NACELLES

CLEEN PHASE III CONSORTIUM – Safran Nacelles – LEAD Project

May, 3rd 2023

PUBLIC PRESENTATION

SAFRAN

Agenda

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Company overview

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LEAD project overview

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Project main acomplishements and next steps

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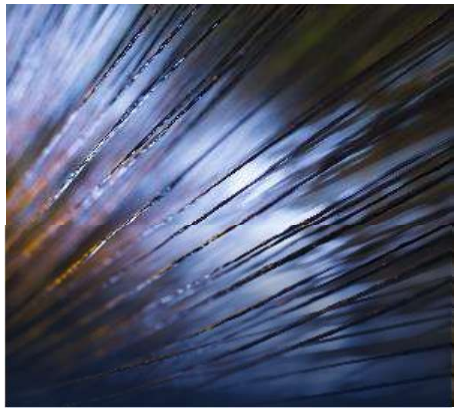
01

Safran Nacelles overview

Safran - An industrial high technology group

76,800
employees

€15.3
billion in revenues
in 2021



125 years
of history:
the oldest aerospace
manufacturer
in the world

No.3
aerospace company
worldwide (excluding
aircraft manufacturers)

Safran in the United States

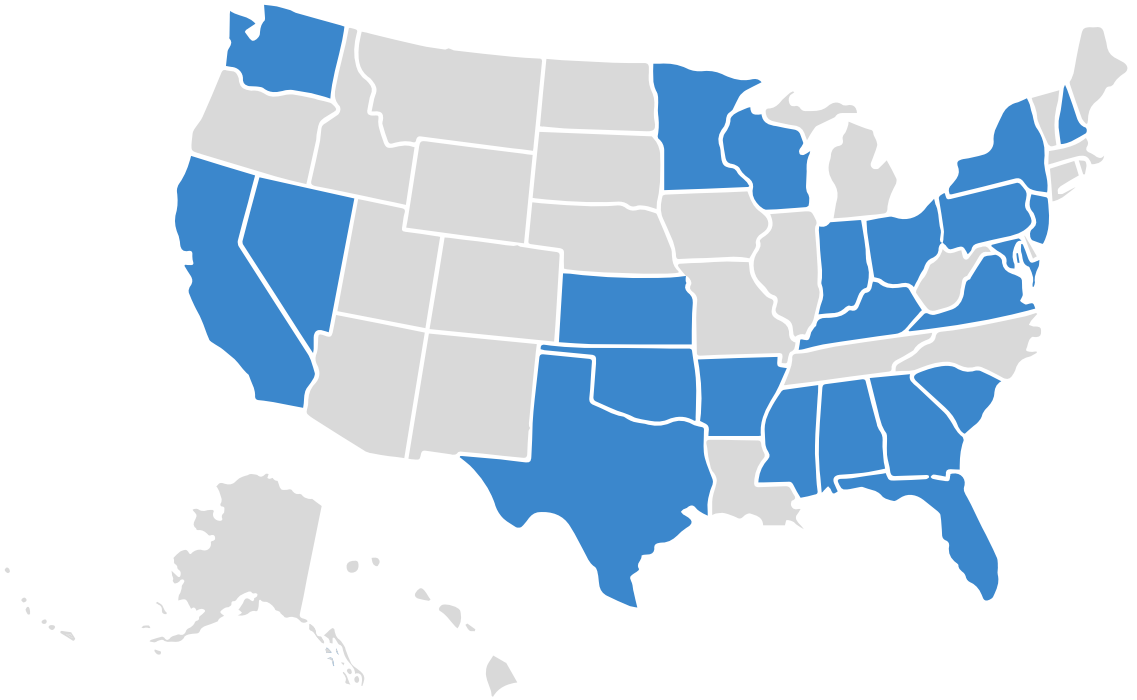
Nearly
8,000
employees

Nearly
50
years of presence in the country

23 States

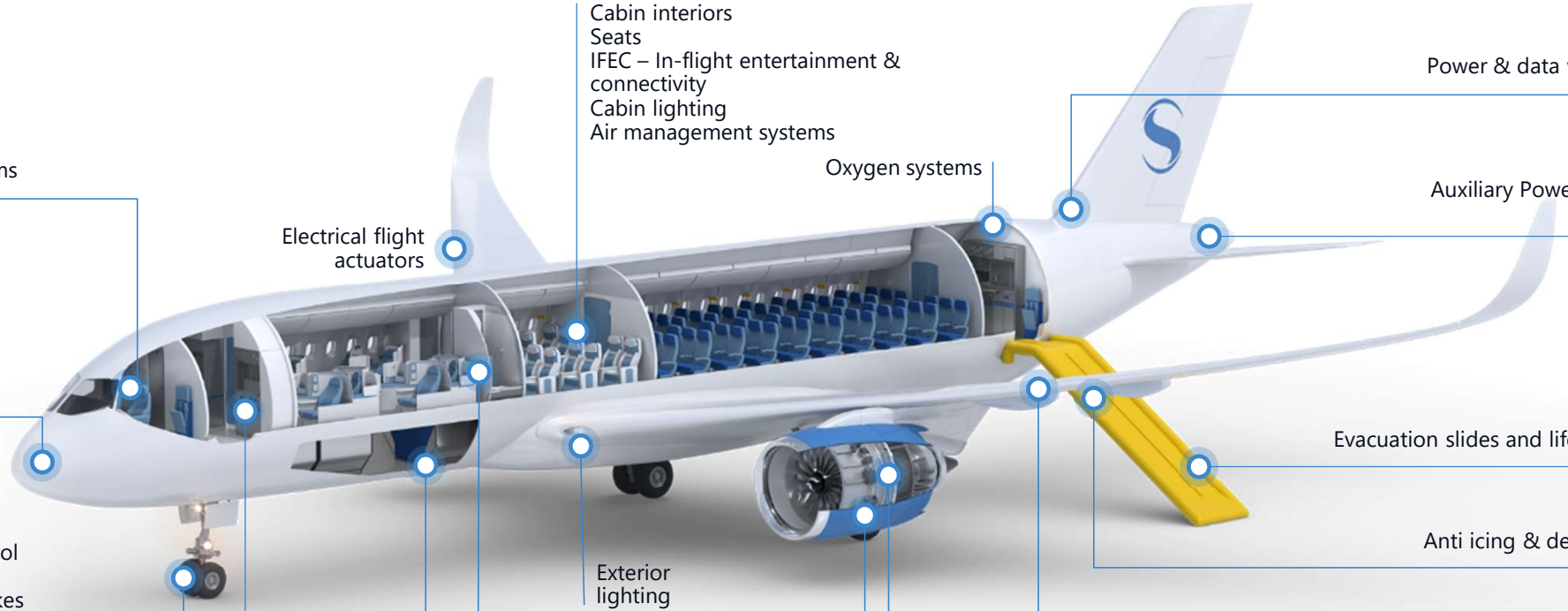
Safran Aero Boosters
Safran Aerosystems
Safran Aircraft Engines*
Safran Cabin
Safran Electrical & Power
Safran Electronics & Defense
Safran Helicopter Engines
Safran Landing Systems
Safran Nacelles
Safran Passenger Innovations
Safran Power Units
Safran Seats
**Through joint ventures and subsidiaries*

Safran Joint Ventures:
A-Pro
CFAN
CFM International
Greenpoint Technologies
Northwest Aerospace Technologies
Nexcelle
Propulsion Technologies International



Service and maintenance activities
Commercial and administrative activities
R&D and production activities

A comprehensive range of aircraft systems and equipment



Pilot control systems
Panel & displays
Seats
Windshield wiper systems

Avionics
Inertial navigation systems
Flight data acquisition unit

Landing gears
Braking & landing control systems
Wheels and carbon brakes

Galleys and equipment

Cargo equipment and compartments

Electrical flight actuators

Cabin interiors
Seats
IFEC – In-flight entertainment & connectivity
Cabin lighting
Air management systems

