

Publications

Thesis

- [1] M. Klein. *Towards LES as an Engineering Tool*, Habilitation, Technische Universität Darmstadt. 2009.
- [2] M. Klein. *Direkte Numerische Simulation des primären Strahlzerfalls in Einstoffzerstäuberdüsen*. PhD thesis, Technische Universität Darmstadt, 2002.

Journal Articles

- [3] T. Hehn, F. Zimmer, M. Klein, and J. Holtmannspötter. An optimized additive manufacturing strategy for low-impedance electronics. *Electronics*, 2025, accepted.
- [4] Min Son, Alexander Doehring, Markus Klein, Lars Zigan, Michael Pfitzner, and Tobias Sander. Experimental and numerical investigation of cyclopentane sprays in transcritical environment. *Atomization and Sprays*, 2025, accepted.
- [5] Rixin Yu, Marco Herbert, Markus Klein, and Erdzan Hodzic. Koopman theory-inspired method for learning time advancement operators in unstable flame front evolution. *Physics of Fluids*, 2025, accepted.
- [6] T. Hehn, F. Zimmer, M. Klein, and J. Holtmannspötter. Enhancing electrical high-frequency performance by an optimized additive manufacturing strategy. *International Journal of Advanced Manufacturing Technology*, 2025, accepted.
- [7] L. Schier, B. Blau, C. Heinrich, and M. Klein. Experimental analysis of microscopic spray properties of non-stabilized water-in-gasoline emulsions using shadowgraph imaging. *Atomization and Sprays*, 2024, accepted.
- [8] M. Klein and N. Chakraborty. Relation between 3D and 2D wrinkling factors in turbulent premixed flames. *Flow Turbulence and Combustion*, 2024, accepted.
- [9] Elias Trautner, Josef Hasslberger, and Markus Klein. Towards LES of liquid jet atomization using an Eulerian-Lagrangian multiscale approach. *Flow Turbulence and Combustion*, 2024, accepted.
- [10] M. Klein. Synthetic turbulence with prescribed probability density function and application to scalar quantities occurring in reactive flows. *Flow Turbulence and Combustion*, 2024, accepted.
- [11] Elfego Ruiz-Gutierrez, Josef Hasslberger, Markus Klein, Kenny Dalgarno, and Nilanjan Chakraborty. Binary droplet collisions in bioprinting: Influence of material properties on mixing and repeatability. *Flow Turbulence and Combustion*, 2024, accepted.
- [12] Umair Ahmed, Nilanjan Chakraborty, and Markus Klein. Effects of laminar burning velocity to friction velocity ratio on turbulent premixed flame-wall interaction within turbulent boundary layers. *Physical Review Fluids*, 2024, accepted.
- [13] Sanjeev Kumar Ghai, Umair Ahmed, Nilanjan Chakraborty, and Markus Klein. Multiscale analysis of Reynolds stresses and its dissipation rates for premixed flame wall interaction. *Physics of Fluids*, 2024, accepted.

- [14] Marianne Abdelsayed, Elias Trautner, Jakob Berchtenbreiter, and Markus Klein. Primary atomization of shear-thinning liquid jets: A direct numerical simulation study. *Scientific Reports*, 2024, accepted.
- [15] Vinzenz Silvester Wehrmann, Markus Klein, and Josef Hasslberger. Direct numerical simulation and modeling of the flame propagation characteristics in lean premixed turbulent h₂/co/air combustion. *International Journal of Hydrogen Energy*, 2024, accepted.
- [16] Riccardo Concetti, Josef Hasslberger, Nilanjan Chakraborty, and Markus Klein. Effects of water mist on the initial evolution of turbulent premixed hydrogen/air flame kernels. *Energies*, 2024, accepted.
- [17] Ruiyun Ji, Stephan Kelm, and Markus Klein. An efficient method for input uncertainty propagation in CFD and the application to buoyancy-driven flows. *Nuclear Engineering and Design*, 2024, accepted.
- [18] Tony Di Fabbio, Yuan Fang, Eike Tangermann, Richard D. Sandberg, and Markus Klein. Strategies for enhancing one-equation turbulence model predictions using gene-expression programming. *Fluids*, 9:191, 2024.
- [19] Marianne Abdelsayed, Josef Hasslberger, Moritz Ertl, Bernhard Weigand, and Markus Klein. Towards large eddy simulation of shear-thinning liquid jets: A-priori analysis of subgrid scale closures for multiphase flows. *Physics of Fluids*, 36:085130, 2024.
- [20] Antony Premkumar, Francesca Loffredo, Heinz Pitsch, and Markus Klein. Towards direct numerical simulations of a reactivity-controlled compression ignition engine using n-octanol/ethanol fuel blends. *Flow Turbulence and Combustion*, 2024.
- [21] Riccardo Concetti, Josef Hasslberger, Nilanjan Chakraborty, and Markus Klein. Effects of liquid water addition on turbulent premixed hydrogen/air combustion. *Fuel*, 373:132314, 2024.
- [22] Maximilian Bambauer, Michael Pfitzner, and Markus Klein. LES of premixed turbulent combustion using filtered tabulated chemistry. *Flow Turbulence and Combustion*, 2024.
- [23] Vinzenz Silvester Wehrmann, Nilanjan Chakraborty, Markus Klein, and Josef Hasslberger. Choice of reaction progress variable under preferential diffusion effects in turbulent syngas combustion based on detailed chemistry direct numerical simulations. *Scientific Reports*, 14:14861, 2024.
- [24] Marco Herbert, Nilanjan Chakraborty, and Markus Klein. A comparison of evaluation methodologies of the fractal dimension of premixed turbulent flames in 2D and 3D using direct numerical simulation data. *Flow Turbulence and Combustion*, 2024.
- [25] Alexander Doehring, Theresa Trummler, Michael Pfitzner, and Markus Klein. Two-dimensional DNS study of multicomponent mixing with phase transition in a transcritical shear layer. *Physics of Fluids*, 36:065141, 2024.
- [26] E. Ruiz-Gutierrez, J. Hasslberger, M. Klein, K. Dalgarno, and N. Chakraborty. Physically consistent modelling of surface tension forces in the volume-of-fluid method for three or more phases. *Journal of Computational Physics*, 513:113149, 2024.
- [27] Karthick Rajkumar, Tony Di Fabbio, Eike Tangermann, and Markus Klein. Physical aspects of vortex-shock dynamics in delta-wing configurations. *Physics of Fluids*, 36:066112, 2024.

- [28] Benjamin Blau, Oscar Krzeczek, Christoph Heinrich, and Markus Klein. Analysis of water-in-gasoline emulsions using experiments and direct numerical simulations. *Experimental and Computational Multiphase Flow*, 2024, accepted.
- [29] Riccardo Concetti, Josef Hasslberger, Thomas Sattelmayer, and Markus Klein. On the chemical effect of steam addition to premixed hydrogen flames with respect to NO_x emissions and flame speed. *Flow Turbulence and Combustion*, 113:519–534, 2024.
- [30] Riccardo Concetti, Josef Hasslberger, Nilanjan Chakraborty, and Markus Klein. Effects of liquid water injection on flame surface topology and propagation characteristics in spray flames: A direct numerical simulation analysis. *Physics of Fluids*, 36:043335, 2024.
- [31] Elias Trautner, Josef Hasslberger, Paolo Cifani, and Markus Klein. Enforcing accurate volume conservation in VOF-based long-term simulations of turbulent bubble-laden flows on coarse grids. *International Journal for Numerical Methods in Fluids*, 96:1057–1077, 2024.
- [32] Tony Di Fabbio, Karthick Rajkumar, Eike Tangermann, and Markus Klein. Towards the understanding of vortex breakdown for improved RANS turbulence modeling. *Aerospace Science and Technology*, 146:108973, 2024.
- [33] M. Errante, M. Klein, A. Ferrero, F. Larocca, G. Scovazzi, and M. Germano. Mixed averaging procedures. *Flow Turbulence and Combustion*, 112:1001–1008, 2024.
- [34] M. Klein. Integral turbulent length and time scales of higher order moments. *Flow Turbulence and Combustion*, 112:397–405, 2024.
- [35] E. Ruiz-Gutierrez, J. Hasslberger, M. Klein, K. Dalgarno, and N. Chakraborty. Analysis and optimisation of mixing in binary droplet collisions. *Journal of Fluid Mechanics*, 973:A38, 2023.
- [36] S. Lomada, M. Pfitzner, and M. Klein. Flame surface density and artificially thickened flame combustion models applied to a turbulent partially-premixed flame. *Flow Turbulence and Combustion*, 112:729–750, 2024.
- [37] K. Rajkumar, E. Tangermann, and M. Klein. Efficient scale-resolving simulations of open cavity flows for straight and sideslip conditions. *Fluids*, 8:227, 2023.
- [38] P. Wenig, S. Kelm, and M. Klein. CFD uncertainty quantification using PCE-HDMR - exemplary application to a buoyancy-driven mixing process. *Flow Turbulence and Combustion*, 112:191–216, 2023.
- [39] M. Pfitzner, J. Shin, and M. Klein. A priori validation of a multidimensional turbulent premixed combustion model for high-pressure Bunsen flames. *Combustion Science and Technology*, 195:3262–3280, 2023.
- [40] L. Engelmann, J. Hasslberger, S.-J. Baik, M. Klein, and A. Kempf. Direct numerical simulation of an unsteady wall-bounded turbulent flow configuration for the assessment of large-eddy simulation models. *Scientific Reports*, 13:11202, 2023.
- [41] E. Tangermann and M. Klein. On hybrid RANS-LES of transition in a separated boundary layer. *International Journal of Heat and Fluid Flow*, 103:109188, 2023.
- [42] U. Ahmed, N. Chakraborty, and M. Klein. Influence of flow configuration and thermal wall boundary conditions on turbulence during premixed flame-wall interaction within low Reynolds number boundary layers. *Flow, Turbulence and Combustion*, 111, 2023.

- [43] P. Wenig, S. Kelm, and M. Klein. CFD uncertainty quantification using stochastic spectral methods - exemplary application to a buoyancy-driven mixing process. *Nuclear Engineering and Design*, 409:112317, 2023.
- [44] O. Krzeczek, T. Trummler, E. Trautner, and M. Klein. Effect of the density ratio on emulsions and their segregation: A direct numerical simulation study. *Energies*, 16:3160, 2023.
- [45] T. Di Fabbio, E. Tangermann, and M. Klein. Analysis of the vortex dominated flow field over a delta wing at transonic speed. *The Aeronautical Journal*, 127:1851–1868, 2023.
- [46] V. Mohan, M. Herbert, M. Klein, and N. Chakraborty. A direct numerical simulation assessment of turbulent burning velocity parametrizations for non-unity Lewis numbers. *Energies*, 16:2590, 2023.
- [47] A. Begemann, T. Trummler, A. Doehring, M. Pfitzner, and M. Klein. Assessment of the thermodynamic and numerical modeling of LES of multi-component jet mixing at high pressure. *Energies*, 16:2113, 2023.
- [48] M. Bambauer, J. Hasslberger, G. Ozel-Erol, N. Chakraborty, and M. Klein. Surface topologies and self interactions in reactive and nonreactive Richtmyer-Meshkov instability. *Scientific Reports*, 13:837, 2023.
- [49] M. Klein, N. Chakraborty, A. Kempf, and A. Sadiki. Development and validation of models for turbulent reacting flows. *Physics of Fluids*, 34:120401, 2022.
- [50] E. Trautner, J. Hasslberger, S. Ketterl, and M. Klein. Primary atomization of liquid jets: identification and investigation of droplets at the instant of their formation using direct numerical simulation. *International Journal of Multiphase Flow*, 160:104360, 2023.
- [51] M. B. Vocke, R. Kapulla, C. Morton, M. Klein, and R.J. Martinuzzi. Advection-based temporal reconstruction technique for turbulent velocity fields. *Physics of Fluids*, 35:015123, 2023.
- [52] R. Ji, P. Wenig, S. Kelm, and M. Klein. Epistemic uncertainty in URANS based CFD analysis of buoyancy driven flows - comparison of URANS and LES. *Annals of Nuclear Energy*, 181:109563, 2022.
- [53] T. Trummler, M. Glatzle, A. Doehring, N. Urban, and M. Klein. Thermodynamic modeling for numerical simulations based on the generalized cubic equation of state. *Physics of Fluids*, 34:116126, 2022.
- [54] T. Trummler, A. Begemann, E. Trautner, and M. Klein. Numerical investigation of the segregation of turbulent emulsions. *Physics of Fluids*, 34:113324, 2022.
- [55] G. Ozel-Erol, J. Hasslberger, N. Chakraborty, and M. Klein. Effects of water droplet injection on turbulent premixed flame propagation: A direct numerical simulation investigation. *Flow Turbulence and Combustion*, 110:105–123, 2022.
- [56] S.K. Ghai, U. Ahmed, M. Klein, and N. Chakraborty. Turbulent kinetic energy evolution in turbulent boundary layers during head-on interaction of premixed flames with inert walls for different thermal boundary conditions. *Proc. Comb. Inst.*, 39:2169–2178, 2022.
- [57] R. Concetti, J. Hasslberger, N. Chakraborty, and M. Klein. Analysis of water droplet interaction with turbulent premixed and spray flames using carrier phase direct numerical simulations. *Combustion Science and Technology*, 195:1411–1433, 2022.

