



LOW-SPEED WIND TUNNEL FACILITY FOR CFD VALIDATION

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FIFTH INTERNATIONAL WORKSHOP

COMPUTATIONAL
EXPERIMENT
IN AEROACOUSTICS



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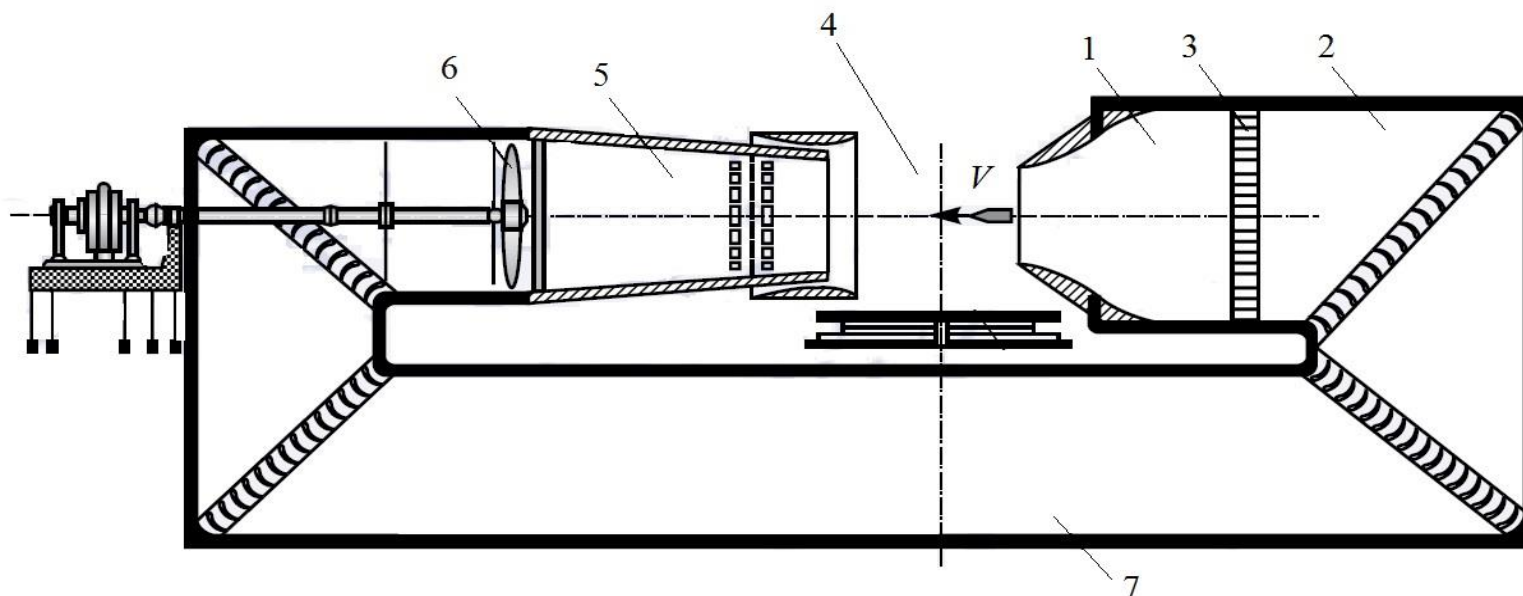
Outline

- Motivation and objectives;
- T-1K wind tunnel and its possibilities;
- Rotor rig of the T-1K;
- Anechoic chamber of T-1K description;
- MLS research brief description;
- Example experiment description;
- CFD validation example;
- NACA-0012 rotor experiment description.

Motivation and objectives

- The key mission of the project is a modification of the conventional low-speed, closed-circuit wind tunnel with opened test section for aeroacoustic measurements;
- Essential part of the work is finding the most convenient test object;
- First target is a creation of the anechoic chamber around the test section;
- Second target is an acquiring an experimental database suitable for CFD validation;
- In this presentation, all the results are for hover mode.

