ICE GENESIS Final Public Workshop

6-7 December 2023
Toulouse, France

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.

Introduction to the Final Public Workshop

06/12/2023

E. LAINE (AIRBUS)
Project Coordinator

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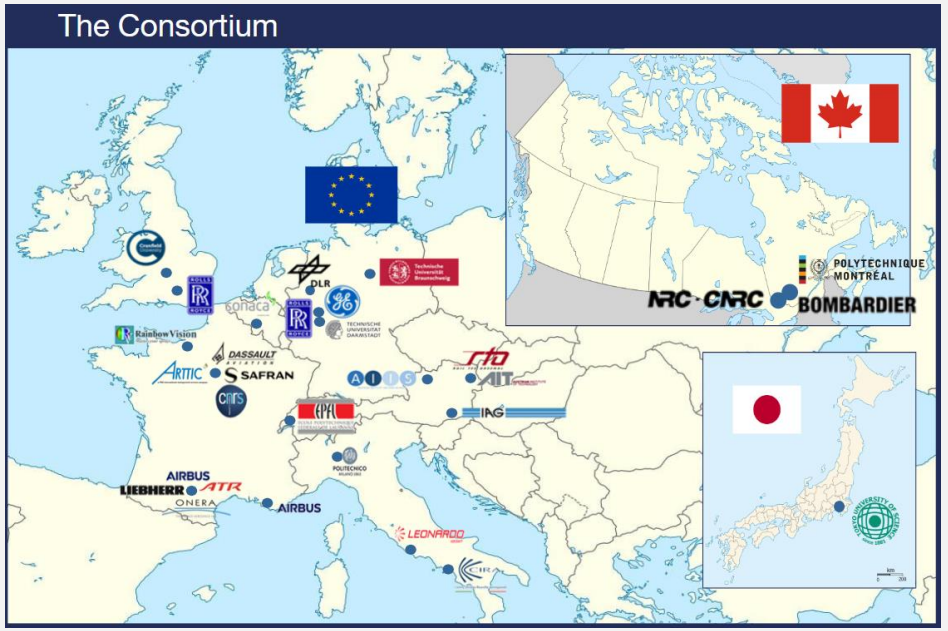
OVERVIEW

Top level objective: To provide the European aeronautical industry with a validated new generation of **3D icing engineering tools** (numerical simulation and test capabilities), addressing **supercooled liquid water** (Appendices C & O) **and snow conditions**, for safe, efficient and cost effective design and certification of future aircraft and rotorcraft.

Technical objectives

1. Improve and validate existing **3D numerical tools** to predict ice accretion in Appendix C, Appendix O and Snow conditions.
2. Upgrade and calibrate **icing wind tunnels** to allow reproduction of:
   - Supercooled Large Drops in Freezing drizzle conditions.
   - Snow icing conditions
   - Additionally, to assess the potential of current icing wind tunnels to represent Supercooled Large Drops in Freezing rain conditions.
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



- Grant agreement ID: 824310
- Start date : 01/01/2019 - End date : 31/12/2023
- Total cost : € 12 352 417
- EU contribution : € 11 964 300
- 30 Partners, 26 EU / 4 non-EU, 9 countries
- Website : https://www.ice-genesis.eu/

Faced Challenges

- ICE GENESIS faced several challenges over the 4 years that impacted the outcome of the project
- COVID-19 : +1 year
- Partnership with Russian project stopped in 2022 due to geopolitical reasons :
  - missing some test data on Supercooled Large Drops and Snow (WP8)
  - mitigation had to be found for the validation of the numerical tools with other existing data (WP11)

LIQUID WATER CONTEXT

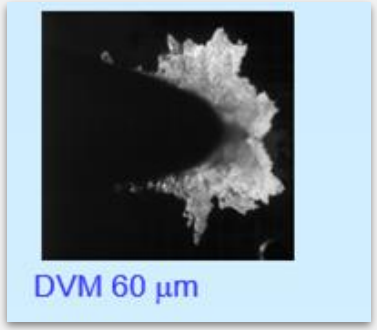
- **For future A/C certifications**, liquid conditions have to be addressed within:
  - CS25 / Part 25 Appendix C (“small” cloud droplets)
  - **CS25 / Part 25 Appendix O** (Supercooled Large Drops)

