

Hair Proficiency Testing

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***Drug Testing Advisory Board
Open Session***

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Objectives

- **Design and Results of SAMHSA's Hair Pilot Proficiency Testing (PT) Program, 2000 to 2007**
- **Design and Results of Society of Hair Testing (SoHT) Hair Proficiency Testing Program, 1995-present**
- **Design of Other Hair Proficiency Testing Programs**

Background

SAMHSA's Pilot Hair PT Program

- **April 1997, DTAB meeting discussed drug testing in alternate matrices**
- **Duration: 2000-2007**
- **Up to 13 laboratories participated**
- **23 cycles of samples tested**
 - **Cycles 1-8: Method Optimization**
 - **Cycles 9-11: Same samples over 6 months**
 - **Cycles 12-23: Inter- and intra-lab variability**

Background

SAMHSA's Pilot Hair PT Program

- **Important finding was a large variation in reported results**
- **2006-2007 PT samples evaluated laboratory variability and sample stability**

Design of Pilot PT Program 2007

- 6 or 7 participant laboratories
- Laboratories investigated accuracy and precision
- Single PT production
 - Decontaminated hair samples in PT production
 - Authentic hair fortified with drug analytes or known drug users
 - Stored ambient temperature prior to shipments



Design of Pilot PT Program (Continued)

- **Three sample sets sent to each lab over 1 year (0, 3, 6, 12 months)**
- **Concentrations were 1.5 to 3 times the 2004 proposed confirmatory test cutoffs**
- **Laboratories quantitated each analyte 5 times in multiple batches**

Design of Pilot PT Program (Continued)

- **Set 1 (pg/mg):**
 - **THCA (0.82)***
 - **THCA (0.15)**
 - **AMP/MAMP/MDA/MDEA/MDMA (900)**
 - **AMP/MAMP/MDA/MDEA/MDMA (450)**
 - **Set 2 (pg/mg):**
 - **COC (5770)/BE (2547)/CE(54)/ NCOC (85)***
 - **COC (750)/NCOC (75)/CE (75)**
 - **COC (1500)**
 - **BE (75)**
- *Drug User Hair**

Design of Pilot PT Program (Continued)

- **Set 3 (pg/mg):**
 - **6-AM (1411)/MOR (630)/COD (183)***
 - **6-AM/MOR/COD (600)**
 - **6-AM/MOR/COD (300)**
 - **PCP (450)**
- **No decontamination**
- **Confirmatory testing only**

