BI-DIRECTIONAL HIGH-RESOLUTION INSPECTION OF A SUBSEA FLEXIBLE RISER PIPELINE

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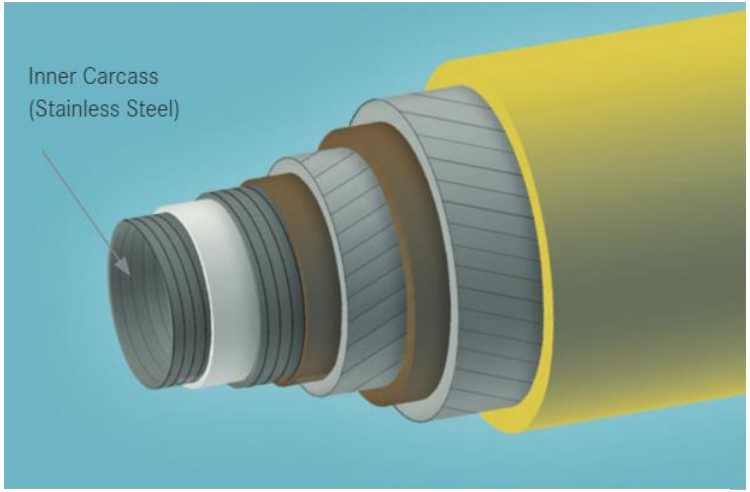
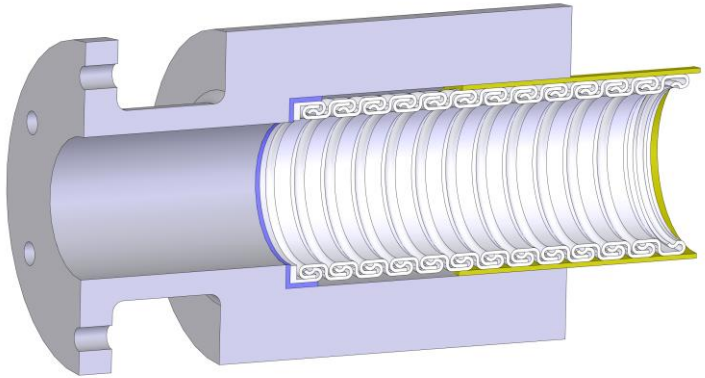
Agenda

1. Equinor Flexible Riser Portfolio and Challenges
2. Critical Components of Flexible Risers
3. NDT Global Solution
4. Results

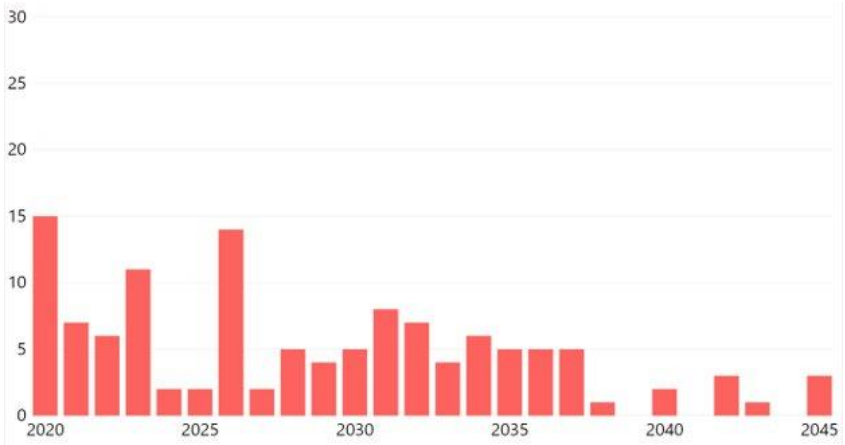




Flexible risers in Equinor

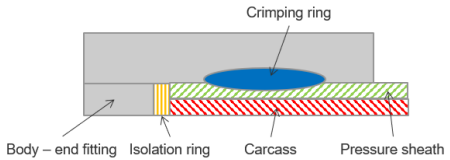
1. Total of 233 flexible risers in operation
2. Design life typical 20-25 years
3. Increasing number of flexible risers require lifetime extension or replacement
4. Known failure modes exist and unknown failure modes expected to appear in the future

