SEXUAL ASSAULT KITS IN AMERICA

EXPERIENCES OF A FORENSIC LABORATORY DELUGED WITH SEXUAL ASSAULT KITS

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HIDS ROME MAY 2018

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Bode Cellmark

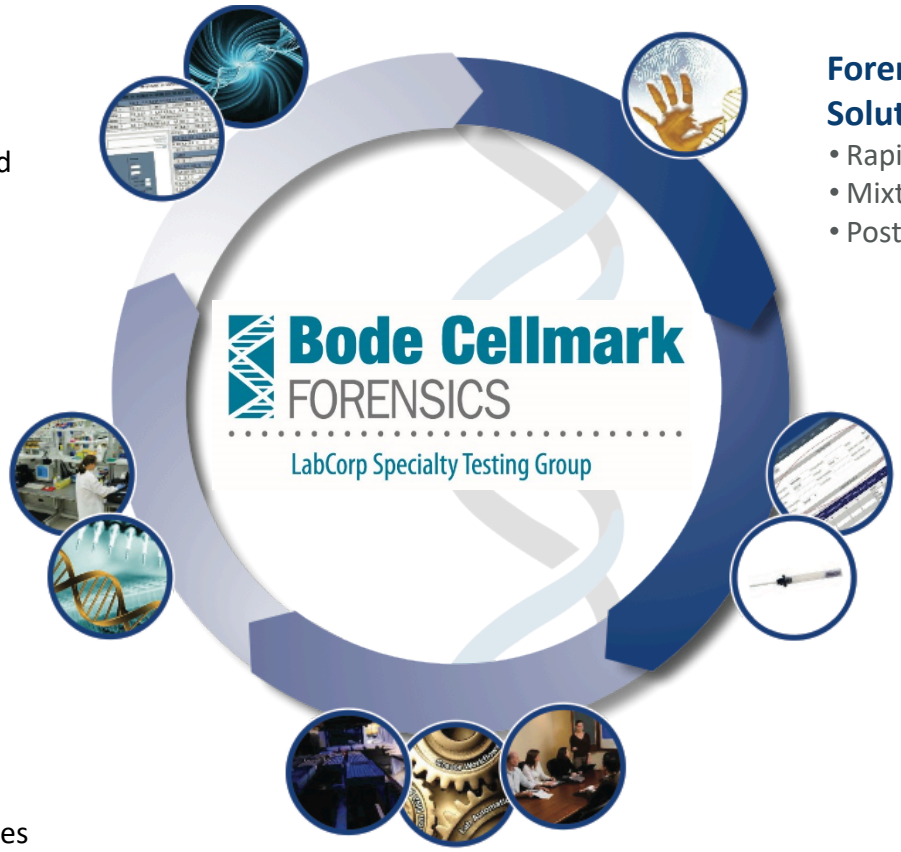
Forensic DNA Solutions

Data Management/ Reporting

DNA Database Services and Software

-BodeMatch

-BodeHITS



Forensic Intelligence Solutions

- Rapid DNA
- Mixture Deconvolution
- Post-Blast Exploitation

DNA Analysis

DNA Casework

- Casework
- Post Conviction
- Cold Cases
- Databanking
- Missing Persons

DNA Investigative Services

Collection Products

- Buccal DNA Sample Collection System
- Crime Scene Evidence Collection

Lab Management

Lean Six Sigma Consulting

Validation Services

Proficiency Test Kits

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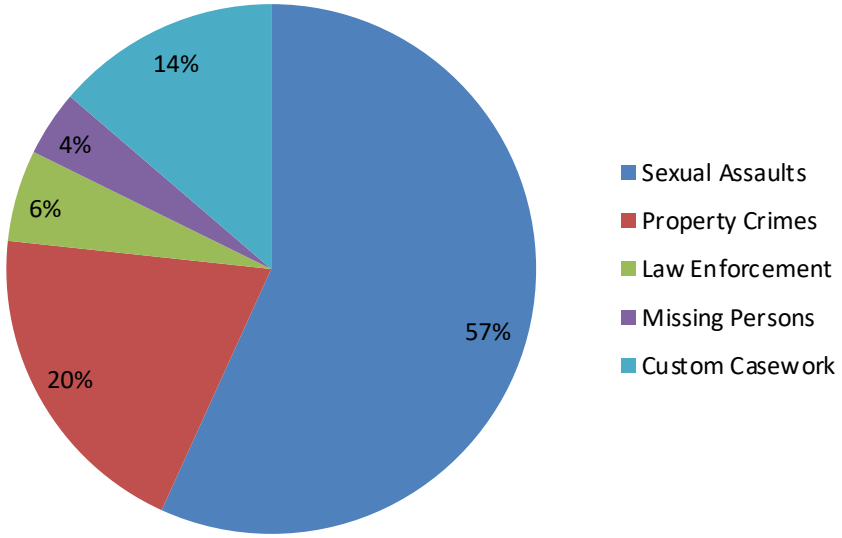
Sexual Assault Kit Testing at Bode

More than 50% of Bode work is SAK Testing



Notable Projects
Los Angeles – 10,000 kits
Las Vegas – 7,000+ (ongoing)
New York City – 6,000
Houston – 5,800
Texas – 5,500+
Detroit – 4,000+
Utah – 4,000+ (ongoing)
Illinois – 3,000+ (ongoing)
Memphis – 3,000+

- More than 65,000 SAKs tested
- >20,000 SAKs in 2018 alone

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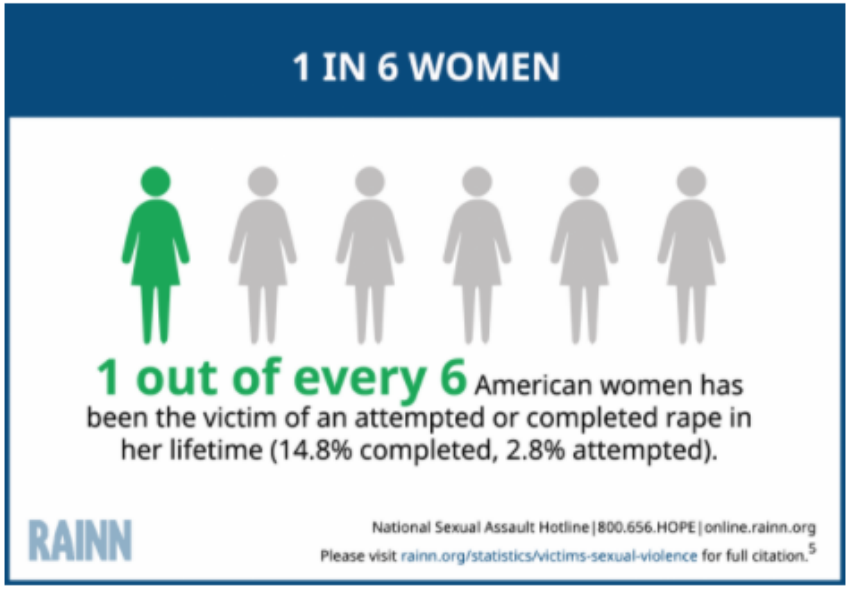
Sexual Assault Crisis

Every 98 seconds, an American is sexually assaulted.

And every 8 minutes, that victim is a child. Meanwhile, only 6 out of every 1,000 perpetrators will end up in prison.



