Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin
National Metrology Institute

Performance of the LDA Volumetric Flow Rate Standard Under Severly Disturbed Flow Conditions

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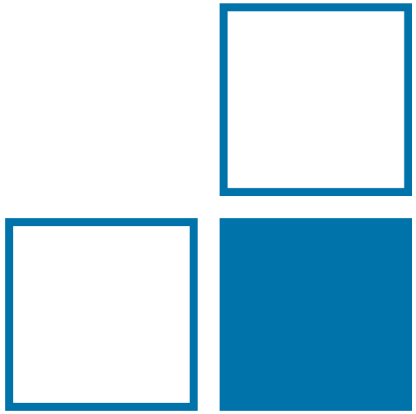
Working Group 7.52
Volume Flow Rate



Motivation

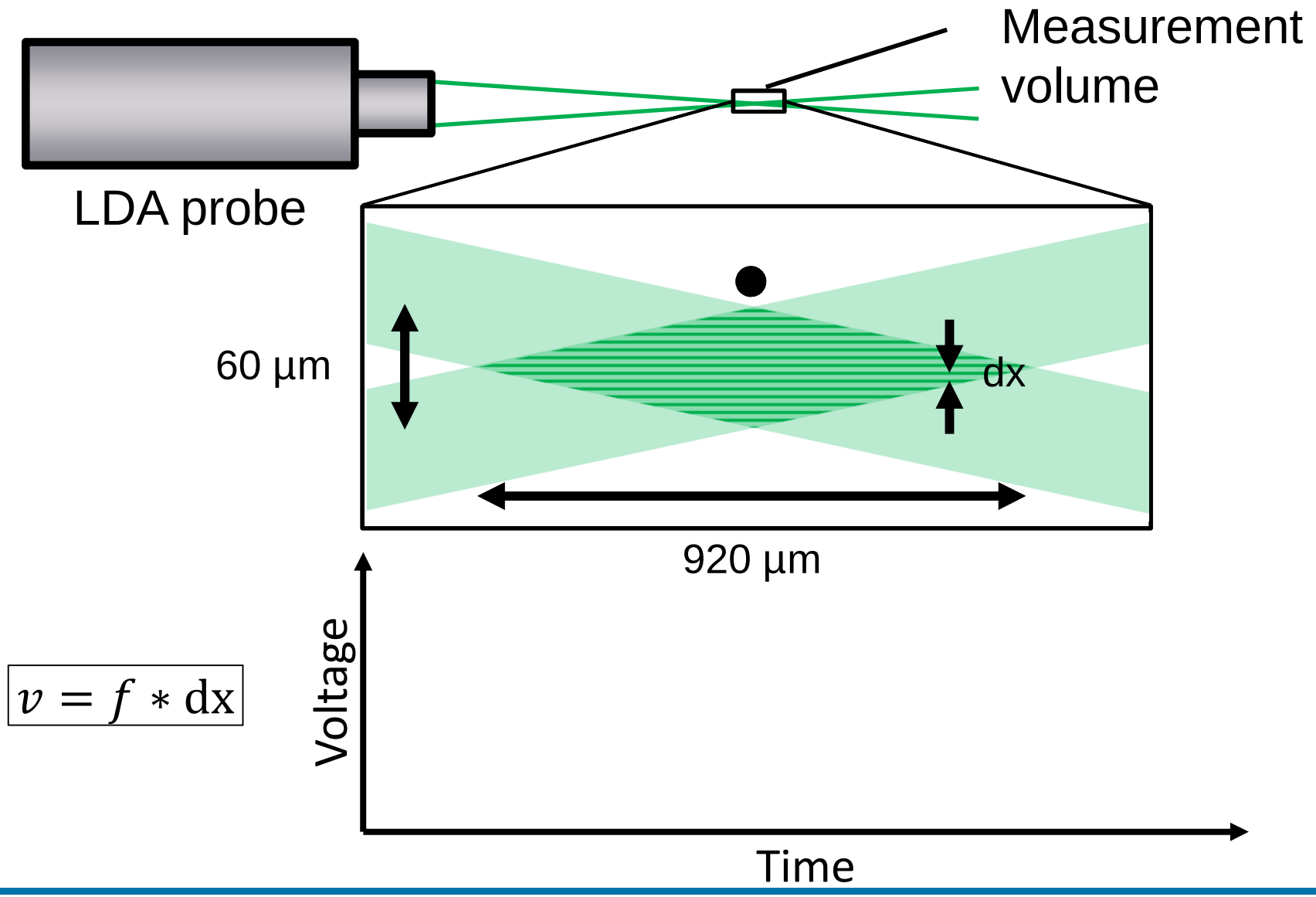
- High T/P, disturbances and aging effects
- Elevated flow rate uncertainties in thermal power plants (up to 2 %)

