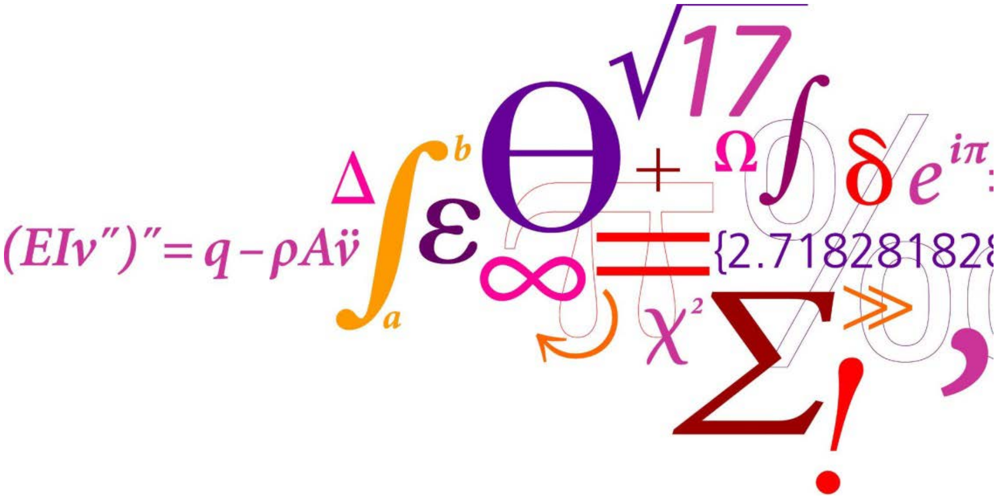
Line-of-sight measurements of stable gas flames

By Anders Ivarsson



DTU Mechanical Engineering
Department of Mechanical Engineering

Purpose?

Line-of-sight measurements

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Tomographic reconstruction

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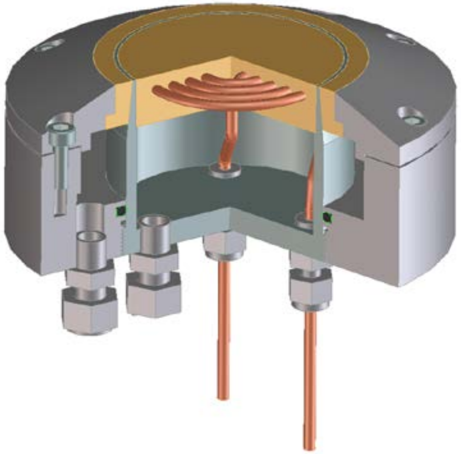
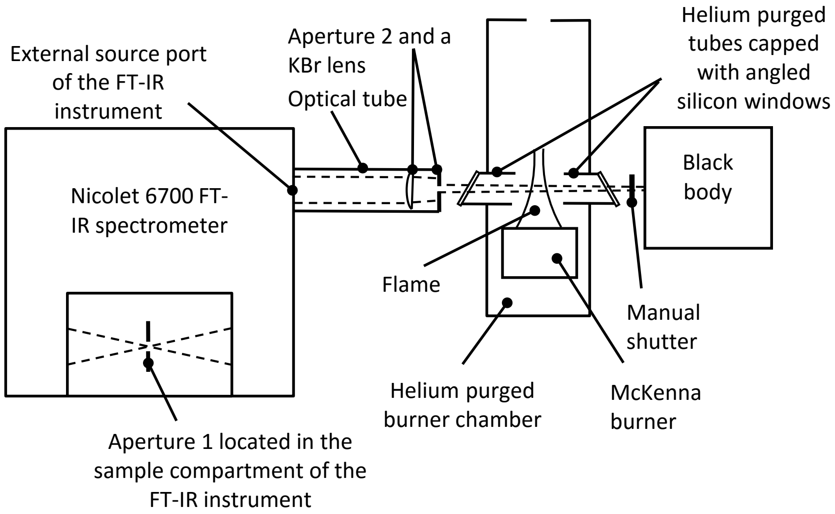
Point measurements

