



# AFMES-AFDIL's DNA Capability and Capacity



## Korea Cold War Annual Briefing August 1-2, 2019

**Timothy P McMahon, PhD**  
Director, DoD DNA Operations  
Armed Forces Medical Examiner System





# Outline



- Armed Forces Medical Examiner System
- DNA Capabilities and Capacity
- Korea 55 update
- Fit For Use technology



# Armed Forces DNA Identification Laboratory (AFMES-AFDIL)



- Division of the Armed Forces Medical Examiner System (AFMES)
  - Defense Health Agency (DHA)
- Established in 1990
  - Utilize DNA methods to identify the remains of US service members
- Mission Partner with the Defense POW/MIA Accounting Agency (DPAA) and predecessor organizations since 1990





# DoD's Only Human Remains Testing Laboratory



**American Society of Crime  
Laboratory Directors-Laboratory  
Accreditation Board  
(ASCLD – ISO 17025  
International Certification)**



**Federal Bureau Of Investigation  
(FBI) Quality Assurance  
Standards**



**DoD DA Oversight Committee  
(Defense Science Board 1995)**





# AFMES Missions Supported By AFDIL



**Present Day Accounting**



**Past Accounting**

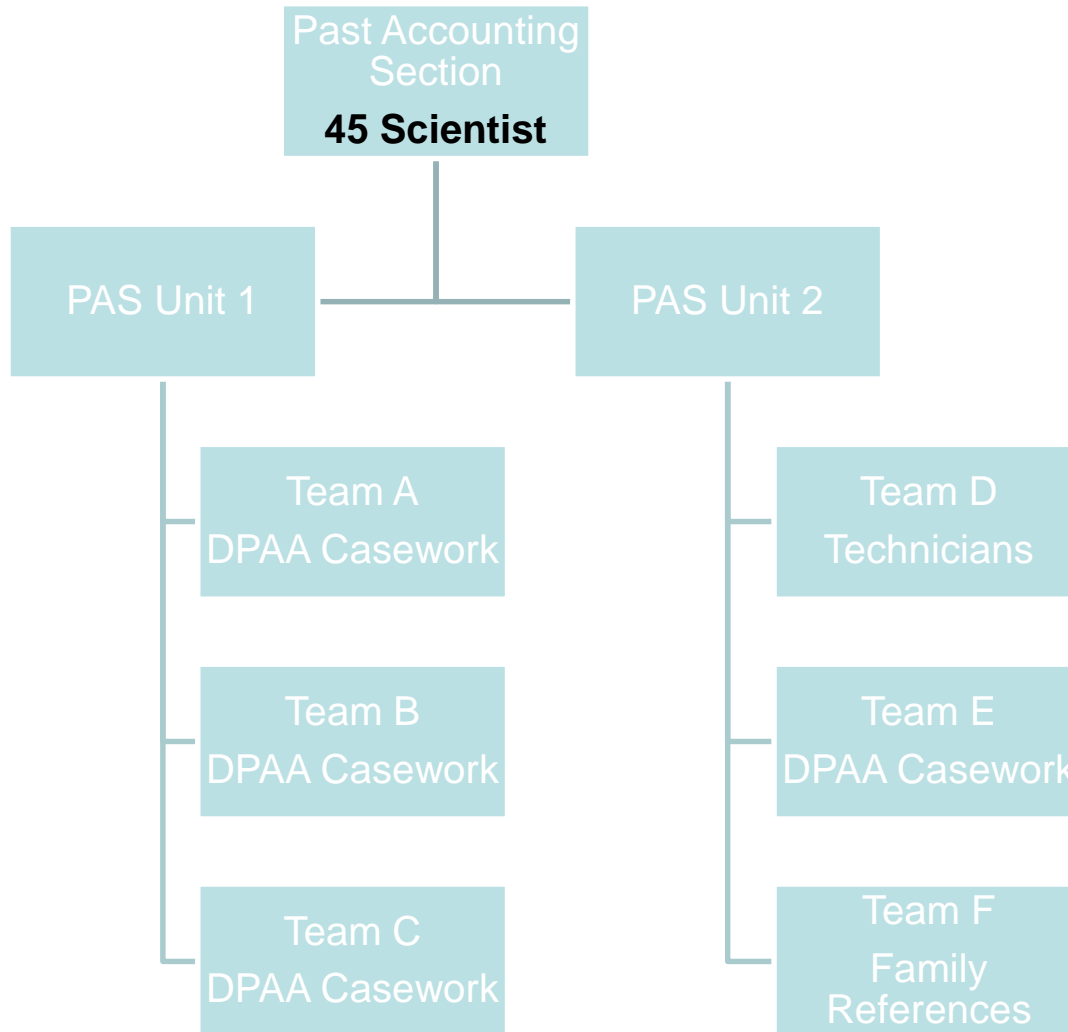


**FRS Databasing**



**World Wide Support**

# Past Accounting Section 2013



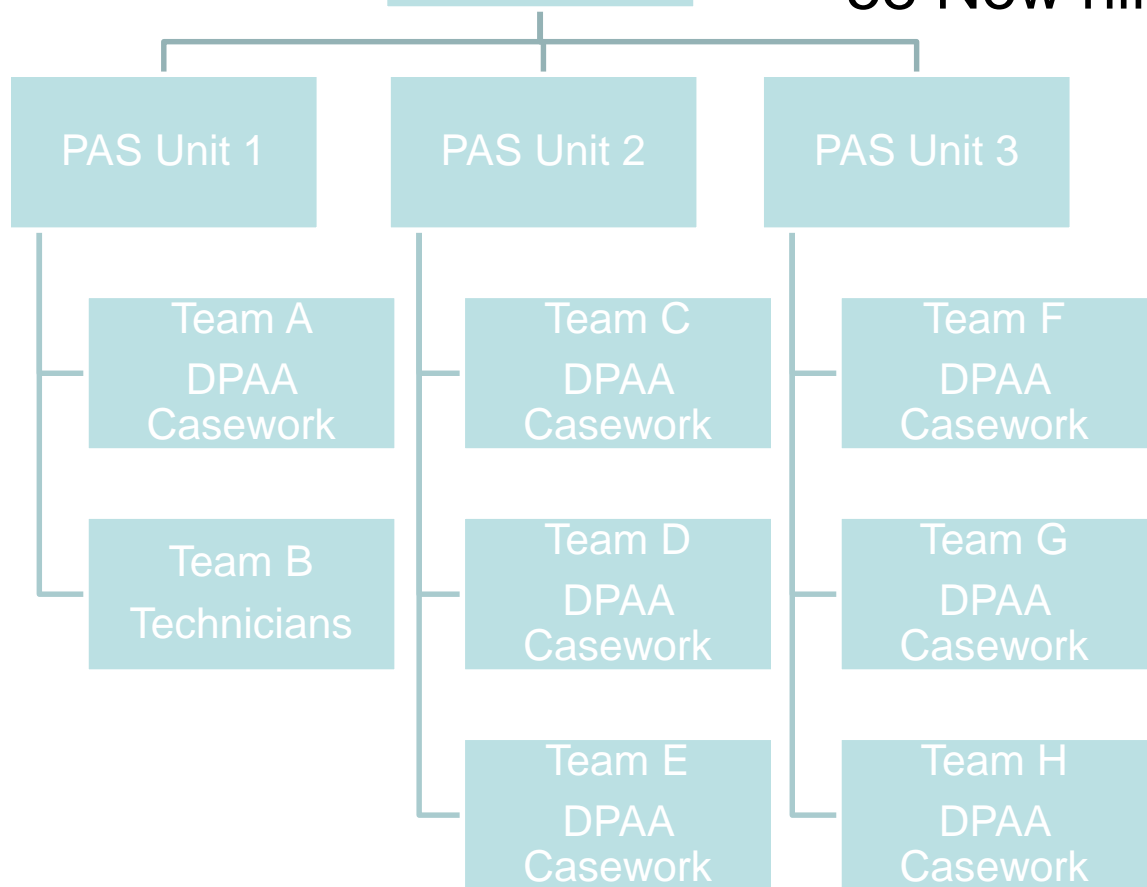
**6 Teams**  
**Casework**  
**Family References**

