# Analysis of Greenhouse Gasses by GC/MS

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This work was a cooperative effort between Shimadzu Scientific Instruments and the Biological Systems Engineering Department at Virginia Tech.



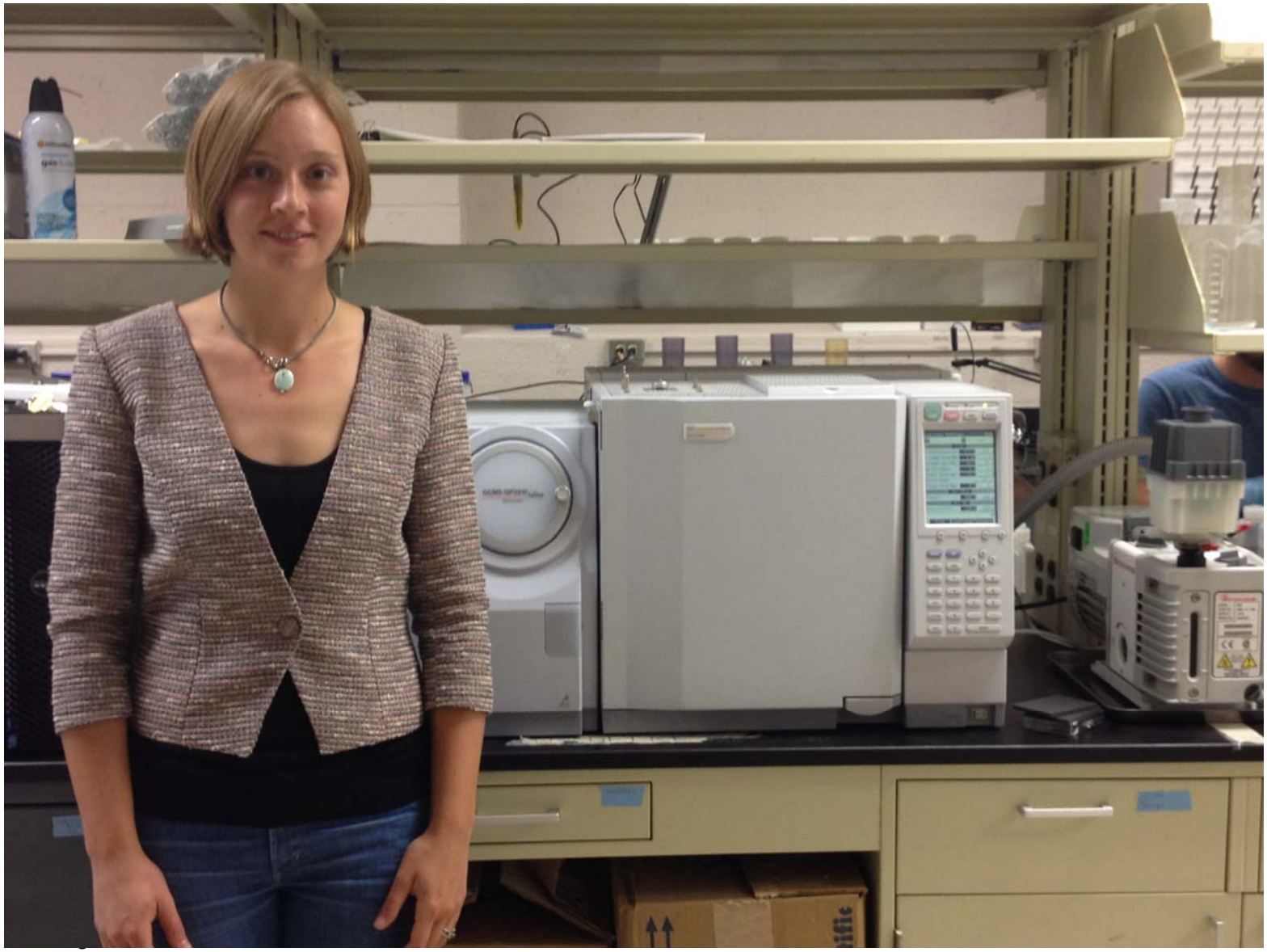

# Objective

- Develop a method that uses common laboratory instrumentation
- Existing instrumentation is dedicated to GHG analysis only
- Dedicated GHG analyzers are complex, multicolumn instruments
- Most modern labs are equipped with a GC/MS

# GHG Analyzer

SHIMADZU Virginia Tech Invent the Future Biological Systems Engineering Virginia WATER RESOURCES Research Center

