

A Hybrid Vehicle Mounted Membrane Inlet Mass Spectrometer for Spatial Analysis of Atmospheric Chemical Concerns

Dr. Guido Verbeck
Phillip Mach
Ethan McBride



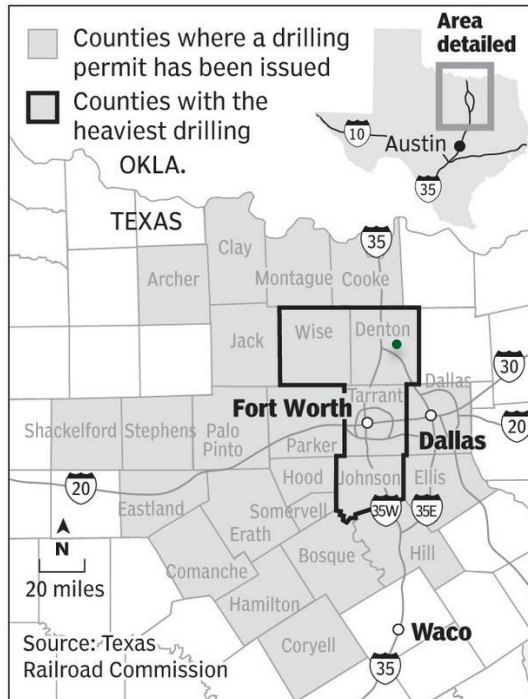
Dr. Kenneth Wright



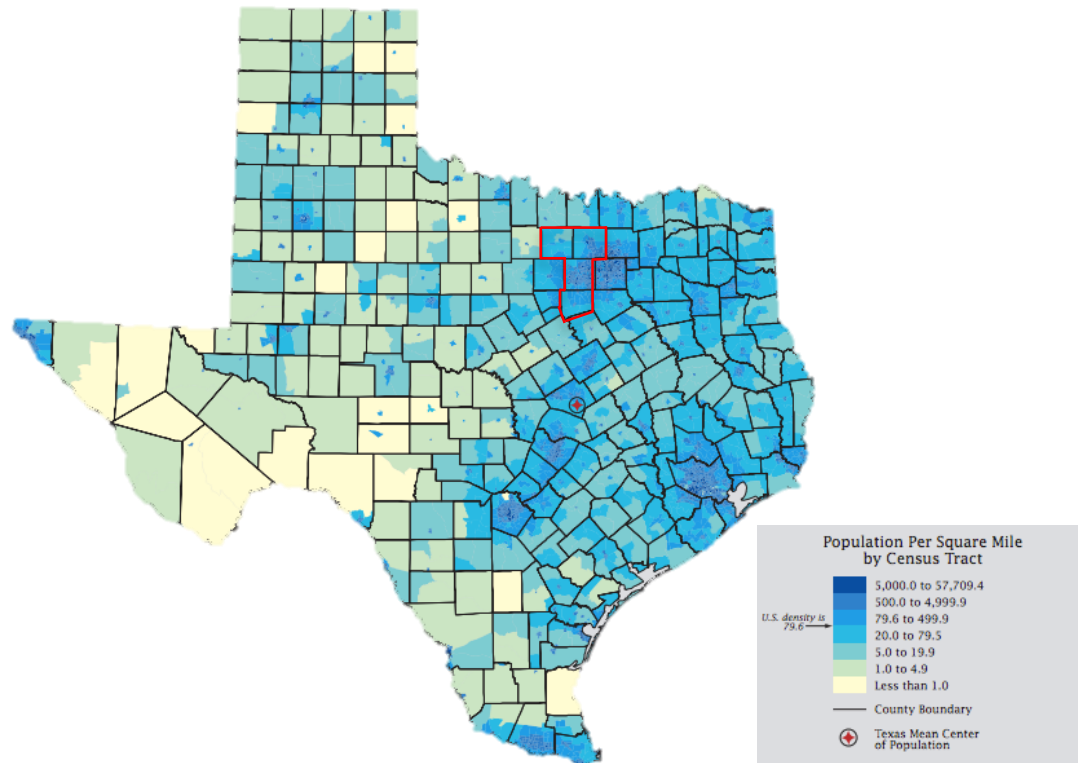
Oil and Gas Well Drilling in DFW

Drilling in the Barnett Shale

The Texas Railroad Commission has issued at least 17,800 permits between 2000 and 2009 to drill in the Barnett Shale.



- ◆ Increased urban drilling presence has raised environmental impact concerns
- ◆ NOAA led studies have shown that wells emit more fugitive effluent than previously estimated



Potential Environmental Impacts

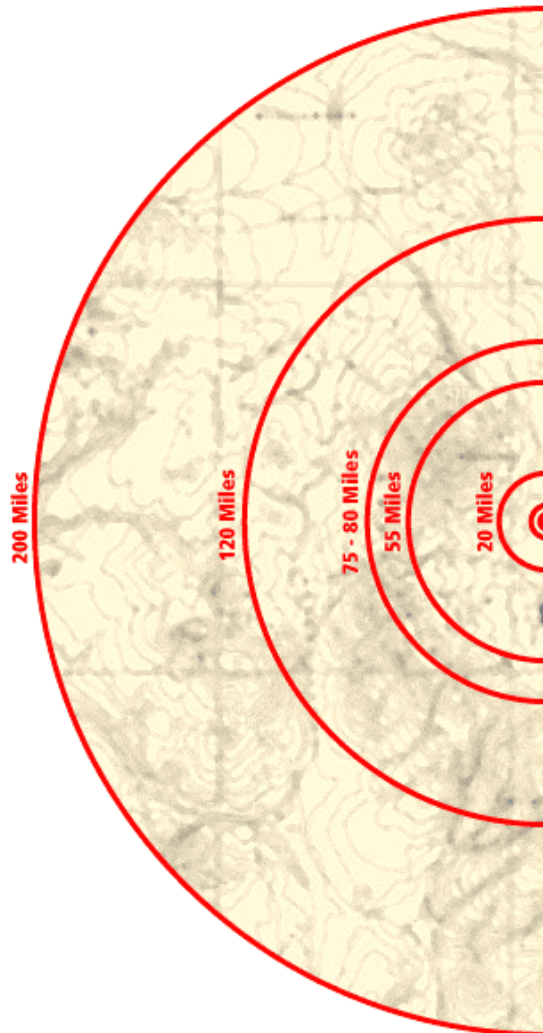


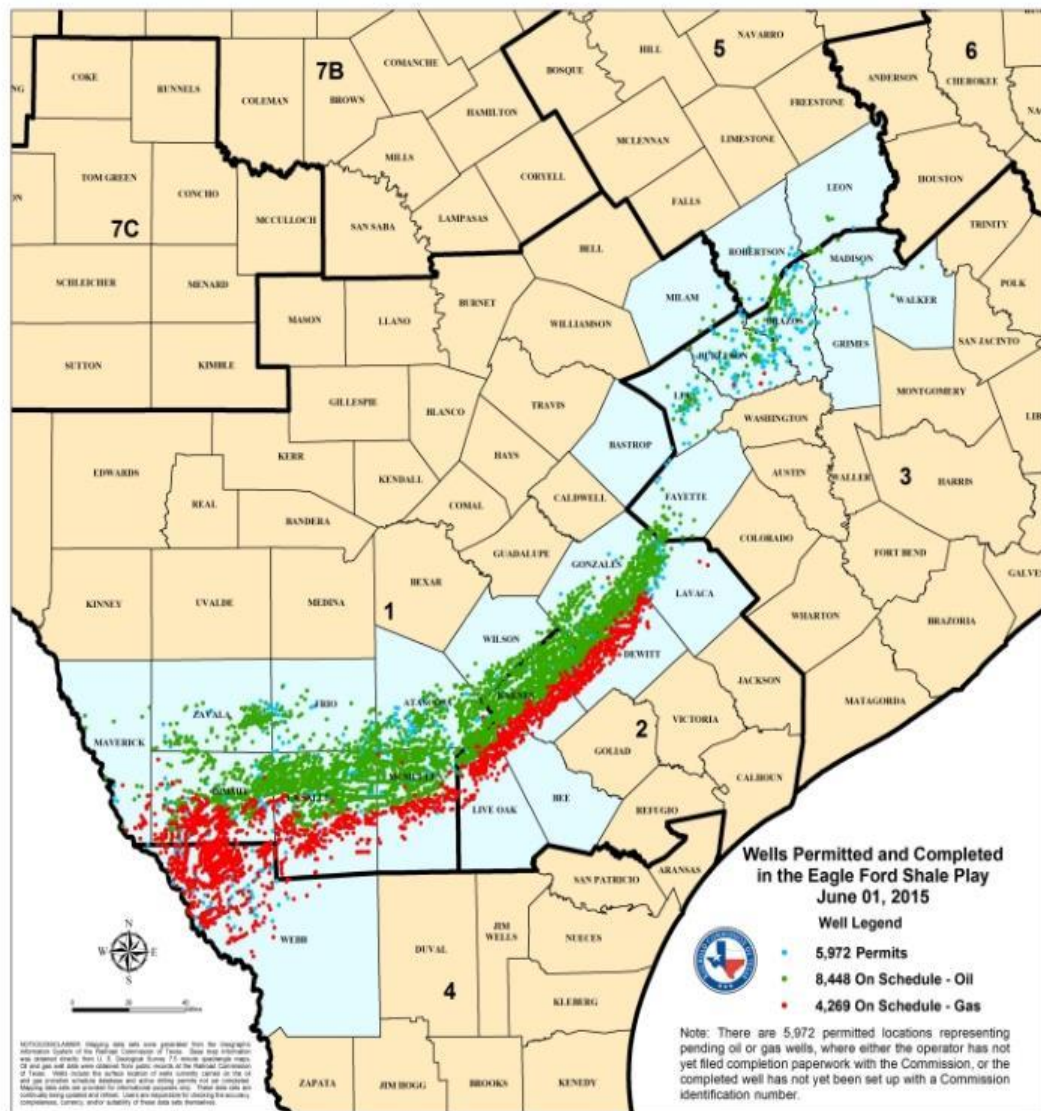
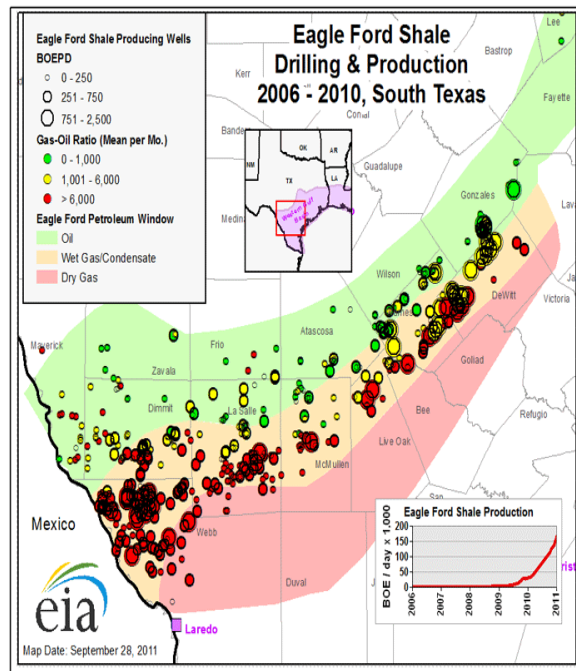
INDUSTRY'S "FOOTPRINT"

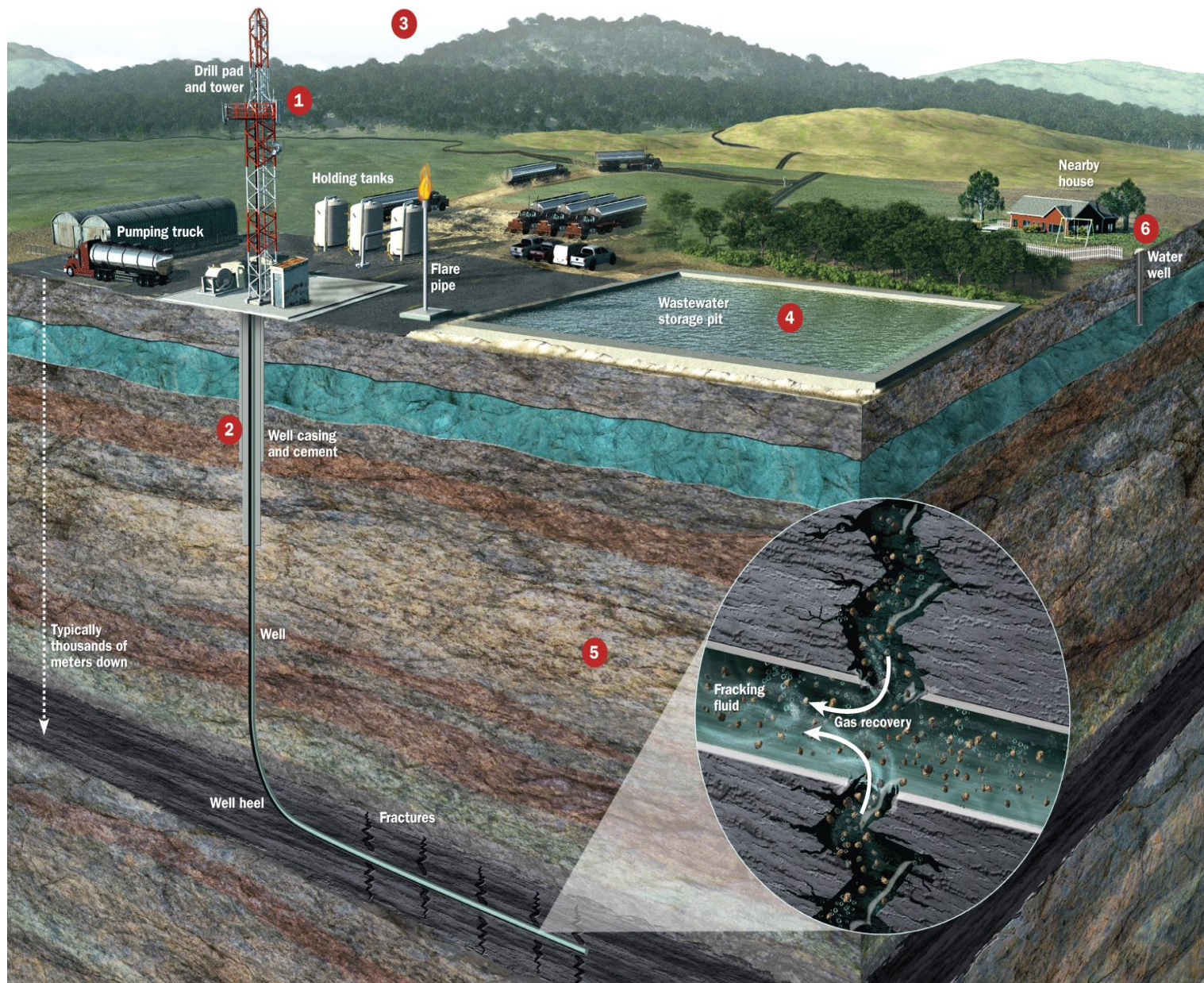
When a mining, oil or gas corporation proposes to mine or drill on pristine public lands, the company often defends its development plans with statistics on the size of the operational "footprint" – the amount of land that will be denuded of vegetation for roads, buildings, concrete well pads, waste pits, processing facilities and other infrastructure.

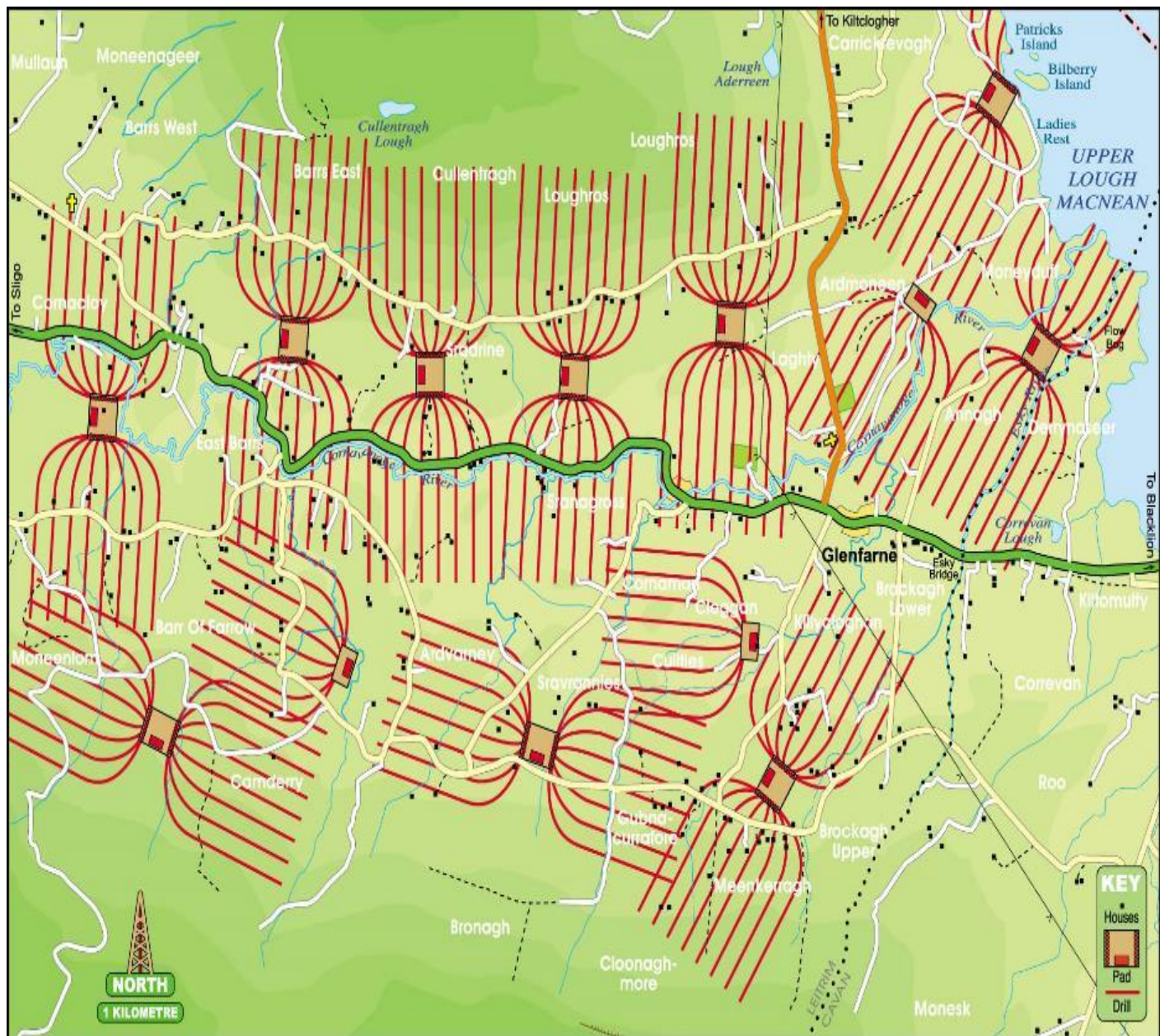
In reality the footprint is rarely so remarkably contained as industry would have officials believe: government studies document that 40 percent of all Western headwaters are polluted with mine waste, and that in some cases plumes of smog that rival big city pollution will extend hundreds of miles from well fields.

