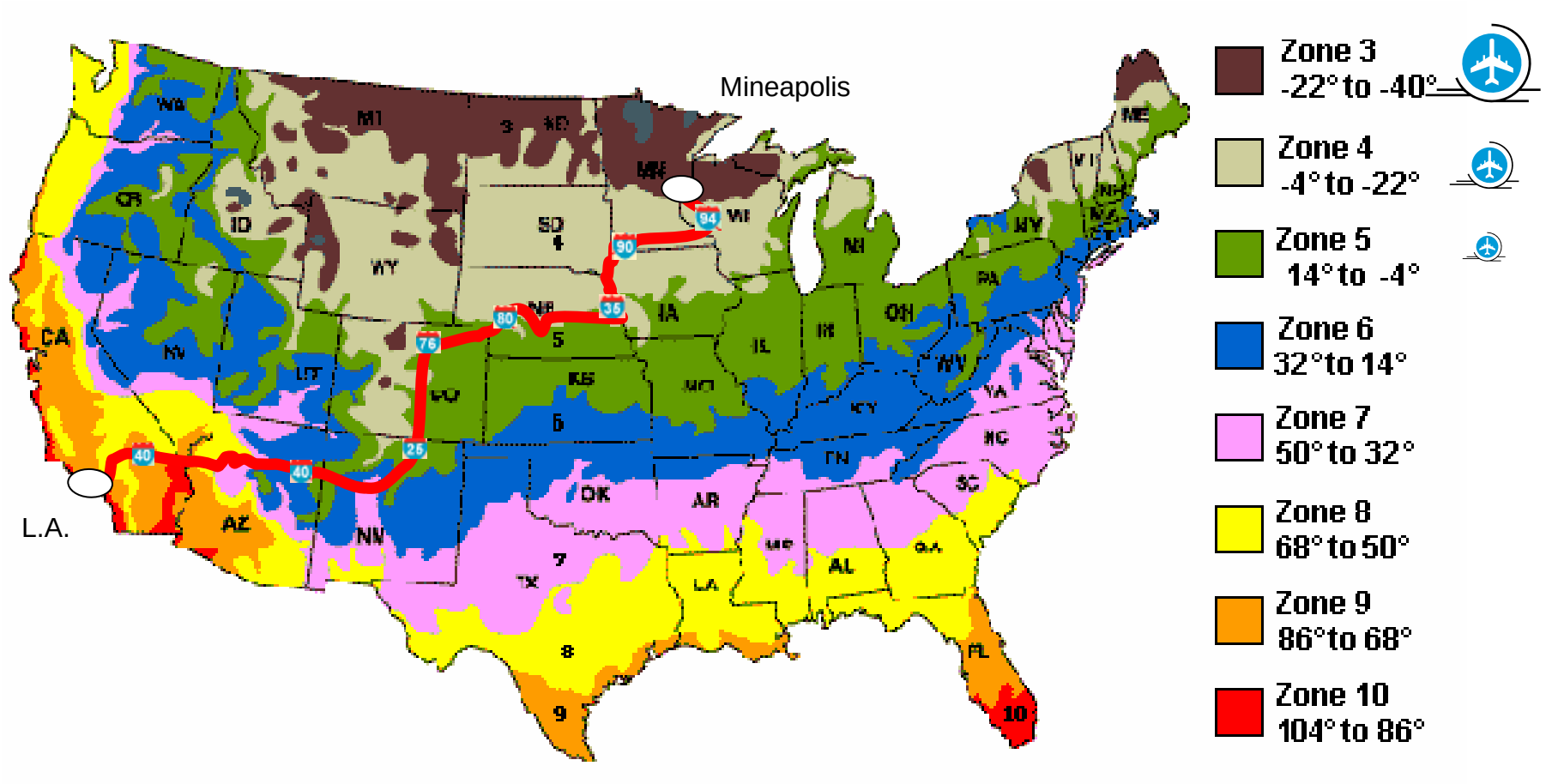
ON BOARD FUEL QUALITY SENSOR

16th August 2007

Dr Alain LUNATI

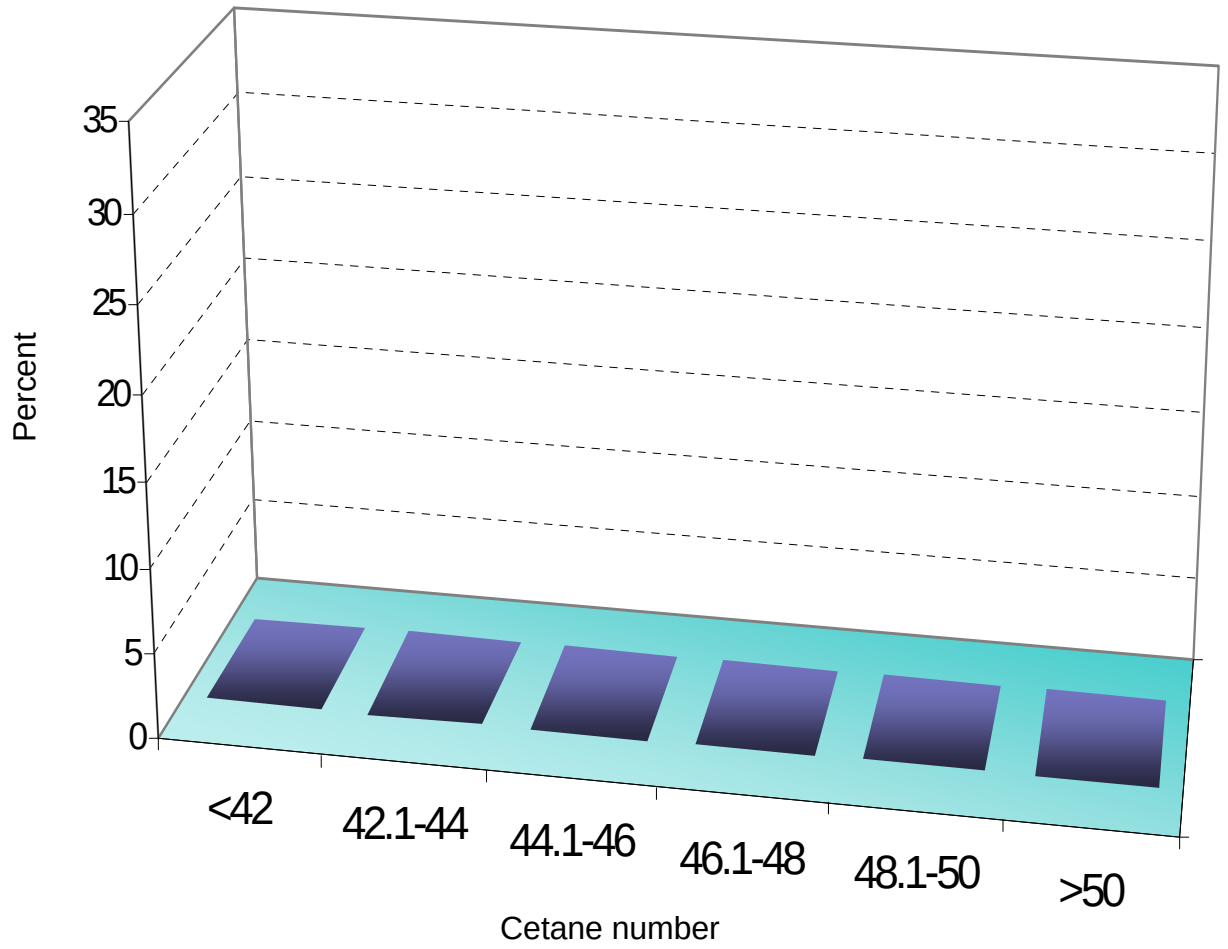
DIESEL VARIABILITY
GEOGRAPHICAL CONSTRAINTS - COLD START PROBLEM



Source : World climate review 2005

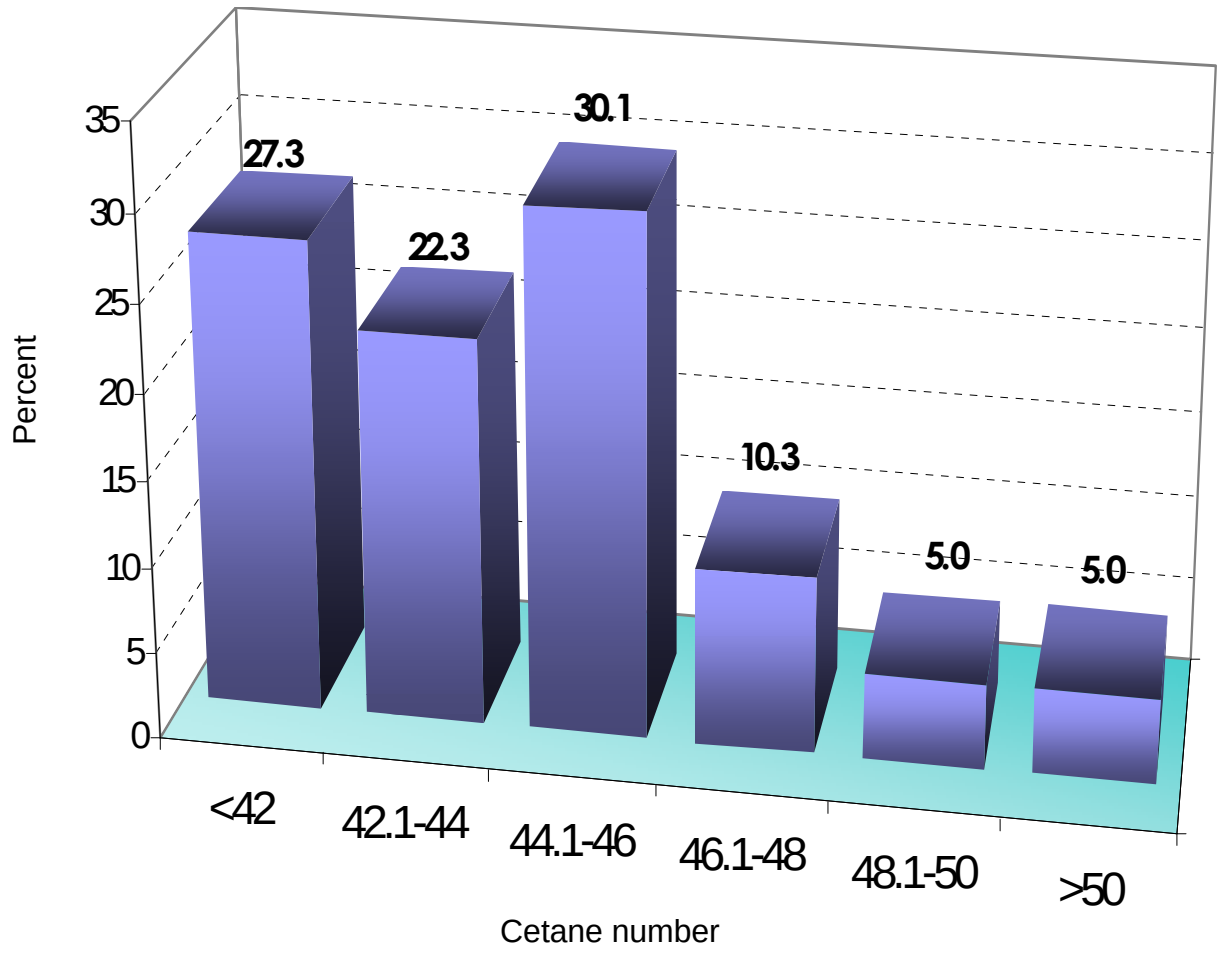
