



# ▶ UMI SCANS OF PLATES WITH PENETRATIONS AND PASSIVE MONITORING

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NATIONAL SHIPBUILDING RESEARCH PROGRAM (NSRP) FY25 PANEL PROJECT (PP25-29)

23 September 2026

Antech Team

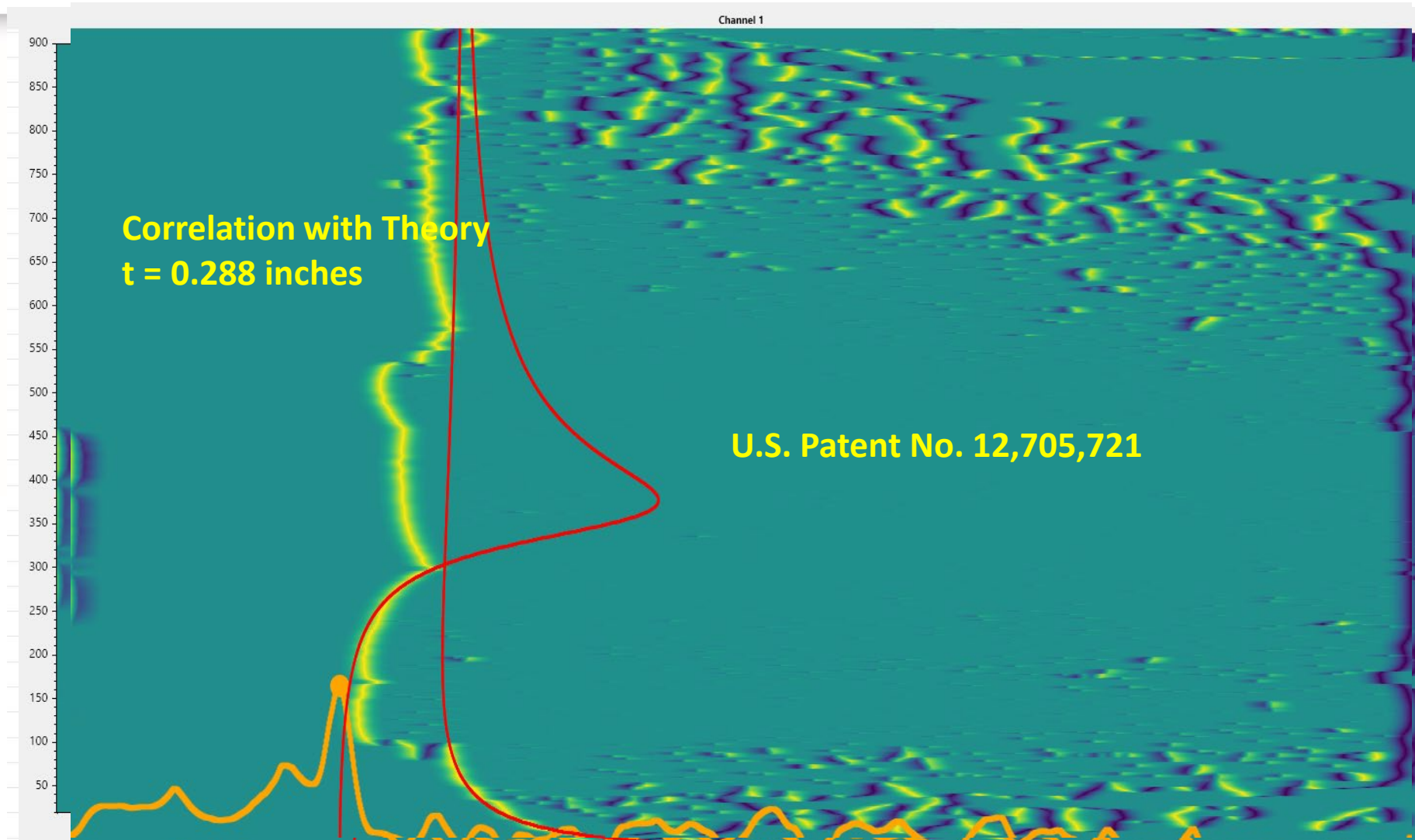
## ► UMI

- Ultrasonic mode imaging (UMI)
- Uses a highly researched ultrasonic wave called a Lamb wave (Sir Horace Lamb, 1917)
- Lamb wave propagation is extremely complex; first measurements made in the 1960s using a 22 Swift rifle and a large aluminum plate
- Since then, scanning using this mode has been researched
- This wave propagates down the length of a plate-like structure – very different from conventional ultrasound
- No point-by-point measurements needed for a scan

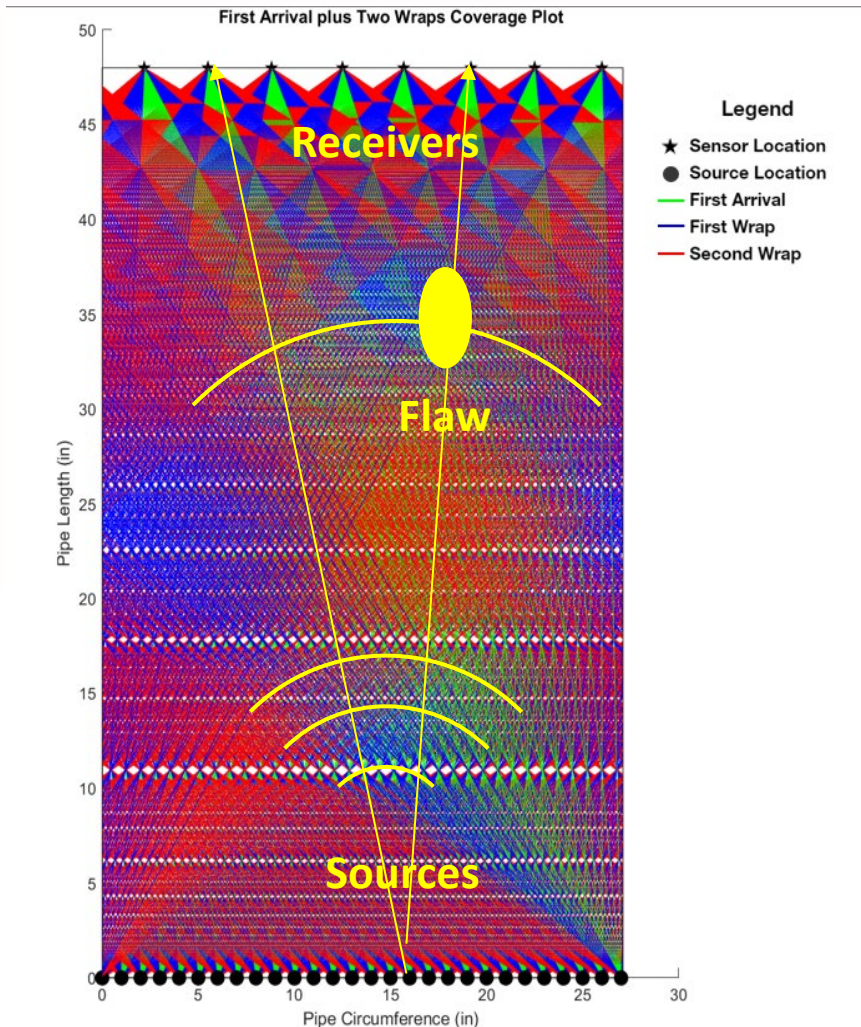
## ► APPLICATION

- Lamb waves stretch and compress the thickness of the plate as they propagate – think rubber band
- The ultrasonic source is like a throwing a rock into a pond, the wave spreads out in a circle, the wavefront interacts with the flaw, we measure that interaction
- We measure the flaw/wave interaction via the surface displacement with piezoelectric transducers, then correlate it directly to theory via image correlation
- Velocity is dependent on stiffness (thickness) – we measure changes in average velocity over the propagation distance, gives us average thickness measurements from source to receiver

