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Enhanced Bolt-Hole Eddy Current (BHEC) Inspection

A4A NDT Forum September 21st – 23rd, 2026

Agenda

01 Introduction

02 History of Bolt Hole Eddy Current (BHEC) Inspection

03 The Technology Used in BHEC Inspection

04 What Is New for BHEC

05 Conclusion

01

Introduction

What is BHEC?

A dedicated inspection method

- Widely used throughout the aircraft industry for crack detection
- It is also a fast and effective way to inspect large areas where there is multiple holes requiring eddy current inspection looking for surface cracks within the holes
- Majority of aircraft still in service today are continuously manufactured using aluminum as primary structure



Use of BHEC

Applicable to many conditions

- Various types of "fastener" holes ➡ *Rivets, Bolts, Rods, Mechanical Attachment Fittings, etc.*
- Adaptable to many materials ➡ *Aluminium, Steel, Stainless Steel, Titanium or other Metals and Alloys*
- Found in several assemblies ➡ *Engine Pylons, Wing Attachment Fittings, Vertical & Horizontal Fittings, etc.*



02

History of BHEC Inspection

BHEC along the years...

Initially

Before impedance EC instruments and bolt hole scanners, inspectors had to use analog meter instruments and manual bolt hole probes to inspect holes for cracks

- Advantage
 - You had a fair ideal where the crack was located
 - Limited ability to estimate the crack location in a multi layer stack up "still some guess work"
- Limitations
 - Slow and time consuming "army of inspectors"
 - Edge-Effect issues if using an absolute probe
 - Noise signals
 - No data analyzes
 - High percentage of false calls
 - Cable issues "wrestling with the probe cable"



BHEC along the years...

Introduction of impedance plane representation

The release of the impedance eddy current instruments and scanners, help tremendously with BHEC inspection

- Advantages
 - Speed up inspection time
 - Eliminating Edge-Effect issues while using reflection-differential scanner probes
 - Improved signal-to-noise
 - No more wrestling with the probe cable
- Limitations
 - Still limited ability to analyze the data
 - Still could have false calls



BHEC along the years...

Digital area

Digital signals enables to provide improved and additional displays with filter syncing with the scanner speed, such as swept view, "figure 6" or "figure 8" options and improved impedance plane

■ Advantages

- Speed up inspection time
- Eliminated Edge-Effect issues using reflection-differential scanner probes
- Improved signal-to-noise
- Some ability to estimate crack position
- Reduction the number of false calls
- New figure 8 and 6 signals

■ Limitations

- Still limited ability to analyze the data
- Still difficult to determine crack location in multi layer stack up