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Driving Sexual Assault Kit Testing

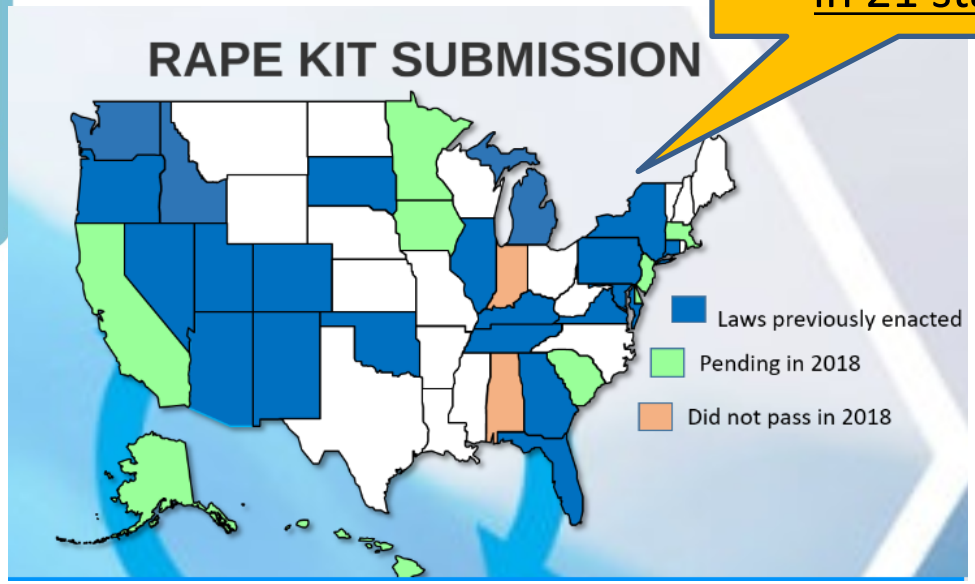
Legislation (2017)

- 76 pieces of reform introduced
  - 22 reforms enacted

Funding: ~$200 million

- 2015 - Manhattan's DA Office - $38M
- 2015-2020 - Dept Justice - $160M+

29 active projects in 21 states



Bode Kits Tested per year	
2014	4,300
2015	6,400
2016	10,000
2017	16,000
2018 (proj)	20,000

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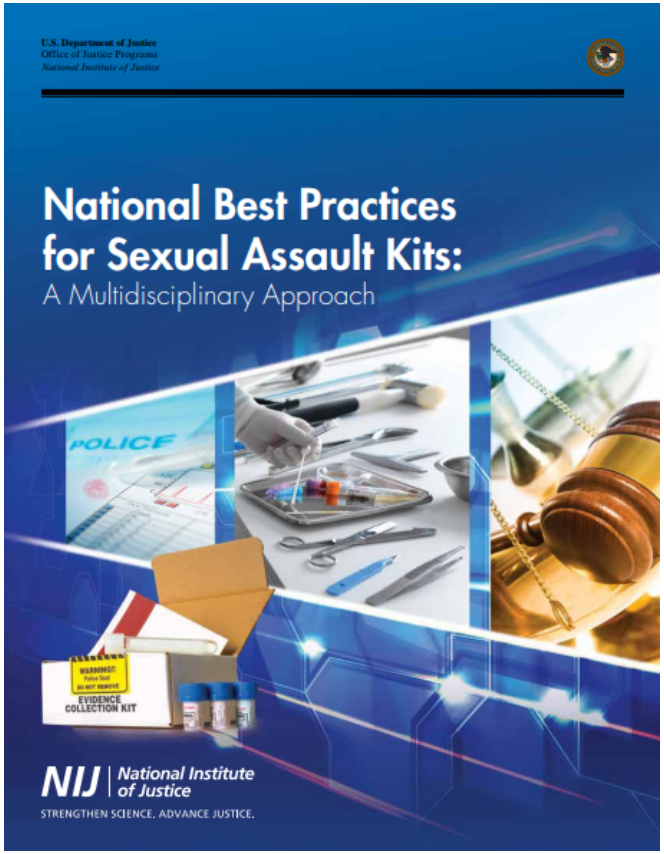
TECHNICAL APPROACHES

GOALS:

1) Optimize the Process
   - Direct-to-DNA
2) Improve Efficiency
   - Automation
3) Maintain Quality
   - Simplify



Goal #1: Optimize the Process
Direct-to-DNA

RECOMMENDATION 27:

Laboratories should consider changing the order of processing the evidence by going to Direct to DNA and then, only if needed, proceed with serology.

- More efficient
- Maximize chances of CODIS eligible profiles
- Focus resources on probative cases
- Stretch funding to more cases

