Development of Technology for High-Throughput and Passive Monitoring for Earlier Detection of Colorectal Cancer

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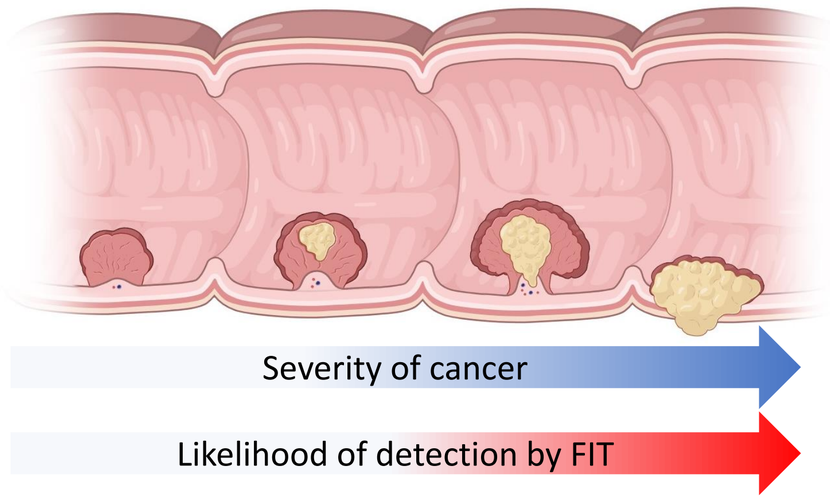
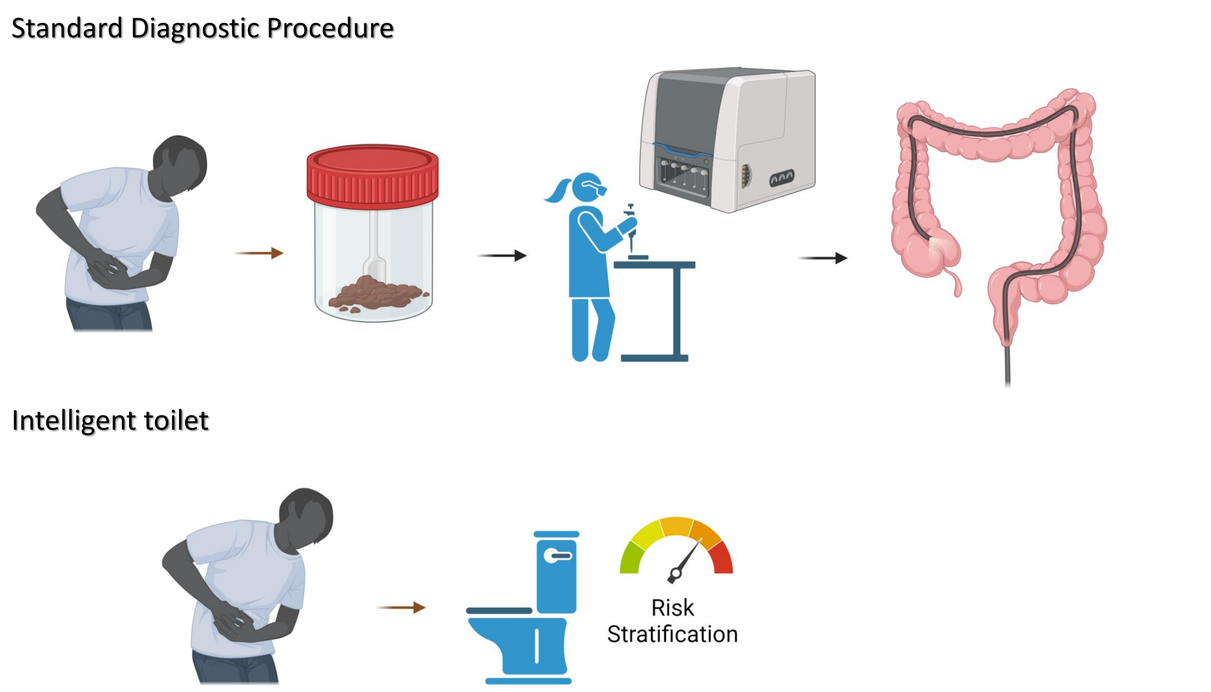
Introduction:

Colorectal cancer (CRC) is the **third most common** cancer globally. Symptoms can often be none specific such as changes in bowel habit which makes early detection difficult to diagnose.



