

3D LDV MEASUREMENTS IN OSCILLATORY BOUNDARY LAYERS

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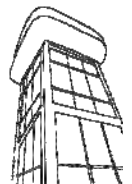


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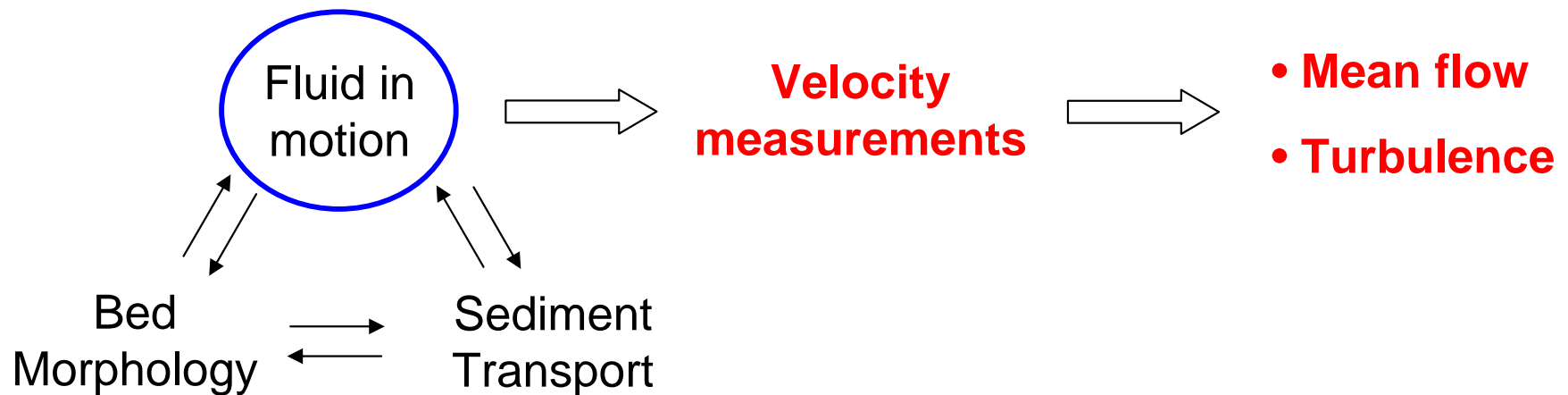
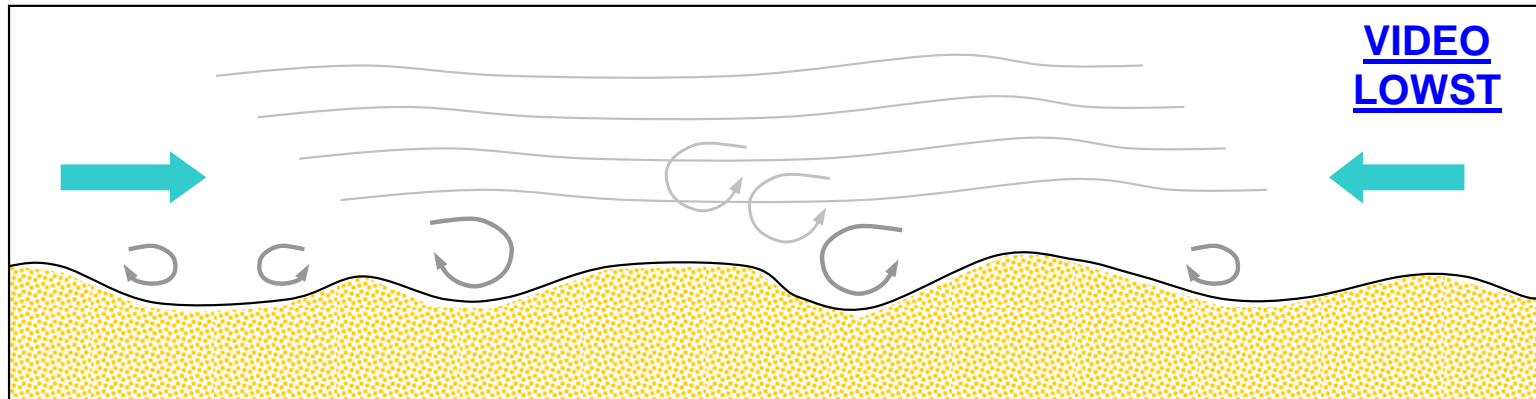
Ven Te Chow Hydrosystems Laboratory
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MOTIVATION

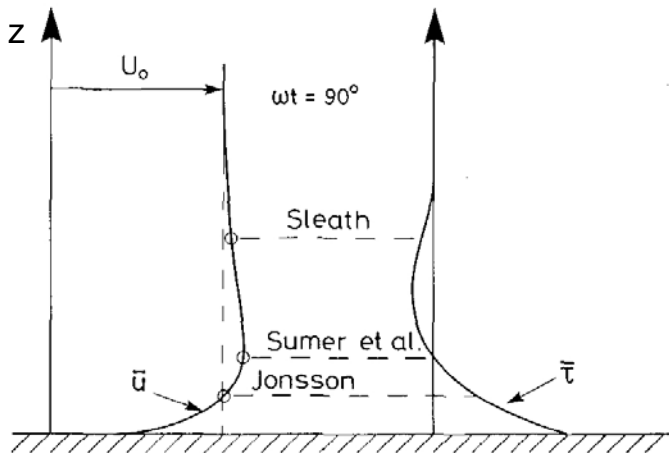
OSCILLATORY FLOWS AT THE BOTTOM OF THE SEA:

Getting to understand the processes of interaction between fluid and sediment.



