# *Indoor Air Quality, Environmental Tobacco Smoke, and Patron Perception: A Three Restaurant Case Study*

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*This research was sponsored by the Brown and Williamson Tobacco Company, Louisville, KY, under contract no. ERD-99-01736 with the Oak Ridge National Laboratory, managed by Lockheed Martin Energy Research Corp., Oak Ridge, TN, for the U.S. Department of Energy under contract number DE-AC05-84OR9622464.*

*Presented at the 53rd Tobacco Science Research Conference, Montreal, Quebec, September 12 - 15, 1999*

# *Objective*

- Assess public perception to indoor air quality in three similar restaurants with somewhat different demographics.
- Measure common parameters for IAQ assessment.
- Determine extent to which IAQ could be improved with cost effective ventilation changes.

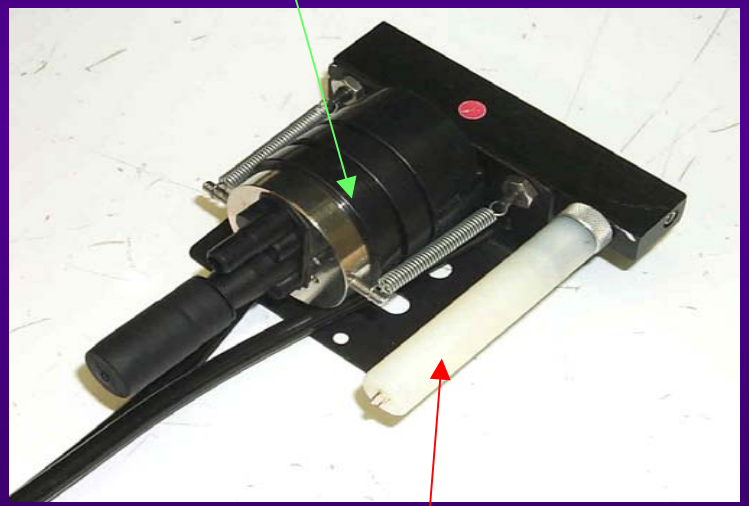
# *Experimental Design*

- Measure IAQ/ETS components on five consecutive evenings, each of three facilities: smoking/non-smoking sections, selected components outside.

- Conduct interviews of patrons, determine perception of air quality

# *Sampling System is Same as ETS Personal Sampler*


Particle phase collected on Teflon membrane filter



Gas phase collected on XAD-4 resin

# *ETS Markers Used and Analytical Methods*

- Particulate Phase
  - RSP (<4 μm MMAD) - gravimetric
  - UVPM and FPM - "columnless" HPLC
  - Solanesol (or Sol-PM) - HPLC
- Vapor Phase
  - 3-Ethenyl Pyridine and Nicotine - GC with nitrogen specific detection

# *Additional Measurements*

- Temperature, relative humidity
- Real time carbon monoxide and carbon dioxide.
- Inside and outside

