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Well Placement: Where We're Headed; Why Non-Drillers Should Care

John M. Clegg CEng FIMechE

J M Clegg Ltd

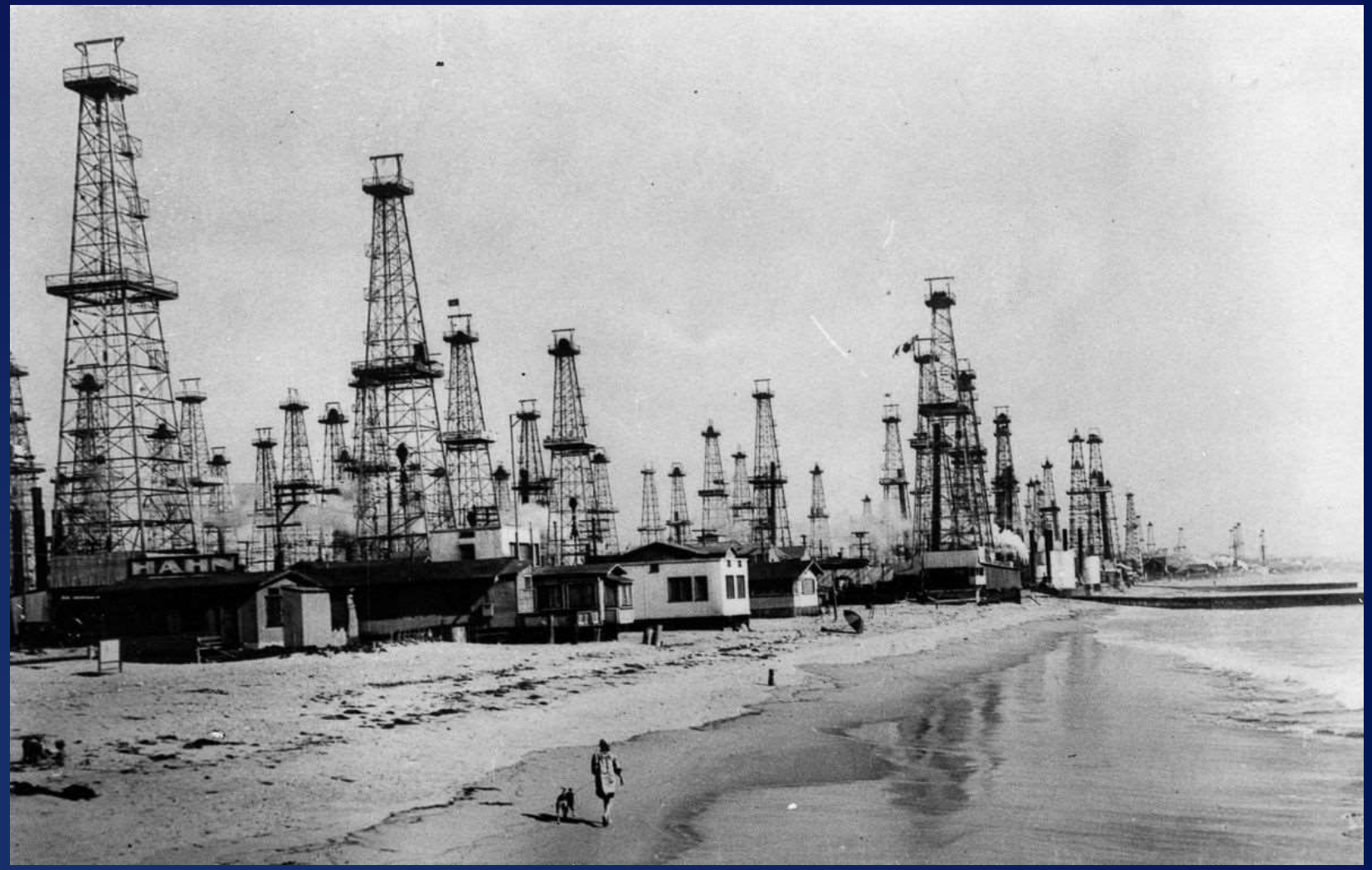
www.johnmclegg.com

Presentation Outline

- Key drivers for directional drilling and well placement. And why non-drillers should be interested!