Exterior lighting

Lavatories, water & waste

Nacelles and components
Power transmission system

Oxygen systems

Power & data wiring

Auxiliary Power Unit (APU)

Evacuation slides and life rafts

Anti icing & de-icing

Inerting & fuel systems
Fluid management systems

Engines
Engine control systems (FADEC)
Power distribution and generation

Safran Nacelles

3,500
employees

13 sites
in **8 countries**

Nacelles for every type of aircraft: regional and business jets, single and twin-aisle commercial airliners

Maintenance, repair and associated support services

Composite materials for aerostructures with acoustic treatments

SAFRAN

Areas of Expertise

Composites & Assembly
Casablanca
Florange
Le Havre
Burnley

Podding
Hamburg
Mobile
Toulouse

Sheet metal
(Titanium, Aluminum)
Burnley

Exhaust systems
(Titanium, acoustic)
Le Havre

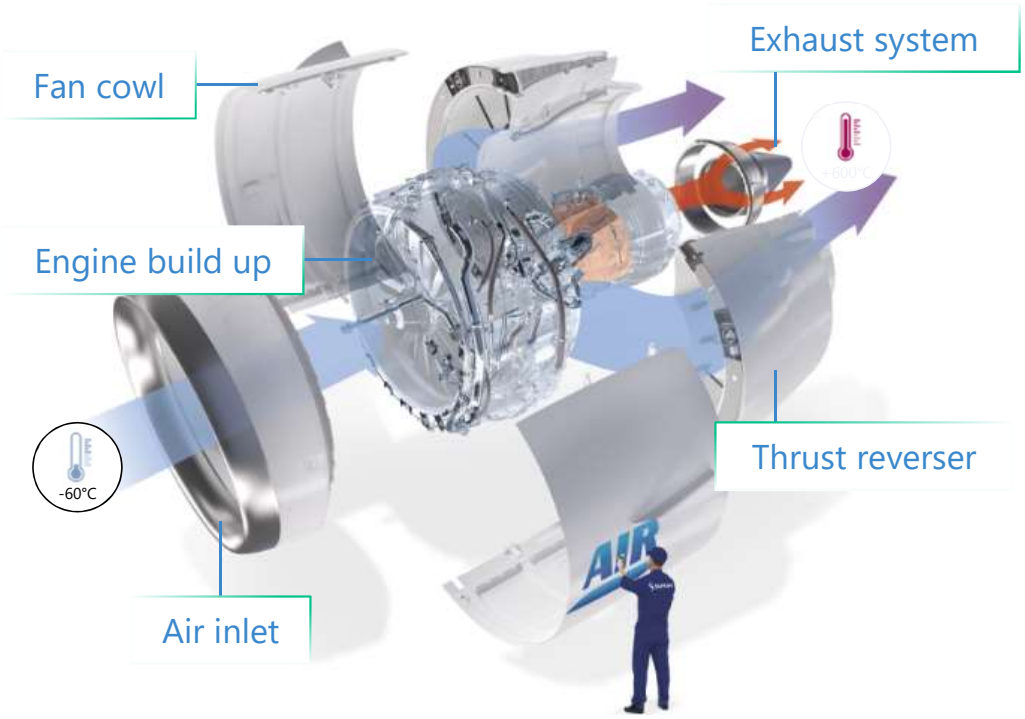
The nacelle - A major, high-tech system at the interface between the engine and the aircraft

