Ambient/Source Technology Integration for the Development of a Multi-Metals Air Toxics Monitoring System

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Technology Integration Team Goal and Membership

- **Drive policy decisions by integrating source and ambient monitoring technology**
- **Membership: Jim Homolya (lead), Dan Bivins, Tom Logan, Dennis Mikel, Barrett Parker, Lew Weinstock, Phil Lorang (coach)**

Process

- **Assess current monitoring programs and upcoming needs**
- **Identify opportunities for integration**
- **Initiate project and recommend options to incorporate process as routine procedure**

Integration Approach

- **Discussed needs and examined open path optical and semi-continuous air toxics metals monitoring**
- **Decided to explore integration of commercially-available source emission air toxics metals XRF monitor into ambient air PM2.5 beta attenuation mass monitor**
- **Conducted discussions with collaborators and launched proof-of-concept project**

Proof of Concept: Adapt Metals CEM Technology for Ambient Air Toxics Continuous Monitor

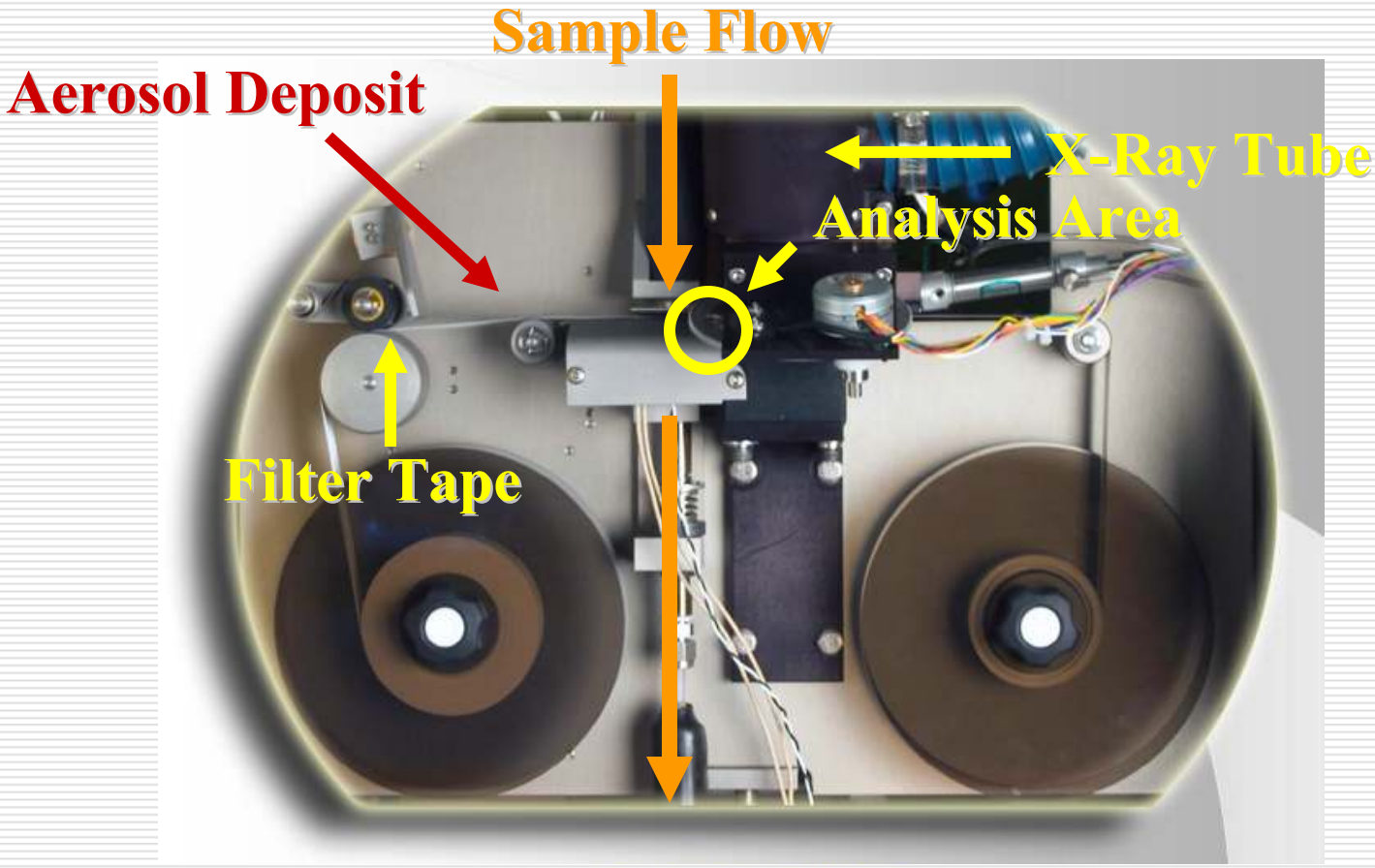
- **Project Goal: Determine ability to measure non-cancer risk levels (<50pg/dscm) for Cr, Mn, Ni, As, Cd, Hg, and Pb in PM2.5 samples collected semi-continuously at 4 hour intervals**
- **Final Objective: Optimize technology for practical and cost-effective system to produce detection limits at cancer risk levels (<20pg/dscm) for the above metals at comparable temporal resolution**

