CORESTA Electronic Cigarette Task Force

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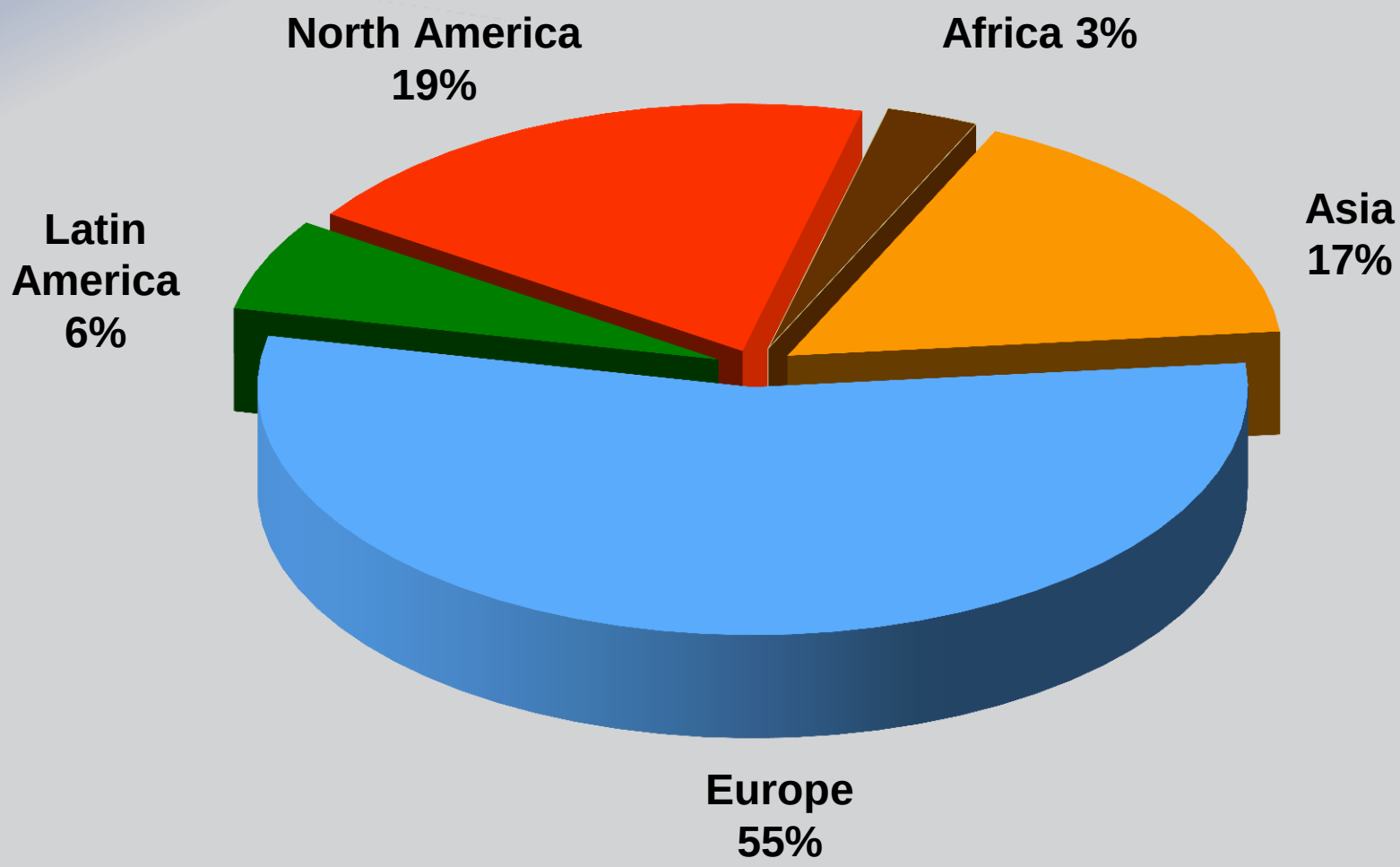
Introduction & Purpose of CORESTA

- **CORESTA is the Cooperation Centre for Scientific Research Relative to Tobacco**

