LOW SPEED vs HIGH SPEED TESTING OF LP TURBINE BLADE WAKE INTERACTION

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Contents

Introduction

- Experiments simulating blade wake interaction at high Mach numbers are needed

BUT

- Only IF they are worth it

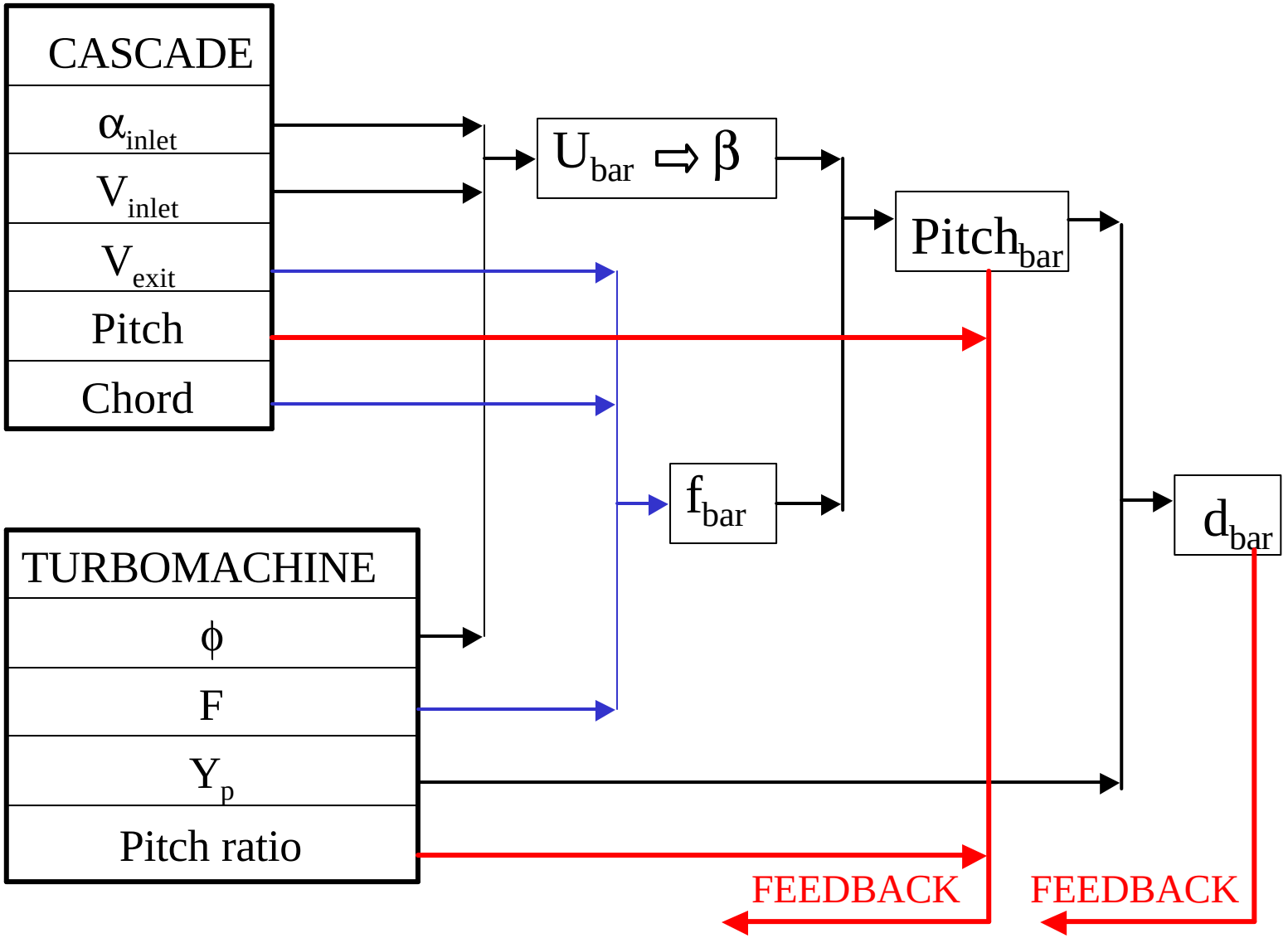
This seminar presents

- Techniques for testing of low and high speed LPT cascades
- The extent to which results from low speed are meaningful

