

**MUSAF III – Session 2: Icing**  
F.Dezitter, Airbus

**MUSAF III**  
**27-29 September 2016**  
**Toulouse**

**Airbus Icing Simulation Capability  
& Perspectives**

# Airbus Icing Simulation Capability & Perspectives

## Content

- **Context**
- **Icing Simulation Capabilities**
- **Conclusion**

# Airbus Icing Simulation Capability & Perspectives

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- **Context**
- *Icing Simulation Capabilities*
- *Conclusion*

# Airbus Icing Simulation Capability & Perspectives Context

- Current Ice & Protection Functions

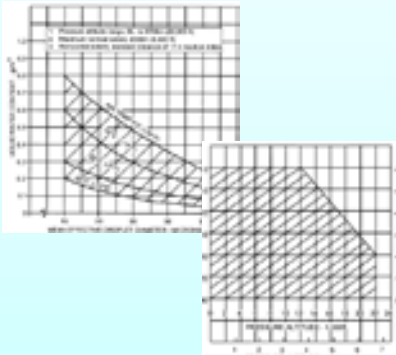
Wing (Slats 3 4 5) **Handling Quality** protection: bleed anti-ice

ATA30 cockpit systems  
Probes protection  
Advisory Ice Detection System



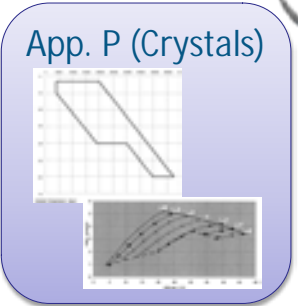
Nacelle inlet cowl **Foreign Object Damage** protection: bleed anti-ice

App. C



# Airbus Icing Simulation Capability & Perspectives Context

- Future A/C Ice & Protection Functions



HTP/VTP  
**Handling Quality (HQ)**  
 protection TBC

Pylon & Nacelle  
**FOD** protection

Inboard Wing  
 Engine **Foreign Object Damage** protection TBC

Outboard Wing  
**Handling Quality** protection

ATA30 Cockpit systems  
 Probes protection  
 Primary detection system  
 Weather on-board

Radome ice shedding



# Airbus Icing Simulation Capability & Perspectives

## Context

- Evolution of **icing regulation** (SLD, Glaciated & mixed phase icing conditions,...)
  - Development and integration of **new and disruptive technologies** (eWIPS, PFIDS,...) to enable new A/C configuration, bleedless A/C,...
  - Development and validation of **capabilities** to support technologies development, integration and certification (Test facilities, M&T, processes,...)
  - Improvement of **A/C operations** through availability of enhanced weather information
  - Continuous development and securisation of **icing expertise** in Europe
- ...While maintaining the highest level of **safety**