- Where is directional drilling going? How can you influence it?

Quick Look Back In Time



100 Years of Directional Drilling

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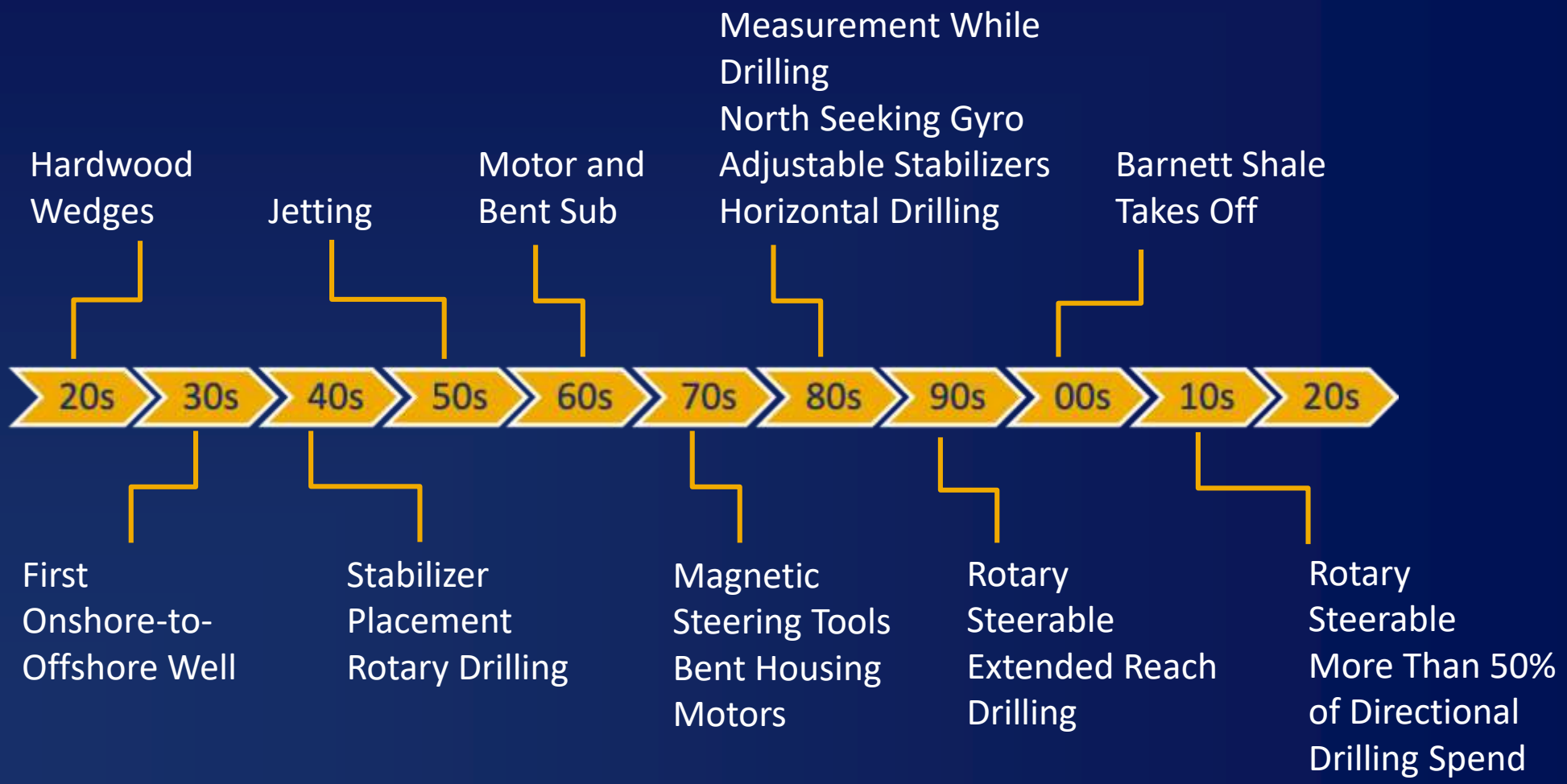
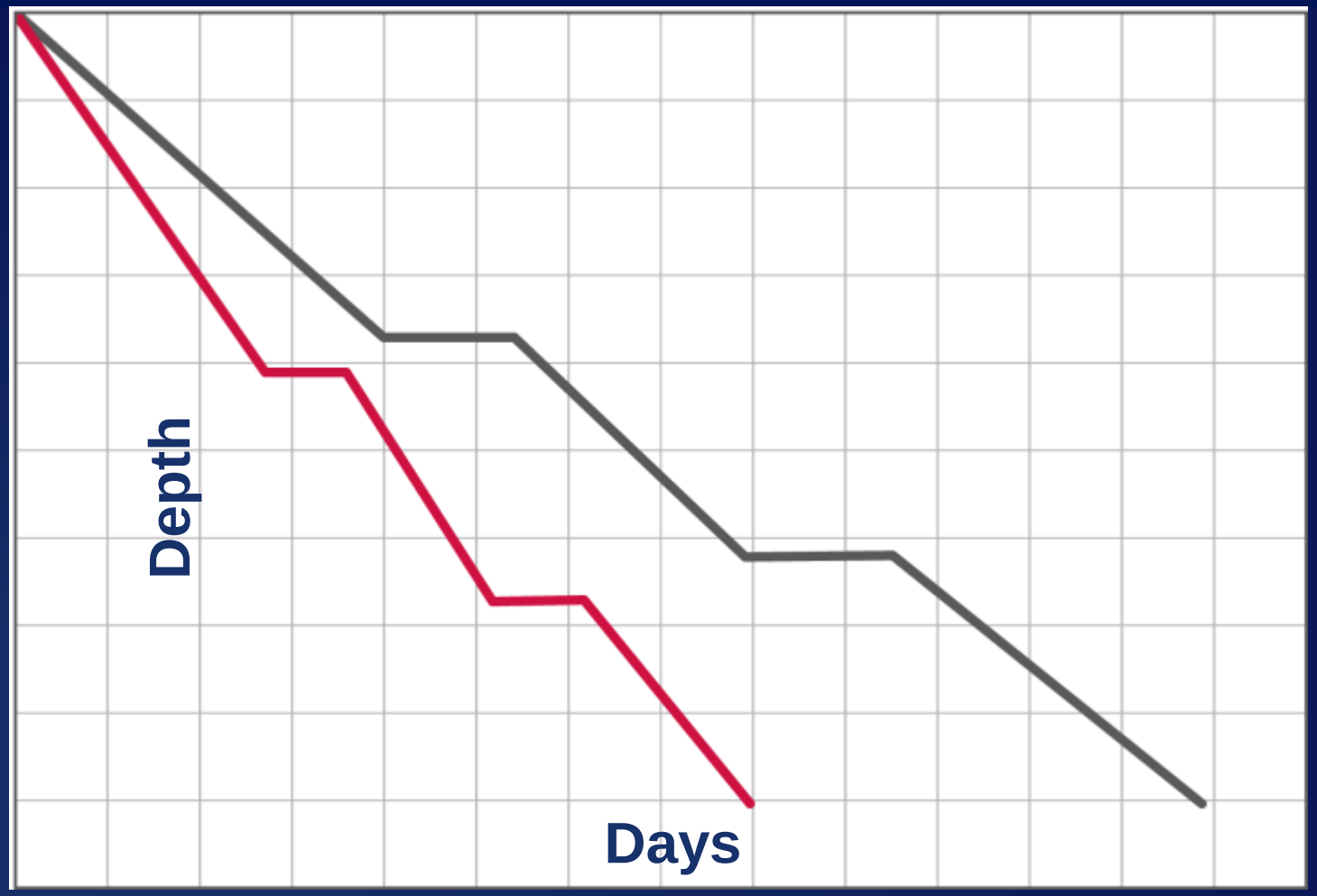
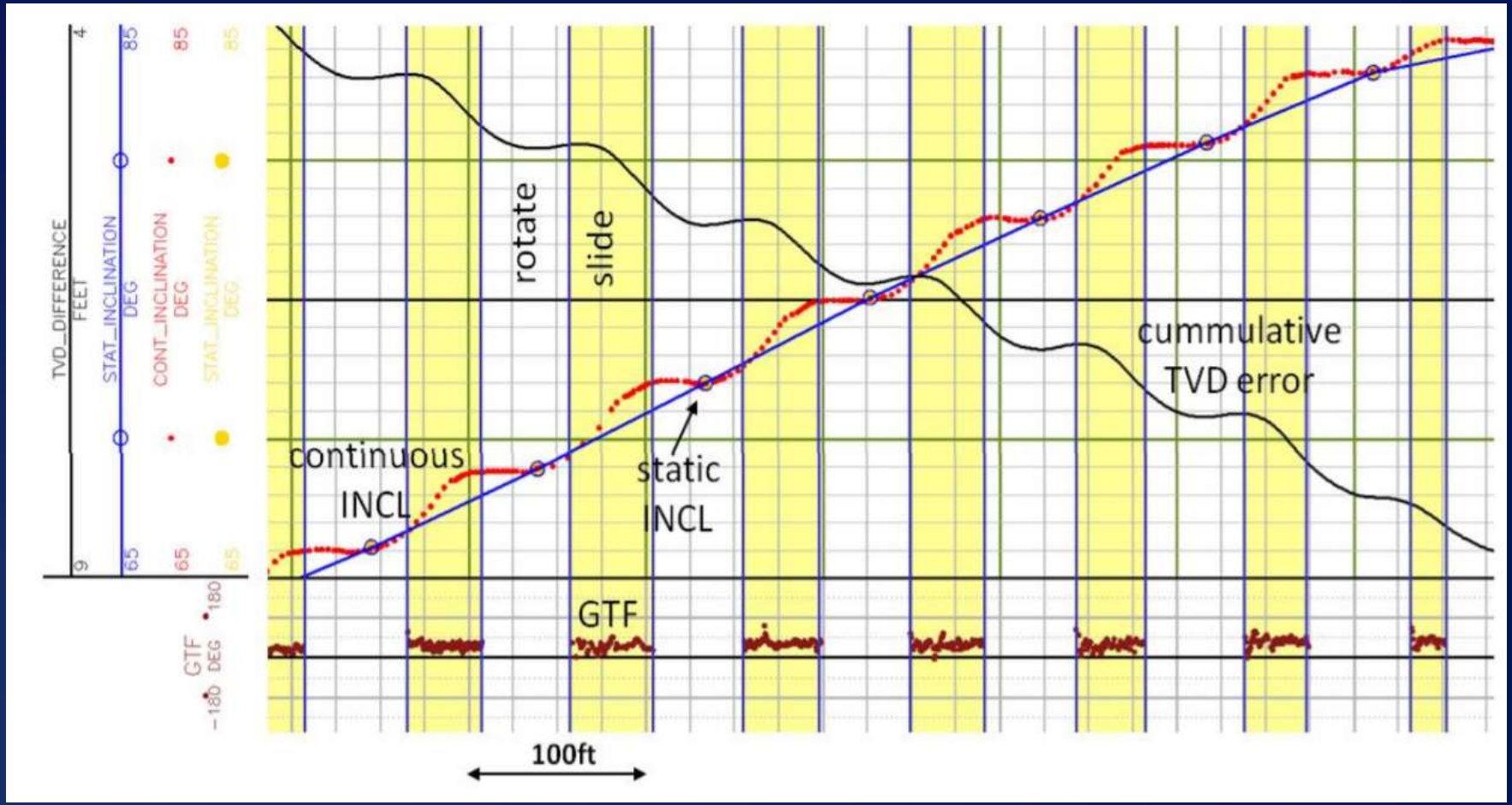


