SENS4ICE

SENSORS AND CERTIFIABLE HYBRID ARCHITECTURES
FOR SAFER AVIATION IN ICING ENVIRONMENT

The SENS4ICE EU project

June 2019

Carsten Schwarz - DLR

Minneapolis, MN, USA – June 2019

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

SENS4ICE Project Overview

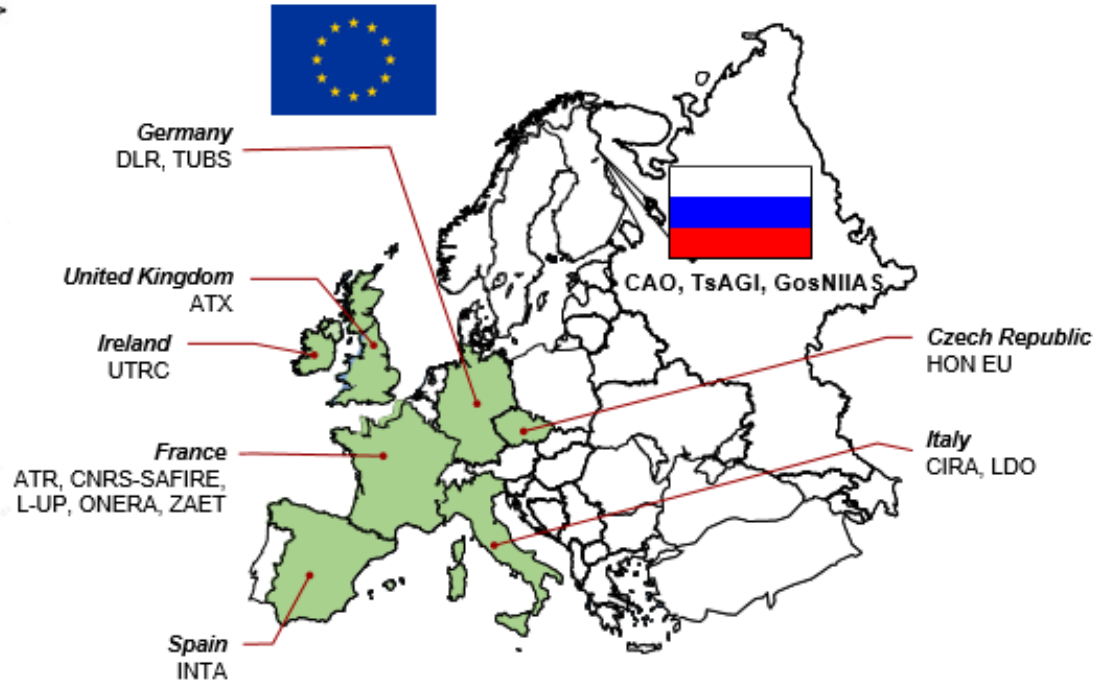
SENSors and certifiable hybrid architectures for safer aviation in ICing Environment

- JAN 2019 - DEC 2022
- Coordinator: DLR
- Budget:
  - max. EU contribution 6.6 M EUR
  - total estimated project costs 11.9 M EUR
  - project effort in person-months approx. 1100 PM

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) UNITED TECHNOLOGIES RESEARCH CENTRE IRELAND, LIMITED
17) ZODIAC AEROTECHNICS SAS (*SAFRAN*)
18) HONEYWELL INTERNATIONAL INC
19) GOODRICH DE-ICING AND SPECIALTY SYSTEMS (*COLLINS AEROSPACE*)

SENS4ICE 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 non-EU
  - 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)
  - operations (VC - *Vereinigung Cockpit*, German Pilot's Association)
- Coordination with EU icing projects ICE GENESIS and MUSIC-haic

SENS4ICE
Scope and positioning

- SENS4ICE fills the gap of SLD icing detection (App. O)
  → 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

