Explosives Research and Future Applications of Rapid DNA Technology at the ATF Laboratory

STEVE WEITZ | ATF | AUGUST 16, 2017

ANDE™ Explosives Research – Background

- Sample Types
  - **Buccal cells**: Fresh buccal swabs - Estimated amount of DNA unknown due to the nature of the sample
  - **Blood**: 10ul of a 1:10 dilution of whole blood - Estimated amount of DNA ~5ng.
  - **Fingerprints**: "Loaded" fingerprints – Estimated amount of DNA unknown due to the nature of the sample.

- Rapid DNA Instrument – ANDE™
- FlexPlex™ 27 (FP27)
- BioChipSet™ – Low DNA Content
  - 4 Samples/run
- DNA Interpretation
  - ANDE™ Expert System
  - Adaptive Expert System (AES)

Image courtesy of Karen Olson, DFSC

ANDE™ Adaptive Expert System (AES)

- Designed to optimize first-run results and minimize the need to re-run samples
  - Assesses overall profile peak height
  - Applies appropriate analytical/stochastic thresholds
  - High signal samples:
    - Can remove iNTA/-A allele calls
    - Widens bins at longest loci
  - Low signal samples:
    - Increases tolerance for heterozygote balance
  - Relaxed mixture rules

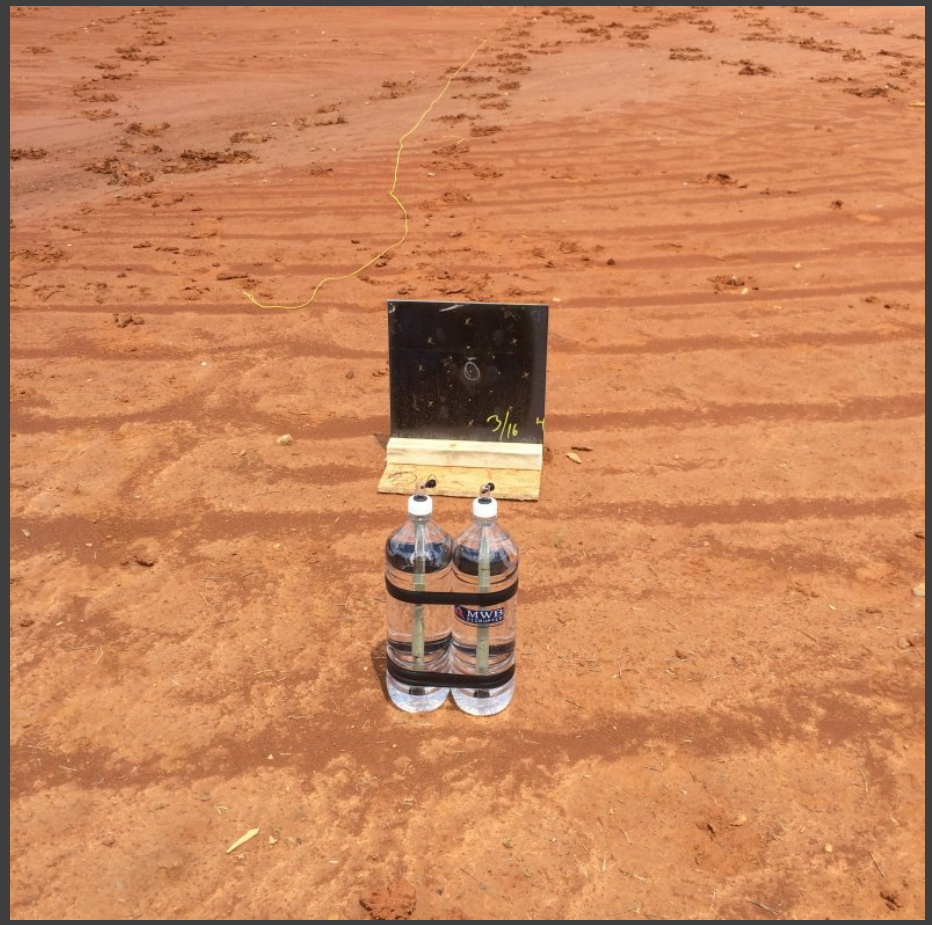
Information courtesy of Karen Olson, DFSC

ANDE™ Explosives Research – Evidence and Explosive

- USPS Public Mail Drop
  - ~1 lb. of smokeless black powder placed in the mail hold
  - Blood spotted in duplicate on multiple areas of the mailbox.
  - One replicate was covered with duct tape.
- Car
  - ¼ stick of C4 placed on the transmission hump
  - Blood and buccal cells placed in multiple areas inside car. One blood replicate was covered with duct tape.

ANDE™ Explosives Research – Render Safe Procedures (RSP)

- Plate 2
  - RSP: Mineral Water Bottle (MWB)
  - Mechanism: Explosive charge is placed inside water bottle(s). MWB device is placed in close proximity to explosive device. MWB is activated, forcing the water at high velocity in the direction of the device in an attempt to dismantle and disarm.
  - Substrate: Steel plate
  - DNA source: Blood and fingerprints



ANDE™ Explosives Research – Render Safe Procedures (RSP)

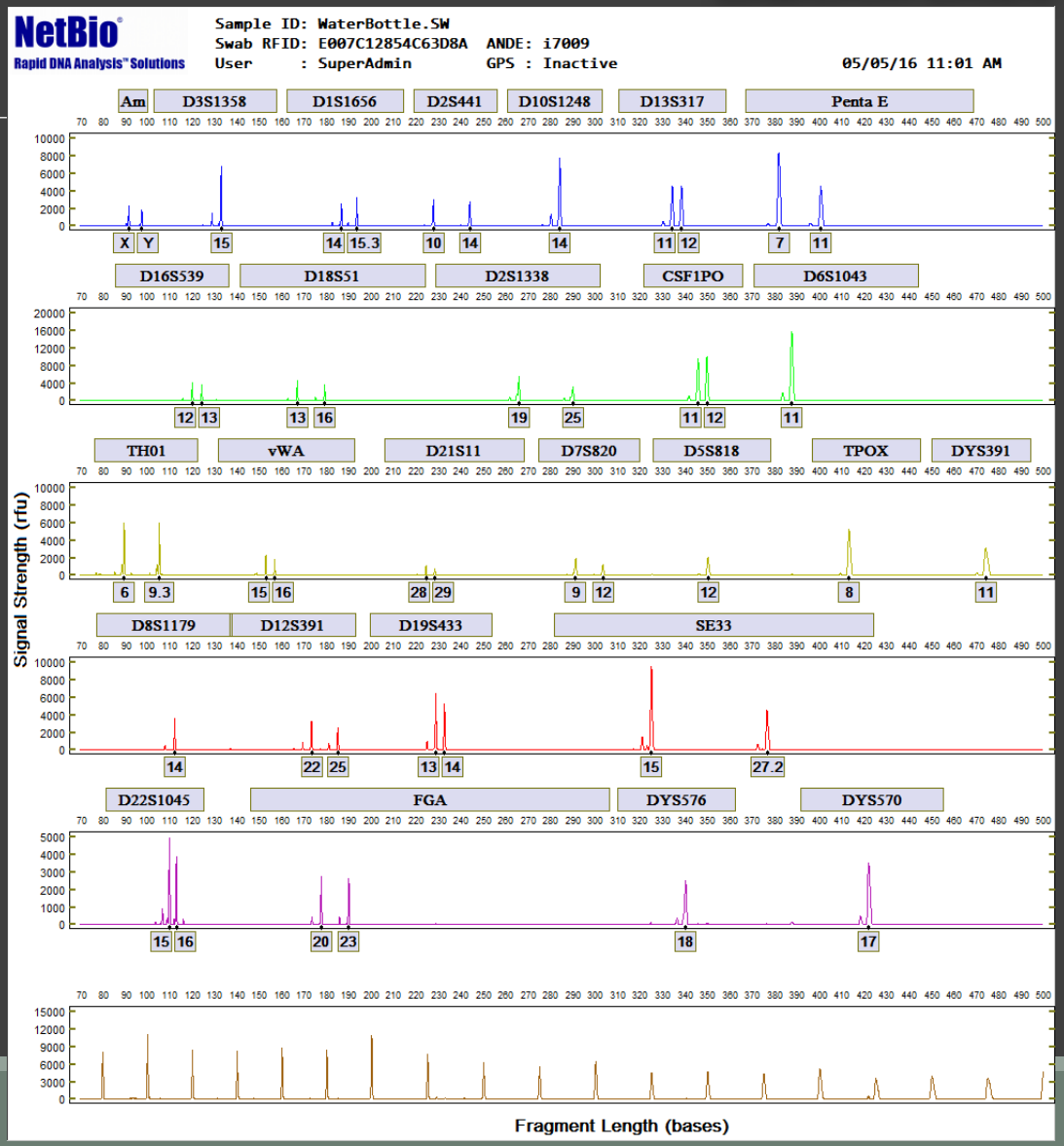
ATF LABORATORIES

- Plate 3
  - RSP: Percussion Actuated Non-Electric (PAN) Water
  - Mechanism: Remote triggered device is powered by a commercial 12 gauge blank shotgun shell. The tube is filled with water and capped. The device is aimed in the direction of the explosive device and fired. The water in the tube in propelled toward the target at high velocity in an attempt to dismantle and disarm.
  - Substrate: Steel plate
  - DNA Source: Blood and fingerprints

ANDE™ Post-Blast Testing

- Run 1, Lane 1 – Water Bottle
  - Sample ID: WaterBottle
  - DNA Source: Buccal cells/Saliva
  - Description: Control Sample
  - Rim of water bottle was swabbed with a moistened ANDE™ swab.