THE OSCILLATORY BOUNDARY LAYER

Bottom → Shear → Turbulence → upward propagation → boundary layer



Outer, inviscid region

$$u = U = f(\omega t)$$

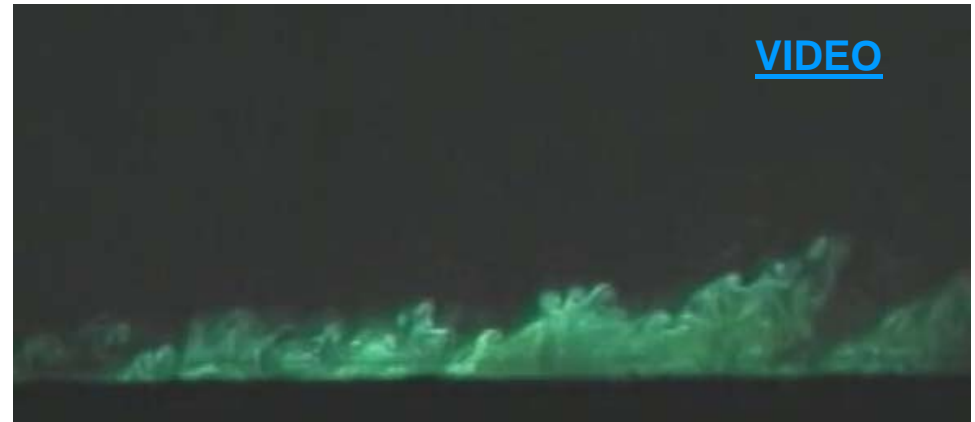
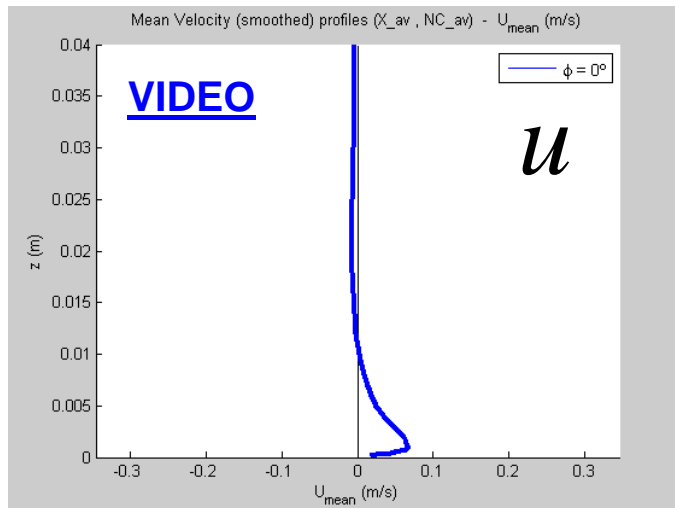
$$\tau = f(\omega t)$$

Inner, viscous region
(boundary layer)

$$u = f(z, \omega t)$$

$$\tau = f(z, \omega t)$$

From Jensen (1988)