Laser-optical flow rate measurement

- On-site calibration and monitoring
- Potential for process optimization
- Other high temperature applications
- Transfer Standard

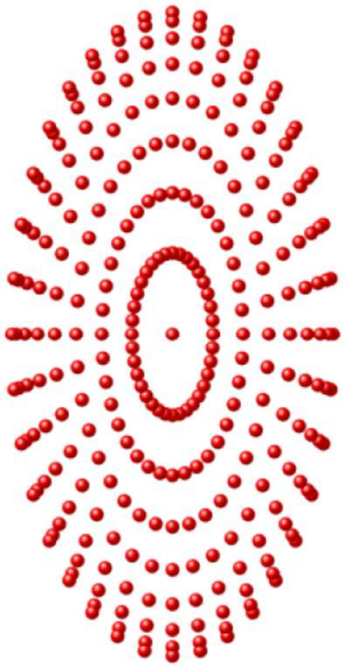
SIFAB

Laser Doppler Anemometry (LDA)



$$v = f * \mathrm{dx}$$

Determination of the volumetric flow rate

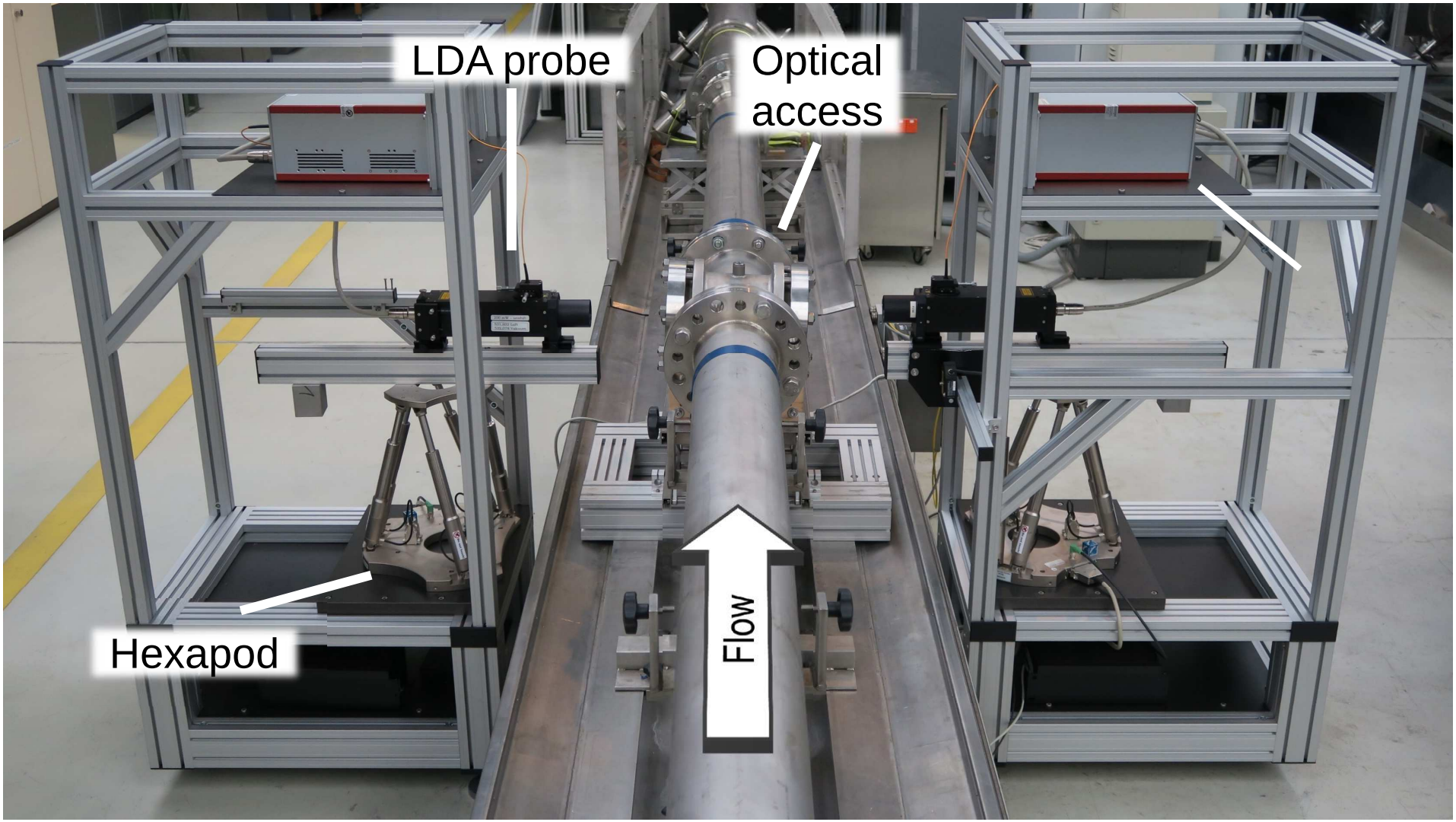


Measurement grid

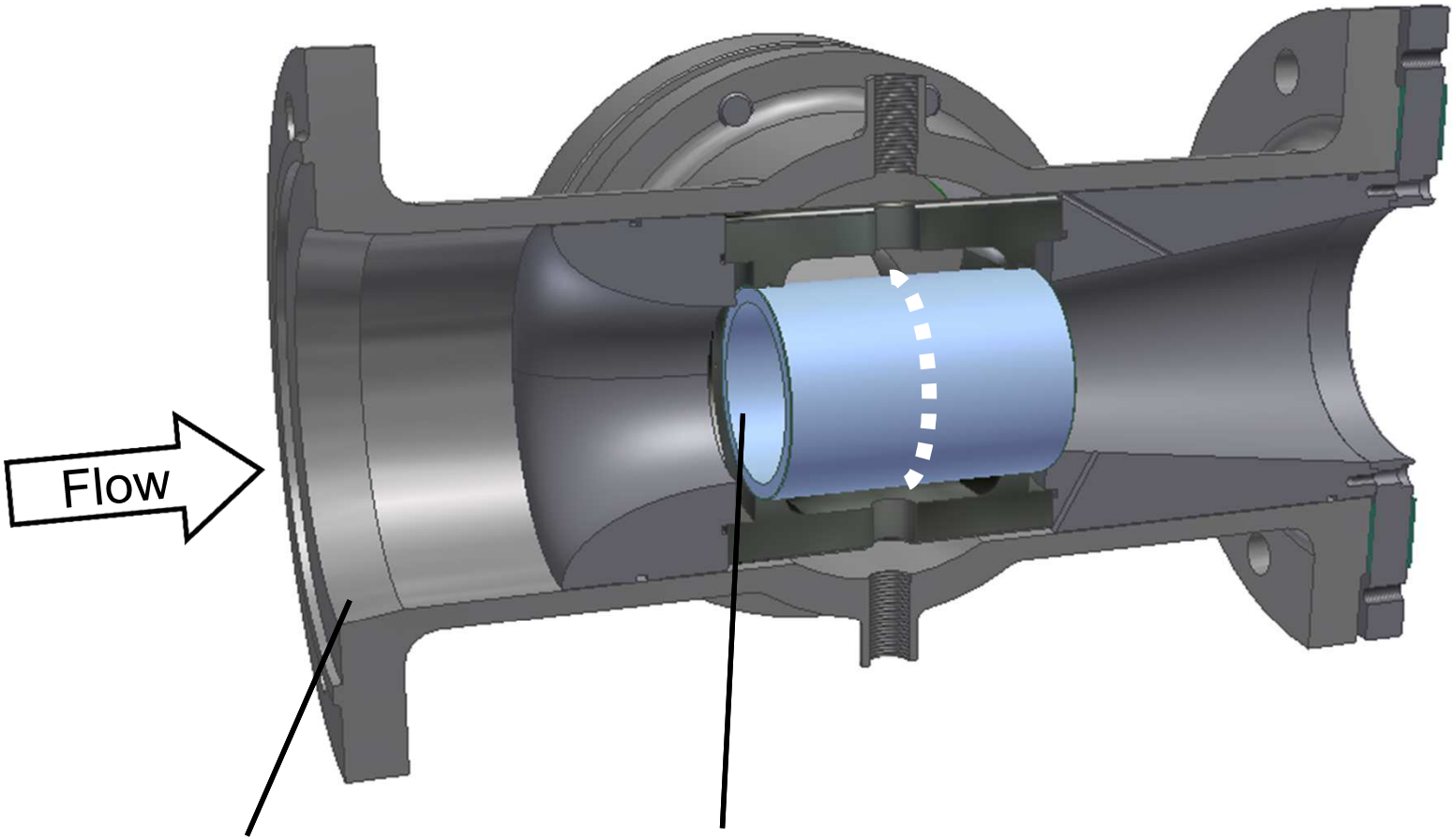
Velocity profile

Volumetric flow rate

LDA Volumetric Flow Rate Standard



Optical access

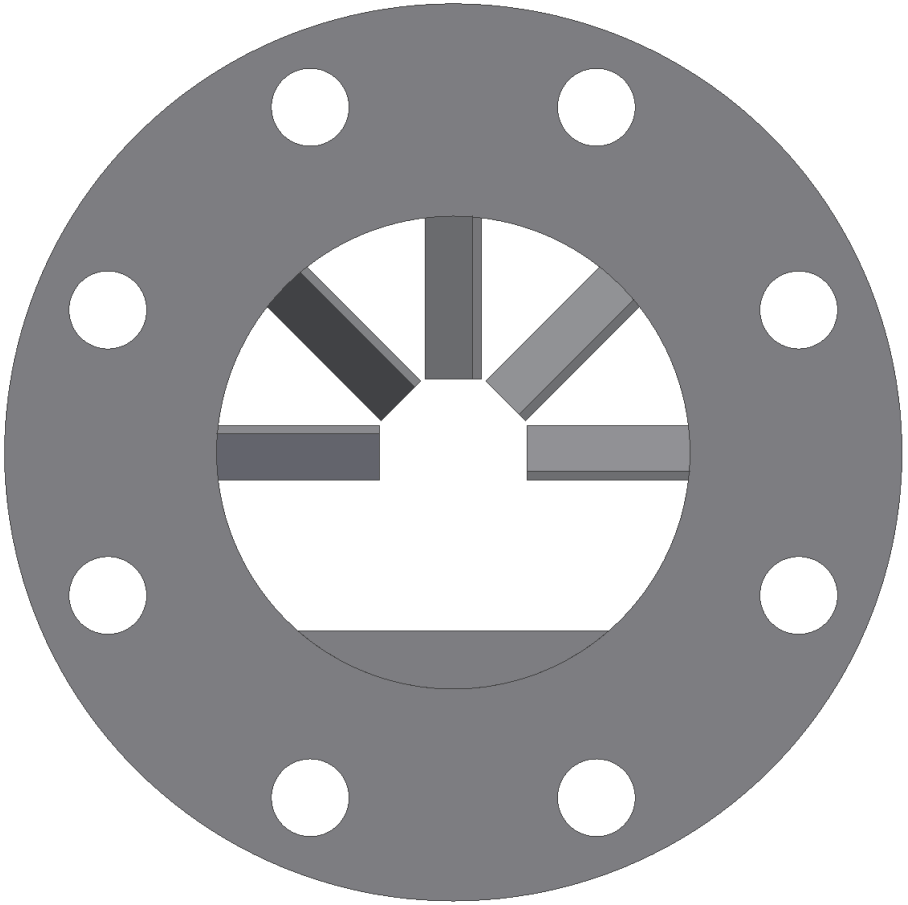


Heat water calibration rig

- Gravimetric method
