

ZEISS Research Microscopy Solutions

Zeiss Microscopes in Forensic Sciences Laboratories

MICROSCOPY • METROLOGY SERVICES
Suisse made



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ZEISS Microscopes in Forensic Sciences Laboratories

Speaker:
Heinrich Bunger
Carl ZEISS Microscopy GmbH
Jena, Germany



Information



- **Discretion is advised**
- **Ongoing cases / cold cases**
- **Personal information separated from trace evidence**
- **Technical capabilities not for public**



<https://www.wort.lu>

A Strong Foundation for a Strong Future



Carl Zeiss
Founder

Ernst Abbe
Partner

Otto Schott
Partner

Facts

ZEISS Contributions as an Enabling Partner



36

Nobel Laureates

used ZEISS systems to advance scientific progress

80%

of microchips worldwide

made on ASML lithography systems with ZEISS optics

50

ZEISS Camera Lenses were sent into space

during the NASA Apollo Mission

10

Oscar-nominated movies in 2019

filmed with ZEISS Cine Lenses

15,000,000

operations worldwide per year

with ZEISS Surgical Systems

Portfolio

Shaping the Future – ZEISS Segments



Semiconductor Manufacturing Technology



Industrial Quality & Research



Medical Technology



Consumer Markets



Strategic Business Units

Semiconductor Manufacturing Optics
Semiconductor Mask Solutions
Process Control Solutions

Industrial Quality Solutions
Research Microscopy Solutions

Microsurgery
Ophthalmic Devices

Vision Care
Consumer Products

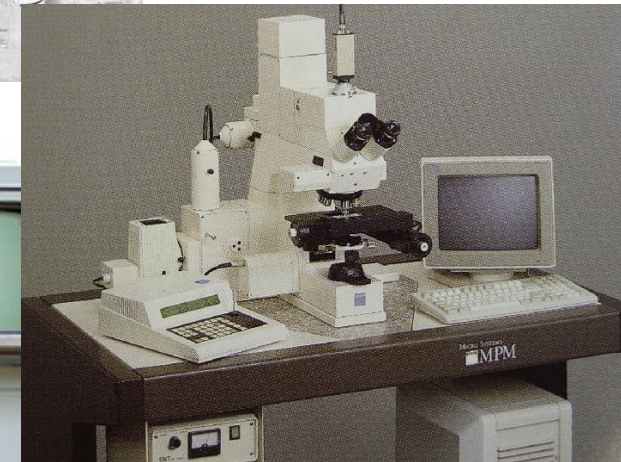
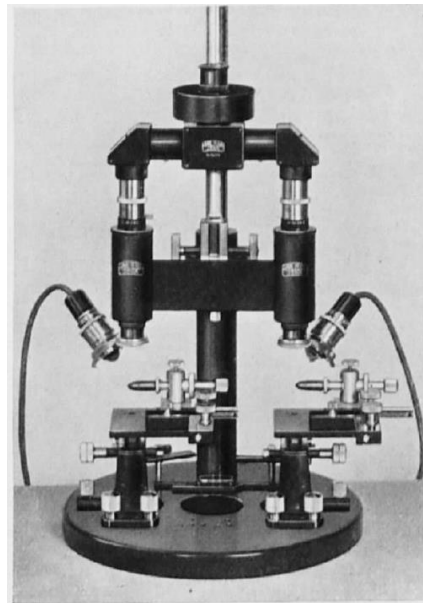
ZEISS Microscopes in Forensic labs

> Introduction <

What accelerated forensic sciences?



- **Photography**
- **Chemistry**
- **Microscopy**
- **Pathology**
- **Biology**



ZEISS Microscopy Portfolio

Types of microscope technologies



Light
Microscopy



Confocal
Microscopy



Electron
Microscopy



Helium Ion
Microscopy



X-ray
Microscopy

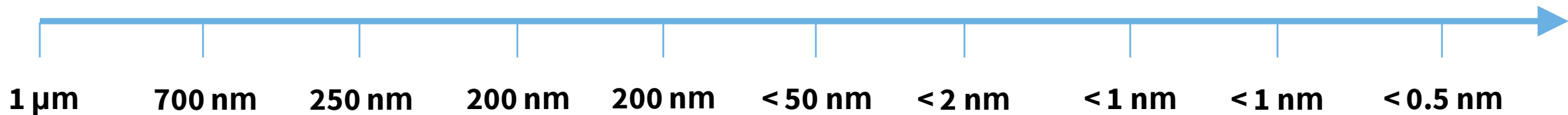
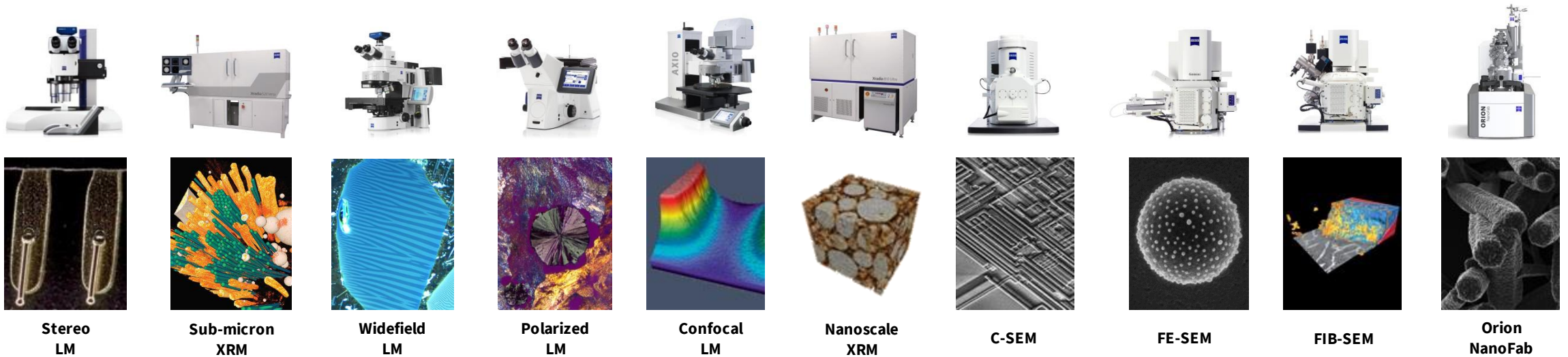


ZEISS Microscopy Portfolio

Multi-Scale Characterization for Multi-Scale Research



A complete microscope portfolio...



Human hair diameter: 40-100 μm
1mm = 1/1000 of 1m
1 μm = 1/1000 of 1mm
1nm = 1/1000 of 1 μm

...to address your multi-scale research and analysis challenges

Enabling Customers

What is trace evidence?



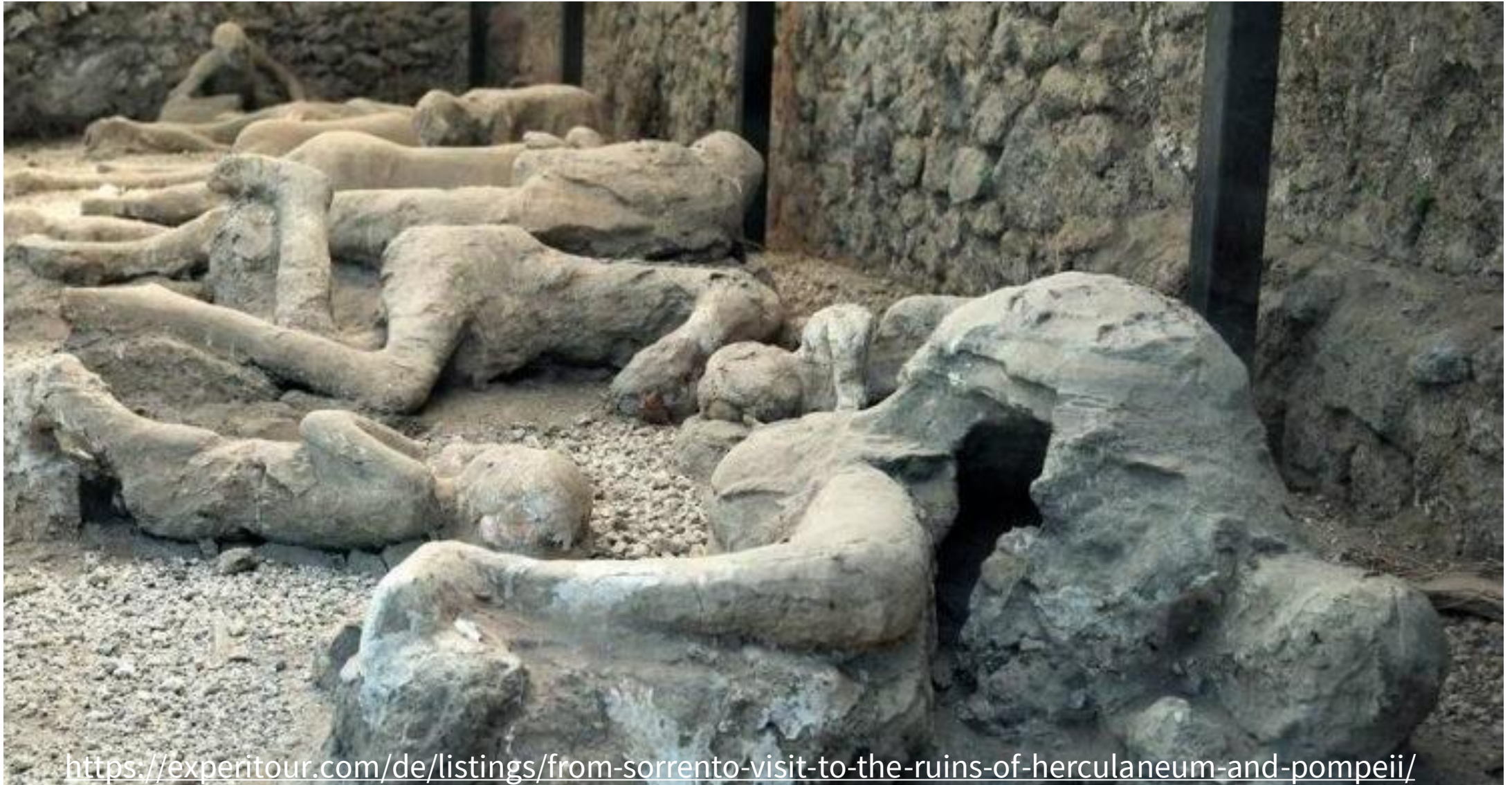
- **Ammunition**
- **Blood, semen and saliva**
- **Documents, paper**
- **Drugs**
- **Debris**
- **Electronics**
- **Explosives**
- **Fibers**
- **Fingerprints**
- **Firearms and ammunition**
- **Glass**
- **Hair**
- **Impressions**
- **Metals**
- **Minerals**
- **Paint**
- **Petroleum products**
- **Plastic, rubber**
- **Powders**
- **Soil**
- **Toolmarks**
- **Wood and vegetative matter**