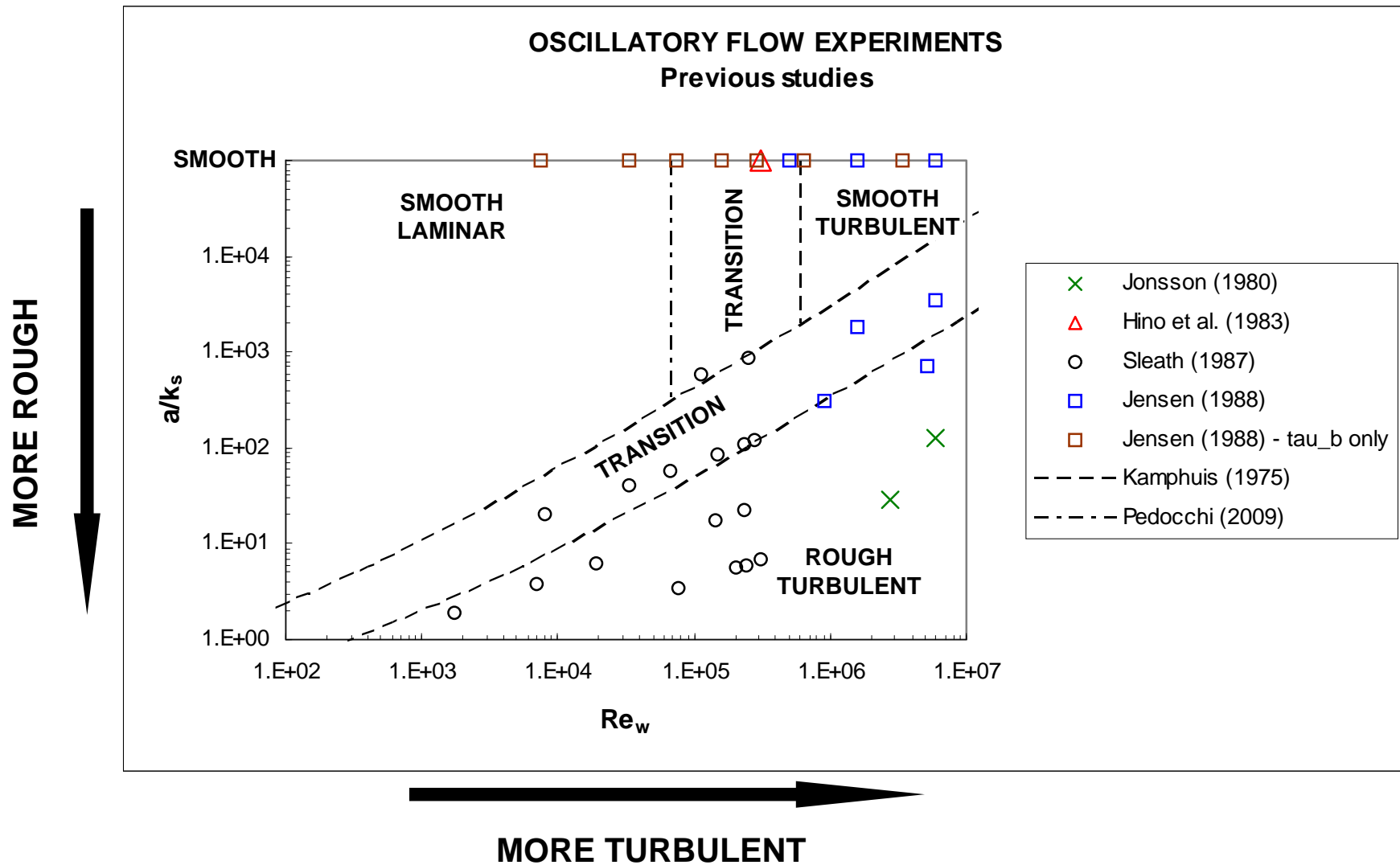


Smooth bed, $Re_w = 3.0 \times 10^5$ From Carstensen *et al.* (2010)