Direct impact on all the others physical and chemical properties :
Density / distillation curve / cetane number or %Aro

NORTH AMERICA DIESEL EXISTING VARIABILITY FOR CETANE NUMBER



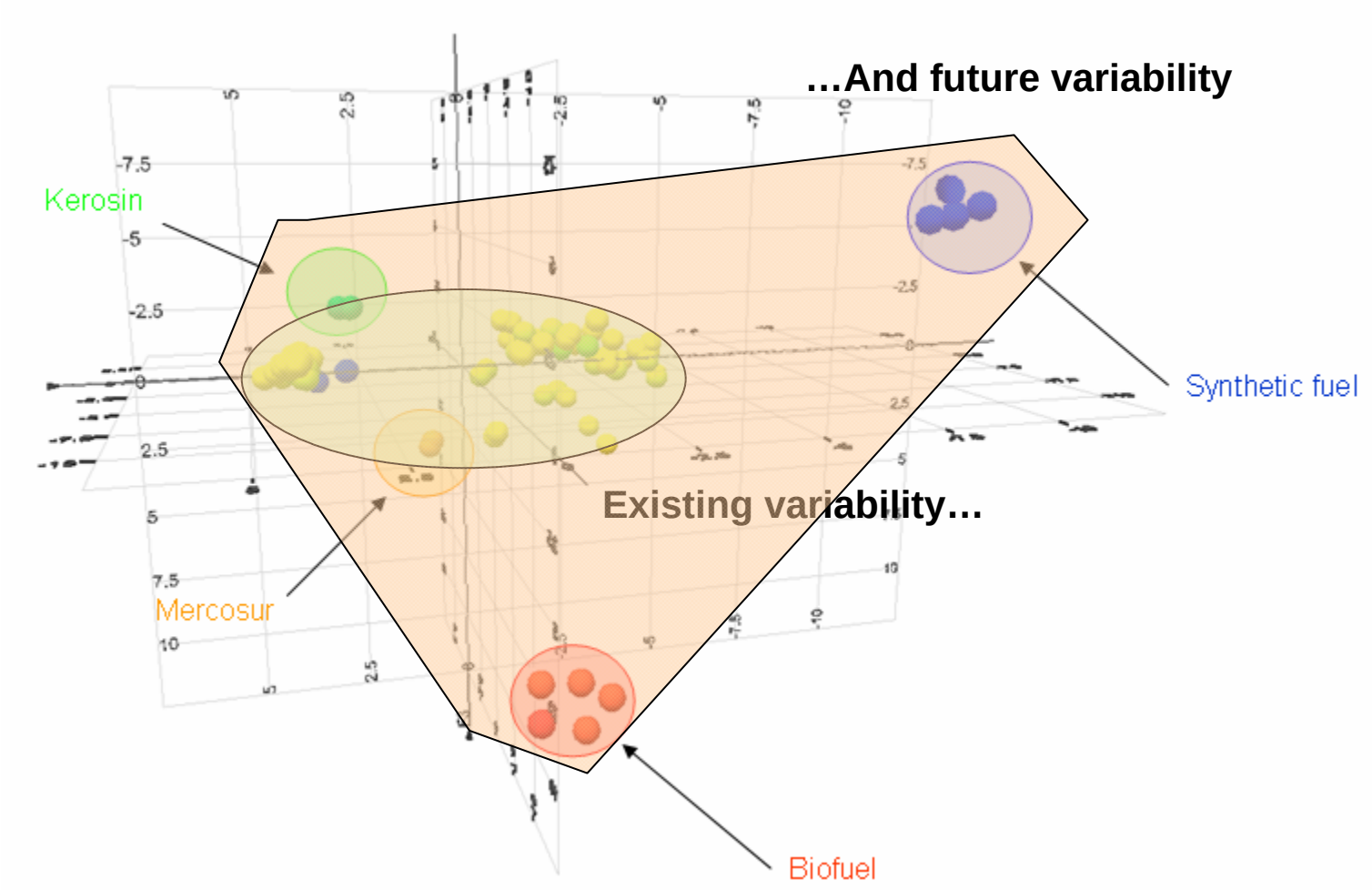
Source GM-DEER 2006 from 2005 AAM winter & Summer Diesel Fuel survey

