UNIVERSITY OF OXFORD

Development and application of Background Oriented Schlieren (BOS) for hypersonic free-flight experiments

Jake Watson[1], Luke Doherty[1], Matthew McGilvray[1]

[1] Oxford Thermofluids Institute, University of Oxford

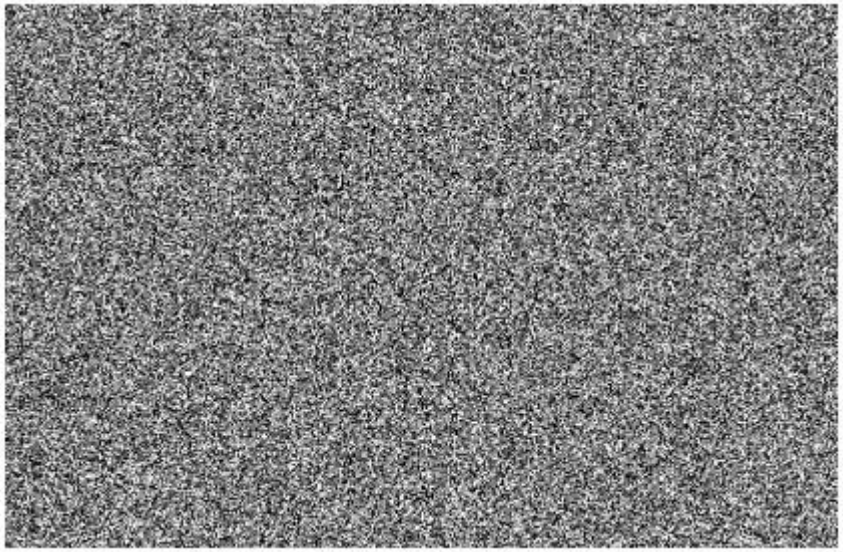
Scope:

- Introduction
- High Density Tunnel (HDT): Static & Free-Flying testing
  - Patterns
  - Models
  - Experimental Setup
  - Processing
  - Results
- Summary

Introduction:

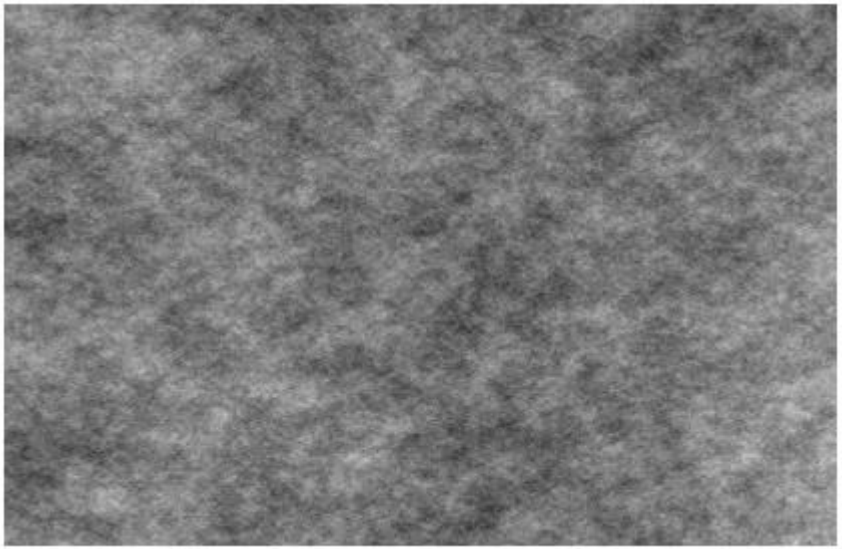
- Normal Schlieren requires accurate alignment and provides a limited flow field (determined by the size of the mirrors).
- Background Oriented Schlieren (BOS) allows a for a larger field of view (determined by size of background image and camera setup).
- BOS can easily be coupled with existing optical measurement techniques.
- **Aim: Development and application of BOS to hypersonic free-flight experiments, *to be used in conjunction with optical tracking and Pressure Sensitive Paint (PSP).***

High Density Tunnel (HDT) - Patterns:



Chaotic

(Cross-Correlation)

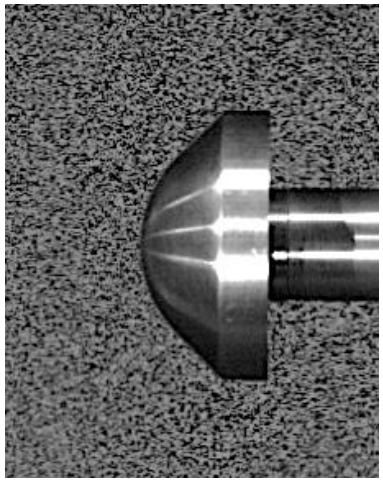


Wavelet

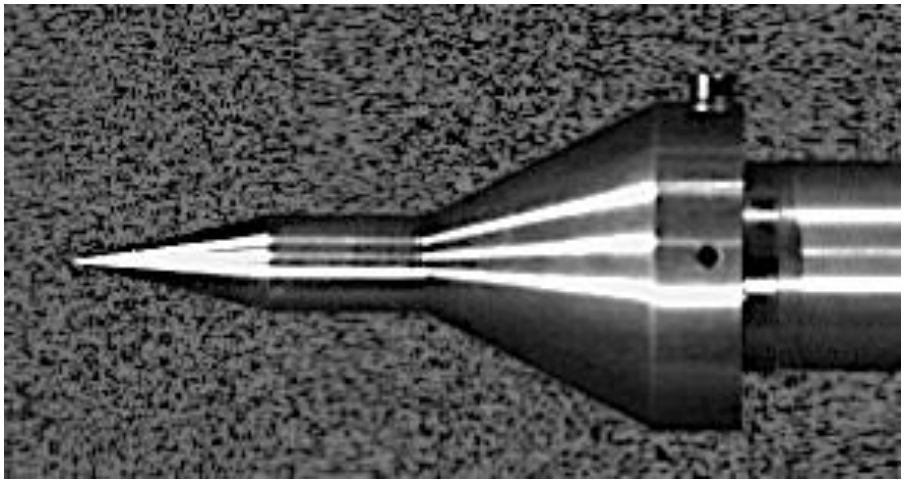
(Optical flow)

