Current Technology Used in the Laboratory

William E. Demuth II

Chair, AFTE Standardization and Training Committee

Training Coordinator, Illinois State Police, Division of Forensic Services, Forensic Sciences Command, Statewide Training Program

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      - Mass/weight, force
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    - The types of measurements collected

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    - Microscopes
    - Measuring Devices
      - Mass/weight, force
      - Dimensional
    - The types of measurements collected
      - Purpose
      - Possible issues

Microscopes

- Stereomicroscope

  "An optical instrument, which provides three dimensional viewing of an object through paired objectives and eyepieces. Some models share a common main objective"

  AFTE Glossary, 5th Edition

Microscopes

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  - Provides stereoscopic view
  - Allows for less restricted manipulation of items
  - May be used in conjunction with standard measuring devices
  - Bridges the gap between visual examination of items and the use of the comparison microscope

Microscopes

- Stereomicroscope
  - Greenough

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    - Two identical optical systems slightly offset to create the stereoscopic effect

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    - Two identical optical systems slightly offset to create the stereoscopic effect
    - Rugged
    - Compact
    - Relatively inexpensive

Microscopes

American Optical Cycloptic® Stereomicroscope

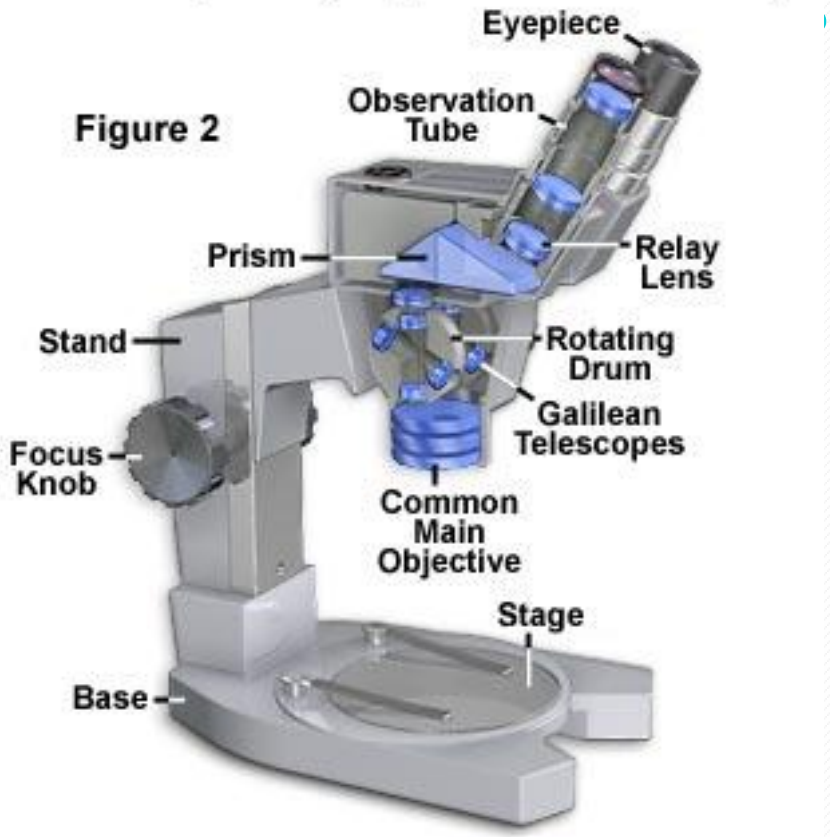
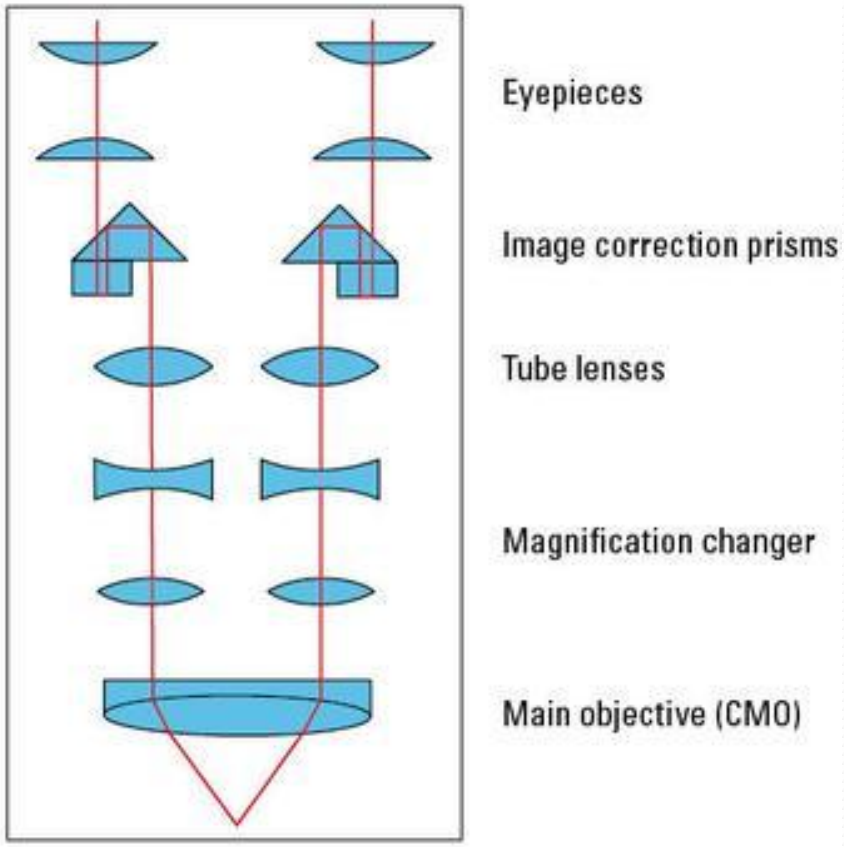


Image courtesy of Nikon's MicrscopyU

Stereomicroscope

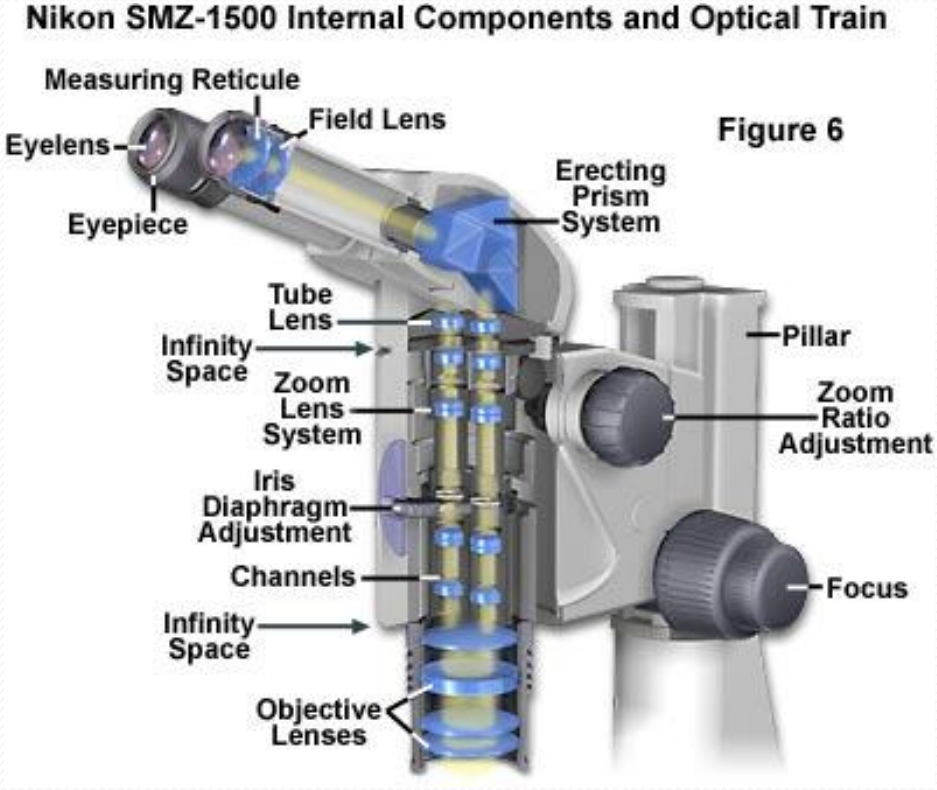
- Common Main Objective (CMO)

Microscopes



- Stereomicroscope
  - Common Main Objective (CMO)
    - Single, large diameter objective lens

Microscopes



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Stereomicroscope

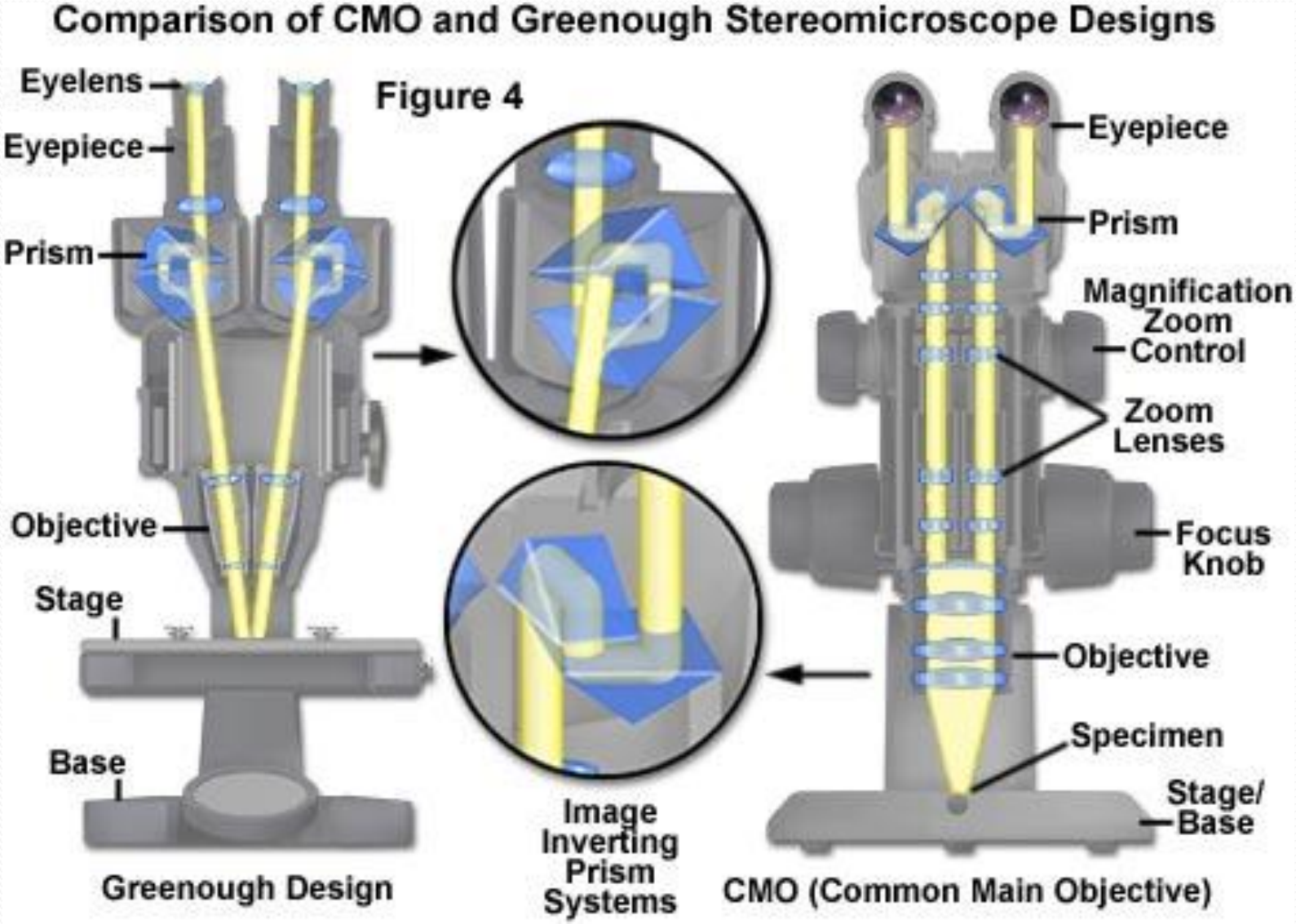
- Common Main Objective (CMO)
  - Single, large diameter objective lens
  - Collimated light path
    - Accessories can be introduced into the infinity space with little to no image aberrations