T-1K wind tunnel of KNRTU-KAI, Kazan



1. Nozzle
2. Prechamber
3. Honeycomb
4. Test section
5. Collector
6. Fan
7. Returning channel

Characteristics:

Wind tunnel: low-speed, closed-circuit with opened test section

Wind speed, m/s up to 50

Initial turbulence intensity less than 0,5%

Test section diameter, m 2,25

Test section length, m 3

Experimental measurement systems



Distributed characteristics measurement systems:

- Dantec 3D PIV system;
- Dantec 3D LDA system;
- Dantec 6-channel CTA system;
- High-speed camera;

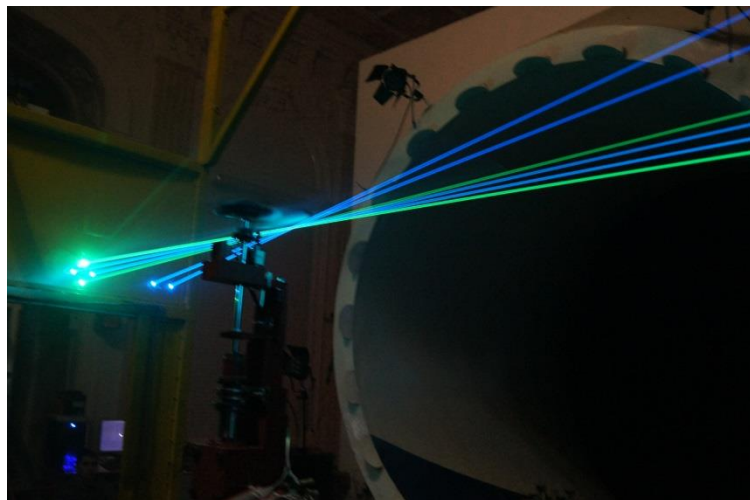
Conventional measurement systems:

- Pressure distribution measurements: 128 channel Scanivalve system;
- High-frequency pressure measurement : 20 Endevco piezo sensors;
- Integral loads: two 6-channel balances: high-load and small-load;

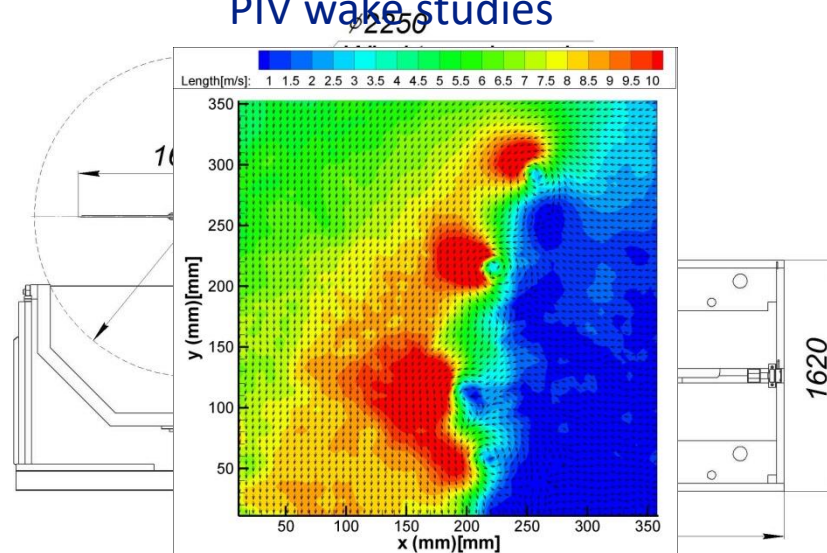
Acoustic measurement systems:

- Acoustic chamber;
- CAE Acoustic camera;
- Proprietary system based on DBX RTA-M and National Instruments technique;

