Assessment of corrosion on rail axles

Dorothee Panggabean

WOLAXIM Seminar

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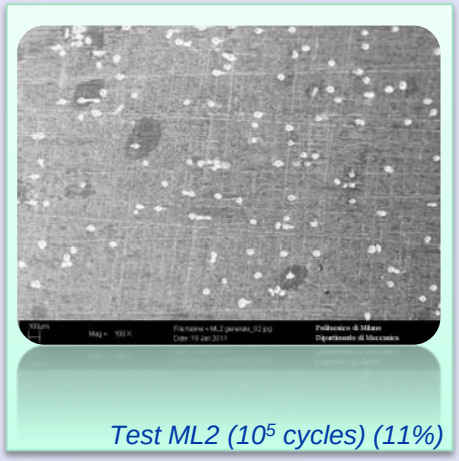
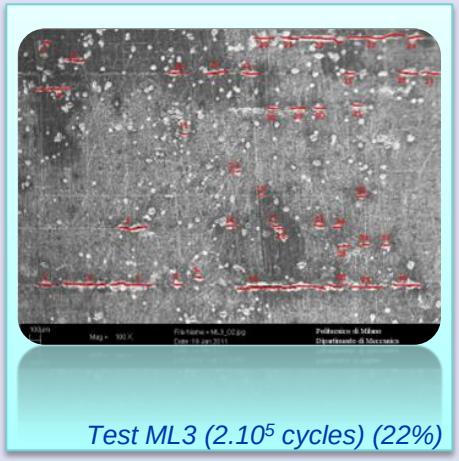
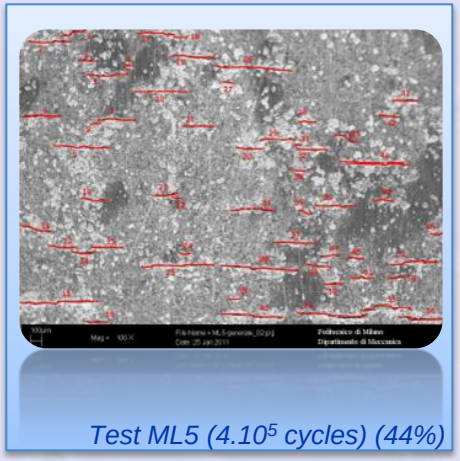
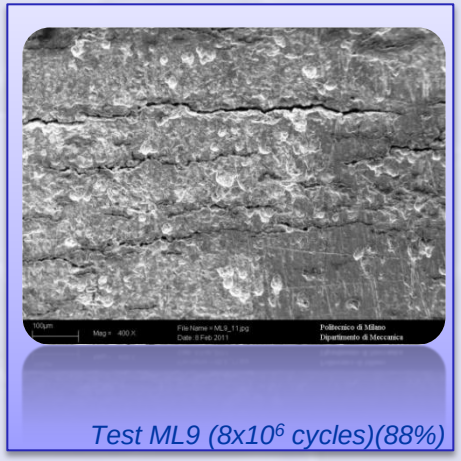
WOLAXIM Project

- FP7 Research for SME's project. SME Partners - Applied Inspection (UK), CGM (Italy), Diatek and RCP (Germany).
- RTDs TWI, Polimi and BAM
- LEs Lucchini UK and ATM (Italy)

- Possible developments identified
  - Better knowledge and detection of corrosion fatigue
  - Improved hollow axle inspection with non-rotating probe
  - Inspection of exposed axle surfaces of moving train
  - Improved axle life software

Corrosion Fatigue Crack Growth

- **Corrosion fatigue occurs in 4 stages**

Stage 1	Stage 2	Stage 3	Stage 4
 *Test ML2 (10^5 cycles) (11%)*	 *Test ML3 (2.10^5 cycles) (22%)*	 *Test ML5 (4.10^5 cycles) (44%)*	 *Test ML9 ($8x10^6$ cycles)(88%)*
Pitting only	**Formation of micro-cracks**	**Coalescence of micro-cracks (when depth exceeds 0.3mm)**	**Growth of macro-cracks detectable by conventional NDT techniques**

