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http://www.nist.gov/director/international_forensics_home.cfm

Interlaboratory Studies

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Full Title

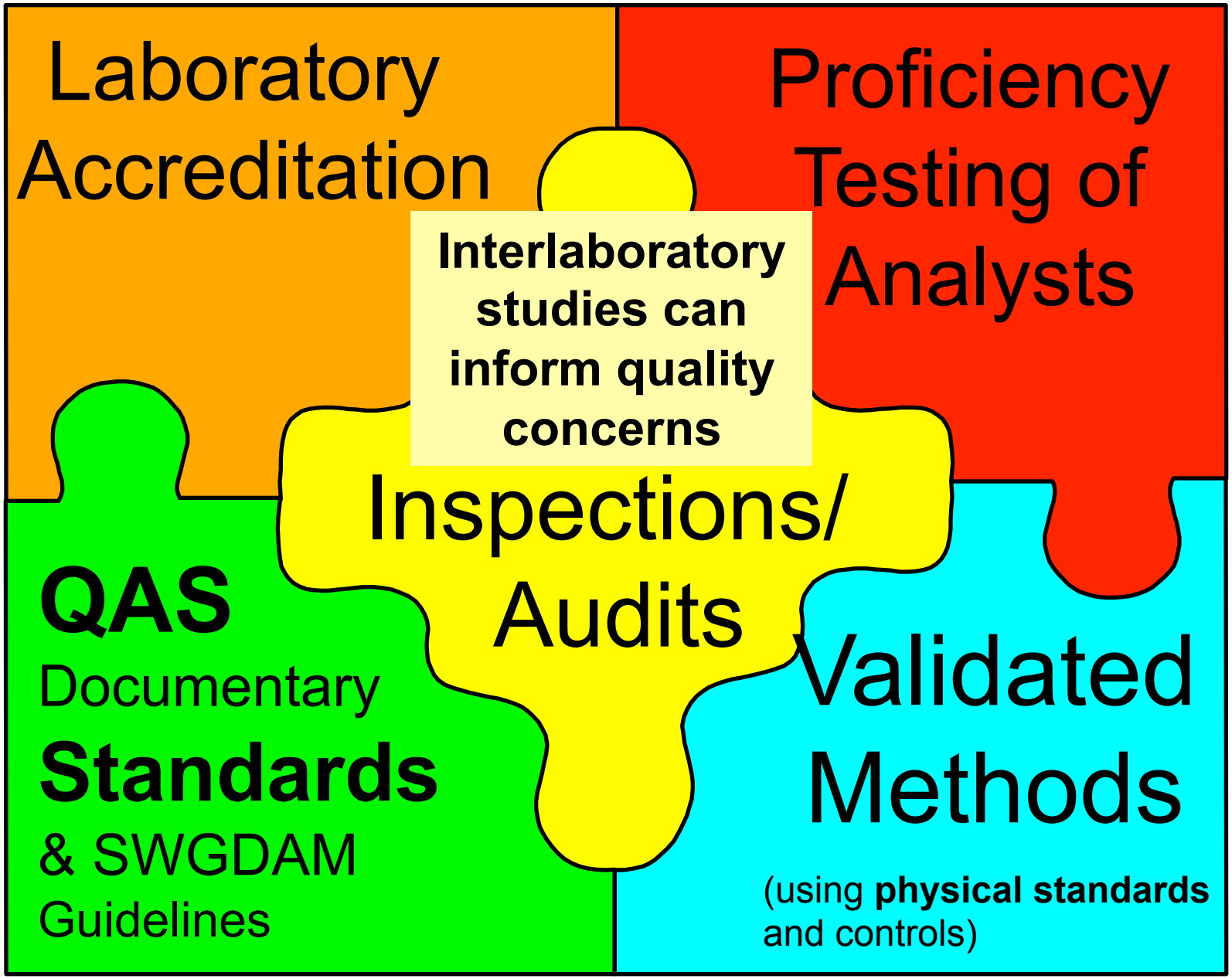
The Value of Regular Benchmarking Studies in Forensic Science to Understand Where Errors Can Occur: Lessons Learned from NIST DNA Interlaboratory Studies

Purpose in preparing this presentation

- National Commission on Forensic Science (NCFS) Subcommittee on Scientific Inquiry and Research is advocating for benchmarking interlaboratory studies to assess quality of work performed in forensic laboratories

