Volatile organic compounds (VOCs) produced by metabolic processes in the body can be detected in various media including breath, urine, stool, sputum, and sweat as non-invasive biomarkers in the early diagnosis of cancers, inflammatory and infectious diseases.

GC-MS and similar spectrometer based techniques are used to identify individual compounds but can be limited due to equipment size, cost, and complexity including sample preparation and data analysis. Blood test with biochemical markers such as carcinoembryonic antigen (CEA) and CA19-9 can be used to monitor treatment of advanced diseases such as Colorectal Cancer (CRC) however lack of sensitivity and specificity precluding their usage in early stage screening.

Field Asymmetric Ion Mobility Spectrometry (FAIMS) enables a pattern based analysis of biological samples by producing a chemical spectrum or profile that is characteristic of specific diseases and has shown strong potential as an early stage screening tool.

To evaluate the capability of FAIMS (Field Asymmetric Ion Mobility Spectrometry) technology as a tool for non-invasive detection of Colorectal Cancer (CRC) through urinary volatile organic compound analysis. This investigation expands on the research in “Detection of Colorectal Cancer (CRC) by Urinary Volatile Organic Compound Analysis” (Ramesh P. Arasadam et al, 2014) with an increased sample population and local to Japan, also comparing in-house data of CA19-9 and CEA markers from the same sample source.

METHODS AND MATERIALS

SAMPLES - Conducted at Nippon Medical School Chiba Hokusoh Hospital, urine samples were collected and frozen at -80°C from 139 patients at various stages of CRC and 78 healthy control samples (Table 1).

FAIMS & ION MOBILITY - FAIMS separates and identifies chemical ions within a microchip filter (Figure 2) according to differences in the speed (mobility) they move through a buffer gas under the influence of an oscillating asymmetric electric field to a detector (Figure 3).

FAIMS technology achieved a high rate of separation between the CRC and healthy control urine samples as illustrated in Figure 5. Results as the CRC stage advances, and biomarker concentrations increase, the sensitivity increased from 67.3% (Stage I) to 100% (Stage IV). Our data suggest there is excellent potential to use FAIMS technology as an early screening tool for CRC, particularly impressive compared to in-house sensitivity data of CA19-9 and CEA markers.

It is recommended to research further into FAIMS screening of other cancer types through VOC biomarker analysis of urine, breath, feces and other media, as well as method optimization. Our next study will investigate urinary VOC analysis of stomach and breast cancer.

REFERENCES