ICE GENESIS
Project Overview

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824310.

The Consortium

- 37 project partners
- 27 EU / 10 non-EU
- 10 countries

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824310.

ICE GENESIS project overview

Creating the next generation of 3D simulation means for icing

- **Duration:** From 1st January 2019 until 31st December 2022
- **Coordinator:** AIRBUS OPERATION SAS

- **Budget:**
  - Max EU Contribution: €11 964 300
  - Total Estimated Project costs: €21 984 549
  - Project effort in Person-months ~ 1858

- **Advisory board:** EASA, FAA, ADSE, AEROTEX,
  AIRBUS Defense&Space, CSTB, DAHER, EMBRAER,PIAGGIO, SAFRAN nacelles

ICE GENESIS project overview

Top level objective

The top level objective of the ICE GENESIS project is to provide the European aeronautical industry with a validated new generation of:

3D icing engineering tools
(numerical simulation and Icing Wind Tunnels capabilities)

addressing

Regulation CS25 Appendix C (well-known icing envionment)

Appendix O (SLD or Supercooled Large Droplet)

and snow conditions,

for safe, efficient and cost effective design and certification of future aircraft and rotorcraft.

Novelties in Europe : 3D ice scanning system
droplet temperature measurement
snow characterization and campaigns

ICE GENESIS project overview

Sub-objectives

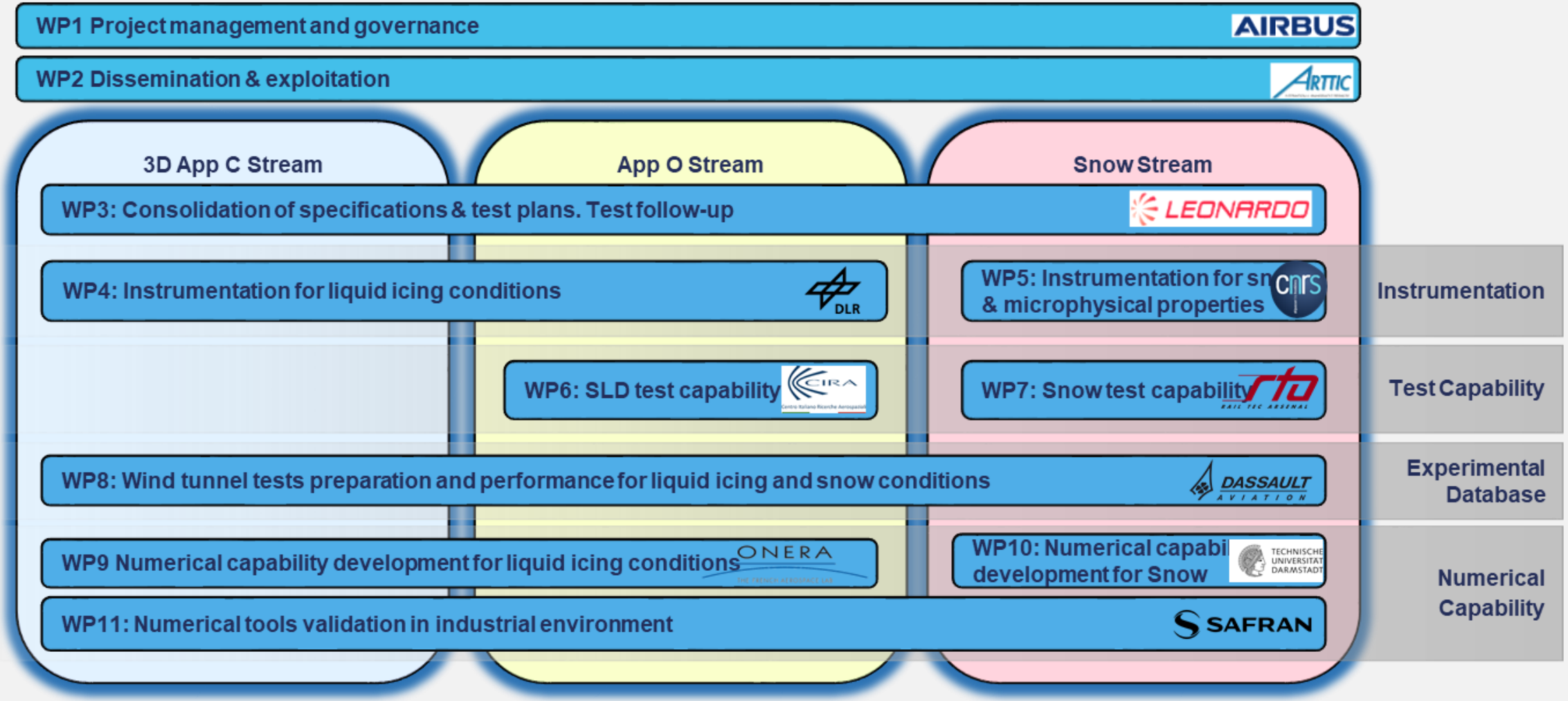
Obj#1: Improve and validate existing **3D numerical tools** to predict ice accretion in Appendix C, Appendix O and Snow conditions.

