STEPPING UP IN THE NEW NORM
SPE Asia Pacific Health, Safety, Security, Environment and Social Responsibility Conference
4-6 April 2017 • Kuala Lumpur, Malaysia

SPE-185195
Rapid Field Analytical Methods for Total Petroleum Hydrocarbons

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Project Background

Opportunity

Soil samples from hydrocarbon impacted soil in CPI operations need to be tested for Total Petroleum Hydrocarbon (TPH)

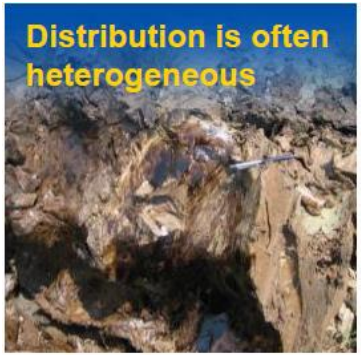
- **Delays in sample analyses** and **decision making** due to thousands of soil samples per week needing analysis
- Lab analysis can take 2-4 weeks

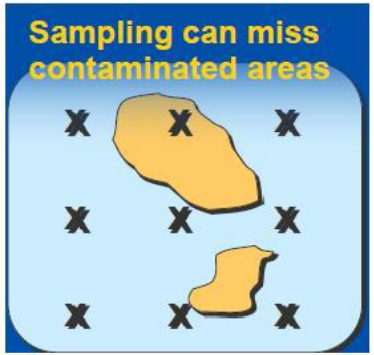
Approach

Development of rapid TPH analytical method to increase accuracy and efficiency

1) real-time remediation process monitoring

2) reducing the number of samples going to lab

