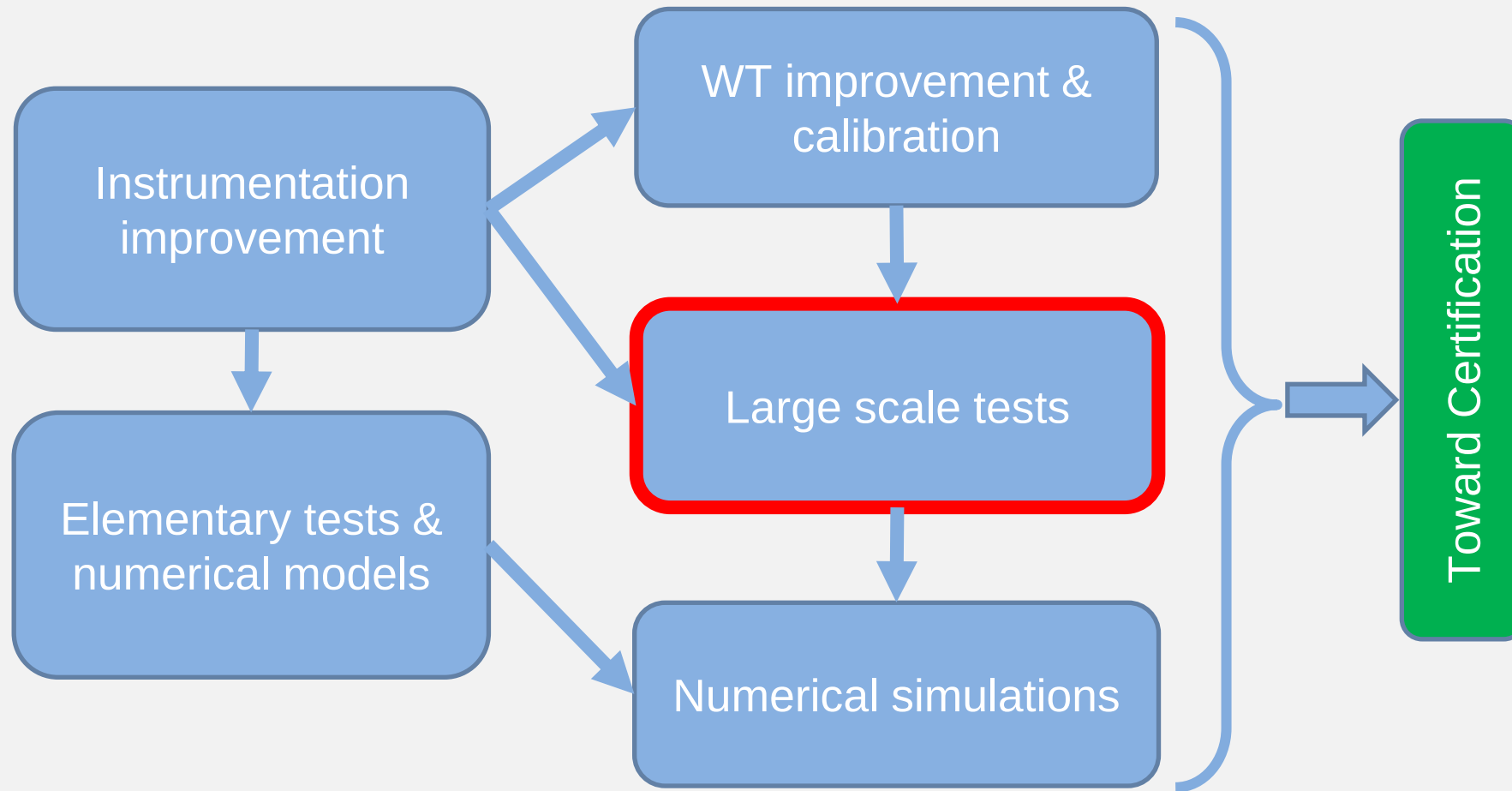


Tests in industrial environment



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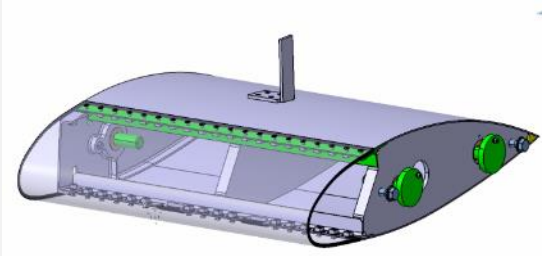
LIQUID CONDITIONS (APP C AND O) AND SNOW TESTS PREPARATION



Tests in industrial environment : 7 mockups (3 for snow)