- NIST has performed a number of interlaboratory studies in forensic DNA since the early 1990s – lessons learned may be helpful in preparing benchmarking studies for other disciplines

Ensuring Accurate Forensic DNA Results



My Definitions

Analyst Assessment

- **Proficiency Testing**: graded tests evaluating individual analysts (typically are not complicated)
  - Internal: administered by someone within the same laboratory
  - External: administered by someone outside one's laboratory
- **Blind Proficiency Testing**: analyst (and sometimes laboratory) is unaware they are being tested

Protocol, Laboratory, System Assessment

- **Interlaboratory Study**: evaluation of results across multiple laboratories to assess relative performance (not grading individual analysts)
- **Benchmarking Study**: interlaboratory results are published as an indication of the state of the field at a particular point in time

Study of Blind Proficiency Testing Funded by NIJ (requested by DNA Identification Act of 1994)

J Forensic Sci, Jan. 2003, Vol. 48, No. 1
Paper ID JFS2002042_481
Available online at: www.astm.org

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The Feasibility of External Blind DNA P
Testing. I. Background and Findings*

The Feasibility of External Blind DNA
Testing. II. Experience with Actual Bli

TABLE 3—*Cost estimate summary.*

Blind Proficiency Test Program Model	Cost/Test	Estimates Extrapolated from This Pr One Test Per Year Total
Blind/LE, Blind/CL	$3,500	$535,000†
Blind Analyst	$2,000	$310,000†
Random Reanalysis‖	$2,000–3,450	$330,000–517,500
		Estimate from a Government Agency Tes
Blind/LE, Blind/CL	$10,000	$1,510,000
		Estimate from a Commercial Test Pr
Blind/LE, Blind/CL	$3,400	$520,000
Blind Analyst	$1,400	$220,000

$10,000 price tag

* All values are in US dollars.
† Includes costs of one proficiency test review meeting.
‡ 150% of one-test-per-year costs and includes two proficiency test review meetings.
§ Includes two proficiency test review meetings.
‖ The low-end figure does not include reanalysis of the biological evidence.

"We have shown that **external blind proficiency testing** in forensic DNA laboratories **is possible**, and that somewhat complicated cases involving bloodstain patterns could be replicated and manufactured. Our tests were conducted in small numbers as proof of principle. To scale up to a national program involving 100–200 laboratories in one or two tests per year **would be significantly costly**. In addition, **a number of questions would have to be decided by policy makers** in consultation with the forensic-science community to define the shape of a viable, comprehensive, national program."

GEDNAP Forensic DNA Proficiency Testing Scheme

http://www.gednap.org/

- Dedicated staff with forensic discipline expertise
- A German Stain Commission designs the studies
- Multiple studies are conducted each year
- Certificates are provided to each participating laboratory with errors being classified
- Yearly conference is held to review results, to understand study design, and to explore mistakes made

