

NIST Research & ***Forensic Science***

Susan Ballou, MS

Program Manager & Supervisor

Special Programs Office

Forensic Science Research Program

NIST and Forensic Science

The NIST laboratory programs work at the frontiers of measurement science to ensure that the U.S. system of measurements is firmly grounded on sound scientific and technical principles. Today, the NIST laboratories address increasingly complex measurement challenges, ranging from the very small to the very large and from the physical to the virtual. As new technologies develop and evolve, NIST's measurement research and services remain central to innovation, productivity, trade, and public safety.

[NIST three year Programmatic Plan 2015-2017]

Areas are selected according to:

1. A nexus with measurement science
2. NIST staff have applicable expertise
3. Availability and engagement of NIST staff
4. Priority need for the nation/community
5. Identified funding

NIST and Forensic Science

Our assistance and technical expertise was requested by DOJ and others:

- Establishment of FBI Laboratory (early 1930s)
- Automated fingerprint detection (1960s to present)
- Law Enforcement Standards Laboratory (established in 1971) – initially NIJ funded
- “Starch Wars” (1977 to 1978)
- Input on Technical and Scientific Working Groups (1988 to present)
- FBI’s DNA Advisory Board (1995 to 2000)
- Digital forensics (late 1990s to present)
- National Institute of Justice (NIJ) research funding (1970s to present)
- White House Subcommittee on Forensic Science (2009-2012)
- MOU leading to NCFS and OSAC and base funding for forensics research (2013-present)

SPO

Forensic Science Research Program

GOAL:

To advance the use of scientifically valid methods and techniques to improve the understanding of evidence including error and uncertainty analysis

SPO

Forensic Science Research Program

Objectives:

1. Provide tools, reference materials, and techniques to support validation of existing methods and technologies
2. Initiate new projects to strengthen existing measurement methods and technologies and create infrastructure to support development and use of new ones.
3. Educate the forensics community

Common Themes

- Error and Uncertainty
- Data and Information
- Algorithm Development
- Method Validation
- Training

SPO

Forensic Science Research Program

Focus Area Programs:

1. Ballistics and Tool Marks (8 projects)
 - Lead: Engineering Physics Division (Physics Measurement Laboratory)
2. Digital and Identification Forensics (17 projects)
 - Lead: Software and Systems Division (Information Technology Laboratory)
3. Forensic Genetics (8 projects)
 - Lead: Biomolecular Measurement Division (Materials Measurement Laboratory)
4. Statistical Methods (11 projects)
 - Lead: Statistical Engineering Division (Information Technology Laboratory)
5. Toxins (11 projects)
 - Lead: Materials Measurement Science Division (Materials Measurement Laboratory)
6. Trace (14 projects)
 - Lead: Materials Measurement Science Division (Materials Measurement Laboratory)

NIST Focus Area: Ballistics and Associated Tool Marks

Objectives:

Metrics, procedures, quantitative error rates and uncertainties.

Metrology, quality assurance, and standards.

Scientific knowledge base for similarity of marks and tool mark variability.

Motivation:

ATF requested Standard Reference Material...NIST and ATF have proposed a joint project to establish nationwide ballistics measurement traceability and quality control using NIST SRM 2460/2461 standard bullets and casings.

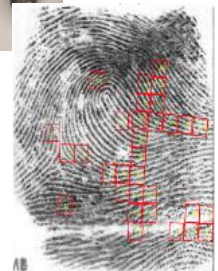
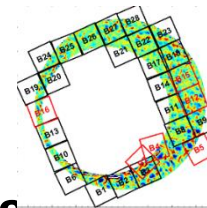
2009 NRC Report “...the decision of the tool mark examiner remains a subjective decision based on unarticulated standards and no statistical foundation for estimation of error rates.”

2016 PCAST Report “...firearms analysis currently falls short of the criteria for foundational validity, because there is only a single appropriately designed study to measure validity and estimate reliability.”

