Environmental issues for a supersonic business jet

ICAS Workshop 2009
28th, September 2009

Introduction

- Supersonic Transport Aircraft in 2009 :
  - Potential strong interest for a small transport aircraft that could significantly reduce travel time (20% to 50%) as compared to current subsonic aircraft
  - Intermediate step towards commercial supersonic airliner
  - New technologies drivers
  - But supersonic transport must overcome difficult challenges :
    - “Respect for environment” (emissions, community noise)
    - Regulations for sonic boom (supersonic flights prohibited over the US and in more than 50 countries) contradictory with need for supersonic overland flights


http://www.hisacproject.com
SIXTH FRAMEWORK PROGRAMME
HISAC
37 partners, from 13 European countries incl. Russia from Industries, SMEs, Research Centers and Universities
DASSAULT AVIATION
AleniaAeronautica
A Finmeccanica Company
CFS Engineering SA
Computational Fluids & Structures Engineering
EADS DEFENCE & SECURITY
Rolls-Royce
RUAG
SUKHOI
CIVIL AIRCRAFT
SENER
Snecma
Groupe SAFRAN
SONACA
VOLVO AERO
Dipartimento Progettazione Aeronautica
ADSE
ESTECO
KTH
ROYAL INSTITUTE OF TECHNOLOGY
Ingenieur-Büro Dr. Kretzschmar
IBK
University of Southampton
isvr
INASCO
INTEGRATED AEROSPACE SCIENCES CORPORATION
EPFL
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
NUMECA
INTERNATIONAL
ARA
Cranfield UNIVERSITY
CHALMERS
ONERA
INRIA
FOI
DLR
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE
EUROCONTROL

HISAC General Objectives

To establish the ***Technological Feasibility*** *of an*

Environmentally Compliant

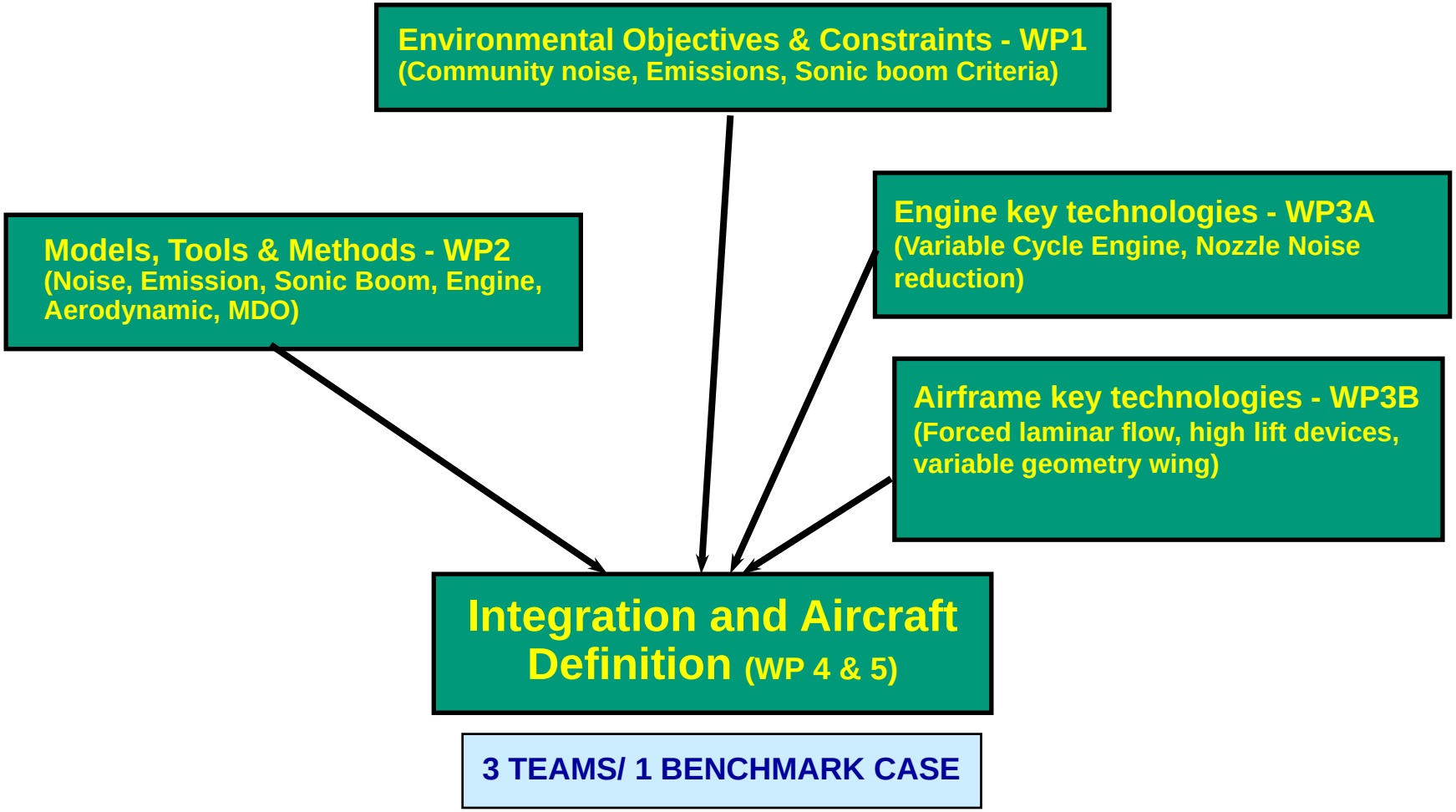
*SuperSonic Small Size Transport Aircraft**

