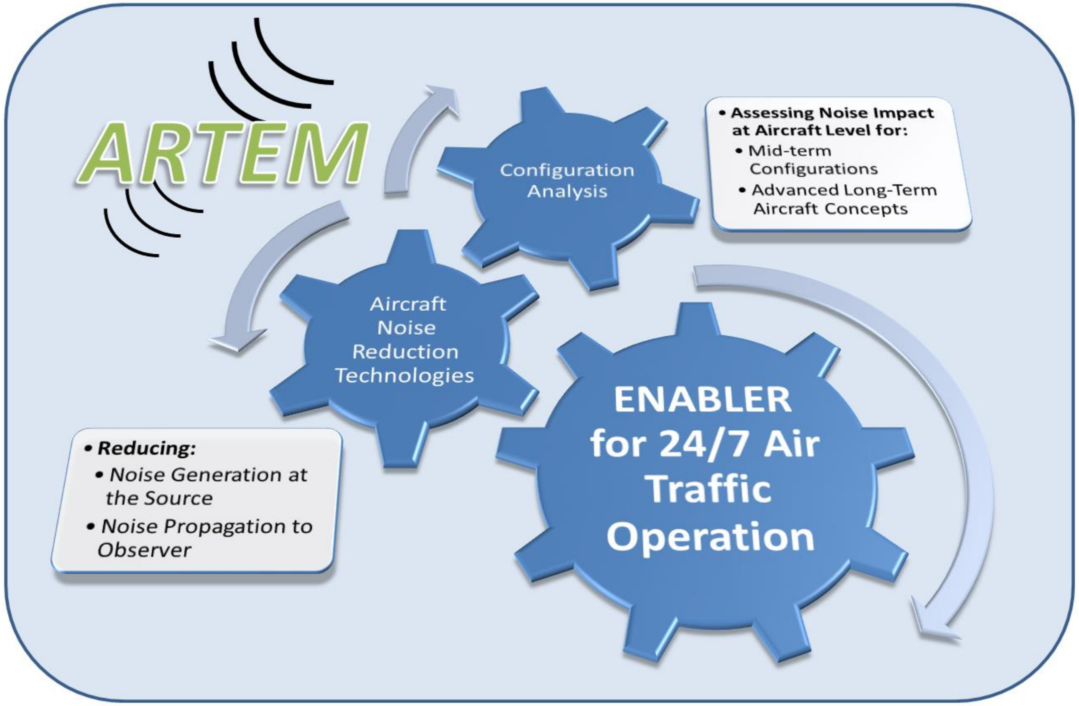
Noise reduction pathways

Noise Reduction Technologies for Future Aircraft Concepts -
First results of the H2020 project "ARTEM"

Dr.-Ing. Karsten Knobloch
German Aerospace Center (DLR)

ARTEM is an Enabler Project



By assessing "Generation 3" Noise Reduction Technologies, ARTEM is the "Technology Project" among the projects of MG-1-2-2017 "Reducing aviation noise"

Duration: 4 years, Start: 01.12.2017

7.5M€ funding from EC

Coordination: DLR

ARTEM

24 Partners from

Industry	SME	Research Establishments	Universities
AIRBUS	AEDS	DLR	Université de Cergy-Pontoise
DASSAULT AVIATION	PIPISTREL VERTICAL SOLUTIONS	ONERA THE FRENCH AEROSPACE LAB	École Centrale Lyon
Rolls-Royce		nlr	University of BRISTOL
SAFRAN		CIRA Italian Aerospace Research Centre	ROMA TRE UNIVERSITÀ DEGLI STUDI
		Empa Materials Science and Technology	University of Southampton
		The von Karman Institute for Fluid Dynamics	EPFL
		COMOTI ROMANIAN RESEARCH & DEVELOPMENT INSTITUTE FOR GAS TURBINES	TU Delft
		cnrs	Technische Universität Braunschweig
		INCAS	
		ЦАГИ	

aerodays 2019 2020 TANDEM

Bucharest, 27-30 May 2019

European Commission

ARTEM will advance low-TRL technologies

Novel and innovative ideas for liners and dissipative surfaces will be taken up and their potential assessed.

ARTEM considers the interaction noise sources

The interaction of components and associated noise generation must be understood to reduce the overall aircraft noise signature.