# *"Challenges"*

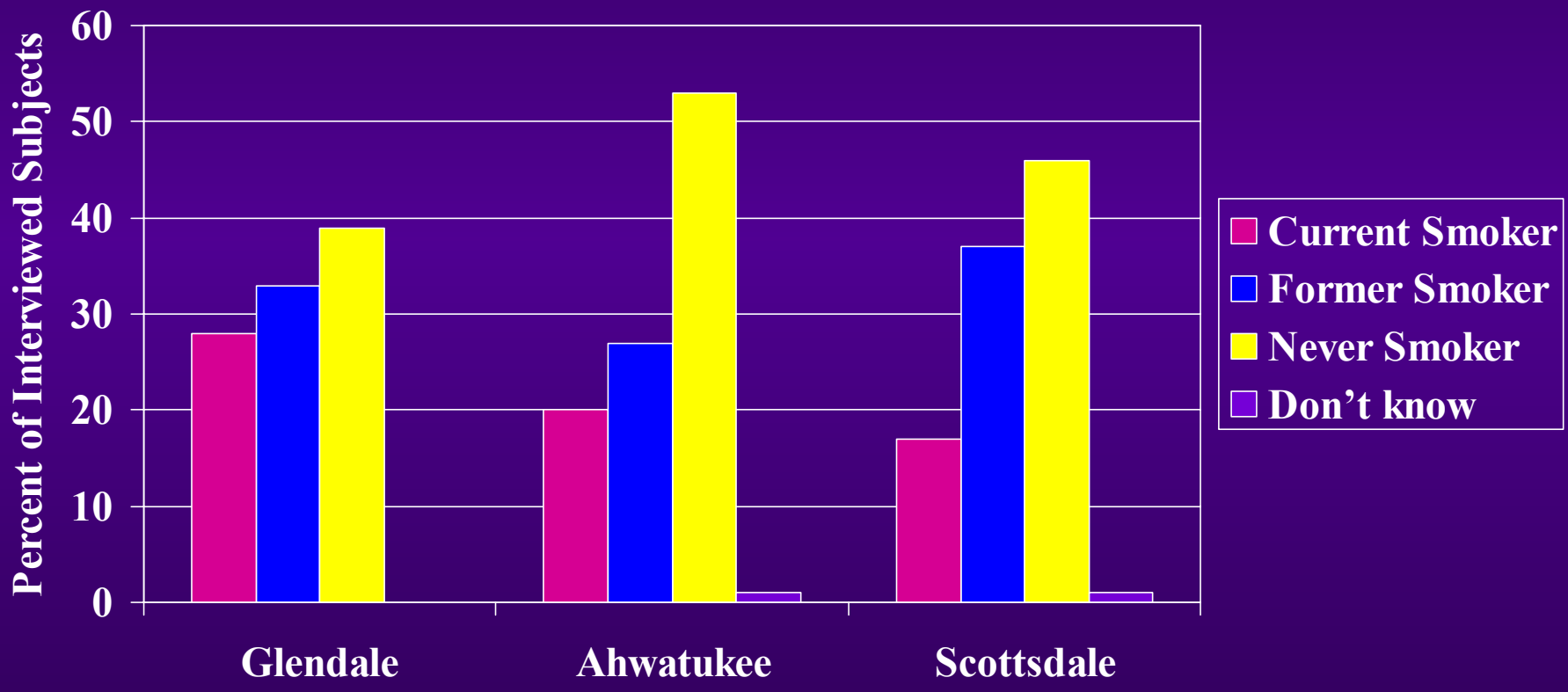
External Sources

"Recycled" air

# *Data Generated*

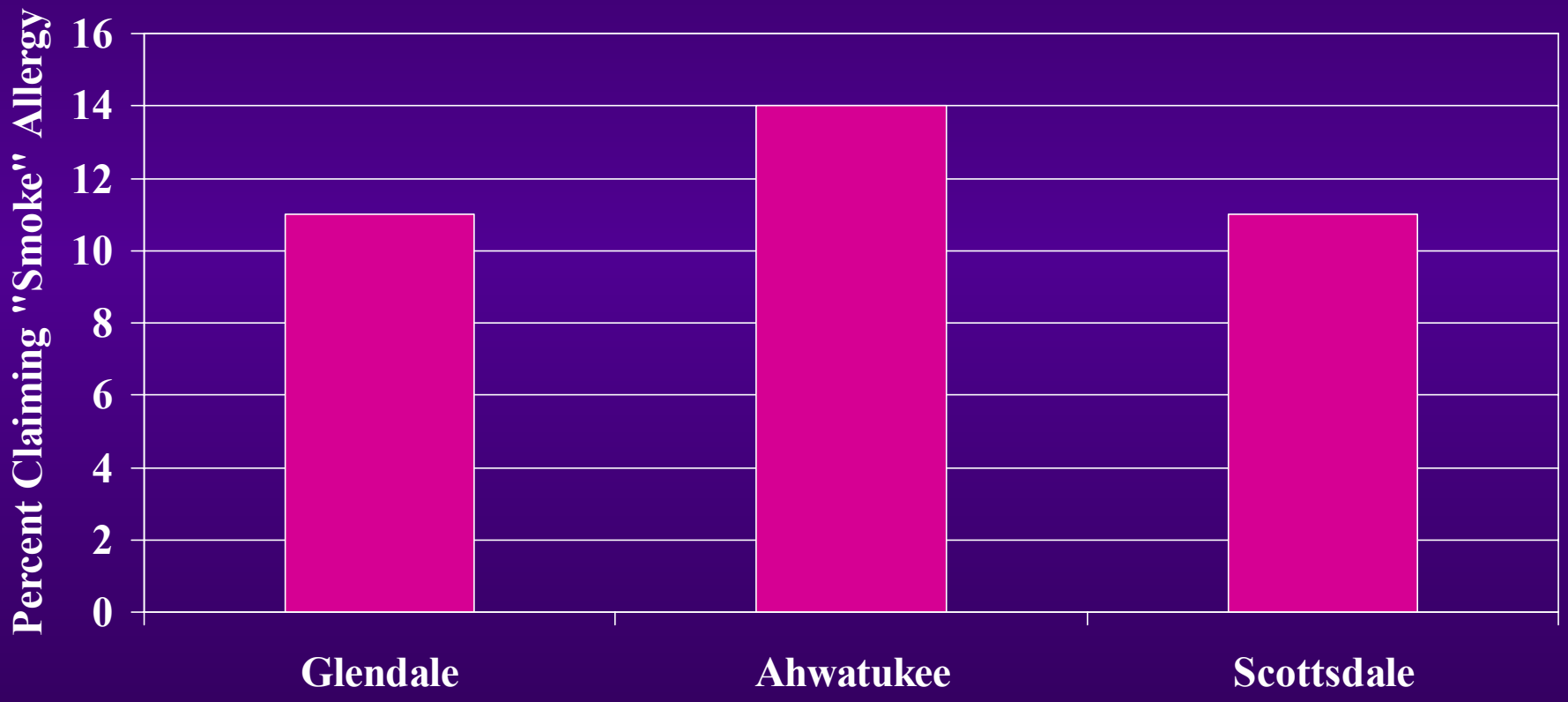
- 80 Particulate samples, 80 vapor samples.
- 60 + hours of real time CO, $CO_2$, temperature, RH measurements.
- 597 patron interviews

