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Center for Nondestructive Evaluation

Innovative Materials Testing Technologies, Inc.

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Detecting Cracks under Bushings in Aircraft Structures Using FG RFEC & SSEC Technique

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1. A challenge to detect cracks in cross-bolt holes when the cracks are located beneath repair bushings.
2. Removal of a bushing is costly and may bring new damage to the holes.
3. There has been a demand for techniques that is capable of detecting cracks in cross-bolt holes through a bushing.

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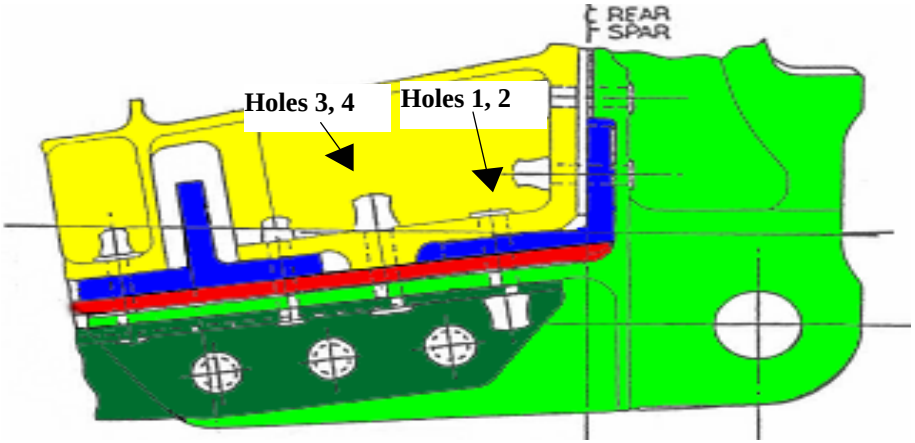
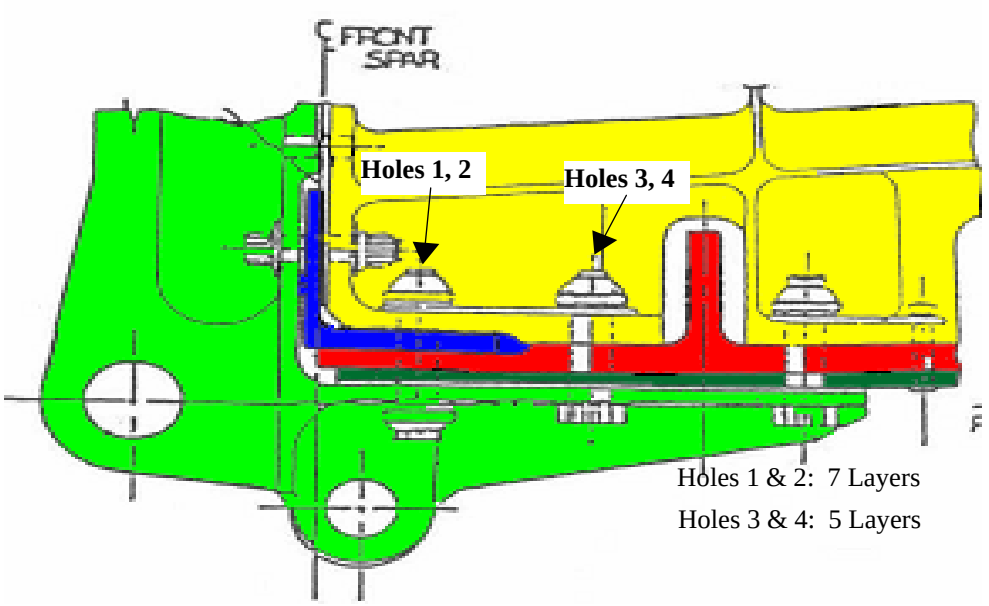
Target Aircraft Component:
Wing Attach Fitting Inspection through bushing.



