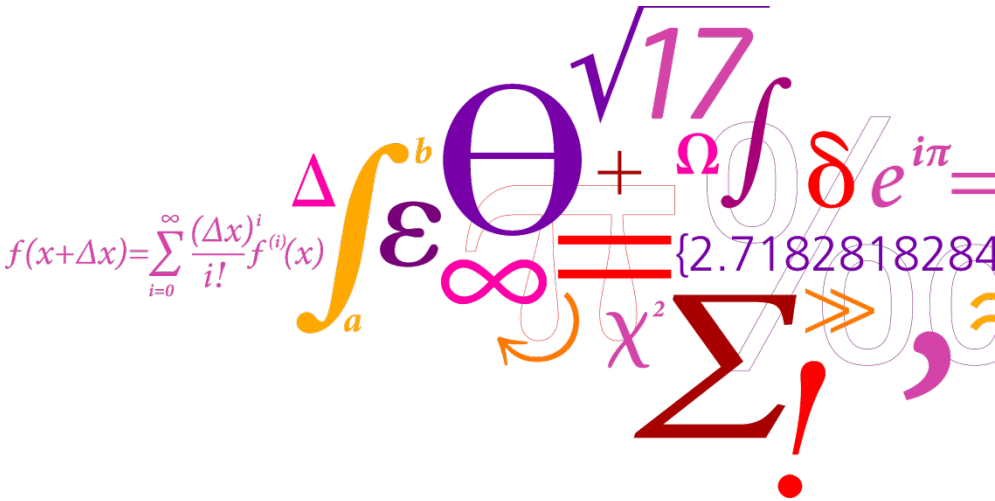
Radiation measurements in a large 2-stroke diesel engine