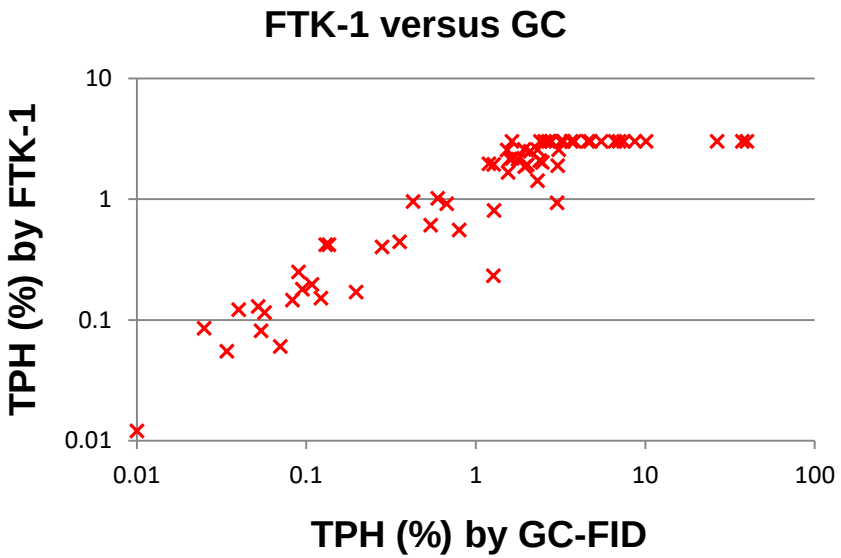


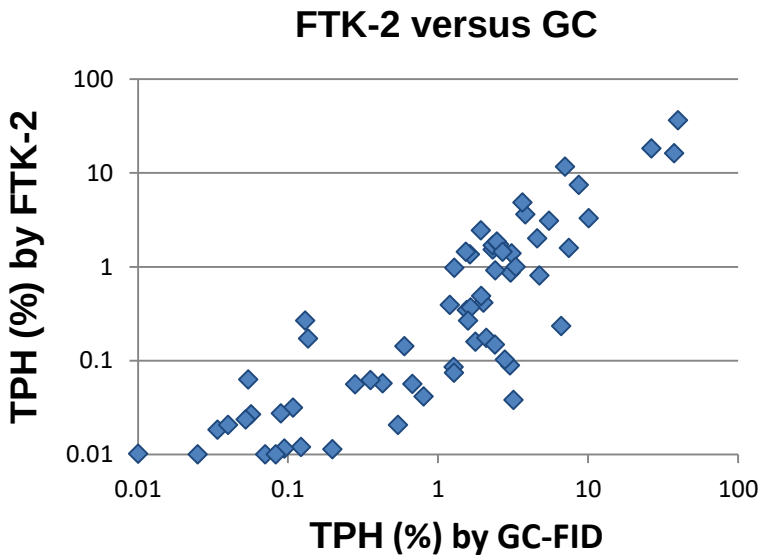


Six FTKs have been Selected and tested with field soil samples

	Method	Extraction	Extraction Solvent	Data Quality
FTK-1	Turbidity	Yes	Methanol	semi-quantitative screening
FTK-2	Infrared	Yes	Hexane	quantitative
FTK-3	Ultraviolet fluorescence	Yes	Methanol	semi-quantitative screening
FTK-4	Colorimetry	Yes	Dichloromethane	semi-quantitative screening
FTK-5	Visual	Yes	Heptane	qualitative screening
FTK-6	Visual	No	Water	qualitative screening

FTKs Performance Evaluation Results





FTK-1 and FTK-2 demonstrated the good correlation with referenced lab GC data

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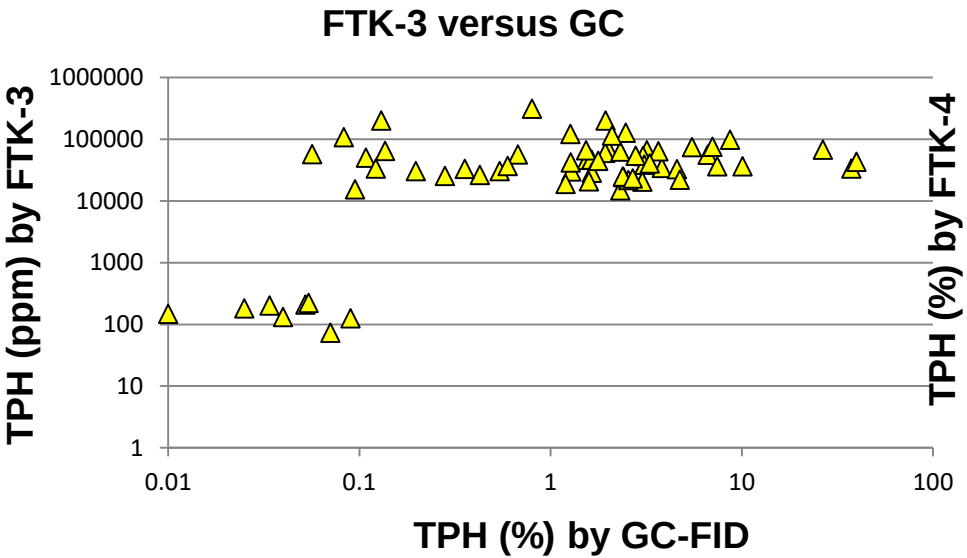
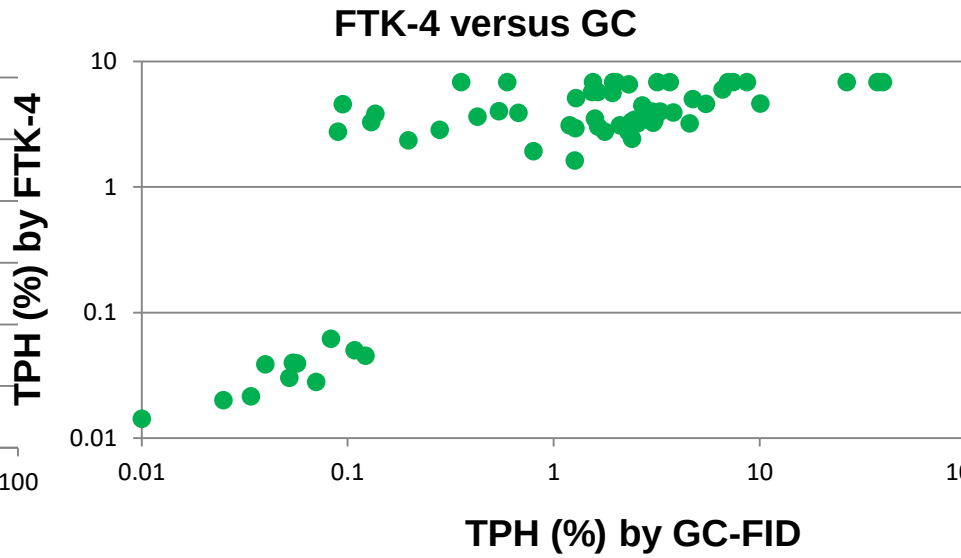
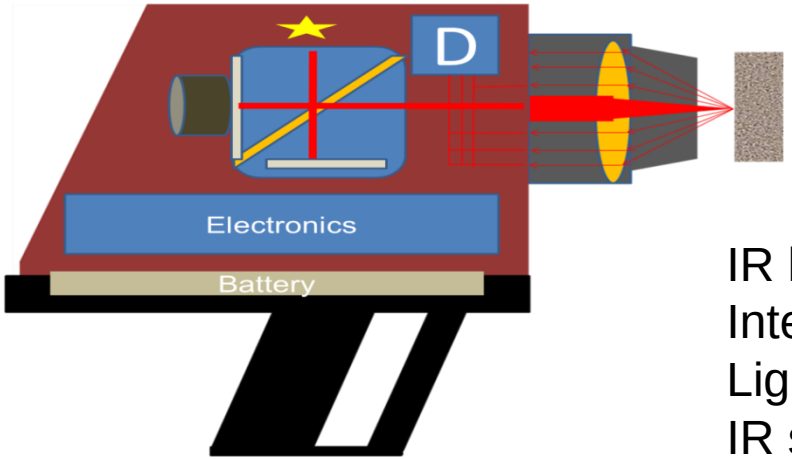