NIST Experiences Provided Five Years Ago

Forensics @ NIST
December 7, 2010 – Gaithersburg, MD

DNA Interlaboratory Studies

David L. Duewer
Margaret C. Kline

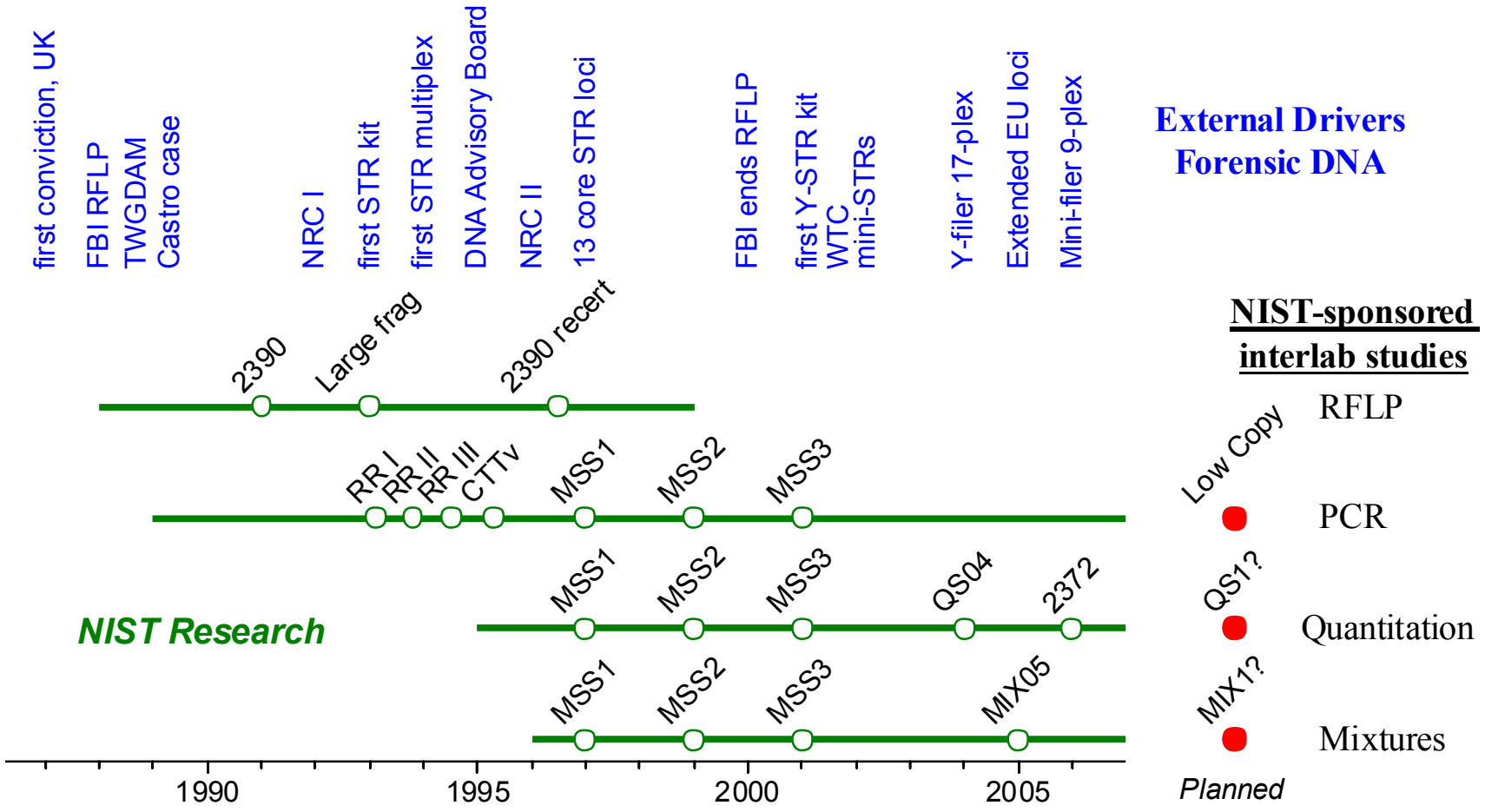
http://www.cstl.nist.gov/strbase/pub_pres/ForensicsNIST-DNA-interlab-studies.pdf

NIST-Sponsored Interlab Studies

13 interlaboratory studies conducted
over the past 20 years


Margaret Kline


Dave Duewer



http://www.cstl.nist.gov/strbase/pub_pres/ForensicsNIST-DNA-interlab-studies.pdf

Interlaboratory Studies

- Multiple participants evaluate same materials
- NIST DNA interlabs are typically designed to…
  - ☺ Certify: Characterize material properties
  - ☺ Survey: Define state-of-the-measurement art
  - ☺ Gap-fill: Explore specific issues
  - 😐 Method development: Performance characteristics
    - mostly used with standardized, prescriptive methods
  - ☠ Proficiency Test (PT)
    - role of commercial providers
    - must be conducted “by the book”

http://www.cstl.nist.gov/strbase/pub_pres/ForensicsNIST-DNA-interlab-studies.pdf

NIST Interlaboratory Mixture Studies

http://www.cstl.nist.gov/biotech/strbase/interlab.htm

- **Provide a big-picture view of the community**
  - not graded proficiency tests
  - offers laboratories an opportunity to directly compare themselves to others in an anonymous fashion
- Some lessons learned:
  - instrument sensitivities can vary significantly
  - amount of input DNA plays important role in ability to detect minor component(s)
  - **protocols and approaches are often different between forensic labs**
- Studies Conducted