High speed vs. low speed

	High speed	Low speed
Reynolds number	✓	✓
Mach number	✓	✗
Exit angle	✓	✓
Stream tube divergence	✗	✗
Chord	50mm	200mm
Bar passing frequency	3KHz	60Hz
Bar diameter	0.4mm	2mm

Choosing the size

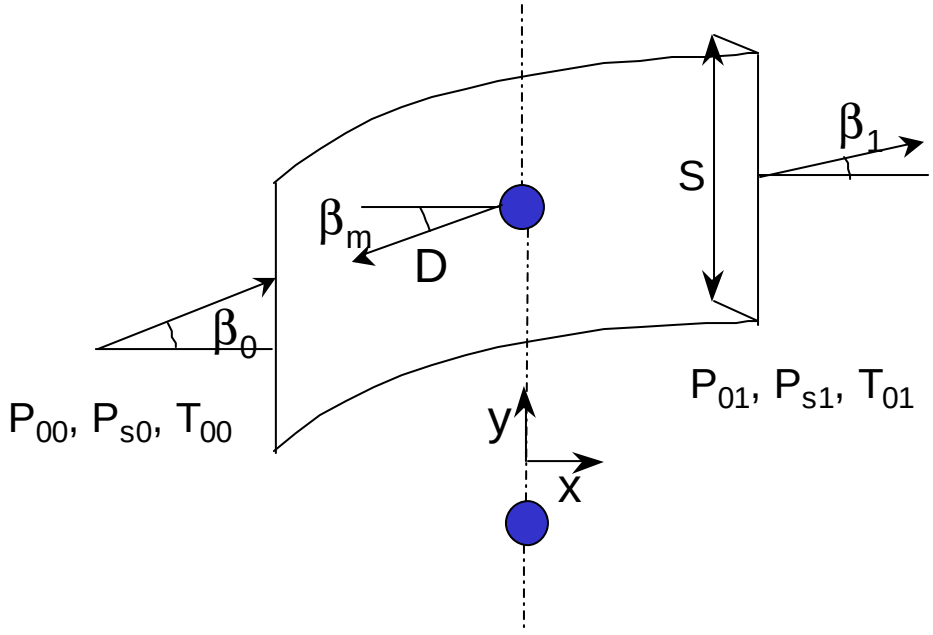


Determination of bar losses

Stagnation pressure across the bar row changes due to

- Losses due to the drag of the bars