Jesper Schramm

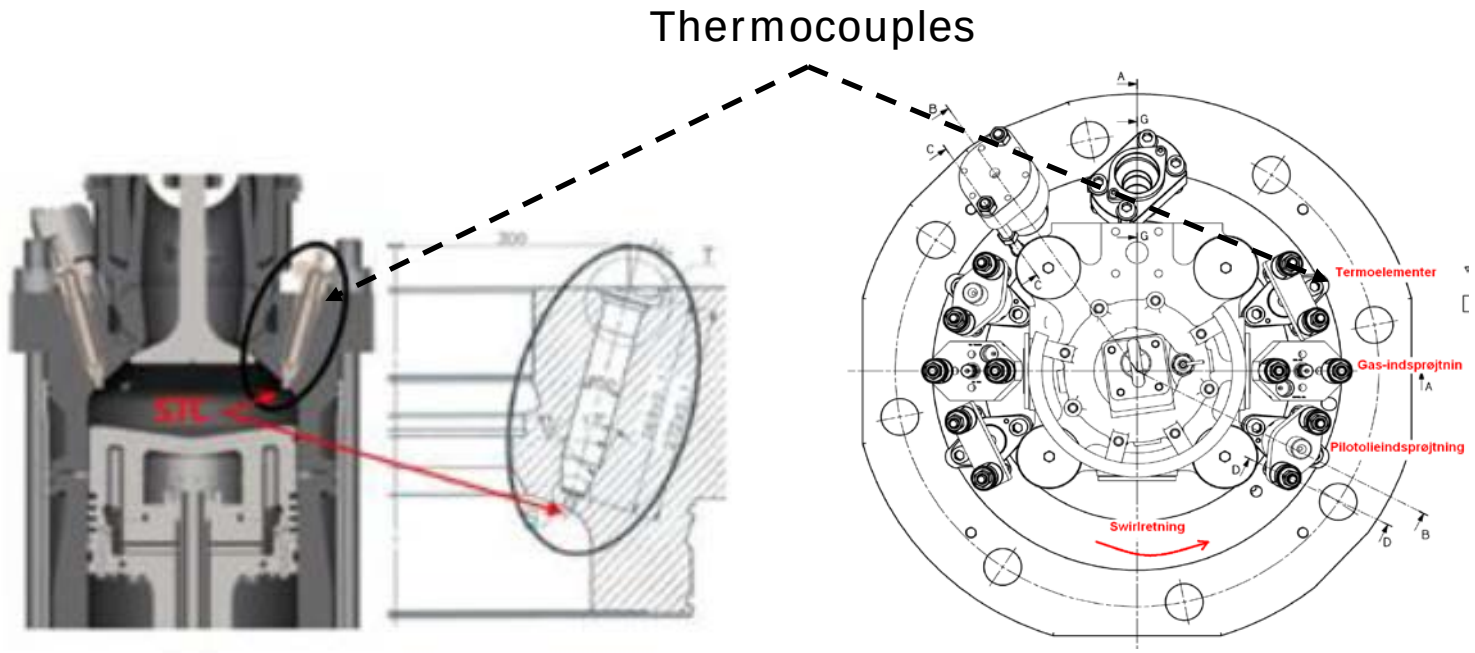


DTU Mechanical Engineering
Department of Mechanical Engineering

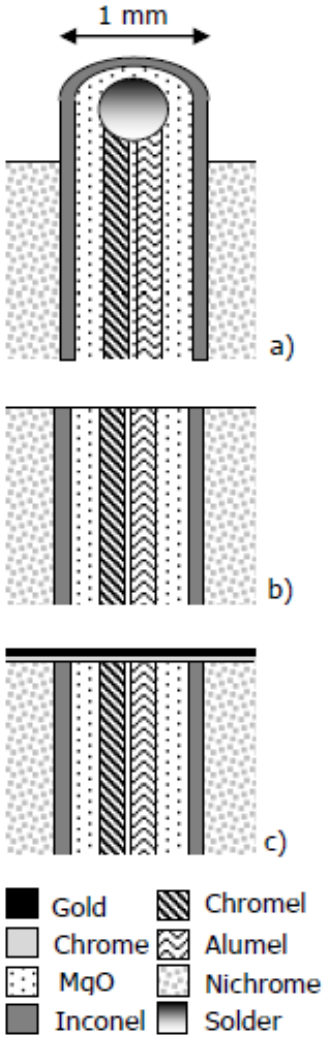
- Thermocouple measurements
- 2-color method

