Jahrestagung zum Energieforschungsprogramm

Gas- und Dampfkraftwerke ("Kraftwerk 2020")

Mittwoch, 28. August 2013

Staged, Gas Turbine Combustion System for Enhanced Operational Flexibility

FHNW

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

ALSTOM

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OUTLINE

- Motivation and Goals
- Setup
- Operative concept and test matrix
- Results
- Conclusions and Outlook

MOTIVATION: operational flexibility

- Load-Flex

Renewable energy sources (solar, wind) lead to unpredictable fluctuations in the grid to be balanced

- Fuel-Flex

Renewable fuel sources (biogas, syngas, etc.) require flexible engines

- Goals

Rapid power turndown 1:5 (CO < 20 ppm)
Operation up to 20 % C_2 and 20 % H_2
Pressure drop < 5 %
Flame temperature up to 1800 K (NO_X < 10 ppm)

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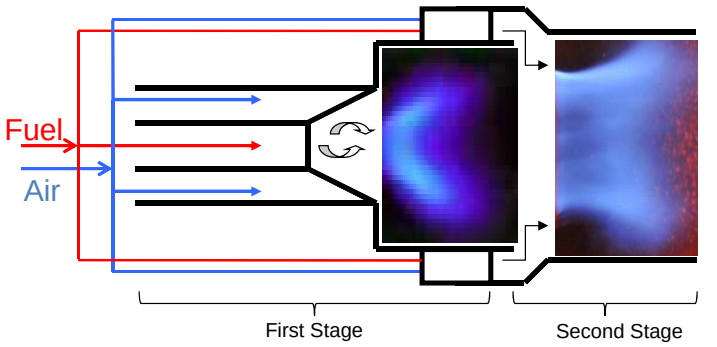
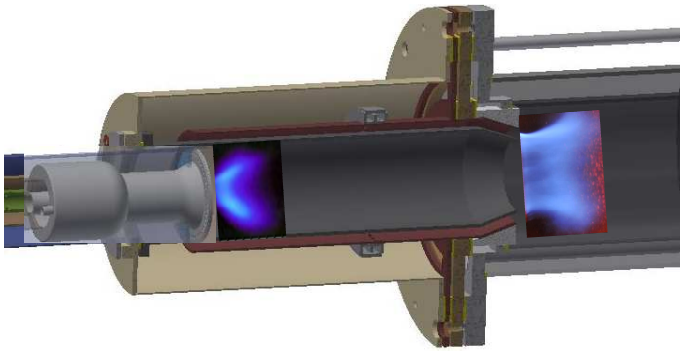
Setup: staged combustor





Advantages of staging

- second stage with wide operational range
- heat release volumetrically distributed
- part load emissions improved
- steady (rapid) turndown

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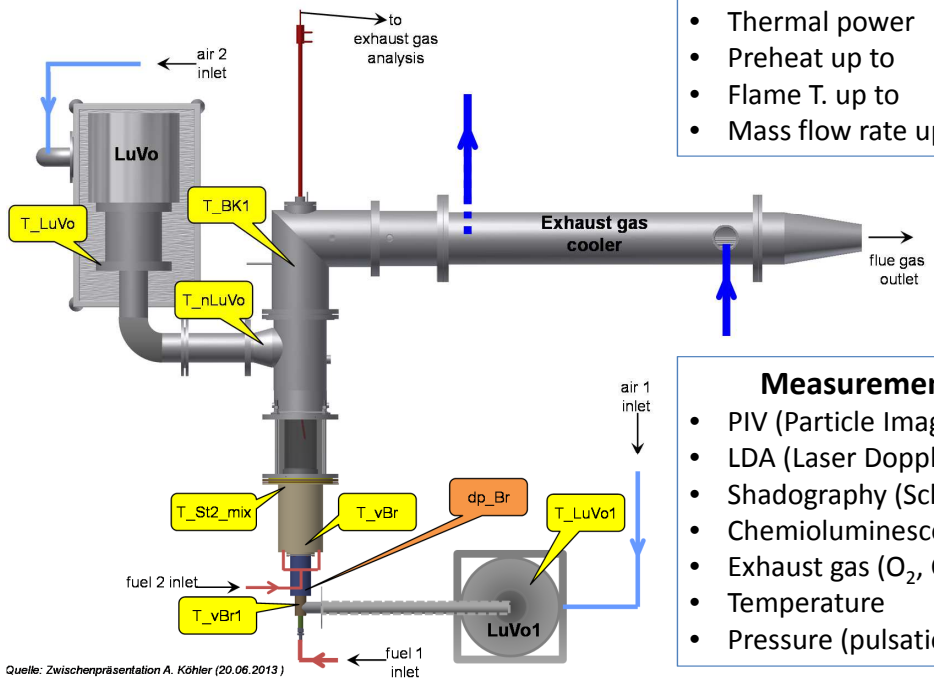
Setup: test-rig



