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

HISAC

37 partners, from 13 European countries incl. Russia from Industries, SMEs, Research Centers and Universities

HISAC General Objectives

To establish the *Technological Feasibility* *of an*

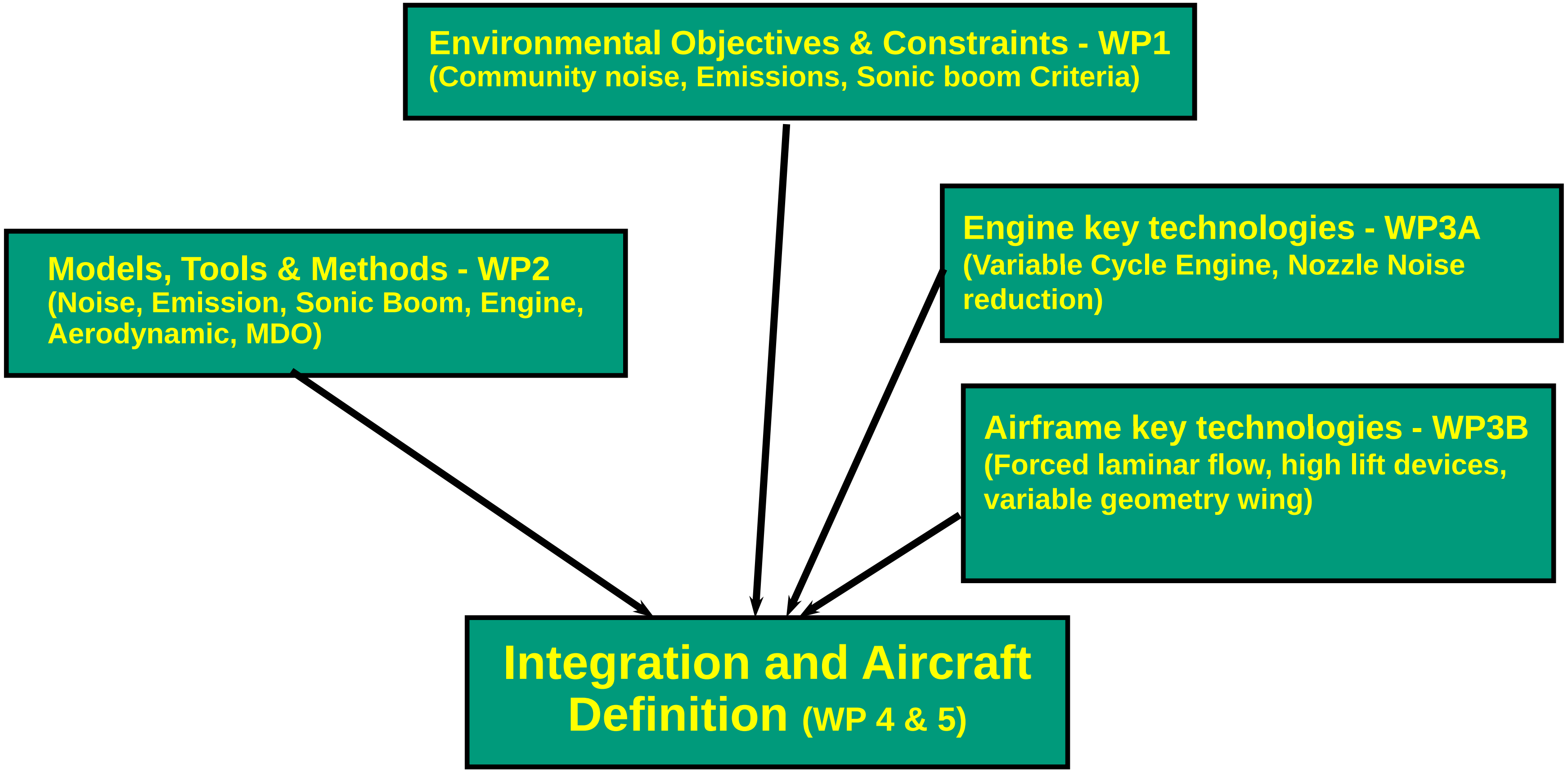
Environmentally Compliant