  - **Base assessment on these stages (ie no pit depth measurement)**
  - **Design instrument to measure**

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Selection of equipment

- Equipment requirement
  - Site operable rust removal
  - Portable microscope to obtain images
  - Stability on the surface
  - Automatic sentencing
  - Site deployable etc

Prototype design

- Decide to use USB Microscope as basis for data collection
  - Many varieties – selection made of 3 for testing
- Prototype design: need to be able to inspect curved areas (wheel seats) as well as flat part of the axle
  - Enable orientation of microscope in various direction
  - Enable lift off variations
- Can use some kind of scanner to go around the axle circumference
  - Enable free movement around the axle
  - Use of encoder to monitor the location of inspection

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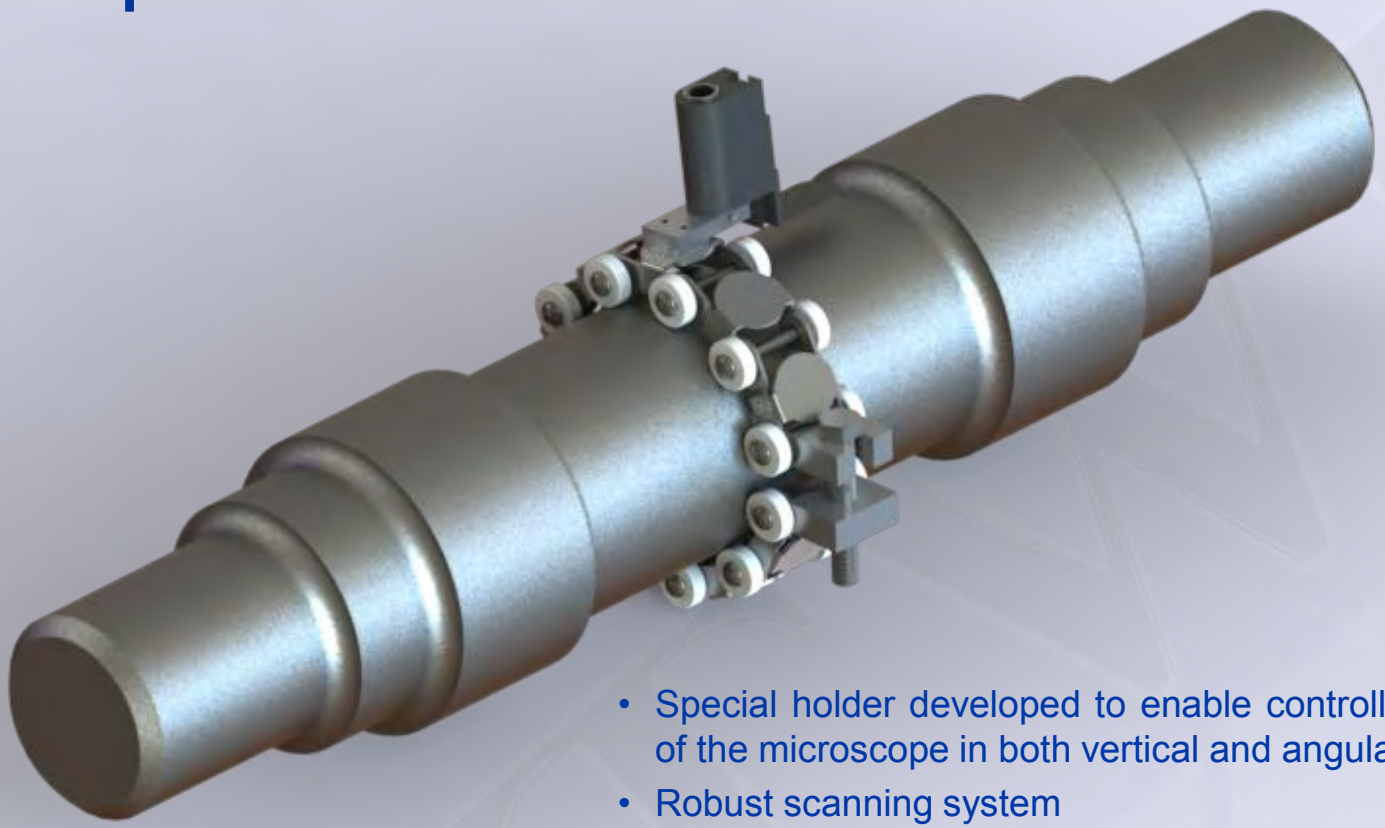
Prototype design