# ► IMAGE PROCESSING OF LAMB WAVES

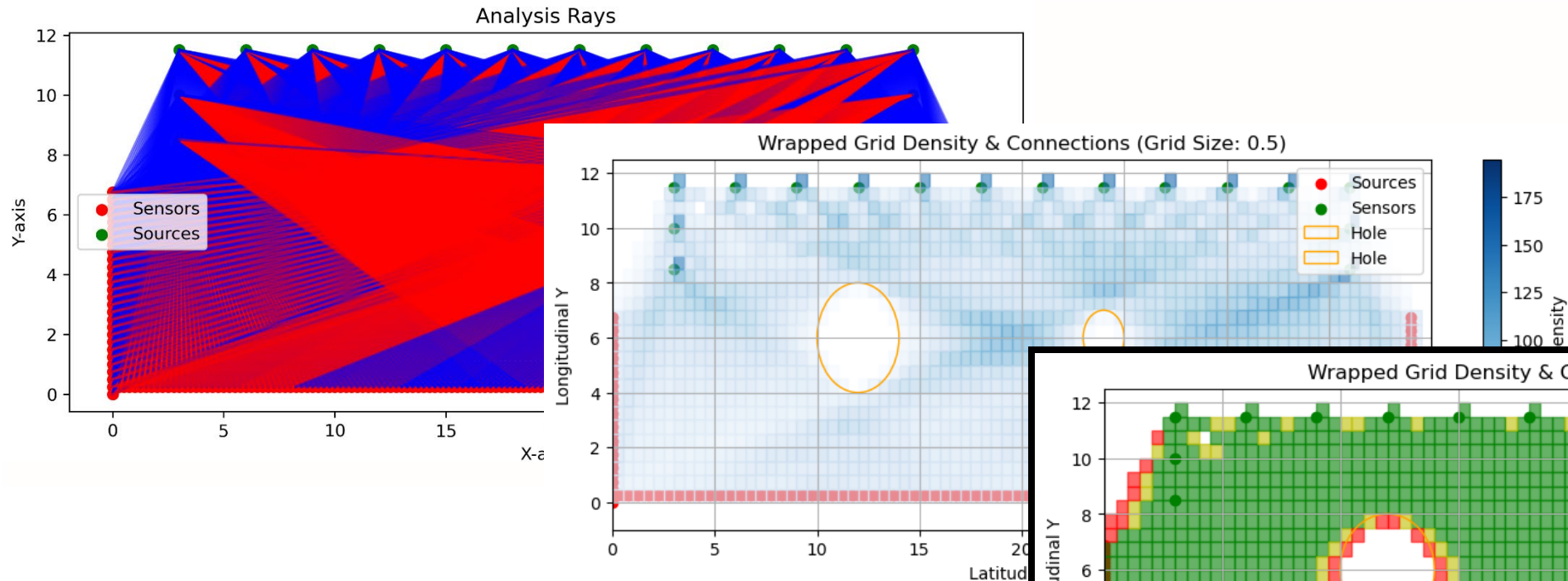


## ► IMAGING THE FLAW WITH TOMOGRAPHY



- Each ray, or beam, from source to receiver measures the average thickness along that beam – not overly useful
- Tomography is used to image pipe (CAT scan), and provide flaw information
- Summing and averaging the rays will image flaws

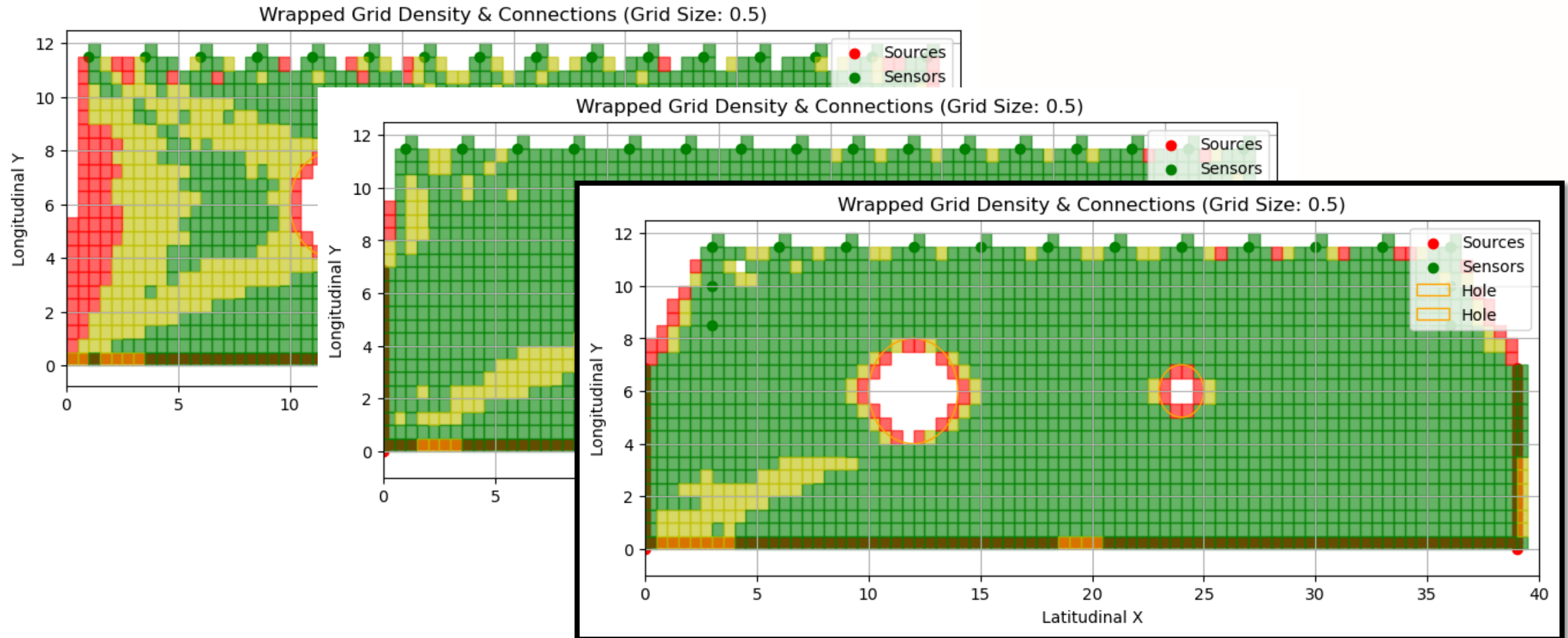
# ► BEAM MAPPING TO BEAM DENSITY



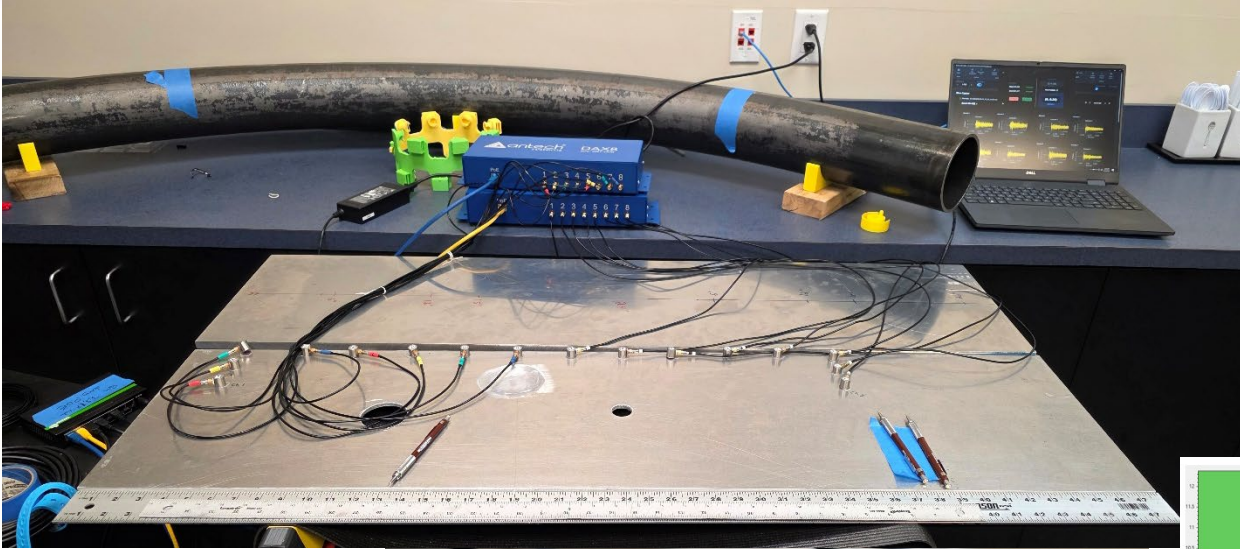
- Used new interface for test configurations

- Generated user interface concepts for conducting a UMI scan around a penetration

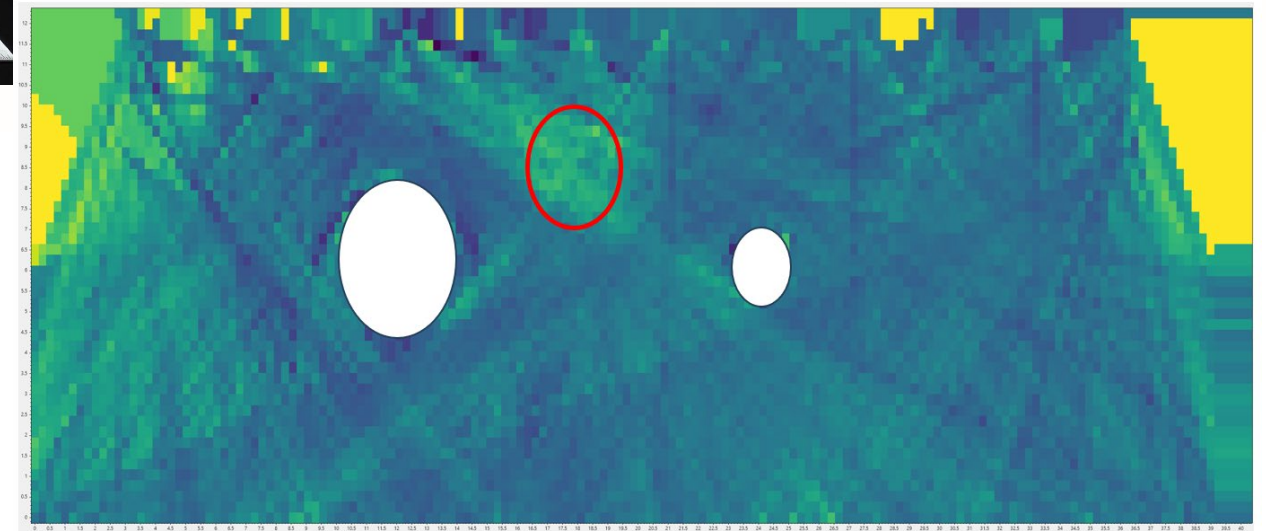
# ► CONFIGURATION ITERATIONS



## ► LAB TESTING

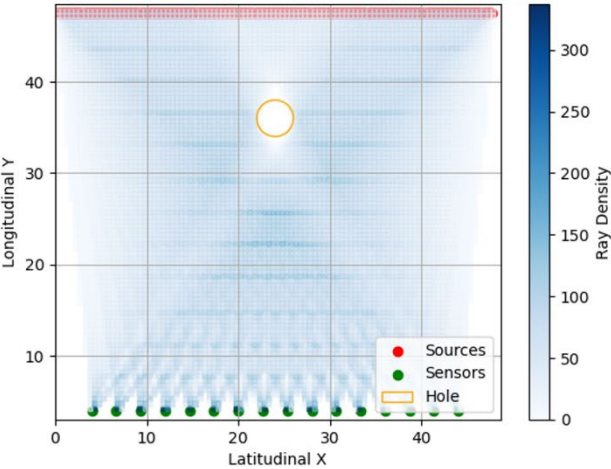


- Initial Lab test on 4' x 1' plate
- Plate has 2" and 1" holes
- Plate has a 50% flaw
- UMI Scan Successfully found flaw