Quelle: Zwischenpräsentation A. Köhler (20.06.2013)

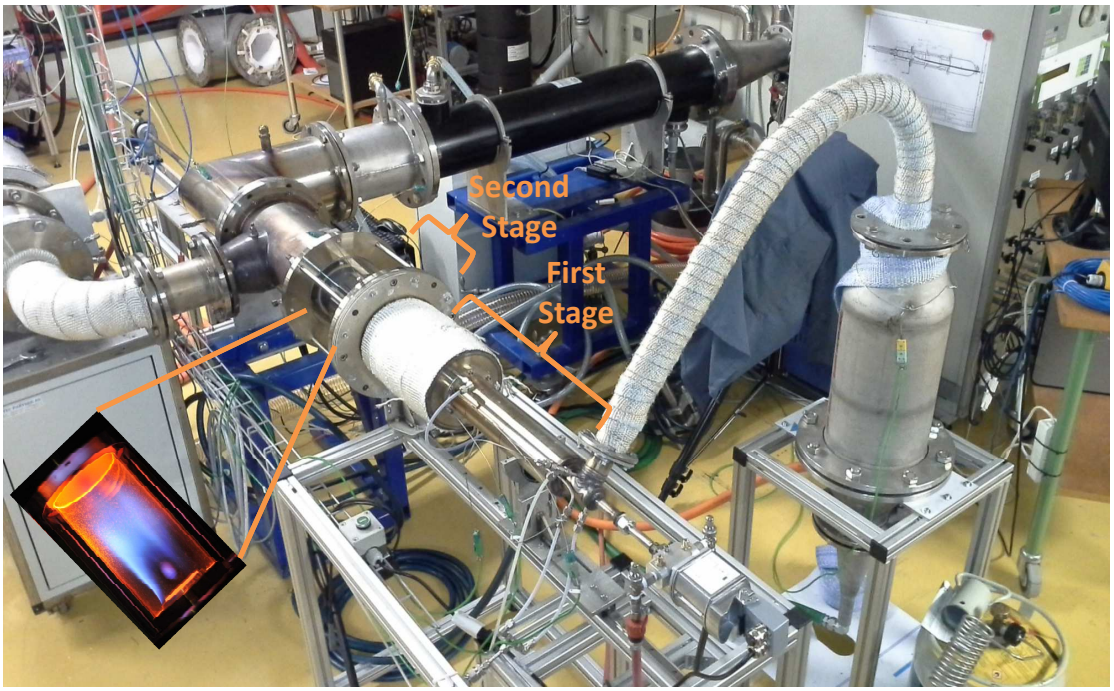
COBRA Combustion Facility

• Thermal power	200 kW
• Preheat up to	750 K
• Flame T. up to	1850 K
• Mass flow rate up to	150 g/s

Measurement techniques

- PIV (Particle Image Velocimetry)
- LDA (Laser Doppler Anemometry)
- Shadography (Schlieren)
- Chemioluminescence (OH*, CH*)
- Exhaust gas (O_2, CO_2, NO_x, CO, UHC)
- Temperature
- Pressure (pulsation)

