# E-cigarette Aerosol Dynamics in a Physical Model of the Adult Human Oral/Pharyngeal/Tracheal Cavity

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# Objective

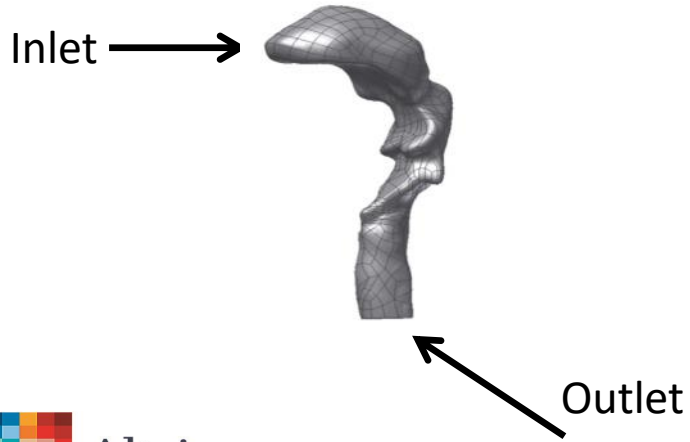
- To generate experimental data to validate a computational fluid dynamic (CFD) model for e-cigarette aerosol deposition in respiratory tract

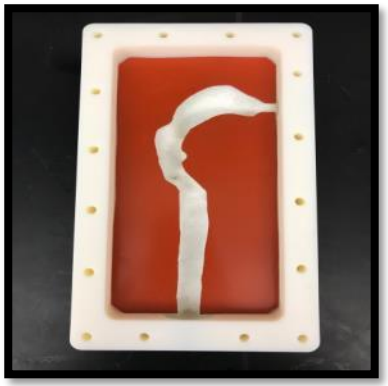
# Physical Model

- Physical Prototypes created from digital geometry using 3D printer

- Wall covered with a layer of cotton cloth that can be saturated with water to reflect high relative humidity in respiratory tract

**Oral/Larynx/Pharynx/Tracheal section**



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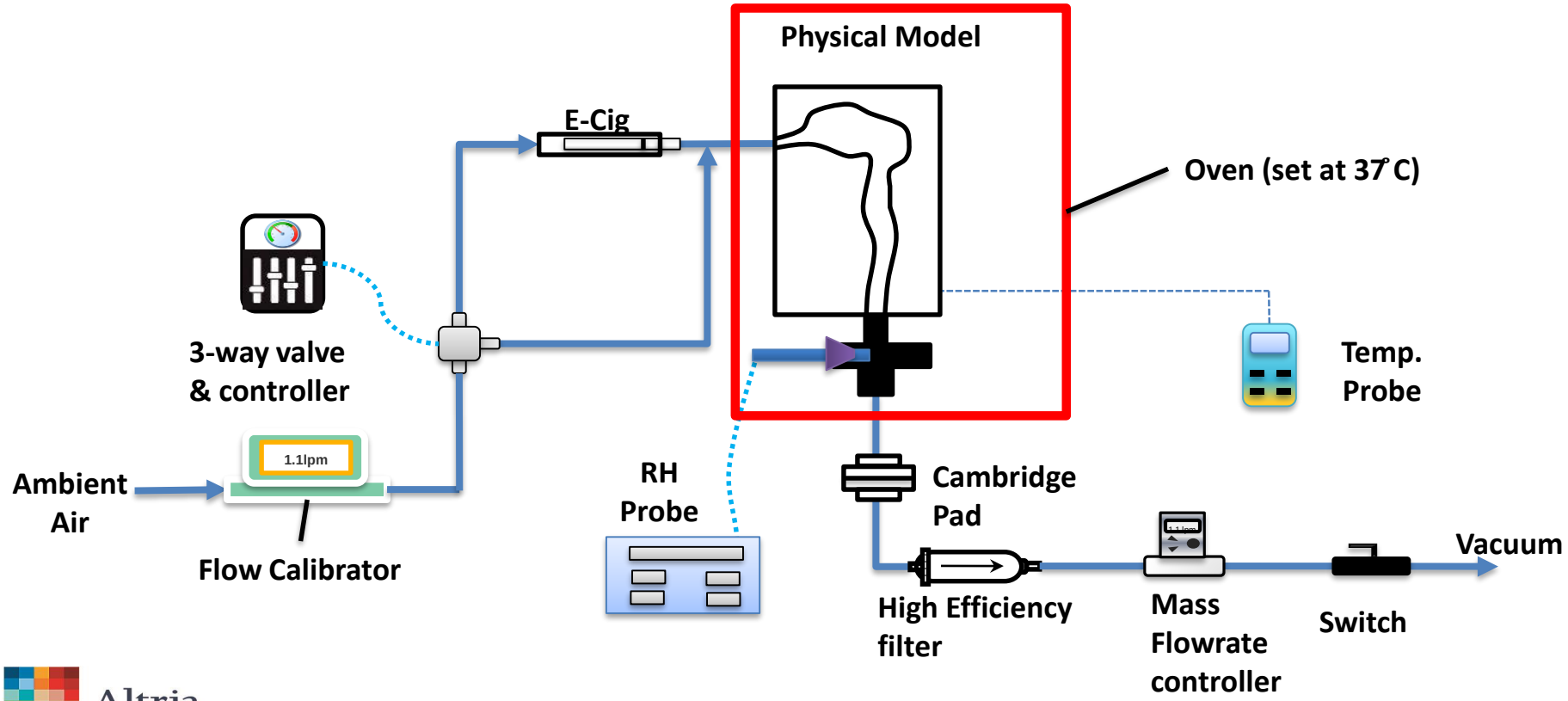
# Diagram of the Experimental Setup



