# Digital Radiography Condition Assessment of Valves, Fire Plugs, and Pipes.

Presenter/ Authors:

Penny Wrightson, Mason Erkelens, Young-il Kim, Stephen Simmons





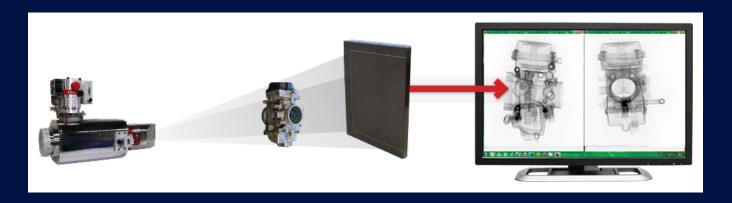
#### Detection Services / DS Insight

- Undertaken the longest pipeline test to date
  - 2015 150km BHP Olympic dam PCAT
  - 2017 180km BMA
  - 2018 110km BMA
- Commonly 200+km a year of pipeline inspection
- A wide range of tools
- Located in WA, Victoria, South Australia, Sydney, Queensland, Auckland, Wellington, and Christchurch
- We mobilise worldwide to test pipelines

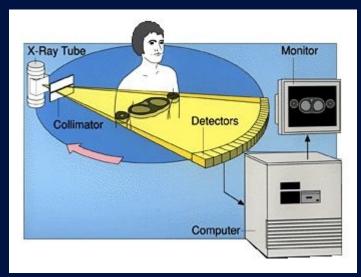
DETECTION SERVICES PIPELINE INSPECTION AND ANALYSIS		'n	OUTPUT APPLICATION							SUITABLE PIPELINE MATERIAL												
		Method	RESOLUTION	NON-INVASIVE	Pipe Wall Thickness	Cement Uning Loss	Gas and Air Pocket	Corrosion Pitting	Valve condition	Leakage Detaction	Soil Conditions	Rising Main	Water Pipes	टा के टाटा	DI & DICL.	MS	MS-MSCL	Concrete	AC.	HDPE	HOBAS	689
INSIGHT imaging		Chemical composition and material losses heat mapping of pipeline samples	Sample	×	٠	٠		(*)	7.60			٠	٠	٠	٠	٠	٠	٠	٠	٠	*	*
INSIGHT Analysis		Environmental chemistry analysis (water, gas, soil) of pipeline deterioration/cornosion condition to identify high risk areas and potential corrosion rates	Sample	1			٠				٠	٠	٠	٠	٠	٠	٠	٠	٠	٠	٠	٠
INSIGHT Microbial analysis		Microbial corresion and deterioration analysis via eDNA	Sample	1				٠				٠	٠	٠	٠	٠	٠	٠	٠	٠	•	٠
P-CAT*   pipeline contilion susessment		Inverse transient pipeline condition assessment	Screening	1		٠	٠	٠	٠				•	+	+	+	+	+	+			
g-CAT" gas and sir pucket detection		High accuracy non-invasive gas and air pocket detection	High	1	ė.							٠	٠	٠	٠	٠	٠	٠	+	٠	٠	•
V-CAT valve condition assessment		Valve sealing condition assessment, Valve closure measurement	High	1					٠			٠	٠	٠	٠	٠	*	٠		+	٠	٠
#-CAT" accordic leahage condition assessment	i usys	Acoustic leakage monitoring and detection	High	1			٠						٠	+	٠	٠	*	٠	٠	+	+	٠
vid-CAT internal under pressure video impaction	EXTERNAL	In-pipe under pressure video inspection	Med	×		•	٠	•					•	*	٠	*	•	+		+	٠	٠
SIMBIFT - CAT Mrt external place well economing	EXT	Magnetic flux leakage for high resolution pipe wall thickness	High	1	٠			٠				٠	٠	•	٠	*	٠					
SCT Stress Concentration Tomography	8)	Magnetic stress measurement	Screening	1	•			•				•	(			٠	٠					
Ultrasonics Point Ultrasonics		Point testing well thickness	High	×	٠			٠				٠	٠	٠	٠	٠	٠					
PCM Pipeline Coating Measurements	22	Detection of pipeline coating integrity	High	1								٠		٠	٠	٠	٠					
LPR Linear Polarisation Resistivity		Corresive soil mapping	Low								*	•		٠	٠	٠	٠					
DCM Direct Dielectric Constant	VI 	Dielectric constant soil mapping	Med	1								٠		+	٠	٠	٠					
GPR Ground Penetrating Radar	57 57	Soil and pipe, AC wall thickness mapping	High	1	٠						•	٠	•	٠	٠	٠	٠	٠	٠	٠	٠	٠
Valve Condition Assessment		Exercise, release, measure torque load	High	1					٠			٠		٠	٠	٠	٠	٠	٠	٠	٠	*
inscan	7	Most advanced internal scanning, video and acoustics leakage analysis technology	High	×		٠	٠		٠	٠		٠	٠	*	٠	٠	٠	٠	٠	*	٠	٠
DEEP TREKKER	INTERNAL	Pressure rated ROV inspections systems and HDCCTV tractor cameras for potable water	High	×		٠		٠	٠		٠		Ī	٠	٠	*	٠	٠	٠	٠	٠	+
PIPE - INSPECTOR	N	In pipe free flow acoustic leakage and air pocket detection, HD CCTV, pressure, temperature and turbidity	Med high	×		٠	•		٠	٠		٠	•	٠	٠	+	٠	٠	٠	٠	٠	٠
visenti	N	Transient, hydraulic monitoring, burst detection, condition monitoring, failure prediction, real time detection 24/7	High	1						٠		٠	*	٠	٠	٠	٠	٠	٠	٠	٠	٠

