

Streamline Curvature Wall Model for Pressure from PIV

Julian Powers¹, Adrián Lozano-Durán²

¹ Masters Student
Massachusetts Institute of Technology

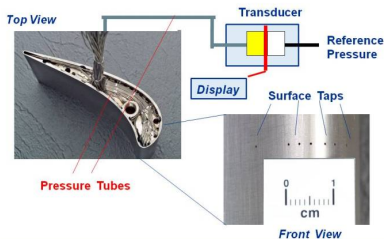
² Faculty
Massachusetts Institute of Technology
California Institute of Technology

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Motivation: Why Pressure from PIV?

Pressure Taps

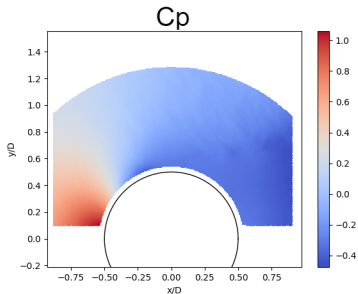
- ▶ Measurements dependent on leakage, hole diameter, flushness
- ▶ Difficult to install
- ▶ Length of tubing limits sampling rate!



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Pressure from PIV

- ▶ Completely non-invasive
- ▶ High time resolution possible
- ▶ High spatial resolution possible



Motivation: Literature Review

Case	Max Cp Error	Extrapolation Approach	Source
NACA 0012	0.5	parabola fit	Tagliabue et al., 2017
Sphere	0.15	nearest neighbor	Jux et al., 2020
Cyclist	0.2*	nearest neighbor	Jux et al., 2020
Bullet Step	0.02	nearest neighbor	Gent et al., 2018
NACA 0012	0.25	line fit	Ragni et al., 2009

*based on uncertainty analysis (no pressure tap reference)

Motivation: Issues with Extracting Surface Pressure

- ▶ Reflections and low particle density
- ▶ Strong gradients due to curvature and boundary layer

Goals:

- ▶ Avoid extrapolation
- ▶ No numerical derivatives close to the wall

Method: Streamline Coordinates

[Insert Streamline Diagram]

Method: Summary

1. Compute Streamlines
2. Fit Circles
3. Integration
4. Differentiation

Results: LES Airfoil

- ▶ Data from Asada and Kawai, 2018
- ▶ Grid coarsened from LES
- ▶ Added 2% random velocity error

Results: Rough Cylinder

[Details and visualization]

Results: NACA 0018 (?)

[Details and visualization]

Conclusions and Next Steps

- ▶ Robust to noise
- ▶ Robust to distance from wall
- ▶ Similar or better results in regions with strong pressure gradient

Next Steps:

- ▶ Improve treatment of Reynolds stresses
- ▶ Improve treatment of critical points (separation, stagnation point)
- ▶ Generalization to 3D