FACULTY OF ENGINEERING AND ARCHITECTURE

FLAME EXTINCTION AND CARBON MONOXIDE EMISSIONS IN COMPARTMENT FIRES

Boris Kruljevic, Ivana Stankovic and Bart Merci

Ghent University – Belgium

Research Group – Combustion, fire & fire safety

Pretref

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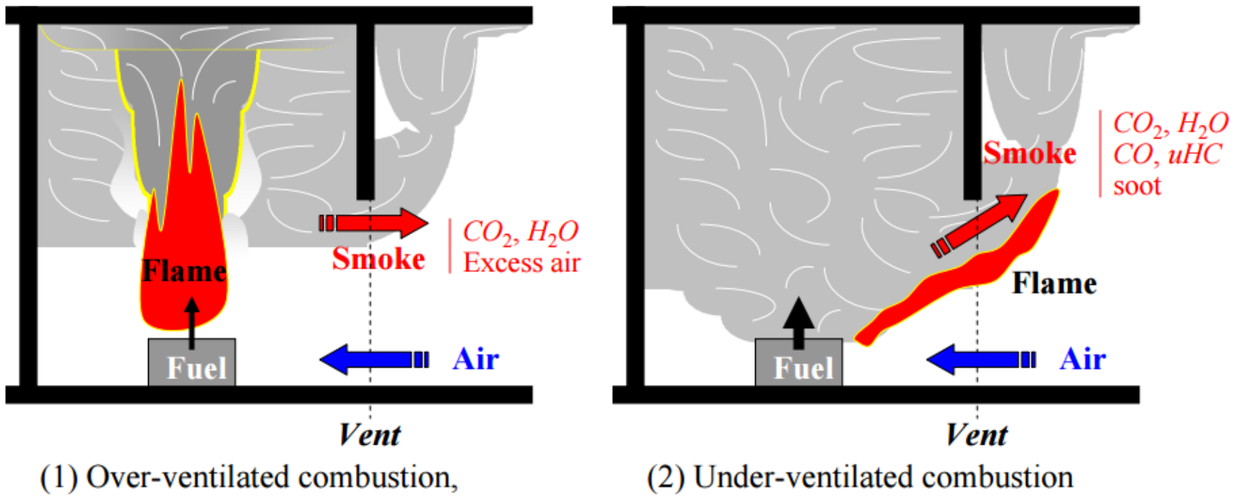
RESEARCH GOALS

1. Extinction

- Promoted by a vitiated environment
- Strong impact of radiation on extinction in fires

2. CO production

- Lack of oxygen promotes CO production
  → CO is a product of incomplete combustion
- Extinction also promotes CO production, due to incomplete combustion



(1) Over-ventilated combustion, (2) Under-ventilated combustion

Under-ventilated conditions promote CO production and flame extinction

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MODELLING ISSUES

Extinction Modelling

- Turbulence
- Chemistry
- Radiation

Coupled! Difficult to model!

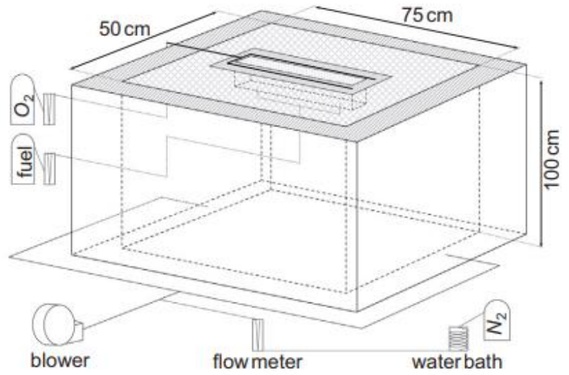
Conditional Moment Closure Method - very rarely tested in fire scenarios, due to large domains!

Compartment Fires

- Turbulence, radiation, reactions (chemistry)
- Fuel? Pyrolysis, evaporation
- Confined space – wall interactions
- Meshing issues – domain size?