AFT

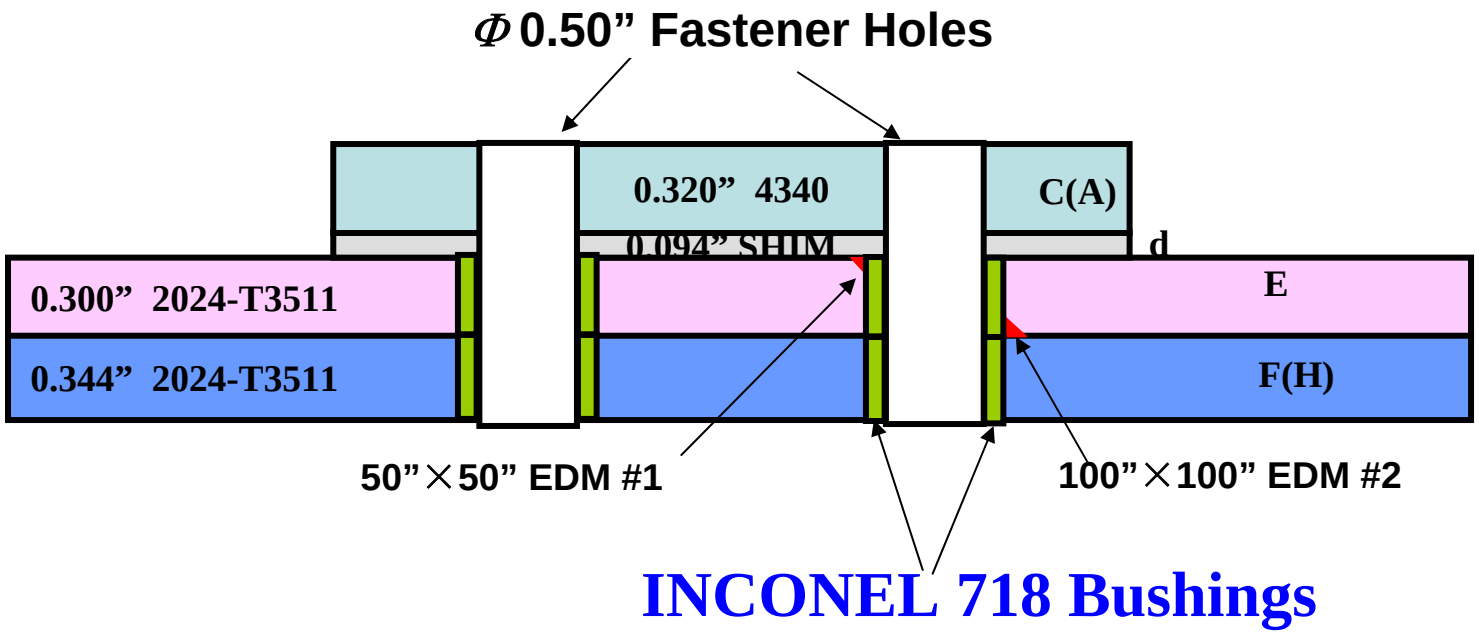
FWD



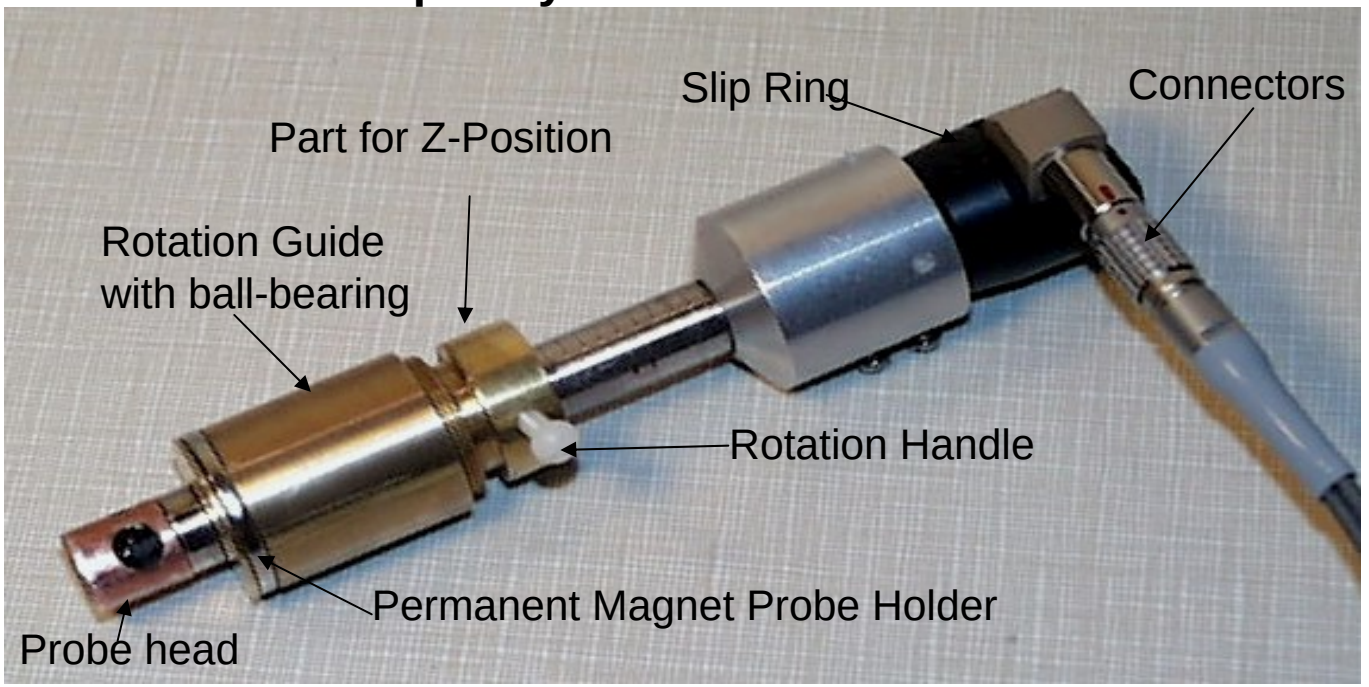
Holes 1 & 2: 7 Layers

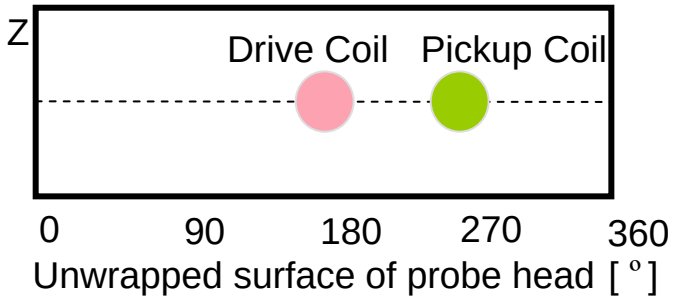
