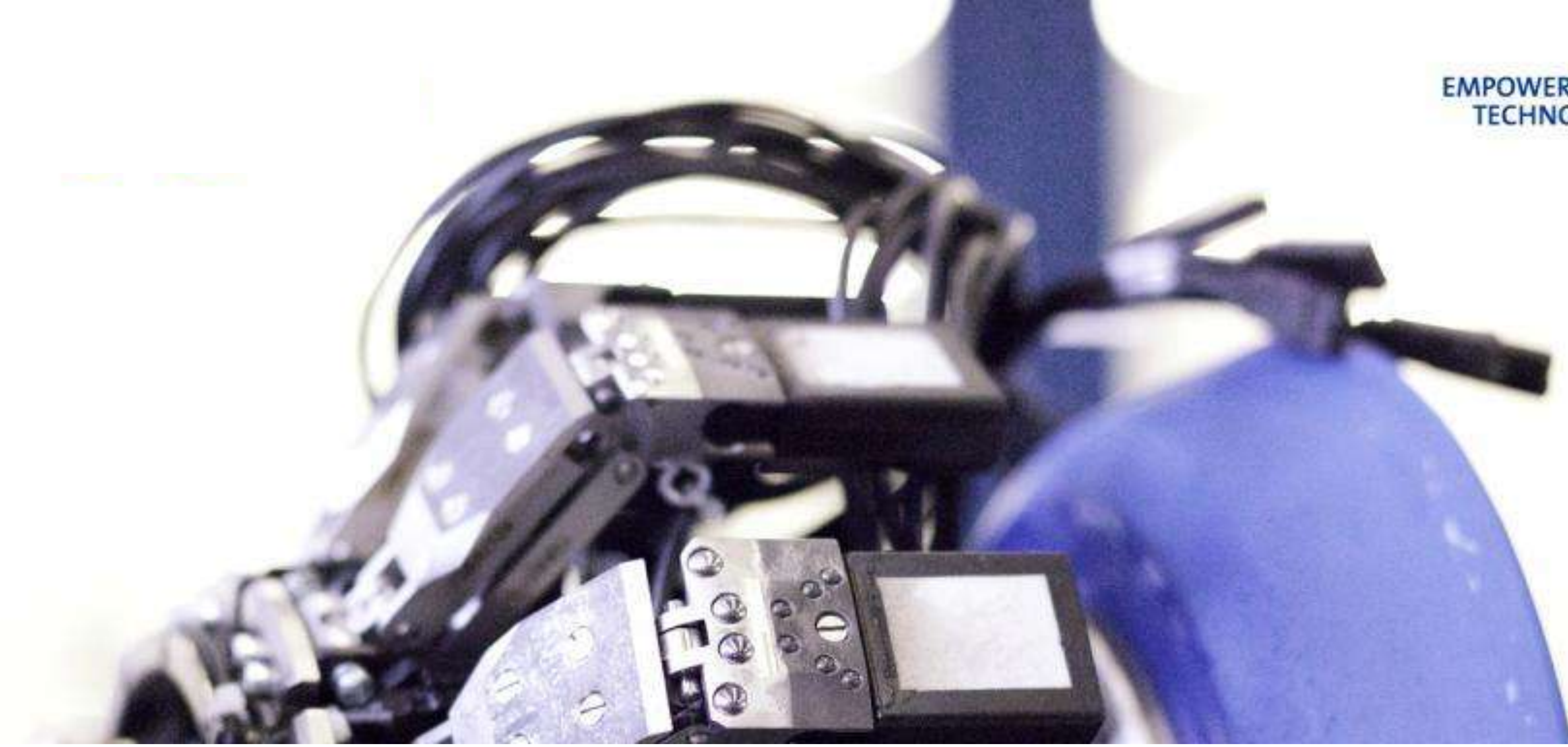

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A Practical Approach for the Inspection of Unpiggable Pipelines

UKOPA 2012 Technical Seminar
Thomas Beuker
29-May-2012

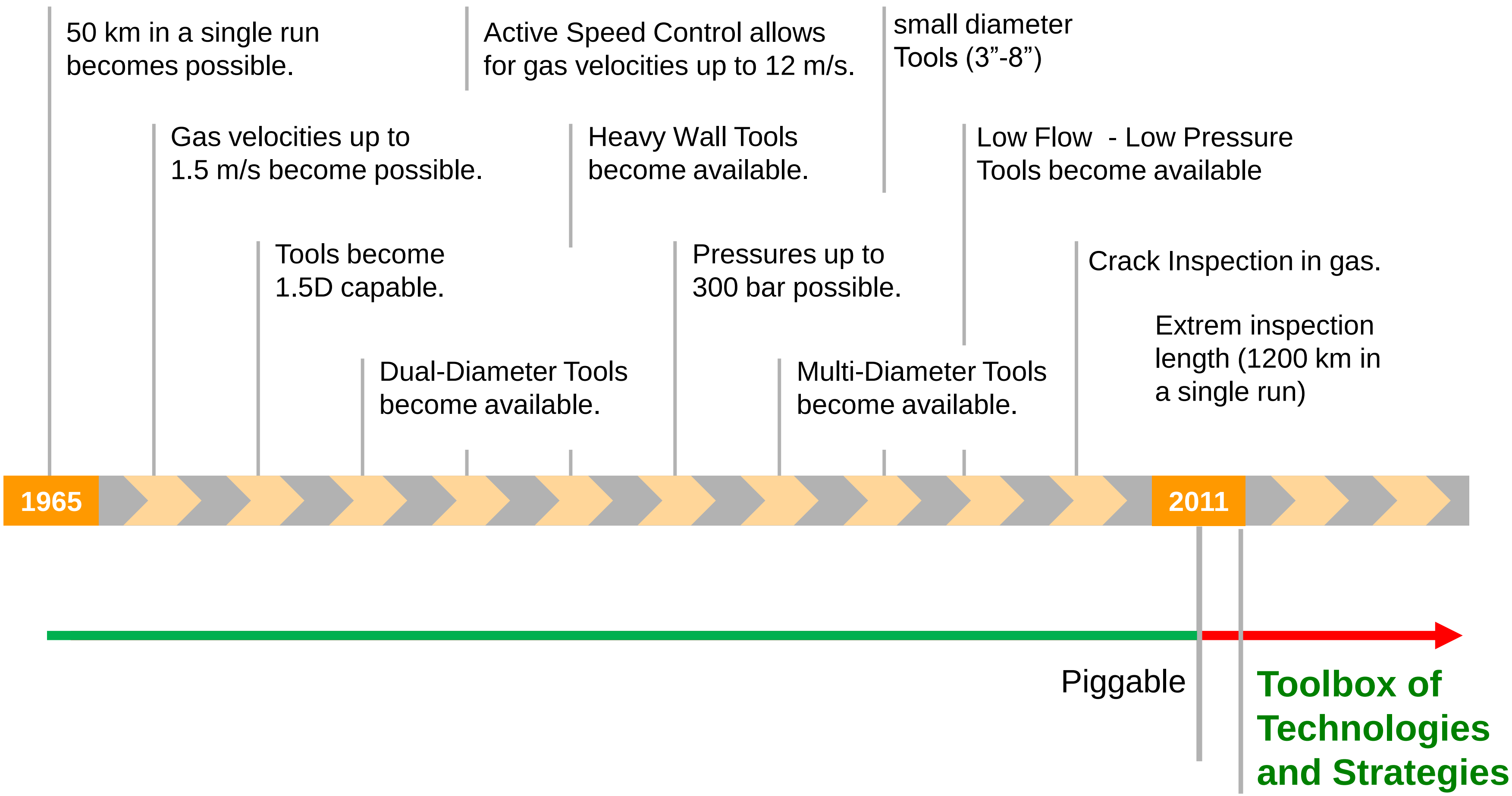
Content

Introduction

- **Challenging** Pipelines or **Unpiggable** Pipelines ?
- It is a **Challenge** to make Pipelines **Piggable** !
- In-Line Inspection has changed over **Time** !
- Recently some **Gaps** have been closed by Technology
- **Upcoming Challenges** need more:
  - Pipeline Preparation
  - Inspection Strategies
  - Concept for Operation
  - Tool Technology

