electricity north west

Bringing energy to your door

Hyperspectral Imaging for Soils

Electricity North West and the Manufacturing Technology Centre

Stay connected...

www.enwl.co.uk

Electricity North West – background

Operate and maintain over 56,000km of network

2.4 million connections

Supply around 5 million customers

Diverse geographical area

Switched on, adaptable and take pride in what we do

The Manufacturing Technology Centre

- Opened in 2011
- Independent RTO
- To bridge the valley of death
- Prove innovative manufacturing ideas
- Manufacturing system solutions
- Training & Skills

Hyperspectral Imaging for Soils

- With **repeal of Environmental Agency (EA) Regulatory Position Statement 211**, small amounts of spoil – less than 10 m^3, or approx. 13 tonnes – can no longer presumptively be disposed of as non-hazardous waste.
- Companies like Electricity North West will be **required to classify all spoil as hazardous or non-hazardous**, and dispose of accordingly, with costs for hazardous spoil being substantially higher than non-hazardous.
- **Highly desirable to classify waste on site**, and immediately dispose of as appropriate, rather than store, classify, and segregate offsite, or dispose of spoil as hazardous unnecessarily.
- This requires technology capable of inspecting spoil at the work site and providing results in near-real-time.

Hyperspectral Imaging for Soils

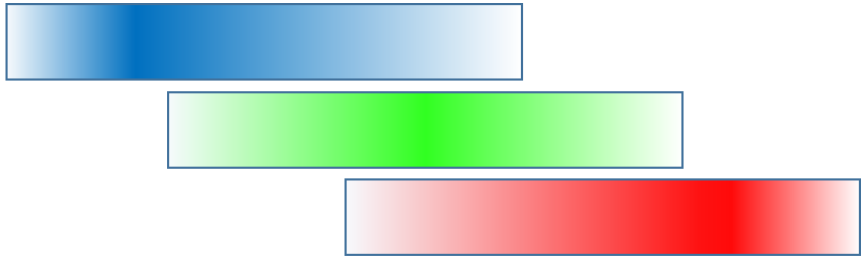
- The Manufacturing Technology Centre has proposed **Hyperspectral Imaging** (HSI) to identify and measure any contaminants chemicals within soil.
- The measurement could be carried out on site and in real-time to then allow appropriate action to take place immediately, in line with environmental management procedures.
- Hyperspectral cameras range from self-contained handheld digital-camera-like devices to larger, more powerful units designed for integration into more complex systems.

Specim IQ, which can be operated like a conventional digital camera.

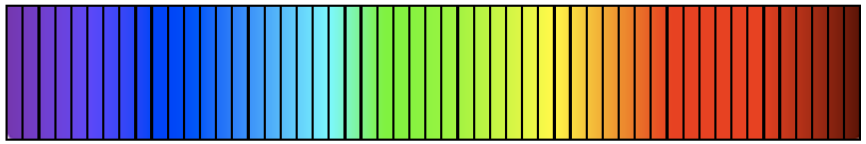
Resonon Pika, mounted on outdoor scanning system.

