JAXA Experimental Dataset Overview

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Acknowledgments

- **Dataset B.1:**

Shunsuke KOIKE, Fundamental Technology Research Unit, Aviation Technology Directorate, JAXA

- **Dataset B.2:**

Yosuke SUGIOKA, Fundamental Technology Research Unit, Aviation Technology Directorate, JAXA

- **FEM:**

Hitoshi ARIZONO, Aviation Environment Sustainability Innovation Hub, Fundamental Technology Research Unit, Aviation Technology Directorate, JAXA

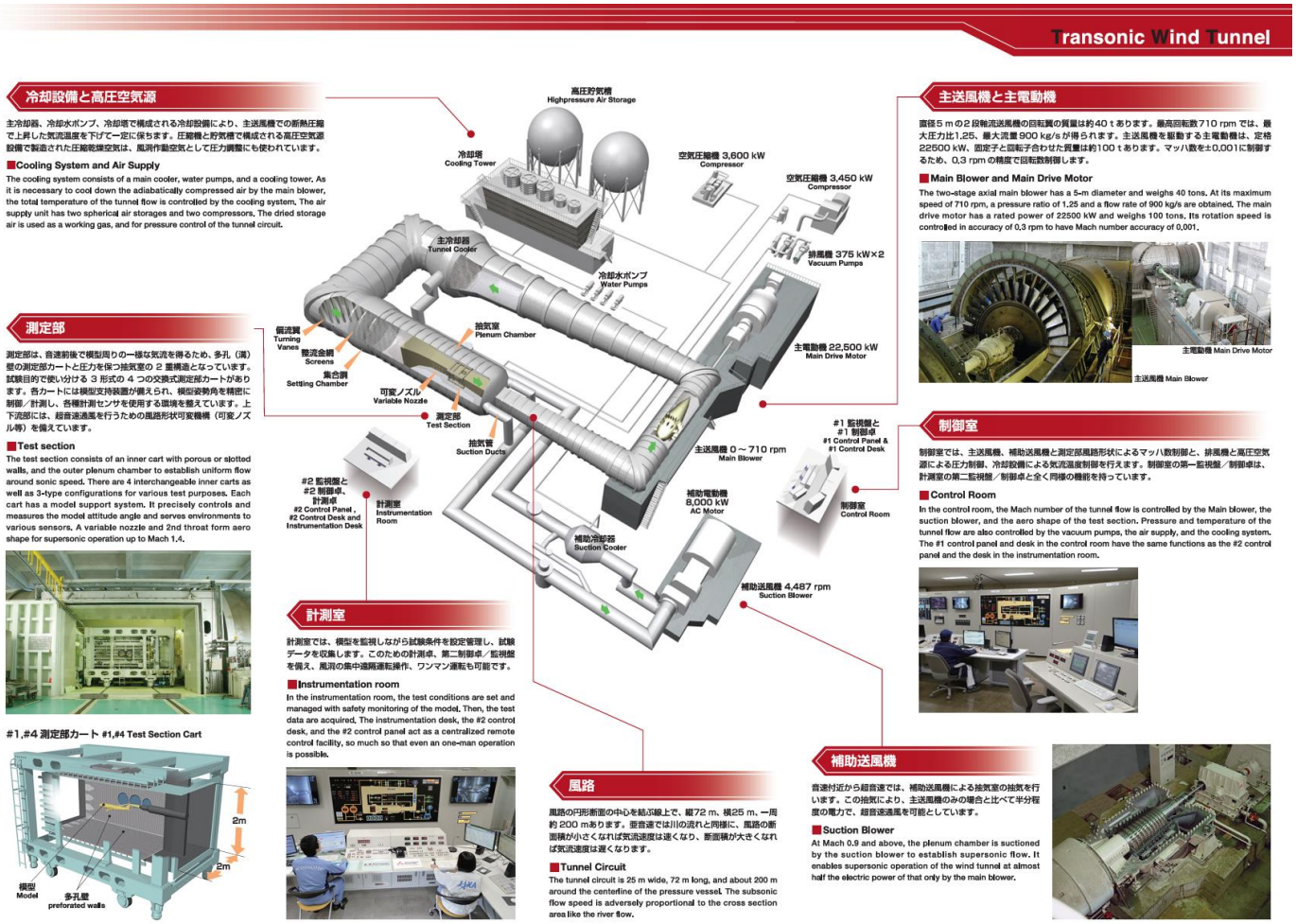
+ many others (M. UENO, K. NAKAKITA, S. NAKAJIMA, …)

JAXA Experimental Dataset: Overview

Dataset name	Dataset B.1	Dataset B.2
Test Case	Buffet Working Group: Test Case 2 [Unsteady CFD + Rigid wing]	Buffet Working Group: Test Case 3 (Unsteady CFD + FSI)
Wind tunnel	JAXA Transonic Wind Tunnel 2m x 2m	
Geometry	Wing-Body-Tail 2.16% scale CRM (80% scale of NASA model)	
Mach number	0.85	
Reynolds number	1.52×10^6	2.27×10^6
Wing deformation	Measured for all angles of attack	Limited information released
Buffet onset	Approximately at 3.1 deg	Measured, at 3.7 deg
Data available	Forces and moments, Kulite	Forces and moments, Kulite, unsteady PSP
FEM	N/A	Stick FEM provided
Reference	Koike *et al*, AIAA 2016-4044, 2016	Sugioka *et al*, Experiments in Fluids, 2021

JAXA Transonic Wind Tunnel (JTWT1)