Microscopes

Nikon SMZ-1500 Equipped For Photomicrography

Image courtesy of Nikon's MicrscopyU

- Stereomicroscope
  - Common Main Objective (CMO)
    - Single, large diameter objective lens
    - Collimated light path
      - Accessories can be introduced into the infinity space with little to no image aberrations
    - Can cost several times as much as a Greenough-type



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Microscopes

- Comparison Microscope

  " Essentially two microscopes connected to an optical bridge which allows the viewer to observe two objects simultaneously with the same degree of magnification. This instrument can have a monocular or binocular eyepiece. Sometimes referred to as a COMPARISON MACROSCOPE."

  AFTE Glossary, 5th Edition

Microscopes

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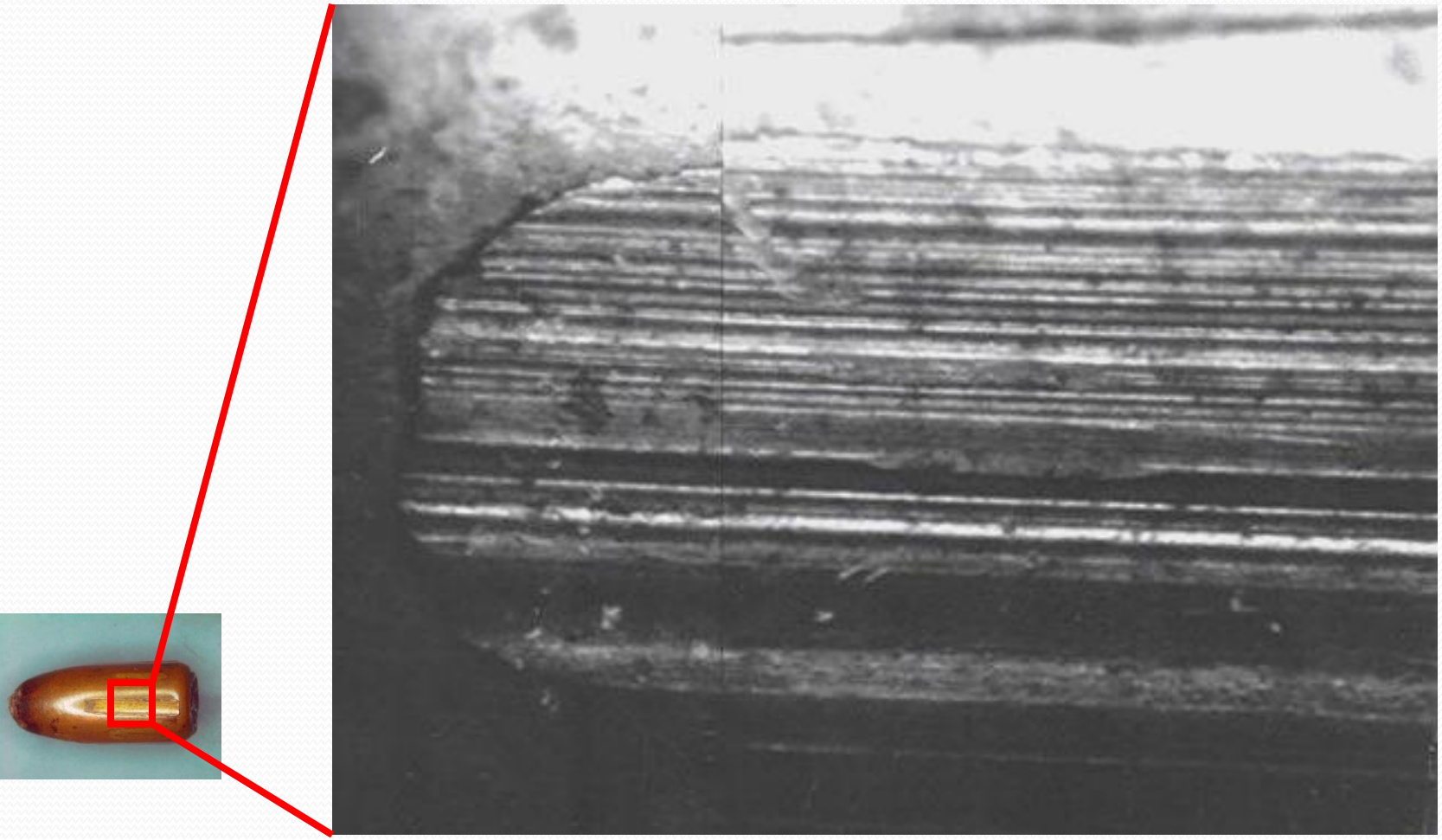
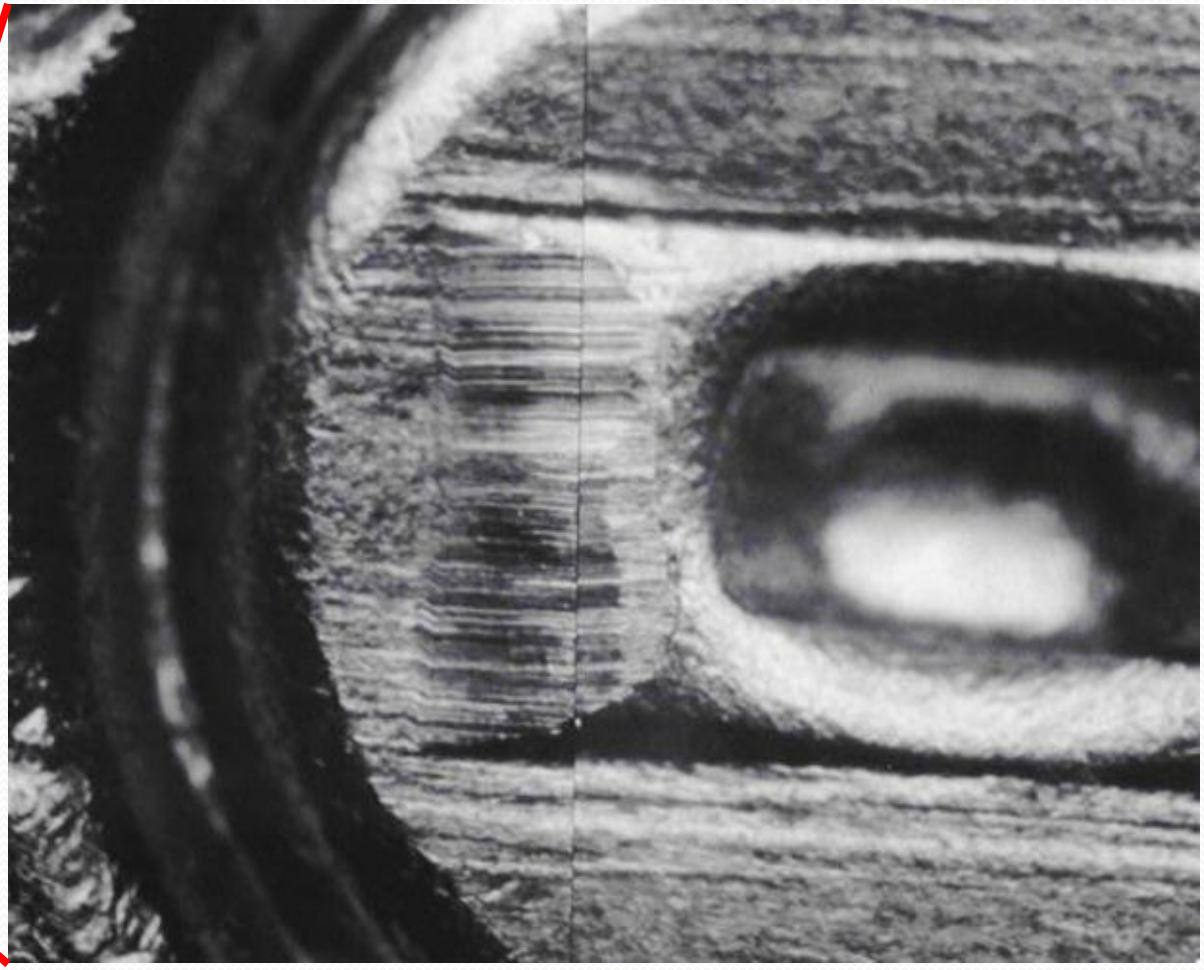
- Comparison Microscope
  - Instrument by which fired ammunition components are directly compared to one another

Bullets Fired from the Same Barrel



Cartridge Cases Fired in the Same Firearm



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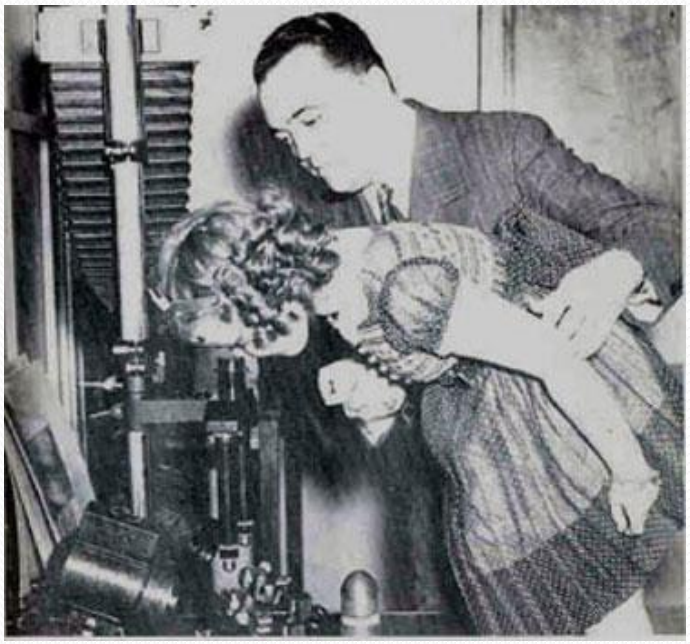
  - Has remained largely unchanged since it's introduction