# Past Accounting Section 2019

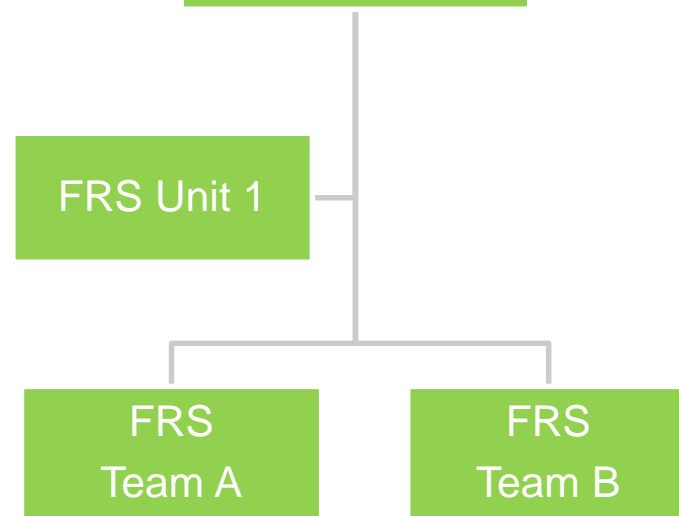


2 New Past Accounting Teams  
New FRS section  
58 New hires

Past Accounting  
Section  
**90 Scientist**

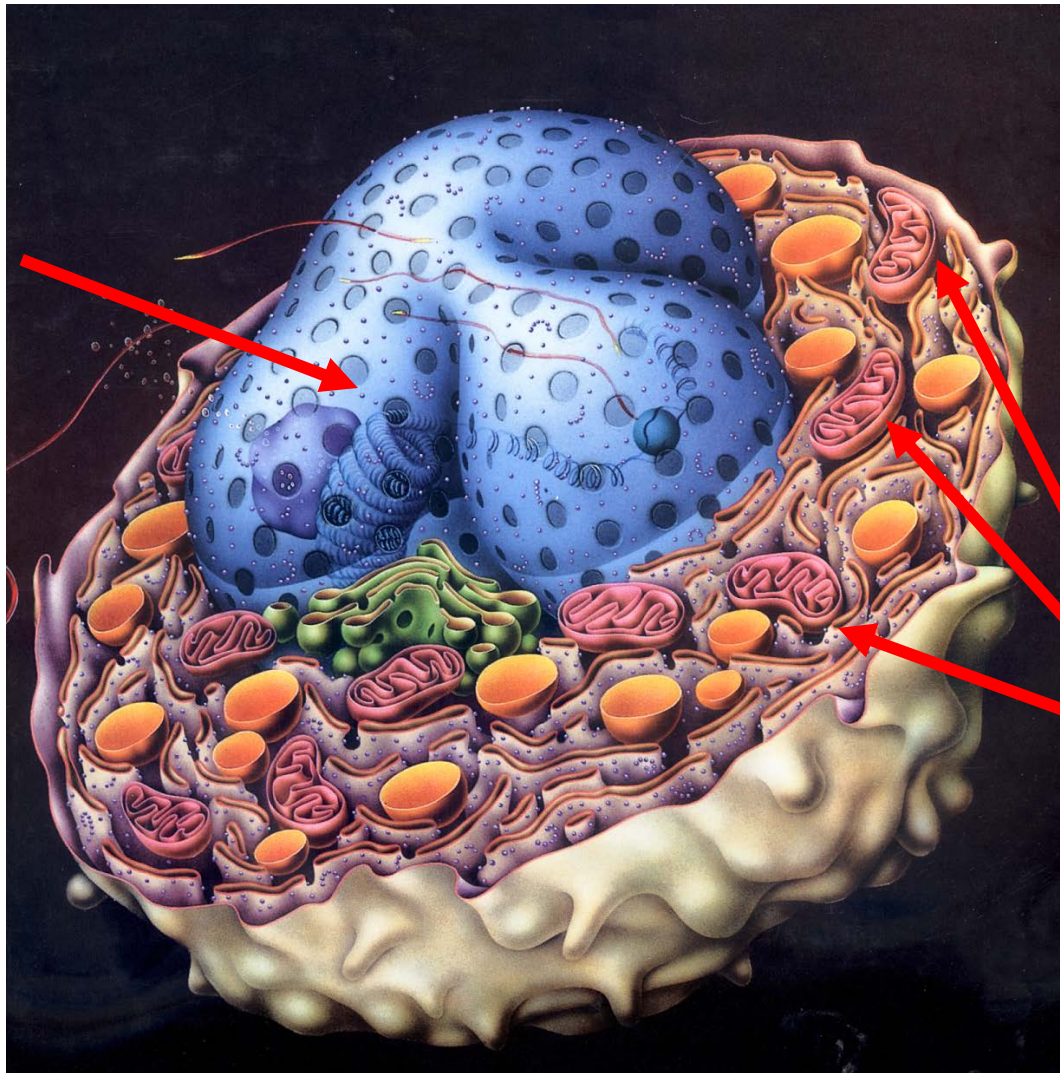