Study	Year	# Labs	# Samples	Mixture Types
MSS 1	1997	22	11 stains	ss, 2p, 3p
MSS 2	1999	45	11 stains	ss, 2p, 3p
MSS 3	2000-01	74	7 extracts	ss, 2p, 3p
MIX05	2005	69	4 cases (.fsa)	only 2p
MIX13	2013	108	5 cases (.fsa)	2p, 3p, 4p

MSS: mixed stain study


Margaret Kline


Dave Duewer


Jan Redman


John Butler

Interlaboratory Studies

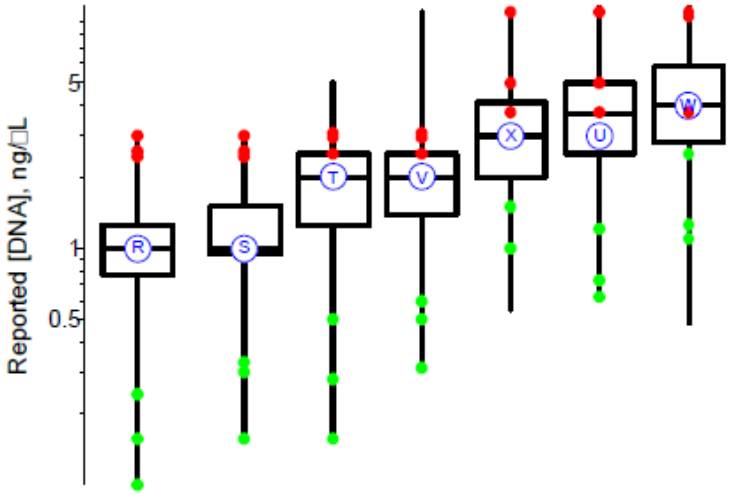
- DNA Quantitation Study (QS04)
  - 8 DNA samples supplied
  - 84 laboratories signed up (80 labs returned results)
  - 287 data sets using 19 different methods
  - 60 data sets with real-time qPCR (37 Quantifiler data sets)
  - Publication in May 2005: *J. Forensic Sci.* 50(3): 571-578

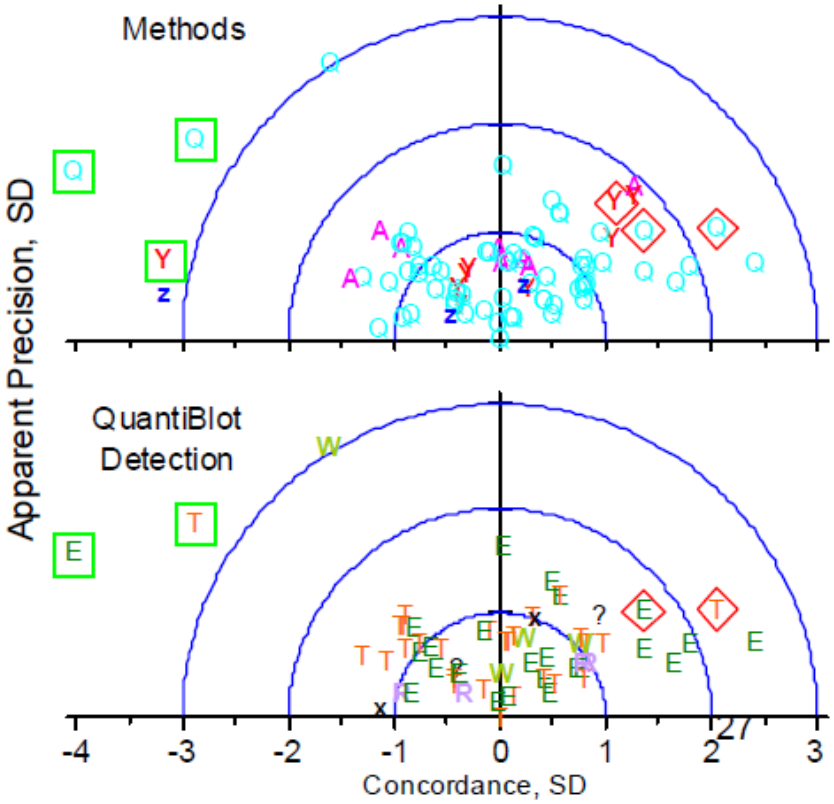
- Mixture Interpretation Study (MIX05)
  - 105 labs signed up (**69** labs returned data)
  - Interpretation requested of provided e-grams for 4 mock sexual assault cases
  - Presentations made but results not published (yet?)

http://www.cstl.nist.gov/biotech/strbase/interlab.htm

Lessons Learned

- Quantifications issues may be related to the different “standards” used.

