RECOGNITION OF HORIZONTAL LAYERS IN A SEGMENTED RADARGRAM AFTER THE APPLICATION OF CANNY EDGE DETECTOR

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Motivation & Related work

- In the first step of the algorithm Canny edge detector is used on entire radargram in order to reduce the number of pixels for further processing.

- Recognition of horizontal layers is important for two reasons:
  1. Estimation of the number of soil layers (e.g. in road survey)
  2. Detection of hyperbolic reflections in radargram is easier and more reliable when the noise, such as horizontal layers, is removed.

Methodology

- Each edge pixel is examined if it belongs to horizontal layer or not.

- A 3xn matrix is formed with analyzed pixel in the center and the number of edge pixels is examined.

- Condition:
  - If the zone contains at least one edge pixel within 70-90% of the columns than analyzed pixel is considered to belong to horizontal layer.

200MHzGn14-20-2.dzt
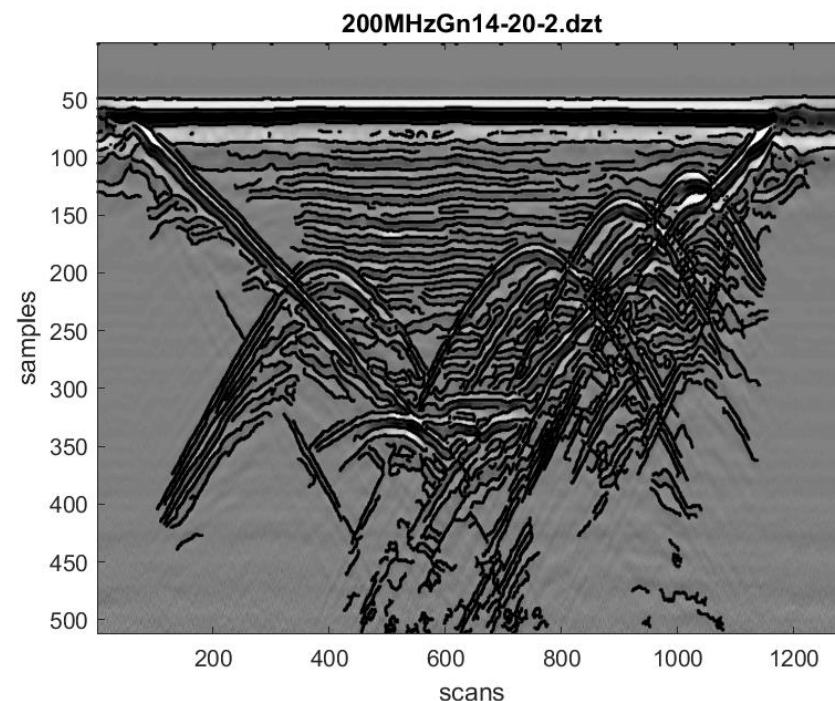
Recognition of horizontal layers

- Two criteria are analyzed:

1. Matrix dimensions:
   - 3x31 (15 columns on each side of analyzed pixel)
   - 3x41 (20 columns on each side of analyzed pixel)
   - 3x51 (25 columns on each side of analyzed pixel)

2. Percentage of edge pixels:
   - 70% of columns of the matrix contains edge pixels
   - 80% of columns of the matrix contains edge pixels
   - 90% of columns of the matrix contains edge pixels
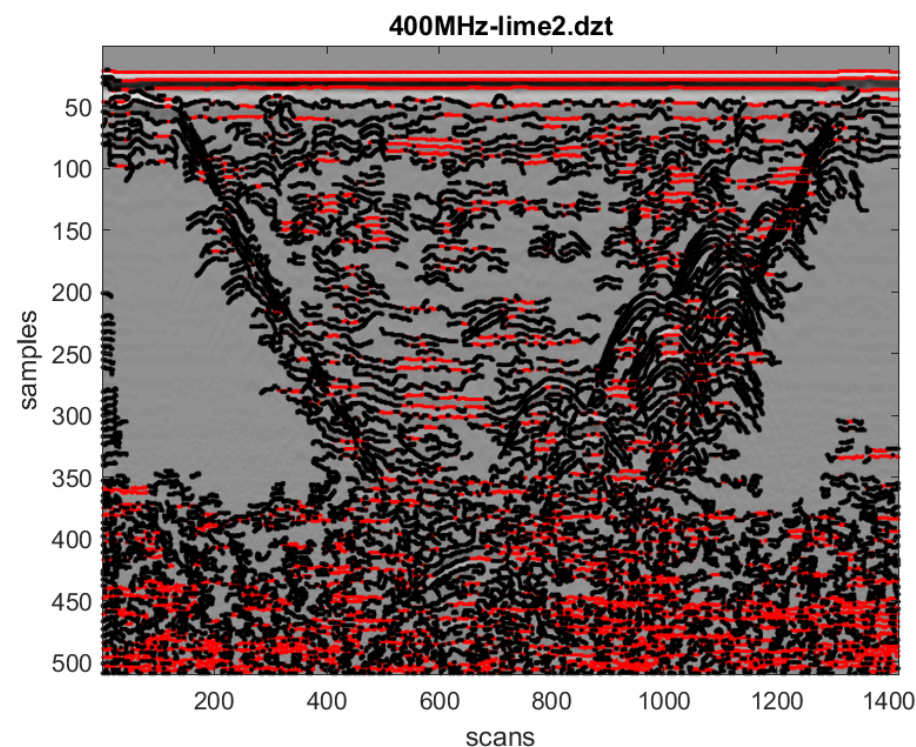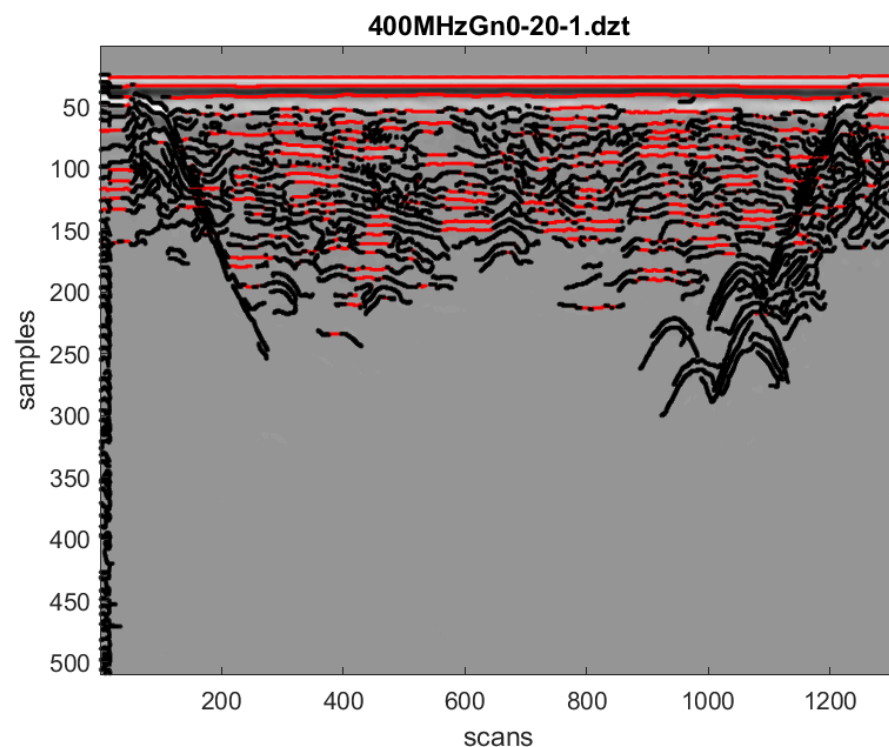
Results 70% ; Matrix dimensions: 3x31

