Aerodynamic characterisation of fairings in ONERA B2A test bench : pressure drop and laser doppler velocimetry measurements

Fabien Méry (ONERA)

ENODISE Workshop « Advanced Porous,treatment, liners and meta-materilas for engine and airframe noise mitigation »

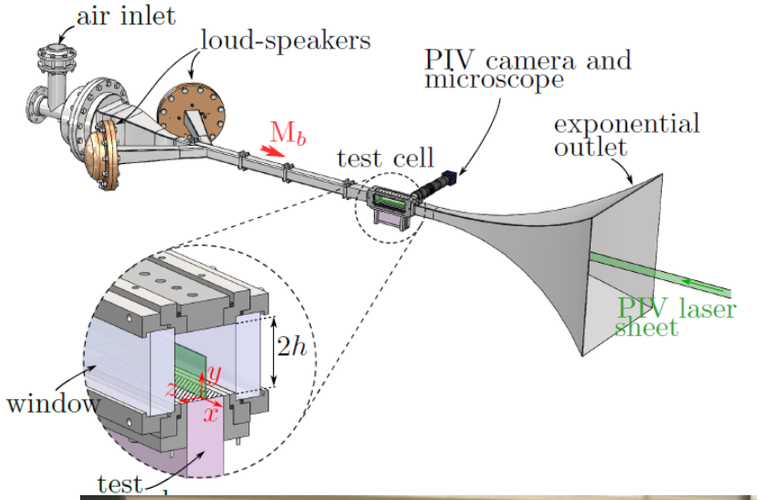
07/11/2022

Outlines

- INVENTOR Setup and test rig
  - B2A Windtunnel
  - Test section setup
- Pressure drop measurement
  - Post-processing
  - Overview
- LDV measurement:
  - Overview
  - Highlights results

INVENTOR Setup and test rig : B2A windtunnel

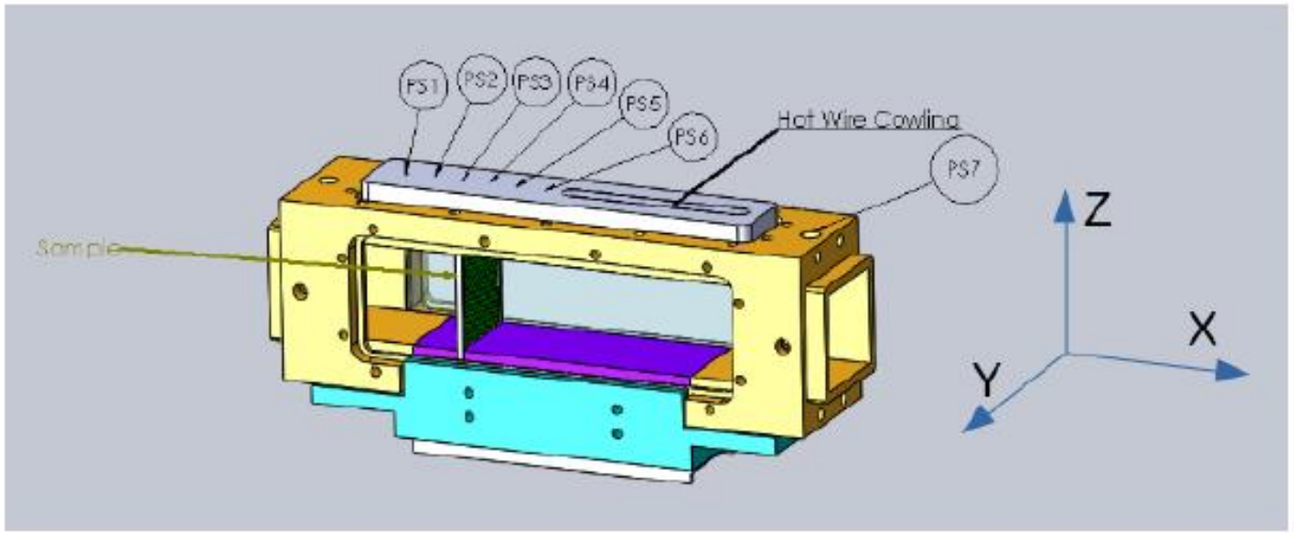
- 50X50mm test section
- Fully developped flow: Bulk Mach Number from 0 up to 0.5
- Freestream turbulence : few percent
- Mass Flow rate regulation and temperature regulation➔Freestream conditions controlled
- Static pressure measurements, LDV measurements, PIV measurements, IR measurements, Microphone mesurements