**S4TA*

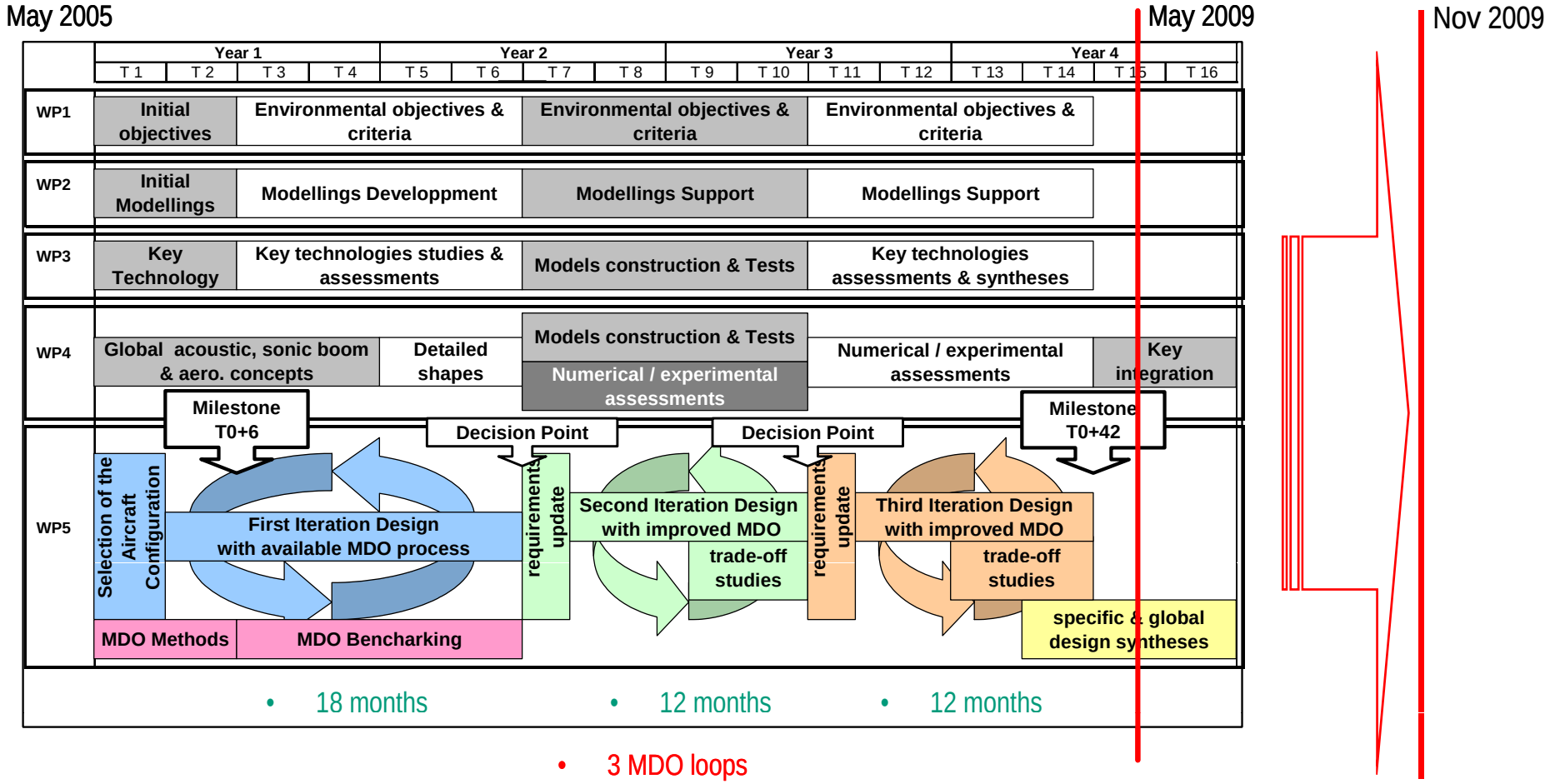
- Provide specifications for an environmentally friendly and economically viable S4TA