Too complex, a simple configuration is initially tested

The UMD line burner



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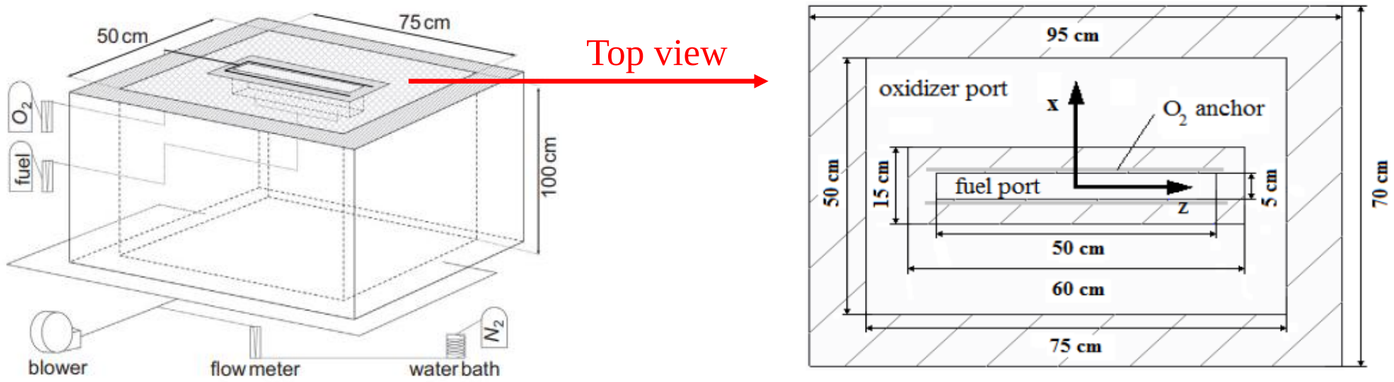
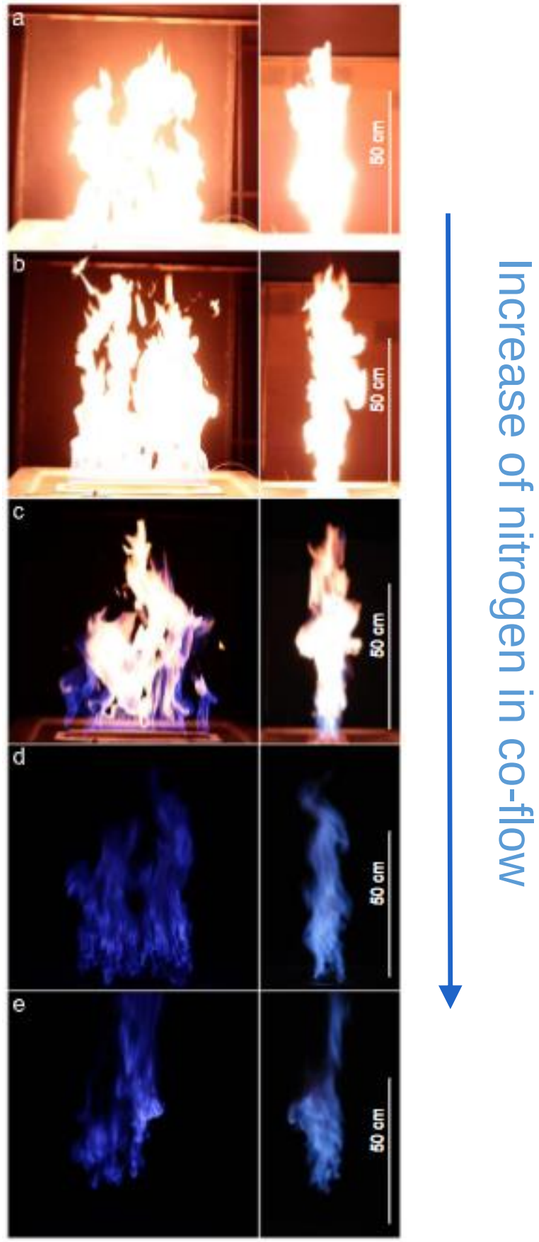
PRELIMINARY TESTING – UMD LINE BURNER

UMD Line Burner

- Developed to study fire extinction
- Methane-fueled diffusion flame, with a controlled co-flowing oxidizer
- Co-flow – water mist/**nitrogen**
- Open domain – no wall interactions



Experimental Set-up



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LES-CMC COUPLING

Mass

Momentum

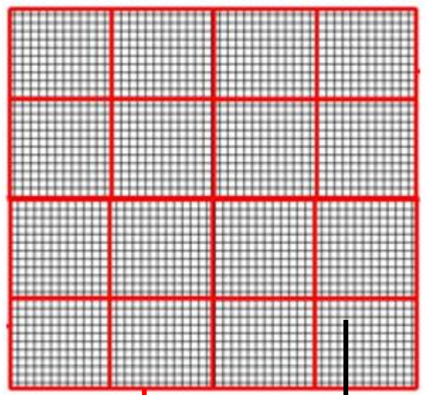
Mixture Fraction

Mixture Fraction Variance

Scalar Dissipation Rate

LES

OpenFOAM



CMC

LES

Conditional Species

Conditional Total Enthalpy

CMC

Stand-Alone Fortran Code

Conditional equations are solved on a coarser mesh!