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Measuring Devices – Weight/Mass, Force

- Powder Balance

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  - Mass of bullet

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  - Mass of bullet
    - Aid in caliber determination

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  - Mass of bullet
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  - Mass of powder

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  - Mass of powder
    - Downloading cartridges

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    - Aid in caliber determination
  - Mass of powder
    - Downloading cartridges
    - Reloaded/handloaded cartridges

Measuring Devices – Weight/Mass, Force

- Trigger Pull

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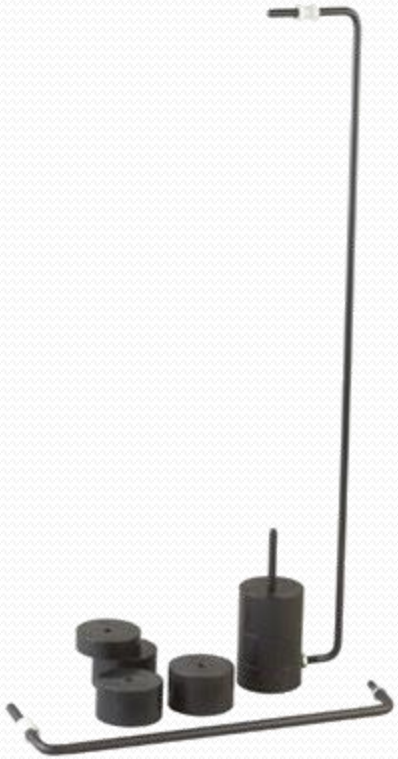
    - Weight is an easier term for most jurors to understand
  - Some agencies may use this information to form a conclusion with regards to accidental/unintentional shooting cases

Measuring Devices – Weight/Mass, Force

- Arsenal weights



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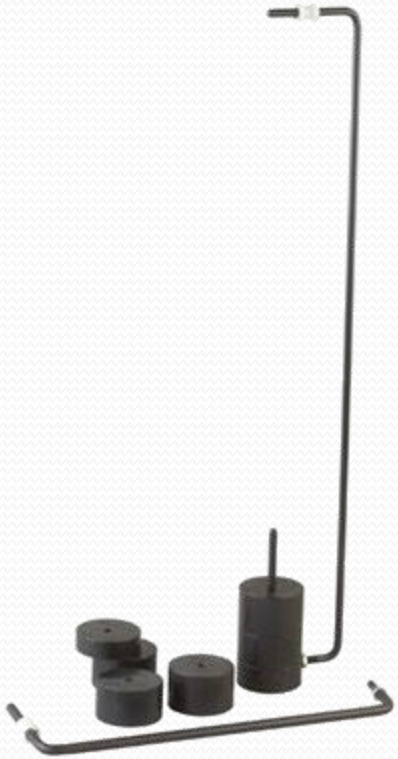

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  - Increasing amounts of weight added until trigger releases sear

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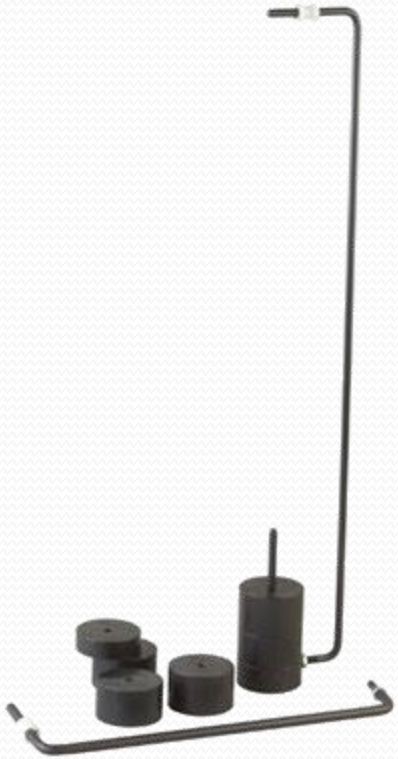

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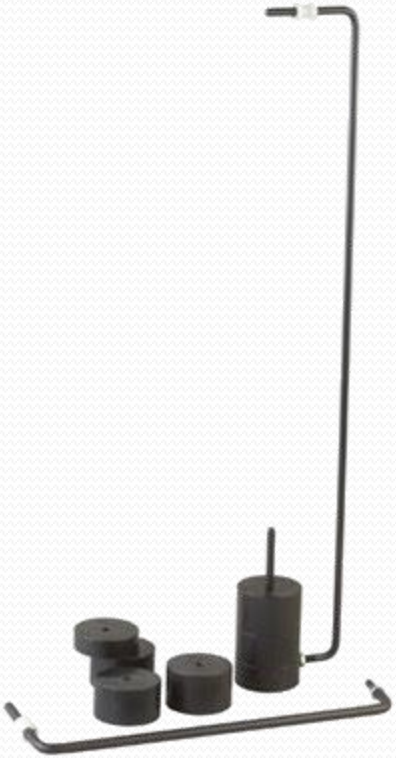

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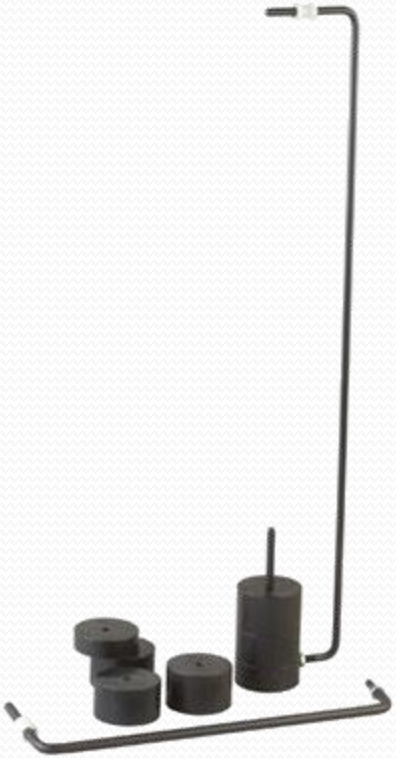

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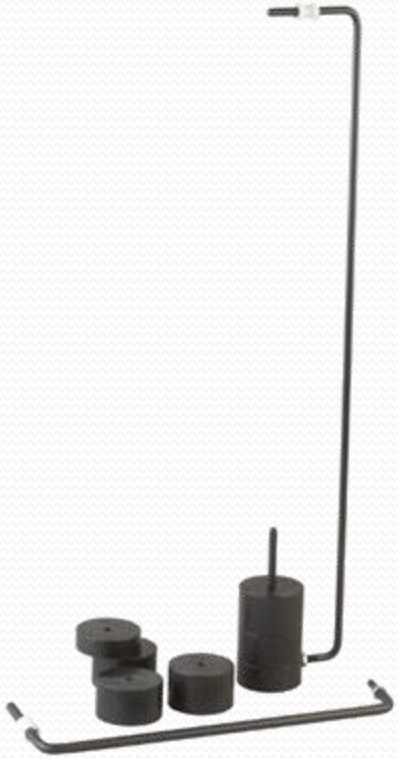

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  - Increasing amounts of weight added until trigger releases sear
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- Poor technique yields poor results

Measuring Devices – Weight/Mass, Force

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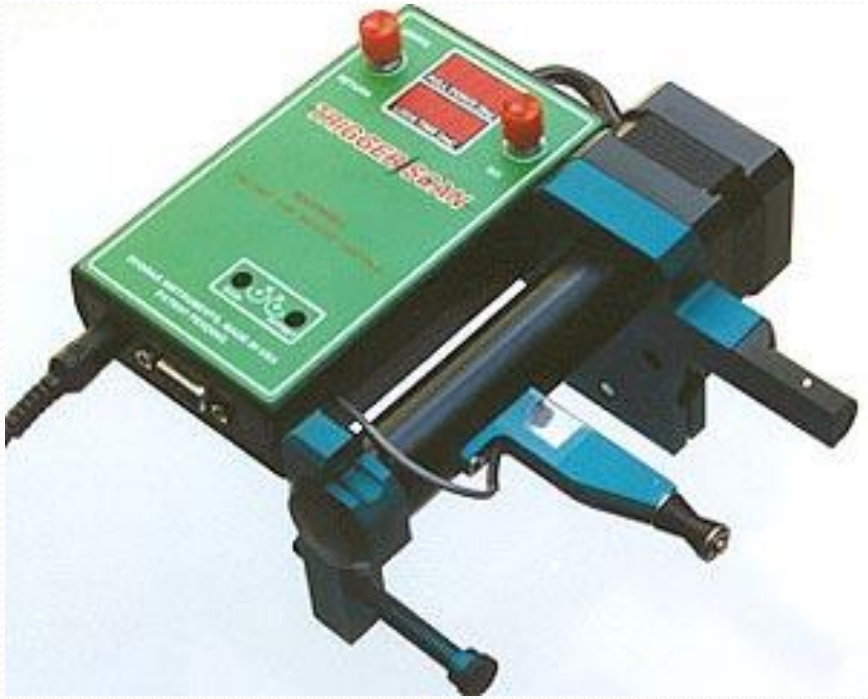
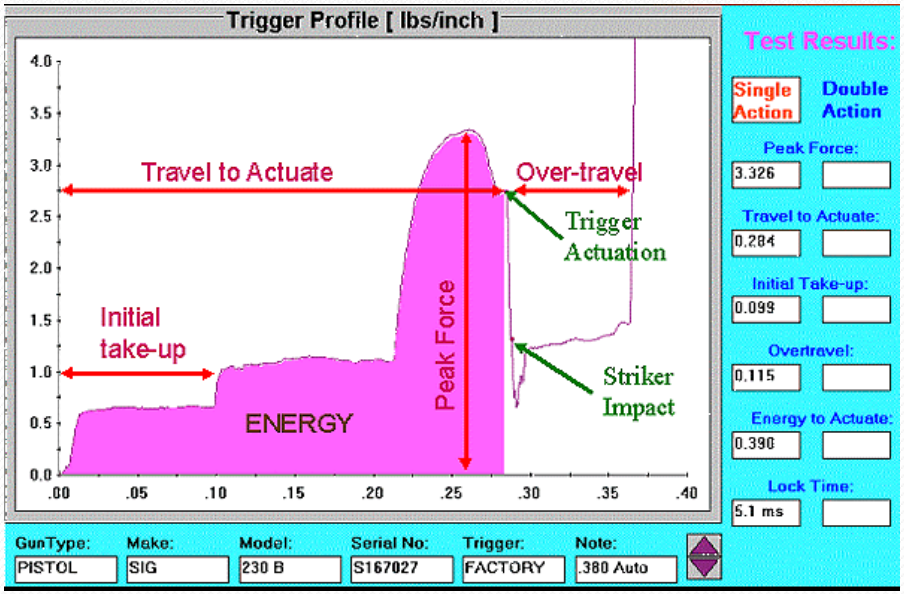


Measuring Devices – Weight/Mass, Force

- Force gauge
- Automated models that recognize when the trigger "breaks"

Measuring Devices – Weight/Mass, Force

- Force gauge
- Automated models that recognize when the trigger "breaks"
- Measurements given in Joules or Inch-Pound Force



Measuring Devices - Dimensional

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    - Barrel length of firearms
  - May be inexpensive, simple devices
  - May be special-purpose devices
  - Should be certified and traceable to a NIST standard
    - Used for critical measurements

Measuring Devices - Dimensional

- Barrel Length and Overall Length
  - The term "short-barreled shotgun" means a shotgun having one or more barrels less than eighteen inches in length and any weapon made from a shotgun (whether by alteration, modification, or otherwise) if such weapon as modified has an overall length of less than twenty-six inches.