Air supply function

Aerodynamics function

Acoustics function

Heat function



Structure function

Propulsion function

Braking function

Engine access function

Cosmetic function

Our nacelle is a key system for performance and operating cost

Driving innovation for sustainable growth

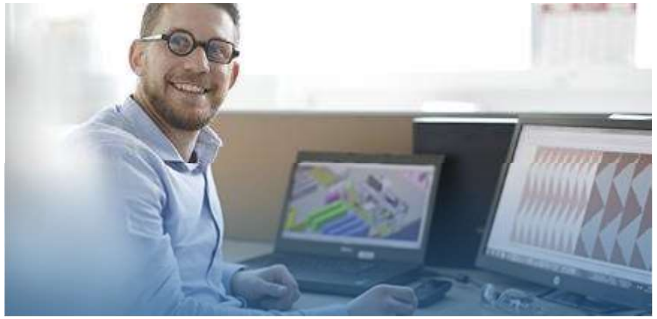
€1.43
billion invested
in R&D in 2021

12,000+
employees
involved in R&D

Invent, build
and deliver tangible
high-tech solutions
to shape tomorrow's aviation sector

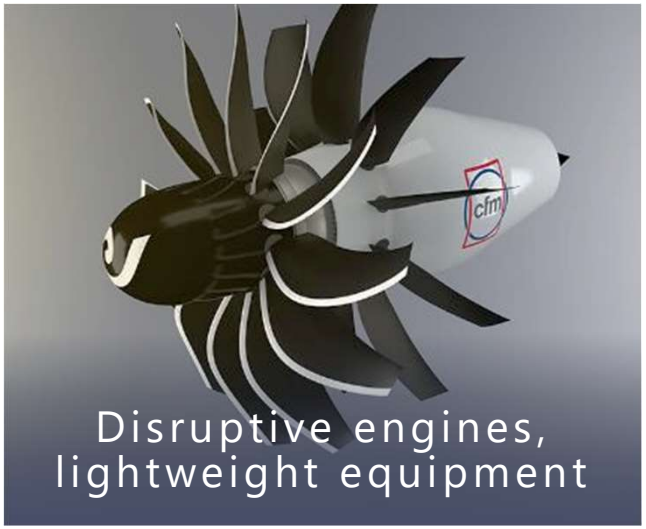
75%
of Safran's R&T investment goes to reduce the environmental impact of air transport

1,176
patent applications filed in 2021 worldwide
(Safran, **No. 1 in France for patents filed** – 1,037 applications)



Decarbonizing aviation, our strategic priority

Innovative technologies
to contribute to a “zero emission” aviation by 2050



The path to successful decarbonization

80% improvement in energy efficiency since the start of commercial aviation

2020
100% jet fuel

Long-haul

Regional short and medium-haul

Commuters and helicopters

Public policies and regulations

Technology

2030-35
Low carbon

"Skip a generation"

Disruptive aircraft
with thermal propulsion, ultra-efficient and greater use of alternative fuels

Small electric aircraft
hybrid regional aircraft

New air mobility
short range

Public policies and regulations

Technology

2050
Zero emission

Future aircraft
with carbon-free energy source

Green synthetic fuel and/or Liquid hydrogen
Fuel cells
Ultra-high energy density batteries

SAFRAN

Innovation axes to imagine new high-added value products and services

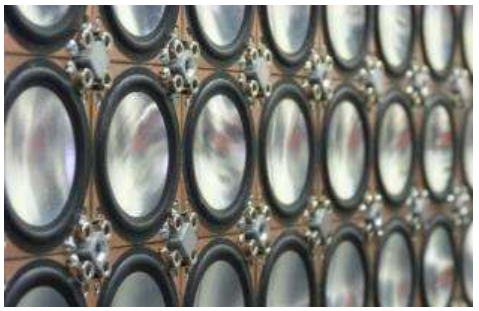
ARCHITECTURE

- Optimum propulsion to aircraft integration to reduce fuel burn

RISE

NEW SOLUTIONS

- More light-weight
- More resistant to high temperature exposure
- Quieter (noise reduction)
- More electric
- More predictable (maintenance)