Ballistics and Toolmarks:

Major Efforts

1. Quality assurance, reference artifacts, documentary standards
2. Metrics and algorithms for objective identification
3. Quantitative uncertainty evaluation
4. Ballistics tool mark database for research and validation
5. Tool mark identification for non-firearm tools
6. Applications to forensic pattern matching
7. Optics research, Fourier methods, Expectation & Maximization modeling



Ballistics and Toolmarks:

Major Efforts

1. Quality assurance, reference artifacts, documentary standards
2. Metrics and algorithms for objective identification



Project Titles:

Next Generation National Integrated Ballistic Information Network (NIBIN)

Uncertainty and error rate analysis for firearm identification and other pattern evidence

Congruent matching methods for firearm identification and other pattern evidence

NIST Focus Area: Digital Forensics

Objectives:

To provide standards and measurement to improve the quality, efficiency and understanding of digitally-based forensics

Motivation:

FBI: Requested an automated filter program that will assist a computer examiner in the elimination of thousands of legal files that have no forensic value.

DoD: To establish a methodology for testing computer forensic software tools by development of general tool specifications, test procedures, test criteria, test sets, and test hardware.

Law Enforcement: Facing increased use of multimedia devices in criminal activities.

Digital Forensics - Mobile

Best Practices Guide

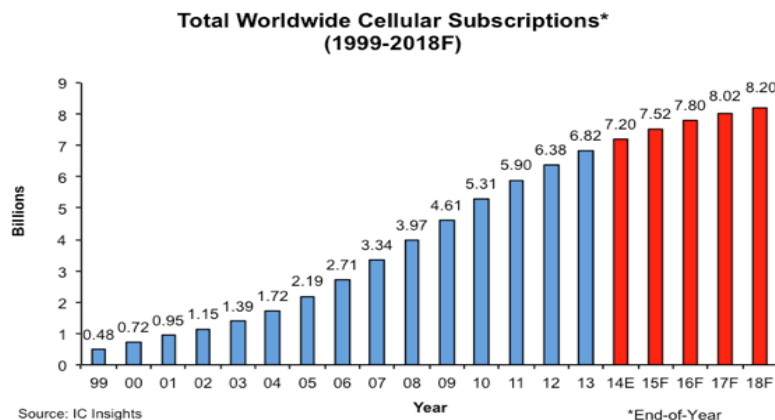
- Cited by Supreme Court in *Riley v California* (used for technical background in ruling on search of phones incident to arrest)

Mobile App Dataset for NSRL

- Released in 2016 with 30,000 apps. Will grow to 300,000 in 2017.
- Will create a new capability for mobile analysis based on NSRL “De-NISTing,” which is used daily by digital forensics labs

CFTT Test Reports

- DHS/NIJ have issued 44 test reports based on NIST work
- “When I came to court the next day, I was armed with both ... reports ... and that avenue was rapidly closed off, and the text messages (which proved to be central in this highly circumstantial case) were admitted into evidence.”



NIST Focus Area: Forensic Genetics

Objectives:

To produce reference materials to support accurate measurements within the forensic DNA testing community, assess new technologies and genetic markers for forensic applications, and support the deconvolution and interpretation of complex DNA mixtures through software exploration and inter-laboratory studies.

Motivation:

Emerging Technologies: Methods such 'Next Generation Sequencing' and 'Rapid DNA' provide greater amounts of information in a reduced time. However, these also require validation to ensure accuracy

Challenging Conditions: The analysis of degraded DNA samples (e.g. WTC-9/11, mass fatality sites) require technical advancements and interpretational validation

