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Influence of oxygenated fuels on the sooting behaviour within a laminar diffusion flame

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Influence of oxygenated fuels on the sooting behaviour of laminar diffusion flames

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Motivation

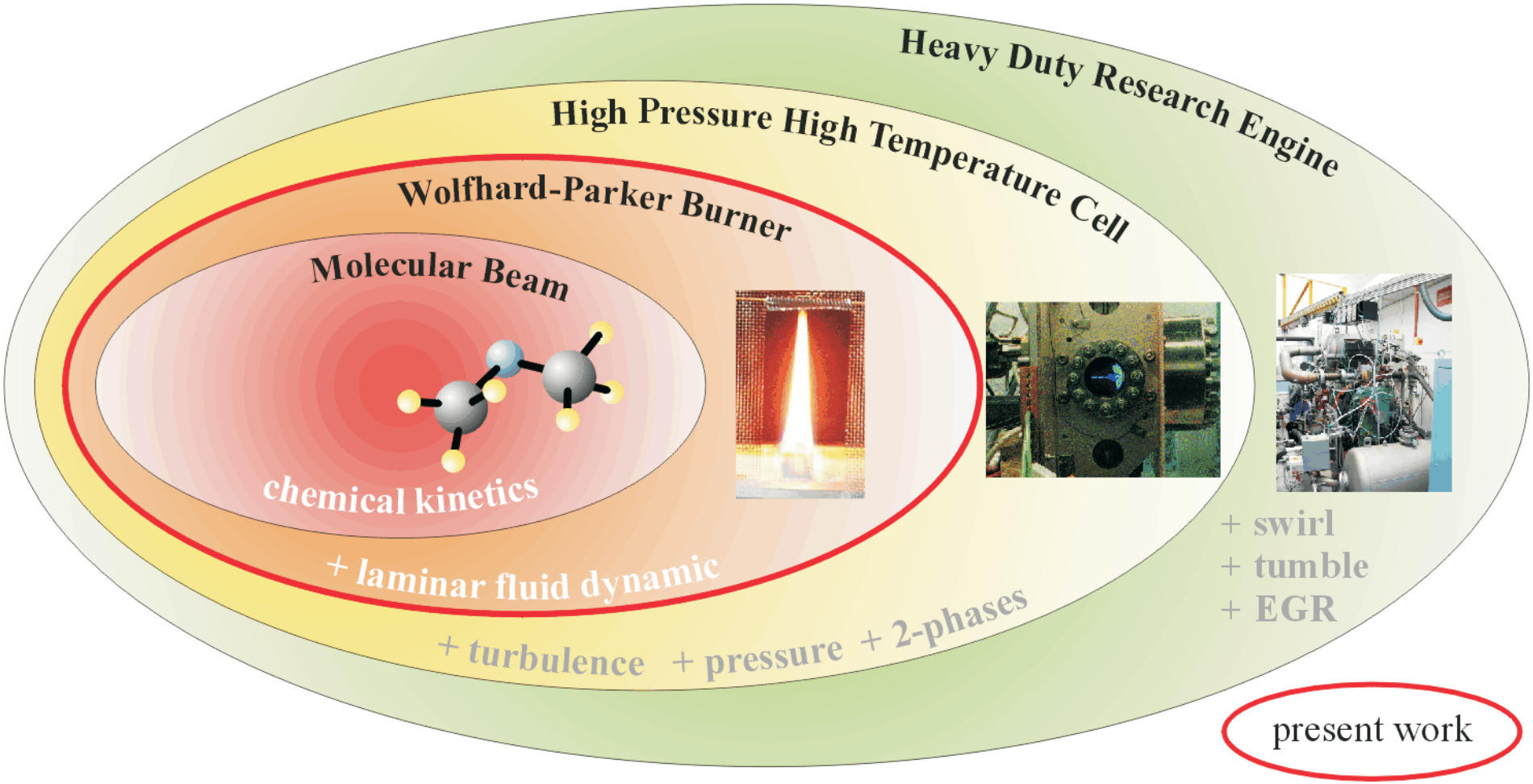
- insight into the the soot problematic as well as ***better understanding of the underlying mechanisms***

- investigation of the influence of oxygenated fuels on the soot production and oxidation

- basic work with the pretension of at least partially transferability on Diesel combustion