Active acoustics

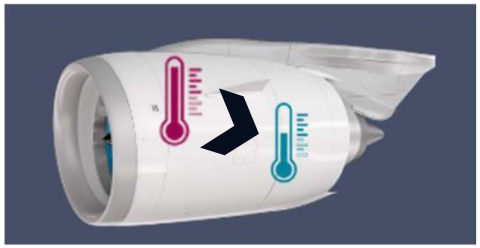
ADVANCED MATERIALS & PROCESSES

- Non-destructive testing solution using infrared thermography and augmented reality with IRIS

Infra Red Inspection System (IRIS)

NEW FUNCTIONALITIES

- New functions meeting new architectures



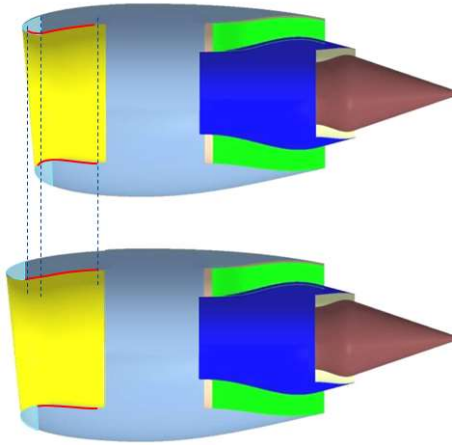
Heat-exchange nacelle

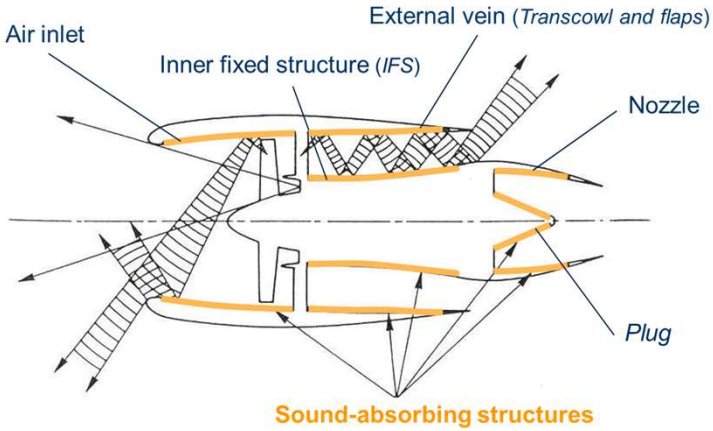
02

LEAD Project overview

Context

- **Fuel reduction and new engine architectures** → **Shorter nacelles**
- **Higher requirements of noise reduction** → **More acoustic treated surface**

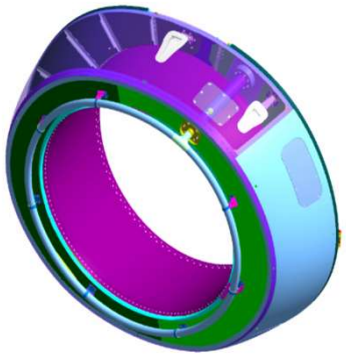


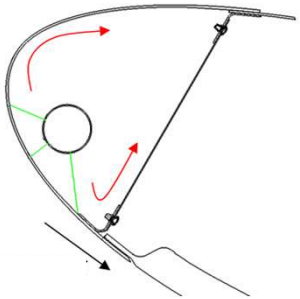


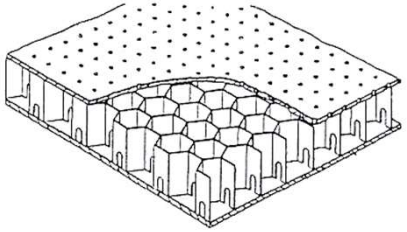
Need to add acoustic liner to new nacelles parts