Information and images courtesy of Karen Olson, DFSC



ANDE™ Post-Blast Testing

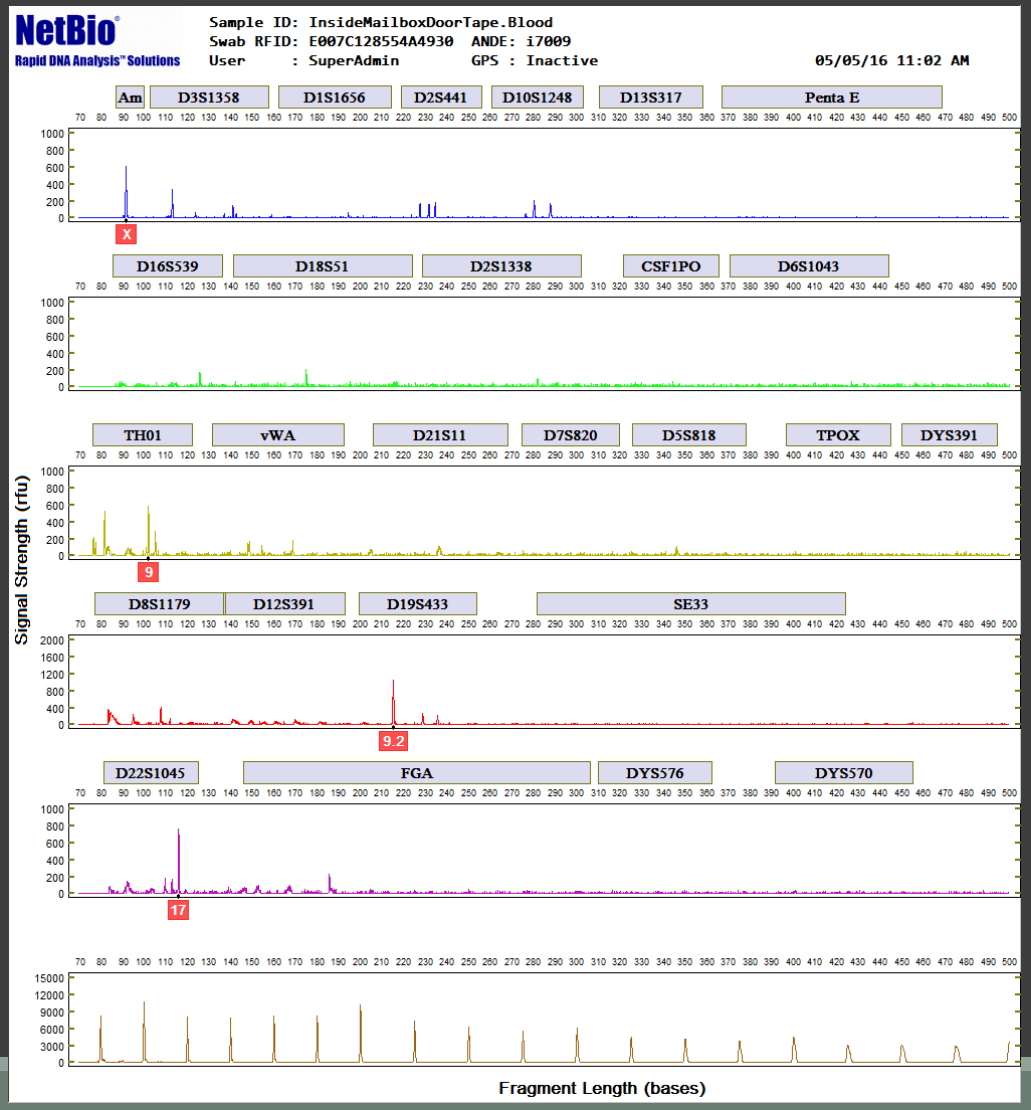
- Run 1, Lane 2 – Mailbox Door Tape Blood
  - Sample ID: InsideMailboxDoorTape.Blood
  - DNA Source: Blood
  - Description: Sample spotted on inside of mailbox door. Duct tape was placed over sample while still wet. Duct tape was not present post-blast.
  - Sample was collected with moistened swab.