Obj#2: Upgrade and calibrate **icing wind tunnels** to allow reproduction of:

- **Supercooled Large Droplets (SLD) in FZDZ (Freezing drizzle) conditions**.
- **Snow conditions**
- Additionally, to **assess the potential of current icing wind tunnels to represent SLD in FZRA (Freezing rain) conditions**.

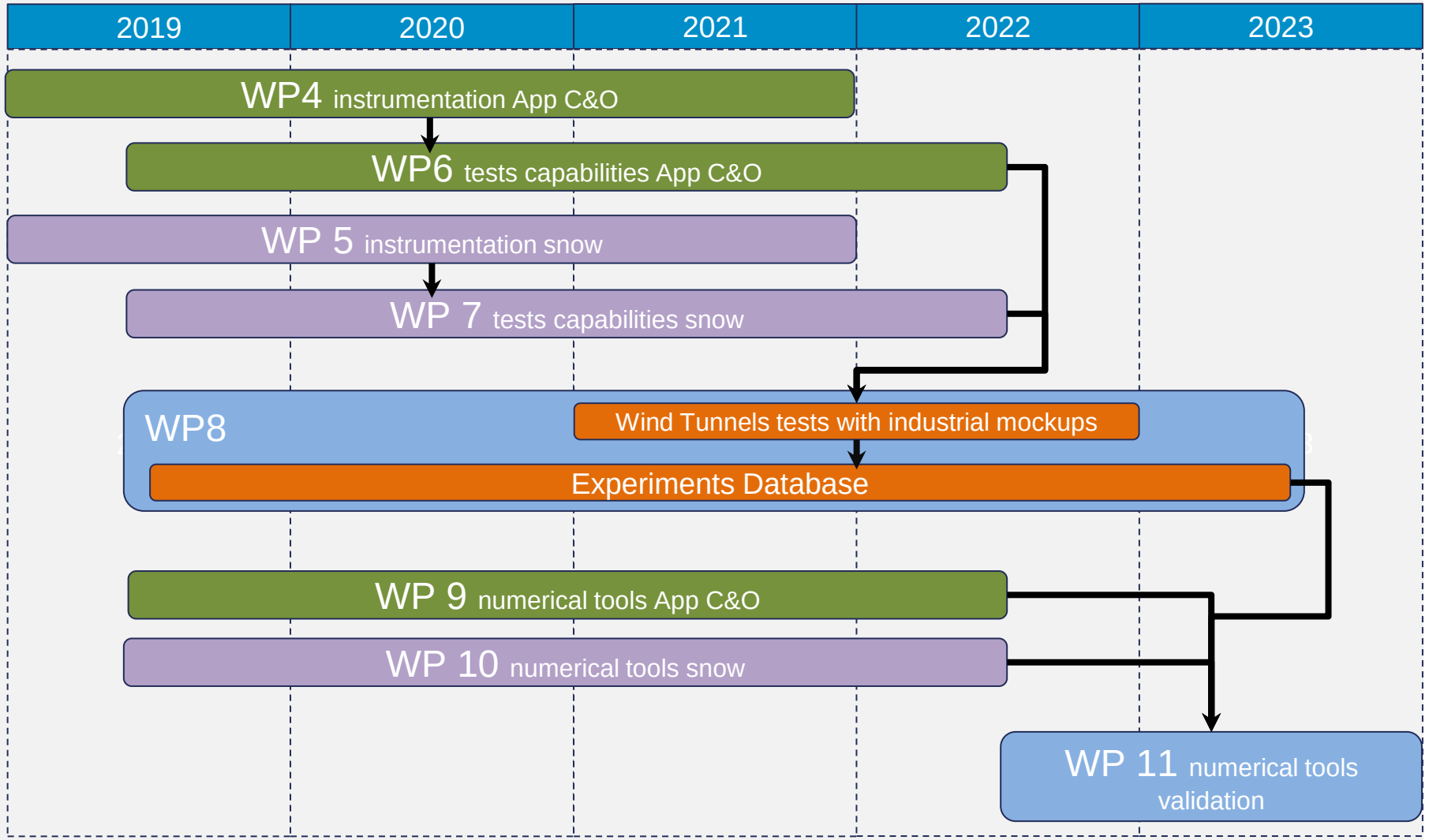
Obj#3: Build a **large scale experimental database** on representative 3D configurations to be used as a solid reference (“ground truth”) for future numerical tools validation.