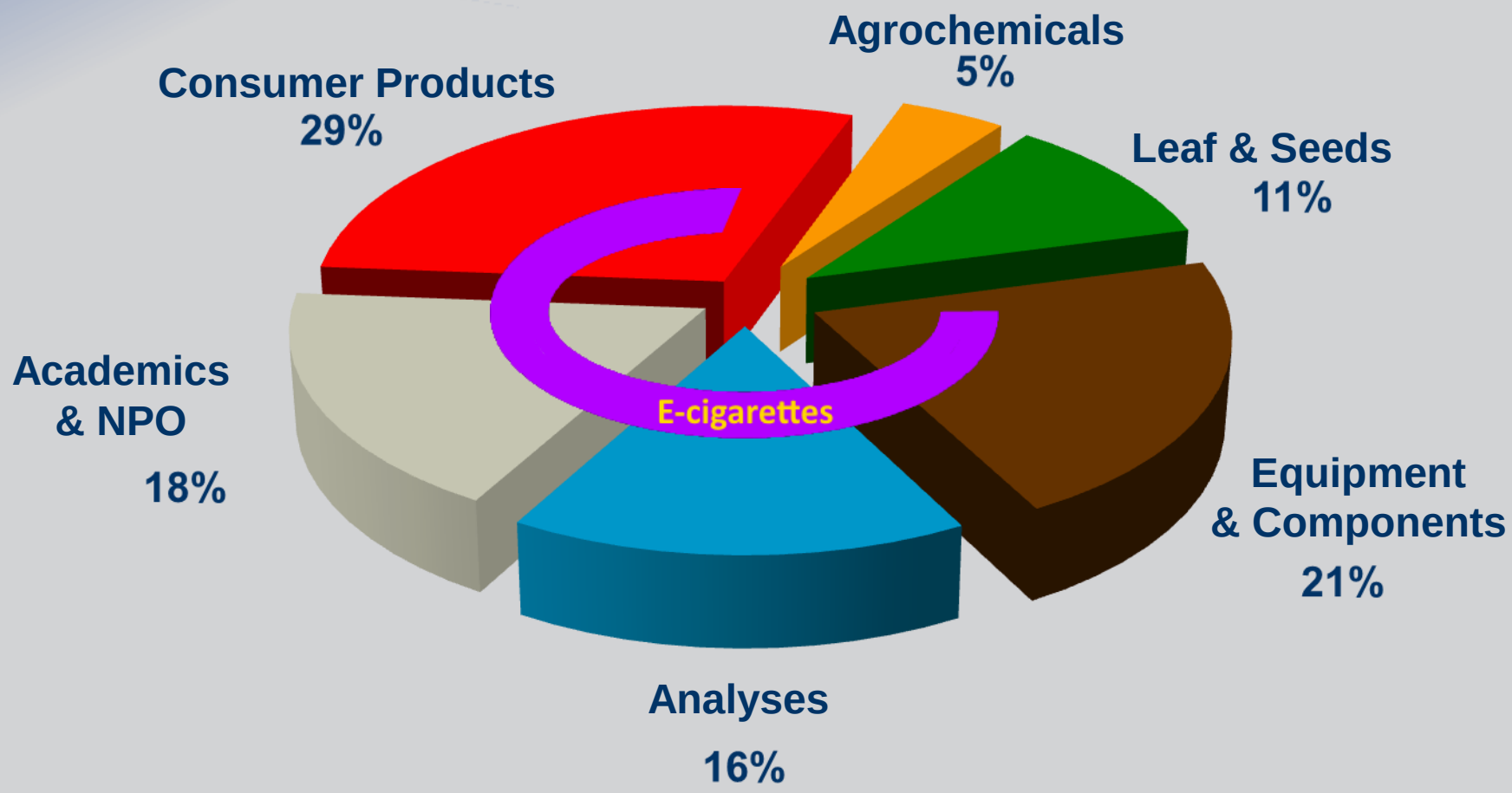
- **It is an Independent Association:**
  - **Founded in 1956**
  - **Headquartered in Paris**
  - **Governed under French law**

- **<u>Purpose of CORESTA:</u>**
  - **Encourage international cooperation to actively work on tobacco-related areas of research**

CORESTA Membership
(by Geographic Region)



CORESTA Membership
(by core activity)



E-Cigarette Task Force (TF)

- First TF meeting was on May 2013
- TF Coordinator
  - Dr. Charles Garner - RJ Reynolds Tobacco
- TF Secretary
  - Dr. Rob Stevens - Lorillard Tobacco Company
- TF membership continues to expand
  - ≈ 55 people from more than 45 different organizations
  - 15 countries
  - North America, Europe, Asia

E-Cigarette TF Objectives

1. To create a document on worldwide product definition and definitions of terms to support harmonization of nomenclature.

2. To gather and share preliminary data on analysis relevant to e-cigarettes worldwide with a view to making recommendations for product testing.

