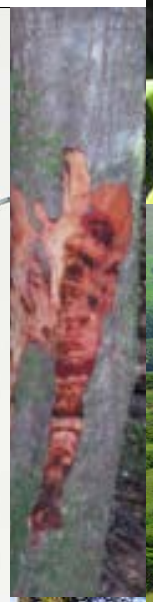
New approaches for the early detection of tree health pests and pathogens

Rick Mumford

Tree health: our greatest current biosecurity challenge









NATURAL
TRADE

Import inspection: the frontline in plant biosecurity

Inspection is a real challenge

Inland surveillance is challenging too

Finding new outbreaks

Identifying new pathogens

Speed of spotting new problems

UK Tree Health & Plant Biosecurity Initiative

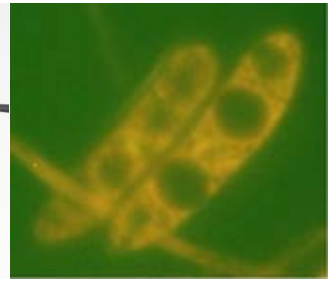
A joint initiative as part of the Living With Environmental Change (LWEC) Partnership, with the aim of bringing the widest possible research capacity and capability in the UK to focus on the area of tree health & associated plant biosecurity issues

Seven projects (worth ca. £7M) were funded and these started in 2014

New approaches for the early detection of tree health pests and pathogens

Project lead: Rick Mumford (rick.mumford@fera.co.uk)

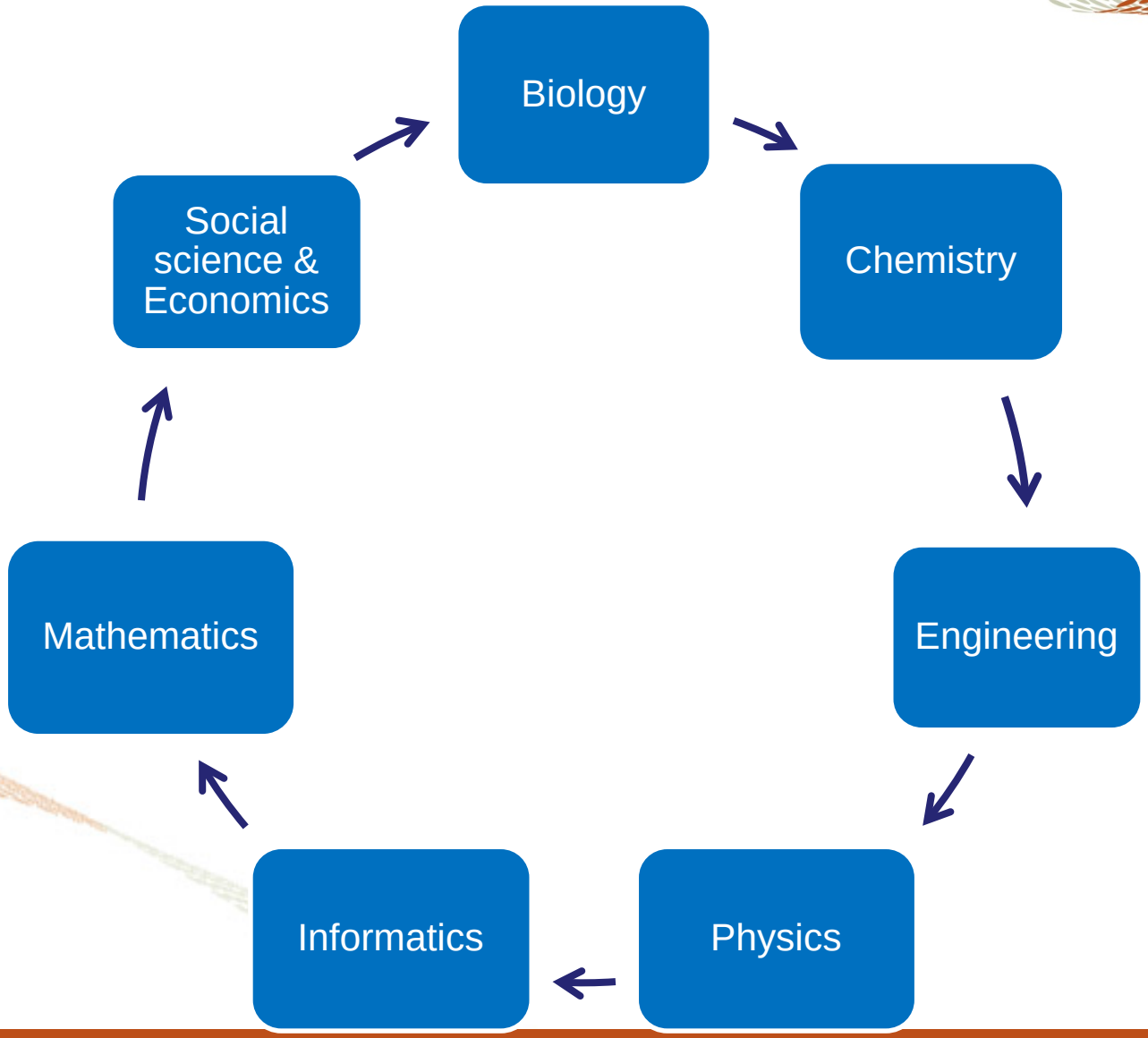
WORKPACKAGES:					
1	2	3	4	5	6
Lead: Mariella Marzano, FR	Lead: Steve Woodward, Aberdeen	Lead: Hugh Mortimer, RAL	Lead: Neil Boonham, Fera	Lead: David Hall, NRI	Lead: David Cooke, JHI
Interdisciplinary approaches ('The Learning Platform')	Volatiles Detection	Multispectral Imaging	Spore trapping	Pest Trapping	Water surveillance



