Operating Experience with a Near-Real-Time Ambient Airborne Metals Instrument System (Cooper Environmental Systems Xact 620)

National Ambient Air Monitoring Conference, Nashville, Tennessee

November 2-5, 2009

Missouri Department of Natural Resources, Air Pollution Control Program and Environmental Services Program

Washington University, St. Louis

U. S. EPA

Introduction

- **The St. Louis Community Air Project (CAP) and the Blair St. National Air Toxics Trends Station (NATTS) have measured elevated concentrations of airborne arsenic in St. Louis.**
- **Missouri DNR and Washington University obtained a Community-Scale Air Toxics grant from EPA to better determine sources of arsenic and other species in St. Louis.**
- **A Cooper Xact 620 was purchased on this grant and operated at multiple sites.**

Project Plan

- **Phase I. Spatially and Temporally Enhanced 24-hour Integrated Measurements**
  - 1-in-3 day PM10 sampling and metals analysis by ICPMS at 4 sites in the St. Louis area for 1 year (MDL~0.02-0.03 ng/m3, 24-hr samples)
- **Phase II. High Time Resolution Measurements**
  - Time-resolved near-real-time analysis at six sites in the St. Louis area for 1 month at each site (MDL<0.1 ng/m3, possibly as low as 0.01 ng/m3, 2-hr samples)
- **Data Analysis and Reporting**
  - Source apportionment, source identification, model comparisons

Cooper Environmental Services
Xact 620 Ambient Air Toxic Metals Monitor

PM10 size-selective inlet

Temperature controlled cabinet

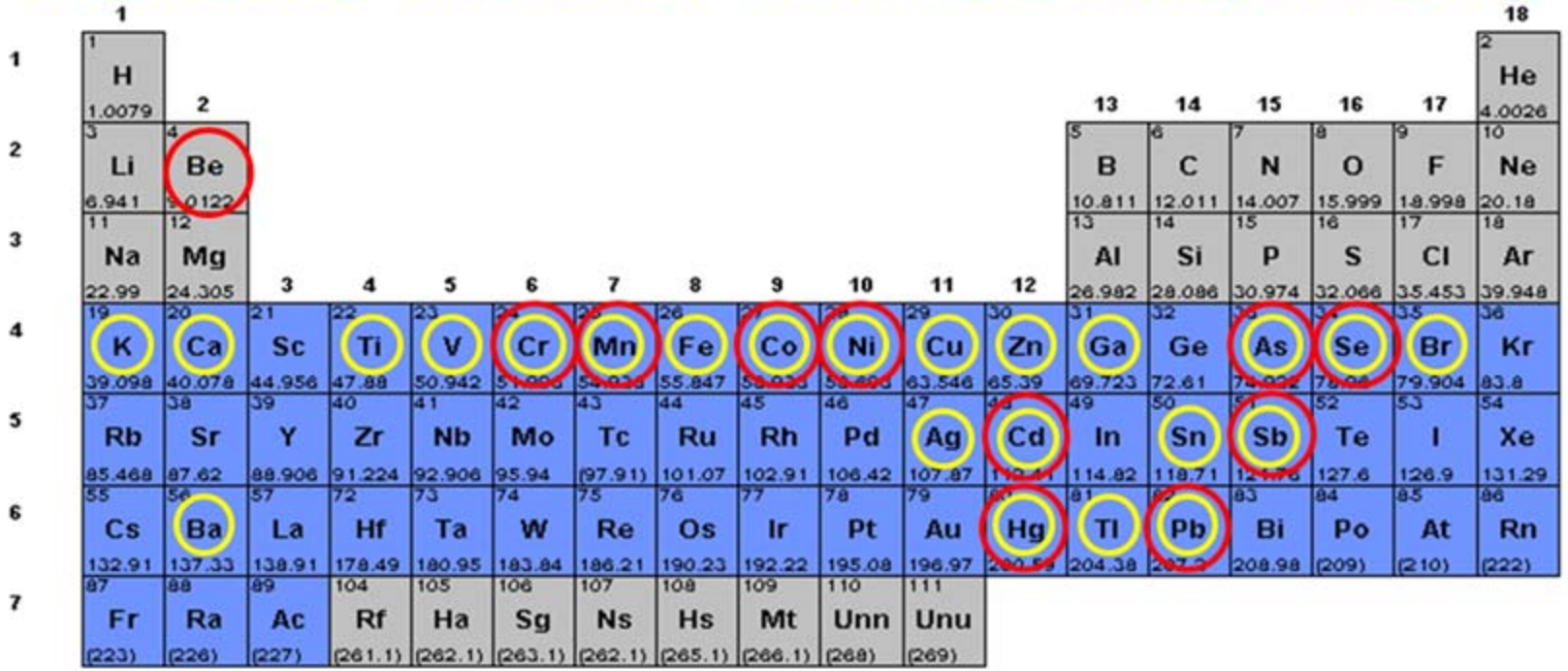
Heater

Sampling & Analysis Module

Operator interface/control panel

Flow control module

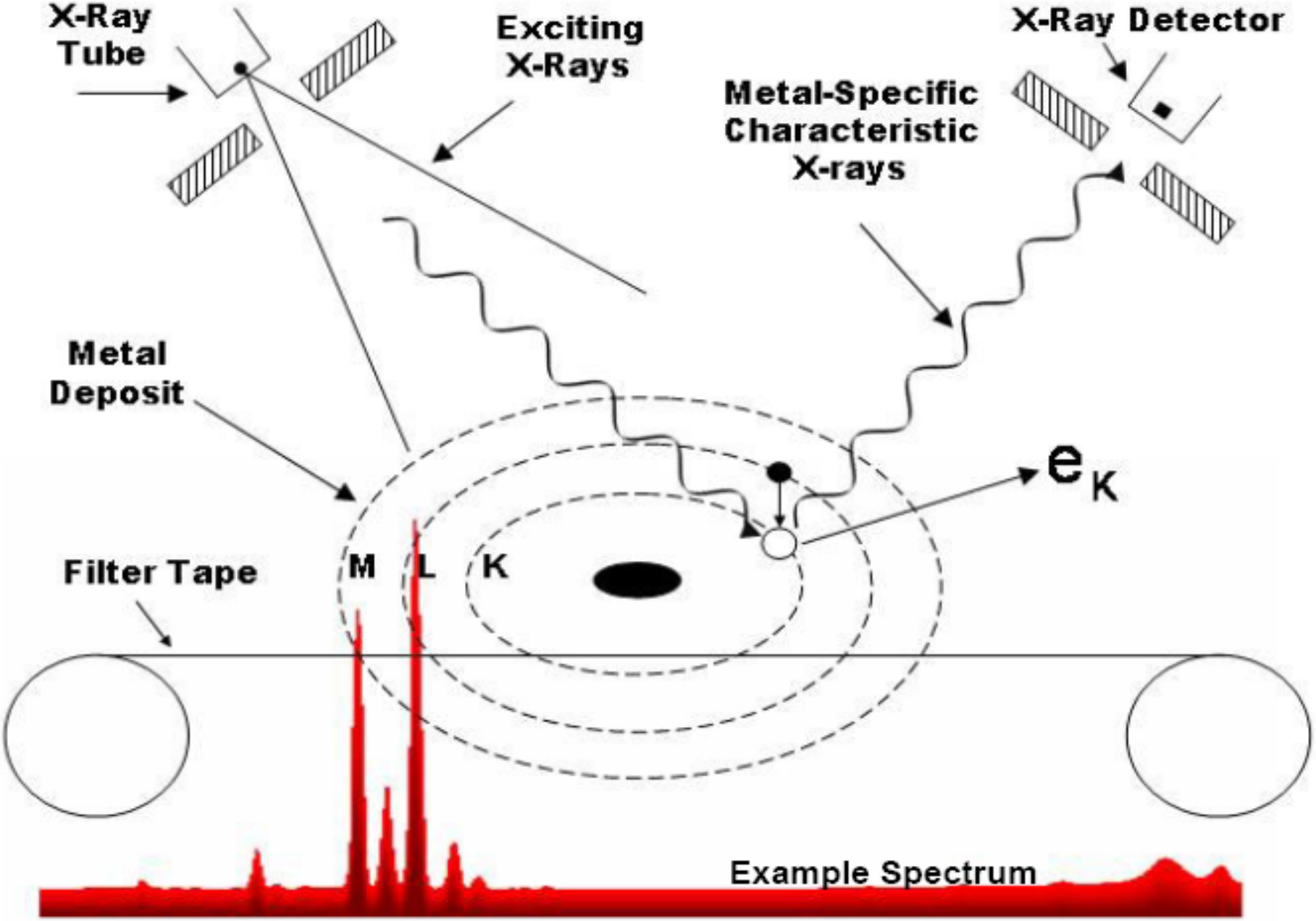
ELEMENTS THE XACT CAN MEASURE (IN BLUE)