- Make progress on elementary technologies and define road map for their future maturation and validation, up to a future proof of concept.

HISAC General Logic



HISAC Work Logic



Environmental targets

- Close work between partners to define criteria

- Definition of a set of ambitious environmental targets for design activities:
  - Low sonic boom: criterion used ~65 dBA

  - Noise: Chap. IV or less (and local noise constraint)

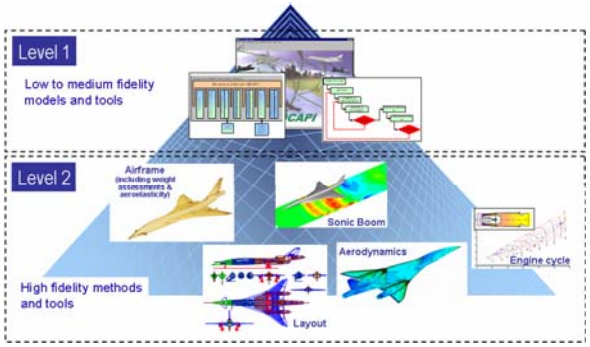
  - Emissions: Temperature change [mK] between 2000 and 2100 (250 a/c and 100 flights/year/ac)

	anthropogenic	air traffic	SSBJ float
dT [mK]	3000	190	~ 0.08

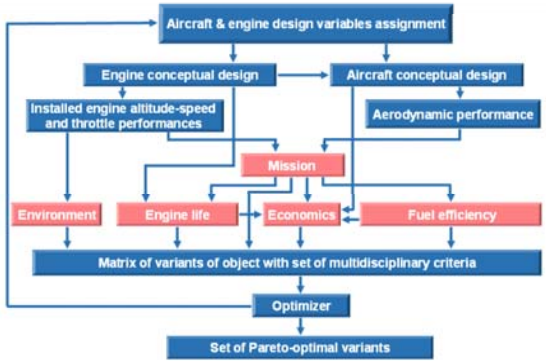
Different accumulation time periodes not directly comparable, nor to be scaled

S4TA design process : a multidisciplinary approach

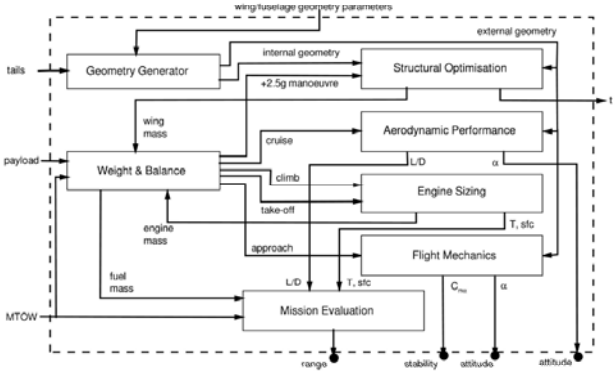
- Taking into account conflicting requirements (performances vs. environmental drivers) requires the use of design processes that can exploit the synergisms of interacting disciplines : the MDO methodologies have been used and compared within HISAC