Directional Drilling Drivers

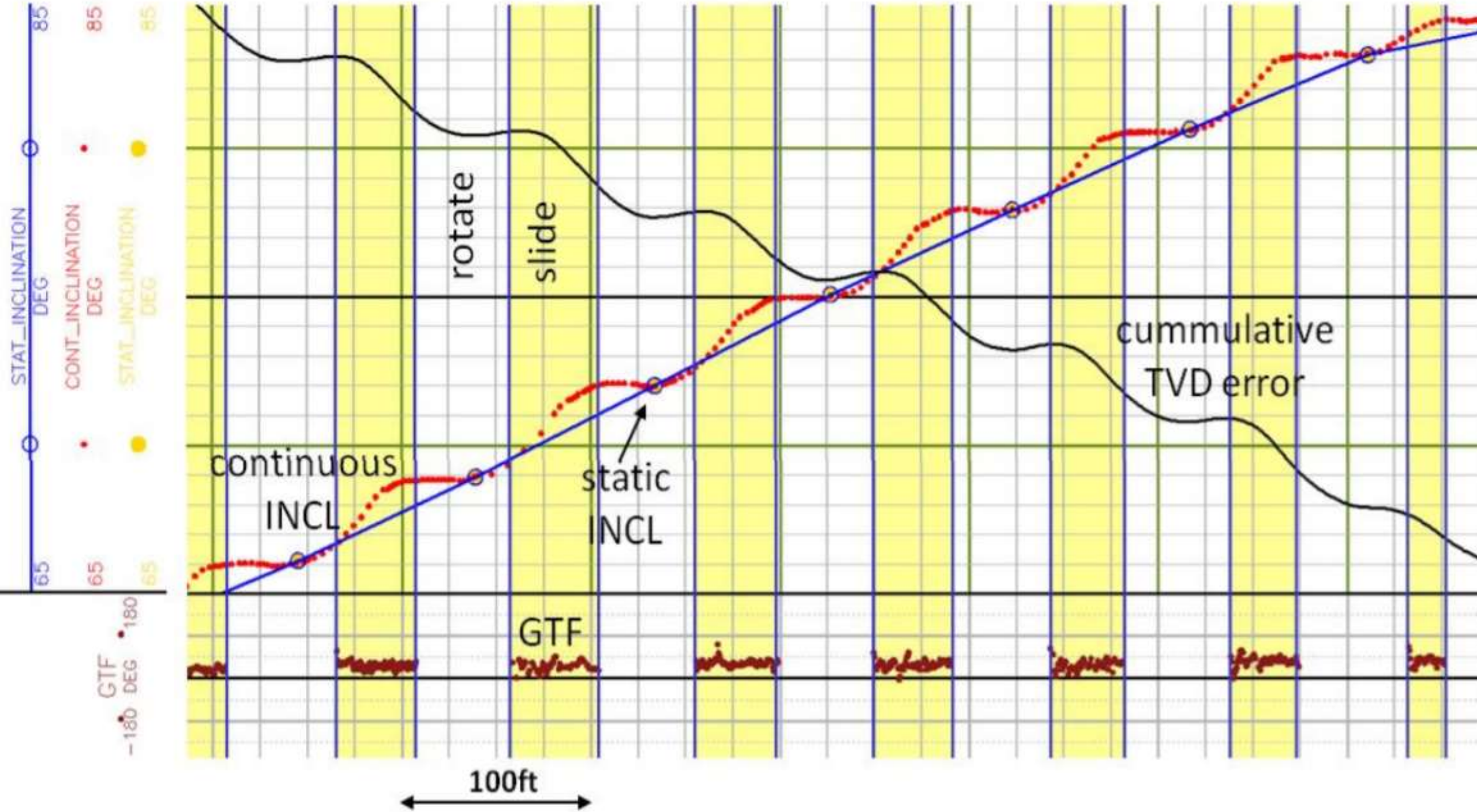
Drilling Engineer’s View



What the Directional Driller Won’t Tell You



IADC/SPE 151248 Stockhausen, Lowden and Lesso, 2012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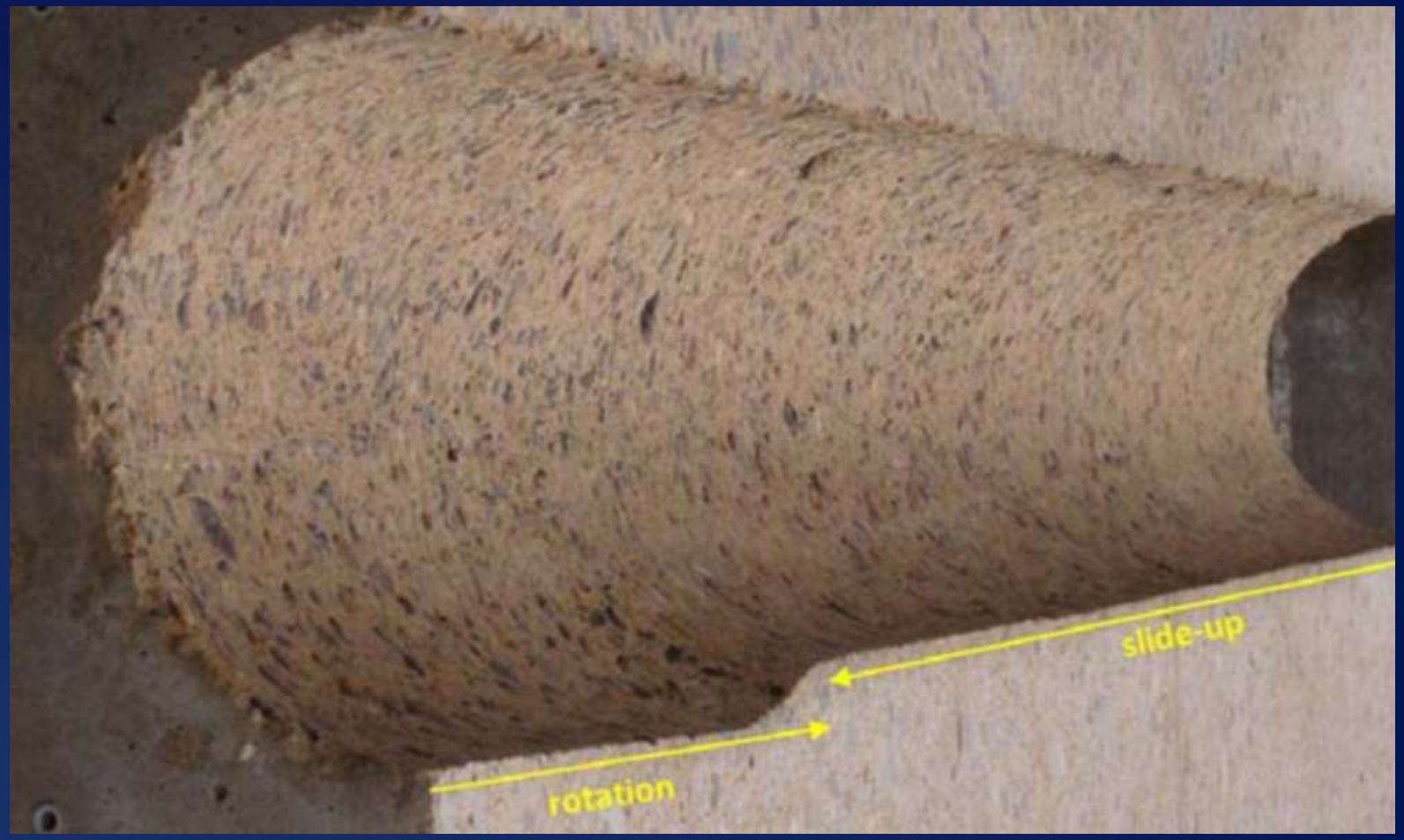
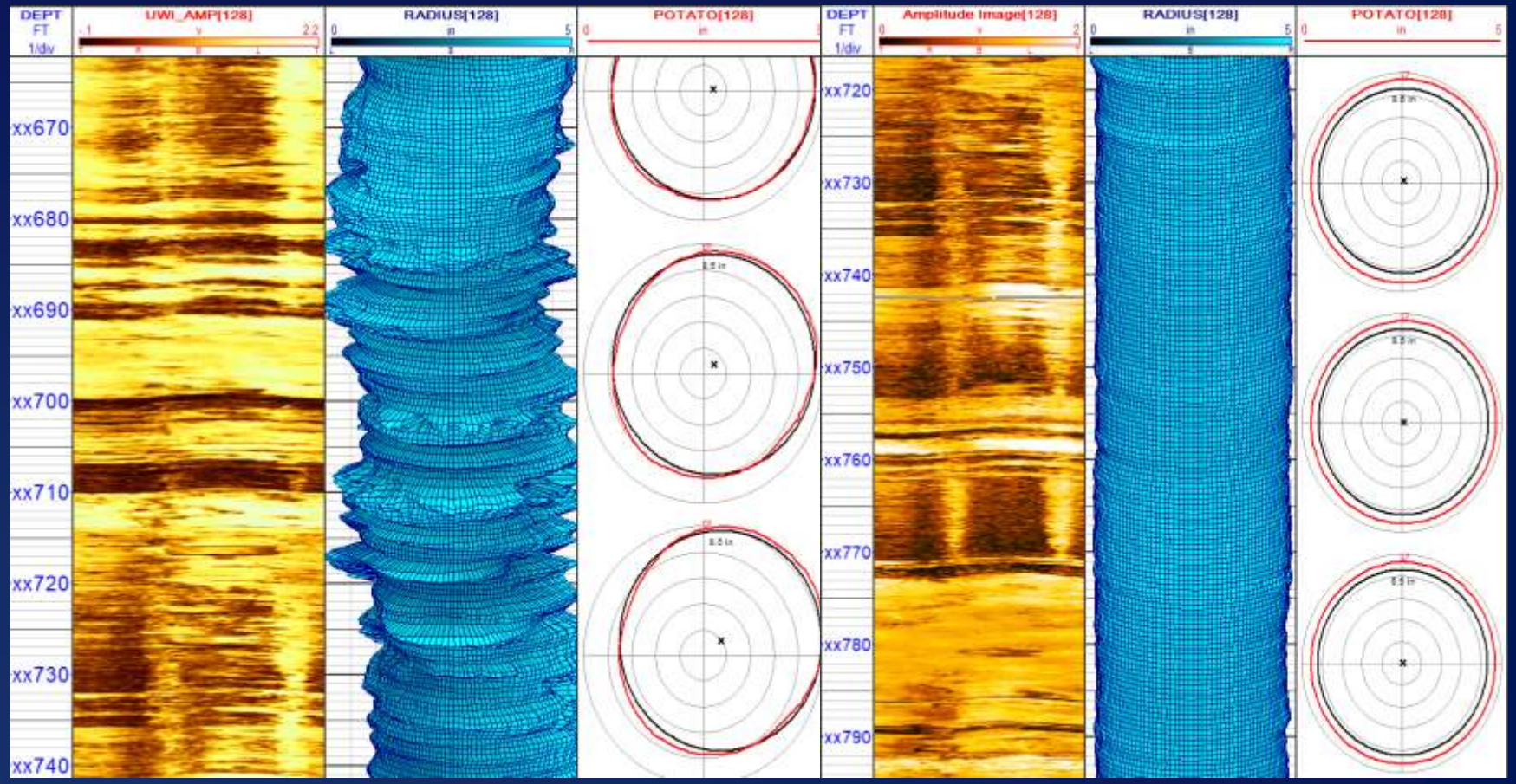
What the Directional Driller Won’t Tell You



IADC/SPE 151248 Stockhausen, Lowden and Lesso, 2012

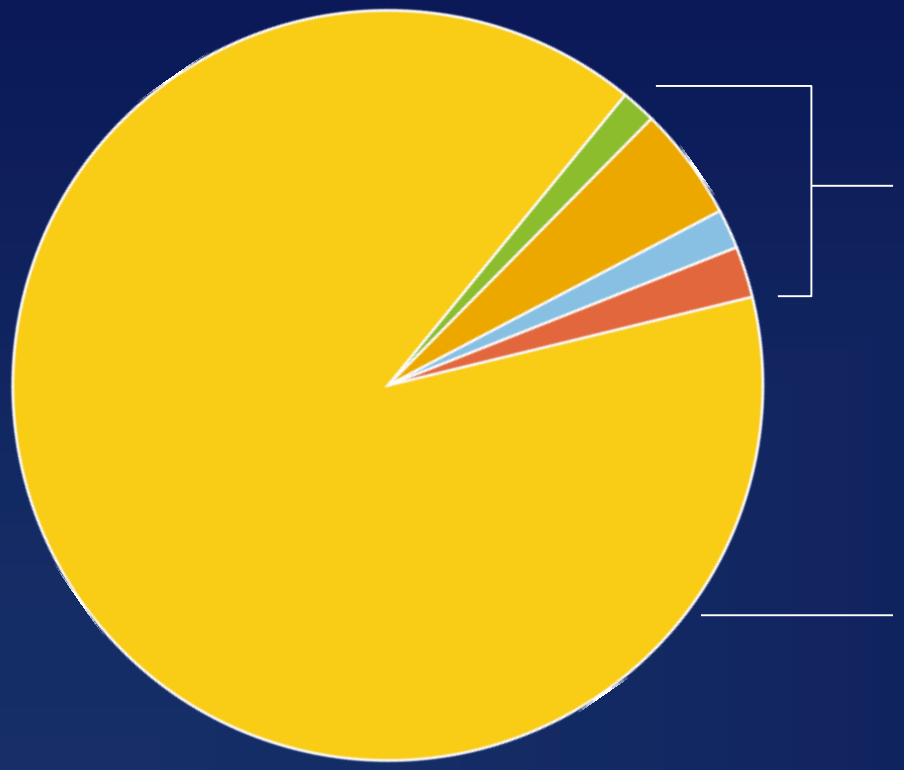
Case Study: What Can Be Done



Ultrasonic caliper logs showing reduction in tortuosity

IADC/SPE 194170 Clegg, Mejia and Farley, 2019

Why Does Tortuosity Matter?