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  - The term "short-barreled rifle"means a rifle having one or more barrels less than sixteen inches in length and any weapon made from a rifle (whether by alteration, modification, or otherwise) if such weapon, as modified, has an overall length of less than twenty-six inches.

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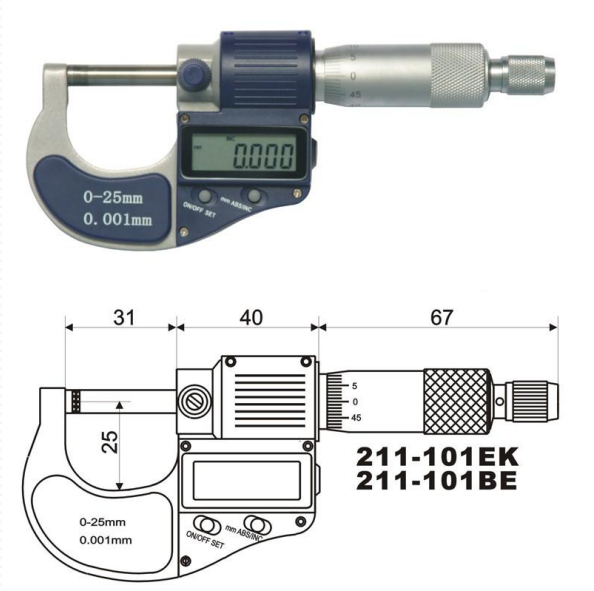
  - Additional charges may be leveled based on the measurements collected and reported
    - Use of certified measuring devices
    - Calculation of Measurement Uncertainty

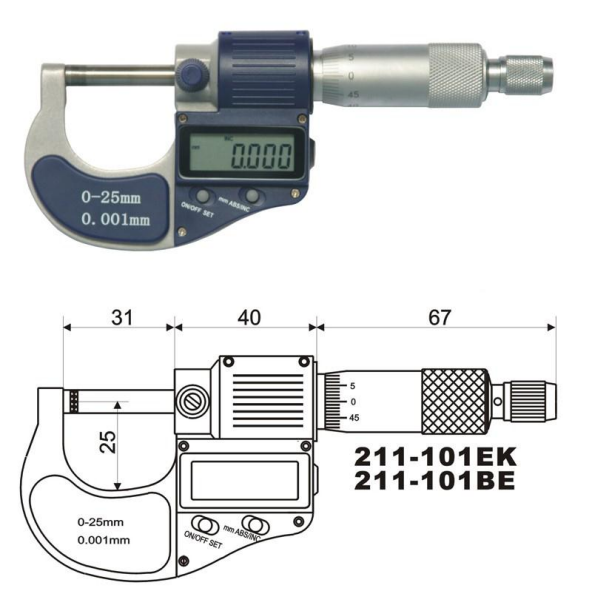
Measuring Devices - Dimensional

- Micrometer



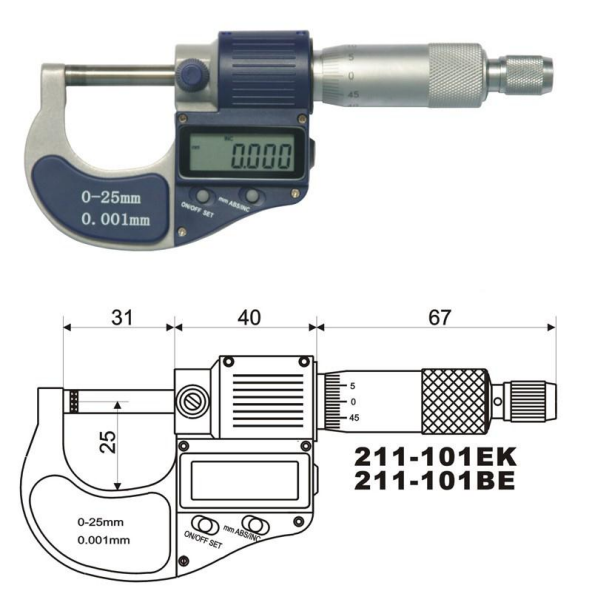
Measuring Devices - Dimensional

- Micrometer
  - Used for dimensional measurements on fired evidence



Measuring Devices - Dimensional

- Micrometer
  - Used for dimensional measurements on fired evidence
    - Determining caliber for cartridge cases with inadequate/misleading headstamp markings



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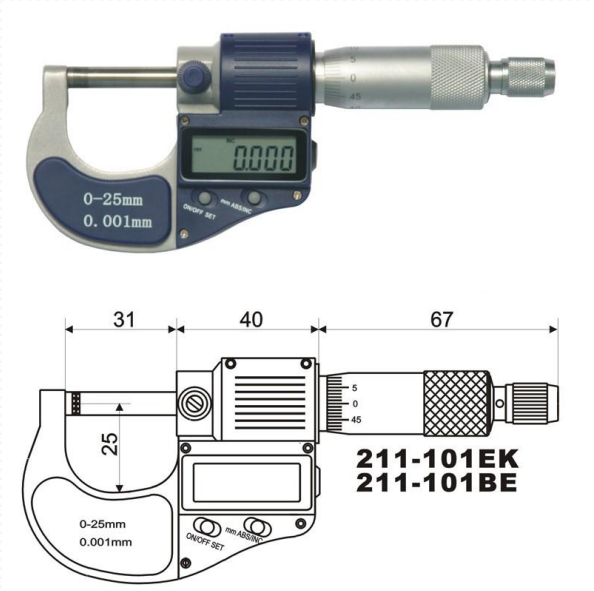

Measuring Devices - Dimensional

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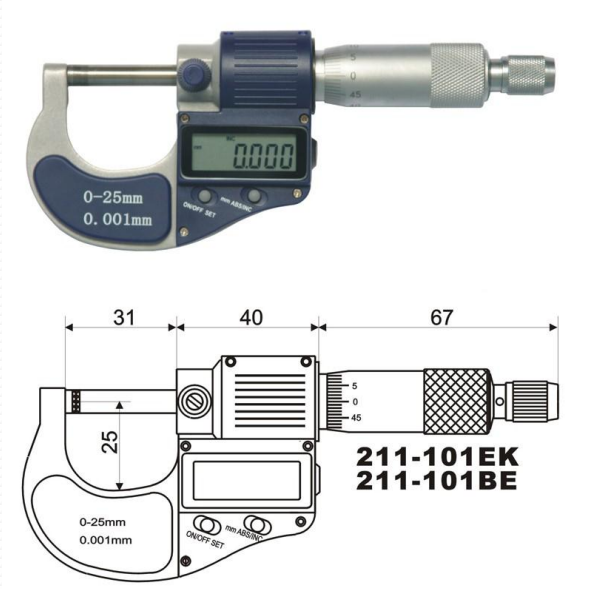
    - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
    - Caliber of fired bullets
      - Diameter of bearing surface



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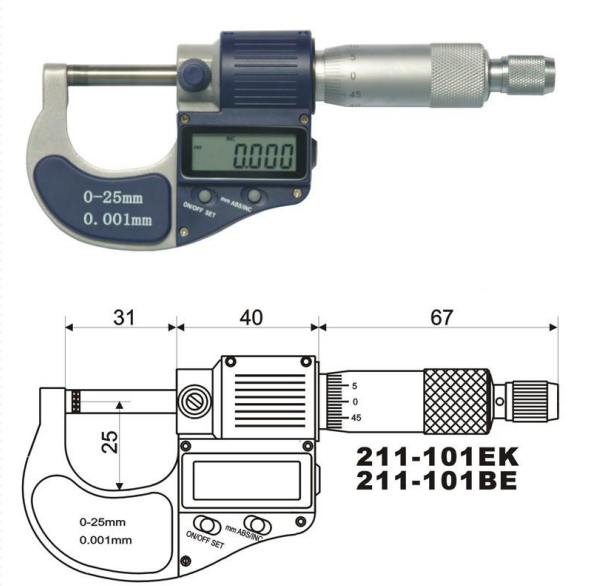
      - Diameter of bearing surface
      - Width of land and groove impressions



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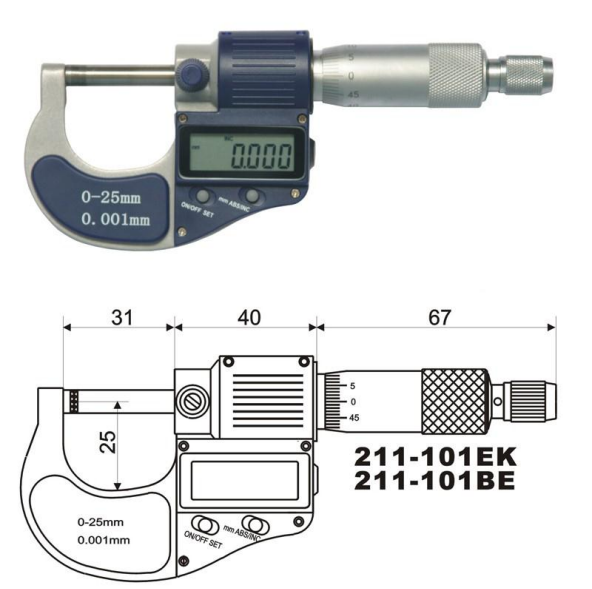
        - When used in conjunction with stereo or comparison microscope



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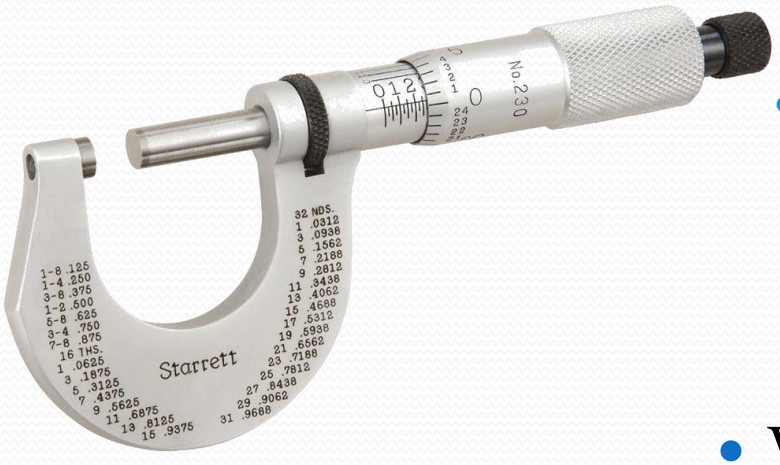

