

# Laboratory-Scale Drillstring Vibration Analysis with Realistic Drilling Fluid Circulation

2026 AADE Mid-Continent Technical Symposium

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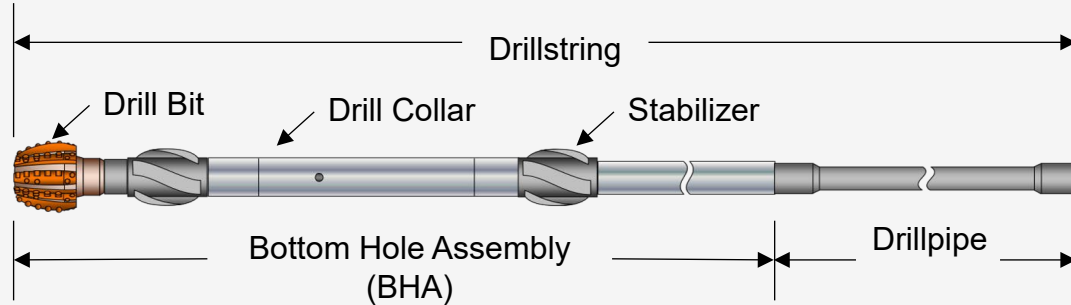
# Outline

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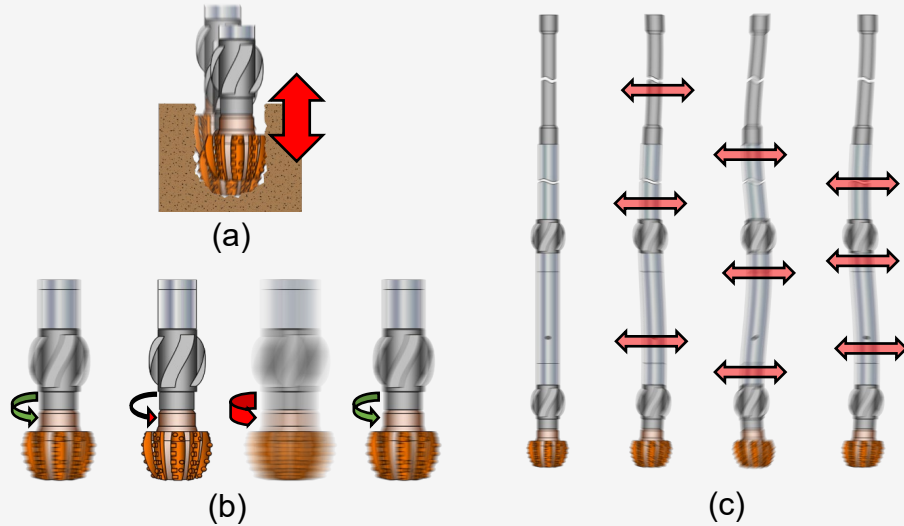
- Engineering & Scientific Motivation
- SEEDD Laboratory & FIDD Test Facility
- Recent Findings
- Ongoing Experiments

# Motivation: Drillstring Vibration

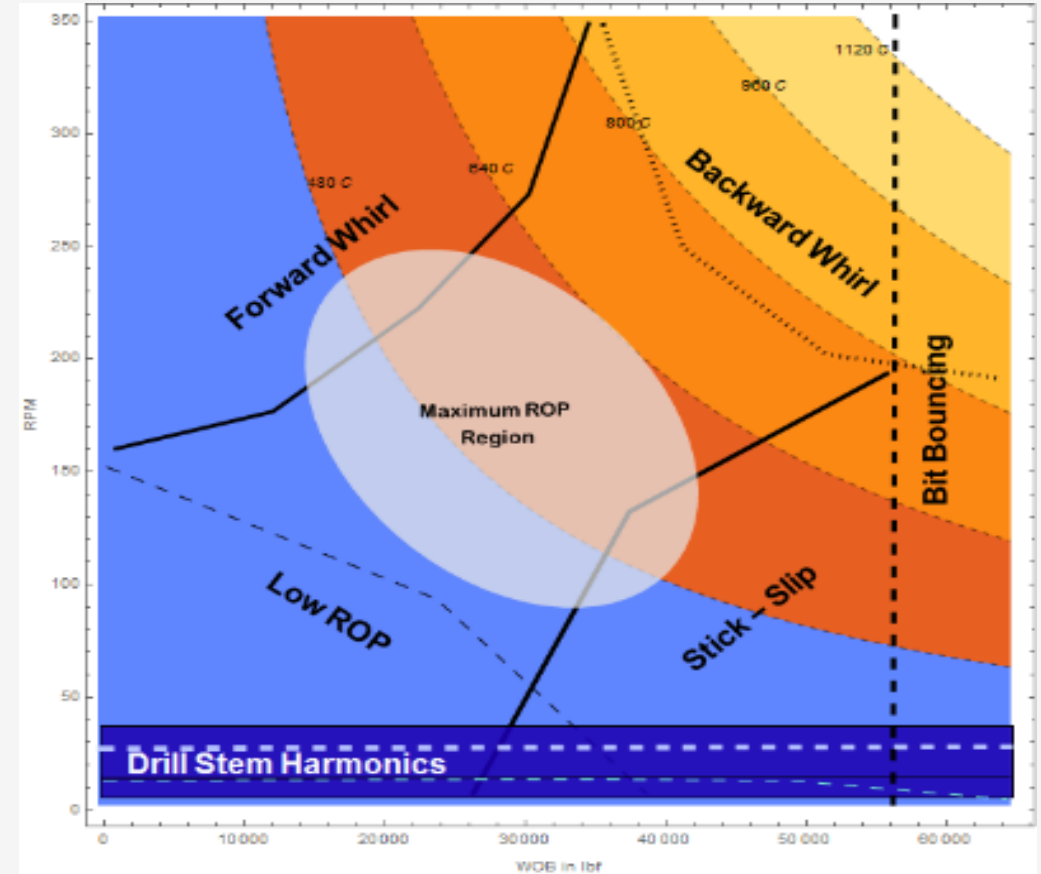
The **physical configuration** of the drillstring makes it prone to vibrations. (Dareing, 1984)



