

# Differential Absorption LiDAR measurements of non-CO<sub>2</sub> greenhouses gases

Iain Robinson

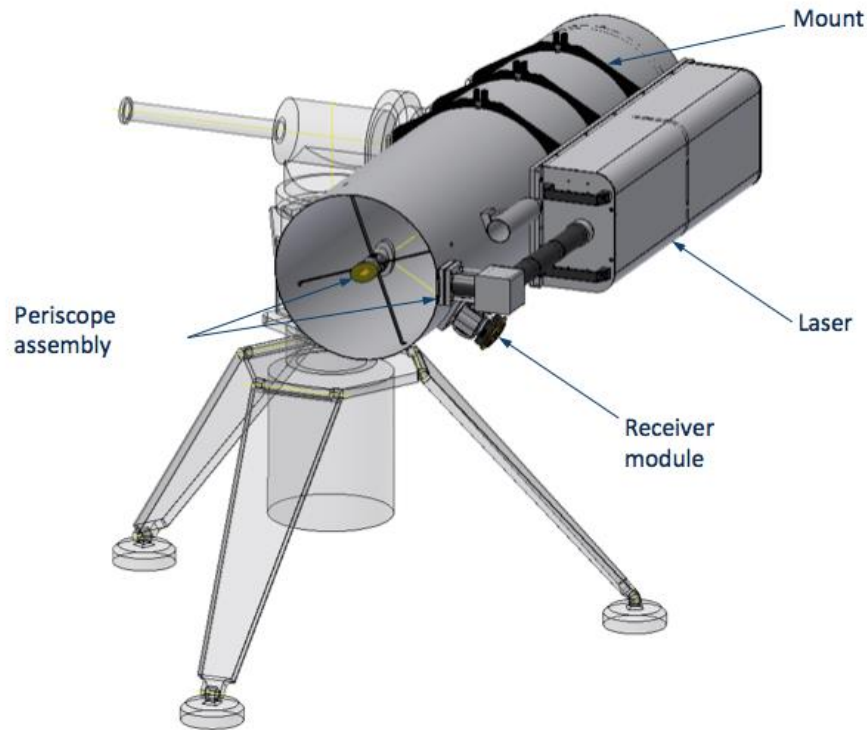
Jim Jack

John Moncrieff

