Energigasteknik 8-9 juni 2017 Göteborg

Hydrogen as fuel in Gas Turbines

Jenny Larfeldt

Acknowledgement

2013 Larfeldt, Larsson and Andersson, "Co-firing with hydrogen in industrial gas turbines", SGC report 2013:256.

2015 Nilsson E., Larfeldt J., Rokka M., Karlsson V., "Hydrogen gas as fuel in gas turbines", Energiforsk 2015:121.

2017 Elna J. K. Nilsson, Christian Brackmann, Abdallah Abou-Taouk, Jenny Larfeldt and Daniel Moell, "Hydrogen addition to flames at gas turbine relevant conditions", Energiforsk 2017:391.

Project partners;

- Lund University
- Chalmers University of Technology
- Siemens
- Infraserv GmbH Frankfurt
- Göteborg Energi AB

SGT-800 53MW

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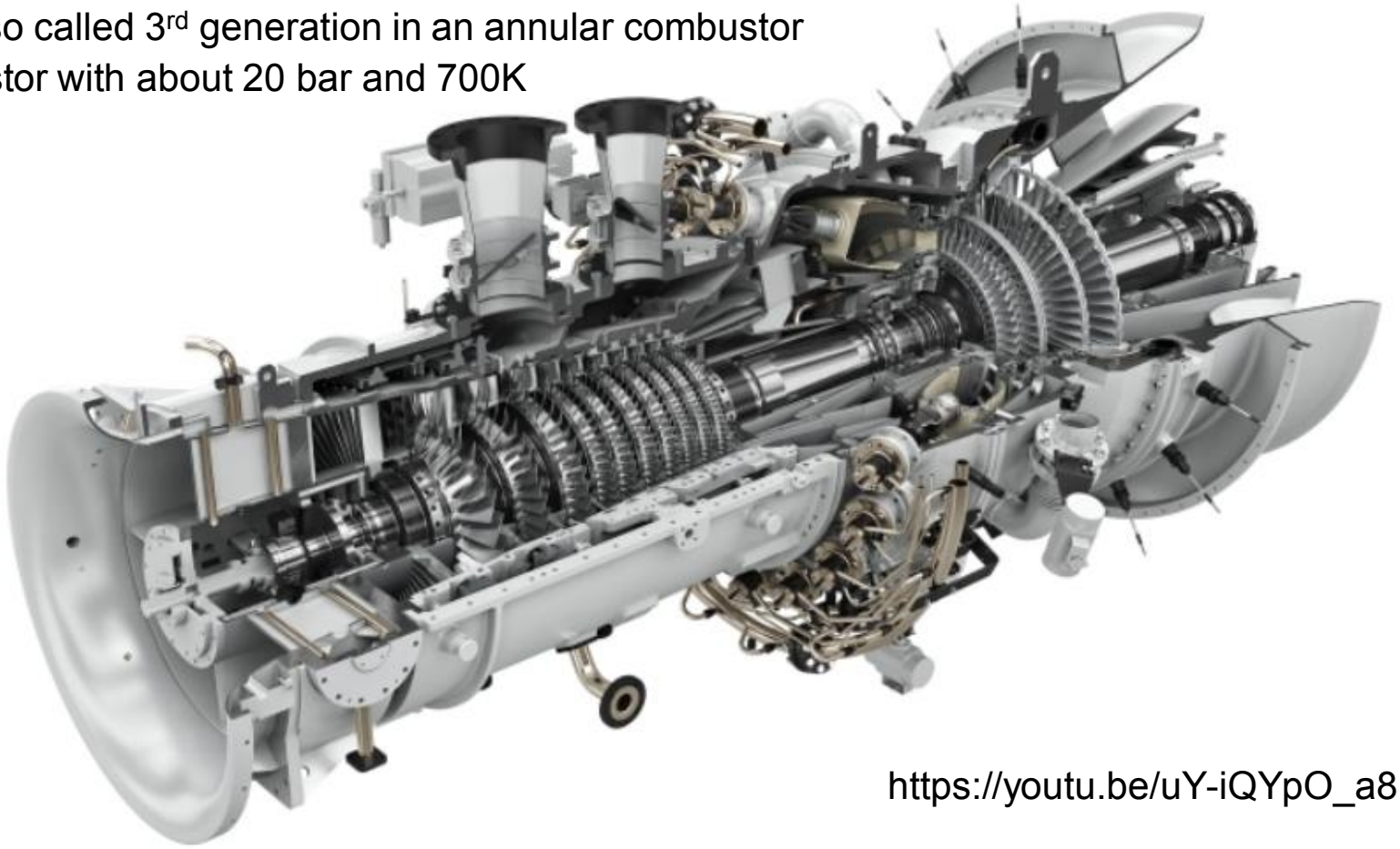
30 DLE burners of so called 3rd generation in an annular combustor
Air entering combustor with about 20 bar and 700K



