PHMSA contract DTPH56-13-T-000008
Fourth Quarter Report

RTD Quality Services – Houston, TX
Kiefner and Associates – Worthington, OH

Three Items Completed in 3rd Qtr

- Item 15 – Implementing recommended improvements
  - Comparison between 7.5 & 10 MHz transducer
  - Scanned 5 joints simulating field conditions
  - Rescanned 16-in EWR with focused wedges
- Item 16 – Gathering and preparing samples
  - 8-in samples with seam corrosion and gouges in seam
  - 12, 20, & 22 in ERW samples, will shared with PRCI
  - 24-in ERW stopple coupons with seam anomalies
  - SCC coupons
  - 36-in SCC sample in Rotterdam
  - 26-in ERW coupon with ID seam defect
- Item 38 – presented paper at QNDE & presented at PHMSA crack workshop

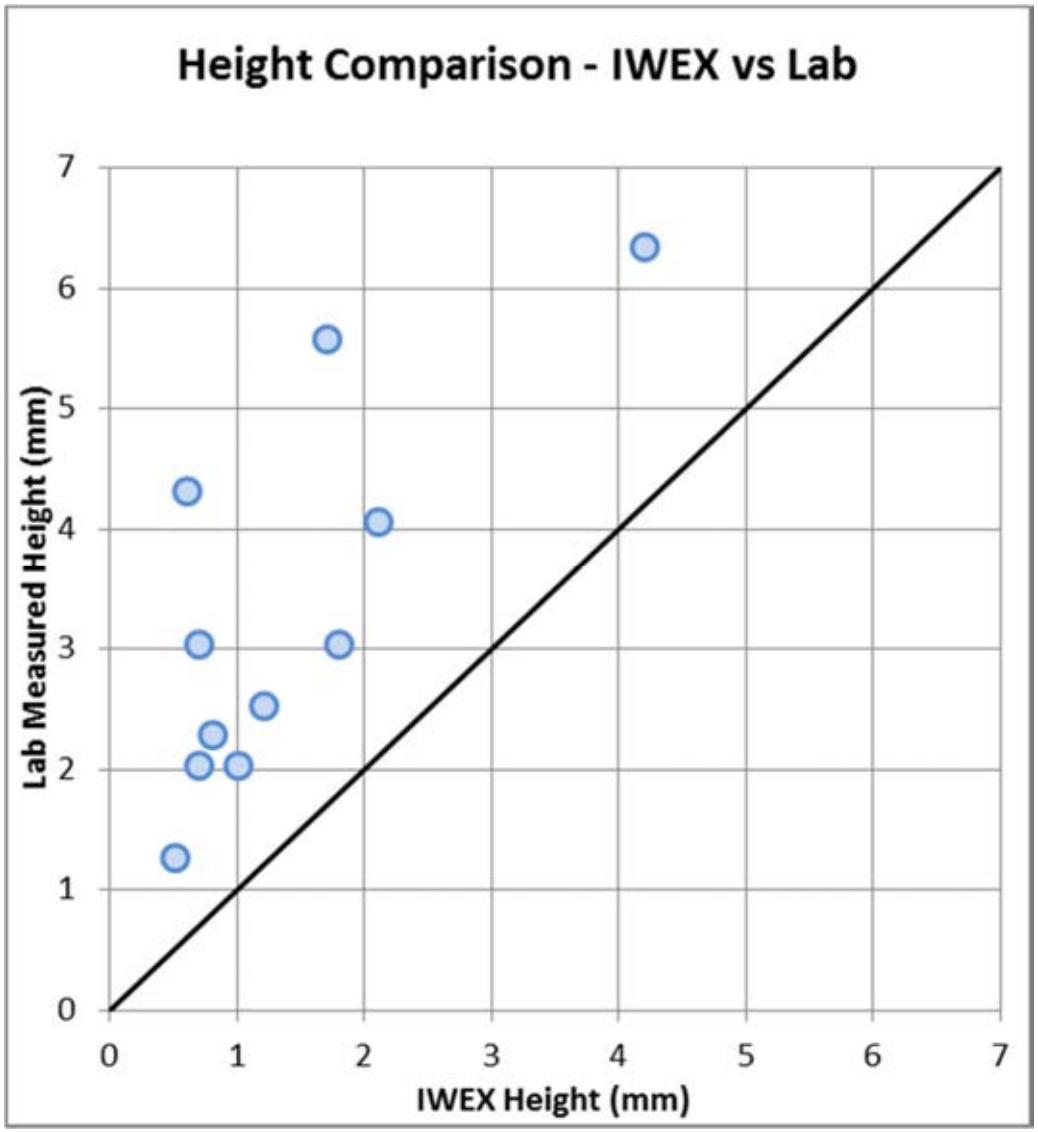
Item 15 – System Improvements

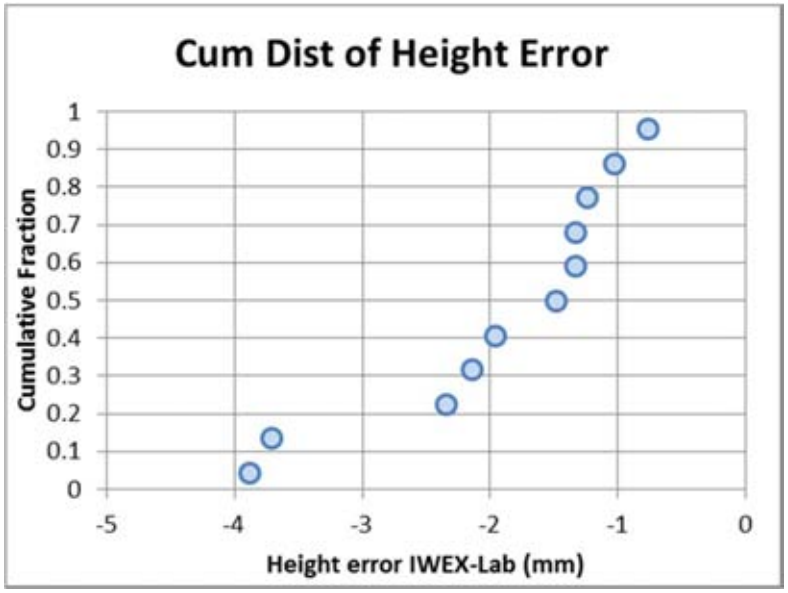
- 7.5 & 10 MHz comparisons presented at last teleconf
- 5 joints simulating field conditions presented at last teleconf
  - Still awaiting results from pipe breaks
  - Suction cup scanner works well in larger diameters
- Rescanned 16-in ERW samples
  - Improved results from last quarter because of axial focusing using focusing wedges

