Detector óptico de crecimiento y formación de hielo

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Ice detection: What for?

Wind turbine blades

- Powering off the turbine on time

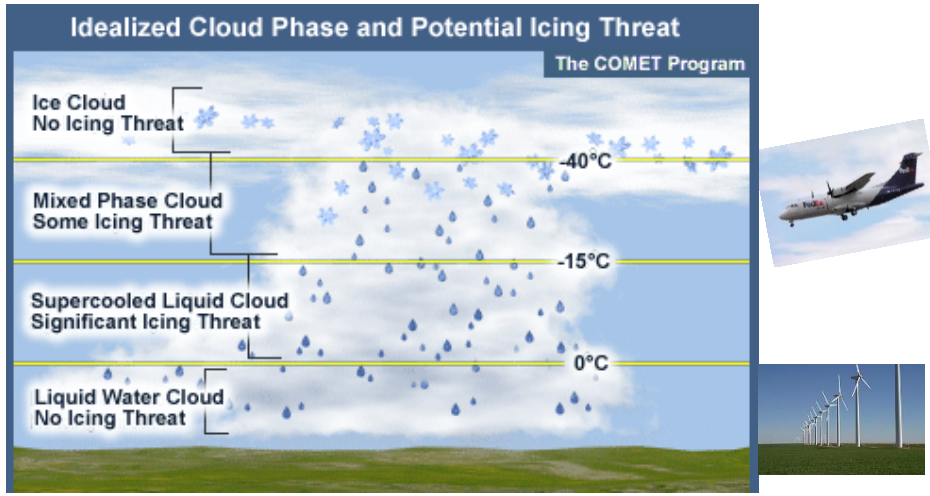
Electric power lines

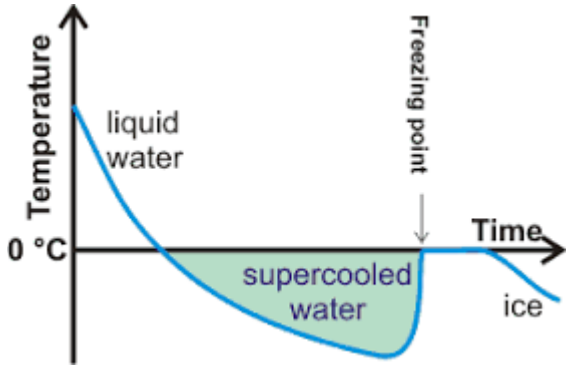
- De-icing or power shut off

Aircraft

- Switch on de-icing system
- Leave the actual flight path

Why ice is formed on aircraft wing, power line and …





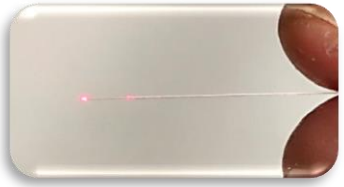
https://www.weather.gov/source/zhu/ZHU_Training_Page/icing_stuff/icing/icing.htm

Water can be liquid at -20ºC and deeper !!!

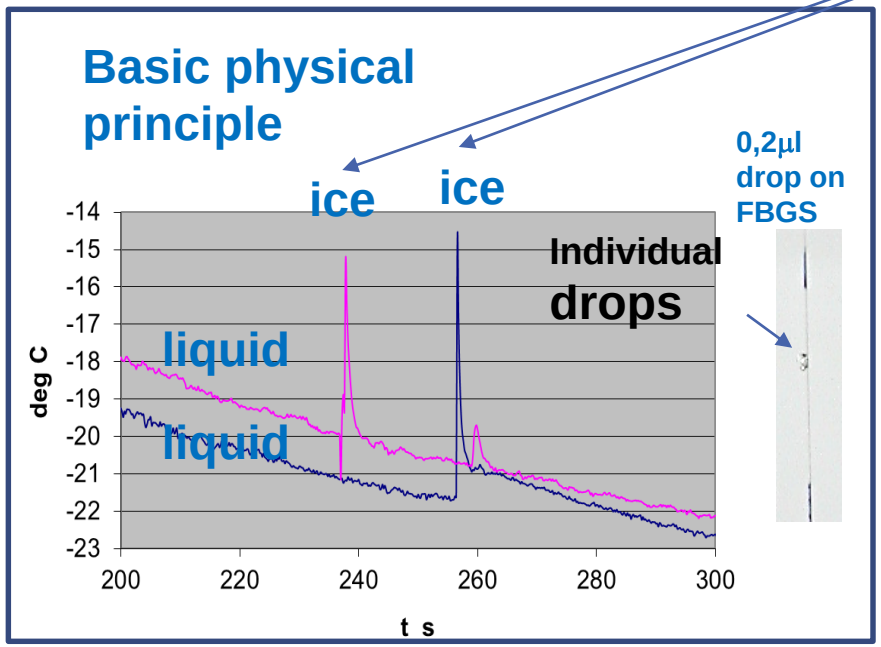
Causing:

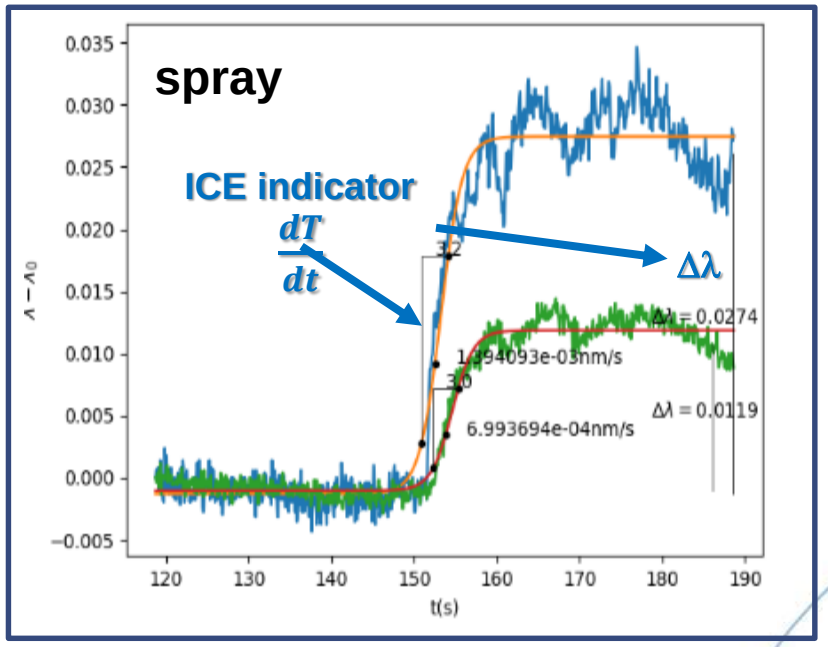
Freezing Rain, freezing drizzle in flight and on ground

INTA Ice detection: FOD



- **Basic physical principle:**
  - Fiber optic Bragg grating sensors (FBGS)_ **Energy release** due to liquid/ solid transformation