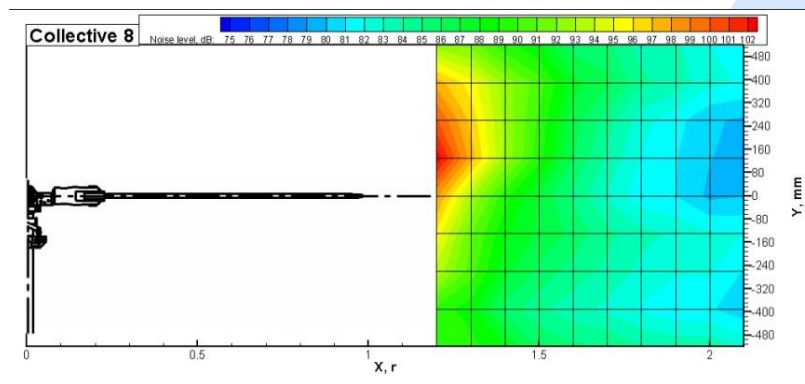
Rotor rig researches



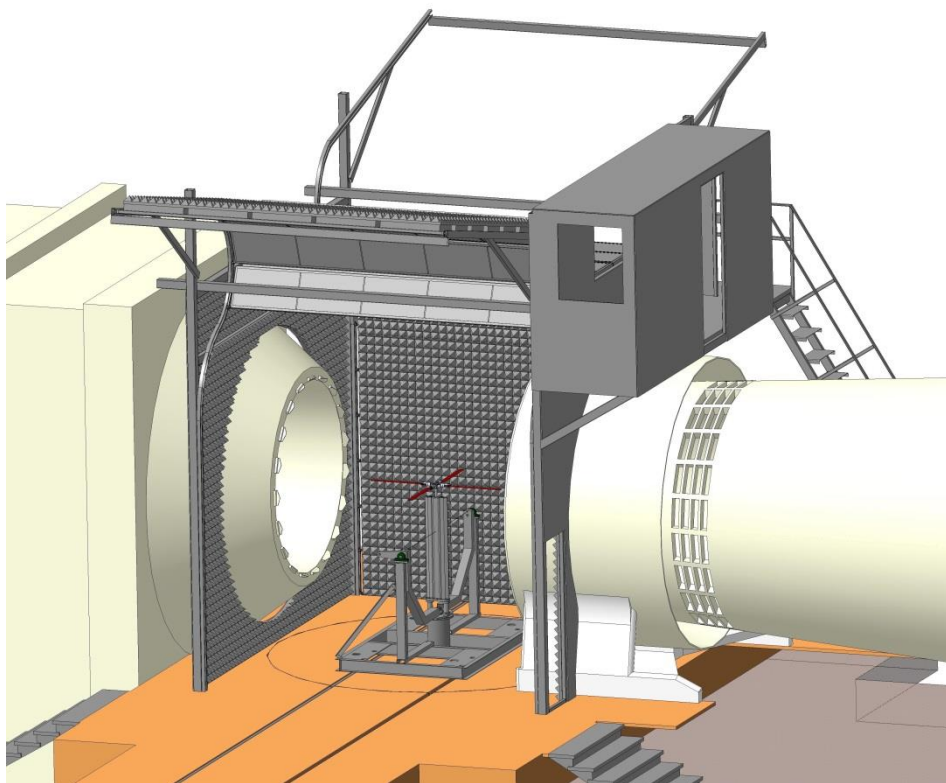
PIV wake studies



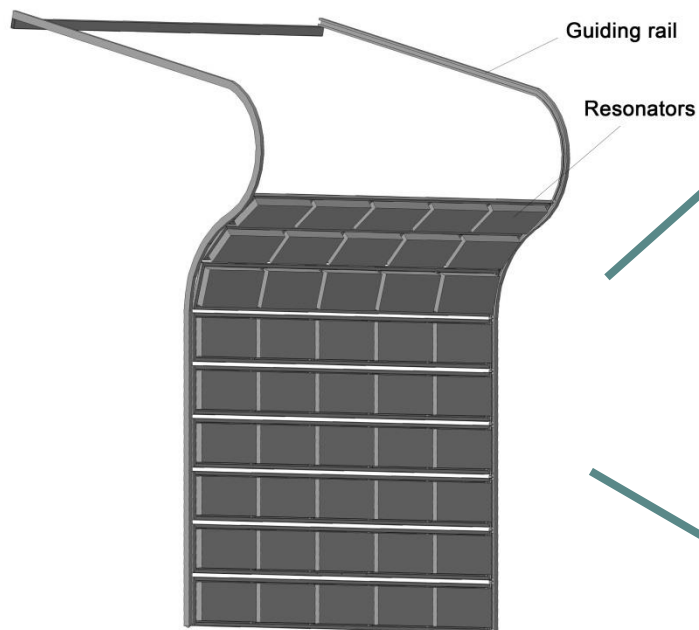
Rotor rig schematic Acoustic researches



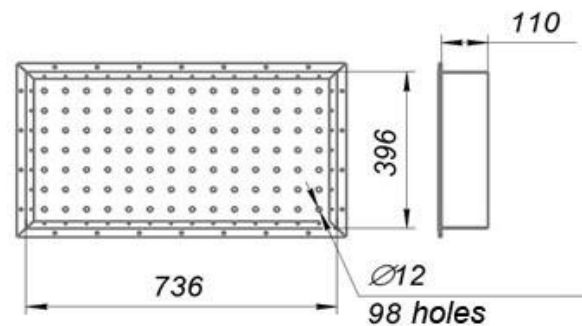
