

## The Problem



**10 million** people affected in the UK



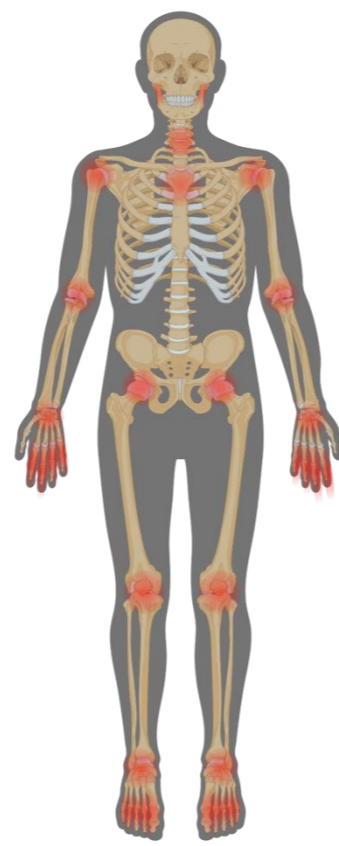
**1 in every 2** over 75+ and **1 in every 3** over 45+ have Osteoarthritis (OA).



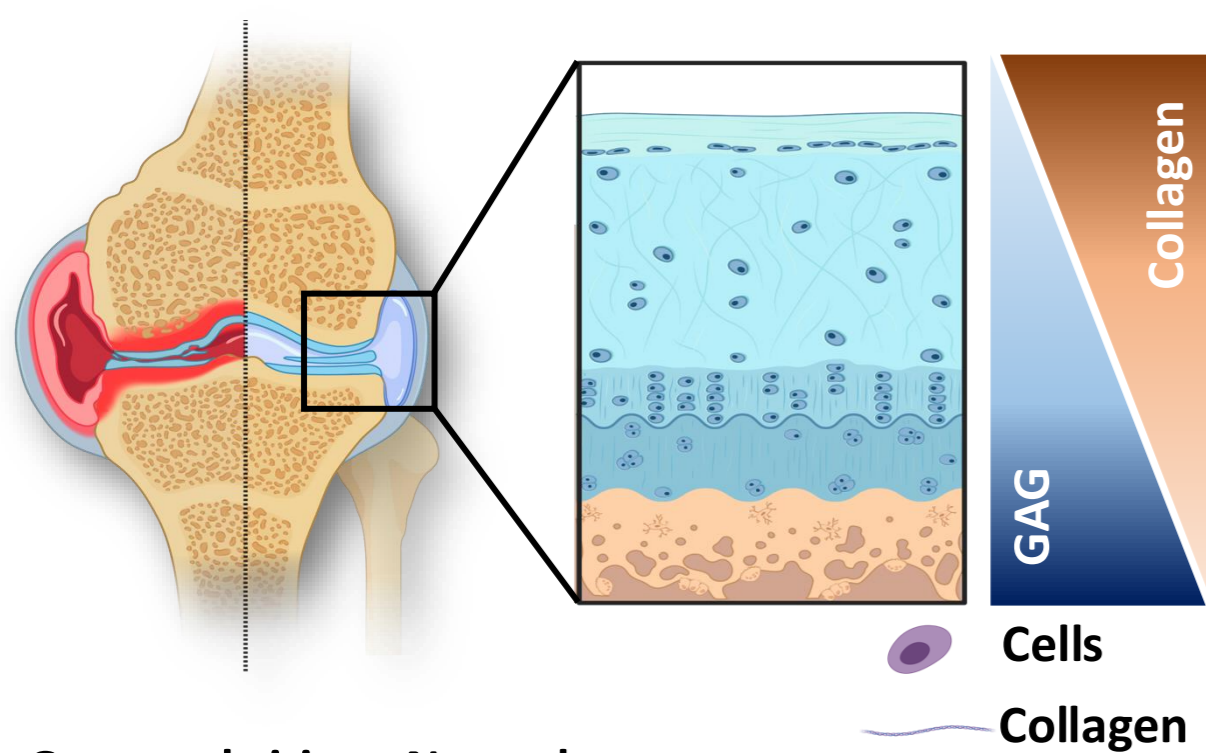
Knee and hip OA cause worst pain and disability.



