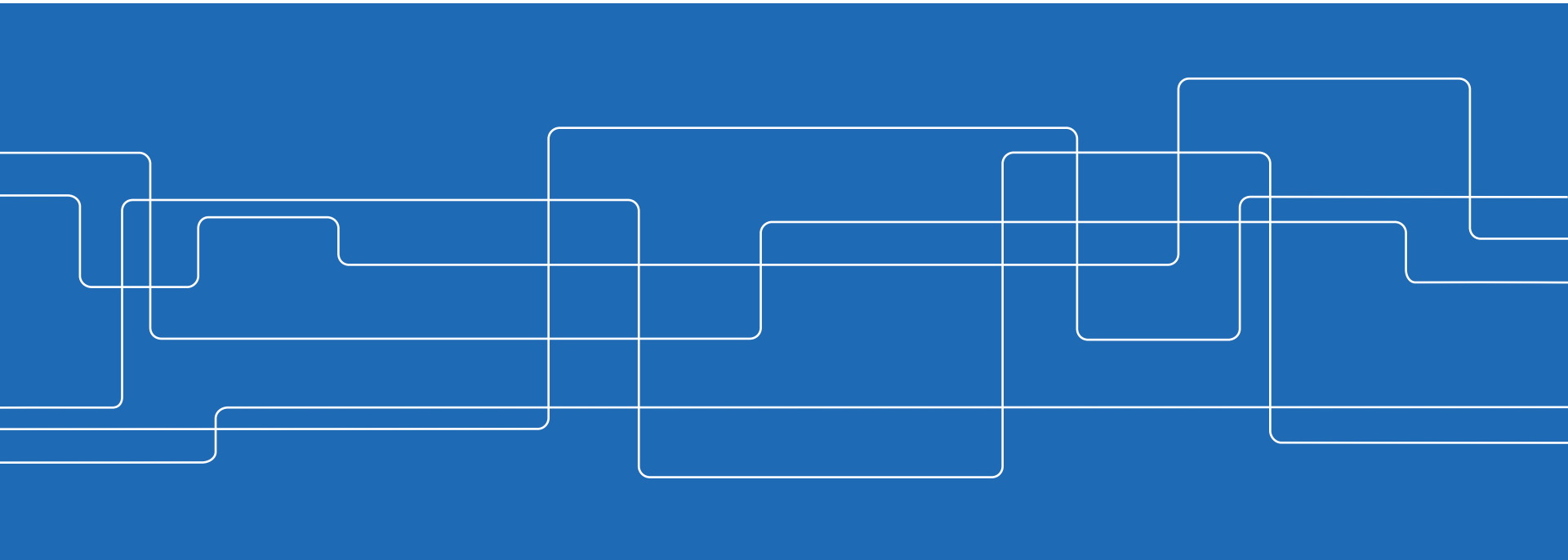
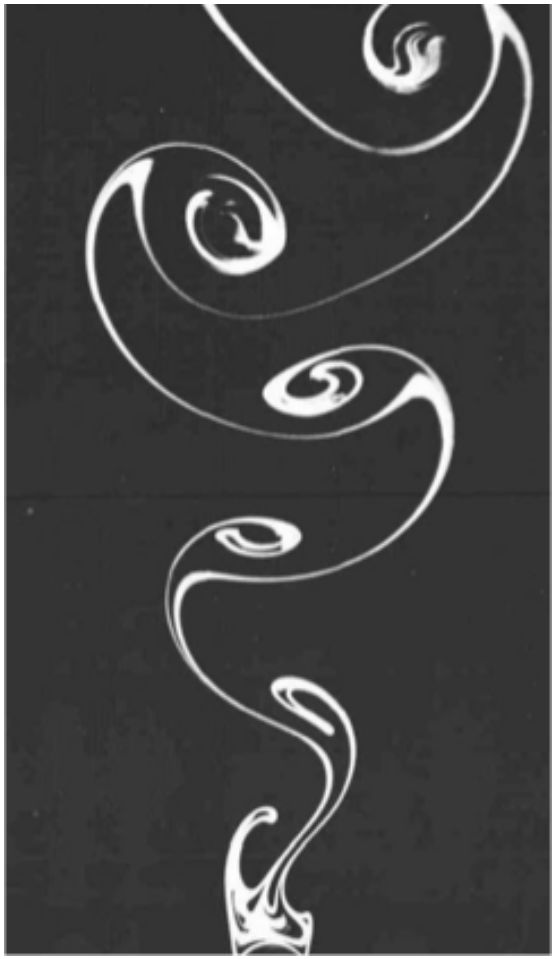
# The Vortex Meter