MINDEF

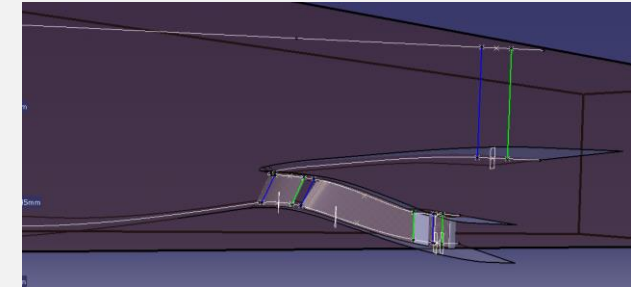
SONACA, LIEBHERR



DASSAV



SAFRAN

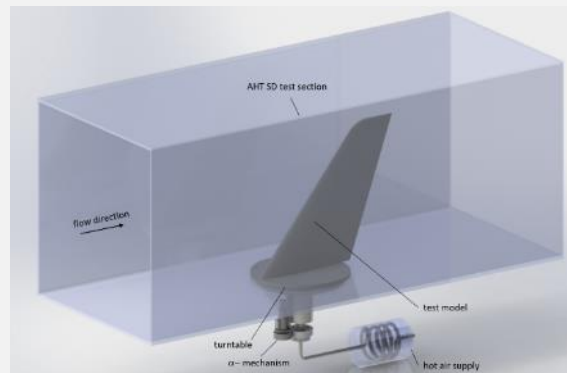


In Russia

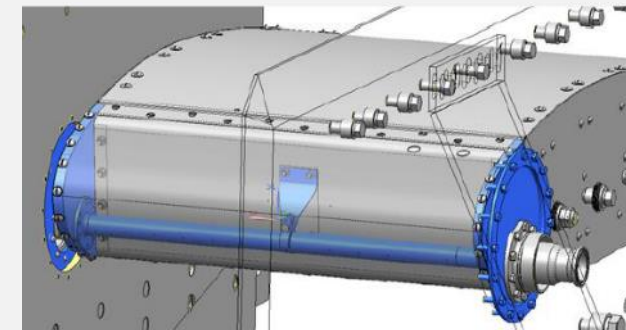
LDO



TSAGI



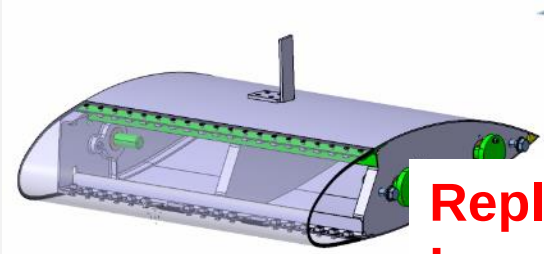
Nacelle + Splitter



Tests in industrial environment : 7 mockups (3 for snow)

MINDEF

SONACA, LIEBHERR



**Replaces :
Loss of 2D**

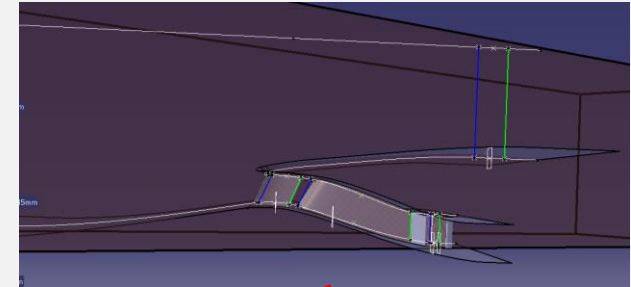
DASSAV



Replaces

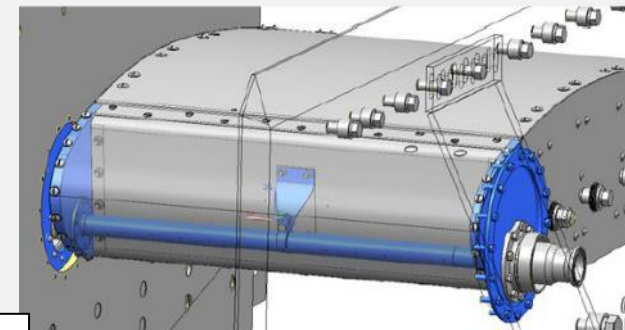
**Replaces :
Loss of 2D**

SAFRAN



Replaces

Nacelle + Splitter



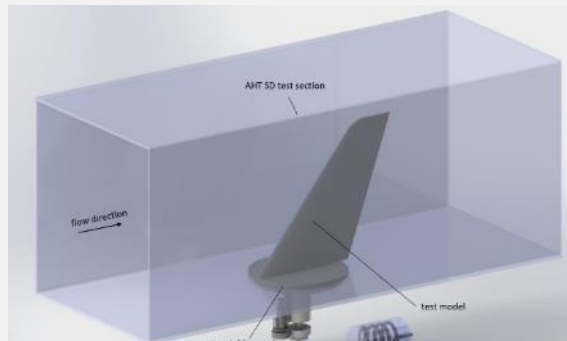
In Russia

LDO



Nothing similar

TSAGI



-> Addition of 2D HMDI Airfoil

3D WING



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Dassault 3D Wing

- 🧬 Dassault Generic 3D Wing
- 🧬 High lift device (slat) retracted or extended
- 🧬 Tested at CIRA facility July, 2022



