NIST Technology Showcase

FutureScan

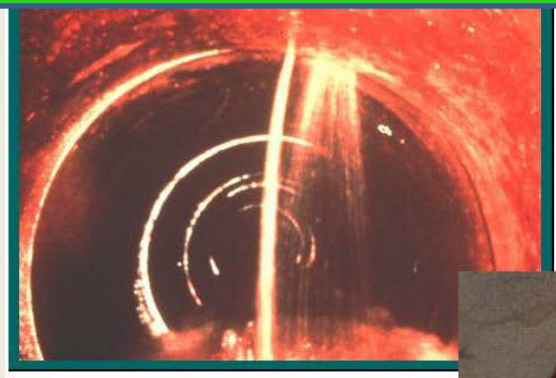
Next-Generation Pipe Penetrating Radar for Sewer and Water Infrastructure Inspection

Project NANB9H9009

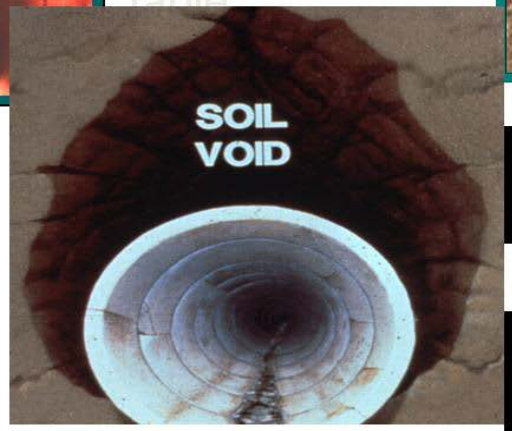
An Example of a Catastrophic Void

Impact of Floods, Earthquakes, etc.



Fine granular soil and high ground- water table



Brackish water & prolong inundation

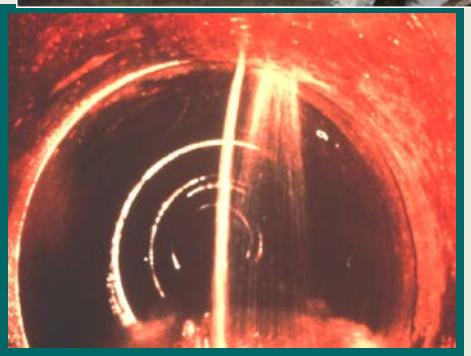
Rapid evacuation of water from sewer & drainage

Compromised buried infrastructure systems

High in-pipe water loss / supersaturated

Early Examples of In-Pipe GPR

- Borehole GPR unit looks for debris under I-5 (1998)
- Arizona Public Utility modified surface GPR mounted on standard transporter to detect voids behind a PVC liner (2004)
- Requires expert operators and Data Interpreters
- No common platform or User Interface
- Utilizes existing GPR technology—low resolution



Technology Objectives

- ✓ **It can tell us how thick the pipe's wall is and allow estimation for rates of decay.**
- ✓ **It can identify voids (sinkholes) that may exist outside of the pipe and their approximate size.**
- ✓ **Can provide information about the 'anatomy' of the pipe (i.e., distance from inner wall to reinforcement cage), resulting in more informed decision making process.**
- ✓ **Technology leant itself to fully automated, rapid, data collection and analysis**

- **An <u>innovative</u>, unique technology that establishes a new <u>gold standard</u> in the characterization and <u>condition assessment</u> of buried infrastructure elements**

Project Objectives

- **Develop radar sensor technology for sewer and water infrastructure that:**

  1. Provides new and advanced capabilities beyond TV, sonar, & Laser Profiler

  2. Is easy to operate and results are easy to interpret

  3. Can be readily commercialized onto the 17,000 assessment platforms in operation today.

  4. Cost Competitive

FutureScan

Pipe Penetrating Radar

Economical radar for…

-- Pipe Inspection

--New Installation Certification

FutureScan vs. Existing Technology

Technology / Attribute / Feature	CCTV (digital & analog)	Sonar	Laser Profiler	FutureScan
Detection of cracks on inner surface	✔			✔
Detection of off-set joint	✔			✔
Measuring the length & width of cracks	✔ (Digital Only)			✔
Measuring the depth of cracks				✔
Detection of defects beneath encrustation				✔
Detection of defects behind liners				✔
Measurements of pipe wall and Liner thickness				✔
Detection of soil voids				✔
Detection of corroded reinforcement bars				✔
Measurement of pipe ovality			✔	✔
Quantify the amount of sediments		✔ (Charged Pipe Only)		✔
Detection of lateral connections in newly lined pipe				✔