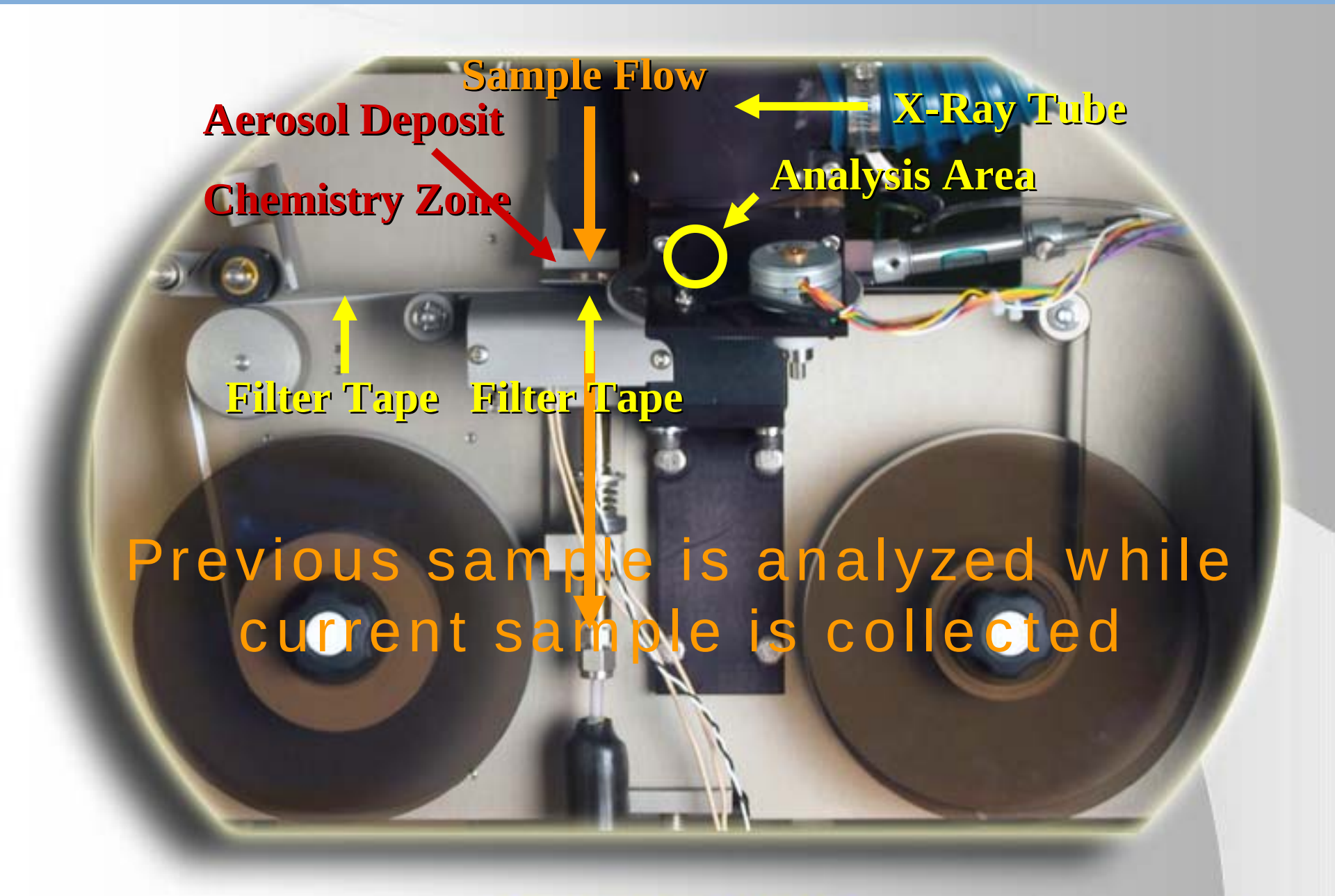
measured by Xact in this study

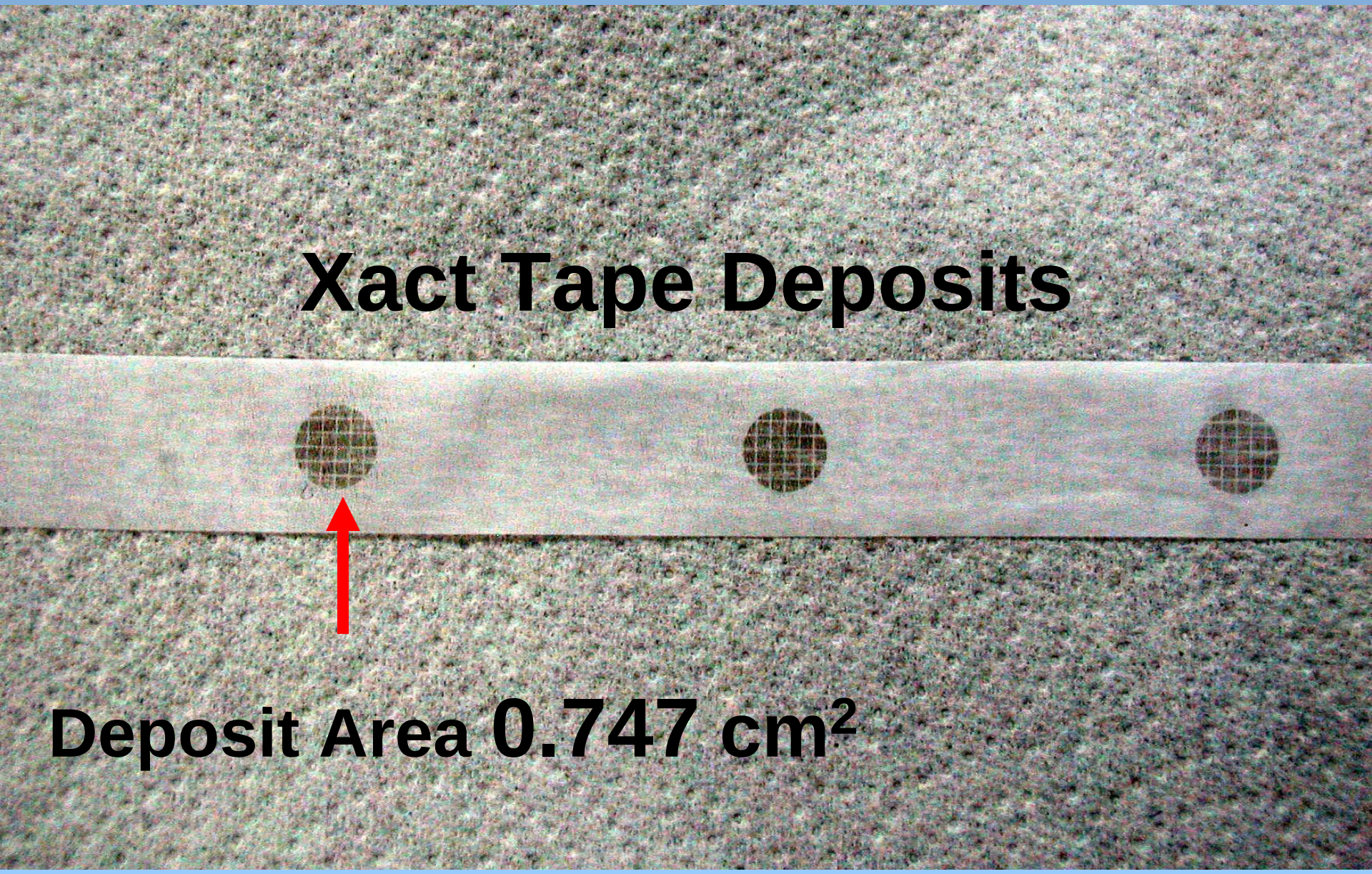
EPA Air Toxics PM metals

DIAGRAM OF X-RAY FLUORESCENCE TECHNOLOGY

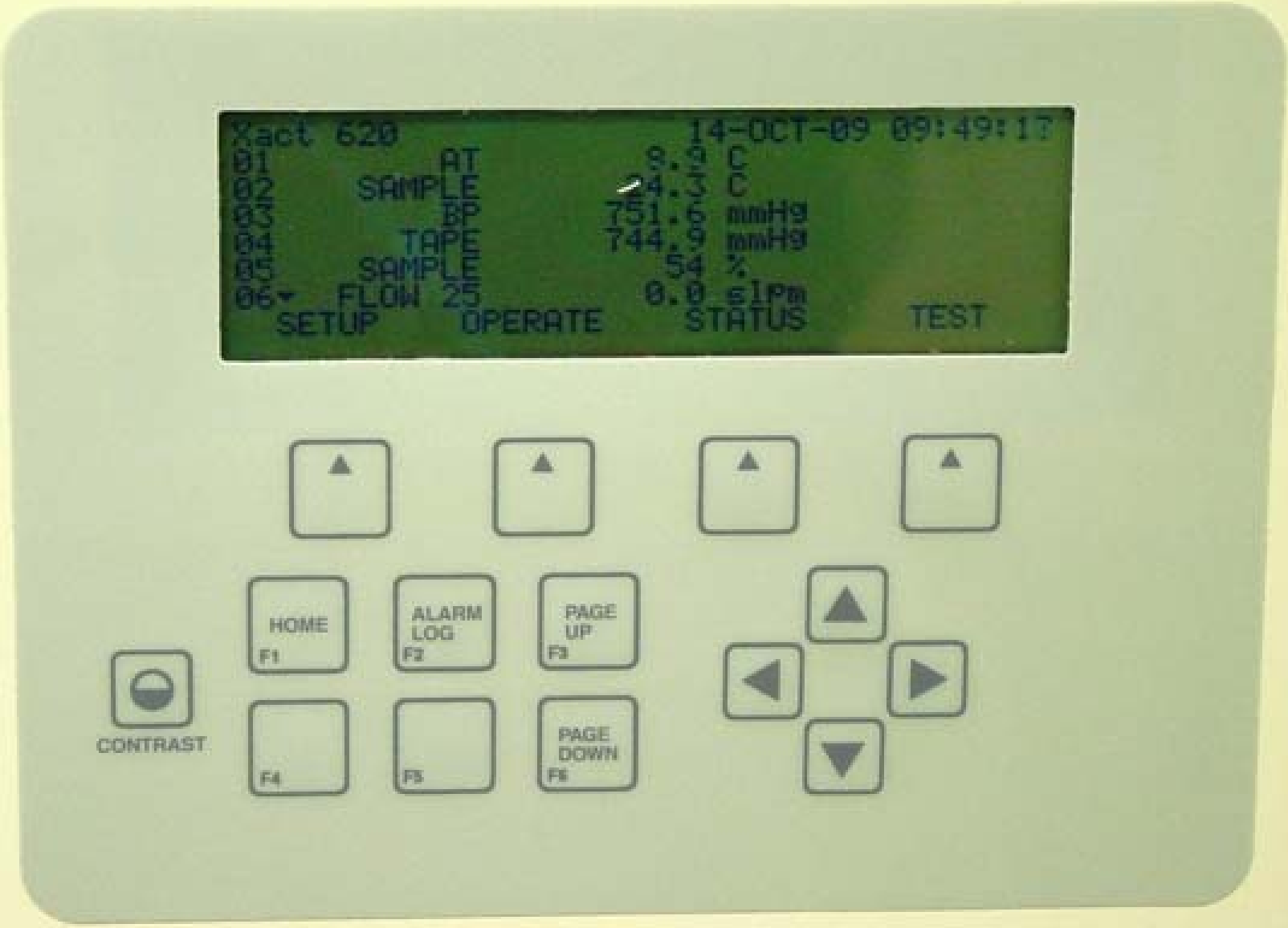


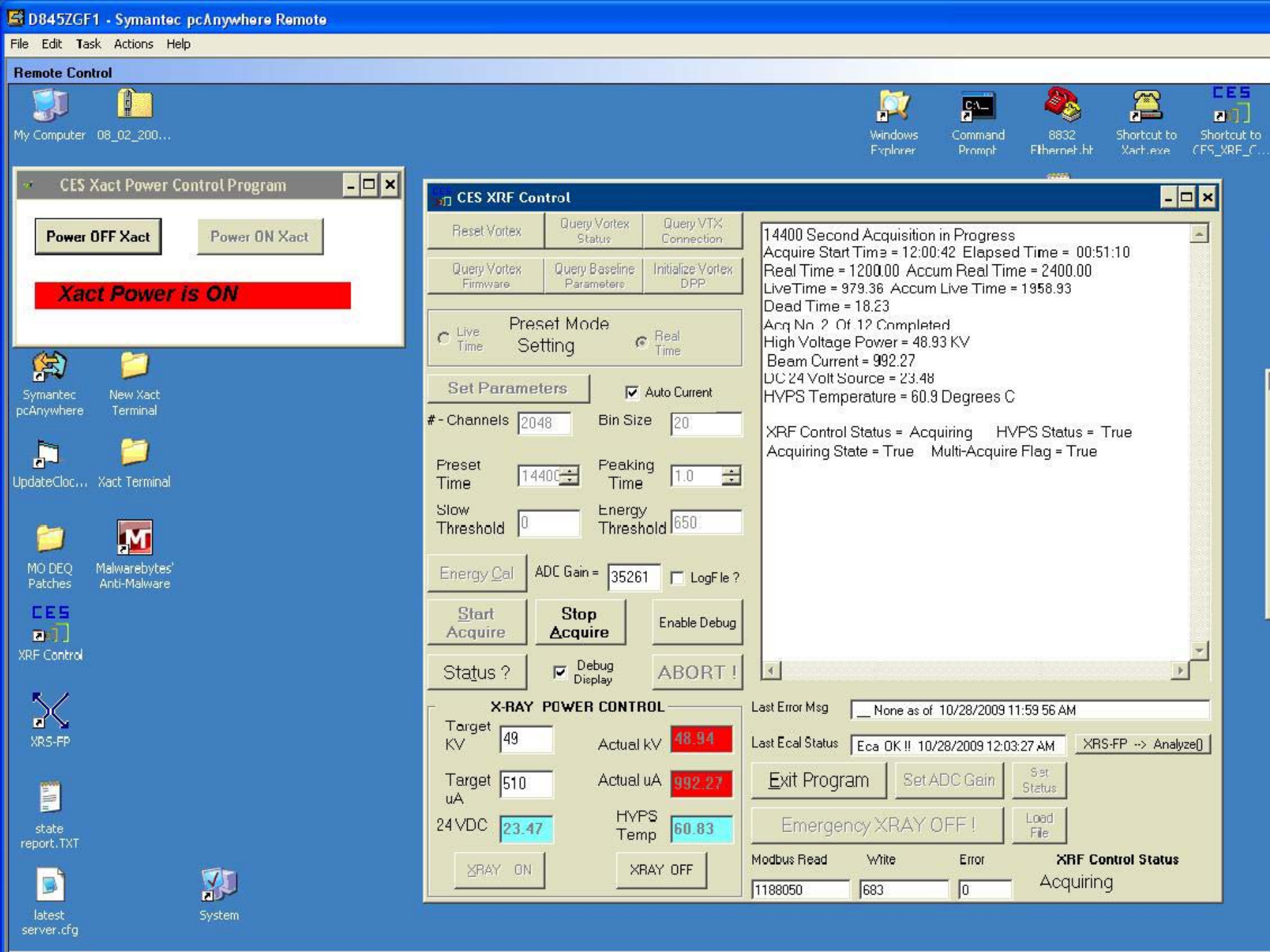
Xact Sampling and Analysis




Xact Tape Deposits
Deposit Area 0.747 cm²


Xact CES
Metals Monitor
Xact CES
Metals Monitor
X-RAY SCREENING


Xact 620
14-OCT-09 09:49:17
01 AT 8.9 C
02 SAMPLE 24.3 C
03 BP 751.6 mmHg
04 TAPE 744.9 mmHg
05 SAMPLE 54 %
06 FLOW 25 0.0 slpm
SETUP
OPERATE
STATUS
TEST
HOME
F1
ALARM LOG
F2
PAGE UP
F3
F4
F5
PAGE DOWN
F6
CONTRAST


D845ZGF1 - Symantec pcAnywhere Remote
File Edit Task Actions Help
Remote Control
My Computer
08_02_200...
Windows Explorer
Command Prompt
8832 Ethernet.ht
Shortcut to Xact.exe
Shortcut to CES_XRF_C...
CES Xact Power Control Program
Power OFF Xact
Power ON Xact
Xact Power is ON
Symantec pcAnywhere
New Xact Terminal
UpdateCloc...
Xact Terminal
MO DEQ Patches
Malwarebytes' Anti-Malware
CES XRF Control
XRS-FP
state report.TXT
latest server.cfg
System
CES XRF Control
Reset Vortex
Query Vortex Status
Query VTX Connection
Query Vortex Firmware
Query Baseline Parameters
Initialize Vortex DPP
Live Time
Preset Mode Setting
Real Time
Set Parameters
Auto Current
- Channels 2048
Bin Size 20
Preset Time 14400
Peaking Time 1.0
Slow Threshold 0
Energy Threshold 650
Energy Cal
ADC Gain = 35261
LogFle ?
Start Acquire
Stop Acquire
Enable Debug
Status ?
Debug Display
ABORT !
X-RAY POWER CONTROL
Target KV 49
Actual kV 48.94
Target uA 510
Actual uA 992.27
24 VDC 23.47
HVPS Temp 60.83
XRAY ON
XRAY OFF
14400 Second Acquisition in Progress
Acquire Start Time = 12:00:42 Elapsed Time = 00:51:10
Real Time = 1200.00 Accum Real Time = 2400.00
LiveTime = 979.36 Accum Live Time = 1958.93
Dead Time = 18.23
Acq No 2 Of 12 Completed
High Voltage Power = 48.93 KV
Beam Current = 992.27
DC 24 Volt Source = 23.48
HVPS Temperature = 60.9 Degrees C
XRF Control Status = Acquiring HVPS Status = True
Acquiring State = True Multi-Acquire Flag = True
Last Error Msg None as of 10/28/2009 11:59 56 AM
Last Ecal Status Eca OK !! 10/28/2009 12:03:27 AM
XRS-FP --> Analyze()
Exit Program
Set ADC Gain
Set Status
Emergency XRAY OFF !
Load File
Modbus Read
Write
Error
1188050
683
0
XRF Control Status
Acquiring