Dassault 3D Wing – 3 configurations

Holding : Flap 0°
 Slat retracted
 AOA 4.5°



Circle to land : Flap 0°
 Slat ext
 AOA 8.5°

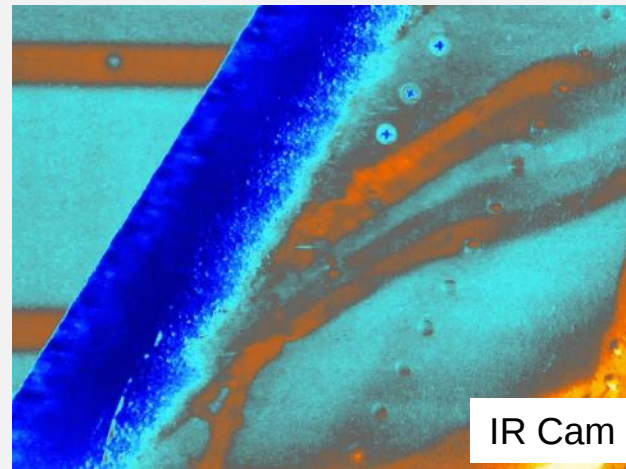
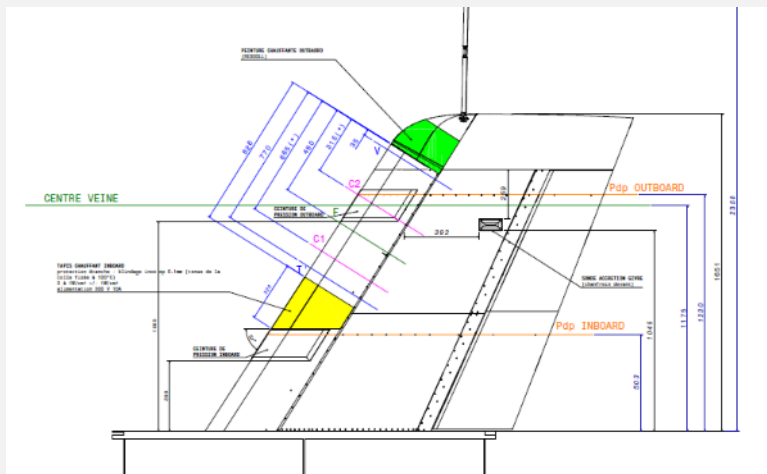
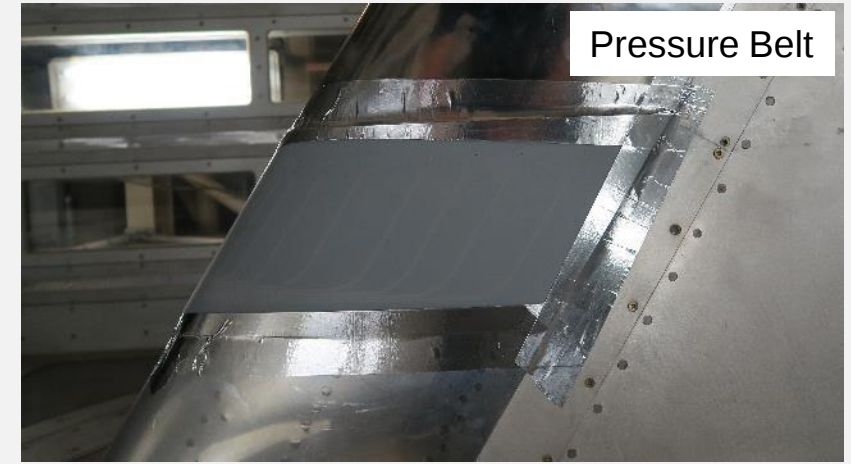


Landing : Flap 15°
 Slat ext°
 AOA 13°



Measurements

- External pressure (aero tests)
- Manual ice tracings on 2 sections
- Laser scans
- Icing blade
- Ice density (mass & volume)
- Skin thermocouples
- Hot air mass flow & temperature



Test matrix sum-up

 **Total amount of 22 runs**

 **3 App. O conditions :**

- FZDZ1 : MVD= 18.4 μm ; LWC= 0.35 g/m^3 ; bimodal
- FZDZ2_1 : MVD= 65 μm ; LWC= 0.21 g/m^3 ; bimodal
- FZDZ2_2 : MVD= 98 μm ; LWC= 0.21 g/m^3 ; monomodal

Mach : 0.25 – 0.34 – 0.36
SAT : -12°C – -15°C
Alt : 15kft – 17kft

 **1 App. C condition :**

- DVM= 20 μm ; LWC= 0.34 g/m^3

 3 impingement test case (SLD ice accretion with a short duration)

 10 App.O FZDZ ice shapes (45 min. exposure)

 2 App. C ice shapes (45 min. exposure)

 7 ice protection system (bleed air) runs (6 App.O, 1 App.C)

 For a test specimen configuration, ability to follow the ice shape variations from App.C to App.O

Test matrix sum-up

- 🧬 Total amount of 22 runs
- 🧬 3 App. O conditions :
 - FZDZ1 : MVD= 18.4 μm ; LWC= 0.35 g/m^3 ; bimodal
 - FZDZ2_1 : MVD= 65 μm ; LWC= 0.21 g/m^3 ; bimodal
 - FZDZ2_2 : MVD= 98 μm ; LWC= 0.21 g/m^3 ; monomodal
- 🧬 1 App. C condition :
 - DVM= 20 μm ; LWC= 0.34 g/m^3
- 🧬 **3 impingement test case : FZDZ2_1, SLD ice accretion with a short duration**
- 🧬 10 App.O FZDZ ice shapes (45 min. exposure)
- 🧬 2 App. C ice shapes (45 min. exposure)
- 🧬 7 ice protection system (bleed air) runs (6 App.O, 1 App.C)
- 🧬 For a test specimen configuration, ability to follow the complete evolutive ice shapes from App.C to App.O

