



See undermining for structural rehabilitation



Backscatter Computed Tomography to Enhance Culvert Rehabilitation



Increase Confidence and Expected Service Life for Rehab Projects

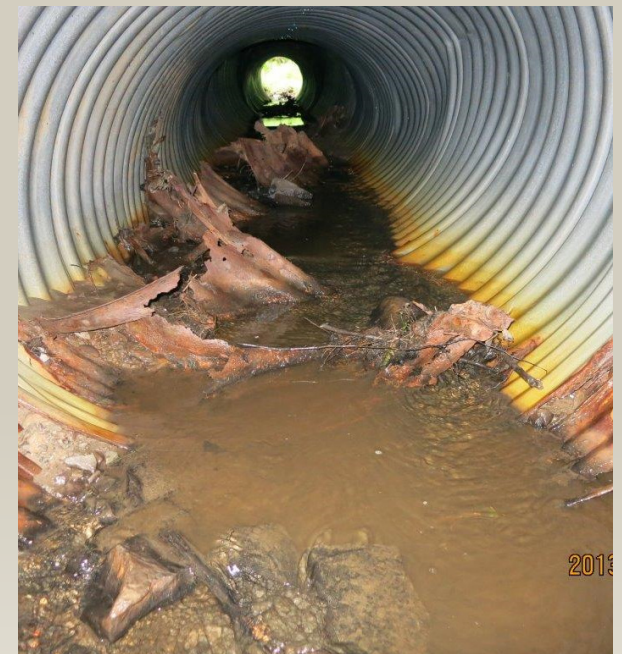
- **It is possible to conduct a rehab that achieves the same results as a new installation.**
 - Proper understanding of the problem
 - Allows a precise solution to be engineered
 - Meeting performance specs of a new installation and exceeding performance specs of the original installation

Voids Leading to Structural Instability

- The soil envelop is load bearing
- Soil instability will compromise the entire structure
- Voids create stress risers in the pipe
- Ultimately leads to deformations in the roadway and potential failure



- **Visual Inspection** can Identify
 - Corrosion, Joint failure and misalignment, deformation, ovality, channel misalignment and scour
 - **Difficult to make consistent and repeatable and ultimately it is impossible to assess structural integrity based on visual results alone**
- **Acoustic (Knock) Test** can identify
 - Regions suspected of undermining or voiding
 - **Good screening tool, however it is subject to false positive void results and is difficult to report in a systematic fashion**
- **Neither provide conclusive information about structural integrity or soil stability**



- Unseen cues of structural deficiency represent an information gap
 - Undermining
 - Soil movement
 - Piping
 - Void formation
- Visual and Acoustic
 - Are not definitive but are useful as a screening tool
- Backscatter Computed Tomography (BCT) is used to fill the information gap
 - Identify, visualize and quantify voids
 - Post construction QA/QC (grout placement)



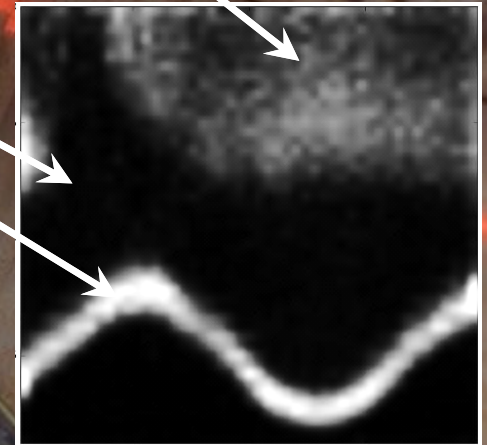


INSIGHT™, the first CAT scan for infrastructure

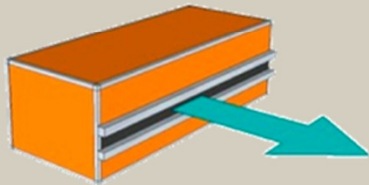
backing material

void

steel wall

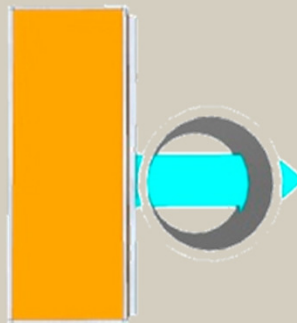


1



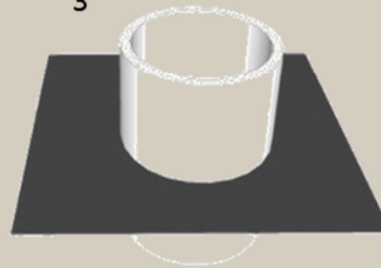
Scanner houses radiation collimator and detector

