European
Commission

TOWARDS QUIETER AVIATION

Contributions of Horizon 2020 projects managed by CINEA

European Climate,
Infrastructure
and Environment
Executive Agency

European Climate, Infrastructure and Environment Executive Agency (CINEA)

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PROJECTS OVERVIEW

> “CINEA’s implementation of EU-funded projects makes an important contribution towards achieving the EU’s strategic goals in aviation.”

FOREWORD

The aviation and air transport industries are among the main contributors to the European Union’s economic prosperity, and the demand for air transport continues to grow worldwide. However, as well as positive impacts, this also brings challenges, including that of noise pollution.

That is why seeking solutions to balance the benefits of enhanced global connectivity with the needs of people living in the vicinities of airports, is of utmost importance. Achieving a reduction in aviation noise will help to improve the quality of life of citizens, and mitigate the impact on local communities – not least given the growth in air traffic and expanding urbanisation around airports.

In CINEA, the European Climate, Infrastructure and Environment Executive Agency, we are addressing this challenge through a growing number of collaborative research and innovation (R&I) projects, selected through competitive calls under the EU’s research programme, Horizon 2020. Implemented by the Agency, the projects are exploring and developing technologies that can help mitigate aviation noise. Some look further into the future, addressing technologies and regulatory noise challenges of potential new means of international commercial air transport.

These projects have already made an important contribution towards the reduction of perceived noise emissions of a single aircraft – 65% compared to the capabilities of typical new aircraft in 2000. They are also playing a key role towards achieving other EU aviation strategic goals, such as those specified in Advisory Council for Aeronautics Research in Europe’s (ACARE) “Flightpath 2050”, and in the European Commission’s “Sustainable and Smart Mobility Strategy”. This project portfolio is expected to expand in the future under the successor research programme, Horizon Europe.

I am delighted to present this new brochure, highlighting the important contribution of this cluster of R&I projects, managed by CINEA, towards quieter and more sustainable aviation in Europe. It includes examples of developing novel technologies aimed to reduce noise at the source, improving the understanding of aircraft noise generation and its perception, and assessing noise management methods for airports and communities.

The publication showcases key results and impacts of completed projects, and also underlines the objectives of those still ongoing. I hope that you will find it informative and interesting.

DIRK BECKERS,
Director, CINEA

INTRODUCTION

Aviation is one of the European Union's (EU) industries of excellence. Air transport supports close to 10 million jobs hence contributing to 4.2 % of European GDP[1], while strengthening ties between citizens, businesses, and communities across Europe and all over the world. With worldwide air-traffic demand increasing by more than 4% every year before the global pandemic, aviation is among the most rapidly growing transport sectors. In 2019, 1.034 million people in the EU travelled by air[2], while over 11.1 million flights were undertaken (an average of 30,427 daily flights)[3].

Despite the adverse industry-wide effects of the COVID-19 pandemic, global demand for air transport services is expected to recover in the long term[4,5]. However, without further measures this growth in air traffic will be accompanied by growing noise emissions impacting the communities in the vicinity of airports.

During the past two decades, the specific noise level per aircraft has decreased by roughly 2dB. However, the increasing fleet of commercial aircraft and expanding urbanisation around airports has rendered aircraft noise an important contributor to noise pollution in modern society[6,7]. Aircraft noise, particularly during aircraft take-off and landing, is a major societal concern. It has been proven to cause a range of negative impacts including hearing and cognitive impairment, cardiovascular disease, sleep disturbance and annoyance, while also impacting quality of life, mental health and wellbeing[8]. Health risks associated with exposure to aviation noise have been proven to impact approximately ten million European residents[9]. This is why, regulatory responses of local, national and international authorities to aircraft noise, as well as ambitious policy initiatives and relevant technical developments, are of critical importance to lower the noise emissions and mitigate the negative externalities of aviation noise pollution.

In this context, the UN International Civil Aviation Organisation (ICAO) has provided guidance for airports through its Balanced Approach to noise management[10], which has been incorporated to EU legislation[11]. The European Commission's (EC) Environmental Noise Directive (2002/49/EC), provides a basis for the development of measures aimed to reduce noise pollution from significant sources, including aircraft. The Advisory Council for Aeronautics Research in Europe (ACARE) has set ambitious targets to mitigate aircraft noise pollution, in its Research and Innovation Agenda (SRIA), or Flightpath 2050[12] (namely a goal of 65% reduction in perceived noise emission of flying aircraft, compared to typical new aircraft in 2000). Recently, the EC "Sustainable and Smart Mobility Strategy"[13] and the "Zero Pollution Action Plan"[14] have also outlined the importance of reducing noise pollution from mobility and transport, in the context of the "European Green Deal".

Over the next two decades, further technological advancements and the fleet penetration of new and quieter aircraft are expected to first stabilise and then reduce the average noise exposure around airports. However, this may start to increase again in the longer term if the development of new quieter aircraft cannot offset the growth in traffic[15]. As such, mitigation of aviation noise impact is sought by leveraging on technologies capable of reducing noise at the source, while improving aircraft operations around airports and environmental noise management. Since mitigating aviation's noise impact on communities neighbouring airports is of primary importance for the health, well-being, and quality of life of the European citizens, the EU aviation R&I community is currently addressing these challenges through a growing number of dedicated R&I projects financed under the EU Horizon 2020 Framework Programme.

This publication presents the contribution of a cluster of R&I projects in the aviation domain to the EU policy priority of reducing aviation's noise footprint. It includes a concrete overview of project objectives, activities and results aimed towards quiet and sustainable aviation. In particular, R&I in the following areas is outlined:

- acoustic metamaterials;
- noise and annoyance management, including aircraft operations;
- passive and active noise reduction technologies;
- fan noise reduction;
- airframe noise reduction;
- optimisation of propulsion-airframe integration;
- sonic boom regulation and sustainability of future commercial supersonic transport;

EU research towards quieter aviation is contributing to the FlightPath 2050 goal of reducing perceived aircraft noise levels. It is also strengthening the European aviation industry and fostering cooperation beyond EU borders. As a number of countries non-EU countries are associated to the Horizon 2020 programme, several projects include partners from outside the EU, hence contributing to addressing aviation noise challenges at a global level.

