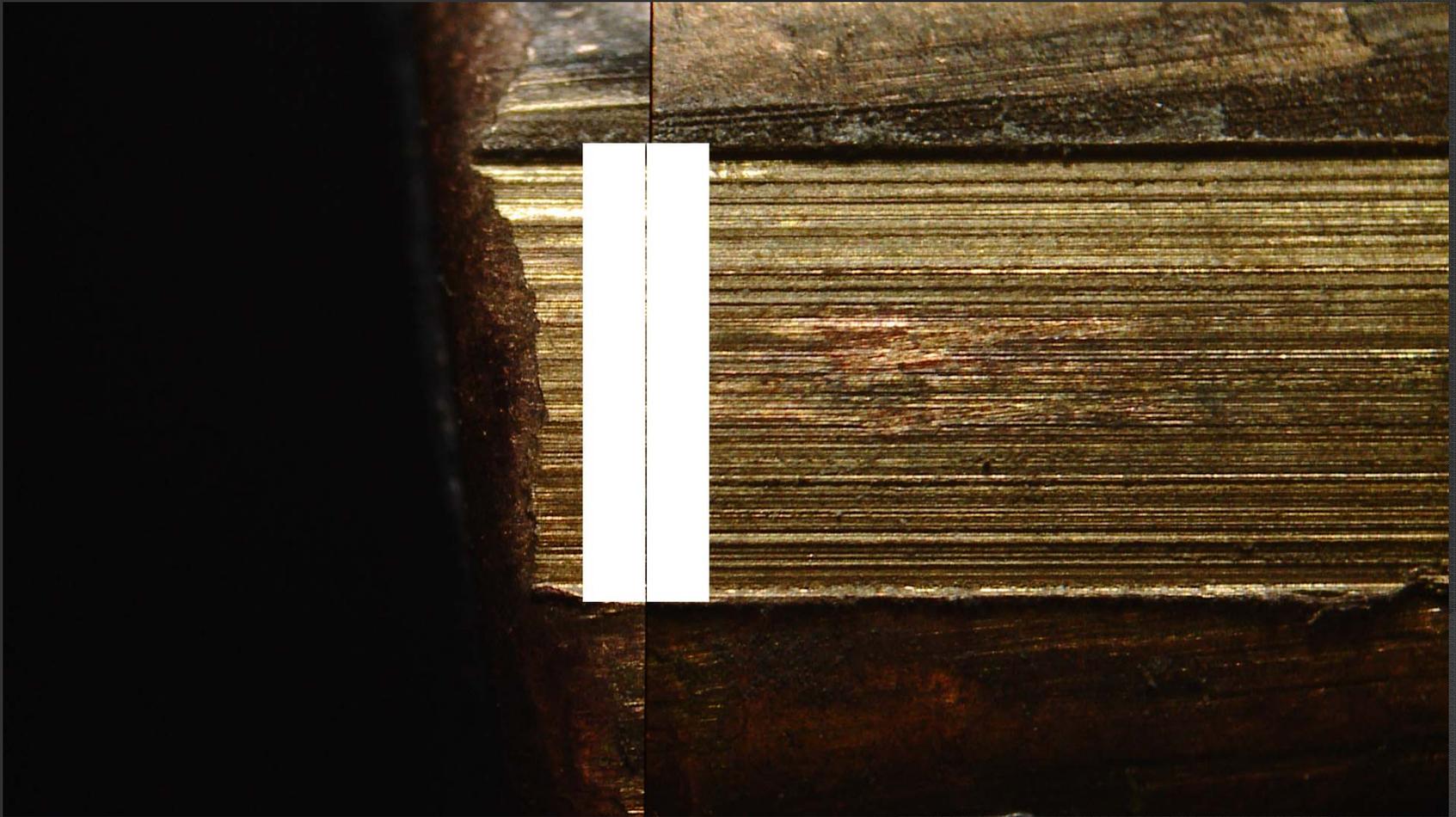
Examples

(Non-match)



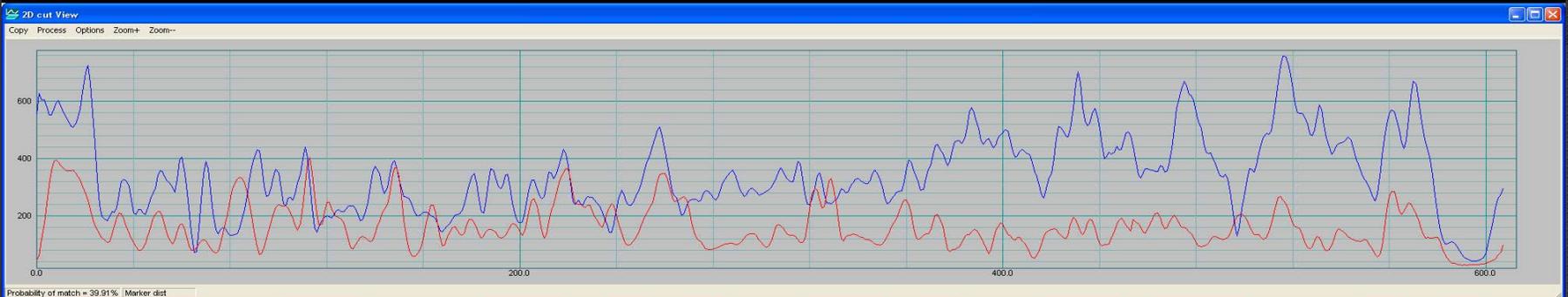
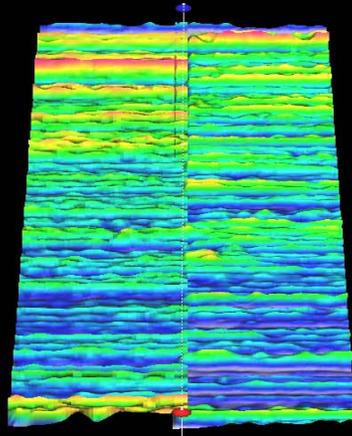
Examples

(Non-match)



Examples

(Non-match)



39.91%

Subjectivity/Objectivity

- Even though this is giving an objective value on the agreement, the lining up of the two images can still be considered subjective
- Currently working with Science GL to make the software more pertinent to the Firearms discipline
 - Creating an auto fit function that would put the two images together at the point at which the agreement is best (this would increase the objectivity of the calculation).