Preparation: 7 to 14 weeks

Drilling: 2 to 4 weeks

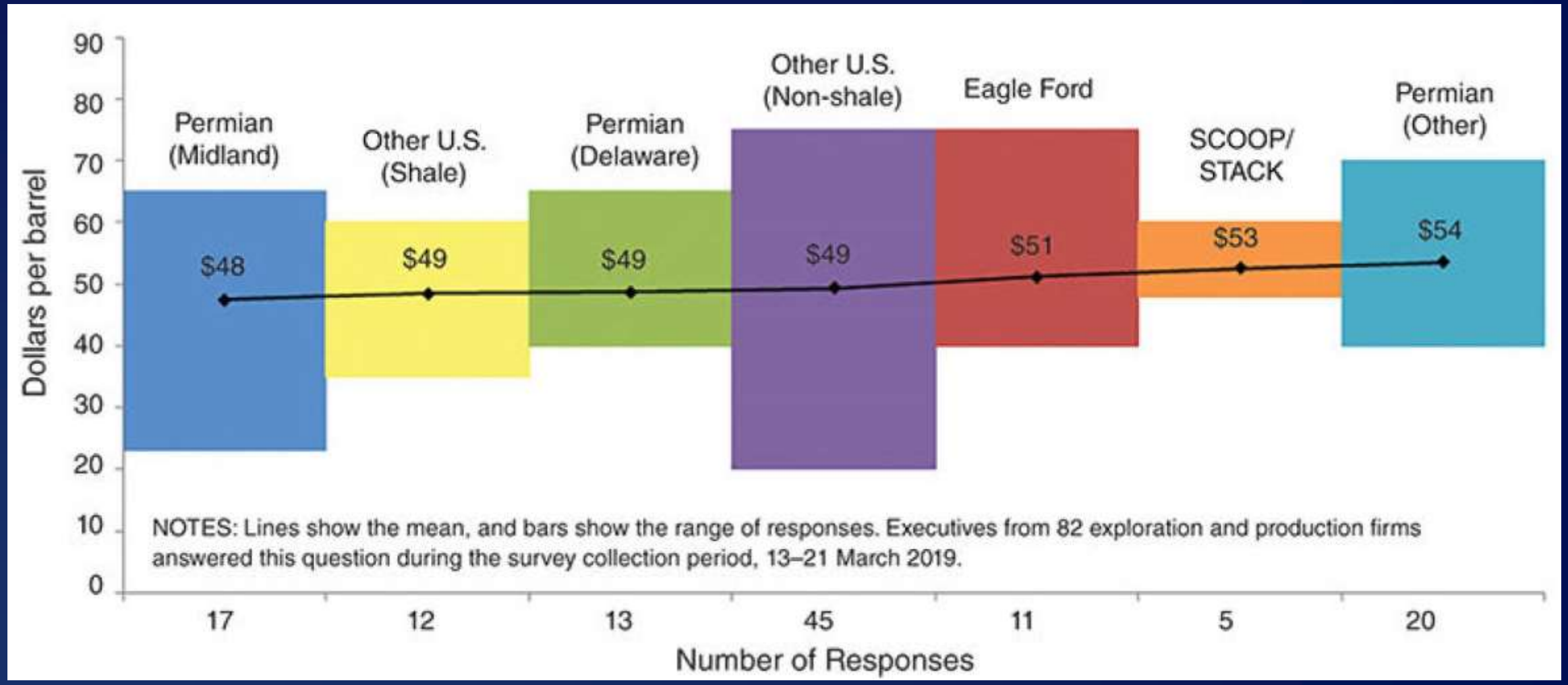
Completions: 3 to 6 weeks

P&A: 2 to 4 weeks

Production: **5 to 70 years**

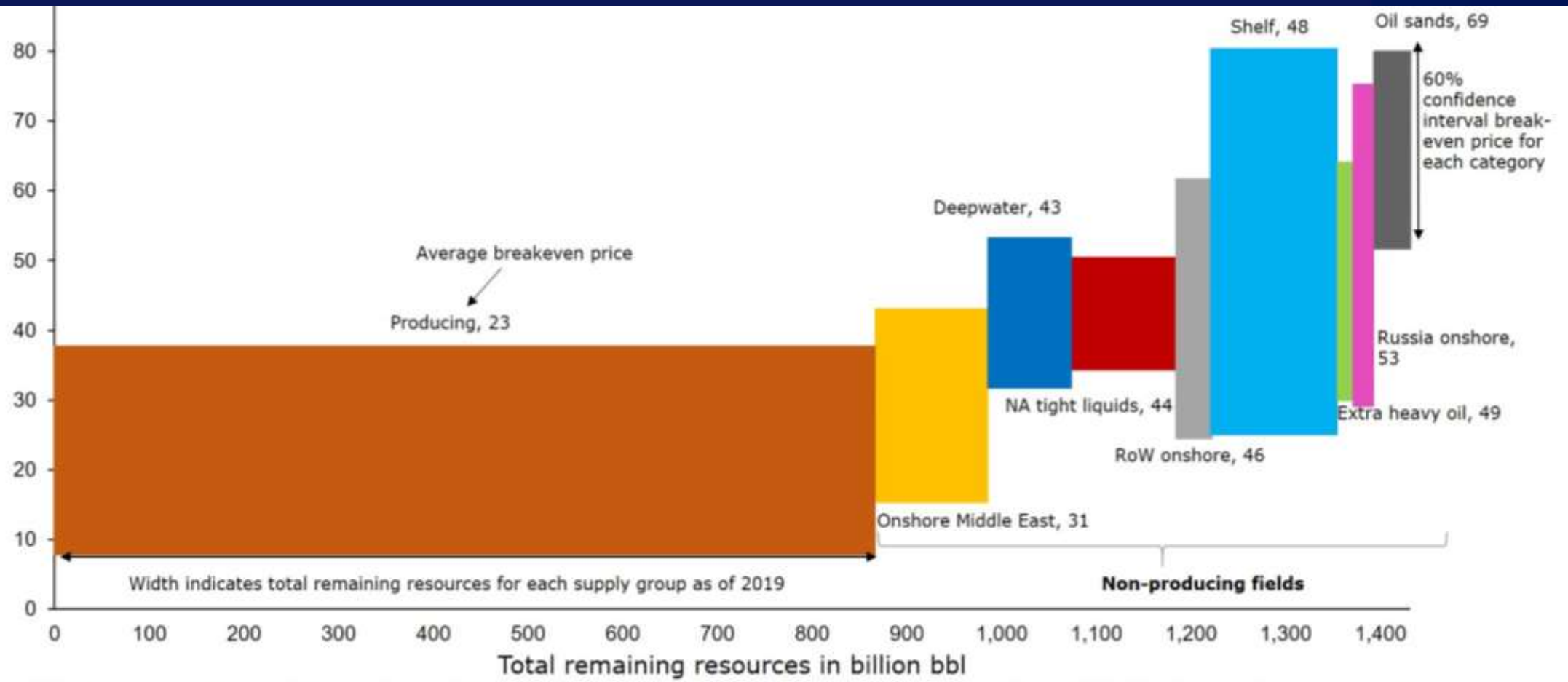
"Well Development – How Long Does It Take?"
IADC Drilling Matters, 2016

Why Does Production Matter?



Rassenfoss, Journal of Petroleum Technology, August 2019

Why Does Production Matter?



*The breakeven price is the real Brent oil price that gives an NPV of zero given a real discount rate of 7.5%. The breakeven price only includes future costs. The boxes are an average of all fields within each category

rystad.com, October 2020

Why Does Production Matter?

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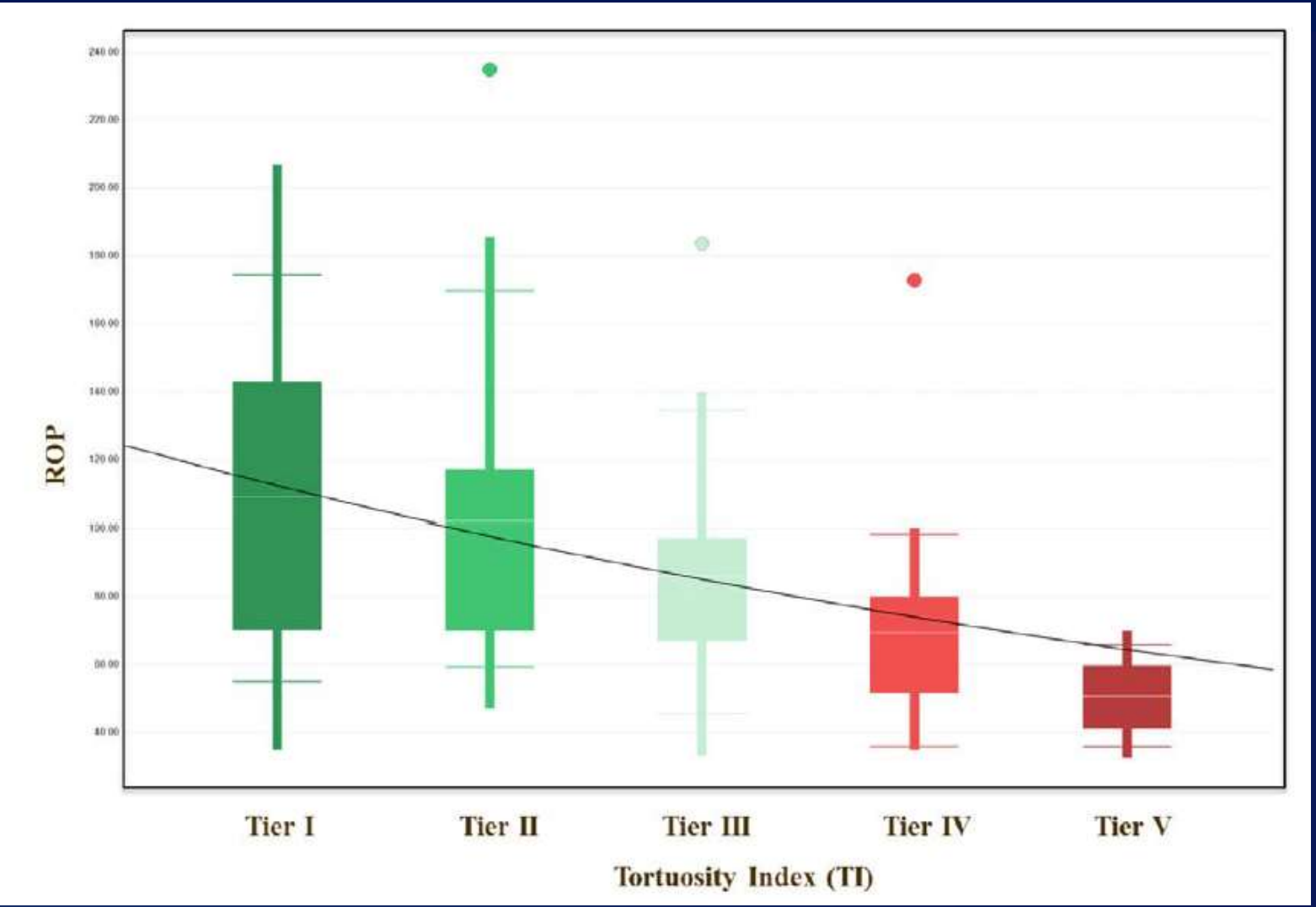
Total capex per well for US onshore = $4.9M to $8.3M

US Energy Information Administration, 2016

Typical Permian Basin Estimated Ultimate Recovery 500 to 750 Mbbls ($25M to $38M)

(Wood Mackenzie plus shale producer investor relations slides)

