SURREY
CHANGING THE ECONOMICS OF SPACE

UNIVERSITY OF OXFORD

Smart Optics for Satellite Applications

CEOI Project Showcase

ECSAT - 10th December 2018

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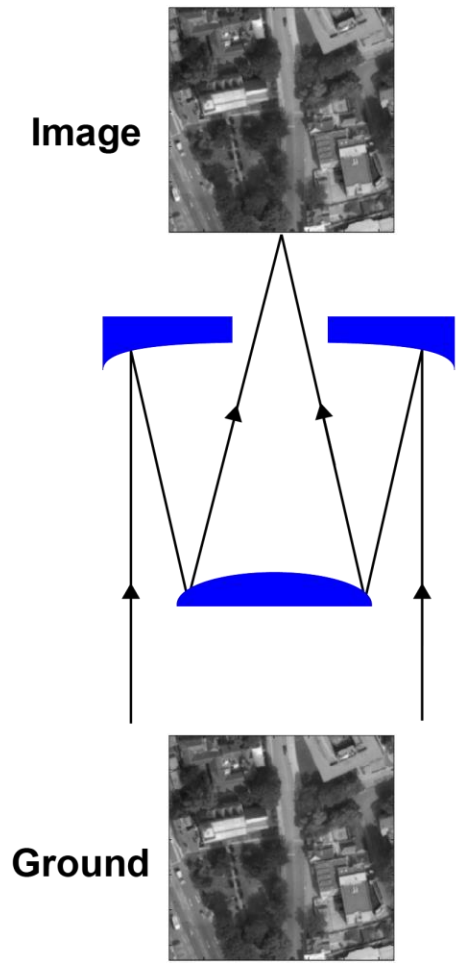
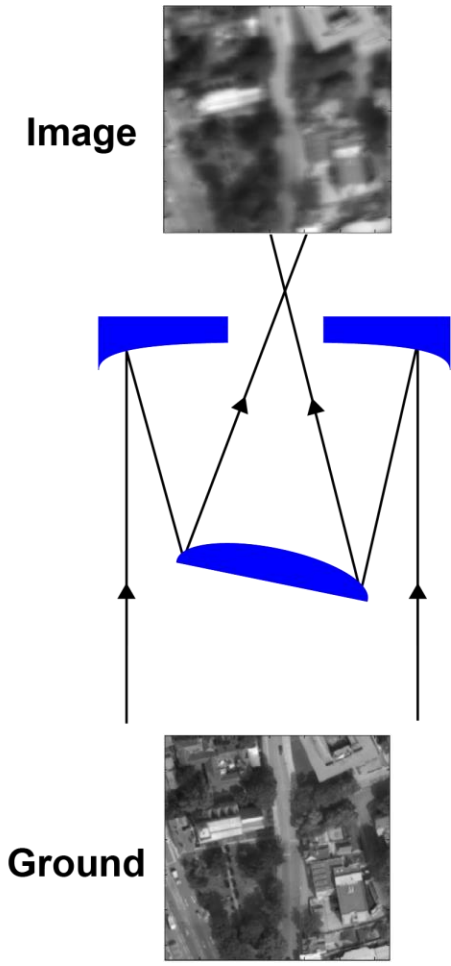
Centre for EO Instrumentation

Motivation

- Quality of imagery is dependent on the alignment accuracy of optical elements
- Manual alignment during build can be time consuming and difficult
- When building many imagers this can drastically increase the cost of the final product
- First step towards in-orbit alignment





