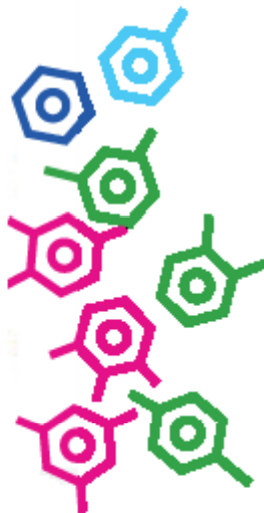




BEn**Z**En**E**
and other
Toxics
EXpo**s**ure
Study



The BEE-TEX Study

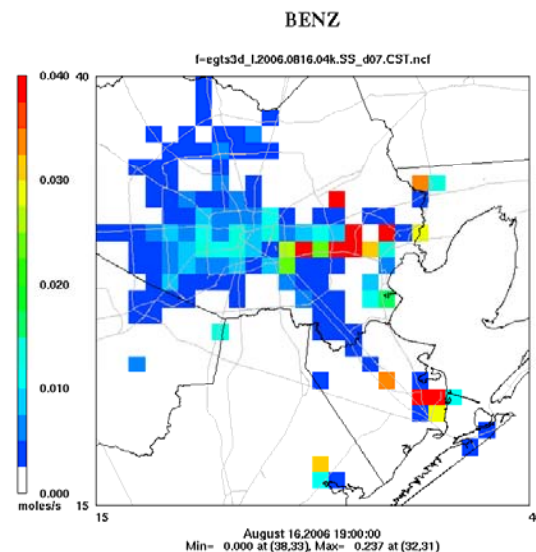
Jay Olaguer
HARC

The Goal

- Facilitate the establishment of **cost-effective**, state-of-the-art **neighborhood-scale monitoring** networks in the Houston Ship Channel and other potential areas of **high toxic emissions** around the country.
- Use them in the improvement of **emission inventories**, the conduct of **epidemiological studies** for air toxics, and ultimately the **enforcement** of regulations.

Basic Description

- The Benzene and other Toxics Exposure (BEE-TEX) Study is a two-part, 3-year field study of **human exposure** to and **source attribution** of the air toxics: benzene, toluene, ethyl benzene and xylenes (BTEX).
- The study will be conducted in the Houston Ship Channel where **intense industrial sources** of BTEX are located in **close proximity to residential neighborhoods**.



Benzene
Emissions
in UH
CMAQ
Model

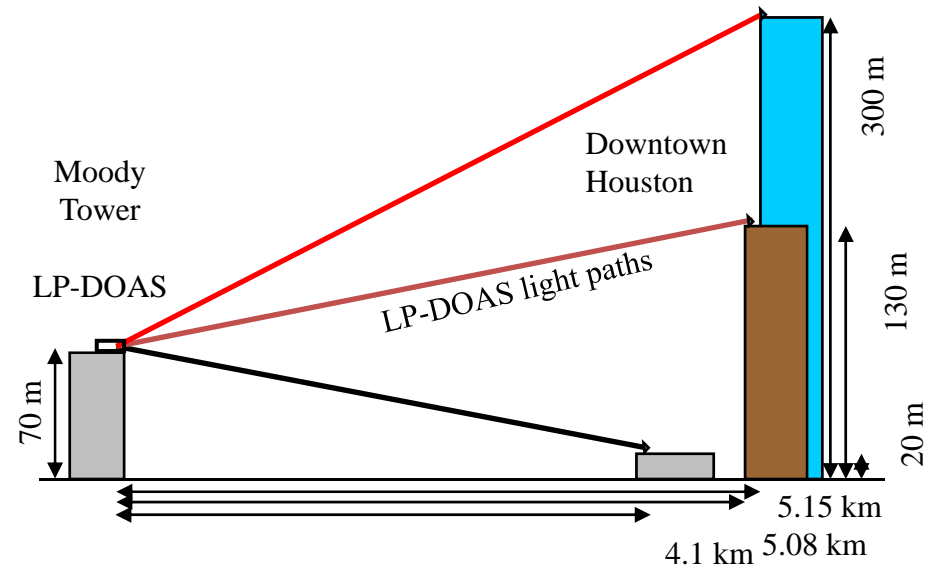
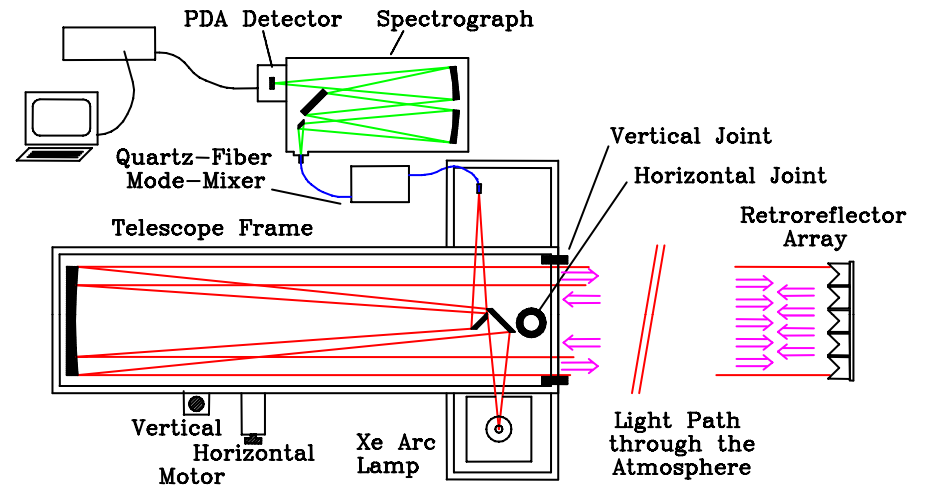