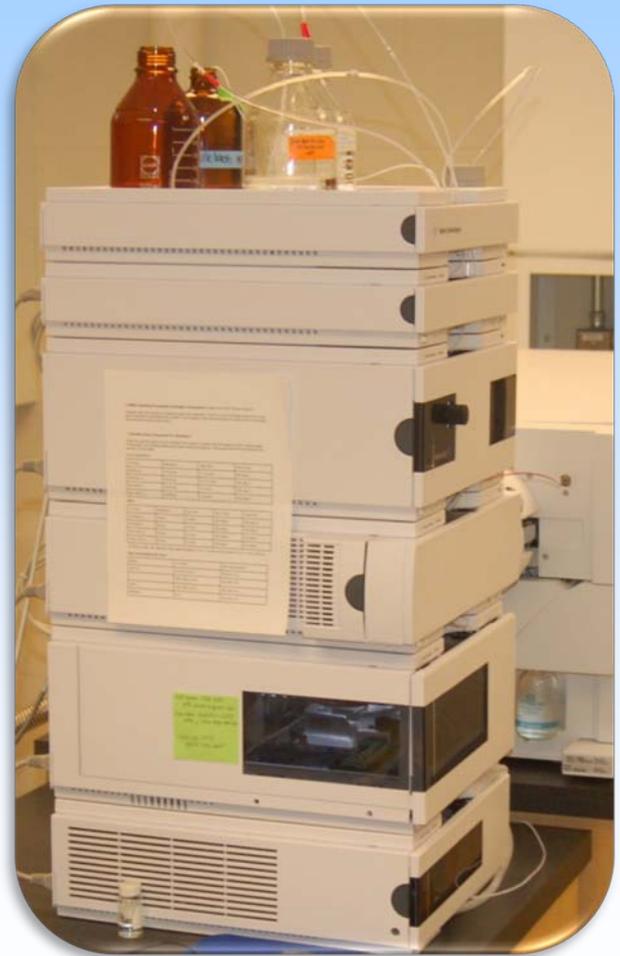
***Drug User Hair**

NLCP Pilot Hair PT — Methods

- Deuterated internal standards
- Not all analytes reported by all labs
- Powdering vs Strands
- Pre-Treatment Techniques
 - None/DI H₂O/Solvent (MeOH/MeCl₂/Acetone)
- Digestion Techniques
 - None/Acidic/Basic/Enzymatic
- Extraction Techniques
 - L/L and SPE

NLCP Pilot Hair PT — Confirmatory Testing

- **Confirmatory Testing**
- **Quantitation and identification by a confirmatory mass spectrometry method**
- **PT result reports with group statistics sent to each lab for self-assessment**