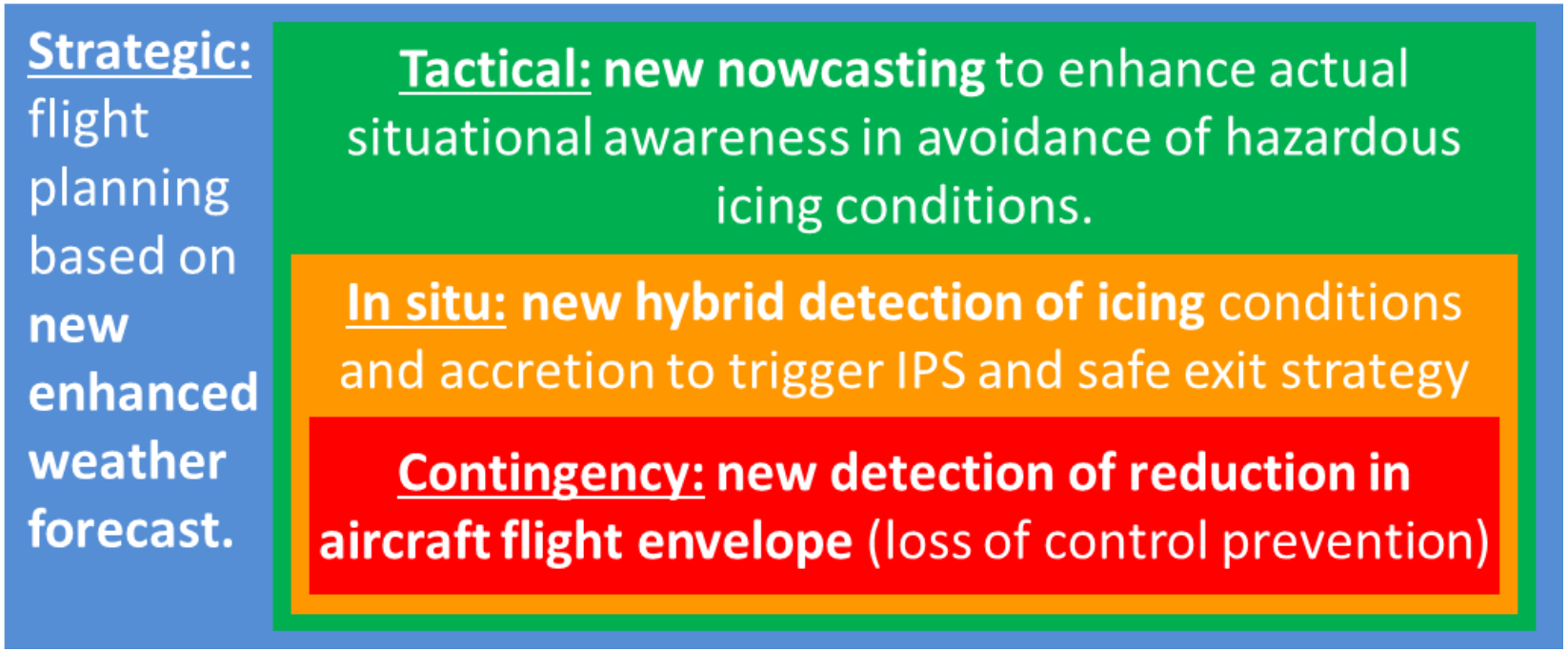
→ SENS4ICE contributes to increase aviation safety in SLD icing conditions