- [58] K. Rajkumar, E. Tangermann, M. Klein, S. Ketterl, and A. Winkler. Time-efficient simulations of fighter aircraft weapon bay. *CEAS Aeronautical Journal*, 14:91–102, 2022.
- [59] E. Tangermann, G. Ercolani, and M. Klein. Aerodynamic behavior of a biomimetic wing in soaring flight - a numerical study. *Flow Turbulence and Combustion*, 109:1155–1173, 2022.
- [60] N. Chakraborty, R. Rasool, U. Ahmed, and M. Klein. Relations between statistics of three-dimensional flame curvature and their two-dimensional counterpart in turbulent premixed flames. *Flow Turbulence and Combustion*, 2022.
- [61] M. Klein, T. Trummler, and J. Radtke. Multiscale analysis of the Reynolds stress, dissipation and subgrid-scale tensor in turbulent bubbly channel flows - characterisation of anisotropy and modelling implications. *Physics of Fluids*, 34:085122, 2022.
- [62] C. Kasten, J. Shin, M. Pfitzner, and M. Klein. Modelling filtered reaction rate in turbulent premixed flames using feature importance analysis, gene expression programming and tiny artificial neural networks. *International Journal of Heat and Fluid Flow*, 2022.
- [63] L. Engelmann, J. Laichter, P. Wollny, M. Klein, S.A. Kaiser, and A.M. Kempf. Cyclic variations in the flame propagation in an spark-ignited engine: multi cycle large eddy simulation supported by imaging diagnostics. *Flow Turbulence and Combustion*, 2022.
- [64] C. Kasten, J. Fahr, and M. Klein. An efficient way of introducing gender into evolutionary algorithms. *IEEE Transactions on Evolutionary Computation*, 2022.
- [65] C. Kasten, J. Shin, R.D. Sandberg, M. Pfitzner, N. Chakraborty, and M. Klein. Modelling subgrid-scale scalar dissipation rate in turbulent premixed flames using gene expression programming and deep artificial neural networks. *Physics of Fluids*, 34:085113, 2022.
- [66] S. Ghai, U. Ahmed, M. Klein, and N. Chakraborty. Energy integral equation for premixed flame-wall interaction in turbulent boundary layers and its application to turbulent burning velocity and wall flux evaluations. *International Journal of Heat and Mass Transfer*, 196:123230, 2022.
- [67] J. Hasslberger, R. Concetti, N. Chakraborty, and M. Klein. Inertial effects on the interaction of water droplets with turbulent premixed flames: a direct numerical simulation analysis. *Proc. Comb. Inst.*, 2022.
- [68] S. Ghai, N. Chakraborty, U. Ahmed, and M. Klein. Enstrophy evolution during head-on wall interaction of premixed flames within turbulent boundary layers. *Physics of Fluids*, 34:075124, 2022.
- [69] N. Chakraborty, U. Ahmed, M. Klein, and H.G. Im. Alignment statistics of pressure Hessian with strain rate tensor and reactive scalar gradient in turbulent premixed flames. *Physics of Fluids*, 34:065120, 2022.
- [70] J. Shin, M. Hansinger, M. Pfitzner, and M. Klein. A priori analysis on deep learning of filtered reaction rate. *Flow Turbulence and Combustion*, 109:383–409, 2022.
- [71] H. S. Awad, K. Abo-Amsha, U. Ahmed, M. Klein, and N. Chakraborty. Assessment of Damköhler’s hypotheses in the thin reaction zones regime using multi-step chemistry direct numerical simulations of statistically planar turbulent premixed flames. *Physics of Fluids*, 34:055120, 2022.
- [72] A. Begemann, T. Trummler, E. Trautner, J. Hasslberger, and M. Klein. Effect of turbulence intensity and surface tension on the emulsification process and its stationary state -A numerical study. *Canadian Journal of Chemical Engineering*, 2022.

- [73] L. Engelmann, J. Hasslberger, E. Inanc, M. Klein, and A. Kempf. A-posteriori assessment of Large-Eddy Simulation subgrid-closures for momentum and scalar fluxes in a turbulent premixed burner experiment. *Computers and Fluids*, 240:105441, 2022.
- [74] S. Ghai, U. Ahmed, N. Chakraborty, and M. Klein. Entropy generation during head-on interaction of premixed flames with inert walls within turbulent boundary layers. *Entropy*, 24(4):463, 2022.
- [75] M. Pfitzner, J. Shin, and M. Klein. A multidimensional combustion model for oblique, wrinkled premixed flames. *Combustion and Flame*, 241:112121, 2022.
- [76] M. Klein, T. Trummler, N. Urban, and N. Chakraborty. Multiscale analysis of anisotropy of Reynolds stresses, sub-grid stresses and dissipation in statistically planar turbulent premixed flames. *Applied Sciences*, 12(5):2275, 2022.
- [77] T. Di Fabbio, E. Tangermann, and M. Klein. Investigation of transonic aerodynamics on a triple-delta wing in side slip conditions. *CEAS Aeronautical Journal*, 2022.
- [78] N. Chakraborty, C. Kasten, U. Ahmed, and M. Klein. Evolutions of strain rate and dissipation rate of kinetic energy in turbulent premixed flames. *Physics of Fluids*, 33:125132, 2021.
- [79] J. Lai, U. Ahmed, M. Klein, and N. Chakraborty. A comparison between head-on quenching of stoichiometric methane-air and hydrogen-air premixed flames using direct numerical simulations. *International Journal of Heat and Fluid Flow*, 93:108896, 2021.
- [80] U. Ahmed, N. Chakraborty, and M. Klein. Influence of thermal wall boundary condition on scalar statistics during flame-wall interaction of premixed combustion in turbulent boundary layers. *International Journal of Heat and Fluid Flow*, 92:108881, 2021.
- [81] R. Rasool, N. Chakraborty, and M. Klein. Flame surface density based mean reaction rate closure for Reynolds averaged Navier Stokes methodology in turbulent premixed Bunsen flames with non-unity Lewis number. *Combustion and Flame*, 239:111766, 2021.
- [82] F.B. Keil, M. Amzeshhoff, U. Ahmed, N. Chakraborty, and M. Klein. Comparison of flame propagation statistics based on DNS of simple and detailed chemistry. Part 2: Influence of choice of reaction progress variable. *Energies*, 14:5695, 2021.
- [83] F.B. Keil, M. Amzeshhoff, U. Ahmed, N. Chakraborty, and M. Klein. Comparison of flame propagation statistics extracted from DNS based on simple and detailed chemistry Part 1: Fundamental flame turbulence interaction. *Energies*, 14:5548, 2021.
- [84] R. Meller, F. Schlegel, and M. Klein. Sub-grid scale modelling and a-posteriori tests with a morphology adaptive multifield two-fluid model considering rising gas bubbles. *Flow Turbulence and Combustion*, 108:895–922, 2021.
- [85] N. Chakraborty, A. Herbert, U. Ahmed, H.G. Im, and M. Klein. Assessment of extrapolation relations of displacement speed for detailed chemistry direct numerical simulation database of statistically planar turbulent premixed flames. *Flow Turbulence and Combustion*, 108:489–507, 2021.
- [86] U. Ahmed, N. Chakraborty, and M. Klein. Assessment of Bray Moss Libby formulation for premixed flame-wall interaction within turbulent boundary layers: Influence of flow configuration. *Combustion and Flame*, 233:111575, 2021.
- [87] A.R. Varma, U. Ahmed, N. Chakraborty, and M. Klein. Effects of turbulent length scale on the bending effect of turbulent burning velocity in premixed turbulent combustion. *Combustion and Flame*, 233:111569, 2021.

- [88] R. Rasool, N. Chakraborty, and M. Klein. Effect of non-ambient pressure conditions and Lewis number variation on direct numerical simulation of turbulent Bunsen flames at low turbulence intensity combustion and flame. *Combustion and Flame*, 231:111500, 2021.
- [89] E. Trautner, M. Klein, F. Braeuer, and J. Hasslberger. Conditional and unconditional second-order structure functions in bubbly channel flows of power-law fluids. *Physics of Fluids*, 33:055121, 2021.
- [90] P.J. Wenig, R. Ji, S. Kelm, and M. Klein. Towards uncertainty quantification of LES and URANS for the buoyancy-driven mixing process between two miscible fluids - differentially heated cavity of aspect ratio 4. *Fluids*, 6:161, 2021.
- [91] M. Bambauer, N. Chakraborty, M. Klein, and J. Hasslberger. Vortex dynamics and fractal structures in reactive and nonreactive Richtmyer-Meshkov instability. *Physics of Fluids*, 33 (4):044114, 2021.
- [92] J. Hasslberger, G. Ozel-Erol, N. Chakraborty, M. Klein, and S. Cant. Physical effects of water droplets interacting with turbulent premixed flames: A direct numerical simulation analysis. *Combustion and Flame*, 229:111404, 2021.
- [93] L. Engelmann, M. Klein, and A. Kempf. A-posteriori LES assessment of subgrid-scale closures for bounded passive scalars. *Computers and Fluids*, 218:104840, 2021.
- [94] M. Klein and M. Germano. Analysis and modelling of the commutation error. *Fluids*, 6(1):15, 2020.
- [95] J. Hasslberger, L. Engelmann, A. Kempf, and M. Klein. Robust dynamic adaptation of the Smagorinsky model based on a sub-grid activity sensor. *Physics of Fluids*, 33:015117, 2021.
- [96] F. Braeuer, E. Trautner, J. Hasslberger, P. Cifani, and M. Klein. Turbulent bubble-laden channel flow of power-law fluids: A direct numerical simulation study. *Fluids*, 6(1):40, 2021.
- [97] C. Kasten, U. Ahmed, M. Klein, and N. Chakraborty. Principal strain rate evolution within turbulent premixed flames for different combustion regimes. *Physics of Fluids*, 33:015111, 2021.
- [98] M. Pfitzner and M. Klein. A near-exact analytic solution of progress variable and pdf for single-step Arrhenius chemistry. *Combustion and Flame*, 226:380–395, 2020.
- [99] M. Reissmann, J. Hasslberger, R.D. Sandberg, and M. Klein. Application of gene expression programming to a-posteriori LES modeling of a Taylor Green vortex. *Journal of Computational Physics*, 424:109859, 2021.
- [100] G. Ozel Erol, N. Chakraborty, and M. Klein. Lewis number effects on flame speed statistics in spherical turbulent premixed flames. *Flow Turbulence and Combustion*, 106:1043–1063, 2021.
- [101] J. Hasslberger, P. Cifani, N. Chakraborty, and M. Klein. A direct numerical simulation analysis of coherent structures in bubble-laden channel flows. *Journal of Fluid Mechanics*, 905:A37, 2020.
- [102] S. Yigit, J. Hasslberger, M. Klein, and N. Chakraborty. Near wall Prandtl number effects on velocity gradient invariants and flow topologies in turbulent Rayleigh-Benard convection. *Scientific Reports*, 10:14887, 2020.

- [103] G. Ozel Erol, J. Hasslberger, M. Klein, and N. Chakraborty. A direct numerical simulation analysis of turbulent v-shaped flames propagating into droplet-laden mixture. *International Journal of Multiphase Flows*, 133:103455, 2020.
- [104] E. Tangermann and M. Klein. Controlled synthetic freestream turbulence intensity introduced by a local volume force. *Fluids*, 5(3):130, 2020.
- [105] A. Herbert, U. Ahmed, N. Chakraborty, and M. Klein. Applicability of extrapolation relations for curvature and stretch rate dependences of displacement speed for statistically planar turbulent premixed flames. *Combustion Theory and Modelling*, 24:1021–1038, 2020.
- [106] U. Ahmed, A. Herbert, N. Chakraborty, and M. Klein. On the validity of Damkoehler’s second hypothesis in statistically planar turbulent premixed flames in the thin reaction zones regime. *Proc. Comb. Inst.*, 37, 2020.
- [107] S. Yigit, F. Braeuer, N. Chakraborty, and M. Klein. Comparison of two and three-dimensional Rayleigh-Benard convection of power-law fluids in cylindrical and annular enclosures. *International Journal of Heat and Mass Transfer*, 160:120211, 2020.
- [108] K. Amend and M. Klein. Uncertainty of rivulet flows on heterogeneous surfaces - a numerical study. *Nuclear Engineering and Design*, 366:110745, 2020.
- [109] F.B. Keil, N. Chakraborty, and M. Klein. Flame surface density transport statistics for high pressure turbulent premixed Bunsen flames in the context of large eddy simulation. *Combustion Science and Technology*, 192:2070–2092, 2020.
- [110] E. Tangermann, N. Wegh, M. Klein, S. Weiland, and T. Link. Simulation of Ariane 5 solid rocket booster deformation by internal ballistics. *Journal of Propulsion and Power*, 37:139–150, 2021.
- [111] S. Yigit, J. Hasslberger, and M. Klein. Determination of numerical errors in under-resolved DNS of turbulent non-isothermal flows. *Flow Turbulence and Combustion*, 106:357–372, 2021.
- [112] N. Chakraborty, M. Klein, and H. Im. A comparison of entrainment velocity and displacement speed statistics in different regimes of turbulent premixed combustion. *Proc. Comb. Inst.*, 2020.
- [113] M. Hansinger, M. Pfitzner, and M. Klein. Statistical analysis and verification of a new premixed combustion model with DNS data. *Combustion Science and Technology*, 192(11):2093–2114, 2020.
- [114] P. Brearley, U. Ahmed, N. Chakraborty, and M. Klein. Scaling of second-order structure functions in turbulent premixed flames in the flamelet combustion regime. *Fluids*, 5(2):89, 2020.
- [115] C. Kasten, F.B. Keil, N. Chakraborty, and M. Klein. Statistical behaviours of turbulent scalar fluxes in high pressure turbulent premixed combustion in the context of large eddy simulations. *Combustion Science and Technology*, 192 (11):2050–2069, 2020.
- [116] F.B. Keil, N. Chakraborty, and M. Klein. Analysis of the closures of sub-grid scale variance of reaction progress variable for turbulent Bunsen burner flames at different pressure levels. *Flow Turbulence and Combustion*, 105:869–888, 2020.
- [117] U. Ahmed, N. Chakraborty, and M. Klein. Scalar gradient and strain rate statistics in oblique premixed flame-wall interaction within turbulent channel flows. *Flow Turbulence and Combustion*, 106:701–732, 2021.