ZEISS Microscopes in Forensic labs

> Forensic pathology <

Enabling Customers

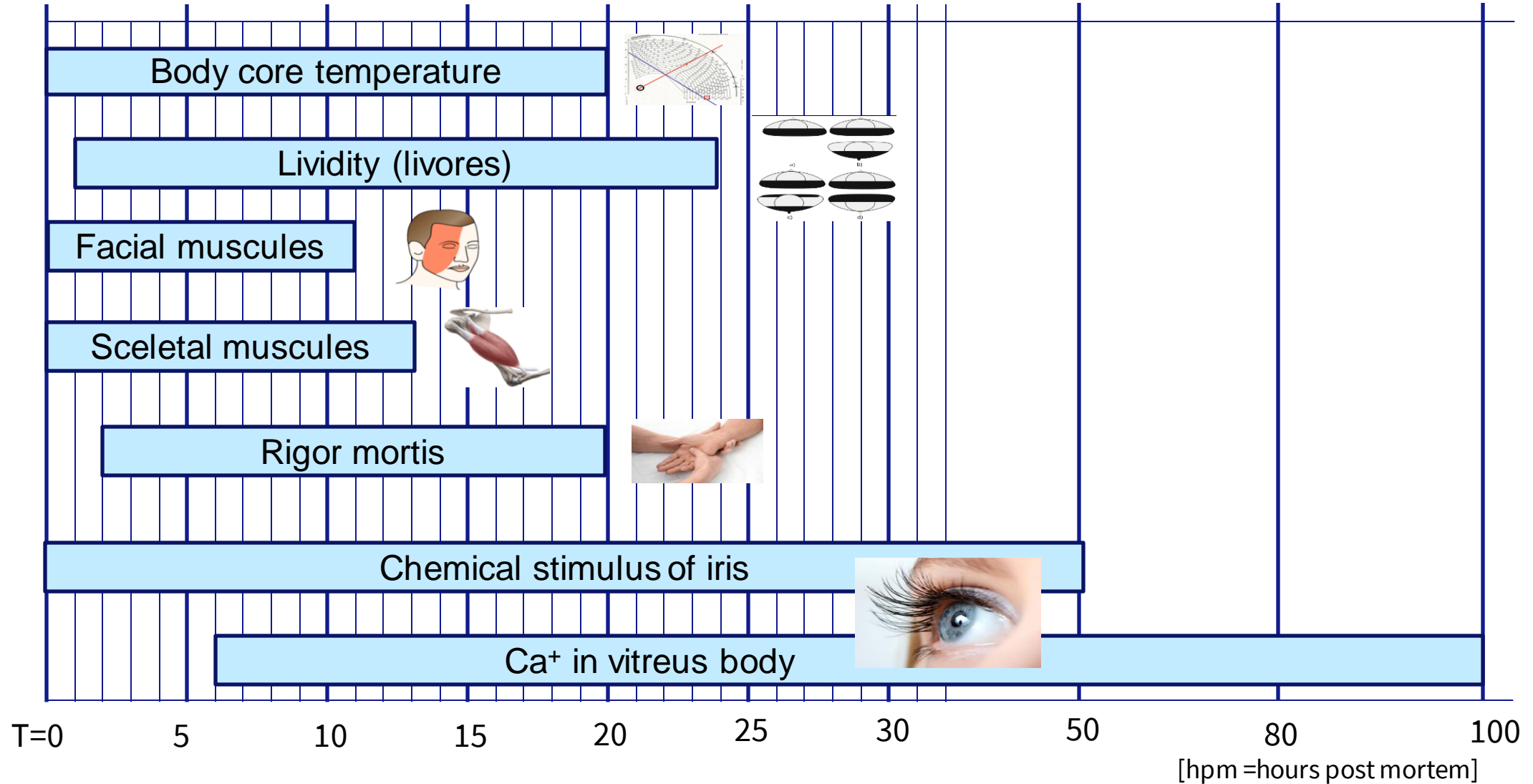
Hours post mortem [hpm] determination



<https://experitour.com/de/listings/from-sorrento-visit-to-the-ruins-of-herculaneum-and-pompeii/>

Enabling Customers

Hours post mortem [hpm] determination - coroner

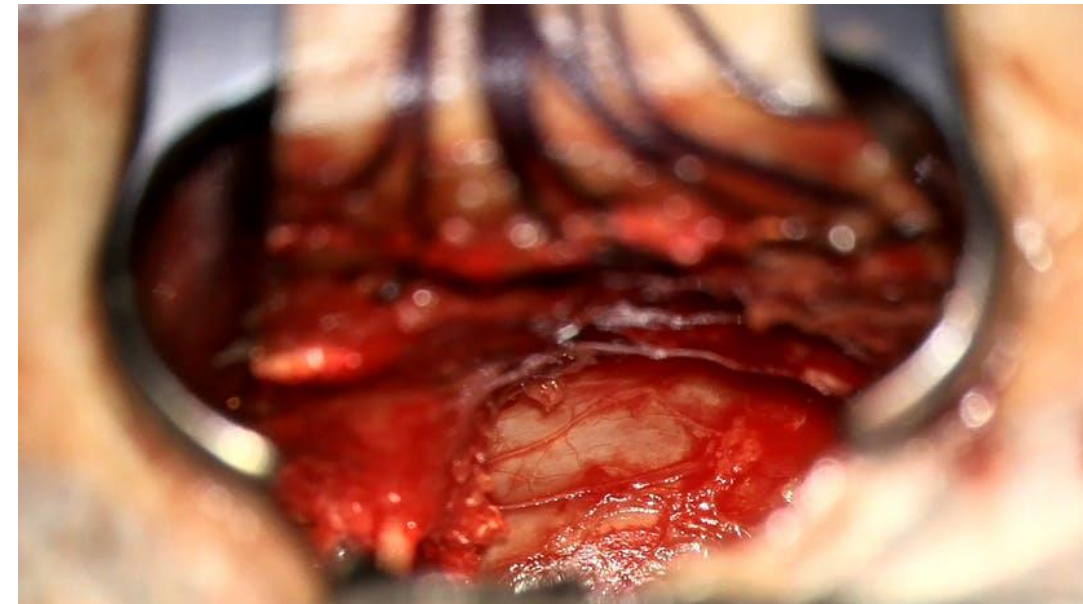


Forensic Pathology (coroner)

Requirements for a surgical microscope



- **very high color fidelity of optics**
- **3D visualization**
- **long working distances (WD)**
- **long depth of focus (DoF)**
- **documentation functions**

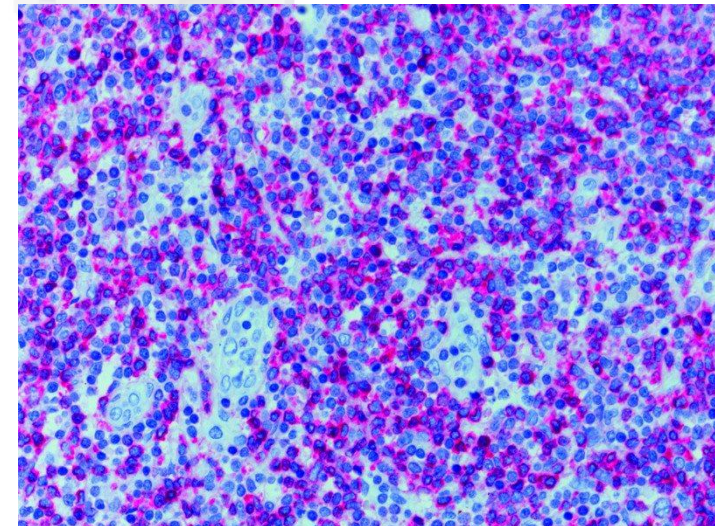


Forensic Pathology (coroner)

Requirements for an upright light microscope



- **high color fidelity of optics**
- **transmitted light and fluorescence illumination**
- **ergonomy**
- **large and flat sample stage**
- **documentation and measuring functions**
- **Axioscope 5, Axio Imager Z2**



The new Axiolab 5 & Axioscope 5 smart documentation systems for transmitted light and fluorescence



Axiolab 5



Axioscope 5 FL



Axiocam 208 color Axiocam 202 mono



- **Automatic adjustments** in camera for high **color & contrast** reproducibility
- Integrated system without additional computer **saves space and money**
- Automatic **storage of all metadata** with your images, including scaling
- Even „**one key**“ **multichannel fluorescence** acquisition possible