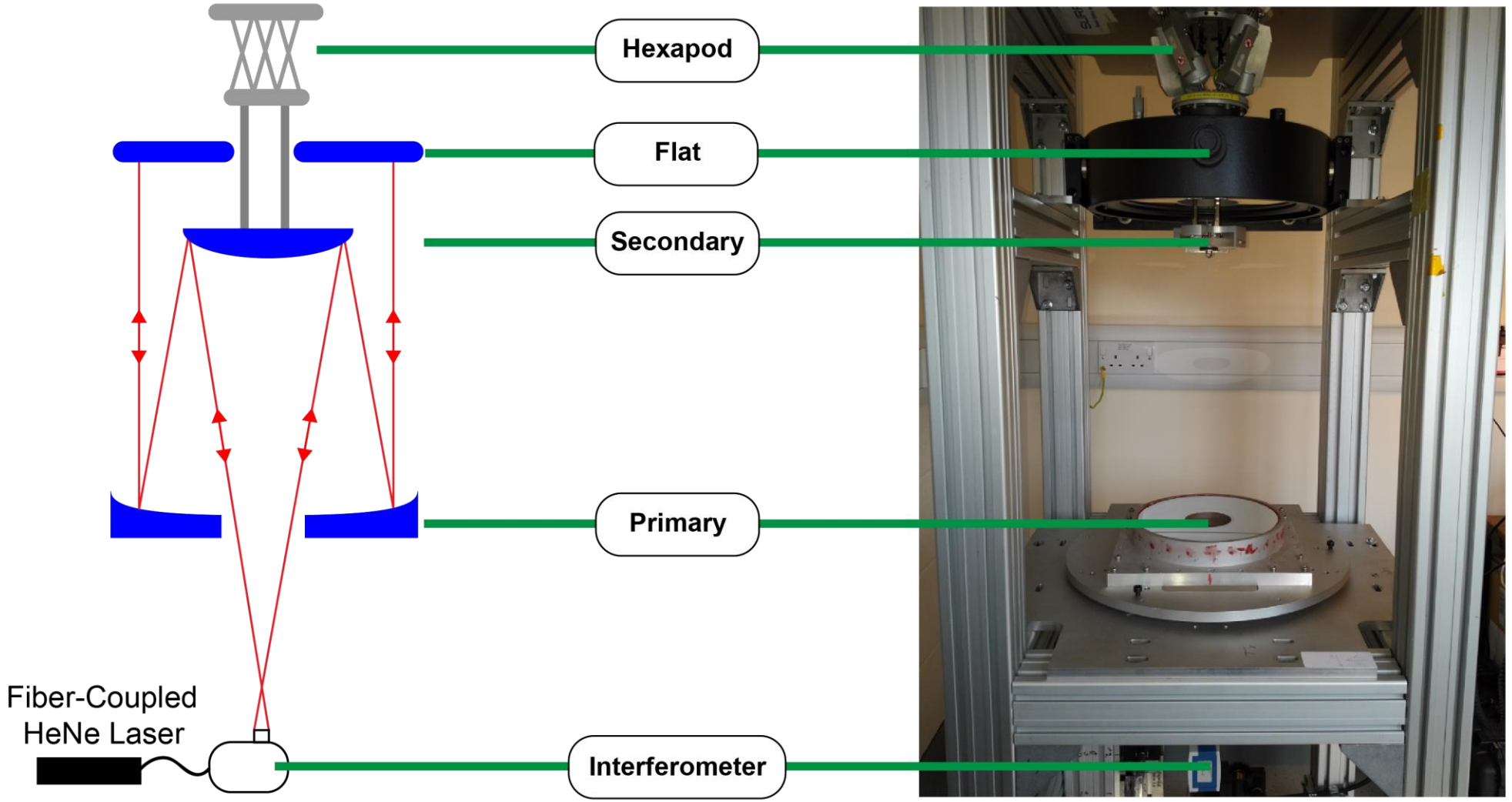
Project Goals

Automatically align Cassegrain style telescope in factory build context

Reducing the alignment time to minutes

Automatic alignment in-orbit

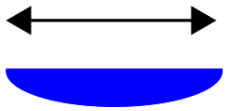
Technical Description: test setup



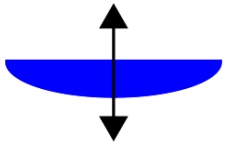
Technical Description: alignment procedure

