

22nd CRC REAL WORLD EMISSIONS WORKSHOP
San Diego, California
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COMPARISON OF VEHICLE EXHAUST ACROSS DIFFERENT FUEL AND COMBUSTION TECHNOLOGIES

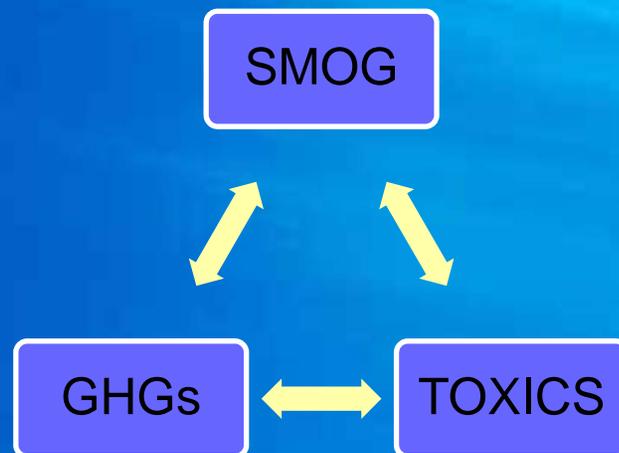
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California Air Resources Board

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Fuels and Technologies



California needs zero emissions, but until then...

New Fuels and Technologies:

- *Aftertreatment:* GPF, DPF, SCR
- *Combustion:* GDI
- *Fuels* CNG, E85, bio- and renewable diesel



Emissions Work at ARB Laboratories

Many individual studies are contributing to an understanding of the progression of technologies

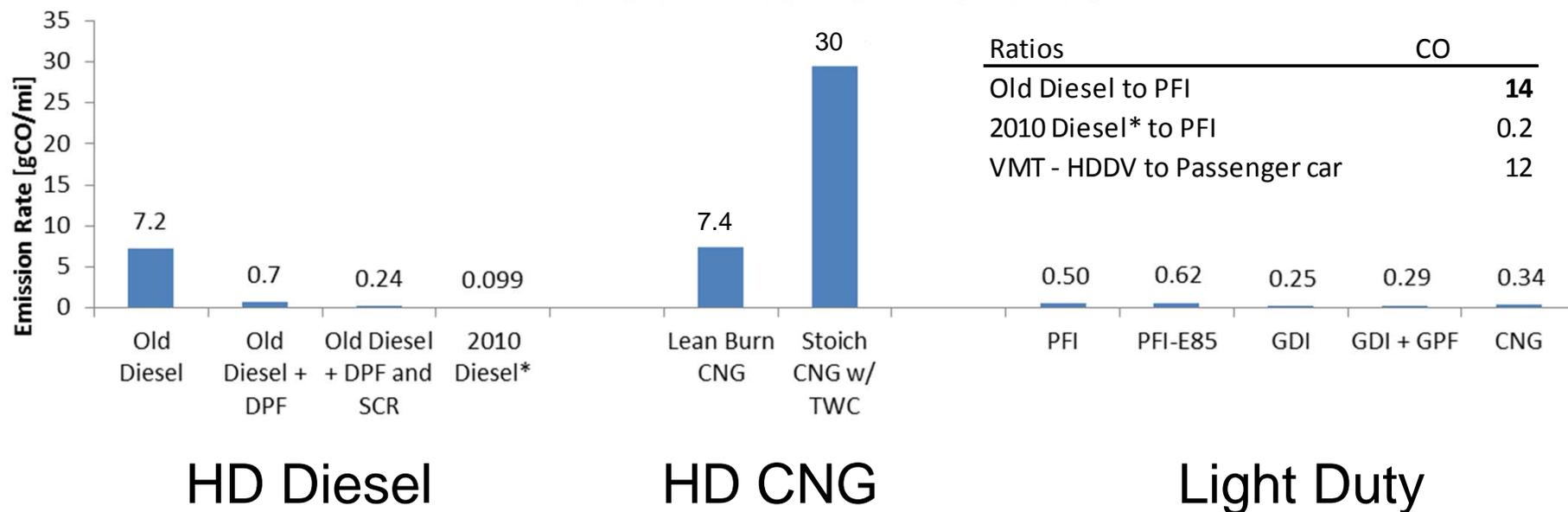
HD Diesel – Uncontrolled, Retrofit, 2007, 2010