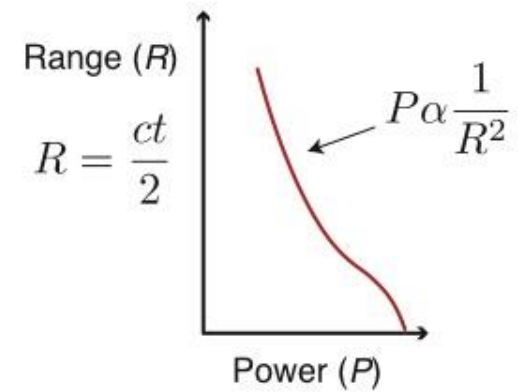
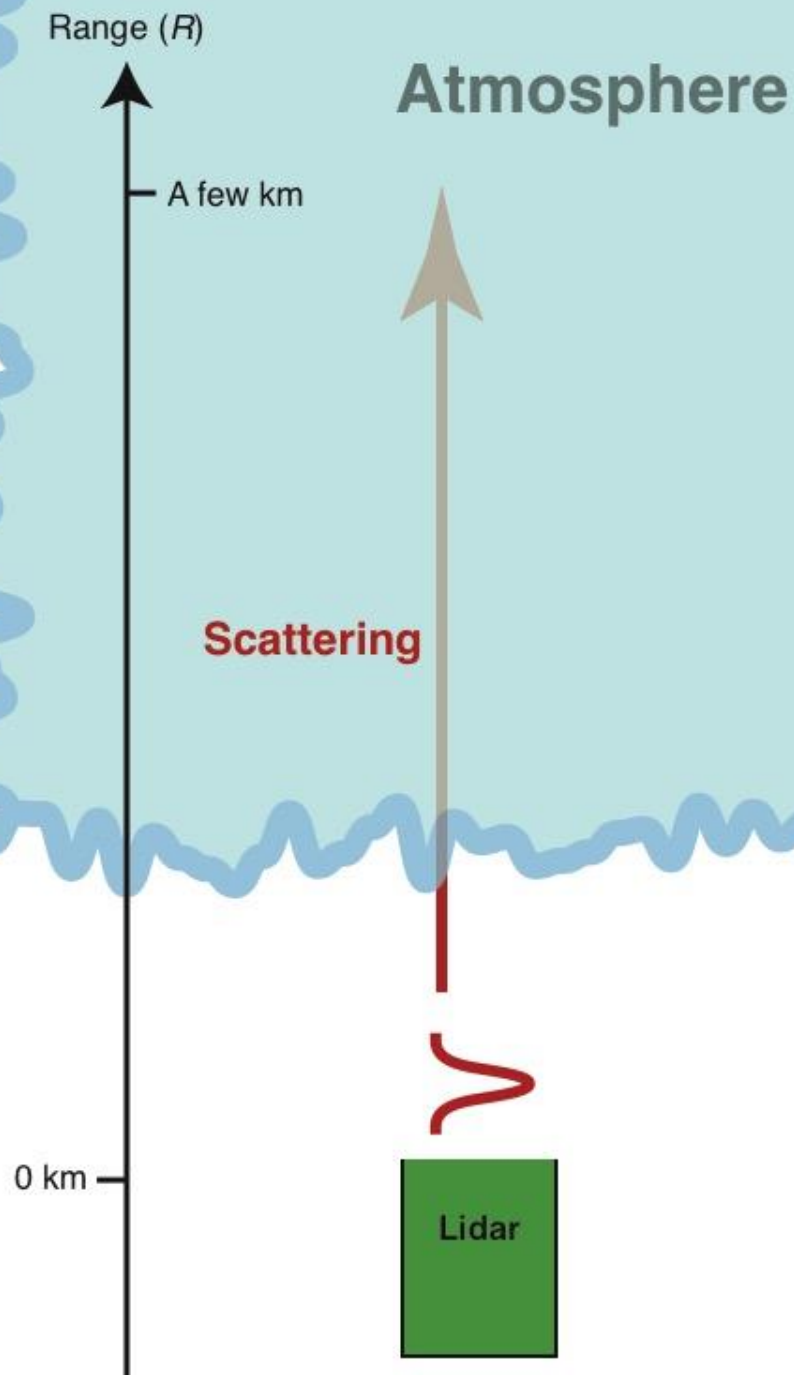
## InGOS brief:

Task: To evaluate the possibilities for DIAL techniques  
In the tall tower network