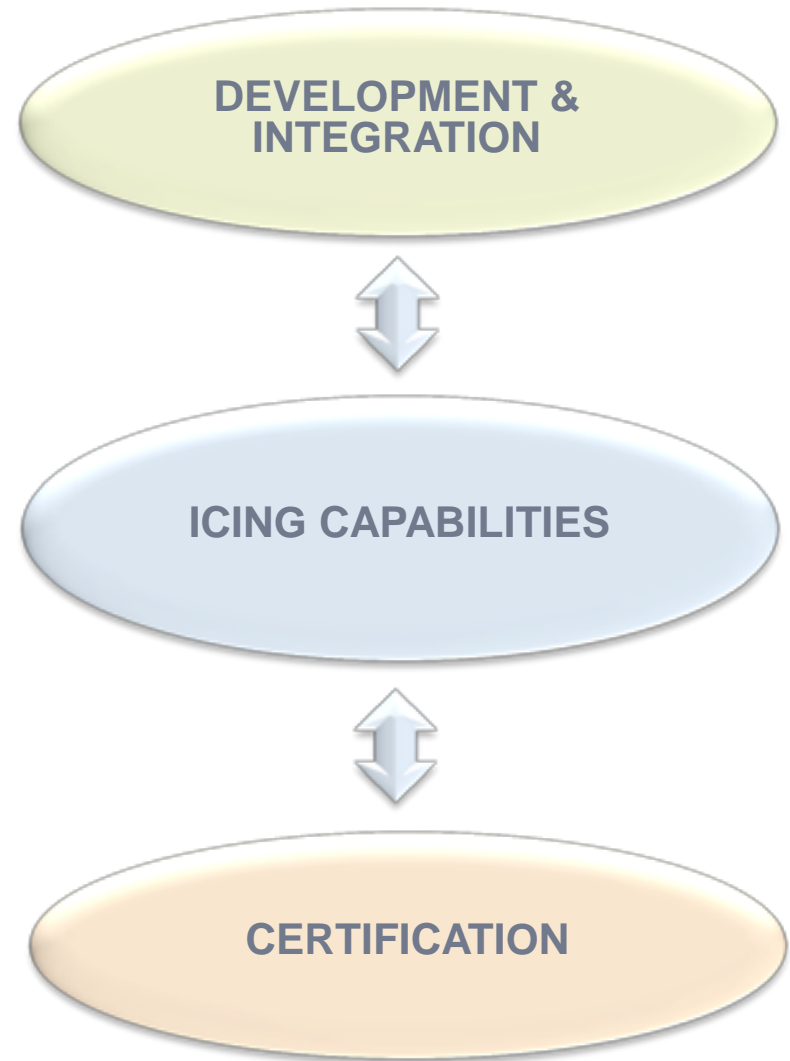
# Airbus Icing Simulation Capability & Perspectives

## Context

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# Airbus Icing Simulation Capability & Perspectives Context

- On time and in quality availability of **validated capabilities** is key to support
  - **Development** of new A/C products
    - New features to support sizing and integration of new technologies
    - Develop trade capability
    - Reduce cost thanks to less tests
    - Improve efficiency thanks to lead time reduction
  - **Certification** of new A/C products
    - Availability of Means of Compliance (MoC) to deal with new regulation (e.g. SLD, Ice Crystals,...)





# Airbus Icing Simulation Capability & Perspectives

## Content

- *Context*
- **Icing Simulation Capabilities**
  - **Computational Fluid Dynamics (CFD)**
  - **Ice Accretion**
  - **Ice Protection**
- *Conclusion*

# Airbus Icing Simulation Capability & Perspectives

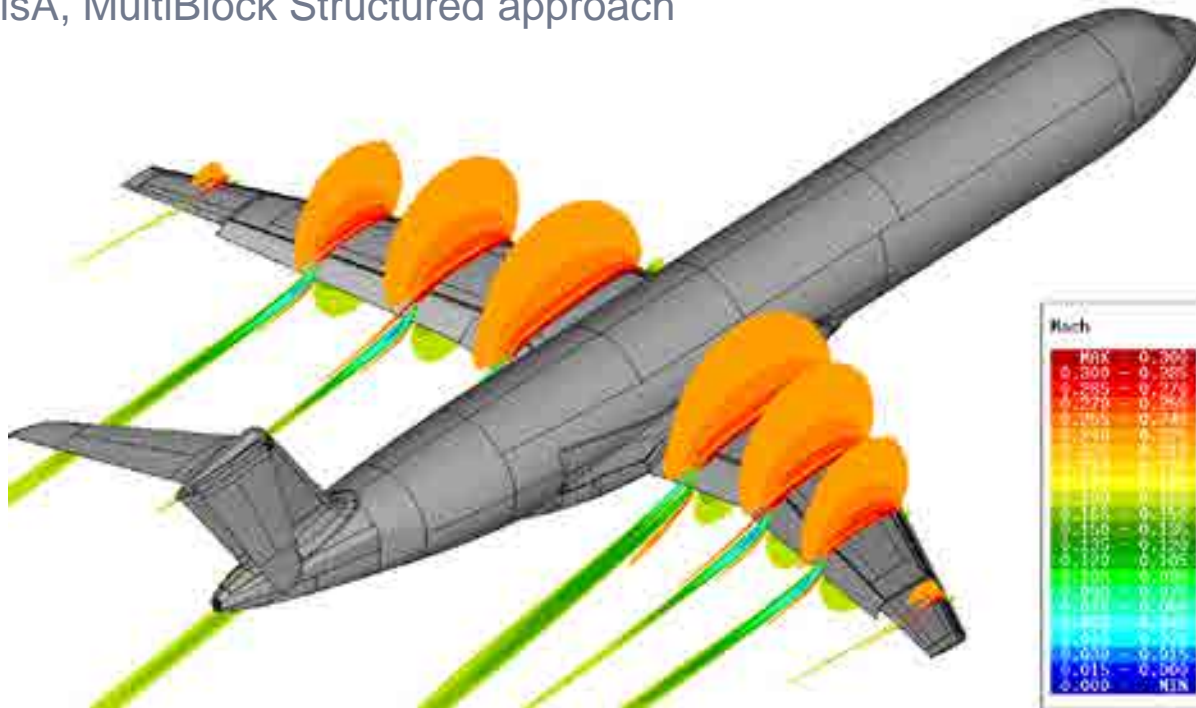
## Computational Fluid Dynamics (CFD)