ZEISS Microscopes in Forensic labs

> Forensic entomology <

Enabling Customers

Hours post mortem [hpm] determination - entomology



- Forensic entomology is the study of insects and other arthropods in criminal investigation
- Determination of the colonization interval of a corpse
- Insects can accumulate drugs or other chemicals
- Insects may reveal if a body was moved – some insects are specific to cities, some to rural areas
- Weather conditions have influence on development times
- Maggots can produce heat and raise temperature in immediate vicinity by up to 20°C



Forensic Entomology

Requirements for stereo microscope



- **low distortion of optics**
- **incident, coaxial and indirect illumination**
- **ergonomy**
- **large and flat sample stage**
- **documentation and measuring functions**
- **Stemi 305, Stemi 508, Discovery V8**



Stereo and Zoom Microscopes



Stereo and Zoom Microscopes

<https://www.zeiss.com/microscopy/int/products/light-microscopes.html#stereozoom>



Stemi 305



Stemi 508



Discovery.V8



Discovery.V12



Discovery.V20



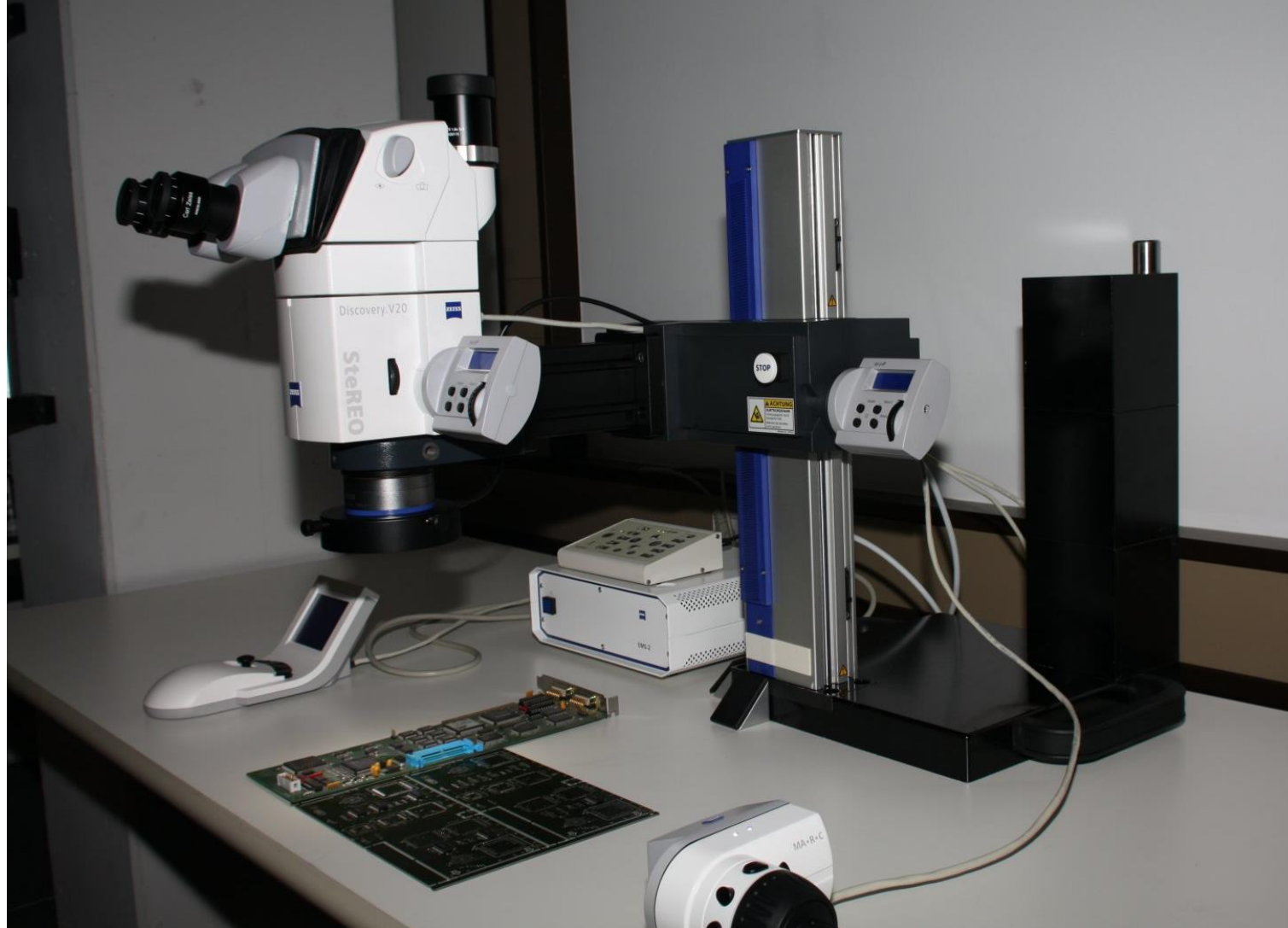
Axio Zoom.V16



Smartzoom 5

Forensic Entomology

Requirements for stereo microscope

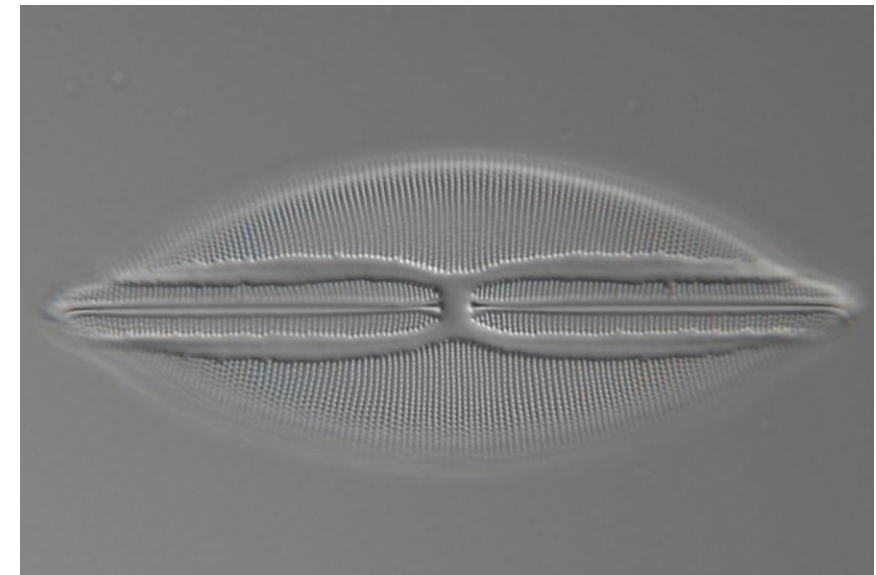
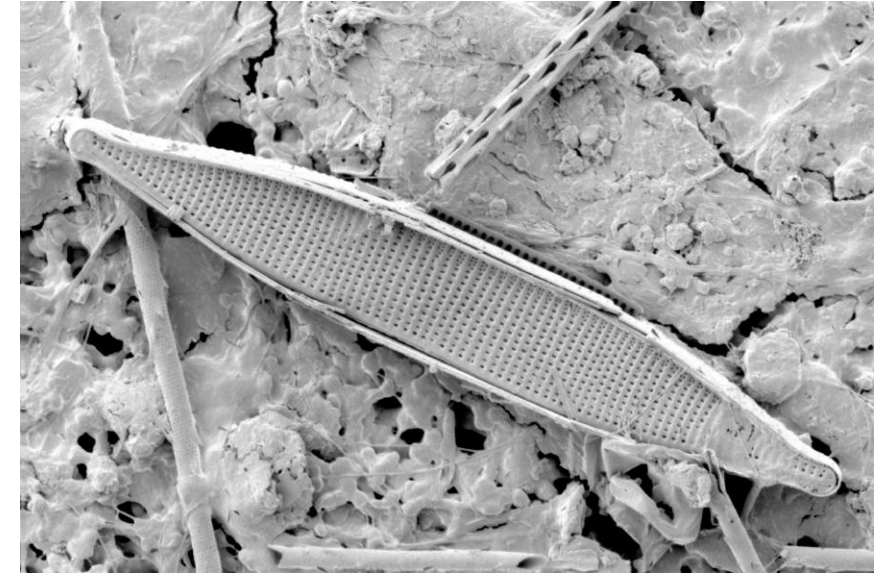
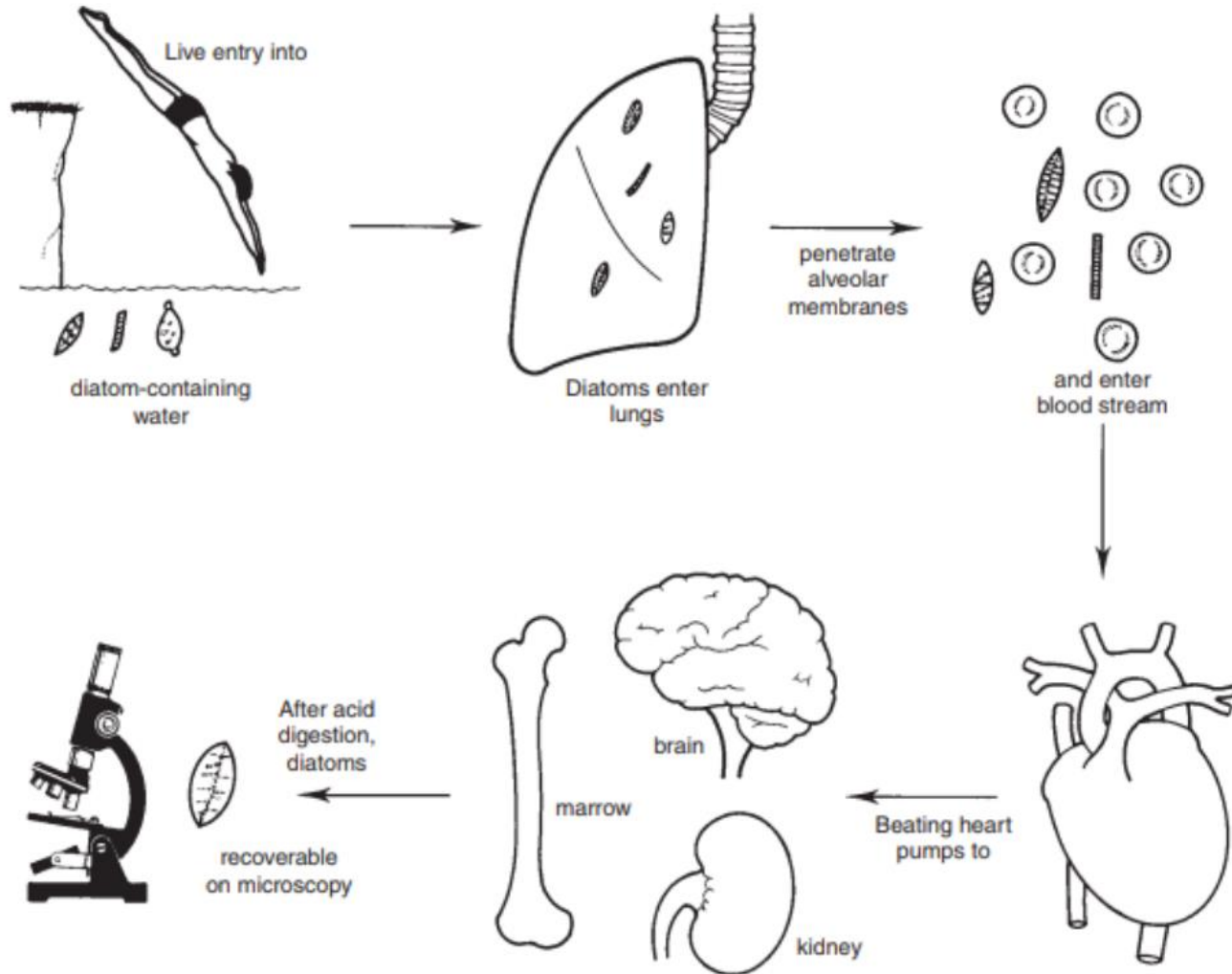


