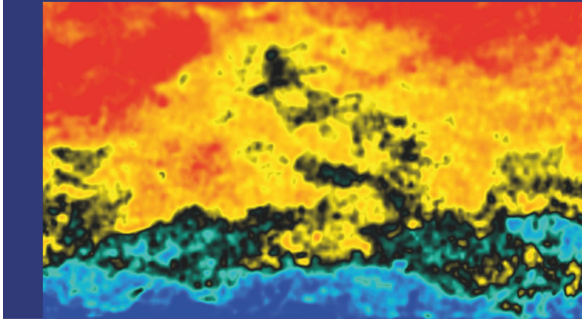




Zeinab Hallol (Autor)

Behaviour of Energetic Coherent Structures in Turbulent Pipe Flow at High Reynolds Numbers



Zeinab Hallol

Behaviour of Energetic Coherent Structures in Turbulent Pipe Flow at High Reynolds Numbers



Cuvillier Verlag Göttingen
Internationaler wissenschaftlicher Fachverlag

<https://cuvillier.de/de/shop/publications/8522>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen, Germany

Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>

Contents

Contents	viii
List of Figures	xi
List of Tables	xvi
List of Symbols	xvii
1 Introduction	1
1.1 Motivation	1
1.1.1 How is the High Reynolds Number Differ from the Low Reynolds Number?	2
1.1.2 Turbulent Structures	5
1.1.3 Pipe Flow Boundary Layers	8
1.2 Theoretical Background	10
1.2.1 Pipe Flow	11
1.3 Objectives of the Thesis	12
1.4 Outline of the Thesis	13
2 Experimental Facilities and Measurements Techniques	15
2.1 CoLaPipe	17
2.2 Measurement Techniques	21
2.2.1 Hot-Wire Anemometer	21
2.2.2 Types of Hot-Wire Probes	22
2.2.3 Overheat Ratio	23
2.2.4 Hot-Wire Anemometer Velocity Calibration	24
2.2.5 Polynomial Curve Fitting	24
2.2.6 Power Law Curve Fitting	25

2.2.7	Particle Image Velocimetry (PIV)	26
2.2.8	PIV Main Components	27
2.2.9	How Nd: YLF Laser Emits the Laser Ray ?	27
2.2.10	Pressure Gradient Measurements	29
2.2.11	Application at CoLaPipe Test Facility	29
2.2.12	Fluid Parameters	30
3	Influence of Calibration Methods on HWA Measurements	32
3.1	Theoretical Background	32
3.2	Experimental Setup	33
3.3	Results	36
3.4	Conclusion	44
4	Kinetic Energy Contribution of Coherent Structures in Fully Developed Turbulent Pipe Flow at High Reynolds Numbers	45
4.1	Experimental Background	45
4.2	Experimental Setup	47
4.3	Validation of Hot-Wire Measurements	48
4.4	Results	50
4.5	Conclusion	62
5	PIV Measurements in Pipe Flow	64
5.1	Introduction	64
5.2	Experimental Setup	64
5.3	PIV Measurements Validation	66
5.3.1	Validation of Spectral Analysis	68
5.4	Characterization of Turbulent Structures	70
5.5	Temporal-spatial Analysis	75
5.6	Quadrant Analysis	77
6	Two-dimensional Spectral Analysis in Pipe Flow	78
6.1	Introduction	78
6.2	Results	80
6.2.1	Pre-multiplied Spectral Analysis	80
6.2.2	Contribution of Reynolds Shear Stress	83
6.3	Conclusion	87

7 Proper Orthogonal Decomposition Analysis (POD)	89
7.1 Introduction	89
7.2 Proper Orthogonal Decomposition	90
7.3 POD Analysis	92
7.3.1 Contributions to Reynolds Stresses ($-uv^+$, u^{2+} , and v^{2+})	97
7.3.2 Q_2 and Q_4 Events Contribution in Reynolds Stresses	99
7.4 Conclusion	100
8 Conclusions and Final Remarks	102
8.1 Comparison Between In-situ and Ex-situ Calibration Methods	102
8.2 One-dimensional Spectral Analysis	103
8.3 Two-dimensional Spectral Analysis	104
8.4 Proper Orthogonal Decomposition Analysis	106
8.5 Recommendations for Future Work	107
Bibliography	109