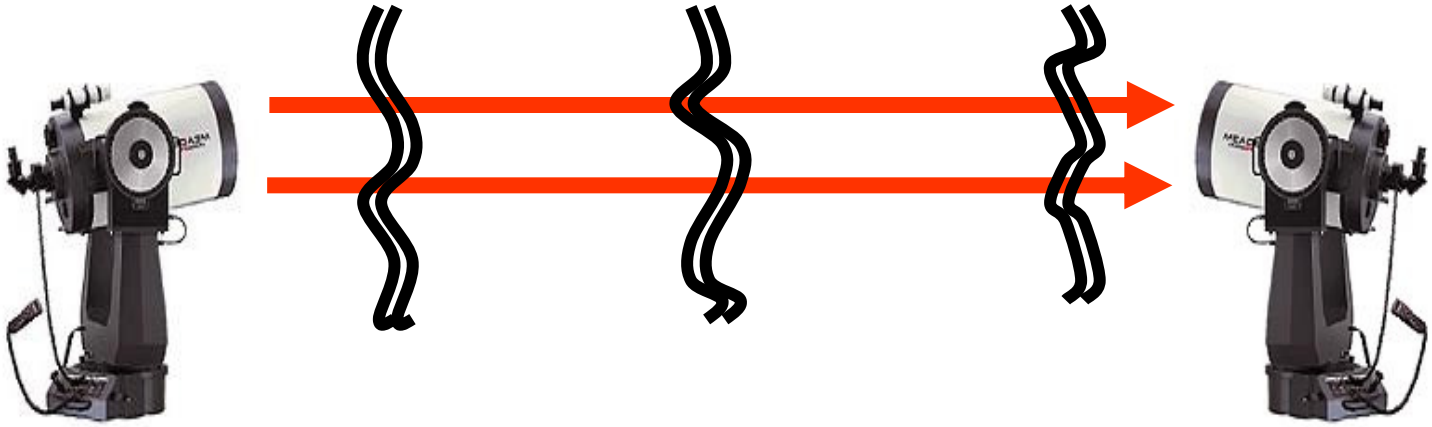
AO & Free Space Optical Comms: An Overview



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Why Free Space?

1. The so-called last mile problem

+ optics is higher speed, license-free, more secure than radio

2. Space-communications

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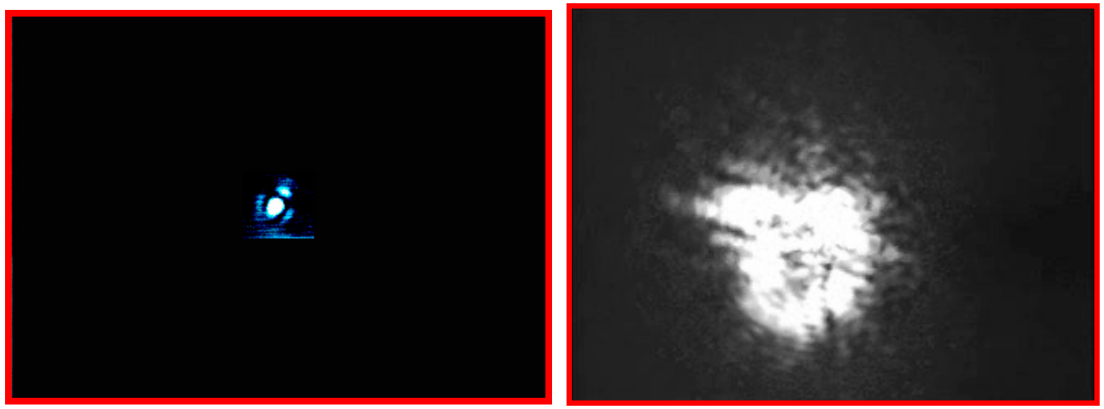
Turbulence for free space optics

(Terrestrial) free space optical comms typically involves the horizontal propagation of light, in which case the turbulence is both STRONG and DISTRIBUTED.