A method for measuring unsteady mass flows

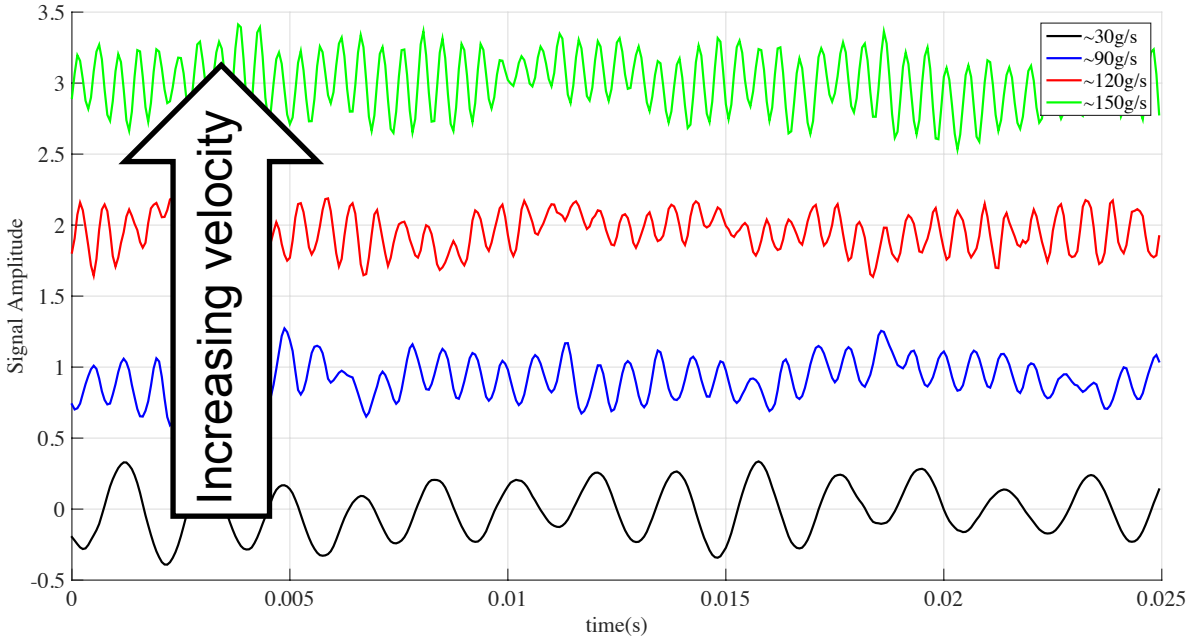
**Chris Ford**, Henrik Alfredson, Marcus Winroth



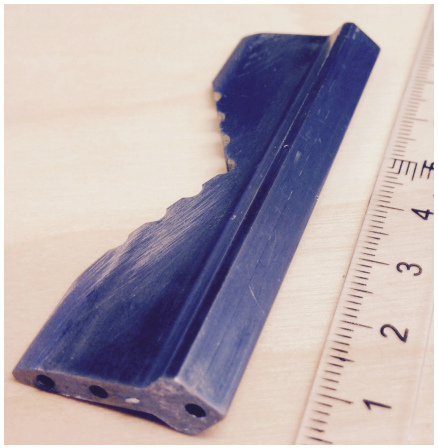
# Measurement Principal

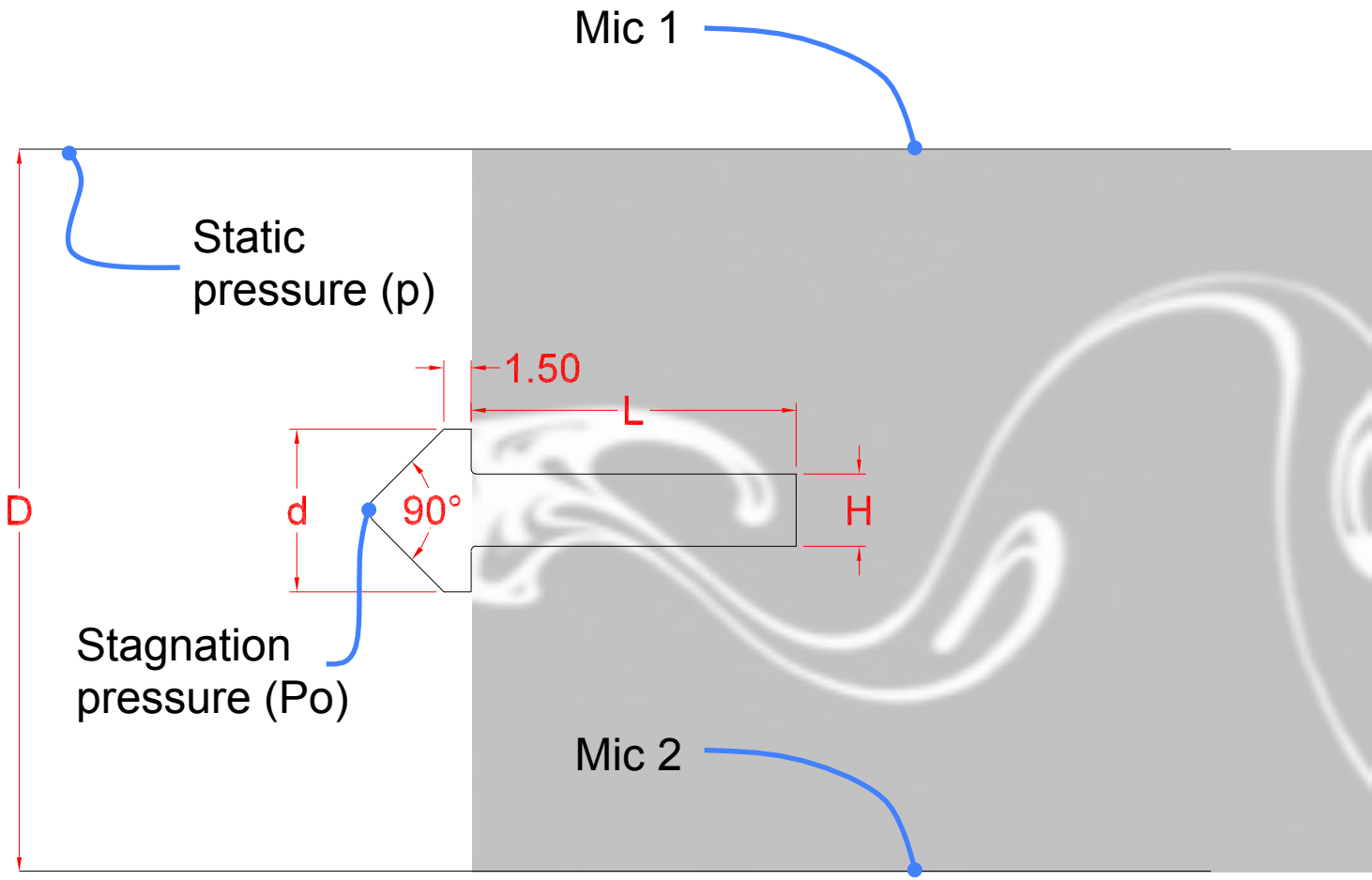


- Shedding frequency is a function of fluid velocity
- For well designed meters this relationship should be linear (constant Strouhal number)
- Thus volume flow may be computed by identifying the shedding frequency.



