



SENS4ICE

SENSORS AND CERTIFIABLE HYBRID ARCHITECTURES
FOR SAFER AVIATION IN ICING ENVIRONMENT

Public Project Overview

October 2020

This project has received funding from European Union's Horizon 2020 research and innovation programme under grant agreement n° 824253



SENS4ICE Project Overview

SENSors and certifiable hybrid architectures for safer aviation in ICing Environment

💧 JAN 2019 - DEC 2022 (project extension expected)

💧 Coordinator: DLR

💧 Budget:

💧 max. EU contribution	6.6 M EUR
💧 total estimated eligible costs	11.9 M EUR
💧 project effort in person-months approx.	1100 PM

💧 <https://www.sens4ice-project.eu>

💧 #sens4iceproject on LinkedIn



SENS4ICE Consortium Partners



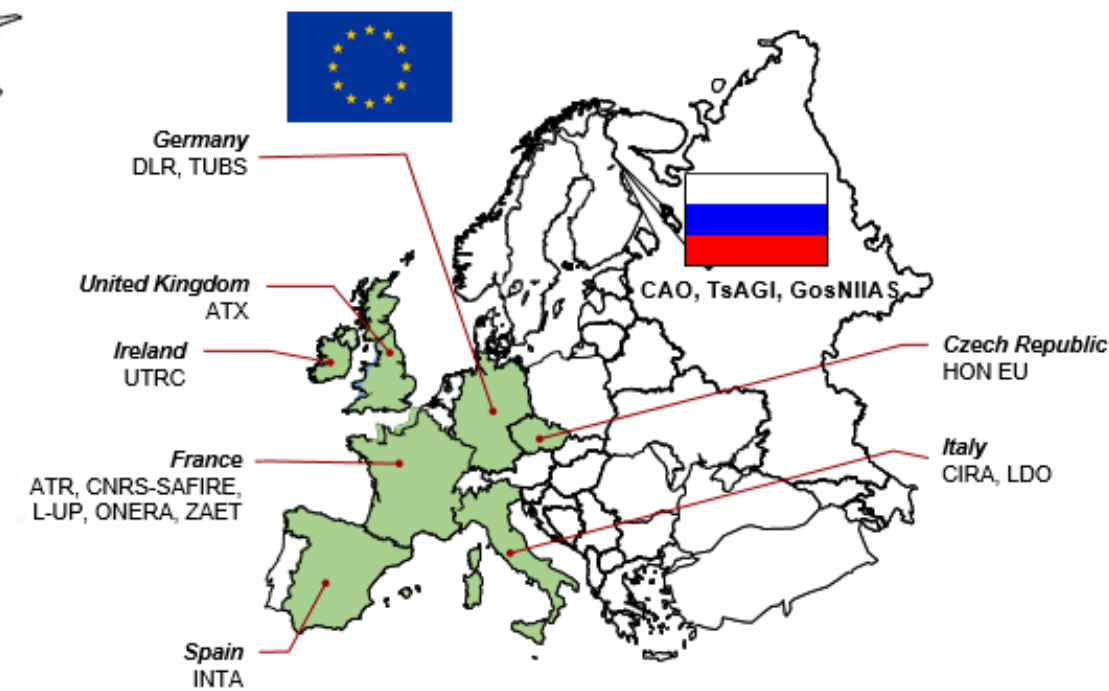
- 1) DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT e.V. (DLR)
- 2) AVIONS DE TRANSPORT REGIONAL (ATR)
- 3) AEROTEX UK LLP
- 4) CENTRAL AEROLOGICAL OBSERVATORY
- 5) CENTRO ITALIANO RICERCHE AEROSPAZIALI SCPA (CIRA)
- 6) CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS)
- 7) EMBRAER SA
- 8) STATE RESEARCH INSTITUTE OF AVIATION SYSTEMS
- 9) HONEYWELL INTERNATIONAL SRO
- 10) INSTITUTO NACIONAL DE TECNICA AEROESPACIAL ESTEBAN TERRADAS (INTA)

