6SCAN

MT in Civil Engineering

Karl V. Valter | June 4th
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Compact muon source combined with the GScan detector system for tomographic imaging

GSCAN
UNIVERSITY OF TARTU Institute of Physics
Karl Vilhelm Valter Supervisors: Madis Kiisk, Siiri Salupere

EPACE
Funded by the European Union

Atmospheric Muon Flux

~1 μ per cm² in 1 min

Long measurement time

MU-RAY TECH Artificial Muon Source

Laser Plasma Accelerator

Electron Beam

Converter

Muon Beam

>1000 μ per cm² in 1 min

Short measurement time

μ

Muons are elementary particles
Same charge as electrons
200x heavier than electrons
Can penetrate meters of material
Less damaging to tissue than X-ray radiation

System of particle track detectors recording the trajectories of incoming and outgoing muons.

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Scattering

Absorption

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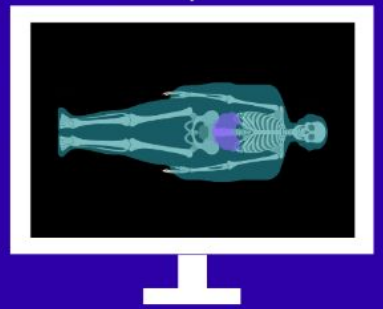
Measured Trajectory

Scattering Angle

Expected Trajectory

Raw data from detectors filtered and processed into trajectories

Reconstruction algorithm produces a 3D model of the volume of interest



GScan in Civil Engineering

- **Team:** 50+ Full Time Employees
- **MT commercial deployments:**
  - 12 bridges
  - 2 tunnels
  - 2 legacy submarine nuclear reactors
- **Countries:**
  - In-service structures — EE, UK, NL, JP
  - Specimens — DE, CH, FR
  - Discussions - FI, NO, AT, UAE, DE, CA
- **Revenue 2025:** €1.6M + grants €1.9M
- **Revenue 2026 goal:** €3.2M + grants €2M
- **Revenue 2027 goal:** €6M

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Key Developments (past 2 years)

- Developed fully integrated deployment ready detectors
- Production of detector fleet
  - L-size (1.7 m^2) and XL-size (2.1 m^2)
- Reconstruction algorithms (analytical and ML)
- UI interface for operation and results
- Automated reconstruction pipeline
- Object detection ML models
- Detector deployment by external partners
- Partially automated defect analysis
- Method calibration and validation (on going)

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Example: Llanrhystud Bridge

UK's First In-Service Structure to be Inspected by Cutting-Edge Muon Tomography in October 2025

1.2 meters thick concrete
4 XL detectors
16 days of acquisition

“We are very happy with the results GScan have provided; the MFT successfully located all the PT apparatus and steel reinforcement of the area scanned. We are now in a much better position to manage the structure.”
- Bob Humphreys Principal Engineer at YGC

Particle Detector Installation

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Reconstruction and Annotation

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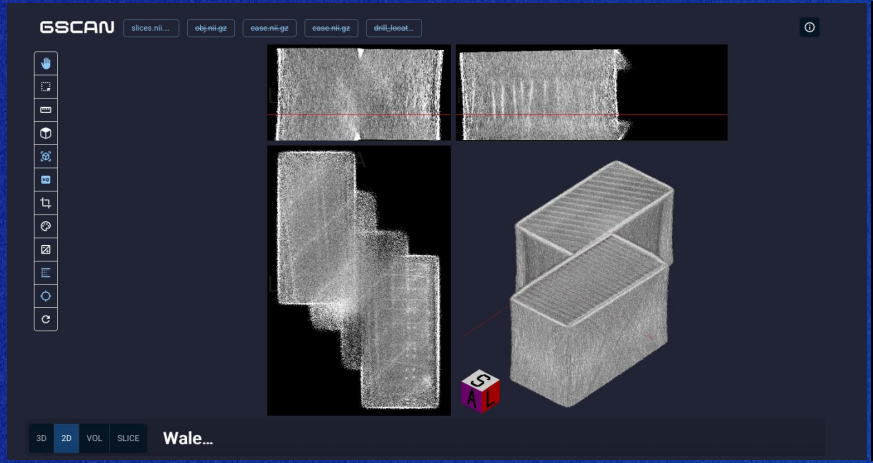