Setup: test-rig



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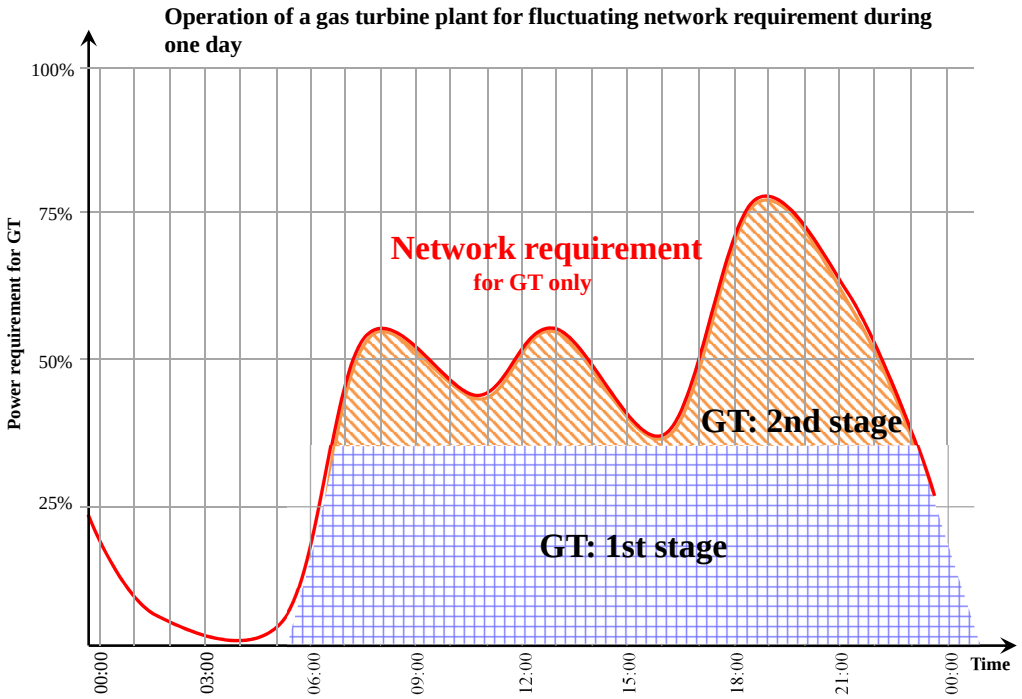
Operative concept