Exp. Y6: Smooth bed. $Re_w = 1.7 \times 10^5$

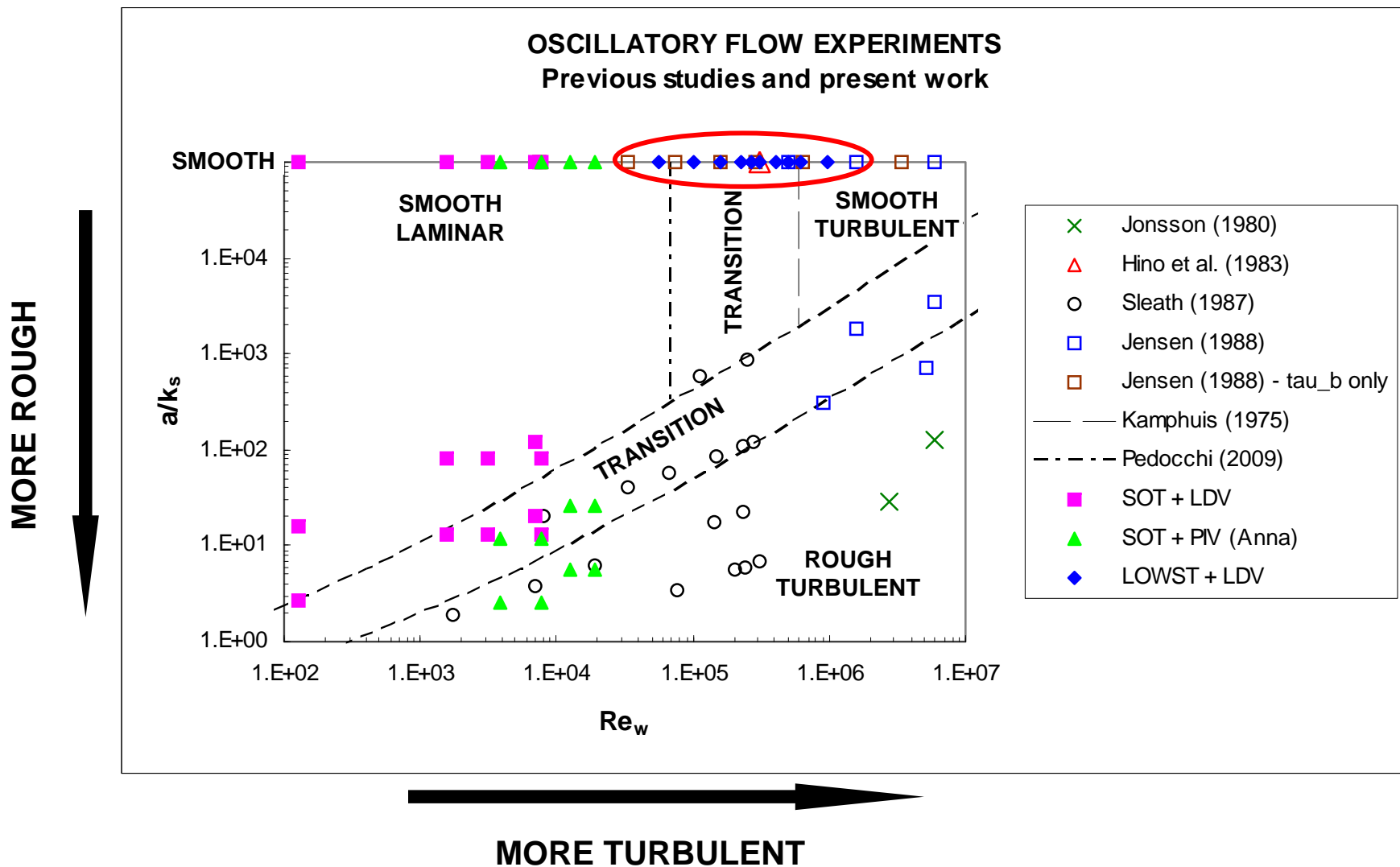


PREVIOUS EXPERIMENTAL WORK

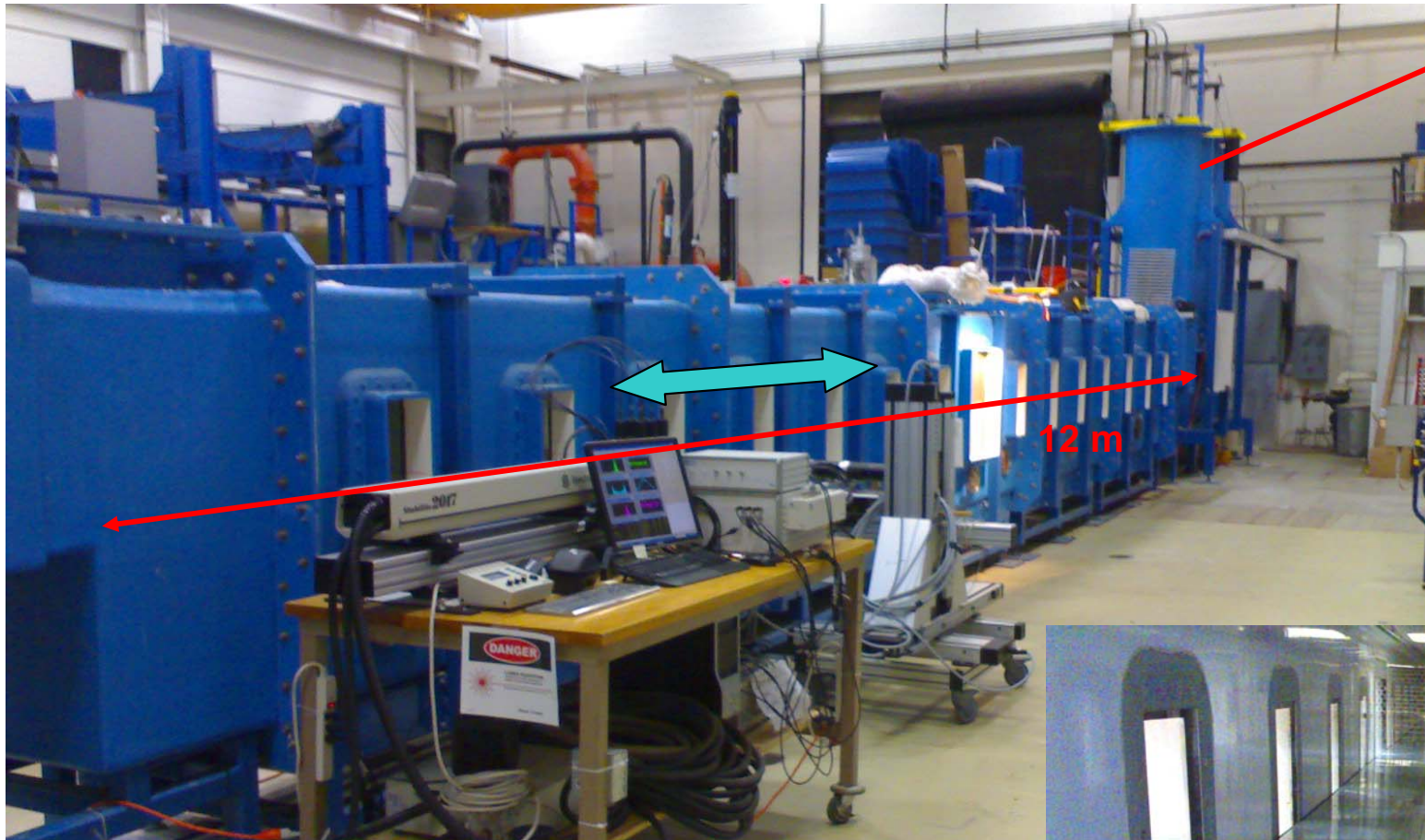


RESEARCH GOAL

- Characteristics of the mean flow and turbulence in the **laminar-turbulent transition** of the oscillatory boundary layer with **smooth** bed.



LARGE OSCILLATORY TUNNEL



**Experimental setup:
fixed, flat, smooth, PVC floor**

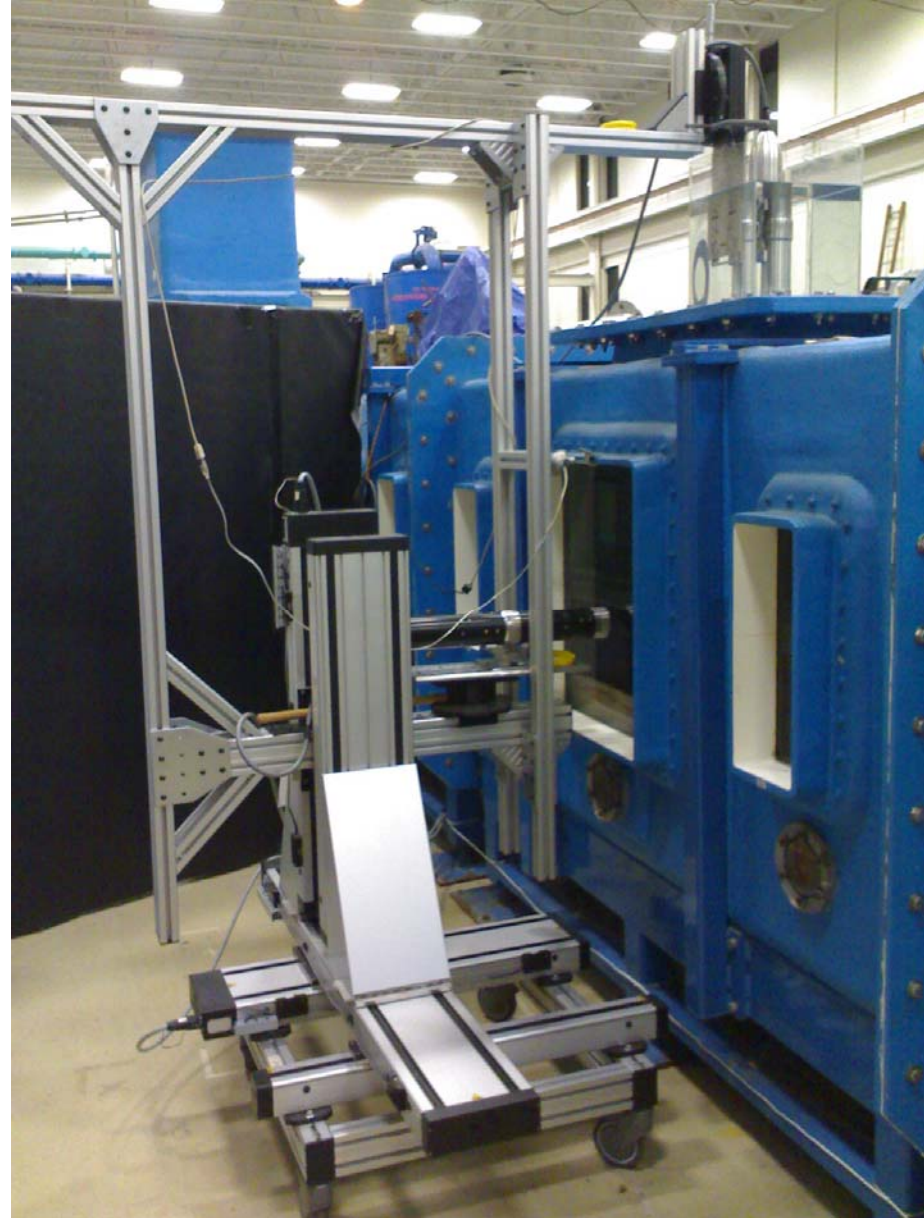
Setup team: Andy Waratuke, Andrew Rehn, Nicholas Möller, CEE shop