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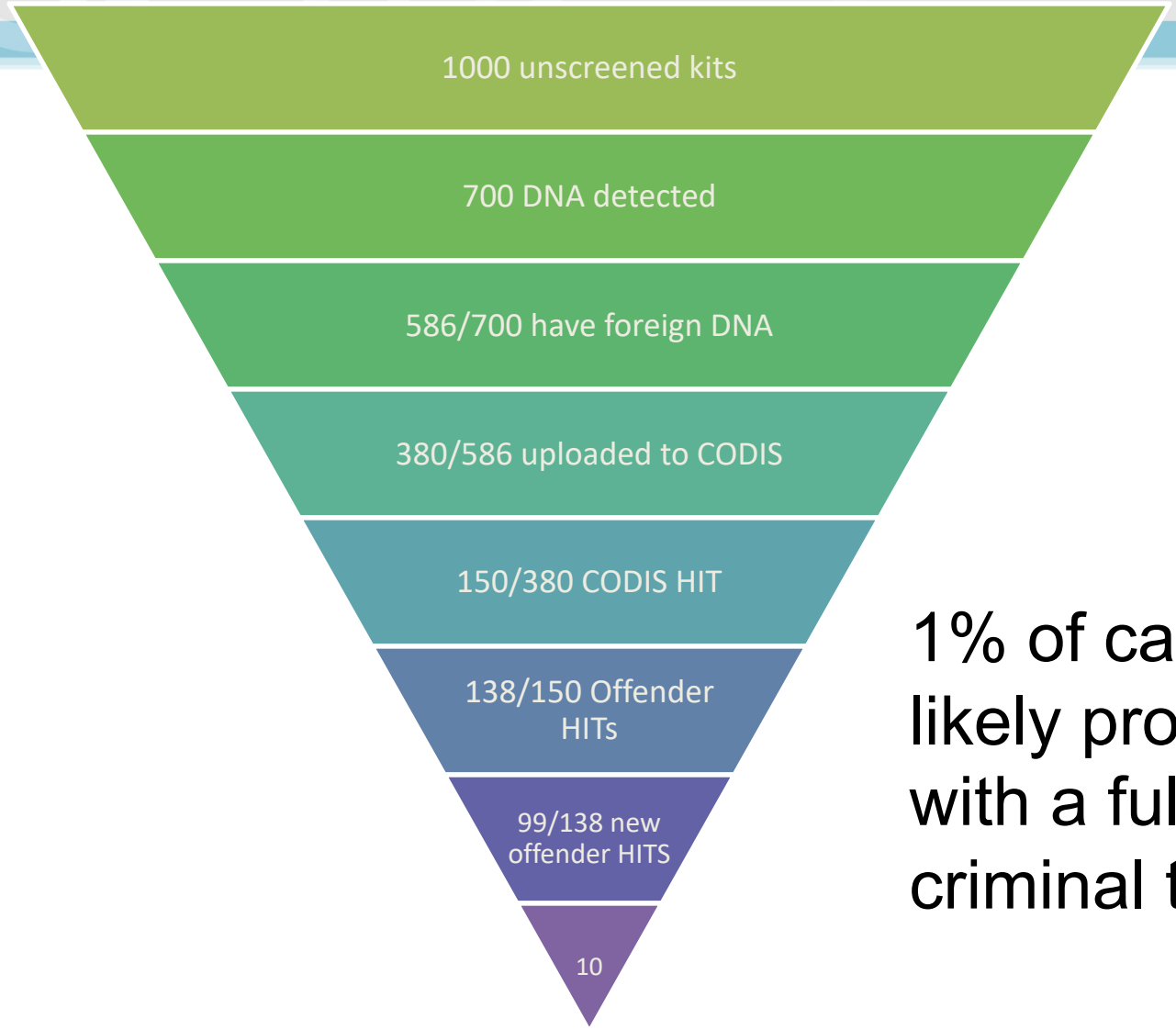
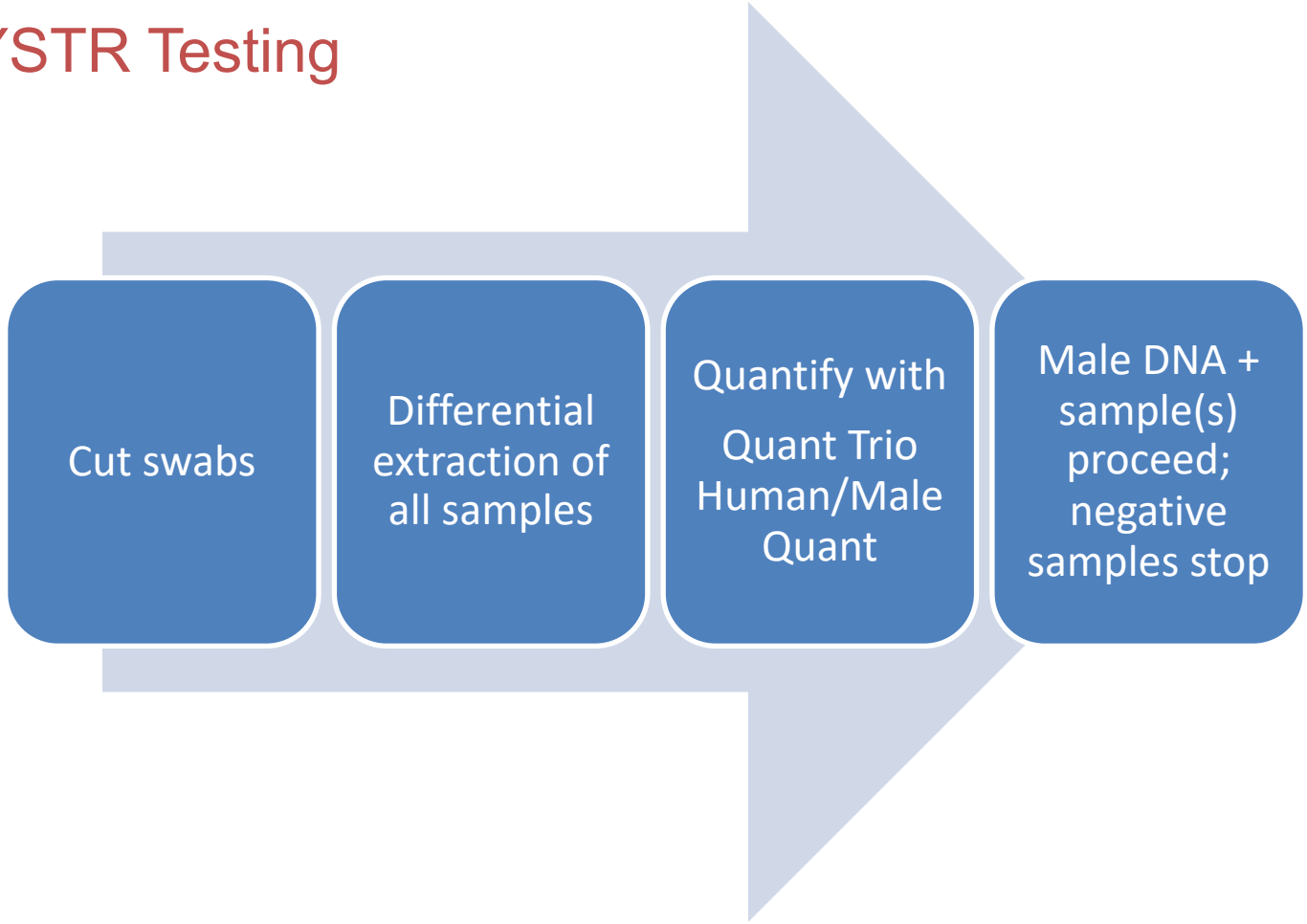
Direct-to-DNA



1% of cases will likely proceed with a full criminal trial

Direct-to-DNA
aka- YSCR, Y-screen, Y-chromosome screening

NOT YSTR Testing



Direct-to-DNA

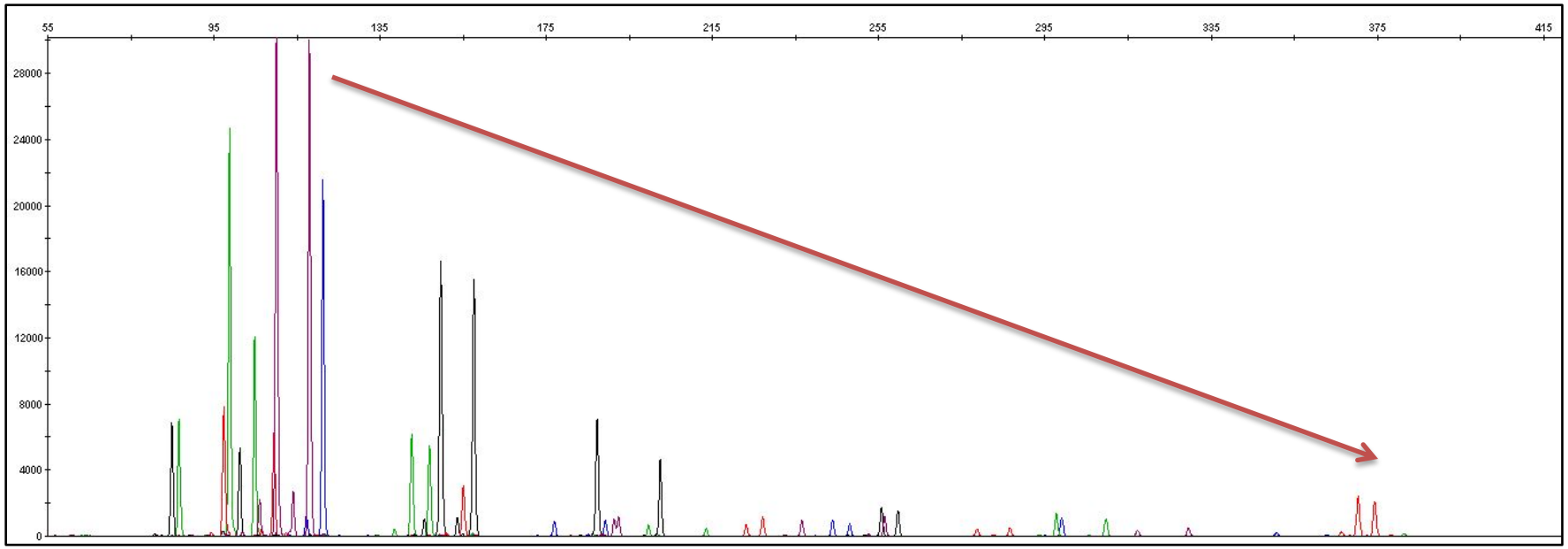
A TRIO OF SUCCESS!!