Tortuosity and Penetration Rate



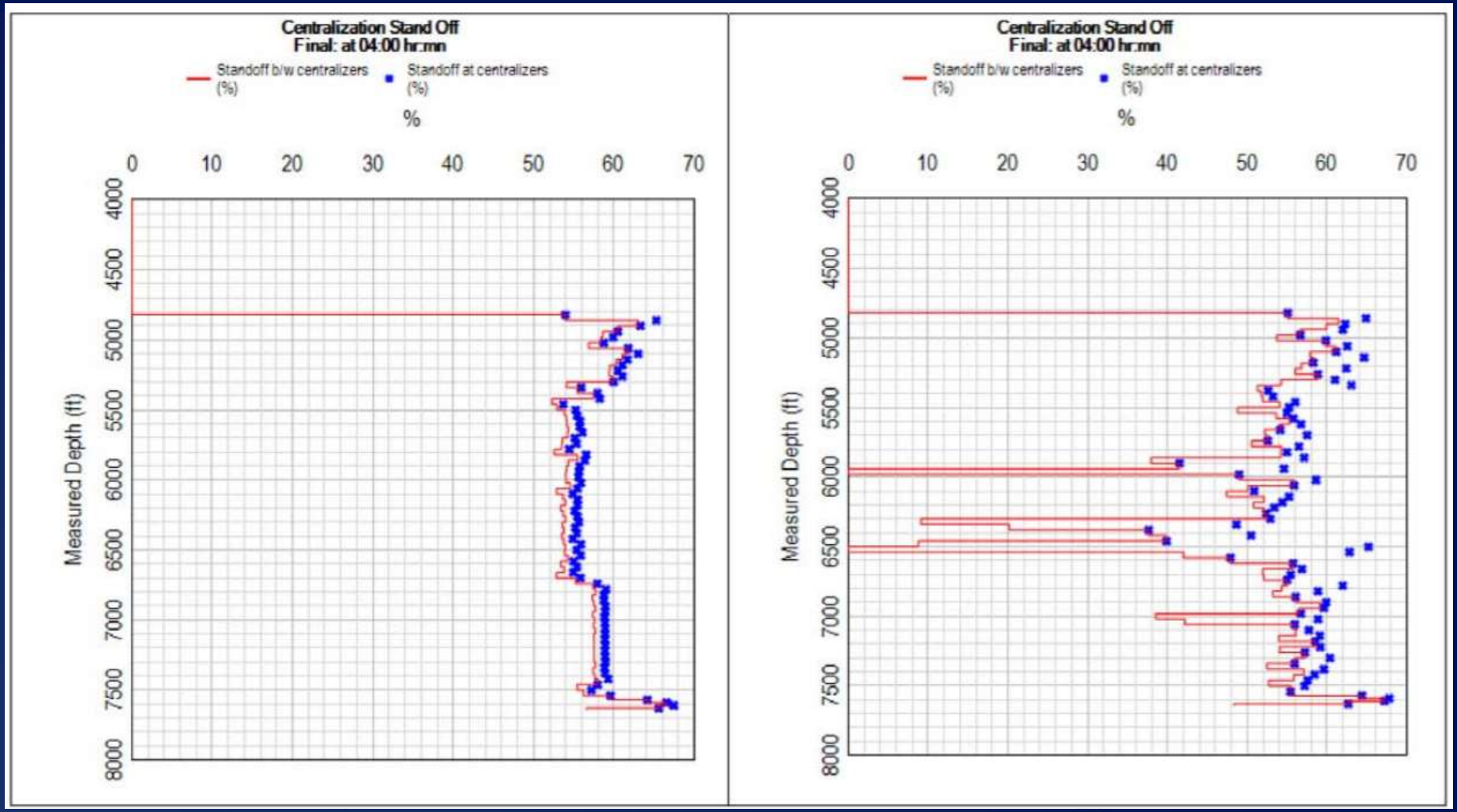
SPE 196020 Shahri *et al*, 2019

Tortuosity and Stuck Pipe

	Vertical		Lateral	
Quartile	**Tortuosity Index average from 849 wells**	**% stuck pipe wells**	**Tortuosity Index average from 793 wells**	**% of stuck pipe wells**
BOTTOM	0.082	10%	0.393	16%
TOP	0.287	50%	1.985	51%

IADC/SPE 194182 Baumgartner *et al*, 2019

Tortuosity and Cementing



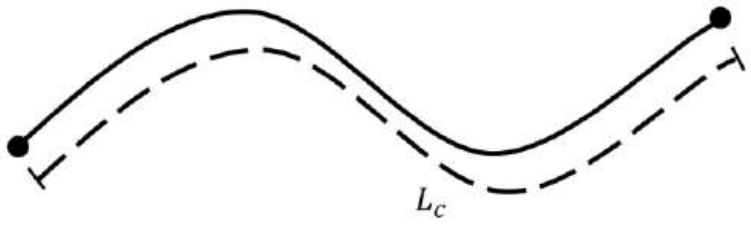
IADC/SPE 194101 Monterrosa *et al*, 2019

Tortuosity and Production Equipment

"As Tortuosity Index increases, the average rod pump failures per well increase.

As Tortuosity Index increases, the average initial production decreases"

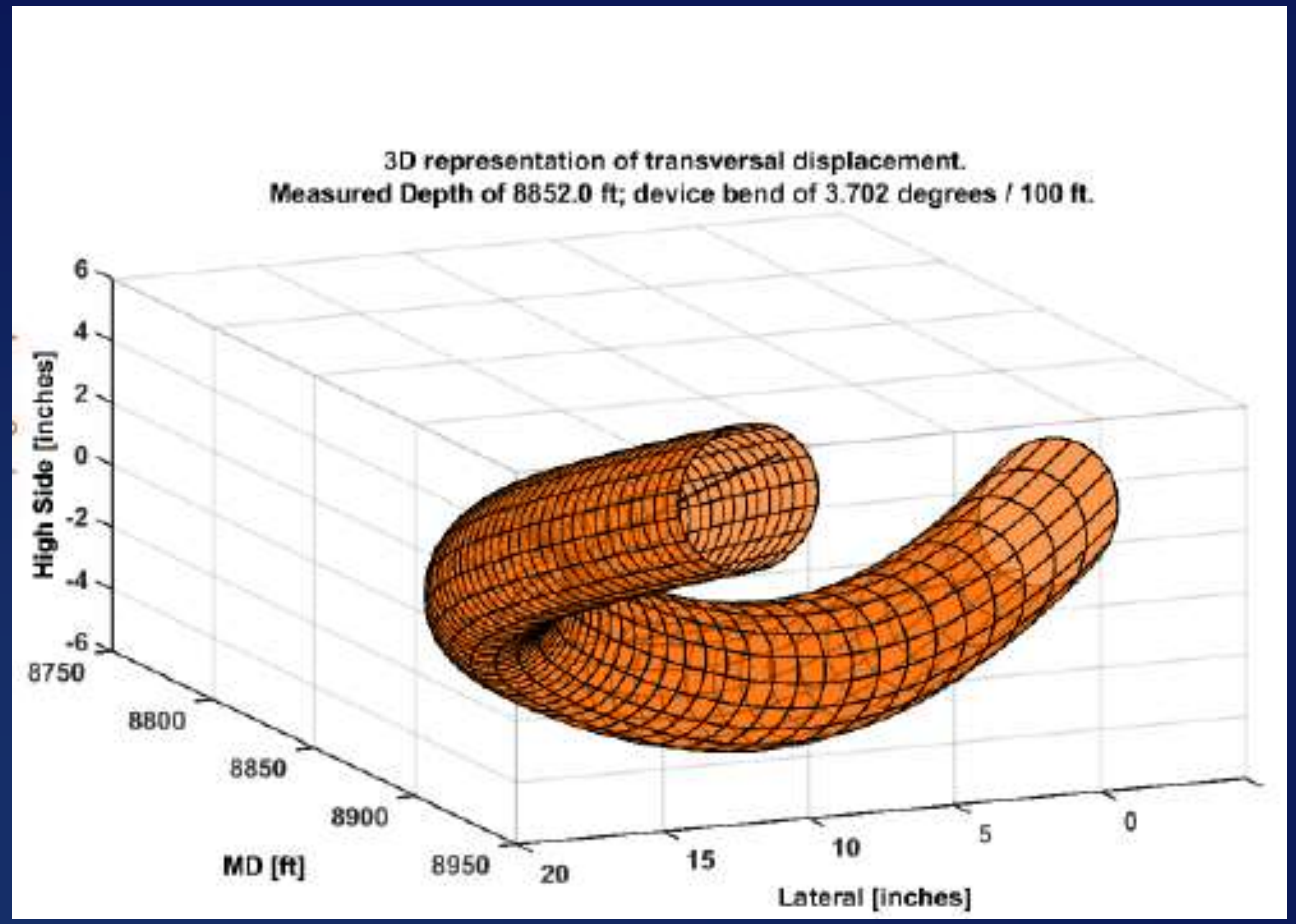
Ashok, UT Austin, 2018



$$TI_{Incl/Azm} = \frac{n-1}{n}\frac{1}{L_c}\sum_{i=1}^{n}\left(\frac{L_{csi}}{L_{xsi}} - 1\right)$$

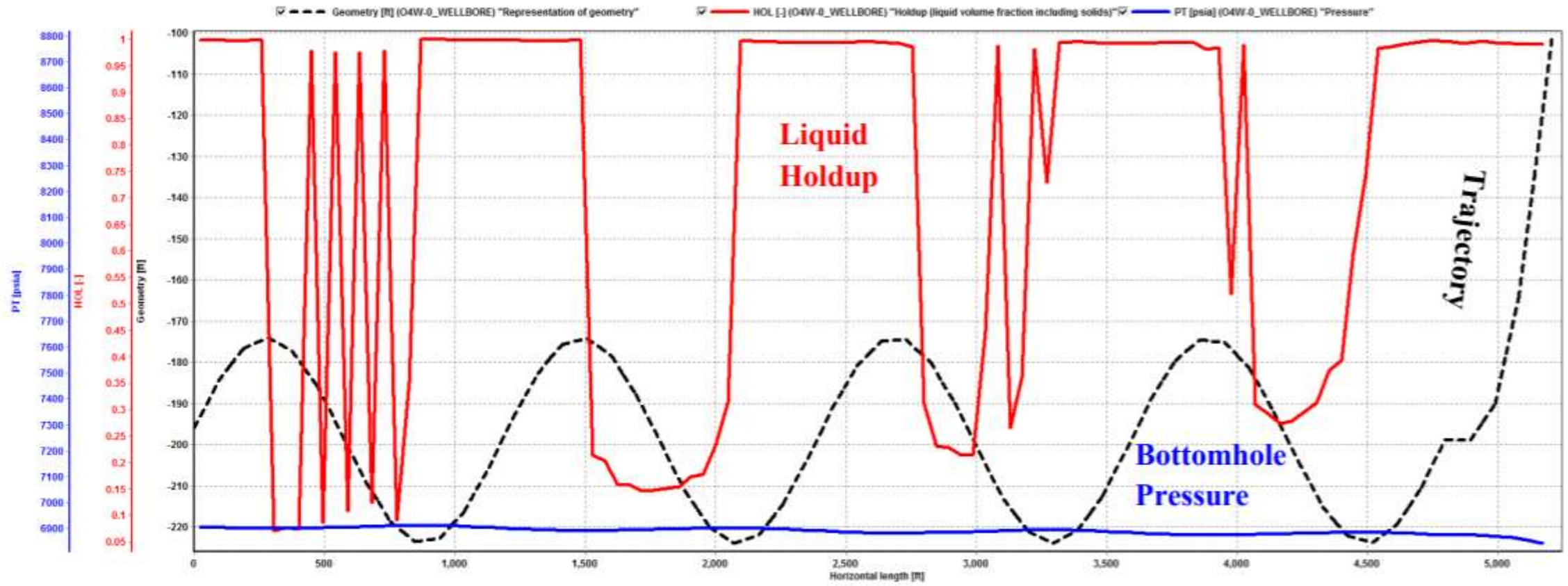
$$TI_{3D} = \sqrt{(TI_{Incl})^2 + (TI_{Azm})^2}$$