XMF Control initialization file parameter description

GF1 - Symantec pcAnywhere Remote

Task Actions Help

ontrol

SpectraX

File View Process Setup Help

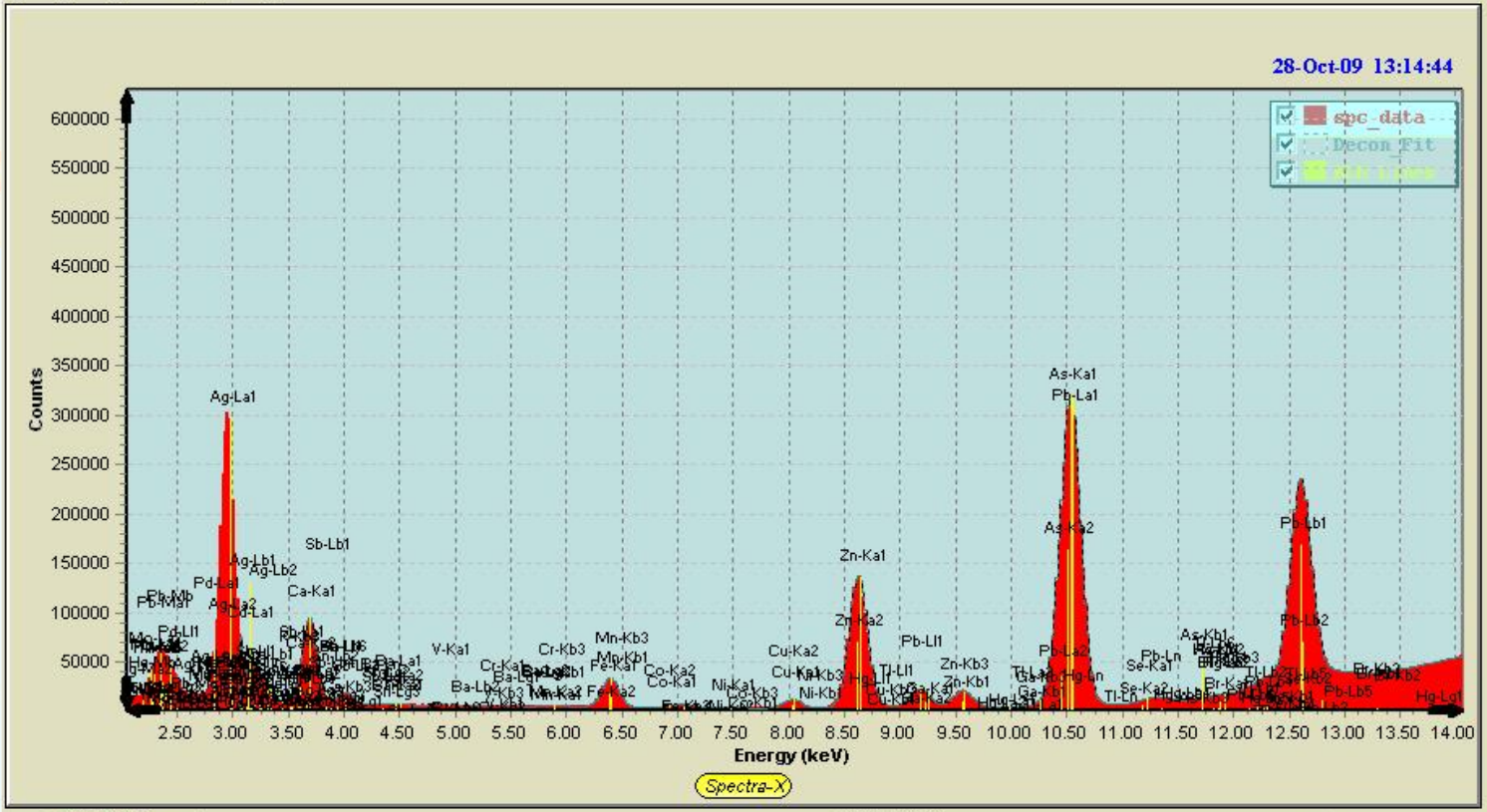


Chart Tools

KLM Markers 25 Pb Add Clear

SpectraX Controls

AutoVS

Log

--> Analyze()

24 VDC 23.48

HVPS Temp 60.10

XRAY ON

XRAY OFF

Emergency XRAY OFF !

Load File

Modbus Read 1188349

Write 685

Error 0

XRF Control Status

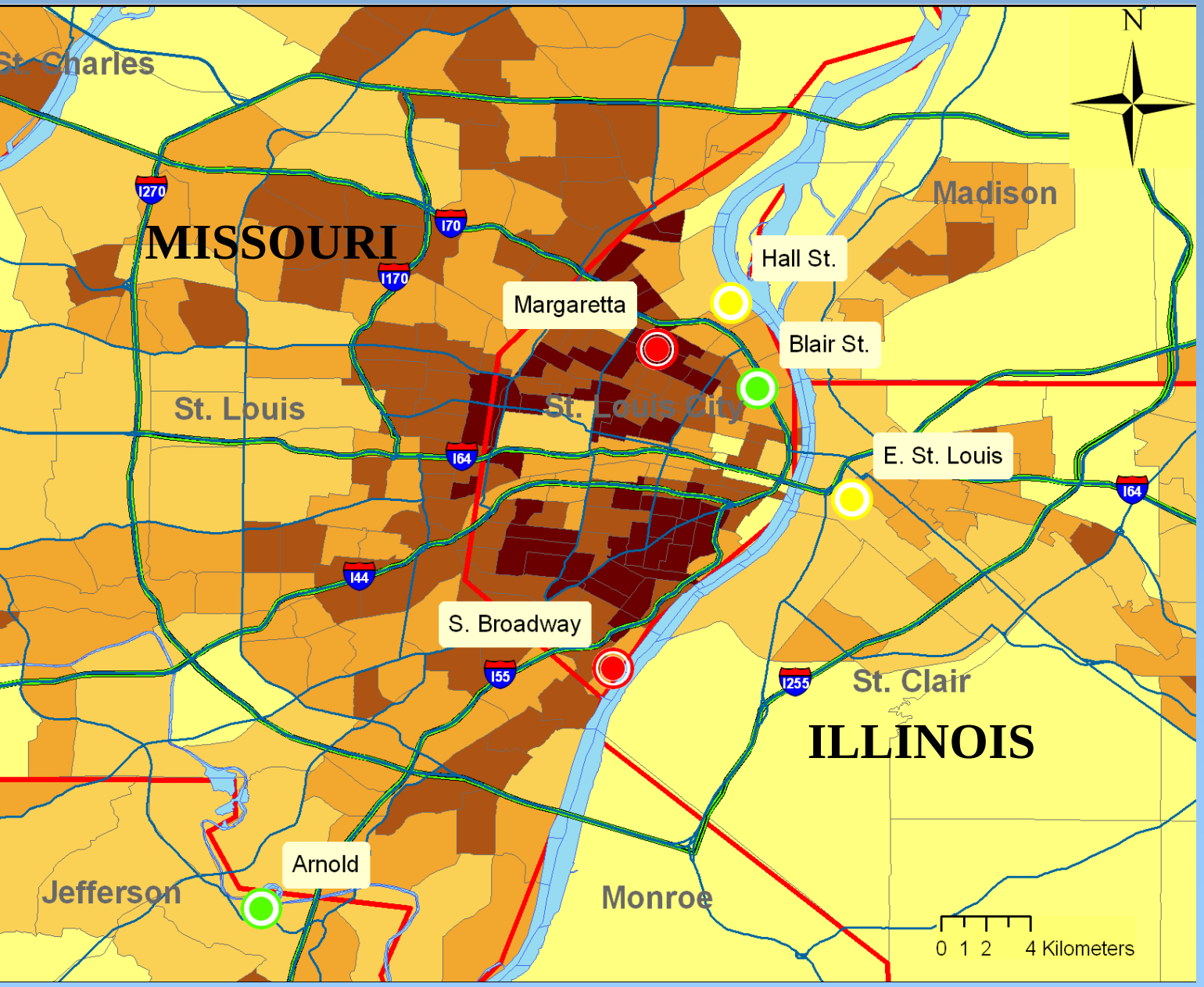
Acquiring

System

CES Xact Power C... SpectraX Controls SpectraX Automatic CES Spec... CES XRF Control Visual Basic Termin...

1:14

Phase II Xact Monitoring Sites

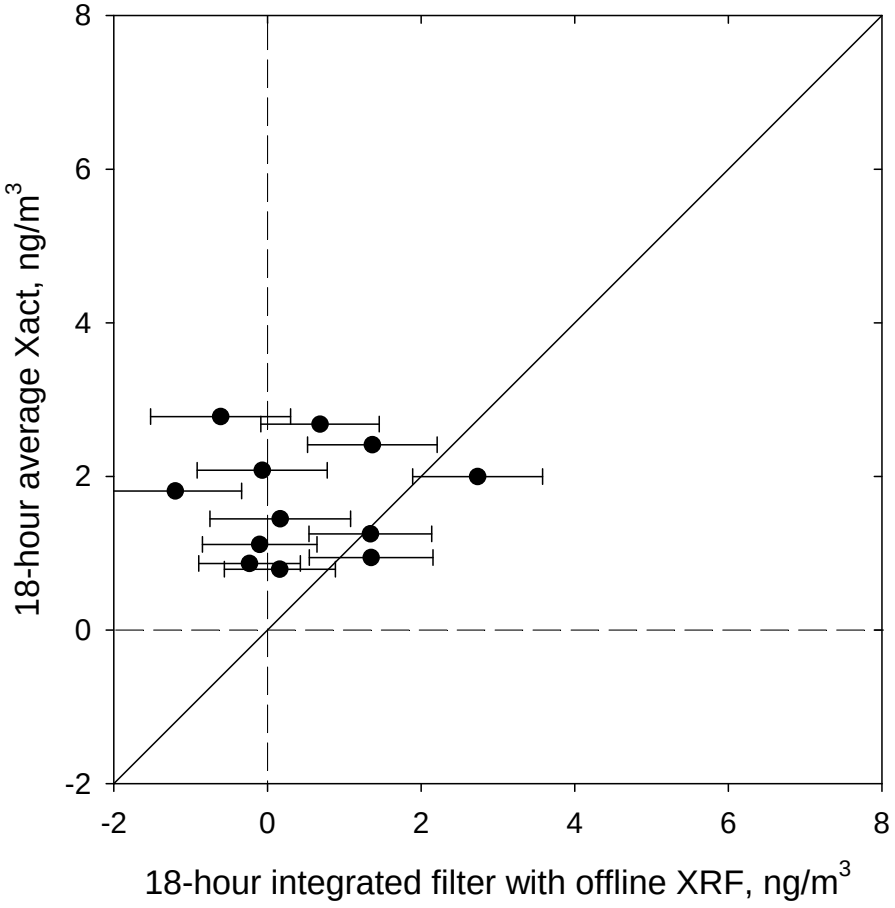


Pop. Density (#/sq. mile)

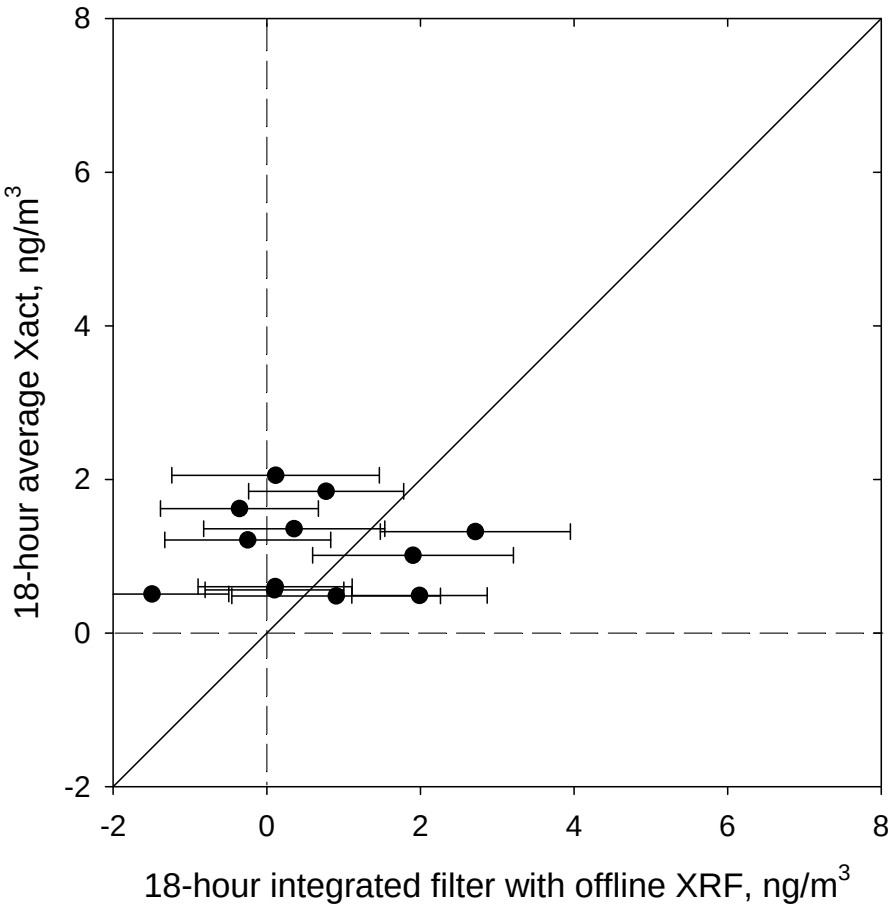
- 0 - 599
- 600 - 1723
- 1724 - 3833
- 3834 - 7792
- 7793 - 15224

