



MISSOURI
DEPARTMENT OF
NATURAL RESOURCES

NO₂ Measurement

*A Comparison of Direct vs. Traditional
methods at a Near-Roadway Site*

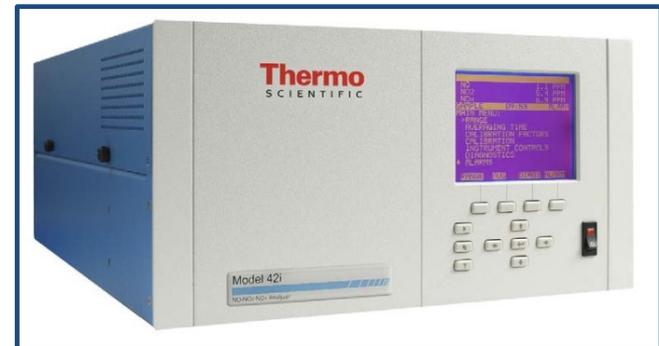
Presented by
Dustin Kuebler

Prepared by
Satchel Gaddie

*Missouri Dept. of Natural Resources
Environmental Service Program
Air Quality Monitoring Section*



- **Teledyne API T500U
CAPS NO₂ Analyzer**
 - Cavity Attenuated Phase Shift (CAPS)
- **Teledyne API T200-UP
Ultra-Sensitive
Photolytic NO-NO₂
Analyzer**
 - Photolytic converter
- **Thermo Scientific™
42i NO-NO₂-NO_x
Analyzer**
 - Moly converter





Thermo Scientific™ 42i NO-NO₂-NO_x Analyzer

- Designated Reference Method Number: (**RFNA-1289-074**)
 - Nitric oxide (NO) and Ozone (O₃) react to produce a characteristic luminescence
 - Moly converter heated to about 325 °C
 - Solenoid cycles every 10 seconds between the reaction chamber (NO mode) or through the NO₂ converter and then to the reaction chamber (NO_x mode)

Zero Drift: < 0.40 ppb/24hrs

Zero Noise: 0.2 ppb



Teledyne API T200-UP Ultra-Sensitive Photolytic NO-NO₂ Analyzer

- US EPA Approval for Federal Equivalent Method
(EQNA-0512-200)
 - Includes a UV based photolytic converter that allows for selective conversion of NO₂ with negligible interference from other gases (HNO₃, PAN, etc.)
 - Teflon cell with reflective properties that increase the overall conversion efficiency

Zero Drift: < 0.1 ppb/24 hrs

Zero Noise: < 25 ppt



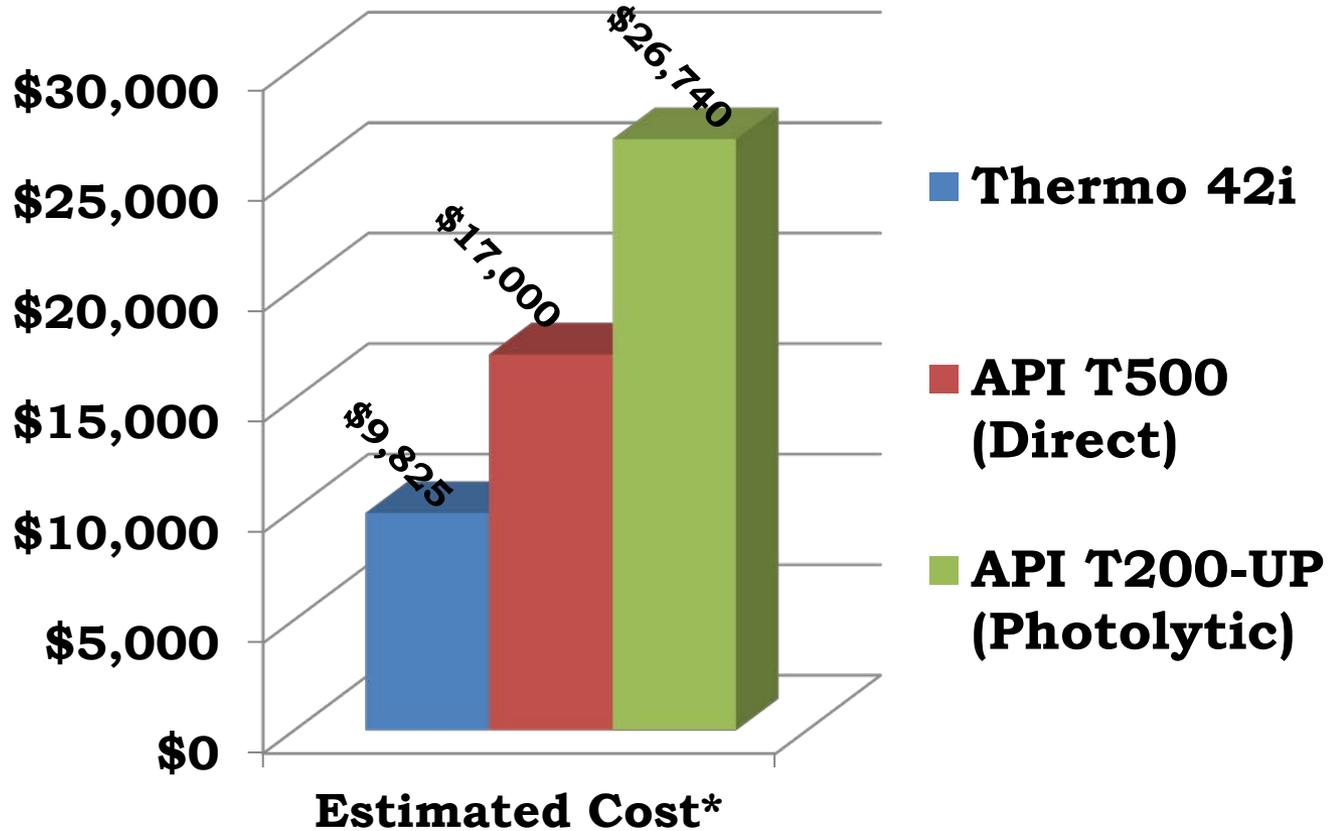
Teledyne API T500U CAPS NO₂ Analyzer

- US EPA Approval for Federal Equivalent Method (**EQNA-0514-212**)
 - Cavity attenuated phase shift (CAPS) spectroscopy
 - No molybdenum converter
 - Blue Ultraviolet LED centered at 450 nm, a prominent absorption band for NO₂
 - Beer's Law: Absorbance (A) = Molar absorptivity (e) * Mean path Length (l) * Concentration (c)