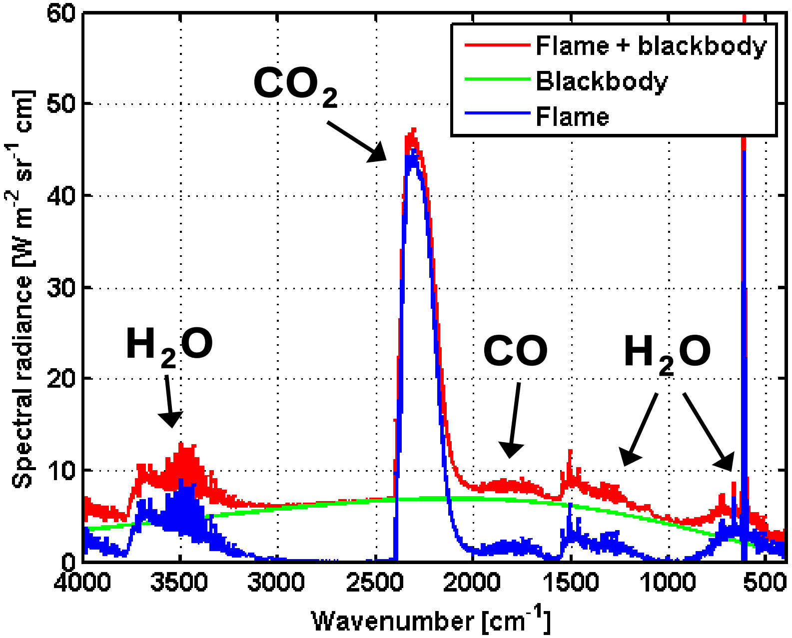
Laminar flat flames

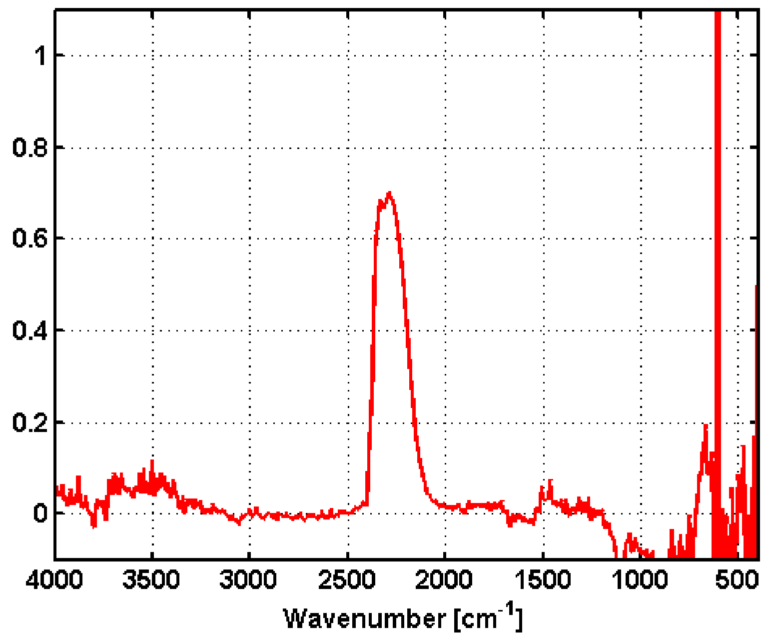


IR emission absorption thermometry



IR emission absorption thermometry

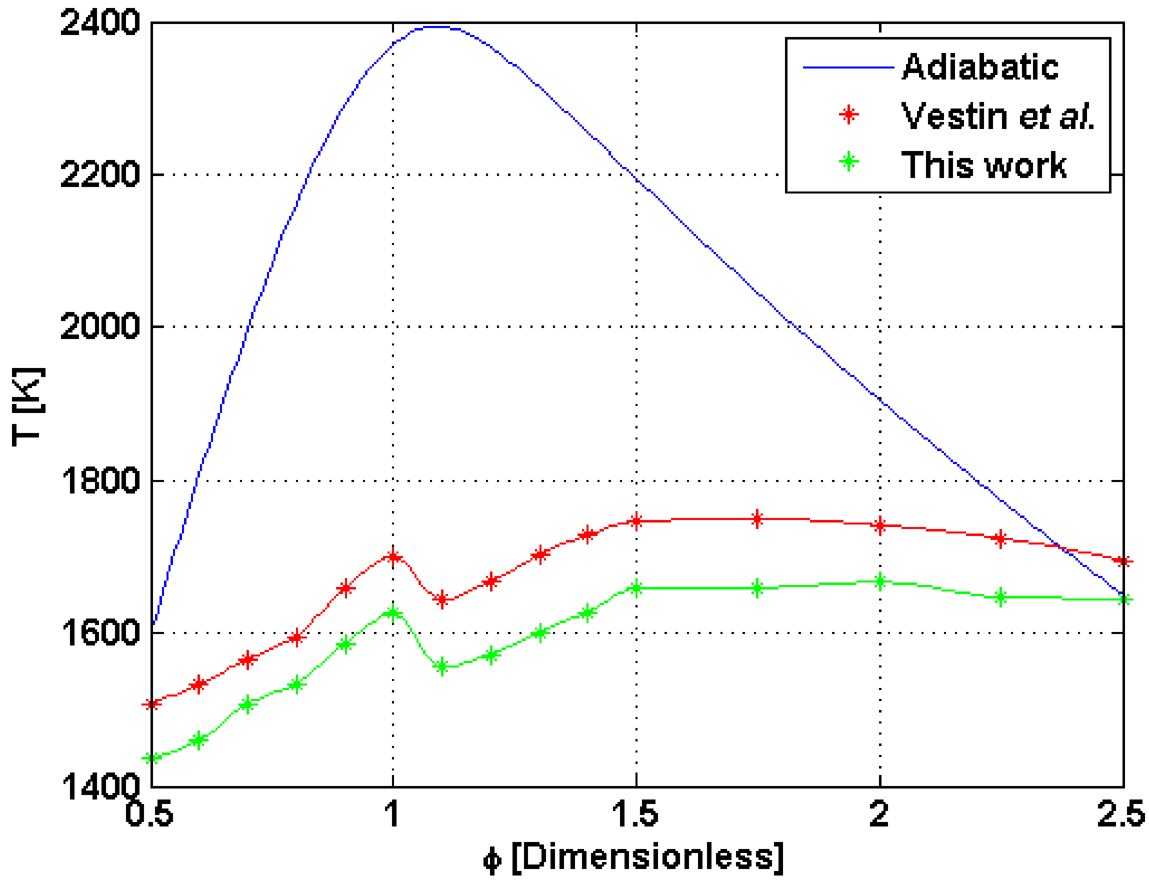




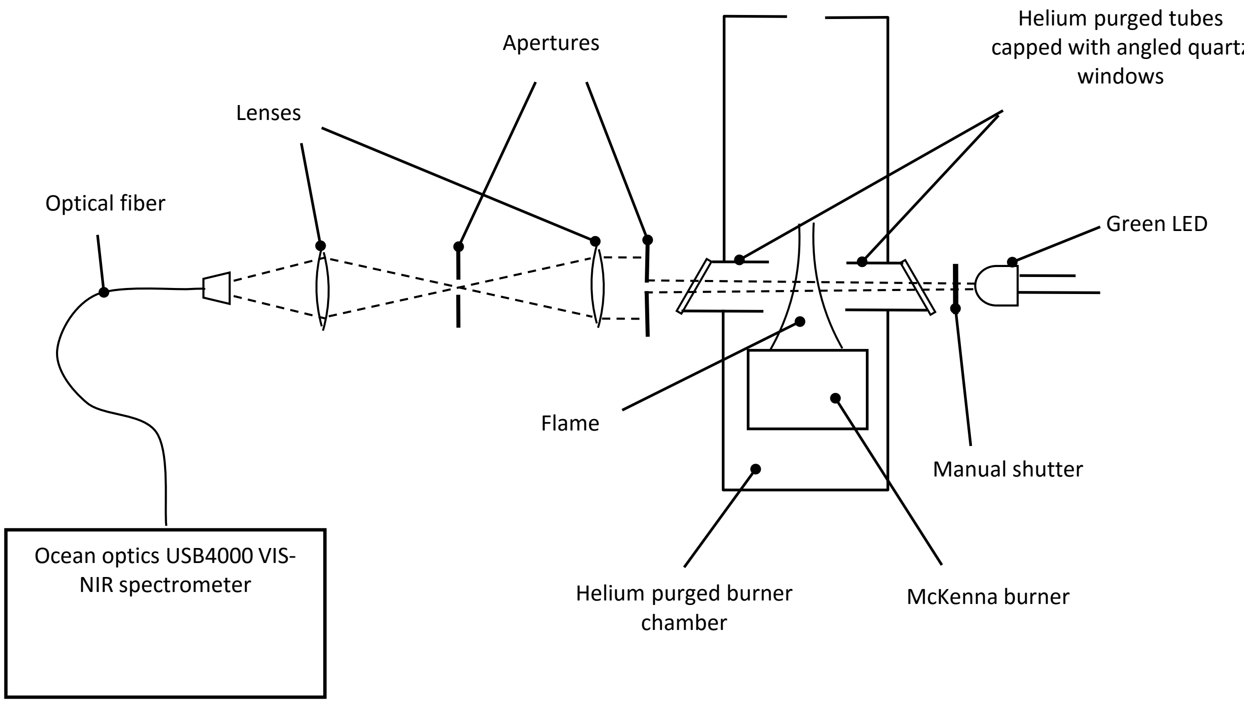
IR emission absorption thermometry