Anechoic chamber



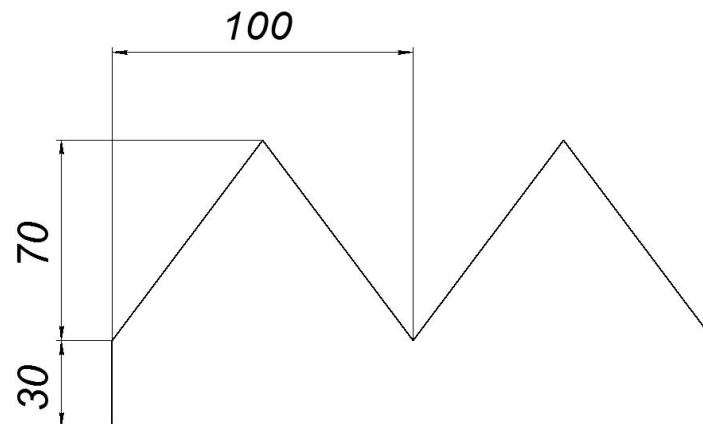
Anechoic walls



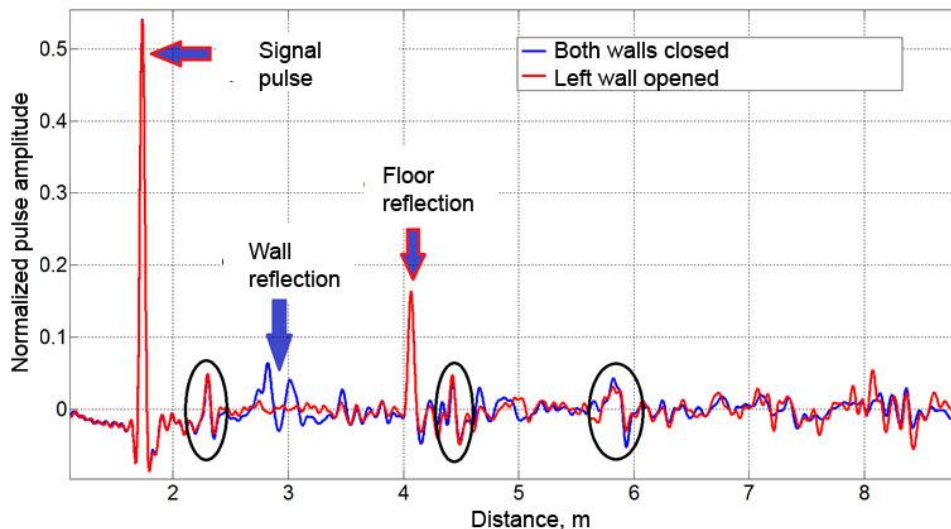
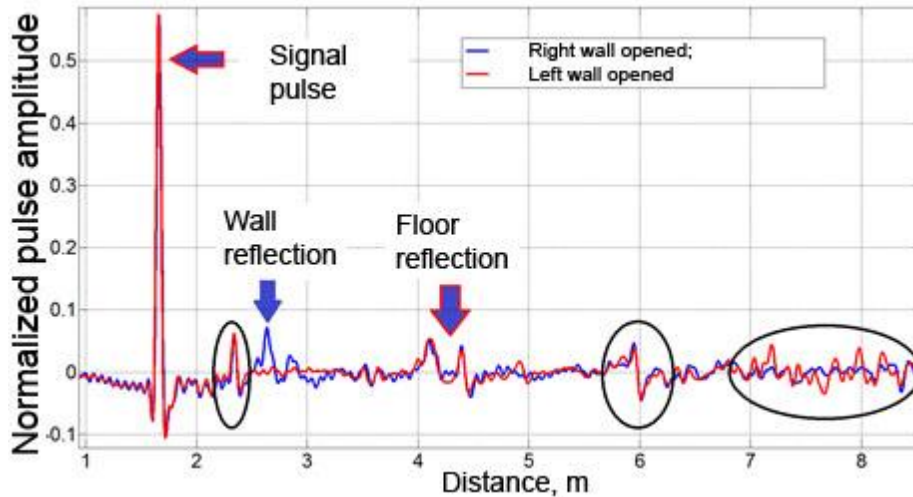
Layer 1: Helmholtz resonator:



Layer 2: Melamin-based anechoic material for 1-4 KHz:

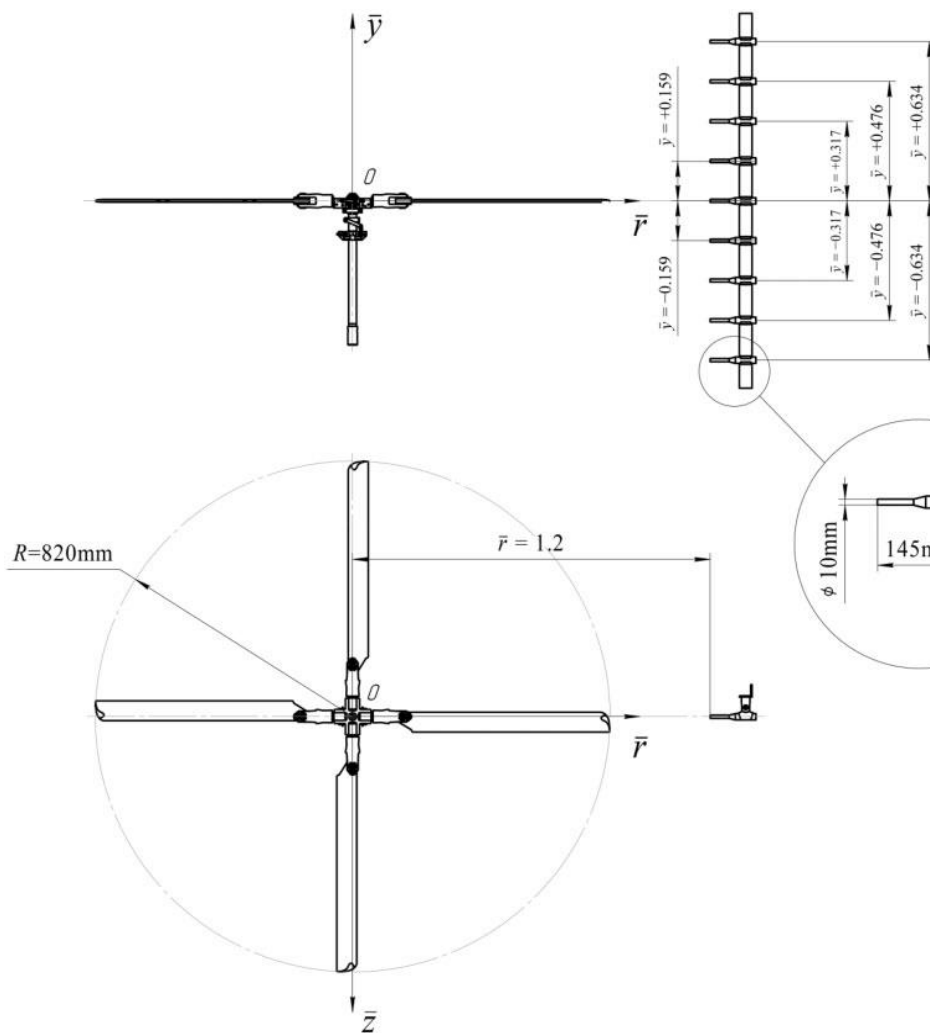


Anechoic chamber MLS research

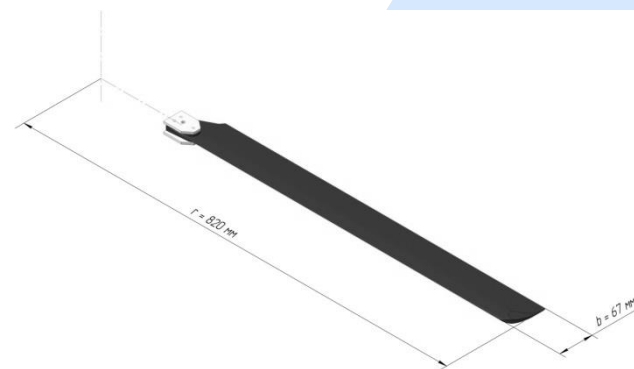
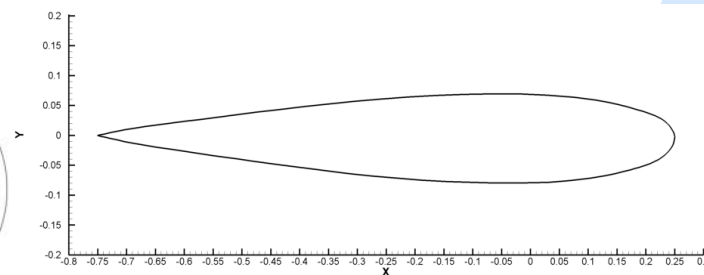


- Both walls closed case is acoustically most drownd out test section of the T-1K wind tunnel;
- Overall reflections amplitude is 6-6,5 times less than initial signal;
- Reflection analysis shown that for all retractable walls open-closed configurations the biggest parasite contribution to the signal caused by the closest retractable wall. Main microphones positions has been tested. Also floor contribution is clearly seen.