Reduction of edge pixels: **36.01** [%]   Reduction of edge pixels: **30.48** [%]

Processing time: 0.081 [s]   Processing time: 0.206 [s]

Red – horizontal pixels   Black – remaining edge pixels
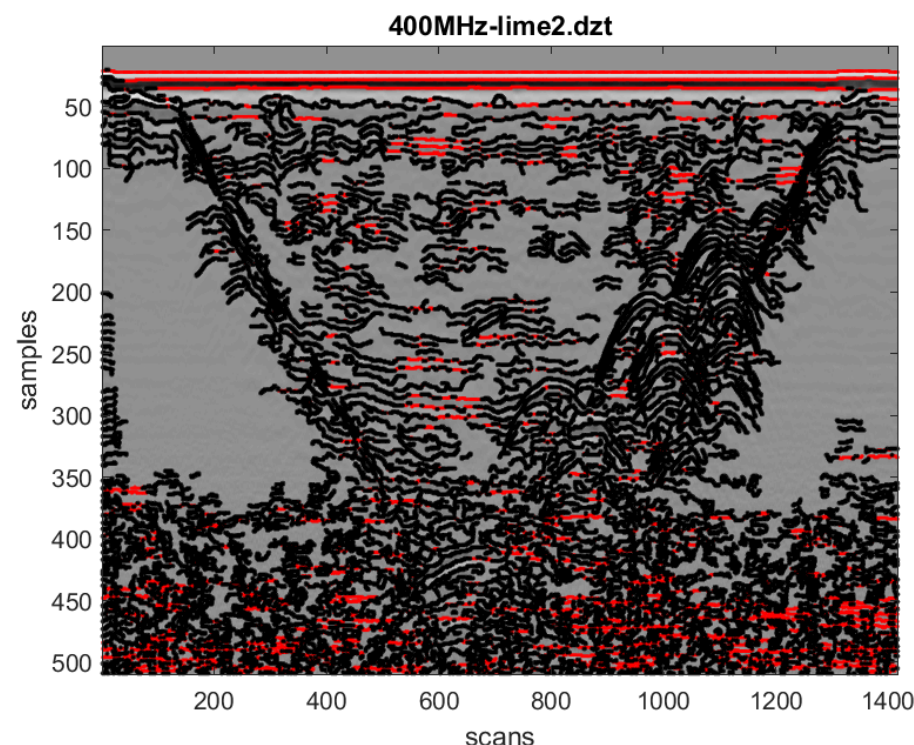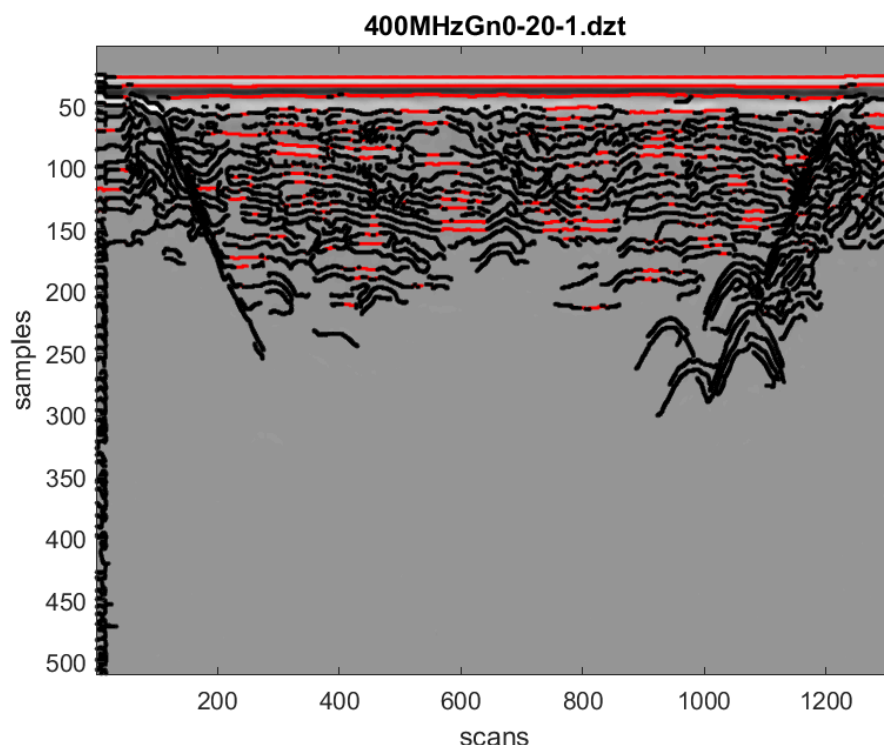
Results 80% ; Matrix dimensions: 3x31