Key Objectives

1. Develop improved, cost-effective tools for the early detection, surveillance & monitoring of alien pests and pathogens of trees and other plants to improve the UK's biosecurity.
2. Exploit technical advances in fields such as genomics, bioinformatics, pest & disease detection, trapping and environmental sampling, including risk and social impact valuation to support the health and resilience of UK trees and woodlands.
3. Based on an interdisciplinary consortium bringing together natural science specialists in tree research and plant biosecurity with leading-edge scientists from the physical, engineering, social & economic science research communities to develop these tools.

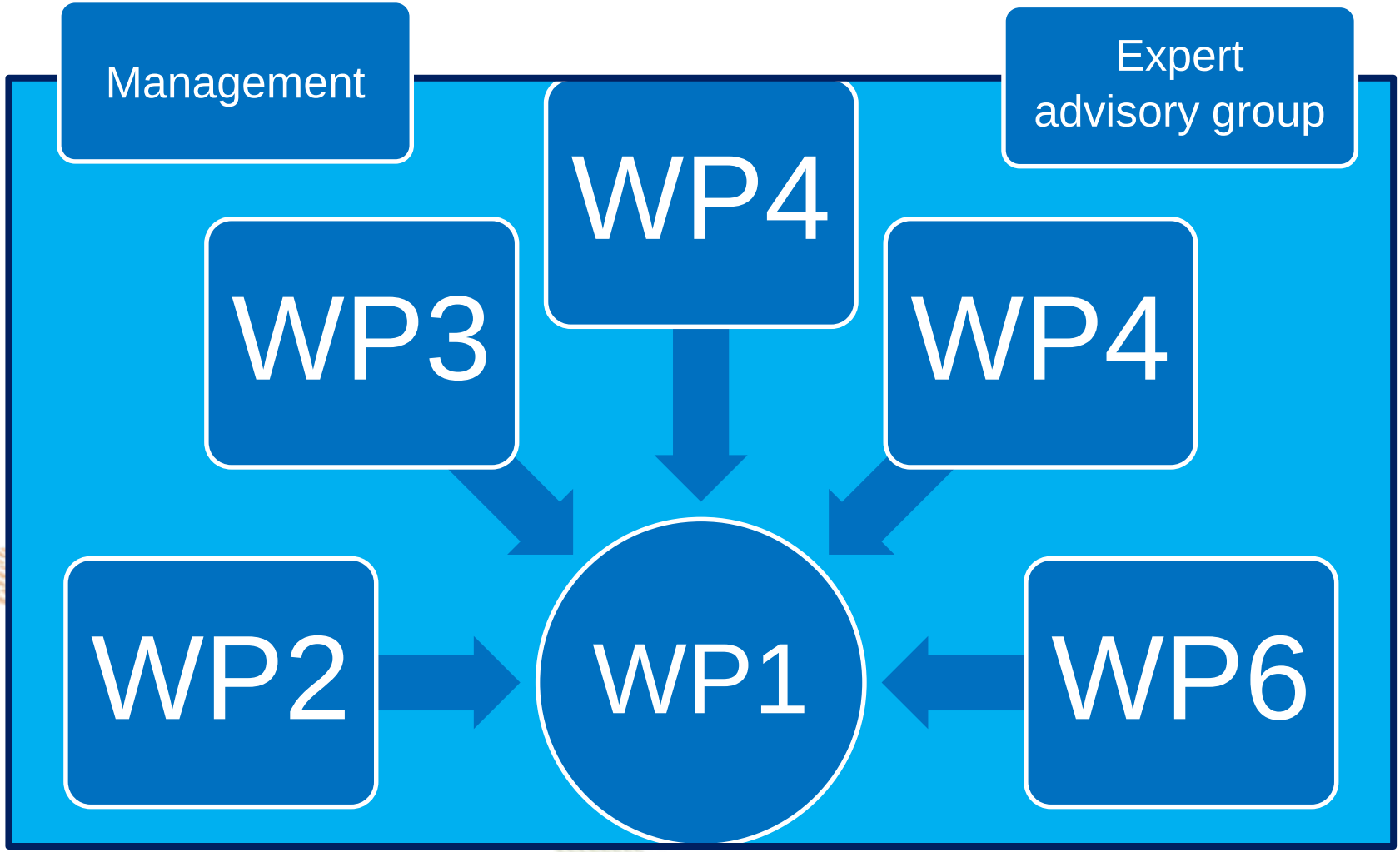
An interdisciplinary approach



Our approach

1. To ensure that the tools developed are fit-for-purpose in the real-world: offer a genuine cost-efficiency benefit, are deployed based on risk and that there is positive uptake by end-users
2. To create tools that can be used in a range of inspection contexts
3. To add to our national capabilities in plant health
4. Create generic tools that can be used beyond tree health surveillance and monitoring

Six work packages



WP1: The use of an interdisciplinary approach to the effective deployment of detection technology ('The Learning Platform')