**Build of drillstring**



**Drillstring vibration modes: (a) Axial/Bit-Bounce, (b) Torsional/Stick-Slip, and (c) Lateral/Whirling**



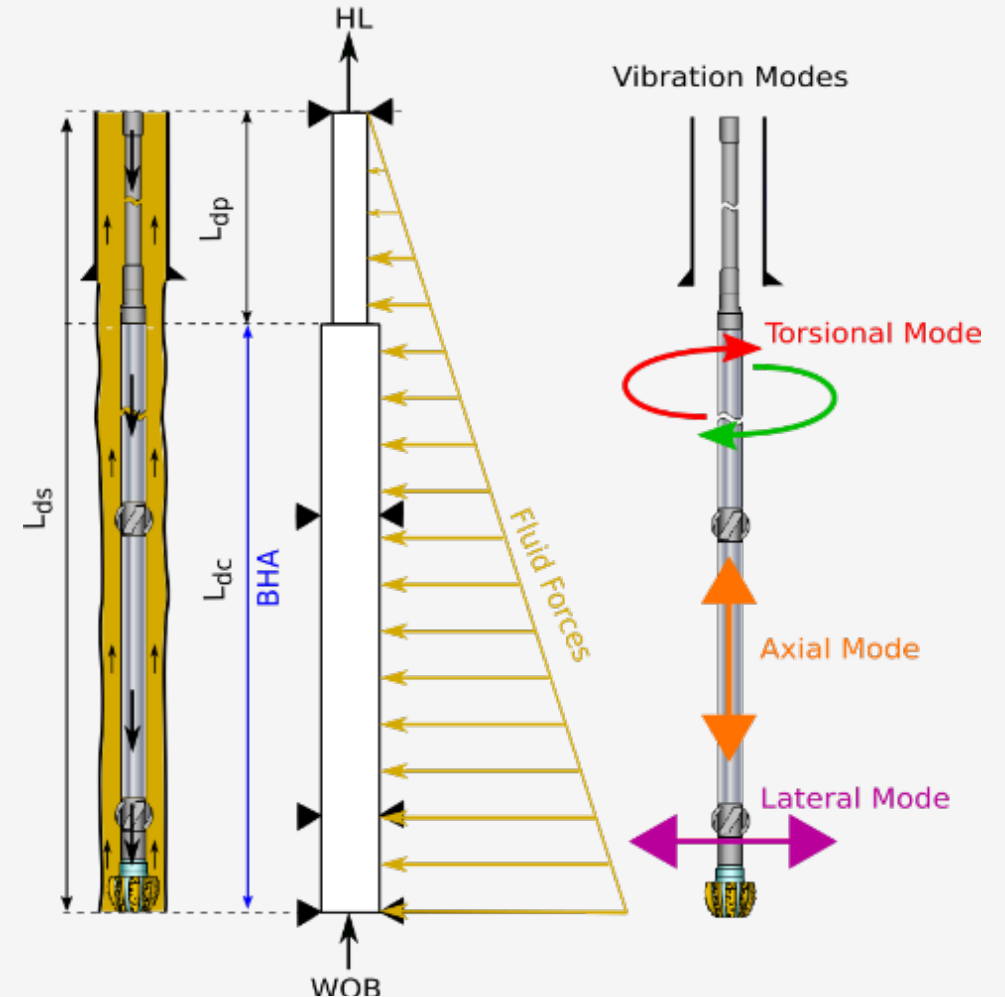
**Drilling Window**

# Motivation: Effect of Fluid

- **Higher density** of fluid column leads **higher vibration damping** (Antunes et al., 1996)
- Increasing fluid density **decrease lateral vibration frequency** (Berlioz et al., 1996)
- The fluid friction **depends on the vibrating frequency** (Khulief & Sulaiman 2009)
- Annulus **flow regime affects** damping nature (Chehrehghani et al., 2023)

## The Question

- *Does drilling fluid circulation play a dynamic role on drillstring vibration?*



Wellbore Fluid Force Distribution

# Ideal Test Facility

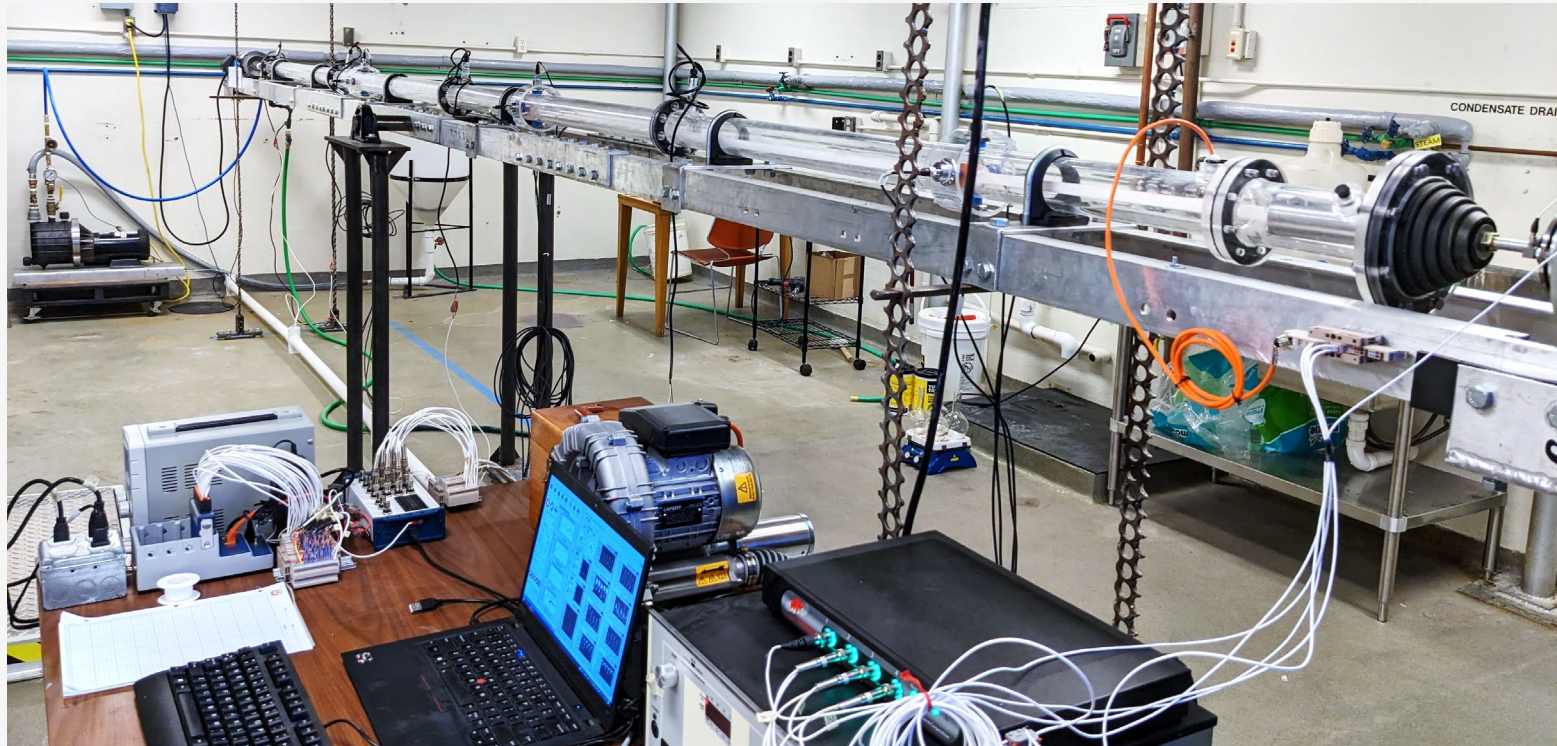
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- Field Relevant - Mechanical Scaling
- Drilling Dynamics - Rotation & Bit Interaction
- Realistic Drilling Fluid Circulation
- High Frequency Measurement