High Density Tunnel (HDT) - Models:

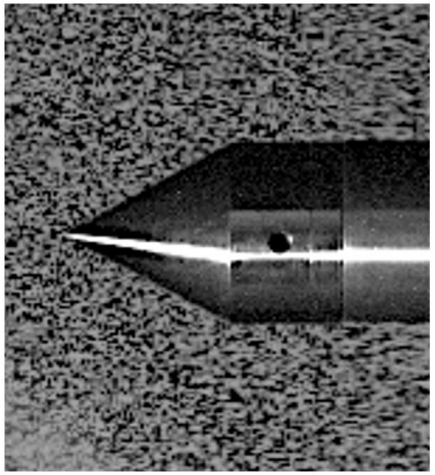
Blunt Cone

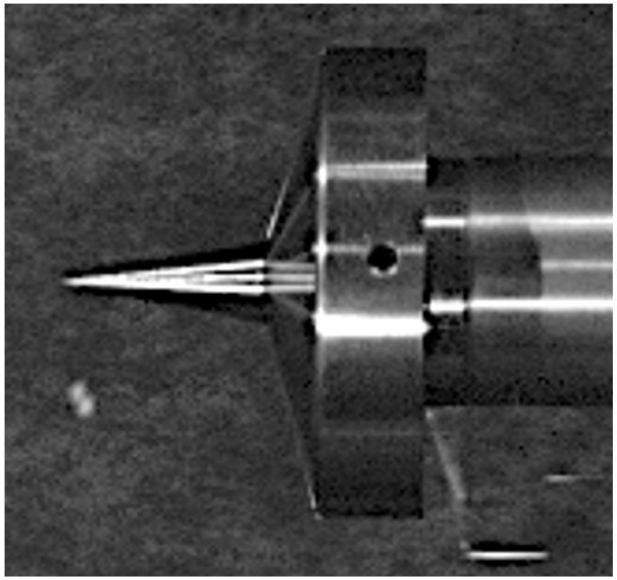


Flared Cone



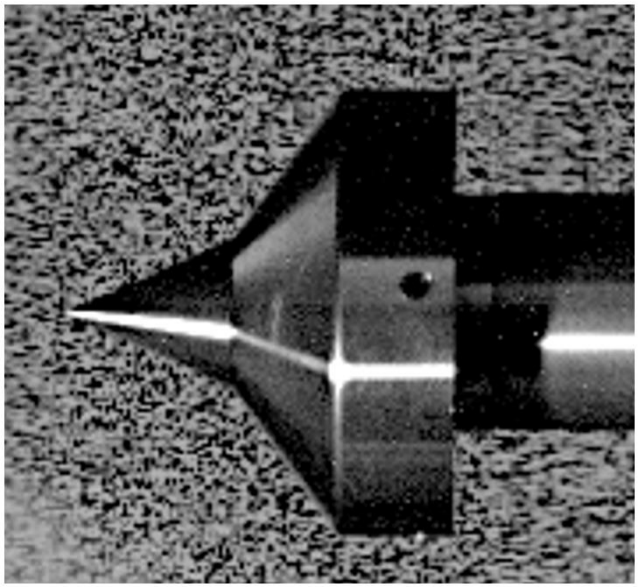
Straight Cone





Double Cone

(Unsteady)



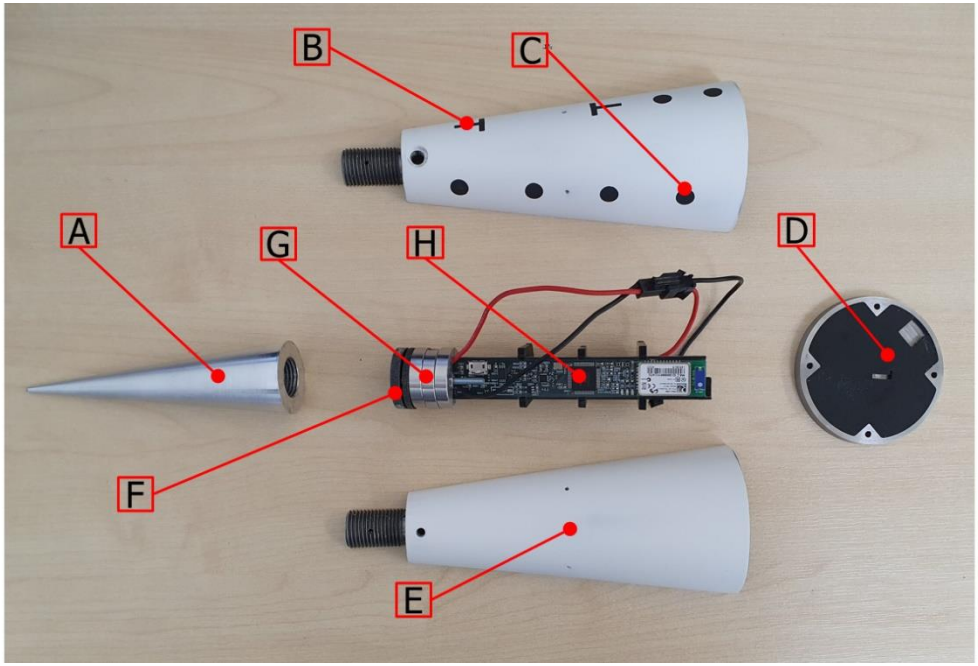
Double Cone

(Steady)