**7.6%** of global population is struggling with OA.



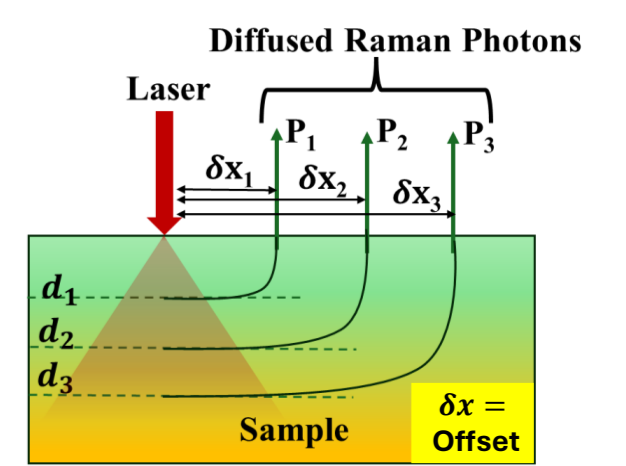
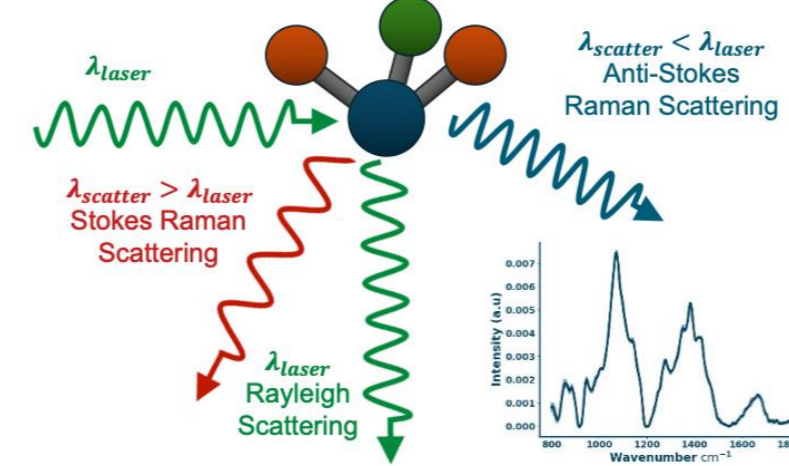
Affected joints



Osteoarthritis vs Normal

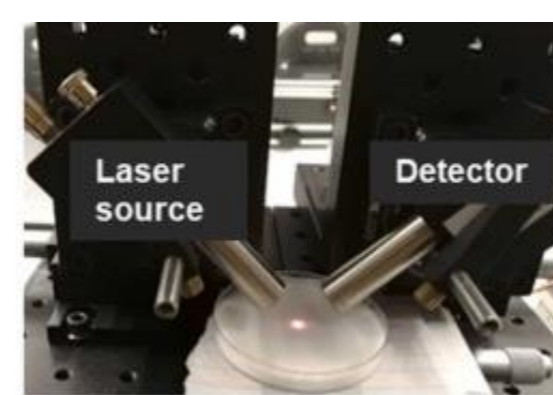
- X-ray and MRI detect structural damage, not early biochemical changes.
- OA is often diagnosed late.
- Detection of GAG → onset of OA.