NORTH AMERICA DIESEL RANGE VARIABILITY FOR CETANE NUMBER



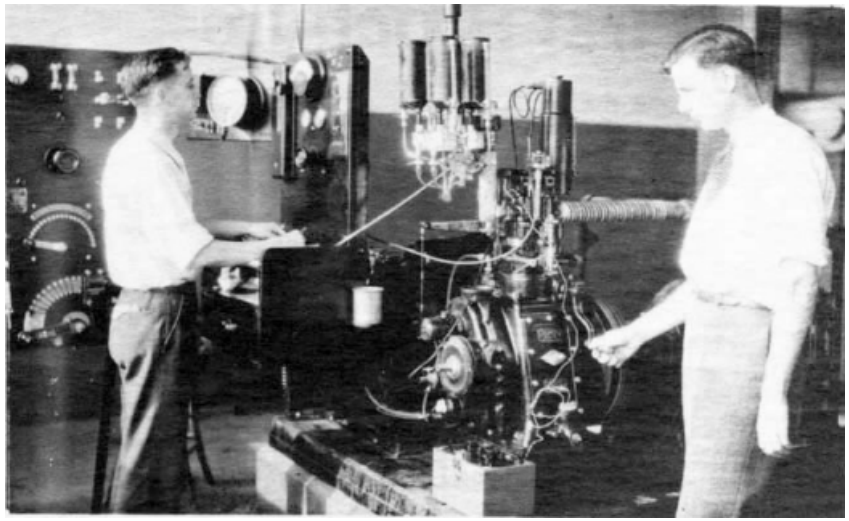
Source GM-DEER 2006 from 2005 AAM winter & Summer Diesel Fuel survey

FACING THE FUEL DIVERSITY CHALLENGE TODAY AND TOMORROW



LIMITATIONS COME FROM EXISTING METHODS AND STANDARDS…

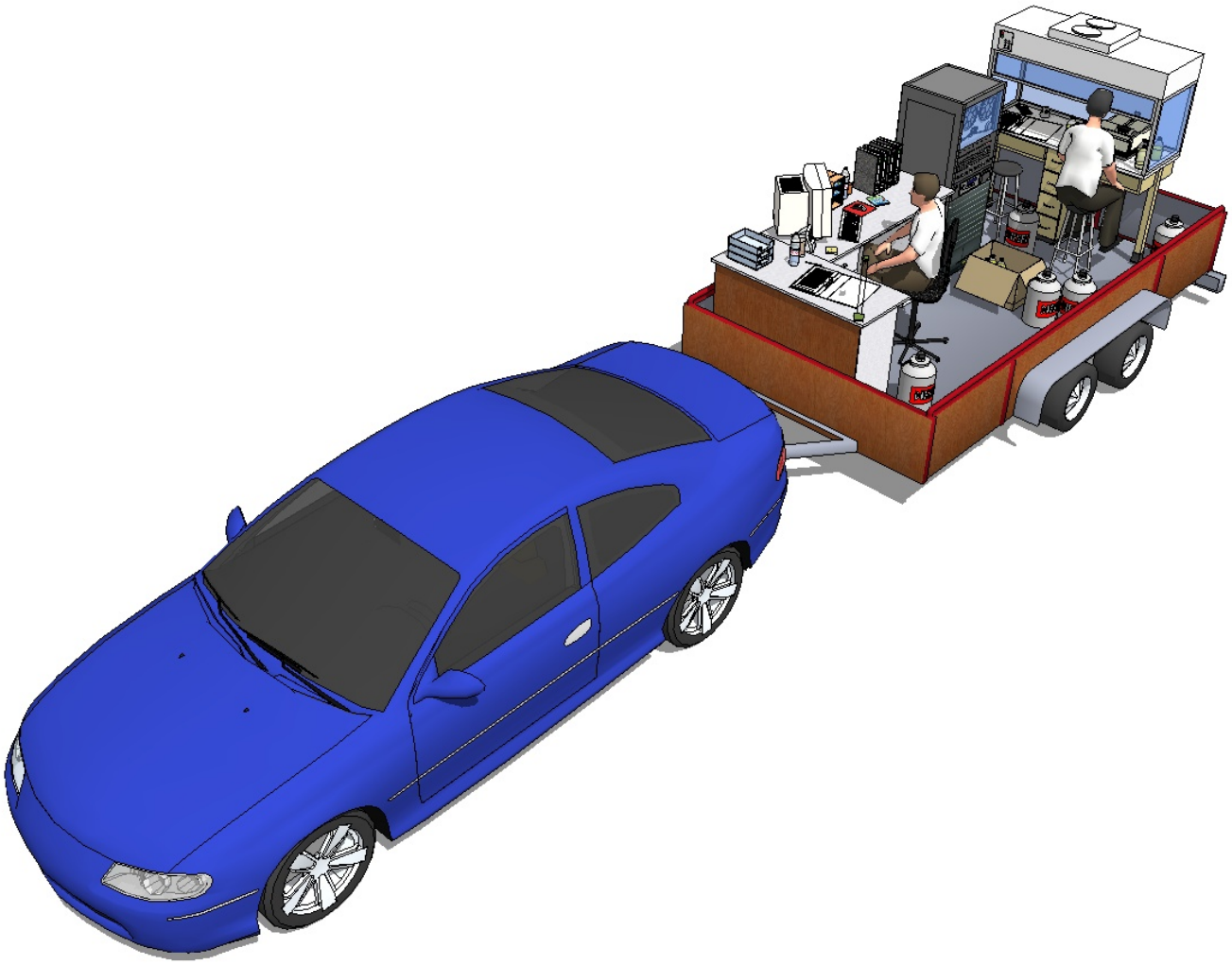
- **Fuel products characterization with normalized properties is a macroscopic approach and therefore no longer compatible with DI diesel technologies**
  - **Cetane Number**
  - **Viscosity**
  - **Density**
  - **ASTM distillation**
  - **Aromatics**
  - **Cold flow properties …**



CFR (cetane) in 1940's

CFR (cetane) in 2007

...AND MUCH MORE ABOUT ANY REALISTIC ON BOARD SOLUTION...



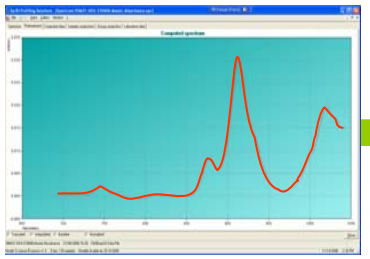
SP3H ONBOARD PROCESS DESCRIPTION

- **Proprietary technology using near infrared hardware, dedicated software and specific algorithms**

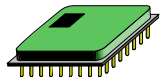
(II)
Information extraction

(I)
Data acquisition

NIR sensor



NIR spectrum
= RAW data



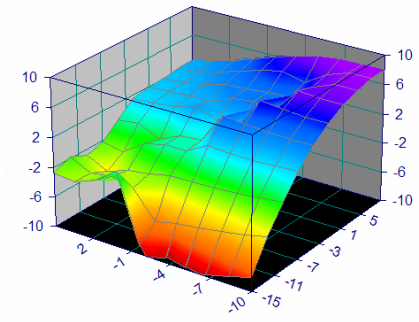
MCU

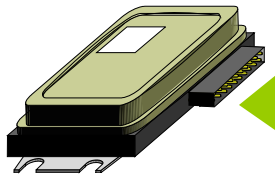
HCP Aro
HCP Lin
HCP Oxy
. . . . .

