GARTEUR
GROUP FOR AERONAUTICAL RESEARCH AND TECHNOLOGY IN EUROPE
FRANCE GERMANY ITALY THE NETHERLANDS SPAIN SWEDEN UNITED KINGDOM

AD/AG-48: Lateral Jet Interactions at Supersonic Speeds

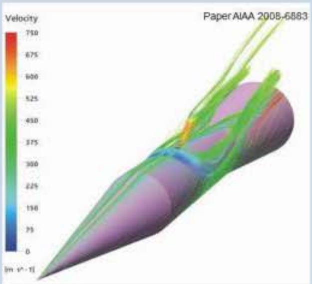
Action Group Chairman: Dr Patrick Gnemmi, ISL (patrick.gnemmi@isl.eu)

Background

Guidance of a supersonic missile: low-velocity or high-altitude missiles, fast response time of hot-gas jets, reproduction in wind tunnels of real hot-gas jet effects by the use of cold-gas jets

Application of RANS CFD methods: multi-species RANS numerical simulations, validation of different codes

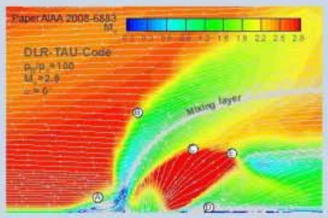
Challenge: defining the most appropriate similarity parameters for wind-tunnel tests using a cold-gas jet



Previous activity: basic experiments and wind-tunnel tests on generic missiles conducted at DLR, ISL and ONERA allowed a better understanding of the phenomenological aspects of the jet interference; effects of Reynolds number and jet pressure ratio studied, not the jet nature

State of the art: reliable steady-state CFD of cold-gas jets interacting with a supersonic flow

Critical flow region: multi-species real-gas flow interacting with the missile cross-flow



P. Gnemmi, R. Adeli, J. Longo, "Computational Comparisons of the Interaction of a Lateral Jet on a Supersonic Generic Missile", Paper AIAA 2008-6883

Programme/Objectives

Main objectives of AD/AG48: (1) to accurately predict by CFD the steady-state aerodynamics of the interaction of a hot multi-species gas jet with the cross-flow of a supersonic missile at acceptable computational costs; (2) to deeply analyze the effect of the hot-gas jet from numerical simulations; (3) to define the most appropriate similarity parameters for wind-tunnel tests using a cold-gas jet

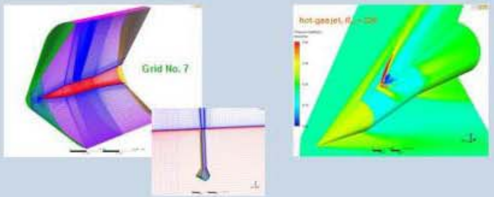
Focus: (1) numerical simulation validations of the interaction of cold-air and hot-gas jets with the cross-flow of supersonic missiles using different Reynolds-Averaged Navier-Stokes (RANS) codes and experimental data from DLR Cologne and ONERA/MBDA-France; (2) numerical simulations for the replacement of the hot-gas jet by a cold-gas jet able to reproduce the effects of the hot-gas jet

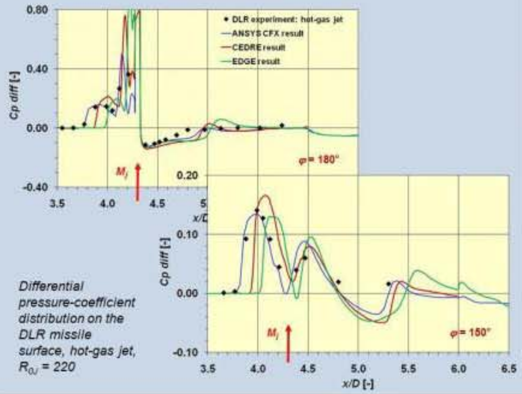
Partners: DLR Cologne, FOI, ISL, MBDA-France, MBDA-LFK, ONERA

Activity: numerical simulations with different RANS codes and validations using high-quality wind-tunnel data

DLR Cologne configurations:

- supersonic flow at Mach 3.00, $\alpha = 0°$
- cold-air and hot-gas jets
- ejection pressure ratio of 130 and 220

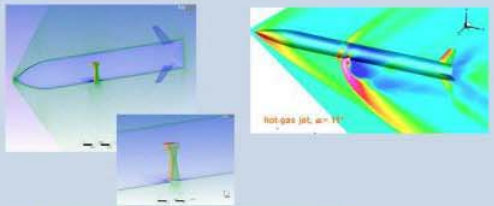


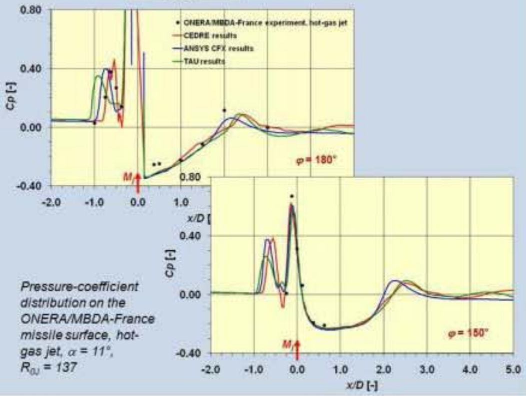


Differential pressure-coefficient distribution on the DLR missile surface, hot-gas jet, R_{0J} = 220

ONERA/MBDA-France configurations:

- supersonic flow Mach 2.01, $\alpha = 0°$ and 11°
- cold-air and hot-gas jets
- ejection pressure ratio of 81 and 137





Pressure-coefficient distribution on the ONERA/MBDA-France missile surface, hot-gas jet, α = 11°, R_{0J} = 137

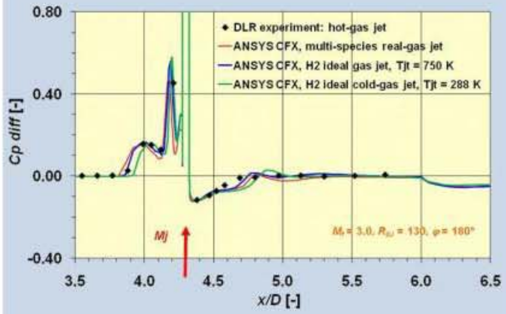
Results

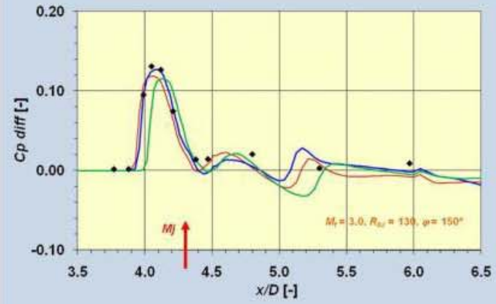
Prediction of cold-gas and hot-gas lateral jet interaction with missile cross-flow

- steady-state numerical simulations able to accurately predict the aerodynamics of cold-gas and hot-gas jets interacting with the missile cross-flow
- less accurate for hot-gas jets with some codes in case of sonic jet flow

Most appropriate similarity parameters for wind-tunnel tests using cold-gas jets

- steady-state numerical simulations used to try to reproduce the effects of a hot-gas jet by the use of a cold-gas jet
- numerous numerical simulations in progress which must be analyzed





DLR FOI ISL MBDA MISSILE SYSTEMS ONERA THE FRENCH AEROSPACE LAB