3. To define the relevant categories of products for potential further CORESTA studies.

E-Cigarette Task Force Studies

- **E-Liquid Proficiency Study**
  - Major Ingredients
  - Methods Comparison
- **Aerosol Proficiency Study**
  - Major Ingredients
  - Puff by Puff and Total Yields
  - Selection of Puffing Parameters
  - Methods Comparison

E-Liquid Study Objective & Design

- To determine consistency of results between labs using their own methods for analysis of the same set of e-liquid samples
- 9 Labs tested the same 11 samples including a study control
- Analytes Tested:
  - Nicotine (0 – 1.6%)
  - Glycerin (0 – ~100%)
  - Propylene Glycol (0 – ~100%)
  - Water (0 – 10%)

E-Liquid Methods Summary

	General Information across Methods
Sample Prep	• Weigh 100 – 1000 mg* • Dilute with alcohol (10 – 100 mL) • Mix/Shake (10s – 3 hours) • Weight and volume used varied by analyte

Analysis	• GC-TCD or Karl Fischer for water
	  • Packed column if TCD (most)
	• GC-FID for other analytes
	  • Capillary column
	  • DB-Wax columns for most
	• 4 – 12 calibration standards (GC)
	• Linear (IS) calibration
	• r^2 >0.99

***Lab 6 measured by volume (25 – 100 µL) and diluted with 1mL solvent**

%Error for Control Sample

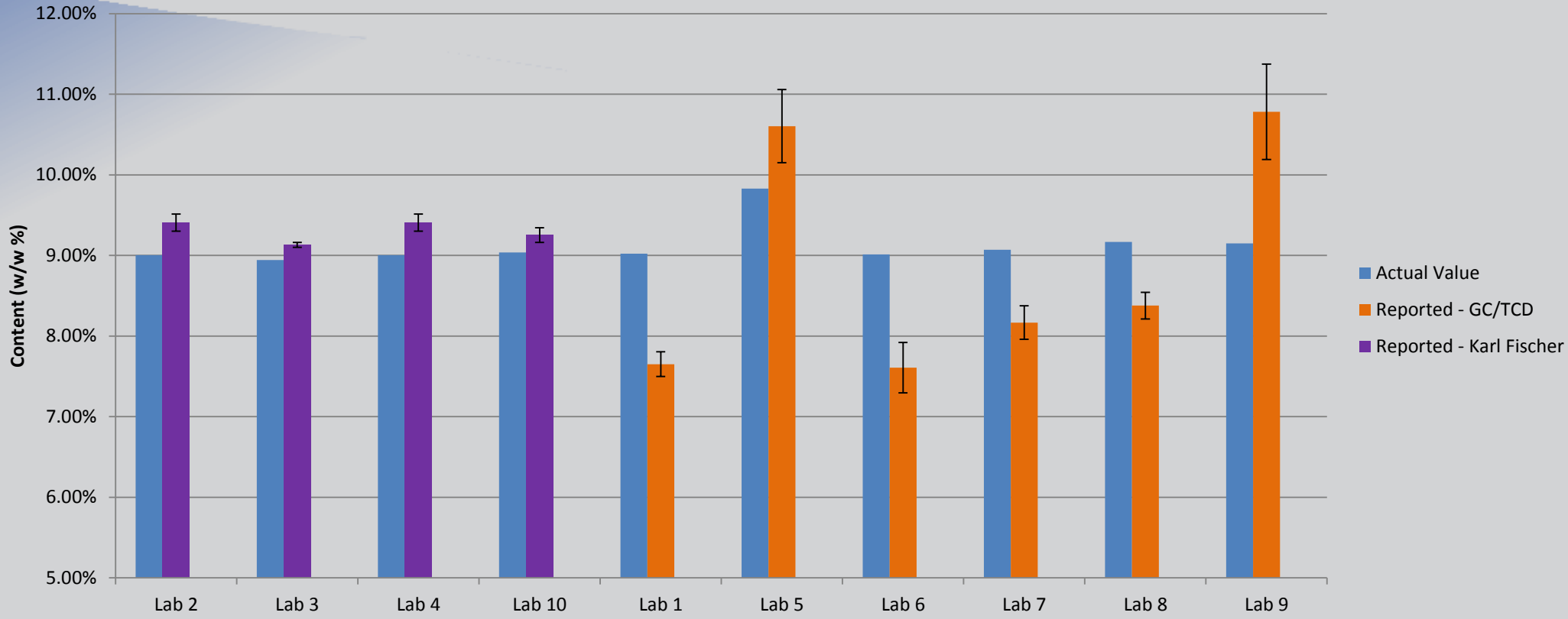
	Nicotine	Glycerin	PG	Water
Error range for all labs	0.2 – 4.5 %	1.6 – 13%	0.2 – 10%	2.1 – 18%

- A Study Control was made by directly weighing analytical grade chemicals into tared sample vessels using a 5-place analytical balance
- Precision for each lab was high (<5% RSD)
- Error from Actual value was low for all labs for each analyte
- Error was highest for water (<18% error)

%Error Calculated as (Reported – Actual)/Actual * 100

The actual value is based on each lab's control sample rather than on the target value.