Practicality

- Must be understood that this is a 3D rendering and not true 3D
- Hypothesized that objective acceptance criteria may be achieved by looking at test to test values
- 2D analysis is still under investigation due to limited number of analyzed samples

Disadvantages

- ⦿ Lighting (and focus) plays a huge role in data acquisition.
 - 10 consecutive sample images with the same lighting (93-96%) vs. sample images acquired using different lighting (68-87%).
 - Fluorescent lighting, LED lighting, Co-axial lighting
- ⦿ 3D Rendering not True 3D

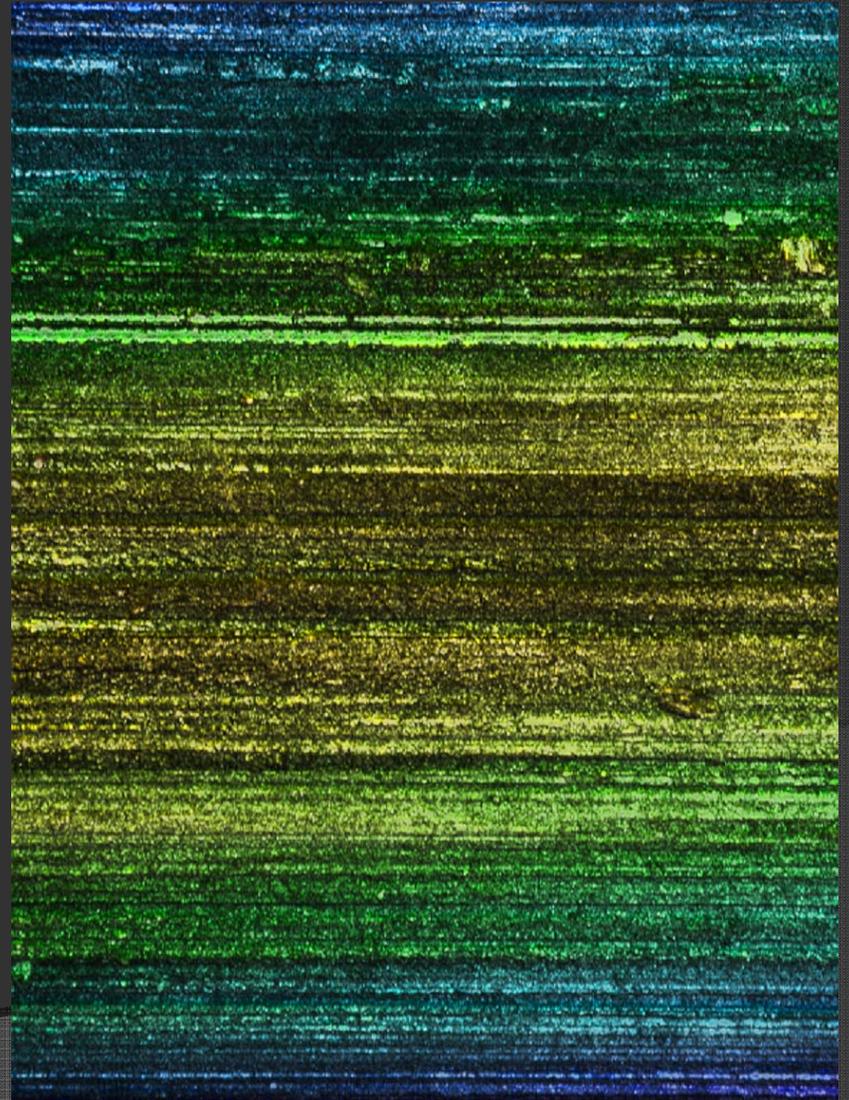
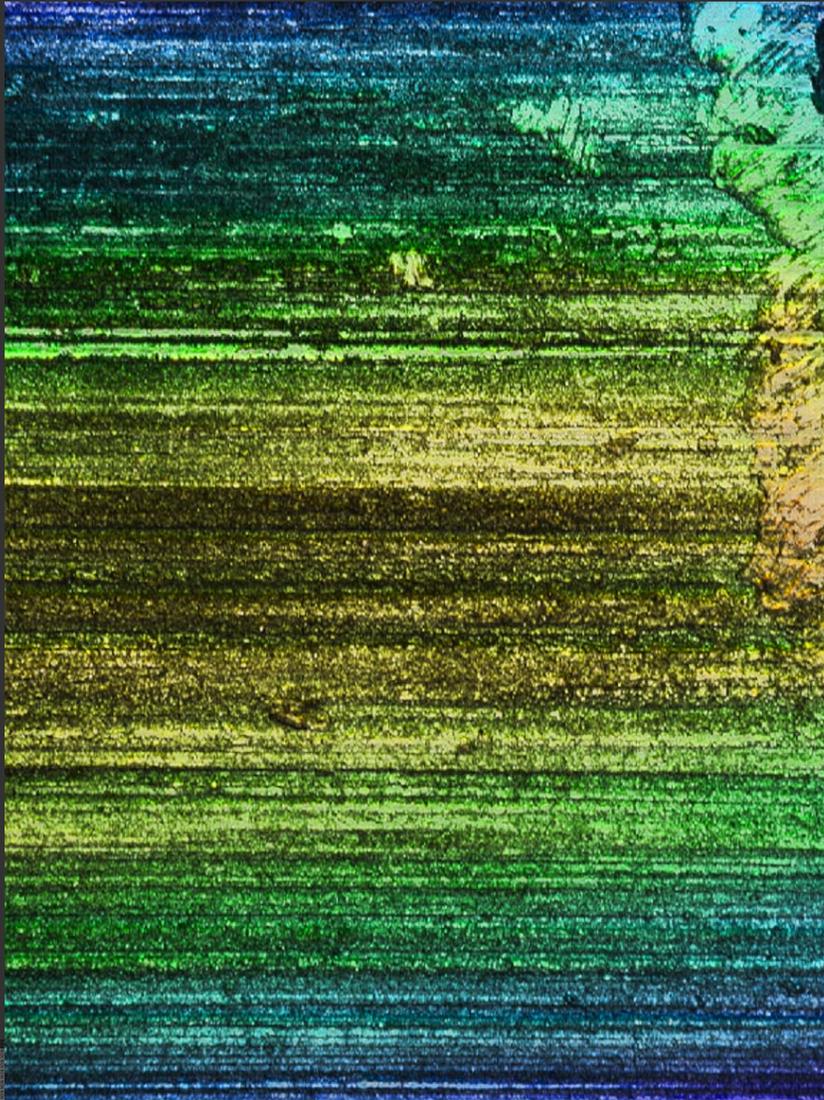
Evaluation in True 3D

- We began investigating true 3D instrumentation
- We narrowed the applicable instrumentation to interferometry and confocal microscopy
- We have assessed instruments from 6 different companies.