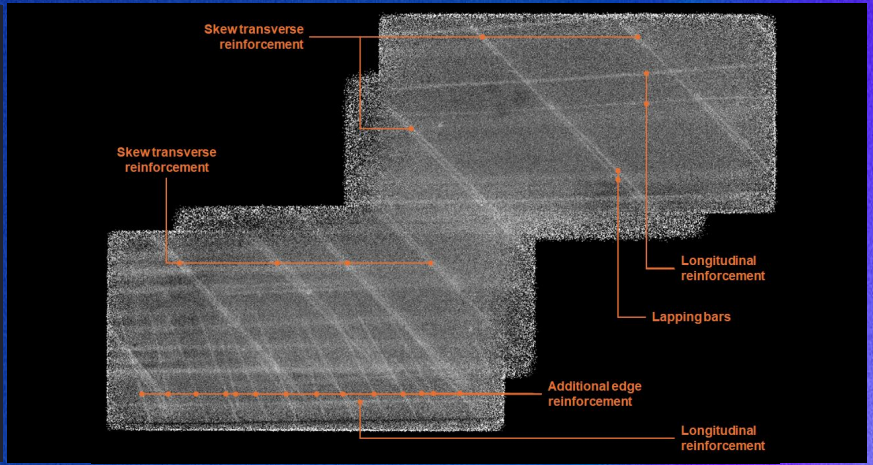

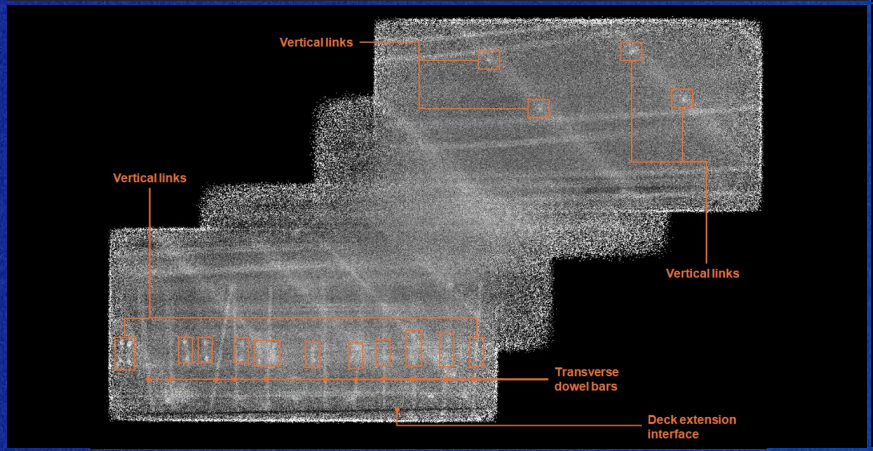

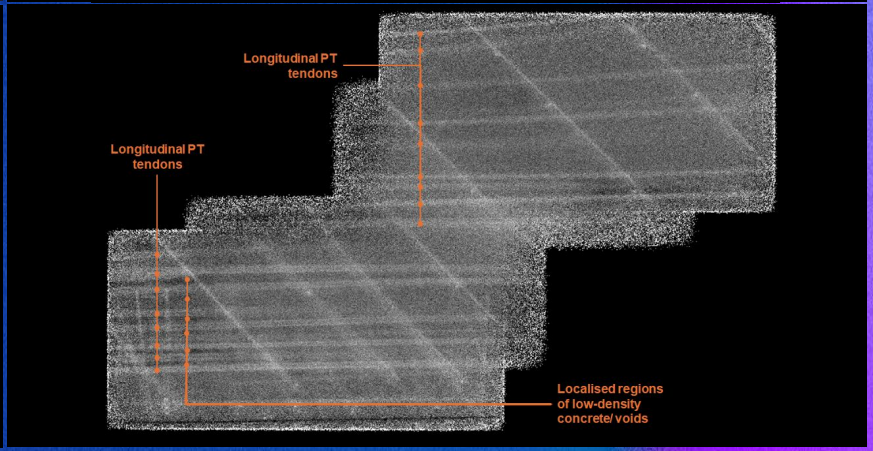