	OUTPUT APPLICATION									SUITABLE PIPELINE MATERIAL											
Method	RESOLUTION	NON-INVASIVE	Pipe Wall Thickness Cement Uning Loss	Gas and Air Pocket	Compsion Pitting	Valve Condition	Leakage Detaction Soil Conditions	Rising Main	Water Pipes	टा के टाटा,	DI & DICL.	MS	MS-MSCI.	Concrete	PC.	HDPE	HOBAS	683			
Chemical composition and material losses heat mapping of pipeline samples	Sample	×			٠			•	٠	*	*	٠	*	٠	*	٠	*	*			
Environmental chemistry analysis (water, gas, soil) of pipeline deterioration/cornosion condition to identify high risk areas and potential corrosion rates	Sample	1		٠		Ì	٠	٠	٠	٠	٠	٠	٠	٠	٠	٠	٠	٠			
Microbial corresion and deterioration analysis via eDNA	Sample	1	*		٠			•	٠	٠	٠	٠	٠	٠	٠	٠	*	٠			
Inverse transient pipeline condition assessment	Screening	1								٠	٠	٠	+	٠	٠						
High accuracy non-invasive gas and air pocket detection	High	1								٠	٠	٠	٠	٠	٠	٠	٠	٠			
Valve sealing condition assessment, Valve closure measurement	High	1								•	+		+	•	+	+		+			
Acoustic leakage monitoring and detection	High	1								٠	+	+	+	+	+	+	+	+			
In-pipe under pressure Video inspection	Med	×								٠			+	+	+	+	+	+			
Magnetic flux leakage for high resolution pipe wall thickness	High	1	•	1	٠			٠	•	*	+	+	٠								
Magnetic stress measurement	Screening	1			٨							+	+								
Point testing wall thickness	High	×			٠				•	٠	+	+	*								
Detection of pipeline coating integrity	High	1	12				٠	٠	10	٠	•	٠	٠								
Corrosive soil mapping	Low						*		٠	٠	+	٠	*								
Dielectric constant soil mapping	Med	1	(2 ()				٠	٠	•	*	+	٠	*								
Soil and pipe, AC wall thickness mapping	High	<b>V</b>	•					. (6)	•	*		+	+	+	•	+	+	+			
Exercise, release, measure torque load	High	1				٠		٠	10	*	*	*	٠	٠	٠	+	٠	+			
Most advanced internal scanning, video and acoustics inskage analysis technology	High	×								٠		+	+	•	+	+	+				
Pressure rated ROV inspections systems and HDCCTV tractor cameras for potable water	High	×								٠	+	+	+	٠	+	+	+	+			
In pipe free flow acoustic leakage and air pocket detection, HD CCTV, pressure, temperature and turbidity	Med high	×	٠							٠	+	+	•	+	+	+		+			
Transient, hydraulic monitoring, burst detection, condition monitoring, failure prediction, real time detection 24/7	High	1					٠	٠		٠	+	+	+	٠	٠	٠	*	*			
	Chemical composition and material losses heat mapping of pipeline samples  Environmental chemistry analysis (water, gas, soli) of pipeline deterioration/cornosion condition to identify high risk areas and potential corrosion rates  Microbial corrosion and deterioration analysis via eDNA.  Inverse transient pipeline condition assessment  High accuracy non-invasive gas and ale pocket detection  Valve sealing condition assessment.  Accustic leakage monitoring and detection.  In-pipe under pressure video inspection  Magnetic flux leakage for high resolution pipe wall: thickness  Magnetic stress measurement  Point testing wall thickness  Detection of pipeline coating integrity  Cerrosive soil mapping  Dielectric constant soil mapping  Soil and pipe, AC wall thickness mapping  Exercise, release, measure torque load  Mont advanced leterinal scanning, video and scoustics leakage analysis technology  Pressure rated ROV inspections systems and NDCCTV tractor careeras for potable water  In pipe free Flow accustic leakage and air pocket detection, NO CCTV, pressure, temperature and turbidity  Transient, hydraulic monitoring, burst detection, condition	Chemical composition and material losses heat mapping of pipeline samples  Environmental chemistry analysis (water, gas, soli) of pipeline deterioration/corrosion condition to identify high risk areas and potential corresion rates  Microbial corrosion and deterioration analysis via eDNA.  Sample  Inverse transient pipeline condition assessment  Figh securacy non-investive gas and sir pocket detection  High  Valve sealing condition assessment.  High  Valve sealing condition assessment.  High  Acoustic leskage monitoring and detection.  High  In pipe under pressure video impection  Med  Magnetic flux leakage for high resolution pipe wall thickness.  Magnetic stress measurement.  Point testing wall thickness  High  Detection of pipeline coating integrity.  Dielectric constant soil mapping.  Dielectric constant soil mapping.  Med  Soil and pipe, AC wall thickness mapping.  High  Exerction, release, measure torque load.  Migh  Most advanced leternal scanning, video and acoustics reakage analysis technology.  Pressure rated RDV imperitions systems and NDCCTV tractor cameras for potable water.  In pipe firm flow acoustic leskage and air pocket detection, Med high.  Transient, hydraulic monitoring, burst detection, condition.	Method  Chemical composition and material losses heat mapping of pipeline samples  Environmental chemistry analysis (water, gas, soli) of pipeline deterioration/cornosion condition to identify high risk areas and potential corrosion condition to identify high risk areas and potential corrosion areas  Microbial corrosion and deterioration analysis via ebhA. Sample  Inverse transient pipeline condition assessment  Figh accuracy non-invasive gas and six pocket detection  High  Valve sealing condition assessment.  High  Valve sealing condi	Chemical composition and material losses heat mapping of pipeline samples  Environmental chemistry analysis (winter, gas, sais) of pipeline deterrioration/consistion to identify high risk areas and potential correction rates  Microbial correction and deterioration analysis via eBNA  Inverse transient pipeline condition assessment  Figh accuracy non-invasive gas and six pocket detection  Valve sealing condition assessment  Accuratic leakage monitoring and deteraction  In pipel under pressure video inspection  Magnetic flux leakage for high resolution pipe wall  Incorrect flux leakage for high resolution pipe wall  Magnetic stress measurement  Point testing wall thickness  Med  Detection of pipeline conting integrity  Corrostive soll magging  Low  Diesectic constant soil magging  Med  Most advanced laternal scenning, video and accounts Instage analysis technology  Pressure related 60V imperations systems and NDCCTV  Usake analysis technology  Pressure related 60V imperations systems and NDCCTV  Usake analysis technology  Transperse, temperature and surficing  In pipe fire flow accusted leakage and also pocked detection, Med high  Transperse, hydraulic monitoring, burst detection, condition  Med high  Transperse, hydraulic monitoring, burst detection, condition  Med high  Transperse, hydraulic monitoring, burst detection, condition	Chemical composition and material losses heat mapping of pipeline samples.  Chemical composition and material losses heat mapping of pipeline samples.  Environmental chemistry analysis (water, gas, sail) of sipeline deterioration/corrosson condition to identify high risk areas and potential correction and deterioration analysis via eithi.  Anticrobial corrosson and deterioration analysis via eithi.  Inverse transient pipeline condition assessment  Figh accuracy non-invasive gas and air pocket detection  High accuracy non-invasive gas and air pocket detection  High accuracy non-invasive gas and detection.  Magnistic stress measurement  Froint testing wall thickness.  High accuracy non-invasive torigin load.  High accuracy non-invasive torigin load.  Med accuracy non-invasive torigin load.  Med bigh accuracy non-invasive torigin load.  Transier non-invasive torigin load accustors.  In pipe first four scalable water.  In pipe first four scalable water.	Chemical composition and material losses heat mapping of pipeline sensus.  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In pipe free flow accusing leasage and all pocket detection, Ind CCTV, persoure, temperature and turbidity.  Transpert, hydraulit monitoring, burst detection, 100 CCTV, persoure, temperature and turbidity.  Transpert, hydraulit monitoring, burst detection, 100 CCTV, persoure, temperature and turbidity.	Method  Chemical composition and material losses hear magning of pipeline samples  Environmental chemistry analysis (water, pas, soli) of pipeline description and control to identify high risk areas and gociental convolant rates  Nitorobial corrosion and deterioration analysis via ebtid.  Sample  Inversal transient pipeline condition assessment  Screening  Valve scaling condition assessment  Valve scaling condition assessment, Valve (latve moster mosterment)  Accordic leakage monitoring and deterioration  In pipe under pressure video impection  Med   Magnetic flux leakage for high resolution pipe wall  High  Valve scaling condition assessment  Accordic leakage monitoring and detection  Med   Magnetic flux leakage for high resolution pipe wall  High  Corrosive soil magning  Low  Detection of pipeline contine integrity  High  Low  Detection of pipeline contine integrity  High  Med   Incorporate video imagning  Defercine contant soil magning  Med   Incorporate rate flot/ imagning video and accordics leakage and any pocket detection. High  Incorporate rate floty imagning video and accordics leakage and any pocket detection. High  In pipe from flow according to solidate under leakage and any pocket detection. High  In pipe from flow according to solidate under leakage and any pocket detection. Med high  Transier, systraulic monitoring, source detection, condition  In pipe from flow according to solidate under leakage and any pocket detection. Med high  Transier, systraulic monitoring, source detection, condition  Transier, systraulic monitoring, source detection, condition.	Method  Chemical composition and material losses hast magning of popular control of popular samples.  Environmental chemistry snithis (water, pas, sail) of popular control popular snithis (water, pas, sail) of popular control popular cont	Chemical composition and material losses heat majority of pipeline samples.  Environmental chemistry analysis (switer, gas, soli) of pipeline samples.  Environmental chemistry analysis (switer, gas, soli) of pipeline samples.  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Sample  Information correction and deterioration analysis is either.  Information correction and deterioration analysis is either.  Information correction and deterioration analysis is either.  Information pipeline condition anaexament.  High  Vulne debutes invasionate and deterioration.  High  Information final peakage for figin resolution pipeline and deterioration.  High  Magnetic final peakage for figin resolution pipeline wall high.  Informative totil mapping  Point testing wall thickness  High  Informative totil mapping  Detertion of pipeline conting integrity  High  Cerrotive totil mapping  Med  Informative totil mapping  Med Migh  Informative totil mapping  Med Migh  Transport, Medallal membrane, and as power of execution, and the problem to total mapping  Transport, Medallal membrane, and testing to the problem to total mapping  Transport, Medallal membrane, and testing to the problem to total mapping  Transport, Medallal membrane, and testing to the problem to total	Method  Chemical composition and material losses heat mapping of pipeline samples  Choismonants chemistry analysis (water, pa., wall) of pipeline samples  Choismonants chemistry analysis (water, pa., wall) of pipeline desire invalidation to identify high risk latas and potential consolation to identify high risk latas and potential consolation analysis via eDNA  Altrodulal correction and deterioration analysis via eDNA  Sample  Inverse transcent pipeline condition analysis via eDNA  Sample  Value closure measurement  High  Value closure measurement  Med  In pipe another pressure oddes impection  Med  Magnetic final leskage for high resolution pipe wall thickness  High  Magnetic final leskage for high resolution pipe wall thickness  Point testing wall thickness  High  Cerrolive roll mapping  Low  Christine constant to il mapping  Med  Med  Med  Med  Med  Med  Med  Me	Method    Description   Descri	Method    Chemical composition and material losses heat mapping of profess samples   Sample   Sample	Chemical composition and material brosses heat magains of principles stronges.  Chemical composition and material brosses heat magains of principles stronges.  Chemical composition and material brosses heat magains of principles stronges.  Chemical composition and material brosses heat magains of principles stronges.  Sample  Sample  Chemical composition and deterioration analysis size office.  Microbial controlling and deterioration analysis size office.  Magnetic flust realized professor assessment.  Med.  Magnetic flust realized for high resolution piper wall.  Microbial citizes of measurement.  Med.  Magnetic flust realized for high resolution piper wall.  Microbial citizes of measurement.  Med.  Magnetic flust realized for high resolution piper wall.  Microbial citizes of measurement.  Med.  Med.  Microbial citizes of measurement.  Med.  Med.  Microbial control magging.  Med.  Microbial citizes of measurement.  Med.  Microbial control magging.  Med.  Microbial control magning.  Med.  Microbial control magning.  Med.  Microbial control magning.  Med.  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Microbial correction and	Method  Committed compositions and material bases fleat mapping of profitting sample.  Endocromostatic fleating positions and material bases fleat mapping of profitting sample.  Endocromostatic fleating positions and material bases fleating fleating pass said at the sample of the s	Method  Sometiment demonstrated and material boses hear marging of professional analysis for a series of the profe	Method  Cheroida dissipation and material losses heat margining of profits assessed.  Cheroida dissipation and material losses heat margining of profits assessed.  Environmental chemistry analysis (souther, pas, soil) of profits assessed.  Environmental chemistry analysis (souther, pas, soil) of profits assessed and electrical profits assessed assess			