- Work input

Mixed out conditions downstream the bars are needed

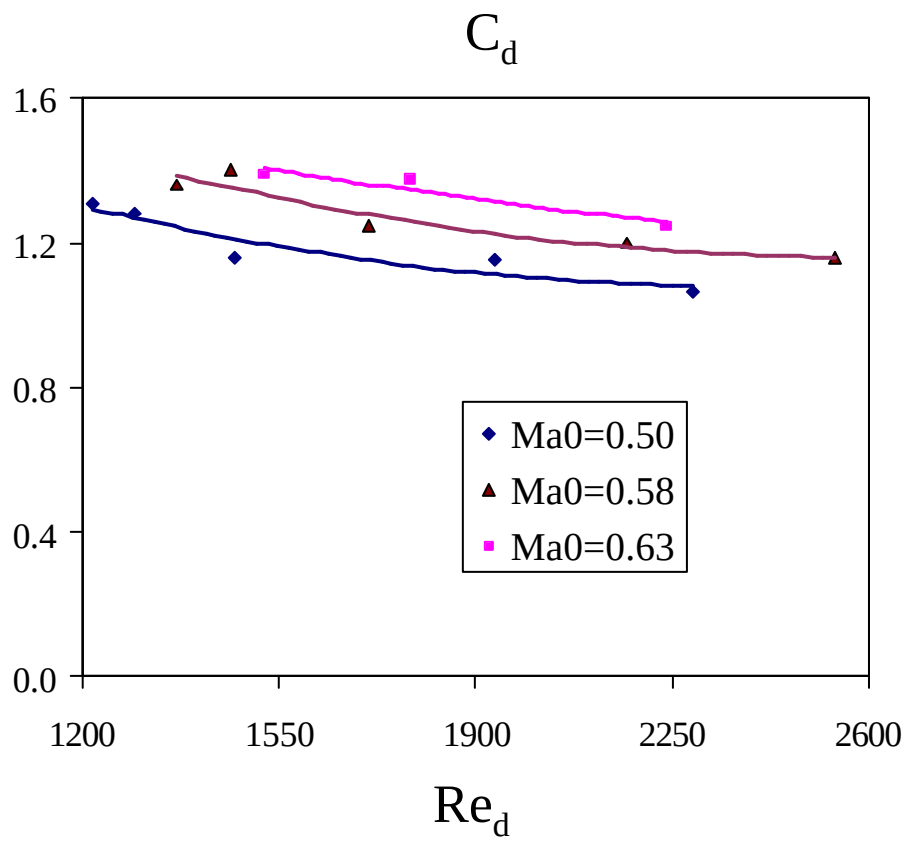


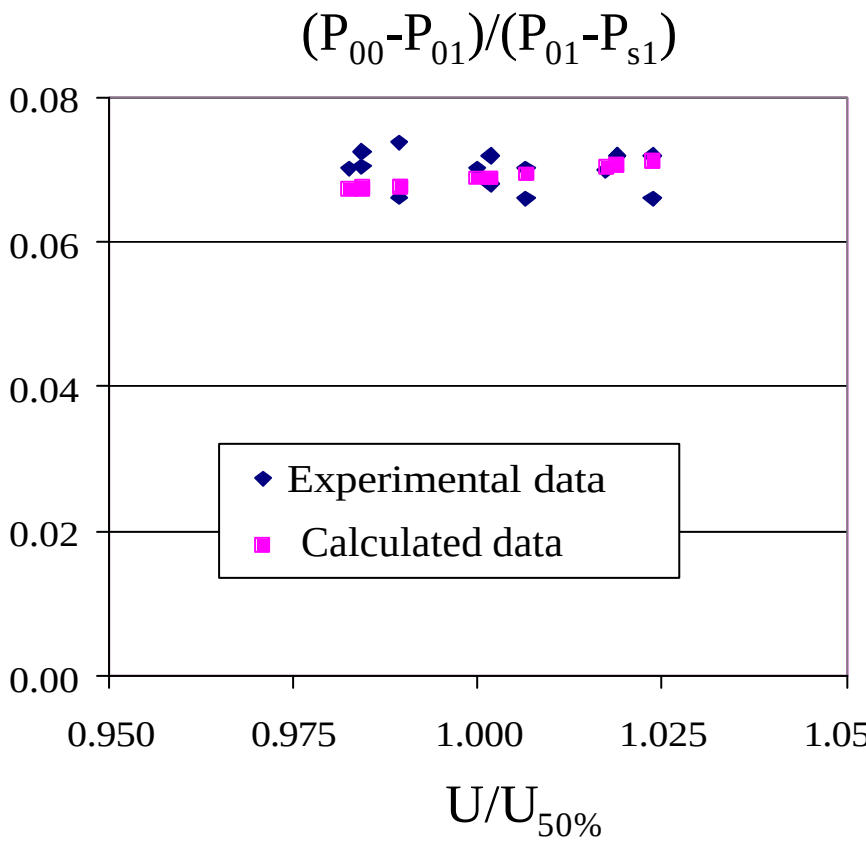
Calculation procedure

Frame of reference fixed to the bars

$$D = d \cdot Cd \cdot \begin{cases} 1/2 \cdot ? \cdot W^2 & \text{Low speed} \\ (P_{00} - P_{s0}) & \text{High speed} \end{cases}$$