INTA Ice detector prototypes

Aerodynamic profile detector

- Detects ice accretion
- Evaluates LWC, **MVD,** ACR

Flat detector

- Detects ice accretion
- LWC, ACR

Metallic Tube detector

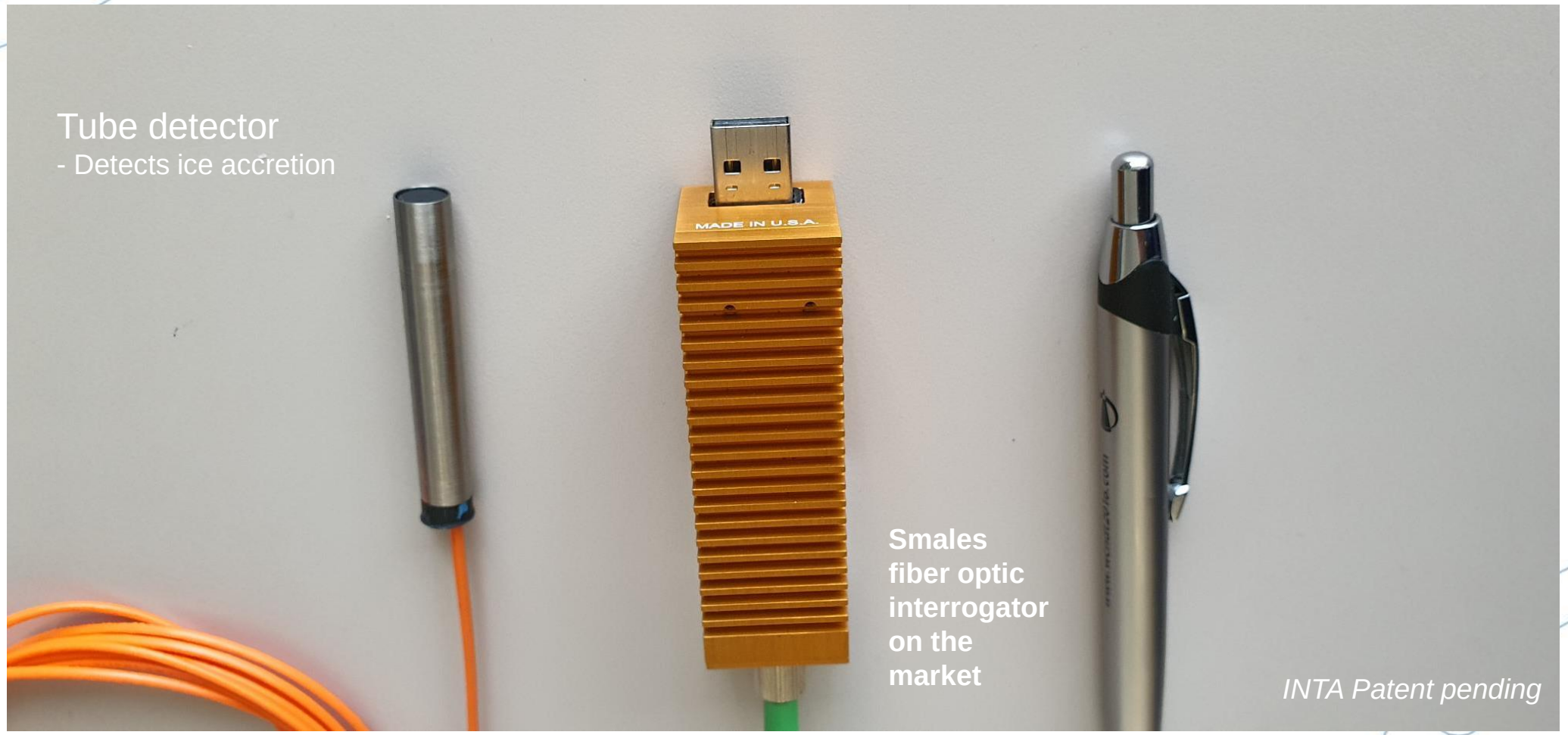
- Detects ice accretion
- LWC, ACR

Polymeric Tube detector

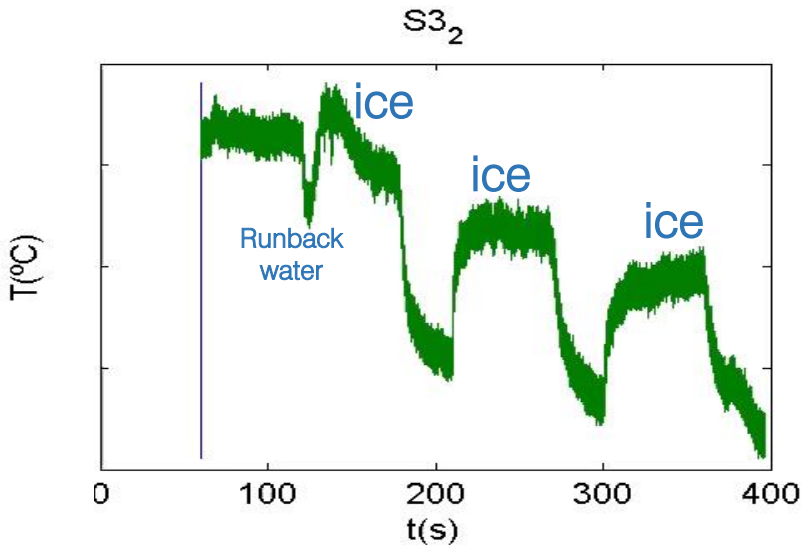
- Detects ice accretion
- Applicable where EMC is an issue
- Evaluates LWC, ice accretion rate (ACR)