Reduction of edge pixels: **25.54** [%]   Reduction of edge pixels: **22.27** [%]

Processing time: 0.095 [s]   Processing time: 0.234 [s]
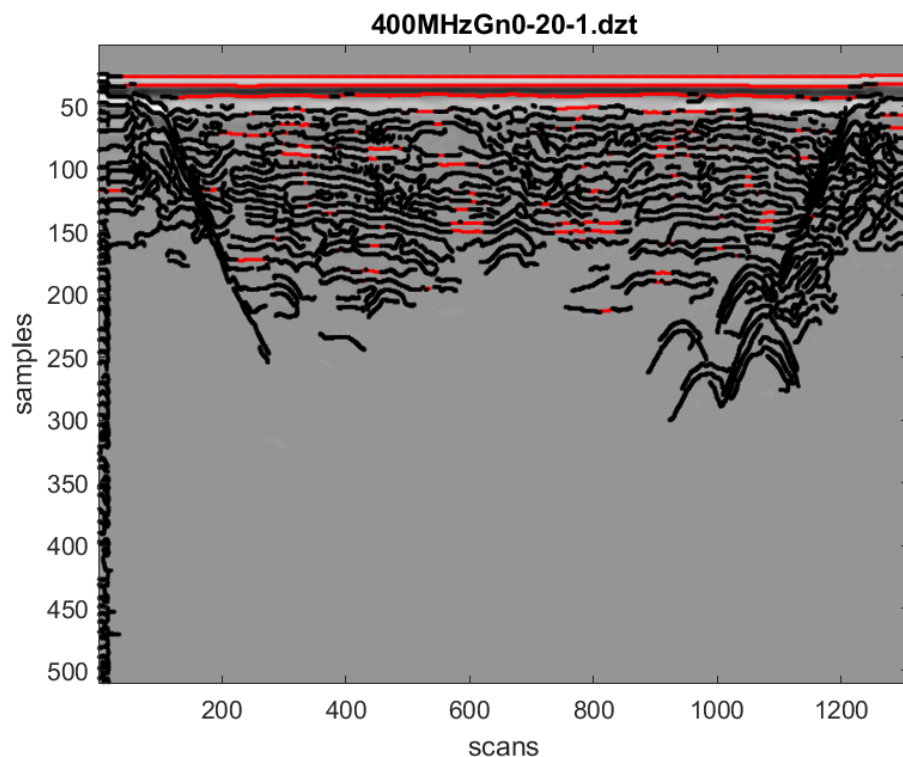
Red – horizontal pixels   Black – remaining edge pixels

Results 90% ; Matrix dimensions: 3x31

Reduction of edge pixels: **18.30** [%]   Reduction of edge pixels: **12.13** [%]
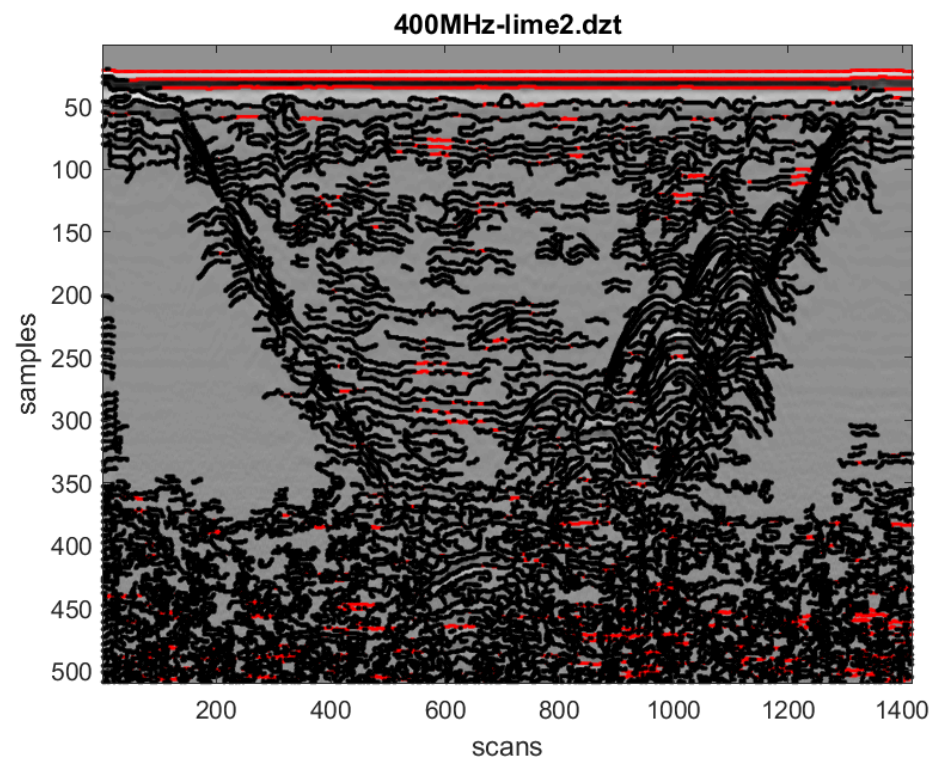
Processing time: 0.073 [s]   Processing time: 0.204 [s]

