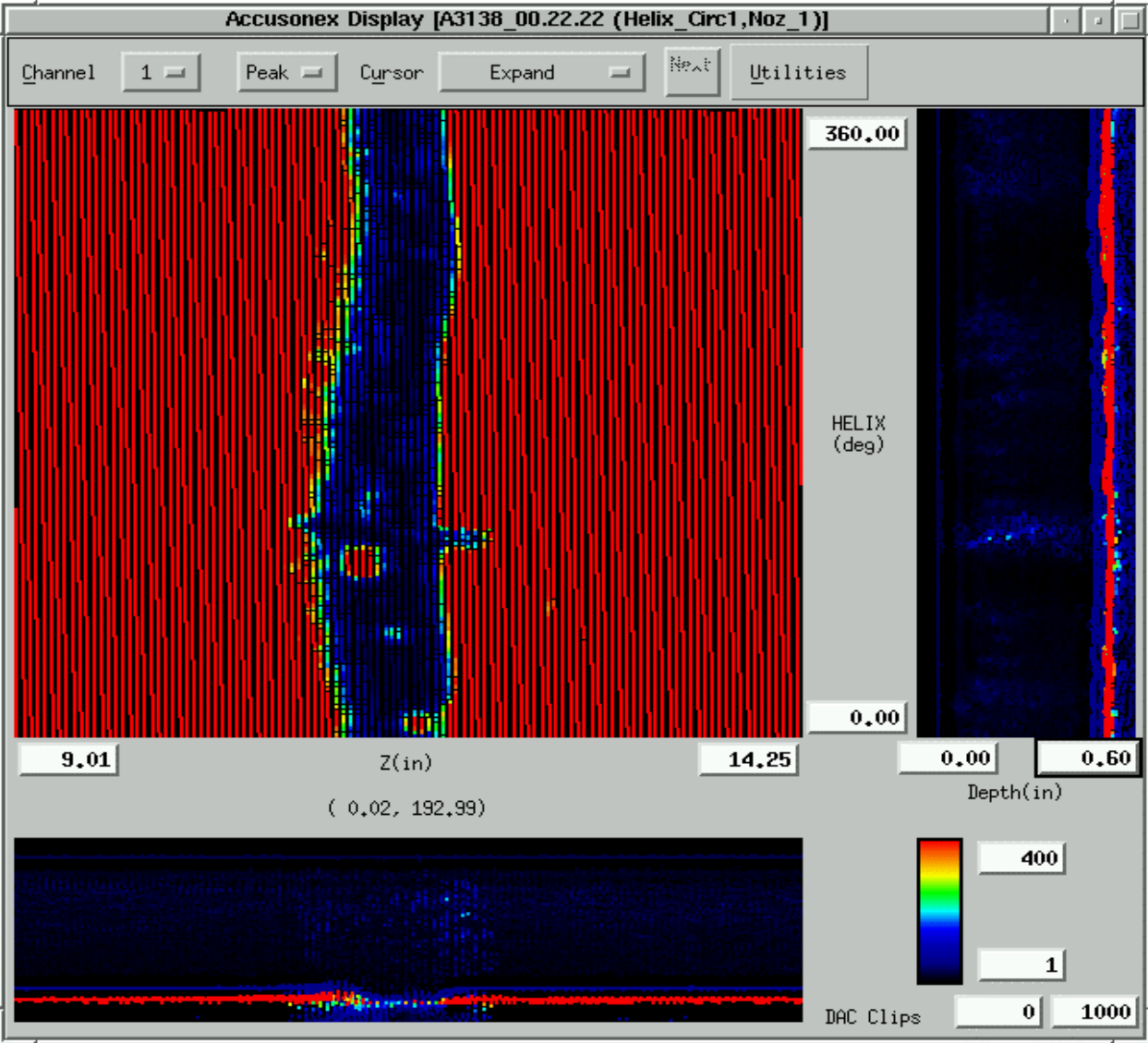
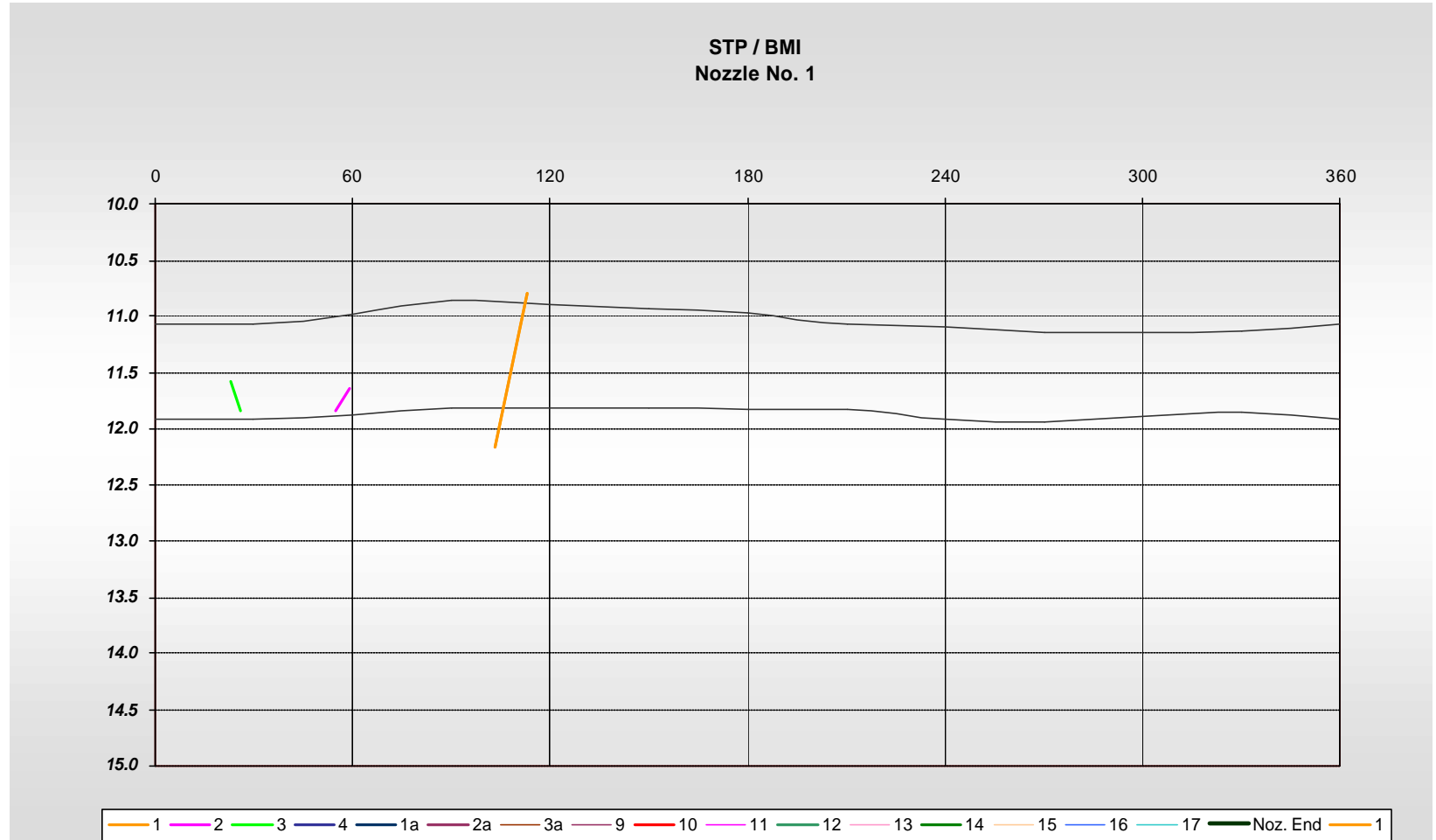


