Temperature and CH* Measurements in Laminar Premixed Jet-Wall Stagnation Flames

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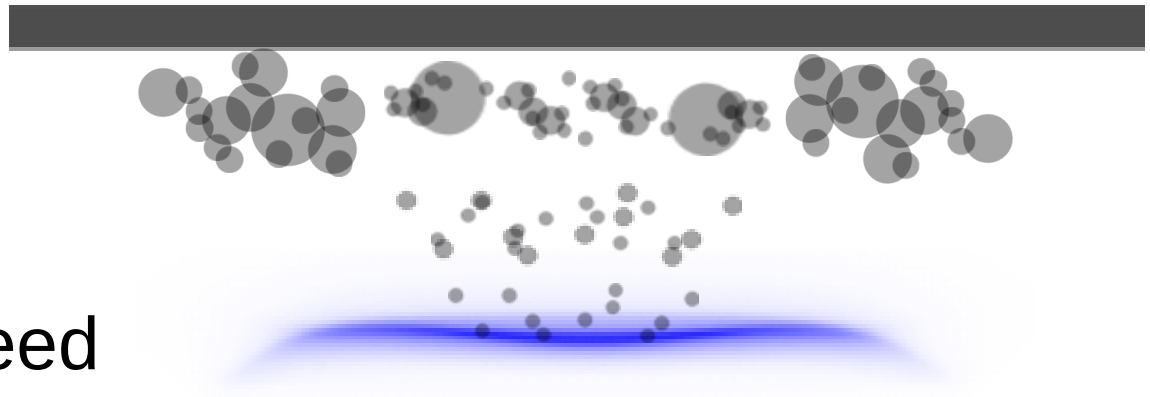
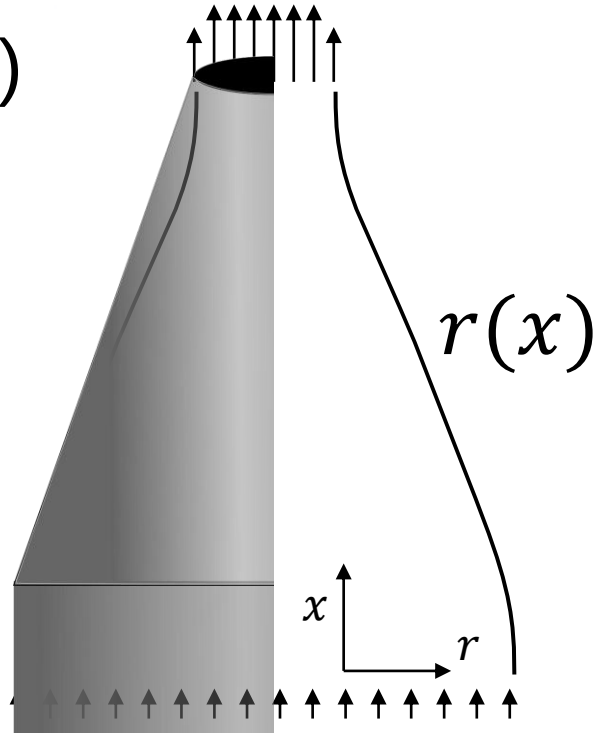
Jet-Wall Stagnation Flames



Flame Uses:
Laminar Flame Speed
Mechanism Development
Chemical Pathway (CH, NO_x)
Particle Synthesis



Nozzle Purpose:
accelerate laminar flow;
min(boundary layer)

