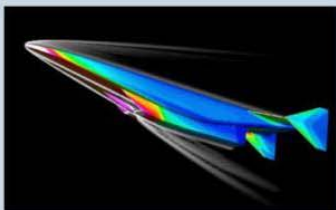


The Background

Transition laminar/turbulent:

Thrust-drag balance and air intake adaptation (air breathing hypersonic vehicles)
Heat fluxes (re-entry vehicles)



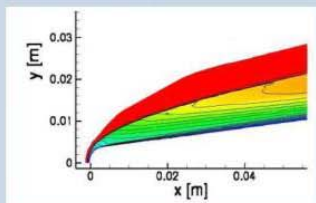
Different experimental data sources in Europe

Increasing capability of CFD :

Need of tools/methods to predict laminar/turbulent transition in hypersonic using RANS code

Challenges:

Cross studies between configurations and tools (RANS, LST, wind tunnel)

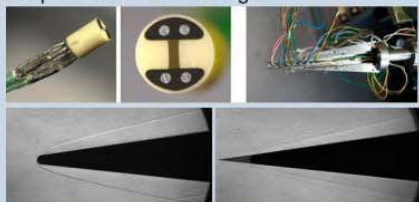


State of the art:

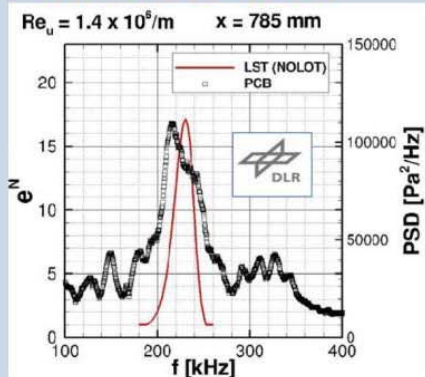
Linear stability theory, Wind tunnel experiments

Critical aspect:

Measurement techniques, wind tunnel noise, extrapolation to the real flight



Activities 2013



WP1 :

Experimental data described in a draft report, to be completed.

Part of the data bank available at ONERA ftp site.

Figure :

Linear stability calculation compared to experimental wall pressure spectra measured using miniature PCB pressure sensor.

Sharp and blunt cones

Natural transition

Mach=7

Re=3.7 10^6/m



WP2 :

Transition prediction model has been extended to non zero pressure gradients, for adiabatic wall.

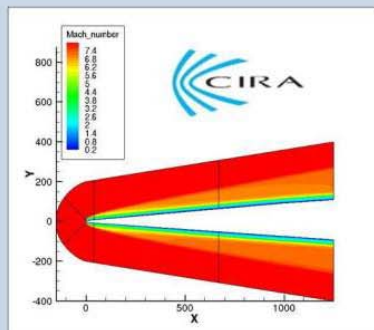
The model has been introduced into codes 3C3D (boundary layer) and elsA (RANS) in replacement of AHD transition criteria.

Figure : validation in 3C3D (5 pressure gradients using velocity ramps, 3 turbulence levels)

Validation underway in elsA

WP3 :

First computations on the LEA forebody done at CIRA



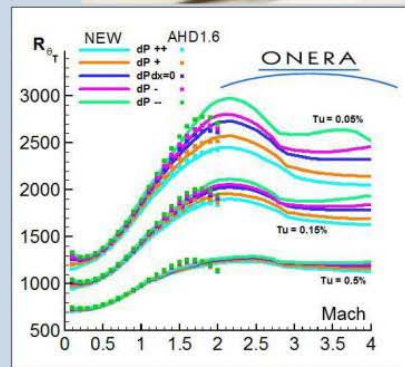
Mach=[4-8]

Re=[1.4 - 14] 10^6/m

Hypersonic forebody

Natural and triggered transition

- Schlieren, Pitot pressure, Oil flow, TSP



Programme

Objectives of the Action Group AD-AG51:

- Cross studies between different wind tunnel tests (blow-down and hot shot)
- Comparisons to numerical approaches
 - Extension of transition criteria to hypersonics
 - Implementation into elsA solver
 - validation based on above test cases
 - Impact of wind tunnel on transition extrapolation to real flight
 - Study of the design of triggering devices

- Navier-Stokes solver with extended criteria (AHD)
- Linear stability codes

Partners: industries and research establishments : CIRA, DLR, ISL, MBDA-F, ONERA, VKI, UniBwM

Current status :

- Submission to GARTEUR council: June 2011
- Project approval : September 2011
- Kick-off meeting: 1st Feb 2012
- Meeting 1 at VKI: 22nd Nov 2012
- Meeting 2 at MBDA : February 2014

Next Steps :

- Validation and application of the extended AHD criterion to LEA forebody
- Work plan for tasks 3.3 / 3.4
 - Navier-stokes computations on ISL cones
 - Laminar BL extraction and comparison
 - LST codes benchmark for natural transition
- Next meeting : Feb 2014, MBDA