- T = 3 to 90 °C
- Q = 3 to 1000 m³/h
- $U \leq 0.04$ % (k=2)

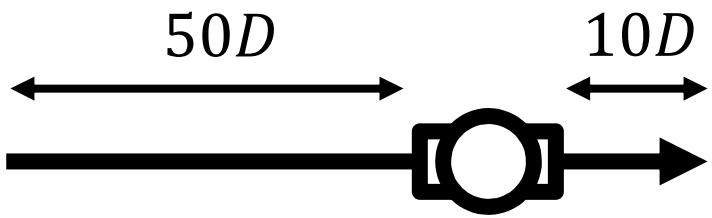
Asymmetric swirl disturbance generator

- Proposed by Tawackolian
- 5 angled blades
- Plate covering 7 % of area

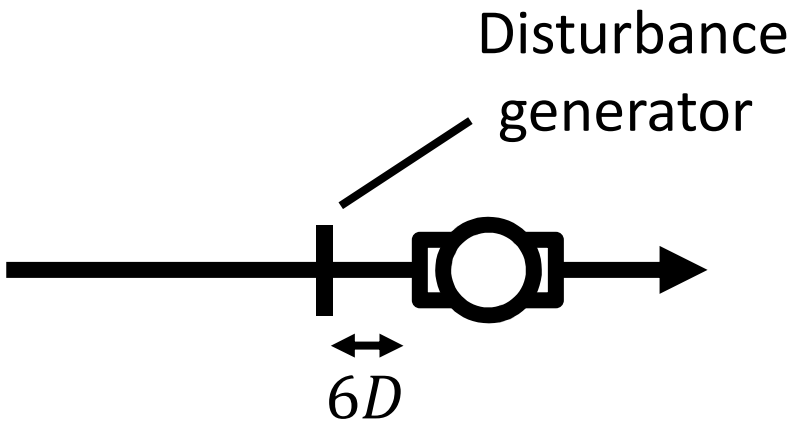


Test parameters

- Configuration 1 – undisturbed:

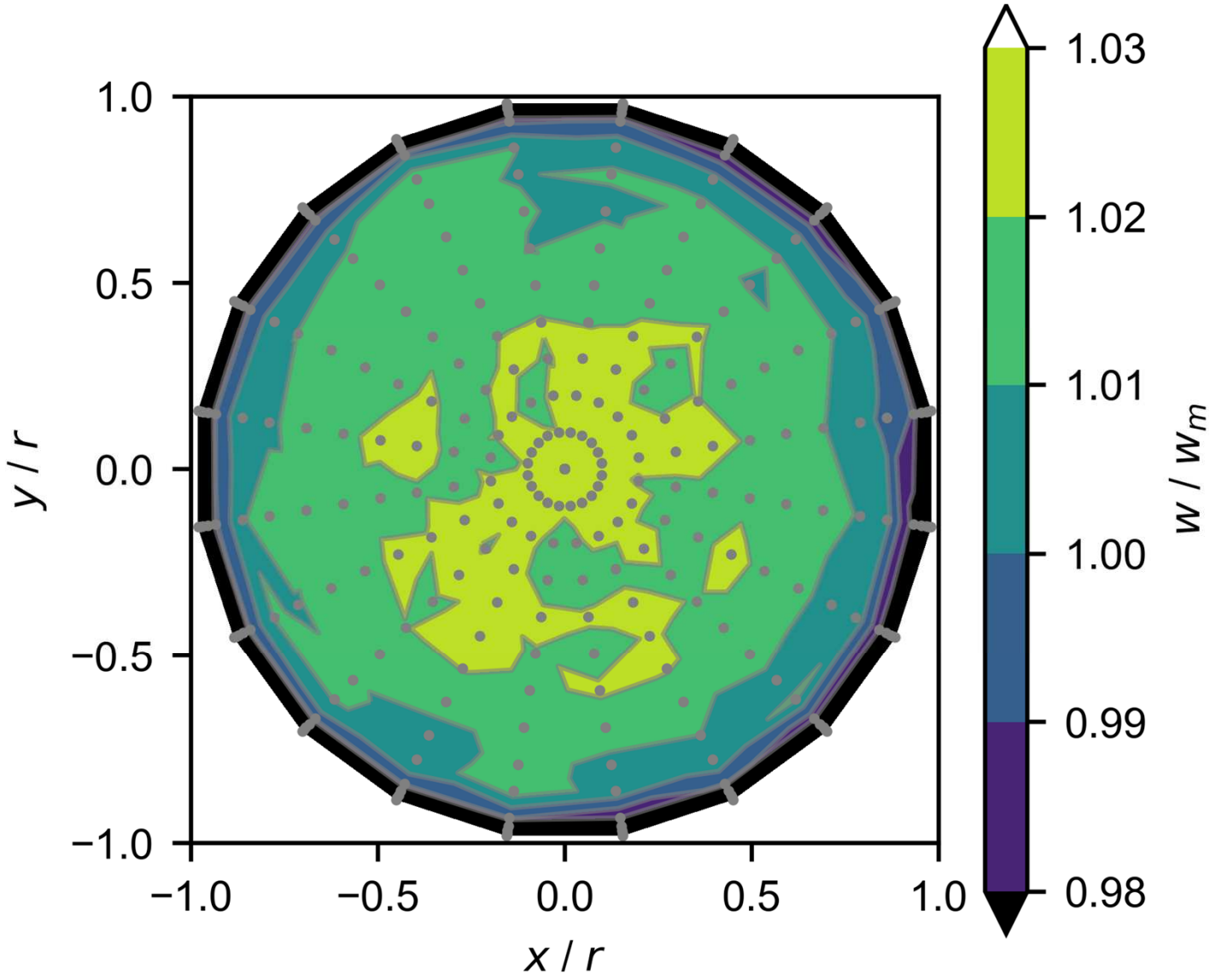


- Configuration 2 – disturbed:

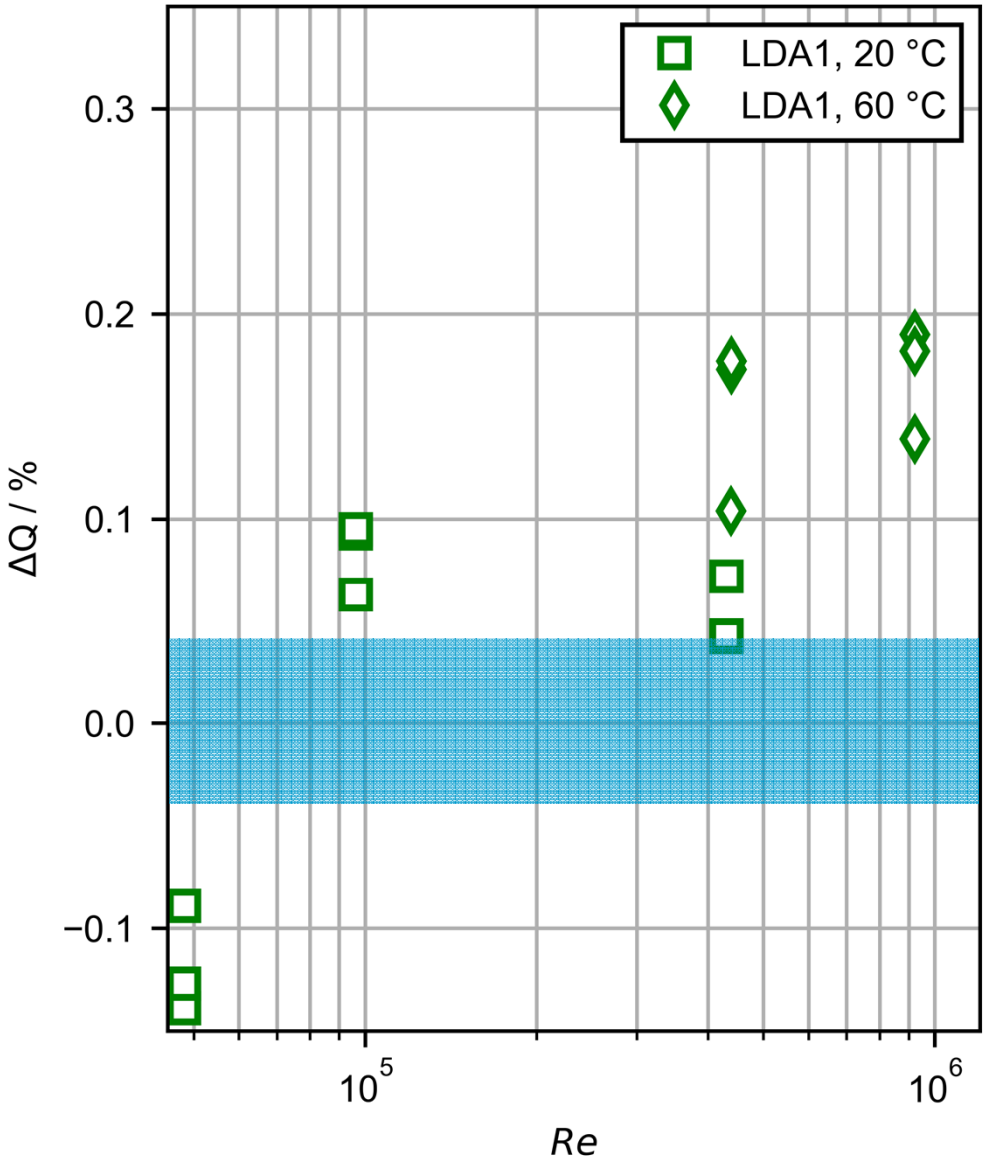


Nr.	T / °C	Re / 10^3
1	20	50
2	20	100
3	20	450
4	60	450
5	60	945

Results – Undisturbed



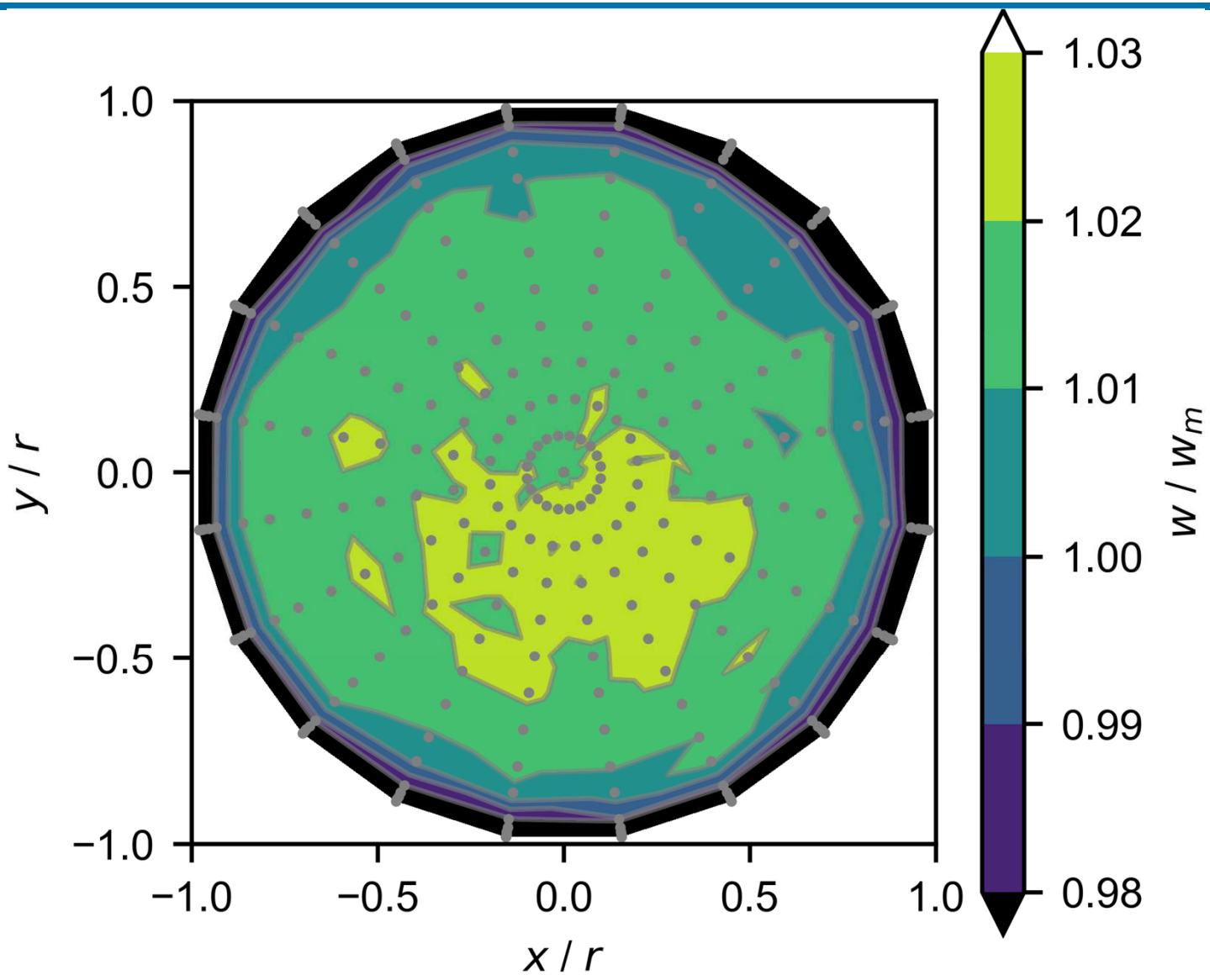
Results – Fully developed turbulent flow