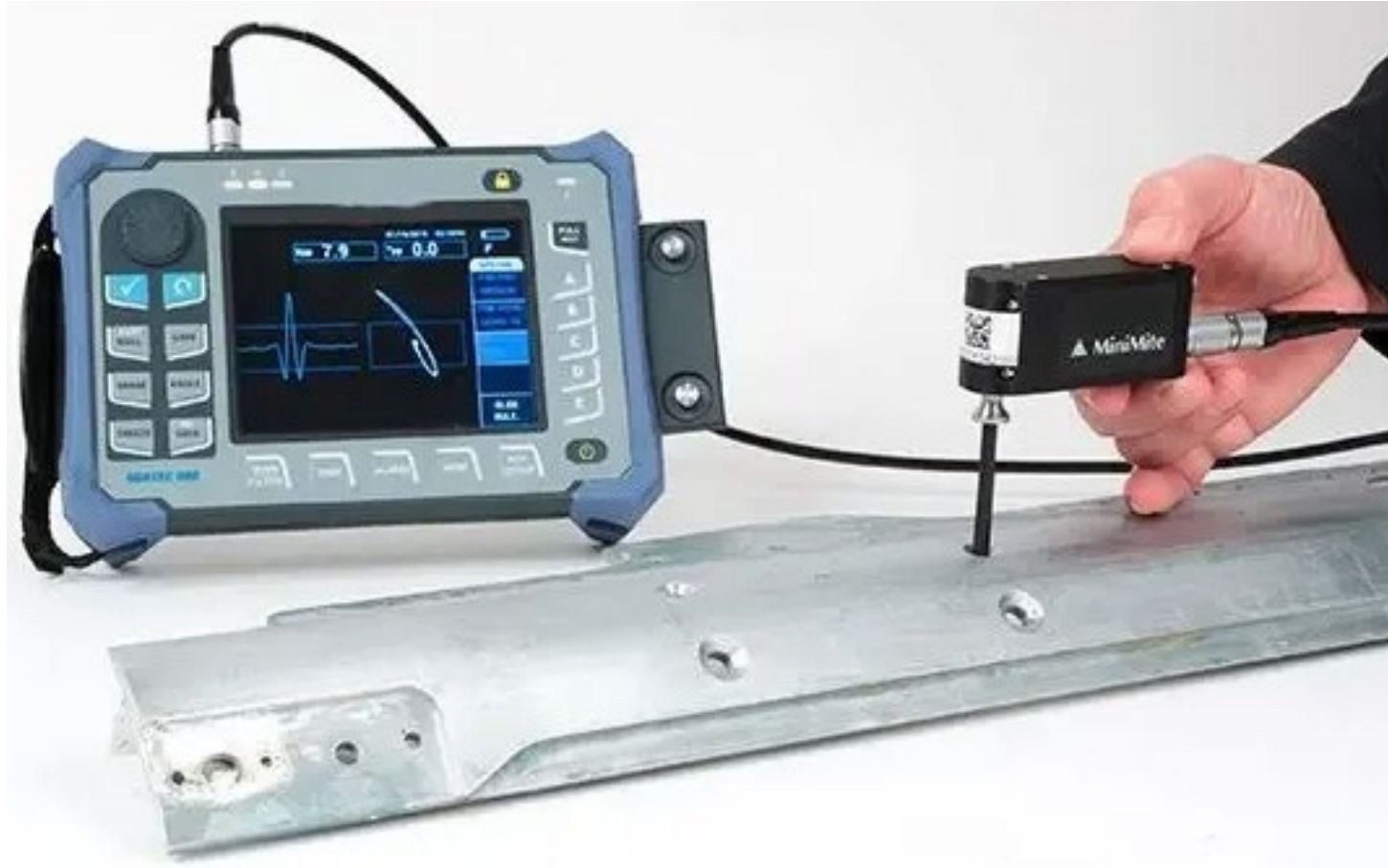


03

The Technology Used in BHEC Inspection

A complete solution

The breakdown of the equipment used for ECBH inspection

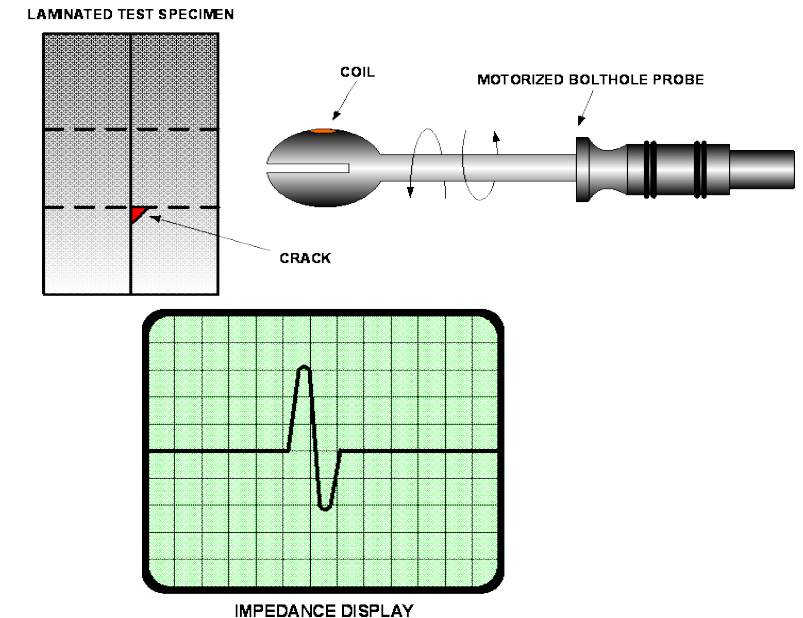
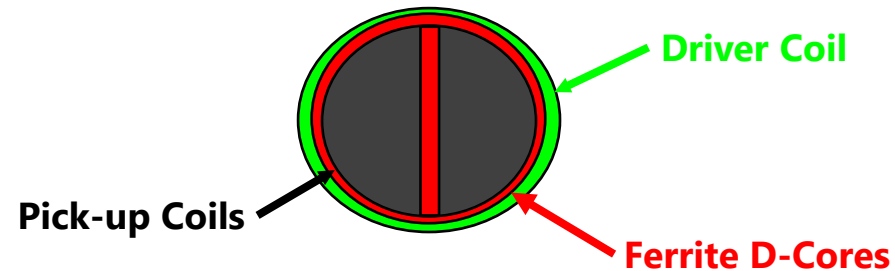
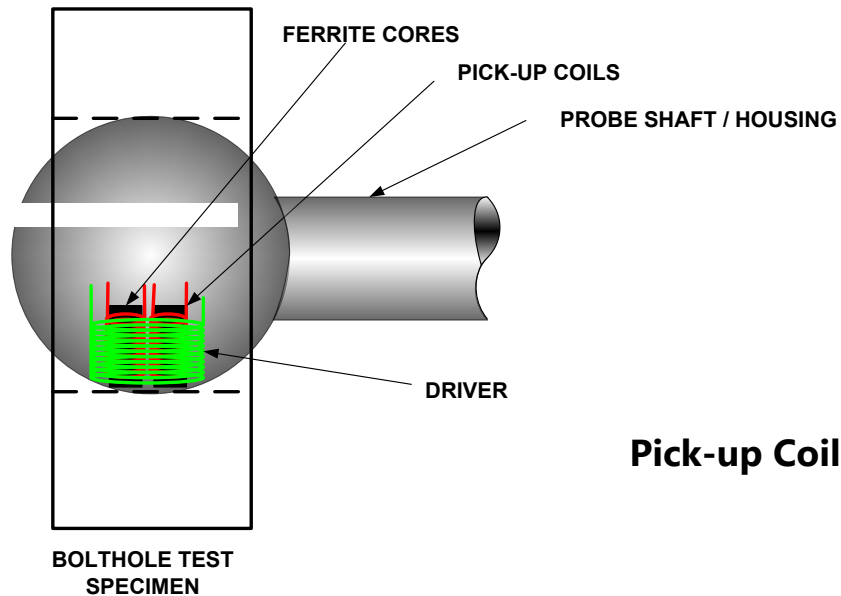


Scanner Probes

Reflection-Differential

- Three coils are making contact with the surface of interest: one driver and two pick-ups
- Most sensitive to small surface cracks and less sensitive to lift-off
- Most of the rotating scanner bolt hole probes uses this type of coil arrangement

REFLECTION DIFFERENTIAL COIL ARRANGEMENT



Dedicated scanner

Breakdown of an eddy current scanner

- The motor enable to rotate the rotor assembly and the probe
- Rotor and Stator assembly passes the signal from the probe through the scanner to the instrument
- Hall effect sensor is a solid-state device that measures the strength and presence of a magnetic field
- The sensor times the rotation of the Rotor and Stator assembly to create the swept signal and scanner speed measurement



**Rotation 600 RPM to 3,000 RPM
(1,000 to 1,500 typical)**

Eddy Current Flaw Detector

The instrument

- The heart and brain used for BHEC Inspection
- Drives the rotary scanner, collects the data, and displays the impedance plane and sweep signals



Eddy Current Flaw Detector

Tailored setup

- Besides the main parameters...
 - Frequency
 - Phase Angle
 - Horizontal Gain
 - Vertical Gain
- ... several critical instrument setting require the operator's attention



Eddy Current Flaw Detector

Tailored setup

Here are the other critical adjustment needed for BHEC inspection

■ Filters

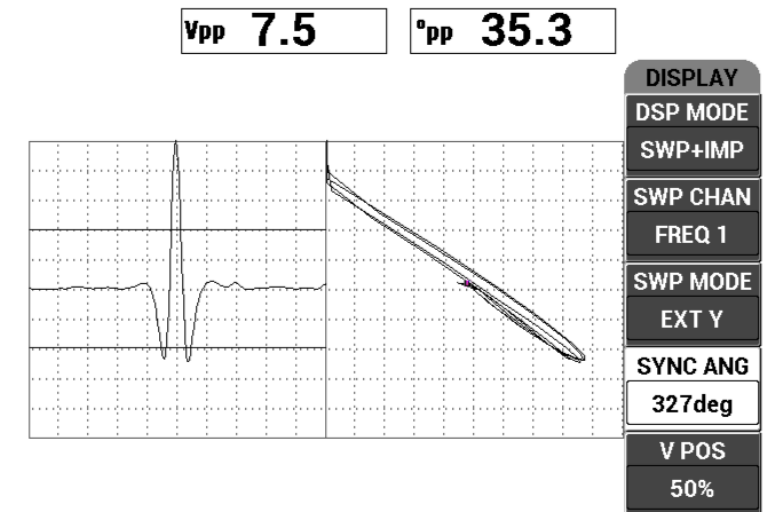
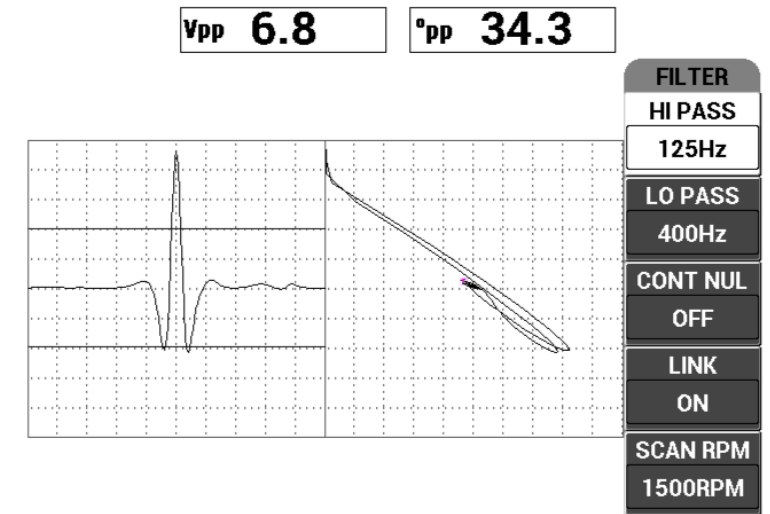
- Filters are necessary to allow easy signal interpretation
- High-Pass Filter (HPF) aims to reduce strong rotation noise (vibration = lift-off)
- Low-Pass Filter (LPF) aims to smooth signal for easier analysis (cleans up signal)
- HPF and LPF operate together as a "band pass"