Object Detection Model for Steel Rebar

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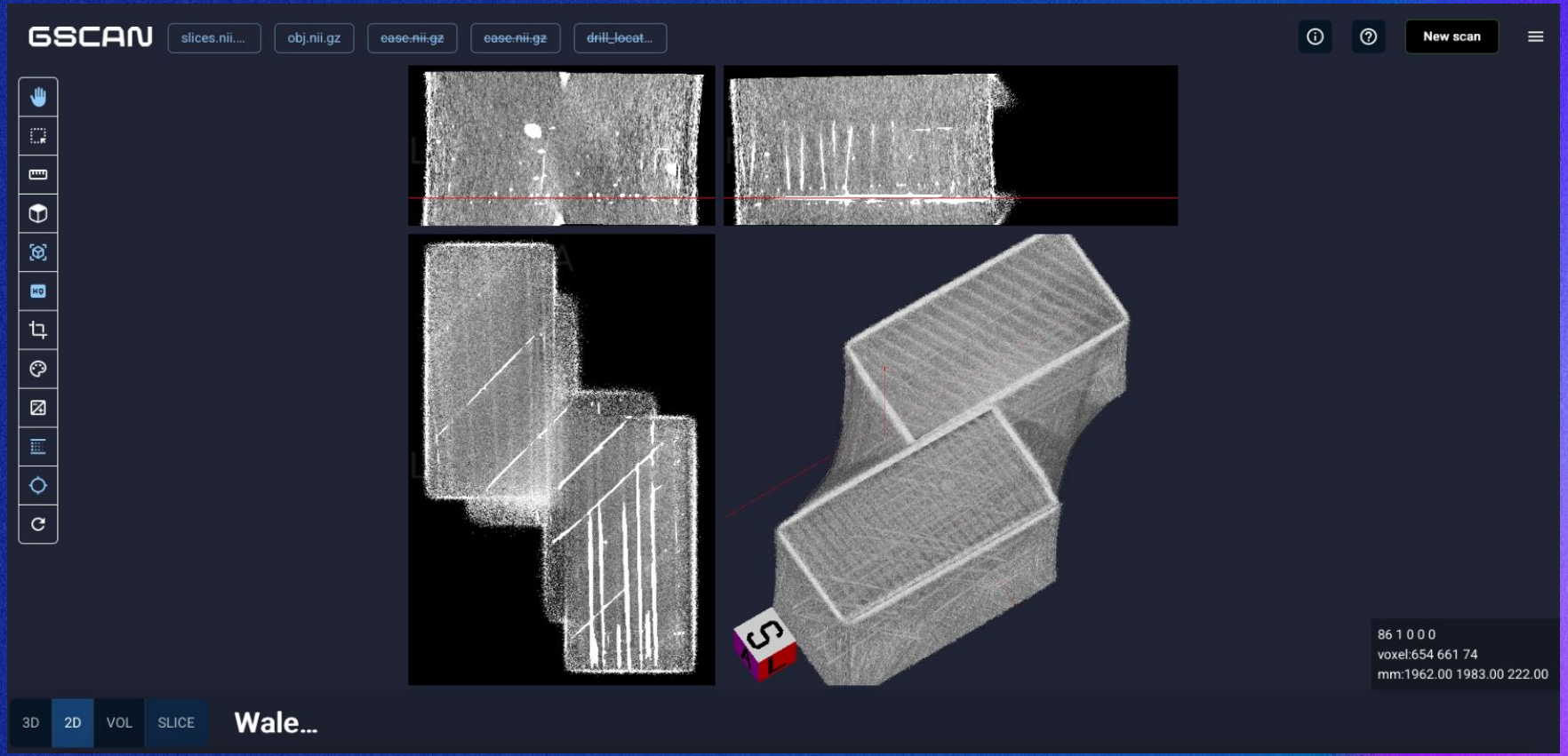