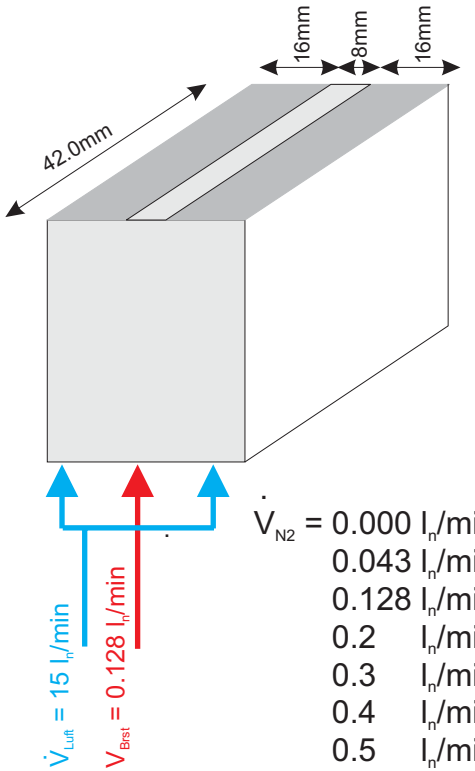
Framework of soot research LVV/PSI

fundamental research — engine application

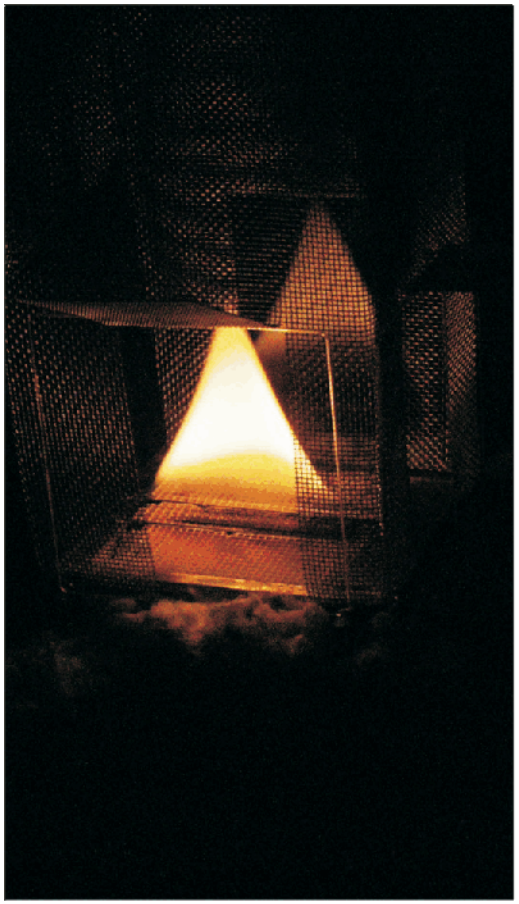


Overventilated laminar diffusion flame

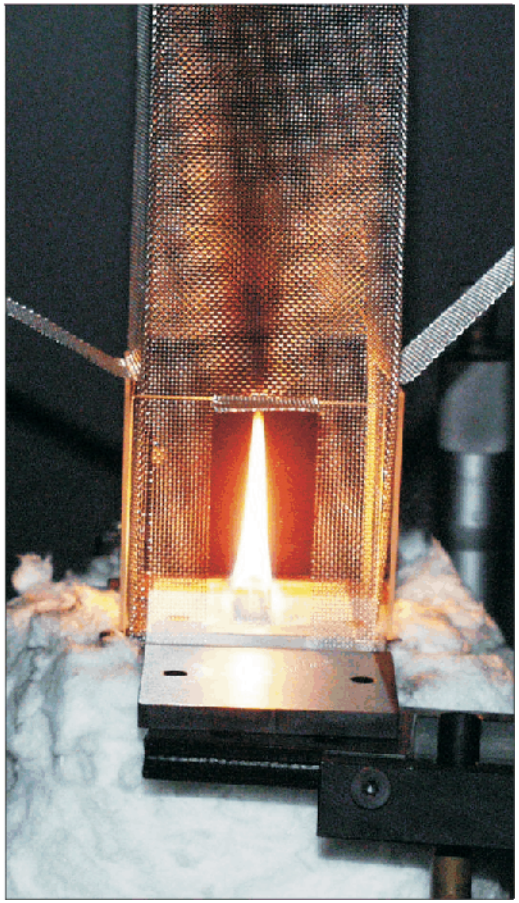
Wolfhard-Parker burner



$\dot{V}_{N2}$ =	0.000 l_n/min	X_{fuel}=1.00
	0.043 l_n/min	0.75
	0.128 l_n/min	0.50
	0.2 l_n/min	0.39
	0.3 l_n/min	0.30
	0.4 l_n/min	0.24
	0.5 l_n/min	0.20
	0.6 l_n/min	0.18
	0.7 l_n/min	0.15



