ECN 6: TOPIC FLAME STRUCTURE

Contributors of which data is used

- Yigit Akargun, Amin Maghbouli, *Bart Somers*, Noud Maes, TU/e
- Jose Marie-Garcia Oliver and friends, CMT
- Tommaso Lucchini, Gianluca D'Errico, POLIMI
- Sebastian Fernandez, Dan Haworth, Penn State University

Compared to earlier ECN's:

- data exchange remains troublesome (many different servers), typically 6-10Gb per case.
- But data files themselves were really without much issues. ECN5 scripts worked without much modification.

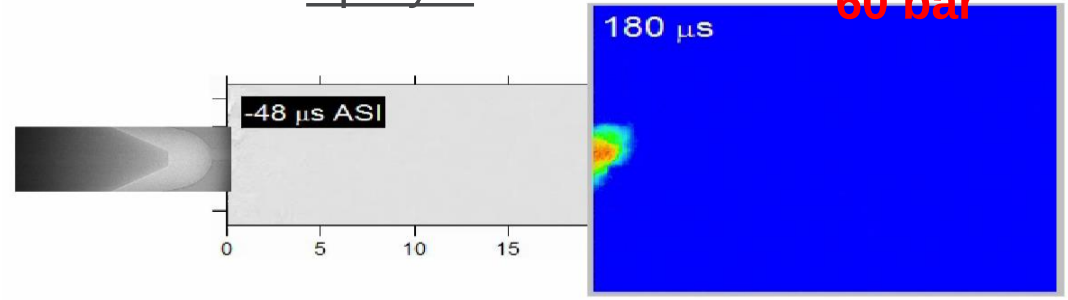
ECN6
Ignition-BS

10 Sept - 11 Sept 2018

UPV

Diesel
Spray A

900 K
60 bar



IGNITION CONTRIBUTIONS

RANS

- CMT, Converge, UFPV, β-PDF
- POLIMI, OpenFOAM 2.2.x/libIce, ADF, β-PDF
- *Penn State (PSU)*, code ??, tPDF
- TUE, OpenFOAM 2.2.x/libIce, FGM,WM

Note: in the plots where it states PSU, CMC it is WM

LES

- TUE, OpenFOAM 2.4.x, FGM-WM,RANS

Adapted code from CMT, Mesh from CMT

IGNITION CONTRIBUTIONS

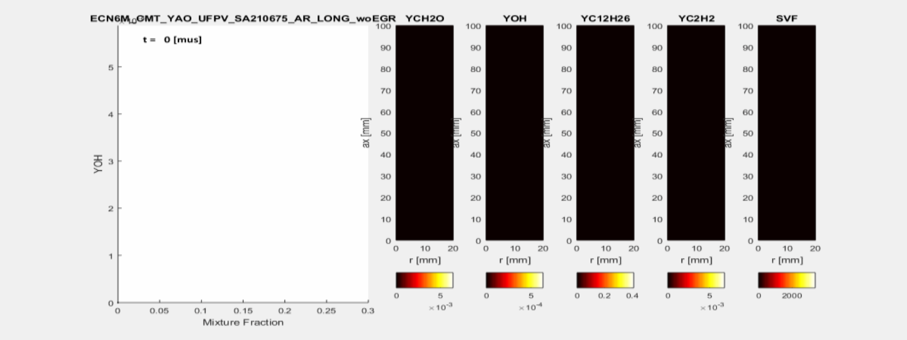
Tabulated chemistry approaches

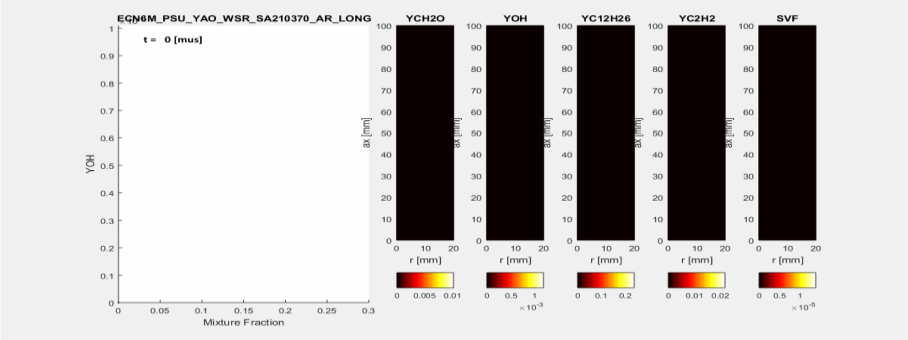
- CMT, UFPV, β-PDF
- POLIMI, ADF, β-PDF
- TUE, FGM, WM

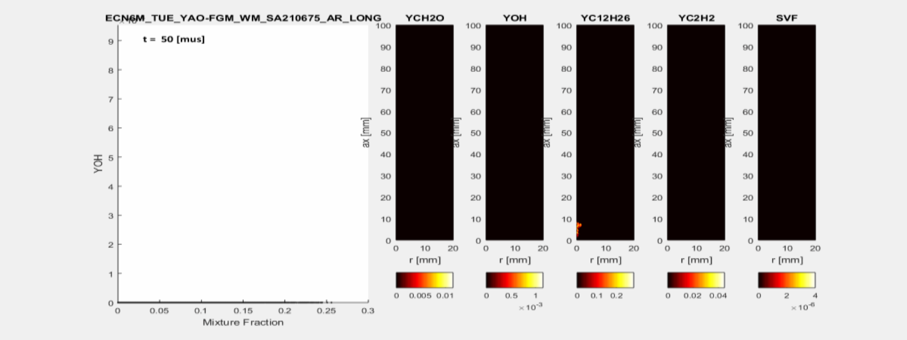
Transported PDF

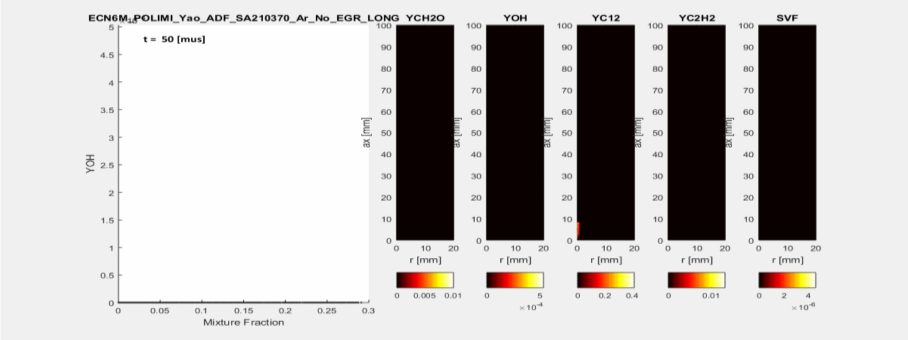
- PSU

OVERVIEW









Sorry PSU: I only got the WM files in time…

CONTENT

Ignition

Spray A, Base case (AR)

