Numerics & Experiments on Low-Speed High-Altitude Wings

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FRAMEWORK

High-Altitude Pseudo-Satellites
- Semi-persistent coverage of areas
- Chaper than satellite systems
- High response capability

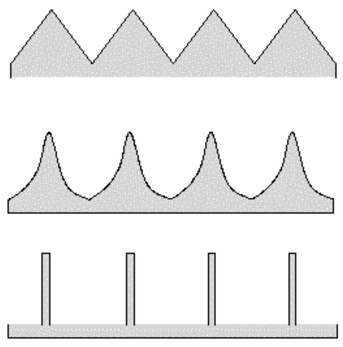
Requirements:
- High altidute cruise: 16-20km
- Low Speed: Mach = 0.1
- Low Reynolds: Re = 250000

HAPS vehicle

CHALLENGES

Develop numeric method for:
- Wing design
- Aerodynamic performance
- **Passive control flow devices**
- **Laminar Separation Bubble**

Use experimental data:
- Validation
- Tuning



Common types of riblets, passive control flow devices

INITIAL ANALYSIS

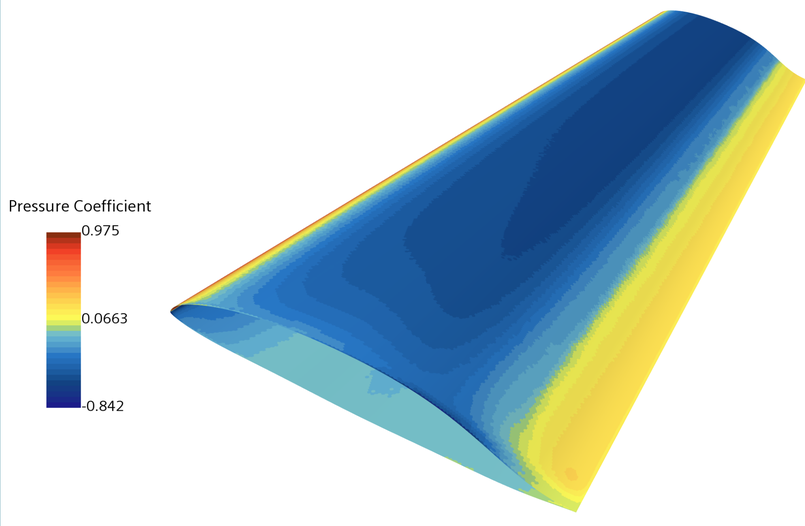
CFD simulations in STAR-CCM+

- 2D CFD profile analysis

- 3D CFD profile analysis

- Estimation of physical quantities for setting experimental measurements

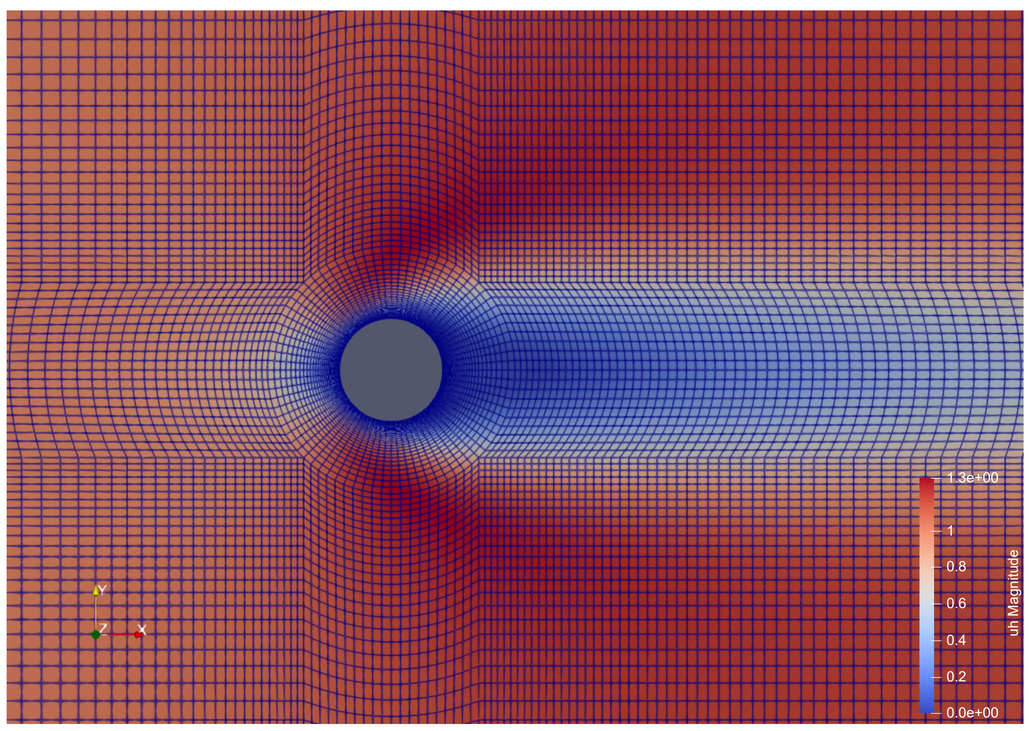
- 3D CFD analysis of the wind tunnel



