ECN 5 topic 4/5
Ignition and flame structure
- model results & analysis (in spray A)

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Questions and discussion
• Spatial comparison at early times

• Spatial comparison at late times

• Conclusions & recommendations
Base(900K, 15%)

IXT plots (radially integrated OH as a function of time), blue line is 0.1 contour of experiments
- 6 contributors
- CAI mechanism
Base(900K, 15%)
Around ignition

- 6 contributors
- CAI mechanism
Base(900K, 15%)
Movies (because we can)
ETHZ, CMC, ?, RANS
Base (900K, 15%) Movies (because we can)
RWTH, MRIF, ?, betaPDF
Base(900K, 15%)
Movies (because we can)
TUE, FGM, OpenFOAM
Base(900K, 15%)  
Movies (because we can)  
UNSW, TPDF, ?, RANS
Base (900K, 15%) 
Movies (because we can)
UNSW, WM, ?, RANS
Base (900K, 15%) Movies (because we can)
CMT, UFPV, OpenFOAM
Conclusions

• Some ‘unphysical’ points still remain mostly this is time-step issue. Near nozzle.

• Ignition on the rich side. Although the actual value depends on combustion model (see dif TUE and Others)

• OHstar ignition correlates with second stage ignition (see scatter plots).

• Second stage ignition mostly confined by Z < 0.1. (Only ETHZ not)

• Well mixed models reach higher T (200 K). Which is logical. Can have its effect on emission models
Base(900K, 15%)

IXT plots (radially integrated OH as fie of time), magenta line is 0.1 contour of experiments
- 4 contributors
- YAO mechanism
Base(900K, 15%)

IXT plots (radially integrated OH as function of time), magenta line is 0.1 contour of experiments.

- 4 contributors
- YAO mechanism
Spatial structure

Base(900K, 15%)
Movies (because we can)
POL, UFPV, OpenFOAM, betPDF, RANS
Base(900K, 15%)
Compare to ignition probability plots

Change the scene from these movies
Base (900K, 15%)
Ignition Kernel analysis, Ignition probability (IFPen)

Extract
0.7 0.9 0.95 contours
Base(900K, 15%), mirrored fields

- Yellow - Zmr and Zst,
- White - 0.02*OHmax
- Greys = 0.7 0.9 0.95 prob contour

First instance OH reaches 0.02 of max (of all times)

CAI

ETHZ ignites at sides

Others at top

CMT issue at nozzle

All at markedly different times
Base(900K, 15%)
Same time instances

CAI
ETHZ ignites at sides
Others at top
CMT issue at nozzle
Base(900K, 15%), mirrored fields
- Yellow - Zmr and Zst,
- White - 0.02*Ohmax
- Greys = 0.7 0.9 0.95 prob contour

First instance OH reaches 0.02 of max (of all times)

YAO
Tough to see.
Far less variation between institutes
YAO
TUE/POL/PSU show also ignition at the flanks

POL-complicated double lobe

USNW ignition at top
PSU also TPDF but first at the top then at foot (sim to TUE)

All at slightly different times (less then for CAI)
Most show ignition at the flanks, only UNSW (TPDF and WM) not.

YAO show more consistent behavior wr to moment of ignition between models, less variation.

The actual code used might factor in… (TPDF results with different codes and different ‘mixing models’)

Conclusions
Base(800K, 15%) Ignition Kernel analysis, Ignition probability

Extract probability plots
Base (800K, 15%), mirrored fields

- Yellow: Zmr and Zst
- White: 0.02*Ohmax
- Greys: 0.7 0.9 0.95 prob contour

First instance OH reaches 0.02 of max (of all times)

YAO

All at slightly different times

TUE/POL: BOTH progress var methods late (1080 mus)
But behavior different
TUE: at Zmr
Base(800K, 15%), mirrored fields
Time sequence

YAO

All at slightly different times

TUE/POL: BOTH progress var methods late (1080 mus)
But behavior different
- TUE deltaPDF
- POL betaPDF

Warning, timestep 100mus for POL at 1000mus.
• TUE ignition at the flanks, only UNSW at top.
• POL at the top although time resolution is maybe reason
• POL/TUE both OpenFOAM and LibIce, both progress variable method (FGM vs ADF)
• Again YAO show more consistent behavior wr to moment of ignition between models, less variation.
• Spatial comparison at late times (recession)

• Conclusions & recommendations
Base(900K, 15%)
IXT plots (radially integrated OH as fie of time), blue line is 0.1 contour of experiments
- 6 contributors
- CAI mechanism
Spatial structure @ignition

Base(900K, 15%)
Movies (because we can)
TUE, FGM, OpenFOAM

CAI
Base(900K, 15%)

Movies (because we can)

UNSW, TPDF, ?, RANS

YAO
Spatial structure @ignition

Base(900K, 15%)
Movies (because we ca
TUE, FGM, OpenFOAM

YAO
• CAI result TUE shows hardly any recession
• YAO does…
Encore Formaldehyde

TUE EXP: PC Bakker/Noud Maes