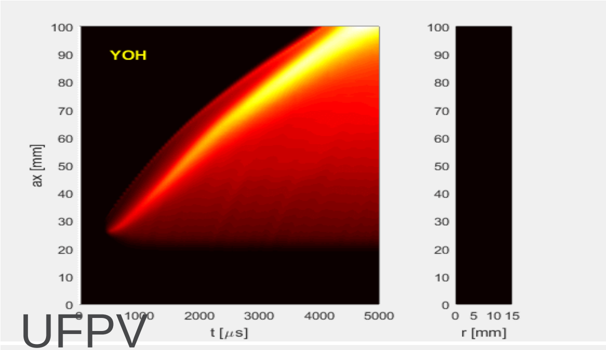
- IXT plots overview
- Focus around ignition
- Fields vs scatter plots
  - OH
  - CH2O
- RGB fields (overlap?)

MAR

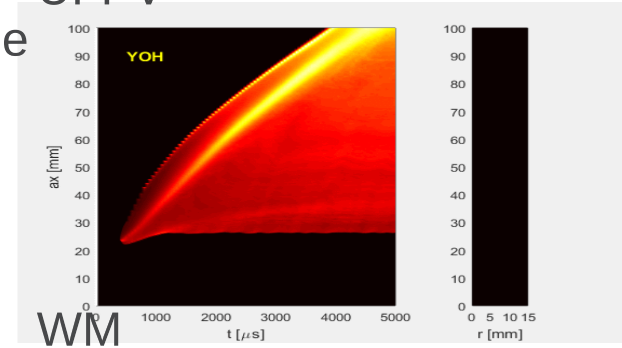
- Impression (TUE, POLIMI)
- ?