ICE GENESIS Organisation



WP DEPENDENCIES

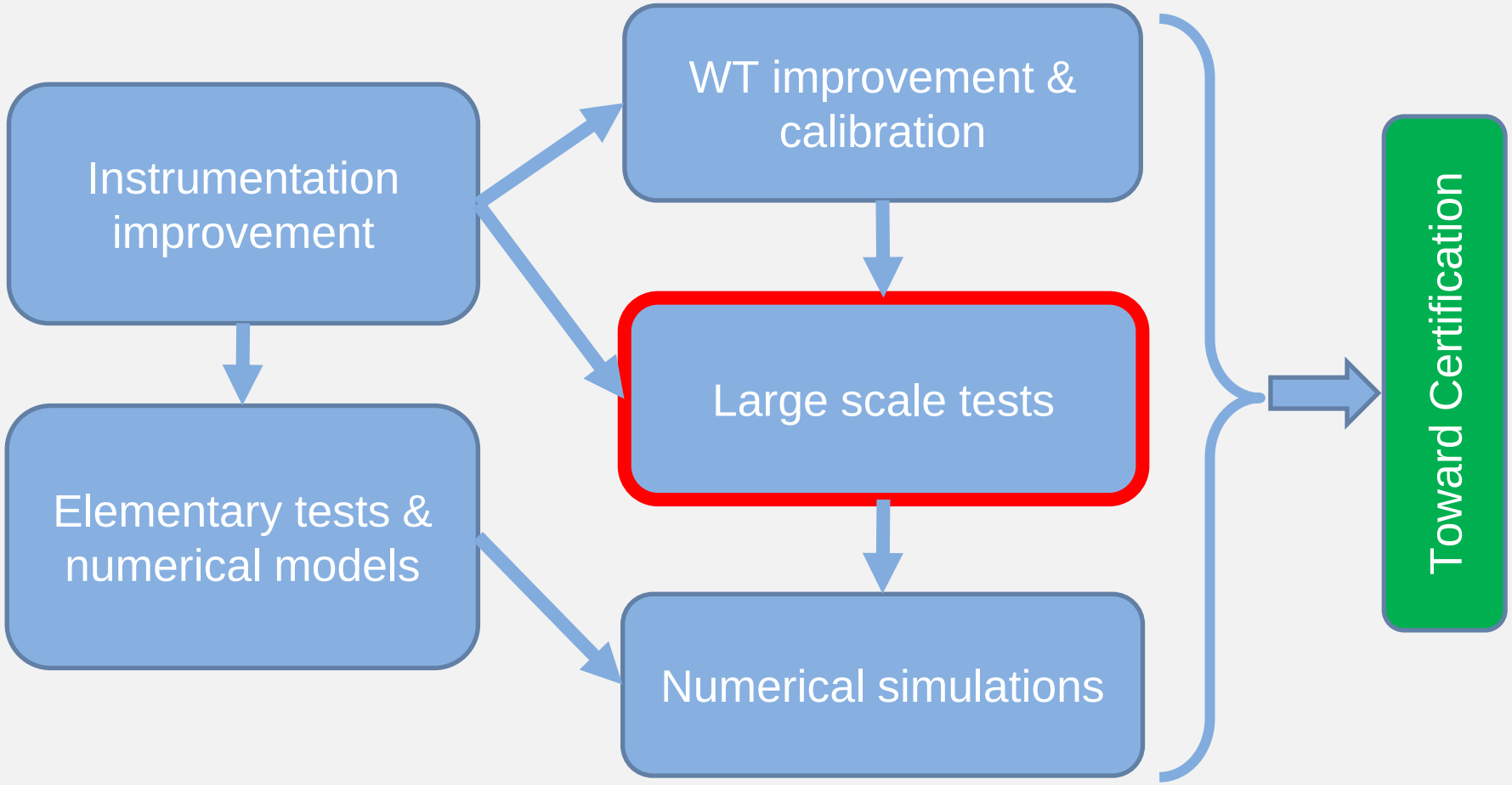
- Perform wind tunnel tests in liquid icing and snow conditions, in industrial environment (IWT and mockups)
- Provide searchable database of experimental results for validation of numerical tools