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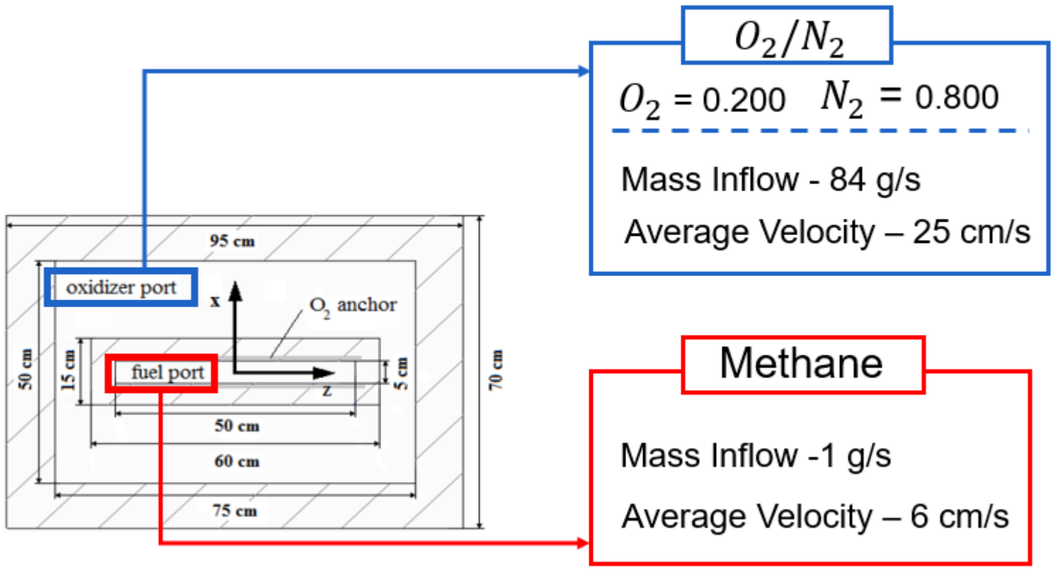
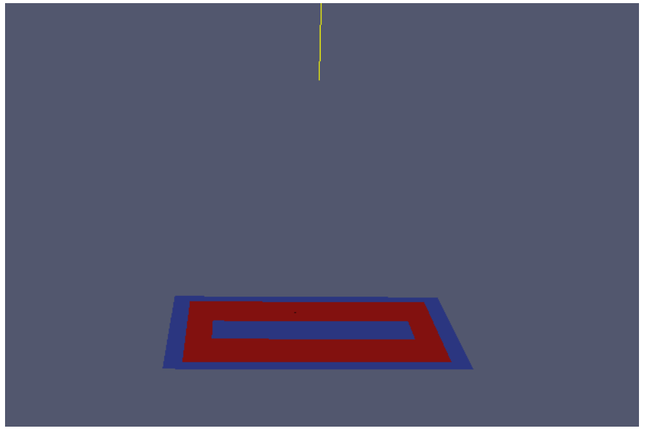
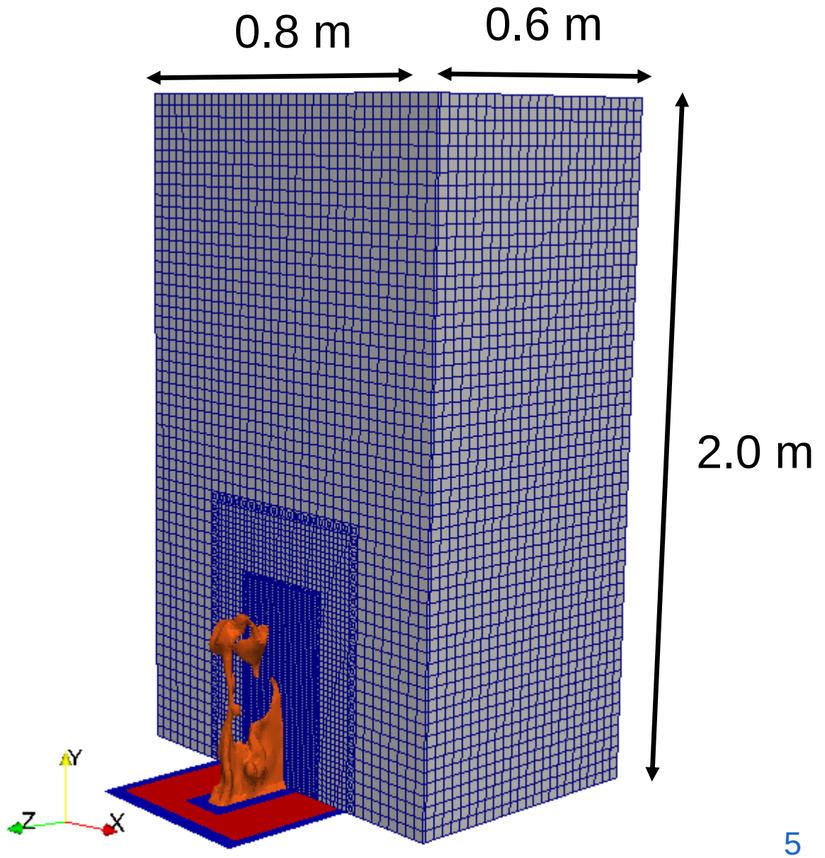
NUMERICAL SET-UP