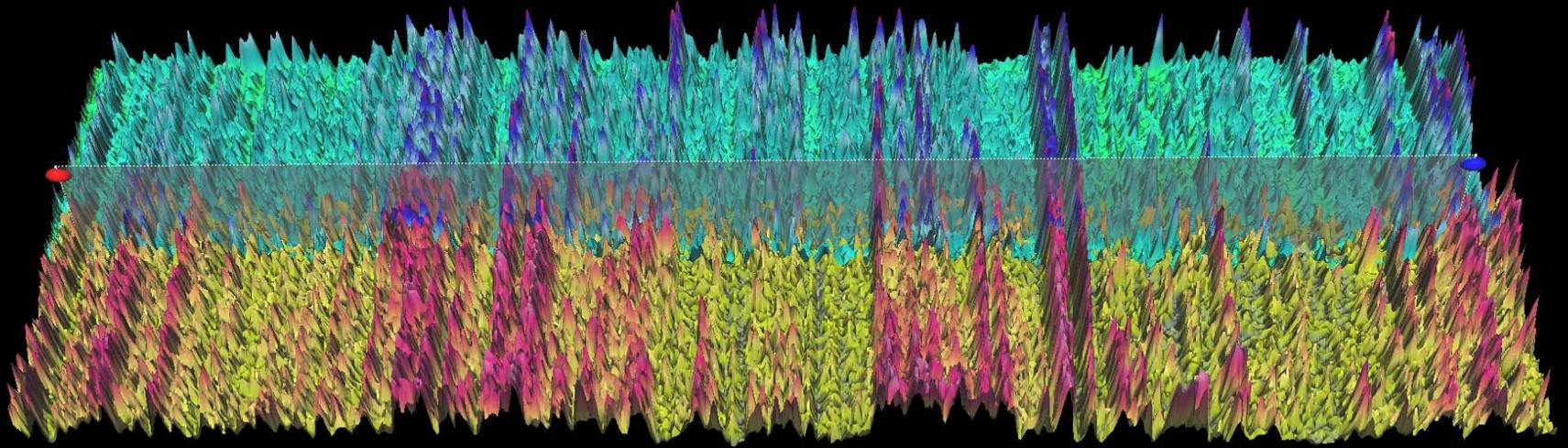
Evaluation in True 3D

- 4 Confocal Microscopes (Keyence, Leica, Sensofar, Zeiss)
- 4 Interferometric Microscopes (Leica, Sensofar, ZeMetrics, Zygo)
- Evaluating True 3D data/images from profilers uploaded into Science GL software.