LIQUID CONDITIONS (APP C AND O) AND **SNOW** TESTS PREPARATION

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824310.

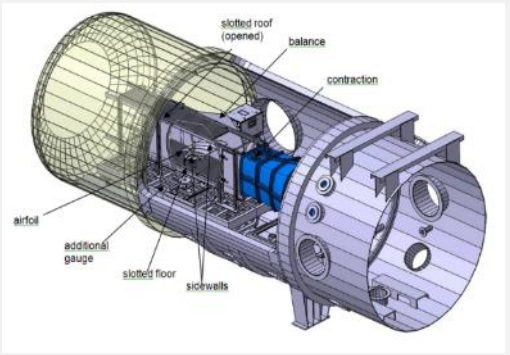
LIQUID CONDITIONS (APP C AND O) AND SNOW TESTS PREPARATION



Tests in industrial environment : 4 Icing Wind Tunnels

TSAGI : Climatic WT

DGA / MINDEF

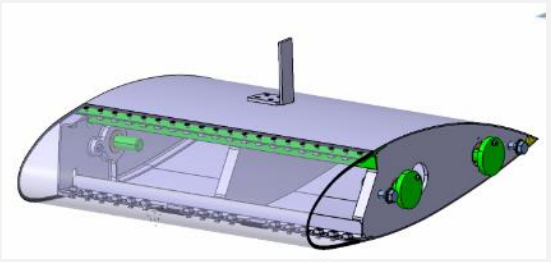


Cranfield University

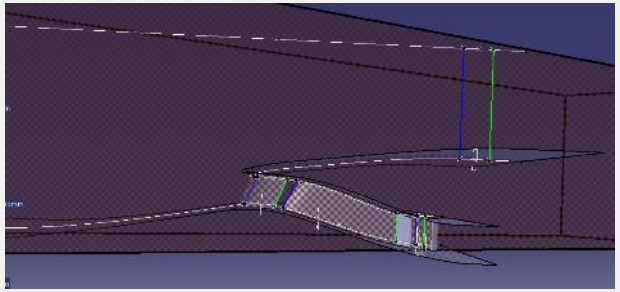
CIRA

Tests in industrial environment : 7 mockups (3 for snow)

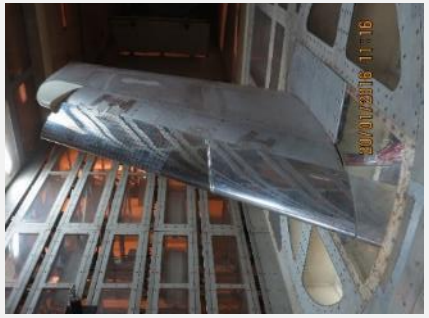
SONACA, LIEBHERR



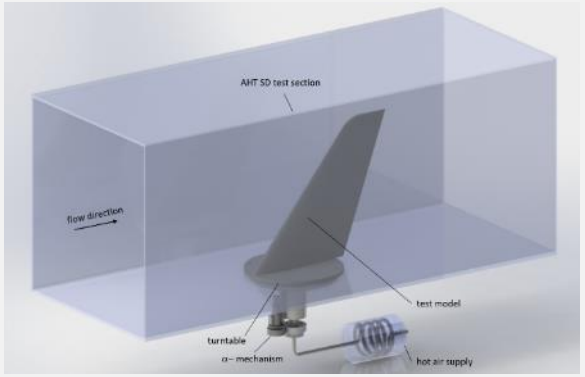
SAFRAN



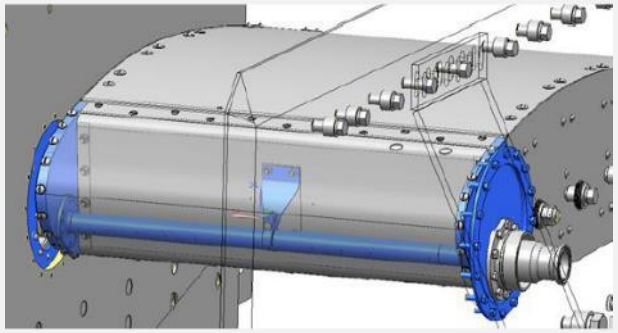
DASSAV



TSAGI



AVI (+ splitter)