Partners: Marzano (FR), Jones/Crowe/Macarthur (Fera), White (St. Andrews), Pocock (CEH)

Promotes collaboration and shared learning to improve uptake of socio-technological innovation:

- **Stakeholder perspectives**
  - Stakeholder networks
  - Economic impacts, risk mapping & sampling strategies
- **Co-design of technologies**
  - Socio-technological learning labs (SLL)
  - Citizen science
- **Learning Platform**
  - Resource hub, 3 annual workshops

Network model of disease spread

Model Parameters

Disease Characteristics

Model Run Controls

Monitoring Strategy

Testing Accuracy

Testing Threshold for Control

Model Run

WP2: The use of volatile organic compounds for the early detection of pests and pathogens (‘Volatiles Detection’)

Partners: Woodward/Ebel (Aberdeen), Brown (FR), Preston (Oxford), Smiths Detection

Analytical chemistry approaches will be used to identify diagnostic volatile organic compounds produced by pests, pathogens and diseased hosts and to translate these onto commercial-available portable platforms for use by inspectors in the field

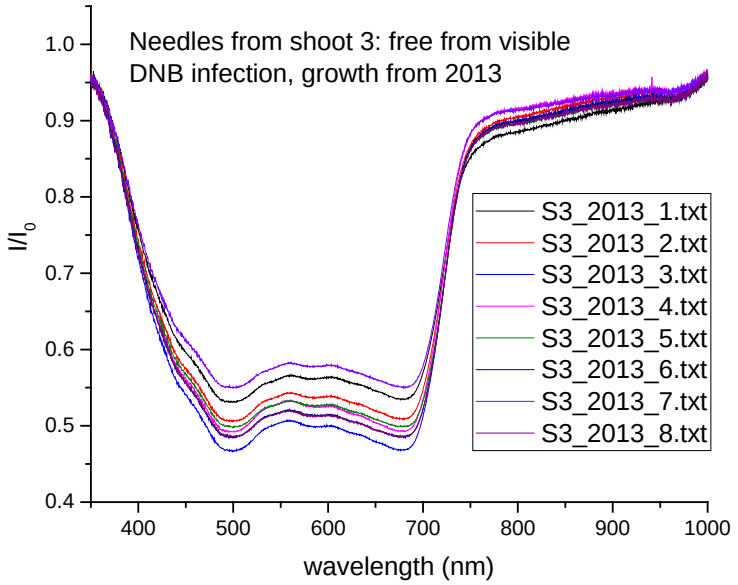
WP3: Multispectral imaging and analysis for the detection of biotic and abiotic stress ('Multispectral Imaging')