Tortuosity and Production Equipment



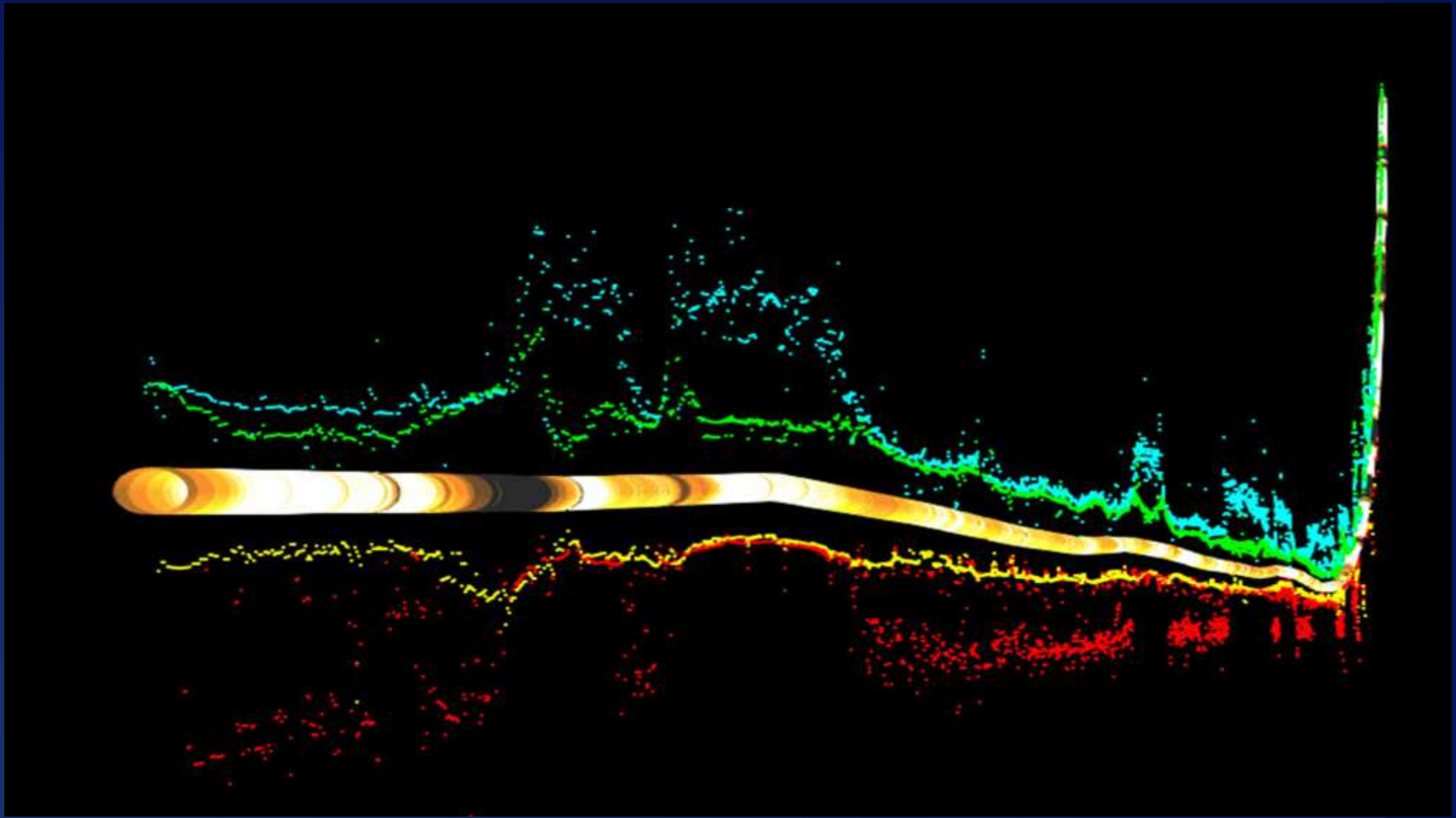
SPE 185140, Ledroz et al, 2017

Tortuosity and Production Performance



URTeC: 2902309 Pradhan and Xiong, 2018

What About the Future?



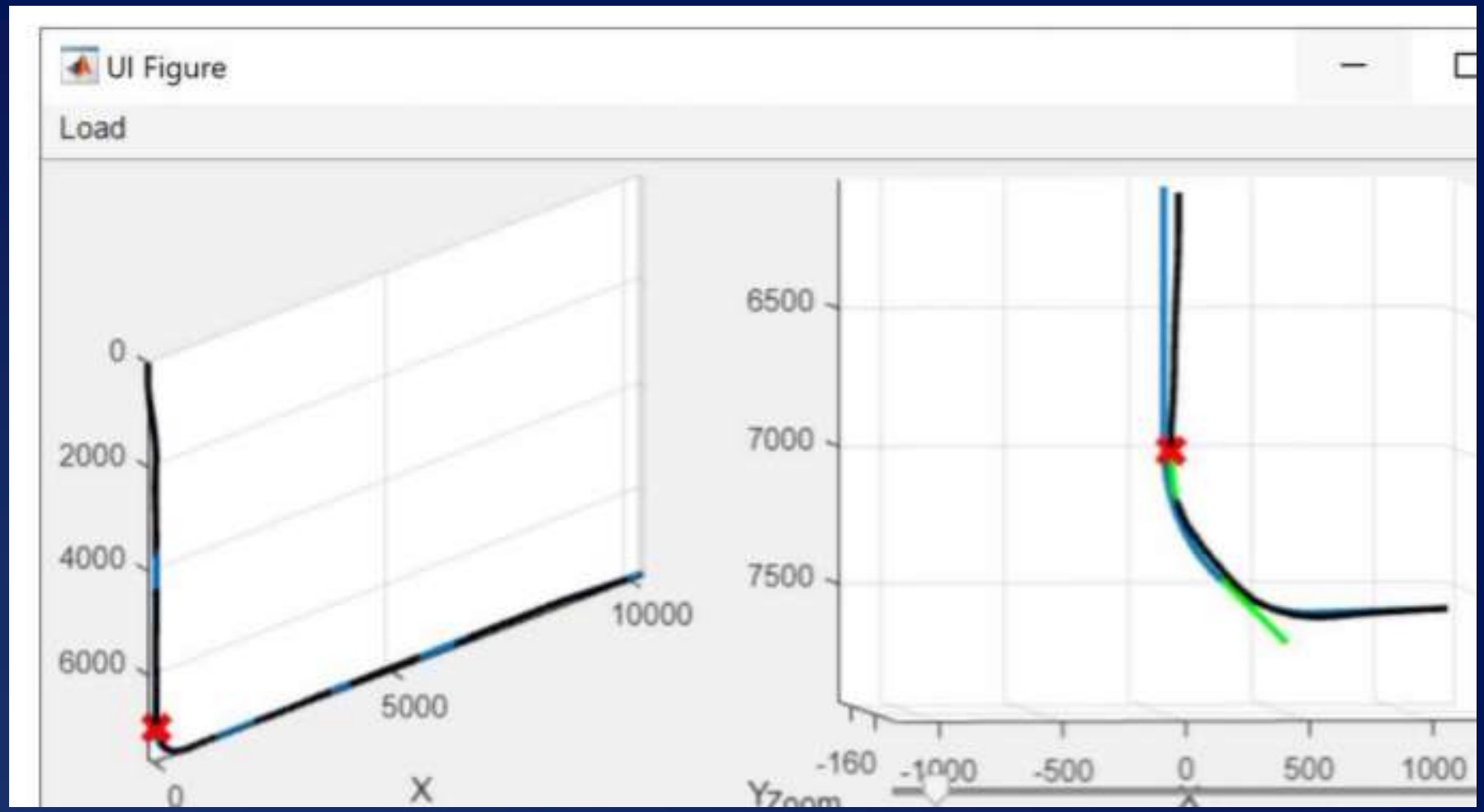
Expert DD Systems – 1990

ODDA Offshore Directional Drilling Advisor

"module identifies the tool face setting required to reach [TD]"