16-in ERW Pipe Samples

- Scanned 3 times
  - First set of scans encoder found to have errors
    - 5 samples scanned one broken open to determine encoder errors
  - Second set of scans used unfocused wedges
    - 4 samples scanned one broken open to determine sizing
  - Third set of scans used focused wedges
    - 3 samples scanned

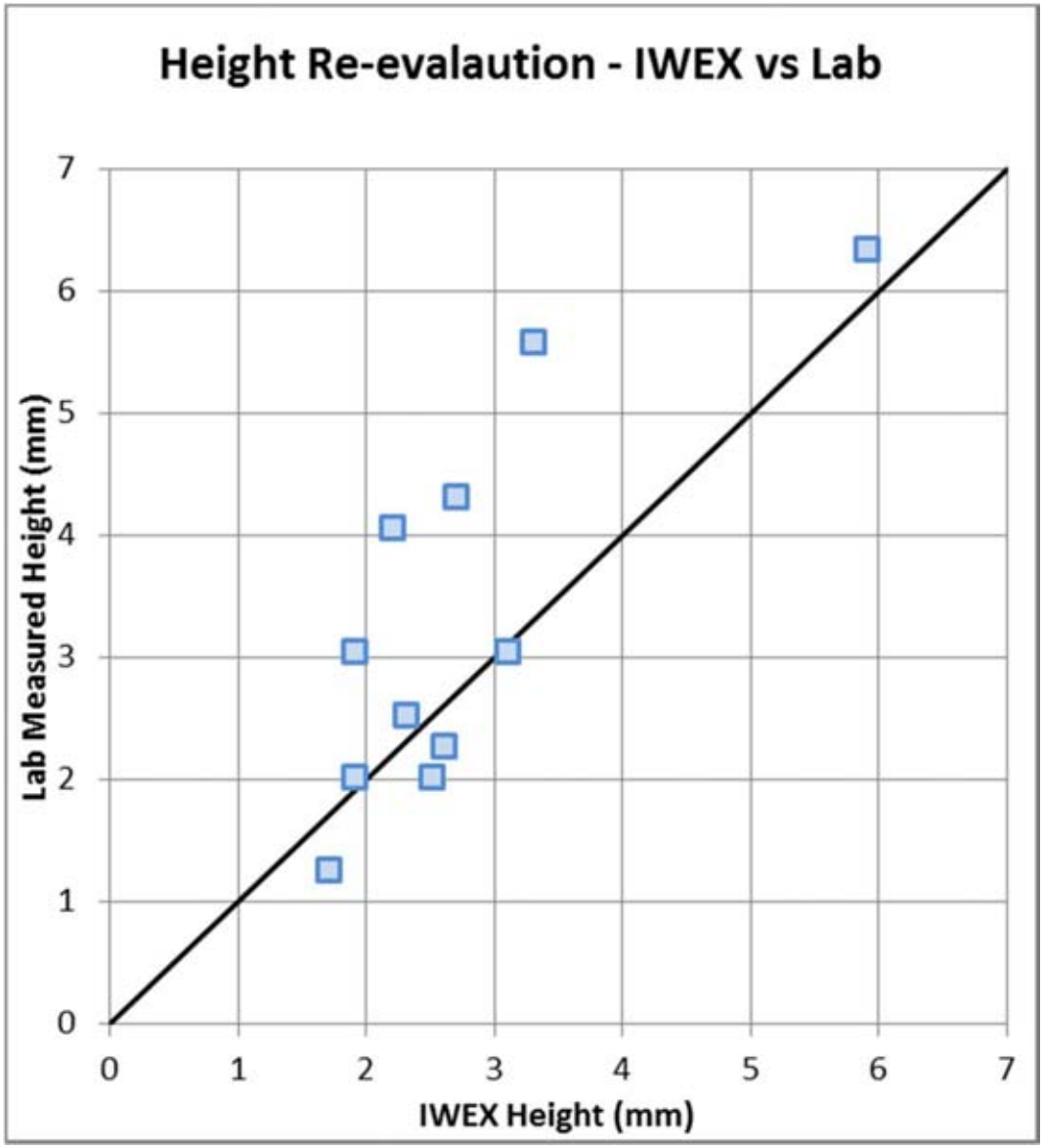
Height Unity Plot from 2nd Set of Scans