Nozzle Design:
1D boundary layer
optimise shape parameters

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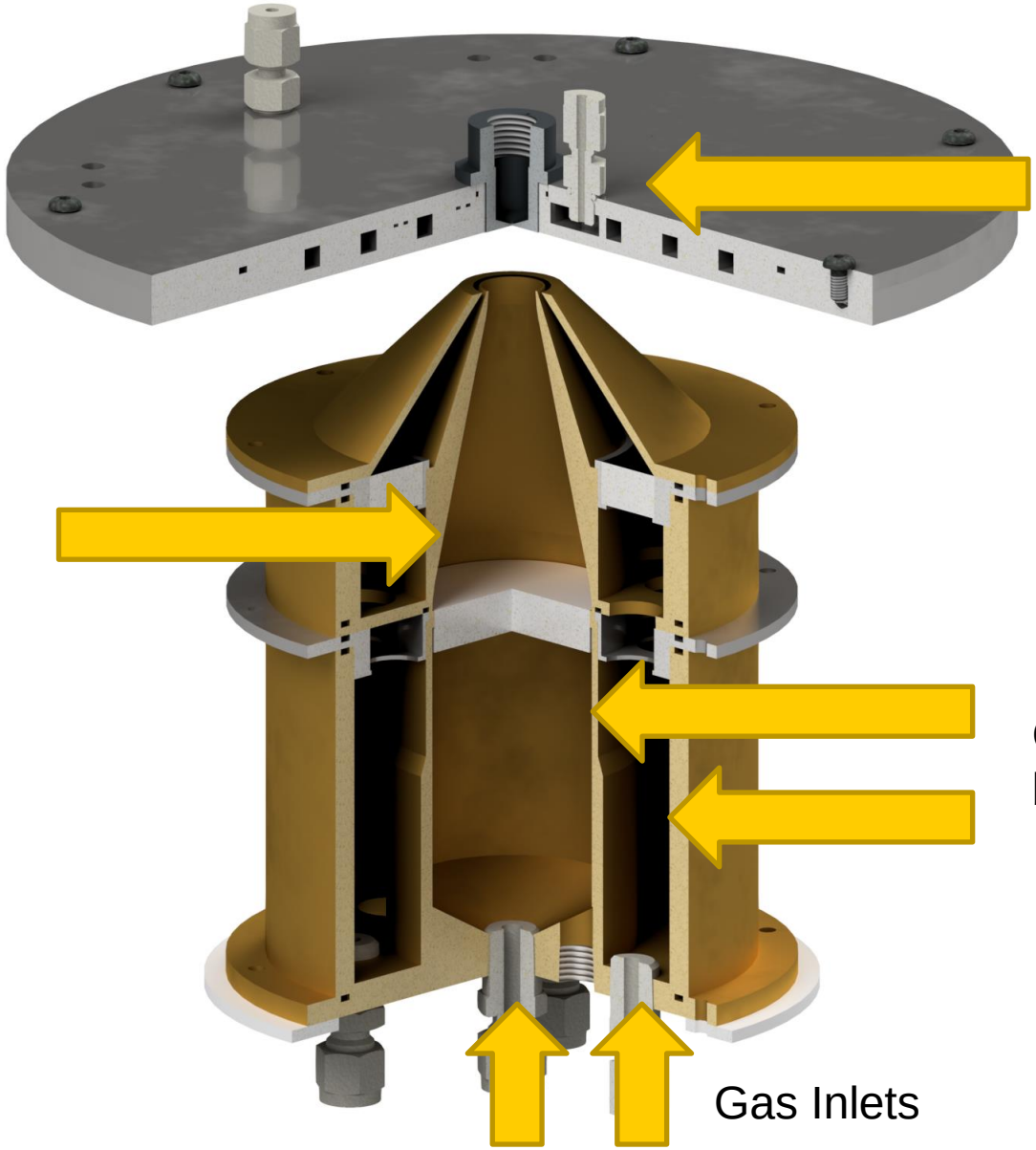
Cambridge CARES Burner



Water-cooled Stagnation plate

Aerodynamic nozzle

Chambers filled with glass beads (to homogenise flow)

Gas Inlets

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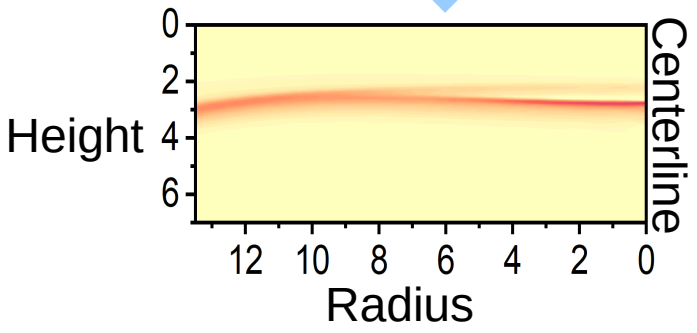
2D Flame Characterisation