Direct-to-DNA: Detection of degraded samples

- The degradation index (DI) is a good gauge of whether profile results will indicate degradation of sample
  - Established DI to profile quality in validation
    - 1-3: no to little degradation – target normal
    - 3-10: moderate degradation – target double
    - >10: severe degradation – target 4X

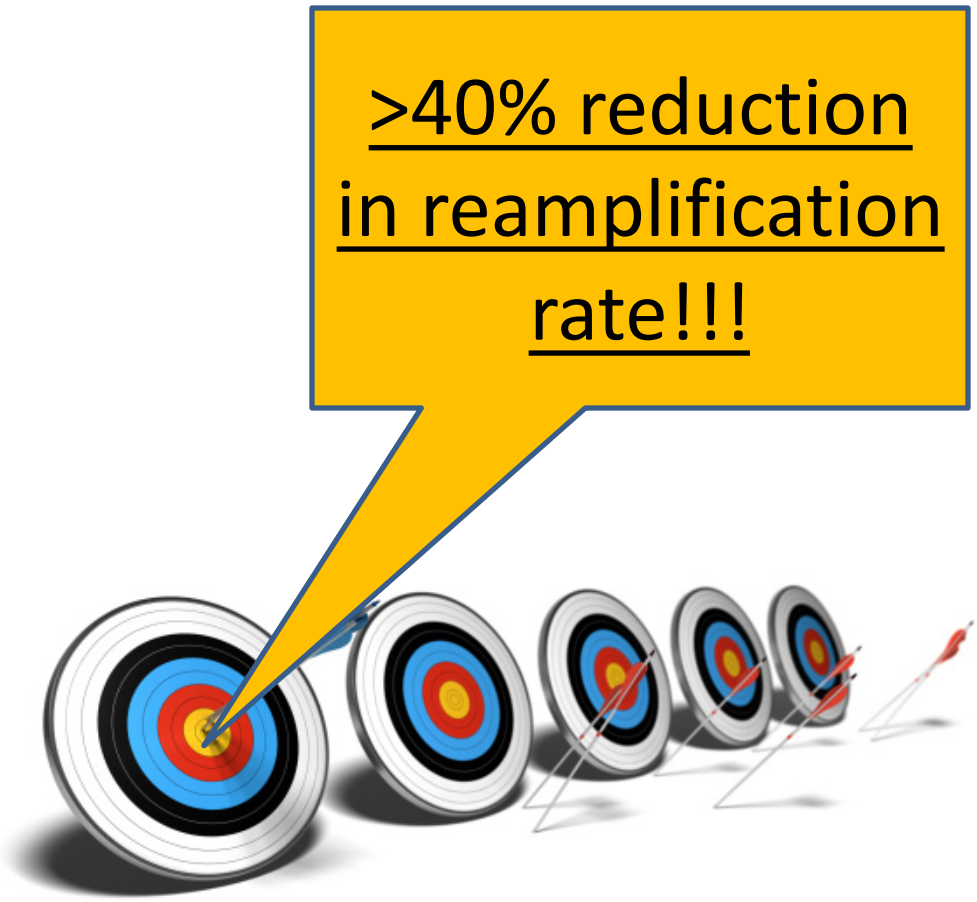
Direct-to-DNA

Degradation index vs. profile quality



- DI = 10.05
- Profile is ski-sloped, indicative of degradation

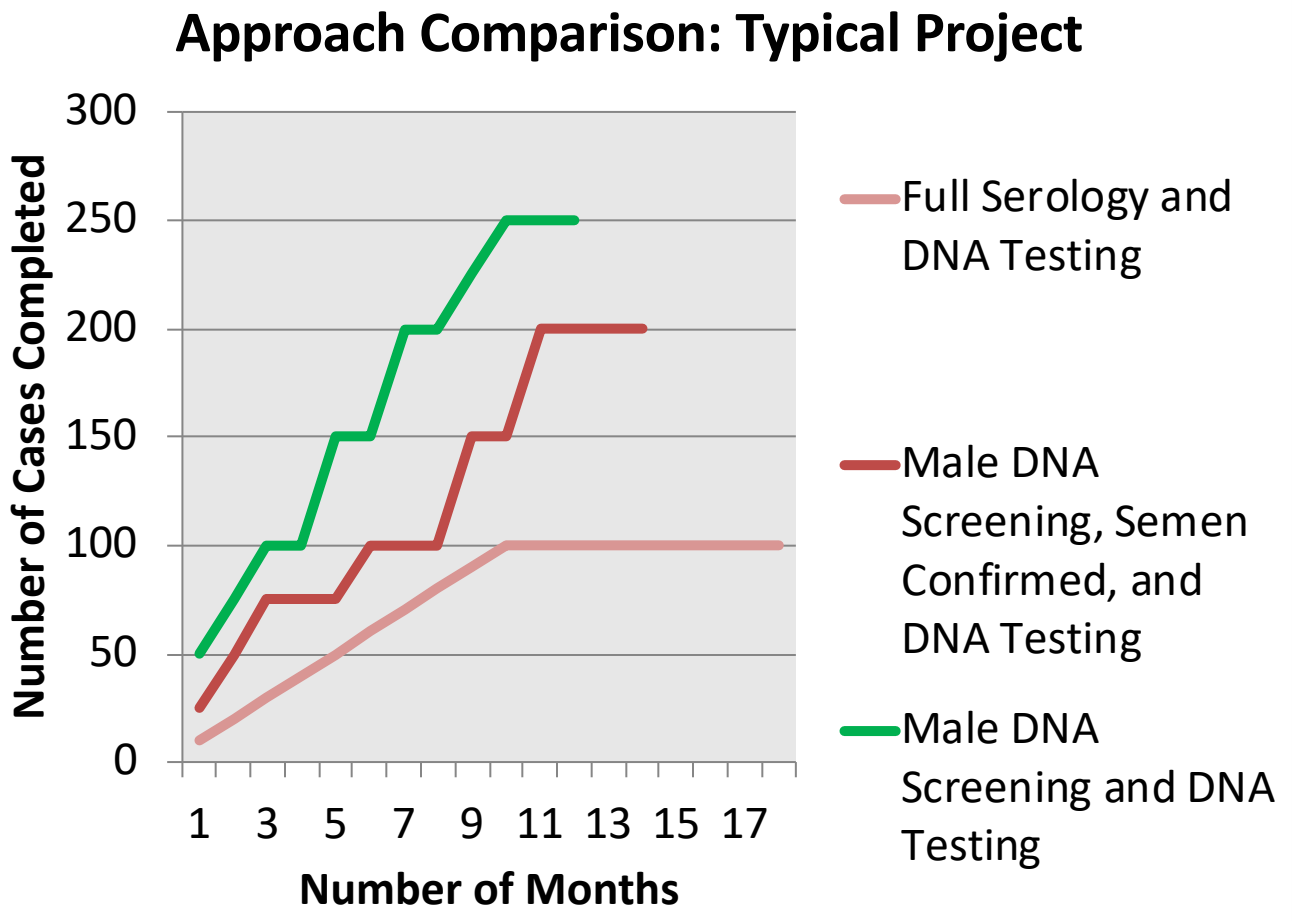
Direct-to-DNA: Accuracy of Quantifiler Trio



Reamp rate impact

- Older Quant Kit: 169 of 1088 required re-amp (15.5%)
- Trio: 77 of 909 required re-amp (8.5%)

Goal #1: Optimize the Process



18 Months

Full Serology

1350 Cases (18 mo)

Male DNA with Semen Confirmed

2000 cases (14mo)

Male DNA Screening*

2000 cases (12 mo)