In-Situ Inspections Only Available in FutureScan

--Void/Utility Detection

--Pipe Wall/Liner Thickness

--Rebar Measurement

--Concrete Degradation

--Liner Irregularities

--Joint Irregularities

--Delamination

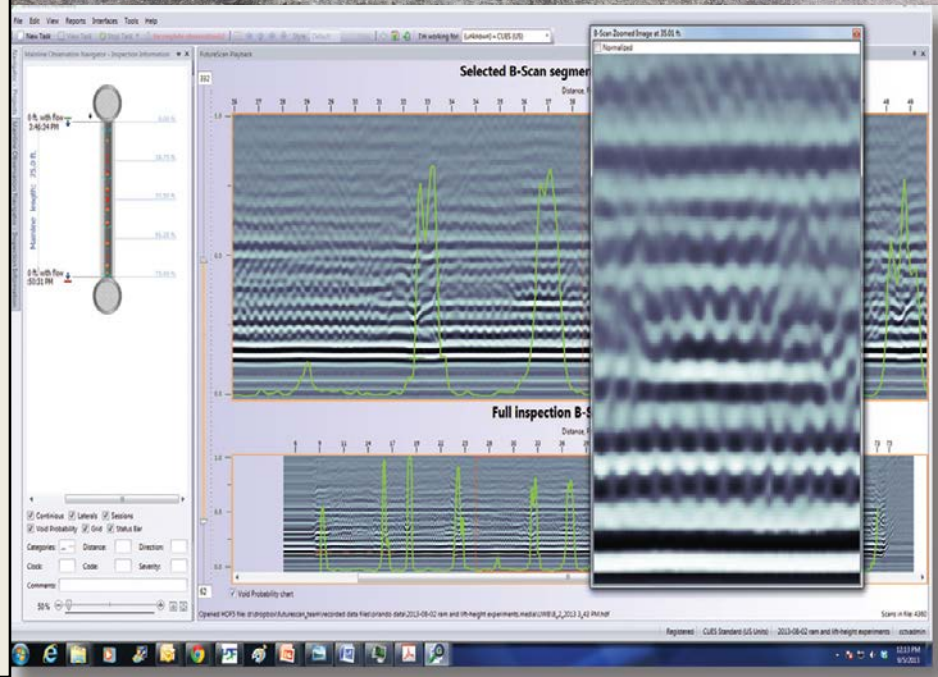
--Ovality

--Compaction and Bedding

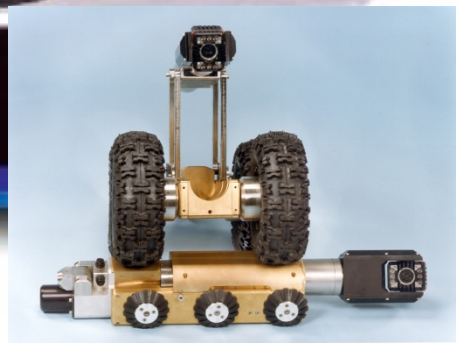
--As-Built Drawing Validation

--New Pipe Verification

--Relining or Rehab Verification



ELXSI (CUES) Assessment Products

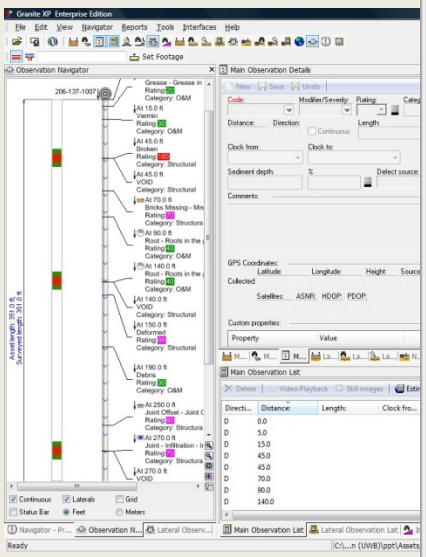


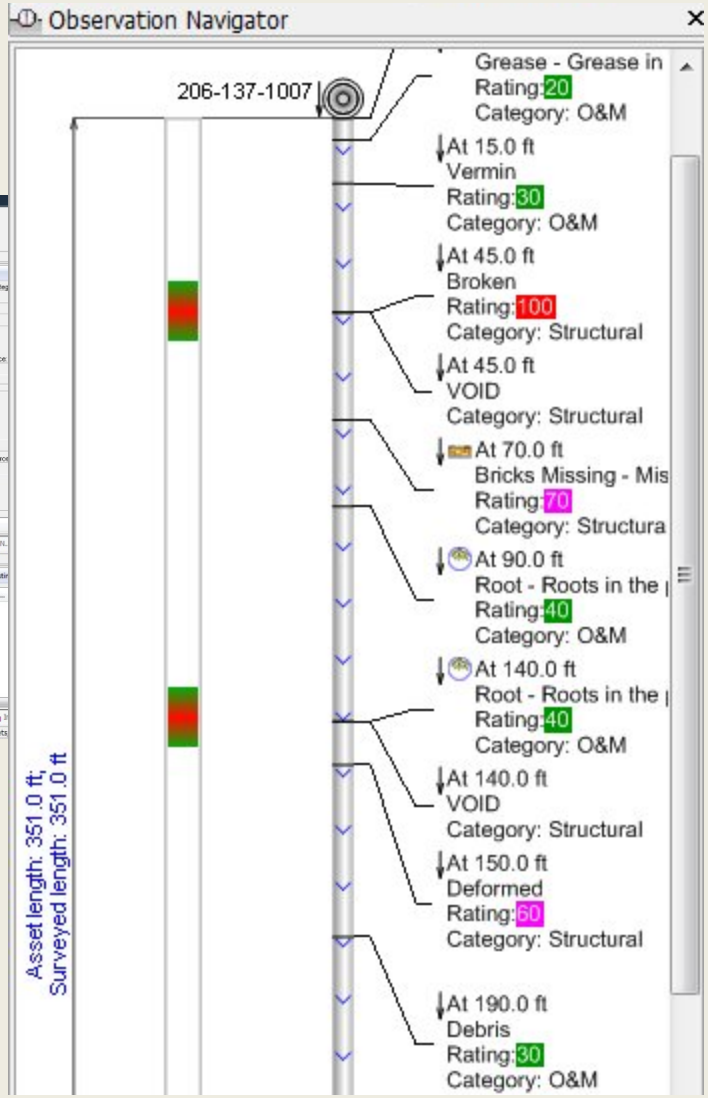
Performing the inspection in the field.

GRANITE XP

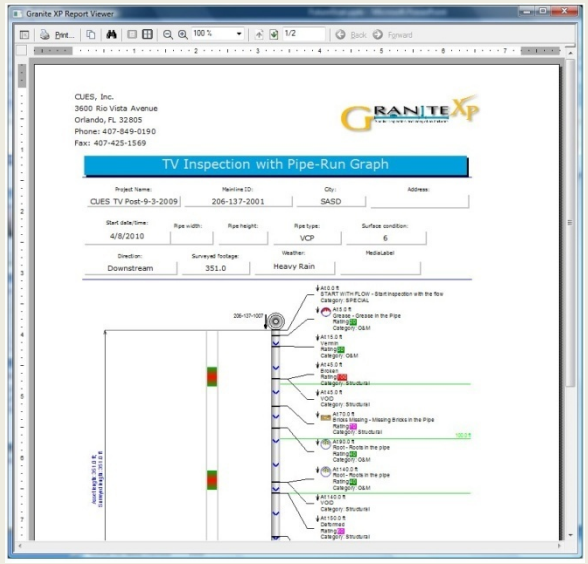
PIPELINE CONDITION ASSESSMENT SOFTWARE

Pipe-Run Report View





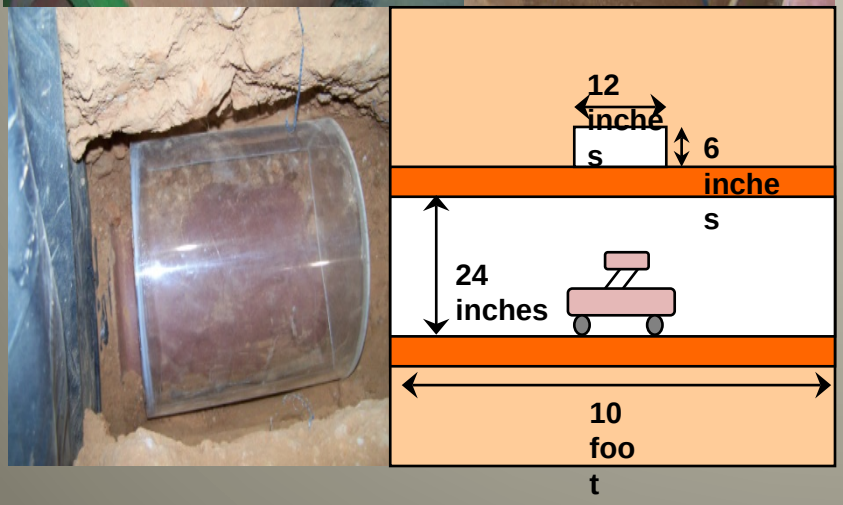
- Color real-time indication
- VOID observations are added automatically for each detected void
- Voids are available in all reports, including the pipe-run one



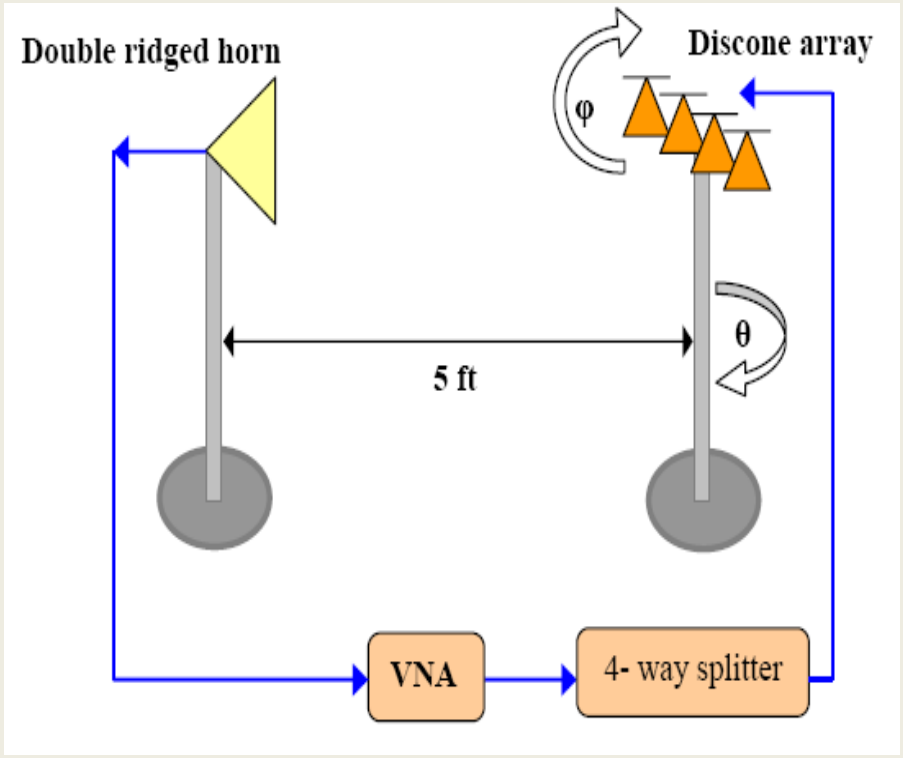
Louisiana Tech University—JV Partner

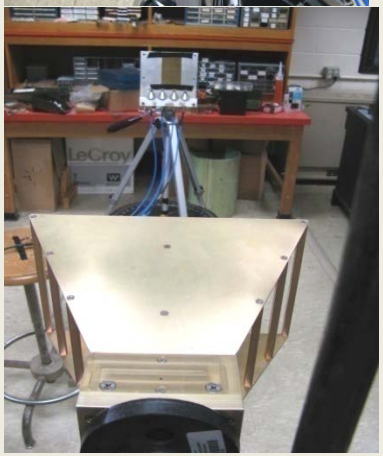
- Founded 1894
- Total Enrolment 10,950
- www.latech.edu
- Voted 3rd in nation for nanotechnology education
- One of a kind Trenchless Technology research center in the country