Pressure coefficient contour on DU89 3D profile

VARIATIONAL MULTISCALE METHOD

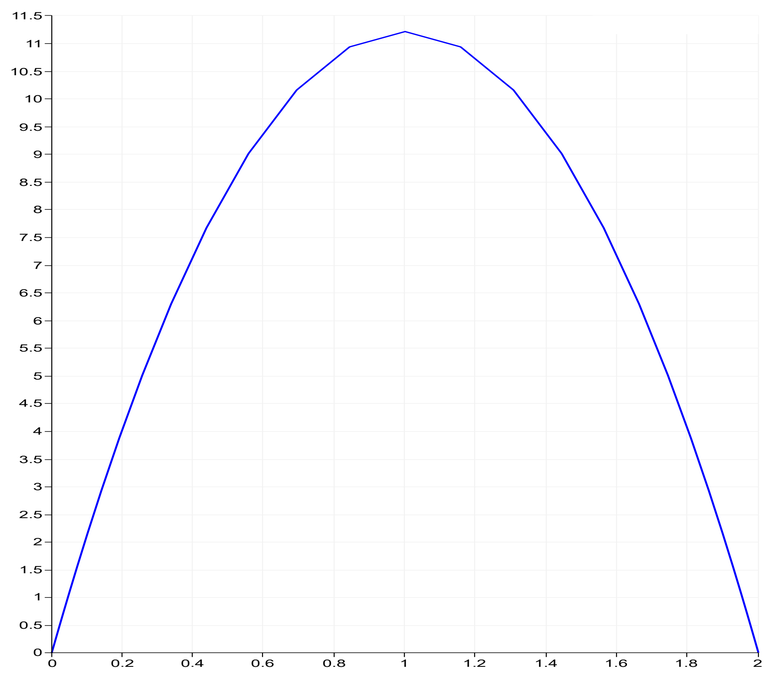
Implementation of the Variational MultiScale (VMS) framework for solving incompressible Navier Stokes
- Based on stabilized **Finite Element Method** in the **Julia programming language**
- Based on FEM → **not sensitive to mesh quality**
- Variational formulation
- Consistent treatment of all the scales of turbulence
- Equations for small scales have asymptotic behavior near walls
- Unresolved small scales influence only resolved small scales



Velocity field of a cylinder and mesh, Re=100

IMPLEMENTATION IN JULIA USING GRIDAP

Using the Julia package **Gridap** for developing VMS:
- Very expressive API
- Extensible and modular
- **High Performance**
- Use PETSc library solvers
- Use GMSH for mesh generation



Velocity profile in a laminar channel with periodic bounday conditions

Industrial Partner STRATOS SOLUTION