■ Scanner speed

- Scanner RPM to adjust the scanner speed as required
- Now linked to the HPF and LPF parameters

■ Synchronizing angle

- Enables to assist with the clock positioning of the defect located within the fastener hole



04

What is New for BHEC

The NEW solution

Introduction of the next generation of Nortec

A portable eddy current flaw detector with enhanced capabilities and including Eddy Current Array (ECA) features

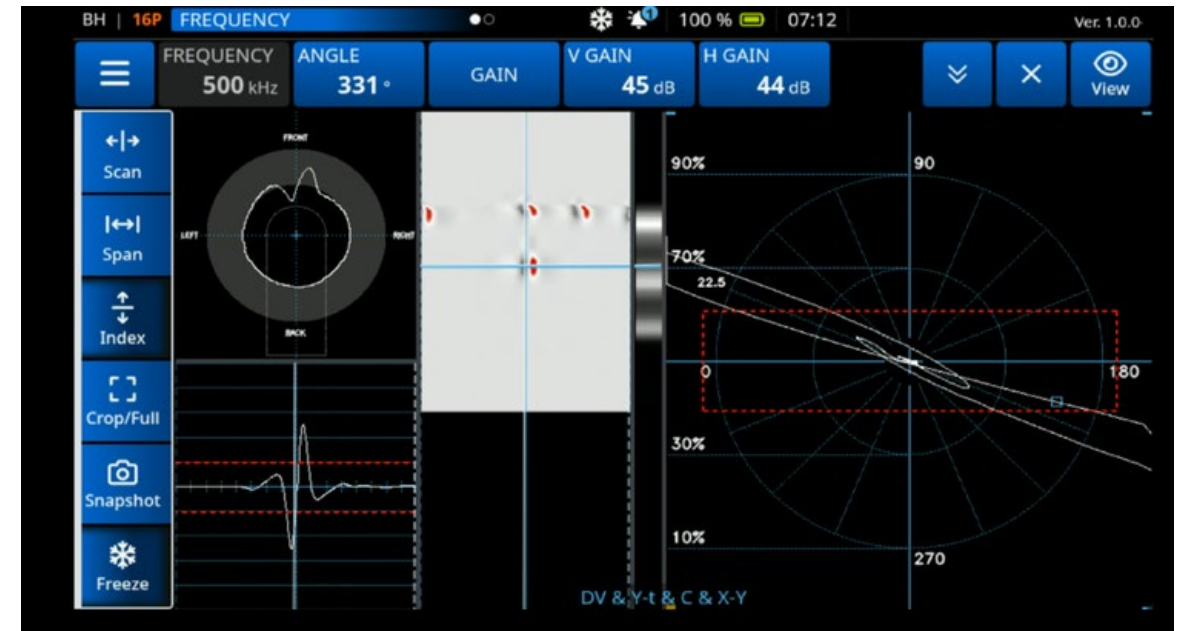
- New and improved menu structure
- Dedicated filters selectable between "figure 6" or "figure 8"
- Simpler configuration thanks to the filter "Link" option to provide the operators with automatically adjusted filters based on the scanner speed (manual adjustment still optional)



The NEW solution

Implementation of dedicated solutions

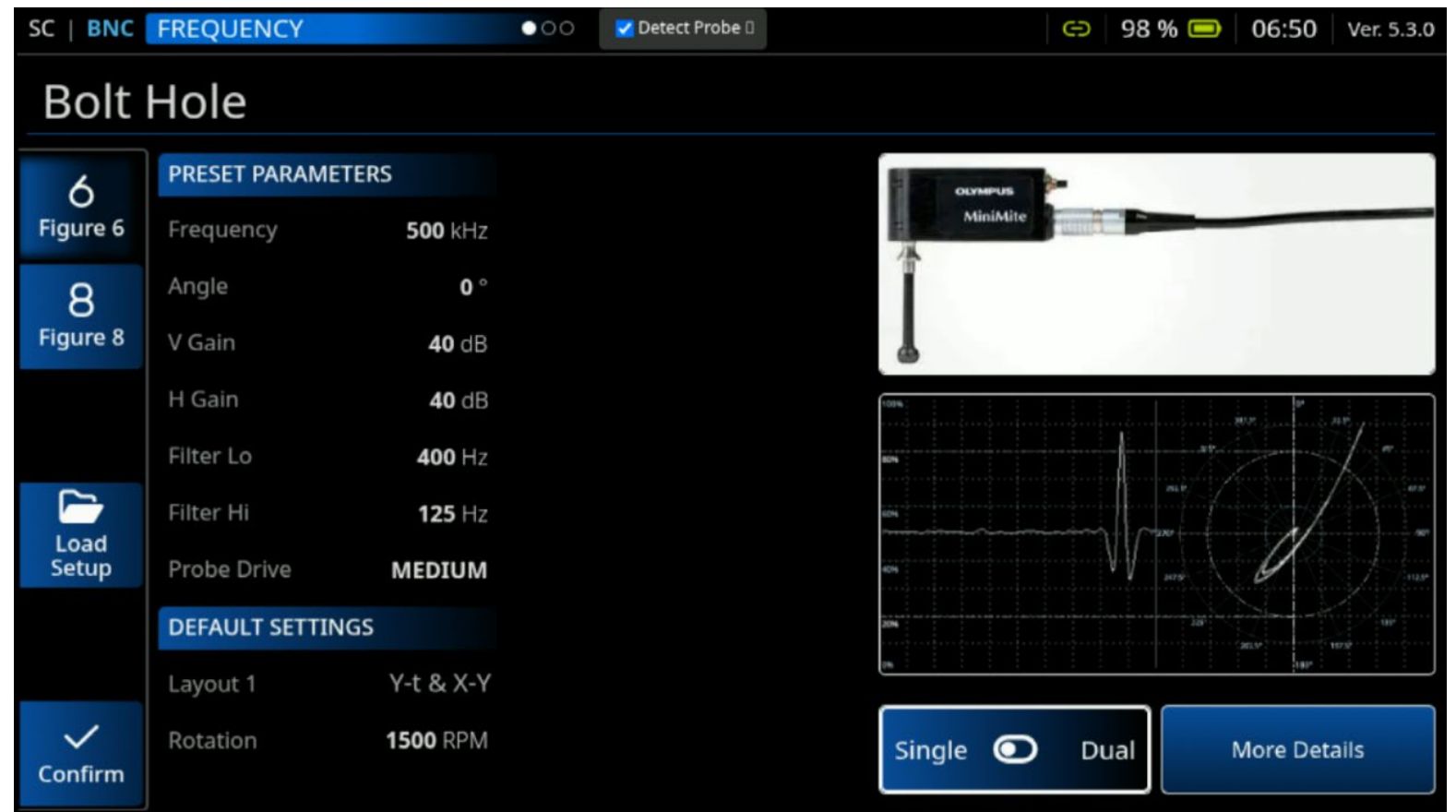
- Automatic layer detection and Freeze mode bringing new levels of precision to bolt-hole and multi-layer inspections
- N700i uses intelligent signal interpretation to accurately distinguish between fastener hole and the structure layers
 - True defect responses
 - Fewer false calls
 - Reduced rework
- The “Defect Viewer” makes defect localization easier with the direct hole view and the overlay image from the Nortec scanner



