Research Actions on Noise Simulation for Sonic Boom

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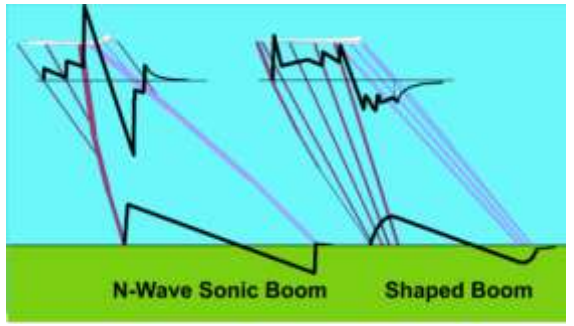
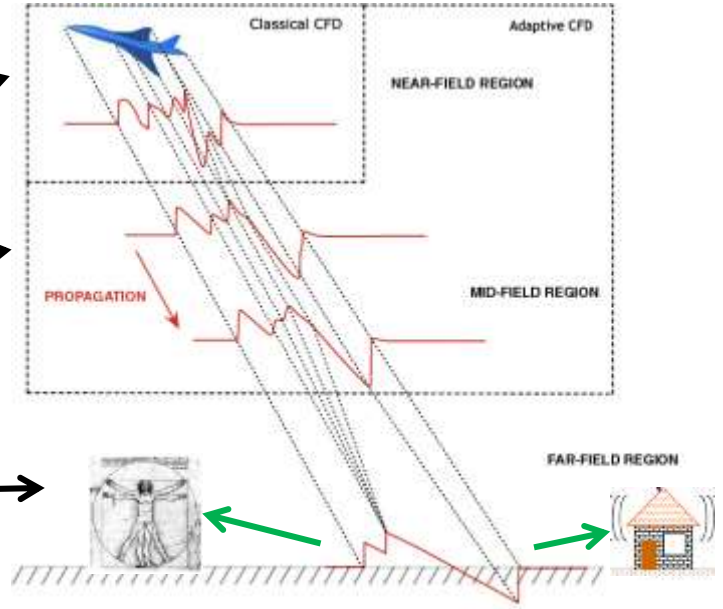
Outline

- Introduction
- Past research actions on sonic boom at ONERA (academic)
- Ongoing institutional collaborations
  - DLR/ONERA/JAXA
  - NASA/ONERA
- European project RUMBLE
- Conclusions and Perspectives

Introduction

- Sonic boom is identified as a key-issue for any future supersonic civil aircraft
  - Significant progresses achieved during last decade toward low-boom shapes
- A topic calling for international/global collaborations
  - A societal/global challenge
  - At pre-competitive stage
  - Regulatory aspects under discussion in ICAO CAEP/SSTG WG1
- Strong need for scientific data, knowledge and validated simulation methods for:
  - Sonic boom source prediction (near-field)
    - CFD methods, mesh dependency/adaptation, …
  - Sonic boom propagation (far-field)
    - Atmosphere variability, turbulence, aircraft maneuver
  - Human response:
    - Psychoacoustic -> appropriate metrics
  - Other possible nuisances (building vibrations, …)



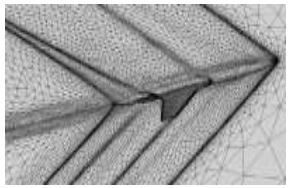


Past research actions on sonic boom at ONERA (academic)

PhD ONERA/INRIA

Aerodynamics /sonic boom optimization (A. Minelli, 2010-2013):

- Advanced multicriteria optimization techniques :
  Nash Games, Multiple Gradient Descent Algorithm (J.A. Désidéri)



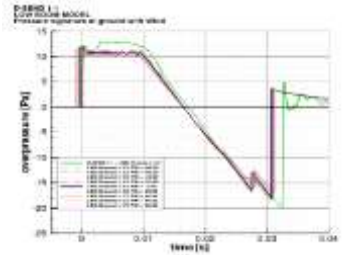
Propagation code

Long term collaboration with F. Coulouvrat (UPMC) since 2000:

- French national projects (COS, DGAC)
- EU projects (HISAC, ATLLAS, ATLLASII)