Zero Drift: < 0.1 ppb / 24 hrs

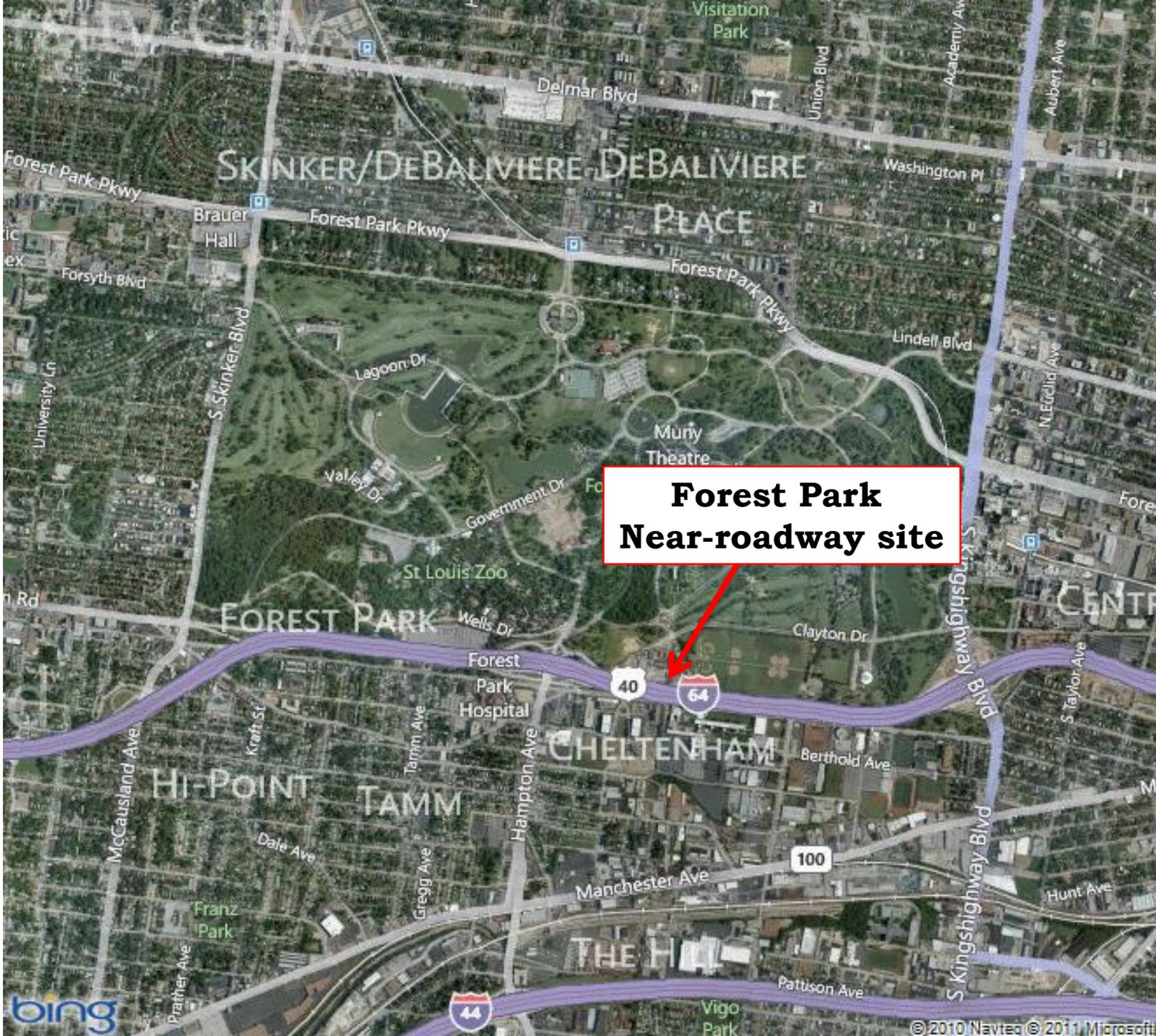
Zero Noise: < 20 ppt

- Equipment Cost**



***Based on estimates obtained by AQMS staff**

**Forest Park
Near-roadway site**





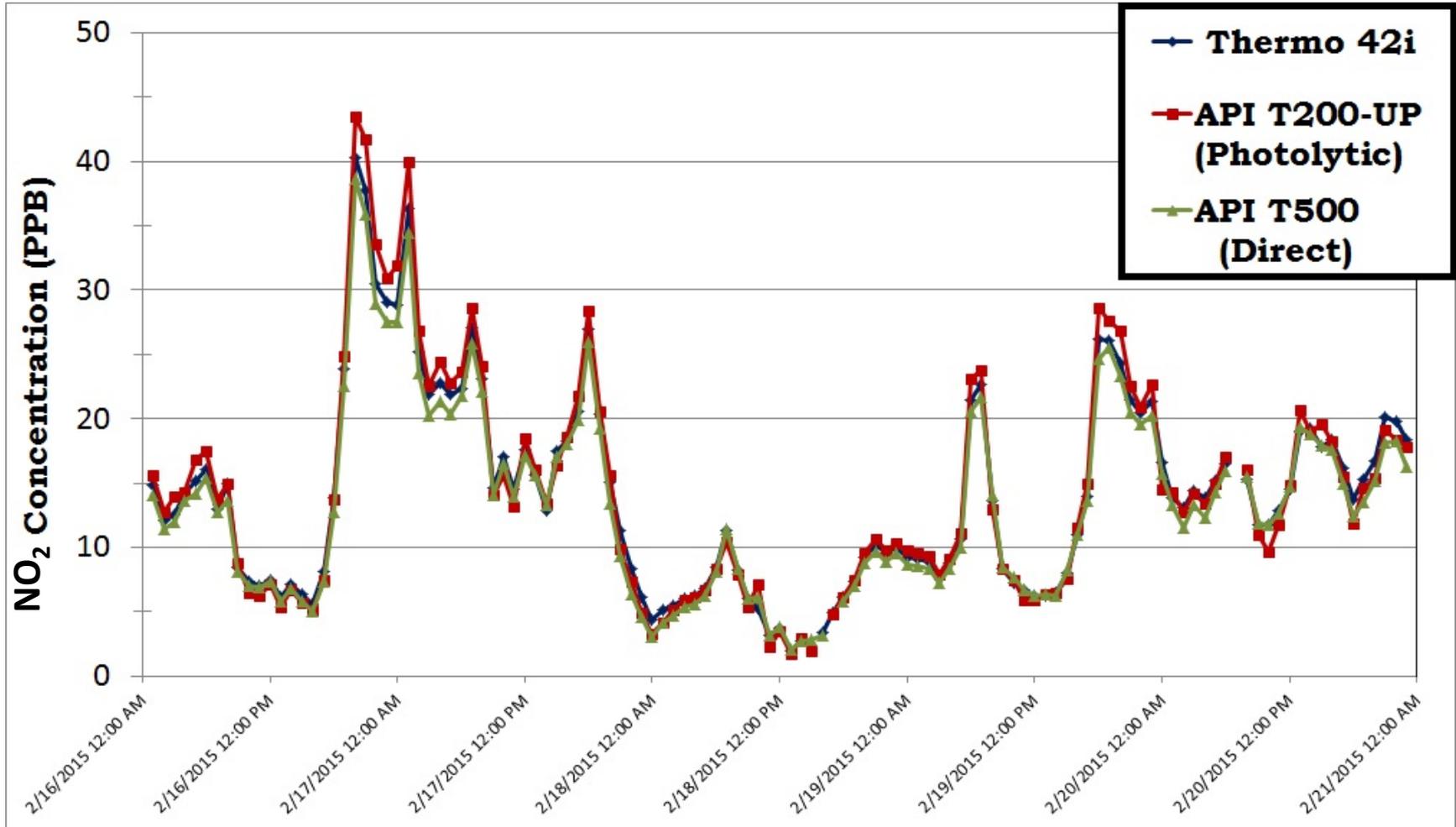
Forest Park