FTK-3 and 4 might be able to use in field settings after proper calibration
FTK-6 showed non-detect for all samples due to matrix effects

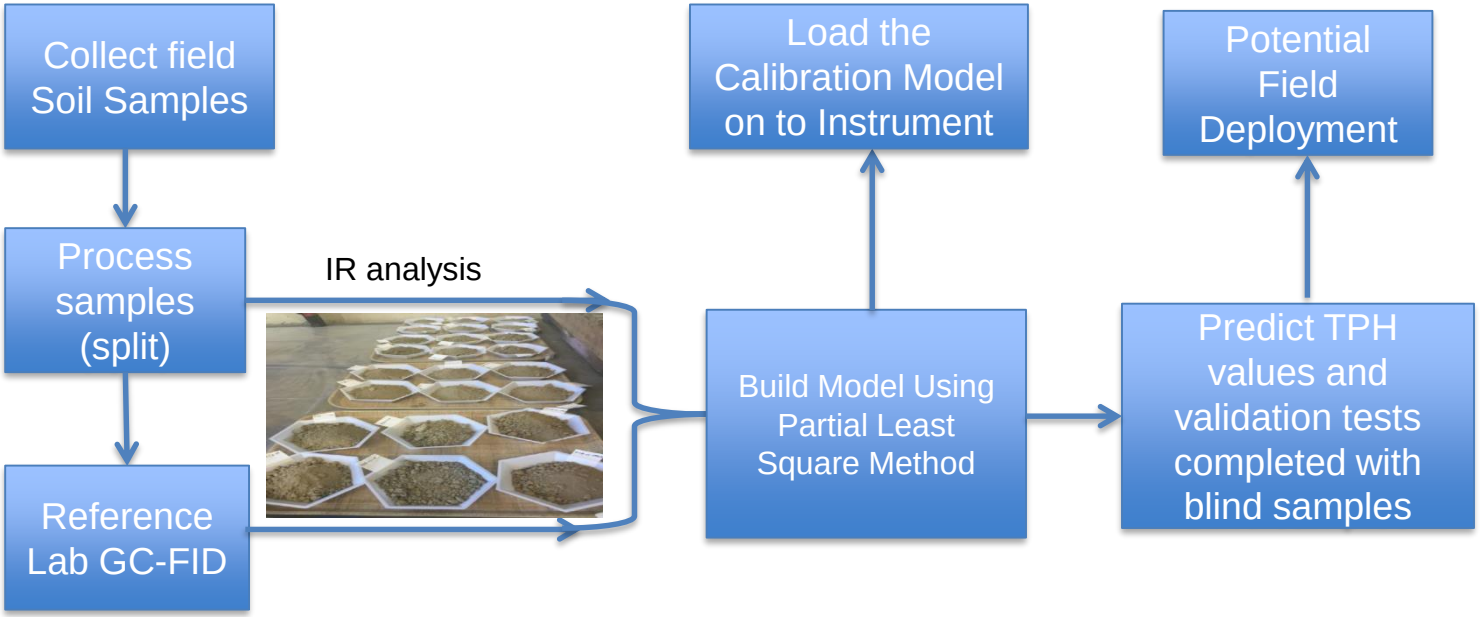
Handheld IR Instrument for non-destructive TPH measurement