*SuperSonic Small Size Transport Aircraft**

**S4TA*

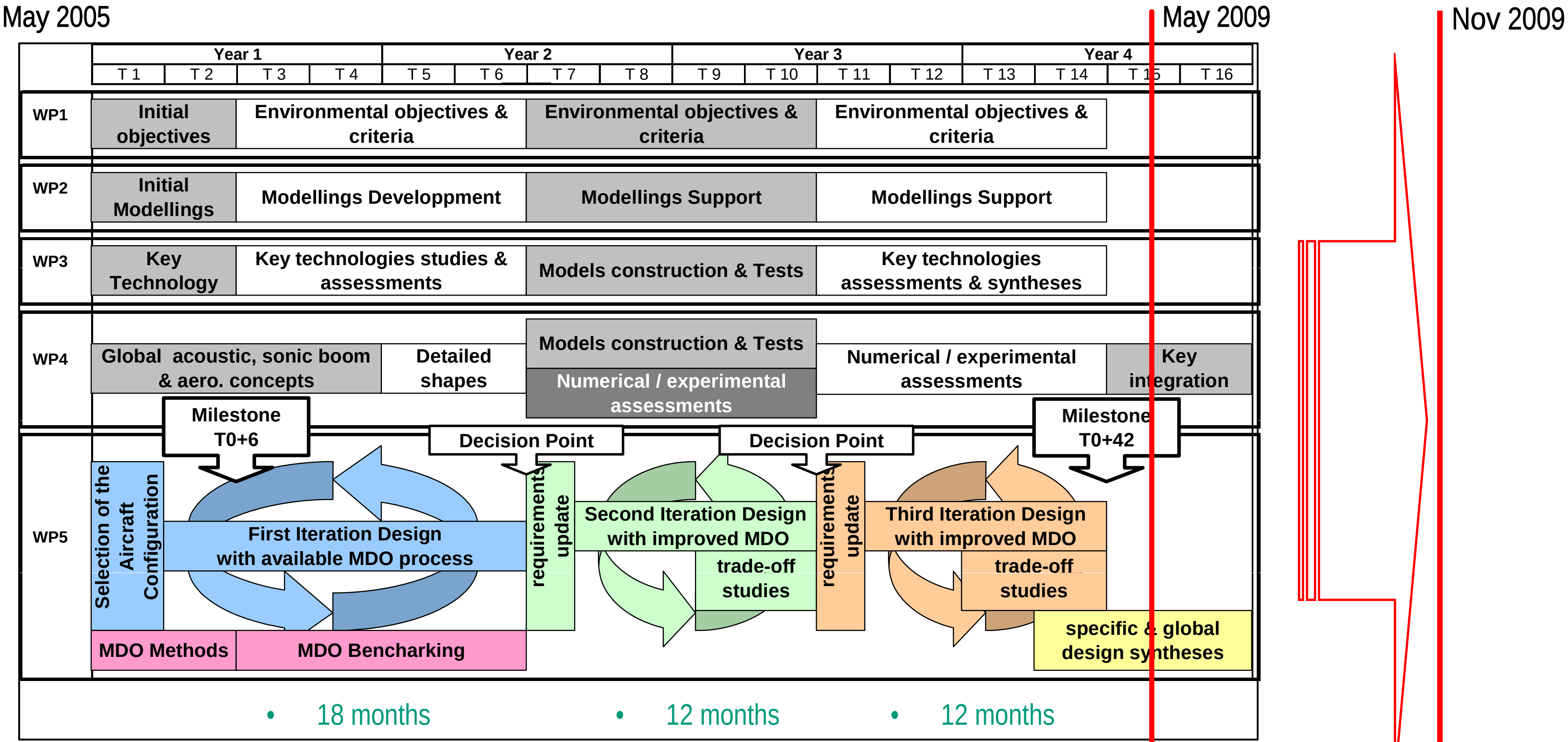
- Provide specifications for an environmentally friendly and economically viable S4TA
- Make progress on elementary technologies and define road map for their future maturation and validation, up to a future proof of concept.