CH* Chemiluminescence

Inverse Abel Transform

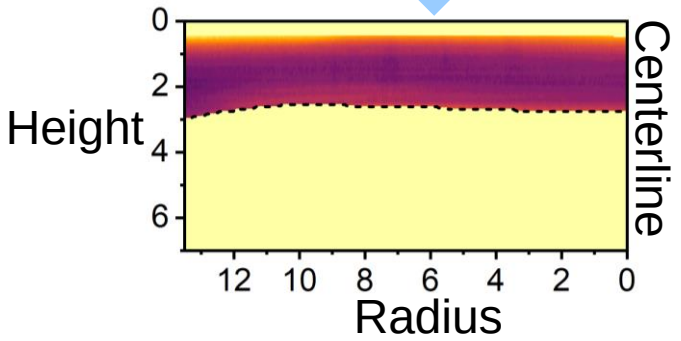


Thin Filament Pyrometry

Calibration

T_{SiC}

Energy Balance



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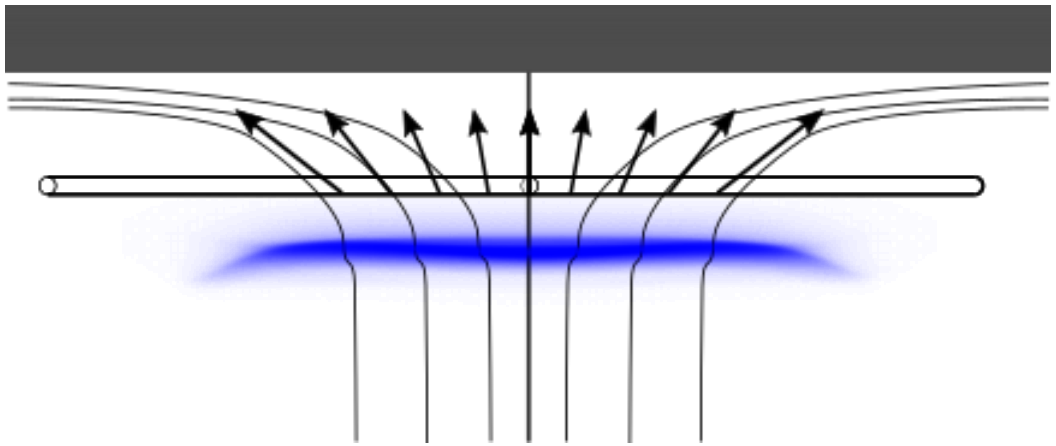
Energy Balance

$$T_{\mathrm{SiC}} \rightarrow T_{\mathrm{g}}$$

Off-centreline flow crosses SiC filament at an angle



Energy balance using correlations for heat transfer over an inclined cylinder

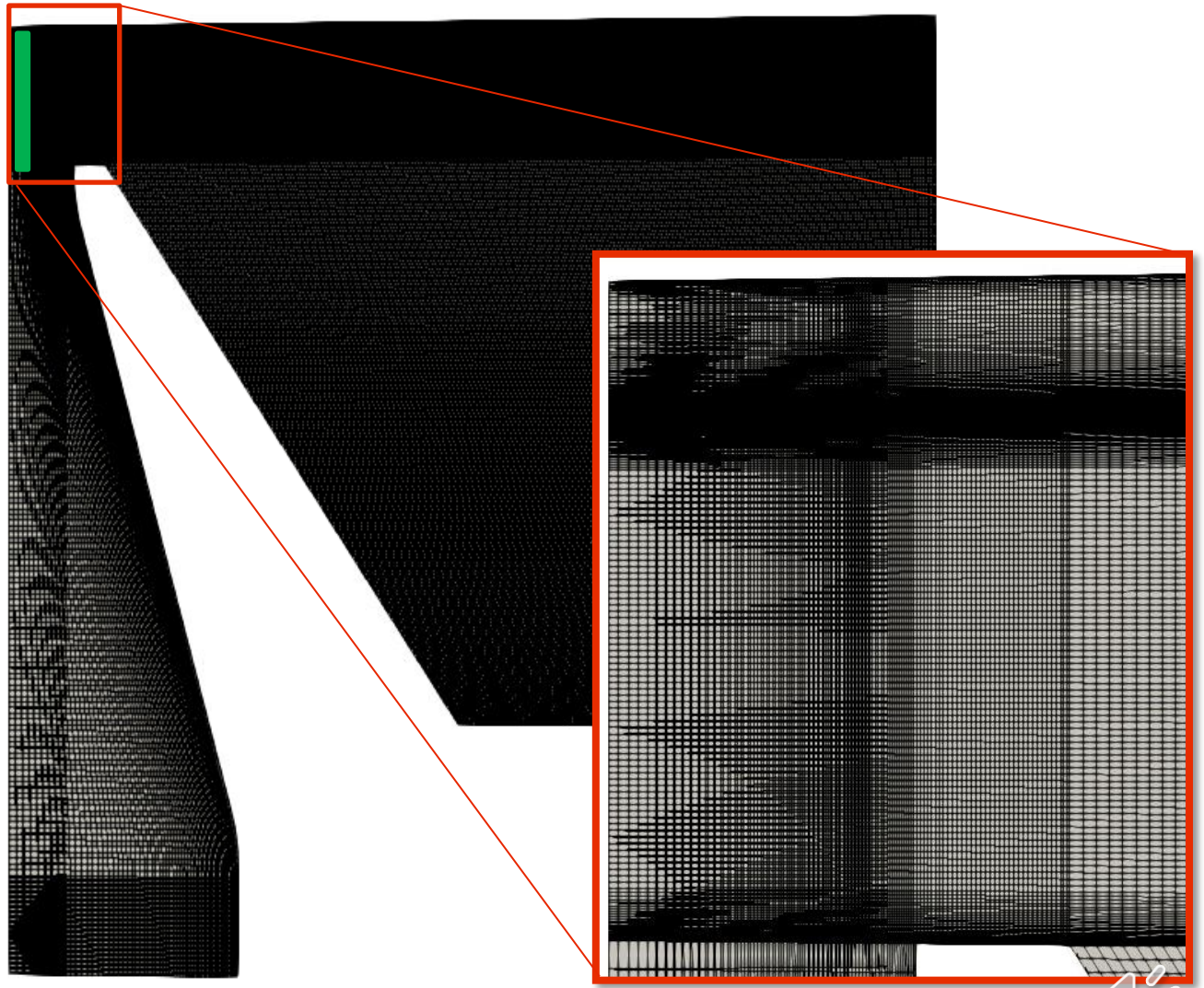
2D simulations provide:
flow field velocity and angle
Multicomponent properties

Modelling

1D Simulations:
Stream function approx.
TWOPNT method

2D Simulations:
Navier Stokes Equations
CFD with PISO Alg.