side view

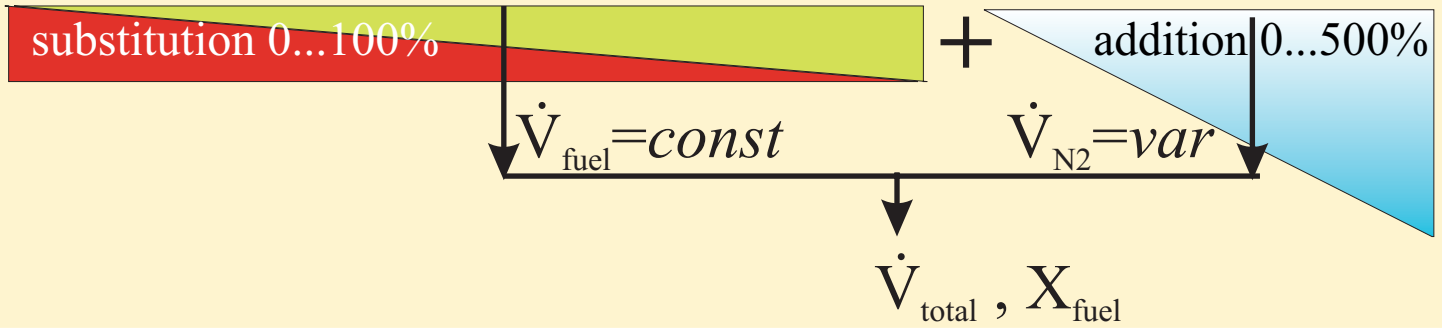


front view

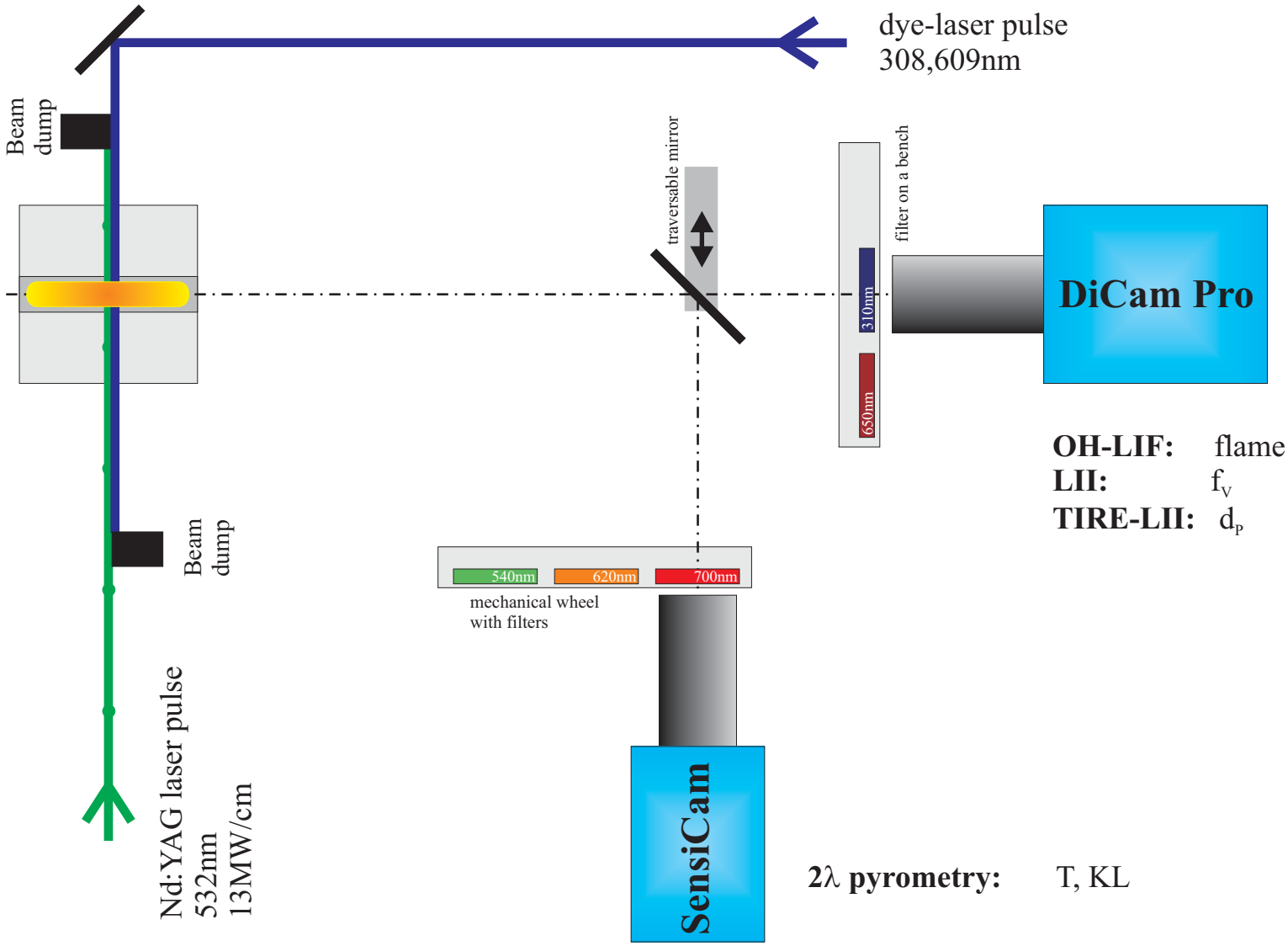
Choice of fuel

Criteria:
- **aliphatic**
- **near 2 “C”-atoms per molecule**
- **comparable adiabatic flame temperatures**

case	highly sooting base fuel	low sooting test fuel	dilution
reference		$H_3C\text{-}CH_3$	
lowly oxygenated	$H_2C{=}CH_2$	$H_3C\text{-}O\text{-}CH_3$	$+ N_2$
highly oxygenated		$H_3C\text{-}O\text{-}CH_2\text{-}O\text{-}CH_3$	