Family Reference  
Section (FRS)  
**12 Scientist**





**Nuclear DNA**  
~3.2 billion  
base pairs  
(bp)



**Mitochondrial  
DNA**

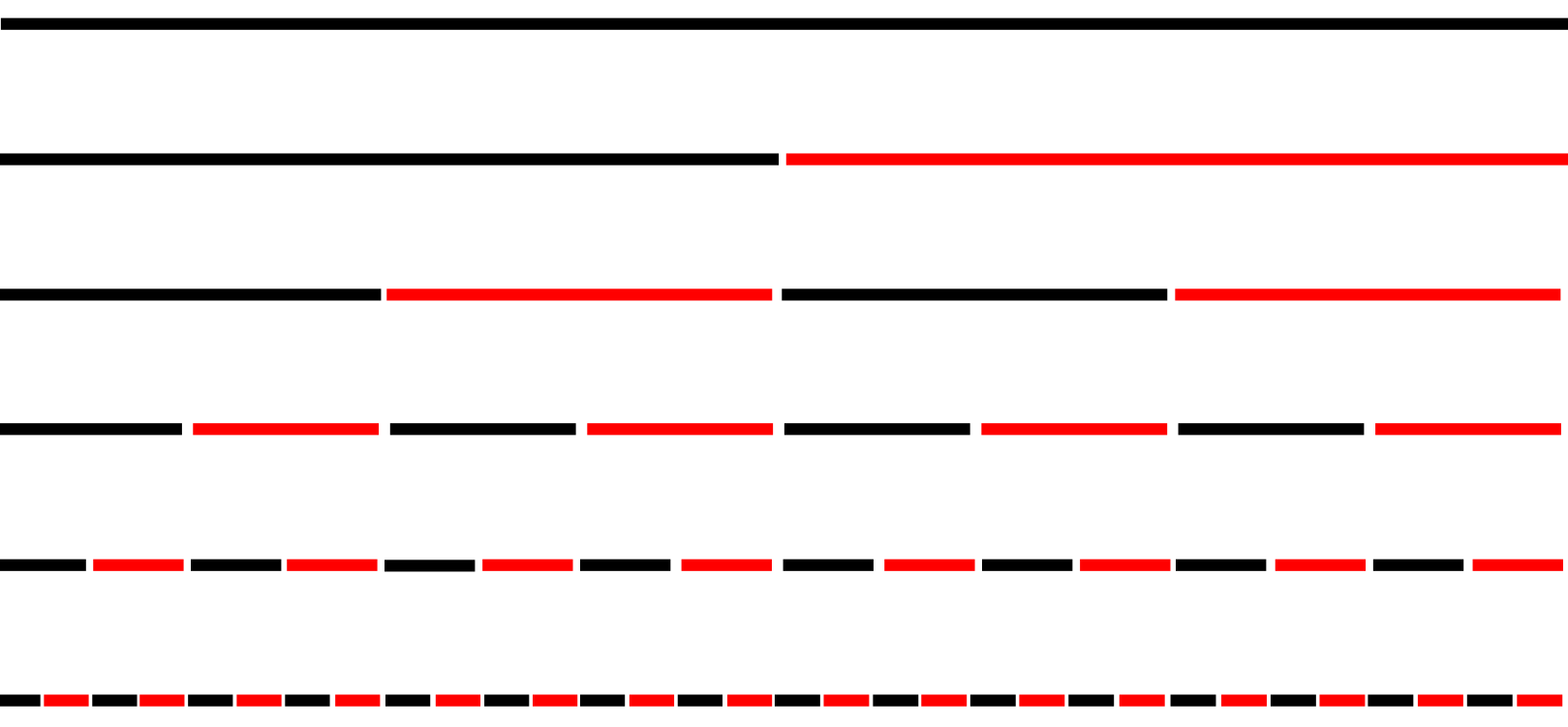
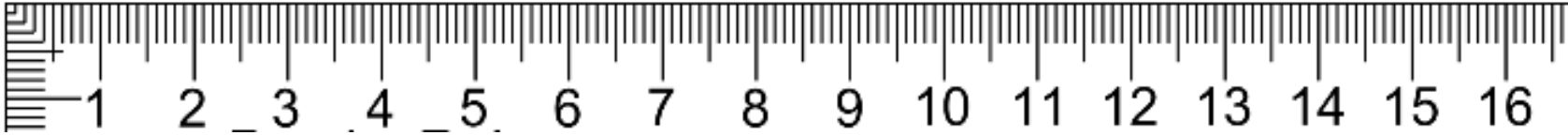
**16,549 bp**