Partners: Mortimer/Hamilton (RAL), Woodhall (Fera), Tubby (FR)

Multispectral imaging will be used to identify markers for the early detection of biotic/abiotic stress in plants. A prototype bio-imaging camera will be constructed that can be used to validate this approach in the field.

Spectral database

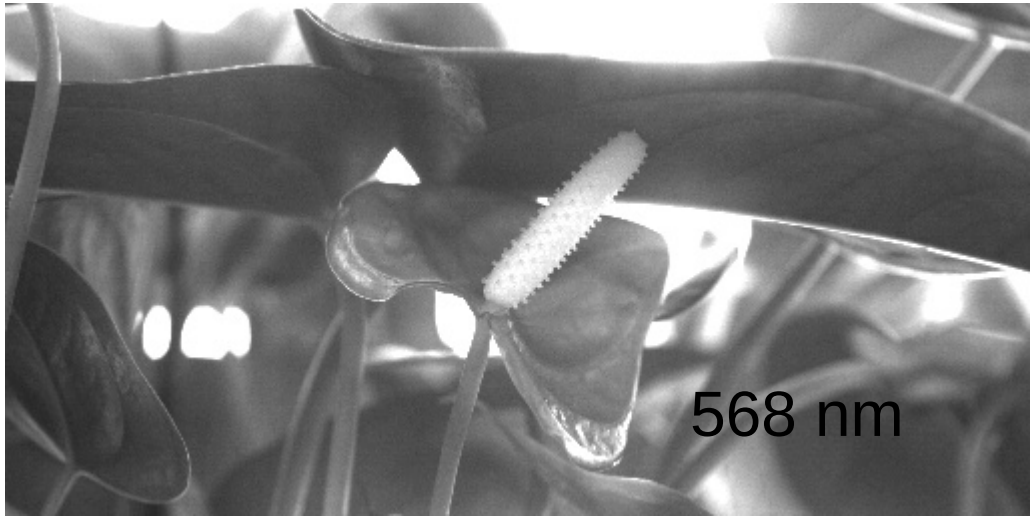
- Model system:
  - Scots Pine
  - Red band needle blight (*Dothistroma septosporum*)
- Continuing to build a spectral database
  - Field samples from around the UK
  - Seedlings grown in a controlled environment
- Used for model building and evaluation

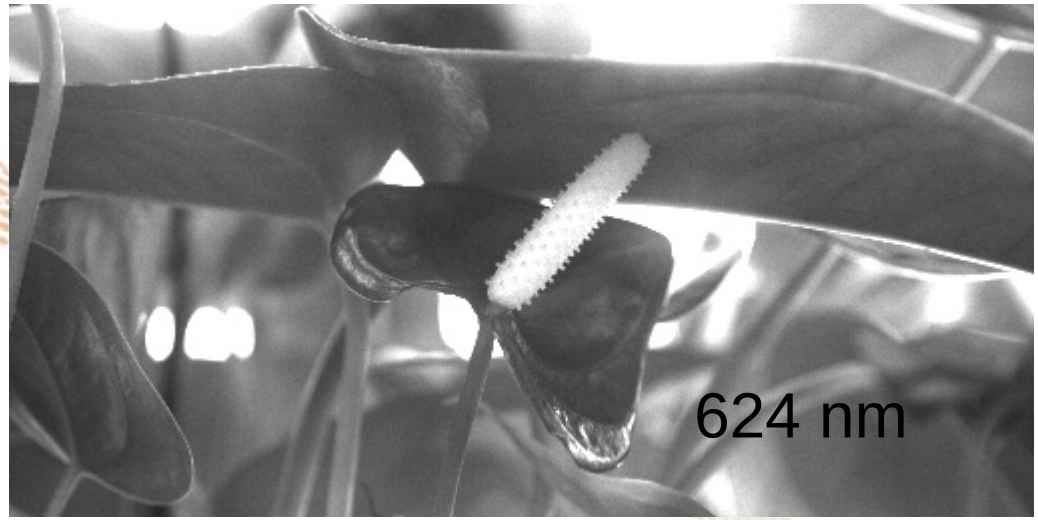


Prototype camera

- Purchased two different xiSpec hyperspectral cameras
- Small, light weight and can be mounted on a UAV or into a handheld device
- Sensitivity in the visible and part of the near infrared