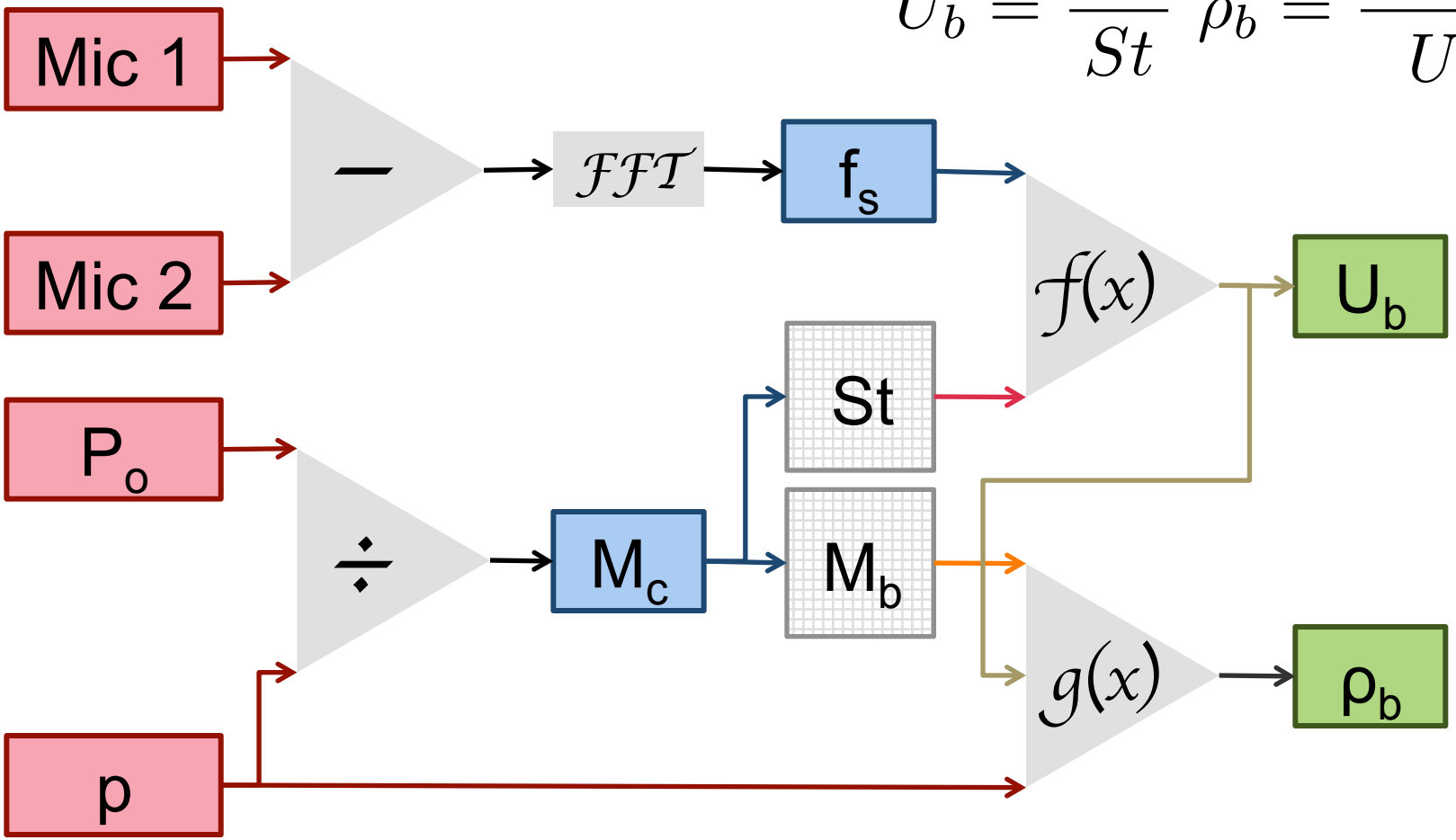
# Shedder Design





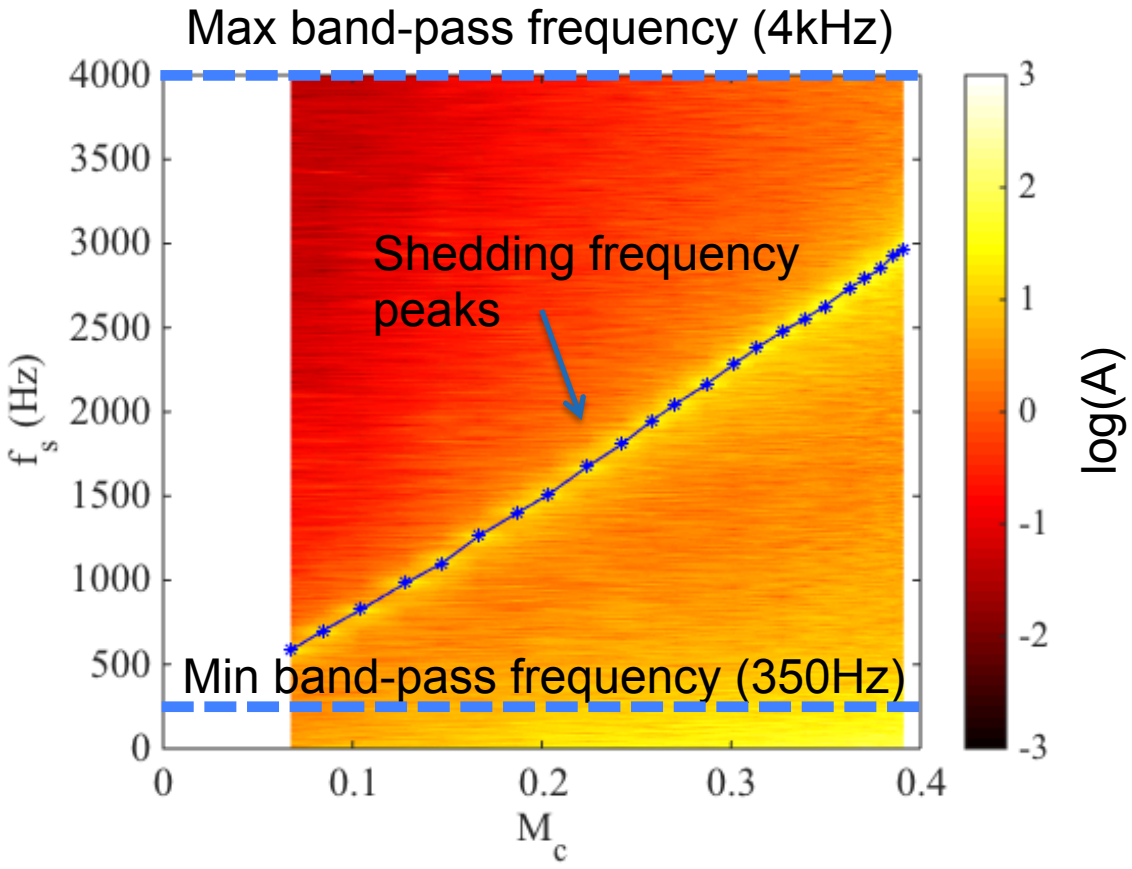
# Reduction Principal

$$U_b = \frac{f_s d}{St} \quad \rho_b = \frac{\gamma p {M_b}^2}{{U_b}^2}$$

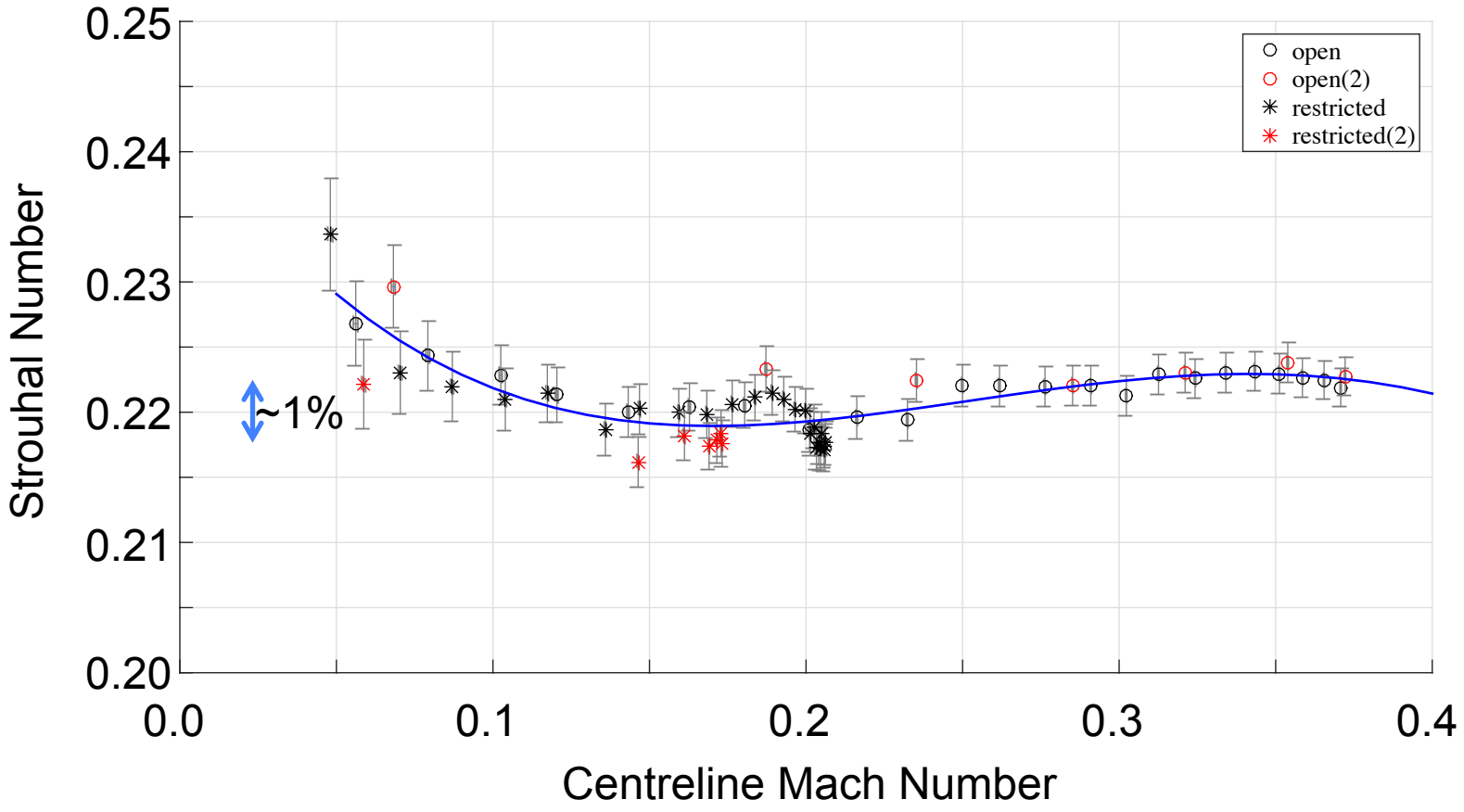


# Strouhal Number Calibration

- Compile spectra across a range of Mach numbers
- Auto-detect spectral peaks
- Characteristic is “clean”
- No obvious low or high frequency noise to make peak identification subjective
- No folds!
- Define band-pass