- **Microscope holder**



- Special holder developed to enable controlled movement of the microscope in both vertical and angular direction
- Robust scanning system
- Use of instrument around the axle circumference
- Battery operated (laptop)

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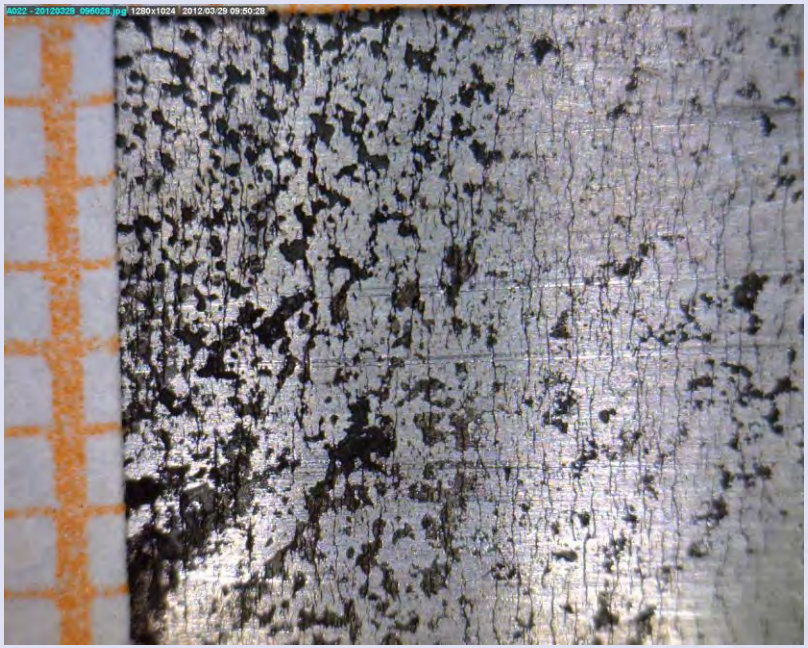
Tests with selected equipment on axles