## Our solution



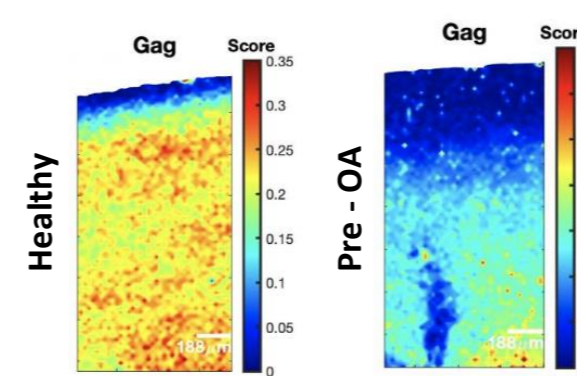
### Conventional Raman Spectroscopy

- ✓ Non-ionizing & Non-destructive
- ✓ Highly sensitive to molecular content



### Open-Optics SORS

- ✓ Adjustable offset
- ✓ Good for excised tissue

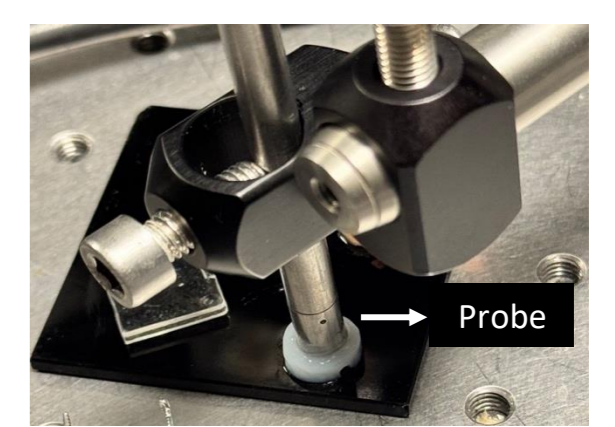


### Monitoring OA

- ✓ Excised tissue
- ✓ 5+ Hours of Raman imaging

### Spatially offset Raman Spectroscopy

- + Depth selectivity



### Our Depth Selective Raman System

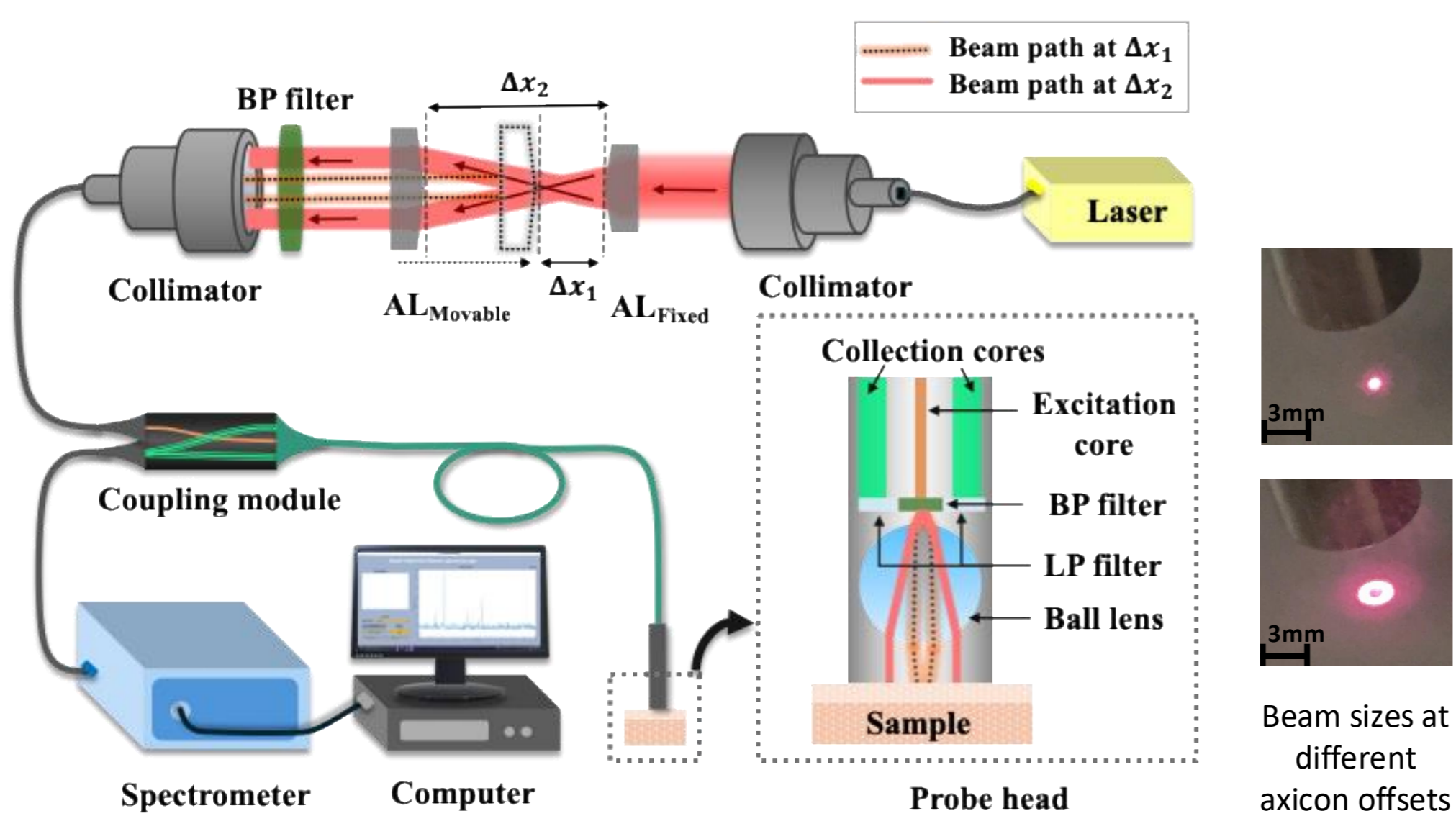
- + Miniaturised, fibre based
- + Suitable for clinical setting