Flexible risers end of life Equinor



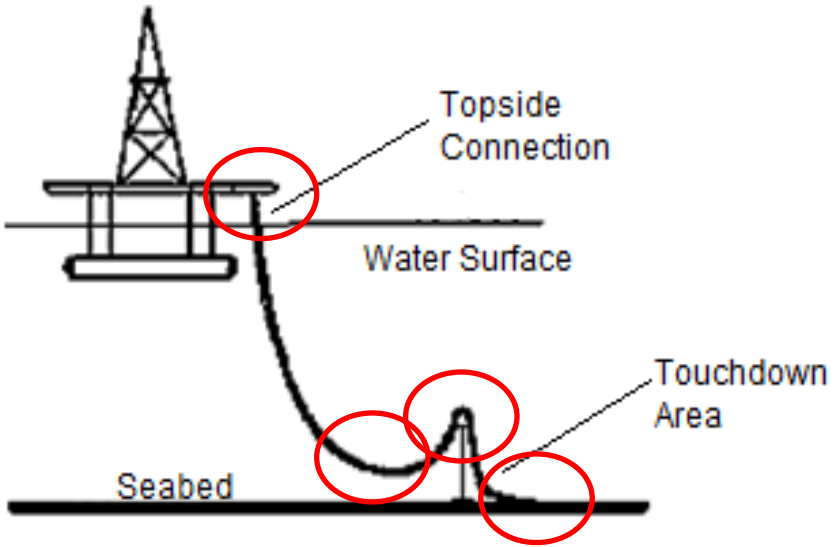
Known failure modes and reporting

1. End fitting – aging/cycling
    1. Sliding – Measure end fitting sliding
    2. Isolation ring degradation – Measure insulation ring condition
2. Carcass – Hydrate plug
    1. Carcass compression/stretching – Measure every pitch distance throughout the riser



		Static section		Dynamic section		
		ΔP	Ph	ΔP	Ph	Interpretation
Red capacity:	[bar]	65,5	137,5	65,5	137,5	Not to be exceeded without expecting damage
Yellow capacity:	[bar]	43,7	115,7	43,7	115,7	Target levels removal of plugs (No significant damage
Green capacity:	[bar]	29,8	101,8	19,9	91,9	Target levels for detecting hydrate plugs

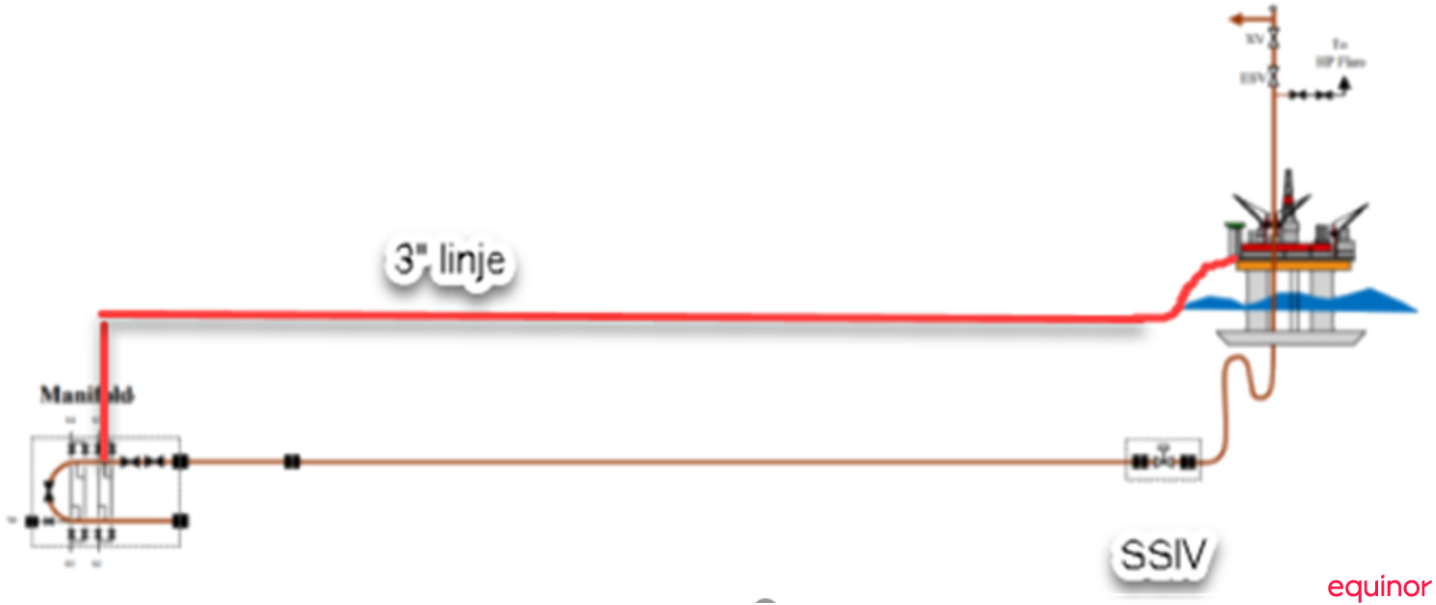
ILI and Operational Challenges



- Inline-Inspection of a subsea flexible riser pipeline
- Assess conditions of the critical part of the asset
- 3D bends
- BiDi solution