LDO

Tests schedule

	MINDEF	Cranfield	Cira	TsAGI
2D Wing (Sonaca, Liebher) *April 2022*	APP O			
3D Wing (DA) *April 2022*			APP C/O	
Engine splitter (SAE) *January 2022*		APP C		
3D rescue hoist (LDO) *November 2021*				APP C/O
3D Wing (TsAGI) *March 2021; December 2021*				APP C/O + Snow
2D Nacelle (AVI) *March 2021; December 2021*				APP C/O +Snow
3D engine splitter (AVI) *March 2021, December 2021*				APP C/O + Snow

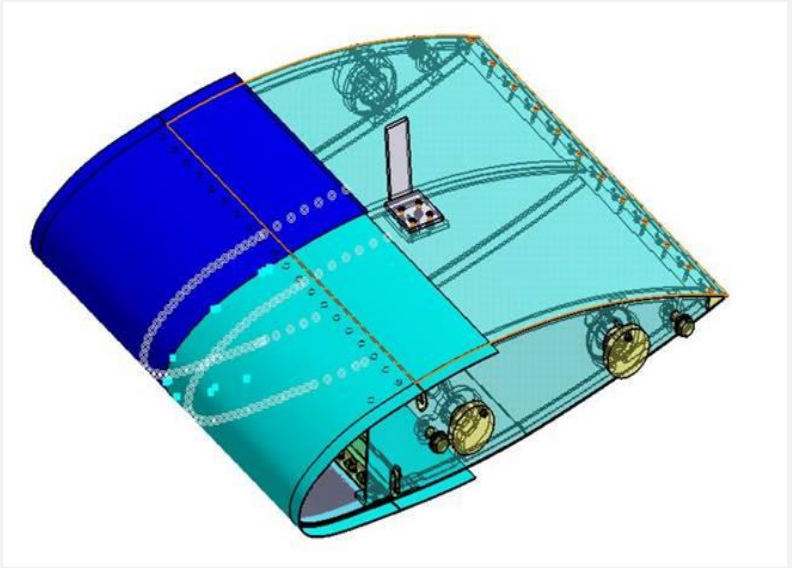
2D wing tests at MINDEF

Manufacturer	Icing WT	Conditions
SONACA + LIEBHR	MINDEF	APP O

2D Wing

- Extruded NACA 3421
- Electrical protection

- Thermal camera
- Icing blade
- Pressure belt



Cruise, Holding, Landing
With and without protection

Mach : 0.18, 0.36, 0.65
AOA : 0°, 4°, 6°
Altiture : 5.000 – 20.000 ft

Freezing Drizzle
LWC : 0.18 - 0.4
Air T° : -35°C - -2°C

3D wing tests at CIRA

Manufacturer	Icing WT	Conditions
DASSAV	CIRA	APP C/O

3D Wing

- 1:1 scale business jet wing with flaps
- Bleed air anti-icing
- Thermo couples
- Pressure belts
- Pressure ports
- Icing blade

Holding & Landing
With and without protection
Different Flap and Slat configuration

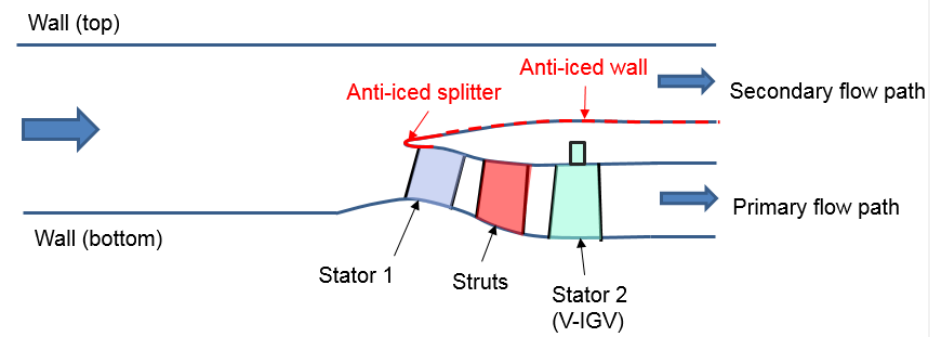
Freezing Drizzle and APPC
LWC : 0.18 – 0.43
Air T° : -25°C - -2°C