SPE 20419 Amara and Martin, 1990

Expert DD Systems



SPE/IADC 194096 Pehlivantürk *et al*, 2019

Expert DD Systems

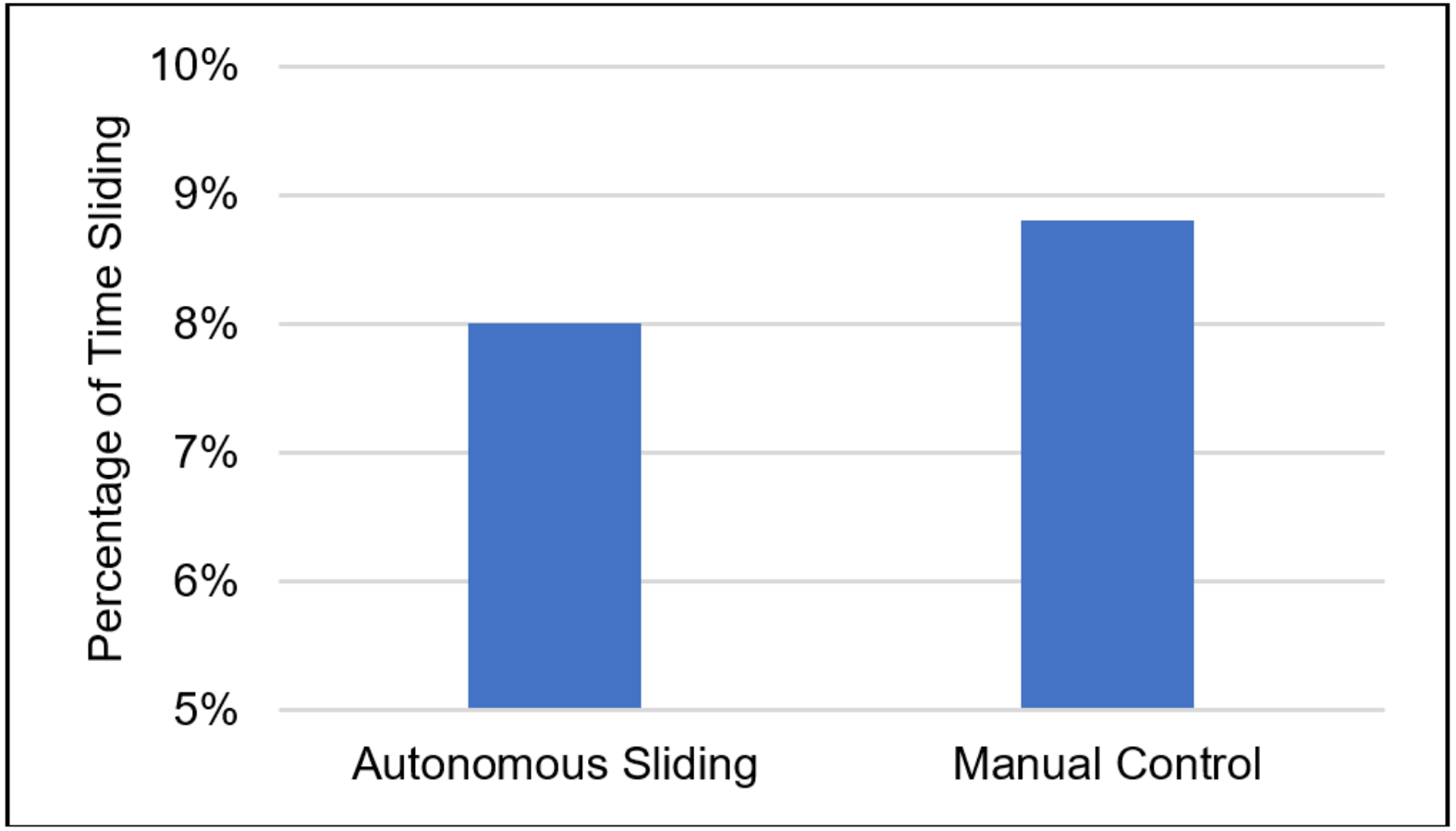
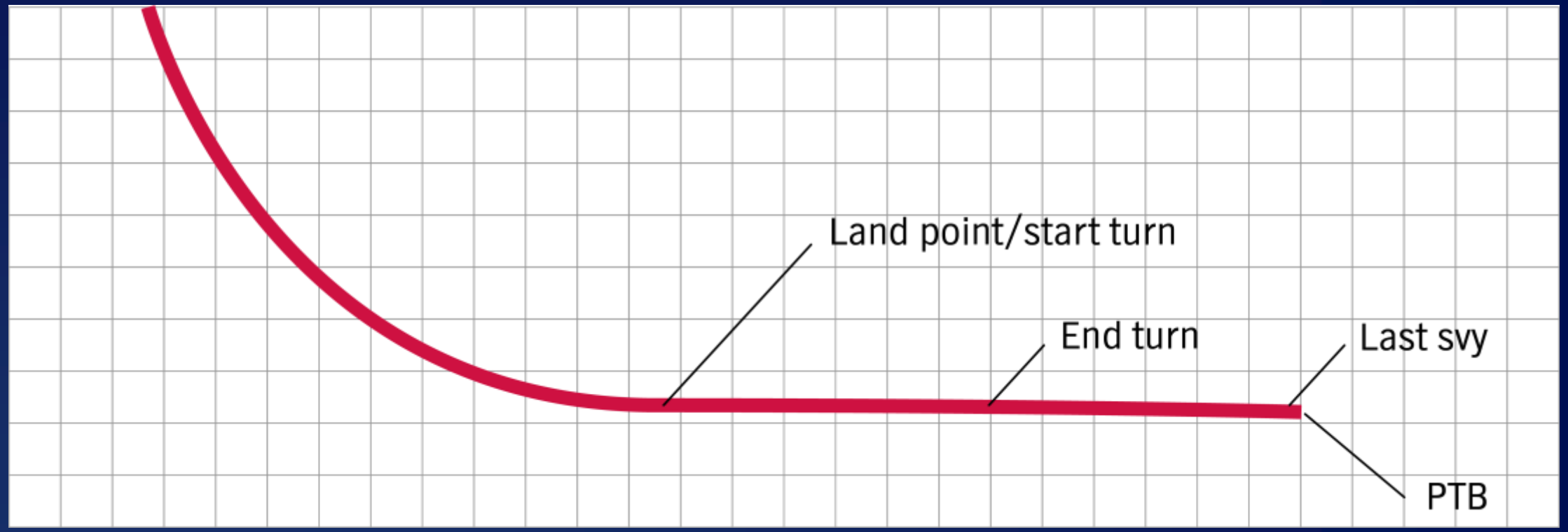


Figure 5: Percentage of Time Sliding in Lateral Section

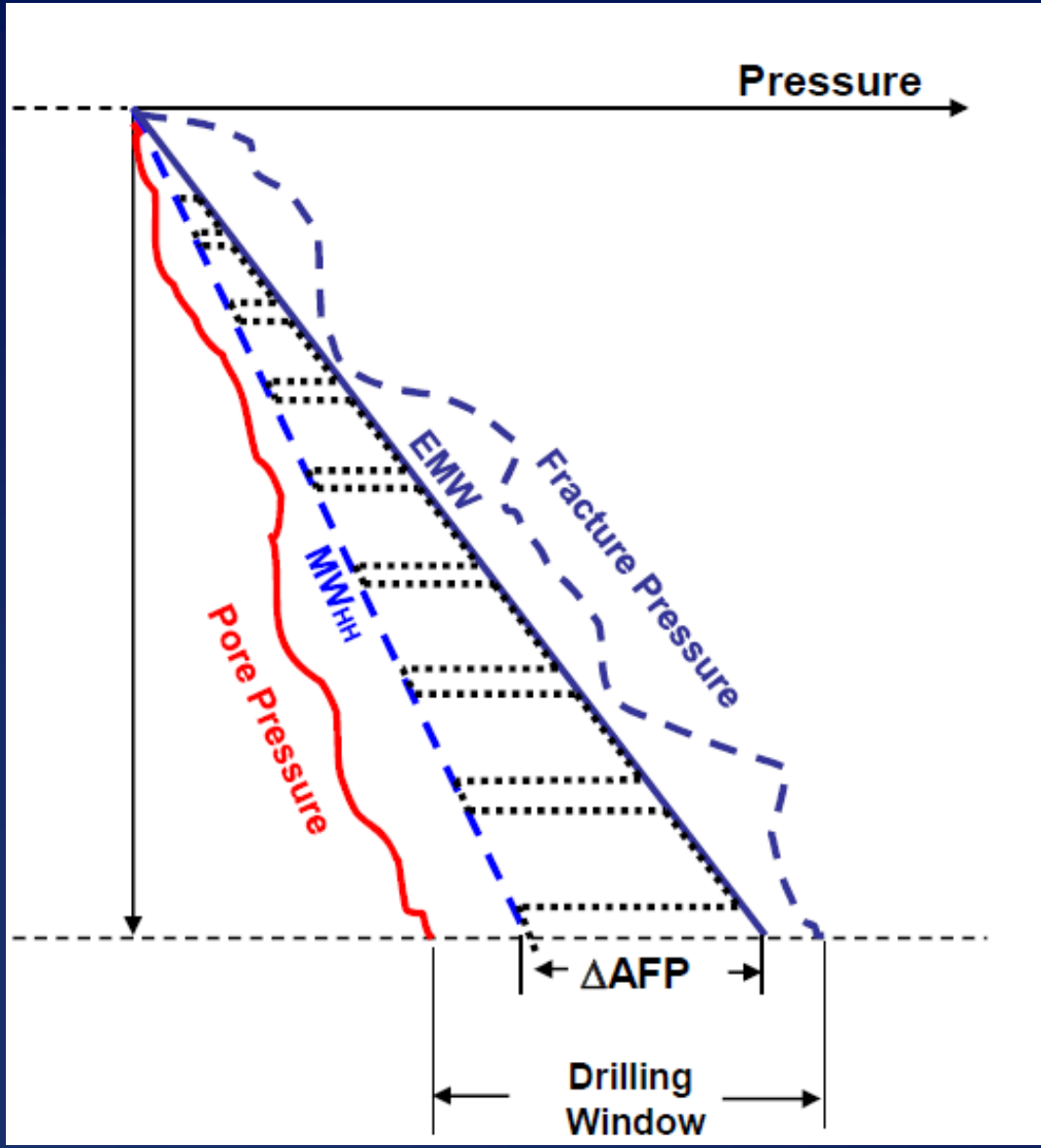
AADE-19-NTCE- 081 Chmela *et al*, 2019

Automating DD Systems



SPE/IADC 194170 Clegg, Mejia and Farley, 2019

Managed Pressure Drilling



SPE 146644, Hannegan, 2011

Automation

- Gradual but continual automation of processes and equipment
- Evolution rather than revolution
- Adding automated processes in a piecemeal way (not suddenly waking up one morning to a fully automated system)

Data

Big data, data analytics, machine learning, Artificial Intelligence

All combining with physics models and measurements (we still have physics!)

Optimization

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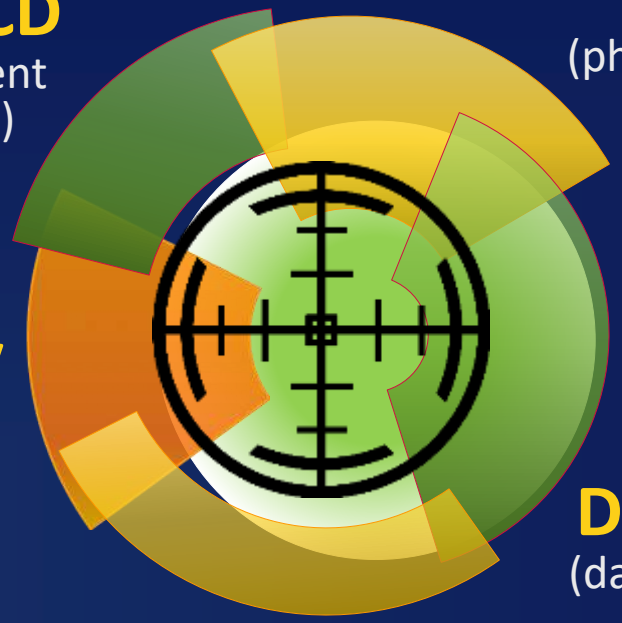
Pressure and ECD
(prediction, measurement and automatic control)

T&D and Hydraulics
(physics-based models and real time measurements)