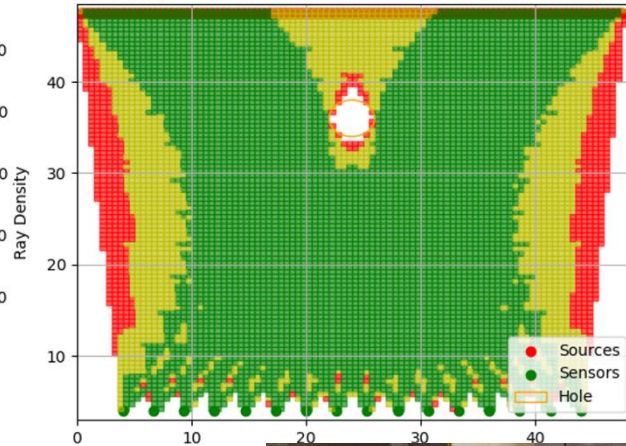


## ► SECOND ROUND LAB TESTING

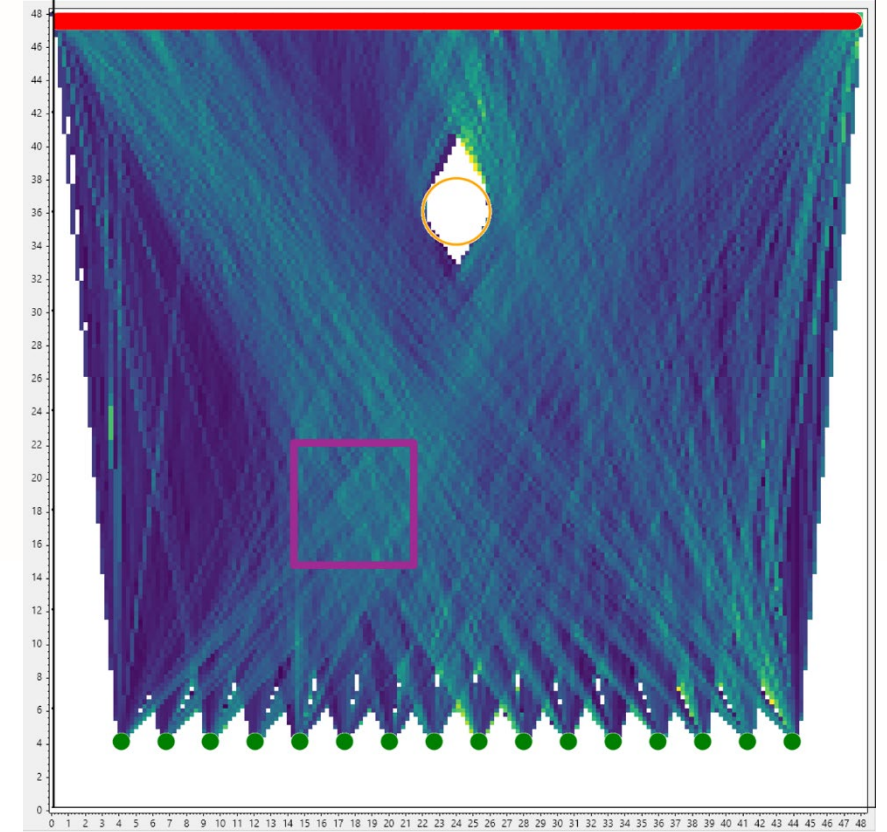
Wrapped Grid Density & Connections (Grid Size: 0.5)



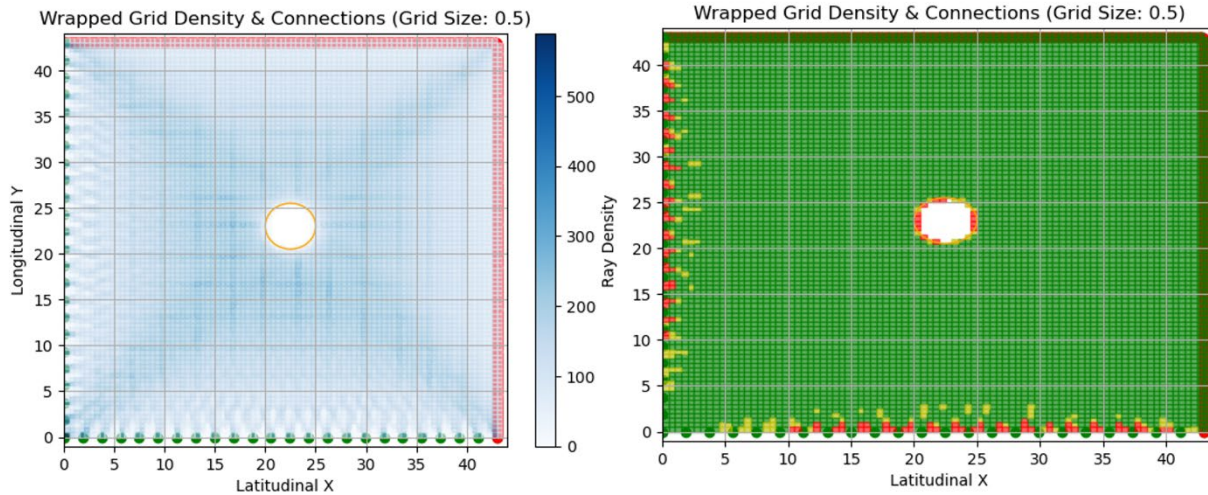
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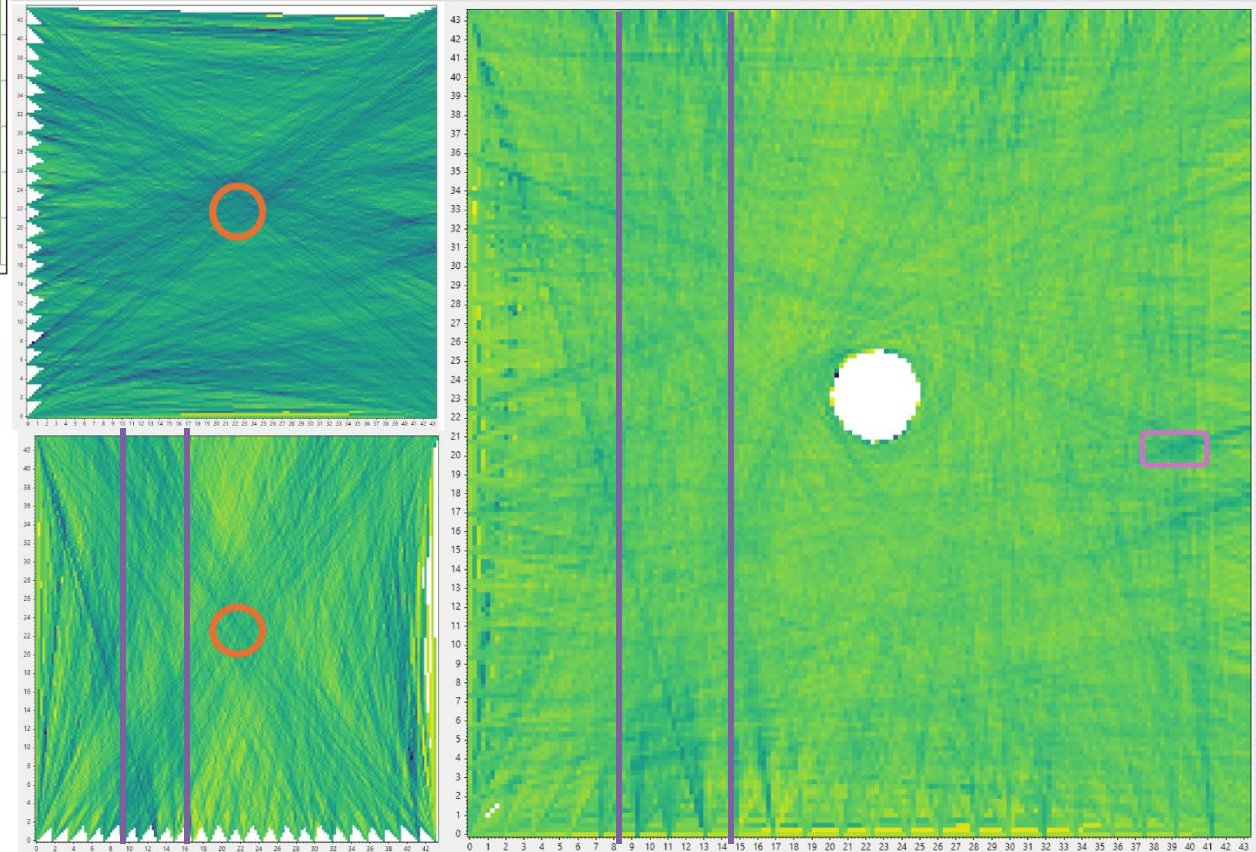
- Second Lab test on 4' x 4' plate
- Plate has 3" hole
- Plate has a 33% flaw
- UMI Scan Successfully found flaw



