SAAB

CFD as a tool for verification of intake-engine compatibility

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Slides in this presentation have been omitted.

Introduction

- Most military aircrafts:

  Engines embedded in the fuselage
- Air is supplied through separate intake openings and a long duct – a lot happens to the air
- Aircraft manufacturer responsible to ensure good flow quality during all normal operating conditions
- Requirements set by the engine manufacturer
- Careful aerodynamic integration of the engine

Verification methodology

- Wind tunnel measurements on Gripen E
- CFD simulations on Gripen E & F
  - Steady-state (RANS)
  - Time-dependent (Hybrid RANS-LES)
- Compare CFD and WT results on Gripen E

CFD simulations

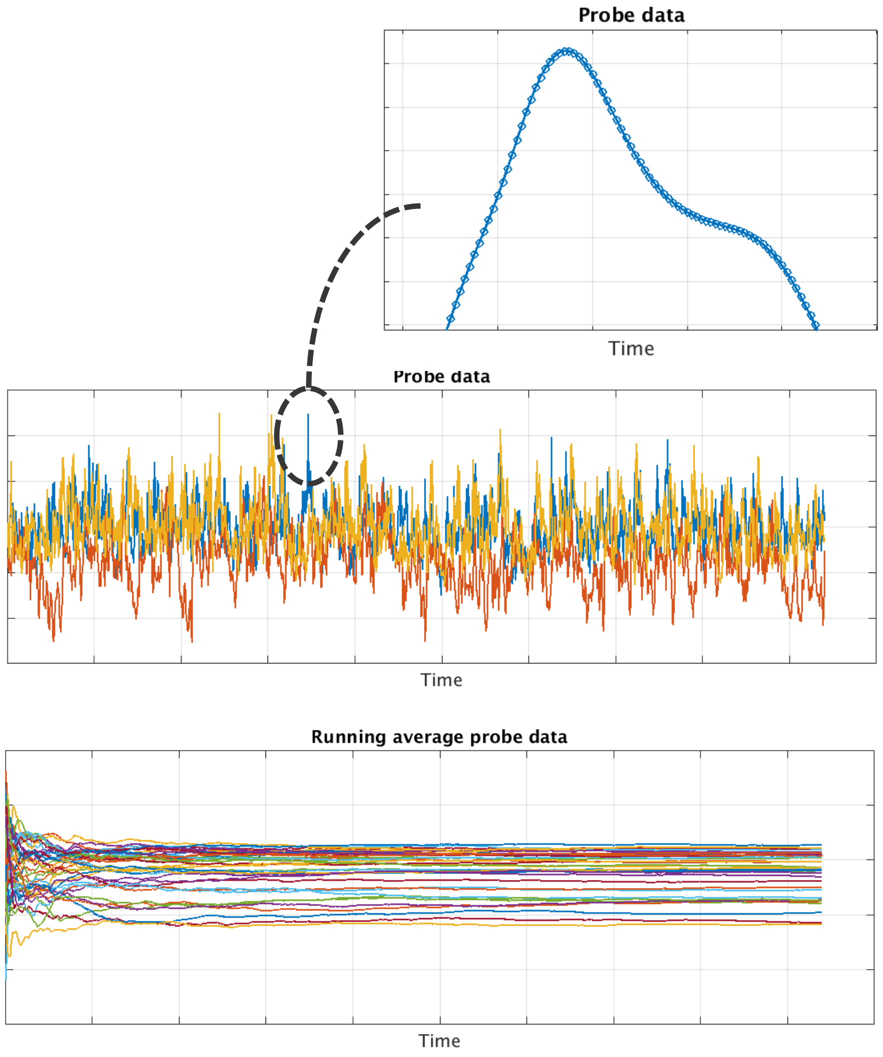
- Geometries
  - Gripen E with WT-like NLG
  - Gripen F with production-like NLG
  - Simplified
- Mesh
  - Unstructured
    - Prism layer
    - Tetra mesh
  - Refined around region of interest (NLG – intakes)

CFD simulations

- Flow solver
  - M-Edge
- Turbulence models
  - RANS / Menter SST k-ω
  - Hybrid RANS-LES / HYB0 by S.-H. Peng

CFD simulations

- Time step = 10^{-5} s
- Reynolds nr. is the same in WT & CFD
- Different geometry scales, WT 1:4 model



Evaluation of flow quality

- Flow visualization
  - Contours of Mach and pressure recovery
  - Iso-surfaces
- Pressure recovery in monitoring points/surfaces
- Distortion indices at the Aerodynamic Interface Plane (AIP)
  - Circumferential
  - Radial

$$Pressure\ recovery = \frac{P_0}{P_{0inf}}$$

Pressure recovery at AIP

- Contour of time averaged pressure recovery and RMS of pressure recovery at AIP
- Pressure recovery
  - WT & Hybrid CFD similar
  - RANS cannot accurately capture the wide range of turbulent scales
- RMS
  - Values match rather well
  - Difference in the distribution

Time-dependent data

- Besides a representative time averaged data typically time variations and especially peak values are of interest
- Engine doesn’t react on turbulence that has higher frequencies than the engine rotational speed
- Dynamic data is filtered in order to match interesting turbulence frequencies

Conclusions

- RANS
  - can be used for pre-studies
  - get an idea of where the wake goes / what happens with the flow
  - at the INTAKES, NOT all the way down to the engine
- HYBRID
  - Provides a good mean field
  - Pressure recovery: both values and distribution are good
  - Even RMS values are rather good, difference in the distribution
- Verified that Hybrid RANS-LES simulations provide results in good agreement with WT measurements
- The method can be used to study the new NLG design on Gripen F

Thank you!