

Two-phase free jet model of an atmospheric entrained flow gasifier

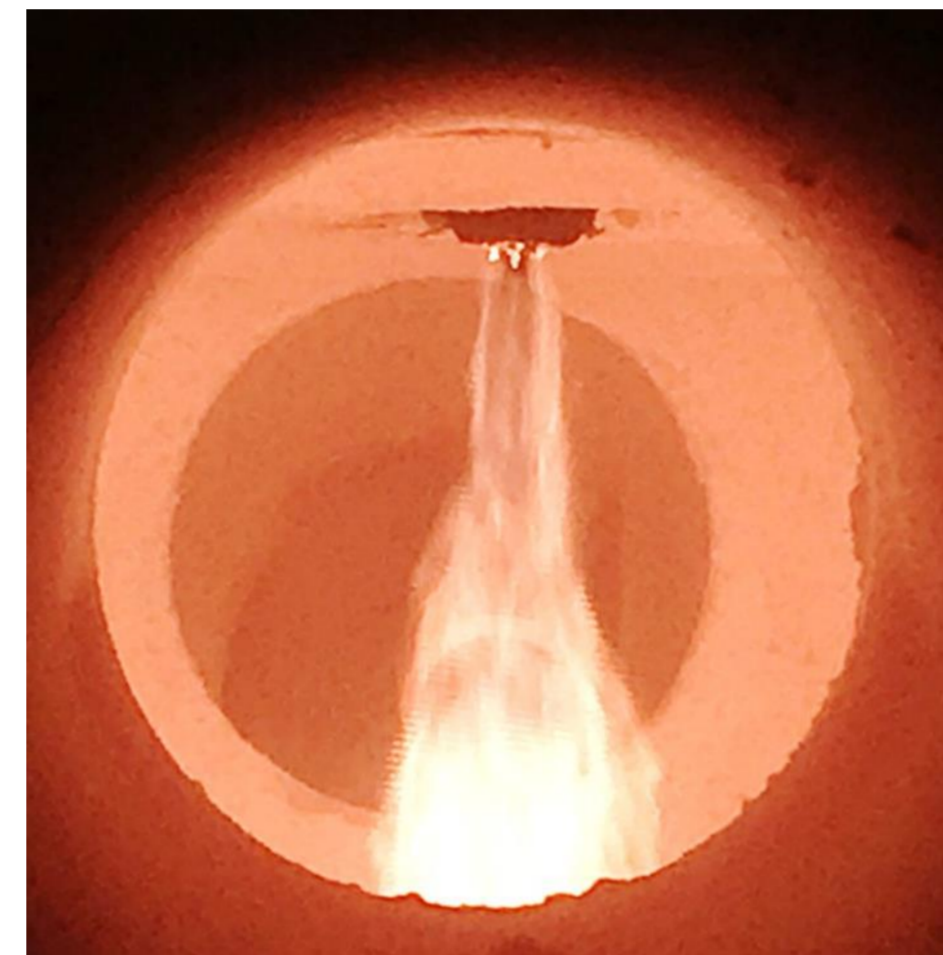
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Challenge

Modeling reacting multi-phase free jet system using an analytical solution of turbulence model

Objectives

- Sensitivity analysis of process parameters
- Comparison of different sub-process models and evaluation of their performance under EFG conditions
- Determine process conditions for evaporation, secondary pyrolysis and char gasification