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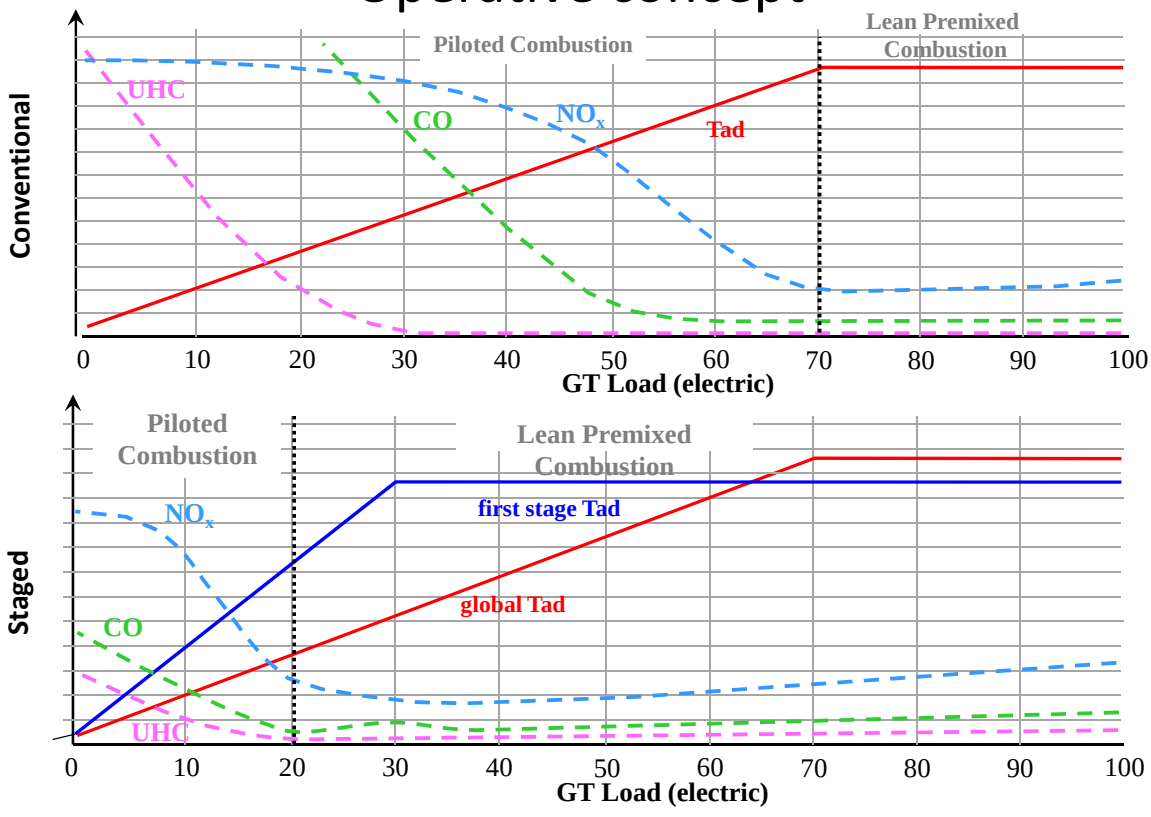
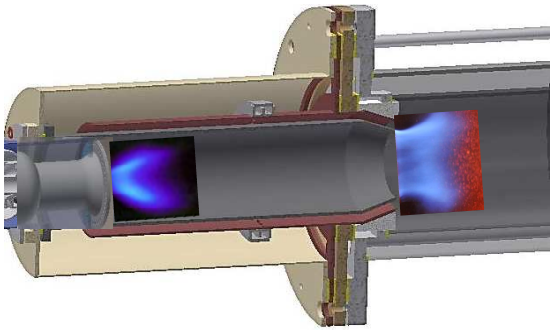
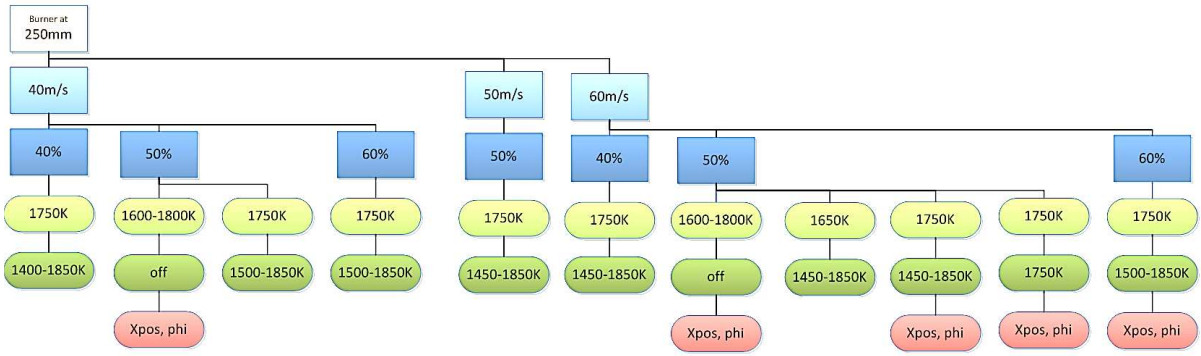
Operative concept



Test matrix

Burner position	0-250	mm
Inlet temperature	725	K
Flame temperature I	1600-1800	K
Flame temperature II	1450-1850	K
Inlet velocity (I Stage)	40-60	m/s
Split (I/II Stage)	40/60	%