Determination of bar losses



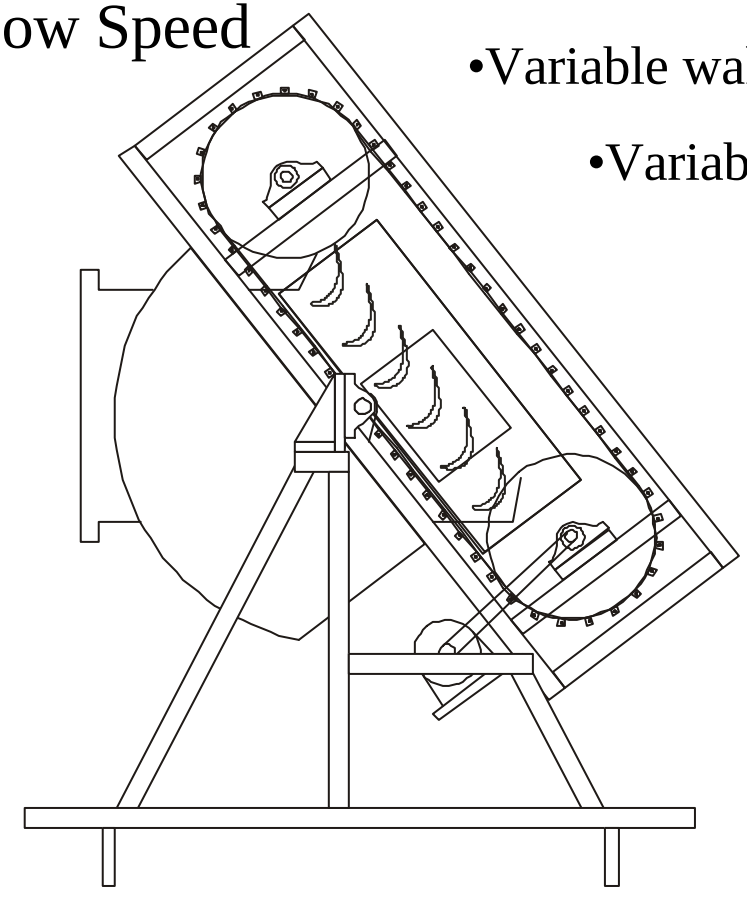


- A good estimation of C_d is needed
- The calculation procedure is validated

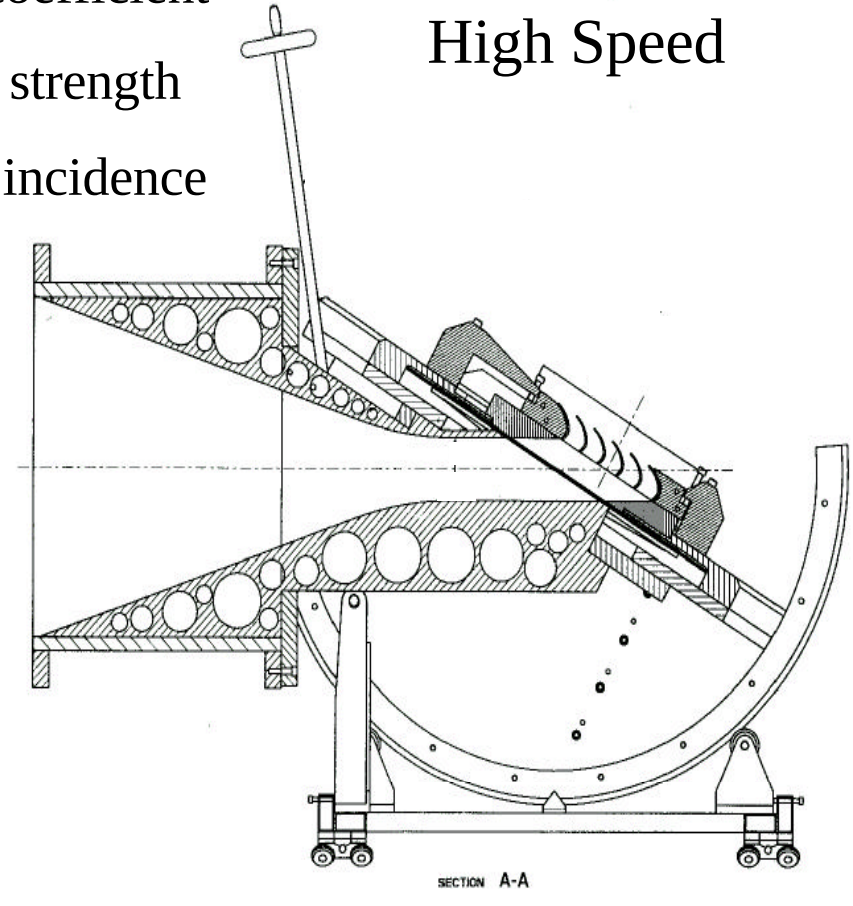
Facilities

- Variable wake passing frequency
- Variable inlet flow coefficient
- Variable wake strength
- Variable incidence