- [118] M. Bambauer, J. Hasslberger, and M. Klein. Direct numerical simulation of the Richtmyer-Meshkov instability in reactive and nonreactive flows. *Combustion Science and Technology*, 192(11):2010–2027, 2020.
- [119] R. Rasool, N. Chakraborty, and M. Klein. Algebraic flame surface density modelling of high pressure turbulent premixed bunsen flames. *Flow Turbulence and Combustion*, pages 1–15, 2020.
- [120] F.B. Keil, M. Klein, and N. Chakraborty. Sub-grid reaction progress variable variance closure in turbulent premixed flames. *Flow Turbulence and Combustion*, pages 1–18, 2020.
- [121] J. Hasslberger, S. Ketterl, and M. Klein. A-priori assessment of interfacial sub-grid scale closures in the two-phase flow LES context. *Flow Turbulence and Combustion*, 105(2):359–375, 2020.
- [122] T. Yu, Q. Wang, C. Ruan, F. Chen, W. Cai, X. Lu, and M. Klein. A quantitative evaluation method of 3d flame curvature from reconstructed flame structure. *Experiments in Fluids*, 61 (2):1–13, 2020.
- [123] S. Yigit, J. Hasslberger, N. Chakraborty, and M. Klein. Effects of Rayleigh-Benard convection on spectra of viscoplastic fluids. *International Journal of Heat and Mass Transfer*, 147:118947, 2020.
- [124] M. Klein, S. Ketterl, L. Engelmann, A. Kempf, and H. Kobayashi. Regularised, parameter free scale similarity type models for large eddy simulation. *International Journal of Heat and Fluid Flow*, 81:108496, 2020.
- [125] M. Klein, A. Herbert, H. Kosaka, B. Böhm, A. Dreizler, N. Chakraborty, V. Papapostolou, H. G. Im, and J. Hasslberger. Evaluation of flame area based on detailed chemistry dns of premixed turbulent hydrogen-air flames in different regimes of combustion. *Flow Turbulence and Combustion*, 104:403–419, 2020.
- [126] J. Hasslberger, S. Marten, and M. Klein. A theoretical investigation of flow topologies in bubble- and droplet-affected flows. *Fluids*, 4:117, 2019.
- [127] W.A. Kareem, M. Klein, S. Izawa, and Y. Fukunishi. A hyperbolic partial differential equation model for filtering turbulent flows. *Computers and Fluids*, 190:156–167, 2019.
- [128] G. Ozel Erol, J. Hasslberger, M. Klein, and N. Chakraborty. Propagation of spherically expanding turbulent flames into fuel droplet-mists. *Flow Turbulence and Combustion*, 103 (4):913–941, 2019.
- [129] S. Ketterl, M. Reissmann, and M. Klein. Towards large eddy simulation of multiphase flow using the volume of fluid method: Part 2 - a-posteriori analysis of liquid jet atomization. *Experimental and Computational Multiphase Flow*, 1:201–211, 2019.
- [130] M. Klein, S. Ketterl, and J. Hasslberger. Towards large eddy simulation of multiphase flows using the volume of fluid method: Part 1 - governing equations and a-priori analysis. *Experimental and Computational Multiphase Flow*, 1:130–144, 2019.
- [131] M. Klein, C. Kasten, and M. Germano. Decomposition of turbulent fluxes from filtered data and application to turbulent premixed combustion modelling. *Flow Turbulence and Combustion*, 103:503–517, 2019.
- [132] A. Alqallaf, M. Klein, C. Dopazo, and N. Chakraborty. Evolution of flame curvature in turbulent premixed bunsen flames at different pressure levels. *Flow Turbulence and Combustion*, 103:439–463, 2019.

- [133] U. Ahmed, N. Chakraborty, and M. Klein. On the stress-strain alignment in premixed turbulent flames. *Scientific Reports*, 9:5092, 2019.
- [134] U. Ahmed, N. Chakraborty, and M. Klein. Insights into the bending effect in premixed turbulent combustion using the flame surface density transport. *Combustion Science and Technology*, 191:898–920, 2019.
- [135] G. Ozel Erol, J. Hasslberger, M. Klein, and N. Chakraborty. A direct numerical simulation investigation of spherically expanding flames propagating in fuel droplet-mists for different droplet diameters and overall equivalence ratios. *Combustion Science and Technology*, 191:833–867, 2019.
- [136] A. Alqallaf, M. Klein, and N. Chakraborty. Effects of lewis number on the evolution of curvature in spherically expanding turbulent premixed flames. *Fluids*, 4(1):4010012, 2019.
- [137] M. Klein and M. Germano. On the decomposition of the Reynolds stress from filtered data. *Physical Review Fluids*, 3:114606, 2018.
- [138] N. Chakraborty, V. Papapostolou, D. H. Wacks, M. Klein, and H. G. Im. Generalised flame surface density transport conditional on flow topologies for turbulent h₂-air premixed flames in different regimes of combustion. *Numerical heat transfer*, 74:1353–1367, 2018.
- [139] J. Hasslberger, S. Ketterl, M. Klein, and Nilanjan Chakraborty. Flow topologies in primary atomization of liquid jets: A direct numerical simulation analysis. *Journal of Fluid Mechanics*, 859:819–838, 2018.
- [140] V. Papapostolou, N. Chakraborty, M. Klein, and H. G. Im. Statistics of scalar flux transport of major species in different premixed turbulent combustion regimes for H₂-air flames. *Flow Turbulence and Combustion*, 102:931–955, 2019.
- [141] K. Amend and M. Klein. Development and validation of a CFD wash-off model for fission products on containment walls. *International Journal for Nuclear Power*, 63:469–473, 2018.
- [142] U. Ahmed, N. Doan, J. Lai, M. Klein, N. Chakraborty, and N. Swaminathan. Multiscale analysis of head-on quenching premixed turbulent flames. *Physics of Fluids*, 30:105102 1–13, 2018.
- [143] Vassilios Papapostolou, Nilanjan Chakraborty, Markus Klein, and Hong G. Im. Effects of reaction progress variable definition on the flame surface density transport statistics and closure for different combustion regimes. *Combustion Science and Technology*, 2018.
- [144] J. Hasslberger, M. Klein, and Nilanjan Chakraborty. Flow topologies in bubble-induced turbulence: A direct numerical simulation analysis. *Journal of Fluid Mechanics*, 857:220–290, 2018.
- [145] G. Ozel Erol, J. Hasslberger, M. Klein, and Nilanjan Chakraborty. A direct numerical simulation analysis of spherically expanding turbulent flames in fuel droplet-mists for an overall equivalence ratio of unity. *Physics of Fluids*, 30 (8):086104, 2018.
- [146] M. Schoepplein, J. Weatheritt, R. Sandberg, M. Talei, and M. Klein. Application of an evolutionary algorithm to LES modeling of turbulent transport in premixed flames. *Journal of Computational Physics*, 374:1166–1179, 2018.
- [147] N. Chakraborty, D. Alwazzan, M. Klein, and R.S. Cant. On the validity of Damköhler’s first hypothesis in turbulent Bunsen burner flames: A computational analysis. *Proc. Comb. Inst.*, 37, 2019.

- [148] M. Klein, H. Nachtigal, M. Hansinger, M. Pfitzner, and N. Chakraborty. Flame curvature distribution in high pressure turbulent Bunsen premixed flames. *Flow Turbulence and Combustion*, 101:1173–1187, 2018.
- [149] N. Chakraborty, D.H. Wacks, S. Ketterl, M. Klein, and H.G. Im. Scalar dissipation rate transport conditional on flow topologies in different regimes of premixed turbulent combustion. *Proc. Comb. Inst.*, 37, 2019.
- [150] N. Chakraborty, M. Klein, D. Alwazzan, and H.G. Im. Surface density function statistics in hydrogen-air flames for different turbulent premixed combustion regimes. *Combustion Science and Technology*, 190:1988–2002, 2018.
- [151] M. Klein, C. Kasten, N. Chakraborty, N. Mukhadiyev, , and H.G. Im. Turbulent scalar fluxes in H_2 -air premixed flames at low and high Karlovitz numbers. *Combustion Theory and Modelling*, 22:1–16, 2018.
- [152] J. Lai, M. Klein, and N. Chakraborty. Direct numerical simulation of head-on quenching of statistically planar turbulent premixed methane-air flames using a detailed chemical mechanism. *Flow Turbulence and Combustion*, 101:1073–1091, 2018.
- [153] M. Klein and N. Chakraborty. A-priori analysis of an alternative wrinkling factor definition for flame surface density based large eddy simulation modelling of turbulent premixed combustion. *Combustion Science and Technology*, 2018.
- [154] M. Klein, D. Alwazzan, and N. Chakraborty. A direct numerical simulation analysis of pressure variation in turbulent premixed bunsen burner flames-part 1: Scalar gradient and strain rate statistics. *Computers and Fluids*, 173:147–156, 2018.
- [155] M. Klein, D. Alwazzan, and N. Chakraborty. A direct numerical simulation analysis of pressure variation in turbulent premixed bunsen burner flames-part 2: Surface density function transport statistics. *Computers and Fluids*, 173:178–188, 2018.
- [156] S. Ketterl and M. Klein. A band-width filtered forcing based generation of turbulent inflow data for direct numerical or large eddy simulations and its application to primary breakup of liquid jets. *Flow Turbulence and Combustion*, 101:413–432, 2018.
- [157] S. Ketterl and M. Klein. A-priori assessment of subgrid scale models for large-eddy simulation of multiphase primary breakup. *Computers and Fluids*, 165:64–77, 2018.
- [158] V. Papapostolou, D.H. Wacks, N. Chakraborty, M. Klein, and H.G. Im. Enstrophy transport conditional on local flow topologies in different regimes of premixed turbulent combustion. *Scientific Reports*, 7:11545, 2017.
- [159] M. Klein, N. Chakraborty, and S. Ketterl. A comparison of strategies for direct numerical simulation of turbulence chemistry interaction in generic planar turbulent premixed flames. *Flow Turbulence and Combustion*, 99:955–971, 2017.
- [160] K. Amend and M. Klein. Modeling and simulation of water flow on containment walls with inhomogeneous contact angle distribution. *International Journal for Nuclear Power*, 62:477–481, 2017.
- [161] J. Lai, M. Klein, and N. Chakraborty. Assessment of algebraic flame surface density closures in the context of large eddy simulations of head-on quenching of turbulent premixed flames. *Combustion Science and Technology*, 189:1966–1991, 2017.
- [162] M. Klein, C. Kasten, and N. Chakraborty. A-priori direct numerical simulation assessment of models for generalized sub-grid scale turbulent kinetic energy in turbulent premixed flames. *Computers and Fluids*, 154:123–131, 2017.