# SEEDD Laboratory

- *Subsurface Energy Extraction & Drilling Dynamics Laboratory*

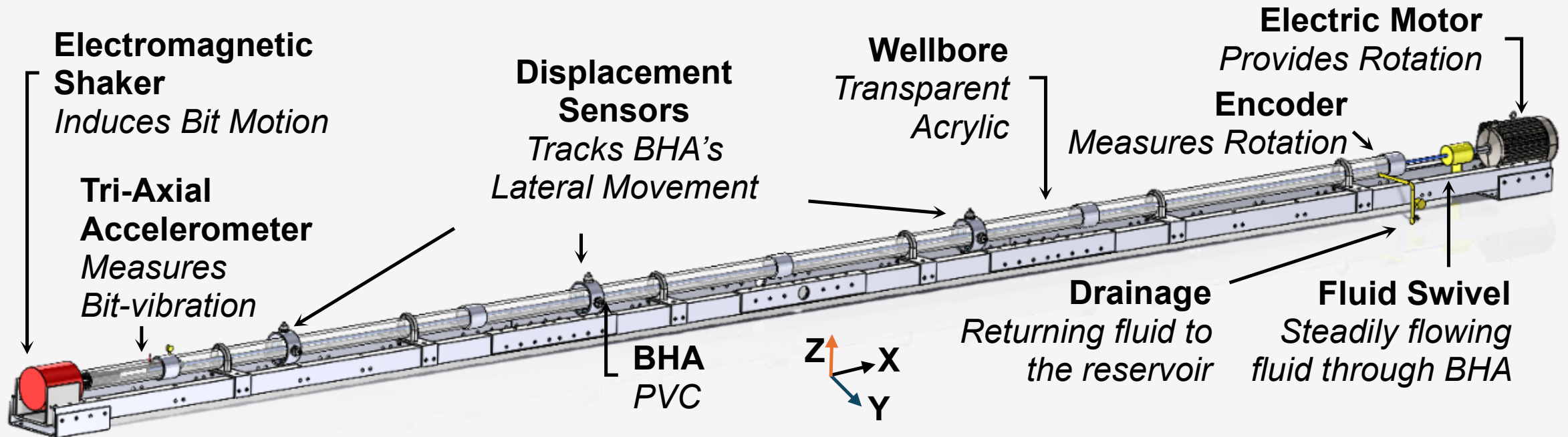
## ***Fluid Induced Drilling Dynamics (FIDD) Test Facility***



Maitra, E.K.; Al Dushaishi, M.F. How does flow rate affect drillstring vibrations? Experimental investigation. In Proceedings of the AADE National Technical Conference, Midland, TX, USA, 4–5 April 2023; p. AADE-23-NTCE-061. Available online: [https://www.aade.org/application/files/6417/2650/2196/AADE-23-NTCE-061\\_-\\_Maitra.pdf](https://www.aade.org/application/files/6417/2650/2196/AADE-23-NTCE-061_-_Maitra.pdf)