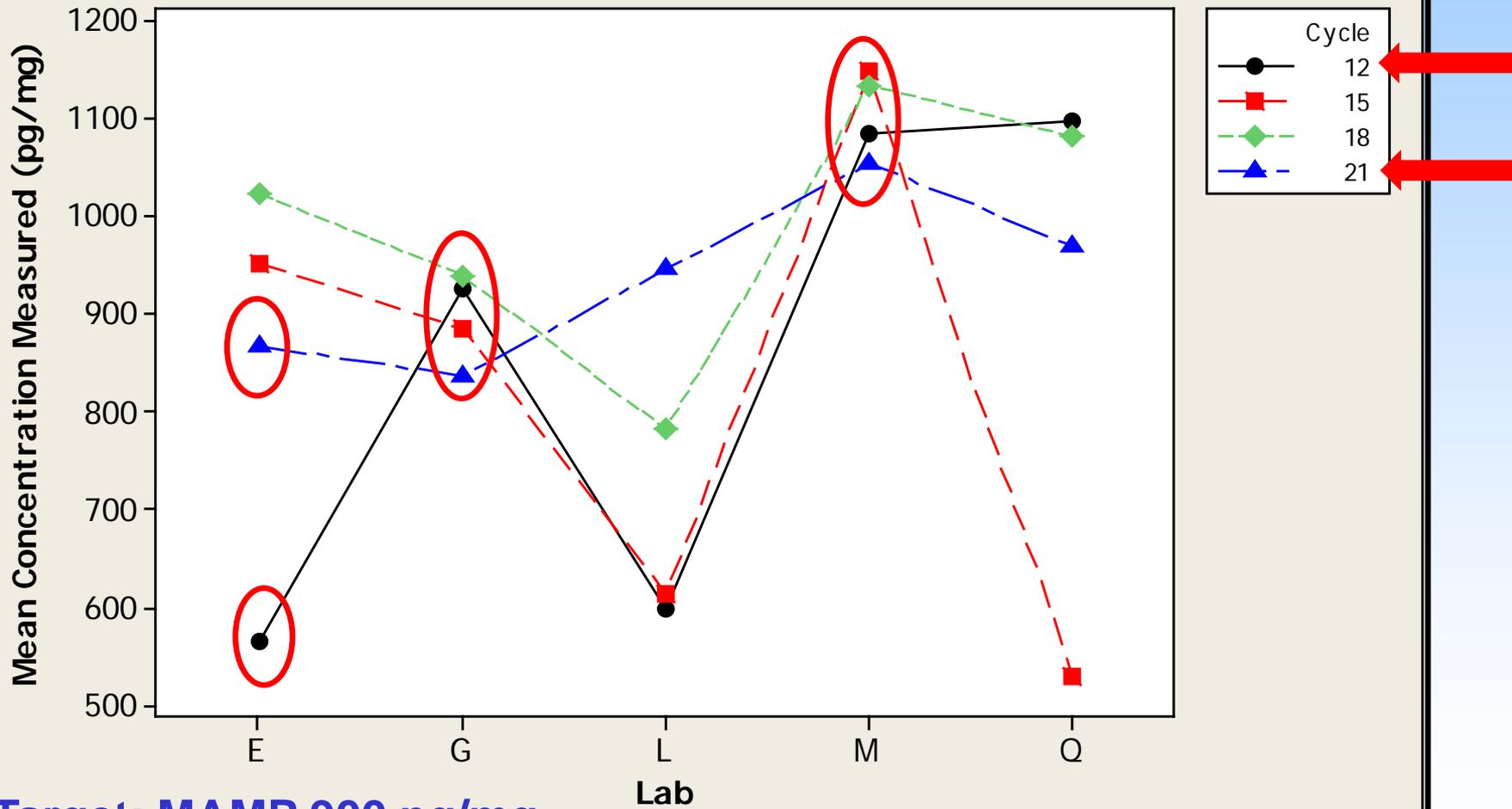


Laboratory Pilot Hair PT Results:2007

(pg/mg)	AMP (450)	MAMP (450)	MDA (450)	MDMA (450)	MDEA (450)	THCA (0.15)
0 months (Cycle 1)	397	411	421	316	278	0.17
3 months (Cycle 2)	463	493	460	397	432	0.16
6 months (Cycle 3)	436	469	467	399	398	0.15
12 months (Cycle 4)	449	481	455	408	412	0.13
Mean ± SD	436 ± 29	464 ± 36	451 ± 20	380 ± 43	380 ± 69	0.15 ± 0.02