The NEW solution

BHEC Application Window on the 700

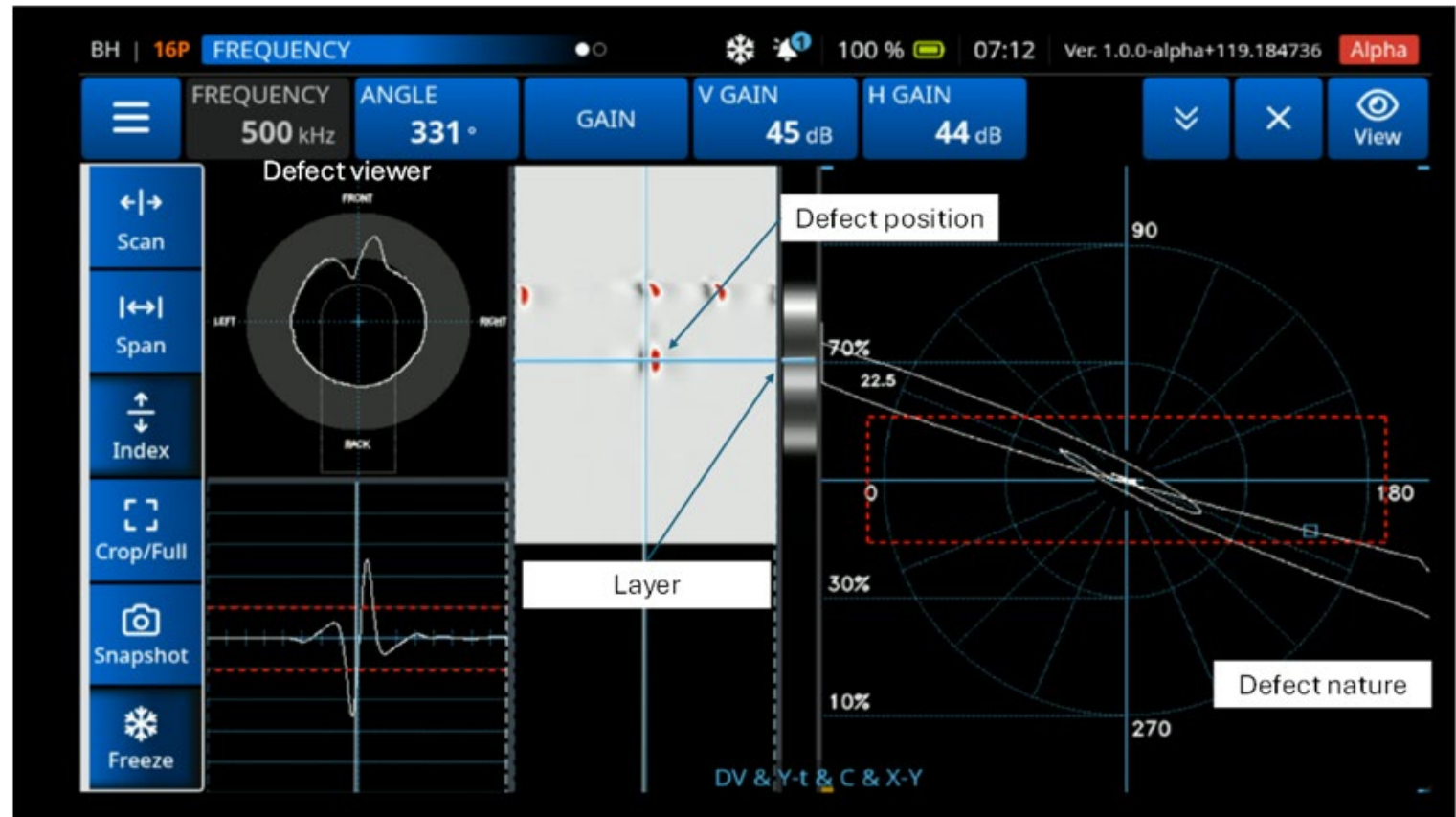
- Option to select Figure 6 or 8
- Single or Dual frequency as needed



The NEW solution

Updated Layout Display

- Defect Viewer
- C-Scan image for defect position
- Layer Viewer for defect location
- Polar Grid (Impedance Display)
- Swept Display



The NEW solution

Adjustment 1

- Scan cursor and Span have been adjusted to show the 1st indication on the outermost layer - Corner Notch
- The indication in the 6 o'clock position
- DV "Defect Viewer," Y-t displays, C-scan, and X-Y displays