- 11) LEONARDO - SOCIETA PER AZIONI
- 12) L-UP SAS
- 13) OFFICE NATIONAL D'ETUDES ET DE RECHERCHES AEROSPATIALES (ONERA)
- 14) FEDERAL STATE UNITARY ENTERPRISE THE CENTRAL AEROHYDRODYNAMIC INSTITUTE NAMED AFTER PROF. N.E. ZHUKOVSKY (TsAGI)
- 15) TECHNISCHE UNIVERSITAET BRAUNSCHWEIG
- 16) RAYTHEON TECHNOLOGIES RESEARCH CENTER
- 17) SAFRAN AEROTECHNICS
- 18) HONEYWELL INTERNATIONAL INC **Honeywell**
- 19) COLLINS AEROSPACE



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international collaboration and cooperation



- ◆ InCo – international cooperation flagship: Aviation International Cooperation Flagship "Safer and Greener Aviation in a Smaller World"

- ◆ 19 project parties (10 countries)

- ◆ 13 EU/6 international

- ◆ 8 research centers, 1 university, 9 industrial partners (OEMs and system developers), 1 consultancy partner

- ◆ Advisory Board (9 members)

- ◆ aviation certification authorities (EASA, FAA, ANAC)
 - ◆ manufacturing (Bombardier, Gulfstream, Airbus DS, DAHER)
 - ◆ research (ITA, NLR)
 - ◆ operations (VC - *Vereinigung Cockpit*, German Pilot's Association)

- ◆ Coordination with EU icing projects ICE GENESIS and MUSIC-haic



SENS4ICE Goal/ Impact

Problem

- 💧 Detect icing conditions (including App. O/ SLD icing) – detection very challenging

Solution

- 💧 Hybrid approach – fusion of input data: sensor(s) and indirect detection

Benefits

- 💧 Operational benefits: activate anti-/de-icing, avoid/ leave icing conditions
- 💧 Certification process benefits – flights in App. O/ SLD icing
 - 💧 safety risk due to severe and unknown aircraft icing
 - 💧 online evaluation of safety margins during flight tests/ certification flights



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Scope and positioning

- 💧 SENS4ICE fills the gap of SLD icing detection (App. 0)
 - hybridisation of different detection techniques
 - 💧 Technology development, test, validation and maturation with specific regards to integration of hybrid system architectures
 - TRL 5 of hybrid system at the end of SENS4ICE
 - 💧 Technology demonstration in relevant icing conditions:
 - 💧 testing facilities
 - 💧 flight test
 - SENS4ICE will provide large data base of icing conditions
 - 💧 Close cooperation with regulation authorities for development of new certifiable hybrid ice detection system
 - SENS4ICE will provide an acceptable means of compliance
- **SENS4ICE contributes to increase aviation safety in SLD icing conditions**



