



Measurement Methods, Innovative Source and Flux Measurements

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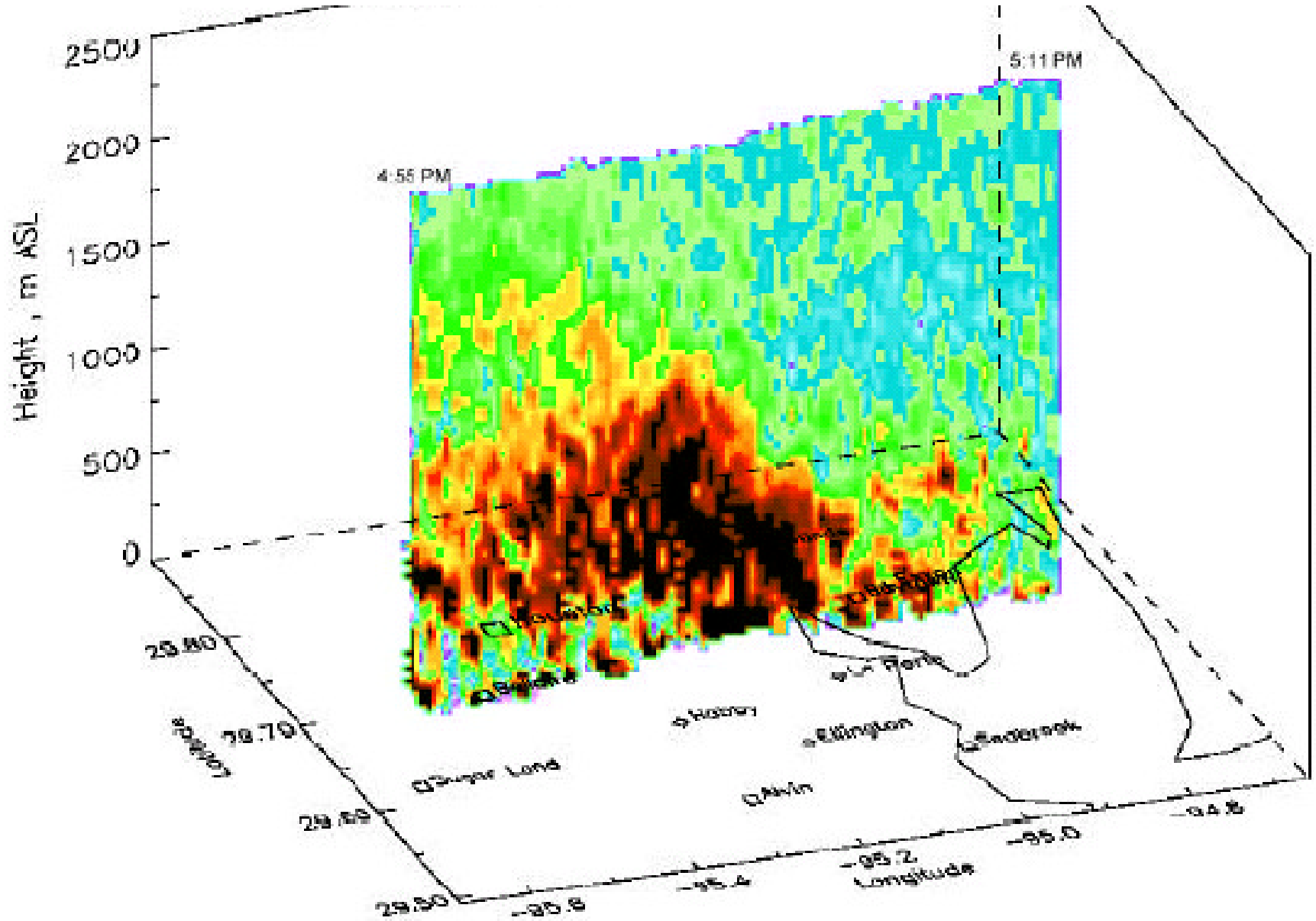


Measuring Emissions

- Standard Leak Detection and Repair Programs (LDAR)
- New VOC measurements at Flares and Cooling Water Towers
- “Smart LDAR” Techniques
- Fence-line Monitoring
- DIAL Lidar



DIAL Measurement of Houston Ozone





Houston Area Emissions

TexAQS 2000 findings indicate that high ozone incidents find their source from the ship channel almost without exception.

