National Ballistics Imaging Comparison

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Disclaimer

Certain commercial equipment, instruments, or materials are identified in this report in order to specify the experimental procedure adequately. Such identification is not intended to imply recommendation or endorsement by the National Institute of Standards and Technology, nor is it intended to imply that the materials or equipment identified are necessarily the best available for the purpose.
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Project Goal and Motivation

• Establish traceability and quality assurance for U.S. ballistics identification using NIST’s Standard Reference Material (SRM) 2460/2461 bullets and cartridge cases.

• Ensure that each ballistic lab has access to a unified standard as well as a statistical control limit. This promotes interoperability and quality assurance.

• Enable each ballistic lab to satisfy ISO lab accreditation requirements.
MEASUREMENT TRACEABILITY POLICY
The laboratory or calibration provider must document the measurement process or system used to demonstrate traceability and provide a description of the chain of comparisons/calibrations that were used to establish a connection to a particular stated reference.

To support traceability, the laboratory records for each step in the chain shall include:
• A clear description of the quantity being measured
• Specific information pertaining to the equipment subject to traceability
• A complete description of the measurement equipment or working standard used to perform the measurement
• A complete specification of the stated reference at the time the measurement system or working standard was compared to it
• A stated measurement result or value, with reference to International System of Units (SI) where possible
• A documented uncertainty of measurement and a description of the process used to develop it
• Appropriate intervals for re-calibration or calibration checks
• Information establishing the competence of the calibration laboratory and/or in-house personnel involved.
Three Steps Towards Traceability

1) **Establish a reference standard:**
   NIST SRM 2460/2461 bullets and cartridge cases and the “Golden Images”;

2) **Establish an unbroken chain of calibrations:**
   For both the topography signature measurements at NIST and ballistics image acquisitions in U.S.;

3) **Uncertainty statement:**
   Control chart and control limit
NIST SRM2460 Standard Bullet
2D Correlation Software
NIST SRM2461 Standard Casing

Master 9 mm Casing

Electroforming Process

Courtesy of Etsy User: Artie

SRM2461 Standard Casing
3D Correlation Software

Reference Surface (A)
SRM2461-153 Pin
X data spacing: 1.5625 μm
Y data spacing: 1.5625 μm

Compared Surface (B)
SRM2461-242 Pin
Gaussian Filter: Long Cutoff X: 0.15 mm
Long Cutoff Y: 0.15 mm

Date comparison: Aug 03, 2012
ACCF_{max}: 98.91 %
Sq(A): 0.8622 μm
Sq(B): 0.8431 μm
Sq(B-A): 0.1273 μm
Sign. Diff. D_s: 2.18 %
Heritage Integrated Ballistics Identification System (IBIS)

There are approximately 200 IBIS stations around the country. It utilizes digital image acquisitions of ballistics signatures and a proprietary correlation algorithm to sort through a database of test fires and evidence.
IBIS Golden Images – SRM2460 Standard Bullet

Land 1 to 3

Land 4 to 6
IBIS Golden Images – SRM2461 Standard Casing

Breech Face  Firing Pin  Ejector Mark
Project Plan

- Divided into three phases for a total of 24 data points.
- Phase 1: Ten consecutive measurements within a day.
- Phase 2: Four measurements once per week.
- Phase 3: Ten measurements once per month.
Histogram of Results

- All participants combined
- Peak phase is not included. It is almost identical to max lea
- Ejector mark scores are not unimodal
- Some skew in distributions may be present
Bullet Max Phase Results for all 19 Examiners

Control Limit (CL) = 3404

- 1927
- 1415
- 3169
- 5592
Casing Breechface Results for all 19 Examiners
Casing Firing Pin Results for all 19 Examiners

[Diagram showing data points with labels P to E, and run numbers along the x-axis.]
Erratic Ejector Mark Results for 19 Examiners
Ejector Mark Correlation Results after FTI Patch
## Heritage IBIS Control Limits

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
<th>95% Control limit</th>
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<tbody>
<tr>
<td>Maximum phase</td>
<td>5662</td>
<td>1373</td>
<td>3404</td>
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<tr>
<td>Maximum LEA</td>
<td>1498</td>
<td>273</td>
<td>1049</td>
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<tr>
<td>Breech phase</td>
<td>276</td>
<td>38</td>
<td>214</td>
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<tr>
<td>Firing pin</td>
<td>233</td>
<td>38</td>
<td>171</td>
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<tr>
<td>Ejector mark</td>
<td>968</td>
<td>345</td>
<td>400</td>
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</tbody>
</table>
IBIS Brasstrax Measurement System

• Currently being rolled out to all NIBIN labs across the United States replacing the heritage IBIS system. Improved automation and image resolution.

• Comparisons of images taken with the Brasstrax versus Heritage system showed differences in the correlation scores.
Problem:
  • The new IBIS Brasstrax system has no reference golden image for the SRM2461 Standard Cartridge Casing.
  • There are no established control limits for the three regions of interests on the SRM2461 Standard Cartridge Casing.

Solution:
  • Run a shortened 6 month study with volunteer crime labs.
  • Study will consist of 5 consecutive measurements of the SRM2461 Standard Cartridge Case within one day.
  • Two measurements per month measurements for six months.
  • Total number of data points: 17 Data Points
NBIC 2 Status

• Measurements of all 175 Standard Cartridge Cases have been completed using the IBIS Brasstrax.

• A set of Golden Images have been established by ATF.

• Data collection from participating crime labs have been completed.

• Statistical analysis will be conducted to establish a set of control limits for Breech Face, Firing Pin, and Ejector Mark.
Acknowledgement

34 U.S. Ballistics Examiners in 17 crime labs of the U.S. NIBIN (National Integrated Ballistics Information Network) participated in the NBIC project:

**NBIC - 1 Participants**
- Ashleigh Vogel – Michigan State Police
- Edward Jachimowicz – CT Dept. of Public Safety
- Caryn Tucker – IL State Police Forensic Science
- Daryl Smith – IL State Police Forensic Science
- Calvin Box – IL State Police Forensic Science
- Jennifer Perry – Arkansas State Crime Lab
- Steve Hargis – Arkansas State Crime Lab
- Jill Errickson – Miami Dade Police Dept.
- Nikki Mincey-McCall – ATF Atlanta
- Nanette Rudolph – FDLE Orlando
- Linzee Willette – FDLE Orlando
- Darrel Stein – Houston PD Crime Lab
- John Ward – VA Div. of Forensic Science Lab
- Helen Schumacher – VA Div. of Forensic Science Lab
- Allison Milam – VA Div. of Forensic Science Lab
- Susan Landen – VA Div. of Forensic Science Lab
- Bill Mori – ATF CA
- Martin Ols – ATF MD
- Erich Smith - FBI

**NBIC - 2 Participants**
- William Best – Allegheny County PD
- Tammy Lyons – Houston PD
- Megan Shaw – ATF CA
- Erica Lawton-McWhite – Broward Sheriff’s Office
- Allen Greenspan – Broward Sheriff’s Office
- Jon Flaskamp – ISP Forensic Science Center
- Mark Rennie – LAPD County Sheriff
- Erik Osbeck – Columbus Crime Lab
- Linzee Willette – FDLE Orlando
- Michael Schoonover – FDLE Orlando
- Kasi Lancaster – FDLE Tampa
- Stephen Garten – ATF Atlanta
- Martin Ols – ATF MD
- Allison Northrop – ATF MD
- Erin Hine – ATF MD
Thanks for your attention!

Questions?

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