- **Type:** Continuous
- **Section:** 2m x 2m x 4.13m
- **Mach:** 0.1 – 1.4
- **Total pressure:** 50 – 120 kPa
- **Carts:** Interchangeable, full and half span models, slotted and perforated walls
- **Supersonic operation:** Variable nozzle and 2nd throat, plus suction blower



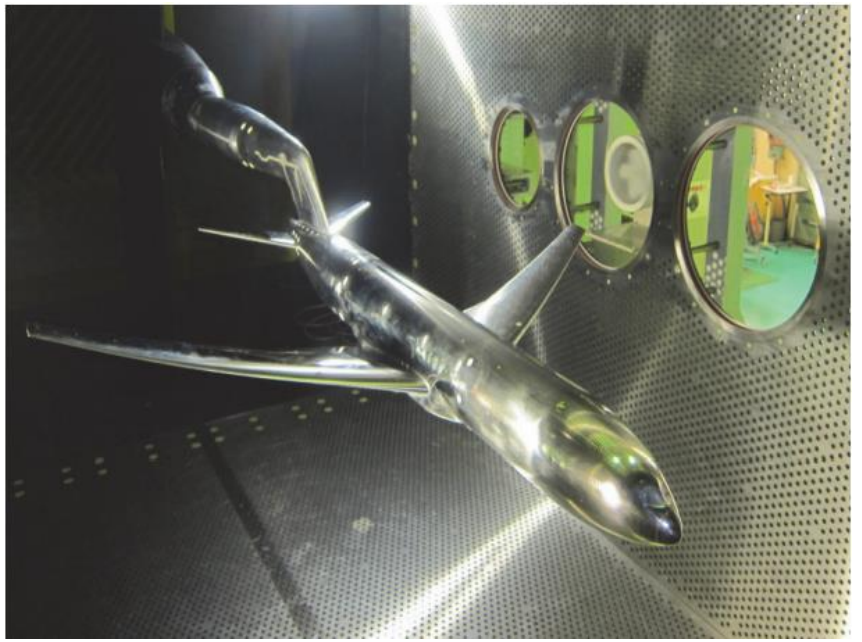
- https://www.aero.jaxa.jp/about/pamphlets/pdf/pam-transonic_windtunnel.pdf
- Greenwell DI. Transonic industrial wind tunnel testing in the 2020s. The Aeronautical Journal. 2022; 126(1295):125-151. doi:10.1017/aer.2021.107

Geometry

- **Scale:**
  - 2.16% scale CRM (80% scale of NASA model)
- **Configuration: WBT0**
  - Wing + Body + Tail (WBT) configuration
  - Stabilizer angle = 0 degrees (WBT0)
- **Model support:**
  - blade sting (on the upper side)
- **Jig shape:**
  - Wind-off wing shape is the as-defined (in 2008) 1-G shape (same as NASA CRM)
  - CAD from NASA Common Research Model website:

https://commonresearchmodel.larc.nasa.gov/geometry/dpw6-geometries/DPW6_v09_2016_01_28_*.*

- **Details in:**
  - Ueno et al., "Transonic Wind Tunnel Test of the NASA CRM: Volume 1", JAXA Technical Report, 2015.
  - https://jaxa.repo.nii.ac.jp/records/2502



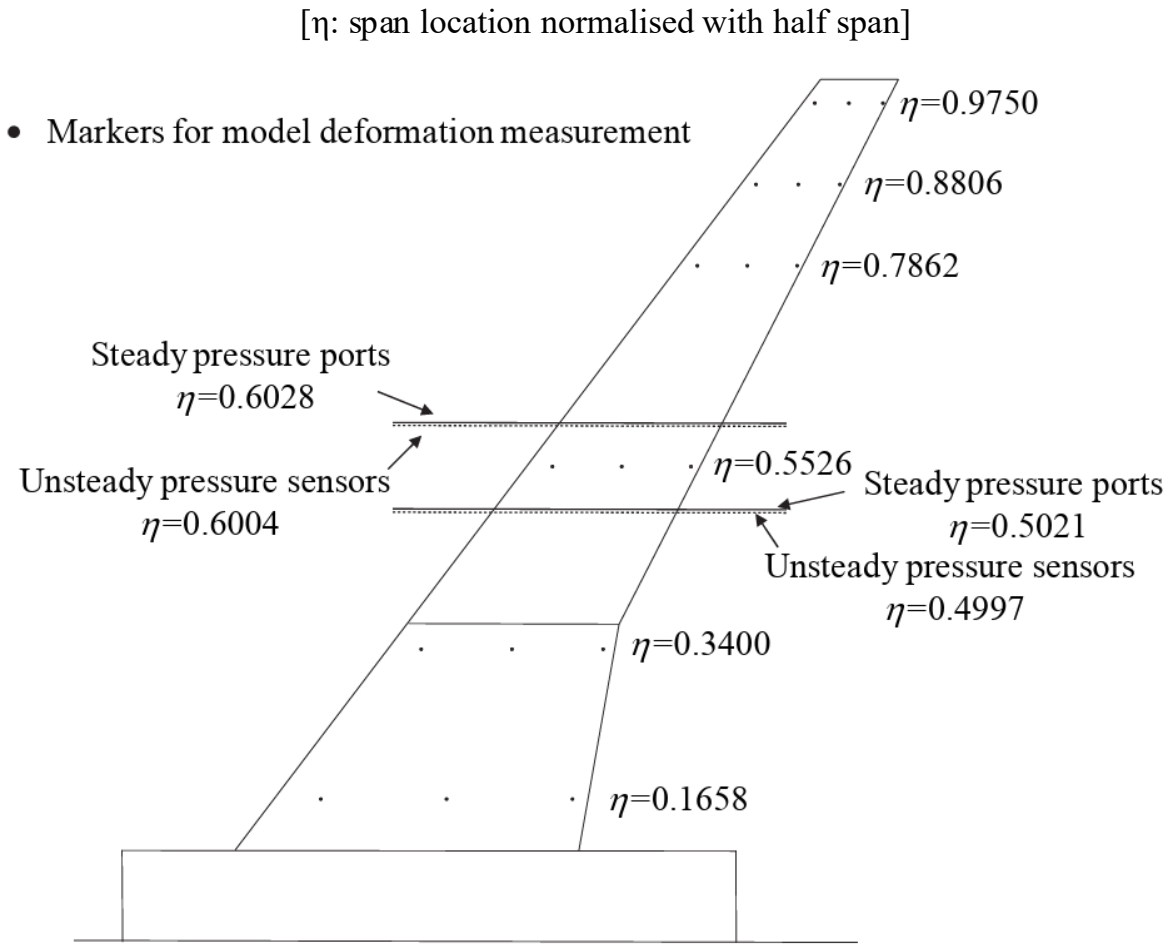
Taper ratio	0.275
25 % chord sweep (deg)	35
Aspect ratio	9.0
Reference area (m^2)	0.179014
Reference chord (m)	0.15131
Span (m)	1.26927