# Strouhal Number Calibration

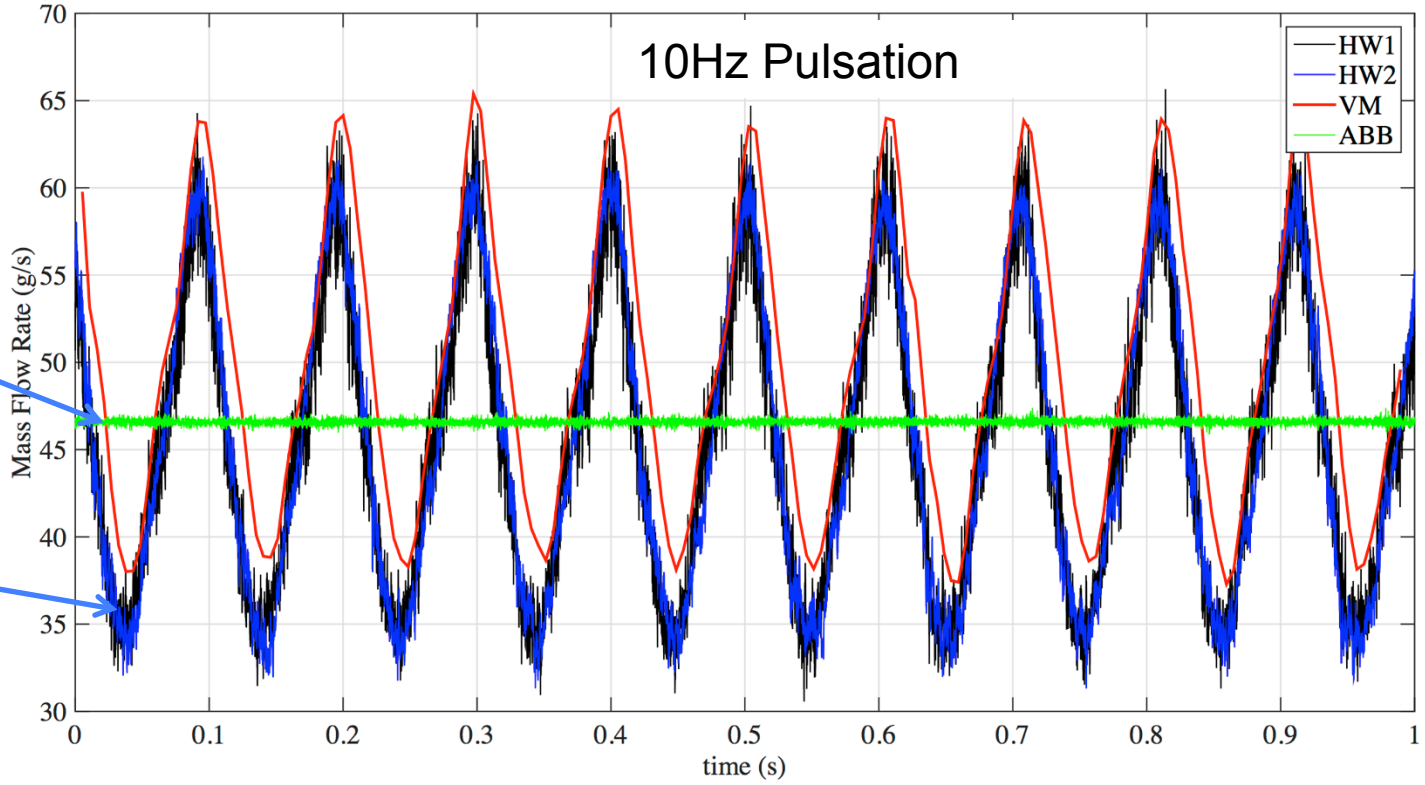


# Use in pulsating flow

~30g/s amplitude
(64% of base flow)

Reference steady state meter

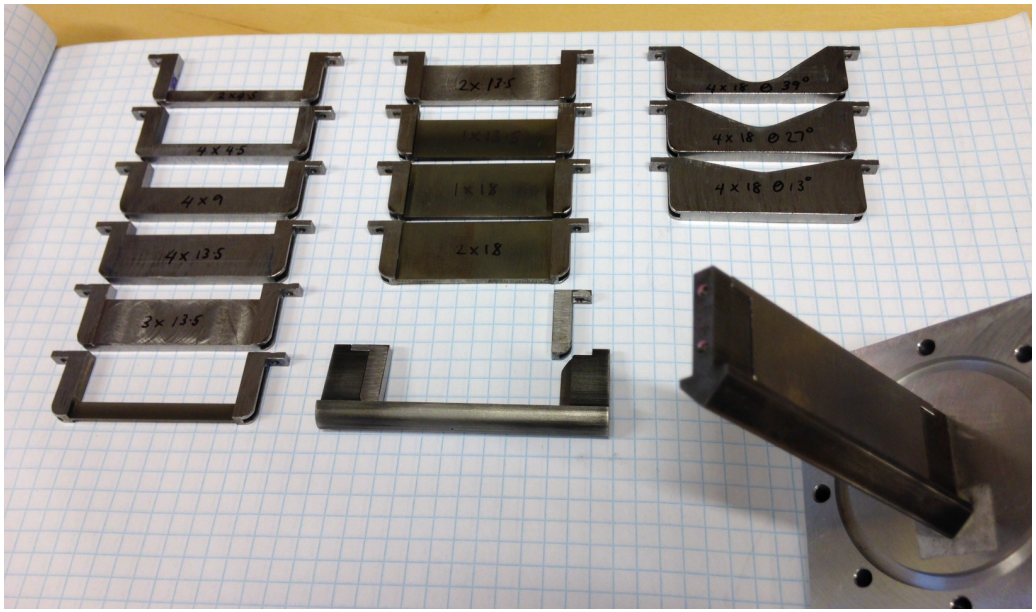
Reference unsteady meters




Work to be published: “Development of a Pressure Based Vortex-Shedding Meter: Measuring Unsteady Mass-Flow in Variable Density Fluids” (Meas. Sci. Tech.)