https://youtu.be/uY-iQYpO_a8

2013 Larfeldt, Larsson and Andersson, "Co-firing with hydrogen in industrial gas turbines", SGC report 2013:256.

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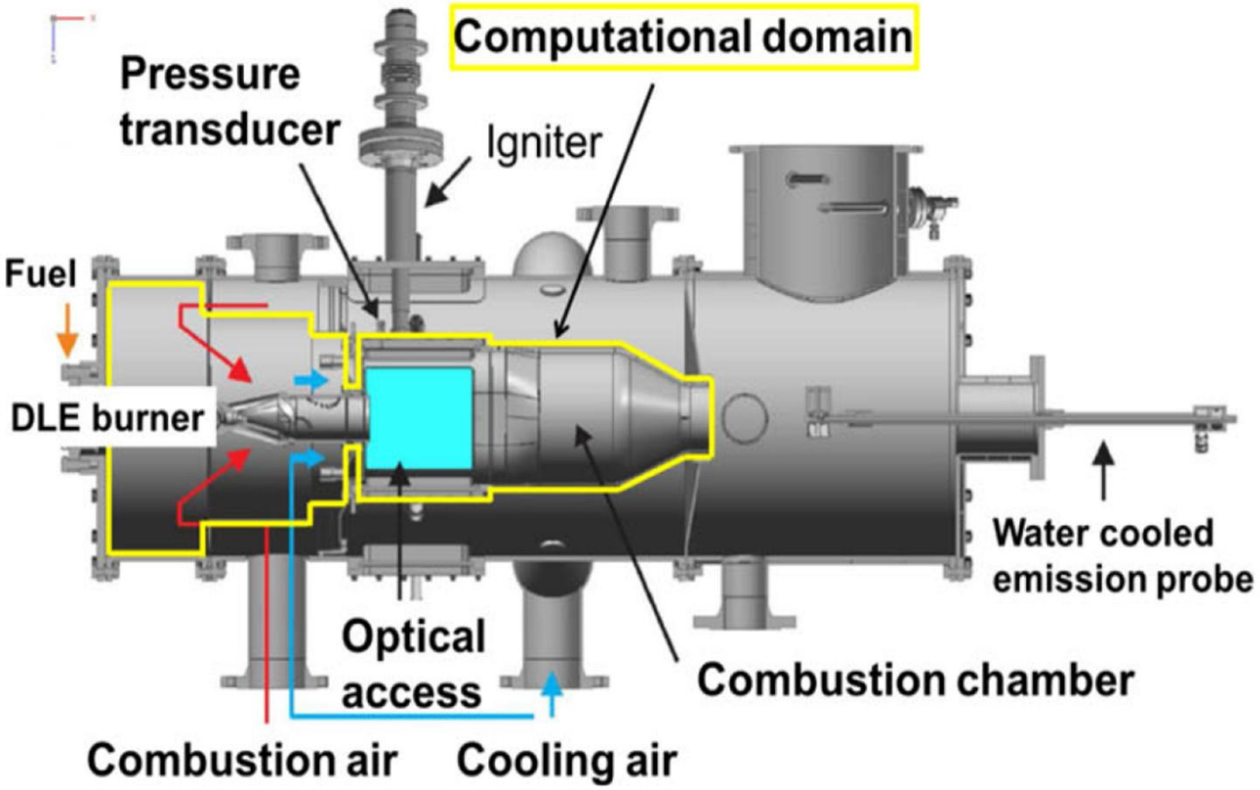