DISTANCE	IMPACTS
0.5 miles	Noise impacts from oil & gas drilling
0.66 miles	Surface water pollution from gas drilling
5+ miles	Views marred by oil & gas wells
20 miles	Groundwater pollution from mining
55 miles	Soil contaminated by mining dust
75 - 80 miles	Migrating wildlife impacted
120 miles	Surface water pollution from mining
200 miles	Air pollution from oil & gas drilling













Austin

San Antonio

Houston

EAGLE FORD SHALE ACTIVITY

GULF OF MEXICO

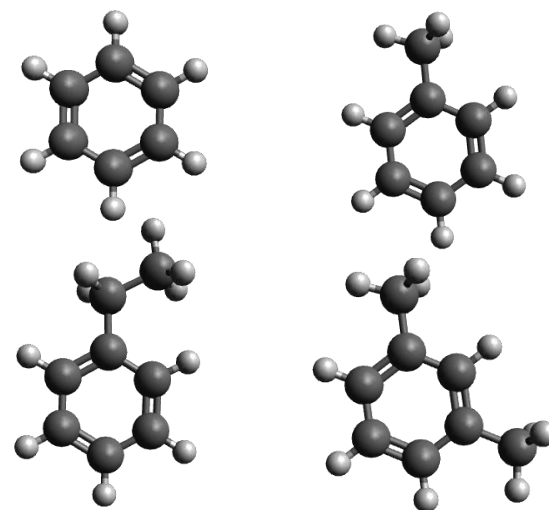
Corpus Christi

Laredo

Emissions to be Monitored

BTEX emissions are of great concern to citizens living in the vicinity of urban oil and gas drilling processes

OSHA PEL: Benzene: 1.0 ppmv
Toluene: 200 ppmv
Ethylbenzene: 100 ppmv
Xylenes: 100 ppmv



Region	Number of Sites Tested	% of Sites with Visible Emissions
Dallas/Ft. Worth	12	100
Amarillo	17	95
Midland	150	100
Houston	46	90
Corpus Christi	25	95

Fugitive Effluent



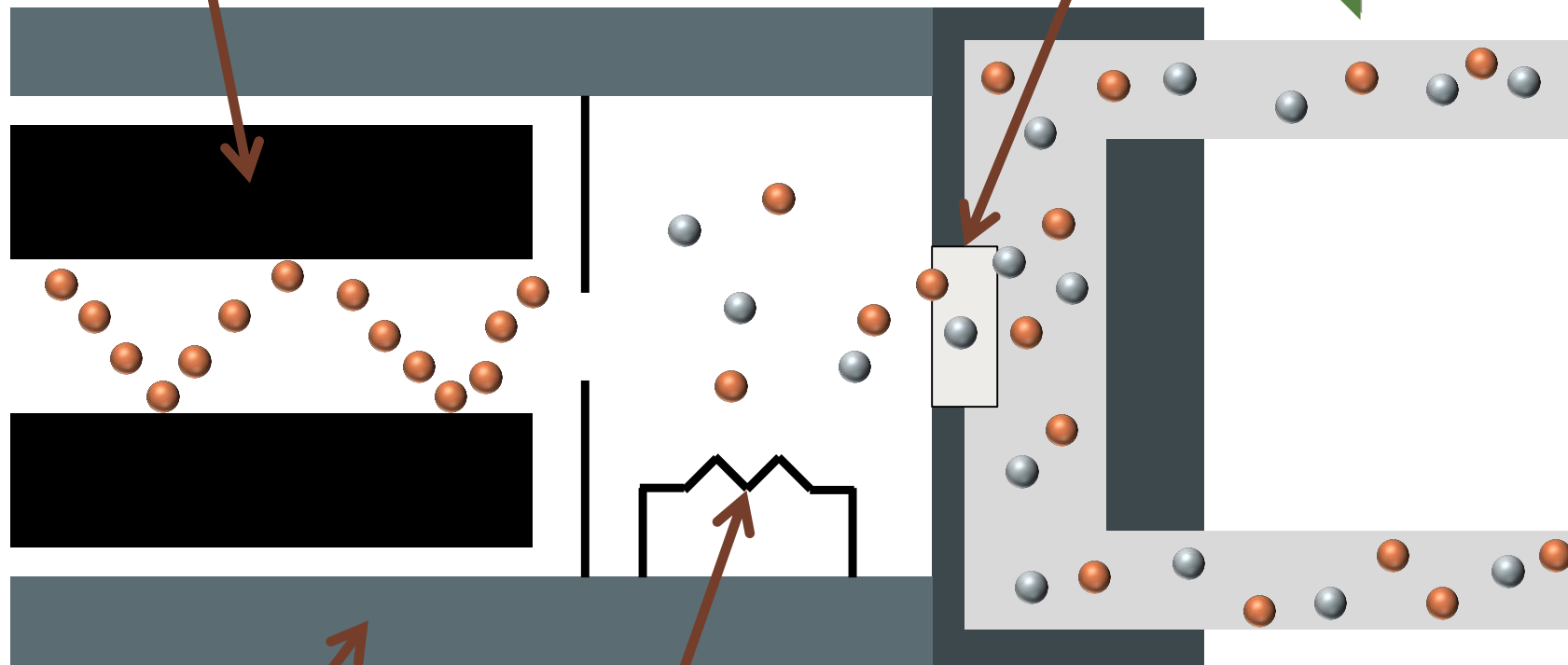
<http://www.tceq.texas.gov/publications/pd/020/2012-NaturalOutlook/making-air-emissions-visible>

MIMS

Quadrupole Rods

Membrane

Analyte In



Vacuum Chamber

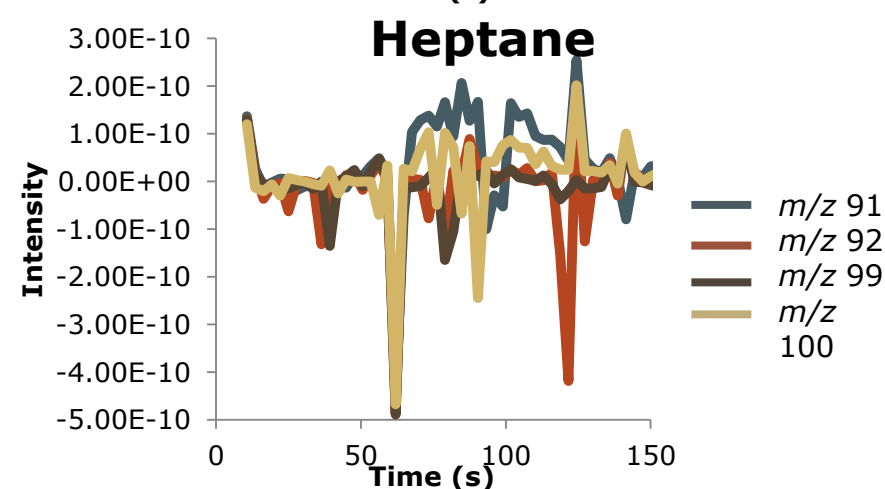
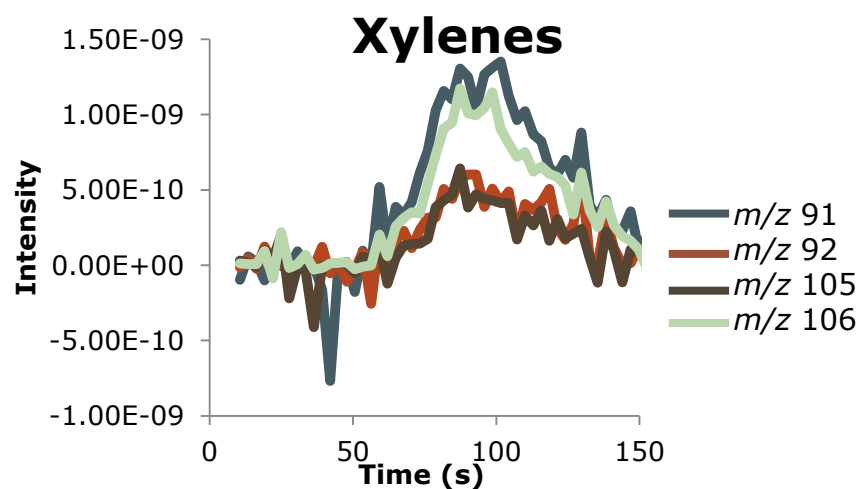
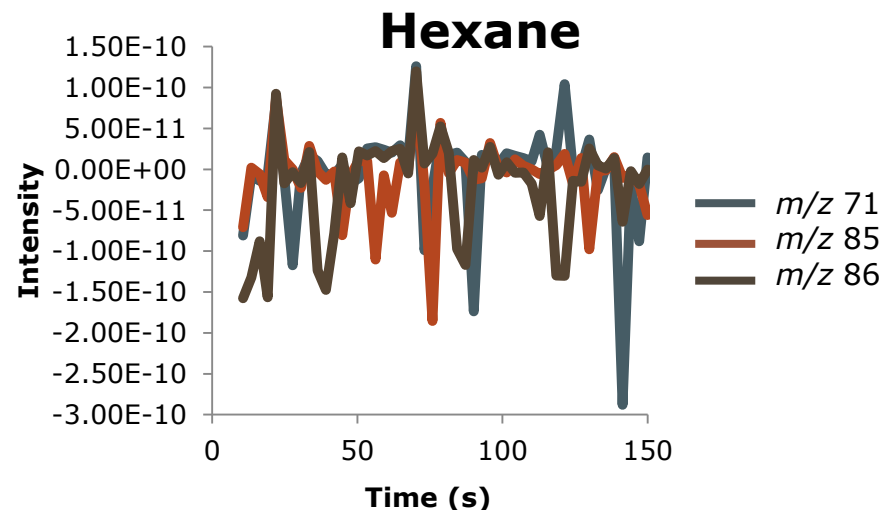
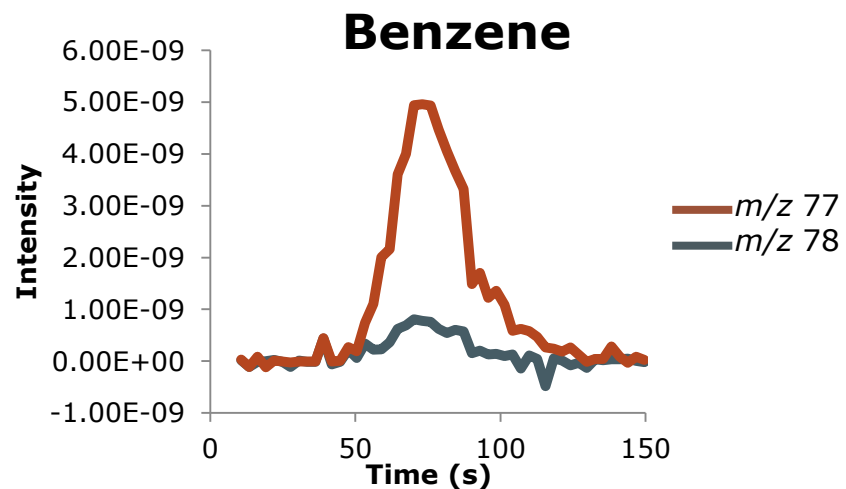
Filament

Analyte Out

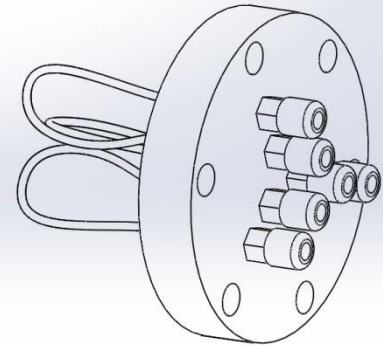
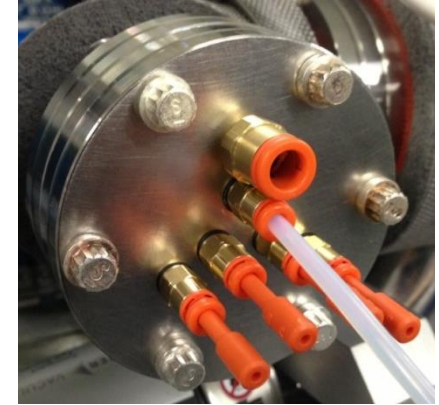
Volume Equivalents at LOD

Compound	Minimum Measured Leak Rate (g/hr)	Volume Equivalent at OSHA PEL (m ³)
Benzene	3.5	1005.7
Toluene	3.8	4.6
Ethylbenzene	1.5	3.2
Xylenes	1.9	4.0
Compound	Minimum Measured Leak Rate (g/hr)	Volume Equivalent at Inficon CPM LOD (m ³)
Benzene	3.5	6095.5
Toluene	3.8	5610.9
Ethylbenzene	1.5	1922.3
Xylenes	1.9	2434.9

Membrane Response

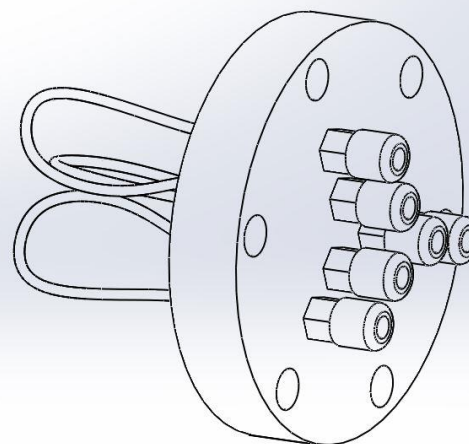
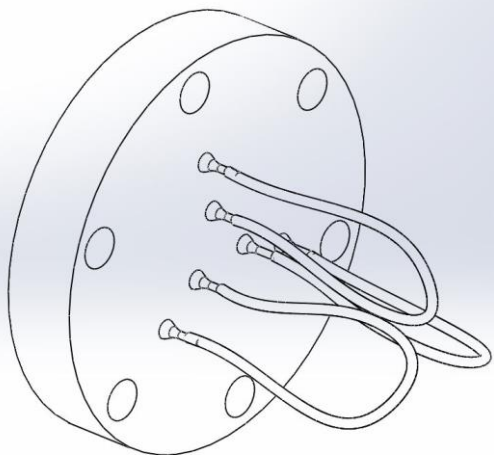
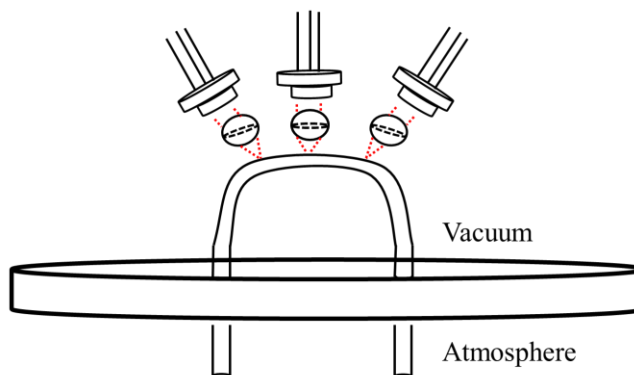
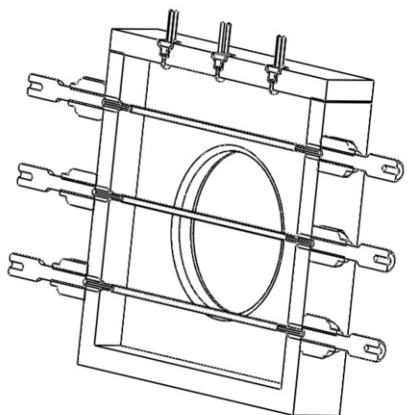