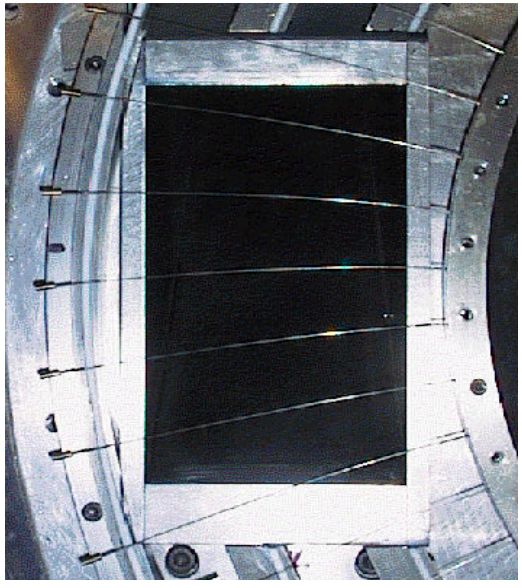
Low Speed

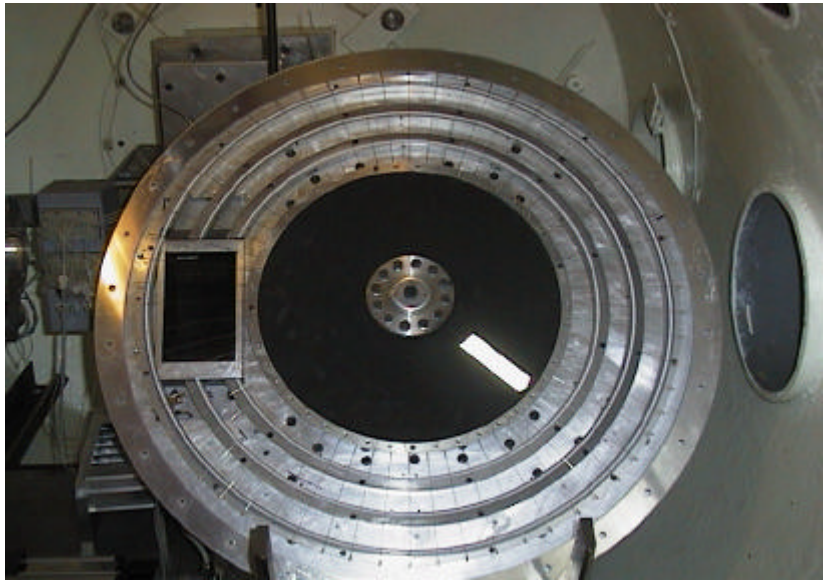


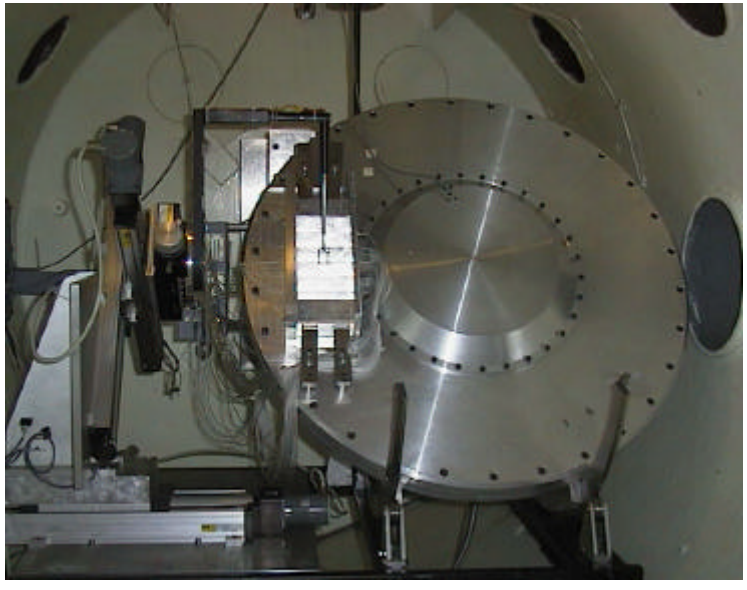
High Speed

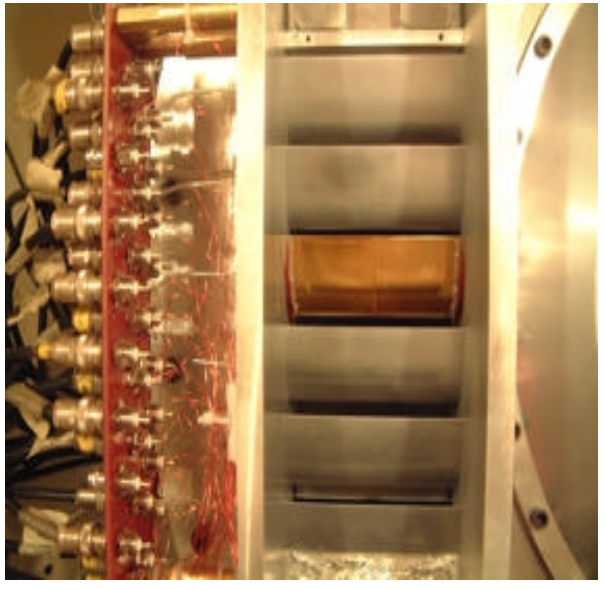


Facilities. High speed rotating bar rig

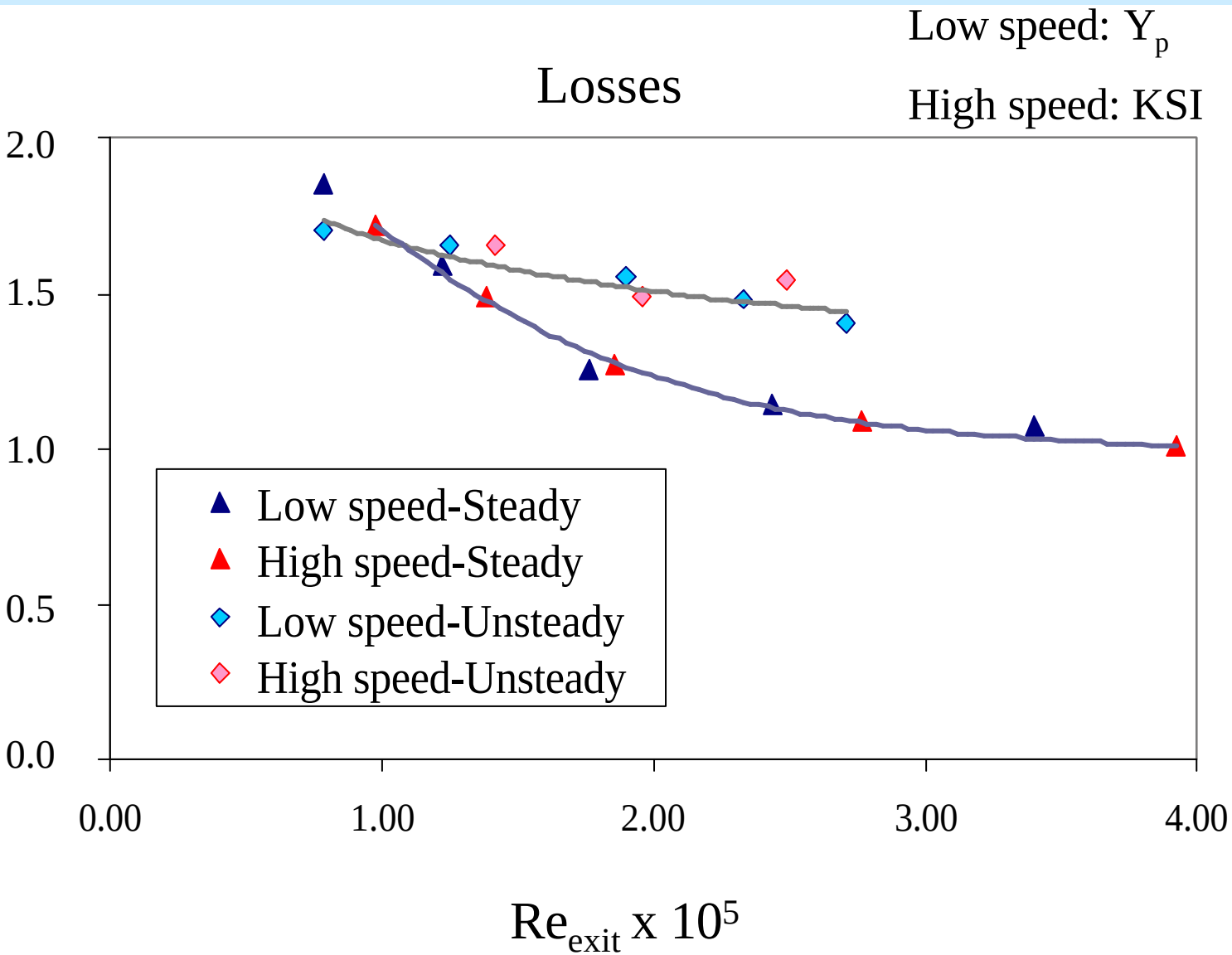