Results for Control Sample - Water



- **Target Value = 9%**
- **Karl Fischer methods averaged 3% error**
- **GC/TCD methods averaged 13% error**

Nicotine Results Compared to Nominal Value

Sample	Nominal Value (w/w)	Avg. of all Labs (w/w)*		
Sample 1	1.6%	1.48	±	0.07
Sample 2	1.6%	1.57	±	0.07
Sample 3	0.0%		--	
Sample 4	0.79%	0.73	±	0.03
Sample 5	0.79%	0.72	±	0.03
Sample 6	0.54%	0.55	±	0.02
Sample 7	0.53%	0.53	±	0.01
Sample 8	0.53%	0.54	±	0.03
Sample 9	0.48%	0.46	±	0.01
Sample 10	0.58%	0.58	±	0.02
Sample 11 (Control)	1.0%	1.03	±	0.03

*** Reported as Average ± Standard Deviation**

E-Liquid Proficiency Study Findings

- Analytical methods used across the 9 different labs were based on alcohol dilution and GC-FID analysis for nicotine, glycerin, and PG.
- Water analyses were performed using either GC-TCD or Karl Fischer analysis.
- The laboratory results showed high accuracy and precision.
- Use of study controls and reporting in mg/mL and mg/mg are recommended.

E-Cigarette Aerosol Studies: Objectives & Designs

- To determine consistency of results between labs using the same puffing regimen and their own methods for analysis
- 4 laboratories conducted a puffing parameters evaluation
- 14 labs tested the same 8 samples using the recommended puffing parameters
- Analytes Tested:
  - Total Yield, Nicotine, Glycerin, Propylene Glycol, Water

E-Cigarette Aerosol Studies Method Summary

	In Common (Most Labs)
Sample Handling	• Stored unopened under ISO conditions* prior to testing
Collection	• 20 port Conventional Linear Smoking machine • 44mm CFP, Conditioned to ISO std* • Room Conditioned to ISO smoking std*
Sample Prep	• Isopropanol with heptadecane and ethanol as IS, 20mL • Shake to extract, 30min • Possible additional dilution for Gly/PG

Analysis	• GC-TCD for water
	  • Packed column (most)
	• GC-FID for other analytes
	  • Capillary column
	  • DB-Wax columns for most
	• 6 – 12 calibration standards
	• Linear (IS) calibration
	• r^2 >0.99