“Un-piggable” is a function of time and market need

Evolutional Process



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  - Multi Diameter – High Pressure Pipelines
  - Long Distance – Combined Inspection Technologies
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  - Tailored Solutions
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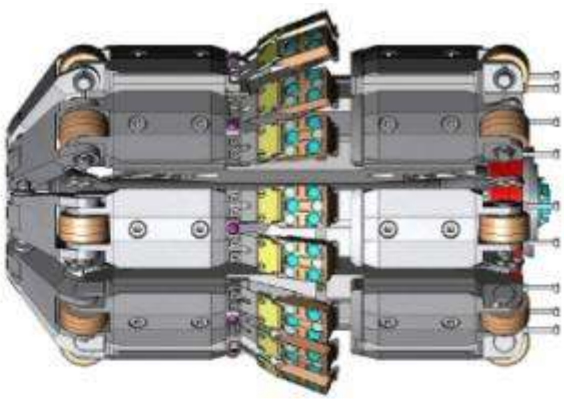
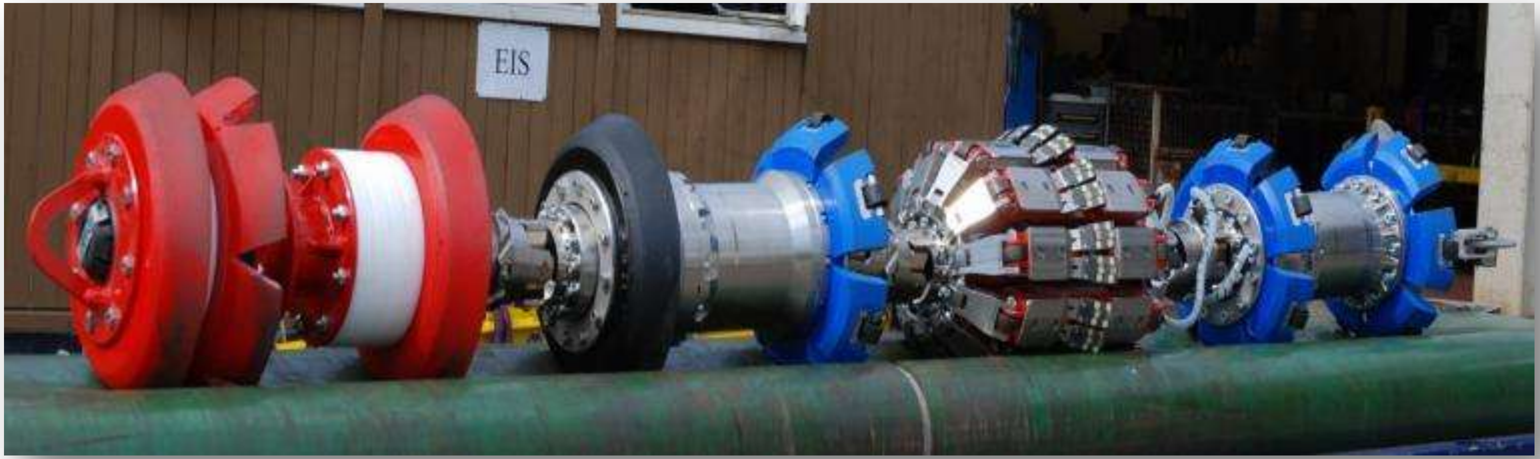
  - Cleaning
- Robotic Solutions
  - Examples and Prototypes
- Conclusion

MFL Tools for Gas Pipelines



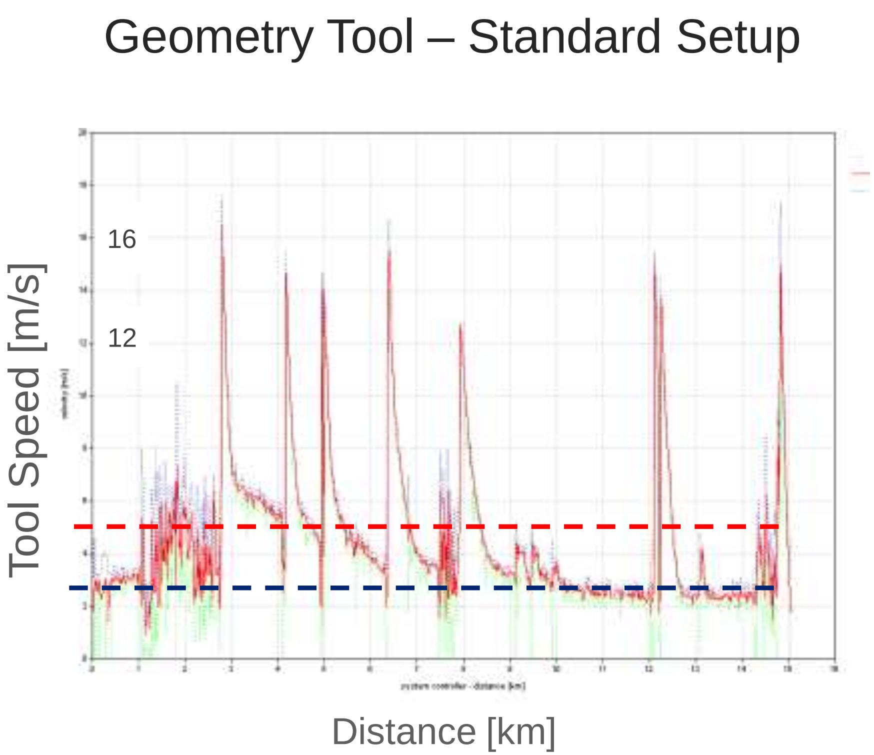
3D Concept of a 12” Low Flow / Low Pressure MFL Magnetizer