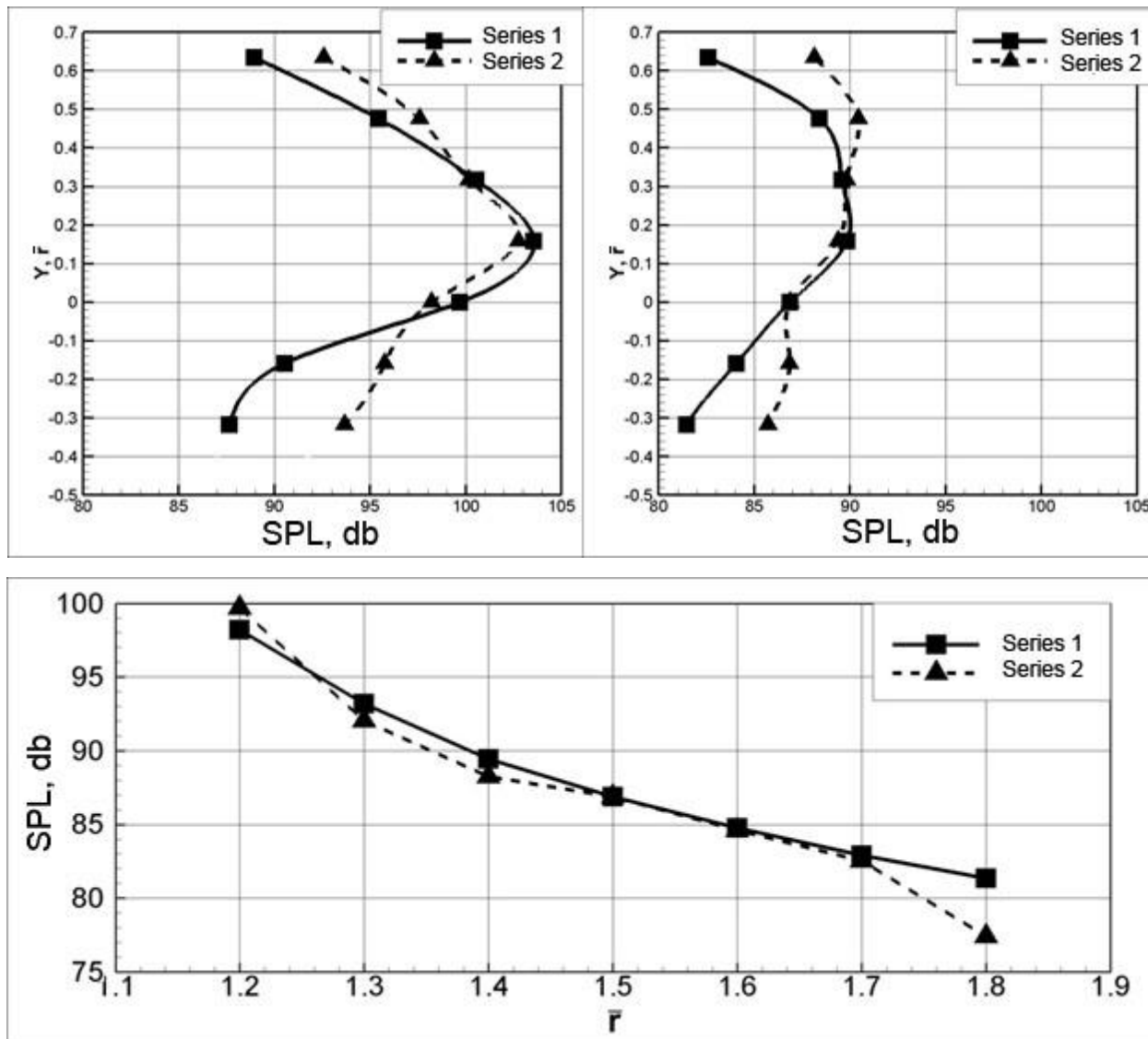
Rotor rig test results: test stand



Rotor diameter	1640 mm
Blade chord	67 mm
Tip	Parabolic

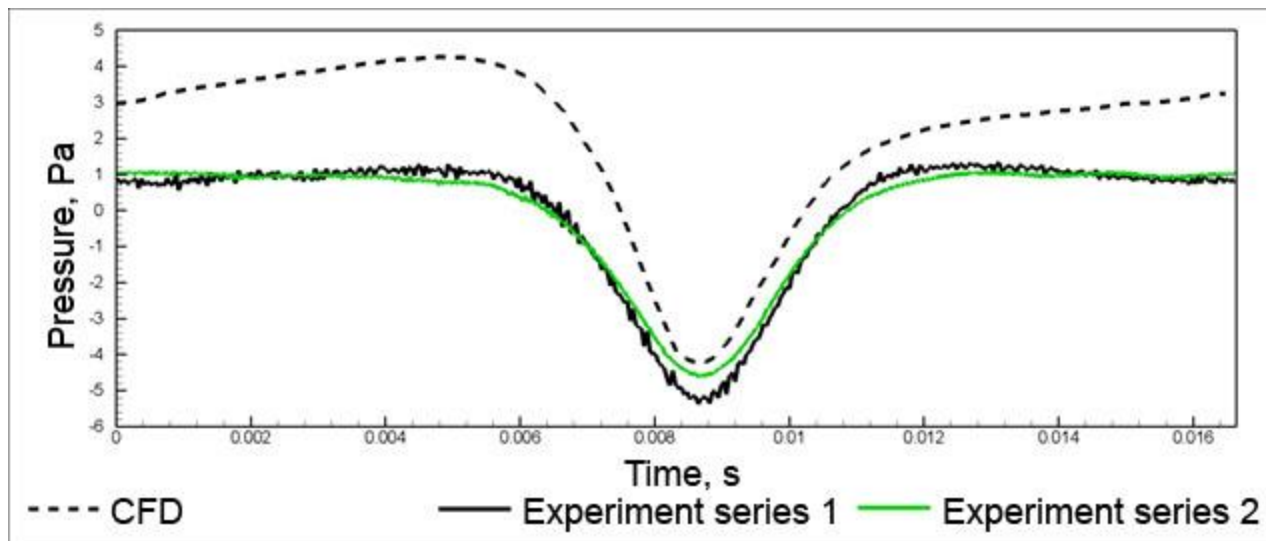


Rotor rig test results: overall SPL