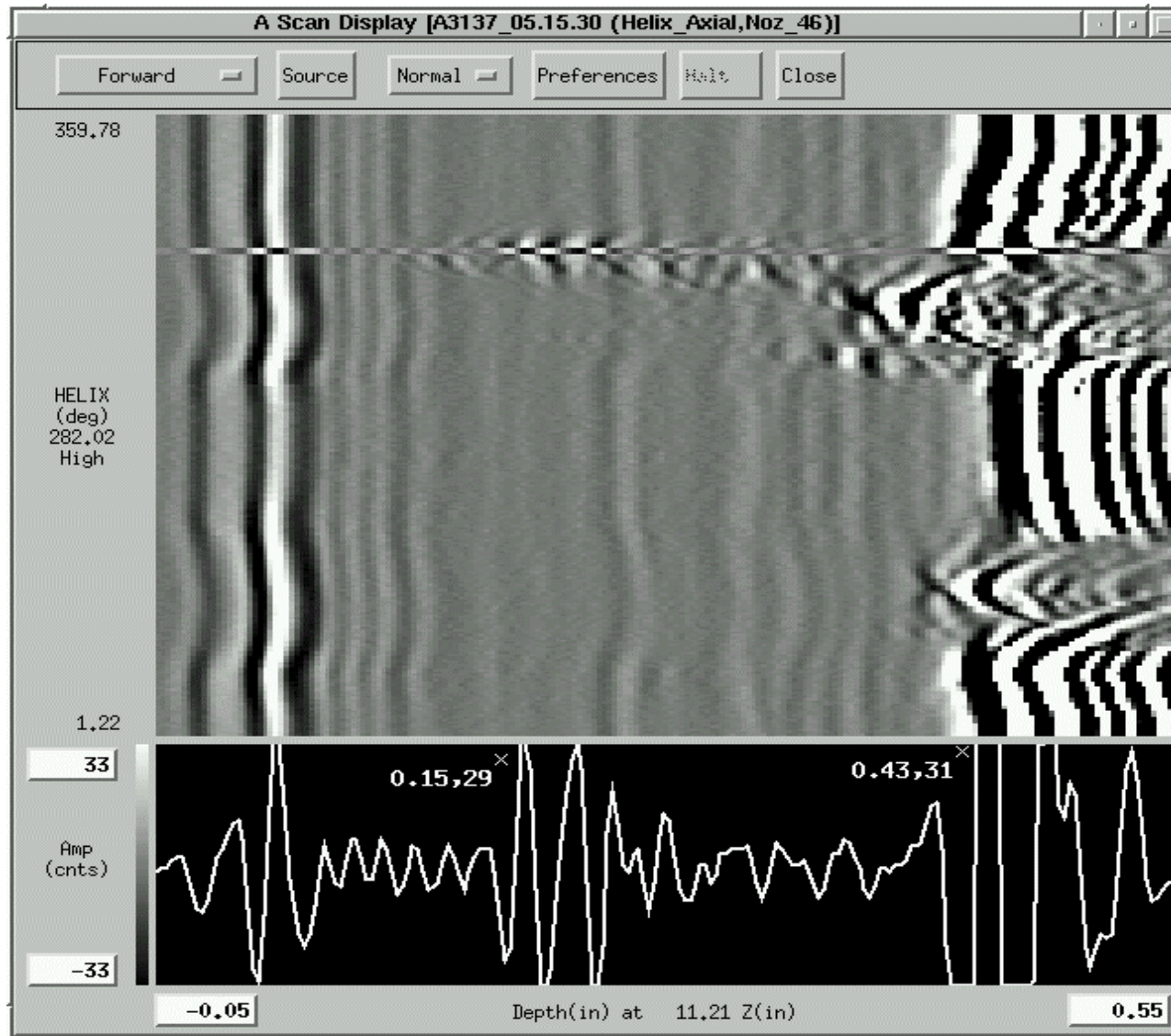
# Penetration #1 Weld Profile



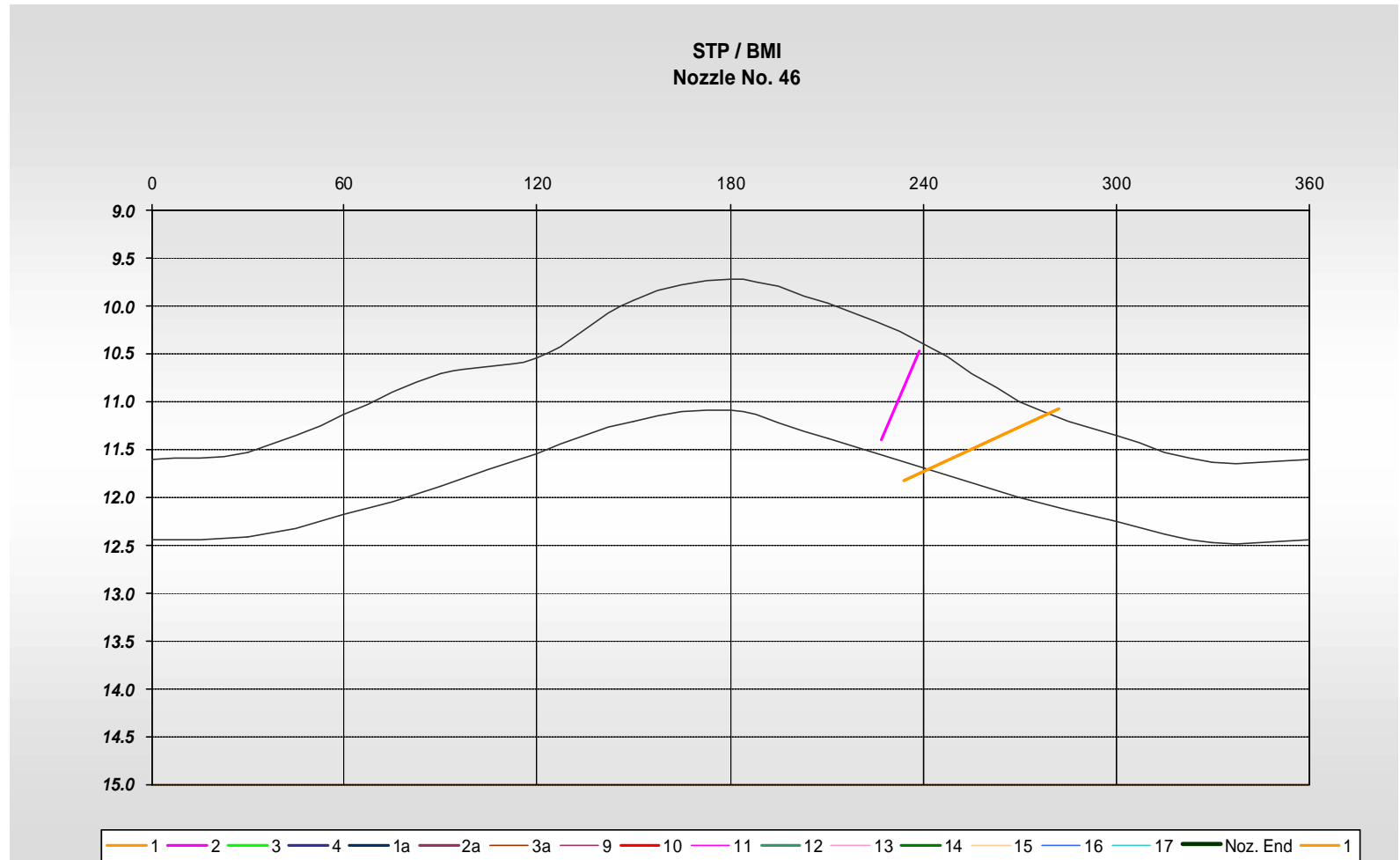
# Penetration #1 Leak Path



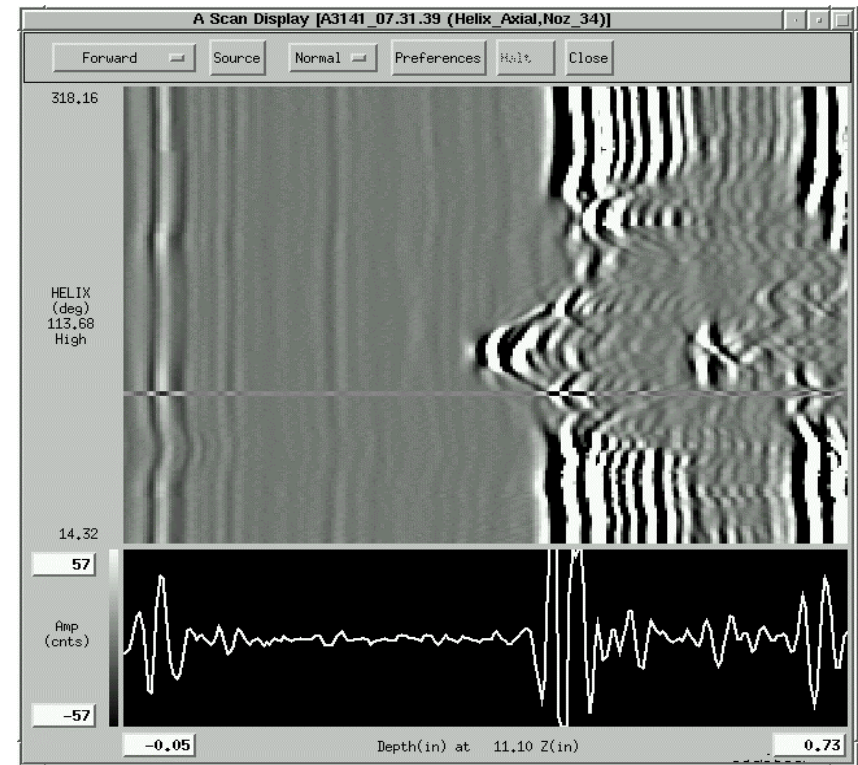
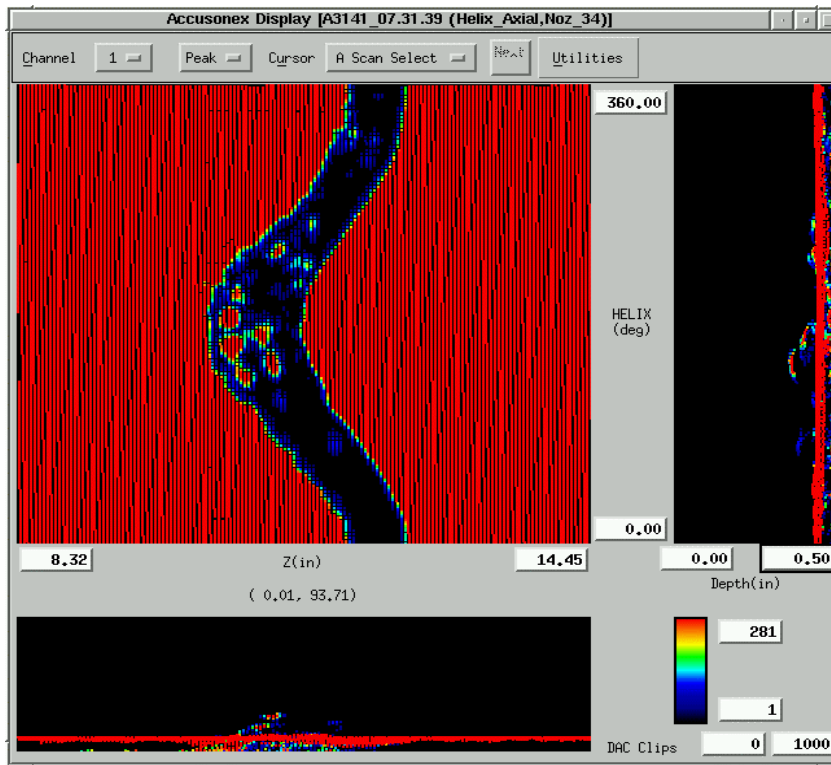
# Penetration #46 Axial Scan