Purpose

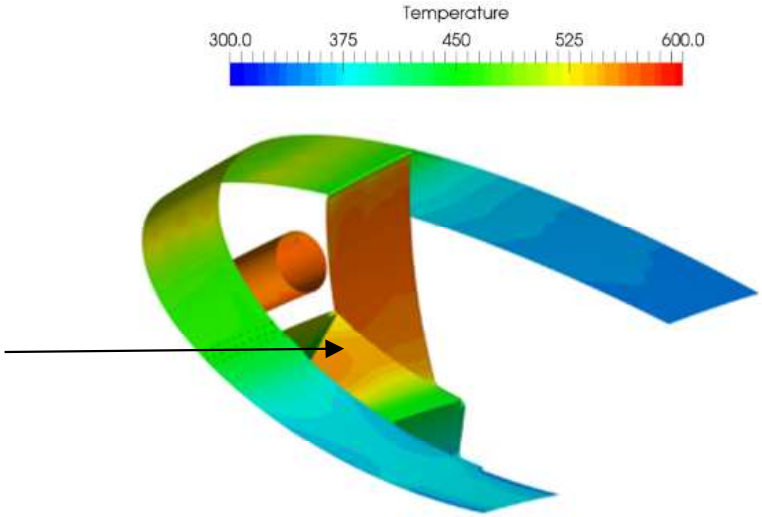
Adding acoustic liner to inlet lip







Acoustic liner



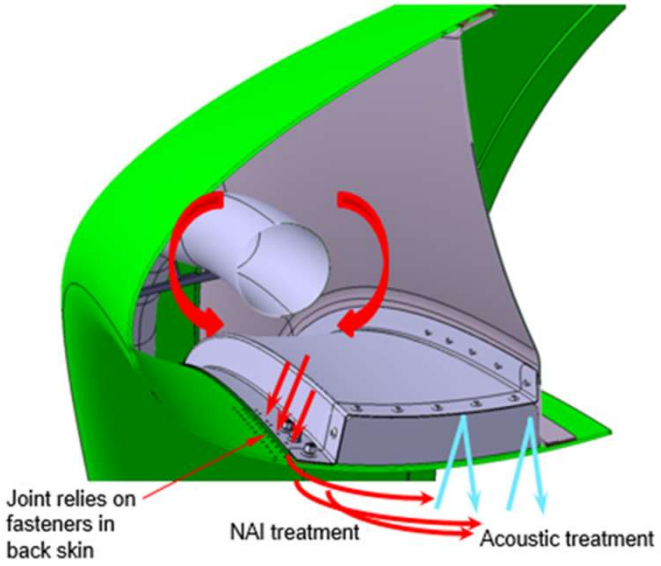
- Standard inlet with piccolo anti-icing
- The acoustic liner becomes a thermal insulator for the anti-icing system

Technical challenge: secure anti-icing function

Concept

LeAD (Lèvre Acoustique Dégivré) – Anti-icing Acoustic Lip

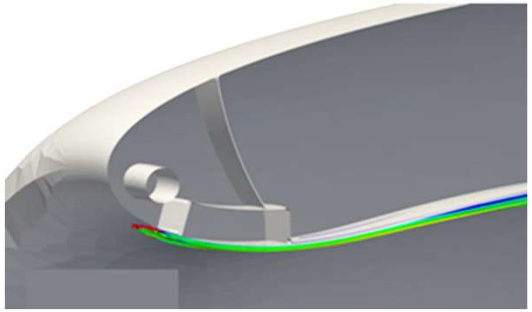
- Bleeding piccolo hot air to prevent ice formation



Benefices:

- Significant Fuel Burn reduction (shorter inlet)
- Opportunity to increase nacelle's acoustic performance
- Quick development as based on mature technologies
- Can be deployed on standard inlet designs

Hot air bleed simulation:



LEAD Project - Objectives

- **Concept / functionality**
  - Demonstrate the performance of anti-icing by heating air film
  - Demonstrate the acceptability of heating air film in the engine operation
  - Demonstrate the acoustic performance

- **Design tools & methods**
  - Structural design of a LEAD inlet

- **Manufacturing materials & processes**
  - Demonstrate LEAD inlet manufacturability