Faecal immunochemical testing (FIT) is used for population level screening but is much more effective for advanced CRC, with detection performance drastically decreasing in earlier cases where they are easier to treat. Furthermore, there is a shift in incidence towards younger adults.

Developing methods for high throughput metabolomics for stool and urine samples could help to triage patients with none specific symptoms and provide clinicians with data to understand the underlying biology in the gut.



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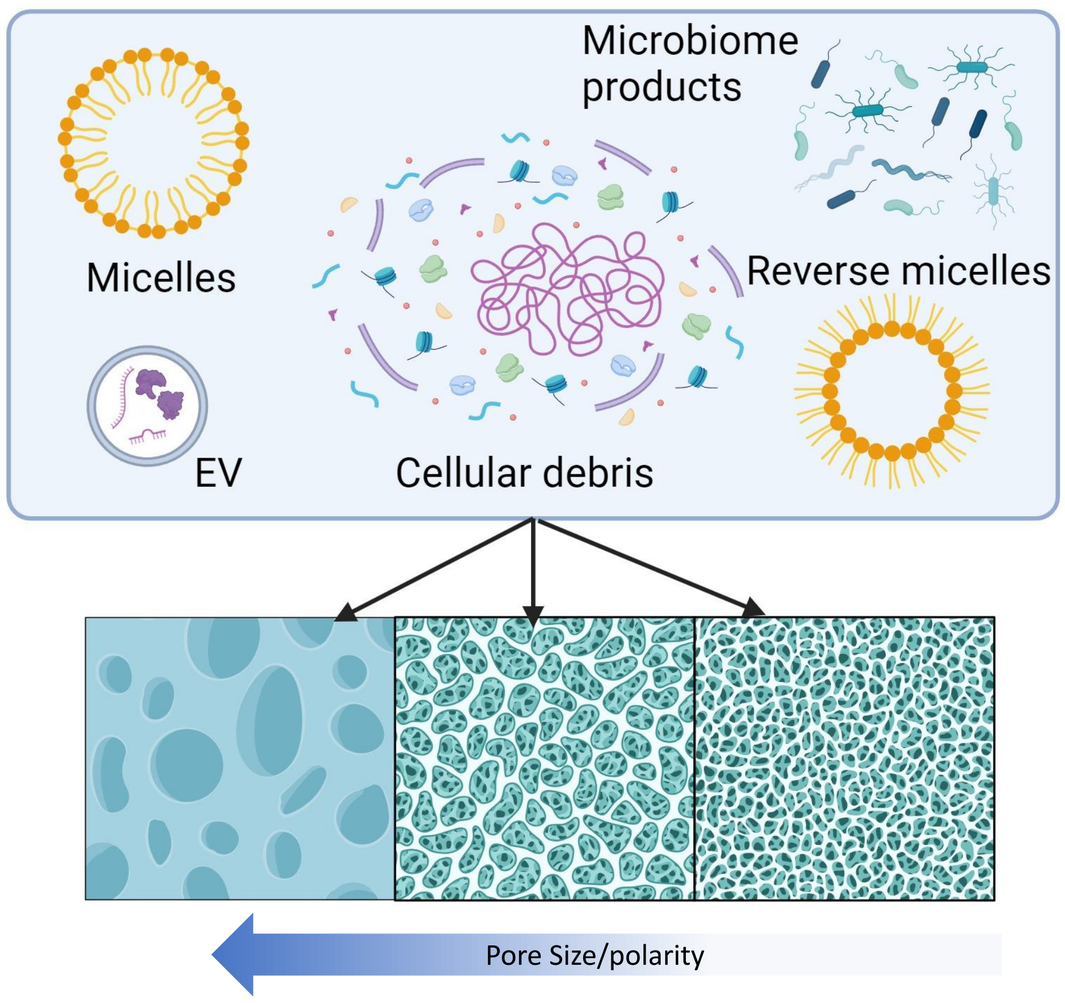