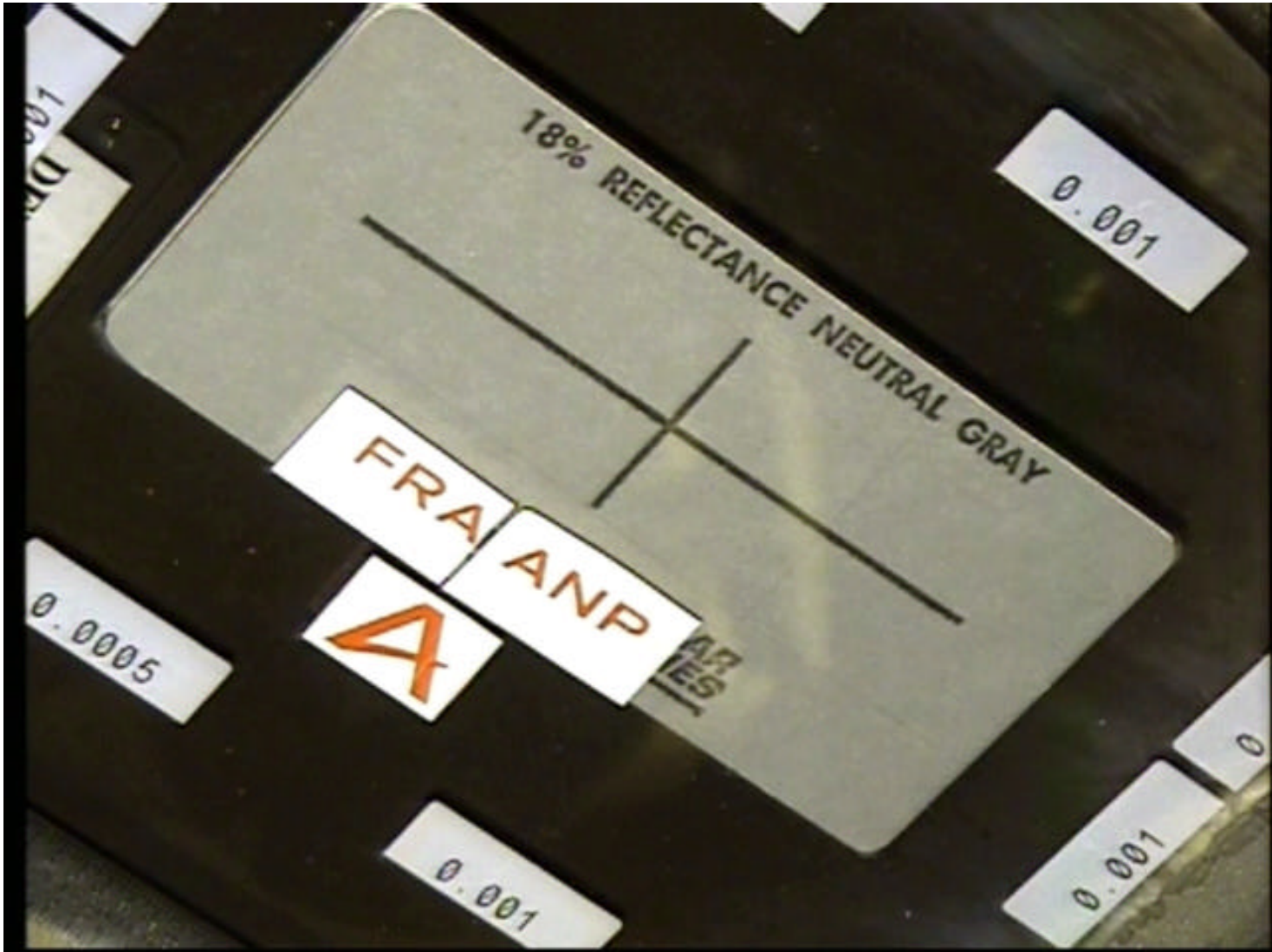
# Penetration #46 Leak Path



# Penetration #34 Fabrication Discontinuity



# Enhanced Visual





# Penetration Overview



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# Penetration #1 Visual



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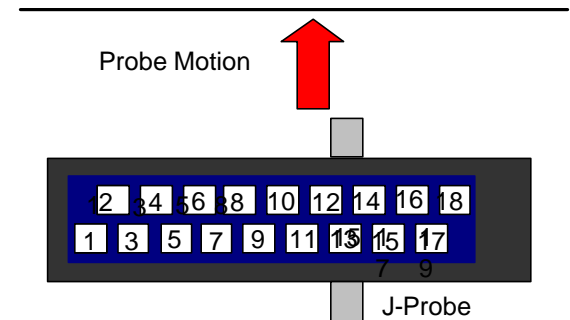


# Confirmatory Examinations

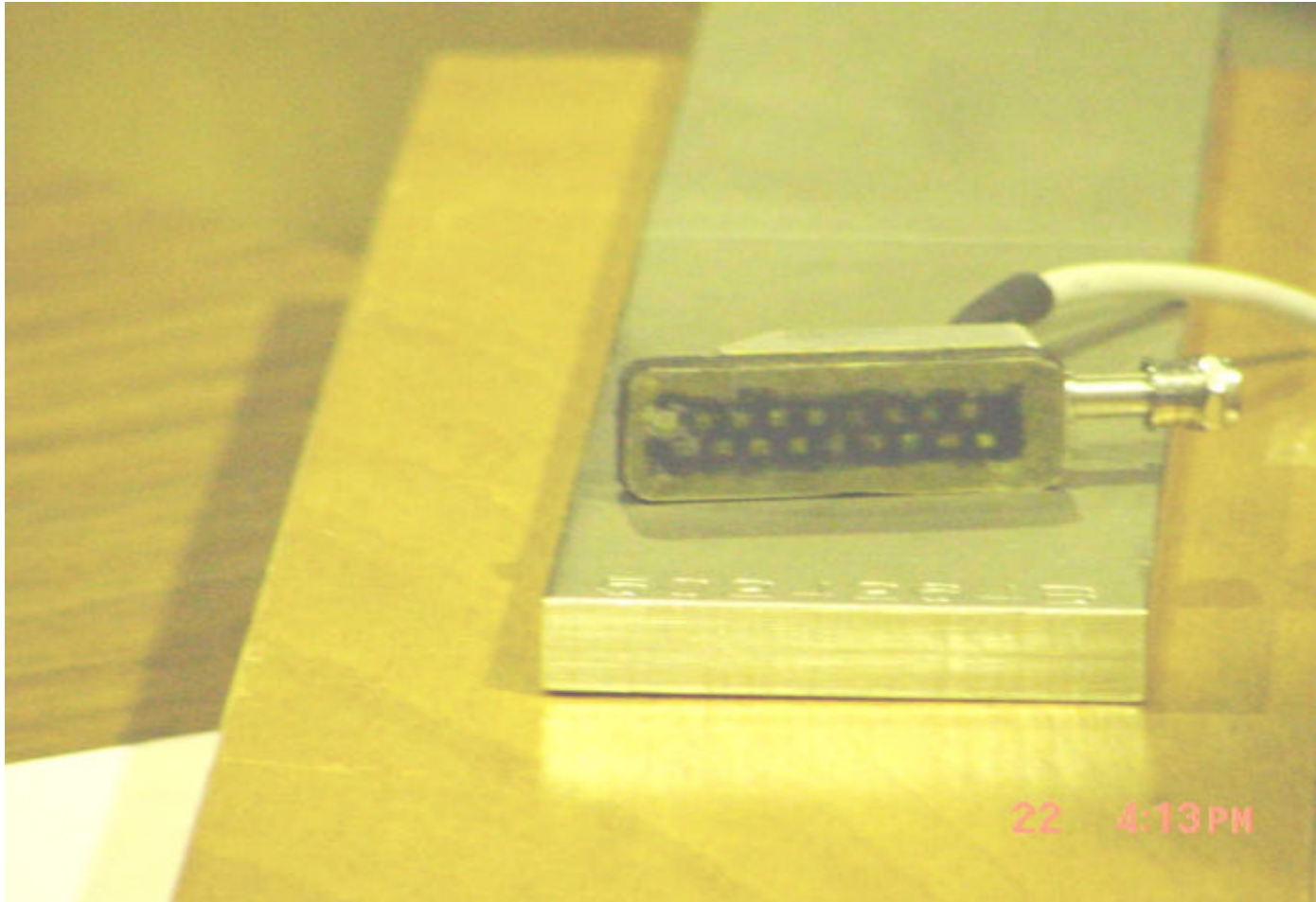
- Bobbin coil eddy current on penetration ID
  - Penetration #1 displayed a tube ID surface-breaking flaw
  - Penetration #46 displayed a tube ID sub-surface flaw
  - Two other reference penetrations displayed no flaws
- Array coil eddy current on J-Groove weld
  - Penetration 1, 46, 33 & 5 others scanned
  - No flaws identified

