Overview - Computational Fluid Dynamics

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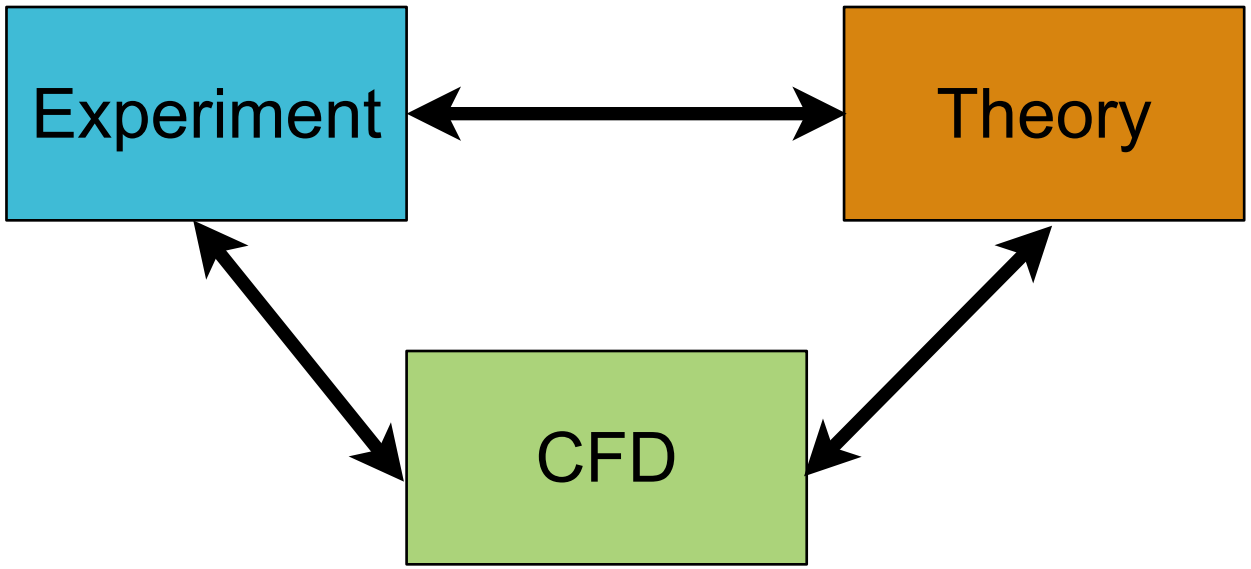
Basque Center for Applied Mathematics (BCAM). February 22nd to 26th, 2010