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

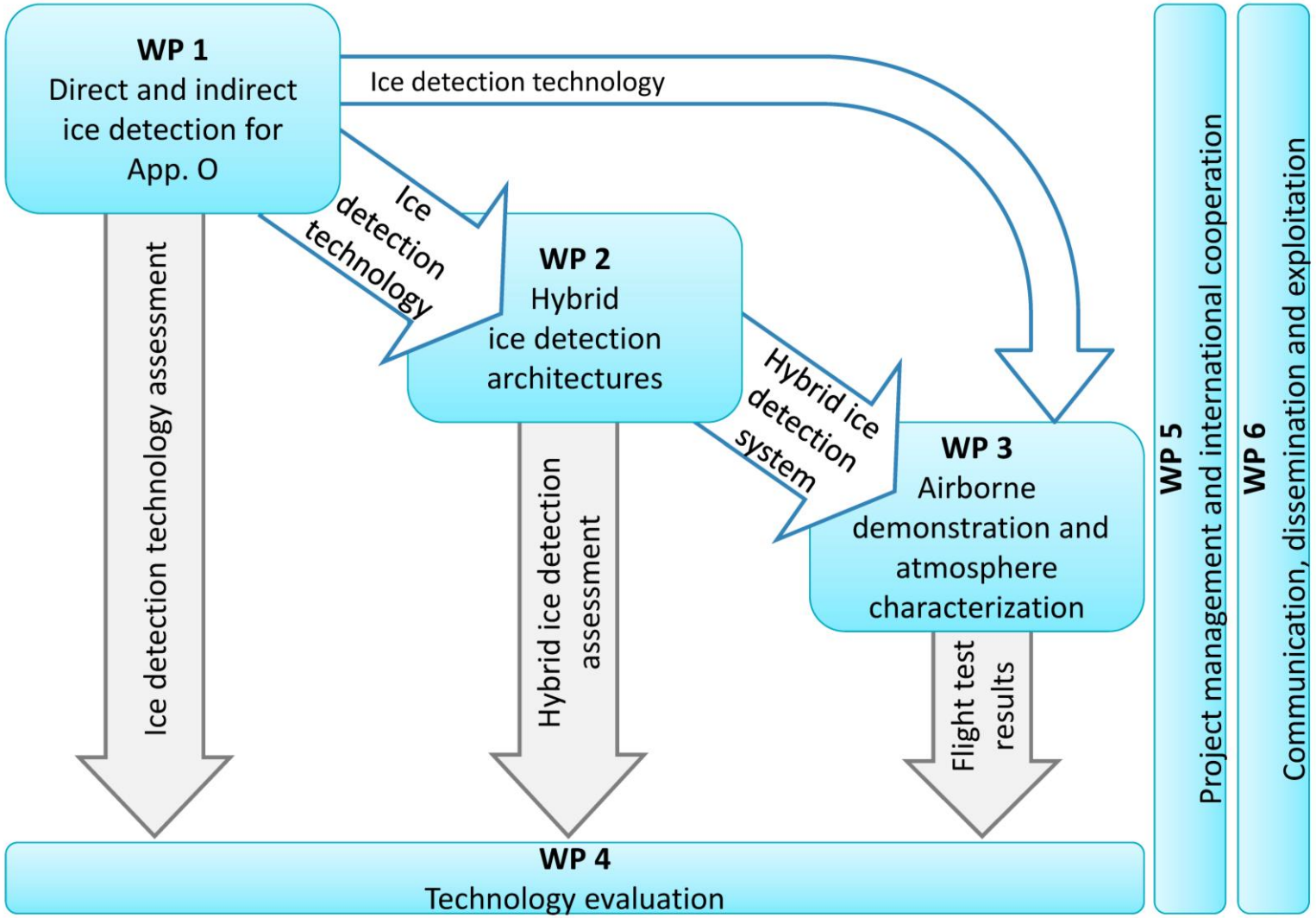
Layered Approach on Ice Detection

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



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

Technical Work Packages interrelation

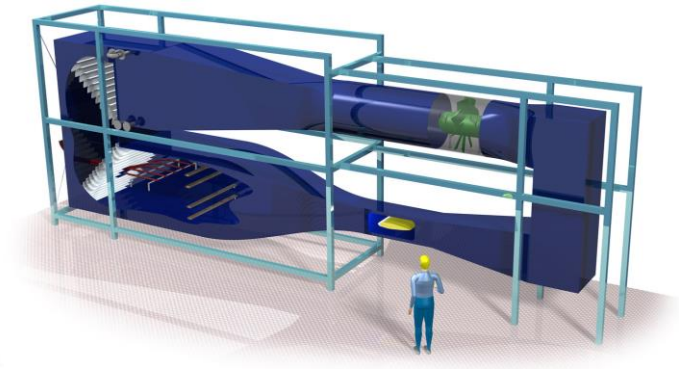


WP1: Direct and indirect ice detection for App. O
High Level Objectives

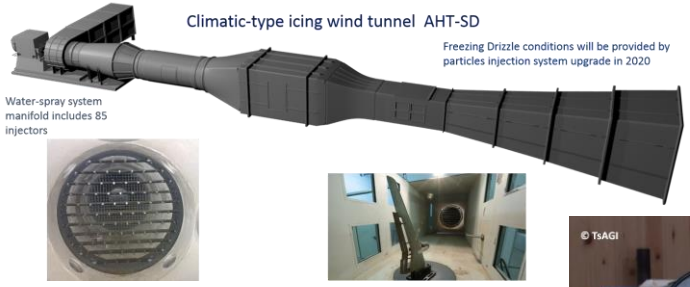
Main Objective: Develop technologies capable of detecting App. O icing conditions using a three-pronged approach:

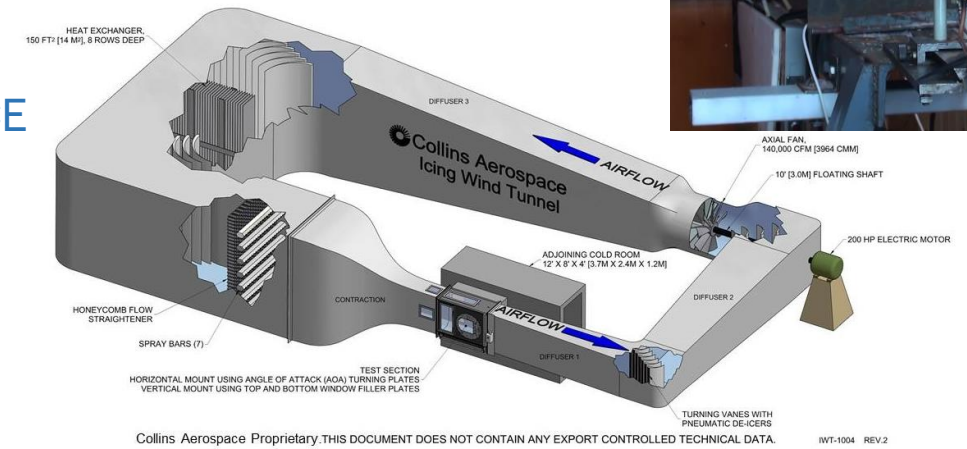
- Direct detection: development of in-situ sensors capable of ice detection
  - 11 technologies under development representing a variety of physical detection principles
  - Evaluation in icing wind tunnel tests under simulated App. O conditions – three tunnels/ total of 26 weeks testing time
  - Two stage evaluation/ selection process to ensure most promising sensors advance to flight test (WP3)
- Indirect detection: utilizing existing sensor information and aircraft performance reference data for early detection of airframe icing
- Remote detection: development of methods to detect App. O 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. O conditions
  - Polarimetric weather radar: development of algorithms to classify icing threats and identify App. O conditions