Xact vs. LowVol PM_{10} FRM / XRF

Selenium

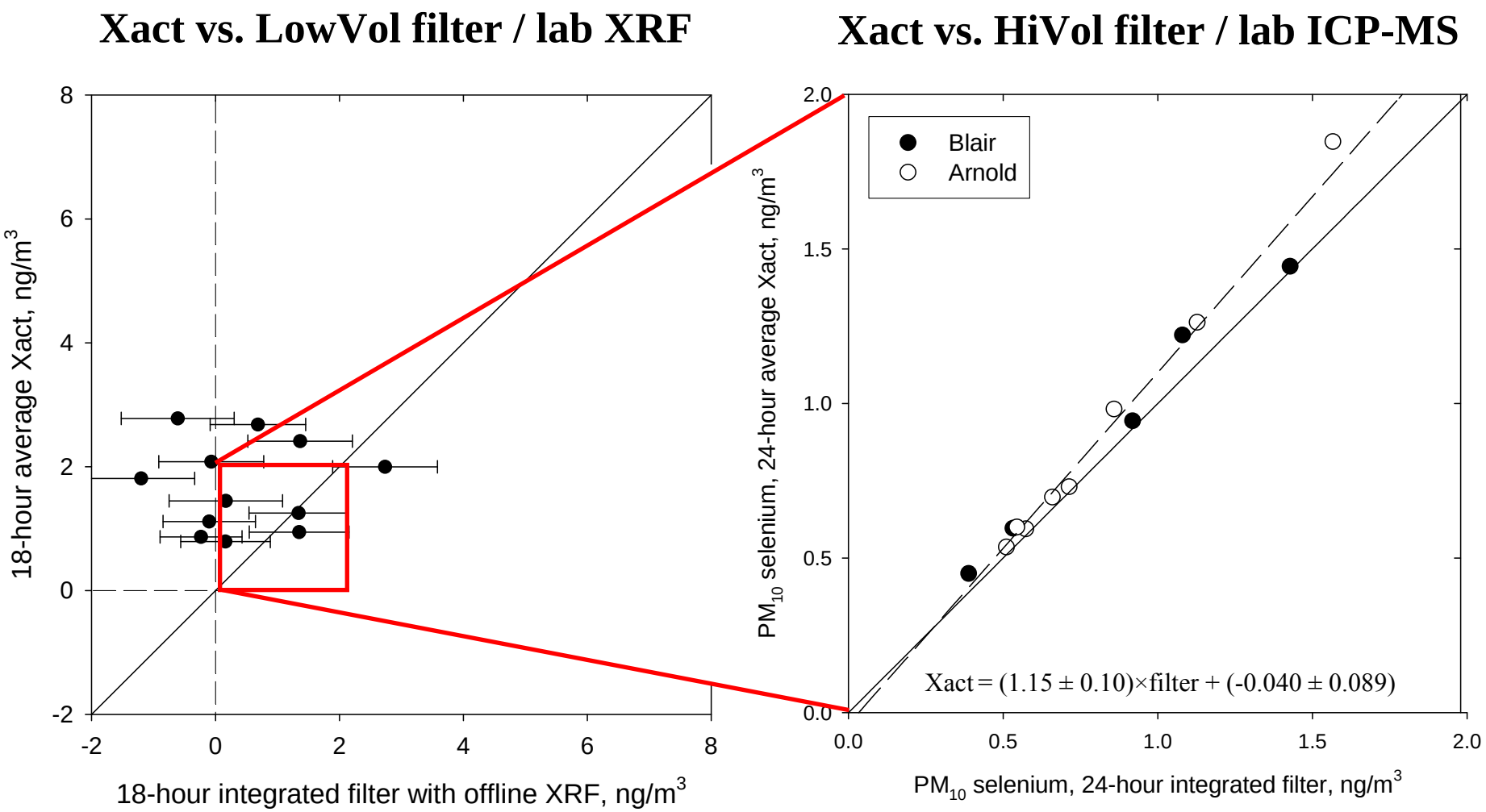


Arsenic



Se and As: pushing the detection limit of the lab-based XRF.
need to compare the Xact to ICP-MS (next slide)…

Selenium: Xact vs. Filter-Based Measurements

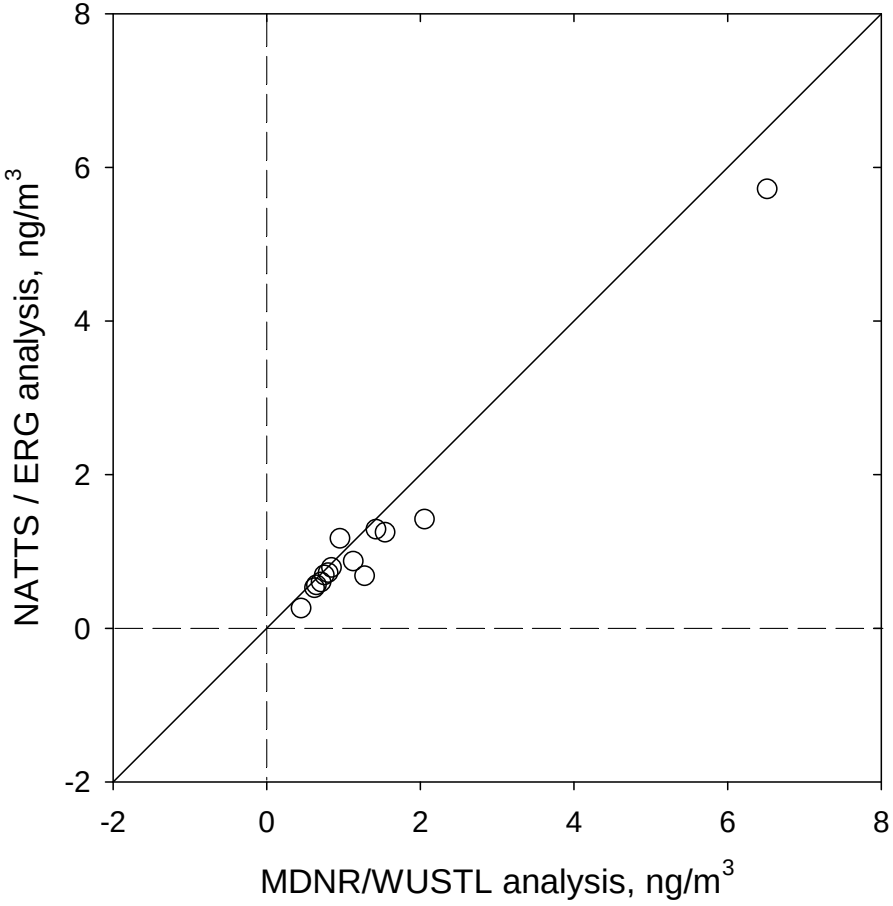


Se: favorable comparison between Xact and PM_{10} HiVol samples with analysis by ICP-MS

Arsenic – Methods Comparisons

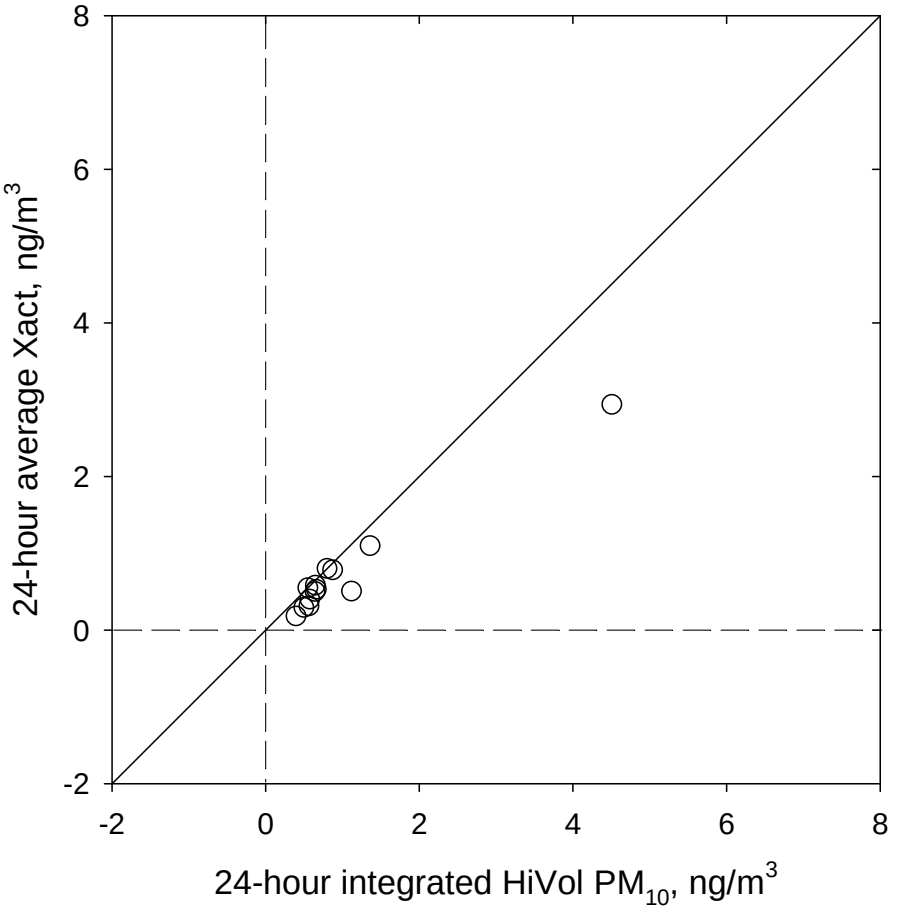
Collocated HiVol Samplers

Blair site, 4th Quarter 2008



Xact vs. WUSTL HiVol

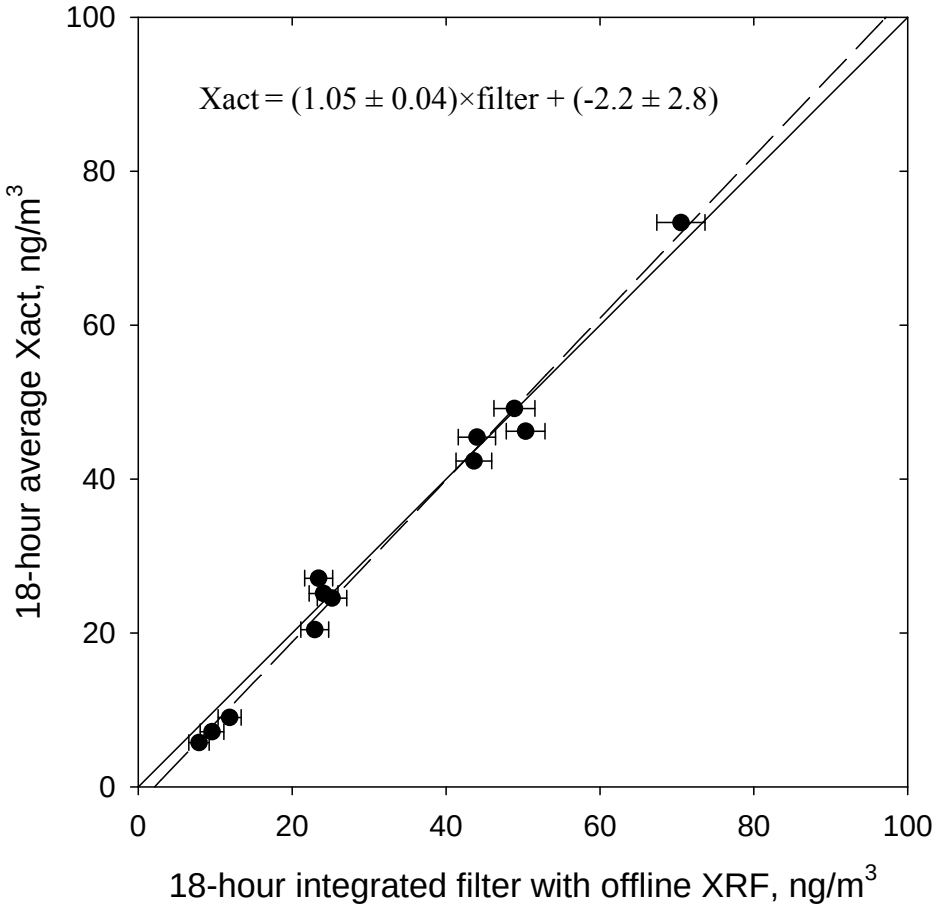
Dec 2008 / Jan 2009



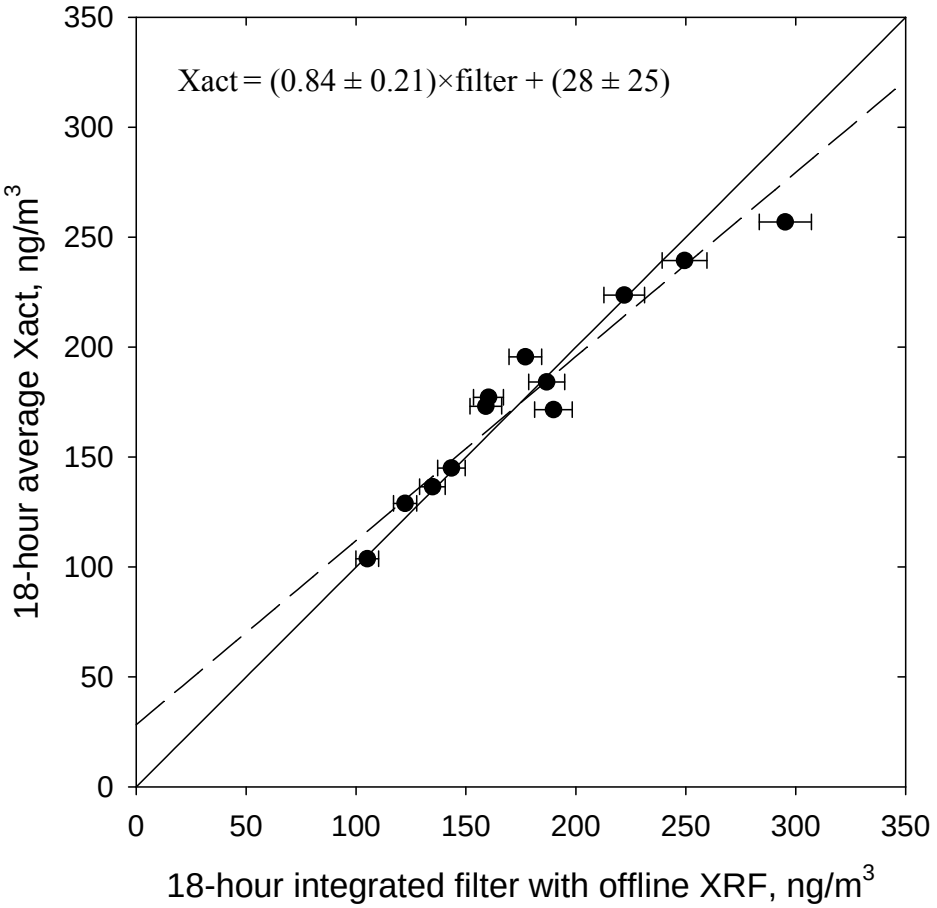
As: favorable comparison between Xact and PM_{10} HiVol samples with analysis by ICP-MS.