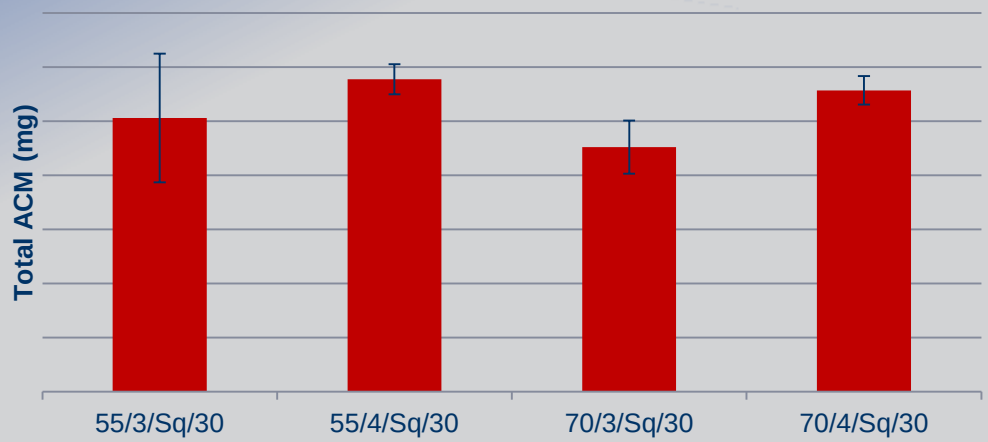
*** ISO 3402:1999**

Methods Summary

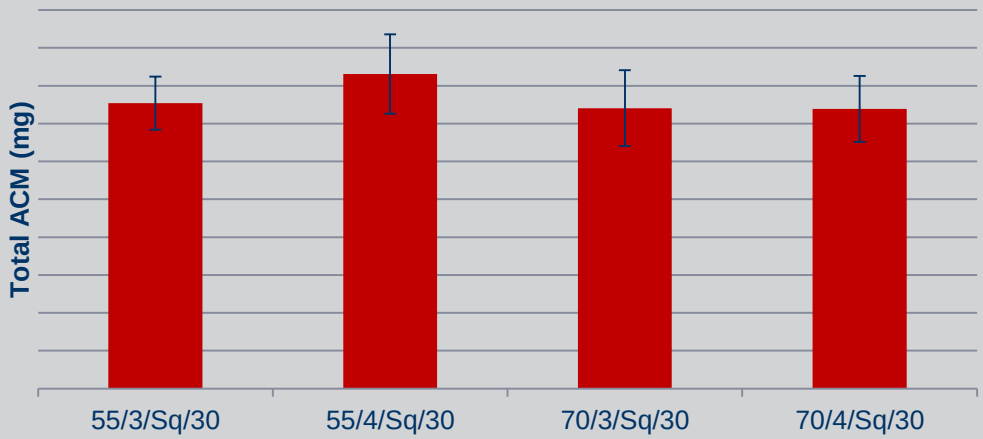
	Differences
Collection	Lab E – used a rotary machine, condition during vaping: 40% RH, pad conditioning: 40% RH
Sample Prep	Lab C – 25mL solvent Labs F, G, H, L – 10mL solvent Shake time 20min - 60min among labs IS anethole, octadecane, quinoline and methanol also used
Analysis	A range of columns and conditions were used; most labs used 2 GC runs some used 3, one used 4 Sometimes dual column (2 runs in one)

Impact of Puffing Parameters on Total Yield

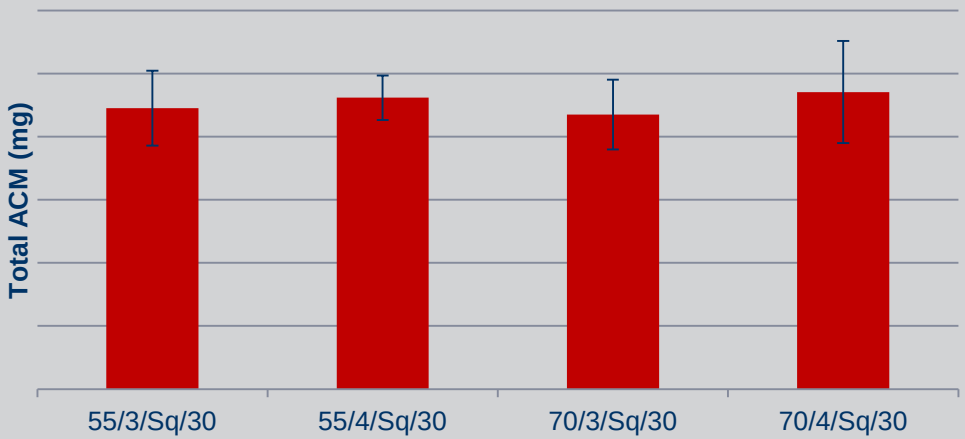
Lab 2 – Disposable Product



Lab 3 – Disposable Product



Lab 4 – Disposable Product



- **No difference in total aerosol collected matter (ACM) yield between puffing regimes**
- **Precision is similar among test sets**

Range in Total Yield across all Puffing Regimes

	(%) Total PG	(%) Total Nicotine	(%) Total Glycerin	(%) Total Water
Lab 1 - Rechargeable	47 - 48	1.21 - 1.24	26 - 27	11 - 13
Lab 2 - Disposable	56 - 58	1.8 - 1.9	28 - 29	8 - 11
Lab 2 - Rechargeable	57 - 59	1.8 - 1.9	28 - 29	8 - 12
Lab 3 - Disposable	0	1.60 - 1.61	71 - 76	19.6 - 20.3
Lab 3 - Rechargeable	0	1.3 - 1.4	72 - 76	15 - 16
Lab 4 - Disposable	42 - 47	1.0 - 1.2	33 - 39	15 - 18
Lab 4 - Rechargeable	34 - 41	1.4 - 1.5	41 - 44	11 - 13