# Current Work

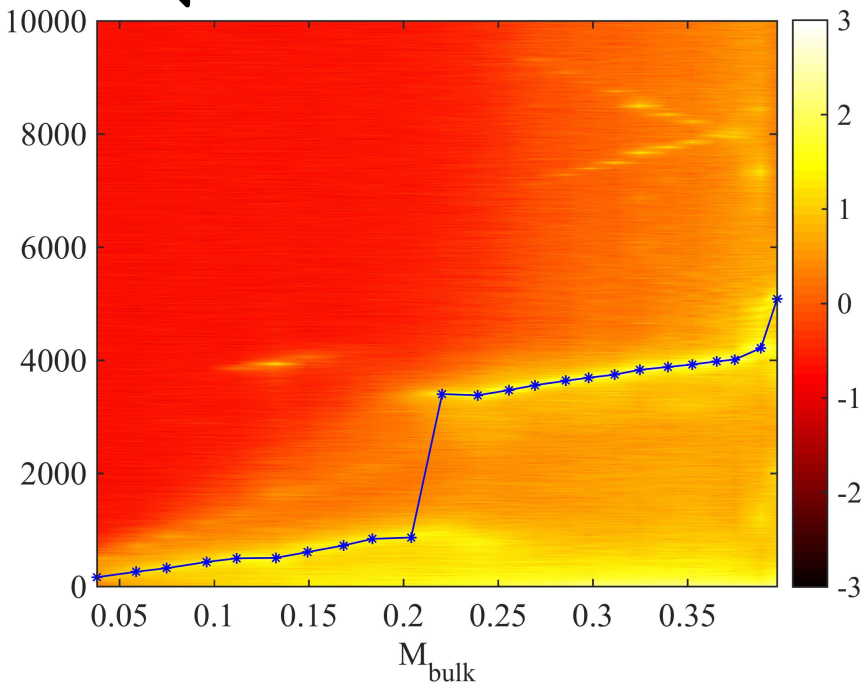
- Investigate influence of tail geometry on performance:
  - Minimise LF noise
  - Optimise range
  - Improve resolution
  - Minimise pressure loss
- Investigate 20+ tails and 2 fore-body designs
- Various L, various H, some non-prismatic