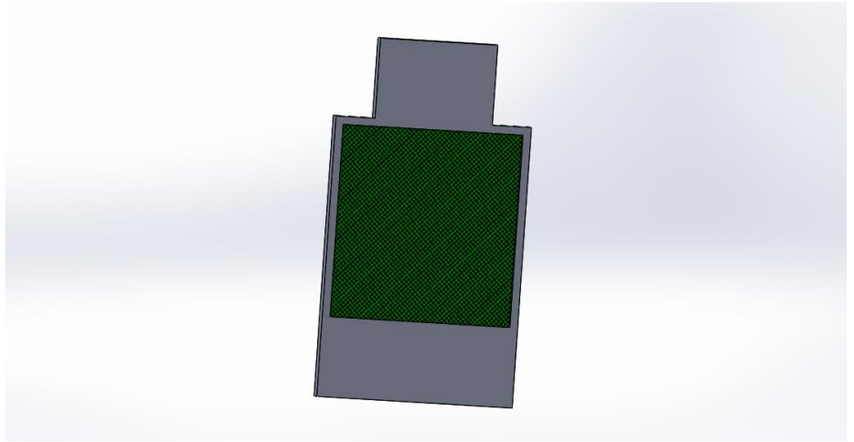




INVENTOR Setup and test rig : Stup

INVENTOR: WTT in B2A





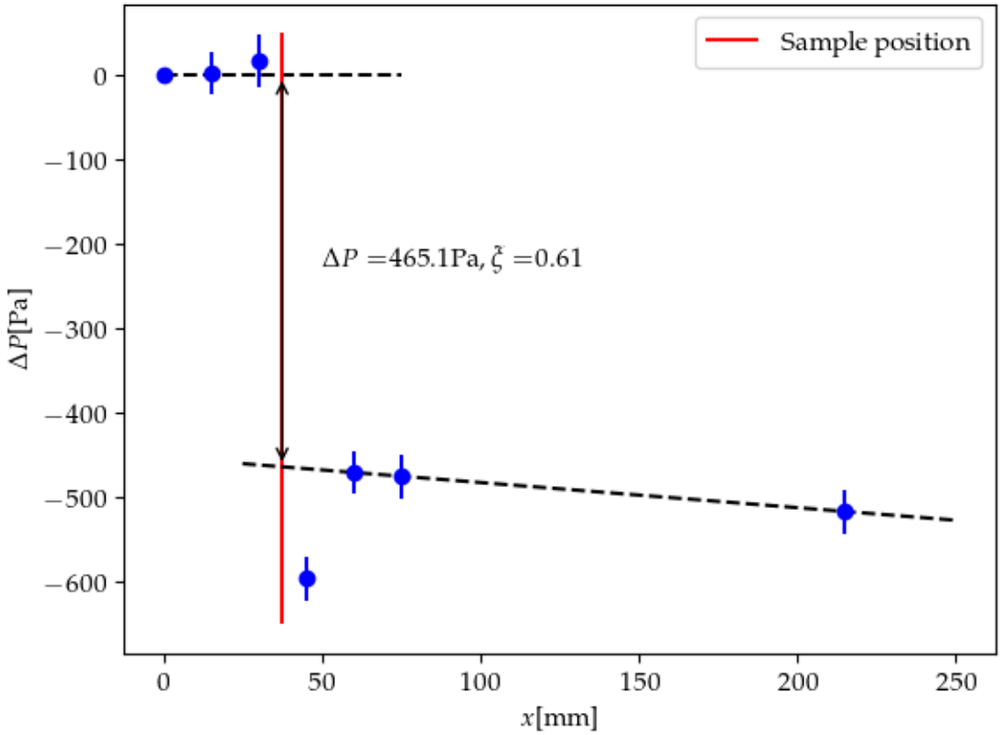
Sample

Mass flow [g/s]	50	75	106
Bulk velocity [m/s]	17	25	36
Reynolds number based on the B2A dimensions	55000	83000	117000