Study Design Elements

- Differential Optical Absorption Spectrometry (DOAS) remote sensing
- Computer-Aided Tomography (CAT)
- Ambient breathing zone measurements using both stationary and mobile techniques
- Meteorological data (CAMS, sondes, sodar, lidar, etc.)
- Inverse plume modeling for source attribution
- Personal exposure monitoring
- Dispersion, atmospheric transformation, and human exposure modeling

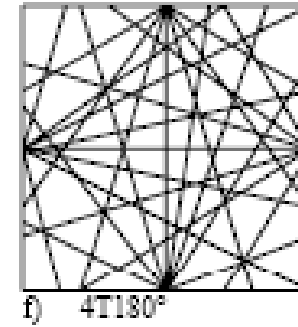
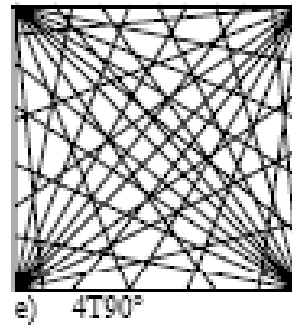
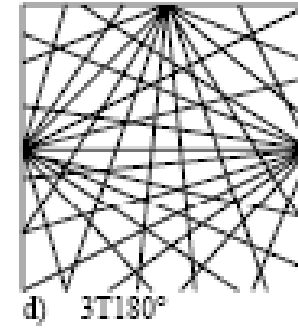
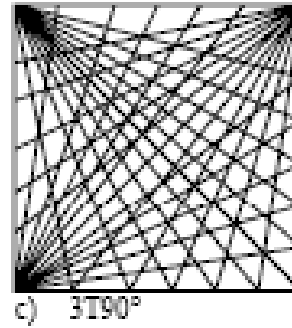
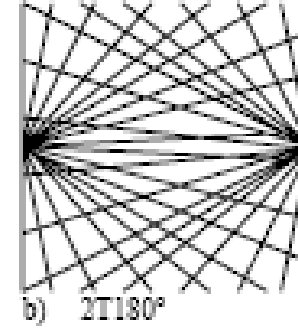
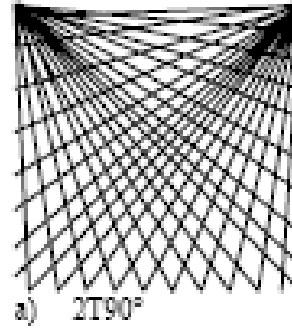
Differential Optical Absorption Spectrometry (DOAS)

- Measures total amount of substance over a long path using visible or UV light absorption.
- BTEX spectra below 290 nm, so cannot use sunlight. Must use artificial light source with retro-reflector mirrors located <2 km away (LP-DOAS).



Computer-Aided Tomography

CAT-DOAS with multiple light paths can be used to derive spatially resolved ambient concentrations (not just path averages) over an entire neighborhood.



Advantages of CAT-DOAS

- Long paths (> 1 km) allow one to observe the influence of intense industrial sources far away from the fenceline.
- Continuous day and night monitoring over long periods of time with little maintenance, if equipment is designed properly.
- Potentially more cost-effective for studies of human exposure and health impacts of BTEX on neighborhood scales than in-situ monitoring or short-range remote sensing.