Leica DCM 3D



Leica DCM 3D

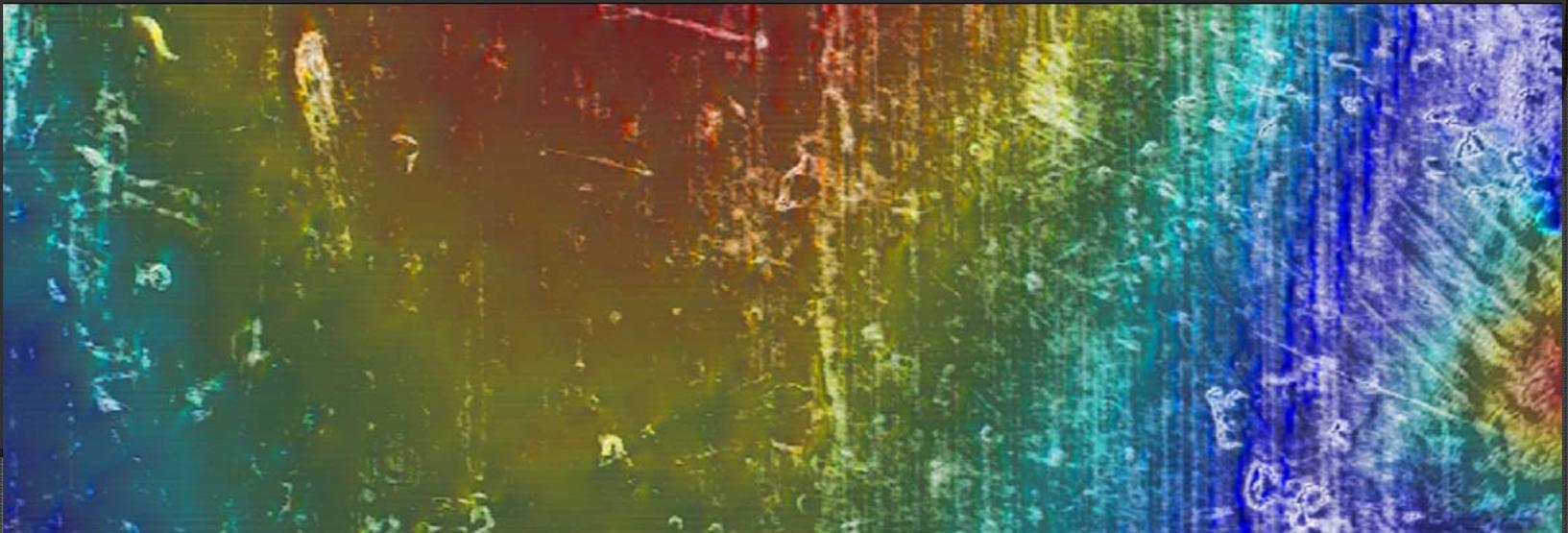
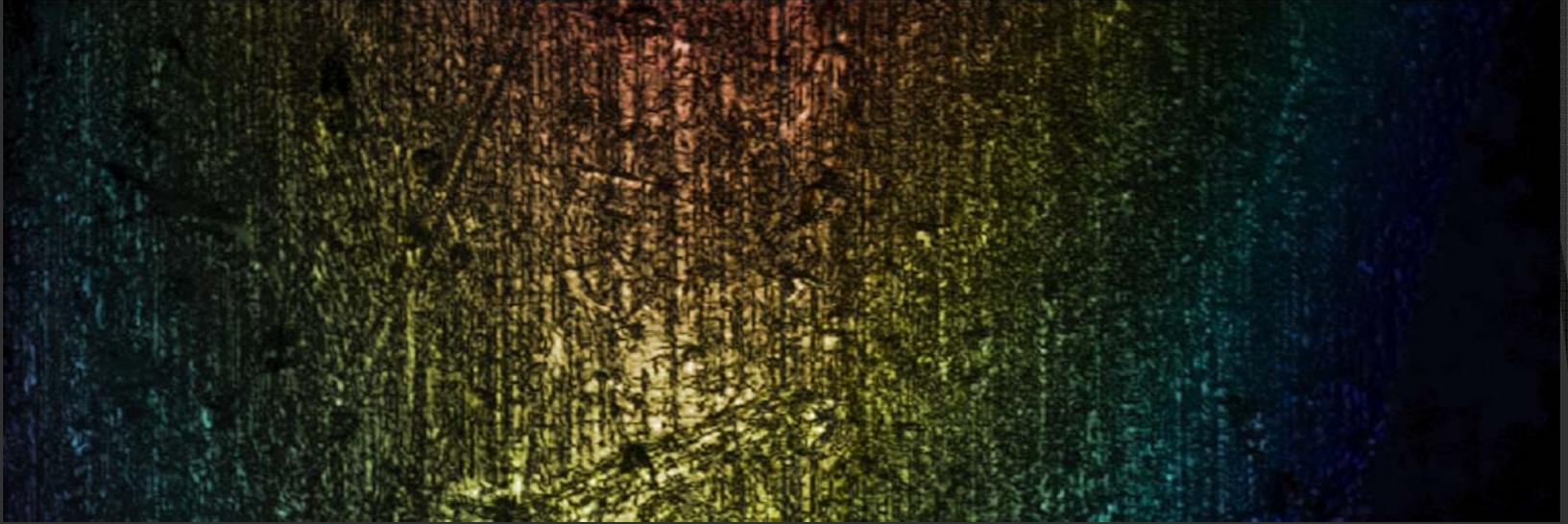


81.13%

Leica DCM 3D

Glock

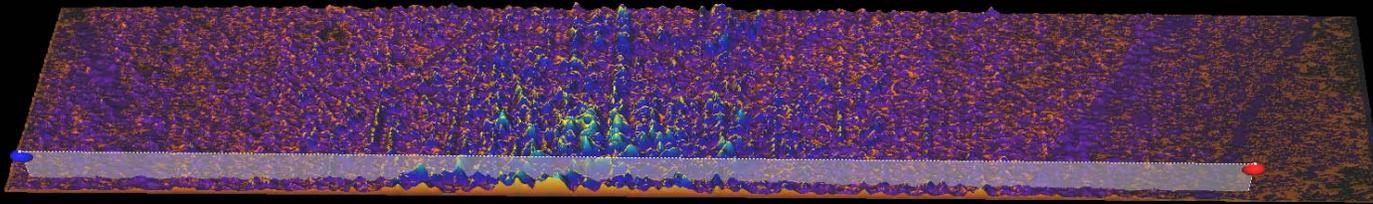
Interferometer



Confocal

Leica DCM 3D

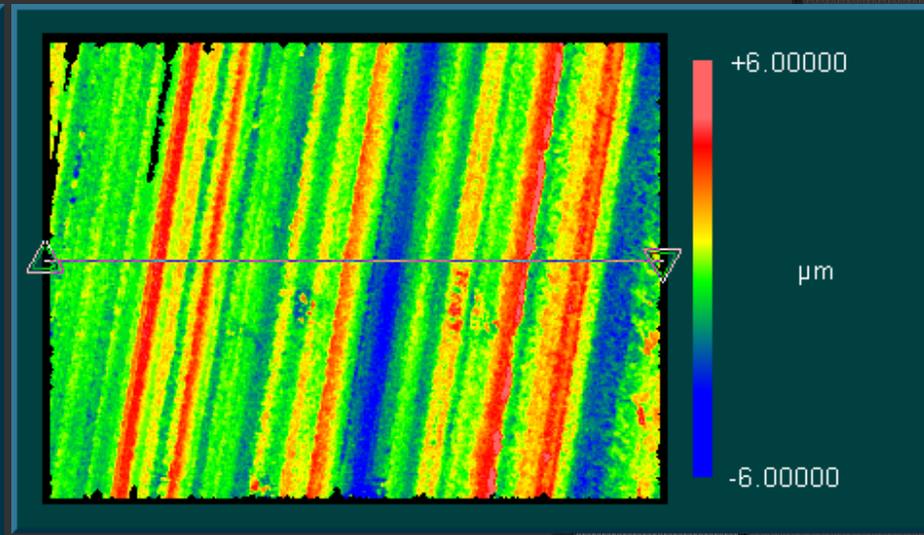
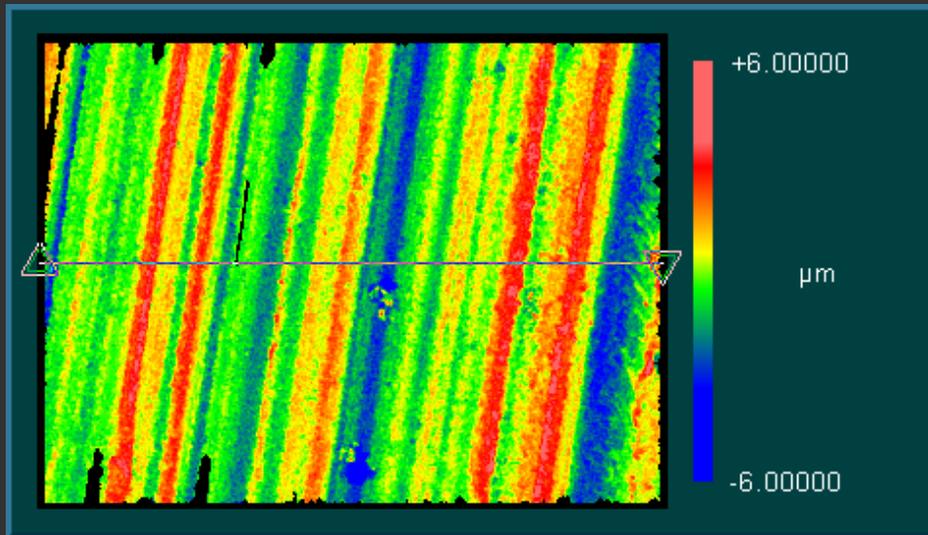
Glock