DETECTION SERVICES PIPELINE INSPECTION AND ANALYSIS			OUTPUT APPLICATION							SUITABLE PIPELINE MATERIAL												
		Method	RESOLUTION	NON-INVASIVE	Pipe Wall Thickness	Cement Uning Loss	Gas and Air Pocket	Corrosion Pitting	Valve Condition	Leakage Detaction	Soil Conditions	Rising Main	Water Pipes	टा के टाटा.	ा के छादा.	MS	MS -MSCI.	Concrete	ų	HDFE	HOBAS	685
INSIGHT maging		Chemical composition and material losses heat mapping of pipeline samples	Sample	×										٠	٠	٠	٠	٠	٠	٠	٠	•
INSIGHT Analysis		Environmental chemistry analysis (water, gas, soil) of pipeline deterioration/cornosion condition to identify high risk areas and potential cornosion rates	Sample	1										٠	٠	٠	٠	٠	٠	٠	٠	٠
INSIGHT Microbial analysis		Microbial corrosion and deterioration analysis via eDNA	Sample	1										٠	٠	٠	٠	٠	٠	٠	٠	•
P-CAT		Inverse transient pipeline condition assessment	Screening	1			٠	•	•			•	•	+	٠	+	+	+	+			
g-CAT" pas and sir pocket defection		High accuracy non-invasive gas and air pocket detection	High	1			٠					٠	٠	٠	٠	٠	٠	٠	•	٠	٠	٠
V-CAT* valve condition assessment		Valve sealing condition assessment, Valve closure measurement	High	1					•			٠	•	•	٠	٠	٠	٠	•	٠	٠	٠
# CAT accordic halvage condition according		Acoustic leakage monitoring and detection	High	1			٠			٠		٠	٠	•	٠	٠	٠	٠	٠	+	٠	٠
VIG-CAT internel under pressure vides impedition		In-pipe under pressure video inspection	Med	×		•	•	*	٠				•	*	٠	٠	•	•	•	+	٠	٠
simari - CAT Mrt external plac soul economy		Magnetic flux leakage for high resolution pipe wall thickness	High	1				٠						•	٠	٠	٠					
SCT Stress Concentration Tomography	30	Magnetic stress measurement	Screening	1	٠							•				٠	٠					
Ultrasonics Point Ultrasonics		Point testing wall thickness	High	×										٠	٠	٠	٠					
PCM Pipeline Coating Measurements		Detection of pipeline coating integrity	High	1										٠	٠	٠	٠					
LPR Linear Polarisation Resistivity		Correstive soft mapping	Low											٠	٠	٠	٠					
DCM Direct Dielectric Constant		Dielectric constant soil mapping	Med	1										٠	٠	٠	٠					
GPR Ground Penetrating Radar		Soil and pipe, AC wall thickness mapping	High	1	٠									٠	٠	٠	٠	٠	٠	٠	٠	٠
Valve Condition Assessment		Exercise, release, measure torque load	High	1										٠	٠	٠	٠	٠	٠	٠	٠	•
INSCAN TOTAL COLORS	INTERNAL	Most advanced internal scanning, video and acoustics leakage analysis technology	High	×	2	٠	٠		•	٠			•	+	+	+	*	•	+	+	•	+
DEEP TREKKER EXPLORING NEW WORLDS		Pressure rated ROV inspections systems and HDCCTV tractor cameras for potable water	High	×	2	٠		٠	٠		٠		ĺ	+	•	*	٠	٠	٠	•	*	•
PIPE - INSPECTOR	Z	In pipe free flow acquistic leakage and air pocket detection, HD ECTV, pressure, temperature and turbidity	Med high	×	e Si	٠	•		٠	٠		٠		+	+	+	٠	٠	*	+	٠	•
visenti	ON	Transient, hydraulic monitoring, burst detection, condition monitoring, failure prediction, real time detection 24/7	High	<b>√</b>	3					٠		٠	٠	٠	٠	٠	٠	٠	٠	٠	٠	٠