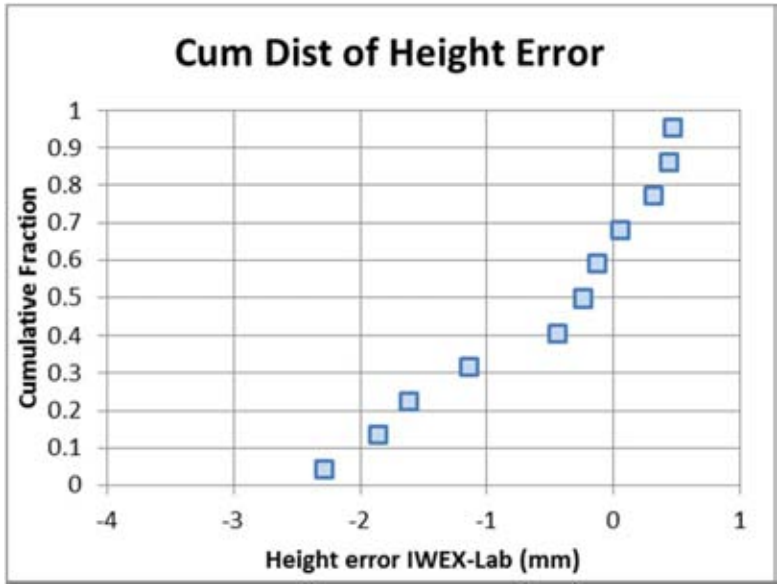




1st try as sizing - blind
average = -1.9 mm
std dev = ±1.0 mm

Height Unity Plot – Re-evaluation
After examining Metallographic breaks





2nd try at sizing after seeing met breaks
average = -0.6 mm
std dev = ±1.0 mm

16-in Wedges Lack Focusing

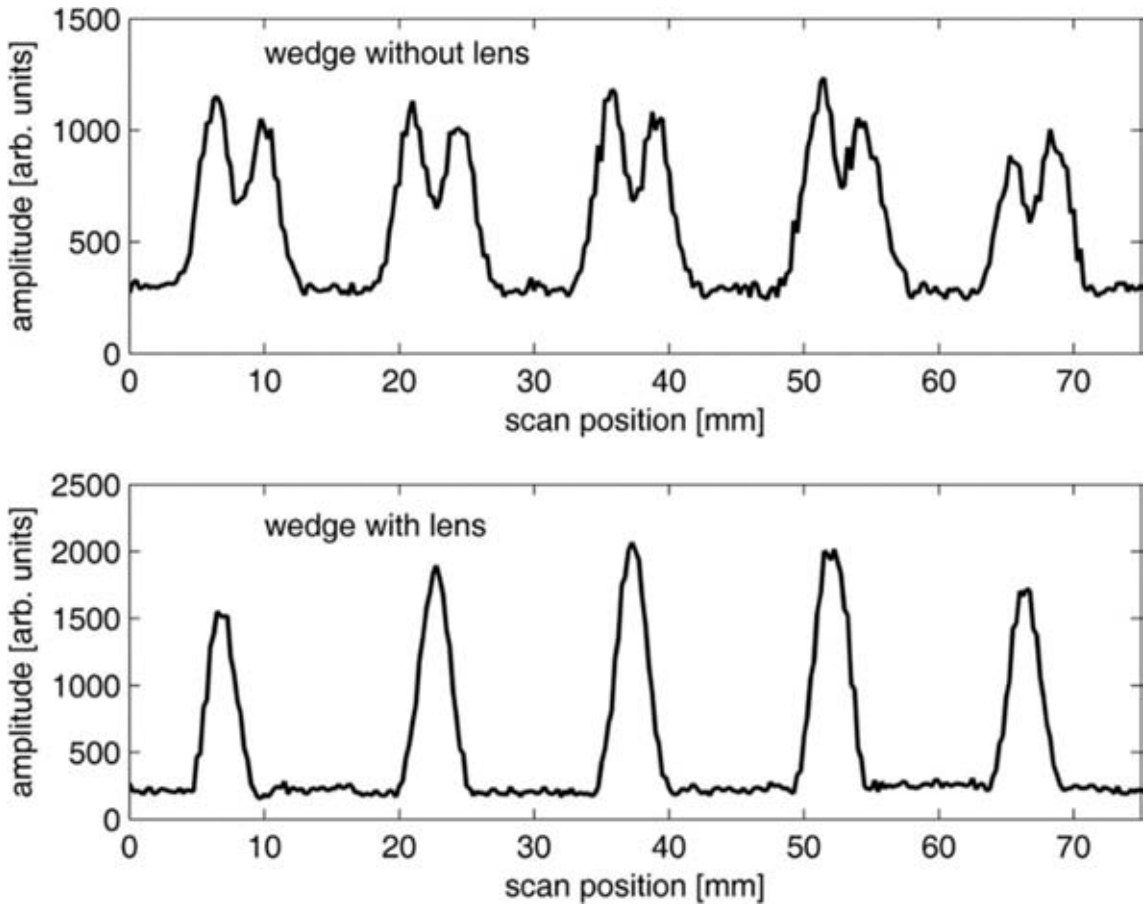
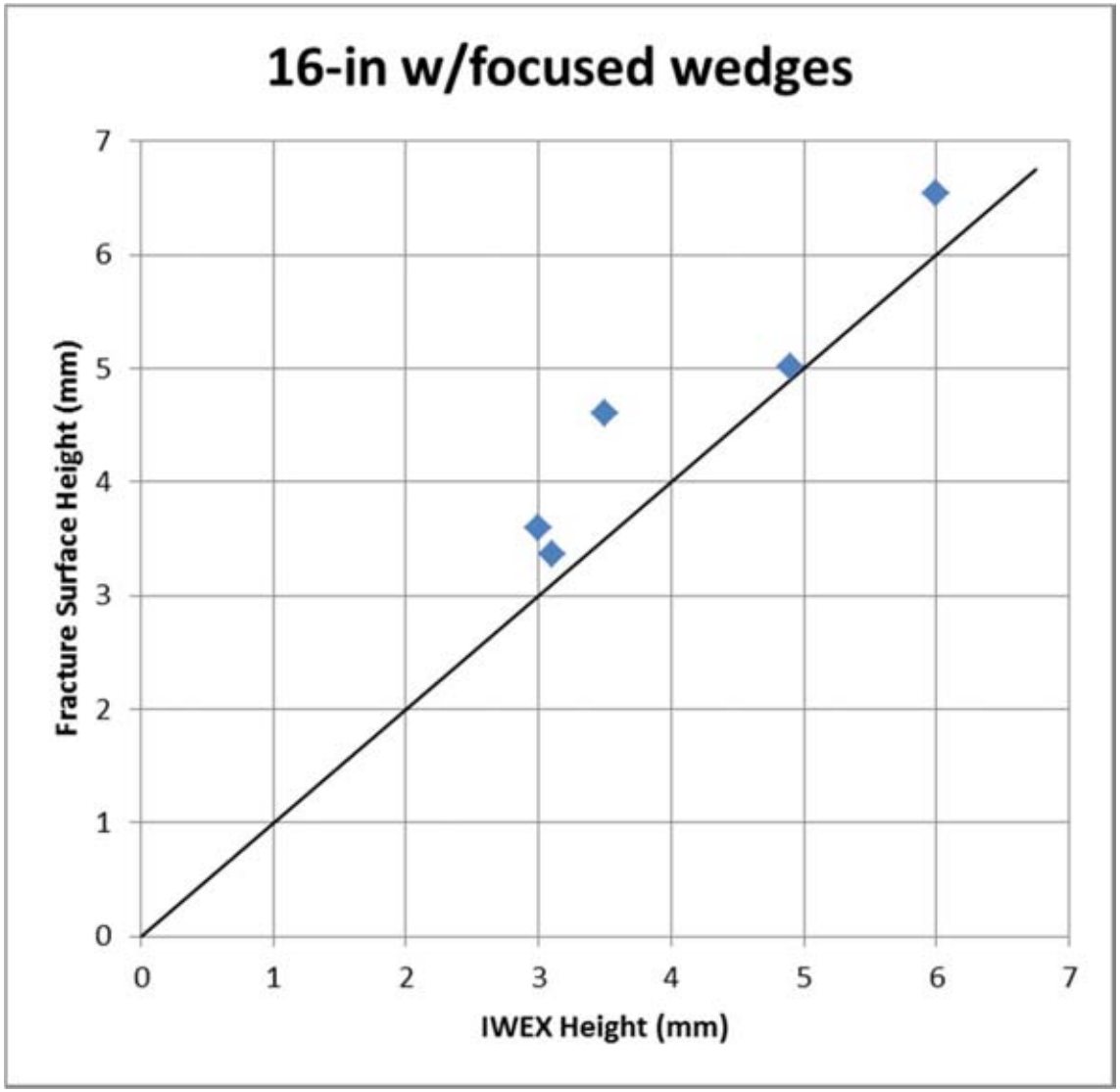
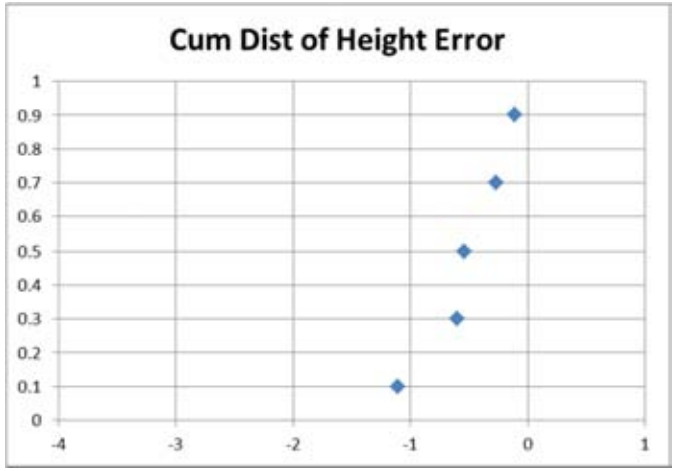