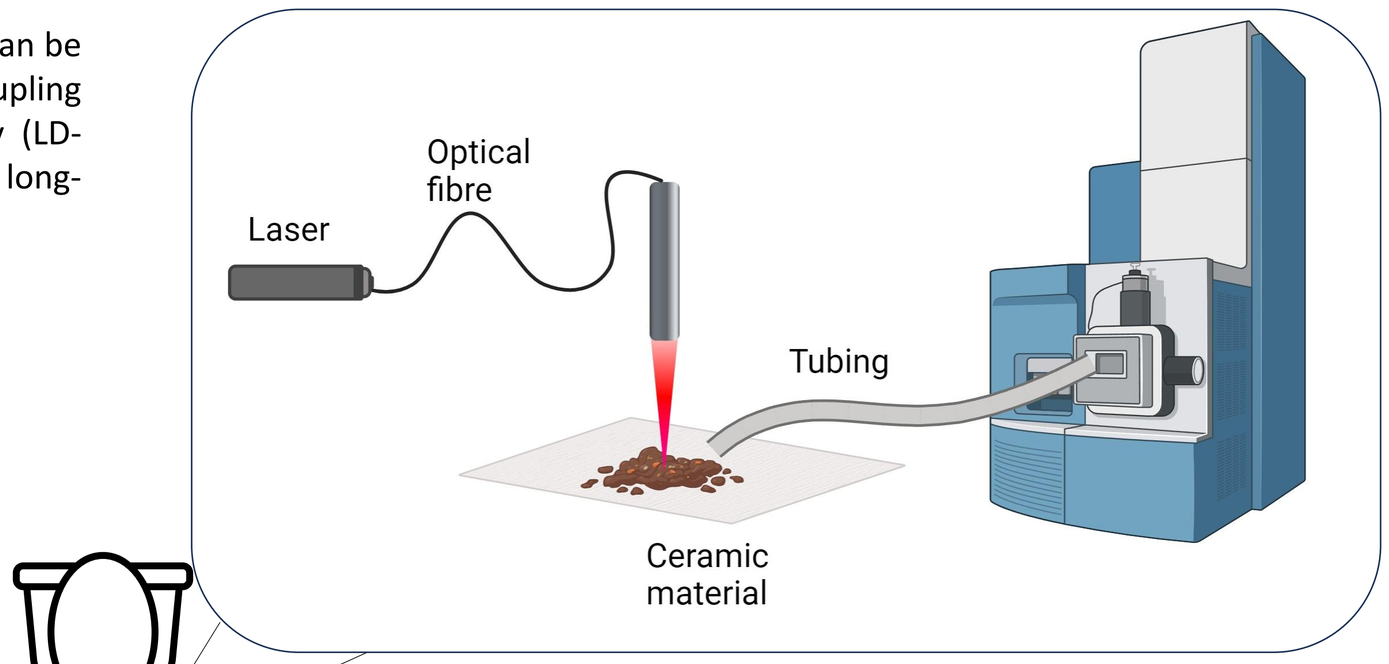
Herein it is hypothesised that the surface chemistry of bespoke ceramics can be used to capture metabolite information in urine and faecal samples. By coupling to Laser Desorption – Rapid Evaporative Ionisation Mass Spectrometry (LD-REIMS) high throughput direct sample analysis can be carried out with the long-term plan of incorporating into a toilet.





Ceramic materials having different physical chemical properties such as pore size, hydrophobicity and porosity were developed in house.