TOWARDS QUIETER AVIATION

HORIZON 2020 PROJECTS

INVENTOR

SENECA

MOREandLESS

AERIALIST

ENODISE

ANIMA

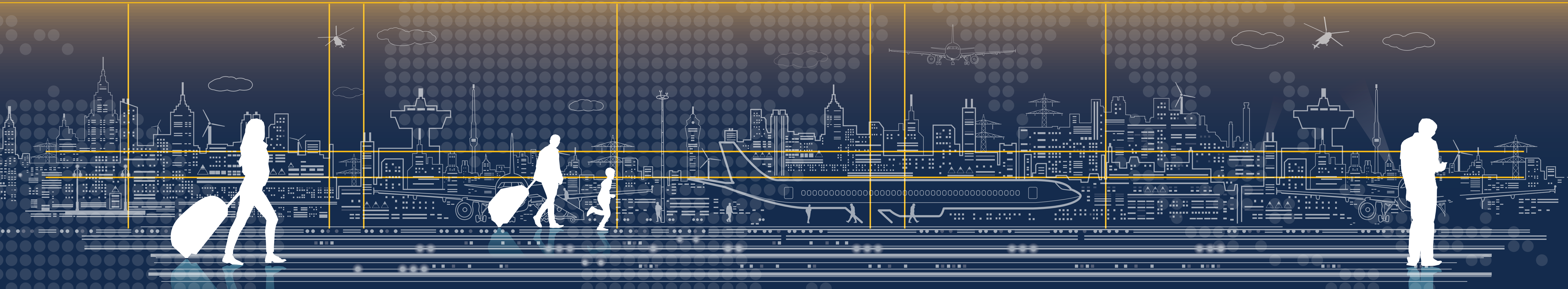
TurboNoiseBB

DJINN

RUMBLE

ARTEM

STRATOFLY



AERIALIST

ADVANCED AIRCRAFT-NOISE-ALLEVIATION DEVICES USING METAMATERIALS —

The AERIALIST project successfully identified and developed breakthrough technologies based on acoustic “metamaterials” for shielding and trapping noise in aeronautic applications. Metamaterials can be defined as advanced materials engineered to have properties not found in naturally occurring materials.

AERIALIST achieved its objectives by:

- **consolidating the theory of metamaterials in aeroacoustics;**
- **developing and assessing methods for efficient additive manufacturing of metamaterials;**
- **experimentally validating models and designs;**
- **assessing the entire toolchain loop modelling-manufacturing-experiments;**
- **while providing a development roadmap towards Technology Readiness Level (TRL) of industrial solutions.**

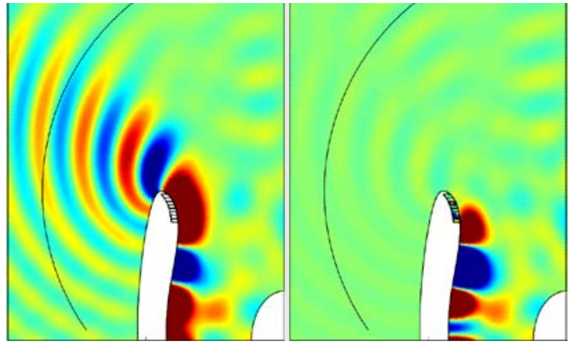


Figure 1 - Numerical simulation of acoustic pressure field at 628 Hz with hard wall nacelle (left) and phase-gradient metafluid lining (right), at M=0.2. All cut on modes at the fan section are considered. Rotor-locked mode targeted for back reflection during metafluid optimization (extension of AERIALIST results obtained in project ARTEM).

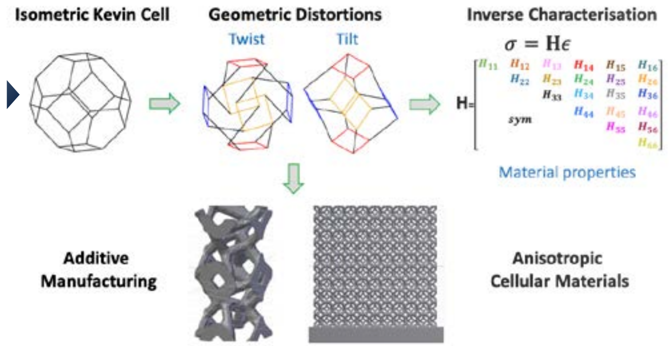


Figure 2 - Process of obtaining anisotropic cellular materials from isometric Kelvin cells.

More specifically, AERIALIST extended the acoustic metamaterials theory to aeroacoustics problems to take into account aerodynamic convection and non-locality of the boundary response. Figure 1 depicts such a numerical simulation, illustrating the effect of an optimised phase-gradient metasurface installed at the lip of a nacelle intake. The AERIALIST consortium also assessed metamaterial design and digital manufacturing techniques using the most advanced 3D printing techniques, while the effects of manufacturing uncertainties on the acoustic response were examined in detail. The metamaterials were produced through a development cycle which began with detailed numerical simulations, including optimisation for additive manufacturing, and ended with experimental validation of the metamaterial performance.

Metamaterials were manufactured as both metals and polymers. AERIALIST produced large volumes of printed materials, with features ranging down to a scale of 0.2 mm. Figure 2 graphically depicts the process of identification of a target anisotropic macro-behaviour through the geometric distortion of the elementary cells, while Figure 3 shows the microstructure of two distorted Kelvin cells, manufactured with masked stereolithography techniques.

The completion of the entire design toolchain confirmed the achievement of TRL 3 for all the concepts developed. AERIALIST’s research activity has also continued after the finalisation of the project as part of the H2020 ARTEM project (see pages 14-15)), aiming to further simulate the outputs of AERIALIST, and to test them on more realistic applications.

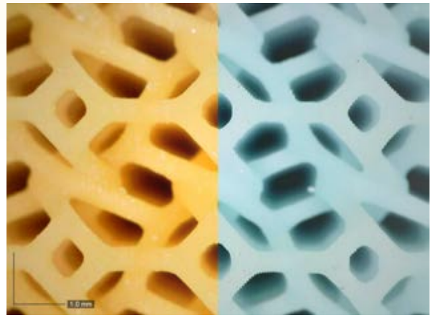


Figure 3 - Masked stereo lithography prints of distorted Kelvin cells producing an anisotropic vibro-acoustic metamaterial (48x magnification).

PROJECT NUMBER

723367

COORDINATOR

UNIVERSITA DEGLI STUDI ROMA TRE

PROJECT DURATION

01/06/2017 - 31/05/2020

EU FUNDING

EUR 2,434,330

WEBSITE

https://cordis.europa.eu/project/id/723367

ANIMA

AVIATION NOISE IMPACT MANAGEMENT THROUGH NOVEL APPROACHES —

The ANIMA project provided solutions for alleviating the noise impact and the annoyance endured by communities living near airports. It supported policymakers, researchers and airport managers to make better decisions, which balance regulatory and economic considerations with the goal of achieving the best outcomes for all stakeholders.

The methodology developed by ANIMA provides airports and aviation authorities with a set of best practices to start an intervention to mitigate noise nuisance, or to engage neighbouring communities and local stakeholders in reaching consensus on noise mitigation measures. ANIMA also maintained and updated the European research Roadmap on Aviation Noise.

