Thin Film Metrology Using Wavefront Sensing.

D M Faichnie, A H Greenaway, I Bain*

Physics, Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, Scotland, EH14 4AS

**Scalar Technologies Ltd, 9 Cochrane Square, Brucefield Industrial Park, Livingston, Scotland, EH54 9DR*

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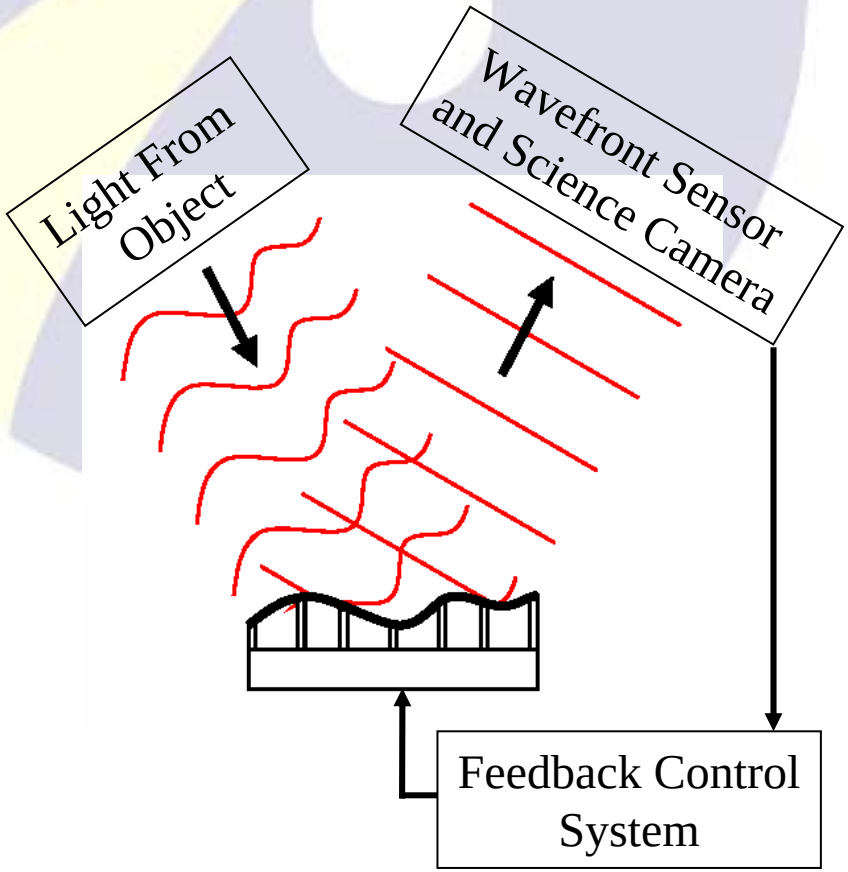
Overview Of Presentation.

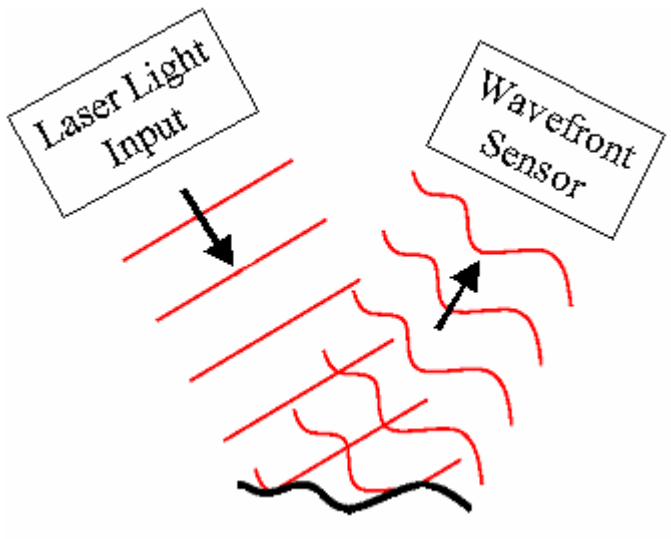
- What is Adaptive Optics and how can we use it for metrology.
- Project aims.
- Analysis of measurement and experimental set-up.
- Results To Date and System Calibration.
- Future Work and sensor design.
- Conclusions.