Xact vs. LowVol PM_{10} FRM / XRF

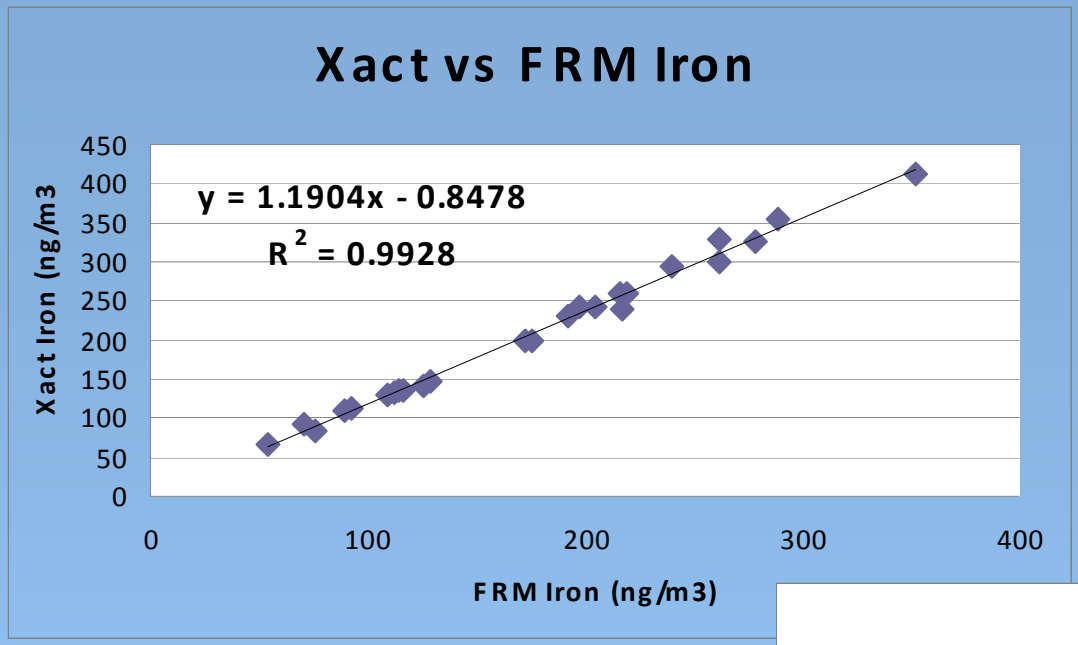
Titanium

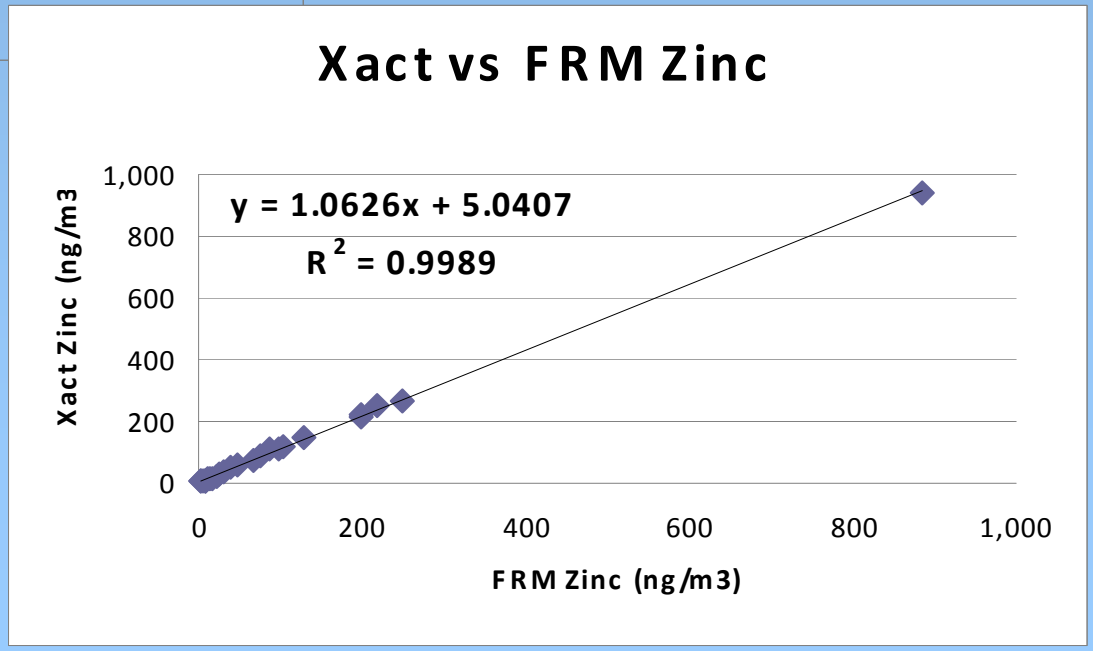


Potassium



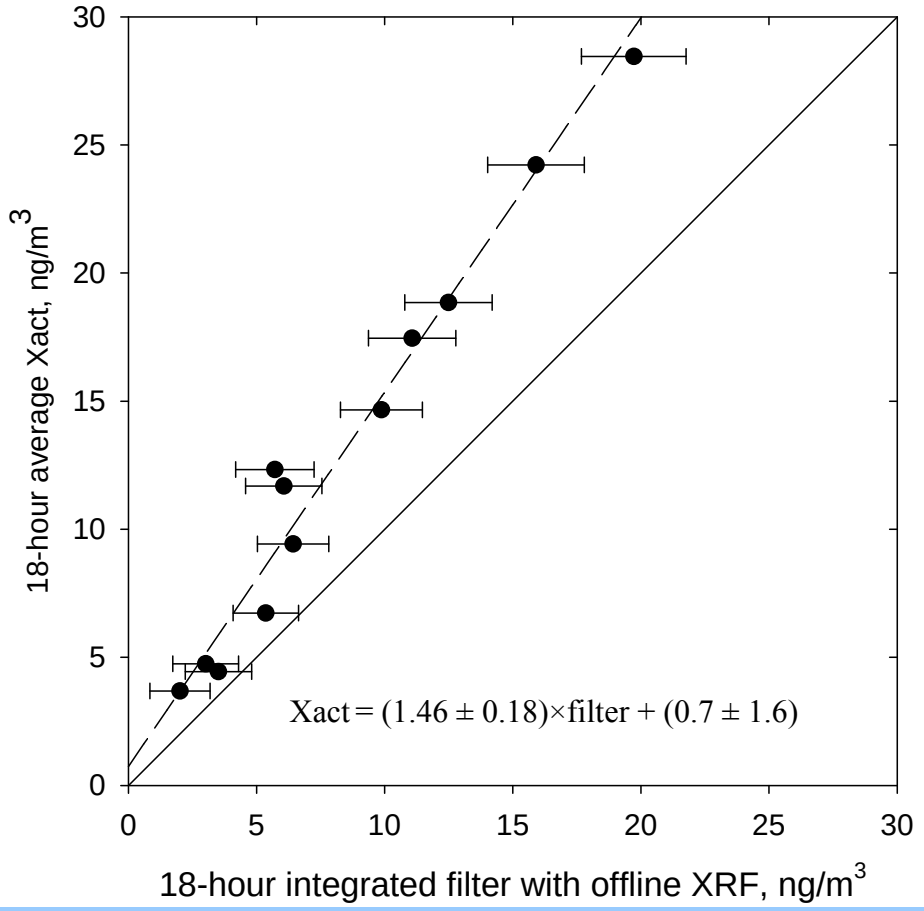
Herculaneum, MO



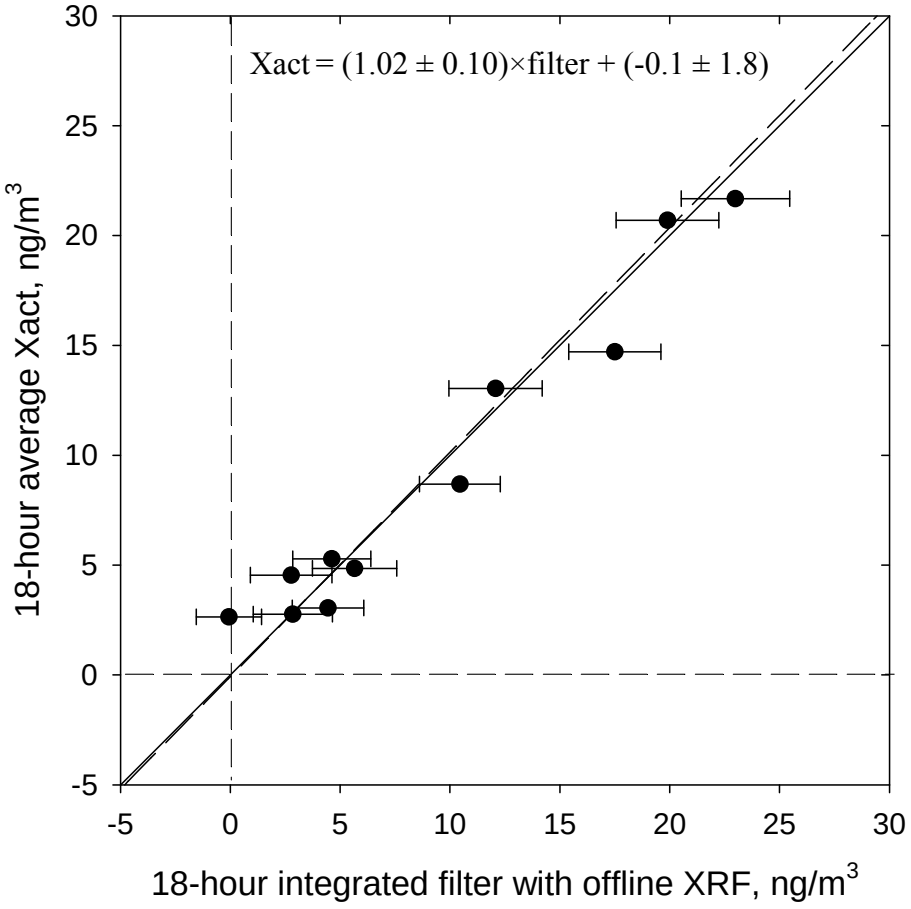


Xact vs. LowVol PM_{10} FRM / XRF

Manganese



Lead

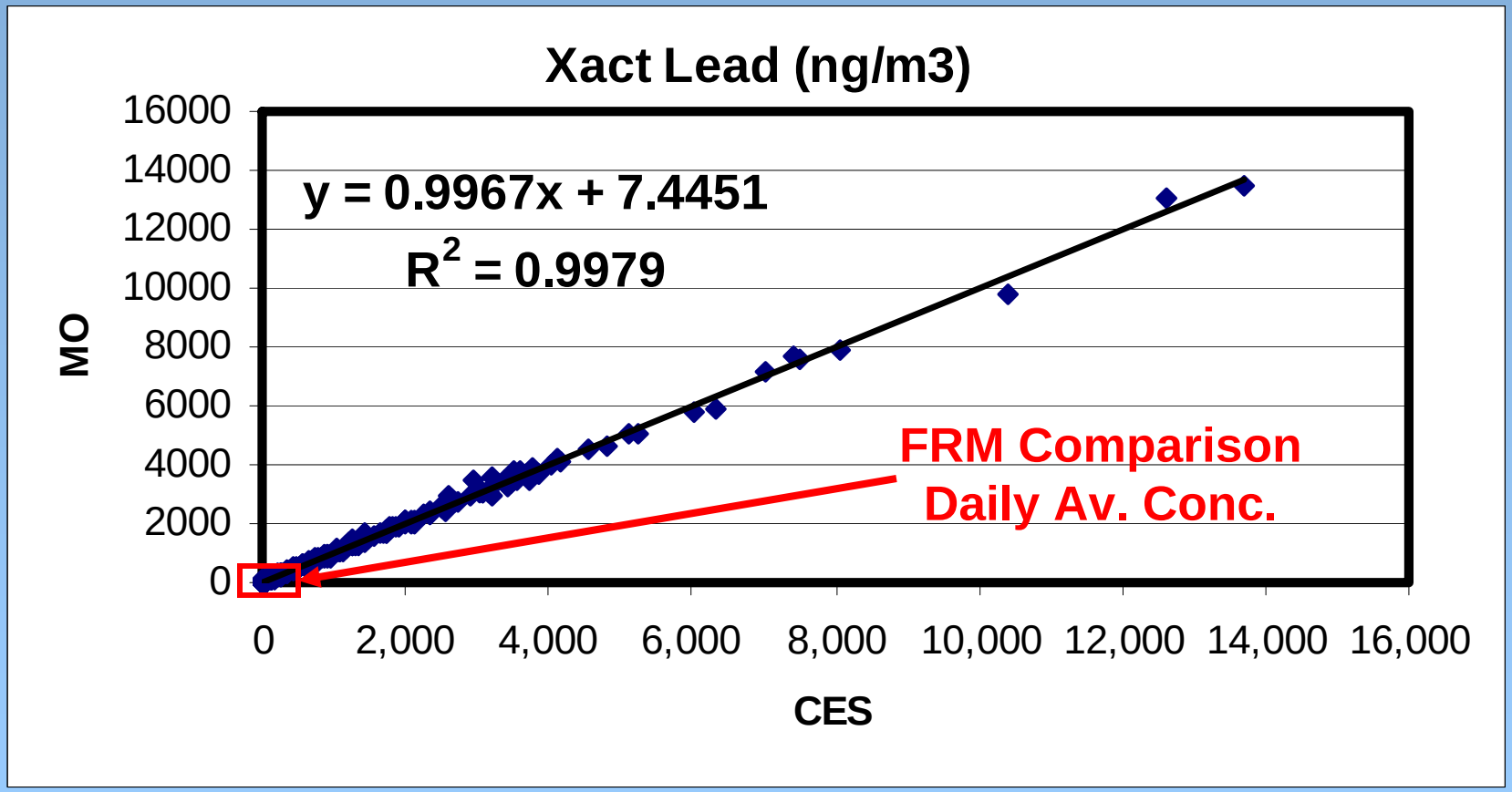


Mn: biased but highly correlated

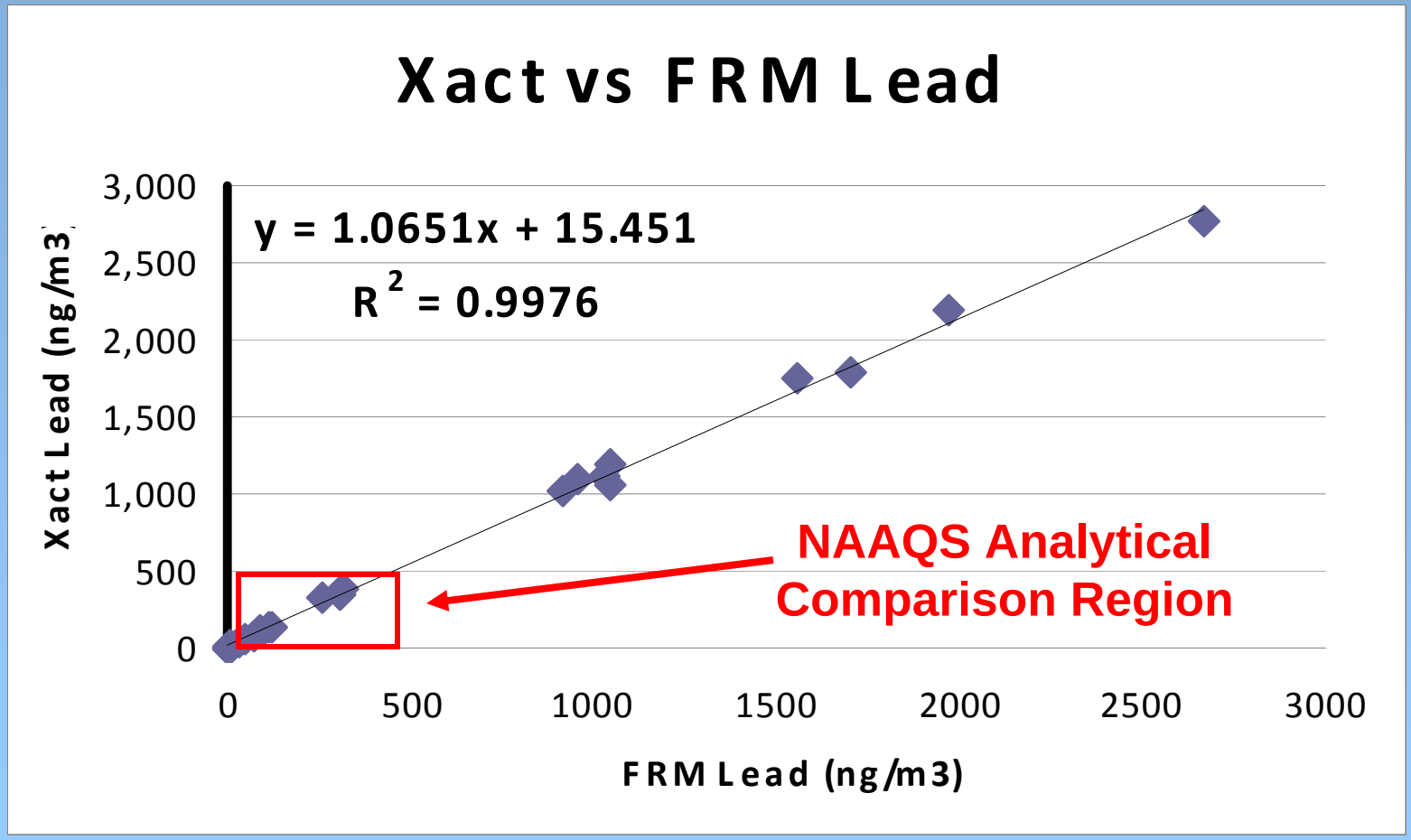
