

SIMPACK in Multidisciplinary Use: Aerodynamics/Flight-Mechanics Coupling

Gunnar Einarsson

Andreas Schütte

Britta Schöning

Wulf Mönnich

**SIMPACK
User Meeting
2001**

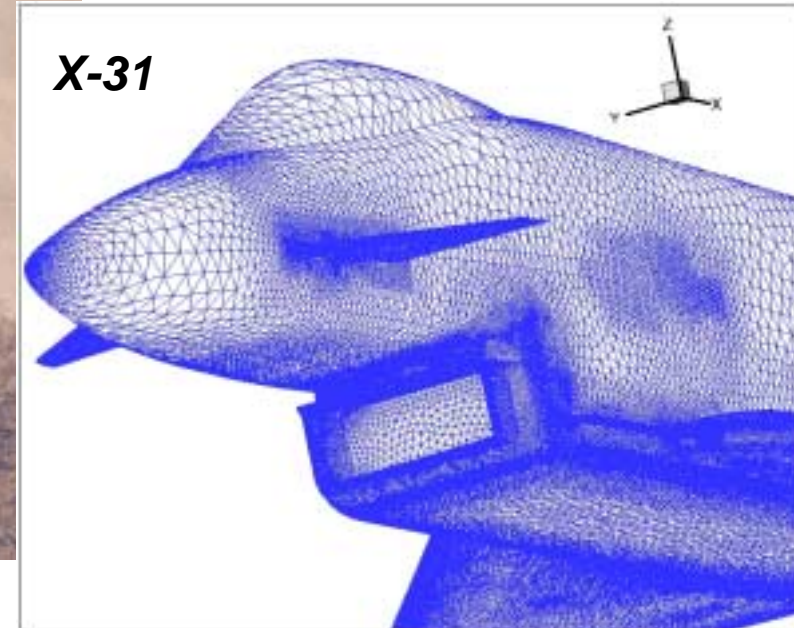
13. - 14 November, Bad Ischl, Austria

OUTLINE

- **Objectives**
- **Simulation Modules**
- **Validation Experiments / Test-Cases**
- **Simulation Results**
- **Conclusions and Perspectives**

Objectives

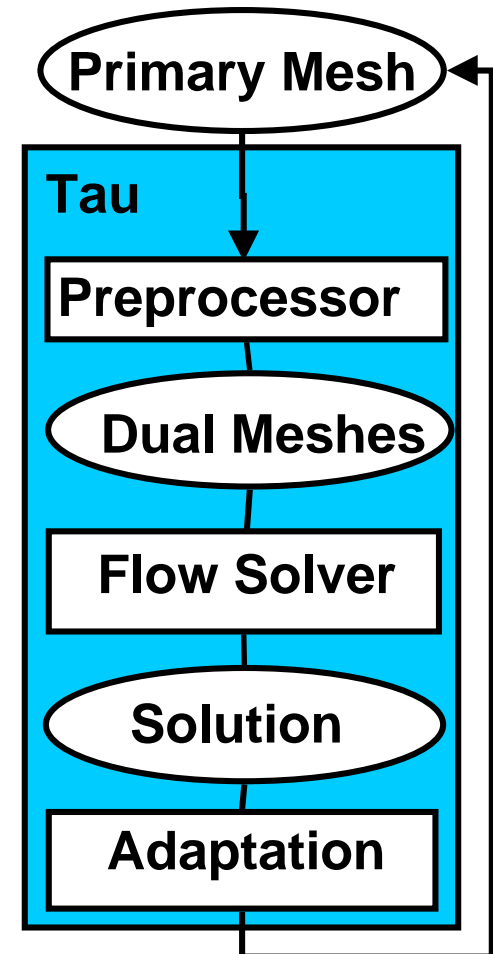
- Tool for CFD / Flight-Mechanic Coupled Simulations
- Aim: Numerical Simulation of a Full Fighter Aircraft



Simulation Modules: Aerodynamics (CFD)