# DNA Degradation: Example



inches



1 yr

2 yr

3 yr

4 yr

5 yr

6 yr

1 in = 100 base-pairs

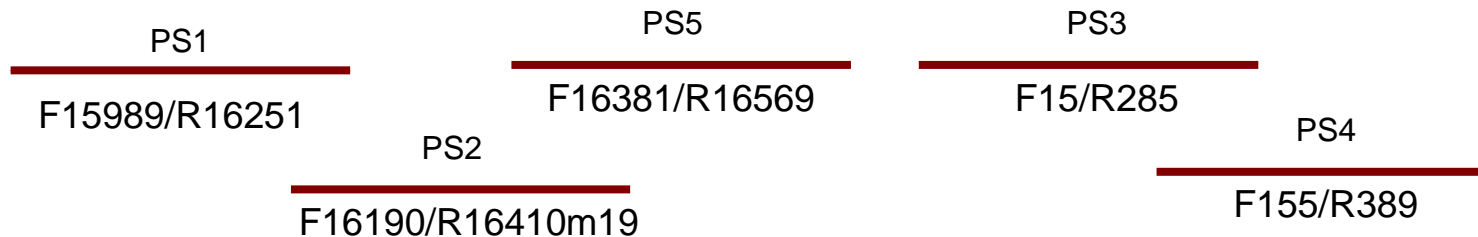
# mtDNA Capabilities



Control Region



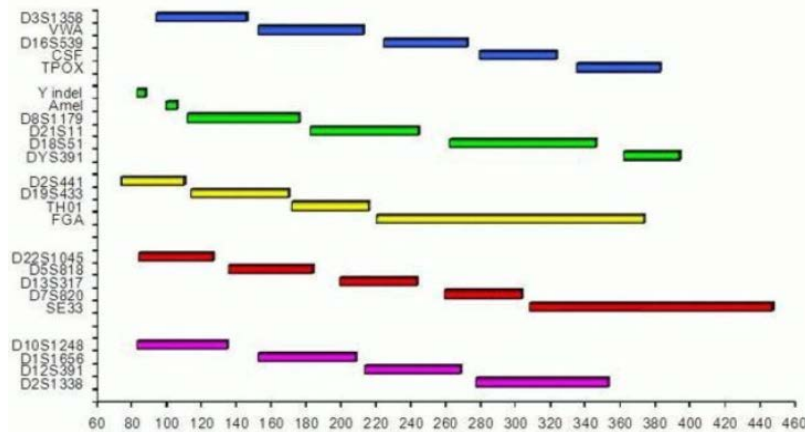
Primer sets (~200bp)



Mini-primer sets (~120bp)