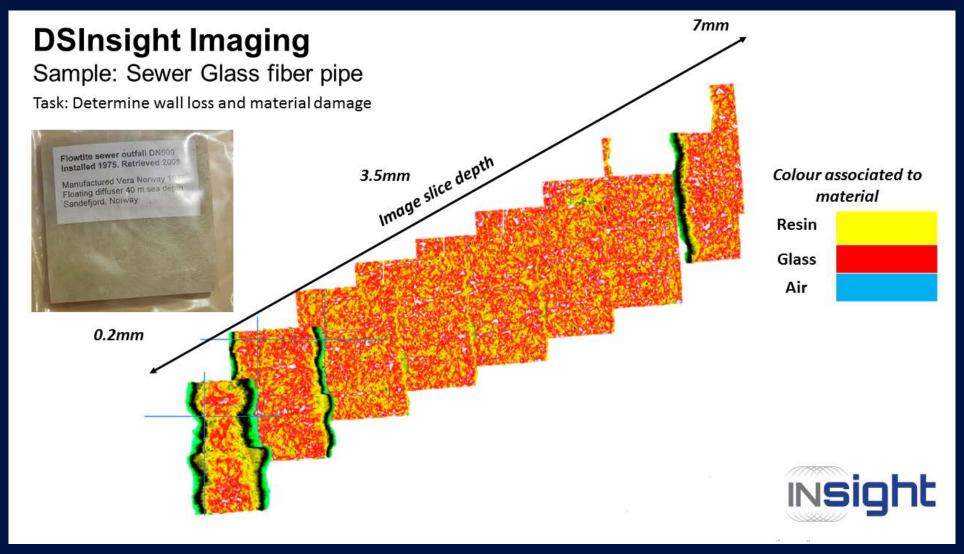


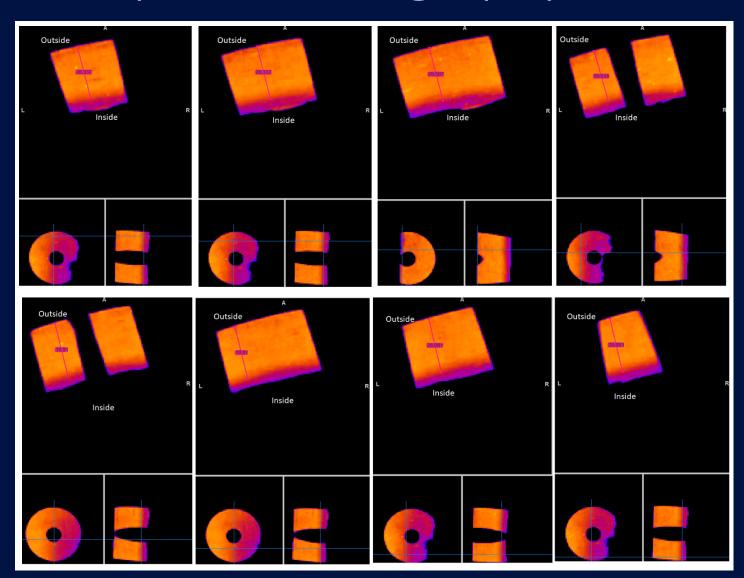








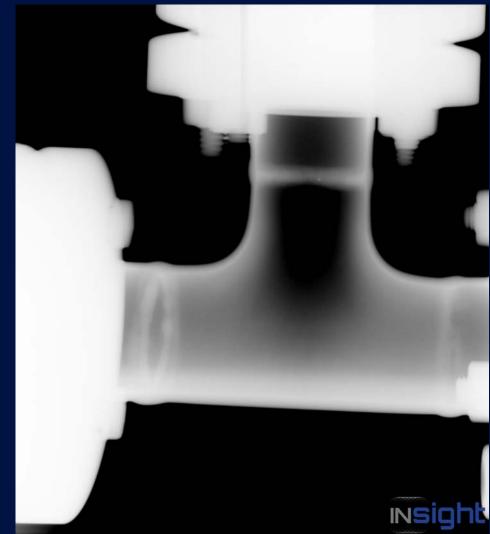






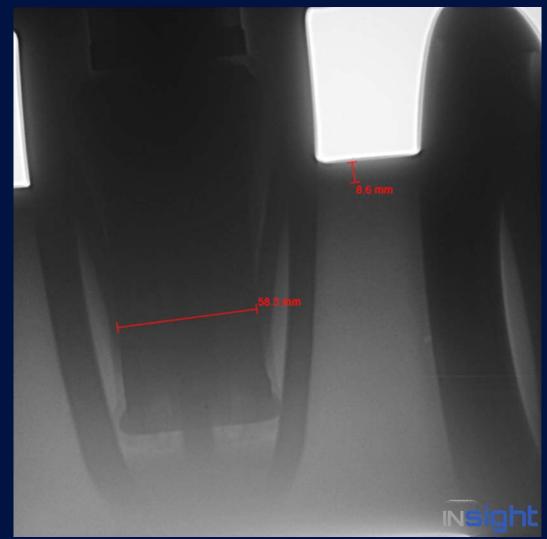
#### Digital Radiography of Critical Assets

- Can penetrate many different materials.
- Data obtained instantly within the field.
- Used for visual inspection and quantitative data can be collect from the images.
- Can be used to identify internal issues.