DA two level design process



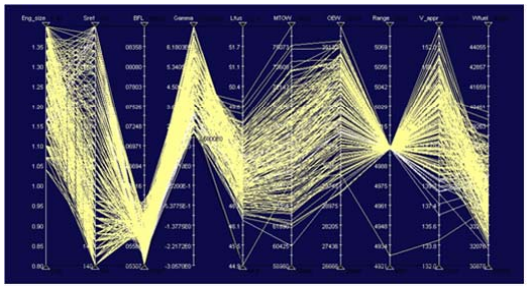
CIAM MDO process

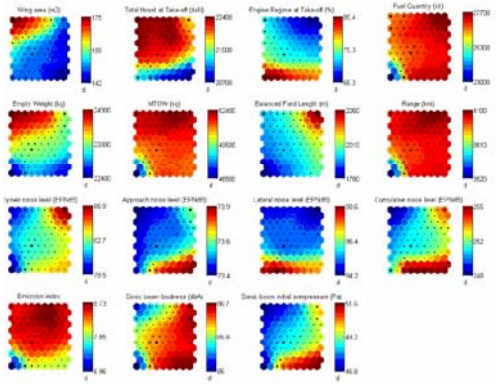


NLR/DLR design process

- In addition, different visualization methods provides the designers with intuitive insight of a complicated design space

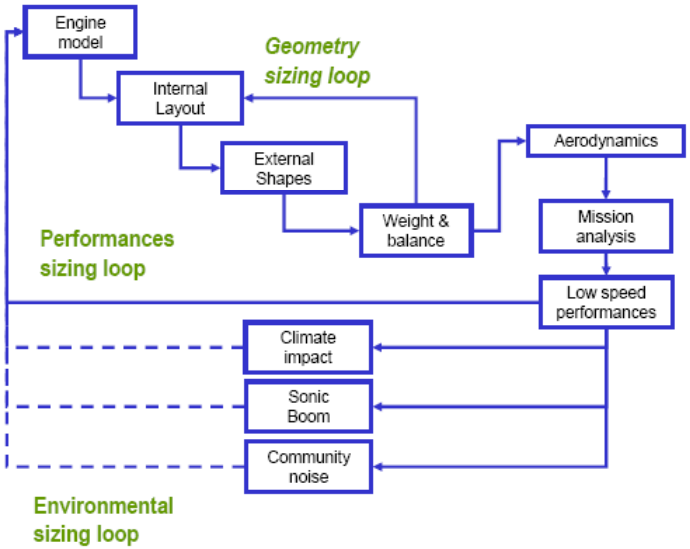
ALA parallel coordinates

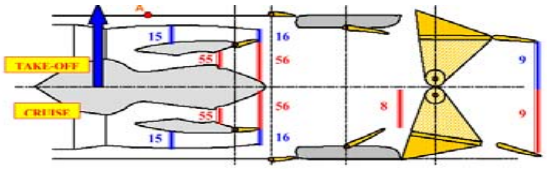




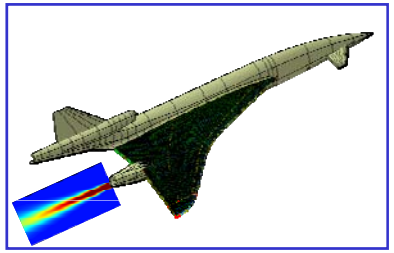
DA Self Organizing Maps

S4TA design process : a multidisciplinary approach fed by detailed environmental models