The assessment will be performed for future aircrafts concepts ranging from 2025-2050

ARTEM considers technologies and configurations for 2035/2050

ARTEM

Reduction Technologies for Sound Radiation

Absorption Technologies for 2035/2050 and Shielding

Noise reduction potential

Noise Reduction at Aircraft Level

Future Aircraft Configuration Analysis with LNT

Noise reduction potential

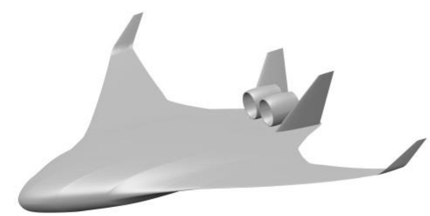
Aircraft related Source Noise Reduction

Airframe/Landing Gear/Propulsion System Interaction

BLI

Define novel aircraft configurations for 2035 and 2050

Ensure that these configurations will build on similar platforms considered in other European and national research programs



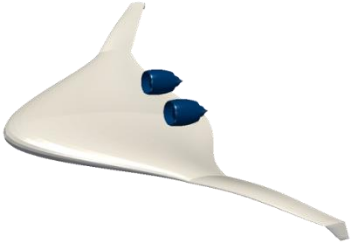
Configurations to be considered

2025-2030: defined outside ARTEM,
e.g. advanced tube-and-wing with UHBR engines

2035: NOVA concept of ONERA,
tube and wing with rear-mounted engines
with BLI

BLI

2050: **B**lended Wing Body
Optimized with **L**N**T** (BOLT)



2050: **RE**gional **B**wb **EL**ectric-propelled (REBEL)

WP1 „Reduction Technologies for Sound Radiation"

Objectives

*Investigation of **novel noise reduction** means to be **applied** in the mid (2035) and long term scenarios (2050) of **all types of future aircraft configurations**.*

Qualification of novel concepts from pure ideas and technology concepts (TRL1/2) to TRL3/4 *(experimental proof of concept and validation in lab environment) for further development towards industrial applications.*

*Study the **capability to reduce noise signature** at the ground by making full use of the available design space of airframe and propulsion system placement and to **shield and reflect the generated noise** away from the ground.*

T1.1 Absorption technologies for 2035

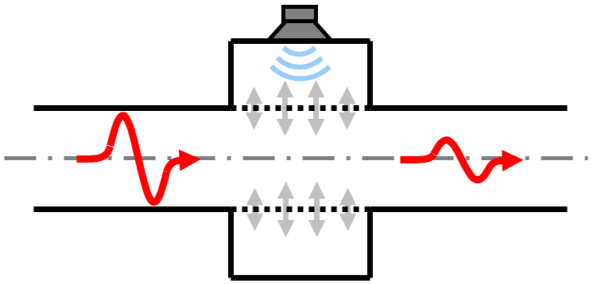
T1.2 Absorption technologies for 2050

T1.3 Shielding

WP1 - Technologies

Absorption Technologies 2035:
…aiming at low-frequency and broadband reduction capabilities

- *3-D printing of complex liner geometries*
- *Zero-Mass-Flow-concept*
- *Assessment of surface roughness effects*



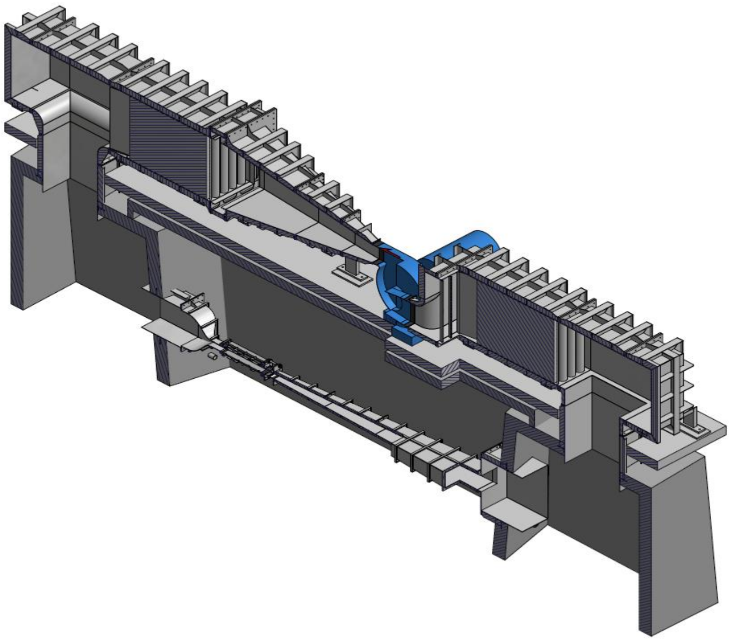
Absorption Technologies 2050:
…qualify innovative ideas and assess potential of