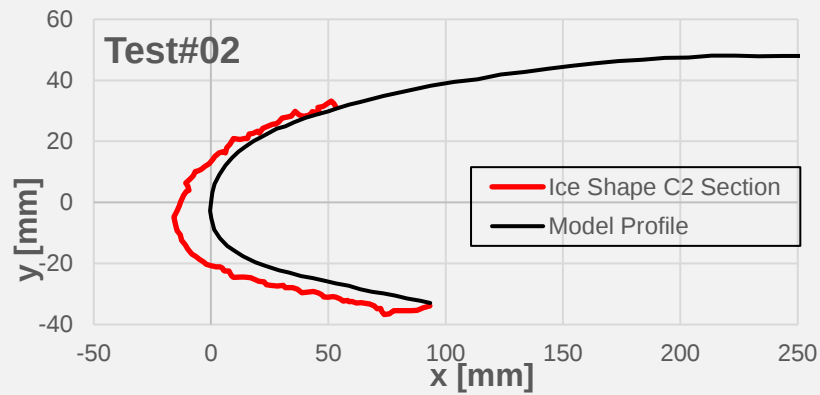


Test matrix sum-up

APP O	MVD	LWC	SAT
Bimodal	65 μm	20 g/m ³	-16 °C

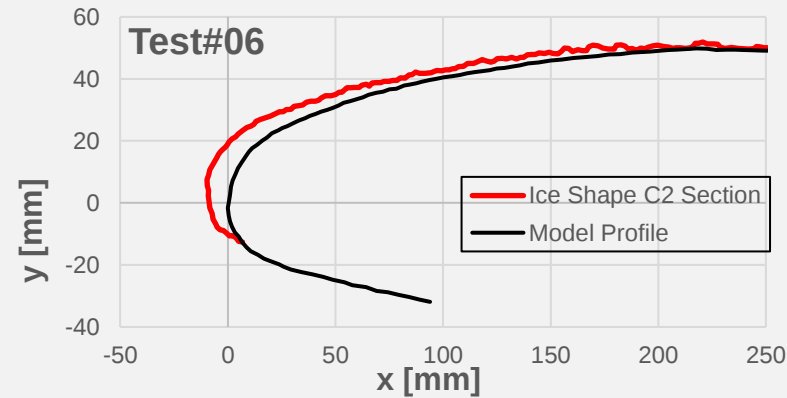
HLD : 4.5°

Mach 0.36
TAT -9,3°C



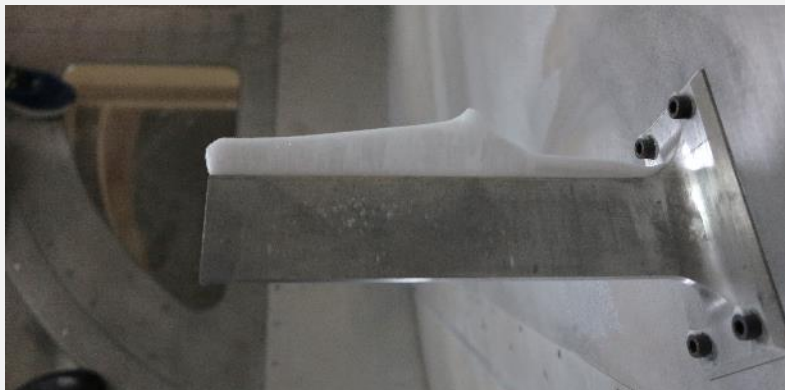
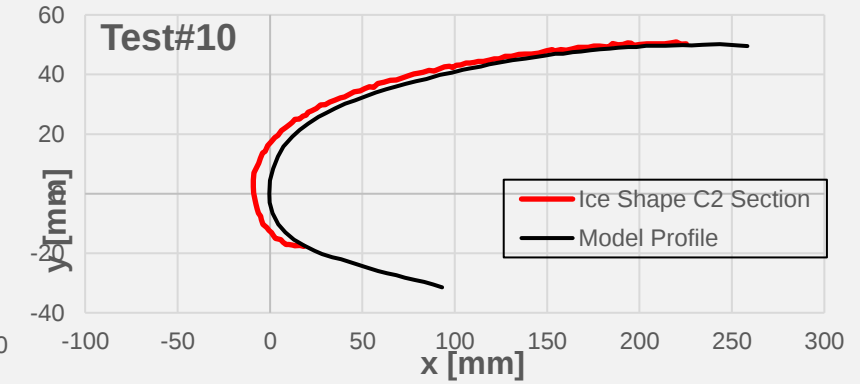
CTL : 8.5°