CMT
Converge

UFPV

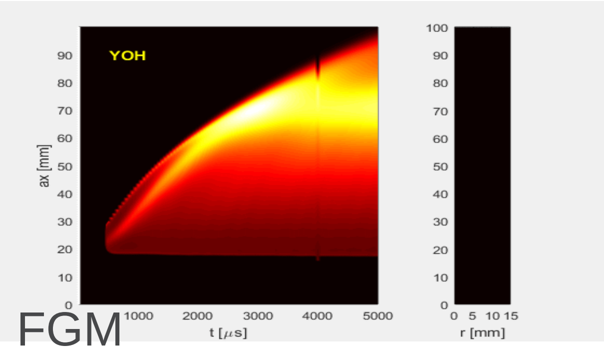


WM

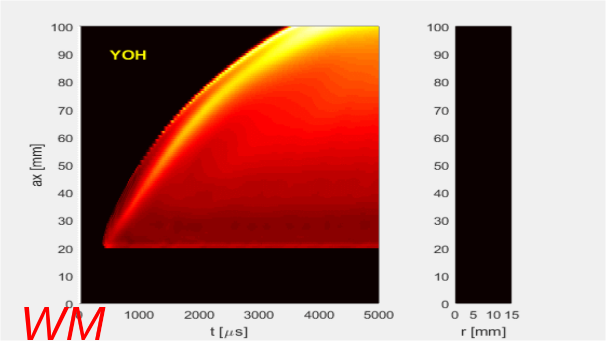


TUE
OF
RANS

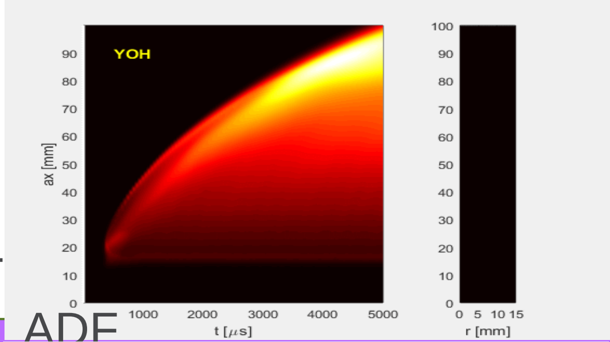
FGM



PSU *WM*

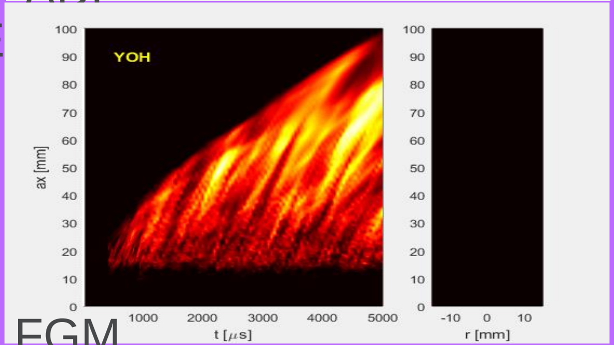


POL
OF
ADF



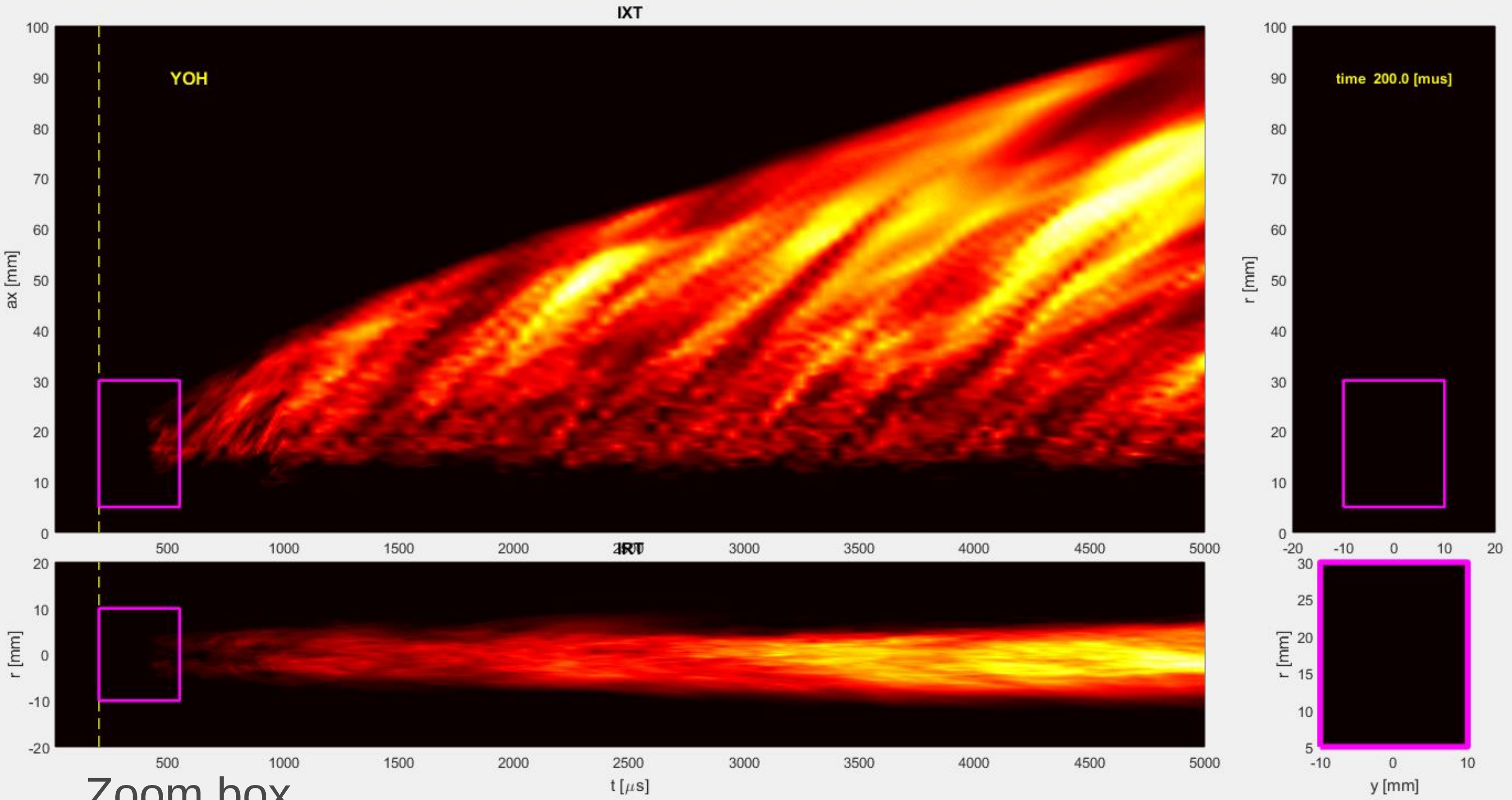
TUE
OF
LES

FGM



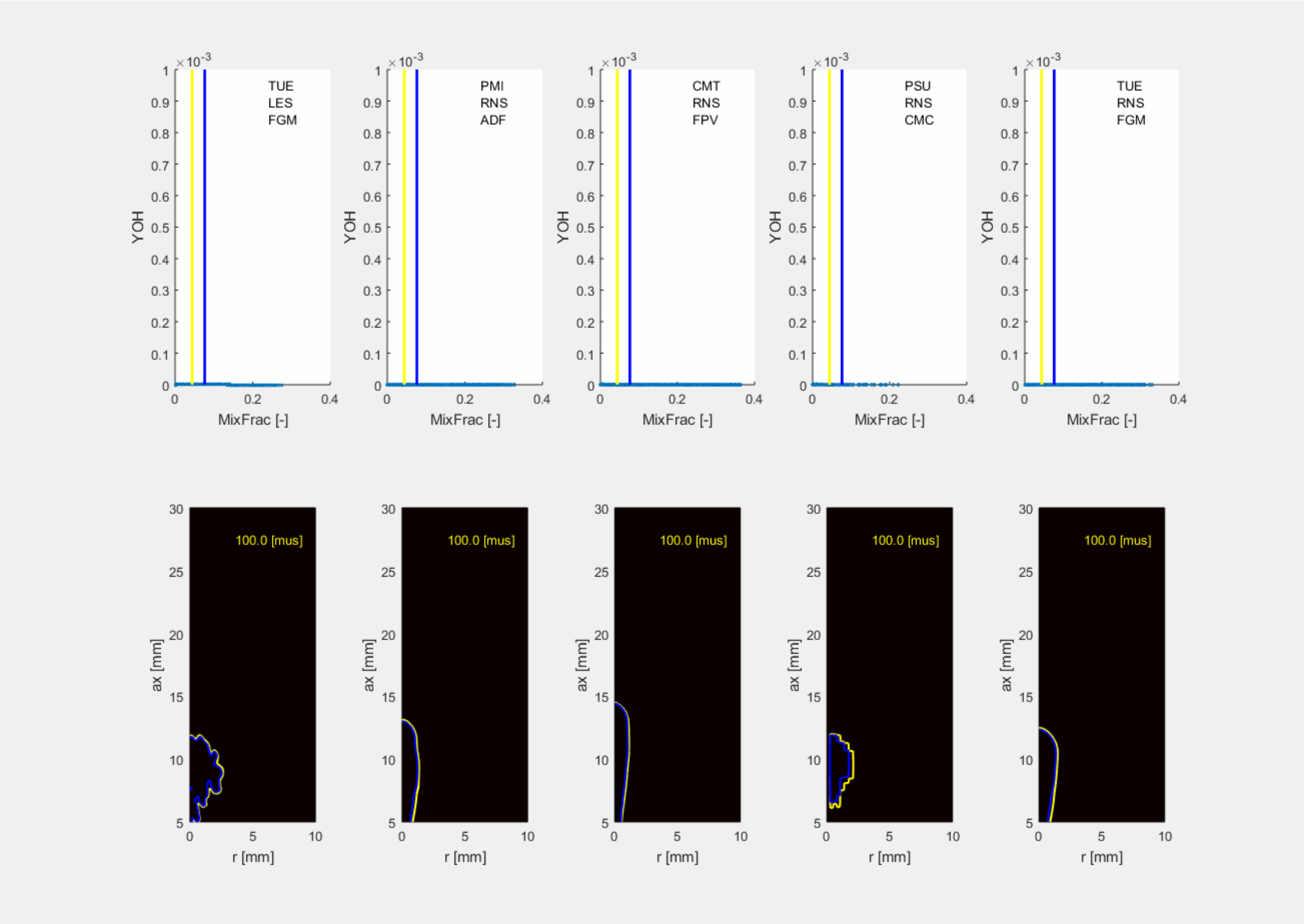
ENGINE COMBUSTION NETWORK

FOCUS AROUND IGNITION