# Experimental Conditions

| Case | E-liquid composition | puff duration (sec.) | puff volume (cc) | Temperature (C) | Wall conditions |
|---|---|---|---|---|---|
| N-1 | 2.5% Nicotine by weight (NBW), 15% water, 49.5% PG/Gly 33% | 3 | 55 | 37 | wet |
| N-2 | 2.5% NBW, 15% water, 49.5% PG/Gly 33% | 3 | 55 | 37 | dry |
| N-3 | 2.5% NBW, 10% water, 87.5% PG | 3 | 55 | 37 | wet |
| N-4 | 2.5% NBW, 10% water, 85.5% Gly | 3 | 55 | 37 | wet |

## Procedures

- 3 puffs E-cig warm up
- 1.1 L/min constant flow rate
- 11 sec air wash between puffs
- 3 replicates /cartridge and 3 cartridges/case
- 5 continuous puffs for gravimetric analysis, single puff for chemical analysis using GC/MS

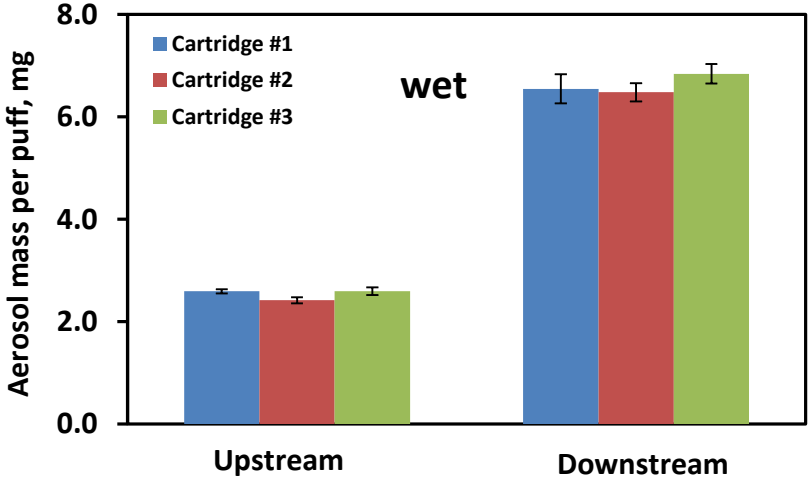
## Limitations

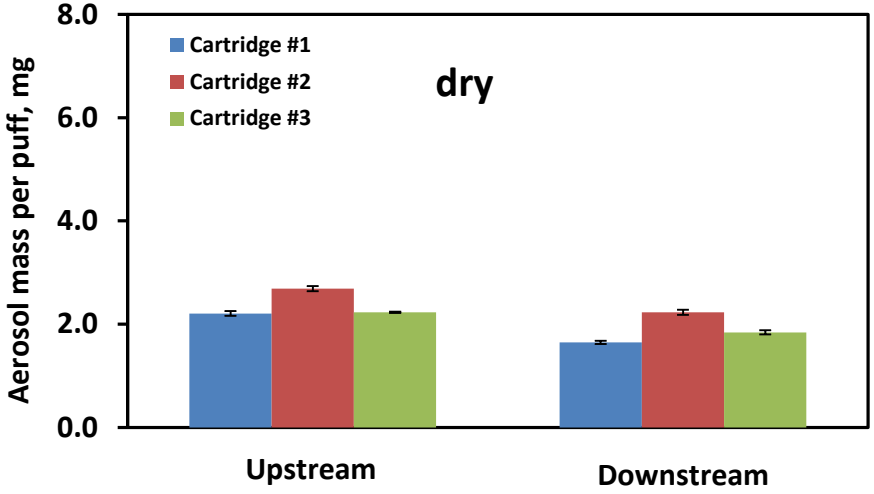
- Doesn't represent real inhalation
- Single fixed geometry
- Simple formulations without flavors

# Gravimetric Analysis

# Results – Gravimetric Analysis

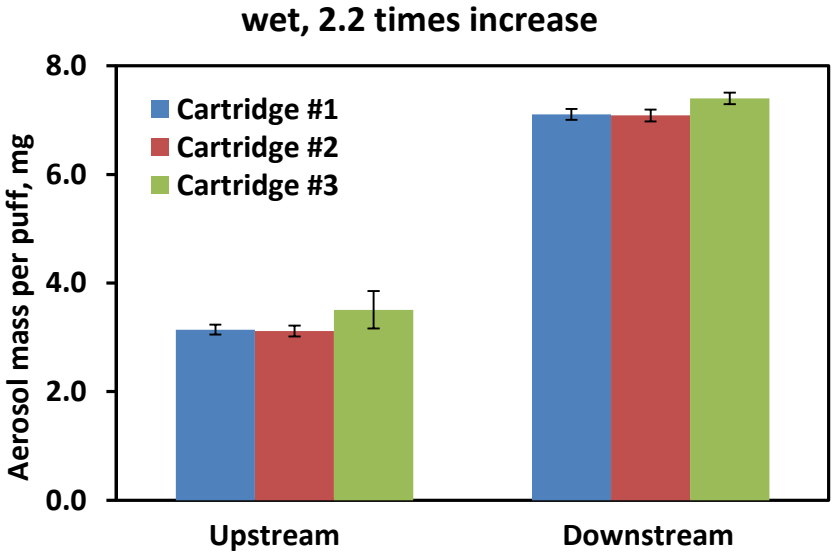
2.5% NBW, 15% water, 49.5% PG/Gly 33%



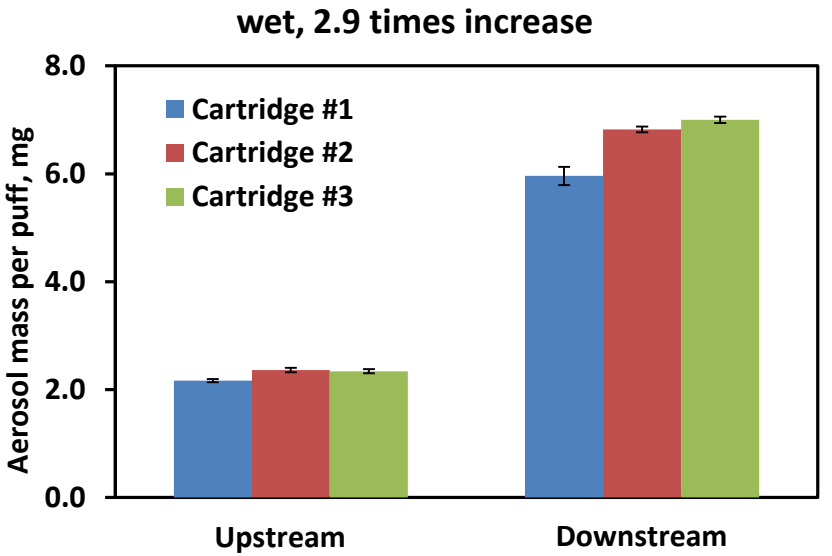




| Physical model | Particle growth (wet), times |
|---|---|
| Oral/Pharyngeal | 2.1 |
| Oral/Pharyngeal/ Tracheal | 2.6 |