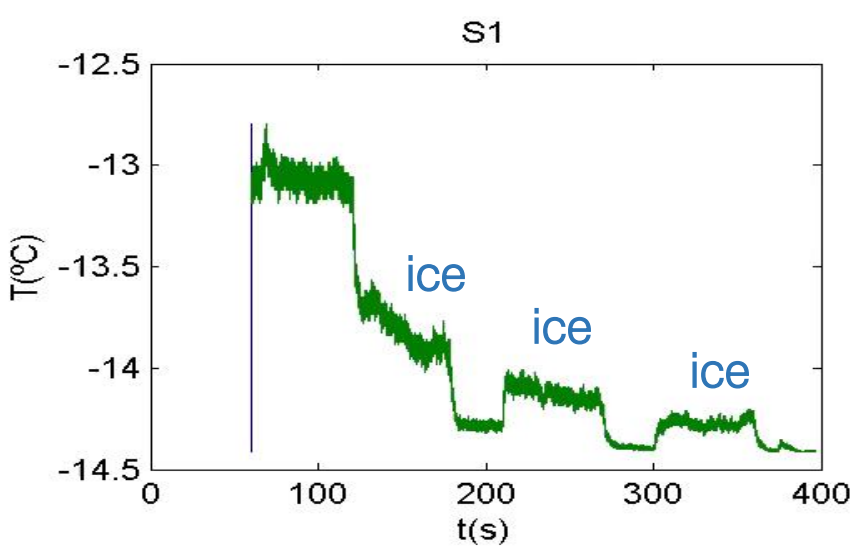
INTA Patent pending

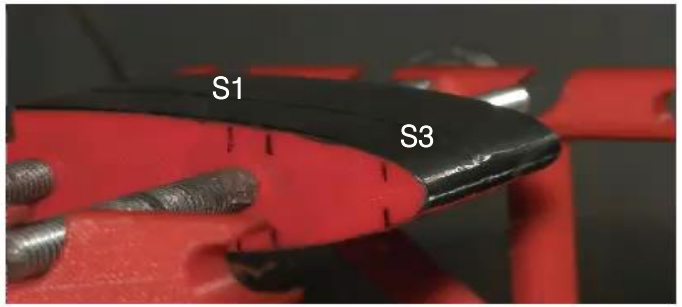
INTA Ice detector prototypes



Test case: MVD= 20 microns, LWC=0,55g/m3







INTA Ice detection

Icing conditions tested at INTA-IWT

		MVD µ	LWC g/m3	T ºC	V m/s	Detected	Differentiatable between App. C and App. O
App. C	Tubes_C1	20	0.25	- 18	50	✔	NA
	Tubes_C2	20	0.42	- 10	50	✔	NA
	Tubes_C3	20	0.55	- 5	50	✔	NA
	NGPDA_C4	20	0.25	- 5	70	✔	✔
	NACA0012_C4	20	0.25	- 7	70	✔	✔
App. O	NGPDA_O1	27	0.26	- 5	70	✔	✔
	NGPDA_O2	64	0.18	- 5	70	✔	✔
	NACA0012_O1	27	0.26	- 7	70	✔	✔
	NACA0012_O2	64	0.18	- 7	70	✔	✔

Icing conditions tested at NRC-IWT

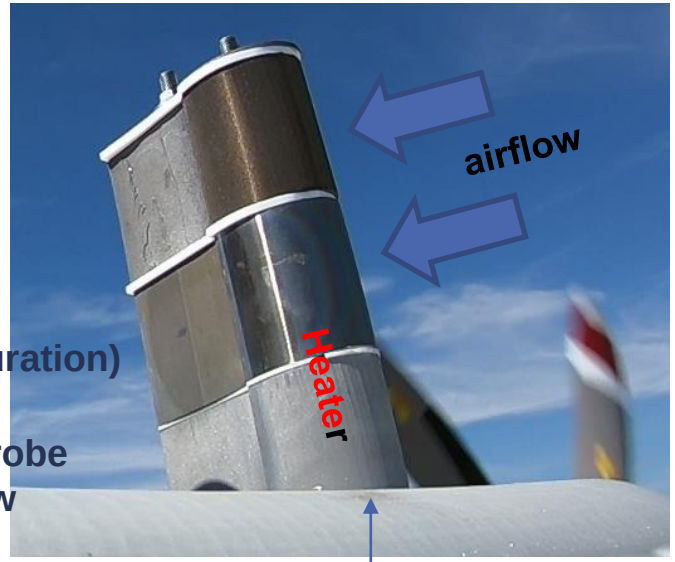
		MVD µ	LWC g/m3	T ºC	V m/s	Detected	Detection time [s]	Permited detection time [s]	Differentiatable between App. C and App. O
App. C	NACA0012	23	0.34	- 10	85	✔	10	23	✔
		30	0.11	- 20	"	✔	21	33	✔
		35	0.05	- 30	"	✔	3	72	✔
		23	1,3	- 20	"	✔	3	3	✔
		20	0.5	- 10	"	✔	3	8	✔
App. O		106	0.4	- 20	80	✔	3	9	✔
		110	0.18	- 25	85	✔	3	18	✔
		110	0.22	- 15	"	✔	3	15	✔
		220	0.25	- 10	"	✔	3	13	✔

INTA Ice detection: Flight test

Optional second sensor probe

First sensor probe (SENS4ICE configuration)

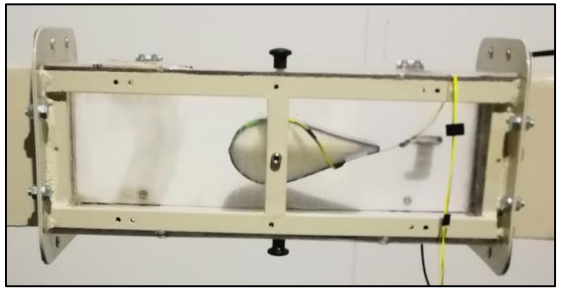
Spacer to lift the probe into the free air flow