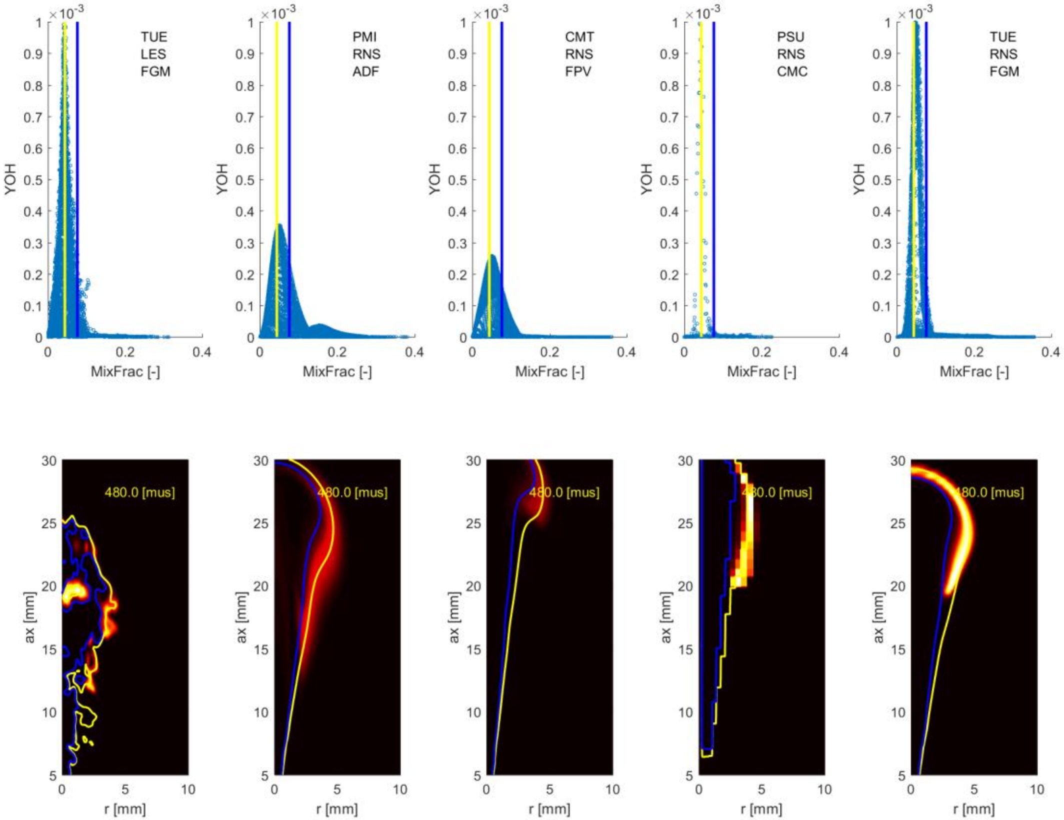


Zoom box

OH BACK TO BACK

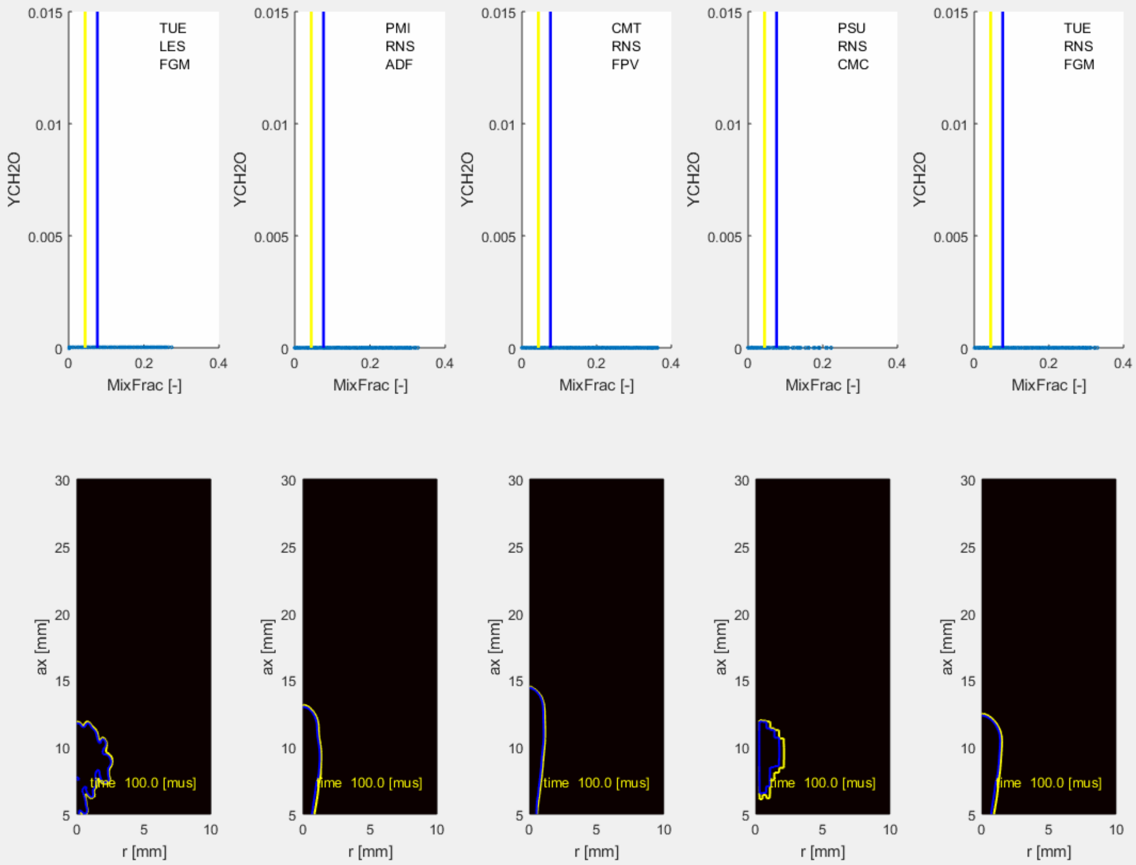


OH BACK TO BACK



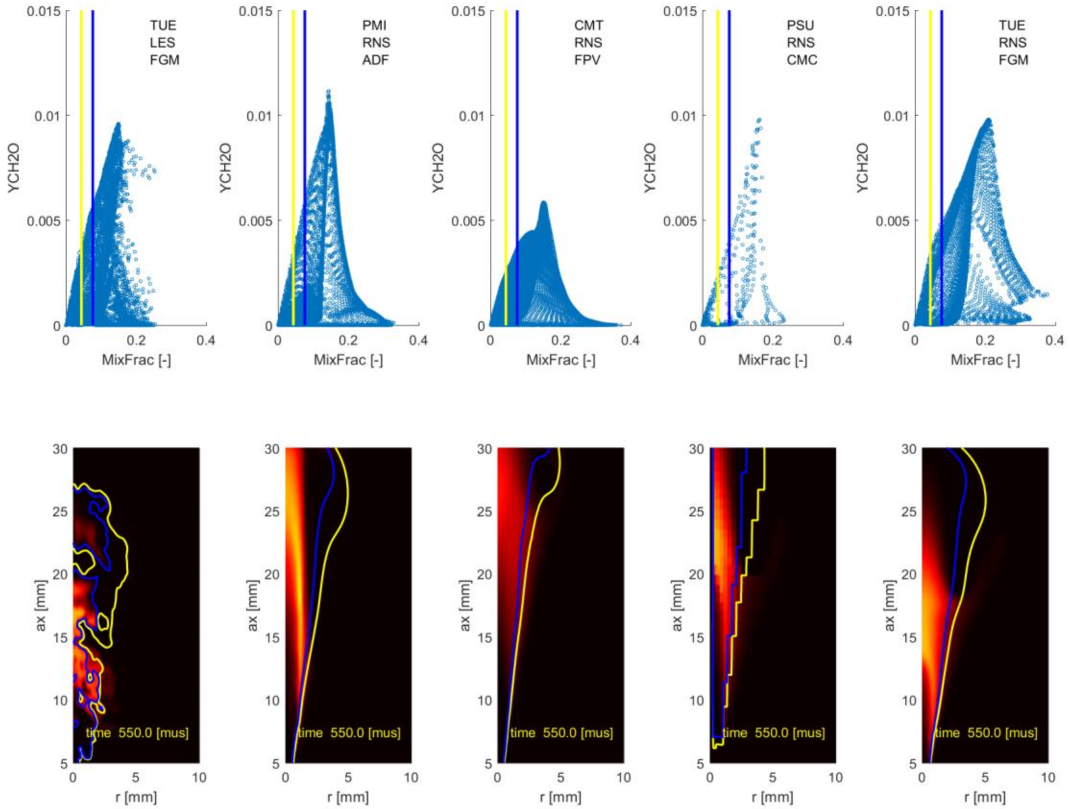
- Differences in peak OH. Logical, WM vs b-pdf!
- All ignite at the side and then progress towards full encapsulation. Could have been missed with lower time resolution.
  – But ADF,FPV not as fast (b-pdf vs d-pdf?). Needs checking.