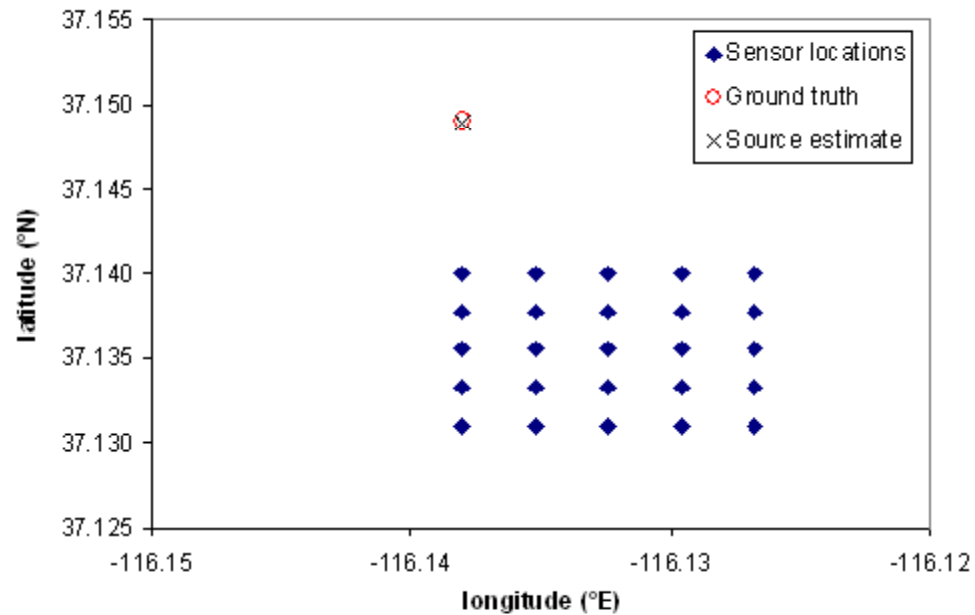
Relation to Human Exposure

- Perform ancillary measurements in the breathing zone below CAT-DOAS elevation to derive transfer functions for use in human exposure modeling.
- Local TCEQ or HRM auto-GC measurements.
- Stationary GC-FID/PID BTEX analyzers for continuous monitoring (15 min cycle).
- Fast (1 s cycle) mobile PTR-MS measurements will allow ground level pollutant concentration maps in receptor neighborhoods.

Source Attribution

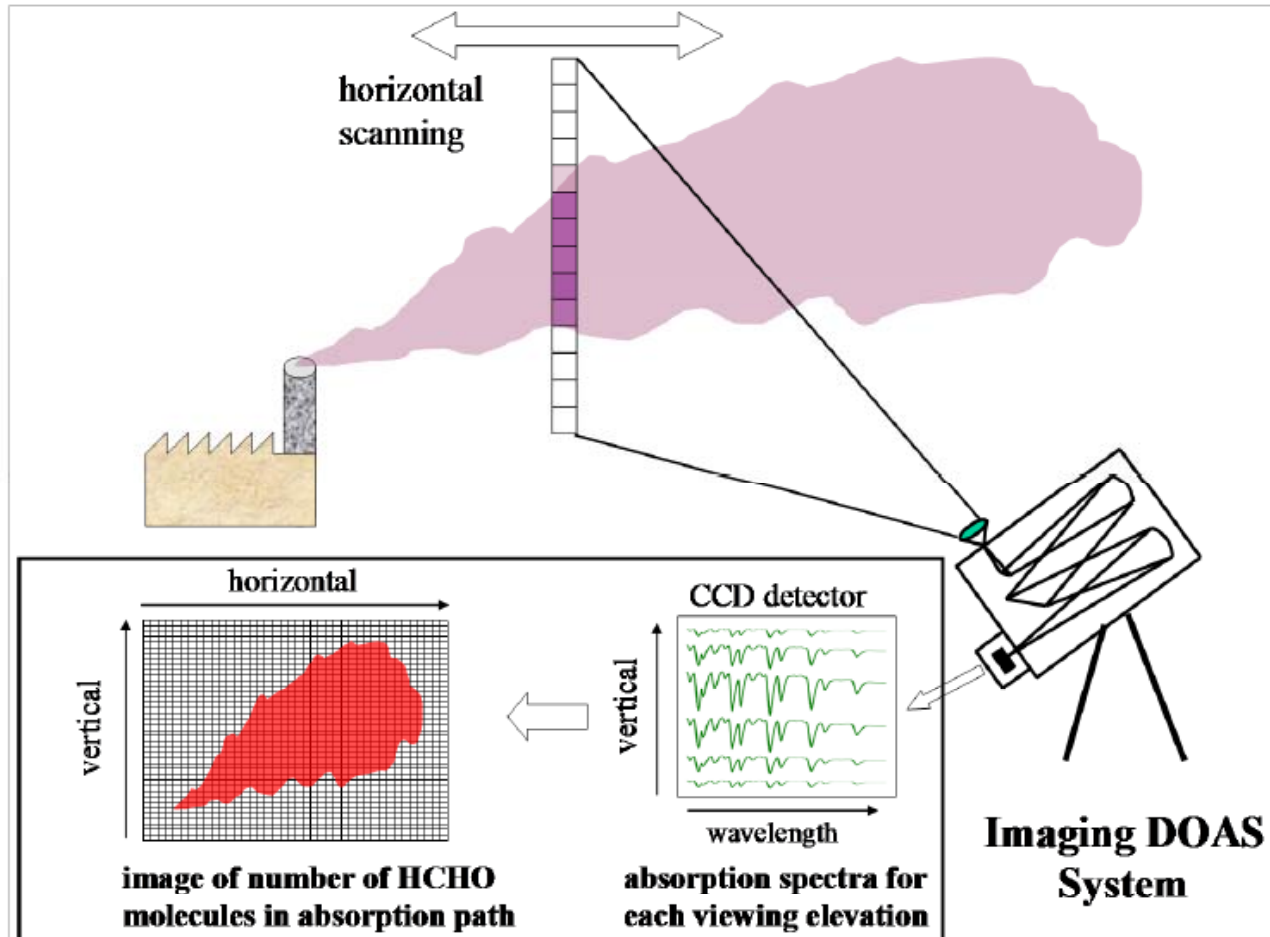
- Use an inverse plume model (SCIPUFF + adjoint method) to derive emission source strengths and locations from CAT-DOAS concentrations.
- Use an imaging DOAS (I-DOAS) to “see” combustion plumes by measuring HCHO.
- Use an IR Camera to “see” non-combustion plumes (e.g., large storage tank leaks).
- Use observed plume spread and meteorological data (CAMS, sondes, sodar, aerosol lidar) to constrain inverse model turbulent transport.