ZEISS Microscopes in Forensic labs

> Diatoms <

Forensic Pathology (coroner)

Cause of death drowning - coroner



Saukko P. Knight's Forensic Pathology (p.406). 3rd ed. London: Hodder Education, 2004

Forensic Pathology (coroner)

Requirements for an upright light microscope



- **very high color fidelity of optics (apochromatic)**
- **transmitted light and fluorescence illumination**
- **large and flat sample stage**
- **documentation and measuring functions**
- **Axio Imager Z2**



Light Microscopes



Primo Star/Tech



Axio Lab



Axio Scope



Axio Imager 2



Primovert HDcam



Axio Vert.A1



Axio Observer

ZEISS Microscopes in Forensic labs

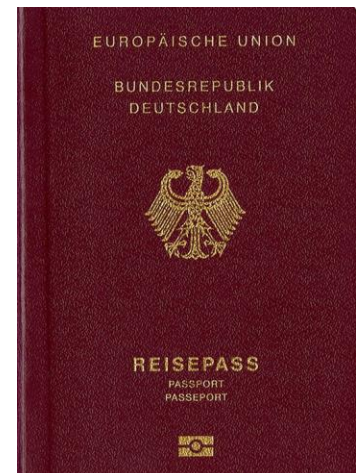
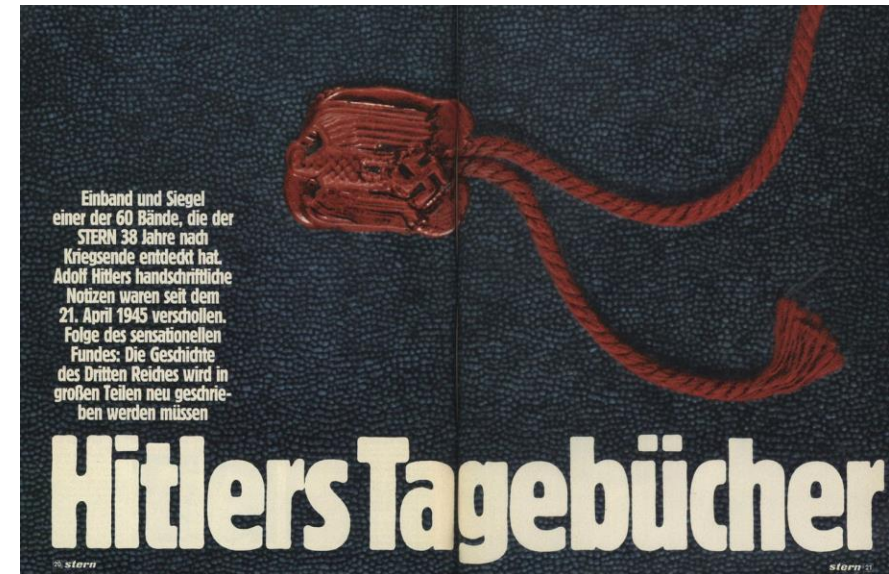
> Fraud & Counterfeiting <

Forensic Trace Evidence

Fraud & Counterfeiting



- **Forgery has been done at all times**
- **can cause economic damage**
- **Typical questioned material:**
 - ID cards / passports / drivers licenses / license plates
 - Contracts / Wills
 - Titles and deeds
 - Seals / Stamps
 - Bank checks / Cash / Lottery tickets / soccer tickets
 - Handwritten correspondence
 - Machine-generated documents
 - Electronic documents



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San Silvestro Chapel at Santi Quattro Coronati, Rome

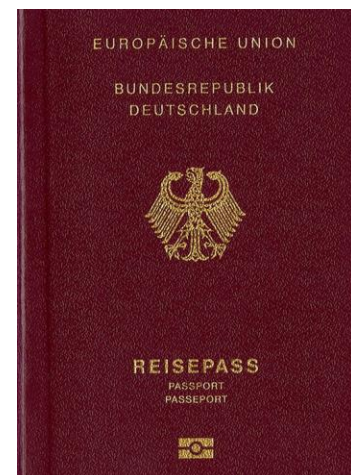


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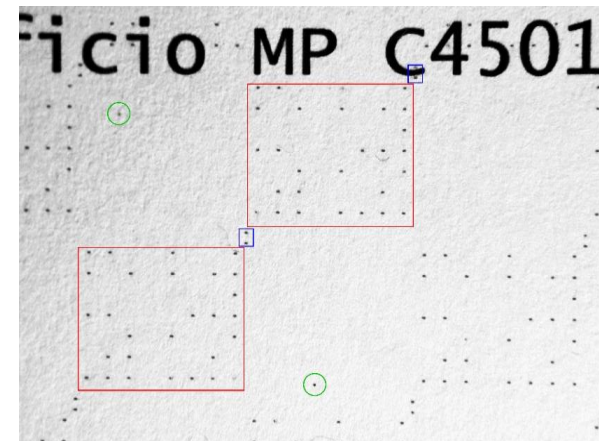


Forensic Trace Evidence

Fraud & Counterfeiting



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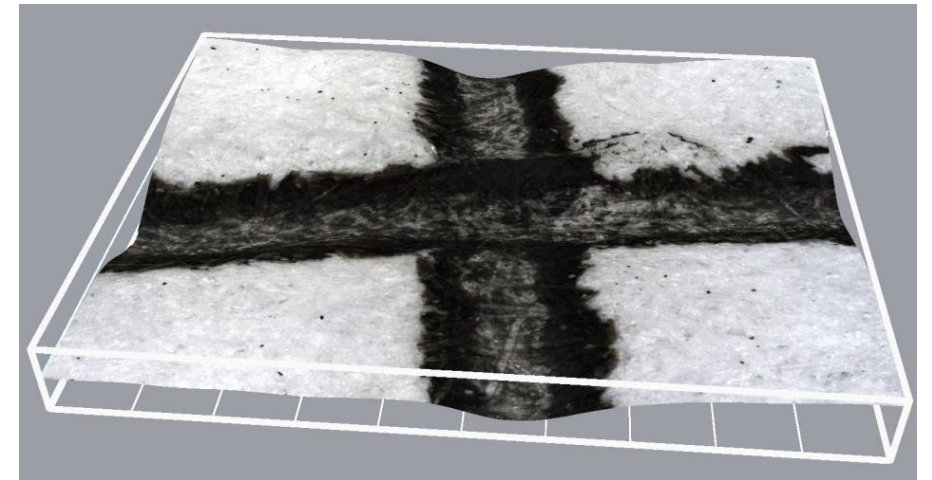


Forensic Trace Evidence

Fraud & Counterfeiting



- Document examination
- Which line was first?