Wing: Pressure ports, sensors and markers

- **Right wing:**
  - Pressure ports and sensors at two spanwise section η = 0.5 and 0.6
  - Markers used for wing deformation measurements
- **Pressure ports and sensors:**
  - Steady pressure ports (12 per section)
  - Unsteady pressure sensors (12 per section)
    - XCQ062-25A, M-Screen, Kulite INC.
  - Locations of ports/sensors for both undeformed and deformed geometries (Test Case 2) are provided here:

https://cfdws.chofu.jaxa.jp/apc/dpw/upc.html

[η: span location normalised with half span]

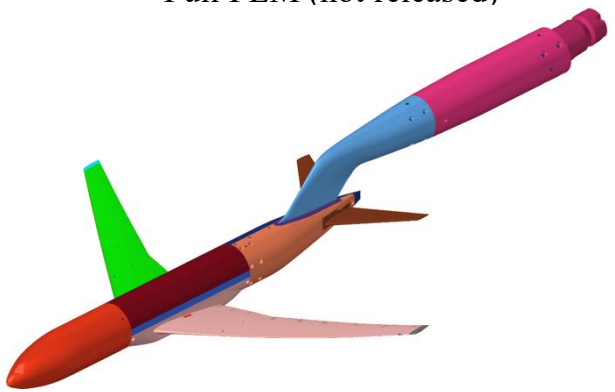


Finite Element Model (FEM)

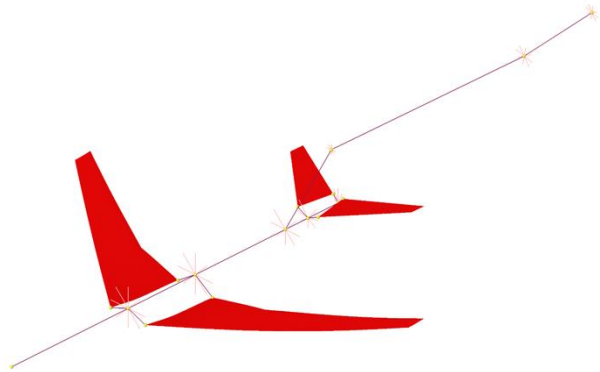
- **ATTENTION!**
  - Due to different instrumentations installed, the "NASA FEM" available on the CRM website cannot be used.
- **"JAXA FEM":**
  - Stick FEM model
  - Full-span and half-span FEMs
  - Nastran input and output files provided
  - Available here:

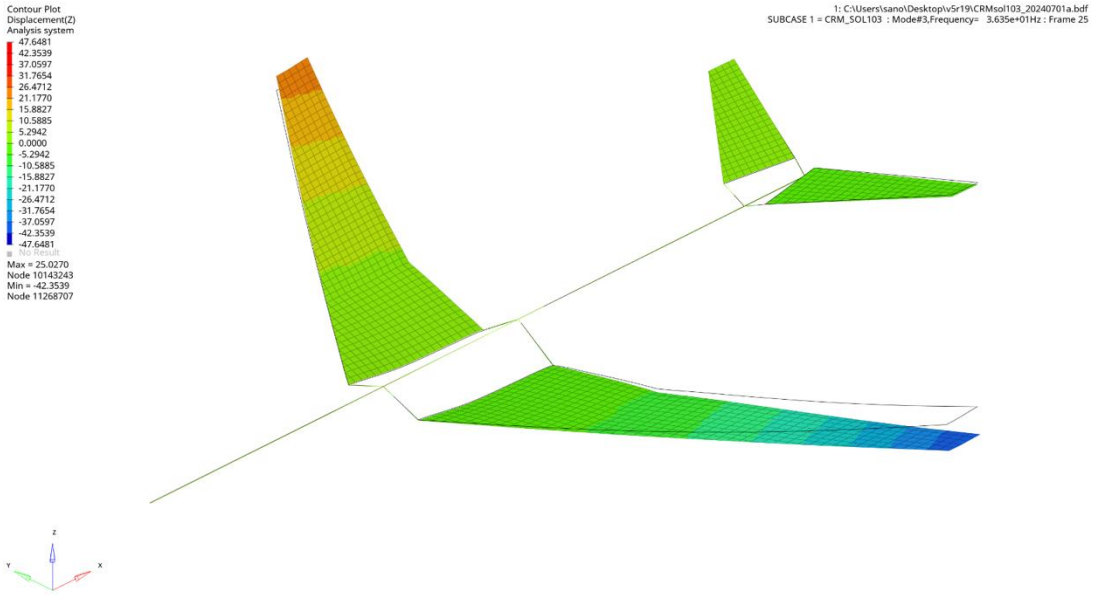
  https://cfdws.chofu.jaxa.jp/apc/dpw/
- **Errata Corrige:**
  - Standard unit of mass is "tons" (1000 kg)

