

Total soil carbon assessment using laser-induced breakdown spectroscopy (LIBS)

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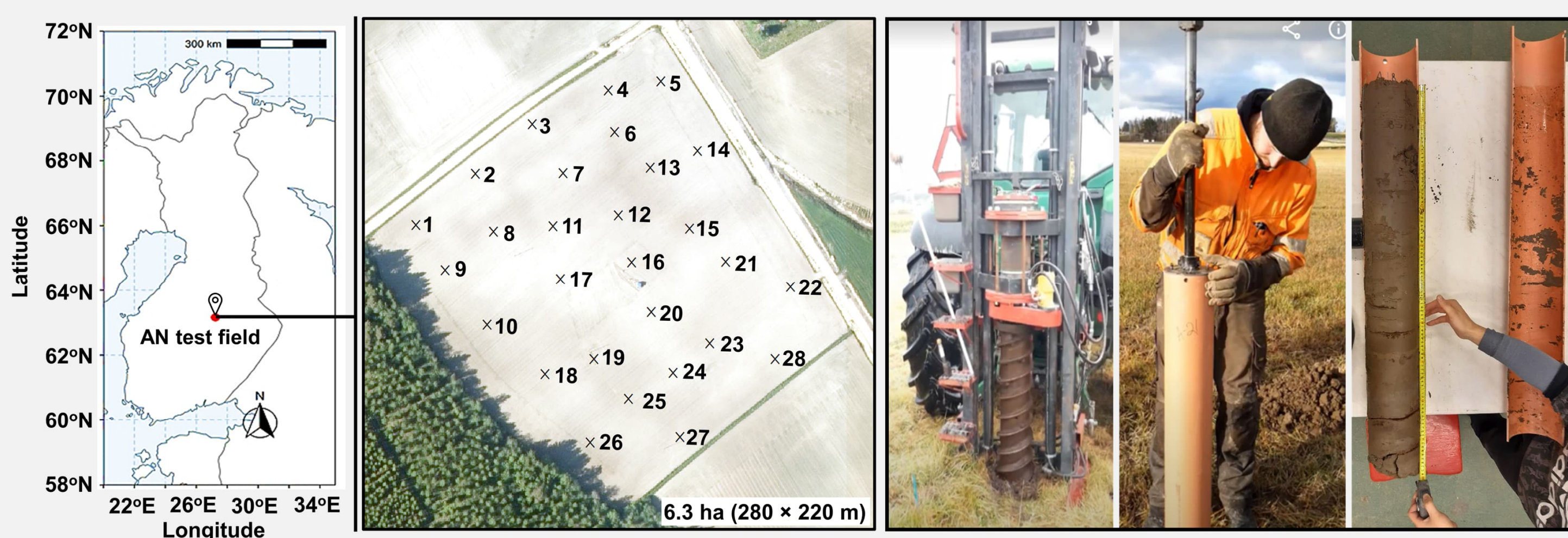
Carbon-LIBS
Tampere University