Object Detection

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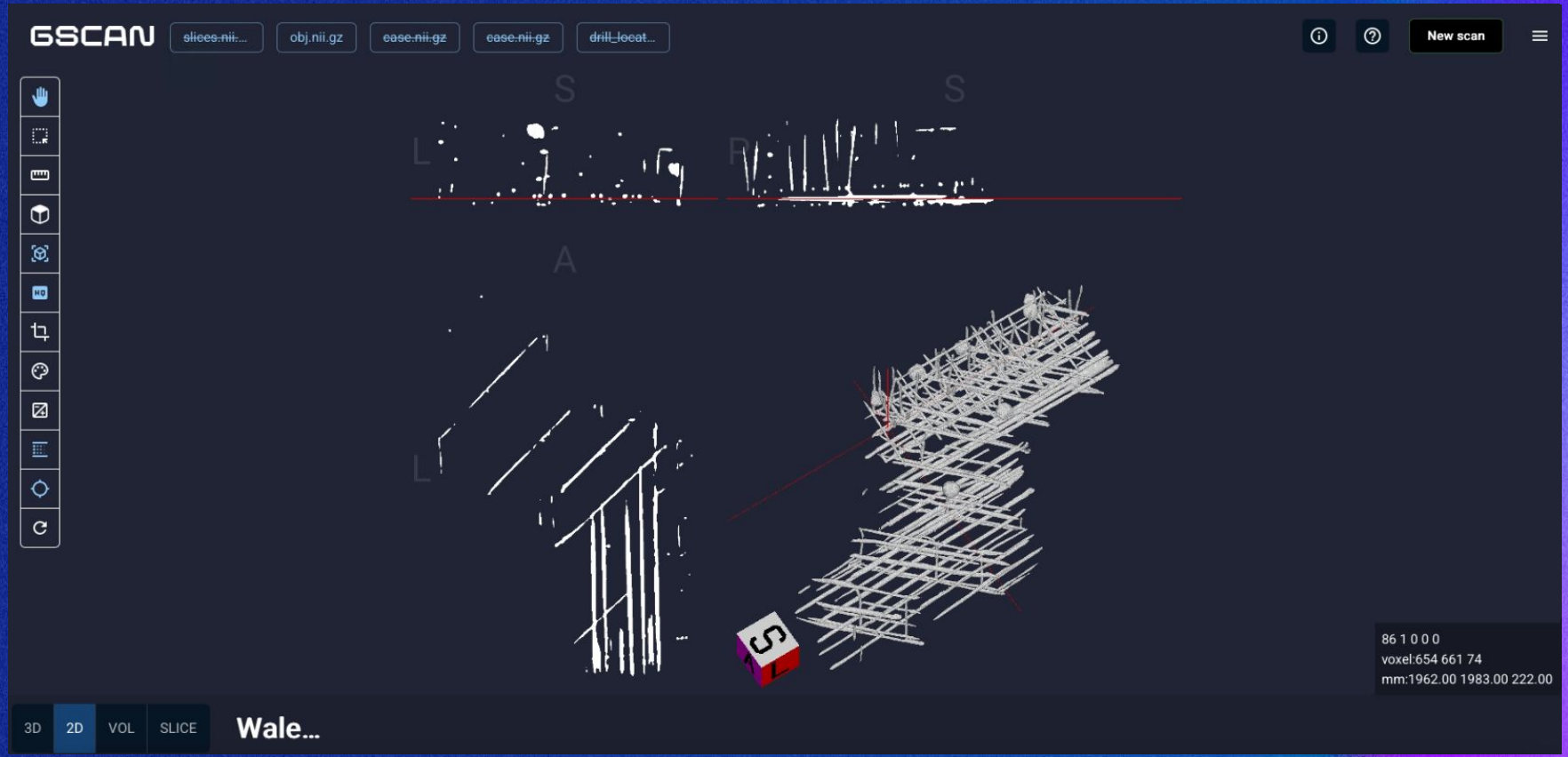