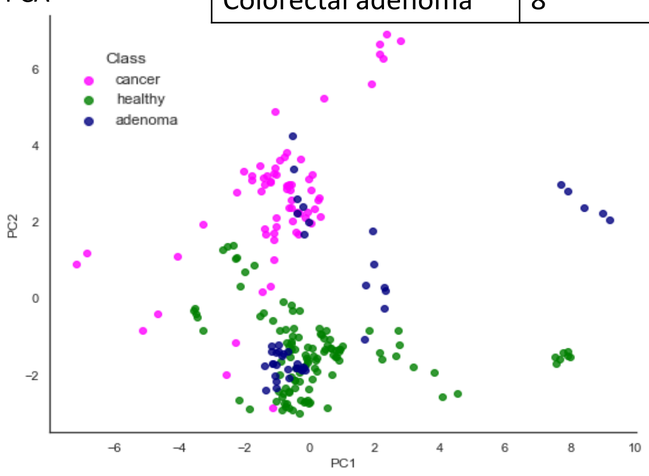
Faecal samples are smeared onto the surface of the ceramic materials and aerosol produced using IR laser, gaseous ions are then transferred to the mass spectrometer for REIMS analysis.

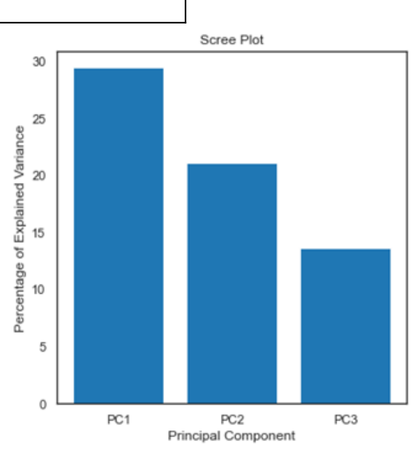
Metabolites detected are used to build machine learning models using unsupervised and supervised multivariate analysis.

Stool samples from 33 participants were included in the preliminary study.
Collected from colorectal cancer clinics at Imperial College London (RE:14/EE/0024)

Group	Number of participants
Colorectal cancer	10
Healthy Control	15
Colorectal adenoma	8

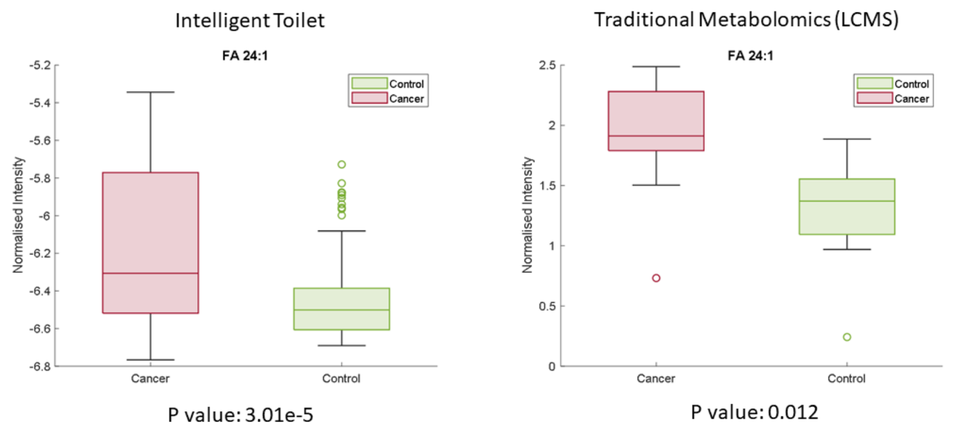
PCA





class	accuracy	sensitivity	specificity	precision	F1
adenoma	0.632437	0.377778	0.887097	0.447368	0.409639
cancer	0.92767	0.898551	0.95679	0.898551	0.898551
healthy	0.830747	0.863248	0.798246	0.814516	0.838174
Average	0.796951	0.713192	0.880711	0.720145	0.715455

The same samples were analysed by LC-MS to validate findings from the ceramic assays. Showing trends in metabolite features consistent with ceramic findings.



Conclusions:

LD-REIMS coupled to smart materials shows promise for development into a high-throughput metabolomic test for passive monitoring of colorectal cancer. The use of ceramic materials increased sensitivity of interesting features in complex biofluids. The increased sensitivity is likely due to the specific cavity sizes and the hydrophobic surface chemistry enabling adhesion to the surface whilst salts can be washed away reducing ion suppression in the samples. This increased sensitivity resulted in good diagnostic accuracy between healthy, adenoma and CRC patient's stool.