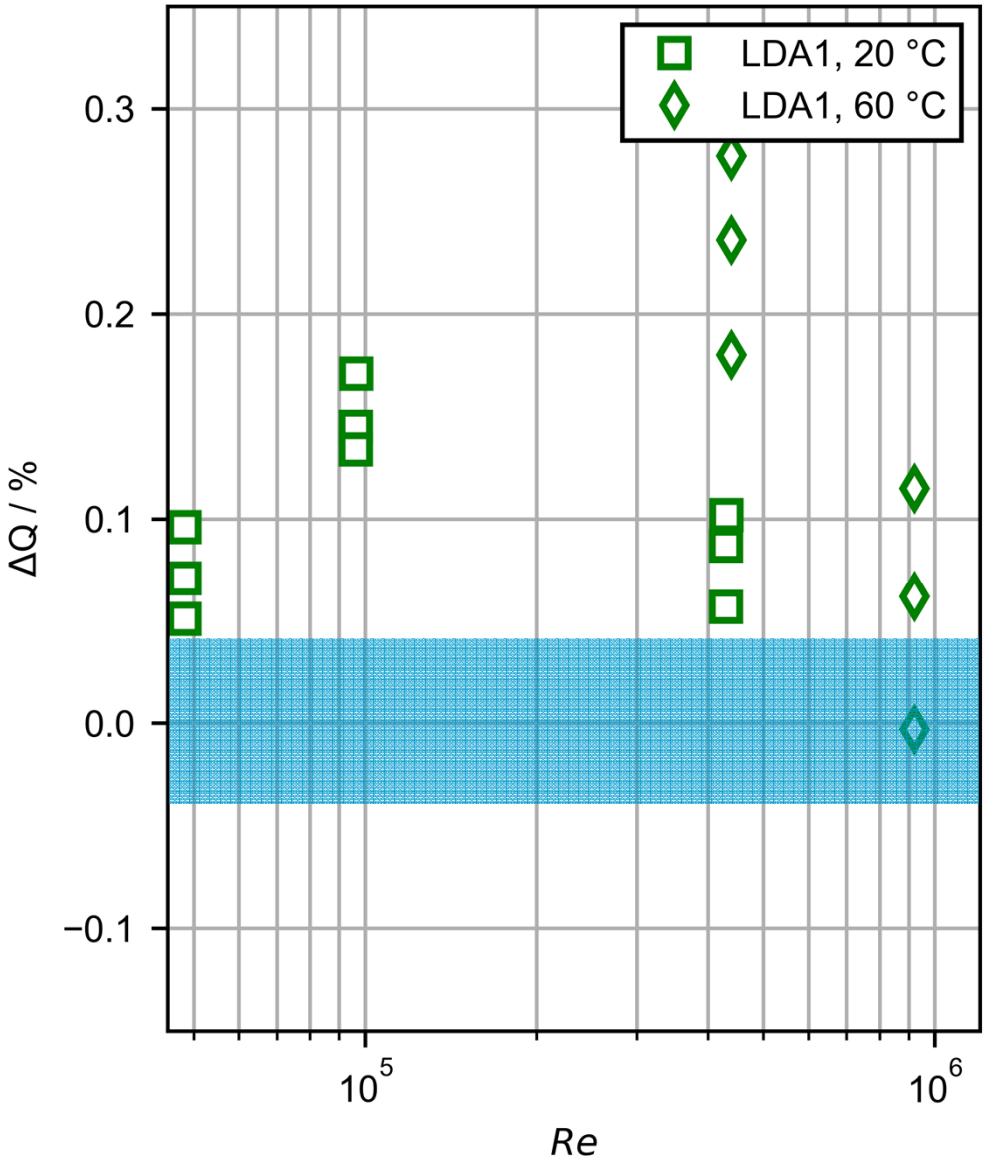
$$\Delta Q = 100 \frac{Q_{LDA} - Q_{ref}}{Q_{ref}}$$

