SENS4ICE

SENSORS AND CERTIFIABLE HYBRID ARCHITECTURES
FOR SAFER AVIATION IN ICING ENVIRONMENT

SAFRAN ICE DETECTOR PFIDS

FINAL DISSEMINATION EVENT OF SENS4ICE PROJECT

Stéphane LE GARREC - SAFRAN AEROSYSTEMS

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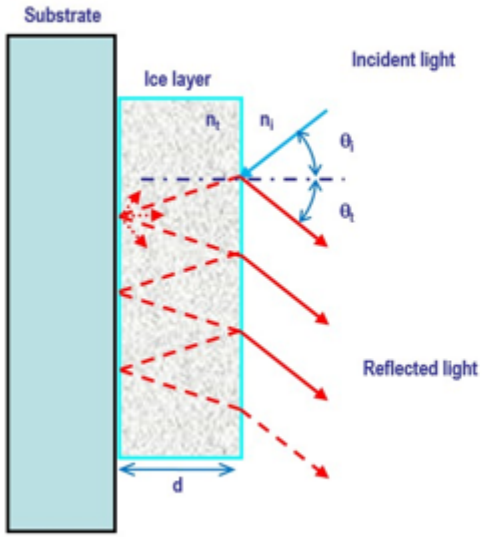
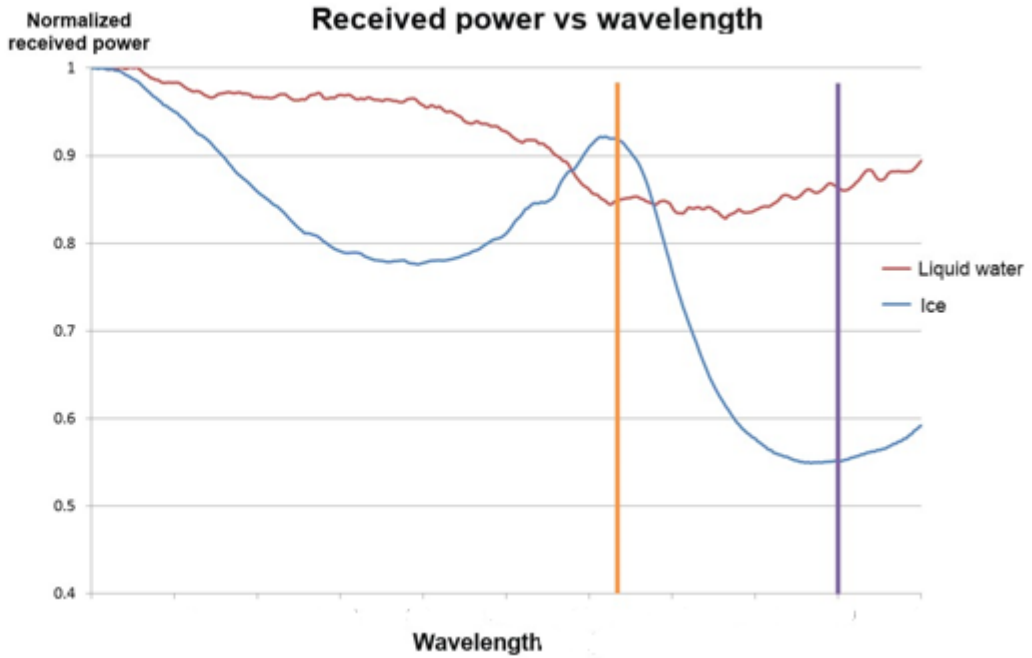
PFIDS– Primary in Flight Ice Detection Systems
SAFRAN AEROSYSTEMS (SAO)

- Detection type: Ice accretion
- Physical principle: Use the optical properties of ice
- It provides:
  - Signal indicating presence of Icing Conditions (App C/O)
  - Signal indicating presence of Ice Crystals (App D/P)
  - IAR, Intensity of encountered Icing Conditions (App C/O)
  - Response time compliant with ED103B
- Two versions:
  - Supplied from 115V AC: 211.2 x101mm / 670g / 500W
  - Supplied from 28VDC: 153.2 x 118mm / 1140g (with harness) / 230W
- Equipment at TRL6 at the beginning of the project
  - Functions of IAR measurements and Ice Crystals Detection TRL3 at project start and TRL5 now
  - Function of discrimination of Supercooled Large Droplet TRL2 at project start and TRL3 now
- Tested in IWT (2015/2019/2022) and Flight tests (2015/2016/2017, 2020 ➔ 2023)