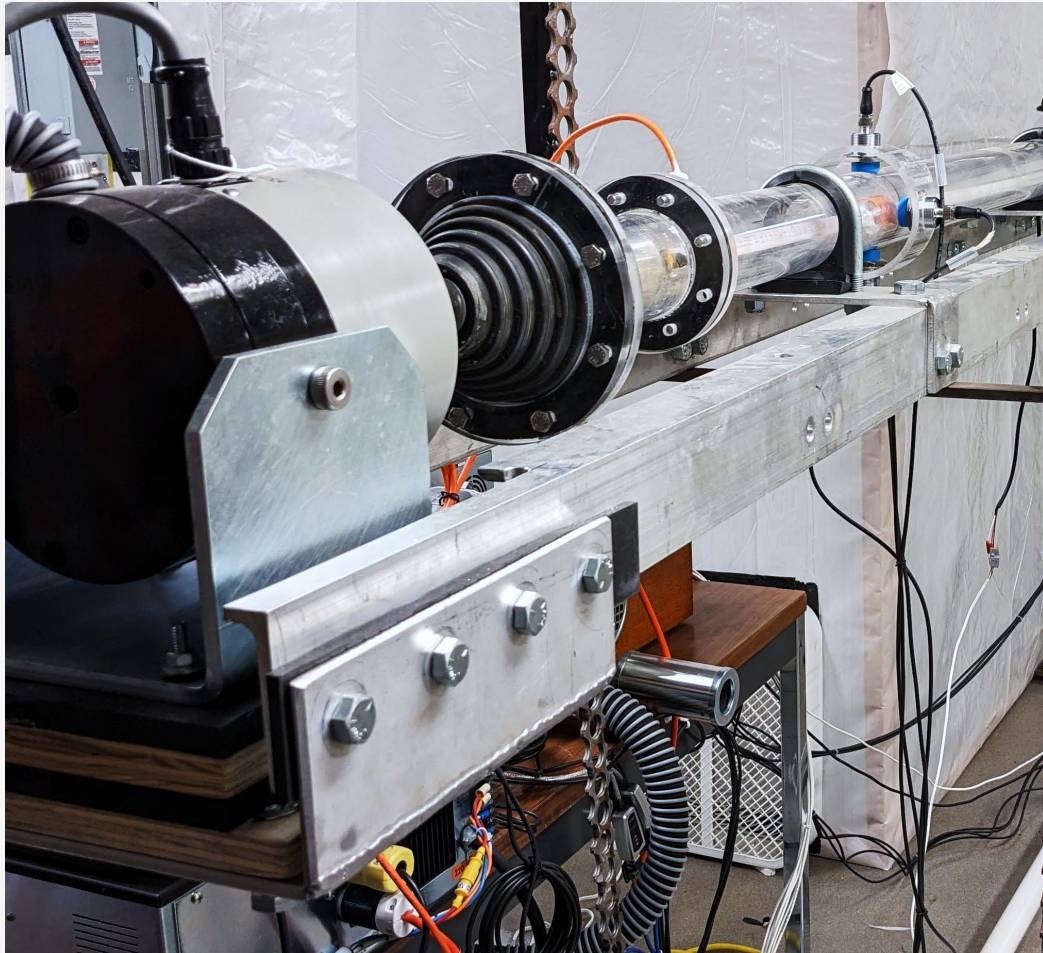
# FIDD Test Facility

- Schematic

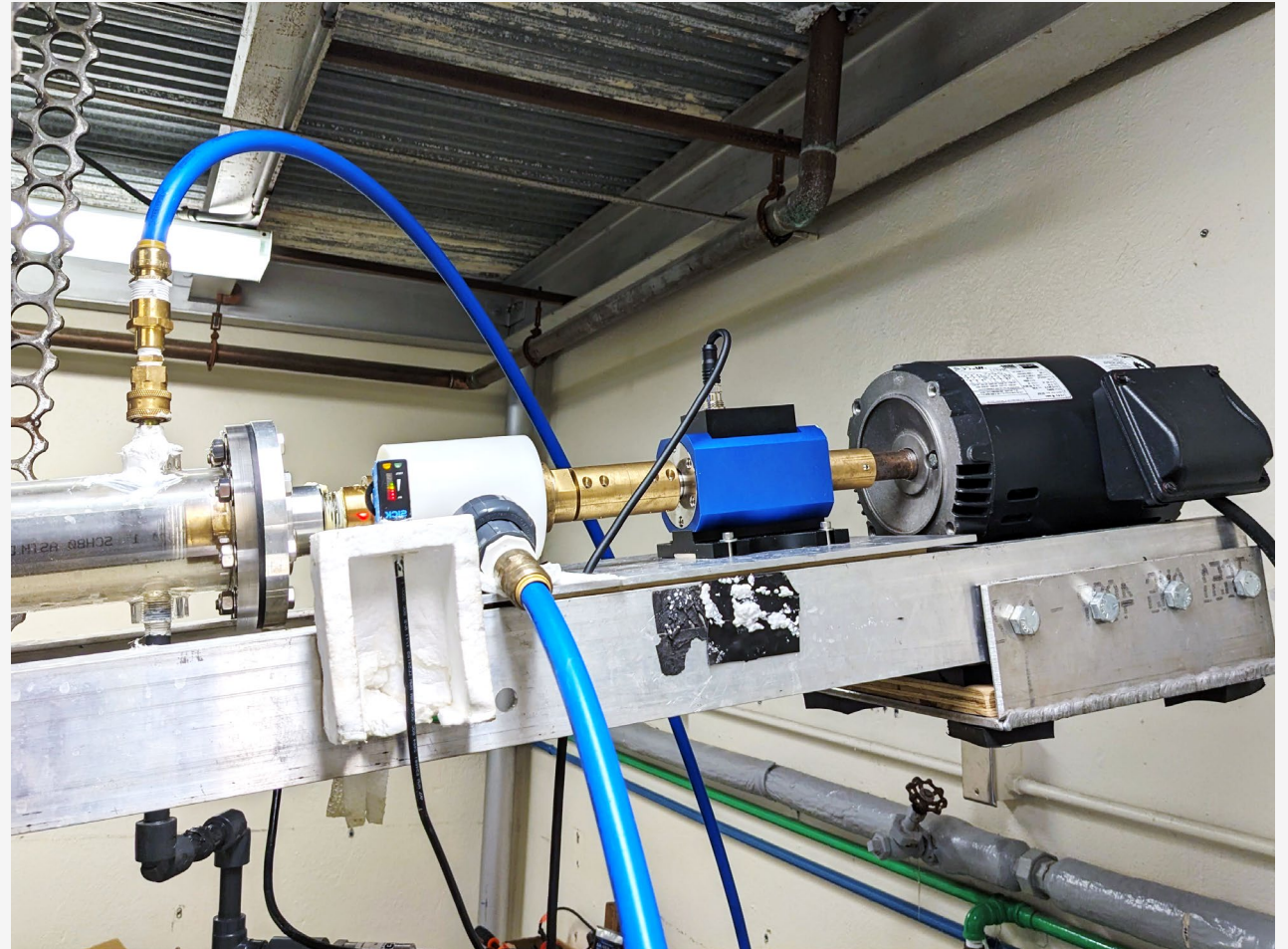


Maitra, E.K. Fluid-Induced Drilling Dynamics—A Mechanically Scaled Experimental Investigation. Master 's Thesis, Oklahoma State University, Stillwater, OK, USA, 2023. Available online: <https://hdl.handle.net/20.500.14446/338937>