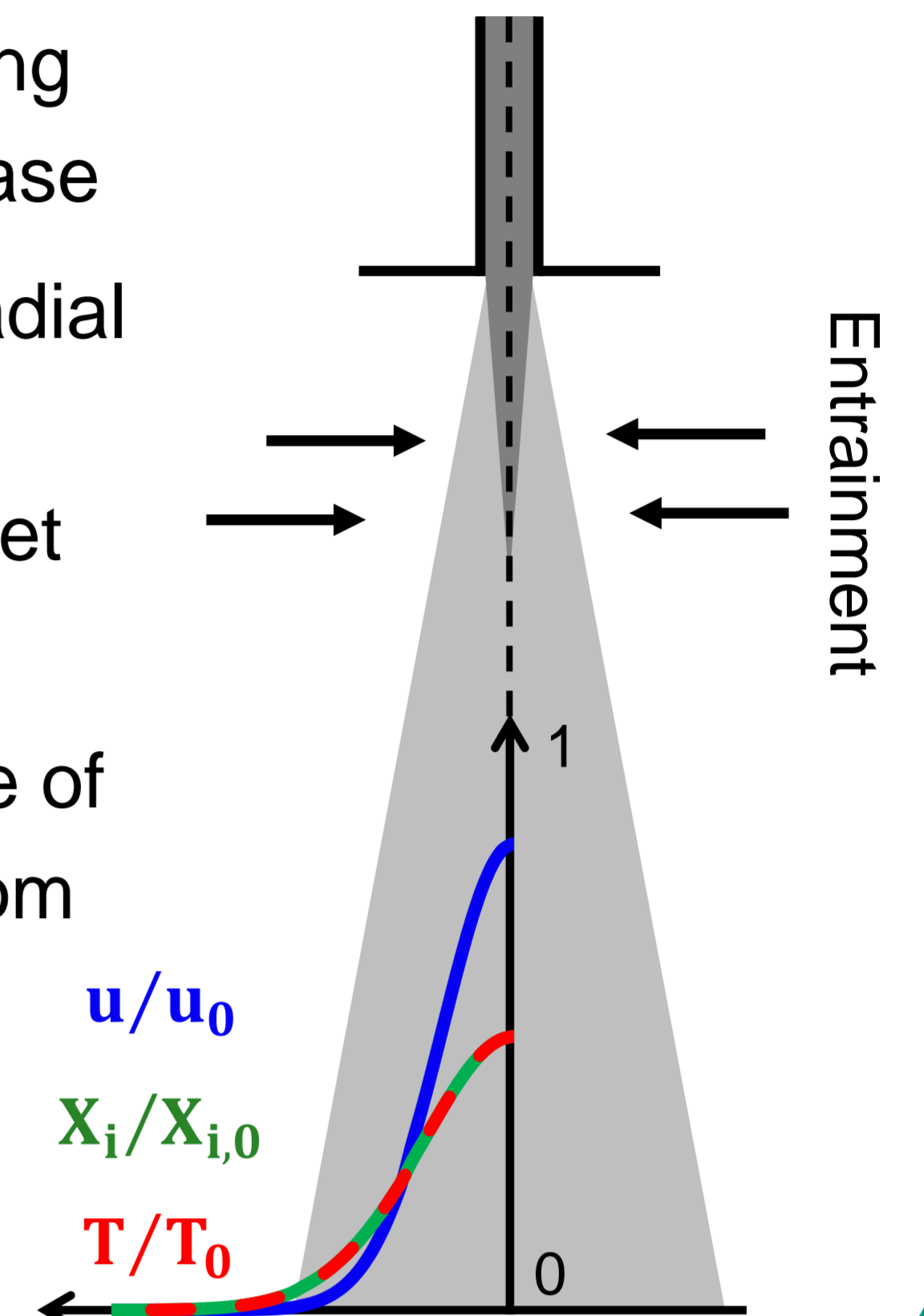


Atmospheric entrained flow gasifier REGA