E.g. – 100m propagation path length at Durham

But – we are only dealing with a single point (i.e. not imaging)

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(Horizontal) Path Length Propagation
Main Issues

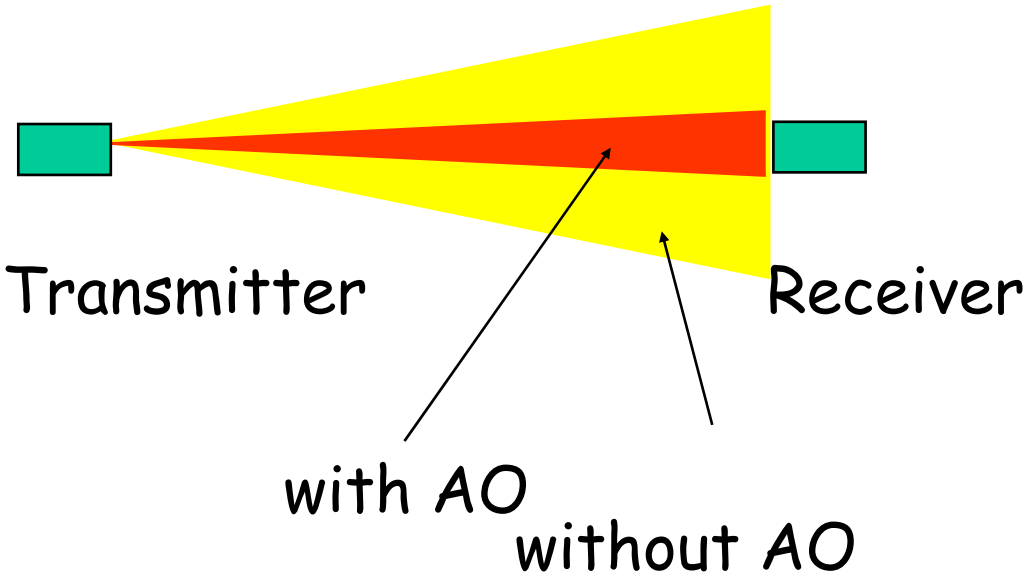
There are 3 main issues

1. Beam tilt
2. Beam blurring, or distortion
3. Scintillation

(For looking upwards and most lab situations we can ignore 3. - scintillation)

Beam Tilt

- Beam tilt (without AO) is solved by increasing beam divergence (and hence power).



Tip/tilt correction is required on both the transmit and the receive beams, and WFS data needs to be exchanged. There are a multitude of possible optical configurations

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Blurring

- Turbulence spreads out the beam, which requires an increase in detector size, and therefore a decrease in achievable bandwidth (aim is up to 10Gbit/s^{-1}).

- Wavefront correction can be achieved just using the receive telescope.

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Scintillation

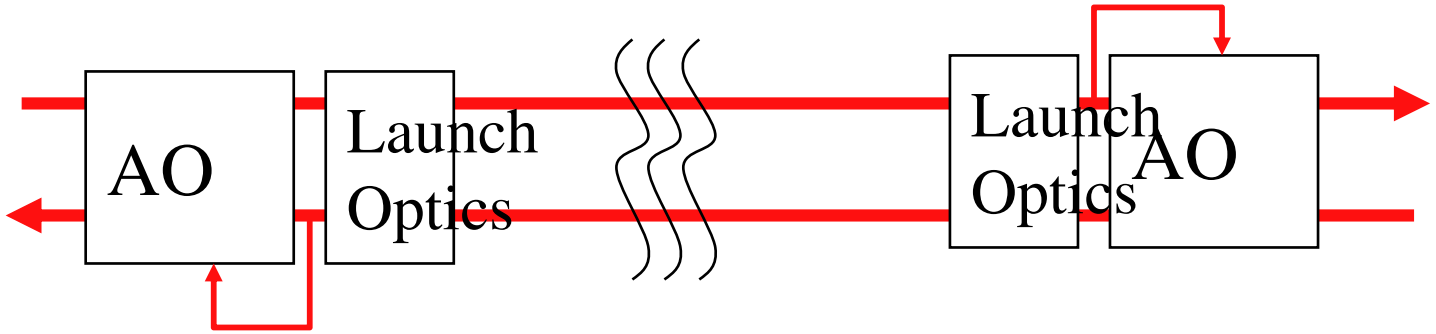
- Scintillation is produced by the propagation of phase errors which evolve into intensity variations.
- In order to correct for scintillation there are 2 options

1. Use a big aperture, or multiple apertures
2. Use multiconjugate adaptive optics.

- Requires correction of the transmit beam

Bi-directional link with AO at both ends

- 2 AO systems at both ends of system. The control of both is independent, although the light is reflected from both deformable mirrors.