# FIDD Test Facility

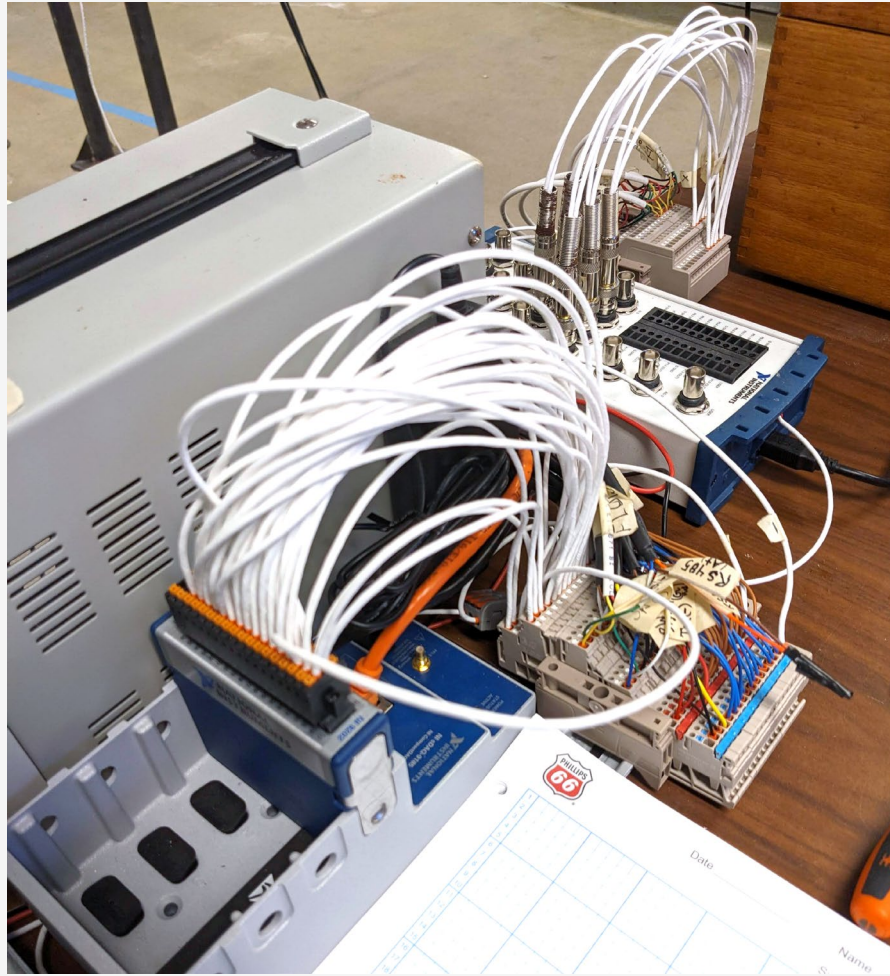


**Downhole**



**Surface**

# FIDD Test Facility



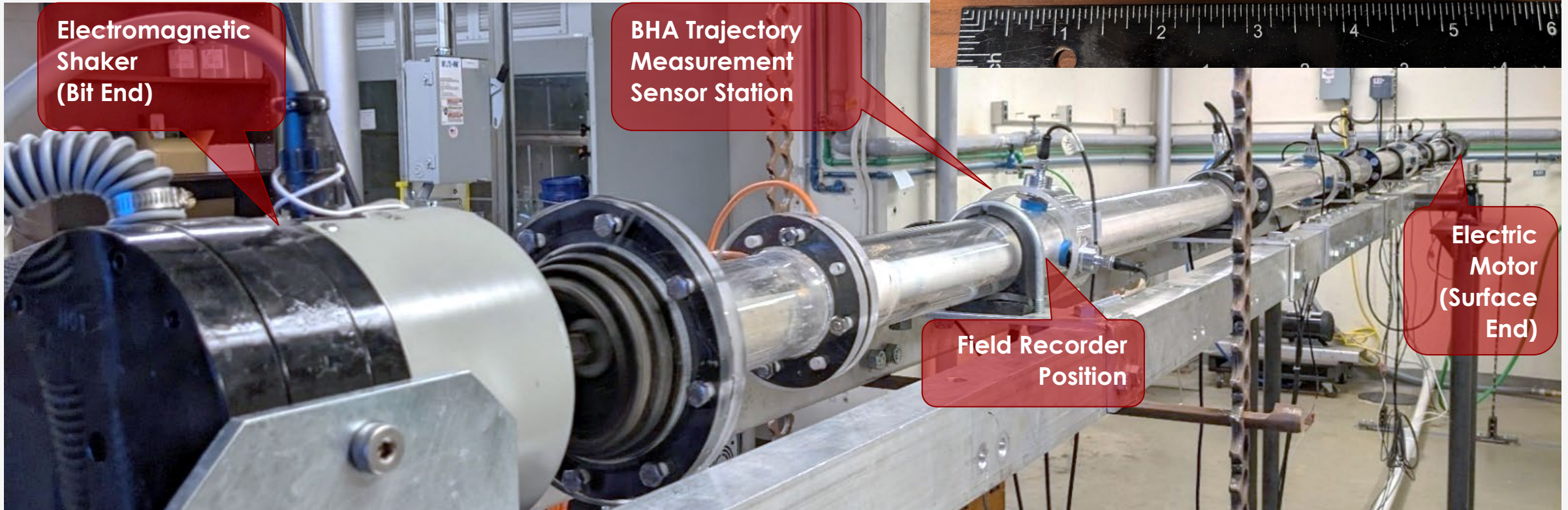
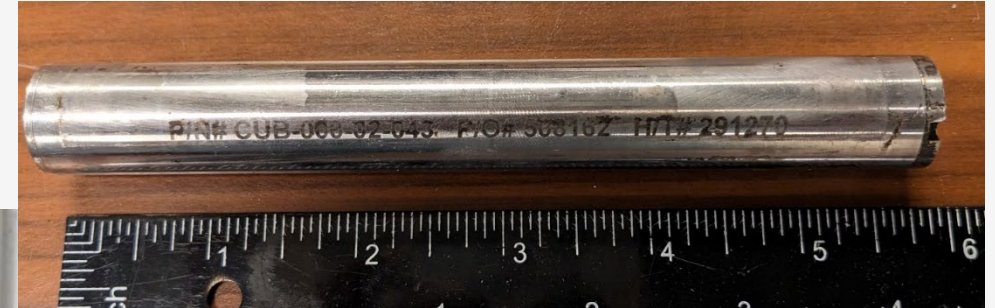
**Data Acquisition Terminal**



**One Central Control & Monitoring System**

# FIDD Test Facility

Maitra, E.K.; Al Dushaishi, M.F.; Sugiura, J.; Jones, S. Experimental Visualization of Downhole Drilling Vibration Using Industrial Drilling Dynamic Recorder. In Proceedings of the International Petroleum Technology Conference, Dhahran, Saudi Arabia, 12 February 2024. DOI 10.2523/IPTC-23494-MS