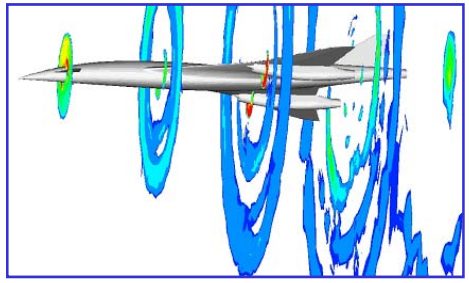




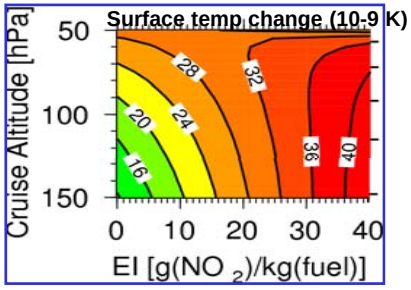
Engines models



Noise models

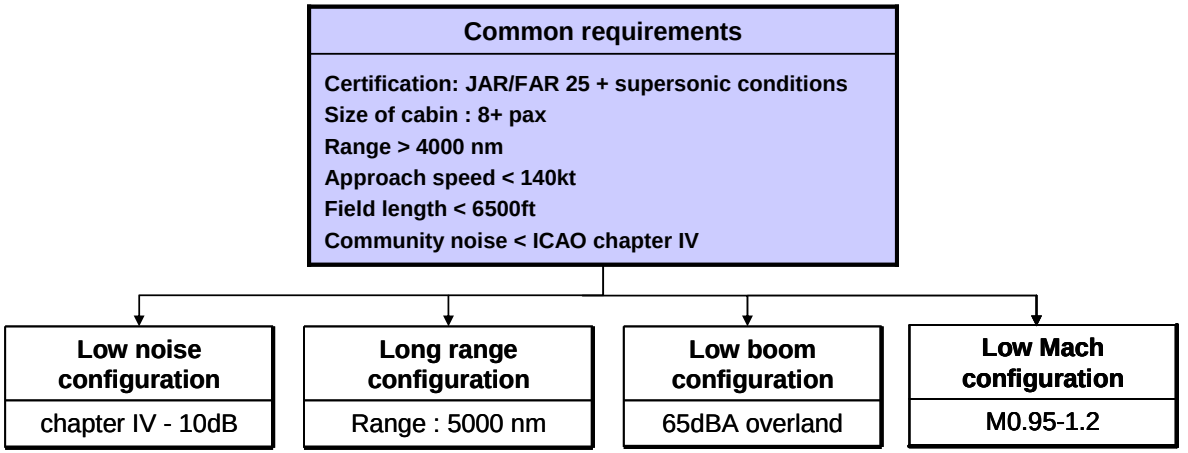


Aero / sonic boon models



Emissions models

HISAC : various S4TA concepts



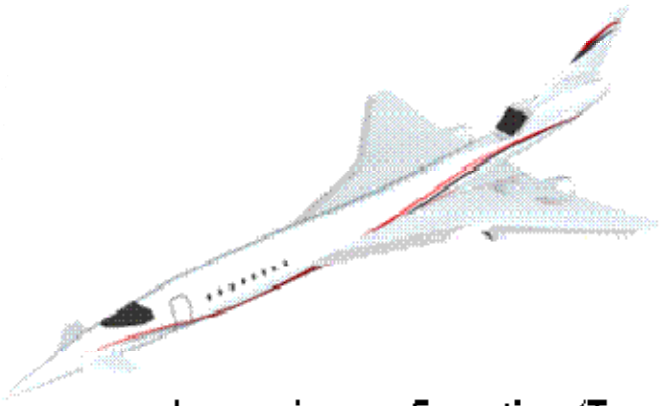
- All configurations share common objectives :

- Passenger comfort :
  - Provide sufficient passenger comfort for all missions
  - Cabin altitude / Cabin noise compatible with existing small size A/C or business jets

- Performance
  - Increased speed with at least transatlantic range
  - Operate from today's airport
  - Top today's business jets cruise altitudes
  - Meet the most stringent environmental requirements

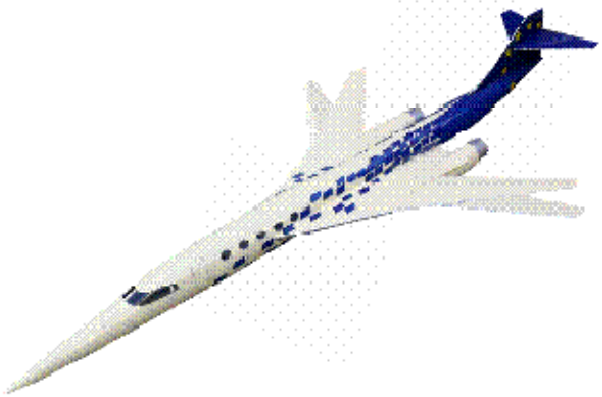
- Design and manufacturing
  - Design incorporate the latest technologies
  - Use of best available material for increased weight reductions