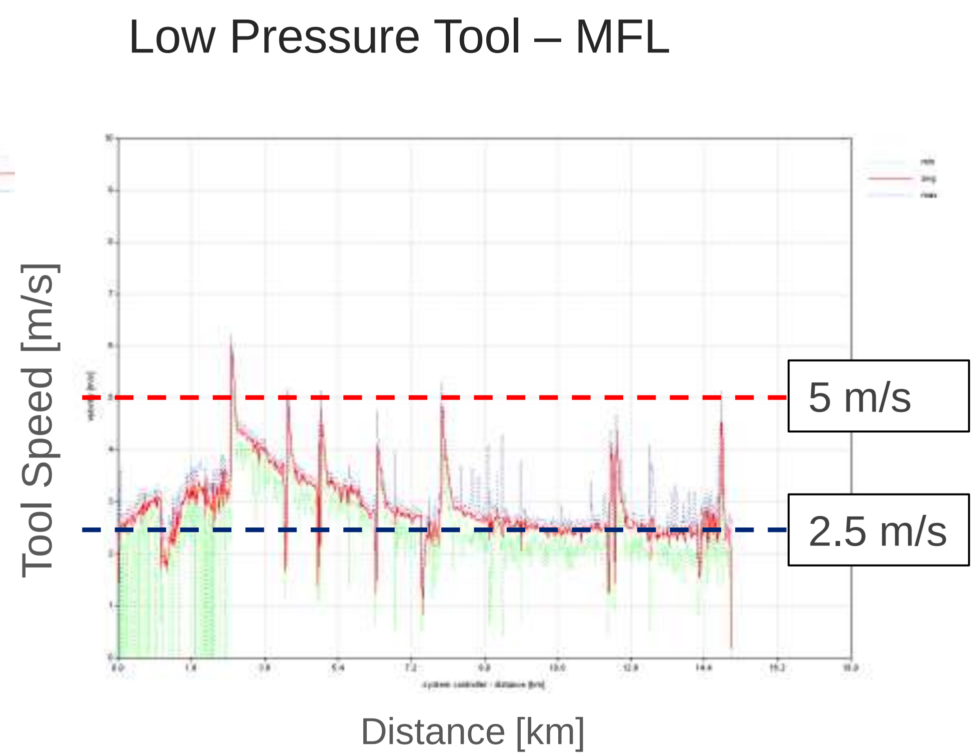
Reduce the Drag !



12” Low Flow / Low Pressure MFL Tool

Low Pressure Example

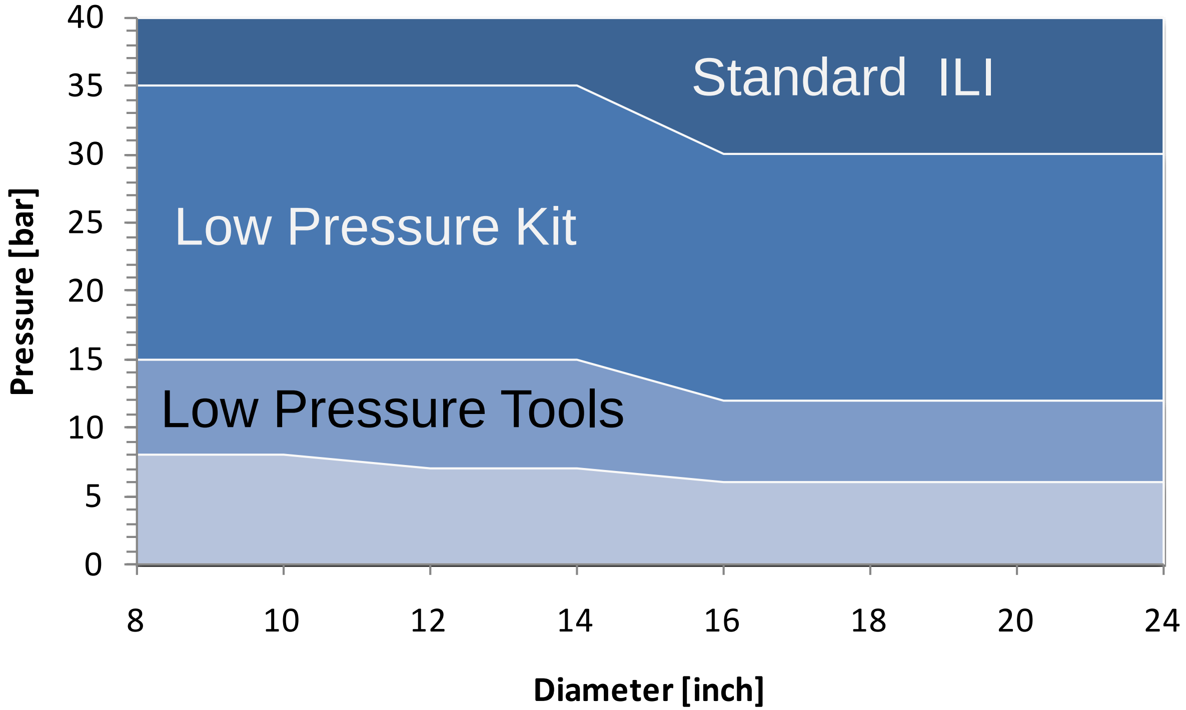




OD nom.	10” (273.1mm)
Pressure:	16 - 18 bar
Wall Thickness:	6.35mm – 12.7 mm
Length:	15km

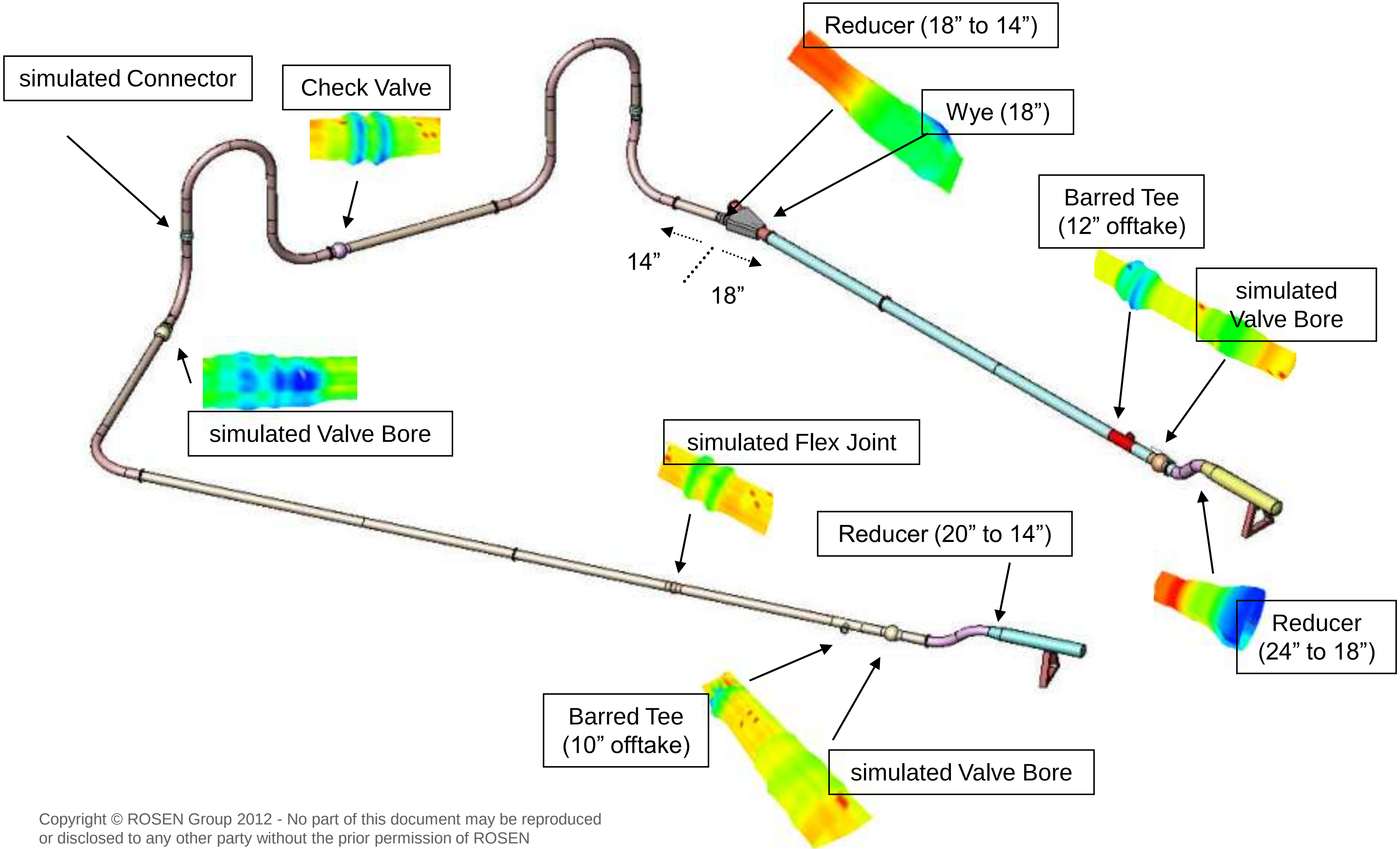
Closing the Gap – Low Flow Low Pressure

Tool Selection Scheme for Low Pressure Gas Lines



LFLP Tool have been successfully deployed in the past, providing solutions for applications before classified as "Unpiggable"