Hyperspectral Imaging for Soils

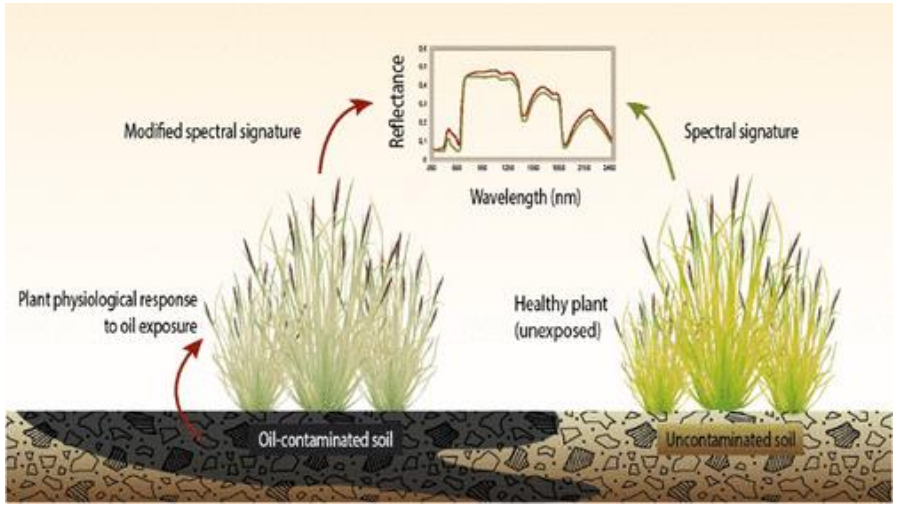
- Conventional digital cameras capture light in overlapping red-, green-, and blue-centred wavebands, mimicking the human eye.
- Hyperspectral imaging captures many narrow, non-overlapping wavebands – typically hundreds per image and extending into infrared light.
- Materials have characteristic spectra based on their physical and chemical properties.
- By identifying these features in hyperspectral images, the material composition of an object – or soil – can be identified.
- Hyperspectral imaging is already used for this kind of application in fields like agriculture and geology.



Conventional RGB



Hyperspectral



Inferring oil contamination from hyperspectral imaging of plants. (Lassalle et al., 2018)

Hyperspectral Imaging for Soils

- A **downselection** of potential hyperspectral hardware is used to identify best candidates for practical trials.
- Information from the problem definition and ENWL's current processes is used to generate quantifiable criteria against which candidates can be scored.
    - These criteria consider both imaging capability (e.g. spectral resolution, frame rate) and practical considerations (e.g. durability, portability).
- Laboratory trials – currently in progress – can then be used to refine scoring and make recommendations to ENWL.

Problem Definition

- Capture of information relevant to the inspection problem: current work practice, site conditions, and contaminants to be considered.

Technical Specification

- Identify performance criteria by which hyperspectral cameras will be assessed and ranked, with scoring and weighting for each, producing a numerical matrix of criteria.