- *Friction-powder liners*
- *Semi-active membrane liners*
- *Plasma actuators*
- *Numerical modelling of innovative absorption technologies*
- *Metamaterial-based innovative devices*

Absorption technologies results assessment

- *Use of common facilities for comparative testing and benchmarking of technologies after initial development*

- *Transfer results to WP3 for full scale engine/aircraft assessment*



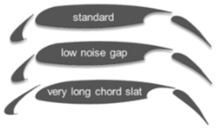
WP2 „Aircraft related Source Noise Reduction "

ARTEM

Objectives

- *Assess installation noise sources on conventional and novel aircraft configurations (aerodynamic and aero-acoustic installation effects)*
- *Assess potential noise reduction solutions (geometrical and technological)*
- *Investigate numerically and experimentally to improve the understanding of physical phenomena*

T2.1 High lift dev. noise

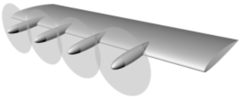


T2.2 Jet installation noise

T2.3 Boundary layer ingestion effects

T2.4 Landing gear installation effects

T2.5 Distributed elect. propulsion



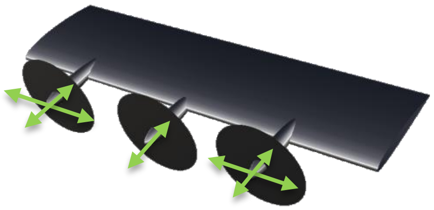
Selection of Noise Reduction Technologies and Effects

- *HLD:*

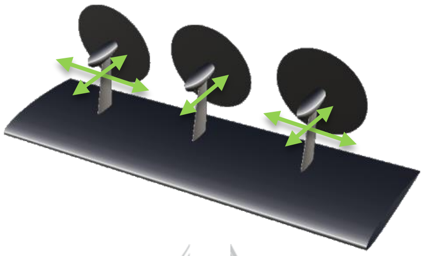
  porous flaps, serrated trailing edges, micro-surface structuring, thrust gates, Chevrons, plasma actuators,…

- *Assess the acoustic implications of BLI installation*
- *Assess installation options (and associated interaction effects) for landing gear*
- *Assess effects of distributed (electric) propulsion*

Puller propellers



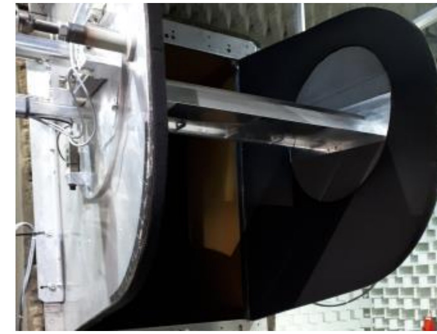
Over-wing pusher propellers

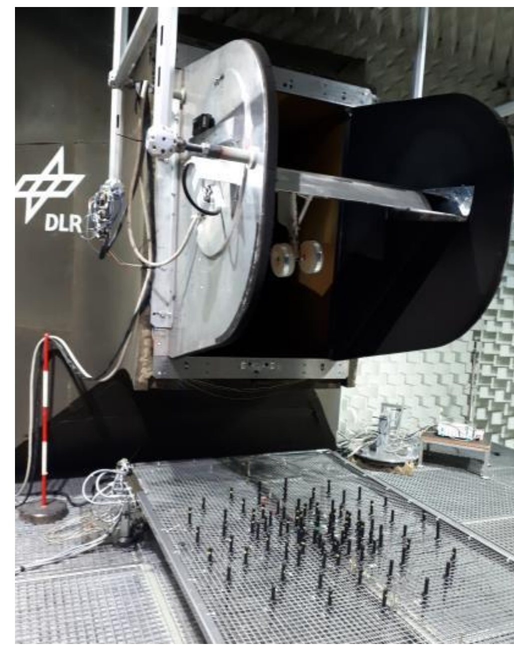


Current Achievements -1

First test campaign on Landing gear configurations in aero-acoustic wind tunnel AWB finished (May 2019)