DLR-Tau Code: Finite Volume Scheme for solving Euler/RANS Equations

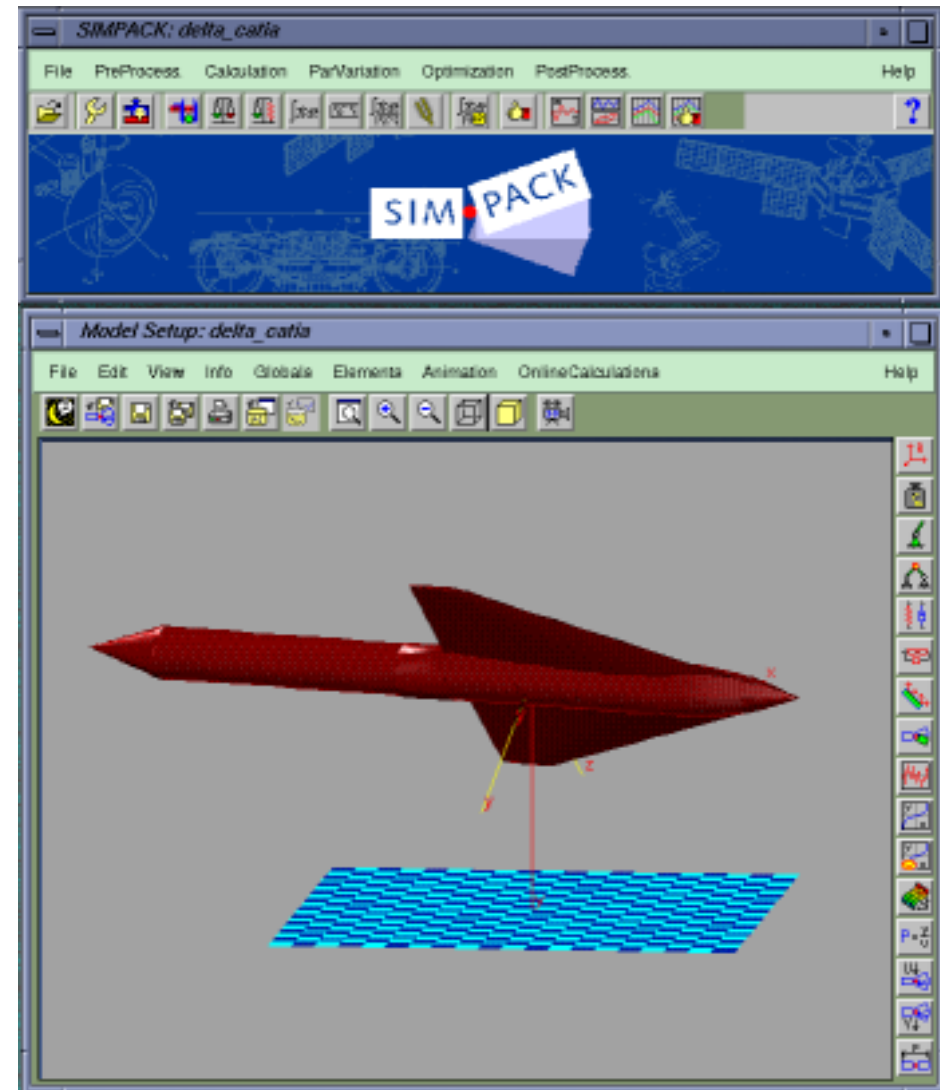
- **Unstructured Grid / Dual-Mesh Approach**
- **Multigrid Computation**
- **One- and Two-Equation Turbulence Models**
- **Dual Time-Stepping for Unsteady Cases**
- **Explicit Runge-Kutta Time-Integration Scheme**
- **Central and Upwind Flux-Calculation Schemes**
- **Guided and Free Rigid-Body Motion**
- **Parallelized using MPI**
- **Local Grid Refinement (steady computations)**