Project Collaborators

- **Source and Ambient Technology Integration Team**
- **Cooper Environmental Services**
  - **Metals CEMS (XACT) vendor**
- **Met One Instruments**
  - **Continuous PM2.5 mass monitor (BAM-1020) vendor**
- **California Air Resources Board**
  - **Extensive air monitoring network operator of BAM-1020s**

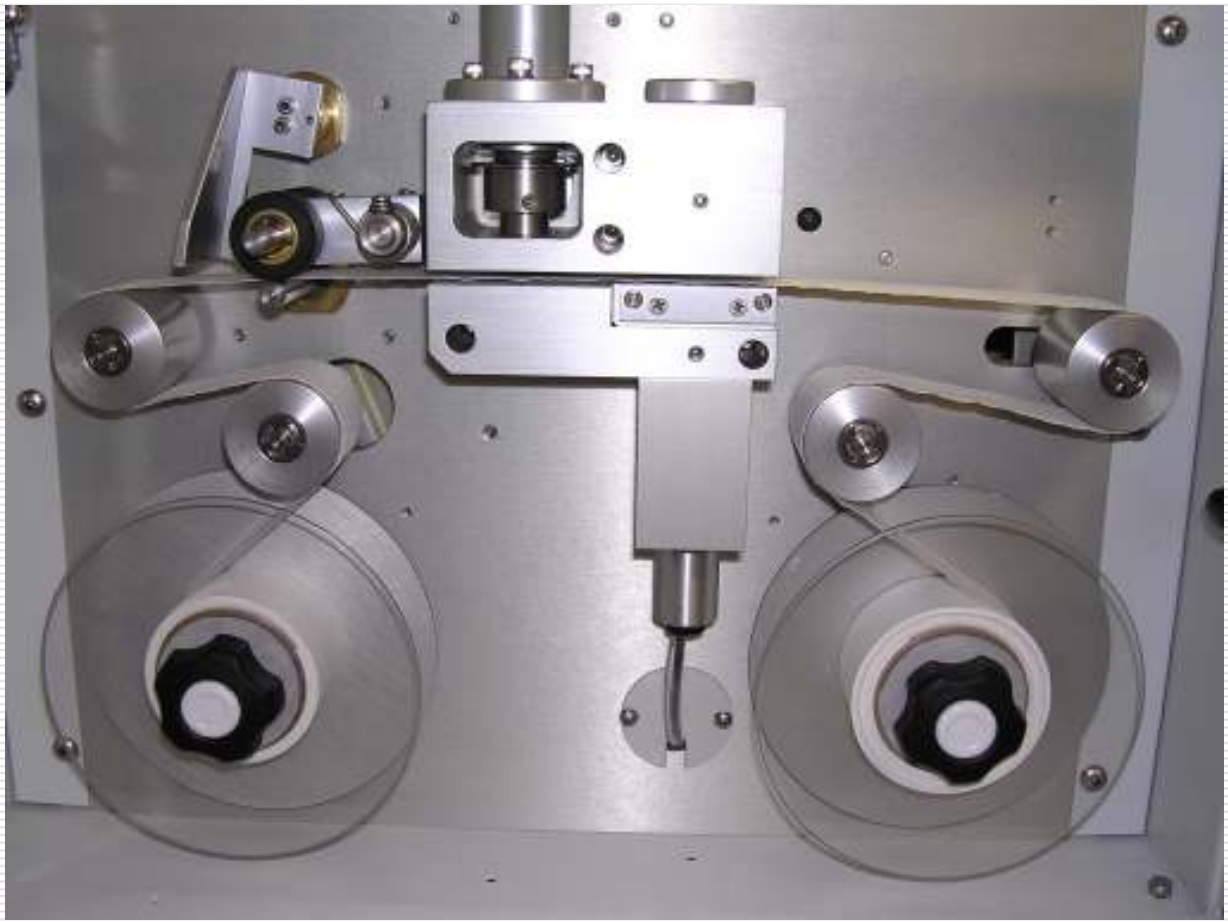
Cooper Environmental XACT Multi-Metals Continuous Emissions Monitor