Figure show benefit of focusing from 2nd qtr report

16-in Samples 3rd Try





3rd dataset only 5 pts

average = -0.5 mm

std dev = ±0.4 mm

16-in Samples 3rd try

Results from a partial dataset of only 5 samples

Pipe ID	Axial Length (IWEX)	Axial Length (Fracture Surface)	Depth from OD (IWEX)	Depth from OD (Fracture Surface)	Height (IWEX)	Height (Fracture Surface)	Description
D-A	5	5.46	0.6	0	4.9	5.01	Lack of Fusion
D-A	13	13.82	0.3	0	6	6.54	Lack of Fusion
D-A	5	5.94	0.1	0	3.5	3.75 (4.61*)	Lack of Fusion
D-A	6	8.04	0.1	0	3	3.6	Lack of Fusion
B-B	4	6.3	0	0	3.1	3.37	Lack of Fusion

Need to finish breaking samples to obtain a statistically significant sample set on defect depth sizing.

16-in Samples

Worst Error was Defect #3

2 3 4

Item 16 – Gathering & Preparing Samples

- 17 Additional 8-in diameter x 0.188-in wt samples were obtained and scanned.
  - Results are being compared to metallographic sections.
  - Samples contained corrosion on the seam, selective seam corrosion, gouging on the seam and other smaller anomalies
- 12, 20, & 22 in ERW samples, will shared with PRCI
  - Samples were still being scanned as of Monday
  - Many many of anomalies detected
  - Discussion on future plans with operator this afternoon
- 24-in ERW stopple coupons with seam anomalies
  - Samples were sectioned and are being compared to NDT
- 36-in SCC sample in Rotterdam
  - Cracking associated with external corrosion
  - To be scanned by Rotterdam staff

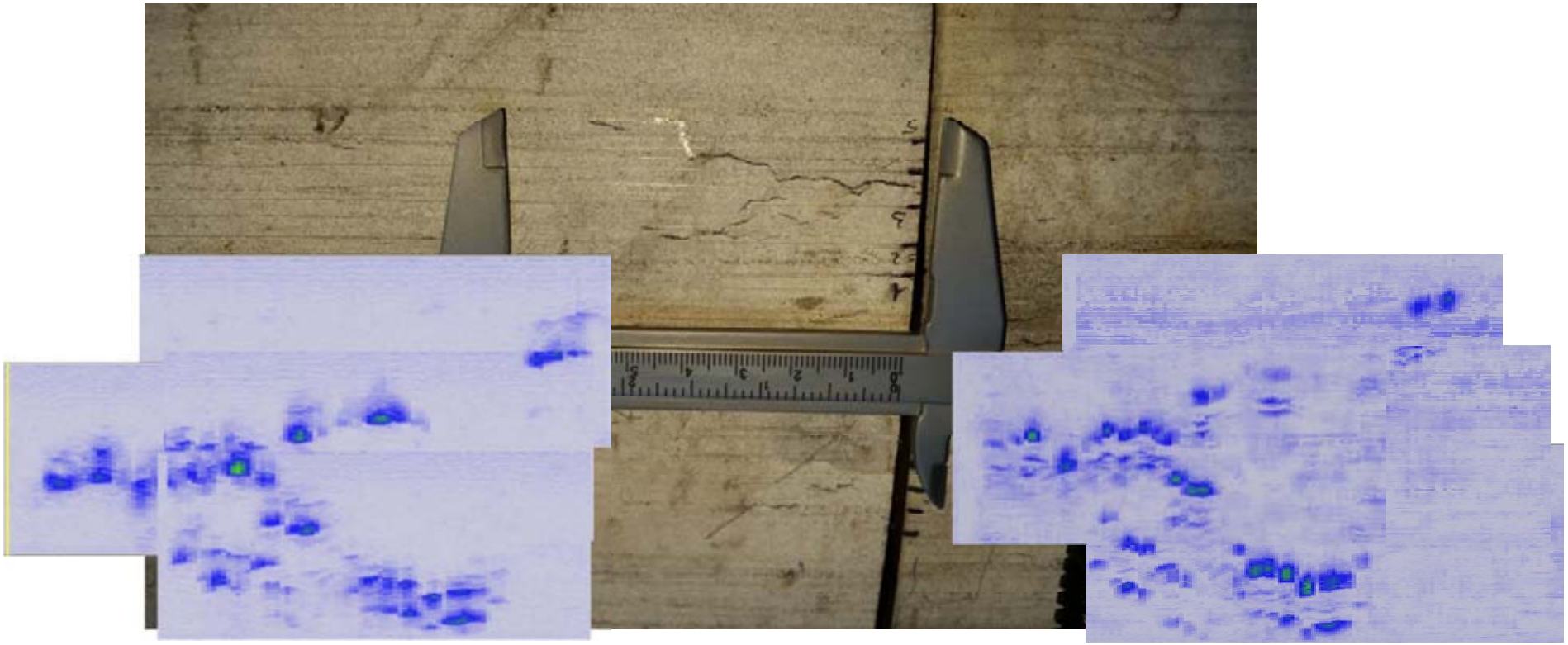
2 SCC coupons were found at the Kiefner lab