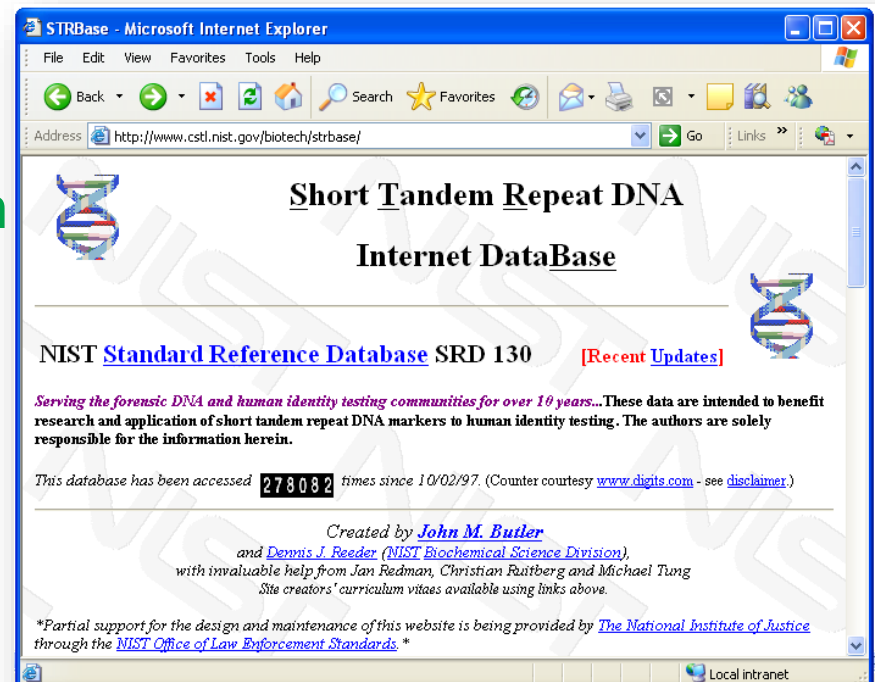
Law Enforcement: Forensic laboratories face the difficulties of dealing with and interpreting data from challenging samples, particularly in the areas of mixture interpretation and low-level DNA analysis

Standard Reference Materials for the Human Identification Community

- SRM 2391c: PCR based DNA profiling standard, used by forensic Laboratories to meet the FBI DNA Quality Assurance Standard.
- SRM 2372: quantification of human DNA. Used to calibrate DNA quantitation kits.
- SRMs enable U.S. manufacturers to provide accurate DNA typing kits

STRBase: Free resource for forensic DNA typing information
<http://www.cstl.nist.gov/biotech/strbase/>

Development of rapid DNA amplification techniques that enable state-of-the-art human identity testing



NIST Focus Area: Statistics

Objective:

To study statistical frameworks for evaluating evidence (e.g. likelihood ratios, Bayes factors, procedural error rates), development or deployment of improved statistical models and methods for different forensic science applications, development and use of appropriate uncertainty assessments for forensic test results and use of reproducible research approaches and the common task method in forensic science research.

Motivation:

Law Enforcement: Some forensic laboratories are unfamiliar with assessing and interpreting measurement uncertainty

2009 NAS Report: “much forensic evidence...is introduced in criminal trials without any meaningful scientific validation, determination of error rates, or reliability testing to explain the limits of the discipline.”

2016 PCAST Report

“Without appropriate estimates of accuracy, an examiner’s statement that two samples are similar-or even indistinguishable-is scientifically meaningless...”

NIST Focus Area: Statistics

Project: Measurements for Footwear Impression Comparisons

Collaborators – NIST (Information Technology Laboratory, SED), FBI, USACIL, Charlotte County (FL) Sheriff's Office, Everspry, Forensic ITC Services



Impact: New quantitative tools that will demonstrate a scientifically and statistically sound basis for footwear examination and will result in greater accuracy, reliability and reproducibility in examination results

NIST Focus Area: Toxins

Objectives:

Improved identification accuracy, interpretation, and efficiency in controlled substance & toxins forensic analysis

Motivation:

IACP: “The threat to public safety on our roadways posed by marijuana-impaired driving is quickly becoming a major concern partially due to the legalization of marijuana as well as by the legalization of medical marijuana in many states.” Marijuana Legalization and Traffic Safety Introduction Statement

DEA: “...fentanyl poses a grave threat to law enforcement officials and first responders, as a lethal dose of fentanyl can be accidentally inhaled or absorbed through the skin.” <https://www.dea.gov/divisions/hq/2016/hq072216.shtml>

NIST Focus Area: Toxins

✓ Mass Spectrometry of Drugs

- Improved reference data and approaches to uncertainty of identification

✓ NMR of Drugs

- Develop approaches to reliable identification of drugs
- Testing benchtop NMR

• Rapid Identification of Emerging Synthetic Drugs

- Synthetic drugs are constantly changing and their structures must be measured

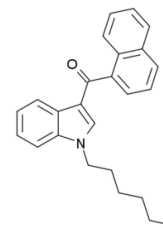
✓ Marijuana Breathalyzer

- Growing decriminalization and legalization of marijuana
- Need for a test for auto/truck driver intoxication