XACT SAMPLING AND ANALYSIS



MetOne BAM-1020 Beta Attenuation PM2.5 Mass Monitor

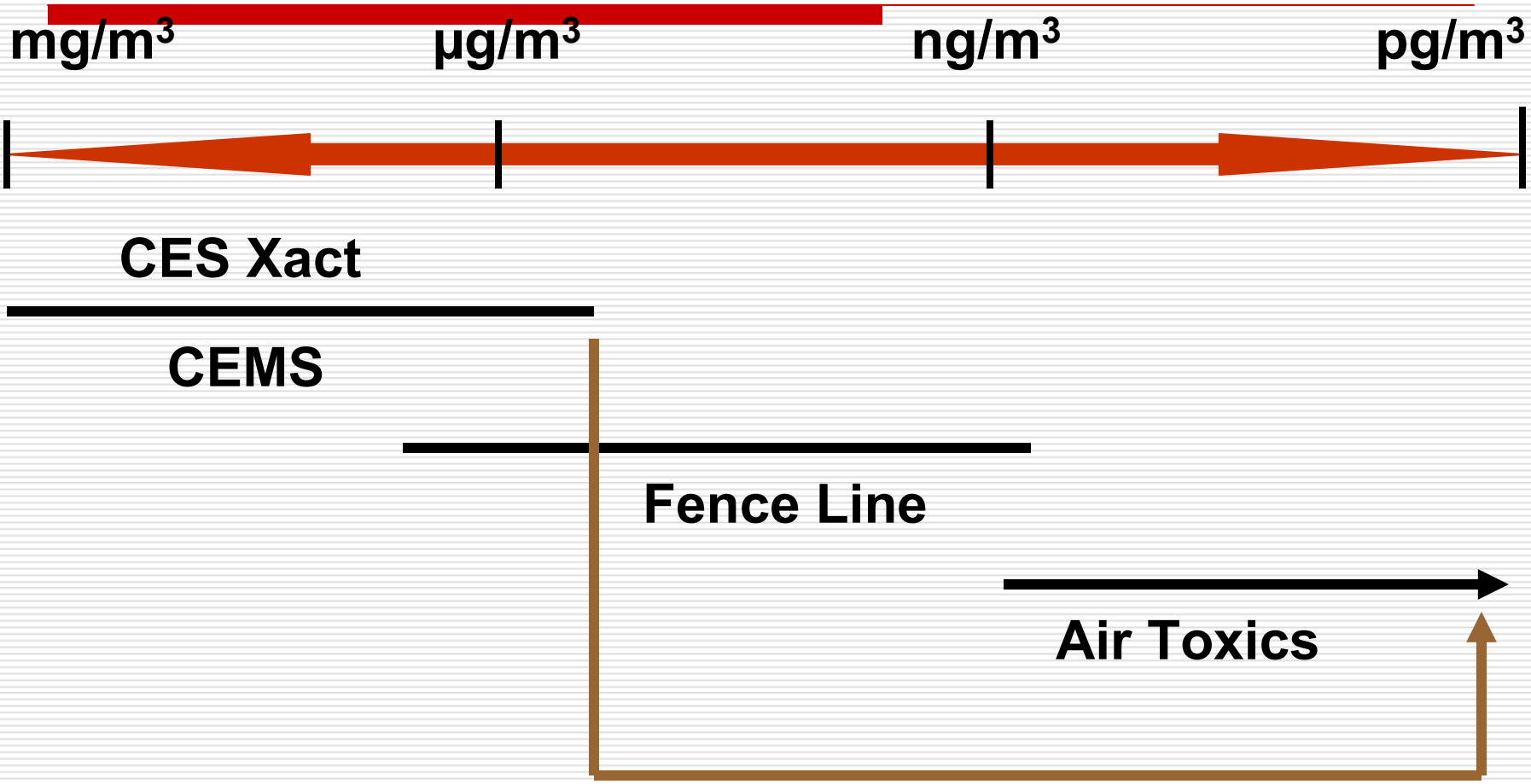
BAM Modified With Stretched-Teflon Tape Transporter