FutureScan Platform Development

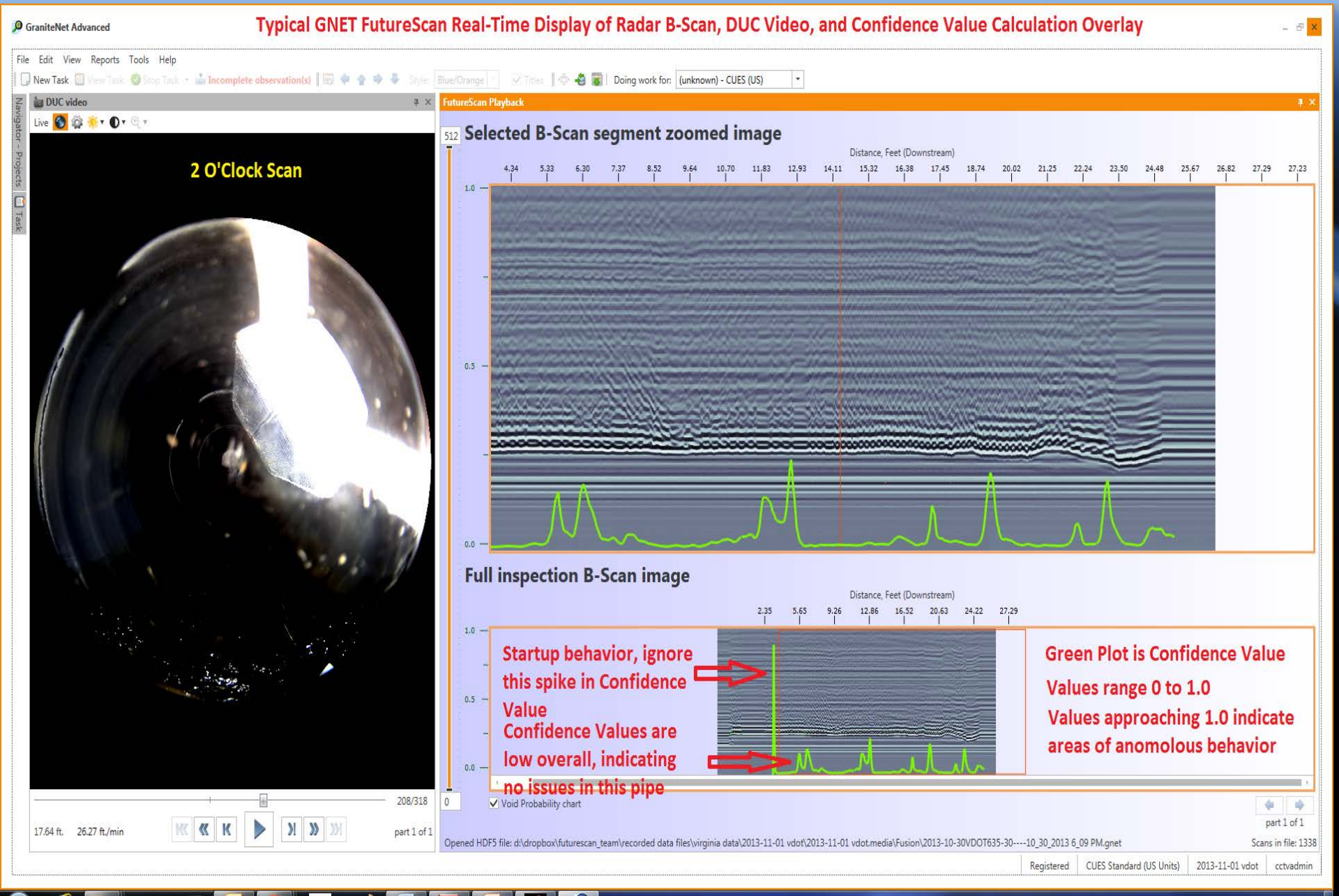


FutureScan Antenna Development





FutureScan User Interface in GNET



Examples of FutureScan Performance

- *In the next few slides, we will illustrate FutureScan performance on some Key Metrics:*

--Void Detection

--Pipe Wall Thickness Measurement

--Delamination (e.g. in PCCP)