- **CFD capability** for prediction of **performance degradations due to ice** & Improvement of **Aerodata process for icing** which today rely on past aircraft experience, engineering judgement and low Reynolds number testing
- A **Step by Step Approach**
  - Adaptation of the current **RANS** based methodology to predict **incremental coefficient changes** due to ice accretion within the **linear range**
  - Improved prediction of performance degradation due to ice (non-linear range, stall) for absolute prediction of performance degradation due to ice (**CL<sub>MAX</sub>**)
    - Advanced turbulence modeling (URANS, SAS, **DES**, **LBM**),
- Capability under development through DGAC CORICE

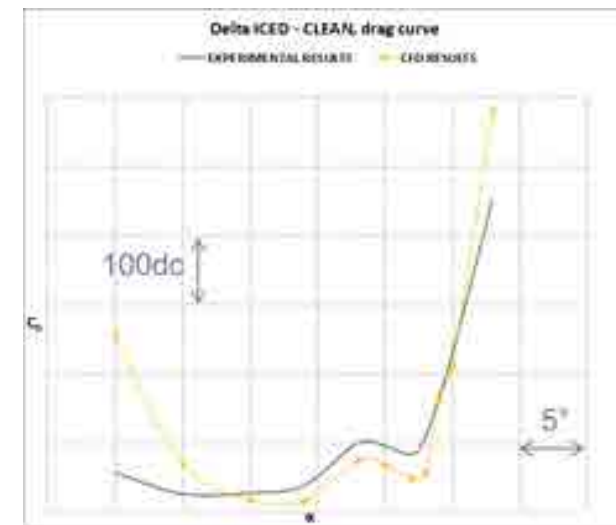
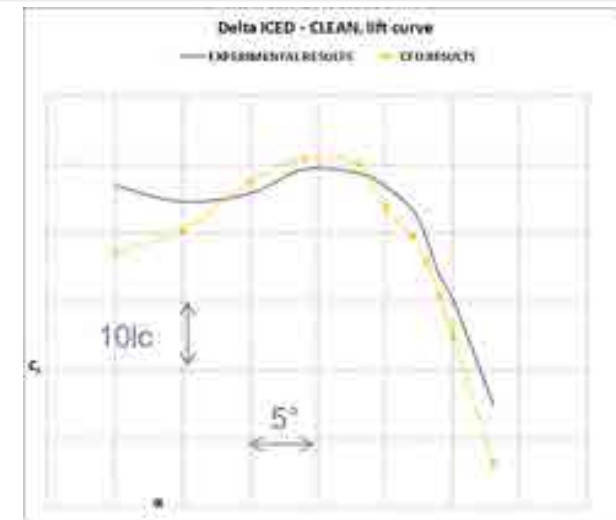
# Airbus Icing Simulation Capability & Perspectives