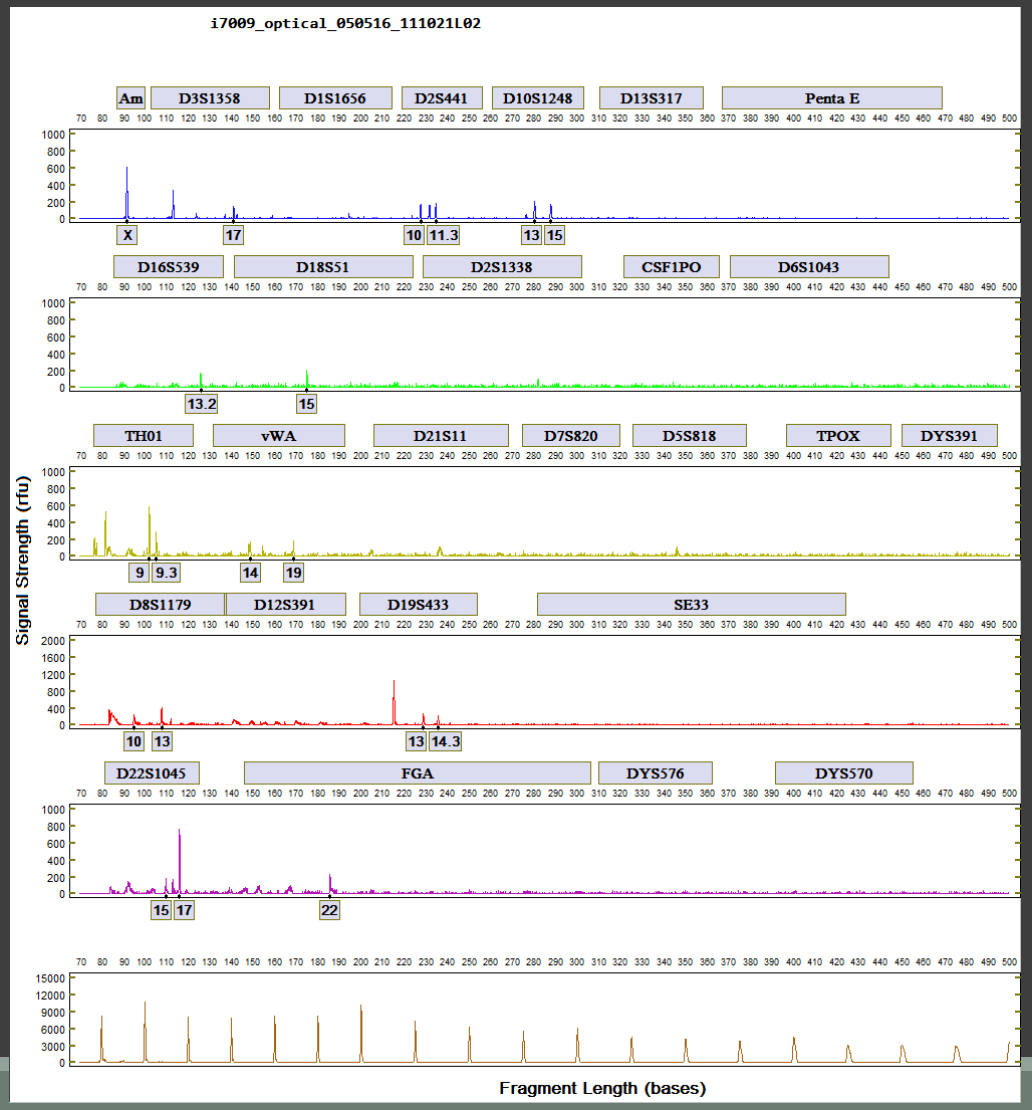
Pre-Blast

Post-Blast

ANDE™ Post-Blast Testing

Run 1, Lane 2 – Mailbox Door Tape Blood





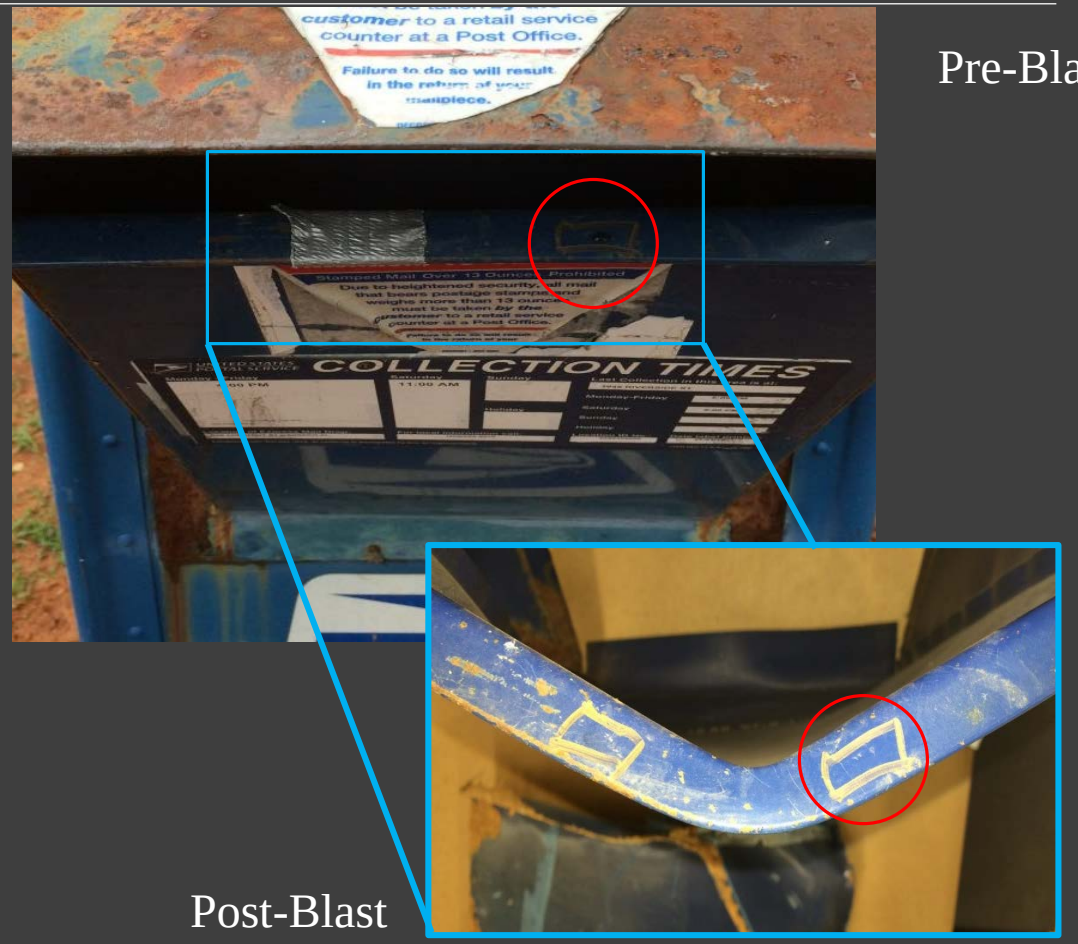
Standard Expert System

Information and images courtesy of Karen Olson, DFSC

Adaptive Expert System

ANDE™ Post-Blast Testing

- Run 1, Lane 3 – Mail Drop Blood
  - Sample ID: MailDrop.Blood
  - DNA Source: Blood
  - Description: Sample spotted on lip of mailbox drop chute. No tape was applied to the sample.
  - Sample was collected with moistened swab.