- **Sensor configuration from flight tests at INTA in C212 aircraft**

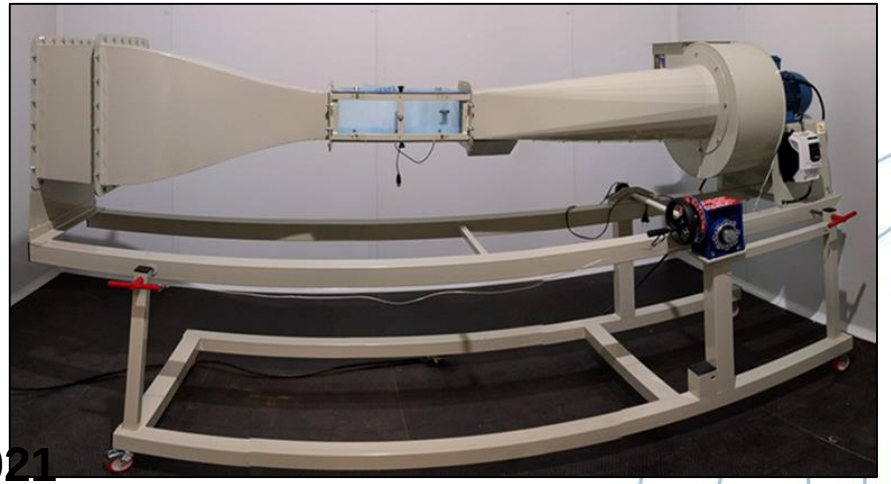
INTA Icing Wind Tunnel

- **Actual Experimental conditions:**
  - **Mean droplet size: 10- 65 µm (improvable)**
  - **liquid water content (LWC): 0,15 - 2 g/m3**
  - **temperature: RT to -25ºC**
  - **wind speed: typically 40-70 m/s**
  - **testing section: 150 x 150 mm**



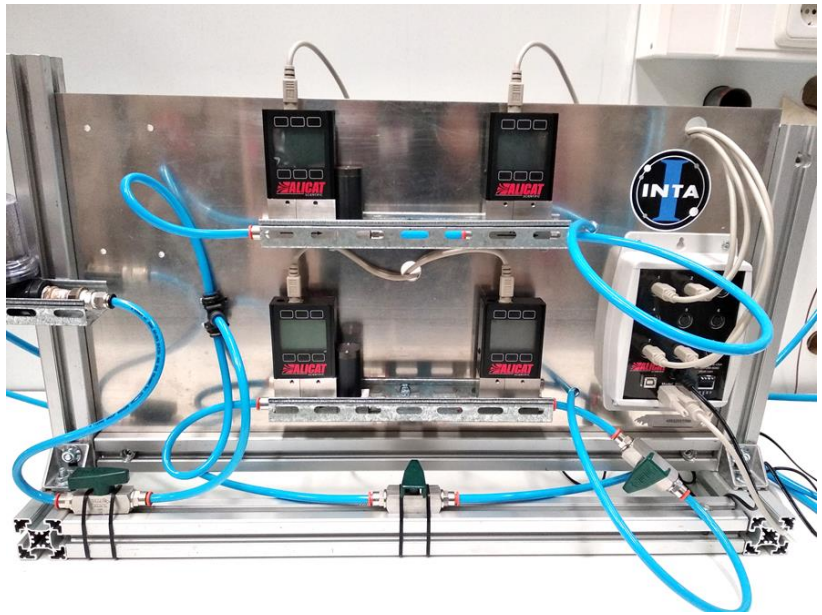
testing area

INTA open IWT in climatic chamber

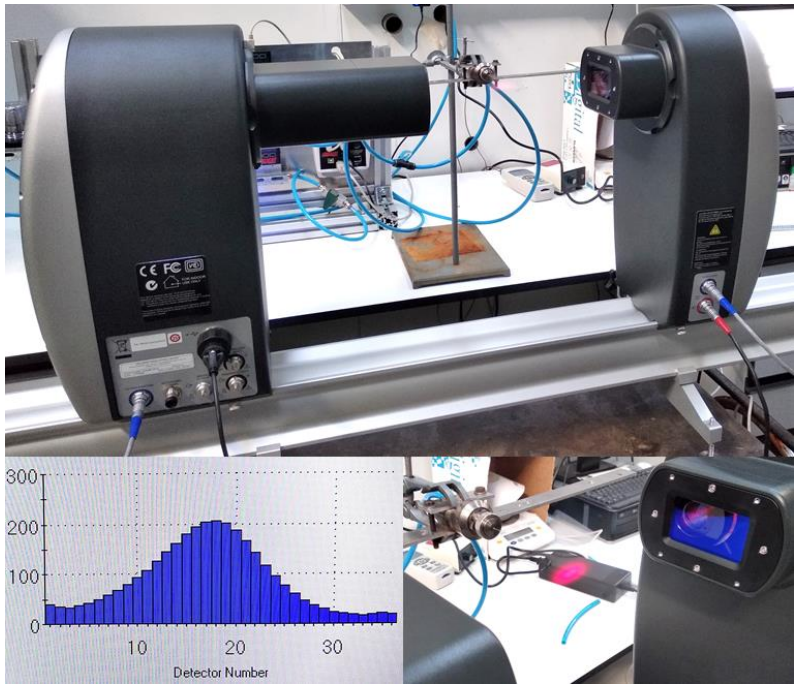


INTA Ice detection: FOD

- New mass flow controllers (low regime), to match low LWC with high MVD (>50 μm): **CONDITIONS IN STUDY**