2



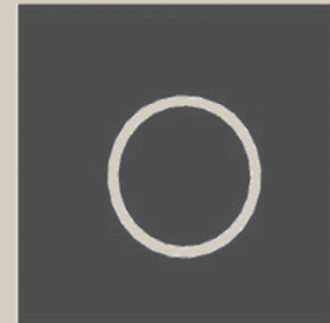
Scanner placed adjacent to asset of interest

3



Data collected for a single plane through the asset

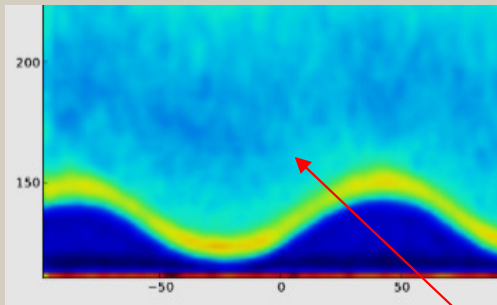
4



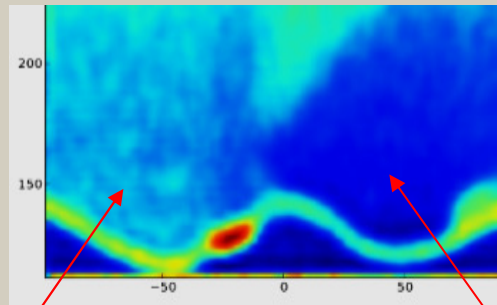
That data represents a density map of the asset

Sample BCT Images No Void

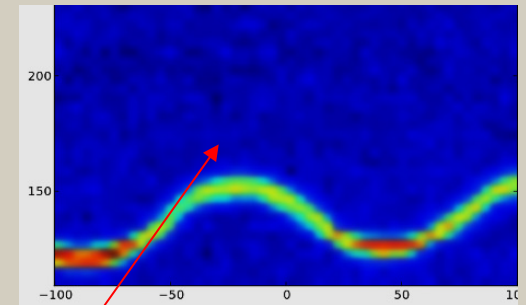
No Void



Transition to Void



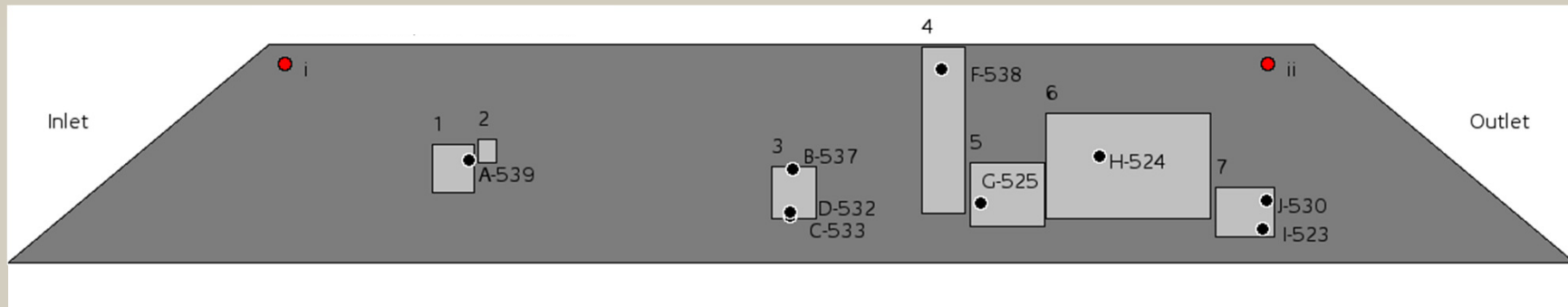
Void



Soil

Void

Inversa's Culvert Map



- To scale representation of the culvert including:
 - visual indicators
 - acoustic anomalies
 - BCT locations
- BCT provides conclusive structural diagnostics of the soil envelope
- All data in the culvert map is referenced in complete culvert report