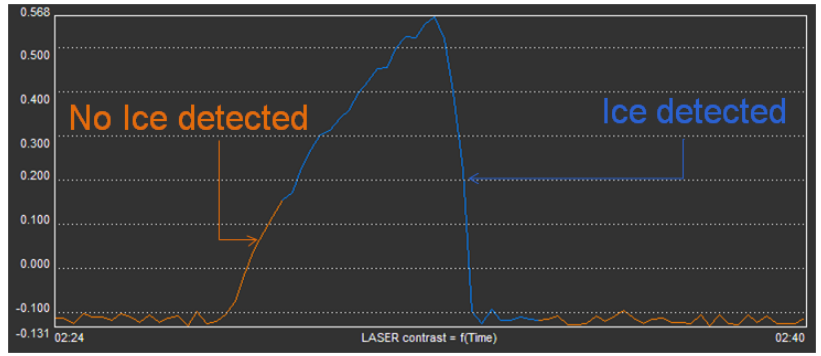
PFIDS– Primary in Flight Ice Detection Systems
SAFRAN AEROSYSTEMS (SAO)

- PFIDS Technology
  - Basic Ice/Icing Conditions Detection Principle
    - Two lasers are emitting on a target at two different wavelengths λ_L and λ_U
    - The detection principle is based on the contrast calculated from the reflected light of the two laser wavelengths from the target area
    - The contrast value depends on the ice thickness