UNIVERSITY OF OXFORD

High Density Tunnel (HDT) - Models:

7° half angle cone

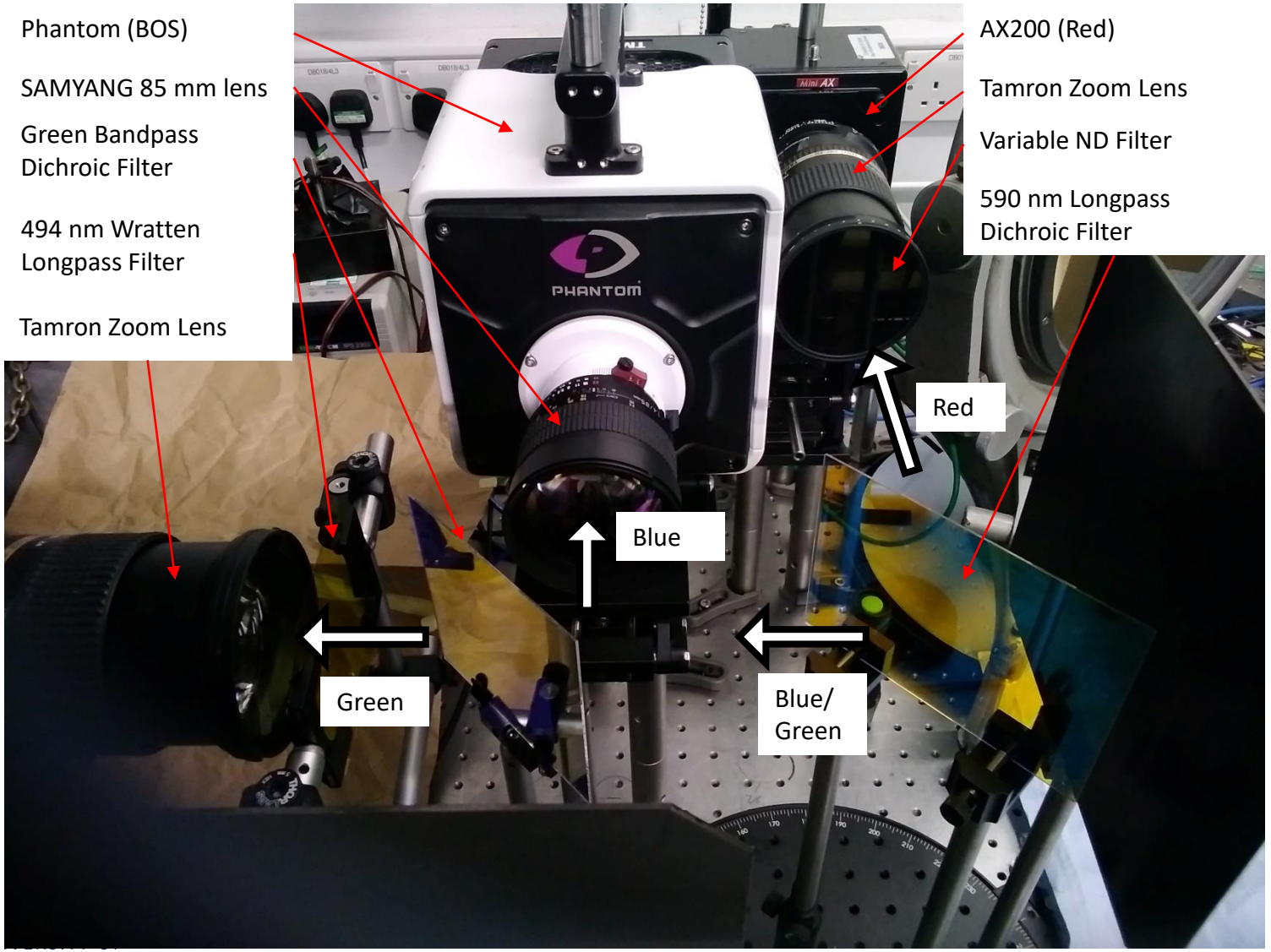


A. Aluminium nose
B. Electromagnetic alignment marker
C. Optical Tracking Dots
D. Steel rear with 3D printed insert
E. Steel cone half
F. 3D printed DAQ mount
G. Tungsten ballast
H. DAQ