HCp™

HydroCarbon Profilers

(III)
Engine Management





ECU

Bus / CAN

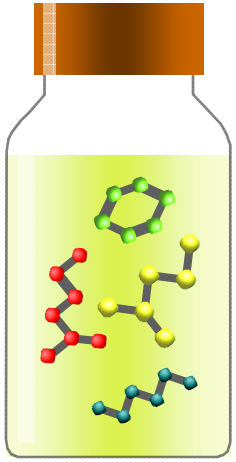
SP3H ON BOARD FUEL QUALITY SENSOR

NEAR INFRARED PRINCIPLES

(I) Data acquisition

Source

Intensity I_0



Fuel sample

Intensity I

NIR detector

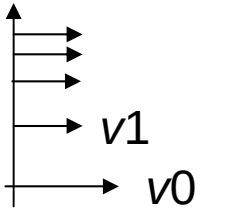
Absorbency = Log(I_0 / I)

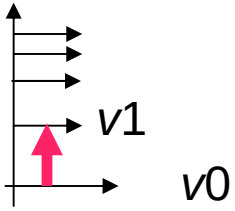
C-H

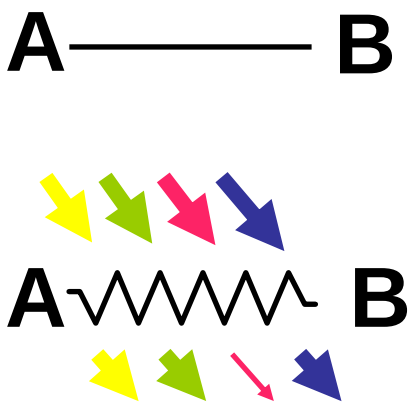
O-H

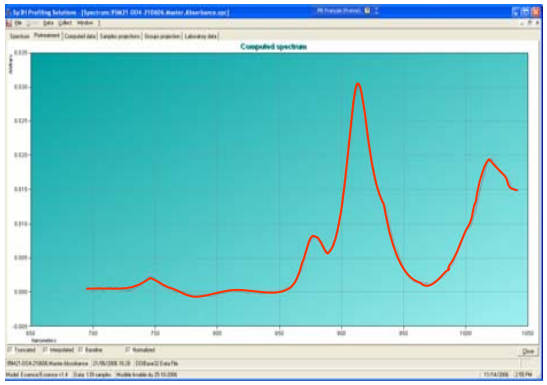
N-H

S-H





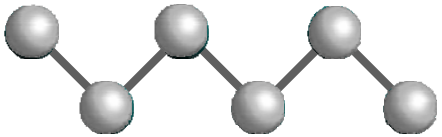


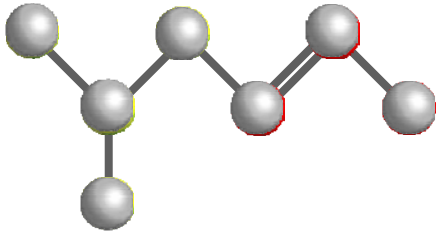


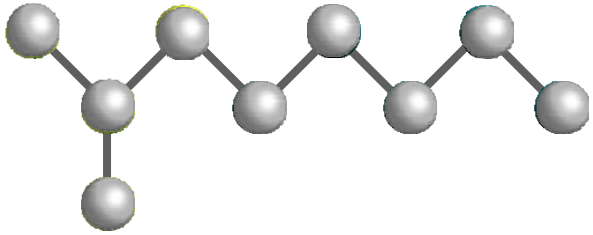
HYDROCARBON PROFILERS : A REAL FUEL "DNA"