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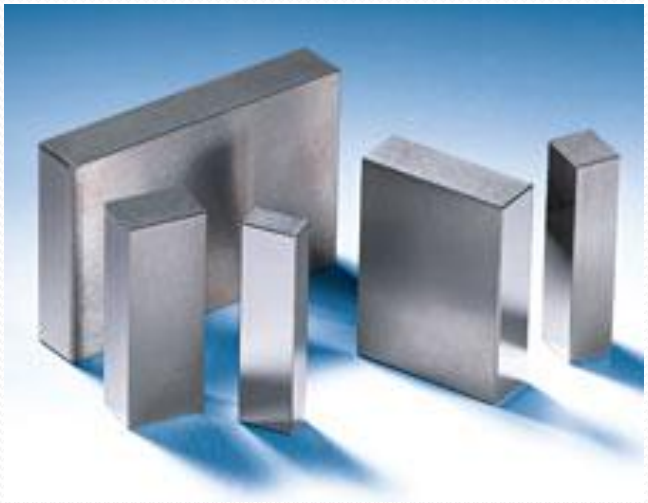
    - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
        - When used in conjunction with stereo or comparison microscope
  - Various levels of quality and readout

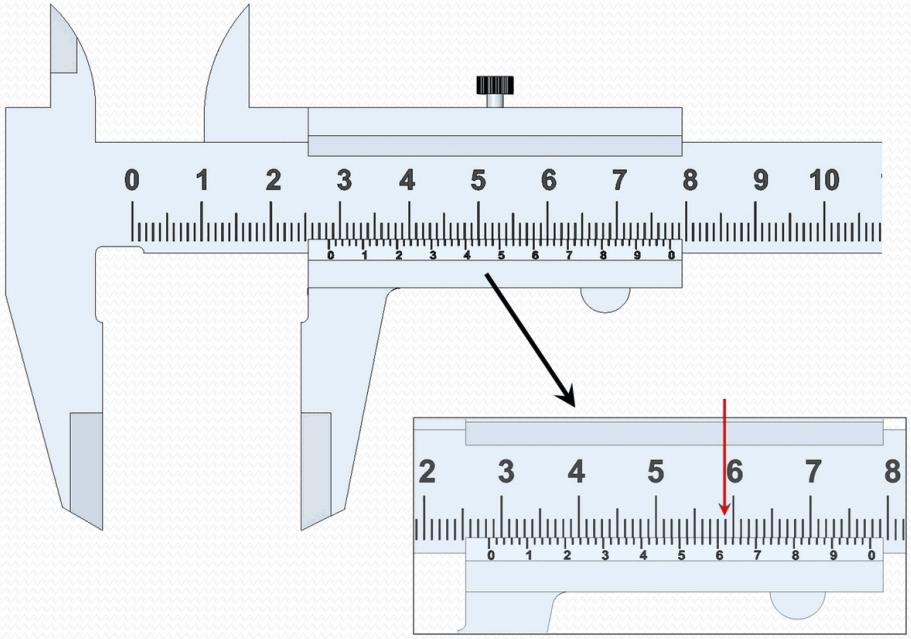
Measuring Devices - Dimensional



- Micrometer
  - Used for dimensional measurements on fired evidence
    - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
        - When used in conjunction with stereo or comparison microscope
  - Various levels of quality and readout
  - Typically are periodically checked against a NIST certified gauge block

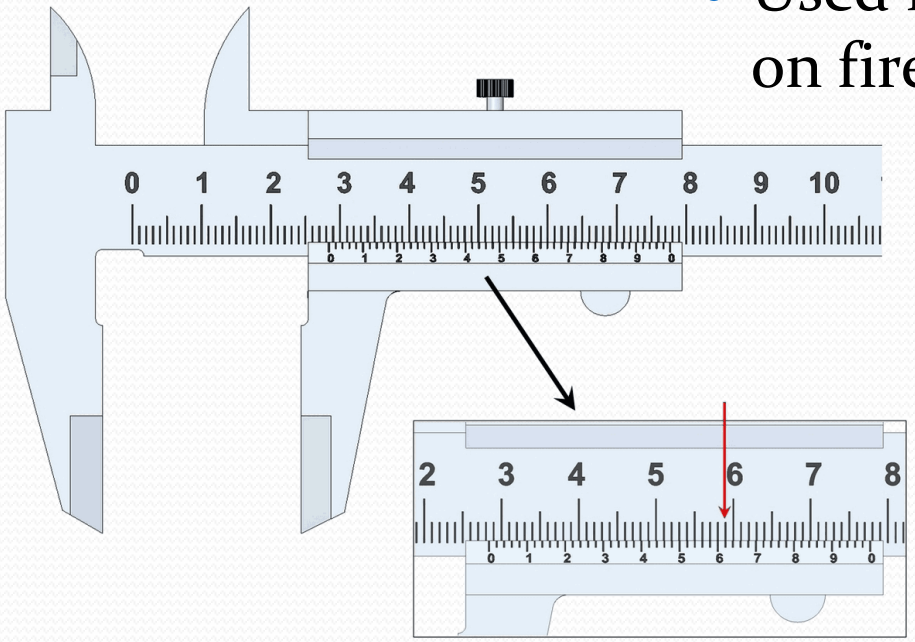
Measuring Devices - Dimensional

- Caliper



Measuring Devices - Dimensional

- Caliper
  - Used for dimensional measurements on fired evidence



Measuring Devices - Dimensional

- Caliper
  - Used for dimensional measurements on fired evidence
    - Determining caliber for cartridge cases with inadequate/misleading headstamp markings

Measuring Devices - Dimensional

- Caliper
  - Used for dimensional measurements on fired evidence
    - Determining caliber for cartridge cases with inadequate/misleading headstamp markings
    - Caliber of fired bullets

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    - Caliber of fired bullets
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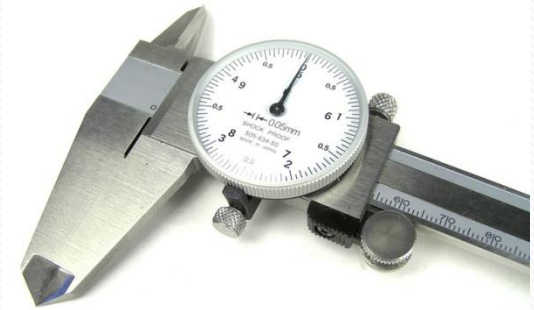
Measuring Devices - Dimensional



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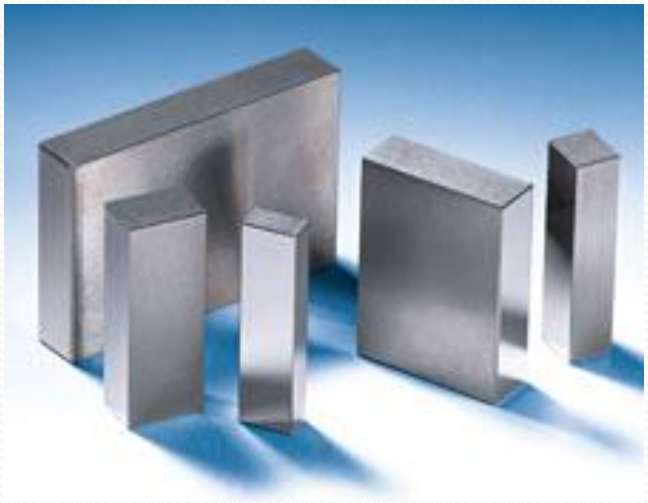
Measuring Devices - Dimensional



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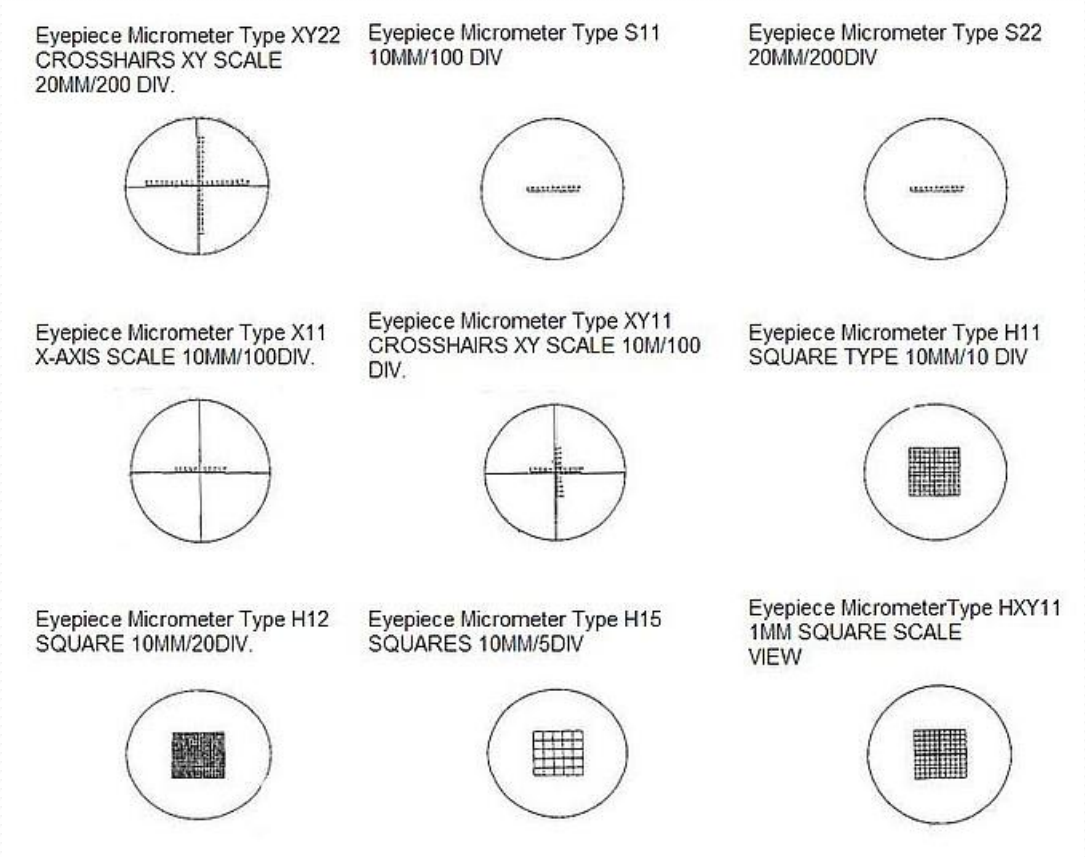
Measuring Devices - Dimensional