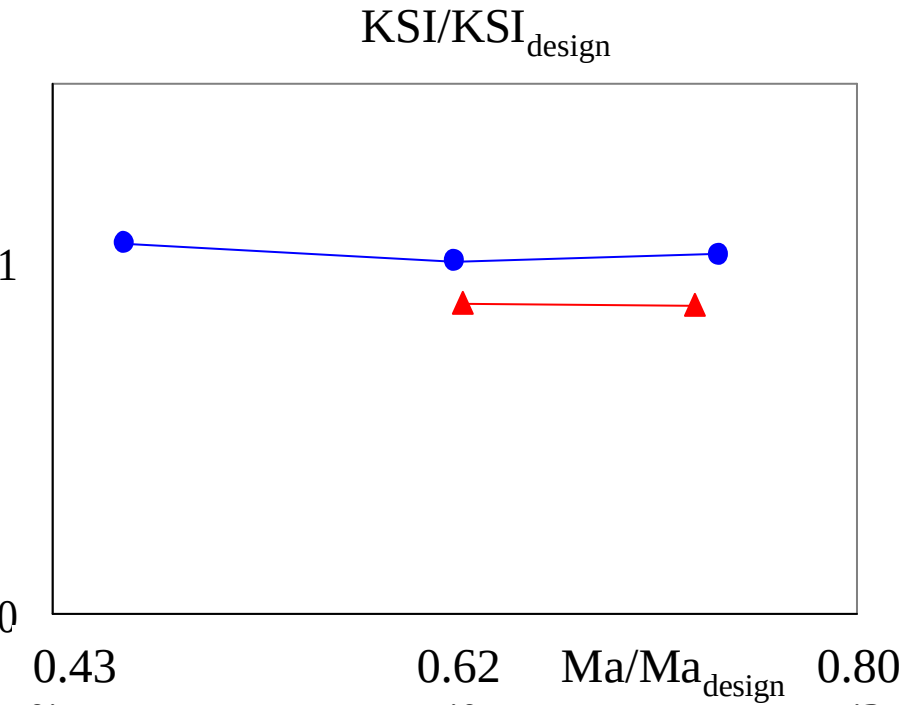


Results

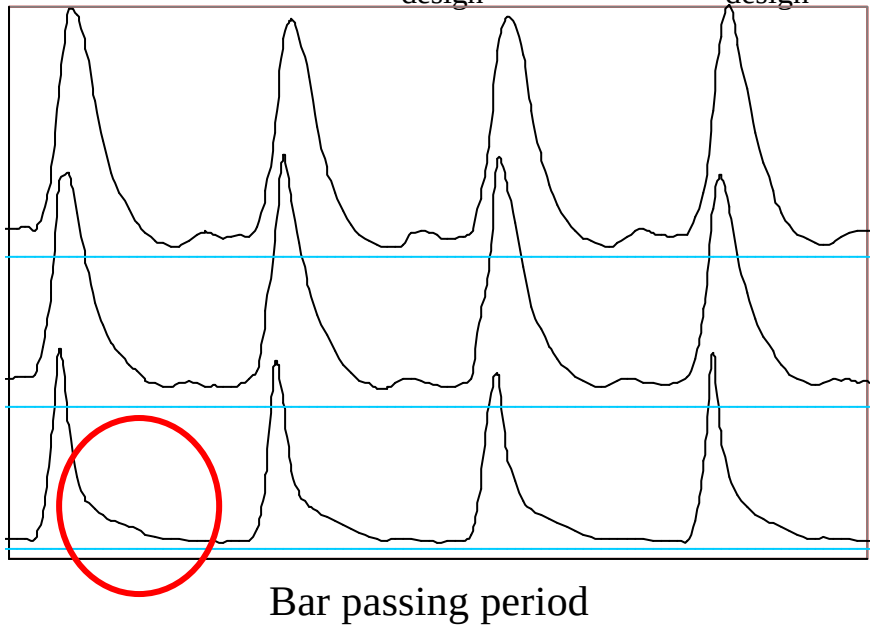

Low speed: Y_p
High speed: KSI
Losses
2.0
1.5
1.0
0.5
0.0
0.00
1.00
2.00
3.00
4.00
Low speed-Steady
High speed-Steady
Low speed-Unsteady
High speed-Unsteady
Re_{exit} x 10^5

Results

High lift, high turning profile



Non-dimensional ensemble averaged quasi shear stress Ma=Ma$_{design}$, Re=0.65Re$_{design}$



- Independency of Mach number below the transonic range
- Existence of becalmed region following the wake induced path

Conclusions

High speed testing presents greater challenges.

At all speeds below transonic:

- Same quantitative results are obtained for loss
- Same wake interaction phenomena are found

Low speed approach is valid below the transonic range

and it is EASIER

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