Near-roadway air monitoring site

- 2010 US40/I64 traffic counts
 - 173,236 AADT
 - 391,513 adjusted AADT (14% trucks)
- Air sample inlet is 24 meters from edge of nearest traffic lane

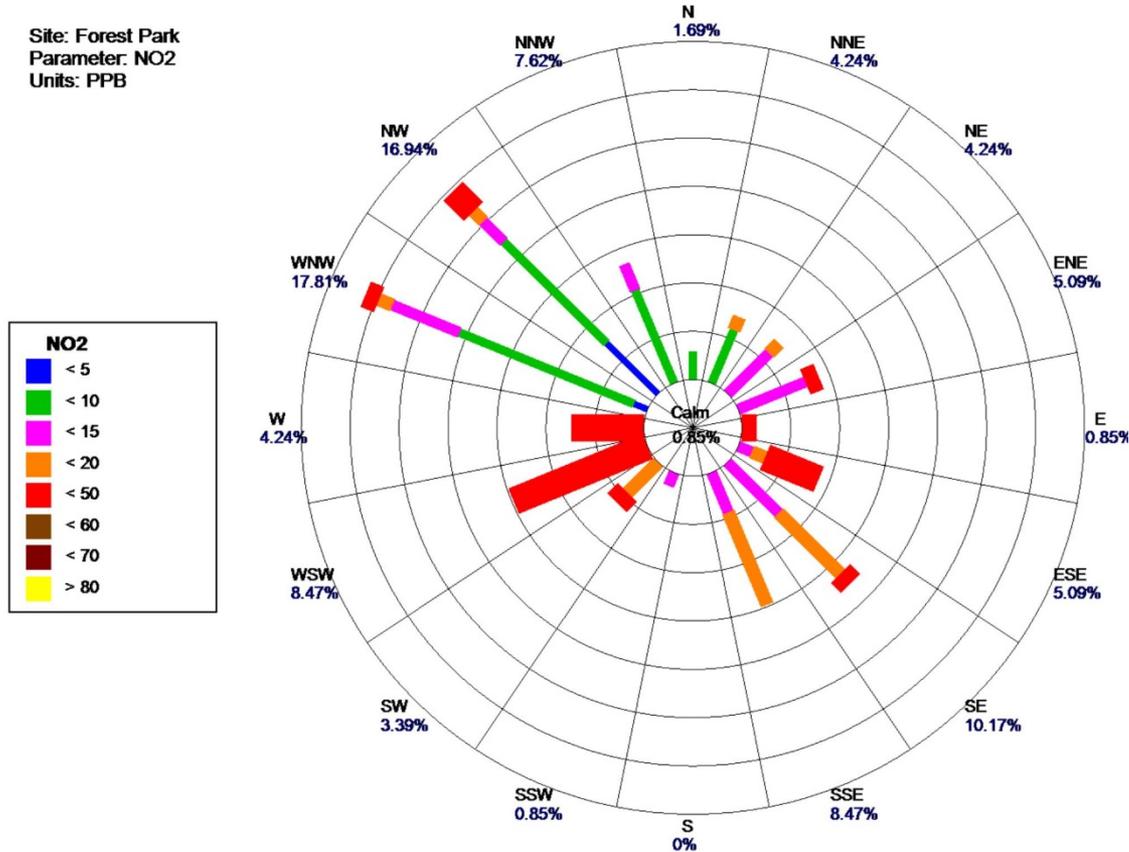


Preliminary Data – Feb 16th to 20th (1hr)