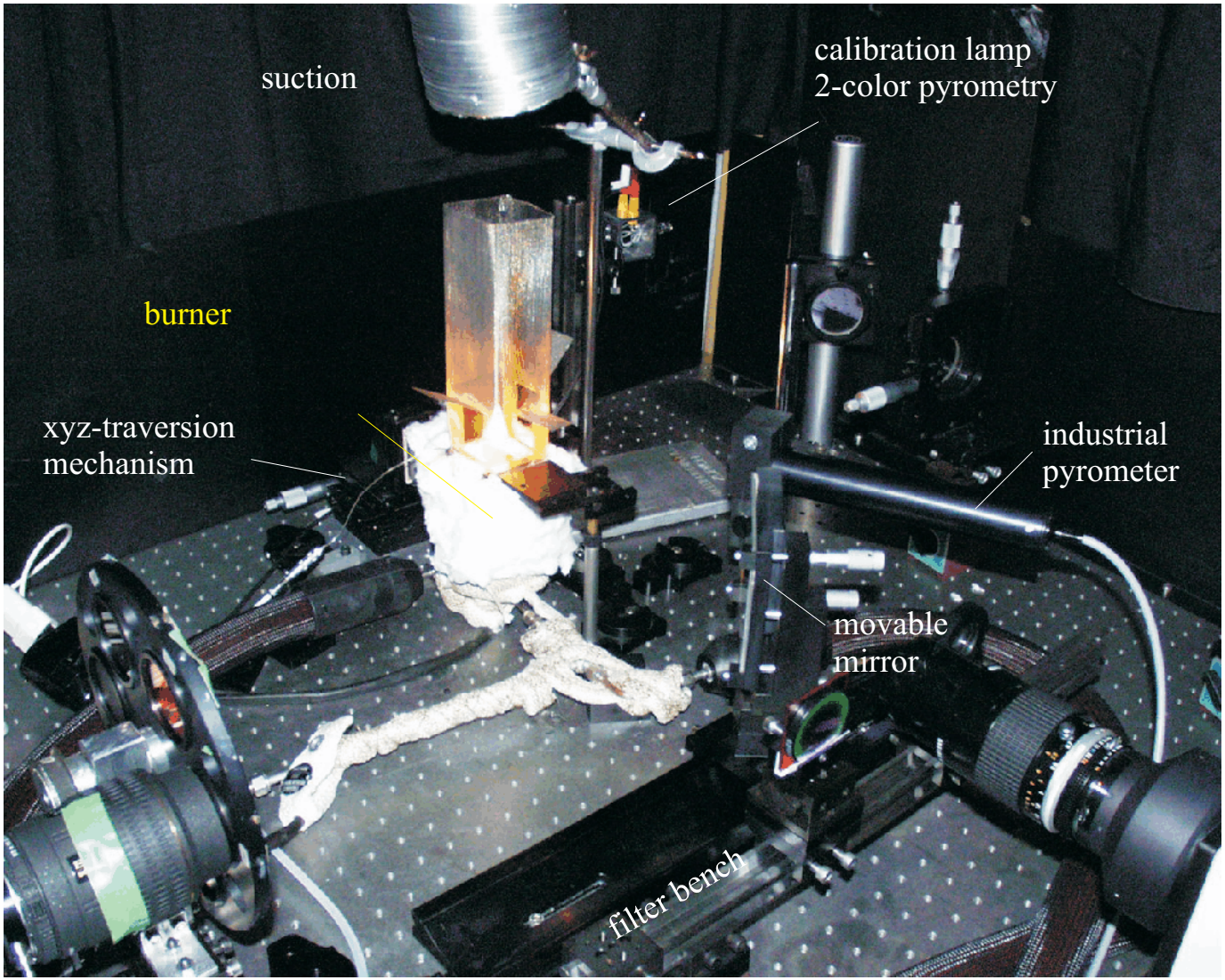
Experimental set-up / measuring techniques