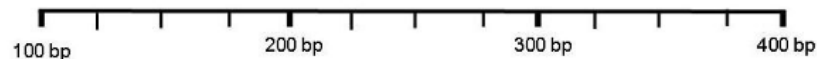


# Nuclear DNA Capabilities (auSTR and YSTR)



## AmpFISTR GlobalFiler

<https://www.thermofisher.com/order/catalog/product/4476135>



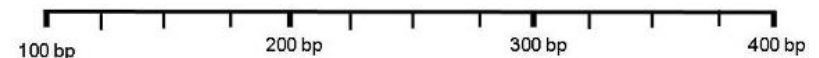
## AmpFISTR MiniFiler

<https://strbase.nist.gov/kits/MiniFiler.htm>



## PowerPlex Fusion

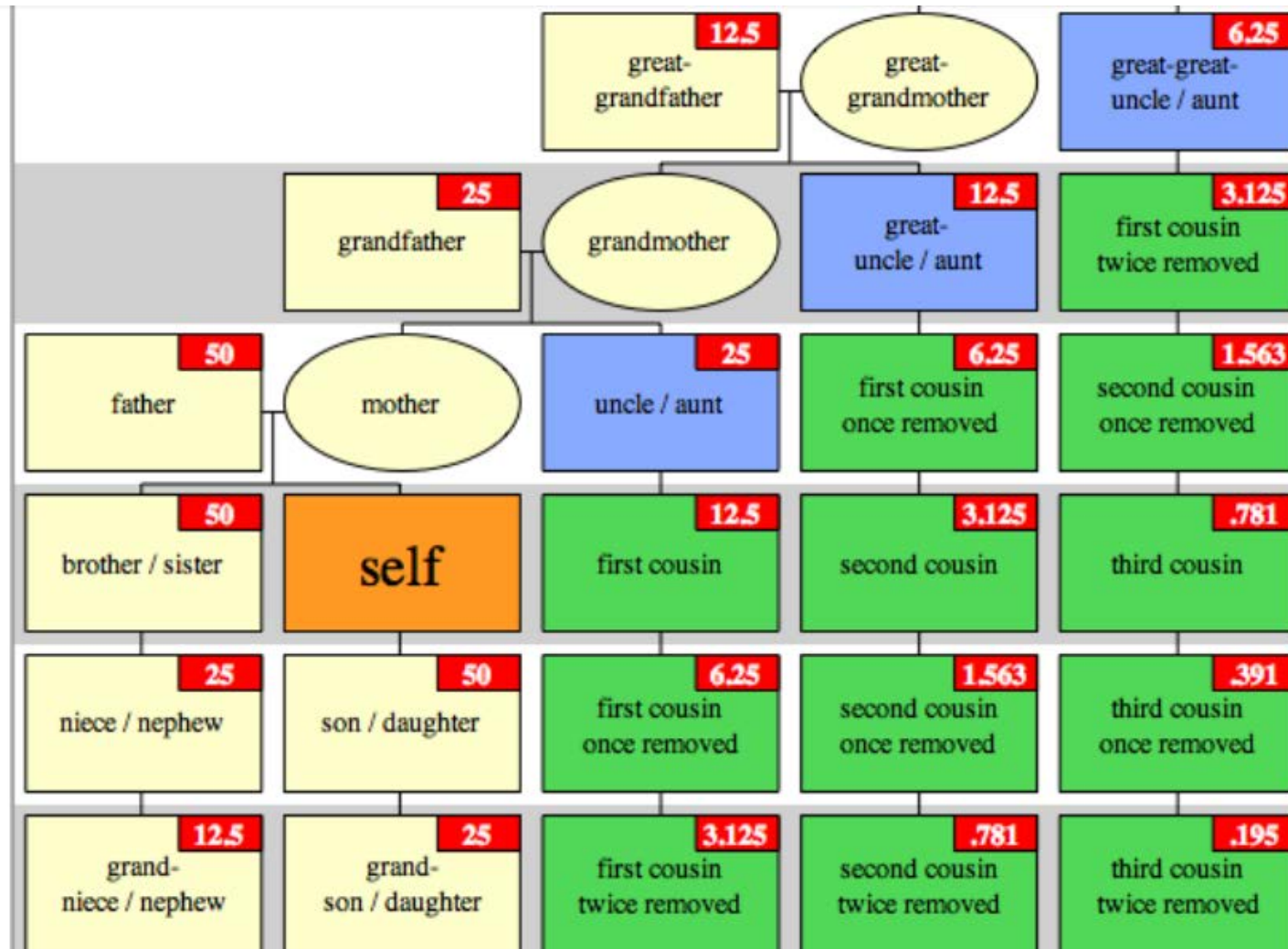
<https://strbase.nist.gov/kits/Fusion.htm>