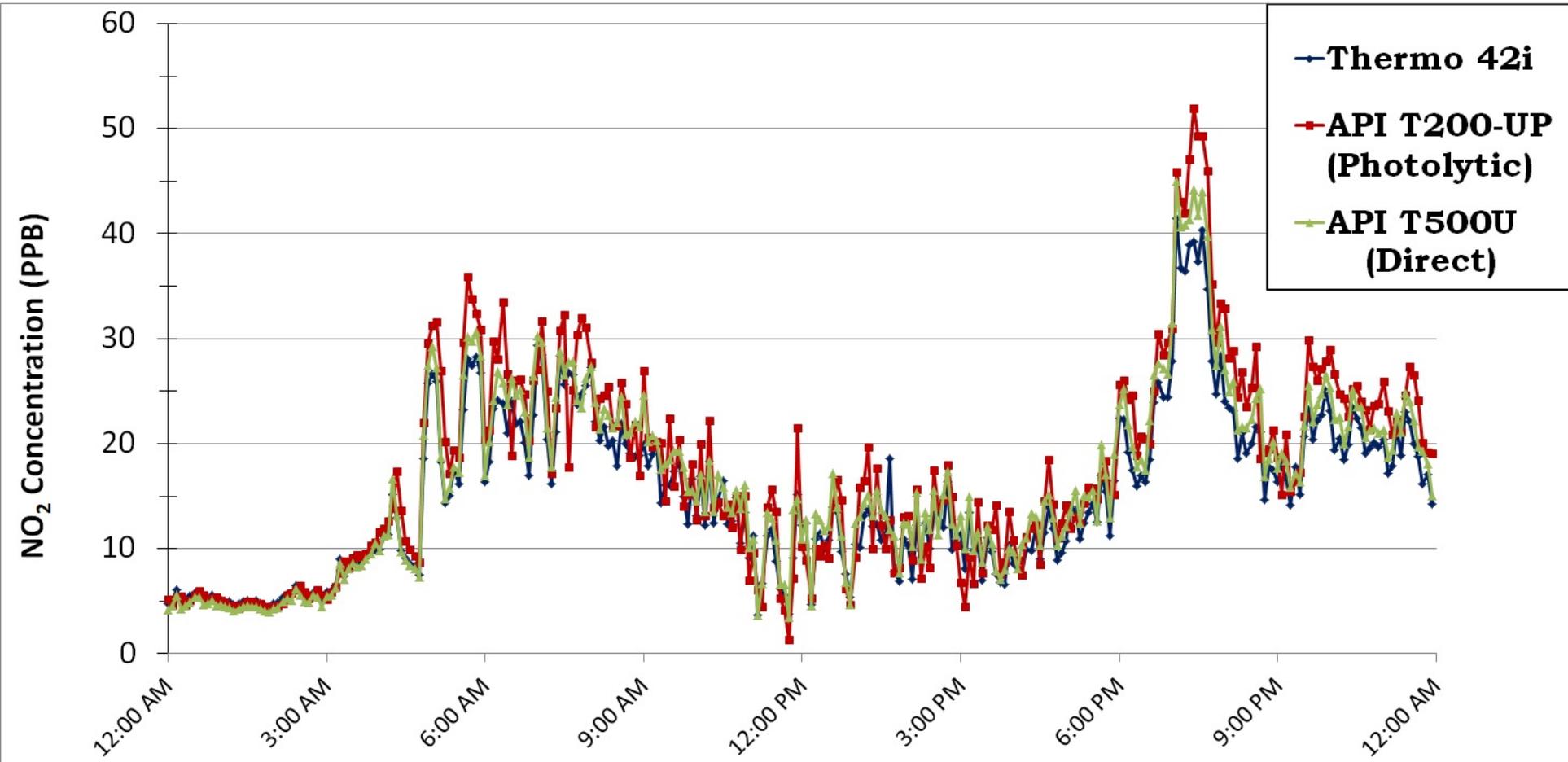
Preliminary Data – Feb 16th to 20th (1hr)

Site: Forest Park
Parameter: NO2
Units: PPB



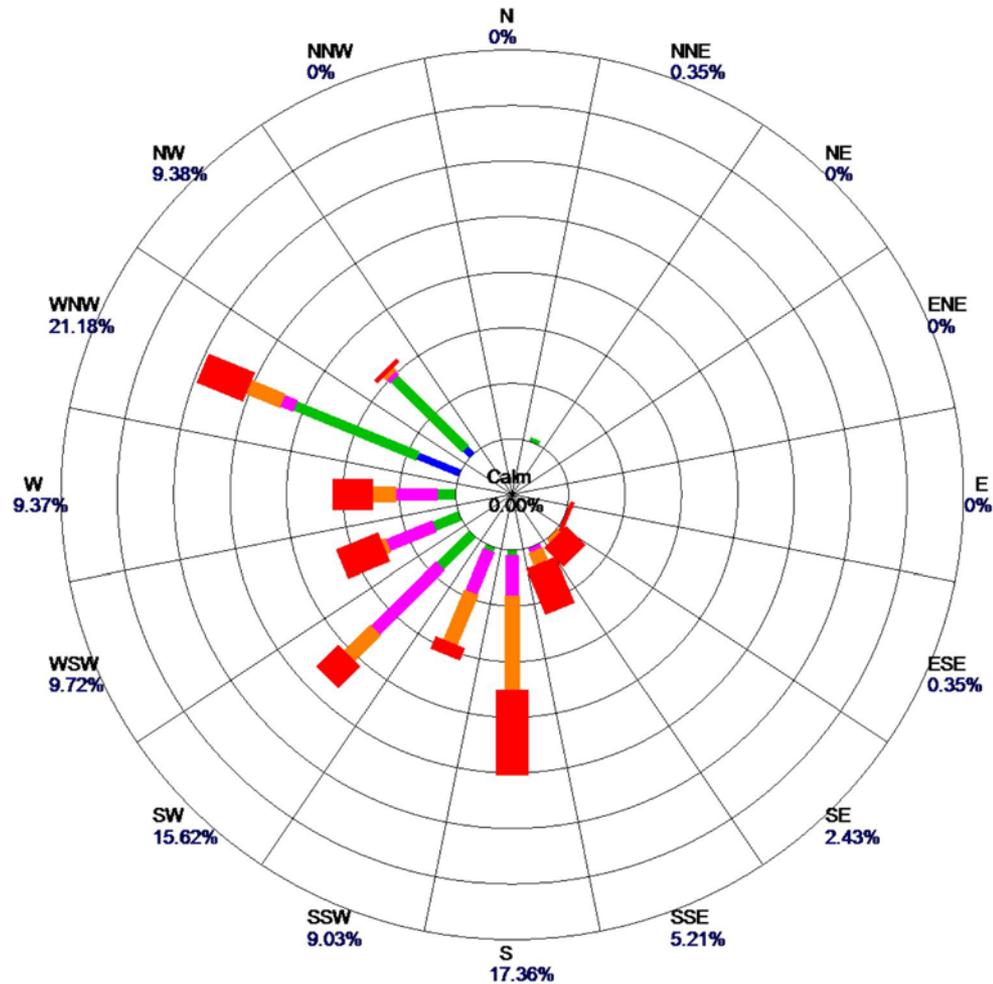
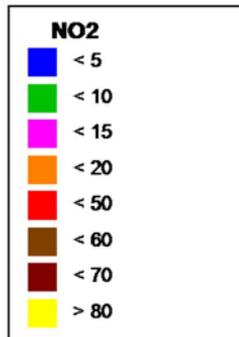
Period: 2/16/2015-2/20/2015