OH-LIF: flame front
LII: f_V
TIRE-LII: d_P

2λ pyrometry: T, KL

Experimental set-up



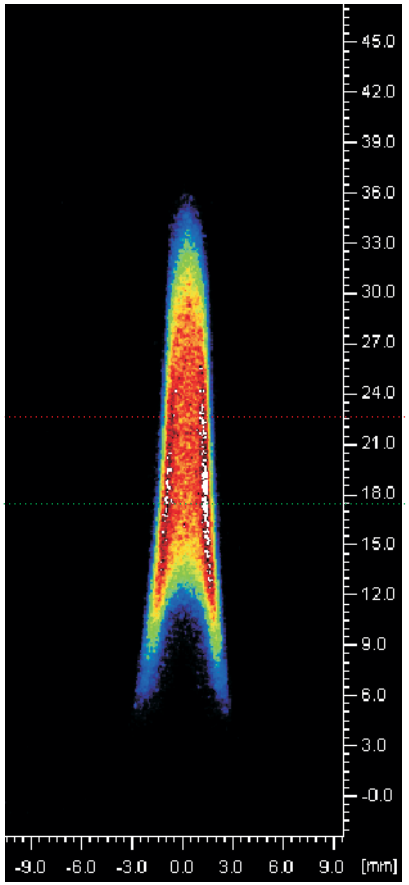
filter wheel
with motor

SensiCam
with
200mm lens

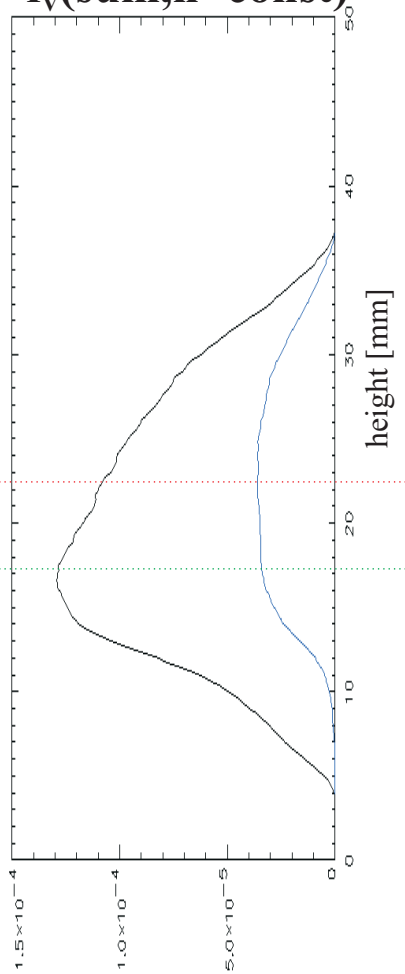
DiCam Pro
with
200mm UV lens

Results: evaluation strategy

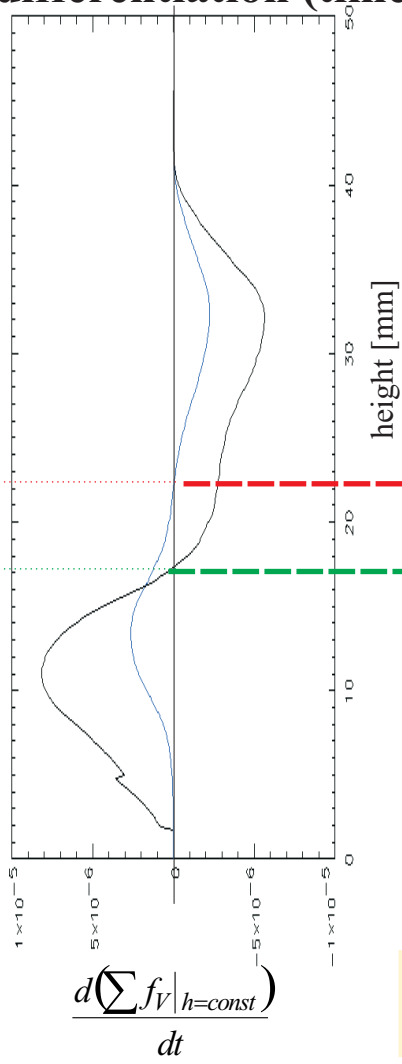
LII -> f_V(2-D)



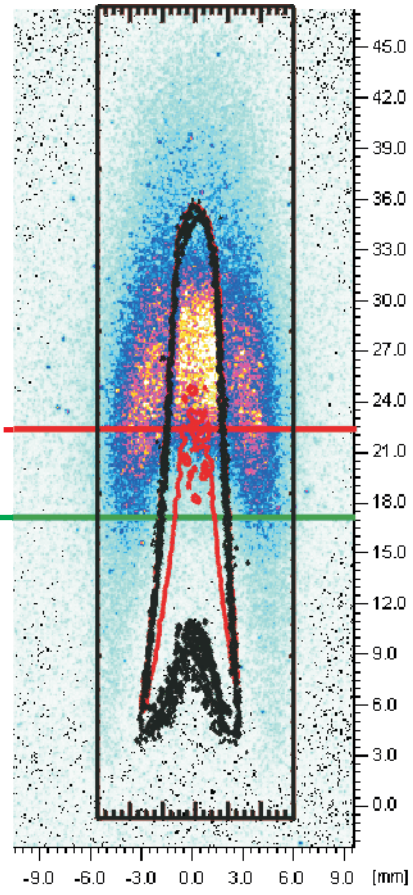
f_V(sum,h=const)



differentiation (time)