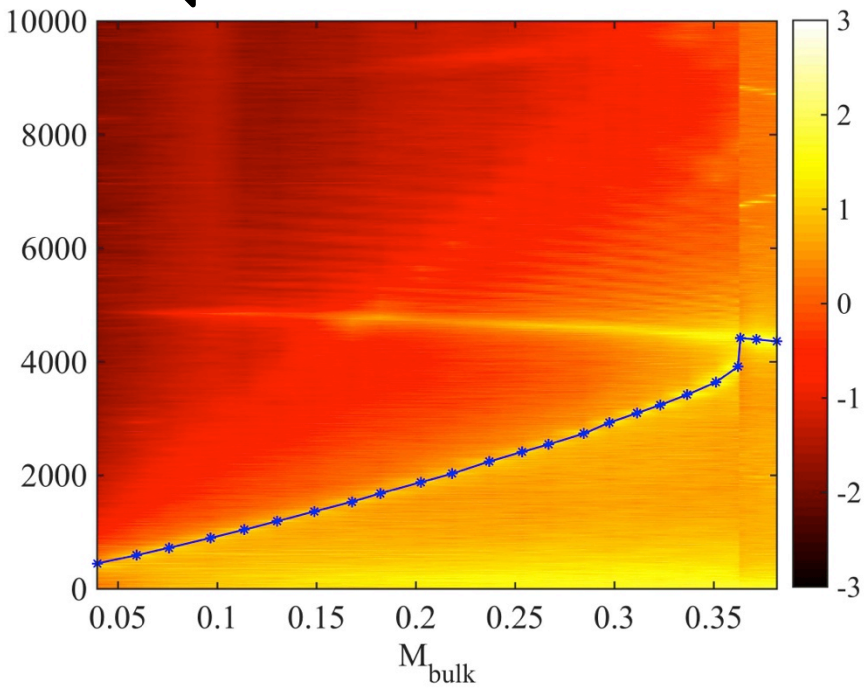

Examples of tail geometries and two fore-body design

# Effect of Changing Tail Length (L)

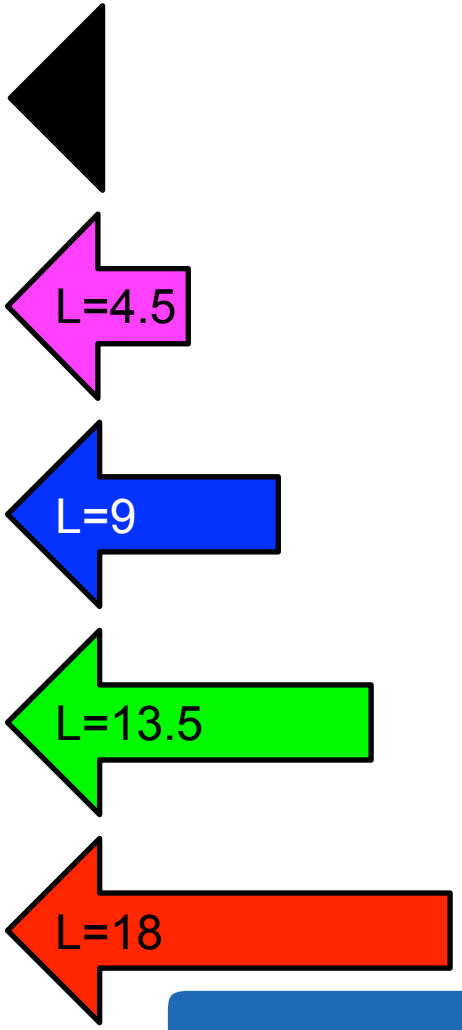
L=18mm
H=4mm

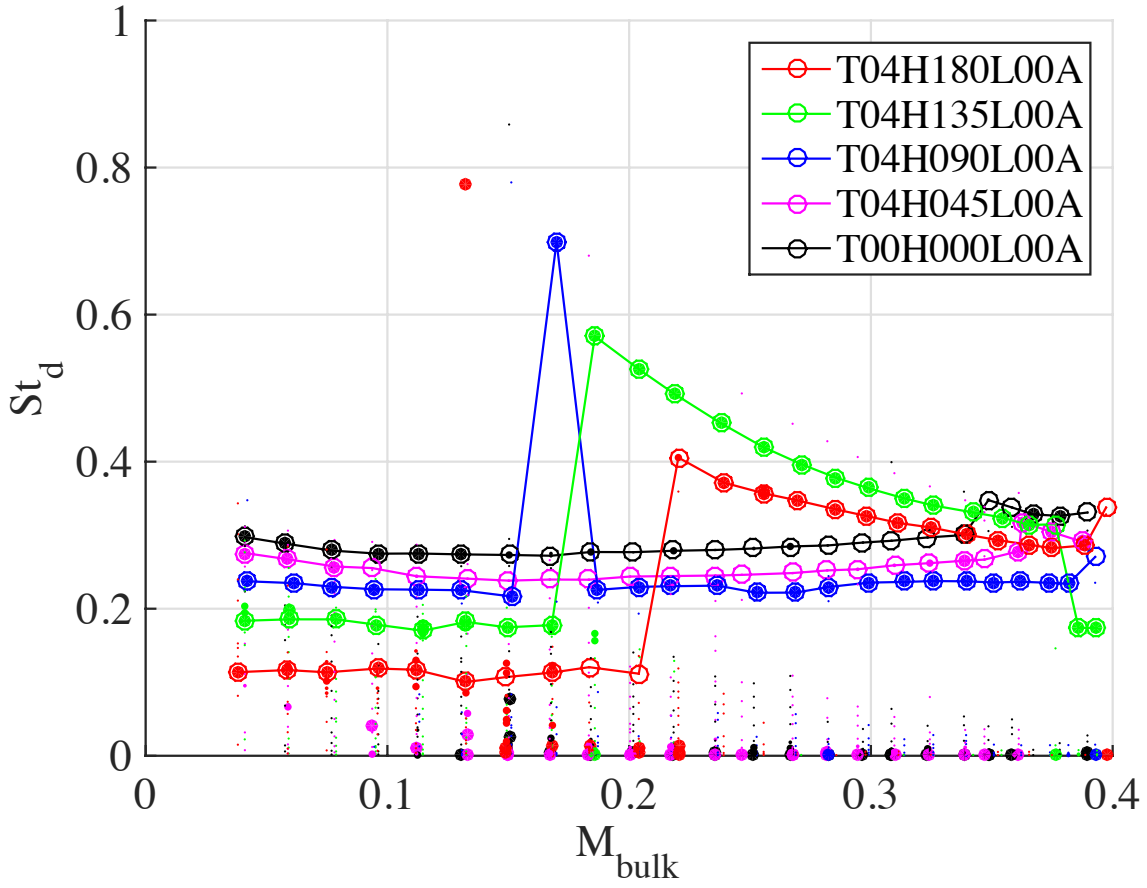



L=4.5mm
H=4mm



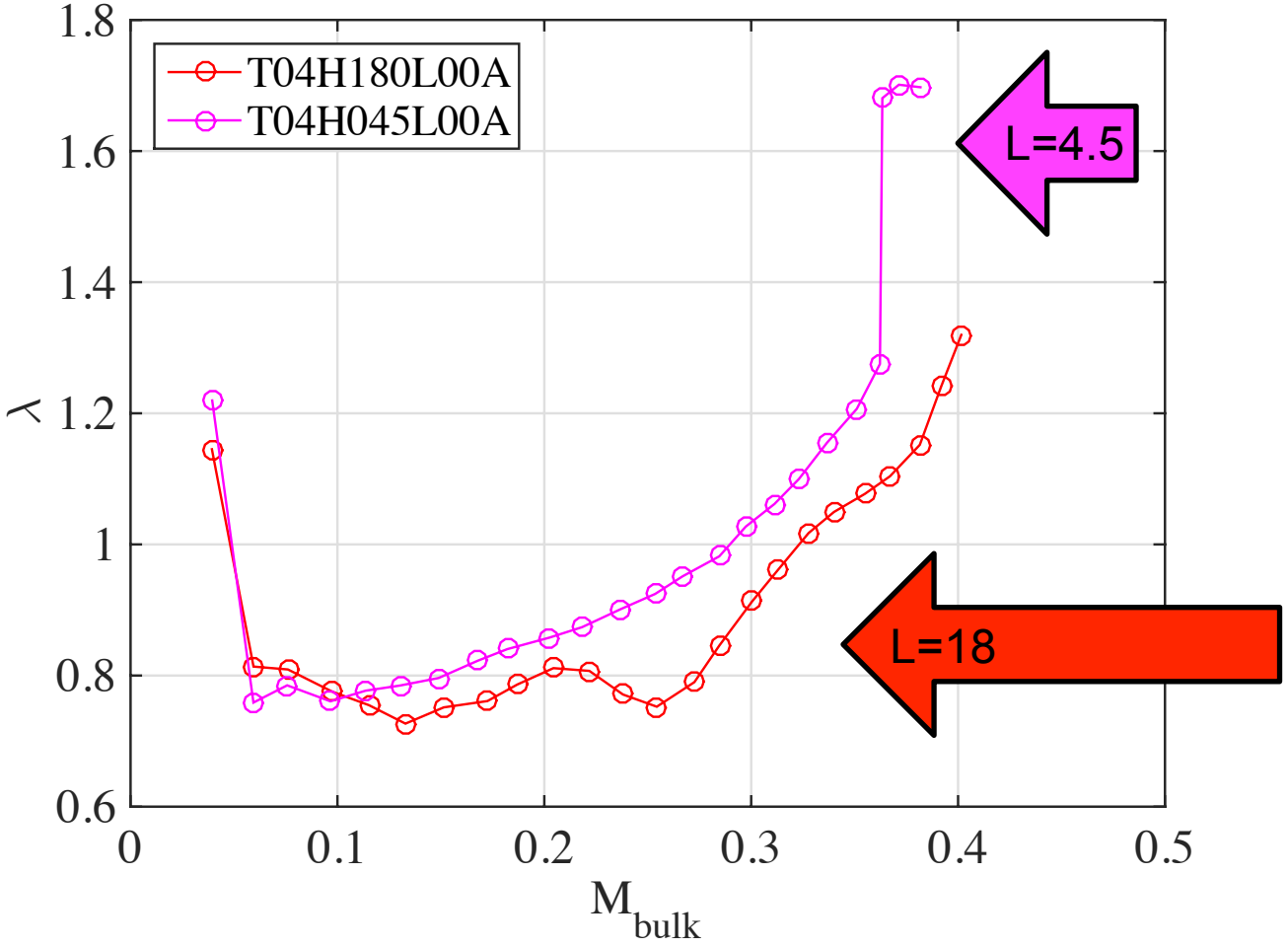
# Effect of Changing Tail Length (L)