VOC emissions are underestimated by a factor between 3 and 10. (David Allen)

Modeling studies are only as good as the data provided.

Ozone reduction strategies must be based on good emissions numbers.





· · · *Measuring Mass Flux with DIAL/LIDAR*

- DIAL – Differential Absorption LIDAR
- LIDAR – Light Detection and Ranging

LIDAR is like RADAR but instead of microwaves it uses light in IR, Visible and UV ranges.



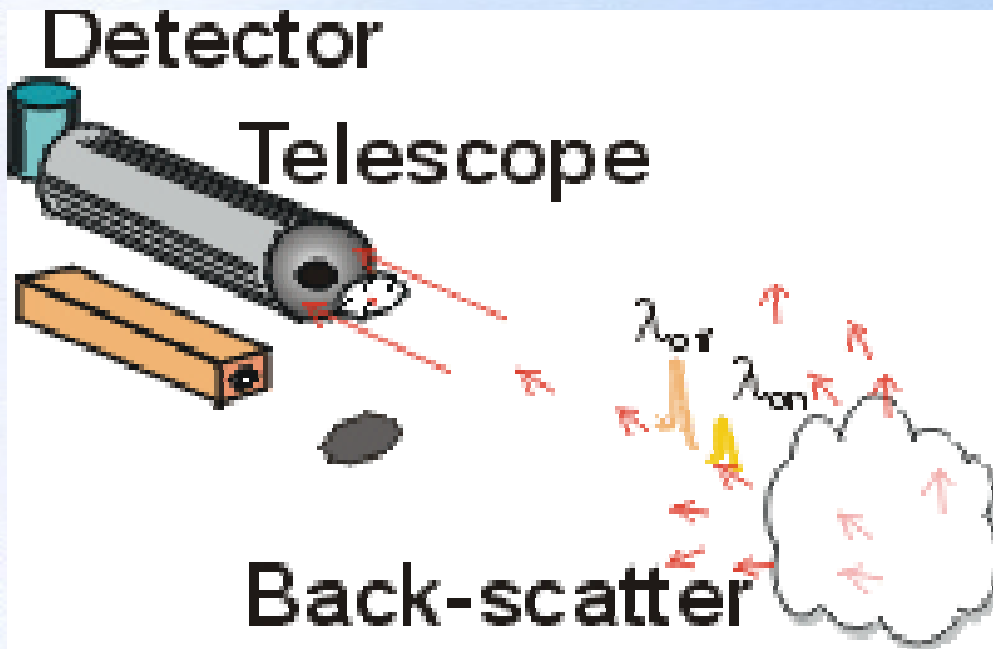
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Measuring Mass Flux

DIAL/LIDAR



LIDAR uses a transmitter (laser), a receiver (telescope) and a detector (photomultiplier tube).



Light is sent in short pulses and is reflected from the gas plume.