Holes 3 & 4: 5 Layers

Test Standard

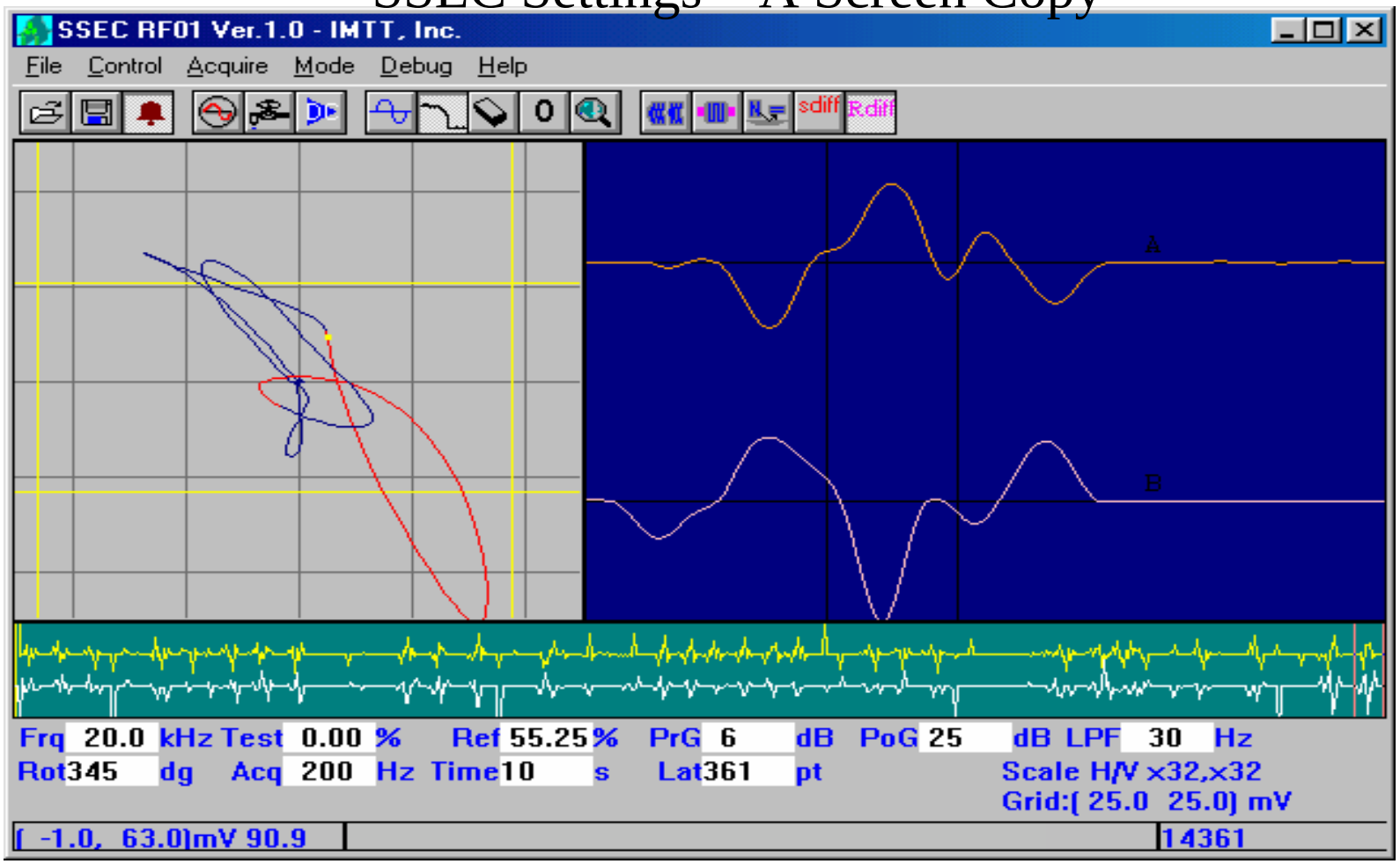


Probe Developed: **RF BSH0.5**
Test Frequency: **10 kHz - 80 kHz**





SSEC Settings – A Screen Copy



Simulated Reflection Differential Mode with step = 5 points
Digital LPF, cutoff frequency = 1.0 Hz