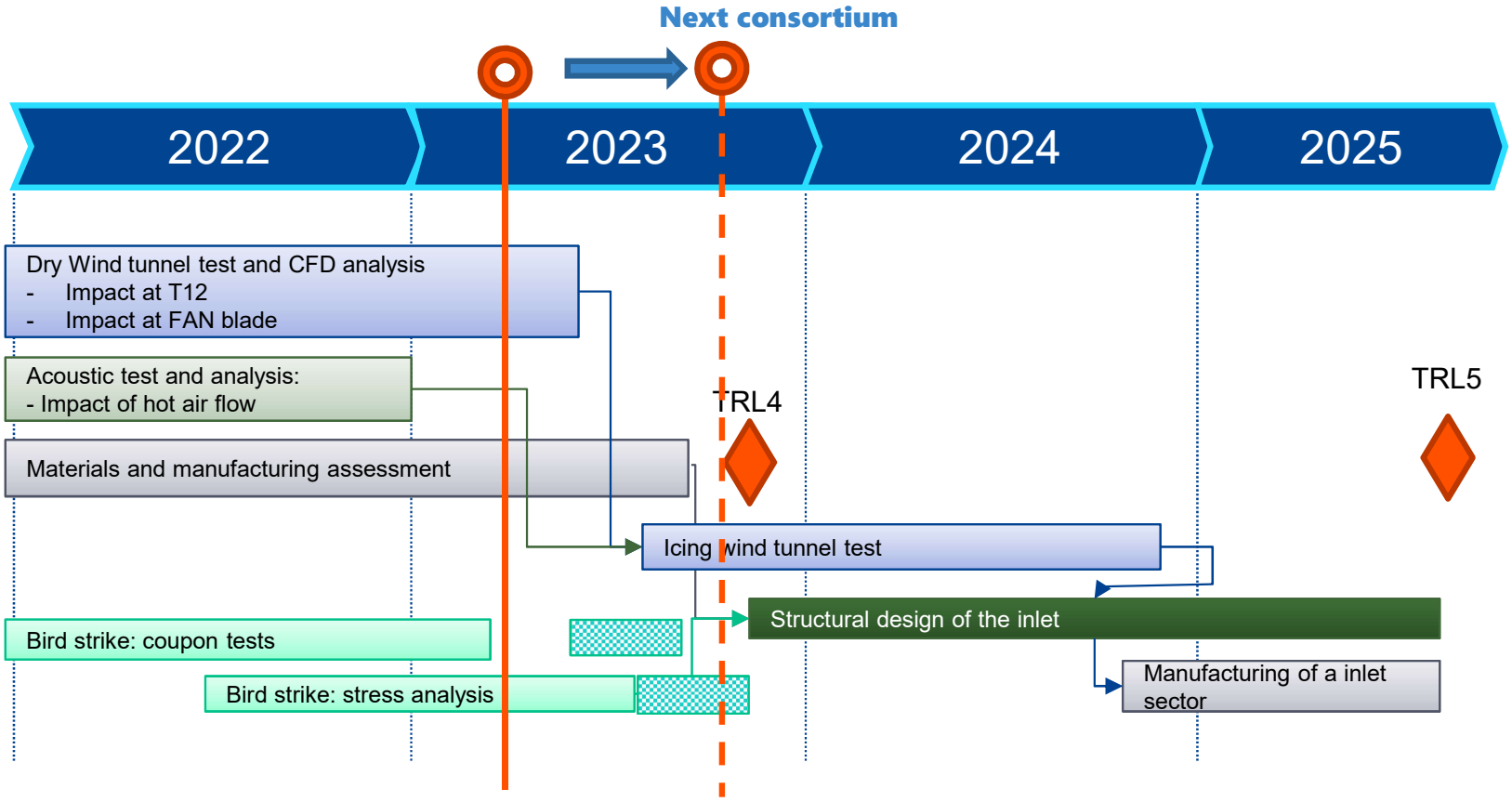
Project Schedule

Achievements

- Wind tunnel equipment design
- Acoustics tests analysis

Upcoming

- Wind tunnel results
- M&P assessment
- Bird trike coupon tests and first analysis



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