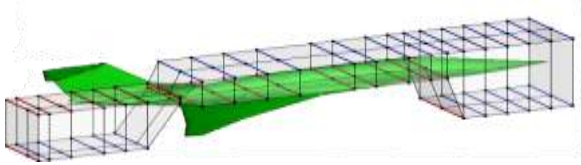
ONERA/JAXA

- Analysis of DSEND#1 experiments :



- QSST DESIGN by inverse design method

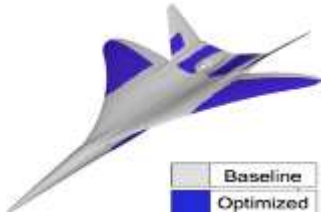
Parametrisation of JAXA SSBJ



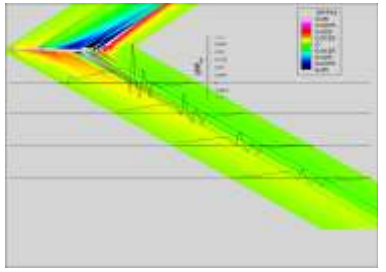
ONERA/STANFORD

Use of Stanford SU² code for sonic boom/aero optimizations

Application of ONERA sonic boom prediction tools on configuration Lockheed-Martin



Adjoint based optimization of sonic boom (SU²)



Sonic boom evaluation of LMCO configuration

ONERA/AIAA

AIAA Sonic Boom Prediction Workshop:

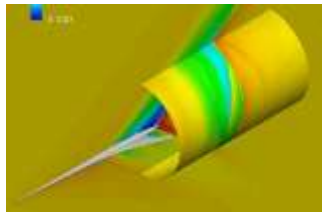
- Participation to the first AIAA SBP workshop in collaboration with **Dassault Aviation** and **INRIA**
- Validation of CFD-based prediction capabilities

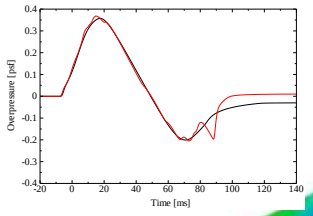
Ongoing institutional collaborations on sonic boom

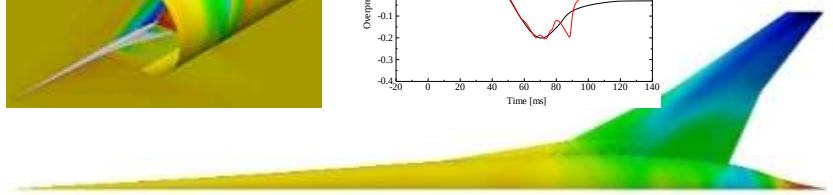
DLR/ONERA/JAXA collaboration (2016 +) :

Sonic-boom assessment for future supersonic en-route noise standard

WP1. Low-boom design validation

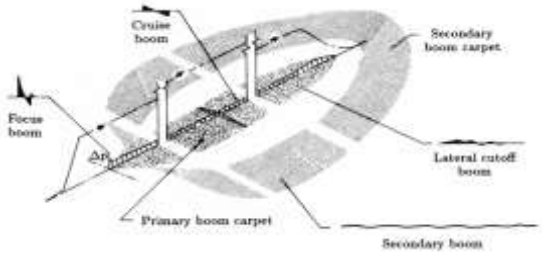






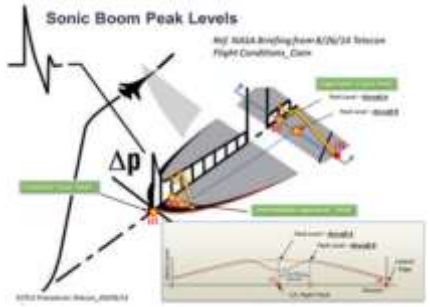
Utilizing 2nd AIAA Sonic Boom Prediction Workshop