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CHALLENGE: LDV SYSTEM IN 3D CONFIGURATION

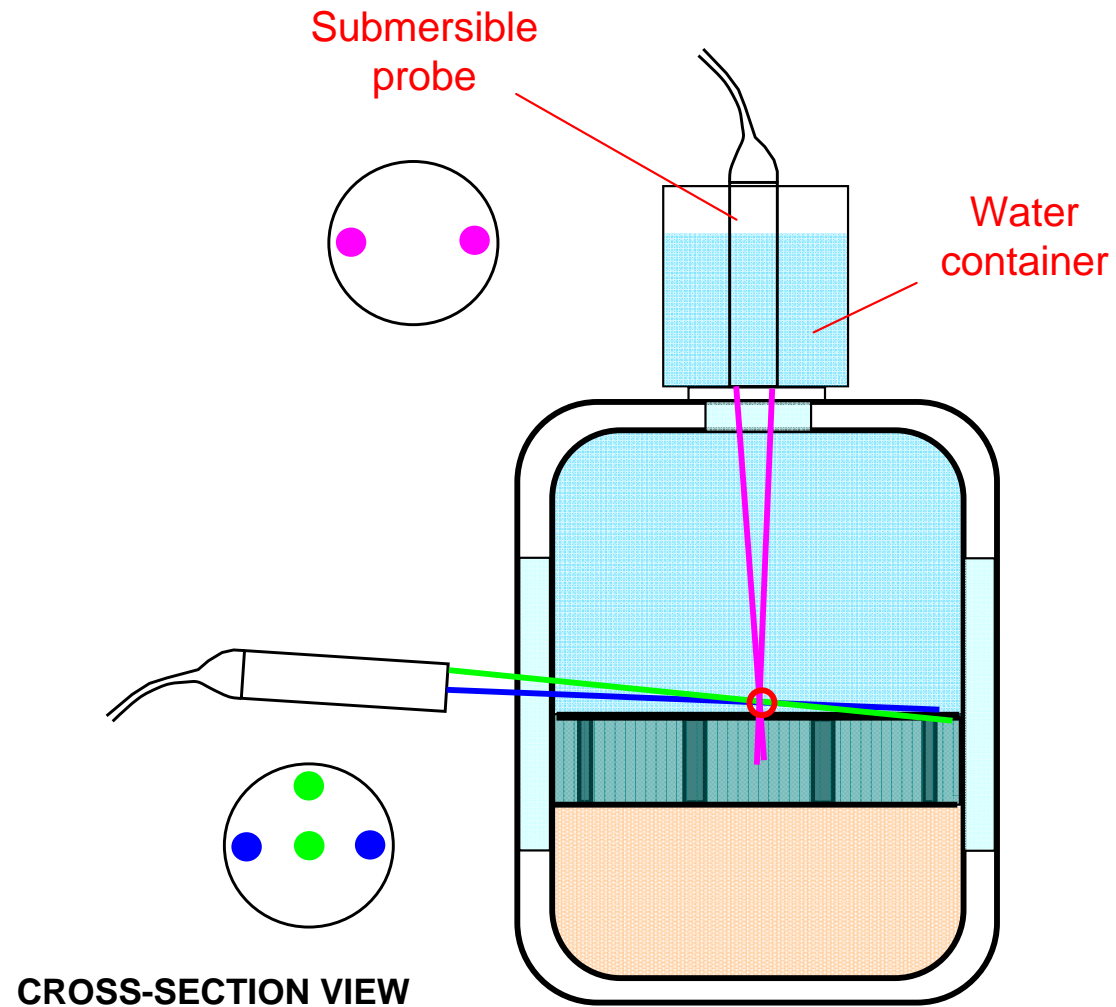
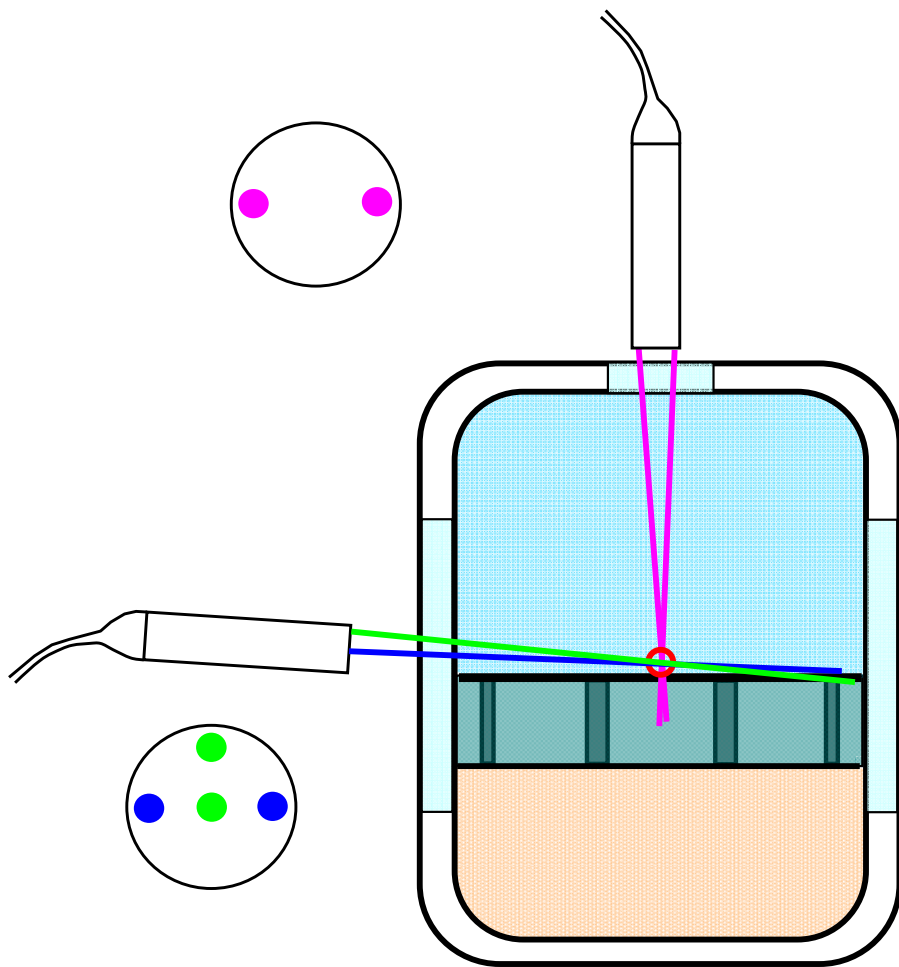
- Closed section
- Limited optical access
- Under pressure
- Window thickness
- Refraction
- Traversing 2 probes
- Alignment
- Bubbles
- Reflections
- Seeding particles