INFICON Rack Mount MIMS Eng Prototype w/ MPH

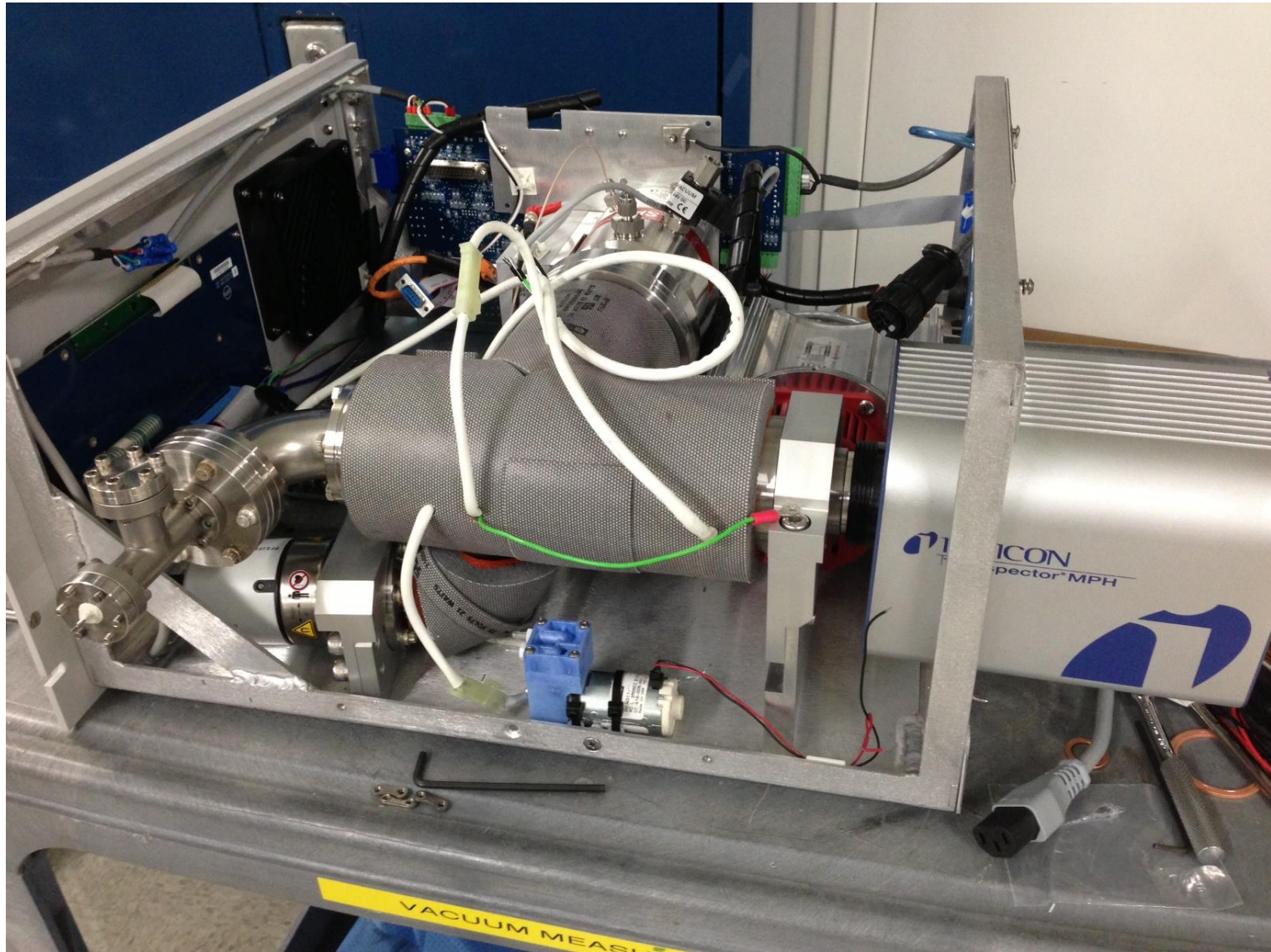


Acknowledgement: Jaime Winfield and Les Volles, INFICON Inc

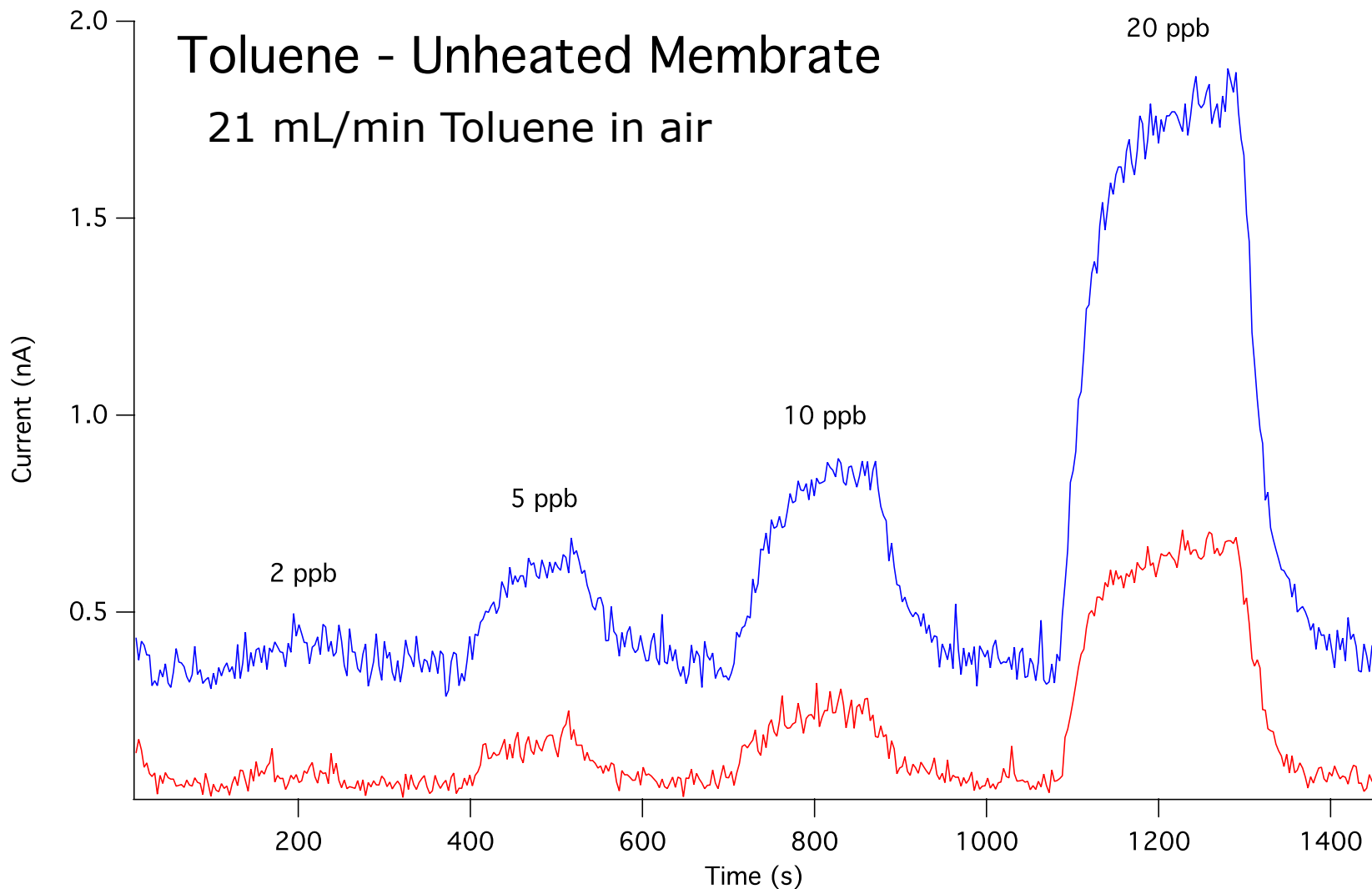
Development of Multi-Membrane Near-Infrared Diode Mass Spectrometer for Field Analysis of Aromatic Hydrocarbons,
JASMS,26 (2015), 281.



INFICON Rack Mount MIMS Eng Prototype w/ MPH



Open Source Data





All Electric Mode

- Analysis Mode

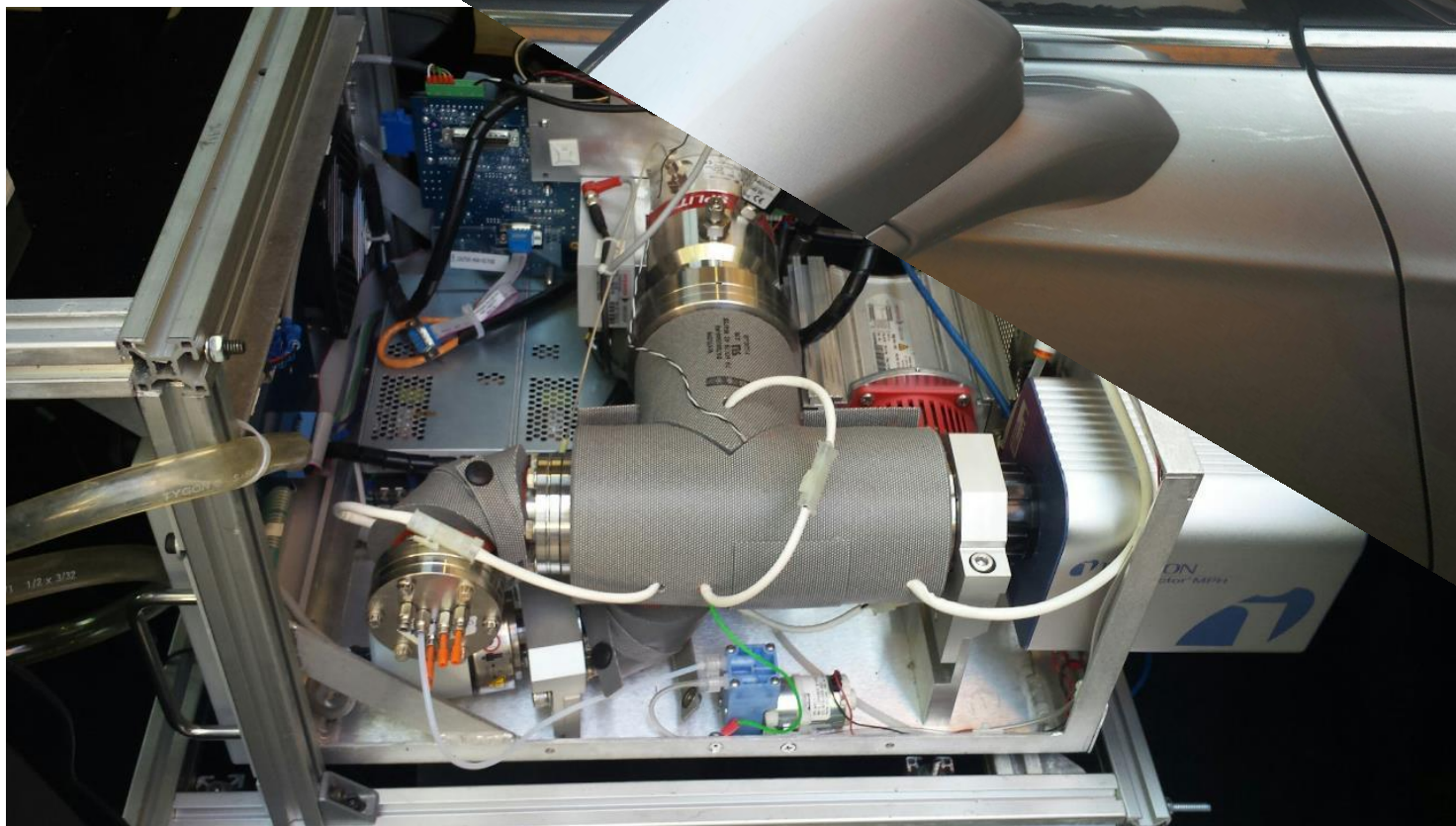
Or Hybrid Mode

All Gas Mode

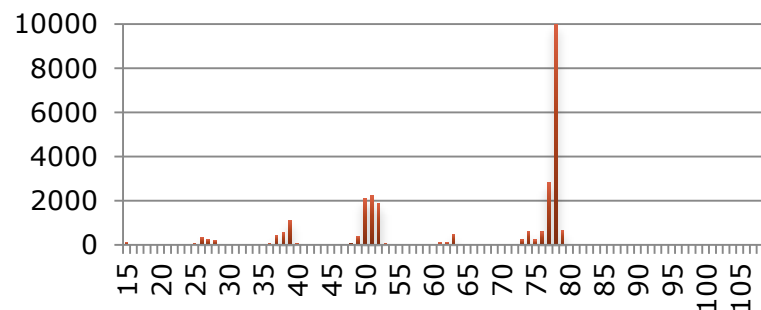
- Drive to location
- Power up Pumps and Peripherals
- Return Home



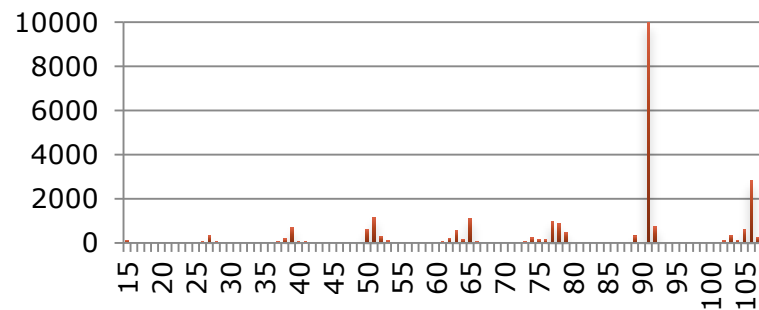




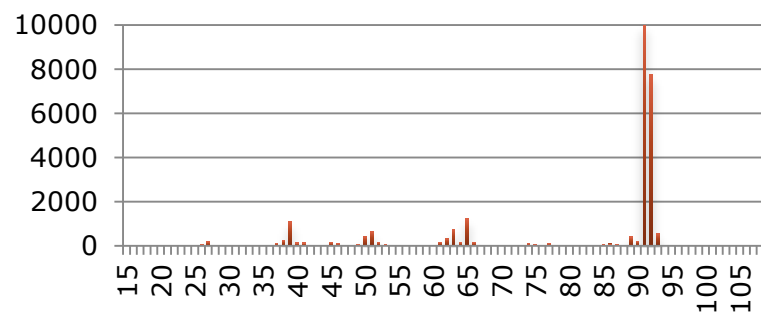
Benzene



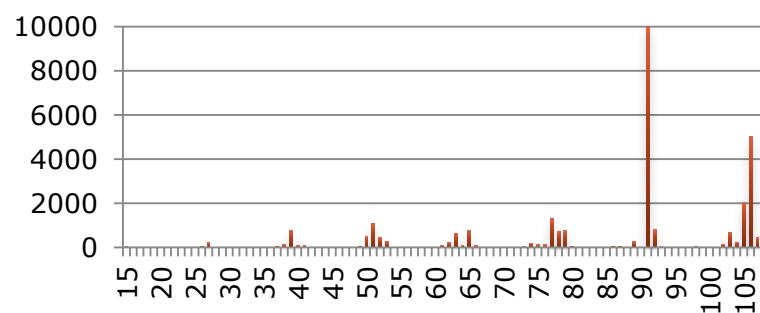
Ethylbenzene



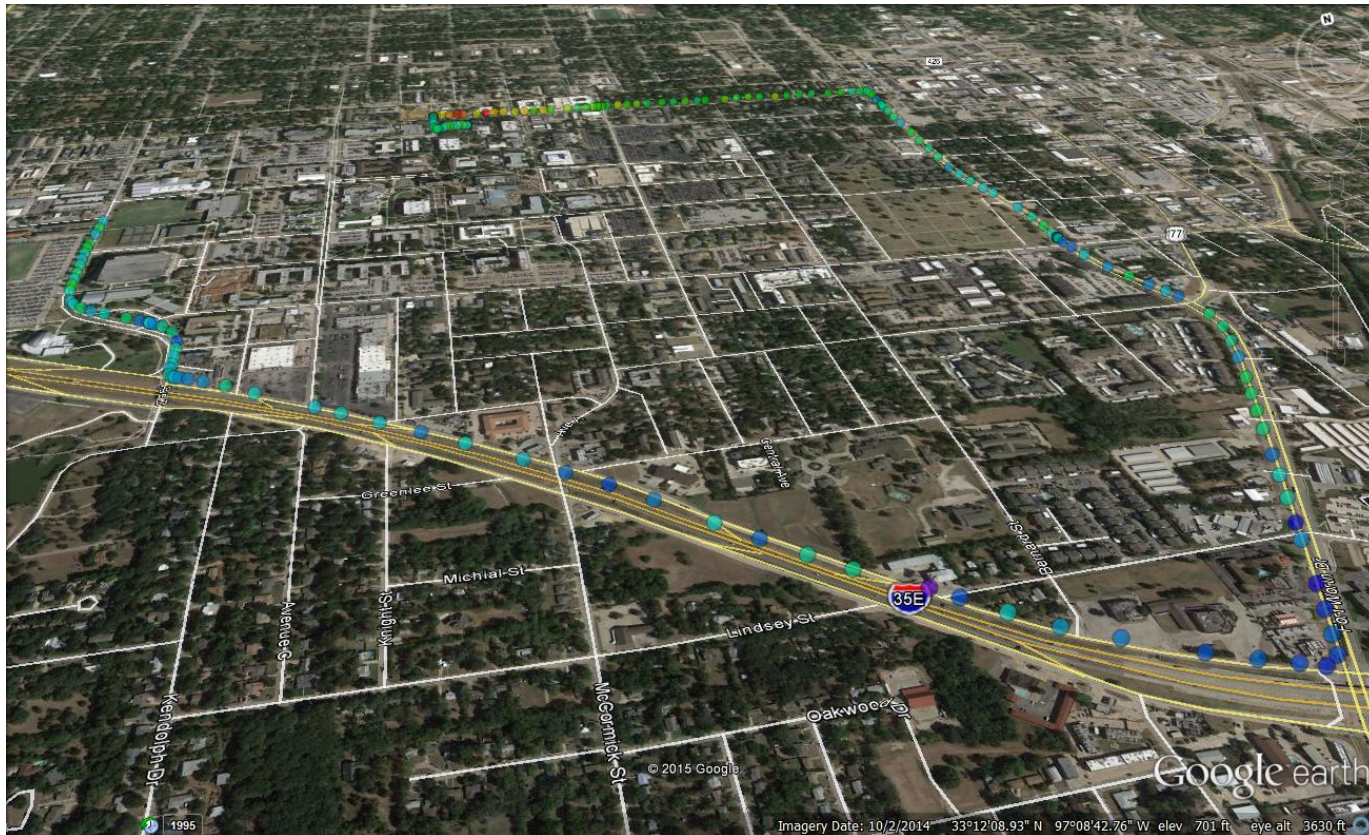
Toluene



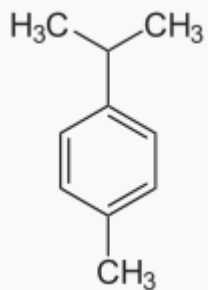
Xylene



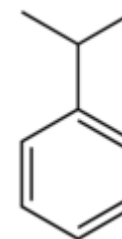
Mapping Data – Campus



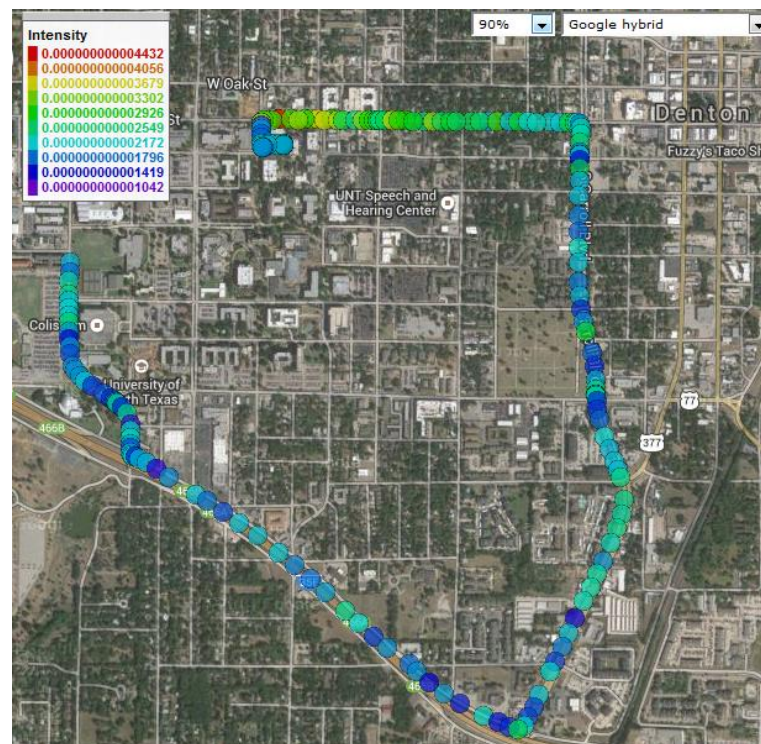
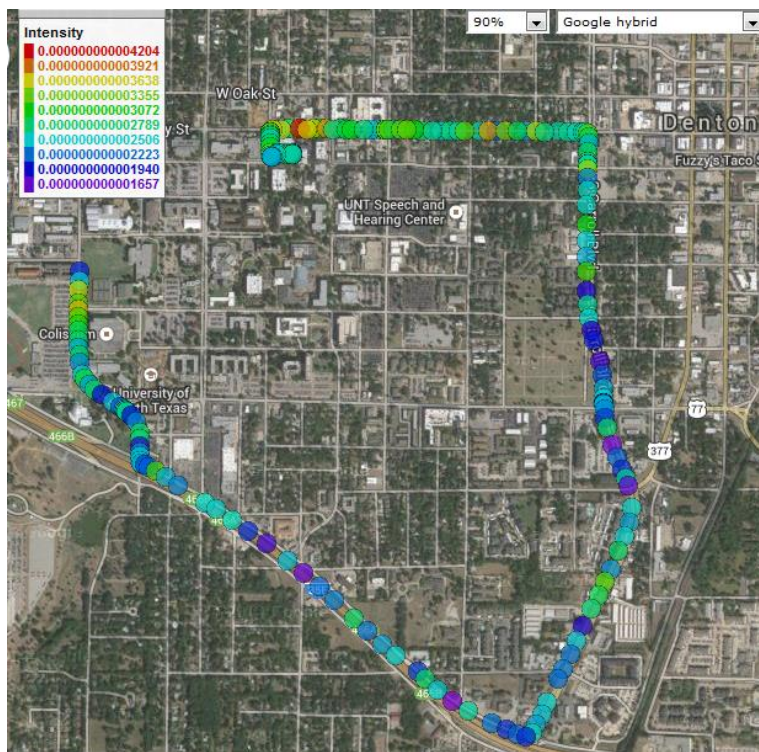