Mach 0.34
TAT -10.1°C



LDG : 13°

Mach 0.28
TAT -12.0°C



Test matrix sum-up

- 🧬 Total amount of 22 runs
- 🧬 3 App. O conditions :
 - FZDZ1 : MVD= 18.4 μm ; LWC= 0.35 g/m^3 ; bimodal
 - FZDZ2_1 : MVD= 65 μm ; LWC= 0.21 g/m^3 ; bimodal
 - FZDZ2_2 : MVD= 98 μm ; LWC= 0.21 g/m^3 ; monomodal
- 🧬 1 App. C condition :
 - DVM= 20 μm ; LWC= 0.34 g/m^3
- 🧬 3 impingement test case (SLD ice accretion with a short duration)
- 🧬 **10 App.O FZDZ ice shapes (45 min. exposure)**
- 🧬 **2 App. C ice shapes (45 min. exposure)**
- 🧬 7 ice protection system (bleed air) runs (6 App.O, 1 App.C)
- 🧬 For a test specimen configuration, ability to follow the ice shape variations from App.C to App.O



Test matrix sum-up

Common : SAT : -15°C

HLD Mach 0.36	APPC	
	APP O	FZDZ1 FZDZ2_1 FZDZ2_2
CTL Mach 0.34	APP C	
	APP O	FZDZ1 FZDZ2_1 FZDZ2_1 (SAT : -10°C) FZDZ2_2
LDG Mach 0.28	APP O	FZDZ1 FZDZ2_1 FZDZ2_2

Test matrix sum-up

- 🧬 Total amount of 22 runs
- 🧬 3 App. O conditions :
 - FZDZ1 : MVD= 18.4 μm ; LWC= 0.35 g/m^3 ; bimodal
 - FZDZ2_1 : MVD= 65 μm ; LWC= 0.21 g/m^3 ; bimodal
 - FZDZ2_2 : MVD= 98 μm ; LWC= 0.21 g/m^3 ; monomodal
- 🧬 1 App. C condition :
 - DVM= 20 μm ; LWC= 0.34 g/m^3
- 🧬 3 impingement test case (SLD ice accretion with a short duration)
- 🧬 10 App.O FZDZ ice shapes (45 min. exposure)
- 🧬 2 App. C ice shapes (45 min. exposure)
- 🧬 **7 ice protection system (bleed air) runs (6 App.O, 1 App.C)**
- 🧬 For a test specimen configuration, ability to follow the ice shape variations from App.C to App.O



Test matrix sum-up

- 🧬 Total amount of 22 runs
- 🧬 3 App. O conditions :
 - FZDZ1 : MVD= 18.4 μm ; LWC= 0.35 g/m^3 ; bimodal
 - FZDZ2_1 : MVD= 65 μm ; LWC= 0.21 g/m^3 ; bimodal
 - FZDZ2_2 : MVD= 98 μm ; LWC= 0.21 g/m^3 ; monomodal
- 🧬 1 App. C condition :
 - DVM= 20 μm ; LWC= 0.34 g/m^3
- 🧬 3 impingement test case (SLD ice accretion with a short duration)
- 🧬 10 App.O FZDZ ice shapes (45 min. exposure)
- 🧬 2 App. C ice shapes (45 min. exposure)
- 🧬 7 ice protection system (bleed air) runs (6 App.O, 1 App.C)
- 🧬 **For a test specimen configuration, ability to follow the ice shape variations from App.C to App.O**