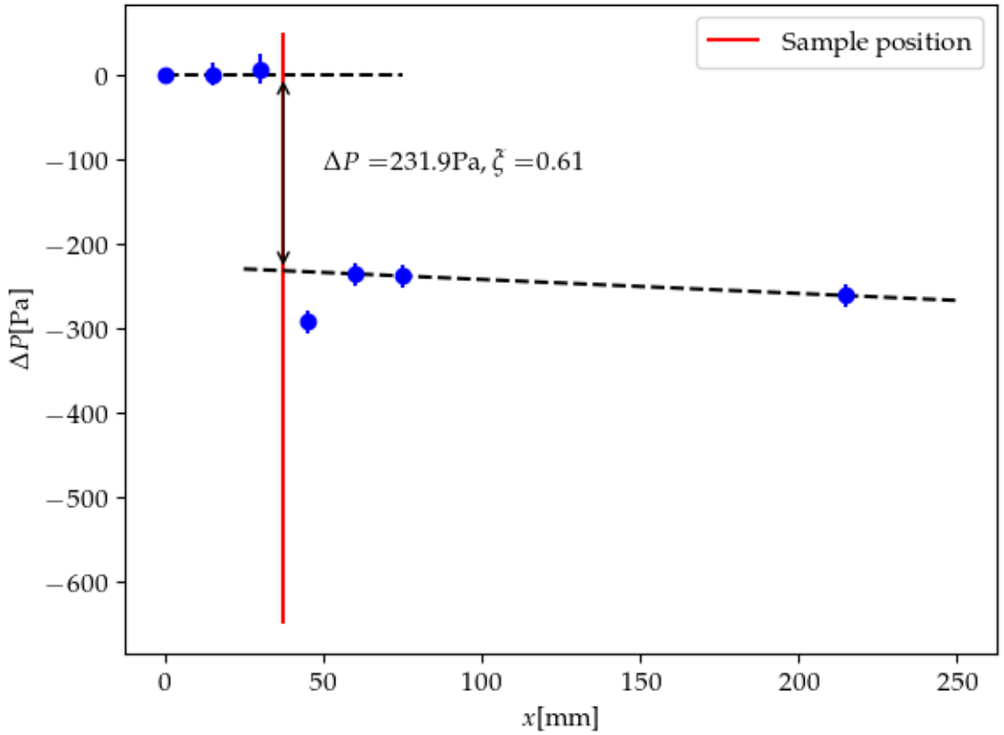
Pressure drop: post-processing procedure

Pressure drop characterization

$$\xi = \frac{\Delta P_i}{\frac{\gamma}{2} P_0 M^2} = \frac{\Delta P_s}{q}$$



17m/s



25m/s

Pressure drop measurement: overview

Pressure drop characterization

$$\xi = \frac{\Delta P_i}{\frac{\gamma}{2} P_0 M^2} = \frac{\Delta P_s}{q}$$

Mass flow [g/s]	50	75	106
Bulk velocity [m/s]	17	25	36
WM Vide4Fil1	0.60	0.61	0.61
SCP D5T6e1	1.21	1.24	1.17
SCP D4T6e1	3.27	3.35	3.22
SCP D2T3e2	2.88	2.60	2.70
SCP D2T3e1	5.03	5.16	5.16
HP	4.13	4.51	4.41
OPAL D2T3.2Phi30e1	13.45	13.99	14.99
Diamond Grids 2.5mm	110.4	117.5	177.6
Diamond Grids 4.5mm	62.2	65.6	70.77
WM DLR	56.88	54.54	56.36