SENS4ICE research facilities: Icing wind tunnels

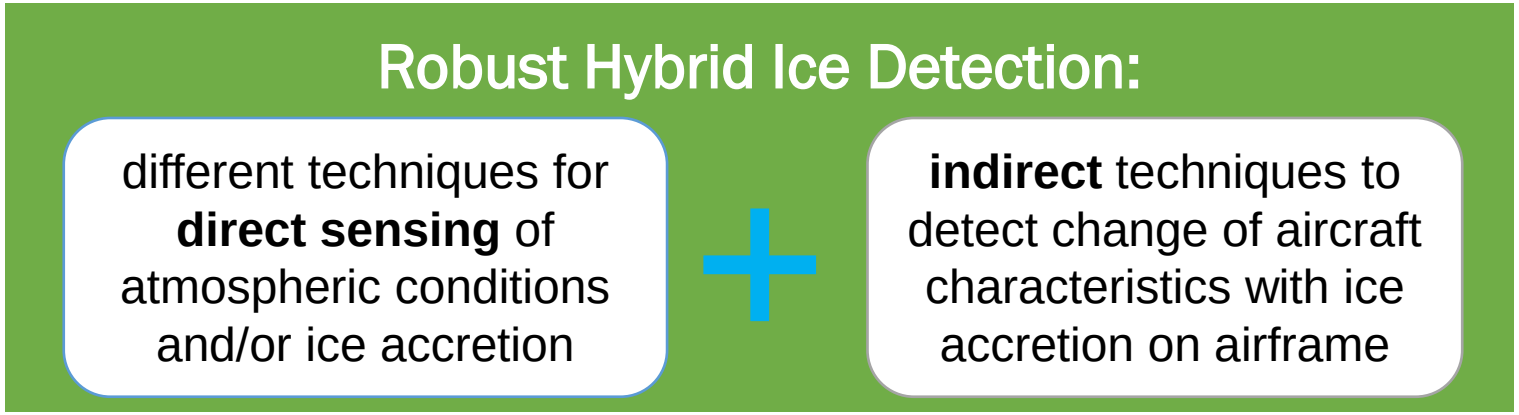


- TU Braunschweig
  - IWT:
    SLD capabilities available and enhanced during SENS4ICE
- TsAGI
  - AHT SD:
    SLD capabilities developed during SENS4ICE
  - EU-1:
    SLD capabilities developed during SENS4ICE
- UTAS Goodrich
  - IWT facilities:
    SLD capabilities available and enhanced during SENS4ICE
- total testing time: 26 weeks
- planned time frame: NOV 2020 – MAR 2021





WP2: Hybrid Ice Detection



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 (+TRL5 review)

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

Hybrid Ice Detection: Development Workflow

WP1: Direct & indirect ice detection

selected direct sensors

WP1 sensor requirements

Icing Wind Tunnel Tests

Laboratory Tests

Hybrid high-level specifications

Certifiability demonstration

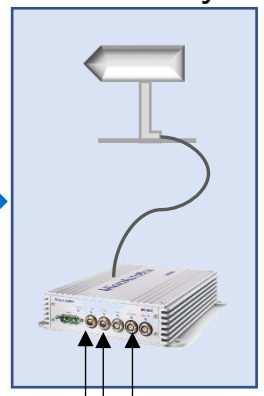
WP2: Hybrid Ice Detection Development

Hybrid demonstrator model

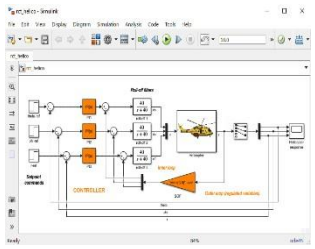
Direct detection

Indirect detection

Hybrid demonstrator assembly



aircraft sensors



Modelling/ Simulation

WP3: Airborne demonstration

Flight Test

WP3: Airborne demonstration and atmosphere characterization

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”
- Characterization of atmosphere from flight test campaigns in App. O conditions

Guidance by special Flight Test Committee (FTC) formed by platform providers and leaders of WP1, WP2 and WP4 to ensure harmonized 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