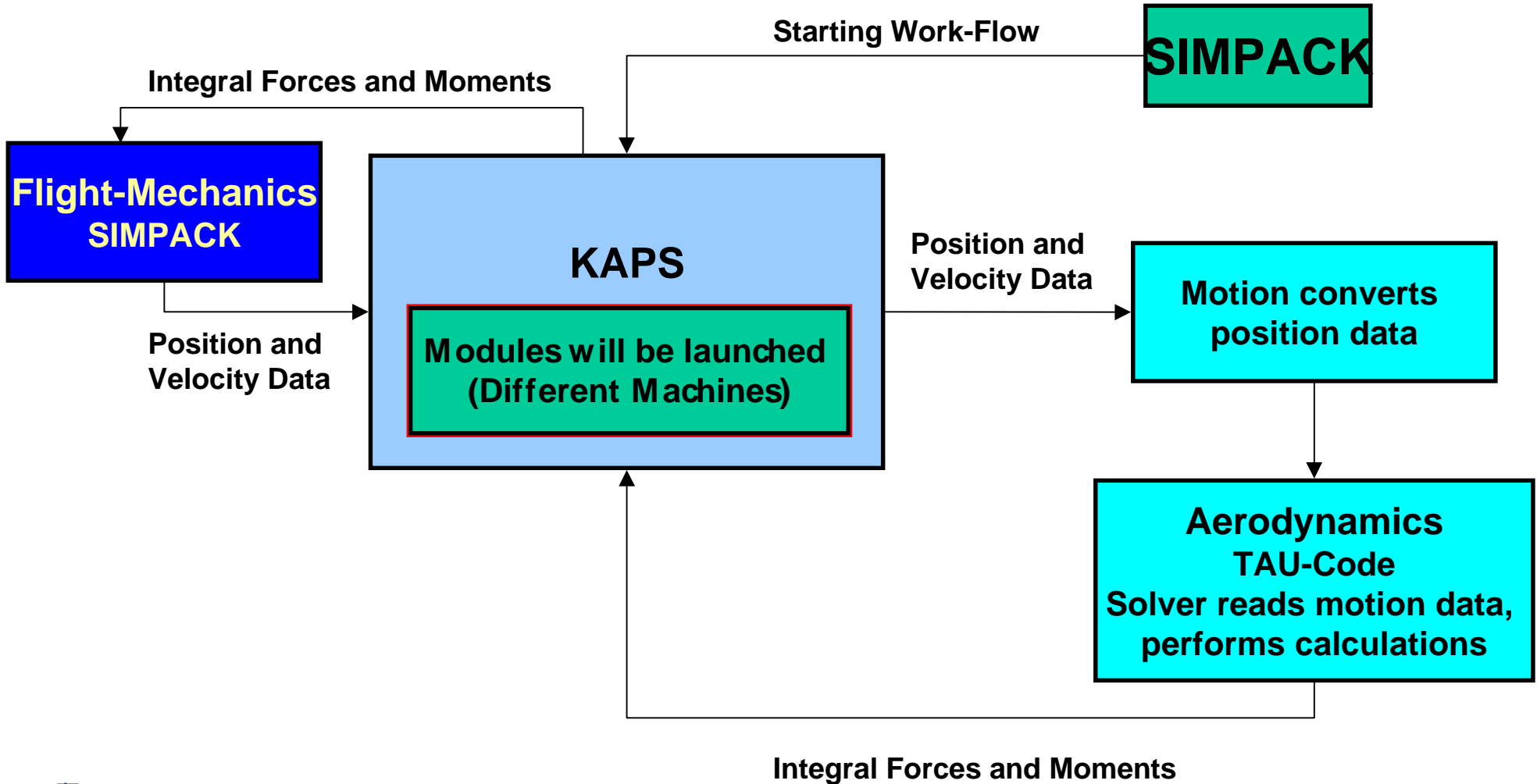
Implemented in the Multi-Body Simulation Software SIMPACK

User Defined Capabilities:

- Flight-Mechanic Equations of Motion (1 to 6 DoF)
- 2nd Order Runge-Kutta Time Integration
- Trim Function
- Communication Interface



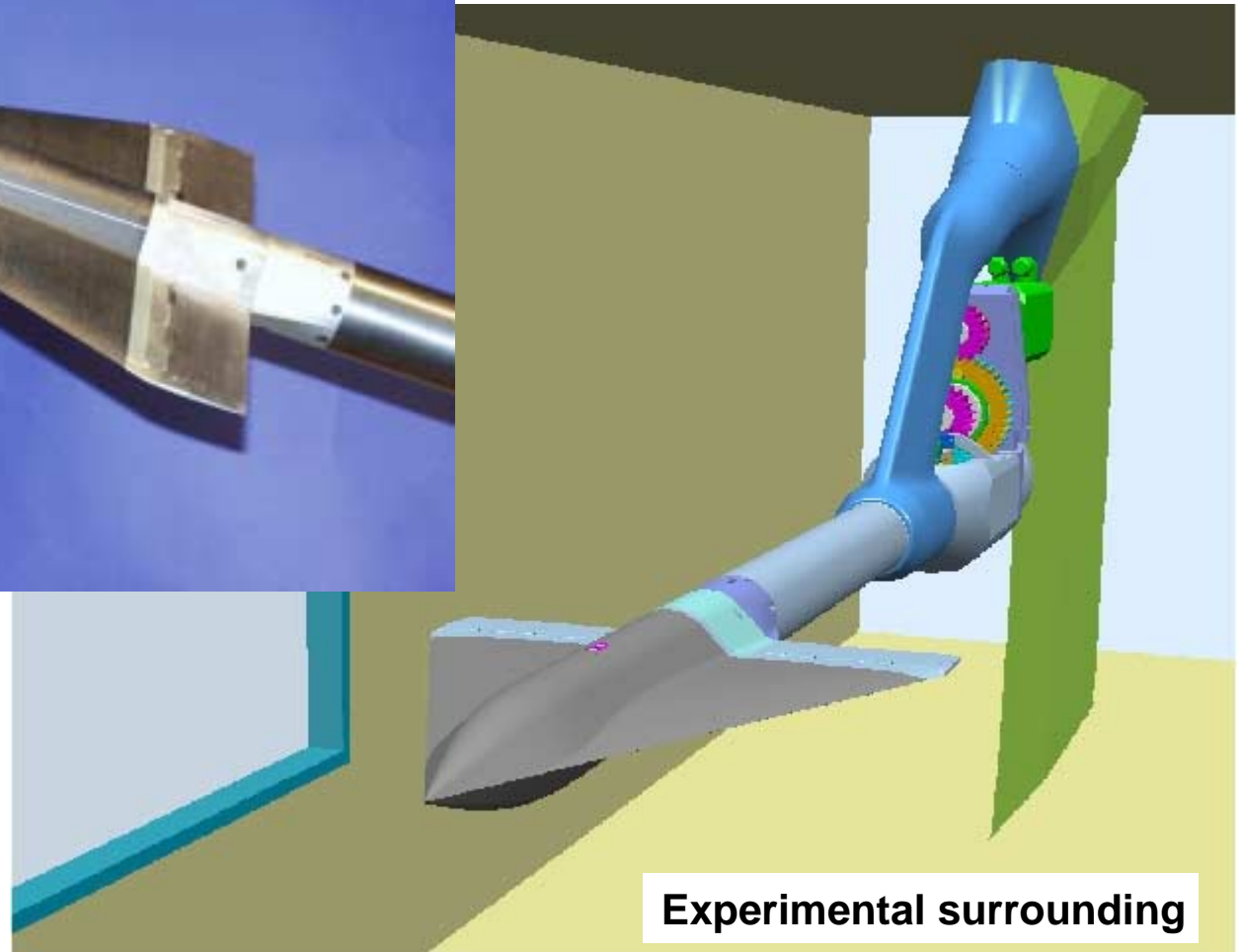
Simulation Modules: Communication Interface (KAPS)