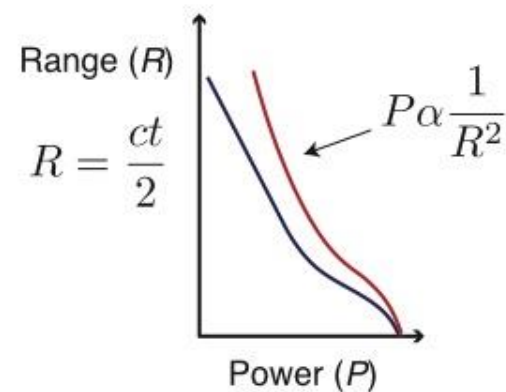
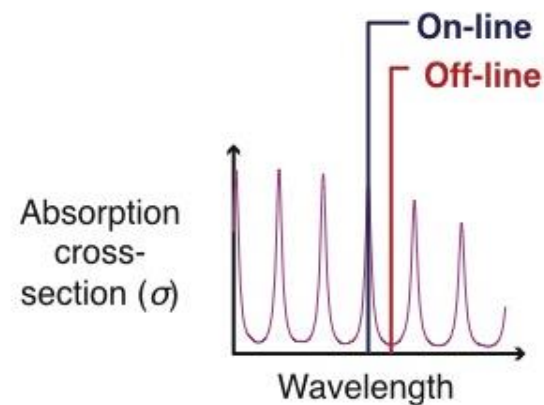
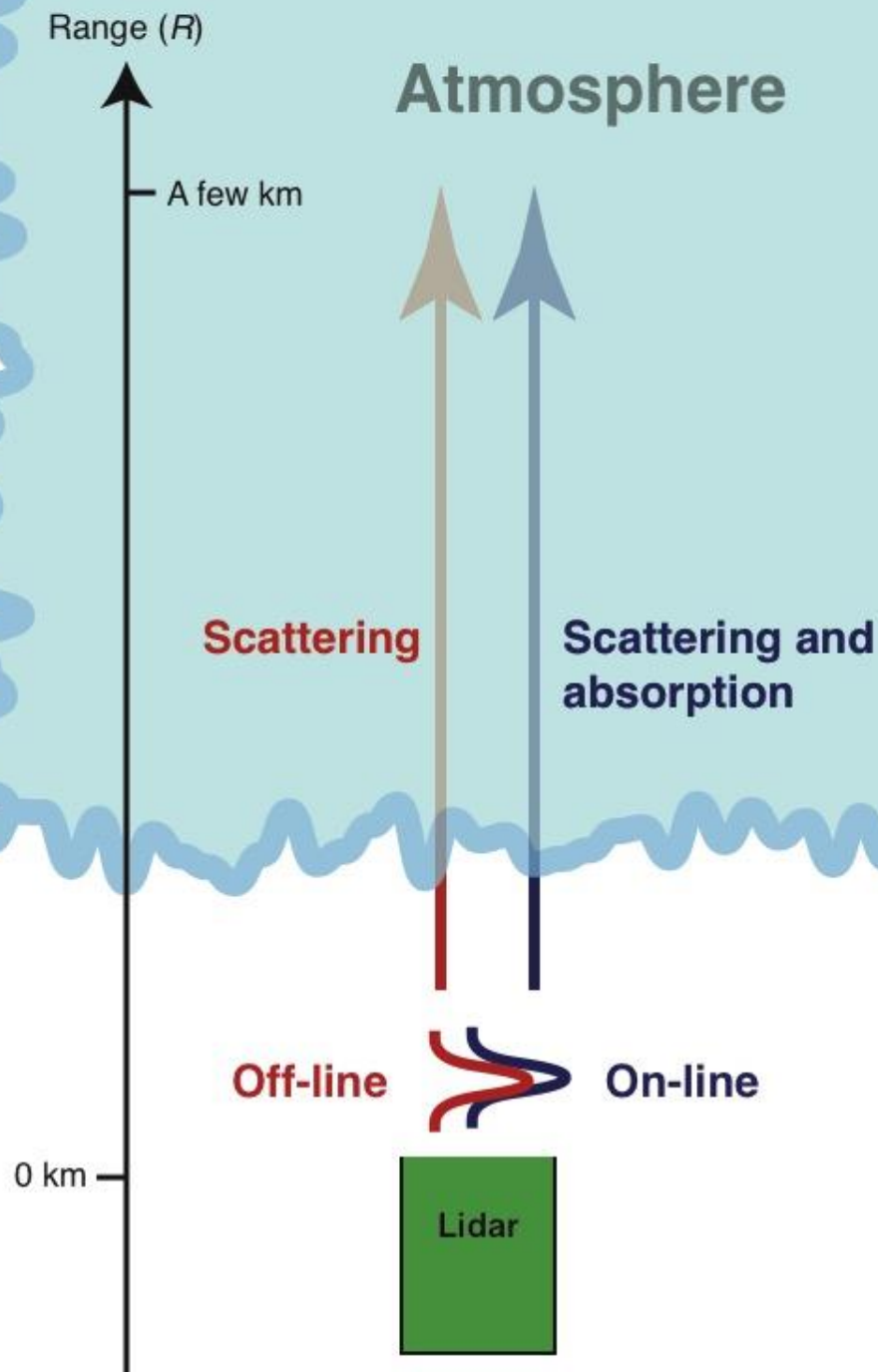
Develop and test an innovative upward looking DIAL  
system for CH<sub>4</sub>.