Red – horizontal pixels   Black – remaining edge pixels

Results 70% ; Matrix dimensions: 3x41

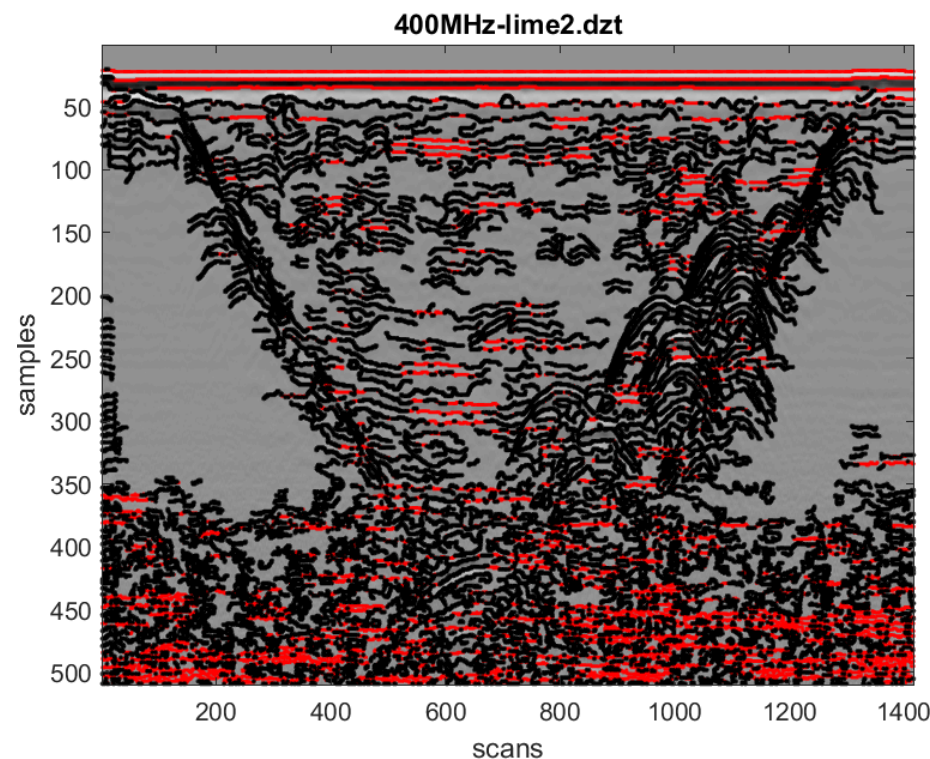Reduction of edge pixels: **29.15** [%]   Reduction of edge pixels: **30.48** [%]
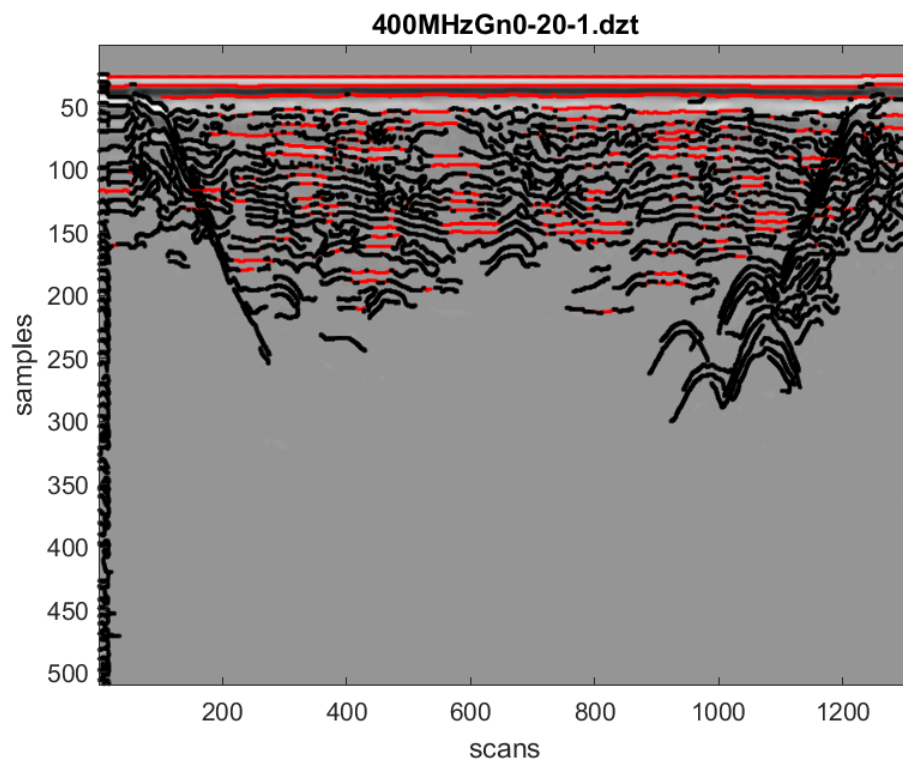
Processing time: 0.091 [s]   Processing time: 0.225 [s]