p-Cymene

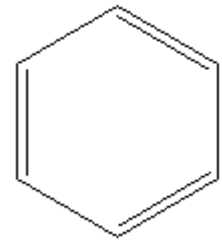


m/z 105 Cumene

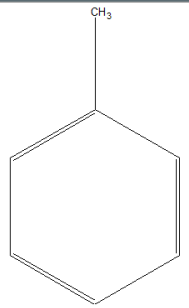




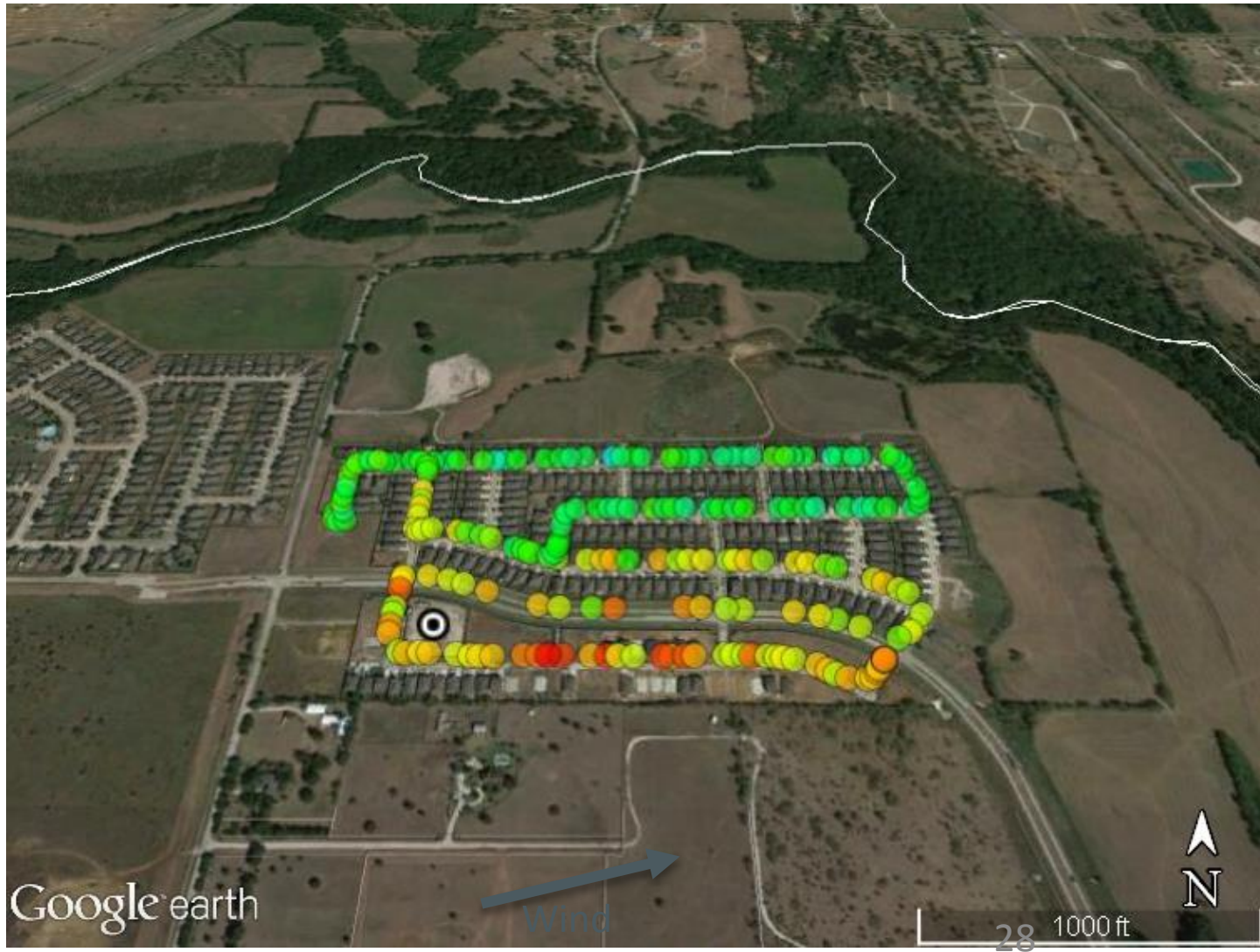
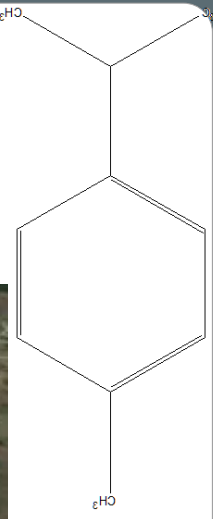
Deep Well Injection - Benzene



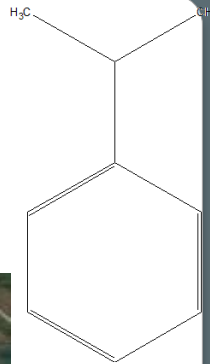
Deep Well Injection – Toluene

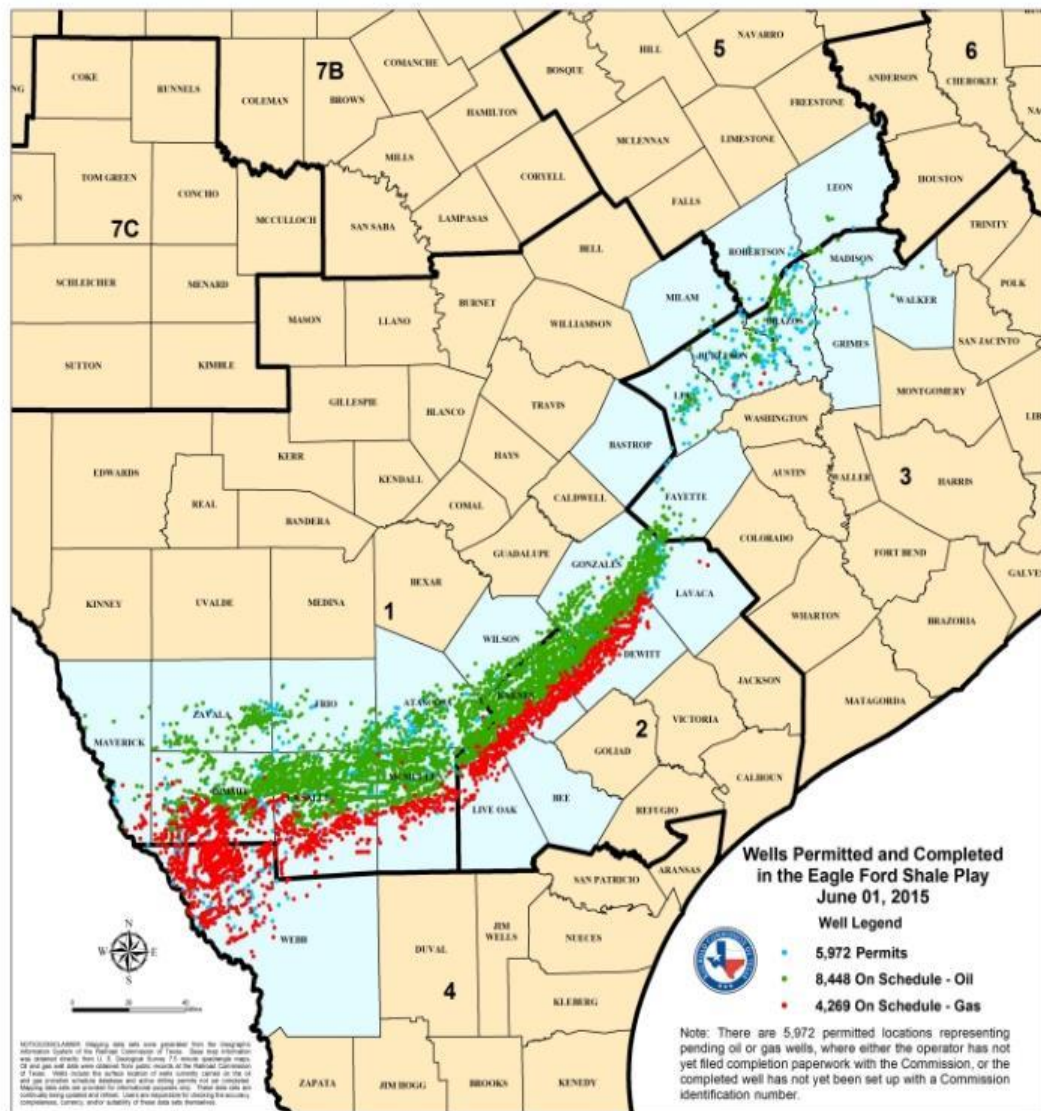
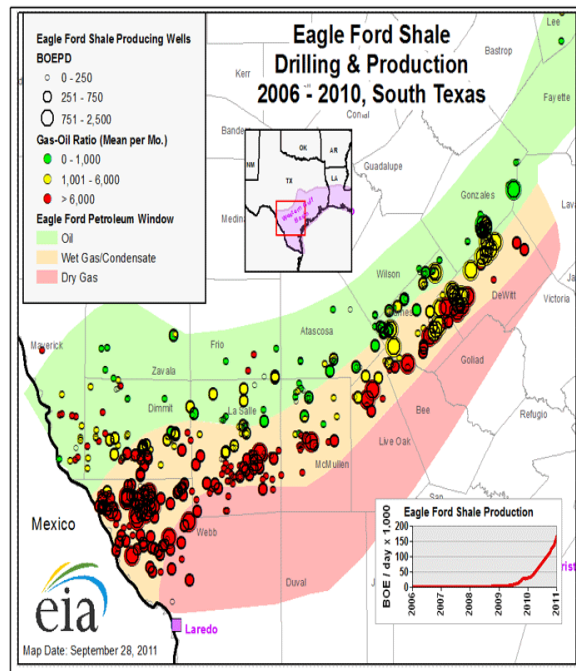


Deep Well Injection - Cymene



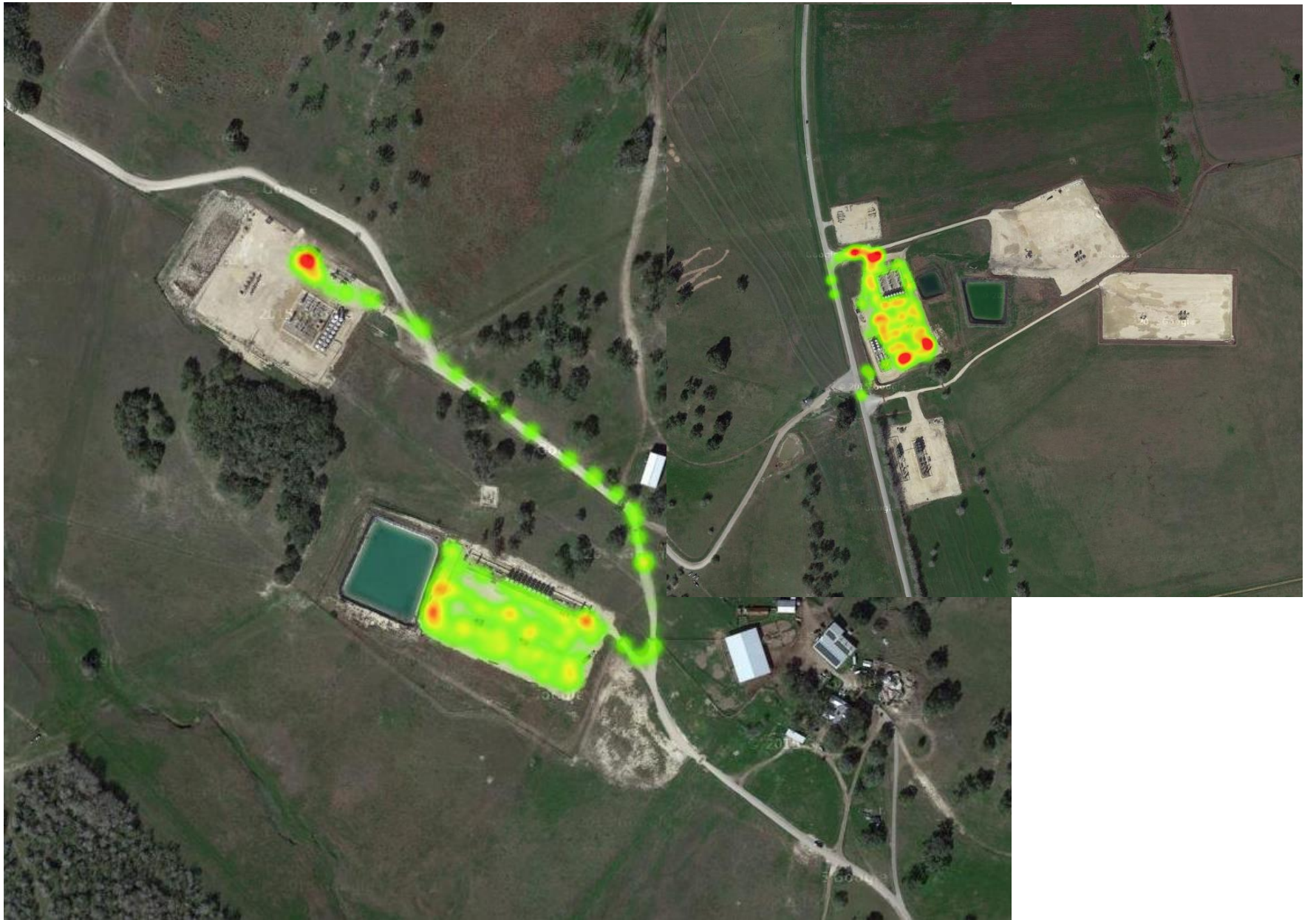
Deep Well Injection – Cumene











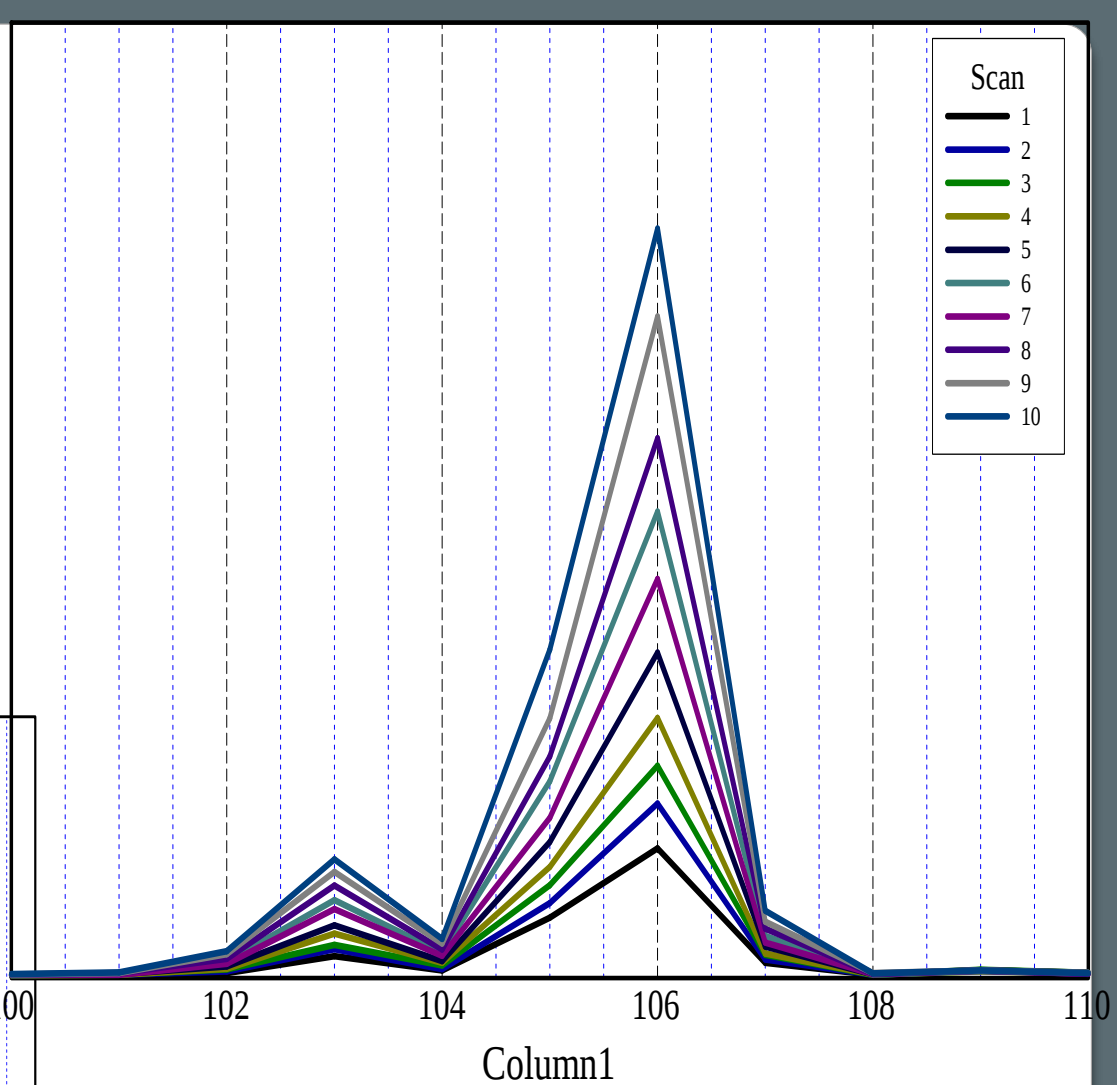
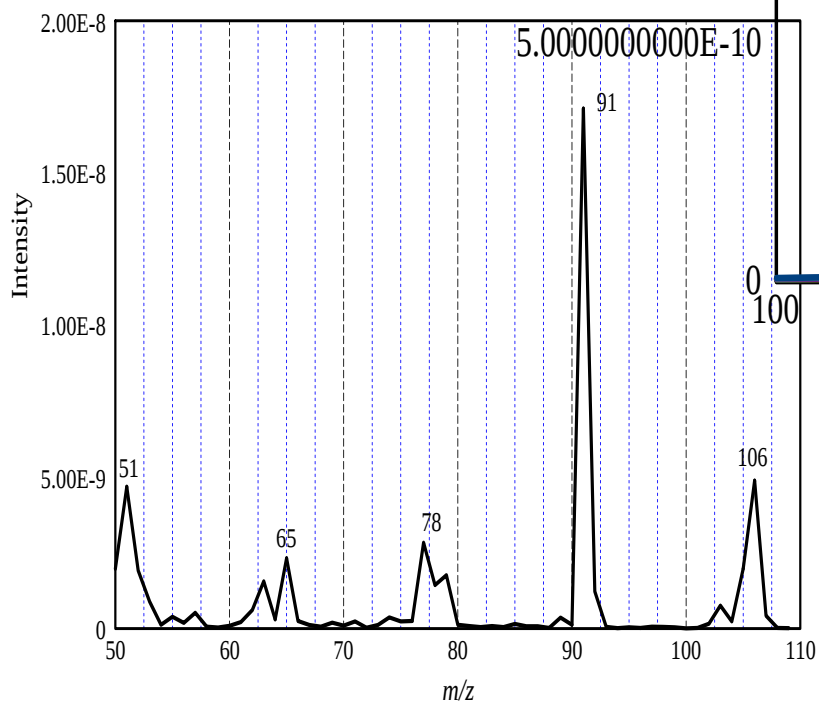