- Portable handheld IR instrument
- Diffuse reflectance of IR light reflected from the sample
- The world's first handheld instrument for the direct measurement of TPH in soil
- User simply pulls the trigger for a 15 second reading of TPH (C_{10}-C_{36}) in mg/kg



IR light is emitted
Interacts with the surface of the sample
Light is diffusely reflected back to detector
IR spectrum (readout) is produced

Field Pilot Approach



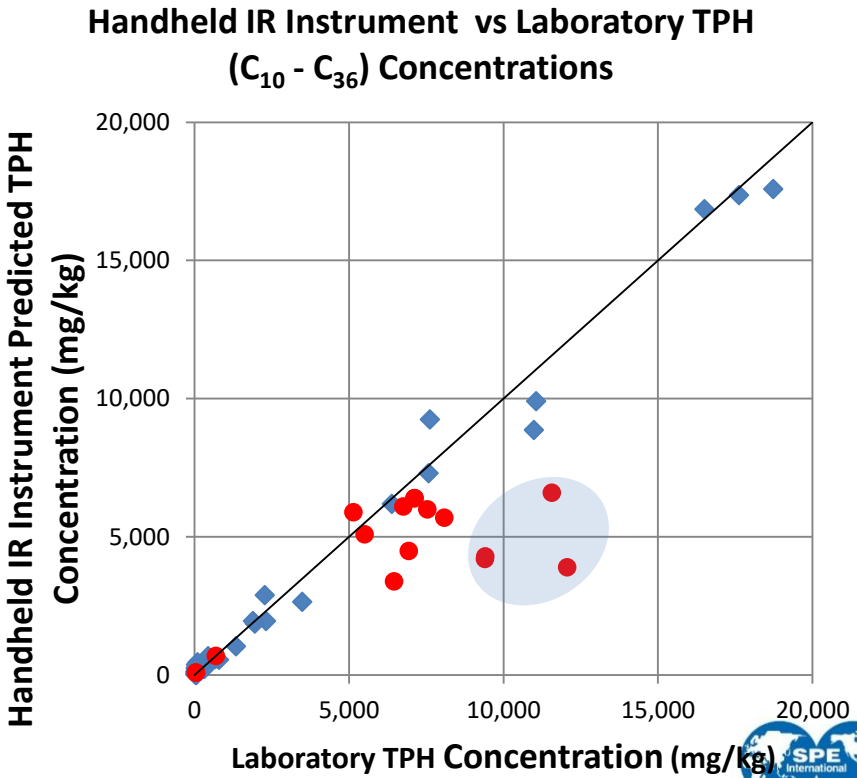
Pilot Studies Results Evaluation- Minas Field

Calibration model completed with 111 soil samples from Minas field at TPH range 0-120,000 mg/kg