## AmpFISTR YFiler

<https://strbase.nist.gov/kits/YFiler.htm>

# Nuclear DNA Shared Between Relatives



Amount of total nuclear DNA in common with ones relatives

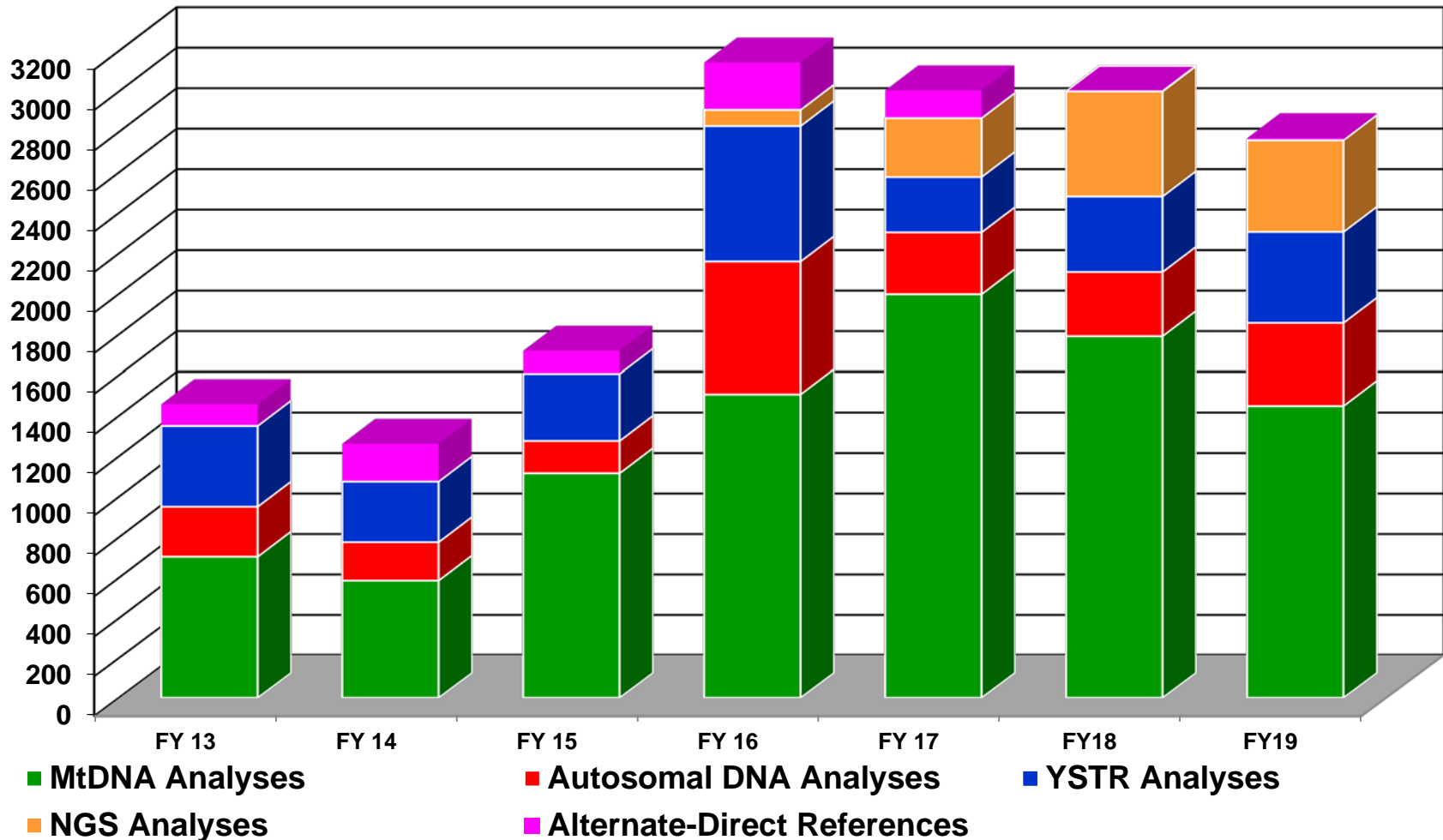


# DNA Tests Reported By AFDIL

As Of June 30, 2019



**94% Success Rate Obtaining MtDNA Sequence Data**  
**62% Success Rate Obtaining Au-STR DNA Data**  
**67% Success Rate Obtaining Y-STR DNA Data**  
**59% Success Rate Obtaining NGS Data**





# DNA Reports

## June 30, 2019



<b>FY</b>	<b>Believe to Be Reports</b>	<b>Addendum Reports</b>	<b>Foreign National</b>	<b>Total Reports</b>
<b>2012</b>	<b>60</b>	<b>103</b>	<b>57</b>	<b>220</b>
<b>2013</b>	<b>55</b>	<b>120</b>	<b>39</b>	<b>214</b>
<b>2014</b>	<b>75</b>	<b>57</b>	<b>51</b>	<b>183</b>
<b>2015</b>	<b>71</b>	<b>77</b>	<b>32</b>	<b>180</b>
<b>2016</b>	<b>133</b>	<b>65</b>	<b>6</b>	<b>204</b>
<b>2017</b>	<b>154</b>	<b>165</b>	<b>26</b>	<b>345</b>
<b>2018</b>	<b>189</b>	<b>496</b>	<b>34</b>	<b>719</b>
<b>2019</b>	<b>128</b>	<b>304</b>	<b>3</b>	<b>435</b>

# Mitogenome NGS



- Capture method was validated in December 2015 (started in June 2015)
  - 60+ page validation summary
  - 7 new SOPs and 18 new forms
- The first set of samples was processed in February 2016
  - Only the technical leader, 1 supervisor, 4 analysts and 1 technician



## Common mtDNA sequence and no auSTR or YSTR results generated:

- Sequence whole mtDNA genome
- Individuals with common mtDNA distinguishable
- Grant to expand whole mtDNA database: better statistics





# NGS Success



- **Overall: 1263 samples in 3 yrs**
  - 645 reportable sequences (51%)
  - World War II, Korea, Vietnam
- **304 Whole Genome FRS**
- **DNA Reports**
  - 281 DNA Comparison Reports
  - 128 First Time Named Reports
  - 153 Addendum Reports
- **Processing Capacity**
  - Increased to ~45 samples/month





# Support to 200 Identifications/Year



<b>FY</b>	<b>Believe to Be Reports (New IDs)</b>	<b>Total BTB Reports*</b>	<b>Number of Analysis Reported</b>	<b>Number of new FTEs Hired</b>	<b>DPAA Number of new IDs</b>
<b>2013</b>	55	214	1457	0	59
<b>2014</b>	75	183	1301	6**	67
<b>2015</b>	71	180	1719	12**	80
<b>2016</b>	133	204	3143	6**	161
<b>2017</b>	154	345	3005	15** †	201
<b>2018</b>	189	719	3000	0	208
<b>June 2019</b>	128	435	2769	6	

\* BTB reports is total of New ID supported reports and addendum reports for additional portions

\*\* Increase in number of analysis reported occurred in FY after individuals were hired