More specifically, ANIMA produced four high-level outcomes on its Noise Platform (an online interactive platform collating all tools developed for the local management of noise):

- A consolidated aviation noise knowledge-base, encompassing basic concepts about aviation noise, information on the roles of the various policy and regulatory actors, insights on the various noise indicators and their relevance, as well as summaries of findings on health impact, on annoyance management, and on impact management (quality of life, rules on communications and engagement);
- A methodology for authorities and airports that would like to set up an intervention to mitigate noise impact on the local community;
- Case studies illustrating what has been experienced by airports, setting out advantages and drawbacks of these interventions;
- Tools such as the Noise Management Toolset (figure 1), the Virtual Community Tool (figure 2) and the Dynamic Noise Maps (figure 3). The NMT exists both in a publicly accessible version for educational purposes, and in a professional version accessible upon request. This tool is also able to predict preliminary noise maps and the annoyance deriving from future air traffic with future aircraft.

ANIMA ensured open access to its publications and results through the OpenAire/Zenodo platform. The consortium also liaised with communities by organising workshops within EU countries and abroad (e.g. ANIMA worked with the Zaporizhzhia airport in Ukraine and organised a workshop in Yerevan, Armenia, bringing together stakeholders from Armenia, Georgia, Moldova and Ukraine). ANIMA also presented its outcomes during a hearing organised by a working group of the ICAO CAEP (Committee on Aviation Environmental Protection), promoting the results of EU R&I on an international stage.

Figure 1 - The Noise Management Toolset displaying present or future noise maps

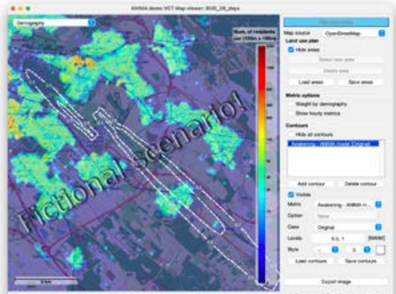


Figure 2 - The Virtual Community Tool showing awakening probability at night

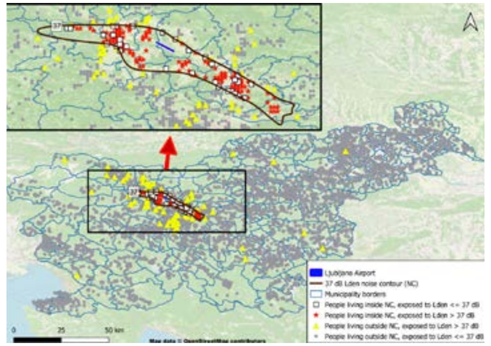


Figure 3 - The experimental Dynamic Noise Map taking into account daily population movements

PROJECT NUMBER
769627

COORDINATOR
ONERA

PROJECT DURATION
01/10/2017 to 31/12/2021

EU FUNDING
EUR 7,479,618

WEBSITE
www.anima-project.eu

ARTEM

AIRCRAFT NOISE REDUCTION TECHNOLOGIES AND RELATED ENVIRONMENTAL IMPACT —

The ARTEM project investigated the aeroacoustic interaction of all relevant components of future aircraft configurations (such as semi-buried engines and blended-wing-body) that are expected to enter into the market between 2035 and 2050, and is developing novel technologies and methods for noise reduction.

ARTEM tackled aircraft noise at its source by assessing absorption and shielding concepts for the reduction of the sound radiated towards the ground (e.g. advanced liners and metamaterials). Additionally, ARTEM investigated the potential of reducing interaction noise between the various parts of the airplane by optimising installation effects between the airframe, the landing gear and the propulsion system.

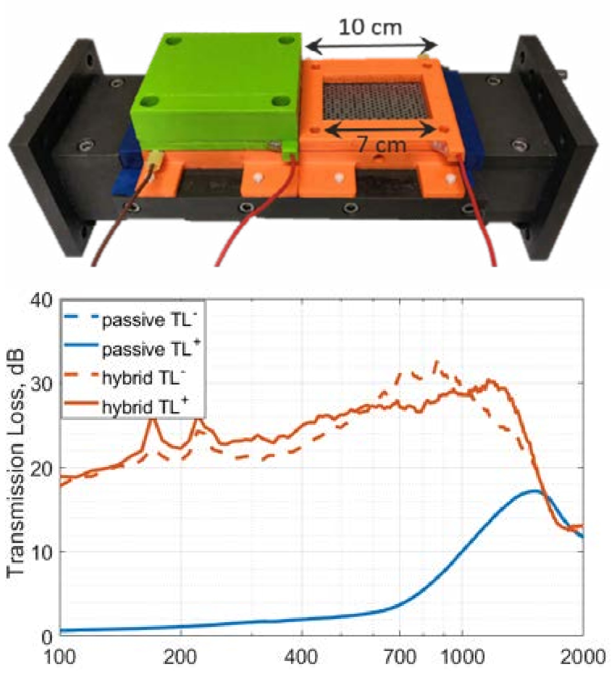


Figure 1 -Plasma actuator setup and measured transmission loss (no flow)

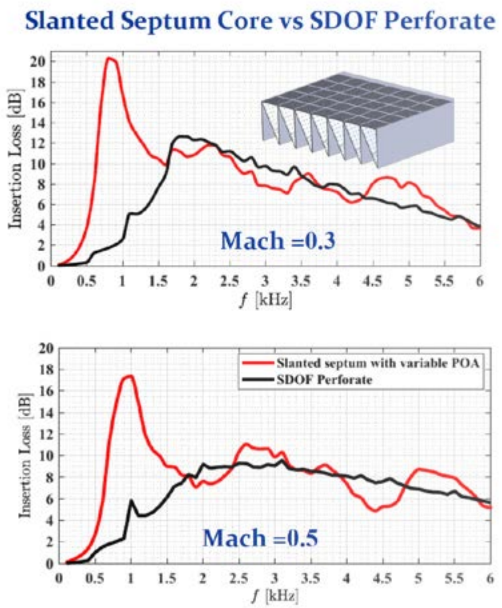


Figure 2 - Slanted Septum liner: Predicted insertion loss performance compared to a standard liner

The ARTEM consortium applied analytical tools, low- and high-fidelity numerical simulations, and dedicated experiments to assess noise interaction effects of the components of future aircraft, while aiming at low-noise design solutions, as well as improvement of numerical noise modelling tools and optimisation strategies.

Several noise reduction technologies investigated within the ARTEM project have reached a technology readiness level (TRL) of 3 to 4. Prominent examples are the:

- Slanted Septum liner (which can be applied on the internal walls of the engine nacelle to dampen the noise emitted from the engine), whose noise reduction performance has been validated in a representative wind tunnel test (Figure 2), and the;
- Plasma actuator liner (which ionises the air with high voltage and controls it with an electrical field, hence allowing noise cancellation) (Figure 1, top), showing an impressive broadband attenuation in first tests for the no-flow case (Figure 1, bottom).