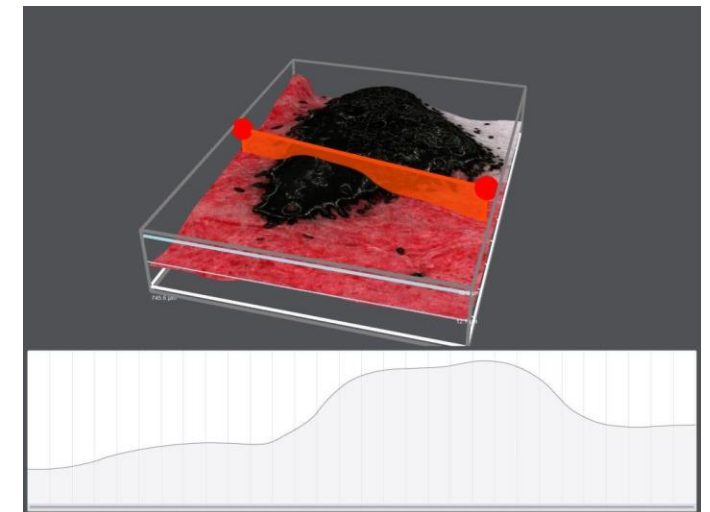
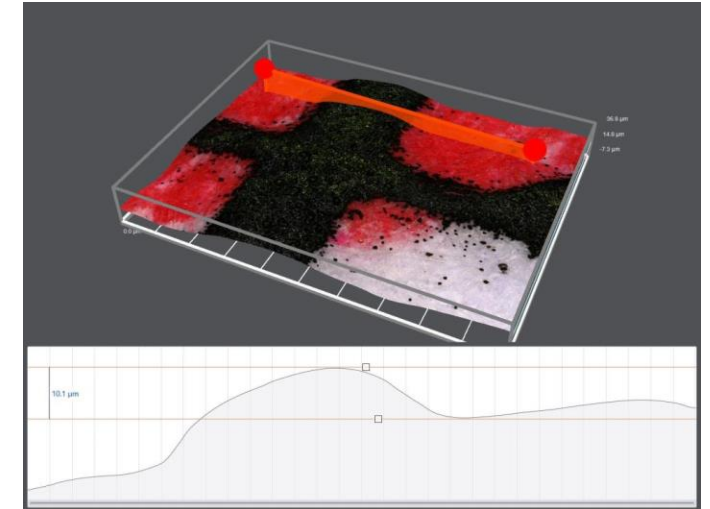


Forensic Trace Evidence

Fraud & Counterfeiting



- **Overlapping parts have yellow green flooding, indicating stamp is on top of print toner**
 - **3D-view and measurement**
 - **328x**
-
- **There is no yellow green glow above the overlap, indicating print toner is on top of stamp**
 - **3D-view and measurement**
 - **477x**



ZEISS Microscopes in Forensic labs

> Burglary / Lockpicking <

Forensic Trace Evidence

Burglary / Lockpicking



- **Toolmarks of a Bolt cutter padlock shackle**
- **cutting marks are unique due to manufacturing process**
- **Comparison can match shackle and tool**
- **bulky samples like door or window frame / crowbar => replica by 2-component-polymer**

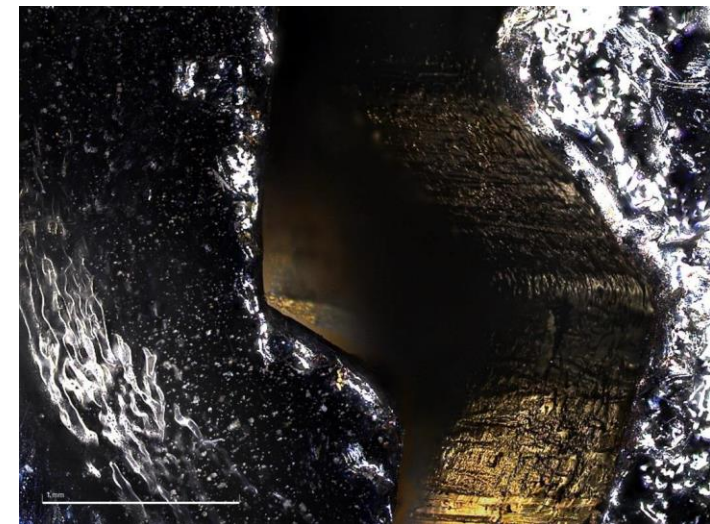
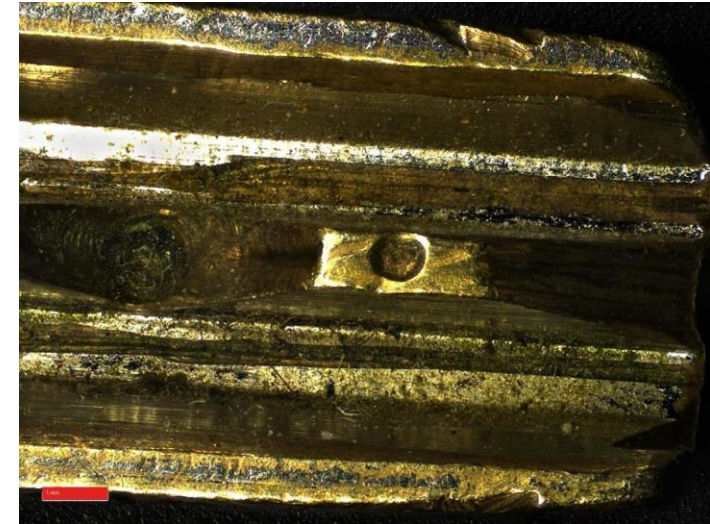


Forensic Trace Evidence

Burglary / Lockpicking



- **Obvious burglary => toolmarks**
- **What if it is not so obvious?**



Forensic Trace Evidence

Burglary / Lockpicking



- **Smartzoom 5**
- **Software designed around workflow approach**
- **tiltable optical engine**
- **high reproducibility**
- **ease of use**



ZEISS Microscopes in Forensic labs

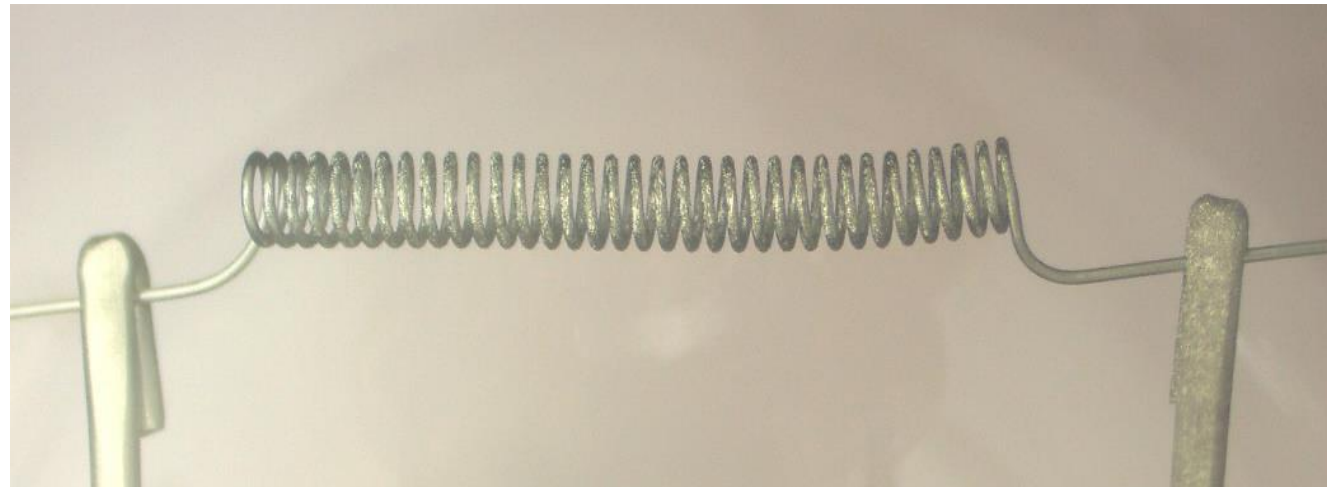
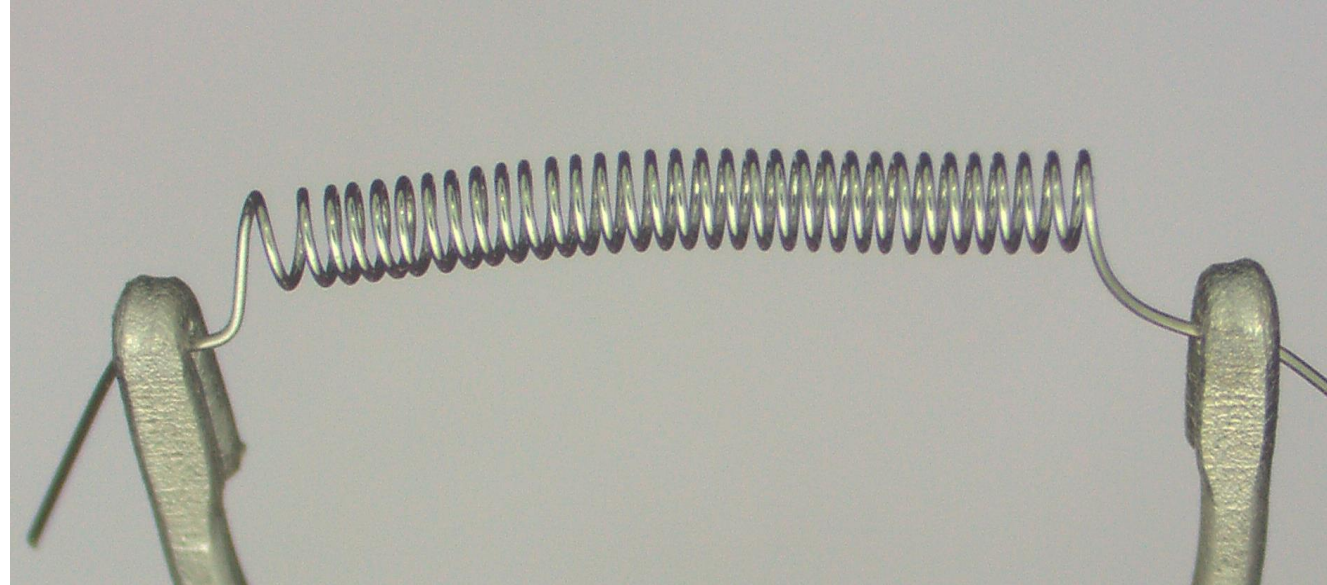
> Lamp Filament Investigation <