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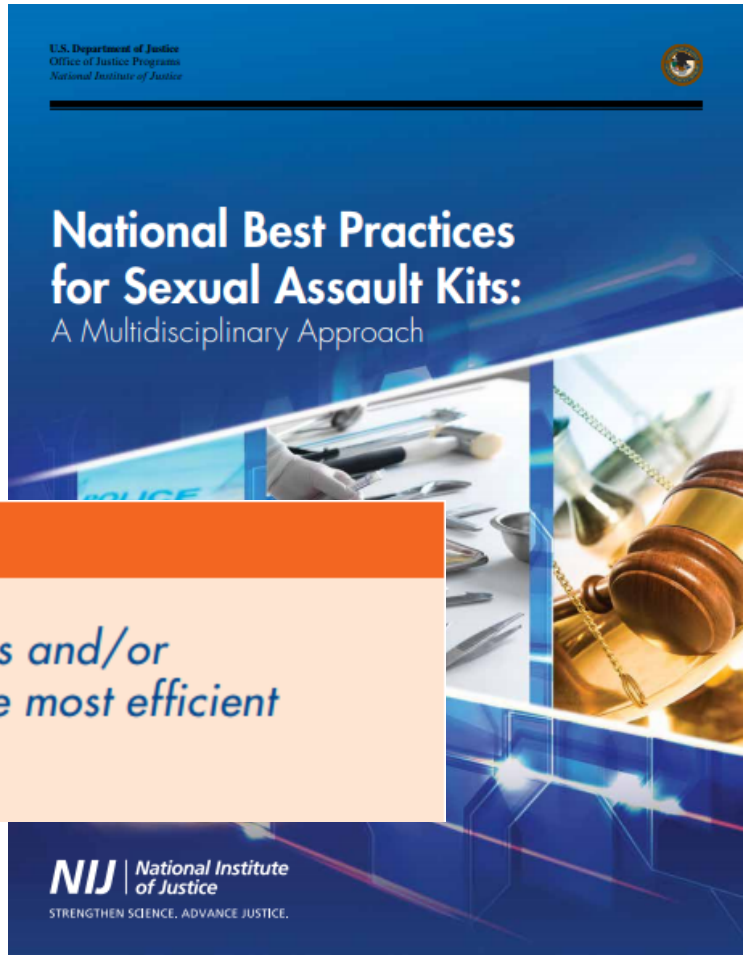
Goal 2: Improve Efficiency
Automation

- Higher Output
- Increase Accuracy
- Maximize use of laboratory personnel



RECOMMENDATION 28:

Laboratories should consider incorporating robotics and/or automation at each step of the DNA process for the most efficient high-throughput approach.

Objective: Automate Differential Extraction

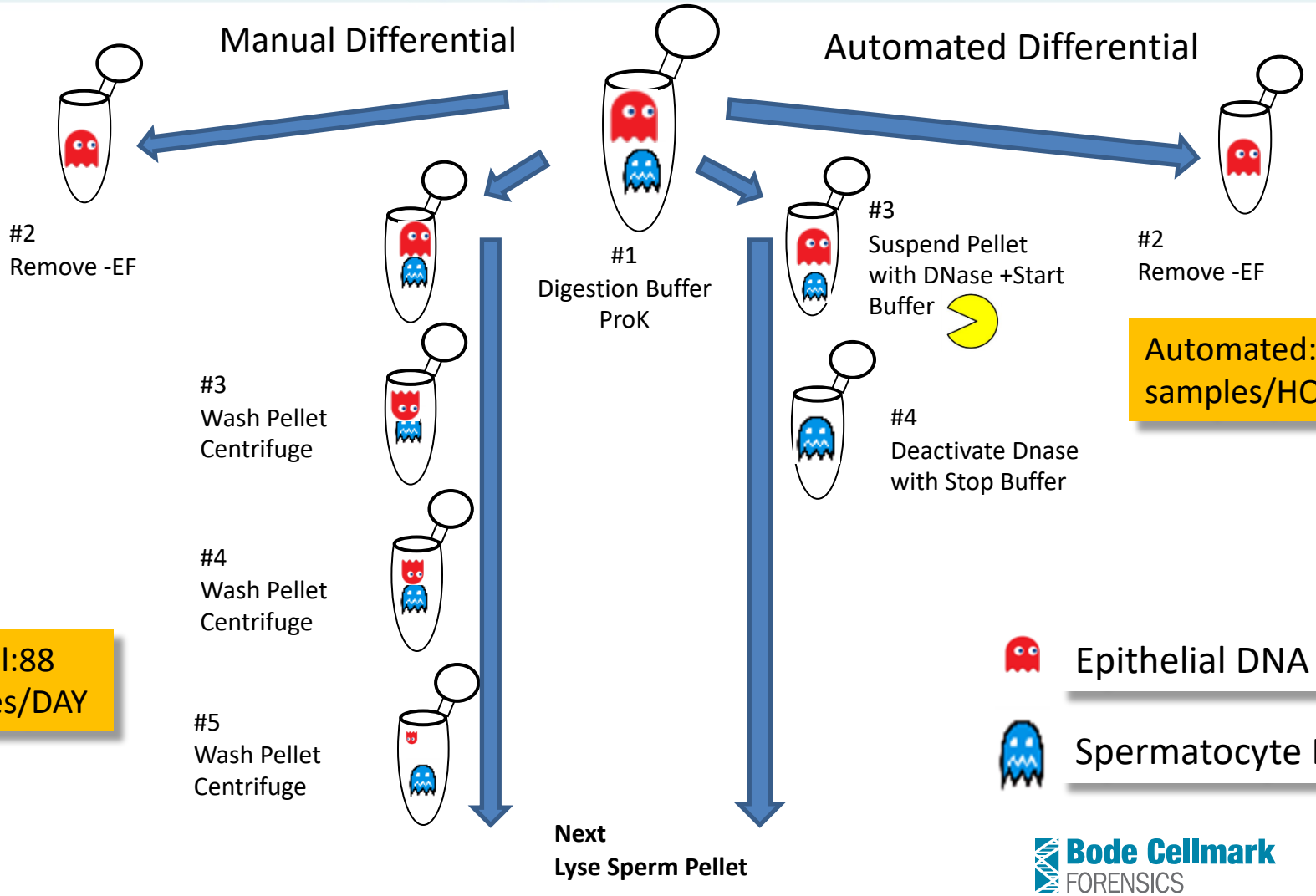
Wish List

- High Quality
- High Quantity
- Clean Male DNA Fraction
- Reduce Sample Handling

Outcomes

- Increase Recovery
- High Throughput
- Increase Process Flow
- Reduce post-extraction purification/concentration

Automated Differential Extraction



Automated: 88 samples/HOUR

Manual:88 samples/DAY

Epithelial DNA

Spermatocyte DNA

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Pilot Study - Time/Cost Comparison

- 350 cases done with Michigan State Police & Detroit PD
- Cases selected
  - Mostly female victims
  - Age of kits 2002-2009
- Time Savings: 1.14hr/case

More than 5 full-time analysts

Time (Hours)	Manual	DNase
Analysis/Kit	4.46	3.42
Review/Kit	0.36	0.26

10,000 Kits (extrapolated)	
Total Time Savings	11,400 hours
Total Cost Savings	$456,000

Internally developed **manual** DNase procedure has minimal consumable/reagent cost savings
Time estimated at $40/hour

Objective: Automate Everywhere

Fully Automated

Automated Differential	Quant/ Normalization/ Amplification	CE Set Up
• Biggest time-savings	• Hamilton STAR and STARlet	• Tecan EVO