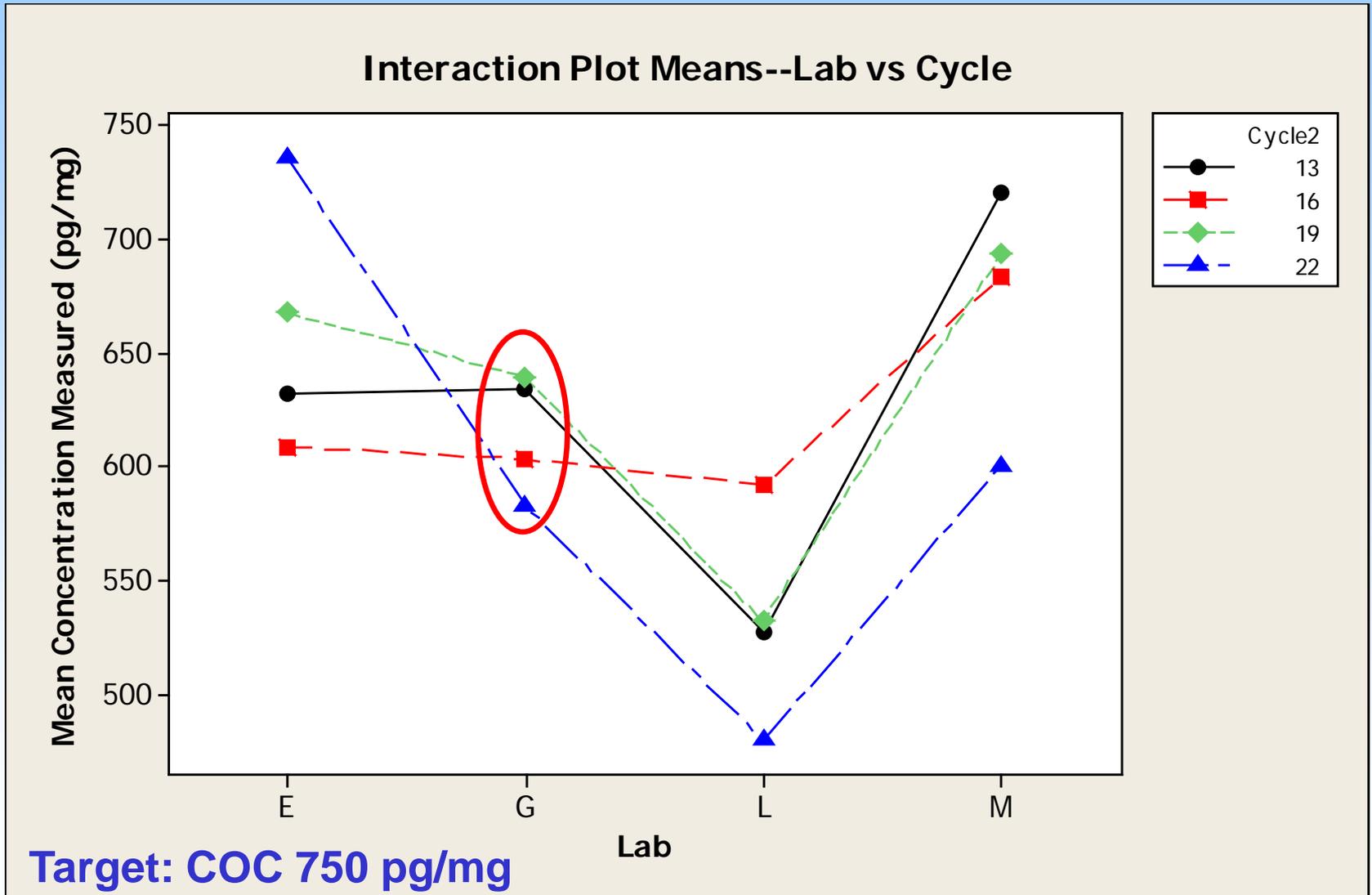
2007 Pilot Hair PT Results: AMPS

Interaction Plot Means--Lab vs Cycle



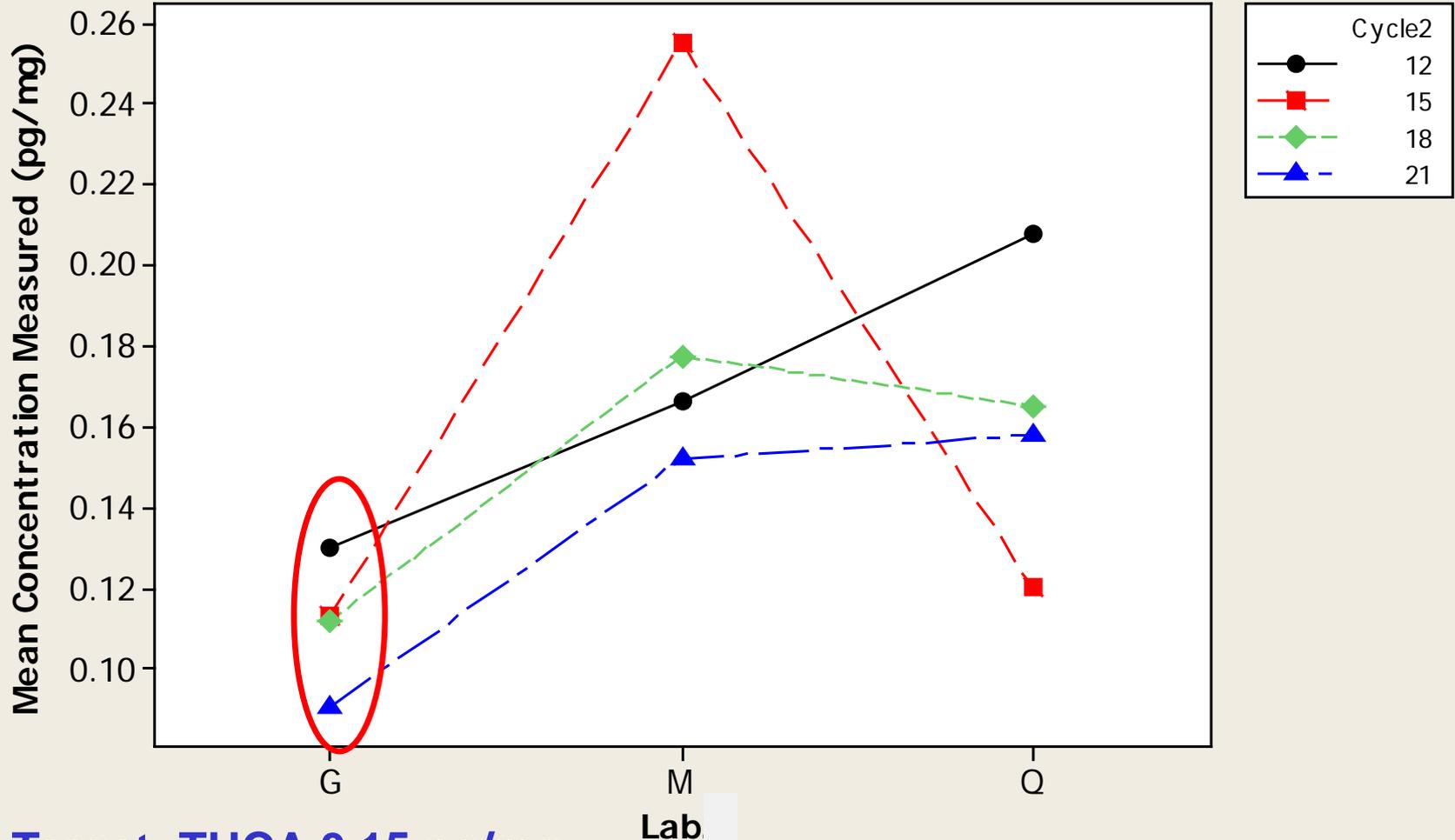
Target: MAMP 900 pg/mg

2007 Pilot Hair PT Results: COC



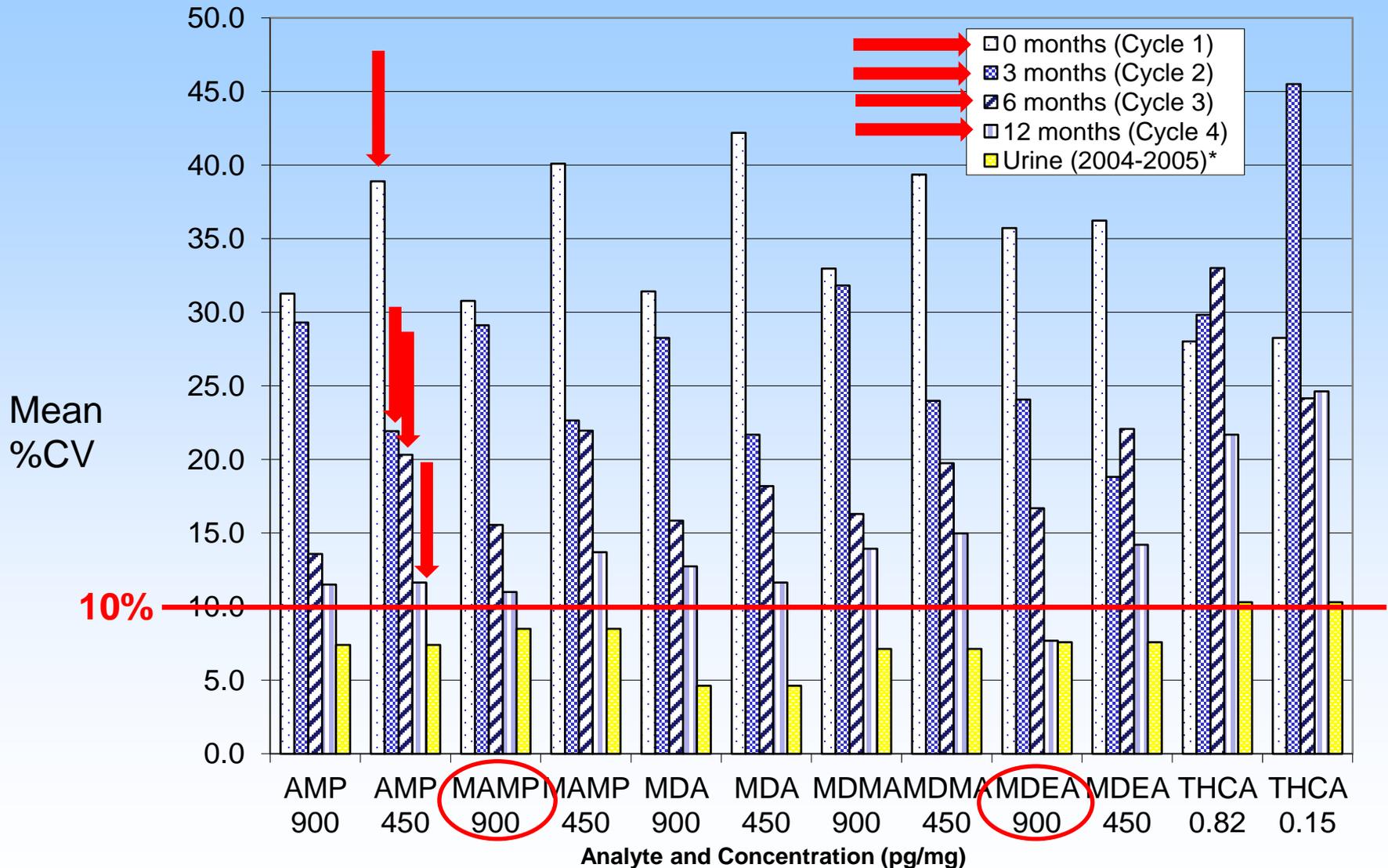
2007 Pilot Hair PT Results: THCA

Interaction Plot Means--Lab by Cycle

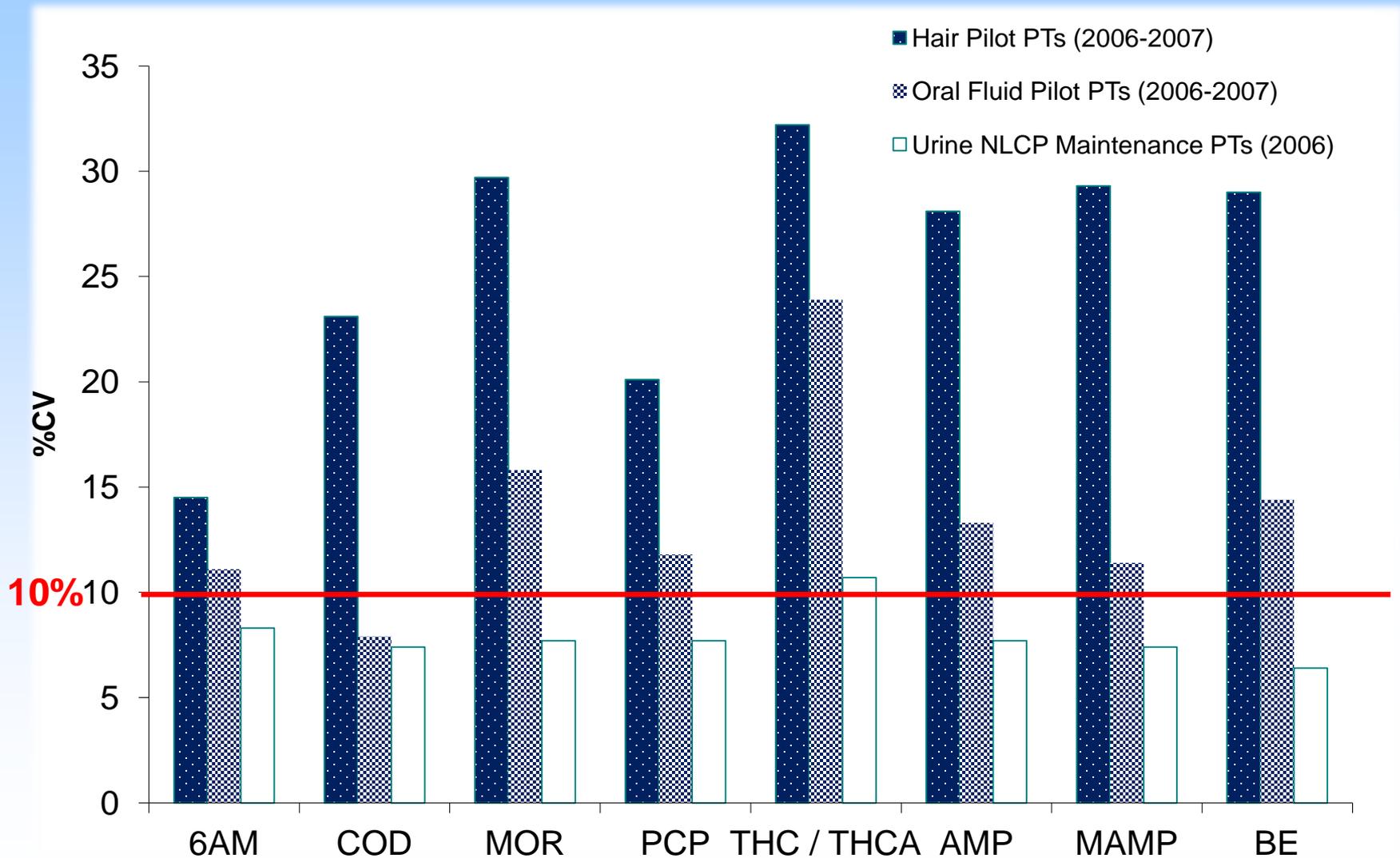


Target: THCA 0.15 pg/mg

System Variance Over 1 Year by Cycle