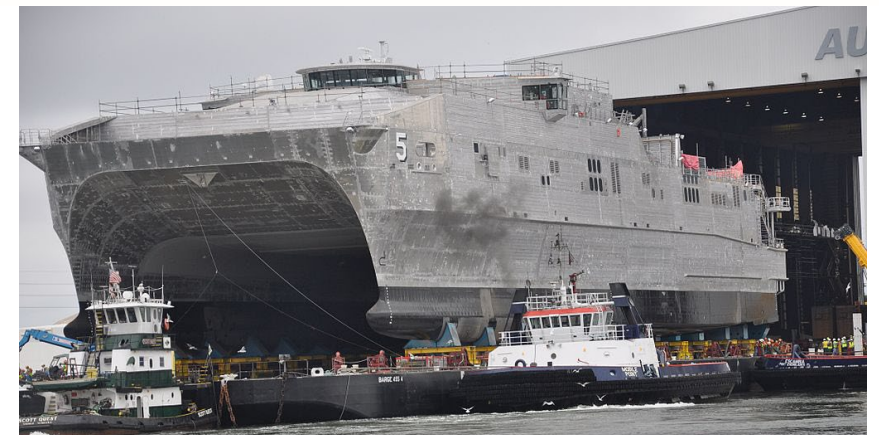
# ► FIELD TESTING AT NNSY



- ▣ Tested a tank at the NNSY
- ▣ Able to scan around flaw on a vertical surface
- ▣ UMI Scan successfully found thick section where pipe support is welded to under side



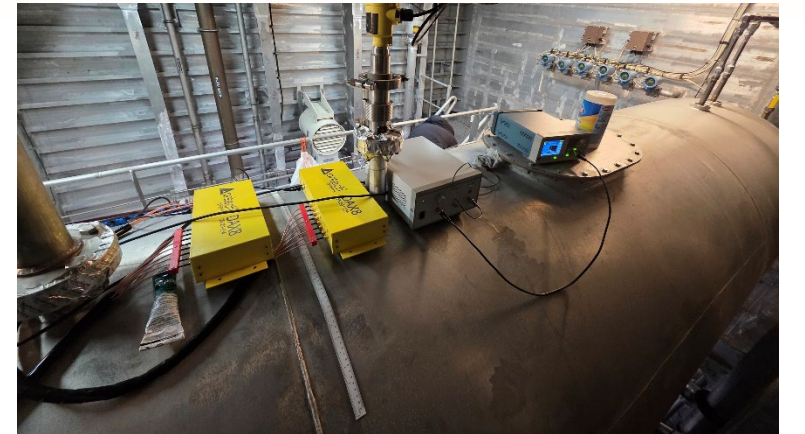
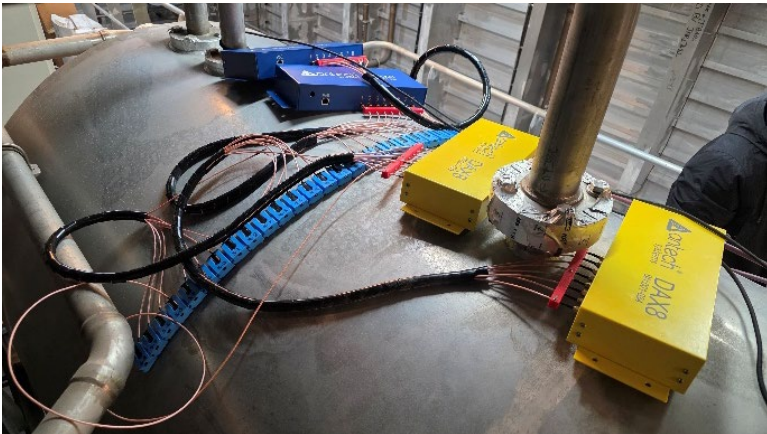
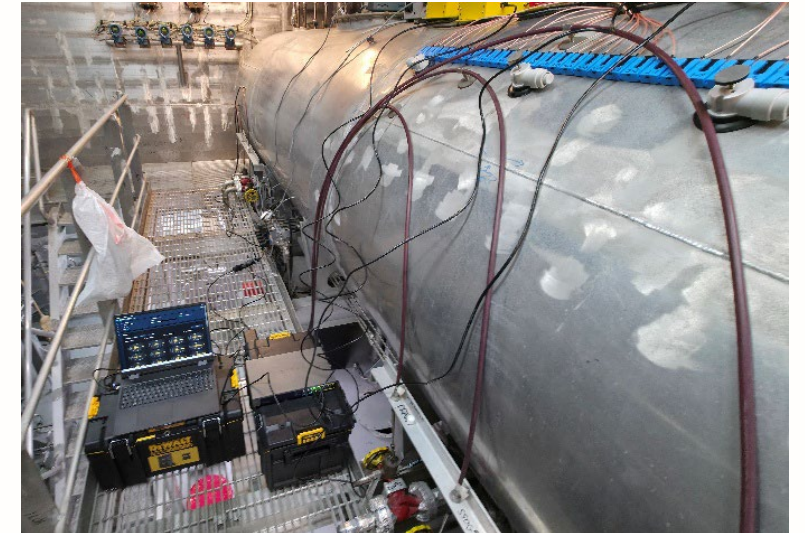
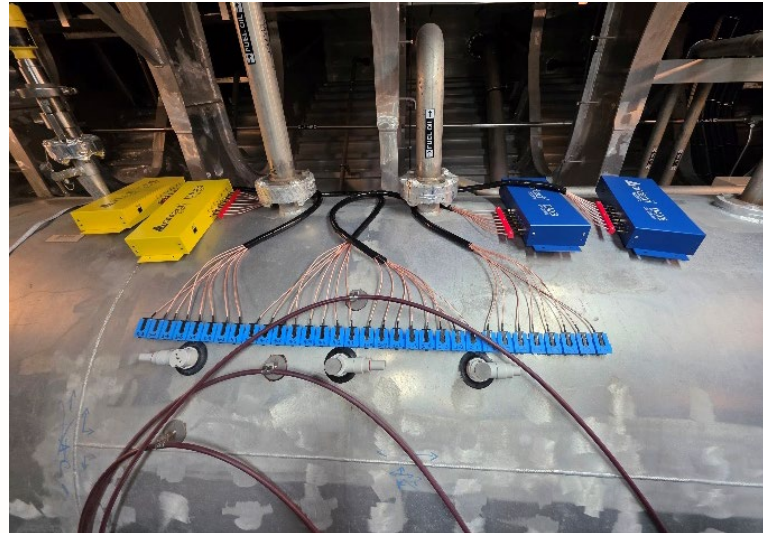
# ► SHIPBOARD TESTING