Forensic Trace evidence

Vehicle accident investigation



- **New vs. aged filament**
- **Bright luster of filament**
- **Evenly spaced coils**
- **Clear glass**
- **Bright base**

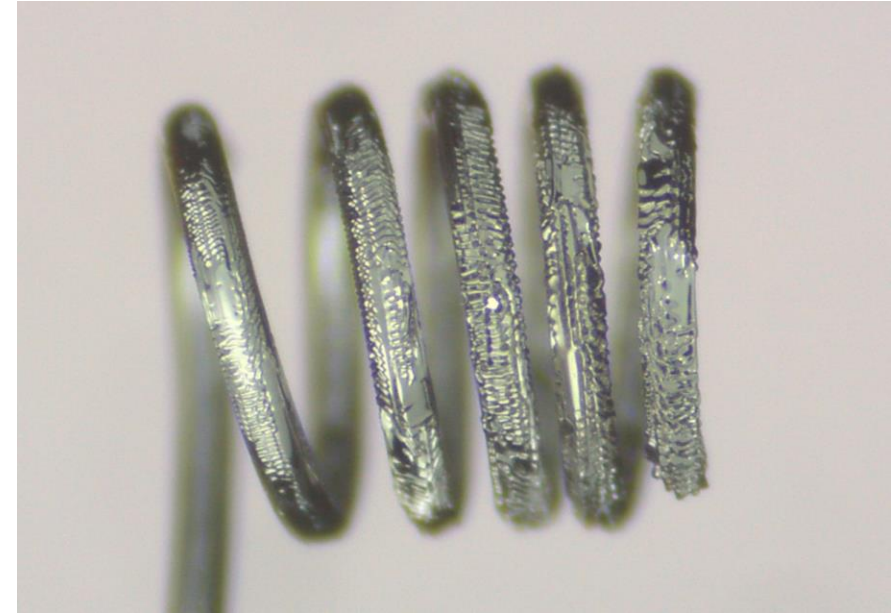


Forensic Trace evidence

Vehicle accident investigation



- **Hot shock**
- **The filaments of light bulbs may be deformed (stretch, tangle or uncoil or break) by the large accelerations involved in collisions**
- **A filament becomes more prone to deformation (ductile) when the bulb is lit because the filament is extremely hot (~ 2500°C)**

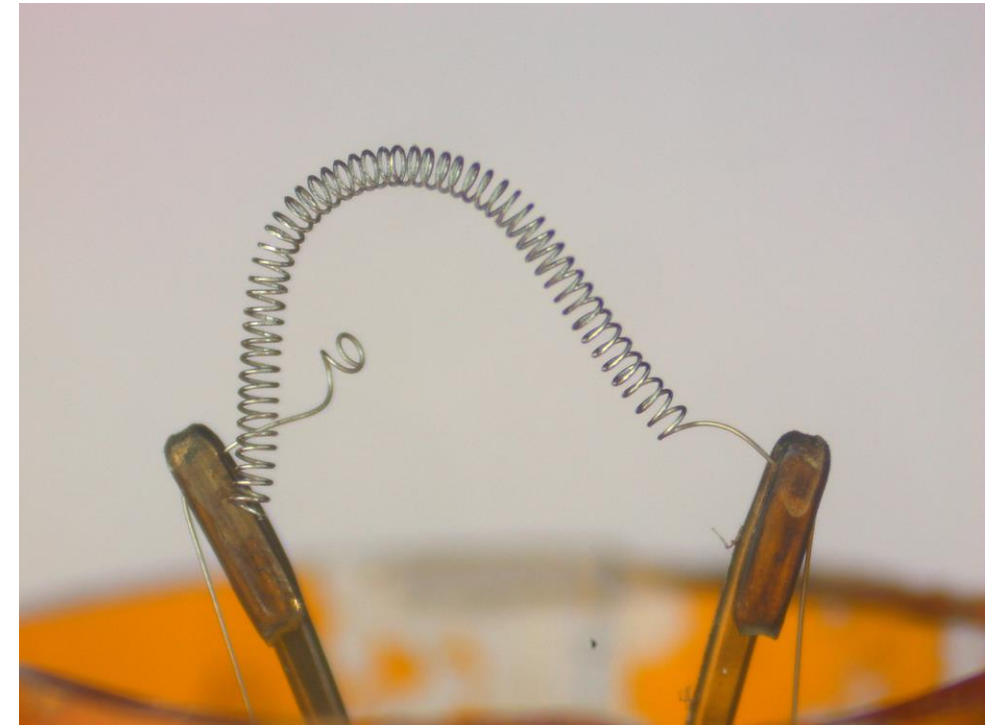


Forensic Trace evidence

Vehicle accident investigation



- **Cold shock**
- **The otherwise intact filament is evenly deformed and broken**
- **Sign for a cold shock**



Forensic Trace evidence

Vehicle accident investigation



- Hot shock
- Glass particles hit the hot filament



Forensic Trace evidence

Requirements for a scanning electron microscope



Powerful, yet affordable

- Match your required resolution
 - LaB6 or W
- Match your sample size
 - Three chamber sizes
- Match your sample type
 - High vacuum, variable pressure, environmental pressure
- Match your application – extend when required
 - SE, BSE, EDX, VP and C2D SE Detectors



Forensic Trace evidence

Requirements for a scanning electron microscope



ZEISS Microscopes in Forensic labs

> Glass examination <

Forensic Trace evidence

Glass examination



- **Physical / chemical properties such as**
 - **Color**
 - **Fluorescence**
 - **Thickness**
 - **Surface features (roughness, coatings, ..)**
 - **Curvature**
 - **Density**
 - **Transmission/absorption**
 - **Refractive index (RI)**
 - **Elemental composition**

are used to classify glass fragments



Image courtesy of [Jonn Leffmann on Wikipedia](#) CC 3.0

Forensic Trace evidence

Glas examination



- **Methods**
- **Refractive Index determination using “Becke’ Line”**
- **GRIM – glas refractive index measurement**
- **Microspectroscopy**
- **Raman Microspectroscopy**
- **EDX**



ZEISS Microscopes in Forensic labs

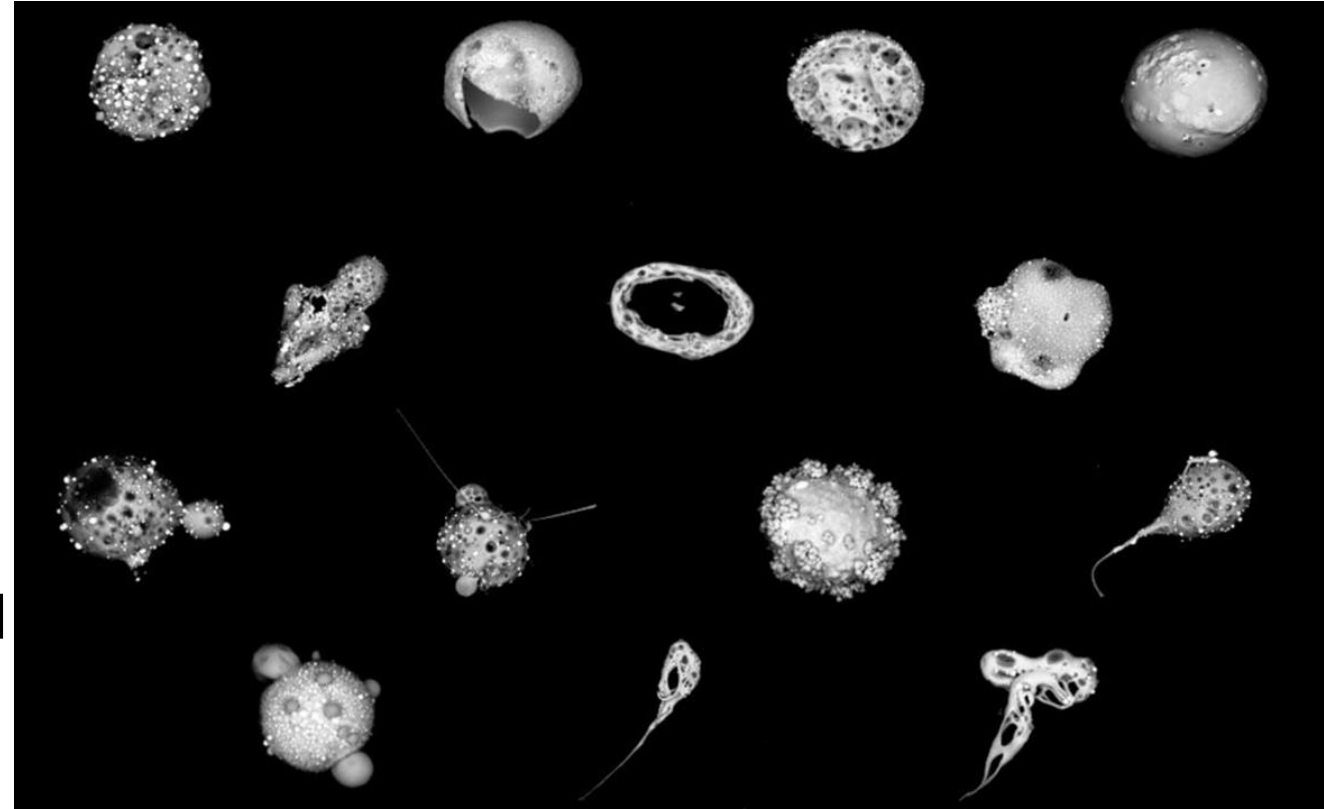
> Gunshot residue (GSR) <

Forensic Trace evidence

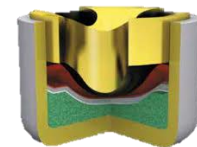
Gunshot residue



- **Gunshot residue (GSR)**
- **Lead / Antimony / Barium**
- **Originates from Primer**
- **Escapes from a gun when discharged**
- **Settles on skin (hand) and clothes**
- **Lead-free ammunition**