- [163] N. Chakraborty, L. Wang, I. Konstantinou, and M. Klein. Vorticity statistics based on velocity and density-weighted velocity in premixed reactive turbulence. *Journal of Turbulence*, 18:825–853, 2017.
- [164] D. H. Wacks, N. Chakraborty, M. Klein, P. G. Arias, and H.G. Im. Flow topologies in different regimes of premixed turbulent combustion: A direct numerical simulation analysis. *Physical Review Fluids*, 1:083401, 2016.
- [165] U. Allauddin, M. Klein, M. Pfitzner, and N. Chakraborty. A-priori and a-posteriori analysis of algebraic flame surface density modeling in the context of large eddy simulation of turbulent premixed combustion. *Numerical Heat Transfer, Part A*, pages 1–19, 2016.
- [166] M. Klein, N. Chakraborty, and M. Pfitzner. Analysis of the combined modelling of sub-grid transport and filtered flame propagation for premixed turbulent combustion. *Flow Turbulence and Combustion*, 96:921–938, 2016.
- [167] M. Klein, N. Chakraborty, and Y. Gao. Scale similarity based models and their application to subgrid scale scalar flux modelling in the context of turbulent premixed flames. *International Journal of Heat and Fluid Flow*, 57:91–108, 2016.
- [168] M. Klein, C. Kasten, and N. Chakraborty Y. Gao. A-priori direct numerical simulation assessment of sub-grid scale stress tensor closures for turbulent premixed combustion. *Computers and Fluids*, 122:1–11, 2015.
- [169] M. Klein Y. Gao and N. Chakraborty. Assessment of sub-grid scalar flux modelling in premixed flames for large eddy simulations: A-priori direct numerical simulation analysis. *European Journal of Mechanics - B/Fluids*, 52:97–108, 2015.
- [170] N. Chakraborty Y. Gao and M. Klein. Assessment of the performances of sub-grid scalar flux models for premixed flames with different global lewis numbers: A direct numerical simulation analysis. *International Journal of Heat and Fluid Flow*, 52:28–39, 2015.
- [171] N. Chakraborty, L. Wang, and M. Klein. Streamline segment statistics of premixed flames with non-unity lewis numbers. *Physical Review E*, E89:033015, 2014.
- [172] N. Chakraborty, M. Klein, and S. Cant. Effects of turbulent reynolds number on the displacement speed statistics in the thin reaction zones regime of turbulent premixed combustion. *Journal of Combustion*, doi:10.1155/2011/473679, 2011.
- [173] D. Goryntsev, A. Sadiki, M. Klein, and J. Janicka. Analysis of cyclic variations of liquid fuel-air mixing processes in a realistic disi ic-engine using large eddy simulation. *International Journal of Heat and Fluid Flow*, 31(5):845–849, 2010.
- [174] D. Goryntsev, M. Klein, A. Sadiki, and J. Janicka. Large eddy simulation for a DI gasoline engine - characterization of cyclic fluctuations of flow and mixing. *Motorentechnische Zeitschrift*, 3, 2009.
- [175] D. Goryntsev, A. Sadiki, M. Klein, and J. Janicka. Large eddy simulation based analysis of the effects of cycle-to-cycle variations on air-fuel mixing in realistic DISI IC-engines. *Proc. Comb. Inst.*, 32:2759–2766, 2009.
- [176] N. Chakraborty, M. Klein, and N. Swaminathan. Effects of Lewis number on the reactive scalar gradient alignment with local strain rate in turbulent premixed flames. *Proc. Comb. Inst.*, 32:1409–1417, 2009.
- [177] N. Chakraborty and M. Klein. Effects of global flame curvature on surface density function transport in turbulent premixed flame kernels in the thin reaction zones regime. *Proc. Comb. Inst.*, 32:1435–1443, 2009.

- [178] N. Chakraborty and M. Klein. A-priori direct numerical simulation assessment of algebraic flame surface density models for turbulent premixed flames in the context of large eddy simulation. *Physics of Fluids*, 20(085108), 2008.
- [179] N. Chakraborty and M. Klein. Influence of Lewis number on the surface density function transport in the thin reaction zones regime for turbulent premixed flames. *Physics of Fluids*, 20(065102), 2008.
- [180] M. Klein, N. Chakraborty, and R.S. Cant. Effects of turbulence on self-sustained combustion in premixed flame kernels: A direct numerical simulation (DNS) study. *Flow Turbulence and Combustion*, DOI 10.1007/s10494-008-9149-z, 2008.
- [181] I. Celik, M. Klein, and J. Janicka. Assessment measures for LES applications. *Journal of Fluids Engineering*, 131(3):031102, 2009.
- [182] M. Fathali, M. Klein, T. Broeckhoven, C. Lacor, and M. Baelmans. Generation of turbulent inflow and initial conditions based on multi correlated random fields. *International Journal for Numerical Methods in Fluids*, DOI: 10.1002 / fld.1627, 2007.
- [183] N. Chakraborty, M. Klein, and S. Cant. Stretch rate effects on displacement speed in turbulent premixed flame kernels in the thin reaction zones regime. *Proc. Comb. Inst.*, 31:1385–1392, 2007.
- [184] J. Hult, S. Gashi, N. Chakraborty, M. Klein, K.W. Jenkins, S. Cant, and C. Kaminski. Measurement of flame surface density for turbulent premixed flames using PLIF and DNS. *Proc. Comb. Inst.*, 31:1319–1326, 2007.
- [185] I. Celik, M. Klein, M. Freitag, and J. Janicka. Assessment measures for URANS/DES/LES: An overview with applications. *Journal of Turbulence*, 7:1–27, 2006.
- [186] K. Luo, M. Klein, J.R. Fan, and K.F. Cen. Effects on particle dispersion by turbulent transition in a jet. *Physics Letters A*, 357:345–350, 2006.
- [187] M. Freitag and M. Klein. An improved method to assess the quality of large eddy simulations in the context of implicit filtering. *Journal of Turbulence*, 7:1–11, 2006.
- [188] M. Klein, N. Chakraborty, K. Jenkins, and S. Cant. Effects of initial radius on the propagation of premixed flame kernels in a turbulent environment. *Physics of Fluids*, 18(055102), 2006.
- [189] M. Freitag, M. Klein, M. Gregor, D. Geyer, C. Schneider, A. Dreizler, and J. Janicka. Mixing analysis of a swirling recirculating flow using DNS and experimental data. *International Journal of Heat and Fluid Flow*, 27:636–643, 2006.
- [190] K. Jenkins, M. Klein, N. Chakraborty, and S. Cant. Effects of strain rate and curvature on the propagation of a spherical flame kernel in the thin reaction zones regime. *Combustion and Flame*, 145:415–434, 2006.
- [191] L. di Mare, M. Klein, W.P. Jones, and J. Janicka. Synthetic turbulence inflow conditions for large eddy simulation. *Physics of Fluids*, 18:025107, 2006.
- [192] M. Ciardi, P. Sagaut, M. Klein, and W.N. Dawes. A dynamic finite volume scheme for large-eddy simulation on unstructured grids. *Journal of Computational Physics*, 210:632–655, 2005.
- [193] M. Freitag and M. Klein. Direct numerical simulation of a recirculating, swirling flow. *Flow Turbulence and Combustion*, 75:51–66, 2005.

- [194] M. Klein. An attempt to assess the quality of large eddy simulations in the context of implicit filtering. *Flow Turbulence and Combustion*, 75:131–147, 2005.
- [195] M. Klein. Direct numerical simulation of a spatially developing water film at moderate Reynolds number. *International Journal of Heat and Fluid Flow*, 26:722–731, 2005.
- [196] A. Kempf, M. Klein, and J. Janicka. Efficient generation of initial- and inflow-conditions for transient turbulent flows in arbitrary geometries. *Flow Turbulence and Combustion*, 74:67–84, 2005.
- [197] M. Klein, A. Sadiki, and J. Janicka. A digital filter based generation of inflow data for spatially developing direct numerical or large eddy simulations. *J. Comp. Physics*, 186:652–665, 2003.
- [198] M. Klein, A. Sadiki, and J. Janicka. Investigation of the influence of the Reynoldsnumber on a plane jet using direct numerical simulation. *International Journal of Heat and Fluid Flow*, 24/6:785–794, 2003.

Book Chapters

- [199] R. Sandberg and M. Klein. *Data-Driven Modeling for Coarse Graining*. Cambridge University Press, 2025.
- [200] M. Germano, G. Scovazzi, A. Cimarelli, A. Ferrero, F. Larocca, F. Grinstein, J. Saenz, and M. Klein. *The Filtering Approach as a Tool for Modeling and Analyzing Turbulence*. Springer Nature Switzerland, 2021.
- [201] K. Rajkumar, E. Tangermann, M. Klein, S. Ketterl, and A. Winkler. *DES of weapon bay in fighter aircraft under high subsonic and supersonic conditions*. Springer International Publishing, Cham, 2021.
- [202] M. Schöpplein, J. Weatheritt, M. Talei, M. Klein, and R. D. Sandberg. *Application of an Evolutionary Algorithm to LES Modelling of Turbulent Premixed Flames*, pages 253–271. Springer International Publishing, Cham, 2020.
- [203] E. Tangermann and M. Klein. Numerical simulation of laminar separation on an airfoil in small-scale freestream turbulence. In A. Dillmann, G. Heller, E. Krämer, C. Wagner, C. Tropea, and S. Jakirlić, editors, *New Results in Numerical and Experimental Fluid Mechanics XII*, pages 619–629, Cham, 2020. Springer International Publishing.
- [204] E. Tangermann and M. Klein. Simulation of a three-dimensional wing with laminar separation in large-scale freestream turbulence. In Y. Hoarau, S.-H. Peng, D. Schwamborn, A. Revell, and C. Mockett, editors, *Progress in Hybrid RANS-LES Modelling*, pages 215–225, Cham, 2020. Springer International Publishing.
- [205] R. Meller, M. Klein, D. Lucas, and F. Schlegel. A-posteriori assessment of sub-filter scale models for turbulence–interface interaction with the two-fluid formulation considering a single rising gas bubble in liquid. In García-V.M., H. Kuerten, and M.V. Salvetti, editors, *Direct and Large Eddy Simulation XII*, pages 167–173, Cham, 2020. Springer International Publishing.
- [206] S. Yigit, J. Hasslberger, and M. Klein. Assessment of numerical dissipation in implicit les of turbulent rayleigh-bénard convection. In García-V.M., H. Kuerten, and M.V. Salvetti, editors, *Direct and Large Eddy Simulation XII*, pages 263–269, Cham, 2020. Springer International Publishing.
- [207] S. Ketterl, H. Kobayashi, and M. Klein. Analysis of regularised scale similarity type models in the context of two-phase flow with moving boundaries. In García-V.M., H. Kuerten, and M.V. Salvetti, editors, *Direct and Large Eddy Simulation XII*, pages 159–165, Cham, 2020. Springer International Publishing.
- [208] M. Klein, G. Scovazzi, and M. Germano. On the richardson extrapolation of the reynolds stress with the systematic grid and model variation method. In M.V. Salvetti, V. Armenio, J. Fröhlich, B.J. Geurts, and H. Kuerten, editors, *Direct and Large-Eddy Simulation XI*, pages 143–149, Cham, 2019. Springer International Publishing.
- [209] E. Tangermann and M. Klein. Detached eddy simulation of an SD7003 airfoil. In Y. Hoarau, S.-H. Peng, D. Schwamborn, and A. Revell, editors, *Progress in Hybrid RANS-LES Modelling*, pages 301–311, Cham, 2018. Springer International Publishing.
- [210] M. Klein, J. Meyers, and B.J. Geurts. *Assessment of LES Quality Measures Using the Error Landscape Approach*, pages 131–142. Springer Netherlands, Dordrecht, 2008.
- [211] A. Kempf, M. Klein, and J. Janicka. Transient inflow-data for les: towards the generation of turbulent inflow conditions for combustion les. In R. Friedrich, B. Geurts, and O. Metais, editors, *Direct and Large-Eddy Simulation V*, pages 367–374. Springer Netherlands, 2004.

Conferences

- [212] Marco Herbert, Oussama Chaib, Isaac Boxx, Simone Hochgreb, Nilanjan Chakraborty, and Markus Klein. Lewis number effects on weakly turbulent premixed bunsen flames: A comparison between dns and experimental investigations. In *13th Mediterranean Combustion Symposium*, Corfu, Greece, June 2025.
- [213] V. S. Wehrmann, N. Chakraborty, M. Klein, and J. Hasslberger. On local equivalence ratio dependence of the burning rate in premixed turbulent lean hydrogen/air flames: A direct numerical simulation analysis. In *13th Mediterranean Combustion Symposium*, Corfu, Greece, June 2025.
- [214] M. Bambauer, M. Pfitzner, and M. Klein. Flame surface density and artificially thickened flame combustion models applied to a turbulent partially-premixed flame. In *13th Mediterranean Combustion Symposium*, Corfu, Greece, June 2025.
- [215] Josef Hasslberger and Markus Klein. A-priori analysis and subgrid-scale modeling of the slip term in the volume-averaged conservation equations for multiphase flows. In *12th International Conference on Multiphase Flows (ICMF 2025)*, Toulouse, France, September 2025.
- [216] Andreas Iberl, Elias Trautner, Markus Klein, and Josef Hasslberger. Towards predicting particle deposition in bubbly flows using an Eulerian-Lagrangian framework. In *12th International Conference on Multiphase Flows (ICMF 2025)*, Toulouse, France, September 2025.
- [217] E. Tangermann, W. Dierl, and M. Klein. Sensitivity of laminar separation to geometric uncertainties. In *AIAA SciTech Forum*, Orlando, USA, January 2025.
- [218] R. Concetti, J. Hasslberger, and M. Klein. Effect of water collision efficiency on emissions of a non-premixed hydrogen/air flames. In *46th Meeting of the Italian section of the Combustion Institute. Towards Net-Zero Carbon Society*, Bari, Italy, June 2024.
- [219] O. Krzeczek, W. Aniszewski, T. Menard, and M. Klein. Direct numerical simulation analysis of turbulent emulsions in linear forced turbulence with controlled length scale. In *International Conference on Numerical Methods in Multiphase Flows*, Reykjavik, Iceland, July 2024.
- [220] J. Hasslberger and M. Klein. A-priori analysis on the sub-grid scale energy transfer in multiphase LES for different governing equations. In *International Conference on Numerical Methods in Multiphase Flows*, Reykjavik, Iceland, July 2024.
- [221] Andreas Iberl, Elias Trautner, Markus Klein, and Josef Hasslberger. A-posteriori assessment of various LES modeling frameworks for polydisperse multiphase flows. In *International Conference on Numerical Methods in Multiphase Flows*, Reykjavik, Iceland, July 2024.
- [222] R. Ji, S. Kelm, and M. Klein. An efficient method for input uncertainty propagation applied to a gas mixing process. In *Conference Best Estimate Modelling Plus Uncertainties in Safety Analyses*, Lucca, Italy, May 2024.
- [223] M. Schweiger, M. Klein, J. Hasslberger, F. Alcantara-Avila, and S. Hoyas. A-priori assessment of sub-grid scale heat flux modeling in large-eddy simulation for varying Prandtl numbers. In *Kerntechnik*, Leipzig, Germany, June 2024.
- [224] M. Klein. Integral length and time scales of higher order moments. In *Direct and Large-Eddy Simulation 14*, Erlangen, Germany, April 2024.