$$C = \frac{R_L - R_U}{R_L + R_U}$$



PFIDS– Primary in Flight Ice Detection Systems
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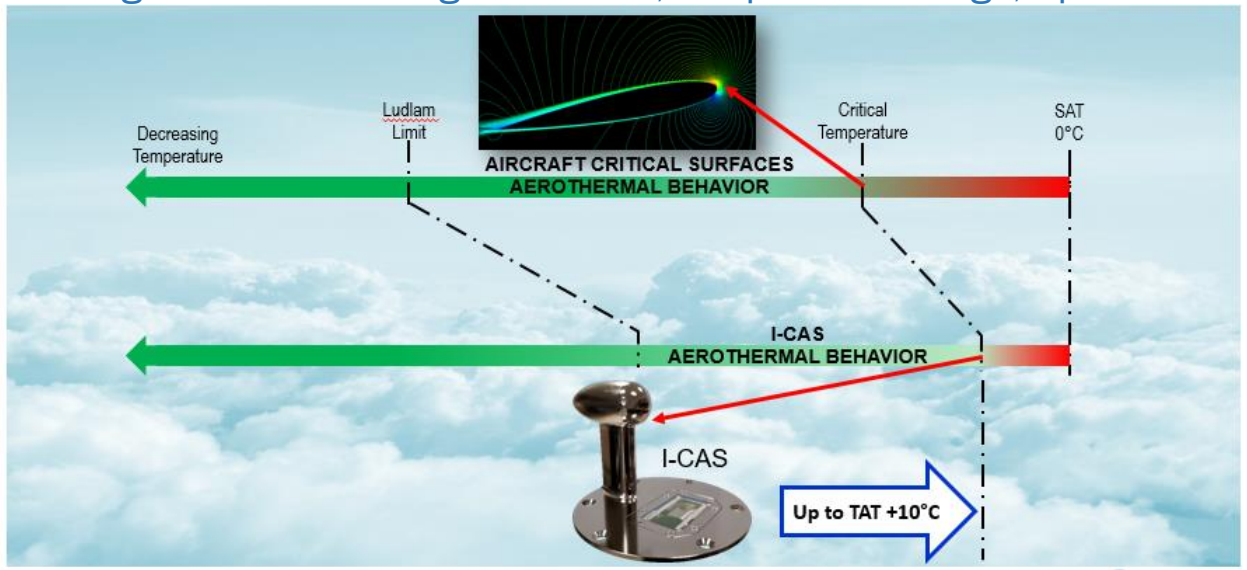
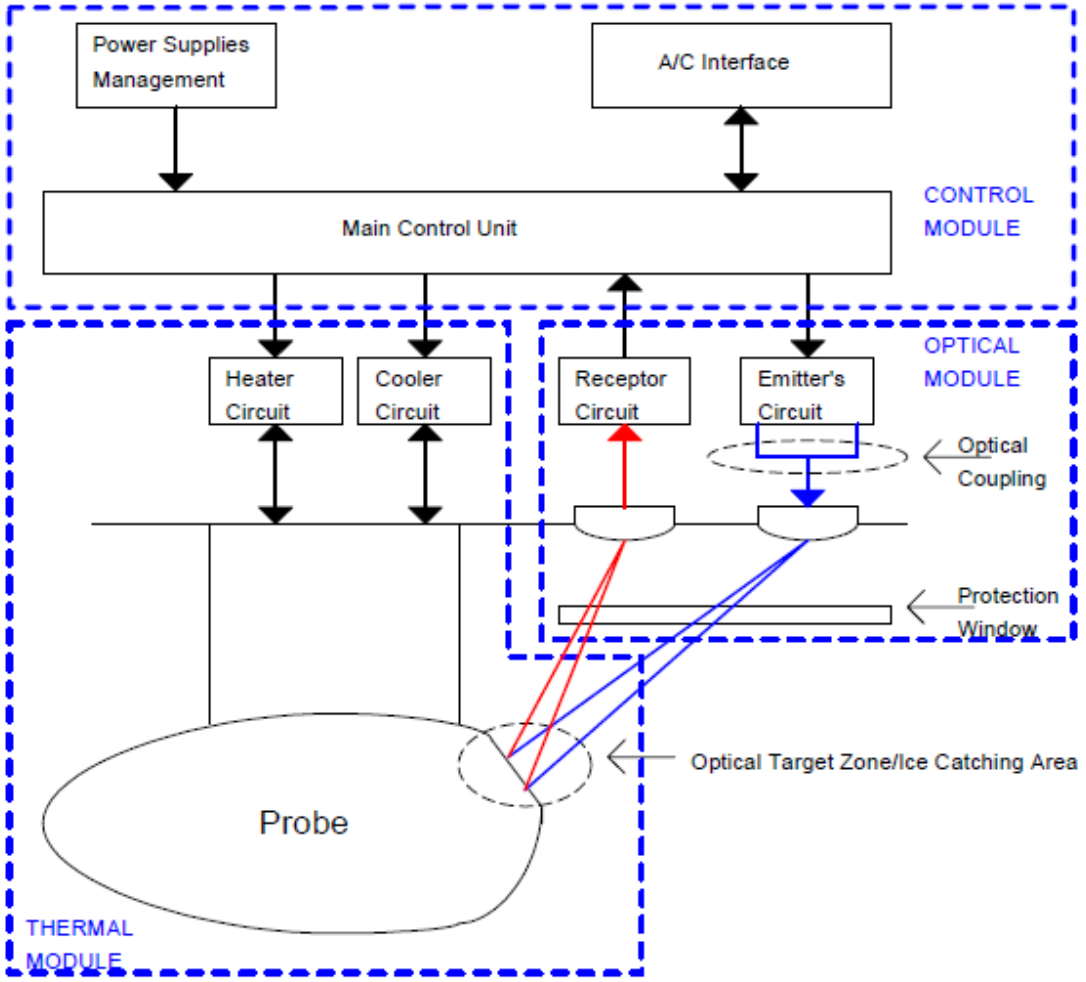
- PFIDS Technology
  - Optical Technology
  - Local Temperature Management
    - Able to compensate the LUDLAM effect (0<Freezing Fraction<1) up to TAT of 10°C
    - Ensuring detection of icing conditions, temperature range, up to SAT=0°C



  - Detect all liquid water drop icing conditions and measure intensity
    - App C/O mixed phase of App D/P