System Variance Over 1 Year by Cycle



Summary 2006 Pilot PT Program

- **Stable material for all drugs over 1 year**
- **Results for the system of participating hair-testing laboratories are not currently consistent**
- **For some analytes, there was increased variability in results after 1 year, illustrative of the laboratory challenge of maintaining performance**
- **Material performed well for all analytical methods**

***SOCIETY OF HAIR TESTING
HAIR PROFICIENCY PROGRAM***

Background

Society of Hair Testing (SoHT)

- ***“...development of proficiency tests (PTs), so that all laboratories which perform hair analysis can produce comparable results, or at least detect the same compounds” (Forens Sci Intl, 2003)***
- **Voluntary Program**
- **PT Rounds**
 - **18-36 participating laboratories**
 - **1995, 1997, 2001, 2007-2012 (2)**
 - **2008, 2009, 2010 (EtG Special PT)**
 - **Qualitative and Quantitative results**

Design of SoHT PT Program - 2001

- **Goals**
 - **Accuracy of Detection and Quantification**
 - **Performance of Extraction Methods**
- **15 Participating Labs & 3 Reference Labs**
- **Samples**
 - **Short Hair Segments**
 - **Drug User Hair- COC, BE, MDMA, MDEA, THC**
 - **Drug User Hair- COC, BE, 6AM, MOR, COD, DHC**
 - **Drug Free Hair**