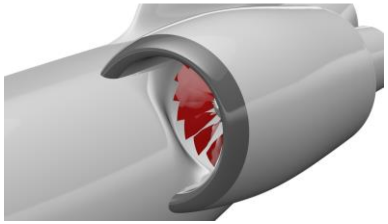
- Global aerodynamic characterisation of 3-element wing for 3 different slat/flap settings
- Local aerodynamics + far-field acoustic measurements of wing with and without LG (3 high lift settings)
- Local aerodynamics + far-field acoustic measurements of fuselage/belly fairing + wing with and without LG (2 high lift settings)





Current Achievements -2

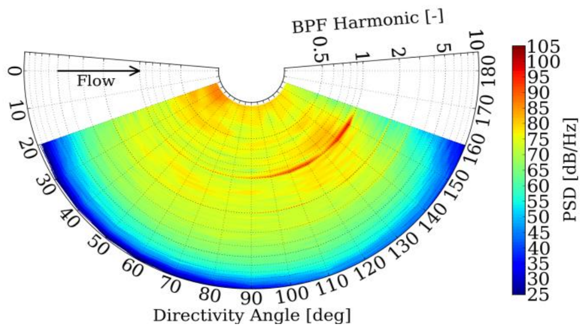
Full-scale assessment on BLI installation of a modified NASA SDT engine for NOVA configuration (for low-speed conditions), comparison with isolated engine



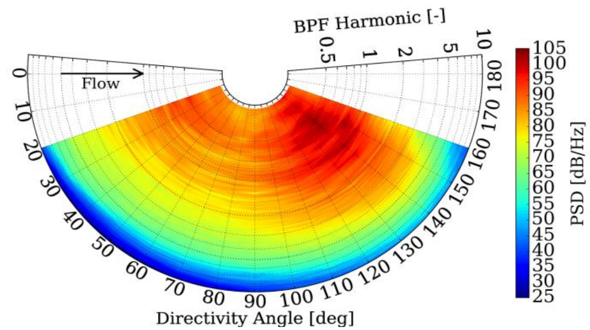
→ TU Delft presented at AIAA-Aeroacoustics Conference May 2019, Delft/The Netherlands, Paper AIAA2019-2429

Below: PSD of far-field noise directivity – 10 m arc at ϕ=0°:

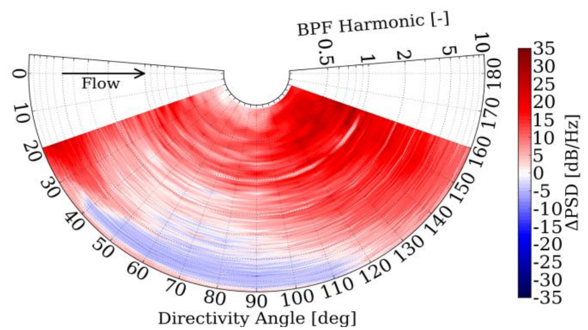
- *Noise radiated most efficiently downstream for both engines*
- *High broadband levels for BLI engine*
- *10-20 dB higher noise levels for BLI engine (except for 40°-110° sector above BPF-2)*