Pressure drop measurements

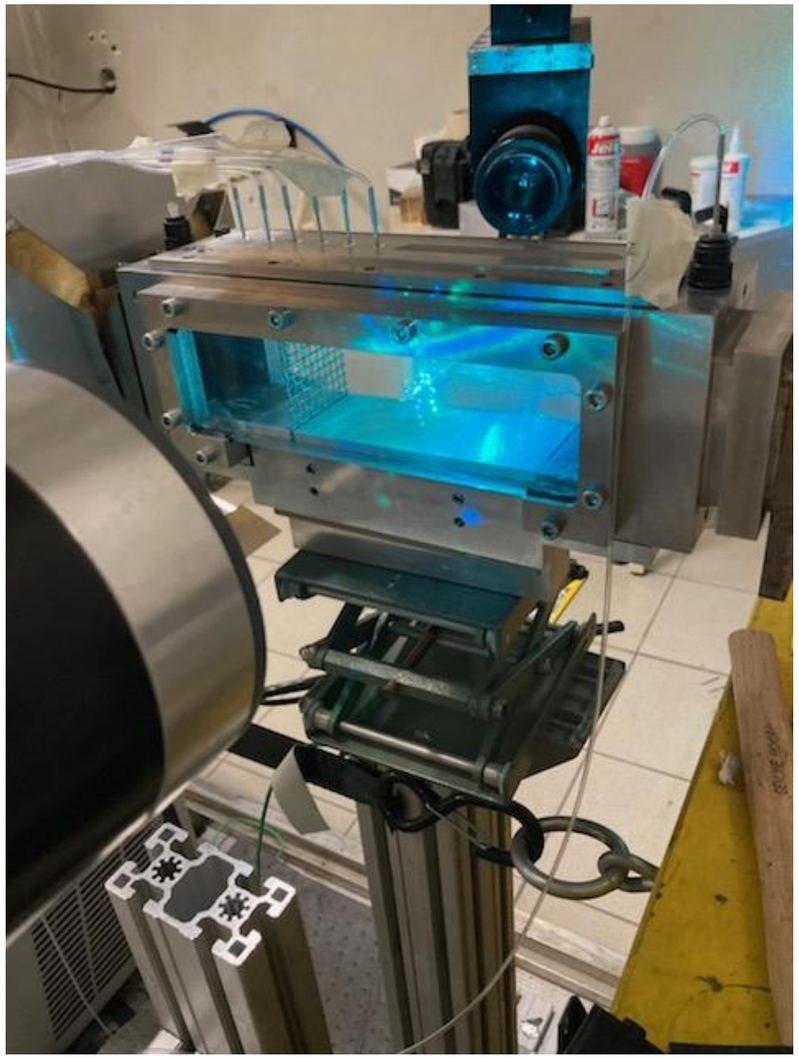
LDV measurements : overview

4 LDV planes (X,Y), U and W component :

- 1 plane upstream (-12mm) the sample
- 3 planes downstream (35,81,128mm) the sample

Mass flow [g/s]	50	75	106
Bulk velocity [m/s]	17	25	36
WM Vide4Fil1	Stats_wmon_50gs_en.dat	Stats_wmon_75gs_en.dat	Stats_wmon_106gs_en.dat
SCP D2T3e2	Stats_scp_50gs_en.dat	Stats_scp_75gs_en.dat	Stats_scp_106gs_en.dat
Diamond Grids 4.5mm	Stats_tud_50gs_en.dat	Stats_tud_75gs_en.dat	-

Mass flow [g/s]	50	75	106
Bulk velocity [m/s]	17	25	36
WM Vide4Fil1	WMON1	WMON2	WMON3
SCP D2T3e2	SCP1	SCP2	SCP3
Diamond Grids 4.5mm	TUD1	TUD2	-