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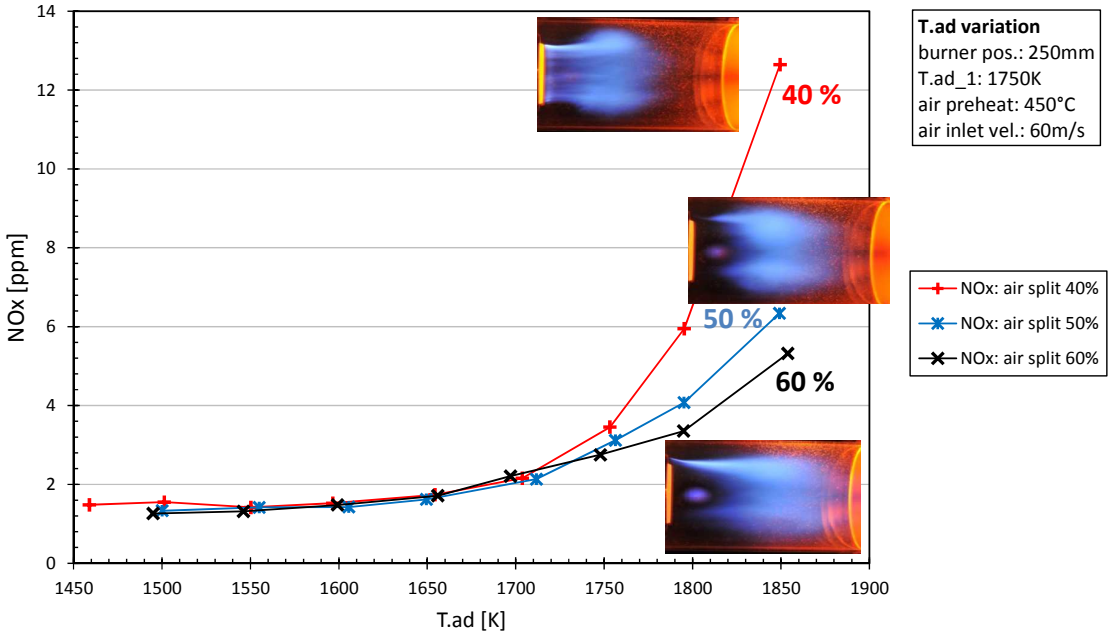