# *Smoking Status of those Interviewed*




*Compares with Arizona 1996 adult current smoking fraction: 23.8%*

# *More than 10% of Interviewees Claimed Allergies to Smoke/Cigarette Smoke*



# *Sampling System in Use*

# *Limits of Quantification*

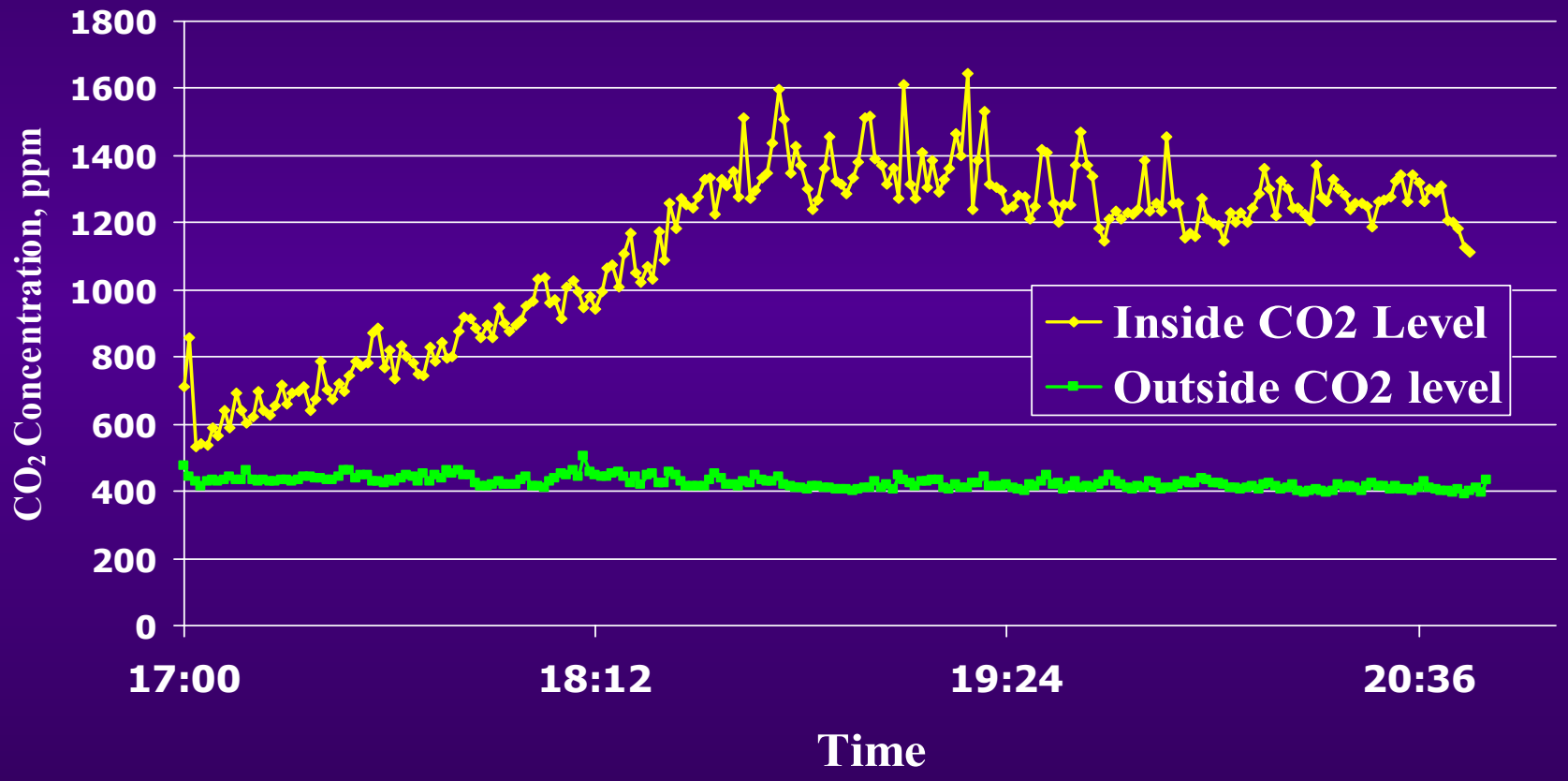
| *Constituent* | *Limit of Quantification, µg/m³* | *Fraction of Real, Blank Corrected Samples at or Below LOQ* |
|---|---|---|
| ***RSP*** | 35* | 50% |
| ***UVPM*** | 11 | 6% |
| ***FPM*** | 1.82 | 1% |
| ***Sol-PM*** | 6.06 | 48% |
| ***3-EP*** | 0.17 | 4%** |
| ***Nicotine*** | 0.56 | 35%** |