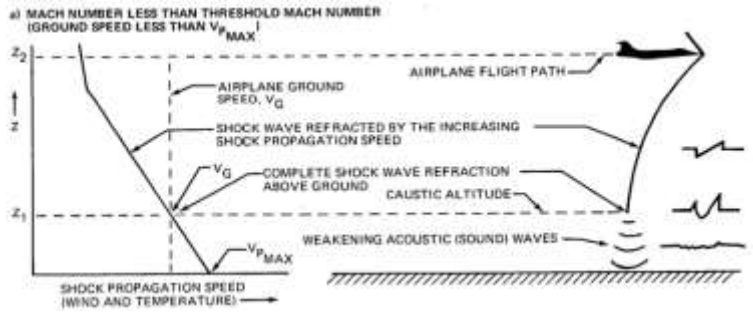
WP2. En-route noise assessment



Looking into ICAO's sonic-boom standard development process

WP3. Robust low-boom design



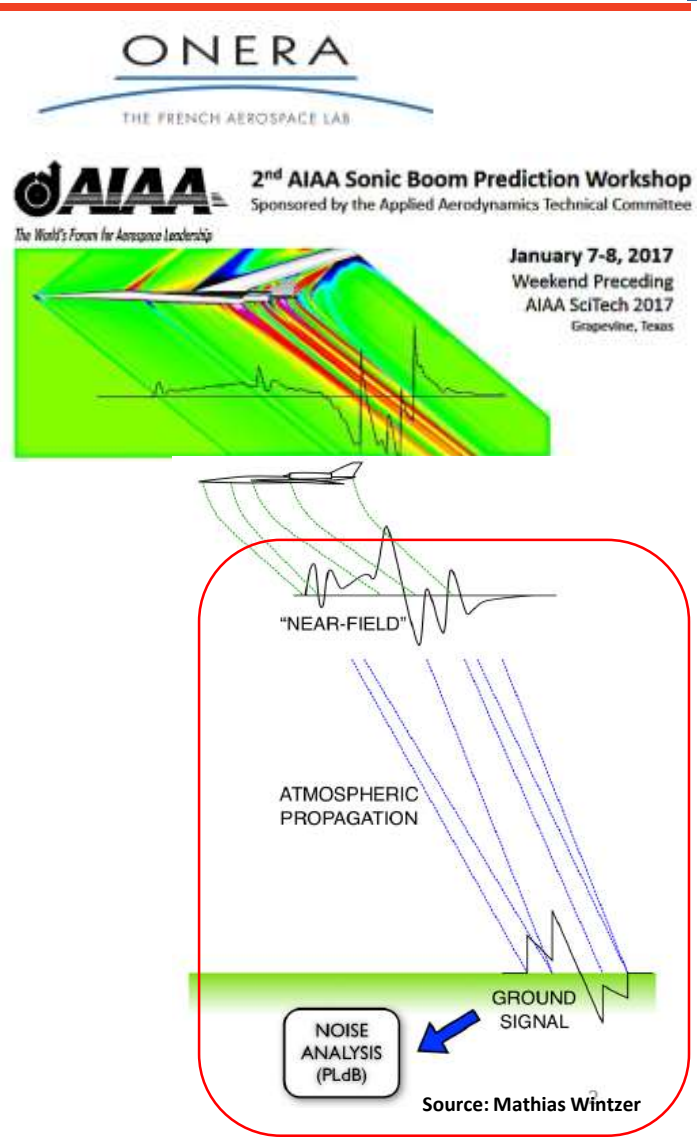


Contributing to the development of future supersonic en-route noise standard

Ongoing institutional collaborations on sonic boom

NASA/ONERA collaboration (2018 +)

- Motivations:
  - consolidate AIAA SBPW2 exercise through bilateral (more detailed) NASA-ONERA results comparisons
  - Possible contribution to the preparation of AIAA SBPW3
- Code to code verifications of sonic boom simulation tools:
  - Far-field propagation
  - Near-field to far field matching (multipole)
  - Sonic boom metrics



What is RUMBLE ?

RegUlation and norM for low sonic Boom LEvels

H2020 MG-1-2-2017 “Reducing Aviation Noise”

Europe – Russia cooperation

Duration: 36 months (Nov. 2017 – Oct. 2020)

Coordinator: Airbus Central Research & Technology – 13 European partners – 6 Russian partners

Purpose: Producing the scientific evidence requested by national, European and international regulation authorities to determine the acceptable level of overland sonic booms and the appropriate ways to comply with it.