<http://www.spectrasyne.ltd.uk/dialworks.htm>

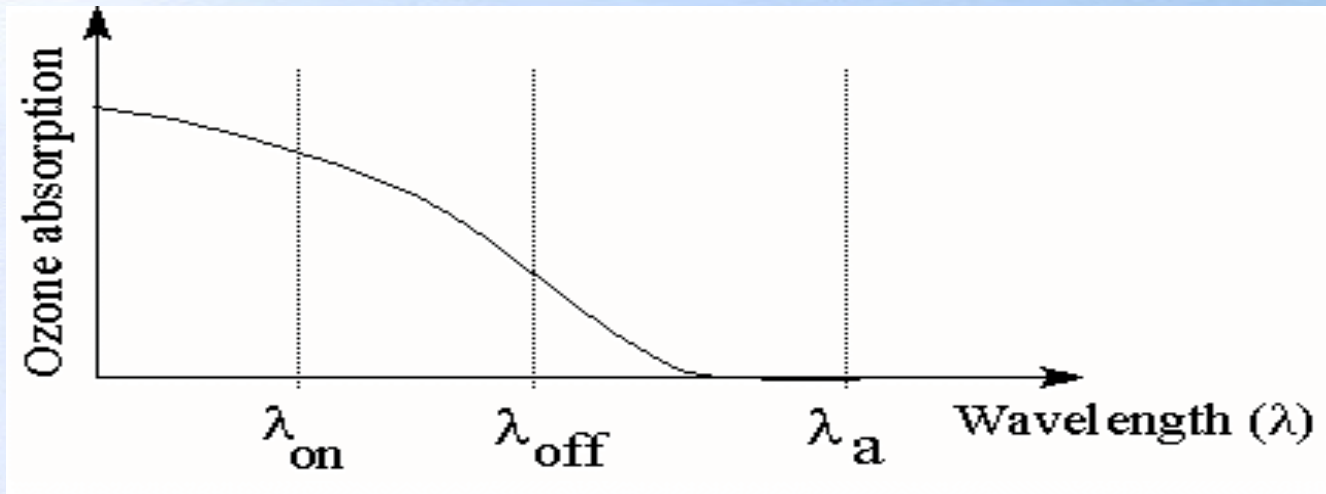


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Measuring Mass Flux DIAL/LIDAR



DIAL operates by recognizing that light absorbs differently at different wavelengths



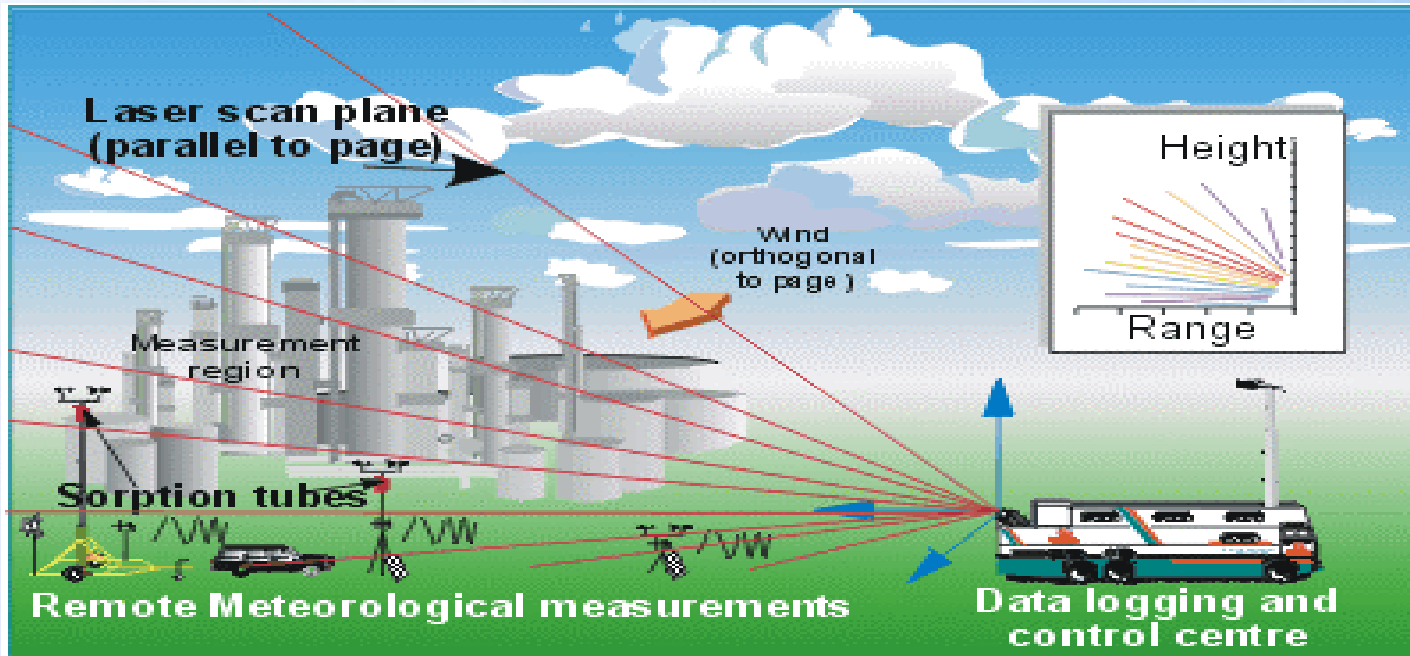
<http://pcl.physics.uwo.ca/pclhtml/introlidar/introlidarf.html>