*Problems with establishing LOQ for blanks

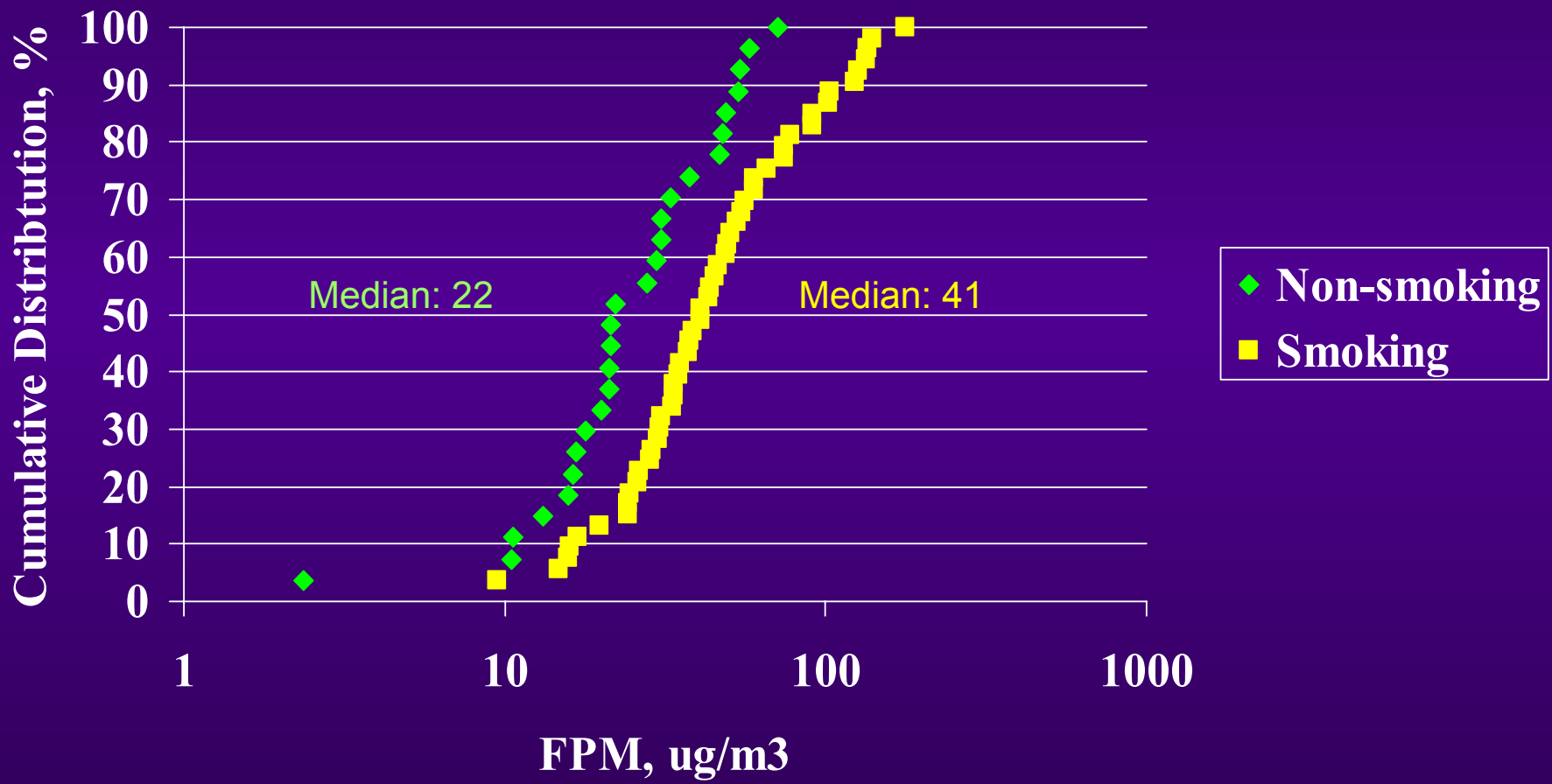
**No measurable blanks

# $CO_2$ Levels Do Exceed Standards

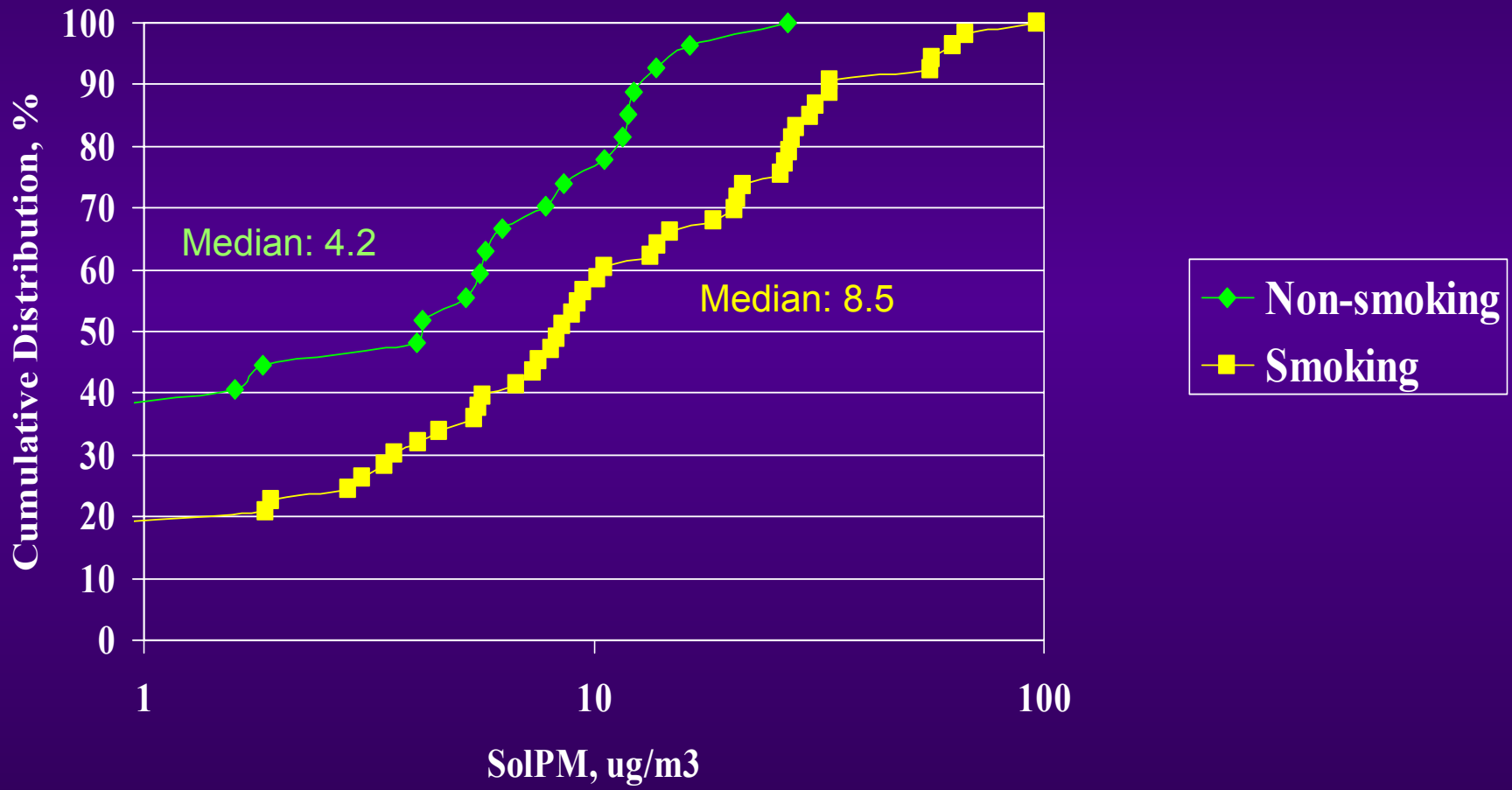
*Friday, February 19th*



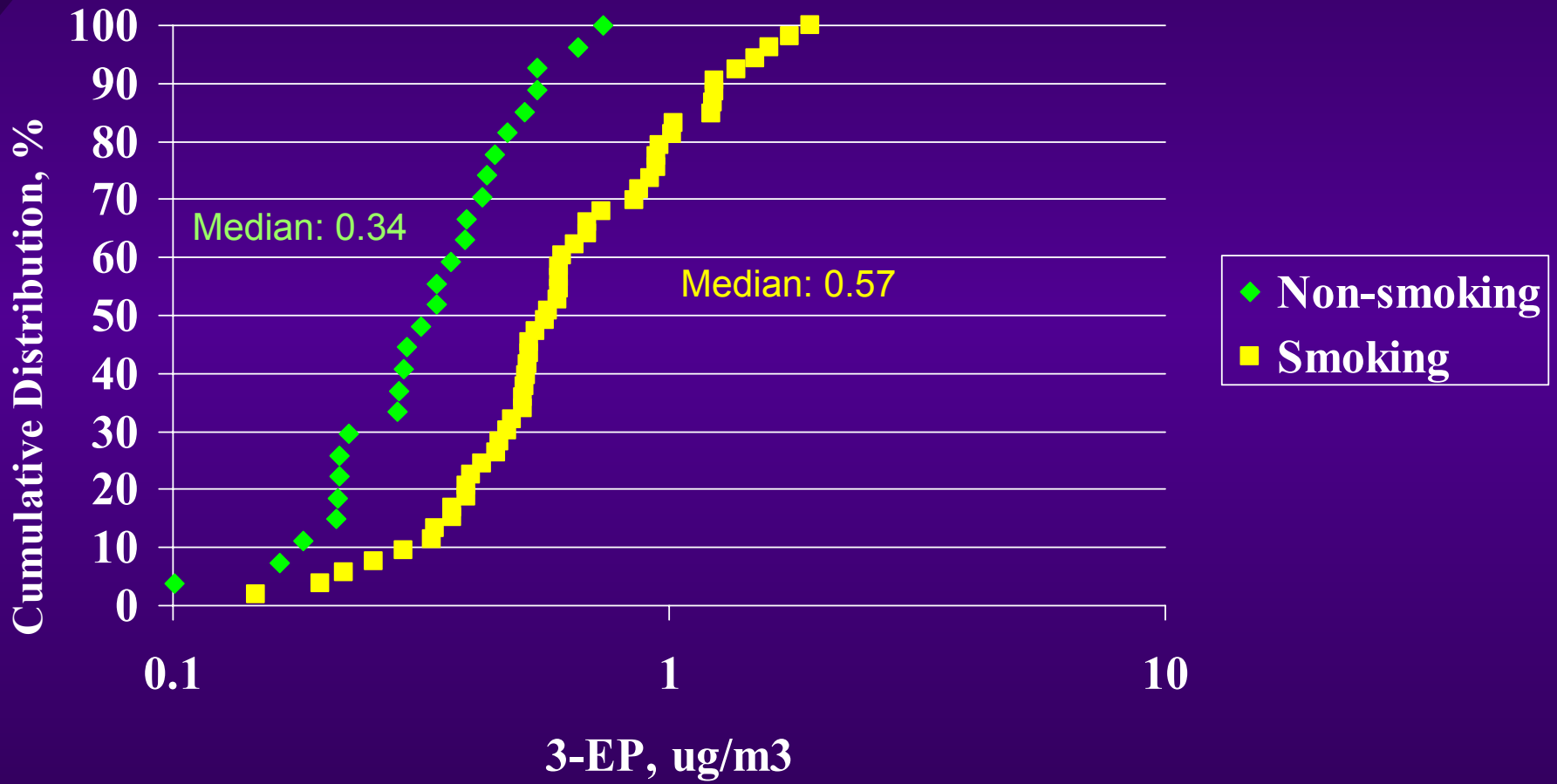
# *Cumulative Distribution: FPM*



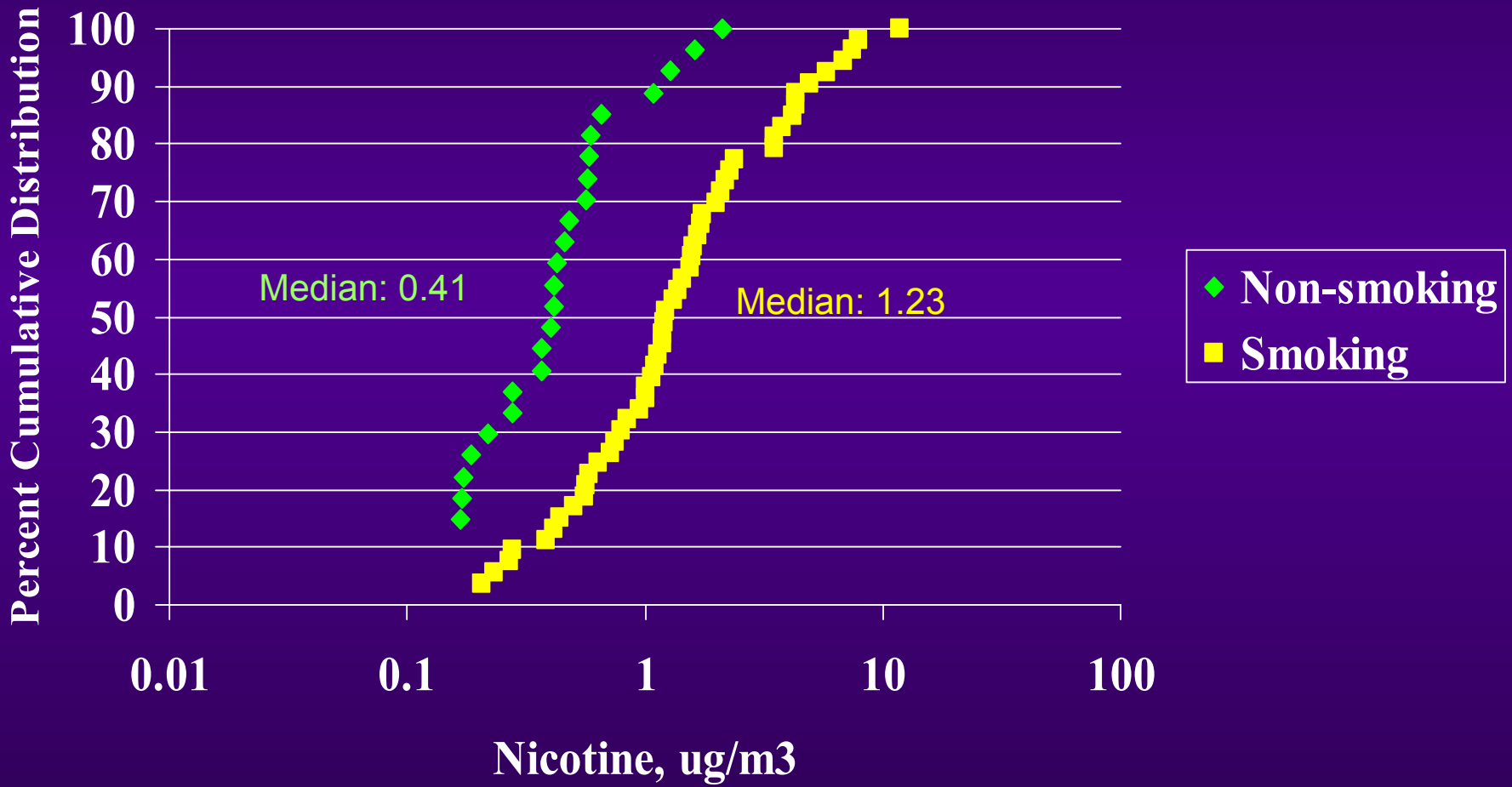
# *Cumulative Distribution - SolPM*



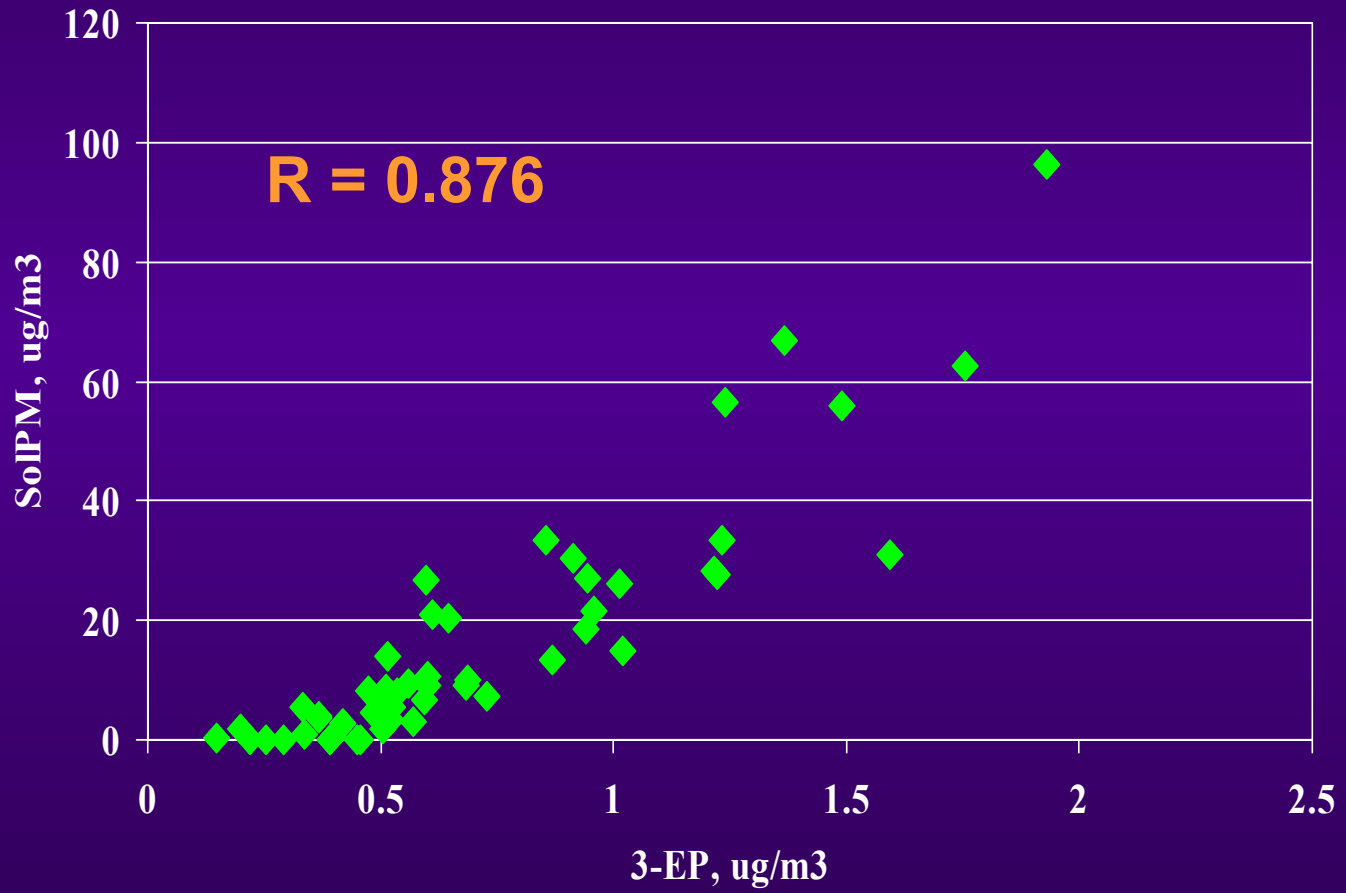