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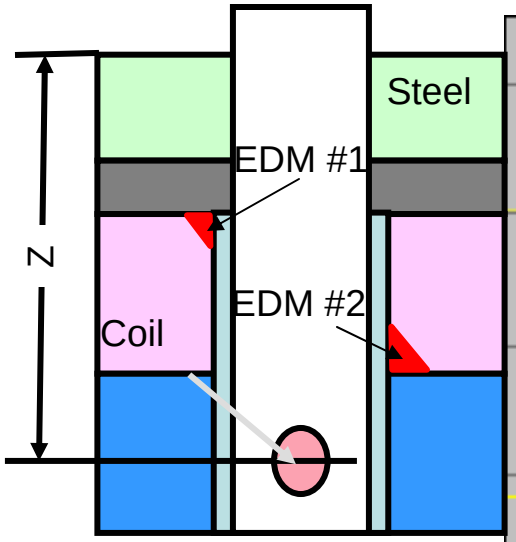
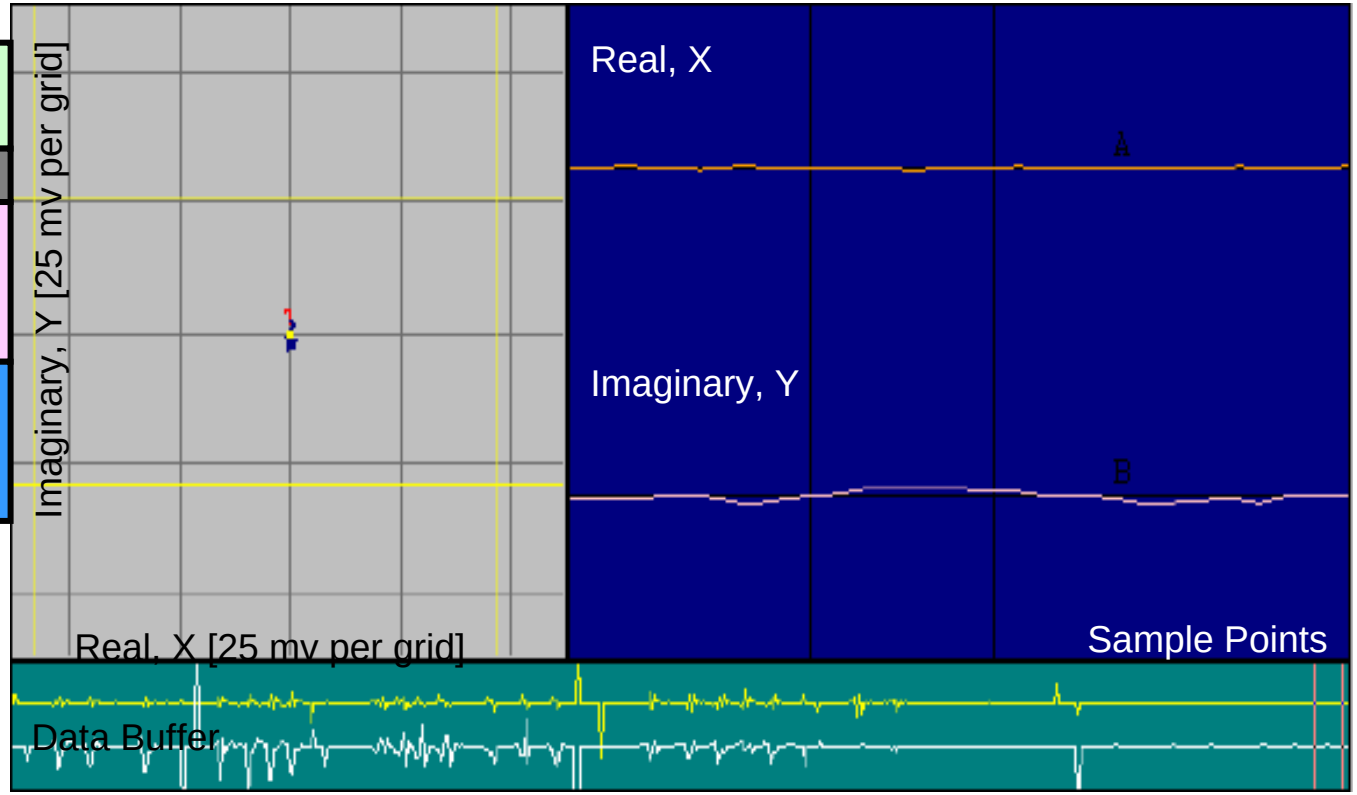
Probe Position 1 Z = 0.885”



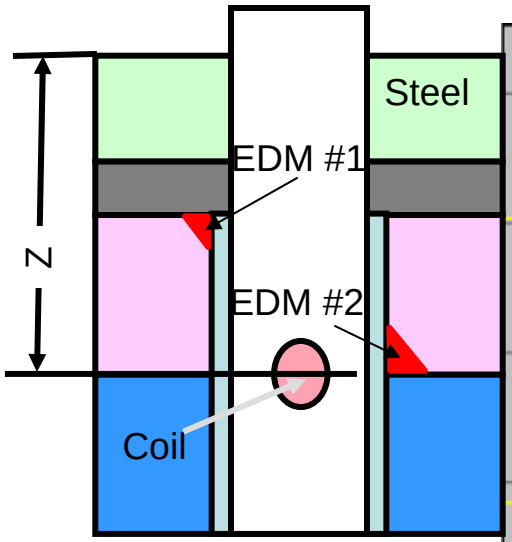
EDM #1: 50”×50”

EDM #2: 100”×100”