3D color-view of Geometry Data



Closing the Gap – Multi Diameter Inspection

Launching of 14”/18” MFL Tool

Receiving of 14”/18” MFL Tool

Closing the Gap – Multi Diameter Inspection

ILI Tools				
Class	**ID-Min [in]**	**ID-Max [in]**	**Passage Ratio**	**Min Bend**
12/18"	10.7	18.0	60%	1.5
14/18"	11.3	18.0	63%	1.5
14/20"	11.8	19.9	59%	1.5
18/24"	15.4	24.0	64%	1.5
24/28"	21.8	27.6	79%	5
24/32"	21.8	32.0	68%	1.5
26/30"	22.1	29.8	74%	1.5
30/36"	26.3	35.8	73%	1.5
32/42"	27.2	42.0	65%	1.5

12”/18”

6”/8”

14”/20”

30”/36”

32”/42”

Closing the Gap – Long Distance Pipelines

One of the worlds longest offshore pipeline

715mi (1173km) Total Length

385mi (632km) 42" x 1.16", 5D

330mi (541km) 44" x 0.91", 5D

Flow 9-21mph (4 – 9.5m/s)

operating pressure

2320psi (160 bar)

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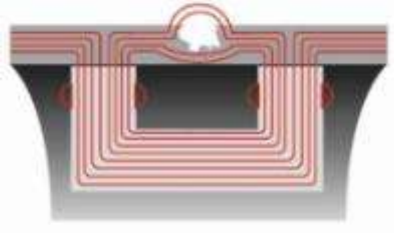
- **MFL, geometry and internal corrosion inspection**
- **baseline survey**
- **374GB of data**
- **127 hours runtime**
- **speed control**
- **dP 0.08 MPa (42”) ; 0.2MPa (44”) (11psi - 42”); (3psi - 44”)**

Closing the Gap – Long Distance Pipelines

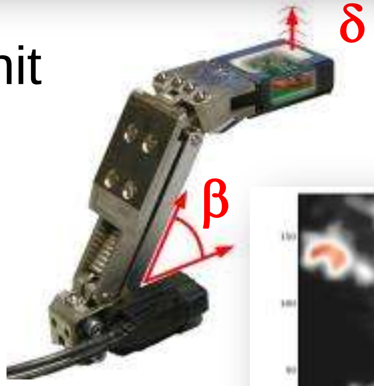
ILI Tool at Receiver after 1200 km

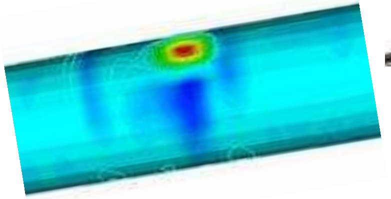
1st unit



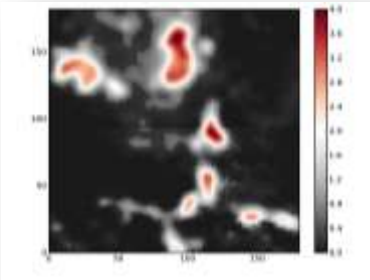
MFL and Speed Control Valve

2nd unit





XGP Geometry and Dent Characterization



SIC Shallow Internal Corrosion

Closing the Gap – Bi-Directional ILI Tools

24" BiDi MFL ILI Tool

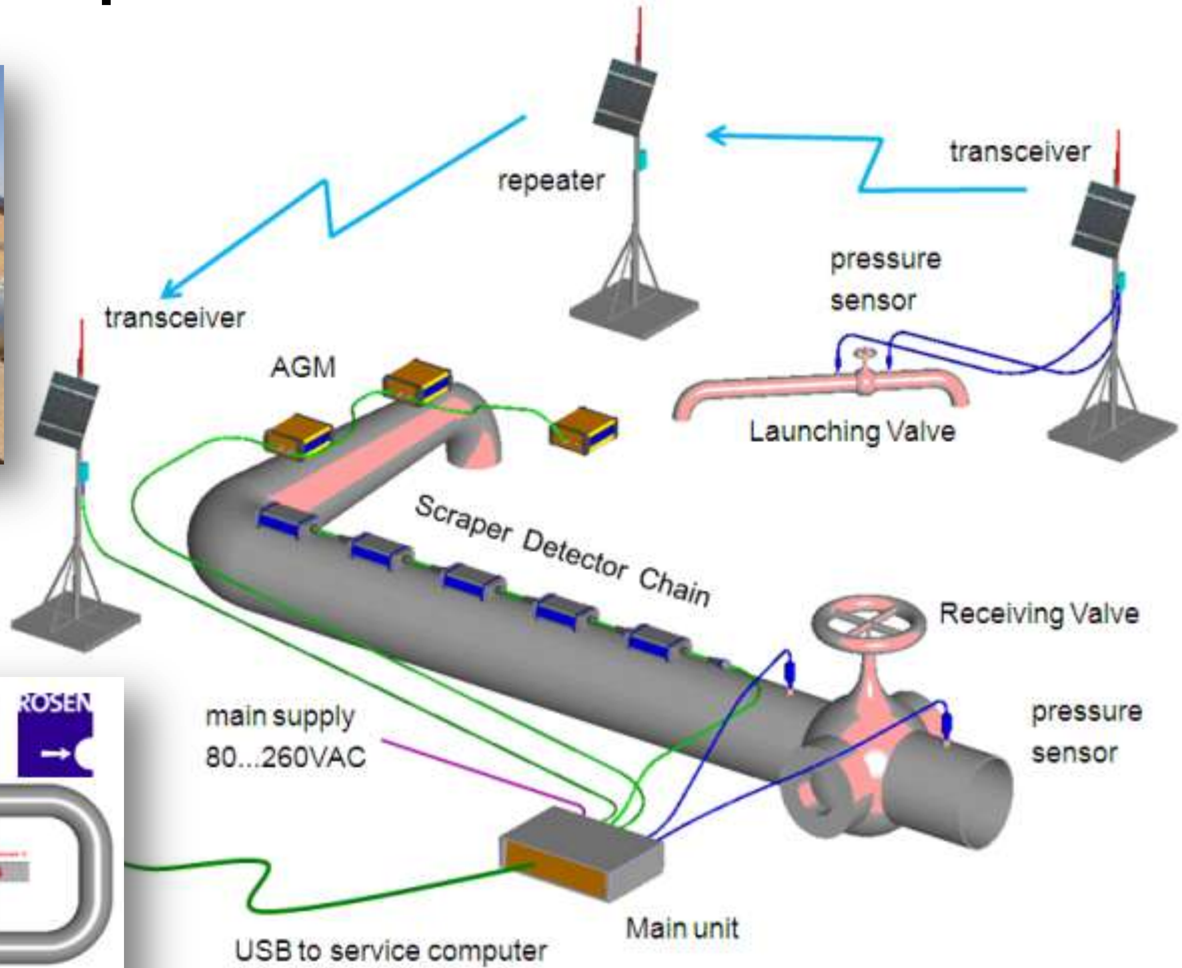
travel in either direction and capture data both ways (redundancy).
Asymmetric pigging operation for cleaning, gauging and inspection