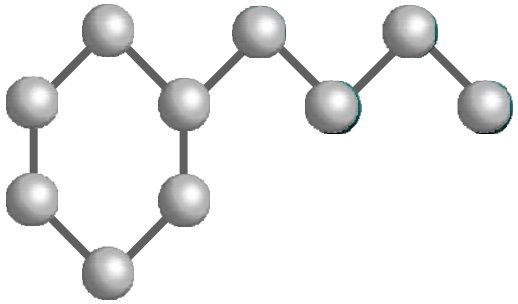
(II) Information extraction

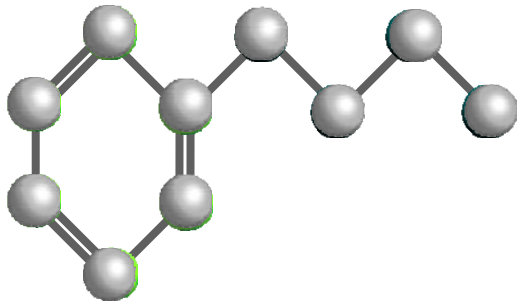
- **Advanced product classification**





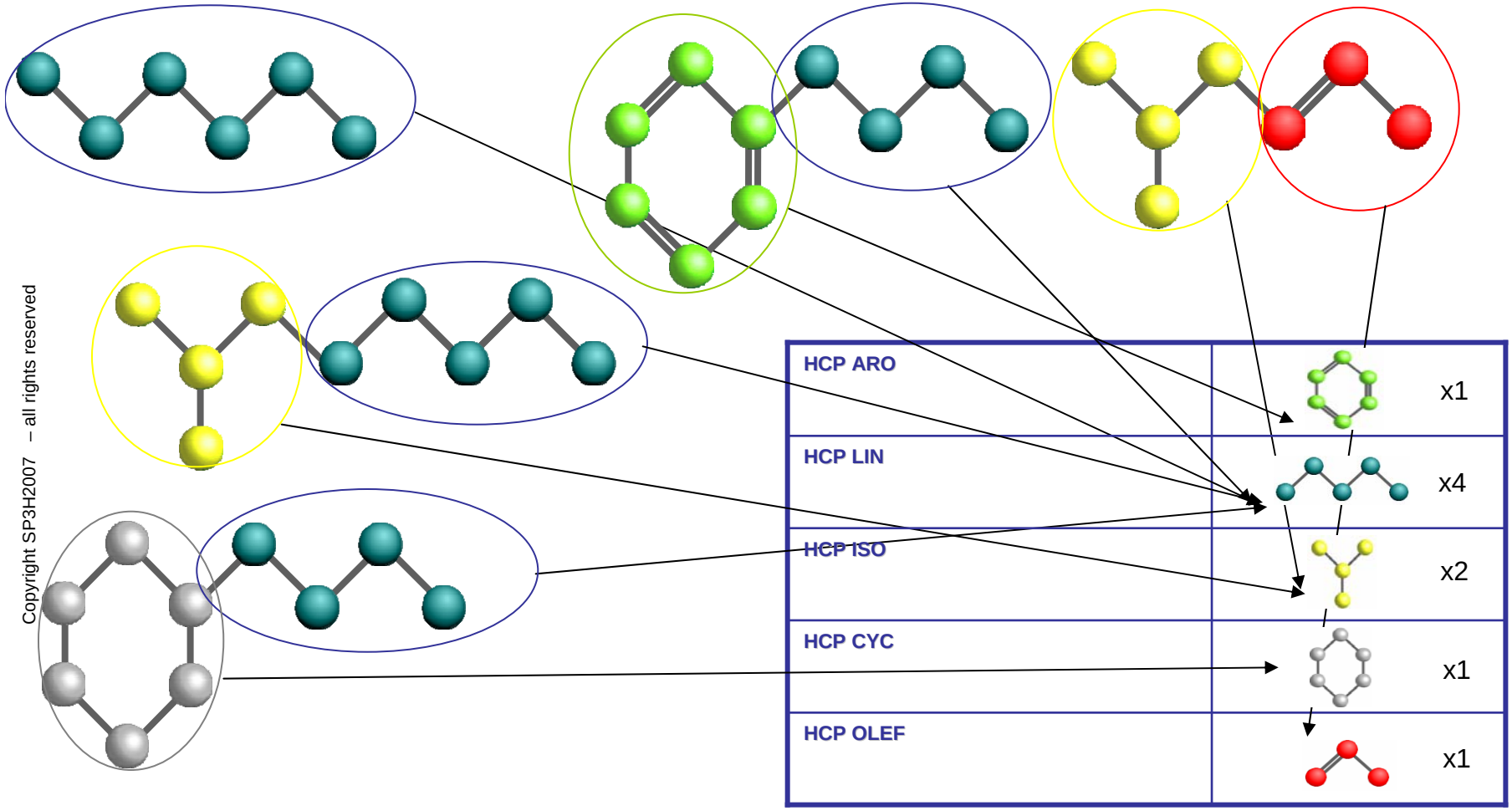






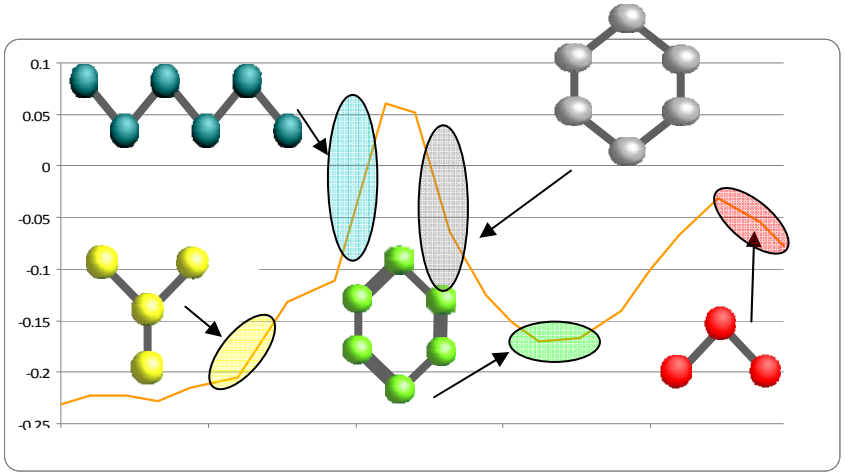
HYDROCARBON PROFILERS : A REAL FUEL "DNA"