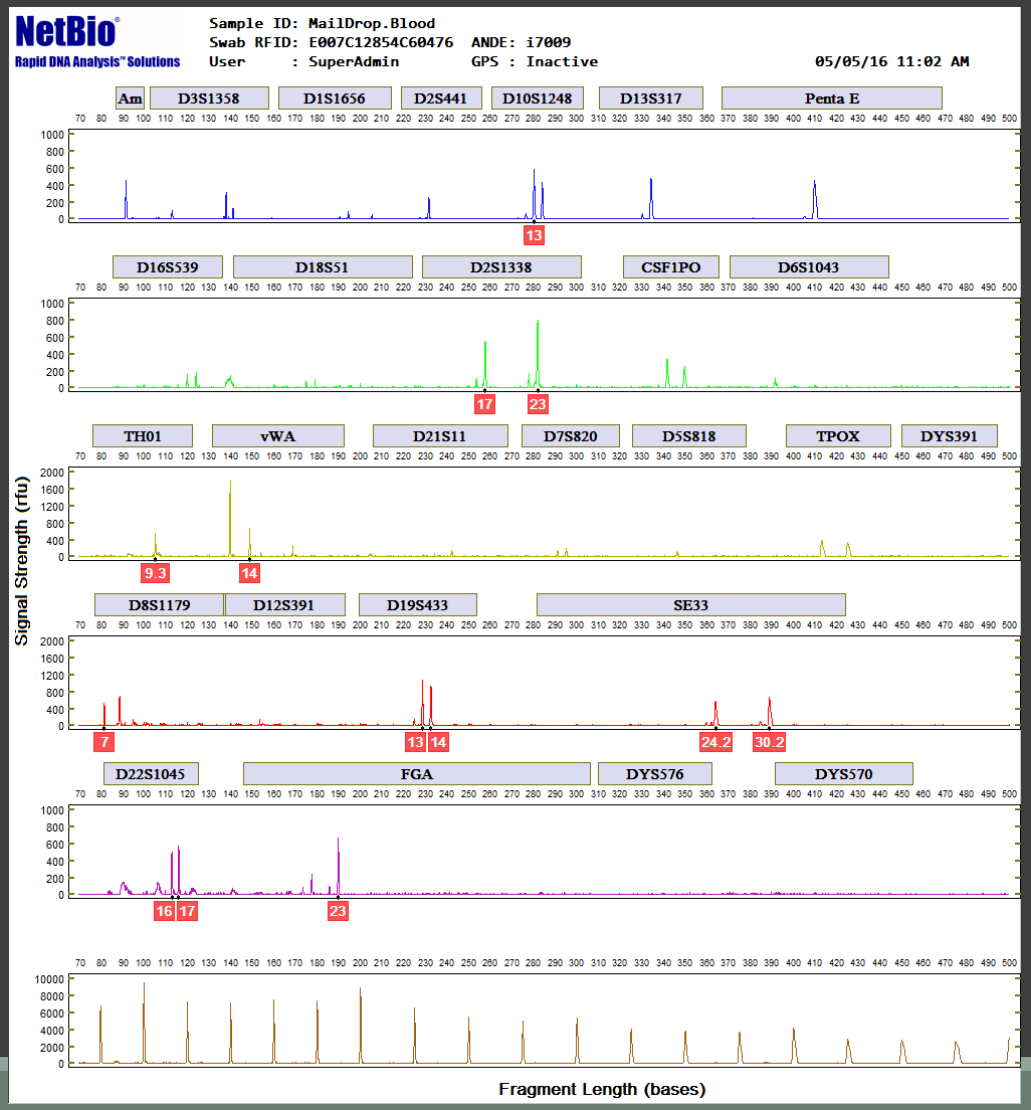


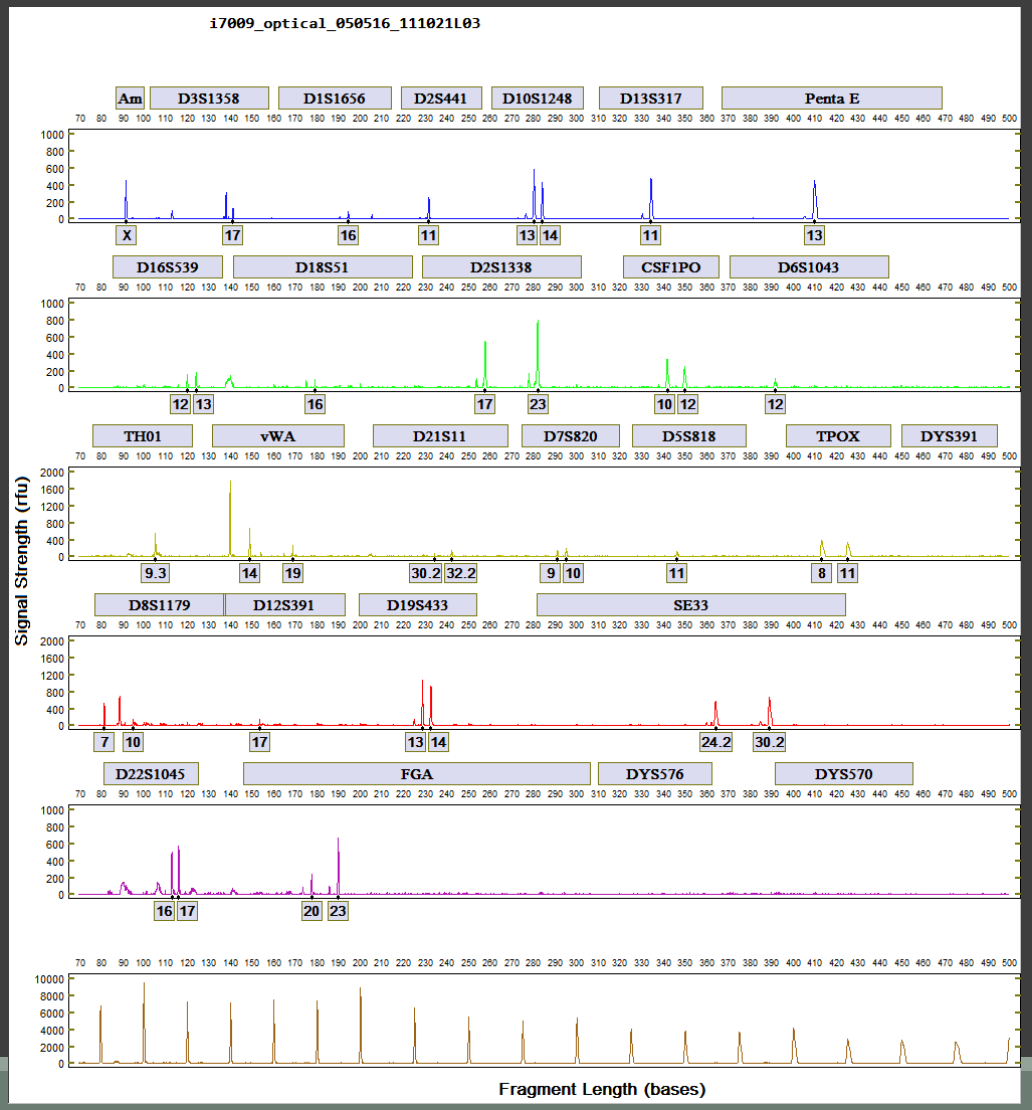
Pre-Blast

Post-Blast

ANDE™ Post-Blast Testing

Run 1, Lane 3 – Mail Drop Blood





Standard Expert System

Information and images courtesy of Karen Olson, DFSC

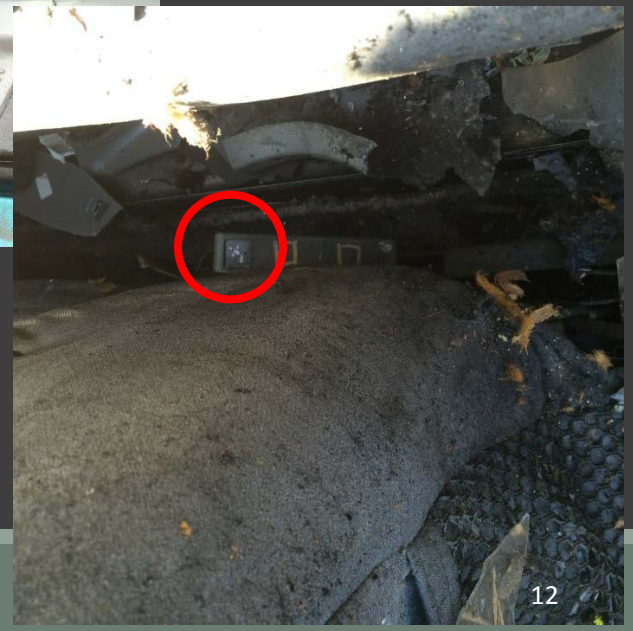
Adaptive Expert System

ANDE™ Post-Blast Testing

- Run 1, Lane 4 – Seat Pull Saliva
  - Sample ID: SeatPull.Saliva
  - DNA Source: Buccal cells
  - Description: Fresh buccal swab applied to passenger side seat back adjust lever.
  - Sample was collected with moistened swab.