# Eddy Current Probe Operation

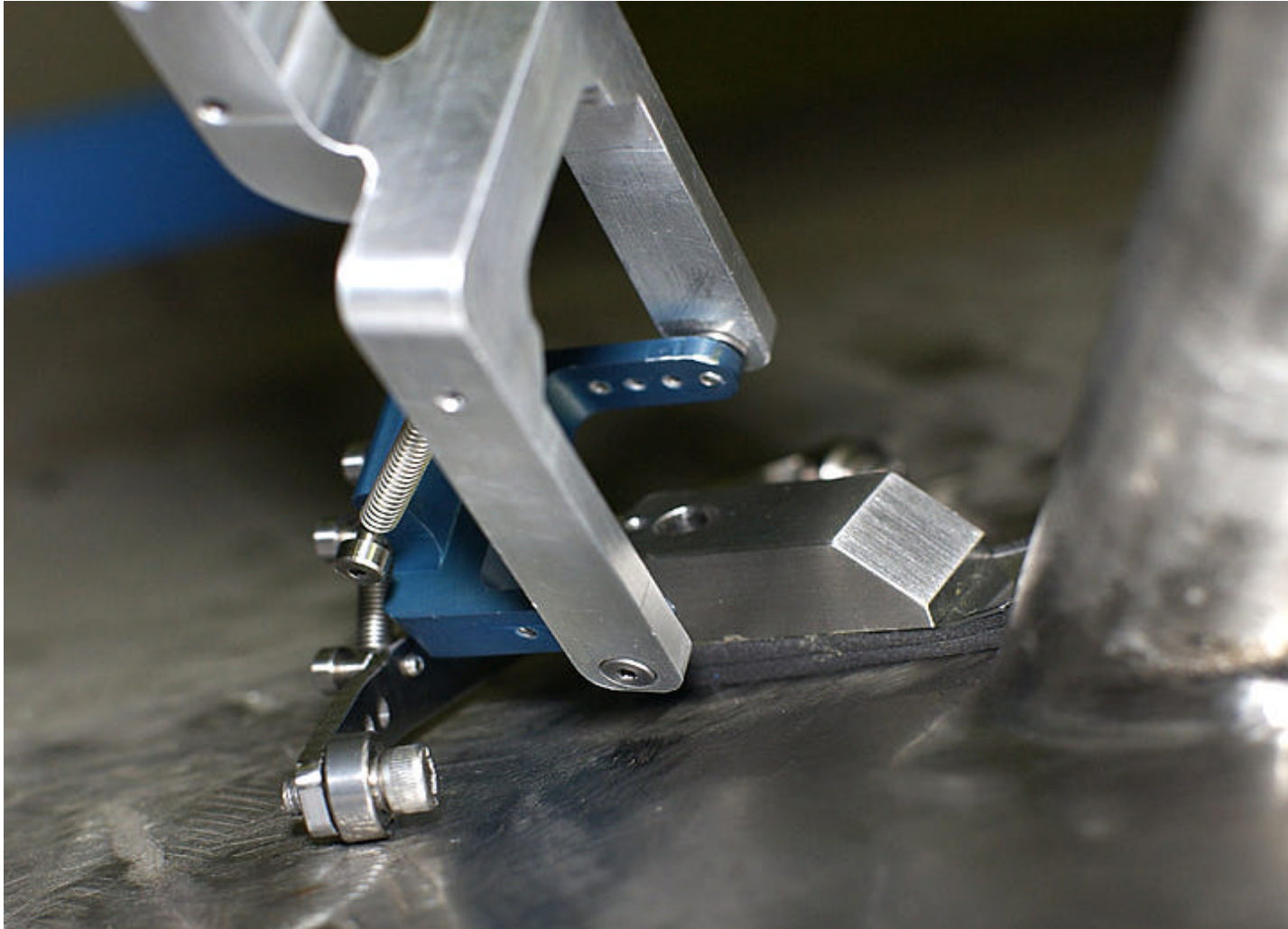
- 18 coil array
- X coil windings
- 2 rows of 9 coils
- 1.6" coverage