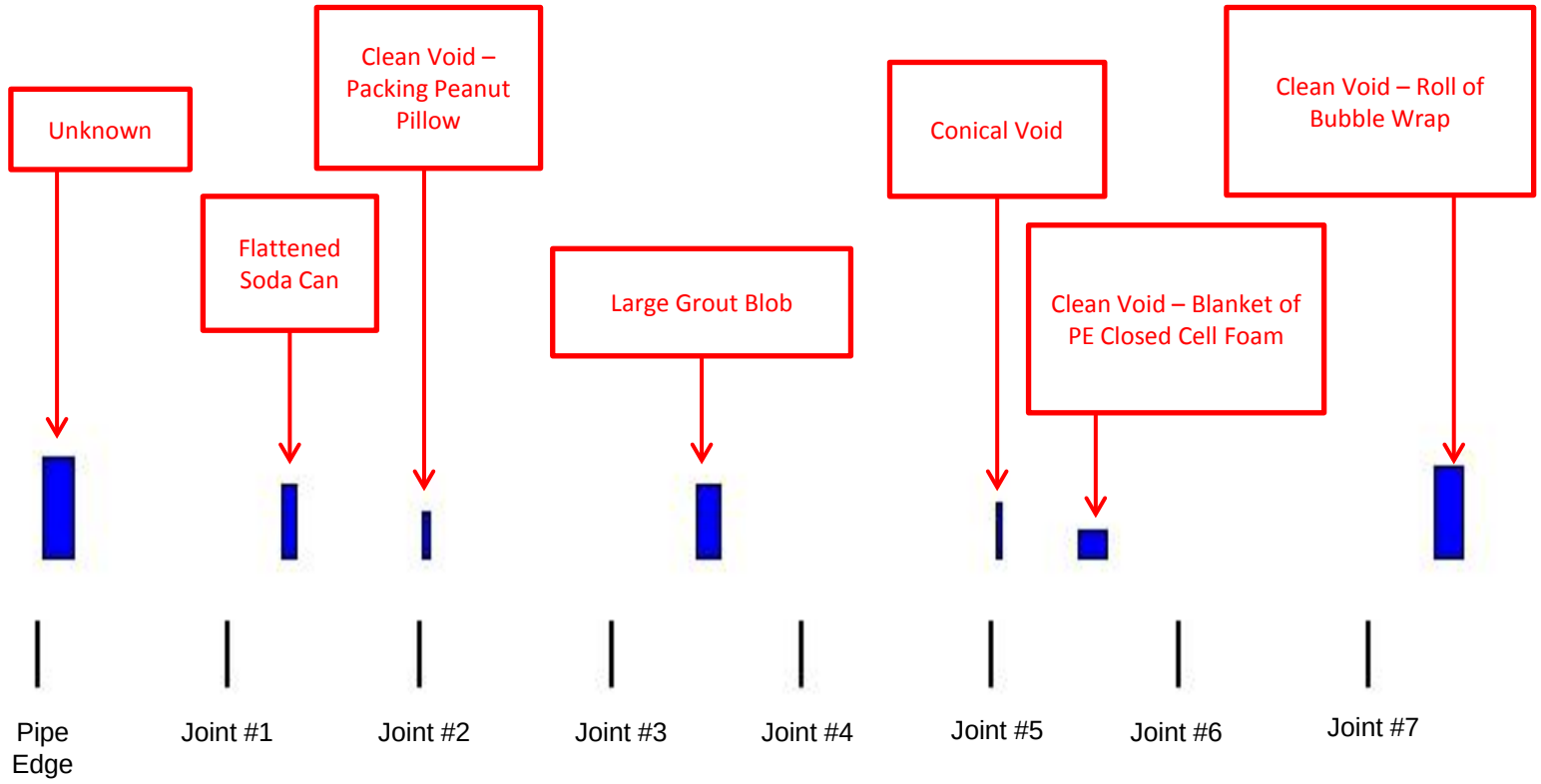
--Rebar Characterization

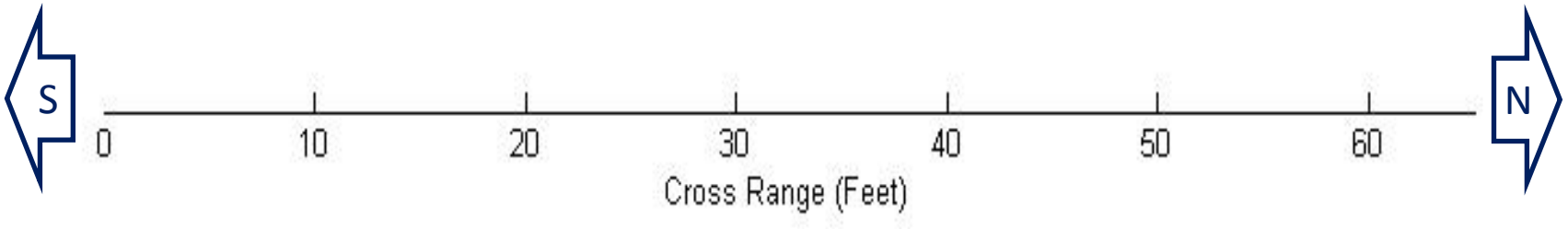
--Bedding Compaction and Homogeneity

---Surface Scanning

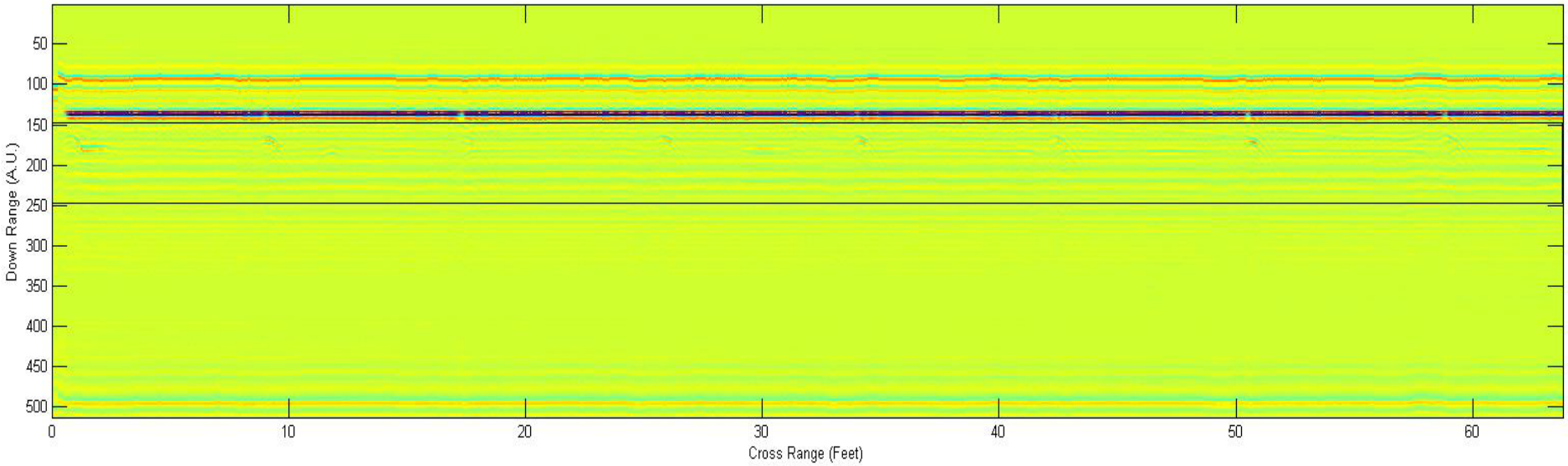
Testing and Improving FutureScan—Orlando Test Lane