Models:
Ideal Gas Law, JANAF,
Mixture Avg. Transport,
UCSD Chemistry



Experimental Parameters: $(\phi, U, H/D)$

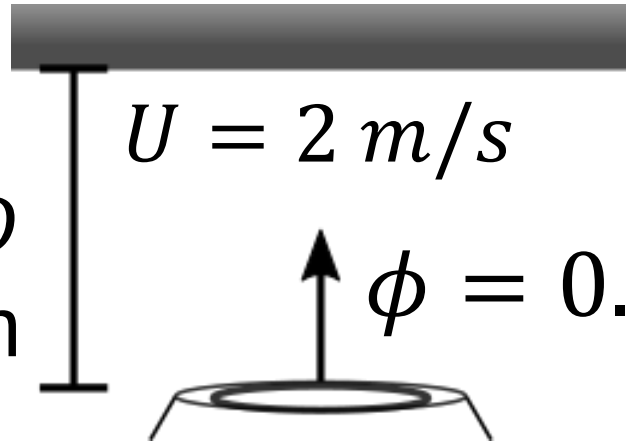
1

$U = 2\ m/s$

$H = D$

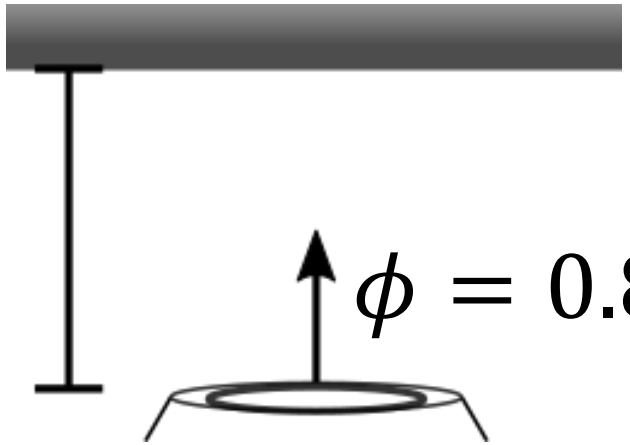
14 mm

$\phi = 0.7$



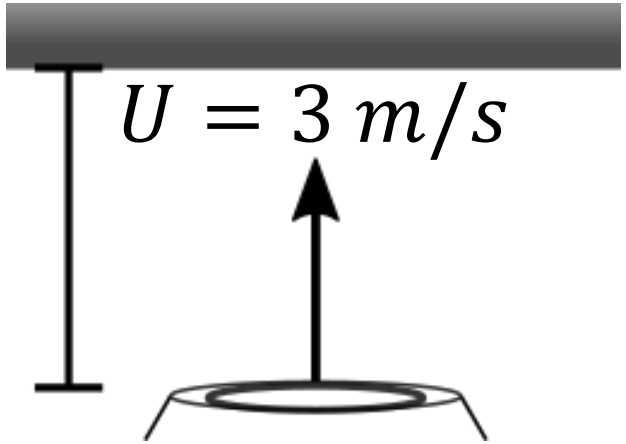
2

$\phi = 0.8$



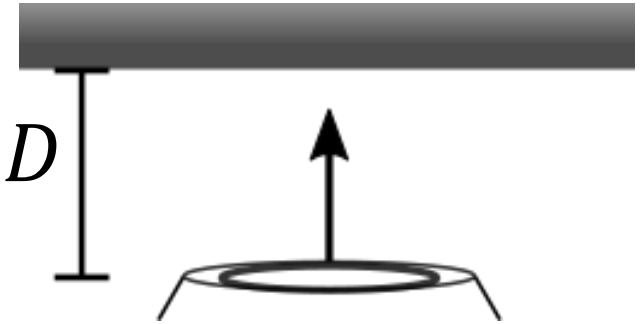
3

$U = 3\ m/s$



4

$H = 0.6D$



ϕ = Equivalence Ratio

U = Premixed Gas Flow Velocity