# Eddy Current Probe

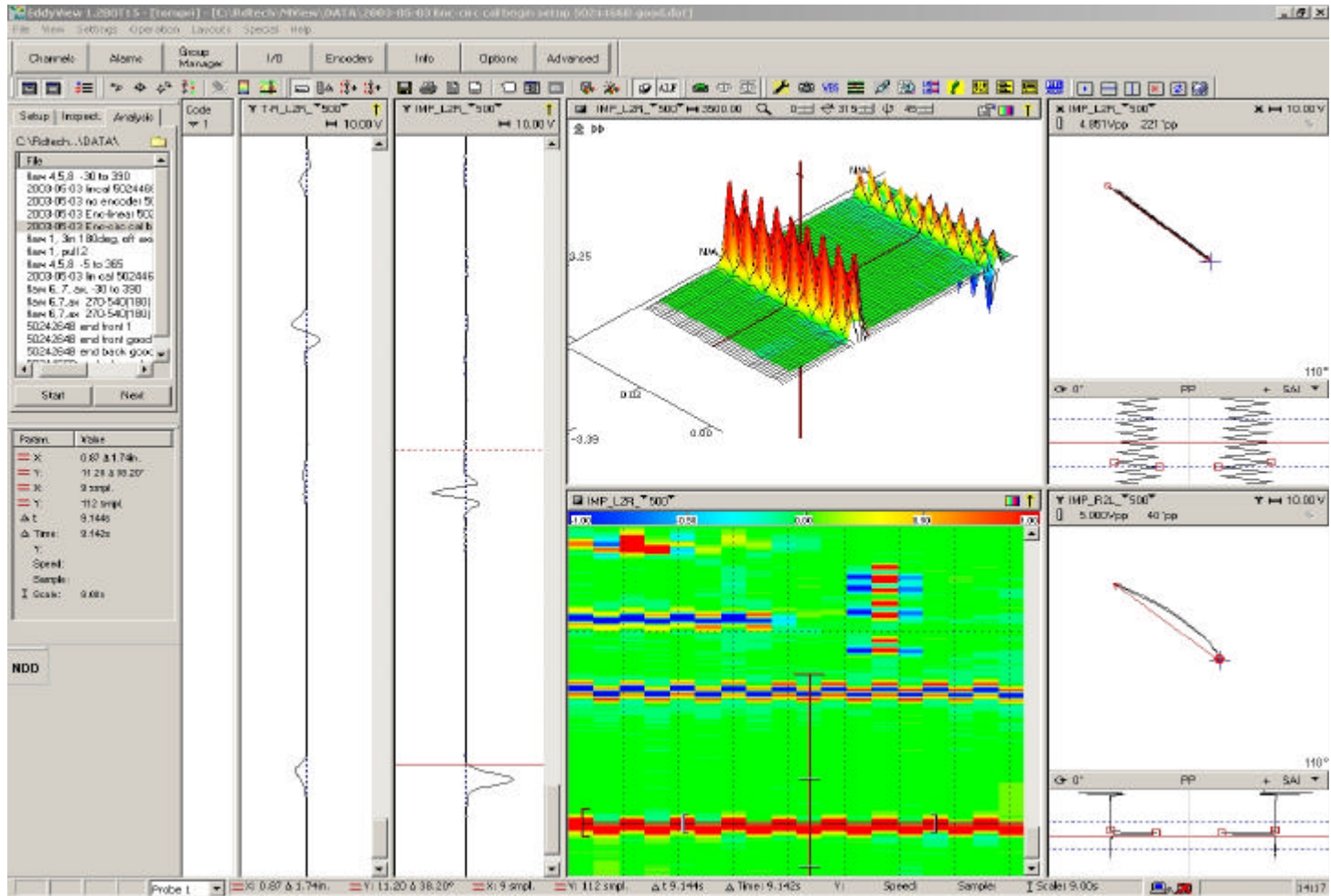


# Eddy Current J-Groove Probe

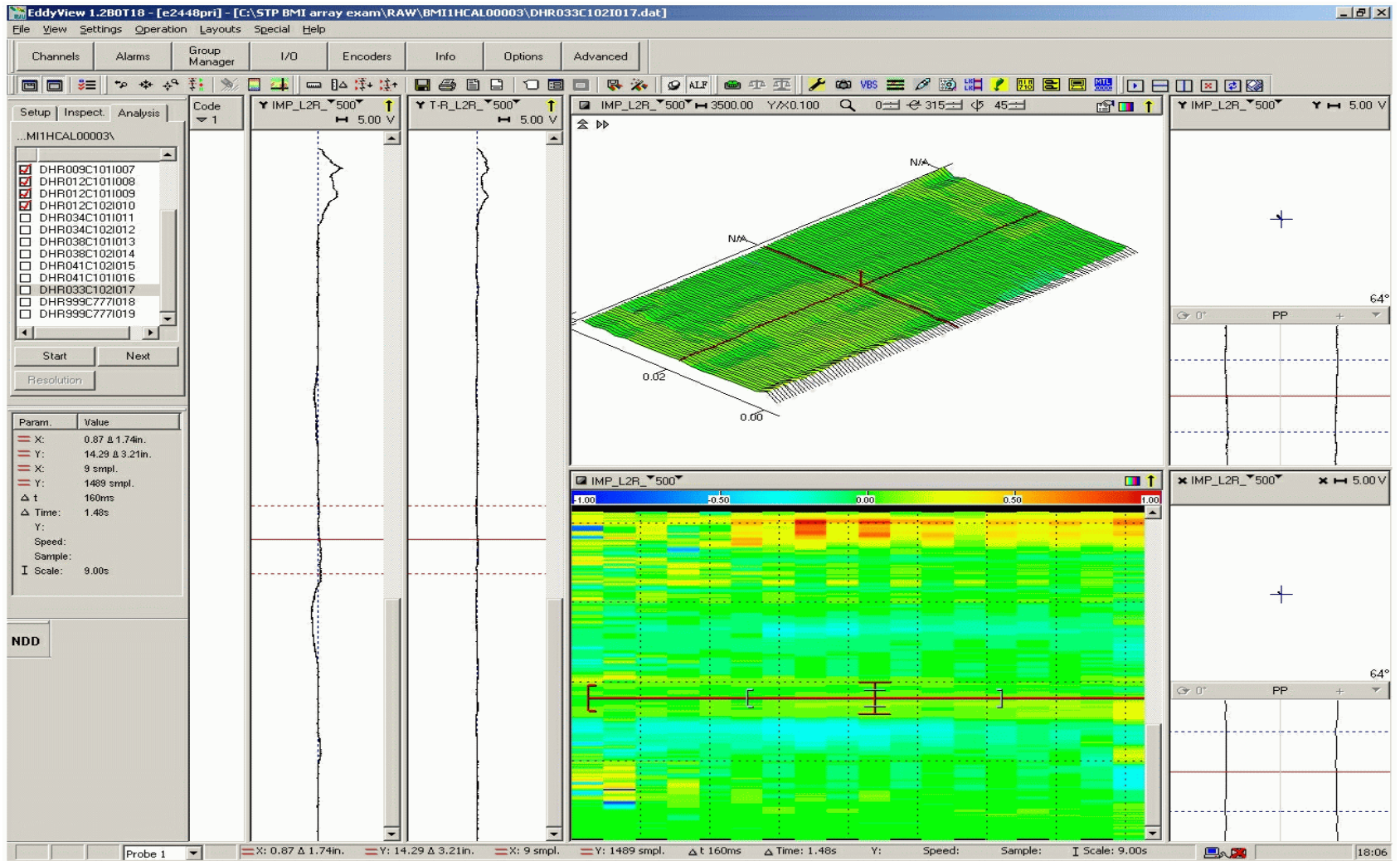