HISAC : various S4TA concepts

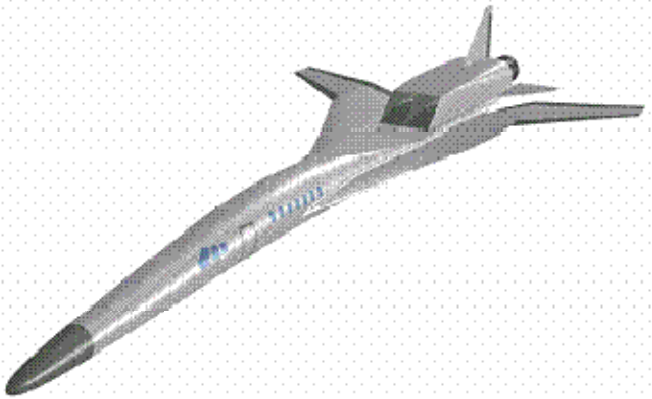


Low noise configuration (Team A)

Long range configuration (Team B)



Variable geometry configuration (Team B)

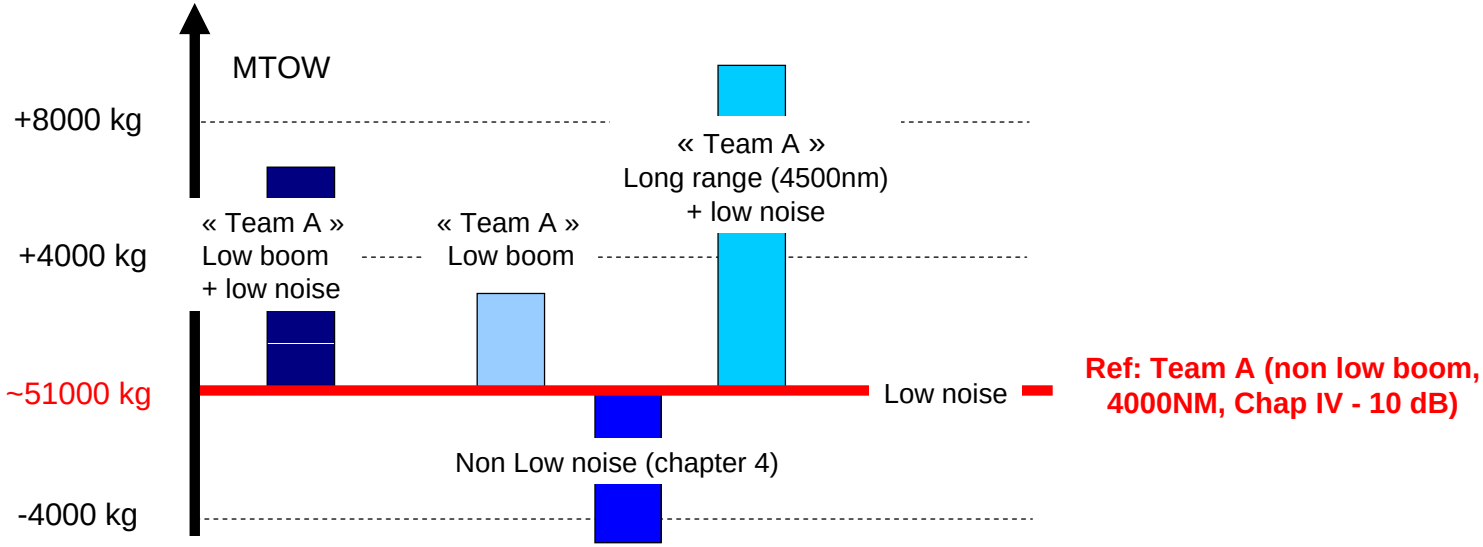


Low sonic boom configuration (Team C)