Typical AO Vs Metrology.

AO System.



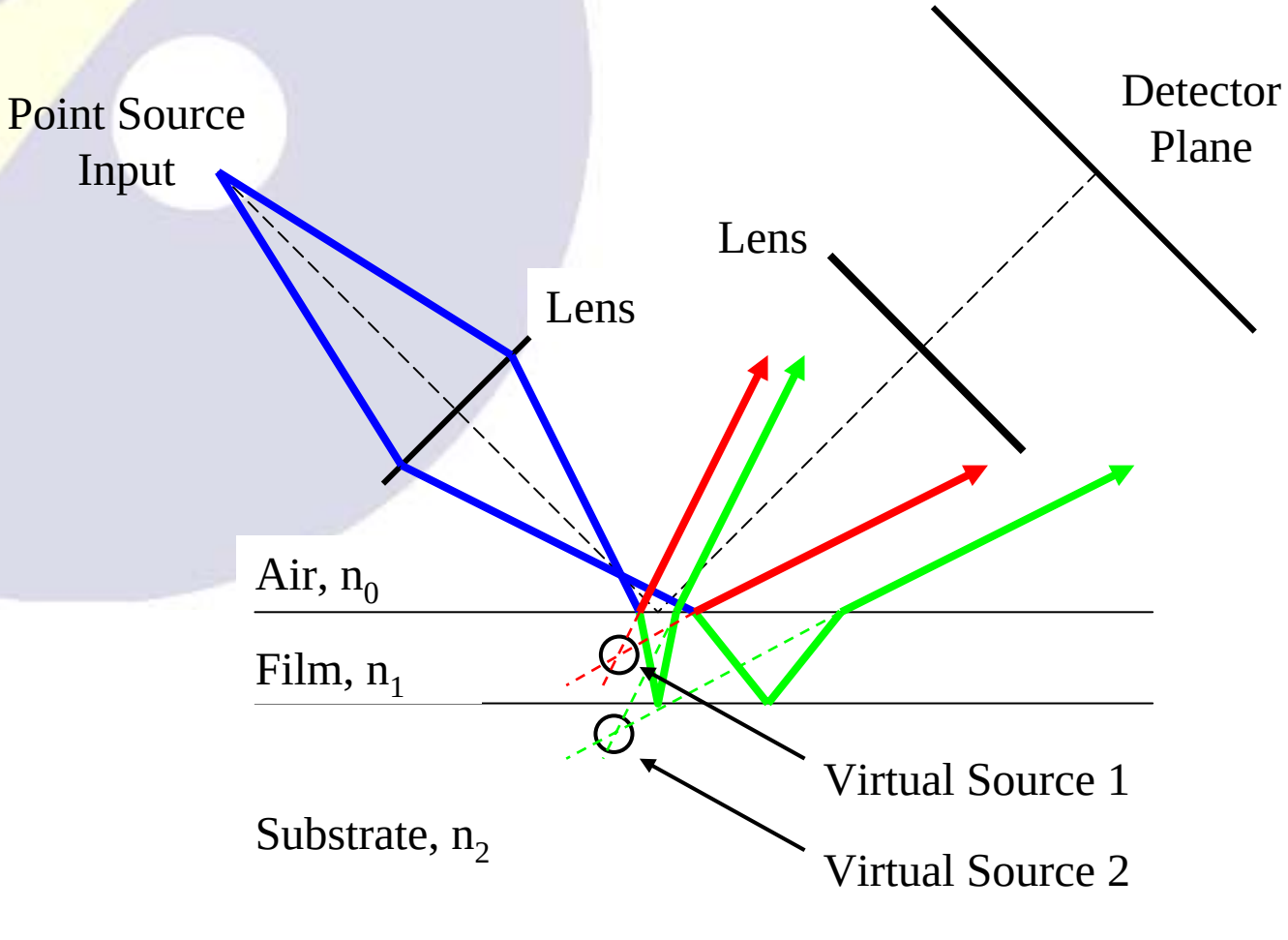
Metrology Using AO



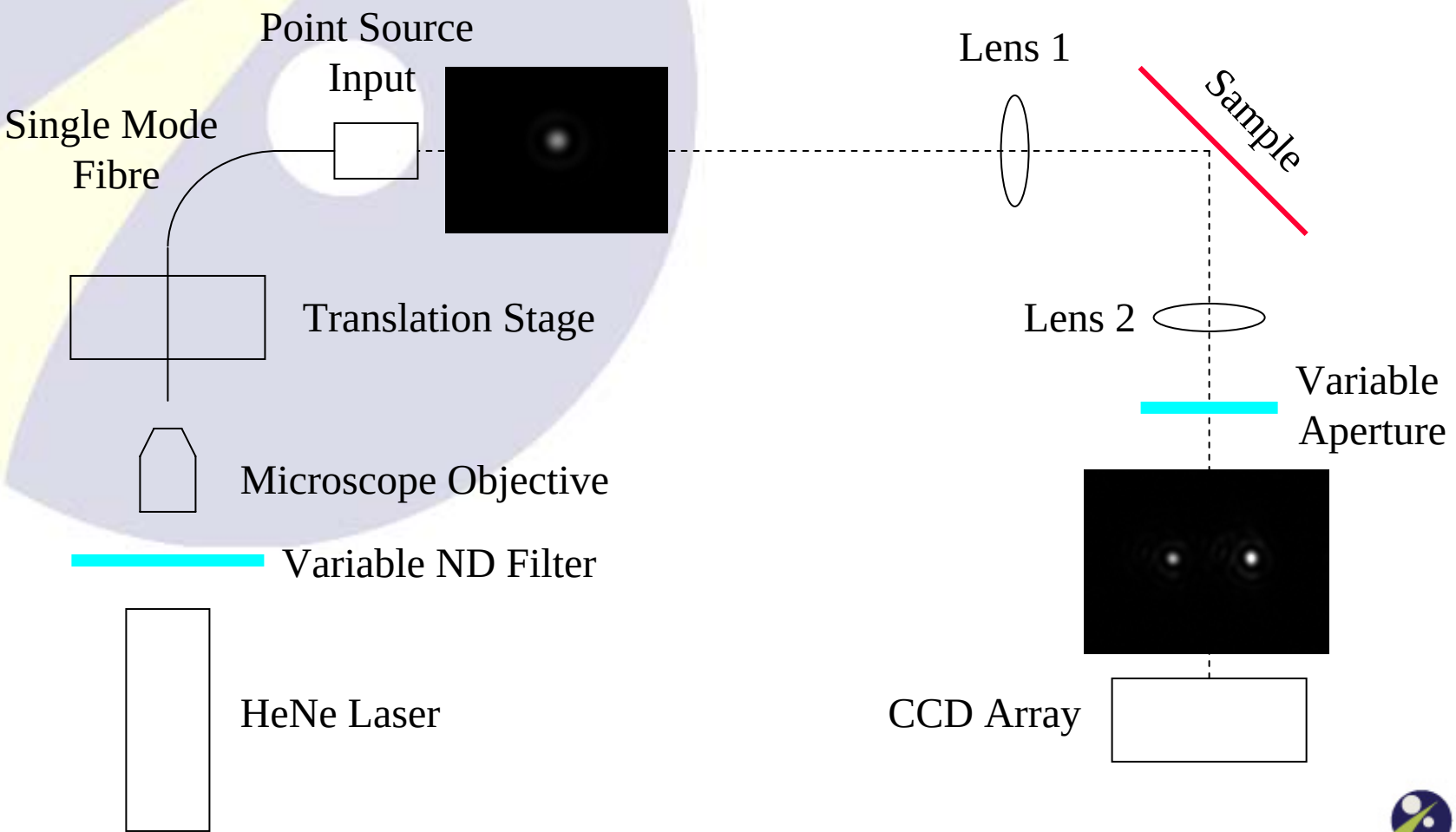
Project Aims.

- Produce robust industrial thickness monitor.
- Sensor must be able to be used in-line for control feedback.
- Sensor should be able to measure coloured films.
- Sensor should be able to cope with rough sample surfaces.
- Sensor should be able to be used with multiple layer laminates.
- Accuracy dependent on application, could be as low as 10nm.