HD CNG – Lean-burn uncontrolled, lean-burn w/ oxy cat, Stoic w/TWC

Light Duty – PFI, E85, CNG, GDI, GDI w/GPF, *Diesel*

***Comparisons needed across vehicle types,
technologies and fuels***

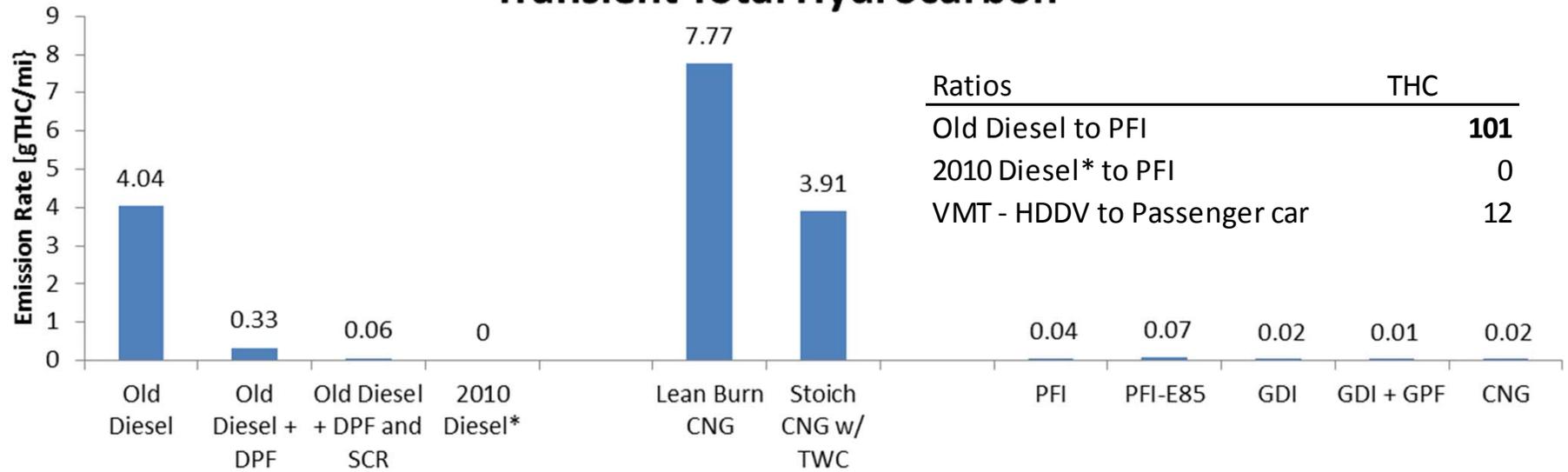
Transient - Carbon Monoxide



* Certified to Interim 2010 NOx Standard of 0.35 gNOx/bhp-hr

- 99% reduction in diesel as exhaust has become catalyzed
- HD CNG high emitting, and not getting better
- Light duty important contributor

Transient-Total Hydrocarbon



Ratios	THC
Old Diesel to PFI	101
2010 Diesel* to PFI	0
VMT - HDDV to Passenger car	12