Preliminary Data – March 30th (5 min)

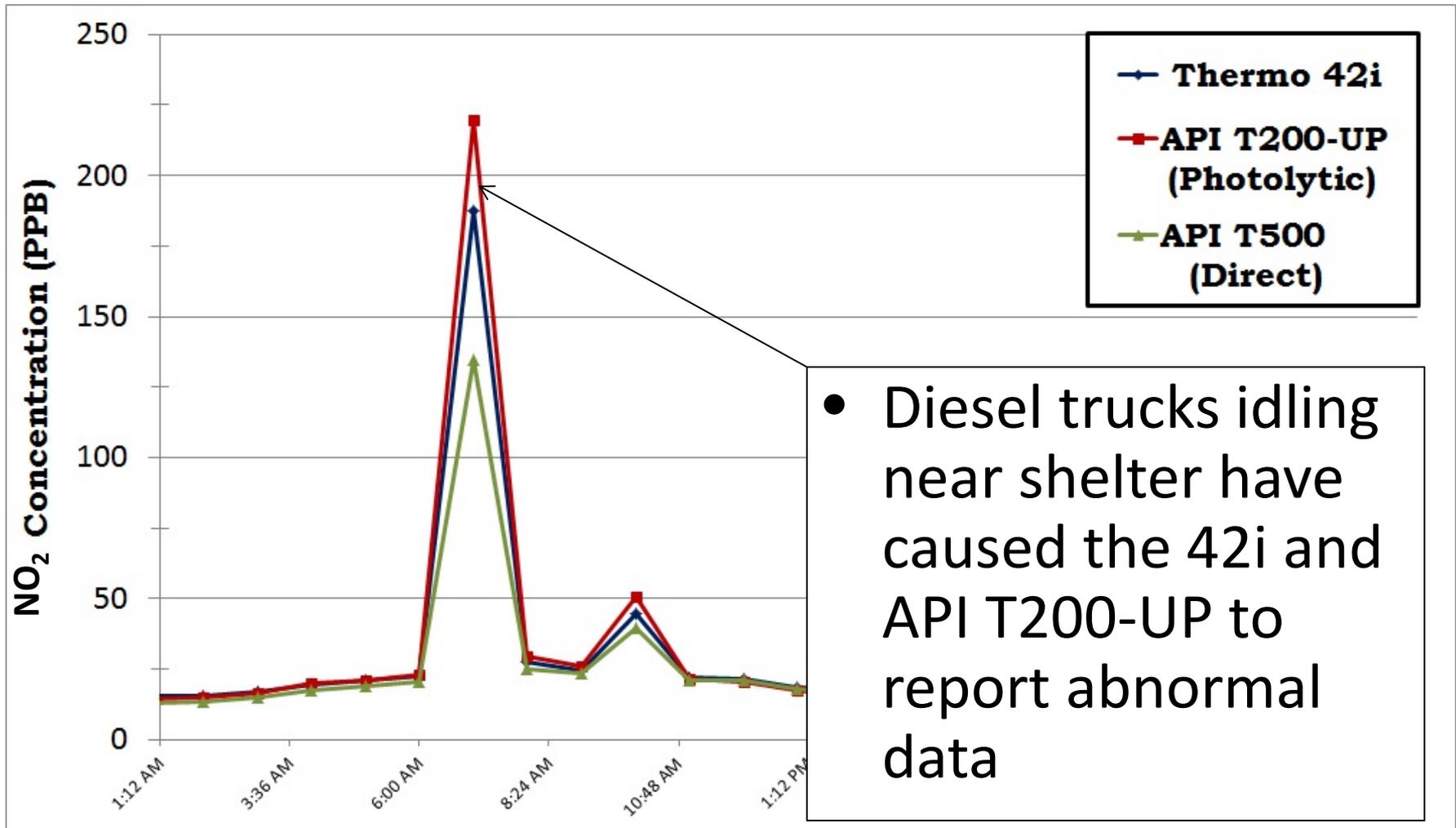


Preliminary Data – March 30th (5 min)

Site: Forest Park
Parameter: NO2
Units: PPB

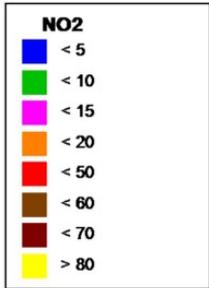
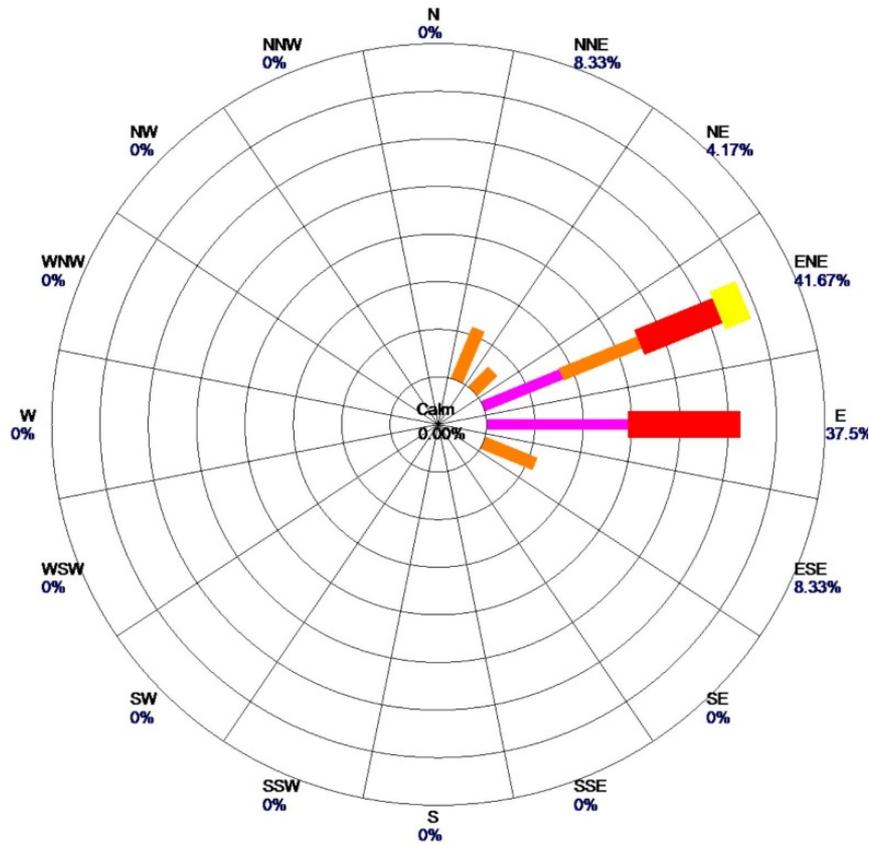