Turbulent free jet

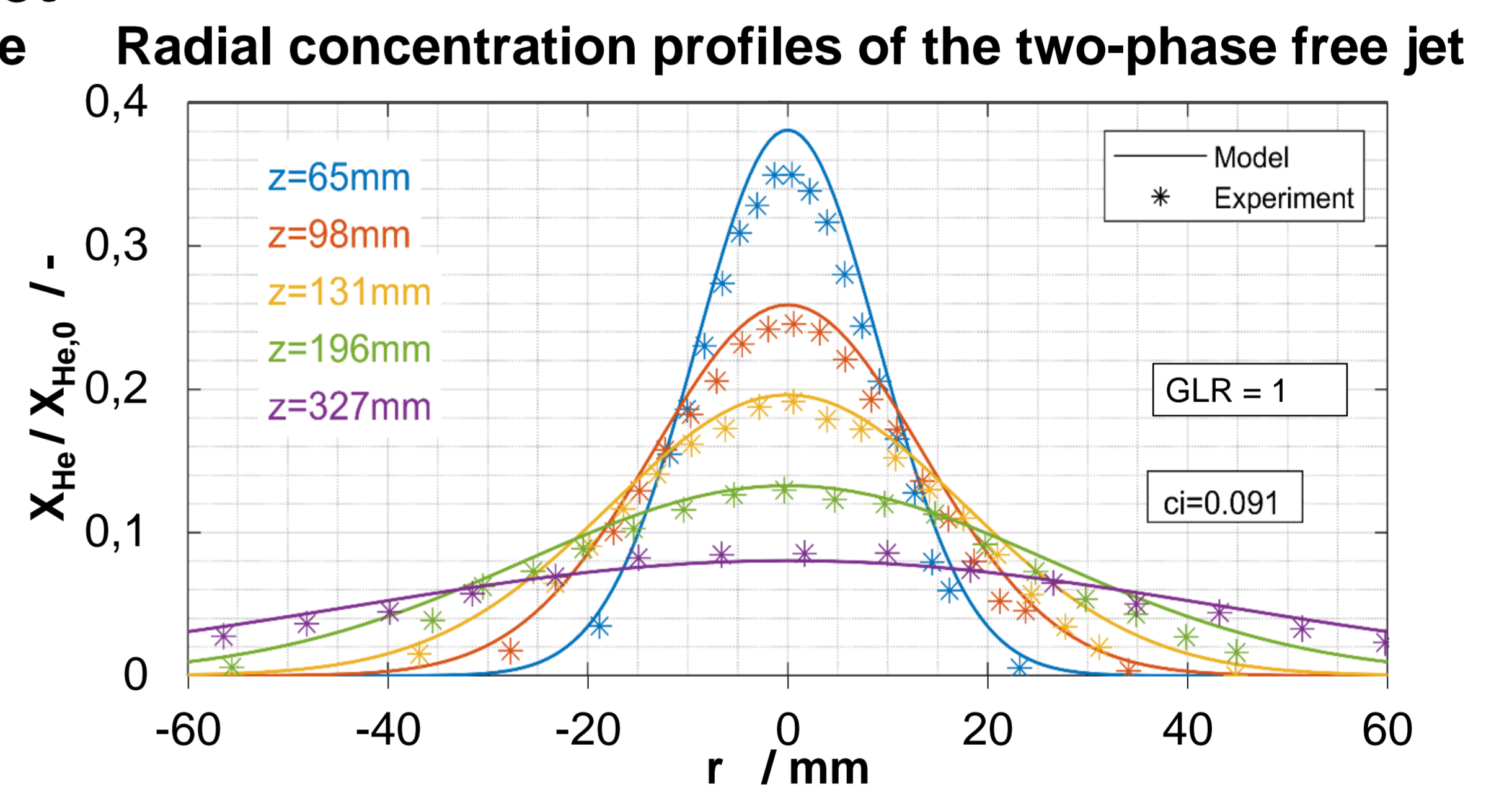
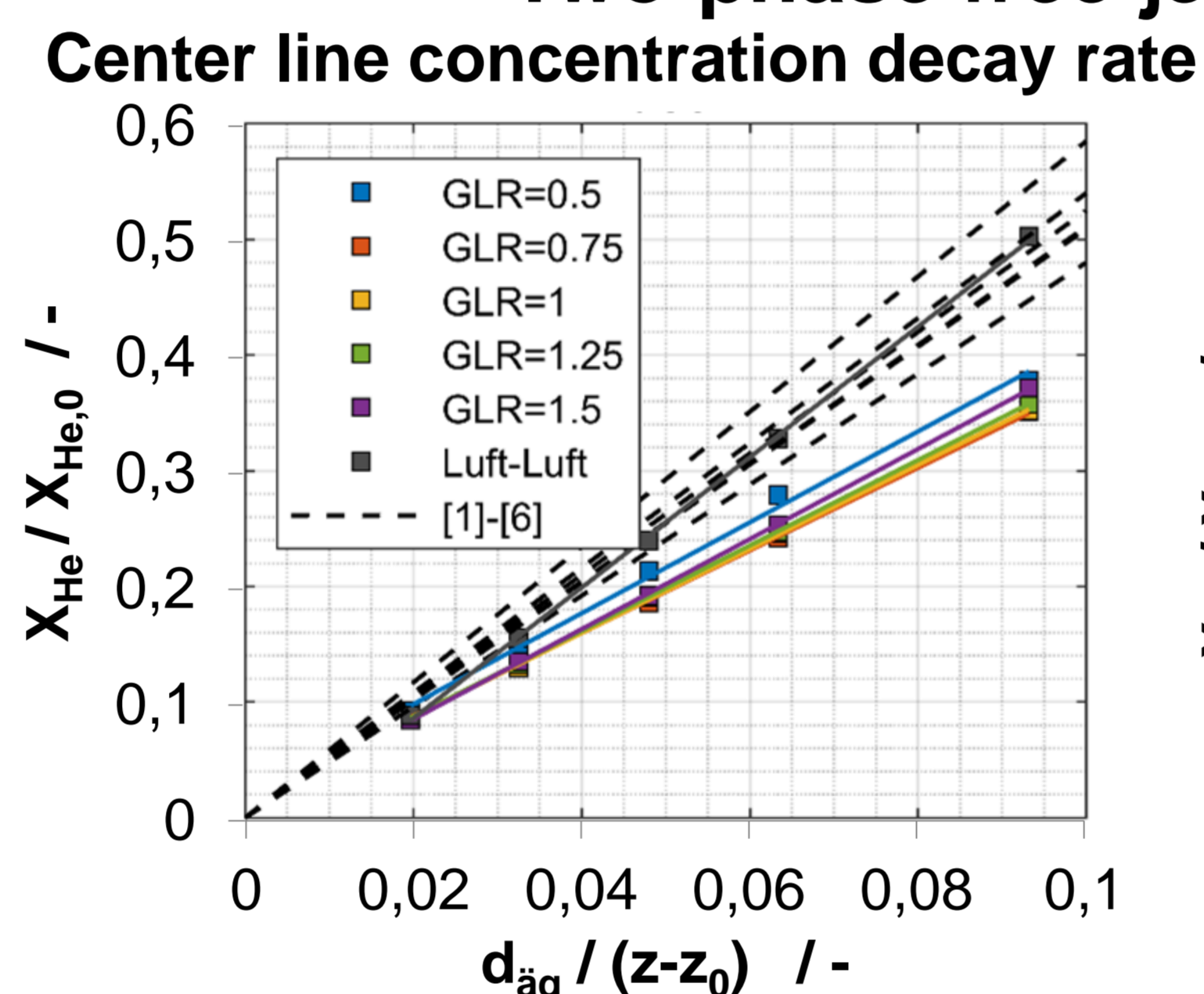
Turbulent mixing of a gas jet emerging from a nozzle into quiescent gas phase