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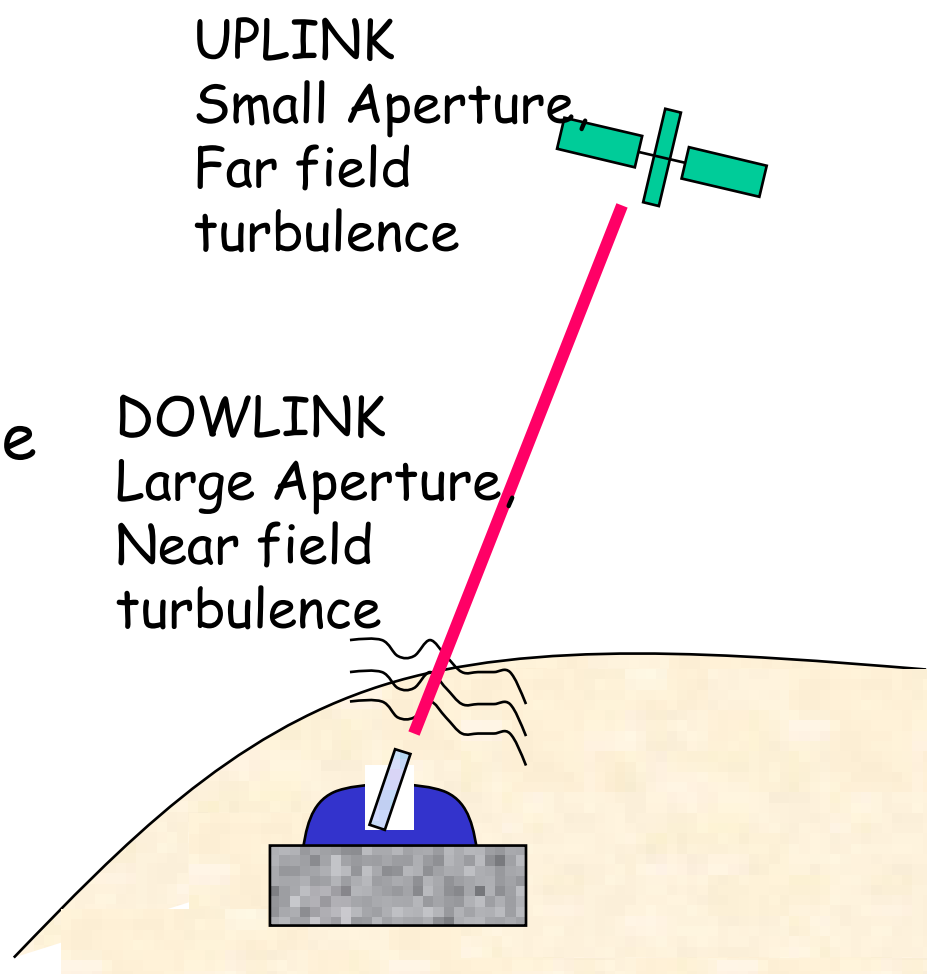
Ground-to-space free space optical comms.

- Scintillation is proportional to the distance of the turbulence from the imaging system, and the aperture size.
- Thus, up-link - turbulence is a long way from the receiver, and the aperture is small.
- Downlink, aperture is larger and turbulence is near the receiver, therefore AO is not necessary



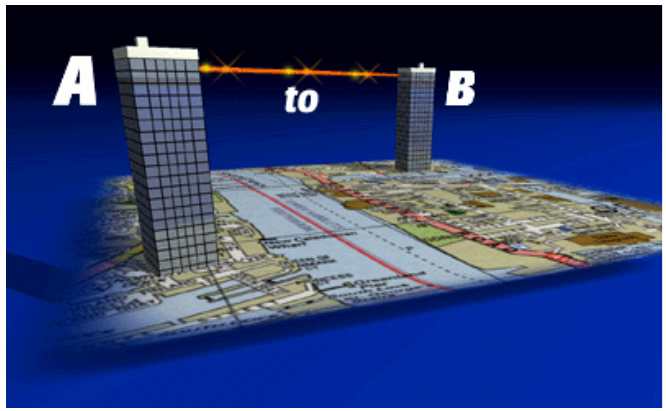
AO and Free Space Optics: A selected overview of work

COMMERCIAL

- aoptix – US company – claim 10GBit/s link of 5km
- Canon canobeam – autotracking

RESEARCH

- Satellite communications.
  - CRL (Japan), JPL.
- Optical interconnects
  - Oxford
- Laguerre-Gauss Modes
  - Imperial



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Summary

- AO & Free Space Optics – how does it compare to other laser apps. of AO?
  - Tip tilt is critically important
  - Scintillation is important
  - Requires subtlety in the implementation of the AO – i.e. control signal is generally required between both ends.