

LOCK-INSPECTOR:

'A Dedicated **Subsurface Inspection Radar System** for Increasing Inland Waterway Infrastructure Resilience'



Fig. 1 – We seek to image lock wall substructure in 2D & 3D.

(0.) Key Project Characteristics:

- ❑ Development of a pioneering Subsurface Inspection Radar (SIR) system to facilitate comprehensive & efficient **Lock Wall Subsurface Inspection (LWSSI)** for improving targeted maintenance of EU Inland Waterways Infrastructure.
- ❑ A key task of **EU-Horizon Europe Project 'CRISTAL'** (Grant no. 101069838), with technology & knowledge transfer from SIR in Rail (Grant no. 835567) (2019).

(1.) Challenges Facing LWSSI Technology:

- ❑ Concealed **void-washout defect growth** behind lock walls. Early identification critical to avoid structural failure and minimise disruption from lock closures.
- ❑ LWSSI-SIR requires: (i) **maximal wall coverage** [1] (ii) **automation**; (iii) **3D visuals**.

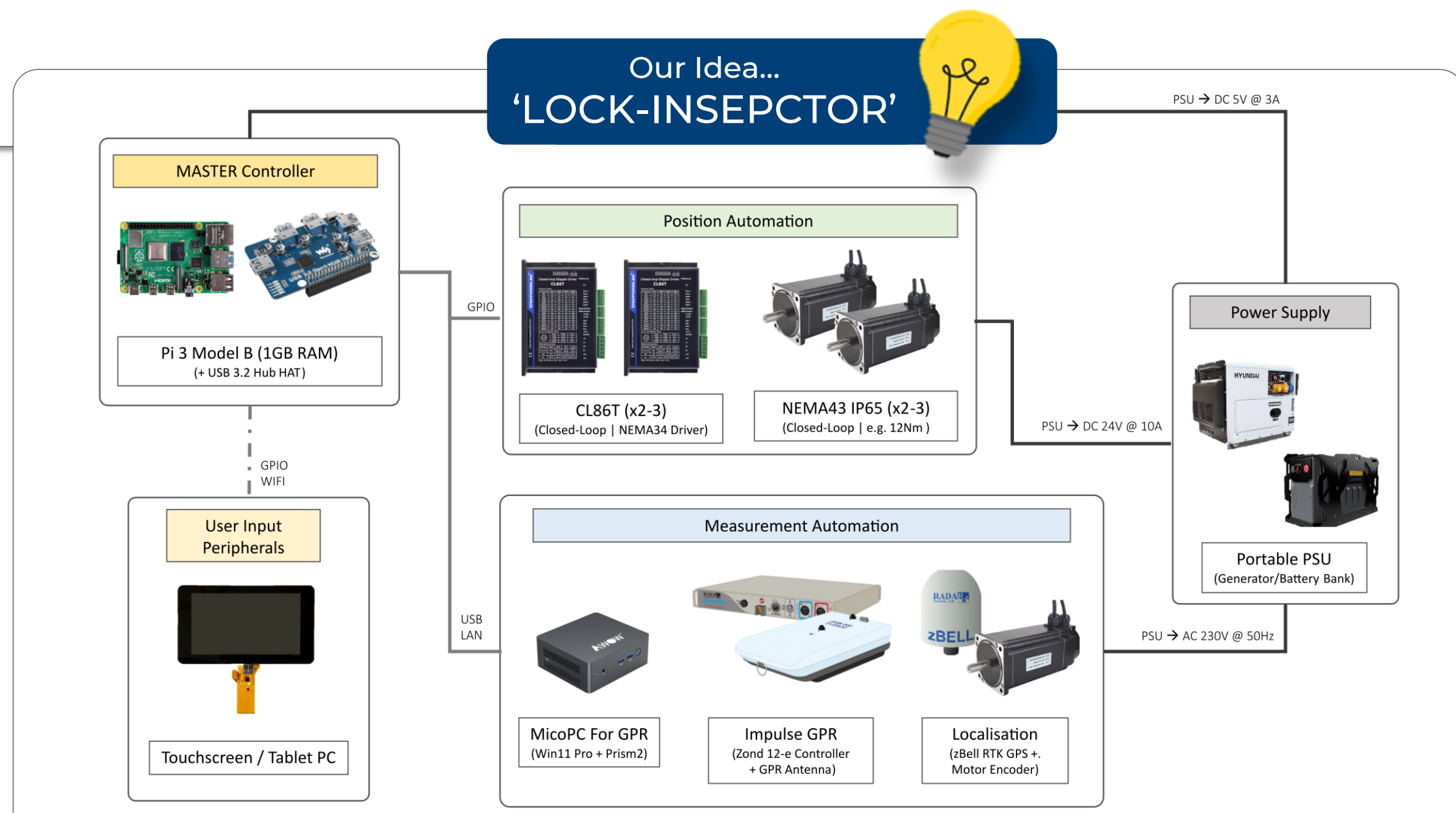


Fig.2 – LOCK-INSPECTOR subsystems include (i) Power Supply; (ii) Positioning & (iii) Measurement Automation. A Pi3 provides central control.