- **Computational mesh – 1 156 868 cells (10 387 CMC cells)**
  - 2 zones of local mesh refinement
  - Cell width in finest region – 3.6 mm
  - Time to reach 20 s
    - About 5 days with a one-step mechanism
    - About a month with the ARM2 mechanism







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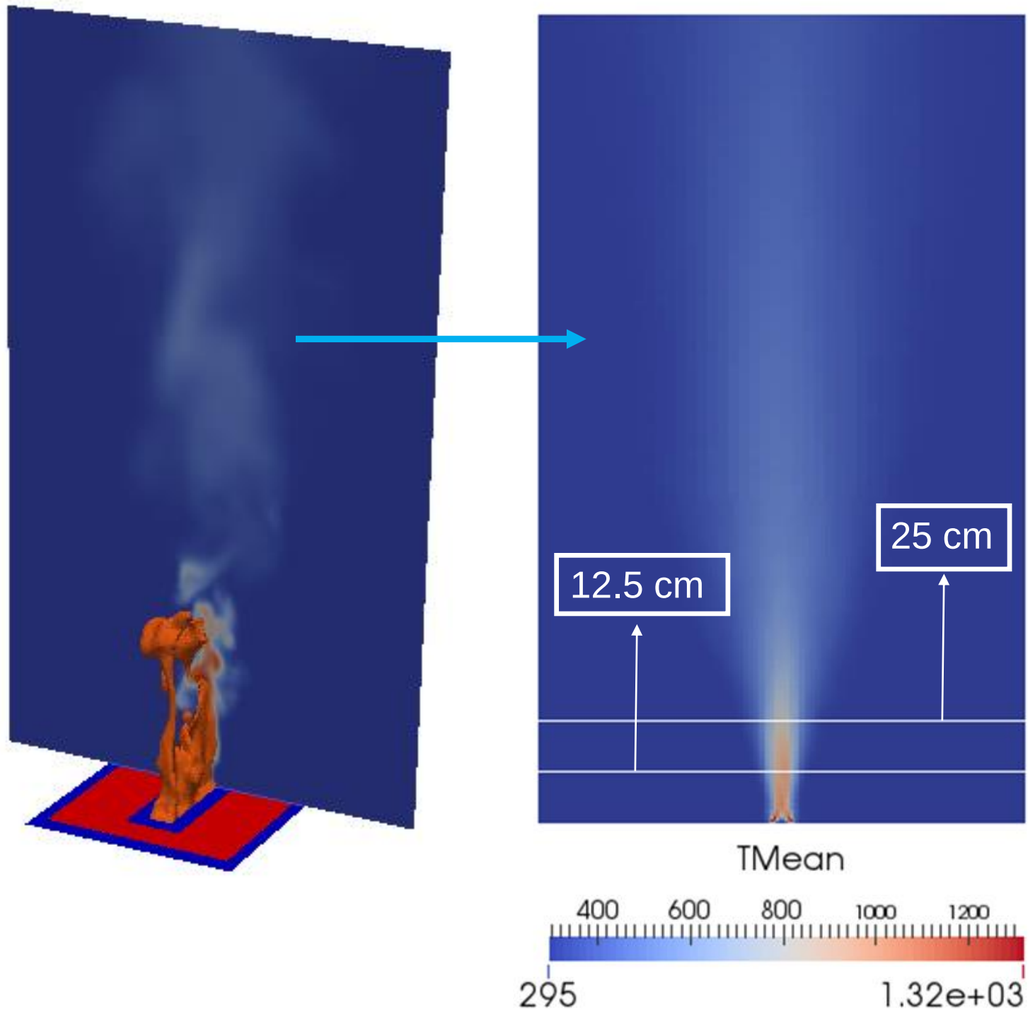
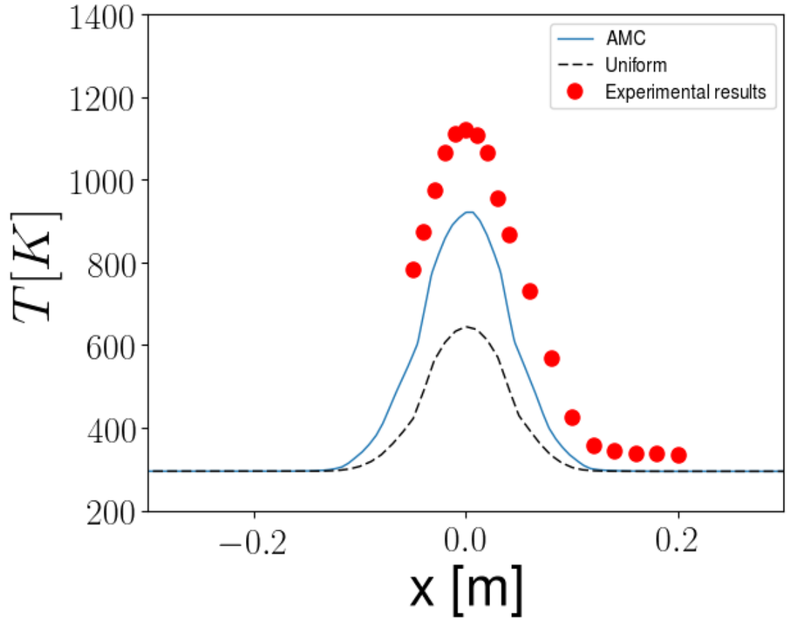
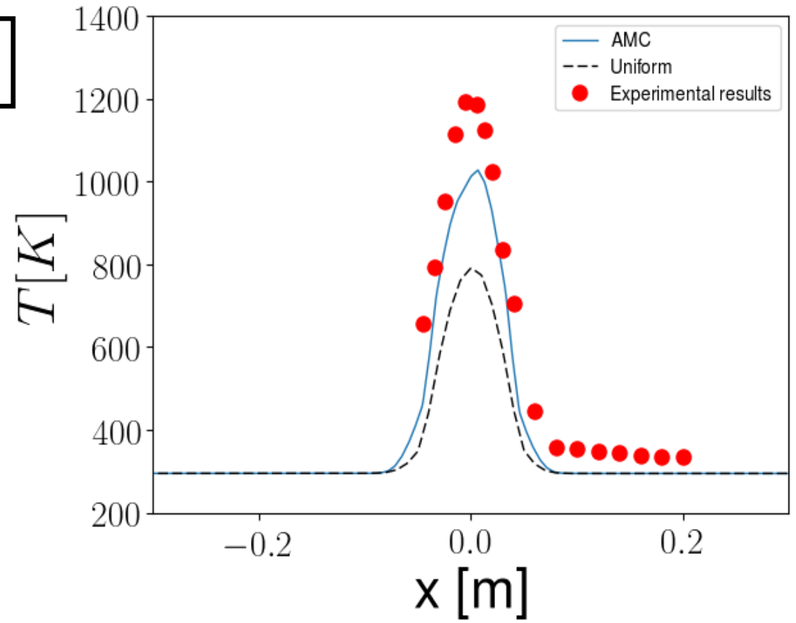
IMPACT OF MIXING MODELS