Computational fluid dynamics
Overview

- Link between Experiment and Theory



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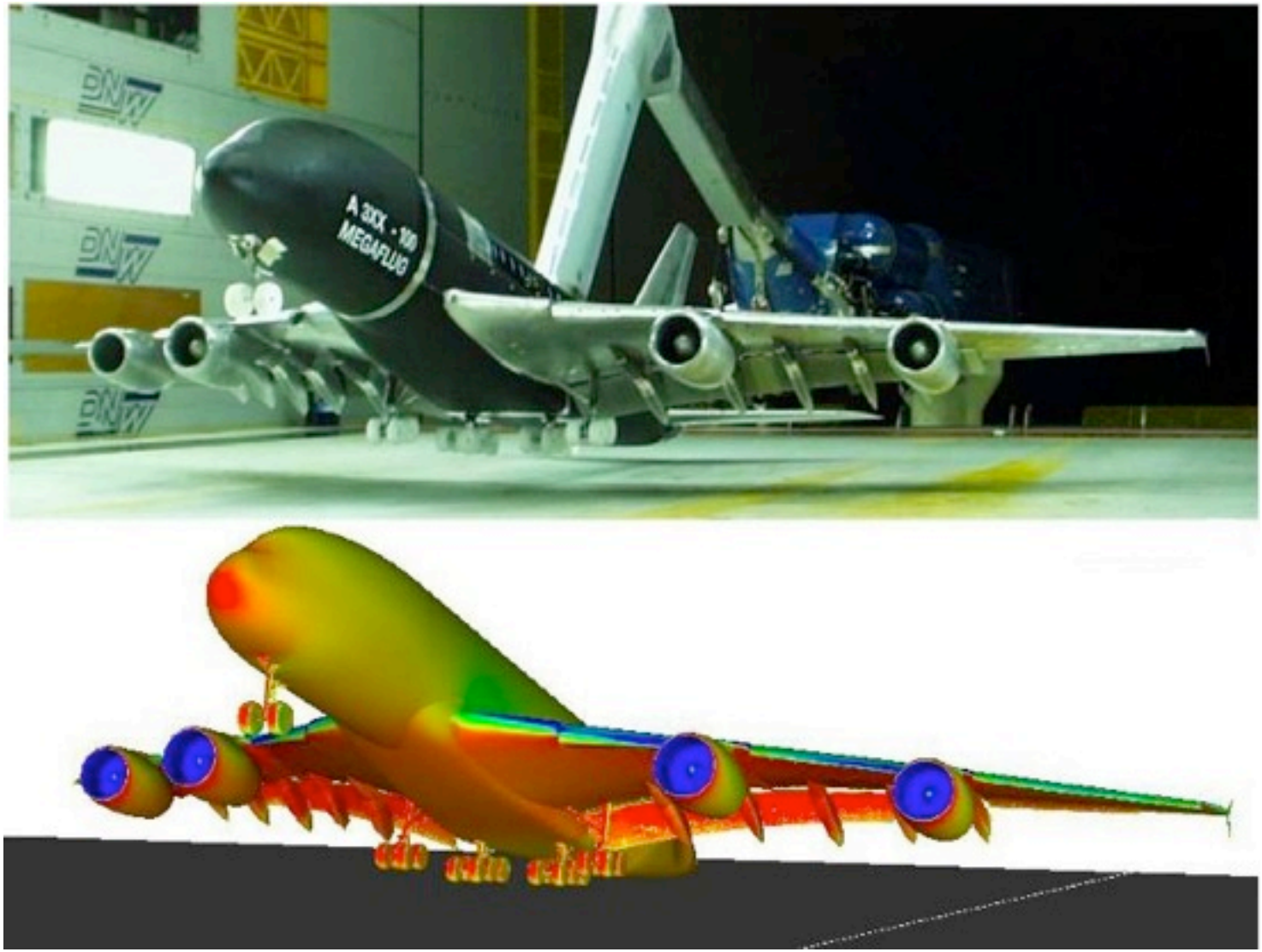

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Numerical Simulation is not a Black Box: Put in the problem and push the button is not sufficient

- Many commercial flow simulation codes are available today
  - BUT
    - Parameter have to be selected from the user
    - Numerical solutions have to be interpreted correctly
    - Numerical solutions must be evaluated for
      - Accuracy and Reliability
    - Uncertainties have to be taken into account due to approximations of the physical and problem modeling