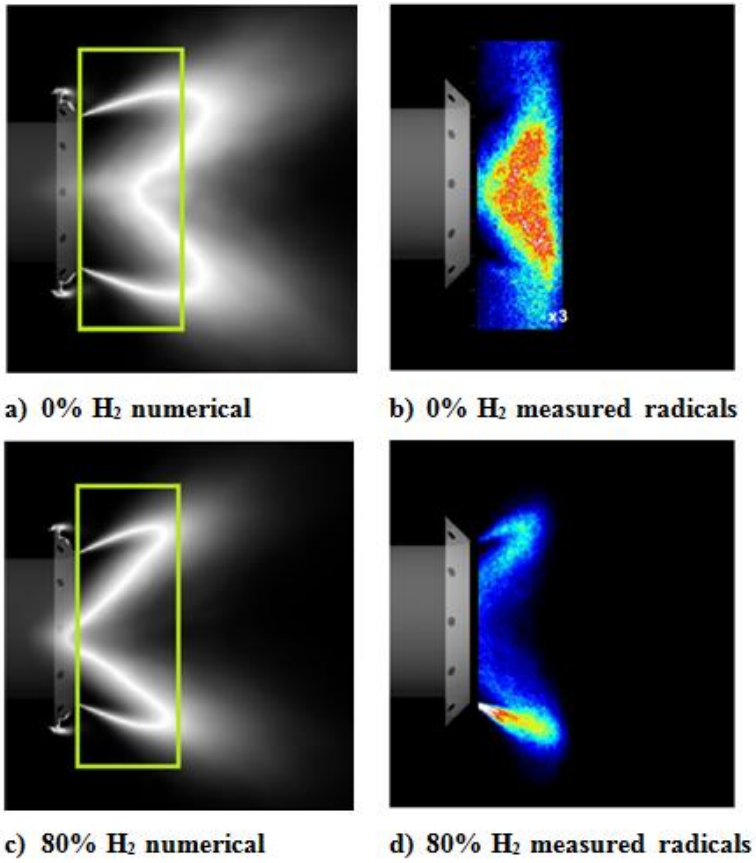

a) 0% H_2 numerical
b) 0% H_2 measured radicals
c) 80% H_2 numerical
d) 80% H_2 measured radicals