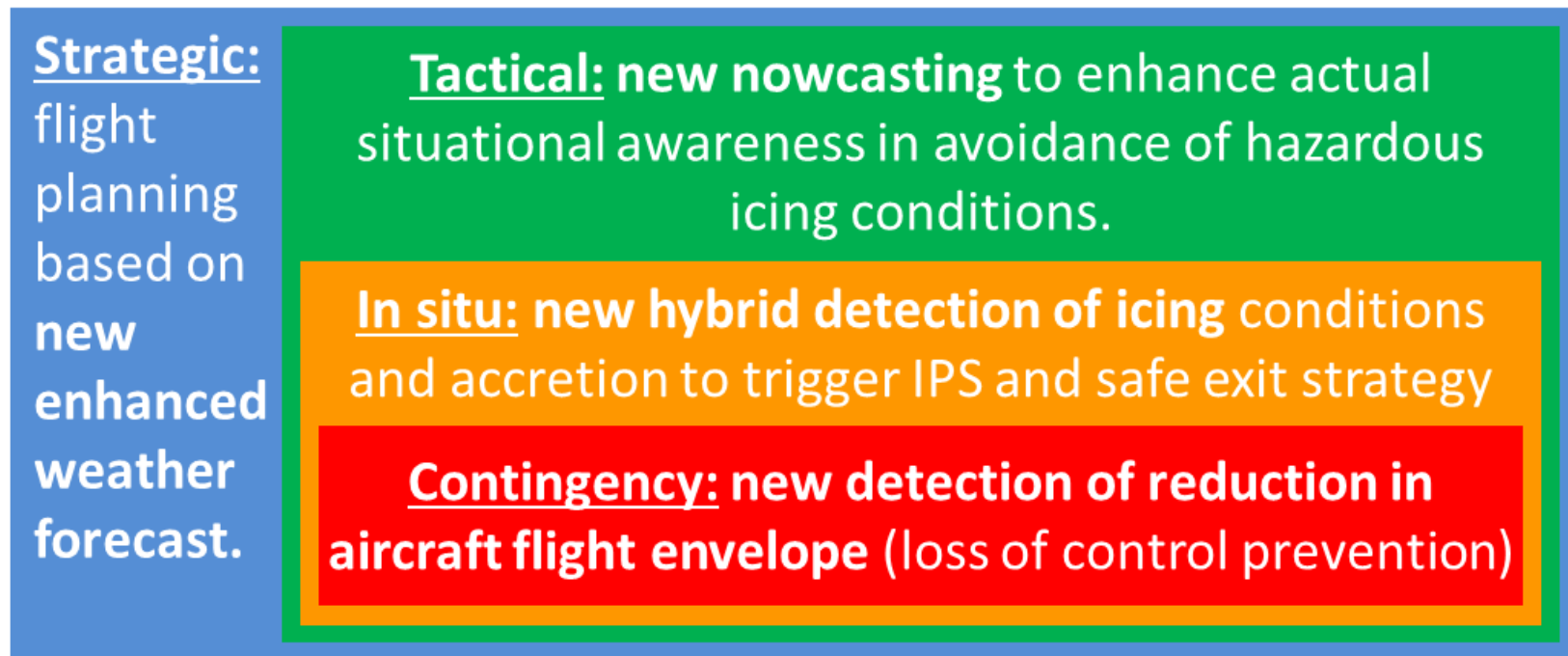
Expected impact

- 💧 Contribute to **increased flight safety**
by fewer accidents and less in-flight events worldwide
- 💧 Contribute to **reduce costs** for all stakeholders
by improved and internationally accepted certification rules, standards and means of compliance, covering all types of icing hazards
- 💧 Contribute to **decrease delays** in operations
thanks to more efficient avoidance of icing hazards and to fewer damages in need of inspection and repair