  – OH peak at the slightly rich side of the flame (all)
- ??

CH2O BACK TO BACK



CH2O BACK TO BACK

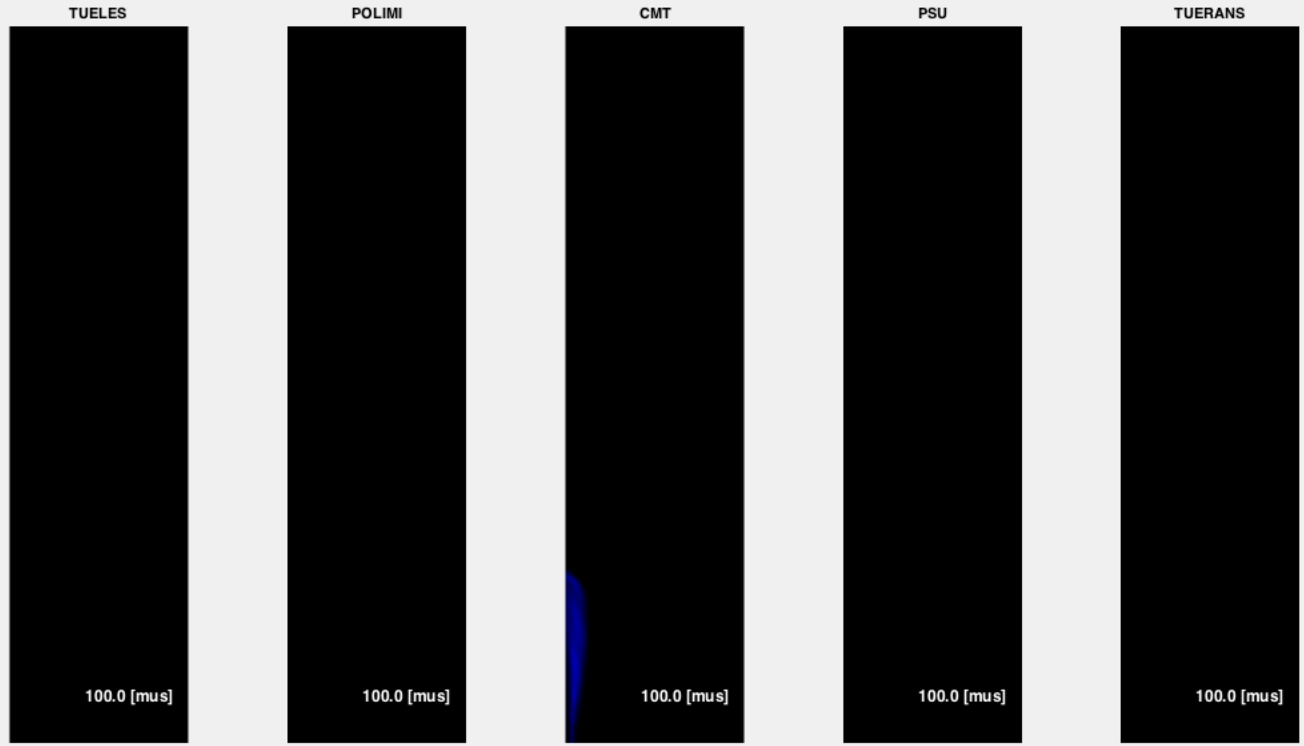
L



ENGINE COMBUSTION NETWORK

- Differences in peak CH_2O in scatter plots. Logical? No straightforward explanation. b-pdf vs WM?
- For all: CH_2O appears at the side and then progresses towards rich side.
  – But final axial ‘extension’ is really different
- ??