OH-LIF

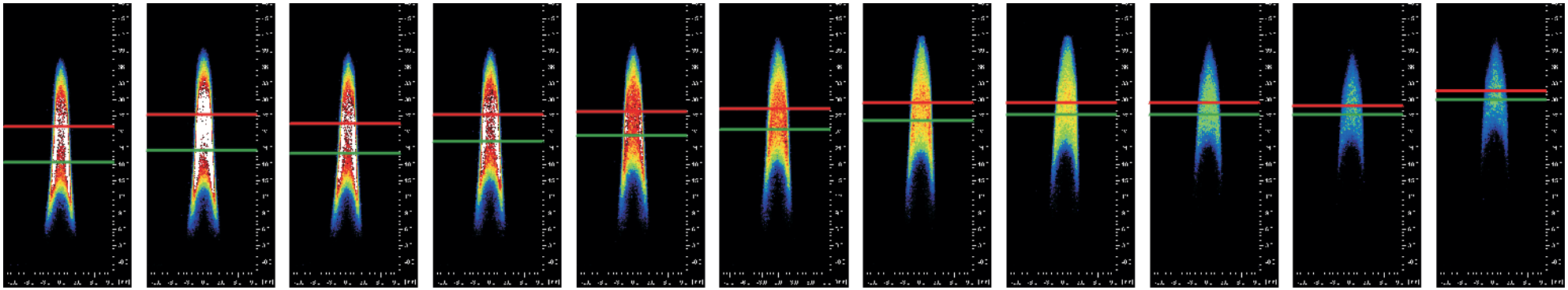


total flame

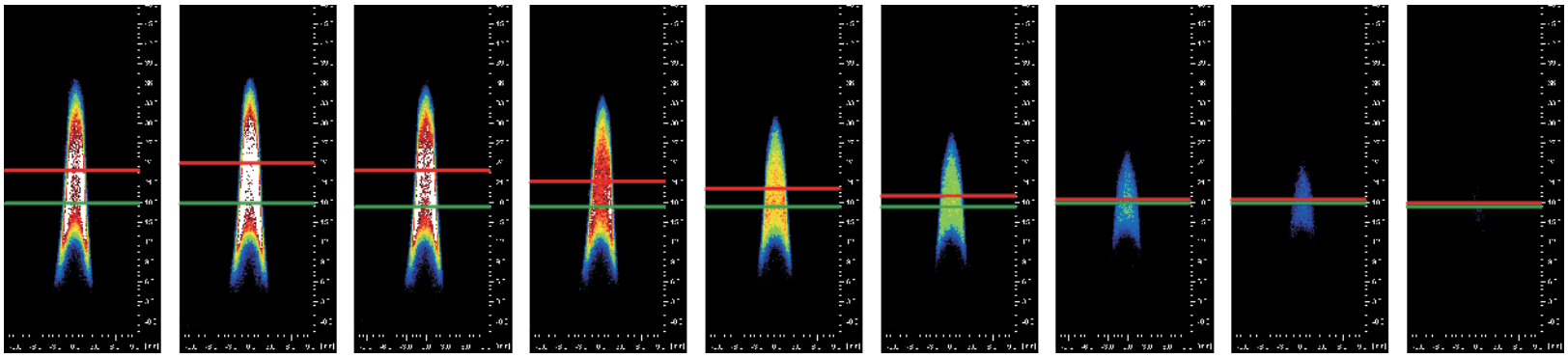
flame axis

Results: LII global flame

Ethylene **Ethane**



Ethylene **DME**



net soot oxidation on flame axis

net soot oxidation over total flame

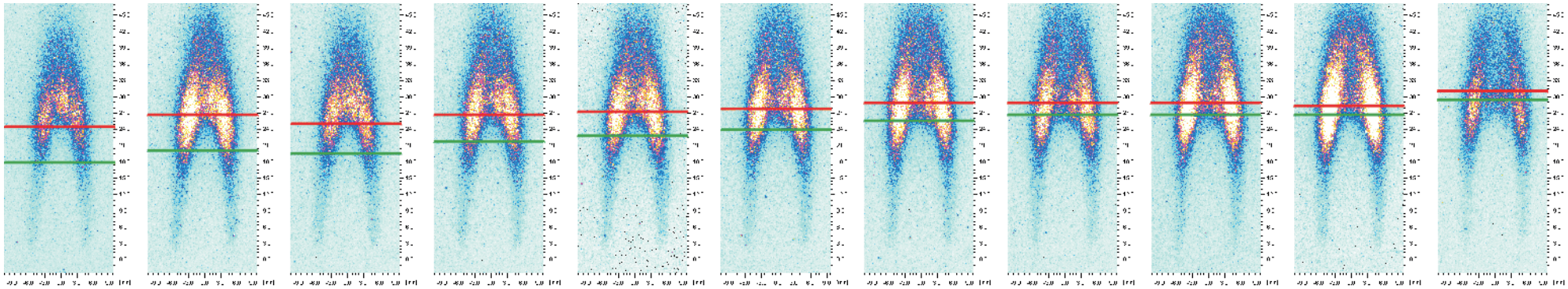
$X_{fuel} = 1.0$

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Results: OH-LIF global flame