Investment thus far (2010-2014): €1.2m from UoE, InGOS, STFC, NERCx2

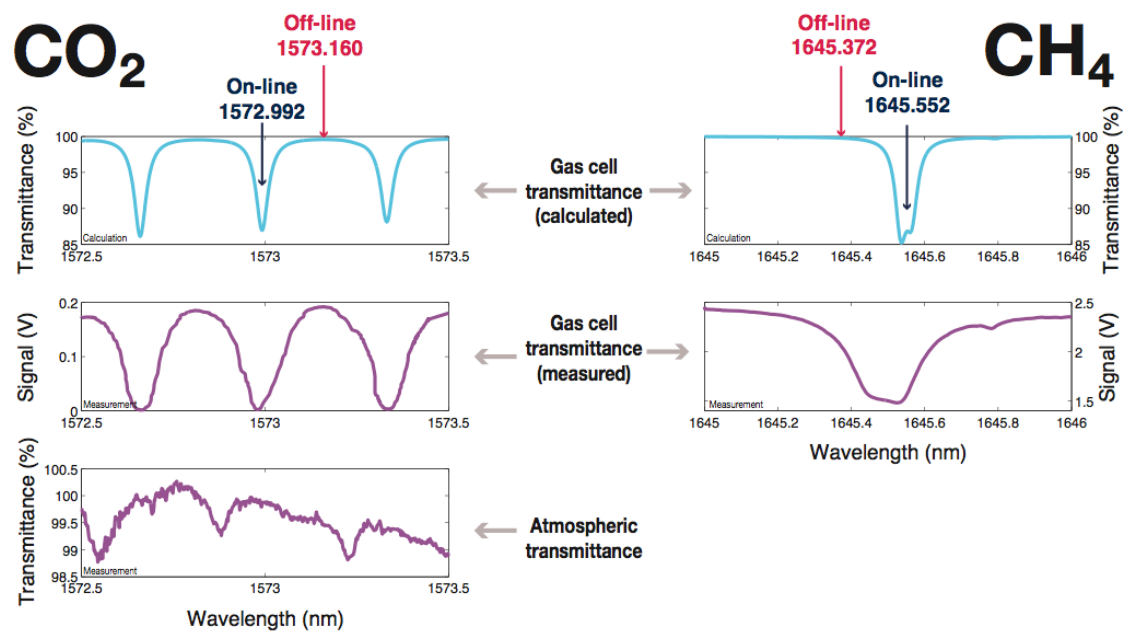
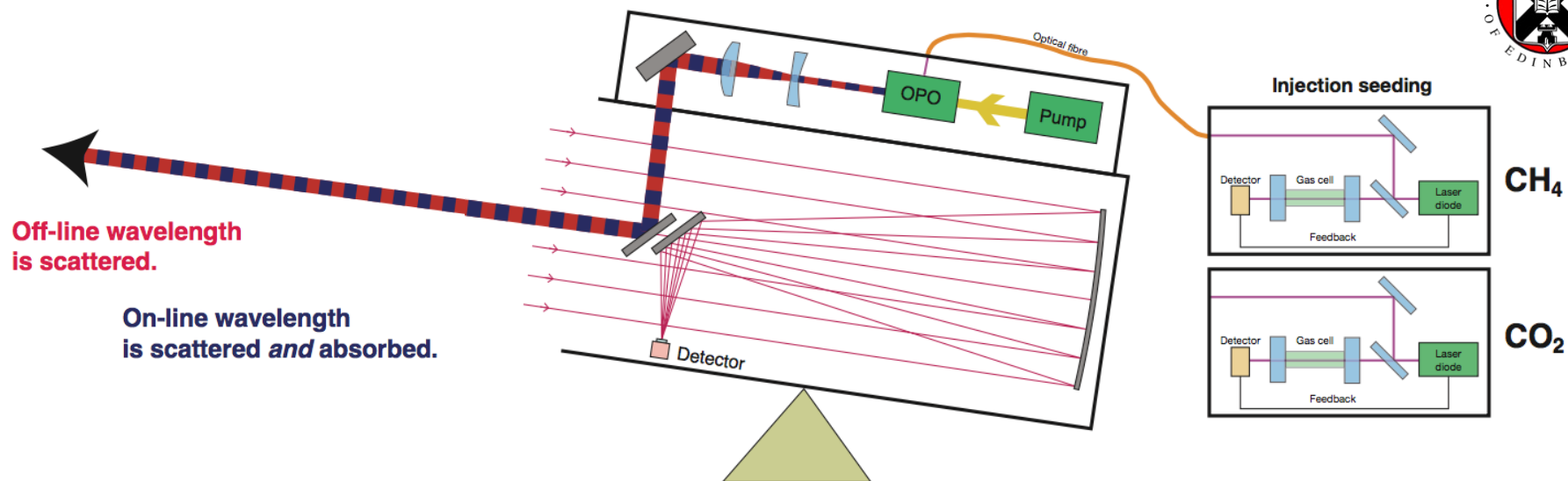