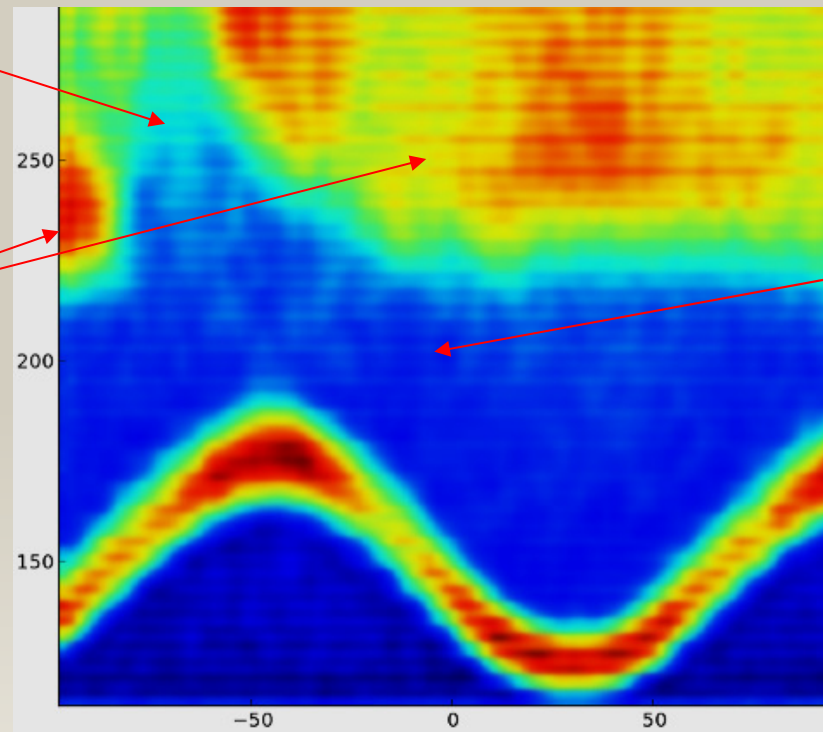
- **Every site is unique**
 - Local soil conditions
 - Construction practices (time of install)
 - Burial depth (soil load requirements)
 - Traffic load (risk of failure)



Large Void from Water Piping

A water channel
(piping)