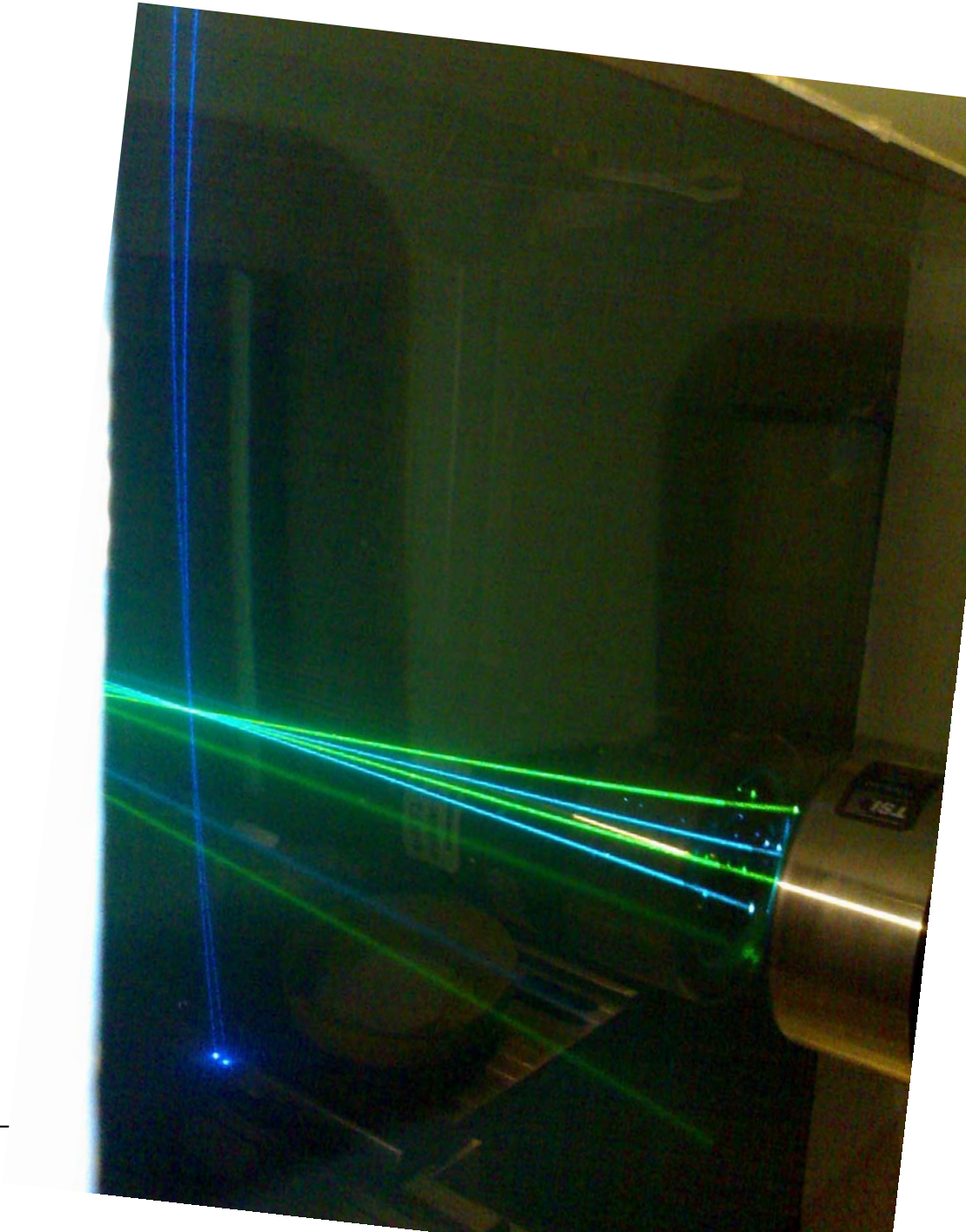
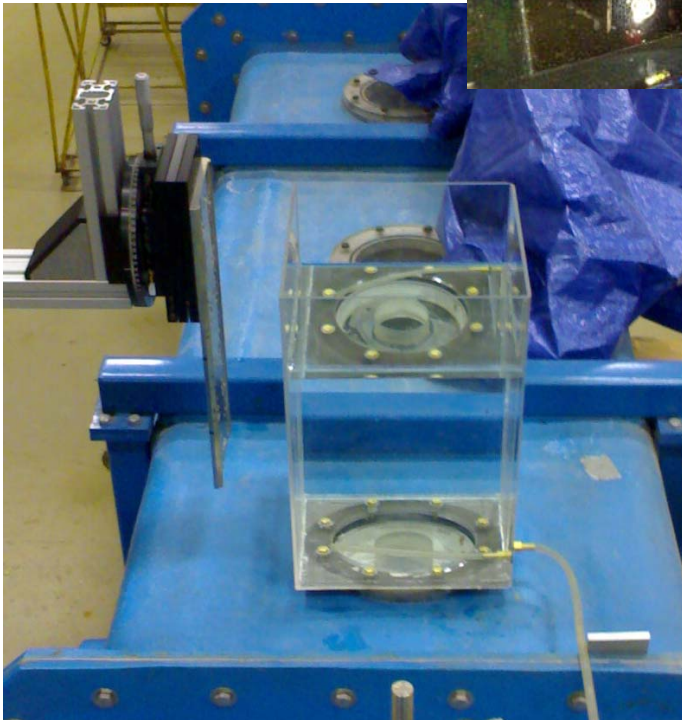
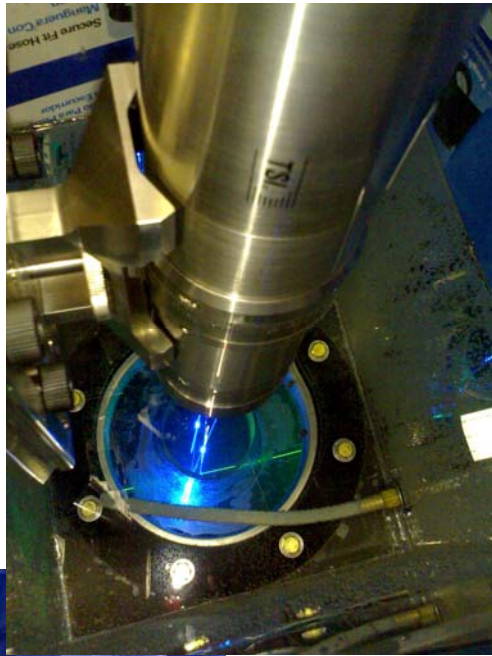
3D LDV TRAVERSING WITH 2 PROBES