3D engine splitter tests at CU

Manufacturer	Icing WT	Conditions
SAF-AE	Cranfield University	APP C

3D Engine splitter

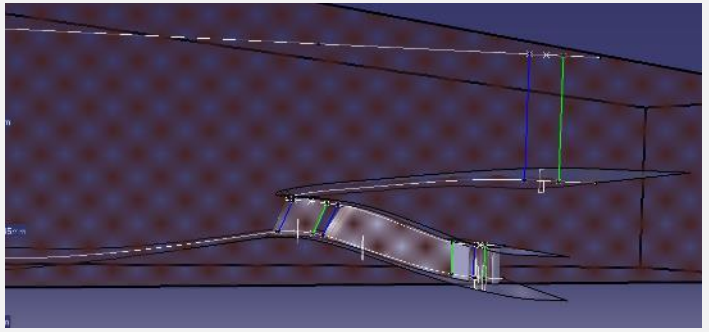
- Primary/secondary flux engine splitter
  - Tested only in APP C (large droplets are atomized through engine fan)
  - Electrical anti-icing protection
- Pressure taps, Pitot tubes
- Thermocouples, IR camera



Idle power
With and without protection

Mach 1 : 0.22, 0.4
Mach 2 : 0.19
Altitude : Ground

APPC
LWC : 0.5 – 1.2
Air T° : -20°C - -5°C



Rotor craft resuce hoist tests at TSAGI

Manufacturer	Icing WT	Conditions
LDO	TsAGI	APP C/O

Rotorcraft Rescue hoist

- 1:2 scale rotorcraft rescue hoist
- No anti-icing protection
- Can only be tested during winter

- High speed camera
- Pressure taps

Mach : 0.2
AOA : -10° - 10°
APPC and APPO
LWC : 0.1 – 0.8
Air T° : -20°C - -5°C

3D swept wing tests at TSAGI

Manufacturer	Icing WT	Conditions
TsAGI	TsAGI	APP C/O + Snow

3D Wing

- 3D swept wing
- Extruded NACA0012 section
- Bleed air anti-icing protection
- Can only be tested during winter
- Only colder months for snow

- Pressure taps
- Thermocouples

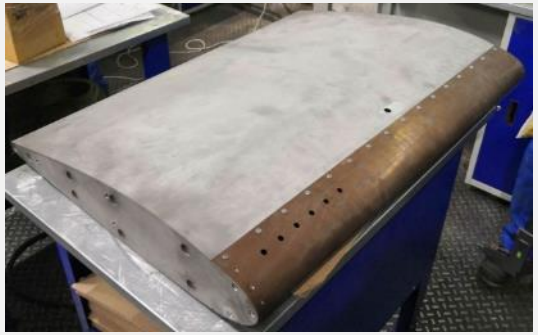
<u>Snow:</u>
Air Speed : 50 – 100 m/s
IWC : 1-3
Air T° : -15°C - 2°C

2D nacelle and 3D engines splitter tests at TSAGI

Manufacturer	Icing WT	Conditions
AVI	TsAGI	APP C/O + Snow

2D Nacelle

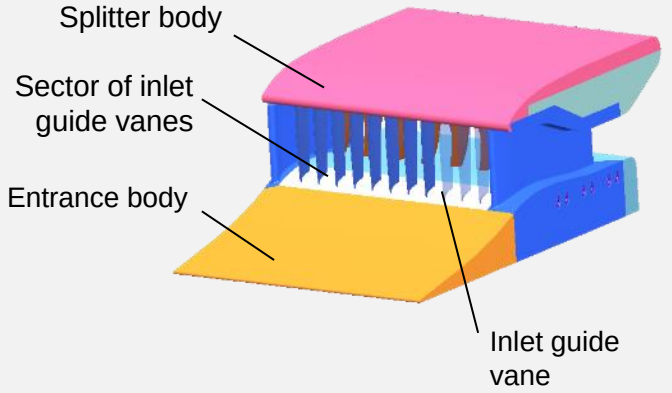
- Engine nacelle inlet
- Bleed air protection
- Can only be tested during winter
- Only colder months for snow