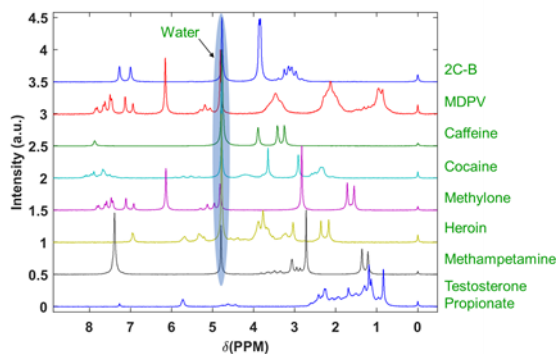
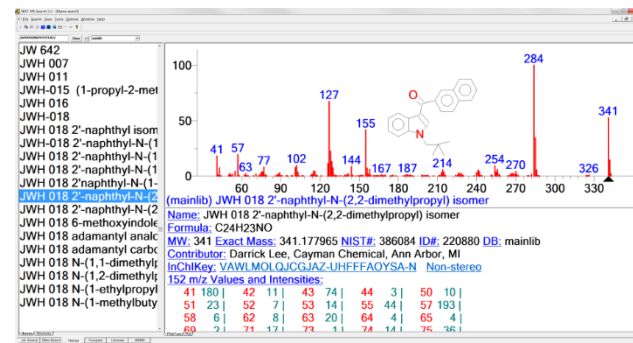
• Field screening approaches



SensAbues™ filter holder



AM-2201,
a synthetic
cannabinoid



Note: Check marks indicate active research

NIST Focus Area: Trace

Objectives:

Solve critical problems in forensic and trace evidence analysis including the understanding of the uncertainties associated with those analyses and their interpretation.

Motivation:

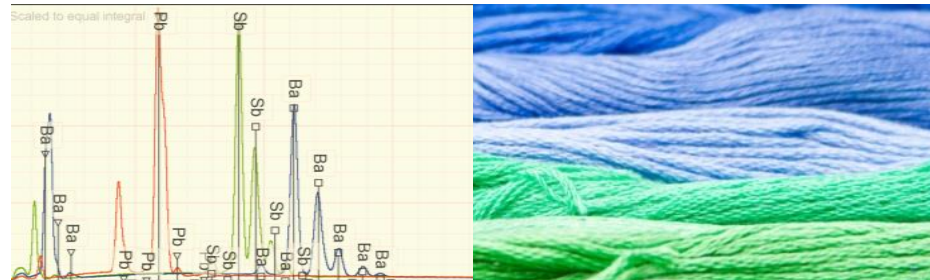
2009 NRC Report: "...no studies to inform judgments about whether environmentally related changes discerned in particular fibers are distinctive enough to reliably individualize their source, and there have been no studies that characterize either reliability or error rates in the procedures."

For paint analysis; "Additional work should be done to provide standard language for reporting conclusions and sources of uncertainty."

NIST Focus Area: Trace

✓ Particles & Surfaces

- Trace explosive & drug particle analysis
- Gunshot Residue – improved elemental identification and sensitivity
- Improved sampling methods
 - Fingerprint Developer Test Material & Method
- Multivariate analysis
 - Morphology, elemental, molecular



✓ Fibers

- Combined morphology and spectral data
- Improved Micro-IR
- Chemimetric Approaches

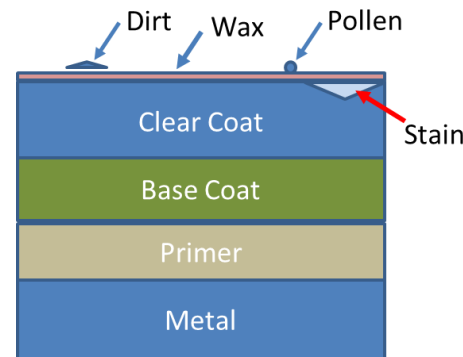


✓ Paint

- Automotive and architectural paint characterization

• Fire/Arson

- More reliable analysis of accelerant vapors
- Thermodynamic reference data



Automotive
Paint

Note: Checkmarks indicate active research

Thank You

For more information go to:

<https://www.nist.gov/topics/forensic-science>