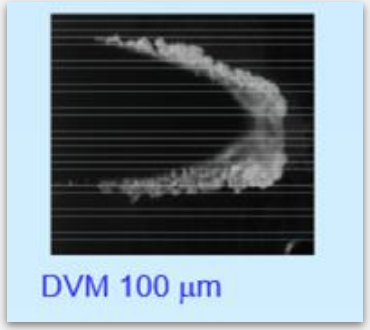
- To help close some of the main gaps, **Ice Genesis focused on**:
  - Improvement and validation of existing **2D/3D numerical tools**
  - Upgrade and calibration of **Icing Wind Tunnels (IWT)** to allow reproduction of:
    - Supercooled Large Drops (SLD) in Freezing drizzle (**FZDZ**) conditions.
    - Additionally, to assess the potential of current icing wind tunnels to represent SLD in Freezing rain (**FZRA**) conditions.

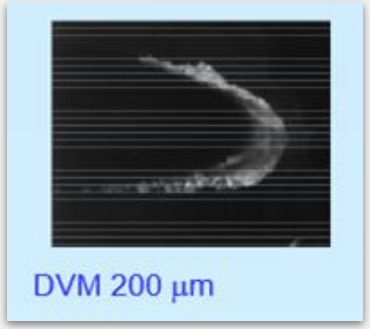
Definition	MVD Range	D_{max} Range	MVD	D_{max}	LWC_{max}
FZDZ In	< 40 µm	100 – 500 µm	20 µm	389 µm	0.44 g/m³
FZDZ Out	> 40 µm	100 – 500 µm	110 µm	474 µm	0.27 g/m³
FZRA In	< 40 µm	> 500 µm	19 µm	1553 µm	0.31 g/m³
FZRA Out	> 40 µm	> 500 µm	526 µm	2229 µm	0.26 g/m³

The 4 drop distributions of Appendix O conditions

FZDZ = Freezing Drizzle ; FZRA = Freezing Rain ; SLD = Supercooled Large Drops







Droplet diameter effect on the ice accretion on a profile

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SNOW CONTEXT

- **Rotorcraft** manufacturers need to demonstrate **safe operations in falling and blowing snow** conditions

- Demonstration is performed at the end of the program development during **certification flights**.
  - The flight tests in natural snowstorms, beside their **intrinsic risk**, are **difficult to schedule** due to the rarity of events ; fewer than 4% of all snowstorms conform to the requirements reported in the AMC
  - Any issue found at this stage of the development can lead to **significant delay and cost to redesign** the air inlet or integrate protection systems

H175 F/T Snow

Preliminary RTA Snow Capability

A400M snow ground test capability

There is a need to develop SNOW TEST & NUMERICAL CAPABILITIES to de-risk power plant system design before in-flight demonstration and as such, secure future program DEVELOPMENT AND CERTIFICATION

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FZDZ = Freezing Drizzle ; FZRA = Freezing Rain ; SLD = Supercooled Large Drops