The NEW solution

Adjustment 2

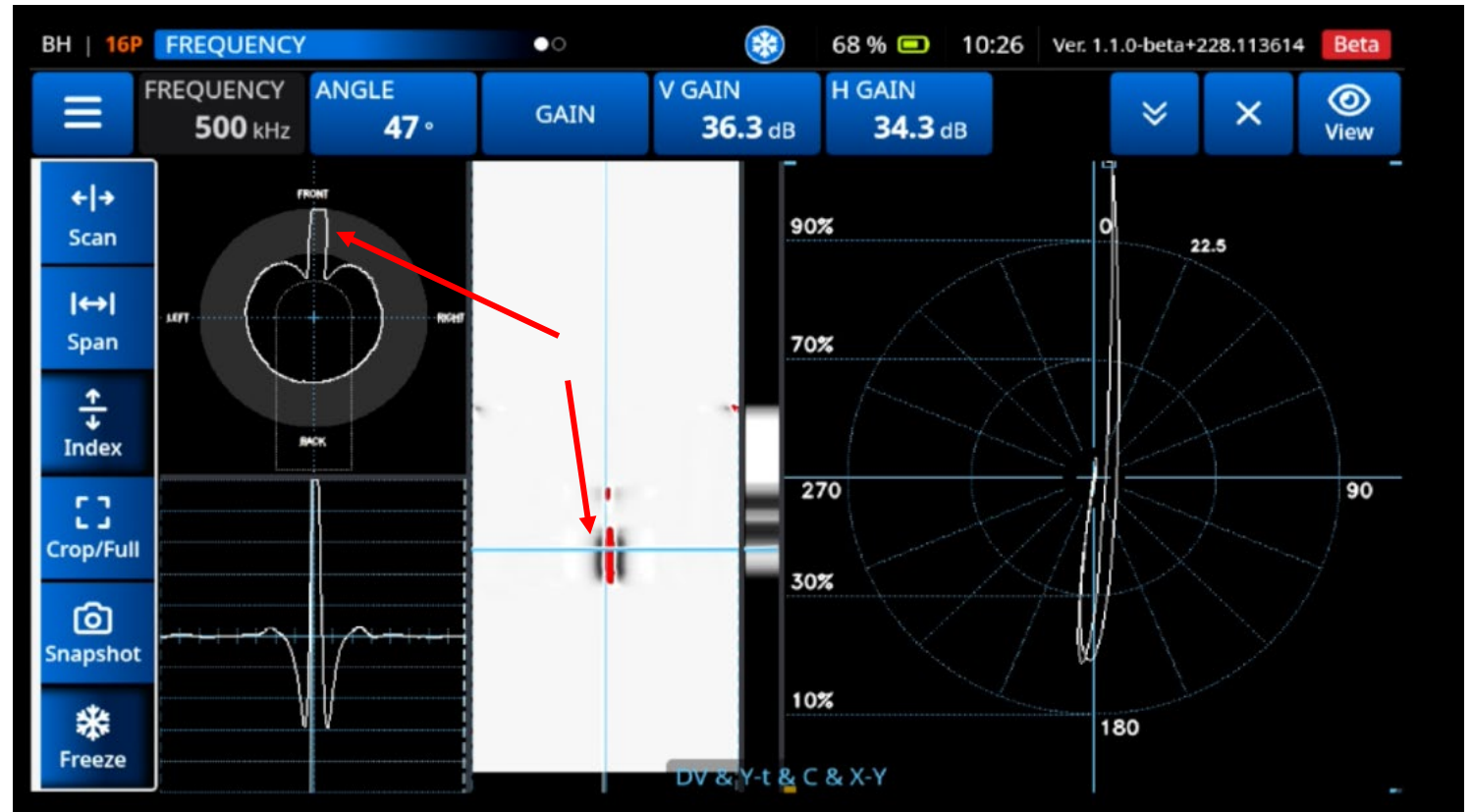
- Scan cursor further down the C-scan, to see that the 2nd indication is another concern notch
- The indication in the 12 o'clock position
- DV "Defect Viewer," Y-t displays, C-scan, and X-Y displays



The NEW solution

Adjustment 3

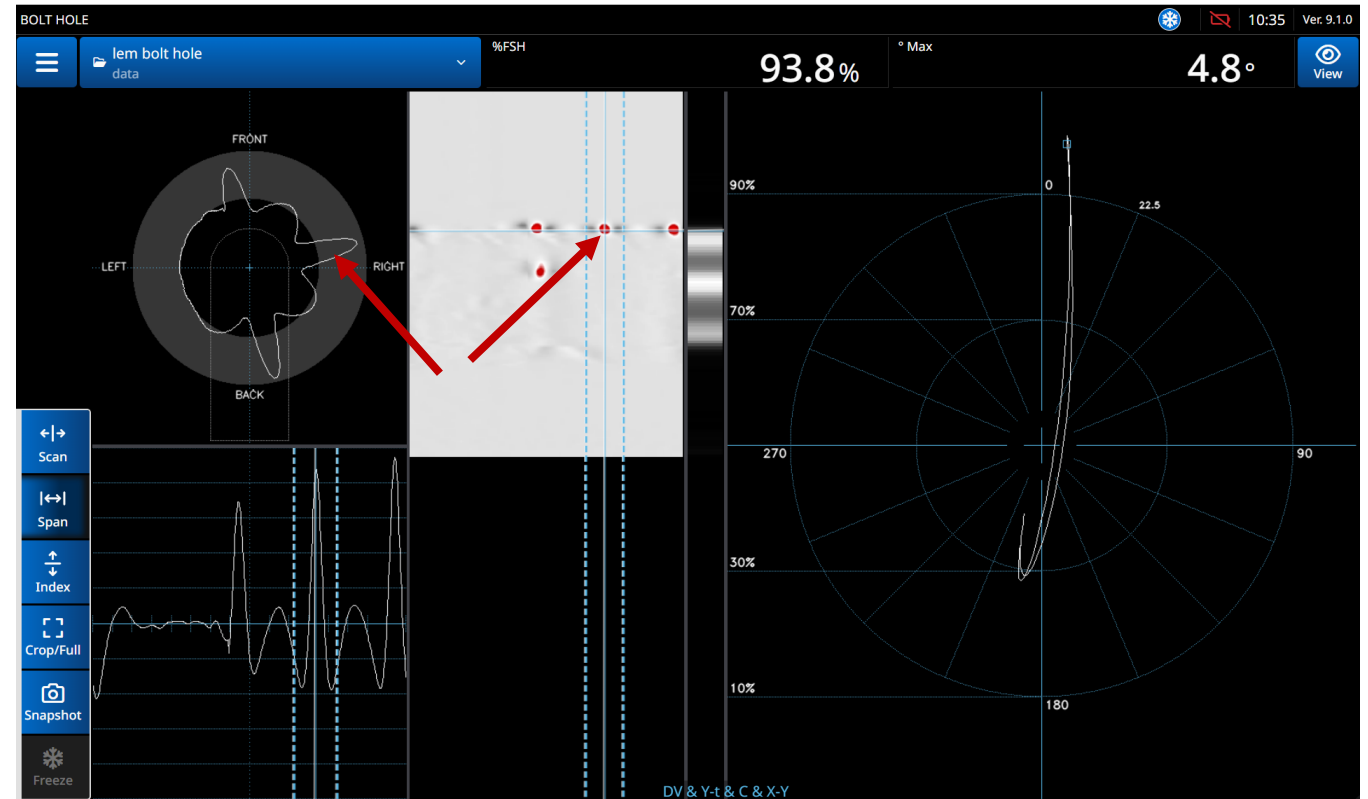
- Scan cursor now adjusted on the 3rd and largest indication on the C-scan
- Notch is through the full length of the 3rd layer
- The indication in the 12 o'clock position
- DV "Defect Viewer," Y-t displays, C-scan, and X-Y displays