Picture taken at Polimi for a sample of 2e6 cycles

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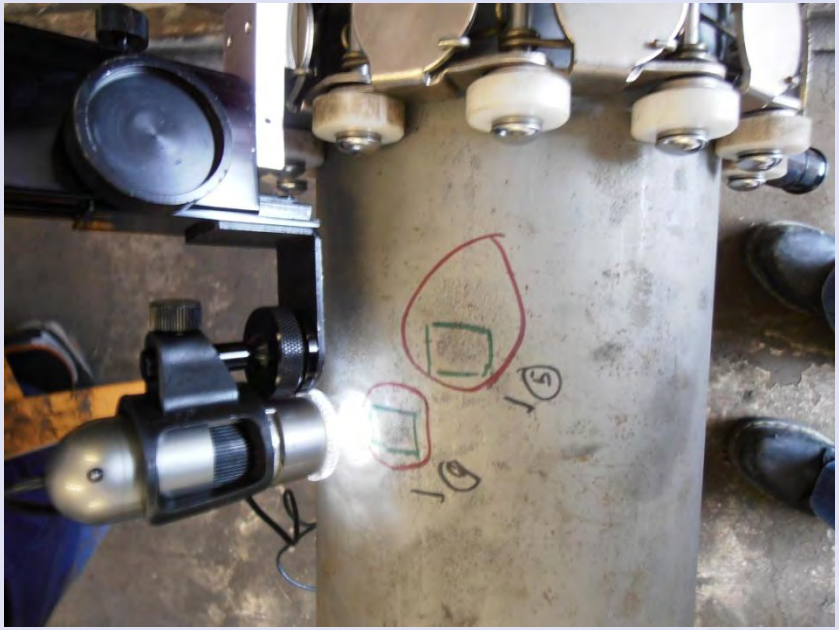
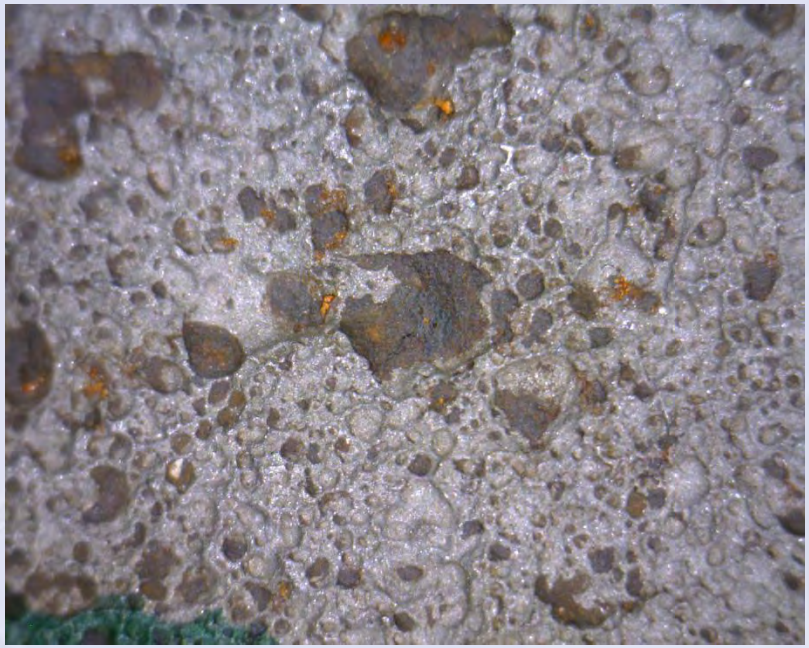
Field trials





Pictures taken in Hamilton of inspected areas on axle (left) and picture of 1.5mm crack in area 9 (right)

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Field trials-Conclusions

- **Process of inspection**
  - Rapid inspection with eddy current array probe
  - Inspection with microscope of regions flagged by EC
  - Inspection of other areas not flagged by EC probe
  - MPI of axle
- **Comparison with other inspection methods**
  - EC array detected defects with length longer than 2mm
  - Microscope could detect all but longer process
  - MPI could only detect defect with length longer than 5mm

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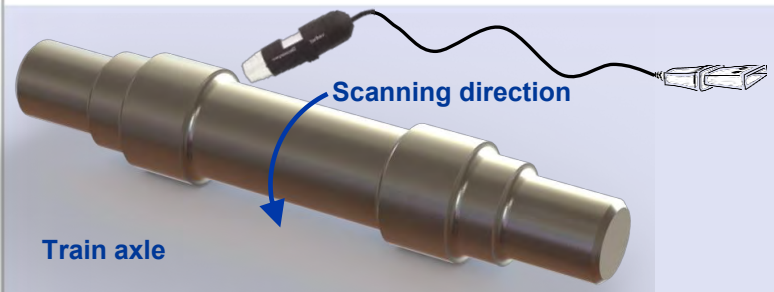
Data Management



Data collection through USB connection

Data analysis

Data analysis

Comparison with acceptance criteria

Data collected via USB microscope and encoder

Frame 1 (Location X_1, 5mm from datum)

Frame 2 (Location X_2, 10mm from datum)

Frame 20 (Location X_{20}, 100mm from datum)

Enhanced image

Object direction

Data Processing routine

No of Objects

Eccentricity

Frame 1 — *Enhanced image* — *Set of parameters*

Frame 2 — *Enhanced image* — *Set of parameters*

Frame 20 — *Enhanced image* — *Set of parameters*

Percentage of cracked area

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Concept of data analysis

- **Data analysis:**
  - Visualise 2D images taken from axles inspection
    - Images extracted from video of the scan
    - Images collected around the pipe circumference
  - Process the images to highlight the presence of crack-like features and remove unwanted objects
  - Obtain statistics on the highlighted features
  - Develop a set of variable that will act as threshold for the sentencing of corroded areas