# Results – Gravimetric Analysis



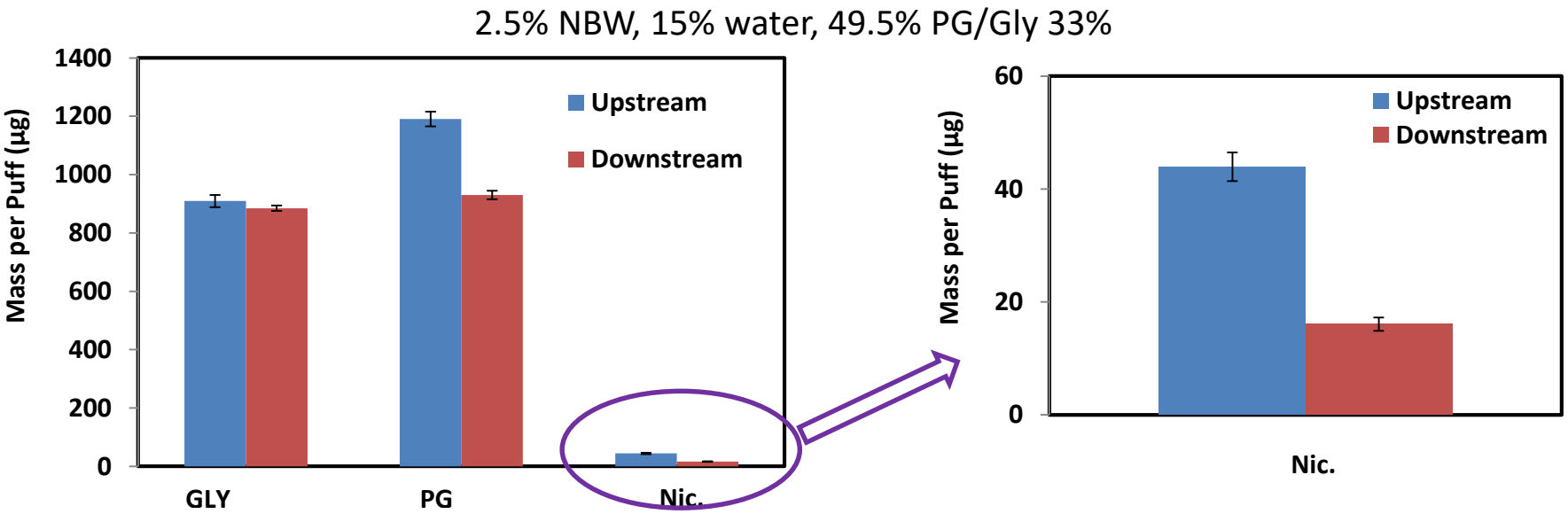

2.5% NBW, 10% water, 87.5% **PG**




2.5% NBW, 10% water, 87.5% **Gly**

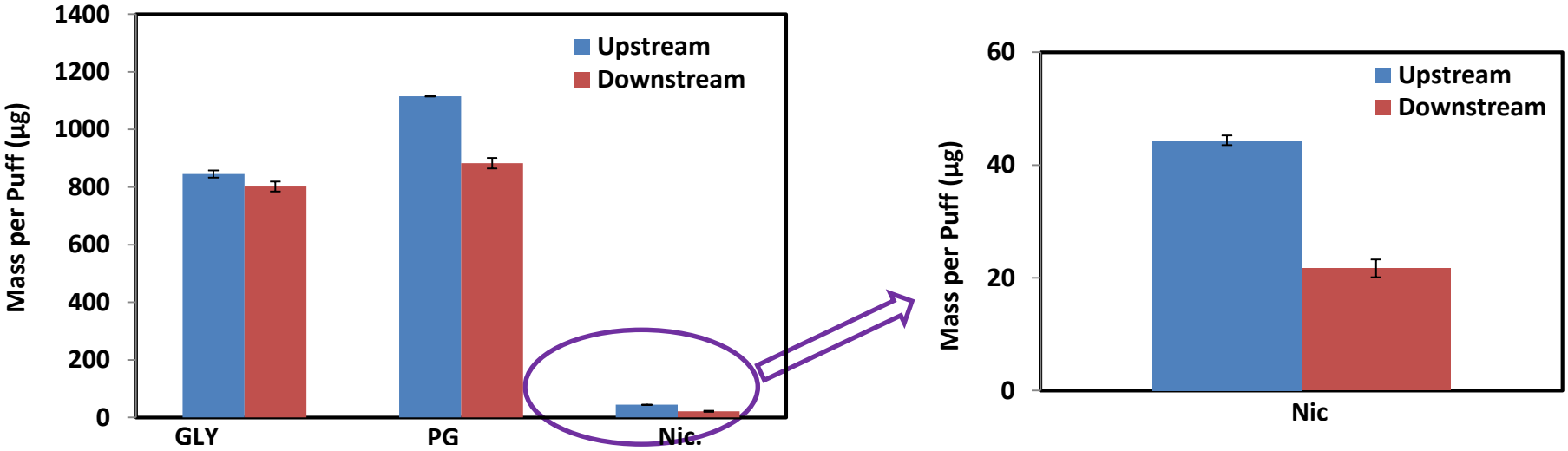