Diameter Calibration +-2.1 mm

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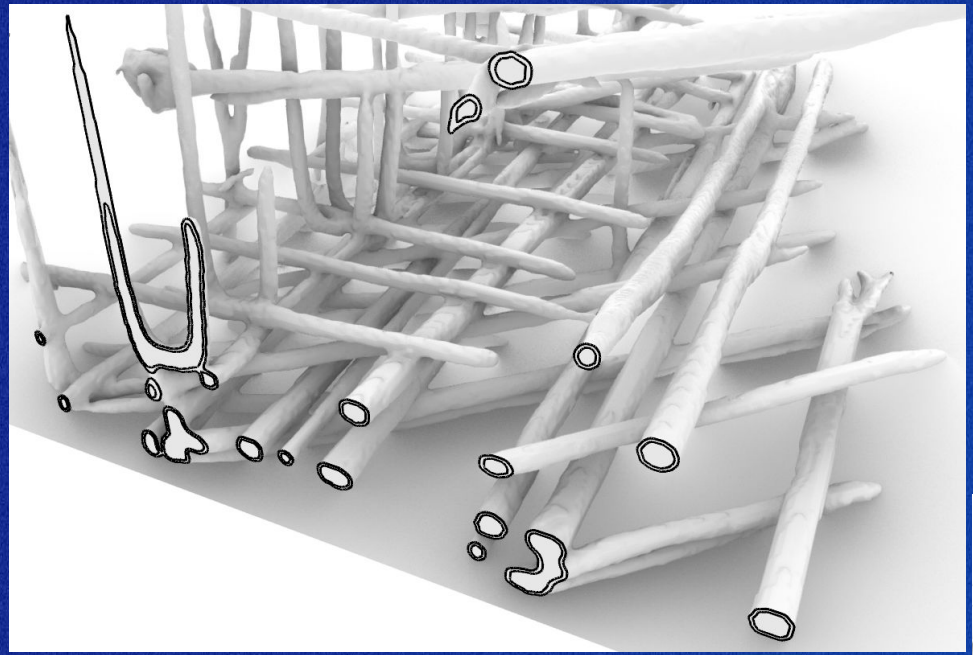