# Calibration Setup



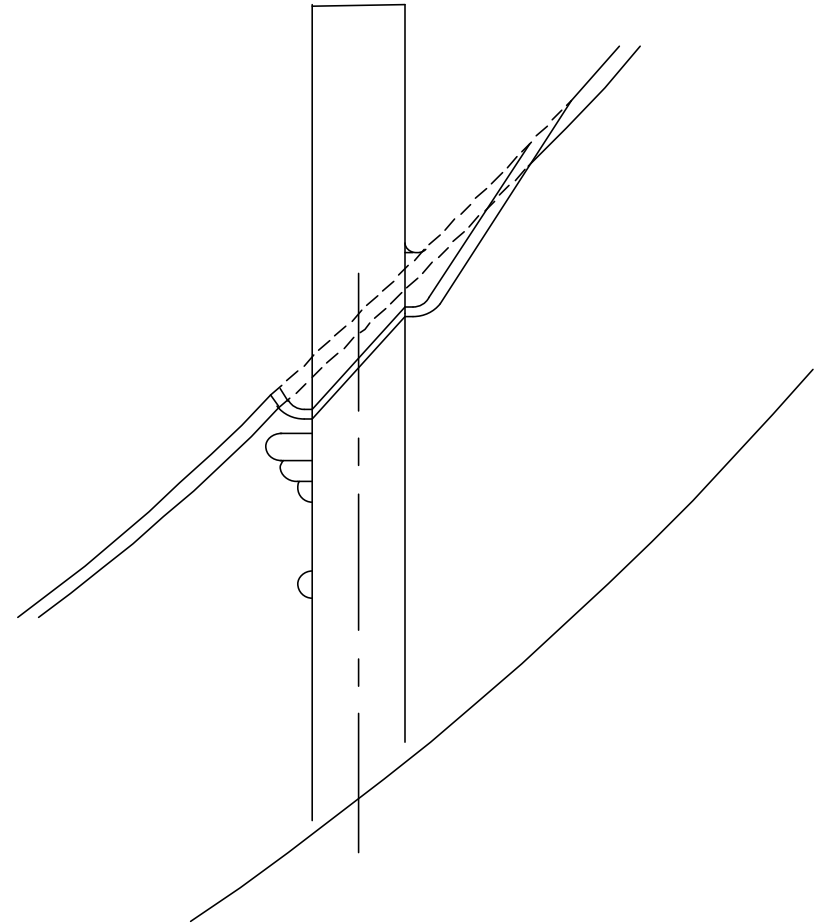
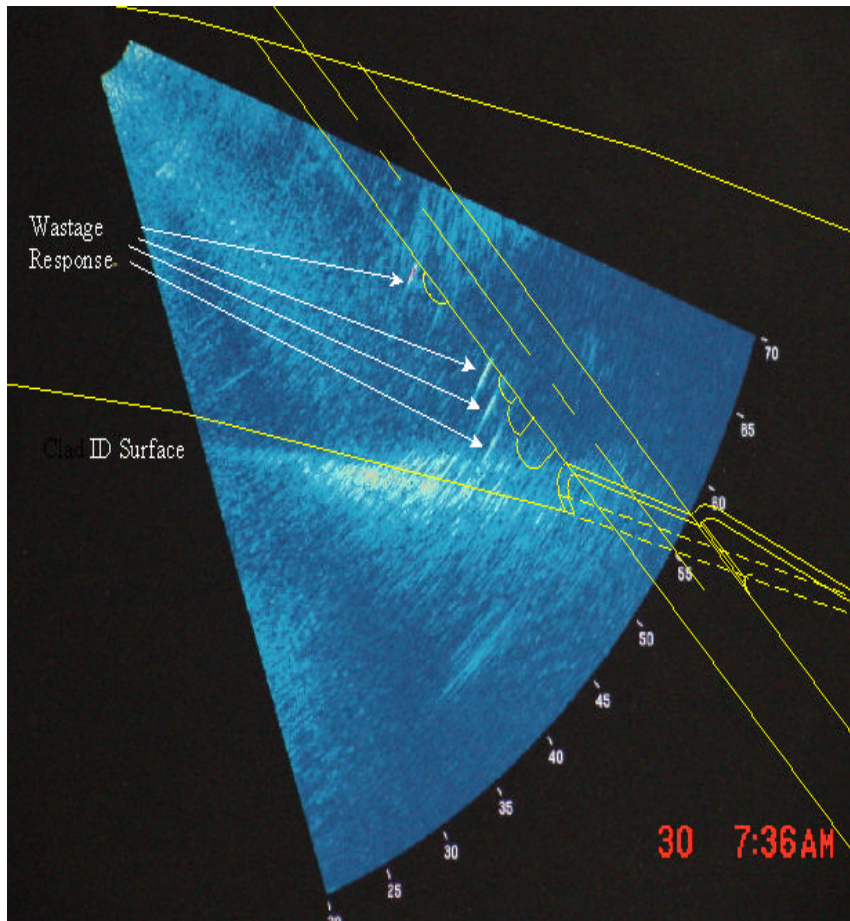
# Penetration 33 J-Groove exam