Layered Approach on Ice Detection

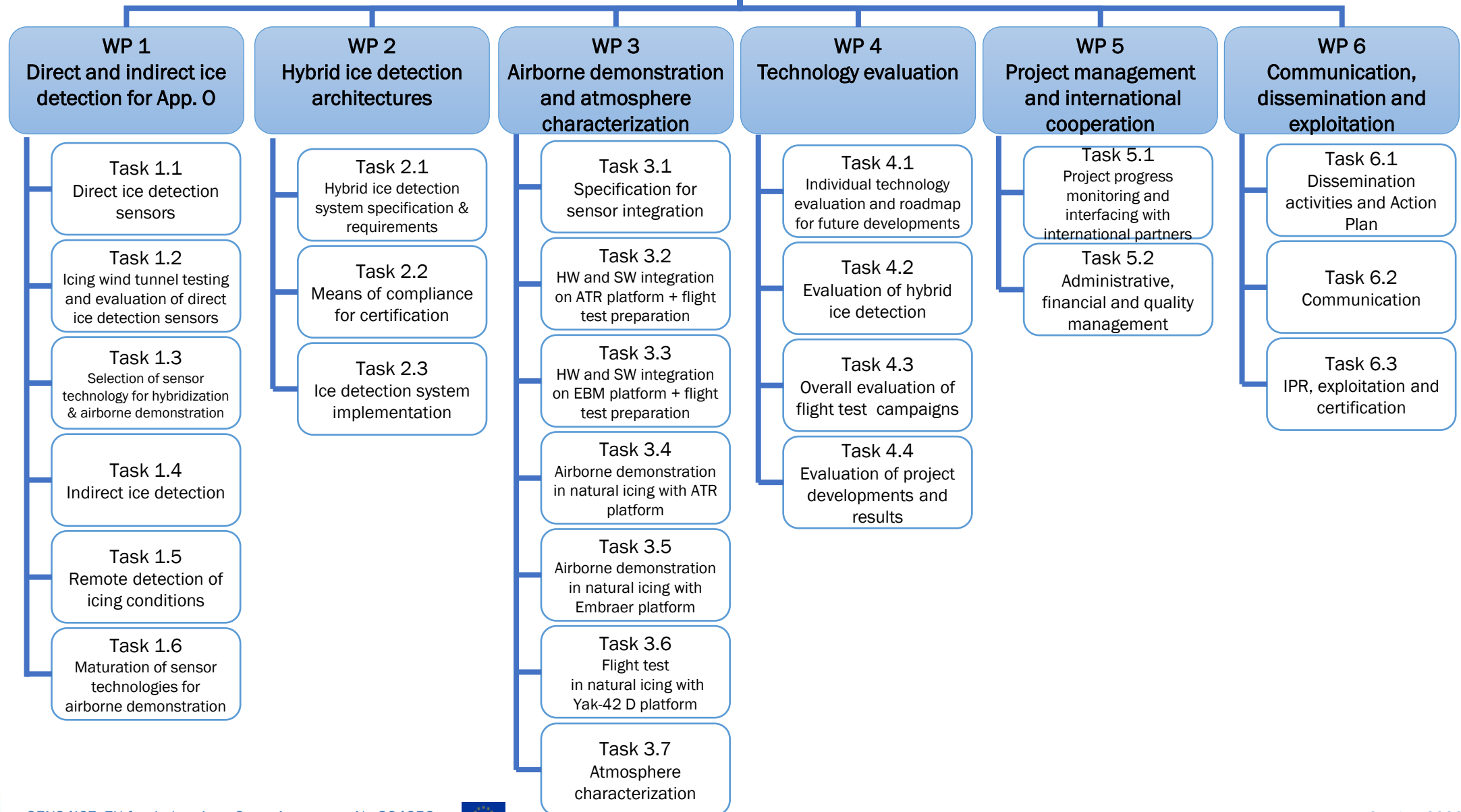
SENS4ICE will address this challenge of reliably detecting and avoiding App. 0 SLD conditions with a unique layered safety approach:



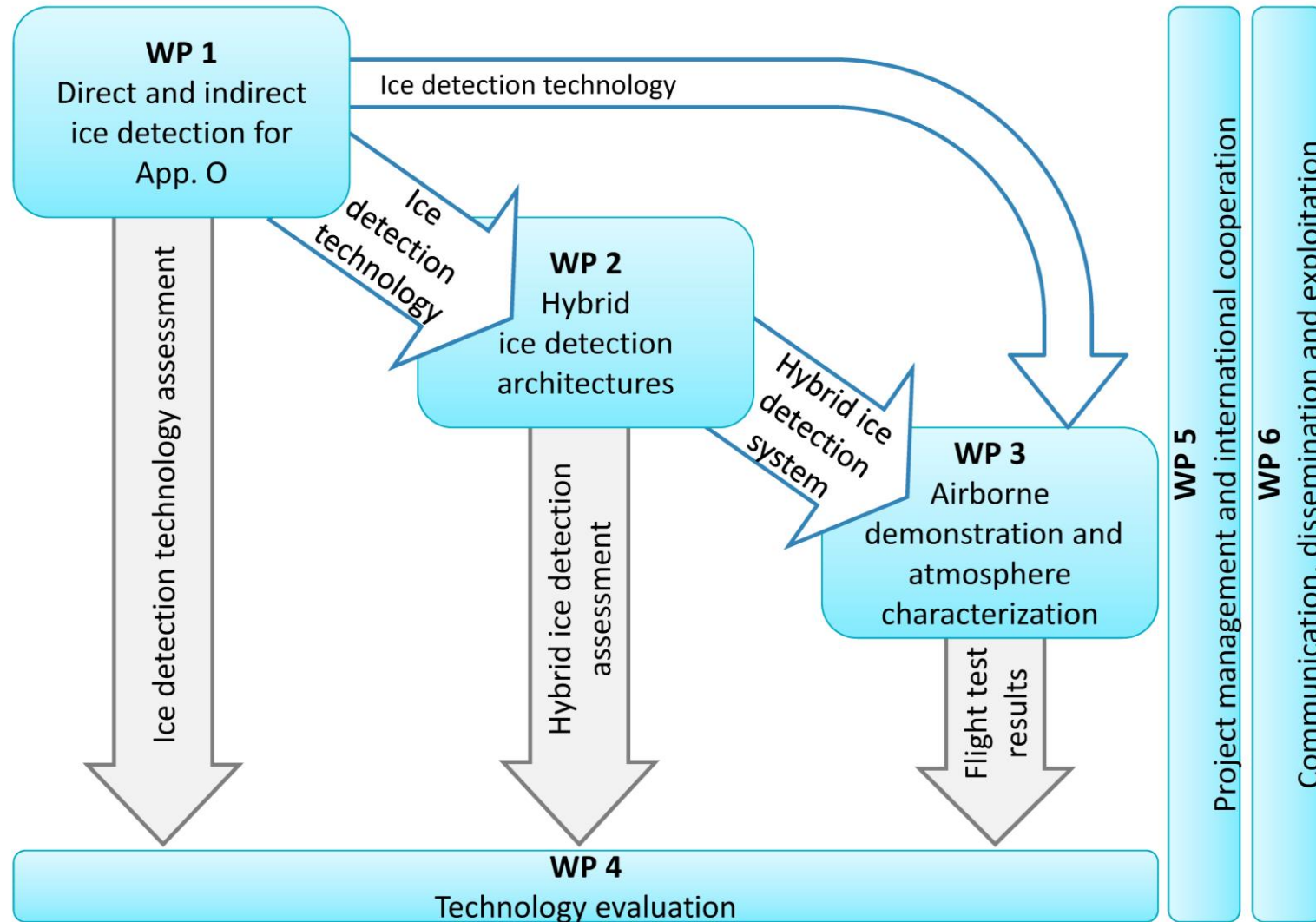
→ Hybrid ice detection is central technology and key to this approach



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Technical Work Packages interrelation



WP1: Direct and indirect ice detection for App. 0

High Level Objectives

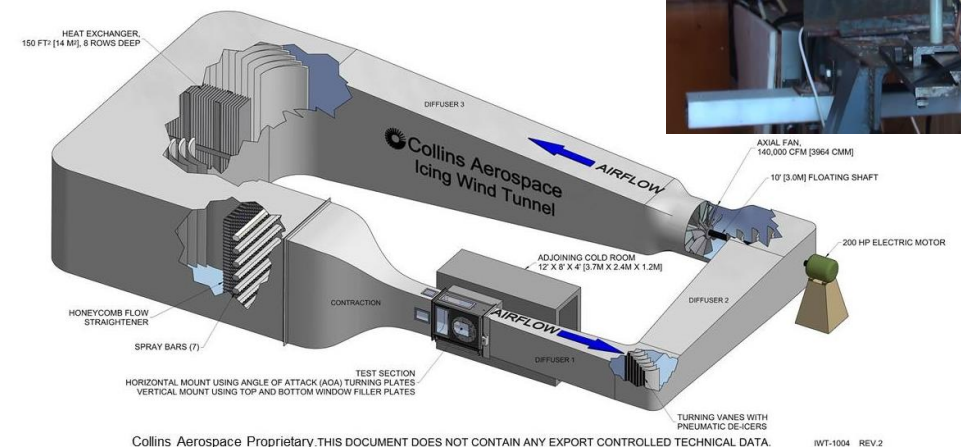
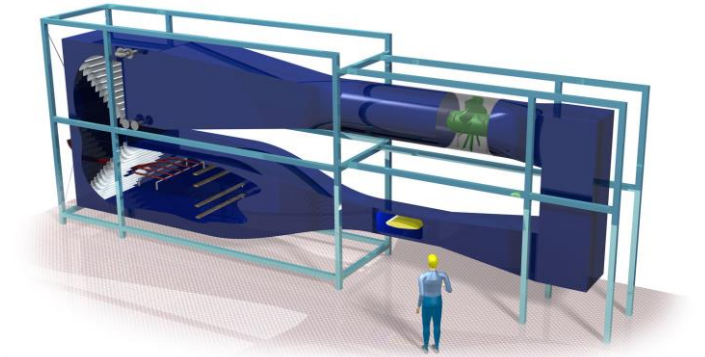
Main Objective: Develop technologies capable of detecting App. 0 icing conditions using a three-pronged approach:

- 💧 Direct detection: development of *in situ* sensors capable of ice detection
 - 💧 11 technologies under development representing a variety of physical detection principles
 - 💧 Evaluation in icing wind tunnel tests under simulated App. 0 conditions – three tunnels/total of 26 weeks testing time
 - 💧 Two-stage evaluation/selection process to ensure most promising sensors advance to flight test (WP3)
- 💧 Indirect detection: utilising existing sensor information and aircraft performance reference data for early detection of airframe icing
- 💧 Remote detection: development of methods to detect App. 0 conditions before the aircraft enters the hazard area
 - 💧 Detection and Nowcasting: development of algorithms that combine meteorological factors retrieved from satellite data to detect and forecast (very short-term range) icing threats in App. 0 conditions
 - 💧 Polarimetric weather radar: development of algorithms to classify icing threats and identify App. 0 conditions



SENS4ICE research facilities: Icing Wind Tunnels

- 💧 TU Braunschweig
 - 💧 SLD capabilities available and enhanced during SENS4ICE
- 💧 TsAGI AHT SD and EU-1:
 - 💧 SLD capabilities developed during SENS4ICE
- 💧 Collins Aerospace
 - 💧 SLD capabilities available and enhanced during SENS4ICE
- 💧 Total testing time: 26 weeks (+ 2 weeks)
- 💧 Planned time frame: NOV 2020 – MAR 2021
- 💧 *New partner: NRC Canada IWT*



Collins Aerospace Proprietary. THIS DOCUMENT DOES NOT CONTAIN ANY EXPORT CONTROLLED TECHNICAL DATA.

IWT-1004 REV.2



WP2: Hybrid Ice Detection

Robust Hybrid Ice Detection:

different techniques for
direct sensing of
atmospheric conditions
and/or ice accretion



indirect techniques to
detect change of aircraft
characteristics with ice
accretion on airframe