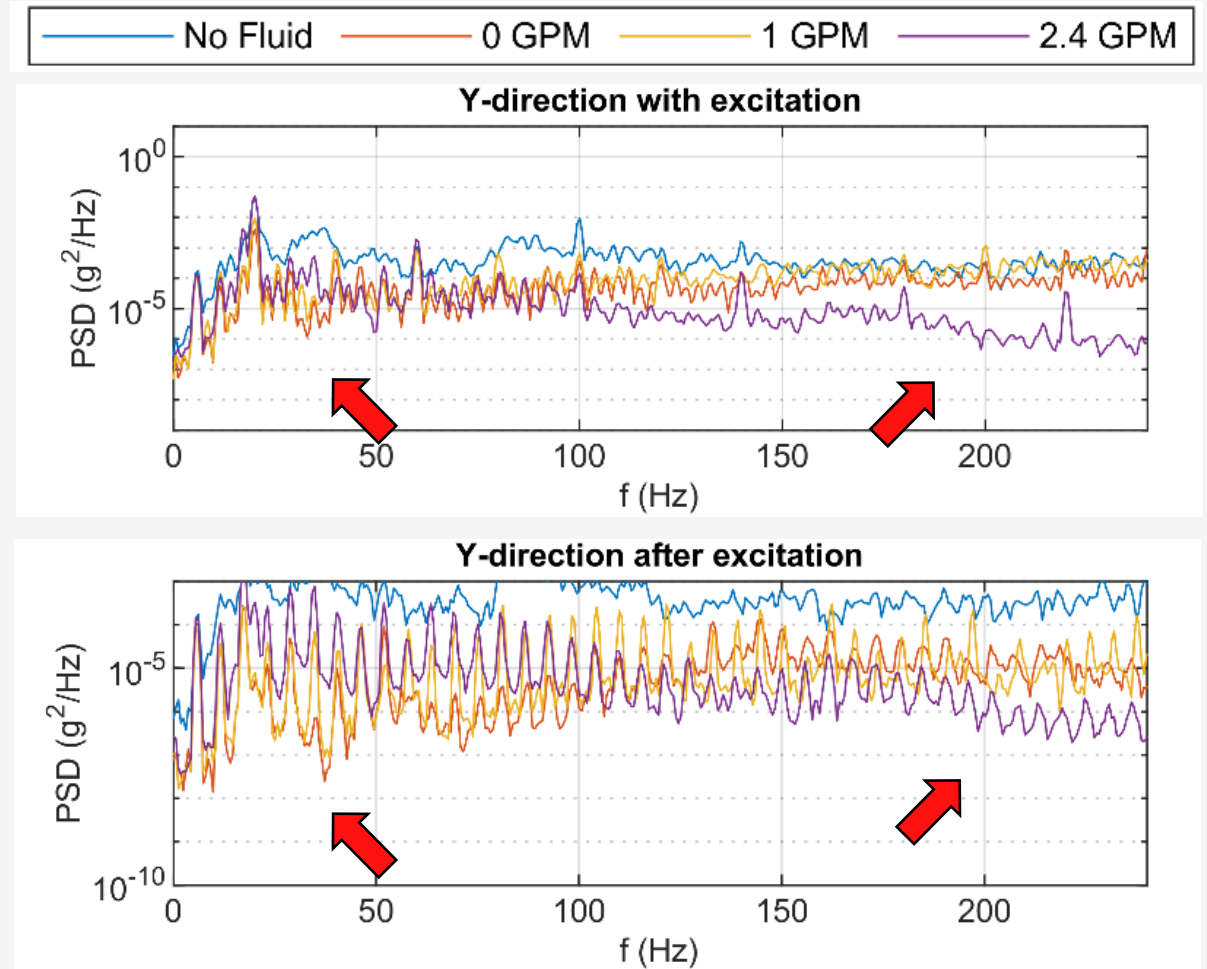


Second Assembly with Field Recorder

# Recent Findings: Effect of Flow Conditions

*Laminar annulus flow is more effective in reducing low frequency vibrations*

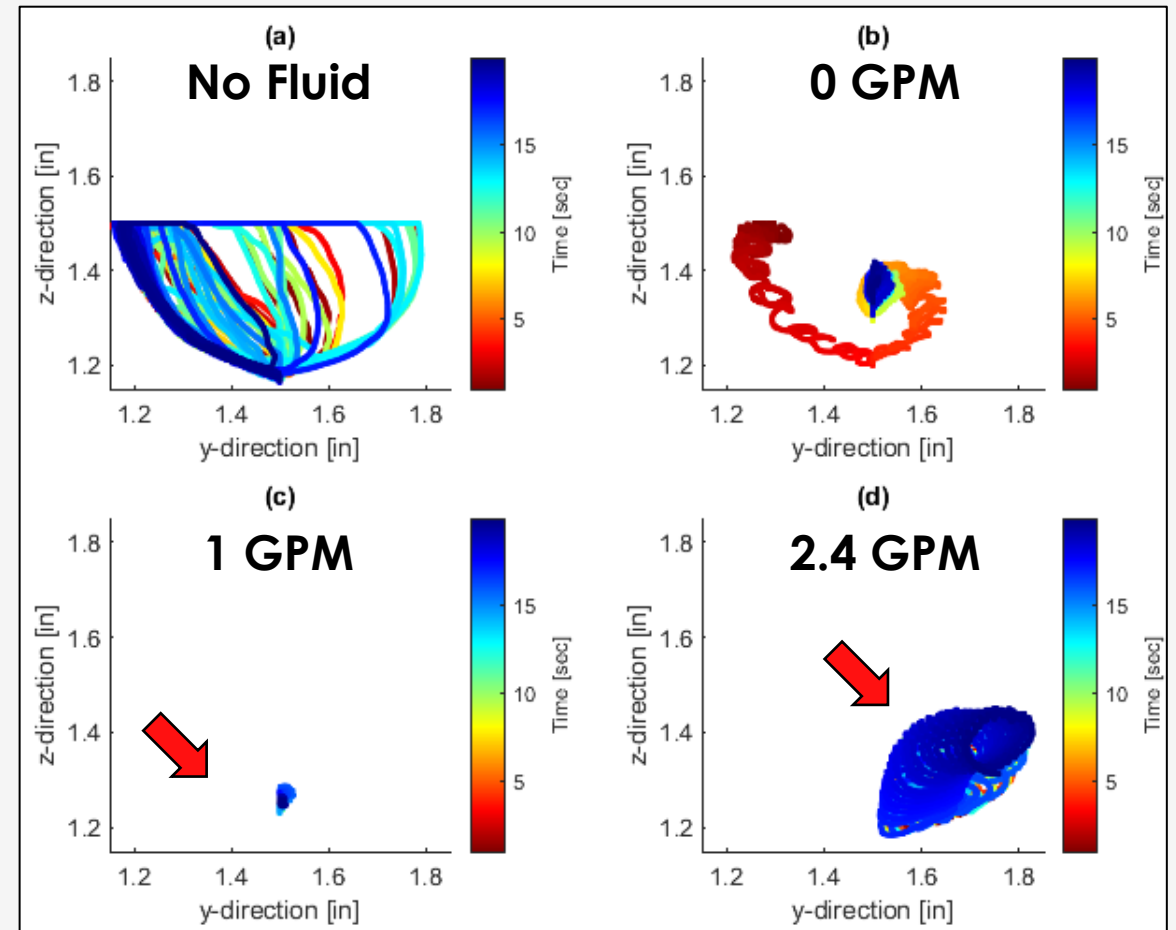
*Turbulent annulus flow is more effective in reducing high frequency vibrations*