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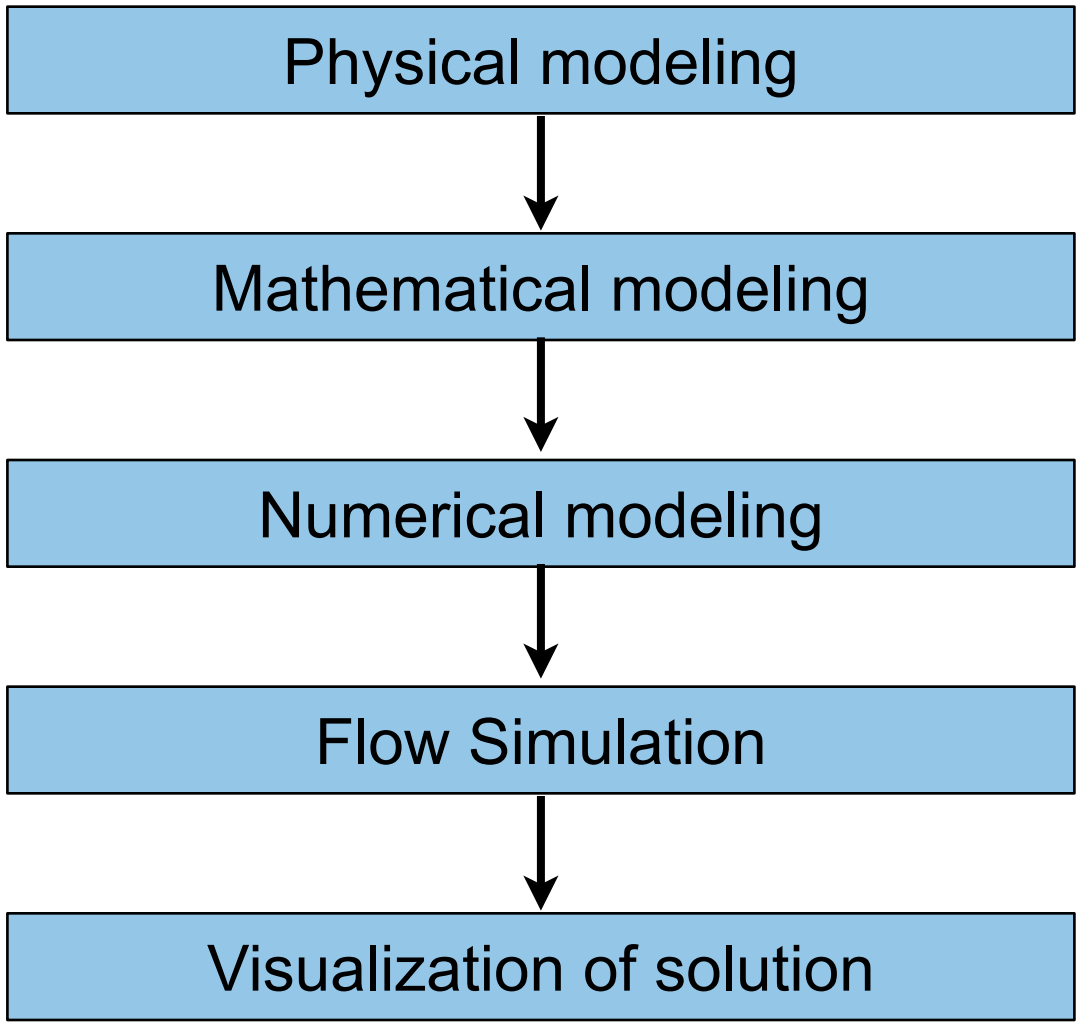

Conservation laws:
Mass, Momentum, Energy

Potential equations, Euler equations, Navier - Stokes equations

Fundamentals in numerical fluid mechanics

Knowledge about flow solver and physical phenomena

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Incompressible Flows

At slow motion of a fluid or gas (low Mach numbers) the density and temperature changes can be neglected. The flow equations can be simplified into incompressible Navier-Stokes equations

Compressible Flows

Density and temperature changes are not anymore neglectable due to higher Mach numbers.

An important characteristic of compressible flows is the occurrence of shocks which leads to discontinuities.