HD Diesel

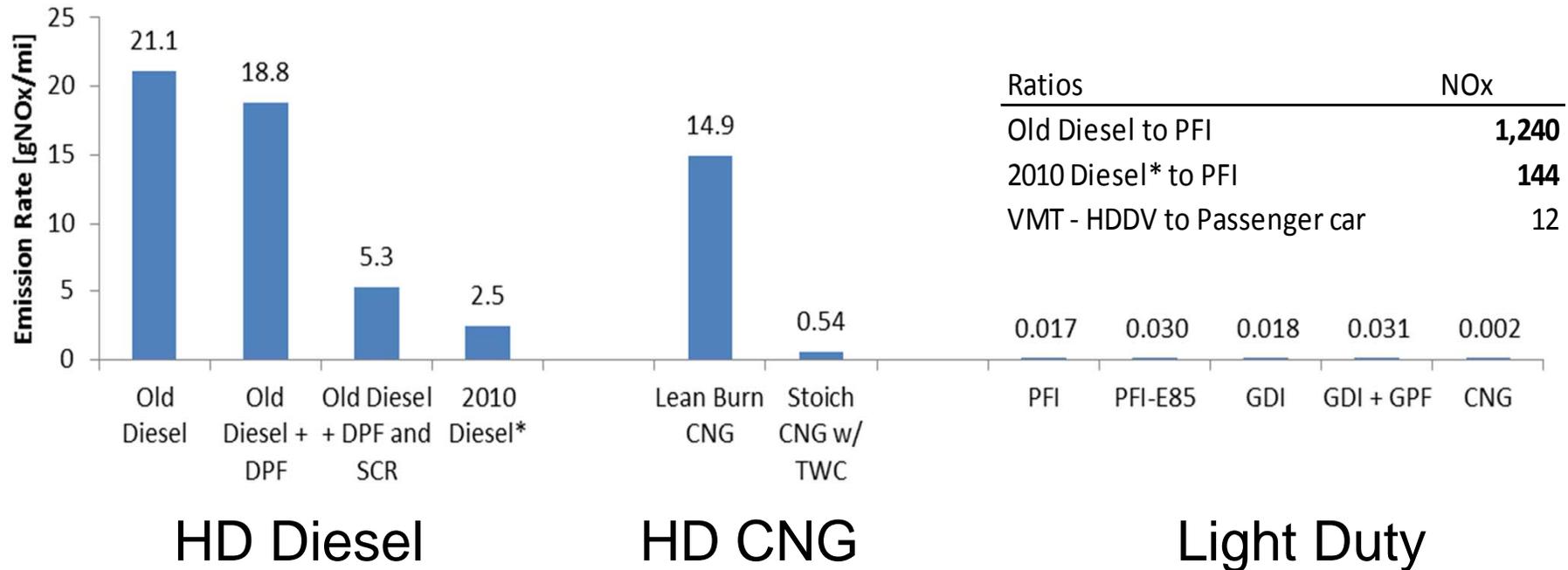
HD CNG

Light Duty

* Certified to Interim 2010 NOx Standard of 0.35 gNOx/bhp-hr

- 99+% reduction in diesel as exhaust has become catalyzed
- CNG high emitting, but 97% methane
- Light duty important contributor