- Advanced product classification



HYDROCARBON PROFILERS MATRIX

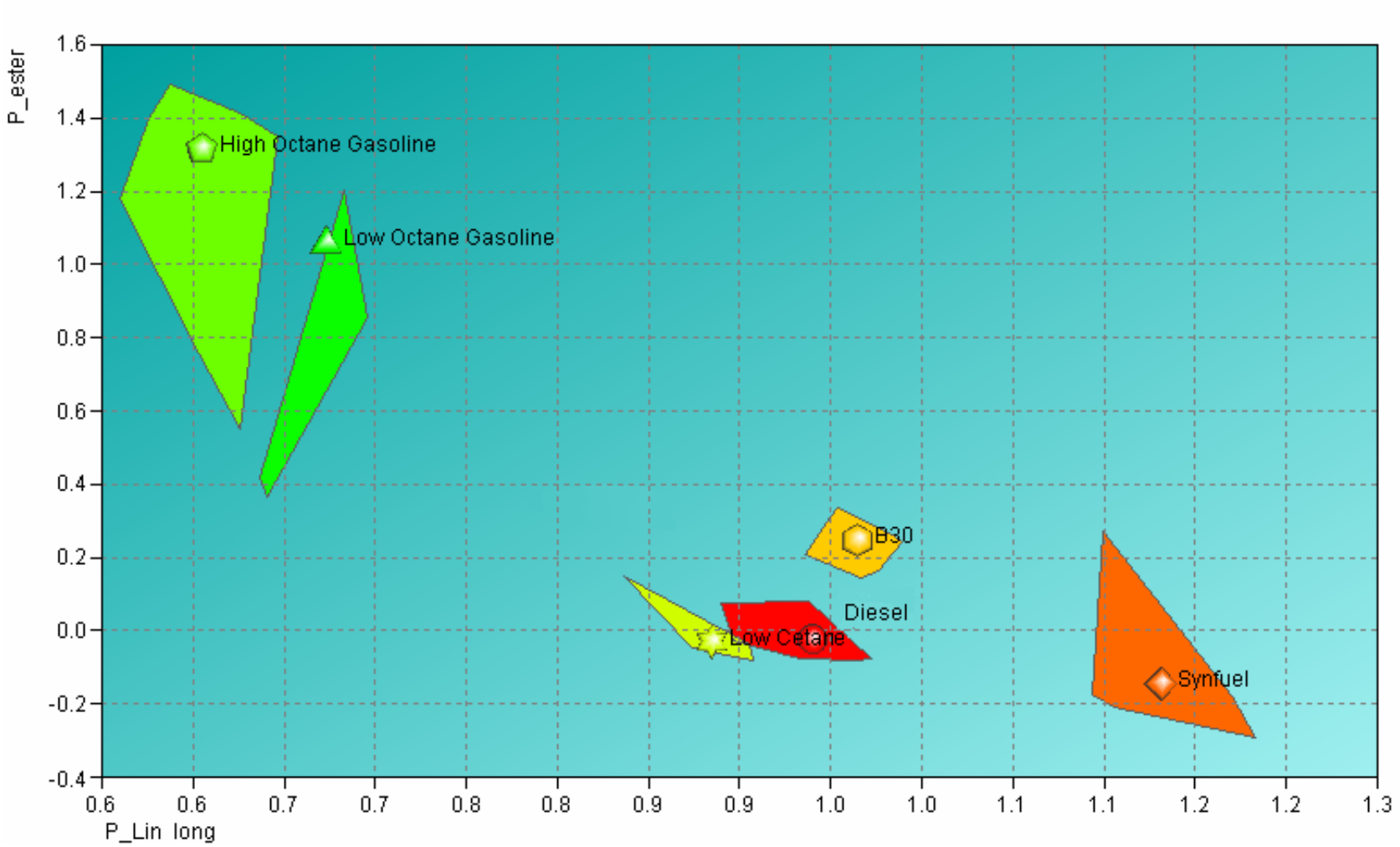
- **Advanced product classification**



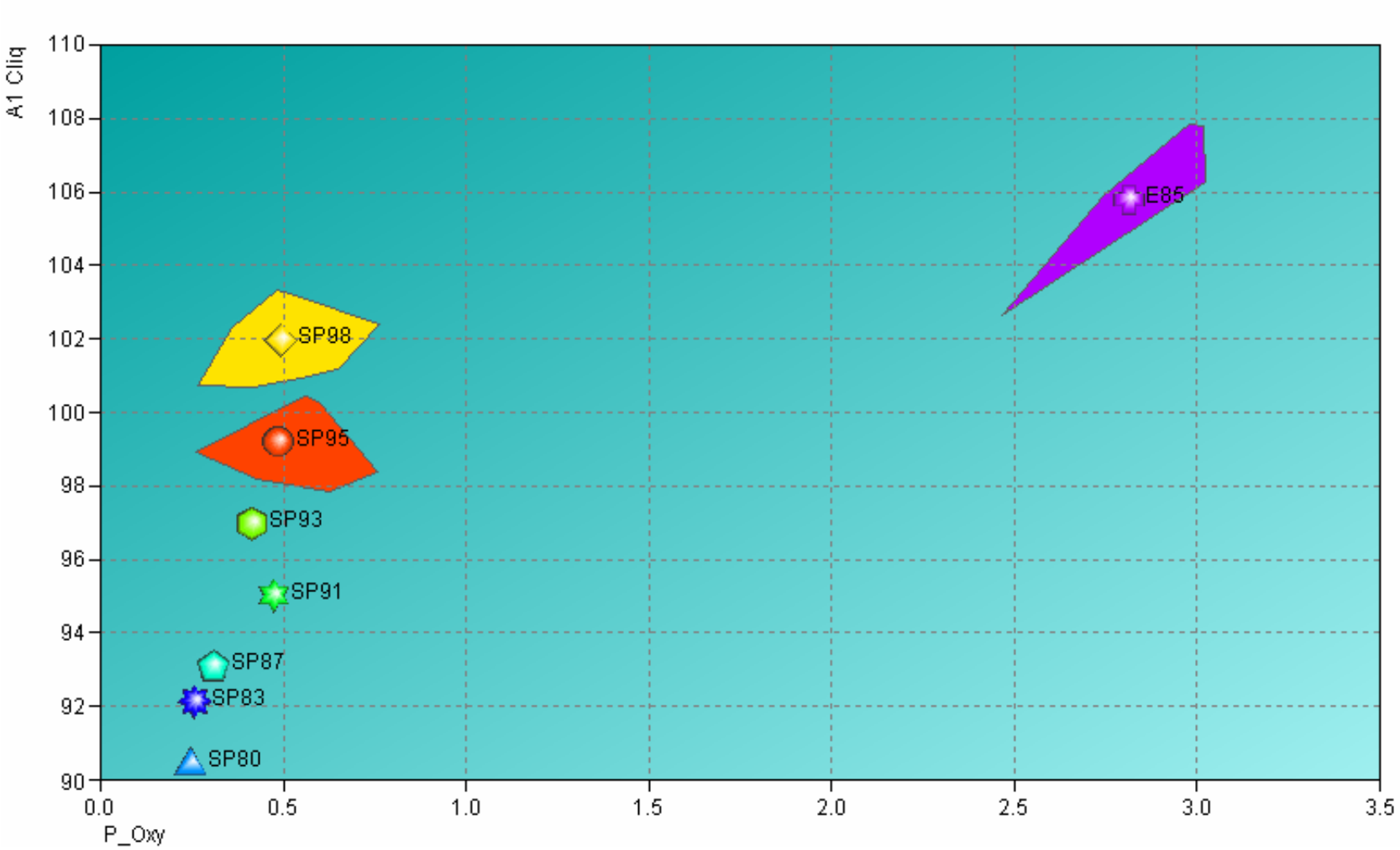
Family (chemical bounds)	Light	Medium	Heavy
Linear Parafins	HCP LIN 1	HCP LIN 2	HCP LIN 3
Iso Parafins (branched)	HCP ISO 1	HCP ISO 2	HCP ISO 3
Olefins (insaturated)	HCP OLEF 1	HCP OLEF 2	HCP OLEF 3
Naphtenes (Cyclanic)	HCP CYCL 1	HCP CYCL 2	HCP CYCL 3
Aromatics	HCP ARO 1	HCP ARO 2	HCP ARO 3
Oxygenates	HCP OXY 1	HCP OXY 2	HCP OXY 3
Alcohols	HCP OH 1		

- **HC, PM=$f_{\text{engine,operating conditions}}$(HCP)**
- **NOx=$f_{\text{engine,operating conditions}}$(HCP)**
- **Ignition delay=$f_{\text{engine,operating conditions}}$(HCP)**

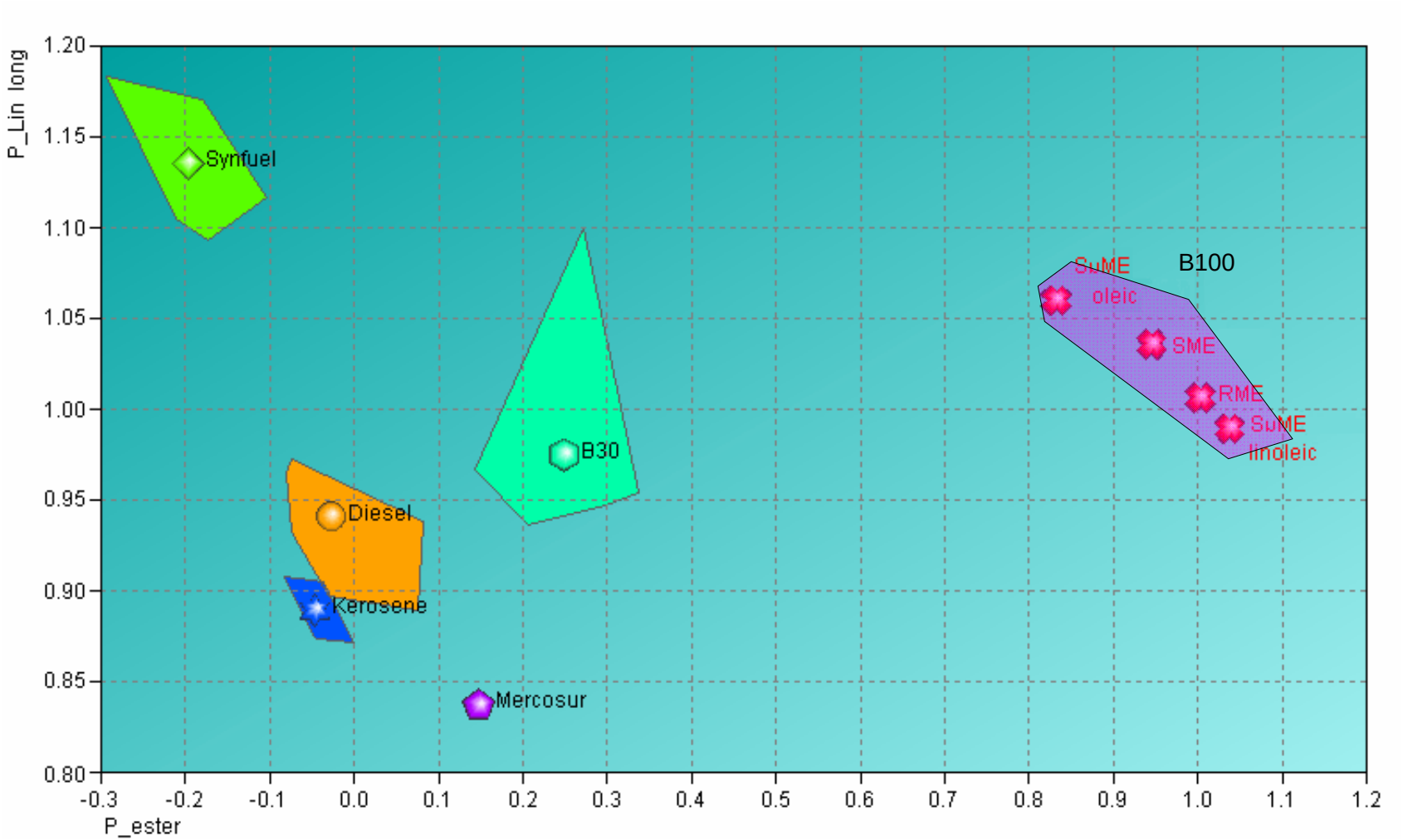
FUEL PRODUCTS DISCRIMINATION USING 2D HCP MAP