LDV measurements:
Highlights on the Wiremesh Vide4Fil1

Upstream

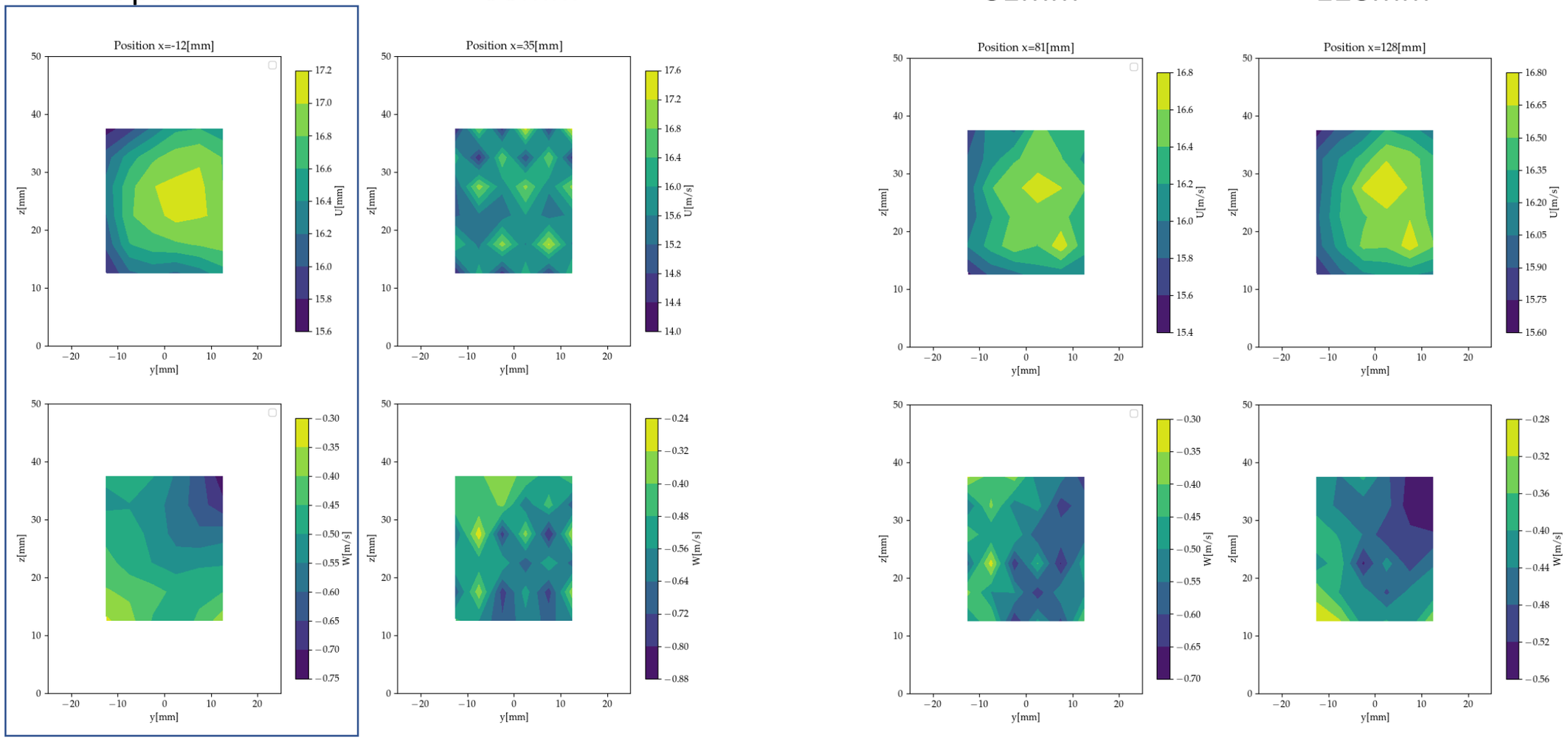
38mm

81mm

128mm

U (m/s)

W(m/s)



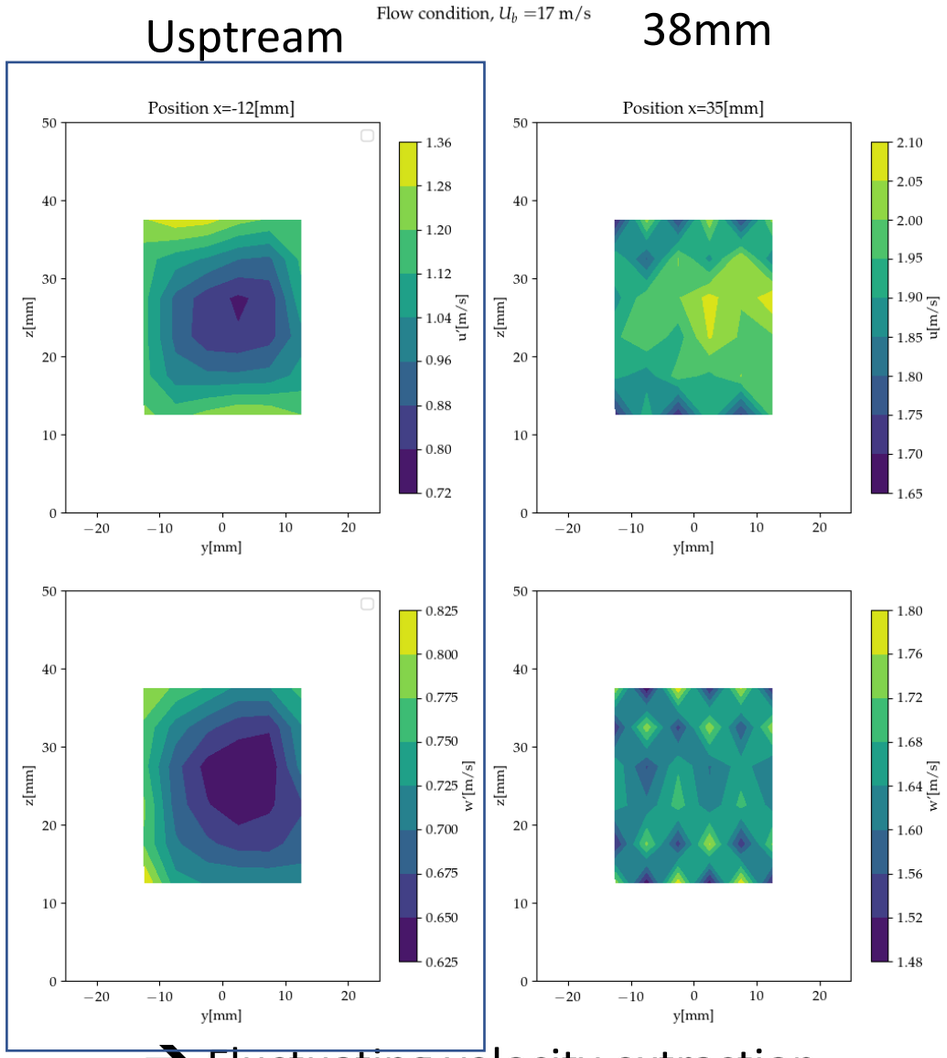
LDV measurements:
Highlights on the Wiremesh Vide4Fil1