The difference in light absorbed at two wavelengths is used to find concentration





Measuring Mass Flux DIAL/LIDAR



<http://www.spectrasyne.ltd.uk/dialworks.htm>

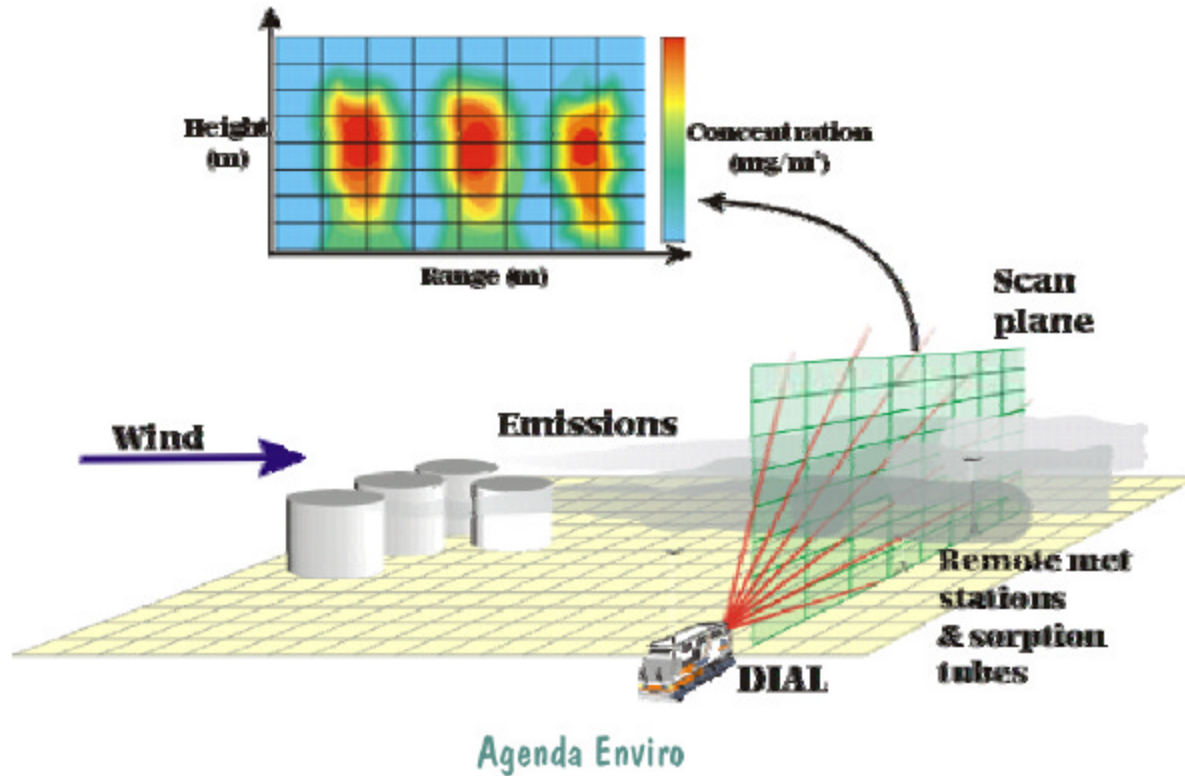
Concentration is converted to mass emissions by scanning along different lines of the plume and combining these with meteorology and sorption tube data.