Focal distance **changes** for top probe when traversing up

Focal distance **is preserved** for top probe when traversing up



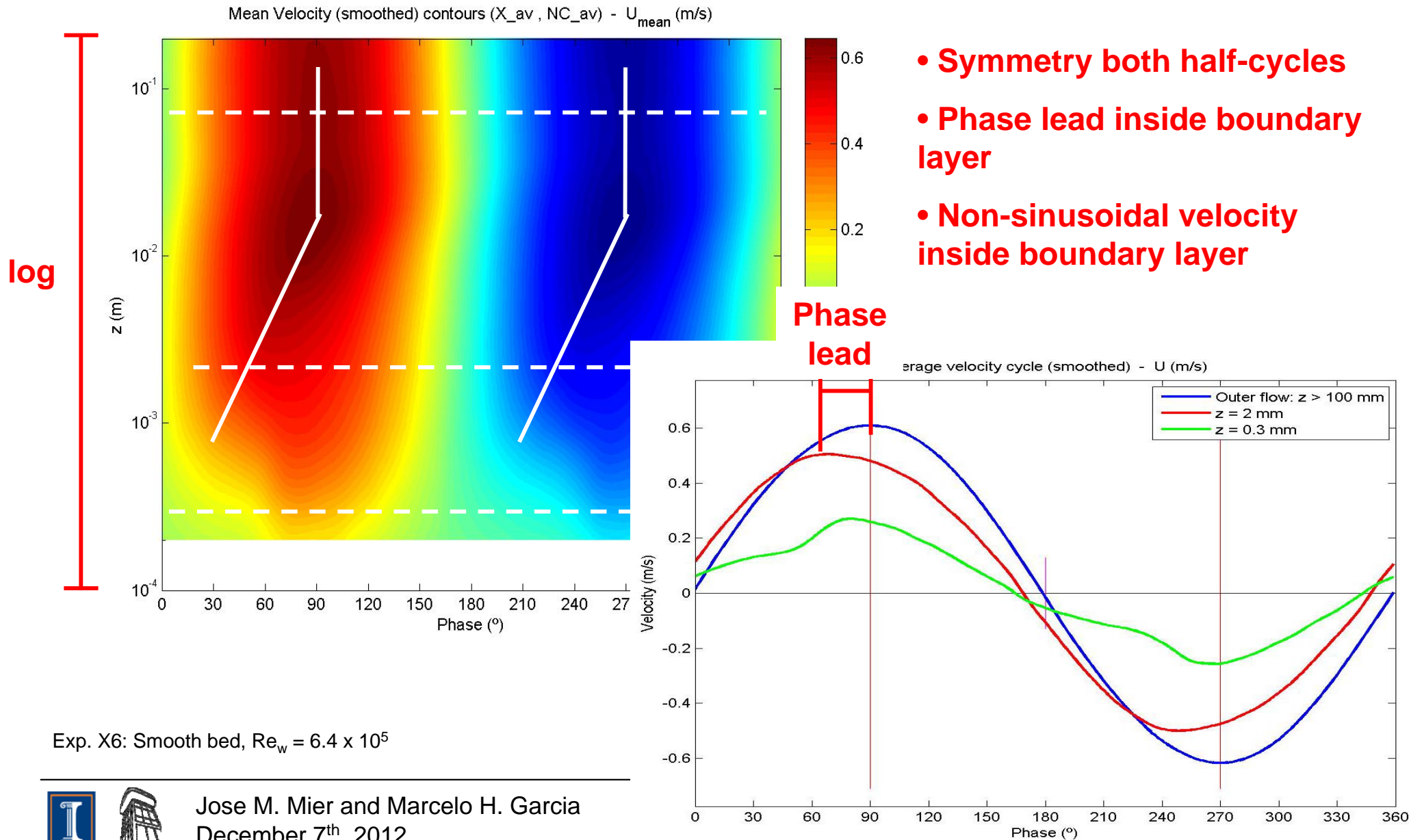
FOCAL DISTANCE CORRECTION: WATER CONTAINER