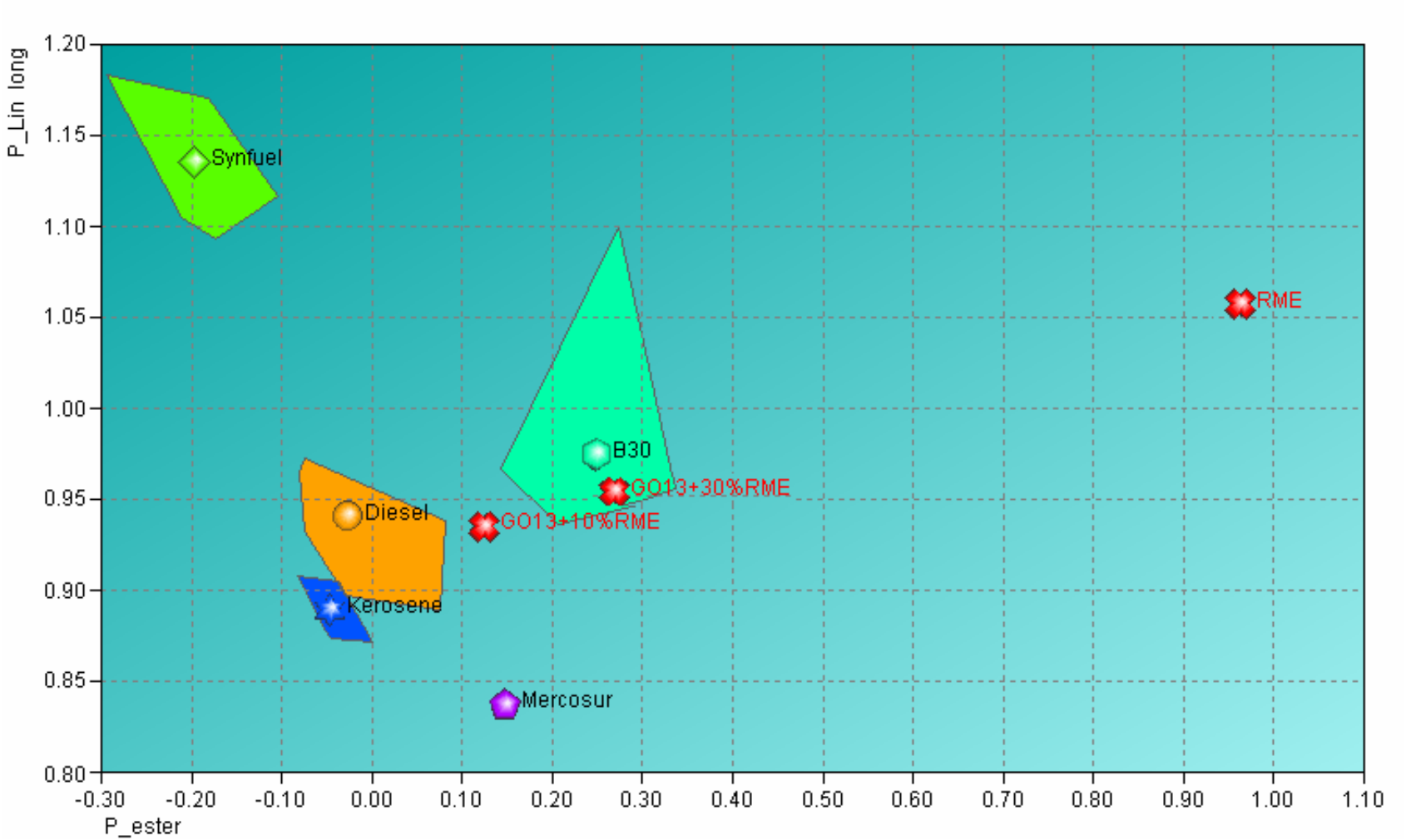
GASOLINE FUEL PRODUCTS DISCRIMINATION USING HCP



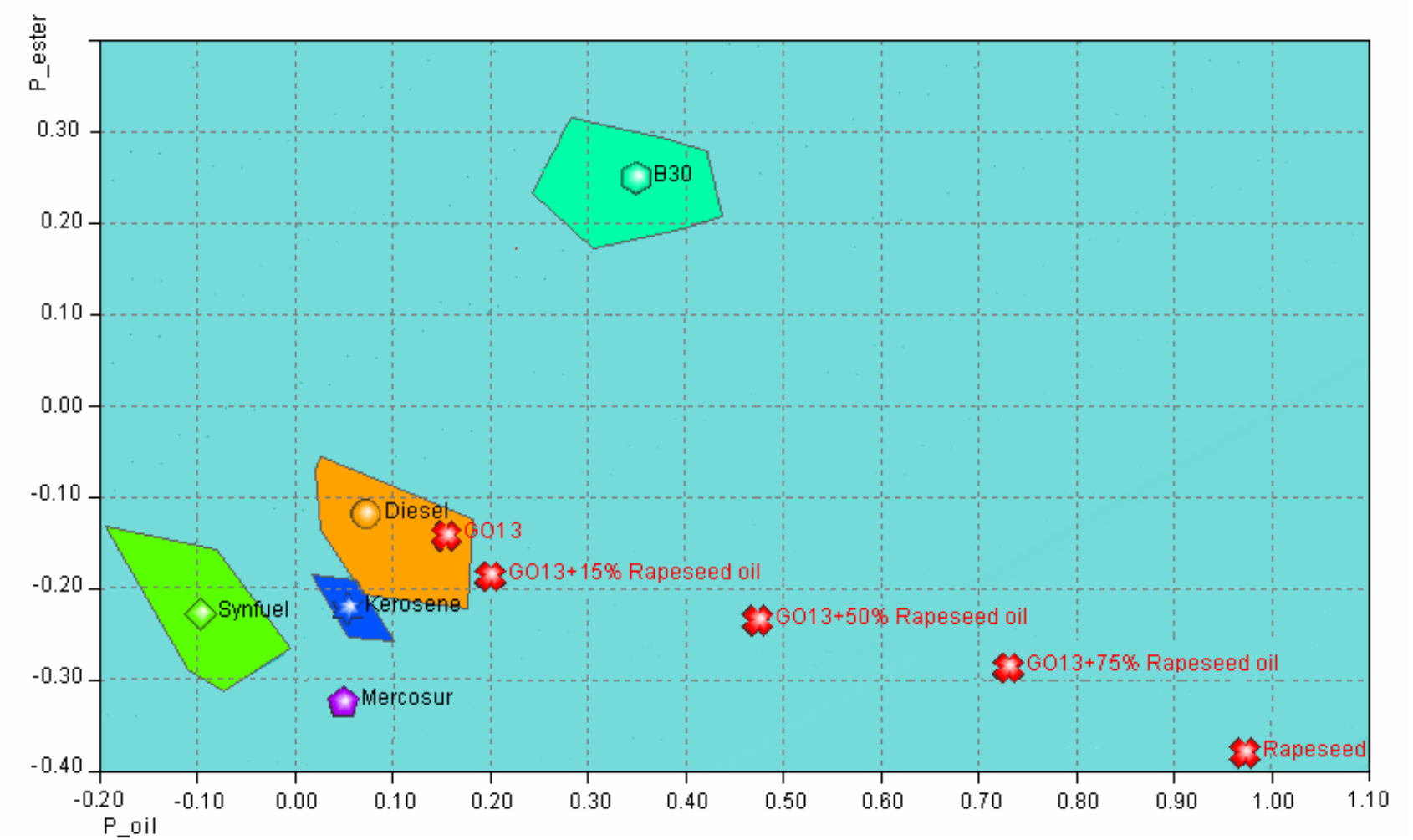
DIESEL PRODUCTS DISCRIMINATION USING HCP