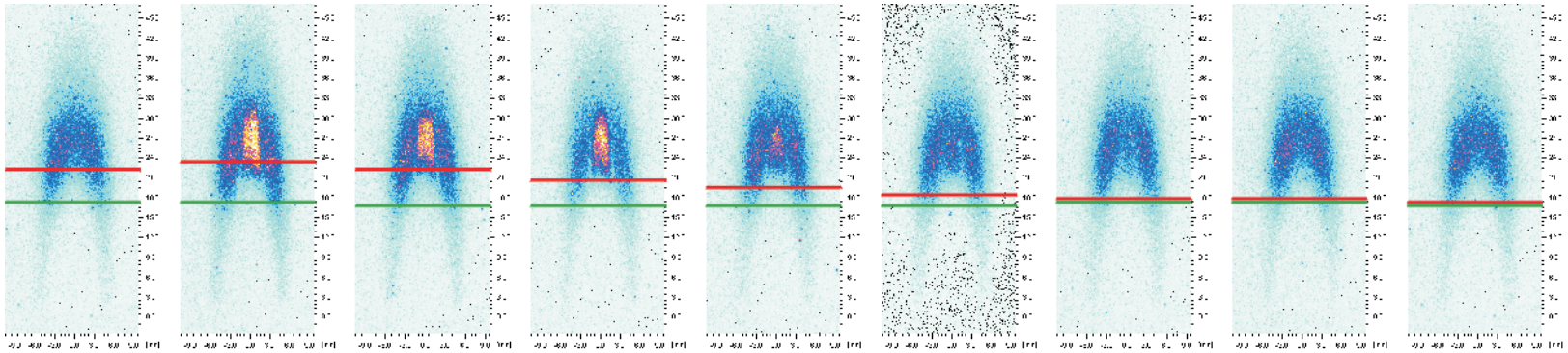
Ethylene

Ethane



Ethylene

DME



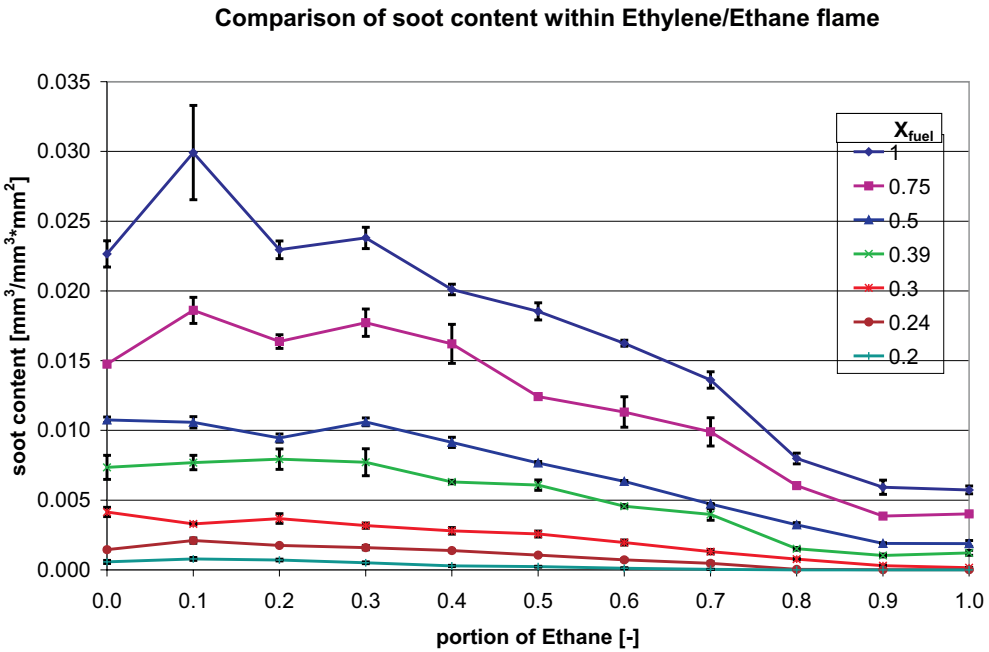
net soot oxidation on flame axis

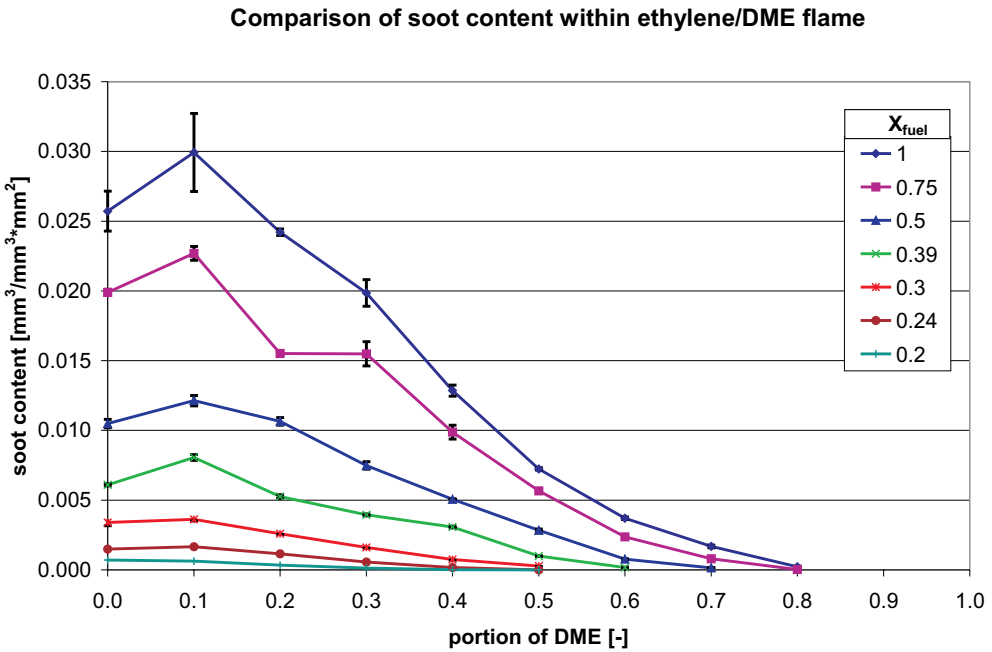
net soot oxidation over total flame

$X_{fuel} = 1.0$

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Results: soot content flames

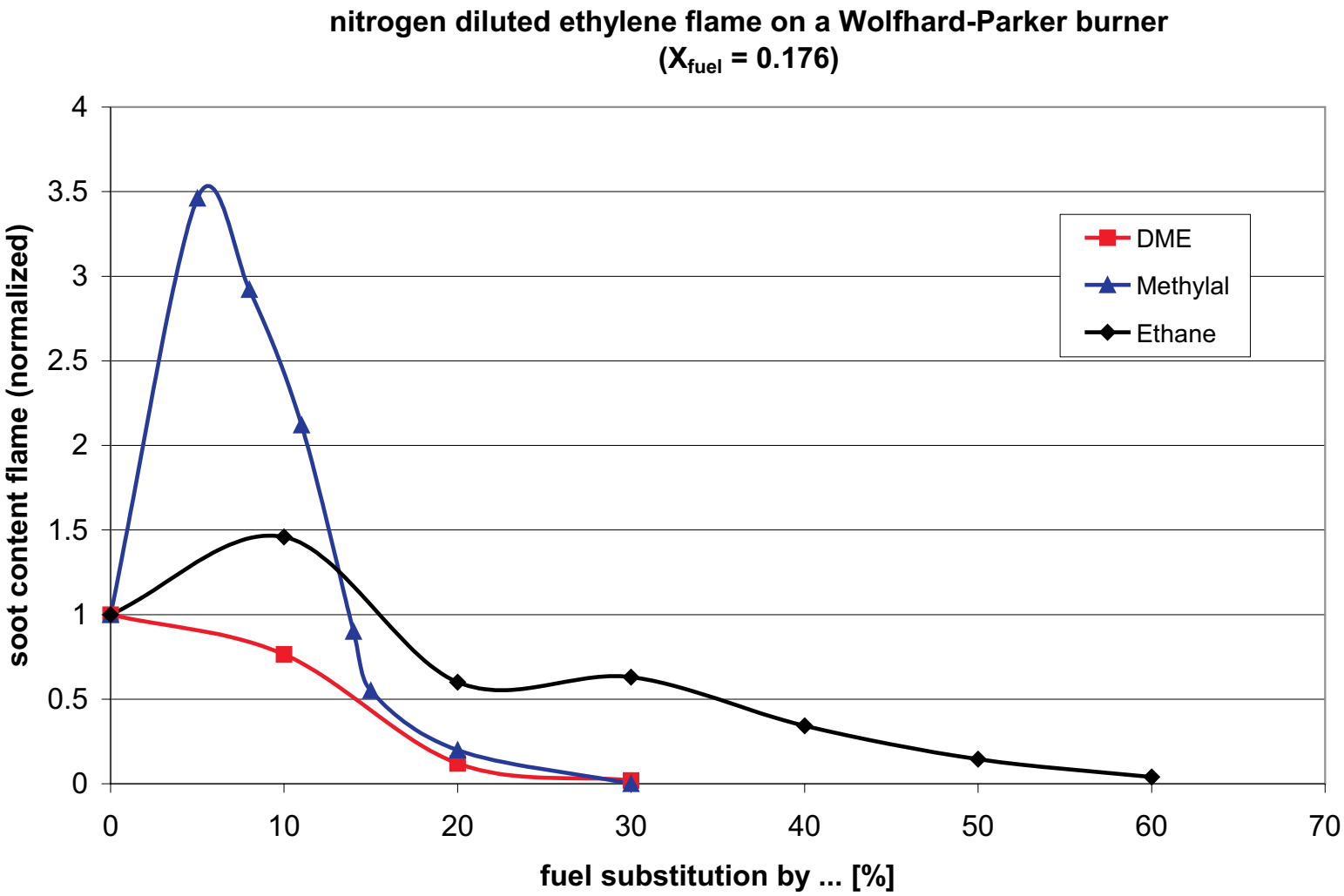




Ethylene <-> Ethane

Ethylene <-> DME

Results: soot reduction potential of oxygenated fuels



Conclusions

- oxygenated fuels **can** -in small amounts- **increase** the soot production

- in **higher quantities**, oxygenated fuels **do reduce** the soot tendency

- oxygenated fuels show a clear **chemical influence** on the sooting behaviour of diffusion flames

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