- Initial sensitivity analysis in Zemax

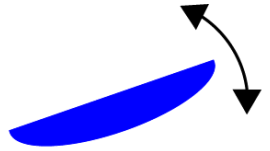
Decenter

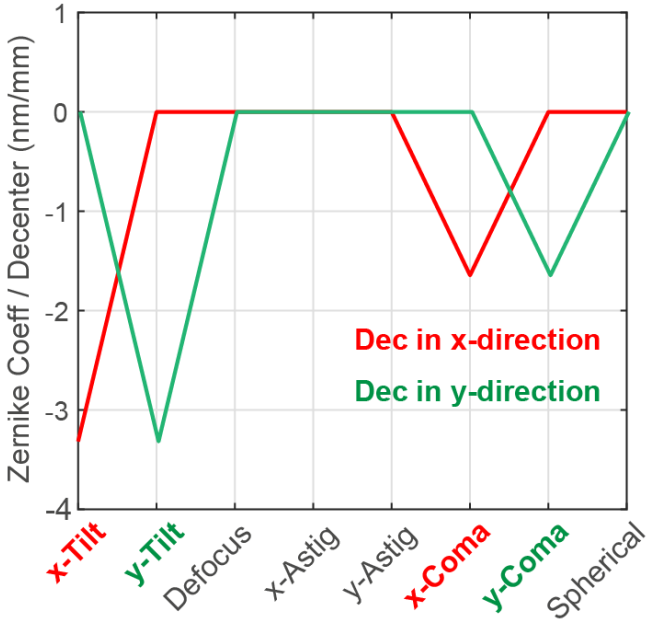


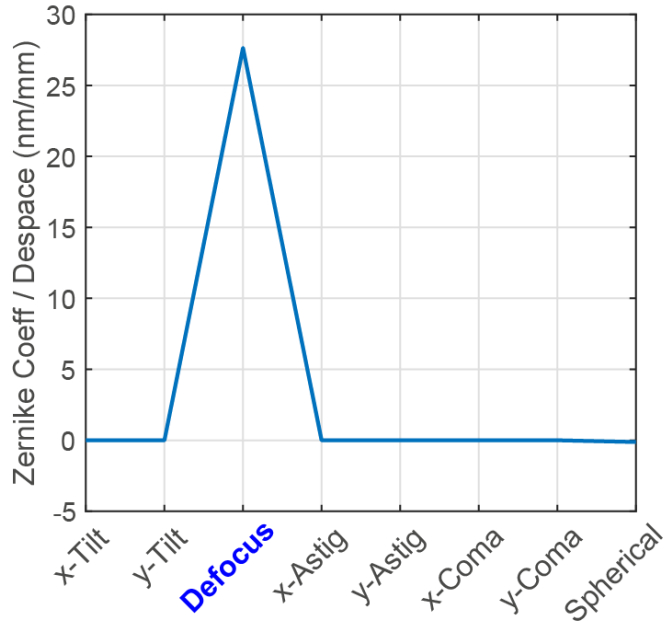
Despace

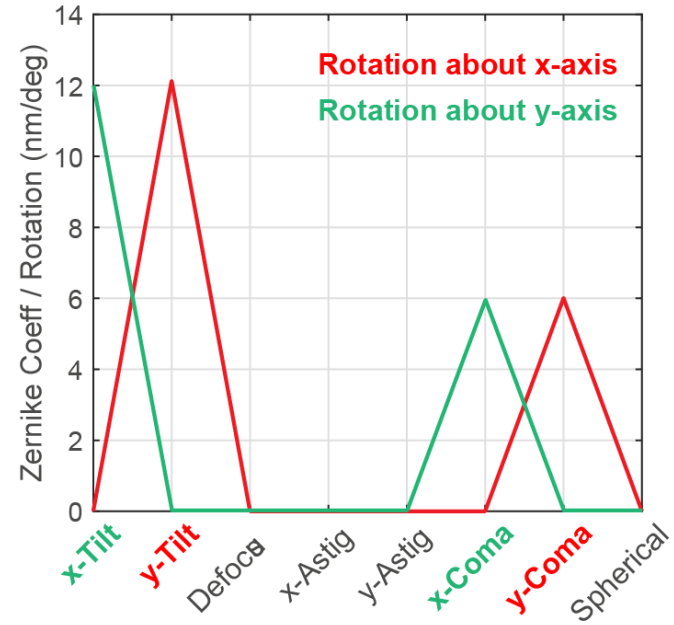


Rotation



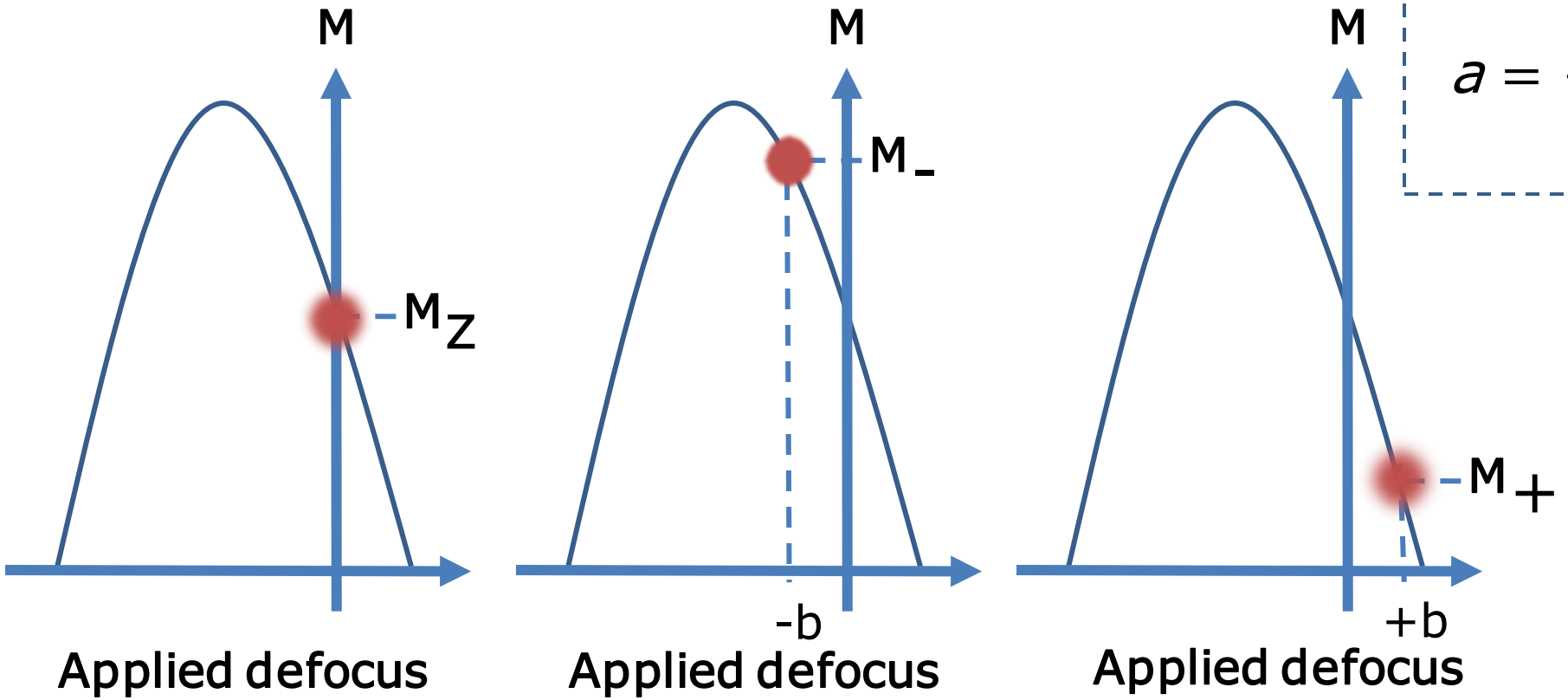