Red – horizontal pixels   Black – remaining edge pixels
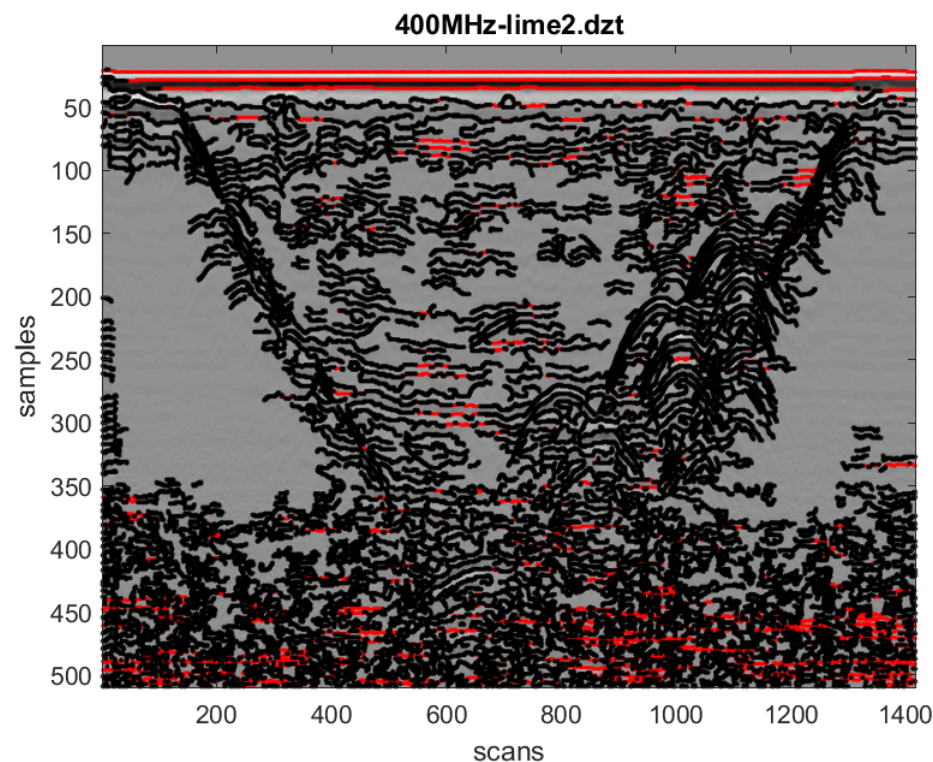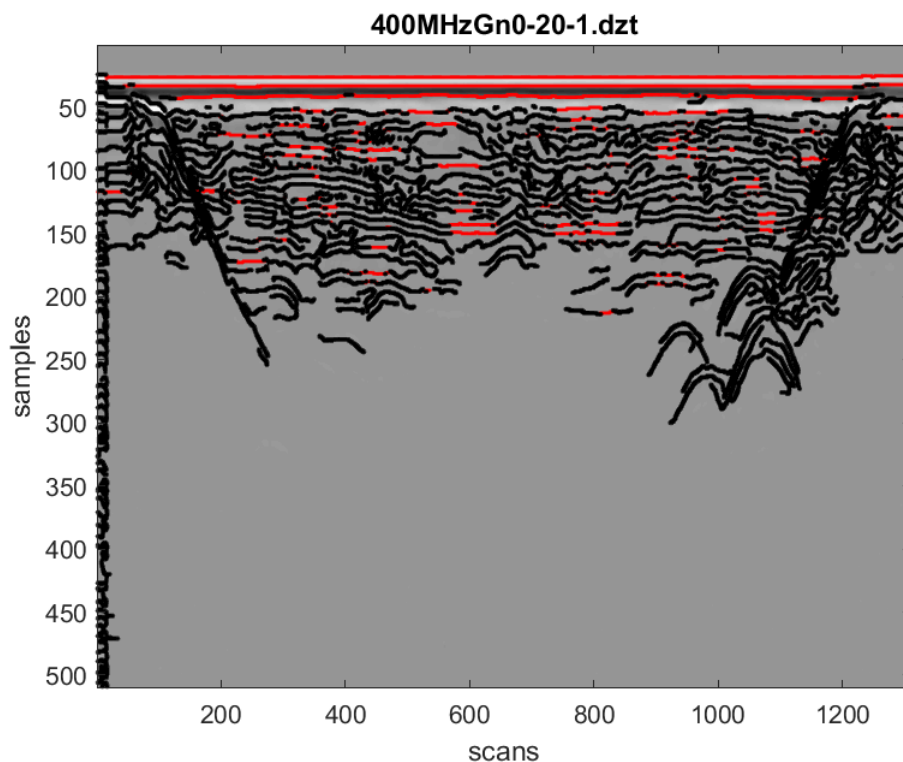
Results 80% ; Matrix dimensions: 3x41

Reduction of edge pixels: **20.17** [%]   Reduction of edge pixels: **16.96** [%]

Processing time: 0.086 [s]   Processing time: 0.236 [s]