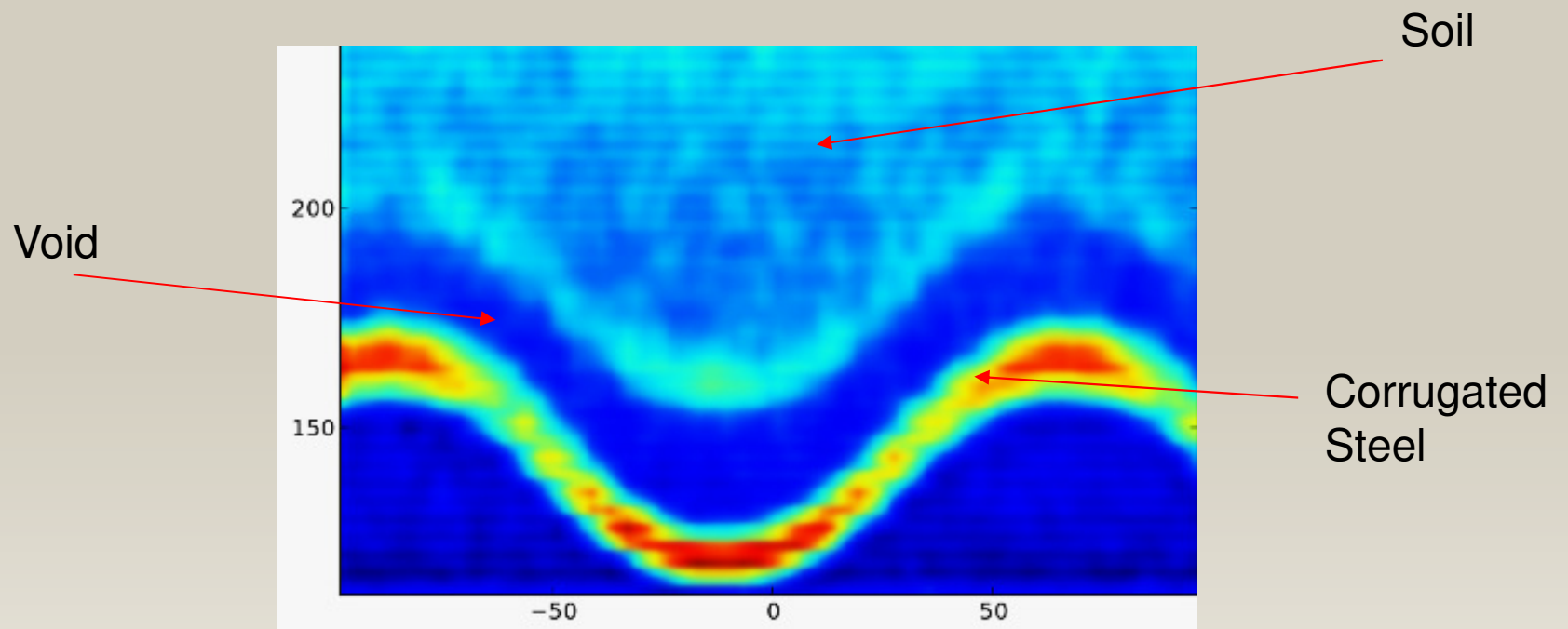
Soil



Void

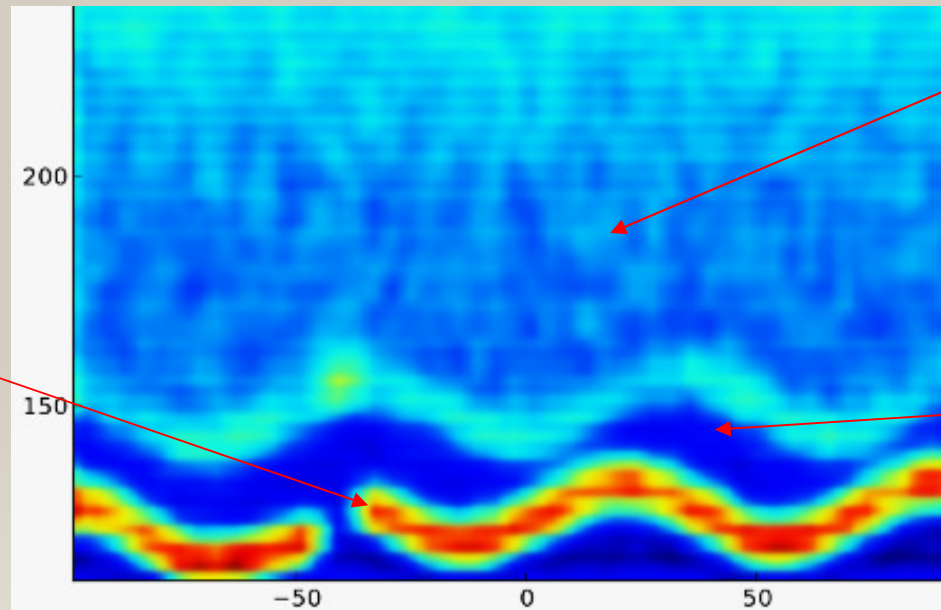
Corrugated
Steel

Uniform Soil Void



Uniform Void, Pipe Slippage

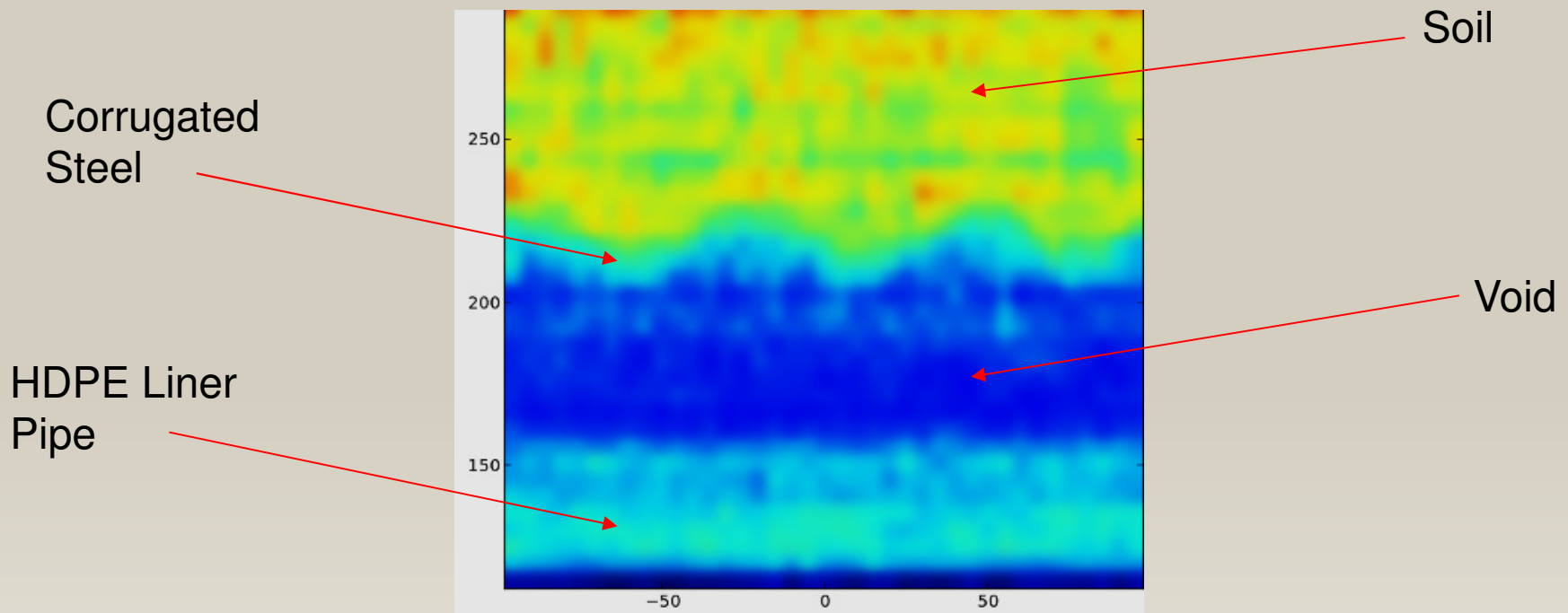
Corrugated
Steel



Soil

Void

Post Liner Rehab Grout Placement



- **Based on currently available information assumptions are made from inconclusive inspection data about**
 - failure mode
 - soil stability
 - grout placement