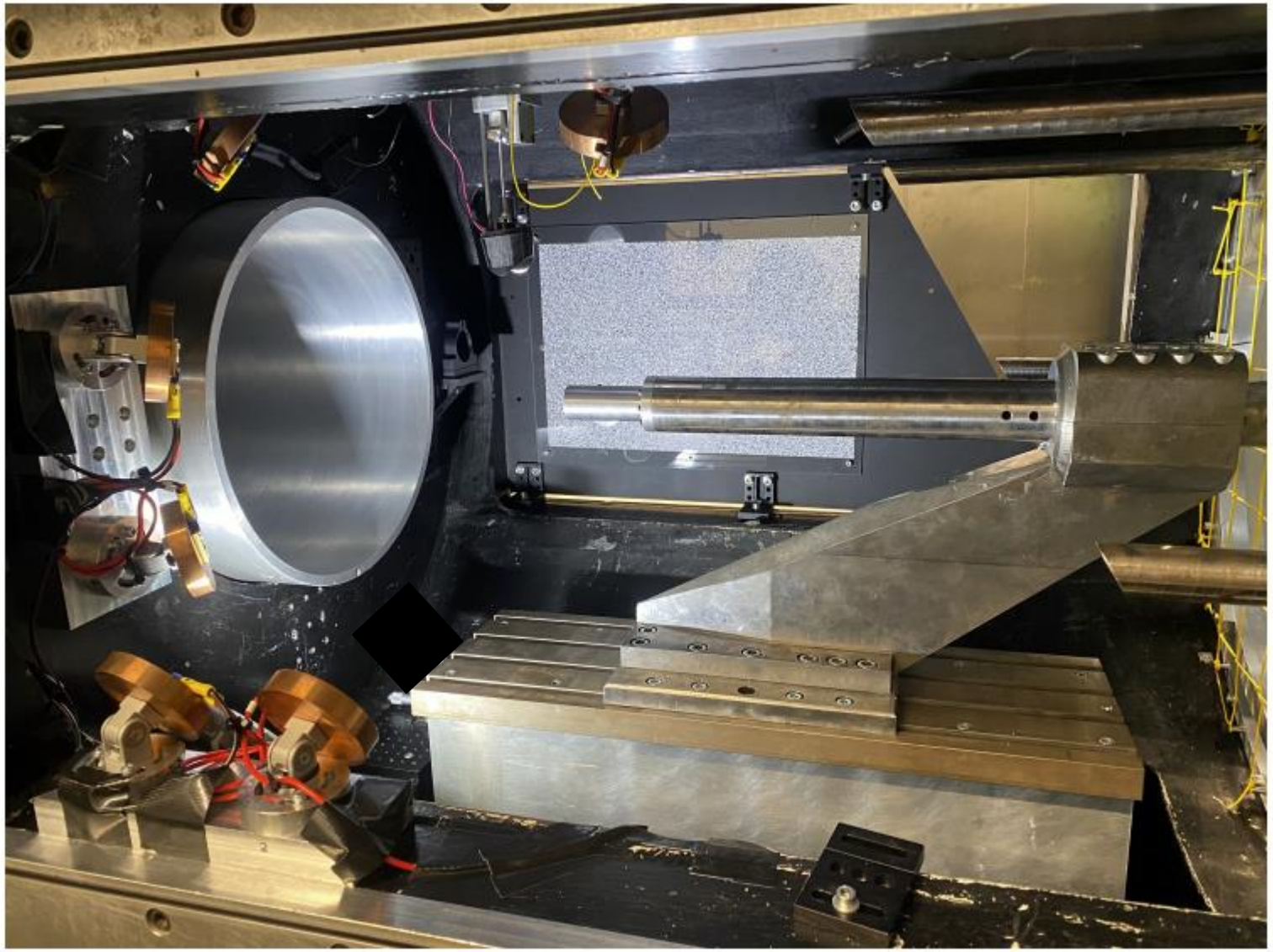
Hyslop *et al.* (2022)
doi:10.2514/6. 2022-1324

UNIVERSITY OF OXFORD

High Density Tunnel (HDT) – Optical Setup:

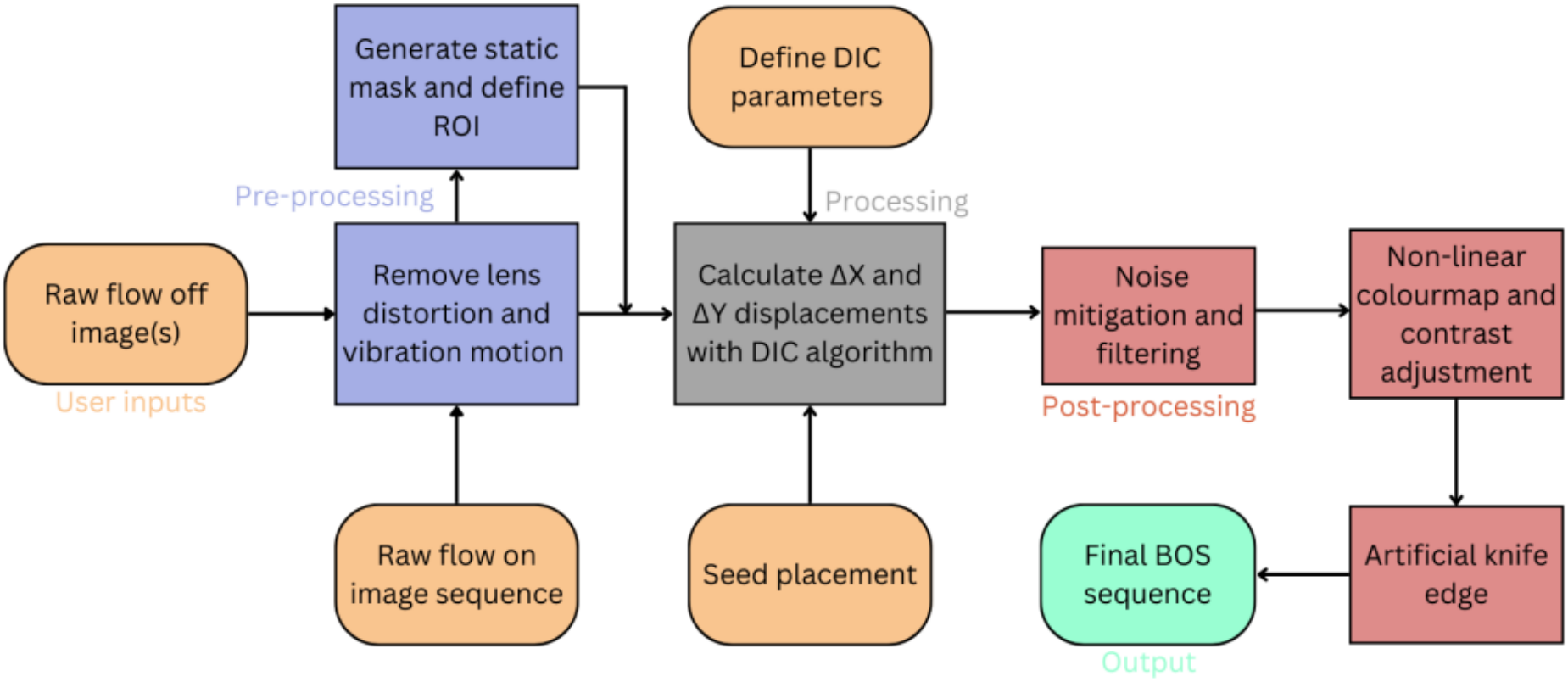


High Density Tunnel (HDT) – Test Section:

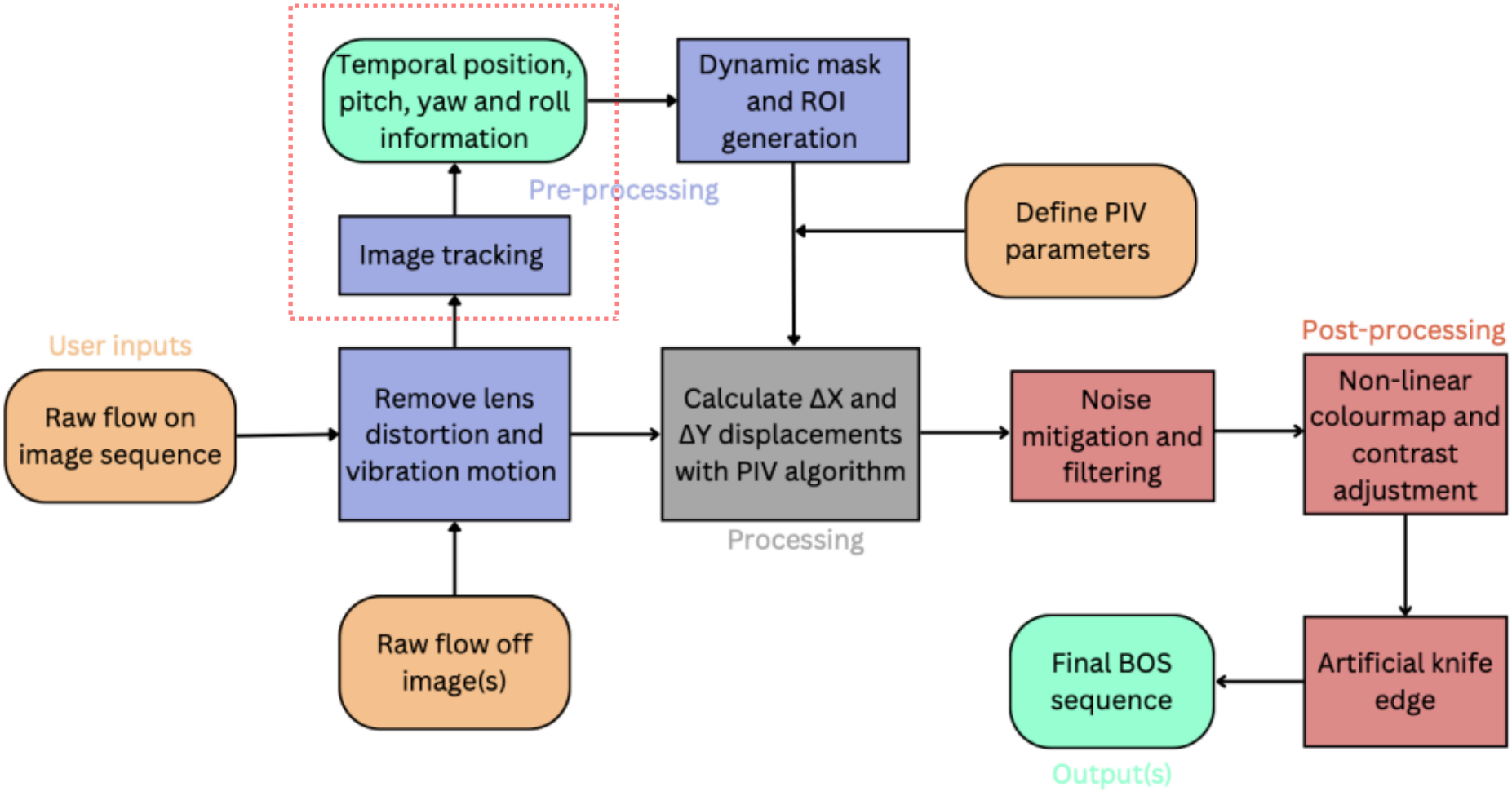


UNIVERSITY OF OXFORD

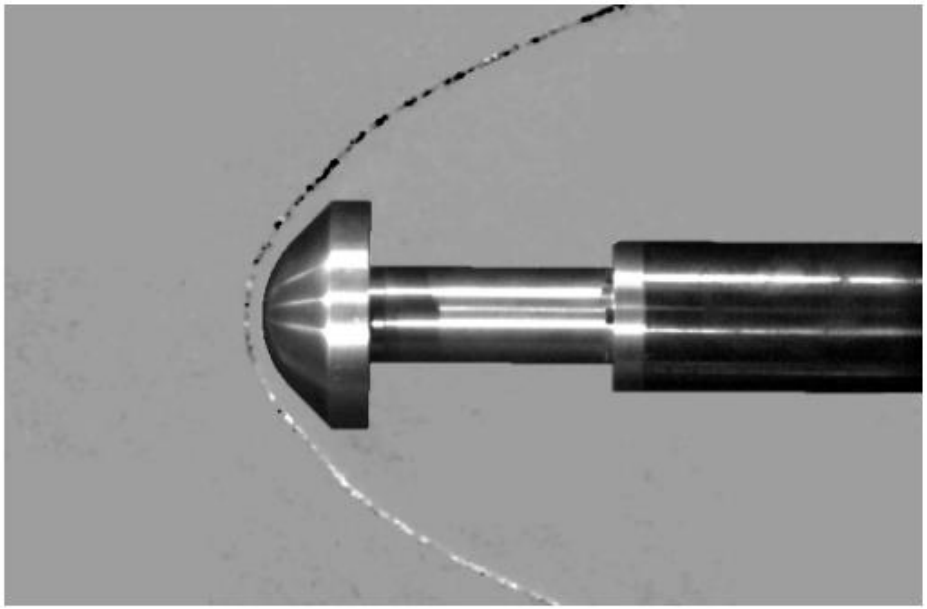
High Density Tunnel (HDT) – Processing (Static):



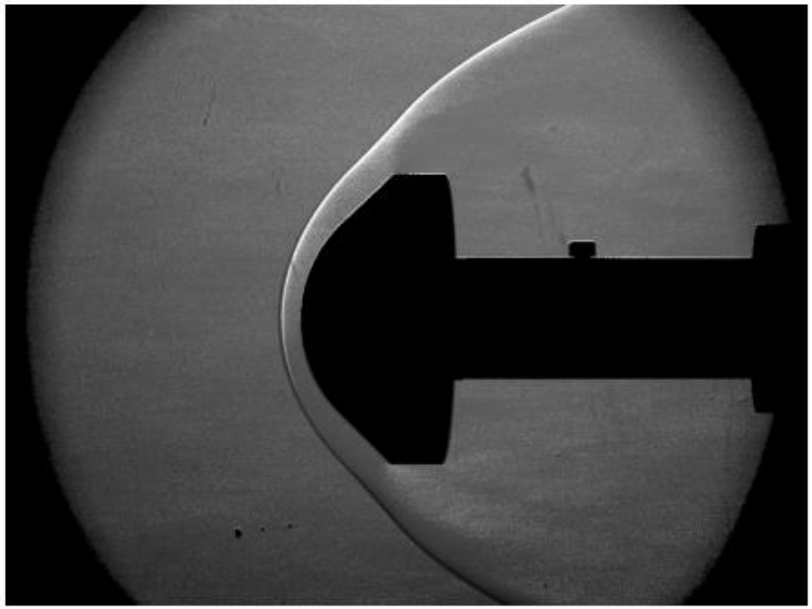
High Density Tunnel (HDT) – Processing (Dynamic):



High Density Tunnel (HDT) – Results:

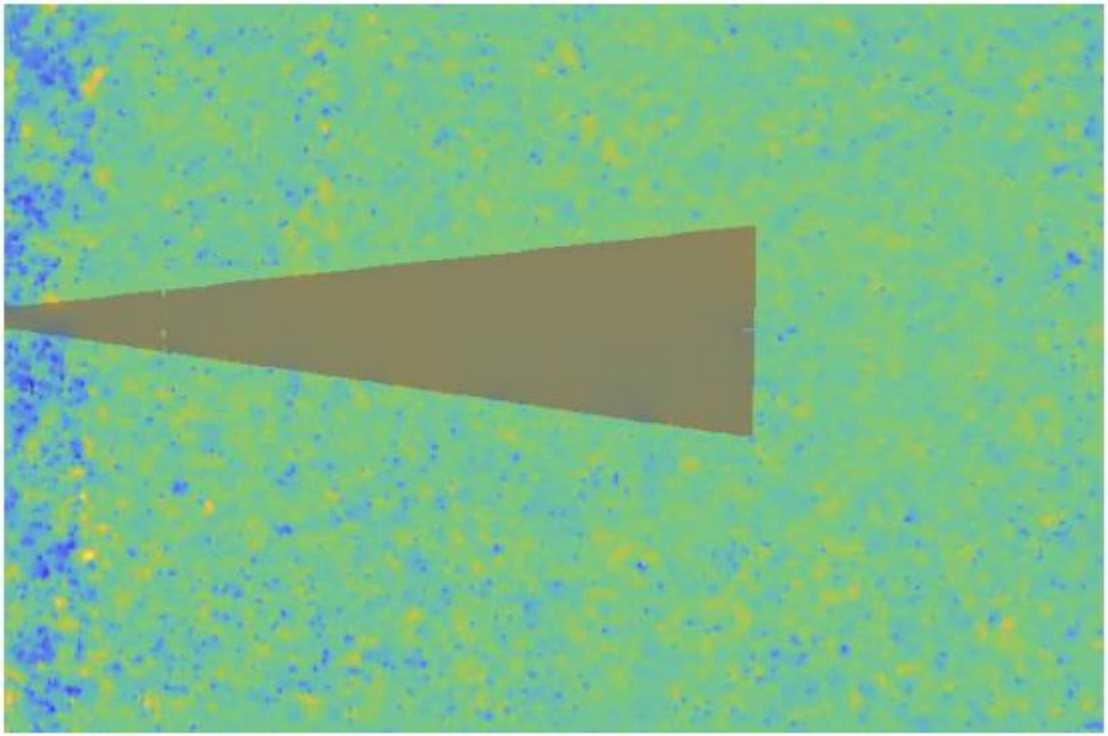


BOS



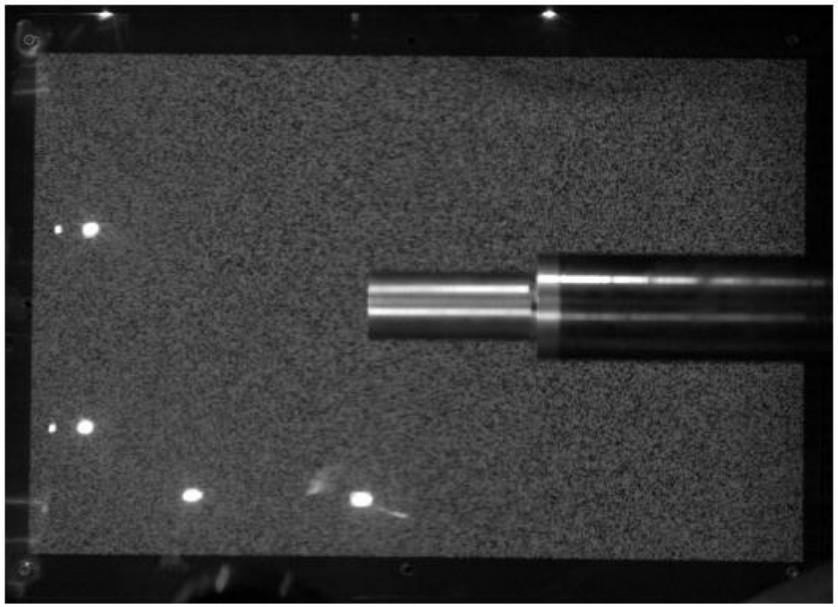
Optical
Schlieren

High Density Tunnel (HDT) – Results:

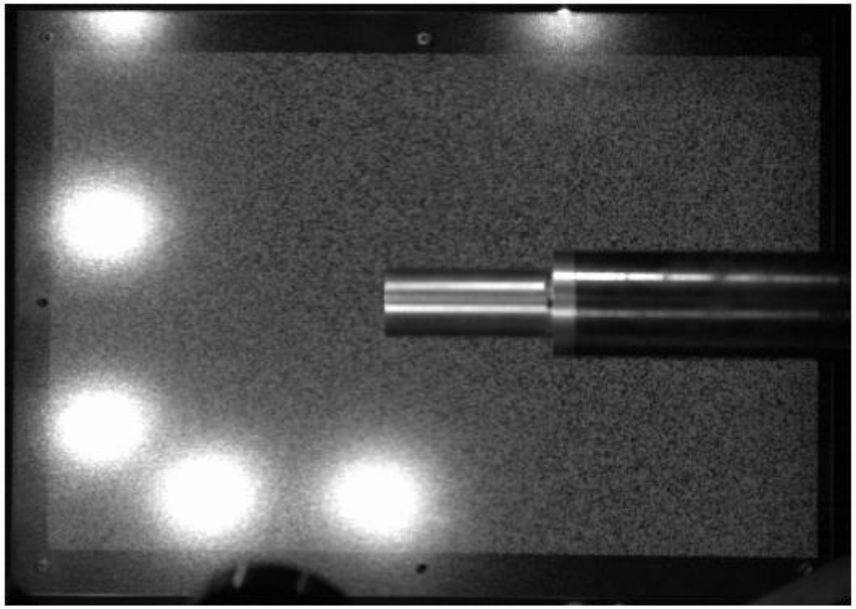


Free-Flight

High Density Tunnel (HDT) – To improve:



Clear Perspex



Anti-reflection Acrylic

UNIVERSITY OF OXFORD

Summary:

- Workable BOS system was integrated into existing free-flight/optical tracking/PSP techniques
- Static tests showed advantages over optical schlieren, but also demonstrated how the technique falls short in others.
- Free-Flying BOS tests require further development.

Further Work:

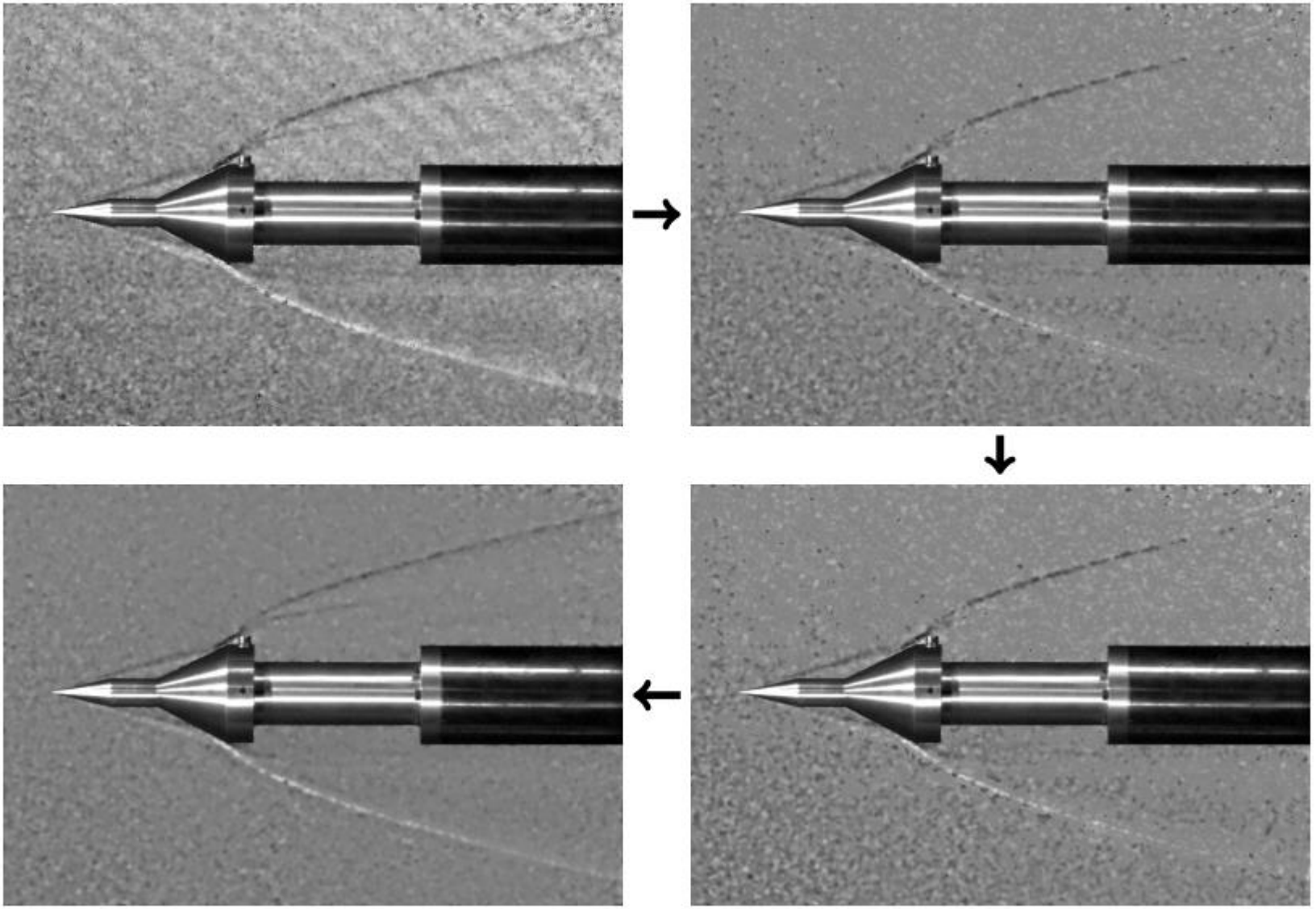
- Re-think background mounting and illumination method
- Re-Analyse free-flying processing technique
- Development of better processing algorithms

Scope:

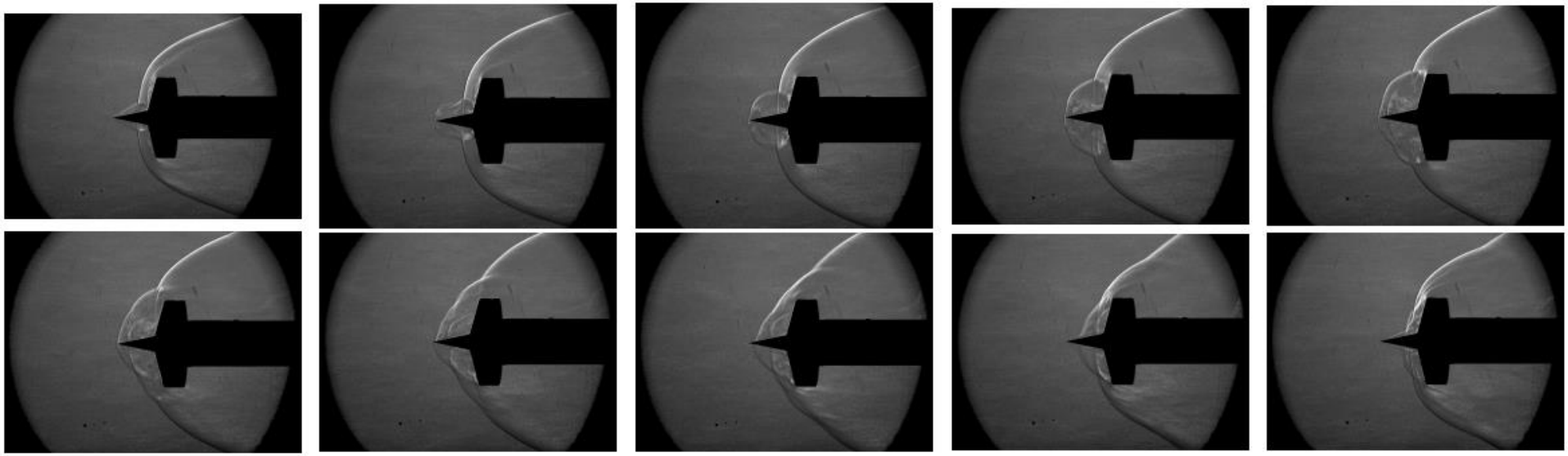
- Introduction
- High Density Tunnel (HDT): Static & Free-Flying testing
  - Patterns
  - Models
  - Experimental Setup
  - Processing
  - Results
- Summary

Questions?

High Density Tunnel (HDT) – Processing (Static):



High Density Tunnel (HDT) – Results



UNIVERSITY OF OXFORD