Core temperatures validated with CARS point measurements

Standard deviation of + / - 1 %



Soot thermometry



Absorption measured between 500 and 520 nm

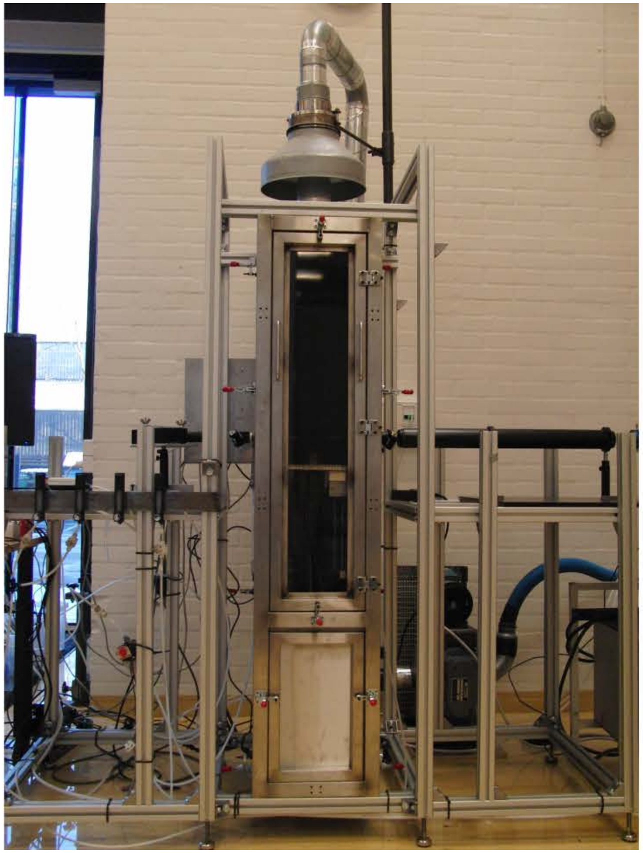
Soot thermometry

Emission absorption method
vs.
color method

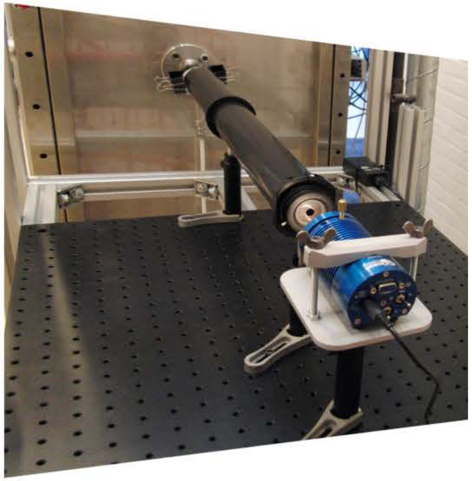