Isolated engine



BLI engine

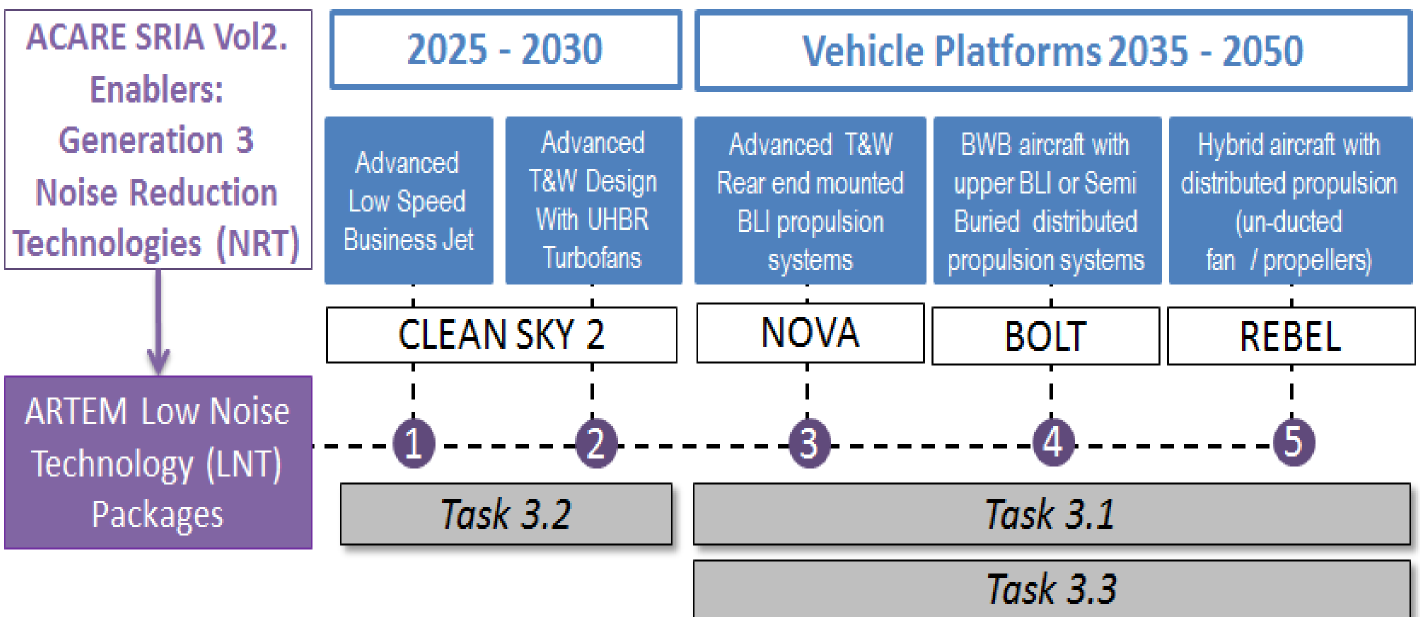


BLI - isolated

➔ Mitigation means: BLI intake and engine internal design optimization, acoustic liners,…

WP3 "Noise Reduction at Aircraft Level"

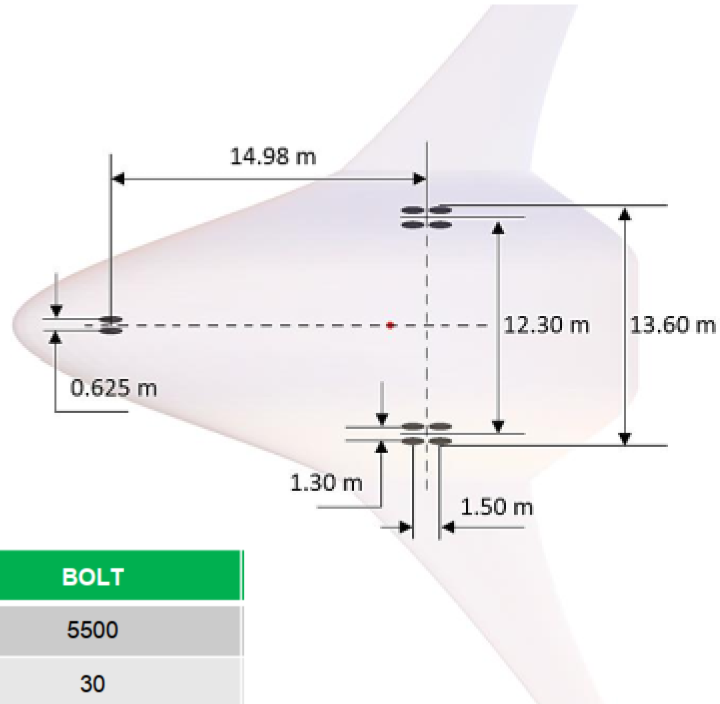
- *Configuration analysis with and without Low-Noise Technology*
- *Noise predictions for fly-over*
- *Auralization*

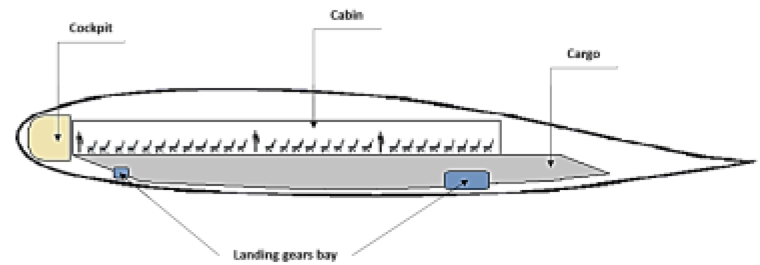


Current Achievements

ARTEM

Configuration definition analysis for BOLT and REBEL using multi-dimensional optimization tool FRIDA (U Roma3)





Landing gear bays volume		m^3	12,6
Main landing gear	No.	#	2
	Wheels per struct	#	4
	Tyre diameter	*m*	1,35
	Struct. length	*m*	3,11
Nose landing gear	No.	#	1
	Wheels per struct	#	2
	Tyre diameter	*m*	1,01
	Struct. length	*m*	2,33