Introduction

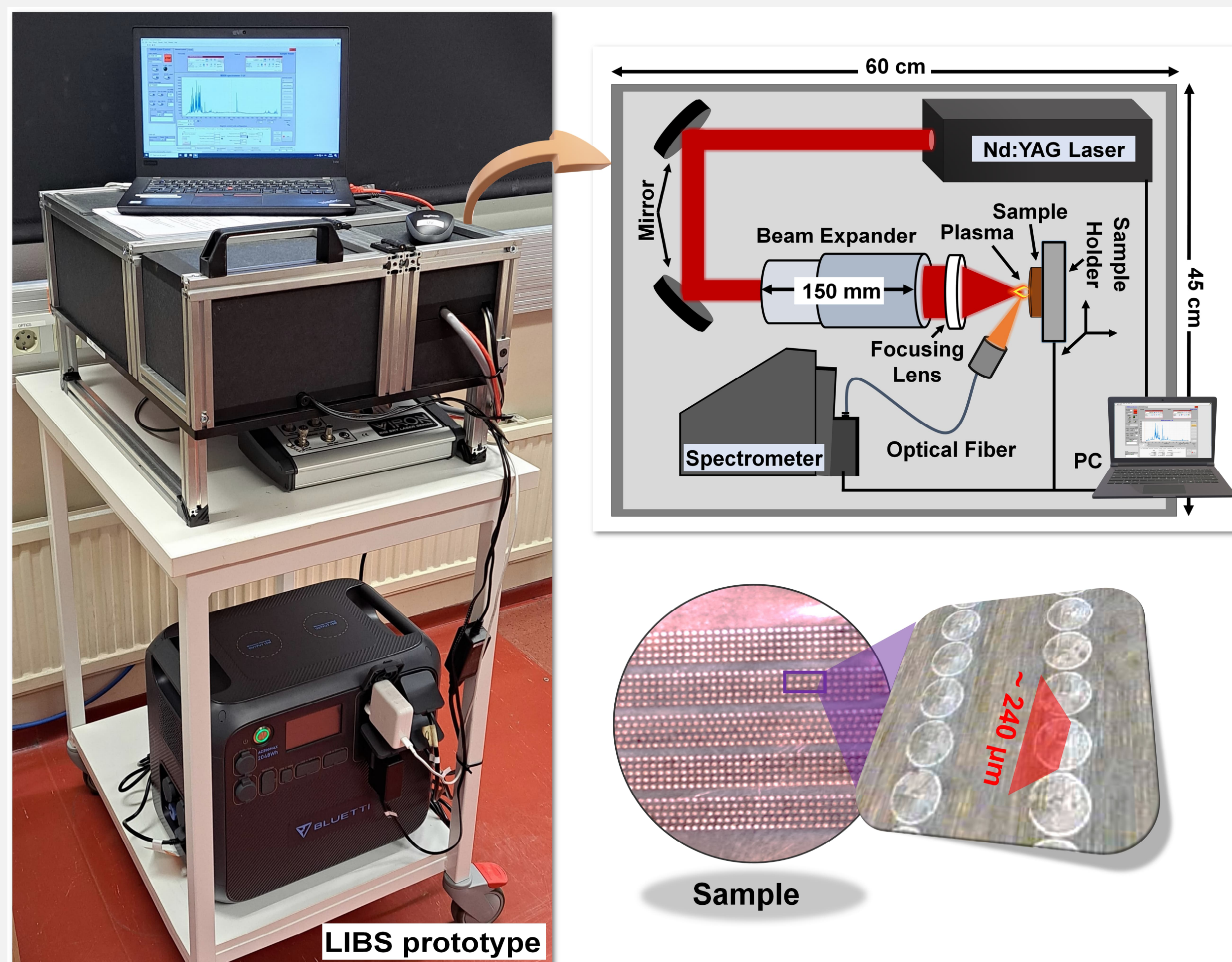
- Carbon storage in soil plays a significant role in regulating global climate.
- In order to understand and control carbon cycle, extensive and rapid monitoring of soil matrices is necessary.
- LIBS offers multiple advantages over other soil carbon measurement techniques, such as speed, portability, multi-element analysis, etc.
- We have developed and tested a compact, robust, and field-capable LIBS device for total soil carbon (TSC) assessment. It is ready for field use.
- Dry combustion (LECO) measurements were used as the reference for carbon content calibration.

Materials and Methods

Soil Sampling (depth up to 1 m)