- [225] P. Wenig, S. Kelm, and M. Klein. CFD uncertainty quantification based on stochastic spectral methods. In *SIAM Conference on Uncertainty Quantification*, Trieste, February 2024.
- [226] E. Tangermann and M. Klein. Coherent flow structures downstream of a laminar separation bubble - a numerical investigation. In *AIAA SciTech Forum*, Orlando, USA, January 2024.
- [227] E. Ruiz-Gutierrez, J. Hasslberger, M. Klein, K.W. Dalgarno, and N. Chakraborty. Mixing in binary droplet collisions of different materials. In *International Symposium on Turbulence, Heat and Mass Transfer*, Rome, September 2023.
- [228] A. Bosco Premkumar, F. Loffredo, H. Pitsch, and M. Klein. DNS of a RCCI engine using octanol-ethanol as the fuel blend. In *14th International Symposium on Engineering Turbulence Modelling and Measurements*, Barcelona Spain, September 2023.
- [229] M. Abdelsayed, E. Trautner, and M. Klein. Detailed numerical investigation of the effect of nozzle flow on primary atomization of liquid jets. In *14th International Symposium on Engineering Turbulence Modelling and Measurements*, Barcelona Spain, September 2023.
- [230] E. Trautner, J. Hasslberger, P. Cifani, and M. Klein. Enforcing accurate volume conservation in VOF-based coarse grid simulations of turbulent bubble-laden flows. In *14th International Symposium on Engineering Turbulence Modelling and Measurements*, Barcelona Spain, September 2023.
- [231] B. Blau, O. Krzeczek, C. Heinrich, and M. Klein. Comparison of experimental and numerical analyses of water-in-gasoline emulsions. In *14th International Symposium on Engineering Turbulence Modelling and Measurements*, Barcelona Spain, September 2023.
- [232] E. Trautner, J. Hasslberger, and M. Klein. Towards LES of liquid jet atomization using an Eulerian-Lagrangian multiscale approach. In *14th International Symposium on Engineering Turbulence Modelling and Measurements*, Barcelona Spain, September 2023.
- [233] A. Doehring, M. Klein, M. Son, T. Sander, M. Pfitzner, and L. Zigan. Assessment of SGS models in transcritical injection processes. In *14th International Symposium on Engineering Turbulence Modelling and Measurements*, Barcelona Spain, September 2023.
- [234] J. Hasslberger, M. Schweiger, E. Trautner, and M. Klein. Assessment of the multiscale formulation of the singular values based LES model for wall-bounded flows. In *14th International Symposium on Engineering Turbulence Modelling and Measurements*, Barcelona Spain, September 2023.
- [235] E. Tangermann and M. Klein. A sensor-based scale-resolving turbulence model for separated shear layers. In *14th International Symposium on Engineering Turbulence Modelling and Measurements*, Barcelona Spain, September 2023.
- [236] R. Concetti, J. Hasslberger, N. Chakraborty, and M. Klein. Effects of liquid water injection on turbulent premixed hydrogen/air combustion. In *15th International Conference on Combustion Technologies for a Clean Environment*, Lisbon, Portugal, June 2023.
- [237] V. Wehrmann, M. Klein, and J. Hasslberger. DNS-Untersuchung der Flammendynamik in turbulenten H₂-CO-Luft-Gemischen. In *31. Deutscher Flammentag fuer nachhaltige Verbrennung*, Berlin, September 2023.
- [238] B. Blau, O. Krzeczek, C. Heinrich, and M. Klein. Water-in-gasoline emulsion droplet size distributions: Comparison of experimental and numerical results. In *19th Multiphase Flow Conference*, Dresden, June 2023.

- [239] M. Abdelsayed, E. Trautner, and M. Klein. A parametric study on the effect of inflow turbulence on primary atomization of liquid jets. In *19th Multiphase Flow Conference*, Dresden, June 2023.
- [240] A. Iberl, E. Trautner, M. Klein, and J. Hasslberger. Numerical investigation of gas bubble behavior for pool scrubbing in nuclear reactors using the volume-of-fluid method. In *19th Multiphase Flow Conference*, Dresden, June 2023.
- [241] E. Ruiz-Gutierrez, J. Hasslberger, N. Chakraborty, K. Dalgarno, and M. Klein. Modelling capillary forces in the volume-of-fluid method for three or more phases. In *19th Multiphase Flow Conference*, Dresden, June 2023.
- [242] U. Ahmed, N. Chakraborty, and M. Klein. Influence of the variation in laminar burning velocity to friction velocity ratio on turbulent premixed flame-wall interaction within turbulent boundary layers. In *11th European Combustion Meeting*, Rouen, France, April 2023.
- [243] M. Son, T. Sander, M. Pfitzner, L. Zigan, A. Doehring, and M. Klein. Experimental and numerical investigation of cyclopentane sprays under sub- and transcritical conditions. In *European Meeting on Liquid Atomization and Spray Systems, ILASS*, Naples, Italy, September 2023.
- [244] T. Hehn, M. Klein, J. Holtmannspötter, and F. Zimmer. Numerical simulation of an additive manufacturing process for low-impedance electronics. In *16th International Conference on Advanced Computational Engineering and Experimenting*, Heraklion, Greece, July 2023.
- [245] P. Wenig, S. Kelm, and M. Klein. Uncertainty quantification of a industrial scale CFD application. In *5th International Conference on Uncertainty Quantification in Computational Science and Engineering*, Athens, Greece, June 2023.
- [246] B. Blau, C. Heinrich, and M. Klein. Droplet size analysis of gasoline-water emulsions in the high-pressure injection system - influence of system design and operating parameters on emulsion quality. In *12. Tagung Einspritzung und Kraftstoffe*, Dessau, Germany, May 2023.
- [247] E. Ruiz-Gutierrez, J. Hasslberger, M. Klein, K. Dalgarno, and N. Chakraborty. Numerical study of mixing in reactive jet impingement (ReJI) for 3d bioprinting. In *11th International Conference on Multiphase Flow*, Kobe, Japan, April 2023.
- [248] S. Lomada, M. Klein, and M. Pfitzner. Flame surface density and artificially thickened flame combustion models applied to a turbulent partially-premixed flame. In *11th Mediterranean Combustion Symposium*, Luxor, Egypt, January 2023.
- [249] M. Pfitzner, J. Shin, and M. Klein. A priori validation of a multidimensional turbulent premixed combustion model. In *11th Mediterranean Combustion Symposium*, Luxor, Egypt, January 2023.
- [250] F.B. Keil, N. Chakraborty, and M. Klein. Comparison of flame propagation statistics in statistically planar turbulent premixed flames using direct numerical simulations with detailed and simple chemistry and transport. In *11th Mediterranean Combustion Symposium*, Luxor, Egypt, January 2023.
- [251] P. Wenig, S. Kelm, and M. Klein. Uncertainty quantification of LES for the buoyancy-driven mixing process between two miscible fluids using staggered PCE and KLE - Differentially heated cavity of aspect ratio 4. In *Direct and Large-Eddy Simulation 13*, Udine, Italy, October 2022.

- [252] E. Trautner, J. Hasslberger, P. Cifani, and M. Klein. Volume conservation methods for VOF-based long-term simulations of turbulent bubble-laden flows on coarse grids. In *Direct and Large-Eddy Simulation 13*, Udine, Italy, October 2022.
- [253] A. Begemann, T. Trummler, E. Trautner, J. Hasslberger, and M. Klein. Assessment of the effect of the surface tension contribution on the emulsification in linearly forced turbulence. In *Direct and Large-Eddy Simulation 13*, Udine, Italy, October 2022.
- [254] A. Doehring, N. Urban, T. Trummler, M. Pfitzner, and M. Klein. Assessment of a state-of-the-art thermodynamic modelling approach for CFD simulations under trans- and supercritical conditions. In *4th International Seminar on Non-Ideal Compressible Fluid Dynamics*, London, UK, November 2022.
- [255] B. Blau, C. Heinrich, and M. Klein. Gasoline water direct injection (GWDI): Optical investigations on fuel-water emulsions in the injection system. In *Aachen Colloquium Sustainable Mobility*, Oktober, Aachen, Germany 2022.
- [256] R. Meller, F. Schlegel, and M. Klein. Modelling and a-posteriori assessment of closure models for sub-grid surface tension considering a rising gas bubble. In *EUROMECH Colloquium Advances in LES of Turbulent Multiphase Flows*, June, Udine, Italy 2022.
- [257] M. Klein, A. Ferrero, F. Larocca, M. Errante, G. Scovazzi, and M. Germano. Mixed averaging procedures. In *33rd International Conference on Parallel Computational Fluid Dynamics*, Alba, Italy, May 2022.
- [258] E. Tangermann, G. Ercolani, and M. Klein. Numerical investigation of a bio-inspired airfoil with air-permeable holes. In *11th International Conference on Computational Fluid Dynamics*, Maui, Hawaii, July 2022.
- [259] U. Ahmed, N. Chakraborty, and M. Klein. Influence of flow configuration and thermal wall boundary conditions on turbulence during premixed flame-wall interaction within boundary layers. In *Eighteenth International Conference on Numerical Combustion*, San Diego, USA, May 2022.
- [260] E. Tangermann and M. Klein. Towards efficient prediction of near wall transition in scale resolving simulations. In *8th European Congress on Computational Methods in Applied Sciences and Engineering*, Oslo, Norway, June 2022.
- [261] J. Hasslberger, M. Hampp, and M. Klein. A-priori analysis of static and dynamic sub-grid scale closures conditional on the coherent structure of the flow. In *8th European Congress on Computational Methods in Applied Sciences and Engineering*, Oslo, Norway, June 2022.
- [262] T. Di Fabbio, E. Tangermann, and M. Klein. Investigation of Reynolds stresses prior to vortex breakdown on a triple delta wing at transonic condition. In *Twelfth International Symposium on Turbulence and Shear Flow Phenomena*, Osaka, Japan, July 2022.
- [263] E. Tangermann and M. Klein. Impact of grid resolution on hybrid RANS-LES of transition in a separated boundary layer. In *Twelfth International Symposium on Turbulence and Shear Flow Phenomena*, Osaka, Japan, July 2022.
- [264] J. Hasslberger, E. Trautner, and M. Klein. Fractal properties of atomizing turbulent two-phase jets. In *Twelfth International Symposium on Turbulence and Shear Flow Phenomena*, Osaka, Japan, July 2022.
- [265] K. Rajkumar, E. Tangermann, and M. Klein. Towards high fidelity cavity simulations at affordable computational cost. In *AIAA Aviation Forum*, Chicago, USA, June 2022.