- Reticules

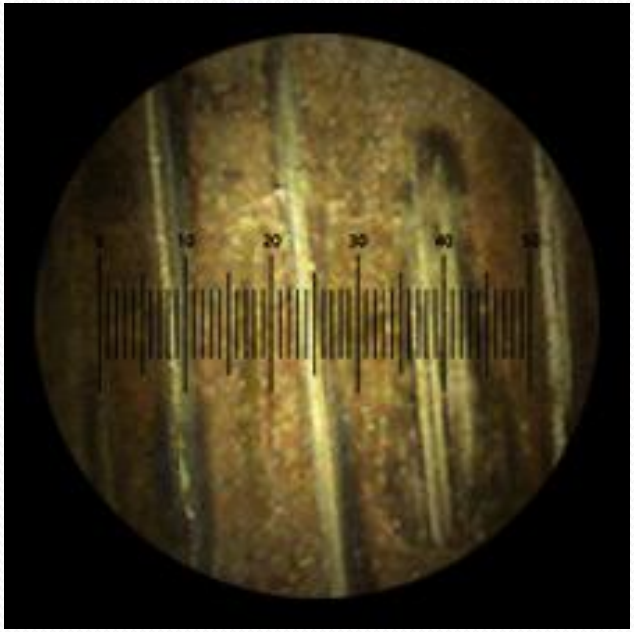


Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope

Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence



Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets

Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface

Measuring Devices - Dimensional

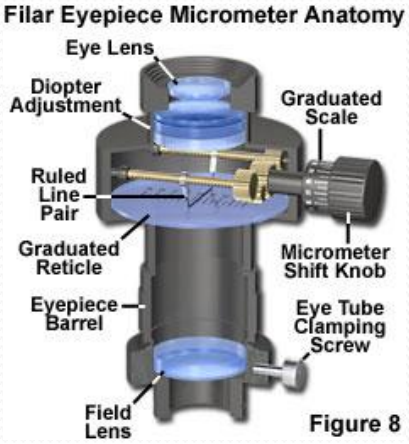
- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions

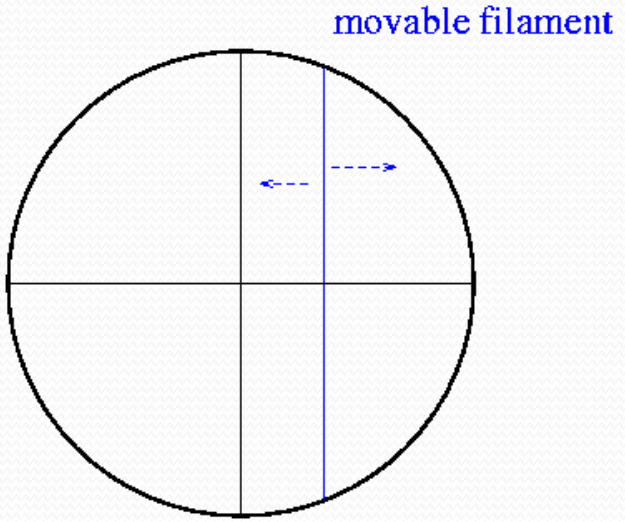
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
  - Ocular with etched division lines

Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
  - Ocular with etched division lines
  - Filar micrometer



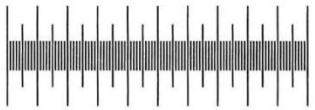


Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
  - Ocular with etched division lines
  - Filar micrometer
  - Digital camera software

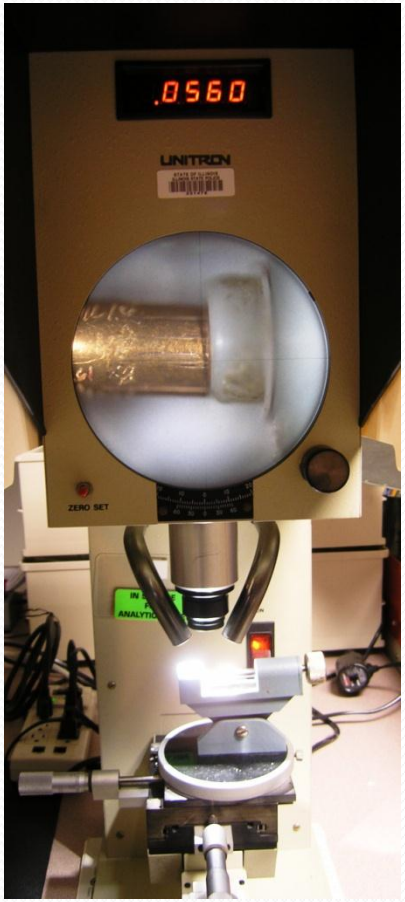
Measuring Devices - Dimensional

- Reticules
  - Employed as a component of a stereo or comparison microscope
  - Used for small scale dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions
  - Ocular with etched division lines
  - Filar micrometer
  - Digital camera software
  - All of these methods should be performance checked regularly against a certified stage micrometer

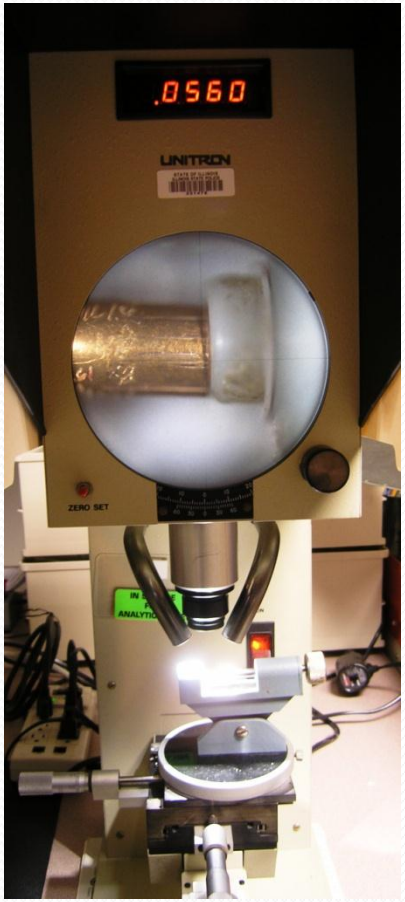


Measuring Devices - Dimensional

- MP6 Measuring Projector

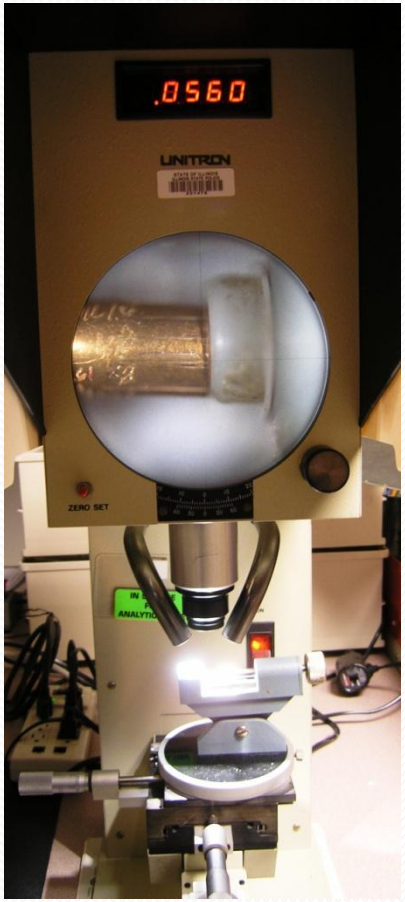


Measuring Devices - Dimensional



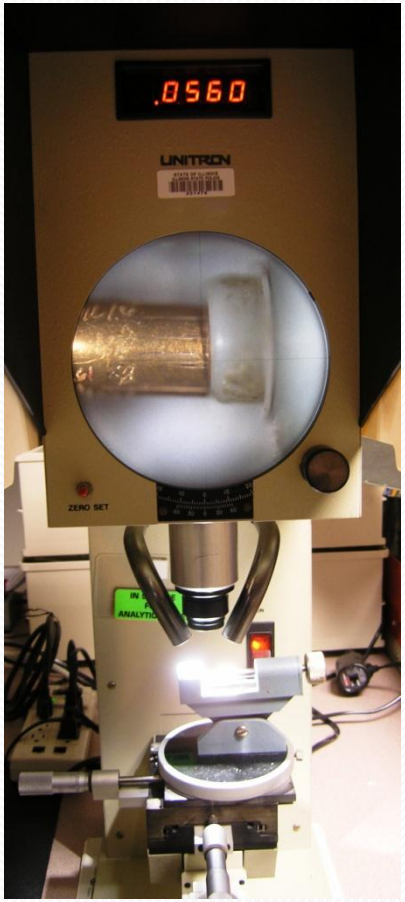
- MP6 Measuring Projector
  - Used for dimensional measurements on fired evidence

Measuring Devices - Dimensional



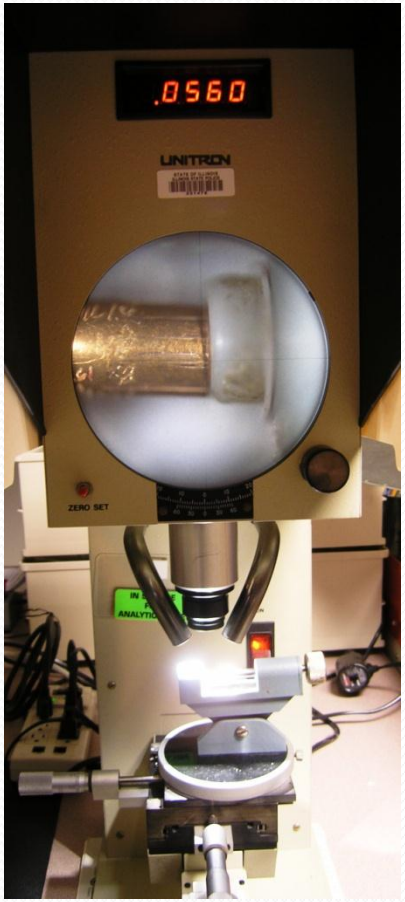
- MP6 Measuring Projector
  - Used for dimensional measurements on fired evidence
    - Caliber of fired bullets

Measuring Devices - Dimensional



- MP6 Measuring Projector
  - Used for dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface

Measuring Devices - Dimensional



- MP6 Measuring Projector
  - Used for dimensional measurements on fired evidence
    - Caliber of fired bullets
      - Diameter of bearing surface
      - Width of land and groove impressions

Measuring Devices - Dimensional

- MP6 Measuring Projector

Measuring Devices - Dimensional

- MP6 Measuring Projector
  - Image of item is projected on a screen with a fixed anchor line

Measuring Devices - Dimensional

- MP6 Measuring Projector
  - Image of item is projected on a screen with a fixed anchor line
  - The stage is connected directly or indirectly to a measuring device

Fired Evidence

- Cartridge Cases
  - Inadequate headstamp

Fired Evidence

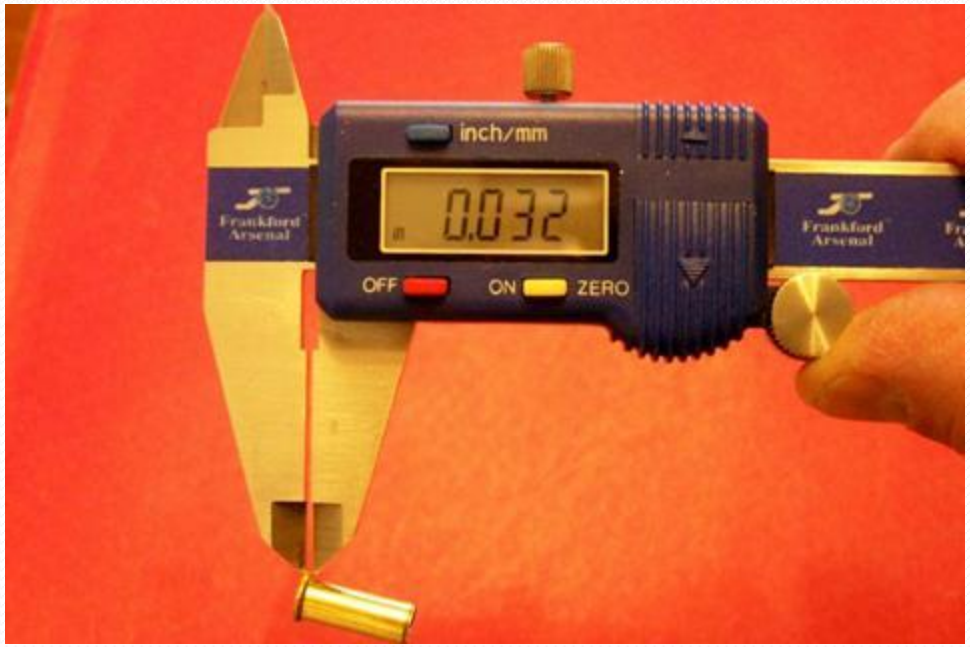
- Cartridge Cases
  - Inadequate headstamp
  - Misleading headstamp