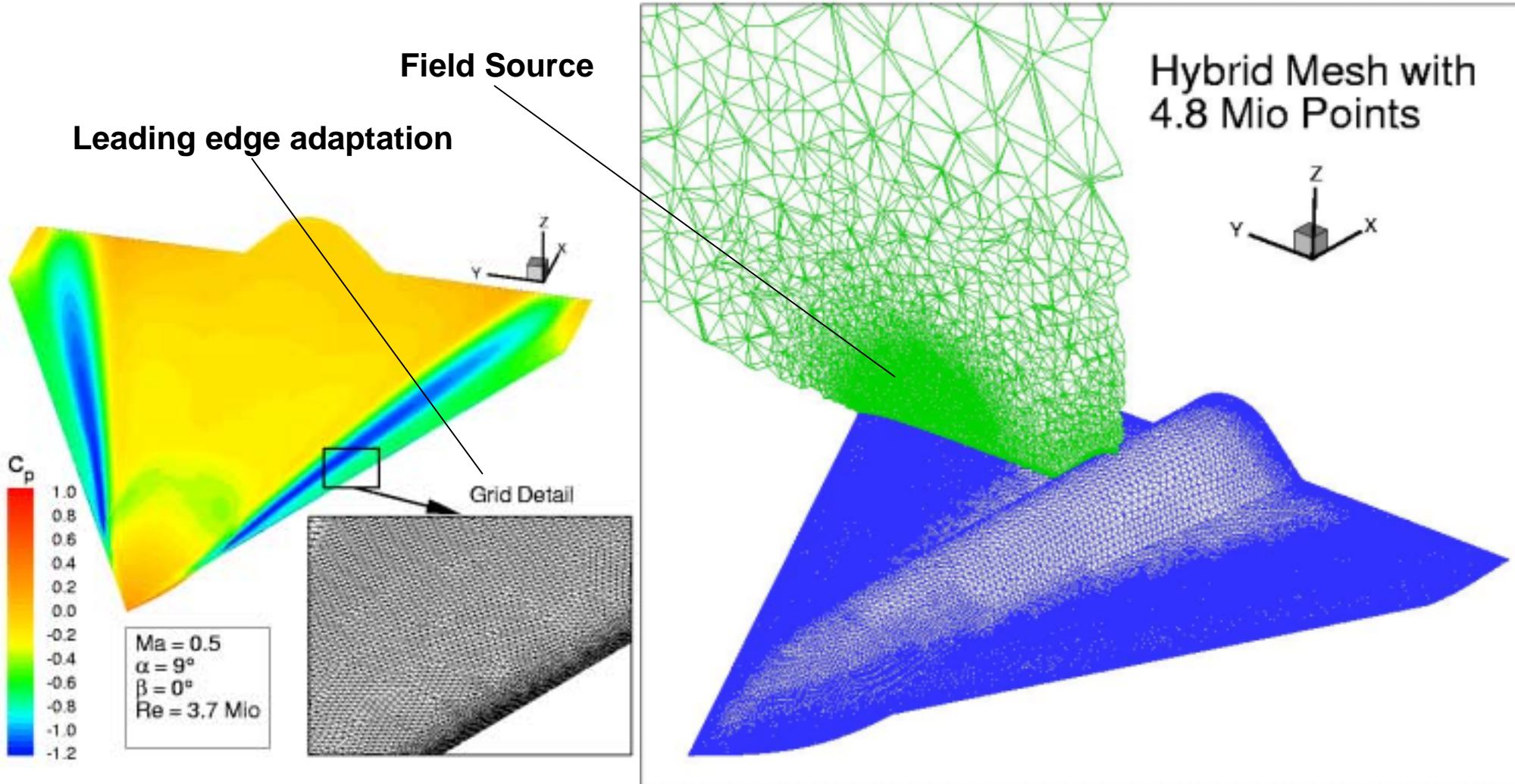
Validation Experiments