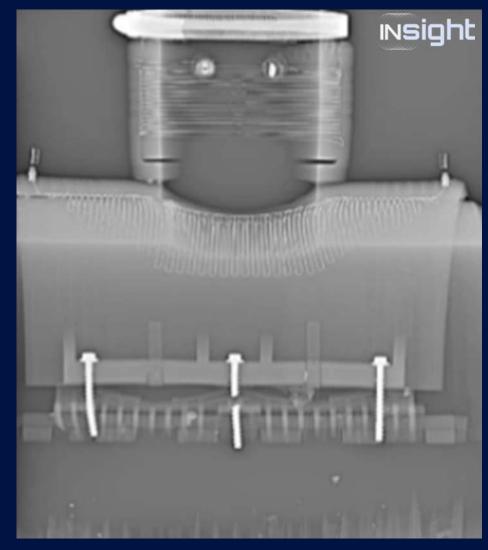
Bends insight

Joints

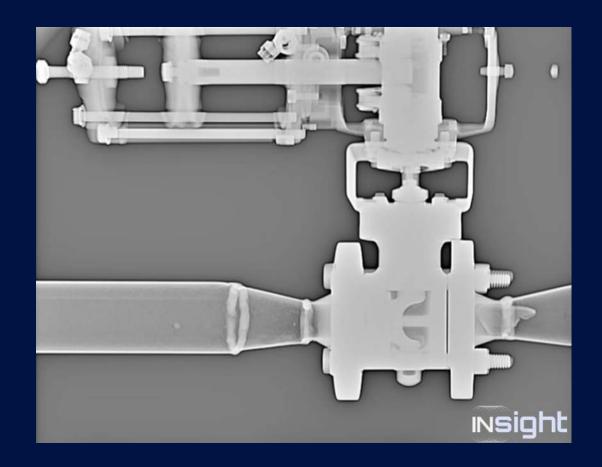


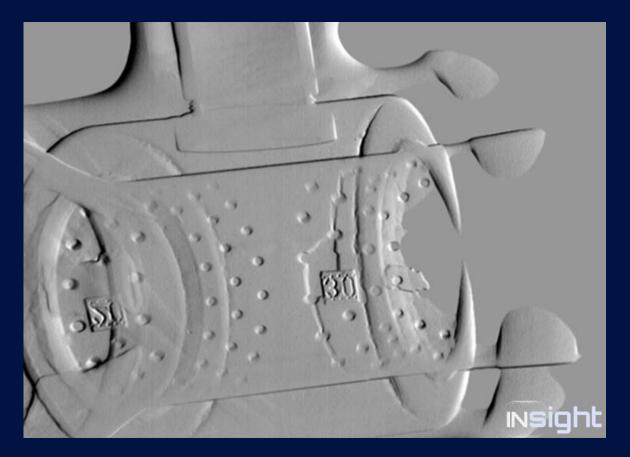


Valves









Valve Condition Assessment





#### Digital Radiography - Example setups





#### HDPE pipe

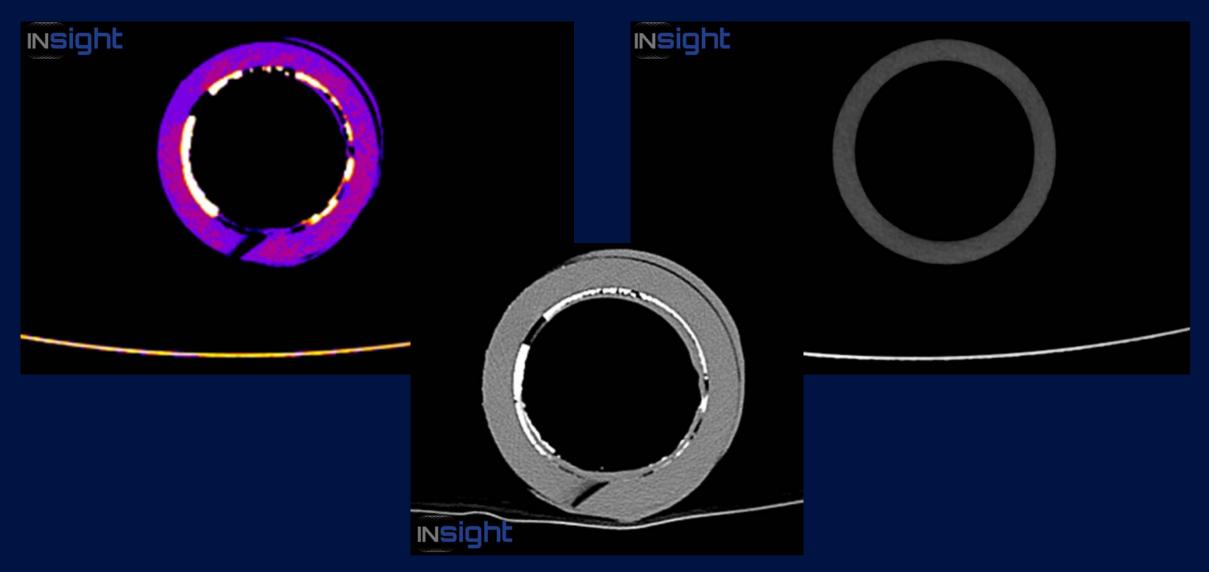
- Issues
  - Joints
  - Welds
  - Electrocoupling