New mass flow controllers



Malvern spraytec system

SENS4ICE

SENSORS AND CERTIFIABLE HYBRID ARCHITECTURES
FOR SAFER AVIATION IN ICING ENVIRONMENT

Public Project Overview

april2021

Malte Frövel and Miguel Gonzalez, INTA

Transfiere, Malaga , 14-15 of April 2021

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

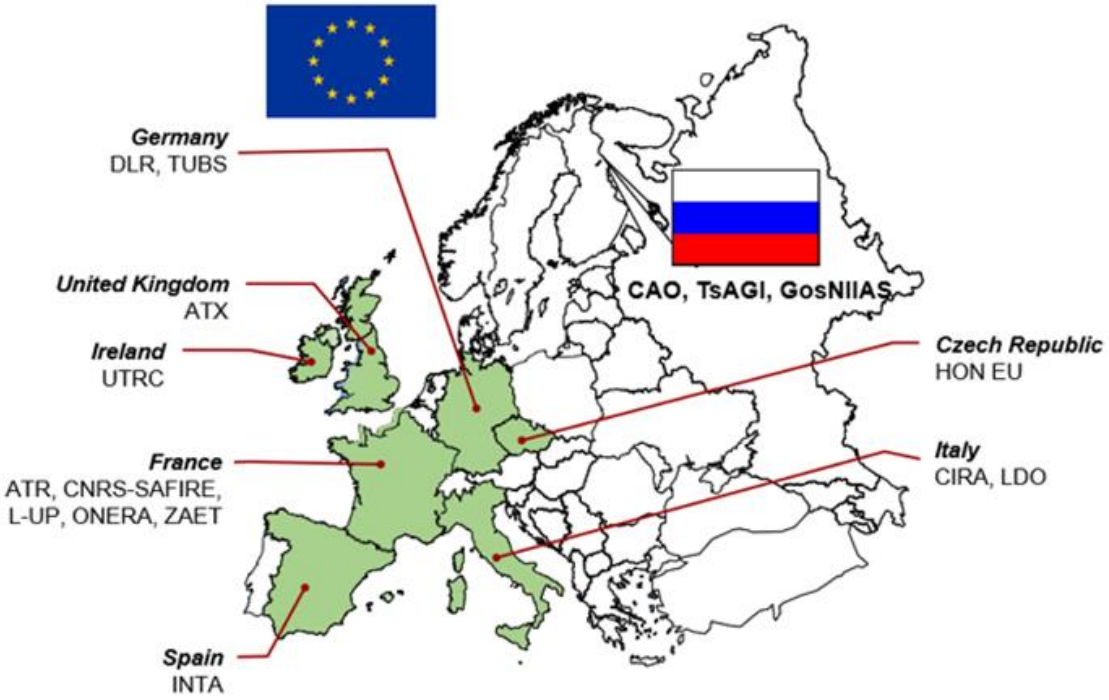
SENS4ICE Project Overview
SENSors and certifiable hybrid architectures for safer aviation in ICing Environment

- 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
19) COLLINS AEROSPACE
20) NATIONAL RESEARCH COUNCIL CANADA

SENS4ICE international collaboration and cooperation



- InCo – international cooperation flagship: Aviation International Cooperation Flagship "Safer and Greener Aviation in a Smaller World"
- 20 project parties (11 countries)
  - 13 European/7 international
  - 9 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