Project Output and Schedule

- **Modified BAM installed at Bakersfield, CA, site**
  - **Beginning 4/15, operate for 10 days to collect 60-4 hr samples on stretched Teflon filters**
- **Cooper selected 16 filters for XRF analysis**
  - **10 filters for dynamic range and MDL, 6 filters to demonstrate diurnal air toxic metals variability**
- **EPA, CARB, Cooper and Met One prepared a joint report of results and recommendations**

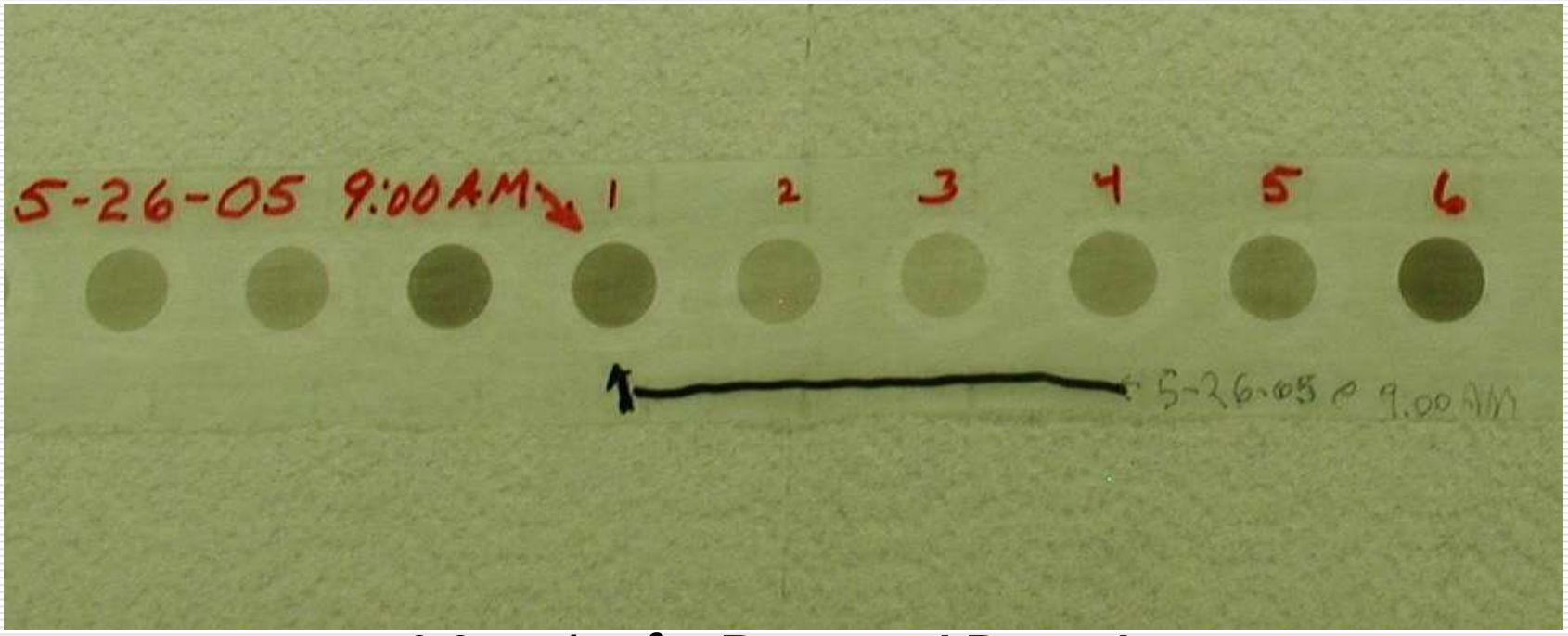
Concentration Range of Interest



Five orders of magnitude lower detection limit

Unsupported PTFE Filter Tape

BAM 1020: 240 min. at 12 lpm/cm2

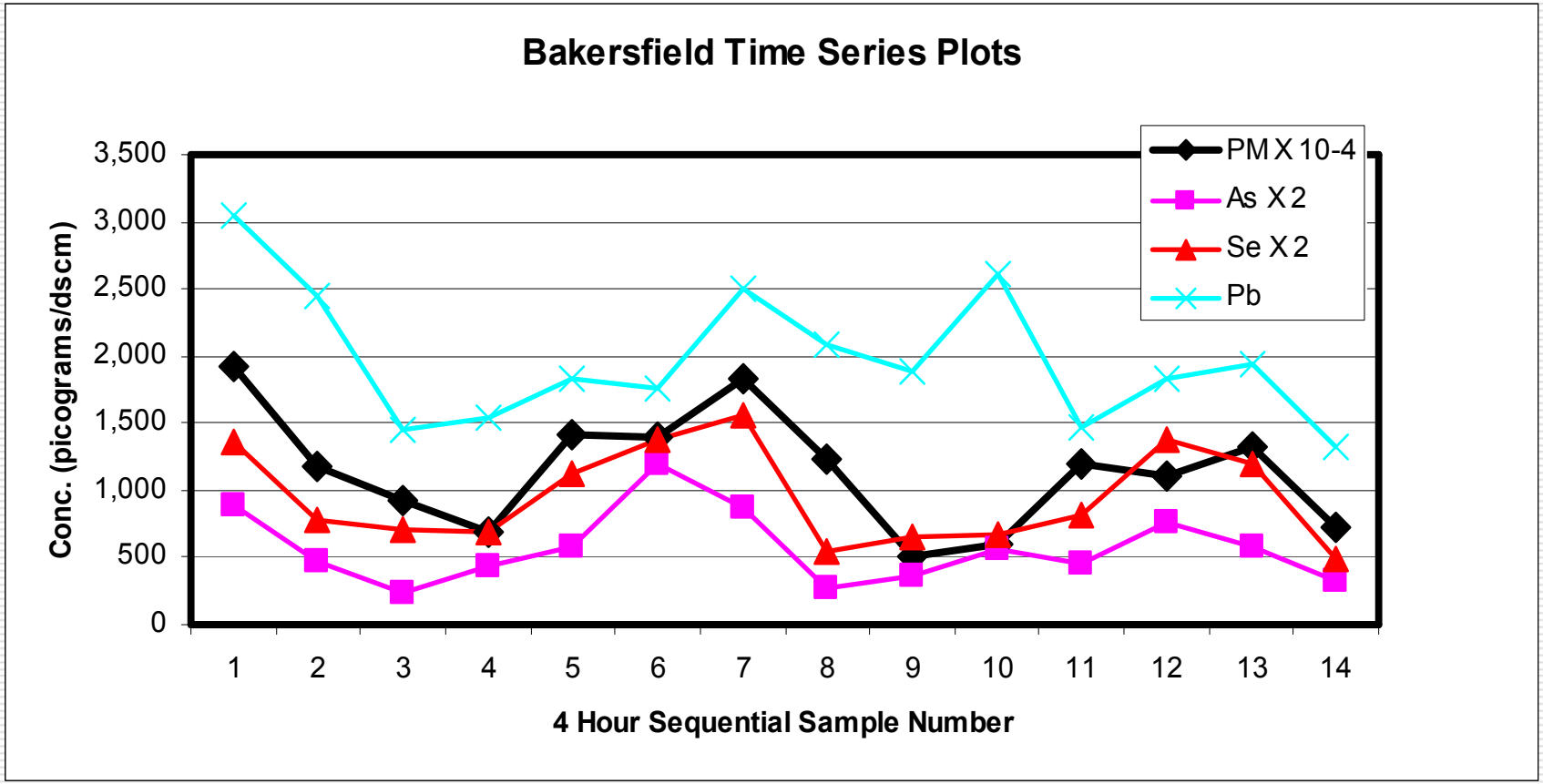


0.3 mg/cm^2 – Recessed Deposit
Maximum flow of 70 lpm/cm^2

Concentrations of Selected Elements (pg/dscm)