2013 Larfeldt, Larsson and Andersson, "Co-firing with hydrogen in industrial gas turbines", SGC report 2013:256

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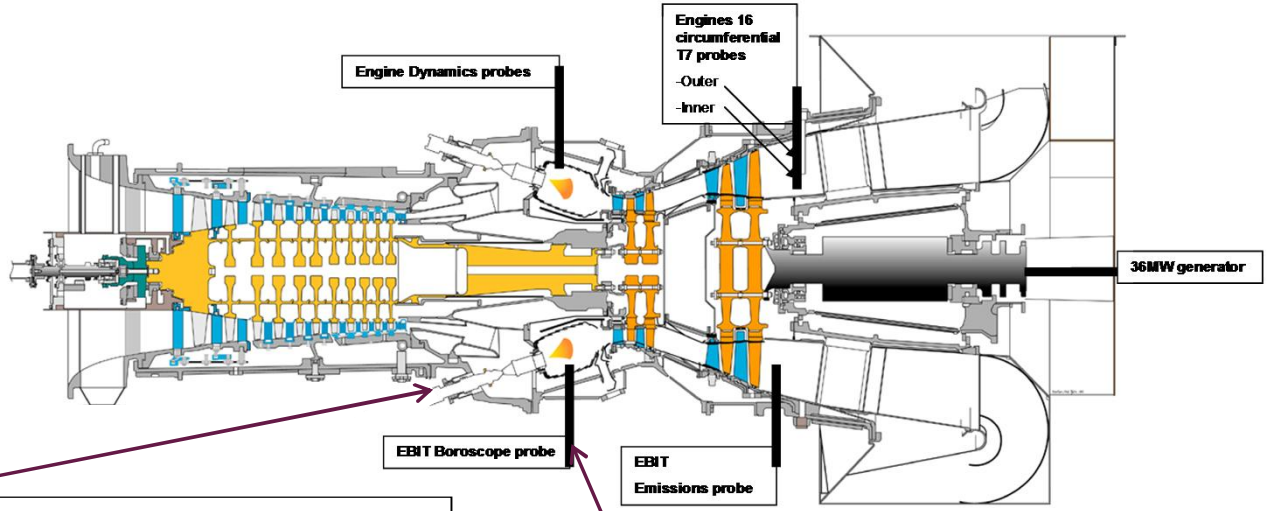
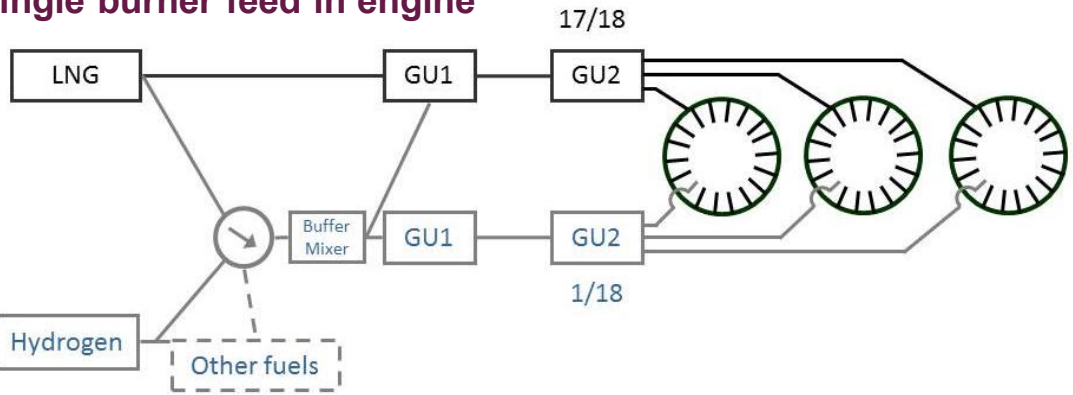
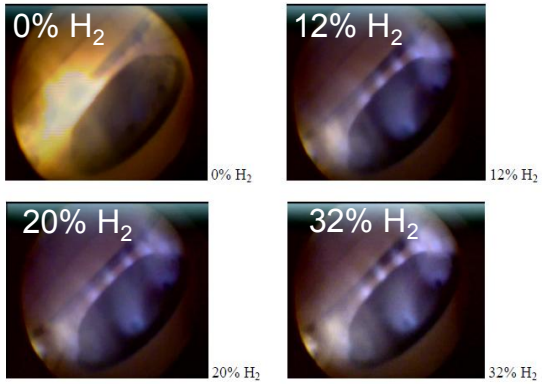


Single burner feed in engine





2015 Nilsson E., Larfeldt J., Rokka M., Karlsson V., "Hydrogen gas as fuel in gas turbines", Energiforsk 2015:121.

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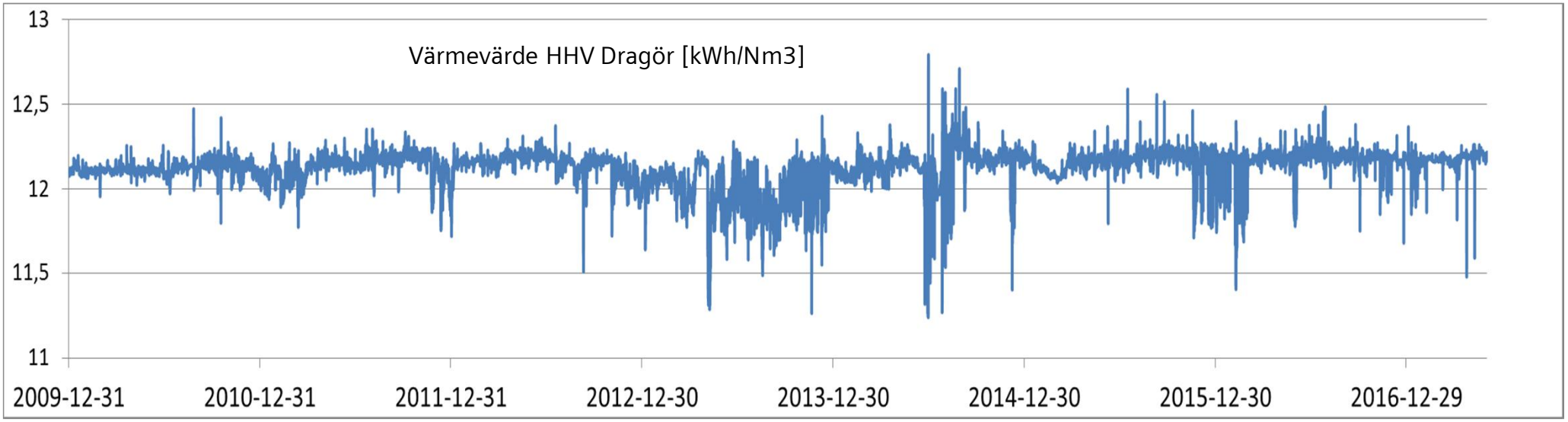
Göteborg Energi: "Fram till år 2012 ligger värmevärdet stabilt mellan och mellan 12,0 och 12,3 kWh/Nm³ i stort sett hela tiden. Från och med 2013 ökar variationerna och det främst nedåt."