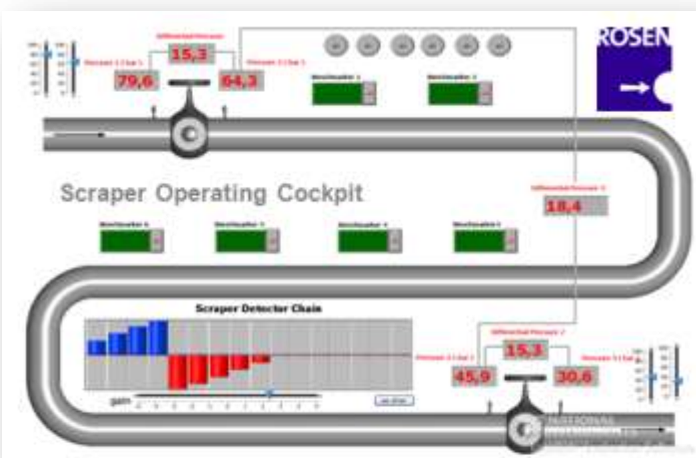
Bi-Directional ILI Tools for Pig-valve operation

10" Pig Valves typically used for spheres and cylindrical pigs with a length of 1.4 x D



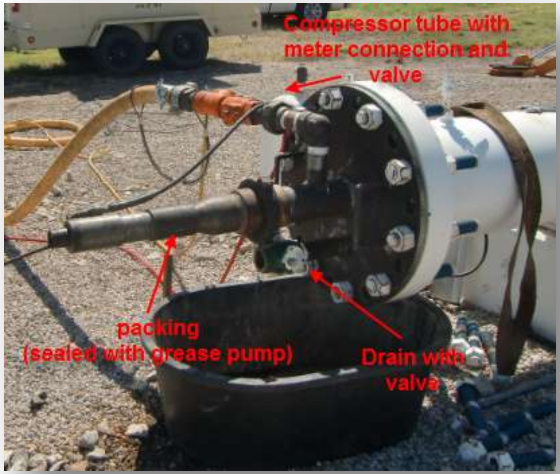

System to control operational conditions





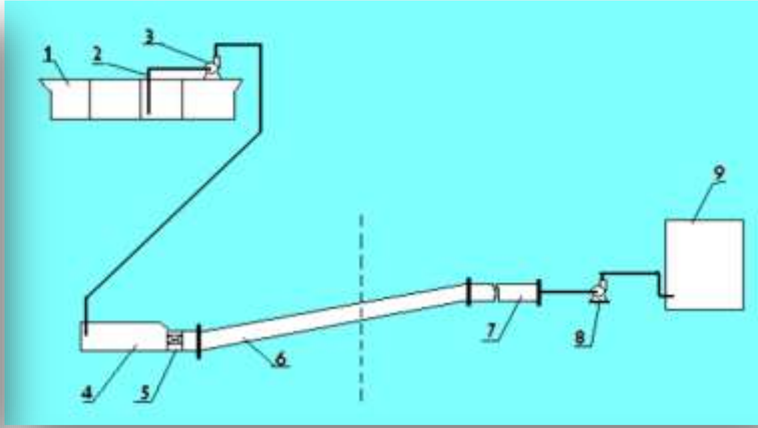
Inspection of 12” Lateral Flow Lines Tied into 16” Trunk Line

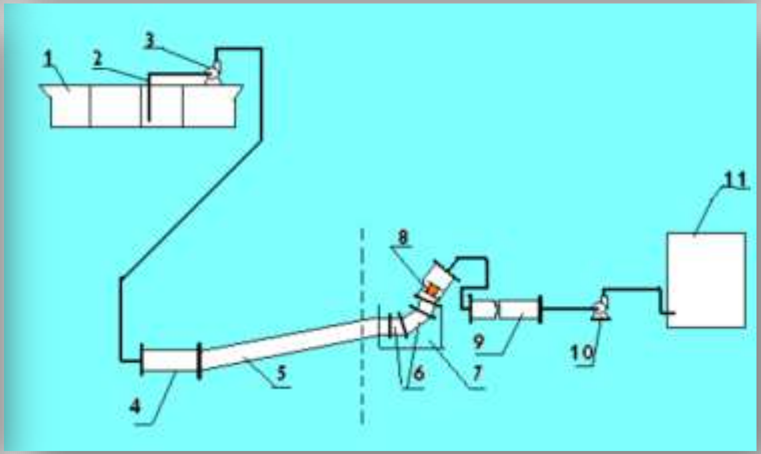
12” BiDi MFL ILI tool used. lateral connection from well to 16” trunk line. Inspection during revision program. Push in with air 7 bar. Pull back with winch. Provision of Gauging, Geometry and Corrosion Services



Inspection of 16”, 24” and 32” Loading Lines

Onshore / Offshore operation. BiDi operation. Gauging program identified severe or impassable dents. First line completed with BiDi MFL. Second line Geometry only. Third line rescheduled.





Content

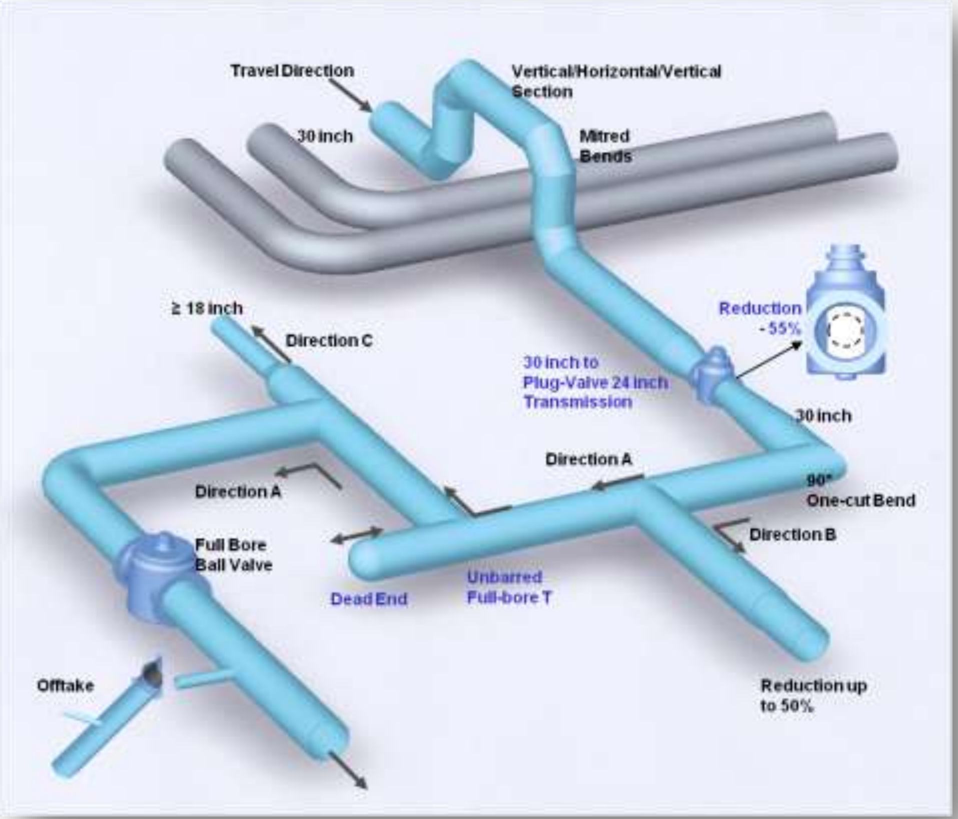
Managing Complexity – Challenges

Main Reasons for Unpiggable Pipelines are:

- Pipeline Access
- Mechanical Pipeline Design
- **Pipeline Operating Conditions**
- Detection & Sizing Accuracies

Main Challenges are:

- Access
- Carrier
- Measurement
- Cleanliness



Managing Complexity – Most Wanted

Another dream: the Swiss Army Knife Approach

More Effective: Tailored Solutions;

Toolbox for the Individual Required Applications

Managing Complexity – Simplified View

Questionaire

Pipeline Modification ?