Fired Evidence

- Cartridge Cases

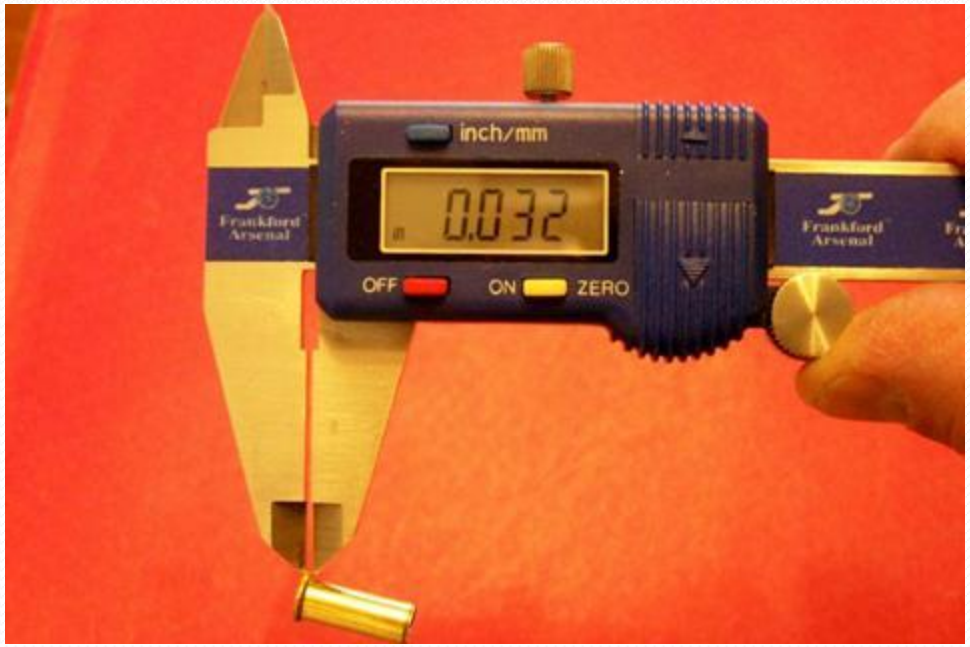
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken



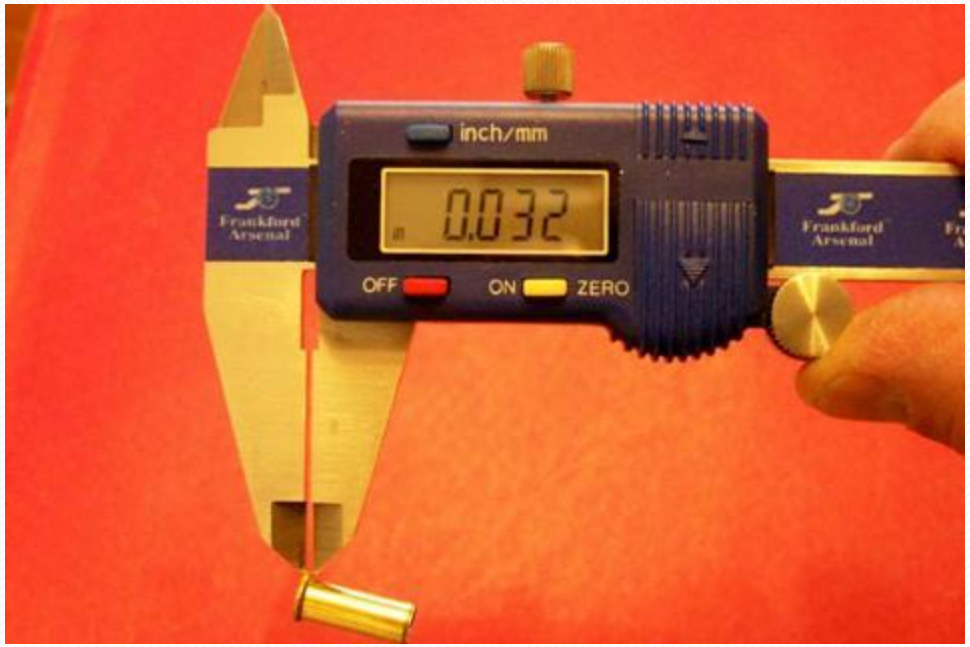
Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer



Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper



Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper
  - Dimensions compared to published standards

Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper
  - Dimensions compared to published standards
    - Reloading manuals

Fired Evidence

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  - Dimensional measurements taken
    - Micrometer
    - Caliper
  - Dimensions compared to published standards
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    - Reference works *(Cartridges of the World)*

Fired Evidence

- Cartridge Cases
  - Dimensional measurements taken
    - Micrometer
    - Caliper
  - Dimensions compared to published standards
    - Reloading manuals
    - Reference works *(Cartridges of the World)*
    - Commercially available databases

Fired Evidence

- Cartridge Cases

Fired Evidence

- Cartridge Cases
  - Potential pitfalls

Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer

Fired Evidence

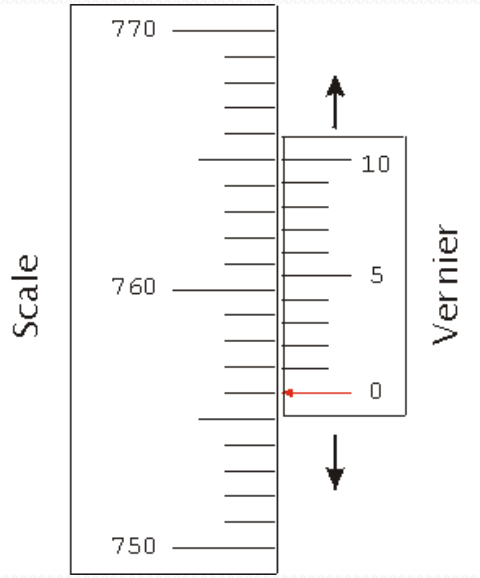
- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges

Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
    - The “human factor”

Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
    - The “human factor”
      - Reading the device



Fired Evidence

- Cartridge Cases
  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
    - The "human factor"
      - Reading the device
      - Selecting the proper areas to measure

Fired Evidence

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  - Potential pitfalls
    - Dimensional tolerances vary slightly by manufacturer
    - Due to obturation, dimensions of fired cartridge cases may vary slightly from unfired cartridges
    - The “human factor”
      - Reading the device
      - Selecting the proper areas to measure
      - Generally poor technique

Fired Evidence

- Bullets
  - Three class characteristics are mathematically linked to each other

Fired Evidence

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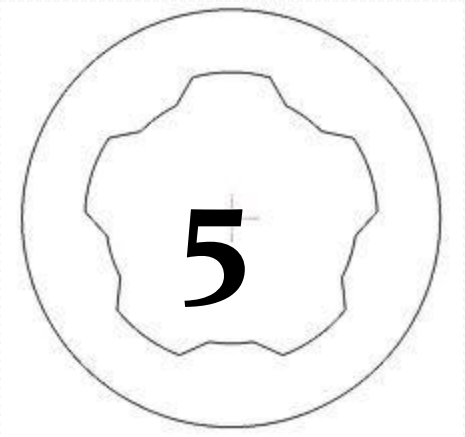
    - Caliber – diameter of the bullet (D)

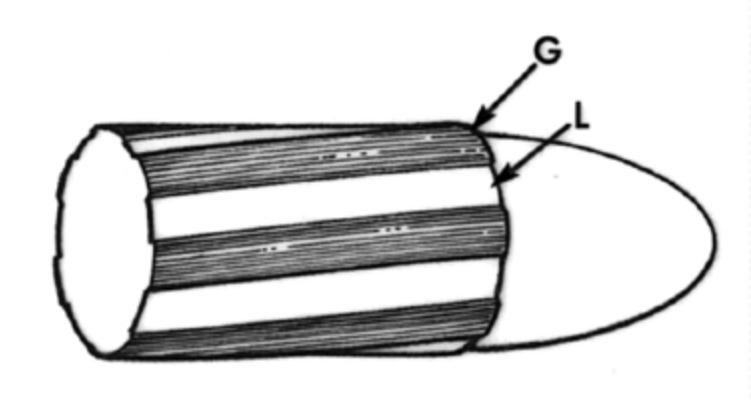
Fired Evidence

- Bullets
  - Three class characteristics are mathematically linked to each other
    - Caliber – diameter of the bullet (D)
    - Number of land and groove impressions (N)



Fired Evidence

- Bullets
  - Three class characteristics are mathematically linked to each other
    - Caliber – diameter of the bullet (D)
    - Number of land and groove impressions (N)
    - Width of the land and groove impressions (L, G)



Fired Evidence

- Bullets
  - Three class characteristics are mathematically linked to each other
    - Caliber – diameter of the bullet (D)
    - Number of land and groove impressions (N)
    - Width of the land and groove impressions (L, G)
  - If two are known, the third can be derived
    - $D = (L + G)(N) / \Pi$

Fired Evidence

- Bullets
  - Example:
    - Damage to bearing surface preventing diameter measurement (D)
    - Measured land impression widths = .056” (L)
    - Measured groove impression widths = .122” (G)
    - Number of land and groove impressions = 6 (N)

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  - $D = (L + G)(N) / \Pi$
  - $D = (.061” + .122”)(6) / 3.14159265$