Usptream

38mm

u’ (m/s)

w’ (m/s)

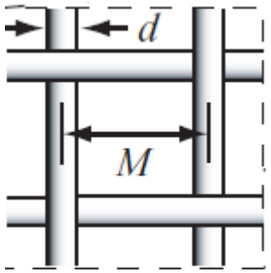


➔ Fluctuating velocity extraction

LDV measurements:
Highlights on the Wiremesh Vide4Fil1

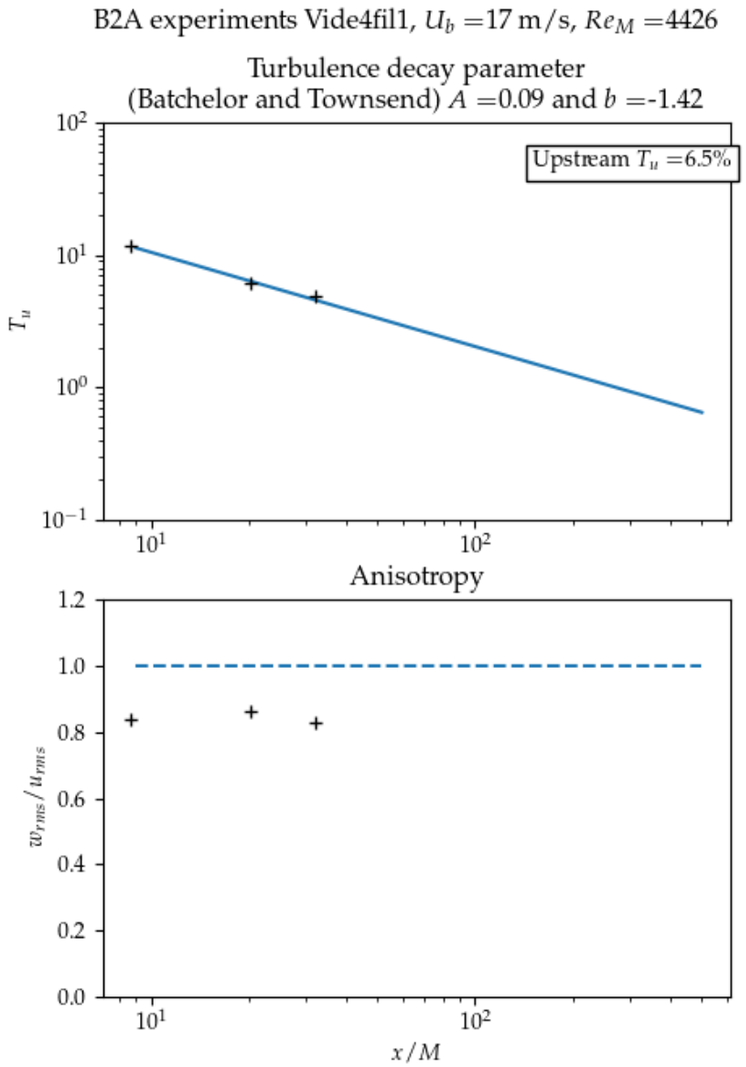
Batchelor &Townsend,1948, decay:

$$Tu^2 = \left(\frac{u_{\mathrm{rms}}}{U_0}\right)^2 = A\left(\frac{x - x_0}{M}\right)^b,$$