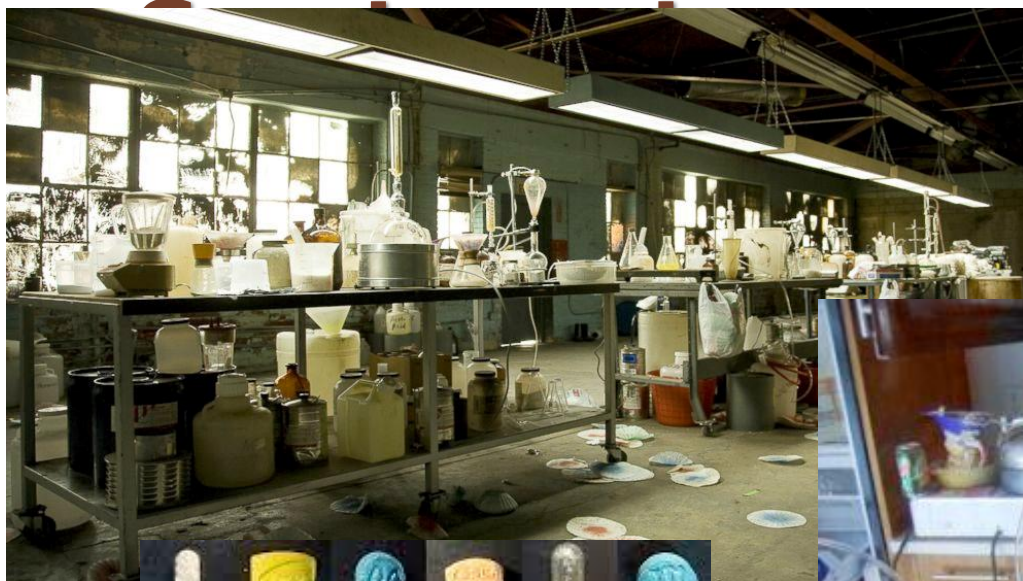


Intensity

2.0000000000E-9
1.5000000000E-9
1.0000000000E-9

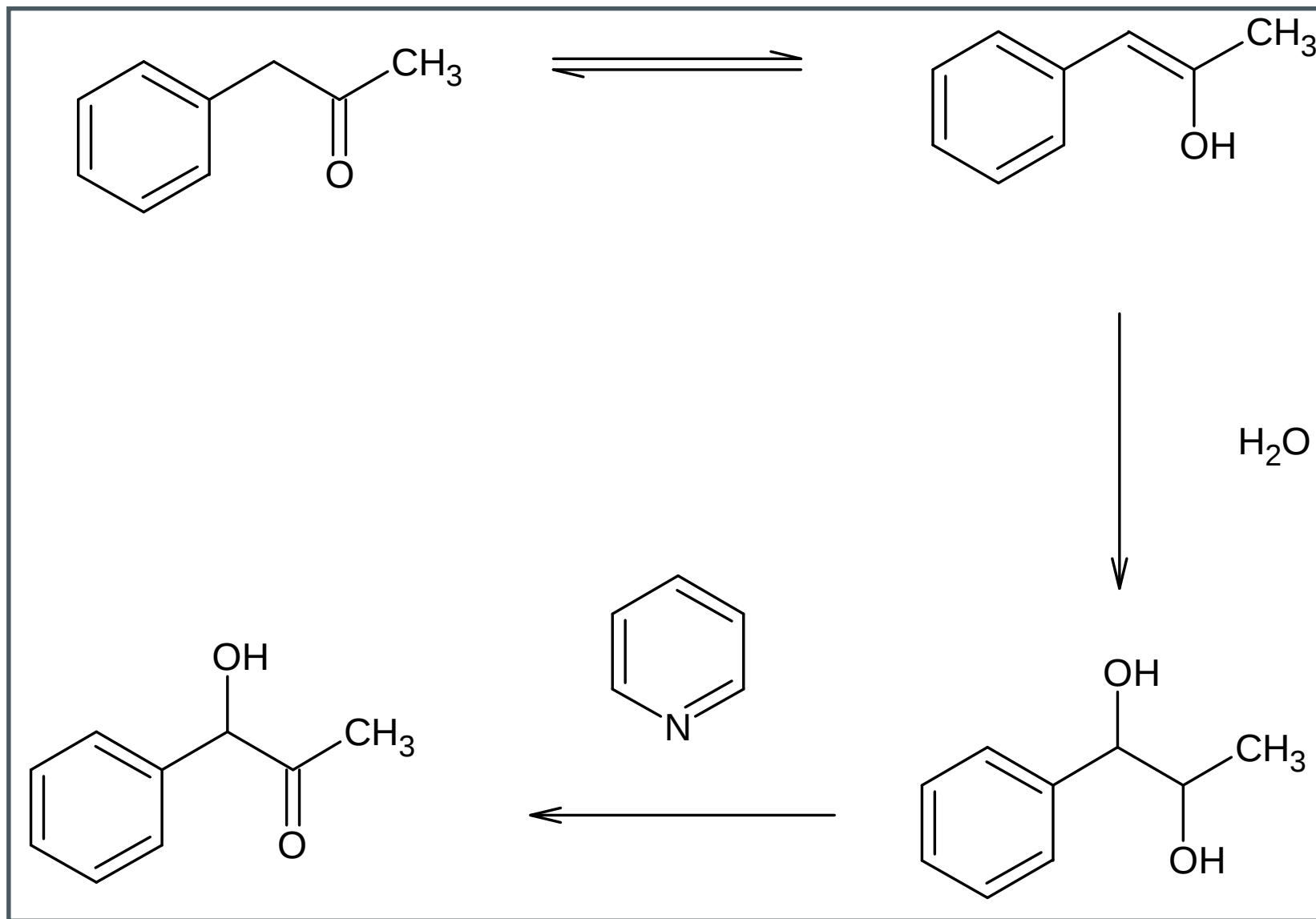


Detection of Simulated Clandestine Laboratory Methamphetamine Precursor Synthesis via Mobile Mass

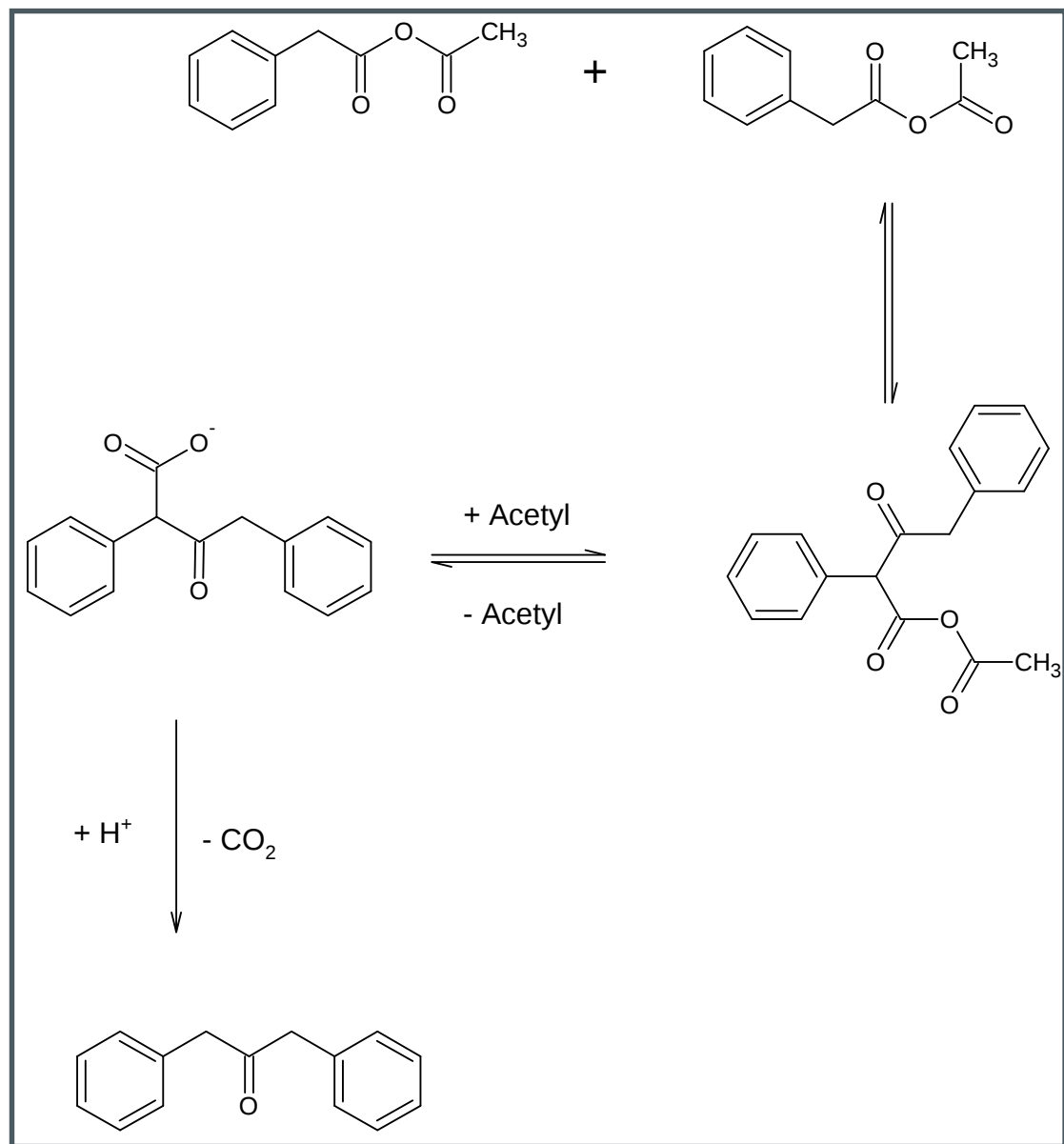




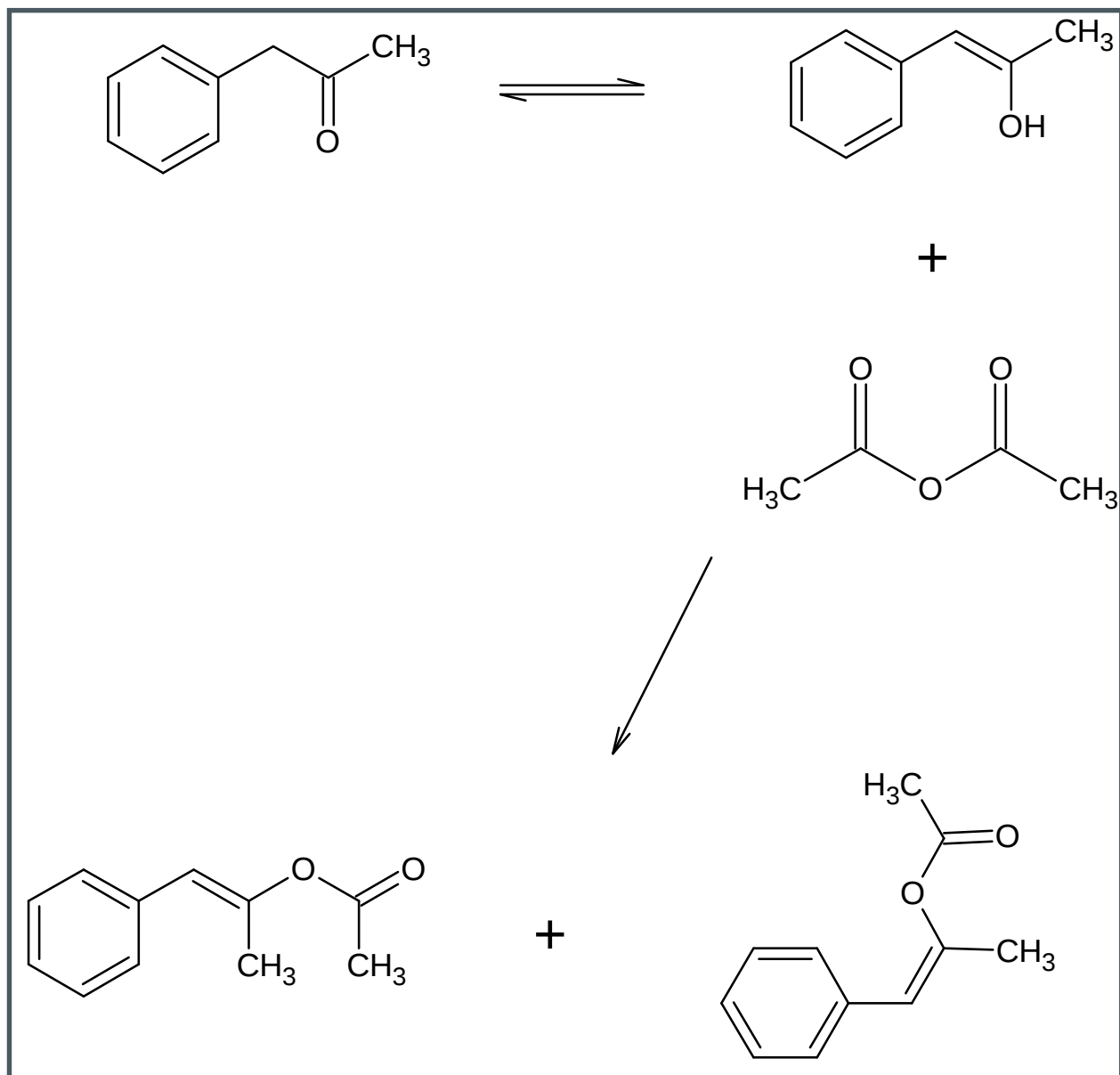
Phenylacetylcarbinol Synthesis



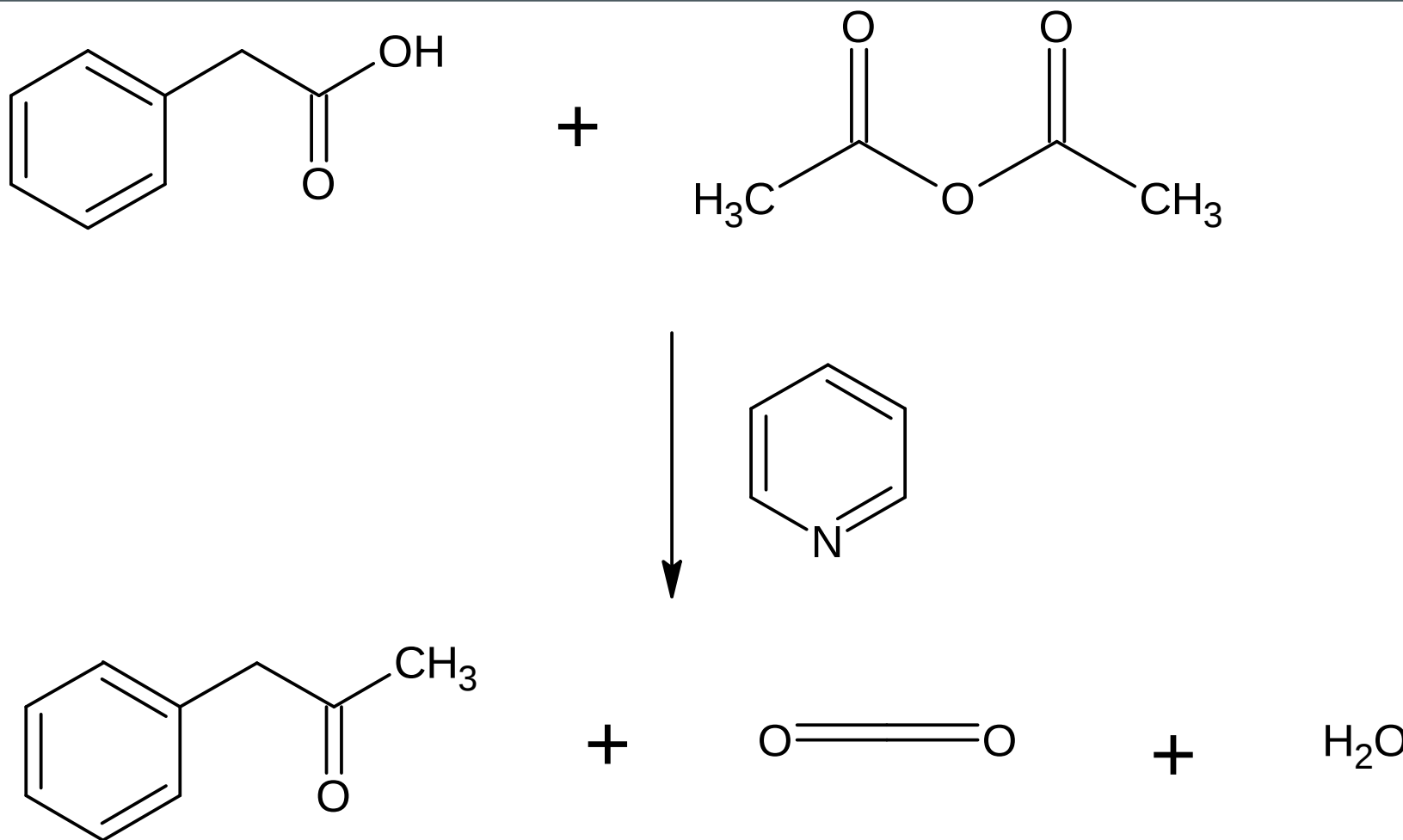
Dibenzyl Ketone Synthesis



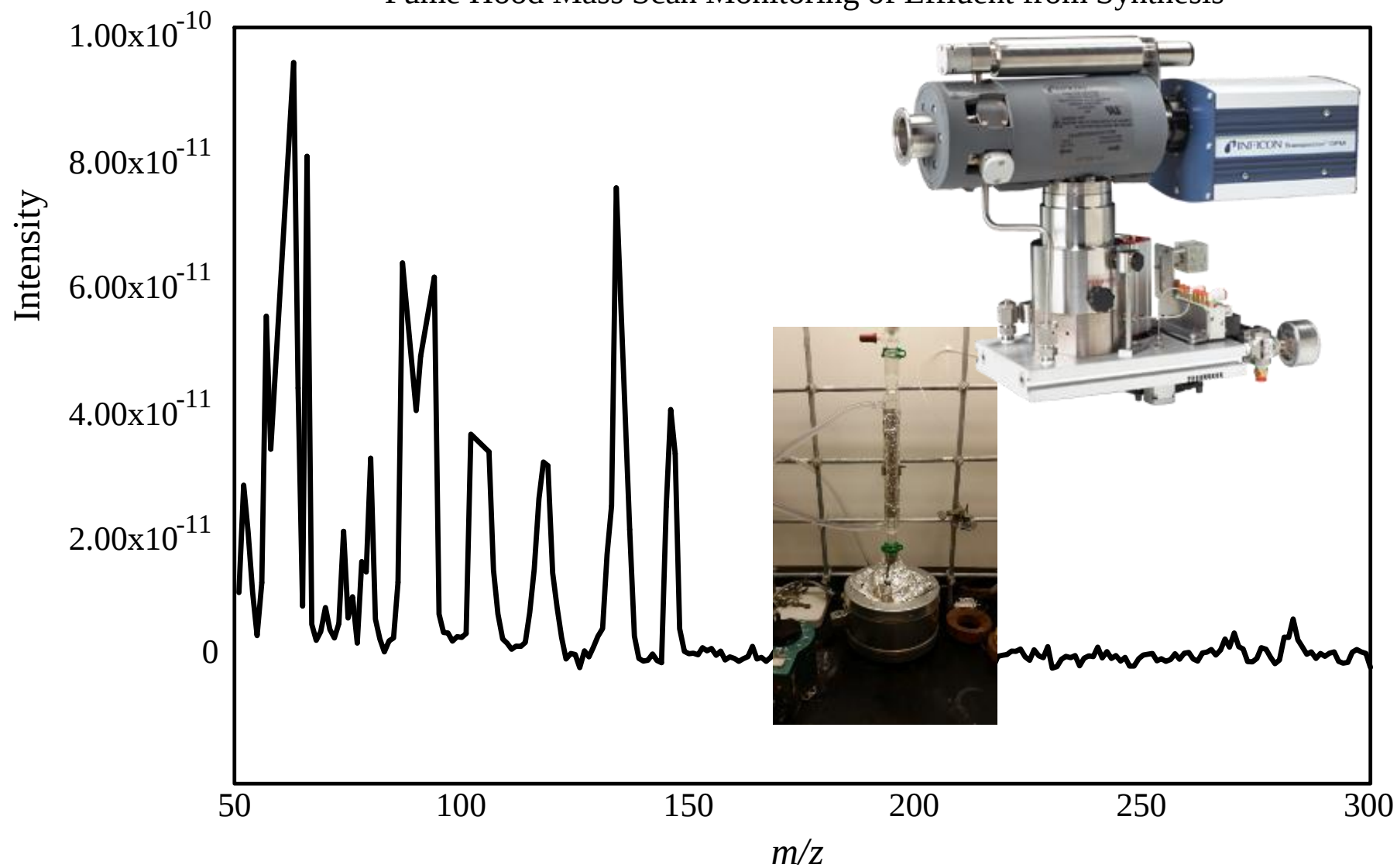
(1E & 1Z)-1-Phenylprop-1-en-2-yl acetate Synthesis