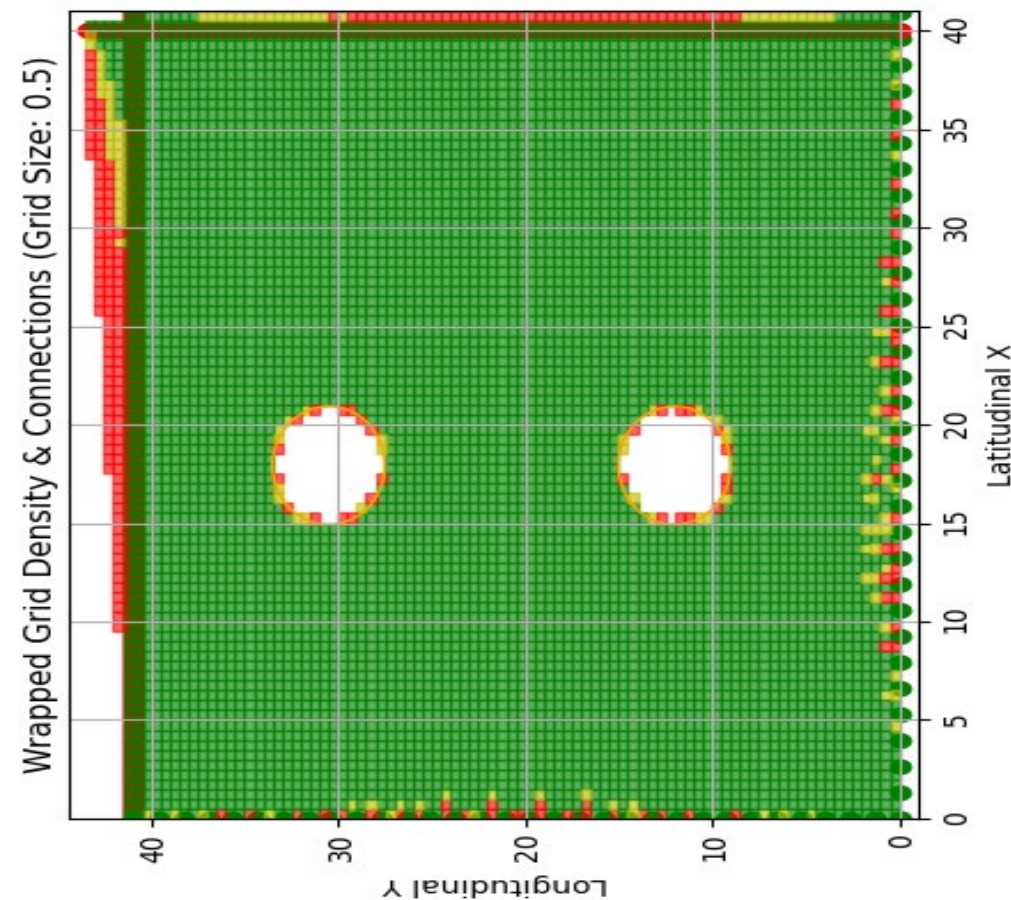
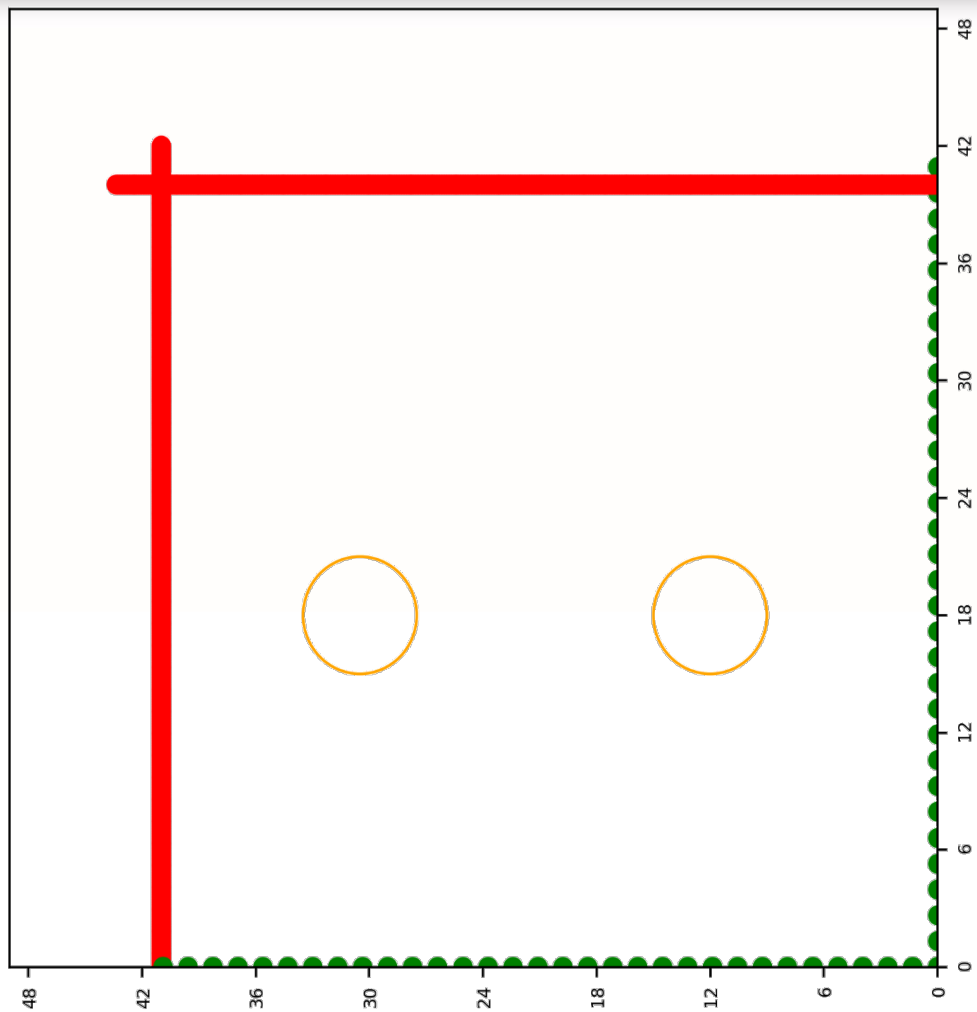
## ► TRANSPORT