No corrosion appears to be associated with SCC.

Multiple Scans performed

Scanner set up to do multiple line scans with 10mm separation from the center of one scan to the next to allow for overlap

Mosaic of Scans for SCC Colony



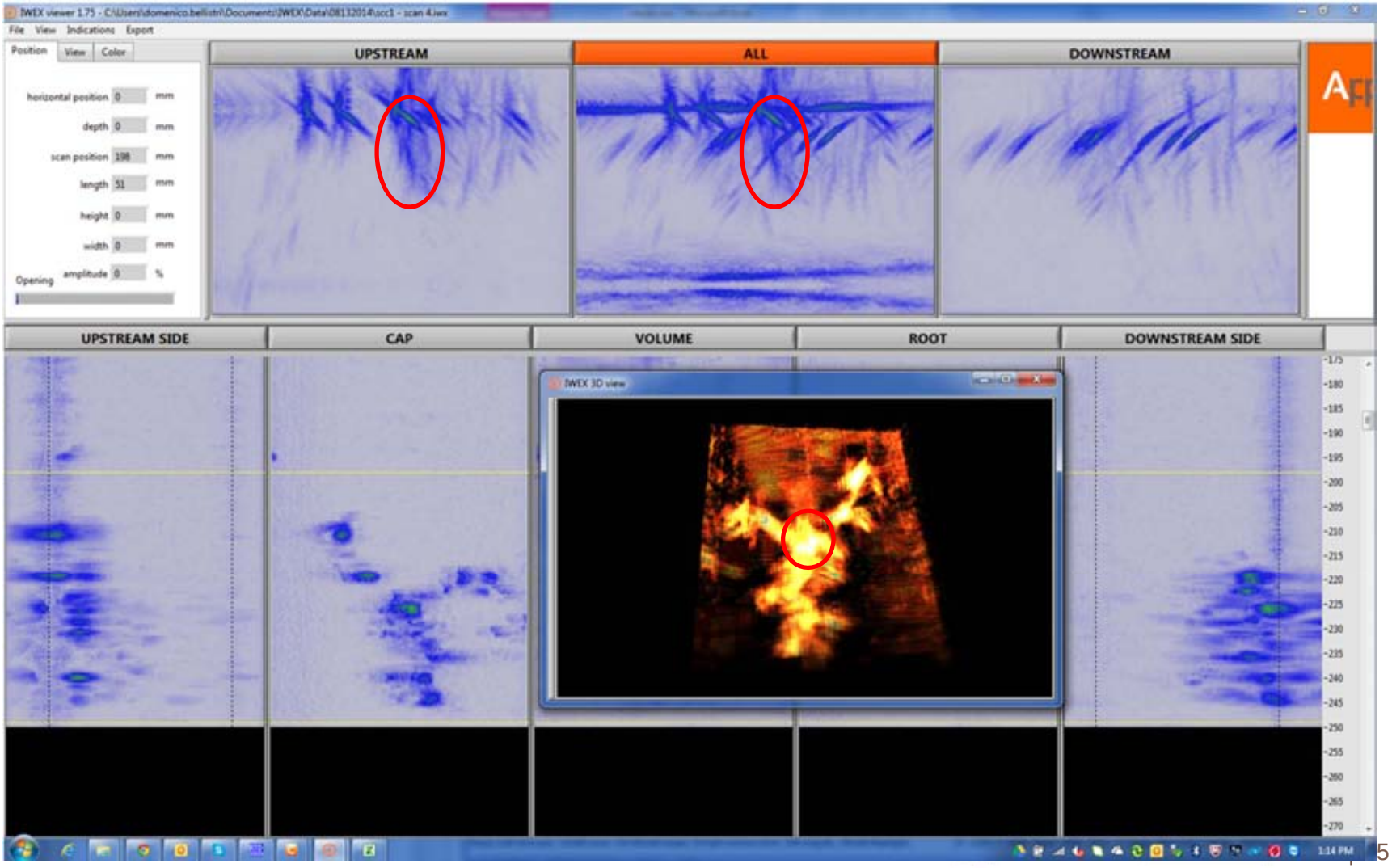
Note: Scan images are flipped (reflected about the vertical axis)

On the left is a mosaic
from cap scans
(the OD 2 mm)

On the right is a mosaic
from mid wall scans
(the mid wall 4 mm)