† Additional people increased NGS testing; increased DNA New IDs



# Increase Scope and Pace



<b>FY</b>	<b>DPAA requested Analysis Reported</b>	<b>AFMES Phased # Analysis to meet DPAA needs</b>	<b>Number of New Scientists Needed</b>
2018	3000†	NA	NA
2019	5870	3400	6
2020	6470	4800	10 (16)
2021	6470	6200	10 (26)
2022	6470	6470	6 (32)
2023	6470	6470	(32)
2024	6470	6470	(32)
2025	6470	6470	(32)

† 3000 Analysis supported 200 IDs in FY17 and FY18

## Why Phased: Budget Growth

# Korea 55 Update



- Received 505 samples for DNA testing
  - First samples 8/23/18
  - Boxes 1-20 mid September
  - Boxes 21-25 early October
- All 505 samples completed for mtDNA
- Success Rates
  - mtDNA - 98%
  - YSTR - 58% (170 samples tested)
  - auSTR - 52% (171 samples tested)
- Currently working additional testing and comparison reports



# Why Does DNA Take Time



- Sample quality and DNA quantity
- Authentic sequence and confidence
- **Forensic instruments and kits geared toward**

- **FIT FOR USE**

- **AFMES has to create new testing method**
  - No commercial kits/have to develop
  - Science needs to catch up
- Family References

# Approaching CSI Shows



Public Law 115-50  
115th Congress

## An Act

To establish a system for integration of Rapid DNA instruments for use by law enforcement to reduce violent crime and reduce the current DNA analysis backlog.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

### SECTION 1. SHORT TITLE.

This Act may be cited as the "Rapid DNA Act of 2017".

### SEC. 2. RAPID DNA INSTRUMENTS.

Aug. 18, 2017  
[H.R. 510]

Rapid DNA Act  
of 2017.  
42 USC 13701  
note.

Nov. 22, 2018, 2:27 p.m.

CAMP FIRE

By RONG-GONG LIN II

Rapid DNA analysis is being used to identify dozens of California fire victims

## NEWS

**State panel approves NYC's use of 'Rapid DNA' technology in disaster situations**



The ANDE Rapid DNA instrument - FBI NDIS Approved

ANDE Corporation's Rapid DNA Identification System First to Receive FBI Approval Under New Standards June 2018

DNA results in under 2 hrs

# RAPID Instruments



- PROS
  - Developed for Swabs
  - High Copy Samples
  - Fast
  - Booking Stations/Family assistance Centers
  - Adoptable to other samples
    - Bone, Cigarettes, tissue



- CONS
  - Modern samples only
  - Fresh Bone/buccal swabs
  - Autosomal STR based only
  - 7 samples/low throughput



# Create New Method



- **No viable mtDNA, YSTR, or auSTR references available**
- Genetic Genealogy:
  - Who am I related to
  - What potential medical issues may I have
  - What is my heritage
- Ancestry.Com, 23 and Me
- Golden State Killer (April 2018)



# Golden State Killer



- 1975-1986: Crime spree (murders, rapes, burglaries)
- Rape case samples frozen: DNA Technology had to catch up
- GedMatch Open Database started in 2011
  - Allows matching independent of vendor results
  - Only shows matches and not raw data
- Can this work for Past Accounting
  - Not in current commercial form
  - DNA too damaged
  - Develop method that will

# Create New Method

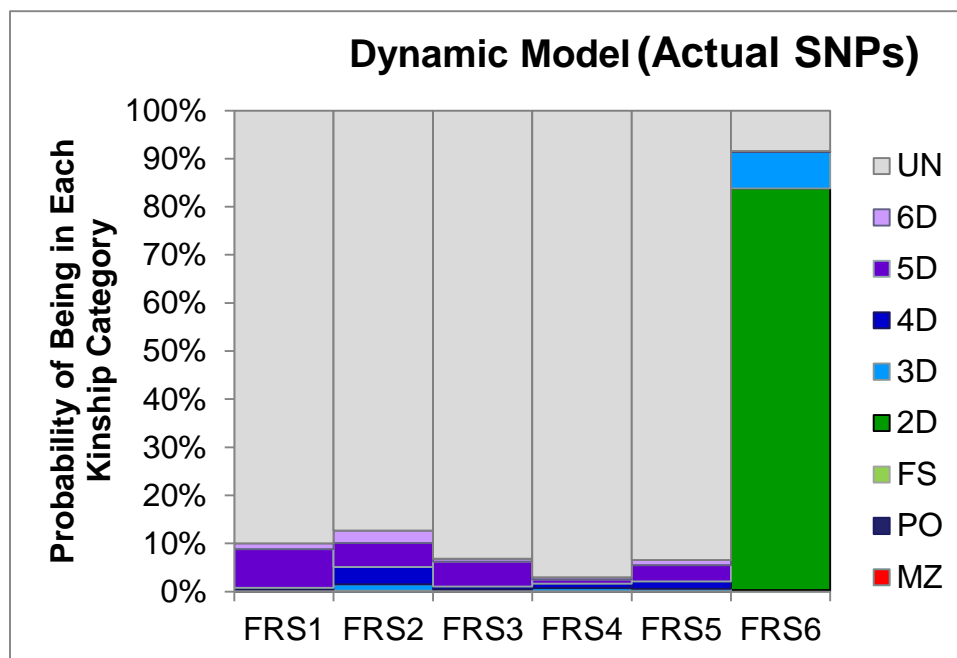


- **No viable mtDNA, YSTR, or auSTR references**
  - Parabon awarded contract 2015
  - Targeted 15,000 SNPs: identify unrelated from related out to a 4th degree relative
    - Nuclear based and reference agnostic
    - Subset of the 100K typically used from the array
    - Great-Great Uncle or First Cousin 1 removed: 6.25% nuclear DNA
  - AFDIL developed SNP capture method
  - Sequencing on the MiSeq