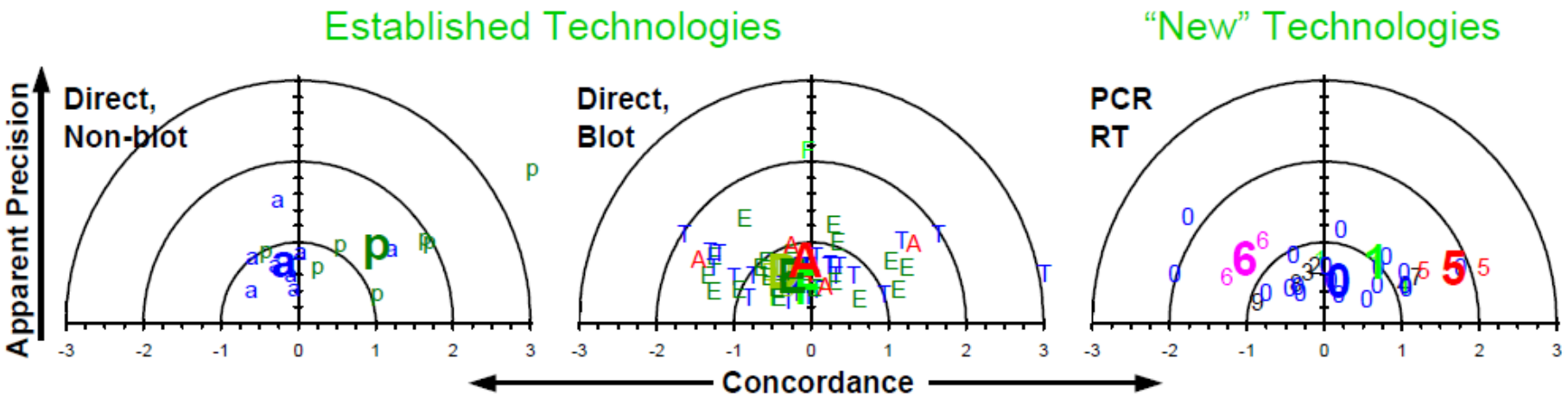




http://www.cstl.nist.gov/strbase/pub_pres/ForensicsNIST-DNA-interlab-studies.pdf

Permits Evaluation of Technologies

QS04: Among-Participant Results

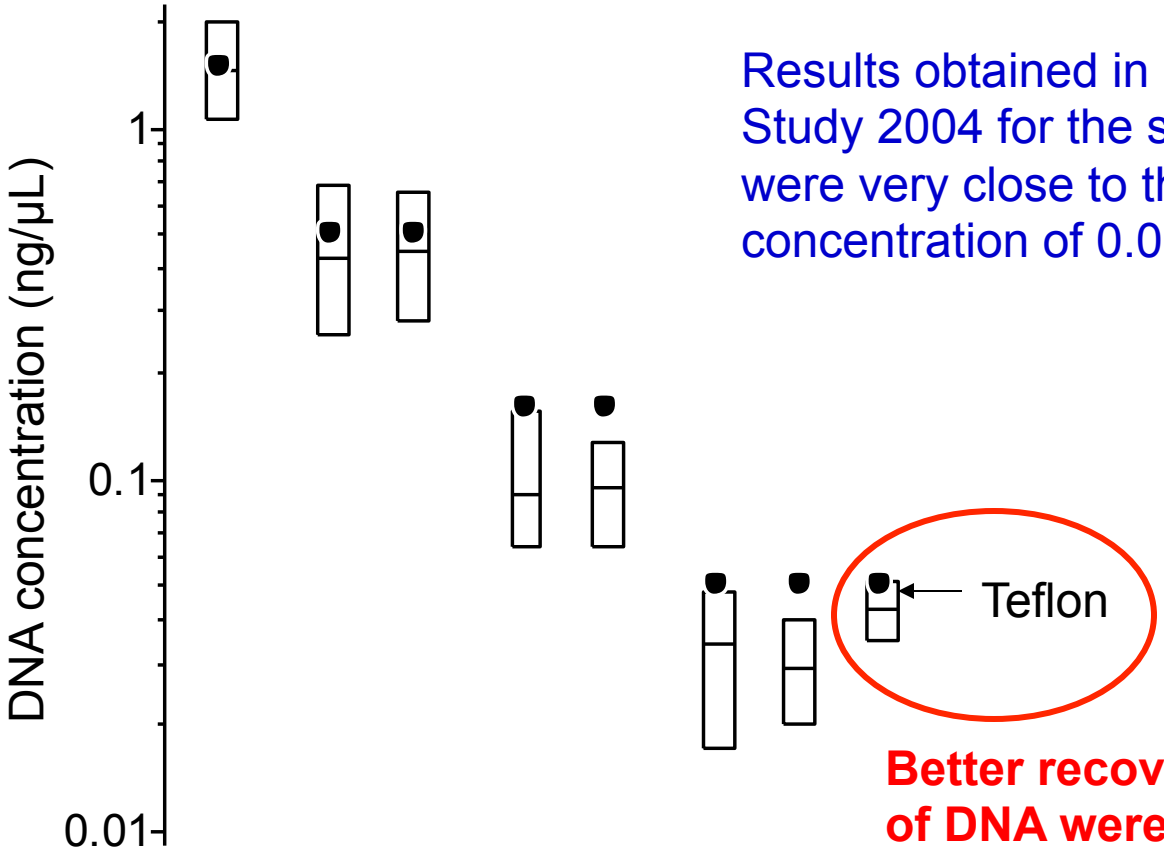


"Bold" characters represent the median performance of all results submitted for a particular method

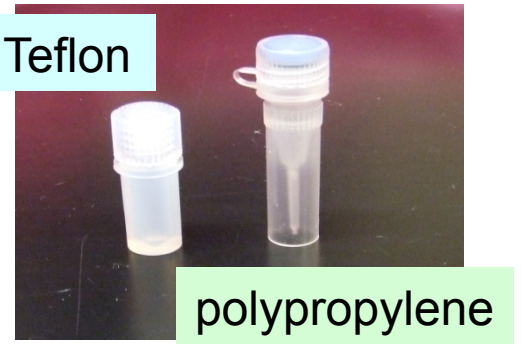
http://www.cstl.nist.gov/strbase/pub_pres/ForensicsNIST-DNA-interlab-studies.pdf

DNA can stick to the wall of its storage tube

- Teflon tubes have been shown to work best for long-term storage and DNA sample recovery at low concentrations