RGB PLOTS



Blue: C_2H_2
Red: OH
Green: CH_2O

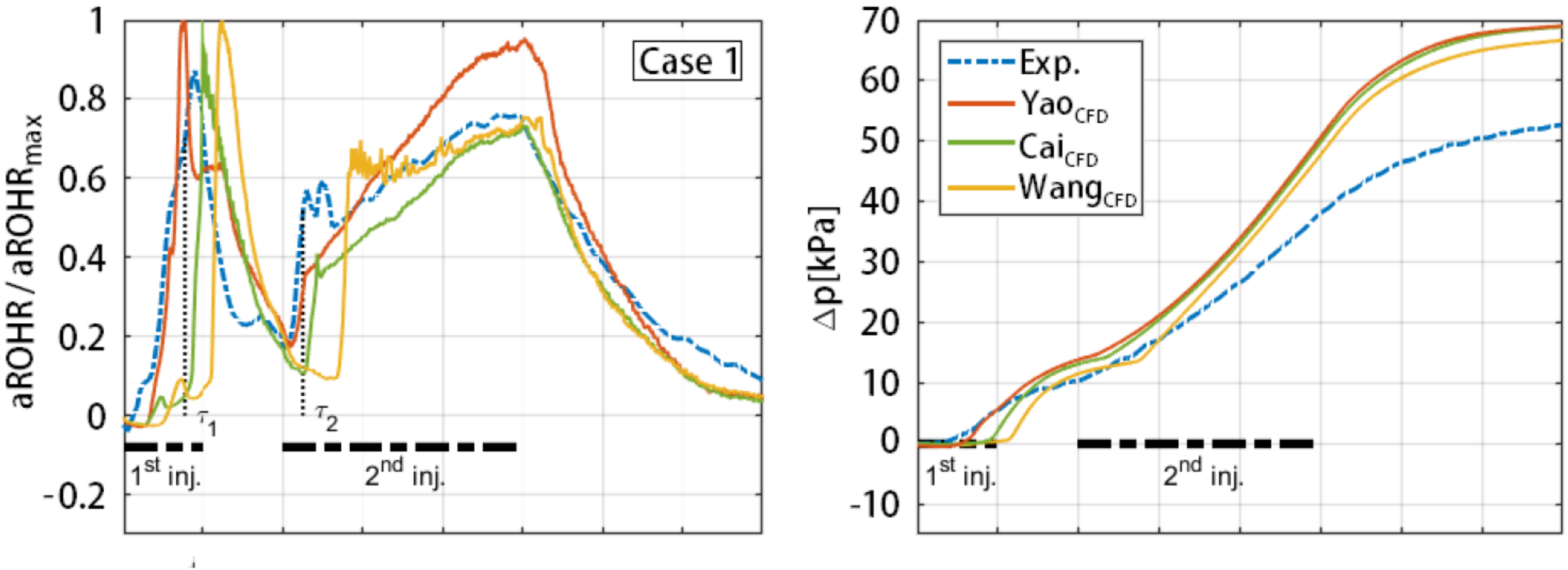
CONCLUSIONS IGNITION PART

- All models predict ignition at the side
- Differences
  - Evolution to full encapsulation (if at all, LES)
  - Does LES add anything, yes ‘streaks in IXT’

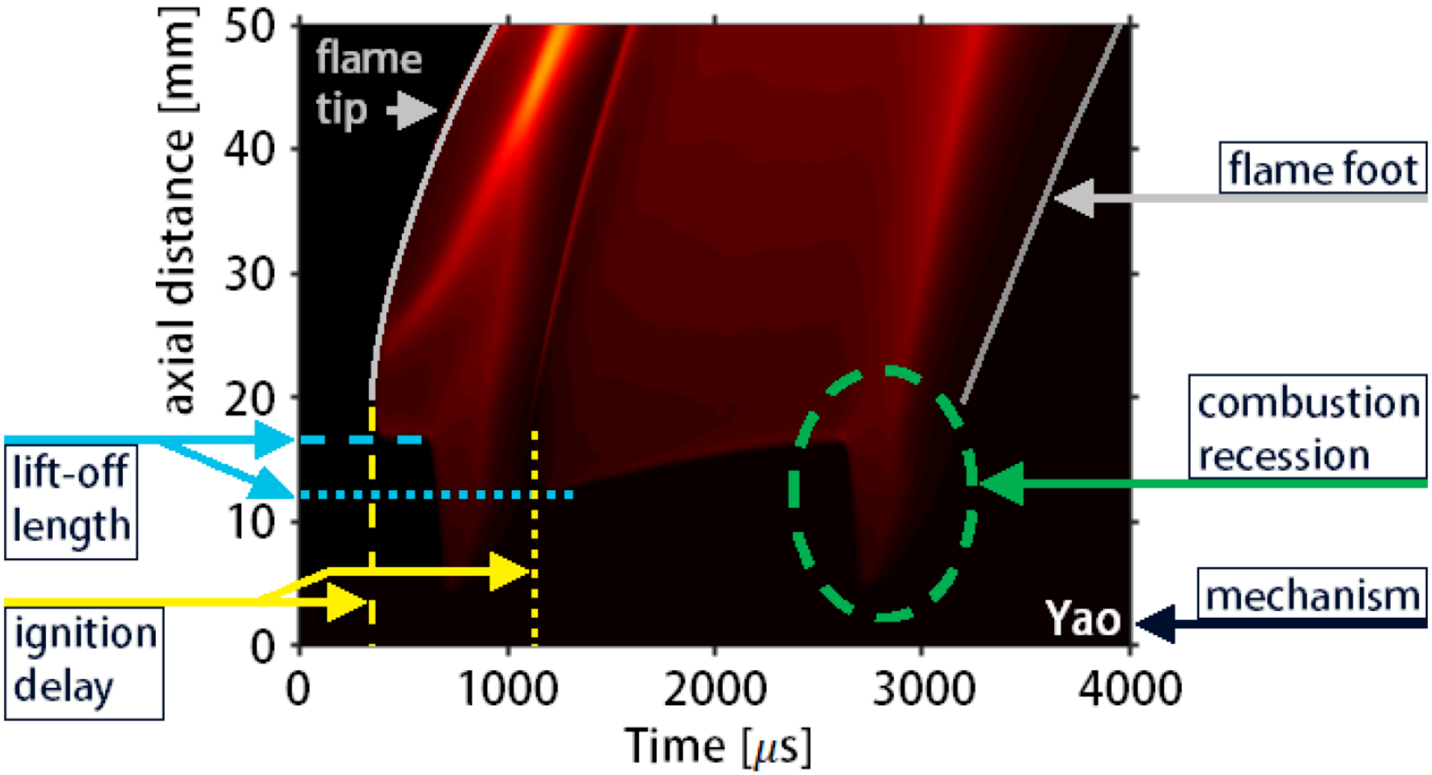
- *Do we have a winner or do we need a more challenging case?*