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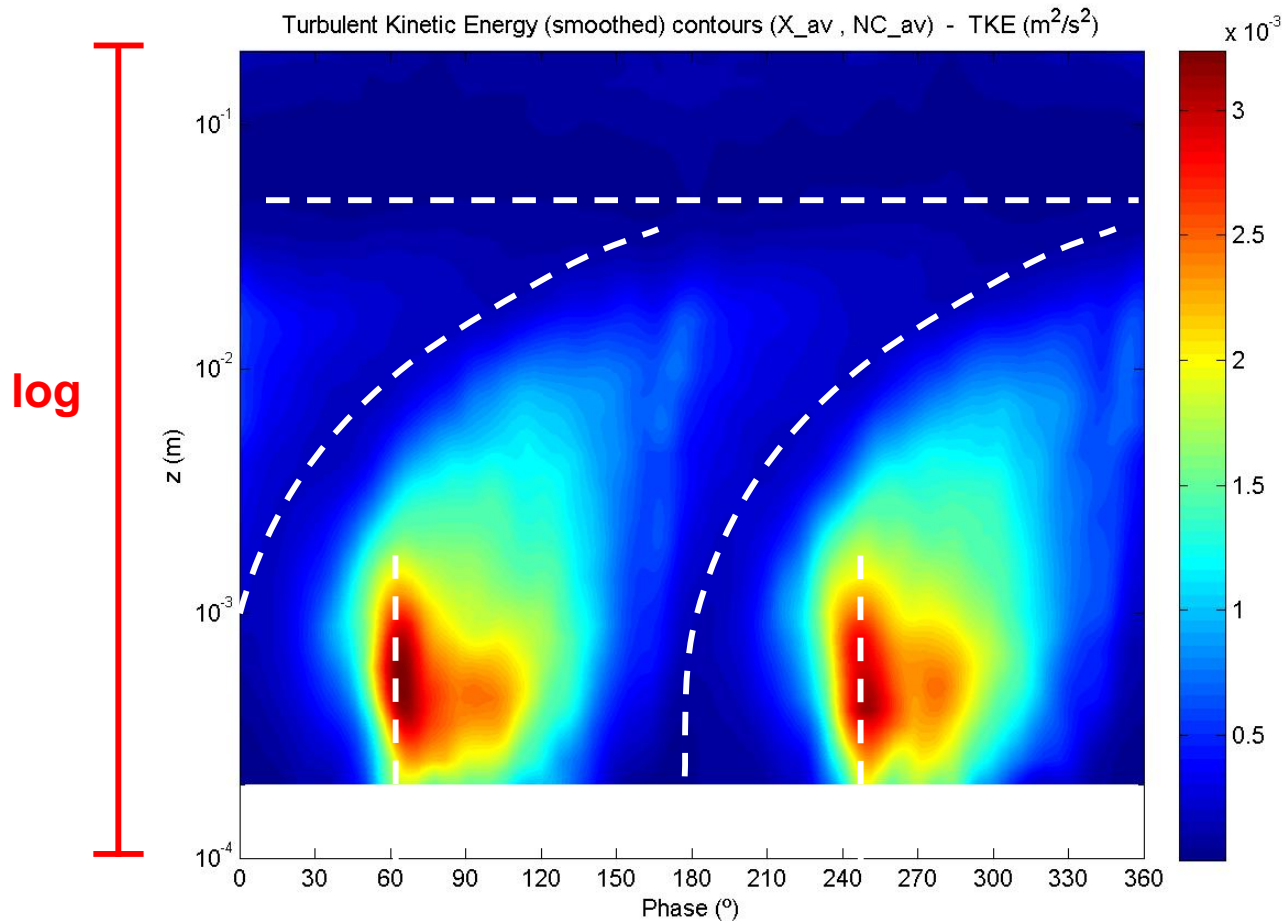
RESULTS: MEAN VELOCITY

U velocity contours:



RESULTS: TKE

TKE contours:



- **Dominated by U contribution**

- **Good symmetry**

- **Peak turbulence near the bed**

- **Phase lead with U_{om}**

- **Upward propagation in time**

- **Upper limit of boundary layer thickness**

Exp. X6: Smooth bed, $Re_w = 6.4 \times 10^5$



QUESTIONS