Distribution sensitivity

Circle to Land

Mach	AOA	Flap/Slat	SAT	TAT
0.34	8.5°	30° / 0°	-15°C	-9°C

APP C

APP O - Bimodal

APP O - Bimodal

APP O - Monomodal

MVD : 19 μm
LWC 0.35 g/m³

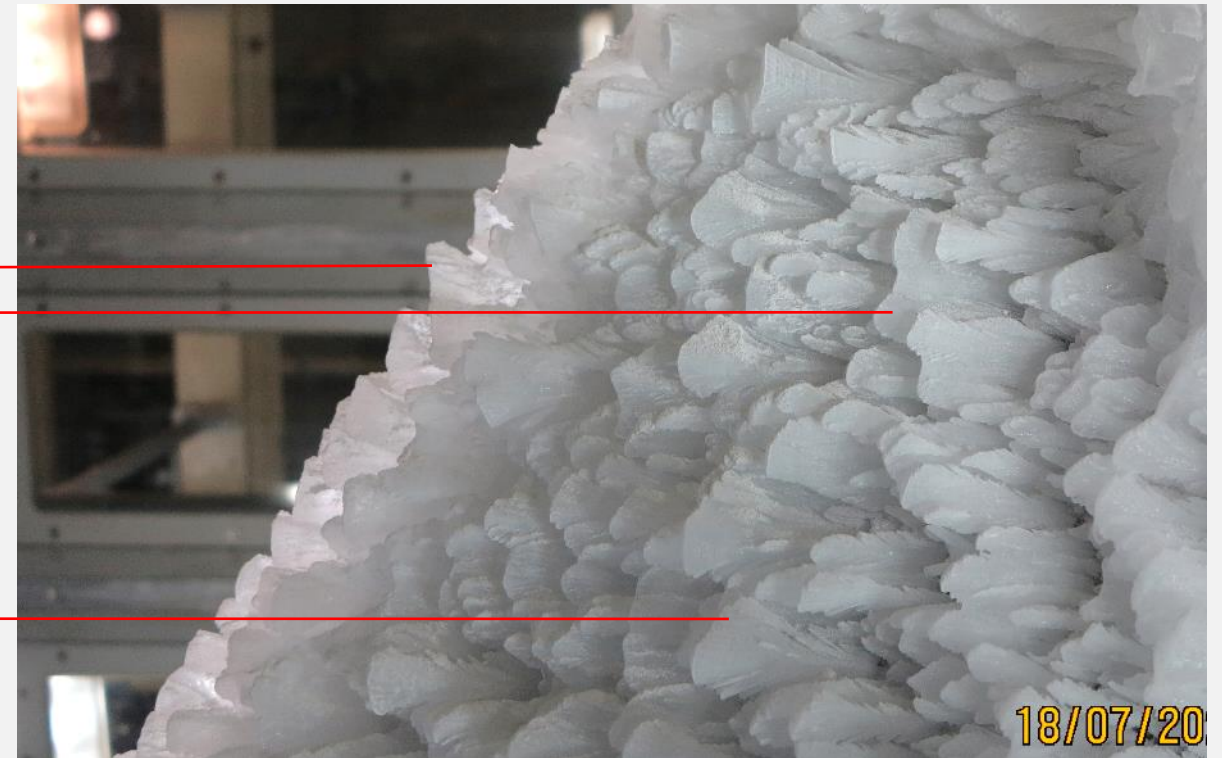
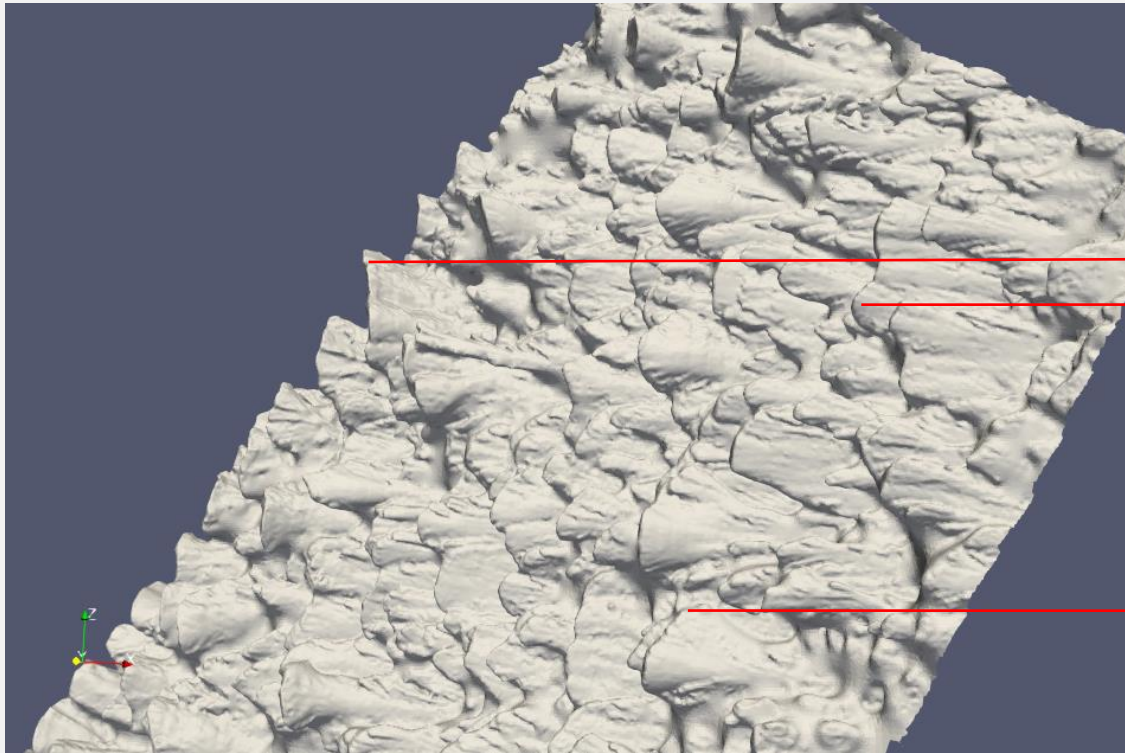
MVD : 18.4 μm
LWC 0.36 g/m³