Tool Modification ?

New Development

Time & Effort

Standard Tool

New Application

Tailored solutions based on tool box concept

Managing Complexity – Simplified View

Questionaire

Pipeline Modification ?

Tool Modification ?

New Development

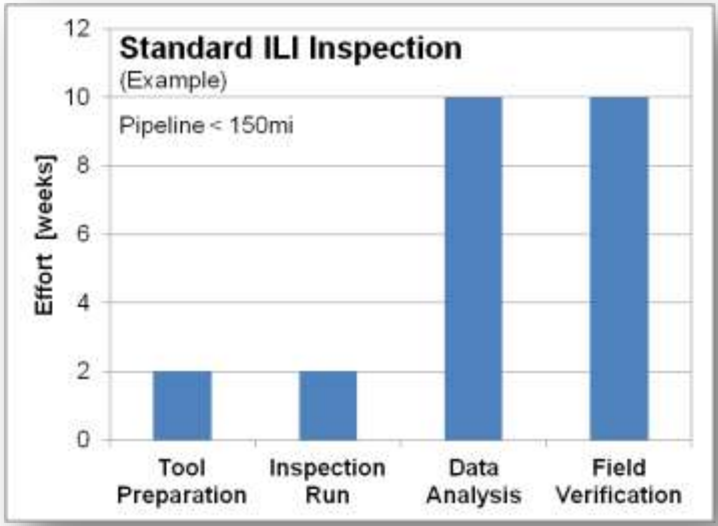
Time & Effort

temporary access launcher / receiver

exchange of fittings and bends

interruption of operation
flow reversal,
batching

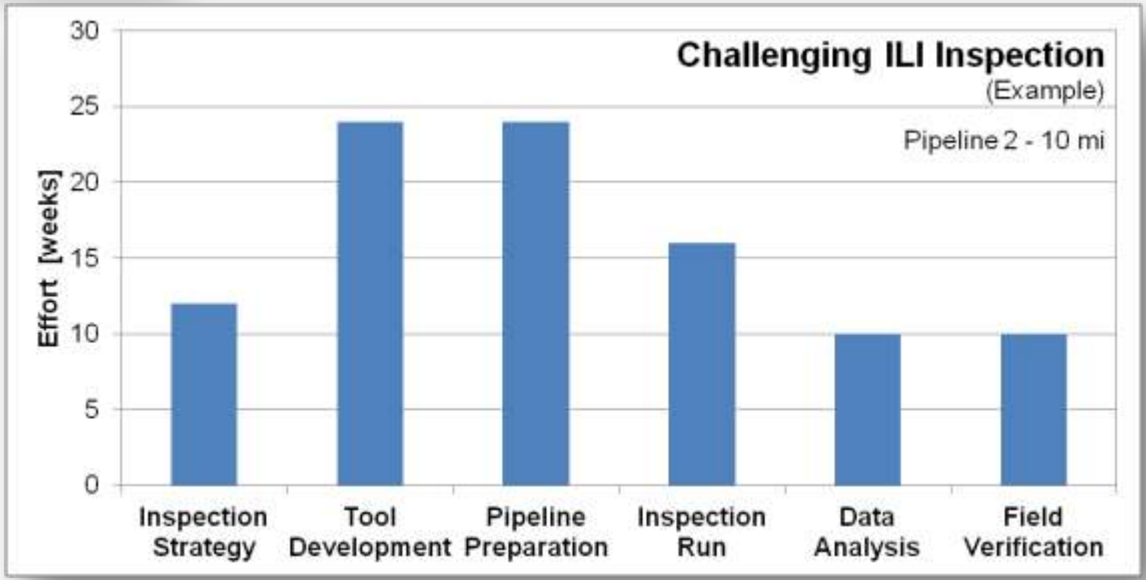
Managing Complexity – Simplified View



ILI Standard focus on Data Analysis and Verification (Repair)

Challenging Pipeline add up-front strategies, preparation and technologies

Note Inspection Run Time is increasing for shorter sections !

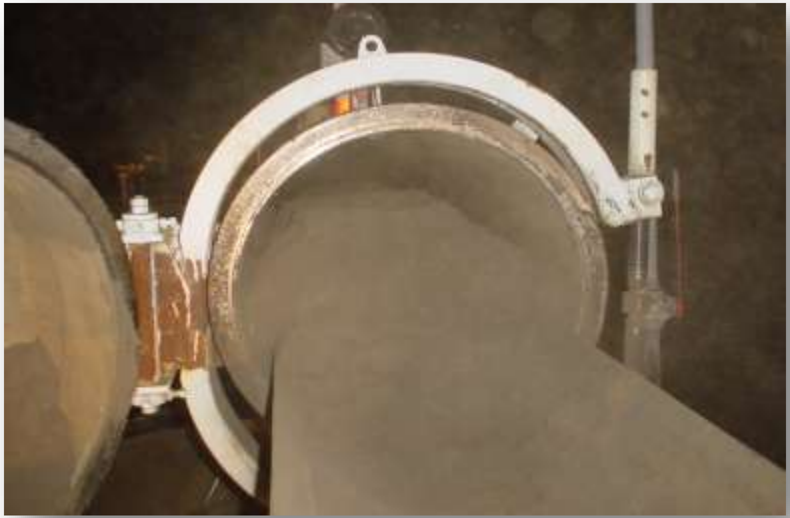


Managing Complexity – Cleaning

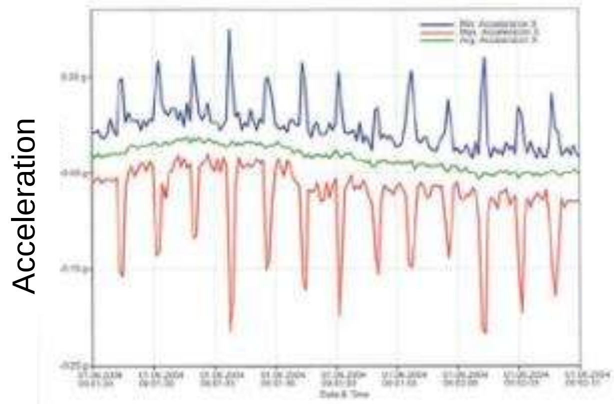
Challenging Pipelines often have a 'bad' cleaning history. Special Cleaning programs are required or maybe impossible at all.

Even a small amount of debris density (debris/length) can accumulate to operational critical volume.