Thermocouple measurements

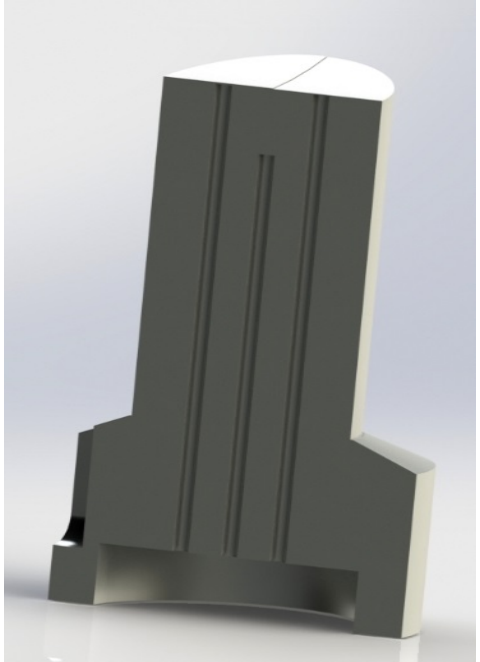
Thermocouples mounting



Thermocouple processing

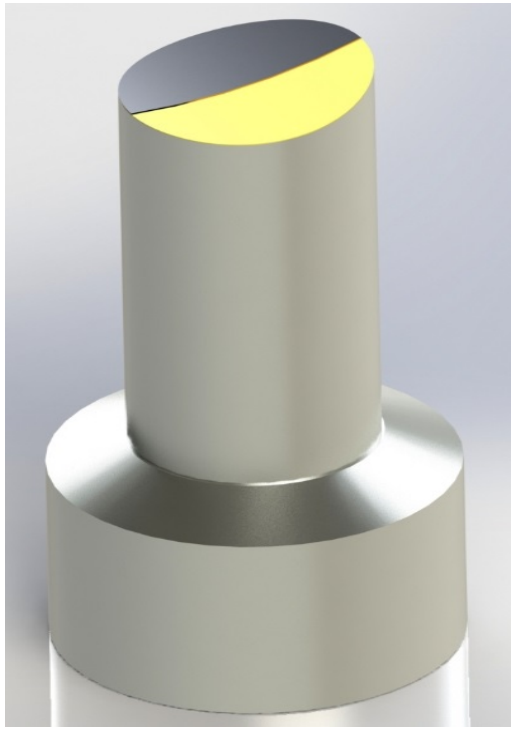