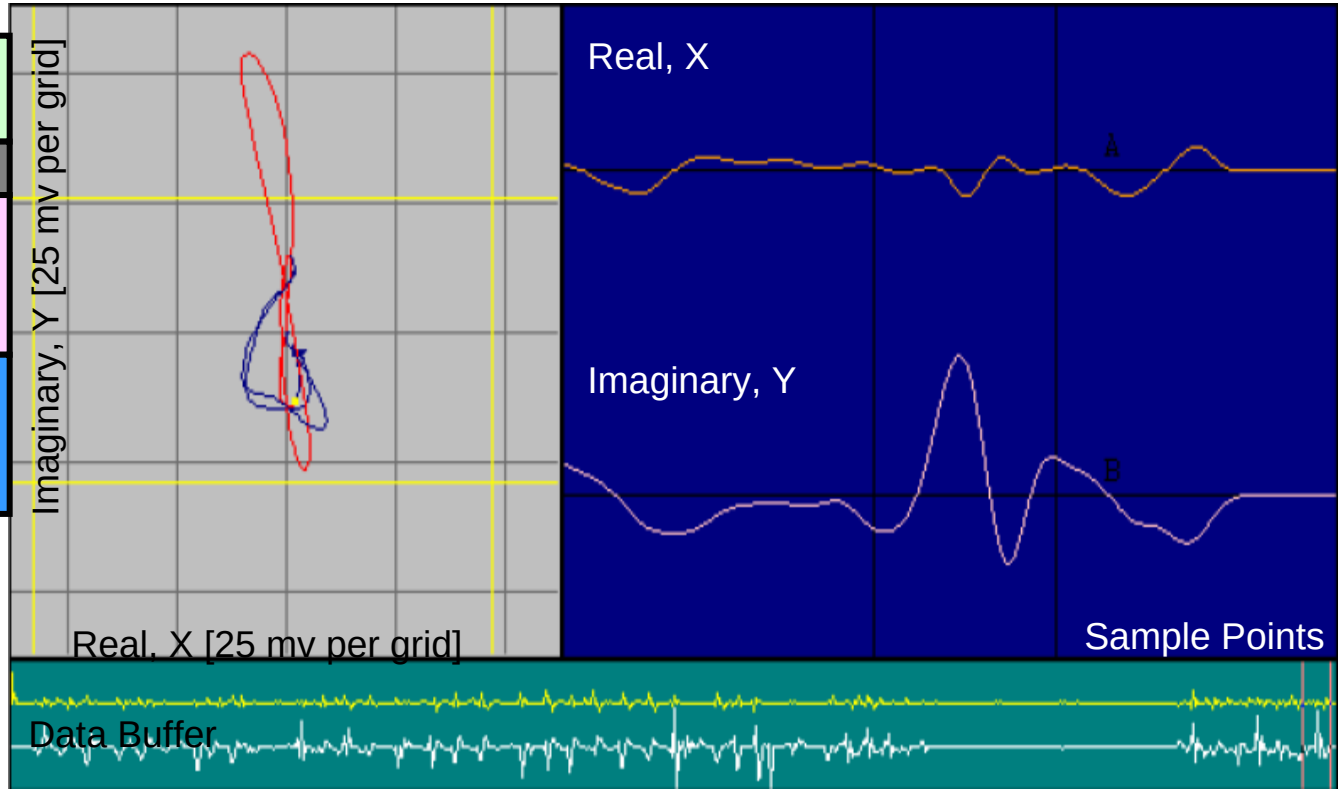
Position 2 Z = 0.715”

EDM #2 can be detected from Z=0.685” to Z=0.760”



EDM #1: 50”×50”

EDM #2: 100”×100”