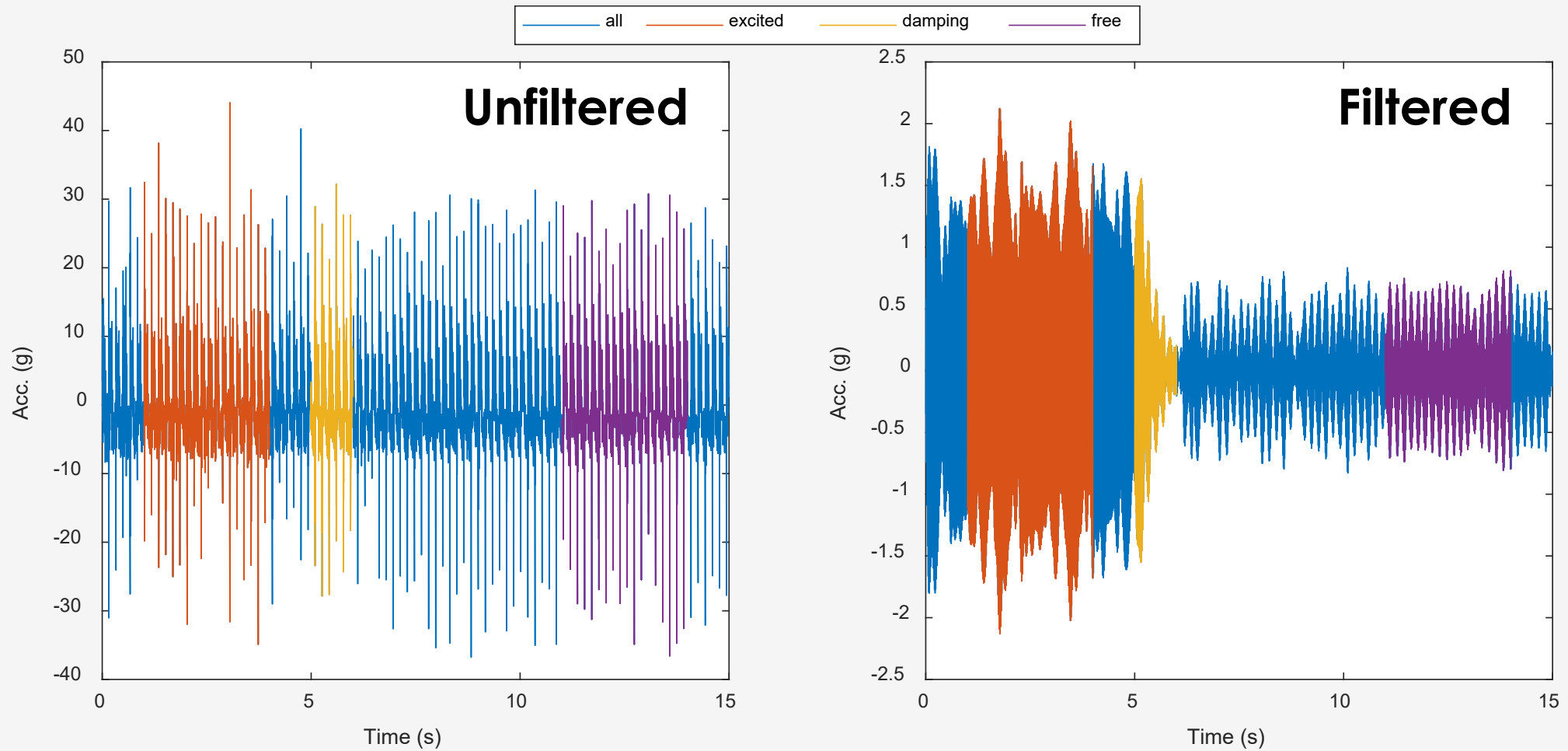
# Recent Findings: Effect of Flow Conditions

*Laminar annulus flow effectively reduces lateral motion*

*Turbulent annulus flow generates erratic lateral motion that hinders whirl development*