Herculaneum

Minus High Concentration Data Point

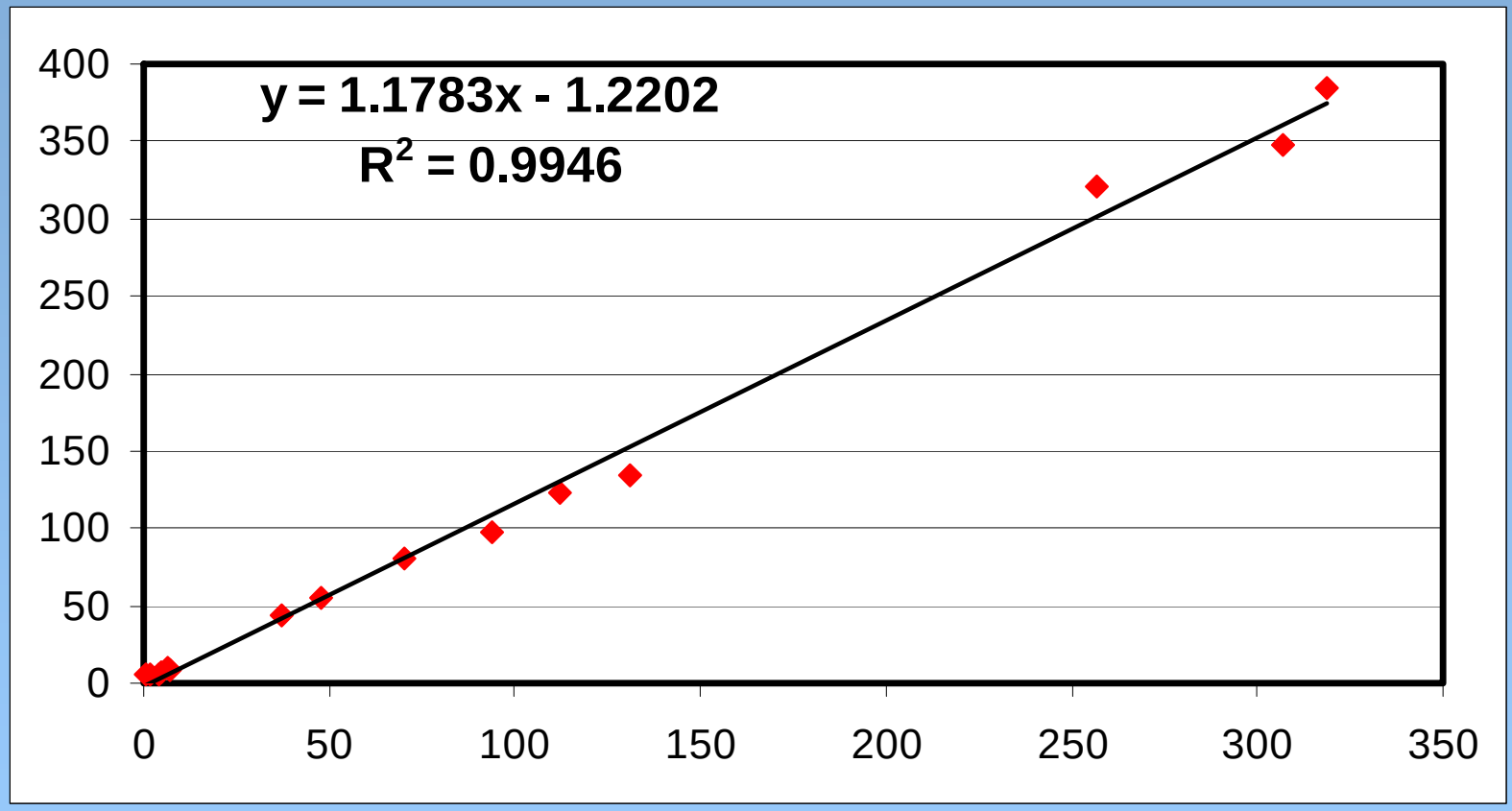
Herculaneum MO



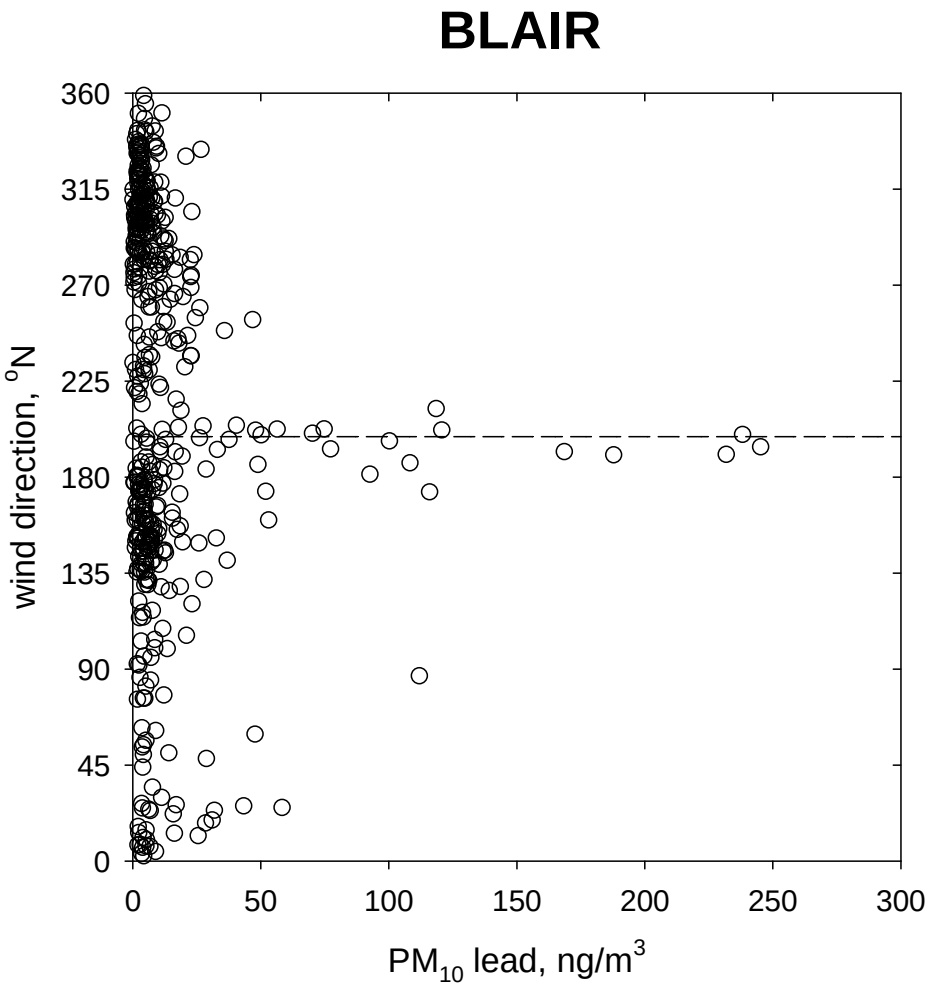
Herculaneum, MO Lead

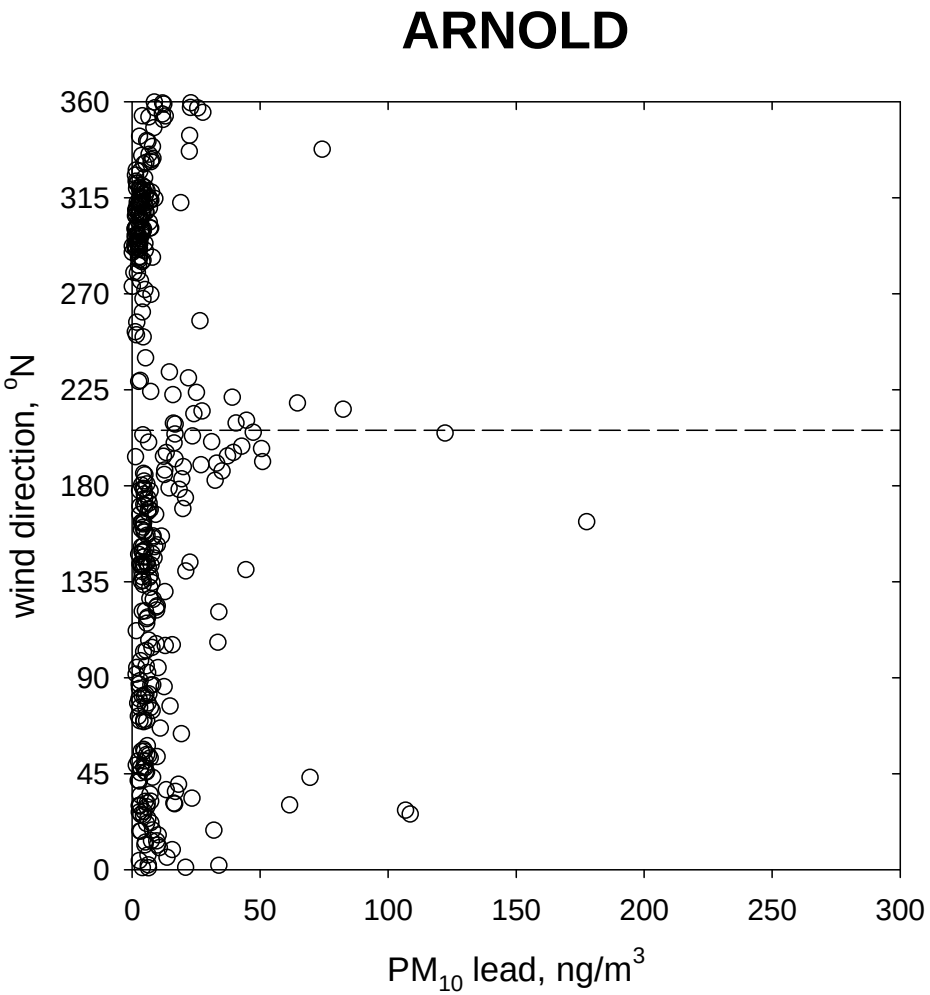


FRM v. Xact Lead Comparison



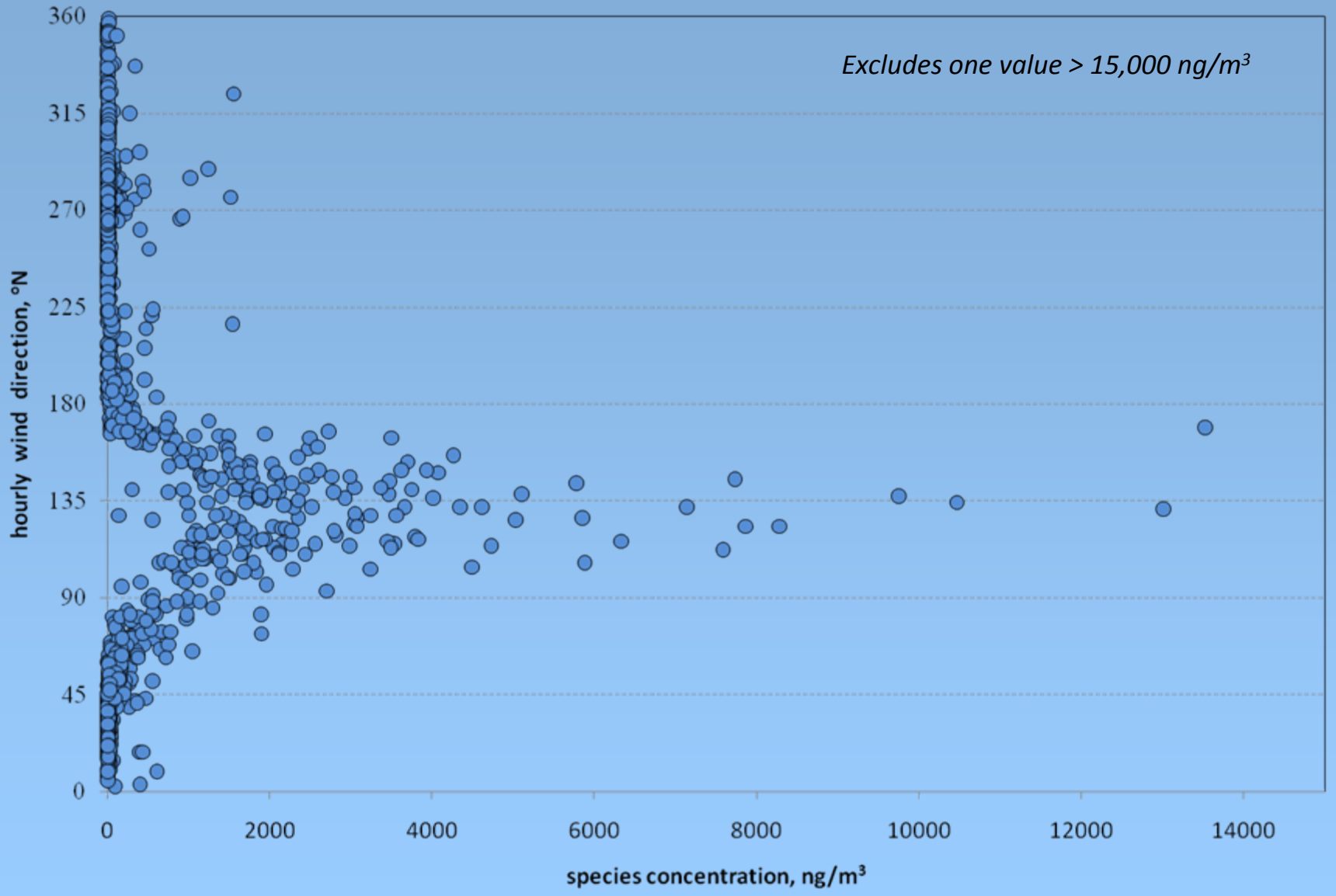
PM_{10} Lead by Xact (2-hour resolution)

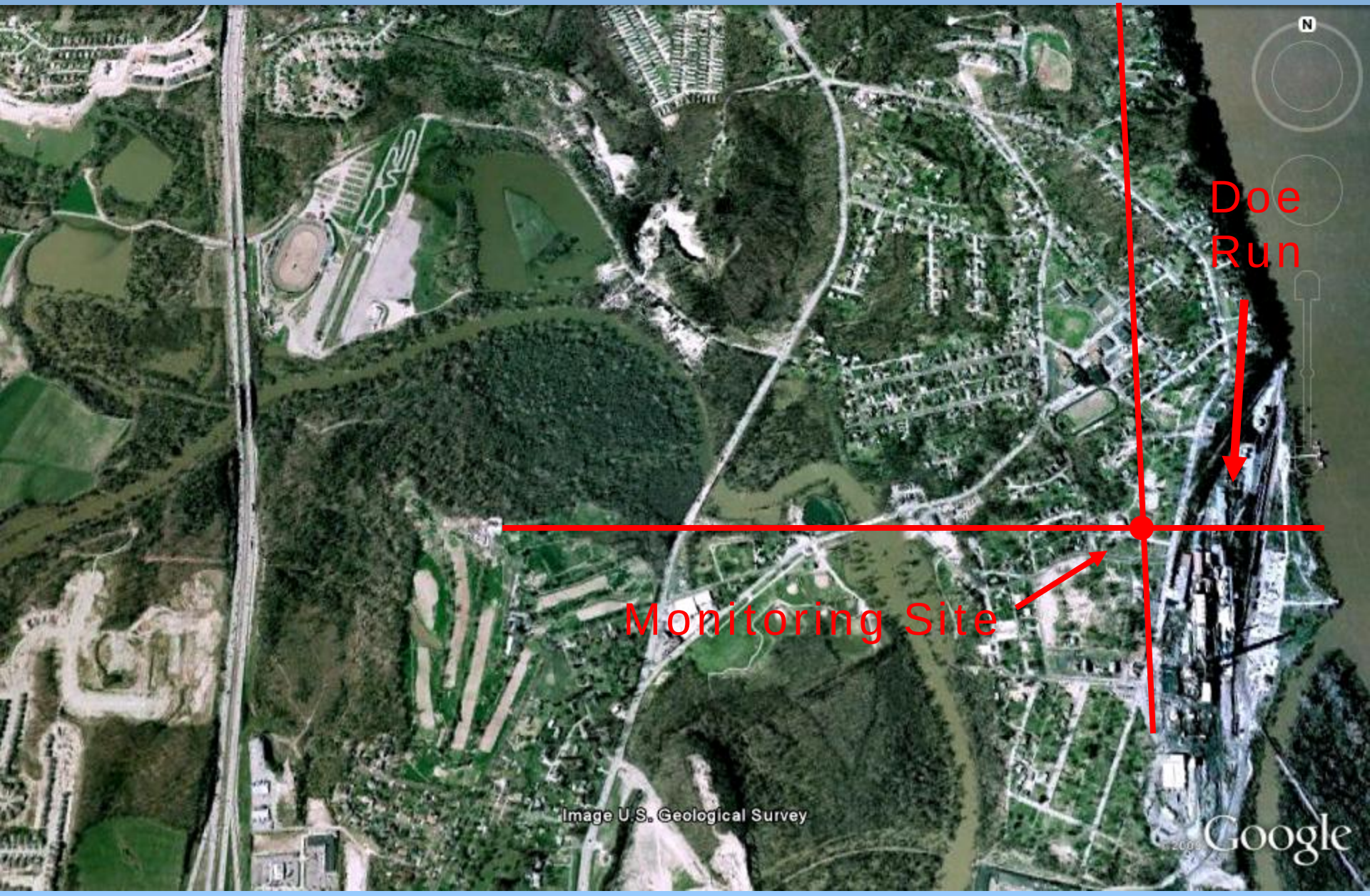




Dashed line is bearing of Doe Run – Herculaneum lead smelter