(2.) Capability Study – Toul Lock (France):

- ❑ Rebar **resonance artifacts** can limit SIR penetration.
- ❑ Estimation **challenges** for SIR penetration in a lock:
 - (i) undocumented rebar geometry → **onsite SIR scan**.
 - (ii) vertical wall inaccessible → **prelim. 'lock-top' scan**.
- ❑ We seek rebar **diameter, pitch and first-layer recess depth** behind vertical wall using a Proceq GP8000 rebar profiler.

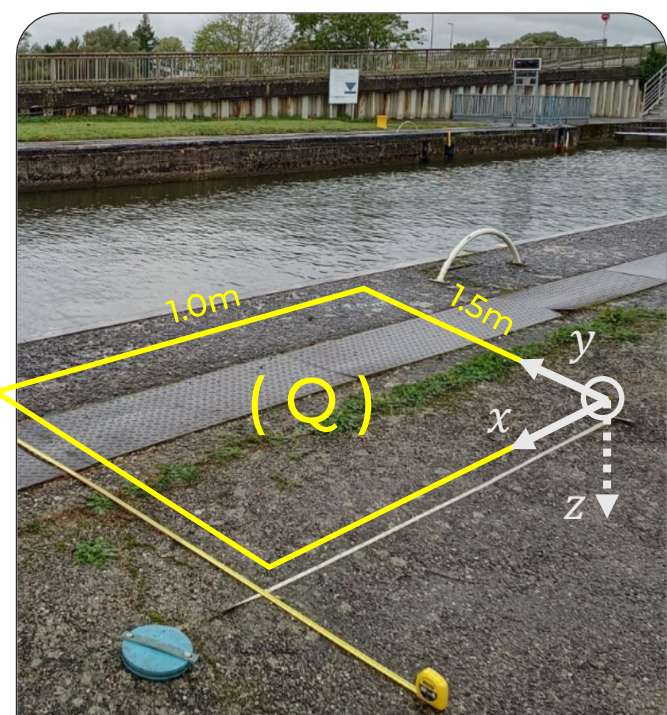


Fig.3 – Our survey quadrant on lock top.

(3.) Findings & Discussion:

- ❑ We can assume rebar profiles are representative of a 'typical' EU lock | **Diameter** ≈ 10mm | **Pitch** ≈ 150mm | **Recess** ≈ 30mm.
- ❑ Results also suggest our UK facility test-wall is a **viable lock wall analogue** | Diameter ≈ 30mm | Pitch ≈ 100mm | Recess ≈ 20mm.

(4.) Research Outlook:

- ❑ Optimisation & integration of 3D visualisation workflow [2].
- ❑ Characterisation study of void-washout defect profile with (i) no rebar; (ii) lock-like rebar; (iii) rebar suppression [3] applied.
- ❑ SIR interfacing with CRISTAL Digital Twin Lock (DTL).