$c$  is the speed of light.  
 $t$  is time.  
 $P$  is the optical power.

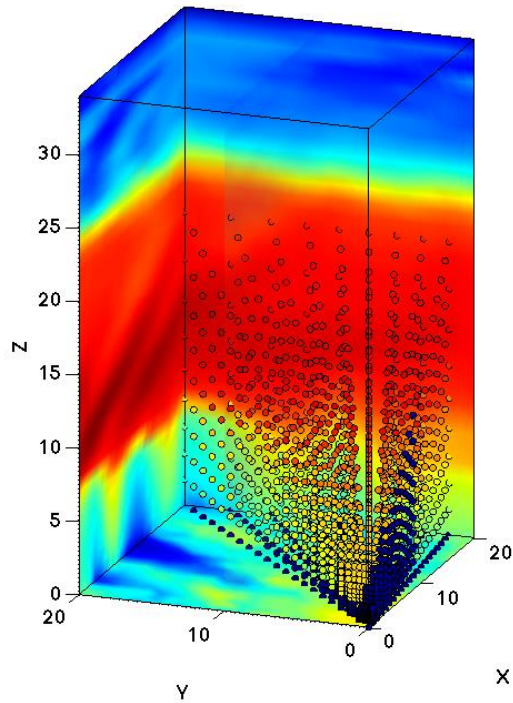


$$N(R) = \frac{1}{2\Delta\sigma} \frac{d}{dR} \ln \frac{P_{\text{on-line}}}{P_{\text{off-line}}}$$

$c$  is the speed of light.  
 $t$  is time.  
 $P$  is the optical power.  
 $N$  is the number density.



CO<sub>2</sub> concentration (ppm) by DIAL Simulation

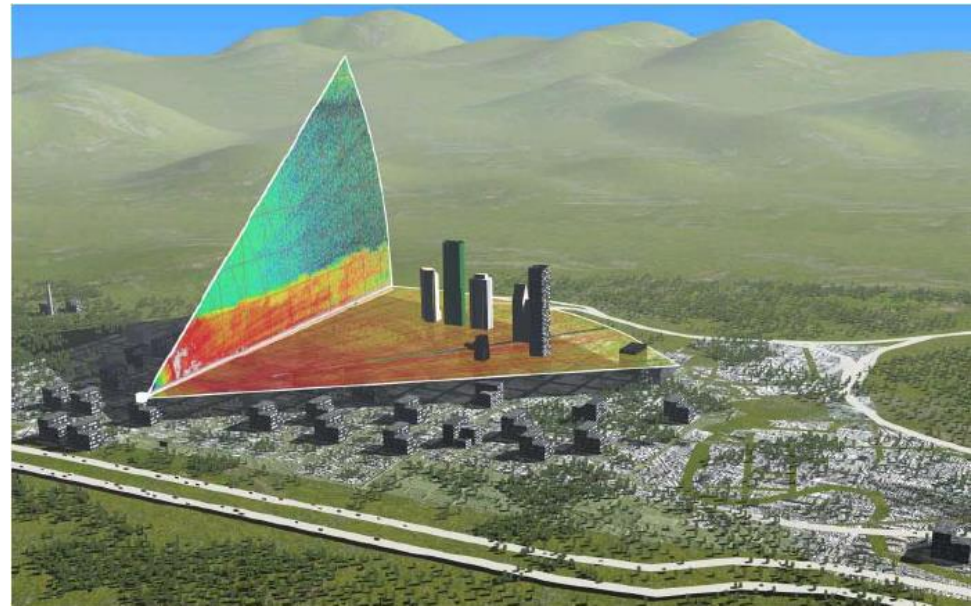


DIAL achieves range-resolved concentrations of CO<sub>2</sub> and CH<sub>4</sub> up to 7 km in range from the laser.