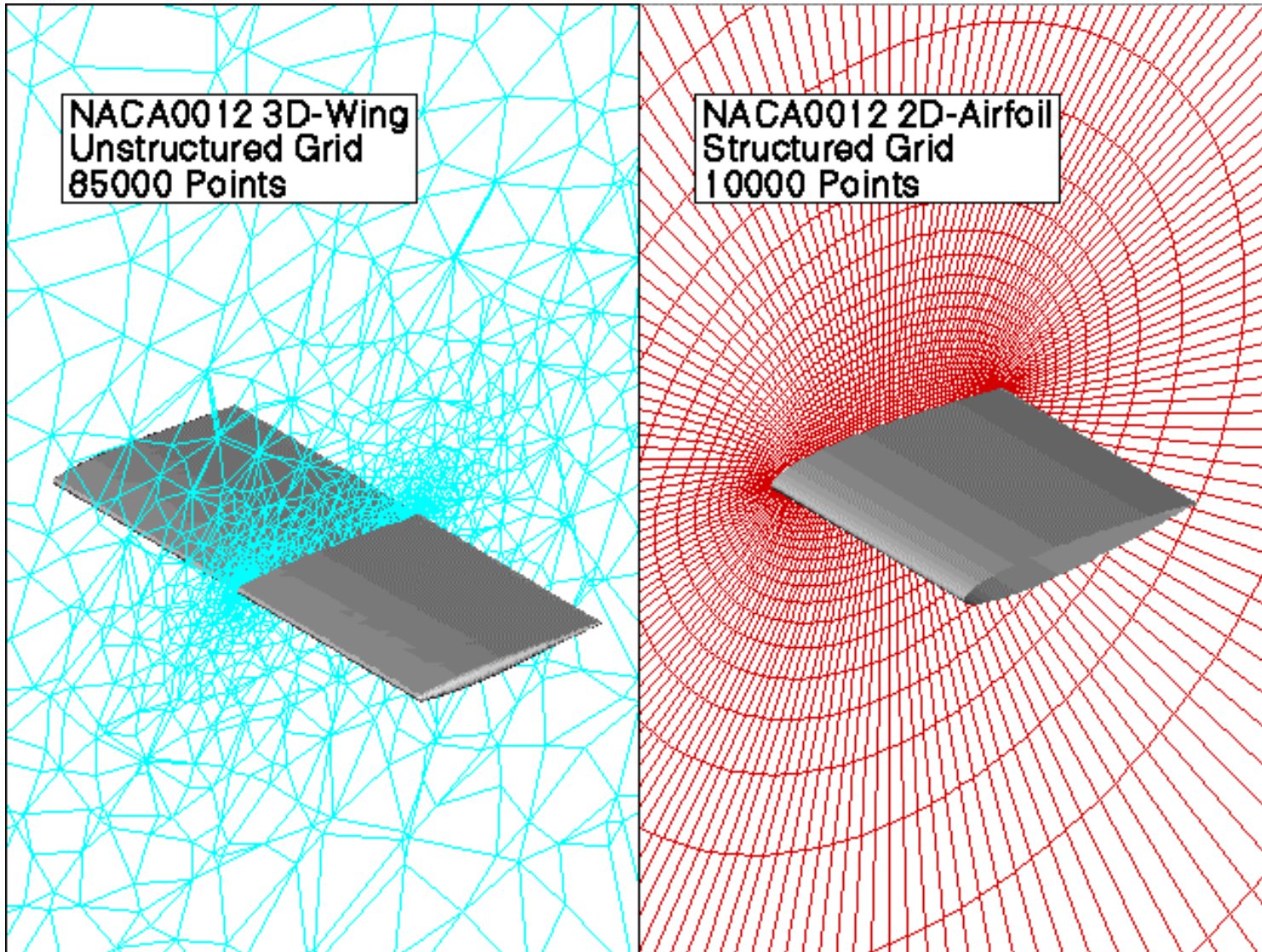


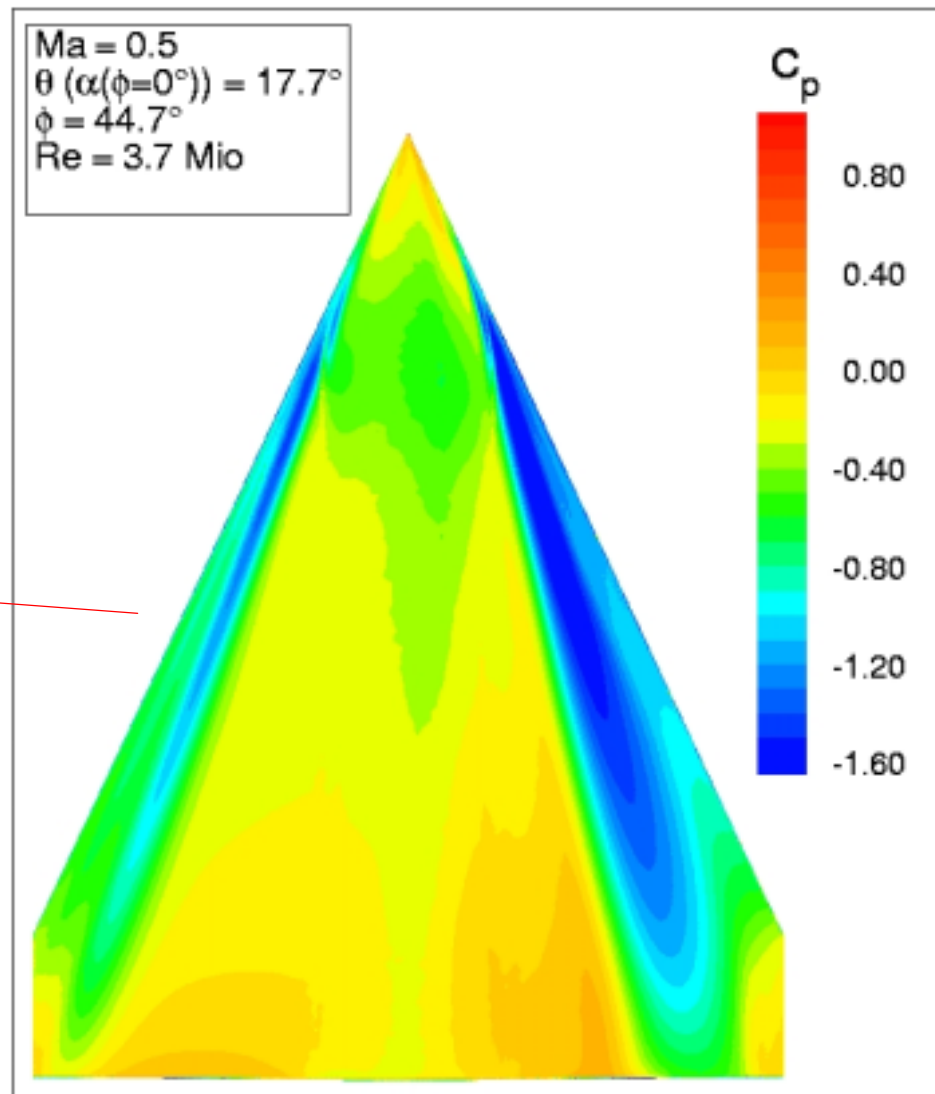