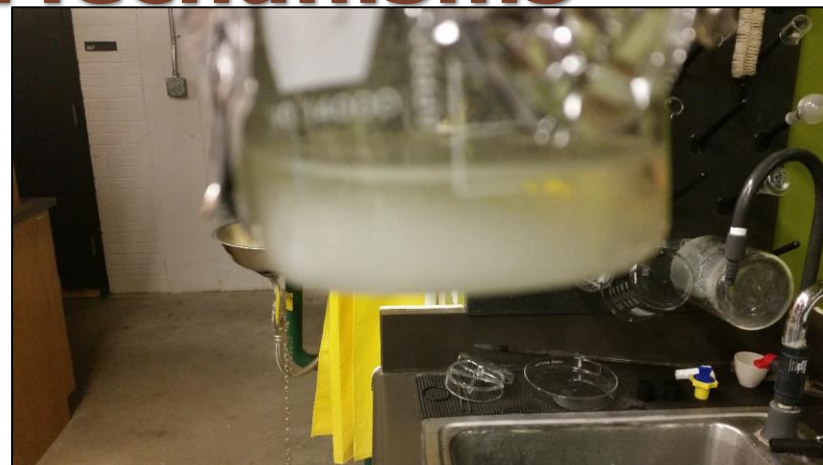
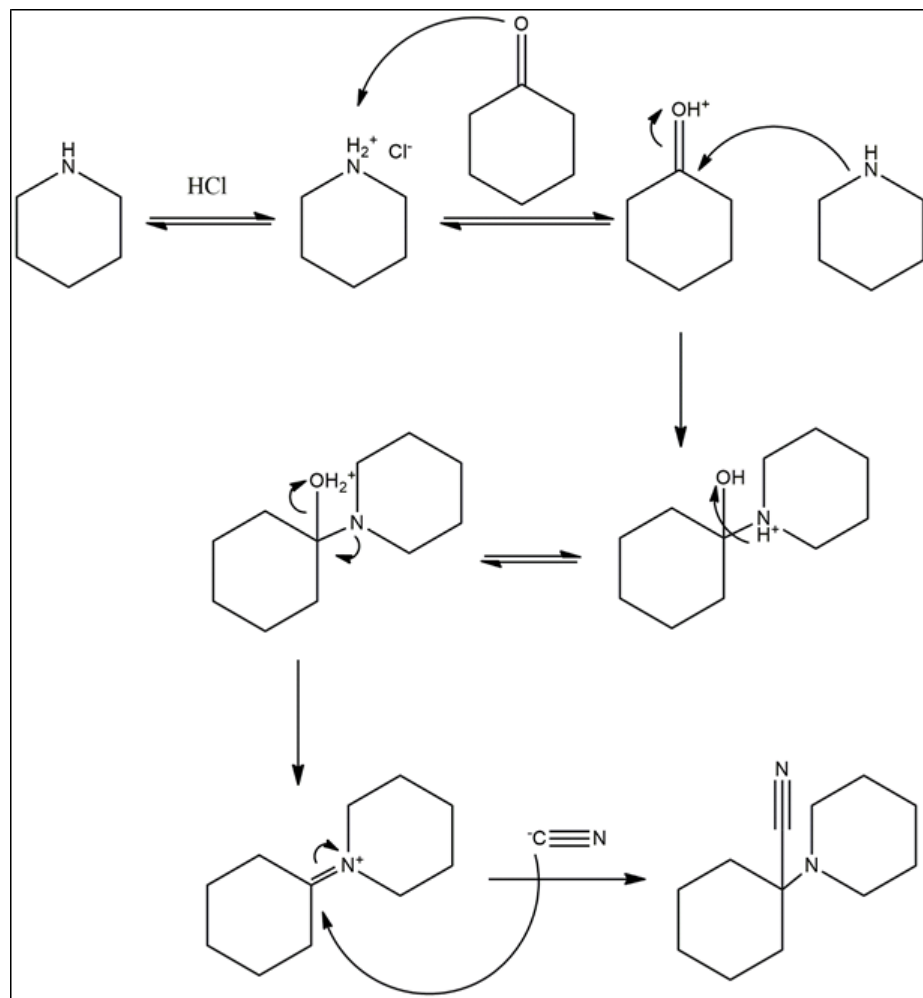
Phenylacetone (P2P) Synthesis



Fume Hood Mass Scan Monitoring of Effluent from Synthesis

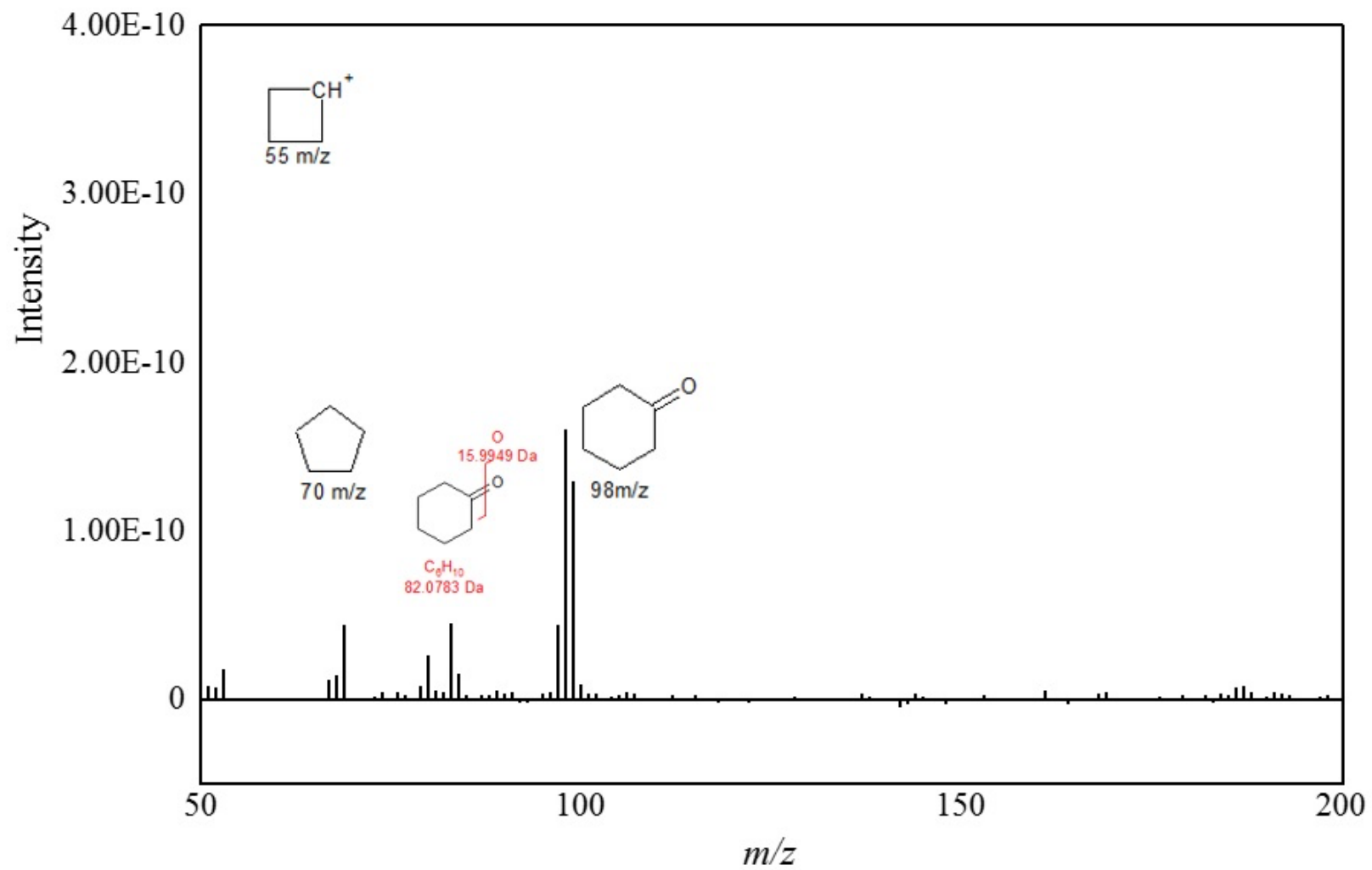


PCC Reaction Mechanisms

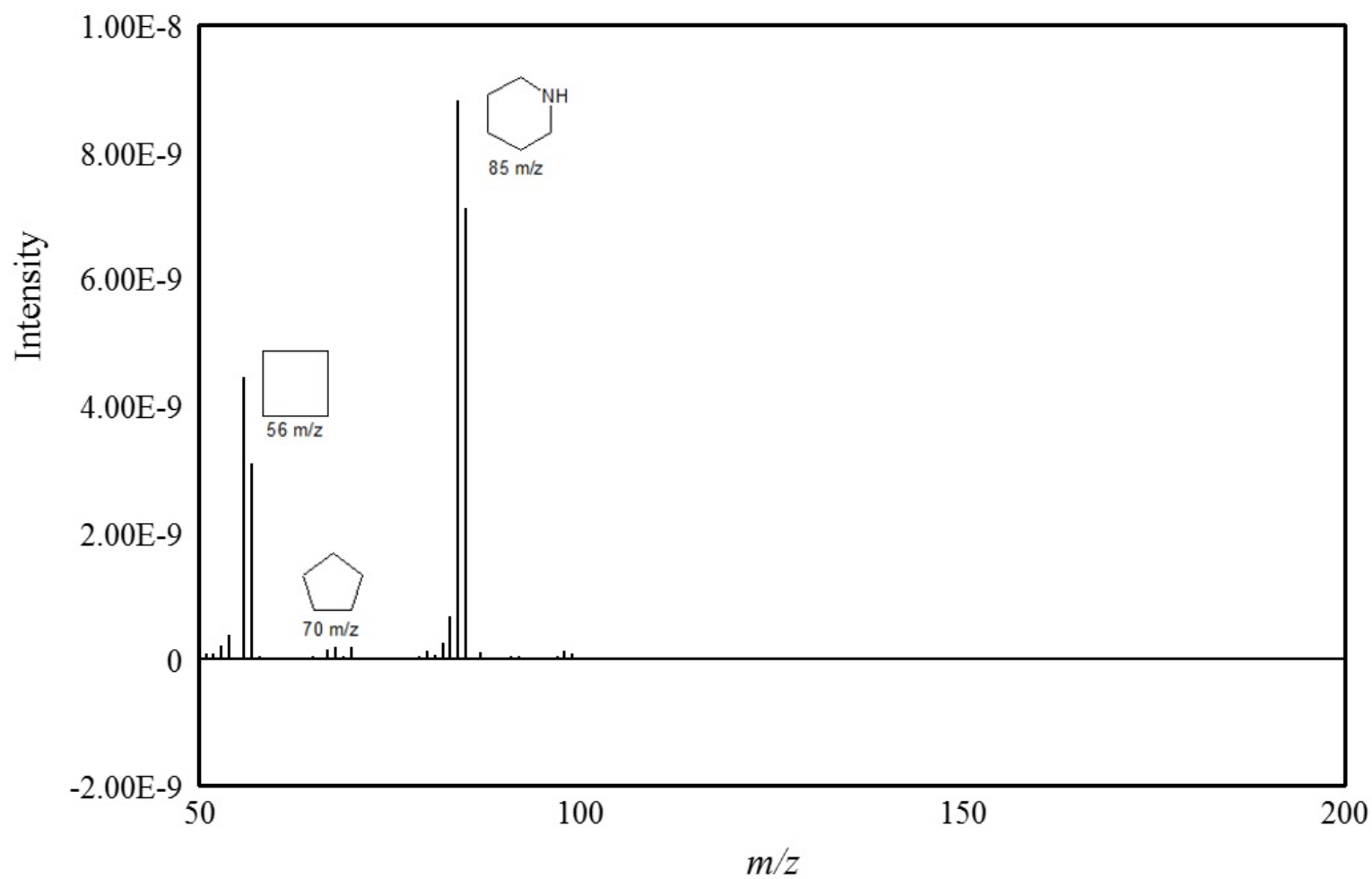


(PCC) 1-piperidinyl cyclohexanecarbonitrile

Cyclohexanone

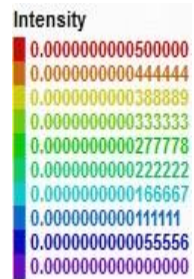


Piperidine

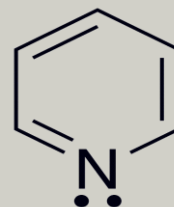
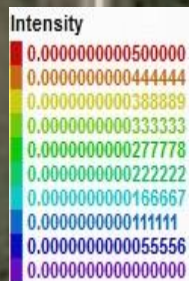




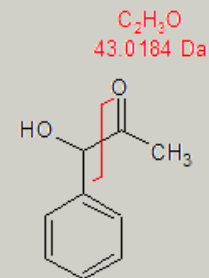
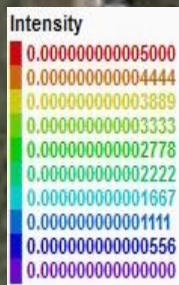




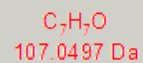
Baseline



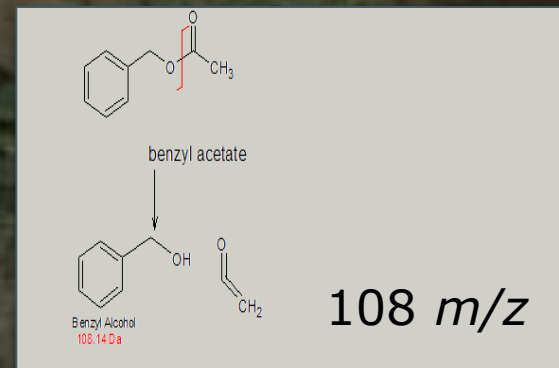
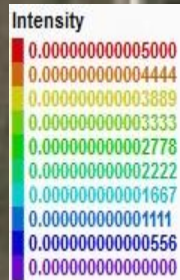
Pyridine
79 *m/z*



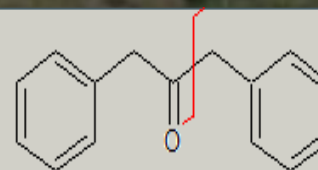
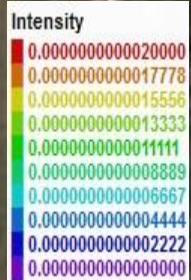
Phenylacetyl
carbinol
107 m/z



Variable Wind ← ↙ ↓



Variable Wind ← ↙ ↓

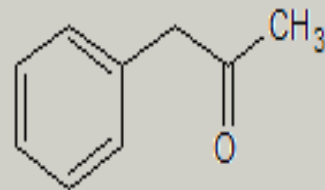
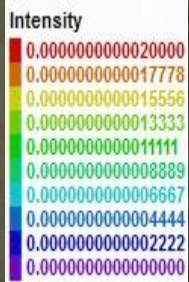