SLD:
Mach : 0.4
APPC and APPO
LWC : 0.2 – 0.45
Air T° : -17°C - -5°C

3D Engine splitter

- Electrothermal protection



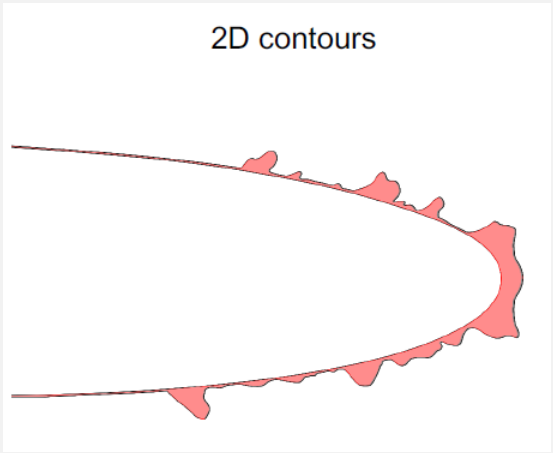
Snow:
Air Speed : 50 – 100 m/s
IWC : 1-3
Air T° : -15°C - 2°C

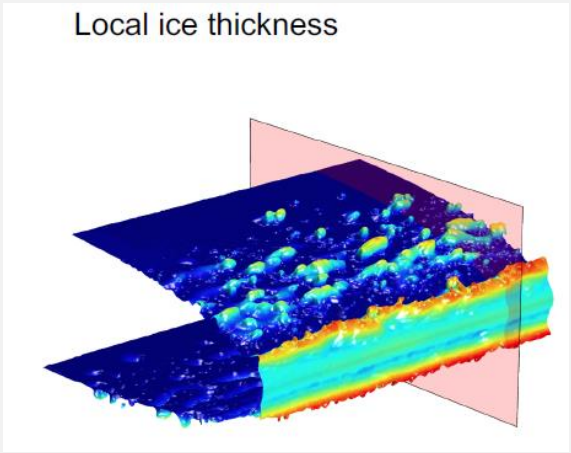
3D Scanning system

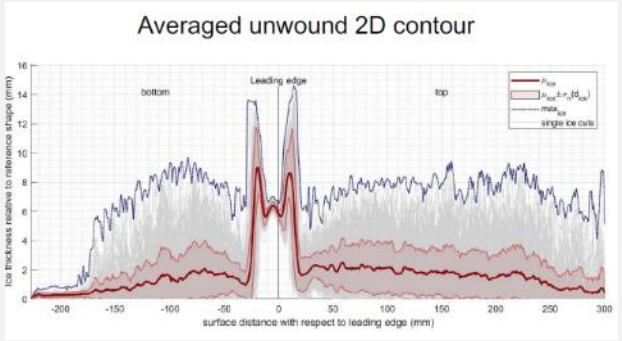
In addition to test report and traditional ice shapes tracings, provide accurate 3D scan and automatic treatment.

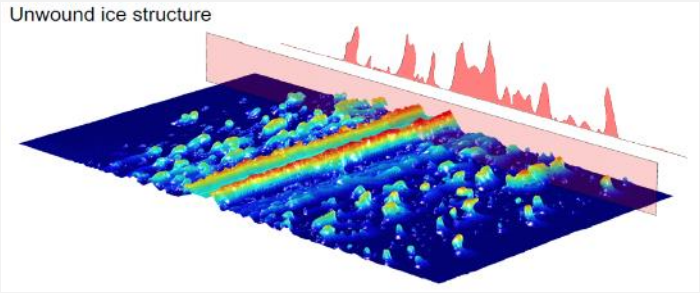
- roughness computation
- contours
- 3D surface shape

=> Developped in instrumentation part.