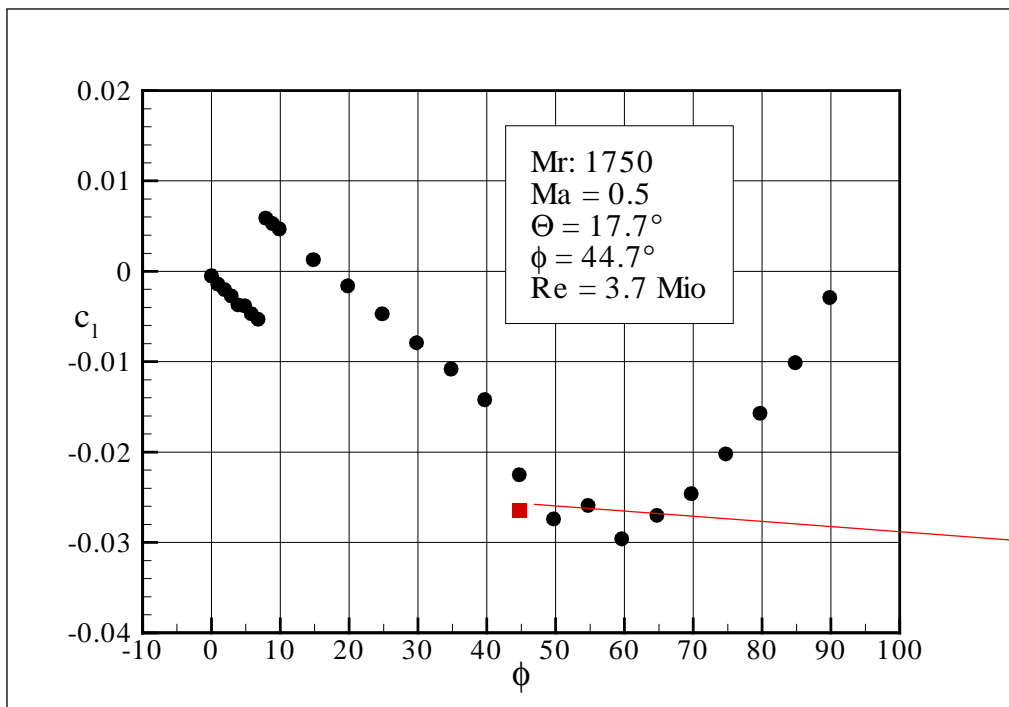
AeroSUM-Model