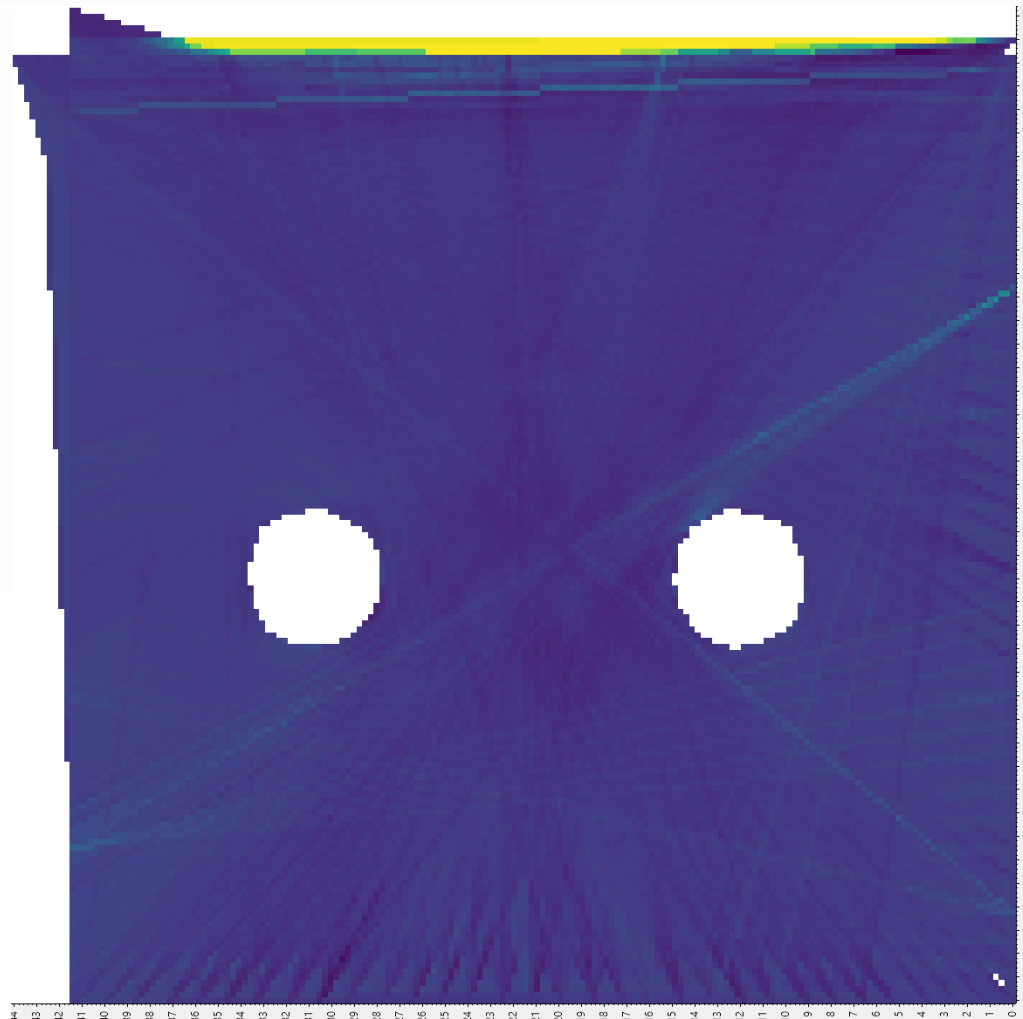
## ► TEST LOCATION



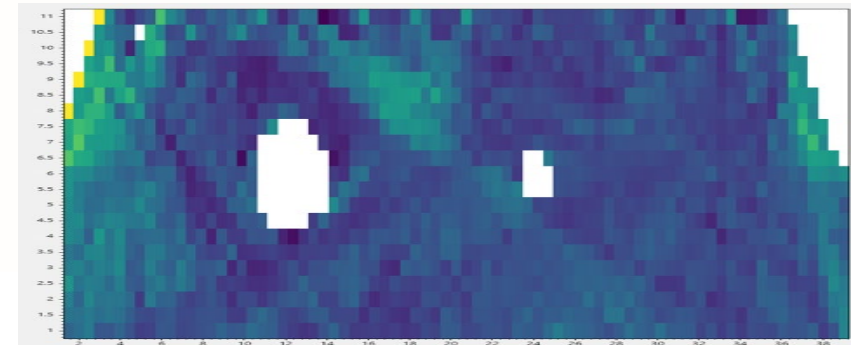
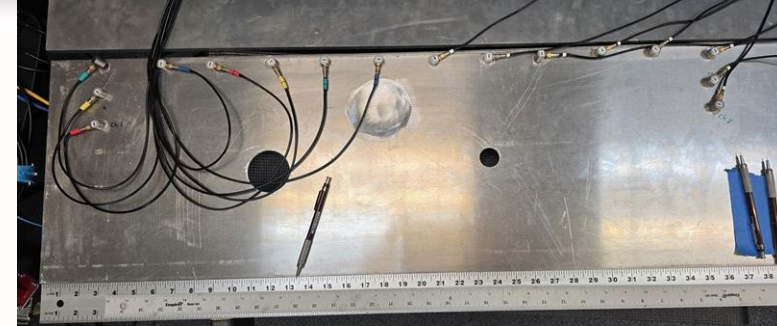
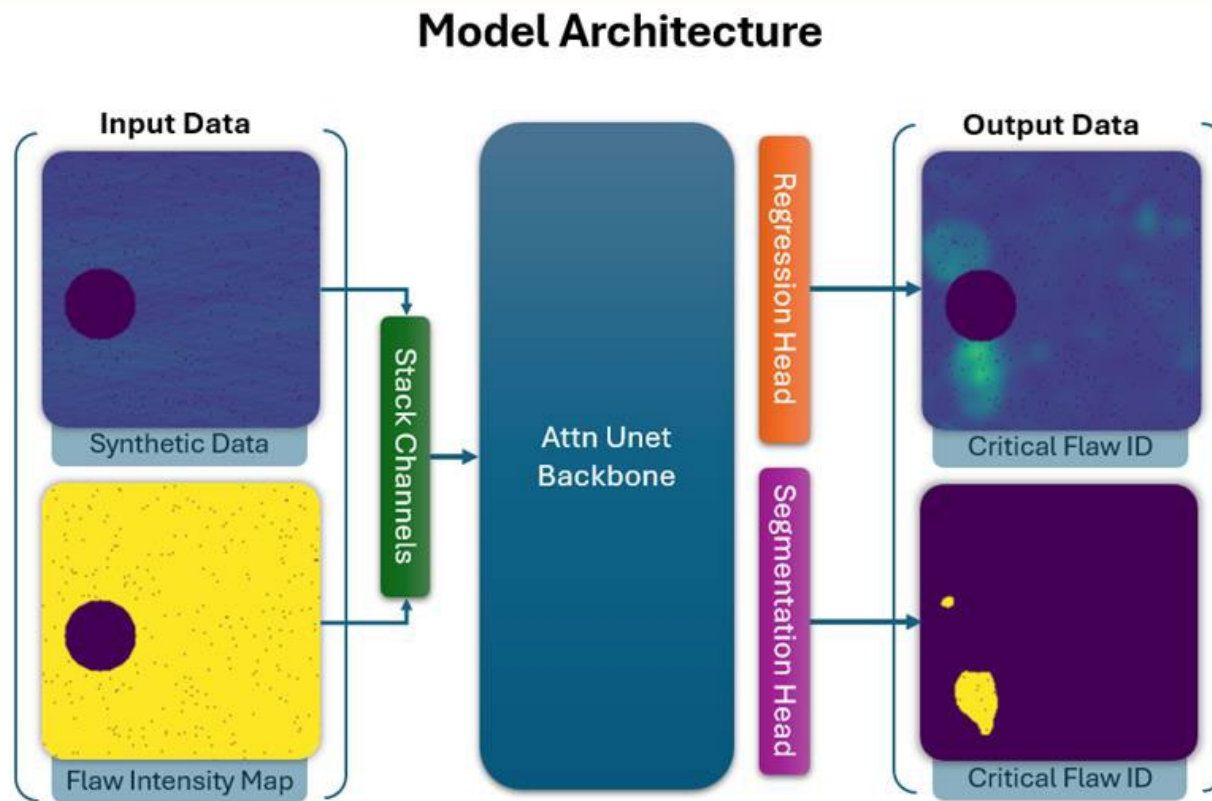
# ► SHIPBOARD TEST SETUP