Full FEM (not released)



Stick FEM





Flow conditions

	Dataset B.1	Dataset B.2
Test Case	Buffet WG: Test Case 2	Buffet WG: Test Case 3
Mach number	0.85	0.85
Reynolds number (based on reference chord)	1.52×10^6	2.27×10^6
Total temperature (K)	323.00	323.15
Total pressure (kPa)	80.0	120.0
Dynamic pressure (kPa)	~25.3	38.0
Selected angles and purpose	• 1.22 deg: pre-onset • 2.29 deg: pre-onset • 4.84 deg: post-onset • 5.89 deg: post-onset	• 3.05 deg: pre-buffet (close to design point) • 3.61 deg: buffet onset • 4.70 deg: deep buffet

NOTES:

- Additional corrections have been applied to the angles of attack in Dataset B.2 with respect to the reference paper (Sugioka *et al*, Experiments in Fluids, 2021)
- To account for the different Reynolds numbers, the tripping dots have been adjusted (see next slide)

Tripping dots

		Dataset B.1 (Re = 1.52 x 10^6)	Dataset B.2 (Re = 2.30 x 10^6)
Test Case		Buffet WG: Test Case 2	Buffet WG: Test Case 3
Trip		Aeronautical trip dot (CAD Cut)	
Diameter (mm)		1.27	
Distance between dot centres (mm)		2.54	
Main wing	**Location**	10% chord (upper and lower sides)	
	Height (mm)	0.11430 (inner-wing) 0.09906 (mid-wing) 0.08890 (outer-wing)	0.09906 (inner-wing) 0.08890 (mid-wing) 0.07874 (outer-wing)
Horizontal stabilisers	**Location**	10% chord (upper and lower sides)	
	Height (mm)	0.09906	0.07874
Body	**Location**	1.5% body length (azimuthally around the nose)	
	Height (mm)	0.08890	0.07874

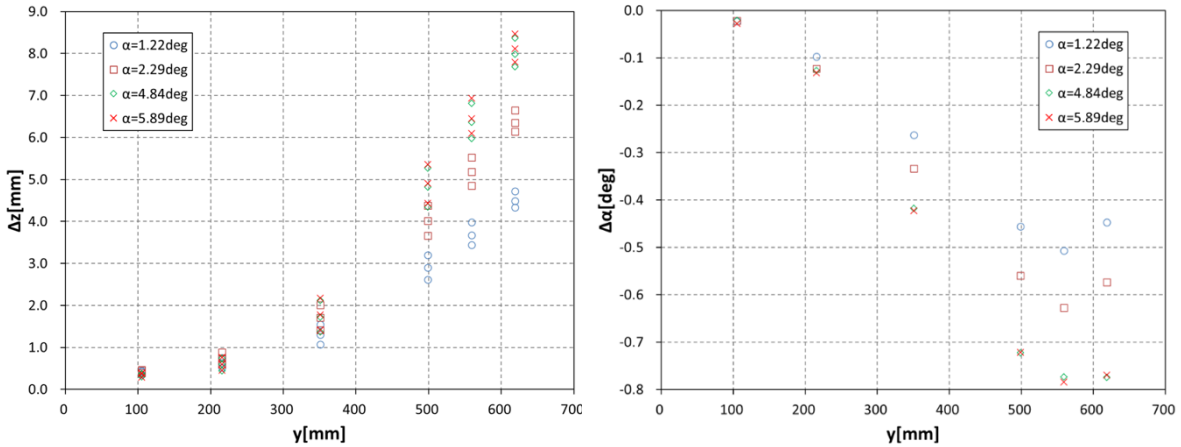
NOTES:

Inner wing: wing-body junction to Yehudi break (trailing-edge discontinuous bend); Mid/Outer wing: equally divided from Yehudi break to wing-tip.

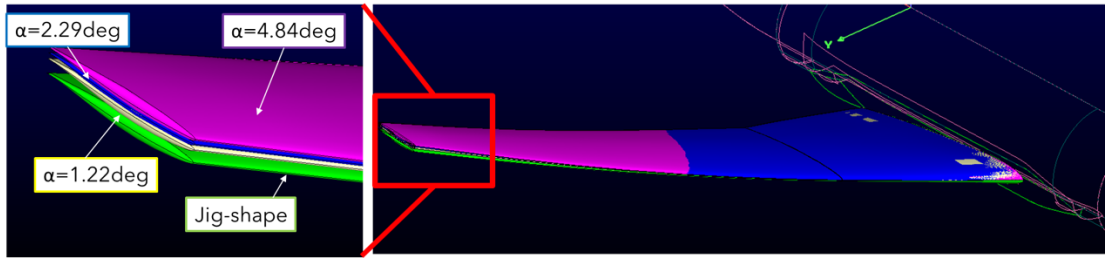
Deformations and CAD

- **Test Case 2**
  - Measured[*] deformations (deflection and torsion)
  - Used to create CAD deformed geometries (for grid generation)
    - Available at: https://cfdws.chofu.jaxa.jp/apc/dpw/geometry.html
    - The original CAD geometries have been smoothed in the cockpit area and named with the "*_updatednose" suffix (credit: HeldenAero)
- **Test Case 3**
  - Deformations not available (are meant to be computed)
  - CAD geometry corresponds to the jig-shape
  - Some limited qualitative deformation information have been provided
    - Wing tip vertical deflection of 10-12mm at AoA=4.7° (values shifted such that wing root deflection is 0 mm)