PROJECT
769350

COORDINATOR
DLR

PROJECT DURATION
01/12/2017 to 31/05/2022

EU FUNDING
EUR 7,498,742.50

WEBSITE
www.dlr.de/ARTEM

TurboNoiseBB

VALIDATION OF IMPROVED TURBOMACHINERY NOISE PREDICTION MODELS AND DEVELOPMENT OF NOVEL DESIGN METHODS FOR FAN STAGES WITH REDUCED BROADBAND NOISE—

PROJECT
690714

EU FUNDING
EUR 6,702,851.25

COORDINATOR
DLR

WEBSITE
https://www.dlr.de/turbonoisebb

PROJECT DURATION
01/09/2016 to 31/08/2020

The TurboNoiseBB project obtained an in-depth understanding of broadband noise (BBN) generated by the fan of ultra-high bypass ratio (UHBR) aircraft engines, and designed optimised low-noise fan concepts. TurbonoiseBB also developed and validated state-of-the-art prediction methods which enable quicker design and implementation of optimised low noise fan systems capable of meeting aerodynamic performance targets.

More specifically, TurboNoiseBB applied advanced analytical and cutting edge computational techniques, and performed a fan BBN test campaign (Figure 1) on an unprecedented scale. With the data obtained, they could establish a new database, a global first in terms of its quality and depth of information.

As the interaction of outlet guide vanes (OGVs) with the turbulent rotor wakes is one of the dominant broadband noise generation mechanisms, TurboNoiseBB designed a novel serrated acoustically-optimised OGV. Its noise reduction potential was demonstrated by means of high-fidelity computational fluid dynamics (CFD) and computational aeroacoustics (CAA) simulations (Figure 2). Finally, TurboNoiseBB successfully assessed the aeroacoustic performance of the low-noise OGV designs at aircraft level, showing a promising reduction of effective perceived noise levels (EPNL) of up to 0.7 dB at approach.

Figure 1 - Experimental test setup at AneCom Aero Test facilities in Wildau (right) and test fan (left).

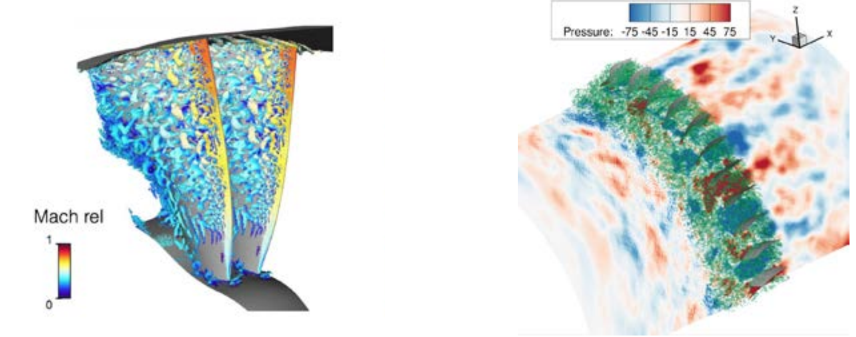


Figure 2 - Snapshots of high-fidelity scale resolving flow simulations for rotor stator stages from Ecole Central Lyon (left) and DLR (right).

In the future, the contribution of jet noise is expected to continue to decrease, given the further increase of modern aero-engine bypass ratios i.e. the air mass flow bypassing the engine core through the fan divided by the mass flow passing through the engine core. Consequently, since approximately 90% of the engine's thrust is generated by the large engine fan, the majority of noise also stems from the fan.

The ambitious goals of the Flightpath2050 vision with regard to noise emissions reduction can thus only be achieved by substantial reductions in fan noise, where broadband noise is significant. TurboNoiseBB showed that optimised low broadband noise engine designs may reduce fan noise by up to 3 dB.

Decrease Jet Installation Noise

DJINN

DECREASE JET-INSTALLATION NOISE —

The DJINN project is developing novel reliable computational fluid dynamic (CFD) methods, to efficiently model and predict jet-airframe interaction noise. These advanced numerical tools will enable the development of "design-to-noise" capabilities for jet-airframe interaction noise of under-wing and rear-fuselage mounted engines. This will improve understanding for assessing promising noise-reduction technologies for future integrated propulsion aircraft.

For large passenger aircraft, UHBR engines are mounted close to the wing, leading to increased installation noise levels due to jet-airframe interaction. The effects of installation noise, compared to an isolated UHBR nozzle are illustrated in Figure 1. Jet-airframe interaction noise is part of the overall noise sources, and the DJINN project aims to halve this noise.

To achieve this goal, DJINN is improving numerical CFD methods, in order to achieve an extended frequency resolution up to St=10, which is in line with high predictive accuracy, improved applicability and lower computation times. The consortium is currently reviewing existing methods regarding grid refinement, input-output strategies for massively parallel architectures, as well as practices for turbulence and acoustic modelling. The results of the DJINN project will offer a numerical framework for multi-disciplinary optimisation (MDO) in aerodynamic and aeroacoustic applications. This 'design-to-noise' capability for jet noise will provide a ground-breaking step towards a fully digital design chain at Technology Readiness Level (TRL) 5. The DJINN project will also advance passive and active noise-reduction technologies to TRL between 4 and 5.

DJINN will have an impact by improving acoustic performance of future aircraft and reducing aircraft design cycle costs. The project is thus contributing to the Flightpath 2050 goals, namely to the reduction of perceived aircraft noise by 65% and to achieving significantly decreased development costs by streamlined systems design.

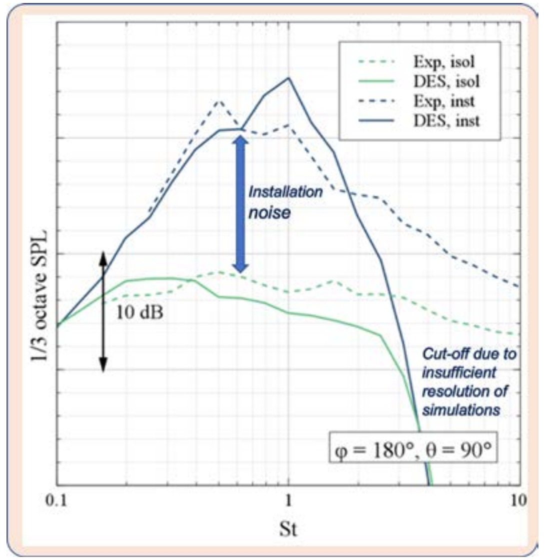


Figure 1 - Sound pressure levels (SPL) of an isolated (green) and an installed (blue) UHBR nozzle at take-off conditions, for an observer located directly below the aircraft. Solid lines indicate experimental measurements and dotted lines indicate numerical predictions by detached eddy simulation (DES).