# Chemical Analysis

# Results – Chemical Analysis (wet)




| Physical model | Nicotine deposition,% |
|---|---|
| Oral/Pharyngeal | 48 |
| Oral/Pharyngeal/ Tracheal | 63 |

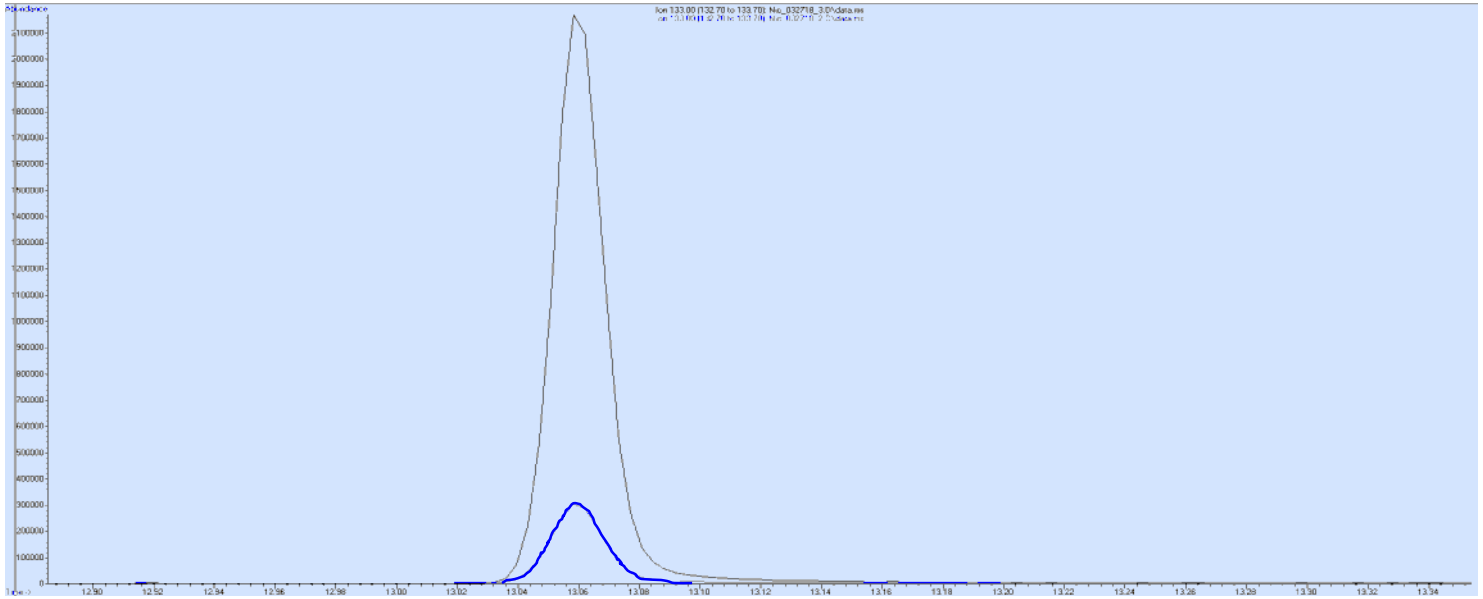
# Results – Chemical Analysis (dry)