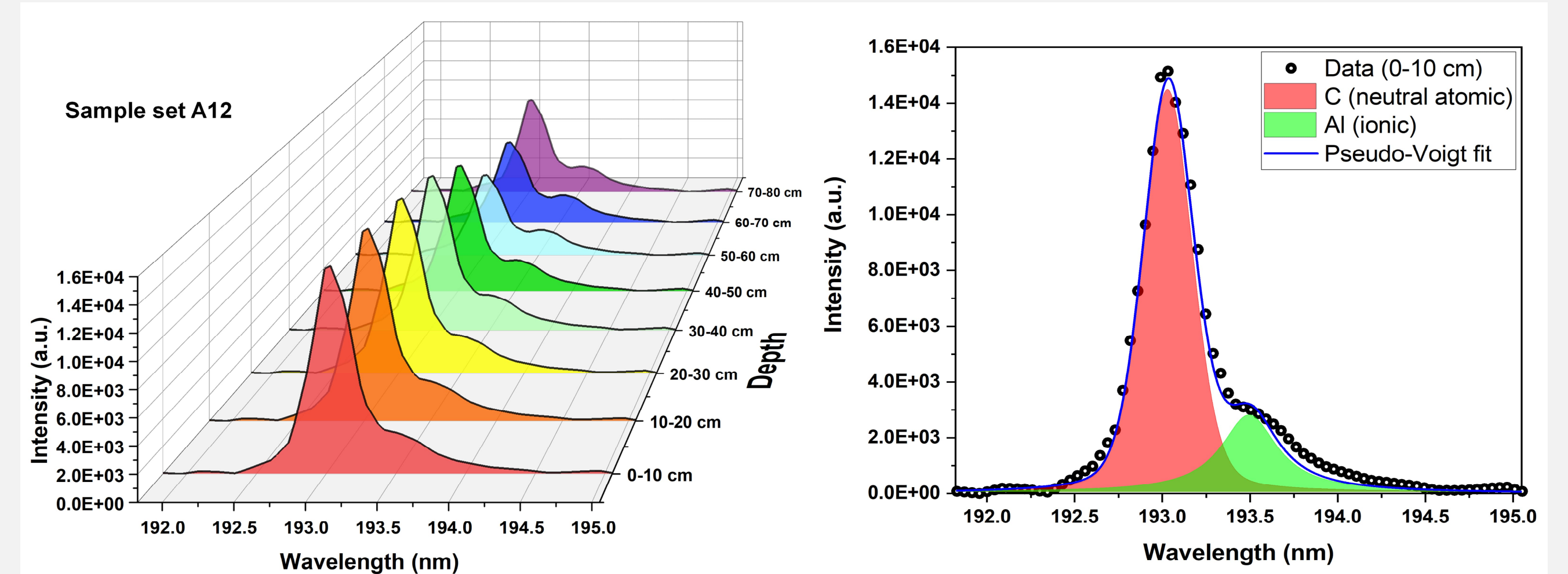


LIBS field-capable device

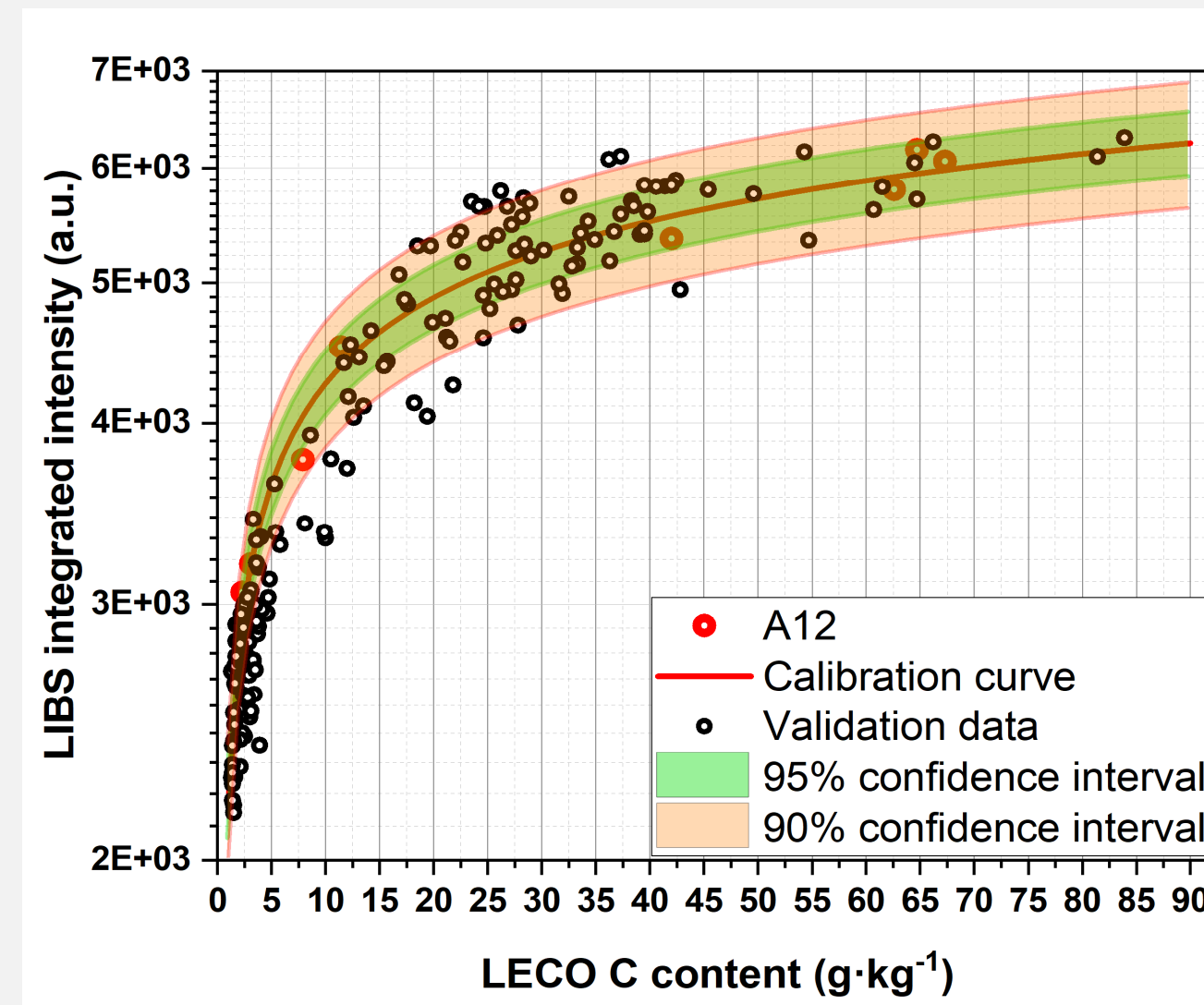


Results

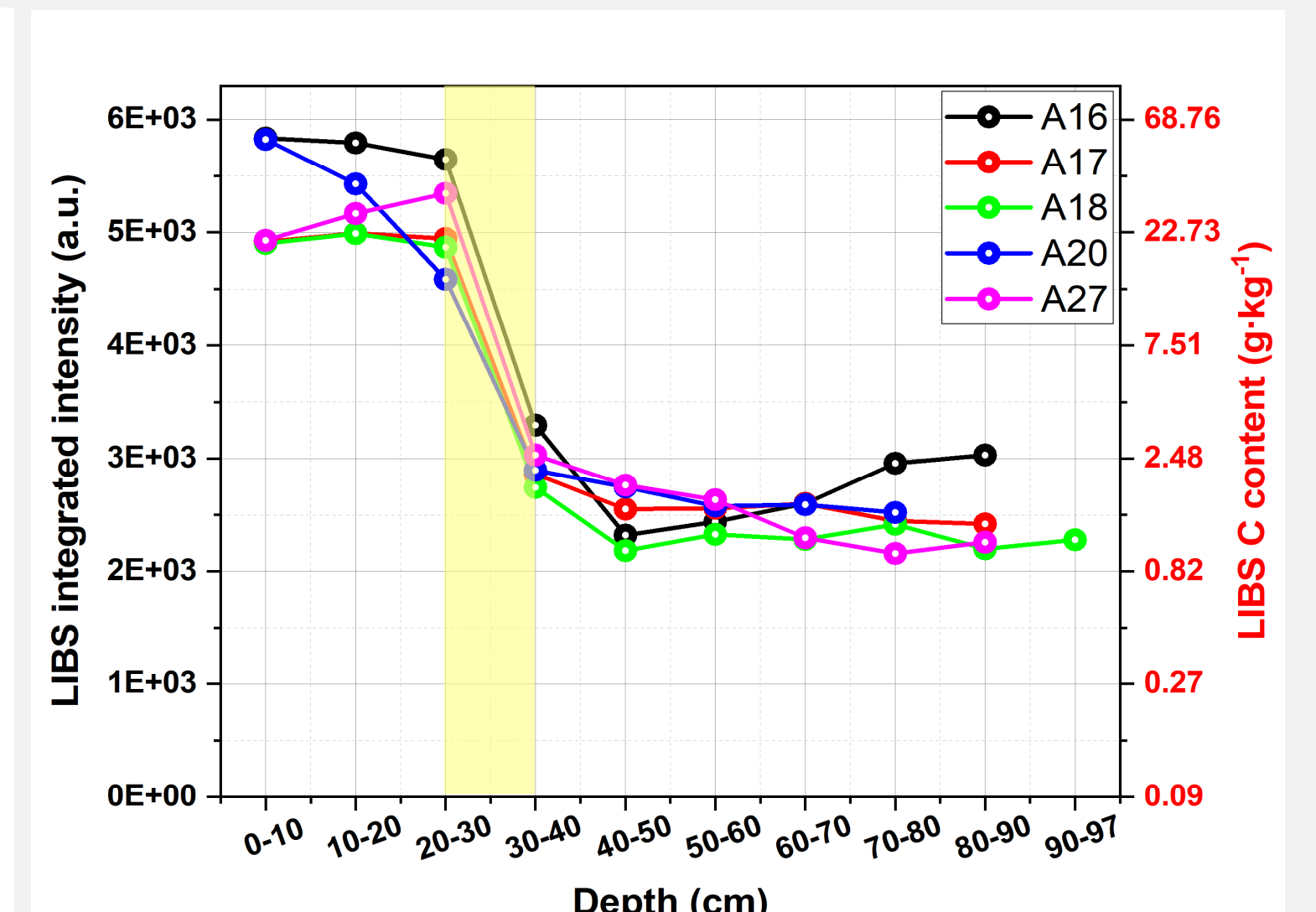
Carbon spectral line at 193.1 nm



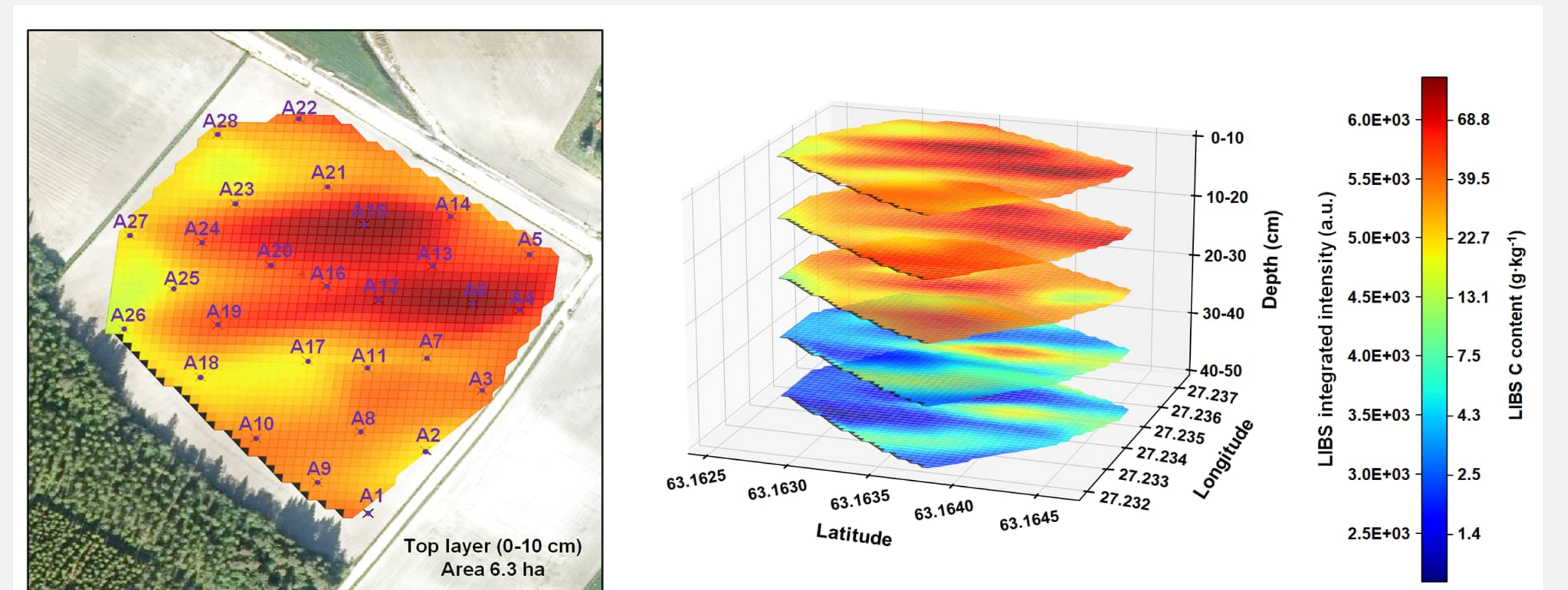
Calibration model



Depth-wise variation



Spatial variation



Conclusions

- A field-capable LIBS device was developed for measuring TSC.
- A calibration model was presented based on limited and randomly chosen sample set for TSC quantification and validated using additional samples.
- The model was found robust in the utilization of fresh samples of similar soil types collected from two completely different fields.
- Significant inter- & intra-layer variation in TSC content was observed.
- The global relative uncertainty in LIBS results was found to be $\pm 10\%$.
- LIBS measurement time was only about one minute per sample.

References

- (1) G. S. Senesi, *et al.*, *Analytica Chimica Acta* 938 (2016) 7-17.
- (2) P. R. Villas-Boas, *et al.*, *European Journal of Soil Science* 71 (2020) 789-804.
- (3) M. Z. Martin, *et al.*, *Soil Science Society of America Journal* 74 (2010) 87-93.

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