HISAC General Logic



3 TEAMS/ 1 BENCHMARK CASE

HISAC Work Logic



- 3 MDO loops

Environmental targets

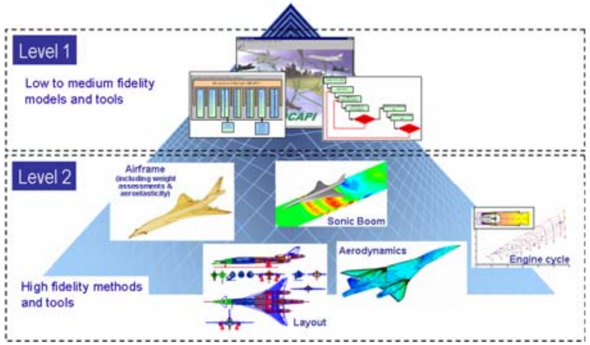
- Close work between partners to define criteria
- Definition of a set of ambitious environmental targets for design activities:
  - Low sonic boom: criterion used ~65 dBA
  - Noise: Chap. IV or less (and local noise constraint)
  - Emissions: Temperature change [mK] between 2000 and 2100 (250 a/c and 100 flights/year/ac)

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

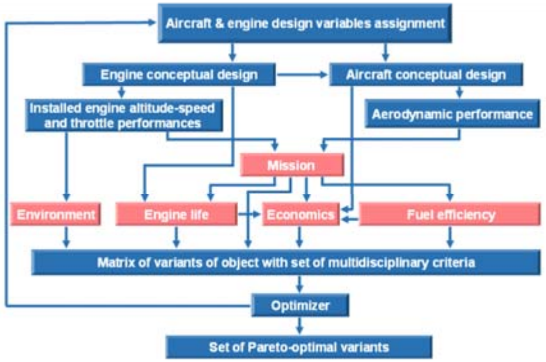
Different accumulation time periodes not directly comparable, nor to be scaled

S4TA design process : a multidisciplinary approach

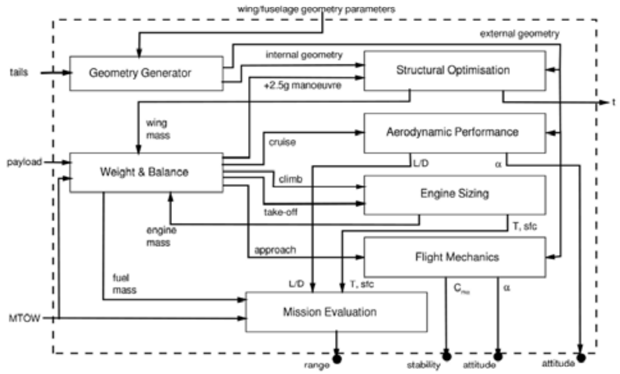
- Taking into account conflicting requirements (performances vs. environmental drivers) requires the use of design processes that can exploit the synergisms of interacting disciplines : the MDO methodologies have been used and compared within HISAC