First Stage Downselection

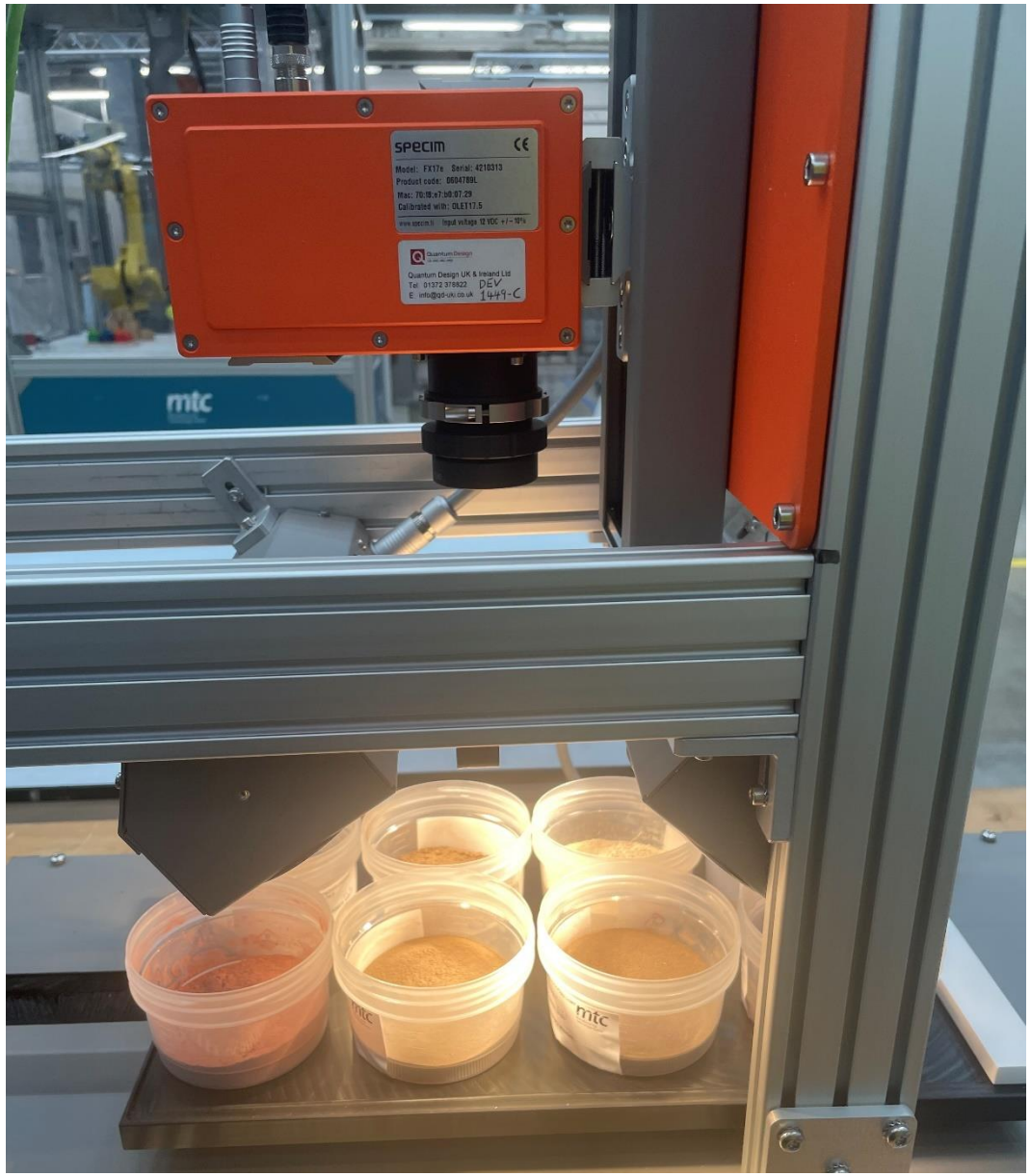
- Review of market to identify candidate hyperspectral cameras.
- Rating of candidate cameras based on the criteria specified in previous stages, filtering out inappropriate cameras and yielding a shortlist for practical trials.

Second Stage Downselection

- Trials to assess and validate the capability of candidates selected in previous stage within the process requirements.
- Reference samples of contaminated soils will be used to evaluate detectability of a subset of potential contaminants.