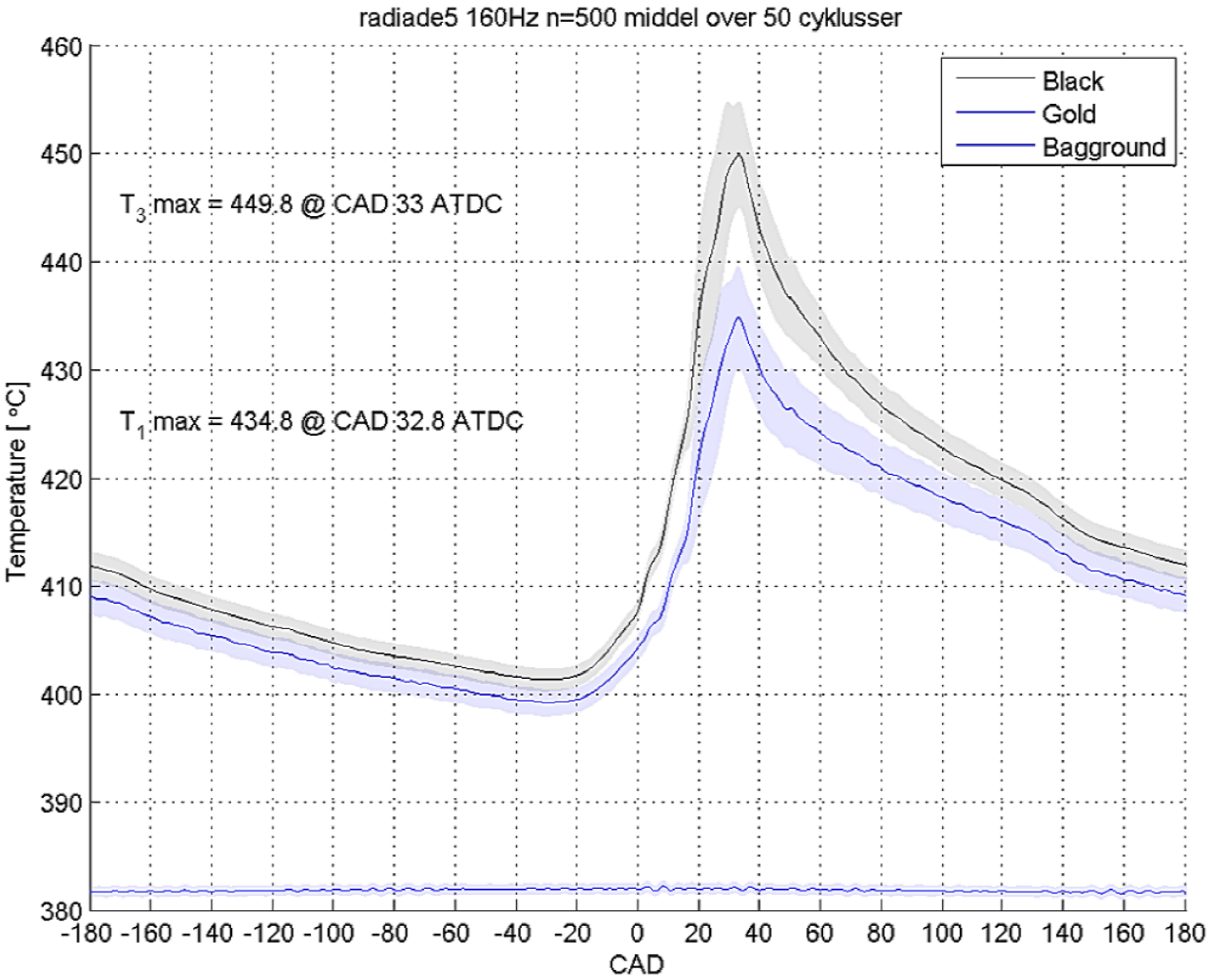
Thermocouple arrangement

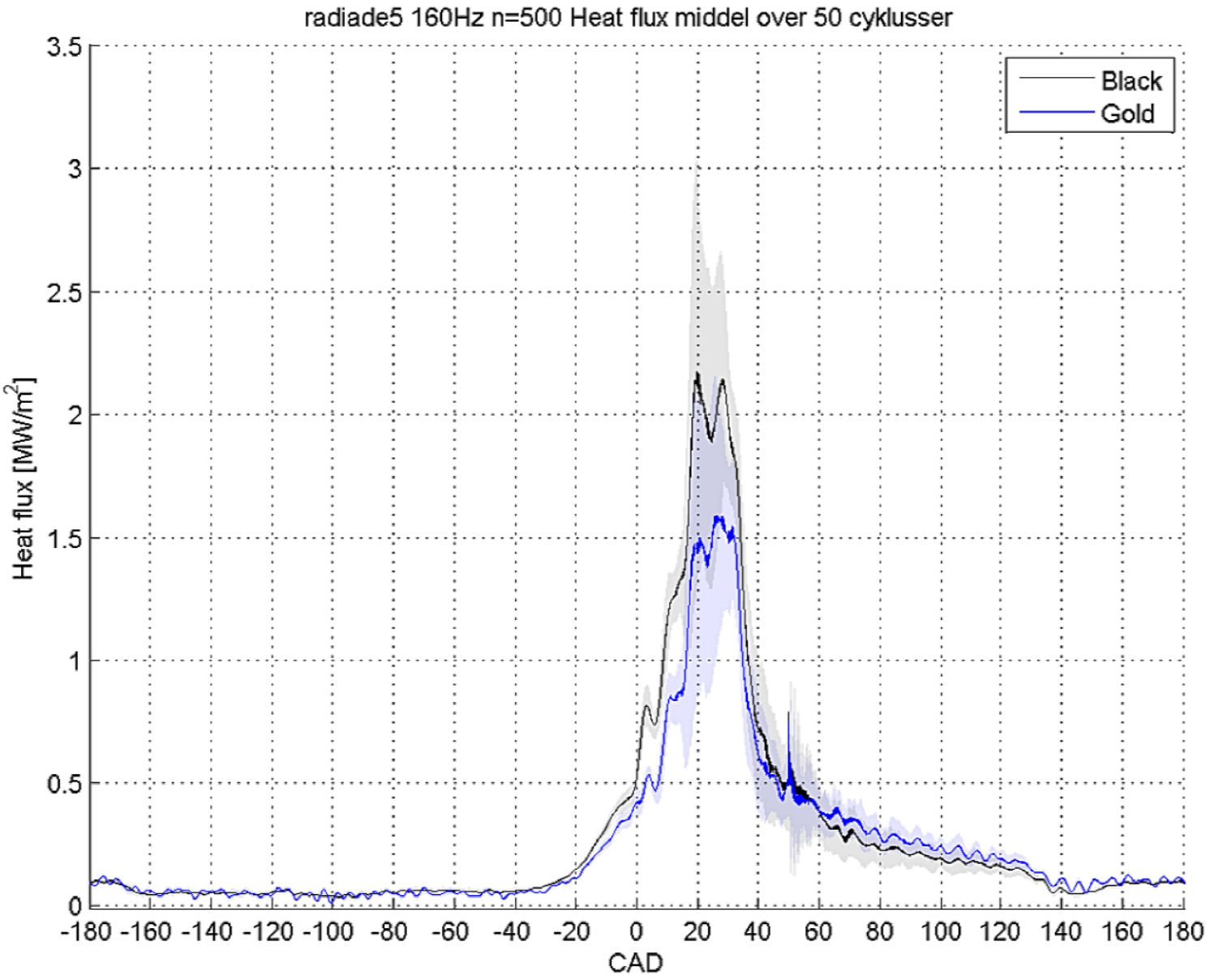