Test Case 2: Deflection and torsion deformations



Test Case 2: CAD deformed geometries



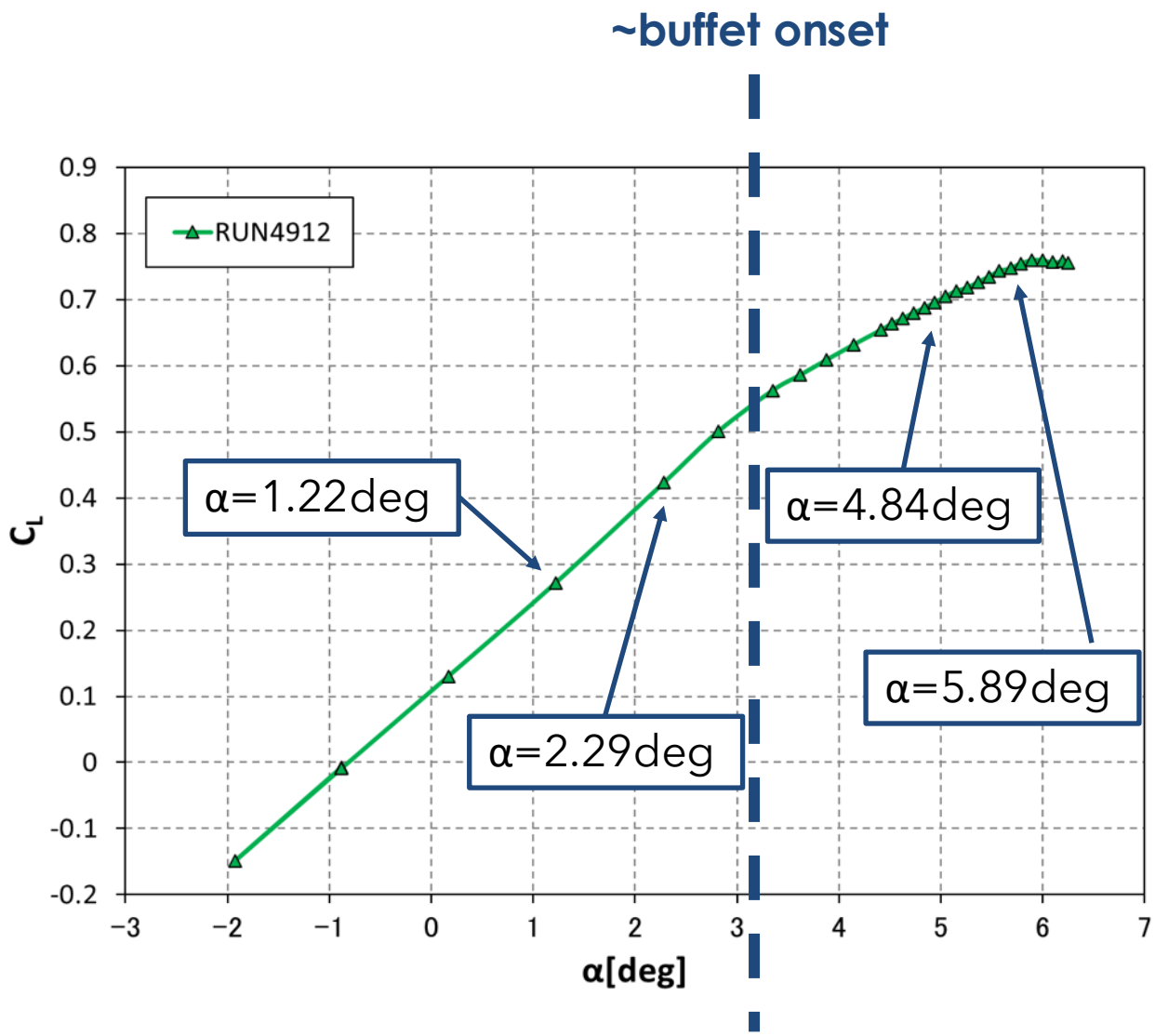
[*] For each angle of attack, the deformation is averaged over 10 images. Each image was taken with two cameras using stereo pattern matching technique and 0.65sec exposure time. Since the main wing vibration time scale is much smaller than the camera exposure time, the wing vibrations cannot be detected and the measured deformation should be considered as an approximate mean deformation.

