DLR-F4 Geometry, Test Cases, and Grids

David Levy, Kelly Laflin,
Shahyar Pirzadeh, and John Vassberg

Overview

- Test geometry selection
- Geometry construction
- Experimental data
- Test case selection
- Multiblock structured grid
- Unstructured grids
- Overset grid

Goals for Test Geometry

- Not too complicated
- Not too simple

} Wing-body

- Available geometry
- Well defined
- Available experimental data

Available Geometry Candidates

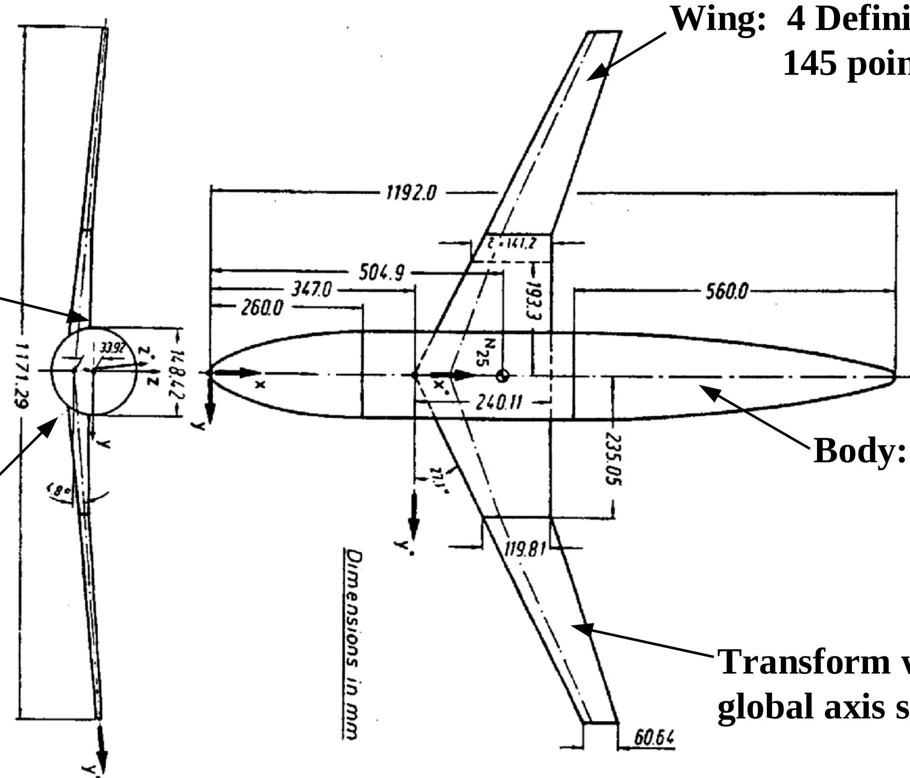
- DLR-F4 Wing-Body
- Pathfinder Wing-Body and
  Wing-Body-Nacelle
- W4 Wing-Body

DLR-F4 Wing Body

Redeker, G., "DLR-F4 Wing-Body Configuration," *A Selection of Experimental Test Cases for the Validation of CFD codes*, AGARD Report AR-303, Aug. 1994.

Wing: 4 Defining Stations, 145 points each

No wing-body fairing



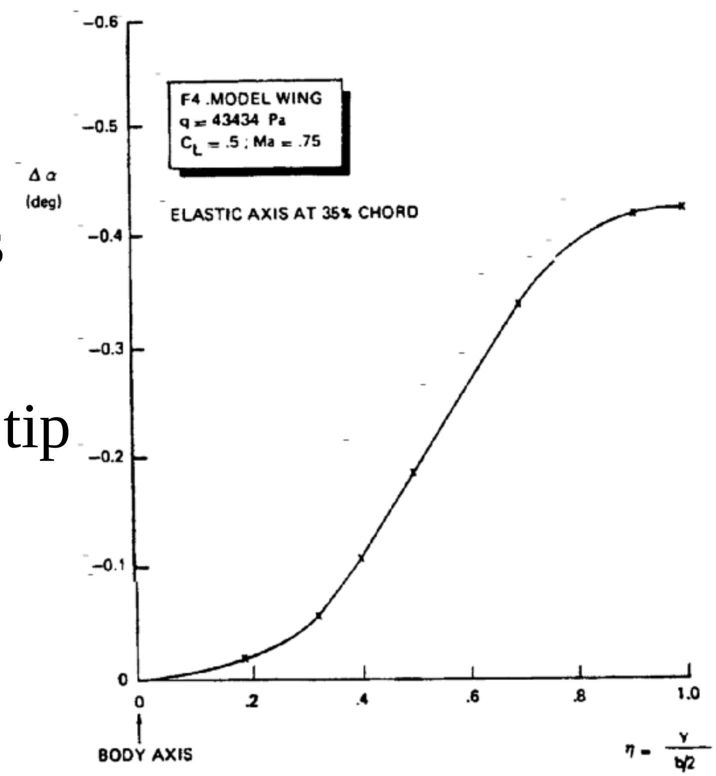
Body: 90 Defining Stations, 66 points each

Extrapolate wing lower surface

Transform wing to global axis system

Finished Geometry

- Surfaces fit in CATIA
- Standard lofting techniques
- Windshield and H. tail flat
- Nose tip, tailcap, and wing tip
- Deformed wing



Cessna
A Textron Company

Experimental Data

- Three sets of data at different wind tunnels
- All data at $R_{Nc}=3x10^6$; Fixed transition
- Alpha sweeps at M_∞= .60, .75, .80
- Wing Pressure Data:

  C_L= .50 @ M_∞ = .60, .70, .75, .76, .77, .78, .79, .80, .81, .82
  C_L= .30, .40, .50, .60 @ M_∞ = .75
- C_D only listed to 3 significant digits

Cessna
A Textron Company

Goals for Test Cases

- Controlled study desired
- Minimize variation (Grids, C_L)
- Perform statistical analysis
- Maximize participation
- Test practicality
- Determine best techniques

Required Test Cases

- **Case 1:** M_∞ =.75, C_L=.500
  Standard grids
  Best for statistics

- **Case 2:** M_∞=.75, α=-3°, -2°, -1°, 0°, 1°, 2°
  Allow better grids
  Can do some statistics
  Closer to industry type data, but still simple

Optional Test Cases

- **Cases 3 and 4:** M_∞ sweep, C_L=.40, .50, .60

  Increasing more difficult
  Separation at higher Mach/C_L combinations
  More like what industry needs and uses