- Both methods -> Low temperatures (100-300 K)
- Color method -> Very low optical thickness

New burner setup

Ocean Optics HR4000CG
UV-NIR Spectrometer

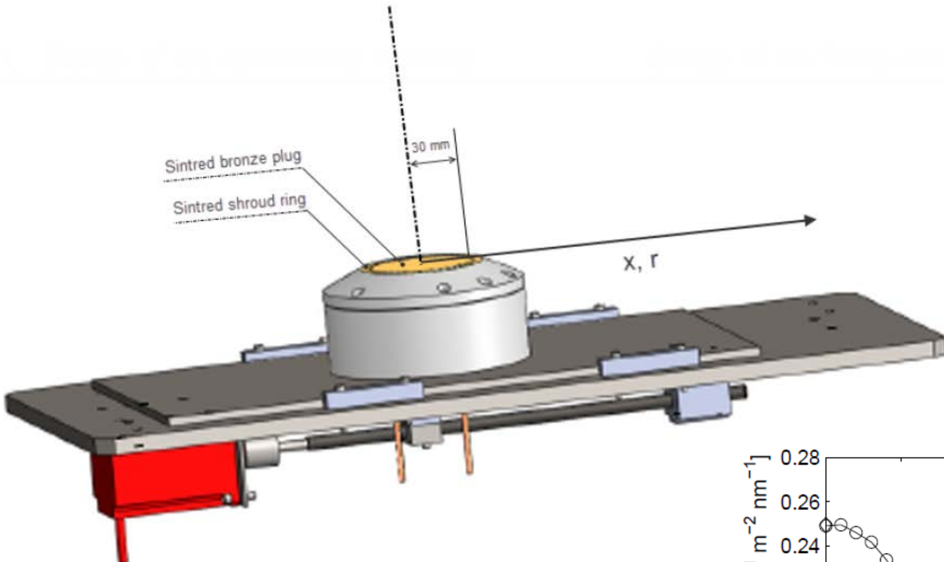


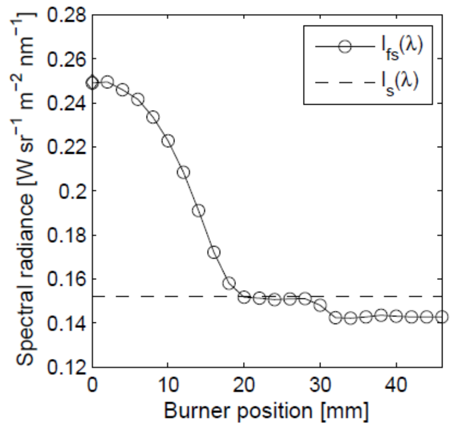
OceanOptics HL-2000
HP-RS-232 Light Source