SAFIRE ATR-42

Copyright © SAFIRE/JC Canonici

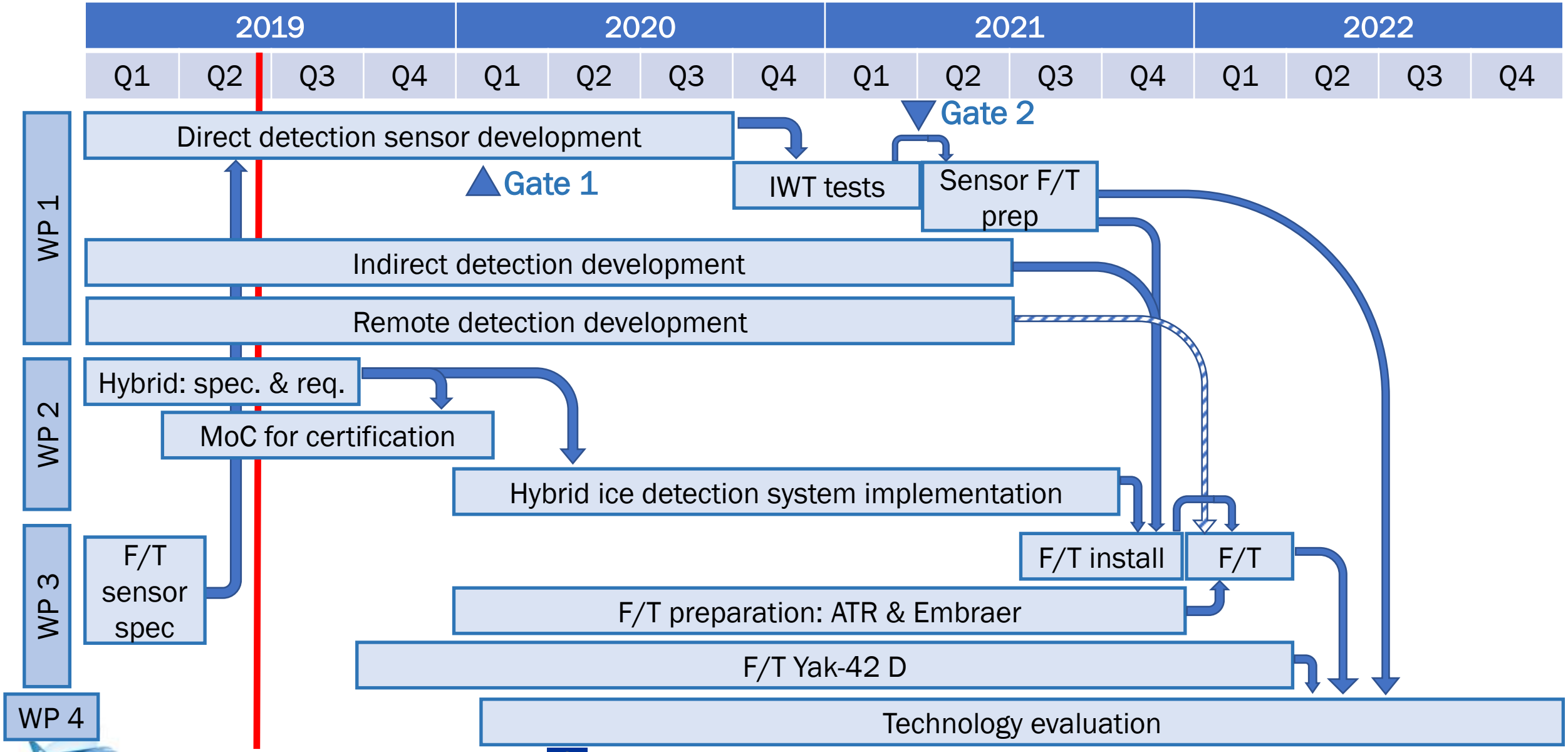
Embraer Phenom 300

Copyright © Embraer

CAO Yak-42D Roshydromet

Copyright © TsAGI / CAO

SENS4ICE Timescale (simplified Gantt)



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

https://www.sens4ice-project.eu

SENS4ICE