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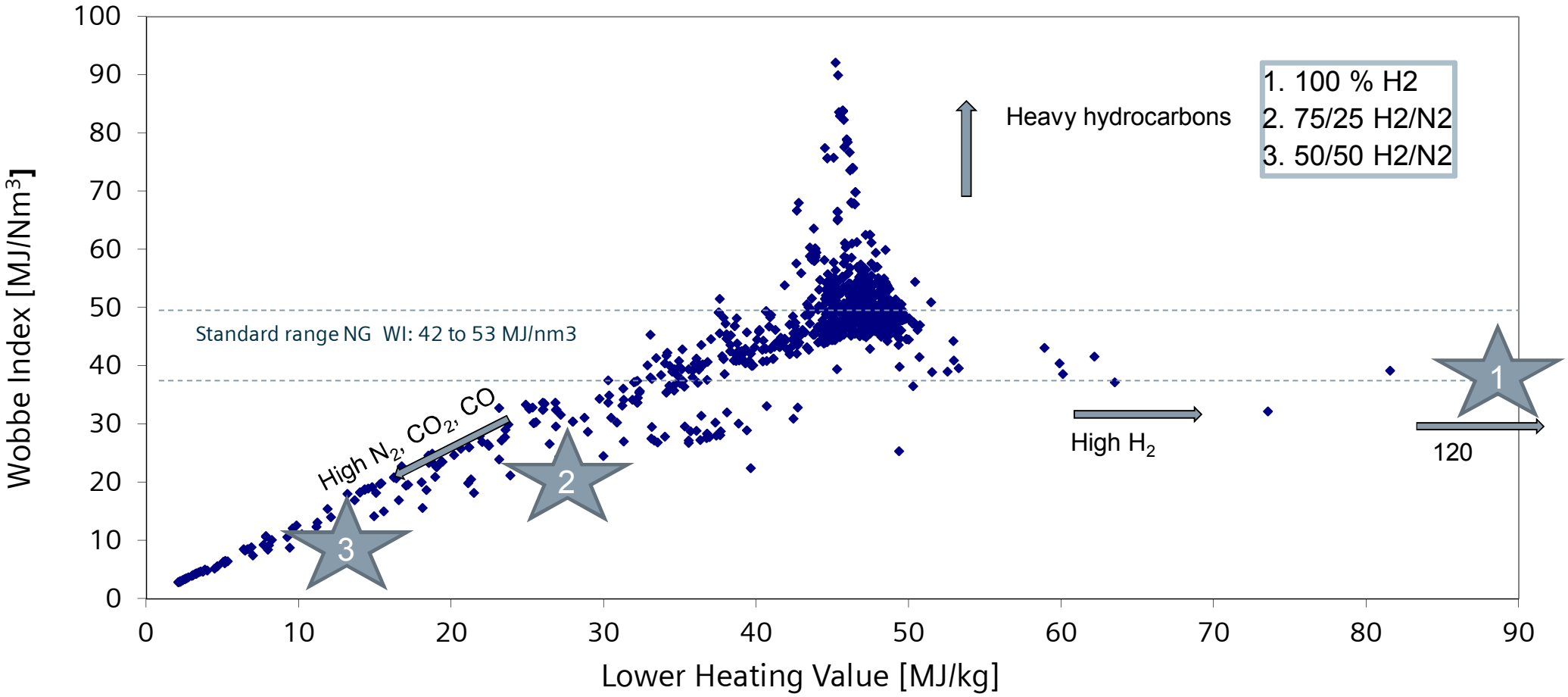