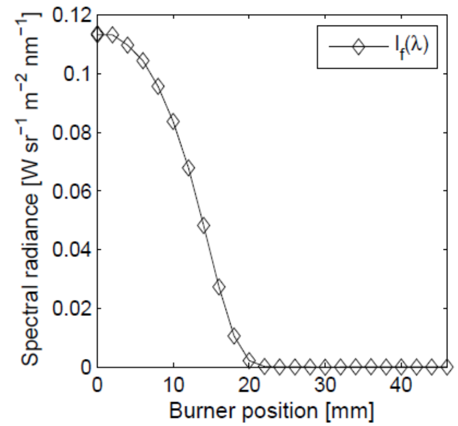


Automatic traversing mechanism

Automatic traversing mechanism



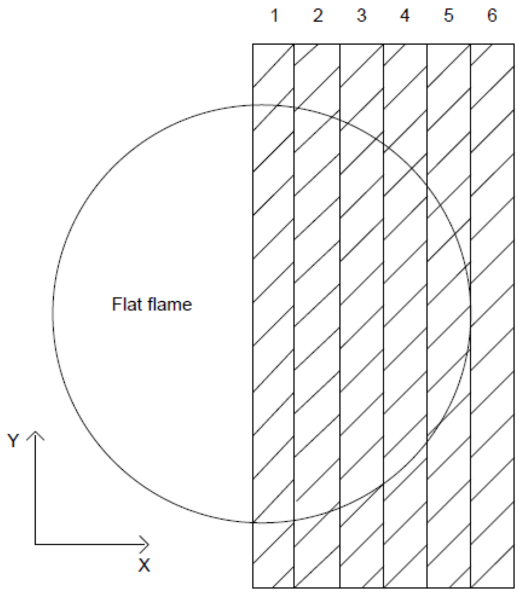


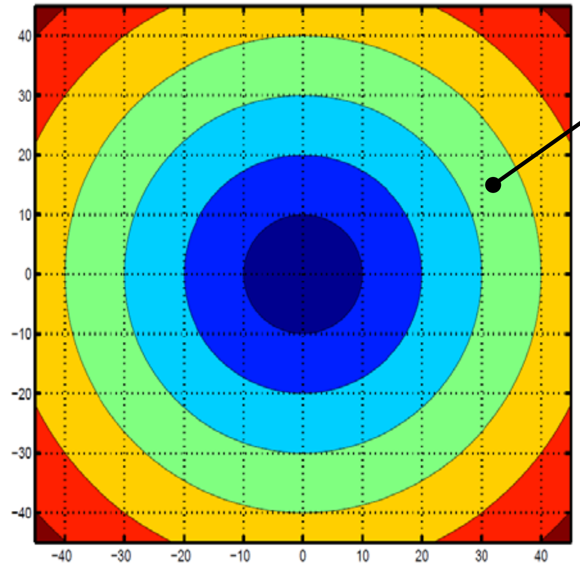


For $r \approx 20$-30mm: No contribution from the flame

For $r > 20$mm: No radiation from the flame

Spatial Tomography





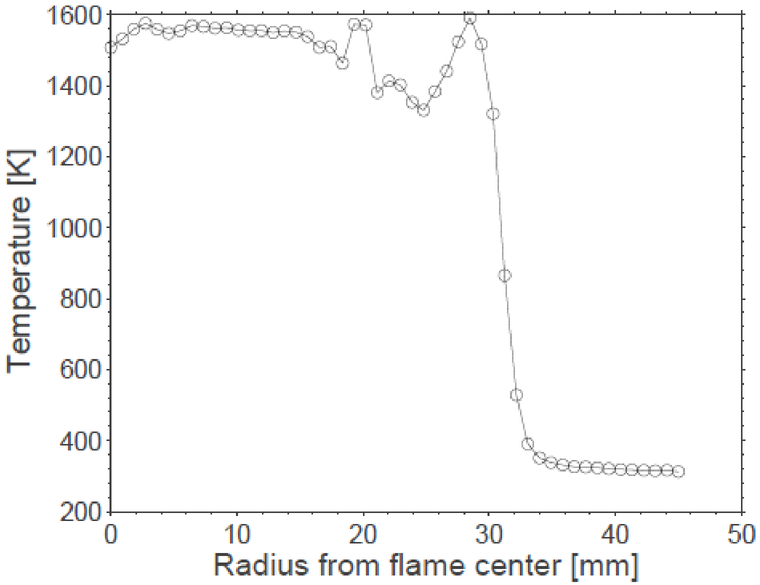
T_{r4}, fv_{r4}

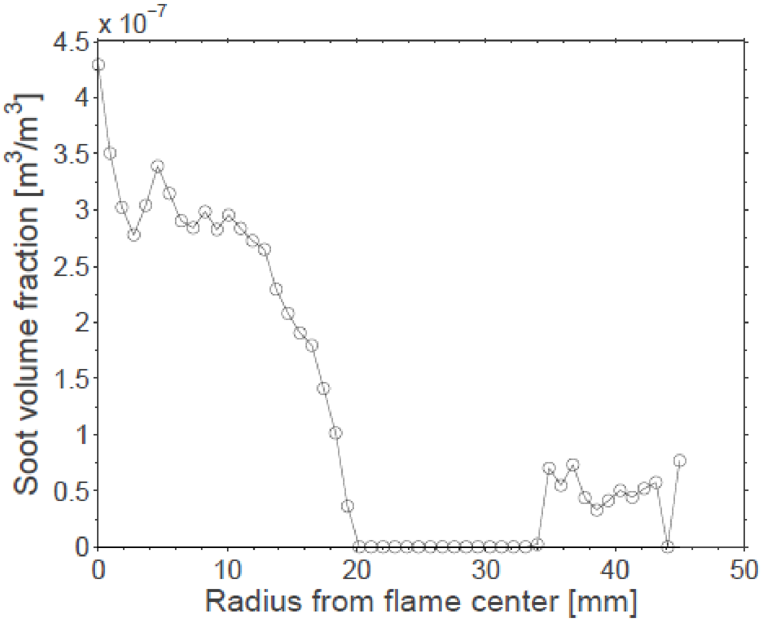
I_x
4
T_x
4

$$I_{fs,i}(\lambda,T_f) = \tau_i(\lambda,T_f)I_{fs,i-1}(\lambda,T_f) + I_{planck,i}(\lambda,T_f)\varepsilon_i(\lambda,T_f)$$

