

following issues:

- **Stabilisation:** we mostly work on designing a FEM-based Variational Multiscale (VMS) extension to compressible flow. VMS belongs to the residual-weighted stabilisation methods family. When shocks are present, we complement the stabilization scheme with an in-house developed anisotropic shock capturing technique.
- **Local preconditioners:** we developed the so-called Preconditioned Variational Multiscale (P-VMS), which integrates local preconditioning with stabilisation. The goal is to solve efficiently problems at all Mach number ranges in an accurate way.
- **Implicit schemes:** we alternatively use monolithic implicit or explicit time schemes. When solved implicitly with iterative methods, either VMS or P-VMS methods require algebraic preconditioners to improve solver convergence. We explore a wide spectrum of possibilities on the solution scheme design.
- **Turbulence modelling:** we program, test and improve different turbulence models for compressible flow, especially those of the LES type to solve transient problems.
- **Higher order spaces:** our methods and their implementation in Alya are designed to work properly in more-than-linear FEM spaces. We explore the high potential of 2nd. order FEM spaces in different regimes, specially the sub-sonic high-Reynolds conditions typically found in aircrafts and high-speed trains and cars.

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