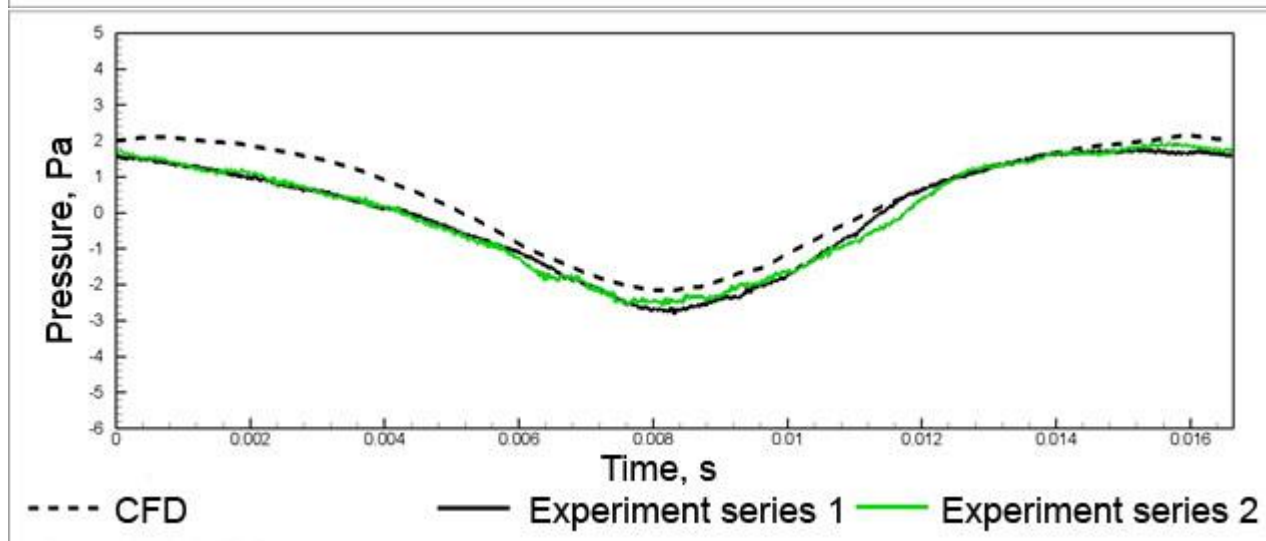


Rotor rig test results: CFD validation case

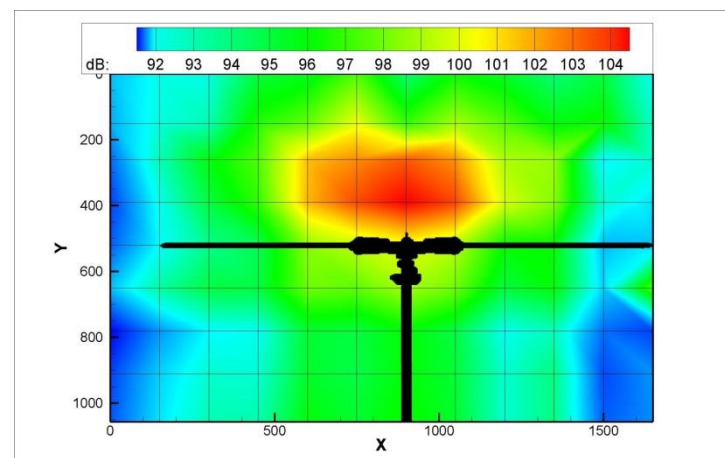
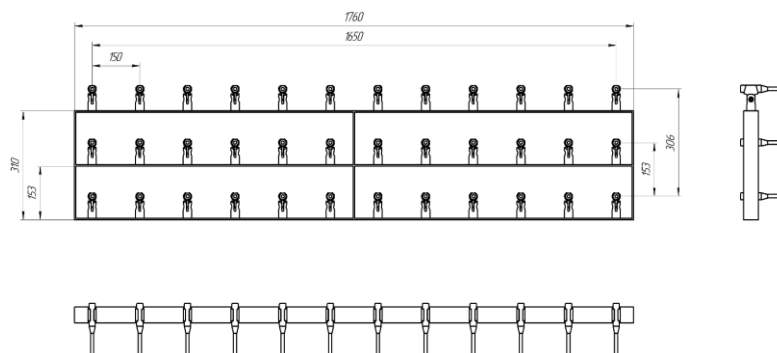