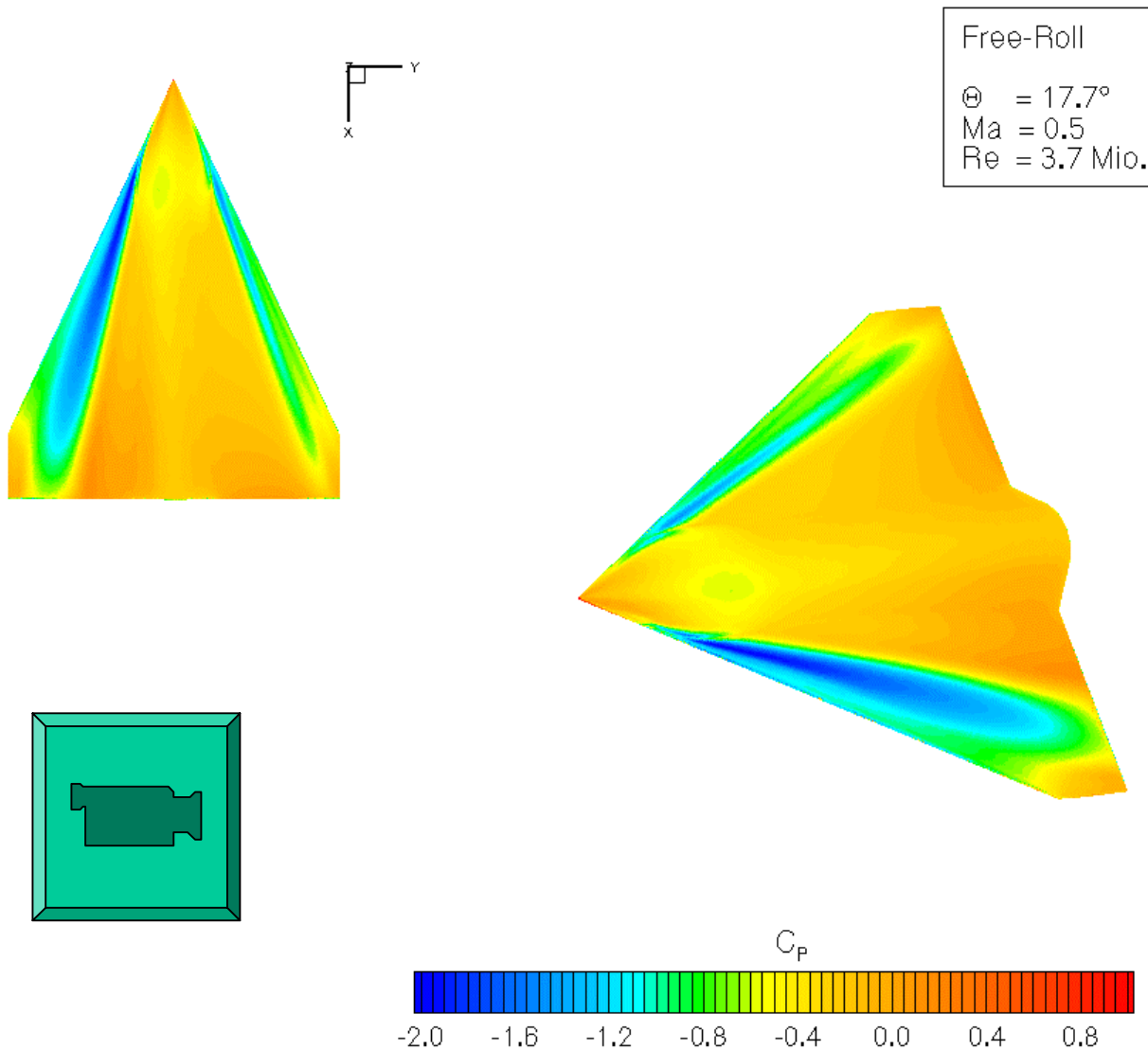
Experimental surrounding



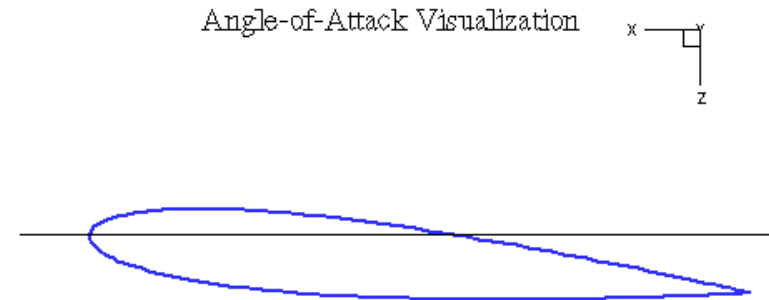
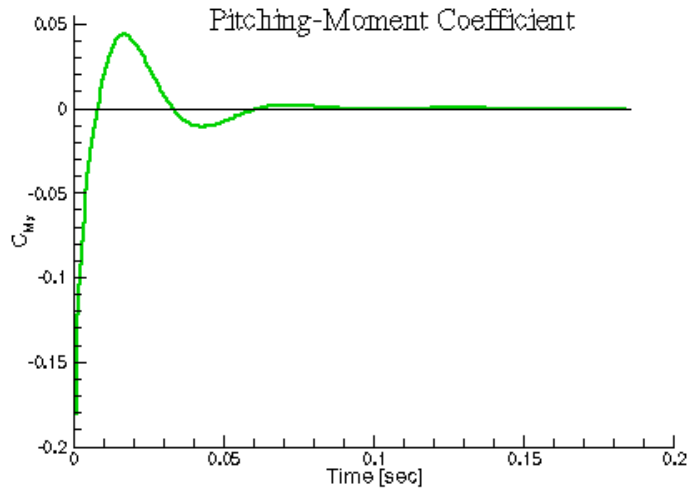




Static starting solution

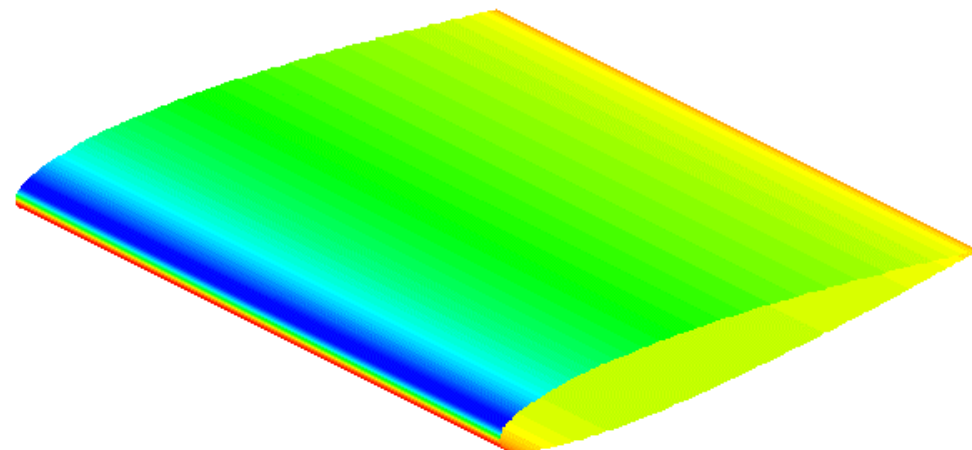
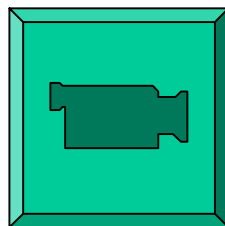
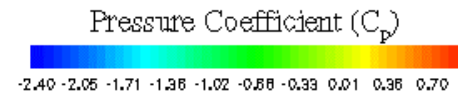


Simulation Results: NACA0012 2D-Airfoil



Free-Pitching NACA0012 2D-Airfoil

Simulation Parameters:
 Euler Flow-Simulation
 Rotation at 0% chord (Leading Edge)
 Chord = 1.0 meters
 Mach Number = 0.5
 Initial Angle-of-Attack, $\alpha_0 = 5^\circ$



Conclusions

- **Coupling of Aerodynamics and Flight-Mechanics is Successful**
- **Free-Pitching Symmetrical Wings Reach the Zero Trim-Condition**

Perspectives

- **Simulation of Delta-Wing with Movable Flaps (Chimera)**
- **Implementation of Adaptation for Unsteady Cases**
- **Investigations of Turbulence Models**
- **Parallel Processing of all Tau-Modules**
- **Increase the Complexity of the Aircraft Configuration**
- **Implementation of Aeroelasticity (Project SikMa, 2002)**