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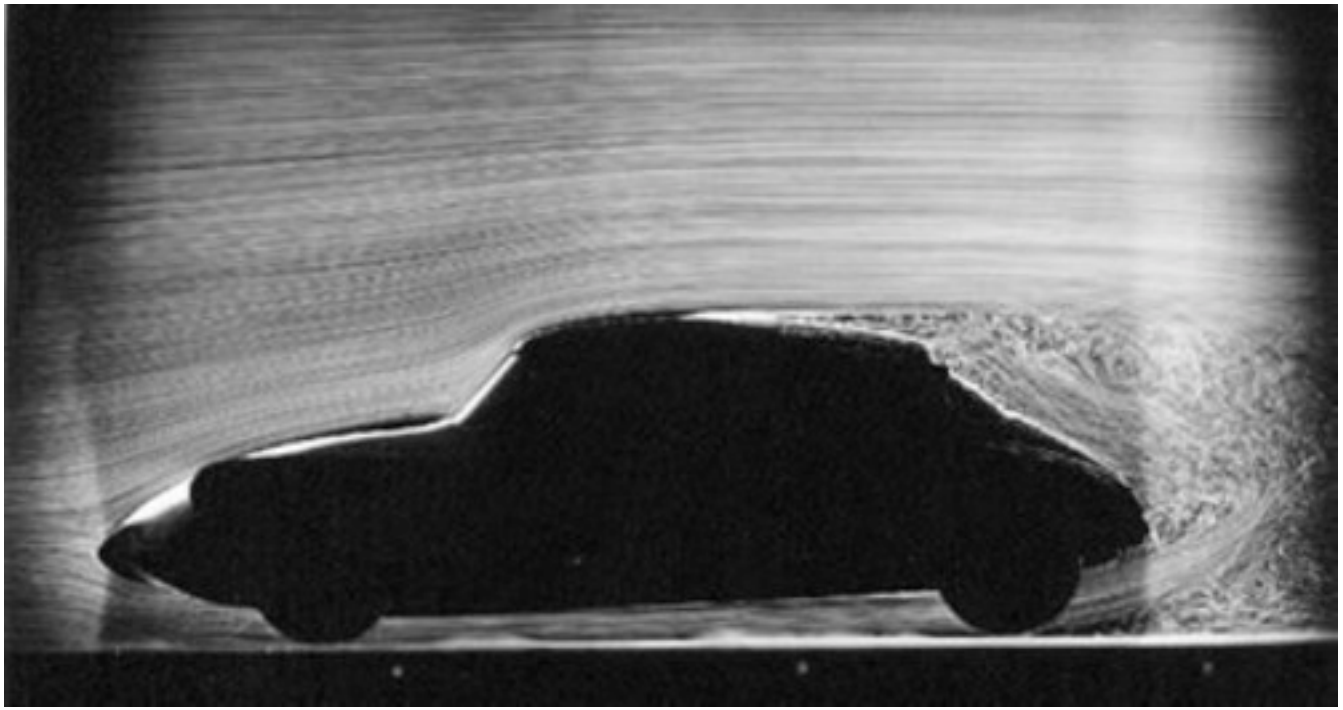
Example for incompressible flow



Source: Onera

Flow with M < 0.3

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Example for incompressible flow

Source: Akaflieg Stuttgart

Soaring plane

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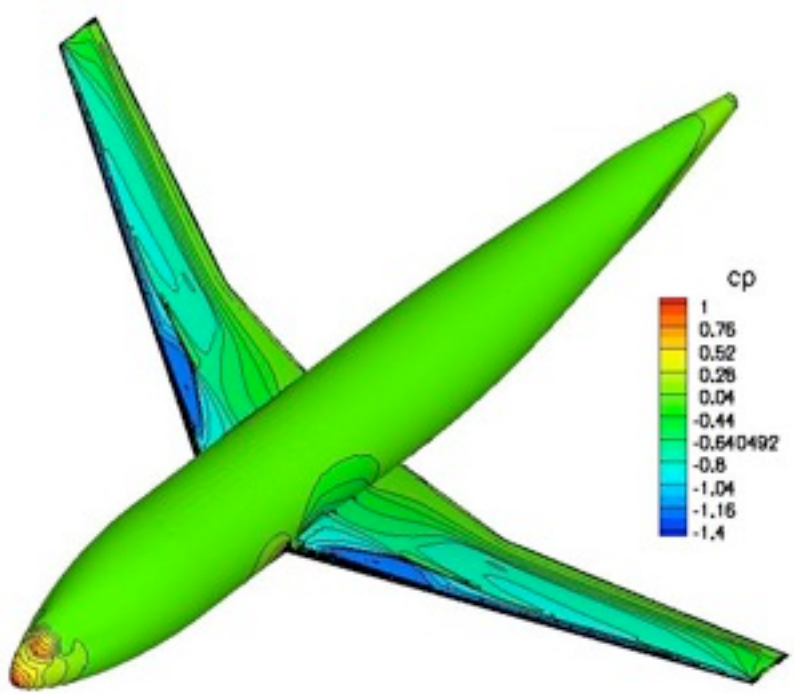
Example for compressible flow