25 cm



12.5 cm



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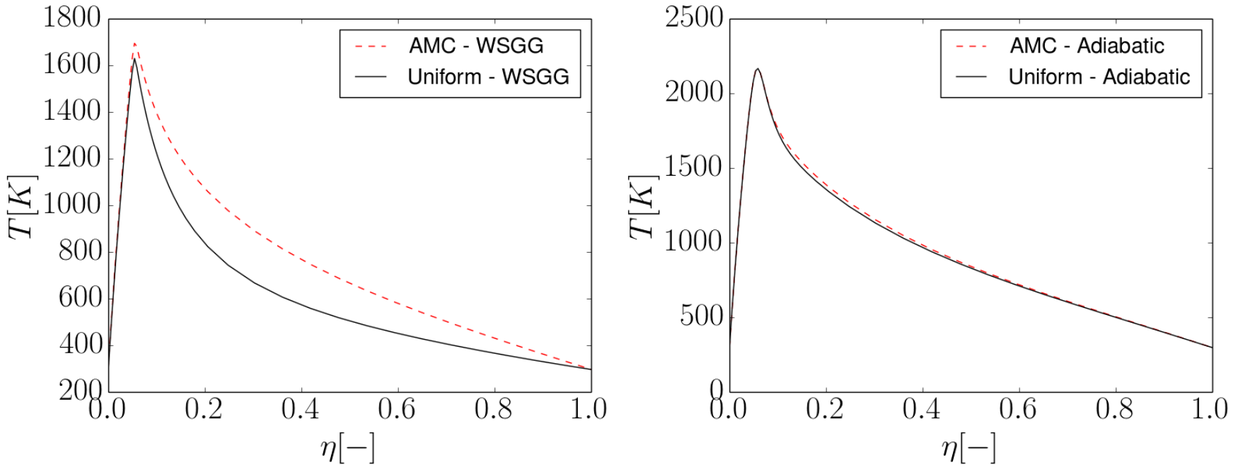

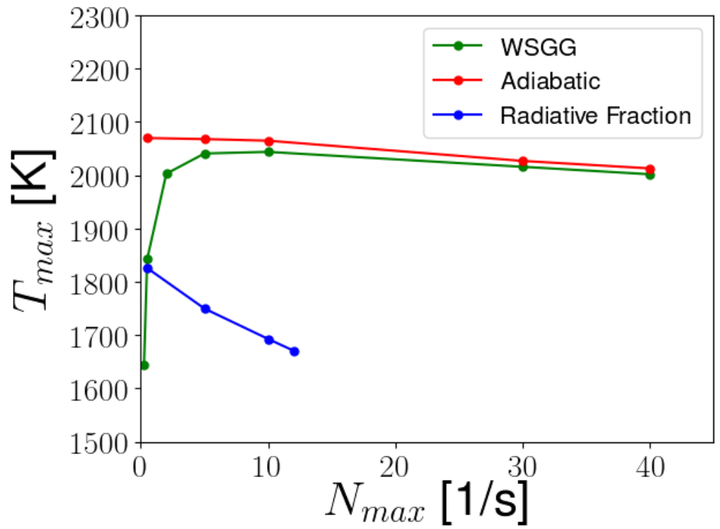

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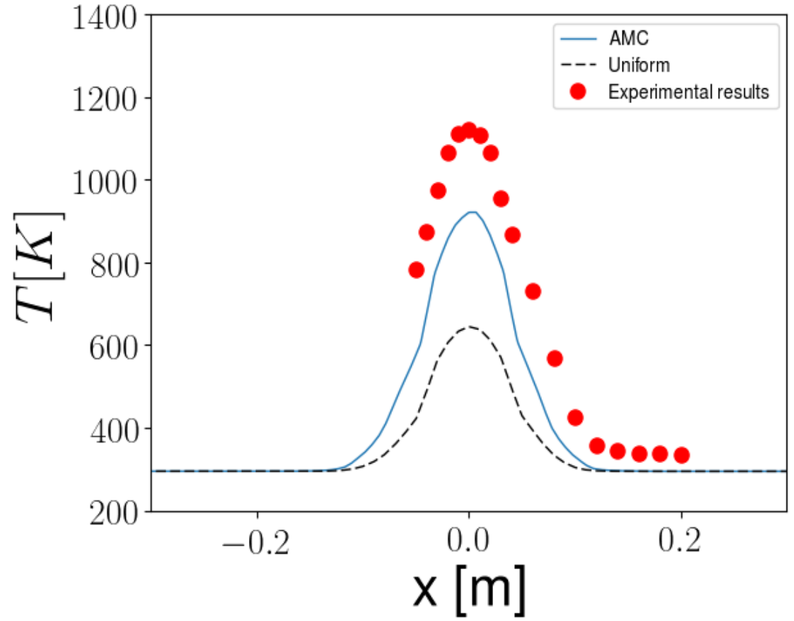