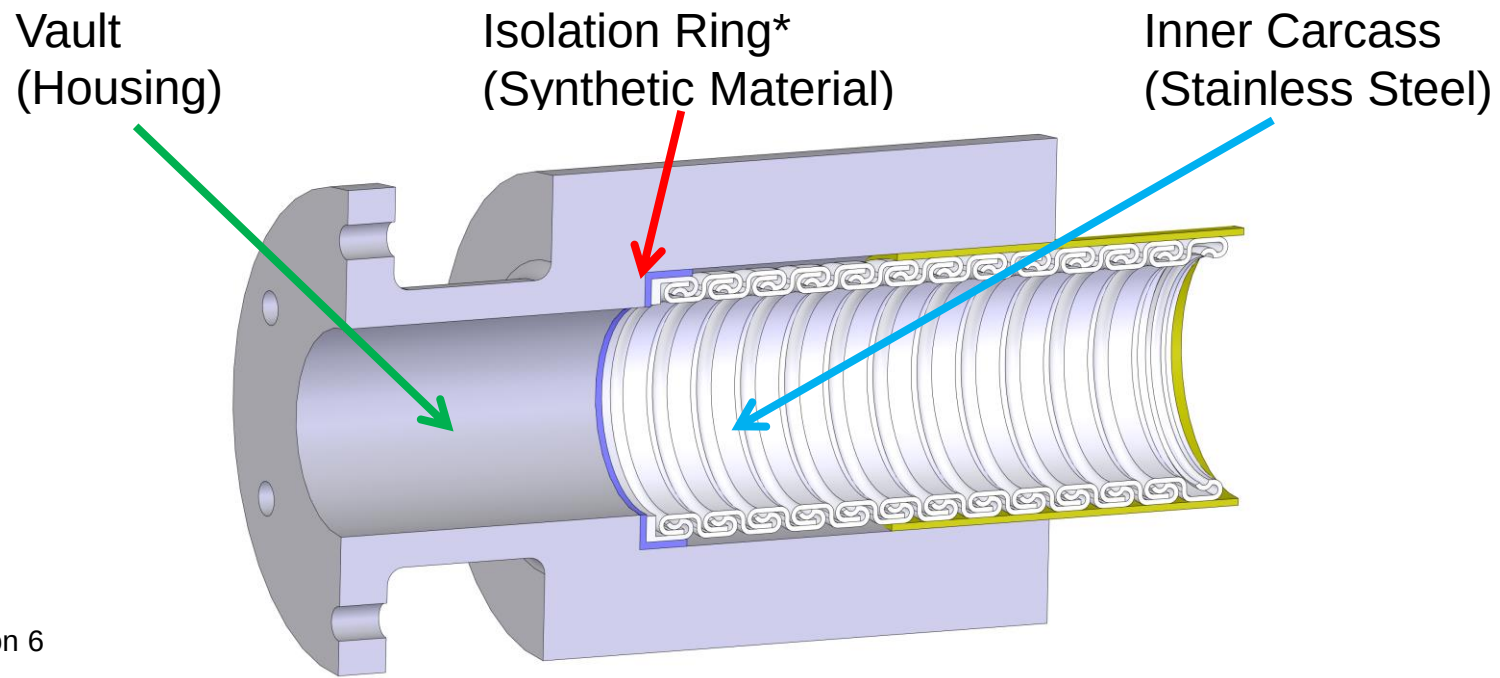
Challenge – System Layout

The flexible riser starts at the platform and descends 322 m to the seabed, where it connects via end fittings to a 6.5 km long, 10" diameter subsea pipeline and ends at a subsea template.



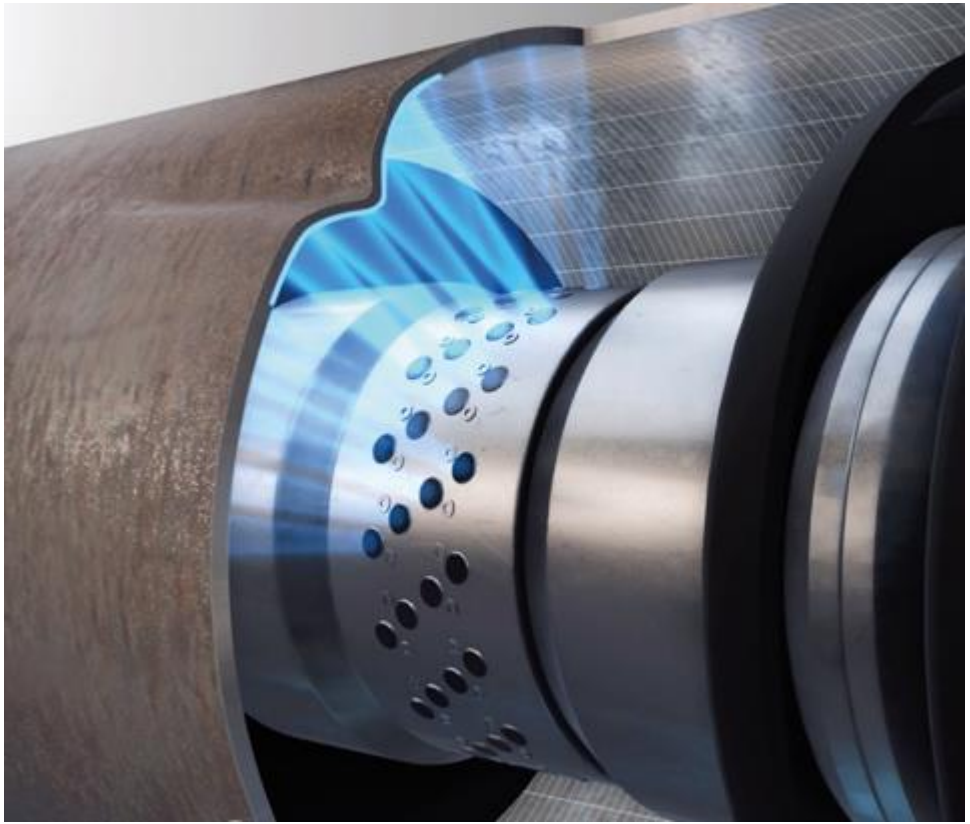
Critical Components of Flexible Risers

Illustration of the end fitting



* material is Nylon 6 (sound velocity ~2600 m/s)