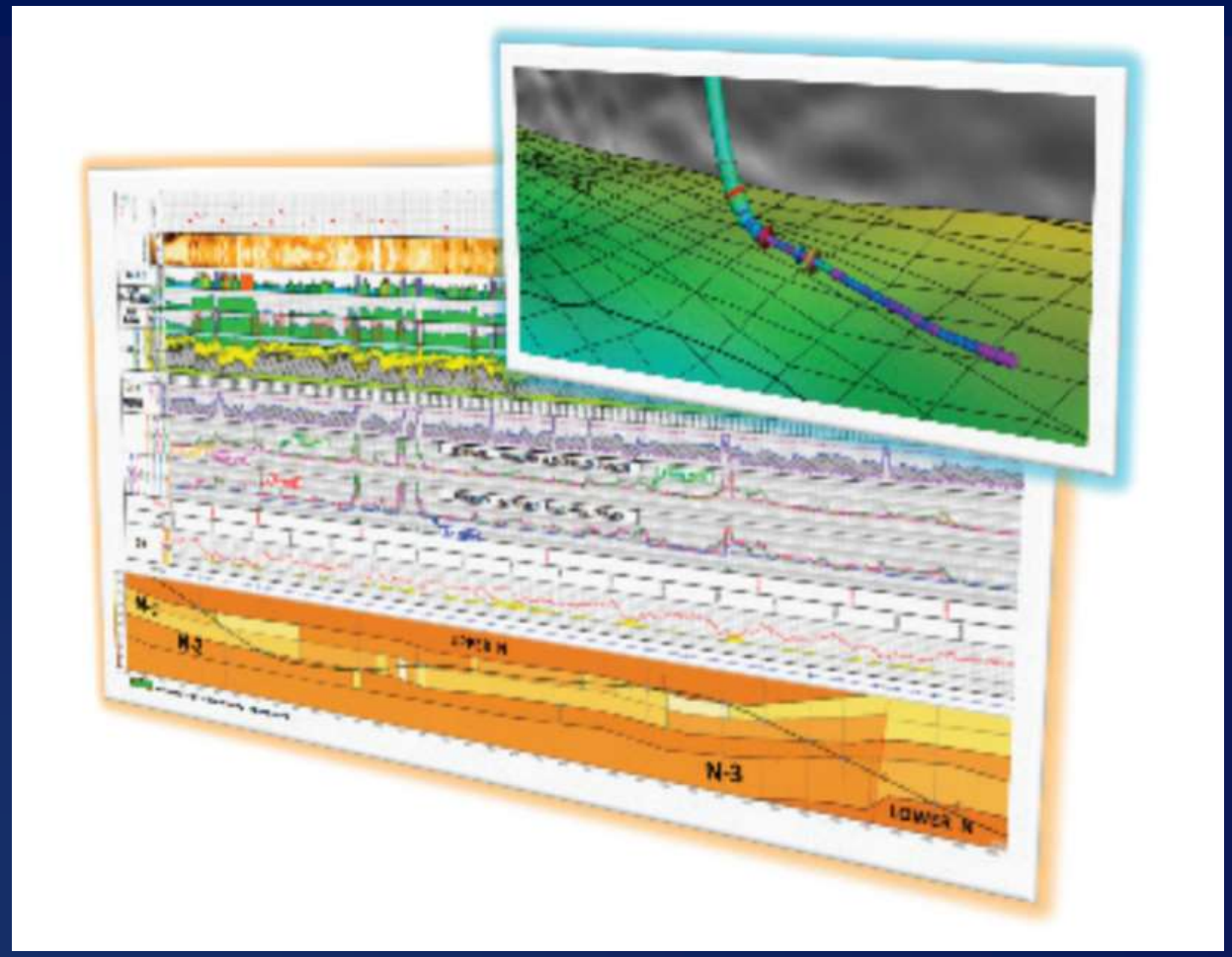


Wellbore Quality

Directional Tendency
(data-driven models and achieved through automatic control)

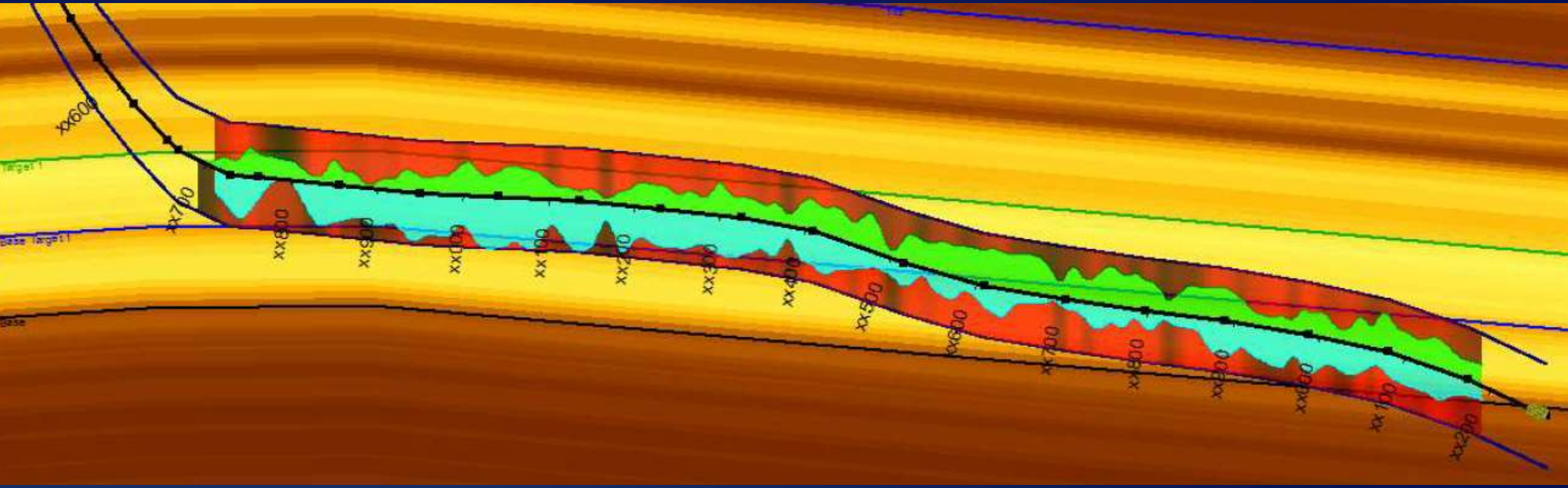
Drilling Dynamics
(data-driven models and real time measurements)

Reservoir Evaluation



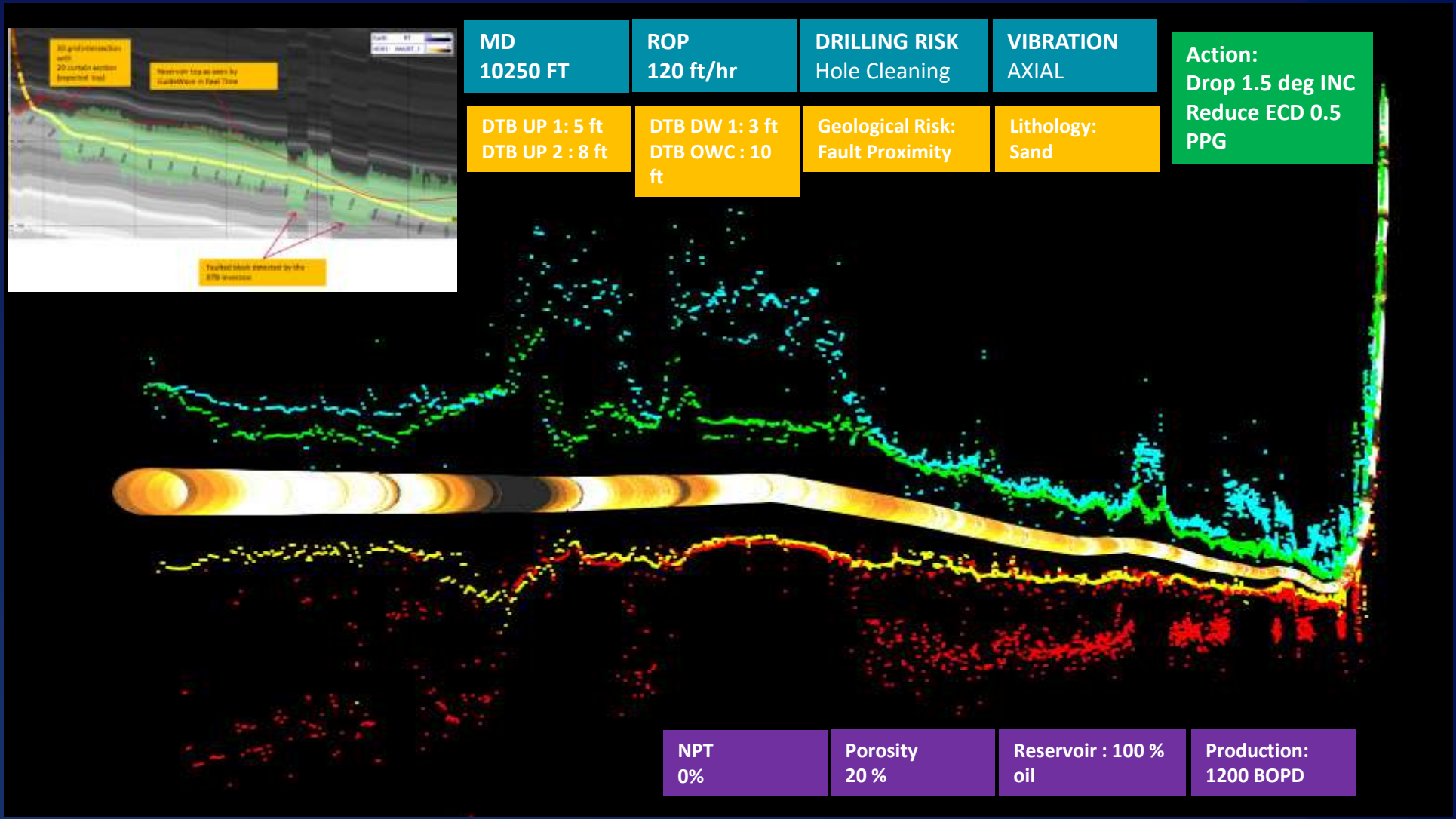
ENI's vision for optimal reservoir management, 2015

Geosteering



OTC-28992, Serry *et al,* 2019

Dreaming of a Holistic System



Conclusions

We've come a long way in 100 years…

…but is drilling faster always better?

The future is more intelligent automated systems…

…but we need to optimize production and integrity

…not just what happens before TD!

Challenge

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"I think people defaulted to drilling fast. It is a simple measure that gets production earlier and reduced well costs because day rates are involved…

…We have to have KPIs for well construction related to the longevity of the well."

John de Wardt, Journal of Petroleum Technology August 2017

Take-Away

How do drilling colleagues impact completions and production?

How do we benefit the overall value of the well?

How should we drill wells in the future?

Not cost per well

Not cost per foot

Cost per barrel

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Thank You For Attending!
Q&A