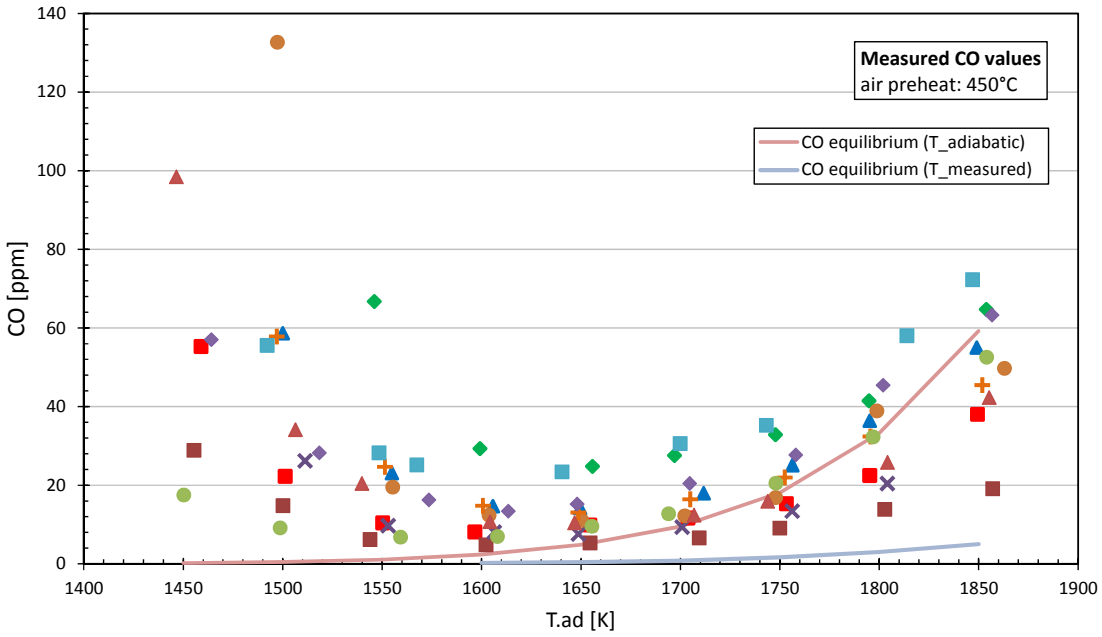
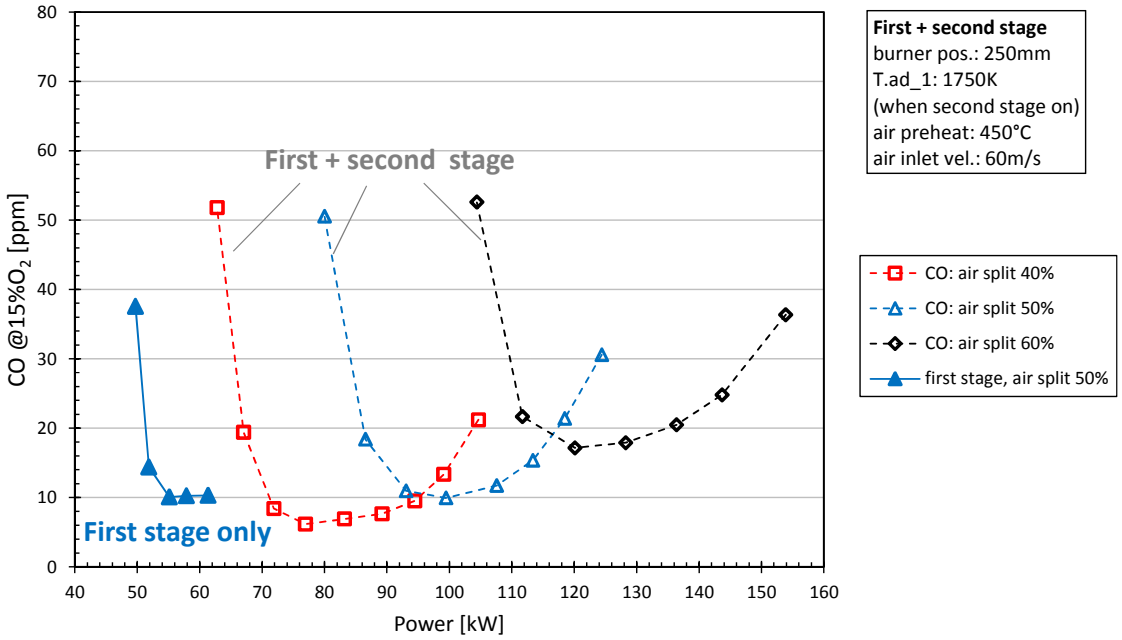
Results: NO_X emission