$\max(\Delta Q)$	0.21 %
$\max(\Delta Q_{LDA})$	0.14 %

Results – Disturbed flow conditions



Results – Disturbed flow conditions

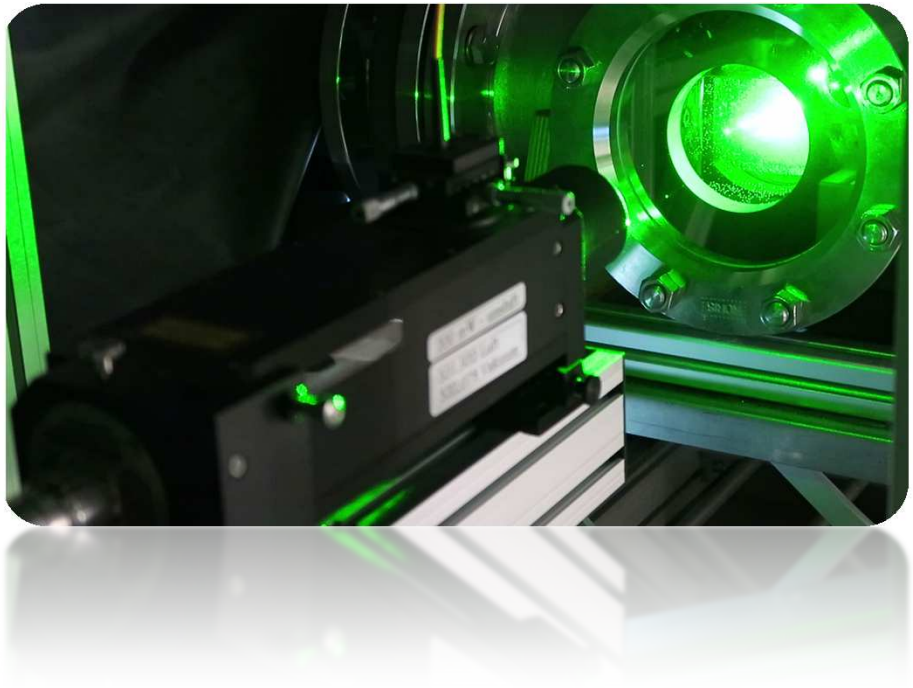


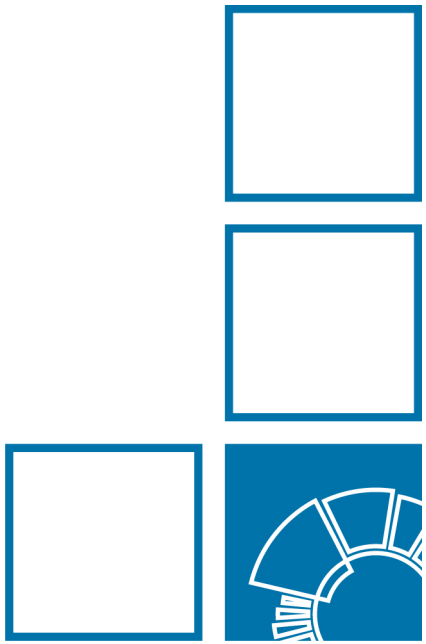
$$\Delta Q = 100 \frac{Q_{LDA} - Q_{ref}}{Q_{ref}}$$

$\max(\Delta Q)$	0.31 %
$\max(\Delta Q_{LDA})$	0.16 %

Summary

- Two measuring systems with good agreement between them (≤ 0.16 %)
- Suitable for high temperature application
- Deviation to reference ≤ 0.31 %
- Small impact of severly disturbed flow condition (≤ 0.1 %)





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