Development, test, validation and maturation of different technologies for

- direct ice detection
- indirect ice detection

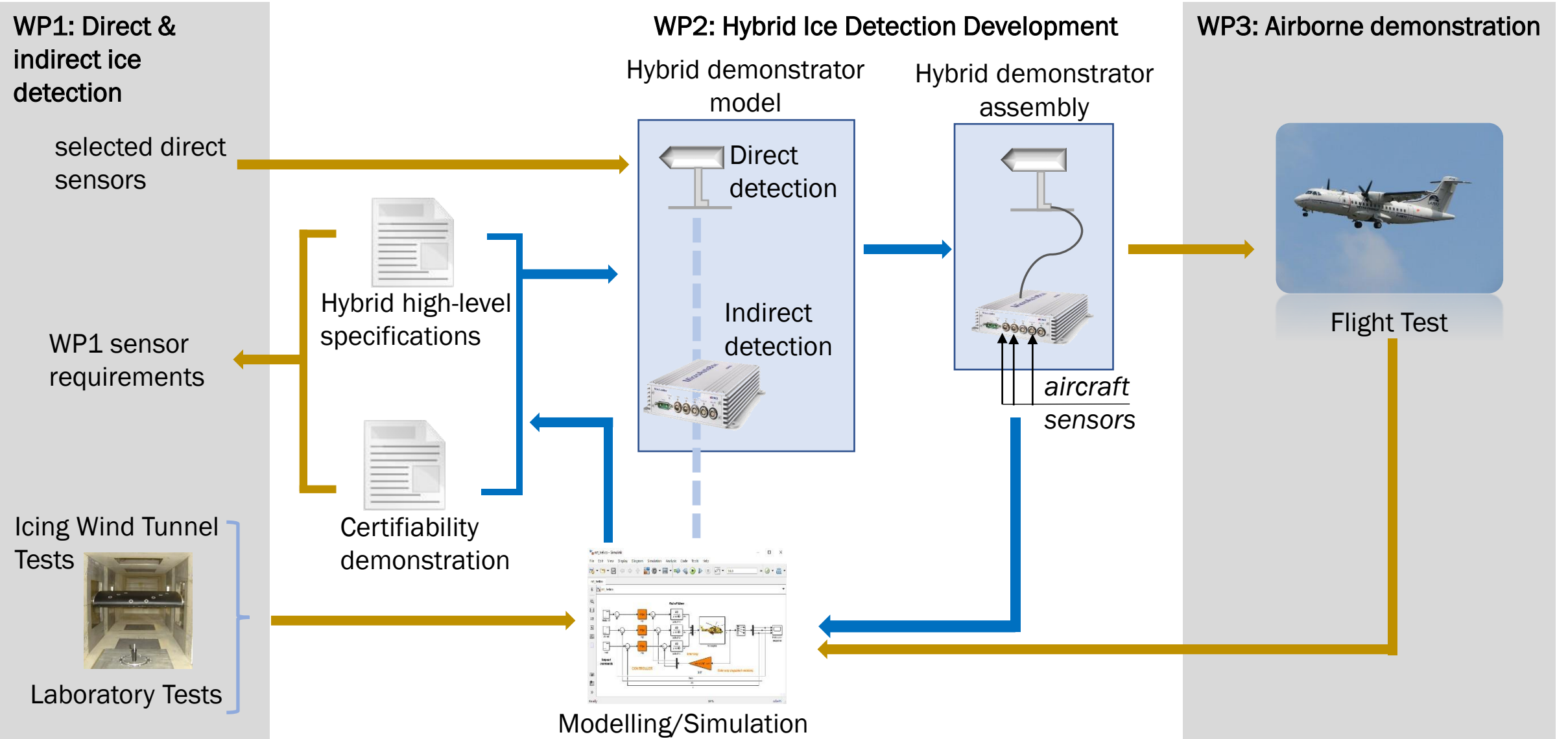
Objectives for hybrid ice detection

1. Hybrid ice detection system specification
2. Certification programme for hybrid ice detection system
3. Hybrid ice detection system modelling
4. Hybrid ice detection design, build & assembly (+ TRL 5 review)

in **close cooperation with OEMs and certification authorities** during SENS4ICE



Hybrid Ice Detection: Development Workflow



WP3: Airborne demonstration and atmosphere characterisation

dedicated to airborne technology demonstration in relevant icing conditions

Objectives

- ✦ Issue main requirements and constraints for integration of sensors and probes on flight test platforms
- ✦ Release flight test program for testing new individual and hybrid technologies in distinct icing conditions
- ✦ Perform airborne demonstration in natural icing conditions:
 - ✦ in Europe with CNRS/SAFIRE ATR-42
 - ✦ in North America with Embraer Phenom 300
 - ✦ in Russia with Yak-42D “Roshydromet”
- ✦ Characterisation of atmosphere from flight test campaigns in App. 0 conditions

Guidance by special Flight Test Committee (FTC) formed by platform providers and leaders of WP1, WP2 and WP4 to ensure harmonised preparation and execution of individual flight test campaigns



SENS4ICE research facilities: Flight Test Platforms

- total flight test time: 125h in natural icing conditions
- planned main time frame: Q1/2022 (*delays expected due to Covid-19*)