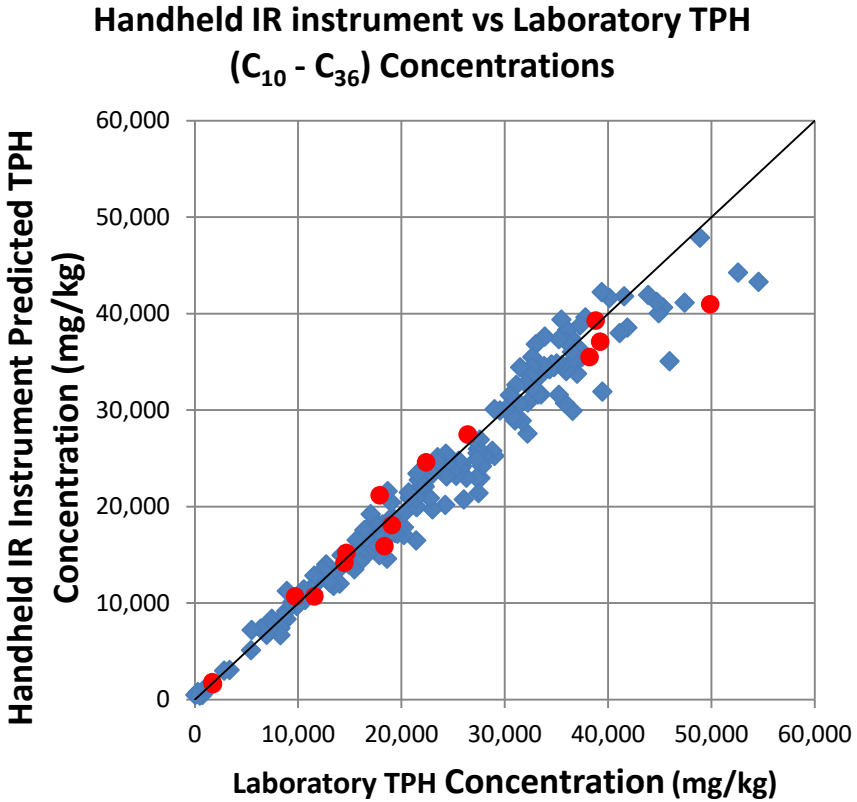
Using Minas calibration model vs. GCFID Data for validation Test
Validation Samples (•)& Calibration Samples (◆)

Outliner analysis- spectrum suggests the high clay contents of those samples

Detection limit of this model- 170 mg/kg



Pilots Studies Results Evaluation- Duri Field



Calibration model completed with 200 soil samples from Duri field at TPH range 0-50,000 mg/kg

Using Duri calibration model vs. GCFID Data for validation Test

Validation Samples (•)& Calibration Samples (◆)

Detection limit of this model- 380 mg/kg

Accuracy for various assay ranges for calibration samples for Duri field vs. Minas field

Duri site (limited calibration range up to 5%)

Assay Range (mg/kg TPH)	RMSECV (mg/kg TPH)	Relative Standard Deviation* (%)
0 - 5,000	376	n/a
5,000 – 15,000	930	≤ 19
15,000 – 20,000	1,390	≤ 9
20,000 – 30,000	2,107	≤ 11
30,000 – 50,000	2,815	≤ 9

Minas (wide range of calibration range up to 12%)

Assay Ranges (mg/kg TPH)	RMSECV mg/kg TPH	Correlation Coefficients (r^2)
0 - 3,000	170	0.92
3,000 - 5,000	184	0.96
5,000 - 15,000	410	0.98
15,000 - 30,000	803	0.99
30,000 - 120,000	2,375	0.99

RMSECV: Root-mean-square Error of Cross-Validation

Summary

- Portable handheld IR Instrument will enable rapid and accurate delineation of CPI sites & allows real time process monitoring for different remediation technologies
  - **Significant time reductions**
    - Real-time process monitoring
    - Rapid, field based testing
    - Improve data density for site assessment
    - Less waiting time for soil movement
  - **Improved Safety**
    - Prevents worker exposure and generation of waste by eliminating the use of solvents (used in the lab and in other field test methods)

Acknowledgements

The authors gratefully acknowledge the support and discussion from Ziltek Pty. Ltd and ALS lab in Bogor, Indonesia for deployment of Handheld IR Instrument