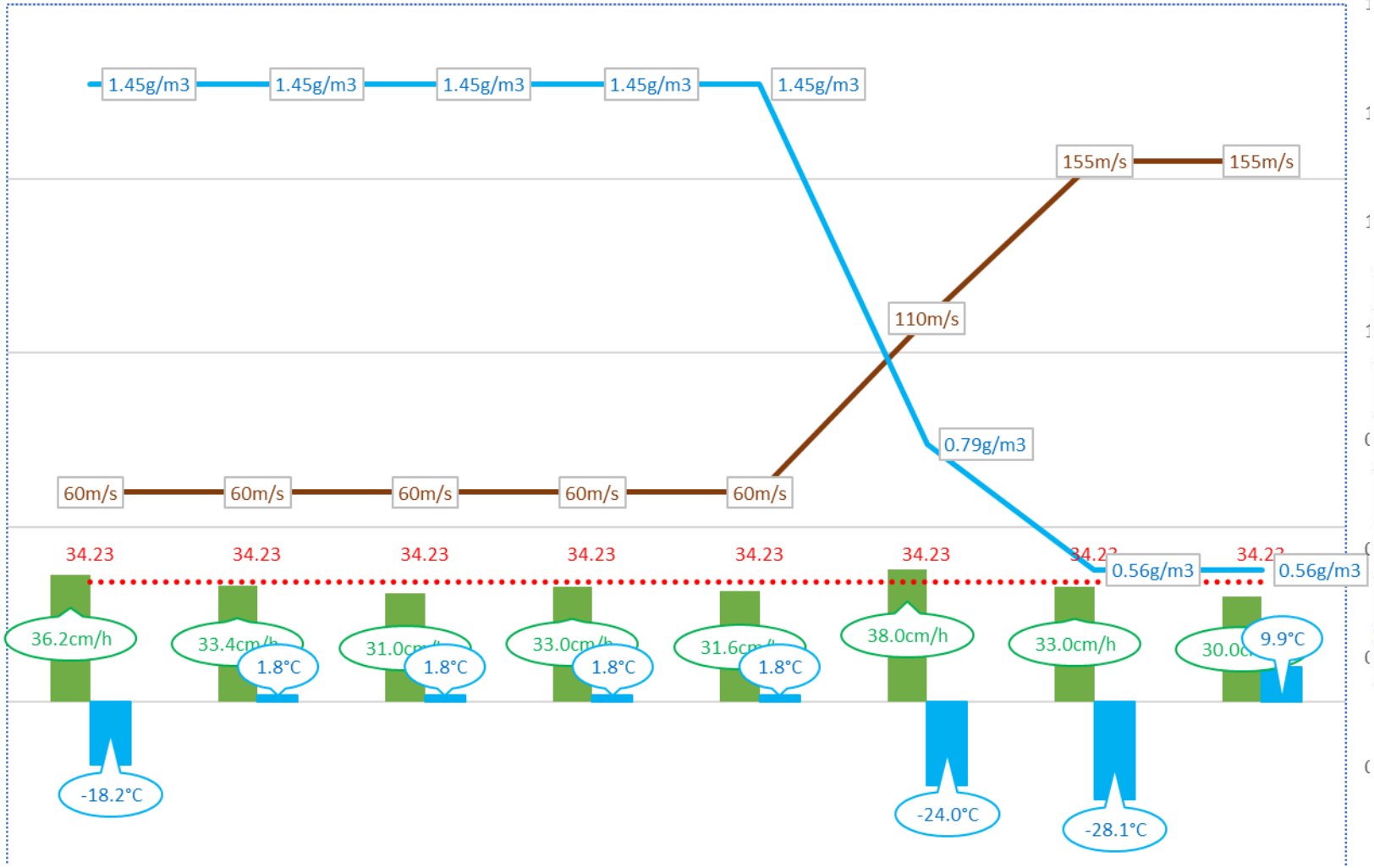
PFIDS– Primary in Flight Ice Detection Systems
SAFRAN AEROSYSTEMS (SAO)