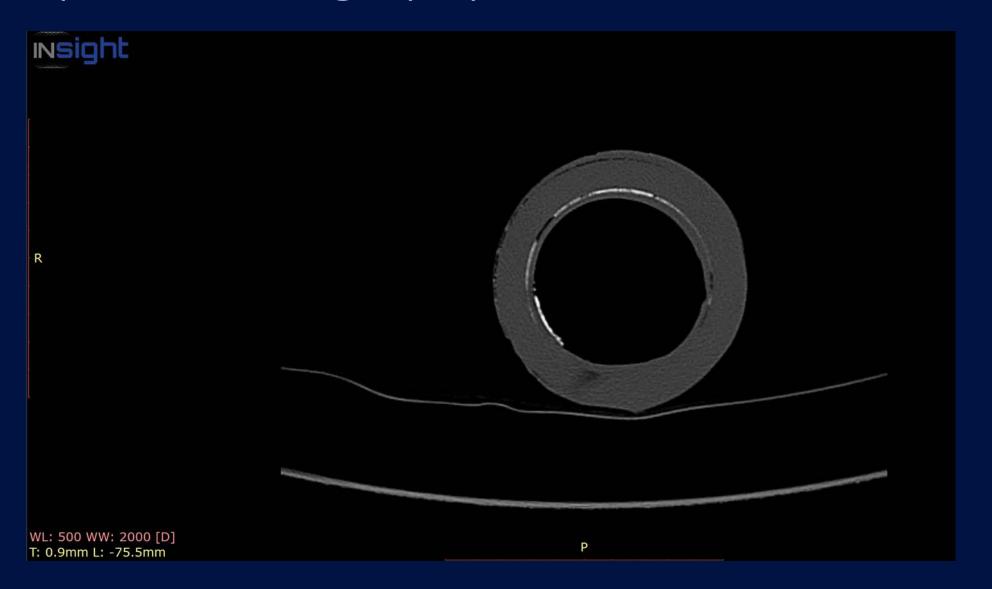
#### Analysed

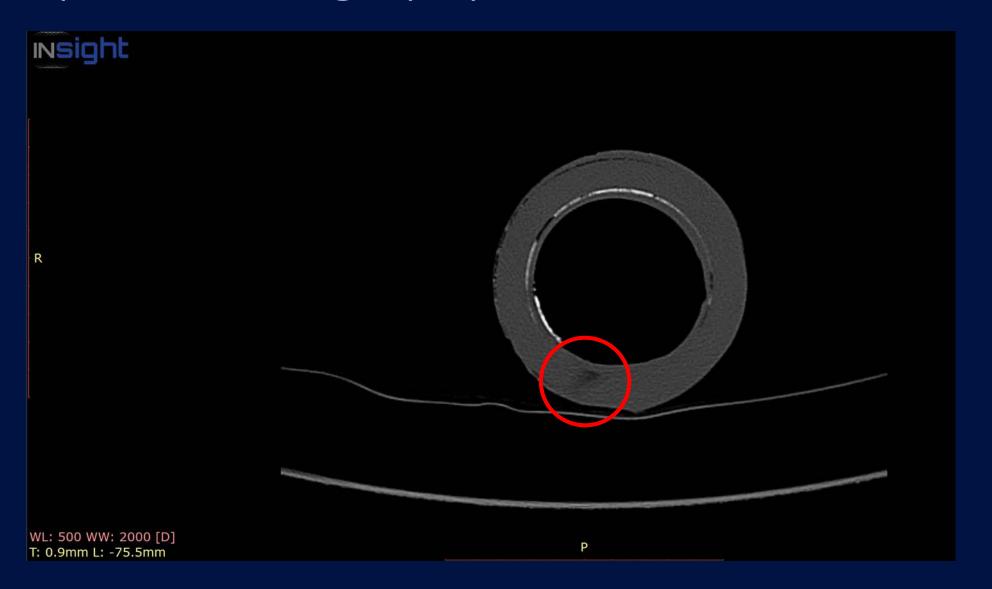
No common method to analyse this pipe

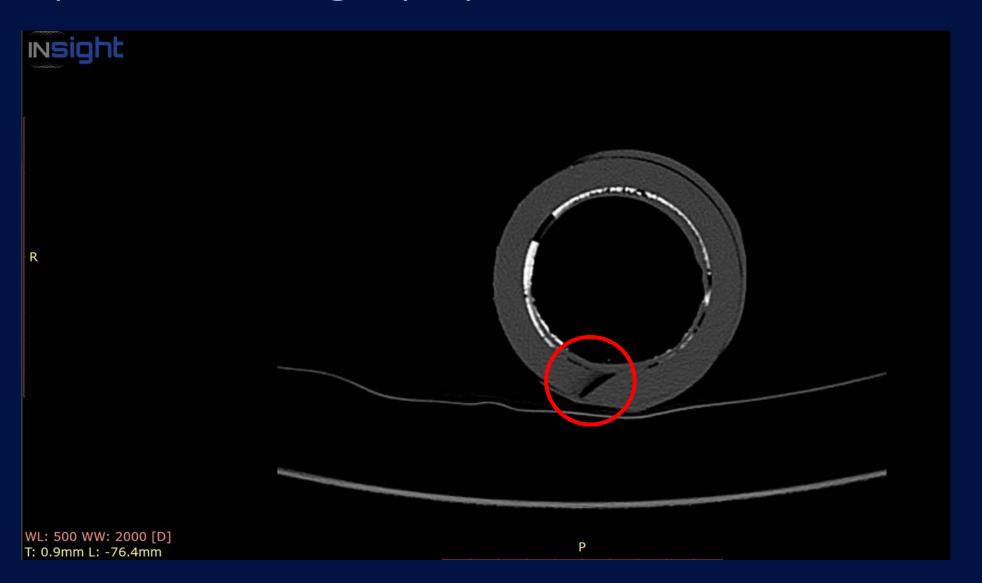
## HDPE Example

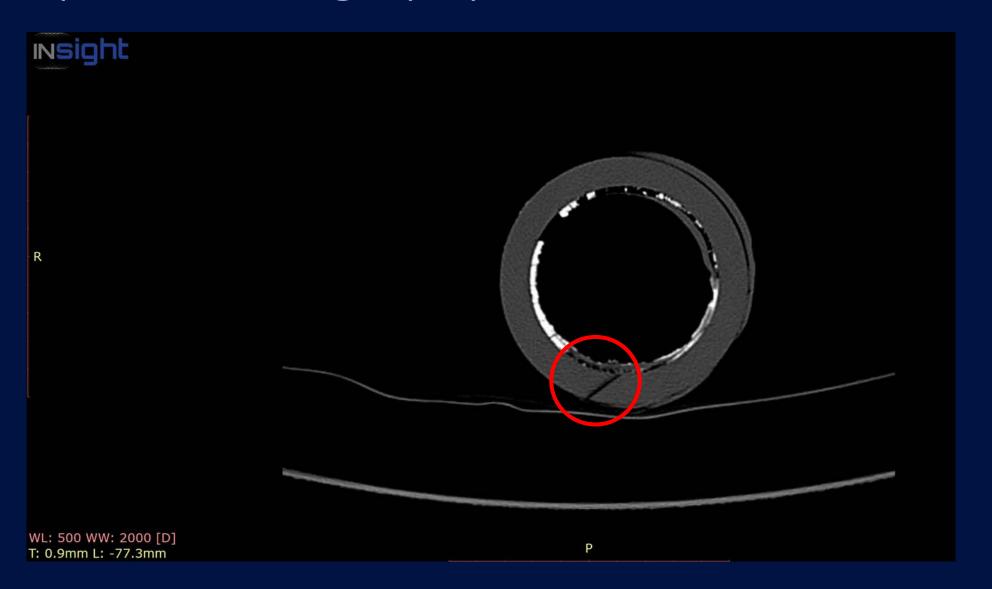


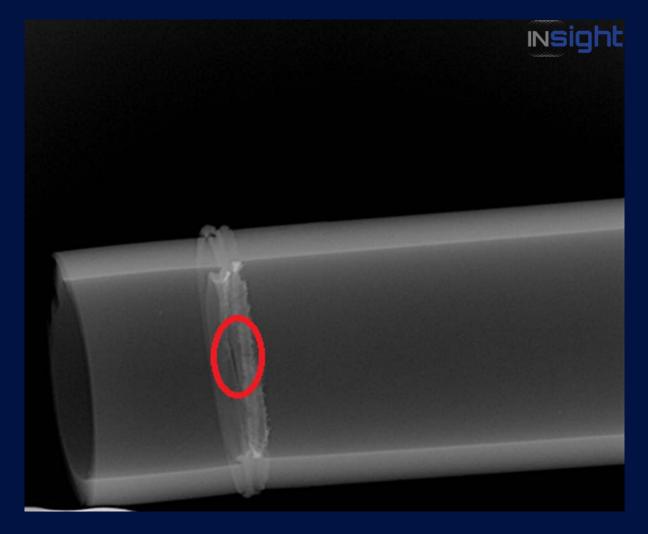


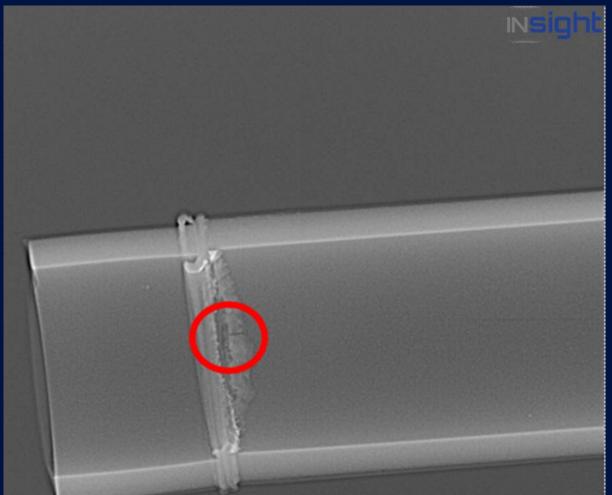












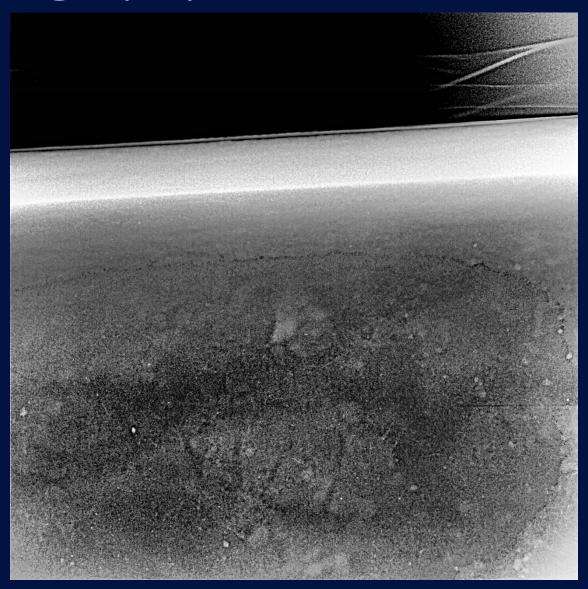
#### Asbestos Cement Pipe

- Issues