PROJECT
861438

EU FUNDING
EUR 4,995,210

COORDINATOR
CFD Software - Entwicklungs- und Forschungsgesellschaft mbH (CFDB)

WEBSITE
https://djinn.online/

PROJECT DURATION
01/06/2020 to 31/05/2023

Figure 2 - The DJINN project will address the whole range of jet-airframe interaction noise using two representative industrial aircraft configurations, an under-wing UHBR engine placed on a large commercial aircraft (left) and a business jet with rear-fuselage-mounted engines (right).

ENODISE

ENABLING OPTIMIZED DISRUPTIVE AIRFRAME-PROPULSION INTEGRATION CONCEPTS —

The ENODISE project is improving the integration of novel aircraft propulsion systems with the airframe, through advanced experimental and numerical methods, aiming to reduce noise and gaseous emissions of future aircraft. To achieve this, the project is accelerating the maturation of radical concepts, such as distributed electric propulsion (DEP), boundary layer ingestion (BLI) and multi-rotor configurations.

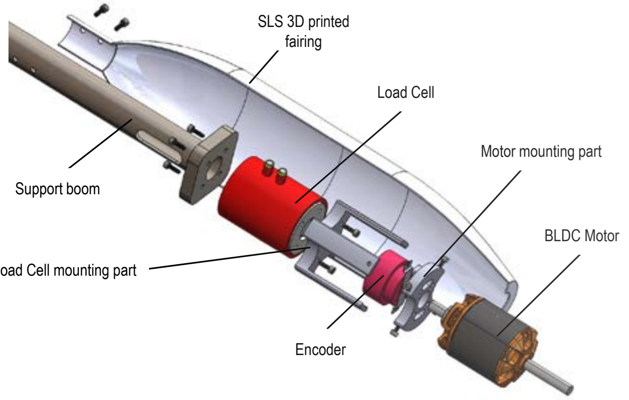
Figure 1 - Distributed electric propulsion model designed and tested at TU Delft, with adjustable relative phase between the propellers.

The research activities of ENODISE are exploring a broad range of physical mechanisms affecting both the aeropropulsive efficiency and noise generation. The project is investigating potential and viscous interactions between the airframe and the propulsion system, rotor-rotor interferences, acoustic shielding and various noise mitigation technologies (porous materials and advanced liners, leading- and trailing-edge serrations).

ENODISE has developed experimental mock-ups for the assessment of the acoustic performance of DEP (Figure 1), BLI (Figures 2 and 3) and multi-rotor systems. Theoretical models have been developed to predict the noise reduction potential of technologies, such as trailing-edge serrations (Figure 4). By the end of the project, ENODISE will progress the Technology Readiness Level (TRL) of the innovative integration concepts, numerical simulation and optimisation techniques, and noise mitigation strategies from 2-3 to 4-5.

The BLI and DEP concepts explored by ENODISE may enable to achieve a 10 to 20% reduction in fuel consumption and between 3dB and 6 dB abatement in noise. The future impact of ENODISE is thus aligned with the FlightPath 2050 goals related to quieter and more efficient commercial aircraft, namely the envisaged 75% reduction of CO_2 emissions, 90% reduction of NOx emissions, and 65% reduction of perceived noise, compared to the year 2000 baseline.

Figure 2: Design of the experimental mock-up for BLI noise studies at the University of Twente. The system permits the measurement of the forces and moments, to be later related to the aeropropulsive efficiency and pollutant emissions.



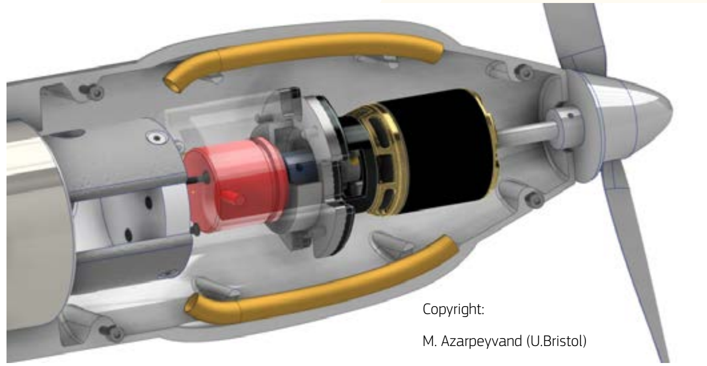
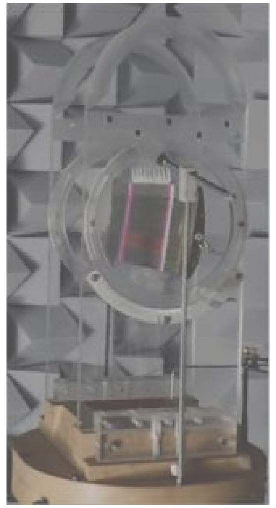


Figure 3: Support system designed by the University of Bristol for measurement of the aeropropulsive efficiency during BLI noise studies, with piping for cooling of the motor (in orange).

Figure 4: Investigation of noise-reduction potential of trailing edge serrations at the VKI anechoic facility JAFAR (Jet Aeroacoustic Facility for Aeronautical Research). The transparent side plates permit the application of optical techniques for the measurement of the flow field, simultaneously with the quantification of the noise emissions.



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C. Schram (VKI)

PROJECT

860103

COORDINATOR

von Karman Institute for Fluid Dynamics (VKI)

PROJECT DURATION

01/06/2020 to 31/05/2024

EU FUNDING

EUR 5,000,000

WEBSITE

https://www.vki.ac.be/index.php/about-enodise

INVENTOR

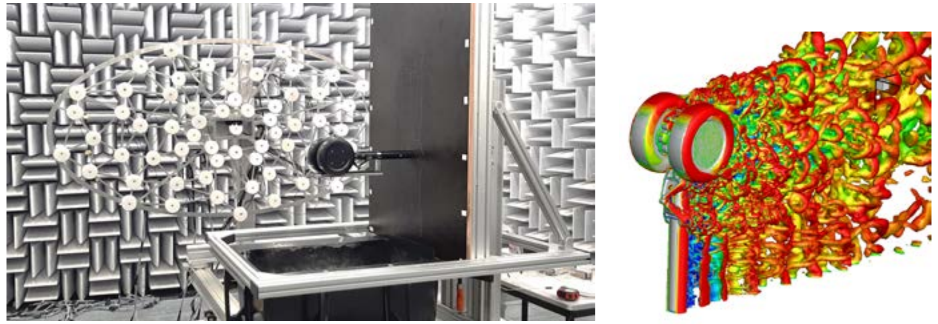
INNOVATIVE DESIGN OF INSTALLED AIRFRAME COMPONENTS FOR AIRCRAFT NOISE REDUCTION —

The INVENTOR project is improving the understanding of noise generation by airframe components, thanks to combined experiments and advanced numerical methods. The project is also developing innovative low-noise installed landing gear (LG) and high-lift devices (HLD), as well as novel noise-reduction technologies, in order to lower noise from business jets and short-medium range (SMR) transport aircraft.