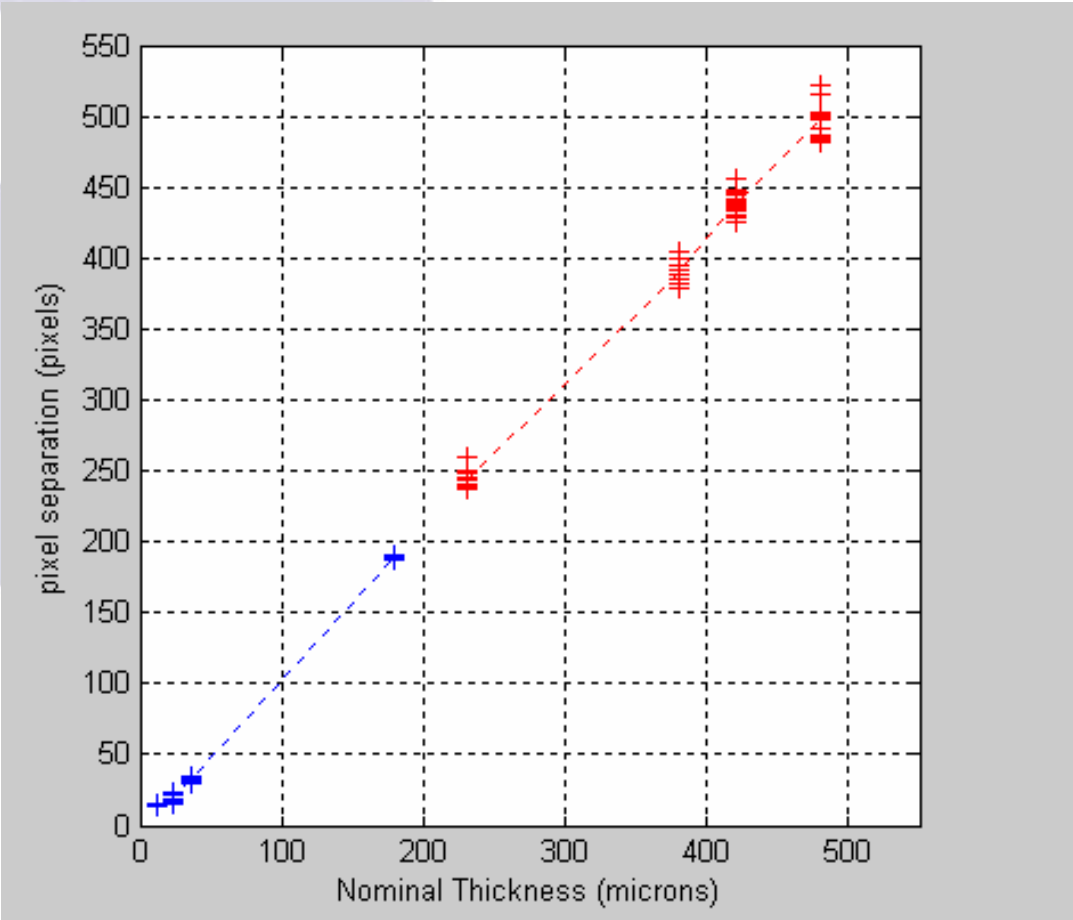
Analysis Of Current Measurement.



Experimental Set-Up.



Results To Date.



System Calibration.

- Our optical system requires calibration before we can relate pixel separation to actual thickness.
- Separation will change with angle of illumination, magnification of optical system, thickness, refractive index and surface tilt.
- Number of options :
  - Absolute calibration with prism + model of refraction.
  - Relative calibration with calibrated sample set.
  - Calibration with system model.
- Choice will be dependent on application.

Example Of Relative Calibration.