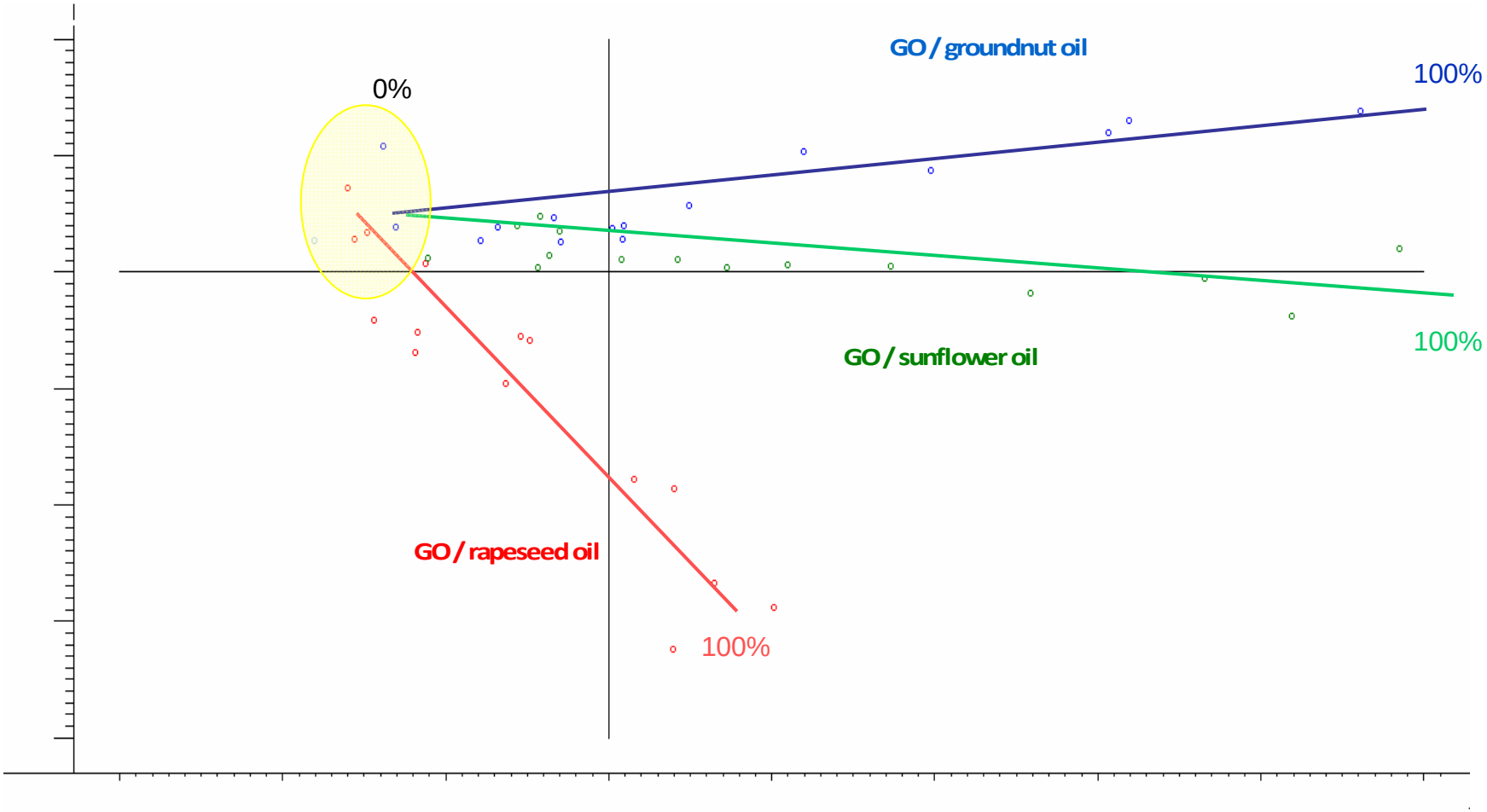
HCP DISCRIMINATION OF %BIODIESEL IN DIESEL
RAPESEED METHYL ESTER VARIATION



HCP DISCRIMINATION OF VIRGIN OIL IN DIESEL FUEL
RAPESEED OIL % VARIATION EXAMPLE

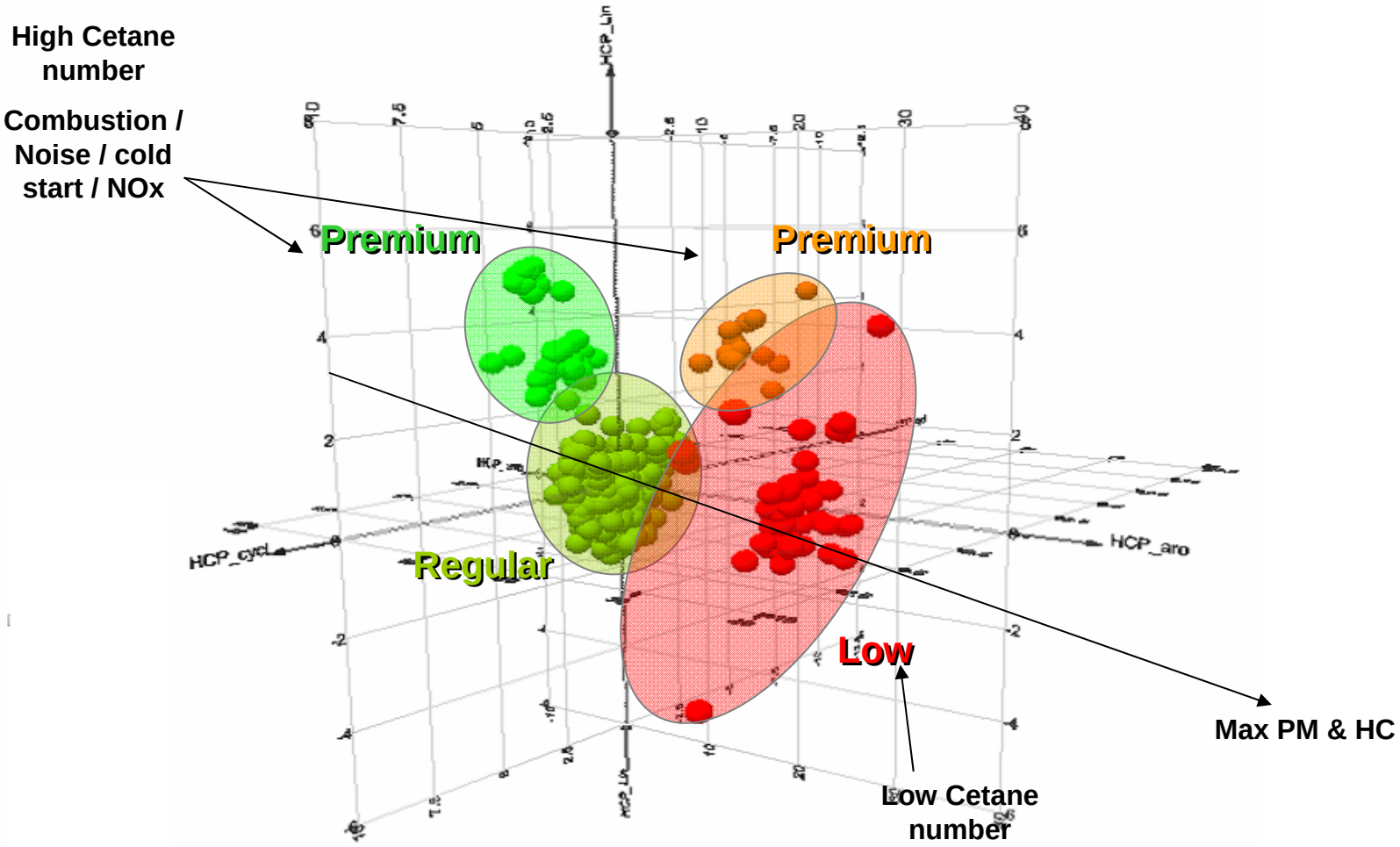


HCP DISCRIMINATION BY ORIGIN
DIFFERENT VIRGIN OILS



HYDROCARBON PROFILERS : PERFORMANCE PROBLEMS IDENTIFICATION

- **Diesel self ignition delay example**



HCP FUEL QUALITY SENSOR VALUE PROPOSITION SUMMARY

Engine parameter	HCP (Fuel parameters equivalent)	SP3H Sensor
Injection advance	Auto ignition delay Bio fuel content and type	
Injection timing & Multi point injection management	Auto ignition delay Density Heavy aromatic content Viscosity Bio fuel type and content Distillation curve	
EGR / TURBO	Auto ignition delay Bio fuel content Bio fuel type Density Heavy aromatic content Viscosity Distillation curve	
After treatment	Density Heavy aromatic content Viscosity Bio fuel type and content	

HCP (Fuel parameters equivalent)	SP3H Sensor
Detection of high Sulfur Content	
Detection of Gasoline in the Diesel Fuel	
Detection of molecules that contributes to fuel dilution	
Detection of cylinder to cylinder variability	
Cycle to cycle instability independent of Fuel quality	

THANK YOU

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