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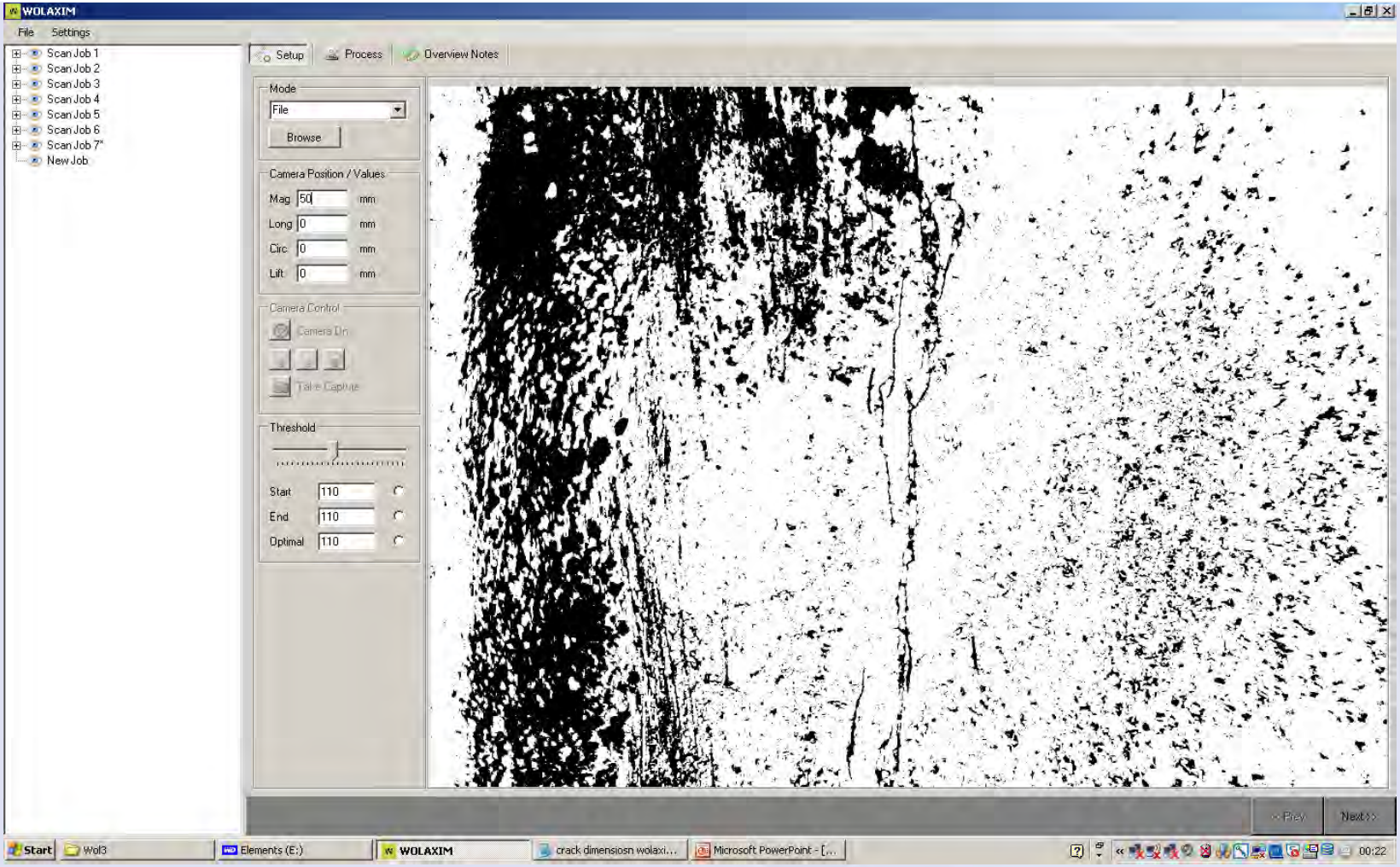