## Computational Fluid Dynamics (CFD)

elsA, MultiBlock Structured approach



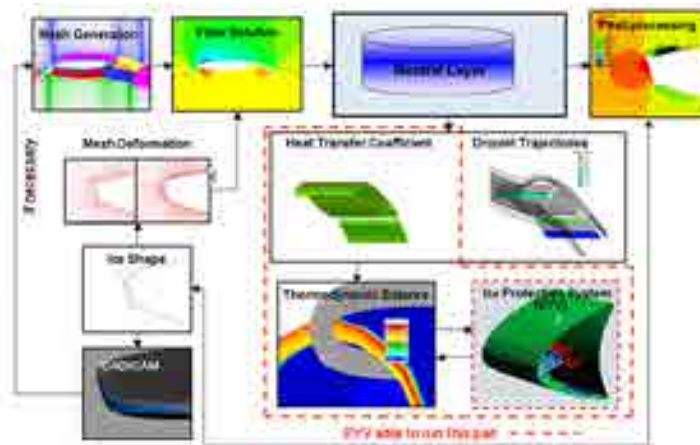
- Encouraging results obtained with RANS but stall prediction , including  $CL_{MAX}$  and  $ALPHA_{MAX}$ , still not achievable
- Advanced CFD (**LBM**, DES) to be speed up for icing applications



# Airbus Icing Simulation Capability & Perspectives

## Ice Accretion

- **2D and 3D Ice accretion prediction capability** to support design and certification of future products.
  - 2D ice accretion capability relies on ONERA icing simulation tools( IGLOO2D)
  - 3D ice accretion capability relies on a series of icing modules (ONERA, ICECREMO, DROP3D). Main challenge is the validation & the industrialisation and automation of the 3D ice accretion process
  - Capability under development through FP7 STORM, DGAC CORICE and CORAC GENOME



**Airbus Icing Tool (AIT)** under development

A single framework for icing tools

Automation of the ice accretion process including 3D

# Airbus Icing Simulation Capability & Perspectives

## Ice Accretion

- **2D and 3D Ice accretion prediction capability** to support design and certification of future products.
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  - Capability under development "CORAC GENOME"

**Importance of the tight integration of the tools towards a modular and interoperable simulation environment organized around standards**

**To makes the tool quickly available to end users and so to the A/C products**



**Airbus Icing Tool (AIT)** under development

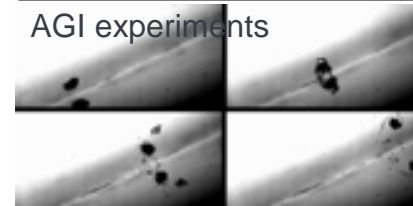
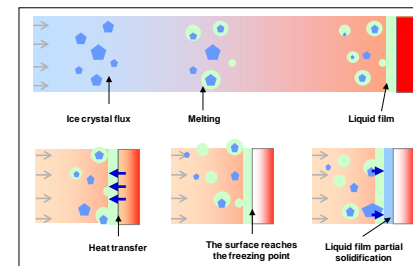
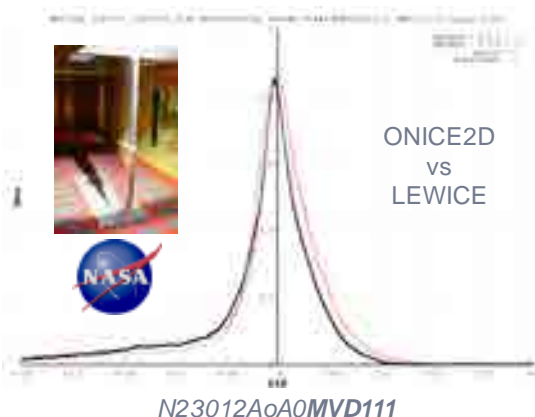
A single framework for icing tools

Automation of the ice accretion process including 3D

# Airbus Icing Simulation Capability & Perspectives

## Ice Accretion

- Understanding and modeling of physical phenomena regarding **Supercooled Large Droplet (SLD)** and **Glaciated and Mixed Phase icing conditions**
  - New regulation (CS-25 Appendix O, P) applicable since early 2015
  - Capability development initiated through FP7 EXTICE and FP7 HAIC. Research activities to be pursued (splashing, bouncing, shattering,...)