Analytes trended with aerosol collected matter (ACM) for all regimes

% Composition was not affected by varying the regime

Puffing Regime Evaluation

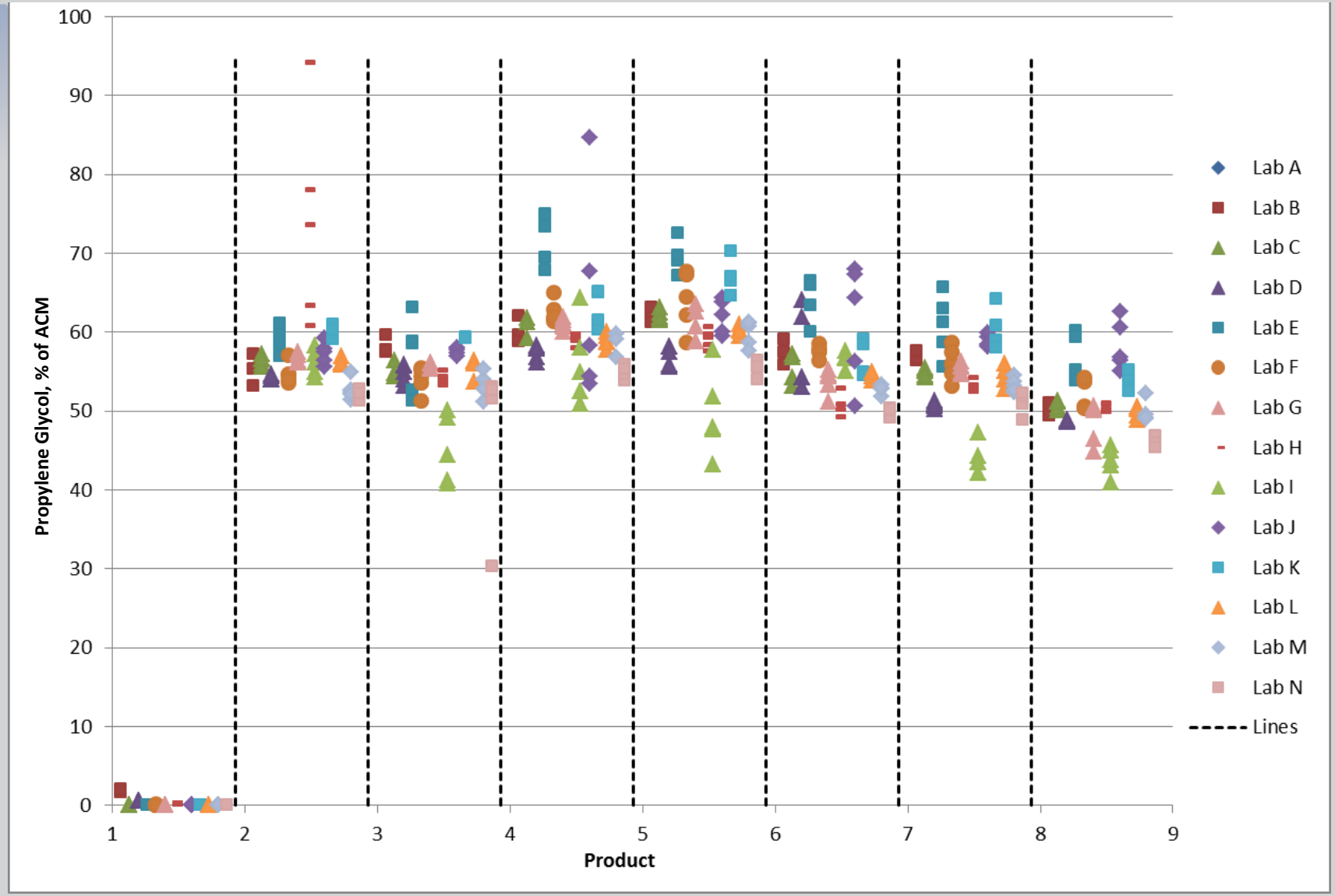
Recommendation:

- 55 ml puff volume, 3 second puff duration, 30 second puff interval, and square wave puff profile

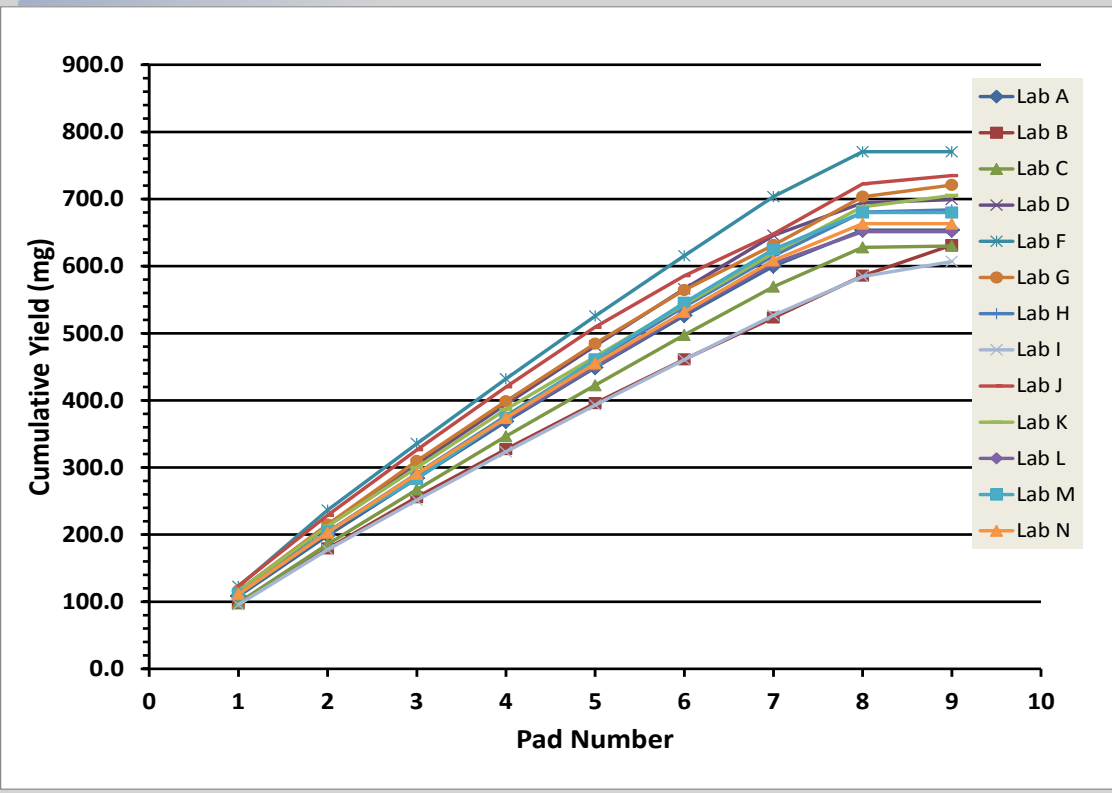
E-Cigarette Aerosol Proficiency Study:

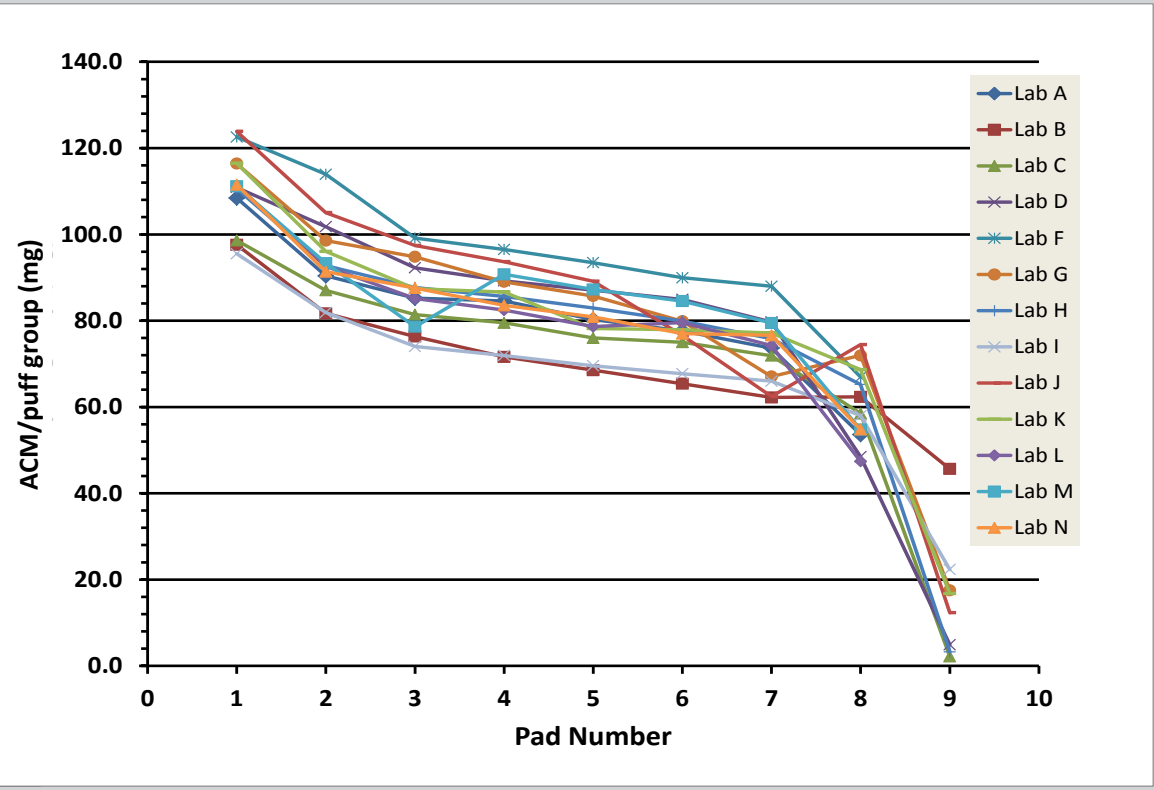
- 14 labs tested the same 8 samples using the recommended puffing parameters
- Analytes Tested:
  - Total Yield, Nicotine, Glycerin, Propylene Glycol, Water