ID	Date/Time	Volume	PM X 10-4	As	Se	Zn	Br	Sr	Hg	Pb
CA 1	5/26/05 7:00	3.8	1,920	446	676	6,117	3,800	892	254	3,038
CA 2	5/26/05 11:00	3.8	1,170	234	386	5,308	4,184	576	313	2,450
CA 3	5/26/05 15:00	3.8	930	122	354	4,124	4,081	655	290	1,447
CA 4	5/26/05 19:00	3.8	690	220	346	5,359	3,156	868	308	1,544
CA 5	5/26/05 23:00	3.8	1,410	287	565	6,157	3,753	882	271	1,837
CA 6	5/27/05 3:00	3.8	1,390	601	686	7,513	4,298	1,053	280	1,757
CA 7	5/27/05 7:00	3.8	1,840	439	776	10,476	5,040	921	356	2,500
CA 8	5/27/05 11:00	3.8	1,240	134	268	3,494	3,138	477	242	2,088
CA 9	5/27/05 15:00	3.8	500	183	326	3,611	3,520	613	312	1,881
CA 10	5/27/05 19:00	3.8	600	282	331	3,893	3,655	892	311	2,604
CA 11	5/27/05 23:00	3.8	1,200	230	410	4,282	2,233	665	210	1,467
CA 12	5/28/05 3:00	3.8	1,100	377	691	6,262	3,139	672	341	1,834
CA 13	5/28/05 7:00	3.8	1,320	286	601	5,797	3,164	666	256	1,944
CA 14	5/28/05 11:00	3.8	720	161	247	3,111	2,204	454	254	1,321
CA 15	5/29/05 11:00	3.8	550	141	298	2,314	2,347	361	354	3,683

Example of Mass/Trace Element Temporal Variability



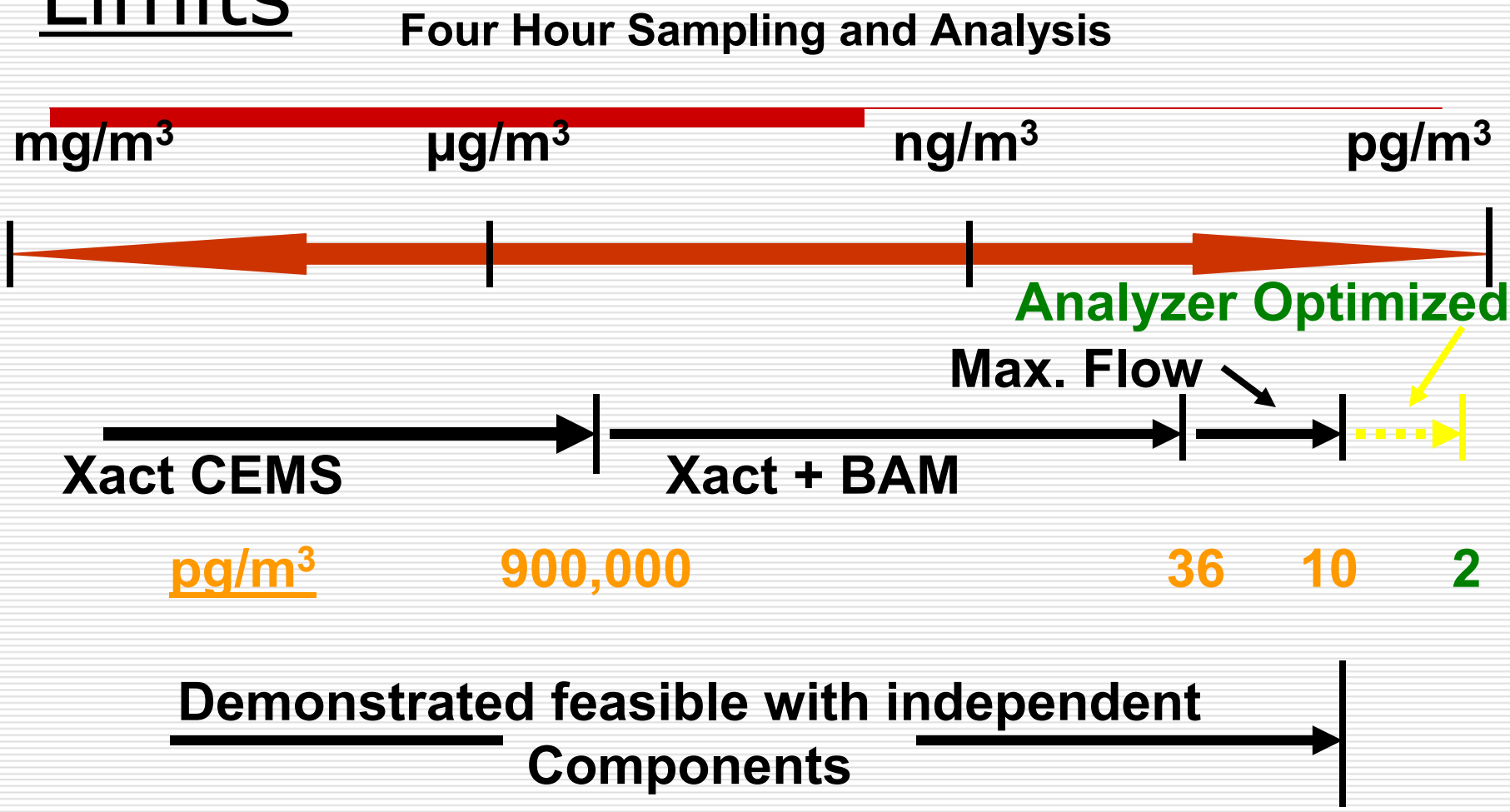
XACT Method Detection Limits (pg/dscm)