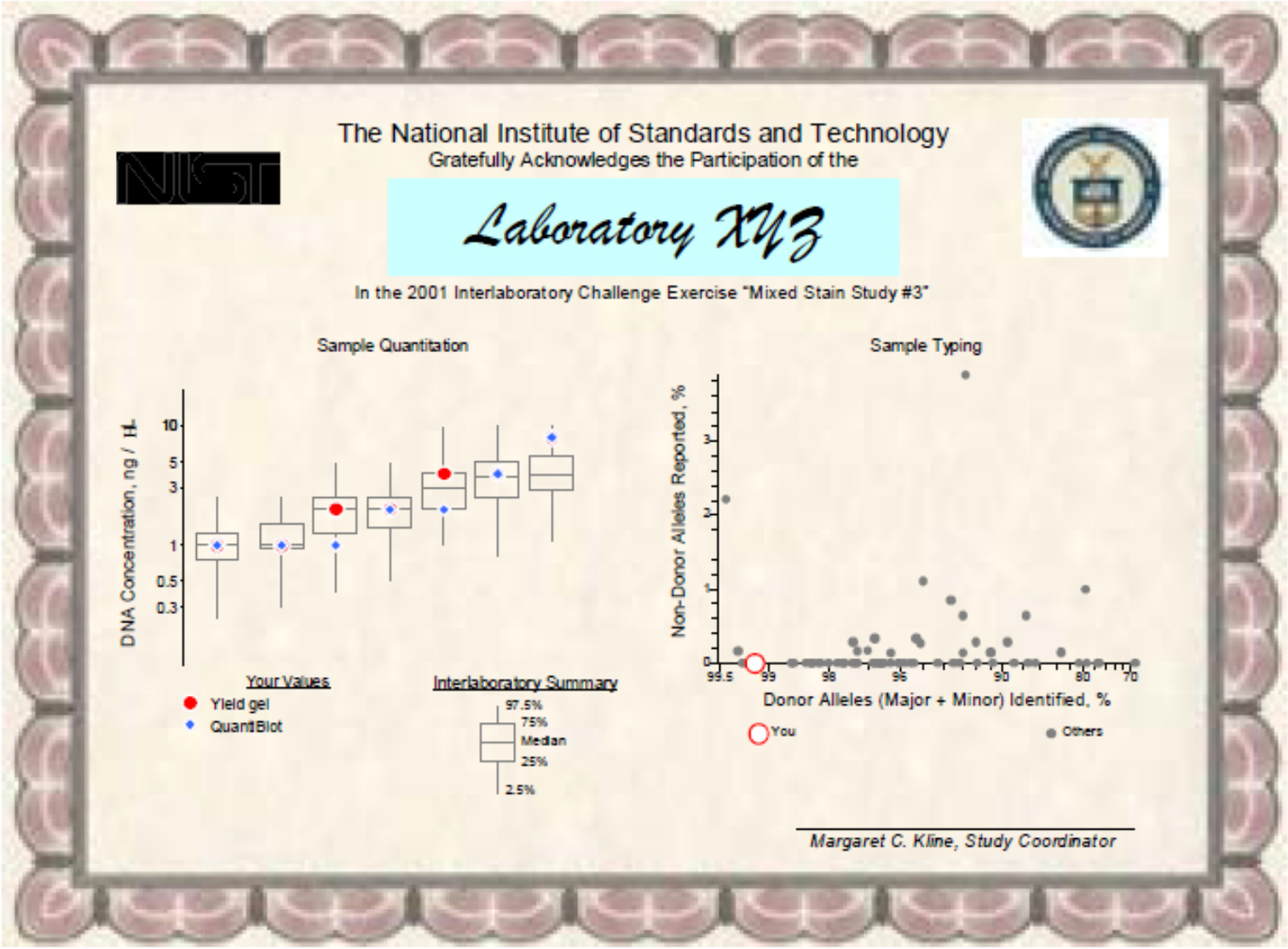


Results obtained in NIST Quantitation Study 2004 for the sample in Teflon were very close to the nominal DNA concentration of 0.05 ng/µL.



Better recoveries of low amounts of DNA were seen with samples stored in Teflon tubes

Participants who did well framed their certificates of participation



Some Lessons Learned (1)

1. Study design requires careful thought to address specific questions
2. Seek input on study design
3. Case scenarios are useful
4. Pre-study announcements
5. Data crunching takes time and expertise
6. Volunteer participation may not get the coverage desired
7. Intra-laboratory variation can also be studied

Some Lessons Learned (2)

7. Sample preparation is a lot of work (homogeneity, stability, shipping issues)
8. Teach backs to explain results will benefit community improvement
9. Feed lessons learned back into the next study
10. Build trust with participants by having anonymous laboratory codes
11. Present and publish benchmarking aspects in the results to benefit community
12. Provide data for further analysis and learning after the study

Pre-study announcements

- Advertise the study sufficiently before the study will be conducted and emphasize the benefit of participating
- Hold a pre-study meeting (webinar) describing what is desired in reporting results
- Need to make specific requests and even supply formats to return data in order to aid data summary