MVD : 65 μm
LWC 0.21 g/m³

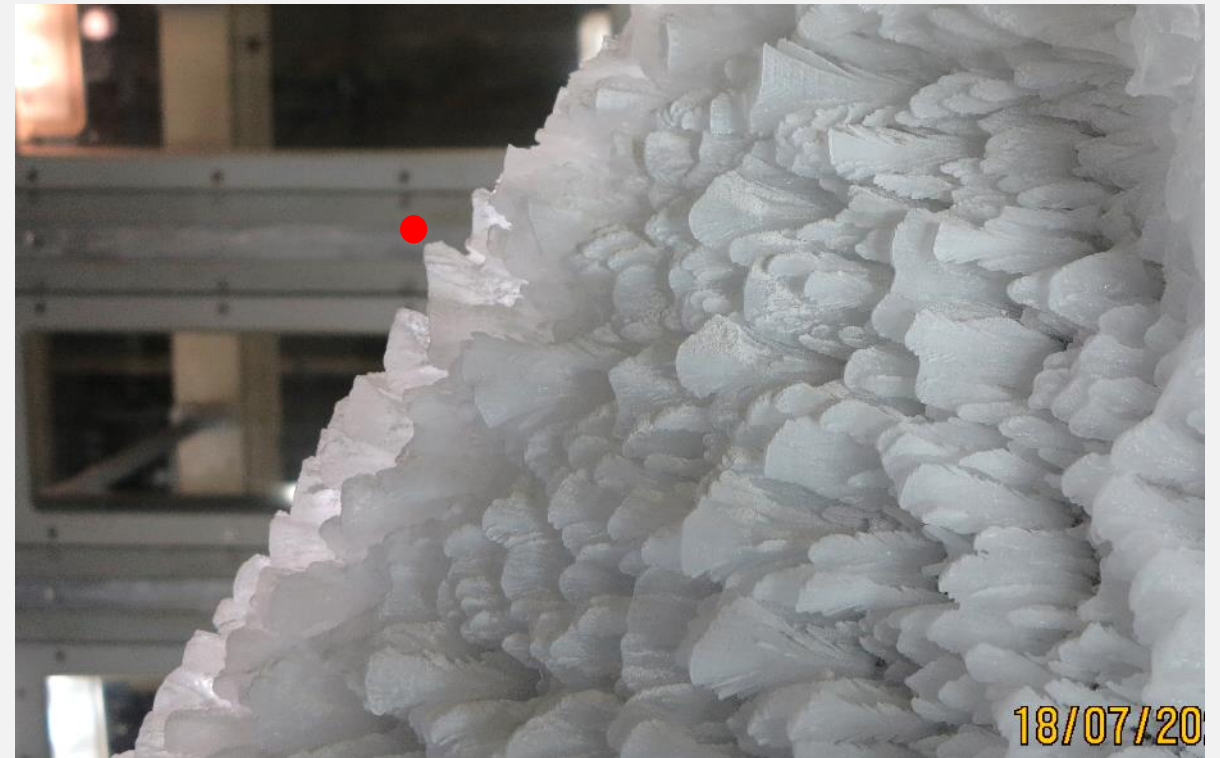
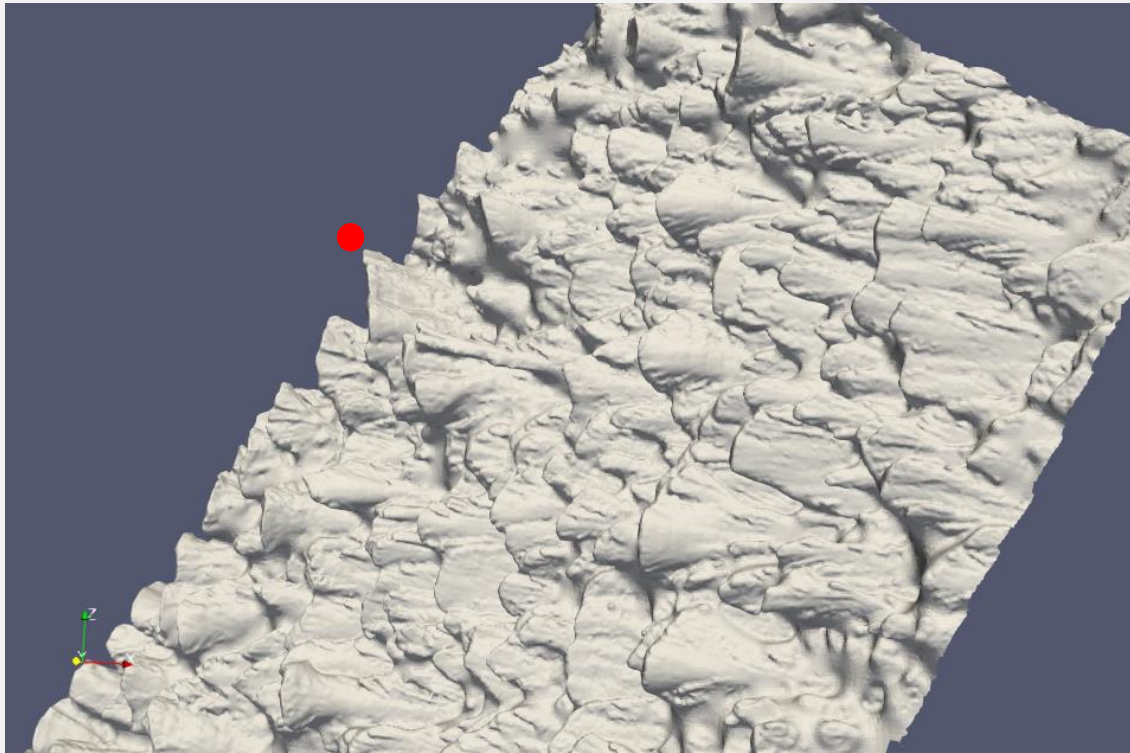
MVD : 98 μm
LWC 0.22 g/m³



3D Scan example



QUESTIONS ?