Development of SLD engineering tools  
within FP7 EXTICE

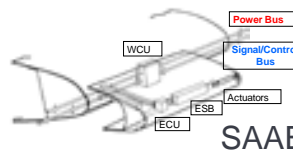
Development of Ice Crystals simulation  
tools within FP7 HAIC



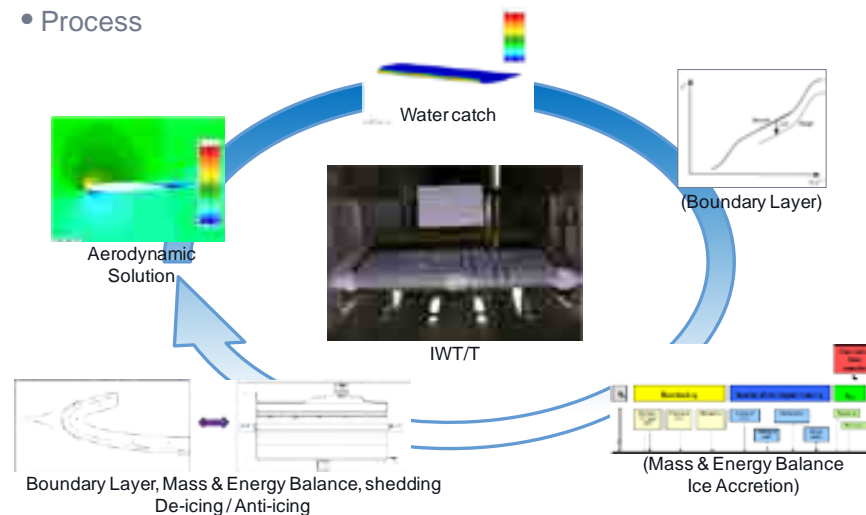
# Airbus Icing Simulation Capability & Perspectives

## Ice Protection

- Capability for prediction of **performances of electrical Ice Protection System** (ETIPS, EMIPS) as enabler for More Electrical Aircraft
- Improved capability under development through FP7 STORM, DGAC CORICE and CORAC GENOME
- Phenomena to be better understood and modeled:
  - **Runback**
  - **Ice shedding, ice mechanical properties** and ice block trajectory including coatings



• Process



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# Airbus Icing Simulation Capability & Perspectives

## Conclusion

- An **interdisciplinary and cross-sectoral topic and network**
- A set of **icing tools available** to support design and certification of current aircraft
- An effort to **streamline icing R&D activities** through the definition of an integrated R&D roadmap including identification of the gaps in the available knowledge and prioritization of areas for improvement
  - To face challenges related to regulation evolution (SLD, Ice Crystals,...)
  - To enable development, integration and certification of new technologies and new aircraft configurations
  - To bring value through the improvement of efficiency and the reduction of the costs

# Airbus Icing Simulation Capability & Perspectives

## Conclusion

- However, some gaps remain...

# Airbus Icing Simulation Capability & Perspectives

## Way Forward

- Pursue the effort to develop the **engineering tools** to face the challenges related to the evolution of regulation
  - Glaciated and mixed phase & Supercooled Large Droplet icing conditions
- **Networking & Coordination at European level** has to be re-enforced to ensure alignment with the needs, avoid gaps and/or overlap and maximize efficiency
- **International Collaboration** has to be promoted. The complexity and costs of current research greatly benefits from international partnerships and coordination of resources
  - Common need for operational safety
  - Expertise required across multiple disciplines, doesn't reside in a single organization
  - Facilities and test assets operated by multiple organizations across national boundaries
  - Reduce duplication of effort / develop complementary research strategies

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