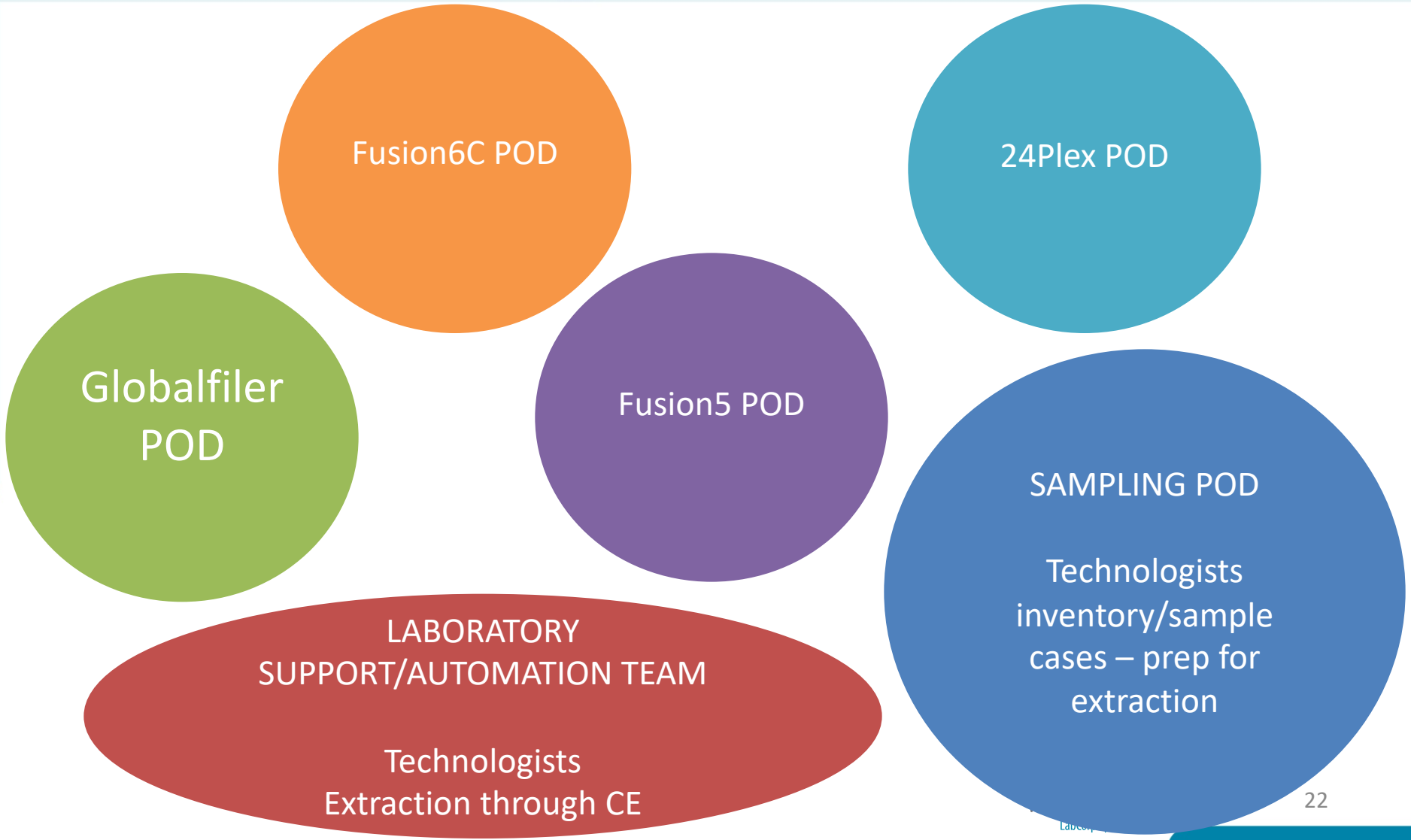
Automation / Workflow Improvement

AUTOMATION	STATUS	IMPACT
Y-Screen / Direct to DNA	**Implemented – 2016**	**No more sperm searches**
Extraction separation of male DNA from female DNA	**Implemented – 2017**	**Estimated $12k or 124 labor hours saved per day**
Quantitation	**Implemented – 2018**	~120 labor hours/month or $13,000/month
Normalization & Amplification	In Review	~120 labor hours/month or $13,000/month
Capillary Electrophoresis	In Progress	~60-70 labor hours/month or $6250/month

Goal #3: Maintain Quality

- LSS principles
- Project Simplify
- Mixture assistance tools
- Barcode labeling

PERSONNEL REORGANIZATION



Project Simplify

Reduced STR Workflows from 11 → 4

1. Thermo Globalfiler on 3500
2. Promega Fusion 6C on 3500
3. Promega Fusion 5C on 3500
4. Qiagen 24plex on 3500
5. ~~Globalfiler on 3130~~
6. ~~Promega Fusion 6C on 3130~~
7. ~~Promega Fusion 5C on 3130~~
8. ~~Identifiler Plus on 3130~~
9. ~~Identifiler on 3130~~
10. ~~PowerPlex 16HS on 3130~~
11. ~~PowerPlex 16 on 3130~~

Project Simplify

Reduced Quant/Norm/Amp worksheets from 30 → 1

Auto-calculates based on kit

DNA Normalization and Amplification Worksheet

Tray ID:

Shipment:

WS created by: Date:

Amp completed by: Date:

Witness: Date:

Extraction Batch	Tube Number	Amp Plate Well	Sample Name	Dilution		Amp Tray		Concentration (ng/µl)	Template Target Amount (ng)	Remaining Volume (µl)
				DNA (µl)	TE (µl)	DNA (µl)	TE (µl)			
--	--	A1.1	--	--	--	--	--	--	--	--
--	--	B1.1	--	--	--	--	--	--	--	--
--	--	C1.1	--	--	--	--	--	--	--	--
--	--	D1.1	--	--	--	--	--	--	--	--
--	--	E1.1	--	--	--	--	--	--	--	--
--	--	F1.1	--	--	--	--	--	--	--	--
--	--	G1.1	--	--	--	--	--	--	--	--
--	--	H1.1	--	--	--	--	--	--	--	--
--	--	A2.1	--	--	--	--	--	--	--	--
--	--	B2.1	--	--	--	--	--	--	--	--
--	--	C2.1	--	--	--	--	--	--	--	--
--	--	D2.1	--	--	--	--	--	--	--	--
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--	--	F2.1	--	--	--	--	--	--	--	--
--	--	G2.1	--	--	--	--	--	--	--	--
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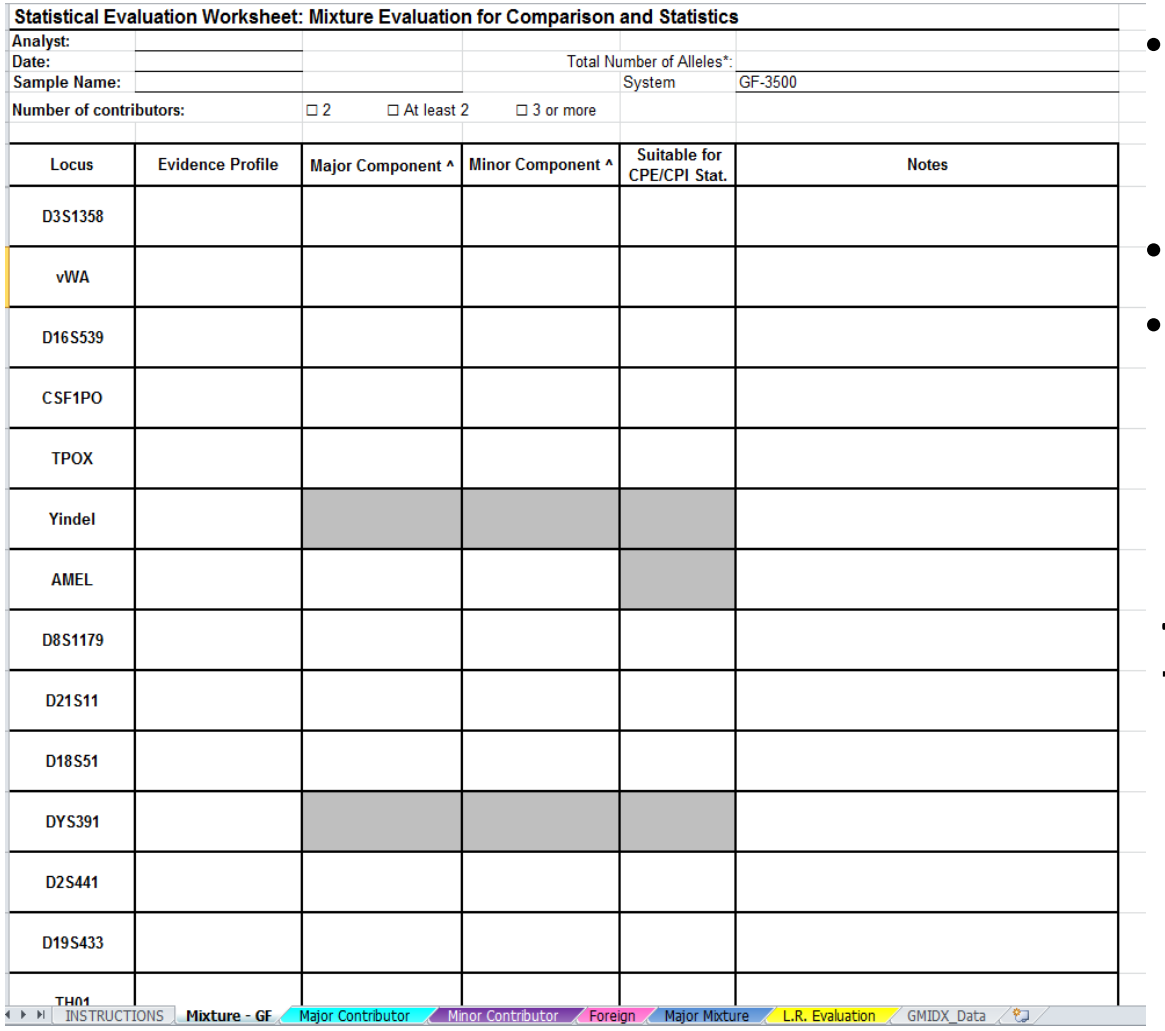
AUTOMATE MIXTURE INTERPRETATION