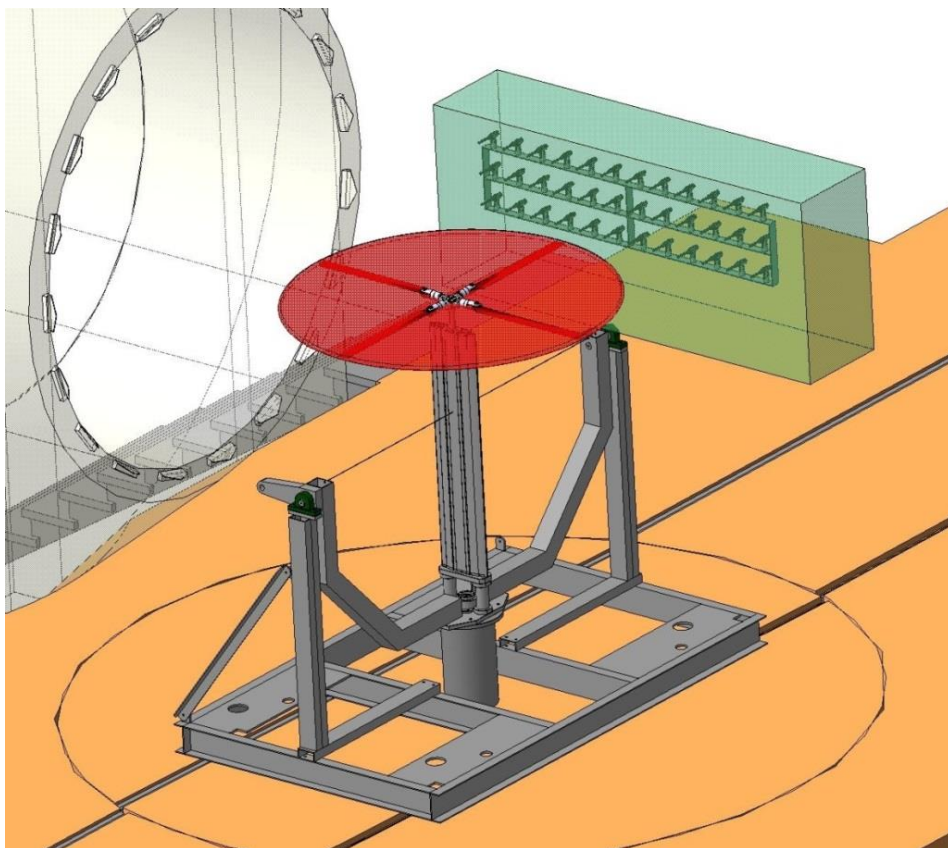
For $\bar{y} = 0$



For $\bar{y} = 0,476$



Rotor rig test results: NACA-0012 experiment



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Thank you for attention!