Hourly PM_{10} Lead, Herculaneum Main Street Site, 8/8/09 – 10/10/09
Excludes hours with wind speeds less than 0.5 mph



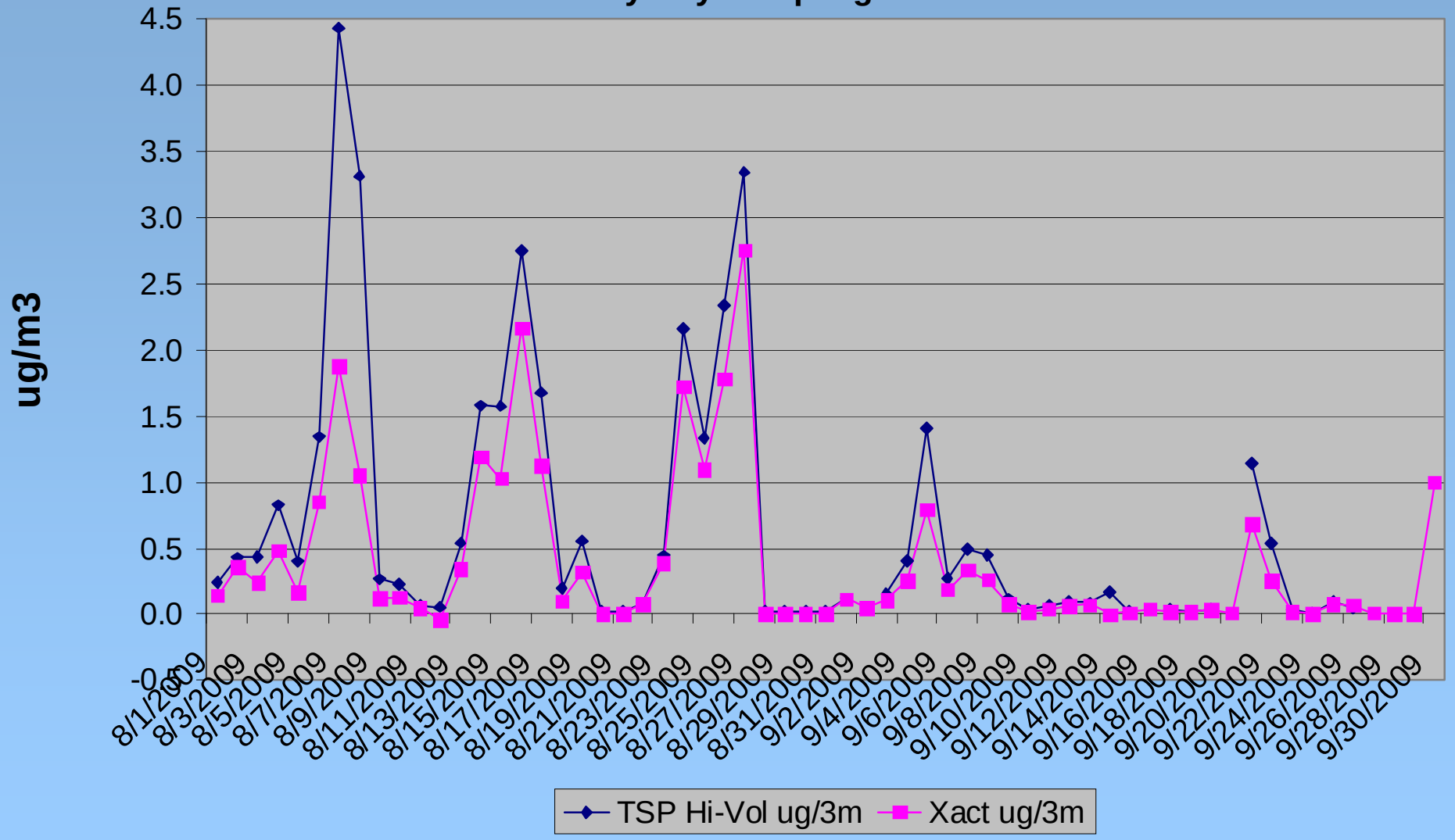

Doe Run
Monitoring Site
Image U.S. Geological Survey
Google


0
30
60
90
120
150
180
210
240
270
300
330
Herc Main Street Site
500
1000
1500
2000
2500
Image U.S. Geological Survey
Image © 2009 DigitalGlobe
©2008 Google