Aircraft are known to be particularly noisy during approach and landing. Since the engines are operated at low levels, the extended HLD (i.e. slats and flaps) and LG are the dominant noise sources (Figure 1) during that flight regime. INVENTOR is thus exploring the potential of several active and passive noise reduction technologies and low-noise designs, aimed to mitigate noise generated by the HLD and LG.

Figure 1 - Extended high-lift devices and landing gear during aircraft approach.

Figure 2 - Flow-through fairings for LG noise reduction. Tests in aeroacoustic wind-tunnel on a simplified LG (left) and DES numerical simulation of the unsteady flow (right), depicting iso-contours of Q-criterion coloured by the streamwise velocity.



PROJECT
860538

COORDINATOR
ONERA

PROJECT DURATION
01/05/2020 to 30/04/2024

EU FUNDING
EUR 4,990,595.00

WEBSITE
https://w3.onera.fr/inventor/

This includes passive porous flow-through fairings, active flow control systems, Design-to-Low-Noise approaches and low-noise LG/flap interaction. For HLD, INVENTOR is investigating low-noise slat tracks designs, porous liners in slat cavities, low-noise spoilers and Krueger slats. These technologies are being assessed via experiments on isolated airframe components. Subsequently, the consortium will experimentally assess at aircraft level the most promising technologies on business jets and SMR aircraft models, and will then extrapolate the results at full scale. By the end of the project, INVENTOR will advance low-noise solutions from Technology Readiness Level (TRL) 3 to TRL 4 for HLD, and from TRL 4 to TRL 5 for LG.

Highlights of INVENTOR's ongoing research are depicted in Figures 2 and 3. The former displays a simplified LG model used for aerodynamic and aeroacoustic assessment of different porous fairing configurations, while the latter illustrates a 2D high-lift airfoil used to rank various low noise slat tracks designs. Both experimental setups are accompanied by corresponding computational studies.

The quantitative goals of INVENTOR comprise reducing the noise perceived from LG and HLD by 2-3 dB and 1 dB, respectively.

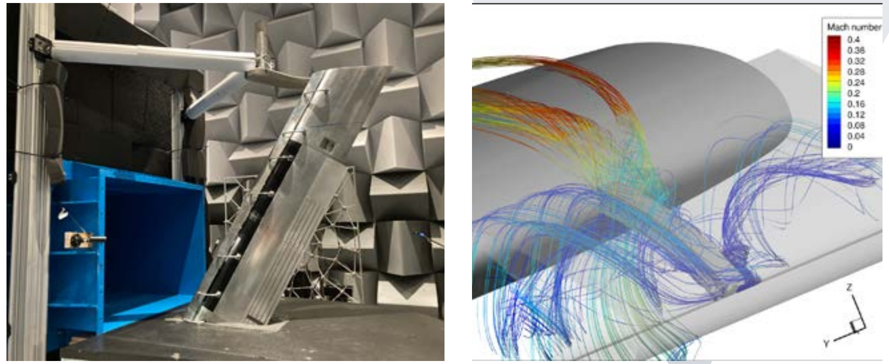


Figure 3 - Low noise slat tracks. Experimental setup in aeroacoustic wind-tunnel on a 2D airfoil (left) and RANS numerical simulation of the mean flow (right), depicting streamlines coloured by Mach number.

RUMBLE

REGULATION AND NORM FOR LOW SONIC BOOM LEVELS —

The RUMBLE project produced the scientific evidence, data and procedures required by national, European and international authorities to determine the acceptable levels of overland sonic booms and the appropriate ways to comply with it. RUMBLE contributed to new international regulations in order to protect European citizens' quality of life by guaranteeing that no unacceptable situation is created by upcoming supersonic commercial flights.

To this end, RUMBLE developed advanced numerical tools to predict the boom generation, its propagation through the atmosphere and the induced building vibratory response. The project designed and constructed indoor and outdoor sonic boom simulators (see Figures 1 and 2, respectively), and explored the human response to low booms. Low-frequency sound transmission induced by sonic booms was numerically assessed.

Figure 1 - Outdoor low boom simulator affixed to the window of a building at campus Saint Cyr of Sorbonne Université, capable of reproducing outdoor low booms within a test house.

Figure 2 - Indoor low boom Simulator at University of Oldenburg, capable of reproducing the acoustic low-boom signatures and the associated vibrations.

PROJECT 769896	**EU FUNDING** EUR 5,042,973.75
COORDINATOR AIRBUS	**WEBSITE** https://rumble-project.eu/
PROJECT DURATION 01/11/2017 to 31/12/2020	

RUMBLE successfully performed two flight test campaigns, gathering experimental data on sonic boom propagation on the ground and inside buildings. The consortium produced recommendations for flight procedures and instrumentation, for low-boom impact assessment. Finally, RUMBLE provided recommendations for a future low-boom aircraft demonstrator and for future low-boom standards, through numerical and experimental (see Figure 3) investigations.

The RUMBLE project also engaged in extensive dissemination activities, to ensure that European considerations are taken into account in the evolution of international regulations affecting civilian supersonic aviation. The consortium submitted ICAO working papers in support of the European position regarding supersonic flights over land.

SENECA

NOISE AND EMISSIONS OF SUPERSONIC AIRCRAFT —

The SENECA project is improving the understanding of noise and emissions of supersonic aircraft. It will assess the global climate impact of supersonic aviation, as well as the noise and emissions in the vicinity of airports. The project will thus provide digitally generated certification data of civil supersonic aircraft, as required by national, European and international regulatory authorities, in order to determine new noise and emissions regulations for supersonic aircraft operations. SENECA will contribute its results to the ICAO CAEP discussions, in order to scientifically accompany and strengthen the European perspective on the necessary regulations for future commercial supersonic aircraft.

SENECA is exploring four civil supersonic aircraft with different payloads and cruise Mach numbers. The consortium will then perform multidisciplinary optimisation of the airframes and engines, aiming to minimise noise, emissions and global climate impact. Landings and take-offs will be simulated in order to explore optimal trajectories along with promising airframe and engine architectures. The project will calculate final emissions and noise certification levels of the four proposed supersonic using several numerical methodologies. To this end, SENECA is advancing novel pre-design as well as noise and emission prediction methods. Furthermore, the project will apply estimates of potential supersonic fleet size and routes, in conjunction with calculated emissions, to predict the global climate impact of supersonic aviation.

By delivering a comprehensive and reliable database on emissions and noise certification levels of supersonic aircraft, the SENECA project will supply certification authorities with a basis for establishing new regulations for commercial supersonic flights.