H/D = Dimensionless Separation

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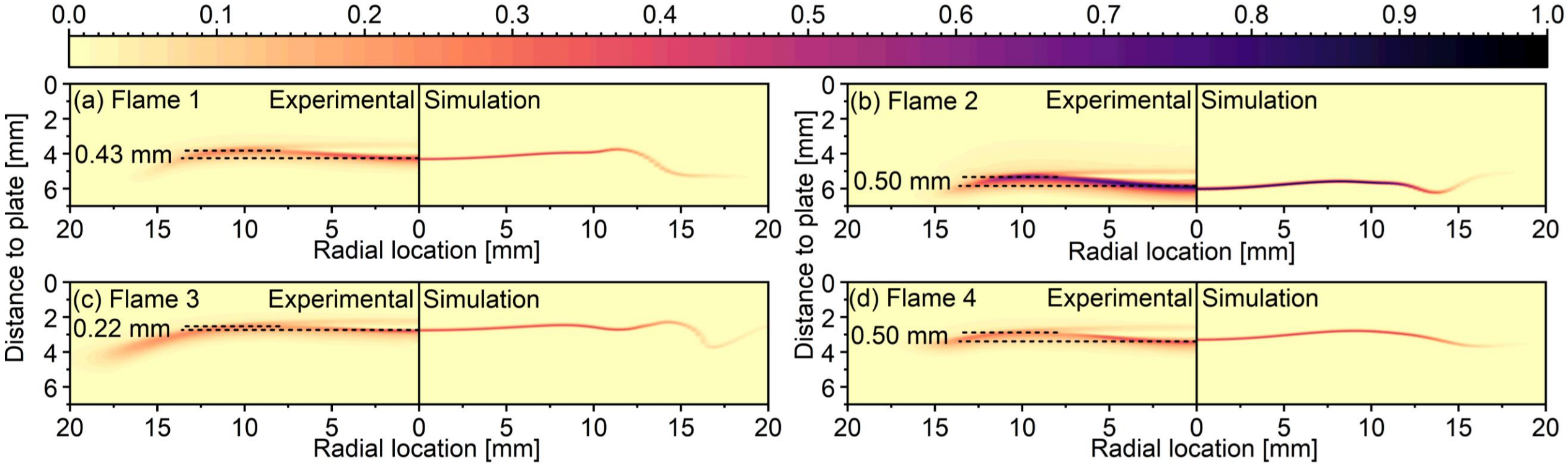
CH* Chemiluminescence



curvature depends on flame-nozzle distance

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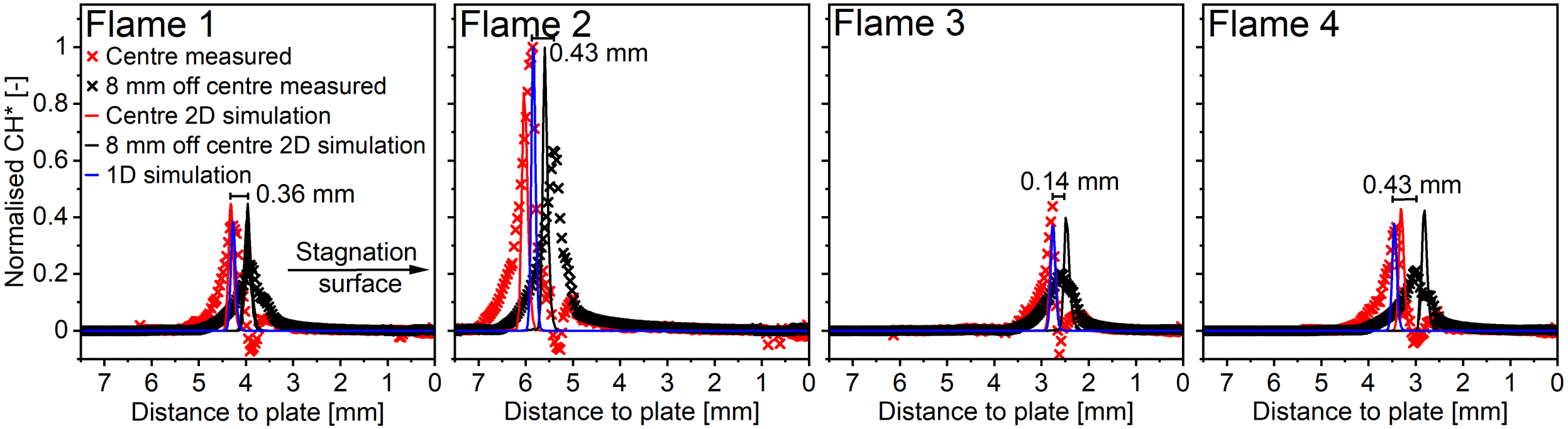
Simulated Flame Shape

2D has simple boundary conditions and is predictive
1D requires strain boundary condition which is guessed