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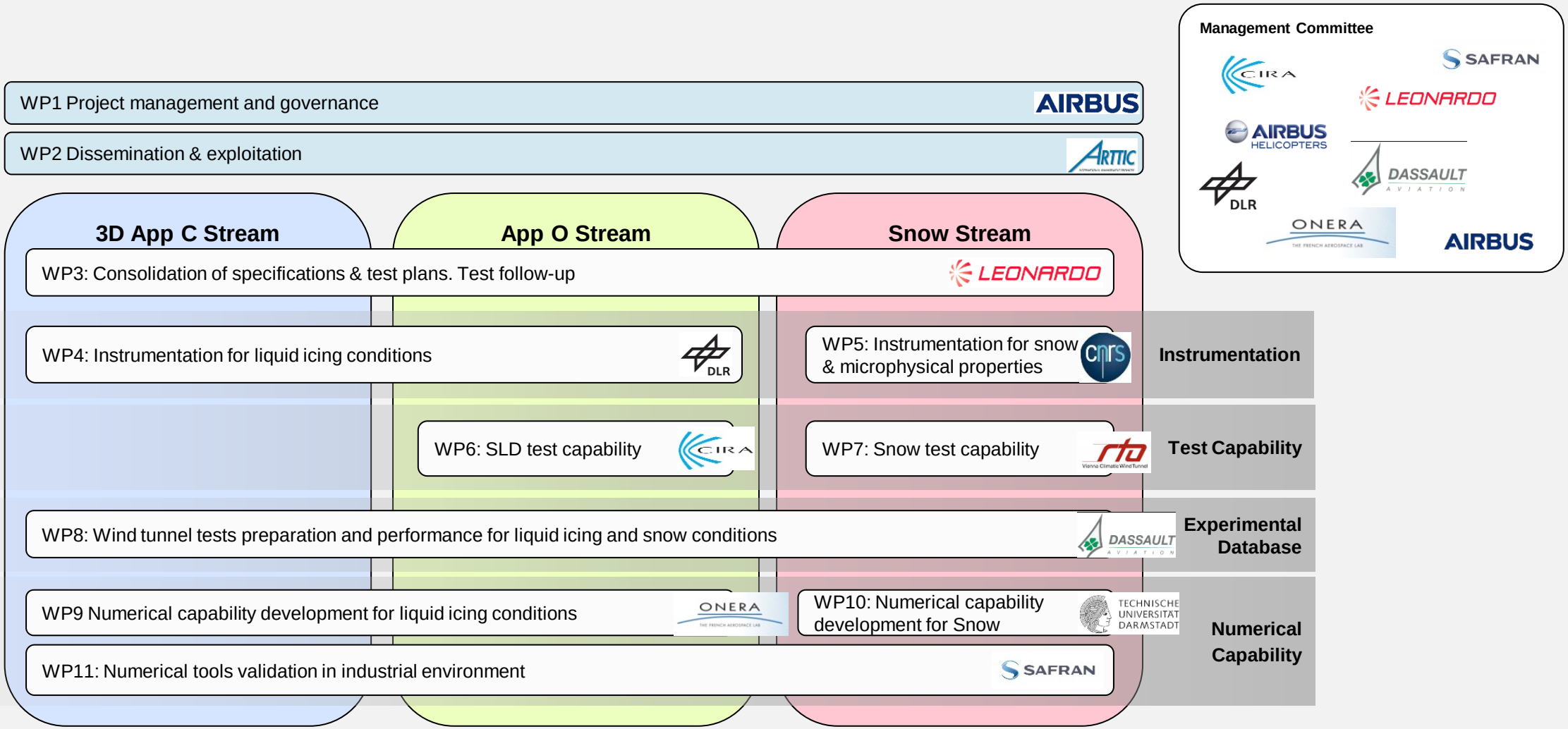
ICE GENESIS Work Package Breakdown



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SLD = Supercooled Large Drops

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Agenda

- **DAY 1 (06/12) - Presentation of ICE-GENESIS results**
  - A particular focus will be made on the validation of the numerical tools and limitations

- **DAY 2 (07/12) - Feedback and Way Forward**
  - Feedback from the Manufacturer Icing Certification Group (MICG)
  - Feedback from Airworthiness Authorities (FAA - *TBC*, EASA)
  - Presentation of 2 other EU projects focusing on icing : SENS4ICE, MUSIC-HAIC
  - Conclusions from ICE-GENESIS internal review
  - Discussion on the needs for the industry
  - Recommendations and way forward

Thank you for your attention.

ICE-GENESIS, SENS4ICE and MUSIC-HAIC teams at the SAE Icing Conference in Vienna, June 2023

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