Red – horizontal pixels   Black – remaining edge pixels

Results 90% ; Matrix dimensions: 3x41
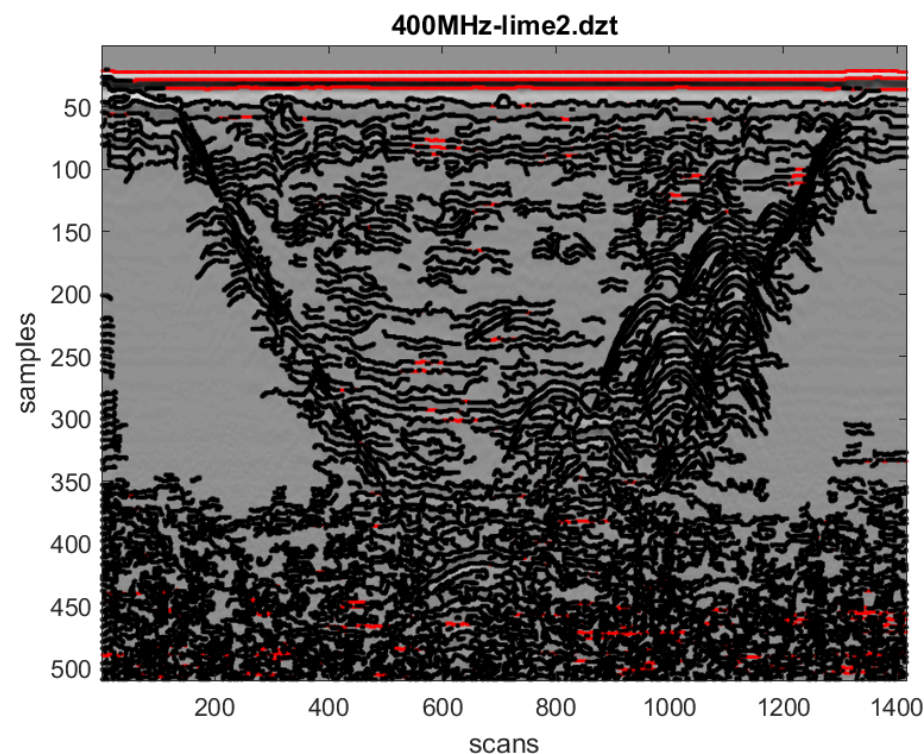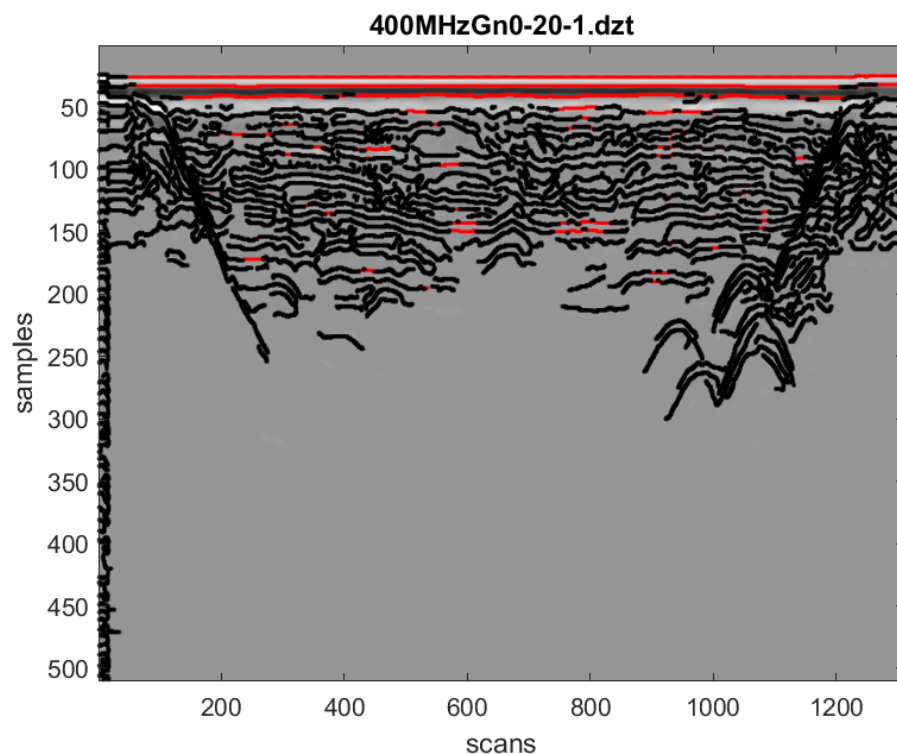
Reduction of edge pixels: **14.85** [%] Reduction of edge pixels: **8.95** [%]

Processing time: 0.080 [s] Processing time: 0.249 [s]

Red – horizontal pixels Black – remaining edge pixels
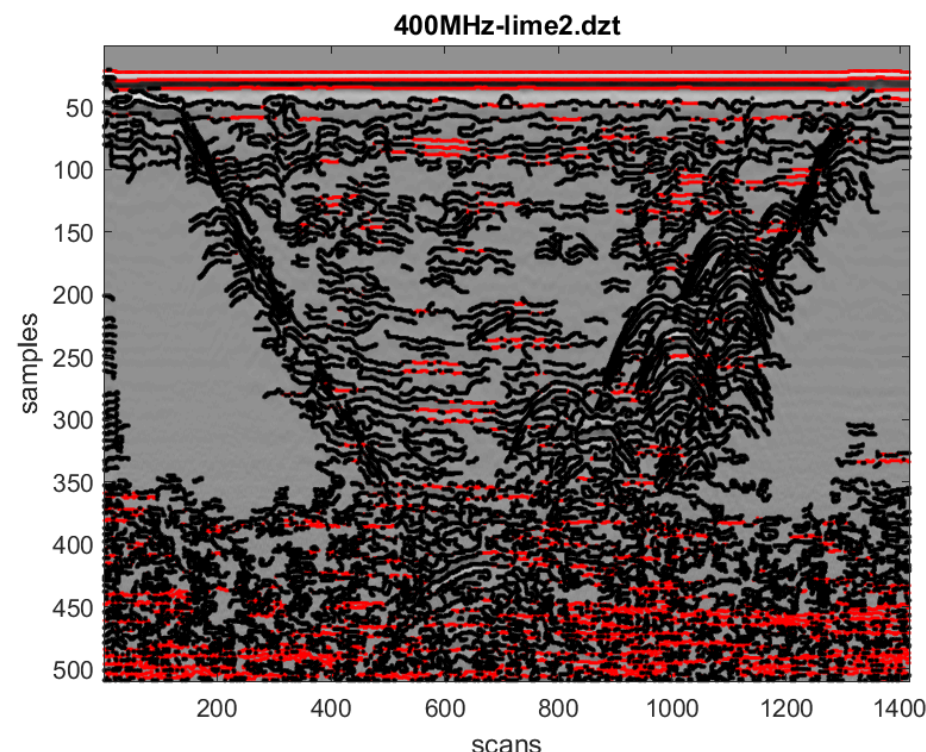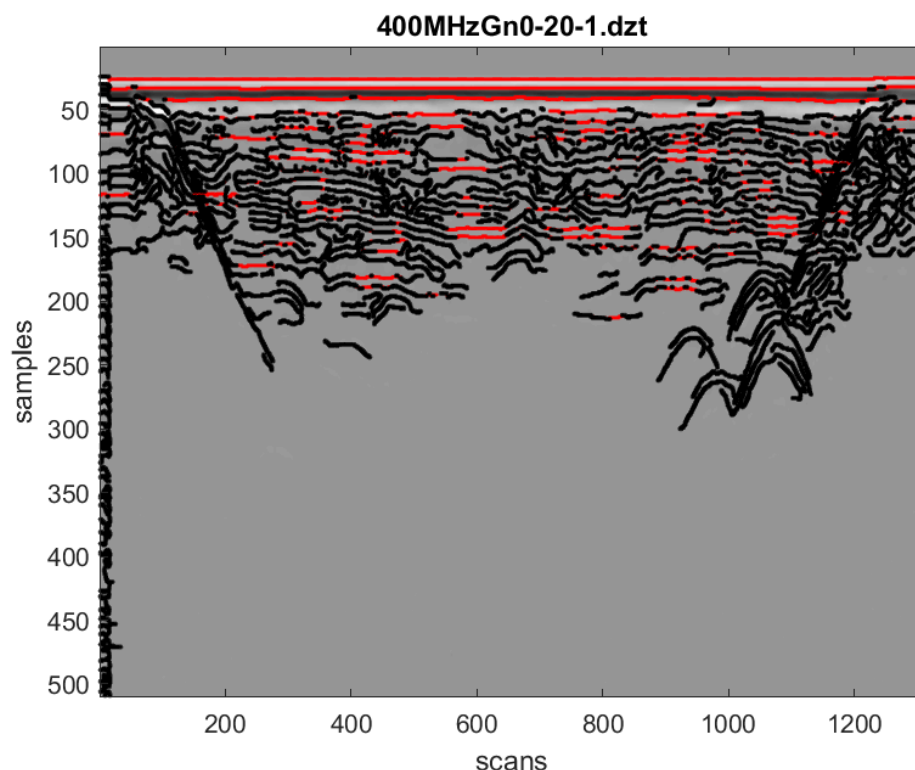
Results 70% ; Matrix dimensions: 3x51