Our hyperspectral data





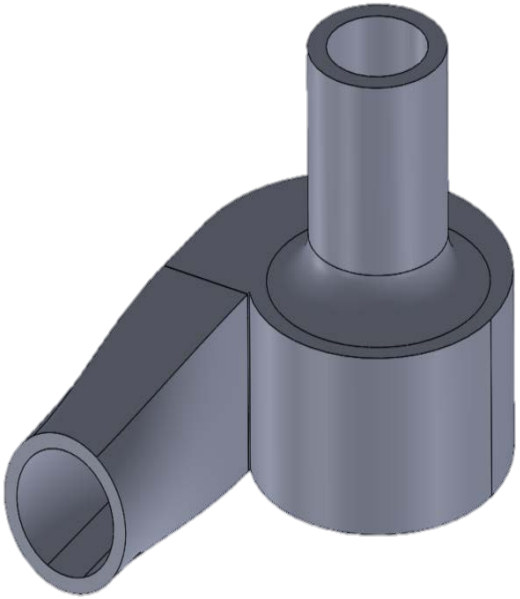
- Images from our 4x4 mosaic xiSpec camera using software written within RAL Space
- 16 images at wavelengths between 460 – 620 nm

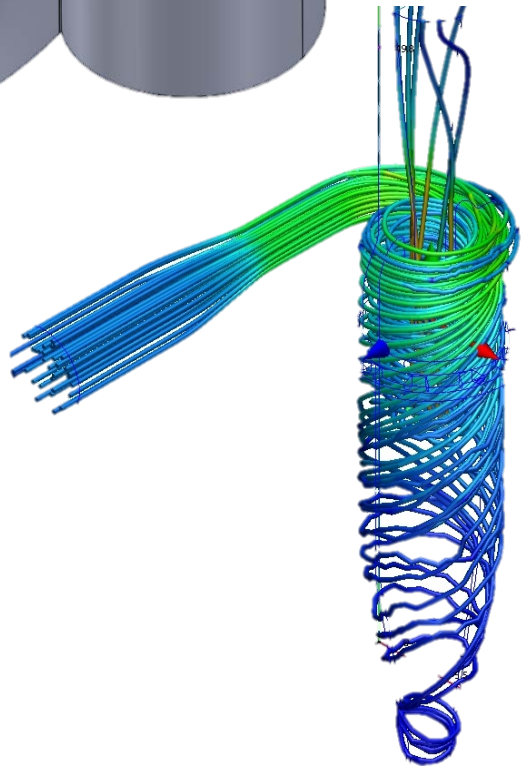
WP4: Airborne spore trapping networks, understanding of spread & development of a distributed network (‘Spore trapping’)

