

# Laser Diagnostics for Rocket Propulsion Systems

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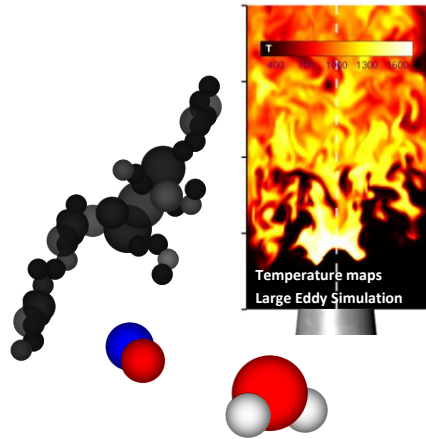
Previous Affiliations:

Tenured Assistant Professor @ Faculty of Aerospace Engineering, TU Delft

Postdoc @ Combustion Chemistry Dept., Sandia National Laboratories

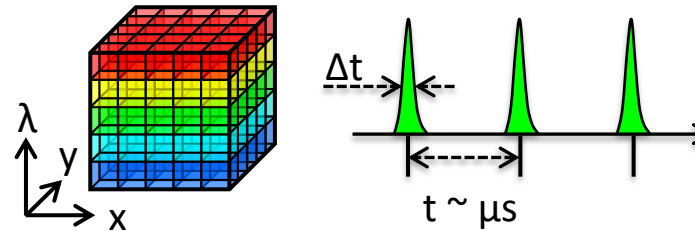
MSc and PhD @ Physics Dept., Lund University

# Benefits of Laser Diagnostics in Reacting Flows



## Measurement challenges

spatial / temporal / spectral  
resolution – data acquisition



## Scalar determination in reacting flows

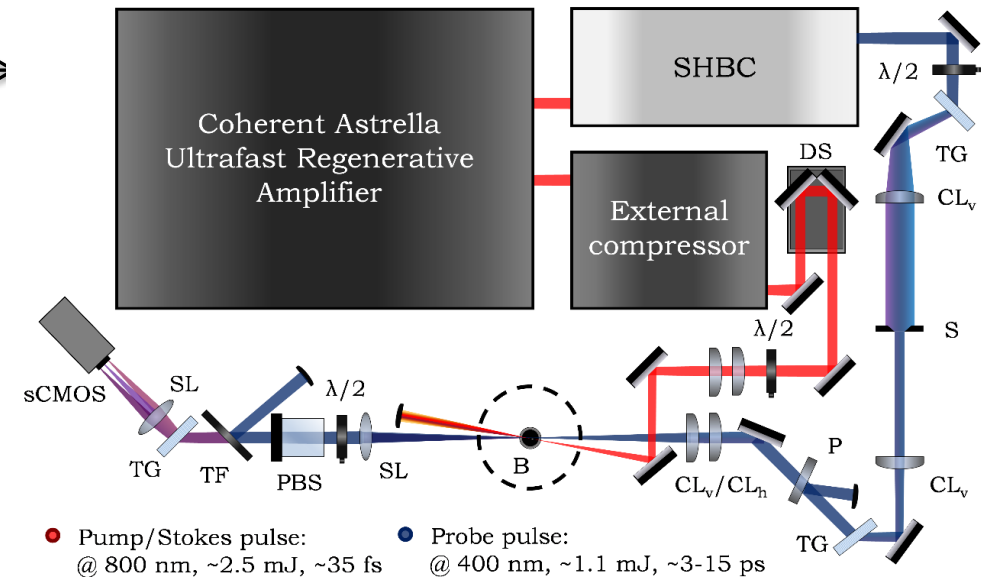
(e.g., temperature, density, and species)

How well is the measurement quantity retrieved?

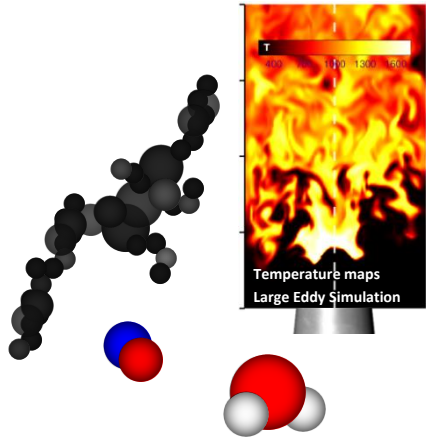
- Non-intrusive and in-situ capabilities with optical probes
- Quantitative single-shot precision and accuracy (<1%)
- Simultaneous measurement resolution/correlation (up to 5D!)