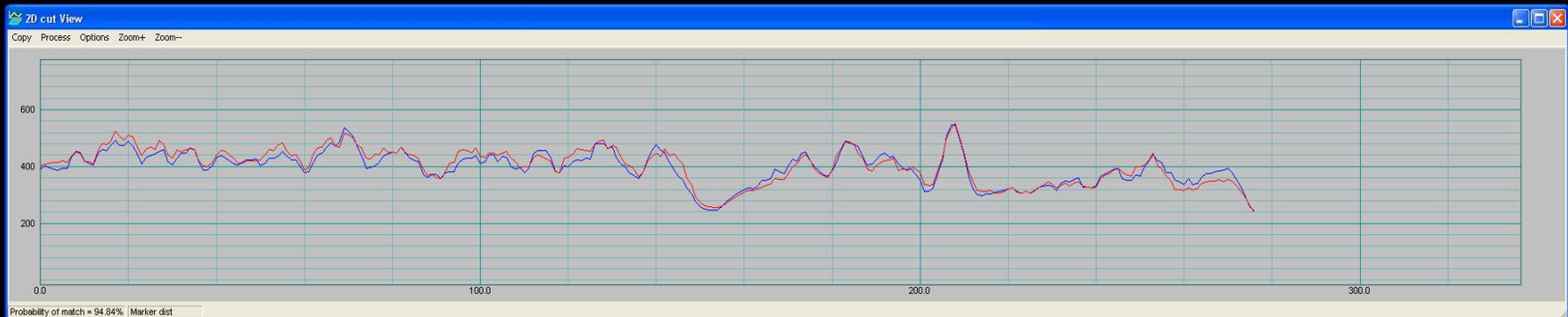
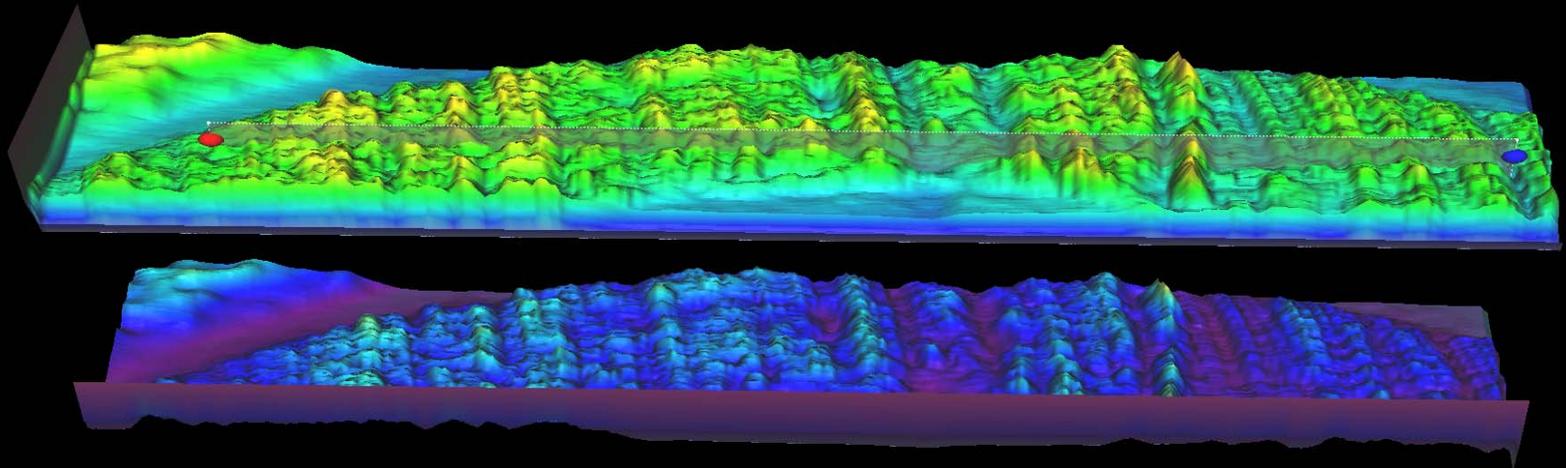
Probability of match = 96.31% | Marker dist