  - Loss of calcium matrix
  - Acid attack
  - Many pipes at the end of their working age

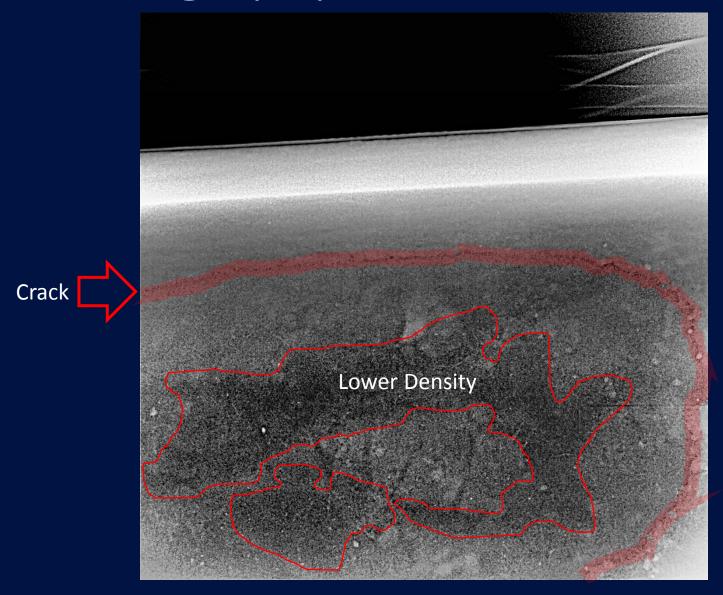
#### Analysed

- Commonly with coupons or cut pipe
- Now coupons are not required, back scatter CT can obtain the same data without the need to cut the pipe.

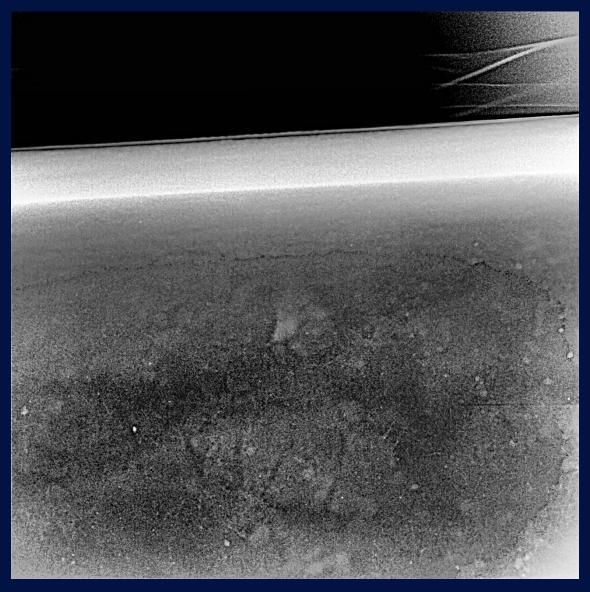
#### Digital Radiography - Asbestos Cement Pipe