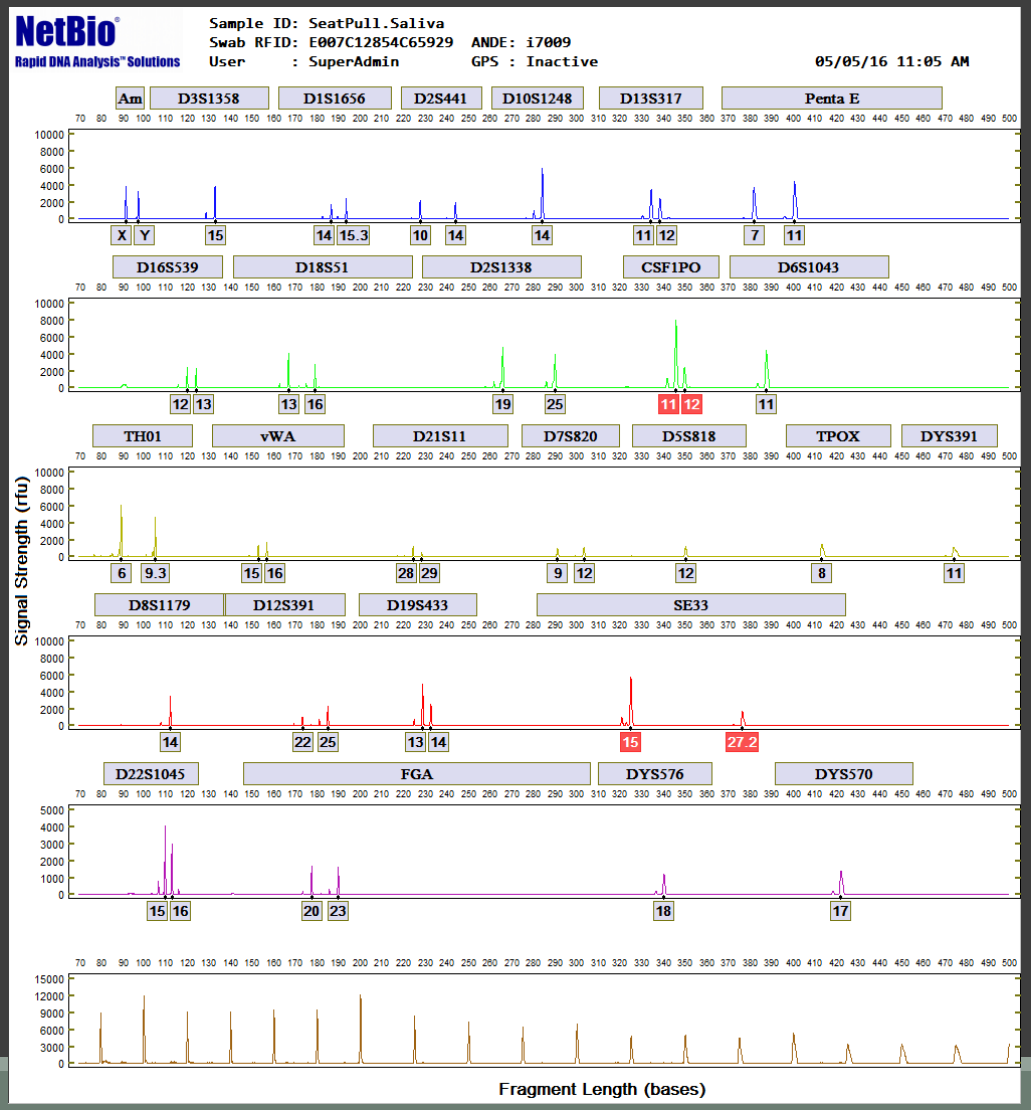
Pre-Blast

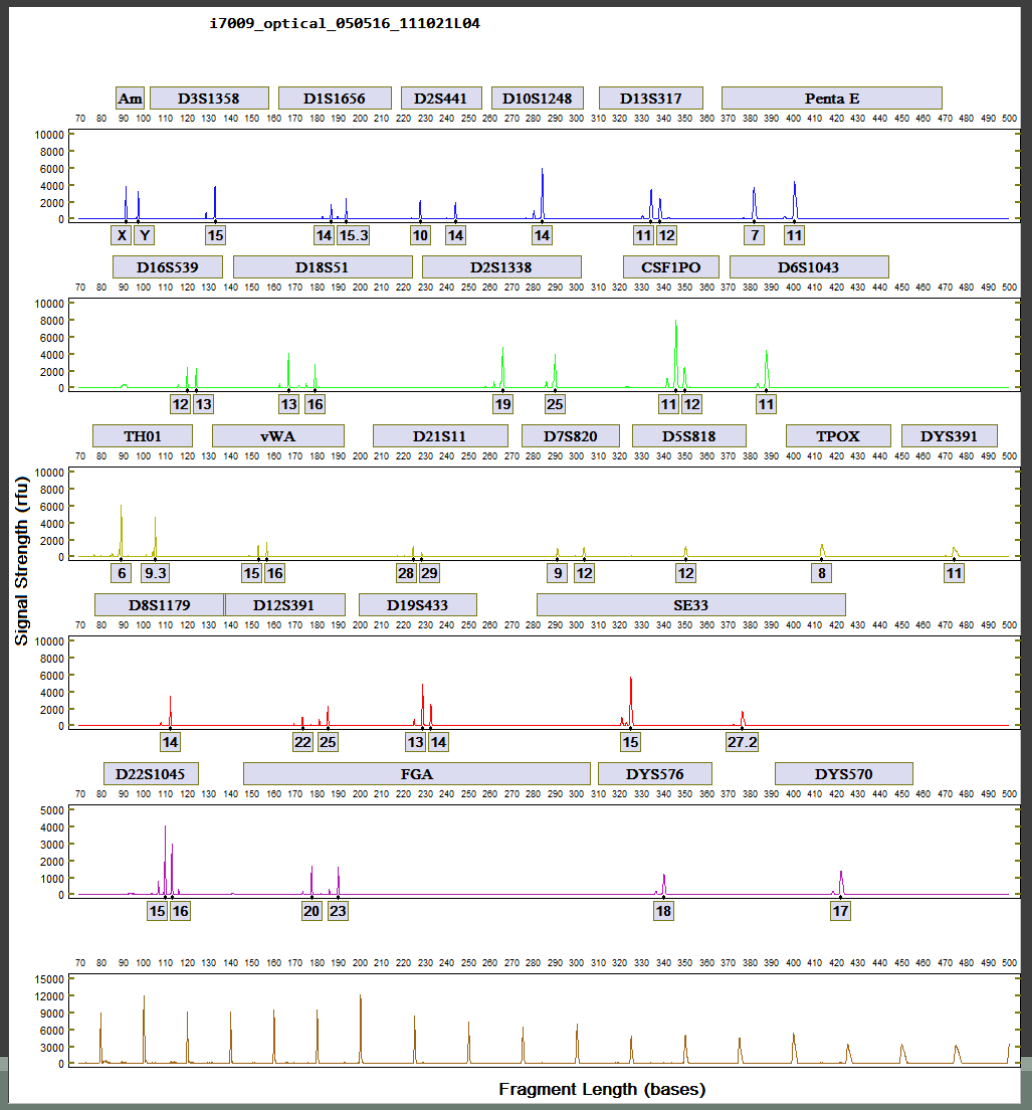
Post-Blast



ANDE™ Post-Blast Testing

Run 1, Lane 4 – Seat Pull Saliva





Standard Expert System

Information and images courtesy of Karen Olson, DFSC

Adaptive Expert System

ANDE™ Post-Blast Testing

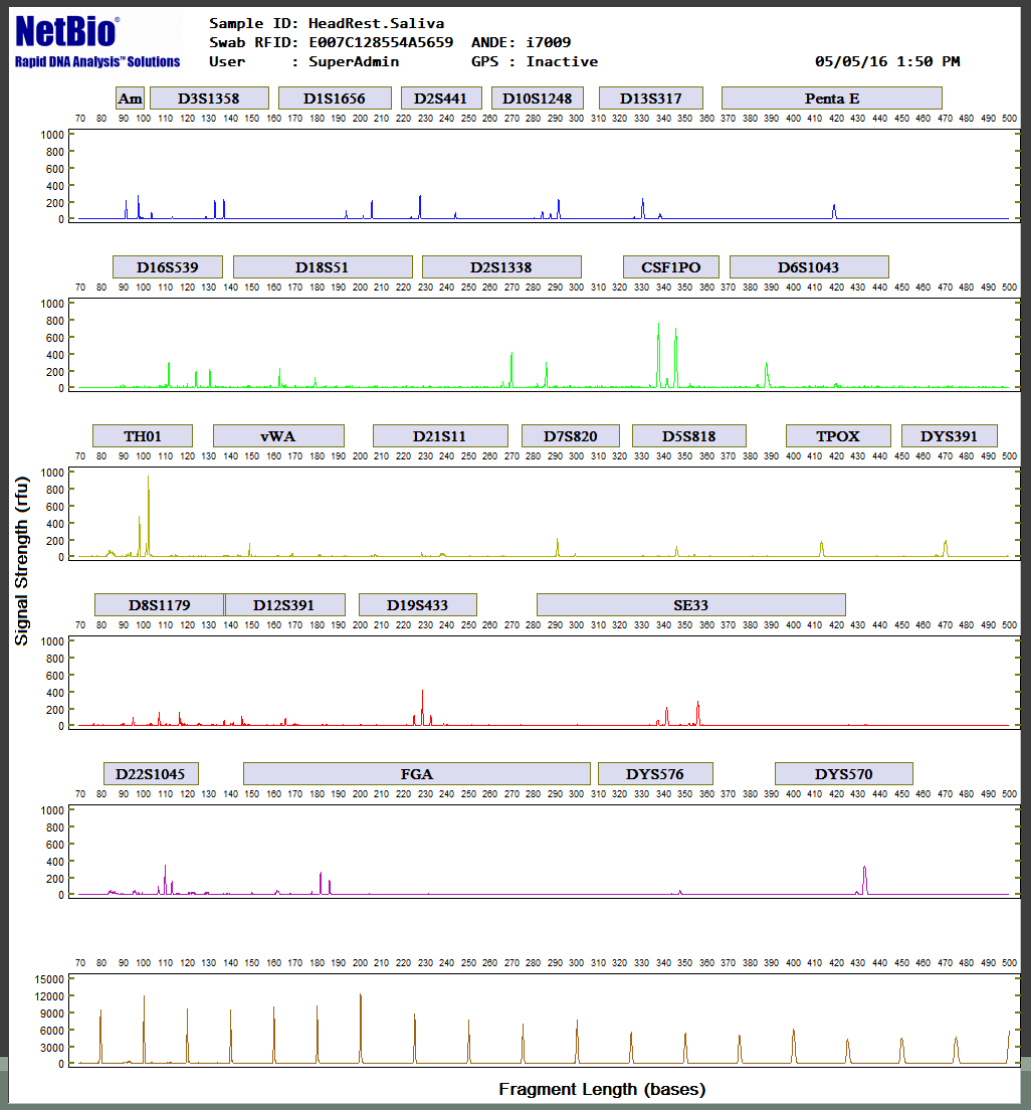
- Run 2, Lane 1 – Head Rest Saliva
  - Sample ID: HeadRest.Saliva
  - DNA Source: Buccal cells
  - Description: Fresh buccal swab applied to rear passenger side head rest.
  - Sample was collected with moistened swab.
  - Note: Fabric on rear of head rest was cut out prior to picture. Fabric remained largely intact with sample areas visible.