Active instrument, 24/7, 365 days per year.



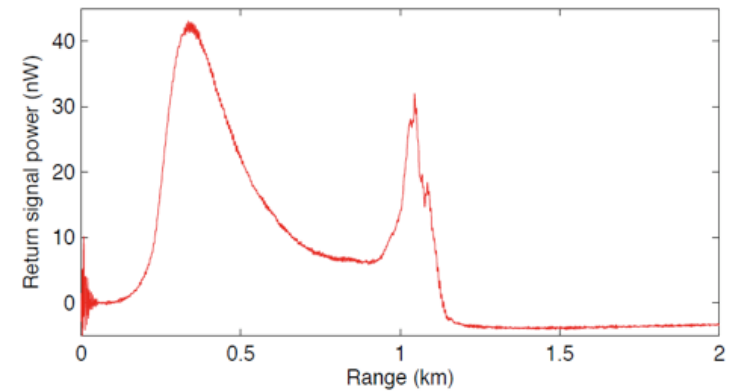
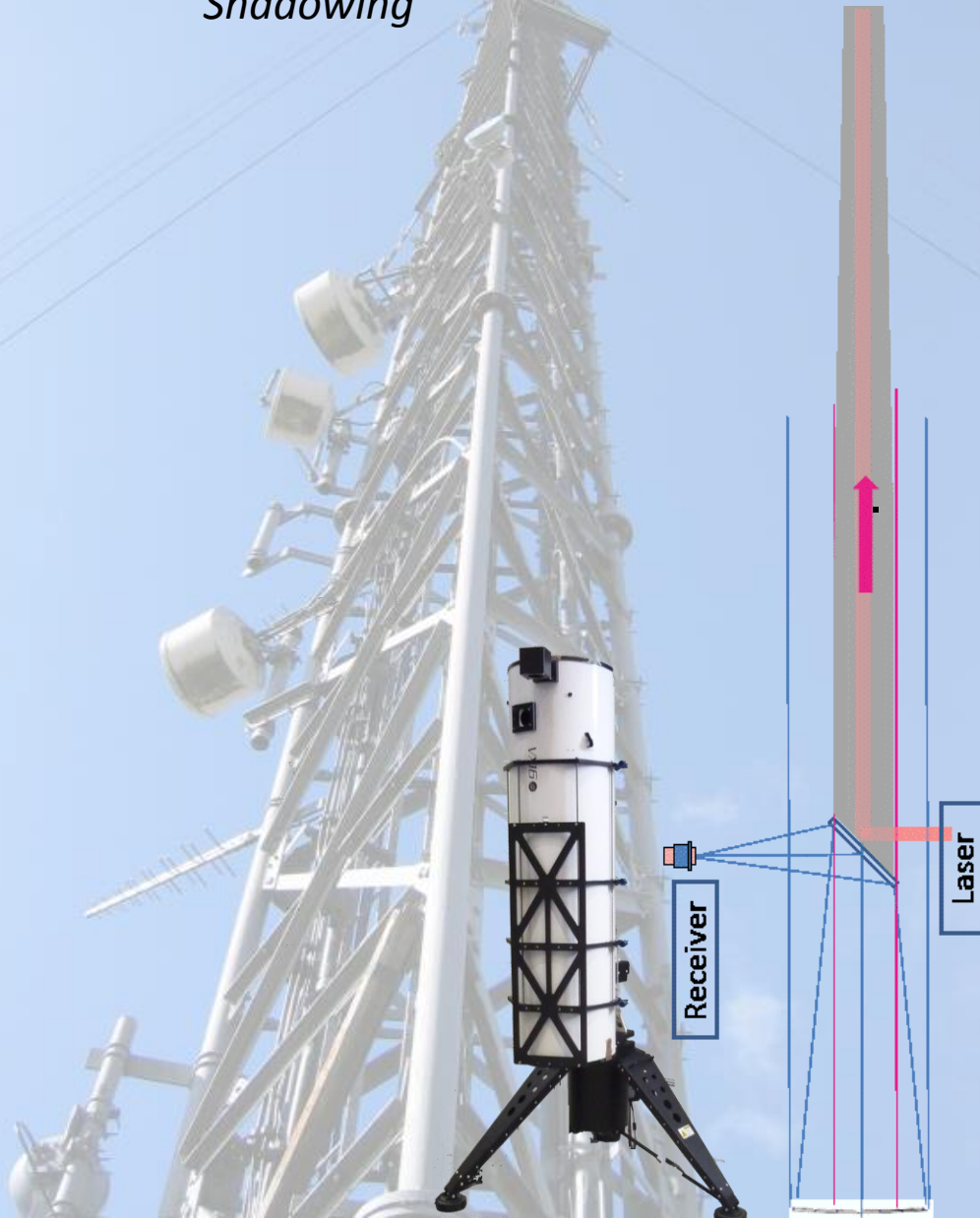
With a scanning capability, DIAL can obtain hemispherical views of GHG or pollutant concentrations across a wide area.