Budget: 13 M€

Funded by the **European Commission** and the **Russian Federation**

With the participation of **EASA** and **DGAC France**

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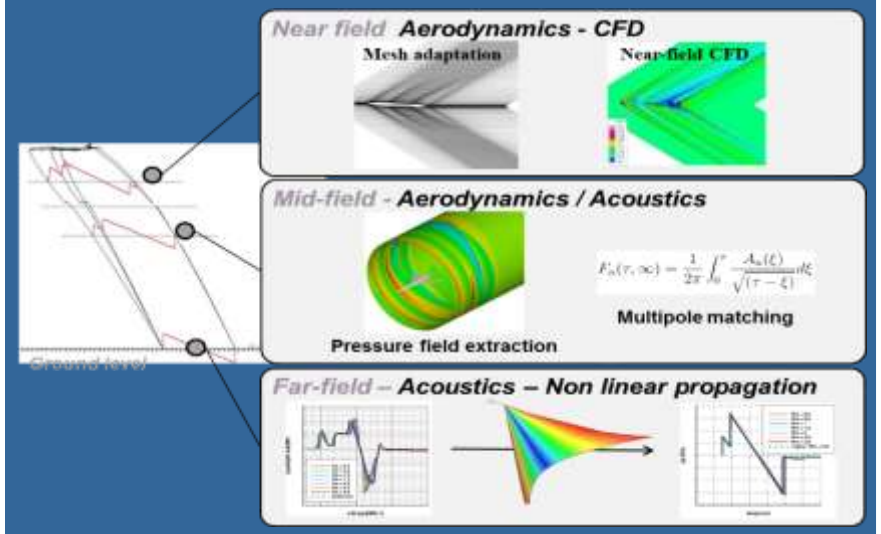
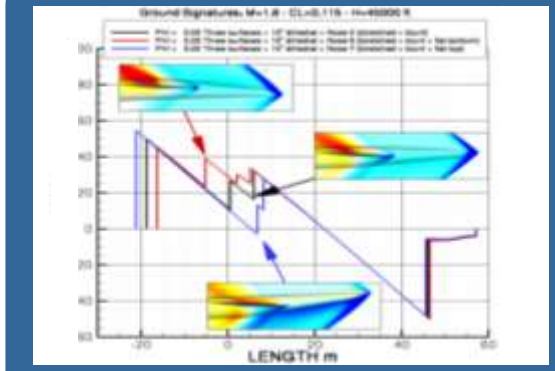
SUMMARY of the ONERA Activity



Validation of sonic boom simulations tools
(far field : Airbus code BANGV)

Human response and metrics



Low-boom design

Wind tunnel test
(ONERA S2MA)

Ground Measurements
(TsAGI flight tests)

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Conclusions and Perspectives

- Sonic boom topic calling for international collaborations :
  - Societal challenge
  - Regulatory aspects (ICAO CAEP/SSTG WG1 activities)

- In Europe, the ongoing RUMBLE project is part of a more general roadmap
  - Work Programme 2020 « MG-3-05-2020: Towards a high-speed global air transportation demonstration"
    → Int'l Cooperation explicitly encouraged

- Opportunities for IFAR actions :
  - IFAR "Noise Working Group" (leader: ONERA) to be soon extended to noise concerns by SST & UAM vehicles

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Thank you for your attention!

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2018 ICAS—IFAR Award Ceremony

Presented By
Susan Ying (ICAS President)
Michel Peters (NLR)

To
Dr. Rei Yamashita (The University of Cambridge)

ICAS-IFAR Award

- A global award to honor an individual who has made a significant contribution to Aeronautical Science within his/her doctoral thesis (Ph.D. or equivalent)
- Eligibility:
  - Within 2 years of the date after the PhD was obtained
  - Under 40 years old at nomination date
- The Award Winner is selected by IFAR Evaluation Team & ICAS Honors & Awards Committee out of candidates nominated by IFAR member organizations worldwide
- Launched in 2016

The 2nd ICAS—IFAR Award Winner

Dr. Rei Yamashita

The University of Cambridge

Japan Society for the Promotion of Science (JSPS) Overseas Research Fellow

Doctoral thesis: *"Full Field Simulation for Sonic Boom Propagation through Real Atmosphere"*

31st Congress of the International Council of the Aeronautical Sciences

Belo Horizonte, Brazil

ICAS
International Council of the Aeronautical Sciences

September 13th, 2018

IFAR
INTERNATIONAL FORUM FOR AVIATION RESEARCH