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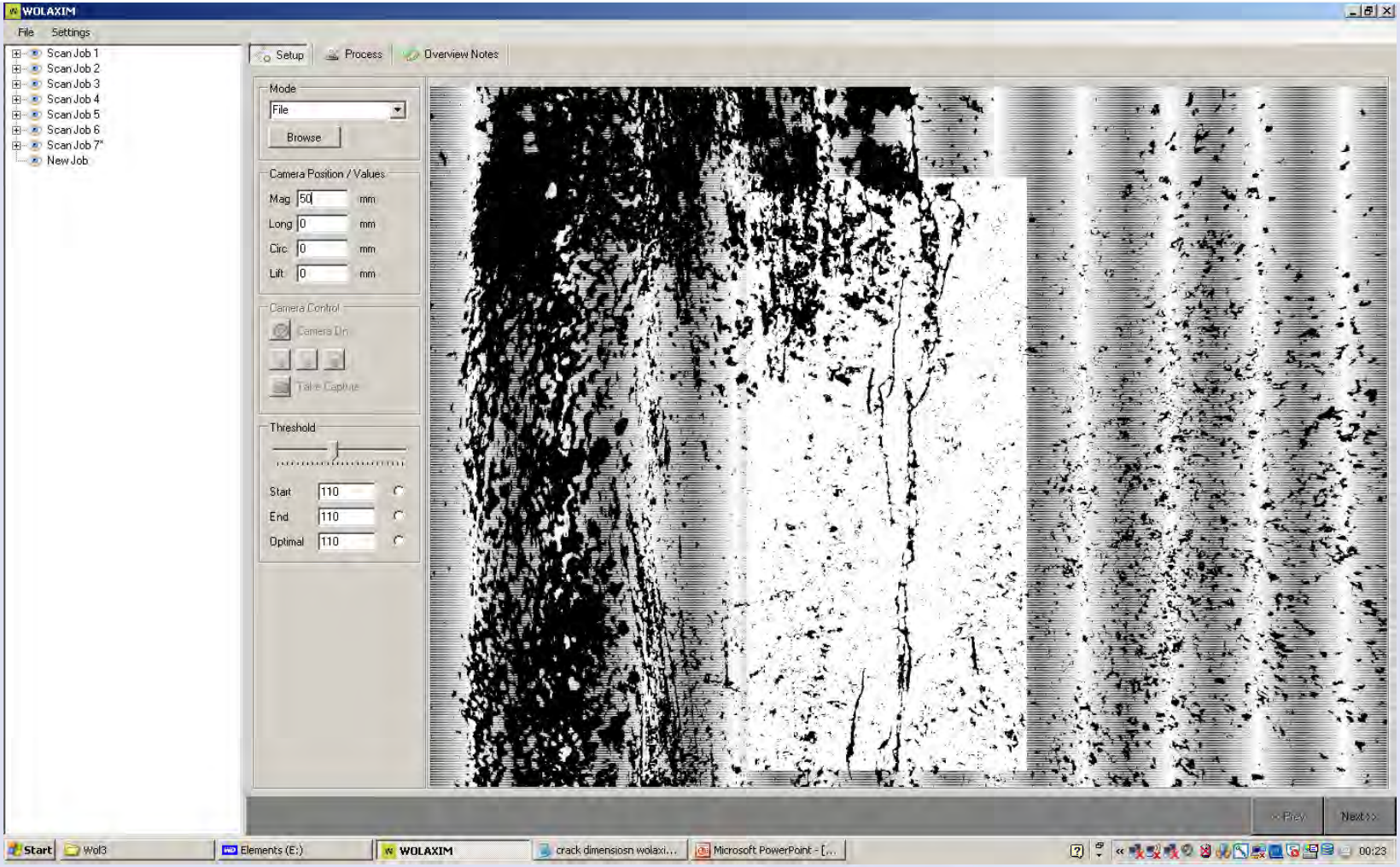