# Technical Challenges

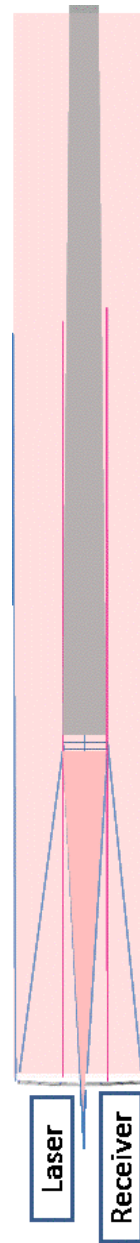
## Shadowing



a typical Lidar return measured with the current instrument, where the signal at short range is initially zero due to the shadow effect and increases as the secondary is able to collect more of the photons scattered by the transmitted laser beam. The signal is reduced to zero beyond approximately 1 km by a cloud.

# Technical Challenges

## *Shadowing*



Solution: Use a Cassegrain telescope and a combined transmit and receive optical path



# Technical Challenges

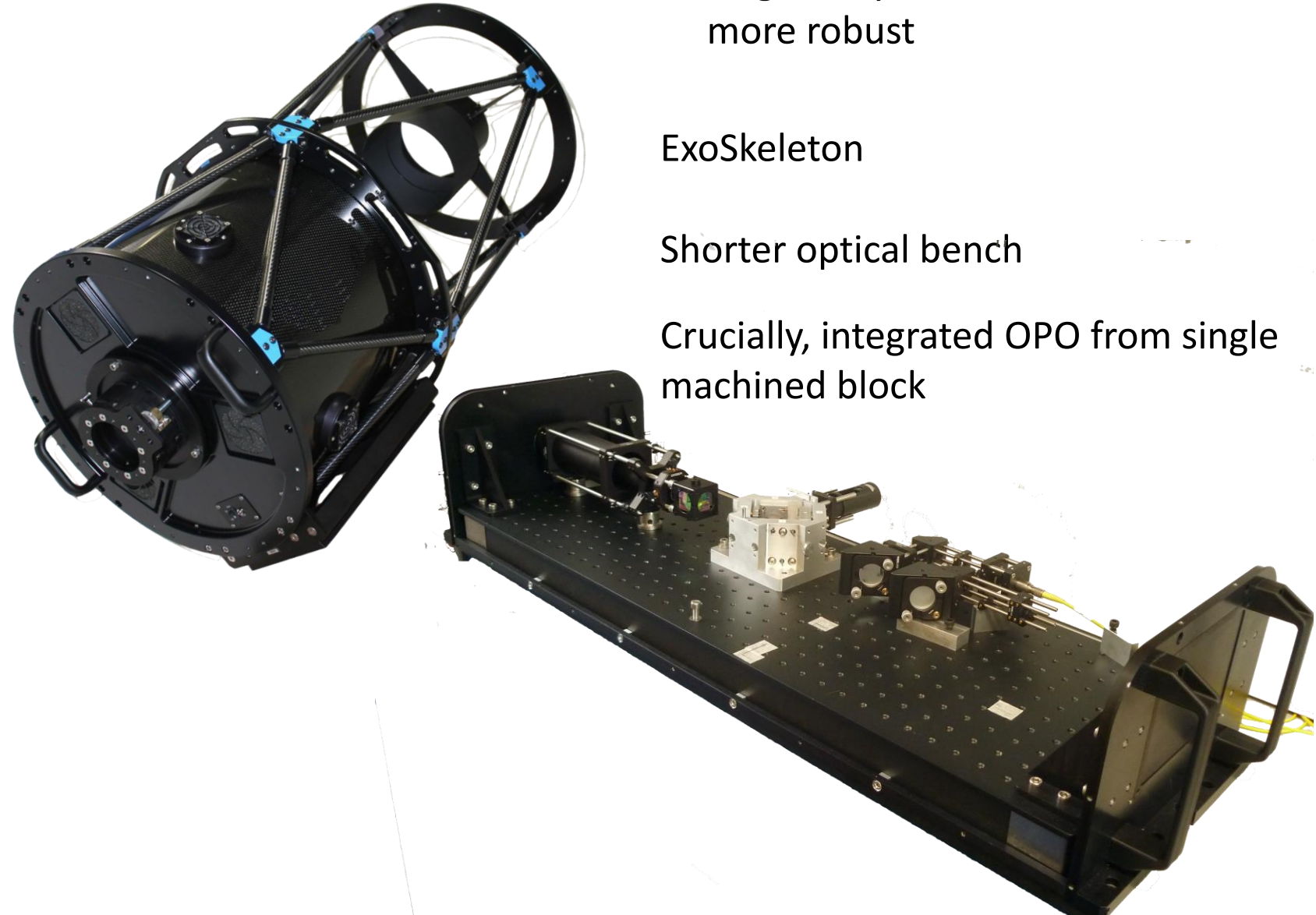
## *Ruggedisation*

Cassegrain by default, shorter,  
more robust

ExoSkeleton

Shorter optical bench

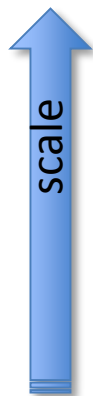
Crucially, integrated OPO from single  
machined block



# Deliverable: Field test

Dunbar Landfill, March 2016

NERC GREENHOUSE Project



DIAL

FTIR

Aircraft

Drones

Eddy Covariance

Chambers



# Deliverable: Field test



## Auchencorth Moss – CEH Edinburgh







# Carbon Telescope

ELIZABETH II

c. 7



## Infrastructure Act 2015

2015 CHAPTER 7

An Act to make provision for strategic highways companies and the funding of transport services by land; to make provision for the control of invasive non-native species; to make provision about nationally significant infrastructure projects; to make provision about town and country planning; to

Royal Assent on 12<sup>th</sup> Feb 2015

### Clause 50, part 3:

(3) Where an application is made, the Secretary of State *may not issue a hydraulic fracturing consent* unless the Secretary of State—

(a) is satisfied that—

Appropriate arrangements have been made for the monitoring of emissions of methane into the air – *for the period of the permit*.

- Also require a 12-month baseline study for methane in air *before* fracking can begin.

**Clause 49, part 1.** The Secretary of State must from time to time request the Committee on Climate Change to provide advice on the impact which combustion of, and fugitive emissions from, petroleum got through onshore activity is likely to have on the Secretary of State's ability to meet the duties imposed by—

(a) section 1 of the CCA 2008 (net UK carbon account target for 2050), and

(b) section 4(1)(b) of the CCA 2008 (UK carbon account not to exceed carbon budget).

# Carbon Telescope

Coverage from one DIAL system – 150 km<sup>2</sup>