**SAFIRE
ATR-42**



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**Embraer
Phenom 300**



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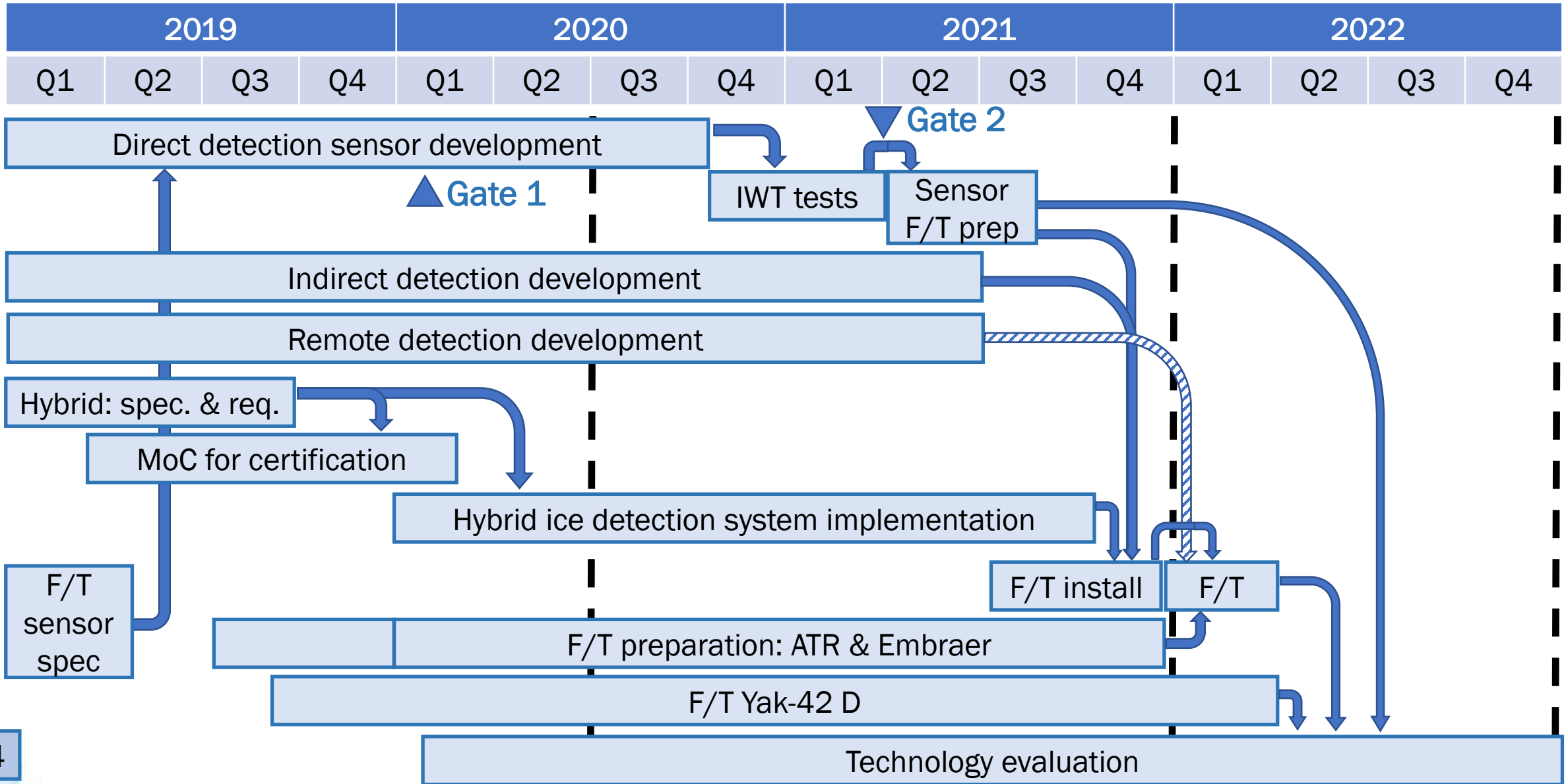
**CAO Yak-42D
Roshydromet**



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SENS4ICE Timescale (simplified Gantt)



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<https://www.sens4ice-project.eu>

in <https://www.linkedin.com/company/sens4ice-project>



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