- Semi-empirical model describes radial and axial distribution of velocity, concentration and temperature of jet medium and ambient gas
- Empirical parameters for exchange of momentum, mass and enthalpy from literature
- Equivalent nozzle diameter
- Entrainment of ambient gas



Two-phase free jet

- Influence of liquid phase on turbulent mixing of jet medium with ambient gas
- Turbulent two-phase free jet model analogous to single-phase
- Model parameter determined from experiments with helium tracer gas under ambient conditions



Free jet model for atmospheric gasification

Two-phase free jet

Mixture fraction of fuel, gasification medium and syngas

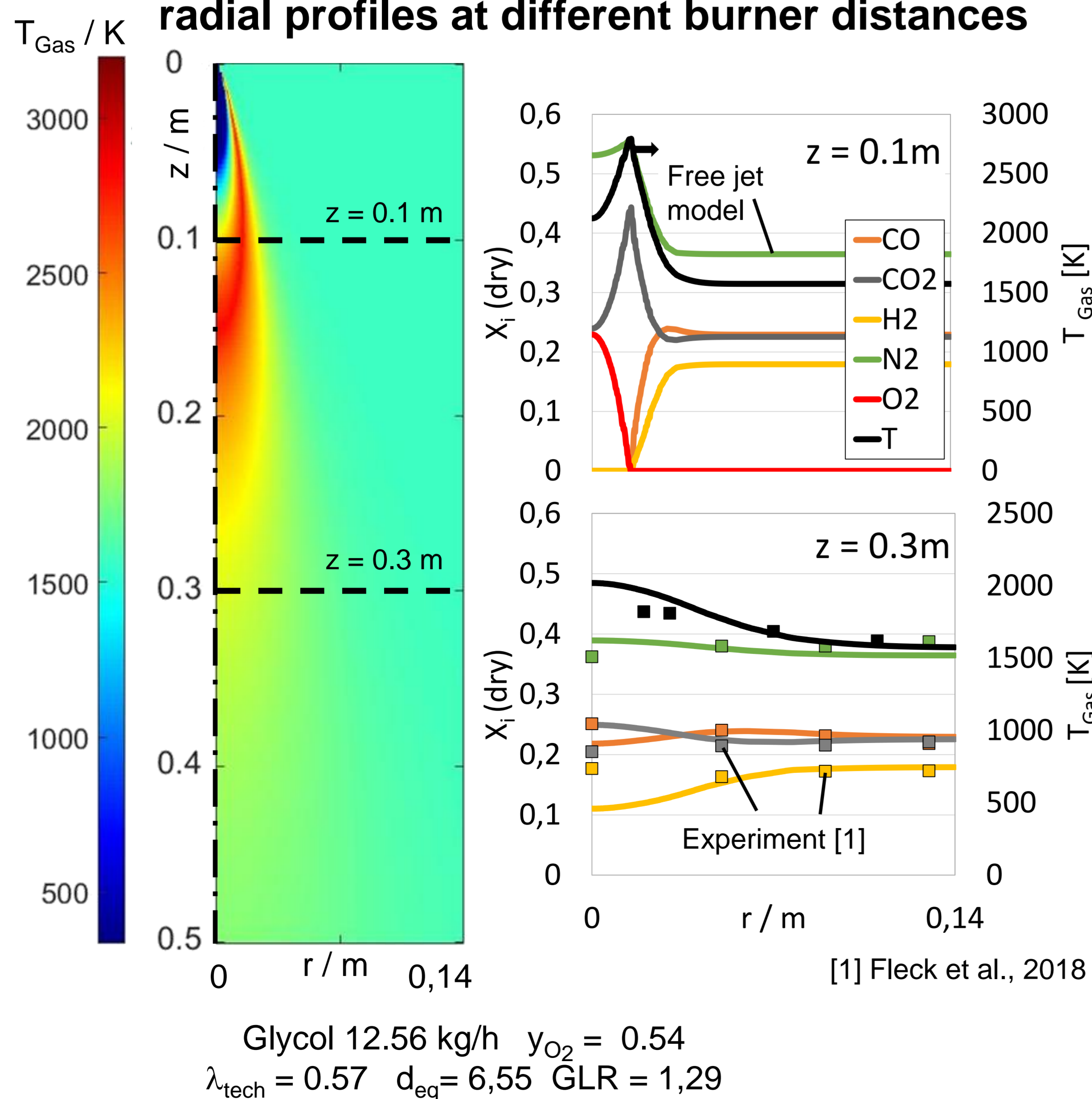
Droplet heat up and evaporation

Vapor fraction of fuel
Decomposition to syngas components

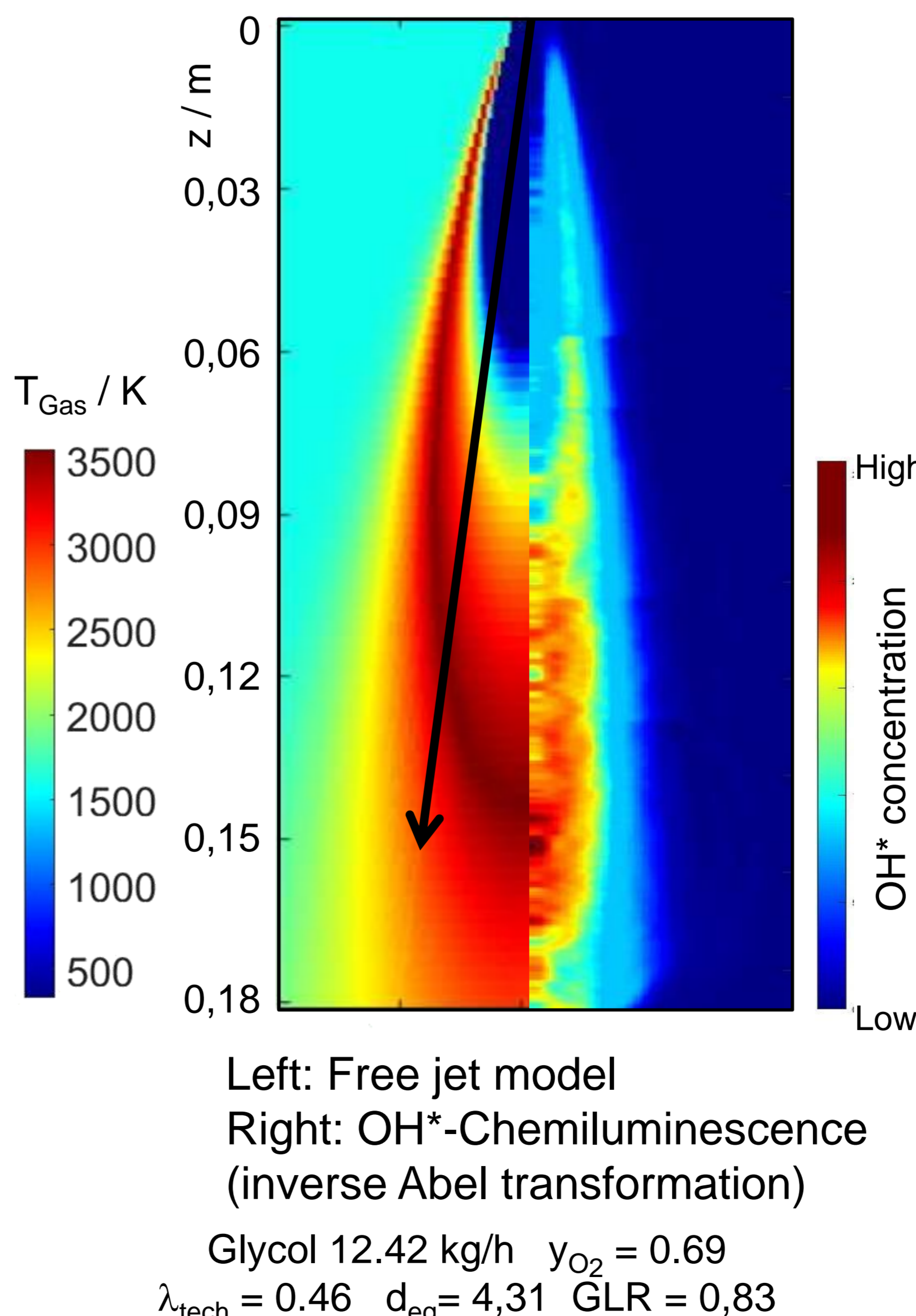
Chemical gas phase reaction

Oxidant: "mixed = burnt"
Syngas: watergas-shift equilibrium

Temperature distribution and gas composition radial profiles at different burner distances



Flame structure



Results and outlook

- Free jet model in good accordance with measured gas temperature and syngas composition in REGA gasifier
- Flame structure matches OH* pattern
- Realistic trajectory of fuel droplets
- Reliable analytical model for independent variation of process parameters and evaluation of sub-process models