Passenger and transport aircraft with transonic flow

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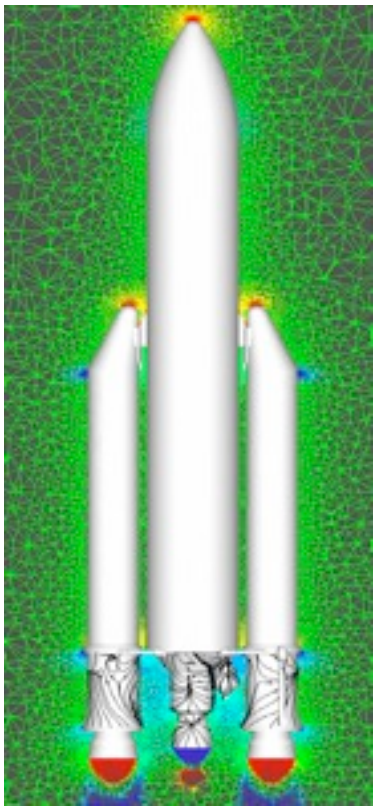
Example for compressible flow

Source: NASA



Hypersonic flow with shocks at the nose

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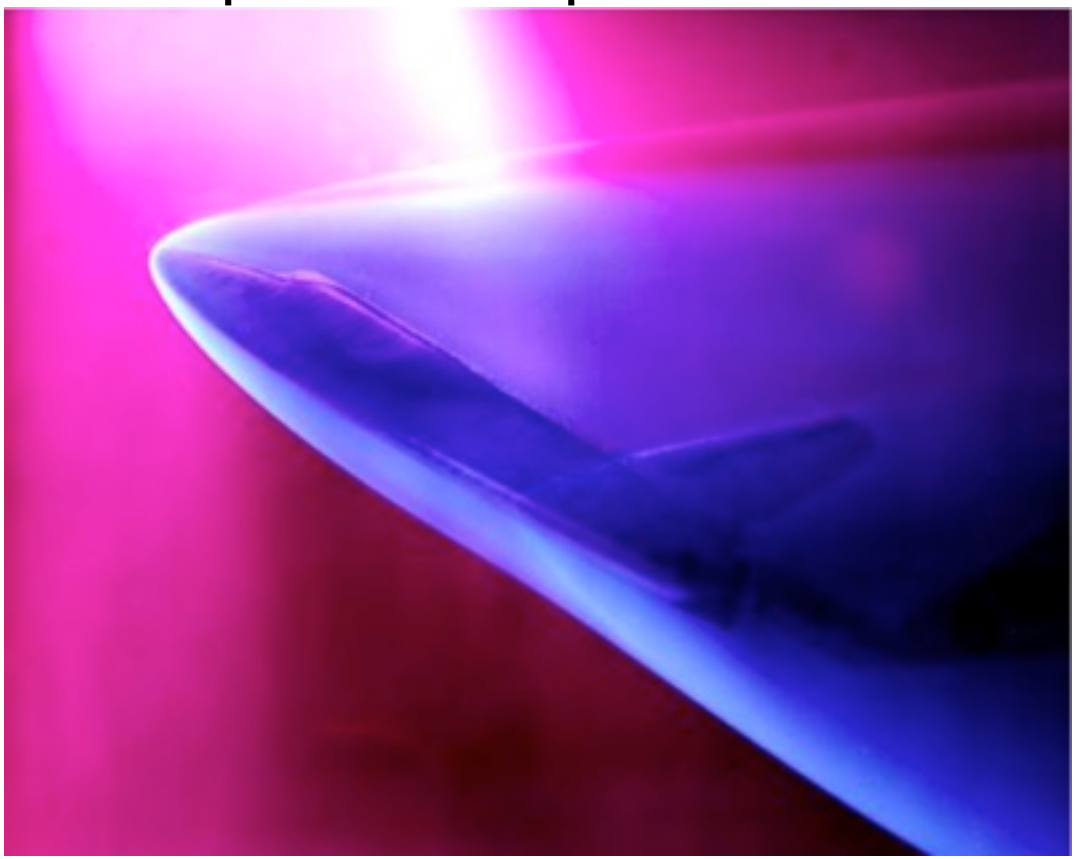
Example for compressible flow



Source: NASA

Visible shocks at the nose in the windtunnel test