C_8H_7O
119.0497 Da
 $C_8H_8O^+$ 118.0412 Da

C_7H_7
91.0548 Da

Dibenzyl
Ketone
118 m/z

Variable Wind ← ↙ ↓



1-phenylpropan-2-one

P2P
Phenylac
etone

Variable Wind ← ↙ ↓

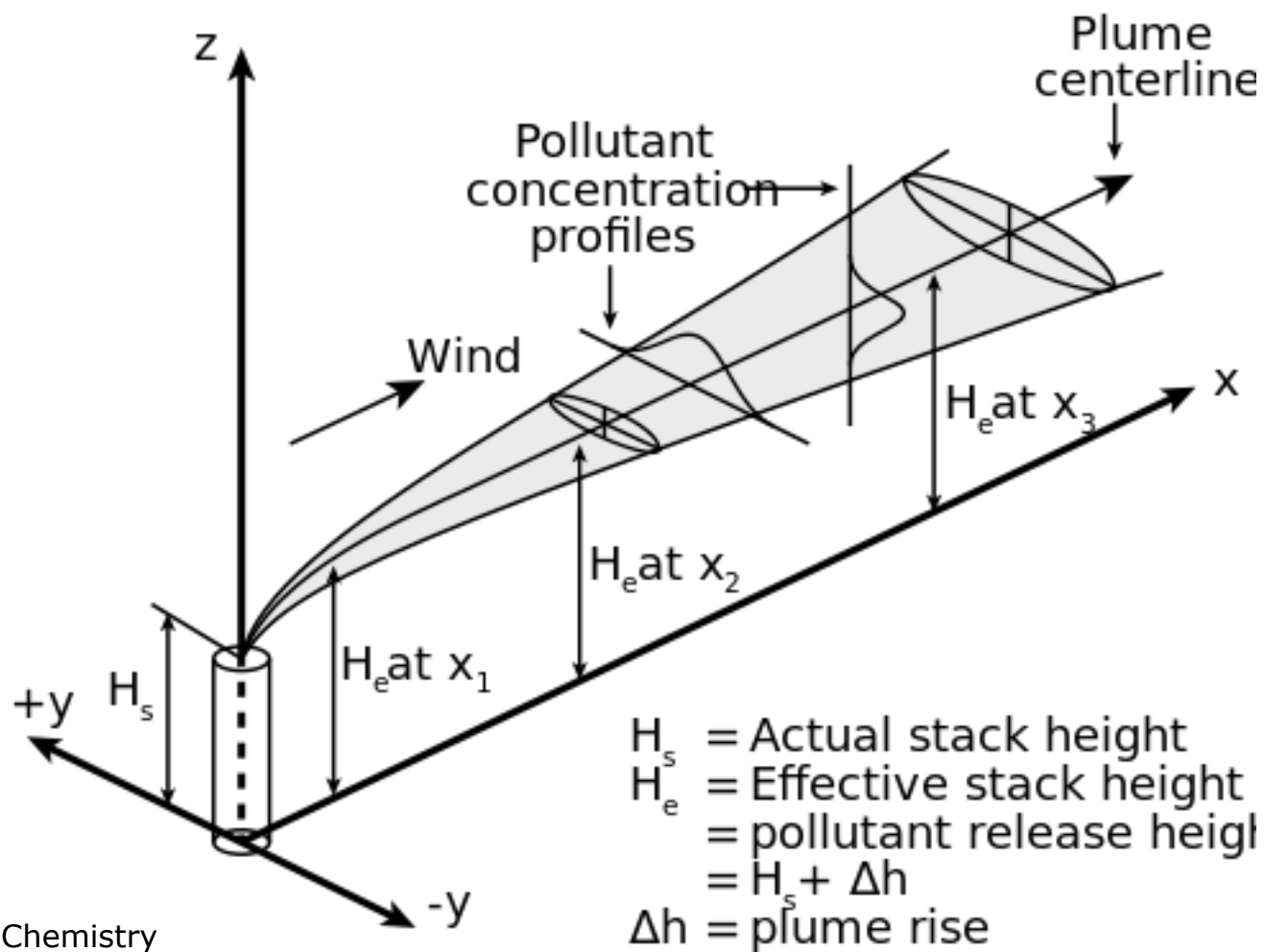
Hourly Weather Conditions Denton Regional Airport

TimeCDT	TemperatureF	Dew PointF	Humidity	Sea Level PressureIn	VisibilityMPH	Wind Direction	Wind SpeedMPH	PrecipitationIn	Conditions	WindDirDegrees	DateUTC
1253 AM	81	71.1	72	29.81	10	SSE	8.1	NA	Clear	160	2015-07-14 005300
153 AM	79	72	79	29.8	10	South	8.1	NA	Clear	170	2015-07-14 065300
253 AM	79	72	79	29.8	10	SSE	8.1	NA	Clear	160	2015-07-14 075300
353 AM	78.1	72	81	29.8	10	SSE	8.1	NA	Clear	160	2015-07-14 085300
453 AM	77	71.1	82	29.8	10	SSE	6.9	NA	Clear	160	2015-07-14 095300
553 AM	75.9	71.1	85	29.81	10	SSE	6.9	NA	Clear	160	2015-07-14 105300
653 AM	75.9	71.1	85	29.83	10	South	5.8	NA	Clear	190	2015-07-14 115300
753 AM	79	72	79	29.84	10	South	5.8	NA	Clear	190	2015-07-14 125300
853 AM	84	70	63	29.85	10	SSW	11.5	NA	Clear	200	2015-07-14 135300
953 AM	87.1	69.1	55	29.86	10	SW	12.7	NA	Clear	220	2015-07-14 145300
1053 AM	90	69.1	50	29.85	10	WSW	11.5	NA	Clear	240	2015-07-14 155300
1153 AM	93	70	47	29.85	10	WSW	9.2	NA	Clear	240	2015-07-14 165300
1253 PM	95	70	44	29.84	9	South	10.4	NA	Clear	190	2015-07-14 175300
153 PM	96.1	70	43	29.83	9	SSW	9.2	NA	Clear	210	2015-07-14 185300
253 PM	98.1	70	40	29.81	10	South	11.5	NA	Clear	190	2015-07-14 195300
353 PM	98.1	70	40	29.79	5	SSE	13.8	NA	Haze	150	2015-07-14 205300
453 PM	98.1	68	37	29.79	6	South	9.2	NA	Haze	180	2015-07-14 215300
553 PM	98.1	70	40	29.78	10	South	15	NA	Clear	170	2015-07-14 225300
653 PM	97	68	39	29.76	10	SSE	11.5	NA	Clear	160	2015-07-14 235300
753 PM	93	69.1	45	29.76	10	South	10.4	NA	Clear	180	2015-07-15 005300
853 PM	88	69.1	53	29.77	10	South	10.4	NA	Clear	170	2015-07-15 015300
953 PM	84	70	63	29.8	10	SSE	9.2	NA	Clear	160	2015-07-15 025300
1053 PM	84	70	63	29.82	10	SSE	8.1	NA	Clear	160	2015-07-15 035300
1153 PM	82	69.1	65	29.85	10	SSE	6.9	NA	Clear	150	2015-07-15 045300

Tests occurred
between 5:00 and
8:00 PM



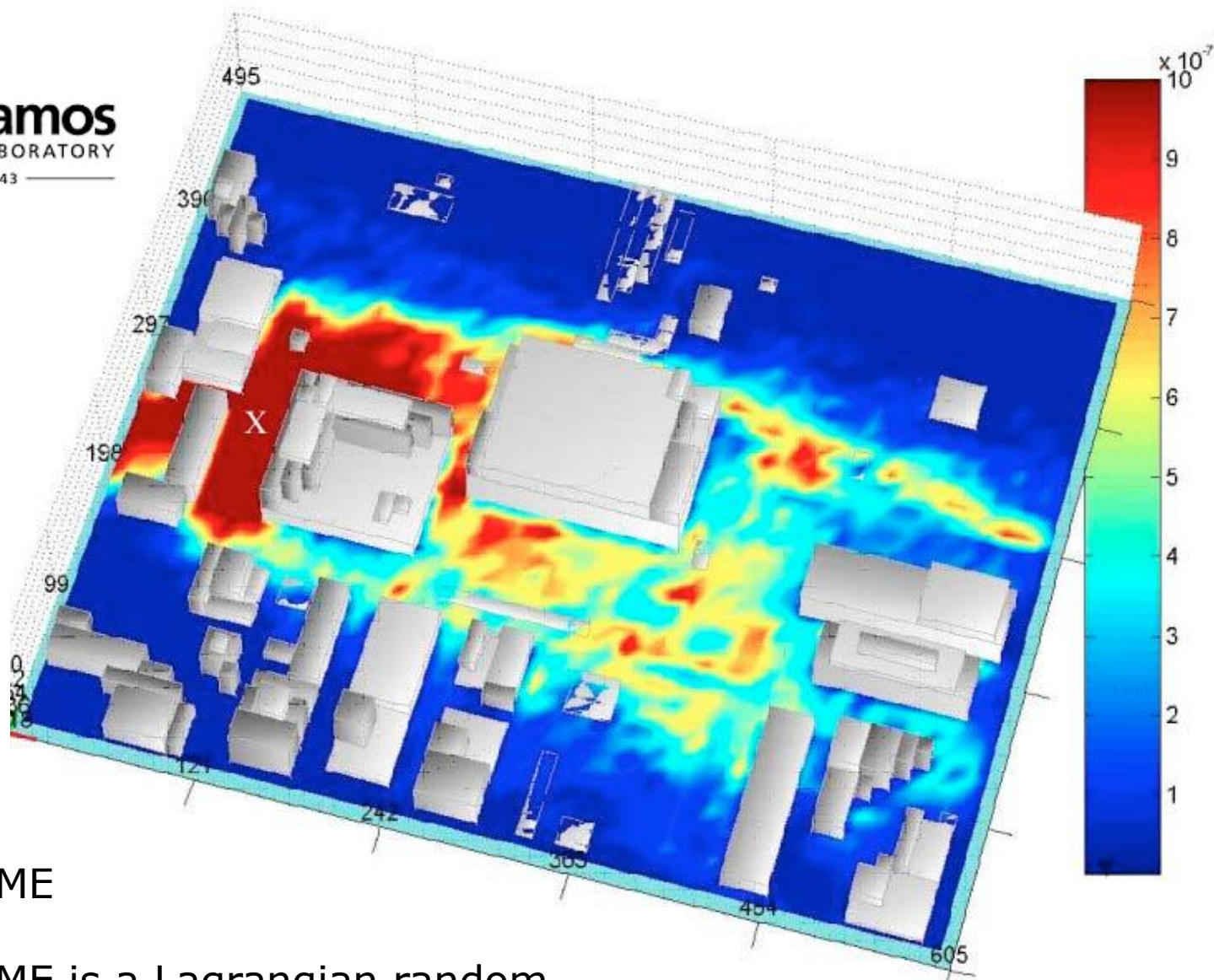
Future Directions





Meth Lab May Have Sparked Bartlesville Building Fire Last Month

Posted: Sep 14, 2009 1:07 PM CDT
By Chris Wright, The News On 6



QUIC-PLUME

QUIC-PLUME is a Lagrangian random-walk dispersion model for computing concentration fields around buildings.

<http://www.lanl.gov/projects/quic/quicplume.shtml>

SITE DATA:

Location: DALLAS, TEXAS

Building Air Exchanges Per Hour: 0.56 (unsheltered single storied)

Time: July 23, 2015 & 1519 hours CDT (using computer's clock)

CHEMICAL DATA:

Chemical Name: BENZENE

Molecular Weight: 78.11 g/mol

AEGL-1 (60 min): 52 ppm AEGL-2 (60 min): 800 ppm AEGL-3 (60 min): 4000 ppm

IDLH: 500 ppm LEL: 12000 ppm UEL: 80000 ppm

Carcinogenic risk - see CAMEO Chemicals

Ambient Boiling Point: 175.3° F

Vapor Pressure at Ambient Temperature: 0.17 atm

Ambient Saturation Concentration: 175,206 ppm or 17.5%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 5 miles/hour from W at 5 meters

Ground Roughness: open country

Cloud Cover: 0 tenths

Air Temperature: 90° F

Stability Class: A

No Inversion Height

Relative Humidity: 50%

SOURCE STRENGTH:

Direct Source: 100 grams/hr

Source Height: 0

Release Duration: 60 minutes

Release Rate: 0.00367 pounds/min

Total Amount Released: 0.22 pounds

THREAT ZONE:

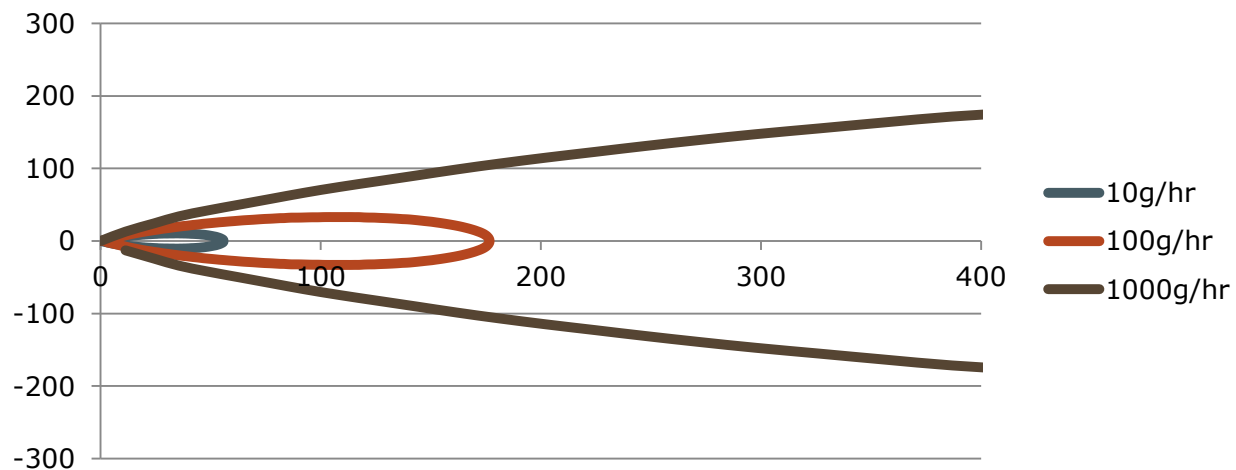
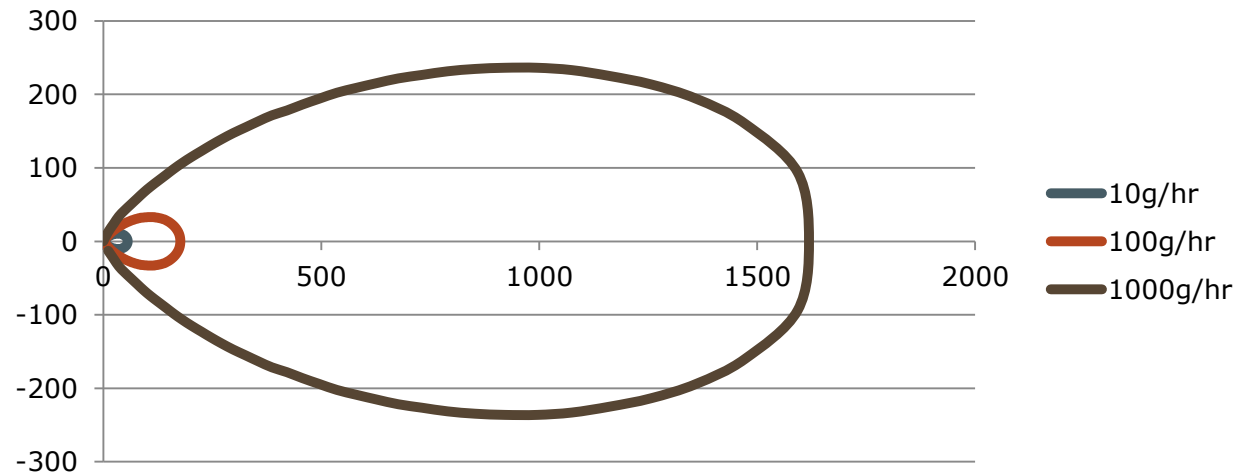
Model Run: Gaussian

Red : 61 yards --- (.01 ppm)

Orange: 86 yards --- (.005 ppm)

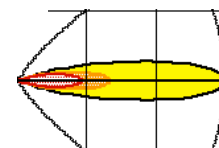
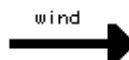
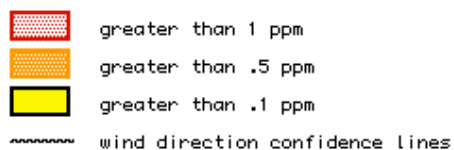
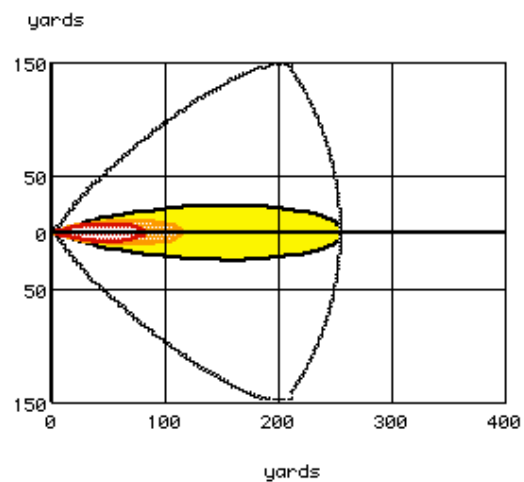
Yellow: 193 yards --- (.001 ppm)

1ppb Benzene, 5mph winds, 50% Humidity, Distance in Yds

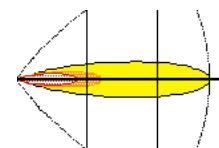




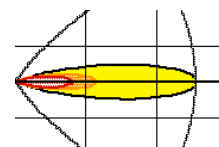
ALOHA®



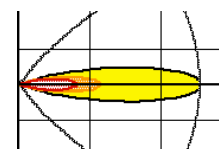
Benzene



Toluene

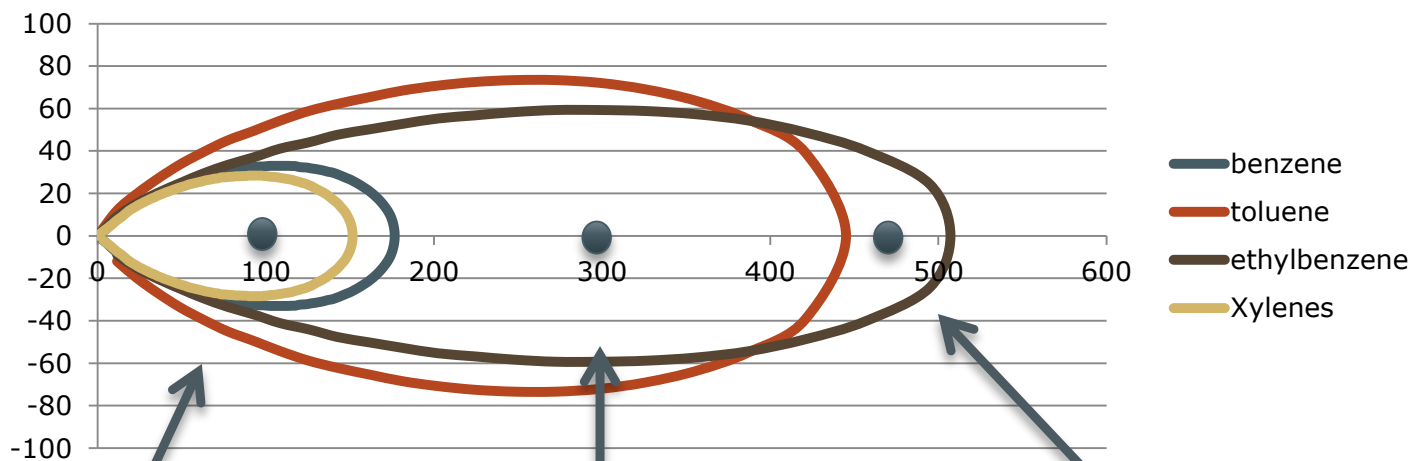


Xylene

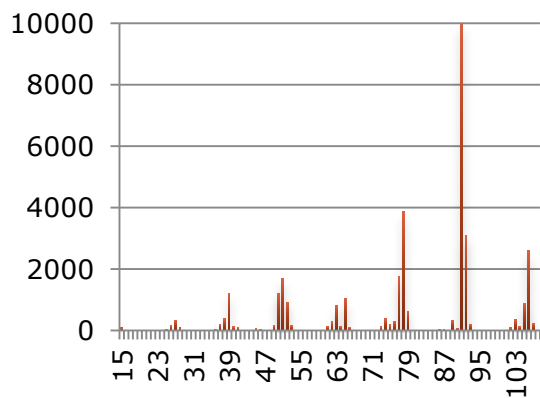


Ethylbenzene

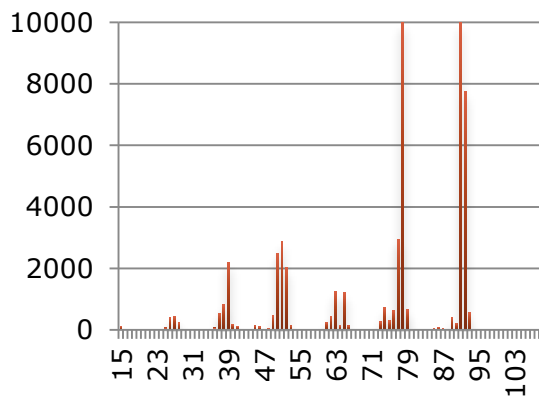
1ppb BTEX from 100g/hr, 5mph winds, 50% Humidity, Distance in Yds