The NEW solution

Multiple indications

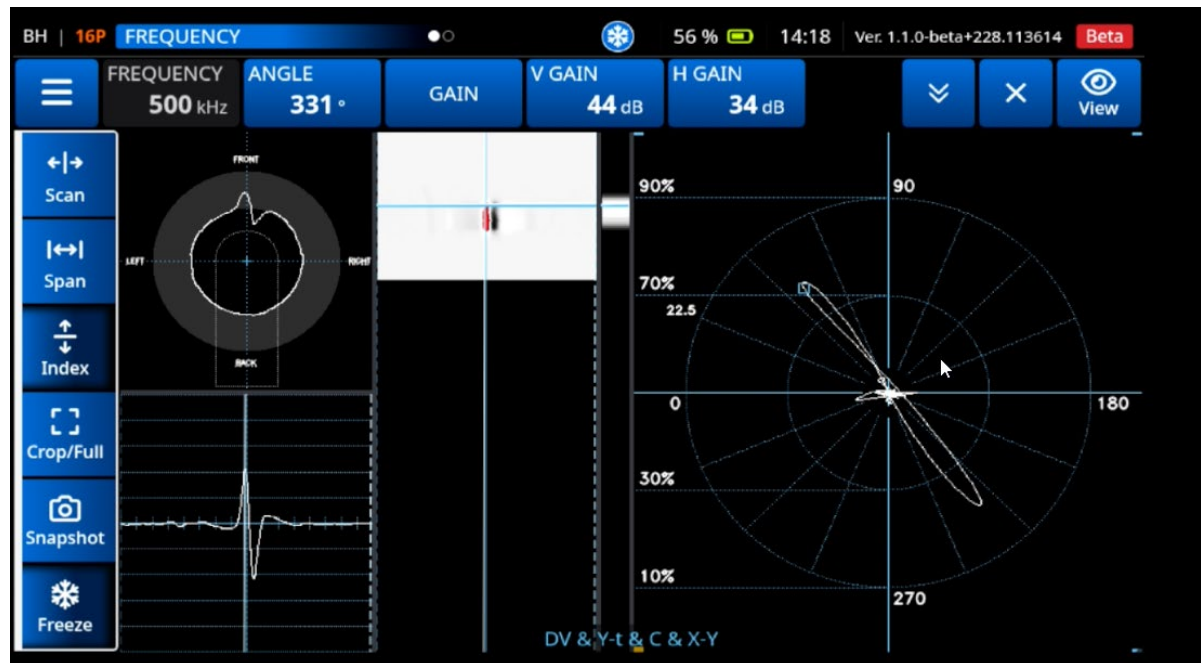
- The scan/span cursor has also been adjusted to highlight one of the indications
- The indication in the 3 o'clock position
- DV "Defect Viewer," Y-t displays, C-scan, and X-Y displays