Performance during exhaust interference – March 12th



Interferences

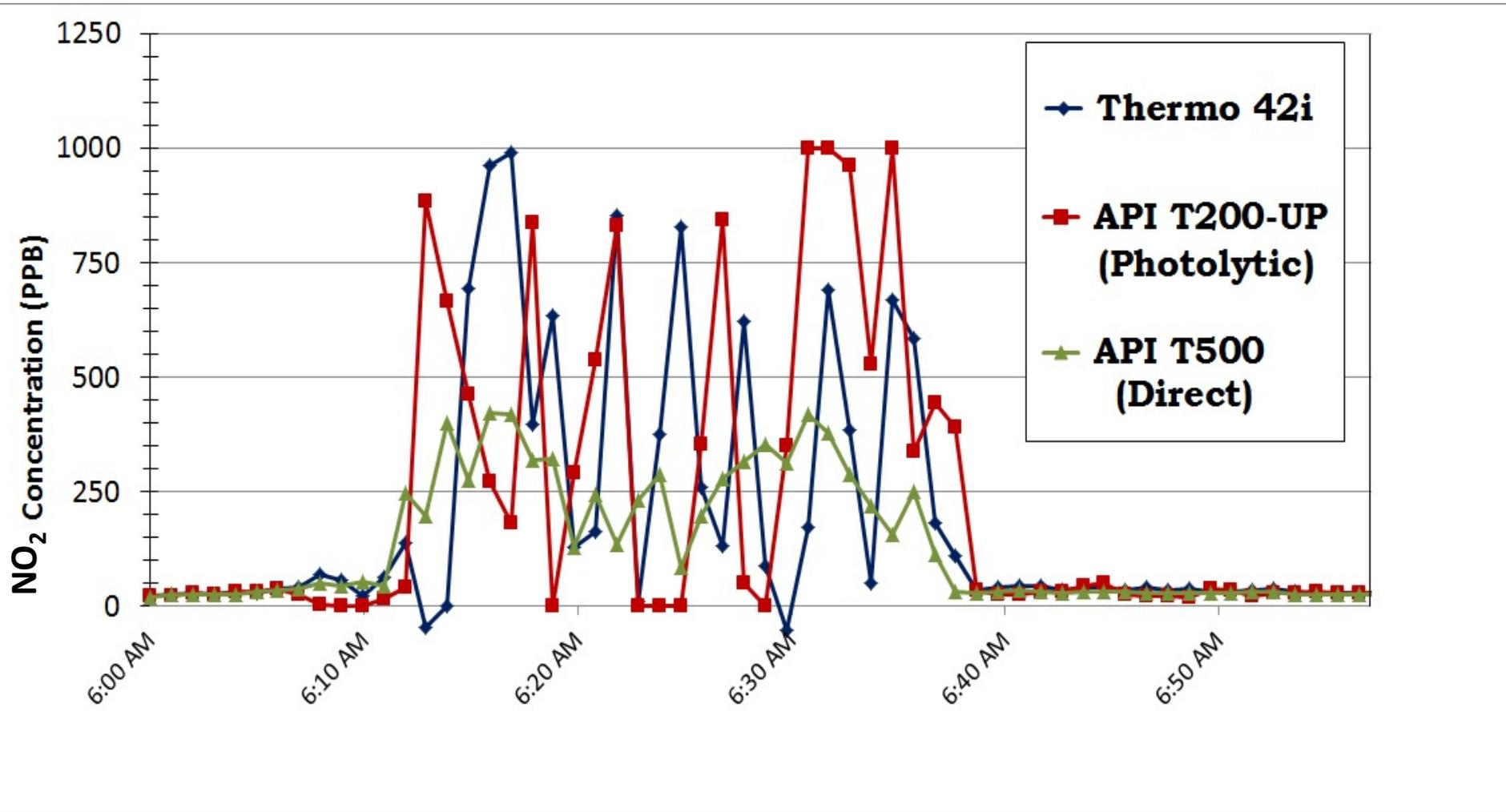
Site: Forest Park
Parameter: NO2
Units: PPB