Measuring Mass Flux DIAL/LIDAR

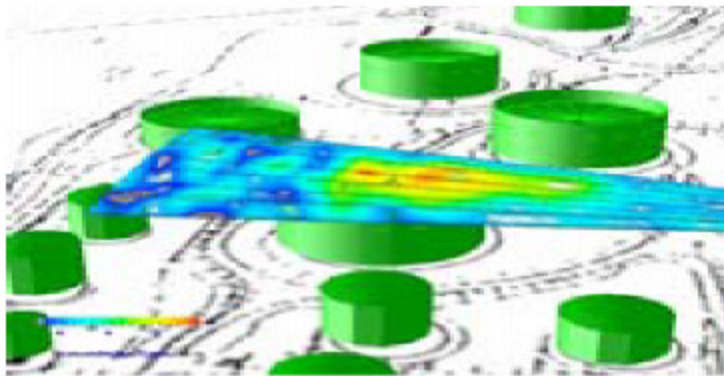
DIAL - Site Measurement



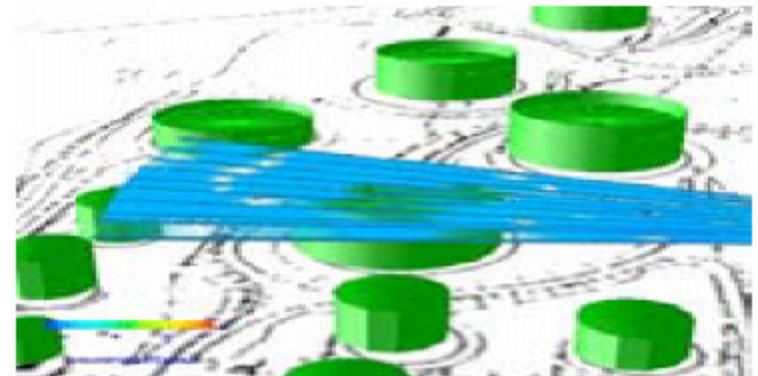


Measuring Mass Flux DIAL/LIDAR

Reducing tank emissions by
identifying true emissions



Before



After

DIAL indicates tanks are the main source of emissions, often 2-5 times the emissions from the process. - L. Frisch

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<http://www.agendaenviro.com>





Advantages of DIAL

- *There is no other proven technique for measuring mass emissions and mapping concentrations of these species from an entire site.*
- *Some species can be measured with point sensors or long point monitors, but these do not give area or mass emission information - only concentrations at a point or along a single path. They cannot identify "hot-spots" or emission sources.*





Disadvantages of DIAL

- *It costs about \$14K/day. For mid to large size sites it takes about two weeks to complete a survey.*
- *Only one company (Spectrasyne in the UK) has developed it to monitor mass emissions of VOC's.*
- *It requires experts to run the system and interpret the data.*
- *It is very cumbersome to operate.*





DIAL in Belgium

- In 1988 one refinery in Sweden was required to measure emissions (or be fined). They estimated less than 1000 tons/yr. Measured amt was close to 15000 tons/yr. New techniques that include BTEX and VOC up to C₁₅ would find a rate of up to about 25000 tons/yr.*
- In the late 90's all refineries in Flanders, Belgium reported emissions of 14000 tons/yr. A DIAL analysis on 2 refineries (about 10% throughput of the total), found emissions of 18000 tons/yr.*