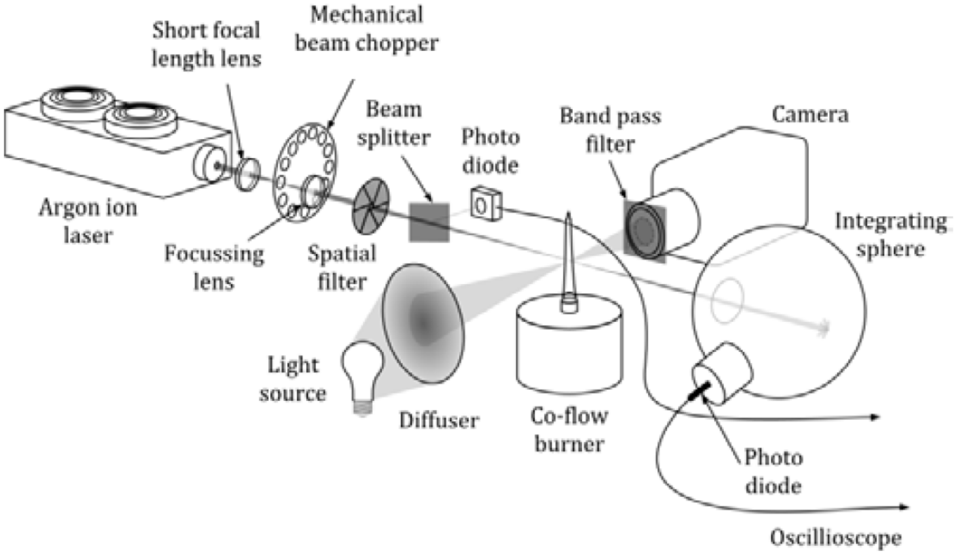
$$f_v = -\frac{ln(\tau(\lambda))\lambda}{K_\lambda(1+\rho_s)L}$$