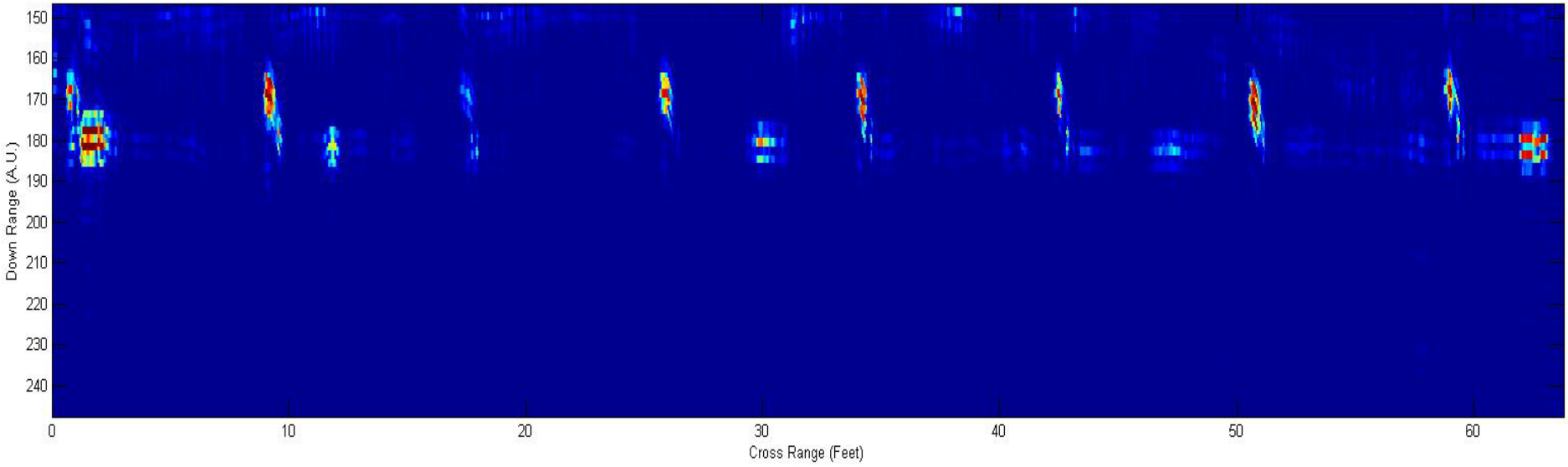
Void “Targets” in Orlando Test Lane





FutureScan Void Detection at Orlando Test Lane





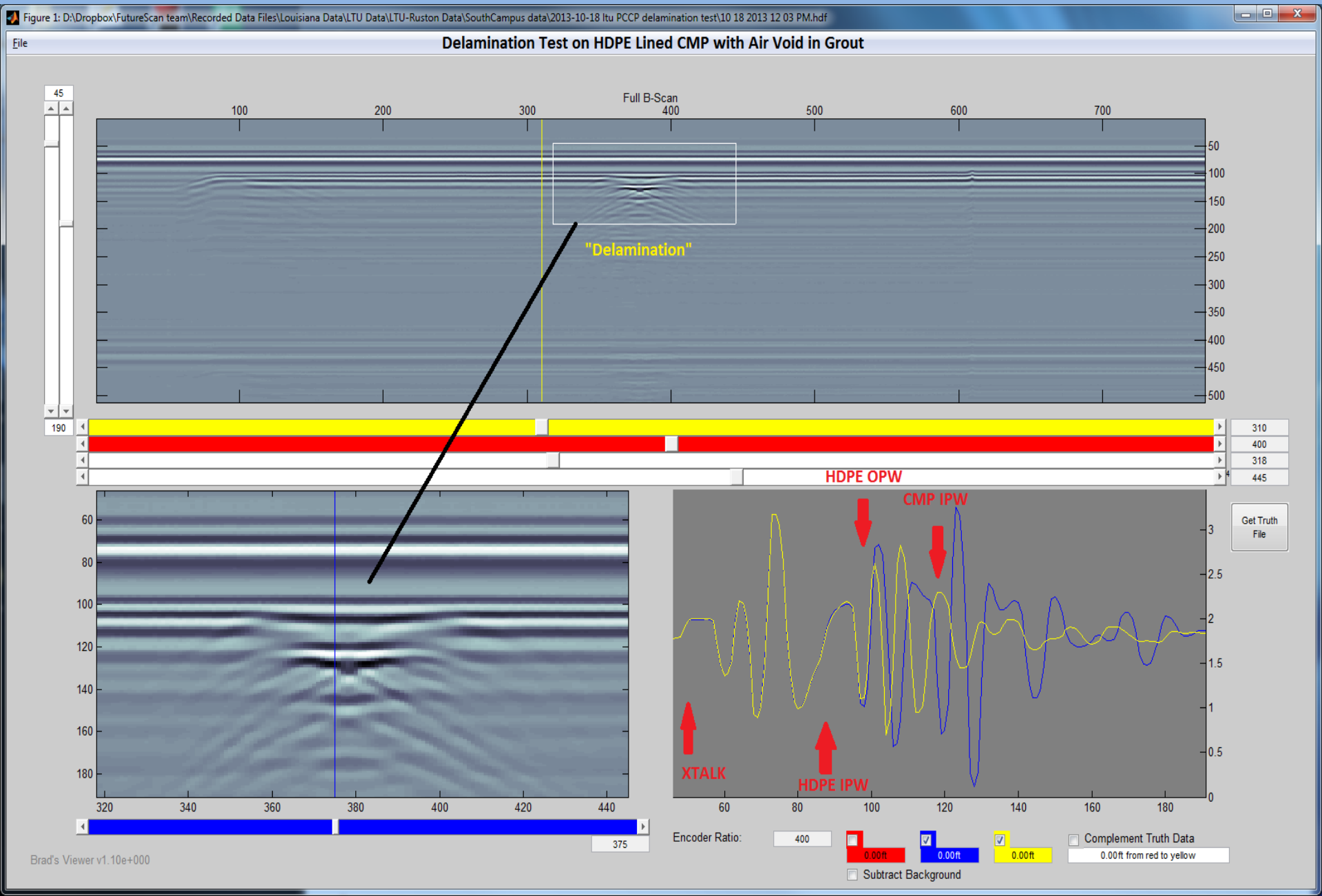
Delamination Measurement—LTU Test Setup

1 inch HDPE

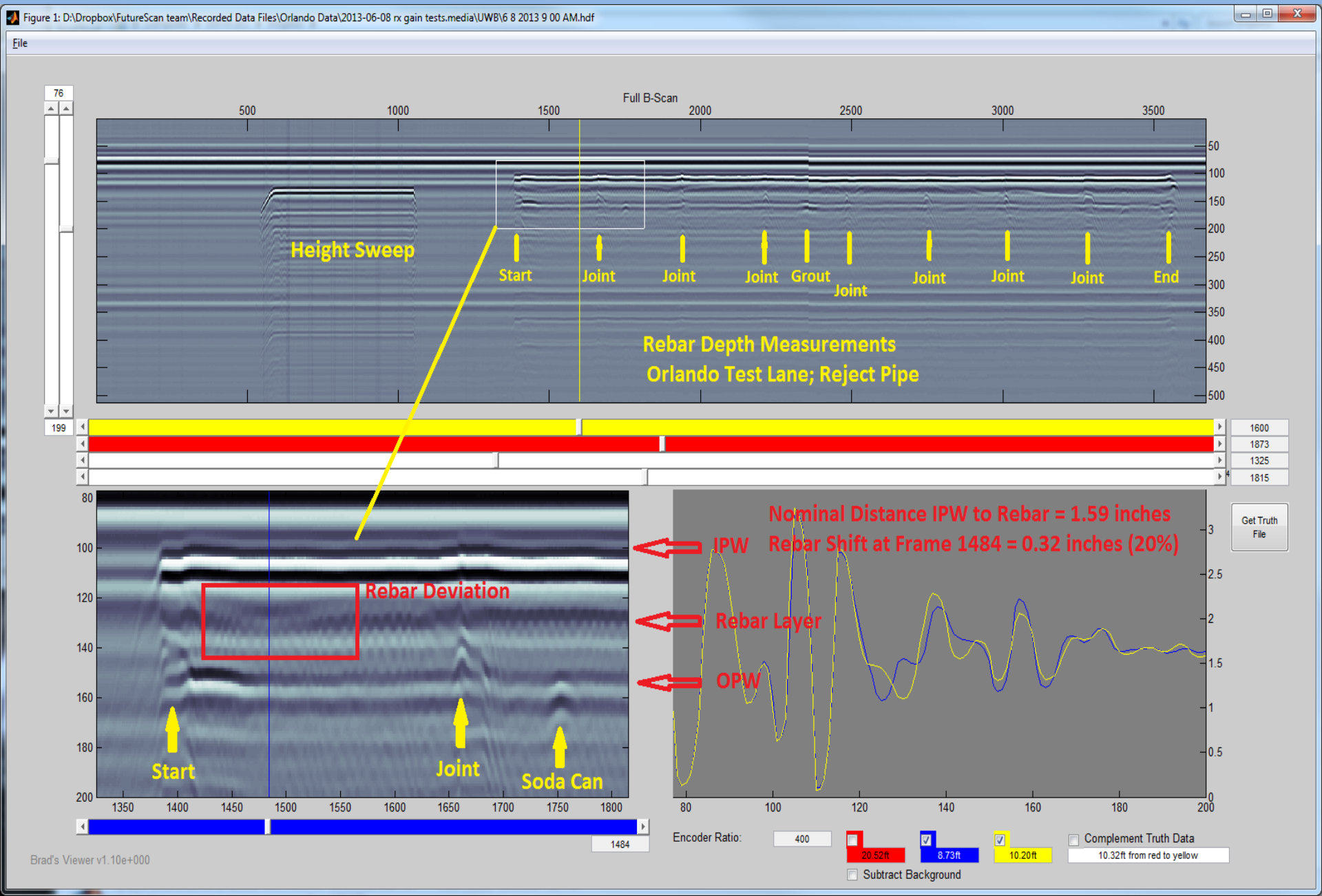
3 inches Grout

Corrugated Metal Pipe

Delamination Measurement—LTU Setup



Rebar Characterization

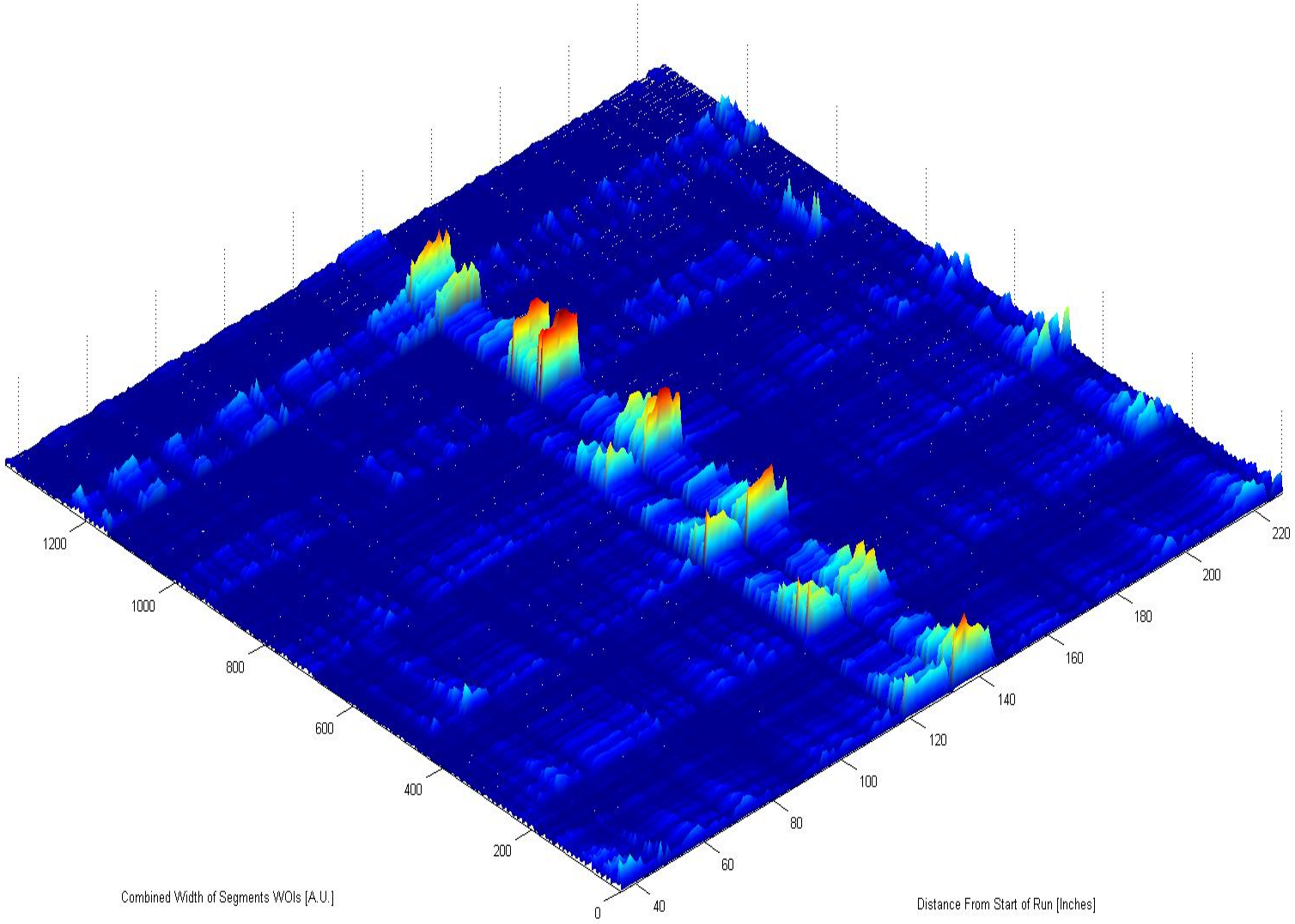


FutureScan Surface Scanning Example

FutureScan Unit Conducting a Pavement Surface Scan

Leakage into adjacent brick-lined sewer created void under roadway, cracking of the concrete plate