---

Parabon Awarded U.S. Department of Defense (DoD) Contract to Aid Identification of Unknown Remains from Past Conflicts

1095 Out of 15000 SNPs Recovered



Related to FRS 6 (93.5%)

**Related to**

FRS 6

# Modern Approach to DNA-Assisted Identification



- Maximize discrimination power of the mtDNA locus using mitogenome sequencing
  - Improved haplogroup/maternal ancestry prediction
- Enhanced laboratory processing using automation
  - Cheaper, better, faster
- Kinship inference using genome-wide SNP analysis
  - Improved nuclear kinship statistics

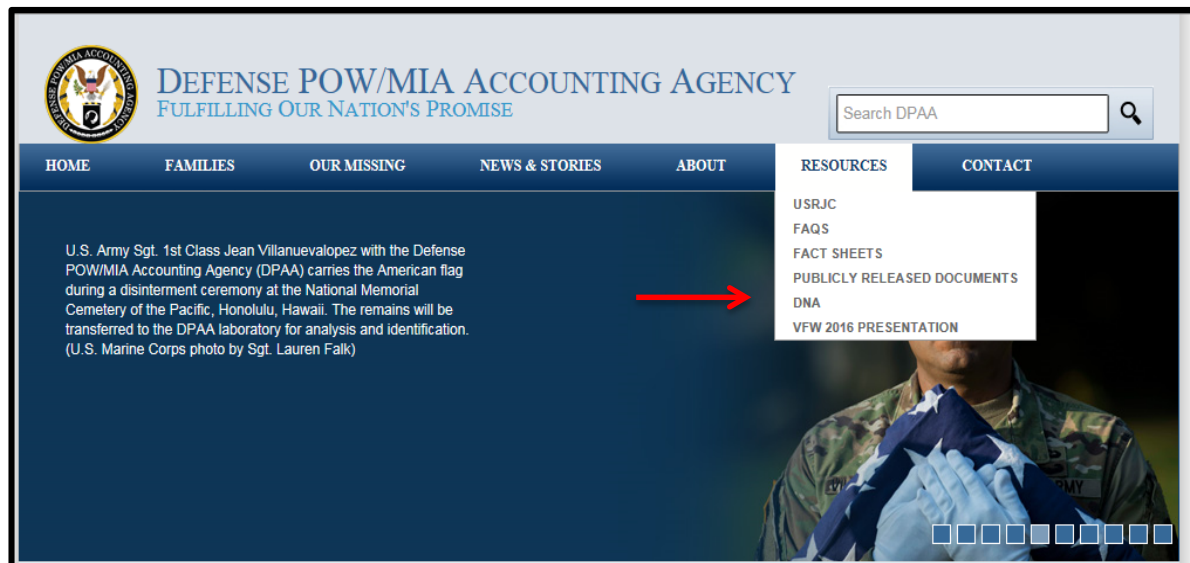
# Family Reference Sample Collections



- **YOU** Are The Key To The Identification Process
- Family References Are Collected Under Informed Consent With the Donor and Can Only Be Used For Human Remains Identification
- All FRS Samples Are Treated As a Medical Specimen
- Protected Under the Health Insurance Portability and Accountability Act of 1996 (HIPAA) For Personally Identifiable Information (PII) To Release of Information
- FRS Database Information Is Restricted and Not Shared Or Uploaded To Any Outside Agency
- Release of Any HIPAA Information With PII Must Be With Consent of Donor



# DNA FAQ



<http://www.dpaa.mil/>

### Research and Innovation

**Armed Forces Medical Examiner System**

- Office of the Armed Forces Medical Examiner
- DoD DNA Operations Forensic Toxicology

MHSRS 2018

Health IT Research and Innovation Strategy

Innovation

Medical Research and Development

Military Health System Studies Inventory Tool

Privacy, Information

## Armed Forces Medical Examiner System

The Armed Forces Medical Examiner System (AFMES) is committed to being the Department of Defense's (DoD's) leader in providing medical-legal services and emerging technologies essential for the readiness, sustainability and survivability of our service members. AFMES provides the DoD and other federal agencies comprehensive forensic investigative services, to include forensic pathology, DNA Forensics, forensic toxicology, and medical mortality surveillance. AFMES is not only the single worldwide medical examiner system, but it also supports the entire U.S. federal government.


### Mission

Investigate deaths, Identify the fallen, Improve readiness

### Vision

Be the global leader in comprehensive and innovative medicolegal services enhancing the readiness, sustainability, and survivability of those we serve.

- Office of the Armed Forces Medical Examiner
- DoD DNA Operations
- Division of Forensic Toxicology



### Contact Us

The Armed Forces Medical Examiner System  
115 Purple Heart Drive  
Dover Air Force Base, DE 19902

[Email Us](#)

DSN: 366-8648  
Phone (During Duty Hours): 1-302-346-8648  
To Report a Death After Hours: 1-202-409-6811  
Fax: 1-302-346-8819

### Related Links

- [Autopsy Diagrams/Paperwork](#)
- [Frequently Asked Questions about Medical-Legal Examinations](#)
- [iSalute](#)

<https://health.mil/afmes>



Director DoD DNA Operations: [Timothy.P.McMahon10.civ@mail.mil](mailto:Timothy.P.McMahon10.civ@mail.mil)