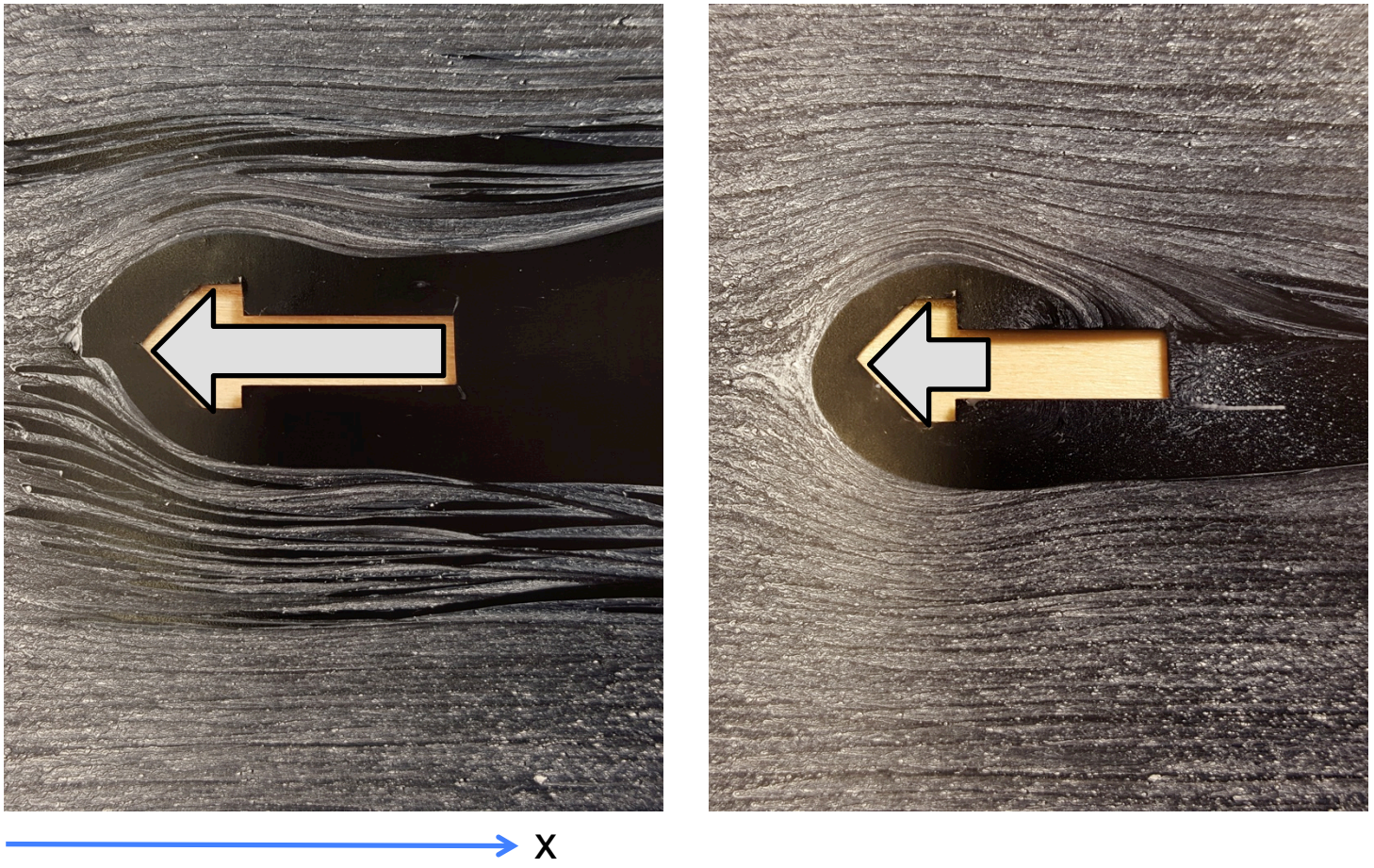



# Effect of Changing Tail Length (L)

- Plot shows pressure loss coefficient (dp/q)
- Short tail -> higher loss
- Rapid increase (4.5) caused by resonant/sonic behaviour
- Increase in (18) loss associated with “death” of primary frequency and mode shift



# Surface Flow Visualisation




Images taken at:
~150g/s
(~Mb=0.27)

# Conclusions and Ongoing Work

- A vortex meter has been developed and demonstrated for use in time dependent flow fields
- To improve meter performance a study of tail/fore-body geometry is underway
- Interesting “modal” behaviour has been noted in several cases, which is very sensitive to tail length
- Flow visualisation techniques have been developed to aid understanding of the flowfield