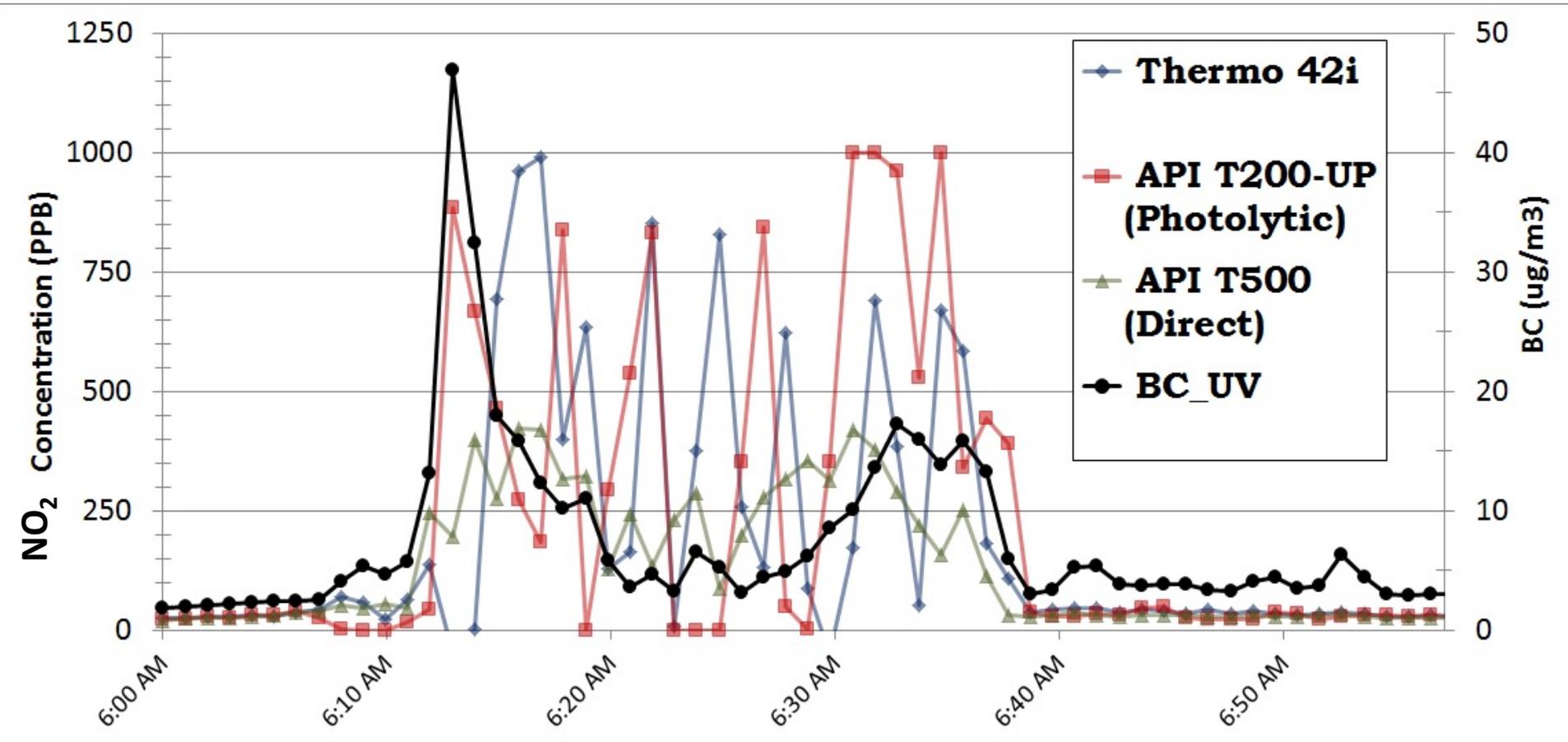
Period: 3/12/2015-3/12/2015



Idling episode – 1 minute data



Idling episode – 1 minute data

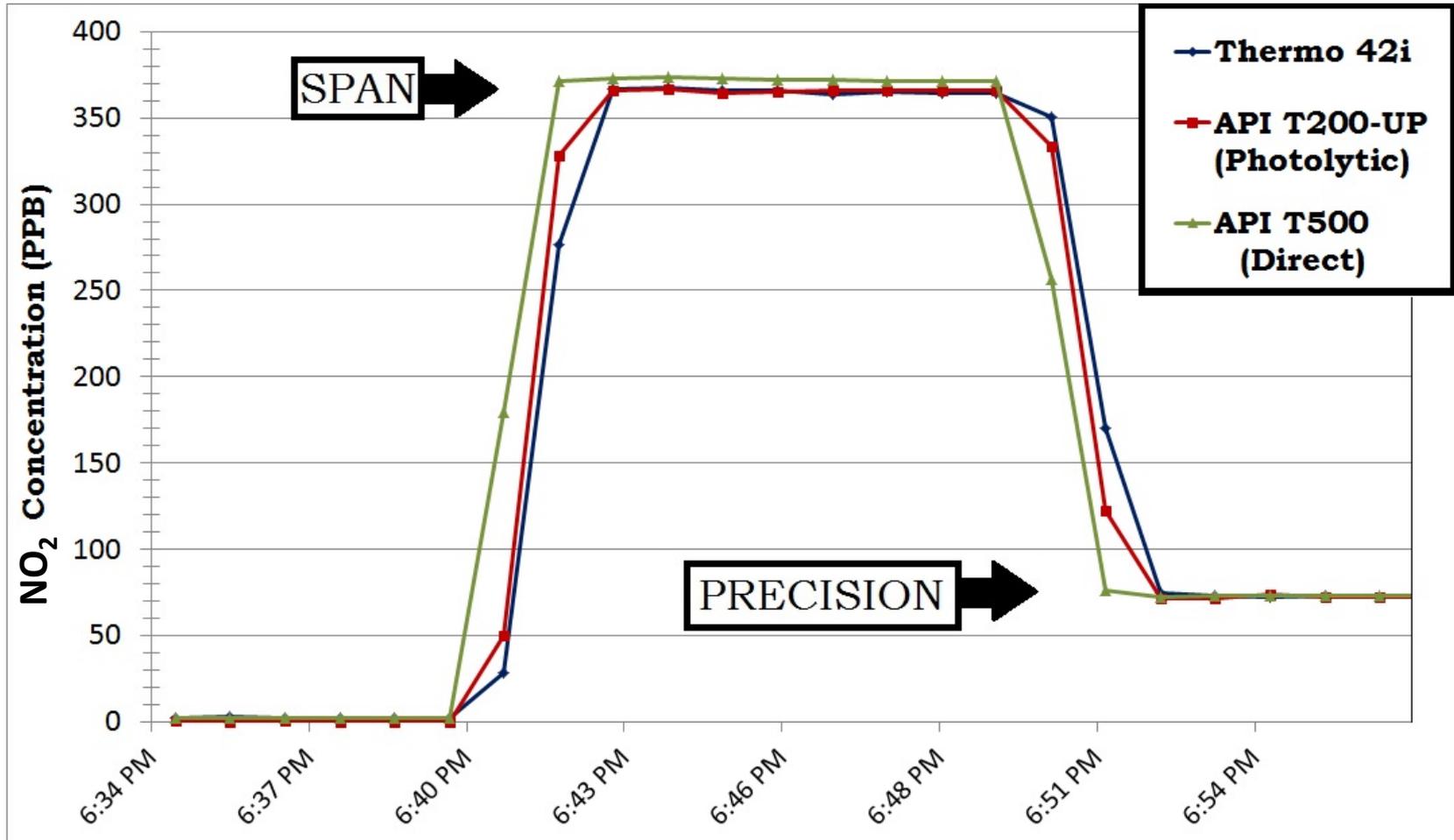


Teledyne API T500U (Direct) Potential Benefits

- **Direct NO₂ measurement**
 - no converter or scrubbers
- **No known ambient air interferences**
- **Fast response and low maintenance**