NDT Solution: Bidirectional High Resolution UT ILI Tool



- High-resolution
- Bi-directional
- Free-swimming ILI ultrasonic technology (UT) tool
- Ultrasonic standoff signals as basis of analysis of the inner surface of the flexible riser carcasses
- Inspection data deliver high-accuracy measurements of the current position of end fittings and the condition of the isolation rings

UT Analysis Capabilities in Flexible Joints

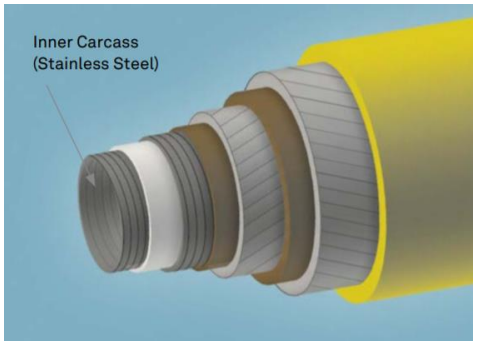
NDT Global is able to perform data analysis for the following special subjects concerning flexible pipes and end fittings:

1. Determination of the position of the inner carcass in the end fitting and detection of possible spacing between the inner carcass and the vault of the end fitting (sliding of the inner carcass)

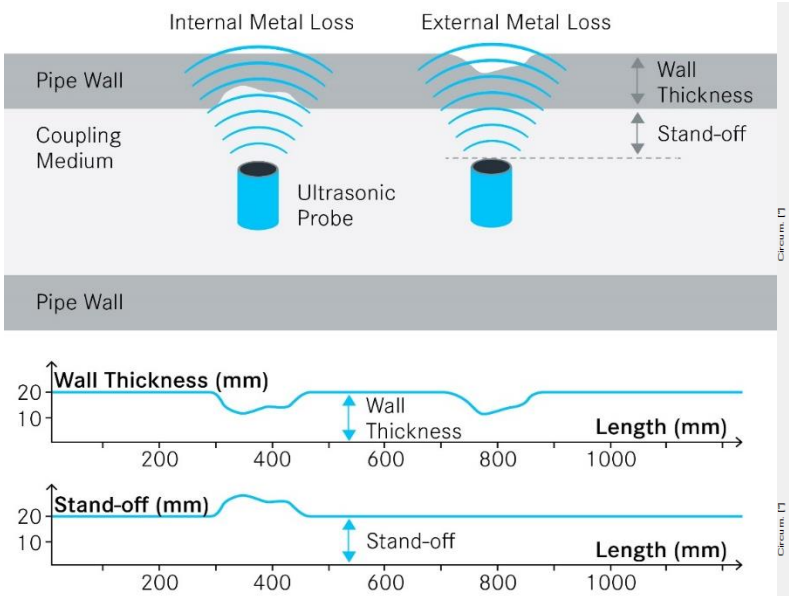
2. Evaluation of the condition of the isolation ring between the inner carcass and the vault of the end fitting

3. Detection of possible deformations of the inner carcass

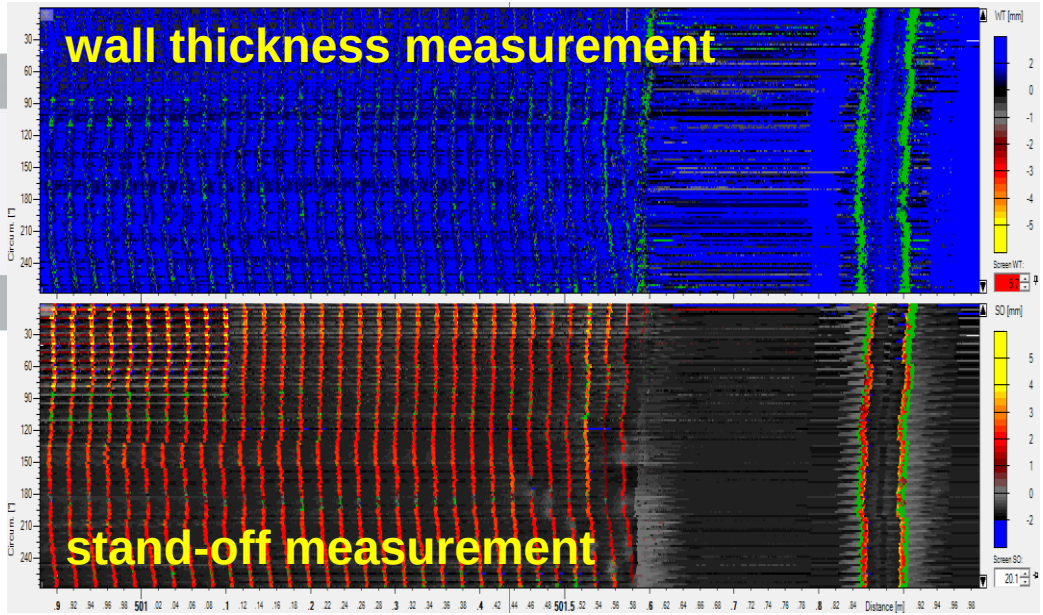
4. Stretch measurement of flexible risers