- [266] T. Di Fabbio, E. Tangermann, and M. Klein. Flow pattern analysis on a delta wing at transonic speed. In *AIAA SciTech Forum*, San Diego, USA, January 2022.
- [267] M. Bambauer, J. Hasslberger, and M. Klein. Investigation of the scale similarity principle for subgrid modelling of the reactive Richtmyer-Meshkov instability. In *28th International Colloquium on the Dynamics of Explosions and Reactive Systems*, Naples, Italy, June 2022.
- [268] R. Concetti, J. Hasslberger, N. Chakraborty, and M. Klein. Statistics of flame topology in turbulent spray flame water droplet interaction. In *28th International Colloquium on the Dynamics of Explosions and Reactive Systems*, Naples, Italy, June 2022.
- [269] J. Hasslberger, R. Concetti, N. Chakraborty, and M. Klein. DNS of turbulent spray flame water droplet interaction using an Euler-Lagrange-Lagrange scheme. In *28th International Colloquium on the Dynamics of Explosions and Reactive Systems*, Naples, Italy, June 2022.
- [270] K. Rajkumar, E. Tangermann, M. Klein, S. Ketterl, and A. Winkler. Time-efficient simulations of weapon bay in fighter aircraft. In *Aerospace Europe Conference*, Warsaw, Poland, November 2021.
- [271] E. Trautner, S. Ketterl, J. Hasslberger, and M. Klein. A direct numerical simulation study of droplet sizes and Weber numbers in primary atomization of liquid jets. In *18th Multiphase Flow Conference and Short Course*, Dresden, November 2021.
- [272] J. Shin, M. Hansinger, M. Pfitzner, and M. Klein. A priori analysis of data-driven premixed combustion subgrid models. In *30. Deutscher Flammentag*, Hannover, Germany, September 2021.
- [273] U. Ahmed, N. Chakraborty, and M. Klein. Scalar statistics in premixed flame-wall interaction within turbulent boundary layers under different flow configurations. In *17th UK Heat Transfer Conference*, Manchester, UK, September 2021.
- [274] R. Ji, P. Wenig, S. Kelm, and M. Klein. Uncertainty quantification with efficient polynomial chaos based methods for CFD analysis of buoyancy driven flow. In *19th International Topical Meeting on Nuclear Reactor Thermal Hydraulics*, Brussels, Belgium, March 2022.
- [275] U. Ahmed, N. Chakraborty, and M. Klein. Influence of wall boundary conditions on premixed flame-wall interaction in turbulent boundary layers. In *10th European Combustion Meeting*, Naples, Italy, April 2021.
- [276] T. Di Fabbio, E. Tangermann, and M. Klein. Comparative scale-resolving and RANS simulations of a delta wing configuration. In *Deutscher Luft- und Raumfahrtkongress*, Online, November 2020.
- [277] M. Reissmann, J. Hasslberger, R. Sandberg, and M. Klein. Application of gene expression programming to a-posteriori LES modelling of a Taylor Green vortex. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [278] J. Hasslberger and M. Klein. A sub-grid activity sensor applied to a-posteriori LES modeling of laminar-turbulent transition. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [279] S. Yigit, J. Hasslberger, and M. Klein. Determination of numerical errors in LES of turbulent Rayleigh-Benard convection. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [280] E. Tangermann, G. Ercolani, and M. Klein. Aerodynamic performance of biomimetic wings in soaring flight - a numerical study. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.

- [281] S. Yigit, J. Hasslberger, N. Chakraborty, and M. Klein. Analysis of the reverse tear-drop shape of the velocity gradient tensor invariants joint pdf close to walls in turbulent Rayleigh-Benard convection. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [282] J. Lai, U. Ahmed, M. Klein, and N. Chakraborty. A comparison between head-on quenching of turbulent methane-air and hydrogen-air flames using detailed chemistry direct numerical simulations. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [283] P. Breda, E. Trautner, M. Klein, and M. Pfitzner. CPU-based deployment of artificial neural networks for LES of reacting flows in OpenFOAM. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [284] P. Wenig, R. Ji, S. Kelm, and M. Klein. Towards uncertainty quantification of LES and URANS for internal natural convection - differentially heated cavity of aspect ratio 4. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [285] E. Trautner, J. Hasslberger, P. Cifani, R. Verstappen, and M. Klein. Towards LES of bubble-laden channel flows: Sub-grid scale closures for momentum advection. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [286] U. Ahmed, N. Chakraborty, and M. Klein. Effects of turbulent boundary layer on the near-wall flame dynamics in the case of adiabatic walls. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [287] M. Germano, J. Hasslberger, and M. Klein. Decomposition of the two point correlations and the dissipation from filtered data. In *13th International Symposium on Engineering Turbulence Modelling and Measurements*, Rhodes, May 2021.
- [288] M. Bambauer, J. Hasslberger, N. Chakraborty, and M. Klein. Vortex dynamics and fractal structures in reactive Richtmyer-Meshkov instability. In *International Symposium on Hazards, Prevention, and Mitigation of Industrial Explosions*, Braunschweig, Germany, July 2020.
- [289] R. Ji, P. Wenig, S. Kelm, and M. Klein. Uncertainty quantification for URANS based CFD analysis of buoyancy driven flows - comparison of the sensitivity of URANS and LES. In *Computational Fluid Dynamics for Nuclear Reactor Safety - Workshop*, Paris, France, November 2020.
- [290] E. Tangermann and M. Klein. Numerical simulation of a separating laminar boundary layer exposed to ambient turbulence. In *WCCM-ECCOMAS 2020 Congress*, Paris, France, July 2020.
- [291] M. Bambauer, J. Hasslberger, M. Klein, and N. Chakraborty. Vortex dynamics and fractal structures in reactive Richtmyer-Meshkov instability. In *International Symposium on Hazards, Prevention and Mitigation of Industrial Explosions*, Braunschweig, July 2020.
- [292] E. Tangermann and M. Klein. Numerical simulation of laminar separation on a nac0018 airfoil in freestream turbulence. In *AIAA SciTech Forum*, Orlando, Florida, January 2020.
- [293] J. Hasslberger, P. Cifani, E. Trautner, M. Klein, and N. Chakraborty. A direct numerical simulation analysis of coherent structures in bubble-laden channel flows. In *17th Multiphase Flow Conference and Short Course*, Dresden, November 2019.

- [294] U. Ahmed, N. Chakraborty, and M. Klein. Statistics of turbulence during head-on quenching of premixed turbulent combustion in boundary layers. In *International Workshop on Clean Combustion: Principles and Applications*, Darmstadt, Germany, September 2019.
- [295] I. Konstantinou, N. Chakraborty U. Ahmed, and M. Klein. Statistics of turbulence during head-on quenching of premixed turbulent combustion in boundary layers. In *International Workshop on Clean Combustion: Principles and Applications*, Darmstadt, Germany, September 2019.
- [296] S. Yigit, J. Hasslberger, and M. Klein. Determination of numerous errors in implicit LES of turbulent Rayleigh Benard convection. In *International Workshop on Clean Combustion: Principles and Applications*, Darmstadt, Germany, September 2019.
- [297] E. Tangermann, G. Ercolani, and M. Klein. Simulation of the flow over cascaded wingtips at low reynolds number. In *14th OpenFOAM Workshop*, Duisburg, Germany, July 2019.
- [298] U. Ahmed, N. Chakraborty, and M. Klein. Oblique flame-wall interaction in premixed turbulent combustion under isothermal and adiabatic wall boundary conditions. In *27th International Colloquium on the Dynamics of Explosions and Reactive Systems*, Beijing, China, August 2019.
- [299] D. Butz, A. Dreizler, M. Klein, S. Popp, C. Hasse, and D. Geyer. Experimentelle Untersuchung der nichtreaktiven Mischungsvorgänge an einem Multi-Regime-Brenner. In *29. Deutscher Flammentag*, Bochum, Germany, September 2019.
- [300] M. Bambauer, J. Hasslberger, and M. Klein. Direkte numerische Simulation der Richtmyer-Meshkov Instabilität im Kontext von Wasserstoffexplosionen. In *29. Deutscher Flammentag*, Bochum, Germany, September 2019.
- [301] R. Meller, M. Klein, D. Lucas, and F. Schlegel. A-posteriori assessment of sub-filter scale models for turbulence-interface interaction with two-fluid formulation in cases of a single rising gas bubble in liquid. In *Direct and Large-Eddy Simulation 12*, Madrid, Spain, June 2019.
- [302] S. Yigit, J. Hasslberger, and M. Klein. Assessment of numerical dissipation in LES of turbulent Rayleigh-Benard convection. In *Direct and Large-Eddy Simulation 12*, Madrid, Spain, June 2019.
- [303] S. Ketterl, H. Kobayashi, and M. Klein. Analysis of regularised scale similarity type models in the context of two-phase flow with moving boundaries. In *Direct and Large-Eddy Simulation 12*, Madrid, Spain, June 2019.
- [304] J. Hasslberger, S. Ketterl, and M. Klein. A-priori assessment of existing and novel interfacial sub-grid scale closures in the two-phase flow les context. In *Direct and Large-Eddy Simulation 12*, Madrid, Spain, June 2019.
- [305] R. Rasool, M. Klein, L. Seilnacht, and N. Chakraborty. Algebraic flame surface density modelling of high pressure turbulent premixed bunsen flames. In *11th Mediterranean Combustion Symposium*, Tenerife, Spain, June 2019.
- [306] F.B. Keil, M. Klein, and N. Chakraborty. Sub-grid reaction progress variable variance closure in turbulent premixed flames. In *11th Mediterranean Combustion Symposium*, Tenerife, Spain, June 2019.
- [307] G. Ozel-Erol, M. Klein, and N. Chakraborty. Lewis number effects on flame speed statistics in spherical turbulent premixed flames. In *11th Mediterranean Combustion Symposium*, Tenerife, Spain, June 2019.

- [308] U. Ahmed, I. Konstantinou, M. Klein, and N. Chakraborty. Near-wall behaviour of turbulence in flame-wall interaction of premixed turbulent combustion. In *9th European Combustion Meeting*, Lisboa, Portugal, April 2019.
- [309] G. Ozel Erol, J. Hasslberger, M. Klein, and N. Chakraborty. A direct numerical simulation analysis of turbulent V-flames propagating into droplet-laden mixtures with overall equivalence ratio of unity. In *9th European Combustion Meeting*, Lisboa, Portugal, April 2019.
- [310] M. Pfitzner, M. Klein, M. Hansinger, and N. Chakraborty. Flame curvature distribution in high pressure turbulent bunsen premixed flames. In *Seventeenth International Conference on Numerical Combustion*, Aachen Germany, May 2019.
- [311] A. Alqallaf, N. Chakraborty, and M. Klein. The signature of flame instabilities on the transport of curvature in turbulent premixed flames. In *Seventeenth International Conference on Numerical Combustion*, Aachen Germany, May 2019.
- [312] M. Klein. Interaction of numerical and modelling errors in the context of LES using implicit filtering. In *Seventeenth International Conference on Numerical Combustion*, Aachen Germany, May 2019.
- [313] S. Ketterl and M. Klein. A new approach for subgrid scale modeling of surface tension for large eddy simulation of liquid atomization. In *10th International Conference on Multiphase Flow*, Rio de Janeiro, Brasil, May 2019.
- [314] K. Amend and M. Klein. Development and validation of a CFD wash-off model for fission products on containment walls. In *49th Annual Meeting on Nuclear Technology*, Berlin, May 2018.
- [315] E. Tangermann and M. Klein. Numerical simulation of laminar separation on an airfoil in small-scale freestream turbulence. In *DGLR-Fachsymposium der STAB*, Darmstadt, Germany, November 2018.
- [316] E. Tangermann and M. Klein. Implementation and validation of a method to introduce synthetic turbulence by volume forces. In *13th OpenFOAM Workshop*, Shanghai, China, June 2018.
- [317] E. Tangermann and M. Klein. Simulation of a three-dimensional wing with laminar separation in large-scale freestream turbulence. In *7th Symposium on Hybrid RANS-LES Methods*, Berlin, Germany, September 2018.
- [318] J. Hasslberger, M. Klein, and N. Chakraborty. Local flow topology analysis applied to bubble-induced turbulence. In *12th International Symposium on Engineering Turbulence Modelling and Measurements*, Montpellier, September 2018.
- [319] M. Klein, R. Sandberg, J. Weatheritt, and M. Schöppl. Application of gene expression programming to LES modelling of turbulent premixed flames. In *12th International Symposium on Engineering Turbulence Modelling and Measurements*, Montpellier, September 2018.
- [320] N. Chakraborty, V. Papapostolou, D. Wacks, M. Klein, and H. Im. Generalised flame surface density statistics conditional on flow topologies for turbulent H₂-air premixed flames in different regimes of combustion. In *12th International Symposium on Engineering Turbulence Modelling and Measurements*, Montpellier, September 2018.
- [321] R. Meller, M. Klein, D. Lucas, and F. Schlegel. Turbulence-interface interaction in large-eddy simulations with a two-fluid model. In *12th International Symposium on Engineering Turbulence Modelling and Measurements*, Montpellier, September 2018.