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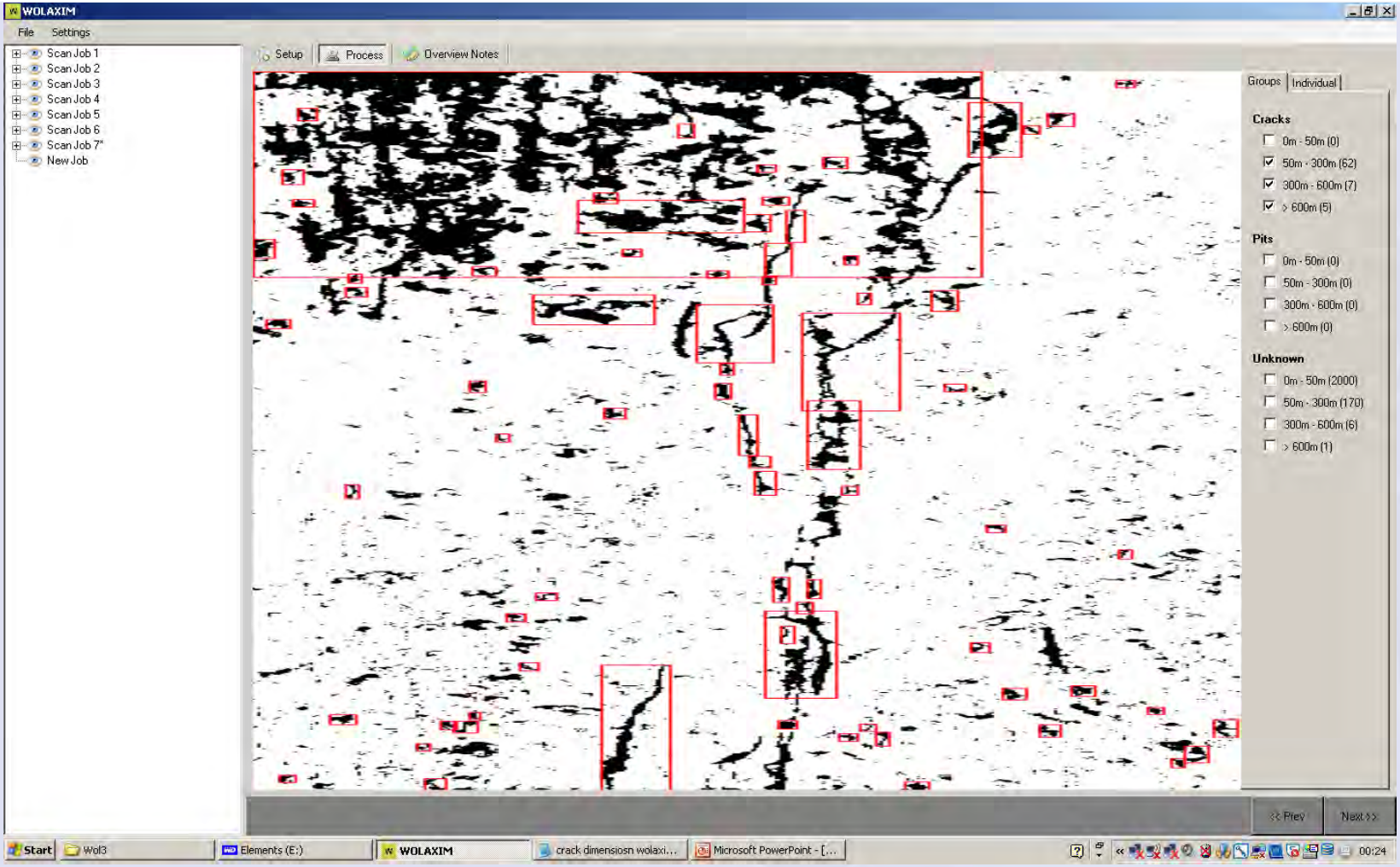

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THANK YOU