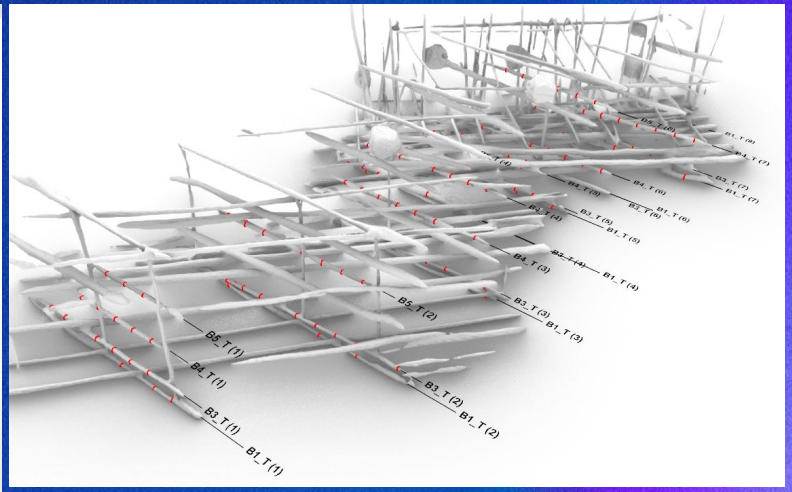

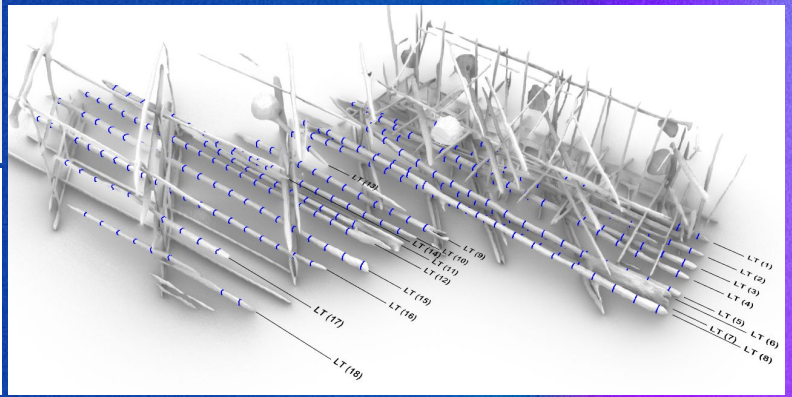

Type	Direction	Location	$\Phi_{ex.}$[1] (mm)	$A_{ex.}$[1] (mm²)	$A_{avg.}$[2] (mm²)	$\Phi_{eq.}$[3] (mm)	$\Delta\Phi$[4] (mm)	Combined CSA[5] (mm²/m)
Reinforcement	Longitudinal	Top mat	16	201	159	14.2	-1.8	375
Reinforcement	Transverse	Top mat	16	201	233	17.2	1.2	728
Reinforcement	Longitudinal	Bottom mat	16	201	184	15.3	0.7	429
Reinforcement	Transverse	Bottom mat	16	201	258	18.1	2.1	1,227
Reinforcement	Vertical[6]	-	-	-	118	12.2	-	343[7]
Tendon	Longitudinal	-	29.2	670	635	28.4	0.8	-
Tendon	Transverse	-	-	-	681	29.4	-	-

Defect Detection

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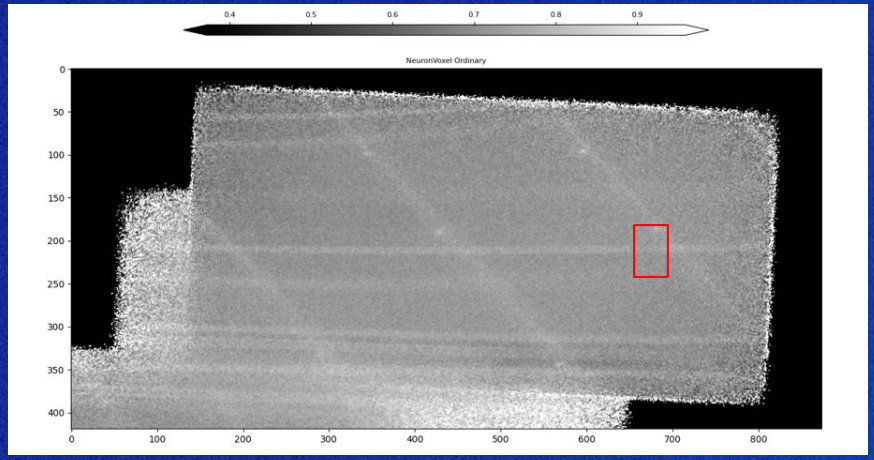