96.31%

Zygo New View 7300

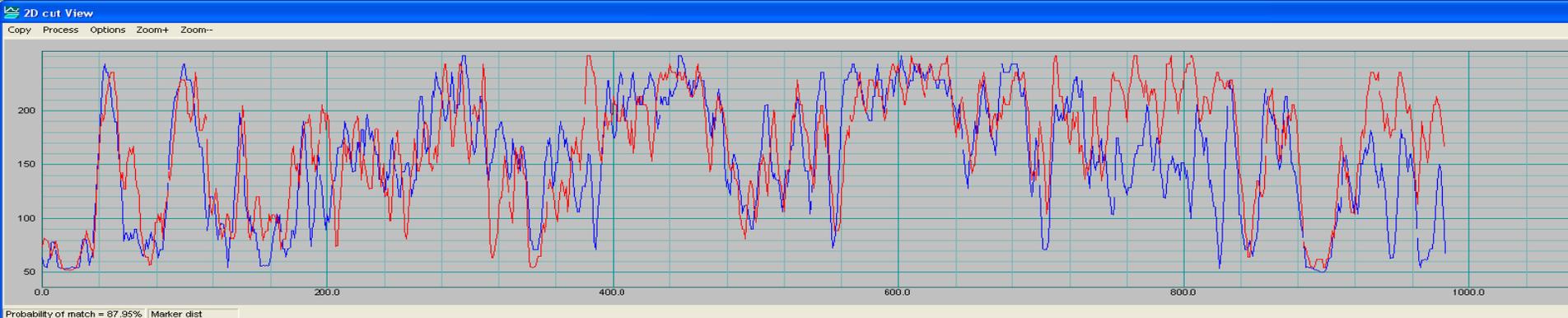
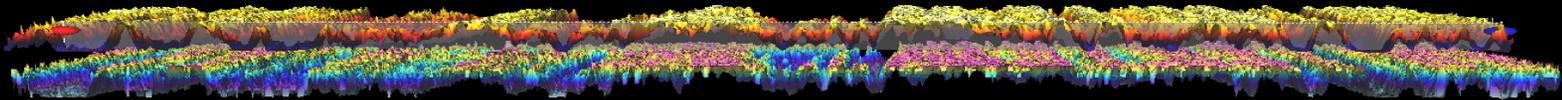
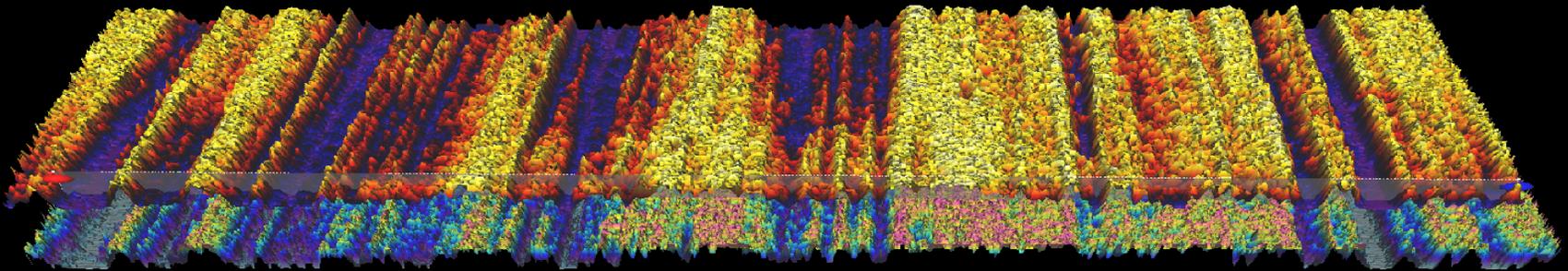