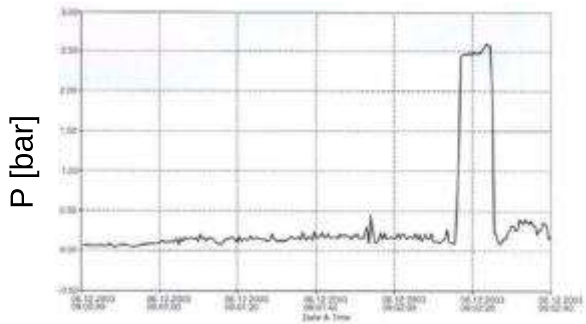
In these cases a careful and progressive cleaning approach has to be planned. If possible asymetric cleaning may be an option

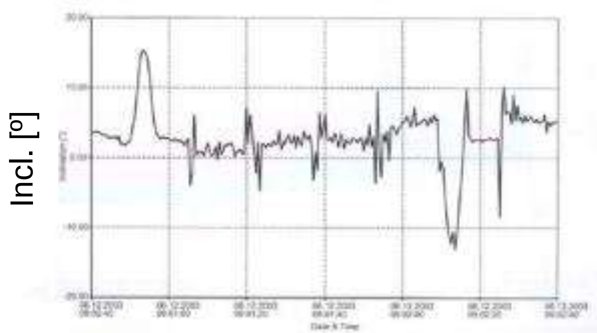


Cleaning – Pipeline Data Logger

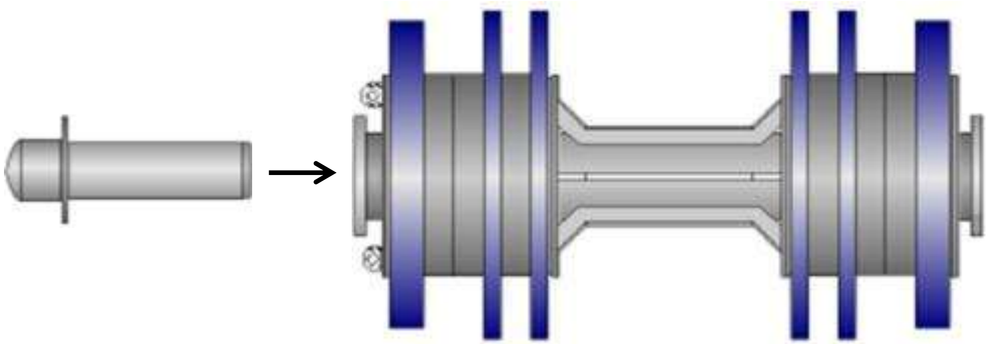


girth weld pattern





pressure peek and inclination dip
identified dent



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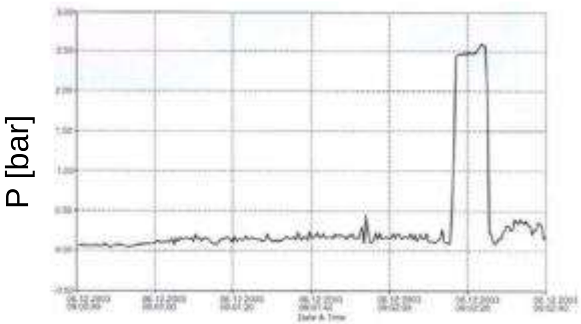

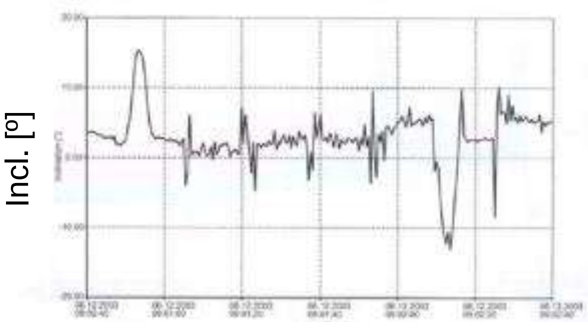

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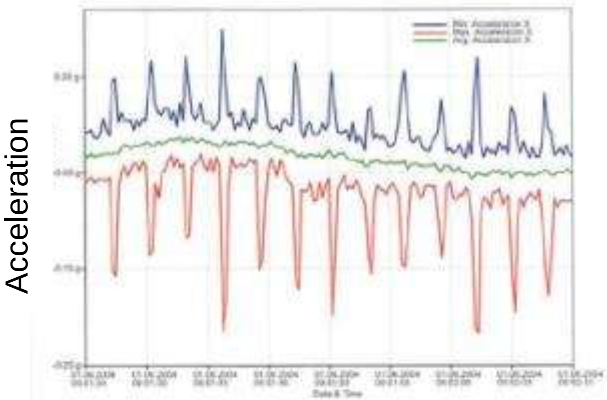
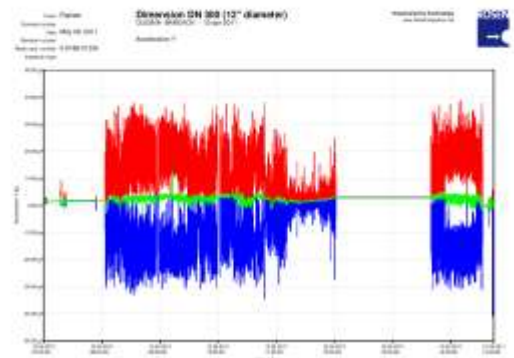


girth weld pattern

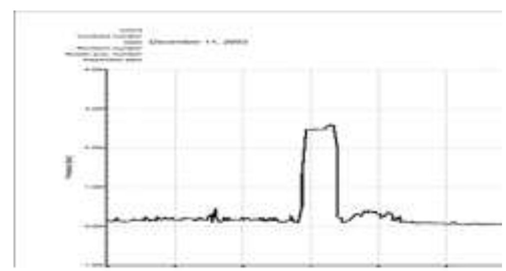
Cleaning Tools Negoiate Obstacles

Obstacles negotiated by Cleaning Tools can be a Reverse Point for Robotic Tools !

acceleration



diff. pressure



progressing knowledge prevents unnecessary expenditures !