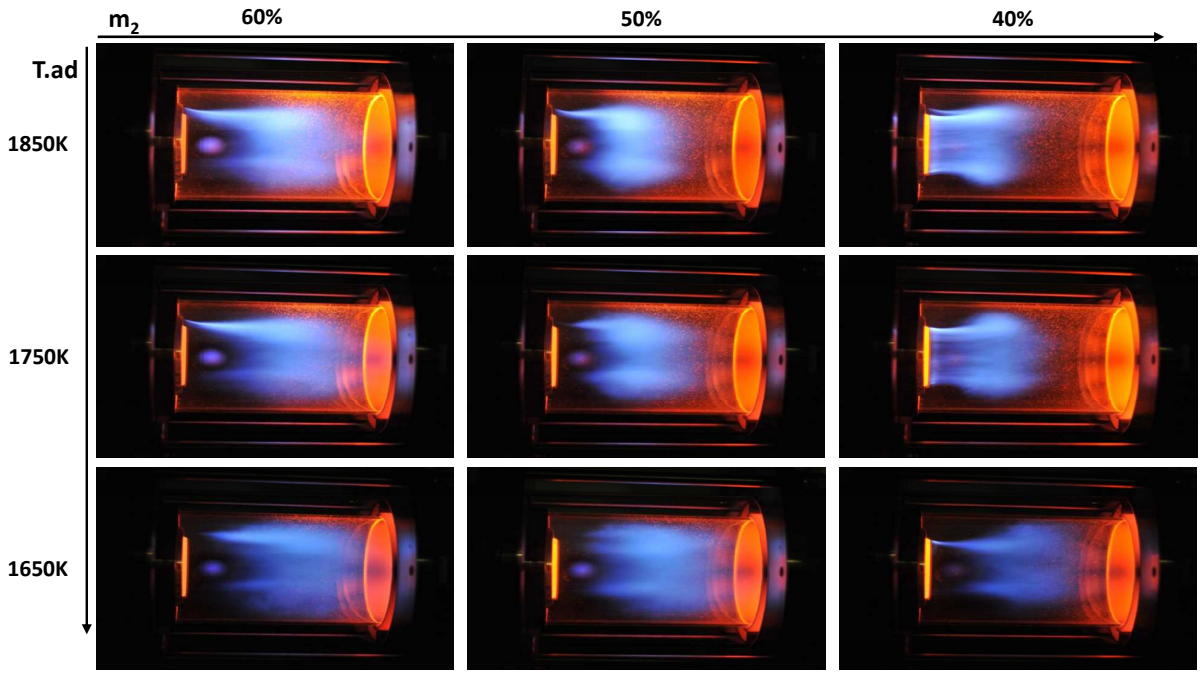
Results: CO emission



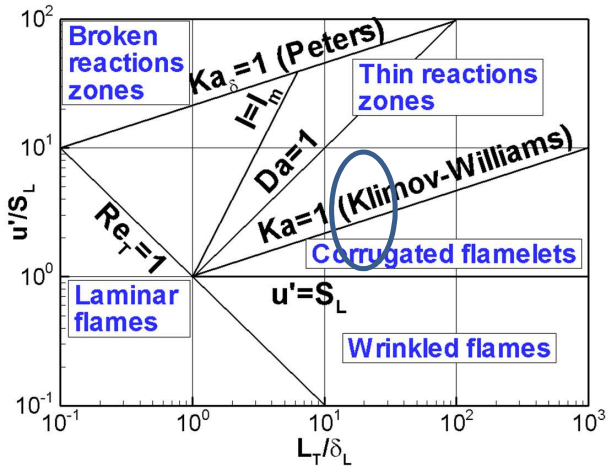
Results: Operation

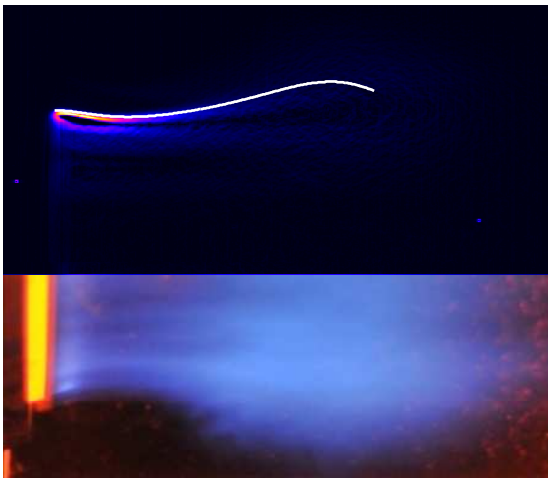


Results: Optical measurements



Results: Flame front





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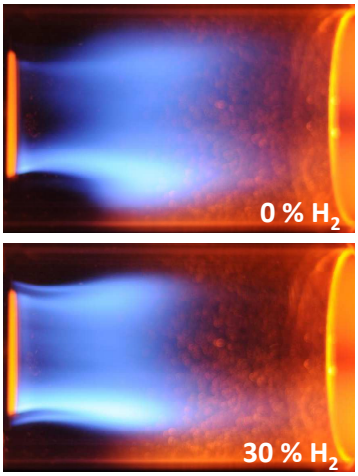
Conclusions and Outlook

• Conclusions

- Load-Flex demonstrated
- Emissions targets are fulfilled (@ GT relevant conditions)

- The project is running on schedule and the implementation partner (Alstom) is satisfied
- Bachelor thesis Anna Köhler



• Outlook

- Fuel-Flex: C_2+, H_2, CO_2, N_2
- II Stage optimization