	Volumes Sampled		
Element (cond.)	**Target (4 m^3/cm^2)**	**Actual (2.9 m^3/cm^2)**	**Potential (8.7 m^3/cm^2)****
Cr (1)	37	51	17
Mn (1)	33	46	15
Ni (2)	59	82	27
Cu (2)	52	72	24
Zn (2)	39	53	18
As (2)	26	36	12
Se (2)	25	34	11
Ag (3)	192	265	88
Cd (3)	248	341	114
Sb (3)	677	934	311
Hg (2)	53	74	25
Tl (2)	45	62	21
Pb (2)	48	66	22

* Assumptions: Interference-free, 95% Currie detection limits using stretched PTFE filter tape and four hour analysis in air.

** Based on Metone filter loading tests with 0.6 µm PM demonstrating capacity for 250 µg/cm2 and current Xact.

Demonstrated Range of Feasible Limits

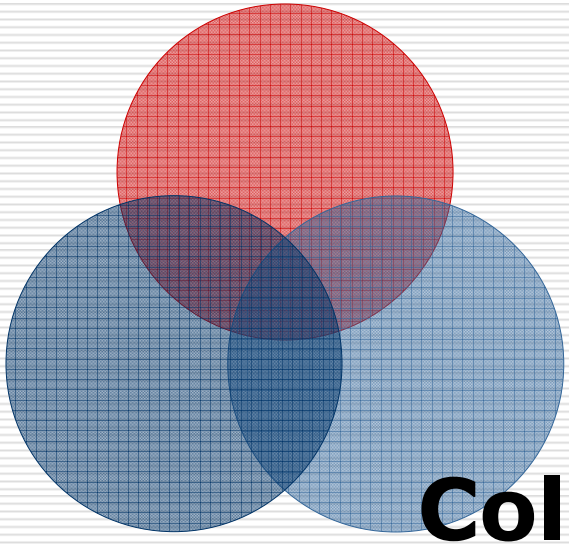


Outcome

- **Collaborators completed project and prepared feasibility study report**
- **Team recommended options to internalize technology integrations as "normal business practice"**
- **Monitoring Technology Group continues project with funding from Air Toxics Program**
  - **Demonstrate deposit uniformity and sample integrity**
  - **Optimize XRF detection design.**

Keys to Successful Technology Integration

Knowledge



Vision **Collaboration**

Knowledge

- Current and near-term ambient and source measurement application needs
- Commercially-available measurement and monitoring technologies
- On-going research, development, and application studies

Vision

- **Make independent technological developments intersect or converge to new measurement needs**
- **Pick "low-hanging fruit"- maximum near-term benefits, high probability of success, manageable resource investment**

Collaboration

- **EPA identifies and prioritizes ambient / source monitoring applications with technology integration benefits**
- **Developers generate new measurement technologies**
- **Vendors recognize opportunities and provide equipment packages**
- **State agency/private sector entities pilot evaluation studies**