#### Digital Radiography - Asbestos Cement Pipe



#### Digital Radiography - Asbestos Cement Pipe



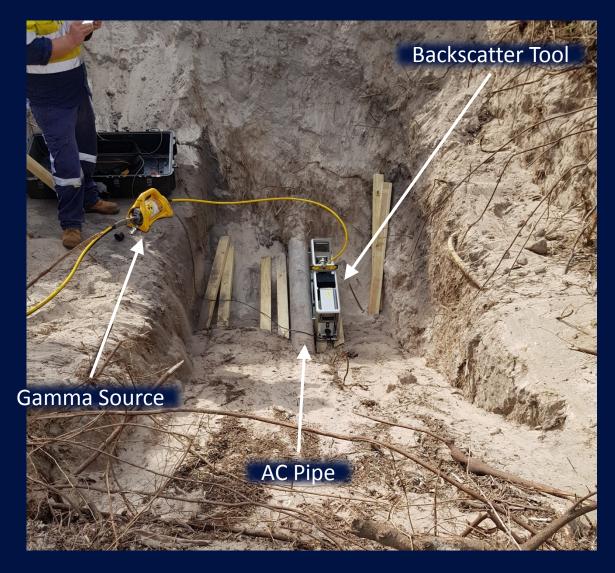
#### Back Scatter CT



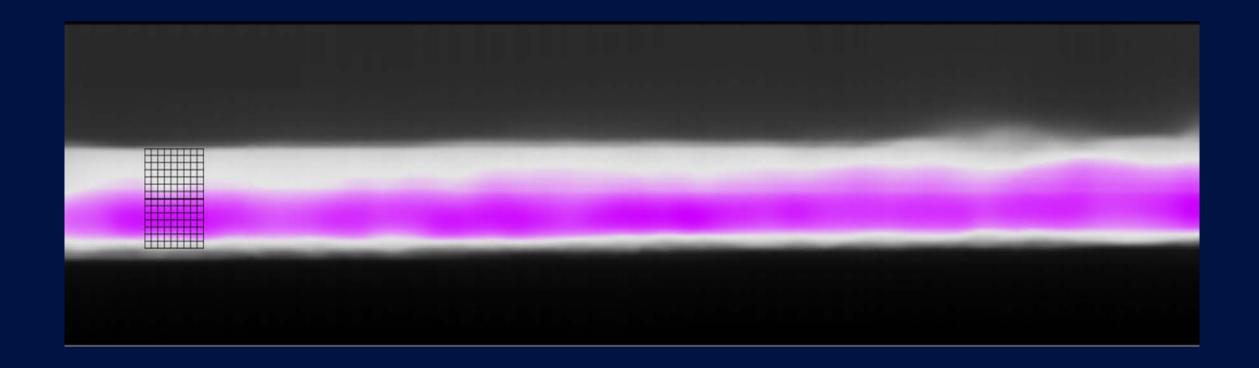
#### Setup

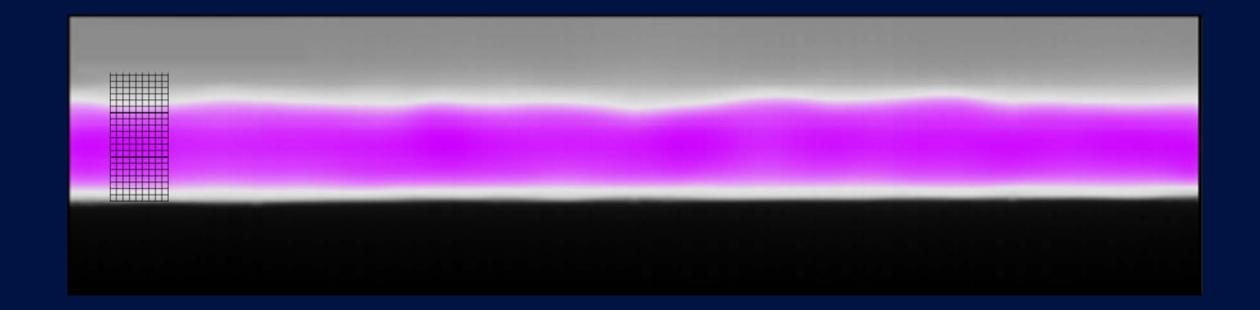
- The imager has to be place onto the pipe of interest.
- The device weighs ~20kgs
- The device is operated by a laptop with a 40m command cable.
- Wood is used to prop up the device and ensure it is square to the pipe.
- 5-10 minutes to set up
- 5-15 minutes to obtain an image

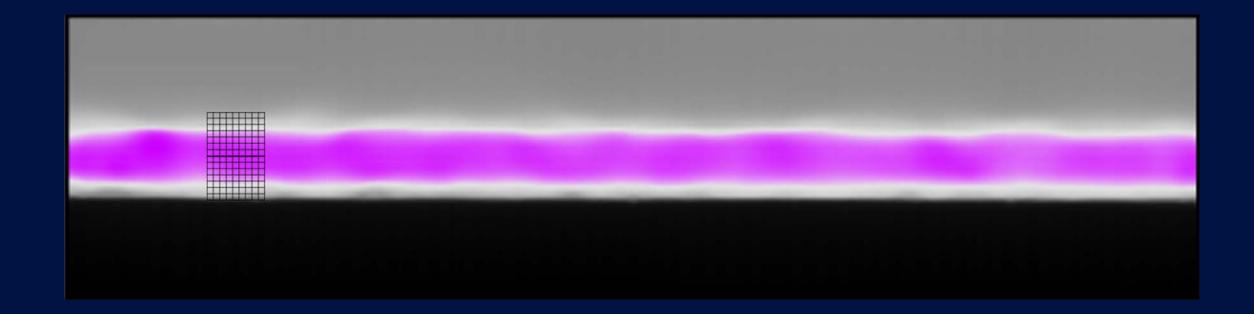
#### Back Scatter CT

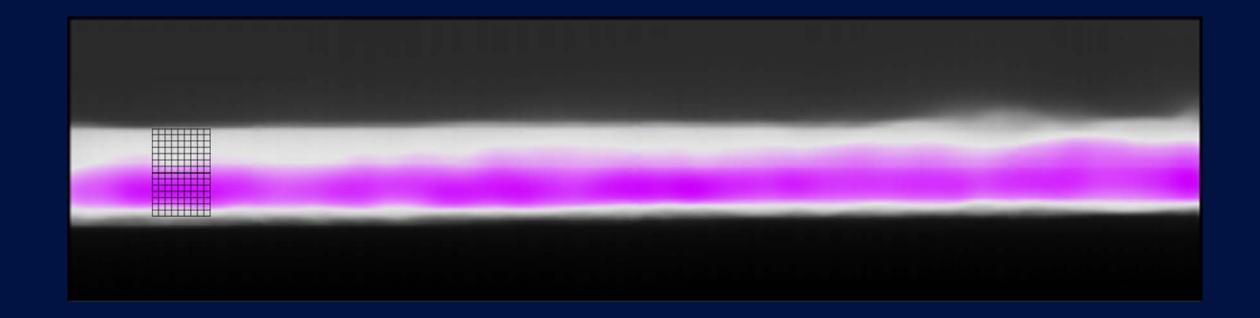


- Safety zone, 1.5m behind, 3m in front. If in a pit, the pit edge
- Raw image can be viewed within the field to get an understanding of what it may look like.









## Questions

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