Fig.6 – We believe combining the finalised DTL with Augmented Reality hardware may soon allow onsite surveyors to **see through lock walls...**

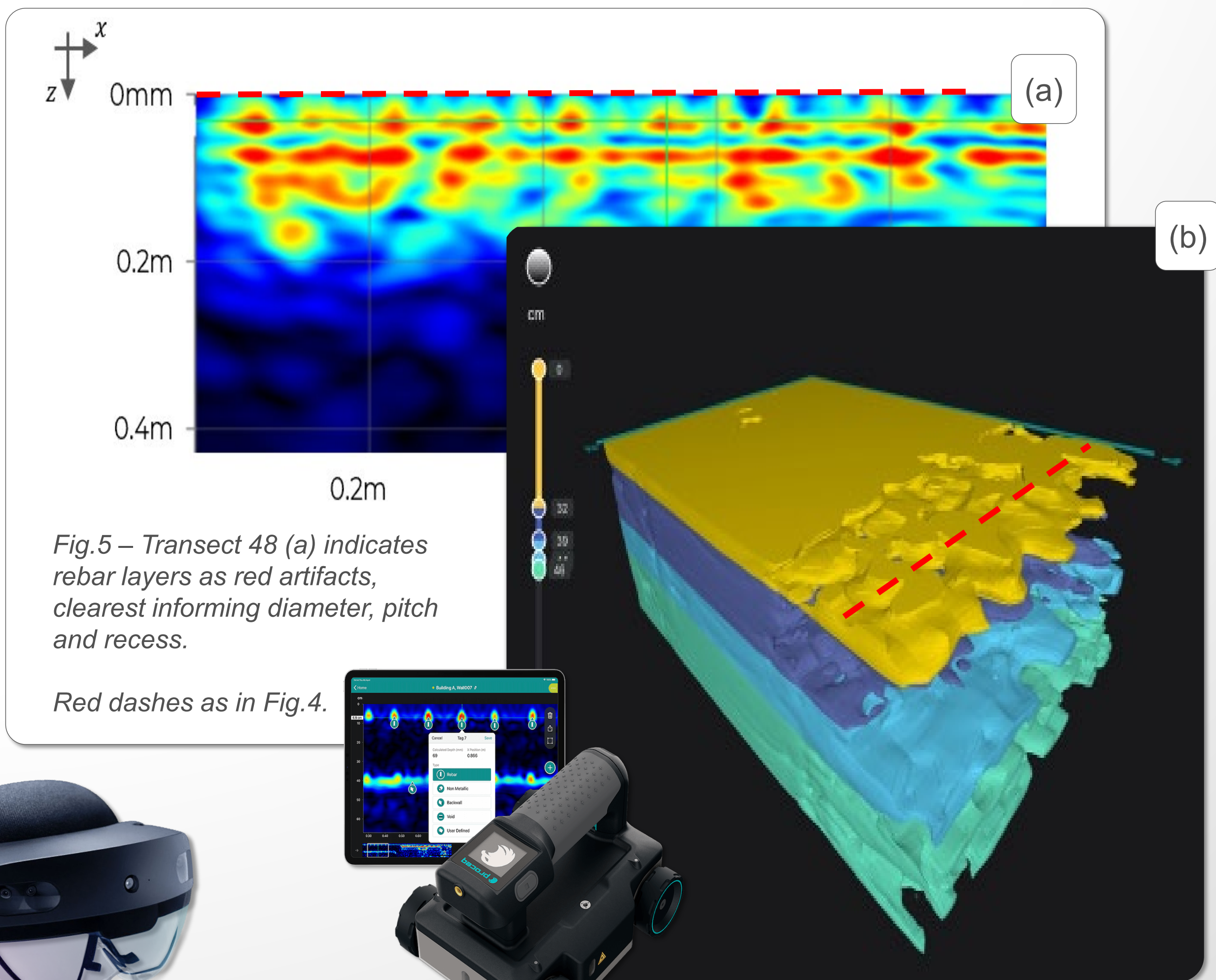


Fig.5 – Transect 48 (a) indicates rebar layers as red artifacts, clearest informing diameter, pitch and recess.

Red dashes as in Fig.4.

Fig.5 cont. – Proceq GP8000 SIR system (left) returns estimated 3D feature profiles (b). Yellow volume denotes rebar artifacts nearest lock top.

1. Seiffert, A., & Bodefeld, J. (2023). *Innovative methods for the inspection of hydraulic structures*. In Life-Cycle of Structures and Infrastructure Systems (pp. 548-554). CRC Press.
2. McDonald, T., et al. (2022). *Developments in 3D Visualisation of the Rail Tunnel Subsurface for Inspection and Monitoring*. Applied Sciences, 12(22), 11310.
3. Wang, Z., et al. (2023). *Unsupervised learning method for rebar signal suppression and defect signal reconstruction and detection in ground penetrating radar images*. Measurement, 211, 112652.



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