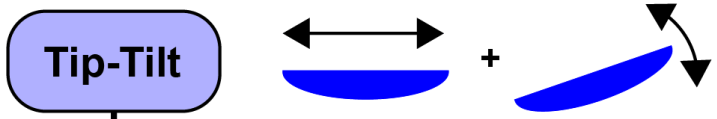
Technical Description: alignment procedure

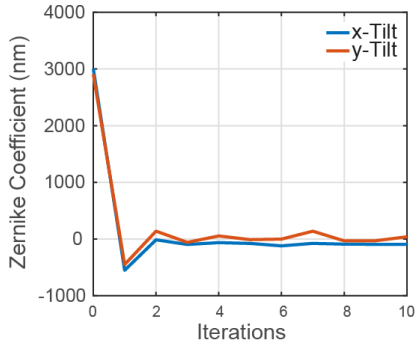
Example of a point object blurred by *a* microns of defocus

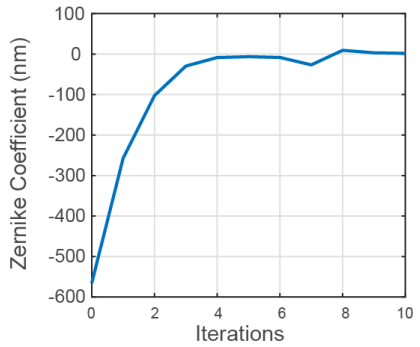


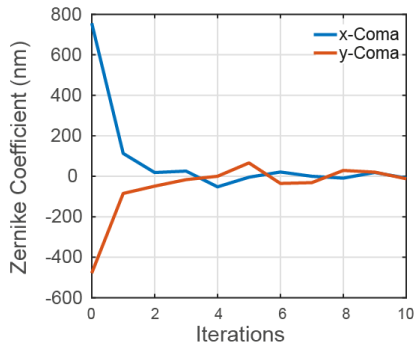
$$a = \frac{b(M_+ - M_-)}{2M_+ - 4M_Z + 2M_-}$$