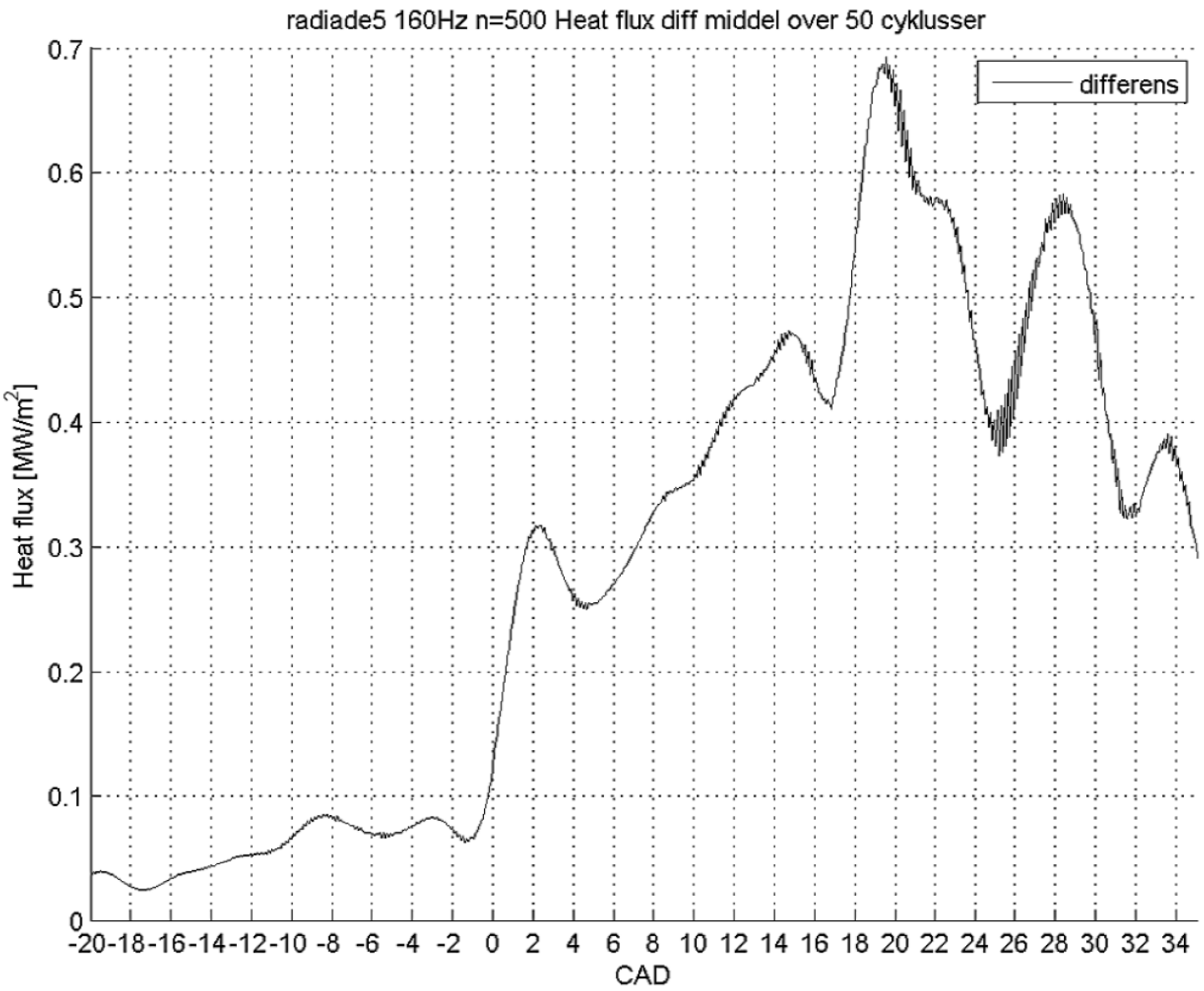
$$\left.\frac{\partial q(t)}{\partial t}\right|_{x=0} = -k\left.\frac{\partial T(x,t)}{\partial x}\right|_{x=0}$$