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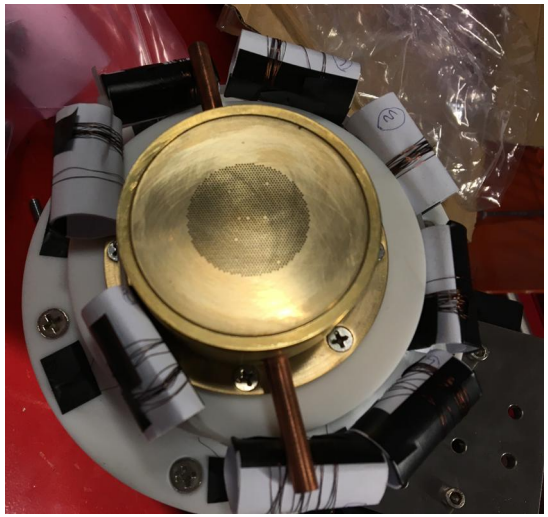
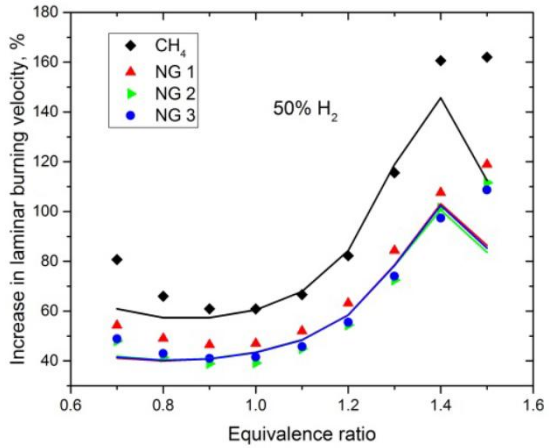
Heat flux burner.



Co-firing H2 and CH4/C2H6/C3H8

- H2 < 60 vol-%: slight increase in burning velocity and chemistry hydrocarbon dominated
- 60 < H2 < 90 vol-% intermediate regime
- H2 > 90 vol-% chemistry is hydrogen dominated and dramatic increase in laminar burning velocity (ten times).

1D flame stabilized on the heat flux burner.



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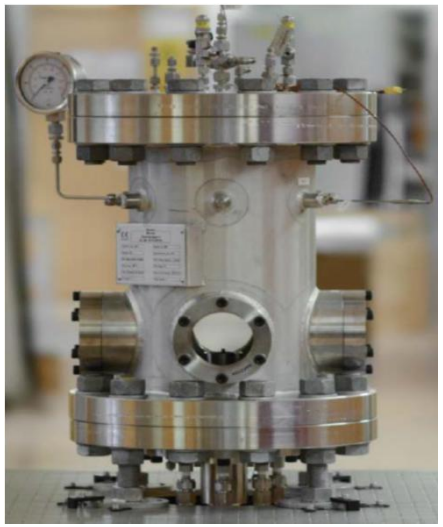