Inspection Data in Flexible Joints



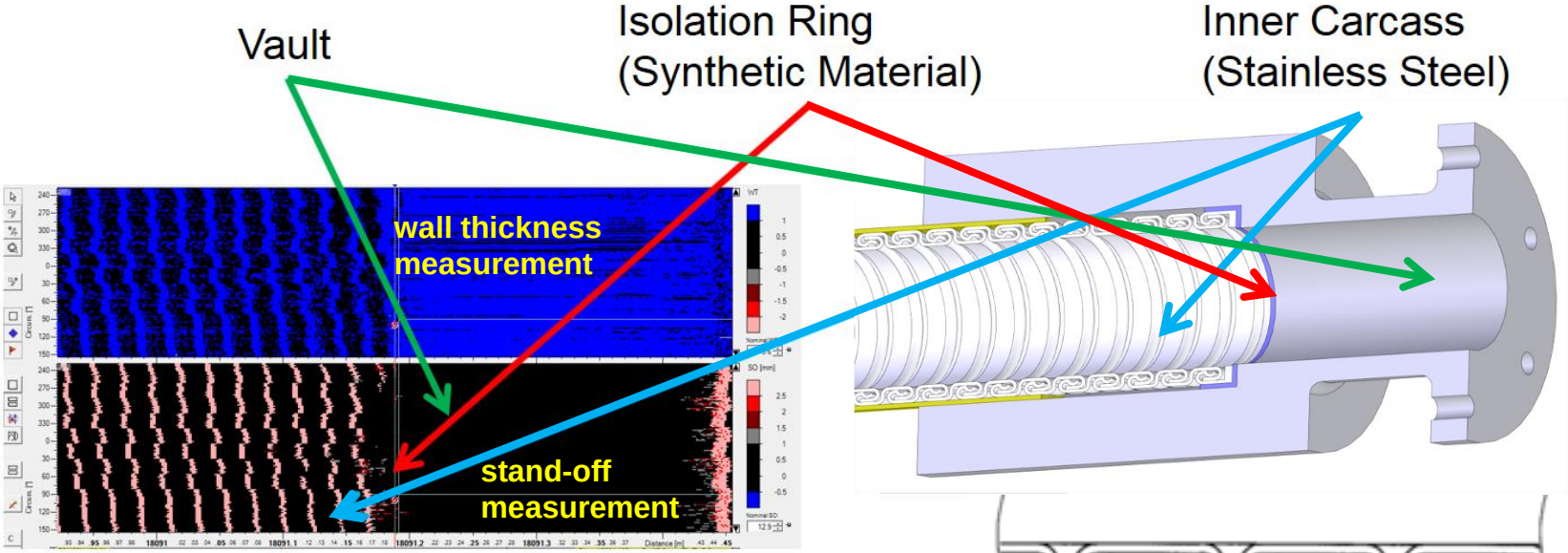
Measurement Principle



Sample Data

End Fitting

End fitting without a damage

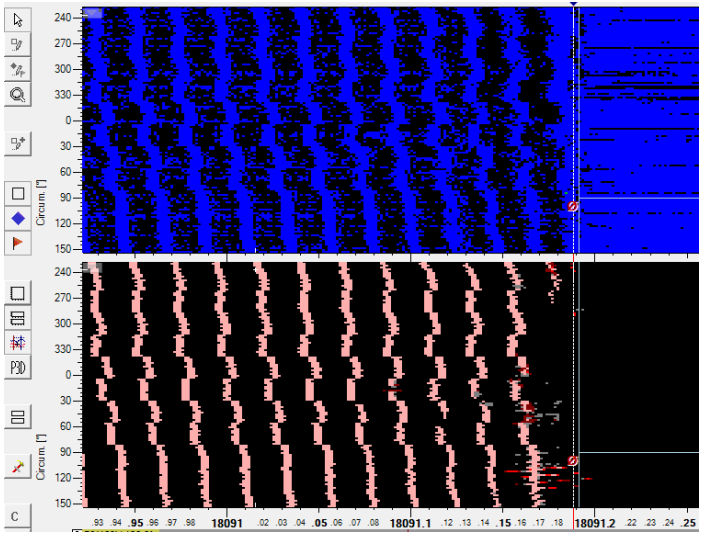


Sample data of a flexible riser inspection

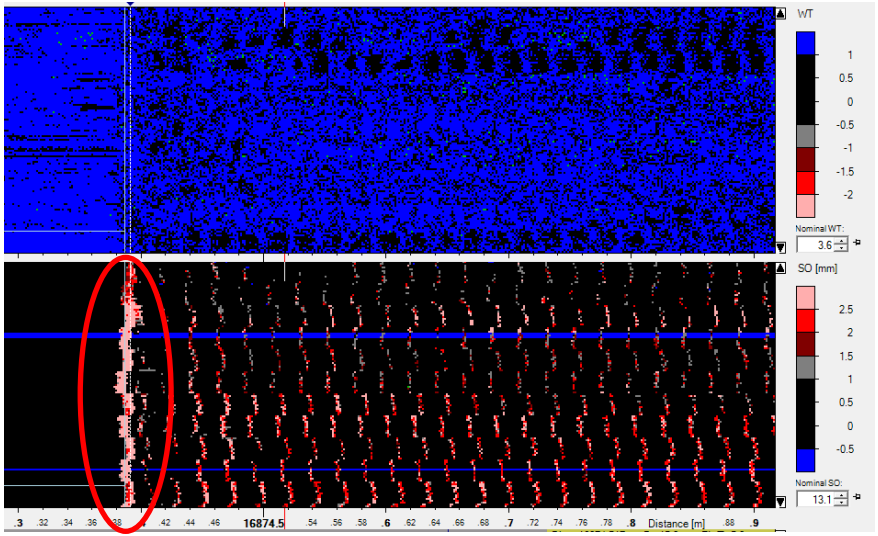
Structure of the inner carcass

End Fitting

End fitting without a damage



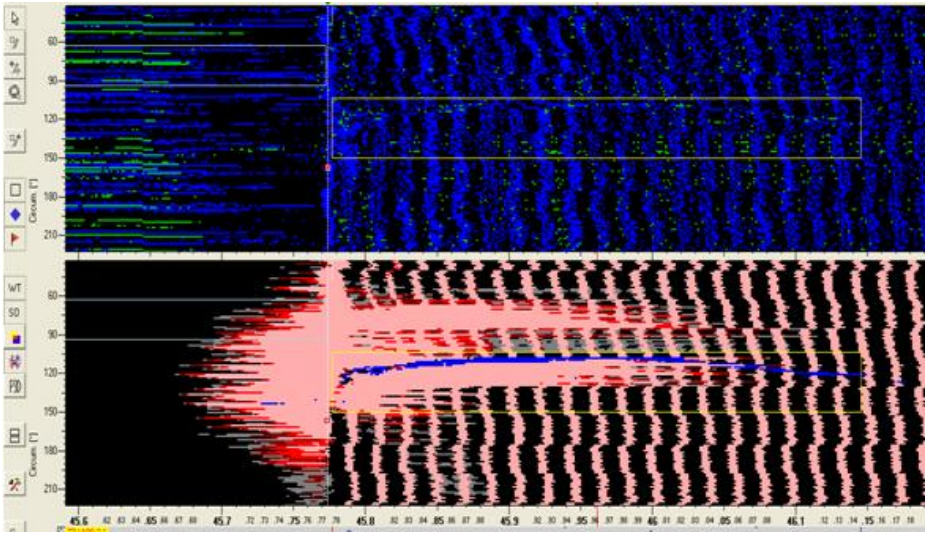
End fitting with a damaged isolation ring