Thermocouple painting

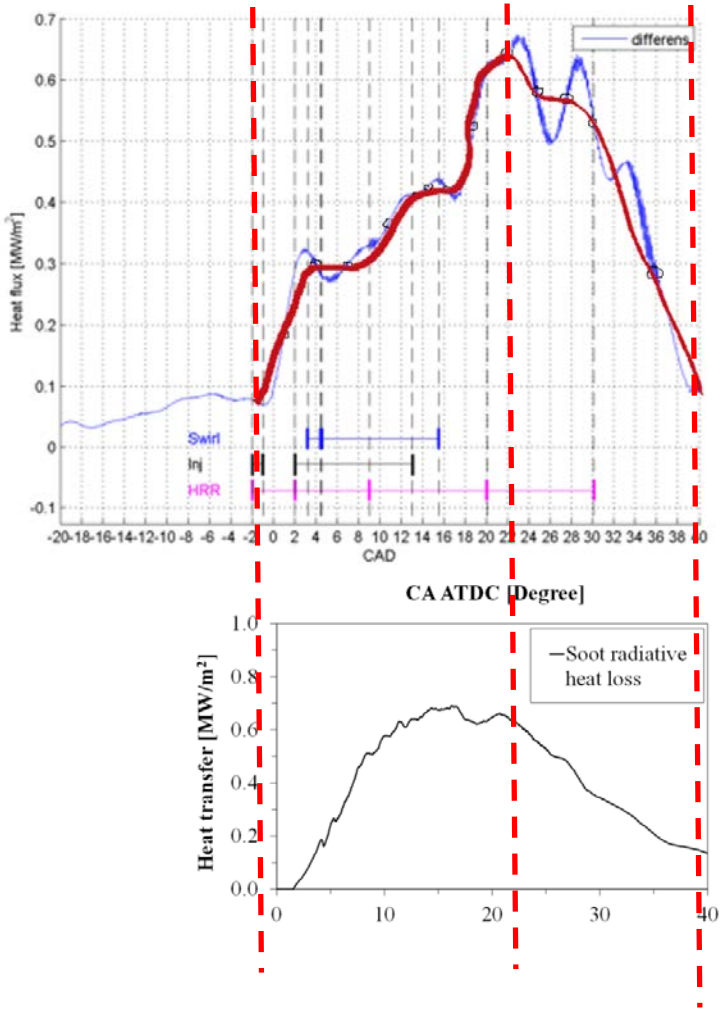



radiade5 160Hz n=500 middel over 50 cyklusser
Black
Gold
Bagground
T3 max = 449.8 @ CAD 33 ATDC
T1 max = 434.8 @ CAD 32.8 ATDC
Temperature [°C]
CAD
460
450
440
430
420
410
400
390
380
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180