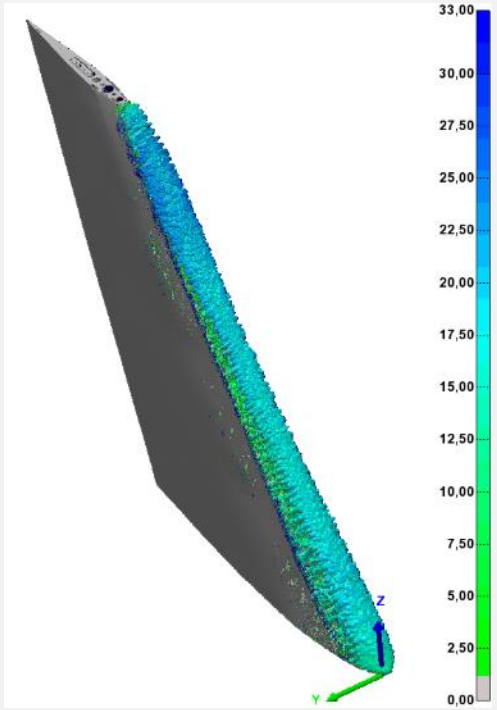


TsAGI 3D wing model tests

Test conditions:
App.C,
cold surface

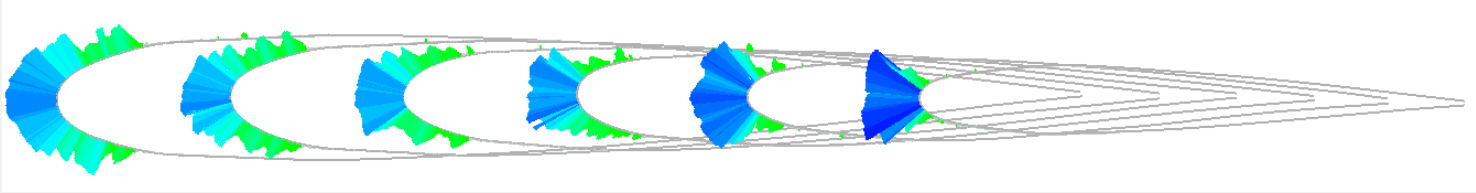
V = 100 m/s
T_a = -9 ºC
LWC = 1,23 g/m^3
MVD = 40 mcm
τ = 4 min

Model view at the end of the run



3D scan of the ice

Ice shapes in
various sections

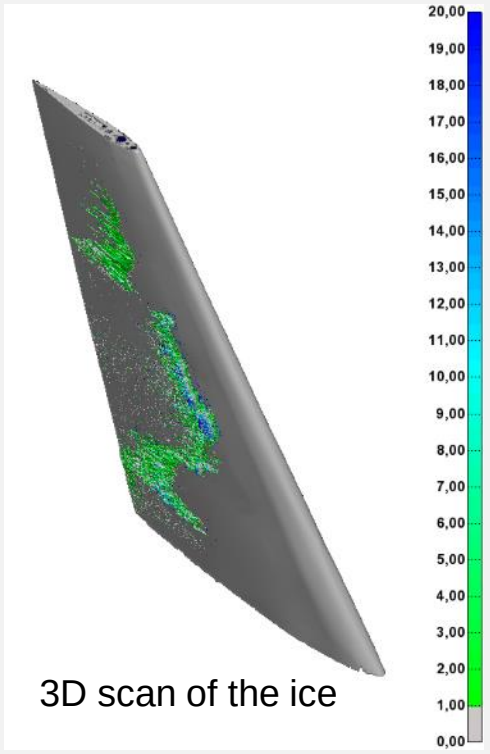


TsAGI 3D wing model tests

Test conditions:
App.C,
heated surface

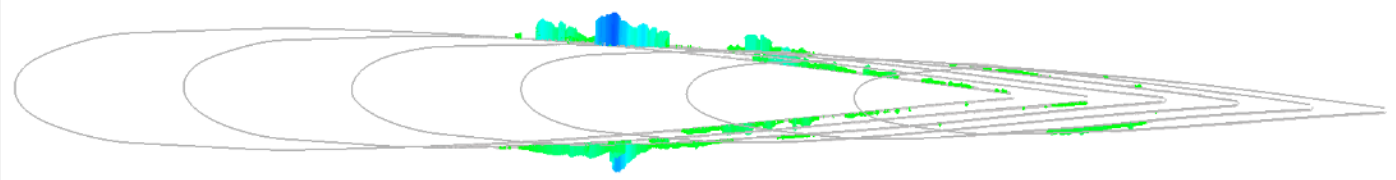
V = 100 m/s
T_a = -7 ºC
T_w = 85ºC
LWC = 2,0 g/m^3
MVD = 52 mcm
τ = 4 min

Model view at the end of the run



3D scan of the ice

Ice shapes in
various sections



DATABASE

Database

THANK YOU FOR YOUR INTEREST

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824310.