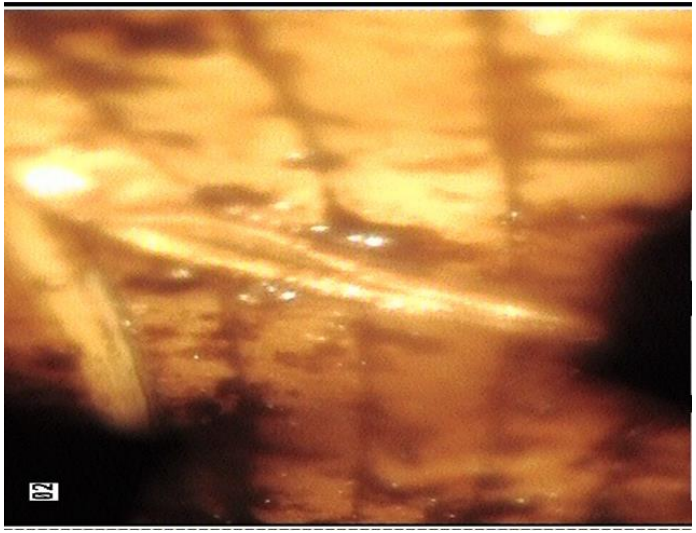
Data from a different project!

End Fitting

Deformation of the inner carcass



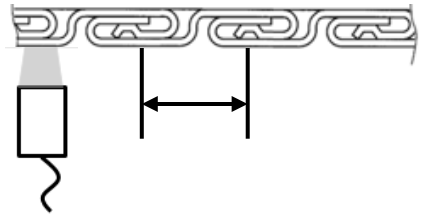
Photography



Data from a different project!

Stretch Measurement using data from BiDi inspection

The recorded data sets from both directions in the flexible riser were analyzed for distance measurements between single rings over the whole length of the riser.