# Ongoing Investigation: Quantifying Damping



# Ongoing Investigation: Quantifying Damping

## Logarithmic Decrement

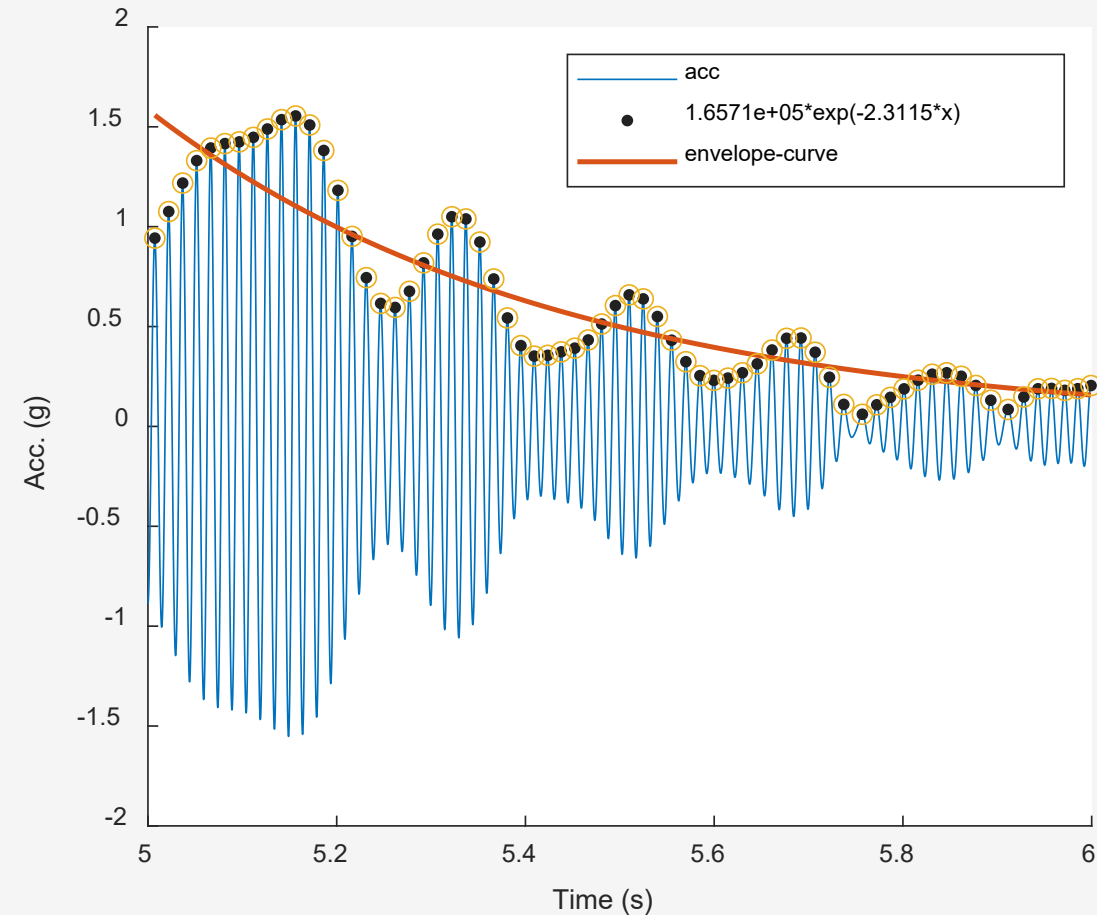
$$A(t) = \pm \alpha e^{-\beta t}$$

## Decay Rate

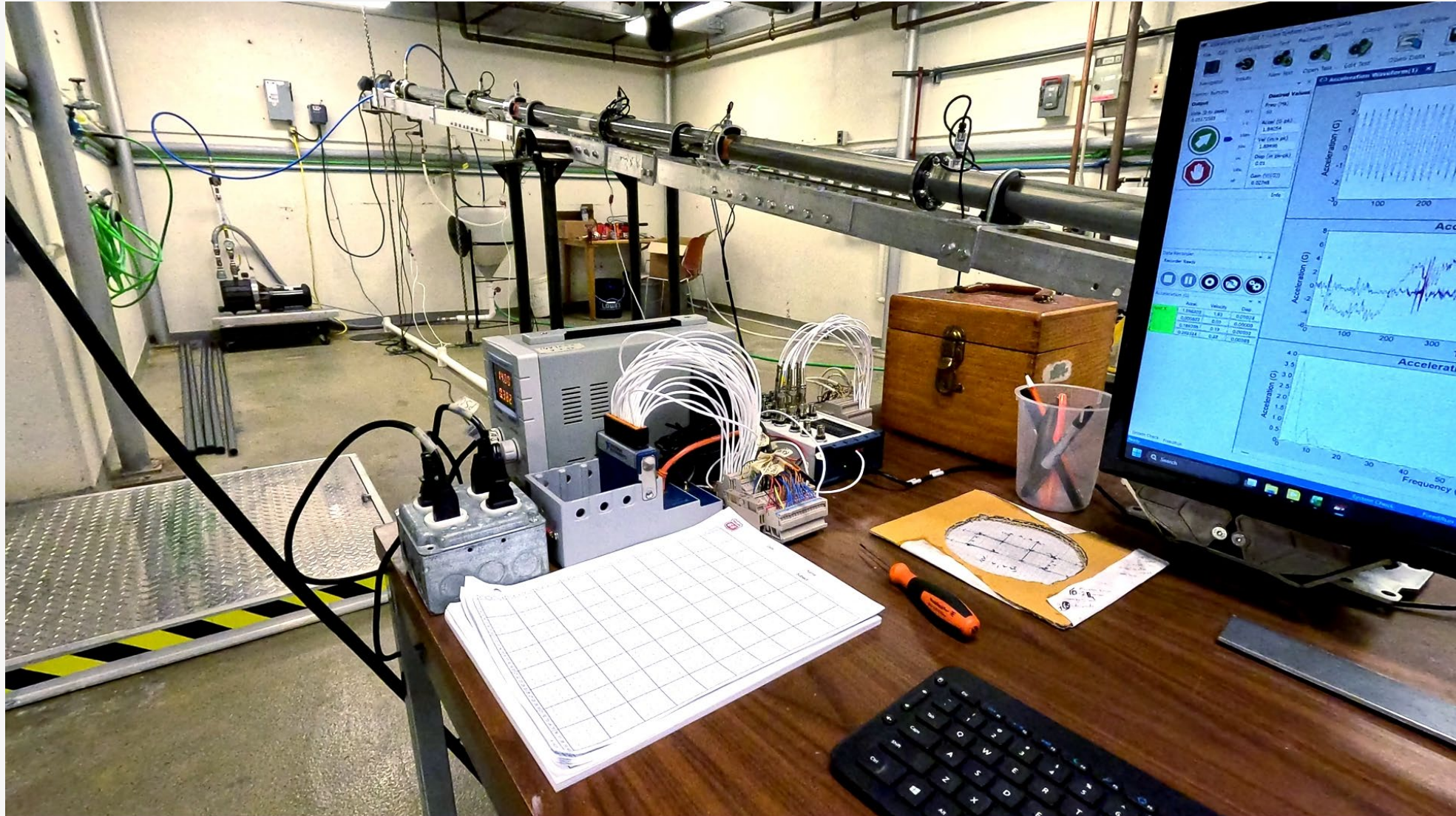
$$\beta = \omega \zeta$$

## Damping Ratio

$\zeta$



# Ongoing Investigation: Effect of Inclination



# Thank you!



- ❑ American Association for Drilling Engineers
- ❑ Y'ALL FOR LISTENING!

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