DA two level design process



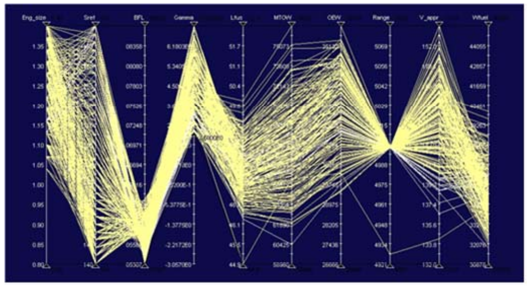
CIAM MDO process

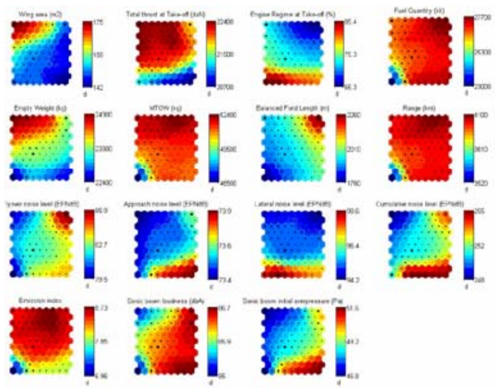


NLR/DLR design process

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

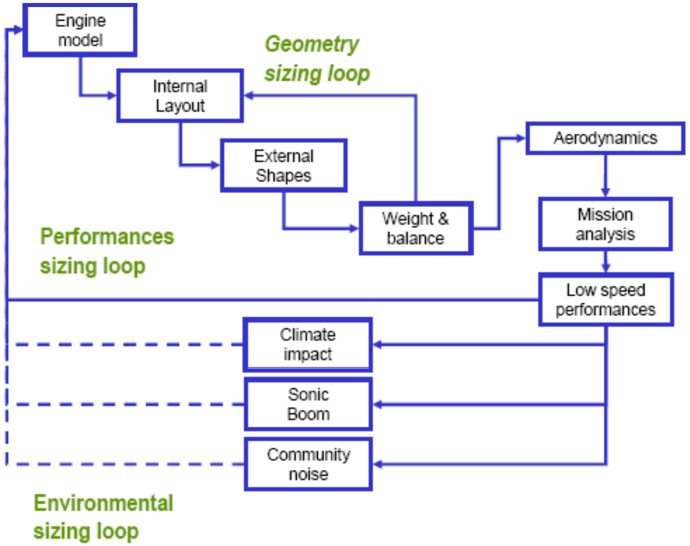
ALA parallel coordinates

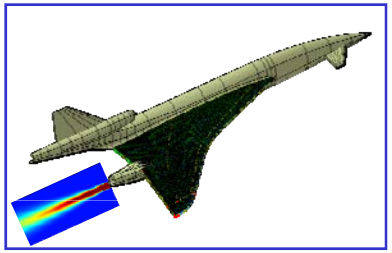




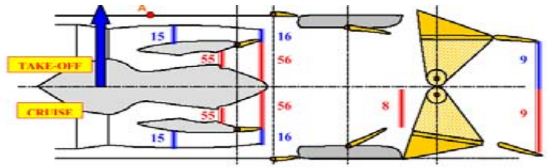
DA Self Organizing Maps

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

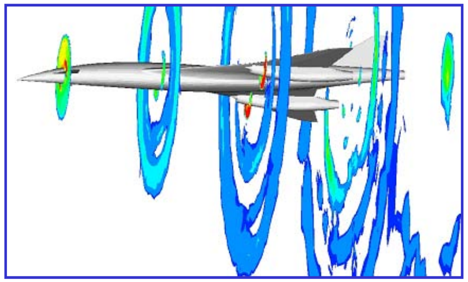




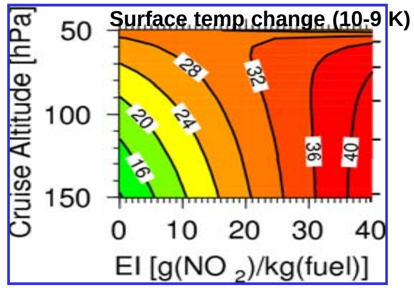
Noise models



Engines models



Aero / sonic boon models



Emissions models

HISAC : various S4TA concepts

Common requirements

Certification: JAR/FAR 25 + supersonic conditions
Size of cabin : 8+ pax
Range > 4000 nm
Approach speed < 140kt
Field length < 6500ft
Community noise < ICAO chapter IV

Low noise configuration	Long range configuration	Low boom configuration	Low Mach configuration
chapter IV - 10dB	Range : 5000 nm	65dBA overland	M0.95-1.2

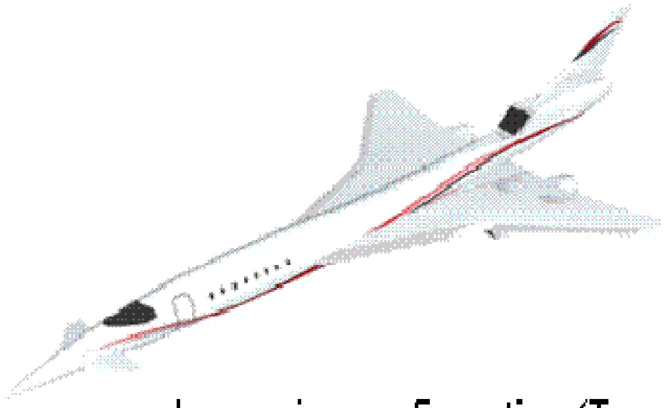
- All configurations share common objectives :