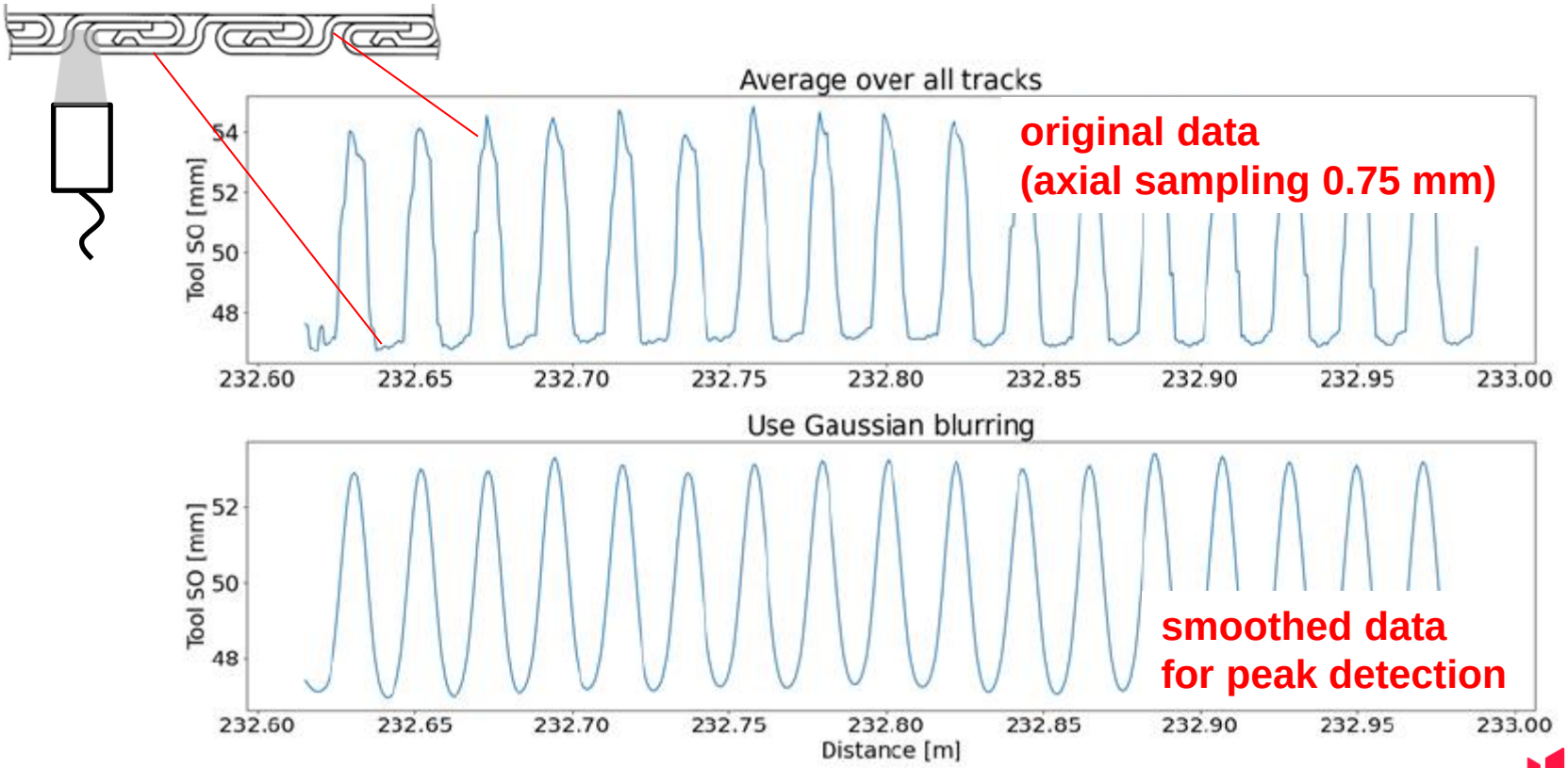


The ring pattern was evaluated for extreme values, using the stand-off measurements in 4 specific circumferential areas:

- 12 o'clock position
- 3 o'clock position
- 6 o'clock position
- 9 o'clock position