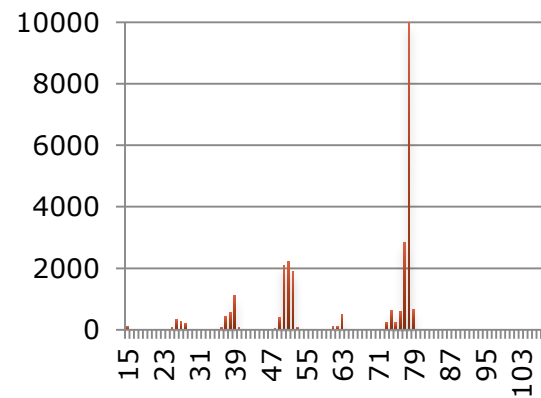
Point 3



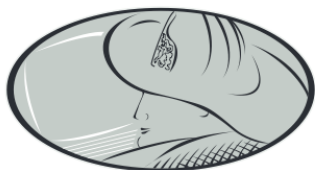
Point 2



Point 1

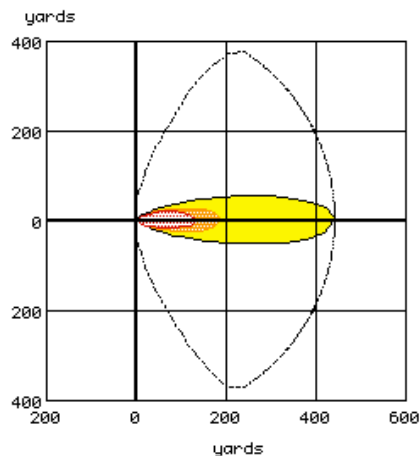


The CAMEO® Software Suite

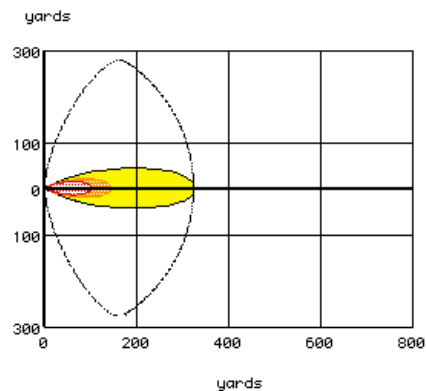


ALOHA®

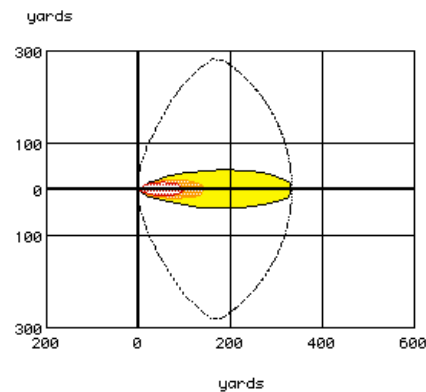
Allow the signal of
Pyridine to initiate
search, MS then
starts looking to
Heavier constituents



wind → Pyridine
440yds



wind → Methylamine
360yds

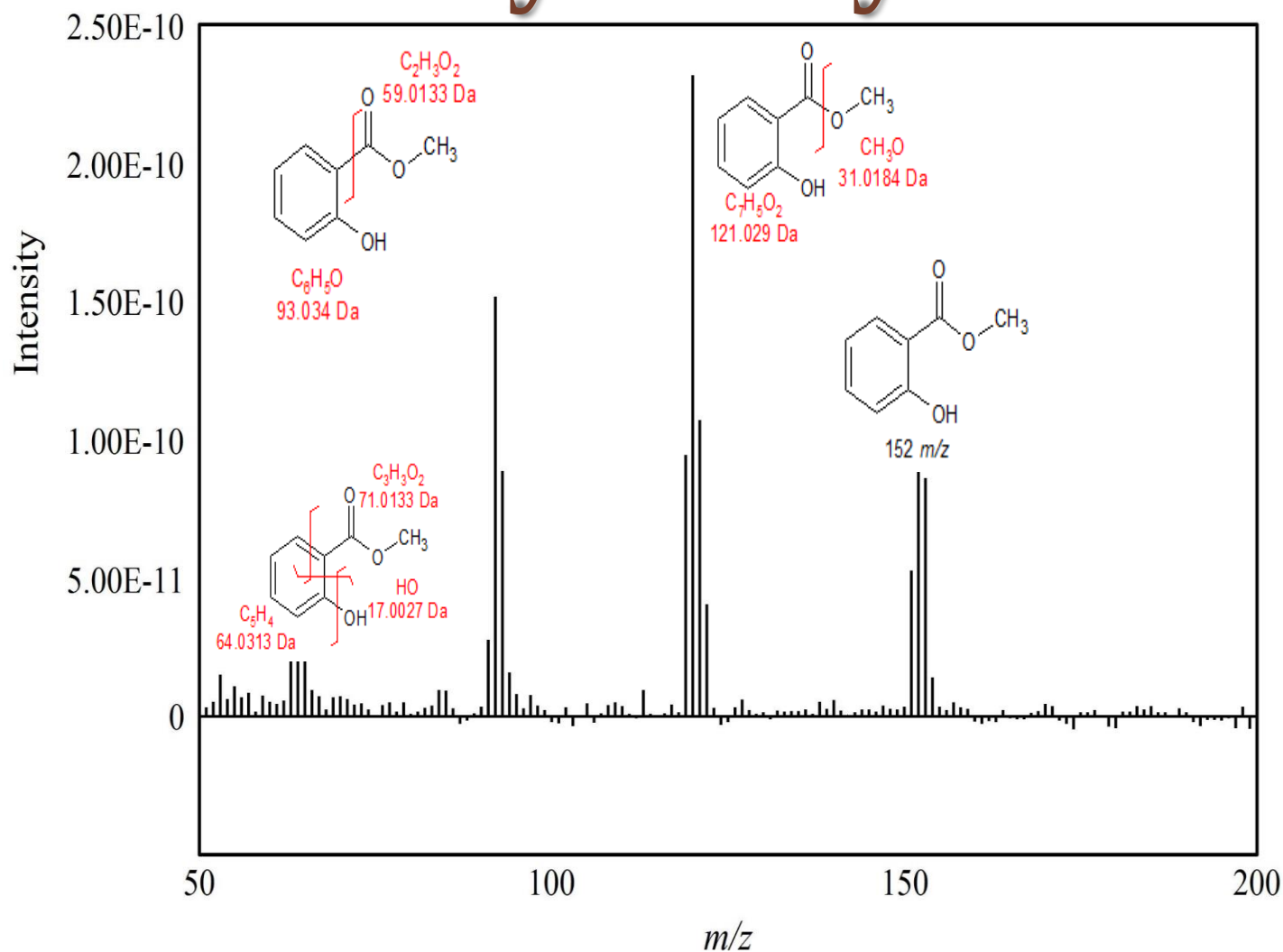


wind → Methylbenzoate
360yds

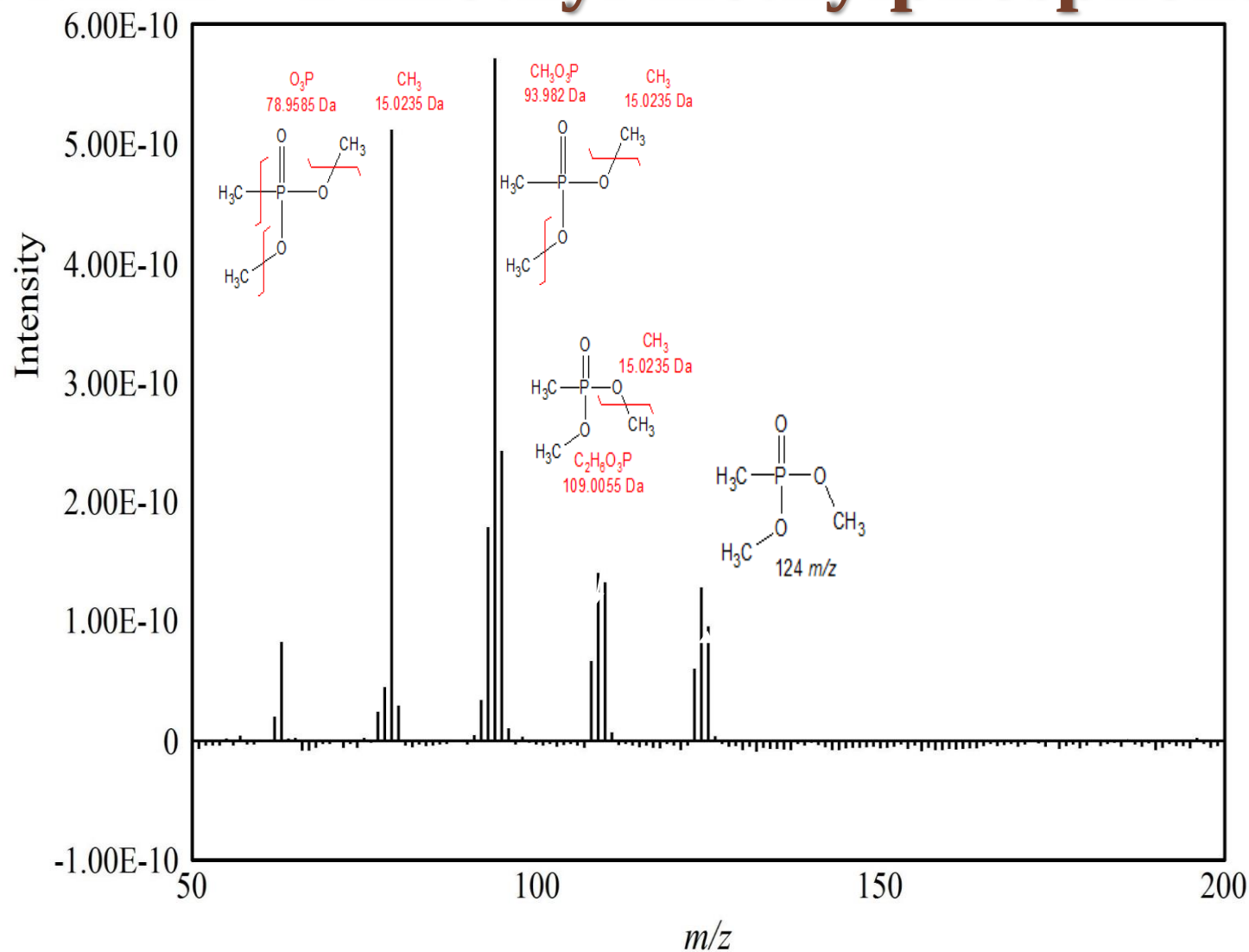


As car travels into stream, decision is made for direction

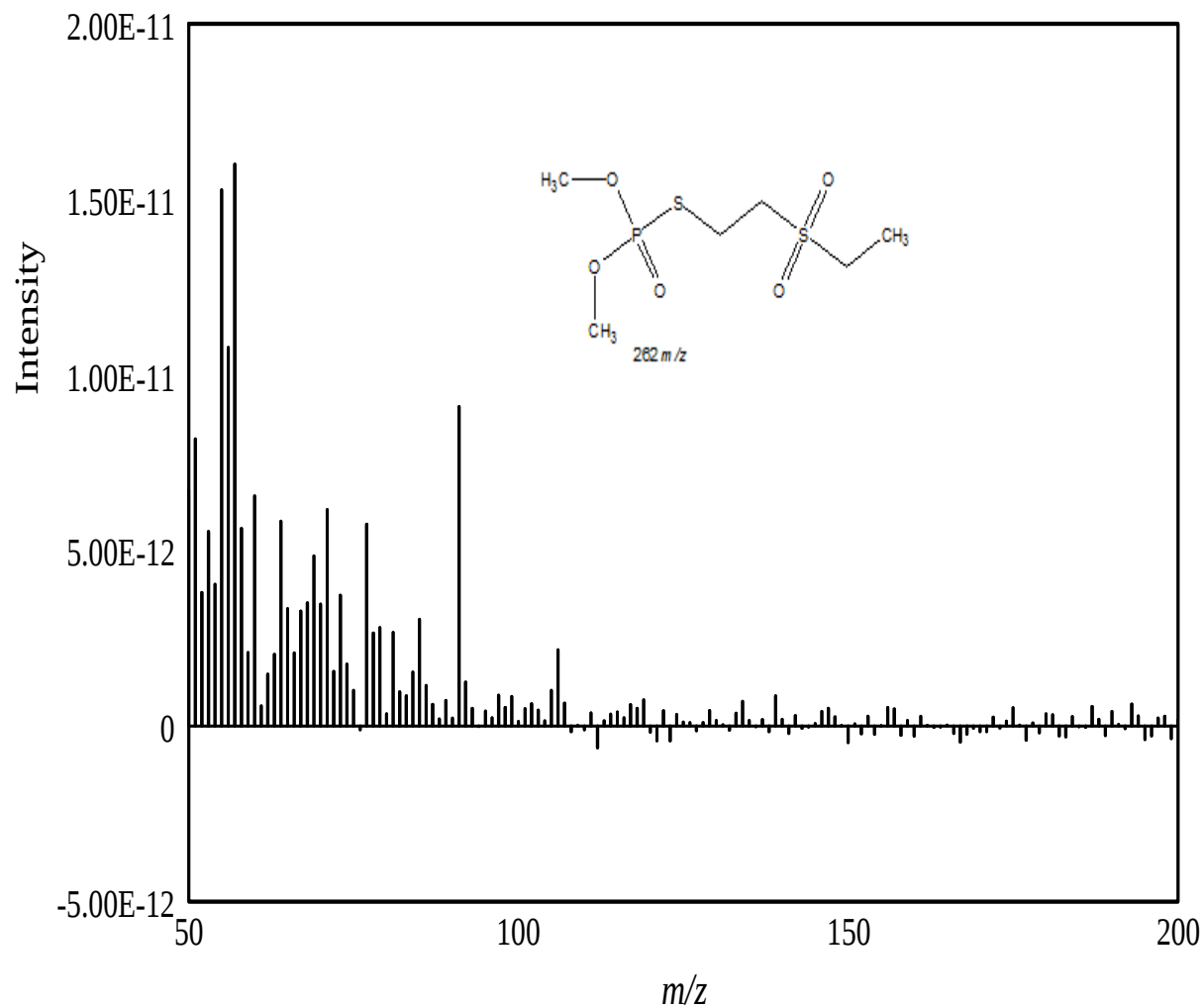
MS - Methyl salicylate



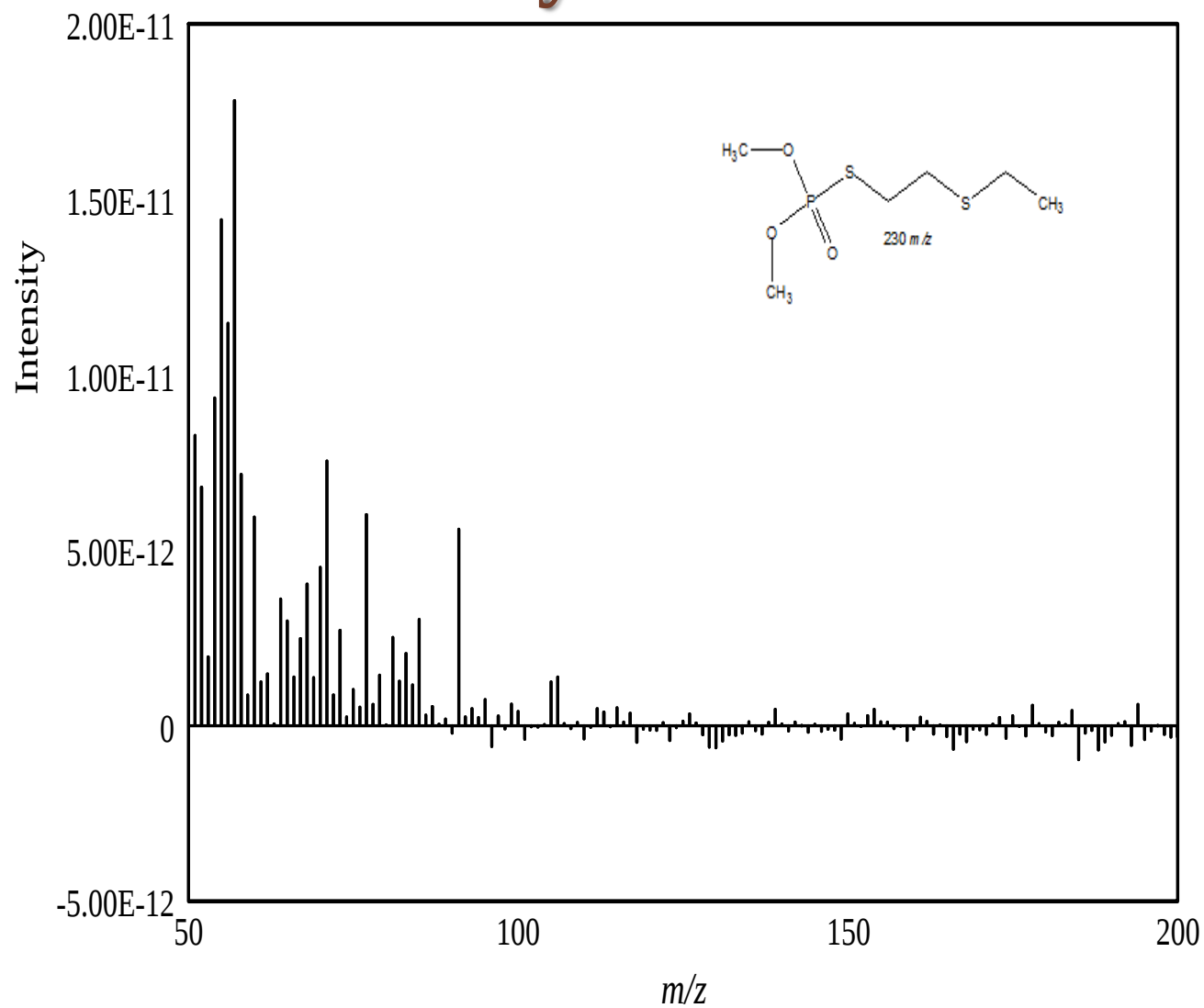
DMMP - Dimethyl methylphosphonate



Demeton-S-methyl-sulfon



Demeton-S-methyl





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OF NORTH TEXAS™

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UNT
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