Herculaneum Airborne Lead Concentration

August and September 2009

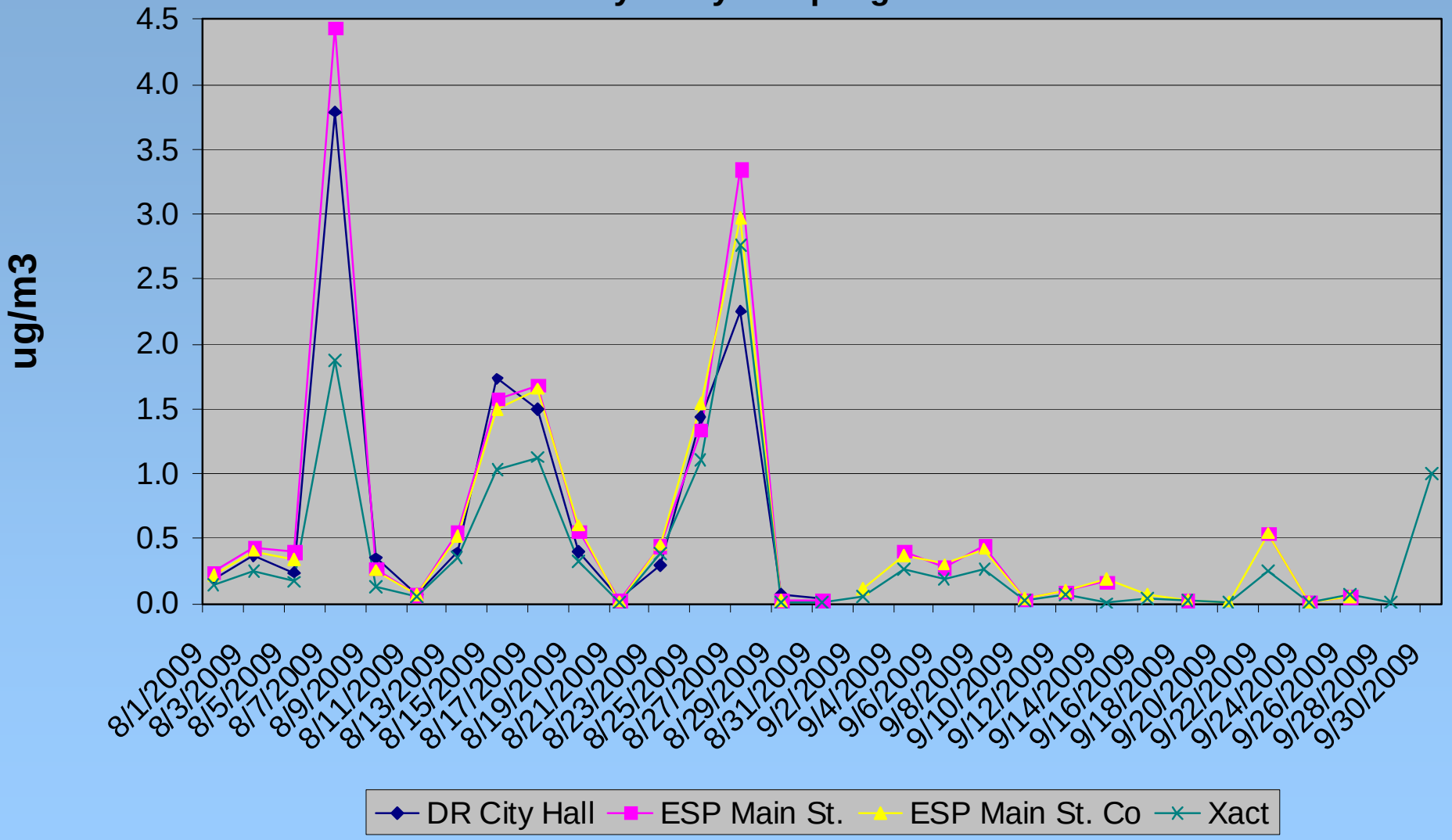
Every Day Sampling



Herculaneum Airborne Lead Concentration

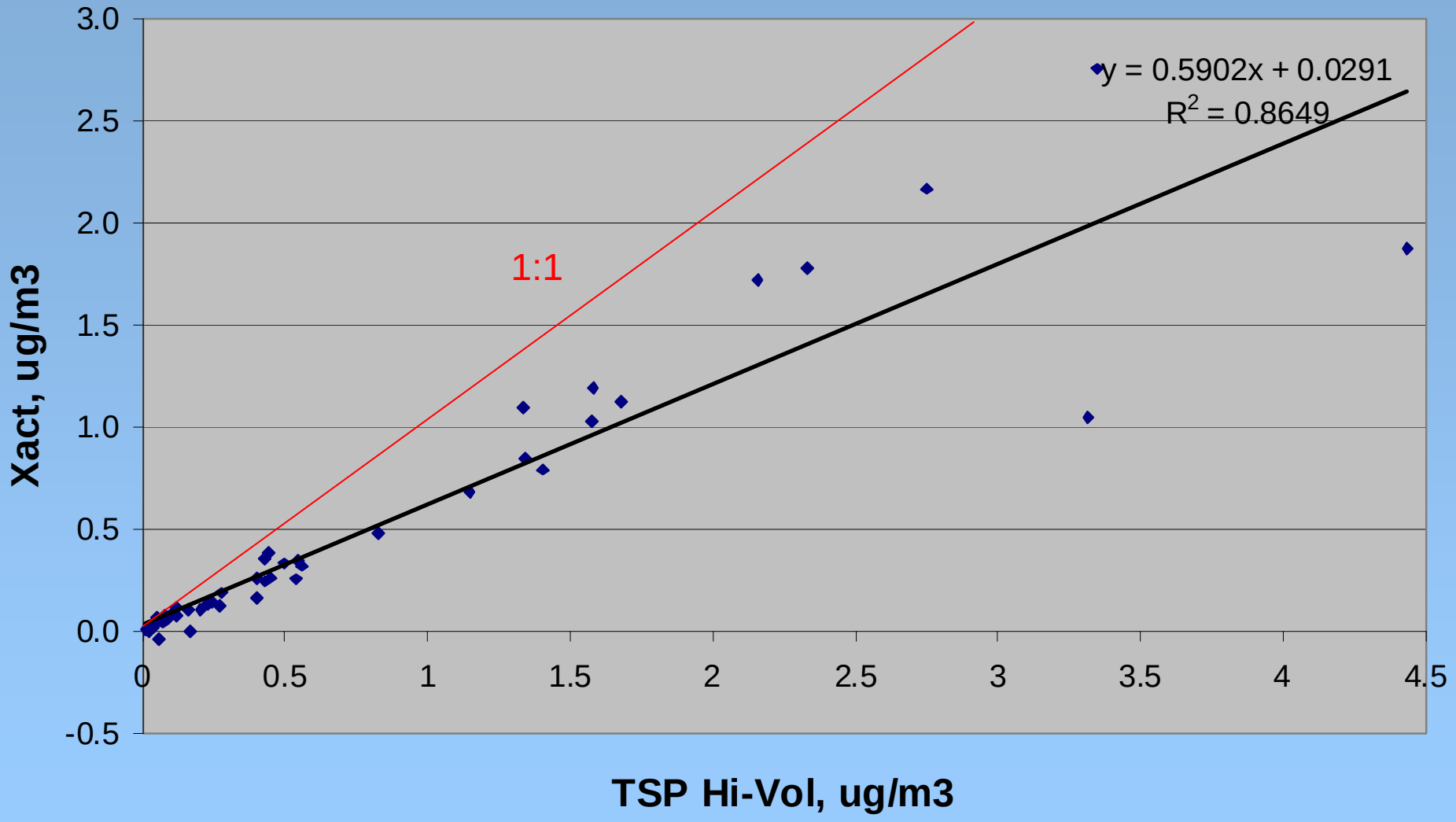
August and September 2009

Every 3 Day Sampling



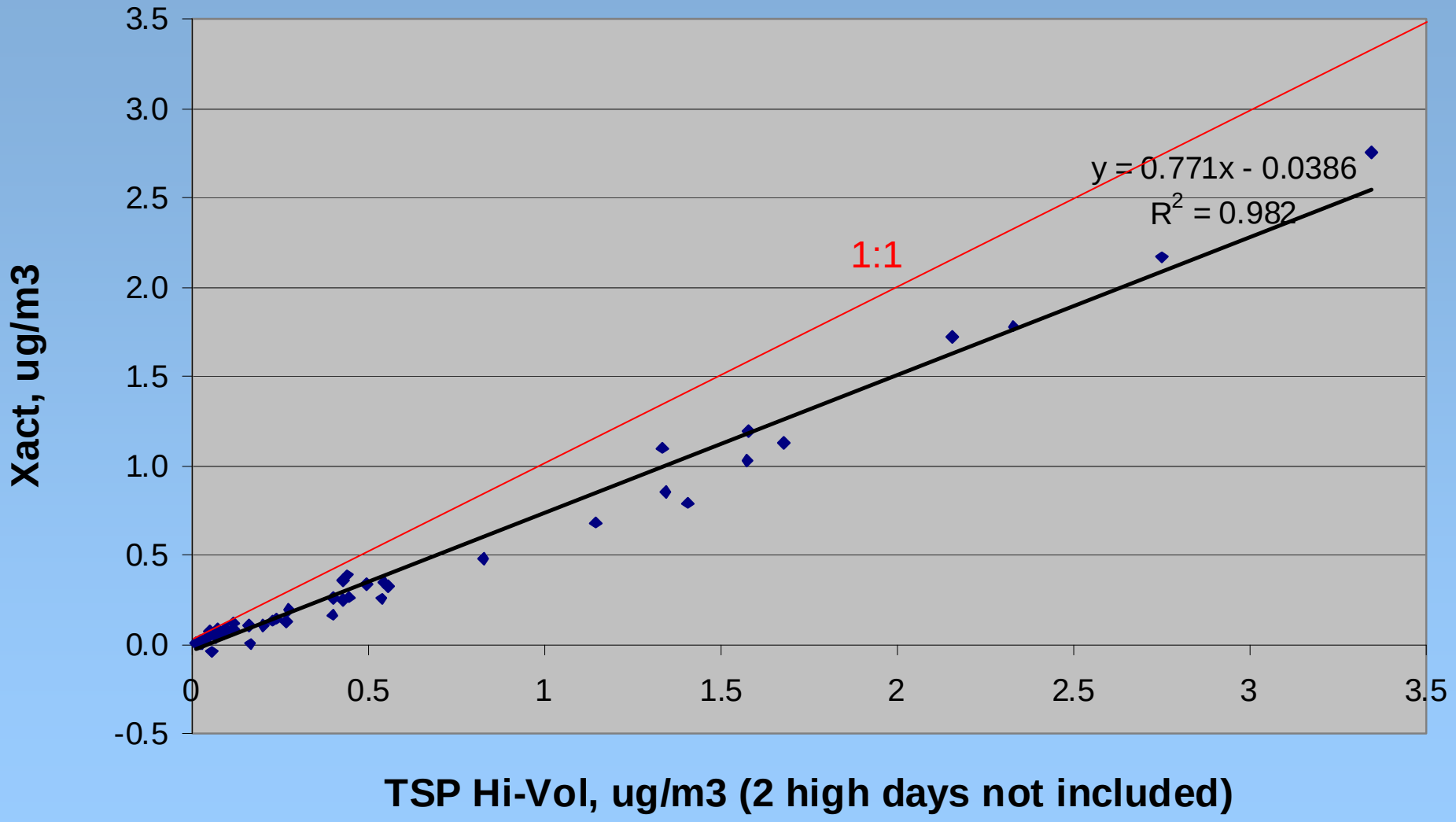
Herculaneum Airborne Lead Concentration

August and September 2009



Herculaneum Airborne Lead Concentration

August and September 2009



Conclusions

- Maintenance and operation of the Xact is comparable to that of other air monitoring instruments. The Xact has operated reliably following initial problems addressed by software and firmware upgrades.
- Xact airborne metallic species results compare well with both low volume and high volume filter sample analysis results.
- Xact results demonstrate the utility of time-dependent measurement for source attribution.

Acknowledgements

- **Missouri Department of Natural Resources**
  - Jim Brunnert, Jerry Downs, Celeste Koon, Dustin Kuebler, Robert Nilges, Terry Rowles, Will Wetherell
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  - John Cooper, Krag Petterson
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- **U.S. EPA / Office of Air Quality Planning and Standards**
  - Mike Jones
- **U.S. EPA / Region VII**
  - Gwen Yoshimura
- **U.S. EPA / Office of Research and Development**
  - Teri Conner, Gary Norris, Bob Willis

Online Current Data

- **http://www.dnr.mo.gov/env/esp/aqm/allguide.htm**

  (Click on “Current Air Pollution Data Report” at mid-page, scroll down to St. Louis Metals Data)