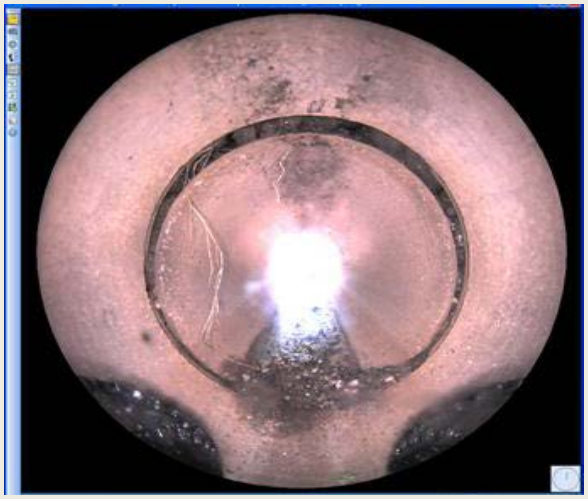
3-D Image of Surface Scan--2948 Front Street

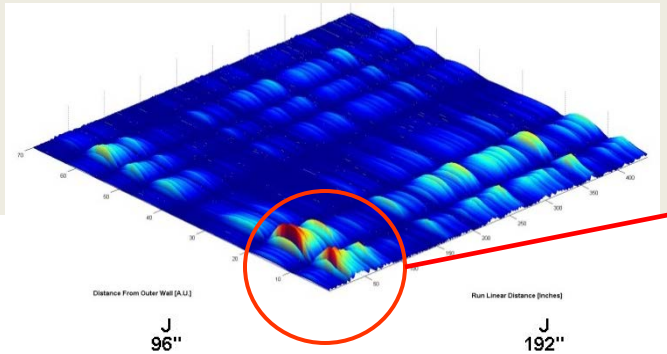


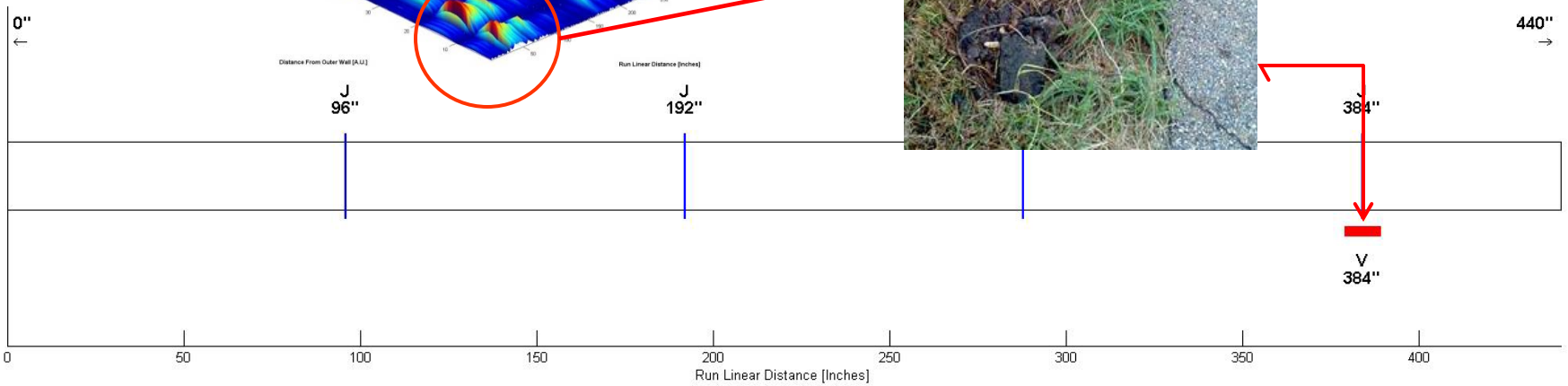
Eight Successful Major Field Trials to Date

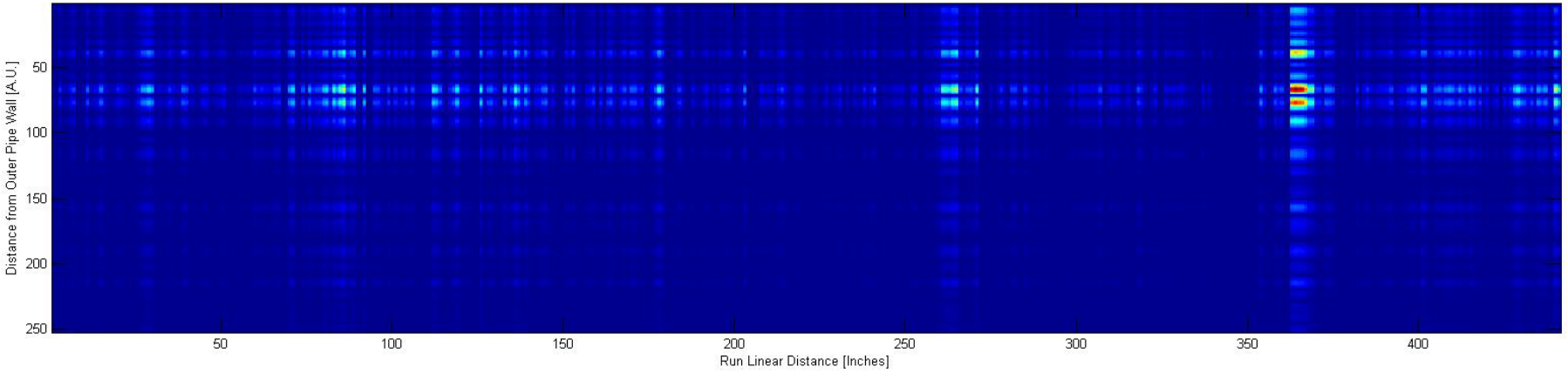
- Ruston La., March 2012; RCP, VCP, HDPE various sizes, Voids
- Slidell La., July 2012; 24 inch RCP, 32 inch Arched Pipe, Voids
- City of Orlando, February 2013; 42 inch RCP; Voids
- New York City, March 2013; 24 inch RCP, Voids
- Okeechobee, Fl., September 2013, RCP various sizes, 30 inch RCP relined with 24 inch A2000, Voids, Grouting, and Rehab Performance
- Ft Worth; September 2013, 48 and 72 inch RCP; Rebar, Pipe Wall Thickness, As-Built Drawing Verification
- Virginia DOT, October 2013; 15 inch HDPE, 30 and 48 inch Polypropylene pipe; Voids, Soil Compaction
- Coachella Valley, Ca., March 2014, Voids and Delamination

Front Street at Clara—Slidell, La.