Test Case 2: Experimental Dataset

- **Flow conditions:**
  - Mach number = 0.85
  - Reynolds number = 1.52 x 10^6
  - Total temperature = 323.0 K
  - Total pressure = 80 kPa
  - AoA = 1.22, 2.29, 4.84, 5.89 deg

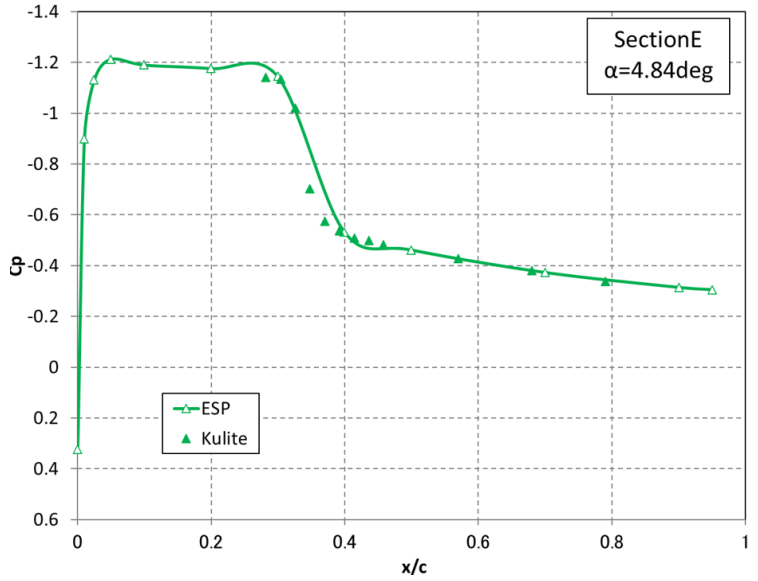
- **Available data:**
  - Forces and moments
  - Steady pressure ports
  - Kulite sensors (ave, RMS)
  - Kulite sensors pressure histories and PSDs
  - Available at:

https://cfdws.chofu.jaxa.jp/apc/dpw/upsp.html

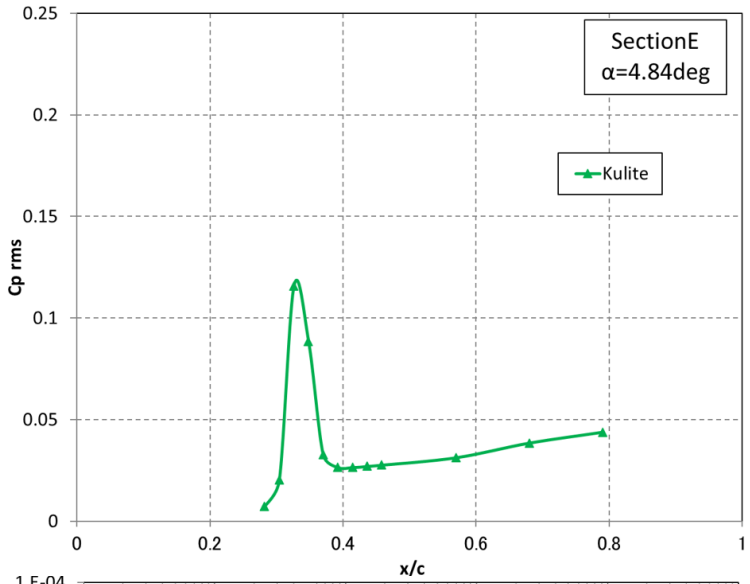


Test Case 2: Experimental Dataset (sample)

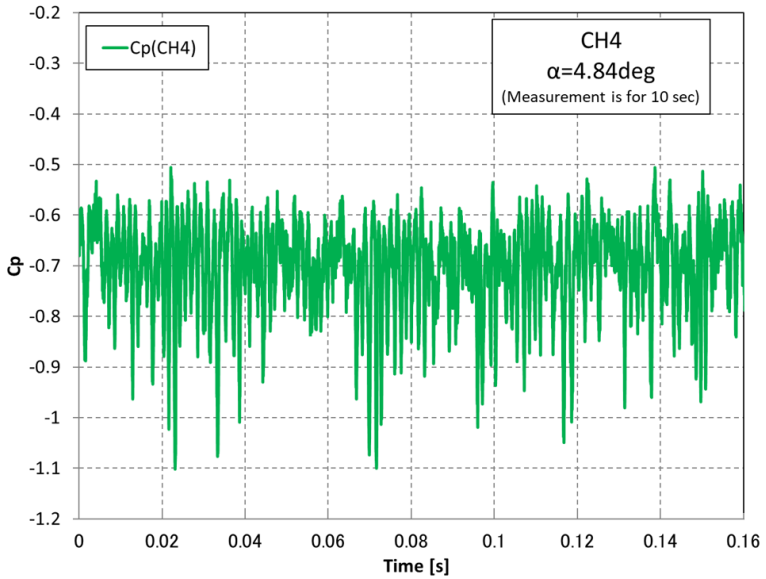
Steady pressure sensor Kulite average pressure