### Our approach

- + Quick scan < 2 mins
- + Machine learning model

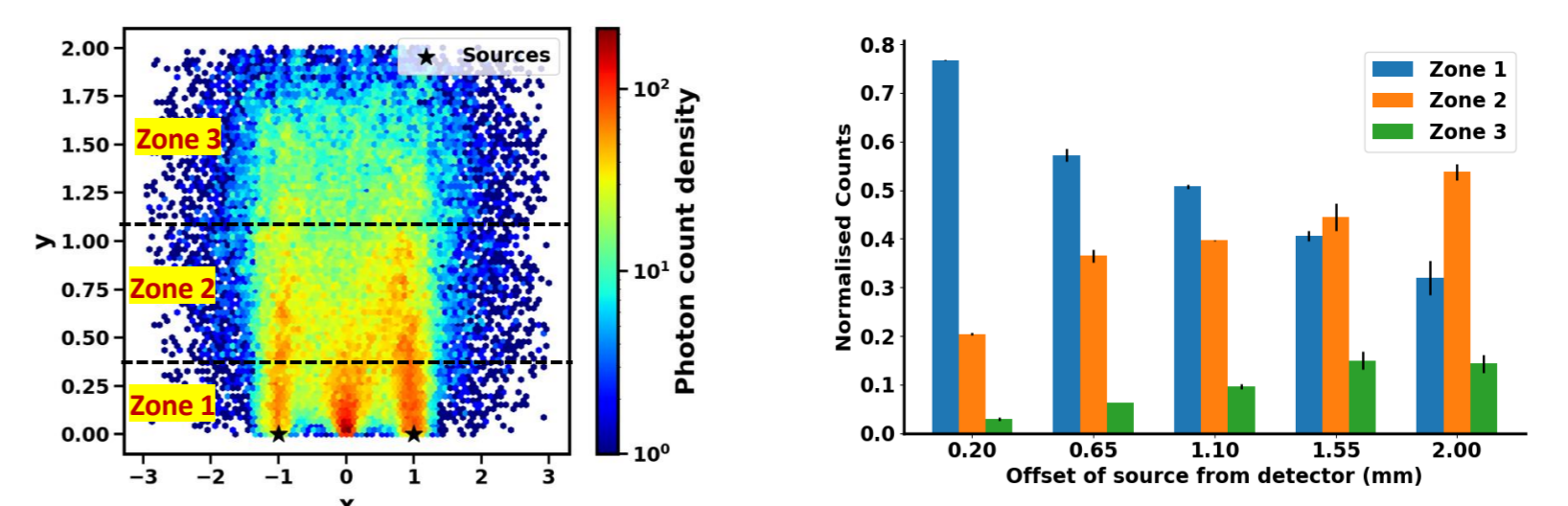
## Developed system



Axicon displacement ( $\Delta x$ )  $\propto$  the radius of ring-shaped beam  
 $\propto$  probing depth in tissue

