## B7 Unlocking Dependable Forensic Results From Shell Casings: Advances in Method Development, Sample Collection, and Genetic Analysis

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**Learning Overview:** After attending this presentation, attendees will have gained up-to-date knowledge regarding the use of genetic forensic techniques for spent shell casing samples in the United States. Attendees will also better understand emerging techniques for sample collection, extraction, and analysis. This includes an update on the general types of analysis currently performed as well as emerging methods. This presentation will demonstrate data resulting from several of these emerging methods, providing attendees with a realistic outlook on what is possible for this very challenging type of analysis.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by providing a foundational summary of shell casing analysis in United States crime labs. This presentation will further build upon this foundation by illustrating emerging techniques for collection, extraction, and analysis of genetic molecules on spent shell casing evidence. This presentation will provide statistically defensible data illustrating the use of these emerging techniques. The competence of attendees will be impacted by demonstrating the current state-of-the-art in shell casing analysis and by presenting new methods that may lead to the adoption of advanced shell casing extraction techniques in forensic labs that currently avoid this type of analysis due to poor past results. The performance of attendees will be impacted by demonstrating methods that could substantially improve shell casing extractions in laboratories that do accept and process this challenging type of evidence.

Extreme heat, reactive chemistry, and trace DNA deposits combine to make DNA analysis of shell casing evidence a tremendous challenge. While some laboratories process shell casing evidence, this practice is generally perceived as high risk, and many labs have opted to not routinely accept this sample type as a result. To overcome these challenges, a new set of capabilities based on the fundamental biology and chemistry associated with touch samples on fired brass casings has been assembled. This recent work demonstrates multiple significant advancements in the preparation, processing, and analysis of these samples that build upon other recent reports of shell casing evidence analysis success.

This study first developed a method for applying artificial fingerprint samples on brass shell casings to overcome issues associated with the high degree of variability associated with human touch samples. This enabled the precise quantitative evaluation of DNA yield and quality from simulated touch samples. The use of artificial fingerprint samples allows for more rapid and meaningful method development as different collection and purification methods can be directly compared in a quantitative fashion. This new approach reduced oxidative damage that previously rendered artificial touch samples too degraded for useful analysis. This approach routinely recovers 25%–30% of the DNA deposited in artificial fingerprints from shell casings with low degradation index values using conventional collection and extraction techniques.

Three collection approaches were compared using both artificial fingerprint and human touch samples on shell casings: (1) a standard flocked fiber swab; (2) Signature Science's casework-validated Forensic Recovery of Identity from Shell Casings (FRISC™) method that combines collection buffer submersion and swabbing; and (3) a novel submersion method engineered to simplify handling, block gunpowder residue contamination, decrease collection buffer volume, and enable parallel collection of protein for genetic protein variant analysis. Fired shell casing samples were processed by each of these methods, and DNA yields, degradation indexes, and Short Tandem Repeat (STR) detections were calculated for each replicate. All three methods proved to be robust, yielding DNA with slightly elevated degradation compared to non-brass surfaces, but of sufficient quality and quantity to generate at least partial STR profiles. For example, the FRISC™ method produced Combined DNA Index System (CODIS) -eligible profiles 38% of the time from fired shell casings ($n$ = 21) using Capillary Electrophoresis (CE).

This study additionally analyzed samples using Next-Generation Sequencing (NGS) to compare the utility of NGS and CE for brass samples. Generally, CE identified a greater number of CODIS markers and a greater percentage of the targeted markers in the kit. However, NGS often identified significantly more markers in total, especially when greater than 70pg of DNA was available for analysis. It is unclear whether these results highlight a sensitivity limitation for the NGS kit or arise from the NGS manufacturer-directed lower DNA input volume. No significant increase in allele calls was observed for shorter amplicons, reflecting modest overall DNA degradation. Taken together, these collection and sample preparation methods significantly advance the ability to obtain defensible forensic genetic results from fired shell casing samples.

**Shell Casings, DNA Analysis, Touch Sample**



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