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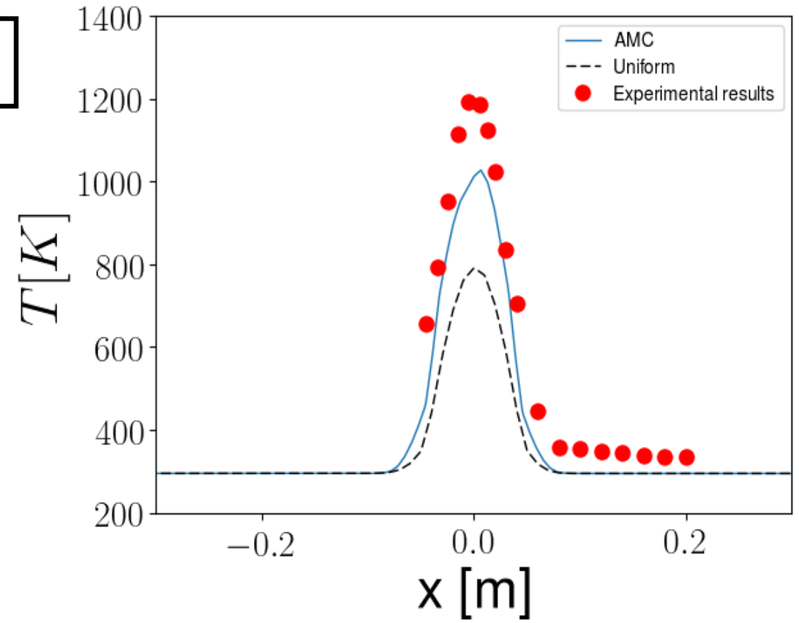

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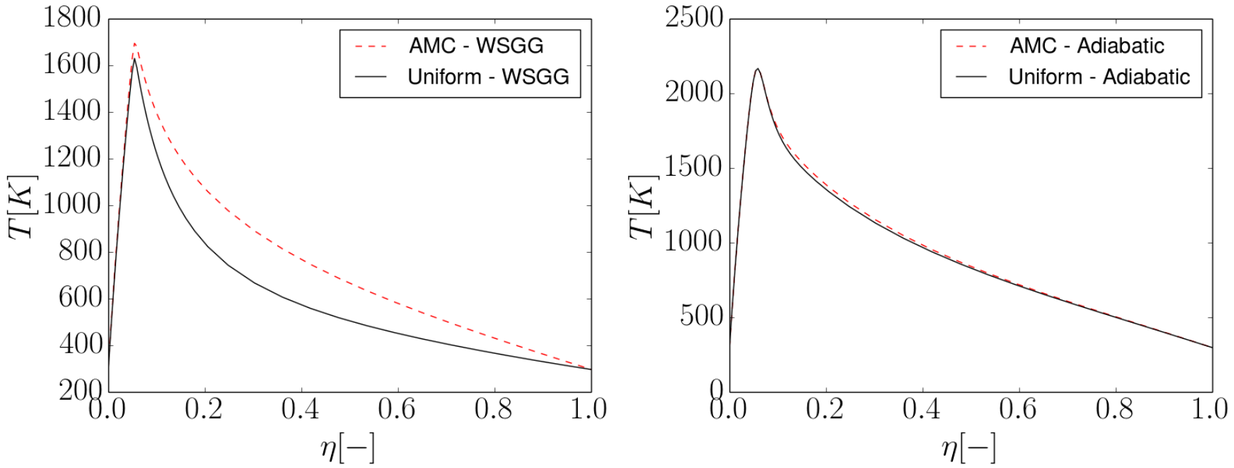
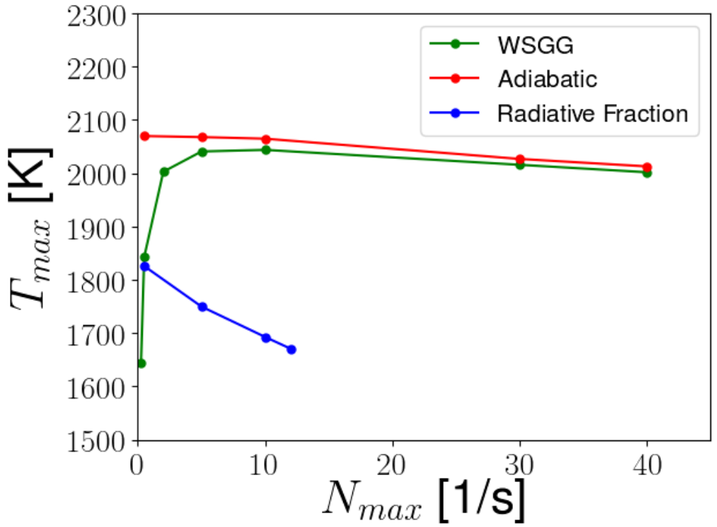
RADIATIVE FRACTION MODEL