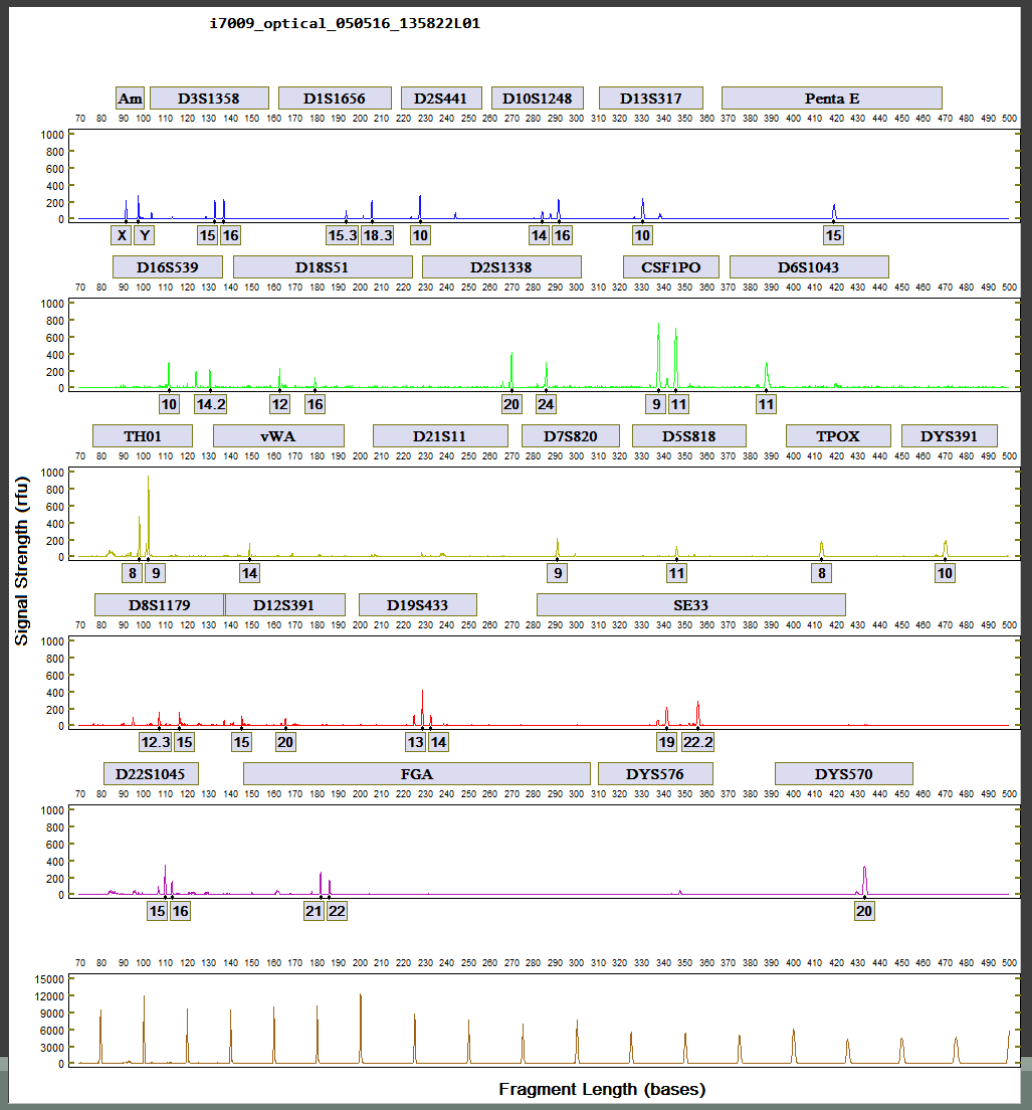
Pre-Blast

Post-Blast

ANDE™ Post-Blast Testing

Run 2, Lane 1 – Head Rest Saliva





Standard Expert System

Information and images courtesy of Karen Olson, DFSC

Adaptive Expert System

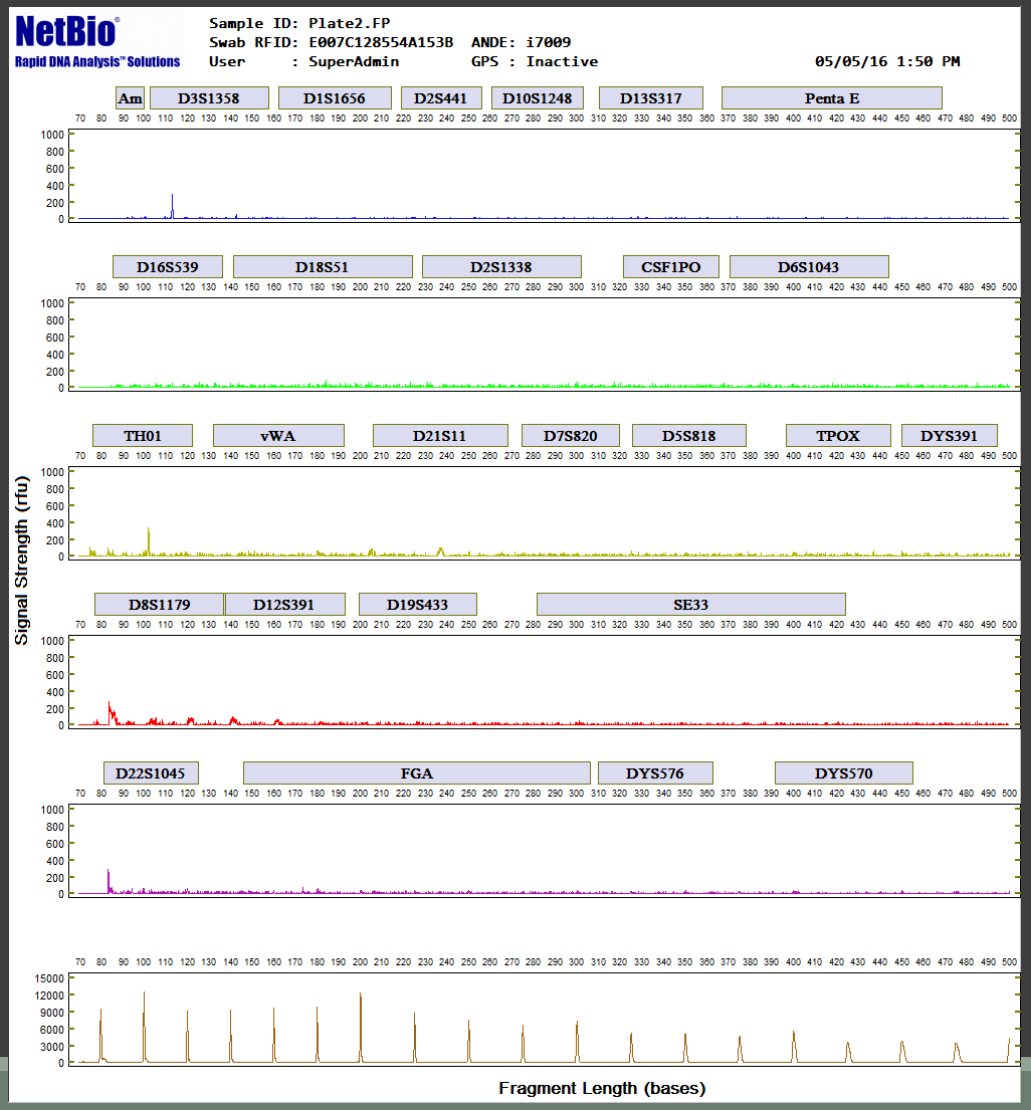
ANDE™ Post-Blast Testing

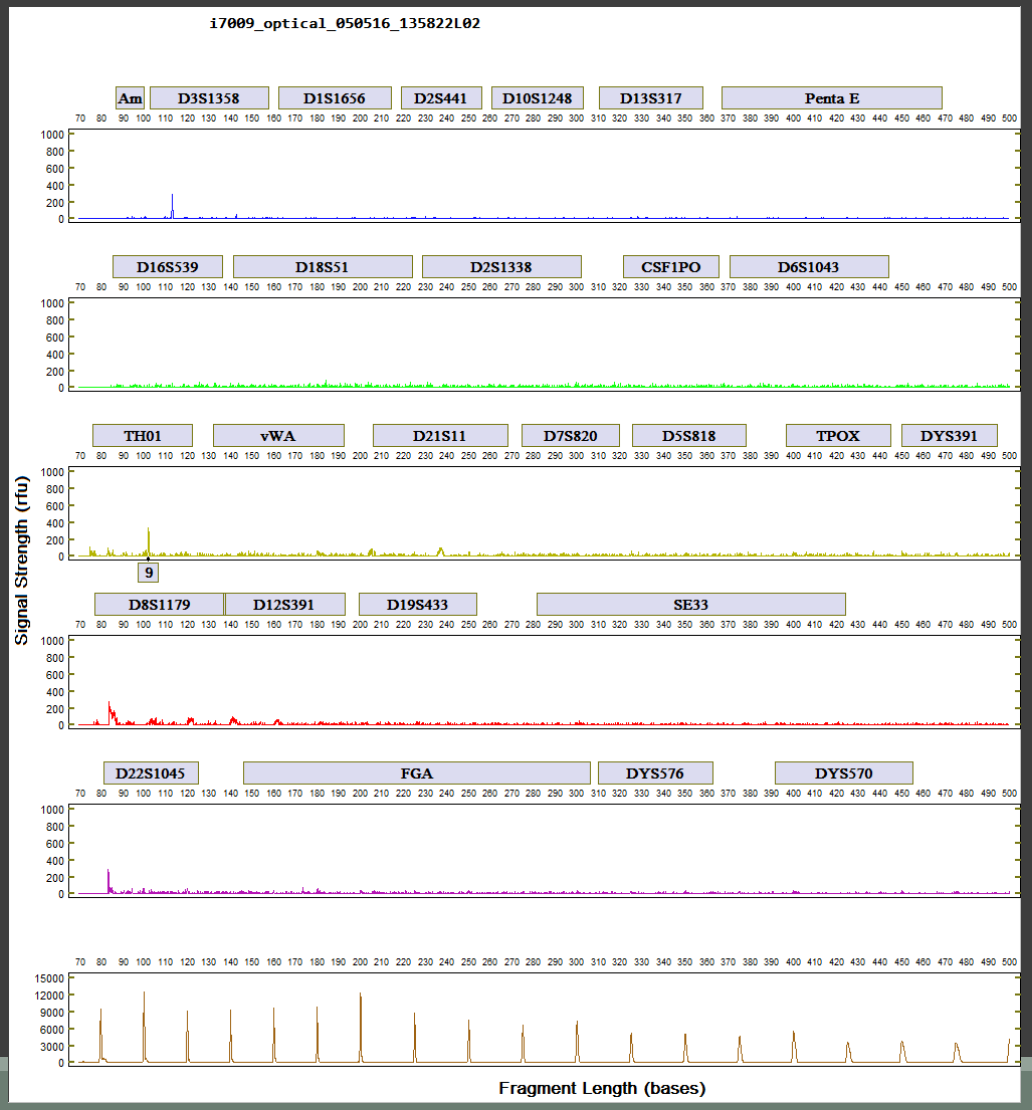
- Run 2, Lane 2 – Plate 2 Fingerprint
  - Sample ID: Plate2.FP
  - DNA Source: Finger prints
  - Description: Finger prints from steel plate were swabbed after MWB RSP performed.
  - Sample was collected with moistened swab.