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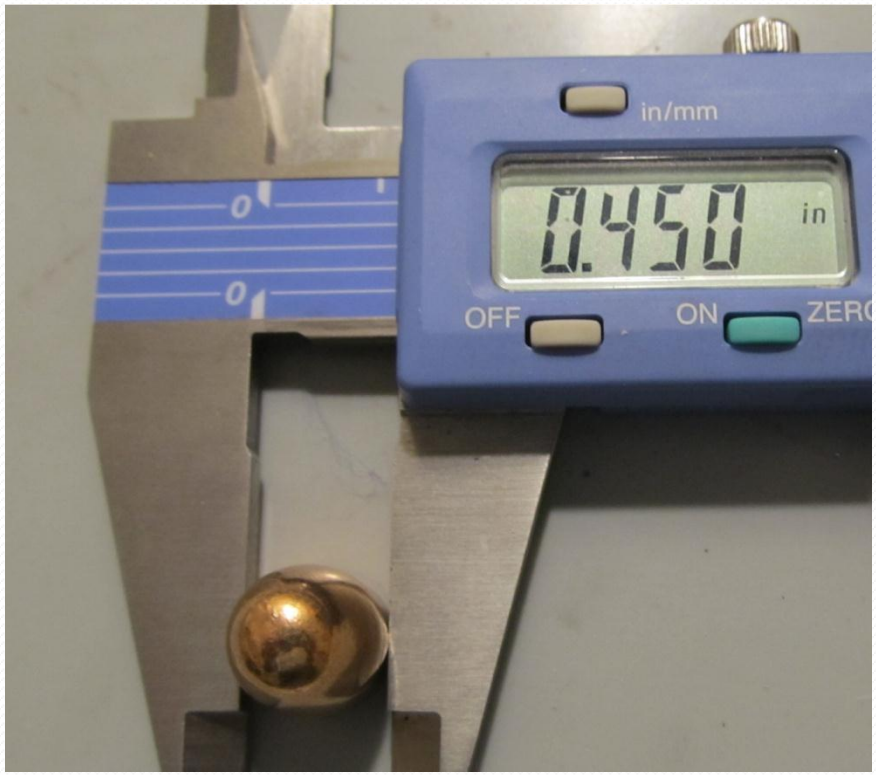
  - D = (.061” + .122”) (6) / 3.14159265
  - D = .349”

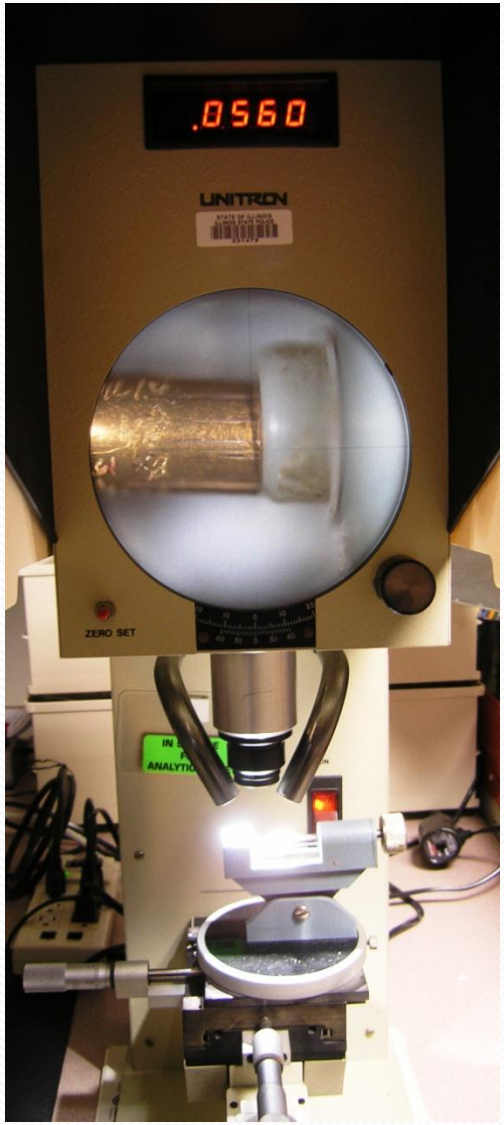
Fired Evidence

- Bullets
  - Diameter can be measured
    - Macroscopically using
      - Caliper
      - Micrometer



Fired Evidence

- Bullets
  - Diameter can be measured
    - Macroscopically using
      - Caliper
      - Micrometer
    - Under magnification using
      - Reticules
      - MP6 measuring projector



Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
    - Under magnification using

Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
    - Under magnification using
      - Reticules

Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
    - Under magnification using
      - Reticules
      - MP6 measuring projector

Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
    - Under magnification using
      - Reticules
      - MP6 measuring projector
      - Ruler

Fired Evidence

- Bullets
  - Land and groove impression widths can be measured
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      - MP6 measuring projector
      - Ruler
      - Caliper (air gap)

Fired Evidence

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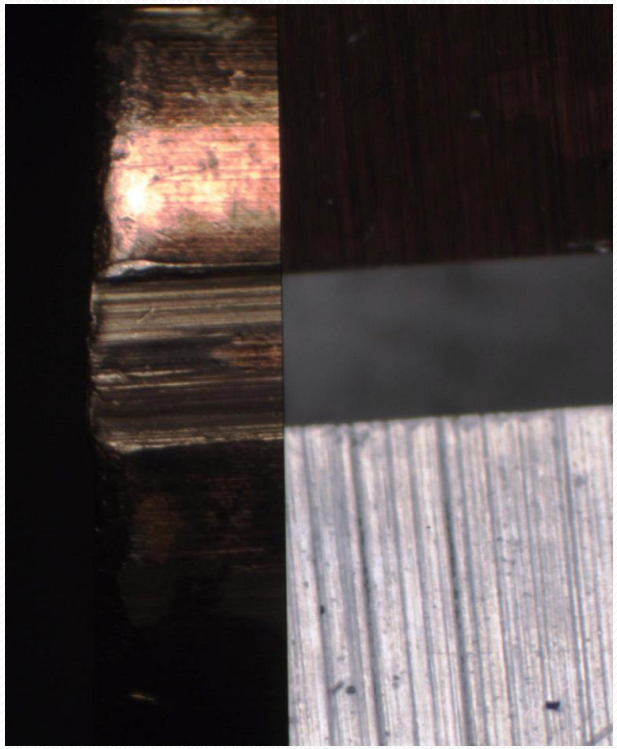
      - Reticules
      - MP6 measuring projector
      - Ruler
      - Caliper (air gap)
      - Micrometer (air gap)



Fired Evidence

- Bullets

Fired Evidence

- Bullets
  - Potential pitfalls

Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions

Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition

Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
    - The “human factor”

Fired Evidence

- Bullets
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
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    - The “human factor”
      - Reading the device

Fired Evidence

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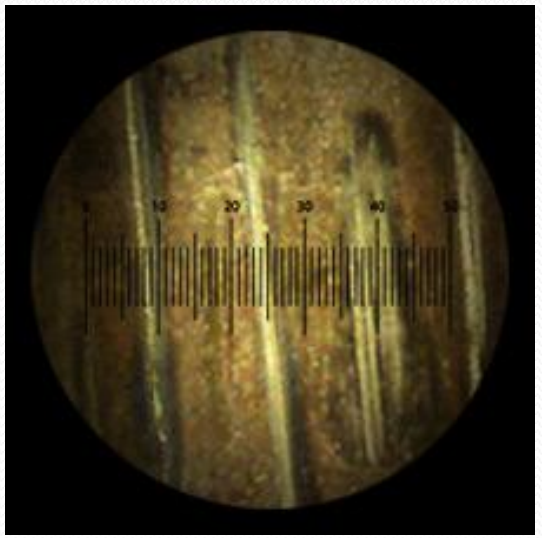
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
    - The “human factor”
      - Reading the device
        - Interpolation between division marks on reticules and rulers



Fired Evidence

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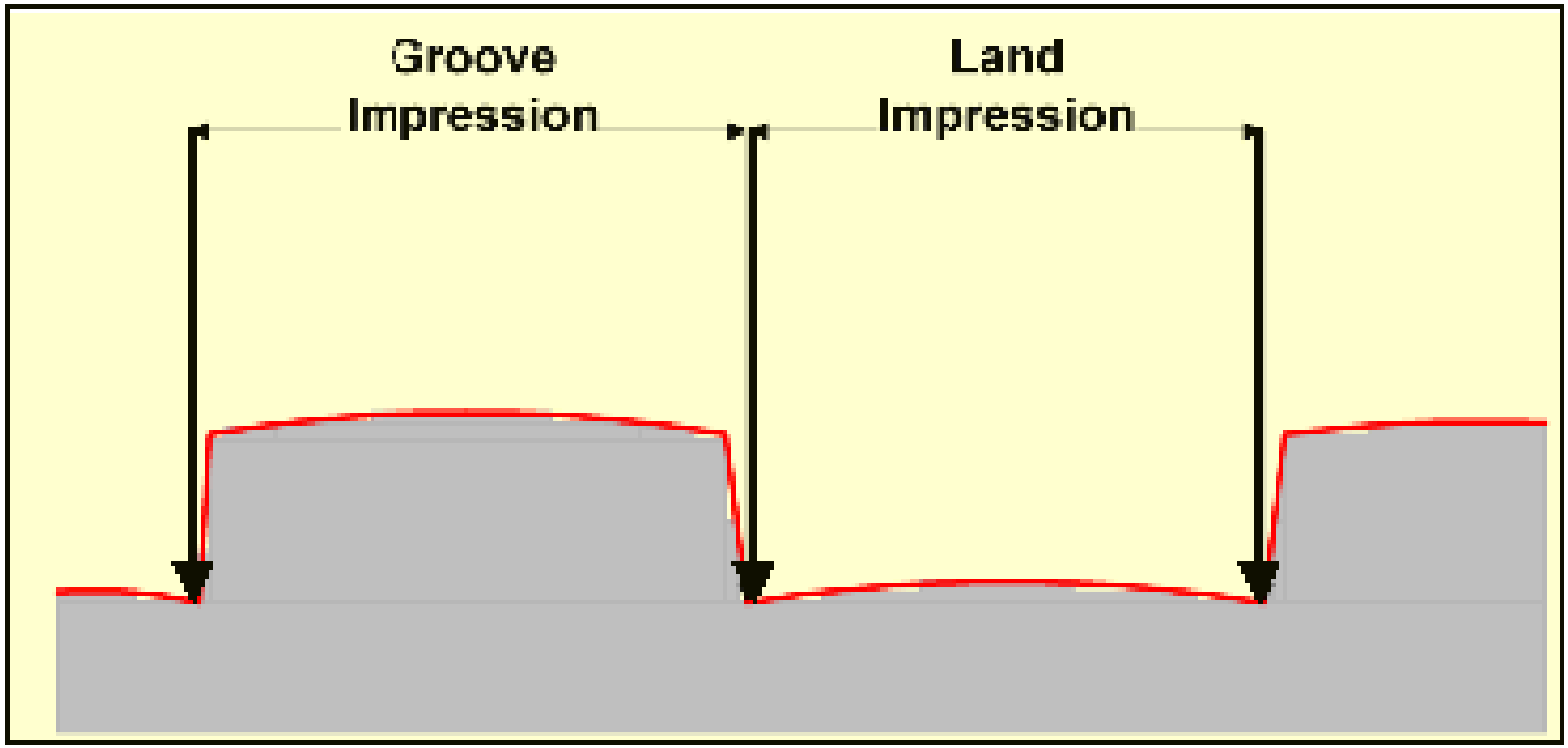
  - Potential pitfalls
    - Damage to bullet can cause distortion of dimensions
    - Poor shoulder definition
    - The “human factor”
      - Reading the device
        - Interpolation between division marks on reticules and rulers
      - Selecting the correct anchor points on the shoulders

Fired Evidence

- Bullets



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  - The types of measurements collected

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    - Purpose
    - Possible issues