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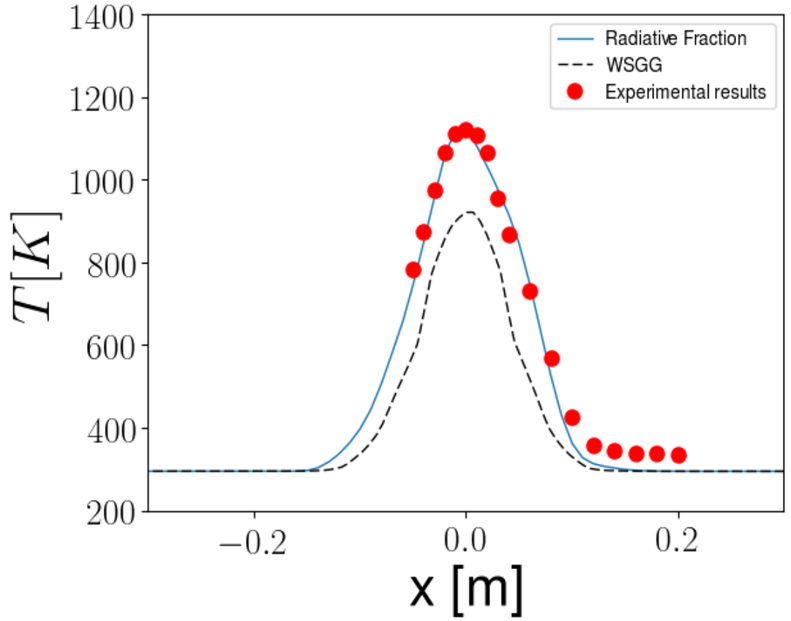

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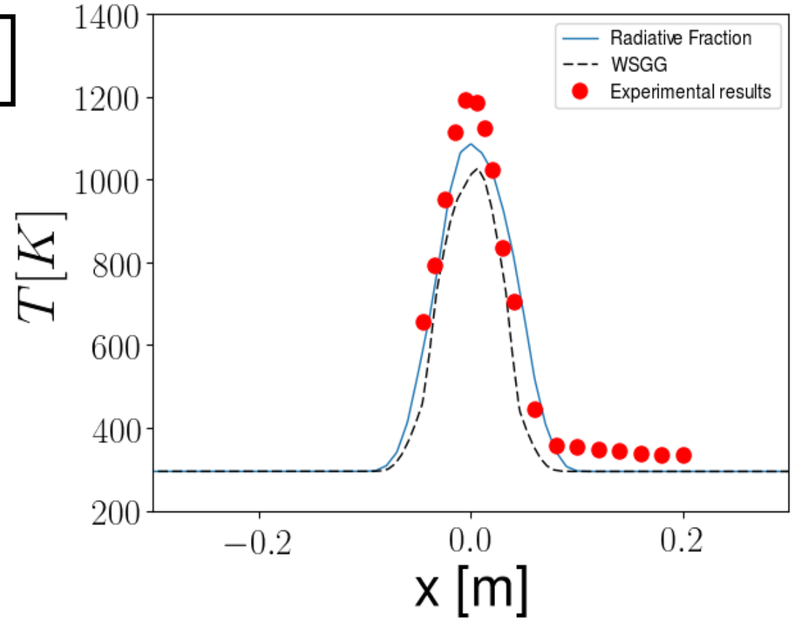

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