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

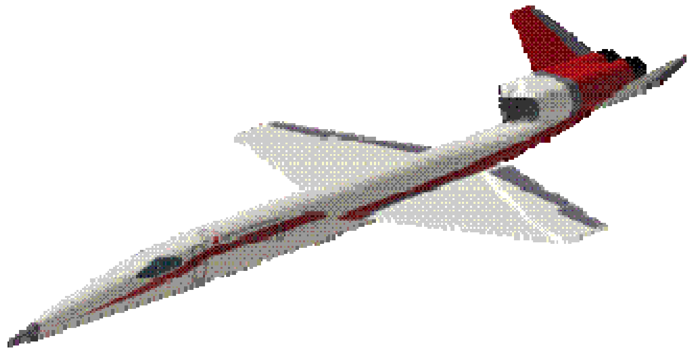
- Performance
  - Increased speed with at least transatlantic range
  - Operate from today's airport
  - Top today's business jets cruise altitudes
  - Meet the most stringent environmental requirements

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

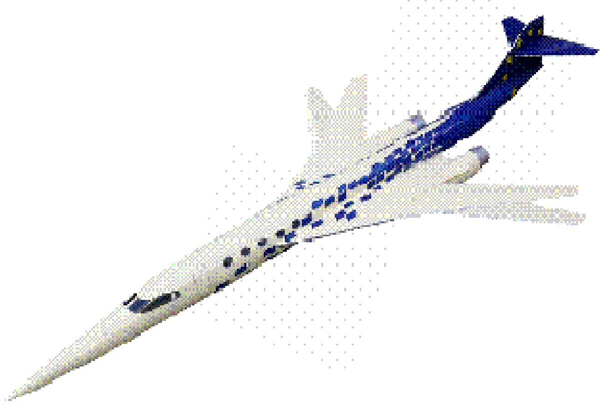
HISAC : various S4TA concepts



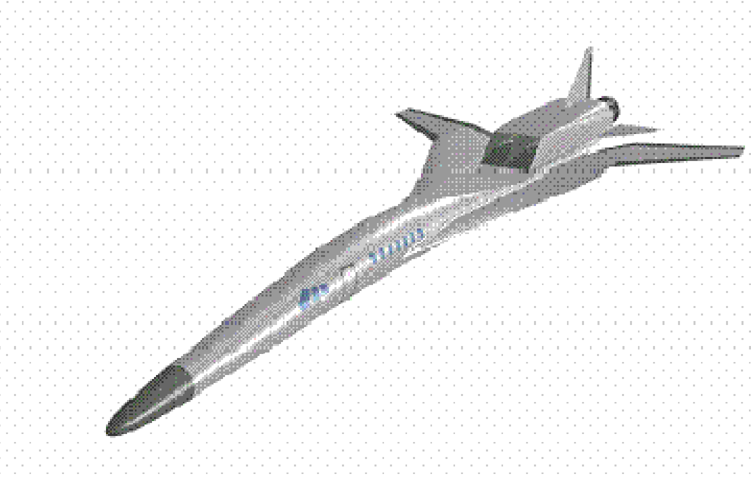
Low noise configuration (Team A)



Long range configuration (Team B)



Variable geometry configuration (Team B)