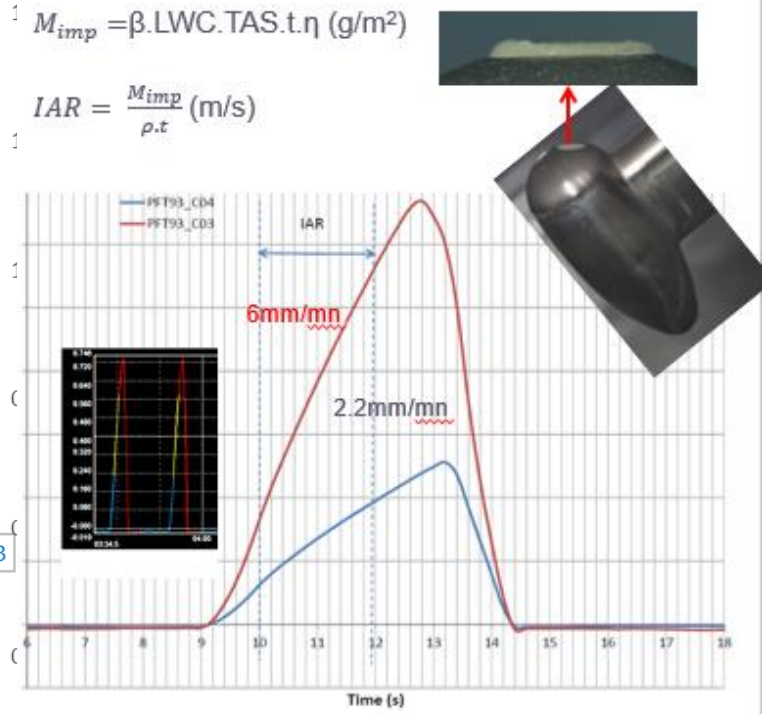
- PFIDS Architecture and Modules
  - Optical
    - Emission / Reception
  - Thermal Management
    - Cooling and heating the target
    - Probe heating for anti icing
    - Window heating
  - Control Module
    - Main control Unit
    - Power supply management
    - A/C Interfaces



PFIDS– Primary in Flight Ice Detection Systems

SAFRAN AEROSYSTEMS (SAO)



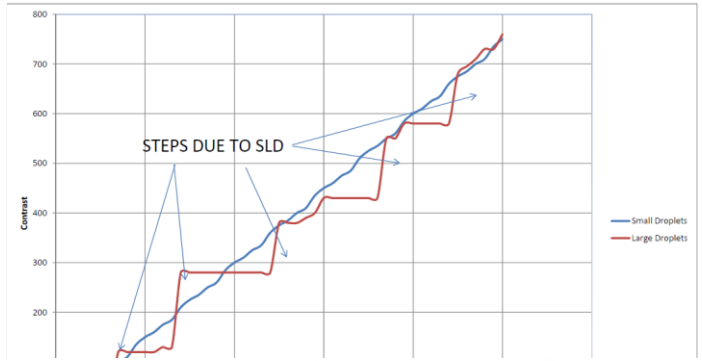


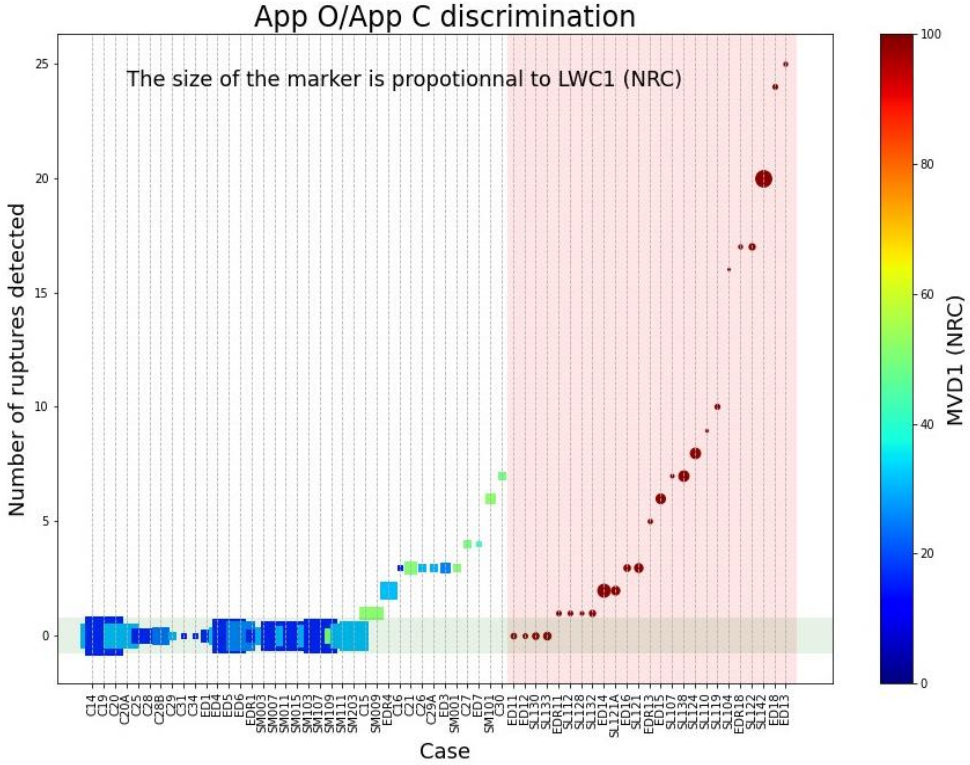
PFIDS– Primary in Flight Ice Detection Systems
SAFRAN AEROSYSTEMS (SAO)