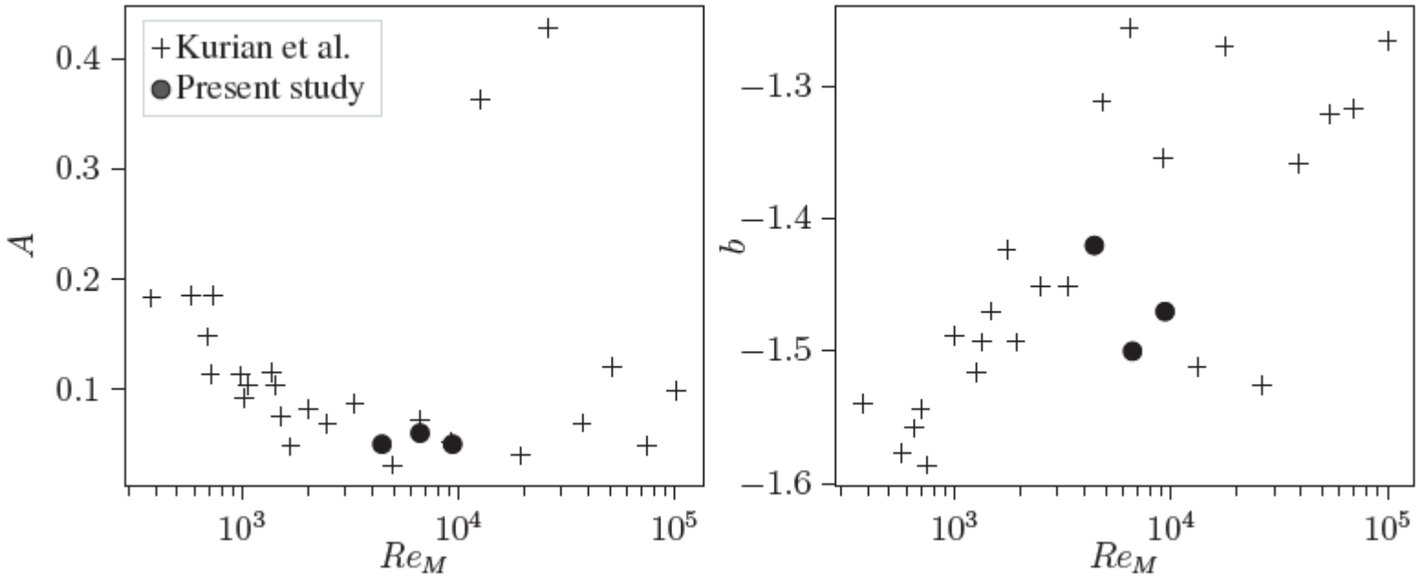


INVENTOR
M=4mm, d=1mm

Kurian&Fransson, Grid generated turbulence revised, 2009, Fluid Dyn. Res. 41 021403



LDV measurements:
Highlights on the Wiremesh Vide4Fil1



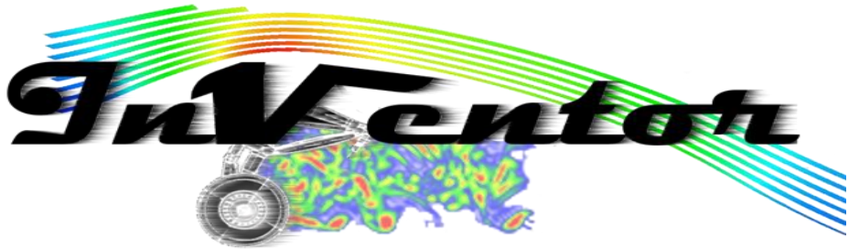
LT5
➔ M=4.2mm, d=0.9mm

INVENTOR
➔M=4mm, d=1mm

Kurian&Fransson, Grid generated turbulence revised, 2009, Fluid Dyn. Res. 41 021403

Conclusion

- Available data base with both pressure drop measurement and LDV measurement DOI : **10.5281/zenodo.7052546**
  - **Raw data**
  - **Python code for rapid post-processing**
  - **Data paper**
- **Data paper : Aerodynamic characterisation of fairings in ONERA B2A test bench : pressure drop and laser doppler velocimetry measurements, Scientific Data, under review.**



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