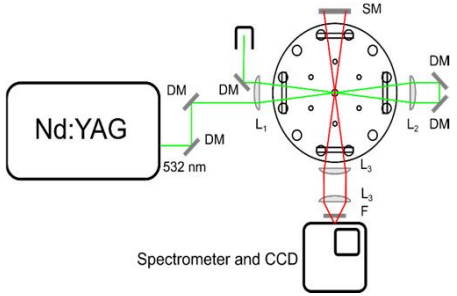

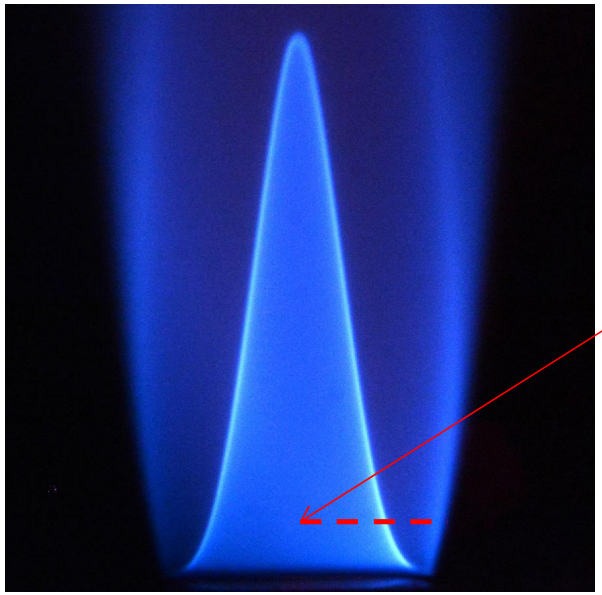

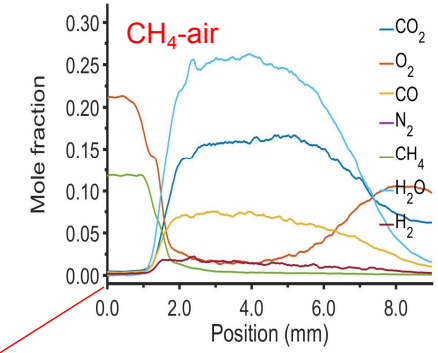

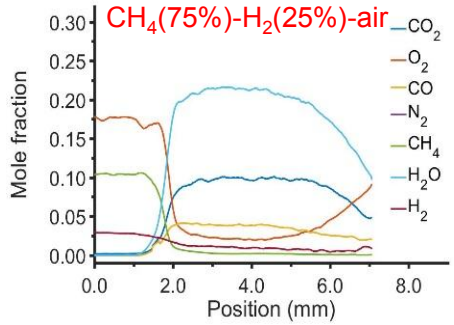

Φ=1.0 and p=3 atm.

2017 Nilsson, Brackmann, Abou-Taouk, Larfeldt and Moell, "Hydrogen addition to flames at gas turbine relevant conditions", Energiforsk 2017:391.

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Three mechanisms at different level of complexity are used in CFD simulations of a laminar flame.
The aim is to compare the results to enable evaluation of the performance in relation to the computational time

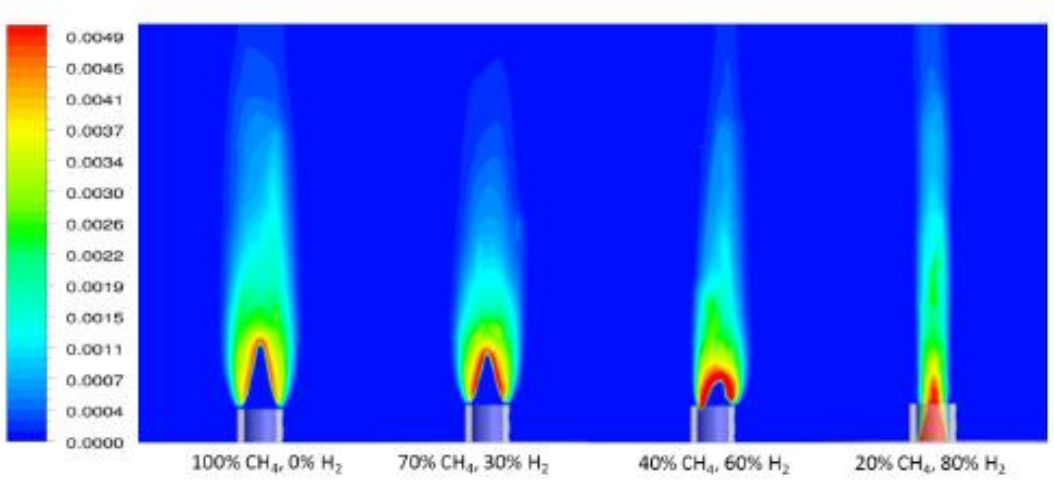
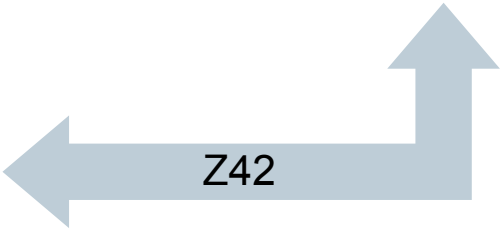


Table 2. Kinetic mechanisms used in the present study.