# GC/MS QP-2010 Ultra at Virginia Tech



# GC Parameters

- Injection Port Temperature: 200 $^0$C
- GC Oven Program
  - Initial Temp: 100$^0$C
  - Initial Hold: 0 min
  - Program Rate 35$^0$C/min
  - Final Temp: 180$^0$C
  - Post Run Temp: 240$^0$C for 1 min
  - Carrier Gas: Helium
  - Linear Velocity: 45 cm/sec
  - Flow Mode: Constant Linear Velocity
  - Split Ratio: 5
  - Injection Volume: 1 mL
  - Column: 60m Carboxen® 1010 PLOT (Supelco) 0.32 mm id

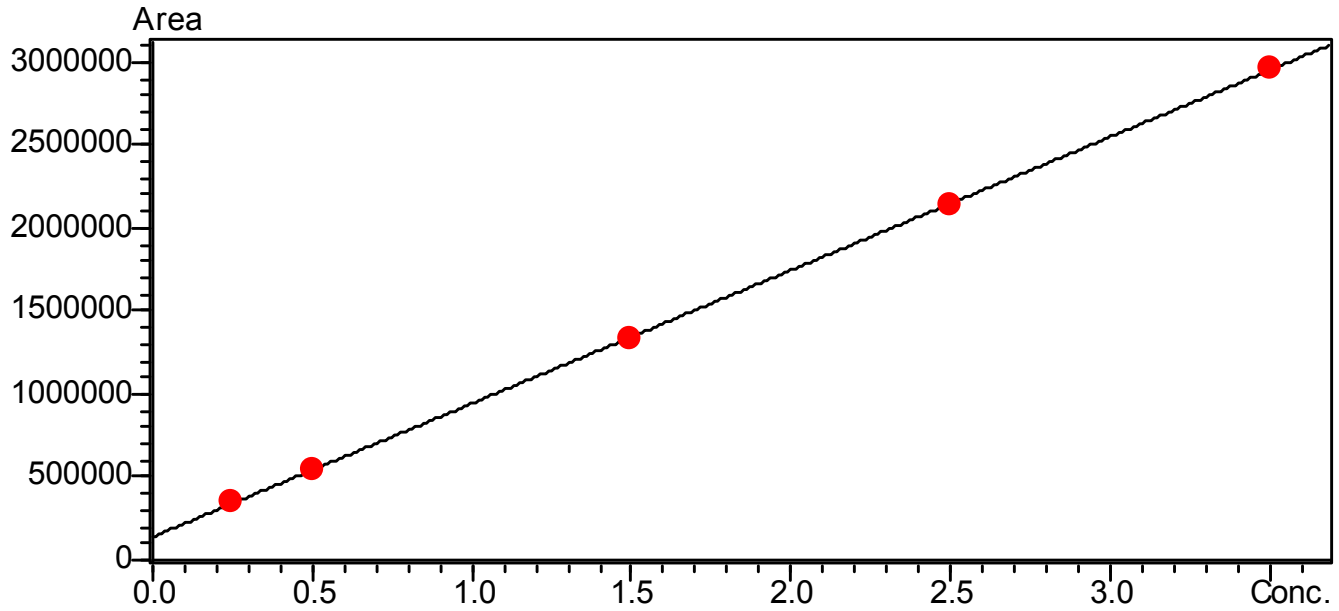
# MS Parameters

- MS Interface Temperature 220$^0$C
- MS Source Temperature 200$^0$C
- Electron Multiplier Voltage:
  - $CH_4$: 1.25 kV
  - $CO_2$: 0.85 kV
  - $N_2O$: 1.25 kV
- Scan Parameters
  - $CH_4$: SIM for m/z 16 and m/z 15;  Quant from m/z 16
  - $CO_2$: Scan from 15 to 50 AMU;  Quant from m/z 44
  - $N_2O$: SIM for m/z 30 and m/z 44; Quant from m/z 30