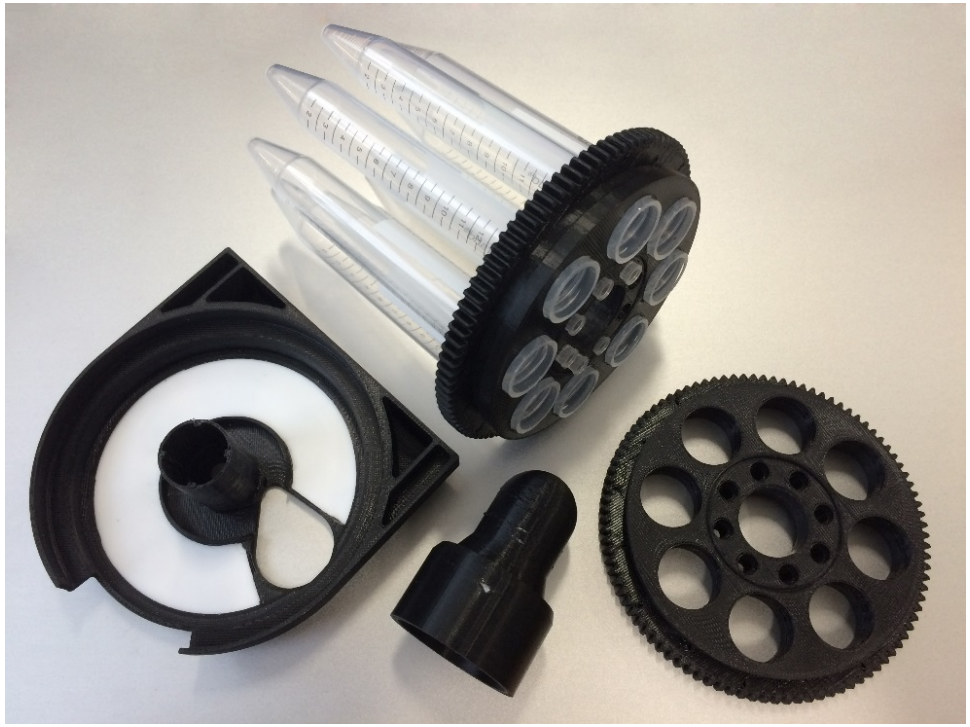
Partners: Boonham/Adams (Fera), Kennedy (Worcester), Tracey/Mclusky (Hertfordshire), Optisense

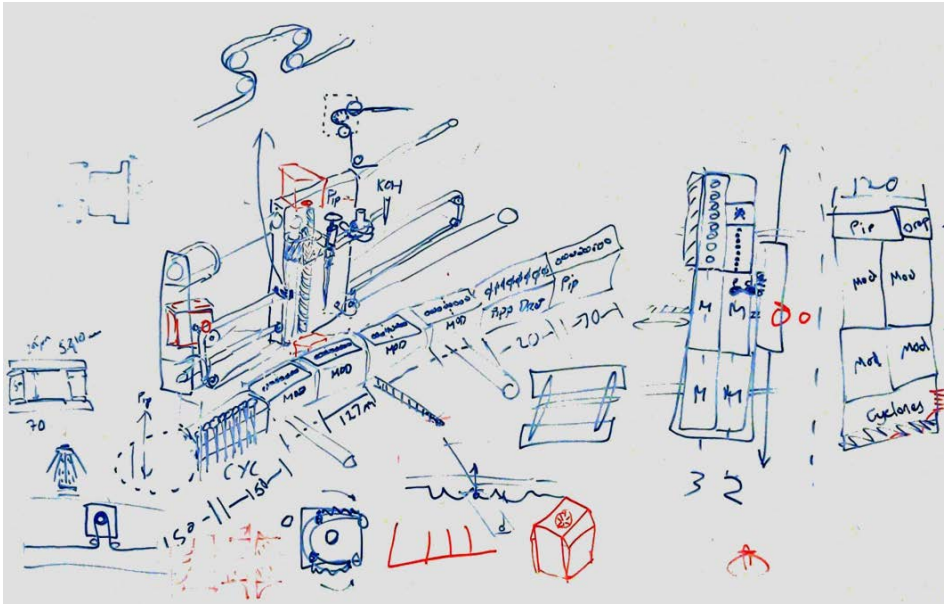
Develop mathematical models of spore movement and investigate metagenomics for broad-spectrum surveillance utilising existing monitoring networks e.g. pollen traps. In addition, a novel integrated cyclone-based trapping and molecular detection system will be developed and evaluated