<https://www.bka.de/>



<https://rws-ammunition.com/de/>

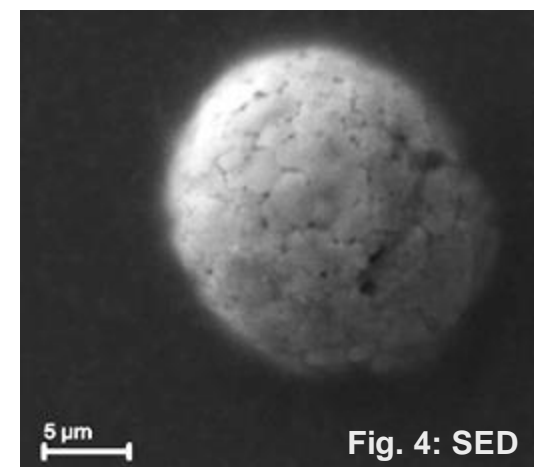
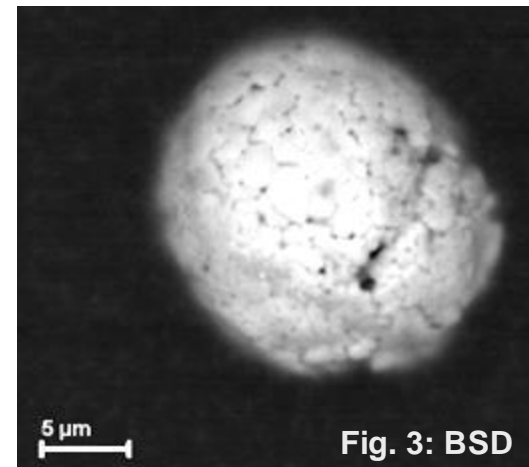
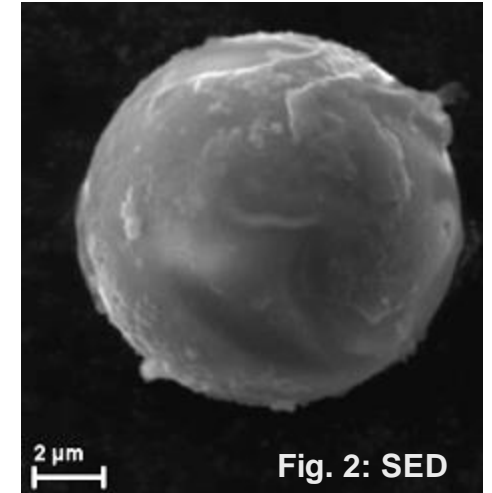
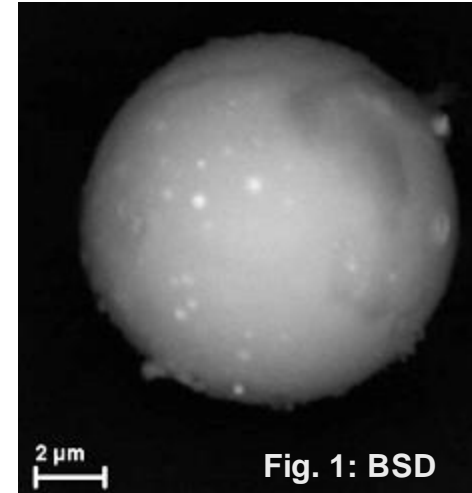
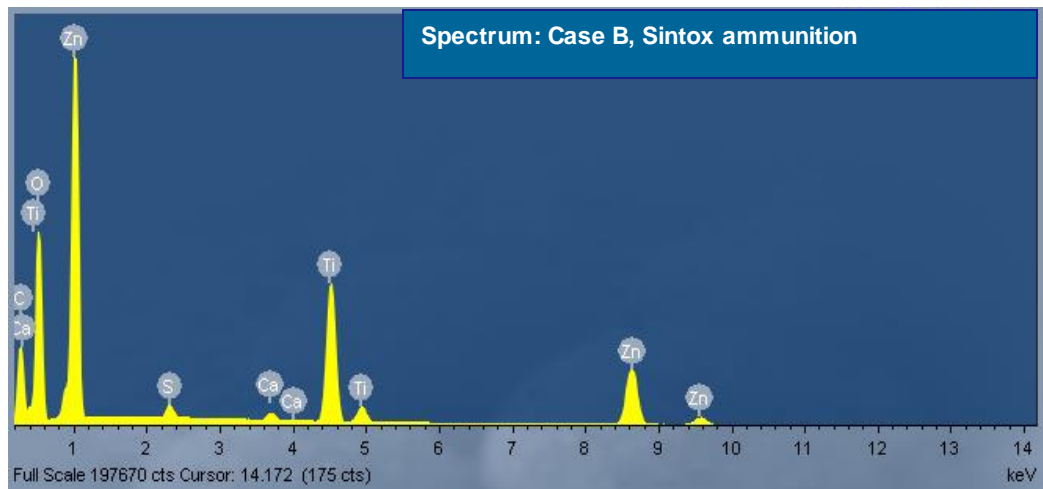
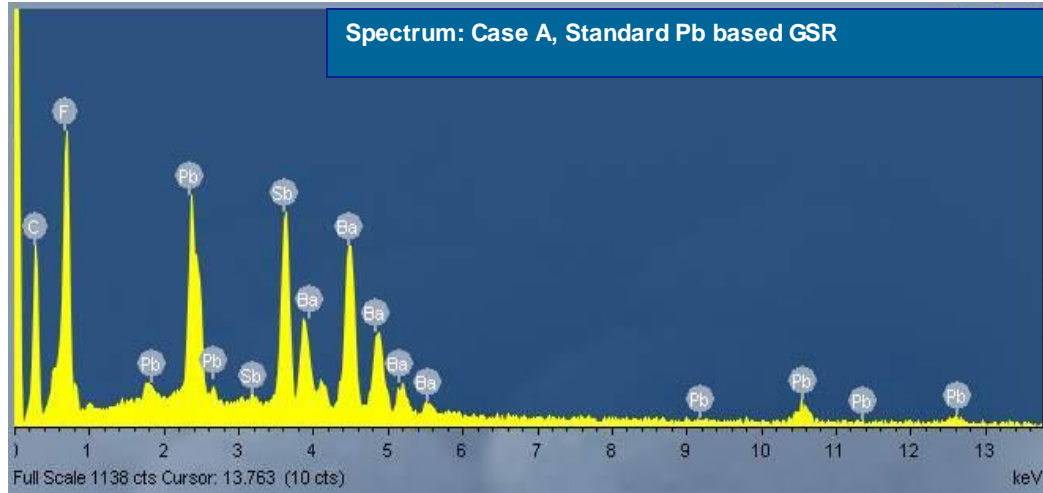
Forensic Trace evidence Gunshot residue



<https://www.bka.de/>

Forensic Trace evidence

Gunshot residue



<https://www.bka.de/>

Forensic Trace evidence

Gunshot residue Sigma 300 / Sigma 500



- **High resolution for smaller particles below 1 μ m**
- **multiple EDX detectors for higher sensitivity in light elements area**
- **Intuitive operation**