- [322] U. Ahmed, J. Lai, N.A.K. Doan, M. Klein, and N. Chakraborty. Effects of detailed chemistry on multiscale analysis of head-on quenching in premixed turbulent combustion. In *12th International Symposium on Engineering Turbulence Modelling and Measurements*, Montpellier, September 2018.
- [323] U. Ahmed, N. Chakraborty, and M. Klein. Stress-strain alignment in premixed turbulent combustion. In *12th International Symposium on Engineering Turbulence Modelling and Measurements*, Montpellier, September 2018.
- [324] A. Herbert, H. Kosaka, B. Böhm, A. Dreizler, and N. Chakraborty. Evaluation of flame area based on detailed chemistry dns of premixed turbulent hydrogen air flames in different regimes of combustion. In *12th International Symposium on Engineering Turbulence Modelling and Measurements*, Montpellier, September 2018.
- [325] K. Haase, J. Hasslberger, C. Kaehler, and M. Klein. Dynamics of (highly) deformable air bubbles rising in water. In *International Conference on Experimental Fluid Mechanics in Munich*, Munich, July 2018.
- [326] V. Papapostolou, N. Chakraborty, M. Klein, and H. G. Im. Statistics of scalar flux transport of major species in different premixed turbulent combustion regimes. In *Turbulence, Heat and Mass Transfer*, Rio de Janeiro, July 2018.
- [327] G. Ozel Erol, J. Hasslberger, M. Klein, and N. Chakraborty. Spherically expanding turbulent flames in fuel droplet-mists: A Direct Numerical Simulation analysis. In *Turbulence, Heat and Mass Transfer*, Rio de Janeiro, July 2018.
- [328] S. Yigit, J. Hasslberger, N. Chakraborty, and M. Klein. Three-dimensional high-fidelity simulations of rayleigh benard convection of yield stress fluids in cubic enclosures at high rayleigh numbers. In *International Conference on Computational Heat and Mass Transfer*, Cracow, Poland, May 2018.
- [329] K. Amend and M. Klein. Modeling and simulation of wash-down of fission products by water on containment walls. In *Computational fluid dynamics (CFD) in nuclear reactor safety (NRS), CFD4NRS*, Shanghai, September 2018.
- [330] J. Lai, M. Klein, and N. Chakraborty. Direct numerical simulation of head-on quenching of statistically planar turbulent premixed methane flames using a detailed chemical mechanism. In *10th Mediterranean Combustion Symposium*, Napoli, Italy, September 2017.
- [331] M. Klein, R. Kashtanov, and N. Chakraborty. Alternative definition of the wrinkling factor in the context of FSD based LES modelling of turbulent premixed combustion. In *10th Mediterranean Combustion Symposium*, Napoli, Italy, September 2017.
- [332] M. Klein, H. Nachtigal, M. Hansinger, M. Pfitzner, and N. Chakraborty. Flame curvature in high pressure bunsen flames. In *10th Mediterranean Combustion Symposium*, Napoli, Italy, September 2017.
- [333] M. Klein, H. Nachtigal, N. Chakraborty, and D. Alwazzan. DNS of turbulent premixed bunsen flames at ambient and elevated pressures. In *Parallel CFD Conference 2017*, Glasgow, UK, May 2017.
- [334] J. Hasslberger, S. Ketterl, and M. Klein. DNS of single bubble dynamics in turbulent counterflow. In *Parallel CFD Conference 2017*, Glasgow, UK, May 2017.
- [335] M. Klein, G. Scovazzi, and M. Germano. On the Richardson extrapolation of the Reynolds stress with the systematic grid and model variation method. In *Direct and Large-Eddy Simulation 11*, Pisa, Italy, May 2017.

- [336] S. Ketterl and M. Klein. A novel turbulent inflow data generation method and its application to the simulation of primary breakup. In *Direct and Large-Eddy Simulation 11*, Pisa, Italy, May 2017.
- [337] K. Amend and M. Klein. Modeling and simulation of water flow on containment walls with inhomogeneous contact angle distribution. In *48th Annual Meeting on Nuclear Technology*, Berlin, May 2017.
- [338] E. Tangermann, M. Klein, S. Herbst, R. Hain, and C. J. Kähler. Numerical and experimental investigation of the flow around a three-dimensional SD7003 wing. In *Tenth International Symposium on Turbulence and Shear Flow Phenomena*, Chicago, USA, July 2017.
- [339] S. Ketterl and M. Klein. A-priori and a-posteriori assessment of LES subgrid models for liquid jet atomization. In *Tenth International Symposium on Turbulence and Shear Flow Phenomena*, Chicago, USA, July 2017.
- [340] B. Papapostolou, D.H. Wacks, M. Klein, N. Chakraborty, and H.G. Im. Distributions of flow topology and enstrophy in different turbulent premixed combustion regimes: a direct numerical simulation investigation. In *SIAM Conference on Numerical Combustion*, Orlando, USA, April 2017.
- [341] K. Amend and M. Klein. Simulation of water flow down inclined containment walls. In *14th Multiphase Flow Conference and Short Course*, Dresden, November 2016.
- [342] H. G. Im, P.G. Arias, N. Chakraborty, M. Klein, and C. Kasten. Modelling of turbulent scalar fluxes in the broken reaction zones regime. In *69th Annual Meeting of the APS Division of Fluid Dynamics*, Portland, USA, November 2016.
- [343] E. Tangermann, T. Prigge, and M. Klein. Detached eddy simulation of an SD7003 airfoil. In *6th Symposium on Hybrid RANS-LES Methods*, Strasbourg, France, September 2016.
- [344] J.Lai, N. Chakraborty, and M. Klein. A priori direct numerical simulation assessment of algebraic flame surface density models for turbulent flame-wall interaction in the context of large eddy simulation. In *11th International ERCOFTAC Symposium on Engineering Turbulence Modelling and Measurements*, Palermo, Italy, September 2016.
- [345] M. Klein, L. Dressler, N. Chakraborty, and C. Stafford. A comparison of strategies for direct numerical simulation of turbulence chemistry interaction in generic planar turbulent premixed flames. In *11th International ERCOFTAC Symposium on Engineering Turbulence Modelling and Measurements*, Palermo, Italy, September 2016.
- [346] M. Klein, C. Kasten, N. Chakraborty, P.G. Arias, and H. G. Im. Turbulent scalar fluxes in detailed chemistry based premixed flame dns simulations of h₂-air flames in different regimes of combustion. In *11th International ERCOFTAC Symposium on Engineering Turbulence Modelling and Measurements*, Palermo, Italy, September 2016.
- [347] E. Tangermann and M. Klein. The flow around an elastic square cylinder. In *11th Open-FOAM Workshop*, Guimaraes, Portugal, June 2016.
- [348] N. Wegh, M. Wagner, D. Gaudlitz, H. Finckh, and M. Klein. Numerical simulation of filling process in resin transfer molding. In *13th International conference on flow processes in composite materials*, Kyoto, Japan, July 2016.
- [349] J. Lai, N. Chakraborty, and M. Klein. Assessment of algebraic LES-flame surface density closures for head-on quenching of turbulent premixed flames with non-unity lewis number. In *Joint British, Spanish and Portuguese Section Combustion Meeting*, Cambridge, UK, April 2016.

- [350] S. Ketterl and M. Klein. A-priori DNS assessment of les subgrid models for liquid jet atomization. In *ILASS 2016 - 27th European Conference on Liquid Atomization and Spray Systems*, Brighton, UK, September 2016.
- [351] M. Freitag, B. von Laufenberg, M. Colombet, K. Amend, and M. Klein. Particulate fission product wash-down from containment walls and installation surfaces. In *Annual Meeting on Nuclear Technology 2016*, Hamburg, Germany, May 2016.
- [352] S. Ketterl and M. Klein. Towards large-eddy simulation of liquid jet atomization: A-priori subgrid analysis. In *International Conference on Multiphase flow 2016*, Firenze, Italy, May 2016.
- [353] S. Ketterl and M. Klein. Towards large-eddy simulation of liquid jet atomization: DNS and a-priori subgrid analysis. In *13th Multiphase Flow Conference & Short Course*, Dresden, Germany, November 2015.
- [354] K. Amend and M. Klein. Influence of the contact angle model on gravity driven water films. In *13th Multiphase Flow Conference & Short Course*, Dresden, Germany, November 2015.
- [355] N. Wegh, S. Bachschuster, D. Gaudlitz, and M. Klein. Multi-phase flow in porous media: 3d simulation of the impregnation stage of the RTM process. In *OpenFOAM User Meeting*, Darmstadt, Germany, August 2015.
- [356] M. Klein. A-priori analysis of physical and numerical modeling of turbulent premixed combustion. In *Symposium on Unsteady Aerodynamics*, Munich, Germany, July 2015.
- [357] N. Wegh, S. Bachschuster, D. Gaudlitz, and M. Klein. 3D Injektionssimulation für RTM-Verfahren unter Berücksichtigung von lokalem Faseraufbau und Harzaushärtung. In *Allianz Faserbasierte Werkstoffe Baden-Württemberg e.V. AG Simulation mit dem Schwerpunkt Infiltrationssimulation für faserbasierte Werkstoffe*, Fellbach, Germany, July 2015.
- [358] M. Klein, C. Wolff, and E. Tangermann. A-priori analysis of a LES model for scalar flux based on interscale energy transfer. In *9th International Symposium on Turbulence and Shear Flow*, Melbourne, Australia, July 2015.
- [359] Eike Tangermann, Markus Klein, and Michael Pfitzner. Large eddy simulation of flame flashback by combustion induced vortex breakdown. In *9th International Symposium on Turbulence and Shear Flow*, Melbourne, Australia, July 2015.
- [360] M. Klein, N. Chakraborty, and Y. Gao. Application of scale similarity based models to subgrid scale scalar flux modelling in the context of turbulent premixed flames. In *9th International Symposium on Turbulence and Shear Flow*, Melbourne, Australia, July 2015.
- [361] M. Klein, N. Chakraborty, Y. Gao, C. Kasten, and M. Pfitzner. Analysis of the combined modelling of subgrid transport and filtered flame propagation for premixed turbulent combustion. In *9th Mediterranean Combustion Symposium*, Rhodes, Greece, June 2015.
- [362] M. Klein, U. Allauddin, R. Keppeler, and M. Pfitzner. Towards uncertainty quantification and quality assessment for large eddy simulation of turbulent premixed combustion. In *Uncertainty Quantification in Computational Fluid Dynamics*, Paris, France, May 2015.
- [363] N. Wegh, S. Bachschuster, D. Gaudlitz, and M. Klein. Three-dimensional simulation of the impregnation stage of the RTM process considering the local structure of the fiber layup. In *8th International Conference on Computational and Experimental Methods in Multiphase and Complex Flow*, Valencia, Spain, April 2015.

- [364] M. Klein, C. Kasten, Y. Gao, and N. Chakraborty. A-priori assessment of sub-grid scale stress tensor closures for turbulent premixed combustion. In *7th European Combustion Meeting*, Budapest, Hungary, April 2015.
- [365] U. Allauddin, M. Klein, M. Pfitzner, and N. Chakraborty. A-priori and a-posteriori analysis of algebraic flame surface density modeling in the context of large eddy simulation of turbulent premixed combustion. In *SPEIC14 - Towards Sustainable Combustion*, Lisboa, Portugal, November 2014.
- [366] N. Chakraborty and M. Klein. A-priori direct numerical simulation assessment of the effects of lewis number on the performances of sub-grid scalar flux models for large eddy simulation of premixed flames. In *CONV-14: Int. Symp. on Convective Heat and Mass Transfer*, Turkey, June 2014.
- [367] M. Klein. Error quantification of passive scalar transport in the context of large eddy simulation using implicit filtering. In *Euromech 543, Quantification of uncertainties in modeling and predictive simulation of fluids*, pages 34–35, Munich, October 2013.
- [368] T. Lauer, M. Heiss, and M. Klein. Impact of the wall film formation on the full load performance of an engine operated with the ethanol blend e85. In *Small engine technology conference 2011*, pages SAE 2011–32–9535, Saporro, November 2011.
- [369] T. Lauer, M. Heiss, S. Fischer, and M. Klein. Prediction of the wall film formation and performance of an engine operated with the ethanol blend e85. In *13th EAEC European automotive congress*, Valencia, June 2011.
- [370] Waldemar Schlidt, Stefan Vogel, Markus Klein, Vural Yanik, and Roland Maucher. Cooling jacket optimization using conjugate heat transfer analysis and direct grid morphing methods. In *Virtual Powertrain Creation, 12th international MTZ conference 2010*, Munich, December 2010.
- [371] T. Lauer and M. Klein. Mechanisms of the mixture preparation and combustion for an engine operation with the ethanol blend E85. In *European GT-Suite Conference*, Frankfurt, November 2009.
- [372] D. Goryntsev, A. Sadiki, M. Klein, and J. Janicka. Analysis of cyclic variations of liquid fuel-air mixing processes in a realistic DISI IC-engine using large eddy simulation. In *6th International Symposium on Turbulence Heat and Mass Transfer*, Rome, September 2009.
- [373] D. Goryntsev, A. Sadiki, M. Klein, and J. Janicka. Effect of cycle-to-cycle variations on air-fuel mixing in realistic DISI IC-engines using LES. In *LES for internal combustion engine flows*, Rueil-Malmaison, December 2008.
- [374] Nilanjan Chakraborty and Markus Klein. The effects of initial kernel radius on the surface density function (sdf) in turbulent flame kernels. In *12th SIAM Numerical Combustion Conference*, Monterey, USA, April 2008.
- [375] M. Klein, V. Yanik, R. Maucher, D. Hakansson, and R. Reinmann. Investigation of the cylinder-to-cylinder variation of volumetric efficiency and charge motion using multi-cylinder CFD. In *GM Global CAE Conference*, Pontiac, Michigan, September 2007.
- [376] M. Klein, J. Meyers, and B.J. Geurts. Assessment of LES quality measures using the error landscape approach. In *Quality and Reliability of LES*, Leuven, Belgium, October 2007.
- [377] M. Freitag, J. Kühne, B. Wegner, D. Goryntsev, M. Klein, and J. Janicka. Toward combustion LES as an engineering prediction method. In *Computational Combustion 2007, ECCOMAS Thematic Conference*, Delft, Netherlands, July 2007.