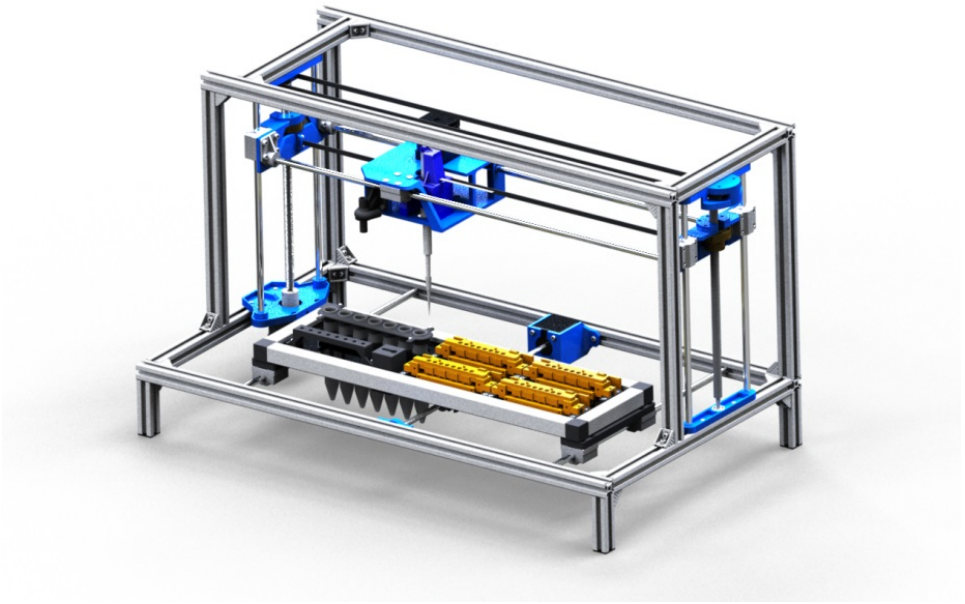

Welcome to MiSeq Control Software
MiSeq
illumina





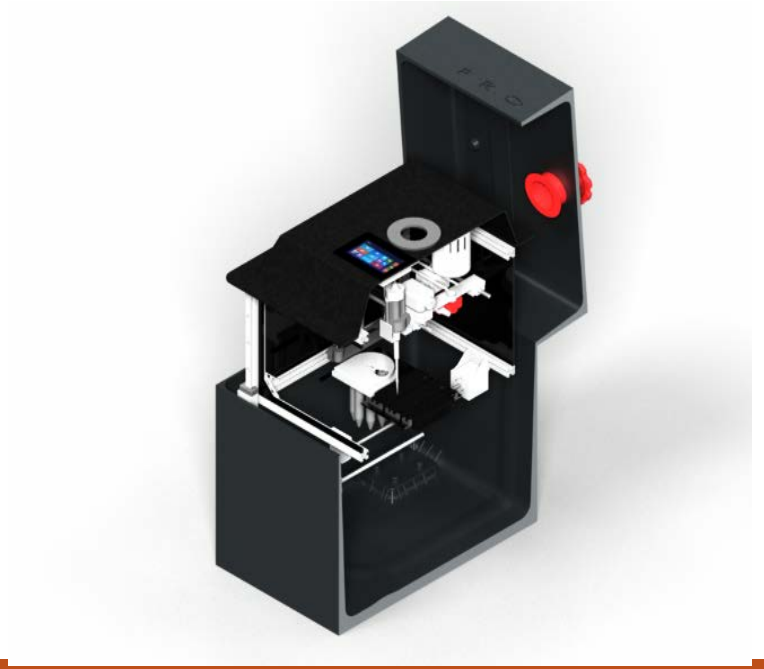







FRONT


FRONT



WP 5: Novel approaches for the improved trapping of wood-boring beetle tree pests ('Pest Trapping')

Partners: Hall (Greenwich), Pocock (CEH)

Novel semio-chemical attractants will be identified for a range of wood-boring beetle pests, incorporated into traps designed for efficient detection and then deployed in a risk-based network

Pheromone trapping for longhorn beetles: a citizen science approach

- Developed a pheromone live-trap for use by volunteers
- Pheromone and kairomone for ALB: potential for early detection
- 3 other pheromones for many other longhorn beetles (Hanks & Millar 2012 Chemoecology)
- Can trap native longhorn beetles – biodiversity monitoring & motivating to volunteers

Early trial

- Traps provided to 10 volunteers, from across England, during August 2015
- No longhorn beetles were found, but will be repeated in June 2016

WP6: Development of non-targeted water surveillance methods for water-borne tree pathogens based on metagenomic approaches ('Water surveillance')

Partners: Cooke (JHI), Studholme (Exeter), Boonham (Fera)

Methods for sampling and rapid screening water for Phytophthora spp., including 'unknowns' will be developed and validated. This will combine high-throughput sequencing with a rapid bioinformatic pipeline

Project website:
http://protectingtreehealth.org.uk/index.php