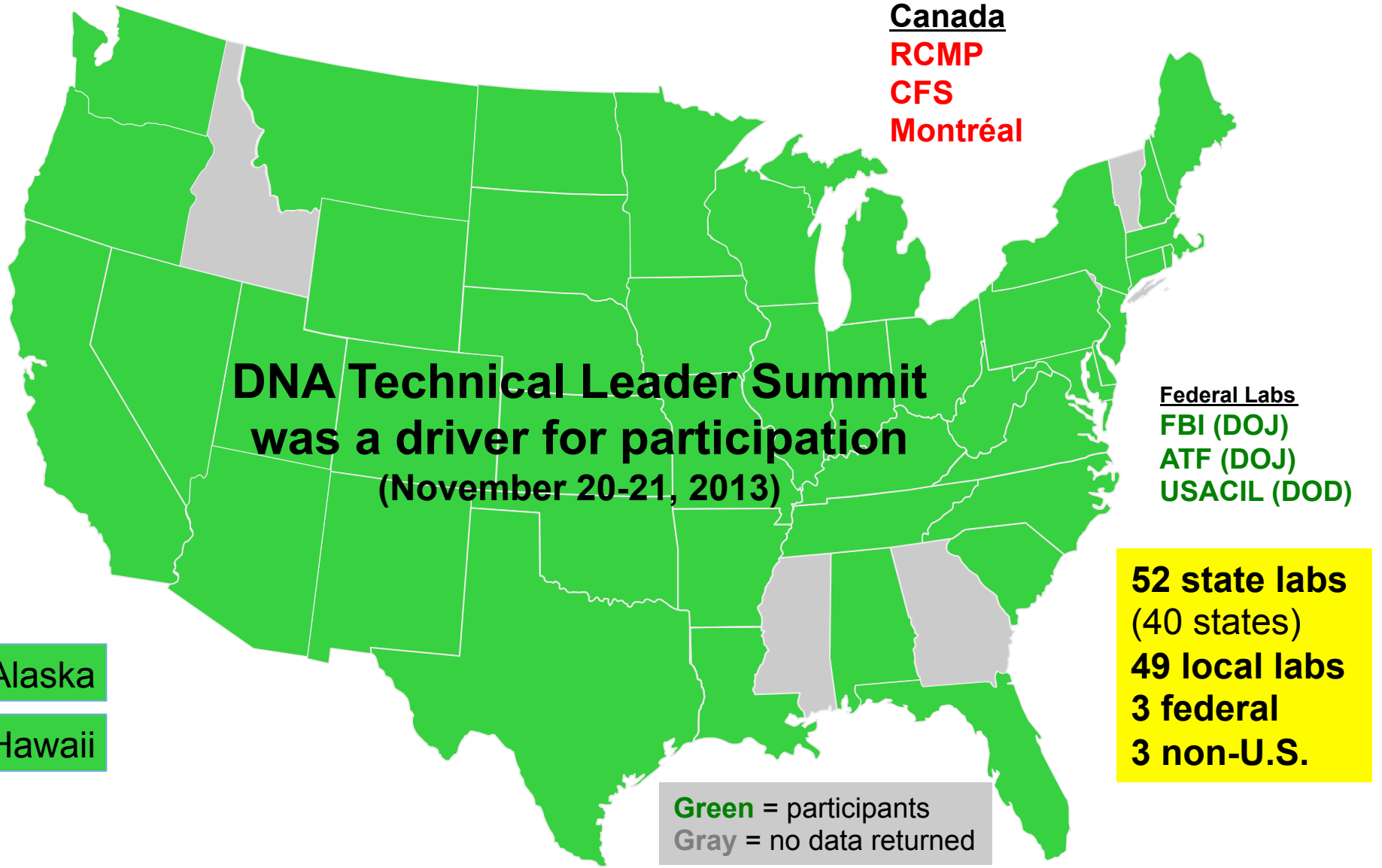
Teach back to explain results will benefit community improvement

- GEDNAP holds an annual conference to review results obtained and to learn from errors made

- NIST and the FBI CODIS Unit co-sponsored a DNA Technical Leader's Summit (November 20-21, 2013) where the results were reviewed from the MIX13 study
  - 95% of public forensic DNA laboratories were represented

MIX13 Participants from **108 Laboratories**

46 states had at least one lab participate



NIST STRBase Website

Short Tandem Repeat DNA Internet DataBase

http://www.cstl.nist.gov/biotech/strbase/

Lab Resources and Tools

- Addresses for scientists working with STRs
- Training Materials
- STR Allele Sequencing
- Population data
- Data from NIST U.S. Population Samples
- NIST-Developed Software including AutoDimer, mixSTR, and Multiplex_QA
- NIST Standard Reference Material for PCR-Based Testing
- New STR Markers under Development at NIST
- Chromosomal Locations
- DNA Advisory Board Quality Assurance Standards
- Interlaboratory Studies
- NIST Mixture 2005 Interlab Study MIX05 Data
- **NIST Mixture 2013 Interlab Study MIX13 Data**
- Validation information
- DNA Quantitation - SRM 2372
- Technology for resolving STR alleles

Anyone can download and review the data used in these interlaboratory studies (helpful for future training)

Acknowledgments

National Institute of Justice funding to NIST in the past

Interlaboratory Study Activities

- **Margaret Kline** (NIST Applied Genetics Group)
- **Mike Coble** (NIST Applied Genetics Group)
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- **Dennis Reeder** (retired NIST Group Leader)

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