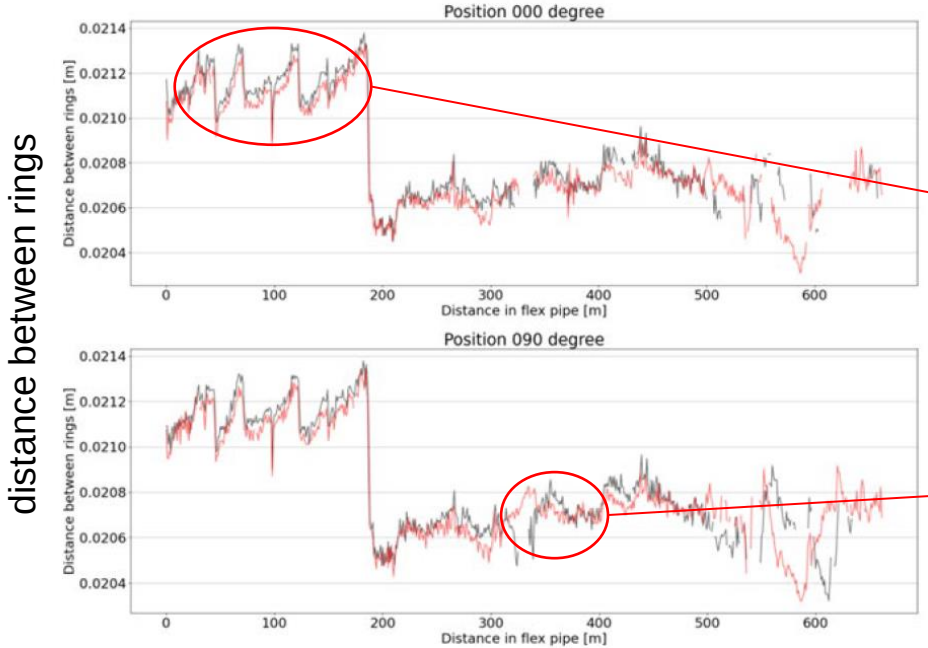
To obtain a smoother signal supporting the automated peak detection using algorithms a Gaussian filter was applied.

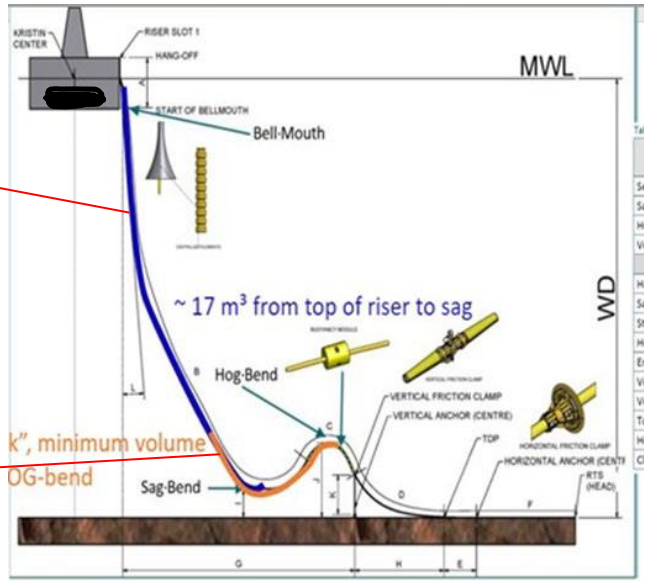
Stretch Measurement



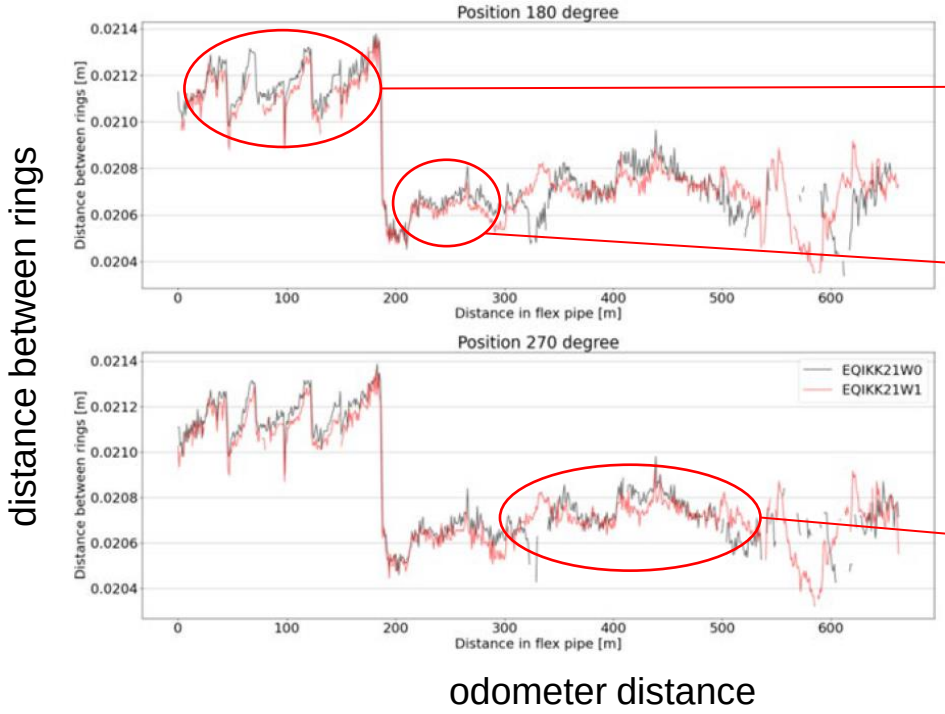
Stretch Measurement

The distances between the single riser rings were measured and plotted over the complete length of the riser.
To enable a comparison, all results are shown in the same reporting direction.





Stretch Measurement



Between the start of the riser and ~190 m the distance between the rings is ~2.13 cm.

From ~190 m onwards both data sets show a steady behaviour with slightly varying distances of ~2.07 cm between the rings.

In the bend area at ~386 m and further downstream smaller ring distances have been observed.

Thank You!

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