PG, % of Aerosol Collected

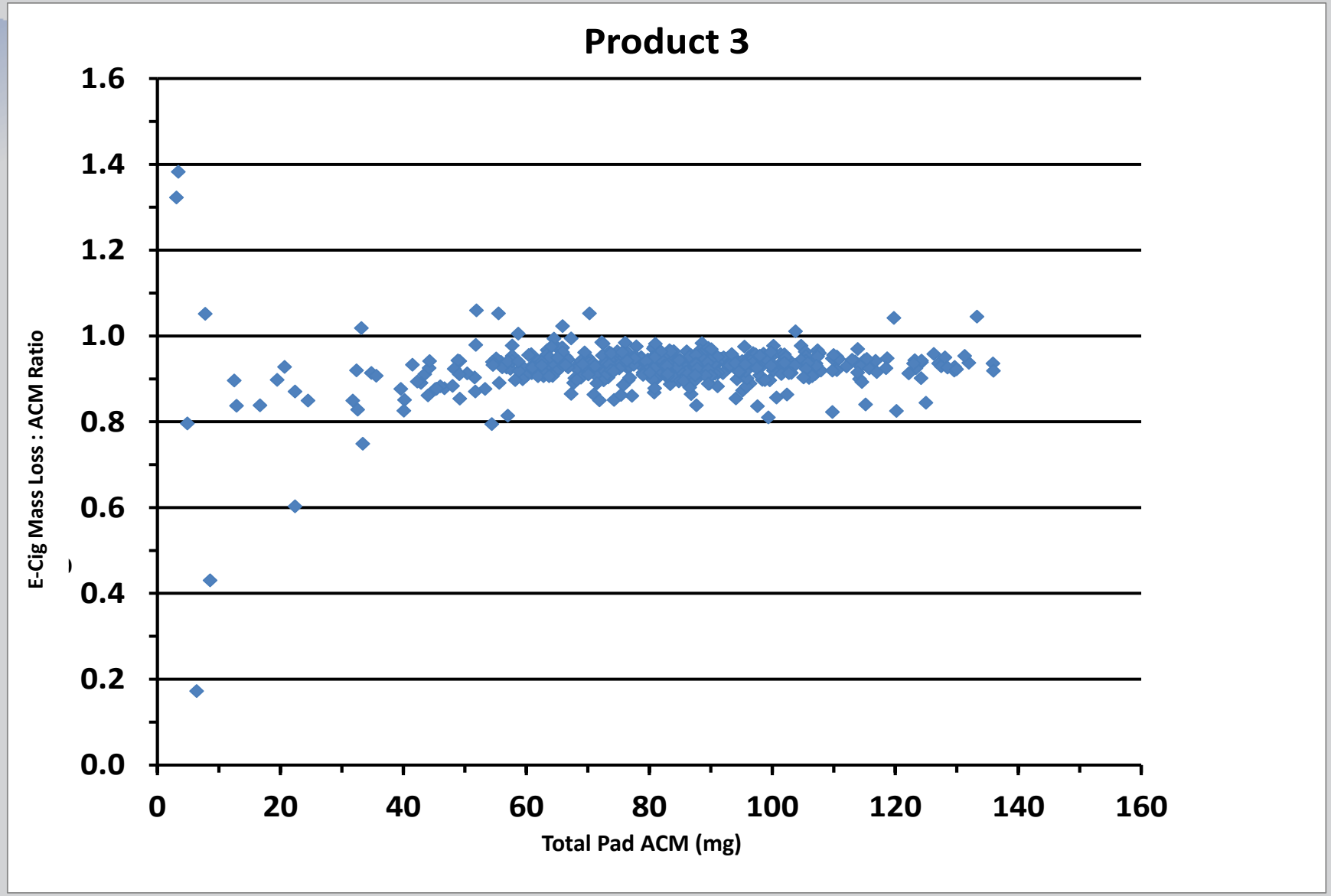


Product 3 – Cumulative and per pad Aerosol yields





E-cig Mass Loss : ACM Ratio as Function of ACM



Aerosol Proficiency Study Findings

- Aerosol methods were similar among the participating labs
  - Alcohol extraction followed by GC-FID and GC-TCD analysis
- Results across most labs were very consistent for Nicotine, Glycerin, PG and Water
- E-cig mass loss to ACM ratios were good metrics to verify results

CORESTA e-cigarette Task Force Accomplishments

- **Preliminary proficiency study for e-liquids**
  - Nicotine, water, glycerin and propylene glycol: Inter-lab study completed (May 2014)
- **Puffing parameters to collect e-cigarette aerosol**
  - Preliminary study completed in May 2014 and recommendation made: (55 ml puff volume, 3 second puff duration, 30 second puff interval, and square wave puff profile)
- **Preliminary proficiency study for e-cigarette aerosol**
  - Nicotine, water, glycerin and propylene glycol: Inter-lab study completed (October 2014)

Value of CORESTA

- Global interdisciplinary expertise from different sectors
- Focus on advancing scientific knowledge
- Well established procedures for developing methods
- Leadership and coordination of inter-lab studies to recommend analytical methods

Questions?