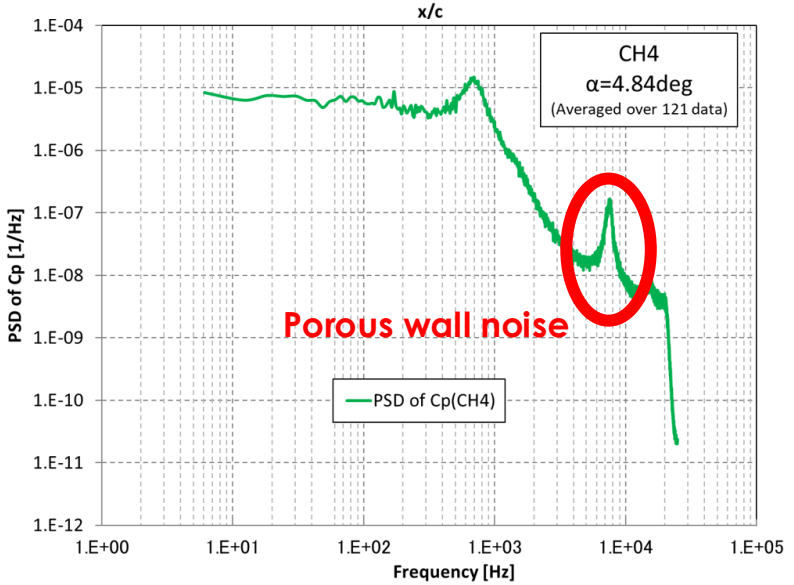
Kulite RMS pressure



Kulite pressure histories



Kulite pressure PSDs



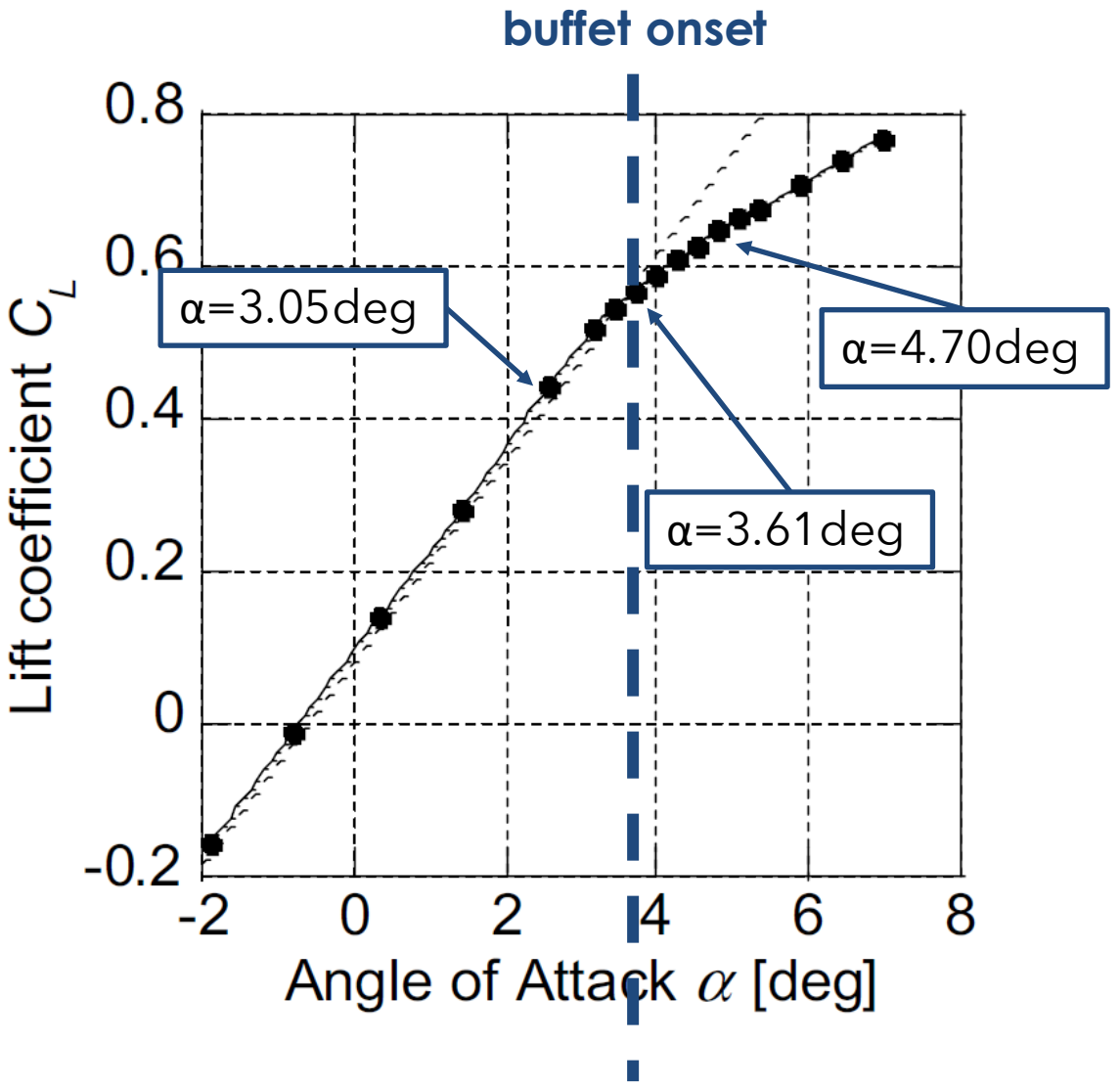
NOTE: fan blade noise is at around 250 Hz (visible at low AoA)

