Erosion by an oscillating disc above a granular bed

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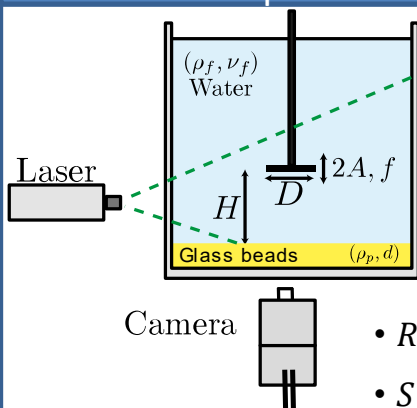2. University of California, Santa Barbara, Department of Mechanical Engineering, USA

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Motivation

- Flatfish bury themselves in the sand
- By swinging their fins they suspend sand and let it fall onto their bodies

Experimental set-up
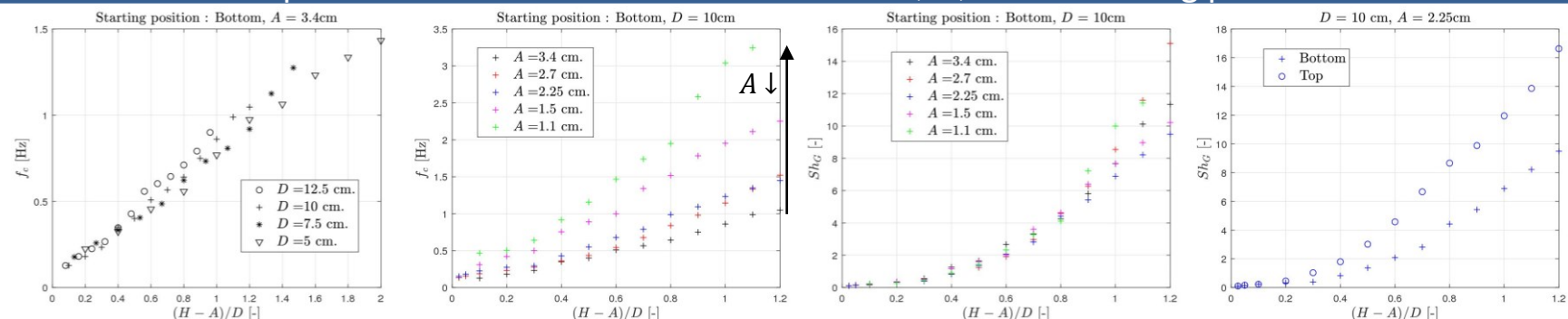

- $d = 300 - 400\ \mu m$
- Shields number :
$$Sh_G = \frac{\rho_f (2\pi A f)^2}{\Delta \rho g d}$$
- $A = [0,2\,cm\,;\,3\,cm]$
- $D = [3,75\,cm\,;\,15\,cm]$
- $f = [0,01\,Hz\,;\,2\,Hz]$
- $Re = \frac{2\pi A f D}{2\nu_f} \approx [10^2\,;\,10^4]$
- $S = D/A = [2,7\,;\,50]$

Onset of erosion

- Minimum frequency f_c for which there is motion in the bed (rolling)
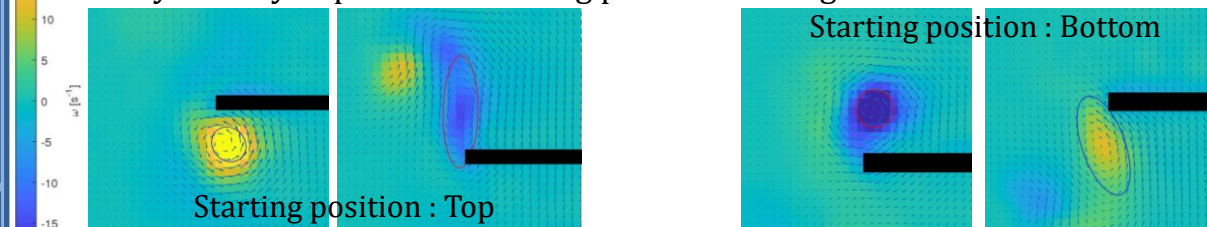- Dependence with H and D

Dependence of the onset of erosion with A, D, H and starting position

- Governing parameters : $(H-A)/D$ and Sh_G & Onset depends on starting position $Sh_{G,top} \geq Sh_{G,bottom}$

Particle Image Velocimetry. Phase-averaged results for 30 oscillations

- During 1 oscillation, 2 vortex rings form : one of circular core and one of « elliptical » core (?)
- Asymmetry depends on starting position for large H → reduces when $H \downarrow$

Starting position : Top

Starting position : Bottom

- Large H, circulation circular vortex : $\Gamma = cfD^{2/3}A^{4/3}$. Can scale vortex radius.