Mechanism	Species	Reactions	Fuels
Aramco 1.3	171	1140	H_2, C1-C3 hydrocarbons
GRI-Mech 3.0	32	177	H_2, C1-C3 hydrocarbons
Z42	18	42	CH_4, H_2
Present four-step	7	4	CH_4, H_2



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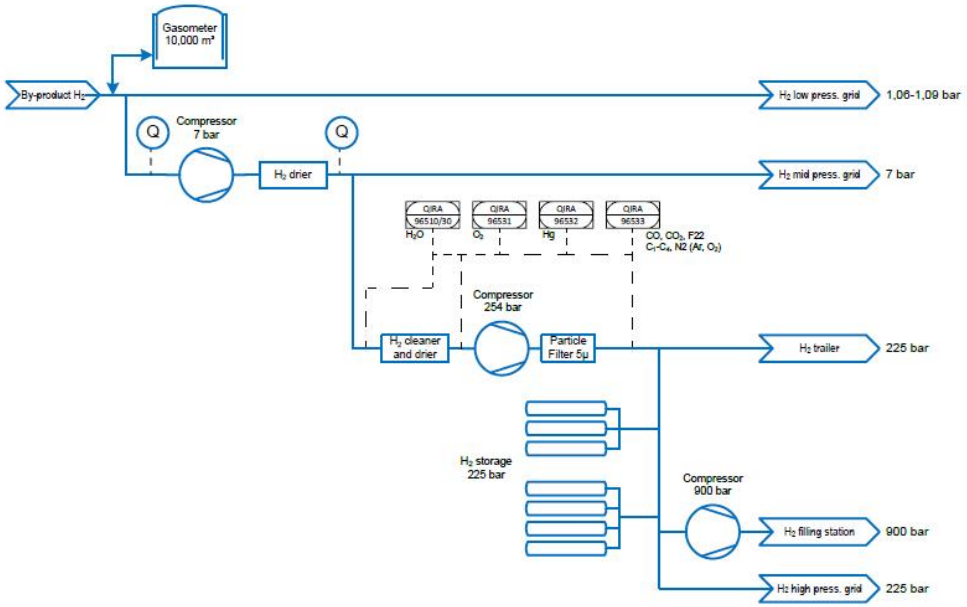
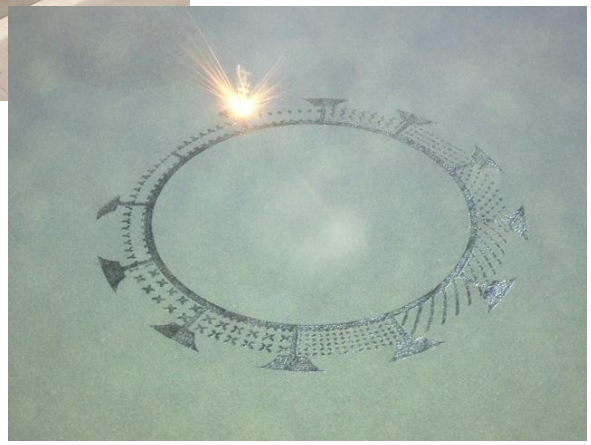
Co-firing with 15 vol% H2 in SGT-800 at Industriepark Höchst, Frankfurt (Dec 2017).



Conclusions and next steps

SGT-800 can today be offered to customer with up to 40 vol% H2 in the fuel and NOx emissions below 25 ppm@15%O2.

- SGT-800 string test in Finspång with 50 vol% H2 co-firing (Aug2017)
- Co-firing with 15 vol% H2 in SGT-800 at Industriepark Höchst, Frankfurt (Dec 2017).
- Burner design for 100 % H2 to be tested at pressure in Siemens combustion test facility in Berlin (ongoing R&D).
- HIGH2 project approved (Heat load distribution in hot parts of industrial gas turbines burning hydrogen rich fuel)…Energimyndighetens Turbines för framtidens energisystem. Chalmers, Lund, GKN, Siemens.



Thank you for your attention

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