**Validation/development of model**  
requires multi-parameter diagnostics

*Lasers, Telescopes, Spectrometers, Cameras*

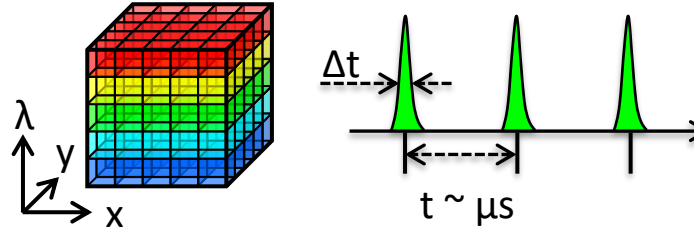


# Benefits of Laser Diagnostics in Reacting Flows

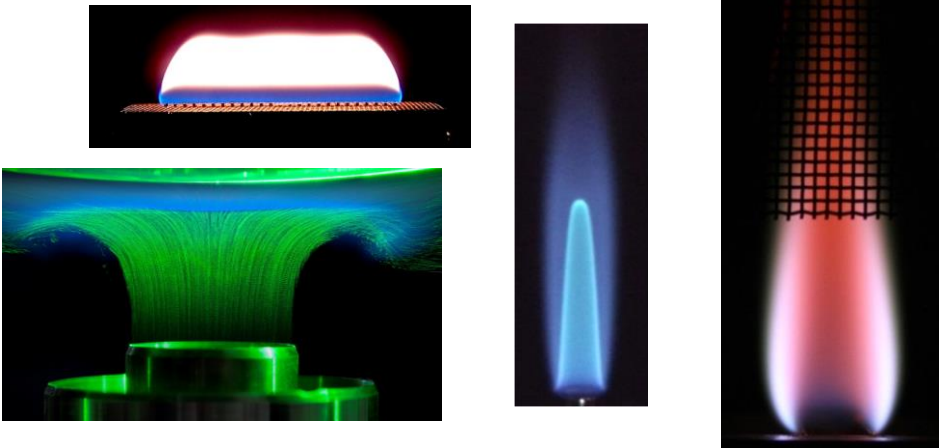


## Measurement challenges

spatial / temporal / spectral  
resolution – data acquisition

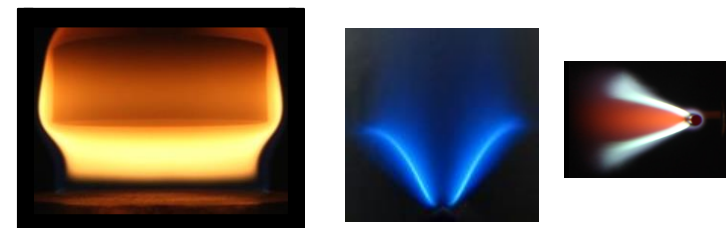
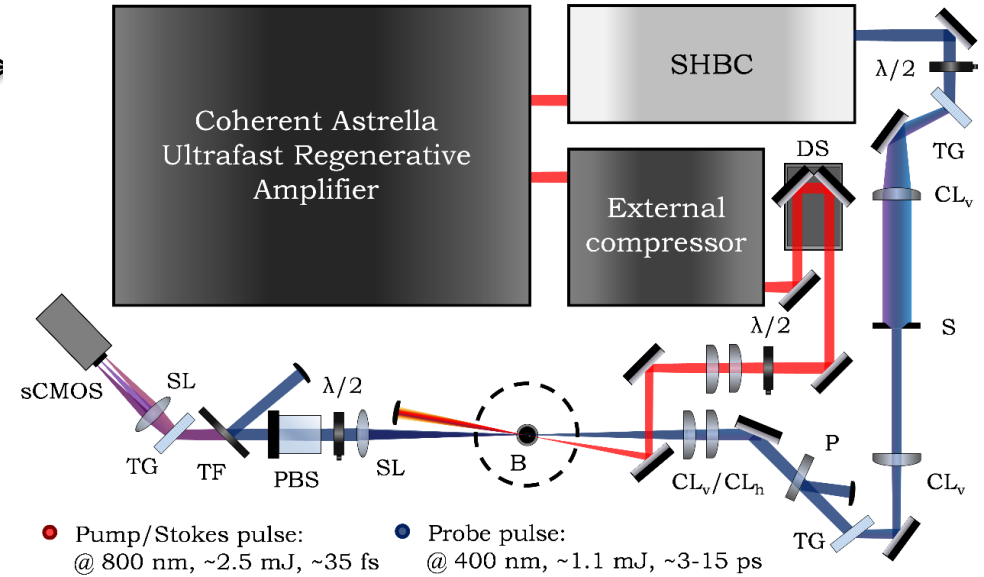