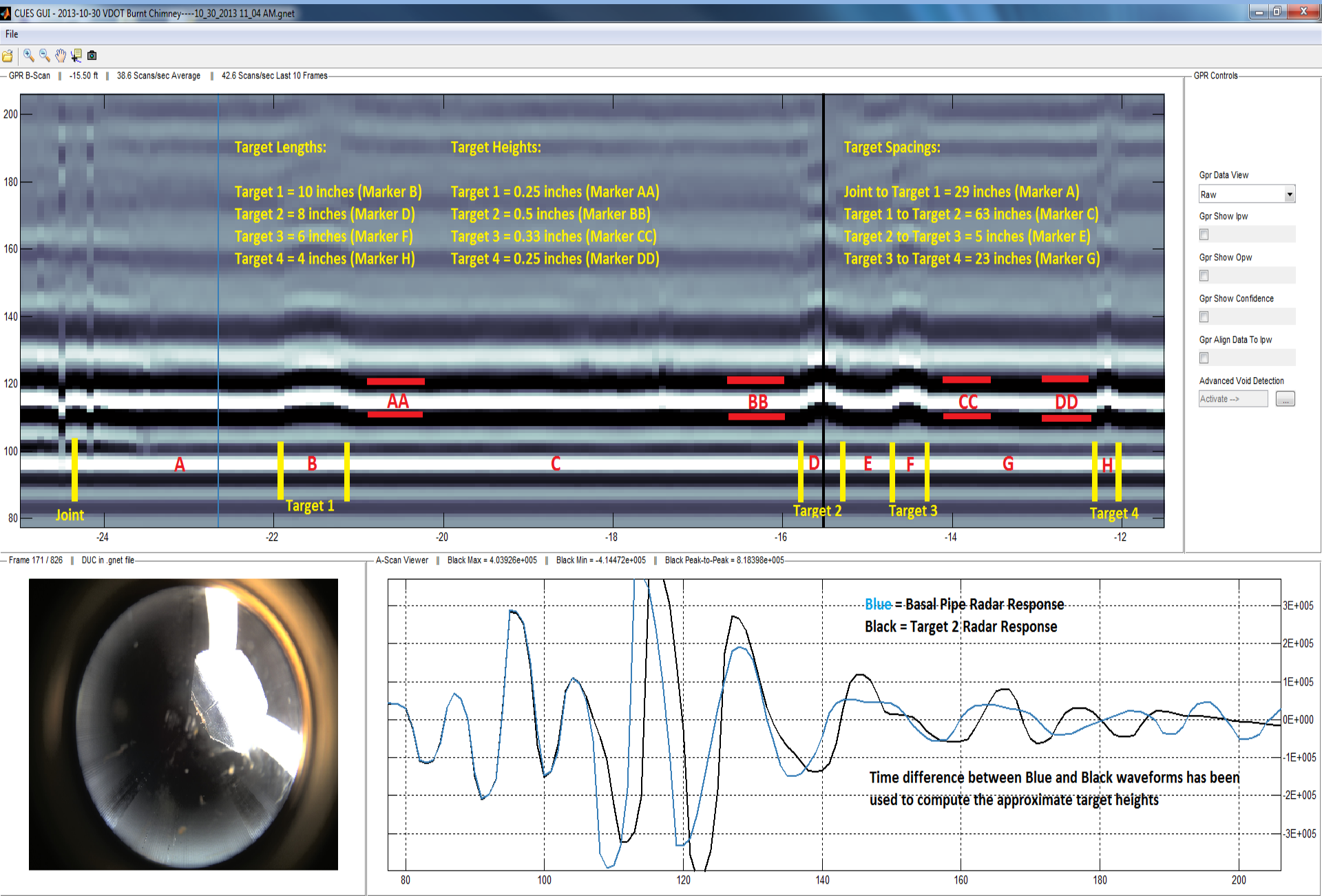


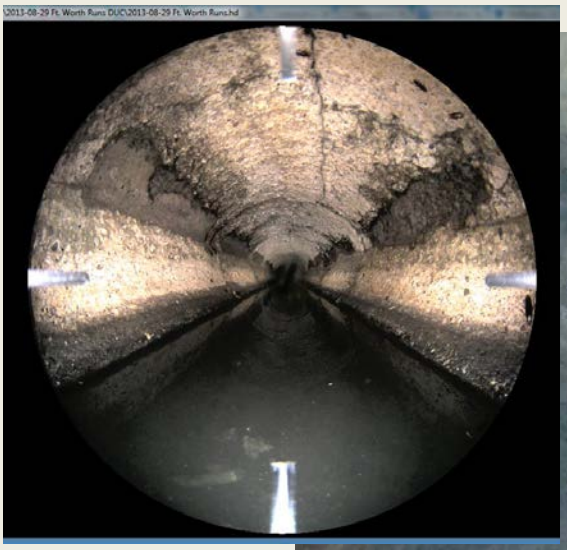

Distance From Outer Wall [A.U.]
Run Linear Distance [Inches]

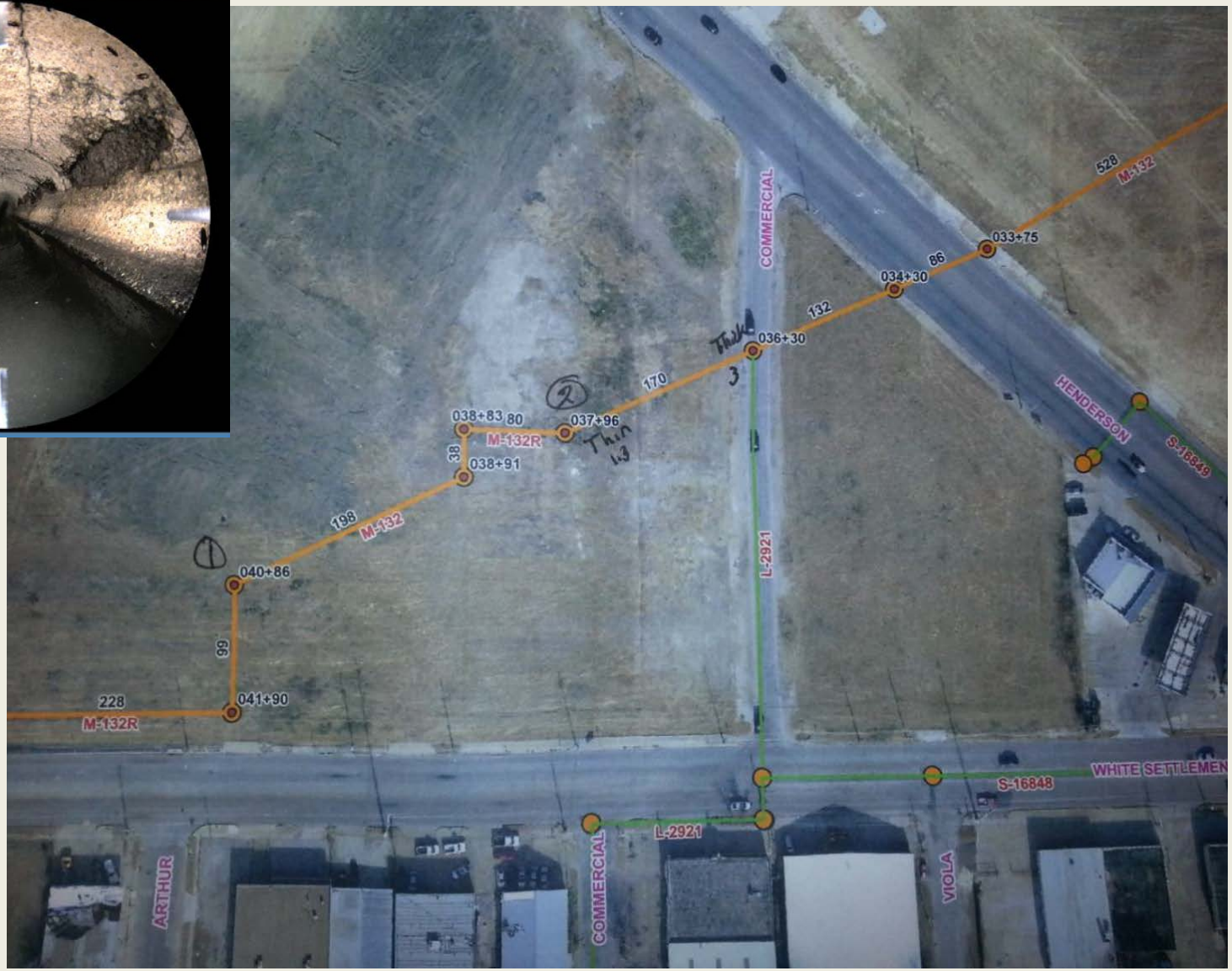

0"
440"
J
96"
J
192"
J
384"
V
384"
0
50
100
150
200
250
300
350
400
Run Linear Distance [Inches]


Distance from Outer Pipe Wall [A.U.]
50
100
150
200
250
50
100
150
200
250
300
350
400
Run Linear Distance [Inches]