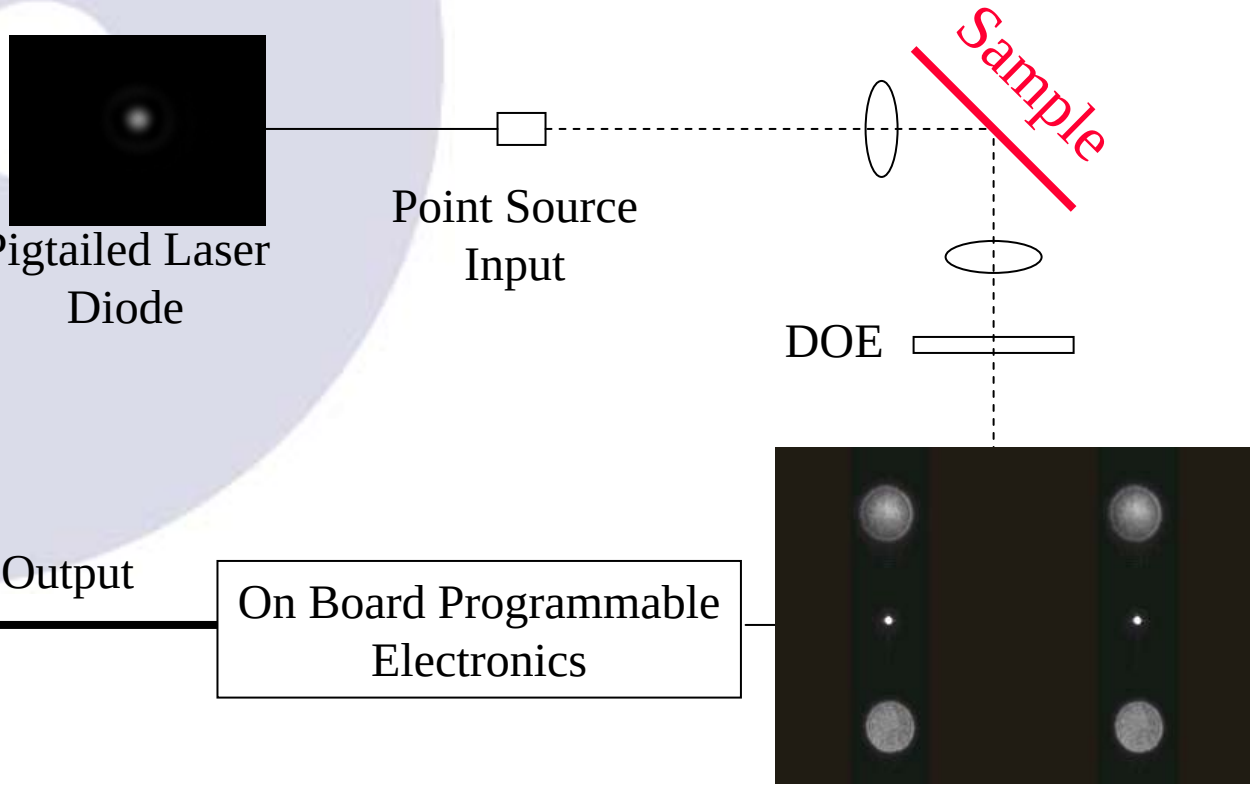
- Results from four samples ranging from 250 to 500 microns.
- Lets make 500 micron sample our calibration sample. Actual thickness 480 microns, use pixel separation to get calibration value to gain measure of pixels/micron for system.

Sample	Nominal Thickness (µm)	Measured Thickness (µm)
450 Micron	426 +/- 5 µm	423.6 +/- 7.7 µm
350 Micron	378 +/- 4.47 µm	377.3 +/- 6.3 µm
250 Micron	234 +/- 5.47 µm	235.8 +/- 5.48 µm

Theory Of Future Measurement.

- Phase Diversity Wavefront sensor used to measure aberrations introduced by the film structure.
- Addition of diffractive optical element to current set-up.
- Use of generalised phase diversity to optimise DOE design for thickness measurement.
- Design sensor to be most sensitive to aberrations expected.
    - Tilt, Defocus, Astigmatism, Coma, Spherical, Trefoil

Future Sensor Design.



- Small compact sensor design
- Can be mounted on industrial scanner

Future Work.

- Model wavefront sensor system using plane wave decomposition.
- Use model results to design appropriate DOE for sensor.
- Incorporate DOE into current system and test.
- Investigate application to curved and textured surfaces.
- Investigate simultaneous measurement of thickness and refractive index.

Conclusions.

- Current measurement can be used for films 8mm to 12 microns.
- Technique should be able to work down to below 3 microns.
- Experimentally shown linear relationship between virtual source position and thickness.
- Shown that relative calibration approach can be accurate.
- Shown that sensor should be compact and will be able to be used in-line in industrial processes.