DIAL in Sweden

- *Sweden has the most experience using DIAL to measure refinery emissions.*
- *Sweden has required remote sensing at refineries since the late 1980's.*
- *Initially also tried Differential Optical Absorption Spectroscopy (DOAS) and other single beam techniques, but by 1995/6 all refineries were required to use DIAL.*





DIAL in Sweden



- *DIAL measurements every 2-3 years.*
- *LDAR Program at least twice/year.*
- *Use live-loaded valves, bellow seals valves, or equivalent on all light materials.*
- *All compressor vents connected to flares.*
- *All tanks with external roofing have secondary seals.*
- *Control wastewater temperature to reduce volatilization. All separators are covered.*
- **NO EMISSIONS ESTIMATIONS**





Sweden

Notes

| Company | Location | Contractor | Year | Measured Annual Emissions (kg/hr) | %Emitted/Rated Capacity |
|------------|--------------------|-------------|------|-----------------------------------|-------------------------|
| AB Nynas | Gothenburg | Spectrasyne | 1999 | 90.9 | 0.12934464 |
| AB Nynas | Gothenburg | Spectrasyne | 1995 | 132 | 0.1878272 |
| Preem | Gothenburg | Spectrasyne | 1999 | 295 | 0.049500629 |
| OK (Preem) | Gothenburg | Spectrasyne | 1995 | 302 | 0.05067522 |
| OK (Preem) | Gothenburg | Spectrasyne | 1992 | 349.9 | 0.05871278 |
| BP (Preem) | Gothenburg | BP Research | 1989 | 926 | 0.155381635 |
| BP (Preem) | Gothenburg | BP Research | 1988 | 1091 | 0.183068428 |
| Shell | Gothenburg | SGS | 1999 | 173 | 0.037988807 |
| Shell | Gothenburg | SGS | 1996 | 184 | 0.04040428 |
| Scanraff | Brofjorden-Lysekil | Spectrasyne | 1999 | 554 | 0.049392548 |
| Scanraff | Brofjorden-Lysekil | Spectrasyne | 1995 | 366 | 0.030999619 |
| Scanraff | Brofjorden-Lysekil | Spectrasyne | 1992 | 762 | 0.0677672 |
| Totals | | | | 5225.8 | 0.070071287 |





Estimates for Texas' Refineries

Texas 1999 Data

| Company | Location | Year | Total Estimated Annual Emissions (tons/yr) | %Emitted/Rated Capacity |
|----------------|-------------|------|--|-------------------------|
| BP Amoco | Texas City | 1999 | 4696 | 0.019637203 |
| ExxonMobil | Baytown | 1999 | 3789 | 0.013710907 |
| Lyondell-Citgo | Channelview | 1999 | 2016.77 | 0.013710714 |
| Phillips | Sweeny | 1999 | 1173.17 | 0.010457793 |
| Shell | Deer Park | 1999 | 2955.67 | 0.01969797 |
| Valero | Texas City | 1999 | 2960.56 | 0.032788601 |
| Crown | Pasadena | 1999 | 910.73 | 0.016642655 |
| Marathon | Texas City | 1999 | 1183.73 | 0.03004368 |
| Valero | Houston | 1999 | 1486.55 | 0.033956467 |
| | | 1999 | 21172.18 | 0.018362593 |





Application?



In the Houston-Galveston area we have the largest (ExxonMobil/Baytown), the 3rd largest (BP/Texas City) and the 5th largest (Shell/Deer Park) U.S. refineries.

What if we “encouraged” them to compete for the title of “Greenest Refinery” using DIAL LIDAR?



Summary



- DIAL may provide numbers that we cannot get by any other means.

- U.S. and Europe are not the same

- U.S. Military looks at DIAL for WMD

- Need to test DIAL for VOC's on US Petrochemical facilities.