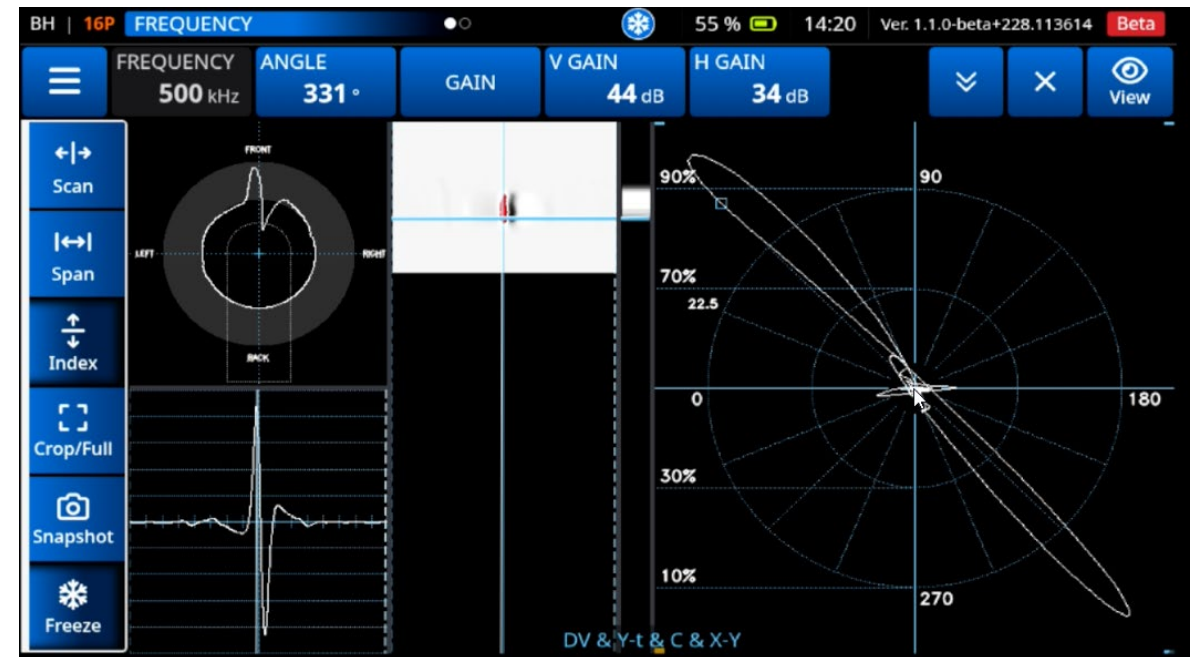
The NEW solution

Example of a tapered notch in a hole standard

70 % screen height



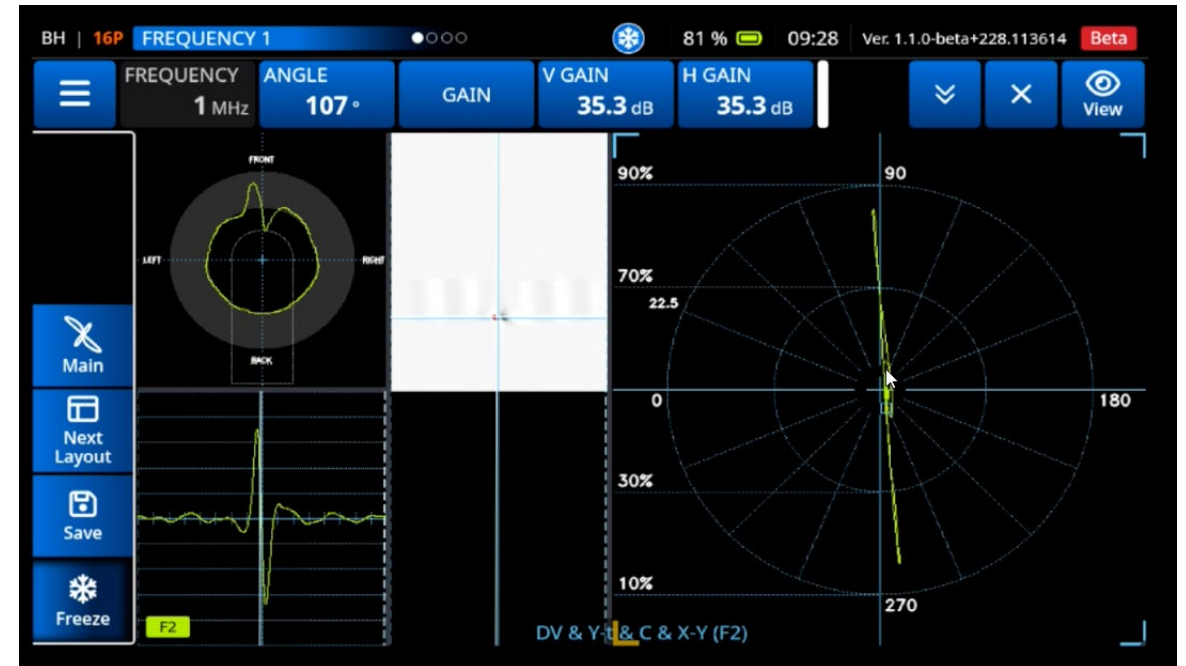
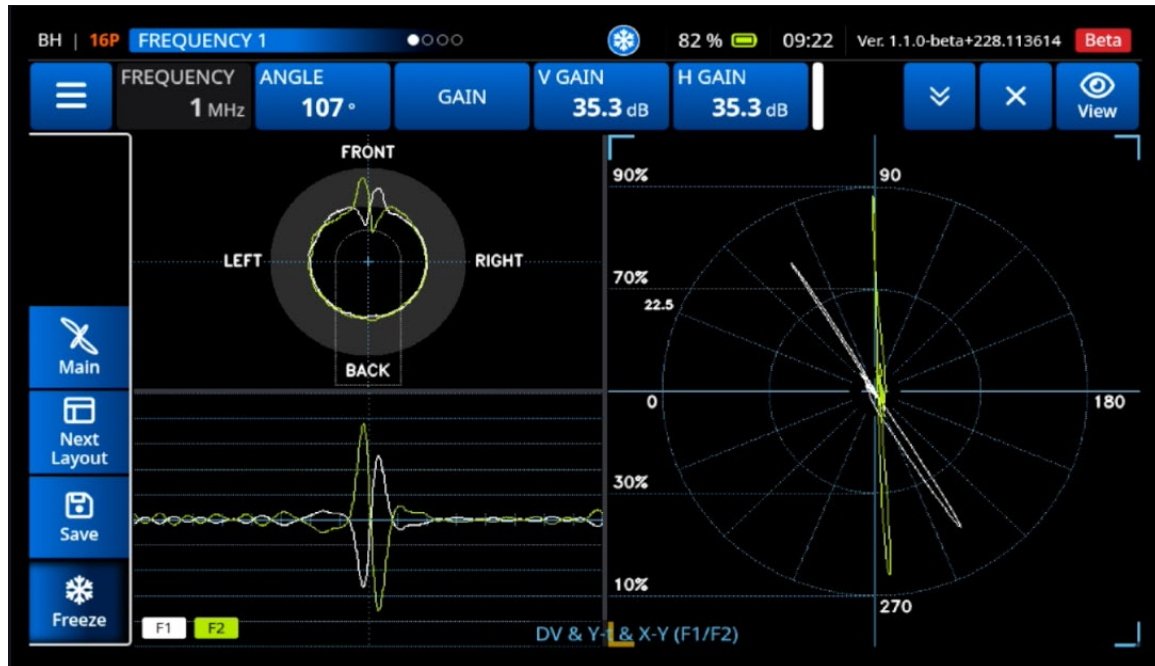
95% screen height



The NEW solution

Dual frequency

- New and improved feature on the N700i
- This will allow the operator to inspect difficult and challenging structures with dual frequency.