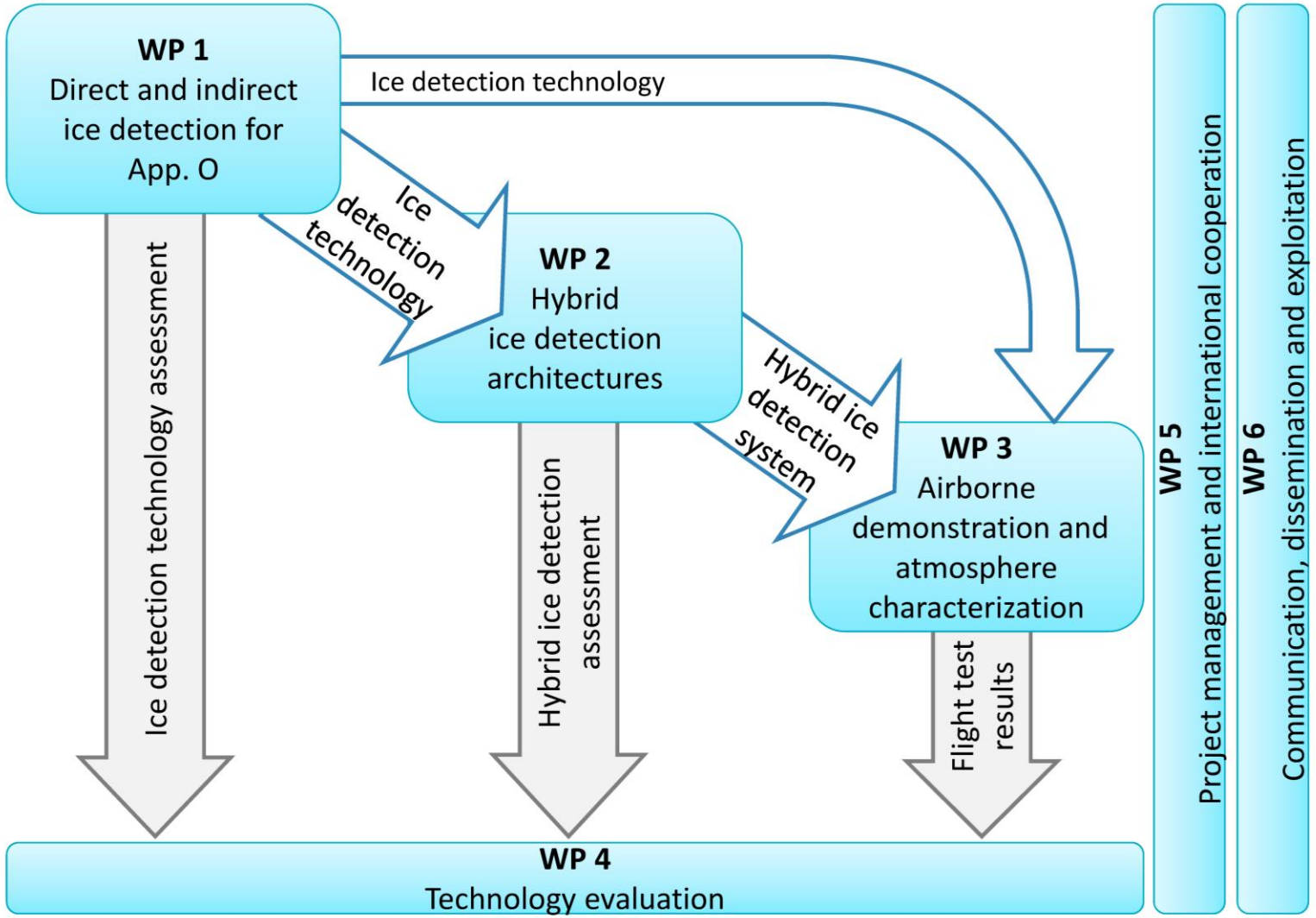
Benefits

- 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

Expected impact

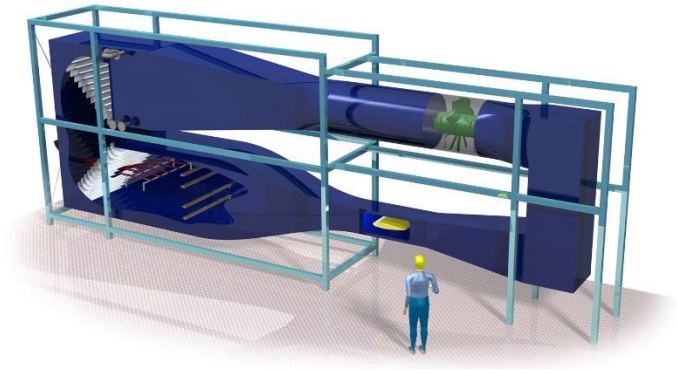
- Contribute to **increased flight safety**
  by fewer accidents and less in-flight events worldwide
- Contribute to **reduce costs** for all stakeholders
  by improved and internationally accepted certification rules, standards and means of compliance, covering all types of icing hazards
- Contribute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