w Mach derivatives

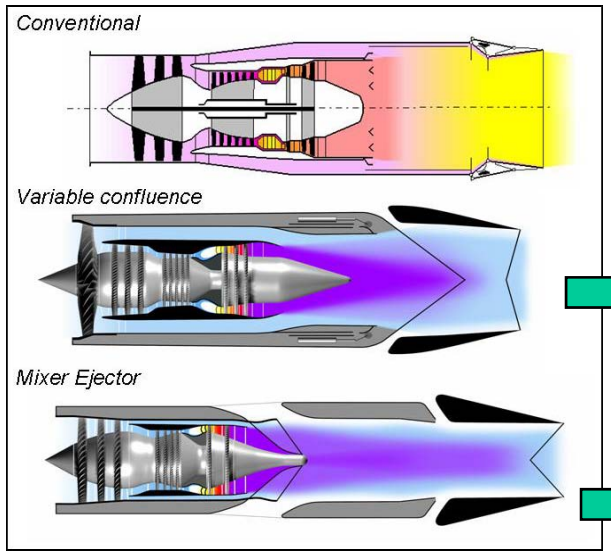
Design activities - trade-offs

- Trade-offs on architectures and technologies
- Trade-offs on aircraft performances
- Trade-offs on environmental specifications:

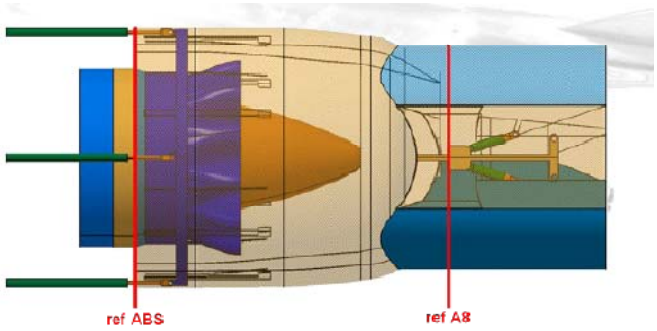


➢ Very high "cost" of specifications on aircraft design

Key technos: engines, nozzles

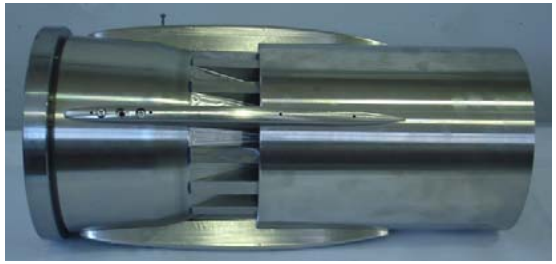


Detailed design of a CVC engine:



Tests of a Mixer-ejector concept:

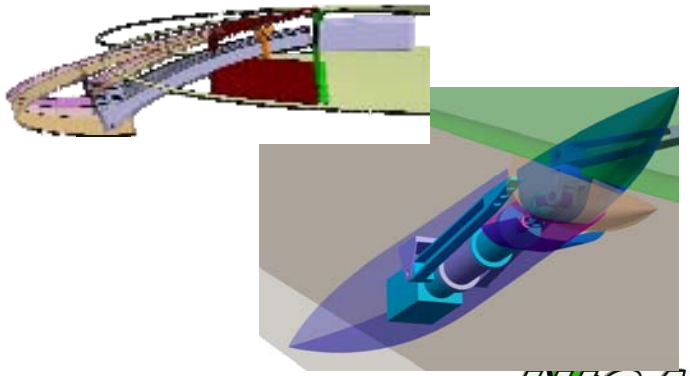
- selection and design (nozzle and liners)
- aero and acoustic tests in Cepra19
- severe and vibratory tests



Key technos: forced laminar, high lift

- Forced laminar flow :
  - The most promising concept is selected and sized (weight, power need, drag reduction): flow suction + anticontamination on inboard wing

- High lift technos:
  - Different concepts of slats / flaps / actuation,
  - De-icing systems sizing



Wind tunnel testing

June 2007: Trans / supersonic in France (S2Ma):

November 2007: Transonic in Russia (T128)

November 2007: Low speed in Switzerland (Emmen):

Way forward

- Synthesis of the project is on-going, mainly about:
  - Roadmap for technologies development
  - Synthesis and Roadmap for environmental targets

- Although compliance with initial HISAC targets seem achievable, technologies and regulation maturation is needed after this 4 year Project

- Interest in Europe is kept for a follow-on of the work and to pave the way for an environmentally compliant supersonic aircraft