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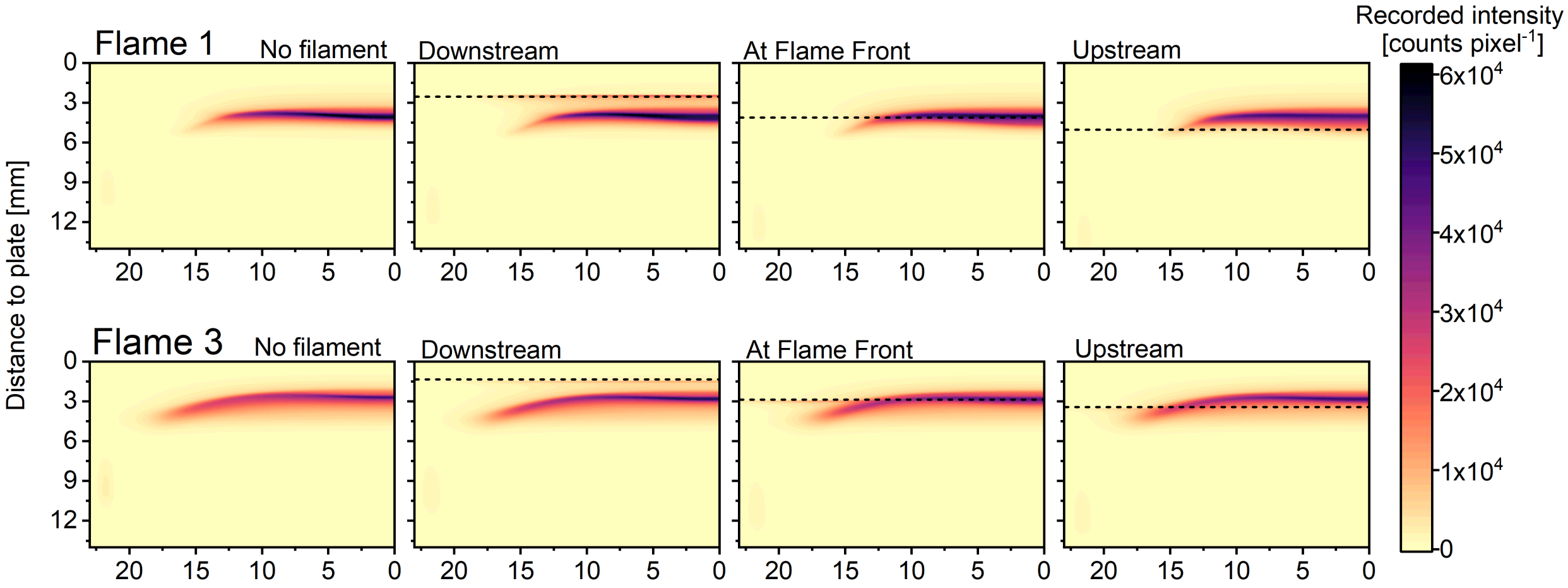
Filament Disturbance