Spatial Tomography

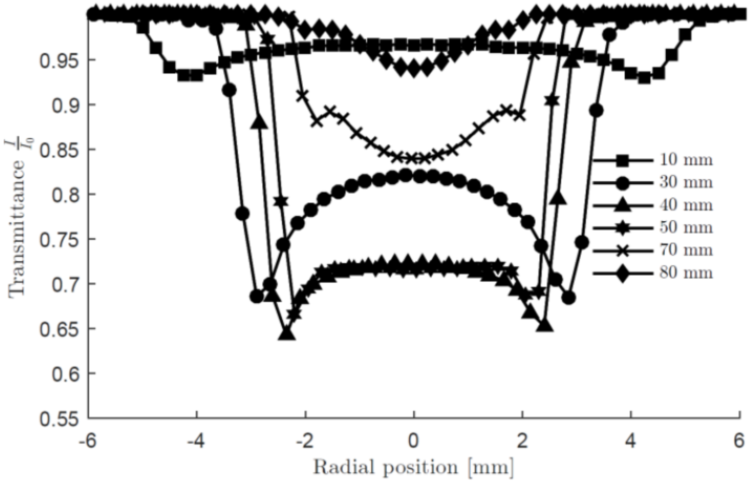


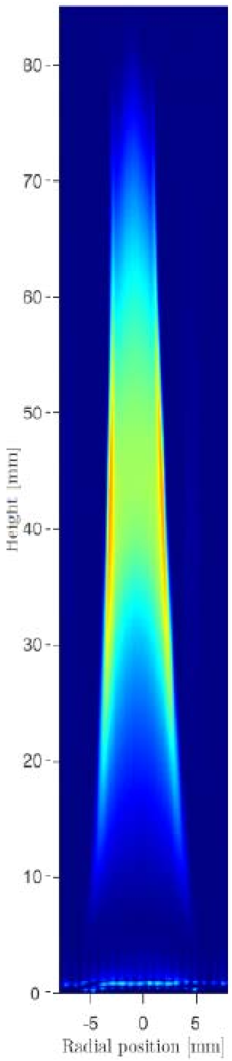


Santoro burner setup

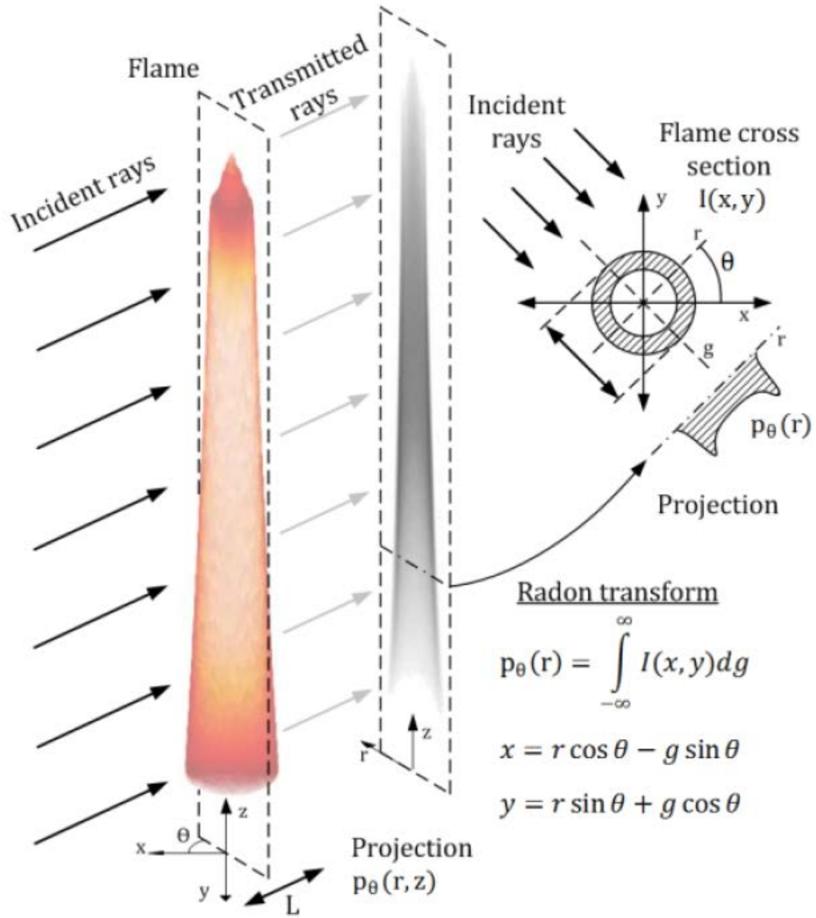


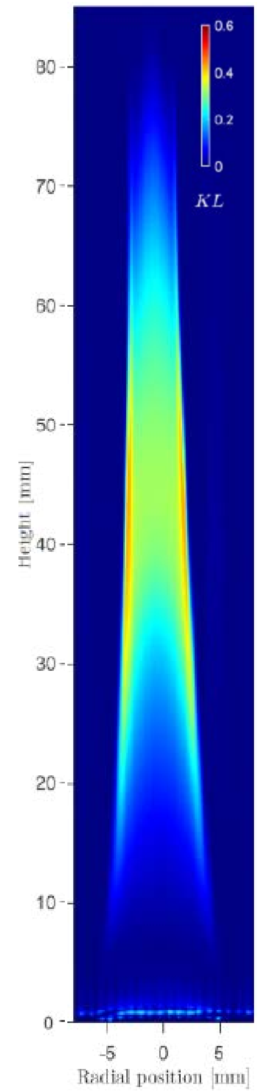
Laser vs. diffuse back-illumination

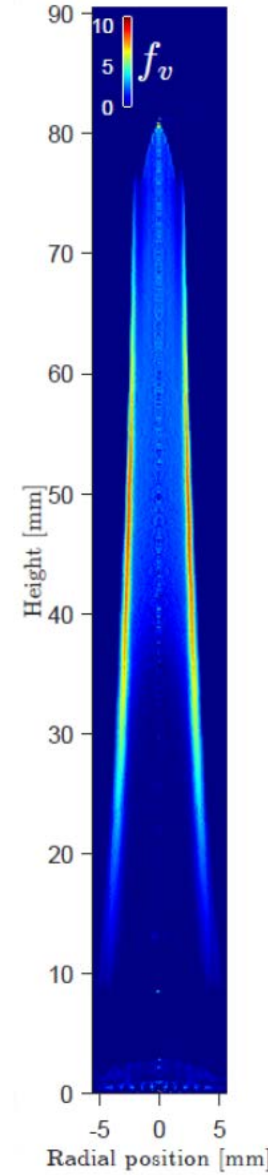




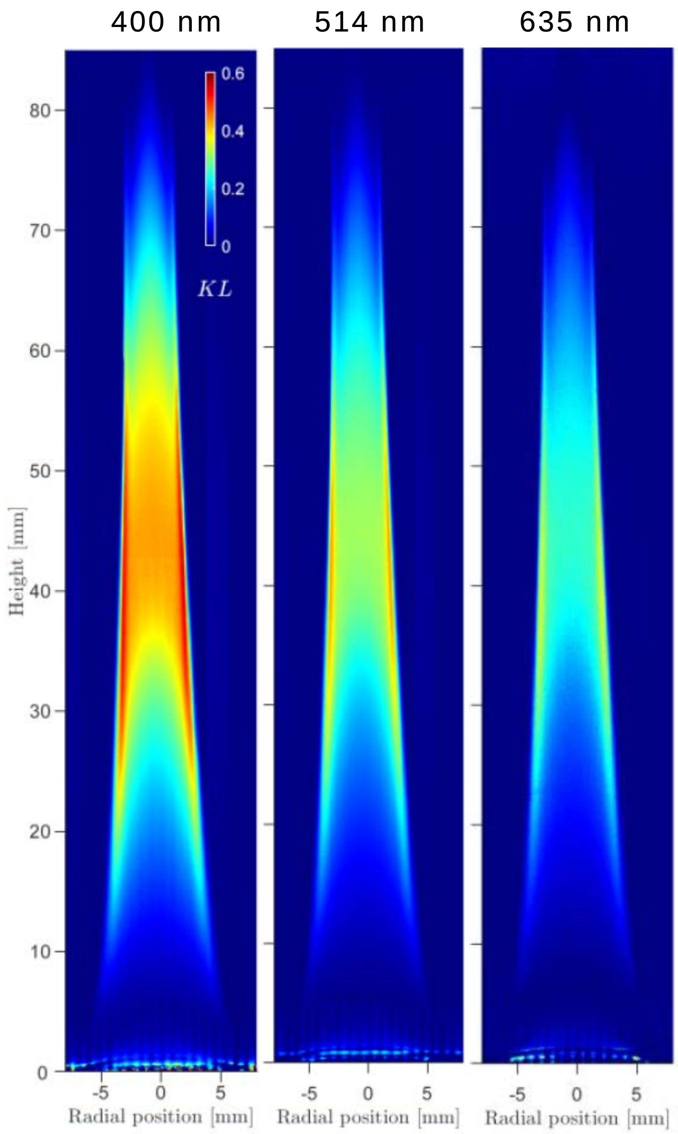