PROJECT
101006742

COORDINATOR
DLR

PROJECT DURATION
01/01/2021 to 31/12/2024

EU FUNDING
EUR 4,999,611.25

WEBSITE
https://seneca-project.eu/

MOREandLESS

MDO and REgulations for Low-boom and Environmentally Sustainable Supersonic aviation —

The MOREandLESS project is exploring how low-boom designs and other cutting-edge technologies will allow supersonic aircraft to comply with environmental requirements. MOREandLESS will also support the establishment of regulations and procedures for future commercial supersonic aircraft, with regard to environmental impact, pollutant emissions and noise.

To this end, MOREandLESS is developing a multidisciplinary optimisation approach to assess the environmental impact of supersonic aircraft technologies, trajectories and operations. The project will explore the entire spectrum of supersonic speed, along with several promising aircraft configurations, propulsion systems and fuels, such as bio-fuels and liquid hydrogen. It will investigate the impact of sonic boom and jet noise, and explore noise reduction concepts through numerical and experimental test campaigns. Regarding the sonic boom, the consortium will develop novel models to accurately predict its generation and propagation, by accounting for meteorology, turbulence, urban environment and buildings. The project will perform outdoor and indoor sonic boom tests (e.g. see Figures 1 and 2) to validate the developed models. Within the research for jet noise reduction, shock-induced and jet-mixing contributions for selected novel supersonic aircraft concepts will be investigated by the consortium, and lab-scale experiments will be performed to validate new models (e.g. see Figure 3). The project will finally perform a noise assessment of the proposed aircraft configurations at airport level.

MOREandLESS is contributing to the Flightpath 2050 goals by performing extensive research on noise reduction, pollutant and greenhouse gas emissions, alternative aviation fuels, and atmospheric composition changes and climate impact. The project is also performing cutting-edge research in the field of aerothermodynamics, propulsion, and mission operations.

Given the international nature of this type of aviation, the project fosters international cooperation with non-EU countries, through the self-funded participation of two U.S. partners in the consortium.

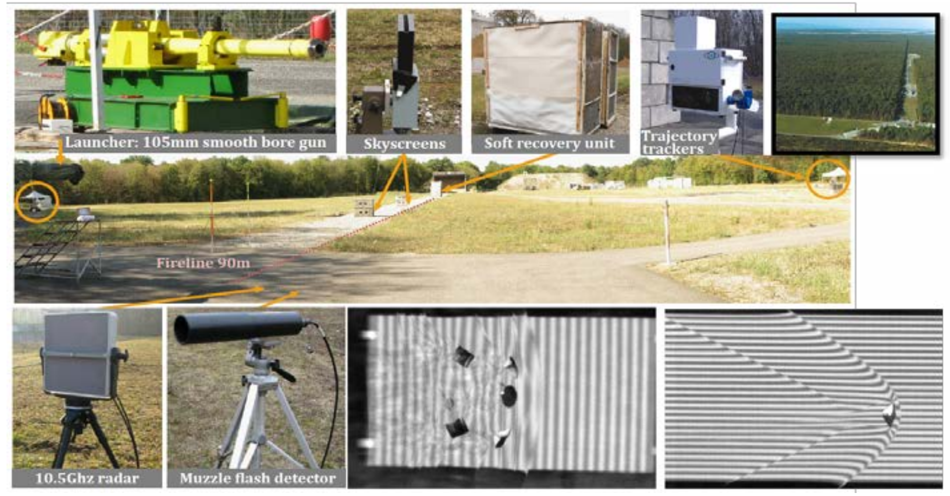


Figure 1 - Sonic boom test outdoor facility at Institut Franco-Allemand de Recherches de Saint Louis (ISL).

Figure 2 - Sonic boom test indoor facility at Institut Franco-Allemand de Recherches de Saint Louis (ISL).

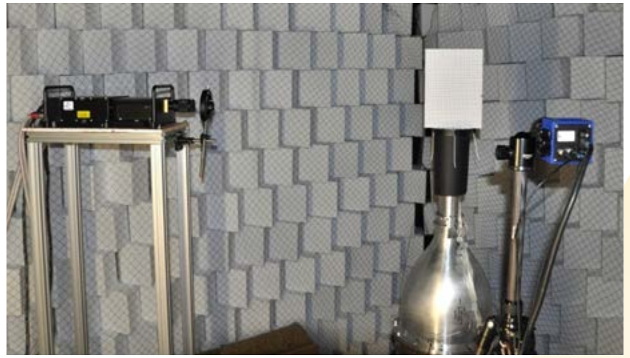


Figure 3 - Jet noise test campaign at the VKI anechoic facility JAFAR.

PROJECT
101006856

COORDINATOR
POLITECNICO DI TORINO

PROJECT DURATION
01/01/2021 to 31/12/2024

EU FUNDING
EUR 4,999,996.25

WEBSITE
https://www.h2020moreandless.eu/

STRATOFLY

Stratospheric Flying Opportunities for High-Speed Propulsion Concepts —

The STRATOFLY project assessed the potential of high-speed stratospheric transport to reach Technology Readiness Level (TRL) 6 by 2035, with respect to key technological, societal and economical aspects. STRATOFLY successfully tackled the integration of an innovative propulsion system based on liquid hydrogen, unconventional structural configurations and systems for thermal and energy management. The project addressed fundamental operative issues such as emissions, sustainability of unexplored trajectories, flight safety, and noise emissions.

The design of the hypersonic civil transport aircraft STRATOFLY MR3 built upon previous EU-funded projects (LAPCAT I-II, ATLLAS I-II, HEXAFLY). It was optimised to fly at 36,000 m of altitude at Mach 8 in cruise condition and to transport 300 passengers along antipodal routes. The STRATOFLY project based the aircraft design on an innovative lightweight multi-bubble structure (Figure 1) and a novel high-efficiency propulsion system, while the exploitation of liquid hydrogen as propellant guaranteed a fully decarbonized flight. The project also adopted advanced noise abatement strategies, systems and procedures for the embedded propulsive configuration.

Figure 1 - STRATOFLY MR3 3D CAD model.

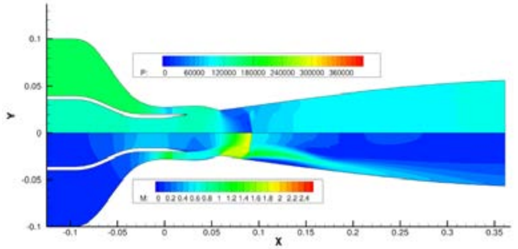


Figure 2 - Simplified coaxial axi-symmetric laboratory nozzle, still retaining the key flow features of the real geometry, which are considered to be aero-acoustically dominant. The flow solution was obtained by a compressible Reynolds-Averaged Navier-Stokes (RANS) simulation.