		BOLT
Range	nmi	5500
Loiter	min	30
Payload	#pax	400
Cruise altitude	ft	43000
Cruise Mach number	-	0,84

Potential gaps and challenges

- *Support of industry is needed for assessment of technology development*
- *Overall schedule is challenging with assessment and exploitation depending on project results availability*

→ data exchange is tested in advance with preliminary data

- *Open access publications are requested, while the field of potential journals is evolving and changing quickly*

→ need to judge between quality, outreach, cost,…

Cross-cutting issues

*Project results of **AERIALIST** regarding meta-materials will feed into ARTEM development work*

→ direct link via the participation of U Roma3

*ARTEM technologies will be assessed by **ANIMA** global coordination action in order to advise for future developments*

→ links via direct involvement of partners (ONERA,UCP, DLR) in both project, exchange between project leads

***CEAS-Workshop** planned for dissemination and discussion of project results*

Impacts

- *Development (up to TRL 3/4) and assessment of potential of novel noise reduction technologies*
  → basis for future high TRL work

- *Compilation of data bases for various effects (shielding, installation effects, distributed propulsion)*
  → enables tool validation

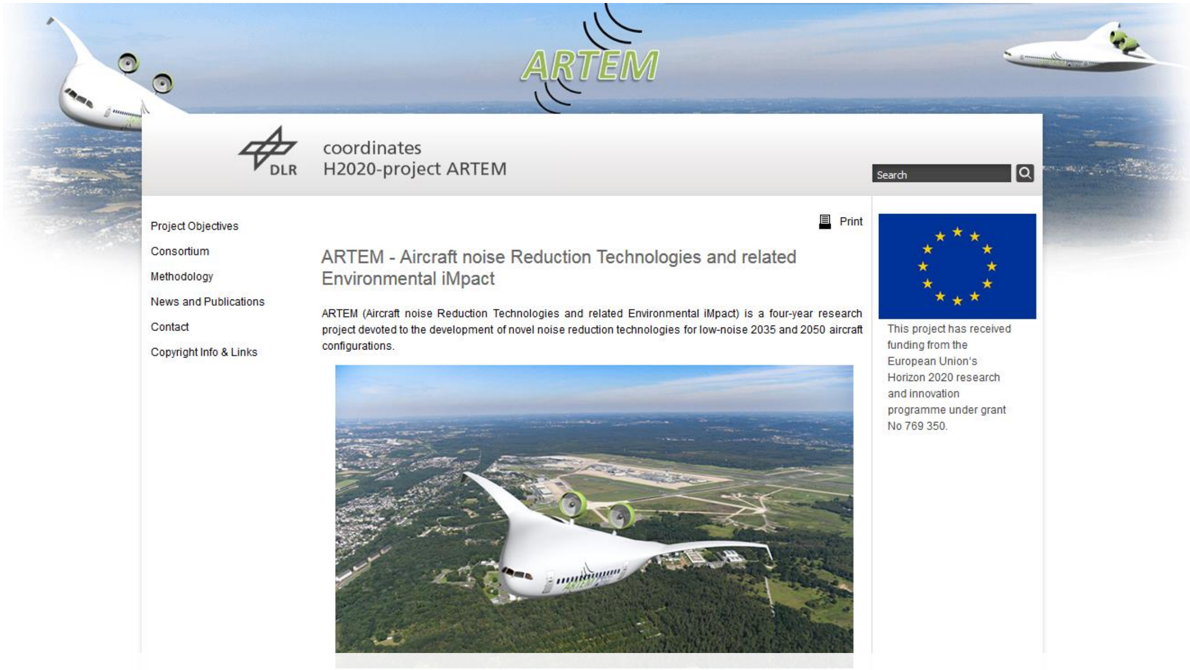
- *Advancement of simulation capabilities and analytical/semi-empirical tools*

- *Direct assessment of technologies also for near-term configurations via CS-configuration analysis*

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant No 769 350.

ARTEM and other projects within the MG1-2-2017 call "Reducing Aviation Noise" were initiated by the EREA "Future Sky" initiative.



ARTEM

Visit us at: www.dlr.de/ARTEM

E-Mail: artem@dlr.de

Coordination: DLR, Engine Acoustics, Berlin
Dr.-Ing. Karsten Knobloch

2019 2020 aerodays TANDEM

Bucharest, 27-30 May 2019

European Commission