Tomographic reconstruction







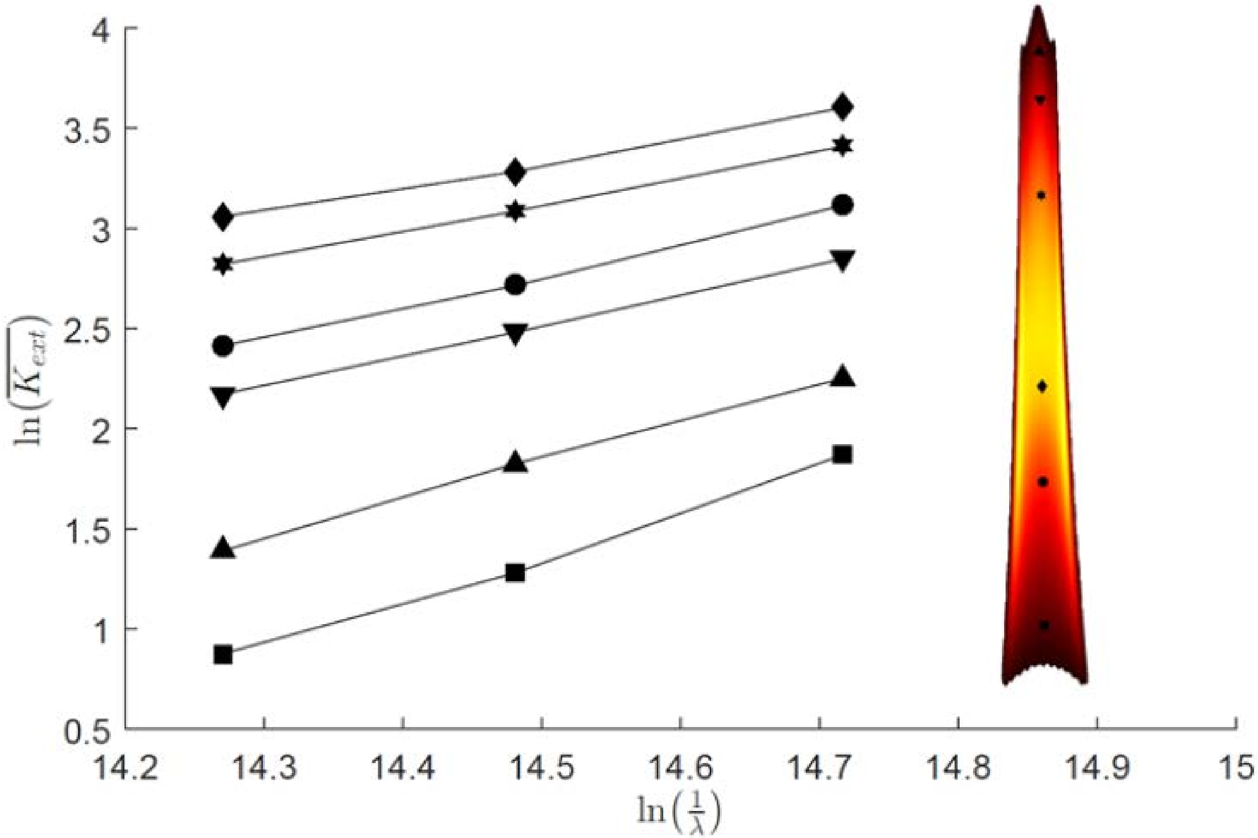
Spectral dependence of optical thickness



$$K_{\text{abs}} = \frac{C f_v}{\lambda^{\alpha}}$$

$$\alpha = -\left(\frac{d \ln K_{\text{ext}}}{d \ln(1/\lambda)}\right)$$

Spectral dependence of dispersion coefficient



Soot maturity