## Scalar determination in reacting flows (e.g., temperature, density, and species)



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## *Lasers, Telescopes, Spectrometers, Cameras*



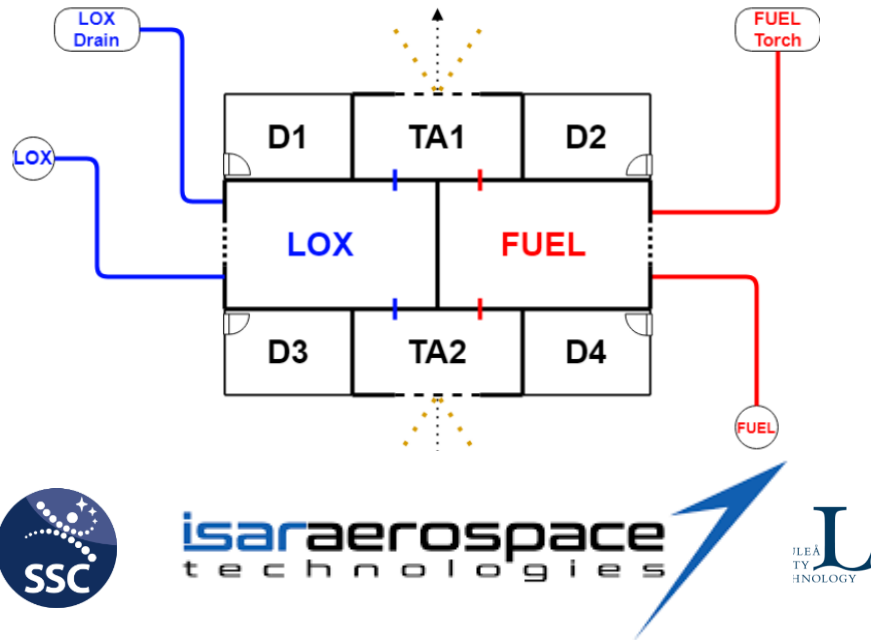
# Why is temperature data important?

- Temperature is a key quantity with impact on, e.g.
  - Transport processes (diffusion, conduction, convection, and heat transfer)
  - Equation of state
  - Chemical kinetics (Arrhenius-type reaction rates)
- Concentration of pollutants ( $\text{NO}_x$ , CO,  $\text{CO}_2$ , UHC, and particulates) are dependent on the temperature history of combustion processes
- Experimental temperature data can be used to improve the fidelity of numerical models for aeronautical vehicle engineering (e.g. TRL 1-2: -> 3)

RIT 2021

# The Green Corridor to Space

an optimal test facility for modern rocketry



*Improved materials, cooling-, injection- and ignition systems, fluid-structure interaction, combustion instabilities, nozzle design (de Laval type), 3D printed technologies – injectors and combustion chamber, sustainable rocket fuels (electrofuels) – liquid methane, ethanol, methanol, hydrogen-peroxide, liquid hydrogen.*