Technical Description: alignment procedure

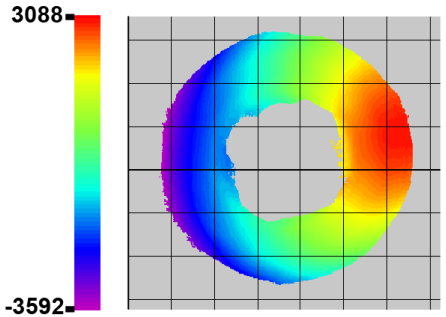






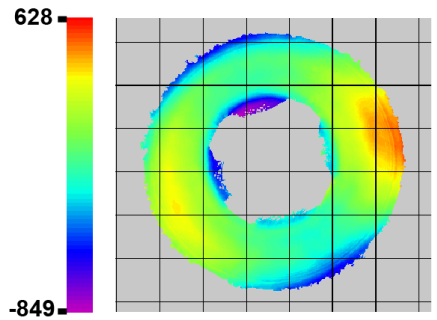


Before



rms = 1851 nm

After



rms = 239 nm

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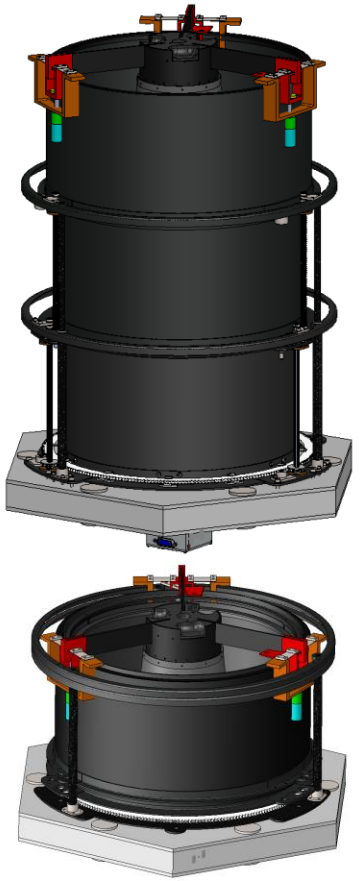
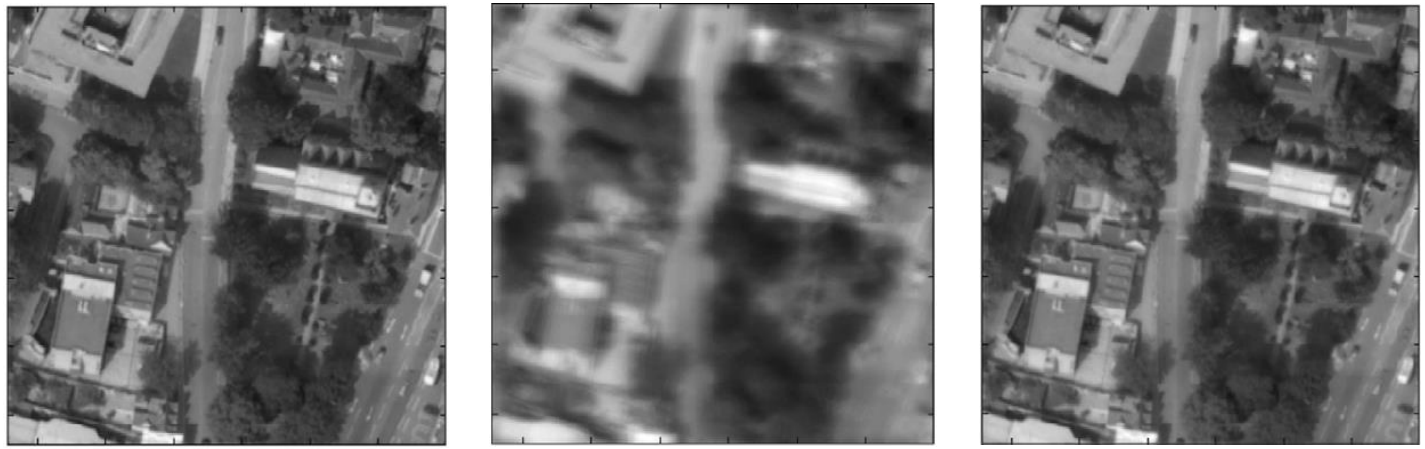
Future Work

- Exploitation of technology in build procedure
- In-orbit alignment of optical elements:
  - Removes need to maintain alignment during launch event
  - Opens door to deployable optical systems
  - Seasonal re-alignment to correct for thermal effects?





Initial Image **Aberrated** **Corrected**

Optimum deformable mirror modes for sensorless adaptive optics, Wang and Booth, Opt Com, 2009

Thank You!

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