Aerodyne Inverse Plume Model



	Source Estimate		"Ground Truth"
	Ideal data	Noisy data	
Mass (kg)	52.9	53.6	54.0
Release Time (p.m.)	11:21	11:21	11:21
Release Duration (hrs)	0.15	0.15	0.15

Imaging DOAS (I-DOAS)



Infrared Camera



The color photo of this barge shows what the human eye sees. The black and white photo shows the Hawk detecting a hydrocarbon leak. Photo by Leak Surveys, Inc.

Personal Exposure Monitoring

- Adopt the successful elements of the Houston Exposure to Air Toxics (HEATS) study.
- Pay special attention to recruitment to enable sound statistical sampling of exposures.
- Pay special attention to the quality and calibration of potential instruments.
- Test novel techniques such as use of cultured human lung cells as exposure indicators.

Air and Exposure Modeling

- Use a standard model such as APEX to simulate human exposure to BTEX in various microenvironments based on time-activity data from neighborhood participants.
- Compare simulated exposures from both observed and modeled concentrations.
- Use a combination of MM5/WRF, CMAQ and plume dispersion models to simulate chemical fate and transport.

Potential Project Participants

- UCLA will build and operate CAT-DOAS.
- Aerodyne Research, Inc. will provide mobile lab and perform inverse plume modeling.
- HARC will provide stationary BTEX measurements and operate IR camera (non-TERC funding).
- UNC will perform cultured lung cell studies.
- Mickey Leland NUATRC will coordinate personal exposure monitoring aspects of study.
- Ted Johnson will apply human exposure model.
- UH will provide meteorological measurements and apply meteorological and air quality models.

Possible Timing

- Pilot Study (1/2010 – 6/2011)
 - Select neighborhood site(s)
 - Build, test, and operate pilot CAT-DOAS network
 - Conduct ancillary measurements and derive transfer functions for human exposure model
 - Perform source attribution
- Intensive Field Study (7/2011 – 12/2012)
 - Recruit neighborhood participants
 - Conduct indoor, outdoor, and personal monitoring
 - Conduct air and human exposure modeling

Estimated Costs and Potential Funding Sources

- Estimated Costs
 - Phase 1 (Pilot Study): \$1,000,000
 - Phase 2 (Intensive): \$3,000,000
- Potential Funding Sources
 - TERC CIAP (\$750,000)
 - Health Effects Institute (\$250,000)
 - USEPA Region 6 STAG (with HGAC)
 - State and Federal (with NUATRC)