**LTU:** Jihyoung Cha + 1 PD, Olle Persson, and Alexis Bohlin

**ISAR:** Felix Kühne + MSc students

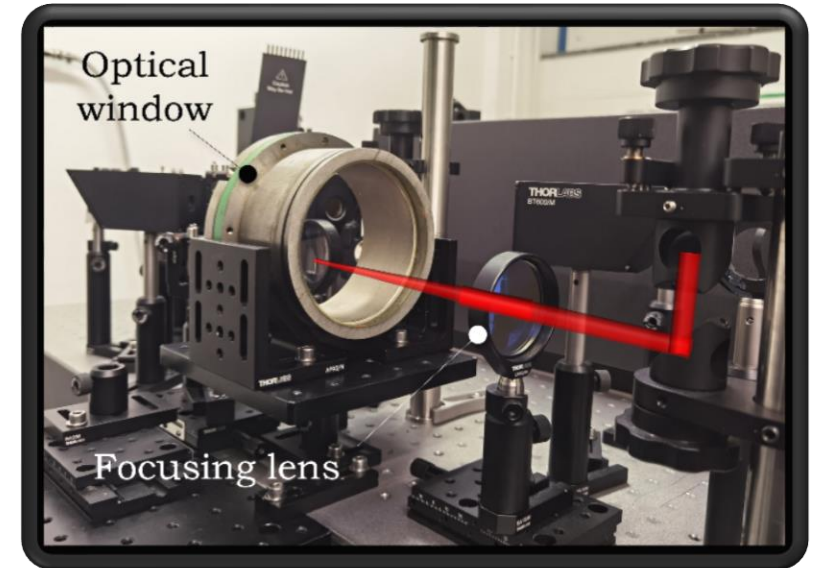
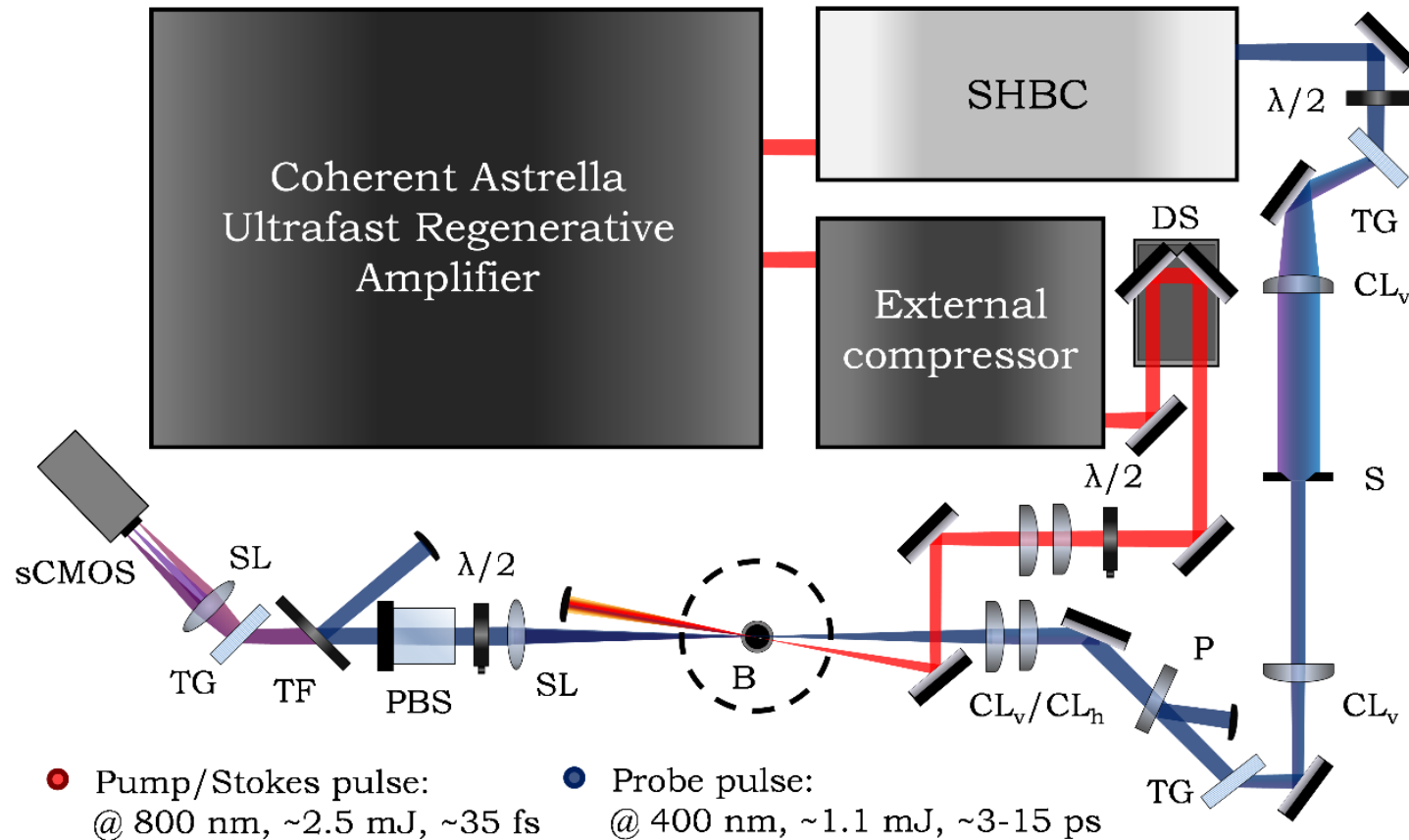
**SSC:** Christian Krokstedt





# White Paper with Coherent Inc.

## “Combustion analysis with CARS – It Really is Rocket Science”



# “News from the Ultrafast Laser Laboratory”

-“See it, measure it, understand it”, Dr. Paul Danehy NASA Langley Research Center



## Current research:

- Spatiotemporal characterization of hydrogen flame-fronts

*Funded by the Netherlands Organisation for Scientific Research (personal Vidi grant)* 

## Future possibilities of collaboration?

- Investigation of the reactivity of hydrogen/helium mixtures
- Gaseous-material interface, extreme heat transfer
- Energetic materials, solid propellants, and plasma