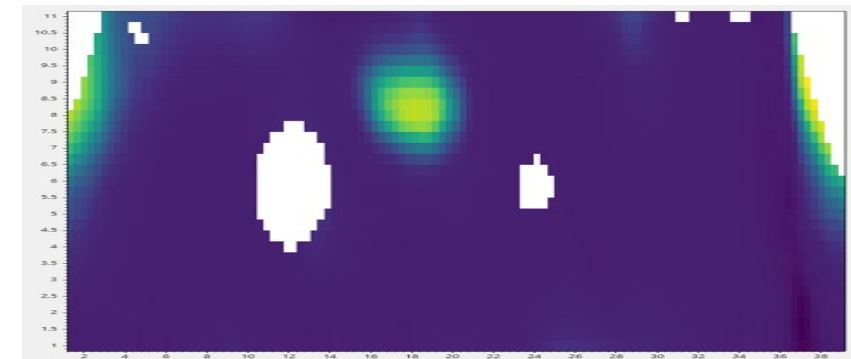
## ► SHIPBOARD TEST RESULTS



# ► AI FOR TOMOGRAPHY ENHANCEMENT



Base Tomography



AI Enhanced

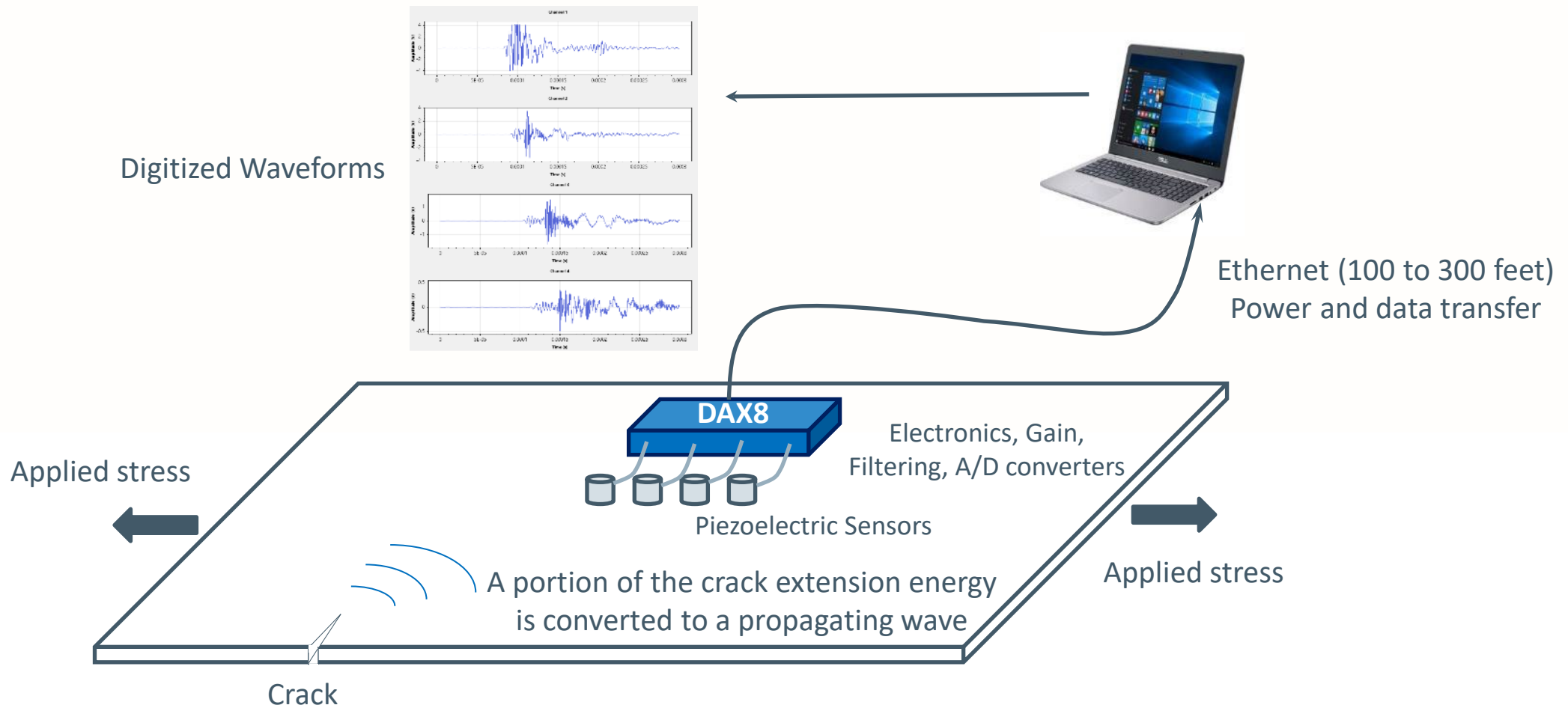
## ► MSC SHIPBOARD HULL MONITORING



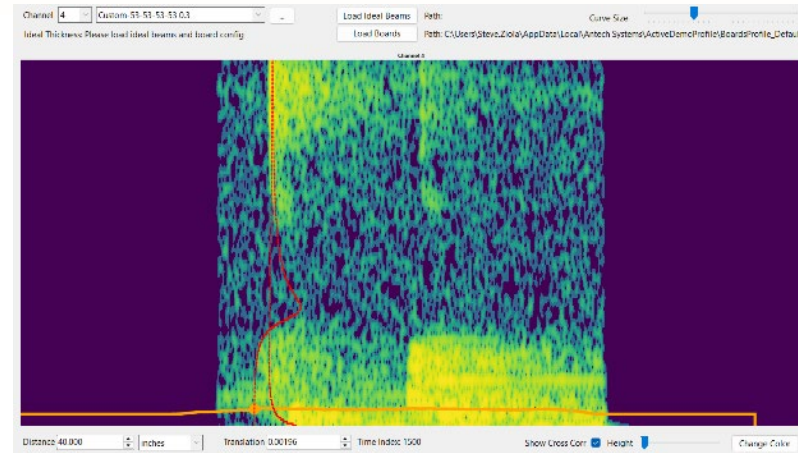
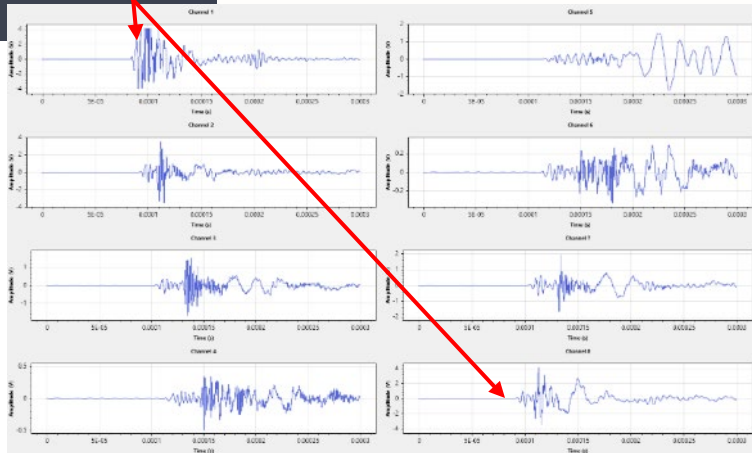
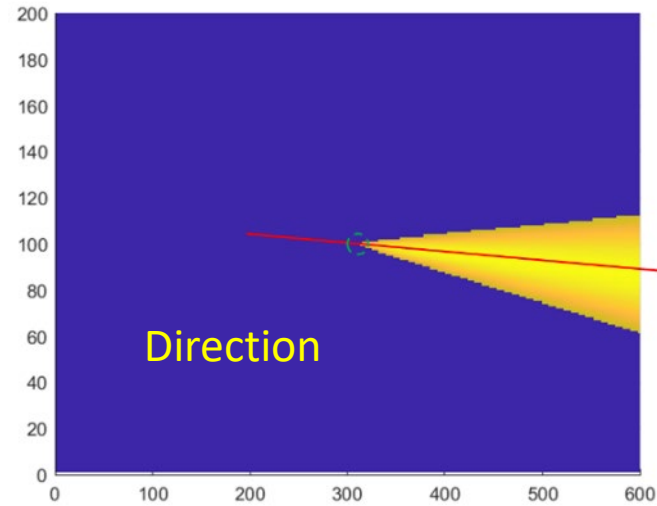
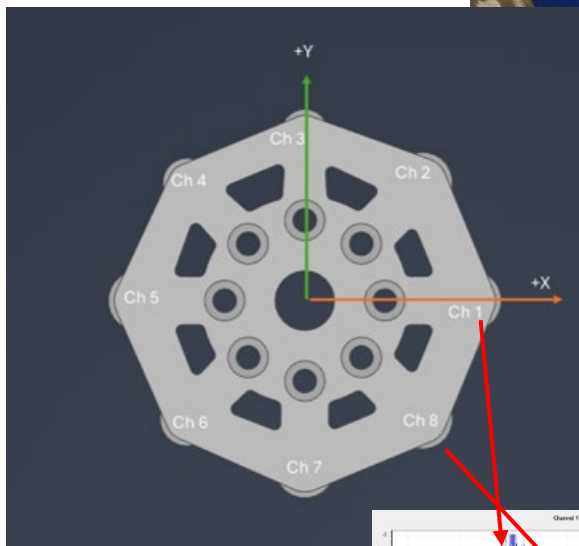
## ► SHIP STRUCTURE CONTINUOUS PASSIVE MONITORING

- ▣ Crack growth excites a wave
- ▣ We detect and analyze
- ▣ Provide real time feedback for ship structure
- ▣ No other technique provides this capability

## ► 2D PASSIVE UMI CONCEPT

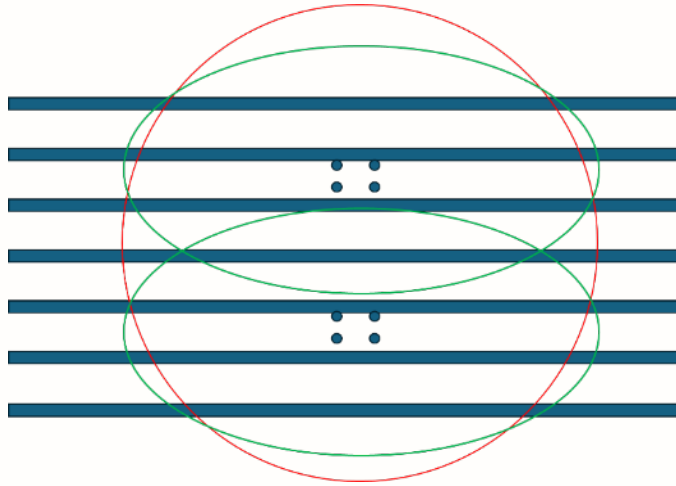


# ► RIDE CONTROL EQUIPMENT ROOM HULL MONITORING

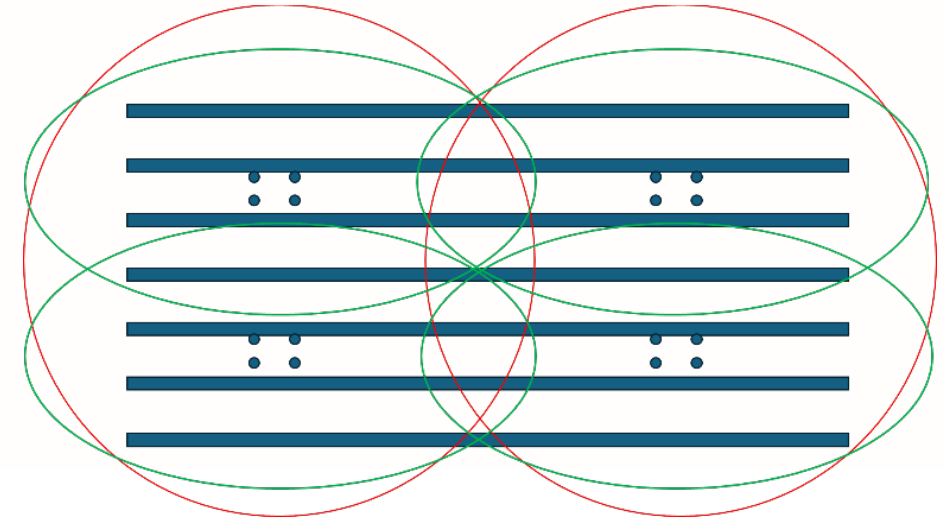
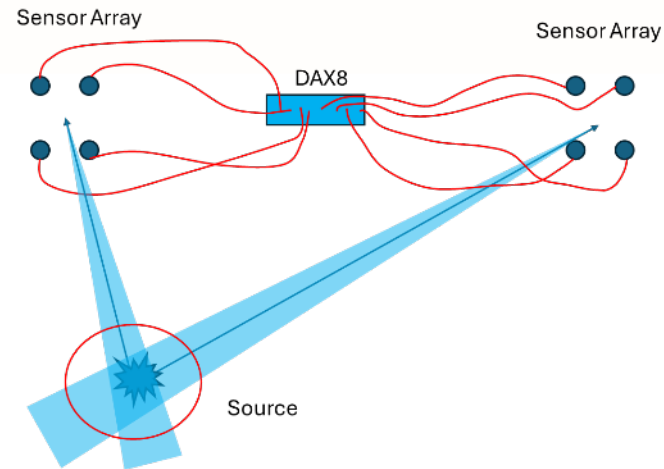