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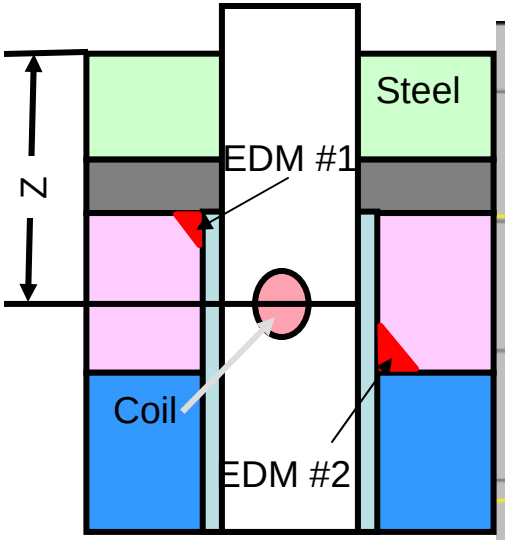
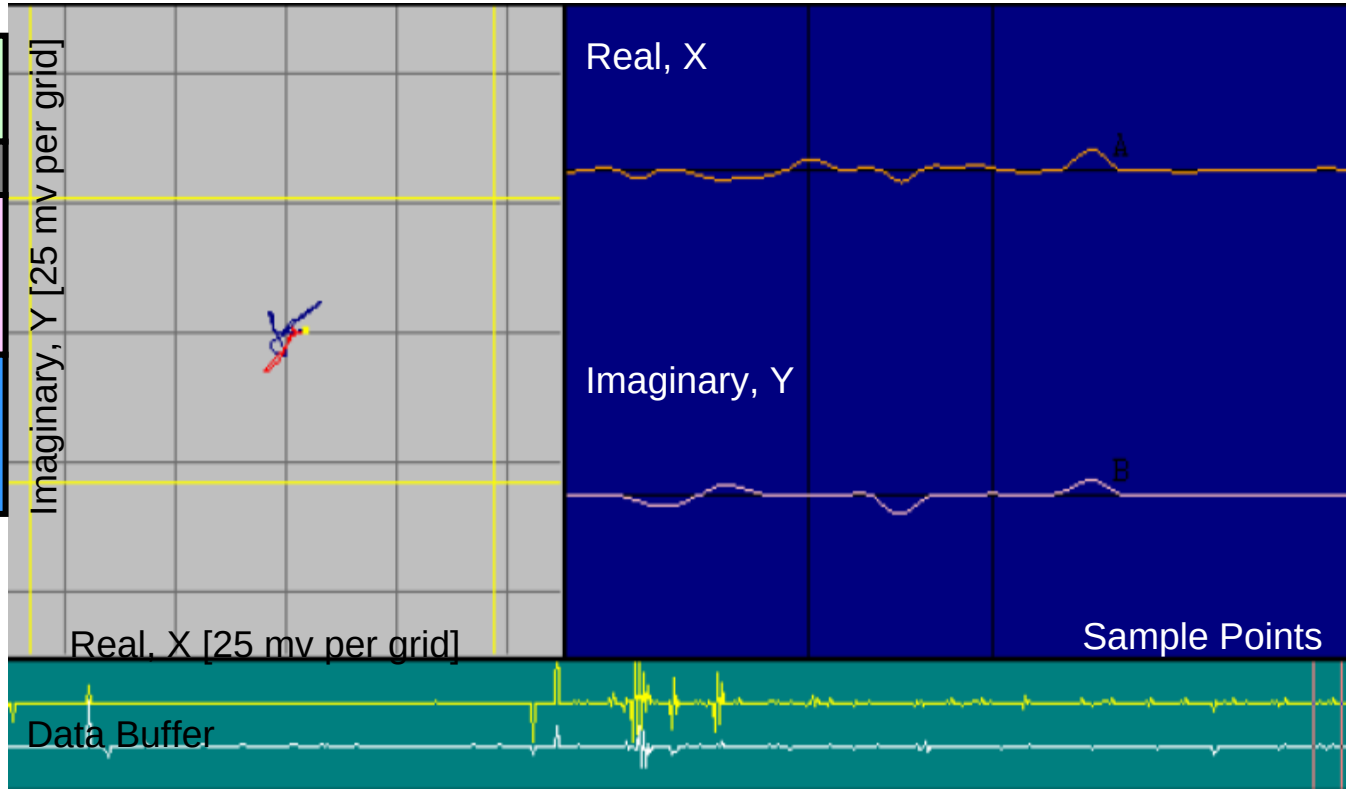
Probe Position 1 Z = 0.565”



EDM #1: 50”×50”

EDM #2: 100”×100”