SCC deepest area

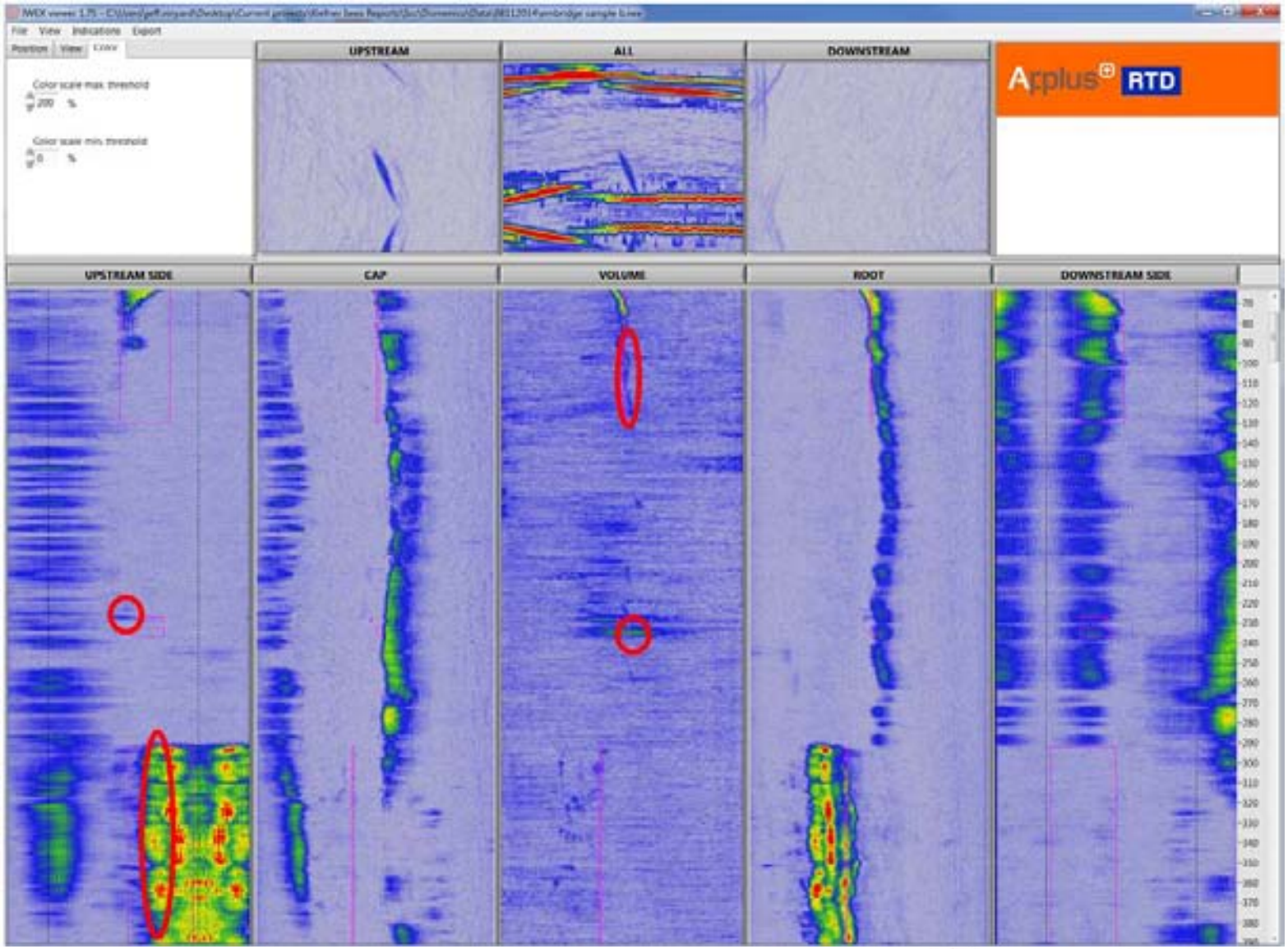
It appears there is a crack that is deeper than others in the colony



SCC #1 & #2

- Samples still need to be broken or sectioned to confirm depths and determine sizing accuracy