Ranging

## ► NEW ARRAY CONFIGURATIONS

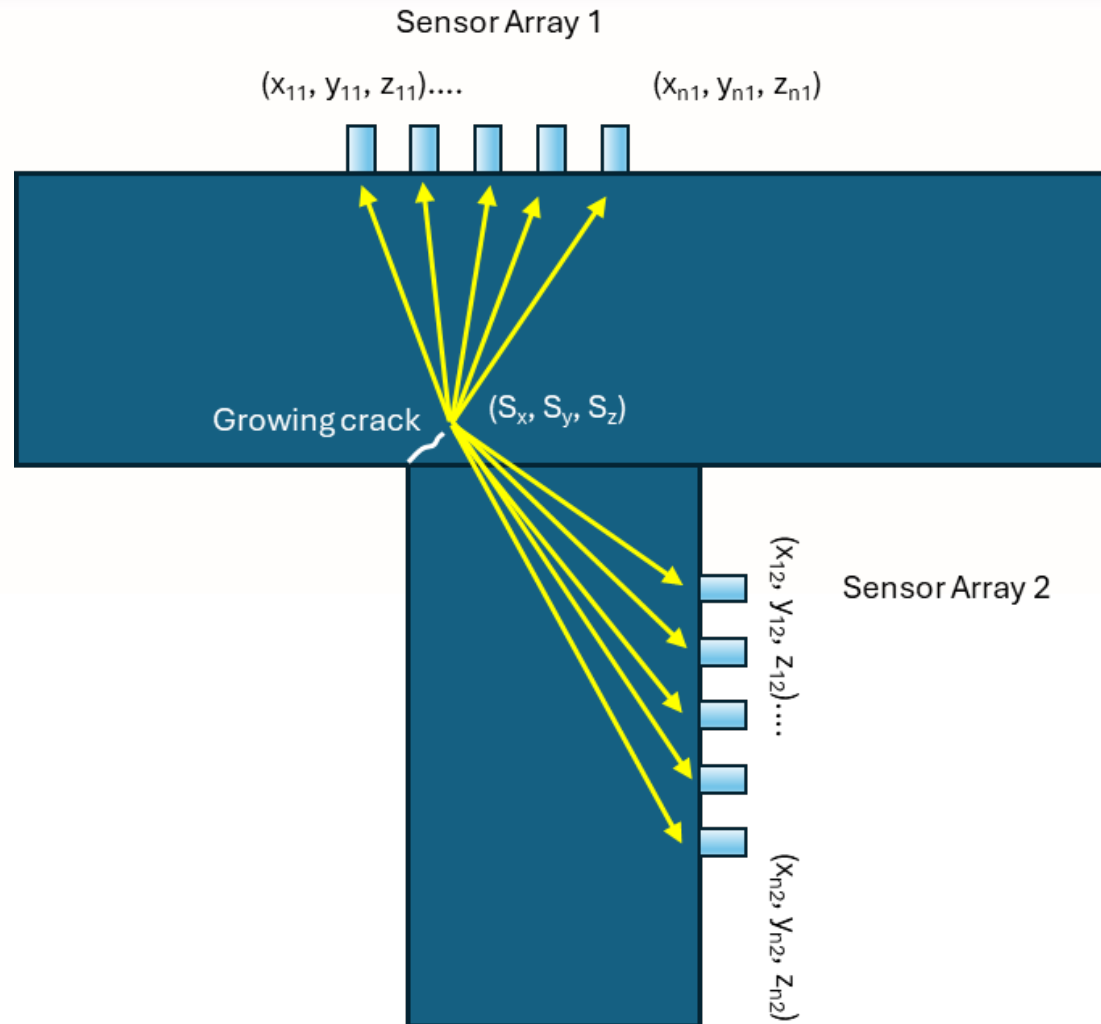


Two arrays expand coverage with no increase in electronics

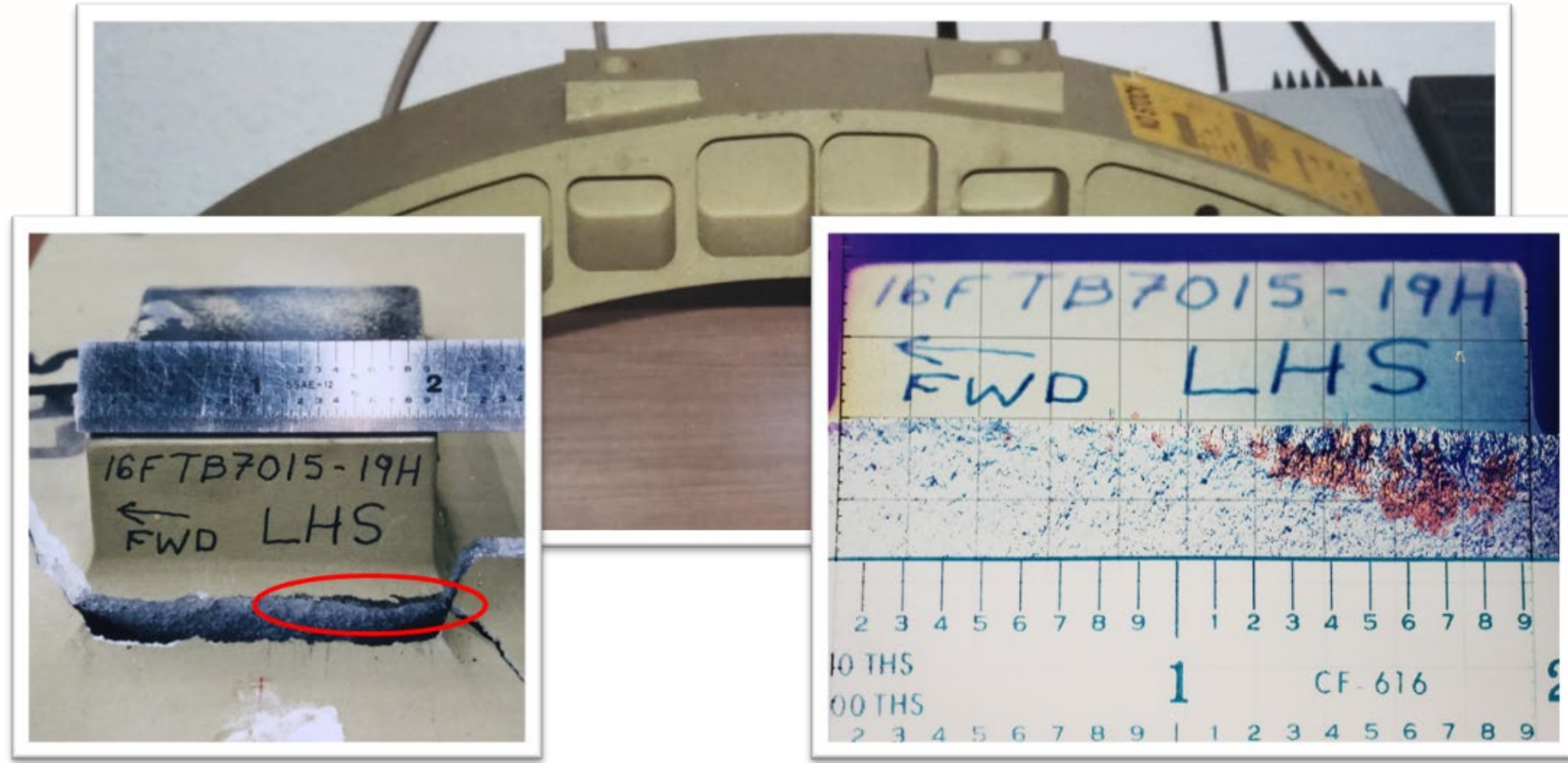


Coverage of the hull of the ride control room electronics

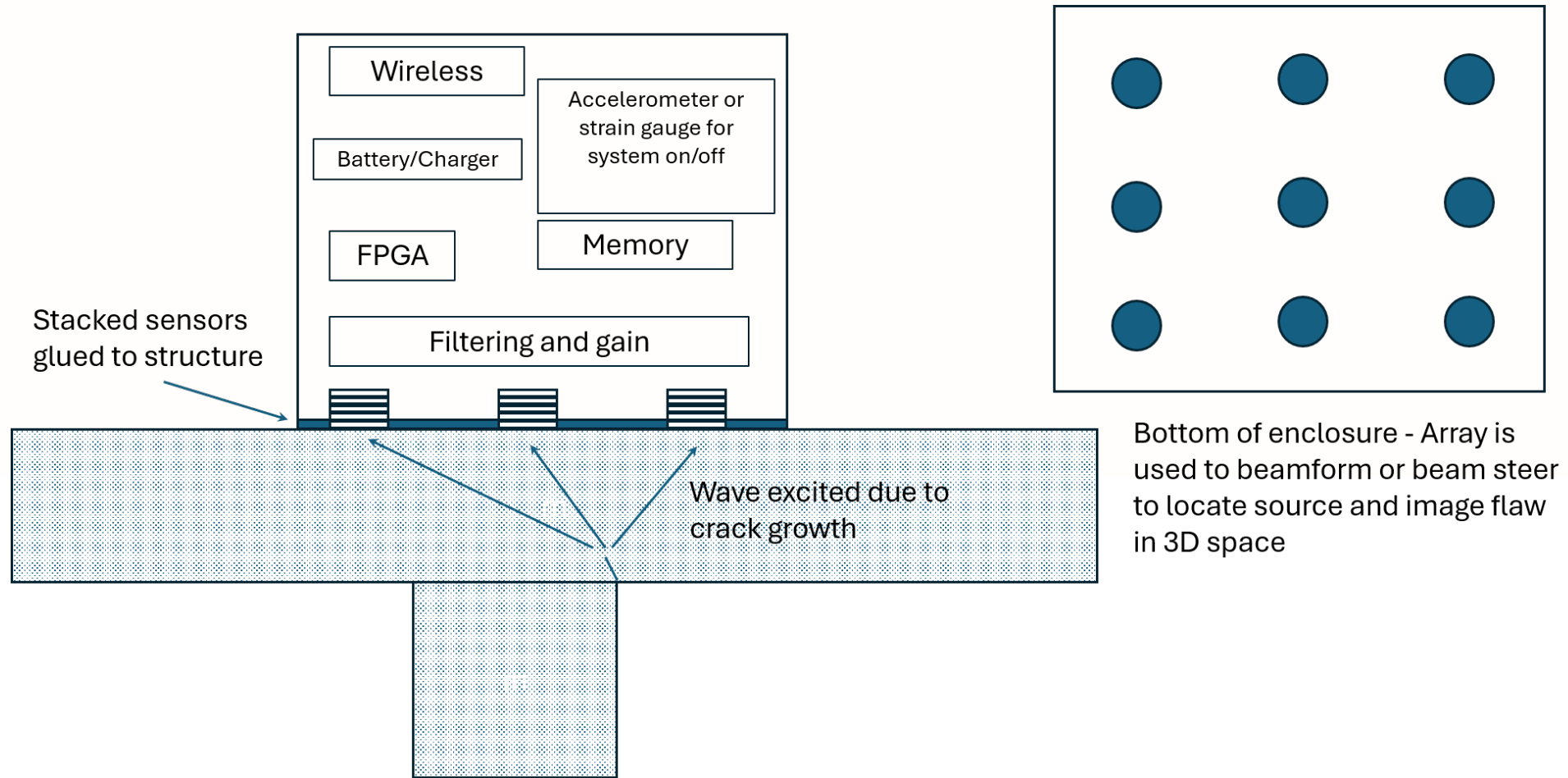
# ► THICK STRUCTURE MONITORING



## ► F-16 VERTICAL BULKHEAD ATTACH POINT MONITORING



# ► DISTRIBUTED STRUCTURAL WAVE-BASED AUTONOMOUS REMOTE MONITORING SYSTEM



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▶ **THANK YOU**

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