Hyperspectral Imaging for Soils

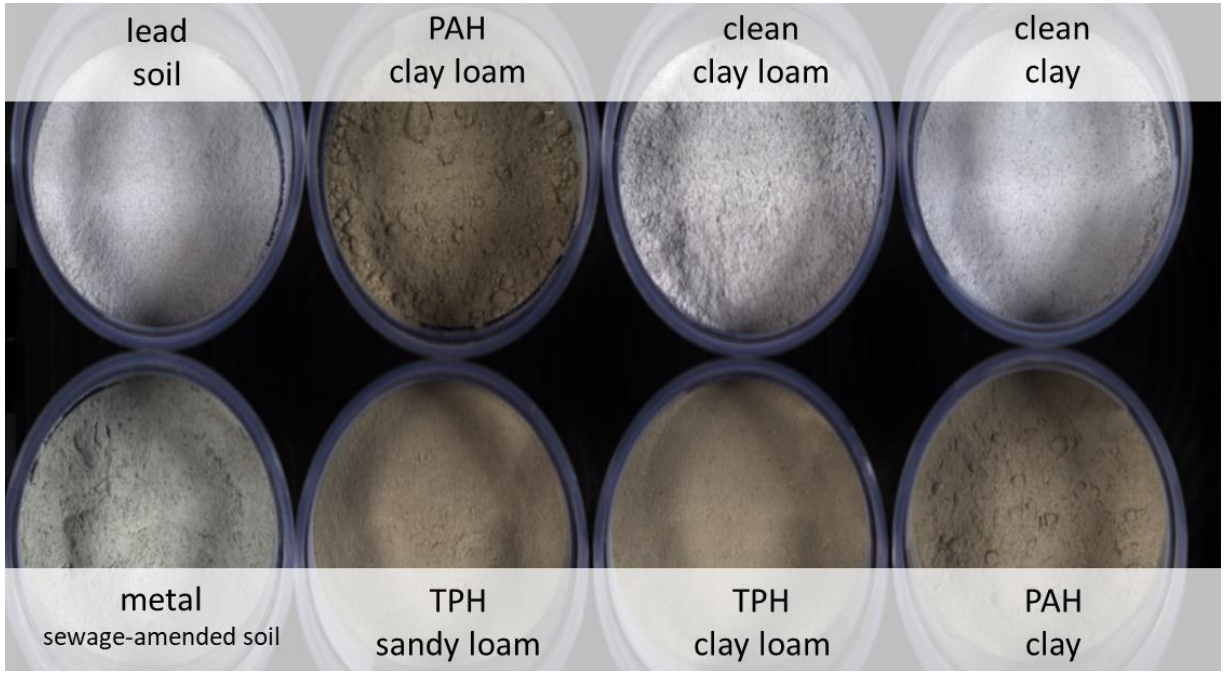
- To evaluate feasibility of contaminant inspection, trials are using reference materials: soils of specific texture and with known contaminants:
  - Total petroleum hydrocarbons;
  - Polycylic aromatic hydrocarbons, including benzo[*a*]pyrene (BaP);
  - Heavy metal compounds;
  - “Clean” samples for comparison.
- Initial trials have used **Specim FX17** and **FX10** cameras.
  - FX17 images in near-infrared (1000 – 1700 nm),
  - FX10 images in visible to very-near-infrared (400 – 1000 nm).



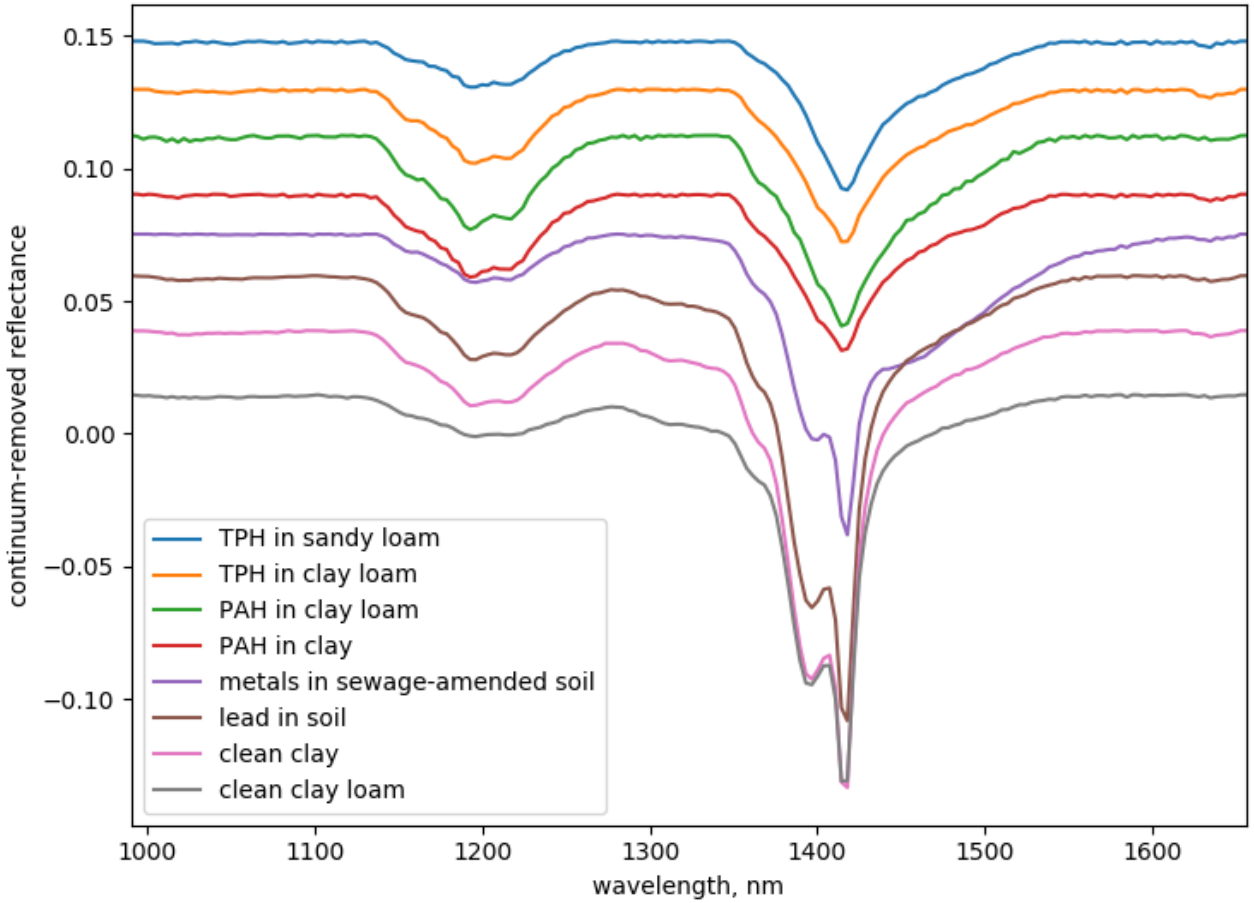
Imaging of reference materials with Specim FX17.