Results for SoHT Hair PT Program- 2001

- **Not all analytes reported by all labs**
 - **Amphetamines- 8**
 - **Cannabis- 9**
- **Qualitative results**
 - **False Negatives- 1 (BE, 6AM, MOR), 3 (COD)**
 - **False Positive- 1 (COD, 6AM)**
- **Quantitative results**
 - **Mean inter-laboratory %CVs — 41.7% to 71% except THC (93.1%)**
 - **Extraction procedures — source of variation**

Design of SoHT PT Program - 2011

- **Goals**
 - **Accuracy of Detection and Quantification**
- **36 Participating Labs & 3 Reference Labs**
- **Samples**
 - **Short Hair Segments**
 - **Drug User Hair- COC, BE, 6AM, MOR, COD, THC**
 - **Drug User Hair- COC, BE, MAMP, THC**
 - **Drug Free Hair**

Results for SoHT Hair PT Program- 2011

- **Z-score** ($Z\text{-score} = (x - \bar{x}) / IQR$)
 - **Satisfactory (>2.0)**
 - **Questionable ($2 < Z\text{-score} \leq 3$)**
 - **Unsatisfactory (≥ 3.0)**
- **Quantitative results- Sample 1**
 - **6-AM: 2 Not analyzed; 1 questionable**
 - **MOR: 1 Not analyzed; 1 questionable**
 - **COD: 13 Not analyzed or Neg; 1 unsatisfactory**
 - **THC: 10 Not analyzed or Neg; 1 unsatisfactory**

Results for SoHT Hair PT Program- 2011

- **Quantitative results-**
 - **COC: 1 Not analyzed; 2 questionable**
 - **BE: 4 Not analyzed**
 - **MAMP: 7 Not analyzed or Neg; 1 questionable**
- **Mean inter-laboratory %CVs — 34% to 55% except COD (306%)**

Comparison of Hair PT Programs

- **Worldwide 5 Hair PT Programs**
- **Professional and governmental programs**
- **Hair PT Programs**
 - **GTFCh- German Society of Toxicological and Forensic Chemistry (late 1990s to Present)**
 - **HAIRVEQ- Germany and Spain (2004, 2006)**
 - **NLCP- National Laboratory Certification Program (2000-2007)**
 - **SFTA- French Society of Analytical Toxicology (1992-1999)**
 - **SoHT- Society of Hair Testing (1995 to Present)**

Comparison of Hair PT Programs

Hair PT Program	Hair Type	PT Type	Analytes	Conc.	Washing	Preparation
GTFCH	Authentic	Spiked; Drug User	All but PCP; +THC (addition of further analytes possible)	≥ SAMHSA PCP: NR	Not Reported Also powdered	Lab Choice
HAIRVEQ	Authentic	Drug User	opiates, cocaine, MDMA, and methadone	≥ SAMHSA PCP: NR	Not Reported Also powdered	Lab Choice; Standardized
SFTA	Authentic	Drug User	All but PCP; +CBD	≥ SAMHSA PCP: NR	Step in PT Production	Standardized
SoHT	Authentic	Drug User	All but PCP; +THC	≥ SAMHSA PCP: NR	Not Reported	Lab Choice
NLCP	Authentic	Spiked; Drug User	AMP/MAMP MDA/MDMA/MDEA COC/BE COD/MOR/6AM THCA PCP	AMP: 200 COC: 500 OPI: 200 THCA: 0.05 PCP: 300	Step in PT Production	Lab Choice

Conclusions

- **Performance Testing is a necessary quality control measure**
- **Results for the systems of participating hair-testing laboratories are not currently consistent**
- **Inter-laboratory and Intra-laboratory results remain higher than other hair testing matrices**
- **PT materials in authentic hair samples are stable**
- **Laboratory preparation and analytical treatment of hair contribute to the variability of PT results**

References

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