Post RSP

ANDE™ Post-Blast Testing

Run 2, Lane 2 – Plate 2 Fingerprint





Standard Expert System

Information and images courtesy of Karen Olson, DFSC

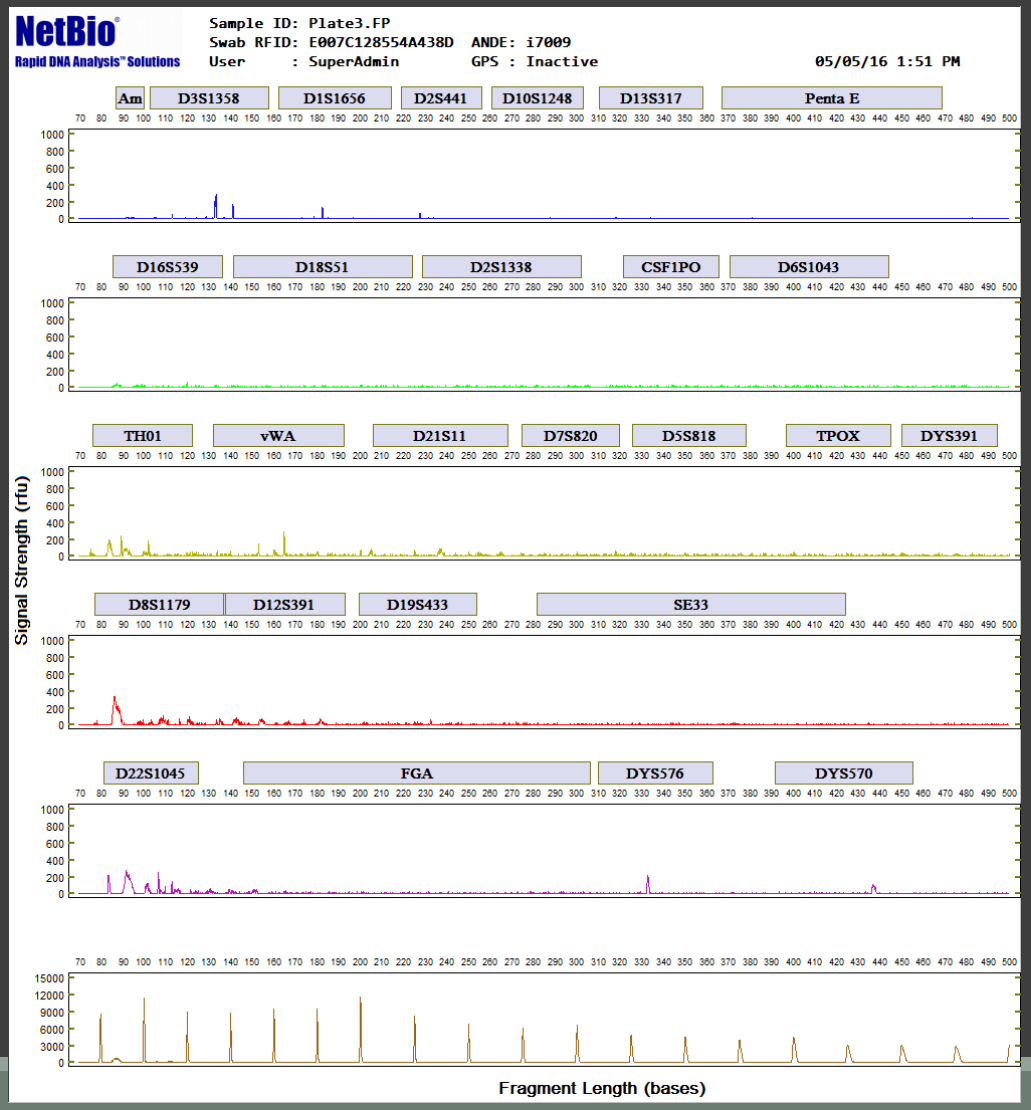
Adaptive Expert System

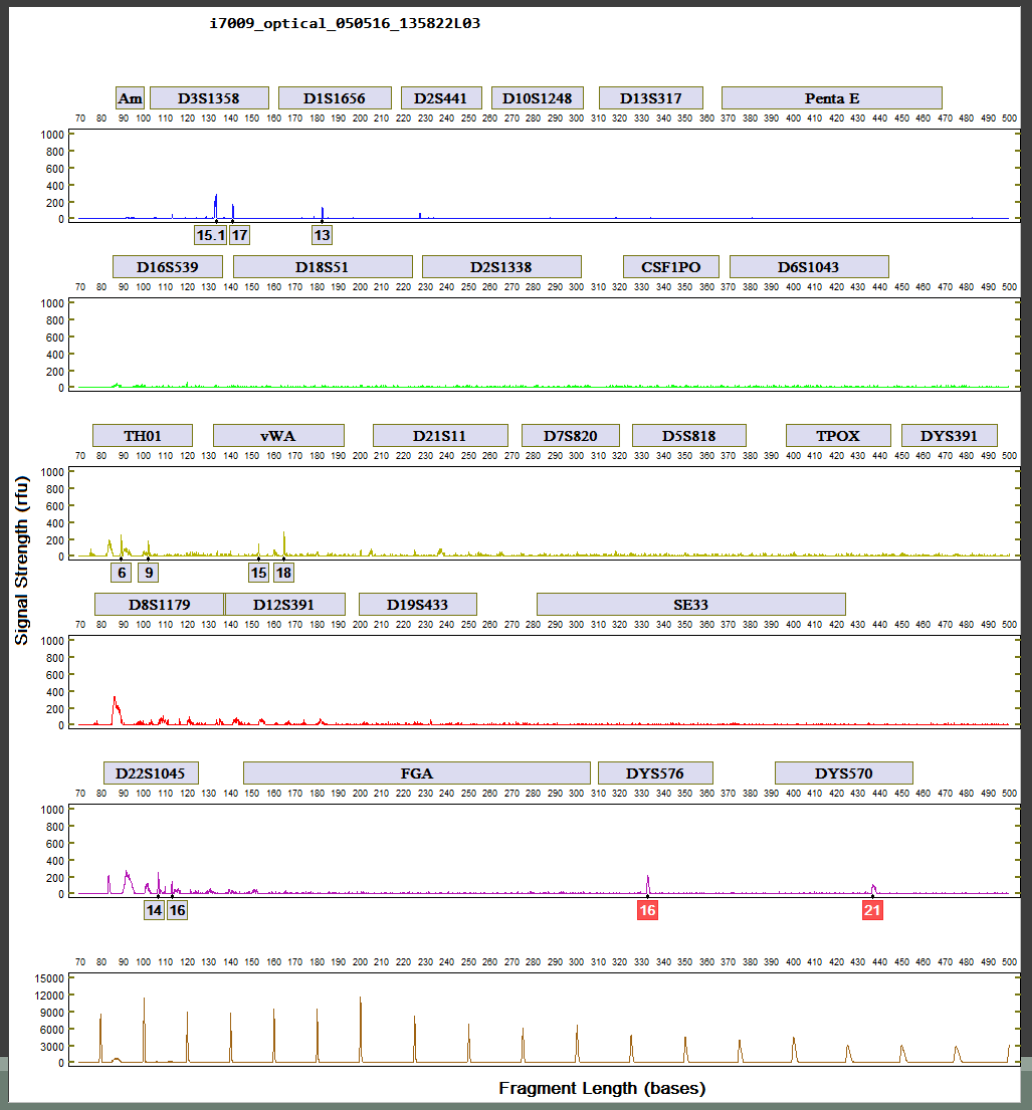
ANDE™ Post-Blast Testing

- Run 2, Lane 3 and 4 – Plate 3
  - Sample IDs: Plate3.FP and Plate3.Blood
  - DNA Source: Finger prints and Blood
  - Description: Finger prints and blood spots from steel plate were swabbed after PAN Water RSP performed.
  - Samples were collected with moistened swab.

ANDE™ Post-Blast Testing

Run 2, Lane 3 – Plate 3 Fingerprint





Standard Expert System

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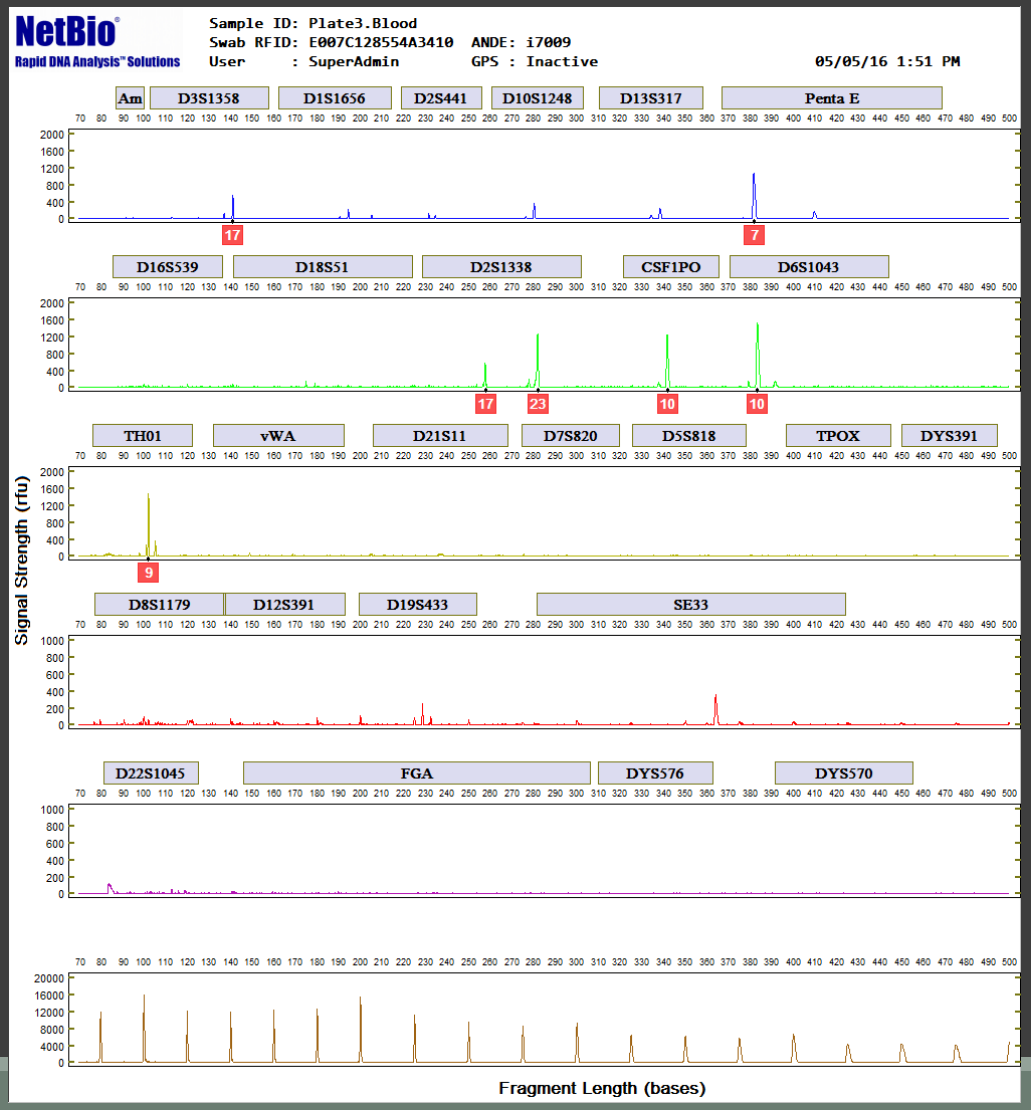
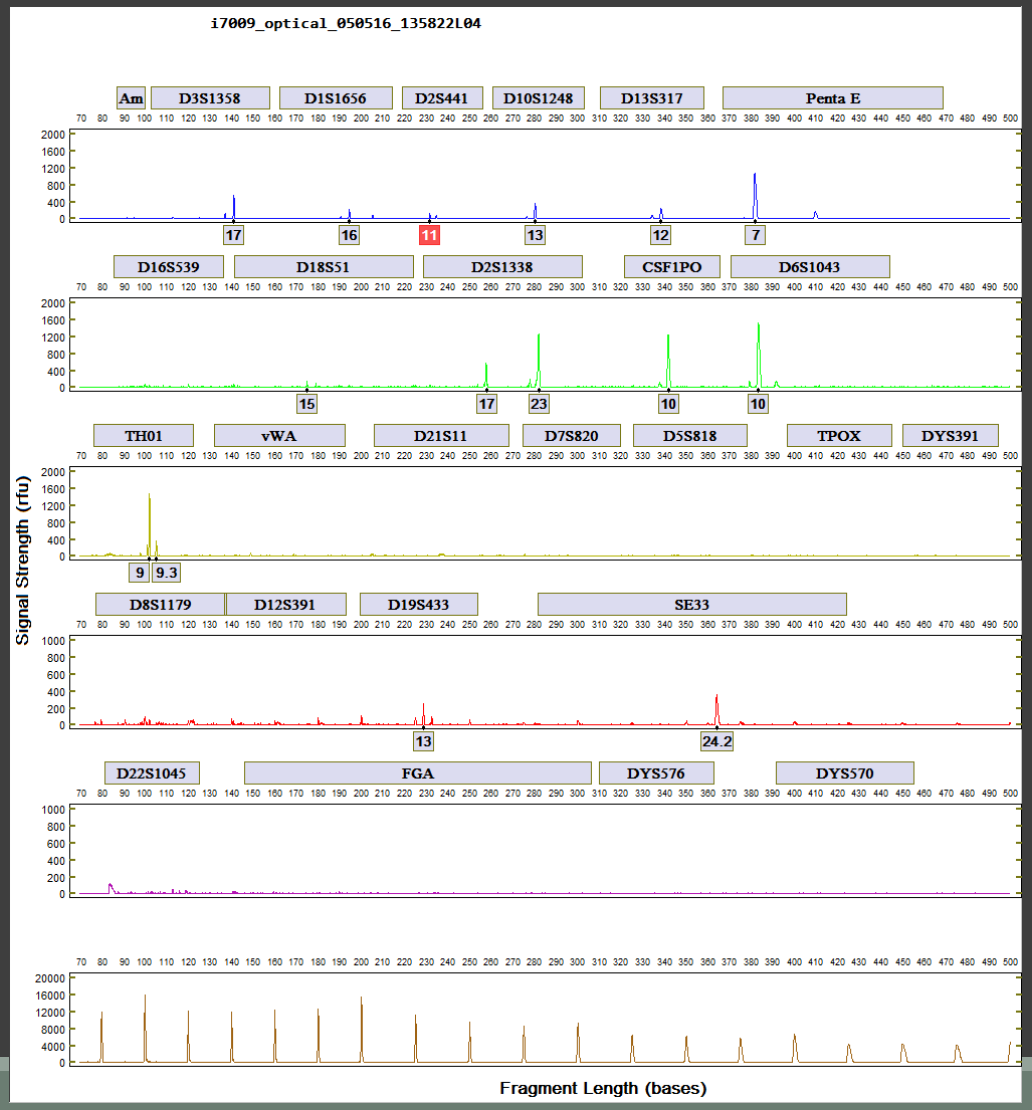
Adaptive Expert System