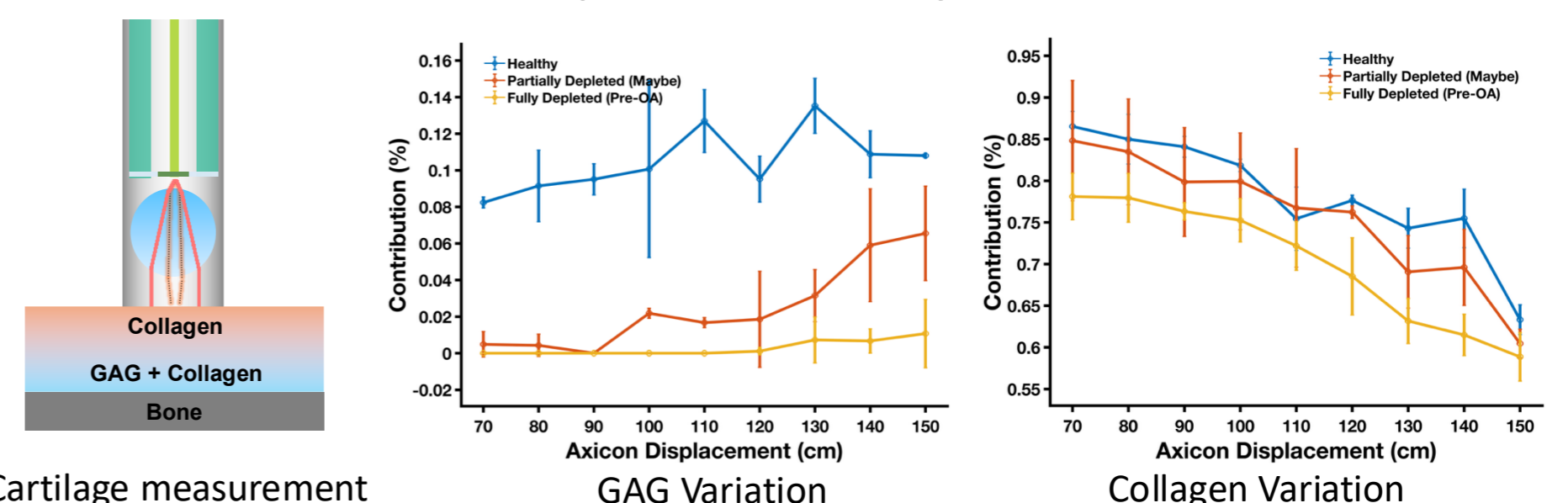
## Validation studies on OA models

### Simulation study



Simulation confirms as we increase offset - we can extract relative contributions from deeper layer of the trilayer tissue model for OA

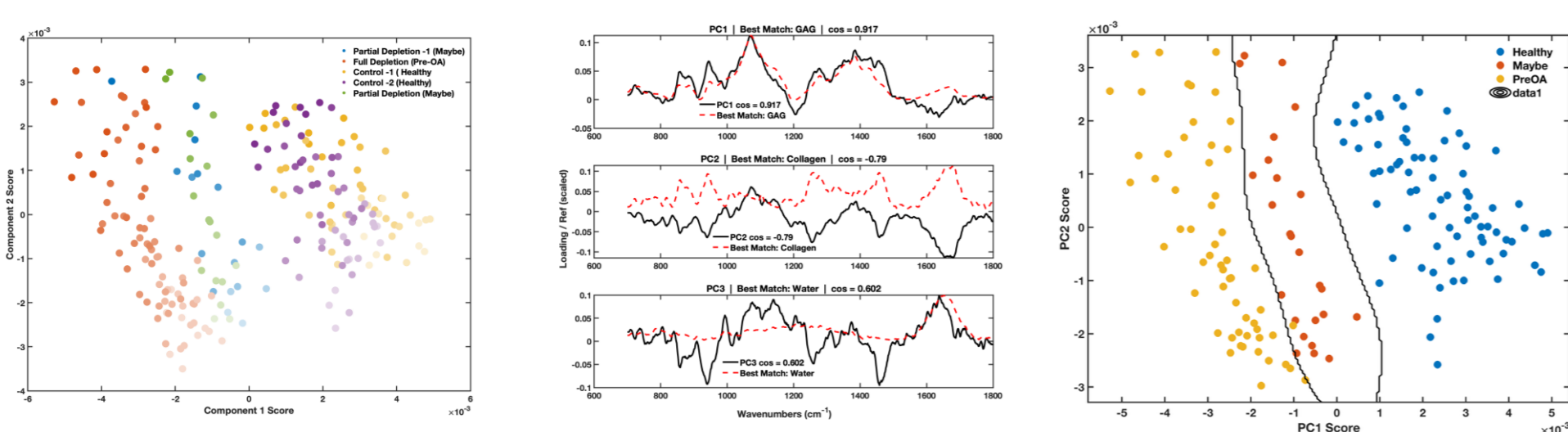
### Experimental study



Cartilage measurement

Extracting exclusive contribution of constituents in OA model of real cartilage confirming potential for OA monitoring

## Machine Learning model – predicting stages of cartilage



Identifying groups with no prior knowledge using PCA

Correlation with predicted components to library

Decision boundary to identify stages of OA using ML

Machine learning models can predict whether the cartilage scanned is healthy or have signs for onset of OA.

## Impact

- **First-ever** miniaturised, clinical-compatible, OA detection depth selective Raman probe.
- The integration of unsupervised techniques and machine learning enables automated, OA staging, **supporting clinical decision-making**.
- Potential for **safe, repeatable monitoring of cartilage** health over time.
- Intervention before irreversible cartilage loss - delays or prevents joint replacement.