Zygo New View 7300



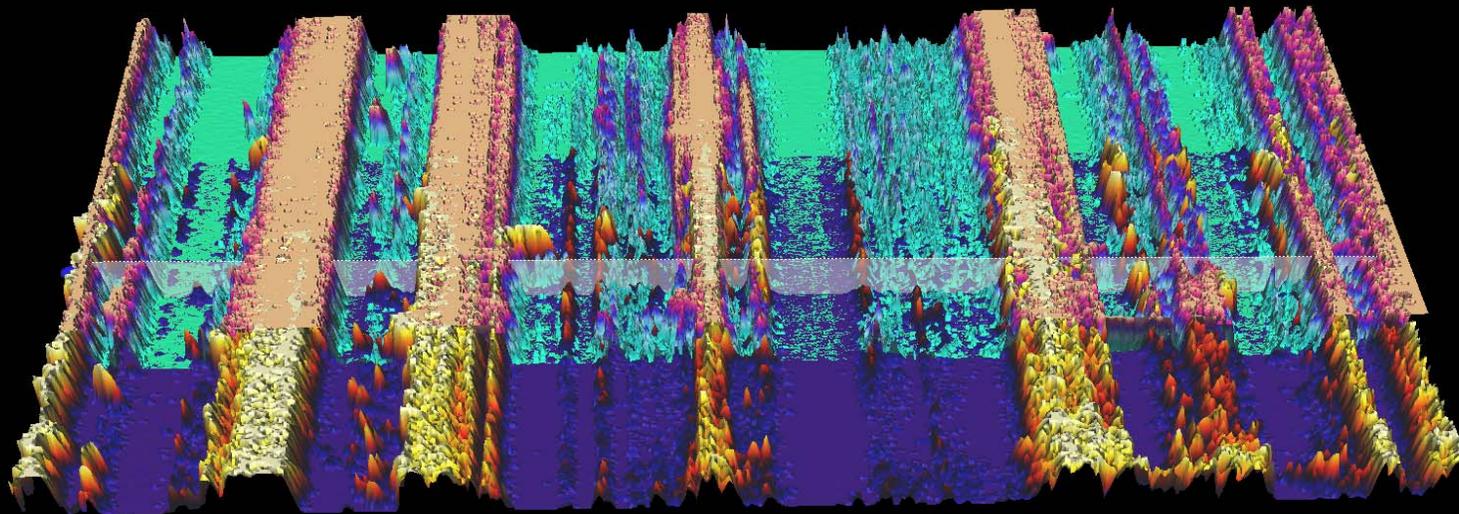
94.84%

Keyence 9700 VK



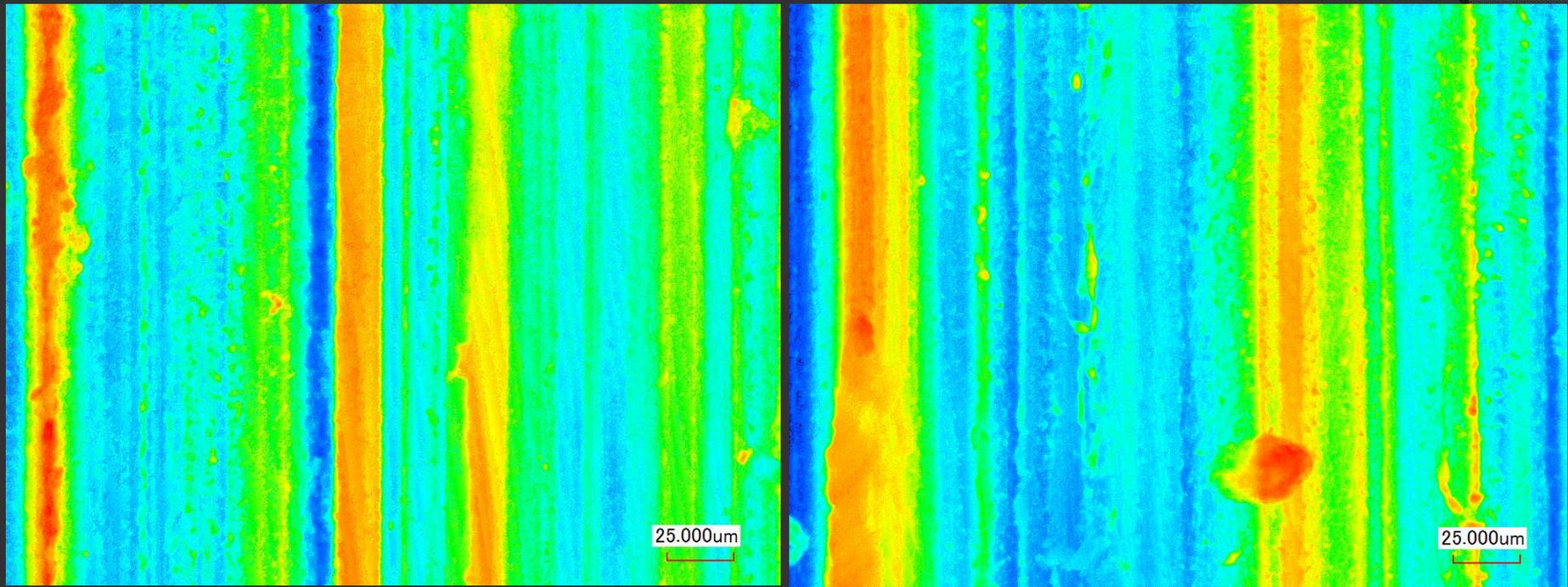
87.95%

Keyence 9700 VK

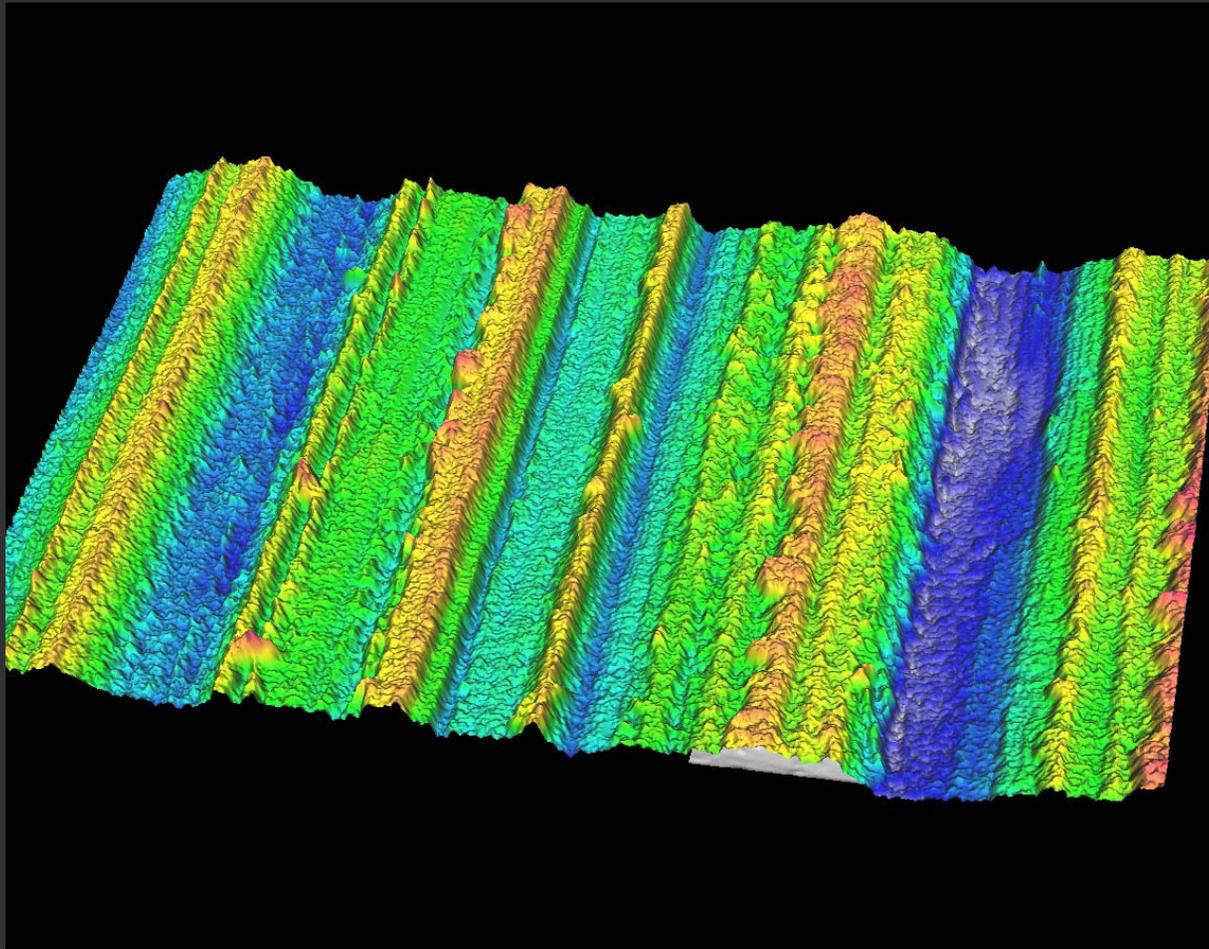


87.92%

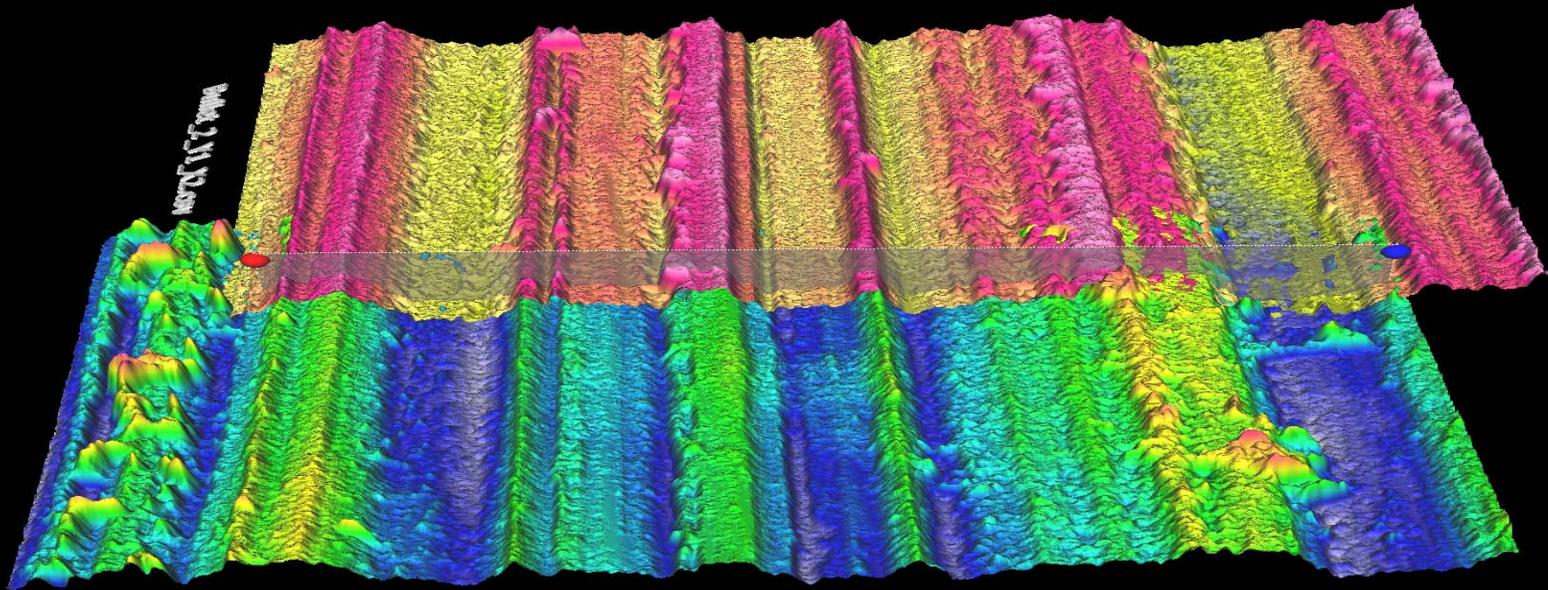
Keyence 9700 VK



Keyence 9700 VK



Keyence 9700 VK



95.67%

Literature

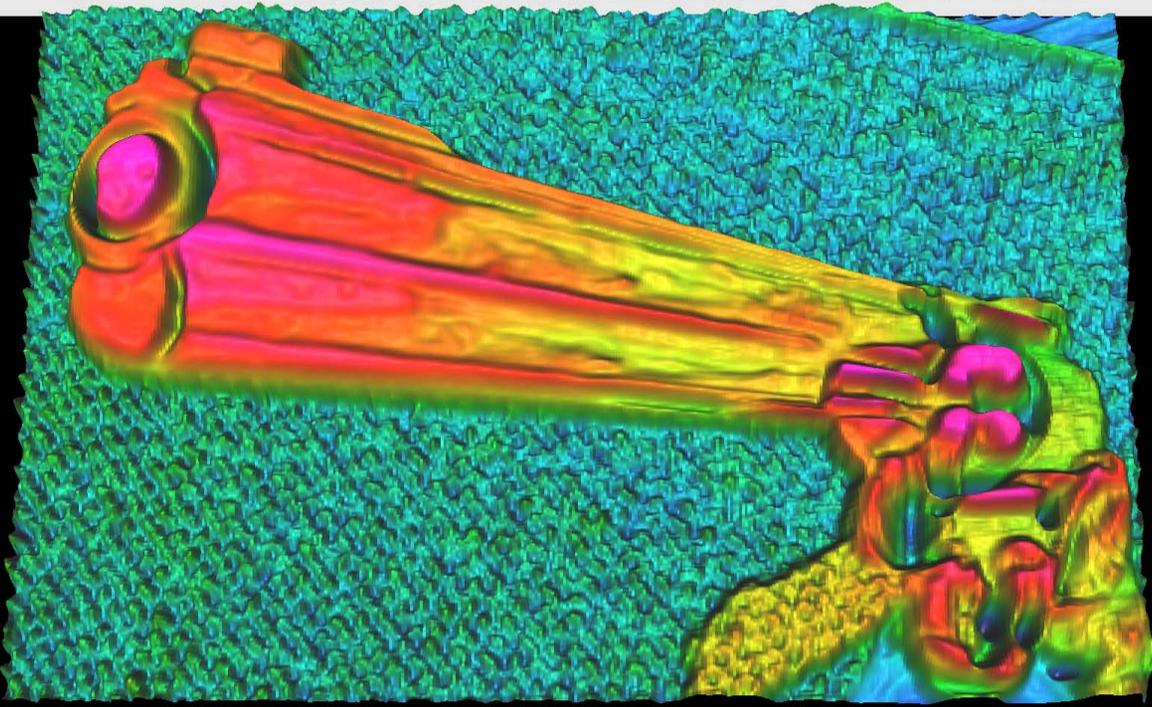
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- Alex Onik (Science GL)
- Igor Malinovsky (Science GL)
- Ryan Pfaff (Keyence)
- Malcolm Davis (Vashaw)
- Wayne Buttermore (Leica)
- Tyler Steele (Zygo)
- AFTE



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- csv1
- csv2
- csv3



44magnum-1.bmp

Contact Information



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DEPARTMENT OF FORENSIC
SCIENCES



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