Statistical Evaluation Worksheet: Mixture Evaluation for Comparison and Statistics

Analyst:
Date: Total Number of Alleles*:
Sample Name: System GF-3500
Number of contributors: ☐ 2 ☐ At least 2 ☐ 3 or more

Locus	Evidence Profile	Major Component ^	Minor Component ^	Suitable for CPE/CPI Stat.	Notes
D3S1358					
vWA					
D16S539					
CSF1PO					
TPOX					
Yindel					
AMEL					
D8S1179					
D21S11					
D18S51					
DYS391					
D2S441					
D19S433					
TH01					

INSTRUCTIONS | Mixture - GF | Major Contributor | Minor Contributor | Foreign | Major Mixture | L.R. Evaluation | GMIDX_Data

- Standardize analyst interpretations and calculations
- Reduce admin errors
- Save time on calculations for analyst & reviewer

Time saved interpreting mixture

Analyst – 50%

Reviewer – 75%

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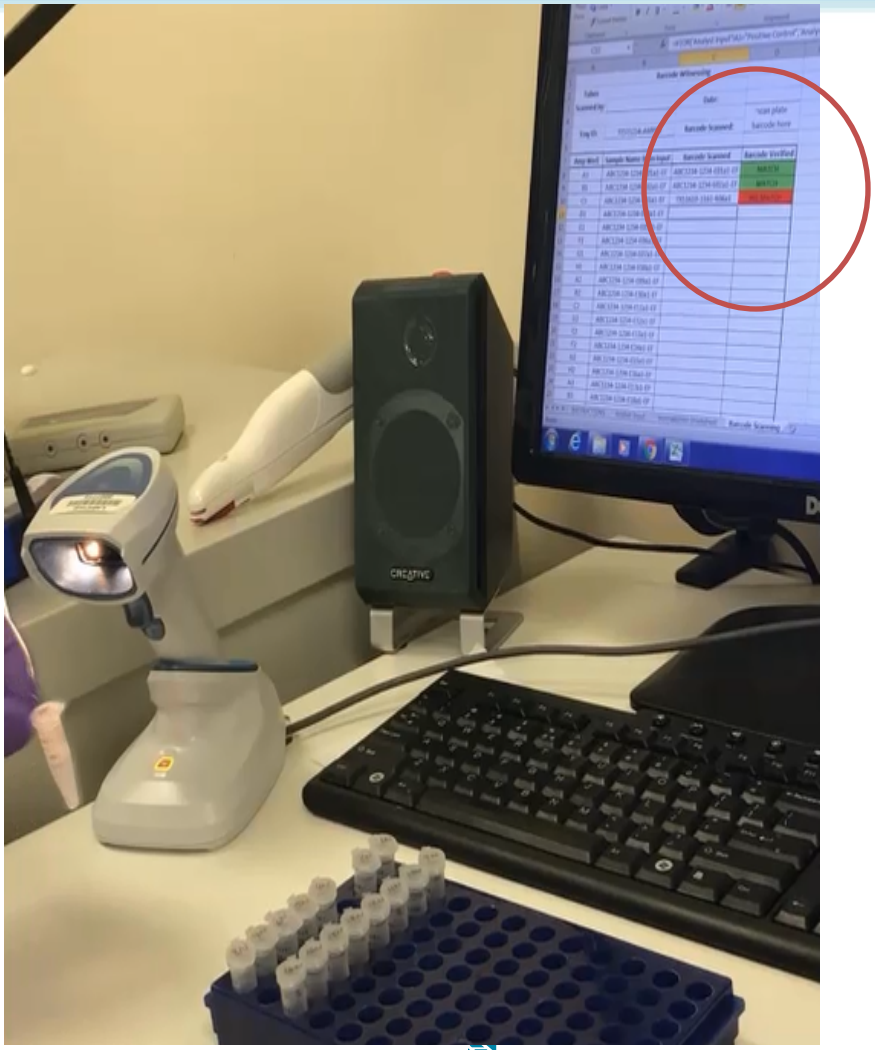
BARCODING

- 2D barcodes replace need for witness
- Reduce errors
- Improve tracking



TECHNICAL APPROACHES

GOALS:

1) Optimize the Process
2) Improve Efficiency
3) Maintain Quality

ACHIEVED THROUGH:

1) Direct-to-DNA Using Quant Trio
2) Automation
3) Project Simplify

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Swap the Swab:
Improved DNA Stability & Recovery

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Swap the Swab: Improved DNA Stability and Recovery of Evidentiary Samples

Sayed Mosavi, MS; Allie Flores, BS; Brian Adams, BS; Dan Watsula, MS; Jangbir Sangha, MA; Robert Bever, Ph.D

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Introduction

In recent years, a combination of new technologies being introduced into the market and the great impact of the use of DNA to solve crimes has led to both increased reliance on DNA and more collections. One often overlooked area is the collection, transport, recovery and storage of biological evidence from crime scenes. This presentation will introduce the Bode BioSafe™ Collection System that can improve sample recovery for DNA analysis from crime scenes.

Cotton swabs are the primary collection devices used to collect biological material. After collection, swabs are often dried and placed in coin envelopes or swab boxes where the swab is unprotected from contact with the envelope or box, but also unprotected from external environmental conditions. Biological materials, even when stored properly, can break down or degrade, resulting in less than desirable results. This can be exacerbated if the sample is limited in quantity or compromised from the start. The Bode BioSafe Swab contains a cotton swab pre-treated with preservative solution that prevents DNA degradation from a variety of factors including enzymes, and bacteria. The result is the ability to resist any degradation that may occur in the weeks, months, or years that may pass before the sample is analyzed.