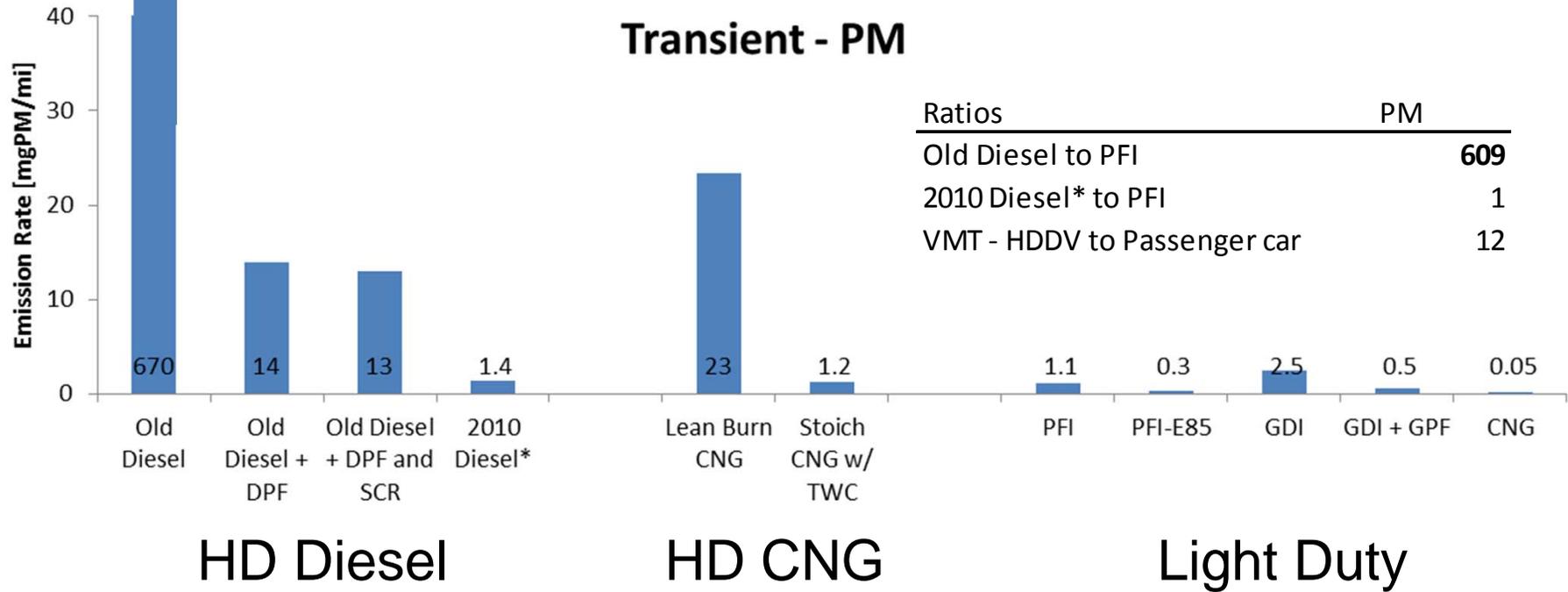
Transient - NOx



* Certified to Interim 2010 NOx Standard of 0.35 gNOx/bhp-hr

- 90% and 95% reduction in diesel* and CNG respectively
- Light duty still significantly lower
- Heavy duty will continue to be the dominant source of NOx

Transient - PM



* Certified to Interim 2010 NOx Standard of 0.35 gNOx/bhp-hr

- 99+% and 95% reduction in diesel and CNG respectively
- Light duty could become the dominant source

Common Screening Method for Toxicity

PM Extraction

Chemical Assays
(cell free)