chemiluminescence used to assess filament disturbance



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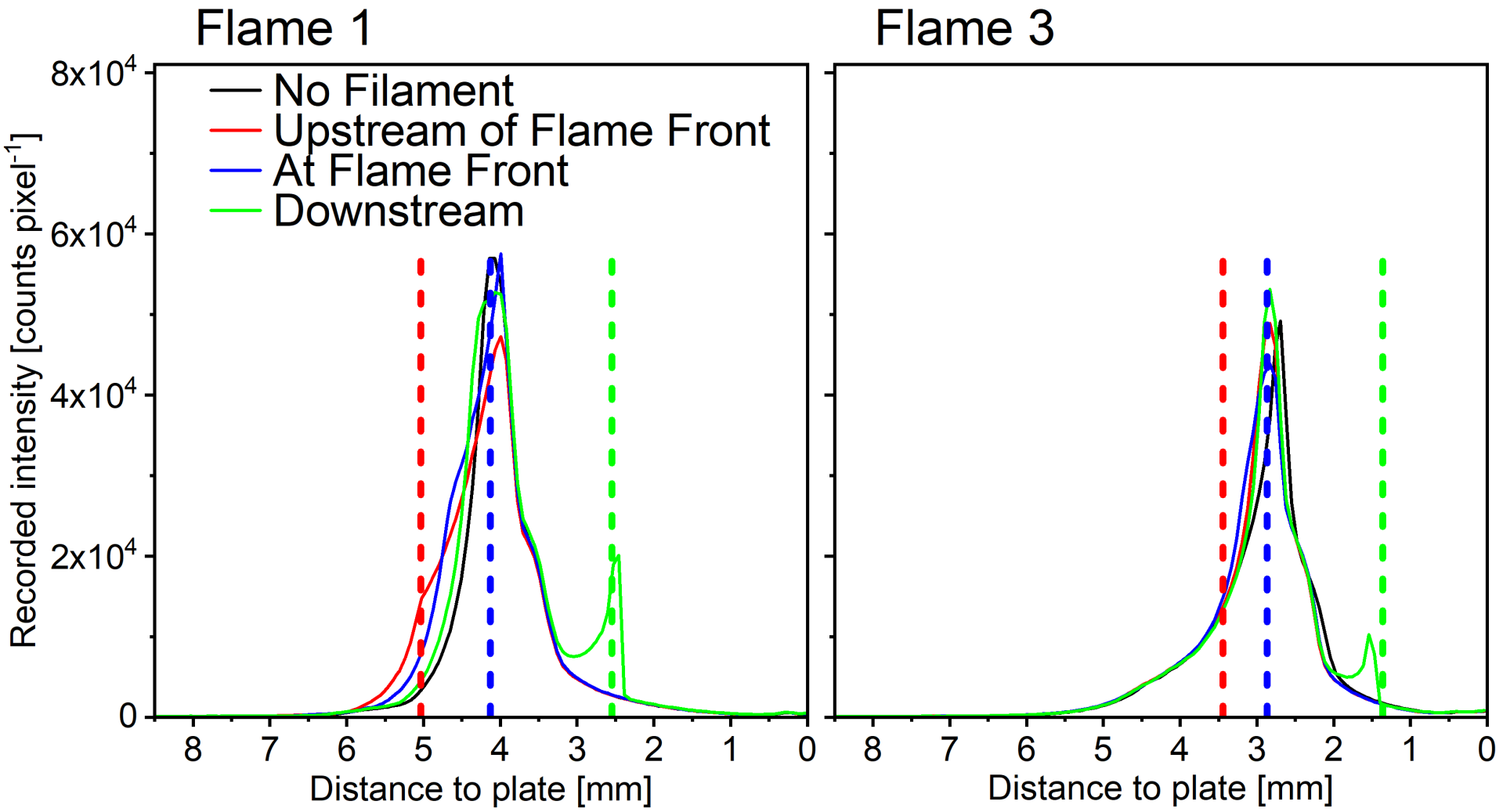
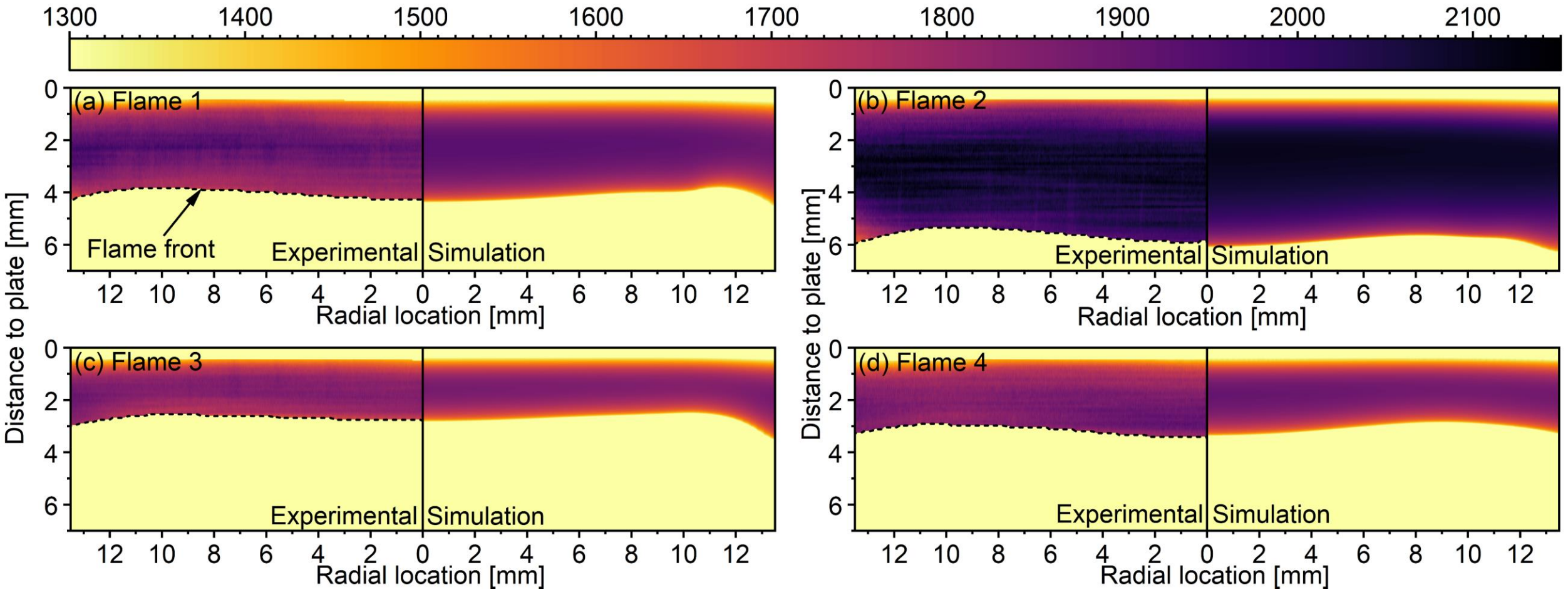
Filament Disturbance

Minimal disturbance from the flame attaching to the filament



Temperature



TFP captures temperature field well downstream, slightly overpredicts flame front