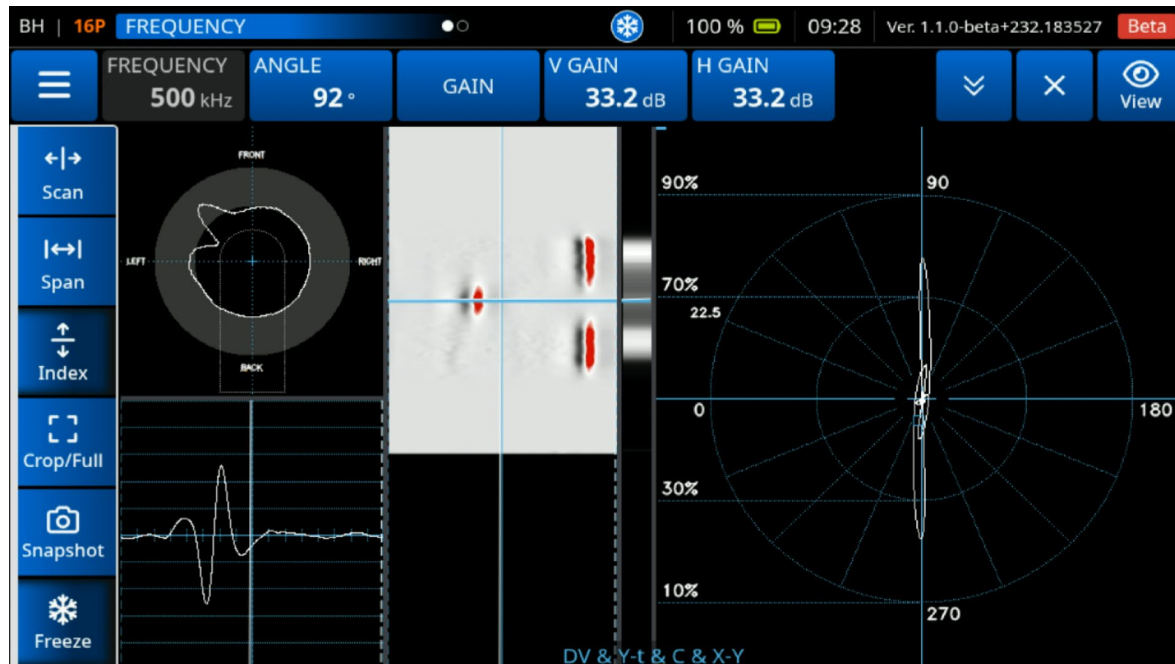


The NEW solution

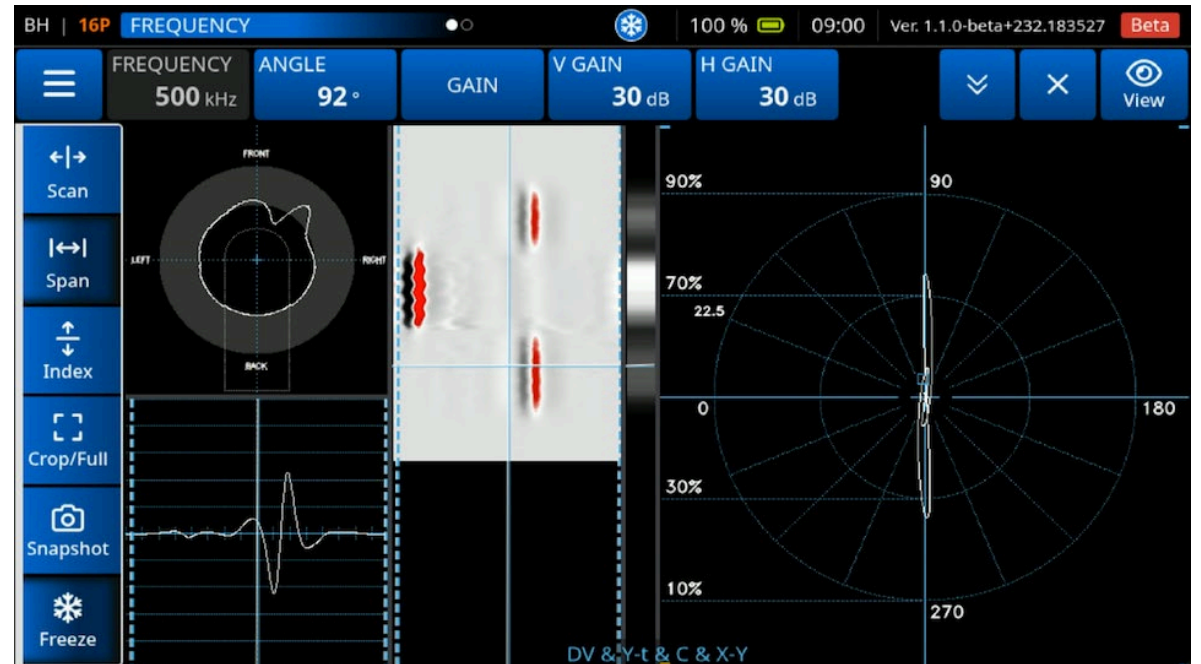
Multi-layers with dissimilar alloys

- Easier to detect the defects between the different alloy layers thanks to the new views
- Examples showing the multi-layer alloy and indicating positions and locations of notches (C-Scan and Layer Viewer)

Al-Ti-Al



Ti-4130-Ti

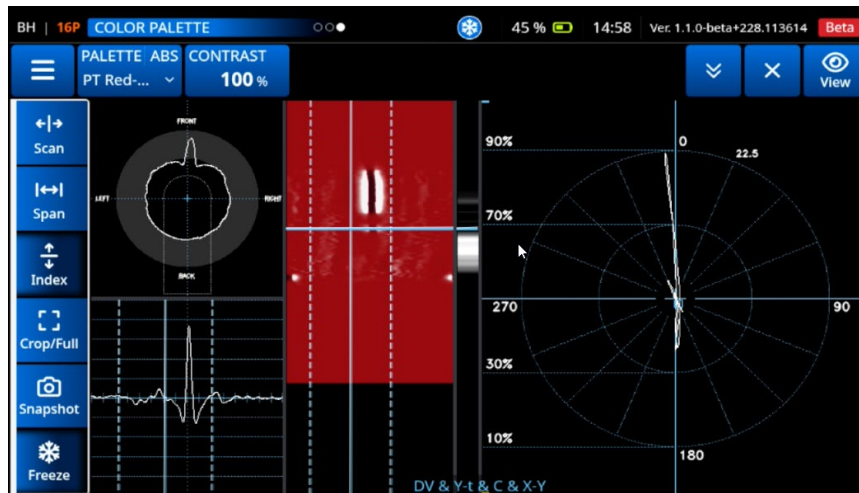


The NEW solution

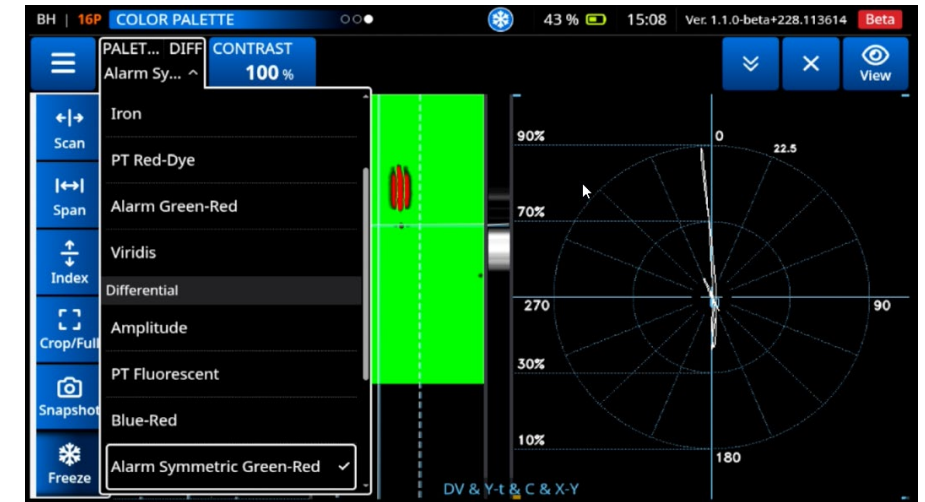
Color Palettes

- BHEC C-Scan also features different color palette options

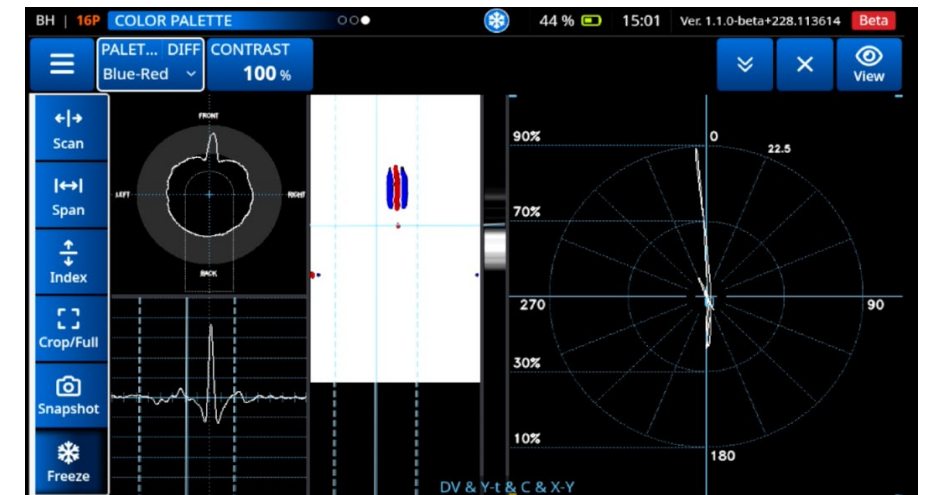
PT Red-Dye



Alarm Symmetric Green-Red



Blue-Red
"USA 250 Year Centennial"



Conclusions

The N700i features numerous improvements that enhance its capabilities for supporting bolt hole inspections

This should enable inspectors to analyze data more effectively and expedite the inspection process

- Speed up inspection time
- Improved signal-to-noise
- Reduction the number of false calls
- Figure 8 and 6 signal options
- Lynched filters to scanner speed
- Ability to analyze the data (New N700 app enables data analysis on a PC.)
- Ability to determine crack location and positions in a multi layer stack up

E IDENT

SEEING IS SOLVING

Thank you!
Any Questions?