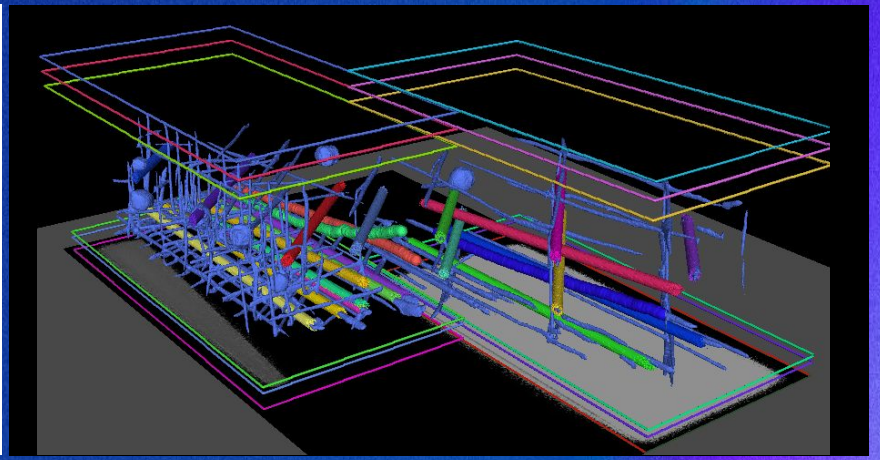

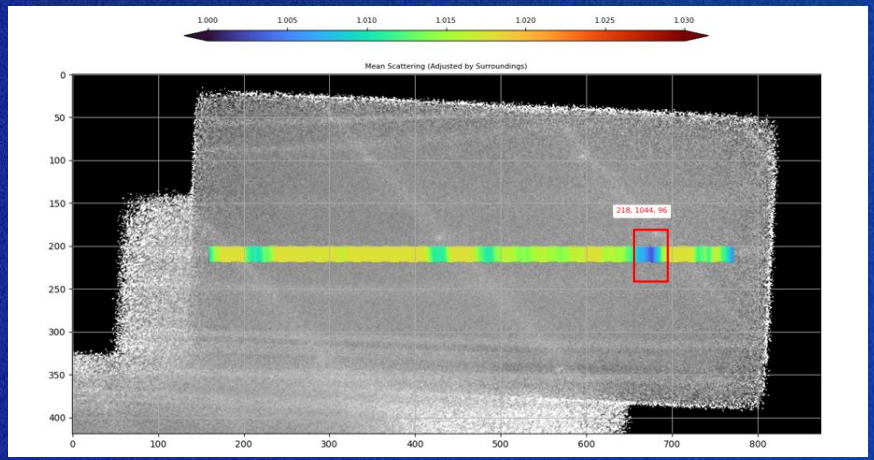

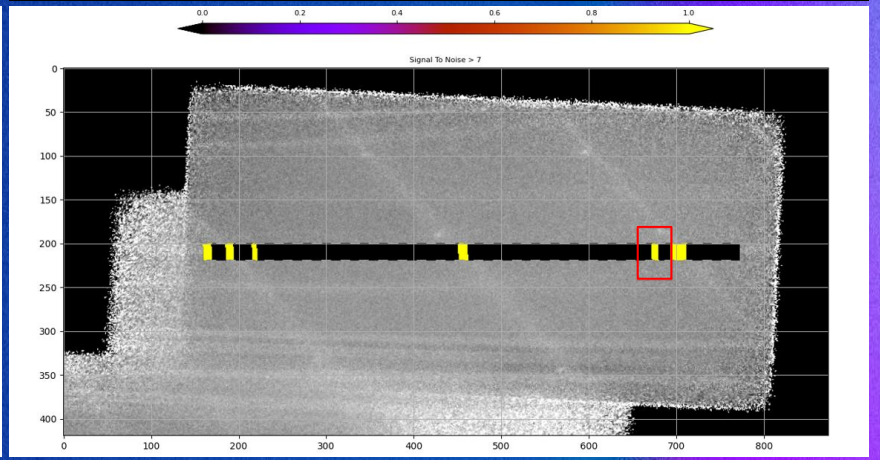

Tendon Exposures

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Confirmation of Concrete Voids