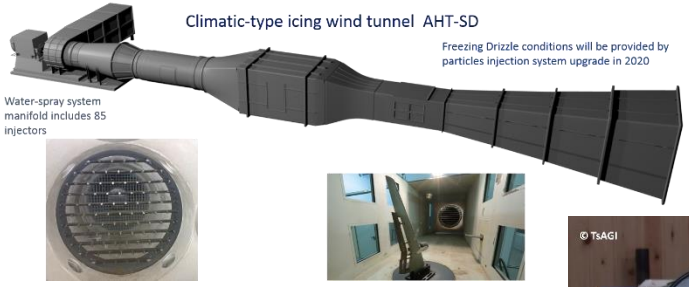
Technical Work Packages interrelation

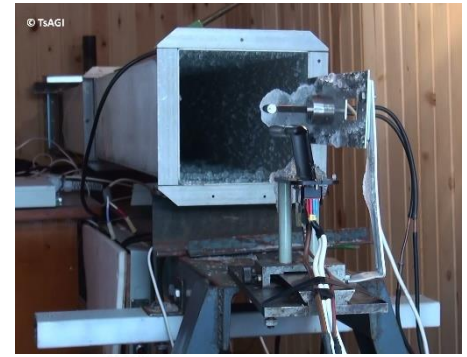


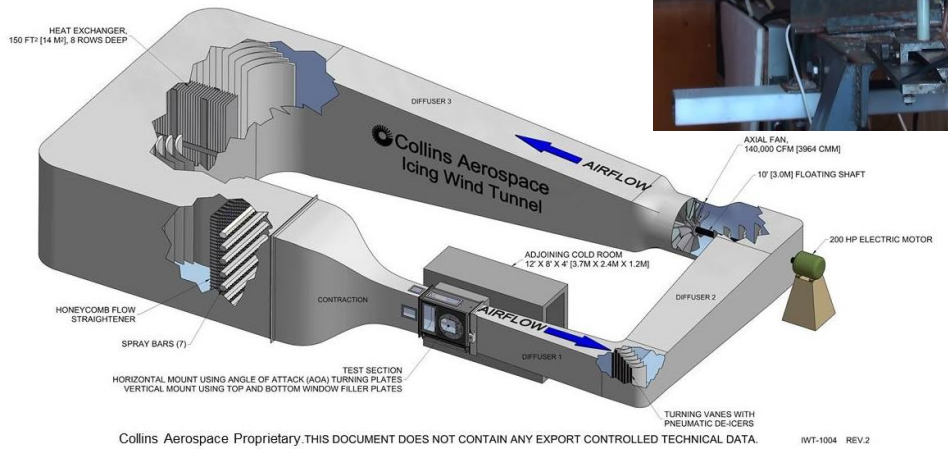
SENS4ICE research facilities: Icing Wind Tunnels

- 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*









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

Copyright © Embraer

CAO Yak-42D Roshydromet

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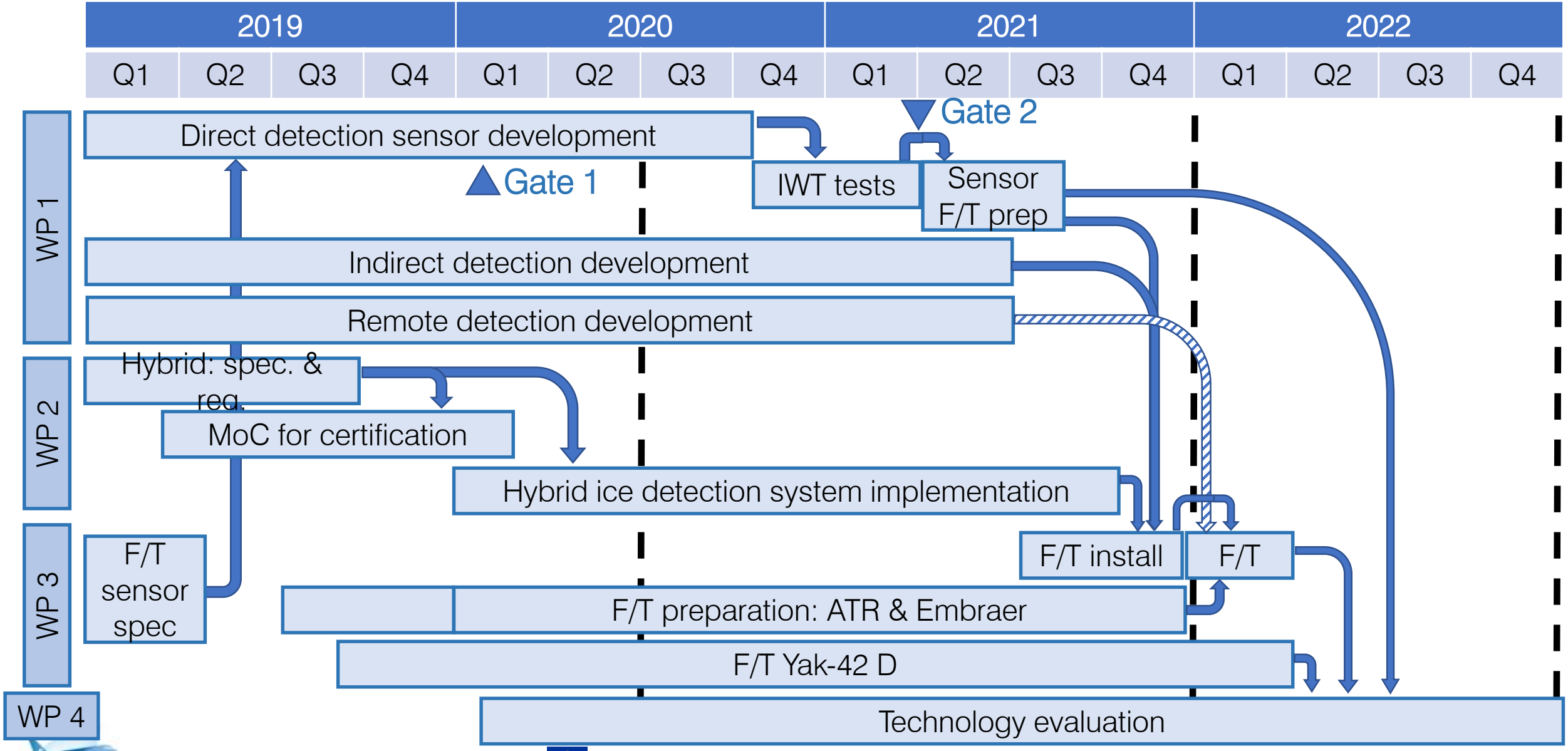
SENS4ICE Timescale (simplified Gantt)



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Muchas gracias por su atención

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