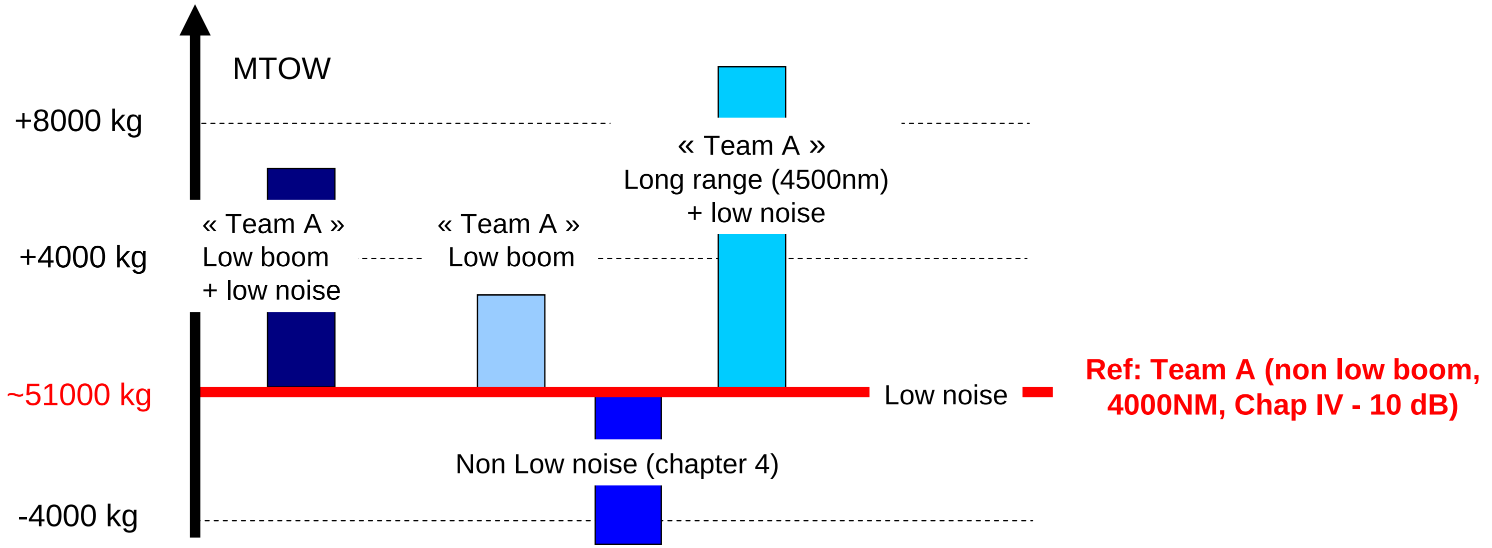


Low sonic boom configuration (Team C)

w Mach derivatives

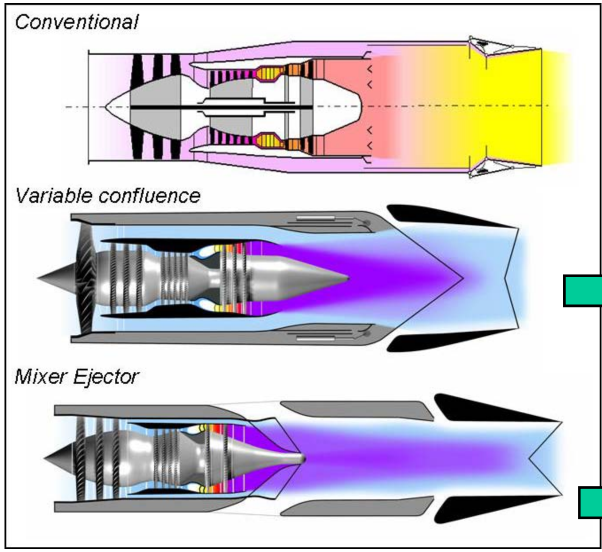
Design activities - trade-offs

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

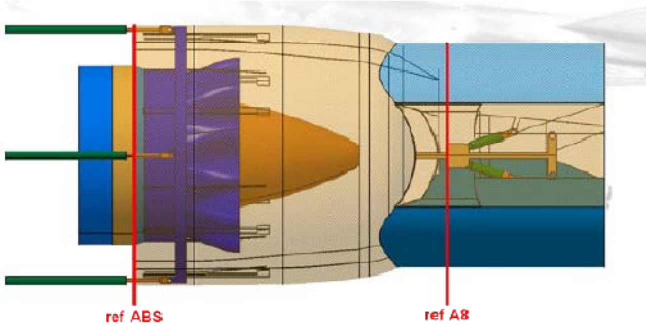


➢ Very high "cost" of specifications on aircraft design

Key technos: engines, nozzles

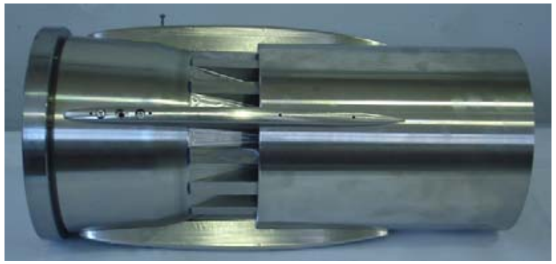


Detailed design of a CVC engine:



Tests of a Mixer-ejector concept:

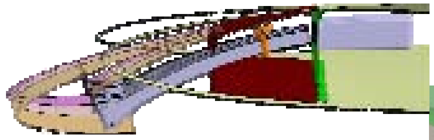
- selection and design (nozzle and liners)
- aero and acoustic tests in Cepra19
- severe and vibratory tests



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