26-in ERW coupon with ID flaw

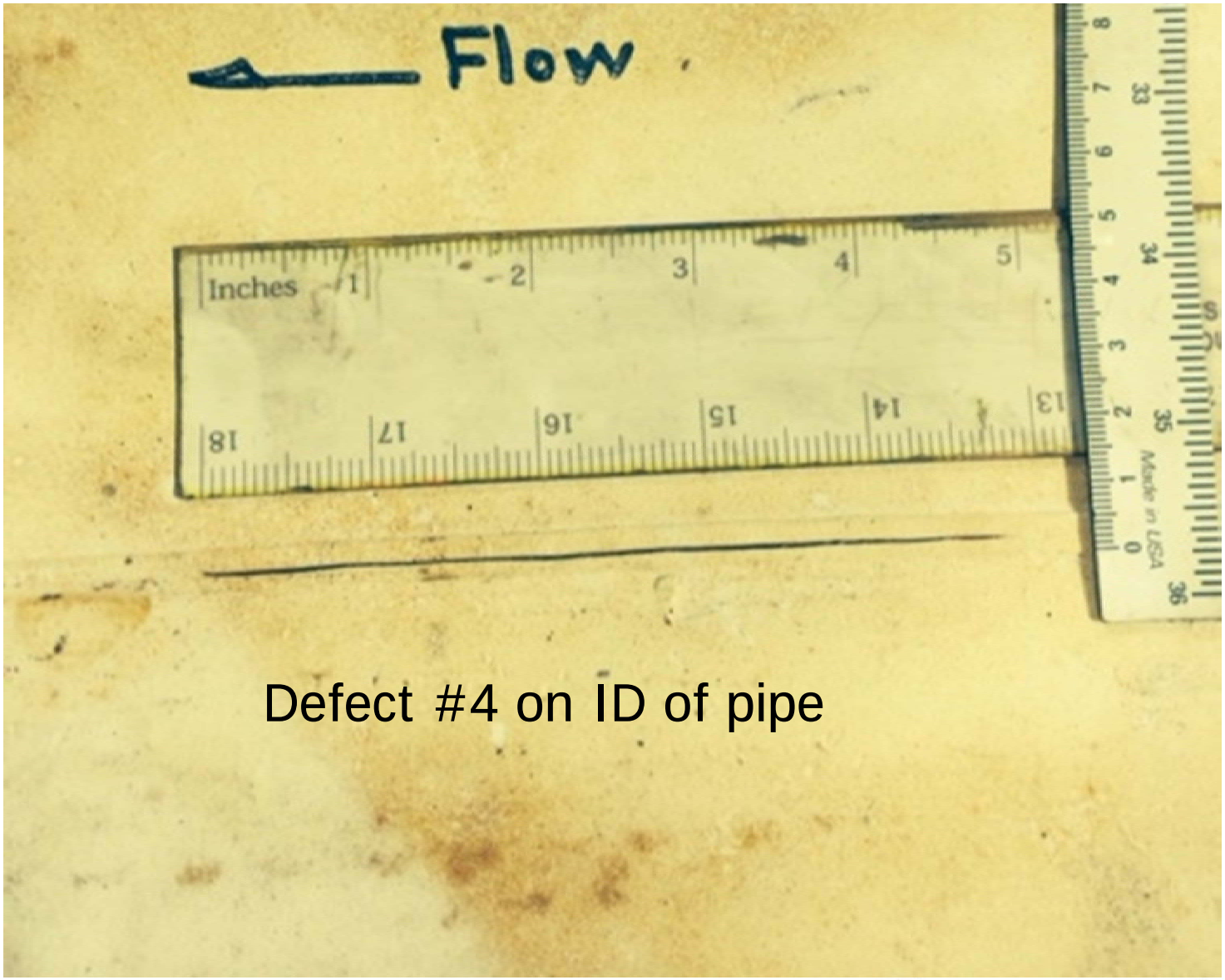

File View Indications Export
Position View Color
Color scale max threshold
200 %
Color scale min threshold
0 %
UPSTREAM
ALL
DOWNSTREAM
Applus RTD
UPSTREAM SIDE
CAP
VOLUME
ROOT
DOWNSTREAM SIDE

26-in Coupon

- Identified 4 anomalies

Part No.	Diameter: 26"		Length:21in	Measured Thickness:	
IWEX Defect Number	Vertical Location from Start (0) mm	Type of Defect	Length (mm)	Depth from the OD (mm)	Height (mm)
1	2	LOF	128	3.6	2.6
2	227	LOF	3	4.4	1.4
3	232	LOF	5	4.3	1.6
4	292	LOF	144	4	3.3

26-in Coupon



5th Quarter Testing Plans

- Finish scanning 12-in, 20-in & 22-in pipe in Kiefner's Metallurgical lab
- Metallurgical comparisons
  - Finish Breaking and evaluating 16-in half shells
  - Break/section SCC coupons
  - Break/section 26-in ERW coupon
  - 22-in pipe in College Station
- 24-in SSAW testing in Edmonton
- Test 36-in SCC sample in Rotterdam
  - Potentially test other large diameter SCC samples in Lingen
- Potential ERW field testing
- 1000+ feet of pipe of ERW in a pipe yard.

5th Quarter

- Need to evaluate more data to obtain a statistical representative sample of sizing.

- Eventual Goal should be accurate enough to use IWEX in the field as a reference standard for sizing cracks.
  - Accuracy Goal needs to be +/- 0.1 to 0.2 mm or better than 3%wt – similar to laser-scanning for corrosion
  - May require non-linear inversion of Full Waveform Capture Data
  - An objective for additional funding

Development activities

- Completed in 4th Quarter
  - Direct comparison of 7.5MHz and 10MHz probes will be performed in Rotterdam in June-July
- On-going
  - Improved C & D scan visualization
  - Suppression of double indications in post-processing
  - Improved alignment for the different mode images (by measurement and/or post-processing)
  - Improvement of the signal-to-noise ratio by adaptations of filters in the hardware
- Item to add
  - Merging of multiple parallel scans in an SCC colony.

Scanning Acknowledgements

Jeff Vinyard – Applications Center RTD Houston

Domenico Bellistri – RTD Houston

Scott Gibbons – RTD Edmonton

Pushpendra Tomar – Kiefner Columbus

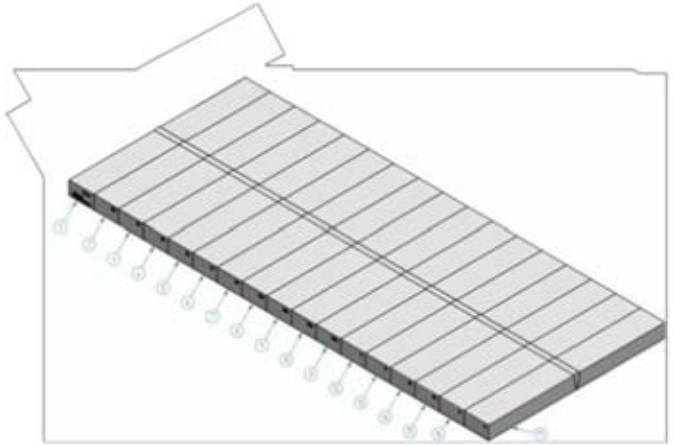
Proposal for Additional Funding

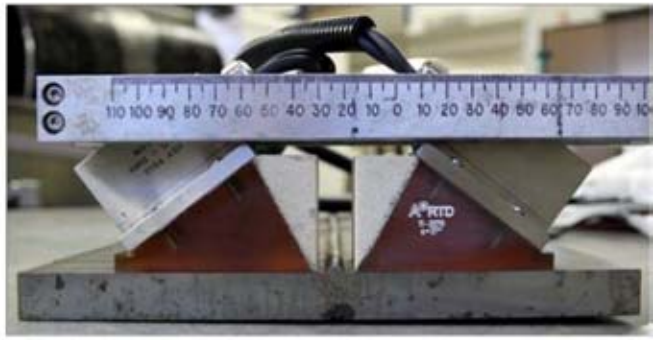
- Desire by several of the Companies Visited in July to accelerate IWEX development and deployment
- 2 Major Objectives
  - Perform Field Testing
    - Gain Experience for Field crews
    - One crew in Edmonton
    - One crew in Houston
  - Determine if improved sizing is possible
    - Goal is ±0.1 mm
    - Need additional PhD to test inversion algorithms
    - Consistent computer interpretation of results
- Plan to finish formal proposal by end of September
- Start work January 2015

Where Does 0.1mm Goal Come From?