ANDE™ Post-Blast Testing

Run 2, Lane 4 – Plate 3 Blood





Standard Expert System

Information and images courtesy of Karen Olson, DFSC

Adaptive Expert System

ANDE™ Post-Blast Results

ATF LABORATORIES

STANDARD EXPERT SYSTEM RESULTS

Sample	Expected Profile ID	Amel	D3S1358	D1S1656	D2S441	D10S1248	D13S317	PentaE	D16S538	D18S51	D2S1338	CSF1PO	D6S1043	TH01	vWA	D21S11	D7S820	D5S818	TPOX	DYS391	D8S1179	D12S391	D19S433	SE33	D22S1045	FGA	DYS576	DYS570
Water Bottle SW	1												?															
Inside Mailbox Door Tape Blood	2																											
Mail Drop Blood	2																											
Seat Pull Saliva	1												?															
Head Rest Saliva	3																											
Plate 2 Fingerprint	Unk																											
Plate 3 Fingerprint	Unk																											
Plate 3 Blood	1																											

2016 PROTOTYPE ADAPTIVE EXPERT SYSTEM (AES) RESULTS

Sample	Expected Profile ID	Amel	D3S1358	D1S1656	D2S441	D10S1248	D13S317	PentaE	D16S538	D18S51	D2S1338	CSF1PO	D6S1043	TH01	vWA	D21S11	D7S820	D5S818	TPOX	DYS391	D8S1179	D12S391	D19S433	SE33	D22S1045	FGA	DYS576	DYS570
Water Bottle SW	1												?															
Inside Mailbox Door Tape Blood	2				{1}	{1}			1														{1}		{1}	1		
Mail Drop Blood	2												?								{1}							
Seat Pull Saliva	1												?															
Head Rest Saliva	3								{1}				?								{1}		{1}					
Plate 2 Fingerprint	Unk													?														
Plate 3 Fingerprint	Unk		{1}	?											{1}										?			
Plate 3 Blood	1												?															

Information and images courtesy of Karen Olson, DFSC

Correct call at locus

No call at locus

One allele correct

Only incorrect alleles called

At least one correct allele with incorrect allele(s) called

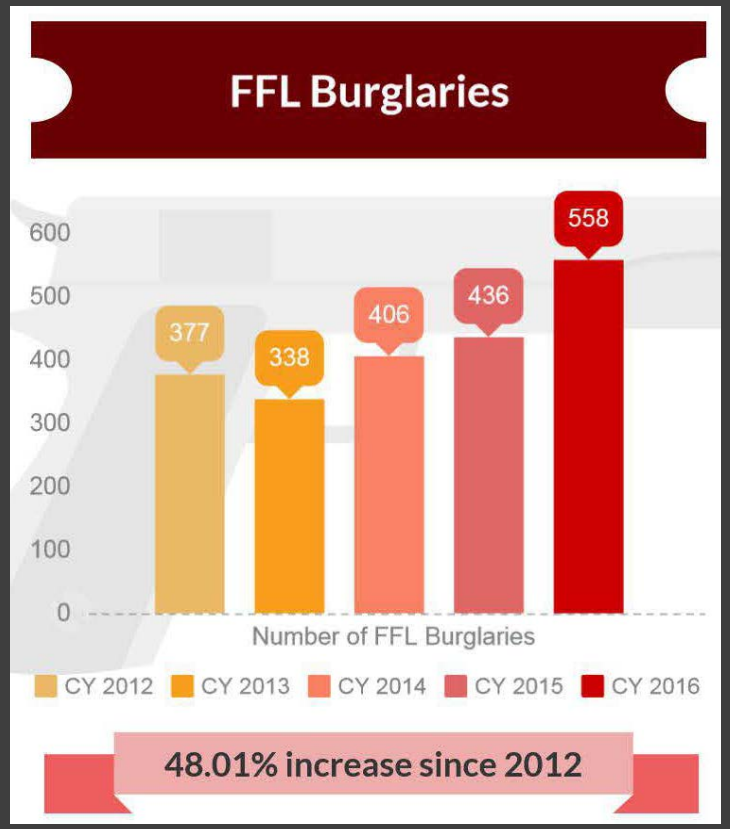
Where Does Rapid DNA fit at the ATF?

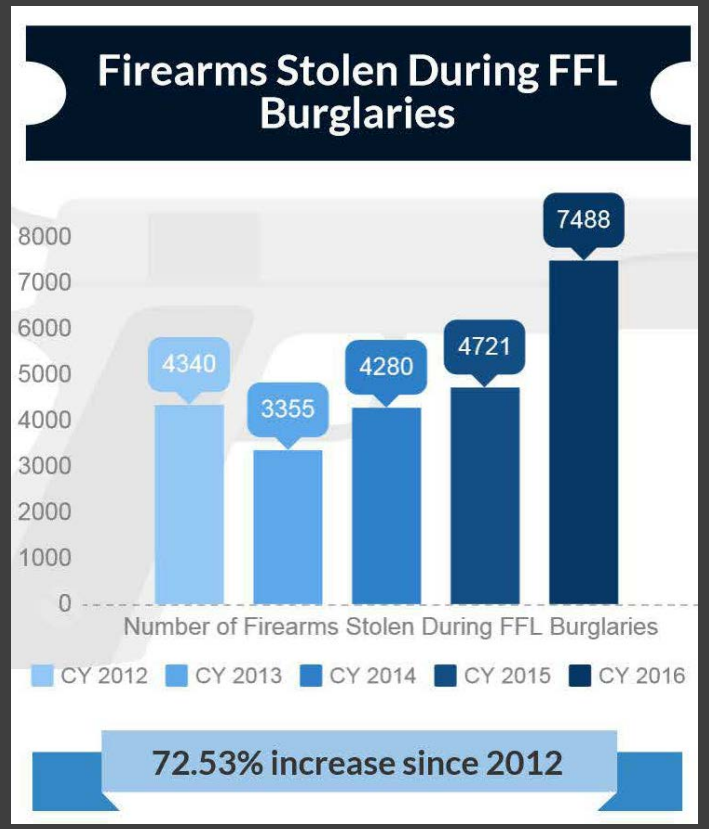
- We don’t make policy
- We don’t perform databasing
- We don’t have booking stations
- Majority of evidence is low level, multiple contributor data
- We don’t have money

- Casework
  - Traditional vs. Rapid DNA
- Research
  - Explosives
  - Arson
  - Cartridge Cases

FFL Burglaries and Rapid DNA

- Federal Firearms Licensee (FFL) burglaries have risen 48.01% resulting in a 72.53% increase in the number of firearms stolen since 2012
- Multiple burglaries tend to happen over a short period of time
- Firearms are being trafficked within days to different states to be sold illegally on the streets





https://www.atf.gov/resource-center/federal-firearms-licensees-ffl-burglary-and-robbery-statistics-calendar-year-2012

FFL Burglaries and Rapid DNA

- Incidents involve breaking through reinforced doors and glass cabinets to obtain firearms
- Results in blood evidence at the scene

http://www.instructables.com/id/Dexter-Blood-Slide-Suckers-Eat-At-Your-Own-Risk/

FFL Burglaries and Rapid DNA

- Traditional Casework Workflow – Expedited = **~6 days**
  - Evidence is collected on scene and forwarded to lab – 2 days
  - DNA Analysis – 1.5 days
  - Technical Review and CODIS Keyboard Search – 0.5 day
  - CODIS Hit Confirmation – 2 – 30+ days
- Rapid DNA Workflow = **~24 hours**
  - Evidence is sampled and collected on scene – 1 hour
  - Rapid DNA Instrument is deployed to scene at first report – 12 hours
  - Instrument setup and sample tested on scene – 3 hours
  - CODIS Keyboard Search with local/state laboratory* - 1 hour
  - CODIS Hit Confirmation* - Unknown
- Sample conserved for re-testing at laboratory.

*Dependent upon passing of laws and cooperation from state/local lab

Questions?

- Acknowledgements
  - DFSC: Karen Olson
  - NetBio®: Michael Kessler
  - ATF: Todd Bille, Emily Head, Greg Peiffer

Image courtesy of Erica Romsos, NIST