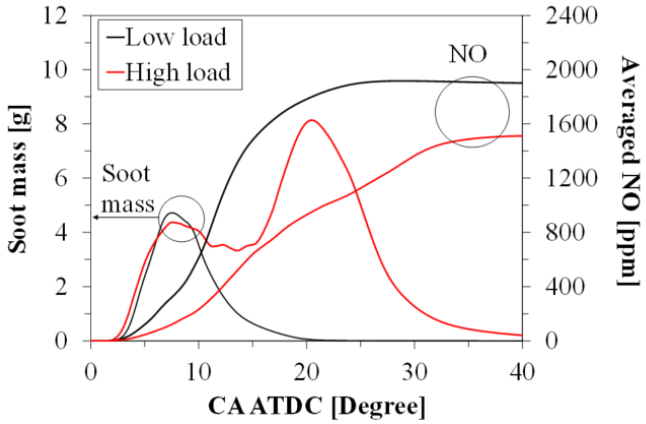

radiade5 160Hz n=500 Heat flux middel over 50 cyklusser
Black
Gold
Heat flux [MW/m^2]
CAD
3.5
3
2.5
2
1.5
1
0.5
0
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180


radiade5 160Hz n=500 Heat flux diff middel over 50 cyklusser
differens
Heat flux [MW/m2]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
-20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
CAD

Radiation measurements in 2-stroke engine (Natural gas) – 50% load

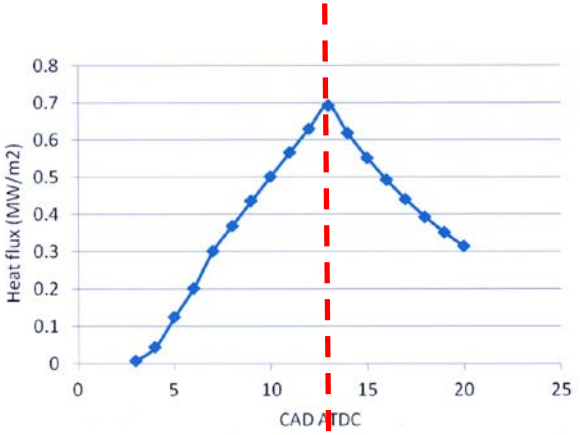


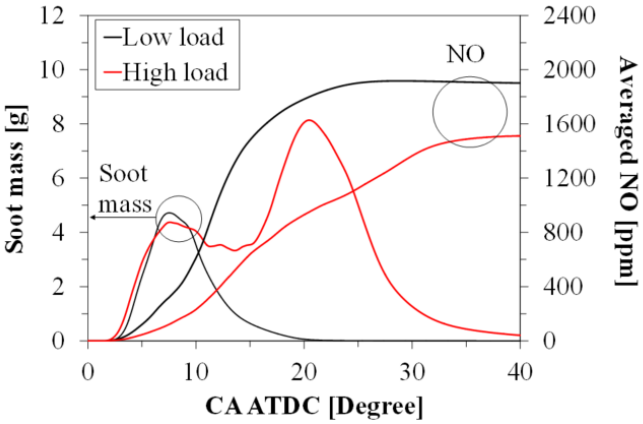
Simulation of radiation from soot - diesel surrogate / full load