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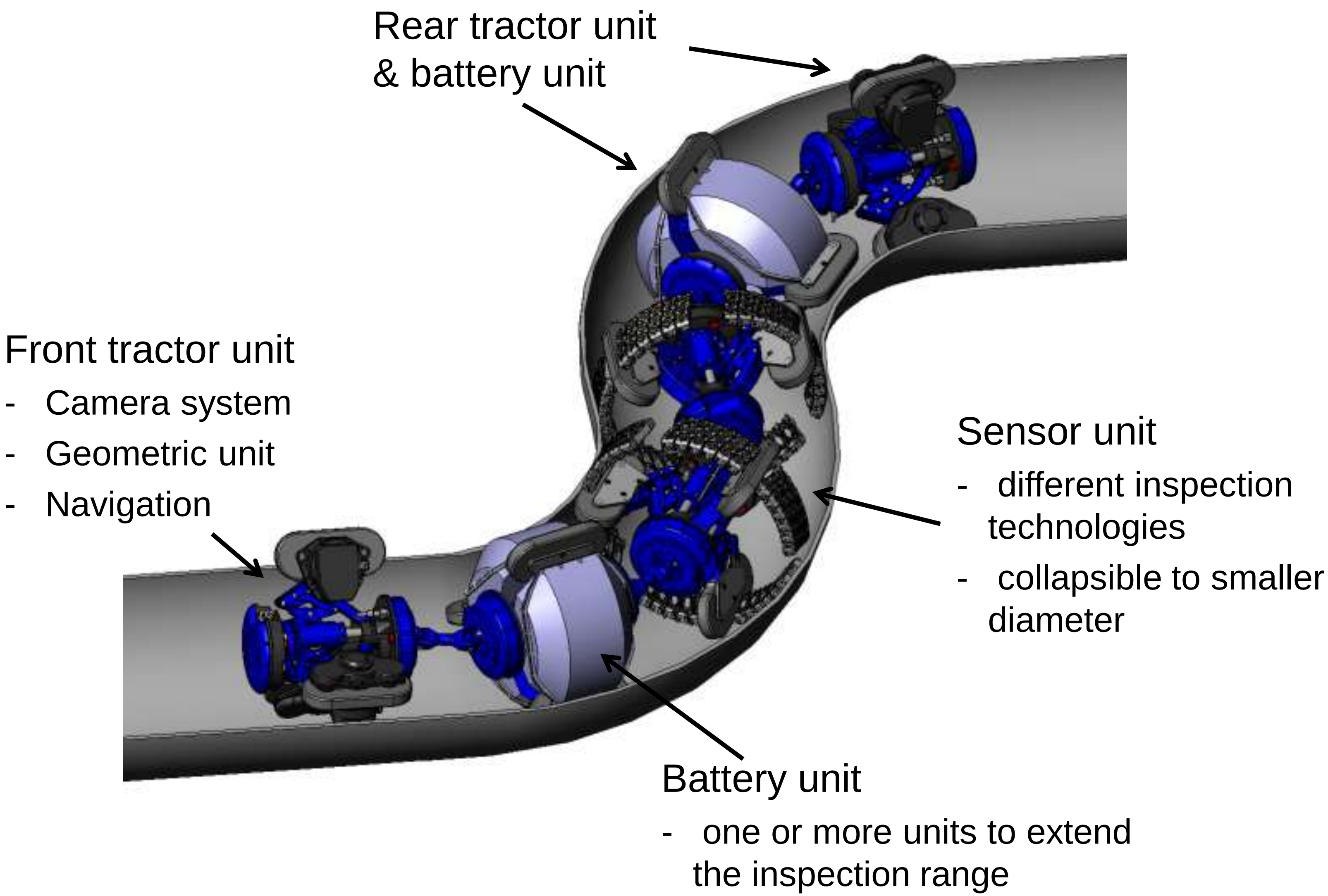
Helix Tool – Self Propelled

40” Helix Inspection Tool

(Loading and launching)

Robotic Survey System



Robotic Survey System 16” Configuration

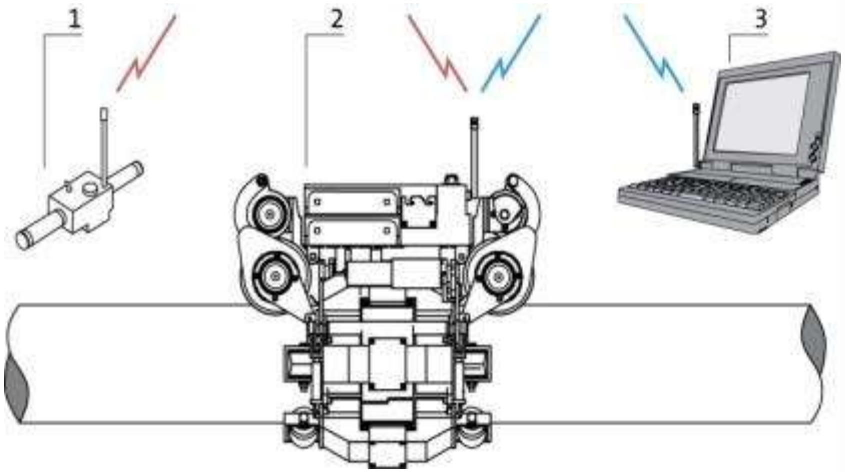
- Eddy current sensor unit for shallow internal corrosion measurements
- Unit with geometric measurement sensors
- Full coverage with 2 sensor carriers for 16”

RSS 16" – Field Test

Field test with the RSS 16".

Line was approximately 150 meter long and subjected to significant debris.

Robotic Pipe Scanner (External)

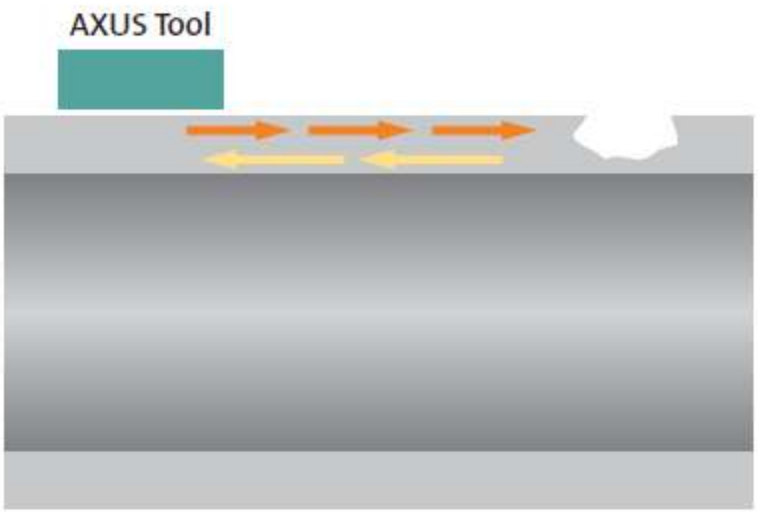


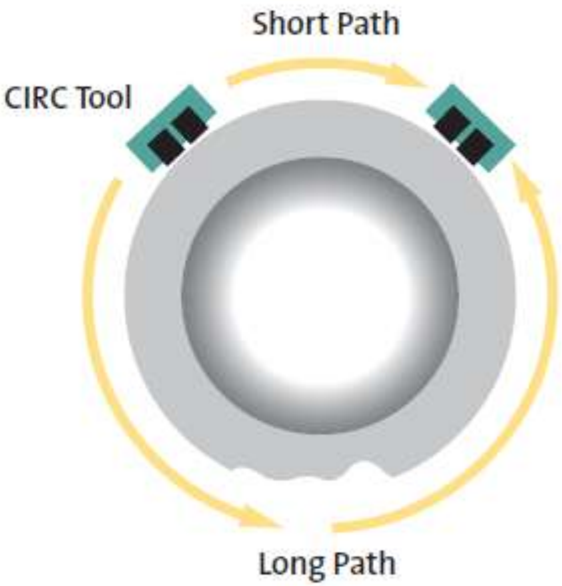
6”, 8”, 10” and 12”

12” Robotic Pipe Scanner

Robotic Tools – EMAT Scanner

Using EMAT to scan remote areas





Robotic Tools – EMAT Scanner

Tablet with Analysis Software

EMAT Sensor

EMAT Electronic
Battery operated
in a backpack

Conclusion

- Further developments of existing ILI technologies have **reduced the gap** between piggable and unpiggable pipelines. However, as can be seen by the different options used, each line will have its **own challenges**
- The Robotic Inspection tools combine **operational versatility** and **operational independency** together with the flexibility in bringing a large variation of NDT techniques, whilst traversing **safely** through the pipeline.
- The inspection of a challenging pipeline has to be a cost effective **optimization of inspection strategies and technologies** (including modification of the pipeline and operation)
- Nevertheless, solutions today for one line however may be **a challenge for the next line**

Thank You