# Additional Confirmatory Inspections and Tests

- Wastage UT (phased array)
- Other
  - Rod test
  - Bubble test
  - Profilometry
  - Visual of tube ID
  - Visual of vessel bore
  - Metallurgical sample
  - Boat sample

# Developing Technology to Identify Wastage





# **CAUSE ANALYSIS and STATUS**

**Steve Thomas  
Manager, Plant Design**

# What Was Found

- Residue on two nozzles
- Total of five flaws in the two nozzles
- One flaw in each nozzle provides a leak path
  - Only one flaw fully penetrated nozzle
- Three embedded flaws
- Discontinuities
- Grinding marks

# Other Observations

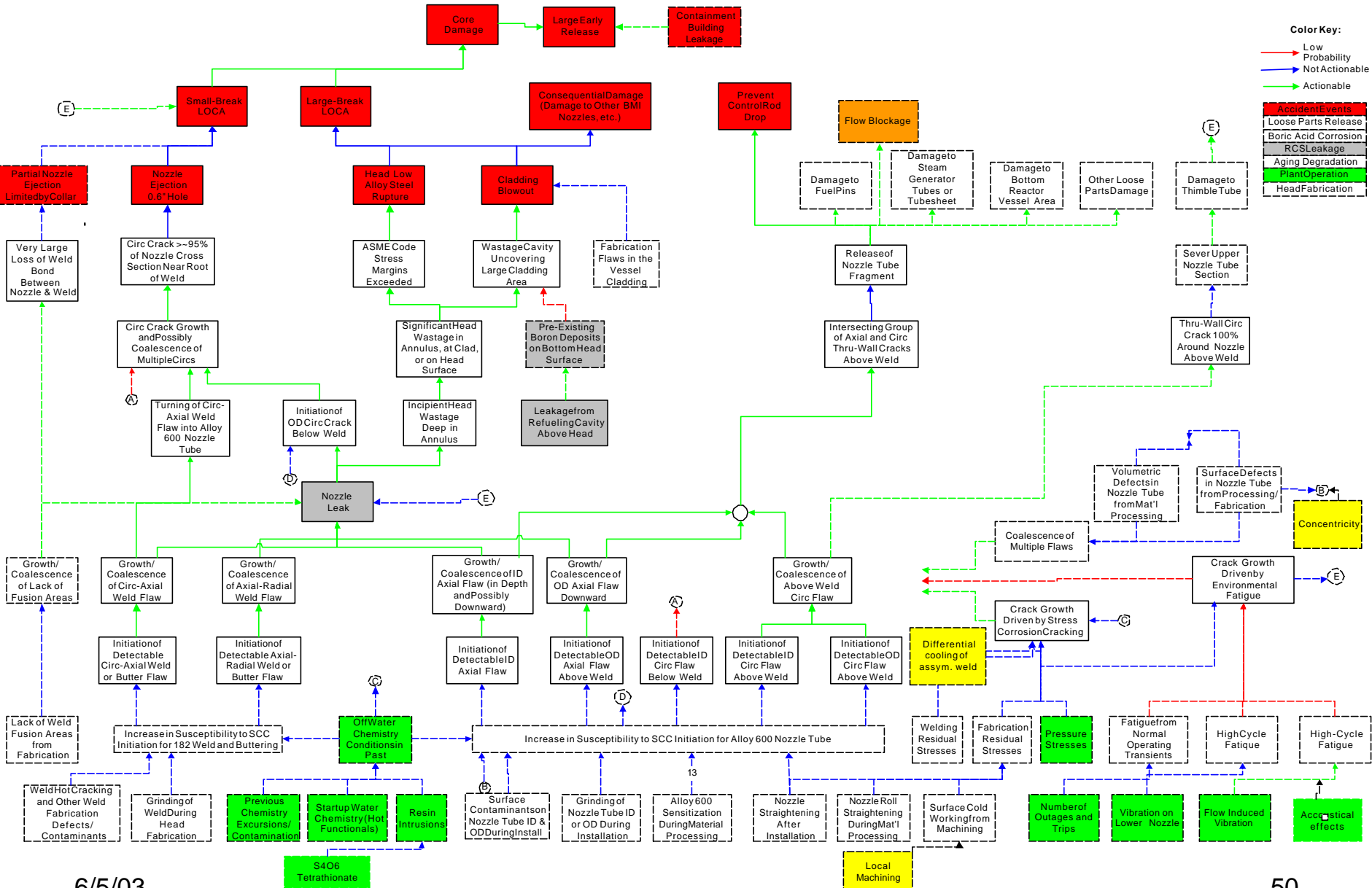
- No flaws in the 55\* other nozzles
- No evidence of circumferential cracks
- No evidence of ID initiated cracks

\* Penetration #31 will be examined during repair

Color Key:

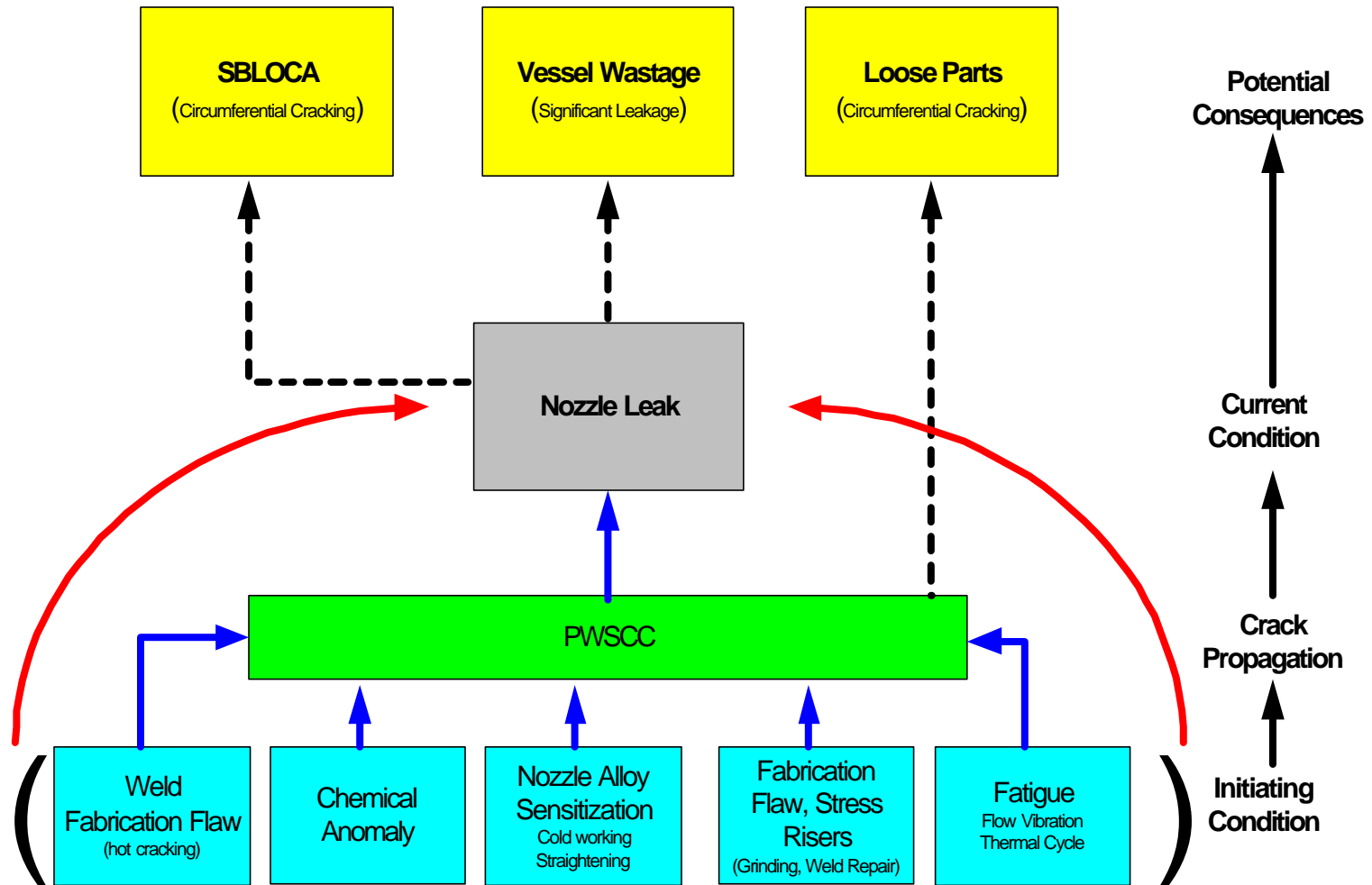
- Low Probability
- Not Actionable
- Actionable

Accident/Events
Loose Parts Release
Boric Acid Corrosion
RCS Leakage
Aging Degradation
Plant Operation
Head Fabrication





# PWSCC May Not Be the Cause



# Tube Coldworking Not a Likely Contributor

1976 Combustion Engineering Nuclear  
Fabrication Practice 101-3-0 states:

5.8.1 REMINDER: Use the bull's eye level and alternate welds as necessary to insure alignment

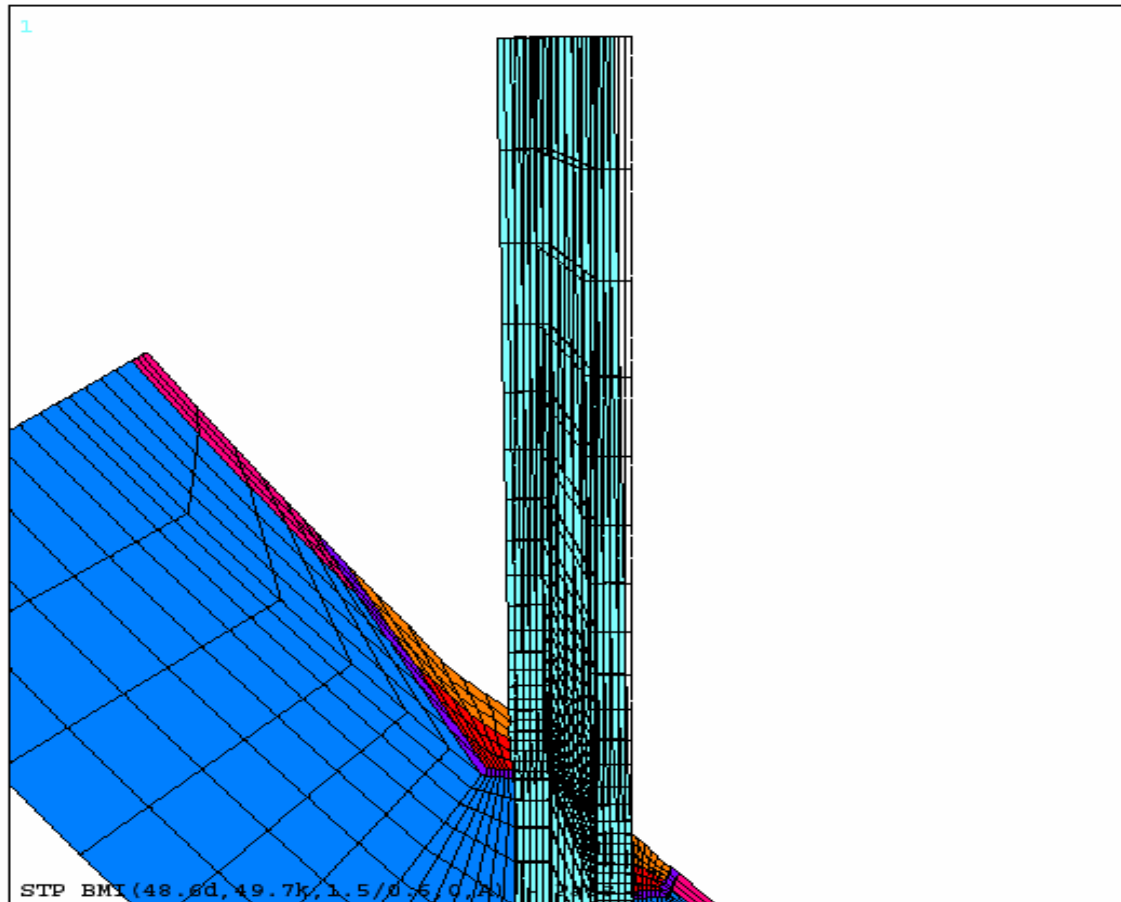
5.8.4 Cold straighten, as necessary, all tubes which are out of alignment



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# Analysis Shows Minimal Displacement During Welding



```
ANSYS 5.7  
MAY 10 2003  
11:03:26  
PLOT NO. 8  
DISPLACEMENT  
TIME=7000  
RSYS=0  
DMX =.021614  
  
DISPLACEMENT  
TIME=7000  
RSYS=0  
DMX =.04814  
  
*DSCA=5  
XV =1  
*DIST=7.25  
*XF =-8.02  
*YF =66.127  
*ZF =53.045  
A-ZS=90  
PRECISE HIDDEN
```