# $CH_4$ Calibration Curve

$R^2 = 0.9999$

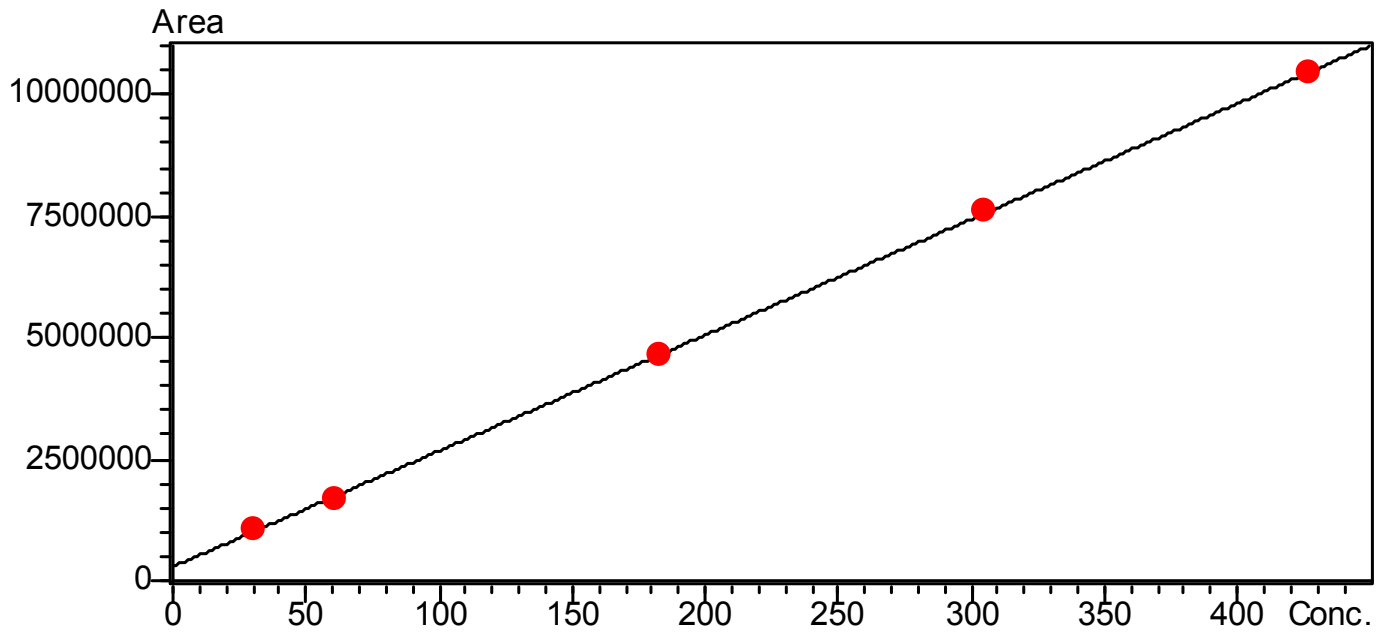
$R = 0.9999$



# $CO_2$ Calibration Curve

$R^2 = 0.9999$

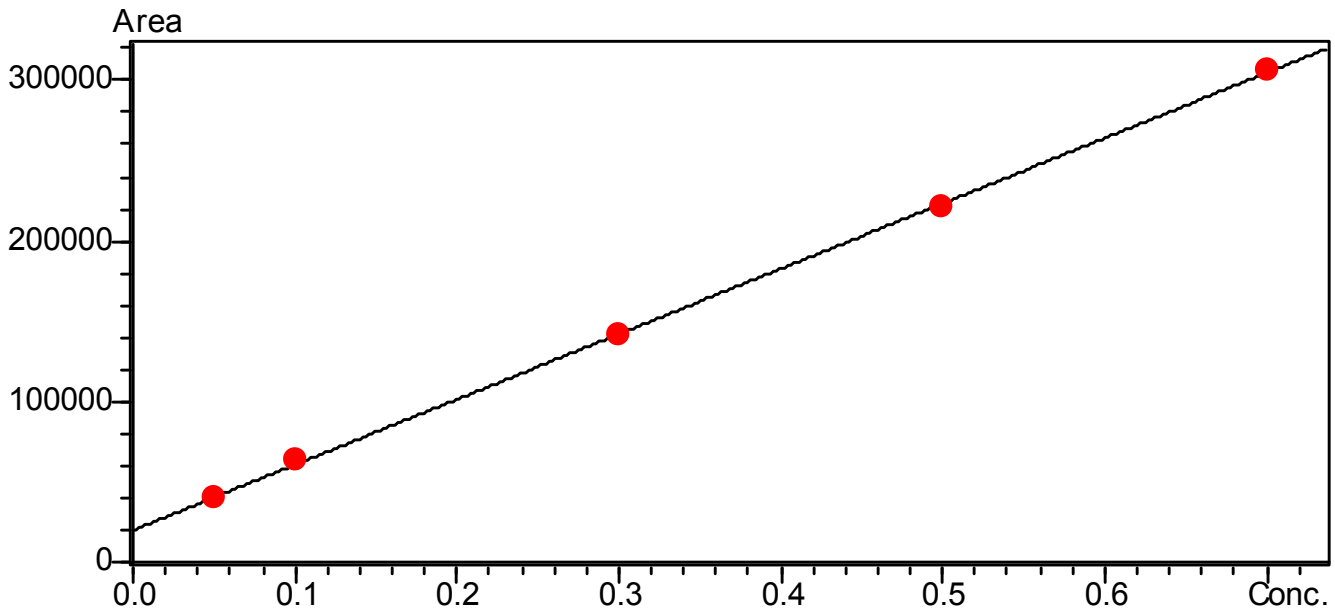
$R = 0.9999$



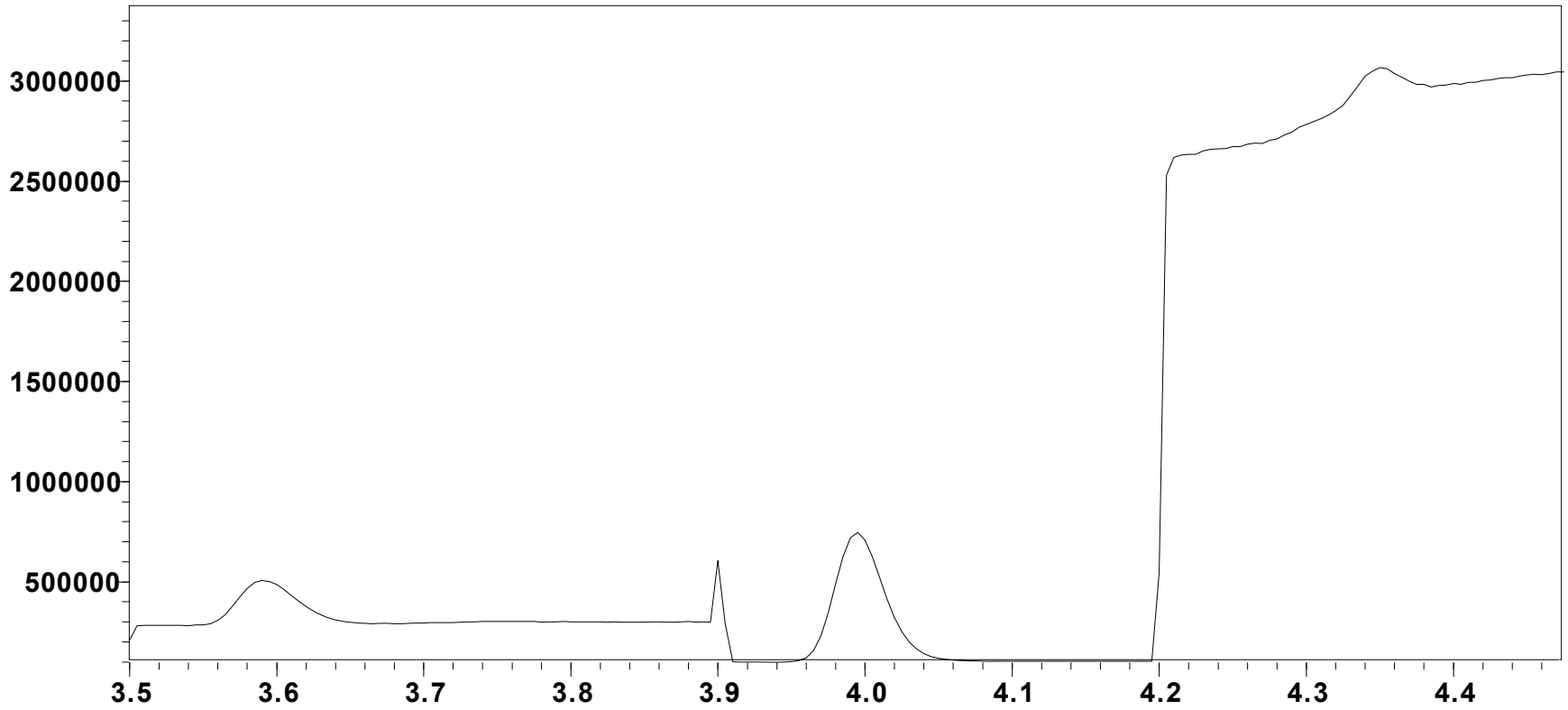
# $N_2O$ Calibration Curve

$R^2 = 0.9996$

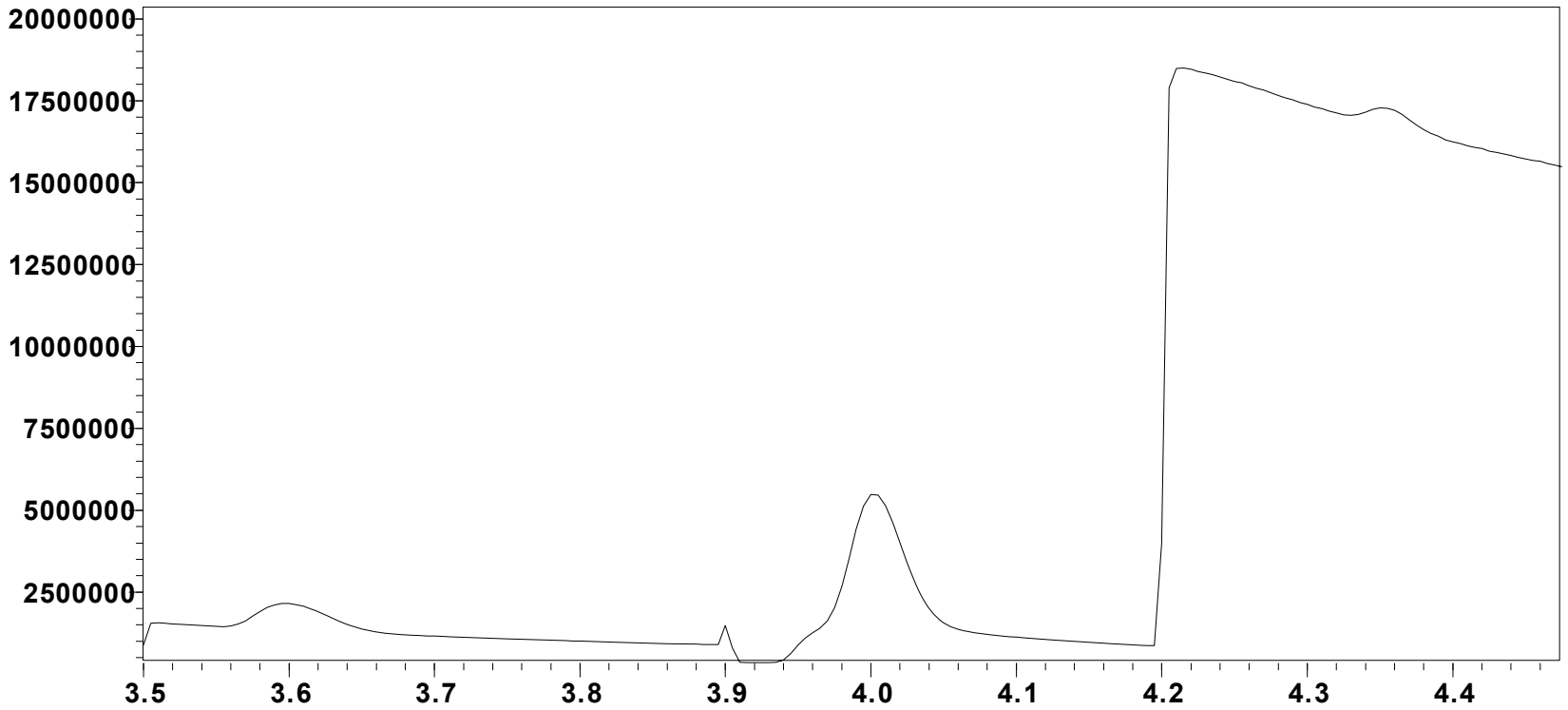
$R = 0.9998$



# GC/MS Chromatogram of GHG Standard



# GC/MS Chromatogram of Outside Air



# Method Detection Limits

Calculated per 40 CFR Part 136 Appendix B

Methane MDL = 0.05 ppmv

Nitrous Oxide MDL = 0.02 ppmv

# Environmental Samples

| Ambient Air Results Sample 1 | | | Ambient Air Results Sample 2 | | |
|---|---|---|---|---|---|
| Methane | 1.6 | ppmv | Methane | 1.6 | ppmv |
| Carbon Dioxide | 397 | ppmv | Carbon Dioxide | 394 | ppmv |
| Nitrous Oxide | 0.27 | ppmv | Nitrous Oxide | 0.30 | ppmv |

Air samples were taken on the campus of Virginia Tech in the Ag Quad

# Acknowledgments


- 40 CFR Part 136 Appendix B
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- Thanks to Jeffery Parish of Shimadzu Scientific Instruments, Inc. for providing a viable manual injection technique.
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