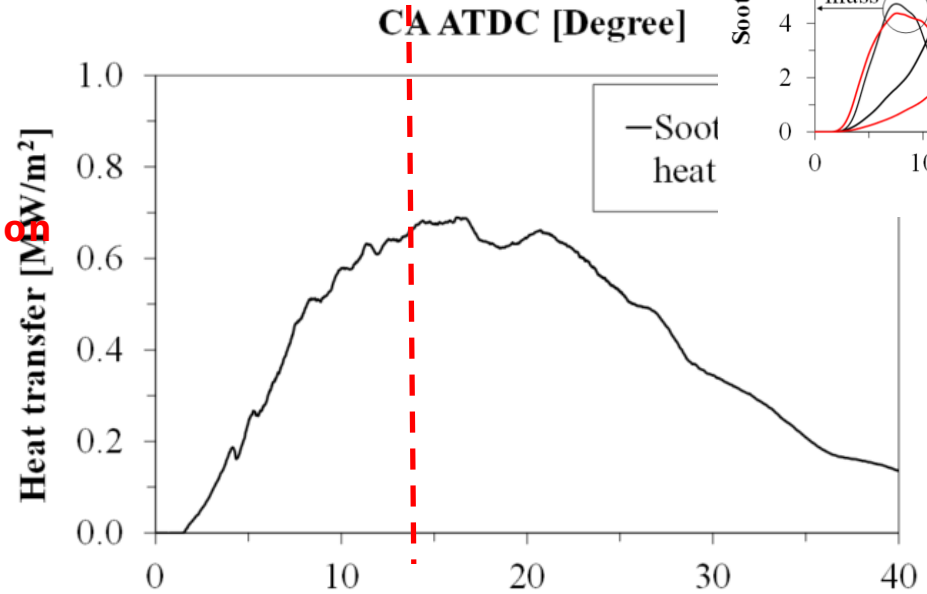
Simulation of soot (diesel surrogate)

2-color method – diesel / 50 % load



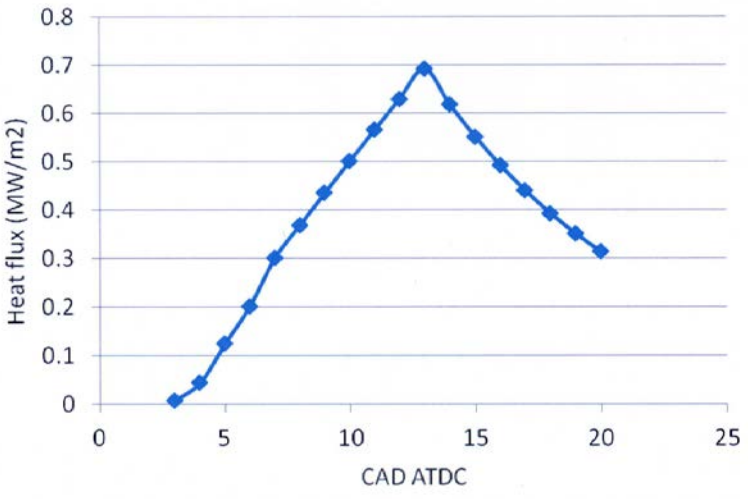


Simulation of radiation from soot - diesel surrogate / full load



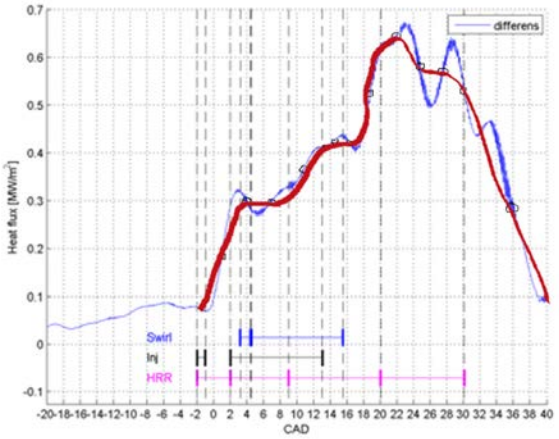
2-color method – diesel / 50 % load

Detects only soot radiation



Radiation measurements in 2-stroke engine (Natural gas) – 50 % load

Detects soot+gas radiation



Conclusions:

- Simulations, 2-color method and thermocouple measurements gives results of the same size order
- The 2-color method applied on diesel combustion shows somewhat higher radiation compared to modeling of soot radiation with diesel surrogate
- More measurements at different locations and for different fuels are needed in order to more precisely estimate the timing of the radiation – however there where quite good agreement between the simulations and both type of measurements
- Modelling of soot formation with LNG would improve the understanding of the thermocouple measurements
- Gas radiation needs to be adressed in modeling

2-color method