2.5% NBW, 15% water, 49.5% PG/Gly 33%

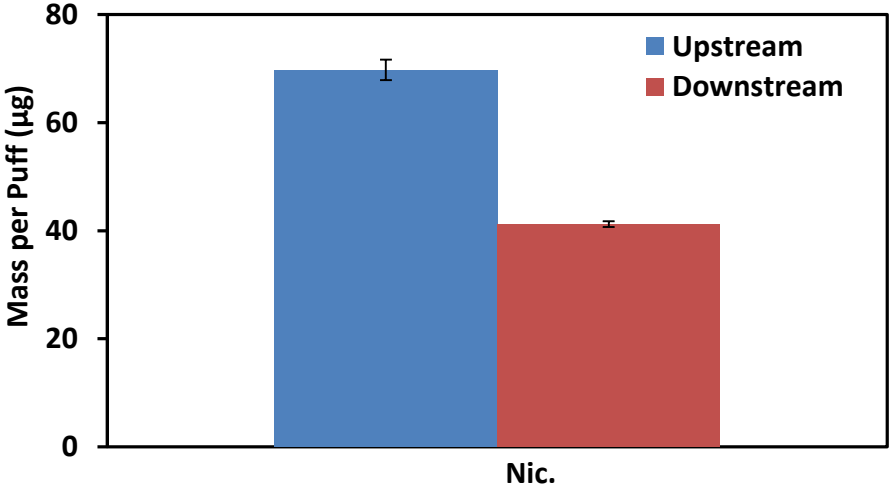
# Nicotine Is Hydrophobic

10 ml water solution (contained 2.5% nicotine) mixed with 10 ml octanol

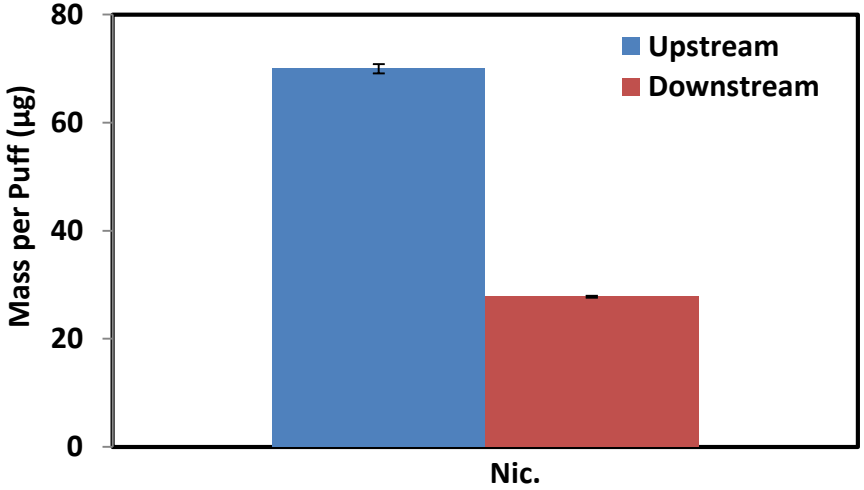



--- nicotine in octanol --- nicotine in water

# Results – Chemical Analysis (wet)




2.5% NBW, 10% water, 87.5% **PG**




4.5% NBW, 10% water, 85.5% **Gly**

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# Summary

- Particle size and Nicotine deposition increases as the length of the physical model increases
- Nicotine deposition increases as a result of hygroscopic growth due to hydrophobicity of Nicotine
- The deposition of Nicotine is higher in Glycerin & water than in PG & water

# Thank You!

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