## B116 NIST Reference Ballistic Tool Mark Database for Research and Development of Identification Systems and Confidence Limits

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After attending this presentation, attendees will understand how the National Institute of Standards and Technology (NIST) established its reference ballistic tool mark database. This includes meta data categorization, standard file exchange format, and test fire selection. Attendees will also learn why this reference database is important to the evolving field of objective firearm and tool mark analysis.

This presentation will impact the forensic science community by sharing how the research database and the infrastructure developed in this project provide a growing, shared, scientific knowledge base on the degree of similarity that can be found between marks made by different firearms and the variability in marks made by an individual firearm. This is achieved through a large variety of challenging datasets representing: (1) test fires conducted using consecutively manufactured barrels, slides, firing pins, and other firearm parts; (2) test fires conducted using the same firearm, with large numbers of intermediate firings to represent varying degrees of firearm wear; and, (3) test fires conducted using different brands of ammunitions.

The database contains test fires characterized by using state-of-the-art measurement equipment and measurement protocols at NIST. The database will drive the development and validation of mathematical criteria, algorithms, and systems for objective firearms identification. This is achieved through a unique focus on challenging scenarios, such as consecutively manufactured firearm components, persistence firings, and different ammunition types. These research datasets cannot be obtained from existing forensic databases such as the National Integrated Ballistic Information Network (NIBIN). It is not economically feasible for a single entity such as a university or system developer to generate the variety of data sets required for broadly applicable results. The database will contain both reflectance microscopy images and 3D surface topography data to ease the transition to 3D surface topography metrology.

The challenging identification scenarios provide researchers, for the first time, with the large variety of data needed to assess worst-case variability and repeatability, providing a path to the development of scientifically justified methods that yield identification results with well-characterized, quantitative confidence limits.

The project objective is an open-access research database of bullet and cartridge reference data, consisting of traditional reflectance microscopy images and 3D surface topography. The database will foster the development and validation of advanced algorithms, mathematical similarity criteria, and quantitative confidence limits for objective ballistics identification.

The 2009 National Academy of Sciences Report, *Strengthening Forensic Science in the United States: A Path Forward*, called into question, among other issues, the objectivity of visual tool mark identification by firearms examiners.[1] The National Academy of Sciences recommended development of objective tool mark identification criteria and error-rate estimates. Industry, academia, and government laboratories are pursuing two promising approaches toward this goal: (1) development of mathematical criteria and advanced algorithms for the objective and automated identification and scoring of potential matches; and, (2) supplementing traditional reflectance microscopy images with 3D surface topography measurement data.

Development and validation of both of these approaches to objective tool mark identification are hindered by a lack of access to tool mark data sets that: (1) represent the large variety of ballistic tool marks encountered by tool mark examiners; and, (2) represent challenging identification scenarios, such as those posed by consecutively manufactured firearms components. It is not economically feasible for individual companies or institutions to generate their own data sets. This makes it difficult for these entities to objectively evaluate their solutions. During the symposium held at NIST entitled, "Measurement Science and Standards in Forensic Firearms Analysis 2012," one of the priority requests from the attendees was the construction of a database where bullet, cartridge case, and tool mark surface data can be shared between researchers to facilitate testing, refinement, and comparison of new systems, methods, and algorithms.

The database will provide the representative variety of tool mark data required, ranging from crime laboratory test fires to test fires conducted using consecutively manufactured barrels, firing pins, slides, and other firearm surfaces. The database will contain both reflectance microscopy images and 3D surface topography data. The database will consist of indexed surface data acquired at NIST using state-of-the-art instruments and measurement procedures. Some of the data collected will be stored in a closed database for possible future application to the validation and comparison of correlation software.

The database will enable researchers to test and validate new approaches to objective, mathematics-based tool mark identification while easing the transition to 3D surface topography data. The database will provide a foundation for a scientific knowledge base on the degree of similarity that can be found between marks made by different firearms and the variability in marks made by an individual firearm. The current "fairly limited" knowledge base is a fundamental barrier to the development and validation of objective mathematical similarity criteria and associated confidence limits applicable to a broad range of firearms and ammunition brands.[1]

**Reference:**

1. National Academy of Sciences, *Strengthening Forensic Science in the United States: A Path Forward,* The National Academies Press, 2009, Washington, DC.

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**Reference Database, Ballistic Tool Marks, Confidence Limits**