Annex : Test Matrix

Test_Id#	D-Run#	Date	Config	Mach	airspeed (m/s)	AoAWT (°)	ZP	Slat / Flap	MVD [µm]	LWC [g/m³]	SAT	Spraying time [s]	TAT	AI system	QAI [kg/min]	TAI	Measurement	Comment	Risk	comment
11	2	25-juil	HLD	0,36	116	4,5	15000	0/0	> 40	0,20	-16	600	-9,3	OFF	N/A	N/A	Scan+Ice tracings	FZDZ 2 impingement	TAT not cold enough	
14	3	26-juil	HLD	0,36	116	4,5	15000	0/0	< 40	0,34	-15	2700	-8,3	OFF	N/A	N/A	Scan+Ice tracings+ Ice mass	FZDZ 1		
12	4	26-juil	HLD	0,36	116	4,5	15000	0/0	>40	0,20	-15	2700	-8,3	OFF	N/A	N/A	Scan+Ice tracings+ Ice mass	FZDZ 2 PSD study		
13	4b	26-juil	HLD	0,36	116	4,5	15000	0/0	>40	0,21	-15	2700	-8,3	OFF	N/A	N/A	Scan+Ice tracings+ Ice mass	FZDZ 2 PSD study		
1	6	15-juil	CTL	0,34	109	8,5	15000	30/0	>40	0,21	-16	600	-10,1	OFF	N/A	N/A	Ice tracings	FZDZ 2 impingement		répartition homogène
5	7	21-juil	CTL	0,34	110	8,5	15000	30/0	<40	0,36	-15	2700	-9,0	OFF	N/A	N/A	Scan+Ice tracings+ ice mass	FZDZ 1		chgt de MVD et LWC
2	8	18-juil	CTL	0,34	111	8,5	15000	30/0	>40	0,21	-10	2700	-3,9	OFF	N/A	N/A	Scan	FZDZ 2 PSD study		à refaire: défaut injecteurs queues de homard Ts pas assez basse
3	8	19-juil	CTL	0,34	110	8,5	15000	30/0	>40	0,21	-15	2700	-9,0	OFF	N/A	N/A	Scan+Ice tracings+ ice mass	FZDZ 2 PSD study		avec 2 injecteurs changés
4	8b	20-juil	CTL	0,34	110	8,5	15000	30/0	>40	0,22	-15	2700	-9,0	OFF	N/A	N/A	Scan+Ice tracings+ ice mass	FZDZ 2 PSD study		monomodal
-	9	-	LDG	0,28	90	13	17000	30/15	< 40	0,43	-16	600	-12,0	OFF	N/A	N/A	Scan+Ice tracings	FZDZ 1 impingement	Colder SAT	
7	10	22-juil	LDG	0,28	90	13	17000	30/15	> 40	0,26	-16	600	-12,0	OFF	N/A	N/A	ice tracings	FZDZ 2 impingement		
8	11	22-juil	LDG	0,28	90	13	17000	30/15	< 40	0,43	-15	2700	-11,0	OFF	N/A	N/A	Scan+Ice tracings	FZDZ 1		
10	12	22-juil	LDG	0,28	90	13	17000	30/15	> 40	0,26	-15	2700	-11,0	OFF	N/A	N/A	Scan+Ice tracings	FZDZ 2 PSD study		
9	12b	22-juil	LDG	0,28	90	13	17000	30/15	> 40	0,27	-15	2700	-11,0	OFF	N/A	N/A	Scan+Ice tracings	FZDZ 2 PSD study		
15	13	27-juil	HLD	0,36	116	4,5	15000	0/0	19	0,33	-15	2700	-8,3	OFF	N/A	N/A	Scan+Ice tracings	App C		
6	14	21-juil	CTL	0,34	110	8,5	15000	30/0	19	0,35	-15	2700	-9,0	OFF	N/A	N/A	Scan+Ice tracings+ ice mass	App C		
18	15	29-juil	CTL	0,34	110	8,5	17000	30/0	20	0,38	-12	1200	-6,0	ON	3.2/2.6/1.4	155	N/A	App C		
19	16	29-juil	CTL	0,34	110	8,5	17000	30/0	< 40	0,35	-12	1200	-6,0	ON	3.2/2.6/1.4	155	N/A	FZDZ 1		
20	17	29-juil	CTL	0,34	110	8,5	17000	30/0	> 40	0,21	-12	1200	-6,0	ON	3.2/2.6/1.4	155	N/A	FZDZ 2		
21	18	01-août	CTL	0,34	109	8,5	17000	30/0	< 40	0,36	-16	1200	-10,1	ON	3/2.6/1.4	155	N/A	FZDZ 1 Temp sweep		
-	19	-	LDG	0,28	90	13	17000	30/15	< 40	0,43	-16	1200	-12,0	ON	2.5/1.7/0	145	N/A	FZDZ 1	low priority	
22	20	01-août	LDG	0,28	90	13	17000	30/15	> 40	0,26	-16	1200	-12,0	ON	2.5/1.7/0	145	N/A	FZDZ 2	low priority	
17	21	28-juil	HLD	0,36	116	4,5	15000	0/0	< 40	0,34	-15	1200	-8,3	ON	2.1/0.8	145	N/A	FZDZ 1		
16	22	28-juil	HLD	0,36	116	4,5	15000	0/0	> 40	0,20	-15	1200	-8,3	ON	2.1/0.8	145	N/A	FZDZ 2		

THANK YOU



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824310. This text reflects only the author's views and the Commission is not liable for any use that may be made of the information contained therein.