# *Cumulative Distribution, 3-EP*



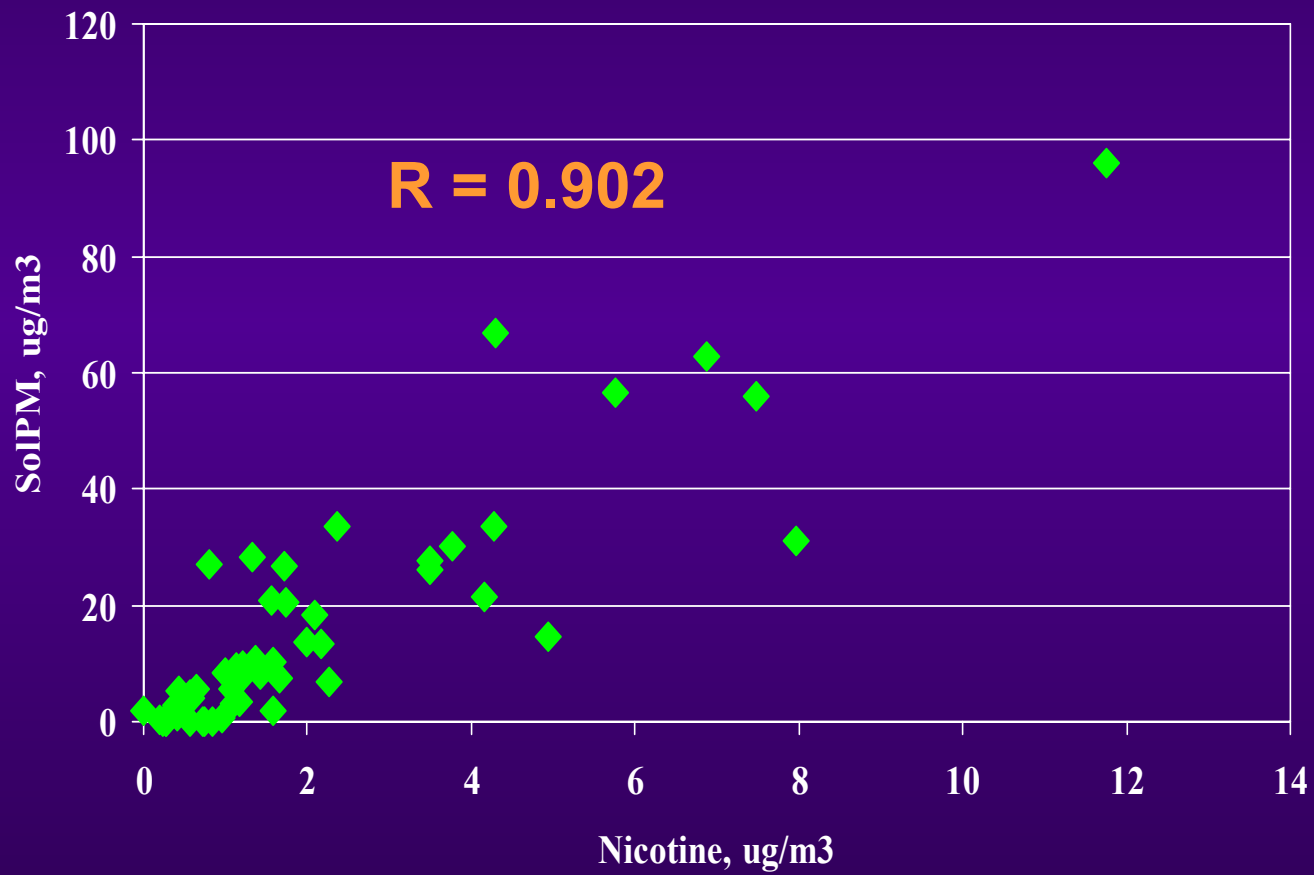
# *Cumulative Distribution, Nicotine*



# SolPM vs 3-EP in Smoking Sections



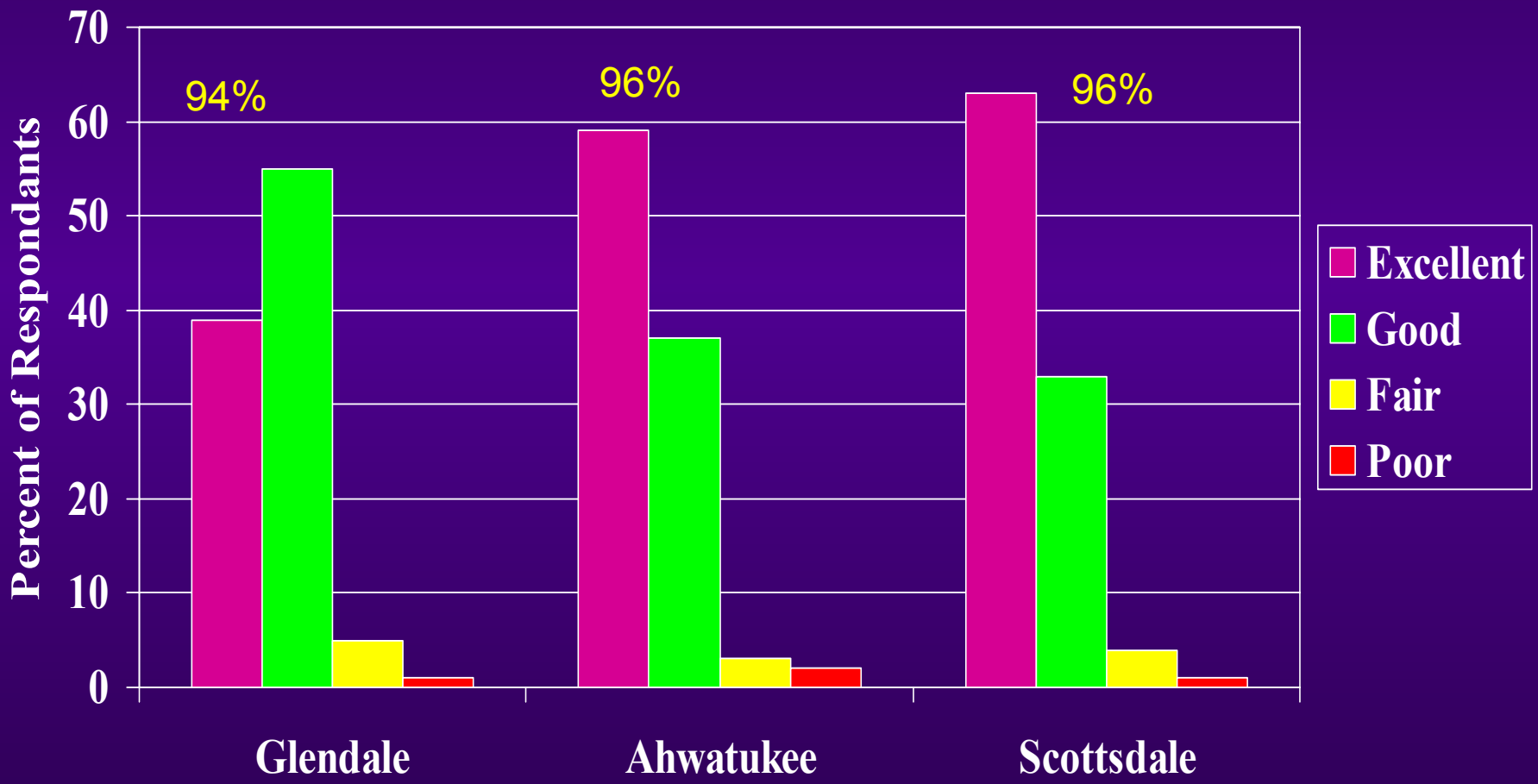
# SolPM vs 3-EP in Smoking Sections



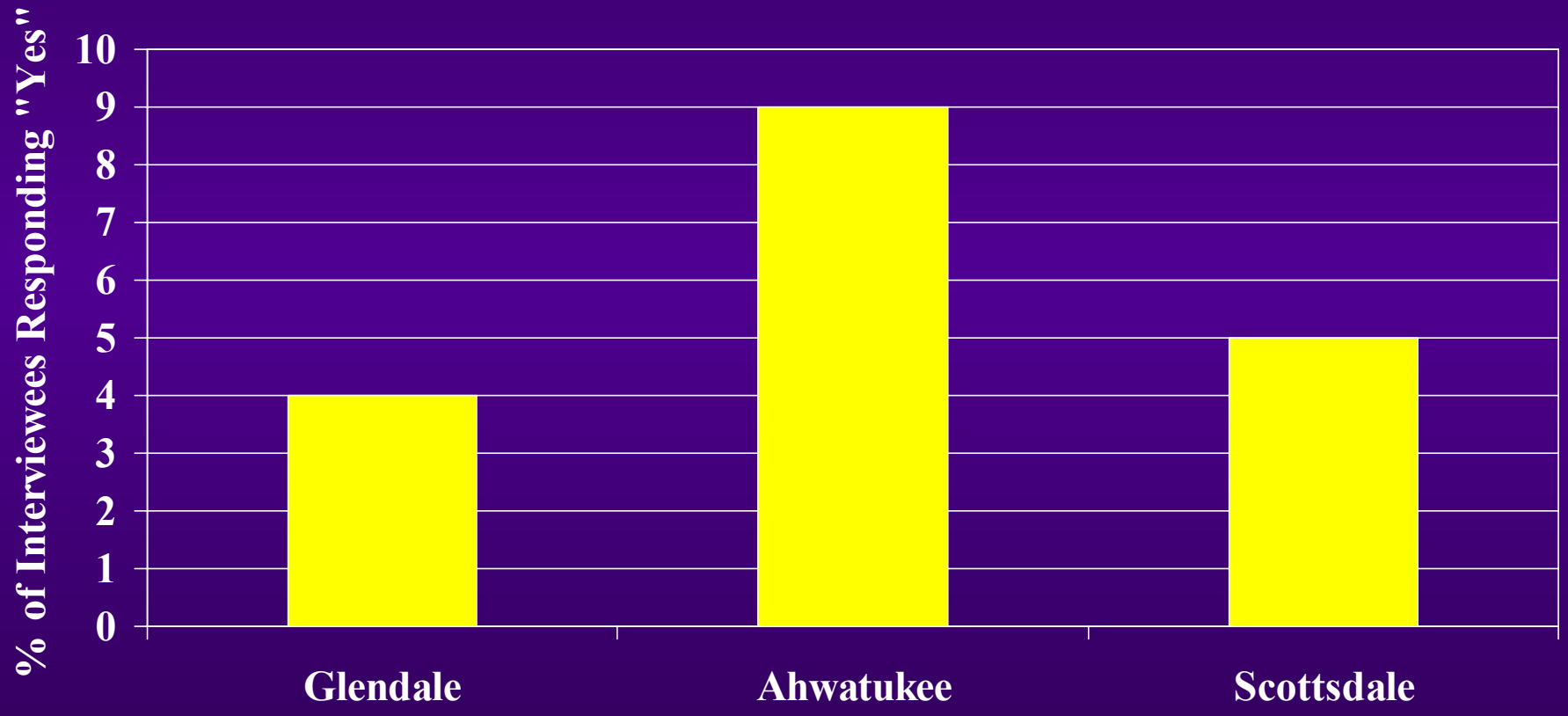
# *Are the Phoenix Facilities Different?*

| | *Glendale Smoking Section* | *Knoxville Multiroom Restaurant-Bars* |