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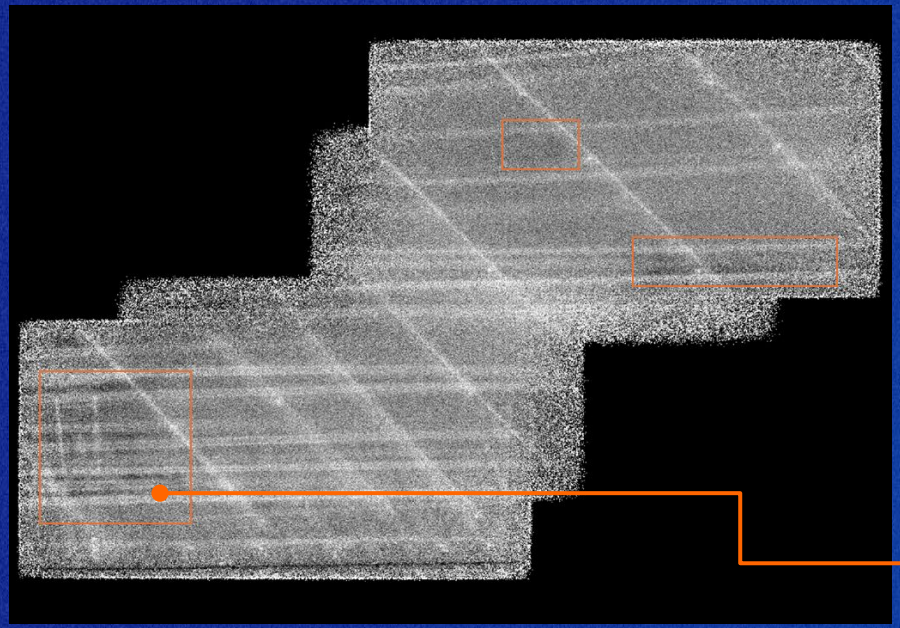
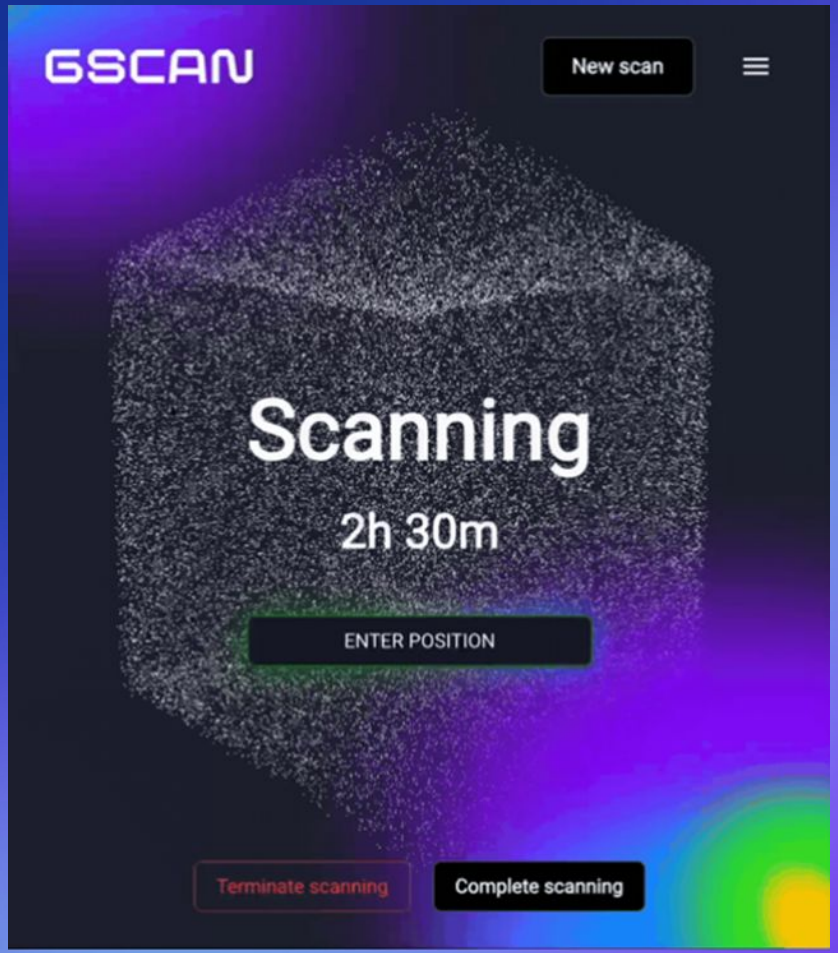


Thanks



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