MULTIPLE INJECTION (MAR)

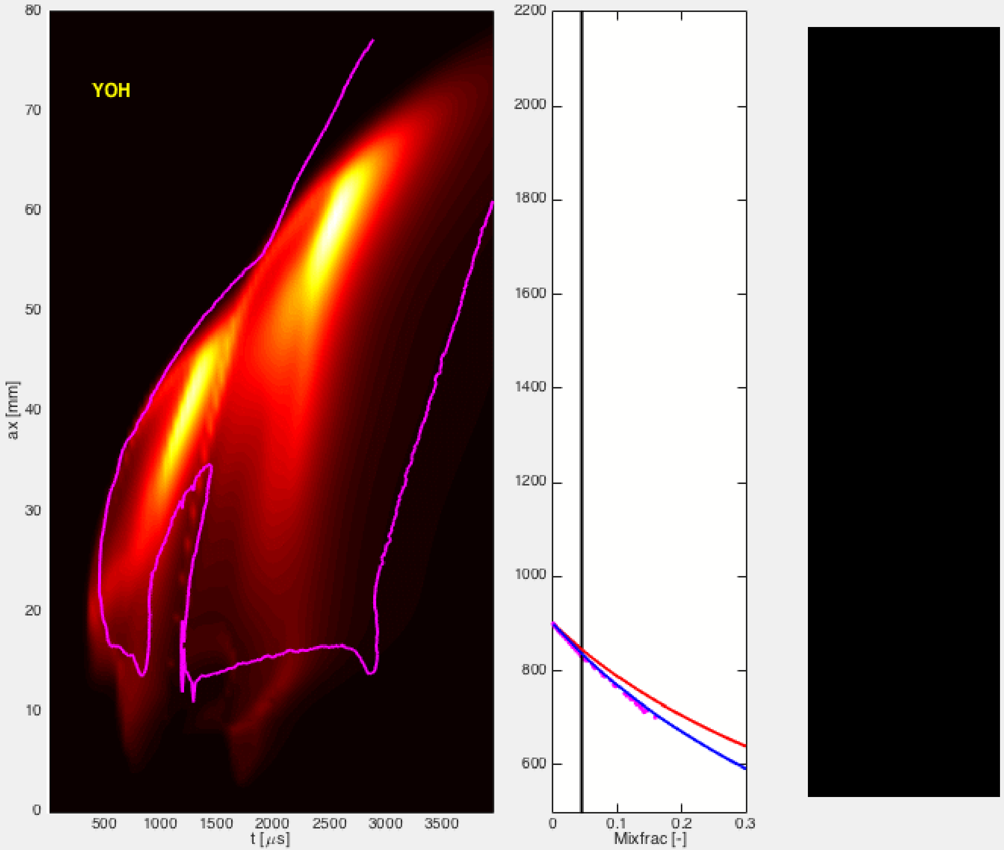
TUERANS data, B. Akkurt, FGM, OF 2.2.x/LibICE
EXP DATA, N. Maes

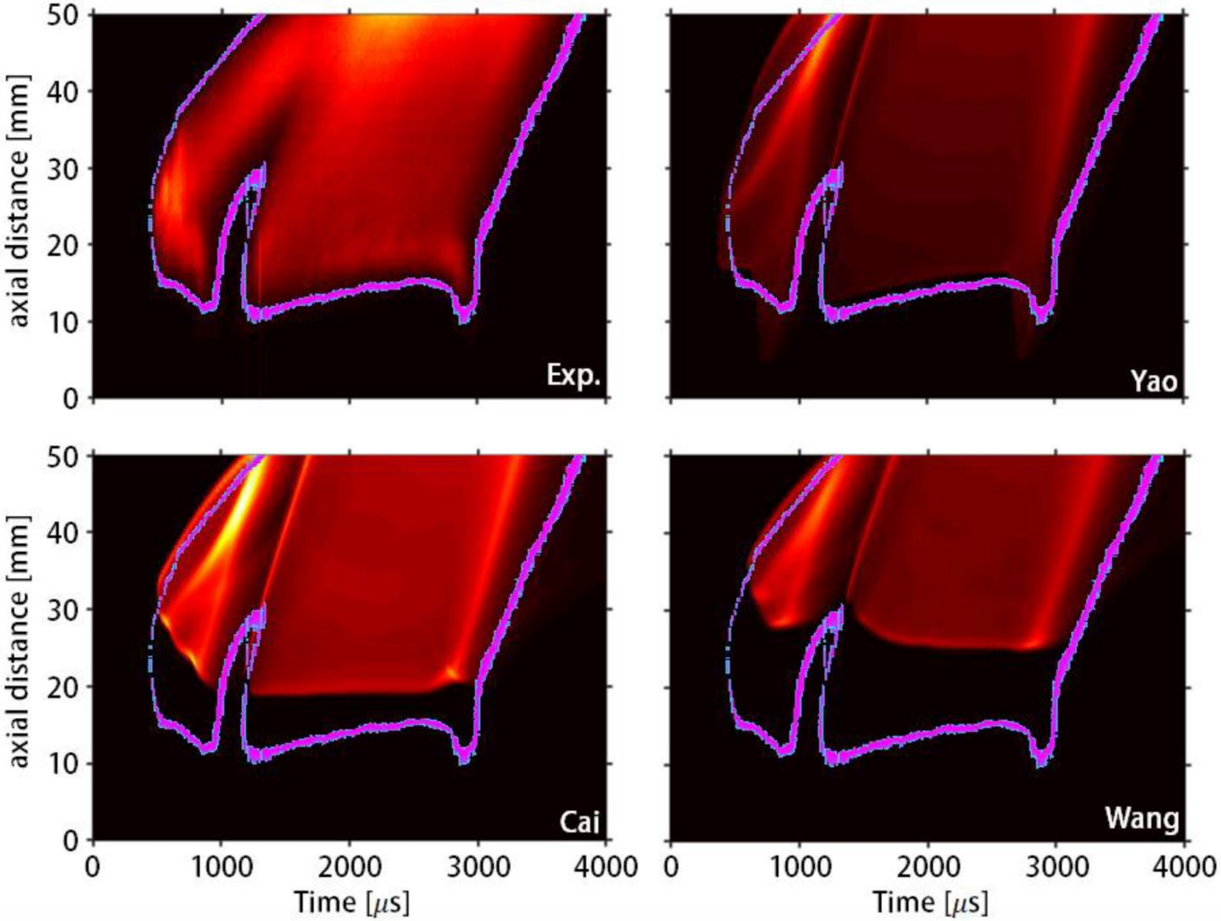


MAR (TUERANS DATA)