Cellular *in vitro*
Assays

Genotoxicity Assays

Oxidative Stress

Inflammation

DNA damage

- DTT
- DTT+DTPA

- Macrophage ROS
- Inflammatory Markers mRNA

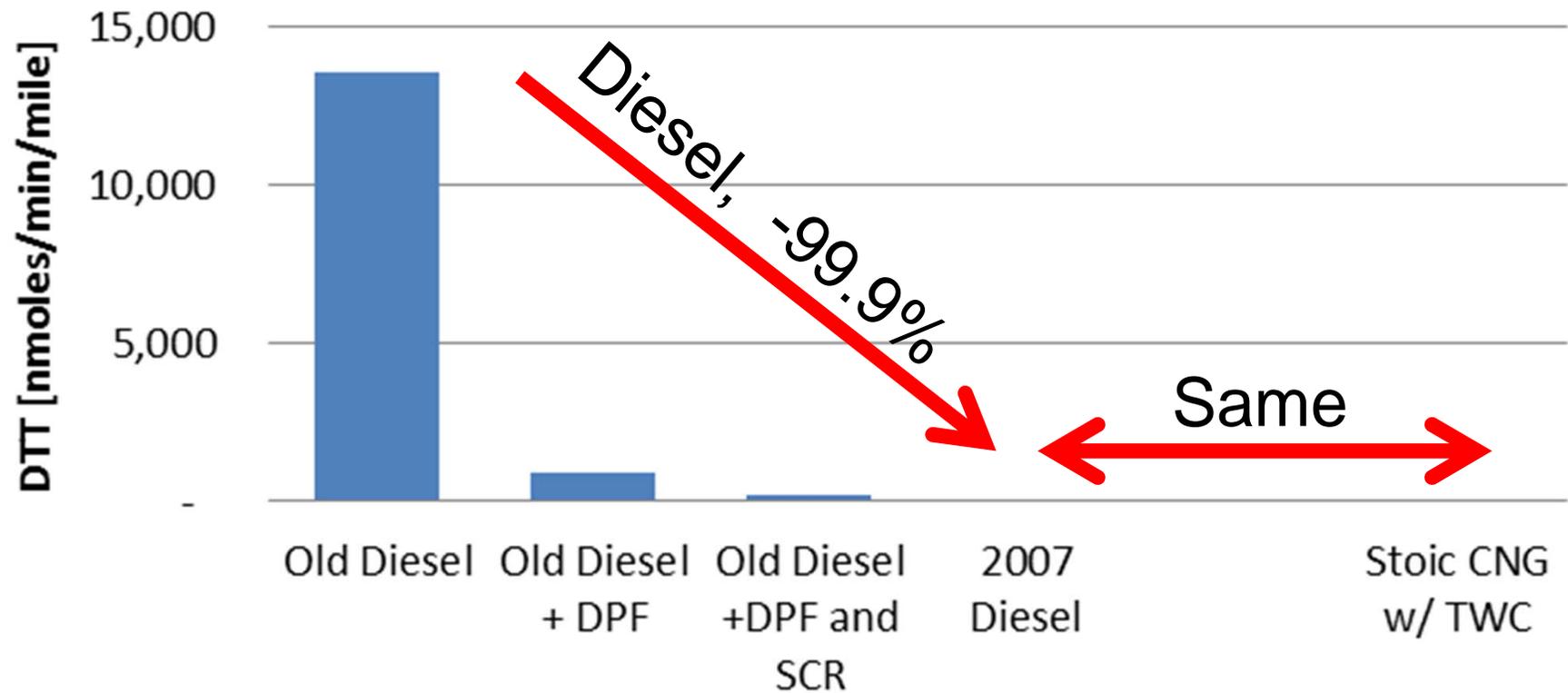
- Ames bio assay
- Comet assay

Type

Endpoints

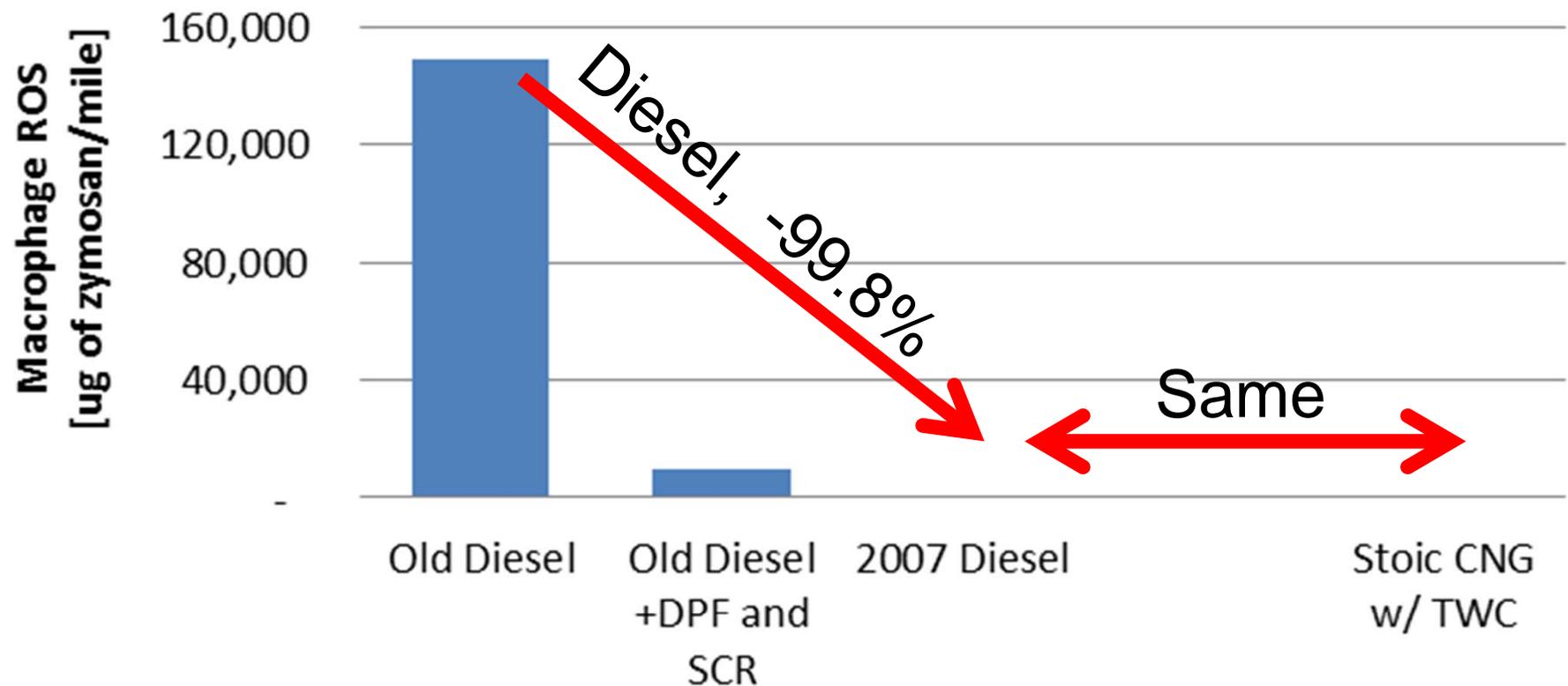
Assay

Toxicity - DTT Assay Transient

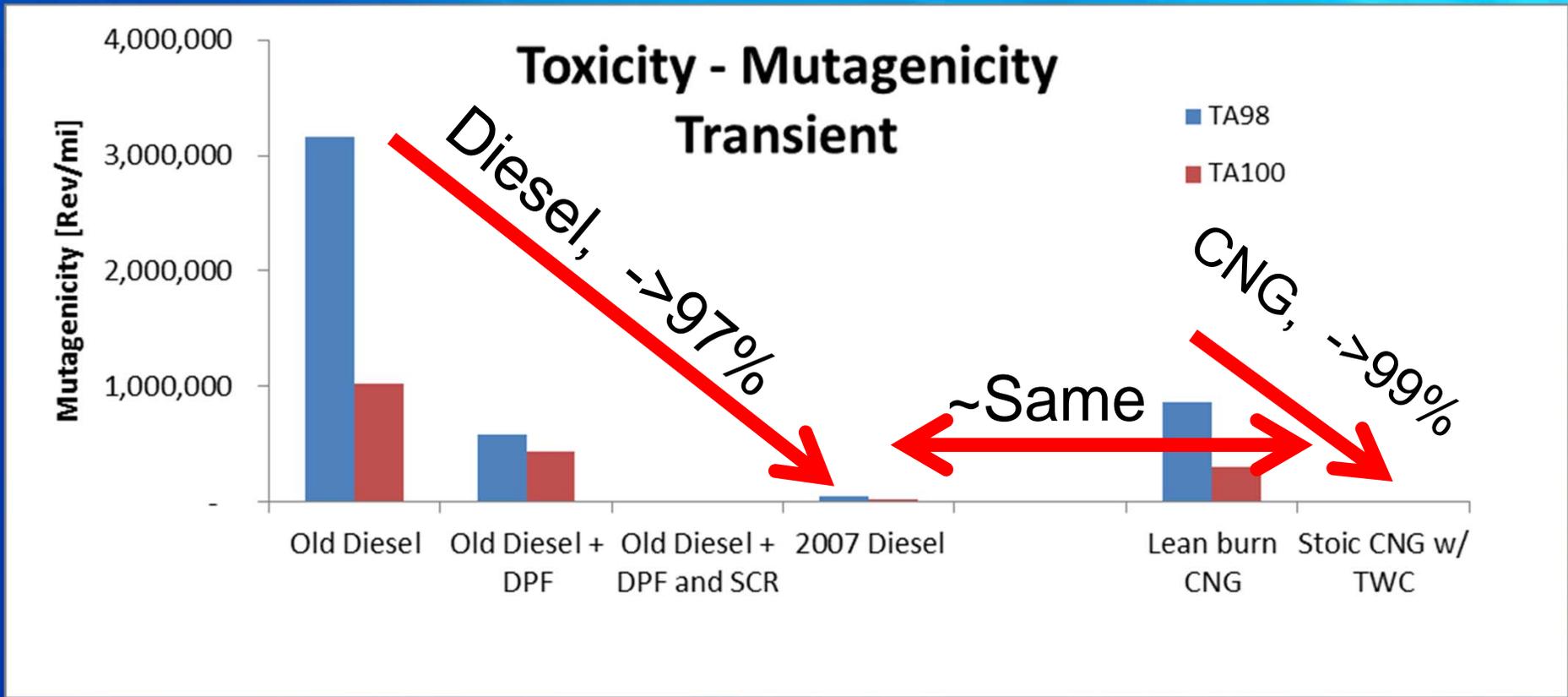


***Oxidative Stress
preliminary results***

Toxicity - Macrophage ROS Transient



**Inflammation
preliminary results**



***DNA Damage
preliminary results***

Conclusions

- Toxicity – need to complete the matrix of measurements, but levels are decreasing with new technology controls.
- Drastic reductions in NO_x and PM in both diesel and CNG, but heavy duty continues to be dominant emitter of NO_x.
- Stoichiometric CNG w/ TWC emit high levels of CO and THC (mostly CH₄).
- Light Duty vehicles are important contributors to CO and THC emissions from the mobile sector and may also become the dominant emitter of PM.
- Need to continue the work to understand how emissions are changing in response to new technologies and fuels that are being introduced in response to regulations.

California needs zero emissions transportation