Hyperspectral Imaging for Soils

- Preliminary results with FX17 show significant differences in spectra of soil references.



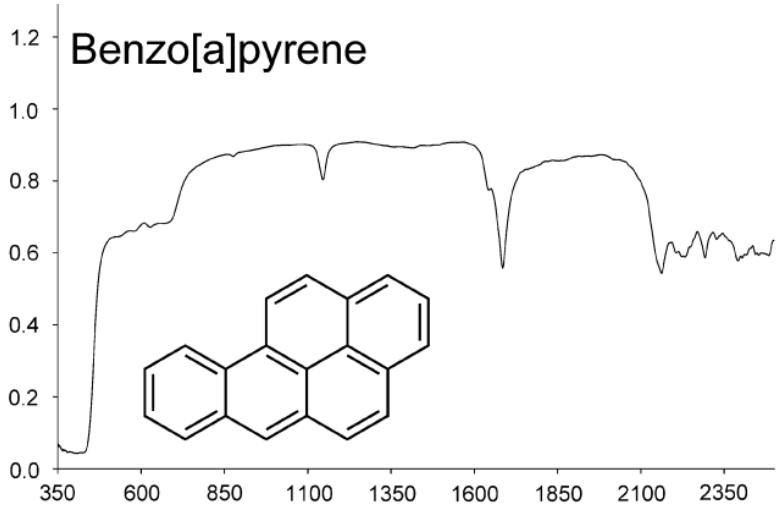
False-colour image of soil reference samples, generated by FX17.



Processed spectra showing variation in absoprtion features around 1200 and 1400 nm.

Hyperspectral Imaging for Soils

- To evaluate feasibility of contaminant detection from these spectra, spectral features will be compared to reference spectra and prior work in literature.
- Trials will be repeated with cameras from different manufacturers and with different wavelengths, providing further insight into contaminant detectability and feeding back into downselection process.



Reference spectrum of benzo[a]pyrene. From (Izawa et al., 2014).

QUESTIONS & ANSWERS

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