|---|---|---|
| *Median 3-EP, µg/m$^3$* | **0.66** | **0.59** |
| *90$^{th}$ %ile 3-EP, µg/m$^3$* | **1.38** | **3.09** |
| *Median Sol-PM:FPM Ratio* | **0.32** | **0.57** |
| *Median Nicotine, µg/m$^3$* | **1.25** | **1.15** |

# *Ratings of Overall Air Quality*



*Responses to: "Were you bothered by cigarette smoke at any time during your stay in the restaurant?"*



# *Contribution from Other Sources?*

- ETS-derived particles as a fraction of all combustion derived particles: 25 - 40%
- Levels of outside and inside CO are so low that trends can not be observed.
- $CO_2$: background not variable, and anthropogenic sources indoors have greatest influence

# *Observations and Conclusions*

- "Alteration" of smoking/non-smoking physical locations during tests complicates interpretation.
- Large fraction of some ETS markers below LOQ.
- ETS concentrations low: Median nicotine < 2 $\mu g/m^3$ Median 3-EP < 1 $\mu g/m^3$ Median SolPM < 10 $\mu g/m^3$.
- Patron perception of air quality was so good that it was deemed unnecessary to "improve" ventilation because an "improvement" was not likely to be detectable.
- Presence of wood smoke may "mask" other odors.