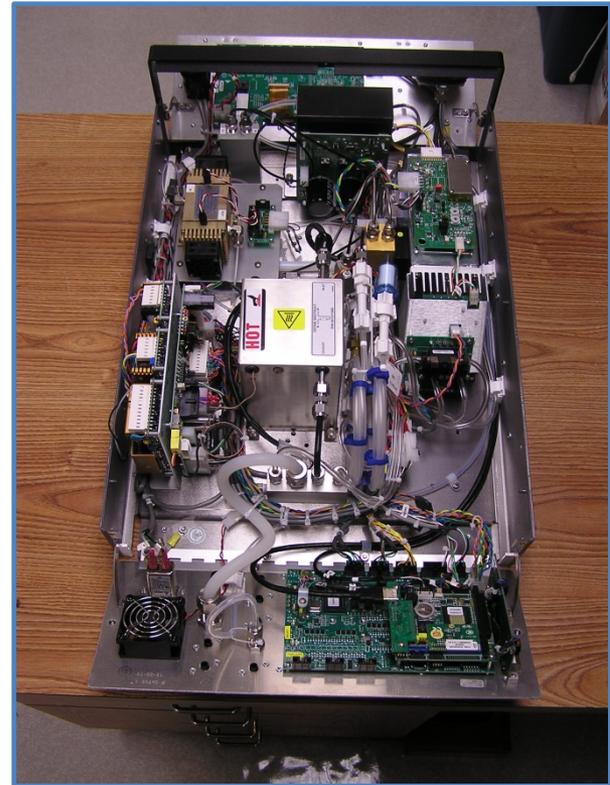
Response Time (1 min data) – Gas-Phase Titration



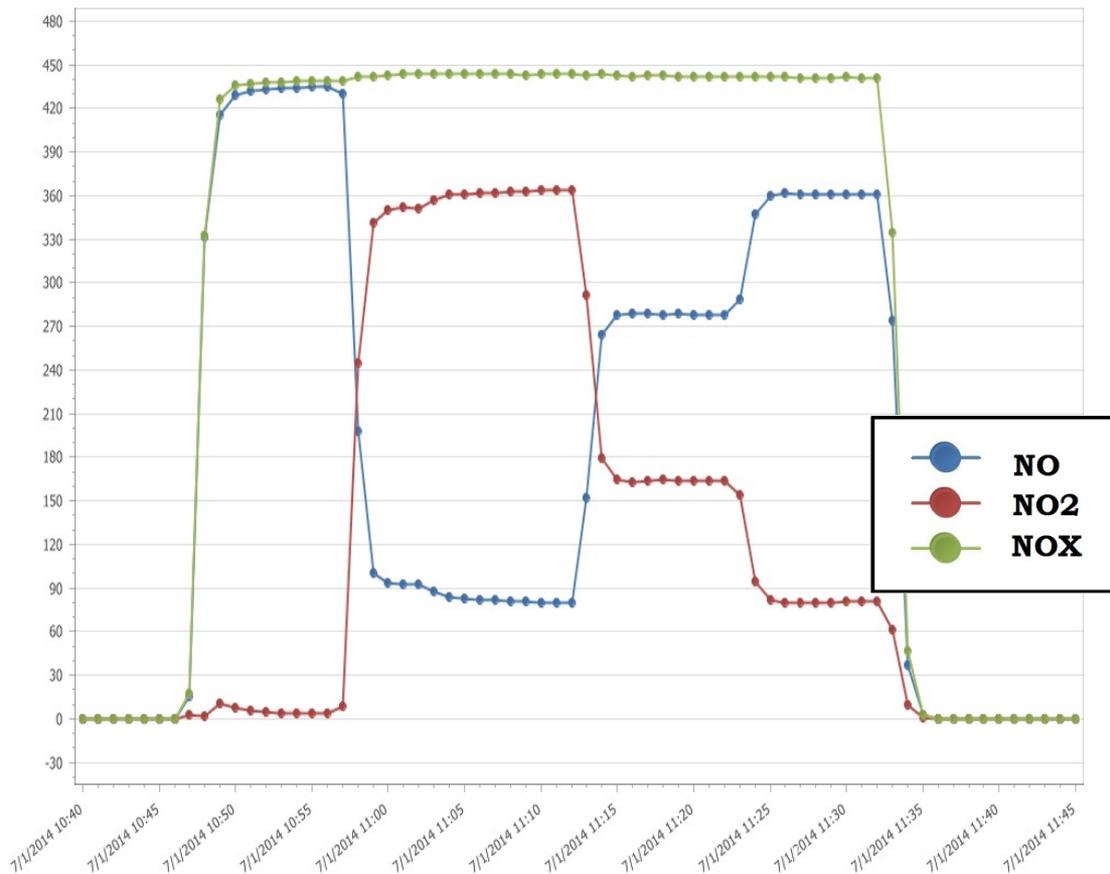
Teledyne API T500U (Direct)

Potential Benefits

- Reduced Maintenance
 - **Once a year:** Change filter
 - **Every 3 years:** Replace internal pump
 - **As needed:** Clean optical mirrors



Teledyne API T500U (Direct)



Disadvantages

- Analyzer calibration
 - Gas-Phase Titration with T200-UP or 42i
 - NO₂ gas cylinder
 - Known instability issues

References:

- (1) Thermo Model 42i Chemiluminescence NO-NO₂-NO_x Analyzer Instruction Manual. Part Number 101350-00. 2007. Thermo Fisher Scientific Inc.
- (2) Teledyne API Model T500U CAPS NO₂ Analyzer Instruction Manual. 2014. Teledyne Advanced Pollution Instrumentation.
- (3) Teledyne API Model T200UP Ultra-Sensitive Photolytic NO-NO₂ Analyzer Instruction Manual. 2012. Teledyne Advanced Pollution Instrumentation.