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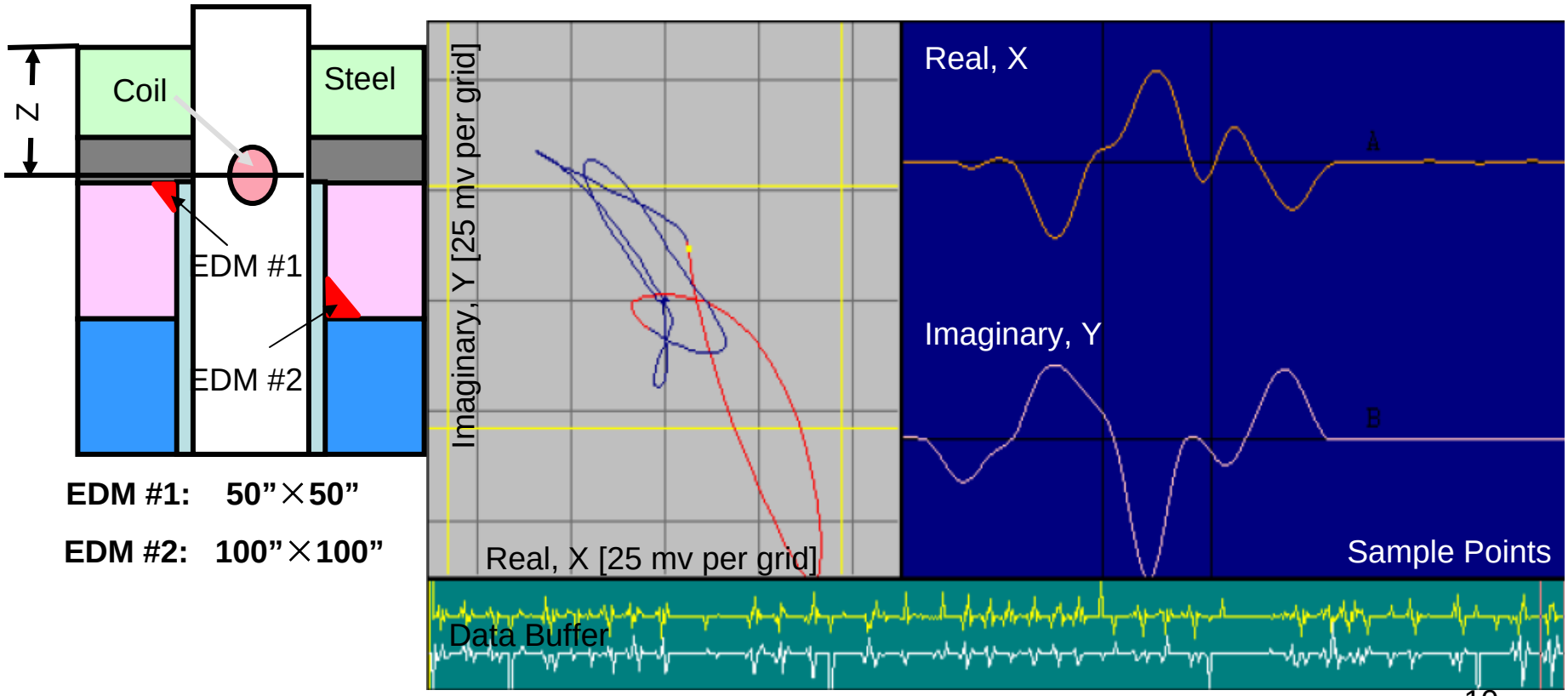
Position 2 Z = 0.395”

EDM #1 can be detected from Z=0.395” to Z=0.415”



EDM #1: 50”×50”

EDM #2: 100”×100”

Conclusions

1. The two EDM Notches made on layer E are detected with high S/N ratios.
2. The permanent magnet probe holder and the ball-bearing rotation guide help with noise reduction and ease of operation.
3. Comparing the signal responses of the two notches the 0.100”×0.100” EDM Notch, Notch #2, can be detected in a large range of probe position Z, see Page 8.
4. The 4340 steel layer enhances the signal response from the 0.050 ”×0.050” EDM notch, Notch #1. However, it moves the location for optimal detection towards steel side, see Page 10.

Future Work

1. Motorize probe rotation
2. Automatic C-Scan and Real-Time Imaging
3. Consider thickness variation of bushing
4. Try detection of bore-hole crack with and without an installed bushing.
5. Commercialization
6. Field testing and POD study