FutureScan Void Detection—Virginia DOT

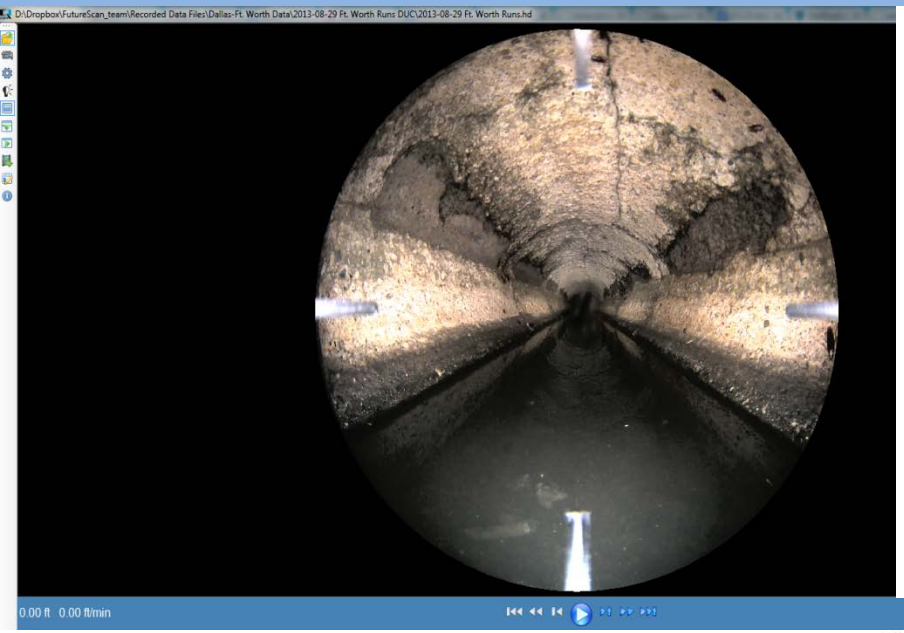


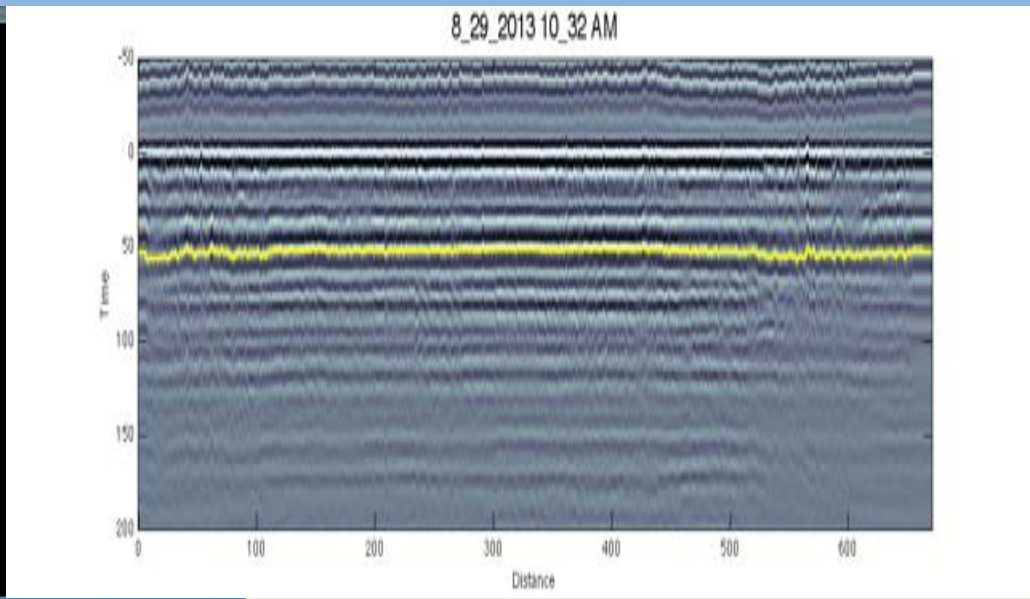


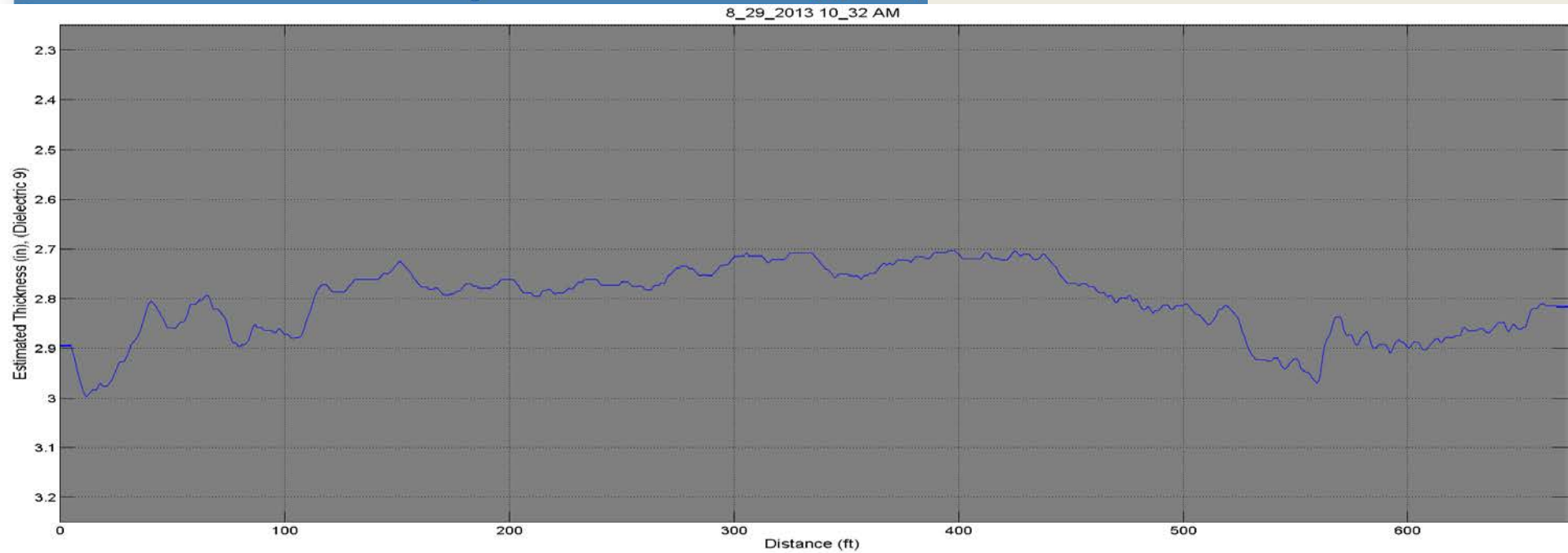


Ft. Worth Pipe Wall Thickness Measurment
24” deteriorated RC Sewer line

Pipe Wall Thickness Measurement—Ft. Worth







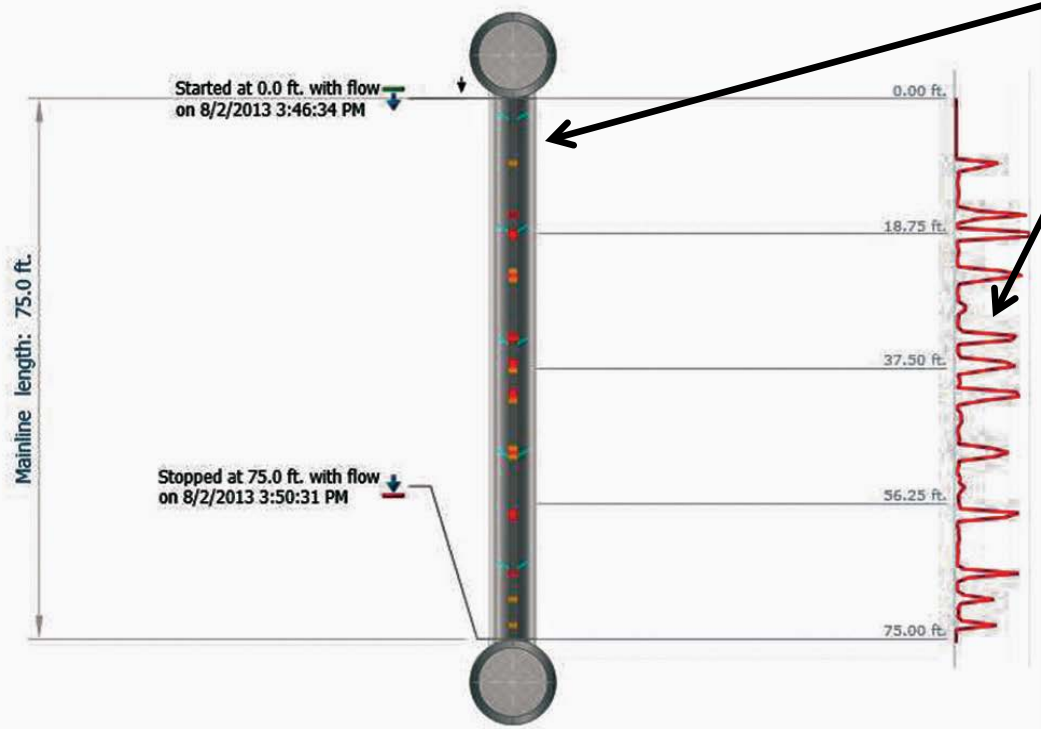
Standard Analysis—Example GNET Report

GraniteNet
ASSET INSPECTION / DECISION SUPPORT SOFTWARE

CUES Inc.
3601 Vineland Road
Suite 1
Orlando, FL 32811

Pipe Run Main Inspections with Void Probability

Project name:	Mainline ID:	City:	Address:
2013-08-02 RAM and Lift-Height Experiments	cues_test_pipe	Orlando	
Start date/time:	**Direction:**	**Weather:**	**Surface condition:**
8/2/2013 3:46 PM	With the flow		
Pipe shape:	**Pipe material:**	**Pipe height:**	**Pipe width:**



Standard Analysis

Void and Anomaly Detection:

Algorithms "tuned" to find differences (i.e. Anomalies) at the Outer Pipe Wall

Results Visualization in Two Formats:

"Heat-Map" of variations, with severity displayed via colorization, and

Confidence Value (CV) StripChart, with values ranging from 0 (no variation) to 1.0 (significant variation)

These visualization tools allow the customer to quickly identify potential problem areas within their system and make informed decisions regarding rehabilitation or repair.