Reduction of edge pixels: **24.57** [%]

Processing time: 0.149 [s]

Red – horizontal pixels

Reduction of edge pixels: **26.68** [%]

Processing time: 0.259 [s]

Black – remaining edge pixels

400MHzGn0-20-1.dzt

400MHz-lime2.dzt

Results 80% ; Matrix dimensions: 3x51

Reduction of edge pixels: **16.87** [%]
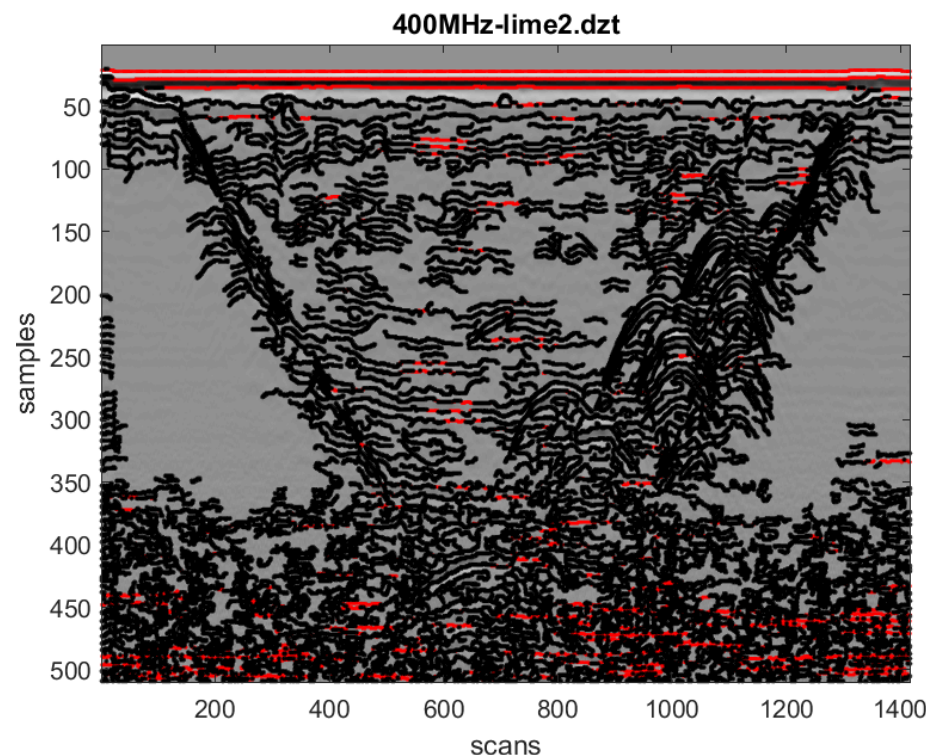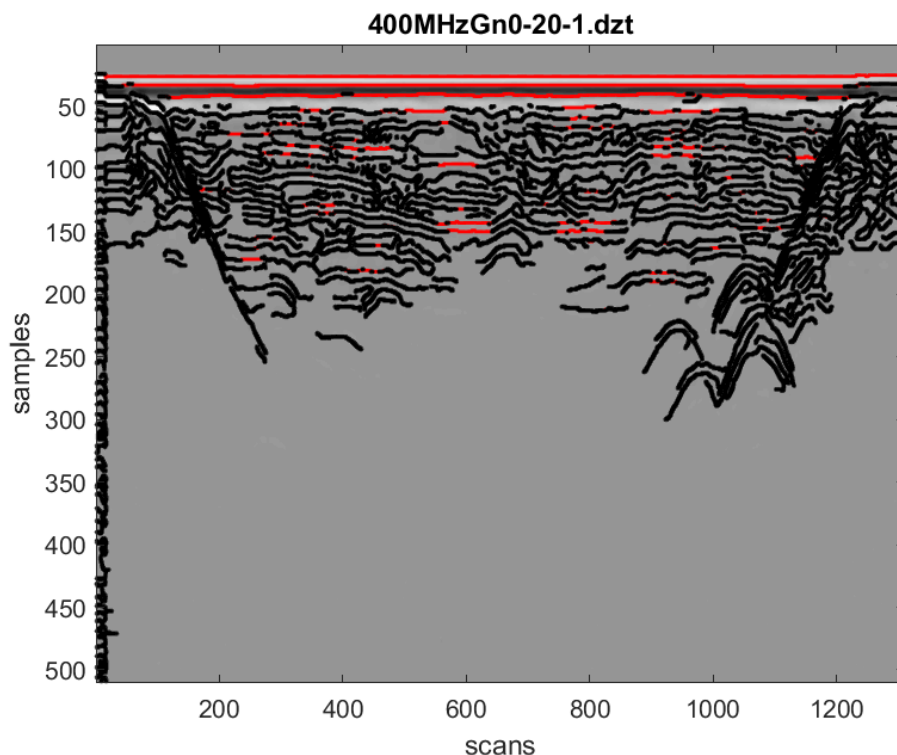
Processing time: 0.135 [s]