Test Case 3: Experimental Dataset

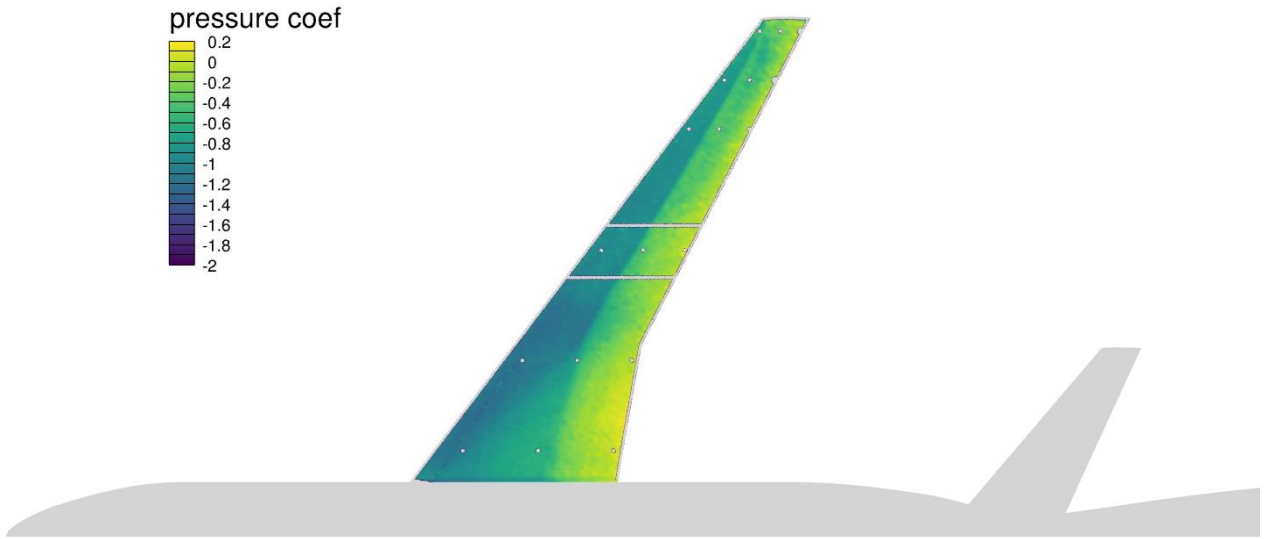
- **Flow conditions:**
  - Mach number = 0.85
  - Reynolds number = 2.27 x 10^6
  - Total temperature = 323.15 K
  - Total pressure = 120 kPa
  - AoA = 3.05, 3.61, 4.70 deg

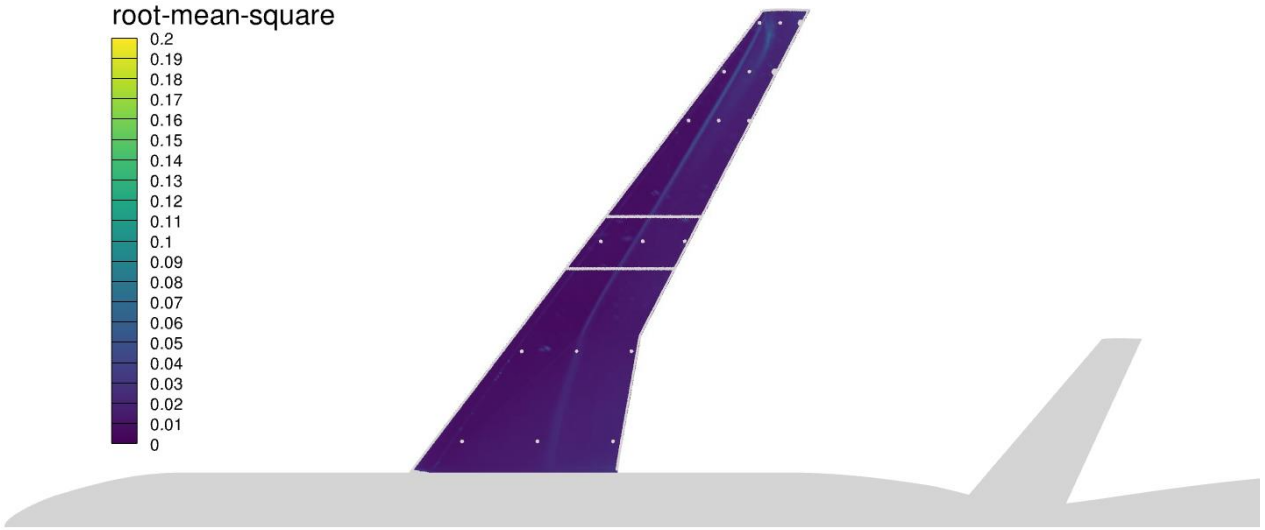
- **Available data:**
  - Forces and moments
  - Wing-root strain gauge
  - Steady pressure ports
  - Kulite sensors (ave, RMS)
  - Kulite sensors pressure histories and PSDs
  - Unsteady PSP (ave, RMS, PSD, fluctuations)
  - Available at:

https://cfdws.chofu.jaxa.jp/apc/dpw/upsp.html



Test Case 3: Experimental Dataset (PSP data)





- **PSP data mapped on the CRM jig shape**
- **.plt files contains (x,y,z) coordinates, "PSP average pressure coefficient" and "PSP RMS pressure" data**
- **Mask has been applied to regions where data are not reliable:**
  - Unsteady pressure sensors lines
  - Markers
  - Areas near model edges

Useful links, reference papers and contacts

- **JAXA Experimental Data Repository:**
  - **Landing page:** https://cfdws.chofu.jaxa.jp/apc/dpw/
  - **Test Case 2 – deformed geometries:** https://cfdws.chofu.jaxa.jp/apc/dpw/geometry.html
  - **Test Case 2 – Experimental data:** https://cfdws.chofu.jaxa.jp/apc/dpw/upc.html
  - **Test Case 3 – Experimental data:** https://cfdws.chofu.jaxa.jp/apc/dpw/upsp.html
- **Reference papers:**
  - JTWT1 and CRM:

    Ueno et al., "Transonic Wind Tunnel Test of the NASA CRM: Volume 1", JAXA Technical Report, 2015
  - Dataset B.1 (Test Case 2):

    Shunsuke Koike, Makoto Ueno, Kazuyuki Nakakita and Atsushi Hashimoto, "Unsteady Pressure Measurement of Transonic Buffet on NASA Common Research Model", AIAA 2016-4044, June 2016.
  - Dataset B.2 (Test Case 3):

    Sugioka, Y., Nakakita, K., Koike, S., Nakajima, T., Nonomura, T., and Asai, K., "Characteristic unsteady pressure field on a civil aifcraft wing related to the onset of transonic buffet", Experiments in Fluids (2021) 62:20
- **Contacts:**
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