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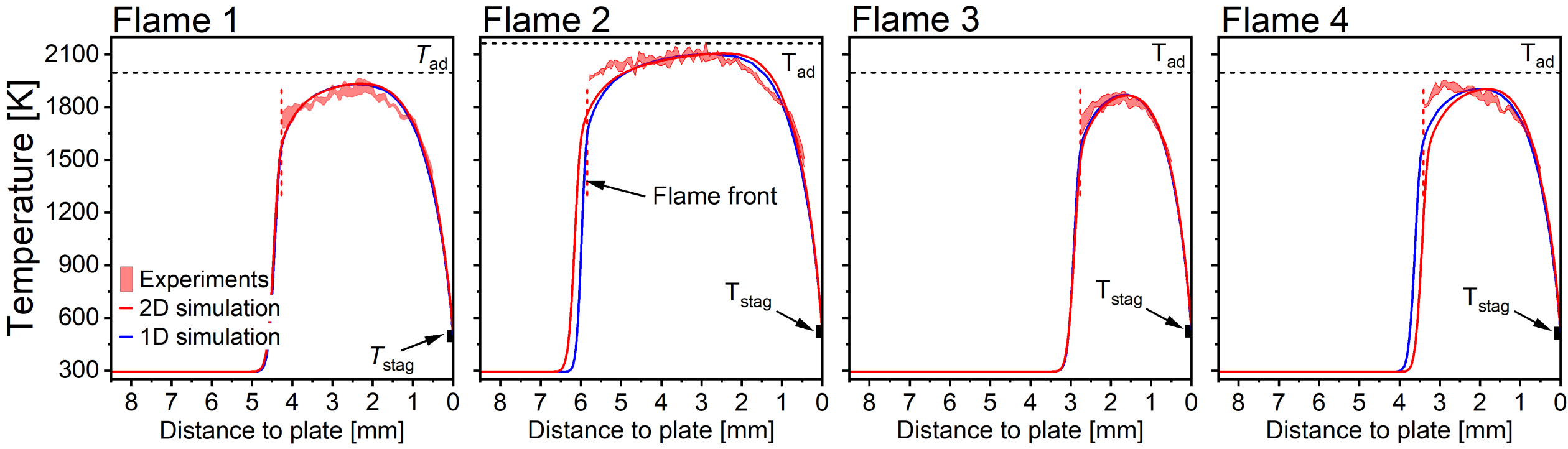
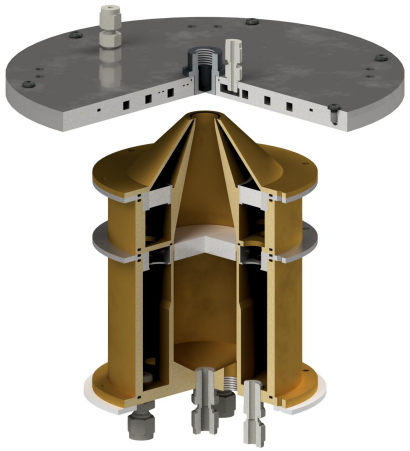
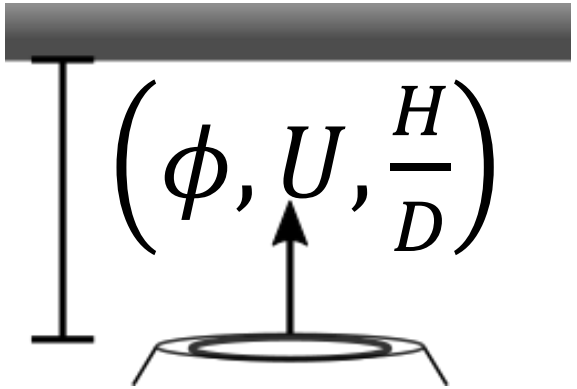
Centreline Temperature

TFP slightly overpredicts flame front temperature

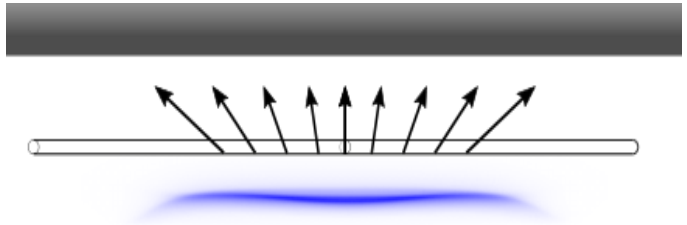


Contributions



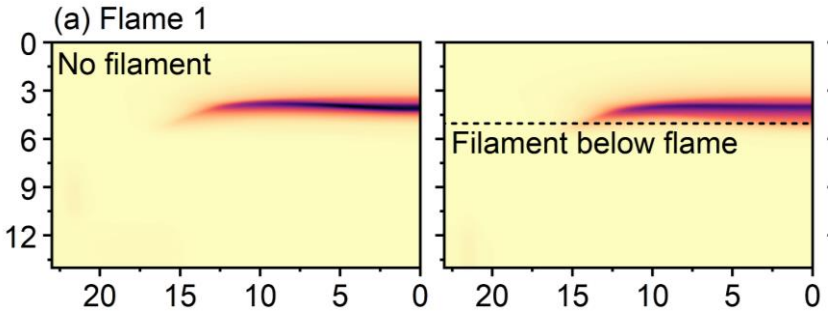


Improved heat balance

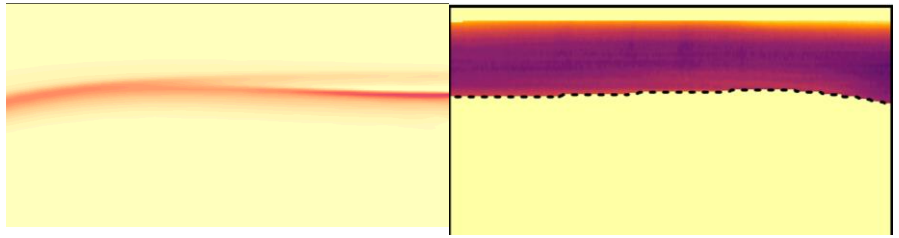


Group:

TFP: Less Disturbance



New Experimental Data



Paper:

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