- [378] D. Goryntsev, M. Klein, A. Sadiki, and J. Janicka. LES of influence of cyclic variations on fuel-air-mixing and combustion in a DISI engine. In *23. Deutscher Flammentag, VDI-Berichte*, Berlin, Germany, September 2007.
- [379] D. Goryntsev, M. Klein, A. Sadiki, and J. Janicka. Large eddy simulation of fuel-air-mixing in a direct injection SI engine. In *TSFP5, Fifth International Symposium on Turbulence and Shear Flow Phenomena*, Munich, Germany, August 2007.
- [380] N. Chakraborty and M. Klein. A-priori direct numerical simulation (DNS) analysis of algebraic flame surface density models for turbulent premixed flames in the context of large eddy simulation. In *European Combustion Meeting*, Chania, Crete, April 2007.
- [381] M. Freitag, M. Klein, and J. Janicka. Numerical analysis of the modeling and numerical uncertainties in large eddy simulation using diffusive numerical schemes. In *TSFP5, Fifth International Symposium on Turbulence and Shear Flow Phenomena*, Munich, Germany, August 2007.
- [382] D. Goryntsev, M. Klein, and J. Janicka. Large Eddy Simulation of cycle-to-cycle variations in a realistic Direct Injection Engine. In *VIII. Tagung Motorische Verbrennung*, March 2007.
- [383] M. Fatali, M. Klein, T. Broeckhoven, C. Lacor, and M. Baelmans. Stochastic generation of velocity fluctuation for turbulent inflow and initial condition. In *Forth International Conference on Computational Fluid Dynamics*, Ghent, Belgium, July 2006.
- [384] I. Celik, M. Klein, and J. Janicka. Assessment measures for LES applications. In *Proceedings of the ASME 2006 Joint U.S. European Fluids Engineering Summer Meeting*, Miami, Florida, July 2006.
- [385] N. Chakraborty, M. Klein, and R.S. Cant. Effects of turbulence on self-sustained combustion in premixed flame kernels: A direct numerical simulation (DNS) study. In *11th International Conference on Numerical Combustion*, Granada, Spain, April 2006.
- [386] M. Freitag, M. Klein, M. Düsing, A. Sadiki, and J. Janicka. LES of a premixed swirl burner. In *22. Deutscher Flammentag, VDI-Berichte*, Braunschweig, 2005.
- [387] M. Klein, M. Freitag, and J. Janicka. Numerical determination of the scaling exponent of the modelled subgrid stresses for eddy viscosity models. In *The Cyprus International Symposium on Complex Effects in Large Eddy Simulations*, September 2005.
- [388] D. Goryntsev, M. Klein, and J. Janicka. Charakterisierung der zyklischen Schwankungen in einem direkteinspritzenden Ottomotor mittels der Grobstruktursimulation. In *BMBF Workshop: Turbulenz in der Energietechnik*, Juni 2005.
- [389] B. Wegner, M. Freitag, M. Klein, and J. Janicka. Vorhersage von Drallströmungen mittels der Grobstruktursimulation. In *BMBF Workshop: Turbulenz in der Energietechnik*, Juni 2005.
- [390] M. Freitag, M. Klein, and J. Janicka. Application of a LES quality assessment procedure to a swirling recirculating flow. In *Quality Assessment of Unsteady Methods for Turbulent Combustion Prediction and Validation*, Darmstadt, June 2005.
- [391] M. Ciardi, M. Klein, P. Sagaut, and W.N. Dawes. Assessment of a new dynamic finite volume scheme for large-eddy simulation on unstructured grids. In *Quality Assessment of Unsteady Methods for Turbulent Combustion Prediction and Validation*, Darmstadt, June 2005.

- [392] M. Freitag, A. Nauert, M. Klein, C. Schneider, A. Dreizler, and J. Janicka. Mixing analysis of a swirling recirculating flow using DNS and experimental data. In *TSFP4, Fourth International Symposium on Turbulence and Shear Flow Phenomena*, Williamsburg, Virginia, June 2005.
- [393] N. Chakraborty, M. Klein, K.W. Jenkins, and R.S. Cant. Effects of strain rate and curvature on flame displacement speed in a spherical kernel in the thin reaction zones regime. In *European Combustion Meeting*, 2005.
- [394] D. Goryntsev, O. Stein, M. Klein, and J. Janicka. Charakterisierung zyklischer Schwankungen der Brennrauminnenströmung eines direkteinspritzenden Ottomotors mittels der Grobstruktursimulation. In *VII. Tagung Motorische Verbrennung*, März 2005.
- [395] M. Klein, J. Scholz, and J. Janicka. Development of an LES based model for the prediction of atomization. In *DFG-Schwerpunktprogramm Fluidzerstäubung und Sprühvorgänge*, Dortmund, March 2004.
- [396] M. Klein. An attempt to assess the quality of large eddy simulations in the context of implicit filtering. In *2nd International Workshop on Trends in Numerical and Physical Modelling for Turbulent Processes in Gas Turbine Combustors*, Heidelberg, 2004.
- [397] D. Goryntsev, M. Klein, and J. Janicka. LES der Strömung und Mischung in einem direkteinspritzenden Ottomotor. In *BMBF Workshop: Turbulenz in der Energietechnik*, Juli 2004.
- [398] M. Klein, A. Kempf, A. Sadiki, and J. Janicka. Mixing analysis of a plane jet using direct numerical simulation. In *Euromech 10th European Turbulence Conference*, Trondheim, Norway, July 2004.
- [399] M. Freitag, M. Klein, and J. Janicka. Direct numerical simulation of a recirculating, swirling flow. In *2nd International Workshop on Trends in Numerical and Physical Modelling for Turbulent Processes in Gas Turbine Combustors*, Heidelberg, 2004.
- [400] M. Klein and J. Janicka. Large-eddy-simulation of the primary breakup of a spatially developing liquid film. In *ICLASS 2003, International Conference on Atomization and Sprays*, Sorrento, July 2003.
- [401] A. Kempf, M. Klein, and J. Janicka. Transient inflow-data for LES:towards the generation of turbulent inflow conditions for combustion LES. In *Workshop on Direct and Large Eddy Simulation 5*, München, Germany, 2003.
- [402] M. Klein, A. Kempf, L. di Mare, and J. Janicka. On the artificial generation of inlet and initial data for unsteady turbulent flow simulation. In *17. TECFLAM-Seminar, ISBN 3926751274*, Stuttgart, Dezember 2003.
- [403] M. Klein, A. Sadiki, and J. Janicka. Direct numerical simulation of the primary breakup of a spatially developing liquid jet. In *TSFP3, 3rd International Symposium on Turbulence and Shear Flow Phenomena*, Sendai, Japan, June 2003.
- [404] M. Klein, A. Sadiki, and J. Janicka. Untersuchung des Primärzerfalls eines Flüssigkeitsfilms: Vergleich Direkte Numerische Simulation, Experiment und lineare Theorie. In *Spray 2002, 7. Workshop über Techniken der Fluidzerstäubung und Untersuchungen von Sprühvorgängen*, pages 63–72, Freiberg, 2002.
- [405] A. Kempf, M. Klein, R. Bauer, A. Sadiki, and J. Janicka. Towards the generation of turbulent inflow conditions for combustion LES. In *Proceedings of the Ninth International Conference on Numerical Combustion*, Sorrento, Italy, 2002.

- [406] M. Klein, A. Sadiki, and J. Janicka. Effects of the surface stretching or the surface deformation rate on the breakup of a viscous drop in simple shear flow: Numerical simulation. In *5th International Symposium on Engineering Turbulence Modelling and Measurements*, Mallorca, September 2002.
- [407] M. Klein, A. Sadiki, and J. Janicka. Influence of the inflow conditions on the direct numerical simulation of primary breakup of liquid jets. In *ILASS-Europe 2001, 17. Annual Conference on Liquid Atomization and Spray Systems*, pages 475–480, Zürich, September 2001.
- [408] M. Klein, A. Sadiki, and J. Janicka. Untersuchung des Einflusses der Düseninnenströmung auf den primären Zerfall eines Flüssigkeitsfilms mittels Direkter Numerischer Simulation. In *Spray 2001, 6. Workshop über Techniken der Fluidzerstäubung und Untersuchungen von Sprühvorgängen*, pages P.9–1 – P.9–8, Hamburg, 2001.
- [409] M. Klein, A. Sadiki, and J. Janicka. Influence of the boundary conditions on the direct numerical simulation of a plane turbulent jet. In *TSFP2, 2nd International Symposium on Turbulence and Shear Flow Phenomena*, volume I, pages 401–406, Stockholm, June 2001.
- [410] M. Klein, A. Sadiki, and J. Janicka. Direct numerical simulations of plane turbulent jets at moderate Reynolds numbers. In *20th IUTAM Congress, ICTAM 2000*, Chicago, September 2000.
- [411] M. Klein, A. Sadiki, and J. Janicka. Study of primary jet breakup using direct numerical simulation. In *ILASS-Europe 2000, 16. Annual Conference on Liquid Atomization and Spray Systems*, Darmstadt, September 2000.

Invited Talks

- [412] M. Klein. Machine learning for (LES based) turbulence modelling. In *Division of Fluid Mechanics*, Lund University, Sweden, June 2023.
- [413] M. Klein. Towards gene expression programming for high fidelity LES closures. In *International Conference on Advanced Computational Engineering and Experimenting*, Florence, Italy, July 2022.
- [414] M. Klein. Part 1: Generation of synthetic turbulent inflow conditions; part 2: LES modelling using gene expression programming. In *Lecture: Innovative approaches to the simulation of turbulent flows in aerospace propulsion systems*, University of Turino, Italy, May 2022.
- [415] M. Klein. Recent efforts in LES modelling using traditional and machine learning techniques. In *Aerodynamics Seminar*, TU Delft, Netherlands, March 2022.
- [416] M. Klein. Towards LES of primary atomization. In *International Workshop on Clean Combustion: Principles and Applications*, Darmstadt, September 2019.
- [417] M. Klein. Towards LES of multiphase flows with moving interfaces. University of Groningen, July 2019.
- [418] M. Klein. Towards LES of multiphase flows with moving interfaces. Darmstadt, May 2019.
- [419] M. Klein. Towards LES of multiphase flows with moving interfaces. In *16th Multiphase Flow Conference and Short Course*, Dresden, November 2018.
- [420] M. Klein. Mathematische und physikalische Modellierung von turbulenten Zweiphasenströmungen. ITLR, University Stuttgart, March 2018.
- [421] M. Klein. Towards LES for two phase flows. Helmholtz-Zentrum Dresden-Rossendorf, July 2017.
- [422] M. Klein. Recent experiences with modelling of turbulence chemistry interaction in the context of LES using DNS of turbulent premixed generic planar flame configurations. Annual meeting of the UK Consortium on Turbulent Reacting Flows, September 2016.
- [423] M. Klein. Analysis of the combined modelling of subgrid transport and filtered flame propagation for premixed turbulent combustion. University of Duisburg, January 2015.
- [424] M. Klein. An attempt to assess the quality of les in the context of implicit filtering. University of Newcastle, November 2013.
- [425] M. Klein. Industrial CFD: Applications and challenges. Technical University of Munich, February 2013.
- [426] M. Klein. 3D CFD base engine development. University of Applied Science, Darmstadt, December 2010.
- [427] M. Klein. 3D CFD base engine development. University of Applied Science, Darmstadt, December 2009.
- [428] M. Klein. 3D CFD base engine development. University of Applied Science, Darmstadt, January 2008.
- [429] M. Klein. LES quality assessment. In *8th Workshop on Turbulent Nonpremixed Flames*, Heidelberg, August 2006.

- [430] M. Klein. Quality assessment of LES in the context of implicit filtering. In *Quality Assessment of Unsteady Methods for Turbulent Combustion Prediction and Validation*, Darmstadt, June 2005.
- [431] M. Klein. Numerical and experimental characterization of the turbulence structure in swirled flows. Cambridge University, November 2004.
- [432] M. Klein. How LES can be made an engineering tool. Cambridge University, July 2004.
- [433] M. Klein. Direkte numerische Simulation von ebenen ein- und zweiphasigen Freistrahlen. University of Zurich, Mai 2003.
- [434] M. Klein. On the artificial generation of inlet and initial data for unsteady turbulent flow simulation. In *17. TECFLAM-Seminar*, Stuttgart, Dezember 2003.

Patent Applications

- [435] M. Klein und S. Kraft. Hydrostößel mit einer zweiten Ölzuführung. *DE102011101239*, 15.11.2012.
- [436] W. Schlidt, P. Seeger, S. Vogel, C. Tauscher, M. Klein, and R. Maucher. Zylinderkopf mit Flüssigkeitskühlung und Verfahren zur Kühlung des Zylinderkopfes. *DE102010052830*, 31.05.2012.
- [437] P. Seeger M. Klein, M. Janeck. Auslasssystem für einen Verbrennungsmotor. *DE102011116360*, 19.10.2011.