- Functions Implemented in PFIDS
  - Detection of Ice Crystals (Xtals)
    - Function implemented and tested/verified (TRL5)
      - In IWT
      - On data recorded during flight tests (HAIC)
      - No discrimination between pure ice crystals and mixed phase

PFIDS– Primary in Flight Ice Detection Systems
SAFRAN AEROSYSTEMS (SAO)

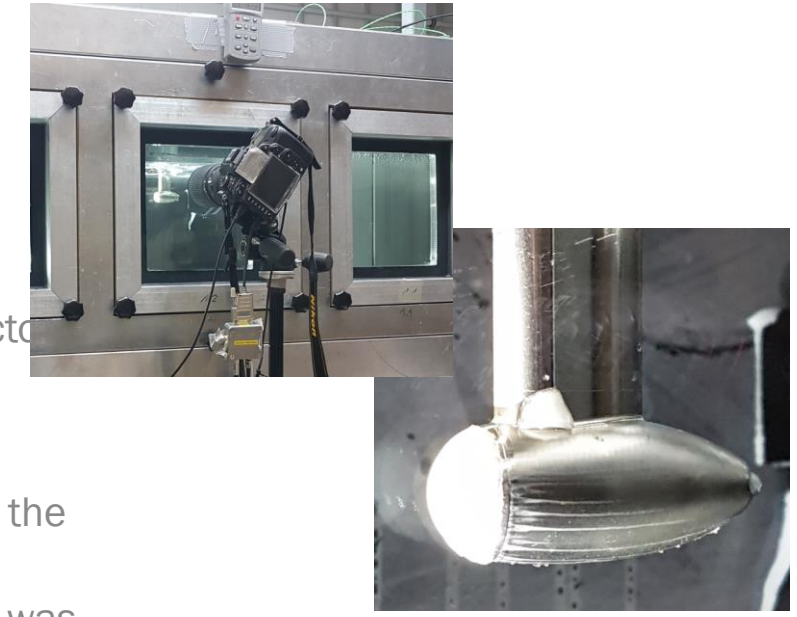
- Functions Implemented in PFIDS
  - Discrimination of Supercooled Large Droplets
    - New certification rules linked to droplets with diameter above 100µm (Appendix O)
      - Extend of ice protection surfaces
      - Detect and exit scenario
    - Use Ice Accretion Rate Steps to detect SLD
      - A thickness of ice accreted on a surface during a certain amount of time may be due to numerous SD or only one SLD
  - SLD Discrimination: First Results
    - Function evaluated in IWT
    - First results are promising





Conclusions and Outlook

- The SENS4ICE project enabled SAO to:
  - Perform first evaluations in IWT of the function of SLD discrimination
  - Perform flight tests and get data to be analysed
  - Demonstrate that PFIDS was a good candidate to be used as direct ice detecto HIDS
- Next step in future programs would consist in:
  - For IAR function understand better aircraft manufacturer needs and improve the measurement, particularly at SAT close to 0°C
  - For SLD discrimination function, only a small part of the App O, mainly FZDZ, was tested during IWT and Flight test campaigns. Due to lack of IWT and simulation capabilities, covering the whole App O, (FZDZ + FZRA), is still a big challenge. Additional flight tests chasing FZRA conditions are necessary to further mature the function in the whole App O domain"
- The different studies using PFIDS technology and performed in different programs allowed the filling of three patents:
  - Device and method for detecting ice deposited on an aircraft structure (US8704181 B2)
  - Method for detecting the presence of ice crystals in an environment (EP3489145 B1)
  - Device for detecting frosting intensity for an aircraft in flight (EP4188801 A1)



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If not acknowledged, images courtesy of the consortium partners.

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