Figure 3 - Jet noise test with the STRATOFLY nozzle in the anechoic wind tunnel of NLR.

PROJECT
769246

COORDINATOR
Politecnico di Torino

PROJECT DURATION
01/06/2018 to 31/05/2021

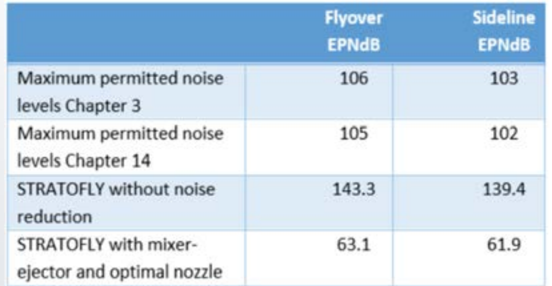
EU FUNDING
EUR 4,000,000

WEBSITE
https://www.h2020-stratofly.eu

More specifically, STRATOFLY performed numerical simulations (e.g. Figure 2) and experimental tests (e.g. Figure 3) of a model nozzle for the subsonic landing and take-off cycle, in order to identify noise sources and to develop a numerical model capable of noise predictions at microphone certification locations. The consortium subsequently utilised the derived model to assess the potential of noise reduction measures to reduce the aircraft's acoustic footprint in the vicinity of airports. The resulting noise levels were then compared against a hypothetical acoustically optimal nozzle, as seen in Table 1.

Table 1 illustrates that the Effective Perceived Noise Level (EPNL) for the STRATOFLY aircraft are unacceptably high without noise reduction measures, whereas an acoustically optimised nozzle has notable potential for noise reduction.

The project notably demonstrated the reduction potential of emissions and noise in relation with stratospheric flights.



	Flyover EPNdB	Sideline EPNdB
Maximum permitted noise levels Chapter 3	106	103
Maximum permitted noise levels Chapter 14	105	102
STRATOFLY without noise reduction	143.3	139.4
STRATOFLY with mixer-ejector and optimal nozzle	63.1	61.9

Table 1 - Overview of maximum permitted EPNL according to ICAO Annex 16 and computed EPNL for STRATOFLY (note: no noise regulation for such aircraft is yet in place, and the levels mentioned are applicable to subsonic aircraft).

ADDITIONAL AVIATION R&I PROJECTS SUPPORTED BY CINEA

CINEA has a project portfolio of more than 100 completed and ongoing aviation R&I projects, and a total implemented EU budget of more than EUR 500 million since 2015. The thematic areas addressed by the aviation projects include climate impact, emissions, noise, air quality, flight and airport operations, SAF (Sustainable Aviation Fuels), electric and hydrogen propulsion, UAM (Urban Air Mobility) and drones, icing, human factors and safety, materials and structures, testing, modelling and simulations, multidisciplinary design and optimisation, and international collaboration.

The contribution of CINEA-supported projects to mitigating aviation noise impact will be enhanced by the projects STARGATE (Grant agreement ID: 101037053) and OLGA (Grant agreement ID: 101036871), funded under the H2020 Green Deal call (topic LC-GD-5-1-2020 "Green airports and ports as multimodal hubs for sustainable and smart mobility"). These projects include activities on quieter airport and aircraft operations, noise monitoring, and community engagement in the vicinity of airports.

This is complemented by a number of CINEA-supported projects on Urban Air Mobility that address noise aspects. For instance, FF2020 (Grant agreement ID: 101006828) includes community surveys to investigate the social perception concerning noise issues, while AURORA (Grant agreement ID: 101007134) includes activities for overflight noise exposure mitigation in UAM operations.

CINEA will further expand its collaborative aviation R&I portfolio within the calls under Horizon Europe's Pillar 2, Cluster 5 (Climate, Energy and Mobility research and innovation). The 2021-2022 Work Programme mainly addresses clean and competitive solutions, with actions aiming at transformative low-TRL (1-4) technologies, generally contributing to policy priorities aimed towards climate neutrality by 2050 and digital transformation. The aviation R&I activities supported and implemented by CINEA are complementary to the European Partnership for Clean Aviation (focused on demonstrators for climate neutral aviation, going beyond Clean Sky 2) and the European Partnership for Integrated Air Traffic Management (SESAR).

New collaborative actions with explicit focus on noise are expected to be funded in 2022 under Horizon Europe topic HORIZON-CL5-2022-D5-01-12 "Towards a silent and ultra-low local air pollution aircraft", under Destination 5 ("Clean and competitive solutions for all transport modes") with an indicative budget of EUR 20 million in EU funding.

ABOUT CINEA

The European Climate, Infrastructure and Environment Executive Agency has been established by the European Commission to implement parts of EU funding programmes for transport, energy, climate action, environment and maritime fisheries and aquaculture.

CINEA has a multinational team, including specialists in project management, financial management, legal affairs and communication, covering the fields of transport, energy and telecommunications.

Seven European Commission's Directorates-General oversee CINEA's activities:

» DG Mobility & Transport (MOVE)

» DG Energy (ENER)

» DG Research & Innovation (RTD)

» DG Climate Action (CLIMA)

» DG Environment (ENV)

» DG Maritime Affairs and Fisheries (MARE)

» DG Regional and Urban Policy (REGIO)

BY 2027
+500 STAFF

BUDGET
2021 - 2027
EUR 58 BILLION

CURRENTLY MANAGING
3,200 PROJECTS

Providing added value to beneficiaries

CINEA's long-standing experience in programme management provides the beneficiaries with:

- Simplified access to EU funding opportunities
- Promotion of project results and achievements for increased visibility of EU actions and promotion of the programmes
- Guidance and technical support in project management, financial engineering, public procurement, and environmental legislation in close collaboration with beneficiaries
- Streamlined and harmonised procedures for a better use of EU funds and maximised programme efficiency, such as shorter payment times and faster response rate
- Efficient evaluation procedures, user friendly and transparent call documentation, and customised IT tools to support applicants.

Supporting the European Commission

The Agency is also supporting the policy makers and the European Commission with:

- Relevant feedback on programme implementation as input to policymaking
- Developing synergies between programmes to bridge the gap between R&I results and infrastructure development
- Bringing innovative ideas, concepts and products to implementation
- Building significant economies of scale

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Awards:

Paul Bernicke received the Hermann-Blenk Research Award for his PhD thesis submitted to TU Braunschweig, within the ARTEM project. The prize was awarded by Aeronautics Research Center (NFL) Lower Saxony, Germany on November, 23rd 2020.

TURBONOISEBB

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European Climate, Infrastructure and Environment Executive Agency

European Commission
W910
B-1049 Brussels, Belgium
+32 (0)2 299 5252

https://cinea.ec.europa.eu

HelpDesk cinea@ec.europa.eu

@cinea_eu

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