Forensic Trace evidence

Gunshot residue



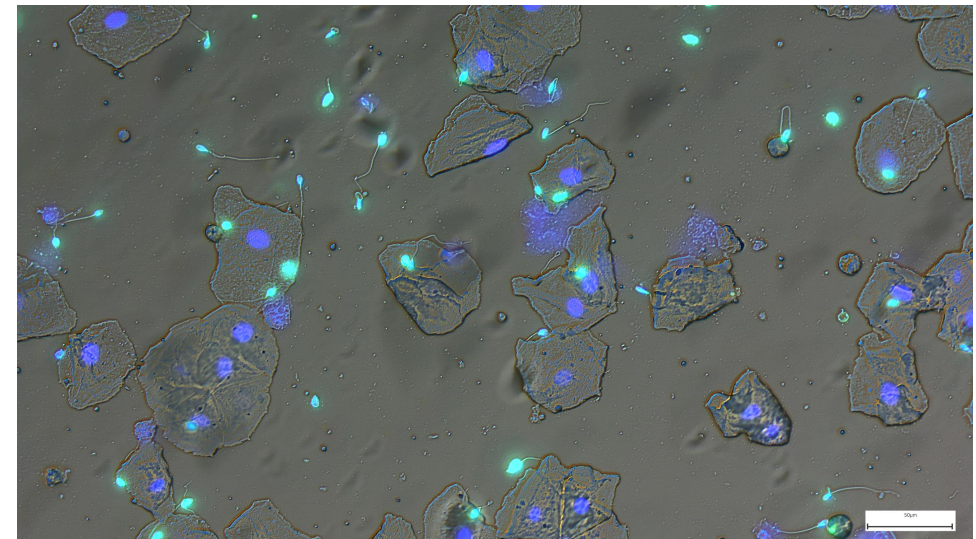
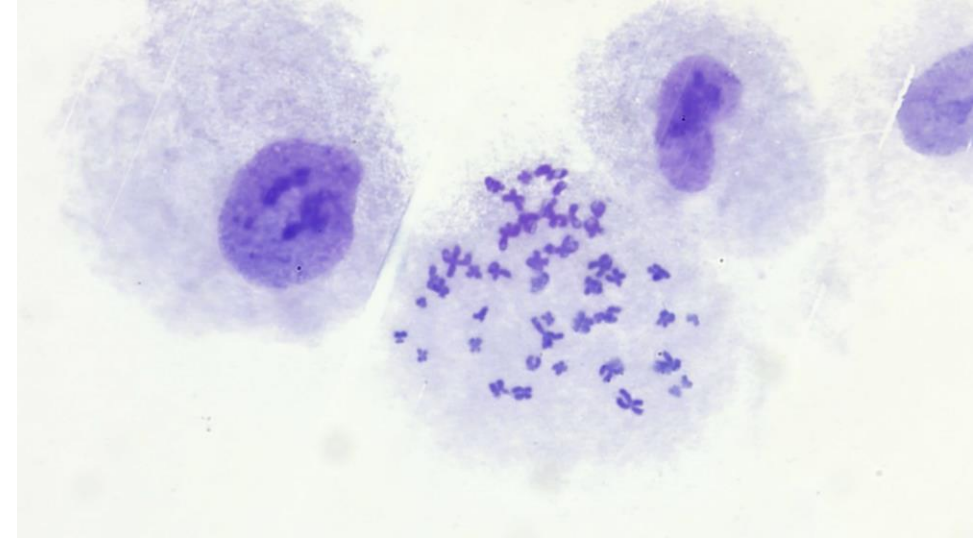
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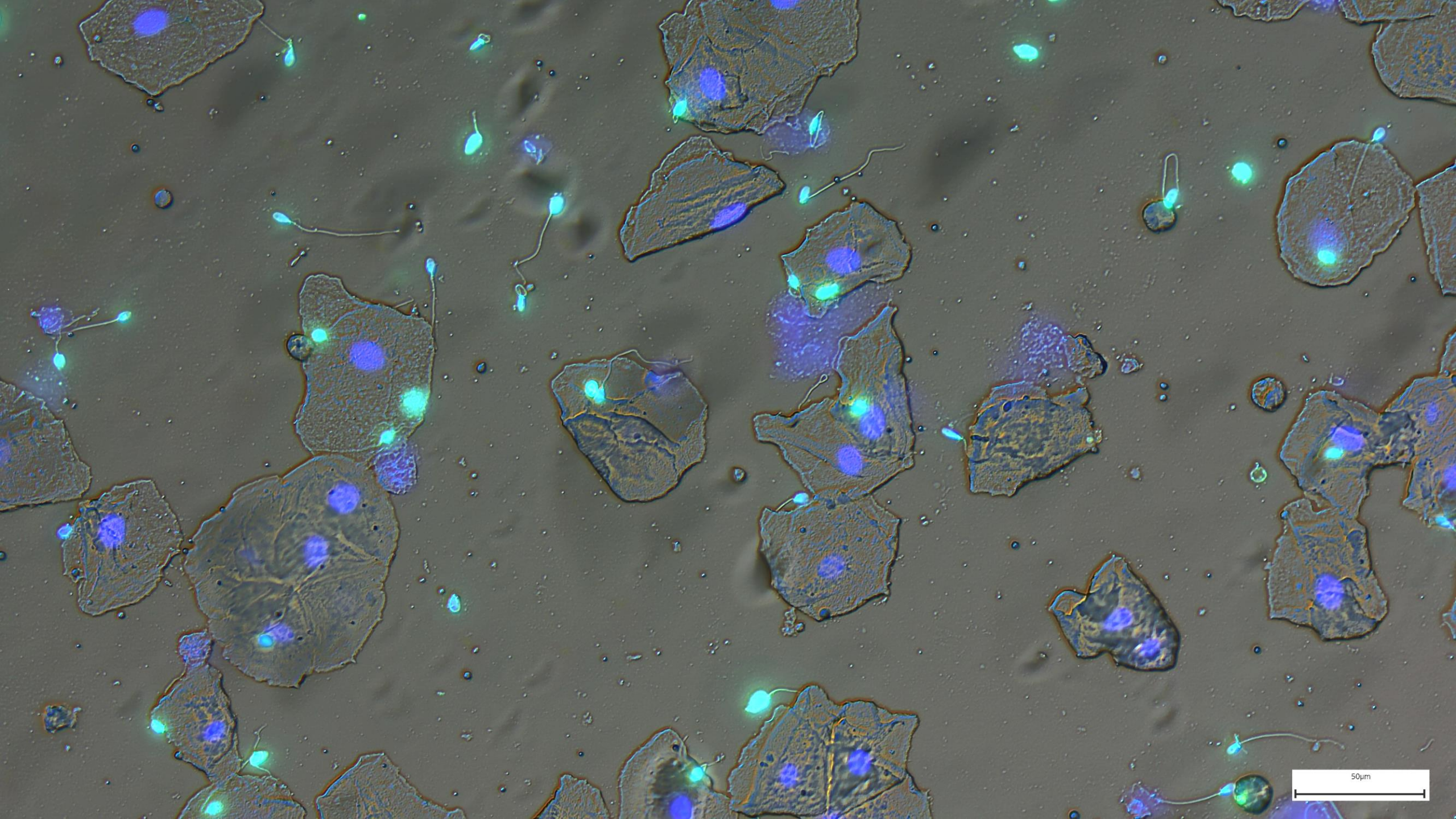
> DNA Analysis <

Forensic Trace evidence DNA Analysis



- **Genetic fingerprint (Jeffreys, 1984)**
- **found in blood, skin, hair, toothbrush, chewing gum, ...**
- **DNA amplification by PCR**
- **STR analysis to compare evidence material with reference sample**
- **Microscopy assists to find DNA traces**





50µm

Light Microscopes



Primo Star/Tech



Axio Lab



Axio Scope



Axio Imager 2



Primovert HDcam



Axio Vert.A1



Axio Observer

Forensic Trace evidence

Laser Microdissection in Sexual Assault Evidence

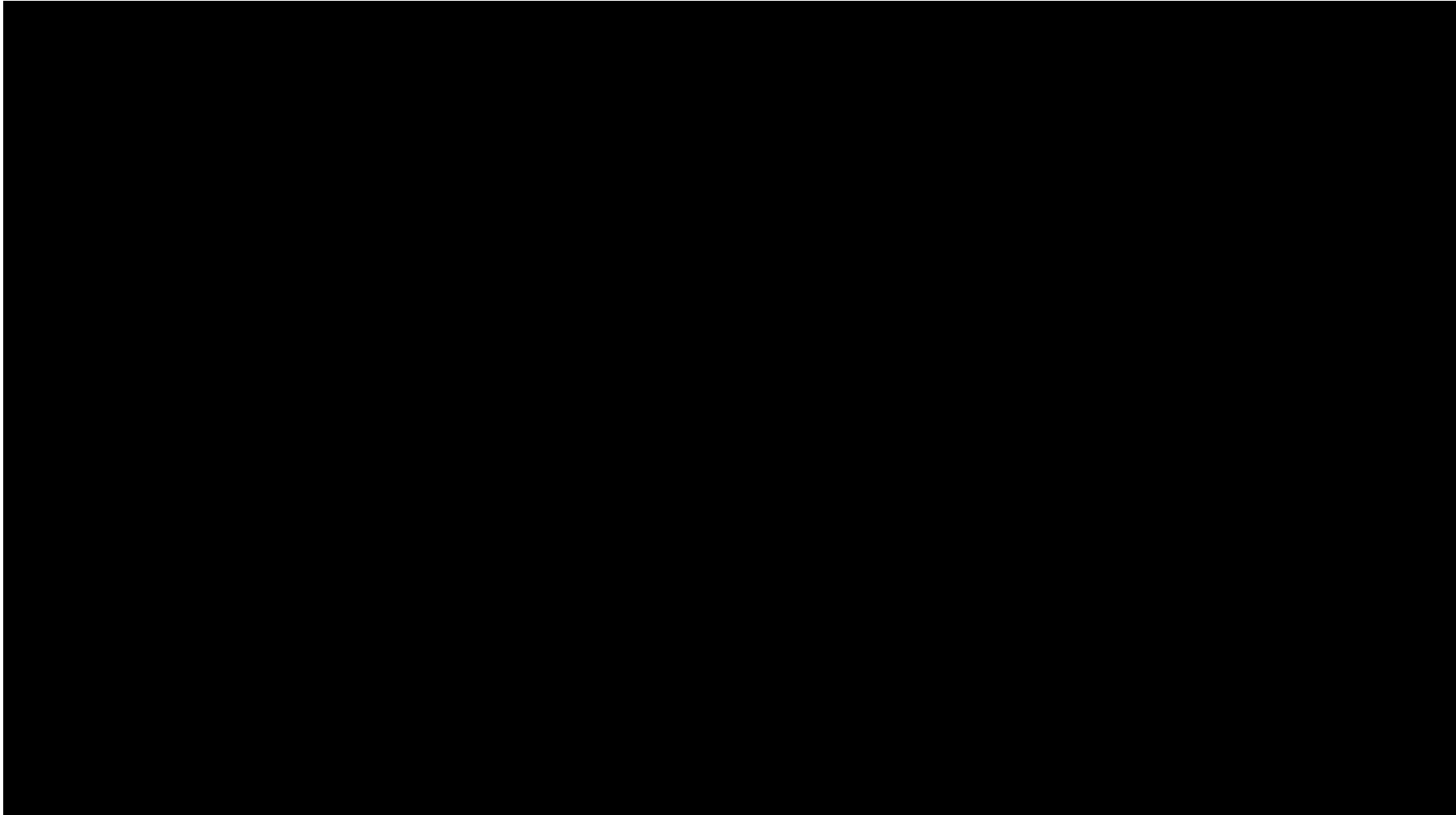


- **Reliable and efficient DNA profiling**
- **non-contact, against gravity => no contamination**
- **automated workflow reduces human error**



Forensic Trace evidence

Laser Microdissection in Sexual Assault Evidence



Forensic Trace evidence Q&A



MICROSCOPY + METROLOGY SERVICES

Spisse made.



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