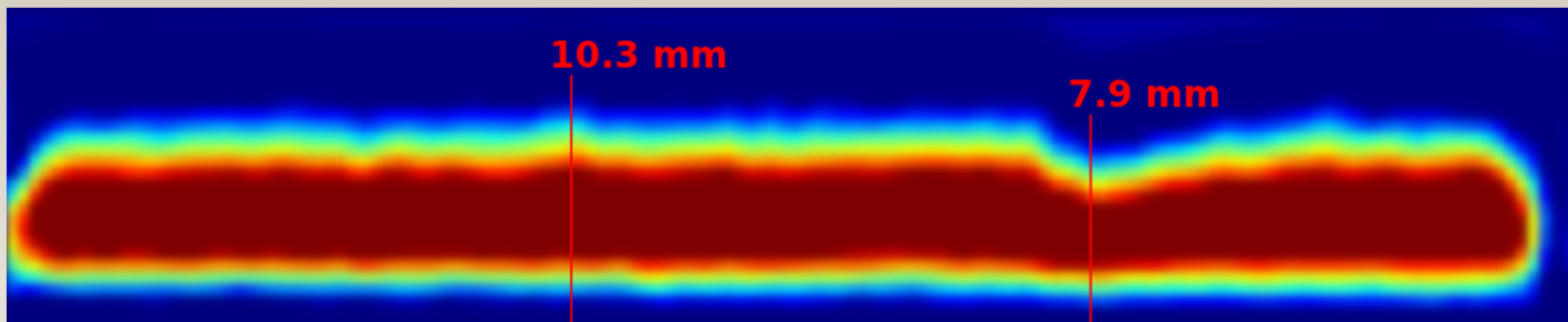
- **With new technology**
 - failure modes, soil stability and grout placement can be accurately visualized and understood
 - Allowing you to engineer a precise solution
 - Meeting performance specs of a new installation and exceeding performance specs of the original installation



CONTACT INFORMATION:

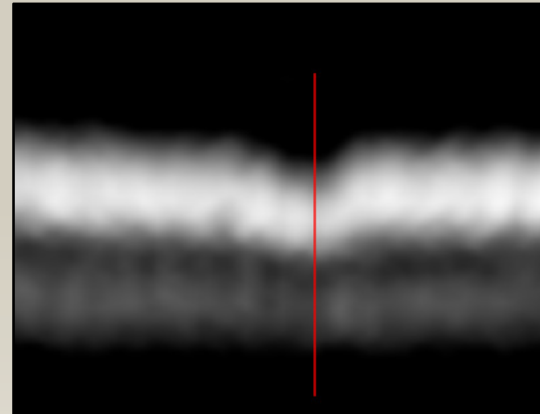
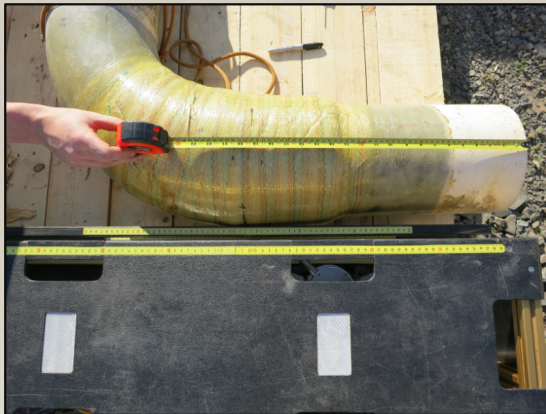
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Cast Iron Water Pipe with Corrosion



Composite Wrap Repaired Pressure Pipe

A BCT image of weld root corrosion on a out of service pipe sent to Inversa by client for qualification.



HDPE with Concrete and Void

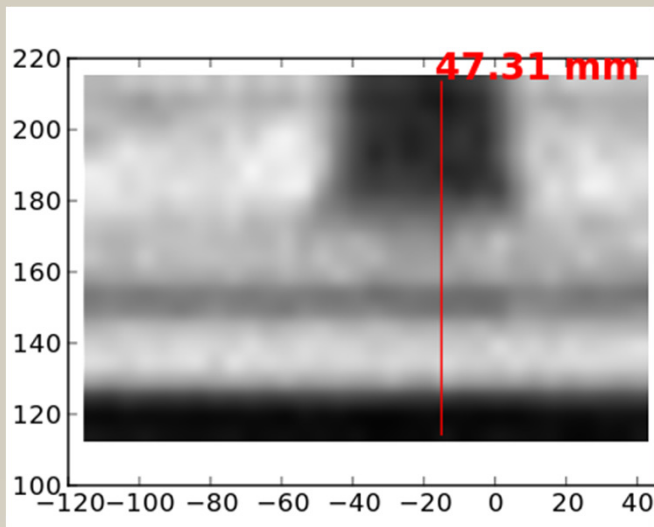


Figure R&D BCT image and graph of 2 layer HDPE pipe with concrete and simulated air gap



Figure R&D physical setup two 21mm thick layers of HDPE filled with concrete