MAR (POLIMI DATA)




Exp.
Yao
Cai
Wang
axial distance [mm]
Time [μs]
0
10
20
30
40
50
0
1000
2000
3000
4000

MAR

Big Q: Why study this

- More relevant for modern engines.
- Second injection meets a quite different environment, can models tackle that. Hotter, certain products. Bigger challenge!
  - *Maybe more decisive for quality/generality of the combustion model.*
  - *But capturing ignition delay is even more important !!*
- Maybe LIF of CH2O, OH around second injection interesting? Doable?
- Do we still want to pursue a better chemistry model and if so why?

Even bigger Q: ‘why study diesel combustion at all?’

Why study diesel engines at all

Tesla truck

Range 500 mile (805 km)

Battery pack ??

Recharging 0,5 hr -> hyperchargers needed

Let’s do the math

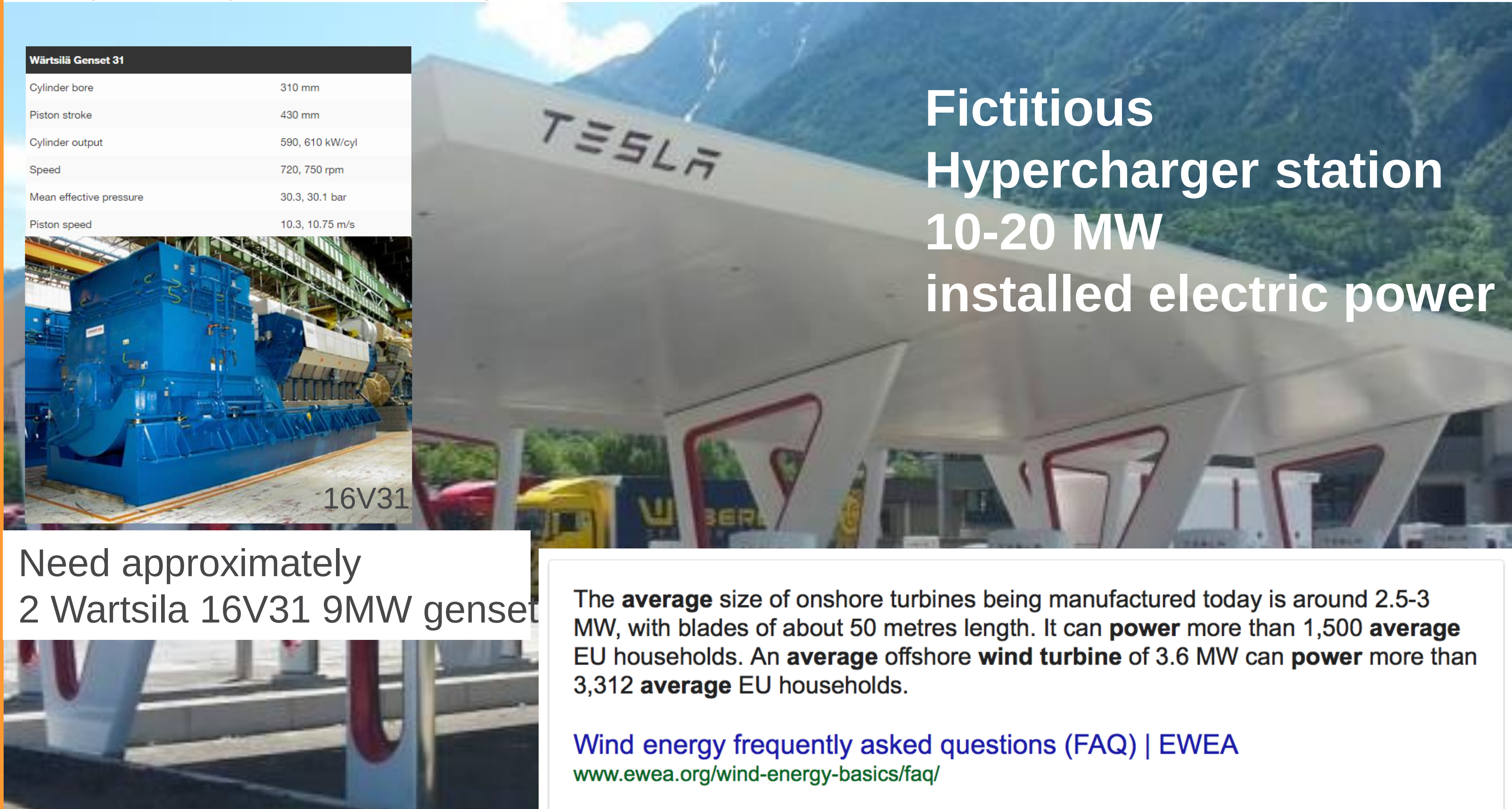
Average energy use truck : 140 kWhr/100 km

Total : 1127 kWhr (Tesla 85D = 85 kWhr)

Weight : 7200 kg (Tesla 85D = 550 kg)

Hypercharger 1127/0.5 = 2MW (Supercharger = 100kW)

Why study diesel engines at all



Wärtsilä Genset 31	
Cylinder bore	310 mm
Piston stroke	430 mm
Cylinder output	590, 610 kW/cyl
Speed	720, 750 rpm
Mean effective pressure	30.3, 30.1 bar
Piston speed	10.3, 10.75 m/s

16V31

Fictitious Hypercharger station 10-20 MW installed electric power

Need approximately
2 Wartsila 16V31 9MW genset

The **average** size of onshore turbines being manufactured today is around 2.5-3 MW, with blades of about 50 metres length. It can **power** more than 1,500 **average** EU households. An **average** offshore **wind turbine** of 3.6 MW can **power** more than 3,312 **average** EU households.

Wind energy frequently asked questions (FAQ) | EWEA
www.ewea.org/wind-energy-basics/faq/