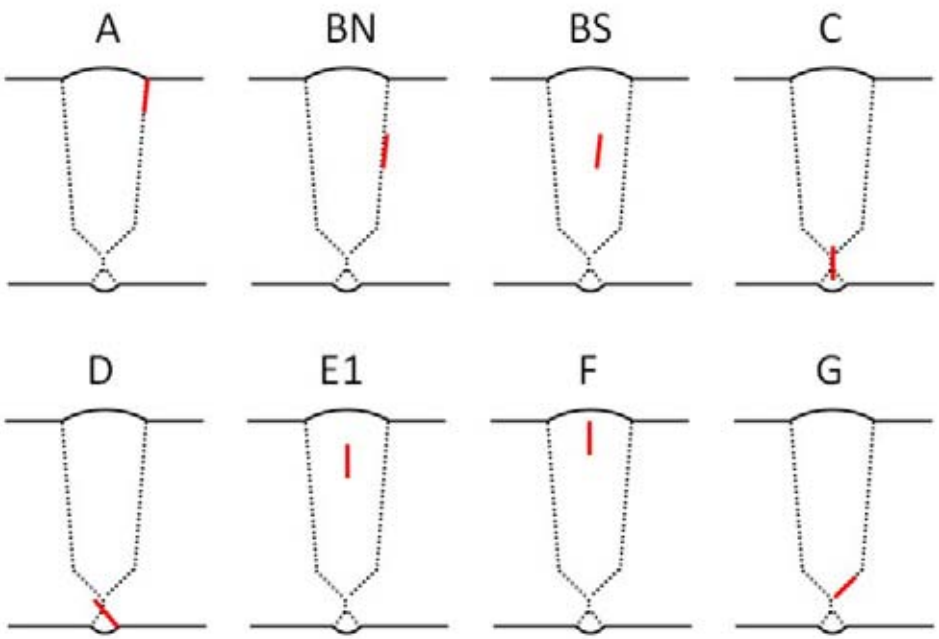
- Two sources:
  - Wall Thickness resolution target
    - 0.1mm is 1% of 10mm (0.394-in) wall pipe
    - 2% of 5mm (0.192-in) wall pipe
    - PRCI project EC 4-3 found laser scans accurate to 3%wt
  - Previous laboratory IWEX paper
    - 18th WCNT, April 2012, Durban, South Africa
    - *Experimental Comparison of Wave-field Based UT Imaging with other Advanced UT Weld Inspection Techniques*
    - Xavier DeLaye, Lars Hörchens, Khalid Chougrani

2012 WCNDT Paper





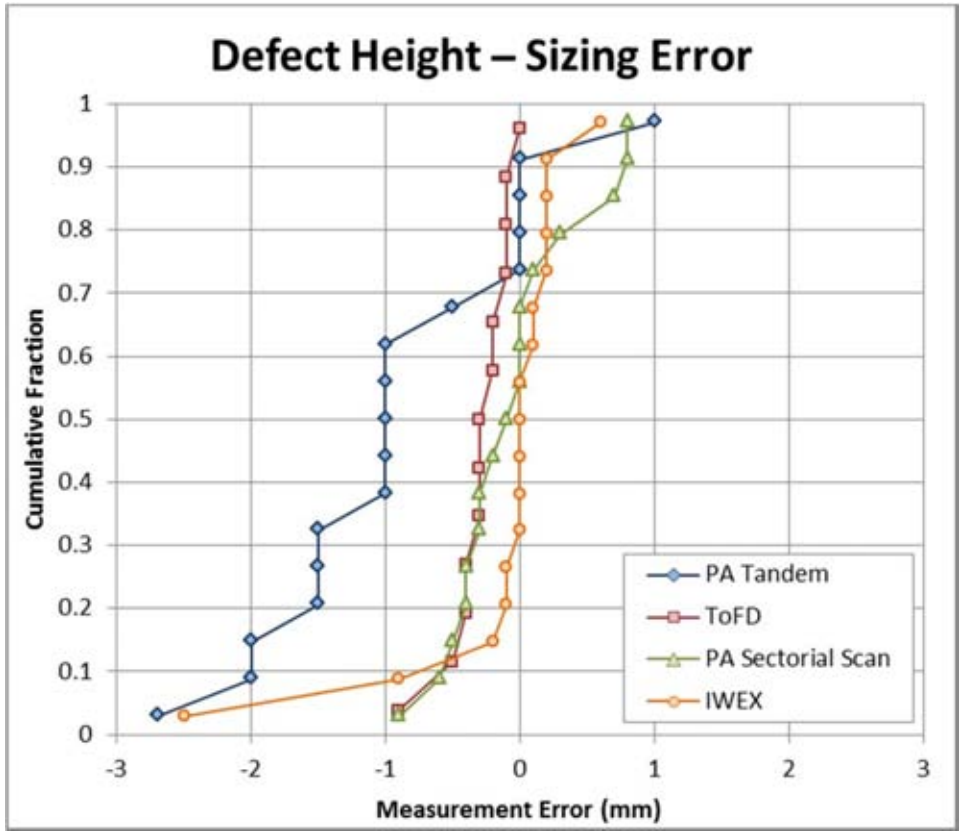
Constructed synthetic defects in flat plate welds for comparisons



WCNDT 2012 results

Sizing deviation per technique [mm]

Defect	PA Tandem	ToFD	PA Sectorial Scan	IWEX
A	-1.5	Not detected	0.1	0.1
BN	1.0	0.0	-0.3	0.0
B1	0.0	-0.3	-0.3	0.2
B2	0.0	-0.3	-0.6	-0.2
B3	-1.0	-0.4	0.8	0.0
B4	-1.0	-0.5	0.0	0.1
BS	0.0	-0.1	-0.4	0.2
BS1	0.0	-0.1	-0.2	0.0
BS2	-0.5	-0.2	0.3	-0.1
BS3	-1.0	-0.2	0.0	-0.1
BS4	-2.0	-0.3	0.8	0.0
C	-1.0	-0.4	0.0	0.6
D	-1.0	-0.9	-0.9	-0.9
E1	-1.5	Not detected	-0.5	0.0
E2	-2.0	Not detected	-0.1	0.2
F	-2.7	Not detected	-0.4	-2.5
G	-1.5	-0.1	0.7	0.2



- IWEX error <0.2mm
  - For 14 of 17 defects
- Lab results on ideal samples
  - Long uniform machined defects
  - Known wall thickness

Questions?