A mock crime scene was created with different surfaces and biological fluids. Samples were collected with both the BioSafe Swab and a cotton swab. Samples were stored at 22°C with high and low humidity and 65°C low humidity over 56 days (3 year accelerated study).

Materials

- Bode BioSafe Swabs and Standard Cotton Swabs
- Blood and Saliva Stains
- Wood, Bricks, Shoes, Plastic Knives, and Metal Surfaces
- Controlled and Uncontrolled Storage Conditions
  - High Heat
  - High Humidity
  - Outdoors
  - Ambient Conditions

Methods

Sample Application and Collection

Serology

BioSafe is tested to be compatible with presumptive and/or confirmatory tests for saliva, blood, and seminal fluid.

Microbiology

Blood Stained Evidence

a) BioSafe, **b)** Cotton, **c)** Control (broth)

- Swab heads placed into 2ml nutrient broth.
- Incubated at 37°C while shaking overnight.
- No bacterial growth (turbidity) observed in BioSafe samples.

Top: Bacterial culture collected with cotton swab from a shoe (Left) or *Serratia marcescens* (Right) is plated on nutrient agar with test disks

Results

Degradation Index (DI) and Average Quantification yield (n=5) BioSafe Vs. Cotton Swab

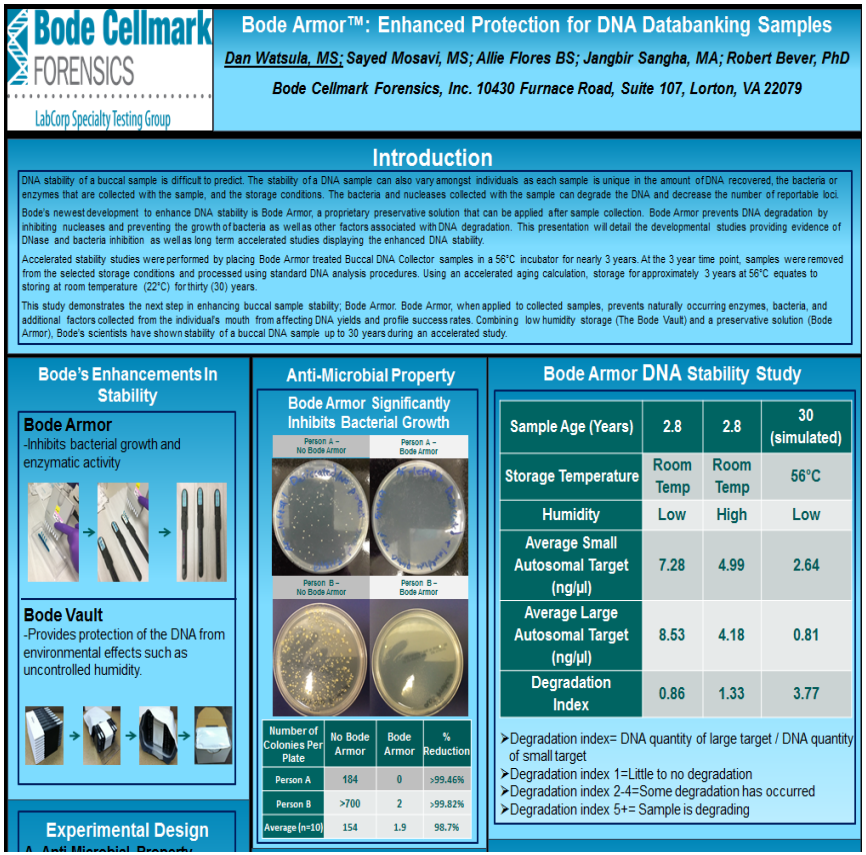
Evidence Item	Collector Type	Quantification (ng/µl)	Degradation Index	Quant. ratio BioSafe: Cotton
65°C Low Humidity				
Wood_Blood	BioSafe Swab	0.076	4.35	38.0
	Cotton Swab	0.002	Und.	
Brick_Blood	BioSafe Swab	0.027	1.9	4.5
	Cotton Swab	0.006	Und.	
Shoe_Blood	BioSafe Swab	0.257	2.2	12.2
	Cotton Swab	0.021	Und.	
Knife_Blood	BioSafe Swab	0.400	1.8	1.4
	Cotton Swab	0.276	2.9	
Knife_Saliva	BioSafe Swab	4.745	1.8	2.6
	Cotton Swab	1.811	3.7	
Metal_Saliva	BioSafe Swab	6.746	2.1	11.3
	Cotton Swab	0.599	5.6	
22°C High Humidity				
Wood_Blood	BioSafe Swab	0.21	1.21	35.0
	Cotton Swab	0.006	Und.	
Brick_Blood	BioSafe Swab	0.052	1.1	2.1
	Cotton Swab	0.025	Und.	

Undetermined: DI was due to no data available for large autosomal fragments.

PowerPlex Fusion, 3 year Accelerated Study

Analytical Threshold: 100 RFUs, Stochastic Threshold: 500 RFUs

Bode Armor:
Enhanced Protection for DNA Samples



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Bode Armor™: Enhanced Protection for DNA Databanking Samples

Dan Watsula, MS; Sayed Mosavi, MS; Allie Flores BS; Jangbir Sangha, MA; Robert Bever, PhD

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Introduction

DNA stability of a buccal sample is difficult to predict. The stability of a DNA sample can also vary amongst individuals as each sample is unique in the amount of DNA recovered, the bacteria or enzymes that are collected with the sample, and the storage conditions. The bacteria and nucleases collected with the sample can degrade the DNA and decrease the number of reportable loci.

Bode's newest development to enhance DNA stability is Bode Armor, a proprietary preservative solution that can be applied after sample collection. Bode Armor prevents DNA degradation by inhibiting nucleases and preventing the growth of bacteria as well as other factors associated with DNA degradation. This presentation will detail the developmental studies providing evidence of DNase and bacteria inhibition as well as long term accelerated studies displaying the enhanced DNA stability.

Accelerated stability studies were performed by placing Bode Armor treated Buccal DNA Collector samples in a 56°C incubator for nearly 3 years. At the 3 year time point, samples were removed from the selected storage conditions and processed using standard DNA analysis procedures. Using an accelerated aging calculation, storage for approximately 3 years at 56°C equates to storing at room temperature (22°C) for thirty (30) years.

This study demonstrates the next step in enhancing buccal sample stability; Bode Armor. Bode Armor, when applied to collected samples, prevents naturally occurring enzymes, bacteria, and additional factors collected from the individual's mouth from affecting DNA yields and profile success rates. Combining low humidity storage (The Bode Vault) and a preservative solution (Bode Armor), Bode's scientists have shown stability of a buccal DNA sample up to 30 years during an accelerated study.

Bode's Enhancements In Stability

Bode Armor

-Inhibits bacterial growth and enzymatic activity

Bode Vault

-Provides protection of the DNA from environmental effects such as uncontrolled humidity.

Experimental Design

Anti-Microbial Property

Bode Armor Significantly Inhibits Bacterial Growth

Number of Colonies Per Plate	No Bode Armor	Bode Armor	% Reduction
Person A	184	0	>99.46%
Person B	>700	2	>99.82%
Average (n=10)	154	1.9	98.7%

Bode Armor DNA Stability Study

Sample Age (Years)	2.8	2.8	30 (simulated)
Storage Temperature	Room Temp	Room Temp	56°C
Humidity	Low	High	Low
Average Small Autosomal Target (ng/µl)	7.28	4.99	2.64
Average Large Autosomal Target (ng/µl)	8.53	4.18	0.81
Degradation Index	0.86	1.33	3.77

- Degradation index= DNA quantity of large target / DNA quantity of small target
- Degradation index 1=Little to no degradation
- Degradation index 2-4=Some degradation has occurred
- Degradation index 5+= Sample is degrading