Red – horizontal pixels

Reduction of edge pixels: **14.07** [%]

Processing time: 0.341 [s]

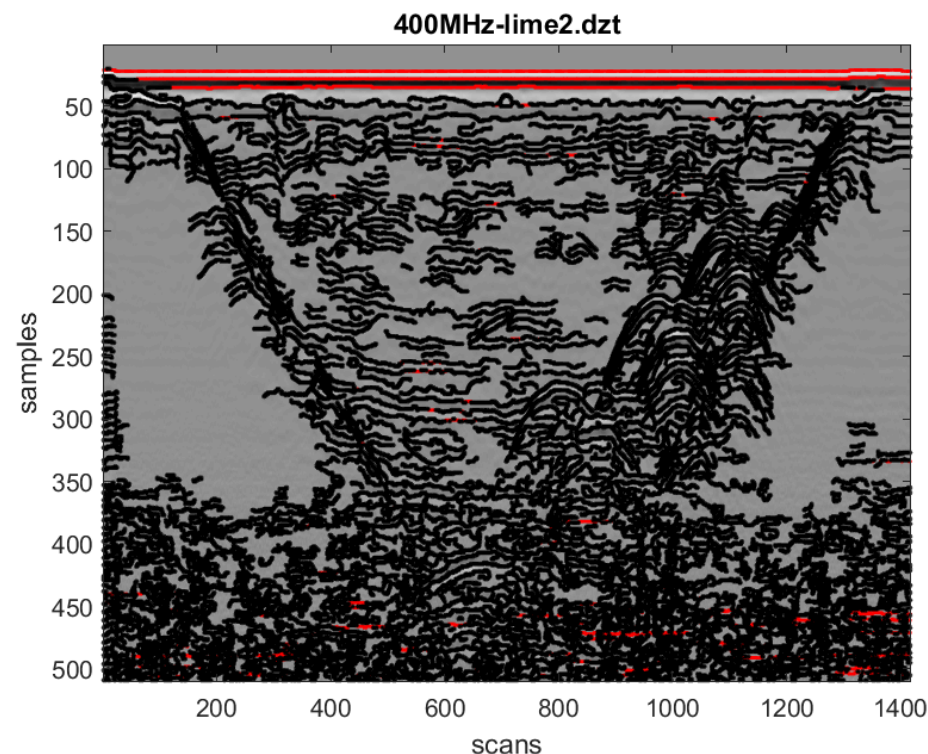Black – remaining edge pixels

Results 90% ; Matrix dimensions: 3x51
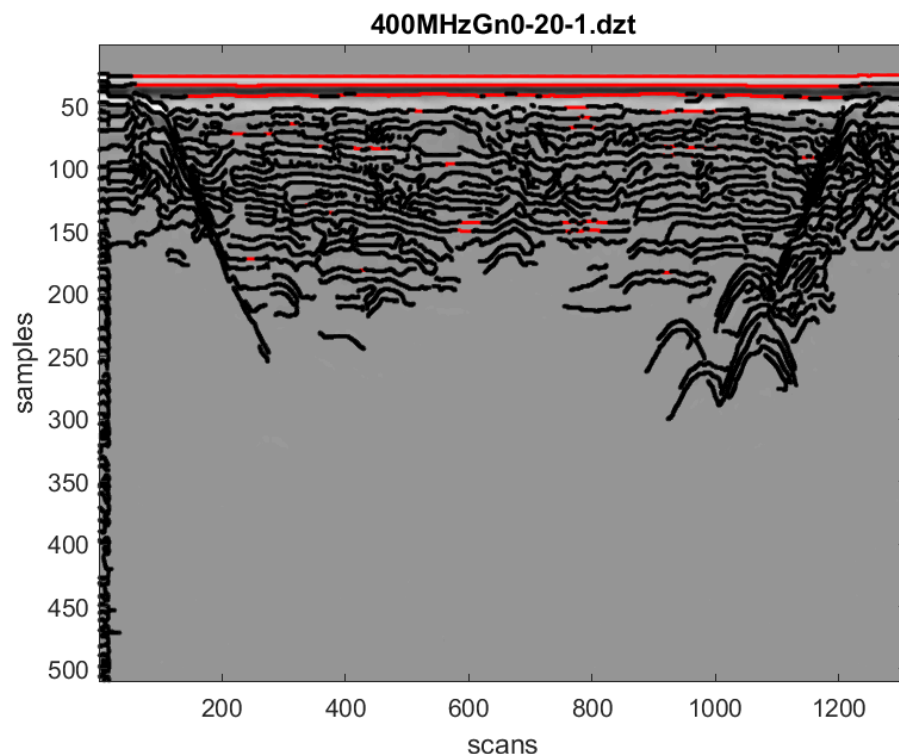
Reduction of edge pixels: **12.80** [%]

Reduction of edge pixels: **7.19** [%]

Processing time: 0.125 [s]

Processing time: 0.320 [s]

Red – horizontal pixels

Black – remaining edge pixels

400MHzGn0-20-1.dzt

400MHz-lime2.dzt

Conclusion

- The biggest percentage of edge pixels (36.01%) in horizontal layers is detected with conditions:
  - 70% of edge pixels in the matrix
  - 3x31matrix

- Increasing percentage in the condition decreases the number of edge pixels forming horizontal layers in radargram.

- Decreasing the matrix dimensions increases the number of edge pixels forming horizontal layers in radargram.

- Processing time depends on the number of edge pixels.

- Since the processing is very time-efficient it can be done in near-real time.

Thank you for your attention!